Inexpensive Broadband Preamp for Satellite Work

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Here is an inexpensive broadband receiver preamp that you can build and use to improve your satellite operating experience. I've included a few different configurations for using the preamp, with one or more diplexers, depending on your choice of radio and choice of antenna (ARROW style, or Elk style antenna).

This simple broadband preamp has served me well for years. It was designed by Glen Gardner, AA8C, and first published in the May/June 2004 issue of QEX. The simplicity of the circuit fit the bill nicely and met my requirements. However, in the presence of strong out of band signals, the preamp, which was based on the MAR-6 device from Mini Circuits, tended to suffer from overload and would self oscillate. This wasn't a problem at my previous QTH which was out in the middle of no-where California. However 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 MAR-6-based broadband 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 few minor modifications to the circuit. The updated circuit diagram is shown in Figure 1.

A picture of the completed preamp board with "it all hanging out" is shown in Figure 2.

Figure 3 shows the preamp in a rugged metal enclosure.

In Figure 4 you can see the preamp alongside a home brew diplexer.

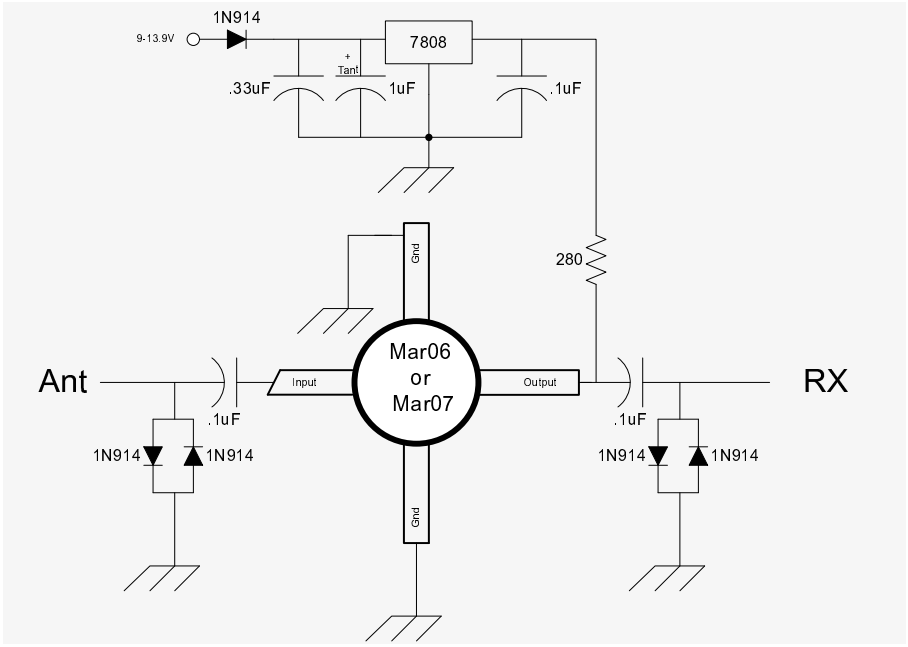

Figure 1: Preamp circuit diagram

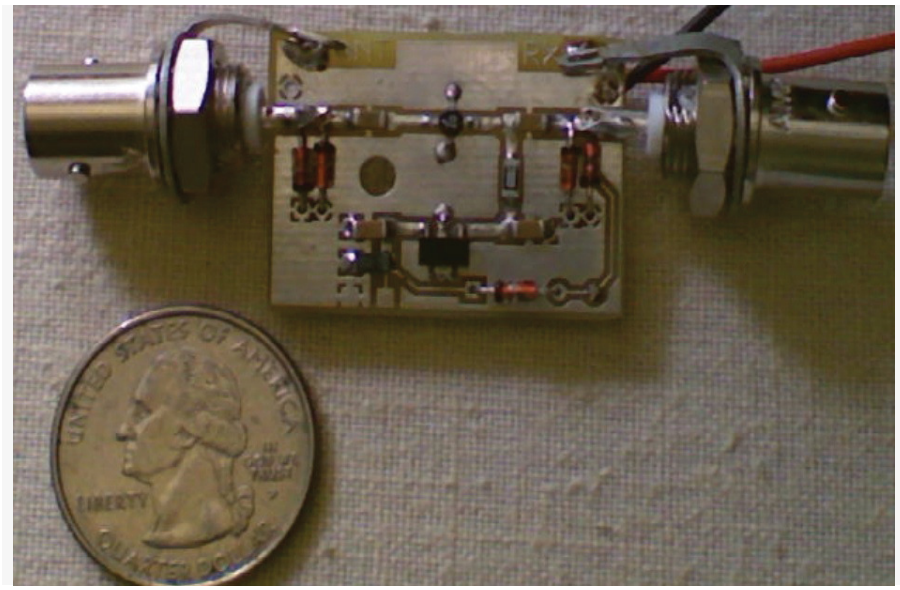

Figure 2: Completed preamp circuit board

This diplexer is based on a design published in the Nov/Dec 2009 AMSAT Journal by Ron Cade, W6ZQ.

A blow-up of the circuit board pattern for the preamp is shown in Figure 5.

I've listed the parts, with the source part numbers, in Table 1. However you should be able to locate all of the components at relatively low cost by searching the internet. The MAR Amplifier can be either a MAR-6 or MAR-7.

The project is made using 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 in mind. So if you have modest construction experience, the construction of this project is well within your reach.

Though I have done some gain measurements (around 15-20 dB of gain) with my limited test equipment, 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. This is particularly important 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 just listening to receiver noise.

The preamp can be powered by a fresh 9-volt battery making it very portable.

One of the issues when using a receiver preamp is how to configure it in the transmission line so that you can listen, and transmit, without damaging it. 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 prevent damage to the preamp. I still would not want to transmit into the preamp at high power and for a long period of time . (The diodes only provide some "oh cr##" insurance when you inadvertently hit the PTT at the wrong time).

Figures 6 and 7 illustrate some configurations that might allow you to use the preamp in your particular rig/antenna configuration.

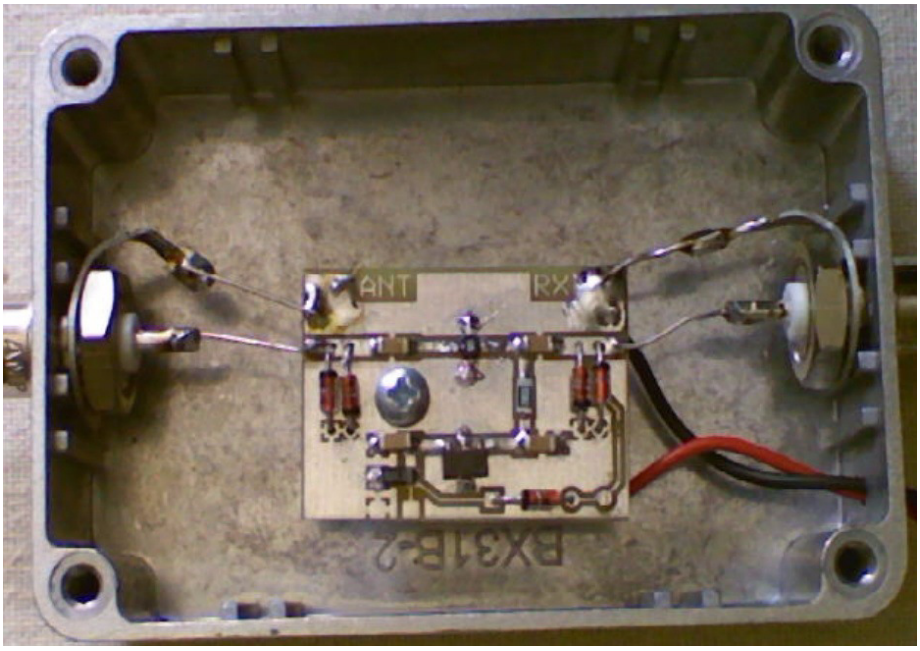

Figure 3: Preamp in a rugged metal enclosure.

Figure 4: Preamp alongside a home brew diplexer.

When using the preamp with an ARROW-like antenna (essentially two antennas mounted on a single boom), the configuration 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.

Elk-like antennas are essentially a single, broad band 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.

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 (Education and Technology Program) 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. Any funds collected over the actual cost will be used to fund the FOX satellite family.

The cost at the time this article was written is projected to be $50 plus shipping for an assembled and tested unit in the metal enclosure. Additional contributions above the cost also go to the FOX project!

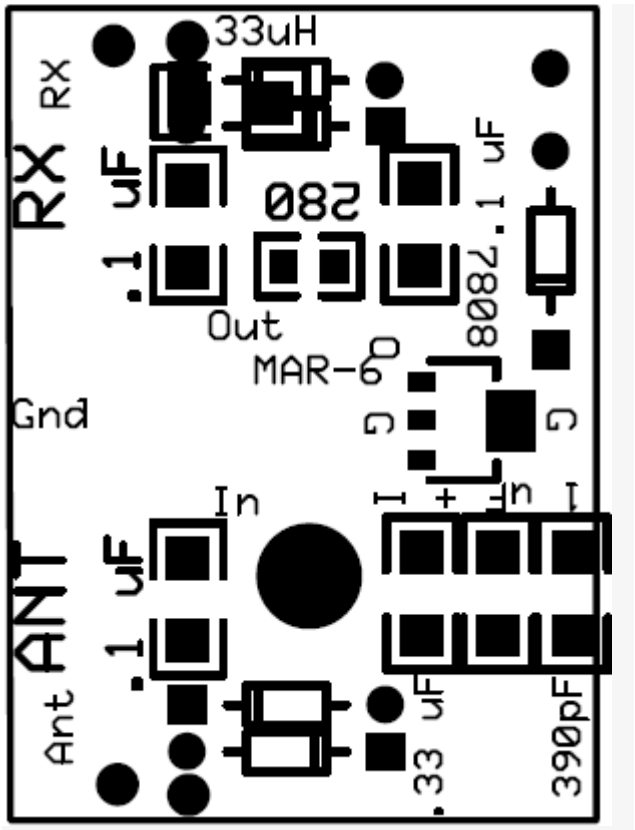

Figure 5. PC board layout for preamp (for illustration only - not scale.)

A preamp assembled and tested, but without the metal enclosure, is projected to be $40 plus shipping. Assembly of these preamps is my personal 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 of you that have never used a receiver preamp with your portable satellite station, I urge you to consider doing so. Once you hear the difference, you will wonder how you did without it.

Table 1: Preamp Parts List

Qty	Description	Part Number	Source
3	.1uF Capacitor	490-1775-1-ND	Digi-Key
1	.33uF Capacitor	445-4010-1-ND	Digi-Key
1	1uF Tantalum	493-2387-1-ND	Digi-Key
1	280 Ohm Resistor	P280FCT-ND	Digi-Key
1	7808 Regulator	296-11125-1-ND	Digi-Key
1	MAR-6 Amplifier	www.minicircuits.com	Minicircuits
5	1N914 Diode	1N914ACT-ND	Digi-Key
2	BNC Connector	A32344-ND	Digi-Key
1	9-V Battery Holder	BH9V-PC-ND	Digi-Key
1	Circuit Board		
1	Box	Mouser 563-CN-5701	Mouser

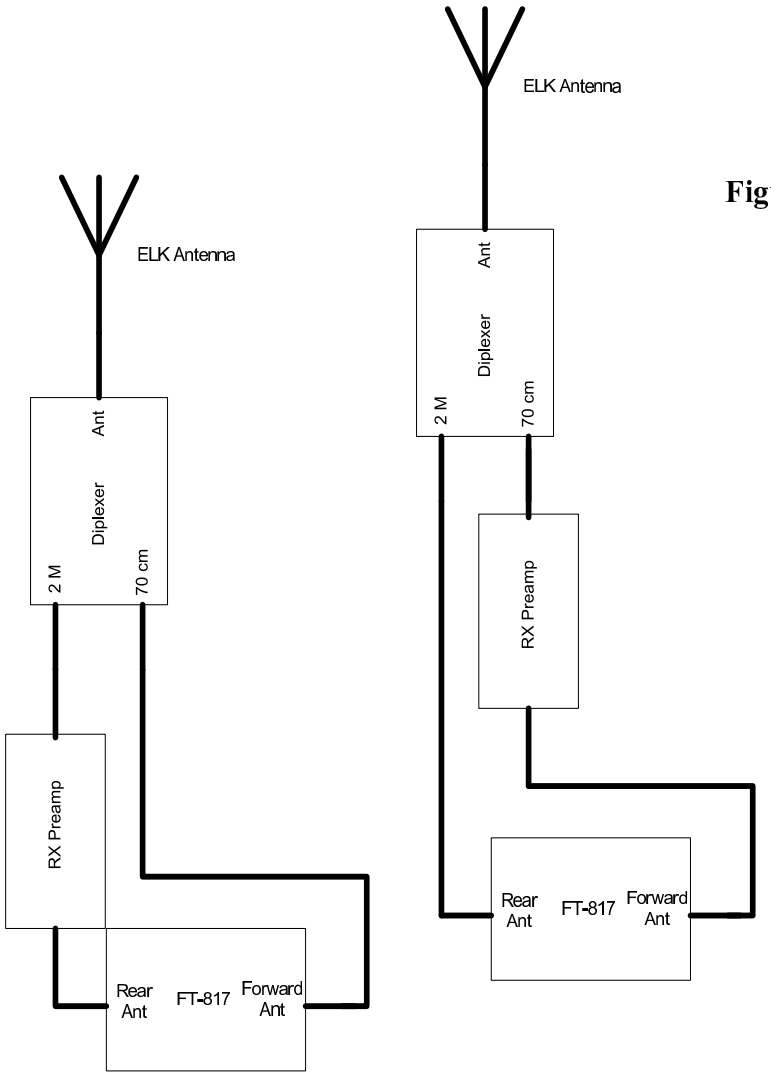

Figure 6 - (left) Elk antenna with diplexer and two antenna connector rig.

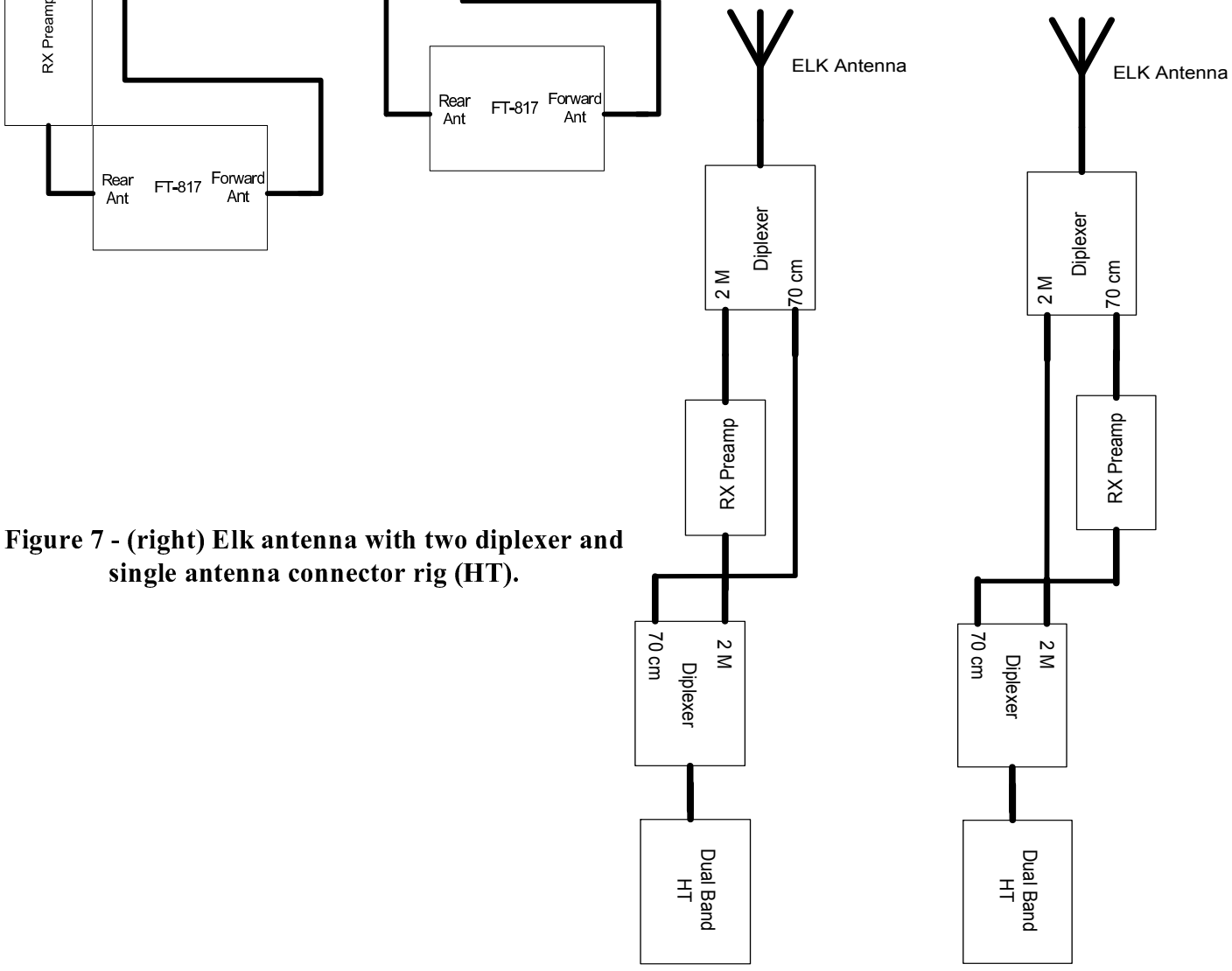

Figure 7 - (right) Elk antenna with two diplexer and single antenna connector rig (HT).

Side bar to: Inexpensive Broadband Preamp for Satellite Work

by: Mark Hammond, N8MH, AMSAT VP for Educational Relations

As a satellite operator that knows well the old adage, "if you can't hear 'em, you can't work 'em," I naturally jumped at the opportunity to put Mark Spencer's (WA8SME) new ARRL/ETP Broad Band Preamp through some on the air testing!

The first round of on the air testing of the preamp occurred during a ride to the beach. With my wife willing to drive, I tossed in the trusty FT-817ND radio, a ¼ wave 2M magmount antenna, the new preamp, a 9V battery, some jumper cables, and various BNC adapters. For these first tests, I limited operations to receive only because the preamp does not have a built in TX/RX by-pass relay. I first caught a VO-52 pass (a 2M downlink), and using the preamp was simply the difference between hearing the bird, and not hearing it at all (note: when no power is applied to the preamp, there is some but very little pass-through of the signal; my simple testing and comparisons included removal of the preamp from the feed line, not just powering it OFF and ON). It was working beyond my expectation for such an inexpensive and broad-banded preamp. A subsequent AO-27 pass again illustrated how much the preamp could improve the downlink, but this time on a 70CM downlink! Multiple bands and a single preamp-very slick indeed, as one considers the application of mobile or portable operations.

I quickly shot off a mobile email to Mark WA8SME and let him know that the preamp was performing brilliantly. So much so, in fact, that the good signals received on the little ¼ wave magmount tempted me to try a contact on the air. Keep in mind that I had to disconnect the preamp anytime I wanted to transmit. It quickly became apparent that without the preamp, I wasn't going to be able to hear the bird; and with the preamp inline, I wasn't going to be able to transmit. There had to be a solution…but first let me better explain the "problem."

My goal was to figure out how to make use of the dual band preamp for
1) both modes U/v and V/u
2) a single radio (FT-817) that is half-duplex - and -
3) a single antenna, like the ¼ wave mag mount in a mobile, an Elk log periodic, or a "herringbone log periodic cheap yagi" by Kent Britain, WA5VJB (which I recently constructed)

Mark WA8SME and I did some brainstorming and came up with two pretty straightforward solutions for my operational situation, both of which involve a diplexer or two and a few cables. You can see the two scenarios in his Figures 6 and 7. With the FT-817, Figure 6 is possible (and was verified by Matt, N8MS) with a single diplexer, but candidly the idea of having to reprogram my frequency memories to ensure they used the right antenna jacks (front or back) seemed tedious and committal, not to mention the complication of switching between modes U/v and V/u.

The elegance of Figure 7 is that it's a solution for any single band radio, including an HT. It does have the complication of requiring two diplexers, but the switch-over between modes U/v and V/u is pretty easy. So for a second round of on-the-air testing, I lashed up the FT-817, a pair of diplexers, and the preamp to the Elk antenna with electrical tape and headed outdoors to attempt a contact. A photo of that setup can be seen in Figures 8 and 9. While a tad cumbersome, it definitely works well, as an on-the-air contact to Drew KO4MA was quickly made on AO-27.

Of course, another useful and attractive solution is to incorporate some type of RF switching. Sitting here on the bench is an old RF sensed relay board, sold long ago by Ramsey Electronics. Hopefully soon I can get that attached to the preamp. A quick look at the Ramsey website shows that a similar model is now being sold fully assembled (http://www.ramseyelectronics.com/cgi-bin/commerce.exe?preadd=action&key=RFS1). Their board is sized to fit into 1.5" PVC pipe, so be creative-for example, I can envision the preamp board, the RF switch, and a pair of 9V batteries slid into a PVC section, with SO-239 connectors on each end cap. That would pair nicely with the FT-817 and an Elk antenna or Herringbone Cheap Yagi.

Users of an Arrow Antenna (and dual band Cheap Yagi variants) have it a bit simpler because they really are two antennas in one; just put the preamp inline with the desired antenna-between the built-in diplexer and the antenna. Mode changes only require swapping the preamp and jumper to the other antenna.

In summary, the new ARRL/ETP

Broad Band Preamp is an affordable, durable, and great performing device for satellite operations. You'll be surprised when you hear what you've been missing!

73,
Mark N8MH

Figure 8: N8MH setup using FT-817, Elk antenna, diplexers, and preamp.

Figure 9: N8MH setup ready to head outside.

The AMSAT Store is back online! Here is a new AMSAT product. A handsome and functional AMSAT 10' locking carpenter's tape with both inch and metric scales. Visit http://www.amsat.org.

Minimum donation: $5