

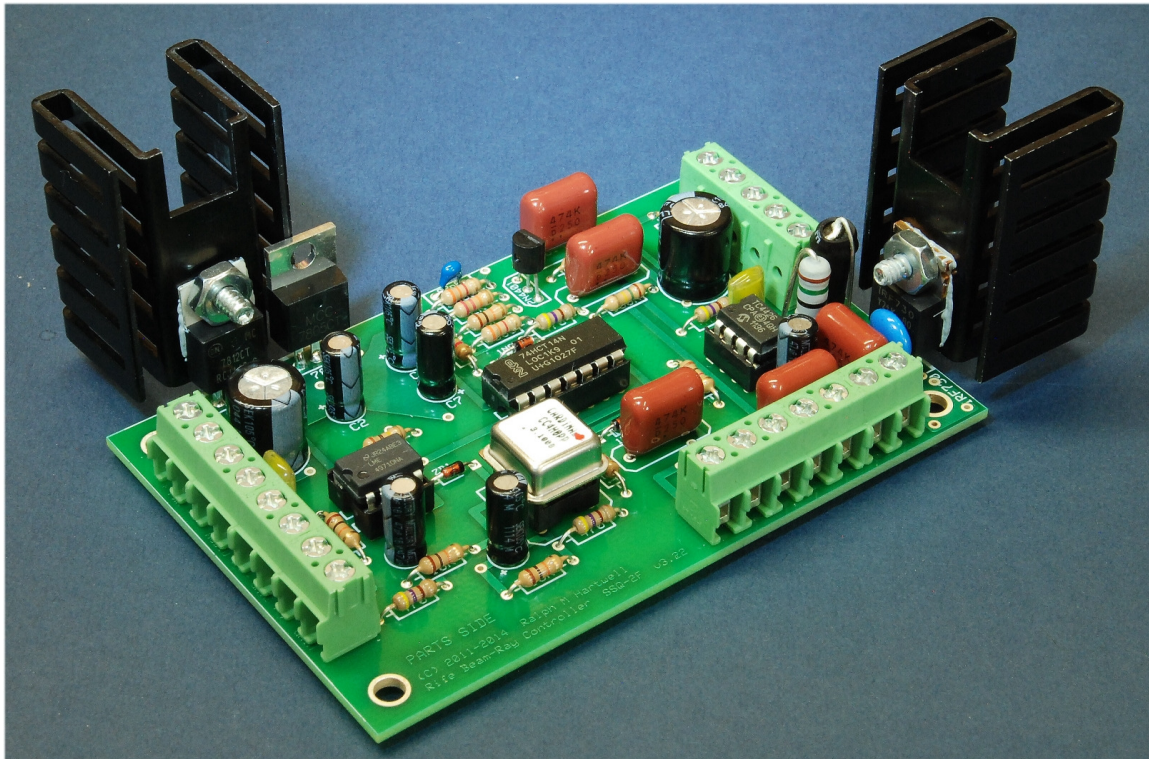
# Assembly Instructions

For the

**SSQ-2F**

**3.1 MHz Rife Controller Board Kit**

V3.22



Manual v1.03

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## 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 used to soldering such items, it is suggested that you seek assistance from an experienced person before starting assembly.

The circuit board of the SSQ-2F has been designed with ruggedness in mind. Extra-wide and thick copper traces have been used on the SSQ-2F. Because of this, the SSQ-2F 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 SSQ-2F.

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 700° F. The tip should be a small conical point.
- Solder, 60/40, 63/37, or 62/36/2 grade, no larger in diameter than 0.032". Rosin core flux only. Suitable types are Radio Shack 64-013 and 64-009.

***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 SSQ-2F 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 transistor (Q1 – 2N4401) 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, because using pliers 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 SSQ-2F 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 following sequence allows you to “build up” from the surface of the board, making it easier to install the rest of the components as you assemble your SSQ-2F.

If you look at the blank circuit board, you will see above the copyright notice, there is a label marked “Parts Side” on the front of the board, and “Solder Side” on the reverse of the board. 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.

Notice that the parts side of the board has outline drawings of all the components, as well as either their part number, (C1, OSC, TC4426) or their value, (1500 [Ohms], 8200 [pF], 0.47 [uF]), making it easy to identify where the various components should 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 the photograph of the complete SSQ-2F in the back of this manual for help in locating the position of the components.

For each assembly step, locate the listed component, and identify where on the circuit board it will be placed. If necessary, bend the leads of the component to fit, and carefully insert the leads through the board. Carefully tug 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 OK.

After inserting the component, bend the free ends of the component’s leads at 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. Assembling the components in sequence helps to prevent assembly errors.

## Installing the Components on the SSQ-2F Circuit Board

*NOTE: References to the “top of the circuit board” means that you are looking at the circuit board so that the copyright notice and the board name are viewed right-side-up, and the 7812 and 7805 regulator modules are at the top left of the circuit board.*

### Install ( 4 ) 1N4148 diodes

( )

( )

( )

( )

### Install ( 1 ) 5.1 V Zener diode

( ) 5.1

### Install ( 21 ) Resistors

( ) 82 Ohm ( Gray Red Black ) **Install at the orange paint mark next to L1.**

( ) 470 Ohm ( Yellow Violet Brown )

( ) 470 Ohm ( Yellow Violet Brown )

( ) 470 Ohm ( Yellow Violet Brown )

( ) 470 Ohm ( Yellow Violet Brown )

**NOTE: Install the next resistor AFTER the terminal strips have been installed.**

( ) 470 Ohm ( Yellow Violet Brown ) **Install between terminals AUDIO – and AUDIO + on the solder side of the circuit board.**

( ) 1000 Ohm ( Brown Black Red )

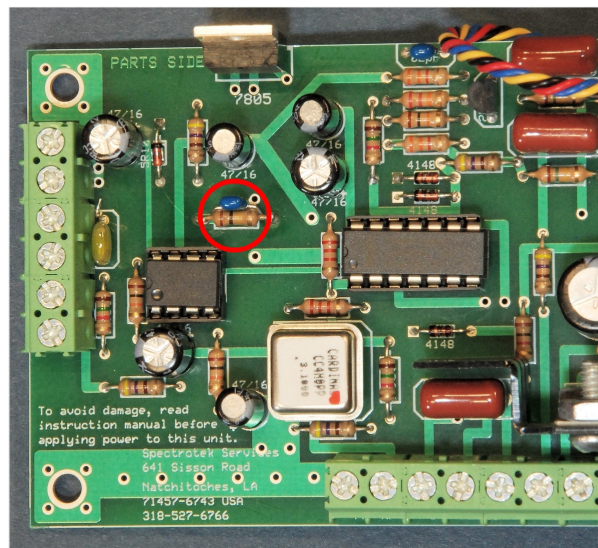
( ) 1500 Ohm ( Brown Green Red )

( ) 1500 Ohm ( Brown Green Red )

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

At this point in the assembly of your SSQ-2F, you must install a 220 pF disc capacitor across the 100 K ohm resistor you have previously installed. Please see Figure 1 (below) for the position of the capacitor.

**( Install 220 pF Capacitor across the 100 K Ohm resistor – see Figure 1. )**



**Figure 1**

**Position of the added 220 pF capacitor.**

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

- ( ) 150 K Ohm ( Brown Green Yellow )
- ( ) 150 K Ohm ( Brown Green Yellow )

**Install IC sockets at these locations, but do NOT insert the IC's themselves 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.

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.

- ( ) LME49710 ( 8-pin socket )
- ( ) OSC ( 8-pin socket )
- ( ) TC4426 ( 8-pin socket )
- ( ) 74HCT14 ( 14-pin socket )

**Install a 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 two 0.047 capacitors that are to the right of the 2N4401 transistor.

- ( )

**Install ( 2 ) 8200 pF film capacitors**

- ( )
- ( )

**Install a 220 uF 35 Volt electrolytic capacitor at location C1**

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.

( ) C1

### **Install a 470 uF 16 Volt electrolytic capacitor at location C8**

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.

( ) C8

### **Install ( 2 ) 470 uF 10 Volt electrolytic capacitors.**

The two capacitors circled in RED are placed on the circuit board according to the polarity markings on 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.

( ) C5

( ) C7

### **Install ( 4 ) 47 uF 16 Volt electrolytic capacitors at these locations:**

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.

( ) C2

( ) C3

C4

C6

**Install (1 ) 82 pF capacitor at this location:**

82 pF

## **TERMINAL BLOCK INSTALLATION**

When installing the two and three position terminal blocks, be sure to install the terminal blocks so that the wire holes are facing the 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.

Using four of the two pin terminal blocks, assemble them together to make one continuous eight position terminal block.

Install an assembled eight position terminal block so that it covers these locations:

PWR

AUDIO IN

GATE

GAIN

Using one of the two pin terminal blocks and one of the three pin terminal blocks, assemble them together to make one continuous five position terminal block.

Install the assembled five position terminal block so that it covers these locations:

S1-X1/X2

MTR

Using two of the two pin terminal blocks and one of the three pin terminal blocks, assemble them together to make one continuous seven position terminal block.



Place the three position terminal block so that it is to the left end of the assembled terminal block when you are holding the terminal block so that the wire holes are facing you and the solder pins are facing down.

Install an assembled seven position terminal block so that it covers these locations:

( ) 0-SW2-100

( ) PA PWR

( ) RF OUT

**Install a 1000 pF capacitor at location:**

( ) 1000

**Install a 15 Ohm, 2 Watt resistor at location:**

Bend one of the resistor's leads all the way down against the body of the resistor so that both leads point in the same direction.

Install the resistor so the SHORTER lead is passing through the hole in the 15 position that is closest to the S1-X1/X2 terminal block position.

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 the 7812 voltage regulator at location:**

Make sure the metal side of the voltage regulator faces away from the circuit board.

( ) 7812

**Install the 7805 voltage regulator at location:**

Make sure the metal side of the voltage regulator faces away from the circuit board.

( ) 7805

**Install the IRF730 transistor at location:**

Make sure the metal side of the voltage regulator faces away from the circuit board.

( ) IRF730

**Install a 4.7 uHy inductor at location:**

Note: Bend one of the inductor's leads all the way down flat against the body of the inductor so that both leads point in the same direction.

Install the inductor so the LONGER lead is passing through the hole in the L1 position that is closest to the S1-X1/X2 terminal block position.

( ) L1

**Install ( 5 ) 0.47 uF capacitors**

( ) 0.47

( ) 0.47

( ) 0.47

( ) 0.47

( ) 0.47

**Install the "Gull-Wing" Heat Sink on the 7812 voltage 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.

The use of thermal compound, a.k.a., "heat sink grease," is optional due to the low power dissipation of the 7812 regulator and the large size of the heat sink.

If the DC supply voltage to the SSQ-2F will never exceed 18 volts, and the SSQ-2F is not in a tightly sealed case, then the heat sink may be omitted if desired. If you are not sure if the heat sink will be needed, then install it to be safe.

## **Install the “M-Shaped” Heat Sink on the IRF730 transistor.**

( )

The use of heat sink grease is required due to the high power dissipation of the IRF730 transistor and the relatively small size of the heat sink.

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.

## **FINAL INSPECTION**

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 SSQ-2F.

Should you wish to remove the solder flux residue from the finished circuit board, you may use a commercial flux remover, 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 assembly of the SSQ-2F circuit board.

## **CONTROLLER CIRCUIT BOARD CHECKOUT PROCEDURE**

NOTE – When referring to components such as terminal blocks on the Controller Circuit Board, the board is viewed from the component side of the board, turned so that the two voltage regulators are at the upper left corner of the circuit board.

## 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.

Using an Ohmmeter, measure the resistance between the + and – terminals of the 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.

## INSTALLING THE INTEGRATED CIRCUITS AND THE 3.1 or 3.3 MHz 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 against the top of the socket. Due to the tight component spacing in the vicinity of U3, TC4426, it is difficult to insert or remove U3 with your fingers. It may be necessary to use a pair of needle nose pliers to carefully hold U3 during installation.

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 it 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 DESTRUCTION OF THE OSCILLATOR MODULE WHEN POWER IS APPLIED.**

Such damage is NOT covered under warranty.

## BEFORE APPLYING POWER

Proper testing of the SSQ-2F V3.22 requires the use of two DC power supplies. The one providing power to the RF amplifier section of the SSQ-2F must have an adjustable output voltage. The power supply for the SSQ-2F logic circuits may be either a fixed-voltage power supply or an adjustable voltage power supply.

Connect the power for the SSQ-2F logic circuits to the terminal block marker “+PWR-.” It is suggested that you use a current-limited “wall-wart” type of power supply, as there is less chance of catastrophic damage to the controller board should an accident occur.

The DC supply voltage must be within the range of +15 to +30 volts DC, reasonably filtered, although it does not need to be well regulated. The maximum current required by the SSQ-2F logic circuits is 0.1 Ampere, or 100 Milliamperes. If the cooling fan for the PA1 amplifier is connected to the SSQ-2F circuit board, then the current drain will increase to approximately 0.25 Amperes, or 250 Milliamperes.

The power supply for the RF amplifier section of the SSQ-2F must be adjustable over the range of +18 to +70 volts DC, with a maximum output current of 1.2 Amperes or 1200 Milliamperes.

## TEST PREPARATION SETUP

Connect a jumper between the right and center pins of the “0-SW2-100” terminal block. This jumper enables normal operation of the frequency doubler circuitry and sets the SSQ-2F to operate in the 0-50% duty cycle mode.

Connect a jumper between the two terminals of the “GAIN” terminal block. This sets the gain of the input amplifier to minimum.

Connect the probe of your oscilloscope between ground and either the top lead of the 15-Ohm, 2-Watt resistor located next to U3, TC4426, or to Pin 5 or 7 of U3. This will allow you to monitor the RF drive signal to the gate of the IRF730 MOSFET. You will be able to see changes in the modulation duty cycle as testing proceeds.

Do NOT connect any power to the PA PWR terminal block at this time.

Connect the duty cycle meter type M1-D to the terminal block marked “MTR.” The negative ground wire from the meter (black wire) connects to the **center** connection of the MTR terminal block. The duty cycle signal wire from the meter (white wire) connects to the **left** connection of the MTR terminal block. The meter power supply wire (red wire) should be connected to the **right** connection of the MTR terminal block.

***CAUTION: Connecting the black or the white wire to the power connection will destroy the meter.***

If you do not have a duty cycle meter M1-D, you may use a DC voltmeter, set to read at least +10 volts full scale. If you are using a high impedance voltmeter instead of duty cycle meter M1-D, then you should connect a 2200-Ohm resistor across the MTR terminal block connections to allow proper meter response time while making duty cycle adjustments.

## **AUDIO INPUT**

Connect a variable level audio source to the AUDIO IN terminal block. The “hot” lead goes to the right side connection of the terminal block, and the “return” lead goes to the left side connection of the terminal block.

Set the audio frequency to 6 KHz and the audio signal level to zero.

**Please do not exceed the maximum allowable input audio level voltage of + or - 12 volts peak to prevent damage to audio input amplifier U1. The audio signal may be offset by a maximum level of +6 or –6 volts DC without damaging input amplifier U1.**

**The SSQ-2F will ignore any DC offsets, as long as they are constant. A varying DC offset voltage will be interpreted by the SSQ-2F as a change in the audio input level and will result in a change in the modulation duty cycle.**

You will need an audio signal source somewhere between 40 to 7,200 mV peak to peak. The audio signal must not change in amplitude as the frequency of the audio signal changes. Most computer sound cards will meet this requirement. Some CD and DVD players will not, but this can usually be remedied by placing a load resistor across the audio output of the CD or DVD player. The required resistance value will usually be within the range of 10 to 100 ohms.

In order to adjust the duty cycle of the modulated RF square wave output, it is necessary to be able to adjust the amplitude of the audio signal being sent to the SSQ-2F, either by adjusting the level at the source or by using potentiometer R2 which should be connected to the GAIN terminal block of the SSQ-2F.

If you wish to use a fixed resistance instead of a potentiometer to set the gain of the SSQ-2F, the following resistance values may be used as a starting point:

Resistance	Peak to Peak Volts for 50% Duty Cycle
0 Ohms (jumper)	7.2 V / 7,200 mV
470 Ohms	3.8 V / 3,800 mV
4,700 Ohms	0.75 V / 750 mV
10,000 Ohms	0.375 V / 375 mV

## AUDIO AND LOGIC CIRCUIT TESTING

Observe that the duty cycle meter reads zero. The oscilloscope trace should be a flat line.

Slowly increase the level of the audio signal until the duty cycle meter starts to read upscale. This may require an audio signal level of up to 10 volts. As the audio signal is increased in amplitude, the duty cycle meter reading will suddenly jump to about 40%. At that point, the frequency doubling function of the SSQ-2F has become active.

Adjust the audio level so that the meter reads close to 50%. (Duty cycle meter calibration is discussed in the Operating manual for the SSQ02F V3.22.)

Observe the oscilloscope screen. You will see a series of square wave pulses that go from zero to +12 volts. These square waves will be at a rate of 12 KHz, which is twice the 6 KHz audio input frequency. The duty cycle of the square waves will be close to a 50% on-to-off ratio, as shown on the oscilloscope display and the duty cycle meter.

Each positive going half of the square wave is composed of a series of 50% duty cycle square waves which occur at the RF carrier frequency rate of 3.1 or 3.3 MHz, depending on your chosen U4 oscillator module..

Varying the audio input level to the SSQ-2F circuit board will change the duty cycle of the 12 KHz modulating signal. It is possible to adjust the duty cycle of the modulating square wave from roughly 40% ON to 100% ON.

Connect a jumper wire between the connections of the S1-X1/X2 terminal block. This takes the SSQ-2F out of the frequency doubling mode.

Note that the 12 KHz modulating square wave has now become 6 KHz, which is the same frequency as the input audio frequency signal. You may have to slightly reduce the amplitude of the audio input signal to obtain the 50% duty cycle signal.

Now, move the jumper to the left and center connections on the 0-SW2-100 terminal block. This sets the SSQ-2F to operate in the 0-50% duty cycle mode.

Adjusting the audio input level now adjusts the duty cycle of the modulating square wave from roughly 40% ON to 0% ON.

Remove the jumper from the connections of the GAIN terminal block. Note that the audio level required to drive the SSQ-2F has greatly decreased. Removing the jumper has set the gain of the audio circuits of the SSQ-2F to maximum.

## RF AMPLIFIER TESTS

Connect a 50-watt, 50-Ohm RF dummy load resistor across the terminals of the “RF OUT” terminal block.

Connect the adjustable voltage DC power supply to the PA PWR terminal block. Do not turn the power supply on at this time.

Connect the probe of your oscilloscope across the 50-Ohm dummy load resistor and ground. This will allow you to monitor the RF output of the amplifier stage.

Adjust the audio input signal level to the SSQ-2F so that a 50% duty cycle reading is obtained on the duty cycle meter M1-D.

Turn on the PA power supply and adjust the output of the power supply to a voltage of 18 volts.

### **WARNING !**

**When using supply voltages above 24 volts, forced air-cooling of the RF amplifier heat sink must be used to prevent destruction of the IRF730.**

**The case temperature of the MOSFET should not be allowed to exceed 70 degrees Celsius.**

The oscilloscope should show an RF carrier that is 50% duty cycle modulated at either the input audio frequency rate or twice the rate, depending on the setting of the S1-X1/X2 jumper.

With a DC power supply voltage of 18 volts, the amplitude of this signal should be about 45 volts peak-to-peak.

With a DC power supply voltage of 24 volts, the amplitude of this signal should be about 60 volts peak-to-peak.

With a DC power supply voltage of 36 volts, the amplitude of this signal should be about 90 volts peak-to-peak.

With a DC power supply voltage of 48 volts, the amplitude of this signal should be about 120 volts peak-to-peak.

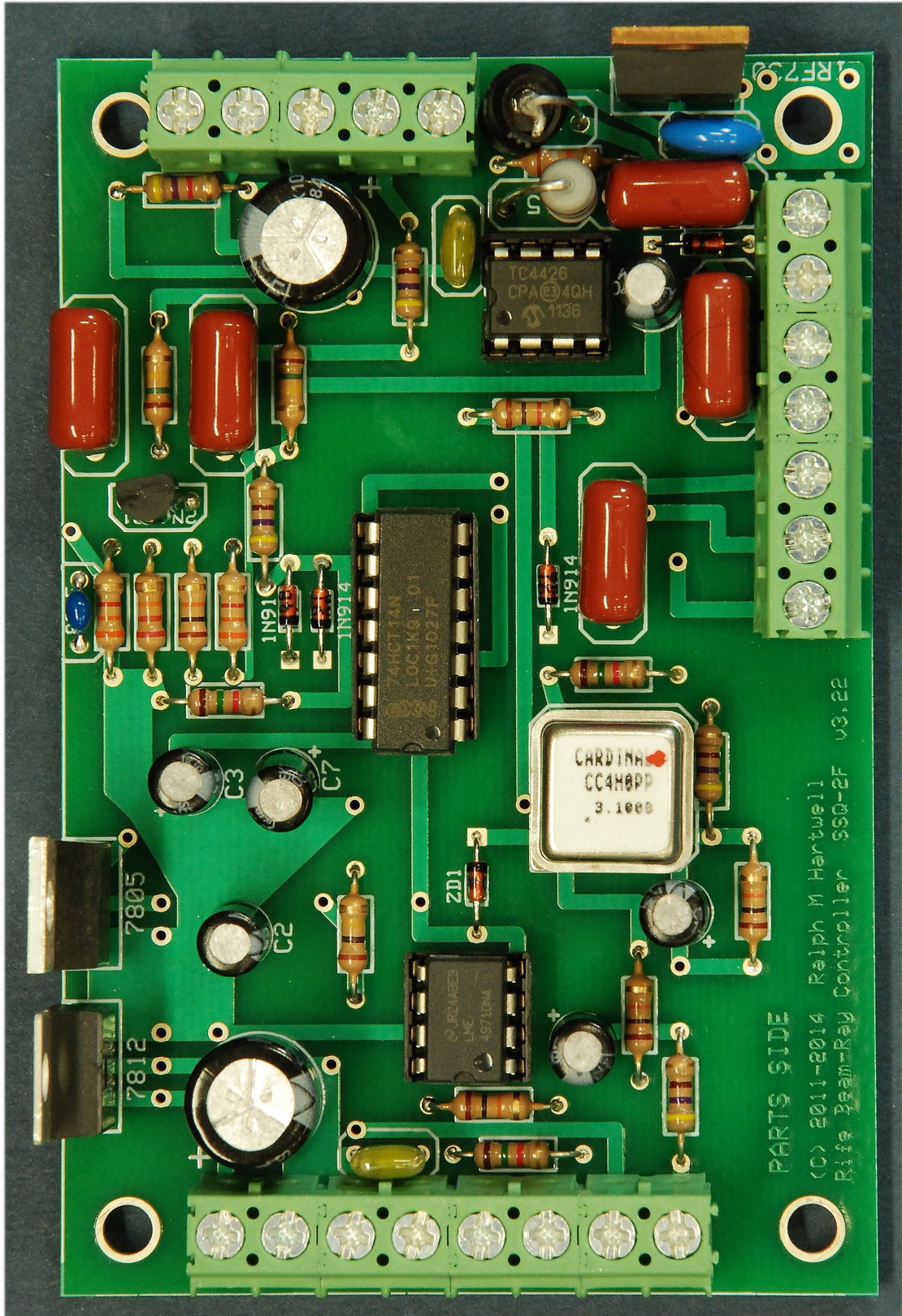
With a DC power supply voltage of 60 volts, the amplitude of this signal should be about 150 volts peak-to-peak.



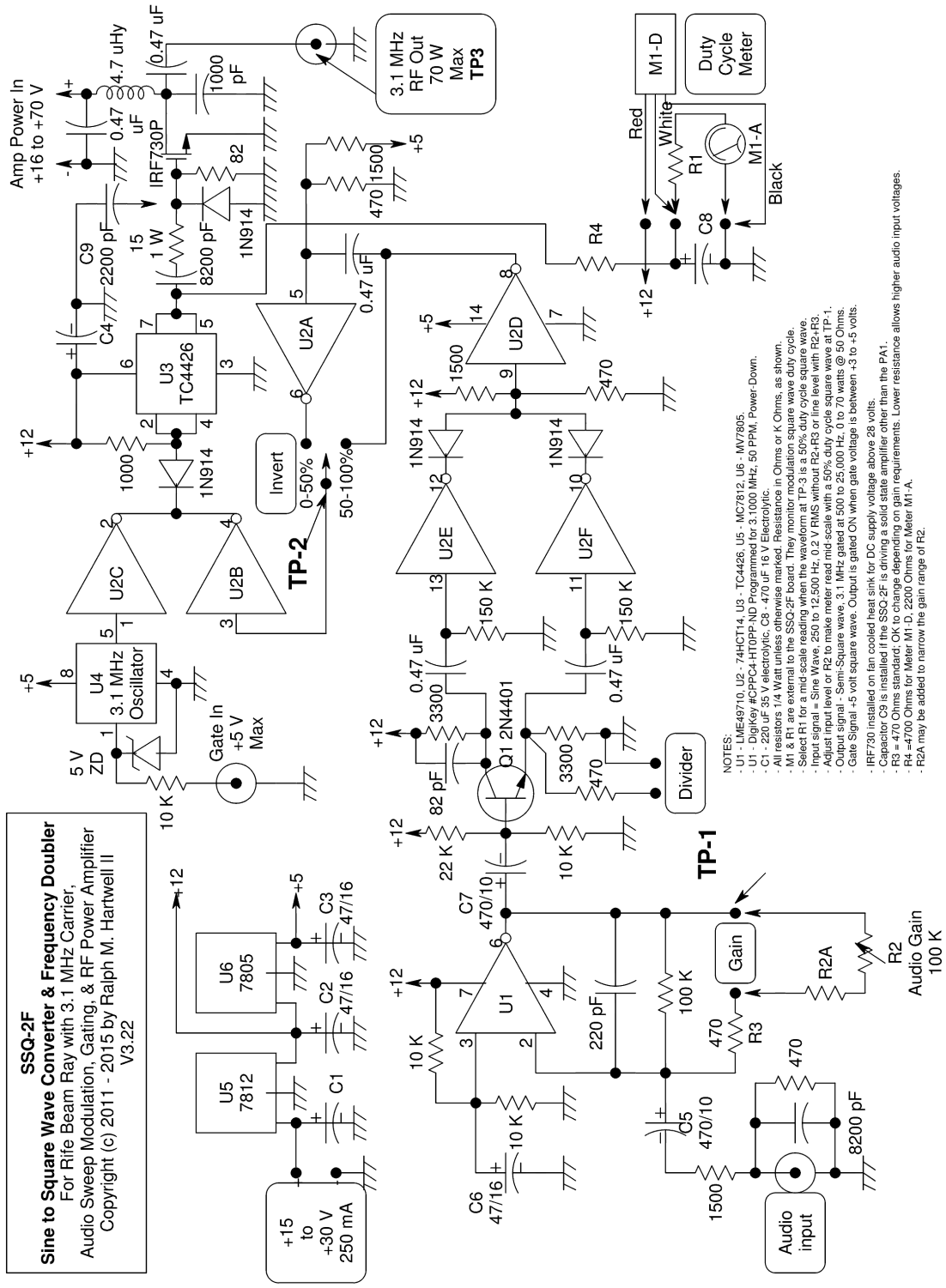
With a DC power supply voltage of 70 volts, the amplitude of this signal should be about 170 volts peak-to-peak.

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This completes the testing of the SSQ-2F. Please consult the Instruction Manual for the SSQ-2F for routine operating instructions.



Assembled SSQ-2F V3.22, less 220 pF capacitor.



Schematic Diagram of the SSQ-2F V3.22