Modifying the Larcan VHF Lo/Hi 1.5KW Amplifier for 144MHz.

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This document details the steps I took to modify the Larcan VHF Lo/Hi 1.5KW Amplifier for 144MHz. With a 50V supply, the modified amplifier achieves 1500W output with about 27W of drive - a gain of almost 17.5dB across the 2M band. The input return loss is better than 20dB. And amplifier efficiency is at least 45% resulting in a peak current draw of about 65A.

Before You Begin

Make sure you are starting with a functioning amplifier. Also verify that each FET is biased for 500mA per side as specified by Larcan. Hopefully the pictures included near the end of this document will add clarity where the descriptions are lacking.

Component Removal

In the Input Splitter and Output Combiner circuits, remove C101 - C142, C144, C145, and C148. Also remove L106 - L111.

For each Amplifier Stage (there are six of these) remove C3, C4, C13 - C16.

That's a grand total of 81 capacitors and 6 inductors that are removed.

Cutting and Bridging Traces

In the Input Splitter and Output Combiner, cut the trace that runs from C101 to C103, C109 to C110, C112 to C113, C119 to C120, C122 to C123, and C127 to C130. Make a small gap in the trace right next to each corresponding vacant capacitor pad. This will result in two cuts per trace. Bridge each trace with a quarter-wave length of coax. I used 14.5” of RG-316. The center conductor connects to each capacitor pad. And the shield connects to ground at both ends. Also place a 0.6” long PTFE-insulated jumper from C102 to C104, C107 to C108, C111 to C114, C117 to C118, C121 to C124, and C128 to C129.

For each Amplifier Stage, solder a 0.125” wide by 0.3” long strap across L1, L2, L7, and L8 as shown in the picture below. For accessibility to L7 and L8, temporarily unsolder the ground side of C5 and C8 to lift these capacitors out of the way.

Slightly reduce the inductance of the Input Matching Stub by short-circuiting its “U”-shaped section with a strap measuring 0.2” wide by 0.7” long.

Also reduce the inductance of the Output Matching Stub using a 0.1” wide by 1.5” long strap connected to a grounding lug. The strap is formed so that it jumps over (about 0.3” high) the large trace leading to the output connector.

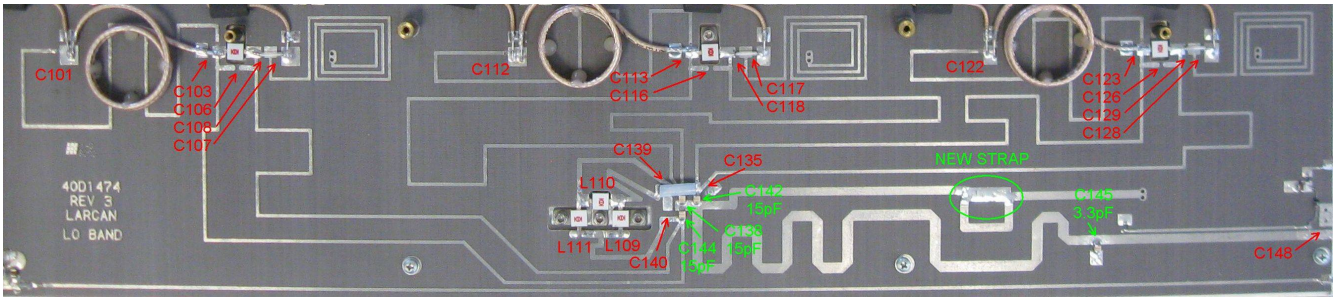
New Component Placement

In the Input Splitter place a 3.3pF at C145, and a 15pF at C138, C142, and C144.

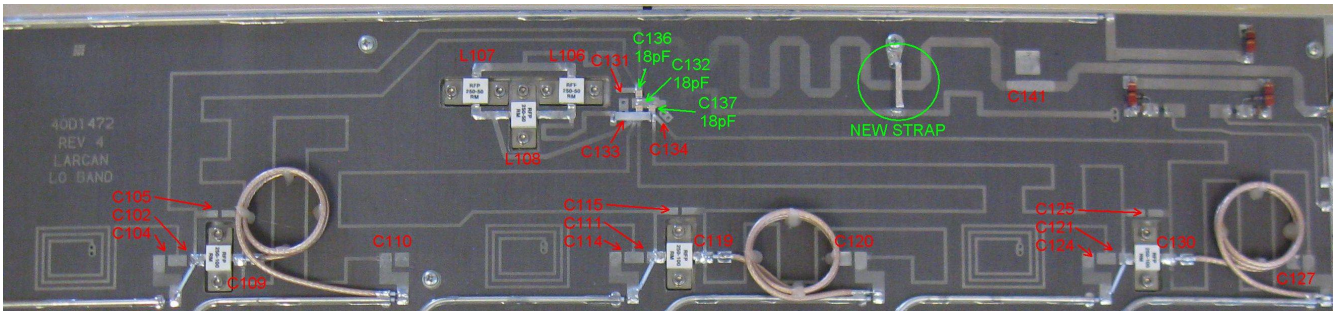
In the Output Combiner place a 18pF at C132, C136, and C137.

For each Amplifier Stage place a 160pF at C4 at its new location about 0.6” away from the body of the FET. Place a 47pF at C3 near C4's old location. And place a 68pF at C13 - C15.

Pictures for Reference

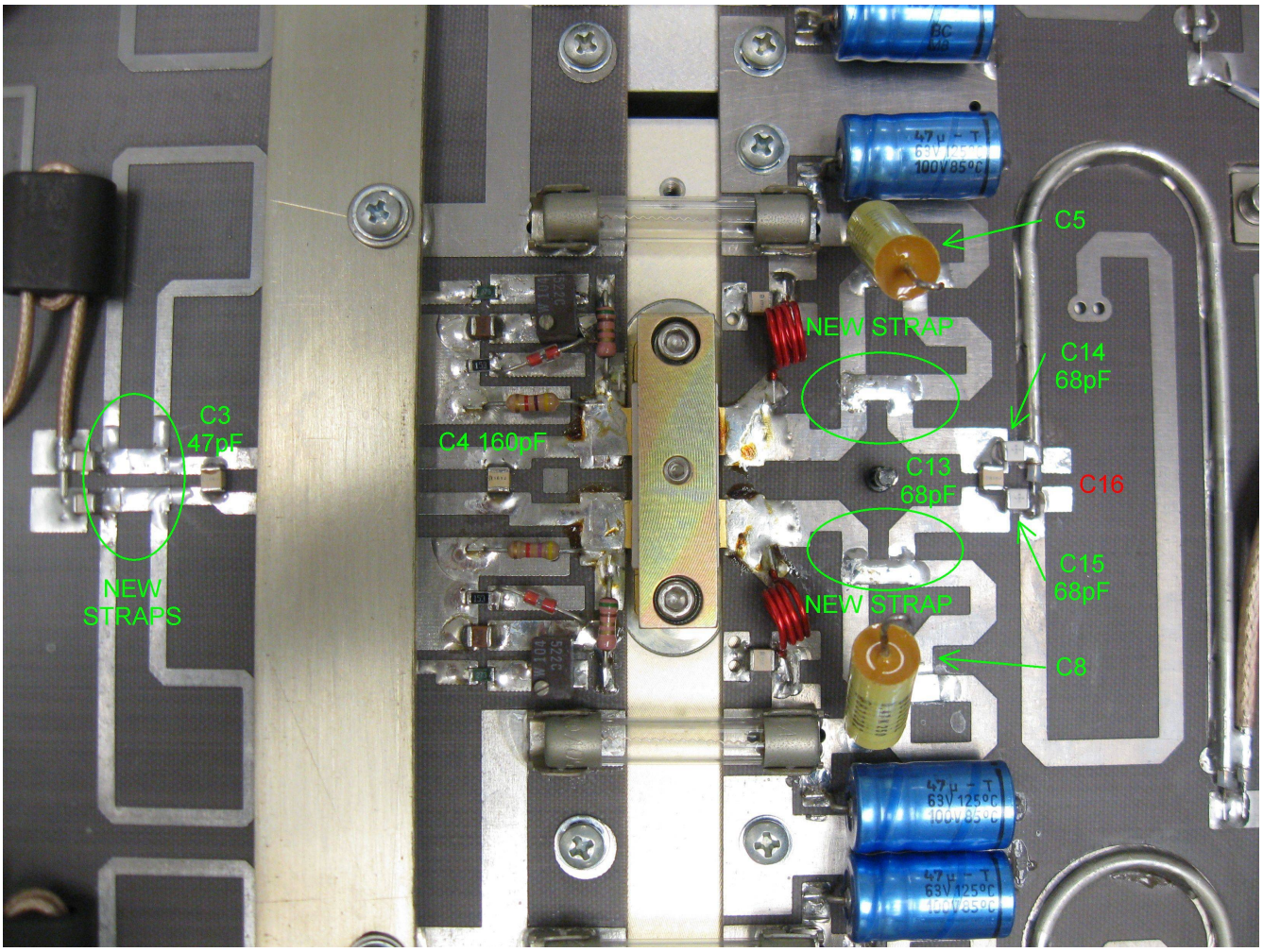


The modified Input Splitter circuit.

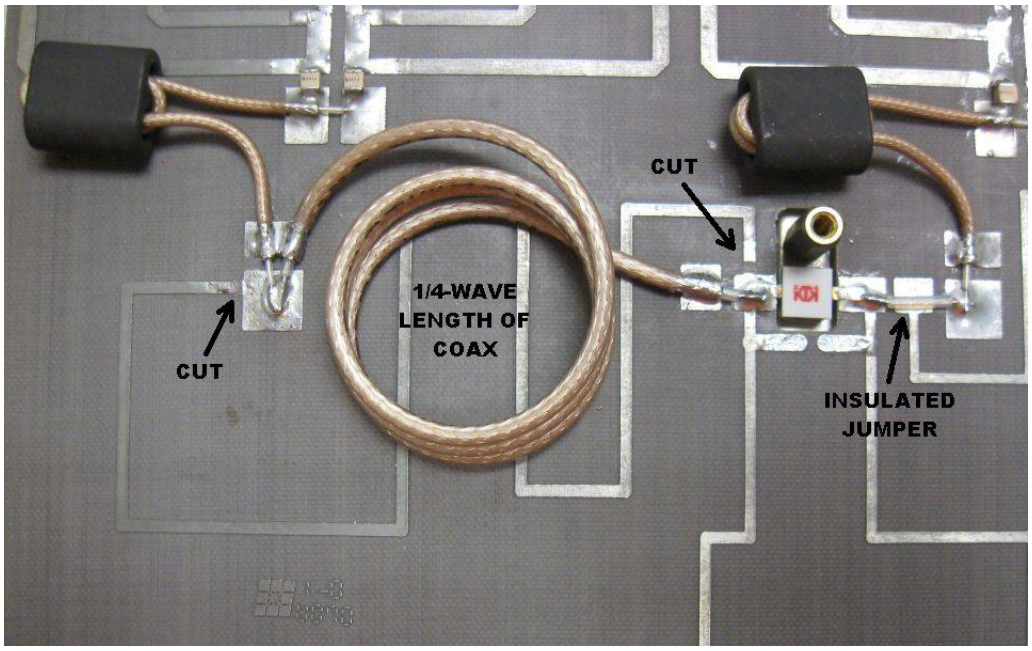


And the modified Output Combiner circuit.

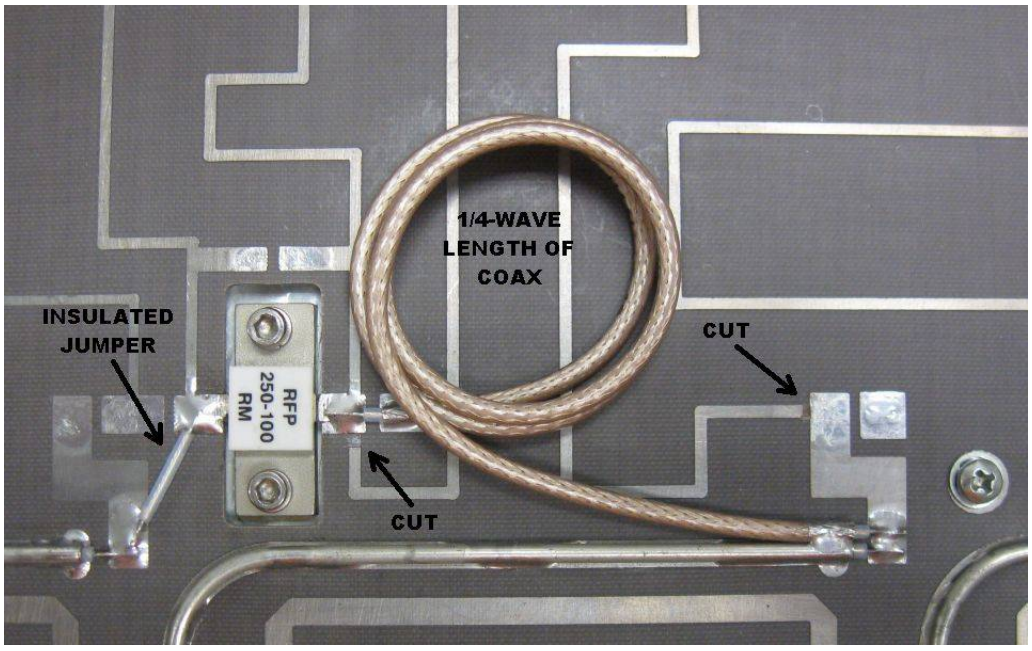
In the two pictures above, the components labeled in red are removed and left vacant.
And the components labeled in green are replaced with new values.
The six coaxial phasing lines can also be seen above. As an optional step, they are held in place with 3M Scotch-Weld Hot-Melt Adhesive #3748.



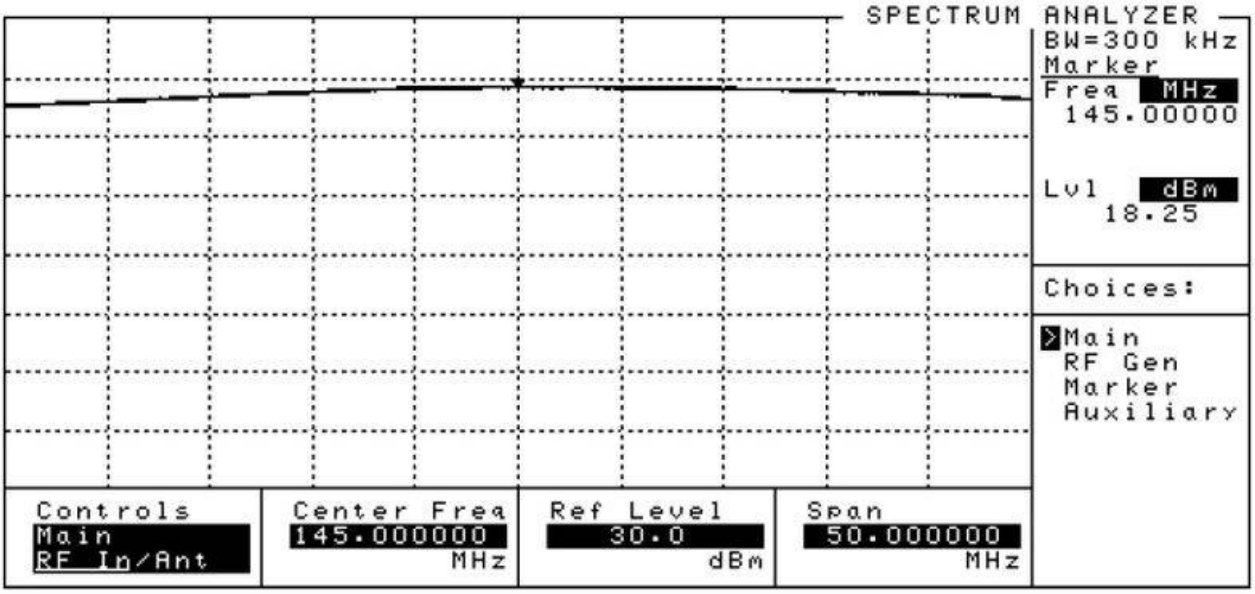
The modified amplifier stage showing the four new bridging straps and locations of the new capacitors. C5 and C8 have been temporarily lifted out of the way to make it easier to add the straps across L7 and L8. Also note that C16 is omitted.



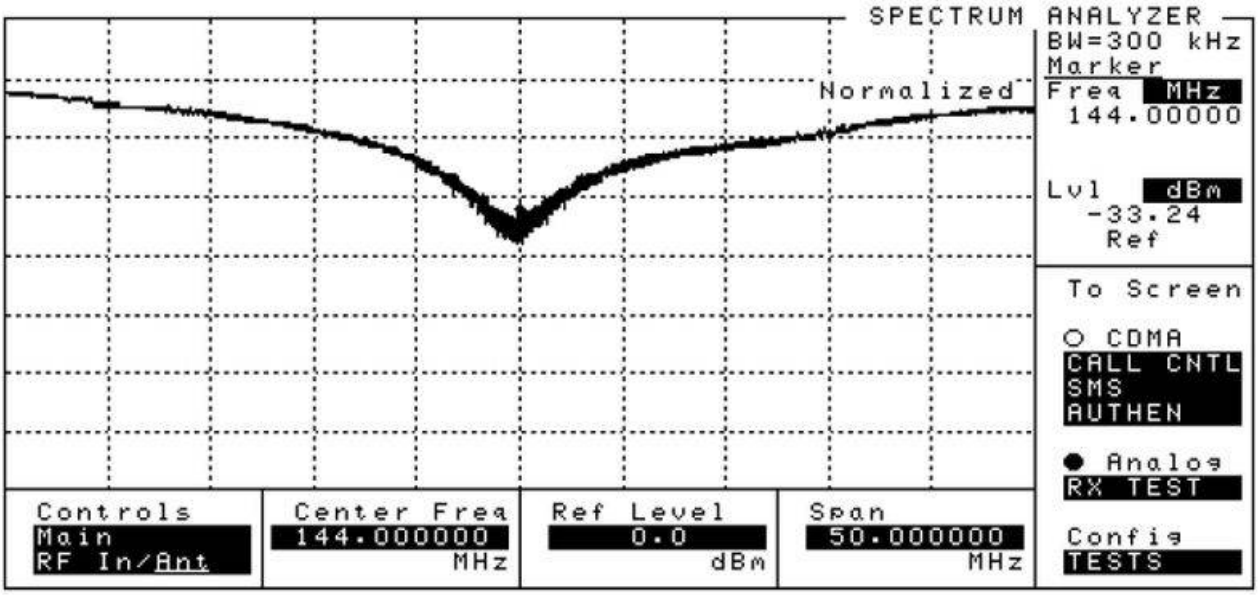
One of the three coax & jumper pairs used on the input side.



And one of the three coax & jumper pairs used on the output side.



Small Signal Gain Response 120MHz to 170MHz
Horizontal = 10dB/div Vertical = 5MHz/div



Input Return Loss 120MHz to 170MHz
Horizontal = 10dB/div Vertical = 5MHz/div

Additional Comments

The original input and output RF connectors were removed for this modification. They were replaced with a SMA connector for the input and N connector for the output. The front panel BNC connector proved to be quite useful during testing. It provides a -30dB sample of the output. With the spectrum analyzer connected to this sample port, the second and third harmonic were measured at -40dBc and -60dBc respectively. As expected, some filtering of the output will be necessary.

All the surface mount capacitors are ATC100B 500V or equivalent. For this modification, most of the “new” capacitor values will be found among the “old” parts that were removed. Because of this, the only capacitor value that had to be obtained from elsewhere was 68pF. Also note that there will be a lot of vacant pads (and leftover cap's and coils) after the modification.

Larcan designed each of the six amplifier stages to operate 90 degrees out of phase with its neighbor. That same design goal is accomplished in this modification, but without the use of lumped element phase shifting networks. Instead, coaxial delay lines are used in an attempt to save a little money. When cutting the lengths of these six coaxial cables and jumpers, consistency and symmetry are more important than exact length. When forming the coax, be careful not to violate its minimum bending radius specification. Be sure to choose a coax that can handle at least 200W continuous and 300W peak.

While this modification should produce a completely usable 1500W amplifier for the 2M Amateur Band, there is still plenty of room for improvement. I look forward to seeing the work of others who either improve upon this modification or take an entirely different approach.