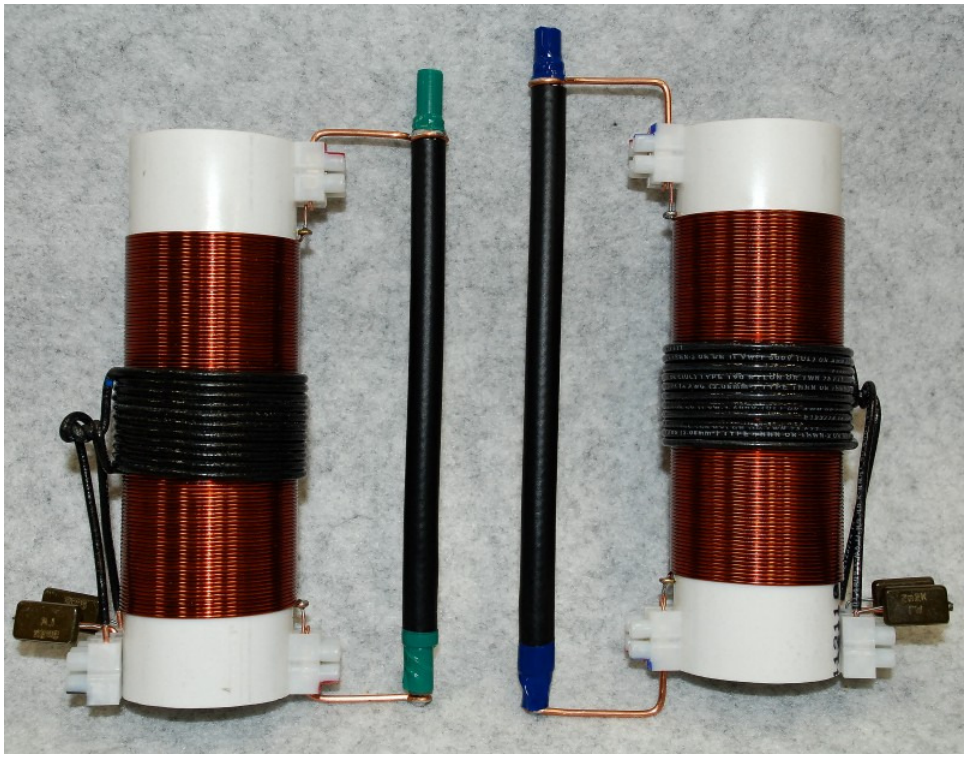
Instruction Manual

For the

LC31 Link Coupler for Plasma Tube Systems



Manual v3.00 – 27 December 2014

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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

- If the LC31 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 LC31 is to be used as a research device only, or as part of a complete system to drive a plasma tube.

- The LC31 is not intended to be used for any form of radio transmission in any manner whatsoever.

- The LC31 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.

- All electrical connections to the input terminals of the LC31 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 LC31, particularly from the wires connecting to the plasma tube.

- The LC31 has been specifically designed to be accept RF power from the SSQ-2F v3.nn, the PA1, PA2, PA3, or SPA4.

- The operating frequency range of the LC31 should be restricted to a one MHz portion of the spectrum centered at 3.1 MHz.

- Avoid physical contact with the LC31 during operation. Very high RF voltages are developed on the secondary coil during operation. Painful RF burns may result from accidental contact with exposed wires.

Index and Table of Contents

What does the LC31 do?

The LC31 is designed to provide an effective means of transferring RF energy from the SSQ-2F v3.10 or the PA1 amplifier to a Cheb 8 inch Phanotron tube or a Cheb SSQ-PT plasma tube. Due to the design of the LC31 the fast rise and fall times of the square wave modulated RF signal are sent to the plasma tube. Commercial antenna tuners will often distort the envelope of the RF signal. The LC31 avoids this distortion.

May I use a different plasma tube with my LC31?

Yes, but some adjustment of the tuning capacitors on the LC31 may be required when using the LC31 with a different plasma tube. Other plasma tubes may be used by changing the TC-series coaxial tuning capacitor to the correct value for the new plasma tube. Note that "LC31" refers only to the coil assembly of the coupler system. The complete LC31(n) coupler is supplied with the correct TC-series coaxial tuning capacitor for the plasma tube to be used with the coupler. So, LC31P or LC31S would be a complete LC31coupler with a TCP or TCS capacitor installed.

What type of amplifier may be used with the LC31?

The LC31 coupler may be used with the SSQ-2F v3.(nn), the PA1, PA2, PA3, and the SPA4. Other RF amplifiers are not recommended due to the coupling characteristics of the LC31 and the driving amplifier.

What makes up a typical Rife Plasma system?

This block diagram shows the setup of a typical Rife-type system.

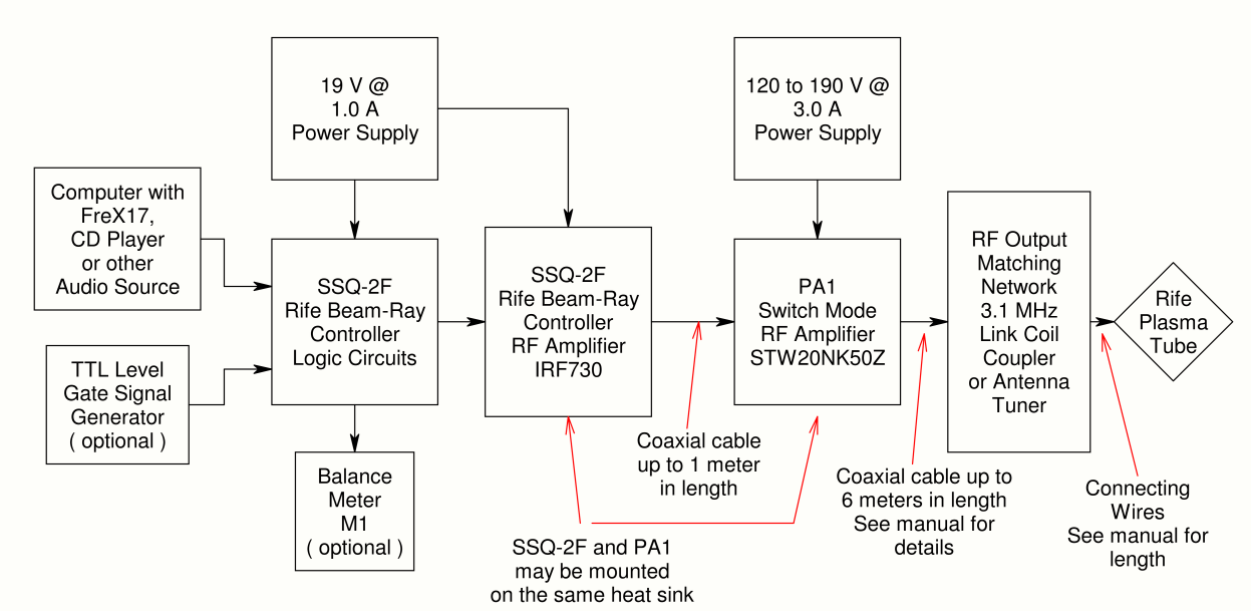

Figure 1

Block diagram of a typical Rife plasma system using the SSQ-2F v3.10, the PA1, and the LC31.

CONNECTIONS to the LC31:

NOTE: The coupler for the Cheb SSQ-BAT plasma tube does not have jumper selectable input link tuning capacitors as is shown in the following pictures. The supplied jumper wire must be installed during normal operation. Removal of the link wire will cause amplifier failure.

All connections to the LC31 are made by using the eight screw terminals that are located in the three plastic terminal blocks that are mounted on the ends of the LC31 coil assembly. These terminals will accept either solid or stranded conductor wire. Stranded wire is preferred for its flexibility when making connections between the LC31 and the plasma tube.

A four-position terminal block is used for the RF input. Two other two-position terminal blocks are used for connecting the RF output from the LC31 to the plasma tube and the TC coaxial tuning capacitor.

When tightening the clamping screws in the terminal blocks, do not over tighten the screws to avoid damaging the connector. To connect the wires, strip approximately 3/8 inch / 9 mm of insulation off of the end of each wire and insert it the bare wire into the hole in the terminal block. Gently, but firmly, tighten the clamping screw to fasten the wire in place.

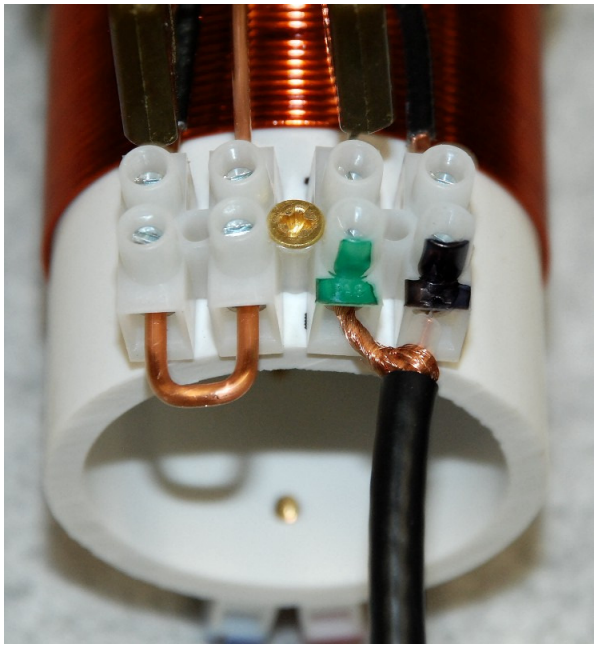

Figure 2

LC31 RF Input Terminal Block

To make the connection between the SSQ-2F v3.10 or the PA1, you will need a 50 ohm coaxial cable with a length of 19 to 25 feet / 5.8 to 7.65 meters. Note that a length of 23 feet / 7 meters is recommended. One end of this cable will be connected to the RF output terminals of the SSQ-2F

v3.nn, PA1, PA2, PA3, or SPA4. The other end of this cable will be connected to the input of the LC 31 coupler system.

Suitable types of coaxial cable are solid dielectric insulation RG-58/U, and RG-213. Coaxial cables with an impedance of 75 ohms should not be used as they will cause mistuning and damage to the RF amplifier.

When connecting the coaxial cable to the LC31, the center wire of the coaxial cable should be connected to the BLACK terminal block. The shield braid of the coaxial cable should be connected to the GREEN terminal block.

Figure 2 (above) shows a small copper wire "U" shaped jumper that is connected between the two WHITE terminal blocks. This jumper must be installed if the LC 31 coupler is being used with the Cheb SSQ-PT plasma tube. It should be removed when the LC 31 coupler is being used with a Cheb 8 inch Phanotron, the SSQ-ST or the SSQ-BAT plasma tubes.

The purpose of this jumper when it is installed is to bypass one of the 2200 pF link tuning capacitors. This capacitor varies the resonant frequency of the link coil on the LC31 coupler and adjusts the loading on the RF amplifier. This allows for proper transfer of the RF power from the RF amplifier to the plasma tube.

INPUT TERMINAL BLOCK CONNECTION OPTIONS

This section of the LC31 manual shows you the proper input terminal block connections for selecting the three input link series tuning capacitors. The three combinations available using the link are, two, one, or no series link tuning capacitors.

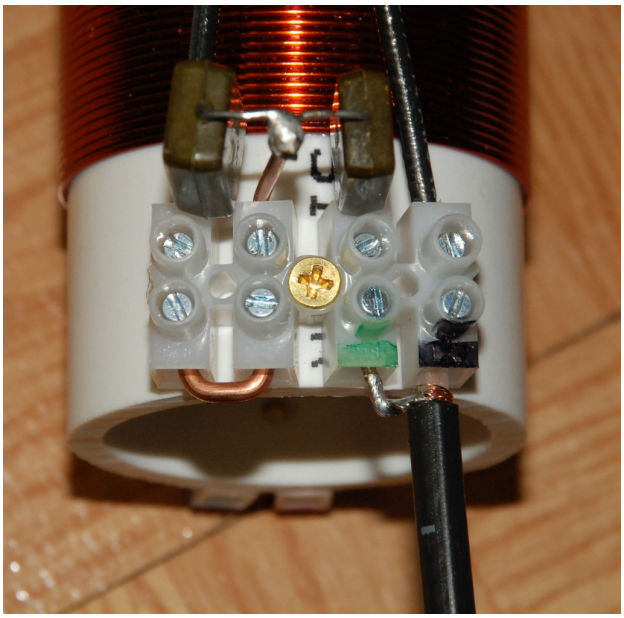

Figure 3

One series link tuning capacitor in use.
This is the jumper position when using the Cheb 1" x 16" SSQ-PT plasma tube.

With the copper wire jumper link installed between the two white terminal connections, only one tuning capacitor is in use. The total effective series link tuning capacity in this configuration is 2200 pF.

Please refer to the section entitled: **"Coaxial cable length, series link tuning capacitor and TCS/TCP coaxial capacitor data for the 3.1 MHz link coil coupler"** further on in this manual for more information on when this connection option is to be used.

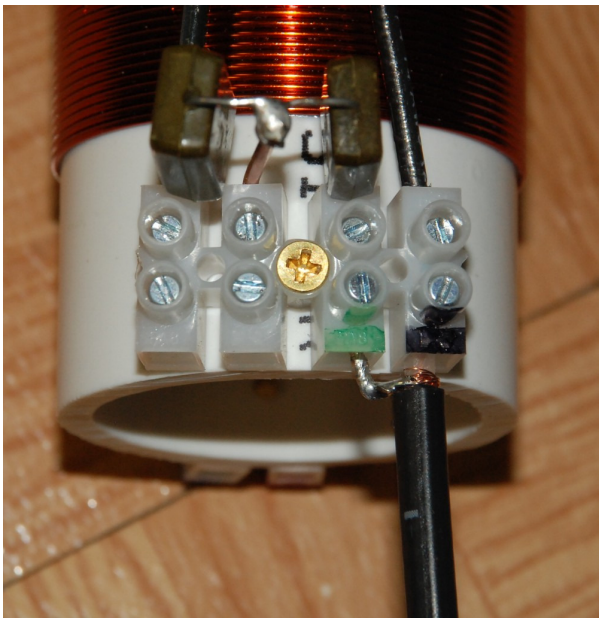

Figure 4

Two series link tuning capacitors in use. (Link removed)
This is the jumper position when using the Cheb 8" Phanotron, or the SSQ-ST plasma tubes.

With the copper wire jumper link disconnected from the two white terminal connections, only both of the tuning capacitors are in use. They are connected in series, and total effective series link tuning capacity in this configuration is 1100 pF. Store the jumper somewhere so you do not lose it!

Please refer to the section entitled: **"Coaxial cable length, series link tuning capacitor and TCS/TCP coaxial capacitor data for the 3.1 MHz link coil coupler"** further on in this manual for more information on when this connection option is to be used.

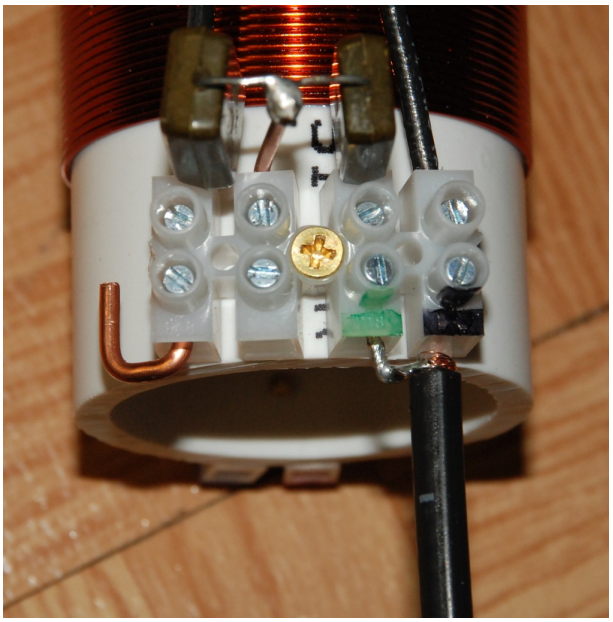

Figure 5

Two series link tuning capacitors in use. (Link Stored)

With the copper wire jumper link disconnected from the two white terminal connections, both of the tuning capacitors are in use. They are connected in series, and the total effective series link tuning capacity in this configuration is 1100 pF. In this alternate procedure, the jumper link is "parked" by clamping it in place with one of the two white terminal connections so that it does not become misplaced.

Please refer to the section entitled: **"Coaxial cable length, series link tuning capacitor and TCS/TCP coaxial capacitor data for the 3.1 MHz link coil coupler"** further on in this manual for more information on when this connection option is to be used.

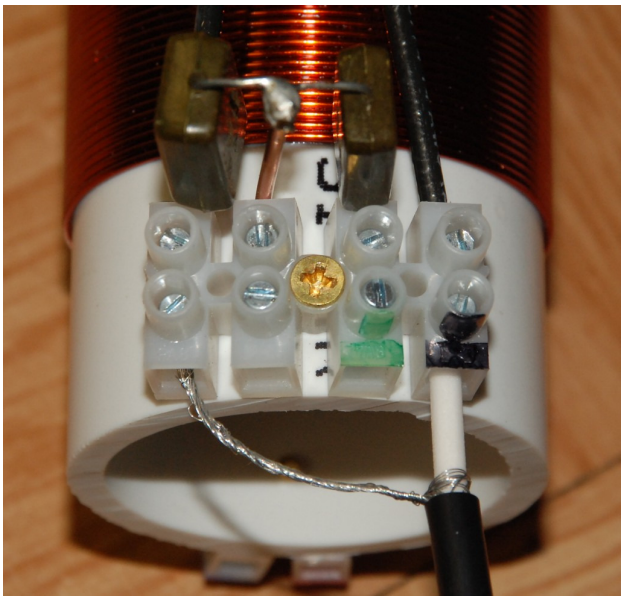

Figure 6

No series link tuning capacitors in use.

In this configuration, there are no series link tuning capacitors in use. Some setups using short coaxial cables may require this configuration. Please see the manual for details. Remember not to misplace the copper jumper link!

Please refer to the section entitled: **”Coaxial cable length, series link tuning capacitor and TCS/TCP coaxial capacitor data for the 3.1 MHz link coil coupler”** further on in this manual for more information on when this connection option is to be used.

The LC31 Coupler for the Cheb SSQ-BAT:

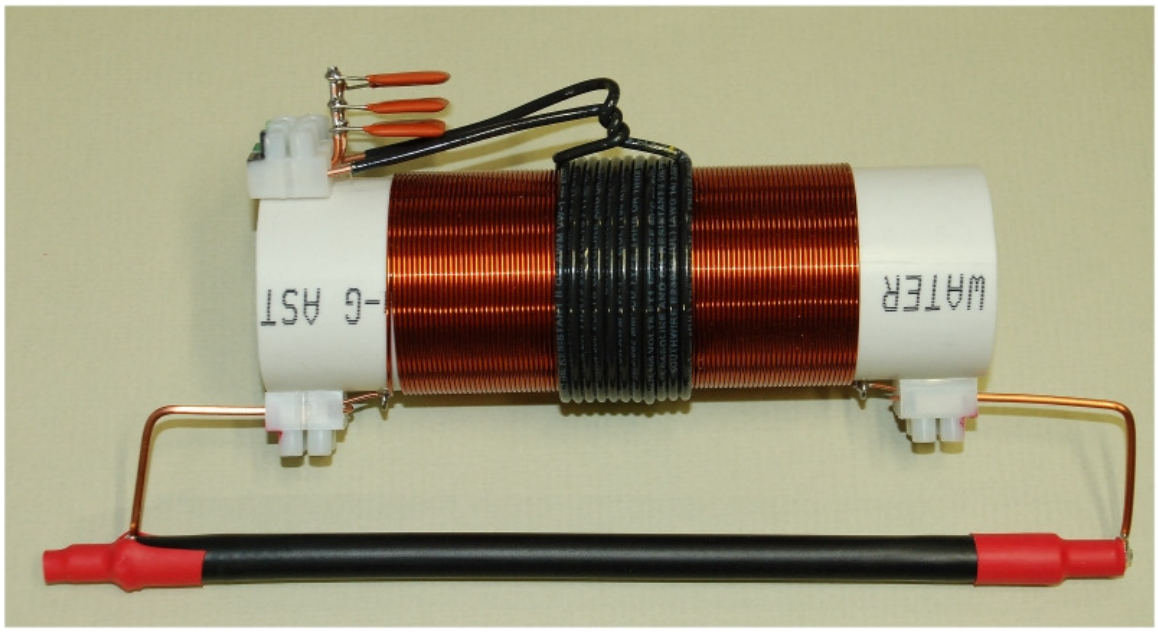

Figure 7

LC31 for use with the Cheb SSQ-BAT plasma tube.

NOTE – The capacitor shown is here is incorrect – the correct tuning capacitor will have yellow end caps and it will be shorter in length.

This coupler uses a different input series link capacitor arrangement. This coupler is not adjustable for use with other types of plasma tubes, as it is designed for use exclusively with the Cheb SSQ-BAT plasma tube

It is required that a small cooling fan must be used to cool the coupler and prevent overheating when power levels in excess of 100 watts are used. Failure to use a cooling fan will result in damage to the coupler due to overheating.

Please be sure to space the three mica capacitors slightly apart from each other to ensure that they are cooled properly.

The output connection terminals that will connect to the plasma tube are the same as shown in Figure 7. The input connections for the coaxial cable are the black and green terminals which are visible in the photograph below.

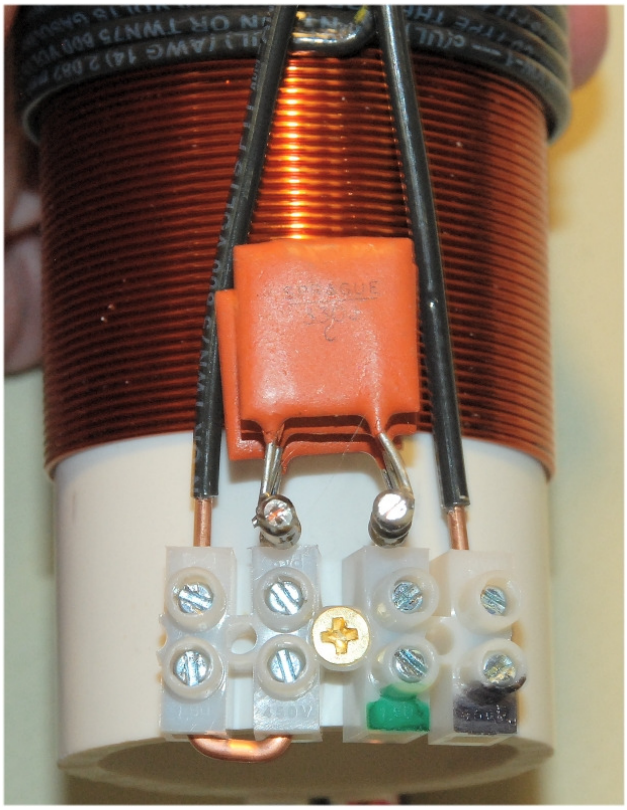

Figure 8.

Input terminal block.

The coaxial cable will connect to the black and green terminals seen here. Please refer to Figure 4 for a picture of how the coaxial cable looks when it is properly connected to the coupler.

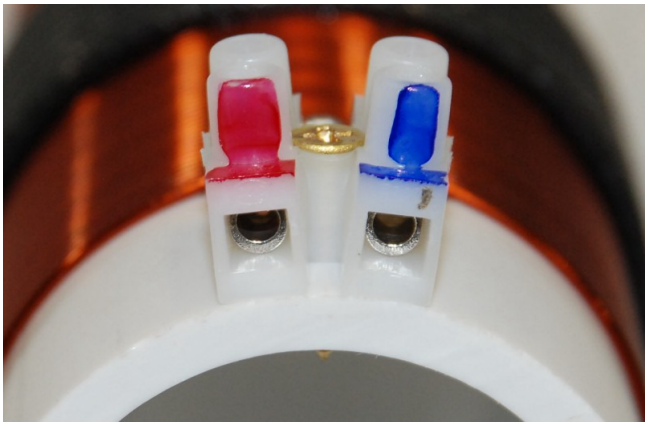

Figure 9.

LC31 RF Output Terminal Block

There are two 2-position terminal blocks mounted on the ends of the LC31 coil assembly. These terminal blocks are used for connecting the TCS, TCP or TCBA coaxial capacitor and the plasma tube to the LC31 coil assembly.

The Type TCS (GREEN,) Type TCP (BLUE), or TCBA (YELLOW) coaxial capacitor should be connected to the BLUE terminal blocks of the LC31 coil assembly.

A pair of well-insulated, flexible wires should be connected between the two RED terminal blocks and the electrodes of the plasma tube. These wires should be 8 inches / 20.5 cm in length for the SSQ-PT tube, and 12 inches / 30.5 cm in length for the Cheb 8" Phanotron, SSQ-ST, or SSQ-BAT plasma tubes. See page 11 for further information. Use of wires of shorter or longer lengths may result in significant detuning of the LC31. This detuning will result in reduced power transfer to the plasma tube.

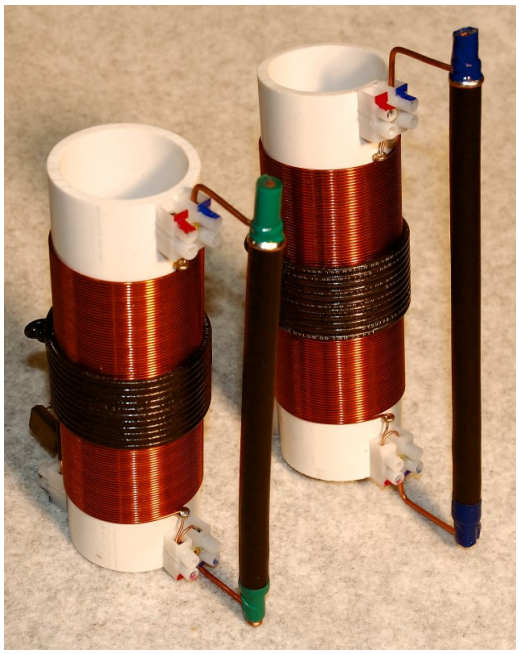

Figure 10.

LC31S with TCS Attached (left) and LC31P with TCP Attached (right.) The plasma tube connecting wires will be attached to the red terminals at either end of the LC31.

Mounting the LC31

If possible, the LC31 should be mounted in a horizontal position. This mounting position allows for the maximum amount of cooling air to flow around the coil of the LC31. The LC31 will become quite warm during operation. This is normal. The temperature rise will depend upon the level of RF power the LC31 must process.

The LC31 should be kept at least 2 inches / 5 cm away from metal objects and wires. Wires or cables that are close to the LC31 can easily pick up a powerful RF signal from the magnetic field surrounding the LC31. This induced signal may cause RF interference to other devices.

Mounting the LC31 to a wooden support will not cause tuning problems for the LC31, but the LC31 assembly should not be placed directly against a wooden support to avoid blocking the flow of cooling air over the coils of the LC31.

When mounting the LC31 assembly it is acceptable to drill one or more holes for mounting hardware in the exposed ends of the PVC coil form of the LC31. These holes should be located at least 3/4 inch / 38 mm away from the ends of the 18 gauge coil winding. Although ordinary iron or stainless steel hardware may be used to mount the LC31, the use of brass hardware for mounting the LC31 will result in less RF loss due to induction heating of the mounting hardware.

Cooling the LC31 at high Power Levels

To avoid damage due to overheating, a small cooling fan must be used to blow air across the LC31 during operation at power levels higher than about 75 watts average power. A fan such as are used in computers, and measuring about 80 x 80 x 20 mm is sufficient. Place the fan about 12 cm away from one end of the LC31. Use a non-metallic (heavy paper or card stock works well) to form an air delivery chute to direct the cooling air toward the open end of the LC31. This will allow cooling air to flow through the inside and over the outside of the coil windings on the LC31.

Preventing Interference to Other Devices

The most likely cause of electrical interference to other devices will be from stray RF radiation from the plasma tube and the wires connecting the plasma tube to the LC31 coupler system. To minimize radiation from the coupler and the connecting wires, the wires should be equal in length, and spaced as close together as reasonably possible. 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 for producing interference to other users of the radio frequency spectrum or other electronic equipment. Please be aware of local regulations before operating this equipment.

SPECIFICATIONS:

Input Load:

Variable, depending on the type of plasma tube being used. To some degree, this is adjustable by changing the value of the input series link tuning capacitors. Designed to match the RF amplifier output of the SSQ-2F v3.nn, the PA1, PA2, PA3, or the SPA4.

Output Load:

Plasma tube, internal or external electrode style. Designed specifically for the Cheb 8-inch Phanotron tube, the Cheb SSQ-PT, SSQ-ST, and the SSQ-BAT plasma tubes.

Power Handling:

Up to 300 Watts average RF power with modulation duty cycles from 0 to 100%.

Up to 500 Watts peak RF power with modulation duty cycles from 0 to 60%.

The power handling ability of the LC31 is limited by the amount of heat it can dissipate during operation. Operation at very high power levels for extended periods of time may cause the PVC coil form to overheat, resulting in deformation or melting of the coil form. Please note that such damage is not covered under warranty.

To avoid damage due to overheating, a small cooling fan must be used to blow air across the LC31 during operation at power levels higher than about 75 watts average power. A fan such as are used in computers, and measuring about 80 x 80 x 20 mm is sufficient. Place the fan about 12 cm away from one end of the LC31. Use a non-metallic (heavy paper or card stock works well) to form an air delivery chute to direct the cooling air toward the open end of the LC31. This will allow cooling air to flow through the inside and over the outside of the coil windings on the LC31.

SPECIAL NOTE ABOUT THE COAXIAL CABLE BETWEEN THE LC31 COUPLER AND THE RF SOURCE

This coupling system has been designed and optimized for use with a 23 foot / 7 meter length of 50-Ohm, solid dielectric insulation coaxial cable such as RG-213 or RG-58. Satisfactory performance will be obtained with cable lengths between 18 to 25 feet / 5.5 to 7.65 meters.

The coaxial cable is to be connected between the RF source (normally the SSQ-2F v3.nn or the PA1, PA2, PA3 or SPA4) and the input terminals of the LC31 RF coupler.

Because the cable is an active part of the matching system, changing either the type of cable or the length of the cable may serious problems or damage to the RF amplifier system.

Cable lengths of between 18 to 25 feet / 5.5 to 7.65 meters may be used with no circuit changes. Should it be desired to use a shorter cable length, it will be necessary to change the value of the link series tuning capacitor, which is normally either 2200 pF or 1100 pF. In general, the shorter the cable length, the greater will be the required tuning capacitance. In some cases, there may be no series tuning capacitor required.

Technically, what happens is that is as the value of the tuning capacitance is reduced, the link coil approaches the condition of series resonance. This causes the load resistance as seen by the RF source to decrease.

Because the SSQ-2F v3.nn or the PA1, PA2, PA3 or SPA4 (and most other solid-state RF amplifiers) behave as voltage sources, as the load on the RF amplifier is decreased as the link coil approaches resonance, the output MOSFET transistor in the RF amplifier stage will try to supply the power demanded by the load. This will cause the output transistor to draw excessive current and fail. For this reason, when changing cable lengths it will be necessary to carefully monitor the DC power supply current drawn by the amplifier and adjust the DC supply voltage to the amplifier to provide sufficient output while not allowing the output transistor to draw enough current to fail.

In normal operation, the LC31 coupler system is operated with the series link tuning capacitor adjusted to a value such that that the circuit is tuned below resonance. This is the most favorable condition for the output amplifier in the SSQ-2F v3.nn or the PA1, PA2, PA3 or SPA4. Operating the system slightly below resonance allows the output transistor to operate at a higher voltage point but with a lower current. This results in reduced losses in the output transistor and decreases the heat the output transistor has to dissipate.

Coaxial cable length, series link tuning capacitor and TCS/TCP coaxial capacitor data for the 3.1 MHz link coil coupler

If you are using a Cheb 8 inch Phanotron, or the SSQ-ST:

8" Phanotron and SSQ-ST - Connect a 7-inch active length coaxial capacitor (Type TCP, BLUE) to the BLUE terminals of the LC31.

Use a pair of 12 inch / 30.5 cm connecting wires between the LC31 and the plasma tube electrodes.

- For coaxial cable lengths of 3 feet to 10 feet or 1 meter to 3 meters, use one series link tuning capacitor with a value of 2200 pF.

- For coaxial cable lengths of 19 feet to 24 feet or 5.8 meters to 7.3 meters, use 2 series link tuning capacitors with a value of 2200 pF each, for a total of 1100 pF.

If you are using a Cheb SSQ-PT - 1" x 14" straight external electrode tube with external 1-3/4 inch / 45 mm collar electrodes:

Connect a 6-inch active length coaxial capacitor (Type TCS, GREEN) to the BLUE terminals of the LC31.

Use a pair of 8 inch / 20.5 cm connecting wires between the LC31 and the plasma tube electrodes.

When using the PA1 at low power or the SSQ-2F v3.10 - For coaxial cable lengths of 4.6 feet or 56 inches to 10 feet or 1.43 meters to 3 meters, use no series capacitors. Install a shorting jumper in place of the link tuning capacitors.

When using either the PA1 at low power or the SSQ-2F v3.10 - For coaxial cable lengths of 19 feet to 24 feet or 5.8 meters to 7.3 meters, use one series link tuning capacitor with a value of 2200 pF.

If you are using a Cheb SSQ-BAT:

SSQ-BAT - Connect a 5-inch active length coaxial capacitor (Type TCBA, YELLOW) to the BLUE terminals of the LC31

Use a pair of 12 inch / 30.5 cm connecting wires between the LC31 and the plasma tube electrodes.
- For coaxial cable lengths of 19 feet to 24 feet or 5.8 meters to 7.3 meters, use 3 parallel link tuning capacitors with a value of 330 pF each, for a total of 900 pF.

ALL LINK TUNING CAPACITORS SHOULD BE MICA CAPACITORS WITH A VOLTAGE RATING OF 500 TO 1000 VOLTS DC.

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.

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.

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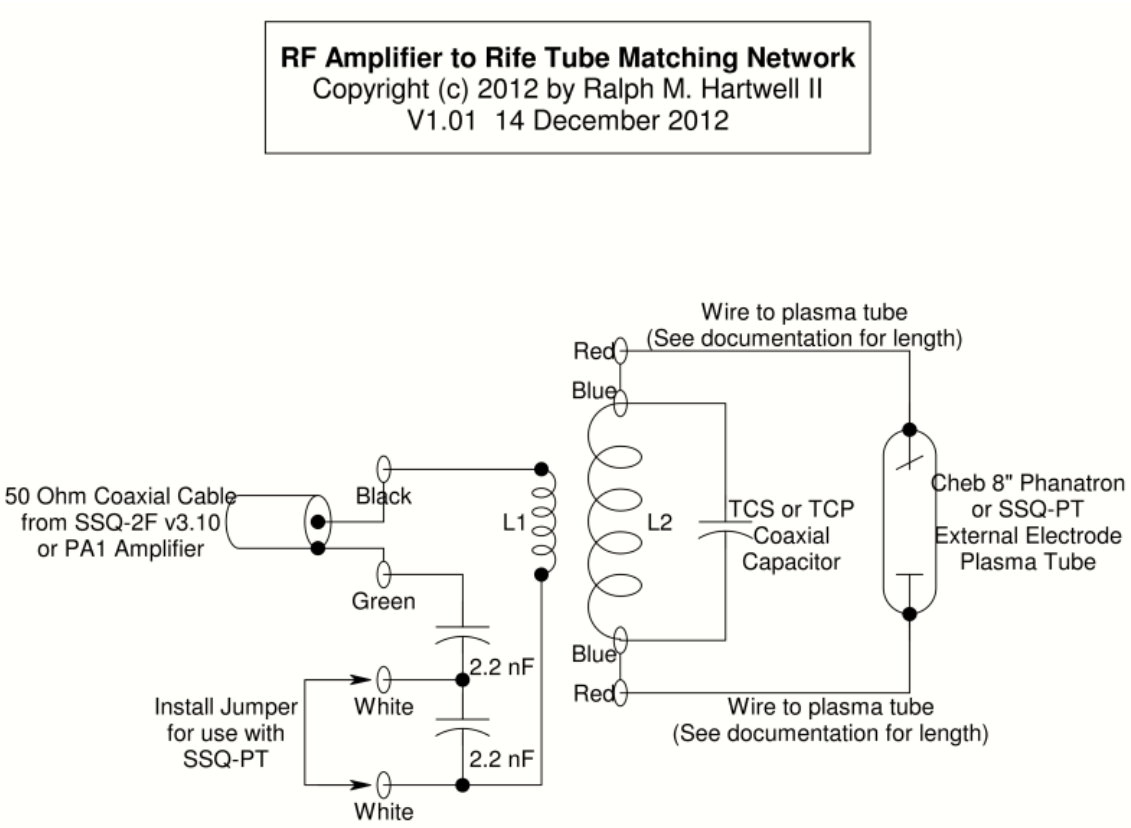

NOTES:

The values specified here are for use with a 50 Ohm coaxial cable with a length of 24 feet / 7.35 meters between the RF source and the matching network. Using a different length of coaxial cable will require adjustment to the value of Coaxial Capacitor.

TCS Capacitor - 17 pF when used with a Cheb 1" x 14" SSQ-PT external electrode tube.
TCP Capacitor - 23 pF when used with a Cheb 8" Phanatron tube.

Input Link Capacitor(s) for L1 - 1100 pF Mica 500 Volts when the coupler is used with a Cheb 8" Phanatron tube, 2200 pF Mica 500 Volts when used with a Cheb 1" x 14" SSQ-PT external electrode tube.

L1 -11 turns #14 THHN copper wire close wound over the center of L2.
L2 - 94 turns # 18 enameled copper wire close wound on a 6" long x 2" diameter length of PVC pipe.

Figure 11.

Schematic Diagram of the LC31 v1.01.

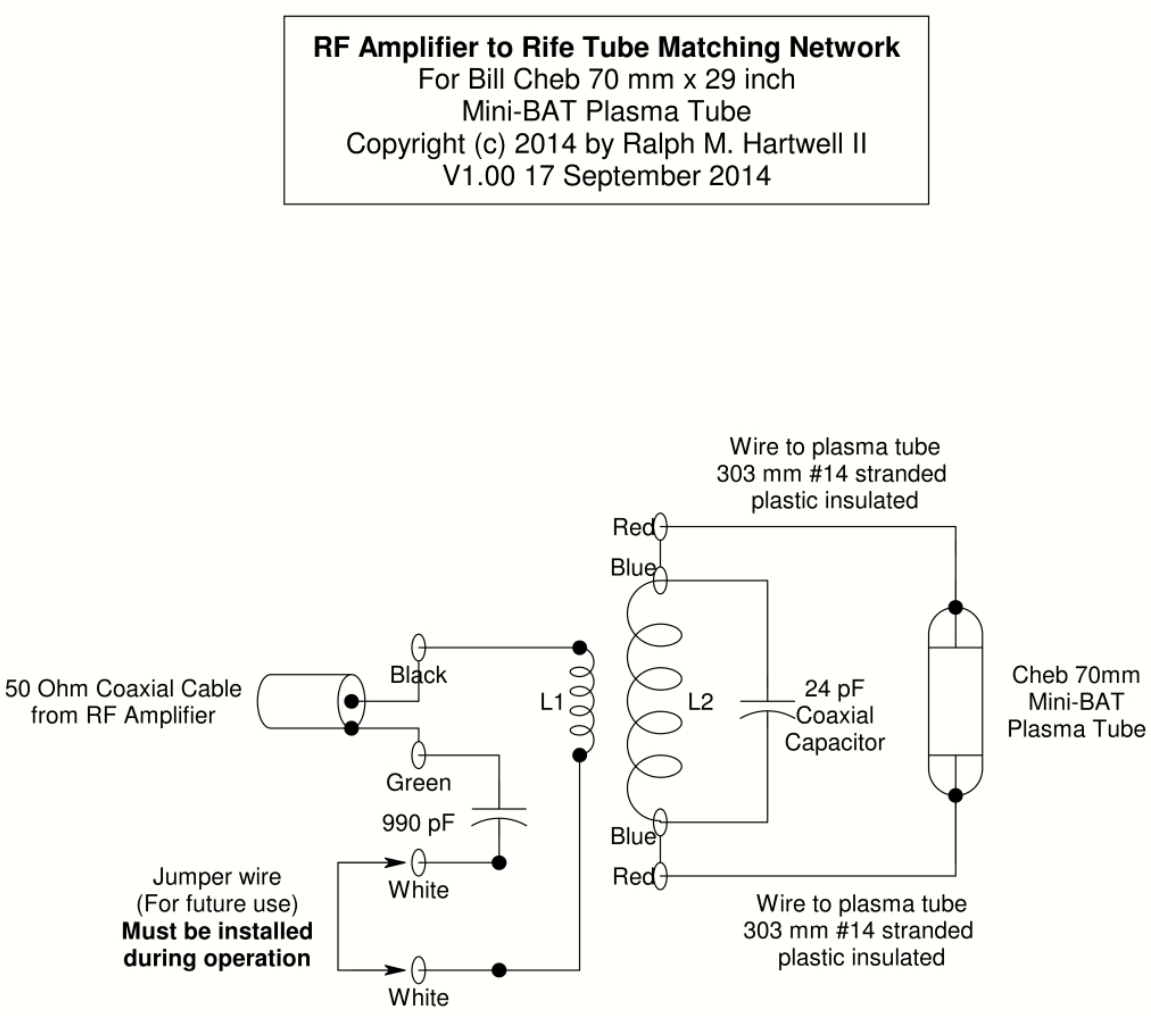

Figure 12.

Schematic Diagram of the LC31 for use with the Cheb SSQ-BAT Plasma Tube.