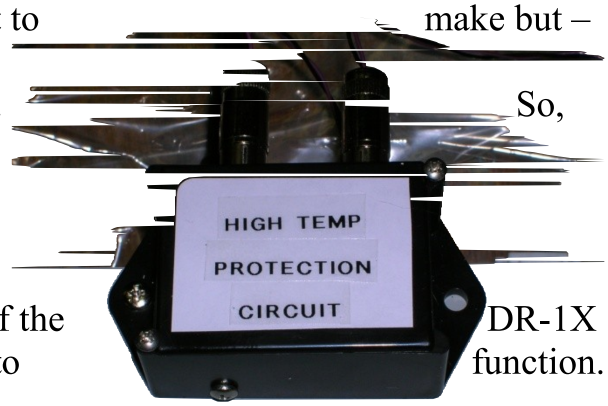
High Temperature Protection for the Yaesu DR-1X Repeater

After completing the setup and testing of our newly received DR-1X repeater for the SARC, I realized that there was no mention of any high temperature protection in the unit. Yes, the repeater is specified to operate up to 140 degree F, but to expect years of trouble free performance, control of the operating temperature just makes sense. Our repeater shack is subject to the ambient temperatures plus! It is in a harsh environment with both heat and dust, it is very important that we have some kind of high or over temperature protection for two reasons. The temperature may exceed 120 degrees during the summer and because of the dust, the cooling fans within the unit will accumulate and possible clog the vents preventing the normal cooling operation. Therefore, to prevent damage to the repeater, a high temperature protection circuit is considered necessary.

It sounded like a simple accessory project to make but – the issue was that the DR-1X does not have a straight forward way of disabling its transmitter. So, after some addition research and testing, this is what I found and decided to do. If you are not familiar with the DR-1X or don't have the operation manual, the following may not make much sense. BUT-- the explanation and set up of the DR-1X is very important to allow the following circuit to function.



With the issue being that there was only one way described in the manual of inhibiting the TX function and it was through an “on screen” command that was permanently set, it dimmed my hope of having a high temperature protection circuit. BUT, I proceeded to test other functions and pin allocations on the MIC, ACC and CONTROL I/O connections. All three had connections to enable the TX function but none to inhibit it. Then I reviewed the functions of the repeater when placed in the Remote Mode. The list is found on Page 25 of the operation manual. After placing the DR-1X into the remote mode and testing all of it functions through the CONTROL I/O 15 pin connector, it became obvious what could be done.

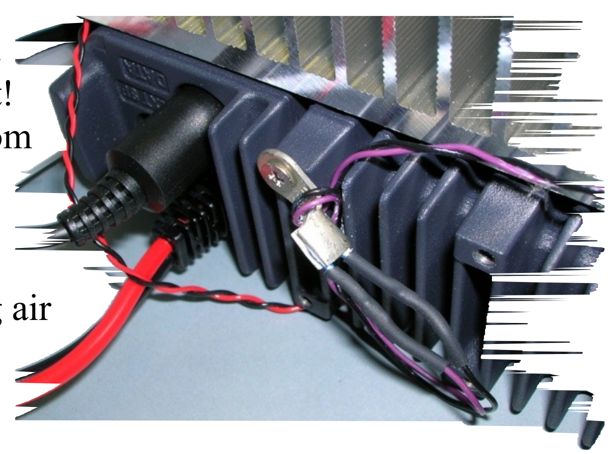
What is not clear in the manual is the description of PIN 1 of the CONTROL connector. The manual states “Mode selection- Fix this input to a low level to enable remote operation”. Then in a separate section of the manual it states “[L] GND: Remote mode [H] OPEN: Repeater Mode”. What the manual doesn't stipulate on either page 25, “Turning Remote Operation ON/OFF” or any of the pin outs of the I/O connector list is that in order for the repeater to function with a remote controller, you must place the DR-1X REMOTE function to “ON” via the screen settings then the remote controller toggles PIN 1 of the I/O connector Low. So with the repeater in the “Remote ON” mode, it still functions as set up by the screen settings until PIN 1 is pulled Low.

What does this mean? It means that while the DR-1X is set for “REMOTE ON”, when PIN 1 is toggled low, the repeater will not transmit unless the PTT line (PIN 2 of the I/O, Pin 3 of the ACC,) or the external MIC is keyed. Any receive signal that comes in will not enable the repeater function and be re-transmitted.

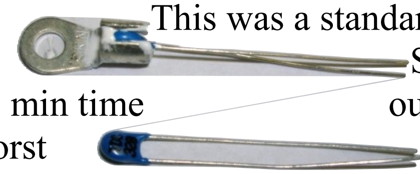
So a High Density 15 pin D-Sub connector that mates to the I/O repeater connector needs to be wired with the following connections. Pins 1 and 5 (Remote enable and Ground) are to toggle the remote function. Now, to keep things straight, depending on how the repeater was set up in its RX and TX “Communication Modes”, pins 11 and 12 need to be set up with the correct combination to match the set-up communication s modes. We decided to keep our DR-1X in the AUTO mode for both RX and TX so this required that we pull pins 11 and 12 to ground. What this does is it keeps the repeater in the same “Communication Mode” when the Remote pin is enabled. It may not be important to you if when the REMOTE pin is toggled that the screen will change to the settings that pins 11 and 12 are configured too as listed in the pin out of the I/O connector. (See page 18 or 26 of the operation manual for the combinations of the settings.) The bottom line is when Pin 1 is toggled low which will be accomplished by the high temperature circuit, the Repeater will not Transmit unless the PTT line is enabled. And since the PTT line cannot be enabled by any repeater user, the TX function is therefore disabled.

Please understand all of this was not tested with an external controller and I have no idea if any of this will apply with an external controller, but I'm sure that a High temperature protection circuit as described next may be implemented with such a controller.

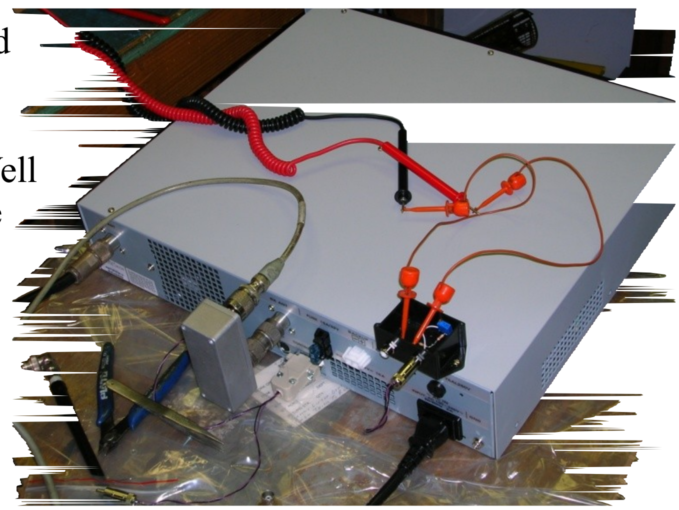
Now for the actual circuit design, I started by setting up the repeater to high power and no PL tone. This allowed me to key the repeater with my signal generator. I had set the Time out to 5 Minutes. I than ran the repeater for the full 5 min and with a digital thermometer, found the hot spot on the transmitters heat sink. It was one rib that had a tapped 5 mm screw hole in it. How convenient! The temperature reached 55 degrees C in a room environment of 80 degree F. This is not the important aspect. It was just important to find the hot spot on the heat sink. Of course, this was found with the cover open and the cooling air plenum not in place which meant that it could change one way or the other but that was also not that important because testing with the enclosure all sealed up would determine the final setting of the circuit as will be show when testing.

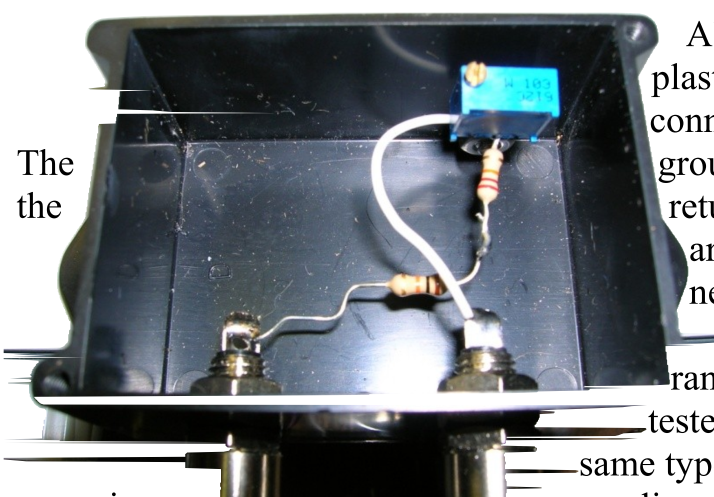


I then fabricated a solder lug, heat sink grease and a Negative Temperature Coefficient (or NTC) thermistor of a 20 kilo- ohm value. When a NTC is “warmed”, it decreases in resistance value. NTC’s can be selected for range, delta, and starting ohm-age. This was a standard unit I use for other projects. I connected it to the “hot Spot”, closed up the Repeater enclosure and ran the same 5 min time out three times in a row with a 1 min rest in between. The worst case I could develop was a change of about 10-11Kohm. Now what I thought was going to be a problem was that 9-10K would not be low enough to toggle the Remote pin. I expected to directly connect the PTC to the PIN 1



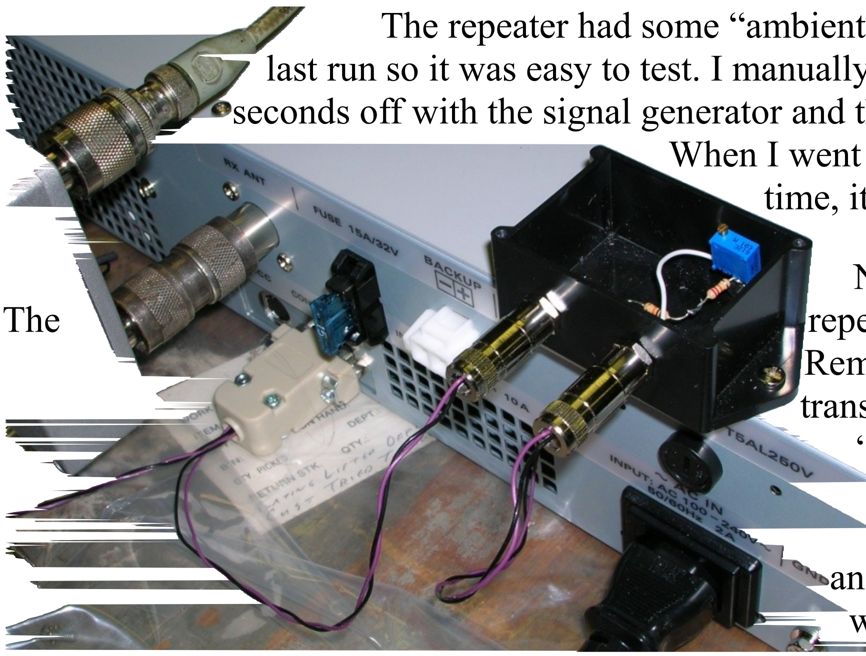
So I tested the Remote pin to ground through a resistor and found out that the repeater would switch to remote with as much as 43K between it and ground!! Well that is great! I have a 10 K swing with the NTC. At that value, I would call it normal operation. If the NTC dropped further in resistance, I would call it excessive heating. This means that I needed a resistor string to make up the difference from the 10 K normal operation of the NTC to the total of 43K, or about 33K. What I chose was a 22K and a10 K fixed with a 10K multi-turn for some “trimming”.





All components were assembled in a small plastic enclosure with two simple RCA connectors separating the resistor network. The ground connection of the I/O is connected to the return side of the NTC. Understand NTC's are not polarity sensitive. The resistor network could adjust between 33 and 43K. Adding the NTC extended the theoretical range of 33K to 63K. The circuit was first tested without the I/O connection. I used the same type of three 5 min temperature runs with one min cooling periods. After that the determination was made that it was a bit warmer than what would be called normal operating temperature. At that point, the trim pot was set to obtain about 45K. During the cooling periods, the resistance could be seen climbing higher. Its working!

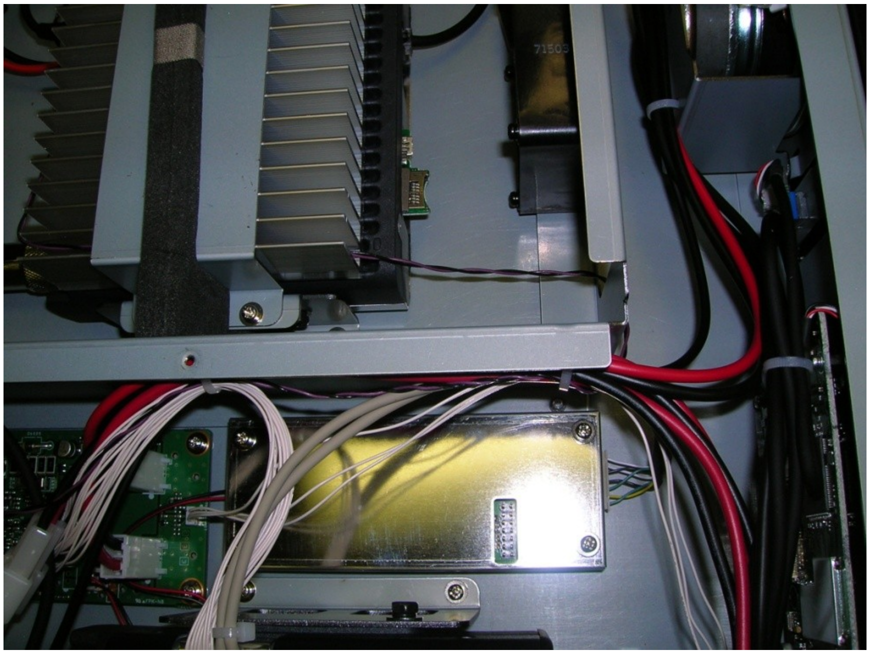
The I/O connector was then connected to the series Resistor network through the other RCA connector. It was verified that the Remote would not toggle through normal operation producing the 45K ohms. Then to test the Remote operation, the 10 K resister in the string was shorted and the repeater switch to remote instantly. So-- all systems are a go, time for the final test which meant time to abuse the new repeater.



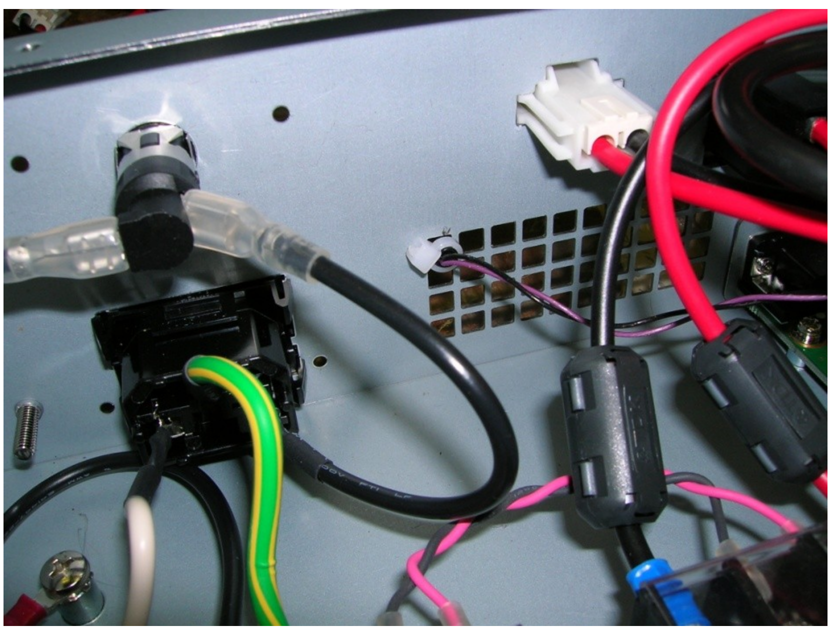
The repeater had some “ambient” temperature built up for the last run so it was easy to test. I manually run 30 second cycles on 10 seconds off with the signal generator and the air intake vents blocked. When I went to key the repeater for the 5th time, it would not respond.

Now to explain what happens. The repeater will not switch to its Remote function in the middle of a transmission. The repeater needs to “Drop” before the remote toggling will happen. So-- if there is a 5 min time out cycle and the repeater is hung up, it will run until it times out or Burns up!! So-- we will be using a 3 min Time out on the N4SVC Live Oak Repeater. Now, if the repeater is being utilized for short QSO's and the temperature raises enough to toggle the I/O line, it will prevent the next transmission as long as the repeater drops. It will remain that way until the cooling system catches up and automatically returns back to normal and operates that way until it overheats again. It is possible that the trim pot will need a tweak or two after being installed in the environment since it is next to impossible to simulate the conditions at the N4SVC repeater shack. But, it can be close by simulating the worst case and setting the trim pot, if anything, to trigger to soon causing the need for re-adjustment. So for now, its set for the repeater’s safety..

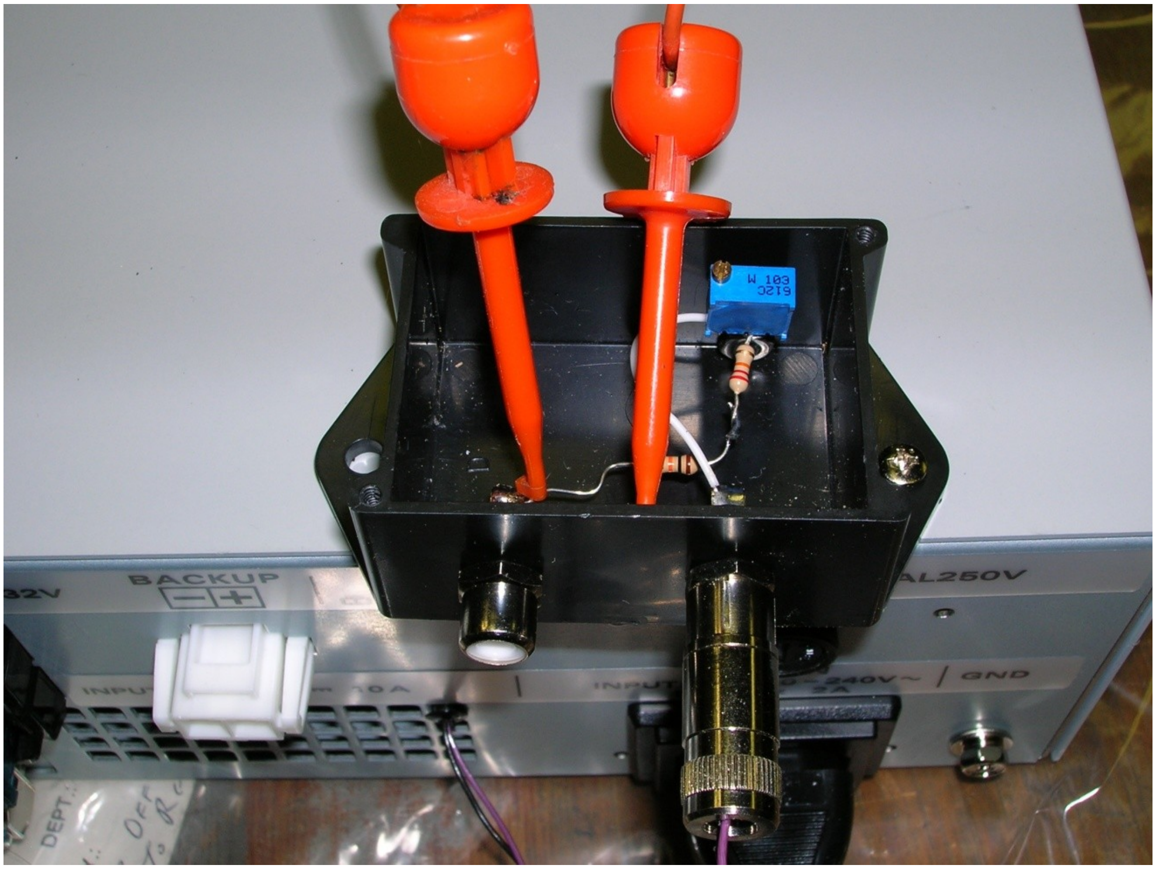
The pictures that accompany this document will depict the assembly and placement of all components along with wire routing. Any questions, I am available to answer them through e-mail or through the SARC website.



Routing wire through the plenum and wire harness



Routing the NTC wire through the vent utilizing a Plastic bushing.



Short the 10K to simulate overheating and verify that the repeater switched to remote

I hope others find this short document helpful and may consider adding this circuit to their DR-1X. You just don’t know! If you lose the air-conditioning in your shack or a bird builds a nest plugging the air vents, the repeater will heat excessively. Remember, we can only measure the external temperatures of the repeater modules, not the where the components are making the heat inside.

Steve Kostro, N2CEI , Communications Director for the Suwannee ARC