ARISS Antenna and Satellite Antenna Tracking Interface

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I encourage schools to develop a portfolio of activities that bring space technology into the classroom. One part of that portfolio can be a scheduled ham radio contact with astronauts on the International Space Station (ISS) through a program called Amateur Radio in the International Space Station (ARISS). (The application for an ARISS contact and other relevant information about ARISS can be found at: http://www.arrl.org/ARISS/) This is a wonderful opportunity for students to experience a connection with space pioneers via ham radio.

There are specific station equipment requirements stipulated to qualify for an ARISS contact. "A typical ARISS ground station includes a 2-meter FM transceiver and 25-100 watts of output power. A circularly polarized crossed-Yagi antenna capable of being pointed in both azimuth (N-S-E-W) and elevation (degrees above the horizon) is desirable." The ARISS applicant details the station capabilities in the application by answering these questions:

Antenna Type (VERTICAL, SATELLITE (AZ/EL?), OTHER) [specify]:
If commercially built, manufacturer and model:
Antenna Gain (dbd or dbi):
Number of Elements:
Polarization (HORIZONTAL, CIRCULAR, or VERTICAL)
Antenna Equipped With a Rotator? (NONE, AZIMUTH ONLY, or AZ/EL):
Satellite Tracking Program Available? (YES or NO):
If YES, Name of Tracking Program:
Do you have Automatic Antenna Control? (YES or NO):

These station specifications can be a little intimidating and sound expensive. The ARRL Education & Technology Grant Program can help with some of the resources needed to qualify for an ARISS contact. The following specifically describes an opportunity for schools to receive help with the automatic antenna control of the satellite antenna. Additionally, plans for an antenna that the students can build for their satellite ground station are provided.

Sat688 Satellite Antenna Tracking Interface

Figure 1

Figure 2

Automatic pointing of satellite antennas helps to improve signal quality while working with satellites and also frees the operator to focus on the satellite contact. There are three components in an automatic pointing system; azimuth (AZ) and elevation (EL) rotors, satellite track software loaded on a computer that calculates where the antennas should be pointed in space, and an interface the connects the rotors to the computer.

Rotors are motors that turn the antenna around the compass horizon (AZ) and above the horizon (EL). Two of the few commercially available rotor systems are the Yeasu G5500 and G5400 rotors (G5400 is available on the used market). These rotors are a little pricy at approximately $550. The Yaesu companion interface that allows a computer to control the rotors is also pricy at an additional $550.

Common software packages that are available to track satellites include NOVA and SatPC32. Both these programs provide good graphics for visual display of satellite positions and also are excellent software packages to assist with instruction about orbital mechanics. Both these software packages can control rotors to point antennas.

The Sat688 interface is available through the ARRL/ETP as a grant to schools and provides an inexpensive alternative to a commercial interface unit (figure 1). The Sat688 interface is based on a PIC that is programmed to interpret satellite position data in EASYCOM format sent by the satellite tracking software and control rotor motors. The Sat688 can be set up through jumper connections to work with both the G5500 and G5400 rotors as well as serial or USB computer connections. The interface has been tested and verified to work with NOVA and SatPC32 software.

A limited number of the interfaces are available to schools who document that they have applied for an ARISS contact and make an application for the interface through the ARRL/ETP.

Circularly Polarized Yagi Antenna for ARISS Contact

While building the required radio transceiver, writing satellite tracking software, and building antenna rotor systems is beyond the capabilities of many, students can actively participate in the construction of their satellite ground station by building the antenna. The antenna plan presented here can easily be duplicated by the students, or better yet, engaged the industrial arts class to build the antenna and include some cross curricular activity in the ARISS experience.

The antenna is made of 1/2-inch copper pipe elements and 3/4-inch copper pipe for the boom and the antenna can be easily duplicated by using the illustrations as a guide. The antenna elements are connected to the boom with "T" fittings. (See figures 3 through 7 for construction suggestions and Table 1 for dimensions) Antenna impedance matching is accomplished through a simple "Gamma" match network. (See figure 8 for dimensions) Phasing and impendence matching is accomplished through coax phasing lines as detailed in *The Radio Amateur's Satellite Handbook* .

The antenna performs very well. The SWR curve of the antenna constructed by the author is in figure 9. The radiation pattern of the antenna as calculated is shown in figures 10 and 11.

Conclusion

Don't let the equipment requirements to qualify for an ARISS contact prevent you from exploring this opportunity. Check out the grant opportunities offered by the ARRL/ETP, check out the Sat688 interface, and look into the suggested antenna construction project presented here and you might find that you can do it. And the end result, connecting your students to the pioneers in space through ham radio, makes the effort more that worth it!

Figure 3 -- Gamma match

Figure 4 -- Gamma and phasing lines

Figure 5 -- Element attachment

Figure 6 -- Boom construction

Table 1 -- 145 MHz Satellite Antenna Dimensions		
	Length	**Spacing**
Reflector	3.28' (39.36")[39 3/8"]	0'
Driven	3.15' (37.8")[37 13/16"]	1.44' (17.28")[17 1/4"]
Director 1	2.96' (35.52")[35 1/2"]	1.57' (18.84")[18 7/8"]
Director 2	2.85' (34.2")[34 3/16"]	2.04' (24.48")[24 1/2"]

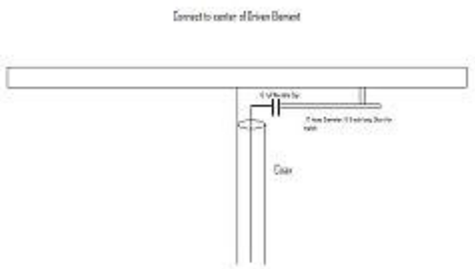

Figure 8 -- Gamma Match Dimensions (larger image)

Figure 9 -- SWR curve (larger image)

Figure 7 -- Completed antenna

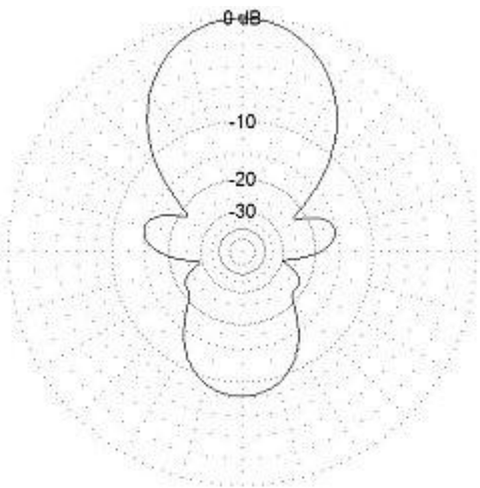

Figure 10 -- Azimuth radiation pattern

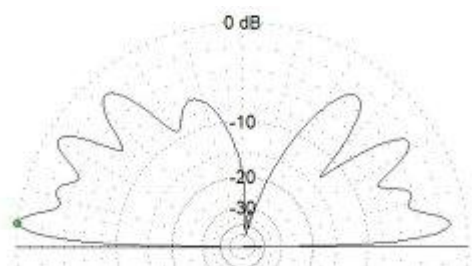

Figure 11 -- Elevation radiation pattern
