RK05 Emulator/Tester v2 & Accessories Assembly Instructions

The RK05 Emulator/Tester system consists of a main unit, various cables, a terminator, and a power supply. These sub-components are available in kit form or parts can be purchased directly from the sources in the bill of materials. Assembly instructions for each of the sub-components are provided below.

The assembly process consists of soldering components to circuit boards and the use of M2 and M3 fasteners to hold parts together. Less common procedures such as heat staking of threaded inserts, and modification of edge connectors have been performed in advance so the kit can be assembled using commonly available tools. Some assemblies describe crimping of quick-connect terminals, but these terminals can be optionally soldered is a crimping tool is not available.

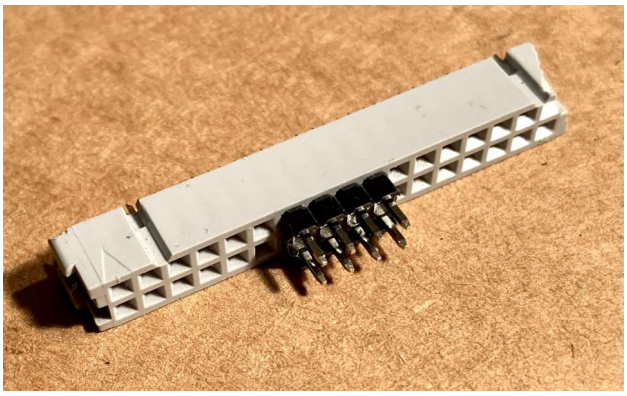
The RK05 Emulator/Tester v2 & Accessories sub-components are:

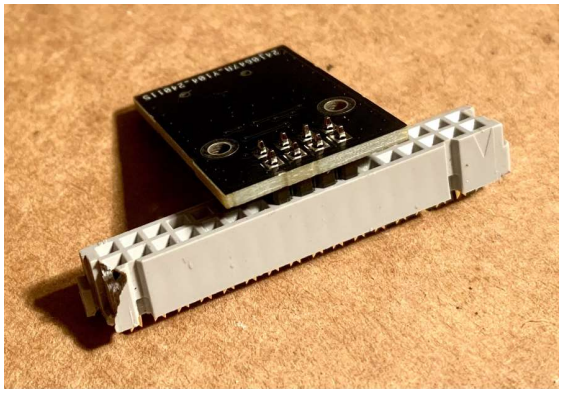
- **E1, RK05 Emulator/Tester v2 main unit** – This main unit emulates an RK05 drive. It can also be configured as an RK05 tester by loading different software and FPGA code.
- **A1, RK05-to-RK8-E Cable, 1 meter length** – Cable to connect an RK05 Emulator/Tester main unit to a DEC RK8-E or Plessey PM-DC/8 disk controller for a PDP-8 Omnibus. This board is intended to work with a DEC RK-11D/E but has not yet been tested. The A1 kit consists of an A4 plus two 1 meter 40-pin flat cables.
- **A2, RK05-to-RK05 Cable, 1 meter length** – Cable to connect two RK05 Emulators or RK05 drives or RK05 Emulator to RK05 drive on an RK05 bus. The A2 kit consists of two A4 boards plus two 1 meter 40-pin flat cables.
- **A3, RK05-to-RK05 Cable, Side-to-Side** – Similar to A2 but without cable clamps on the adapter board and short cables that route to the side.
- **A4, RK05 Adapter Board without Flat Cables** – An adapter board that plugs into the RK05 bus and has two 40-pin flat cable connectors. Pinout compatible with RK8-E and RK-11D/E.
- **A5, RK05-to-Tester Cable, 1 meter length** – Cable to connect an RK05 Tester to an RK05 or RK05 Emulator. Consists of one A6, one A4, and two 1 meter 40-pin flat cables.
- **A6, RK05 Tester Adapter Board without flat cables** – When the main unit is configured as a Tester then the RK05 bus edge connector signals are not compatible with the RK05 bus. This is because the inputs and outputs of the main unit are now reversed. The Tester Adapter Board converts the flipped input-output signals to standard RK05 flat cable signal pinout.
- **A7 and A7N, RK05 Emulator Power Supply** – A Power Supply that powers up to three RK05 Emulators from a 25 watt USB Type C input. A 25 watt USB Type C power adapter is included with the A7. The power cable built in the main unit kit plugs directly into this board. A7N does not include the USB Type C power adapter, for countries with primary power different than in the US.
- **A9, RK05 Emulator Rack Mount Tray for 3 Emulators** – A rack mount tray that holds three RK05 Emulators and a power supply. This can be purchased directly from amazon.com.
- **T1, M930GW Terminator Board** – RK05 bus terminator. Electrically the same as the DEC M930.

Assembly tips:

It's recommended to use Lead-Free solder: 99% tin, 0.3% silver, 0.7% copper (99/0.3/0.7 Sn/Ag/Cu) when building the boards. PCB fabrication and surface mount assembly of all modules in the emulator was performed using a lead-free process. A 0.6mm diameter 99/0.3/0.7 lead-free solder with flux works well for attaching the through-hole parts.

When soldering the headers it is easy for heat from soldering to melt the plastic body of the header and the result is that the pins are crooked. Also, the end pins in the small headers can be slightly loose due to cutting the small headers from a larger header strip. To mitigate this issue, use an old flat cable connector as a holder for the header being soldered. First, rest the header on a hard surface and press the flat cable connector onto the header. This will align the pins in case any are loose. Next, insert the header into the PCB and solder the pins while the flat cable connector is still attached.





The assembly instructions have been written so that the shortest parts are installed first and the tallest are installed last.

Kit Parts Programming & Testing:

The FPGA on the main board has been programmed with the latest released code at the time of shipment. The main board has been tested using a bed-of-nails tester. In this test, all RK05 disk bus input/output signals have been verified using a walking-zeroes test and all other input/output signals such as those to the microSD card, display, front panel switches and LEDs have been similarly checked using an automated test.

The front panel board has been tested using a test clip with pogo pins that contact the 2x8 header pads and by running an automated test to verify all signals related to the display, front panel switches and LEDs.

The Raspberry Pi Pico has been programmed with the latest released code at the time of shipment, and plugged into a known-good system to confirm that the code boots properly.

Refer to the testing description document for details regarding the production testing.

The Raspberry Pi Pico and FPGA can be upgraded in the field. The Raspberry Pi Pico can be loaded with the latest "UF2" file by removing it from the main board and plugging it into a computer and copying the UF2 file to the Pico which appears as a flash drive. The FPGA can be reprogrammed with the latest "bin"

file using a Lattice programming adapter (about $30) that is commonly available on eBay. Refer to the programming document for details regarding the reprogramming of the Pico and FPGA.

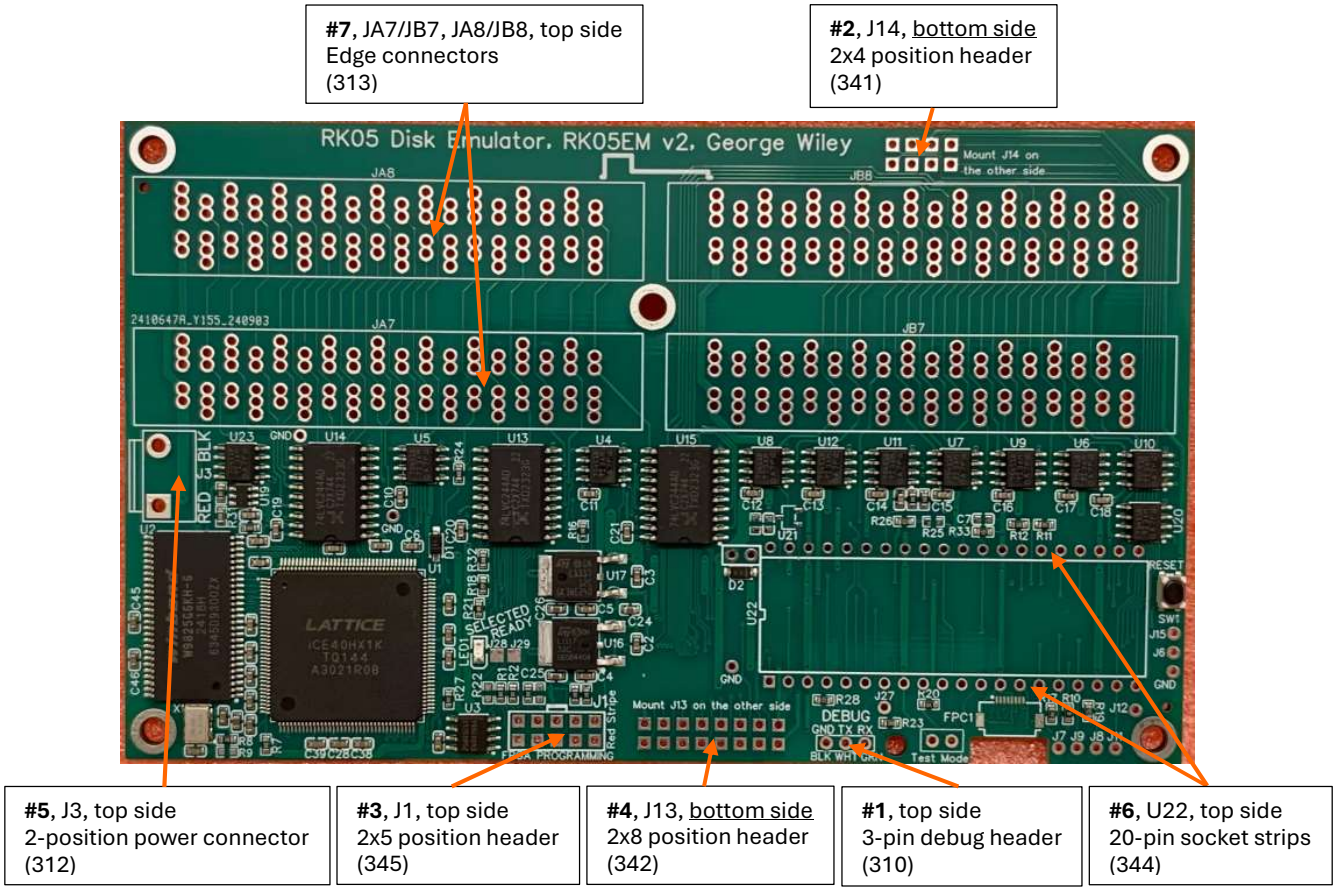
E1 RK05 Emulator/Tester

RK05 Emulator/Tester kit of parts:

Main Board electrical assembly

In the following instructions, "top side" refers to the side of the board with the surface mount components and "bottom side" refers to the side without the surface mount components. Install the following parts on the Emulator Main Board (100) from bag "**G, Main Board**". The parts referenced in the following instructions are from bag "**E, Main Board Electrical**" and bag "**M, Edge Connectors**".

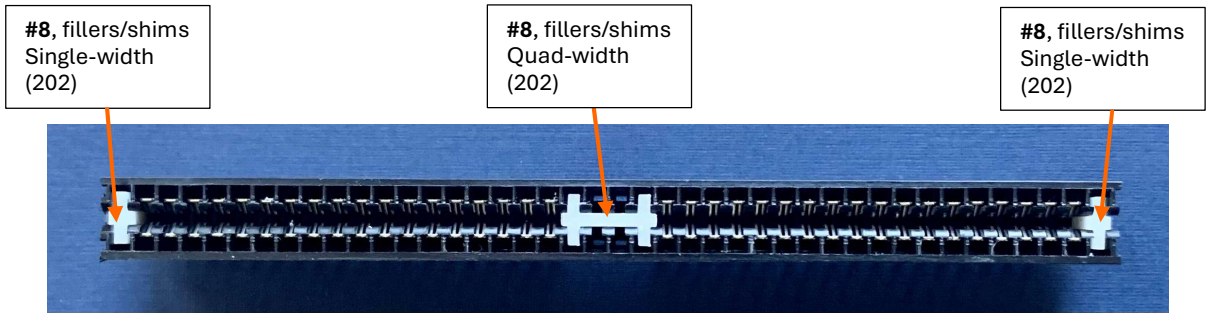
1. Install and solder the 3-pin debug header (310) on the top side.
2. Install and solder J14, a 2 x 4 position header (341) on the ***bottom*** side. Silkscreen text describes proper installation.
3. Install and solder J1, a 2 x 5 position header (345) on the top side.
4. Install and solder J13, a 2 x 8 position header (342) on the ***bottom*** side. Silkscreen text describes proper installation.
5. Install and solder J3, a 2-pin power connector (312) on the top side. Take care to notice the silkscreen text and graphics that describe the proper polarity.
6. Install and solder two 20-pin single row socket strips (344) in the two rows of pins of U22 on the top side. It's helpful to plug the Raspberry Pi Pico into the socket strips while soldering them to keep proper alignment between the two strips. First, solder the four corner pins of the two socket strips and then turn the board over to check the alignment. If necessary, correct the alignment and then turn back and solder the remaining pins of the socket strips.
7. Install and solder two edge connectors (313), one in location JA7/JB7 and the other in location JA8/JB8, both on the top side. There is no polarity so the connectors can be installed in either direction. For consistency, the blue lettering can face the lower edge so it's not visible when the unit is assembled.



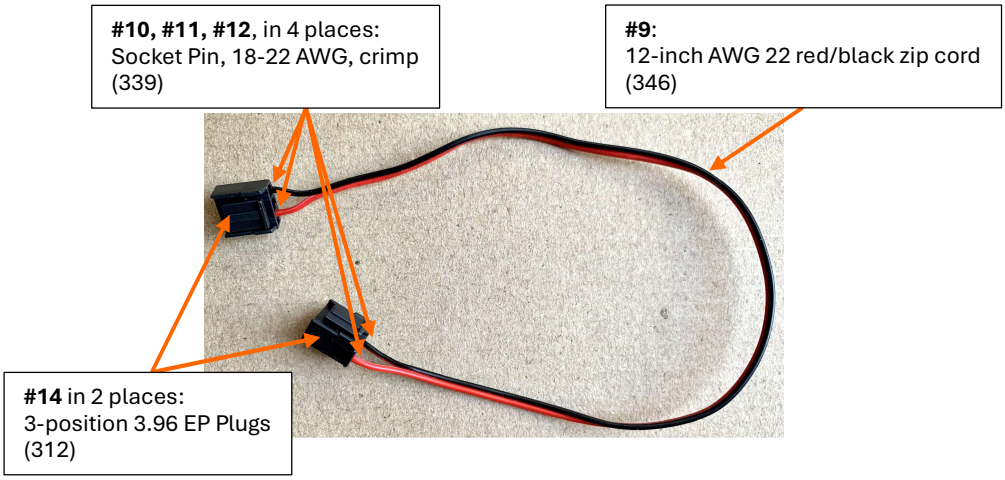
8. Detach the connector fillers/shims (202) from the connecting ribs and insert them into the edge connectors.

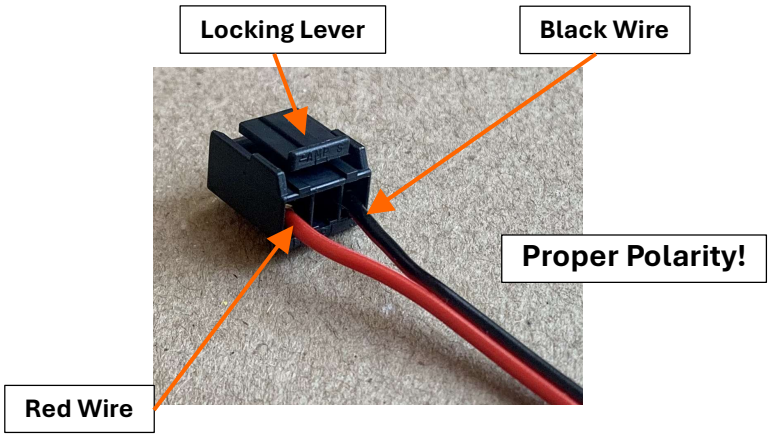
   Keep track of which ends of the shims were attached to the connecting rib in the rack of shims. When the shims are separated (probably with diagonal cutters) the widths of the ends that were cut will be less accurate compared to the top ends of the shims. Insert these cut ends into the bottom of the connectors so the more-precise shim width is at the top where the boards are inserted.

   The single-width shims should be inserted into the single slots without contact pins on the outside of the connectors. The quad-width shims should be inserted into the 4-pin-wide slots without contact pins in the center of the connectors.

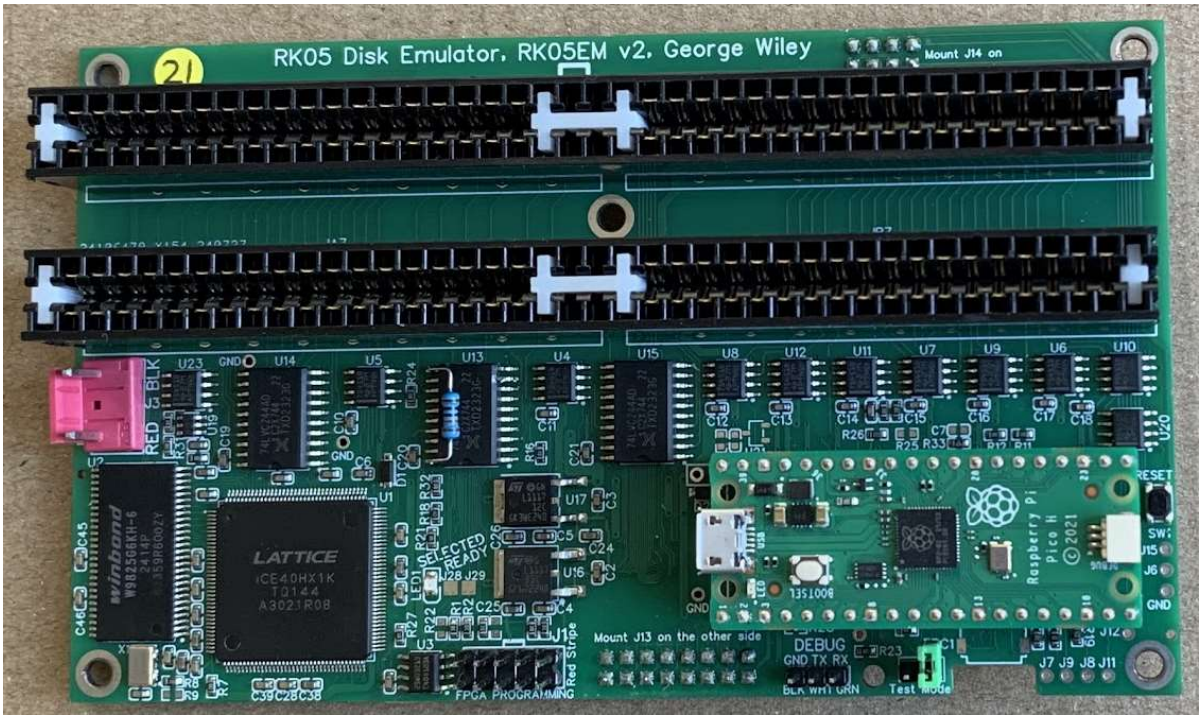


9. Build the Power Cable by stripping about 2.5mm (0.1 inch) of insulation from the ends of the 12-inch (30.5 cm) AWG 22 red-black zip cord (346). Tin the bare ends of the wire for best results.
10. Detach four socket pins (339) from the small metal band. Use needle-nose pliers to crimp the wide-short fins around the bare wire exposed in the previous step.
11. It is recommended to use a small amount of solder to solder the crimped joints and wire. Be careful not to use too much solder so that solder does not run into the contact area of the socket pins.
12. Use needle-nose pliers to crimp the narrow-long fins around the insulation of the wire.
13. Find the two 3-position 3.96 EP Plugs (312) in bag E, and observe how they fit onto the power connector, J3, on the main board. The locking lever on the plug latches to the tall plastic tab on the power connector. This step is to know the orientation of the plug when it is installed. Now notice that the silkscreen on the Main Board has legends “RED” and “BLK” beside J3. This tells which wire color to insert into which position of the plug. The red wire connects to +5V and the black wire connects to ground. Details of the proper polarity are shown in the photo below.
14. Insert the socket pins that we previously attached to the ends of the red/black zip cord into the EP Plugs (312), being careful to insert the red and black wires into the proper slots of the EP Plugs. The proper slots for the red and black wires were determined in the previous step. The center position of the EP Plug will not have a socket pin inserted. The socket pins fit only one way into the EP Plugs. The small locking fins on the socket pins align with the small openings in the side of the EP Plugs.

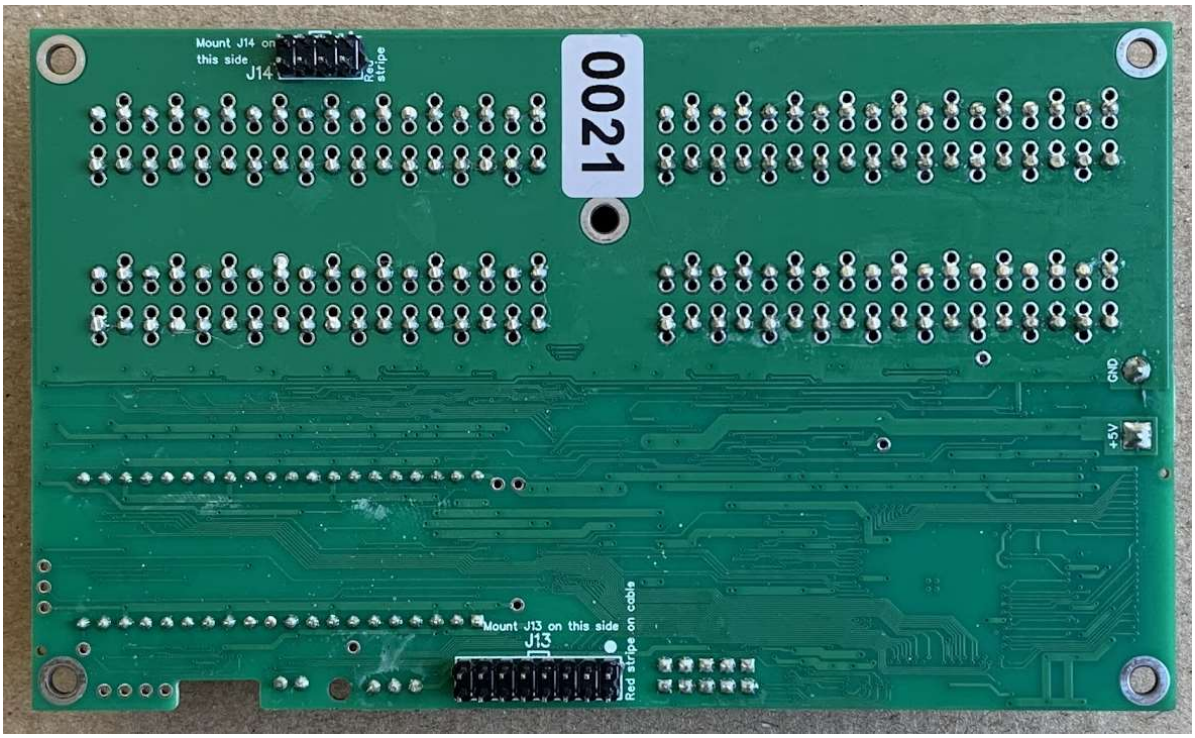




Finished Main Board, top



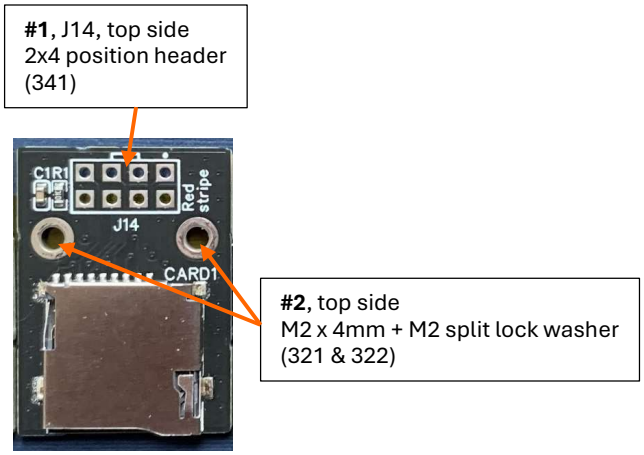
Finished Main Board, bottom



microSD Board assembly

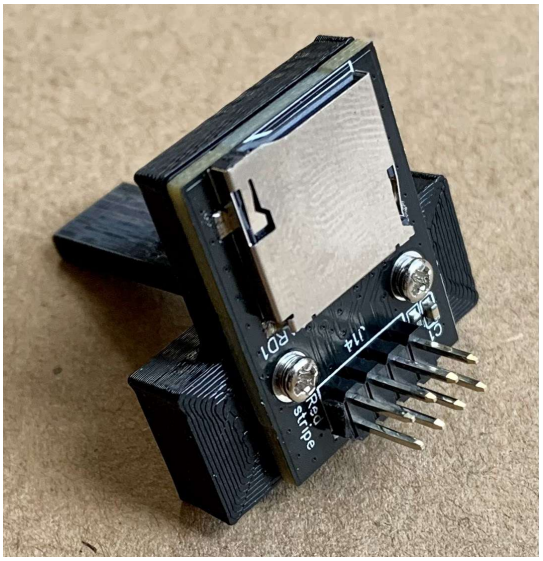
The parts referenced in the following instructions are from bag "**K, microSD Board**".

1. Install and solder J14, a 2 x 4 position header (341) on the top side of the microSD card adapter board (102).
2. Use two M2 x 4mm screws (321) and two M2 split lock washers (322), both in bag K2, to attach the assembled microSD board from step 1 to the microSD card carrier bracket (204).



Finished microSD Card Adapter

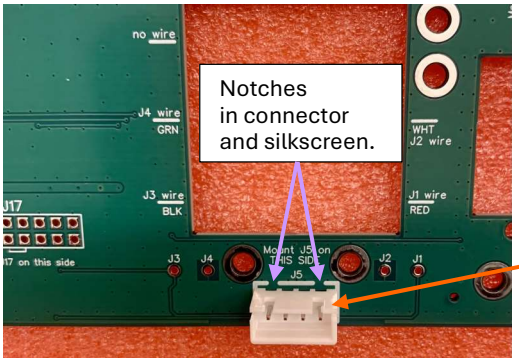
Finished microSD carrier bracket



Front Panel Board electrical assembly

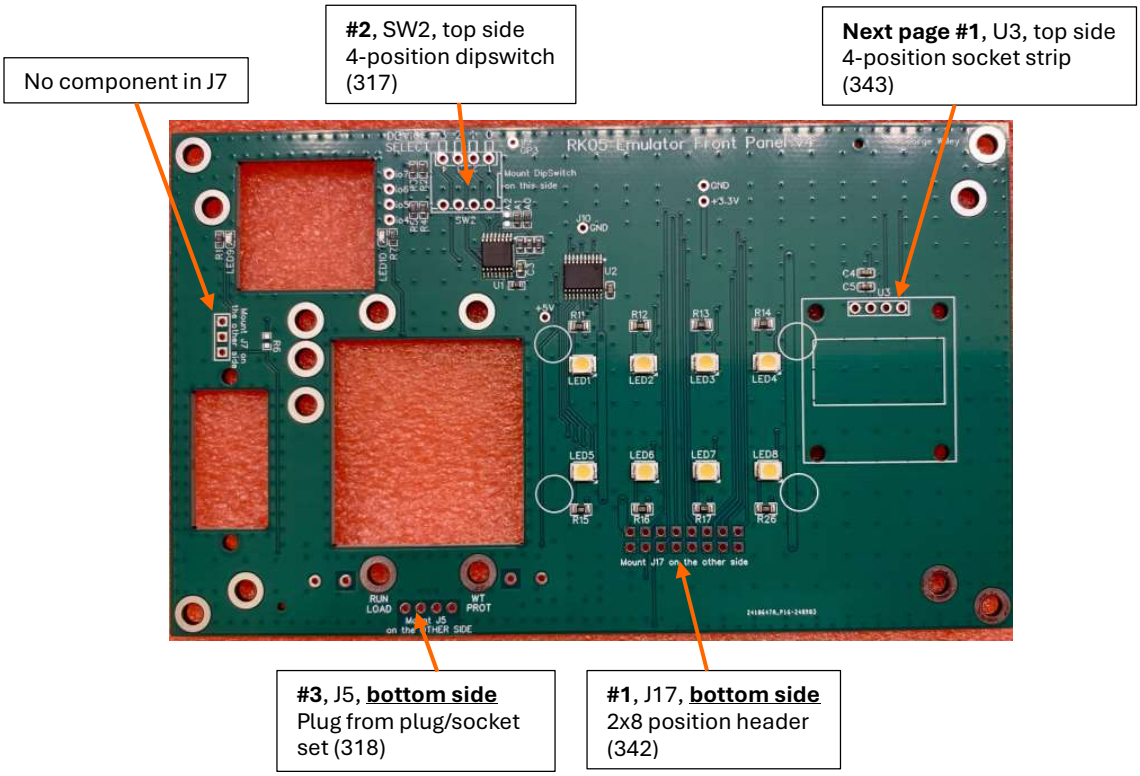
Install the following parts on the Front Panel Board (101) from bag "**J, Front Panel**". The parts referenced in the following instructions are from bag "**H, Front Panel Board Electrical**".

1. Install and solder J17, a 2 x 8 position header (342), on the ***bottom*** side. Silkscreen text describes proper installation.
2. Install and solder SW2, the 4-position right-angle dipswitch (317) on the top side. The switch levers should face the edge of the board as indicated in the silkscreen, so they are easily accessible after the unit is assembled.
3. Install the socket of the plug/socket set (376) at location J5 on the ***bottom*** side. The silkscreen has text to indicate on which side of the board to mount J5. Note that the connector has two notches. Orient the connector so that the notches correspond with the similar features in the silkscreen, as shown.



4. Locate the small white connector from the plug/socket set with 4 wires (red, white, green, and black) protruding from it. Cut the red and black wires (the two wires on the outside) to a length of 2 inches measured from the back of the white plug to the end of the cut wire. Cut the white and green wires (the two wires on the inside) to a length of 2.25 inches measured from the back of the white plug to the end of the cut wire.
5. Strip about 0.25 inches (6.4 mm) of insulation from **the cut end** of each of the wires extending from the plug of the plug/socket set (376).
6. Crimp a Quick Spade Wire Connector (375) onto the ends of the wire that were stripped in the previous step. If a crimping tool isn't available, then it's acceptable to carefully solder the wires inside the barrel of the Quick Spade Wire Connectors.

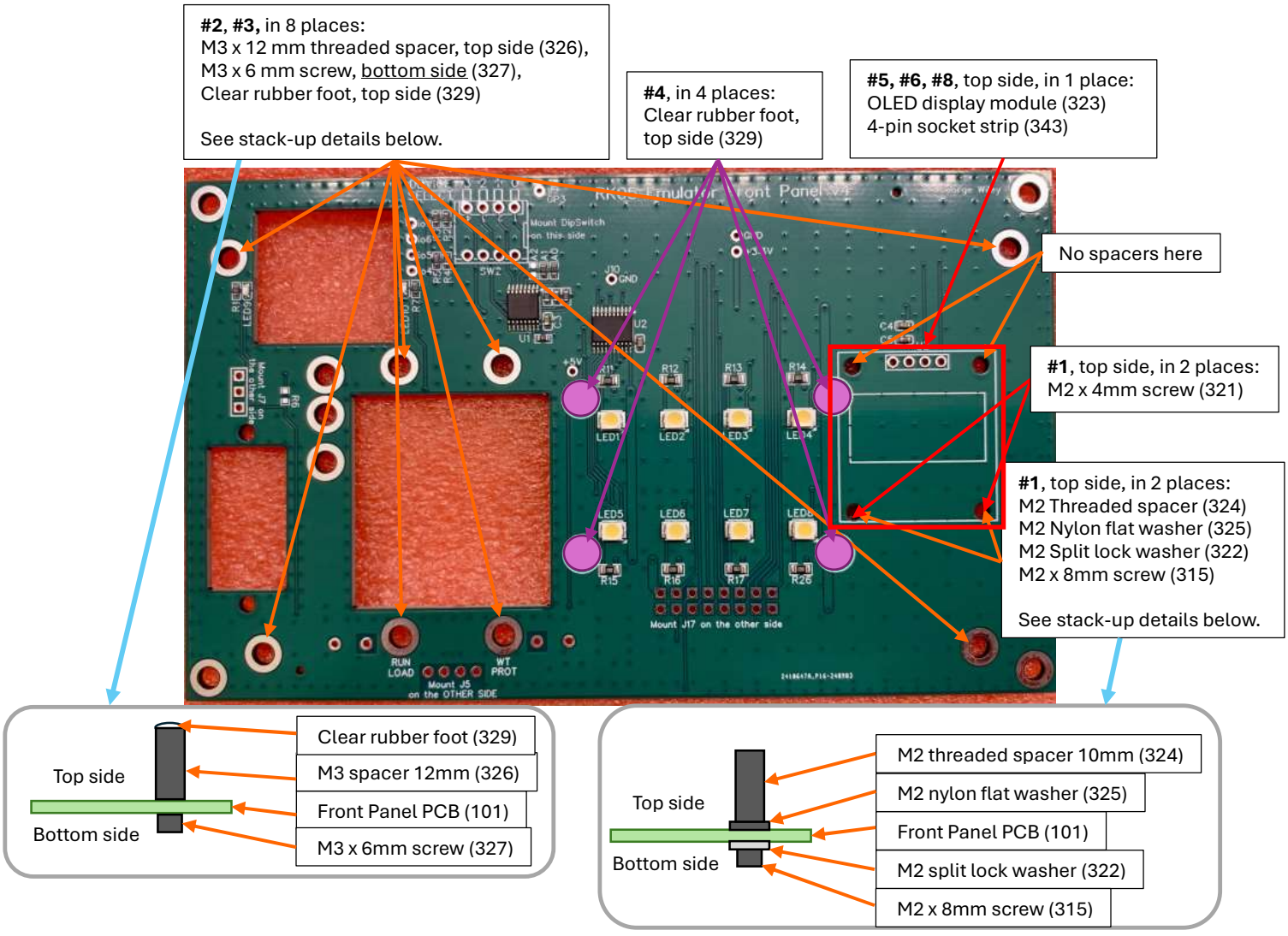
7. The 4-pin socket strip (343) and OLED display module (323) from bag H will be used in the “Front Panel Board mechanical assembly” sequence of steps, which are next.



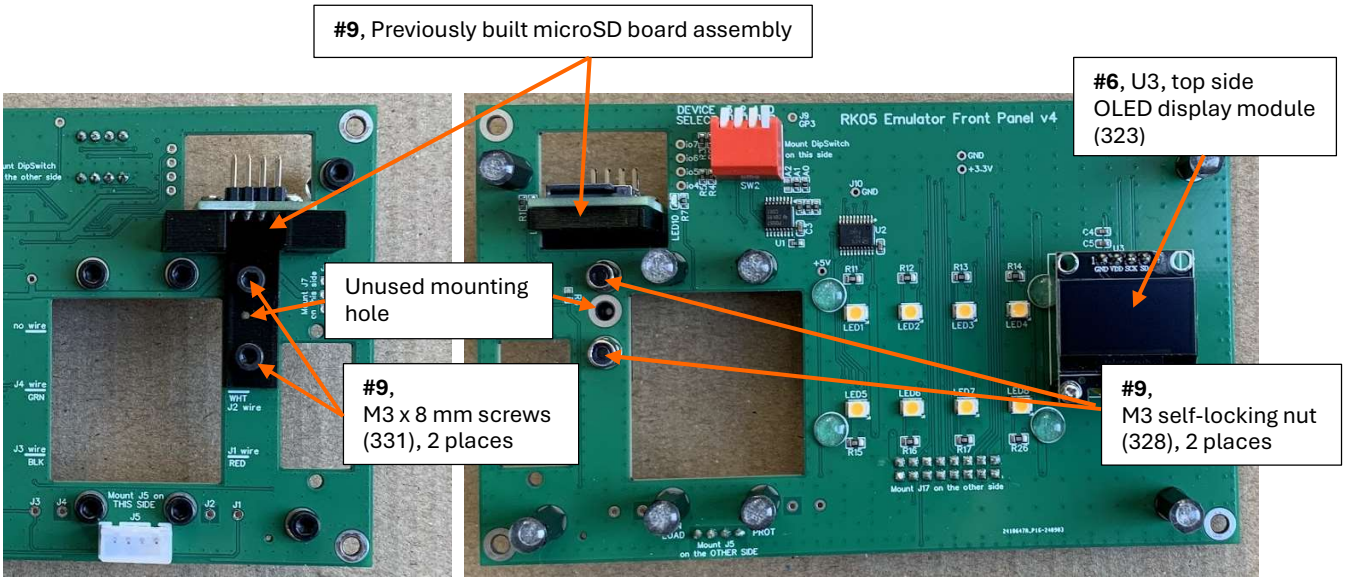
Front Panel Board mechanical assembly

Install the following parts on "**J, Front Panel**". The parts referenced in the following instructions are from bag "**F, Front Panel Board Hardware**" and the previously assembled microSD board and carrier bracket.

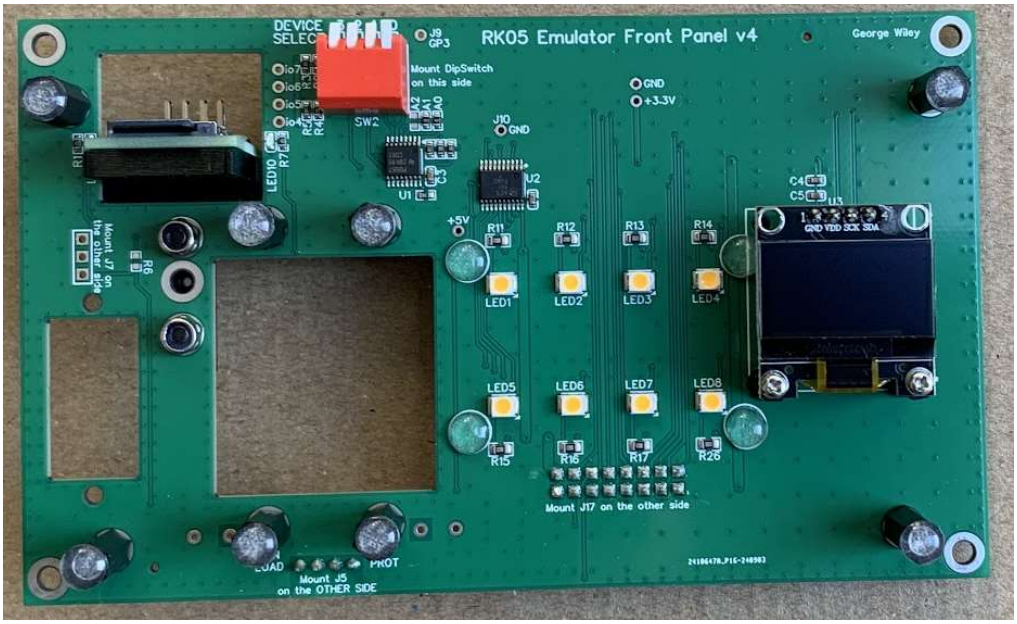
1. In 2 places, near U3, install the M2 nylon flat washer (325) and M2 10mm Threaded Spacer (324) on the top side, and M2 split lock washer (322) on the bottom side and secure this stack of hardware using the M2 x 8 mm screw (315) from the bottom side. A detail of this stack-up is shown below. The recommended sequence is:
   a. place the M2 split lock washer (322) onto the M2 x 8 mm screw (315)
   b. insert the M2 x 8 mm screw into the hole in the PCB
   c. place the M2 nylon flat washer (325) over the end of the screw
   d. thread the M2 10mm Threaded Spacer (324) over the end of the screw
2. In 8 places, install an M3 x 12 mm Threaded Spacer (326) on the top side and secure it using an M3 x 6 mm screw (327) from the bottom side. The locations of the threaded spacers and mounting screws are shown in the diagram below. Be careful not to confuse the M3 x 6 mm screws with the two M3 x 8 mm screws that are in the same bag. The M3 x 8 mm screws are used later in step #6.



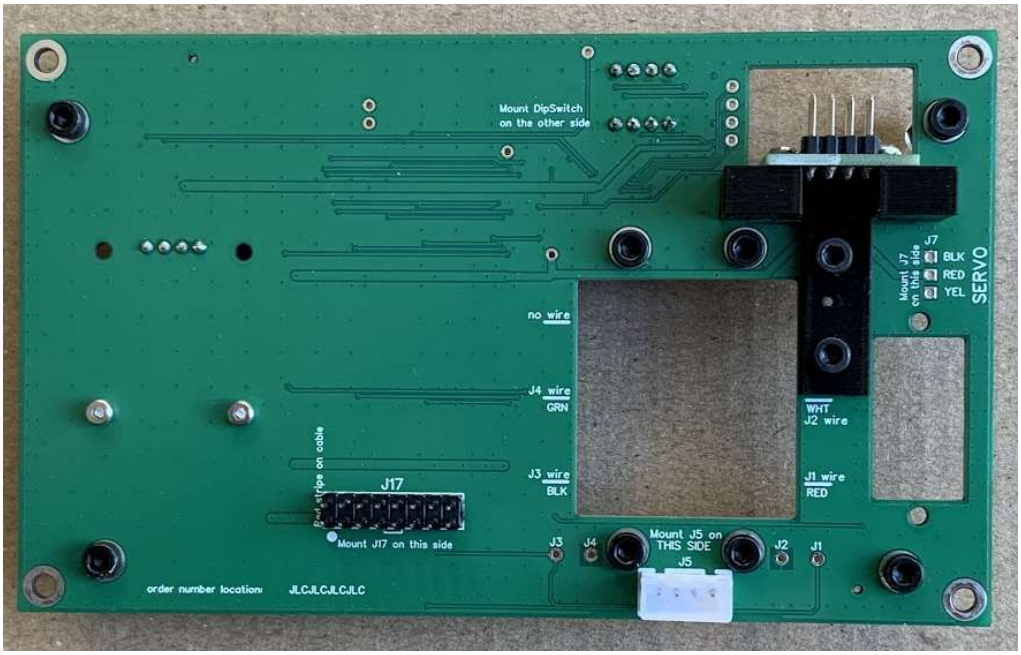
3. In 8 places, as shown in the figure, install 6 mm diameter Self-Adhesive Clear Rubber Feet (329) on top of the standoffs that were installed in step #2.
4. In 4 places, install 6 mm diameter Self-Adhesive Clear Rubber Feet (329) on the top side of the Front Panel Board near LED1, LED4, LED5, and LED8, as shown. These four rubber feet hold the Lamp Lens in place when the unit is assembled.
5. Locate the 4-pin socket strip (343) and OLED display module (323) from bag H. Plug the OLED display module pins into the 4-pin socket strip. The display and socket strip have no polarity.
6. Install the OLED display module with attached 4-pin socket strip so that the 4-pin socket strip pins to into the four pads at location U3 and the lower two mounting holes of the OLED display module are positioned over the two M2 threaded spacers that were installed in step #1.
7. Attach the OLED display module to the two M2 threaded spacers using the M2 x 4 mm screws (321). Before tightening the screws, ensure that the OLED display module is square with the edges of the PCB. This is so the display will be nicely aligned with the front panel when the display is viewed from the front of the unit.
8. Solder the 4-pin socket strip to the PCB on the bottom side at the U3 pad locations.
9. Attach the previously built microSD board assembly to the Front Panel Board (101) using two M3 x 8 mm screws (331) and two M3 self-locking nuts (328). Insert the screws from the bottom side of the Front Panel Board and the microSD mounting bracket and self-locking nuts from the top side of the Front Panel Board. The middle screw hole in the PCB is unused. Tighten the screws while supporting the self-locking nuts, taking care to keep the bracket with the microSD card square.
10. Remove the protective film from the OLED display. There's a small blue tab at the top-right corner of the display that can be pulled to remove the protective film.



Finished Front Panel, top



Finished Front Panel, bottom

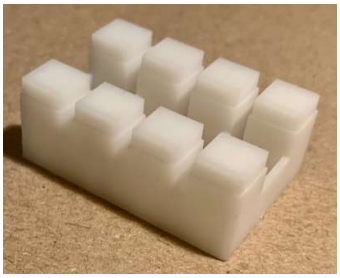


Top Level assembly

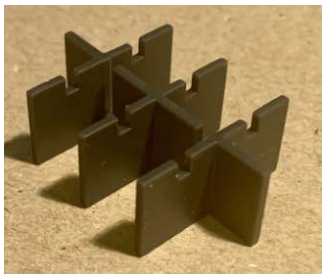
Assemble the modules built in the previous steps using parts from: bag "**A, Top-Level Front Panel**", bag "**B, Bezel**", envelope "**C, Dress Panel**", bag "**D, Top-Level Hardware**", bag "**N, Flat Cables**", and bag "**P, RPi Pico**".

1. Install the momentary Rocker switch, on-mom (303) from bag A into the right switch opening in the Dress Panel (103) from bag C. This opening in the Dress Panel has the legend "WT PROT" on the front side of the Dress Panel. Orient the switch so the dot on the rocker handle is close to the "WT PROT" legend. Press the switch into the opening in the Dress Panel so the latches on the switch lock into place. Graphics and text on the bottom-side silkscreen of the Dress Panel are a helpful guide for inserting the switch with the proper orientation.
2. Install the on-off two-position Rocker switch (304) from bag A into the left switch opening in the Dress Panel (103). This opening in the Dress Panel has the legends "RUN" and "LOAD" on the front side of the Dress Panel. Orient the switch so the two terminals on the back of the switch are toward the lower edge of the Dress Panel. Press the switch into the opening in the Dress Panel so the latches on the switch lock into place. Graphics and text on the bottom-side silkscreen of the Dress Panel are a helpful guide for inserting the switch with the proper orientation.
3. Insert the Light Shield (207) from bag A into the top of the RK05 Lamp Lens (200) from bag A. The slots in the walls of the Light Shield face downward so they engage with the ribs between compartments of the Lamp Lens. The Light Shield is symmetrical so it can be installed in either direction on the long axis of the Lamp Lens. In some kits, the Light Shield and Lamp Lens are already connected. A photo shows an example of the Light Shield installed in the Lamp Lens. The photo of the Light Shield is shown upside down so the slots in the bottom are visible.

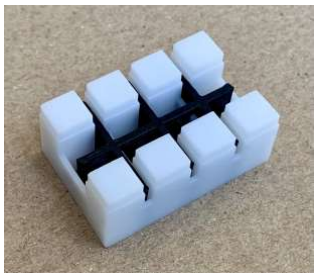
Lamp Lens (200)



Light Shield (207)



Lamp Lens with Light Shield

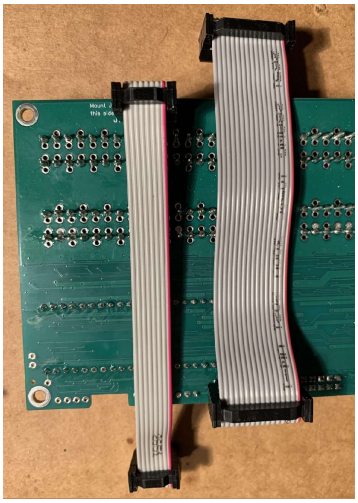


4. Insert the RK05 Lamp Lens with Light Shield into the eight square indicator holes in the Dress Panel (103) from envelope C. The body of the RK05 Lamp Lens should be between the Dress Panel and the Front Panel Board when the unit is assembled. The Lamp Lens is symmetrical so it can be installed in either direction.
5. Insert the assembled Dress Panel into the Bezel (201) from bag B so that the bottom edge of the Dress Panel is adjacent to the long edge of the Bezel that has the high outer wall.
6. Attach the assembled Front Panel Board to the Bezel and Dress Panel so that the large rectangular hole in the Front Panel Board aligns with the rocker switches. The top side of the Front Panel Board is oriented towards the Dress Panel, so the LEDs on the Front Panel Board face the Lamp Lens. Use four 30 mm threaded spacers (369) from bag D to hold the Front Panel Board in place by inserting the spacers through the mounting holes at the four corners of the Front Panel Board and

screwing the posts on the spacers into the threaded inserts in the bezel mounting holes. Be careful not to cross-thread the spacers. They should screw in easily.

7. Connect the Quick Spade Wire Connectors attached to the red and white wires from J5 to the terminals on the “RUN/LOAD” switch. Graphics and text on the bottom-side silkscreen of the Front Panel Board indicate which wire color to attach to each terminal on the switch. (see photo)

8. Connect the Quick Spade Wire Connectors attached to the black and green wires from J5 to the terminals on the “WT PROT” switch. Graphics and text on the bottom-side silkscreen of the Front Panel Board indicate which wire color to attach to each terminal on the switch. (see photo)
9. Connect one end of the 8-pin flat cable (347), from bag N to the 2x4 header, J14, on the bottom-side of the Main Board. Choose the end of the flat cable that has the keying bump facing <u>away</u> from the main part of the cable. Match the keying bump on the side of the flat cable connector with the corresponding silkscreen bump image on J14 of the Main Board. Also, confirm that the red stripe on the cable is on the same side as the “Red stripe” notation on the Main Board silkscreen. When connected properly, the cable will lay across the bottom-side of the Main Board. (see photo)



10. Connect one end of the 16-pin flat cable (348), from bag N to the 2x8 header, J13, on the bottom side of the Main Board. Choose the end of the flat cable that has the keying bump facing <u>toward</u> the main part of the cable. Match the keying bump on the side of the flat cable connector with the corresponding silkscreen bump image on J13 of the Main Board. Also, confirm that the red stripe on the cable is on the same side as the “Red stripe on cable” notation on the Main Board

silkscreen. When connected properly, the cable will lay across the bottom side of the Main Board. (see photo)

11. Connect the free end of the 16-pin flat cable (348), to the 2x8 header, J17, on the bottom side of the Front Panel Board. Match the keying bump on the side of the flat cable connector with the corresponding silkscreen bump image on J17 of the Front Panel Board. Also, confirm that the red stripe on the cable is on the same side as the “Red stripe on cable” notation on the Front Panel Board silkscreen.
12. Connect the free end of the 8-pin flat cable (347), to the 2x4 header, J14, on the microSD Board. Match the keying bump on the side of the flat cable connector with the corresponding silkscreen bump image on J14 of the microSD Board. Also, confirm that the red stripe on the cable is on the same side as the “Red stripe” notation on the microSD Board silkscreen.
13. Use four M3 x 8 mm screws (331) and four M3 split lock-washers (332) to attach the Main Board to the threaded standoffs that hold the Front Panel assembly in place. First insert the screws into the lock-washers and then insert the screws with lock washers through the mounting holes in the corners of the Main Board. Be careful when inserting the screw in the bottom corner of the Main Board that is close to the reference oscillator X1. Tighten all four screws.
14. After the unit is assembled, tuck, fold, and crease the flat cables so they are away from the edge connector pins.
15. Install the Raspberry Pi Pico (309) from bag P into the socket pins at location U22 on the Main Board. The USB connector on the Pico should be aligned with the small notch and “U22” designator on the main board silkscreen.
16. Connect one end of the Power Cable to J3 on the Main Board.
17. The RK05 Emulator assembly is complete.

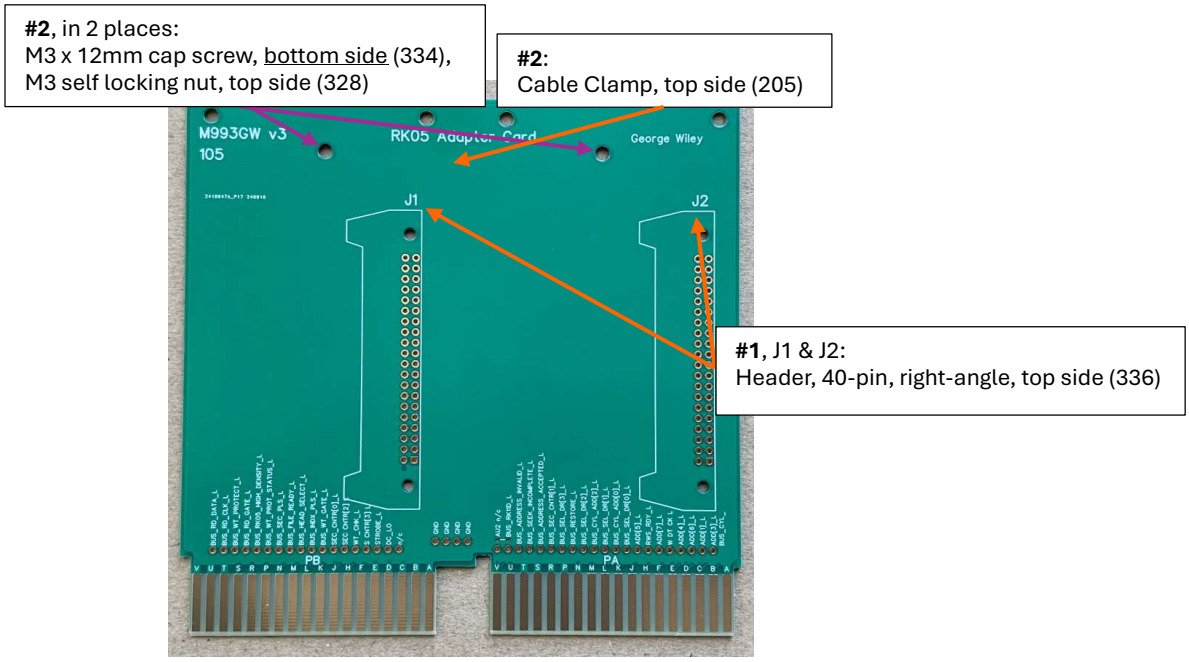
Finished Emulator, top-level

A1 RK05-to-RK8-E Cable, 1 meter length

RK05-to-RK8-E Cable, 1 meter length, kit of parts:

Install the following parts on the M993GW RK05 Adapter Card (105) from bag "**BE, Adapter PCB**". The parts referenced in the following instructions are from bag "**H1, Adapter HW**".

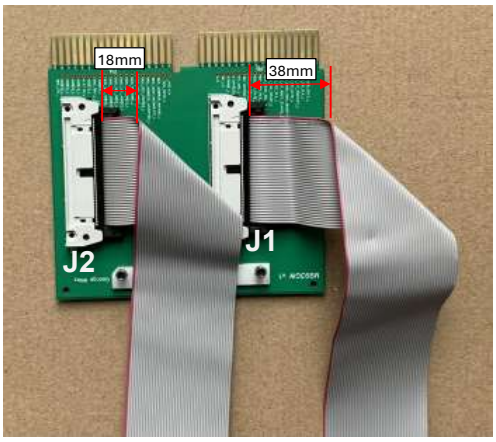
1. Install and solder two 40-pin right-angle headers (336) on the top side of the M993GW RK05 Adapter Board (105) at locations J1 and J2. There is no hardware used to attach J1 and J2.
2. Loosely install the Cable Clamp (205) on the top side of the adapter board using two M3 x 12 mm screws (334) and two M3 self-locking nuts (328). The wide slot on the cable clamp faces the Adapter Board. Also, the beveled corner of the Cable Clamp points towards J2. Don't tighten the screws and nuts now. Wait until flat cables are installed later.



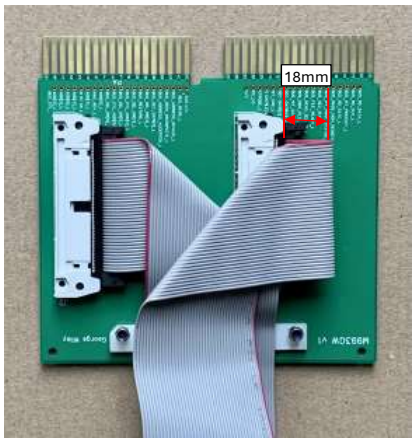
Assemble the cable using the board built in the previous steps and the flat cables from bag "**C1, Cables 1m**".

1. Insert one end of one of the 40-pin flat cables (349) into J1 on the M993GW RK05 Adapter Card. Notice that the keying bump should face up to correspond with the slot on the slot in the J1 connector body. The red stripe on the flat cable should be towards the gold fingers on the Adapter Card.
2. Insert one end of the second flat cable into J2 on the M993GW RK05 Adapter Card. Similarly, notice the keying bump orientation and the direction of the red stripe on the flat cable.
3. Fold each of the flat cables with a diagonal fold as shown in the photo. For the cable in J2, the diagonal fold of the side of the cable with the red stripe should begin about 18 mm from the body of the flat cable connector. For the cable in J1, the diagonal fold of the side of the cable with the red stripe should begin about 38 mm from the body of the flat cable connector.
4. For the cable in J1, fold and crease the cable about 18 mm from the body of the flat cable connector so that the cable folds onto itself. Refer to the photo for an example.
5. Loosen a screw holding one side of the Cable Clamp (205), tuck both cables underneath the Cable Clamp, and re-install the screw and self-locking nut. Tighten the screws that hold each side of the Cable Clamp in place. While tightening the screws, hold and position the flat cables so the cables extend perpendicular to the back edge of the Adapter Card. Take care to route the flat cables through the wide slot underneath the Cable Clamp before completely tightening the screws.
6. The free ends of the flat cables connect to the disk controller: either a DEC RK8-E or Plessey PM-DC/8. The Plessey PM-DC/8 has flat cable connectors with keying notches similar to the connectors used on the M993GW RK05 Adapter Card, so the cables in this kit can plug directly into the PM-DC/8 without any modifications. However, the DEC RK8-E has Berg connectors without a keying notch. When the RK05 emulator is used with the DEC RK8-E it is necessary to sand the keying bumps on the free ends of the flat cables so they can fit into the Berg connectors on the RK8-E. This is easily done using a Dremel tool with a coarse abrasive tool tip.

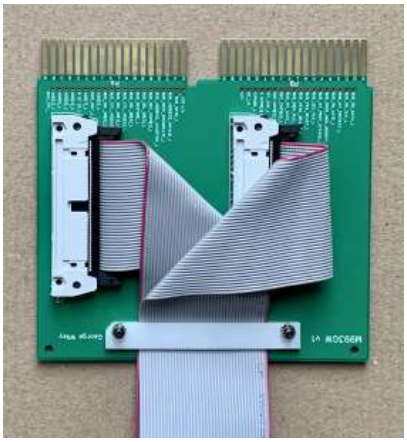
Step #3



Step #4



Step #5



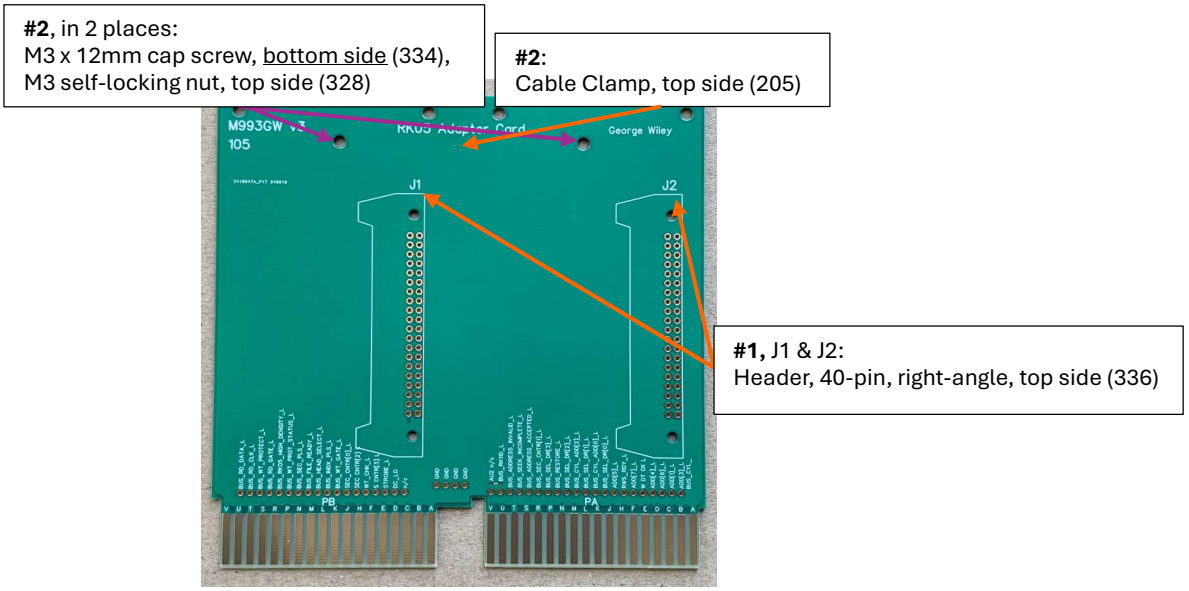
The System Setup Guide describes how to connect the free ends of this cable to the disk controller, either the DEC RK8-E or Plessey PM-DC/8.

A2 RK05-to-RK05 Cable, 1 meter length

RK05-to-RK05 Cable, 1 meter length, kit of parts:

Install the following parts on the M993GW RK05 Adapter Card (105). Since there are two RK05 Adapter PCBs in the kit, the following steps are performed twice. Two M993GW RK05 Adapter PCBs are from bag "**BE2, Adapter PCB**". The parts referenced in the following instructions are from bag "**H2, Adapter HW**".

1. Install and solder two 40-pin right-angle headers (336) on the top side of the M993GW RK05 Adapter Board (105) at locations J1 and J2. There is no hardware used to attach J1 and J2.
2. Loosely install the Cable Clamp (205) on the top side of the adapter board using two M3 x 12 mm screws (334) and two M3 self-locking nuts (328). The wide slot on the cable clamp faces the Adapter Board. Also, the beveled corner of the Cable Clamp points towards J2. Don't tighten the screws and nuts now. Wait until flat cables are installed later.
3. Repeat steps 1 and 2 with the second M993GW RK05 Adapter PCB.

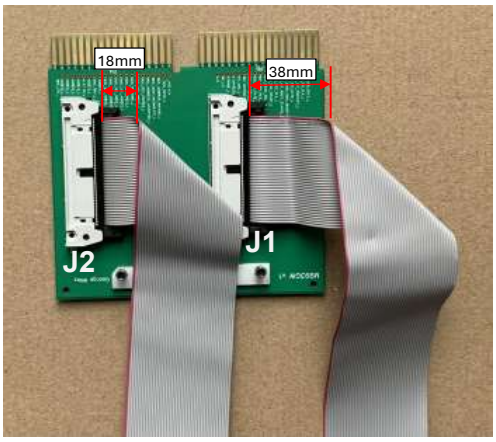


Assemble the cable using the two boards built in the previous steps and the flat cables from bag "**C1, Cables 1m**".

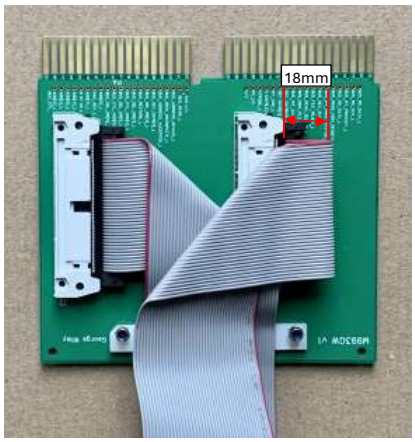
1. Insert one end of one of the flat cables into J1 on the first M993GW RK05 Adapter Card. Notice that the keying bump should face up to correspond with the slot on the slot in the J1 connector body. The red stripe on the flat cable should be towards the gold fingers on the Adapter Card.
2. Insert one end of the second flat cable into J2 on the first M993GW RK05 Adapter Card. Similarly, notice the keying bump orientation and the direction of the red stripe on the flat cable.
3. Fold each of the flat cables with a diagonal fold as shown in the photo. For the cable in J2, the diagonal fold of the side of the cable with the red stripe should begin about 18 mm from the body of the flat cable connector. For the cable in J1, the diagonal fold of the side of the cable with the red stripe should begin about 38 mm from the body of the flat cable connector.
4. For the cable in J1, fold and crease the cable about 18 mm from the body of the flat cable connector so that the cable folds onto itself. Refer to the photo for an example.
5. Loosen a screw holding one side of the Cable Clamp (205), tuck both cables underneath the Cable Clamp, and re-install the screw and self-locking nut. Tighten the screws that hold each side of the Cable Clamp in place. While tightening the screws, hold and position the flat cables so the cables extend perpendicular to the back edge of the Adapter Card. Take care to route the flat cables through the wide slot underneath the Cable Clamp before completely tightening the screws.
6. Connect the free ends of the flat cables to the second M993GW RK05 Adapter Card as before, following steps 1 through 5 above. The cable connected to J1 on the first Adapter Card should connect to J1 on the second Adapter Card. Similarly, the cable connected to J2 on the first Adapter Card should connect to J2 on the second Adapter Card.

   The following tip simplifies routing of the cables to the second Adapter Card: lay the first Adapter Card (that already has the cables attached) face down on the workbench and lay the second Adapter Card face up on the workbench. The gold fingers on each of the Adapter Cards should point away from the other Adapter Card. Now fold and connect the J1 cable per the instructions above, and next connect the J2 cable per the instructions above.

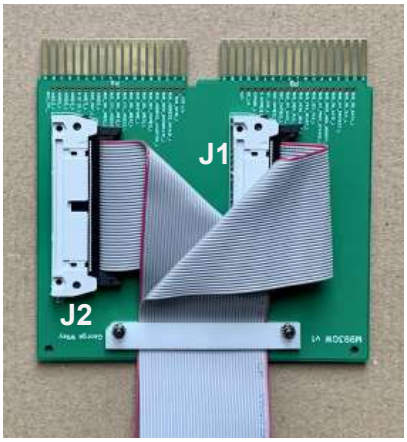
Step #3



Step #4



Step #5



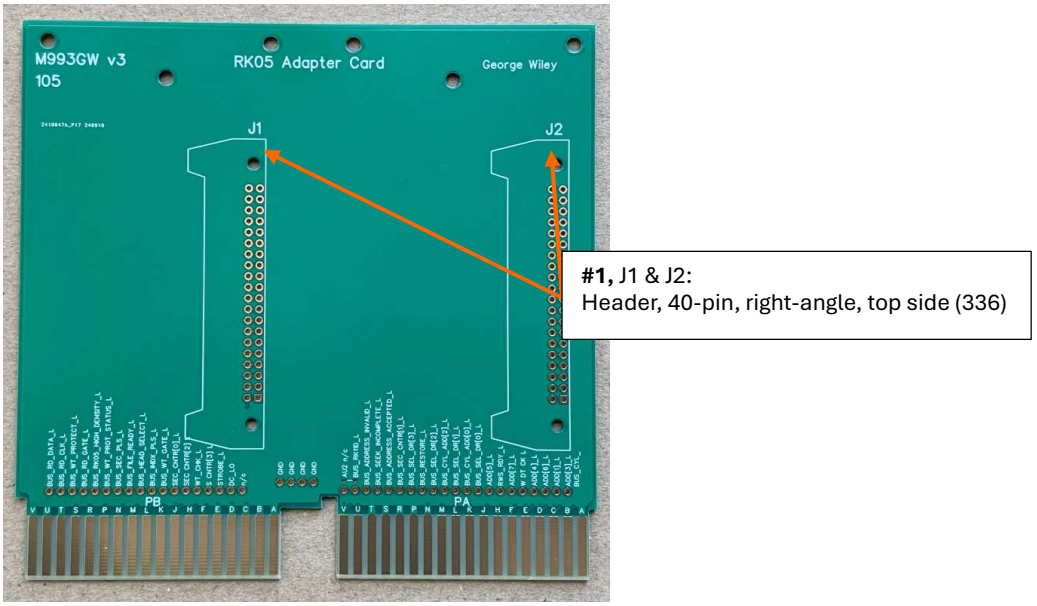
Notice in the Step #5 photo that the J1 cable is on top and the J2 cable is on the bottom. At the other end of the cable, do the reverse. Put the J1 cable on the bottom and the J2 cable on the top. This way, the cables will lay flat without a twist in one of the cables.

A3 RK05-to-RK05 Cable, Side-to-Side

RK05-to-RK05 Cable, Side-to-Side, 20cm length, kit of parts:

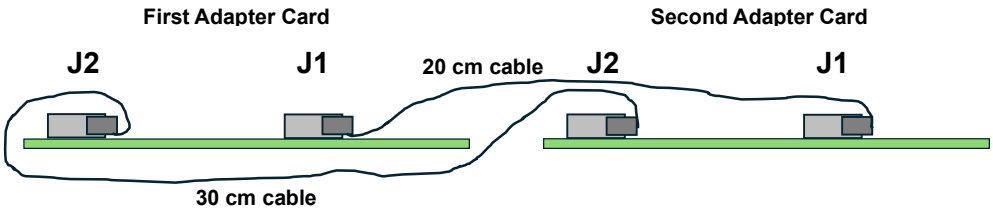
Install the following parts on the M993GW RK05 Adapter PCB. Since there are two RK05 Adapter PCBs in the kit, the following steps are performed twice. Two M993GW RK05 Adapter PCBs are in bag "**BE2, Adapter PCB**". The parts referenced in the following instructions are from bag "**R2, Side-Side Headers**". This kit does not need cable clamps so they are not included.

1. Install and solder two 40-pin right-angle headers (336) on the top side of the M993GW RK05 Adapter Board (105) at locations J1 and J2. There is no hardware used to attach J1 and J2.
2. Repeat step 1 with the second M993GW RK05 Adapter PCB.



Assemble the cable using the two boards built in the previous steps and the flat cables from bag "**C2, Cables 20cm&30cm**".

1. Find the end of the 30 cm flat cable (361) that has the keying bump facing away from the flat cable. This is the longer of the two flat cables. Insert this end of the 30 cm flat cable into J2 of the first M993GW RK05 Adapter Card. Notice that the keying bump should face up to correspond with the slot in the J2 connector body and the cable will be routed close to the Adapter Card. The red stripe on the flat cable should be towards the gold fingers on the Adapter Card.
2. Insert the other end of the 30 cm flat cable connected in the previous step into J2 on the second M993GW RK05 Adapter Card. Similarly, notice the keying bump orientation and the direction of the red stripe on the flat cable. At this end of the cable, the gray flat cable will leave the connector away from the Adapter Card.
3. Find the end of the 20 cm flat cable (370) that has the keying bump facing away from the flat cable. This is the shorter of the two flat cables. Insert this end of the 20 cm flat cable into J1 of the first M993GW RK05 Adapter Card. Notice that the keying bump should face up to correspond with the slot in the J1 connector body and the cable will be routed close to the Adapter Card. The red stripe on the flat cable should be towards the gold fingers on the Adapter Card.
4. Insert the other end of the 20 cm flat cable connected in the previous step into J1 on the second M993GW RK05 Adapter Card. Similarly, notice the keying bump orientation and the direction of the red stripe on the flat cable. At this end of the cable, the gray flat cable will leave the connector away from the Adapter Card.



J2, first Adapter Card

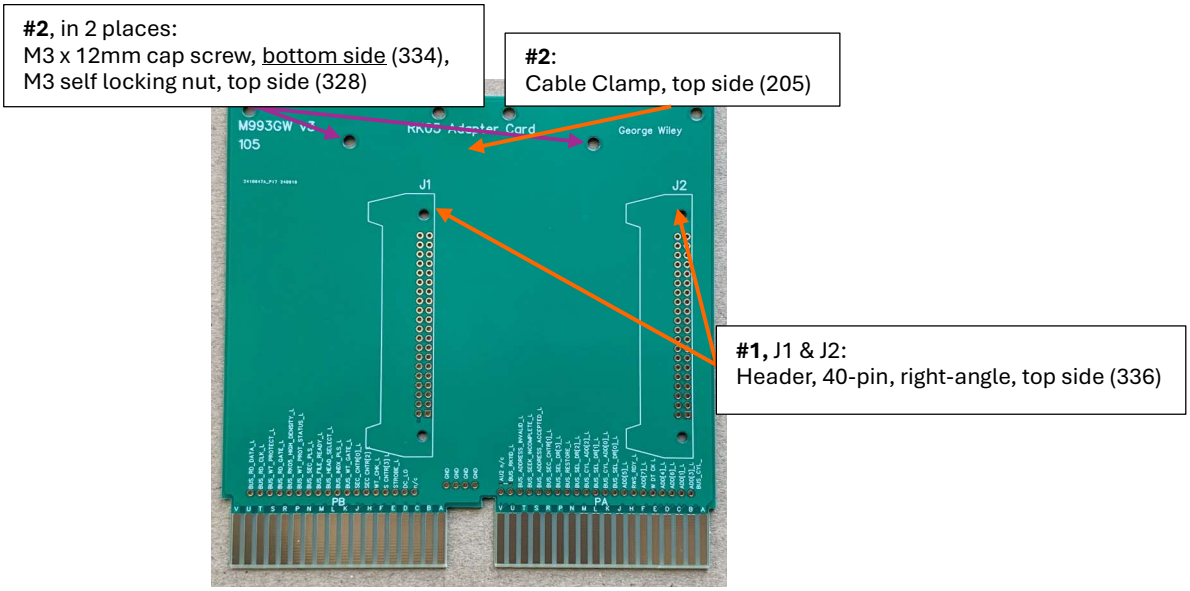
J2, second Adapter Card

A4 RK05 Adapter Board without flat cables

RK05 Adapter Board kit of parts:

Install the following parts on the M993GW RK05 Adapter Card from bag "**BE, Adapter PCB**". The parts referenced in the following instructions are from bag "**H1, Adapter HW**".

1. Install and solder two 40-pin right-angle headers (336) on the top side of the M993GW RK05 Adapter Board (105) at locations J1 and J2. There is no hardware used to attach J1 and J2.
2. Loosely install the Cable Clamp (205) on the top side of the adapter board using two M3 x 12 mm screws (334) and two M3 self-locking nuts (328). The wide slot on the Cable Clamp faces the Adapter Board. Also, the beveled corner of the Cable Clamp points towards J2. Don't tighten the screws and nuts now. Wait until the flat cables are installed later.



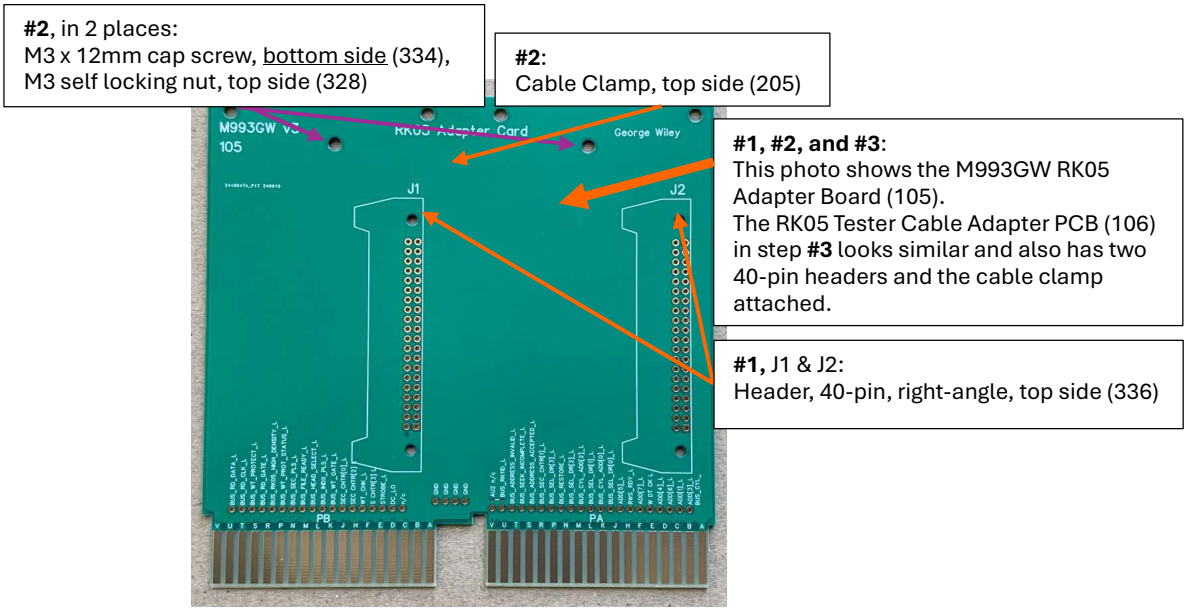
Finished RK05 Adapter Board without flat cables, top

A5 RK05-to-Tester Cable, 1 meter length

RK05-to-Tester Cable, 1 meter length, kit of parts:

Install the following parts on the M993GW RK05 Adapter PCB and the Tester Adapter PCB. Since there are two similar PCBs in the kit, the following steps are performed on each of the two boards. The two PCBs are in bag "**BE, Adapter PCB**" and bag "**BT, Tester Adapter PCB**". The parts referenced in the following instructions are from bag "**H2, Adapter HW**".

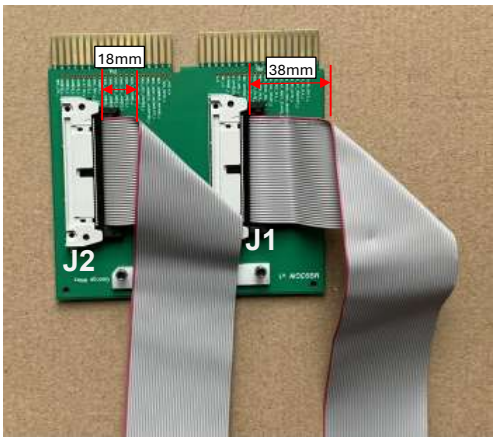
1. Install and solder two 40-pin right-angle headers (336) on the top side of the M993GW RK05 Adapter Board (105) at locations J1 and J2. There is no hardware used to attach J1 and J2.
2. Loosely install the Cable Clamp (205) on the top side of the adapter board using two M3 x 12 mm screws (334) and two M3 self-locking nuts (328). The wide slot on the cable clamp faces the Adapter Board. Also, the beveled corner of the Cable Clamp points towards J2. Don't tighten the screws and nuts now. Wait until flat cables are installed later.
3. Repeat steps 1 and 2 but install parts onto the RK05 Tester Cable Adapter PCB (106).



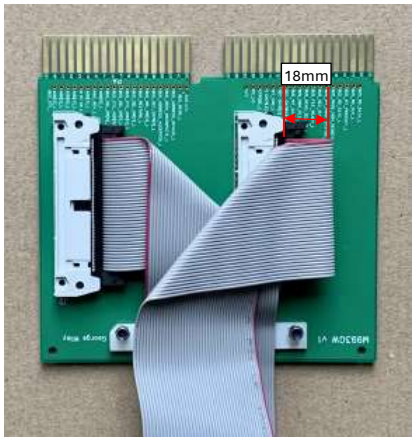
Assemble the cable using the two boards built in the previous steps and the flat cables from bag "**C1, Cables 1m**".

1. Insert one end of one of the flat cables into J1 on the M993GW RK05 Adapter Card. Notice that the keying bump should face up to correspond with the slot on the slot in the J1 connector body. The red stripe on the flat cable should be towards the gold fingers on the Adapter Card.
2. Insert one end of the second flat cable into J2 on the M993GW RK05 Adapter Card. Similarly, notice the keying bump orientation and the direction of the red stripe on the flat cable.
3. Fold each of the flat cables with a diagonal fold as shown in the photo. For the cable in J2, the diagonal fold of the side of the cable with the red stripe should begin about 18 mm from the body of the flat cable connector. For the cable in J1, the diagonal fold of the side of the cable with the red stripe should begin about 38 mm from the body of the flat cable connector.
4. For the cable in J1, fold and crease the cable about 18 mm from the body of the flat cable connector so that the cable folds onto itself. Refer to the photo for an example.
5. Loosen one of the screws holding one side of the Cable Clamp (205), tuck both cables underneath the Cable Clamp, and re-install the screw and self-locking nut. Tighten the screws that hold each side of the Cable Clamp in place. While tightening the screws, hold and position the flat cables so the cables extend perpendicular to the back edge of the Adapter Card. Take care to route the flat cables through the wide slot underneath the Cable Clamp before completely tightening the screws.
6. Connect the free ends of the flat cables to the RK05 Tester Cable Adapter Card as before, following steps 1 through 5 above. The cable connected to J1 on the M993GW RK05 Adapter Card should connect to J1 on the RK05 Tester Cable Adapter Card. Similarly, the cable connected to J2 on the M993GW RK05 Adapter Card should connect to J2 on the RK05 Tester Cable Adapter Card.

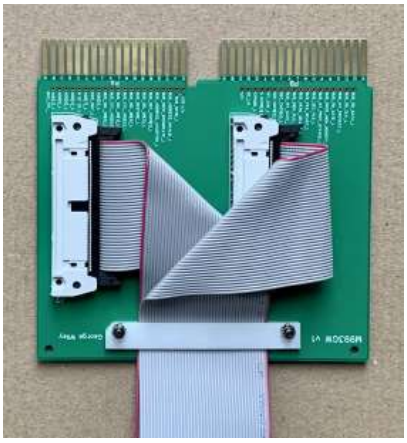
Step #3



Step #4



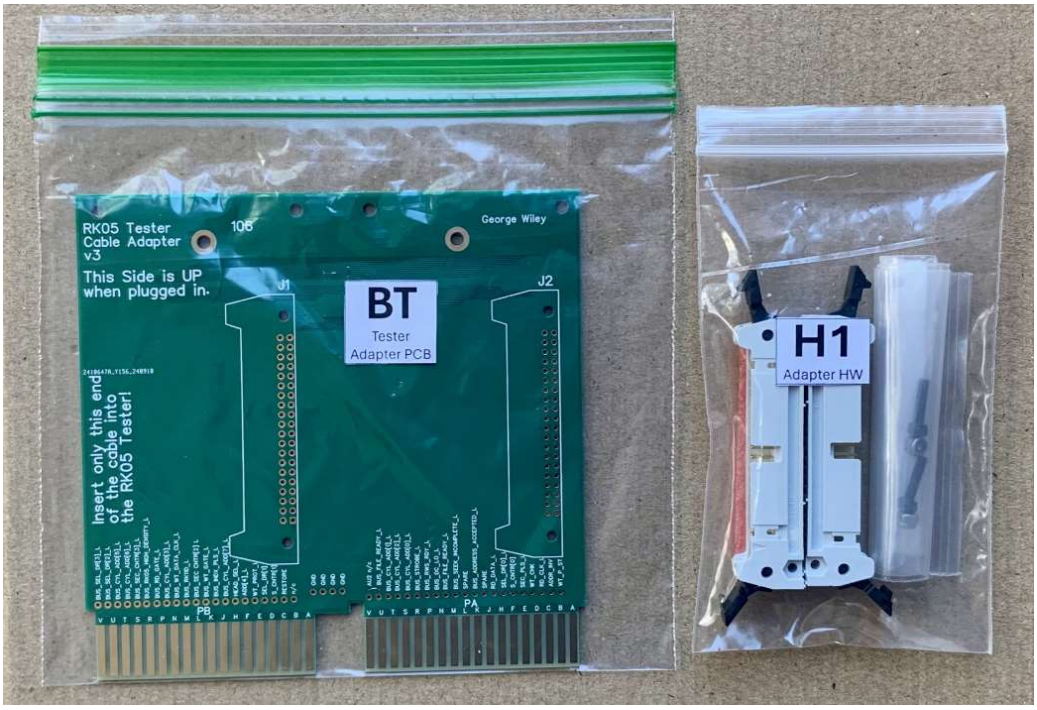
Step #5



The following tip simplifies routing of the cables to the RK05 Tester Cable Adapter Card: lay the M993GW RK05 Adapter Card (that already has the cables attached) face down on the workbench and lay the RK05 Tester Cable Adapter Card face up on the workbench. The gold fingers on each of the Adapter Cards should point away from the other Adapter Card. Now fold and connect the J1 cable per the instructions above, and next connect the J2 cable per the instructions above. To prevent the cables from crossing, stack the J1 cable on top on one board and on the bottom on the other board.

A6 RK05 Tester Board without flat cables

RK05 Tester Board kit of parts:



Install the following parts on the RK05 Tester Cable Adapter Board from bag "**BT, Tester Adapter PCB**". The parts referenced in the following instructions are from bag "**H1, Adapter HW**".

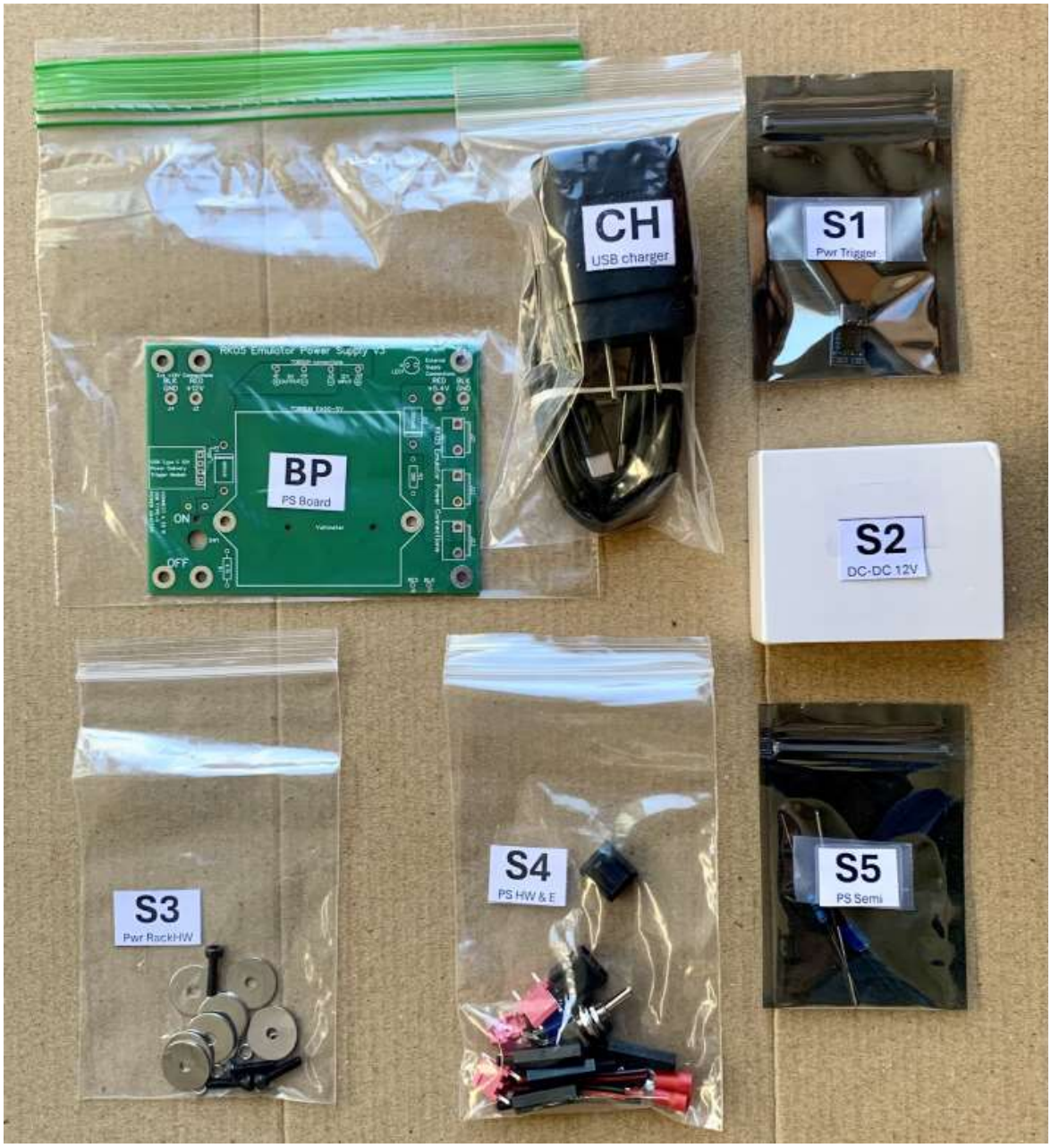
1. Install and solder two 40-pin right-angle headers (336) on the top side of the RK05 Tester Cable Adapter Board (106).
2. Install the Cable Clamp (205) on the top side of the adapter board using two M3 x 12 mm screws (334) and two M3 self-locking nuts (328). The wide slot on the Cable Clamp faces the Adapter Board. Also, the beveled corner of the Cable Clamp points towards J2. Don't tighten the screws now. Wait until the flat cables are installed later.

Refer to the photos and assembly guides for "A4 RK05 Adapter Board without flat cables" for additional details. The A4 and A6 accessories are visually quite similar except they use different PCBs.

Finished RK05 Adapter Board without flat cables, top

A7 & A7N RK05 Emulator Power Supply (version v3)

A7 Power Supply kit of parts:



The kit contents for A7 and A7N are very similar. The only difference is that A7N does not include the USB Charger (CH). The assembly instructions for A7 and A7N are the same.

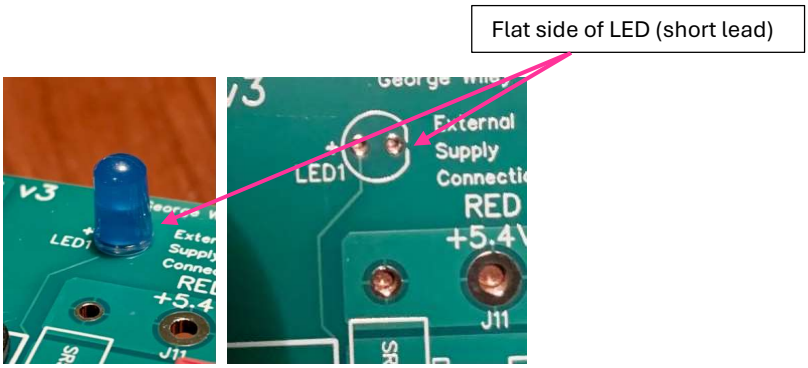
Power Supply Board electrical and mechanical assembly

Install the following parts on the RK05 Emulator Power Supply Board from bag "**BP, PS Board**". The parts referenced in the following instructions can be found in bag "**S4, PS HW & E**", "**S5, PS Semi**", and bag "**S1, Pwr Trigger**".

1. Install and solder the Power Trigger Module (351) from bag "S1, Pwr Trigger" on the top side of the RK05 Emulator Power Supply Board (107) using pins from the 4-pin header connector (352) through the four terminals at the end of the Power Trigger Module. Remove the plastic base of the 4-pin header and use only the pins. Solder the four pins on the top side of the Power Trigger Module and solder again on the bottom side of the RK05 Emulator Power Supply Board. Cut off any excess length of the pins after soldering.
2. Install and solder an SR540L rectifier (371) from bag "S5, PS Semi" on the top side at location D1. Take note of the correct polarity. The band indicating the cathode lead on the part corresponds to a similar band in the silkscreen image on the PCB. Cut the excess lead lengths on the bottom side.
3. Install and solder three 2-pin power connectors (340) on the top side at locations J21, J22, and J23. Take care to notice the silkscreen graphics that indicate the proper polarity.
4. Install the toggle switch (366) at location SW1.
5. Locate one of the 1.5-inch AWG 22 red-black zip cords (360). Slightly separate the red and black wires at each end. Strip about 0.15 inches (3.8 mm) of insulation from each end of the red and black wires. Slightly tin the stripped ends with solder. Remove any solder burrs on the ends of the wire so the wires will fit easily into the PCB pads in the next step.
6. Insert one end of the red wire into the hole closest to the edge of the board. Similarly, insert one end of the black wire into the hole farthest from the edge of the board. The board silkscreen has a guide that describes this. Solder both wires from the top side of the board.
   Bend the other end of each wire in the shape of a small hook, put each wire through the small eyelets in the switch terminals. Connect the black wire to the center switch terminal and the red wire to the lower outside switch terminal as indicated on the silkscreen. Solder both wires to the switch terminals.

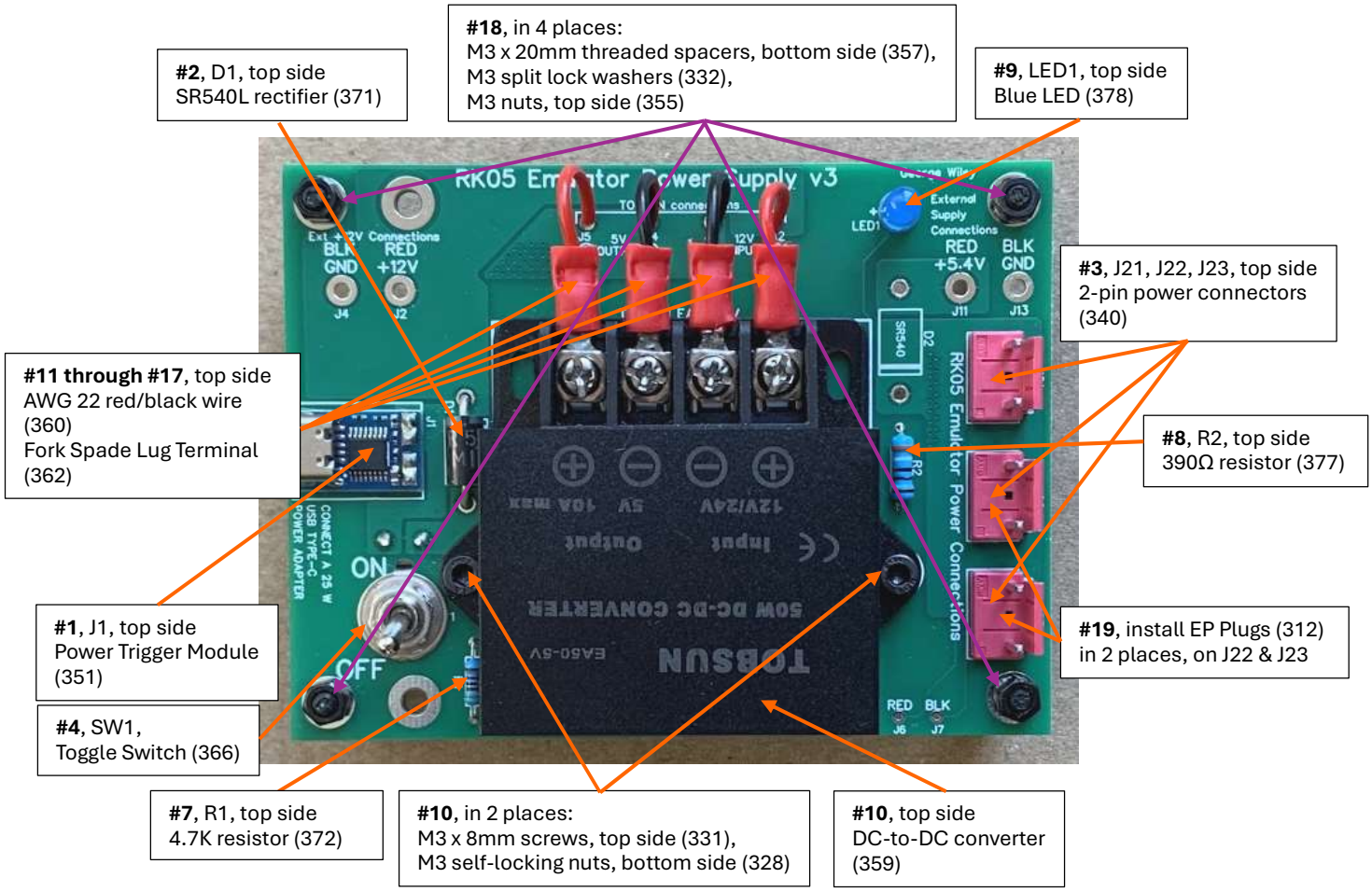
7. Install and solder a 4.7k resistor (372) from bag "S4, PS HW & E" on the top side at location R1. Cut the excess lead lengths on the bottom side.
8. Install and solder a 390 ohm resistor (377) from bag "S5, PS Semi" on the top side at location R2. Cut the excess lead lengths on the bottom side.

9. Install and solder a blue diffused LED (378) from bag “S5, PS Semi” on the top side at location LED1. Be careful to install LED1 with the proper orientation. The flat side of the LED corresponds with the flat side of the graphic in the silkscreen. The flat side of the LED package is the side with the short lead. Cut the excess lead lengths on the bottom side after soldering.



10. Mount the DC-to-DC converter (359) on the top side of the Power Supply Board (107) using the “TOBSUN EA50-5V” silkscreen outline as a guide. Secure the DC-to-DC converter with two M3 x 8 mm screws (331) and two M3 self-locking nuts (328). Insert the M3 screws from the top side and tighten the M3 nuts onto the screws on the bottom side.
11. Locate two 1.5-inch AWG 22 red-black zip cords (360). Separate the red and black wires completely so there are two red wires and two black wires. Strip about 0.25 inches (6.4 mm) of insulation from **one end** of each of the wires.
12. Crimp a Fork Spade Lug terminal (362) onto the bare ends of each of the four wires stripped in the previous step. Optionally, add a small amount of solder to secure each of the crimped wires to the terminal improve the reliability of the connection. This is because the wire size is on the lower end of the compatibility range for the Fork Spade Lug terminals.
13. Strip about 0.15 inches (3.8 mm) of insulation from the other end of each 1.5-inch AWG 22 red and black wire (360). Slightly tin the stripped ends with solder. Remove any solder burrs on the ends of the wire so the wires will fit easily into the PCB pads in the next step.
14. Loosen the four screws on the terminal block on the DC-to-DC converter.
15. Insert the tinned ends of the red and black wires into J5 (red), J14 (black), J3 (black), and J12 (red) so the wires extend from the top side of the board. Silkscreen text describes proper installation: red to “+” and black to “-”. Don’t solder the wires to the PCB yet. Insert the Fork Spade Lugs crimped to the other end of each wire into the corresponding terminal block positions on the DC-to-DC converter that are each directly above J5, J14, J3, and J12.
16. Tighten the screws on the terminal block on the DC-to-DC converter.
17. Solder the four wires on the bottom side of the Power Supply Board and cut any excess length of exposed wire.
18. At each of the four corners of the Power Supply Board, install M3 x 20 mm Threaded Spacers (357) on the bottom side and secure them on the top side using M3 lock washers (332) and M3 nuts (328). Locations of the threaded spacers, lock washers, and nuts are shown in the diagram below. Some kits may have 25mm threaded spacers (301) instead of 20 mm threaded spacers.

19. Install EP Plugs (312) onto J22 and J23. This protects the pins from shorting while in use.

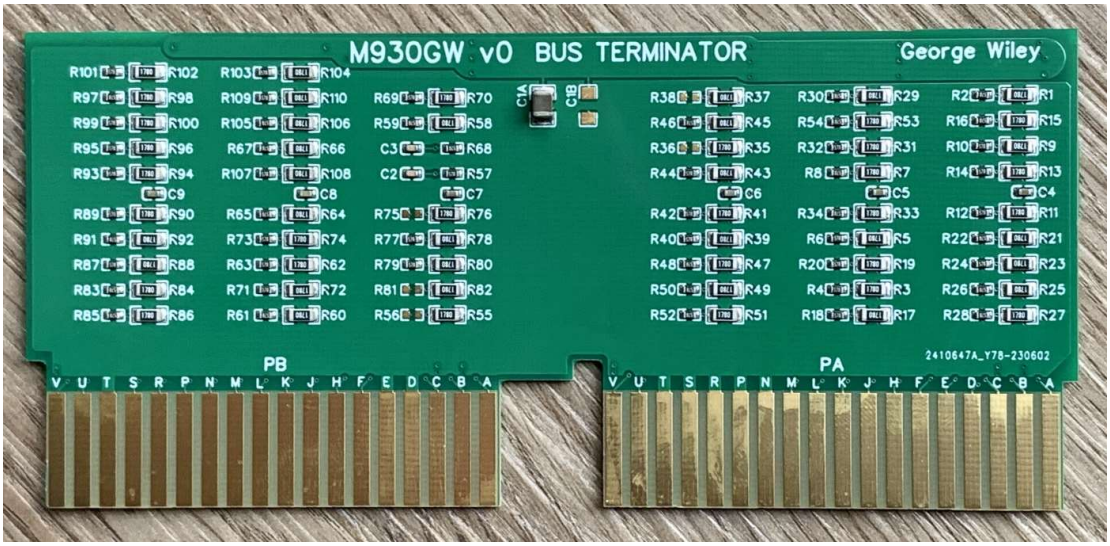


Finished Power Supply, top (A7 & A7N)

25 Watt USB Type C charger (A7 only)

T1 M930GW Terminator Board

Terminator Board parts:



1. No assembly is needed. All SMT assembly of the Terminator Board has been performed by the manufacturer.

Rework Instructions

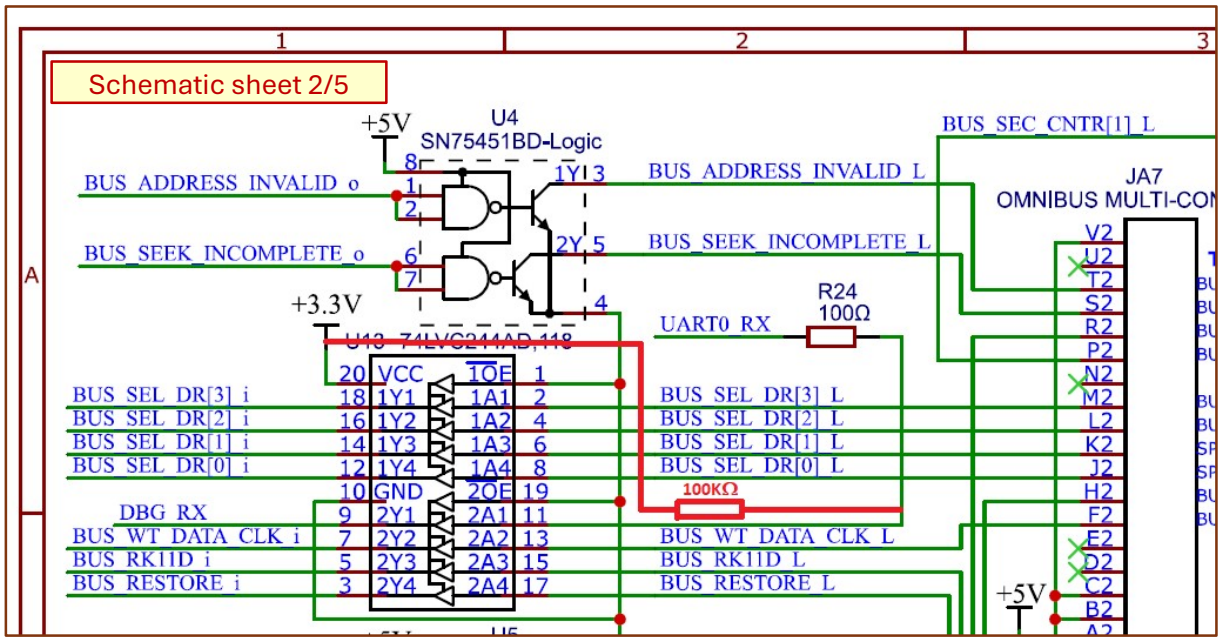
Rework to fix an intermittent boot-up problem (for board serial numbers 0040 and below, serial numbers 0041 and above already have the rework)

An issue was discovered that causes the Raspberry Pi Pico controller in the emulator to intermittently not boot up properly. The symptoms are when power is applied, some of the front panel lights are illuminated, the display is blank, and the emulator hasn't booted up fully.

This is caused by coupling of signals onto the debug port serial input which is floating and not properly pulled to a known state when a USB serial cable is not connected to the debug port. The fix is to solder a 100K Ω pullup resistor between the on-board +3.3V supply and the 74LVC244 receiver input for the serial debug port.

The following instructions describe the procedure to attach the resistor to a convenient place on the main board.

A 100K ohm resistor will be connected from U13-11 to U13-20 as shown in the schematic diagram.

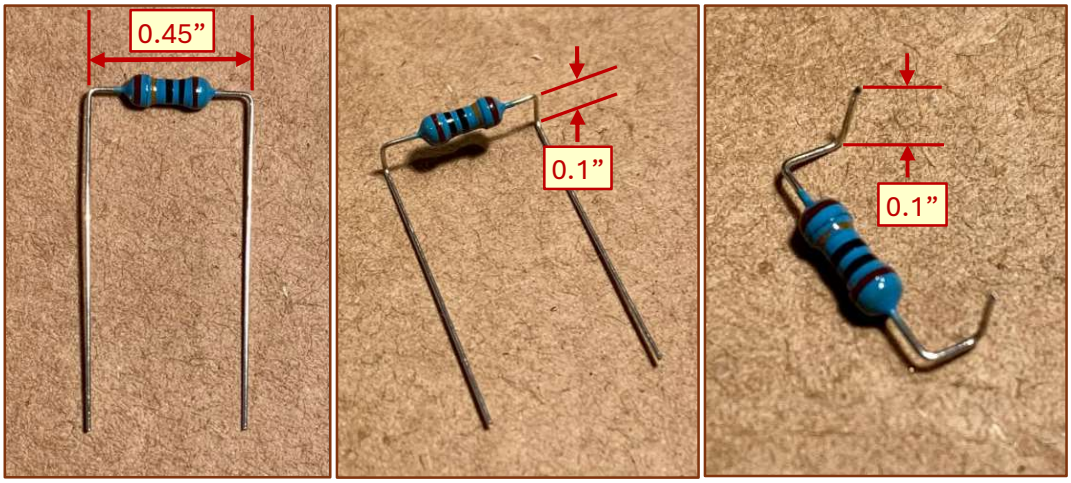


There is a software improvement that prevents the system from locking up due to activity on the serial port input during the boot-up process. It's not required but recommended to install Raspberry Pi software version 2.7 or higher <u>in addition to</u> the rework to add the pullup on the serial port input.

Although the use of software version 2.7 or higher will allow the system to boot properly without performing the rework, the rework is highly recommended because it prevents random characters from appearing on the serial port input during normal operation when a USB serial cable is not attached. The emulator responds to certain one-character commands during normal operation to enable debug logging modes. Inadvertent random characters on the serial input could cause the emulator to enter a logging mode which might change its operating behavior. Adding the pullup prevents this issue from happening.

<u>Recommendation</u>: perform the rework and use software version 2.7 or higher. Main board serial numbers 0041 or higher already have the pullup on the serial port.

Bend the leads of a 100K Ω resistor so that the bent wires are 0.45” apart. Then bend each lead once more and cut, as shown below.



In the following steps we will solder one lead of the resistor to U13 pin 11 and the other to U13 pin 20. For lead-free solder, Sn / Ag / Cu: 99% / 0.3% / 0.7%, use a small pointed soldering tip and set the temperature to about 350°C.

1. Place the 100K Ω resistor, with leads bent, on top of U13.
2. Hold the resistor in-place with tweezers. With a little melted solder on the iron tip, lightly tack one lead first to hold the resistor in place. (If you’re right-handed, it might be easier to hold the tweezers in your left hand and tack the resistor to U13 pin 20 in this step. If you prefer to hold the iron in your left hand then tack U13 pin 11 first.)
3. Next, solder the other resistor lead completely. (There’s no need to use the tweezers to hold the resistor in the step as the resistor is held in place by the action performed in step #2.)
4. Solder the first lead completely that was tacked in place in step #2.