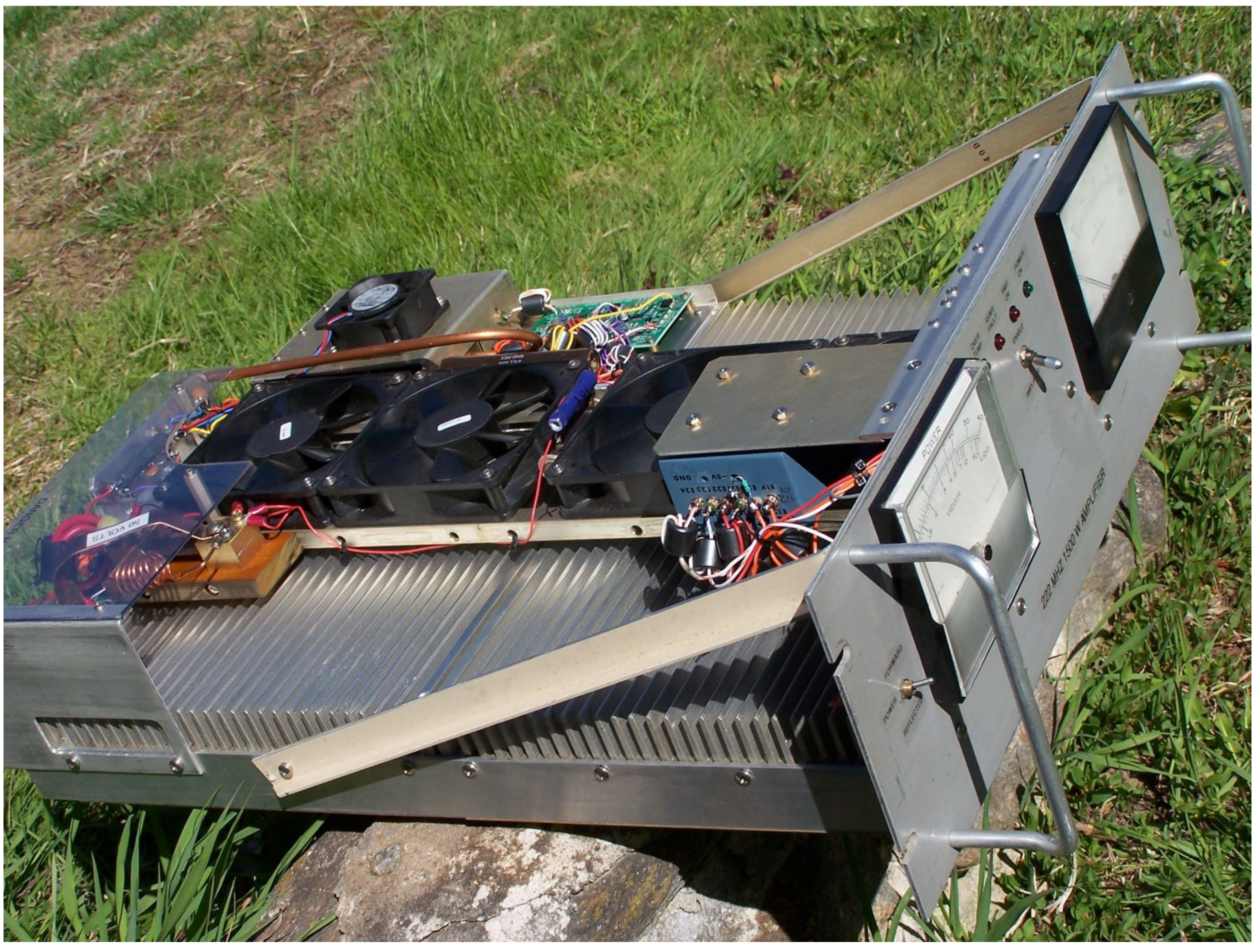
THE LARCAN HIGH BAND 1500 WATT AMPLIFIER ADAPTED FOR 222 MHZ WEAK SIGNAL WORK

Revised 07/28/2022



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FN43mj

CONVERTING THE LARCAN HIGH BAND TV AMPLIFIER FOR 222 MHZ.

I recently obtained a high power Larcan Hi VHF amplifier, a remnant of the analog television days. I had plans to adapt it to the 222 MHz amateur band and replace my vacuum tube 8877 triode amplifier. The 8877 design is a sweet amplifier designed by Bob Sutherland, W6PO. [1.] (SK) The amp relies on a 3000 volt power supply and assorted blowers and filament circuits. It has been a reliable work horse. I estimated that it consumed about 500 watts while just sitting there in standby. I thought that a solid state amplifier might be a bit more efficient. This Larcan project is the end result.

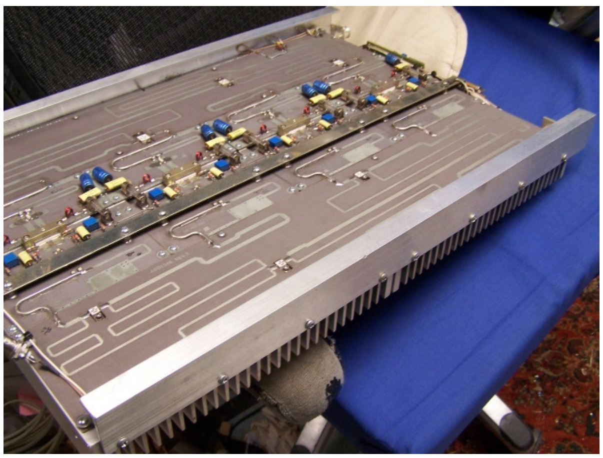
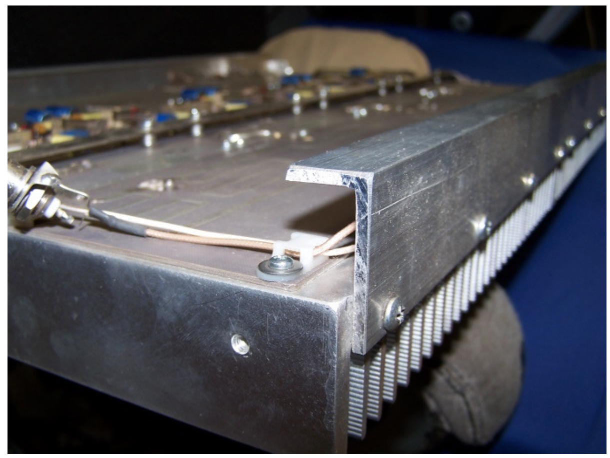
My RF pallet is the 1500 watt 6 FET variety. It uses six MRF151G FETs. The FETs are rated for 300 watts output at 175 MHz. Larcan ran these six pallets at about 1500 watts day in and day out in commercial broadcast service. It makes a nice 222 MHz high power amplifier. These amplifiers exhibit 16 dB gain on 222 MHz. The proper amount of drive is about 40 watts input. There are no modifications needed to get them to work on 222 MHz. They run fine as they are, but they do need some significant filtering on the output to keep within FCC rules. They also require some serious protection circuitry in the event of malfunctions. I vowed that I would never run a solid state amp that wasn't equipped with a good protection circuit. W8ZN has published a good conversion article about getting these Larcan amplifiers running on 222 MHz. [2.] I used a slightly different approach. The amplifier pallet is about 23 inches deep and W8ZN attached his filter board extending out beyond by another six inches or so. I did not have that much room to mount the filter board there, so opted to make things a bit more compact by putting the filter and all the protection circuits up above the heat sink. I also added more protection for the FETs.

For those who are used to tubes, you will recall that they can stand some occasional missteps and live to amplify another day. I once ran my 8877 into a dead short and the only hint was that the grid current dropped when it was shorted. FETs are a different breed. The gate structure is infinitesimal in size. It has no power handling ability and can be ruined by rather low voltages that exceed the gate voltage rating. The MRF151G is not an LDMOS type, but an N channel MOSFET. Both structures have very fragile gates and any overload can destroy it in less than a heartbeat. Many LDMOS devices have very stringent VGS ratings in the range of +10/-6 vdc., while the MRF151G rating is much more lenient at +/- 40 volts. The Larcan amplifier has built in protection from high output VSWR (up to a point). It will remove bias when a high VSWR is encountered, but that does not shut down the amplifier. It is still possible to produce output with no bias voltage, especially with higher drive levels. My plan was to remove the 50 volt drain voltage entirely should any fault occur. The W6PQL control board accomplishes this. [3.] The board has an adjustment for the high VSWR reflected power voltage. I set the on board pot to maximum sensitivity (max CW), and it trips at about -0.380 VDC input. I am not sure, but 0.350 volts forward output voltage from the directional coupler is about 200 watts RF output. The directional coupler has less attenuation on reflected power, so the trip level is most likely in the 75-100 watt reflected power range. I might have to adjust that upwards in real life.

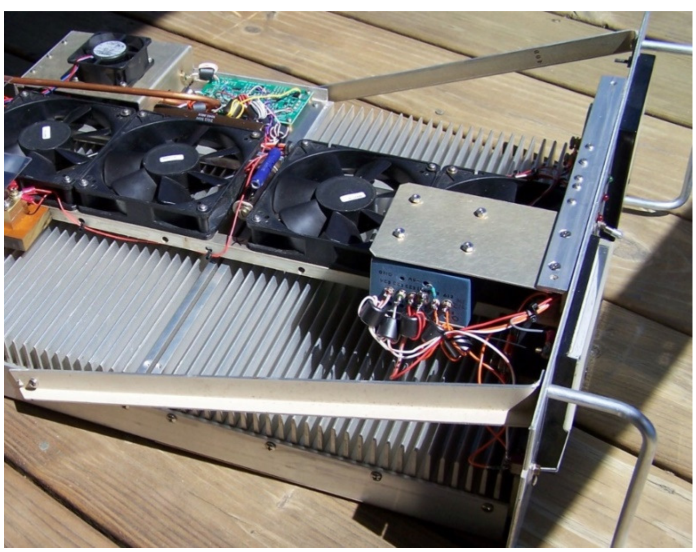
The W6PQL control board provides a good level of protection for any FET amplifier. It will detect over heating in heat sinks, as well as high output VSWR that could destroy the FET. The MRF151G can withstand a 5:1 VSWR at any angle, so this protection circuit will be very effective. What it will **NOT** do is protect against a high voltage pulse into the gate circuit. This failure mode is the most common one for

FETs. The best way to protect the input is to set gains of your exciter at maximum and then use attenuators to adjust that maximum power level at some safe value good enough to drive the amplifier.

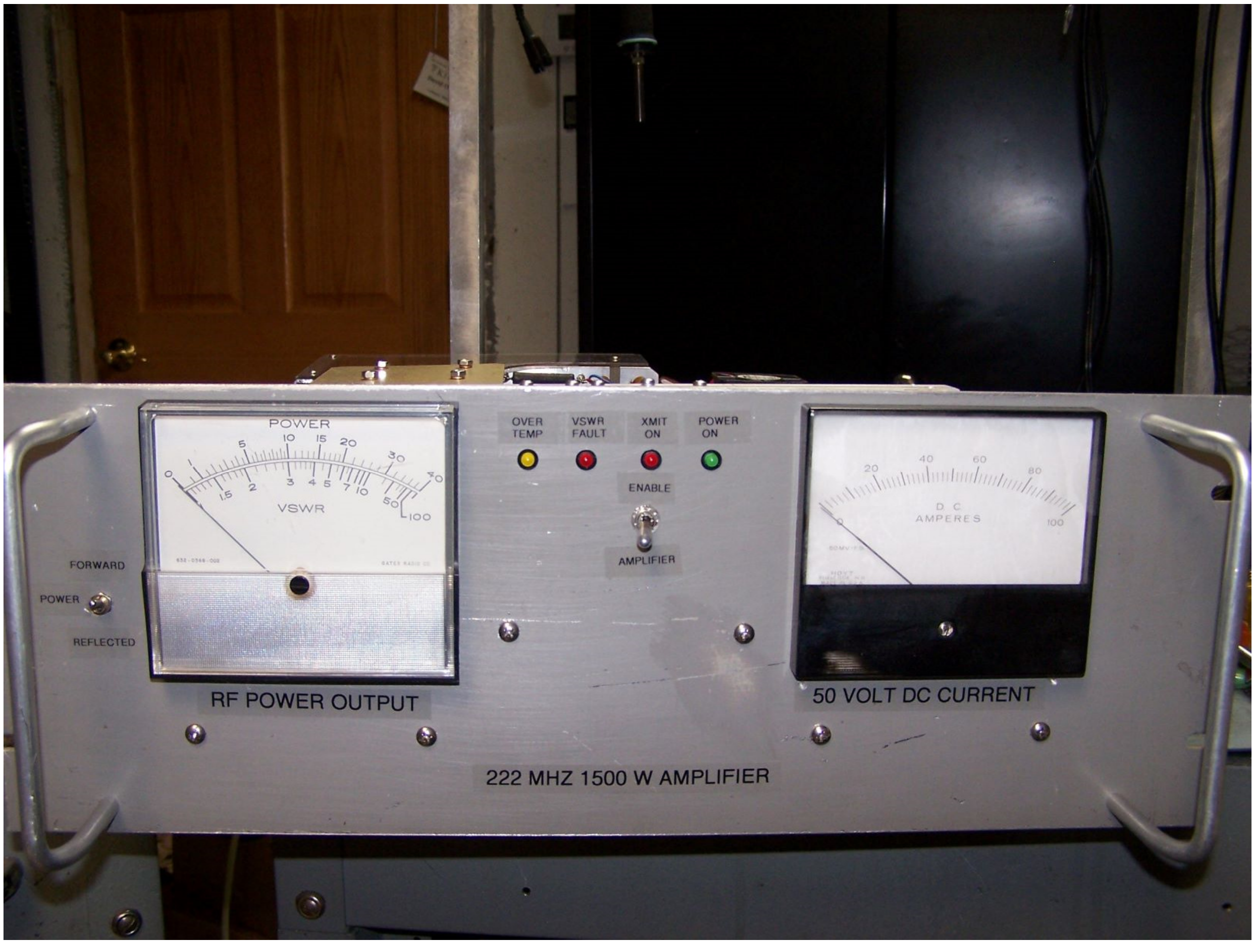
The W8ZN method of modifying the Larcan heat sink / PC board mechanical setup was employed [2]**.** I installed two ¾"X1½" aluminum channel pieces on each side of the amp following Terry's excellent directions. That allows putting a cover over the rf components to protect them from damage. The existing small aluminum rails were originally attached with 8-32 hardware. I drilled the new larger channel pieces to match the existing holes and used the existing hardware. The end result is a nice looking pallet. I attached a 1/8" aluminum front panel to the front of the heatsink and then added two braces as shown in the pictures to give the front panel adequate support. It is quite rugged now.

Aluminum channel stock is used for the side rails. Size is ¾ X 1 ½ X 1/8" wall. (This picture is of a 4 FET amp)



Another view of side rails along with the front panel braces. I used 1/8" aluminum angle bracket material. Panel braces are needed to properly support the 1/8" thick aluminum front panel.

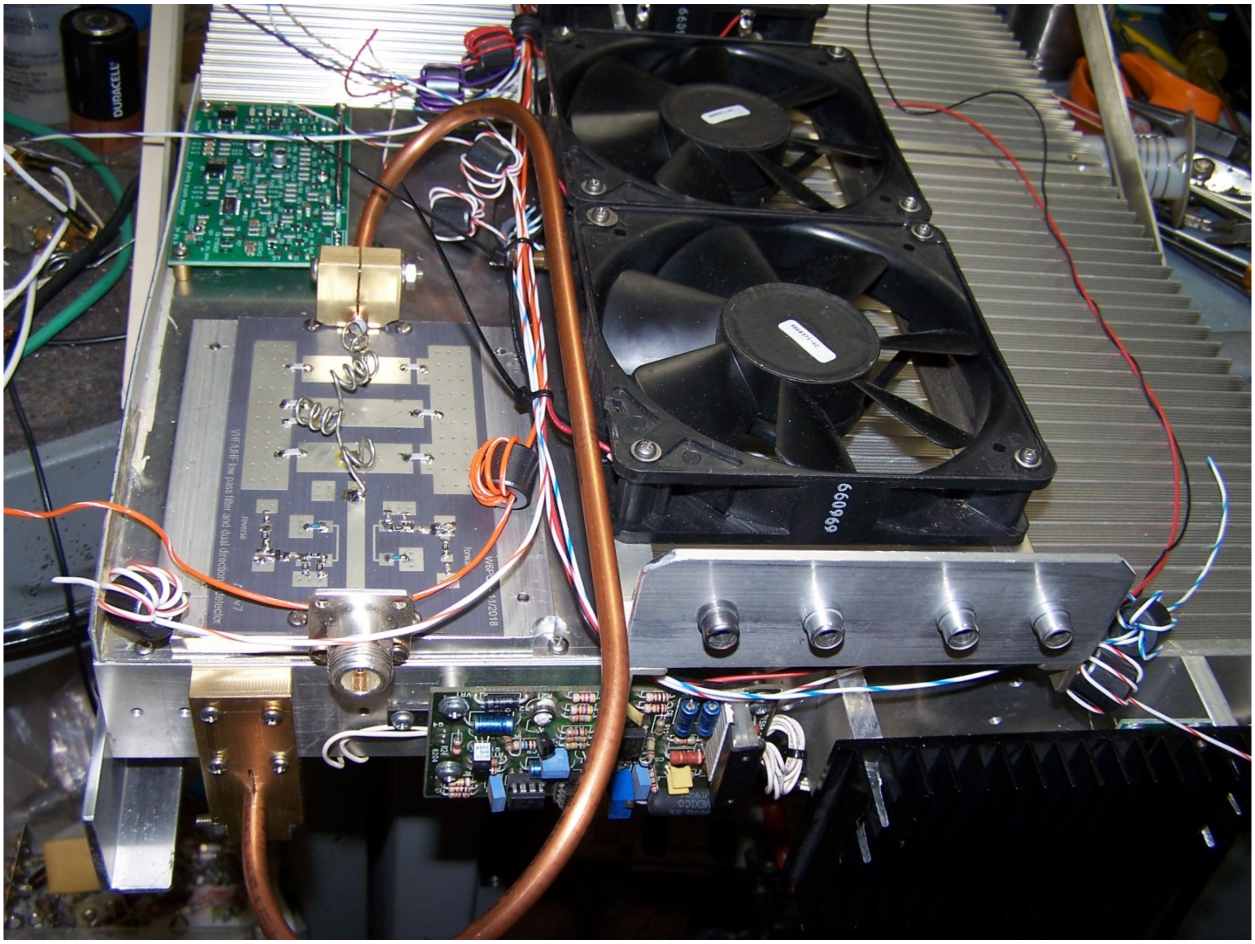


Front panel view of the converted 1500 watt Larcan 222 MHz amplifier

The amplifier is built into a 4U 19” relay rack panel (7”) and has two analog meters on the front panel. The right hand meter is a DC current meter measuring 100 amps full scale. The left hand meter is a nice RF power meter with a 0-40 scale, so a setting at 1500 watts will be approximately at mid scale. Unfortunately the W6PQL filter and FWD/REFL power sensor board does not have enough output to even begin to push the meter anywhere near the proper point. My solution is to incorporate an OP AMP circuit to isolate and boost the forward and reflected output voltage to properly drive the meter.

There are four LEDs mounted on the front panel. These are supplied with the W6PQL control board. A green LED at right indicates that power is ON. The next LED is the TRANSMIT LED, followed by a high VSWR Cutout alarm, and then an over temperature alarm indicator. The small switch under the TX LED is an amplifier enable switch. It energizes the sequencer on the control board.

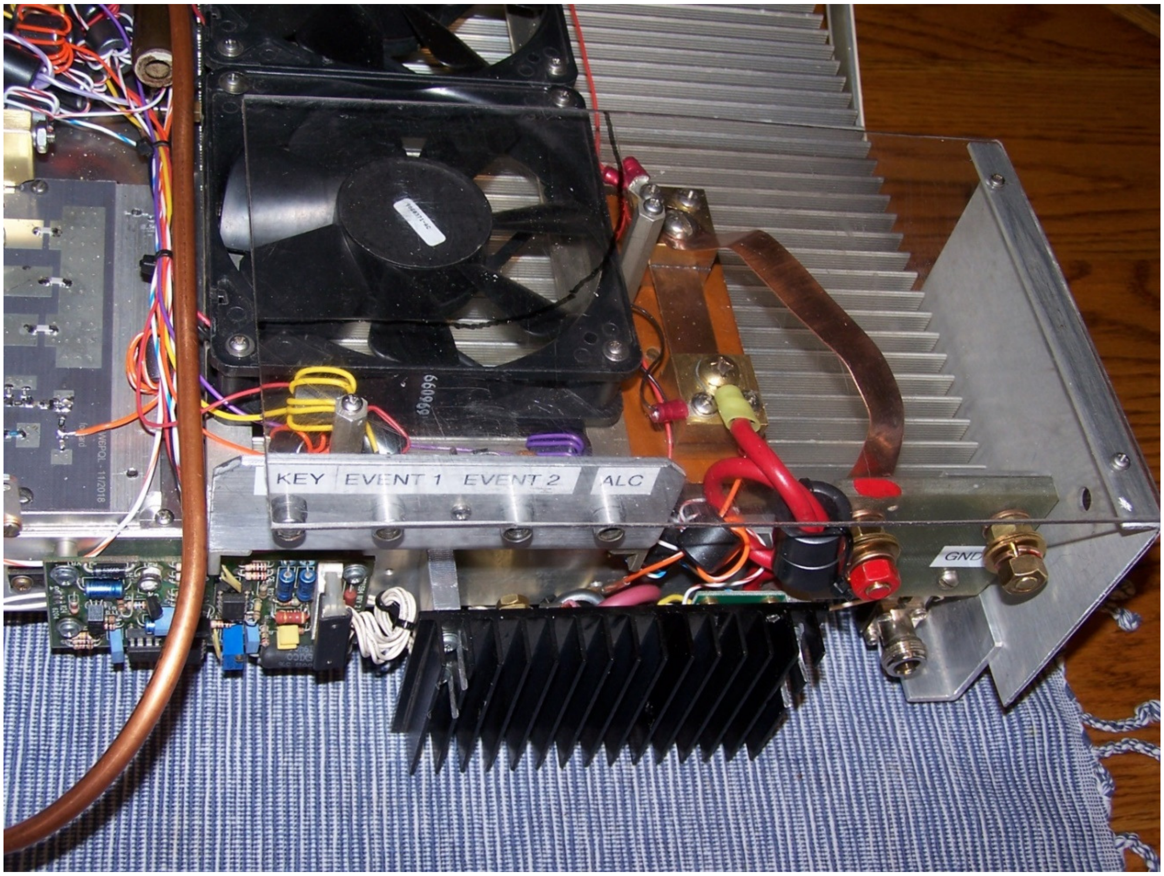
As common with many Larcan conversions, I have installed four 12 volt muffin fans along the midpoint of the large heat sink to help remove heat from the pallet. The fans run off the 50 volt DC supply and are wired in series. They are mounted about 1 inch above the heat sink fins and blow air down and across the fins. I used the original Larcan side rails removed from the heat sink to mount the fans. I provided a power resistor of about 75 ohms to limit the current to the fans and slow them down so they make less noise. There are about 8.5 volts going to each fan rather than the rated 12 volts. This voltage dropping scheme can be altered to adjust the amount of cooling needed in your particular situation.



This is a photo of the back of the amplifier while under construction. The RF filter board sits on top of the main heat sink. The W6PQL Control Board is seen in the back ground just behind the RF filter.

The RF output from the Larcan output combiner is routed through a short length of UT-250 semi rigid coax to allow the filter board to be mounted above the heat sink along with the W6PQL control circuit board. All of the wiring to the control board is fitted with small 43 mix ferrites in an effort to keep rf out of the protection and power measuring circuits. The UT-250 is held down with some custom made brass parts that have been slotted and fitted with 8-32 hardware to allow clamping down the UT-250 as it exits the main PC board and then connects to the filter board up on top. UT-250 coax is rated at 950 watts at 500 MHz, so 1500 watts at 222 MHz is possible and within ratings.

I did provide a small rear panel to accommodate four phono jacks for interfacing other equipment and coax relays. From L to R, they are KEY (PTT in), EVENT #1, EVENT #2, and ALC to inhibit the exciter. ALC is EVENT #3. The ALC jack has a few volts present on receive (-3.5 VDC), that can limit RF output of an exciter, or you can rig up a small transistor switch there to control anything else.



Here is the right rear portion of the amplifier. The Larcan protection board is on the left. The black heat sink in the middle contains the FET DC switch. The 50 volt power terminals are on the far right.

I installed two 5/16” brass lugs for the 50 volt DC power. The lugs are mounted on a ¼” thick fiberglass bracket. That bracket is fastened to the heat sink with tapped holes and 8-32 hardware. The positive 50 volt lead is then connected to a home brew 100 amp shunt for the current meter. The output from the shunt then goes to the black heat sink mounted on the rear of the amplifier to the right of the existing Larcan protection board. This heat sink contains a 50 volt DC FET switch that is also available from W6PQL [4.] For this application, I figured that I needed two FETs there in parallel to handle the high current from the six MRF151Gs. A second plastic 48 volt P FET is mounted on the heat sink and wired in parallel with the existing P-FET. The big red wire from the shunt is fitted with #43 ferrites before and after the DC switch. The output of the DC switch that feeds the six devices, connects directly to the 50 volt buss.

A protective plastic cover is installed over the exposed 50 volt components. It was provided to prevent falling tools from shorting out the 50 volt buss! The available current there is massive to say the least.

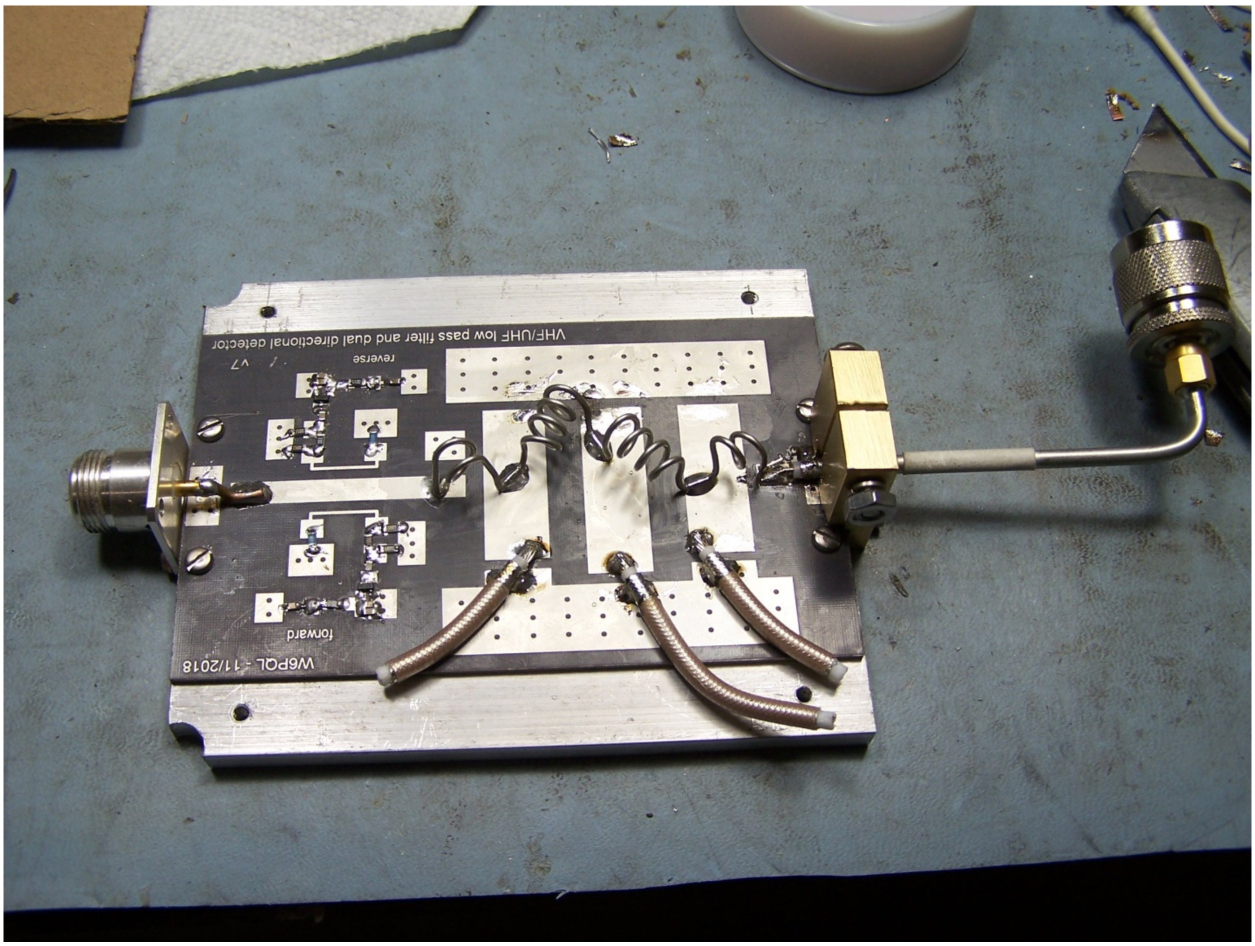
In operation, this design will handle the change over from receive to transmit in a much different manner than that proposed by W8ZN. Terry controls the bias voltage, while leaving 50 volts on the drain connections. Using a W6PQL control board, a sequencer is built in with three time levels or events. Event 1 can turn on coax relays. Event 2 will connect 50 volts to the amp, while event 3 can allow the exciter to make RF. The advantage of this method for switching the 50 volt buss, insures that there is no way that RF can be generated unless the amp is keyed. With the bias turned off and 50 volts of drain voltage applied to the FETs, there will be plenty of RF generated if drive power is accidentally applied to the amp. Disabling the 50 volts is fool proof. There can be no RF exiting the amp.

A few words about the Larcan protection board. It was designed to allow hot switching of the individual amplifier modules in a TV transmitter. We do not need hot switching, so much of the design sits unused, but it does have a high VSWR protection function that will remove bias to all of the FETs if a high VSWR is encountered. It does add a bit of protection, and I left things as is for that reason. Part of the hot swap circuitry involved charging electrolytic caps before the actual drain voltage is applied to the FETS. A Step Start voltage comes in early on PIN 8 of the Larcan board. There is a second 50 volt connection back to the 50 volt drain circuits via PIN 2. R5, a 10 ohm 1 watt resistor limits capacitor charging current and provides a soft start. That other connection on PIN 2 must be dis connected if you use the W6PQL 50 volt DC FET switch to disconnect the drains from 50 volts. Otherwise, current from PIN 8 will flow through R5 and try to power the six FETs when you are in receive or standby! Make sure that you disconnect PIN 2 where it connects to the RF board on the big Larcan RF board, or you will burn up R5 and have voltage on the FETs while R5 is cooking!

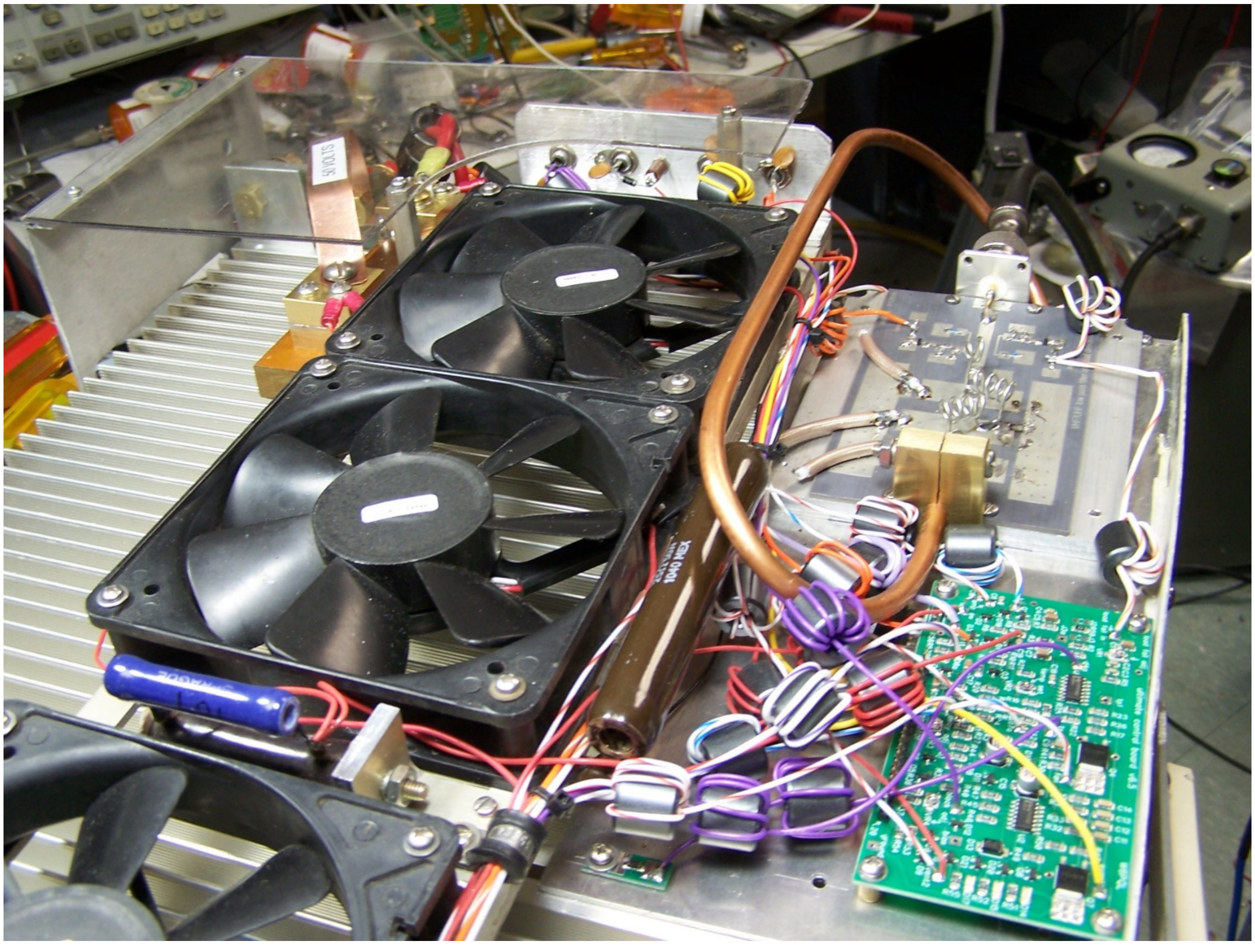
Having a DC FET switch to control the status of the rf amplifier does allow a higher level of protection for those expensive FETs in the amplifier. The W6PQL control board does provide a fast error signal pad to disable the 50 volt buss line at the DC switch. It is labeled “Kill” and immediately turns off the switch should a high reflected power indication appear. The W6PQL 222 MHz RF filter board contains a directional coupler and the reflected power output is routed back to the control board for monitoring. While testing my amplifier, I ran into a small problem with the filter circuit. I had been power testing the amplifier and had no trouble at 250 and 500 watts. Unfortunately, when I increased the input power to get 1000 watts output, I only had about 15 seconds to watch the output RF meter before a huge flash and bang caught my attention. It was as if a flash bulb had gone off. One of the high power chip caps on the filter board self- destructed in true 4th of July fashion. The explosion left a small crater where the cap used to be! It got me to thinking that the filter failure was before the reflected power sensor and the DC switch probably was not triggered off. I mentioned this shortcoming to Jim, W6PQL, and he said that putting the directional coupler before the filter was not a good idea due to the relatively high level of harmonic content in FET amplifiers. Vacuum tubes can achieve a -45 dB harmonic content, while a typical FET will struggle to get under -25 dB. The harmonic content will introduce errors in reflected power readings. Still, I worried that a failure prone filter could cause a disaster and some ruined FETs.

The solution appears to be a more robust RF output filter. W6PQL has a very QRO filter option that uses Teflon coax capacitors instead of the normal chip caps. For this amplifier setup with a 1500 watt capability, you must use the higher power option 222 MHz filter. The chip caps will not withstand 1500 watts output. The teflon coax is of the low impedance variety, so a short piece will have more built in "C" than typical UT-141 50 ohm coax. Values needed for the 222 MHz LPF are 10 pf and 13.5 pf.

So how do you hook all this stuff up? There is considerable documentation on Jim's website, W6PQL.com. A careful reading of his instructions is highly recommended.   I had a few questions, but things came quickly into focus as I started connecting things up. There are many options available with the control board. I used most of them or at least had them available for future use.



The W6PQL 222 MHz Filter modified for high power. Substrate is some ¼" aluminum plate. The chip caps have been replaced by short lengths of Teflon coax. This particular filter measured -48 dB at the 2nd harmonic, and -60 dB at the 3rd harmonic frequency. Return loss through the filter is over 30 dB.

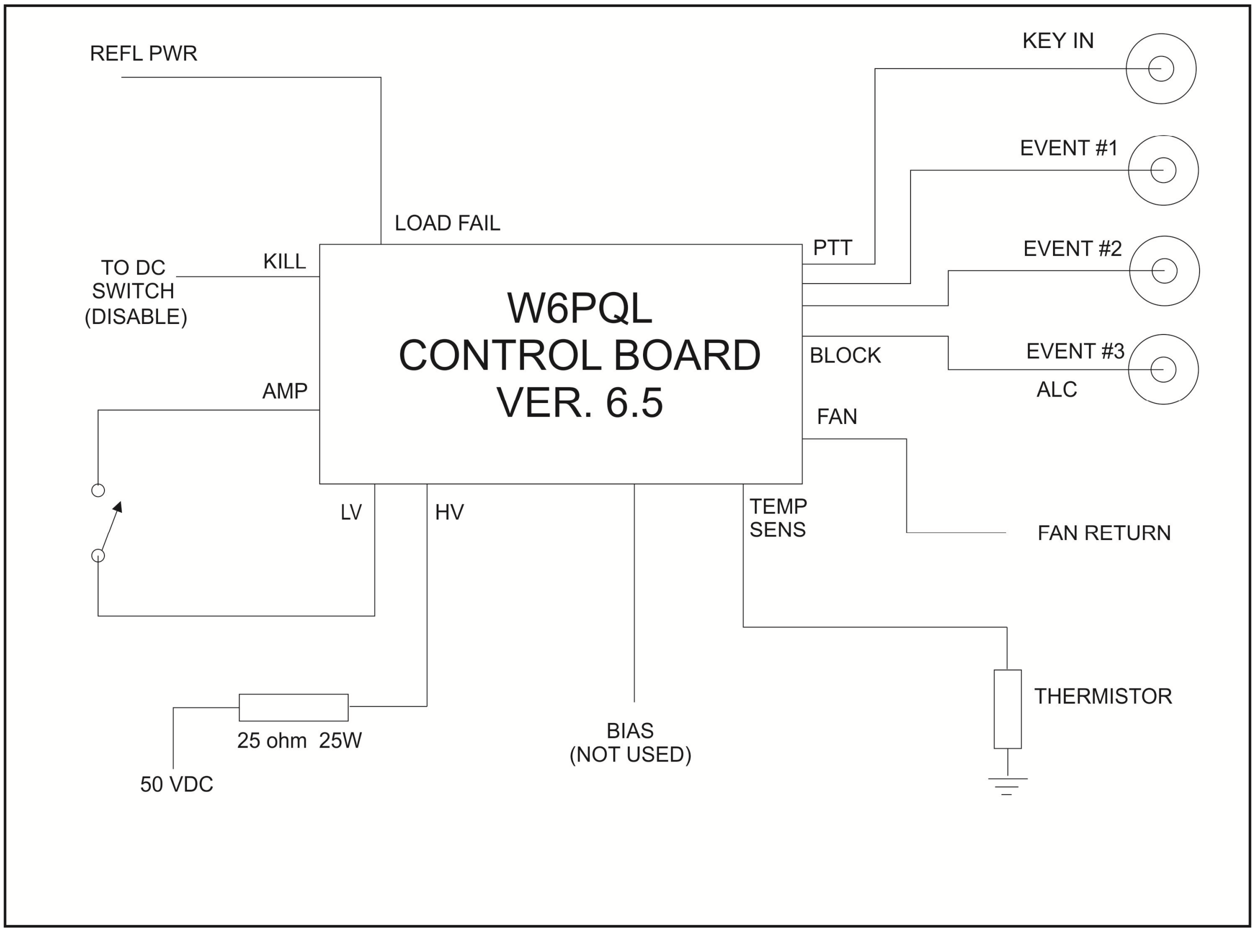


A detailed view of the W6PQL Control Board. I wired all of the connections to the top of the board. I also used some mix 43 toroids on all of the connecting leads to control any RFI problems. For best results at 222 MHz, use no more than three turns of wire on each toroid.

There is an amplifier bypass circuit that must be wired up or the circuit (and the amplifier) will be inoperative. In bypass mode, coax relays can bypass the amp, while in operate mode, the sequencer portion is activated and the amplifier will key up normally. An external switch is located on the front panel and it applies 12 volts to the "AMP" terminal on the circuit board when you want to activate the amplifier. The AMP terminal must have 12 volts wired to it or the control board will not operate!

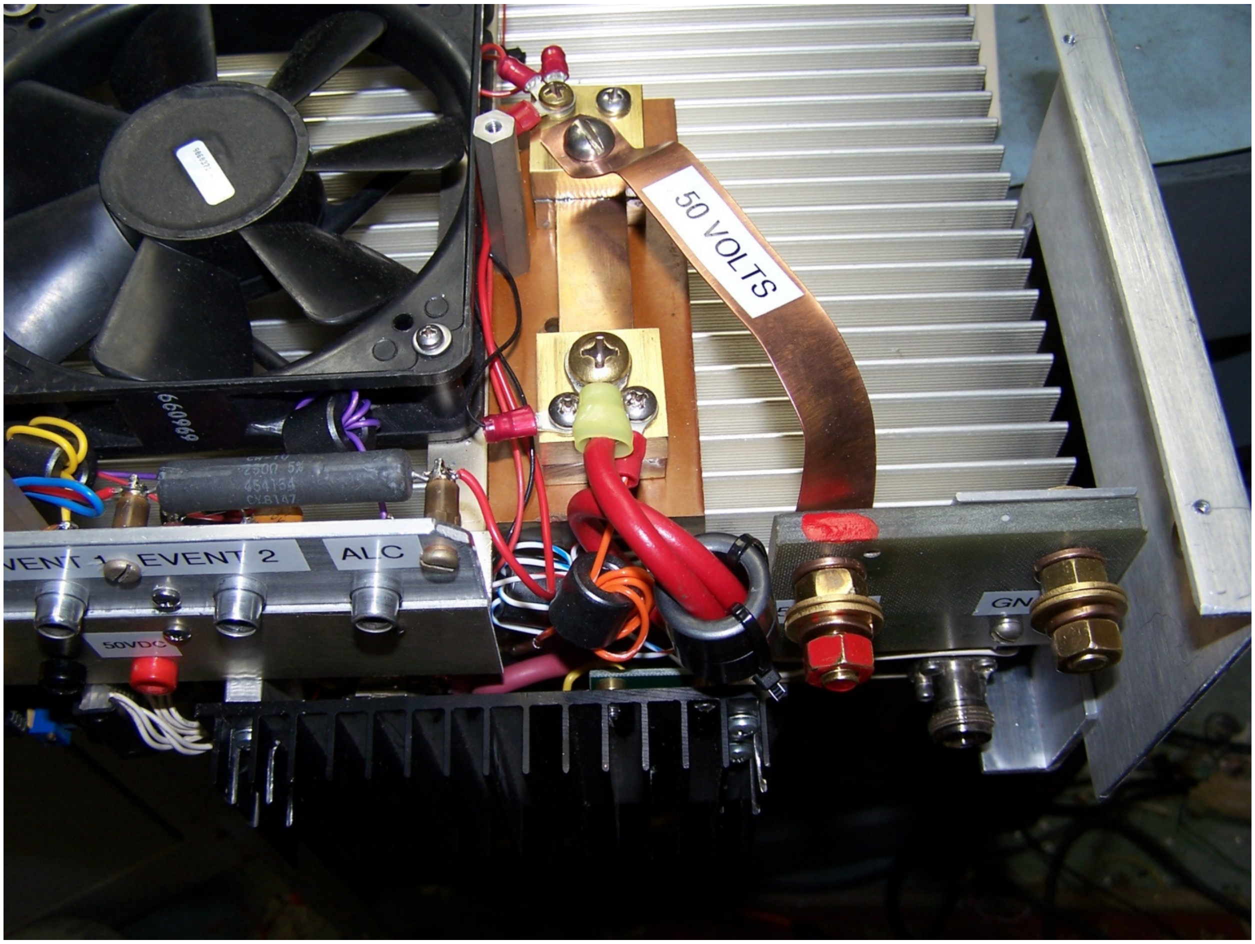
Other provisions available include fan control and a 12 volt bias enable signal. You can have the circuit board provide sequenced bias voltage to the FETs. In my case, I left the Larcan bias system in place. It provides a 39 volt DC level to the Larcan RF board. In the future, I could change some resistor values and use the control board to turn bias on and off in a sequenced procedure.   The fan control circuit activates the fans when the amplifier is keyed up and producing RF. The fans shut down during receive periods.

When the heat sink heats up above a certain point, the fan will run continuously (Receive & Transmit). Should the temperature continue rising, it will eventually shut off the amp until the heat sink cools off. There is an LED high temperature warning indicator, as well as a high VSWR trip LED on the front panel. The remaining LEDs include a TX indicator and an amplifier “ON” LED.



Wiring diagram for Version 6.5 of the W6PQL Amplifier Control Board. The switch shown between the LV & AMP terminals must be included to connect 12 vdc to the “AMP” pad on the board.

There are more connections available on the circuit board. The extra terminals allow connecting up the outboard LEDs etc. I have tried to properly label each point used in the diagram to avoid confusion. The thermistor shown in the above diagram is supplied with the board kit, and should be directly installed on the amplifier heat sink. I located my thermistor in the middle of the heatsink near the FETs. As mentioned earlier, the BIAS connection is a sequenced source of 12 volts that could be used to bias the FET(s). In my case, I already had a working bias circuit in the Larcan amplifier, so that connection was not used. It could be used for other tasks however. The +12 volts at that point is turned on at EVENT #2.



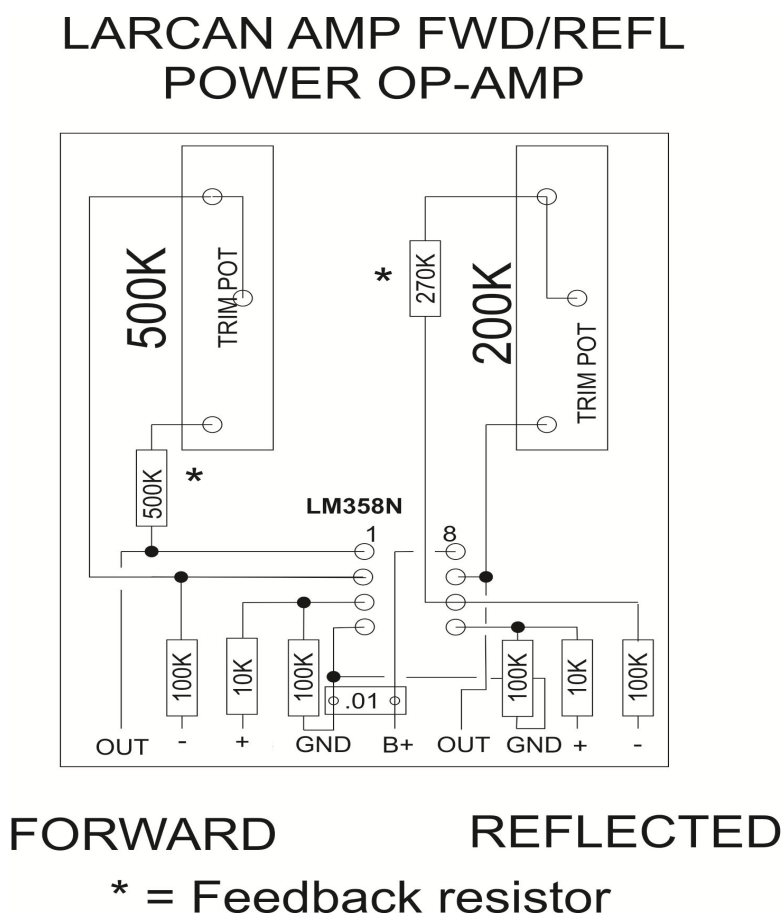
Close up view of the home brew 100 amp shunt and the fiberglass DC input panel. I used 5/16" brass hardware. The negative terminal is directly grounded to part of the aluminum chassis, while the positive lead runs over to the shunt. The big red wire and ferrite donuts attach to the FET DC switch mounted on the black heat sink that extends behind the main chassis/ heat sink.

The final task in this project was to fashion some sort of analog RF output meter circuit. The directional coupler forward power is attenuated by about 16 dB and it will not drive a meter directly. Reflected power is attenuated by about 6 dB for proper action of the control board protection circuit. I added an OP AMP using an LM358N dual Op-Amp 8 pin plastic package. I worried that an analog meter might load down the reflected power line and cause a potential problem. The op amp input is extremely high impedance and serves to decouple both circuits. The two channels have different gains to accommodate the two different output levels of the forward and reflected power monitors. I mounted the circuit on a chunk of perforated board near the big 3" square meter used to indicate forward and reflected power. The LM358 runs on 12 volts stolen from the LV terminal on the control board. I included two multi turn pots on the board to set the proper forward and reflected power levels. The forward indicator requires

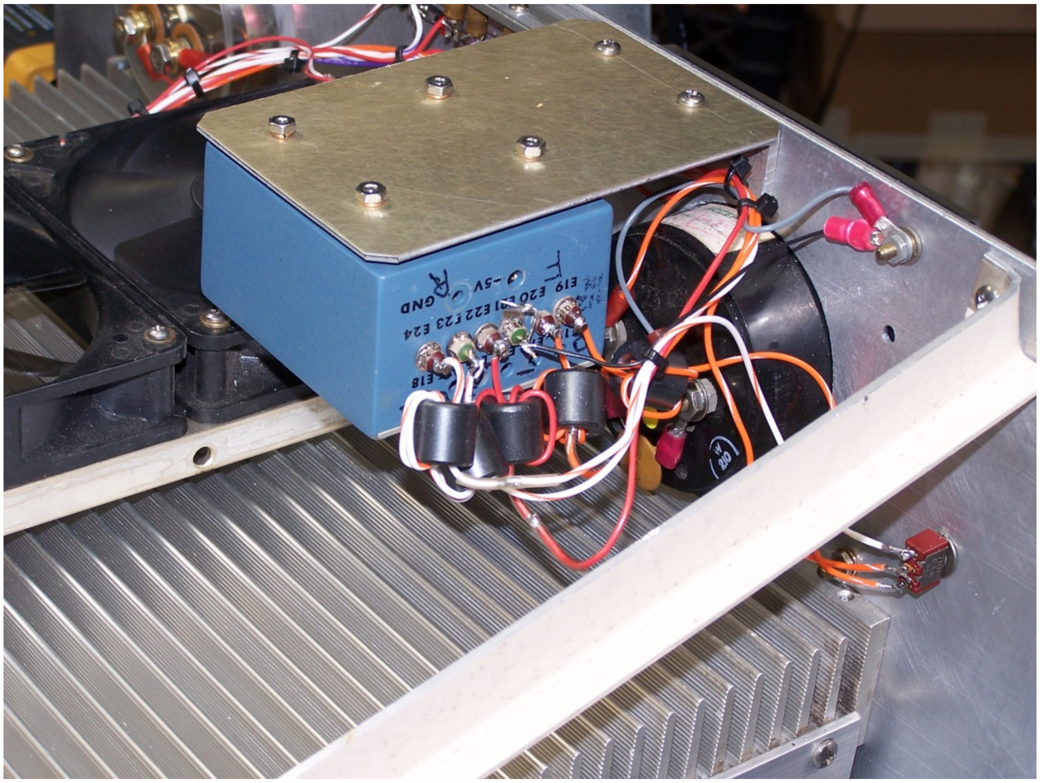
A bit more gain than the reflected power side needs, so the gain of the reflected channel is less than that of the forward power channel. I have included a typical layout for a 2.0 X 2.5” perf board. I really wanted to use a large analog meter rather than the commonly used LED bar graph type displays. My old eyes seem to do better with wiggling meter pointers than with blinking LEDs. Some adjustment of the gain may be required for your particular meter. This is easily accomplished by varying the “feedback” resistors. A one meg overall value is good for 10 dB gain. Lower values provide less gain. I needed much less. In my case, I reduced the feedback resistors to 15 or 20 Kohms, and adjusted the pots.

There is nothing unusual in the circuit for the LM358. I use the negative inverting input, and the analog meter is attached to the output pin. The circuit is directly off the LM358 app note!

I needed a good way to attach wires to my ugly looking perf board, so opted to mount some silver plated stake on terminals so it could attach it to the outside world. If you make a printed circuit board outfitted with plated through holes, you can do away with the terminals and still have a trouble free design.



OP-AMP Circuit for both forward and reflected power indicators. The trim pots are 500K/200K ohm units and are used to set the proper meter calibration for your particular indicator.



OP-AMP METER DRIVER BOARD in an RF proof enclosure is mounted on the front panel near the power meter. There are two multi turn potentiometers inside the enclosure that adjust forward and reflected power through two access holes. Note the front panel side brace.

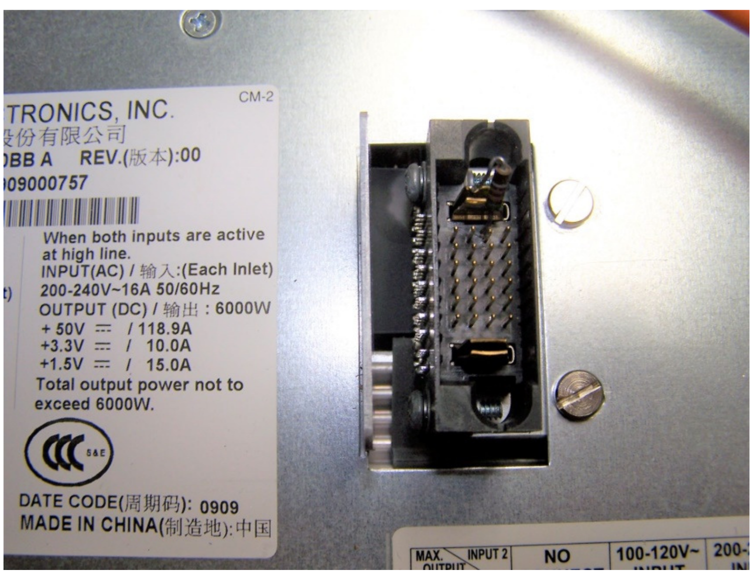
All of the wiring that connects the control circuit board to the various sub systems is liberally sprinkled with #43 mix toroids to reduce any RFI problems with 222 MHz energy getting into sensitive circuits. I used two different sized toroids. The larger size, a Fair Rite product, PN: 5943000501 for big 50 volt primary conductors, and smaller ones, Laird PN: 28B0562-100 for everything else. At first, I wound 5 or 6 turns of wire on each small toroid only to find that distributed capacitance was destroying any choking action at higher frequencies. Six turns works very well at 50 MHz, but not so well at 222 MHz. My advice is to wind only 3 turns maximum for 222 MHz use. I also experimented with some small multi hole cores and threaded 3 turns of #22 bare wire through the holes and tested the effectiveness. They were about the same performance as the #43 toroids and took up a bit less room. Typical suppression at 222 MHz ranged between 20 and 25 dB for two or three turns with either core.

I also found that 222 MHz RF was getting into the LM358 op amp circuit and causing measurement errors. At first, I did not use any toroids on the meter wiring, and even after putting ferrites on all of them, still found that RFI was influencing the readings. I ended up re packaging the LM358 circuit board inside a metal housing and ran wires through the side of the box with feed through capacitors and RF

Choke inductors. Putting the op amp in an RF tight box was a big help. I put a 3.3K limiting resistor in series with the output connection going to the analog meter. The LM358 provides a very high impedance input that will not load down the VSWR bridge circuit. The output impedance is very low and it will drive the analog meters even when set for very low gain. You want to keep the gain as low as possible, and make sure that the input leads are well bypassed for RF. As I mentioned, I ended up putting the entire meter amp circuit in an RF tight box!

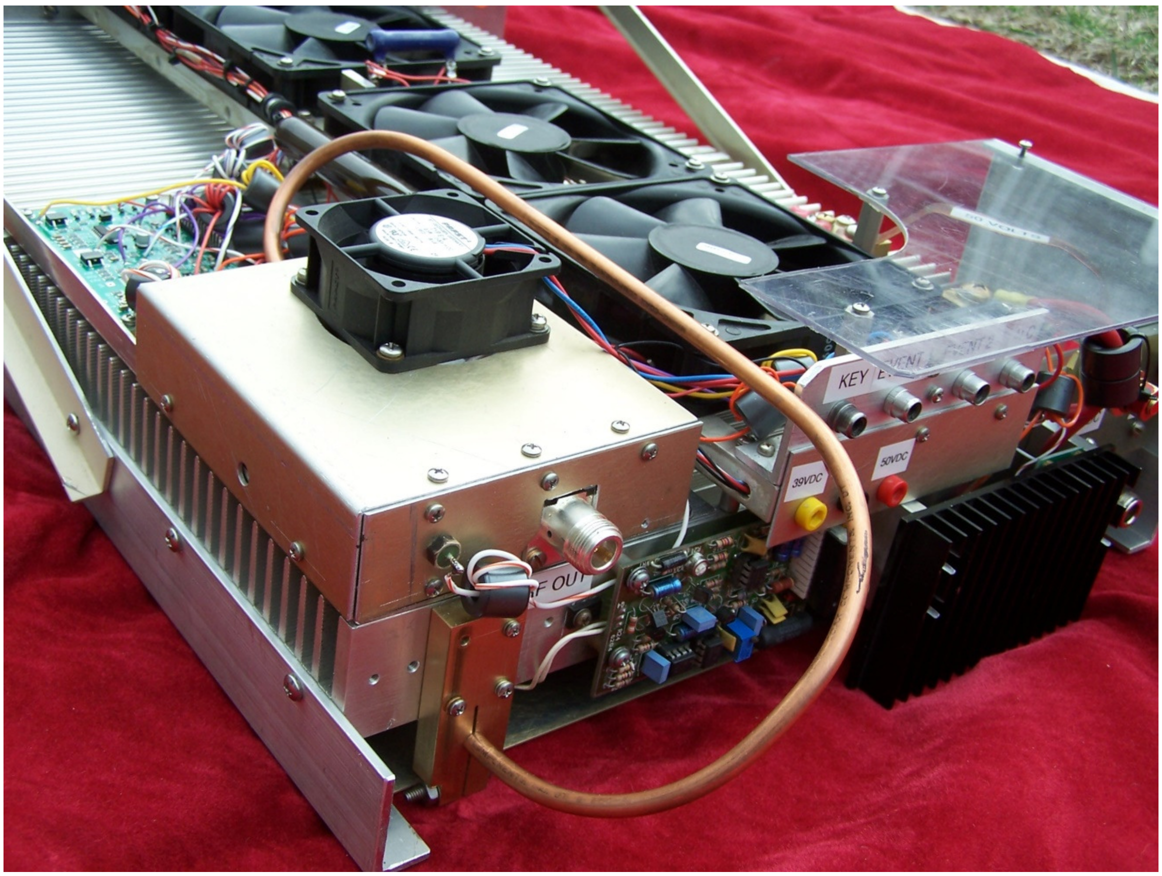
My 50 volt power supply is a rather loud Cisco Systems 6000 watt unit that runs on 240 VAC single phase. (Model # DPST-6000DB A) They occasionally show up on E Bay. Check the part numbers carefully. Some related versions do not supply 50 volts. There are two fans on the top that rev up quite loudly, so I have the supply mounted on the floor behind all of the equipment in hopes of deadening the noise a bit. It will supply up to 119 amps at 50 volts. The more commonly used HP Blade power supplies will produce 57 amps and KL6M has reported that his 1500 watt Larcan amp will overload his Blade supply in the 1500 watt output digital modes. The 57 amp rating is OK for CW and SSB service though. I made the 50 volt connections with heavy copper cables fitted with many 43 mix toroid donuts applied in hopes of keeping DC loss down and taming any common mode RF currents induced on the DC wiring.

There is a trick needed to enable the Cisco power supplies. Thanks to Chris, W1TE for figuring out the trick. With the power supply laying on its side, Connect a small 500 - 1K resistor between the third pin to the right on the top row of small pins to the adjacent large two part blade connector on that multi pin connector. See the picture below.



Cisco DPST 6000BB Power Supply. "ENABLE" connections to activate the 50 volt output. Connect 3rd pin from left on top right (as shown) to the adjacent large blade connector pin with a 500 to 1K resistor.

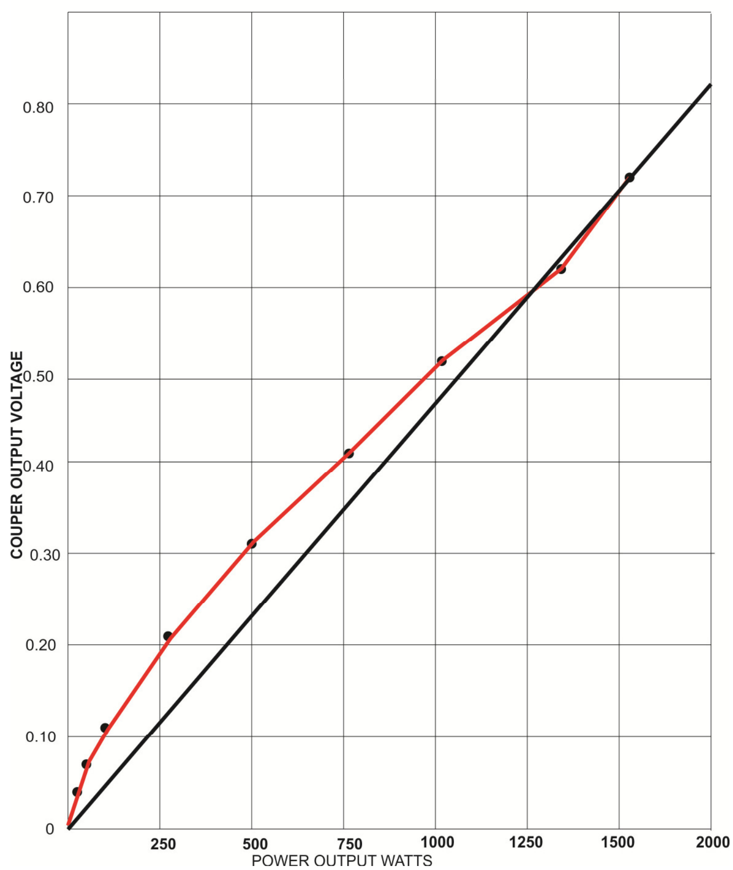
In testing the amplifier, I was curious to see what kind of heat rise I should expect with my cooling system. The four 12 volt fans are in series and a dropping resistor limits voltage to about 8.5 volts per fan. You can hardly hear them in operation at this voltage. After running several sequences of 45 seconds at 1000 watts output, the heatsink temperature only rose 10-12 degrees. This is with the fans only running during TX periods. I did note that the RF filter coils get quite hot at 1000 watts output. I did not have much air passing over the filter, so I added a small fan over the filter on an aluminum cover in an attempt to keep that part cool as well. I reduced the voltage on fan #2 as well, and it provides enough cooling with very low audible noise. At full output, the RF coils do not overheat and all seems fine with the added air.



This is the final version of the amplifier with a metal enclosure over the output filter. Note the cooling fan to keep the filter components cool. It is a small 24 VDC fan with a 500 ohm dropping resistor from the 50 volt buss to limit noise but still provide adequate cooling for the filter coils.

The RF filter may be the weak link in this amplifier design. Fatter, silver plated coils with Teflon capacitors might be a good avenue to proceed with in the future.

222 MHZ LARCAN POWER CALIBRATION CHART

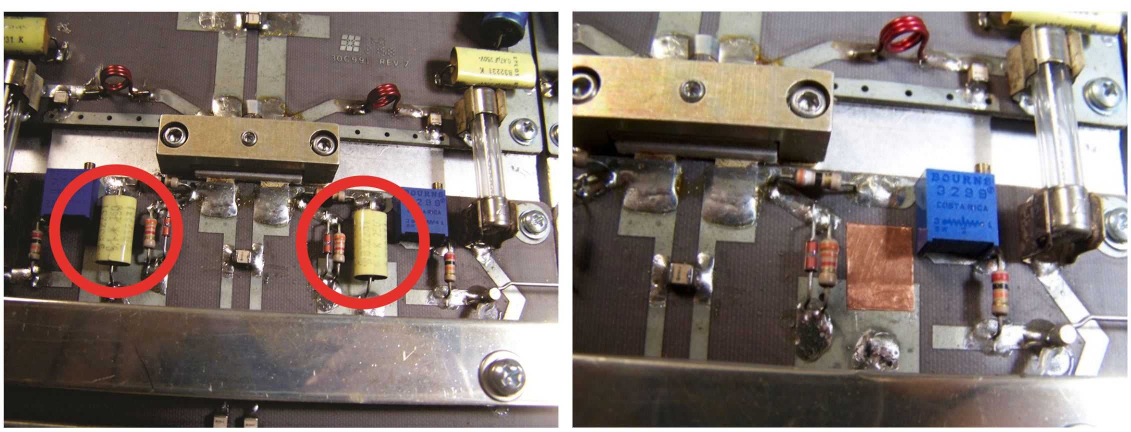


The SWR fault level pot is on the W6PQL Control Board, and is set at approximately 0.40 VDC as measured at the output of the directional coupler output. I set the gain of the LM358 to indicate a VSWR on the meter at about 2.5:1 for that trip level. This is not a real accurate SWR reading, but it does give a relative indication of what your typical reflected power is and lets you know if you are close to the trip out point. I made a calibration curve of the forward power output from the directional coupler and it is not all that linear, with a rather large upward swing of voltage at lower powers. I tried a few load values on the output, 6.8K, and 4K. Results were pretty similar. I ended up calibrating my meter to read accurately at 1000 watts output. It will also indicate about 1500 watts, but lower power amounts will read below where they should be. I view the analog power meter as a relative output indicator.

In the interest of quick troubleshooting, I added voltage measurement terminals on the back of the amplifier to indicate the internal bias level (39 VDC) and the internal 50 volt buss bar that feeds all the FETs. These voltages are not easily accessed as they are located underneath the big heat sink and not easily reached. The two test points are a nice touch. In my opinion, you cannot have too many monitoring points! With the test points, I can then compare the 50 volt input voltage with the 50 volts after the FET DC switch, and check its switching function with a minimum of fussing. Should the FET switch malfunction, a quick connection to the 50 volt test point will show it, and save lots of time.

Many people have reported that some RFI is generated by the high power 50 volt switching power supplies. It is a good idea to check out your power supply when all is connected up and monitor your receive noise floor as the power supply is activated. I added #43 toroids in quantity on each power supply lead from my 50 volt supply. You might want to address the 240 volt primary wiring as well. I have found that my old Alan Broadband RFI sensor, the Zap Checker,[5.] is a good instrument to use when looking for the origins of your RFI. Make sure your PS is RF clean before you put all into operation.

One other point, not to be overlooked, applies to the four FET 1000 watt Larcan amplifiers for both the low and high VHF TV channels. Be careful and check the bias circuit bypassing. The four FET amp versions have sketchy bypassing techniques in the bias circuit. Apparently, there are a few revisions of these things. Some folks have reported stability issues. The six FET 1500 watt amplifier design has a nice chip cap bypass capacitor just after the adjustable pot and before the series resistor that connects the positive bias voltage to the gate lines. The six FET design seems to be OK. This was pointed out to me by Fred, N1DPM. He and John, K1OR were fixing up a mis behaving 1000 watt 222 MHz amplifier that had stability issues. Much of that problem was created by mouse pee that caused corrosion around the FET and heatsink, but another problem was determined to be minimal bypassing at the bias pot junction with that 39 or 51 ohm resistor connected to the gate on each side of the MRF151G Gemini package. There is only a polyester cap of 0.01 MFD at that point, and it has longish lead lengths. This can cause unwanted coupling between gates on different FETs. The solution is to solder some copper flashing under that removed yellow capacitor and put two chip caps to ground from that flashing copper/ bias junction. I used a 0.500 x 0.350" piece of copper foil as shown below. Good chip cap values are 1000 pf and 0.01 MFD. N1DPM also said that you should check your work by powering up just one stage at a time with a heavily current limited power supply to check for stability. Slide the chip cap across the input lines closer to the FET and the wider portion of the lines. If the stage oscillates, the FET will be protected by the current limiting. Or you can take his word for it and just install the chip cap bypasses!



A View of the bias circuit of the four FET 222 MHz Larcan amplifier. The yellow polyester cap on the left photo is the only bias bypass capacitor and it has rather long leads especially for 222 MHz. The 0.50" X 0.35" copper foil addition can be seen in the right photo all ready to accept the two chip cap bypass caps. NOTE THAT THESE CHANGES ARE NOT NEEDED IN THE LARGER SIX FET AMPLIFIERS.

I have observed several FET failures while running the Larcan amplifiers on 50 MHz. Happily, I have had no failures on 222 MHz (yet). Once, I ran the 50 MHz amplifier into no load, but at other times, I simply ran the amplifier at a much higher frequency and had a FET mysteriously flash over and die with the blue flame of death. I suspect that was a stability problem. The Low Band TV amplifiers had different gate bypass caps depending on whether it was a Lo-Lo or a Lo-Hi version. The Lo-Lo amp used 0.39 MFD, while the Lo-Hi units were 0.1 MFD. As far as I can tell, all of the High VHF 222 MHz 1000 watt amplifiers had just the 0.10 MFD leaded capacitor and they should be replaced. The take away message for you is to please check your bypassing before you deem your amplifier ready for prime time.

The end result of all this preparation is a very nice performing amplifier that is capable of the full 1500 watts output for CW, SSB, meteor scatter, and the continuous digital modes. By utilizing the W6PQL control board with the Larcan pallet, some added protection benefits are obtained over the standard Larcan protection circuits. Having a fool proof protection method in place is a prime requirement for any amateur FET solid state amplifier. The converted Larcan amplifier looks to be a good reliable amplifier for use on 222 MHz. Drive power is reasonable at about 40 watts with about 16 dB of gain. The large heatsink with the forced air cooling will allow digital modes at full output. Make sure that your RF output filter is up to the task before you attempt any routine digital mode operation. Remember that harmonic output levels are quite high with solid state devices, and that your filter will take the brunt of this situation! Be sure your filter is adequate. Be absolutely sure that your driver amplifier is also running at full power and has an attenuator in the output to adjust the maximum output power to a non- lethal (to the FET gate) level. You do not want any high voltage pulses going into the gate of your FETs! I hope that some of the ideas used in this amplifier project will help you in the planning and construction stages of your 222 MHz amplifier. Good luck on 222 MHz

Footnotes

1. 220 MHz 8877 Amplifier, Robert I. Sutherland, W6PO, Ham Radio Magazine, June 1980

2. Larcan Hi Band Amplifier Conversion, Terry Price, W8ZN 2013 CSVHF Conference presentation

   https://directivesystems.com/information/tech-notes/larcan-high-band-sspa-conversion-222-MHz

3. https://www.w6pql.com/amplifier_control_board.htm

4. https://www.w6pql.com/high_current_solid-state_dc_switch.htm

5. https://www.cryptomuseum.com/df/zap/index.htm

General Larcan information:

1. https://www.mmra.org/larcan/
2. https://members.rennlist.com/warren/larcanamps.html
3. https://ac0c.com/main/page_acc_shack_larcan_kw_6m_amp.html
4. http://www.users.on.net/~pedroj/larcans/
5. https://dxnews.com/forum/forum/amplifiers/6010-zs4tx-larcan-6m-amplifier-modification
6. https://www.manualslib.com/manual/1352474/Larcan-Dtt250m.html?page=16#manual

Appendix A

Coaxial Relay operation. The W6PQL Control Board will easily handle the coax relays used in almost all situations. My implementation had outboard coax relays, but I understand that most folks like to have the coaxial relays built in to their amplifier. This is easily done with the existing control board. The built in sequencer makes controlling your relays a "snap"! Event #1 is for controlling the coax relay coils by providing a grounded contact when in "transmit". Event #1 is "immediate". Connect the coax relay coil negative returns to the Event#1 terminal. This is grounded immediately when the transmit switch is enabled thus turning on both coax relays. 50 milliseconds later, Event #2 will energize your transmitting components. Event #3 is a negative ALC voltage suitable for holding off the exciter power output, and it is the last to switch on after Event #2 to drop the negative ALC voltage and energize your exciter to full power. Any coax relay voltage may be used as long as it does not conflict with the Event #1 switching ratings of 100 volts DC at a few amps. Event #2 will ground on TX and handle 28 VDC at 300 ma maximum. Use this to turn on the amp and any transverters etc. Event 3 has a negative ALC voltage on it until it is keyed. The negative voltage goes to zero during transmit (after a slight delay) which will allow your exciter to produce full power when Event #3 is connected to the Exciter's ALC input and the transmit sequence is initiated.