Inexpensive Broadband Preamp for Satellite Work

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This article suggests an inexpensive broadband receiver preamp that you can build and use to improve your satellite operating experience. A few different employment configurations will be suggested to use the preamp, with some diplexers, depending on your choice of radio and choice of antenna (ARROW like, or Elk like antenna).

One of the improvements to come out of the ARRL Education & Technology TI2 Space program is a CAT control circuit that assists in using the FT-817 to more effectively access the analog birds (the article describing this project is published in October 2012 QST, *Satellite CAT Interface for Working the Analog Birds*). (Thanks to all satellite users who have supported the TI2 Space by making contacts with the teachers!) There has been some enhanced opportunities for using the ARISS radio equipment (a concept using commands imbedded in text attachments to packet radio transmissions for controlling robotic platforms) and some frequency agility between VHF and UHF of the radio on the ISS. There has been effort to suggest some "minimalist" antenna systems to make accessing the ARISS signals more affordable for schools (and to facilitate school home brew antenna systems). These antenna ideas have been posted to the ARRL web page (http://www.arrl.org/files/file/ETP/ISS%20Minimal%20Antenna/ISS%20Minimalist%20Antenna%20article.pdf, and http://www.arrl.org/files/file/ETP/ISS%20Minimal%20Antenna/ISS%20Minimalist%20UHF%20Version.pdf) Finally, planned CubeSat birds are using a mix of VHF and UHF down links. The frequency agility that resulted because of these recent enhancements to accessing satellites caused me to revisit the receive preamp provided to the TI2 participants (historically we provided the Hamtronics UHF preamp). I wanted to expand the receive capabilities for the TI2 participants to include VHF without adding a separate $100 VHF preamp to the resources provided to the teachers. A single broadband receiver preamp was the solution.

I have successfully used a simple broadband preamp for years that was first published in May/June 2004 QEX by Glen Gardner, AA8C. This circuit fit the bill; however, in the presence of strong, out of band signals, the preamp based on the MAR 6 device by Mini Circuits tended to suffer from overload and would self oscillate. This wasn't a problem at my previous QTH out in the middle of no-where California, but at my new QTH in southeastern Connecticut, on the perimeter of a Navy Submarine Base and within a stone's throw of a commercial FM transmitter site, the simple MAR6 based boardband preamp did not perform as well. The solution was relatively simple, switch the primary active component from the MAR 6 to the MAR 7 device. While making the switch, I also made a some minor modifications to the circuit. The updated circuit diagram is in figure 1, a picture of the completed preamp board alone with "it all hanging out" is in figure 2, a preamp within a rugged metal enclosure is in figure 3, and picture of the preamp alongside a home brew diplexer based on a designed published in Nov/Dec 2009 AMSAT Journal by Ron Cade, W6ZQ is in figure 4. A blow up of the circuit board developed for the preamp is shown in figure 5. The parts list with DigiKey part numbers is in Table 1. The cost of the preamp parts as seen in figure 3 and 4 is inexpensive.

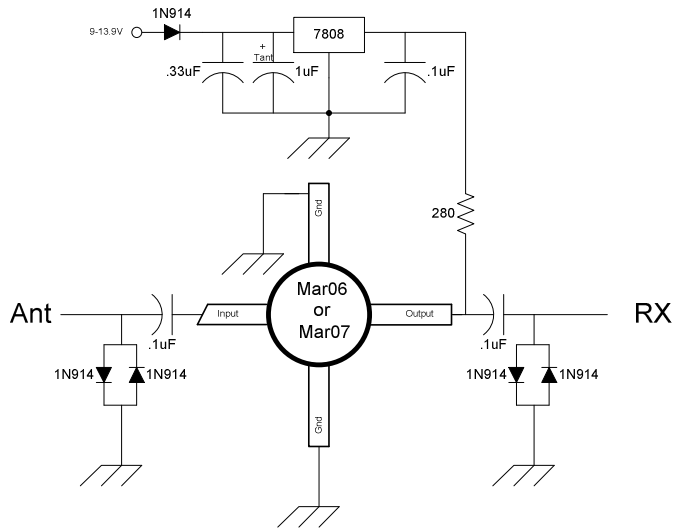

Figure 1.

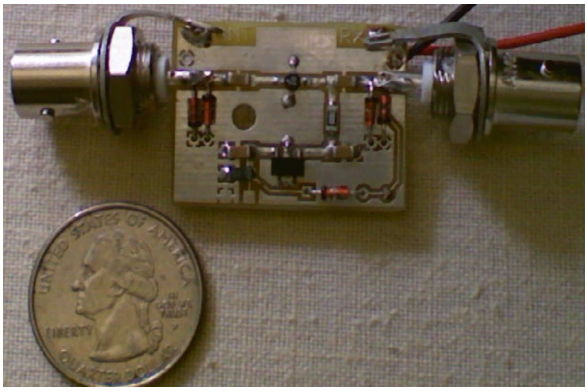

Figure 2.

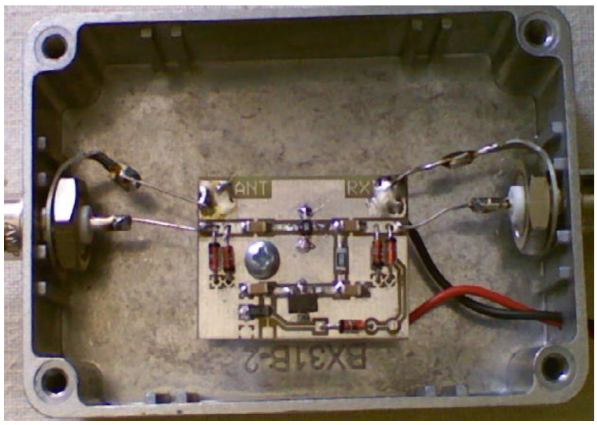

Figure 3.

Figure 4.

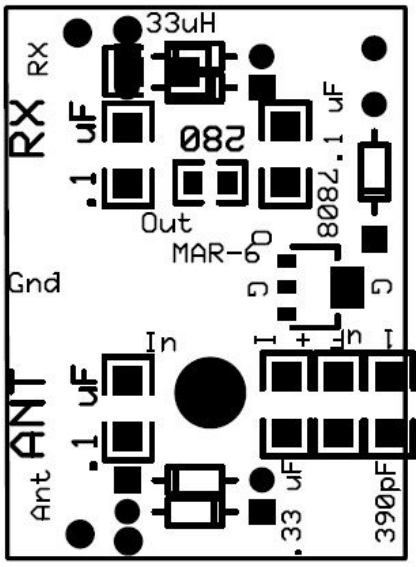

Figure 5

TI-2 Preamp Parts List Table 1		
#	Description	DK Number
Preamp		
3	.1uF Cap	490-1775-1-ND
1	.33uF Cap	445-4010-1-ND
1	1uF Tantilum	493-2387-1-ND
1	280 Ohm Res	P280FCT-ND
1	7808 Reg	296-11125-1-ND
1	MAR-6 Amp	www.minicircuits.com
5	1N914 Diode	1N914ACT-ND
2	BNC Connector	A32344-ND
2	9-V Battery Holder	BH9V-PC-ND
1	Circuit Board	
1	Box	Mouser 563-CN-5701

The final project is made with surface mount components…but before you panic, the surface mount components used in this project are relatively large (my eyes ain't as good as they once were, and the darn things seem to shake on their own too for some reason…so I feel your pain). The board layout is designed with hand soldering of the surface mount components in mind. So if you have modest construction experience, the construction of this project is well within reach.

Though I have done some gain measurements with my limit test equipment (around 15-20 dB of gain), the real gain obtained is documented in anecdotal observations (see side bar by Mark Hammond, N8MH). I do not want to reignite the preamp/no preamp debate, but for me, I find that a receive preamp is essential for "quality" satellite contacts, particularly when doing demonstrations or working with novice satellite operators. This inexpensive preamp can make the difference between hearing the bird and completing a contact or hearing receiver noise.

The preamp can be powered by a fresh 9-volt battery, or two used 9-volt batteries in series, making it very portable. But how flexible can it be employed depending on the antenna or rig in use? One of the issues in using a simple receiver preamp is how to configure it in line so that you can easily listen, and transmit? When using a preamp without automatic switching in-and-out of line during transmit requires extreme caution to prevent transmitting into the preamp…which in all likelihood with damage the preamp. In this particular circuit design, crossed diodes are installed at the input and the output to clip short duration signals strengths to levels that will not damage the preamp (I still would not want to transmit into the preamp at high power and for a long period of time however, the diodes only provide some "oh cr##" insurance when you inadvertently hit the PTT at the wrong time). The following graphics illustrate (figures 6 and 7) some configurations that might allow you to use the preamp in your particular rig/antenna configuration.

When using the preamp with an ARROW like antenna (essentially two antennas mounted on a single boom), the employment is pretty straight forward. You simply insert the preamp in the receiver line between the rig and the receive side of the antenna. If you have a single antenna connector radio (the typical HT), the preamp would be installed downstream of the diplexer. When you change bands, you would need to switch the preamp to the coax for the other band. A problem however comes up when using an Elk like antenna (essentially a single broad banded log periodic antenna) with a single feed point. In the case of an Elk like antenna with a single antenna connector HT, two diplexers would be required with the preamp between the diplexers installed in the appropriate band "loop" between the diplexers. There are of course trade-offs with some insertion losses from the diplexers.

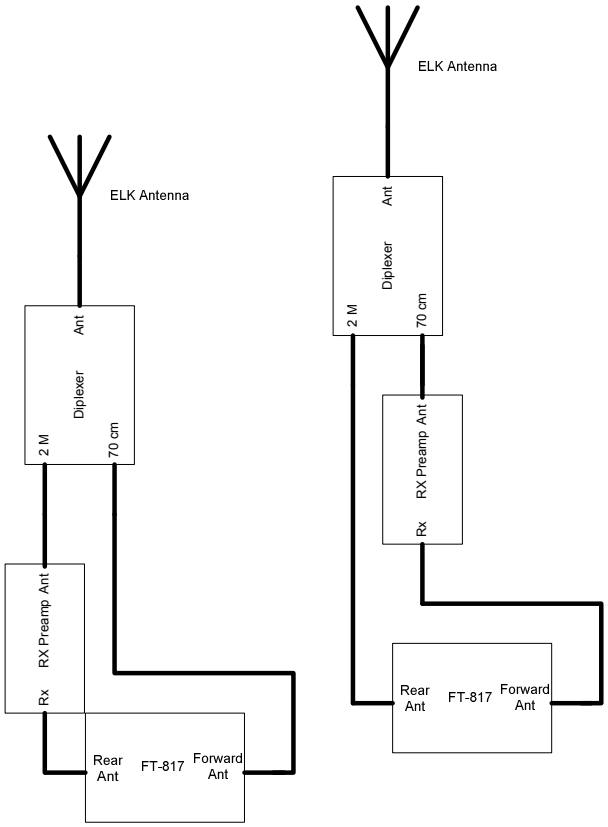

Figure 6.
Elk antenna with diplexer and two antenna connector rig.

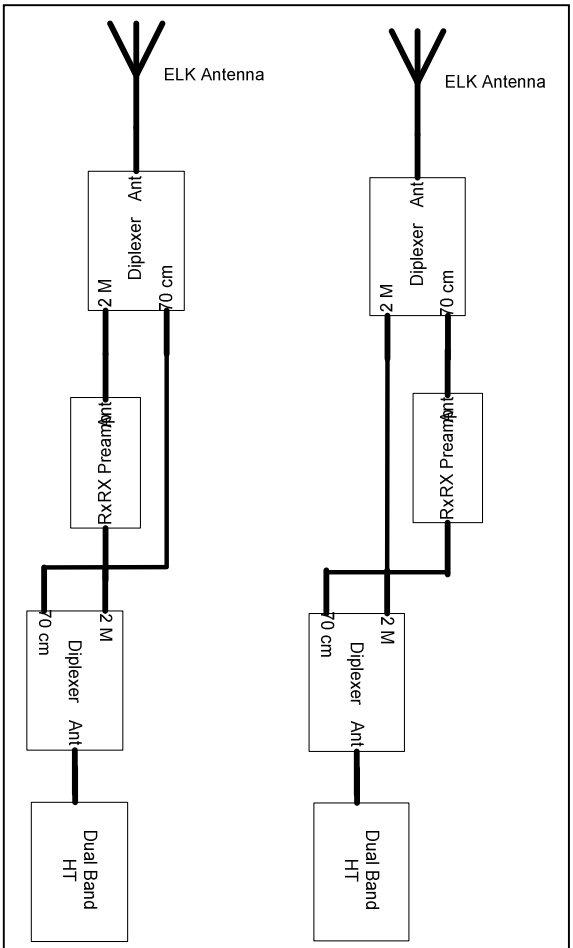

Figure 7.
Elk antenna with two diplexers and single antenna connector rig (HT)

If you are interested in trying out the preamp but you are hesitant to "roll your own", I'd like to offer an alternative on behalf of the ARRL ETP and AMSAT that could benefit you and at the same time benefit the development of future FOX satellites. Through the AMSAT store (beginning in mid-November) the ARRL ETP and AMSAT are cooperatively offering to supply the preamp at a low cost (plus postage) to those interested. Funds collected over the actual cost will be used fund the FOX satellite family. The cost is projected to be $50 plus shipping (additional contributions above the cost also go to FOX!) for an assembled and tested unit in the metal enclosure. A preamp assembled and tested, without the metal enclosure, is projected to be $40 plus shipping. Assembly of the preamps is my volunteer effort in support of my fellow satellite enthusiasts. Please visit the AMSAT store at http://store.amsat.org/catalog/ to place your preamp orders.

For those that have never used a receiver preamp with their portable satellite station, I urge you to consider doing so. Once you hear the difference, you probably will not go back.