

## SSTV images from space

Prepare your radio shack and get ready to receive images from the International Space Station!

**Learning targets:** Discover the world of the International Space Station and of satellite communications - learn how to set up a receiving radio station - learn how to build simple antennas for VHF-UHF reception.

**Description:** During certain periods of the year, the International Space Station (ISS) transmits SSTV images to earth, as a reception challenge for radio enthusiast. Most details can be found in the following websites, dedicated to ham radio communications with satellites and with the ISS:

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

<https://www.ariss.org/>

<https://amsat-uk.org/> and in particular <https://amsat-uk.org/beginners/iss-sstv/>

Dates and frequencies of SSTV transmissions are announced on these websites.

Here the basics steps to receive SSTV images from space are covered

**Timings and ISS path:** The ISS orbit is such that the space station completes an orbit of Earth every 90 minutes. In practice, the ISS will be visible from a point on the ground for not more than 12-15 minutes. While a receiving station might be left working continuously, waiting for a good signal, it's still useful, especially at the beginning, to concentrate efforts exactly when the ISS is passing. Several programs (eg gpredict) and mobile phone apps can be easily found and used to get the ISS pass predictions and the exact path of the ISS above the point of observation. Remember that these predictions are based on orbit information that should be regularly downloaded from the web, at least weekly. The easiest way to start is to use an amsat web tool available at <https://www.amsat.org/track/index.php>. You will have to enter your longitude and latitude data, that can be easily found from Google Maps. Here is an example of predictions:

AMSAT Online Satellite Pass Predictions - ISS							
<a href="#">View the current location of ISS</a>							
Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
31 Jul 21	16:17:58	00:10:56	251	58	344	62	16:28:54
31 Jul 21	17:55:25	00:10:33	282	27	13	71	18:05:58
31 Jul 21	19:32:40	00:10:47	297	38	30	96	19:43:27
31 Jul 21	21:09:33	00:10:47	296	49	204	134	21:20:20
31 Jul 21	22:47:13	00:07:45	277	7	236	185	22:54:58
01 Aug 21	13:54:49	00:09:38	197	16	137	72	14:04:27
01 Aug 21	15:30:35	00:10:58	242	83	319	62	15:41:33
01 Aug 21	17:07:54	00:10:37	276	29	7	67	17:18:31
01 Aug 21	18:45:17	00:10:39	295	31	27	88	18:55:56
01 Aug 21	20:22:12	00:10:56	298	79	217	124	20:33:08

AOS and LOS mean Acquisition Of Signal and Loss Of Signal, respectively. The first refers to the point and time from which the ISS appears from the horizon, the second refers to the point and the time of disappearance. With a compass and the azimuth data, it will be easy to locate these points. Regarding time, be careful of the fact that they are given in UTC, Universal Coordinated Time. Check how this time is related to your time zone and to the season. For example, in the CEST time zone (Germany, Italy, etc.), 8:00 UTC means 9:00 (+1:00) in winter, but 10:00 (+2:00) in the summer. Several websites at the present time can help you identify the correct offset to apply.

A really important information is given by the maximum elevation (data are in degrees from the horizon). If the maximum elevation is below 30°, it's quite unlikely that you can catch the ISS, since several obstacles may be present above the horizon. Also, at low elevation values the distance between your position and the ISS is larger. Attempts to receive the ISS should be made at high points, where the horizon is not blocked by trees, buildings or even hills and mountains.

**The receiver:** To receive ISS signals, you will need a SDR dongle. Several models are available on general ecommerce websites. They appear as USB keys or small boxes that can be connected via USB. Once the device is connected to the PC, the first thing to be done is to download the reception software. The most used one is SDR#: <https://airspy.com/download/>. Several alternative softwares can be found for any operating system.

Once the software package is downloaded, in the resulting folder it is possible to find the program ZADIG, which must be used first to install the proper drivers. Details about this operation can be found at these links:

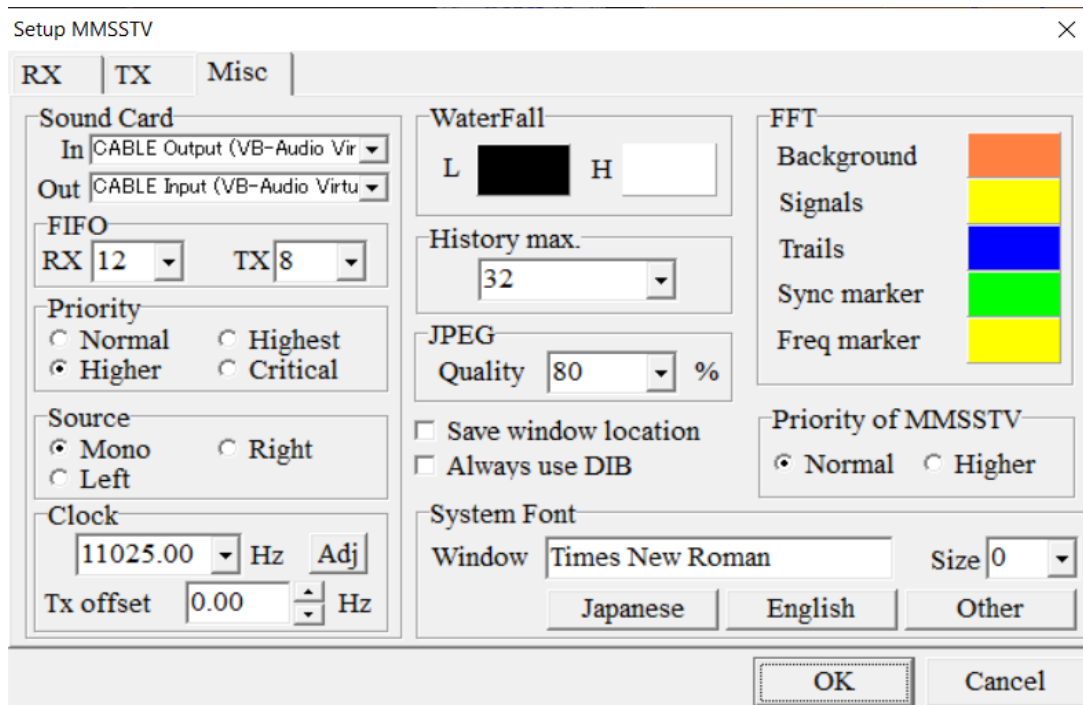
<https://www.rtl-sdr.com/rtl-sdr-quick-start-guide/>

<https://zadig.akeo.ie/#>

At this point, you can put the receiver into operation opening the SDR# main program (SDRSharp.exe); you will have to select the proper reception device clicking on the gear button (with the SDR key connected, the device should appear as RTL-SDR...). Clicking on the play button, reception will start. The spectrum waterfall, the reception mode, the frequency selection work similarly to the online receivers that are described in the broadcasting station listening activity (LINK). To listen to the ISS, select the FM mode and the latest frequency indicated in the mentioned websites (usually it's 145.8 MHz).

SSTV signals are heard as repetitive, fax-like sounds. To decode them into images, there are two main ways:

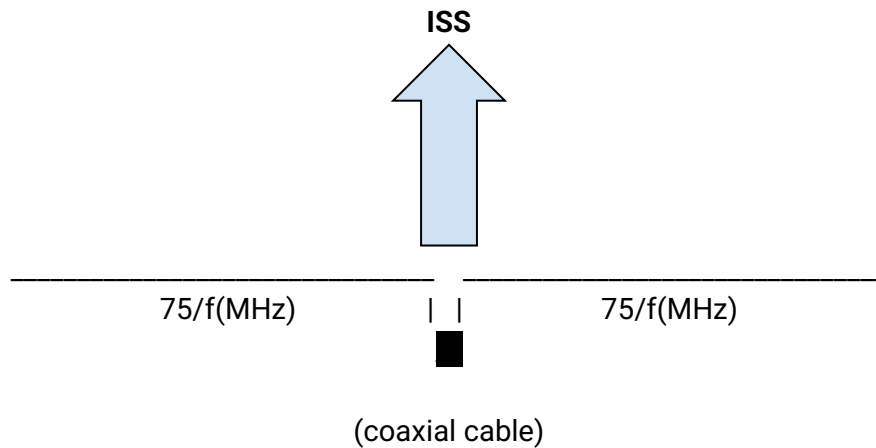
- **The easy but dirty way:** put the PC volume as high as possible, but avoiding audio distortion. On a mobile phone, install and start the Robot36 app (<https://play.google.com/store/apps/details?id=xdsopl.robot36>). Place the mobile phone close to the PC loudspeakers and wait. The noise around should be as minimal as possible.
- **The complex but clean way:** the audio is decoded from a software in the same PC. To do this, install Virtual cable (<https://vb-audio.com/Cable/>) and MMSSTV (<https://hamsoft.ca/pages/mmsstv.php>). The first program creates two virtual audio devices, "Cable input" and "Cable output", that allow you to direct the output sound of SDR# towards the input line to be decoded. In the audio settings, activate the two devices among the input and output devices. In this condition, it's normal that no audio comes from the loudspeakers. At this point, open MMSSTV→ Option→ Setup MMSSTV and select the input device



The program will work autonomously, decoding and saving the SSTV images.

**The antenna:** To receive the ISS, experts often build complex antennas as QFH antennas. For beginners, Scouts/Guides may start with a simple dipole, or directly try to build a YAGI antenna. First get a coaxial cable of suitable length with 52  $\Omega$  impedance (eg RG58) and one end with an SMA connector. This is the end that must be connected to the SDR receiver. On the other side, work with a nipper to detach the central conductor from the braided shield.

These two poles must be connected to two rigid metal wires (you can recycle a metal crutch, or even use a meter metal tape), one put adjacent to the other one. The length of each wire must be (in meters)  $75/(\text{frequency in MHz})$ . Fasten these two wires to a PVC pipe, so that you can hold the antenna. Remember that the antenna best receives perpendicularly to the axis of the wires.



A YAGI antenna is much more directional than a simpler dipole, in the sense that it's much more sensitive in one direction (and much less in the others). This is very important, because you need to get a signal that comes from several hundreds kilometers above you! A YAGI is essentially a dipole, with a reflector wire behind and a number of director wires in front. You can find several projects online. For the 2 m band (about 145 MHz), you can check this project: <https://www.amsat.org/articles/n2spi/SepOct06AmsatJournal.pdf> (dimensions of the components are given in inches; remember that 1 inch equals about 25.4 mm).