Assembling and Testing the Mentor's Friend

Welcome to the Mentor's Friend community! This assembly guide is intended to make the construction and testing of your Mentor's Friend simple and straight-forward. It has been written as a step-by-step checklist, so you may find it useful to print it out and mark it up during construction of your Amigo.

If you are an experienced builder, please take this guide with a grain of salt. But if it's been a while since you've had your soldering iron out, you'll likely find these instructions helpful. Also, if you're sharing the construction of your Amigo with a young one (and I hope you are), the "checklist" approach of this guide allows you to place your youngster in charge of locating components and "checking off" assembly steps as the build proceeds. That's a good way to keep him or her engaged in the build, without having to worry about solder fumes, burned fingers, or faulty solder joints. And you can always share the load and swap roles during the build!

You'll need a few standard electronics tools to construct this kit, but nothing special. I use a 15-watt soldering iron with a pencil tip, standard rosin-core solder, desoldering braid (to clean up messy joints), a small needle nose pliers (for bending leads), a small diagonal cutting pliers (to clip soldered leads flush with the circuit board), and a small heat sink clamp (to hold parts in place until they are soldered). Also, I strongly recommend that you use some sort of magnifier, even if your eyes are young and bright — it never hurts to see the details of your solder joints.

Before you began, please use the checklist in Table 1 to verify that you have all the needed parts on hand. You may find it helpful to remove the discrete components and connectors from their plastic packaging and place them in a flat tray for easy access. I remove cut tape parts from their packaging, but leave them in the tape and write their value on the tape strip. But please leave the static sensitive IC's in their packaging until their turn comes up the the assembly process. If you have a young helper for construction of your Amigo, the parts inventory is a good first step to work together.

I hope your build goes smoothly, without any glitches. But if you do have problems, or ideas for improving the build process, please contact me via the *Nuts and Volts* website or email at danewestonl5@gmail.com. I'll do my best to help, and quickly.

May your Mentor's Friend bring you and your young one many hours of fun together!

Dane Weston
August 2015

√ On Hand	Inventory Item	Digi-Key P/N	QTY
	0.1ufd Capacitor	BC1148CT-ND	6
	10ufd Capacitor	493-10242-1-ND	2
	220ufd Capacitor	P15322CT-ND	2
	100Ω Resistor	CF14JT100RCT-ND	2
	120Ω Resistor	CF14JT120RCT-ND	5
	240Ω Resistor	CF14JT240RCT-ND	5
	270Ω Resistor	CF14JT270RCT-ND	5
	470Ω Resistor	CF14JT470RCT-ND	3
	4.7K Resistor	CF14JT4K70CT-ND	2
	10K Resistor	CF14JT10K0CT-ND	8
	Green LED	1497-1023-ND	2
	Red LED	1497-1031-ND	2
	Yellow LED	1497-1033-ND	1
	1N4001 Diode	1N4001FSCT-ND	1
	P832A-D40 - Propeller	P8X32A-D40-ND	1
	24LC256P - Programmed EEPROM	Nuts and Volts Kit	1
	23K256P - 32K SRAM	23K256-I/P-ND	1
	LM7805 - 5V Regulator	LM7805CT-ND	1
	LM2937 - 3.3V Regulator	LM2937ET-3.3/NOPB-ND	1
	5Mhz Crystal	X410-ND	1
	VGA Connector	A114810-ND	1
	Audio Connector	CP1-3525N-ND	1
	PS/2 Connector	CP-2260-ND	1
	Power Connector	CP-002A-ND	1
	Amigo Printed Circuit Board	Nuts and Volts Kit	1
	1.75” X 1.38” Breadboard	700-00012-ND	1
	40-Pin DIP Socket	ED3048-5-ND	1
	8-Pin DIP Socket	A120347-ND	2
	4-Pin Male Header	S1011EC-04-ND	1
	13-Pin Female Header	S7046-ND	2
	16-Pin Female Header	S7049-ND	1
	Tact Switch	EG1829-ND	3
	SD Card Socket	609-3956-1-ND	1
	2GB SD Card with Files	Nuts and Volts Kit	1

Table 1: Inventory Checklist.

Assembly Checklist

To simplify these instructions, I'll use a top / bottom / left / right frame of reference to describe component locations on the Amigo circuit board, with the Amigo logo on the "bottom left corner" of the board. Thus you'll find breadboard BR1 on the "bottom" edge of the board, the SD card socket on the "middle right edge," and so forth.

First print a copy of this checklist, and make sure your component inventory is complete. Assemble your tools (don't forget your magnifier, and a pencil for checking things off), clear your workspace, and make things comfortable for you and your young helper. Refreshments are authorized, but the school of hard knocks I attended (more than once) suggests deferring that adult beverage until after the build is complete. Plug in your iron, and let's get started!

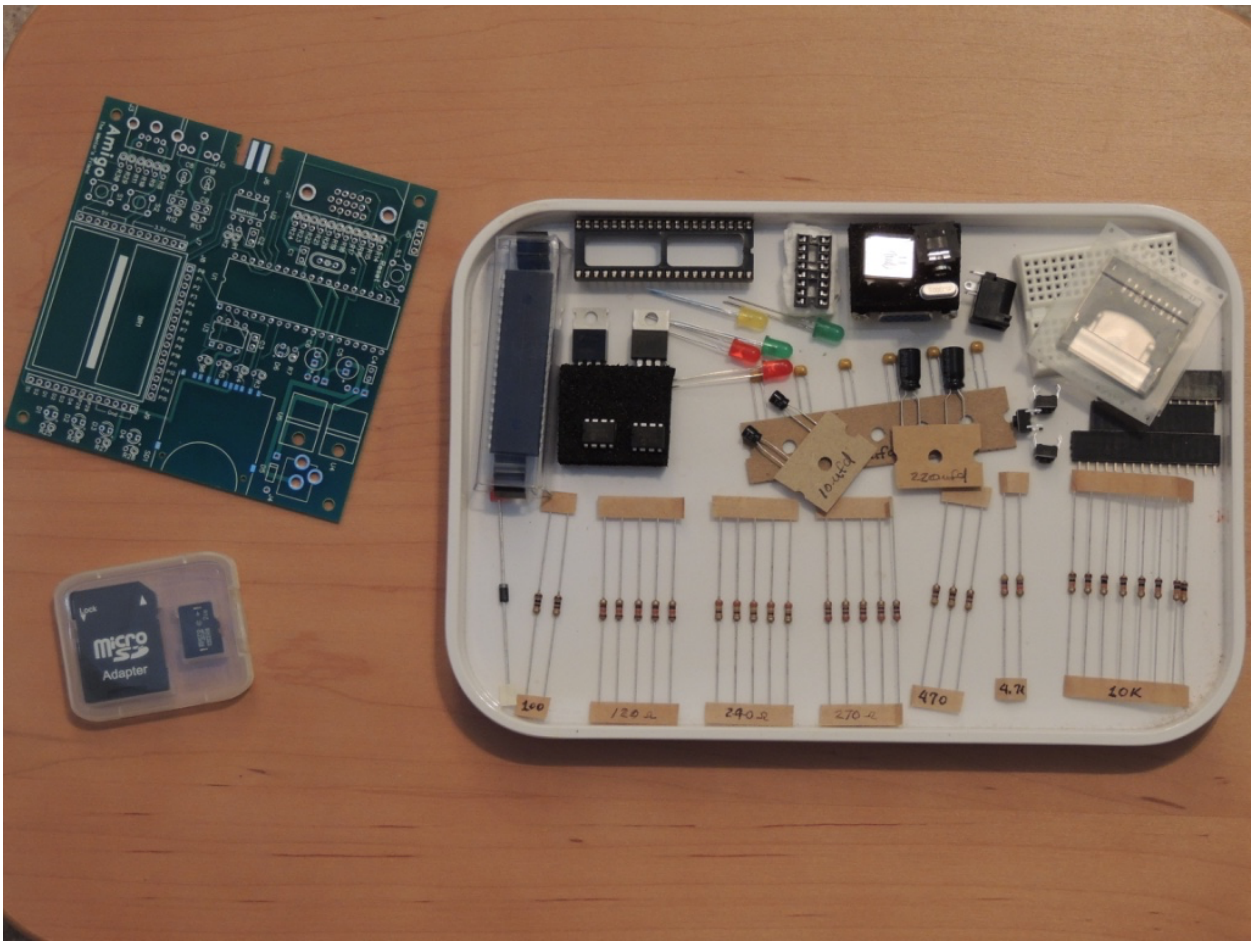

Figure 1: Inventory and Organize Your Components Before You Start Your Build.

1. Begin by installing the SD card socket, which will serve as the “hard drive” of your little retro computer. This is the only surface-mount part in the build (you just can’t find through-hole card sockets), and it’s the trickiest part to install. So let’s get it done first, while no other components can get in the way. Please use your magnifier for all portions of this first step of the build. Thanks — you’ll be glad you did!

Tin the side tabs on the socket with a little solder (not too much), and then tin the corresponding lands on the PCB. Then place the socket onto the PCB so that the plastic pegs on the socket align with the holes in the circuit board. The tabs should align with their corresponding PCB lands, as should each pin at the rear of the socket.

Now, while pressing the socket gently against the PCB, solder both side tabs, securing the tab next to diode D5 first. (Diode D5 is “above” the SD socket.) These two solder joints will keep the socket from wiggling as you insert or remove an SD card, so make sure both tabs are securely fastened to the circuit board before continuing.

Next solder each pin at the rear of the socket, again pressing gently down on the socket to ensure a good mechanical connection to the PCB land below. Then, using your magnifier, triple check the joint on each pin, and reflow or wick (with desoldering braid) each as needed. It will be difficult to reflow these joints after the surrounding components are installed, so use your magnifier, and triple check, triple check!

_____ SD1 - SD Card Socket (Check it off!)

2. Now install the four 10K resistors that support the SD card circuitry. To install a resistor on this build, bend one lead by 180° close to the resistor body, so that the bent lead is parallel to the resistor and the other lead. Then insert both leads into the two PCB holes for that resistor. The unbent lead goes in the hole with the white silkscreen circle. Use a heat sink clamp to hold one lead while you solder the other, then trim each soldered lead flush to the back of the circuit board. Bend and install, in order:

_____ R3 - 10K Resistor

_____ R4 - 10K Resistor

_____ R5 - 10K Resistor

_____ R6 - 10K Resistor

3. Install the 8-pin DIP socket and 0.1ufd decoupling capacitor for U3, the SRAM chip that will give your Amigo 32K of extended memory. I hold the socket snug against the board using a heat sink clamp on the pins on one side of the socket, while I solder the pins on the other side. Note that the socket has a small semicircular cut-out on one end, which should match up with the corresponding marking on the U3 silkscreen. (Don’t install the chip yet, just the socket!) You can also use the heat sink clamp to hold one lead of the capacitor, while you solder the other. Install both components.

_____ S-U3 - 8-pin DIP Socket

_____ C3 - 0.1ufd Capacitor (little yellow-brown one, with a tiny 104 marking)

4. Now let's build the 5Vdc and 3.3Vdc power supplies. Start by installing D5 (the 1N4001 power rectifier diode) in it's location "above" the SD card socket. Bend each lead of the diode 90° in the same direction, close to the diode body. Then insert the leads in the D5 holes on the PCB, with the band on the diode to the "left." The line on the diode should correspond to the line on the D5 silkscreen. Solder D5 in place.

_____ D5 - 1N4001 Diode

5. Install D6, the green Power On indicator, and its current limiting resistor R7. The longer lead on the LED goes in the D6 hole with the "+" marking, toward the SD card socket. Install, in order:

_____ D6 - Green LED

_____ R7 - 270 ohm Resistor

6. Install U4 (LM7805) and U5 (LM2937) voltage regulators for +5Vdc and +3.3Vdc, respectively. Like the other IC's in this build, these devices can be static sensitive, so if static electricity might be an issue in your workspace, ground yourself just before working with them. Start by inserting the LM2937 leads into the three U5 holes to the "left" of the rectangular U5 silkscreen, with the flat heat sink side of the LM2937 facing "right." Then bend the IC flush against the board, so that the mounting hole aligns with the hole in the board. Clamp it in place, then solder and trim the leads. Repeat this process for U4, the LM7805.

_____ U5 - LM2937

_____ U4 - LM7805

7. Now install the filter and decoupling capacitors in the power supply. C5 and C6 are the larger black 220ufd electrolytics, with a gray stripe on one side. Install them with 4the gray stripe (negative lead) facing "left," on the side away from U4 and U5. Next install C4, the small yellow-brown 0.1ufd cap.

_____ C6 - 220ufd Capacitor

_____ C5 - 220ufd Capacitor

_____ C4 - 0.1ufd Capacitor

8. Insert the three terminals of power connector J4 into their PCB mounting holes to the "right" of U4 and U5. Bend them over slightly to make mechanical contact with their corresponding pads, then solder each generously. This completes the power supply section of your Amigo!

_____ J4 - Power Barrel Connector

9. Before proceeding, test the power supply to check our work so far. Connect a 7.5 to 9Vdc, 2.1mm, center-positive power supply to J4. The green LED should light, and, if you have a multimeter, you should be able to read +3.3Vdc and +5Vdc between the corresponding pads on J7 and the Gnd pads on J9 (on the “left” and “right” sides of breadboard BR1).

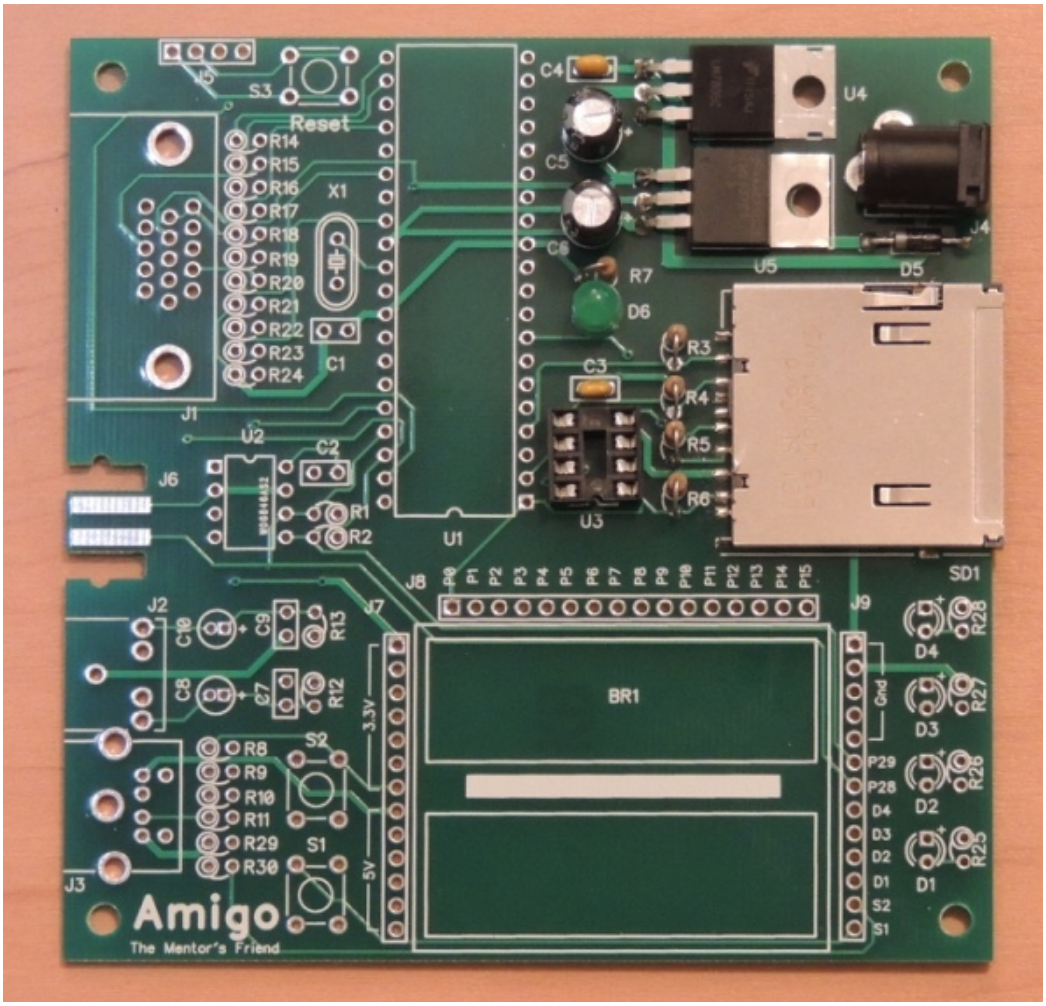

Figure 2: SD Card, SRAM, and Power Supply Complete.

10. Next we’ll install the components surrounding the Experimenter’s Breadboard and its headers. Install the Experimenter’s LEDs (D1 - D4), then their associated limit resistors (R25 - R28). The long lead of each LED goes in the hole with the “+” marking on the PCB, toward the “top” of the board. Install, in order:

_____ D4 - Red LED

_____ D3 - Yellow LED

_____ D2 - Green LED

_____ D1 - Red LED

_____ R28 - 270 ohm Resistor

_____ R27 - 270 ohm Resistor

_____ R26 - 270 ohm Resistor

_____ R25 - 270 ohm Resistor

11. Now move to the other side of the board and install the resistors for the keyboard interface and Experimenter's switches. Install, in order:

_____ R8 - 10K Resistor

_____ R9 - 100 ohm Resistor

_____ R10 - 10K Resistor

_____ R11 - 100 ohm Resistor

_____ R29 - 4.7K Resistor

_____ R30 - 4.7K Resistor

12. Install the tact switches at S1 and S2. Don't straighten the leads on the switches; they should snap easily into the circuit board without adjustment. If they don't, you may need to rotate the switch 90° for proper alignment.

_____ S2 - Tact Switch

_____ S1 - Tact Switch

13. Read this step through before proceeding. Install the components for the audio interface. C8 and C10 are the small black 10ufd electrolytic caps, which in my build did not have any markings to indicate polarity. Instead, the longer lead on the cap indicates the positive terminal. So, don't snip C8 and C10 off their cut tape carrier until you've identified that longer lead, and can position it correctly in the C8 and C10 holes. The longer lead (positive terminal) goes in the hole marked "+" on the "right" side of the silkscreen marking for each cap. Once the electrolytics are installed, you can install the other caps and resistors in this section without concern for polarity. Install, in order:

_____ C8 - 10ufd Capacitor

_____ C10 - 10ufd Capacitor

_____ C7 - 0.1ufd Capacitor

_____ C9 - 0.1ufd Capacitor

_____ R12 - 120 ohm Resistor

_____ R13 - 120 ohm Resistor

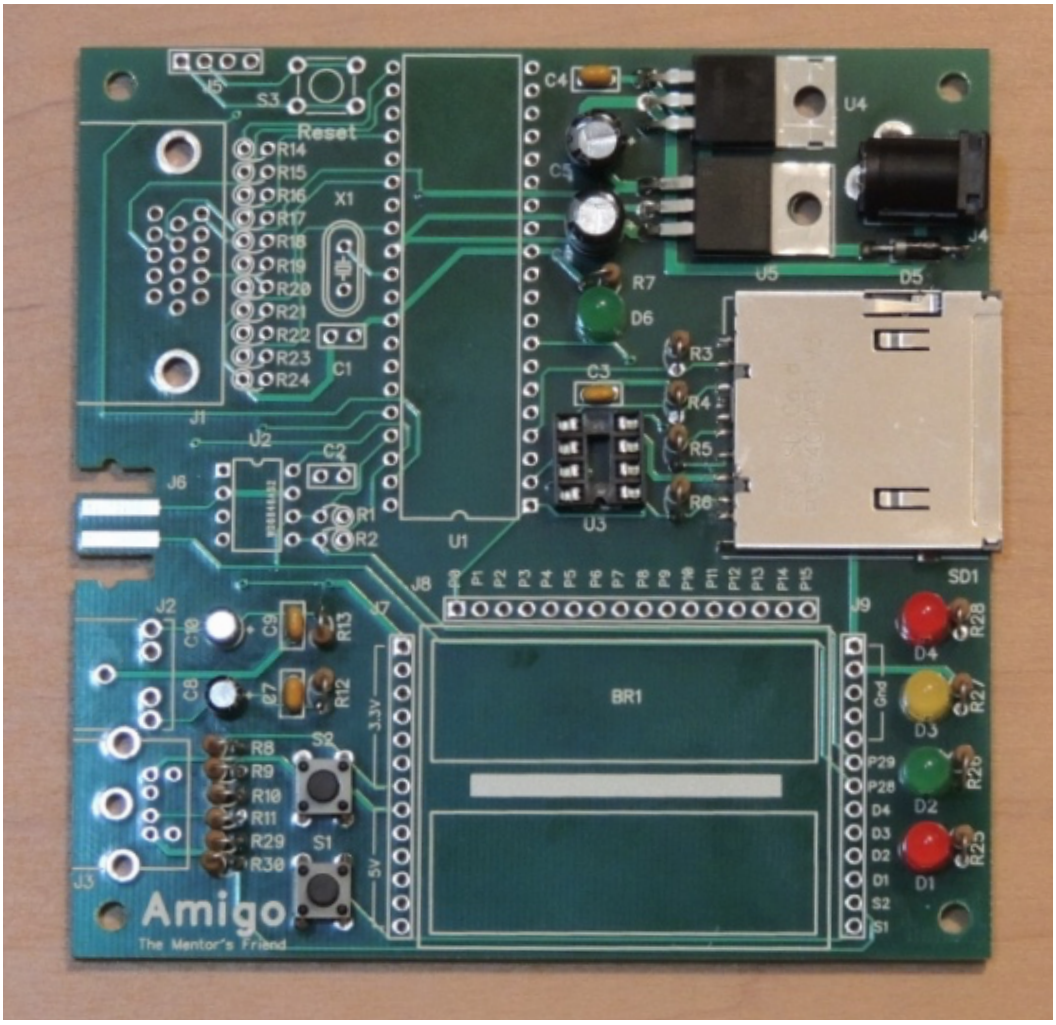

Figure 3: Components Around the Breadboard Section Installed.

14. Now we can install the Experimenter's Breadboard and headers without them getting in the way of adjacent component installation. Install the "top" 16-pin header (J8) by using a heat sink clamp to hold the pins on one end of the header while you solder the pins on the other end. Keep the header snug against the circuit board. Repeat the process for J7, the 13-pin header on the "left" of the breadboard. Now position J9 (the "right" 13-pin header), and dry fit the breadboard between J7 and J9 to make sure it fits. Then install J9, remove the tape backing from the breadboard, and press it down snugly in the space formed by the three headers.

_____ J8 - 16-pin Female Header

_____ J7 - 13-pin Female Header

_____ J9 - 13-pin Female Header

_____ BR1 - Solderless Breadboard

15. Install the audio jack (J2) and the keyboard connector (J3). J2 has little plastic feet that position the connector slightly above the PCB, making it difficult to grab the pins with the heat sink clamp. Instead use tape to hold J2 in securely in position while

you solder the pins. For J3, the mounting tabs should snap in place in their mounting holes. Once you've soldered the J3 pins, solder those tabs to their mounting holes.

_____ J2 - Audio Connector

_____ J3 - PS/2 Keyboard Connector

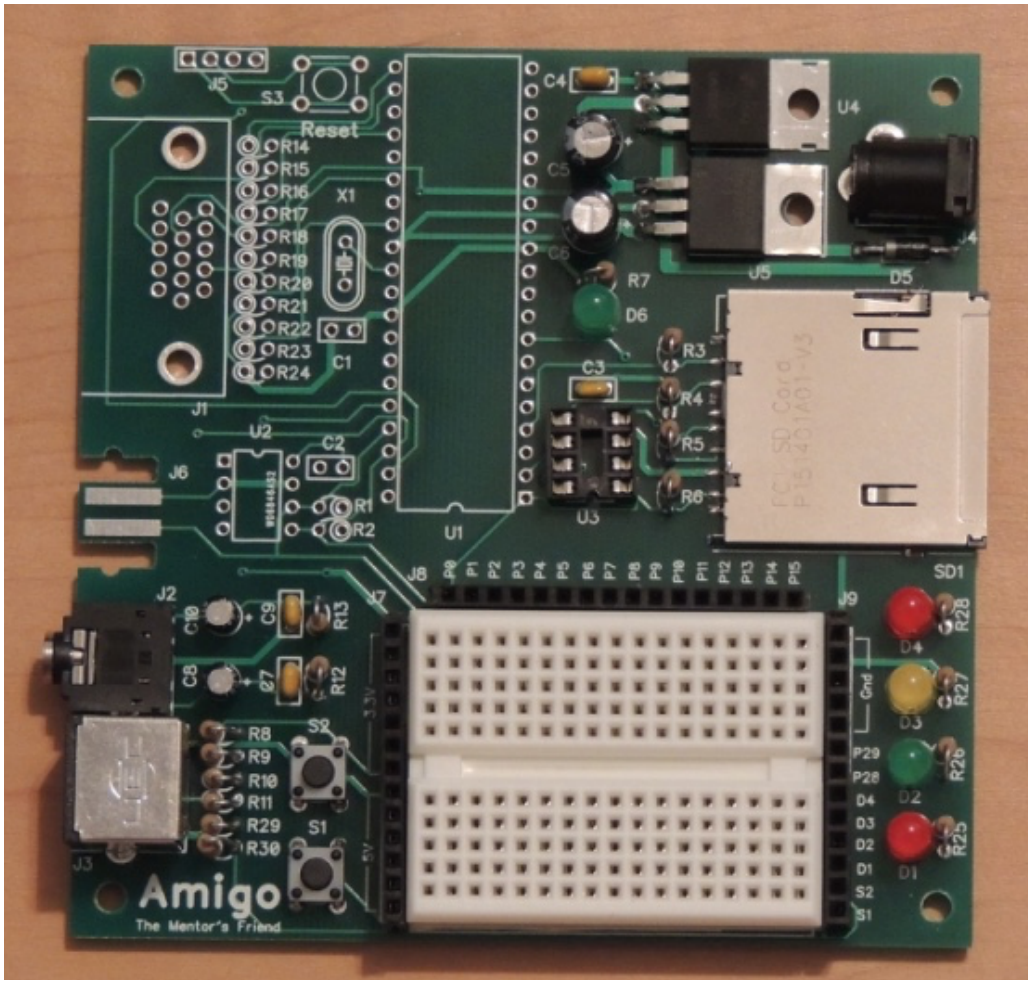

Figure 4: Audio and PS/2 Connectors Installed.

16. Install the EEPROM section, which supplies the Color BASIC firmware for your Amigo. It consists of the 8-pin DIP socket for U2, a 0.1ufd decoupling capacitor, and two 10K resistors. Be sure to align the semicircular dimple on the socket facing "up," matching the U2 image on the silkscreen. Don't install U2 yet, just the socket. Install:

_____ R2 - 10K Resistor

_____ R1 - 10K Resistor

_____ C2 - 0.1ufd Capacitor

_____ S-U2 - 8-pin DIP Socket

17. Install the resistors in the VGA section. These resistors convert digital Propeller outputs into the RGB and sync signals used by your VGA monitor, and there are a lot of them. So take your time and double check each value before you solder. Install:

_____ R24 - 120 ohm Resistor

_____ R23 - 240 ohm Resistor

_____ R22 - 470 ohm Resistor

_____ R21 - 120 ohm Resistor

_____ R20 - 240 ohm Resistor

_____ R19 - 470 ohm Resistor

_____ R18 - 120 ohm Resistor

_____ R17 - 240 ohm Resistor

_____ R16 - 470 ohm Resistor

_____ R15 - 240 ohm Resistor

_____ R14 - 240 ohm Resistor

18. Install the 5Mhz crystal, decoupling cap, and reset switch for the Propeller chip.

_____ X1 - 5Mhz Crystal

_____ C1 - 0.1ufd Capacitor

_____ S3 - Tact Switch

19. Install J1, the VGA connector. You may have to adjust the pins on the connector so they fit cleanly into the holes on the circuit board — use your magnifier, and take your time. Once everything is aligned, the connector should snap into place with a distinct “click.” Then you can solder each of the 15 pins, and the two mounting tabs.

_____ J1 - VGA Connector

20. Now install the 40-pin DIP socket for U1, the Propeller chip. Align the semicircular dimple on the end of the socket with the corresponding mark on the circuit board.

_____ S-U1 - 40-Pin DIP Connector

21. Install J6, the 4-pin male header for a Prop Plug. Unlike the other connectors and headers on your Amigo, you’ll not use this one unless you have a Propeller development environment and want to load different firmware into the EEPROM. Install the header with the short pins in the holes on the circuit board.

_____ J6 - 4-Pin Male Header

22. With your magnifier, carefully inspect your work on the entire circuit board. Look for dull solder joints or solder bridges between adjacent pins, and reflow or wick any suspicious ares with your iron. Take your time — a thorough check now may avoid tough problems later on!

23. Now install the Propeller, EEPROM, and SRAM chips, taking care to align the dimple on one end of each chip with the corresponding mark on the socket. These are static-sensitive parts, so make sure to ground yourself before handling them. You may have to bend the pins on one side of a chip to get them to fit into the socket. I use my magnifier to make sure all the pins are correctly seated. Assembly of your Mentor's Friend is now complete!

_____ U1 - P832A-D40 Propeller

_____ U2 - 24LC256P Programmed EEPROM

_____ U3 - 23K256P 32K SRAM

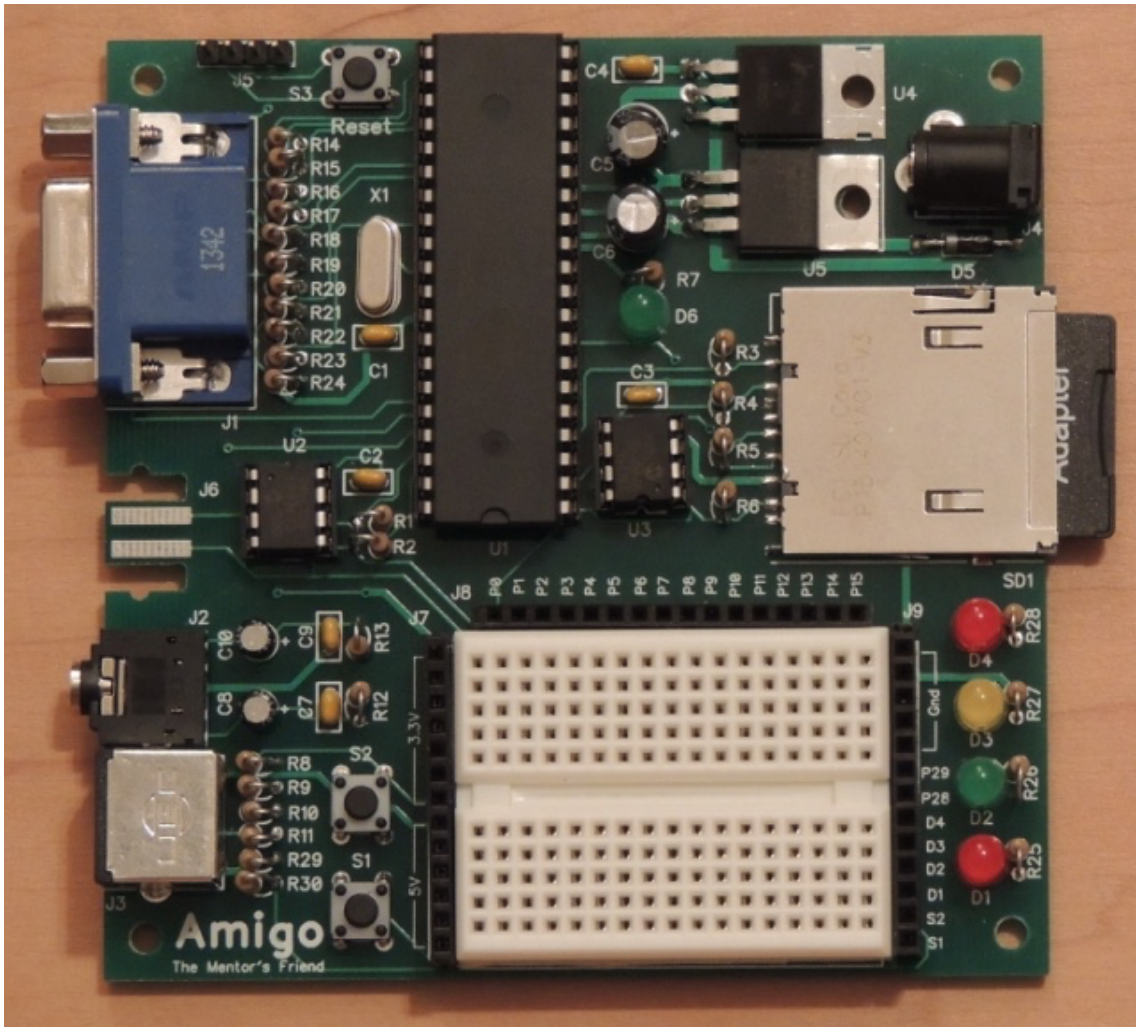

Figure 5: EEPROM, VGA, and Propeller Sections Added, Chips Installed — All Done!

24. It's time to test your build. Connect your PS/2 keyboard to J3 and VGA monitor to J1, then hold your breath and connect your power supply to J4. With any luck you should see the Color BASIC blue and white start-up screen and the READY prompt. If you do, congratulations — good work! Continue testing in Step 25 below. If not:

- Double check that all the pins on U1, U2, and U3 are properly seated.

- Make sure the dimples on each chip are aligned with the semicircular cut-out on each socket. The dimple on each chip should point to the silkscreen designator for that chip (U1, U2, or U3) on the circuit board.

- Make sure U2 and 3 aren't swapped. U2 is the 24LC256P and goes in the socket closest to J6, the Wii™ connector.

- Verify that your EEPROM came from the Nuts and Volts store with your circuit board and SD card. If your EEPROM hasn't been programmed with Color BASIC, you basically have a computer with no operating system, and you won't see any lights on your keyboard or any response from your monitor when you power up your Amigo. In this case, you'll need to get a programmed EEPROM, or program one yourself using your Propeller development environment and a USB Prop Plug.

- If all else fails, post a request for help on the Nuts and Volts site, and email me at daneweston15@gmail.com. We'll get it sorted out!

25. Let's validate the keyboard and monitor interfaces and the BASIC interpreter. Type in this time-honored code:

```
10 PRINT "Hello World!" <Enter>
RUN <Enter>
```

If your Amigo responds with "Hello World!" and the flashing rectangular cursor, you're in business! If not, and you're using a USB-to-PS/2 adapter with a USB keyboard, you may need to change keyboards. Many, but not all, USB keyboards will work with the Amigo using a USB-to-PS/2 adapter.

26. Now let's validate the SRAM in your Amigo. While you can't use it to extend the Amigo program memory (which is just 4K), SRAM does give you a place to store 32K of data while power is on, and you'll find this helpful in a number of programming situations. Type in this code to read the value in SRAM memory location 0, change that value, and verify the change.

```
print peek 0 <Enter>
xxx
poke 0,255 <Enter>
print peek 0 <Enter>
255
```

xxx above will be the value initially stored, which you are changing to 255. If you see this change, your SRAM should be good to go.

27. Now check the audio interface. Connect a powered speaker or some earbuds to the audio connector and enter the command below. Careful if you use earbuds — the volume may be uncomfortably high.

```
pluck 50
```

You should hear a single mid-range note through both audio channels. Depending on your build and component values, you may also hear some faint shifting tones afterwards. This is normal, and you can minimize it using the volume control on your powered speaker.

28. If you have a Wii™ Classic Controller (not the nunchuck), let's verify the Wii™ interface. Connect your controller with the indented side of the connector facing up. (It's crowded on that side of the board, and you may have to remove the VGA cable to connect your Wii™.) Then press the Reset button next to the Propeller chip to reboot your Amigo, press the Caps Lock key, then enter and run this code:

```
10 CLS
20 LOCATE 25,18
30 PRINT JOY,
40 GOTO 20

RUN
```

You should see the number 0 displayed in the middle of the screen. Now push a button on the Classic Controller. The number displayed should change, depending on which button (or combination of buttons) you press. Note that the Amigo interface only works with the buttons, not the joysticks, on the Classic Controller, and it does not work the the nunchuck.

29. Now check the Experimenter's switches and LEDs. You should see their J9 header labels to the right of the breadboard. (For instance, "S1" is the bottom hole of the J9 header.) Connect a jumper wire from the "S1" position to the "D1" position of J9. When you press S1 (the "bottom" switch to the "left" of the breadboard), D1 should light. Repeat this for the other LEDs, then for switch S2.

30. One last check — let's verify the Propeller I/O at the Experimenter's Breadboard. Connect a jumper wire from J8 position P15 to J9 position D4, then enter and run this code:

```
10 OUTA[15]=1
20 PAUSE 250
30 OUTA[15]=0
40 PAUSE 250
```

```
50 GOTO 10
```

When you run the program, LED D4 should flash twice a second until you press <Esc> to terminate the program.

So that completes your build of the Mentor's Friend. I hope everything went smoothly for you, and that your little Amigo will bring you and yours many hours of fun and fellowship. Enjoy!