

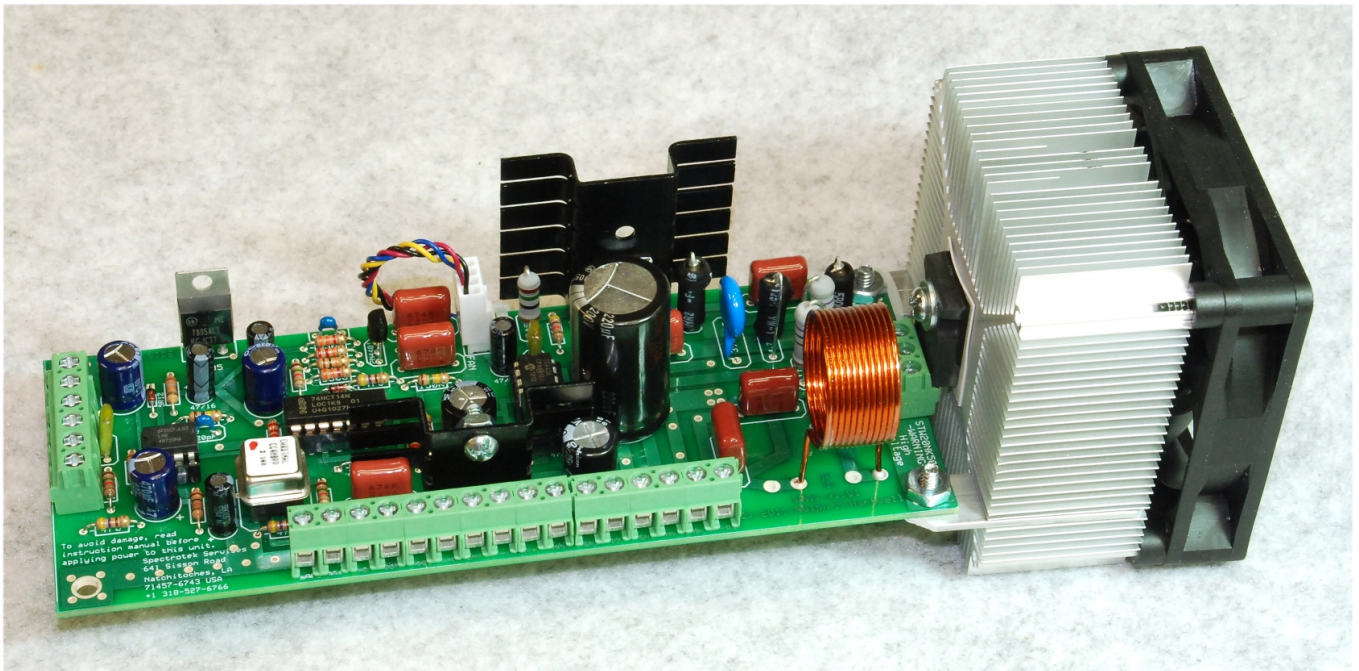
Assembly Instructions

For the

SPA4

Signal Processor and Amplifier Kit

V1.01



2 June 2015

© 2014 by Ralph Hartwell
Spectrotek Services
All rights reserved

GENERAL ASSEMBLY INSTRUCTIONS

Arrange for a clean work surface with adequate lighting. You will be working with small parts, and you may need to use a magnifier for close work. Working on a soft surface, such as a short nap towel, prevents parts from rolling off the work area and falling on the floor.

You will be soldering small components in place. If you are not accustomed to soldering such items, it is suggested that you seek assistance from an experienced person before starting assembly.

The circuit board of the SPA4 has been designed with ruggedness in mind. Extra-wide and thick copper traces have been used on the SPA4. Because of this, the SPA4 will withstand repeated soldering should repairs be necessary, such as if a component has been installed in an incorrect location. Nevertheless, it is strongly recommended that you take care in locating the position of the various components when assembling your SPA4.

You will require the following tools:

- Small needle nose pliers to install the heat sink.
- Small flush cut side cutter pliers to cut off the excess wire ends of components after soldering them in place.
- A #1 Phillips head screwdriver to install the heat sink.
- A soldering iron, with a recommended wattage of between 30-70 watts, and a tip temperature of no more than 750° F / 400° C. The point of the tip should be about 1 mm across.
- Solder, 60/40, 63/37, or 62/36/2 grade, no larger in diameter than 0.050 inches / 1.2 mm, with a non-conductive, flux core. Suitable types are Radio Shack 64-013 and 64-009. Your governmental regulations may require the use of lead-free solder.

WARNING ! DO NOT use acid core solder!!

Doing so will cause damage to the circuit board and will void any and all warranties. We will NOT warranty any circuit boards that have been assembled using any type of acid core solder.

The circuit layout of the SPA4 is such that the leads of all of the capacitors will pass fit through their respective holes on the board without the necessity of bending the leads.

The leads on the 2N4401 transistor will need to be spread slightly apart before inserting it into the circuit board. The leads of the 1N4148 diodes and all of the resistors will need to

be bent at right angles to the body of the component before you insert them into the board.

Bend the component leads using only your fingers. Using pliers or other tools may cause the body of the diode or resistor to break or become cracked where the lead exits the body of the component. This can result in outright failure of the SPA4 to operate, or even worse, cause intermittent malfunctions during operation. Such problems can be difficult to resolve.

Although you may assemble the components in any order, the assembly sequence detailed in this manual allows you to “build up” from the surface of the board, making it easier to install the components as you assemble your SPA4.

If you look at the blank circuit board, you will notice that one side of the board has the component locations and their values identified with white component outlines and lettering. This is the “Parts Side” of the circuit board. The reverse side of the circuit board is the “Solder Side.” All of the components are installed on the Parts Side of the board. All of the soldering is done on the Solder Side of the board.

The identification markings on the Parts Side of the board makes it easy for you to identify where the various components will be placed. It is suggested that you take the time to inspect the blank circuit board and familiarize yourself with where the various components will be placed. **Please refer to Figure 1, Page 20, which shows the assembled SPA4 for assistance in locating the position of the various components.**

For each assembly step, first locate the listed component, and then identify where on the circuit board it will be placed. If necessary, bend the leads of the component to fit through the component mounting holes, and then carefully insert the leads through the board. Carefully pull on the free end of the component’s leads to seat the component close to the circuit board. Do not apply excessive force trying to seat the component firmly against the board. If it is positioned slightly above the board that is satisfactory.

After inserting the component, bend the free ends of the component’s leads (on the Solder Side of the board) at about a 45° angle to prevent the component from slipping out of the circuit board when the board is turned upside down to solder the component in place.

Solder the component in place, inspect the solder joint, and then cut off the excess lead wires with the flush cutter pliers.

As you install each component, put an “X” or a check mark in the box to the left of each component designation in this manual. Assembling the components in the sequence shown here helps to prevent assembly errors.

Installing the Components on the SPA4 Circuit Board

NOTE: References in this assembly manual to the “top of the circuit board” means that you are looking at the circuit board so that the 3-hole mounting location for the STW20NK50Z is at the right side of the circuit board.

Install (5) 1N4148 diodes.

The diodes have a small black band around one end of the diode body. Insert the diodes into the circuit board so that the band is positioned over the white bar shown inside the outline of the diode that is printed on the circuit board.

- 4148
- 4148
- 4148
- 4148
- 4148

Install (1) 5.1 V Zener diode.

- 5R1Z **May be marked “PH C5V1.”**

Install (23) Resistors.

- 470 Ohm (Yellow Violet Brown)
- 470 Ohm (Yellow Violet Brown)
- 470 Ohm (Yellow Violet Brown)
- 470 Ohm (Yellow Violet Brown)

- 1000 Ohm (Brown Black Red)
- 1500 Ohm (Brown Green Red)
- 1500 Ohm (Brown Green Red)
- 1500 Ohm (Brown Green Red)
- 2200 Ohm (Red Red Red)
- 2200 Ohm (Red Red Red)
- 3300 Ohm (Orange Orange Red)
- 3300 Ohm (Orange Orange Red)
- 4700 Ohm (Yellow Violet Red)
- 4700 Ohm (Yellow Violet Red)
- 4700 Ohm (Yellow Violet Red)
- 10 K Ohm (Brown Black Orange)
- 10 K Ohm (Brown Black Orange)
- 10 K Ohm (Brown Black Orange)

NOTE: The next resistor will be installed at the location on the circuit board that is marked with a spot of **BLUE** paint.

- 18 K Ohm (Brown Gray Orange)

NOTE: Because it is easy to confuse the color bands on this resistor with a the color bands on a 2200 Ohm resistor, the 22 K Ohm resistor that you will install next has the paper tabs on the ends of its leads marked with **BLUE** ink

- 22 K Ohm (Red Red Orange).
- 100 K Ohm (Brown Black Yellow)

150 K Ohm (Brown Green Yellow)

150 K Ohm (Brown Green Yellow)

Install IC sockets at the following locations, but do NOT insert the IC's in their sockets at this time.

When installing the sockets, note that there is a small notch at one end of the socket. Also note that there is a small notch in the printed outline of the socket on the circuit board. When installing the socket, be sure to match the notch on the socket to the notch on the printed outline on the circuit board.

The printed outline for the OSC socket does not have a notch. Install the OSC socket with notch pointing towards the top of the circuit board. **Please refer to Figure 1, Page 20, for the correct location of the OSC socket.**

LME49710 (8-pin socket)

OSC (8-pin socket)

TC4426 (8-pin socket)

74HCT14 (14-pin socket)

Install (1) 4-Pin White plastic connector for cooling fan.

FAN

Install (1) 2N4401 transistor.

The leads of the transistor will have to be spread slightly apart in order for the leads to pass through the holes in the circuit board. The flat side of the transistor faces the 150 K Ohm resistor and the two 0.047 capacitors that are to the right of the 2N4401 transistor.

2N4401

Install (1) 82 pF capacitor.

82 pF (marked as 820 on capacitor)

Install (1) 220 pF Disk Capacitor.

- 220 pF capacitor (marked as 221 on the capacitor)

Install (2) 8200 pF film capacitors.

- 8200 **May be marked “.0082K100k” These capacitors have no polarity.**
- 8200

TERMINAL BLOCK INSTALLATION

Your SPA4 kit has been furnished with a total of eleven 2-position terminal blocks, and one 3-position terminal block.

When installing the terminal blocks, please make sure to install the terminal blocks so that the wire holes in the terminal blocks are facing the outside edge of the circuit board.

The terminal blocks may be a tight press fit into the circuit board; this is normal. Be sure to seat the terminal block completely against the circuit board before soldering.

1) Using three of the 2-position terminal blocks, assemble them together to make one continuous 6-position terminal block.

Install this 6-position terminal block so that it covers these locations:

- + B IN -
- A IN +
- A GAIN

2) Using three of the 2-position terminal blocks, assemble them together to make one continuous 6-position terminal block.

Install this 6-position terminal block so that it covers these locations:

- GND +19
- GND HV
- GND RF OUT

3) Using five of the two position terminal blocks, assemble them together to make one continuous 10-position terminal block.

Install this 10-position terminal block so that it covers these locations:

- SW3 TTL / RF
- SW2 0-COM-100
- SW1 1X / 2X
- MTR +12 MPWR

NOTE: Please do not attempt to link together the 6-position and the 10-position terminal blocks into one long terminal block. They will be too tight to fit properly. Forcing the terminal strips into the circuit board holes will warp the circuit board. This may result in cracked circuit traces and eventual failure of your SPA4 to operate at a later time.

4) Using the 3-position terminal block, install the terminal block at the position of the STW20NK50Z.

- STW20NK50Z

Install (1) 3900 pF Disc Ceramic Capacitor.

3900

Install (2) 2200 pF Disc Capacitors.

2200

2200

Install a 1000 pF capacitor.

1 nF

Install a 470 uF 16 Volt electrolytic capacitor.

NOTE - Observe polarity when installing this capacitor. The negative (-) lead of the capacitor goes to the ROUND mounting pad, and the positive (+) lead of the capacitor goes to the SQUARE mounting pad.

The Positive (+) lead of the capacitor is the longer lead. There is a gray or white stripe on the side of the capacitor that is closest to the Negative (-) lead.

470 / 16

Install a 470 uF 25 Volt electrolytic capacitor.

NOTE – Observe polarity when installing this capacitor. The negative (-) lead of the capacitor goes to the ROUND mounting pad, and the positive (+) lead of the capacitor goes to the SQUARE mounting pad.

Please be very careful to observe the correct mounting orientation of this capacitor when you are installing it. If the capacitor is accidentally installed in the reverse direction, it will very likely overheat and burst when power is applied to the circuit board.

The Positive (+) lead of the capacitor is the longer lead. There is a gray or white stripe on the side of the capacitor that is closest to the Negative (-) lead.

470 / 25

Install (3) 470 uF 10 Volt electrolytic capacitors.

- 470 / 10
- 470 / 10
- 470 / 10

Install (5) 47 uF 16 Volt electrolytic capacitors.

NOTE - Observe polarity when installing these capacitors. The negative (-) lead of the capacitor goes to the ROUND mounting pad, and the positive (+) lead of the capacitor goes to the SQUARE mounting pad.

The Positive (+) lead of the capacitor is the longer lead. There is a gray or white stripe on the side of the capacitor that is closest to the Negative (-) lead.

- 47 / 16
- 47 / 16
- 47 / 16
- 47 / 16
- 47 / 16

Install a 15 Ohm, 1 Watt resistor.

Please see Figure 1, Page 20, for the correct orientation of this resistor.

Bend one of the resistor's leads towards the body of the resistor so that both leads point in the same direction. The bent wire should pass through the mounting hole that is closest to the edge of the circuit board. This will allow for proper clearance for the end of the heat sink of the IRF730 which will be installed in a later assembly procedure.

In order to provide sufficient cooling for the resistor when the unit is in operation, be sure to leave about 3 to 4 mm of lead wire between the body of the resistor and the PC board before soldering the leads to the board.

- 15 (Brown Green Black)

Install (2) 7.5 Ohm, 2 Watt Resistors.

Please see Figure 1, Page 20, for the correct orientation of these resistors.

Bend one of the leads of each resistor down towards the body of the resistor so that both leads point in the same direction.

Mount the resistors vertically with the resistor bodies centered over the outermost holes in the mounting pads. There is a diagonal trace connecting the two solder holes where the unbent lead of each of the resistors will be soldered. The bottom end of each resistor should be standing about 1/4 inch or 6 mm above the surface of the circuit board. Mounting the resistors this way allows the maximum cooling air between the resistors.

- 7.5 Ohm (Violet Green Gold Gold)
- 7.5 Ohm (Violet Green Gold Gold)

Install (3) 4.7 uHy Ferrite Core Inductors.

Please see the photographs at the back of this assembly manual for correct orientation of these inductors before soldering them in place.

Bend one of the leads of each inductor down flat against the body so that both leads point in the same direction.

Mount the inductors vertically with the inductor bodies placed against the SPA4 circuit board against the solder holes that do not have traces visible on the Parts Side of the circuit board. The folded over wire lead should pass through the hole in the circuit board which has a copper trace connecting to the solder pad.

- 4.7
- 4.7
- 4.7

Install the 7812 voltage regulator.

Make sure the metal side of the voltage regulator is positioned over the thick white line of the component outline drawing on the circuit board. When mounted correctly, the metal side of the 7812 will face the outside edge of the circuit board. **Please see Figure 1, Page 20, for the correct orientation of the voltage regulator.**

7812

Install the 7805 voltage regulator.

Make sure the metal side of the voltage regulator is positioned over the thick white line of the component outline drawing on the circuit board. When mounted correctly, the metal side of the 7805 will face the outside edge of the circuit board. **Please see Figure 1, Page 20, for the correct orientation of the voltage regulator.**

7805

Install the IRF730 transistor.

Make sure the metal side of the voltage regulator is positioned over the thick white line of the component outline drawing on the circuit board. When mounted correctly, the metal side of the IRF730 will face the outside edge of the circuit board. **Please see Figure 1, Page 20, for the correct orientation of the IRF730.**

IRF730

Install (7) 0.47 uF capacitors. These capacitors have no polarity.

- 0.47
- 0.47
- 0.47
- 0.47
- 0.47
- 0.47
- 0.47

Install (1) 220 uF 200 V Electrolytic Capacitor.

Please be very careful to observe the correct mounting orientation of this capacitor when you are installing it. If the capacitor is accidentally installed in the reverse direction, it will very likely overheat and explode when power is applied to the circuit board.

The negative (-) lead of the capacitor goes to the ROUND mounting pad, and the positive (+) lead of the capacitor goes to the SQUARE mounting pad.

The Positive (+) lead of the capacitor is the longer lead. There is a gray or white stripe on the side of the capacitor that is closest to the Negative (-) lead.

- 220 / 200

Install (1) L4 Air Core Inductor.

L4

Please see Figure 1, Page 20, for the correct orientation of the inductor.

The air core inductor L4 in your SPA4 kit is supplied with leads that are cut to the proper length. Make sure that the enamel insulation is removed from the outermost 1/2 inch / 1.25 cm of each of the lead wires of inductor L4.

Carefully bend the lead wires so that they will pass easily through the mounting holes in the SPA4 circuit board. Be careful not to bend the leads too far so as not to split the plastic insulation that holds the coil turns together. Should the lead wires break free of the plastic coating, the application of a small drop of cyanoacrylate adhesive (Super Glue) to the cracked area will affect a permanent repair. Insert the leads of L4 through the holes in the circuit board so that about 1/4 inch / 6 mm of wire extends through the board. Do not insert the coil wires so far through the board so that any of the insulated part of the lead wire is inside the mounting hole. Should this happen, then you will be unable to properly solder the wire to the circuit board. After inserting the wires through the board, carefully solder them in place.

Inspection of your work.

At this point in the assembly process, all of the components have been mounted on the circuit board except for the small heat sinks on the 7812 voltage regulator and the IRF730 transistor. This is a good time to inspect your work and clean the solder side of the circuit board to remove excess solder flux.

Using a magnifying glass and a bright light, carefully inspect the top and bottom of the finished circuit board for any unwanted solder splashes between connections, and wire clippings, or anything else that may cause problems during operation of the SPA4.

Should you wish to remove the solder flux residue from the finished circuit board, you may use a commercial flux remover, or 100% Isopropyl alcohol. Rubbing alcohol is NOT suitable for removing the flux residue due to the high water content and the denaturing ingredients contained in rubbing alcohol. Use only 100% Isopropyl alcohol. After cleaning the board, allow it to dry thoroughly before continuing.

This completes the main assembly process of the SPA4 circuit board.

Install the Heat Sink on the 7812 voltage regulator.

Please see Figure 1, Page 20, for the correct orientation of the heat sink.

7812

Apply a small amount of thermal heat sink grease to the exposed metal side of the 7812 voltage regulator before assembling the heat sink on the regulator.

Using one 6-32 x 3/8" machine screw and one 6-32 hex nut, attach the heat sink to the metal side of the 7812 voltage regulator. Do not twist or damage the leads of the voltage regulator when installing the heat sink.

Install the Heat Sink on the IRF730 transistor.

Please see Figure 1, Page 20, for the correct orientation of the heat sink.

IRF730

Apply a small amount of thermal heat sink grease to the exposed metal side of the IRF730 transistor before assembling the heat sink to the transistor.

Using one 6-32 x 3/8" machine screw and one 6-32 hex nut, attach the heat sink to the metal side of the IRF730 transistor. Do not twist or damage the leads of the voltage regulator when installing the heat sink.

CONTROLLER CIRCUIT BOARD CHECKOUT PROCEDURE

Circuit Resistance Checks.

The following resistance checks are to be made with no external connections made to the circuit board, and without any of the integrated circuits or the oscillator module plugged into the board sockets. The STW20NK50Z may be installed for these tests.

Using an Ohmmeter, measure the resistance between the + and – terminals of the +19 V Power connector. The resistance reading should be greater than 100 K Ohms. The resistance reading will be low at first when the Ohmmeter leads are connected, but as the filter capacitors charge from the Ohmmeter voltage, the resistance reading will increase.

After the resistance reading stabilizes, reverse the Ohmmeter leads and make sure the resistance in the reverse direction reads greater than 100 K Ohms.

Repeat this resistance test using the + and – HV terminals. The results should be as described above for the +19 volt resistance test.

A low or zero Ohms reading on either of these two tests indicates an incorrectly installed or shorted electrolytic capacitor, or a solder bridge between circuit board traces.

INSTALLING THE INTEGRATED CIRCUITS AND THE OSCILLATOR MODULE

Before installing the integrated circuits (IC's) into their sockets, please make sure all the pins of the IC's are straight and parallel. As supplied from the factory, the leads are slightly angled outwards from the body of the IC. This makes it difficult to plug the IC's into the sockets. Straighten the leads first, and you will reduce the chance of damaging any of the pins on the IC's when you plug them into the sockets.

Plug the integrated circuit chips (IC's) into their respective sockets. Seat them gently, but firmly. The body of the IC's should rest flat against the top of the socket.

Now it is time to plug in the oscillator module. The pins of the oscillator module are rather thin wire, and are easily bent. When the oscillator is plugged onto the socket, the oscillator will stand above the top of the socket by about 2 mm. Do NOT attempt to seat the oscillator module fully against the socket or you may break off one or more of the pins or damage the socket.

Note that the bottom flange of the oscillator module has one corner that is a right angle – the other three corners are rounded. The pointed corner marks the position of Pin 1. Note that the printed outline on the circuit board has one pointer corner. Plug the oscillator module carefully into its socket, making sure that the pointed corner of the oscillator module matches the printed outline on the circuit board.

INSERTING THE OSCILLATOR MODULE INCORRECTLY MAY CAUSE DAMAGE OR POSSIBLE DESTRUCTION OF THE OSCILLATOR MODULE WHEN POWER IS APPLIED.

Such damage is NOT covered under warranty.

Install (1) STW20NK50Z Transistor.

If you have installed the 3-pin terminal block for mounting the STW20NK50Z, simply insert the pins of the STW20NK50Z as far as they will go into the holes of the terminal block and gently but firmly tighten the clamping screws of the terminal block. Note that when you mount the SPA4 circuit board in its final location, it may be necessary to bend the pins of the STW20NK50Z in order to obtain the proper clearance of the SPA4 circuit board from the heat sink.

If you choose to solder the STW20NK50Z to the SPA4 circuit board instead of using the 3-pin terminal block, then the leads of the STW20NK50Z may have to be squeezed together slightly in order for its pins to pass through the holes in the circuit board.

When the STW20NK50Z is correctly positioned, the pins of the STW20NK50Z will be pointing through the three transistor mounting holes on the circuit board. When you look down at the Parts Side of the circuit board, you should be able to see the manufacturer's identification marking visible on the top of the STW20NK50Z.

NOTE: It will be necessary to use a suitable thermal pad between the STW20NK50Z and the heat sink. A suitable thermal pad is supplied with your SPA4 kit. This pad is our stock number PAD-4. The manufacturer is Bergquist, and their part number is SPA2000-0.015-00-104. No other thermal pad has been found which performs as well as this one. If you will be using your SPA4 at high power, then you MUST use this thermal pad.

STW20NK50Z

CONCLUSION

This completes the assembly and basic testing of the SPA4 circuit board. Further setup and tests may be done using the directions in the SPA4 Instruction Manual. If you have assembled your SPA4 correctly, it should function as detailed in the instruction manual. Should this not be so, please carefully inspect your SPA4 for the possibility of incorrectly placed components that may have occurred during assembly.

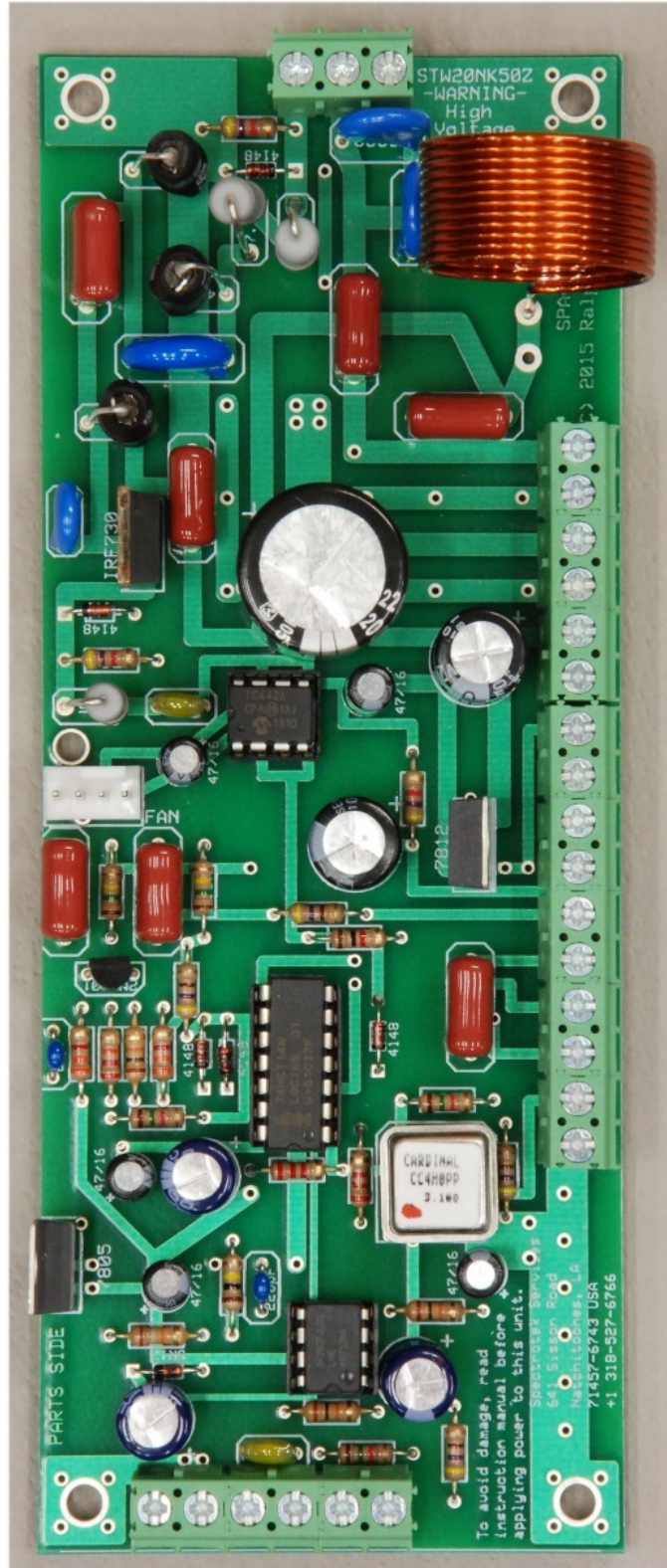


Figure 1

Assembled SPA4 V1.01, STW20NK50Z and heat sinks not installed.

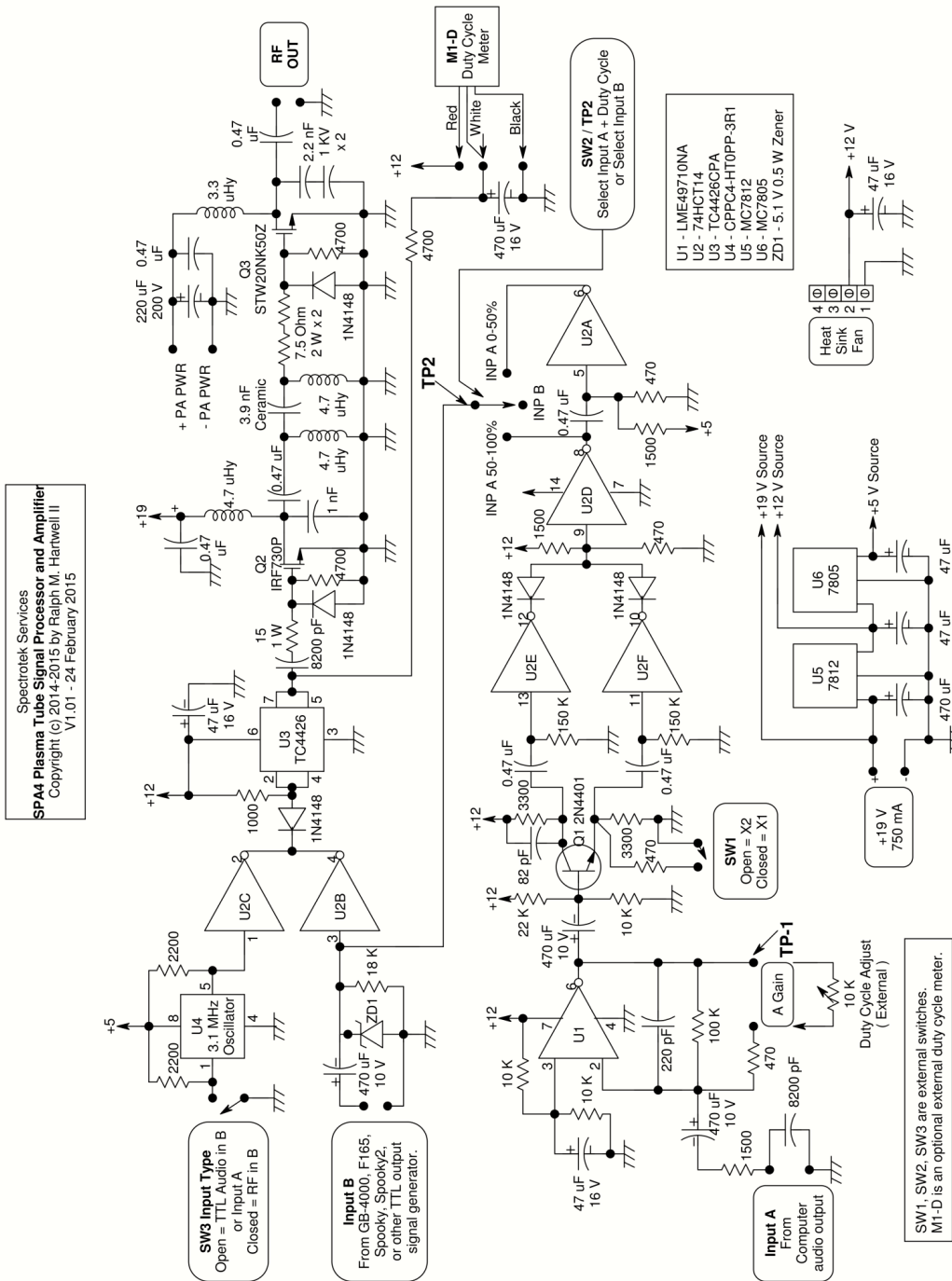


Figure 2
 Schematic Diagram of the SPA4 v1.01