IMPROVING THE LARCAN AMPLIFIER AT 50.0 MHz

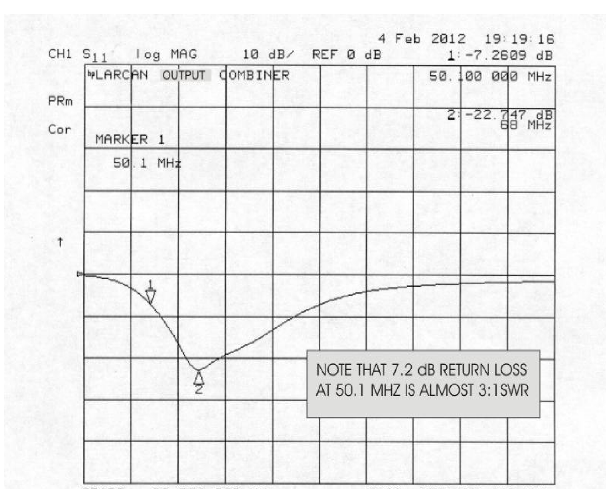
By David Olean K1WHS

February 6, 2012

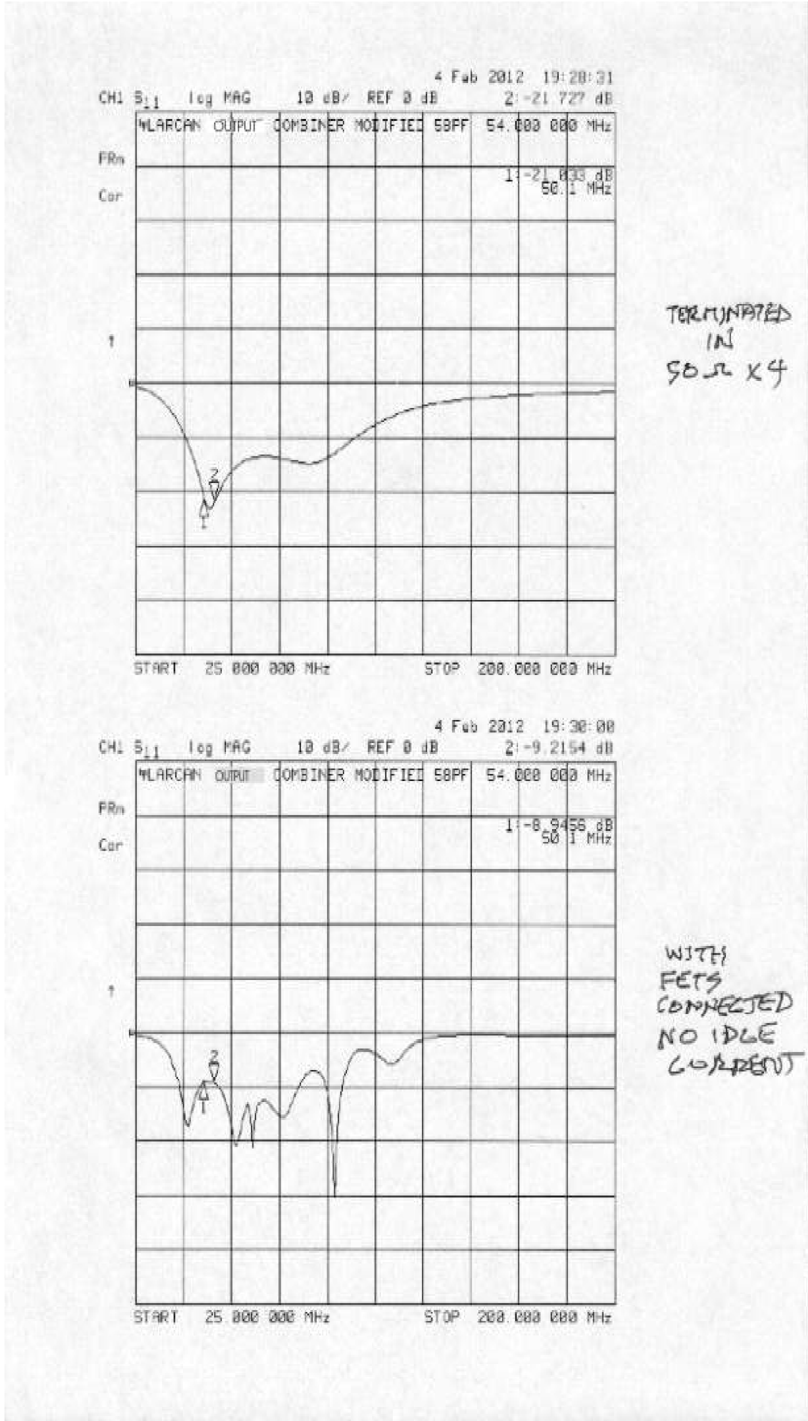
I purchased one of the LO-HI Larcan television amplifiers from the MMRA group last year and have finally gotten around to actually implementing it into my station. As advertised, these amplifiers will provide 300 watts on the FM part of six meters when not converted, and will make 600 watts output in CW and 1000 watts PEP in SSB if component changes are made to convert a LO-HI amp down to a LO-LO amp. My interest was in using the amplifier at 50.1 MHz for SSB and CW service, not FM, and the additional excursion to the bottom of the band resulted in poor efficiency and lower gain. Surely there must be a way to squeeze a few more watts out of the circuit.

My first attempt involved tweaking an individual MRF151G stage on the amplifier chassis for better performance at 50.0 MHz. The input side seemed to be pretty optimum and no improvements were noted, but I was able to increase the performance by modifying the output circuit. I experimented with changing values of C-14 and C-16. C-13 seemed OK as is, but I was able to improve the gain by increasing the value of C-16 from the 51 pf specified by Larcan, to 75 pf. You could piggy back a 24 pf capacitor there, or just install a single 75 pf capacitor in place of the original 51 pf. I also found that increasing C-14 and C-15 from the Larcan value of 180 pf to 225 pf increased the performance as well.

I next attacked the output combiner. My changes to each individual amplifier had improved things, but there was still a huge discrepancy between 50.0 MHz and higher frequencies. Max power was still up beyond 70 MHz. I had only marginally improved the performance. Don, W1FKF had also converted a Larcan unit to 50 MHz SSB previously, and had complained about poor efficiency there. He was seeing efficiency values in the order of 24%. I thought that the problem had to lie in the output combiner as well as the output section of the amplifier. I disconnected all of the MRF151G stages and substituted small 50 ohm resistors at the amplifier output. Then I connected a network analyzer there on the output connector. My feeling was that I should see 50 ohms if everything was working properly. I was greeted by a very poor match at 50 MHz with a return loss of about 7 dB, or almost 3:1! Instead of the normal 6 dB of coupling loss, I was seeing 3.5 dB on one port. That meant another port would have had almost 9 dB! Clearly the combiner was not working well. I then started experimenting with the combiner cap values, and ended up changing the values of C-4 & C-5 and also C-1 & C-8. C-4 & C-5 were originally 47 pf and I increased that to about 86 pf by adding a 39 pf capacitor piggyback style on each one. C-1 & C-8 had an added 12 pf for a total of about 27 pf there. Those changes altered the output combiner more to my liking.

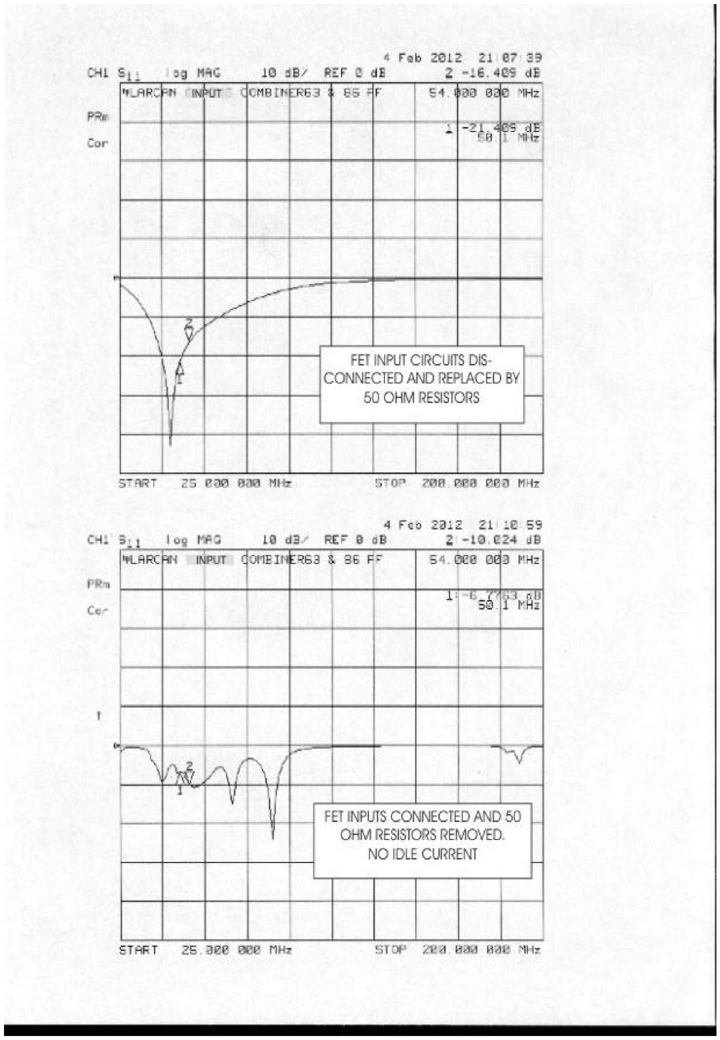


UNMODIFIED OUTPUT COMBINER



This is the modified output combiner with better than 20 dB return loss between 50 and 54 MHz. The lower plot is the combiner terminated in the FET amplifiers rather than 50 ohm resistors.

I could see that the input splitter was very similar in construction to the output combiner, so I figured it needed help as well. I tried the same trick on the input by putting 50 ohm resistors at each amplifier input and measuring the input return loss to the splitter. C-5 & C-6 needed more capacitance and I piggybacked another 30 pf across the 39 pf ones for a total of 68 or 69 pf. I left C-3 & C-4 alone. Changes there did not have much effect. I felt a little better knowing that the amplifiers were now running into a more reasonable load.



Converted INPUT splitter

I tried firing up the amplifier and driving it with a laboratory signal generator and instrument amplifier. With 4.0 watts of drive I had the following results:

FREQUENCY	VOLTS DC	AMPS	POWER OUT	EFFICIENCY
50	51	30	540	35.30%
52	51	31	580	36.70%
54	51	32	630	39.20%

I tried running the converted amplifier at 70 MHz at full power, but was greeted by a blue flash from one of the FETs and a blown fuse. Scratch one $110 LDMOS! (It failed as an open circuit) With the changes I made to the output stage, the maximum RF output of the amplifier alone is reached at about 60 MHz. I guess full power at 70 MHz into the modified output combiner was a bad idea. Note to self: Operate only between 50 and 54 MHz after making these changes!! I ran the drive up at 54 MHz to a bit over 5 watts to obtain 900 watts of carrier. Current drain was 38 amps for an efficiency of 46.94%. There is one caveat. I used a 1000 watt 100-250 MHz Bird slug which is not rated for 50 MHz. I suspect the power accuracy is pretty close though, as it is a high power element with light coupling. (You would think that K1WHS would have his act together and possess a 1000 watt Bird element for 50 MHz. If you did think that, you would be WRONG!) This is drastically better than the unmodified LO-LO module will do, so I feel that my efforts were effective and make a good amplifier even better. I did not have a peak reading watt meter in my shop, but a scope does show PEP values significantly higher than the CW carrier levels when SSB is employed.

The input combiner still favors higher frequencies and you can see the input power to the FET rising as you raise the frequency. I reasoned that reworking the etched lines was not worth the effort in an attempt to correct this. After all, you need only increase the drive a bit to overcome the roll off in the input combiner. Gain ranges from 21.4 dB at 50 MHz to over 22 dB at 54 MHz.

So here are the changes required for better performance at 50-54 MHz:

INPUT SPLITTER:
C-5, C-6 39 pf to 68 pf ATC100B (You could also use a silver mica cap as the drive level is low)

AMPLIFIER OUTPUT :
C-16 51 pf to 75 pf ATC100B chip cap.
C-14, C-15 180 pf to 230 pf ATC100B chip cap.

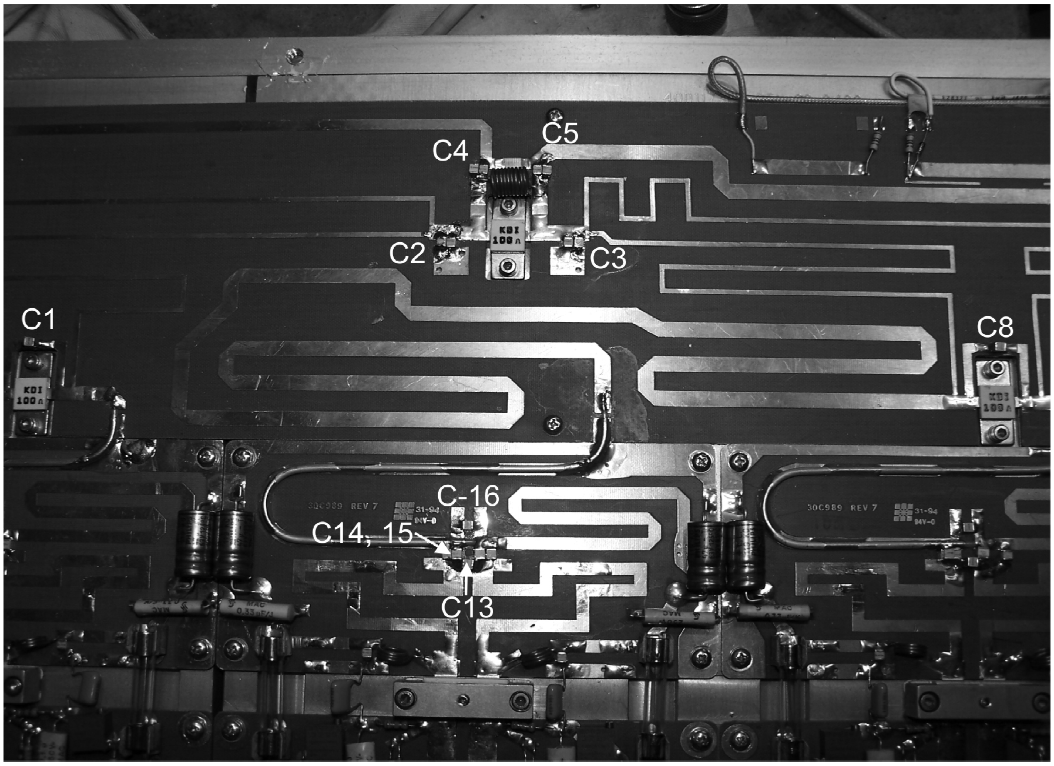
COMBINER OUTPUT:
C-4, C-5 39 pf to 86 pf ATC100B chip cap.
C-2, C-3 24 pf to 68 pf ATC100B chip cap.
C-1, C-8 15 pf to 27 pf ATC100B chip cap.

The capacitor reference numbers are the ones specified in the Larcan schematic diagrams as posted on the MMRA website. (See http://www.mmra.org/larcan/) This website has a wealth of data on the Larcan amplifiers.

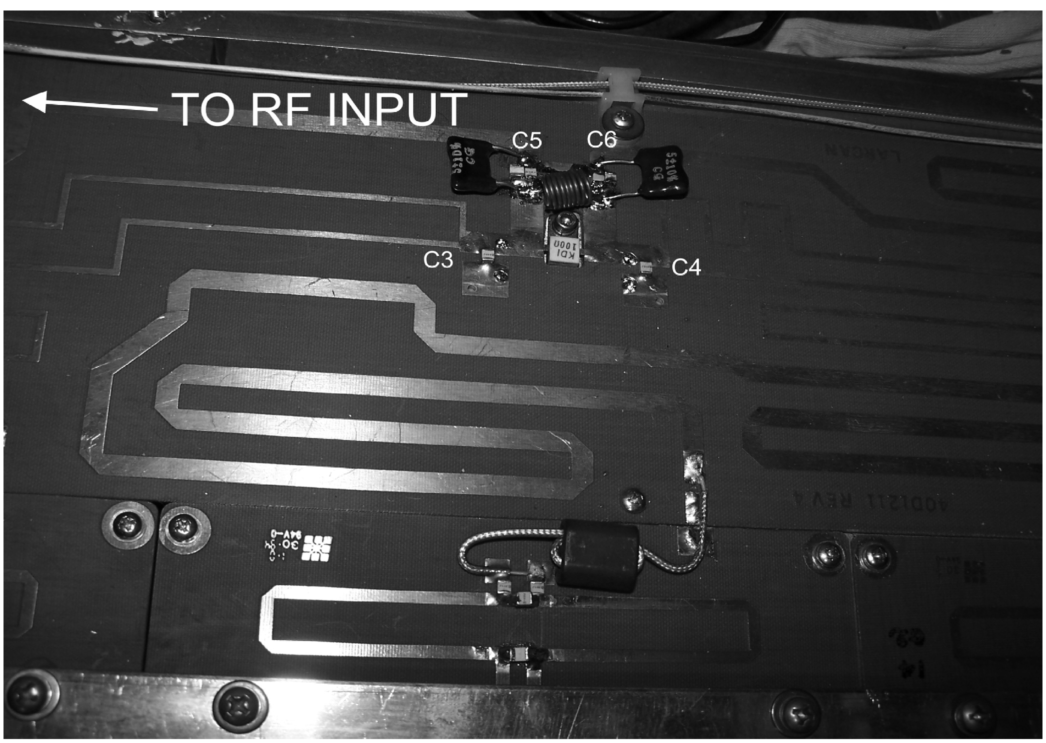
I am sure there is more that can be squeezed out of this unit. In my testing, I was disturbed to see that the isolation between stages, provided by the output combiner was not very good at 50 MHz. I originally tried running a single amplifier stage with the other three terminated in low power 50 ohm resistors, in an effort to match into the combiner. There was too much power being absorbed in the resistors. I did not measure the isolation, but I think that it is much less than the typical 20 dB obtained with Wilkinson dividers. As a result, I abandoned that plan of matching into the terminated combiner in favor of my "bucket of worms " approach! What I ended up with is still quite nice and well worth the effort. This amplifier will make a nice addition to the shack. I can drive this amplifier easily with rigs such as the FT-817 at 5 watts, or my low power (~8 watt) Elecraft K3 on 50 MHz.

As a side note, I obtained a single MRF151G Larcan PC board (¼ of the full amplifier) and built that up on a new heat sink. This single stage has no input and output combiners. After performing the amplifier mods listed above, I saw pretty constant output from 50 MHz up to about 68 MHz. The FET really took off with drive and I had no trouble getting 300 watts out of a single transistor. In fact I drove it to 400 watts CW output with less than 5 watts of drive. DC Current at 50 volts was about 11.5 amps! This is over the rating for the MRF151G I believe. You should keep the current under 9 amps at the 50 volt level so as not to exceed the safe area of operation. At 300 watts it runs beautifully. The efficiency is way up there too at 68% at 400 watts. I noticed that my Larcan amplifier came from the TV station with 7 amp fuses for each FET. The Larcan schematic calls for 5 amp fuses. It would be a good idea to err on the low side with your fuse selection. Incidentally, all of my testing was done with the Larcan recommended 0.50 amps idling current per FET. You can improve the gain by increasing the idle current with a higher bias setting.

In summary, I believe that most of the added gain and increased efficiency is obtained by cleaning up both combining networks on the inputs and the outputs of this amplifier. Some added output amplifier board tweaks (C-14, 15, and 16) over those specified by Larcan for the LO TV channels (2,3 & 4) increased the gain a bit more. This amplifier is now ready to be buttoned up and installed! CU on six this summer!



Photograph of the capacitor locations used in the modification of the output combiner and FET output stages. C14, 15, and 16 are all changed in each of the four power modules. The other capacitors are all used in the output power combiner as shown.



Input splitter photograph, showing the first Wilkinson divider area. C5 and C6 are changed. C3 & C4 are not altered and are shown for reference only. You can see some 5 pf silver mica caps. I

took this picture while "fine tuning" the input. Silver micas are OK here as power levels are low.