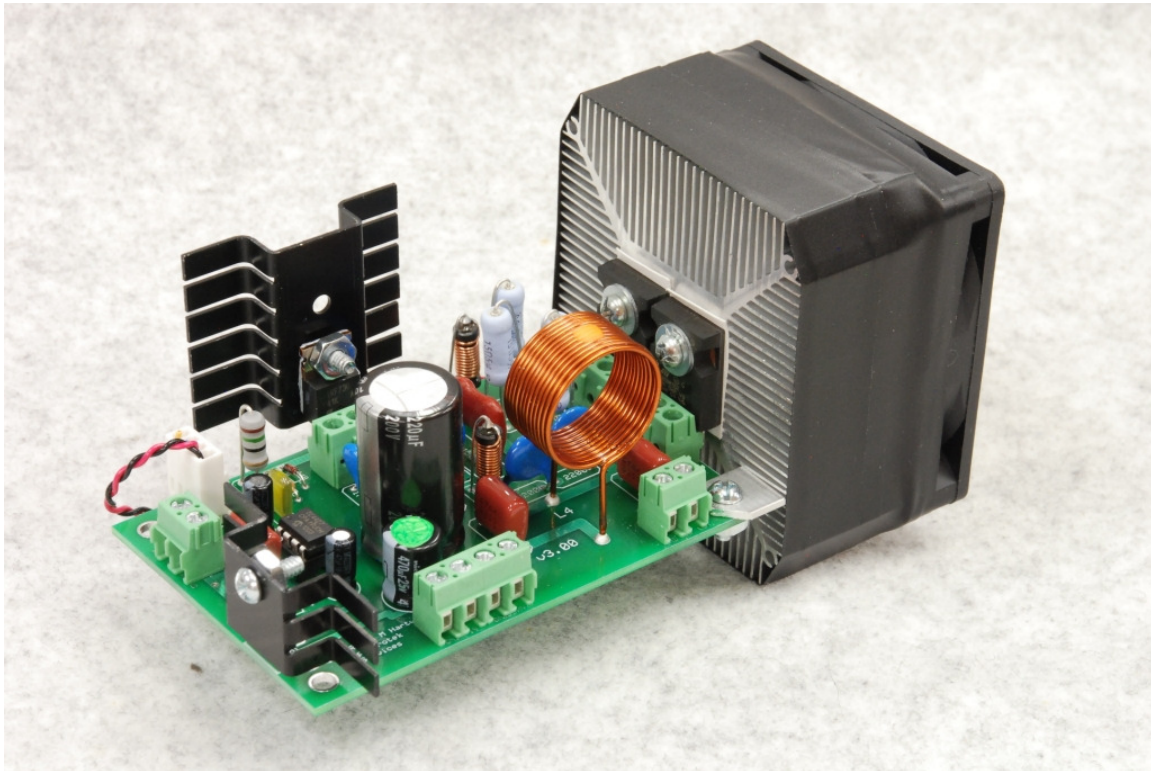


# Instruction Manual

For the

## PA2 v3.0 Plasma Tube Amplifier



18 October 2015

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## **\* LEGAL AND MEDICAL DISCLAIMER \***

Spectrotek Services and Ralph M. Hartwell ARE NOT RESPONSIBLE for any damage or injuries of any sort or form that may be sustained by any person or persons, any animal, or to any equipment or any other thing or things while anyone is using, modifying, testing, or experimenting with the SSQ-2F or the PA2 in any manner whatsoever. This device has not been inspected or approved by any governmental or medical agency or inspection service. No medical claims are made for, nor implied by, the sale or use of this device. Using the PA2 is done solely at your own risk.

You are advised to always consult with your physician or other health care professional at any time should you have or think you might have a health problem of some sort. Please check with your physician or other health care professional before starting any diet, exercise, taking over-the-counter (OTC) medications or supplements and especially before taking any prescribed medication. Never stop taking any prescribed medications without first consulting your physician.

## **RADIO FREQUENCY WARNING NOTICE**

- The PA2 is a high-frequency switch mode power supply module designed to furnish a square wave modulated high voltage alternating current at a frequency of approximately 3.1 MHz across 50 ohms load impedance.
- If the PA2 is installed incorrectly or used improperly, it is capable of causing severe radio frequency interference. To prevent this from occurring, observed the following warnings:
- The PA2 is to be used as a research device only, or as part of a complete system to drive a plasma tube.
- The PA2 is not intended to be used for any form of radio transmission in any manner whatsoever.
- The PA2 is not intended to be connected to an antenna or to any radiating element or to be used for any form of radio communications purposes in any manner whatsoever.
- The PA2 is designed solely to be a source of power to light a plasma tube.
- All electrical connections to the output terminals of the PA2 are to be made by the use of properly shielded 50-ohm coaxial cable capable of handling at least 500 watts at 3.1 MHz.
- All connections are to be made in such a manner as to minimize any RF radiation from the connecting wires to the PA2.
- The PA2 has been specifically designed to be driven by a low-level signal that is generated by the SSQ-2F v1.41 circuit board or any commercial frequency generator such as the GB-4000 that is capable of producing a square wave modulated 3.1 MHz sine wave carrier signal with a peak-to-peak amplitude of 6 volts.
- The operating frequency range of the PA2 has been restricted to a 1 MHz portion of the spectrum centered at 3.1 MHz.
- Any attempt to drive the PA2 with a radio frequency source such as a CB radio transmitter, will result in immediate destruction of the PA2.

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## **A note about the definition of the word POWER as used in this document.**

In this document, unless otherwise specified, when the word "**power**" is used it will mean **peak power**. For example, with a 50% duty cycle, 300 Watts peak power is the equivalent of 150 Watts **average power**. Likewise, with a 100% duty cycle, 300-Watts peak power is equivalent of 300-Watts **average power**.

## **What does the PA2 do?**

The PA2 is designed to increase the power output of the SSQ-2F v1.41 or any other suitable frequency generator to a level as high as 500 Watts peak or average power for driving larger plasma tubes.

The PA2 can also be driven by any low-power, square wave modulated, 3.1 MHz RF source. The RF drive signal to the PA2 amplifier may be either a TTL level (0 to +5V) or a sine wave with peak-to-peak amplitude of 7 to 10 volts. Some commercial frequency/function generators, such as the GB-4000, will also supply the correct signal to drive the PA2.

## **What type of amplifier is the PA2?**

The PA2 is not a conventional RF power amplifier, and it cannot be used as such. It is a switching mode amplifier, and is inherently non-linear with respect to the amplitude of the input signal. It will not accept an RF drive signal from a conventional transmitter, such as a CB radio. The PA2 is actually a high-frequency switch-mode power supply designed to convert DC power into semi-square wave pulses of energy at 3.1 MHz and at a high voltage.

The PA2 has been designed so that its output matches standard 50-ohm load impedance, making it possible to connect the output of the PA2 to a conventional antenna tuner or to the type LC31 link coil coupler.

## **How much power can I get from the PA2?**

When used with the HS2 heat sink and fan assembly, the power output of the PA2 may be up to 500 Watts peak or average power when using up to 100% duty cycle modulation.

For most large plasma tubes, 300 Watts peak power is sufficient to properly drive the tube. Operation at higher power levels may cause overheating and possible damage to your plasma tube. Please consult with your plasma tube manufacturer to determine the correct power level for your plasma tube.

## **What range of frequencies does the PA2 accept?**

The PA2 will operate across the range of 2 to 4 MHz. Operation outside this frequency range may cause serious damage to the PA2. The optimum operating frequency is 3.1 MHz.

**Please refer to the chart shown in Figure 7 for the maximum allowable DC voltage to be used with the PA2 for various frequency ranges.**

Note that the output efficiency of the amplifier will degrade somewhat as the operational frequency departs from 3.10 MHz. This will result in slightly lower RF power output from the amplifier

## **I am uncomfortable soldering wires to circuit boards. What do I do?**

All connections to the PA2 are made using screw terminals, so no soldering is required.

## **How can I power the PA2?**

The output amplifier section of the PA2 may be powered from any power supply that has an output voltage of 50 to 190 V DC. The maximum current required is approximately 4 amperes, although normal power levels required for plasma tubes will usually require lower DC current levels.

A smaller power supply with a voltage of 20 volts DC at a maximum current of 2 Amperes is required to operate the signal processor circuits and to provide DC power for the heat sink cooling fan.

For best results when operating the PA2, the power supply should be both voltage and current regulated. It is advisable to install a fast operating 4 ampere fast blow fuse in the positive voltage line.



## CONNECTIONS:

All connections to the PA2 are made by using the small screw terminals that are located in the plastic terminal blocks mounted on the edges of the circuit board. These will accept either solid or stranded wires.

When tightening the screws, do not over tighten the screws to avoid damaging the connector. Just strip approximately 1/4 inch / 6 mm of insulation off the end of each wire and insert it into the hole in the terminal block, then gently tighten the screw to clamp the wire in place.

The following diagram (Figure 1) shows the relative position of the various connectors on the PA2. They have been color coded in Figure 1 for ease of identification. Note that the terminal blocks on the PA2 will usually all be the same color, blue or green.

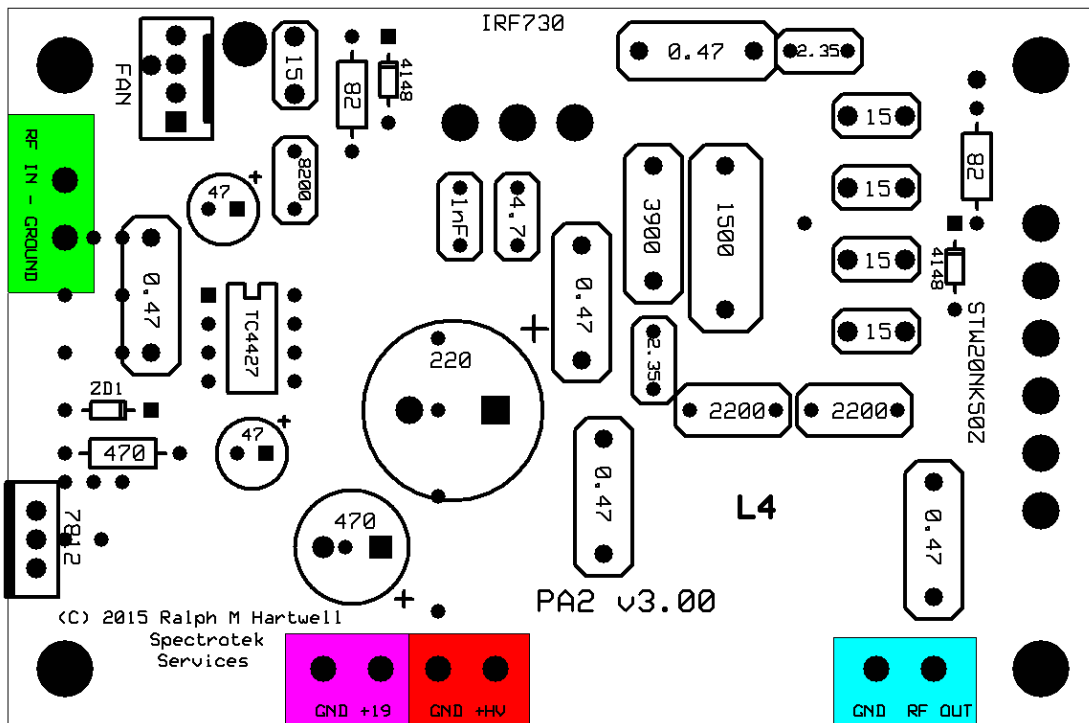


Figure 1

PA2 Terminal block identification as viewed from the component (top) side of the board.

**Please refer to Figure 1 for the location of the following connections.**

**( GND +HV )**

This terminal block is used to connect DC power to the output amplifier stage of the PA2. The left connection is power supply negative, and the right connection is power supply positive.

*The power supply output voltage MUST be isolated from the AC mains for safety.*

**( GND +19 )**

This terminal block is used to connect a source of +19 volts DC power to the signal processor stages of the PA2 and also to provide regulated +12 volts for the heat sink cooling fan. The left connection is power supply negative, and the right connection is power supply positive. Voltages between +18 and +22 may be used.

Note that the GROUND terminal next to the RF OUT connection, the GROUND terminal next to the +HV connection, the GROUND terminal next to the +19 terminal are all connected together and serve as the ground / earth connection for the PA2.

**( RF IN - GROUND )**

This terminal block accepts the drive signal from the signal source, which may be an SSQ-2F v1.41, a GB-4000, or a similar frequency generator. You should use a length of standard coaxial cable to make this connection.

The right connection is the coaxial cable shield, and the left connection is RF drive or coaxial cable center connection.

The characteristic impedance of the coaxial cable is not critical, and either 50 or 75-Ohm coaxial cable may be used. Cable lengths of up to 39 inches / 1 meter in length may be used. The total capacitance of the coaxial cable should be more than 30 pF but less than 100 pF for best signal quality. Using RG-58 coaxial cable with a 1-meter length will result in optimum signal wave shape.

Connect the cable shield to the LEFT terminal of the RF IN terminal block. This is the ground / earth connection.

Connect the center wire of the coaxial cable to the RIGHT terminal of the RF IN terminal block. This is the RF input connection.

## ( RF OUT )

This terminal block is the RF output of the PA2. Connection to this terminal block requires the use of shielded 50-ohm impedance, solid dielectric (not foam) coaxial cable between the terminal block of the PA2 and the matching system that will be connected to the plasma tube.

Connect the shield side of the coaxial cable to the left connection of the RF OUT terminal block.

Connect the center wire of the coaxial cable to the right connection of the RF OUT terminal block.

## Mounting the PA2 and the HS2 Heat Sink / Cooling Fan Assembly

If you have purchased an assembled PA2 amplifier, it will be furnished mounted on the HS2 heat sink / cooling fan assembly. The HS2 heat sink provides the proper cooling to allow the PA2 to operate at full rated power. Please be sure that nothing obstructs the flow of cooling air entering the fan or the warm discharge air leaving the heat sink.

Note that the hot air from the heat sink is exhausted away from the cooling fan and not blown over the PA2 circuit board.

When the PA2 is mounted on the HS2 heat sink, the result is a compact module that allows for easy incorporation of the PA2 into a complete plasma tube RF drive system. If you are using the SSQ-2F v1.41 as a signal source for the PA2, then both the PA2 and the SSQ-2F v1.41 may be mounted in the same enclosure or on the same metal mounting plate.

The HS2 heat sink with the PA2 attached to it may be mounted in place in your system by the use of a clamp, a bracket, or some type of strap that will hold the heat sink assembly firmly in place. It is important that the airflow through the heat sink not be obstructed in any manner. A plentiful supply of cool air must be allowed to enter the fan and the heat sink assembly. Likewise, the warm exhaust air must be allowed to freely exit the area of the heat sink.

### **VERY IMPORTANT !!**

**If the unit is placed in an enclosure, it is advisable to mount the air exhaust side of the fan directly against an opening in the enclosure so that the hot air from the PA2 can be dumped directly outside the enclosure. An unrestricted intake opening must be placed somewhere in the wall of the enclosure to let cool air enter the enclosure. The size of the cool air opening must be equal to or larger than the opening for the hot air outlet. Any restriction of the cooling air entering the heat sink assembly will result in overheating of the PA2 amplifier with possible failure.**

## **The Cooling Fan on the HS2**

The fan on the HS2 heat sink is powered by the PA2 circuit board, so there is no need for a separate power supply to operate the fan.

The PA2 v3.0 has a reverse air flow heat sink-fan assembly along with a heat sink cover which directs cooling air directly through the heat sink and fan. The fan incorporates built-in thermostatic fan speed control. As the heat sink warms up, the fan speed will increase as necessary to maintain a safe operating temperature for the amplifier.

The fan is very quiet and does not make much noise. It is easy to forget that it is running while you are working with your system. Please be careful not to allow your fingers or anything else to come in contact with the fan blades while the fan is in operation. Accidentally hitting the fan blades with your finger or a hard object such as a screwdriver may break one of the blades off of the fan hub. If this happens, it will be necessary to replace the fan.

## **RF Shielding Considerations to Prevent Interference to Other Devices**

If the RF output of the PA2 is taken through a properly installed and terminated coaxial cable, the incidental RF leakage from the PA2 will be minimal and no interference to radios or television receivers should occur due to radiation from the PA2 itself.

The most likely cause of electrical interference to other devices will occur from the radiation from the plasma tube and from the connecting wires between the plasma tube and the 3.1 MHz link coil coupler or the antenna tuner. It is important to minimize the length of these connecting wires. These wires should be equal in length, and spaced as close together as possible consistent with the physical requirements of the plasma tube. Placing the wires close together helps to cancel unwanted RF radiation from the wires.

*In most jurisdictions, it is the responsibility of the operator of any radio frequency producing equipment to prevent the equipment from producing interference to other users of the radio frequency spectrum or other electronic equipment. Please be aware of local regulations before operating this equipment.*

## **Electrically Insulating the STW20NK50Z from the heat sink**

*This section only applies when it is necessary to replace the output transistors on the PA2.*

Because the STW20NK50Z generates a considerable amount of heat in a small package, a high quality thermal pad is required for safe operation of the STW20NK50Z.

The STW20NK50Z is operating at both a high DC voltage and a high RF voltage, therefore it is necessary to insert some form of electrical insulator (thermal pad) between the STW20NK50Z and the heat sink base plate. This insulator must be made of some material which both insulates the high voltage and at the same time it must be a good conductor for heat to allow the heat to flow from the STW20NK50Z to the heat sink base plate. Unfortunately, most materials which are good insulators for electricity are also good insulators for heat. Manufacturers have gone to a

great deal of trouble and expense to produce devices, commonly referred to as "thermal pads" which will function properly.

The Bergquist SPA2000-0.015-00-104 thermal pad is recommended for use with the PA2. If this pad is not available, a Wakefield 174-9-250P thermal pad may be substituted. However, the heat transfer capability of the Wakefield pad is approximately 50% of the Bergquist pad. Therefore when using the Wakefield thermal pad, the PA2 should not be operated above 300 Watts output with modulation duty cycles above 70%.

Before clamping the STW20NK50Z and the Bergquist thermal pad to the heat sink, use a liquid cleaning solution, such as 100% isopropyl alcohol and a lint free rag to carefully clean the underside of the STW20NK50Z and the area of the heat sink where the STW20NK50Z is to be mounted. Make sure that both sides of the thermal pad are very clean. Be sure that there are no stray particles of metal, lint, fiber, or other materials on the surface of the transistor, the thermal pad, or the heat sink before mounting the STW20NK50Z to the heat sink.

**When installing the thermal pad do NOT use any paste type thermal compound.** Using paste type thermal compound will cause decreased heat transfer and may cause damage to the thermal pad and/or destruction of the STW20NK50Z.

## **Operation of the PA2**

### **RF Input to the PA2**

#### **SQ-2F v1.41**

When connecting the RF drive signal from your SSQ-2F v1.41 frequency generator to the RF input of the PA2, an 18 inch / 46 cm to 39 inch / 1 meter length of 50-ohm coaxial cable should be used. Type RG-58 cable is recommended.

#### **GB-4000**

When connecting the RF drive signal from your GB-4000 frequency generator to the RF input of the PA2, a one-meter length of 50-ohm coaxial cable should be used. If desired, this cable may be lengthened to a distance of 20 feet should it be necessary to operate the GB4000 at some distance from the PA2. Type RG-58 cable is recommended for convenience.

### **POWER SUPPLY**

To use the PA2, you will need to use a power supply that provides a DC voltage between +50 to +190 volts, depending on the output power level you require. The higher the voltage, the more power output from the PA2. The current required is approximately 4 amperes maximum. The exact current drawn by the PA2 will depend upon the modulation duty cycle and the plasma tube load to which the PA2 is connected. The current is also affected by the tuning of the antenna tuner or the 3.1 MHz link coil coupler.

When using the PA2 and the LC31 link coupler to drive the Cheb 8 inch Phanotron plasma tube, a power supply voltage of between 100 and 130 V will be required.

When using the PA2 and the LC31 link coupler to drive the Cheb 1" x 16" SSQ-PT plasma tube, a power supply voltage of between 50 and 80 V will be required.

### **POWER ADJUSTMENT**

The power output from the PA2 is adjusted by varying the DC supply voltage connected to the +HV terminal block.

#### **WARNING!**

*Do not attempt to adjust the output for the PA2 by changing the drive level from the SSQ-2F v3.10. Doing so will cause overheating and damage to the STW20NK50Z. Only change the power level of the PA2 by varying the DC power supply voltage of the PA2.*

# Using the PA2 With The GB-4000

Please make the following settings using the buttons on the front panel of the GB-4000 before operating the PA2. These settings should not be changed when running frequencies and sets. The GATE settings may be adjusted as required.

**SINE / SQUARE = set to SQUARE**

**RF / AUDIO = set to RF MODE**

**DUTY CYCLE ("." Button) = set to 50%**

**+ / % MOD = set to 100**

Adjust the RF GAIN knob to somewhere between the 9 and 10 o'clock position.

**CAUTION:** Do not turn the RF GAIN knob above the 11 o'clock position, or the output waveform will be distorted. This may damage the PA2 when it is running at high power levels.

## RF Coupling Systems

### The LC31P or the LC31S 3.1 MHz Link Coupler System

Using the LC31 coupler eliminates most of the RF losses of the antenna tuner and gives the RF signal at the plasma tube a sharper rise and fall time, resulting in a better, brighter plasma discharge and a more effective frequency output.

Using the LC31 coupler is simple. Simply connect a 23-foot length of solid dielectric 50-ohm coaxial cable between the output of the PA2 amplifier, and the input to the LC31 coupler. Connect the appropriate length of wire between the output of the LC31 coupler and the plasma tube. Then turn on the power. There are no tuning adjustments required.

Please see the LC31 instruction manual for more information on using the LC31 3.1 MHz link coil coupler.

## Commercial Antenna Tuners

*The use of commercial antenna tuners with the PA2 is strongly discouraged. The PA2 was designed to work best with the LC31 link coil coupler. While it is possible to use a commercial antenna tuner with the PA2, because of the large number of tuners available, it is impossible to give specific instructions for using each tuner. Therefore, the information presented below is only for general information, and should not to be considered as specific instructions for using a commercial antenna tuner with the PA2.*

*If you are attempting to use a commercial antenna tuner, you should begin your initial tune up with a DC supply voltage to the PA2 of no more than 75 to 90 V to prevent damage to the PA2 during the tuning process. After you have achieved a reasonable impedance match with the tuner, you may increase the DC voltage while simultaneously adjusting the settings on the tuner to compensate for the difference in impedance of the tube as the power level is increased.*

## **Tuning Waveforms if you are Using an Antenna Tuner or Have Built Your own Matching System**

If you have an oscilloscope available, then the best way to tune the matching circuit between the PA2 and the plasma tube is to observe the waveform at the drain of the STW20NK50Z MOSFET.

*Please be careful what taking these measurements!*

*When operating at high power levels, the voltage existing at the drain terminal of the STW20NK50Z may exceed 500 Volts RF along with a steady DC voltage of up to 190 V.*

The following pictures show the RF waveforms at the RF output of the PA2. They are taken at the RF OUT terminal block. For these pictures, the PA2 was connected to either a 50-ohm dummy load or to a plasma tube through the 3.1 MHz link coupler.



Figure 2

PA2 output waveform across a 50-ohm load.

This is also what the waveform looks like when the PA2 is properly tuned and connected to a plasma tube. Note that the upper part of the right-hand side of the waveform slopes slightly to the left. This is correct, and indicates the proper amount of tuning capacitance in the coupling system.



If the waveform slopes to the right, then the tuning capacitance is too low. It is better to operate with too much capacitance, then too little.

***CAUTION!***

**Operating the PA2 at high power levels when the system is tuned with too low a value of tuning capacitance will result in the STW20NK50Z drawing excessive drain current. This may cause the STW20NK50Z to fail due to overheating.**

**Operating the PA2 a high power levels with the system is tuned with too large a value of tuning capacitance will result in the drain voltage of the STW20NK50Z rising to excessively high levels. This may cause the STW20NK50Z to fail due to over voltage.**

The next two pictures show what the waveform looks like when the coupling system has too low a value of tuning capacitance.

**CAUTION!**

**Operating the PA2 at high power in this tuning condition may destroy the STW20NK50Z.**



Figure 3

This photograph shows the waveform from the PA2 when the tuning capacitor of the matching system is too low. In other words, the system is tuned too high in frequency. **Operating the PA2 at high power in this tuning condition may destroy the STW20NK50Z.**



Figure 4

This photograph shows waveform from the PA2 when the tuning capacitor of the matching system is too low. In this case, the system is much closer to resonance, but it is still tuned too high in frequency. Additional tuning capacity must be added or the STW20NK50Z may fail during high power operation. **Operating the PA2 at high power in this tuning condition may destroy the STW20NK50Z.**

## Replacing the STW20NK50Z on the PA2

NOTE – It is necessary to use a pair of matched STW20NK50Z MOSFETs when replacing damaged transistors in the PA2.

Although the STW20NK50Z MOSFETs used in the PA2 are very rugged devices, it is still possible for them to fail if the PA2 is operated under an excessive load or under improper operating conditions. Should this happen, it will be necessary to replace both of the STW20NK50Z MOSFETs with a new matched pair for best performance. This is not particularly difficult to do. Please read the following sequence of operations before attempting to replace the transistor.

1 – Using a small flat-blade screwdriver, carefully loosen the six clamping screws in the terminal strip that fastens the leads of the STW20NK50Z MOSFETs in place.

2 – Remove the two 6-32 x 3/8” Phillips head screws and nuts that hold the PA2 to aluminum mounting bars that are attached to the heat sink. Place the screws and nuts where they will not become lost.

3 – Carefully remove the PA2 from the heat sink assembly.

4 – Using a Phillips head or a flat-blade screwdriver, unscrew the 6-32 x 3/4” screws and flat washers that clamp the STW20NK50Z MOSFETs against their heat sink. Place the screws and flat washers where they will not become lost.

5 – Carefully remove the defective STW20NK50Z MOSFETs from the heat sink.

Because the MOSFETs may stick to the Bergquist thermal pads that are between the MOSFETs and the heat sink, you may have to use a pair of pliers to carefully pull the defective MOSFETs away from the thermal pad. Be sure not to damage the thermal pad. It is very soft, and scratches or punctures easily. If it is damaged in any way, it will be necessary to replace it with a new thermal pad of the same type before installing the new MOSFETs against the heat sink.

6 – Take the new STW20NK50Z MOSFETs and carefully bend their leads into the same shape as the leads of the defective MOSFET.

Do not bend them too sharply or they may weaken and break off at the bend.

7 – Carefully trim approximately 1.5 mm from the end of the pins of each MOSFET. Be careful not to remove too much of the pin length.

8 – Using a small piece of lint free cloth and 100% isopropyl alcohol, gently clean the surface of the Bergquist thermal pad and the metal surface of the STW20NK50Z MOSFET that will mount against the thermal pad.

9 – Carefully position the replacement MOSFETs against the surface of the thermal pad, and press it firmly against the thermal pad.

10 – Using the 6-32 screw and the flat washer, clamp the new MOSFET firmly against the Bergquist thermal pad and heat sink. Do not allow the MOSFET and the thermal pad to twist sideways while tightening the screw.

Although it may seem that the length of the 6-32 screw is a longer than it needs to be, it is necessary to use a long screw in order to spread the clamping force across a number of screw threads that are tapped in the heat sink. The screw must be tightened very firmly against the transistor. The flat washer must be used to spread the clamping force over the transistor body and prevent cracking of the transistor case.

11 – Carefully position the PA2 circuit board so that the leads of the new STW20NK50Zs enter the holes of the mounting block on the PA2. Be sure that you do not bend the leads of the STW20NK50Zs in the process.

12 - When you observe that the leads have entered the mounting block correctly, then you may replace the two Phillips head screws and nuts that clamp the PA2 circuit board to the aluminum mounting bars that are attached to the heat sink.

13 – Gently, but firmly, tighten the six clamp screws that hold the leads of the STW20NK50Zs to the PA2 circuit board. ***Do not omit this step or the MOSFETs may be destroyed during operation!***

14 – Inspect your work to make sure that there are no short circuits, metal particles, or anything else that might interfere with the proper operation of the PA2. If all is correct, you may replace the heat sink assembly and the PA2 in your system and resume normal operation.

# SPECIFICATIONS:

## DC Power Supply Input:

- For the Power Amplifier: +15 to +190 volts DC at a maximum current of 4.0 amperes; nominal operating current less than 2.1 amperes, depending on output power level and modulation duty cycle.
- For the Signal Processor and heat sink fan: +18 to +22 volts DC at a maximum current of 2 mA at a 100% duty cycle modulation rate.

## Input Impedance:

- Approximately 1000 Ohms.

## Input Drive Signal Requirements:

- TTL level (0 to +5 volts) 3.1 MHz square wave square wave duty cycle modulated. Drive signal may be provided by a SSQ-2F v1.41.
- Sine wave 3.1 MHz signal, 7 to 10 volts peak-to-peak, square wave duty cycle modulated. May be provided by a GB-4000 or similar frequency generator.

## Carrier Operating Frequency:

- 2.0 to 4.0 MHz. Operation outside of this frequency range may cause damage to the PA2. Suggested operating frequency 3.1 or 3.3 MHz.
- **Please see Figure 7 for allowable DC voltage vs. operating frequency.**

## RF Power Output:

- Up to 500 watts peak or average power as measured across a 50-ohm load when the carrier is modulated by a square wave with a duty cycle between 1 to 100%.
- The power output of the PA2 is adjusted by varying the DC voltage supplied to the PA2.

## Physical:

- Overall Dimensions: Length, 150 mm, width, 80 mm, height, 80 mm.
- Weight, 352 grams.
- Airflow: Exhaust hot air vented away from the circuit board.

## **Warranty**

All our products carry a one (1) year warranty against manufacturing defects. Mechanical damage is not covered; i.e., you dropped it on the floor and then accidentally stepped on it. For warranty claims, you pay shipping to us; we pay shipping back to you.

Kits assembled by the purchaser are also have a one (1) year against component failure. Breakage or overheating damage from soldering of components during assembly is not covered under warranty.

Damage to the STW20NK50Z MOSFET transistor due to over voltage operation or inadequate cooling is not covered under warranty.

For all warranty claims or equipment service, please contact us by email or telephone before returning equipment for service.

Out-of-Warranty repair service is at the rate of \$20/hour, with a maximum charge of \$50 per item, unless otherwise specified. Please contact us for additional pricing on custom repair services.

## **Contact us**

Ralph Hartwell

Spectrotek Services

641 Sisson Road  
Natchitoches, LA  
71457-6743  
USA

318-527-6766

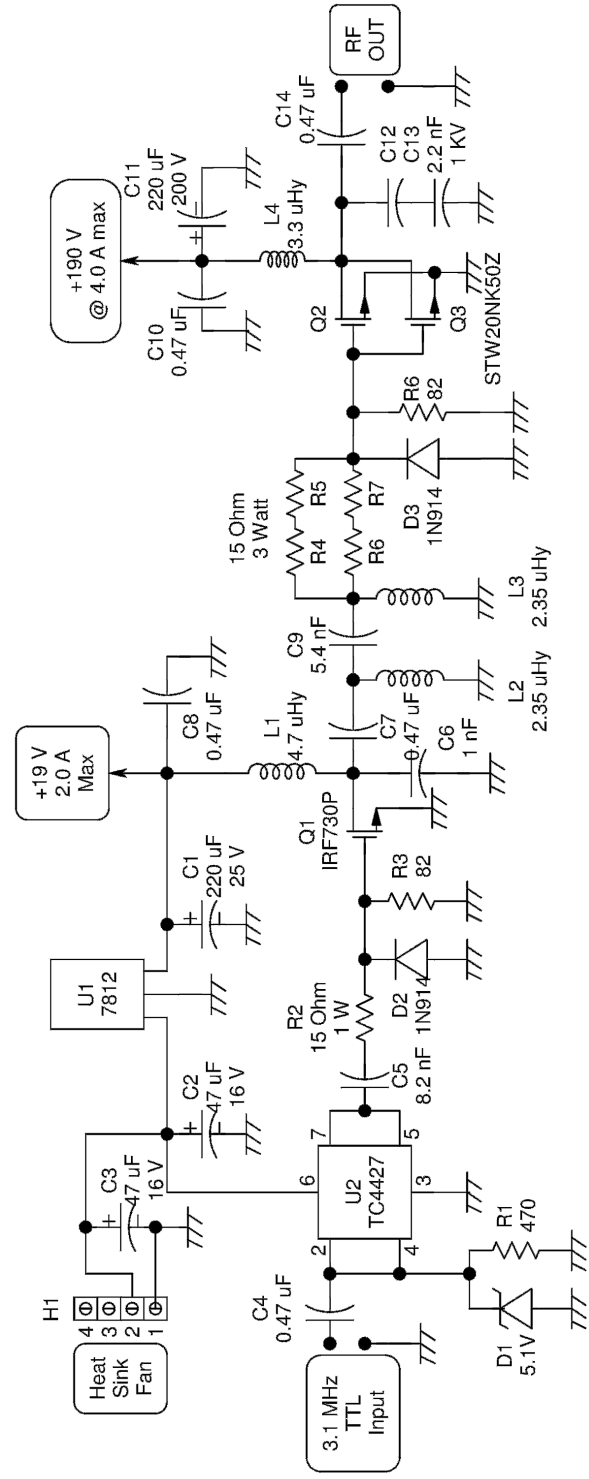
ralph@spectrotek.com

<http://rife-beam-ray.com>

<http://rifebeamray.com>

<http://w5jgv.com/rife>

**PA2 v3.0 - TTL Input 3.1 MHz RF Power Amplifier**  
 For Rife Beam Ray with 3.1 MHz Carrier  
 Copyright (c) 2012 by Ralph M. Hartwell II  
 18 October 2015



500 Watts peak power  
 500 Watts average power  
 @ 50 Ohms.  
 Maximum Drain voltage  
 190 VDC at 4.00 A  
 with a 100%  
 Modulation duty cycle.

NOTES:  
 - Each STW20NK50Z must be mounted on a common heat sink capable of dissipating 125 watts at full power.  
 - Each STW20NK50Z must be insulated from the heat sink with a Bergquist SFA2000-0.015-00-104 Thermal Pad.  
 - The IRF730P and MC7812 each require a small heat sink.  
 - If it is mounted on a grounded heat sink, the IRF730P must be insulated from the heat sink with a Wakefield Thermal Solutions 175-6-280P Thermal Pad.  
 - L3 is a 3.3 uH air core coil. Do not use a ferrite core as it will slow the rise time of the waveform.

Figure 5  
**Schematic Diagram of the PA2 v3.0.**

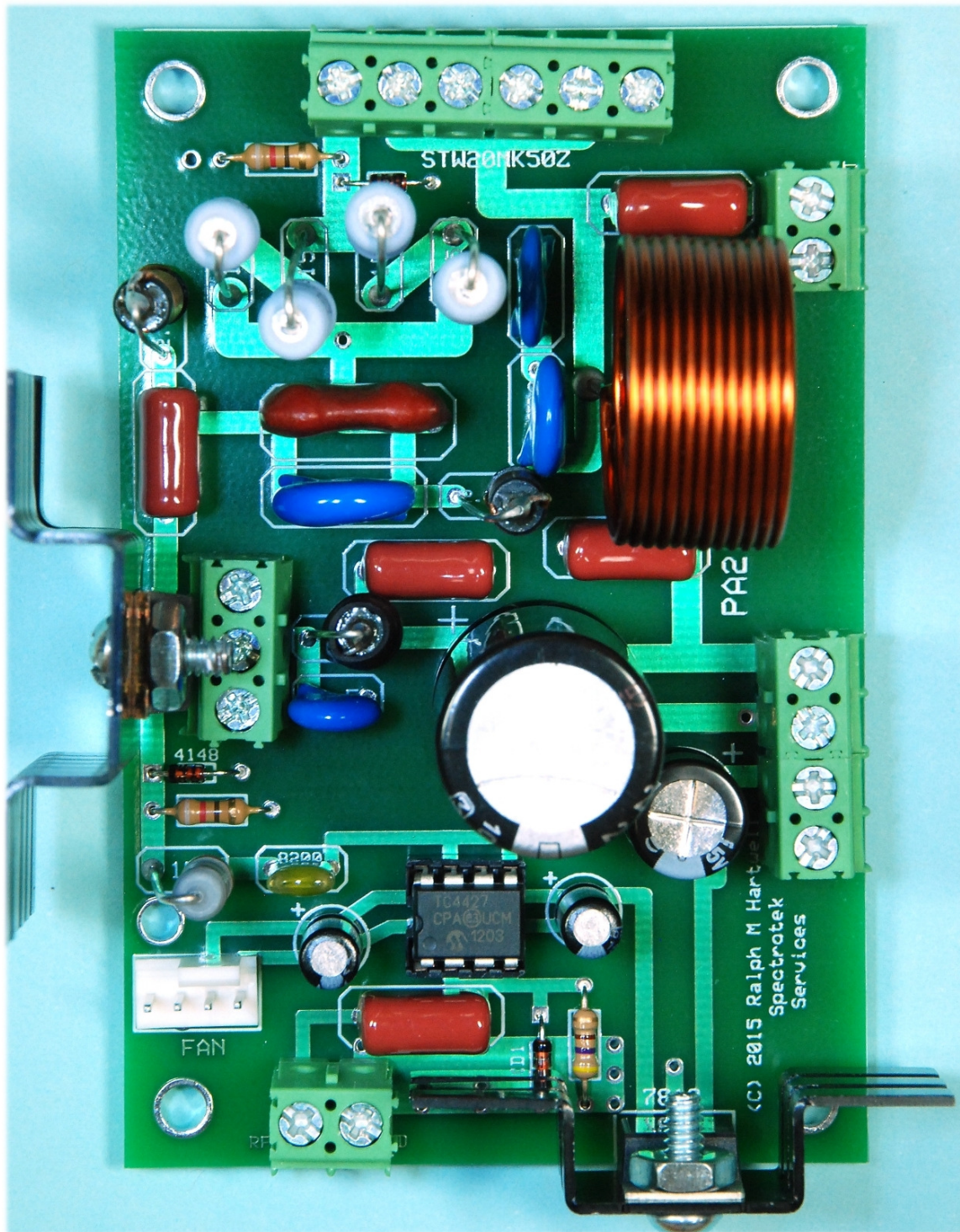


Figure 6

**Component Locations – PA2 v3.0**



| <b>Freq, MHz</b> | <b>Max Allowable DC Volts</b> |
|------------------|-------------------------------|
| 4.0 - 3.0        | 190                           |
| 2.9              | 183                           |
| 2.8              | 180                           |
| 2.7              | 179                           |
| 2.6              | 176                           |
| 2.5              | 175                           |
| 2.4              | 173                           |
| 2.3              | 173                           |
| 2.2              | 172                           |
| 2.1              | 170                           |
| 2.0              | 167                           |

Figure 7

**Allowable DC Voltage for the PA2 v3.0 vs. Frequency**



Edited by CAT