

RADIO MAGIC

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FM Voice and Data and the ISS: Part 1

It's a Bird. It's a Plane. It's the ISS!

It free falls around the Earth every 92 minutes travelling at 27,600 kilometres per hour with an average low Earth orbit (LEO) altitude of 420 km. When its flight path and sun angle are just right, it's visible a few hours after sunset and before sunrise as a bright white "star" (or UFO, to some) gliding swiftly and silently across the sky. Of course, I'm talking about the International Space Station (ISS) or Zarya (Russian for "dawn"). See Figure 1, next page.

In 1998, its first components (Zarya module) and astronaut work crews were lifted into space by the now defunct space shuttle where it was put together over two years like a LEGO bricks (or Tinkertoy) assembly. In the US "Columbus" module there's a Kenwood D710GA (call sign "NA1SS") supporting US scheduled voice contacts, packet radio and voice repeater operations. In the Zvezda (Russian for "star") module there's a Kenwood D710E (call sign "RS0ISS") supporting Russian scheduled voice contacts and SSTV special event transmissions. It's also used as a backup for the Columbus module transceiver but the D710E is usually off air most of the time. There are four dedicated Amateur Radio VHF/UHF antennas mounted on various strategic locations along the outside of the station.

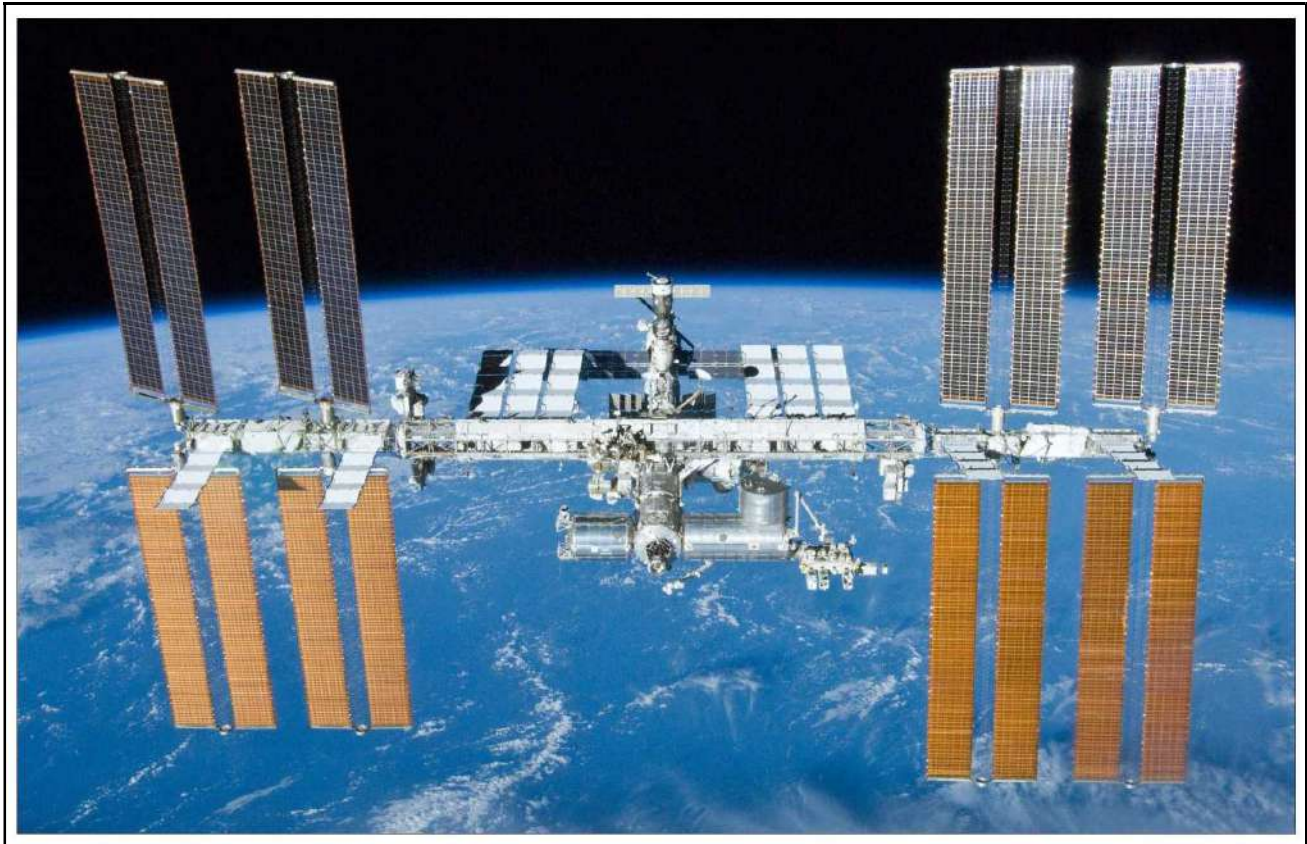


Figure 1: The International Space Station (ISS)

Credit: NASA/Boeing.

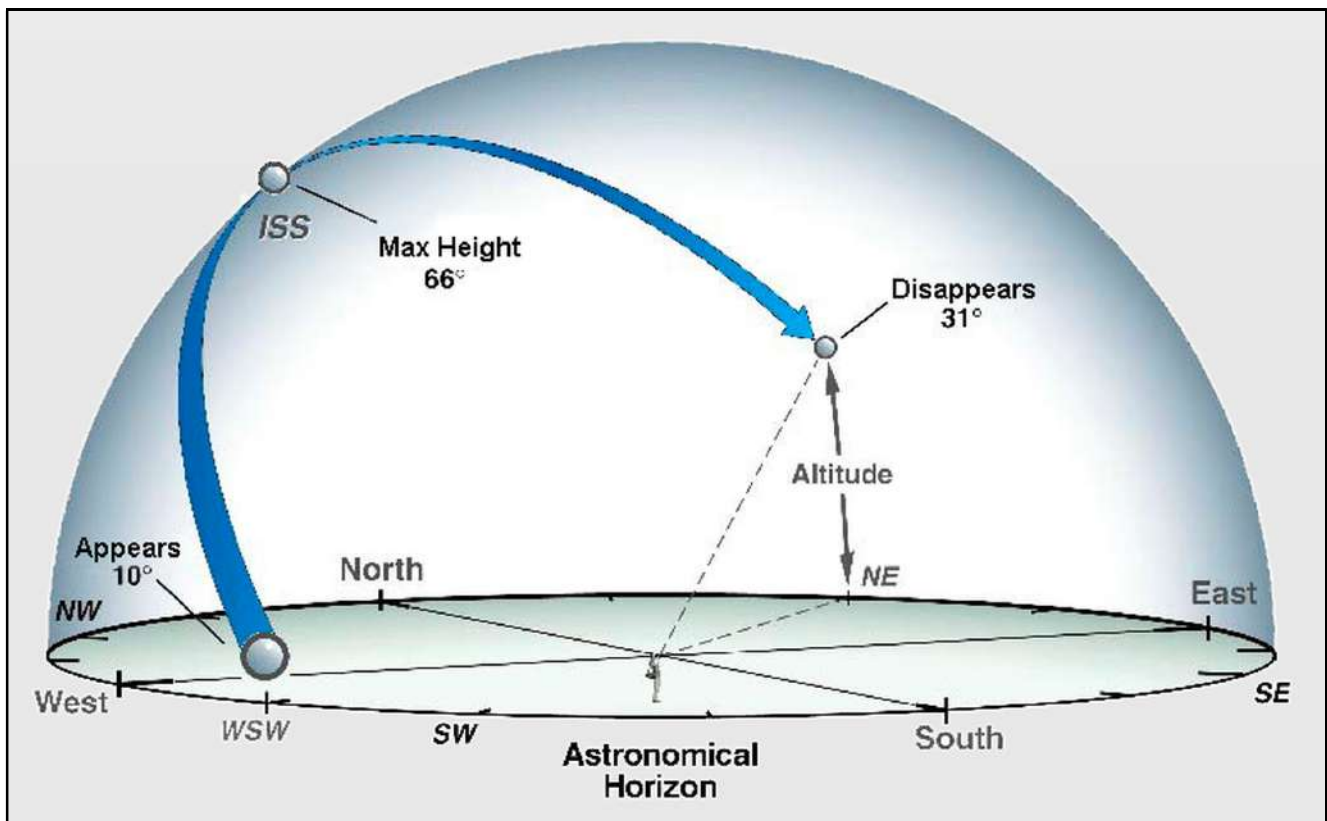
Seeing the ISS

The ISS Fan Club and AMSAT (the Radio Amateur Satellite Corporation) OSCAR (Orbiting Satellite Carrying Amateur Radio) websites provide information about the various activities and events for scheduled for Amateurs, schools and the general public along with the current status of active ISS frequencies and modes. The only caveat is that due to the ISS' nearly circular orbit and the Earth's rotation creates a constantly shifting in time sinusoidal wave orbital pattern. Fly past times always change during the month for any location so sometimes you need to get up in the wee early morning hours or stay up late at night. Because of its low Earth orbit and being such a large satellite (73 x 109 metres) with huge, shiny solar panels it can be extremely bright when sunlit just right so you'll have no problem spotting and following it across your local sky with the naked eye once you know when it will be sunlit (weather permitting) and where to look for it.

The “Spot the Station” website is great for this purpose (see Figure 2) but I also use the Heavens-Above Android app because it generates nifty naked eye star charts (great for binocular astronomy) along with the plotted trajectory showing where in the local sky the ISS is.

Figure 2: Sample Spot the Station Sky Dome

Times (local) are calculated for optimum sky contrast and brightness of the ISS, which are always a few hours before/after local sunrise/sunset, for how long it’s visible to the eye, the maximum sky elevation and from where it appears/disappears in the sky. Credit: NASA.



After a few naked eye sightings of ISS passes, you’ll probably want a more impressive view and tracking it with hand-held binoculars. Image stabilized versions are truly mind blowing (no hand shake) but are also truly mind blowing expensive! Being frugal and not too steady with hand tracking, I’ve had excellent results with my way cheaper Orion Paragon binocular altitude/azimuth mount (see Figure 3, next page) using larger binoculars, but even an inexpensive but stable camera/video tripod with a smooth pan head will well work, too.

Ten times magnification let's you see the do station in all its glory and lets you to smoothly follow it across the night sky, but it also moves quickly through the magnified field of view (FOV). On one magical, clear, moonless night, using my Paragon mount and Celestron 20 x 70's, I spotted the ISS at the predicted time and place in the sky, rapidly approaching getting bigger, brighter and whiter. By chance it crossed my beam and suddenly turned copper-gold with its details clearly visible (wow!) It quickly turned copper-red to deep copper-brown and suddenly it was gone! But for a few fleeting seconds, it felt as if I was flying alongside it! You can take camera/video images (see Figure 4, next page) but this is beyond the scope of this article.



Figure 3: My Orion Paragon Mount

FM Voice

For Amateurs and other radio hobbyists want to listen to voice signals from the ISS, an analog portable (narrow band) FM (NFM) scanner or inexpensive handie-talkie (HT) suffices. *Note: The generic term FM will be used to mean narrow FM (NFM), which is what our transceivers use by default.* To forecast ISS (or other OSCAR) passes over my location for a week or so, I mostly use "Orbitron" so I can track in real-time and because it's supported by both older and newer programs that require satellite tracking information (see Figure 5, next page). Plus you don't need a live internet connection, which I don't have at my summer camp. Once its satellite orbital data are updated when online, it will run orbital calculations just fine for about a week before the data are too out of date.

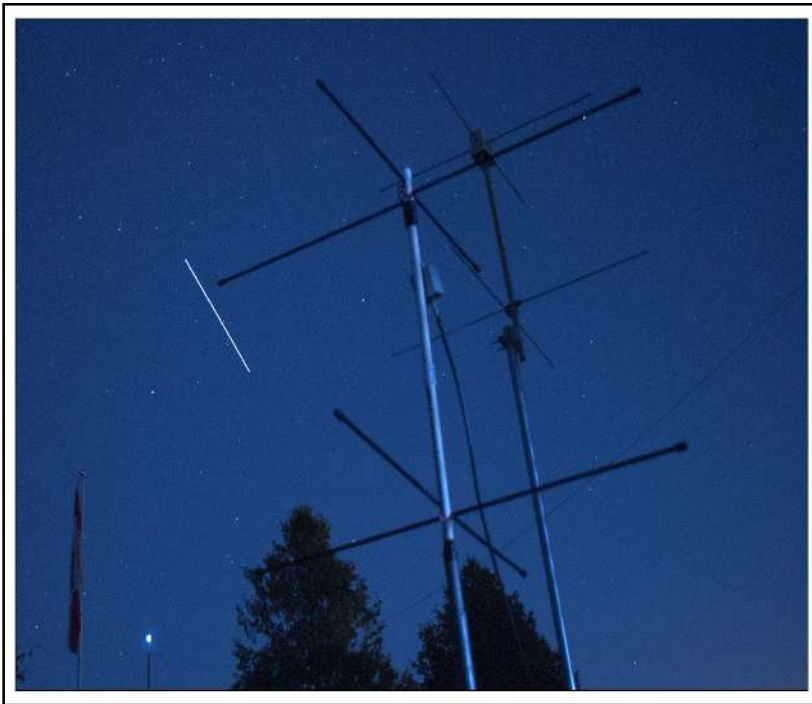


Figure 4: ISS Snapshot using Tripod
 This is a single 15 second exposure of the ISS during a high-angle transit (SW-N-NE) on 22 September 2021 at 0114Z with maximum magnitude of minus 1.3 (the more negative the magnitude the visually brighter the celestial object). I lucked out and got the ISS and my turnstile antennas in the same frame!

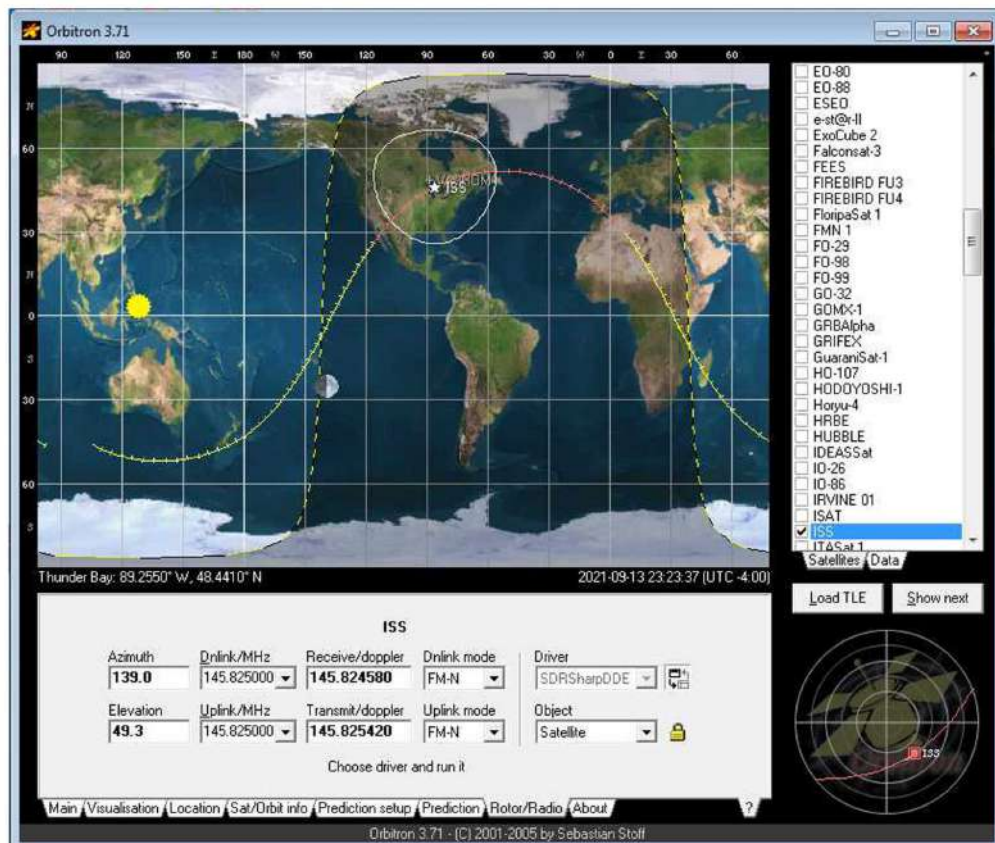


Figure 5: Orbitron
 Orbitron, by Sebastian Stoff, but no longer updated by the author, is a free satellite tracking program. An Internet connection is only required to update the orbital two-line elements (TLE) usually called Keplers or “Keps” (for the famous 16th century astronomer Johannes Kepler).

Any astronaut orbiting over North America wanting to chat with Amateurs uses the voice call “NA1SS” on the FM downlink frequency 145.800 MHz. For Amateurs to try and talk to NA1SS, after hearing a “CQ NA1SS”, you must transmit on the FM uplink frequency 144.490 MHz (split simplex). But remember, many Amateurs will be calling the ISS at the same time, too! The stock comes-with HT antenna with an added “tiger or rat tail” radial (see my “Antenna Tales” Sep/Oct 2021 *TCA*) or a mobile magmount antenna suffices for most mid to high-angle passes (greater than 45 degrees above your local horizon), but most serious satellite Amateurs prefer using a light-weight handheld dual band (VHF/UHF) beam antenna (the Arrow Antenna is very popular). However, do a lot of listening first to learn what to do and what not to do before keying your microphone. Usually the astronauts are too busy for unscheduled Amateur Radio communications, but the very popular ISS FM VHF up (145.990 MHz 67.0 Hz PL tone) and UHF down (437.800 MHz) flying repeater (VHF up/UHF down, V/u or mode J) is available during most passes for Amateur-to-Amateur quick in-and-out contacts . Don’t hog the repeater because it’s used like a contest frequency: call, grid and “73” exchanges. But sometimes, when it’s really quiet in the wee early witching hours, you do have more time to engage in a short chit-chat.

FM APRS and SSTV

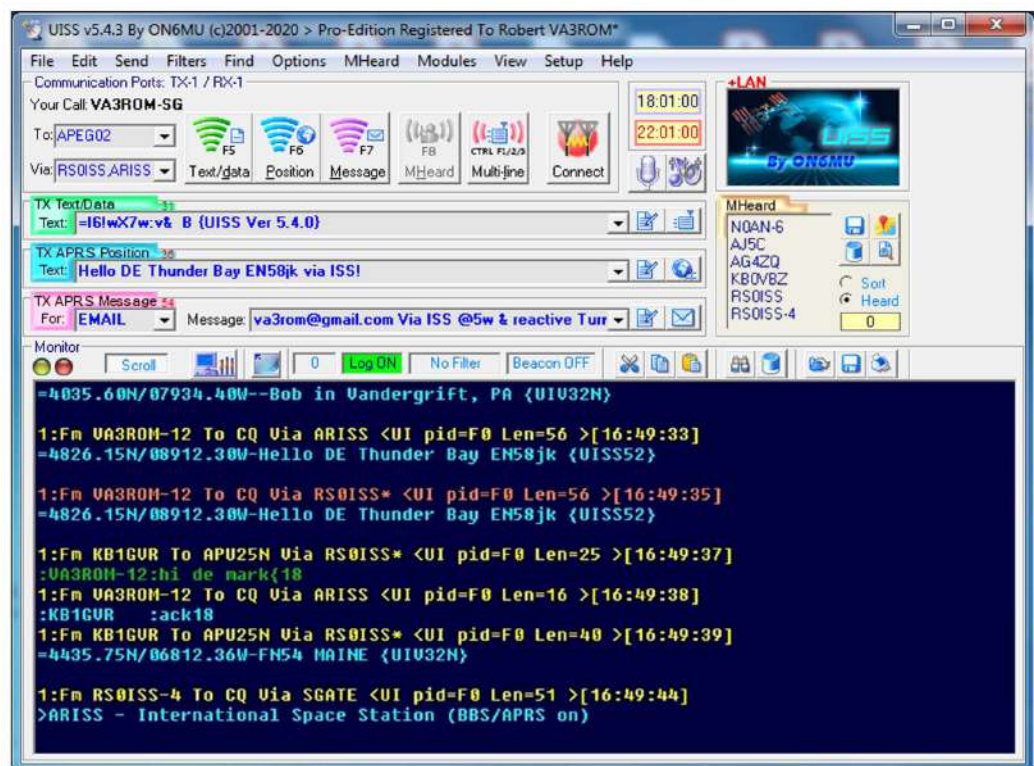
I’ve previously written about APRS and SSTV so I won’t rehash the details because you can download these articles from my “Radio Magic” website. The quick and dirty (but more expensive) way to work the ISS via packet radio is with an APRS enabled HT (handie-talkie) or mobile transceiver (the Kenwood APRS HT and mobile versions are the best, IMHO) tuned to FM 145.825 MHz simplex (same uplink to and downlink from frequencies used). *Important: The preferred APRS packet path is now just “ARISS” and no WIDEn-N statements are used.*

If you’re already a data modes operator, you have all the hardware needed such the soundcard-to-radio interface so you just need to add the ISS specific APRS packet radio software to go with the SSTV software (we only receive SSTV images). For receiving and decoding SSTV images (or packet data), you only need to connect an audio patch cord from your radio’s audio output to your computer soundcard’s line or microphone input, adjust the audio level and run the appropriate decoding software (see Figure 6).

You can also use a software defined radio (SDR) but they route their audio output using a virtual audio cable (VAC) to stream audio to the decoding software. When you hear packet radio signals on 145.825 MHz, it's the ISS digipeating any properly formatted terrestrial packets it hears back down to Earth so it covers a really large geographical area or "footprint" from up on high. You'll also see any decoded packets on your APRS enable radio's display or computer display if using software decoding. When you get solid decodes of other's APRS position reports (posits), you can then transmit a few spaced apart APRS posit beacons of your own, but remember that you won't be the only one! If and when you do see your own APRS posit digipeated by the ISS—stop! One and done. If you or another ground station have setup a UISS satellite gateway (S-GATE) it then streams digipeated APRS posits it hears to the APRS internet system (APRS-IS), and this data is accessible through various APRS server websites. Any packets formatted for the cellular short message service (SMS) or email they are then automatically routed through to the SMSGTE or EMAIL/EMAIL-2 systems.

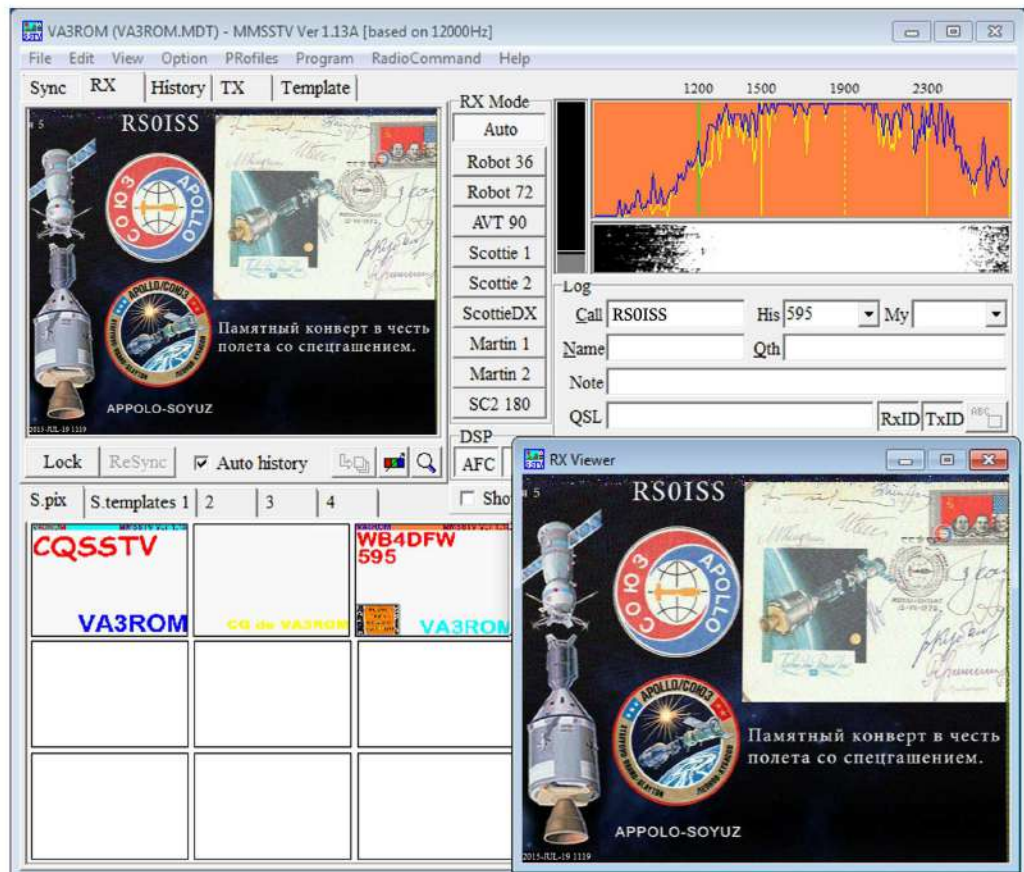
The most commonly used and free programs are "UISS" for monitoring and working through the ISS using APRS and packet radio plus gating packets to the APRS-IS, and "MMSSTV" (see Figure 7, next page) for receiving and decoding SSTV transmissions. These programs and Orbitron run just fine on old recycled XP/W7 laptops.

Figure 6: UISS
 UISS by Guy Roels, ON6MU, this is the control centre of the "pro" (donation ware) version. Screen bottom shows incoming and outgoing APRS posits and other packet radio communications. Guy also created "RXSSTV", a receive only SSTV program for non-Amateurs.



Just like packet radio, SSTV transmissions, which are announced ahead of time and commemorate special space historic events, have very distinctive audio tone, and usually transmitted from the Russian module on the downlink frequency 145.800 MHz. The overlaid call sign on images is “RSOISS” unless the Columbia module transceiver is used instead then it’s “NA1SS”. The current SSTV mode used is “PD120”; images are 640 x 480 pixels and take about 120 seconds to transmit followed by a required transmitter cool down time of a few minutes because a continuous FM carrier (100% duty cycle) heats up the transceiver’s finals fast and they need time to cool.

Figure 7: MMSSTV
MMSSTV by Makoto “Mako” Mori, JE3HHT, but no longer updated, is a free transceiver program for all current analog SSTV modes.



My Final

I'll go into more details in part 2. The ISS is a grand sight to see in the sky and there are real live people (not robots) up there, even possibly looking out a window down at you. So why not wave whenever you see it fly by!—73

References and Resources

AMSAT Sat Status <https://www.amsat.org/status>

AMSAT US <https://www.amsat.org>

APRS-IS Servers <http://www.ariss.net>, <https://findu.com>, <https://aprs.fi>

ARISS <http://www.ariss.org>

Arrow Antennas <http://arrowantennas.com>

ISS Fan Club <https://issfanclub.eu>

ISS Wiki <https://tinyurl.com/mfv7jjuk>

MMSSTV <https://hamsoft.ca/pages/mmsstv.php>

Paragon Mount <https://tinyurl.com/44an93u8>

Spot the Station <https://spotthestation.nasa.gov>

UISS, RXSSTV <https://www.qsl.net/on6mu>

VAC <https://vb-audio.com/Cable>, <https://vac.muzychenko.net/en>