Get On the Air with ARISS Packet

JoAnne Maenpaa, K9JKM
k9jkm@amsat.org

The Amateur Radio station aboard the International Space Station (ISS) is known as ARISS —– the Amateur Radio on the International Space Station. Many astronauts and cosmonauts have Amateur Radio licenses. Amateurs from the ISS partner countries in the U.S., Russia, Japan, Europe and Canada, have set up the ARISS program to foster Amateur Radio communications between the astronauts and cosmonauts who reside on the station and stations on the ground.

ARISS gained access to the IS S to help NASA fulfill Science, Technology, Engineering, and Math (STEM) goals for education. ARISS is an international educational outreach program partnering the participating space agencies — NASA, Russian Space Agency, ESA, CNES, JAXA, and CSA — with the AMSAT, ARRL, and IARU organizations from participating countries.

ARISS offers an opportunity for students to experience the excitement of Amateur Radio by talking directly with crewmembers onboard the ISS. Teachers, parents and communities see, first hand, how Amateur Radio and crewmembers on the ISS can energize youngsters' interest in science, technology, and learning.

In between support of STEM activities, the ARISS Amateur Radio gear offer a side benefit of being available to the Amateur Radio community at large. Often, tight crew schedule timelines prevent the astronauts from engaging in general voice contacts with Amateur Radio operators on Earth, but the ISS packet station remans operational.

Additionally, if one of the ground based Internet Gateway (IGATE) stations receives your broadcast, then it will be posted on the ARISS.net web page. The way it works is volunteer operators around the world host ground stations connected to the Internet through APRS client software that includes an IGATE feature. Digipeated stations and their positions "heard" by the APRS ground station are fed via the IGATE to Internet maps.

To see a log of stations all over the world digipeating through the ISS (including your own packets), go to **ariss.net**. The list at ariss.net has several hours worth of stations logged. If your AX.25 UI formatted message contained an APRS position report, your station would be displayed on the map (Figures 1 and 2). Also available is a chronological list of stations and messages captured by the IGATE stations.

2 Meter and 70 cm Band Uplink and Downlink

Until recently, packet radio activity from the ISS on the 145.825 MHz downlink originated from the ARISS Ericsson two-meter HT. When this 2-meter radio failed, it was replaced with an identical Ericcson 70cm HT operating on 437.550 MHz.

In this mode, the uplink and downlink frequencies are the same. The packet digipeater uses the uplink/downlink on the same 145.825 MHz or 437.550 MHz frequency. The current packet configuration uses the 437.550 MHz frequency.

Since the crew rarely engages in keyboard contacts, most of the packet activity you are hearing is originated from Earth stations using the ARISS digipeater. Lacking packet gear, you will only hear the brzzzzz-brap sound of the 1200 baud audio frequency shift keyed (AFSK) signal.

Getting on the Air with Packet

Getting on the air with the ARISS packet digipeater can likely be accomplished with Amateur Radio gear you already own. No special Amateur Radio equipment beyond what is used for terrestrial packet contacts is needed to begin taking your first steps toward Amateur Radio packet operating in space. This means if you do not own certain items they can likely be acquired

Figure 1 — Ariss.net shows a map of stations digipeated via the ISS on145.825 or 437.550 MHz.

Figure 2 — Selected portions of the Earth can be viewed in detail since the global map is "zoomable" along the lines of using online Google Maps.

inexpensively. Think of ARISS packet radio as regular terrestrial ham radio packet aimed skyward.

Additional good news is that once you have equipped your station for ARISS packet and learned the ropes for ARISS packet operation, your station will be ready for those rare voice contacts with the ISS crew. You will just need to switch the packet gear for a microphone and start calling.

Ground Station Requirements

For your packet ground station, a standard 2-meter 70cm, or dual-band FM transceiver with 5 to 30 W into a Yagi antenna that can be pointed in both azimuth and elevation provides the best performance. Several stations report moderate success with externally mounted vertical antennas so don't let the availability of a Yagi prevent your packet operation via the ISS.

The downlink signal from the ISS is generally easily heard but you will not have much luck trying to get your packets through the digipeater with an indoor antenna or with the flexible antenna on your HT.

The good news is that your external antenna does not require full OSCAR-class tracking and control. Many enjoy success with a VHF vertical antenna on the roof of the house. A small beam need not be complex. A 3-element VHF beam at a fixed elevation of 15-20 degrees on a small TV rotor provides a good start.

Doppler Shift

Doppler shift on 145.825 MHz is minimal enough that most 2-meter radios will not require frequency tracking during an ISS pass. However, on 437.550 MHz the Doppler shift is +/- 10 KHz during an ISS pass. This needs tracking for success (Figure 3).

Operators can choose between three approaches to encode/ transmit and receive/ decode the 1200 baud AX.25 AFSK packet messages:

- Use a Hardware Terminal Node Controller
- Use a software-based computer soundcard Terminal Node Controller, or
- Use an APRS capable HT such as the Kenwood TH-D74A or TH-D72A.

[This article focuses on the hardware and software TNC approaches; see the separate article in this issue about using the Kenwood TH-D72A and TH-D74A.]

```
**********************************
* 70cm ISS packet on 437.550 MHz *
*       (+/- for Doppler)        *
*                                *
* Channel   Receive    Transmit  *
*    1      437.560    437.540   *
*    2      437.555    437.545   *
*    3      437.550    437.550   *
*    4      437.545    437.555   *
*    5      437.540    437.560   *
**********************************
```

Figure 3 — Example of Doppler-shifted UHF ARISS frequencies. [Courtesy of Patrick Stoddard, WD9EWK.]

Use a Hardware TNC

When packet radio was a popular terrestrial operating mode on VHF/UHF many years ago, you may have acquired your Terminal Node Controller (TNC) which you interfaced to your computer and FM radio (Figure 4). You may have a TNC sitting on the shelf collecting dust. This same "old" hardware, capable of operating terrestrial 1200 baud AX.25 AFSK modulation is still useful for packet radio operation via the ISS.

There were many models of the AX.25 TNC including the MFJ-1270C TNC-2 Packet Controller and the Kantronics KPC-3 TNC.

If you don't have a TNC that you used in the "old days," one can often be purchased rather inexpensively at a hamfest. When you see a good deal, grab it if you prefer the hardware approach to packet operation.

Use Your Computer and Software

In the years since the peak of the hardware TNC based activity, software for sending and receiving an AFSK packet signal has been created for the sound card in your personal computer. Your computer with a soundcard interface and packet software will perform the functions previously provided by a TNC hardware box (Figure 5).

In addition to the soundcard software you

Figure 4 — Basic configuration of a hardware-based packet system.

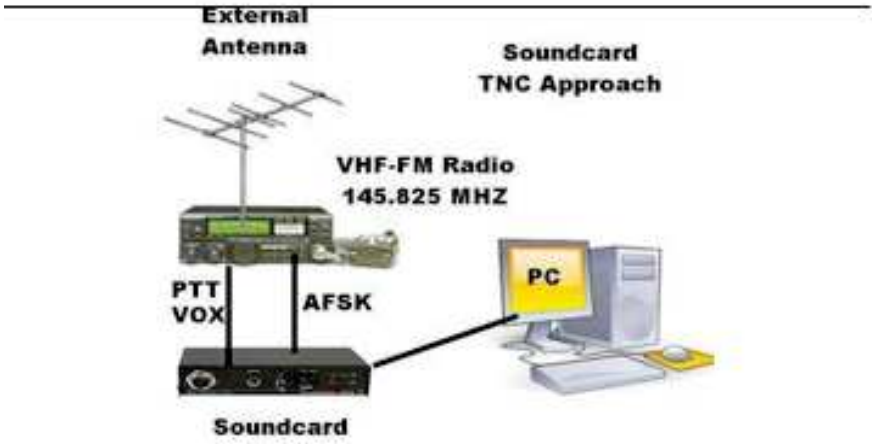


Figure 5 — Basic configuration of a soundcard-based packet system.

will need to install a soundcard interface between your radio and your computer to adapt the signal levels to be compatible with the digital signal processing done by the soundcard. You have a few options to this approach also:

- Build a soundcard interface from plans found on the internet
- Rigblaster by West Mountain Radio $100-$300 (www.westmountainradio.com), or
- Donner Digital Interfaces $40-$100) (**www.k8be.net/donners_ country_ crafts_and_digital_interfaces. html**)

Whether you choose the hardware TNC or the software/soundcard TNC approach depends on what gear you have on-hand. (One added bonus of using a soundcard interface is that you will be able to copy the slow scan TV events from the ISS by simply starting SSTV software instead of the packet software.)

Overview of Operating Through ISS Using the Hardware TNC

Much of terrestrial packet operation consists of you requesting a CONNECTION to another station.Packet communication via ISS almost exclusively relies on using CONNECTIONLESS operation.

The AX.25 protocol defines these types of packets as UI packets. An UI packet is pretty much transmitted out there for anyone and everyone to receive and copy. When stations transmit UI packets, the AX.25 protocol will not be waiting for all of the handshake messages to complete. This greatly simplifies the message exchanges. A few parameters in the TNC make UI operation an easy mode to operate.

Every AX.25 packet that you transmit consists of two main parts: The Packet Header & Message Text. The Header contains your callsign which you set with the MYCALL command. Other packet stations will "know" it is a UI packet - a packet for everyone - based upon what you set using the UNPROTO command.

The most basic, barebones UNPROTO needed for ISS packet is simply set UNPROTO CQ VIA ARISS. Additional strings used for terrestrial packet such as WIDE, WIDE1-1, etc., do nothing for packets routed via space. This additional formatting is ignored. It also adds overhead to your transmitted packet making it more error-prone in congested operation (such as when dozens of stations are attempting to digipeat via the ISS).

Assuming I have my route defined as UNPROTO CQ VIA ARISS (or, UNPROTO CQ VIA RS0ISS), now all I need to do to transmit an UI packet from my station is to enter a short text message via the keyboard and terminal program on the PC. This requires the use of the TNC's CONVERS command as outlined here:

- Set UNPROTO CQ VIA ARISS;
- Enter CONVERS mode from the cmd: prompt on your TNC screen;
- Enter a short message such as Greetings from JoAnne via the space station and hit <enter>; and
- You should see your TNC key your rig and send the message.

While you are in CONVERS mode all input from your keyboard is transmitted every time you hit the <enter> key. To exit the CONVERS mode at the end of a pass use Control-C (usually) to get back to the TNC cmd: prompt.

When the TNC-2 hardware is in a connection with a specific station node or in the CONVERSE mode it generally does not display all packets. Refer to the TNC command summary table for details, but setting MONITOR ON, MALL ON, MCON ON will allow you to see all of what is going on the channel. Refer to the TNC-2 command table for details.

The actual keyboard syntax to enter the commands into your TNC (from the cmd: prompt) will likely vary according to the manufacturer. Refer to the table below for a TNC command summary.

APRS Format Location Information?

ARISS status displayed at **www.ariss. net/** includes an APRS map showing station locations.

You do not need to run any extra APRS software to be displayed on the map. You can generate the APRS format directly at your keyboard if you wish to show up on the map. If you wish to simply send text messages to be digipeated via the spacecraft you simply type your message without the location data. While your QTH isn't showing on the map your packets will in fact still be digipeated – and you will see that on your screen.

Where do you find your APRS location information? This is just your GPS location. If you do not have access to a GPS box simply find your QTH on Google Earth (in the View -> Grid menu).

So if I would like to display K9JKM on the map using my latitude and longitude plus send a message to my fellow space-packeteers, I should send a text string using

Summary of the TNC commands

TNC Parameter	Value	Description or Action
MYCALL	Your Callsign	Default is NOCALL, but you want others to know you are there.
DAYTIME	YYMMDDHHMM	Used if you want to timestamp the packets you are receiving.
MONITOR	ON	Displays all packets on the frequency
MALL	ON	Displays all packets on the frequency (connected or unconnected)
MCOM	ON	Displays the AX.25 protocol with the message
MCON	ON	Allow you to see all packets even when in CONVERS mode
MSTAMP	ON	Monitored packets are timestamped
MRPT	ON	Displays the entire digipeat path for the packets.
CONSTAMP	ON	Connect and disconnect status messages are timestamped
HEADERLN	ON	Header information is displayed on separate line from message text
PASSALL	ON	TNC will accept and display packets that have errors (noise)
PASSALL	OFF	TNC will only accept and display packets that have complete CRC.
CONVERS	<enter>	Starts UI communication mode. Sends packet message from keyboard directly to the TNC
MHEARD	<enter>	Displays your TNC's "heard" list (updated only when PASSALL OFF)
UNPROTO	CQ VIA ARISS	Most basic string for ARISS to copy, route, and digipeat your packet. Also used with NO-84.
UNPROTO	CQ VIA RS0ISS	Most basic string for ARISS to copy, route, and digipeat your packet specifically via the ISS
UNPROTO	CQ VIA W3ADO-1	Basic string for PCSAT-1 for Sunlit ONLY operation.

the UNPROTO and CONVERS steps previously outlined, and make my text message look like: =4211.29N/08827.08W-Greetings
<enter>

The parts of this message string can be explained as follows.

• =4211.29N/08827.08W is simply the = character plus my QTH info from Google Earth.

• The – is the 'dash' or hyphen. It tells the map to display me as the little house with antenna icon. The ARISS packet page above has a link where you can find other icons to represent you on the map

• Greetings <enter> can be any message text you wish. You will likely have better luck getting through and being digipeated if you transmit short messages.

• If I see someone on the downlink who I would like to have a keyboard QSO with, all I would need to do simply enter the message from the keyboard without any APRS-formatted location: "Hi Bob, good to see you this pass" will just send Bob (and everyone reading the packet mail) your message.

The **www.ariss.net/** web page also shows a packet log of stations that have successfully digipeated. In this packet log the callsign with the asterisk (*) is last station to digipeat my packet. When you see RS0ISS* this shows that you were digipeated via the ISS!

Operating packet without the traditional standalone TNC requires a combination of software and hardware connections.

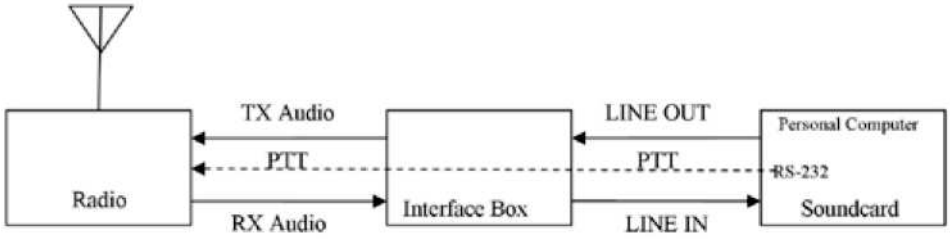
• Software will generate and decode the AX.25 packet signal using the digital signal processing capabilities of the soundcard in your computer.

• A soundcard interface box is needed to set the proper sound levels between the computer and the radio.

• Push-to-talk (PTT) rig control is often generated by the software by setting selected pin(s) of the RS-232 serial interface. Some radios such as a Yaesu FT-857D will reliably switch between TX and RX function if the VOX levels are set in the radio's operating menus.

• If you already have interfaced your radio to the soundcard for other Amateur Radio applications such as RTTY, PSK31, JT65, and SSTV, you are already set for AX.25 ARISS packet operation with the ISS. All you need is to download, install, and configure some free software.

Overview of Operating the ISS Digipeater Using Your Computer's Soundcard and Software



Since the connections between your radio and the soundcard interface of your choice are specific to your situation, we will defer discussion of this because you need to consult your radio operator's manual and the instruction book of the soundcard interface. Careful research before buying an interface box will reveal that many of the leading brands will also sell you an interface cable kit specific to your radio.

Setting Your Soundcard Levels

If you are already using your soundcard for other Amateur Radio applications such as PSK31, etc., usually the same settings can be used for packet. If needed, use the "Wave" slider control to set the transmit level; use the "Line In" slide control to set the receive level (Figure 6).

Install the Software You Need

The software you need for ARISS packet operation is available for free download. The items you will need include:

• AGWPE — Written by George Rossopoulos, SV2AGW, it is an acronym for "SV2AGW's Packet Engine." It was originally created as a TNC management utility and has many features of value to TNC users, plus it has the ability to encode and decode packet tones using your computer's soundcard. Download from: **www.sv2agw.com/.**

• UISS — Guy Roels, ON6MU, designed it for UI packet communication (unproto) packet with ISS. This will be your user interface for packet communications with the ISS. This software is free for amateur and non-commercial use. A PRO version is available, and donations are welcome. Download from: **users.belgacom. net/hamradio/uiss.htm.**

Installation and user guides for the software packages are included on their websites. Here are a few links to websites that will give you the information needed to get on the air quickly:

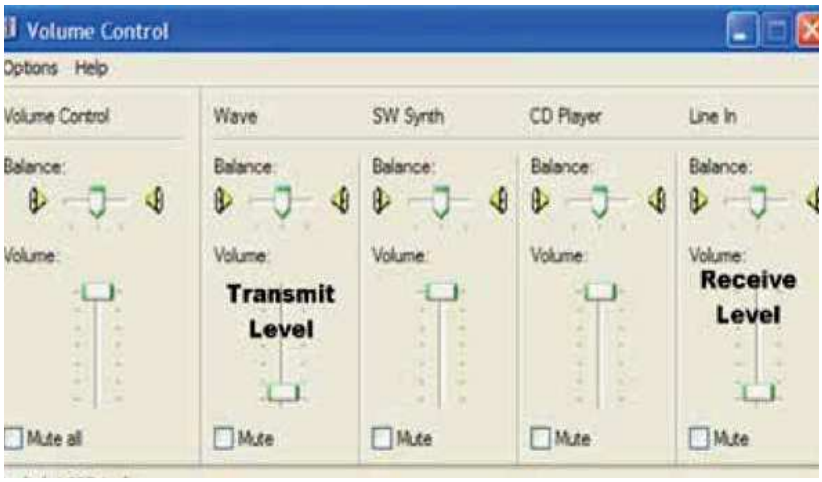


Figure 6 — The computer's sound controls are used to adjust the transmit and receive audio levels.

• The "golden" reference for soundcard packet configuration and operation is the "Sound Card Packet" site by Ralph Milnes, NM5RM: **www.soundcardpacket.org/.**

• Additional help for installing AGWPE is provided in a word document, "An Easy Set Up For Soundcard Packet," by Karl Berger, W4KRL. These are basic instructions for getting started, but you will not need the WinPack steps outlined. (We're using UISS instead.) **www. w4ovh.net/SoundcardPacketSetup.doc.**

• Mineo Wakita, JE9PEL, has published several online references for the installation and use of UISS: **www. ne.jp/asahi/hamradio/je9pel/ui32uiss.htm** and UISS setting up APRS satellite: **www.ne.jp/asahi/hamradio/je9pel/ uissagwp.htm.**

• The UISS site has a reference page: **users.belgacom.net/hamradio/uisslinks.htm.**

Example Operating Session With the Soundcard

Here is an example of an operating session to further acquaint you with this mode of operating.

(1) Always start AGWPE first (Figure7). Click on the AGWPE icon on your desktop and you will see the following splash screen telling you things are running. The splash screen will go away in about 10 seconds. You will also see the AGWPE Packet Engine startup "bubble" appear in the toolbar. You can "X" (to exit) the bubble but AGWPE will continue to run as shown by its icon in the toolbar. You can left or right click on the icon to get to AGWPE configuration settings if you ever need them.

(2) Start UISS (Figure 8). Click on the UISS icon on your desktop and the program will open to the operator screen.

• Your UNPROTO string CQ VIAARISS is set by using the pulldown menus in the To and Via windows in the top/left of the screen.

• The APRS-formatted location information which was also used in the hardware TNC configuration is entered in the TX Text/Data window.

• The MHEARD command used with the hardware TNC to show who is on the frequency has its equivalent display shown in the MHEARD list on the right side of the screen.

• To transmit my packet configured for digipeating via ARISS =4211.29N/08827.08W- I just click on the Text/Data button in the top row.

• UISS will show all of the packets being received when the ISS is within range. Your packet will be highlighted when you (and everyone else in range) receives the digipeated packet.

(3) Alternatively, you can display the stations you receive on an APRS-format map. In the example here, UI-View shows the stations received that were transmitting their location data during a pass of the ISS over the eastern half of North America. Start AGWPE first, then start UI-View (Figure 9).

Using a Packet "Hard-Connect" to RS0ISS-11 BBS

In a word, please don't! The ISS PBBS with the ID RS0ISS-11 operates in the same manner as a terrestrial Packet BBS operates.

Figure 7 — Opening screen of the AGW Packet Engine (AGWPE). Once the program is initialized, it will become a icon in the system tools tray.

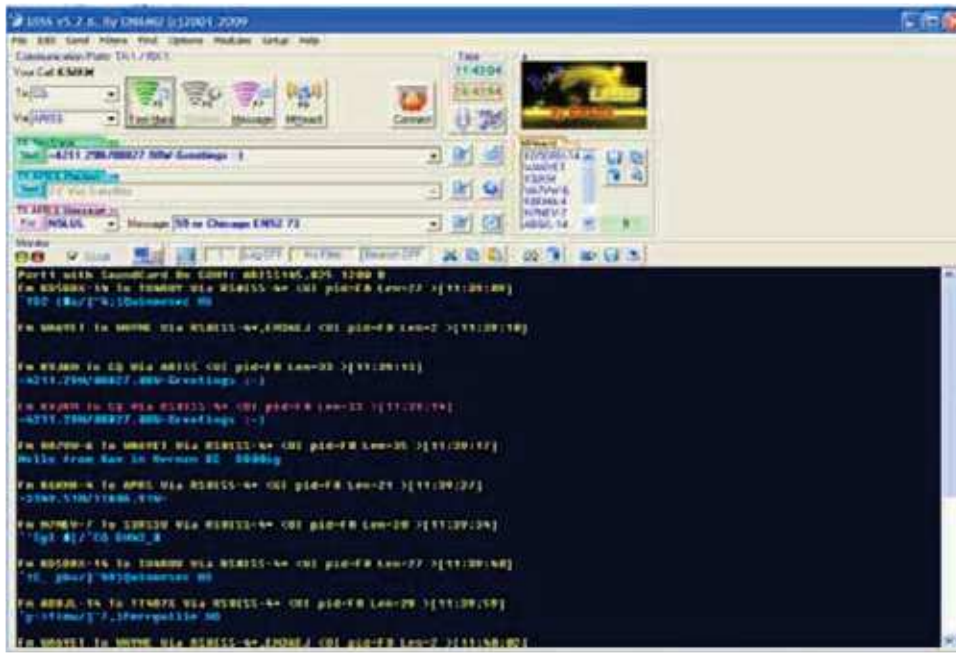


Figure 8 — UISS screenshot.

A "hard-connection" (C RS0ISS-11) establishes a full AX.25 connection which brings the entire messaging handshaking protocol into operation. The handshake messages will faithfully repeat, and repeat, and repeat all error messages, per protocol, until they are properly acknowledged.

The usual case is that many stations are sending packets to the ISS resulting in data collisions when RS0ISS-11 is expecting its handshake. Everyone tuned into the pass will see the endlessly repeating AX.25 handshake bytes until the sequence times out. You may have been out of range for several minutes already but the ISS is still listening for you. Although the PBBS is still configured there are NO useful files or messages. The ISS crew does not access these messages either. So, all of the greetings to crew have successfully tied up the channel but have failed to be delivered to the intended recipents.

Swapping the UZ7HO Soundmodem Packet Program in Place of AGWPP

Many operators note that often a strong sounding downlink is heard from the ISS but the AGWPE and UISS combination of software will not decode and display the packet message. This is because the checksum was not correct. Losing only a bit or two of the digital packet due to noise or fading will result in that packet's checksum not being correct. AGWPE only passes the received packets that have a correct checksum. When using a hardware TNC with the PASSALL command enabled, you can see all packets, including the incomplete packets, or with reception errors. Often the packets with errors contain enough useful data for a human to still understand them. However, in the software TNC emulation, this command is not available.

I have read of other operator's experiences having better error condition response using the UZ7HO Soundmodem software in place of the AGWPE packet engine. Conveniently, the UZ7HO Soundmodem software, an AX.25 packet TNC for your computer's soundcard, can be used in place of the AGWPE software mentioned in this article. Either program will work but the setup in UISS differs for the UZ7HO software.

To get started using this optional approach, get the UZ7HO Soundmodem from **uz7.ho.ua/packetradio.htm**. Download and unzip these files:

- **soundmodem95.zip 02-Aug-16 08:20**
- **user_guide_v045b_EN.pdf.**

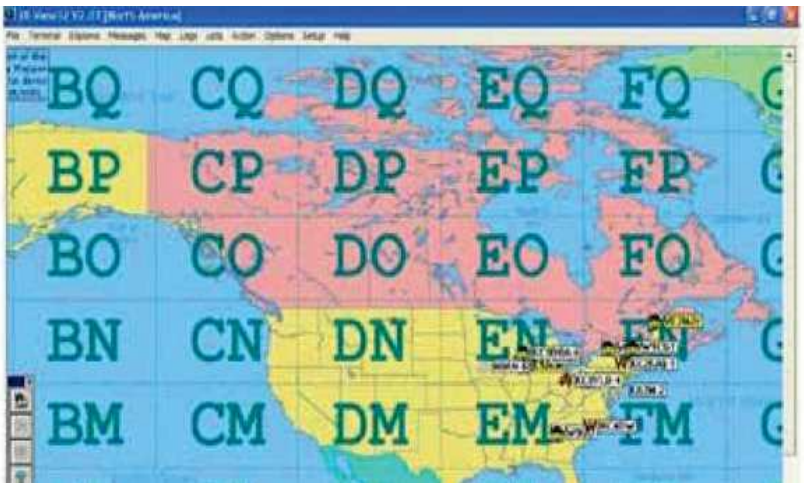


Figure 9 — UI-View APRS application showing station locations.

The setup guide and user guide are easy to follow. It is easy to test the UZ7HO Soundmodem. I tuned my receiver to the 144.390 MHz APRS frequency. I immediately saw the APRS messages. Good! The setup is receiving. I tuned back to 145.825 MHZ or 437.550 MHz ARISS packet frequency to wait for the next ISS pass over my station.

ISS Operating Hints

• Listen before transmitting. The most prevalent mode is digipeat mode on 145.825. If you want to make a voice contact, listen to 145.80. Do not call until you hear voices; then make sure they are not from confused ground based operators.

• Keep your Keplerian elements up to date. The ISS repositions itself quite often. Check the AMSAT website Pass Predictions page **www.amsat.org/track/index.php** or other sources for current ISS keps every few days.

• Be patient, a large number of hams are

Figure 10 — The UISS program will require settings to be changed to operate with UZ7HO Soundmodem: In UISS top menu, select Setup >UISS>LAN (above screen).

just as anxious as you to communicate with the ISS.

• Keep your calls short and pass along your name, call sign and grid square.

• Up to date QSL information can be found on the ARISS web sites.

• The ISS is in process of upgrading the ARISS station, so check the web sites **ariss.org** or the AMSAT website's Current Status page **www.amsat.org/status/**

Resources

www.ariss.org
www.issfanclub.com/
www.nasa.gov/mission_pages/station/multimedia/index.html (great ISS photos)
spaceflight.nasa.gov/station/reference/radio/index.html
www.arrl.org/amateur-radio-on-the-international-space-station
www.amsat.org

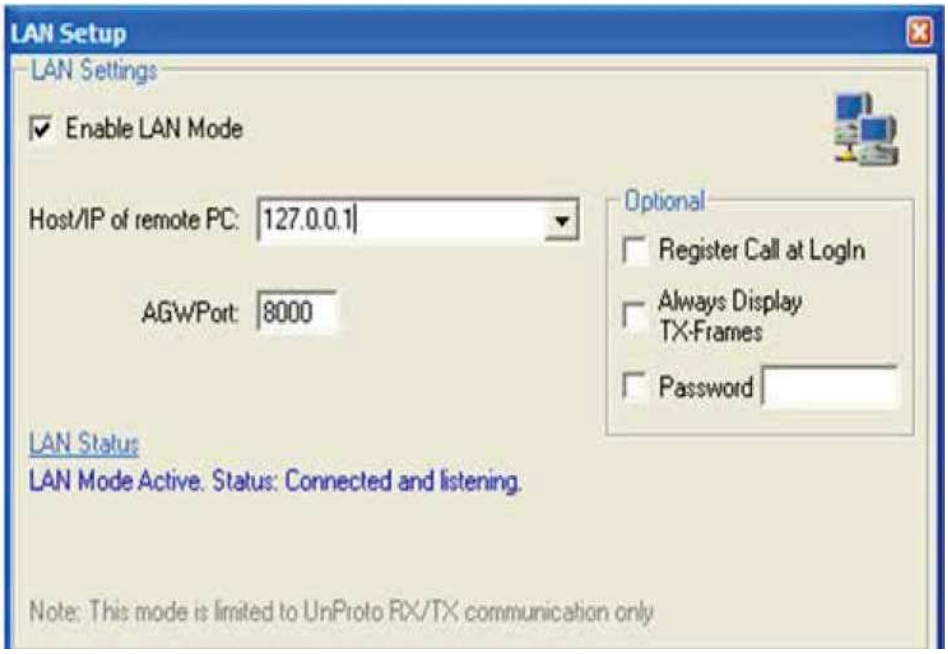


Figure 11 — In LAN setup, click on *Enable LAN Mode* Host 127.0.0.1 Port 8000.

Figure 12 — UISS may prompt you to restart. Go ahead and restart UISS. To return to operation with the AGWPE software, unclick the Enable LAN Mode option and restart UISS. Your setup is now ready for the next ISS pass! To send your APRS position report, click on the UISS Text/Data button. You can enter custom messages for quick packet contacts with other stations into the TX APRS Message box and then click on the Message button.