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**MIT WORLD PEACE  
UNIVERSITY** | PUNE

TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS



# Ground Station

## TECHNICAL REPORT

# Ground Station

A ground station is basically an earth-based point of communication with the space segment. They are our source of interaction with the satellite; hence play an important part for any satellite related operation and it is very important to have a very good communication link between the ground station and the satellite/space segment.

Usually a ground segment/ground system involves following tasks: -

- Tracking and determine the position of satellite orbit
- Telemetry operation to acquire and record satellite data and status
- Controlling operation to determine orbital parameters, to schedule all satellite passes and to monitor and load the on-board computer
- Data processing operations to present all the engineering and the scientific data in formats required for the successful progress of the mission.
- Voice and data links to the other worldwide ground station and processing centres

## Objective:

The Ground Station's main objective will be to **help in the reception of the Nano satellite project** that will be taken up by college in near future, therefore our ground station will be a basic framework and first step towards our Nano Satellite project.

The ground station can also be used to receive signals from open-source satellites to collect weather data as well as Other CubeSat, Nanosat, Micro-sat to know their telemetry (Station and condition). **we can also communicate with International Space Station** orbiting the Earth and upload data on various satellite after acquiring a HAM license.

Our Proposed Ground station is **capable to receive not only from LEO but also from MEO, HEO as well as GSO/GEO satellites**. (LEO-Low Earth Orbit, MEO – Medium Earth orbit, HEO – High Elliptical Orbit, GEO – Geostationary Earth Orbit)

The small and cost-effective Ground station Upgrade will not only help students in studying the higher frequency reception but it will also be used as one of the major antennas for **Radio Astronomy & Geostationary satellites** specifically, therefore a Dish & Horn Antenna are absolute necessities in the ground station framework.

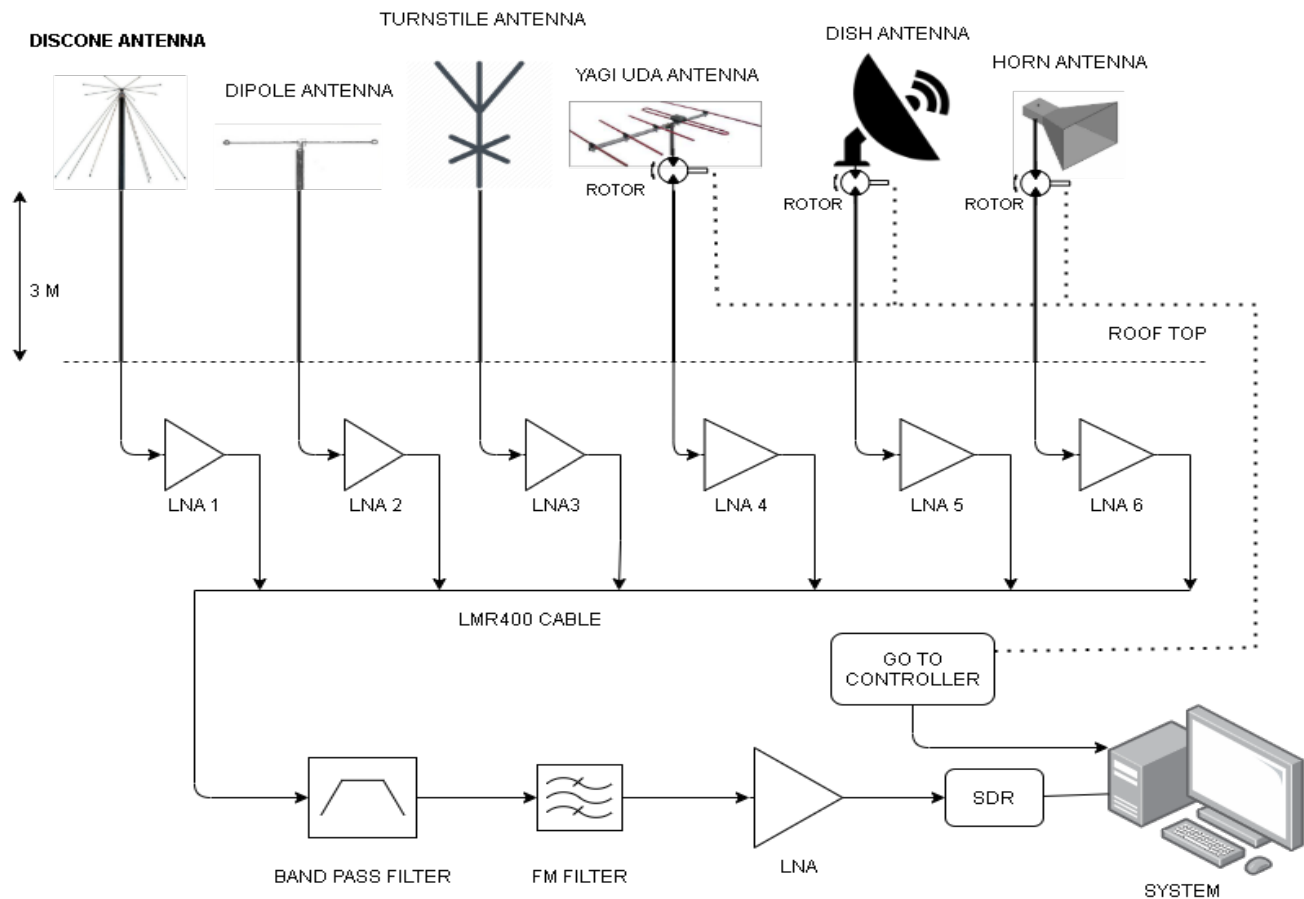
With this Small and Cost-effective upgrade of specialized antenna, we can not only receive minute signals from far end of the universe but also map our galaxy, verify why dark matter theory was proposed and even research on radio imagery of our Universe as a whole.

This would make our facility **India's 1<sup>st</sup> Ground Station-Radio Telescope Combination Facility** which is also rare around the world. Our design has been supported by researchers from IUCAA & RRI who themselves have small radio telescope facilities. On realizing its compatibility with our Ground station, we can easily combine both with help from these research institutes. It would be a Historic Moment for MITWPU and Club Cosmos.

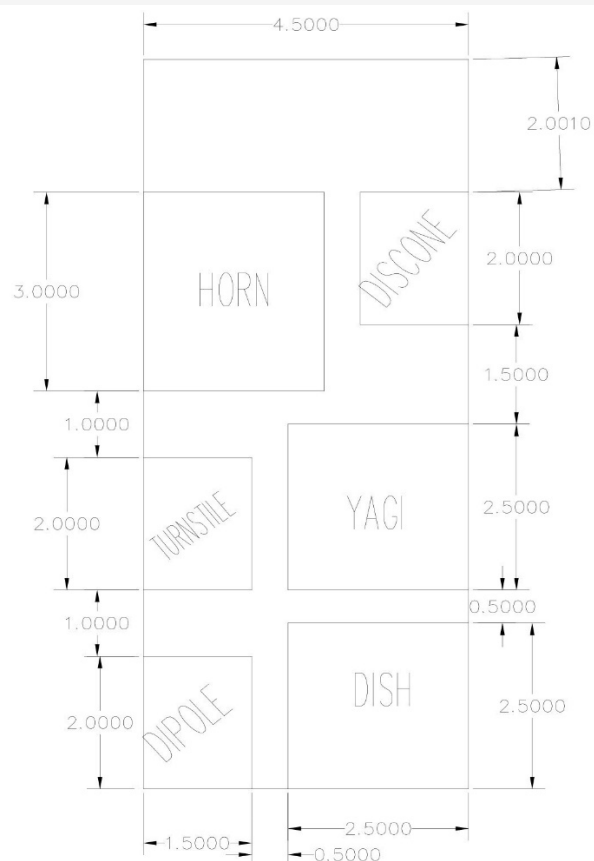
*Hence here we propose a state-of-the-art facility to the management which can receive & transmit almost any signal in any frequency of amazingly large bandwidth at any point of time without any issue.*

A ground-station segment can be divided into 3 main components viz. Hardware, Software and Operations.

# 1) Ground Station Electric Circuit Design



## GROUND-STATION LAYOUT DESIGN:



**\* We need Railing Guards of 1.5 TO 2 Meter Height Around the Antenna Mounting Terrace Edges For safety and security. We expect College to facilitate the same.**

## Hardware:

The hardware consists of antennas, rotors, Software Defined Radios, Computer System, Power supplies, peripherals, data recorders etc.

## Antenna Specifications:

*Parameters for Antenna Characterisation and their importance:*

### • Polarization

*Polarization is a property of certain types of waves that describes the orientation of their oscillations. By convention, the polarization of light is described by specifying the orientation of the wave's electric field at a point in space over one period of the oscillation. It can be basically defined as the orientation of the electric field vector with respect to the earth's magnetic field.*

*Mainly there are two kinds of polarization:*

#### 1. Linear polarization:

*When the direction of propagation of an electric field vector is perpendicular to the earth's magnetic field then it is linearly polarised. Here the E-field vector exists in a single plane (vertical or horizontal).*

#### 2. Circular polarization

*Signal having two plane waves of equal amplitude but differ in phase by 90 degree.*

### • SWR (Standing wave ratio)

*Measurement of efficiency of antenna systems regarding power radiation.*

*Mathematically,  $V_{SWR} = V_{max} / V_{min}$*

### • Antenna Bandwidth

*Pass band bandwidth is the difference between the upper and lower cutoff frequencies of, for example, an electronic filter, a communication channel, or a signal spectrum*

*Range of frequency over which antenna can be used to obtain a specified level of performance with good efficiency.*

### • Impedance

*Ratio of the voltage to current at any given point of antenna.*

*It may be either resistive or complex depending on operating frequency.*

### • Directivity Of Antenna and Beamwidth

*Directivity is defined by direction to the radiation intensity averaged over all directions.*

*Directivity is defined as a measure that takes into account only the directional properties of the antenna and therefore it is only influenced by the antenna pattern.*

### • Radiation pattern

*Graphical Representation of the intensity of the radiation plotted against angle.*

*Major parts of signals radiated and received are through the main lobe.*

*Side lobes usually attract spurious noise.*

### • Gain Of The Antenna

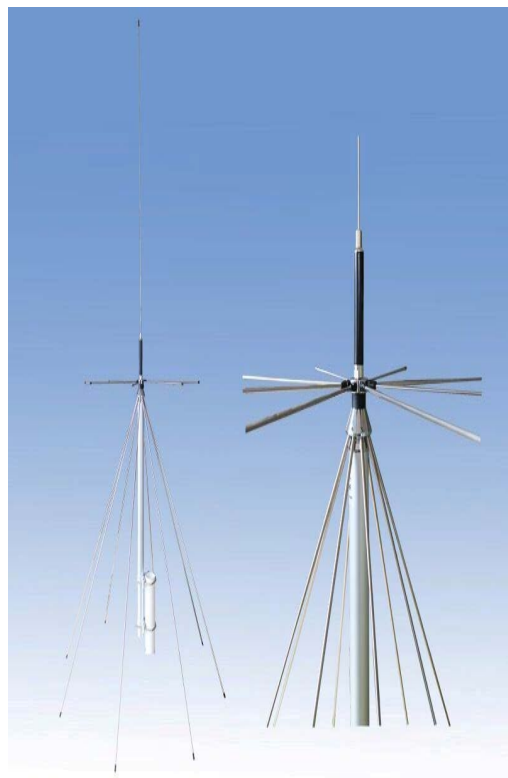
*Antenna gain relates the intensity of an antenna in a given direction to the intensity that would be produced by a hypothetical ideal antenna that radiates equally in all directions (isotropically) and has no losses.*

## Various Antennas used for our Ground Station:

### 1)Discone Antenna

Frequency Bandwidth: 25 MHz - 1300 MHz

The antenna with best range, Discone is the antenna which can receive right from 25MHz to 1300MHz, it is said to be a scanner Antenna. It is not recommended for Delicate signals but it is needed for any Ground station as a Scanner. We would also assemble this in campus, since it's Omnidirectional, it doesn't need a rotating mount and hence can be manually handled. This will ensure no Sat will get out of our sight.



#### Electrical specifications

Frequency Range(MHz)	25-1300MHZ
Impedance(ohm)	50
Gain (dBi)	5.5dBi
Polarization	Vertical
Radiation	Omni
VSWR	<1.5
Maximum input power (W)	Max power 300 watts CB/200 watts VHF-UHF
Transmit band	26-27-46-49-72-144-220-440-900-1290 MHz

#### Mechanical specifications

Connector	SO239
Height (MAST)	1390 mm
Mast Diameter	35mm
HEIGHT RADIALS	6 lower radials 32" (81cm)
HEIGHT RADIALS	8 upper radials 10.5" (26cm)
Material	STAINLESS STEEL
COLOR	SILVER
Weight	1.5Kg
Operating temperature (°C)	-40~80



## 2) Dipole Antenna

Frequency – VHF & UHF

1x portable multipurpose dipole antenna set. Dipole set includes 1x dipole base with 60cm RG174, 2x 23cm to 1m telescopic antenna, 2x 5cm to 13cm telescopic antenna, 1x 3m RG173 extension cable, 1x flex tripod mount, 1x suction cup mount.



The simplest yet the most effective type of antenna which we would go for. We would be using telescopic type dipoles which enable us to receive any different frequency just by changing the lengths of the Dipoles, these dipoles would be provided with the reflectors. They are also mostly omnidirectional. Analysis of these Dipoles are done on MMANA-GAL Software. They would be Optimized for the frequency we set them. The range of these telescopic type Dipole antennas are set as 70MHz to 1030MHz which covers both VHF - UHF range altogether. These Antennas would be made and Assembled IN HOUSE, we will prepare this within our college itself and assemble it. These antennas would be manually set and

may not be suggested for delicate receptions but they are very useful for strong signal receptions as well as general scanning, they provide value for their presence.

## 3) Turnstile Antenna:

Frequency Range: UHF + VHF

Buying Option: Home made ( Aluminium Rods + Connectors)

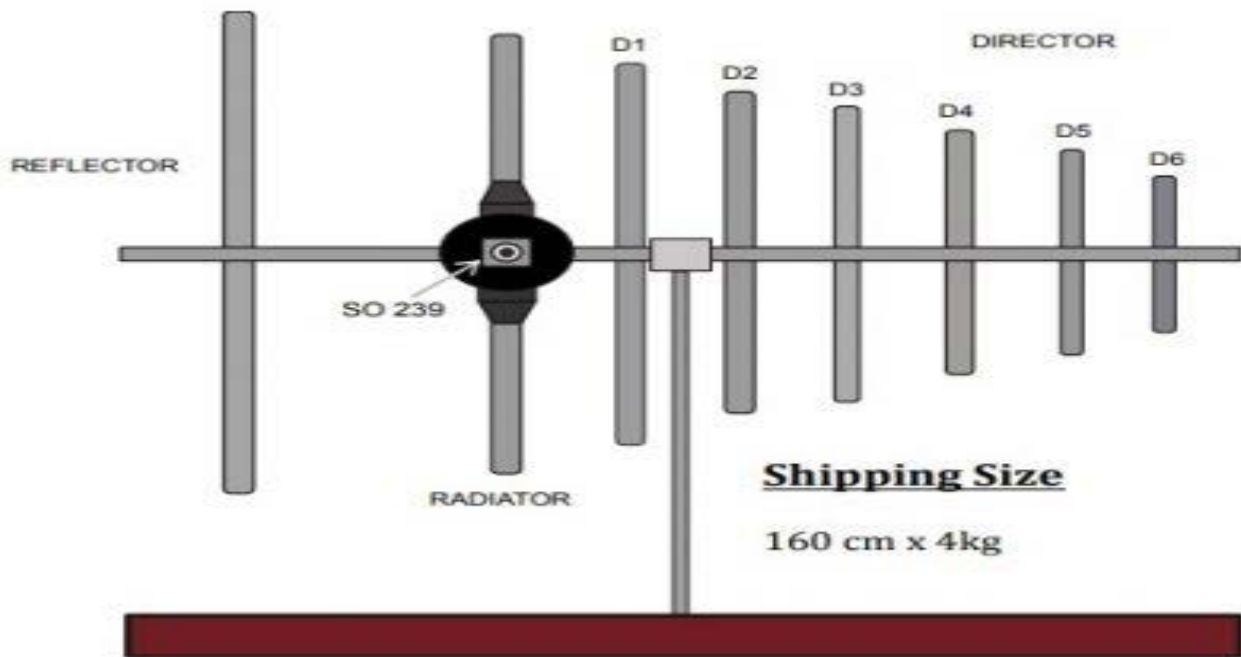


Turnstile Antenna is the antenna which has given us amazing results in our Ground station prototype which was tested and operated by one of our ex-student Ankit Sharma at Bharuch. Even many delicate signals were captured with amazing clarity and precision. Many data were downloaded by amazing accuracy from satellites using these Antennas. We would be using these antennas in a pair, one for VHF (Very high frequency Range) and UHF (Ultra High Frequency Range). These antennas would be specifically designed for University CubeSats and Nanosats. It has capability to receive and transmit Circularly as well as linearly Polarized signals which adds to our advantage. These Antennas would be made and Assembled IN HOUSE,

We will prepare this within our college itself and assemble it. This Antenna is omnidirectional in nature hence manual setting would be recommended here. We can upgrade it to a motorized control setting later on for better accuracy.

#### 4)Yagi Antenna

Frequency Range: VHF + UHF



##### Specification

1. FREQUENCY: 143-148 MHz & 480-520 MHz
2. GAIN: >8dB
3. INPUT IMPEDANCE: 50 ohms
4. POWER HANDLING CAPACITY: 100 watts (max.)
5. INPUT TERMINATION: SO 239
6. POLARIZATION: Vertical/Horizontal
7. PROPAGATION: Skywave/Line of Sight
8. CONSTRUCTION: Aluminium

##### Assembly Procedure

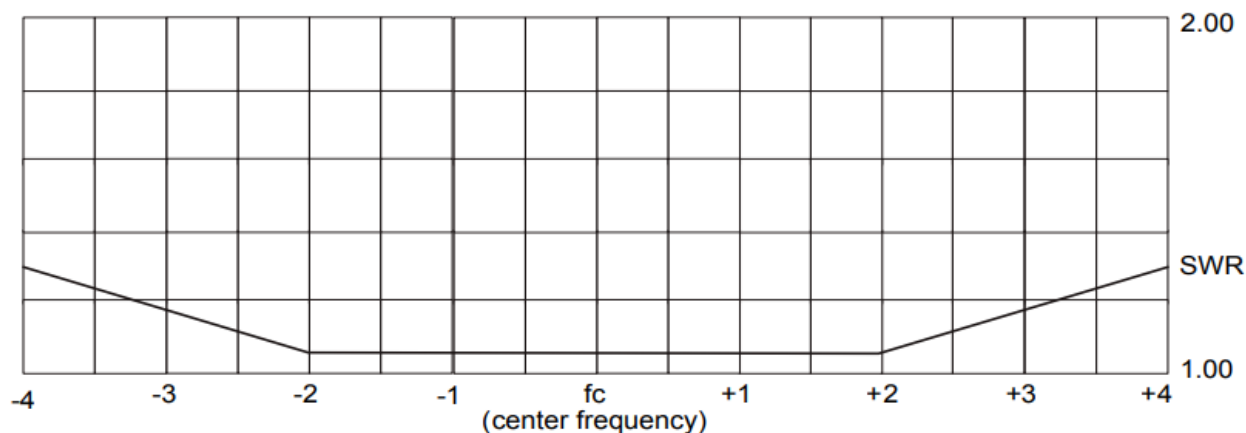
- The Antenna consists of an aluminium driver element called the Radiator, a Reflector and 6 nos. Directors. The driver element is a resonant half-wave dipole usually at a frequency of transmitter operation.
- The Radiator, Reflector, and Director D1, D2, D3, D4, D5, and D6 are to be arranged on the boom as shown in the diagram and also marked

##### Tuning

- YAGI Antenna is commonly used in control stations, Paging and repeater applications for point to point communication. The narrow beamwidth and high front-to-back ratio are effective in reducing interference from other systems.

- For point to point communication usually, horizontally polarized antennas are required. Hence, Antenna radiator can be directly installed as usual. Radiator perpendicular to the ground with live end up is perfectly matched/recommended.
- For fixed to the mobile usually vertical polarized antennas are needed. For vertical polarization remove ground connections and install accordingly. TO check gain/SWR use RF Power meter preferably make bird/diamond.

**Typical Frequency to SWR Chart**



The

Yagi-Uda antenna is highly directional and has very high gain. It is most useful against very delicate signals. We would certainly plan to have it on our side for the same.

We have planned yagi uda for VHF & UHF range for which it is known to be very accurate. COEP has been using the same for their ground station too. We also plan to design a motorized control for Yagi Uda since it's highly directional and needs accurate pointing towards the satellite all the time for best results. We would Assemble and Erect Yagi-uda In-Campus, Motorized base (2 stepper motor for Elevation and Azimuth) would be provided and configured in the campus itself. This would not only cut the cost but also improve accuracy of pointing.

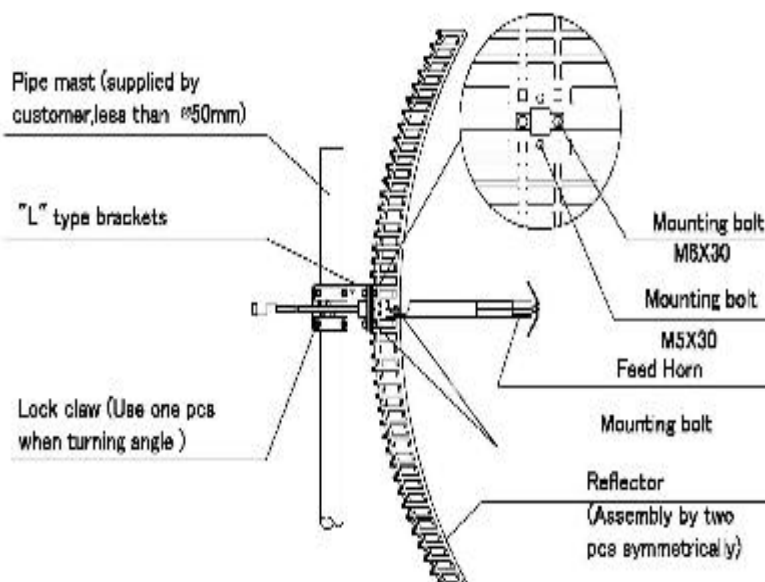
With Yagi-Uda by our side, detecting even the faintest signal in the range is possible.

## 5) Dish Antenna (Parabolic Grid Antenna 1-2.5GHz)

Frequency Range: 1 GHz -2.5 GHz



**Mounting diagram**





This all-weather wireless antenna operates with a frequency range of 1 GHz -2.5 GHz, adding to the high speed wireless signaling. Also, the welded-steel reflector provides a wonderful performance.

- Type: Directional
- Frequency Range: 1GHz-2.5 GHz
- Gain: 24dBi
- Polarization: Linear/vertical
- Connector Type: N female jack
- Extended Cable/Length: 30cm
- Mounting: Pole mount
- Application: Outdoor
- Approximate Range: 56km
- Wireless Standards: IEEE 802.11n/b/g
- Dimensions: 39.4 x 23.6 inch
- Weight: 3.5kg
- Grid parabolic antenna

Grid parabolic antenna is designed for the spread spectrum system, operates in the 1GHz-2.5 GHz band and provides 24dBi directional operation. The surface design with welded-steel reflector to bring out the best performance. This antenna features high gain, long coverage, light weight, compact structure and excellent wind-resistance.

This Antenna is used commonly for Geostationary Satellites in L band (1-2GHz). It will need a rotating mount as it is highly directional. This would be the only Antenna which would be specifically used for Geostationary Satellite. We plan to assemble them on campus , followed by mounting on our motorized stand.

## 6)Horn Antenna

Frequency Range: 1420 MHz - Center Frequency



It is used to measure the intensity of radio waves coming from the sky's strongest non-solar radio source. This antenna is the most easy to make antenna for Radio S band reception. This antenna would also be used similar to our dish antenna. We plan to take help of IUCAA for making and assembling this antenna.

## Balun

### 1) Balun One Nine v2 Barebones – Small Low-Cost 9:1 HF Antenna Balun/Unun with Multiple Connection Options



Balun One Nine v2 is a very small 9:1 balun/unun meant for attaching long wire and dipole HF antennas to your HF capable SDR, radio or Ham It Up upconverter. It has an SMA output port and 3 different terminal block input options (all included) for your antenna coax. Balun One Nine includes an AntennaGuard varistor on the input, protecting your SDR setup from spurious ESD. The ESD protection is excellent—it passes IEC 61000-4-2, an 8kV contact discharge test, with a response time of just 300ps.

At 38mm x 25.0mm in total size, this balun is a bit larger than our popular Balun One Nine v1, but also has better HF performance and can be used to even lower frequencies.

### 2) BN43-202 BALUN from from Faire-Rite.



This NiZn is our most popular ferrite for suppression of conducted EMI from 20 MHz to 250 MHz. This material is also used for inductive applications such as high-frequency common-mode chokes.

## Computing SYSTEM SPECIFICATIONS:

state of the art processing system with

Product	Brand	Model	Quantity
Processor	AMD	Ryzen 7 5800X (8C, 16T, upto 4.7Ghz)	1
Motherboard	ASUS	ASUS STRIX B550F Gaming-WIFI	1
RAM	Corsair	Corsair 16GB DDR4 3000MHz Vengeance	2
Storage 1	Kingston	Kingston 1TB NVME SSD (A2000)	1
Graphics Card	MSI	Nvidia GeForce MSI RTX 3070 8GB GDDR6 Ventus 3X OC (Triple Fan)	1
Cabinet	Cooler Master	CoolerMaster TD500 Mesh Black	1
SMPS	NZXT	NZXT C850 850Watts 80+ Gold Full-M	1
Cpu Cooler	NZXT	NZXT Z63 RGB LCD DISPLAY 280MM	1
Wifi	ASUS	Asus PCIe AC58BT - AC2100 Dual Band	1
Case Accessory	Cooler Master	COOLER MASTER MF200R RGB (Case Fan)	1
Monitor	Benq	BenQ 28-inch UHD 4K HDR	1

## LNA Specifications

### 1) RTL SDR LNA - WIDEBAND



This is a general purpose SPF5189Z based wideband LNA. Works from 50 MHz to 4 GHz with a noise figure of less than 1dB. Requires bias tee power, but there is an internal header which can be used to switch to external power Requires 3 – 5v bias tee power. The RTL-SDR V3 provides 4.5v so is suitable.

## **2)SAW bird+ GOES Barebones – Premium SAW Filter & Cascaded Ultra-Low Noise LNA Module for NOAA (GOES/LRIT/HRIT) Applications. 1688MHz Centre**



A dual LNA module with an integrated, high-performance SAW filter. Designed for NOAA (GOES/LRIT/HRIT) applications near 1.688GHz.

SAWbird+ GOES is a self-contained LNA module designed for capturing beautiful weather images available from NOAA GOES satellites. It has a very high attenuation outside of the 80MHz bandpass region, centered around 1.688GHz, and a minimum of 30dB of gain within the bandpass region. Nominal current draw is 180mA.

The SAWbird+ series contains 2 ultra-low-noise LNAs sandwiched around a custom-designed, high-performance SAW filter centered at the frequency of interest. Each LNA module has 2 EMI shields to separate each delicate LNA from external interference. There are also M3 mounting holes available to mount the PCB in your custom enclosure or project with standard hardware.

## **3)SAWbird+H1 Barebones – Premium SAW Filter & Cascaded Ultra-Low Noise Amplifier (LNA) Module for Hydrogen Line (21cm) Applications. 1420MHz Center Frequency**



SAWbird+ H1 is a self-contained LNA module designed for hydrogen line applications at 1.42GHz. It has a very high attenuation outside of the 65MHz bandpass region, centered near 1.42GHz, and a minimum of 40dB of gain at the frequency of interest. Nominal current draw is 120mA.

The SAWbird+ H1 Barebones has a special feature which will not appear on the SAWbird+ H1—an RF switch connected to a 50 ohm reference. The switch is controlled through the 4-pin, 0.1" header. This feature can be

very useful for calibration, but increases the noise figure to ~1.05dB.

The SAWbird+ series contains 2 ultra-low-noise LNAs sandwiched around a custom-designed, high-performance SAW filter centered at the frequency of interest. Each LNA module has an EMI shield to separate the LNAs from external interference. There are also M3 mounting holes available to mount the PCB in your custom enclosure or project with standard hardware.

## **4)LNA Module for NOAA Applications. 137MHz Center Frequency**

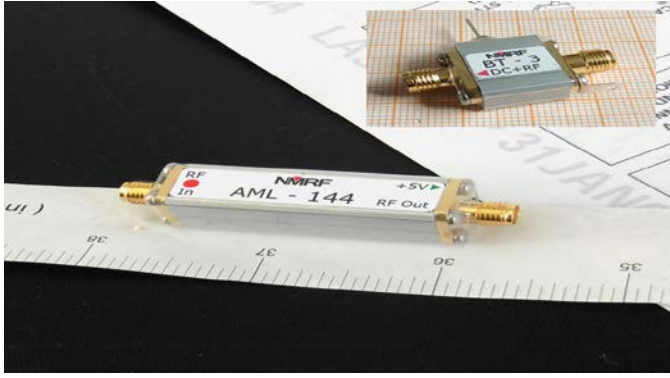


A dual LNA module with an integrated, high-performance SAW filter. Designed for NOAA applications near 137MHz

SAWbird+ NOAA is a self-contained LNA module designed for capturing beautiful weather images available from NOAA satellites. It has a very high attenuation outside of the 5MHz bandpass region, centered

around 137.5MHz, and a minimum of 30dB of gain within the bandpass region. Nominal current draw is 180mA. The SAWbird+ series contains 2 ultra-low-noise LNAs sandwiched around a custom-designed, high-performance SAW filter centered at the frequency of interest. Each LNA module has 2 EMI shields to separate each delicate LNA from external interference. There are also M3 mounting holes available to mount the PCB in your custom enclosure or project with standard hardware.

## 5) Low Noise Amplifier (LNA) for VHF Band(144 Mhz)



It is a narrowband low noise RF amplifier covering the 10MHz to the 2.4GHz frequency band. It can significantly improve the sensitivity of the receiver and reduce system noise. Adopted by feed design, power supply, and an RF output signal multiplexing coaxial cable, simplifying installation. This product has a sturdy aluminum alloy shielded casing, which is small in size and can be directly inserted into the original antenna feeder system.

- Model: AML-144
- Impedance: 50 Ohms
- Noise figure: < 3.6 dB (measured by continuous wave method)
- Centre frequency gain:  $\geq 20$  dB @ 144 MHz
- 3dB bandwidth: 120 to 170 MHz
- Input reflection loss:  $> 15$  dB @ 144 MHz
- Supply voltage: 5 V.DC (wiring method with reference to the attached drawing)
- Working current: 30 ~ 35 mA
- Maximum input power: < 5 dBm
- P1dB power:  $\geq 8$  dBm
- Interface: SMA-F, SMA-F (red dot mark on input)
- Gain curve (labeled as 1 dB bandwidth in the figure, 5 dB vertical)

## 6) SAWbird+ iO Barebones SAW Filter & Cascaded Ultra-Low Noise LNA Module for L-Band (Inmarsat AERO/STD-C )



SAWbird+ iO is a self-contained LNA module designed for capturing L-Band signals, like Inmarsat AERO and STD-C. It has a very high attenuation outside of the 60MHz bandpass region, centered around 1.542GHz, and a minimum of 30dB of gain within the bandpass region. Nominal current draw is 180mA.

The SAWbird+ series contains 2 ultra-low-noise LNAs sandwiched around a custom-designed, high-performance SAW filter centered at the frequency of interest. Each LNA module has 2 EMI shields to separate each delicate LNA from external interference. There are also M3 mounting holes available to mount the PCB in your custom enclosure or project with standard hardware.

## 7) Nooelec LaNA HF Barebones - Ultra Low-Noise LF, MF & HF Amplifier (LNA) Module



Nooelec LaNA HF Barebones is a very high performance, wideband and linear LNA module designed for SDR applications in the HF band and adjacent bands. Power consumption is less than 30mA.

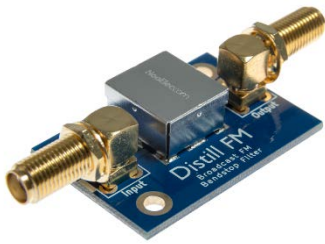
LaNA HF Barebones greatly improves performance when used with Ham It Up upconverters, direct sampling SDRs, and most HF-capable radios and rigs!

Each LaNA HF Barbones module has an EMI shield to protect the sensitive circuitry from external interference and is fully ESD-protected. LaNA HF Barebones also has an RF limiter at the input port to protect the amplifier from very high power external signals



## Band Pass Filter and Band Stop Filter

### 1) Broadcast FM Bandstop Filter for Software Defined Radio Applications



A high-quality, high-performance bandstop filter designed for software defined radio (SDR) applications. Designed and manufactured by NooElec in the United States.

Broadcast FM can be particularly problematic due to the high-powered transmitters used for broadcasting in some areas. These signals can overload the front end of an SDR, causing imaging and a number of other issues.

The designed Distill:FM provides sufficient attenuation for broadcast FM frequencies (>40dB typical) while ensuring adjacent bands, such as the important VHF airband (108-137MHz) are minimally affected. The -3dB rolloff of the filter is 80MHz and 115MHz. Minimal out-of-band insertion loss means the filter can stay in place for most any application. As a true bandstop filter, we are able to pass-through DC (bias power) when it is required.

DC current handling is 250mA (min), and the maximum recommended signal level is +18dBm (5Vp-p), so there is no issue using the filter for higher-power applications. Distill:FM has its filter circuitry fully shielded with an EMI frame, and has its front end protected by an ESD diode meant for RF applications. 2 mounting holes are available on the PCB for various mounting options, and the SMA hardware (washer and nut) is included.

### 2) VHF BAND PASS FILTER(137 MHz) Suitable for NOAA and Meteor Reception



- 137 MHz bandpass filter
- Used for: weather, meteorological satellite reception,
- Bandwidth: 130MHz-150MHz;
- Housing: oxidized black aluminum shell, good shielding effect;
- Weight: 25 grams

### 3) UHF BandPass filter, 470-806MHz bandpass filter



This filter eliminates interferences coming from VHF-and above UHF band frequencies that can influence satellite reception.



## Software Defined Radio

### 1) HACK RF ONE



HackRF One from Great Scott Gadgets is a Software Defined Radio peripheral capable of transmission or reception of radio signals from 1 MHz to 6 GHz. Designed to enable test and development of modern and next generation radio technologies, HackRF One is an open-source hardware platform that can be used as a USB peripheral or programmed for stand-alone operation.

- 1 MHz to 6 GHz operating frequency
- half-duplex transceiver
- up to 20 million samples per second
- 8-bit quadrature samples (8-bit I and 8-bit Q)
- compatible with GNU Radio, SDR#, and more
- software-configurable RX and TX gain and baseband filter
- software-controlled antenna port power (50 mA at 3.3 V)
- SMA female antenna connector
- SMA female clock input and output for synchronization
- convenient buttons for programming
- internal pin headers for expansion
- Hi-Speed USB 2.0
- USB-powered
- open-source hardware

### Key Differences of using HackRF vs USRP 200

Parameters	HACKRF ONE	USRP 200
Radio Spectrum	100 KHz - 6 GHz	50 MHz - 6 GHz
Bandwidth	20 MHz	61.44 MHz
Duplex	Half	Full
Sample Size (ADC/DAC)	8 bit	12 bit
Sample Rate (ADC/DAC)	20 Msps	61.44 Msps
Interface (Speed)	USB 2	USB 3
FPGA Logic Elements	CPLD Architecture	75K
Microcontroller	LPC43XX	CYPRESS X3
Open Source	Everything	HDL + Schematic
Design and Interfacing	Simple	Complex
Cost	50,000 Rs	80,000 Rs

- Bias – TEE Available in Hackrf one which is very Important for our Ground Station.

## SOFTWARE

*There are mainly three different software used in the different ground station operations .*

- *Pre-pass software*
- *Real time software*
- *Post pass software*

*Pre pass software:*

*These are the software which are required in advance to the pass of the spacecraft.*

- *Determination and prediction of the orbit of the satellite.*
- *Observation planning and scheduling.*
- *Command list generation and simulation.*

*Real time software:*

*These are the software which are required when the satellite is visible to the ground station. This includes the antenna tracking software, computer control software, command and data control software*

*Post pass software:*

*These are the software that are required for keeping quality control, health assessment, data processing and orbit determination for data analysis.*

### 1) XRIT DECODER BY USA SATCOM

It is a Windows decoding application for GOES weather satellites



XRIT Decoder software, opens a TCP client connection with GNURadio and takes the hard symbol synced BPSK stream, does Viterbi decoding and performs Manchester decoding (only needed for GOES-16 HRIT, not used for GOES-NOP LRIT), then CADU frames are processed and files are generated.

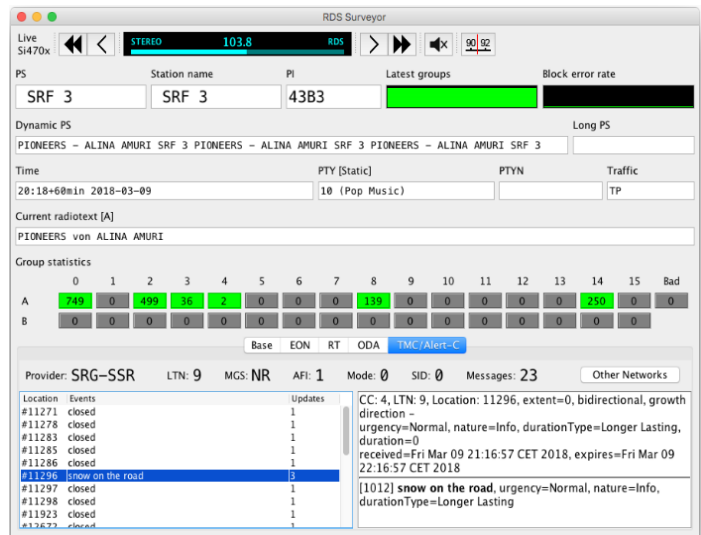
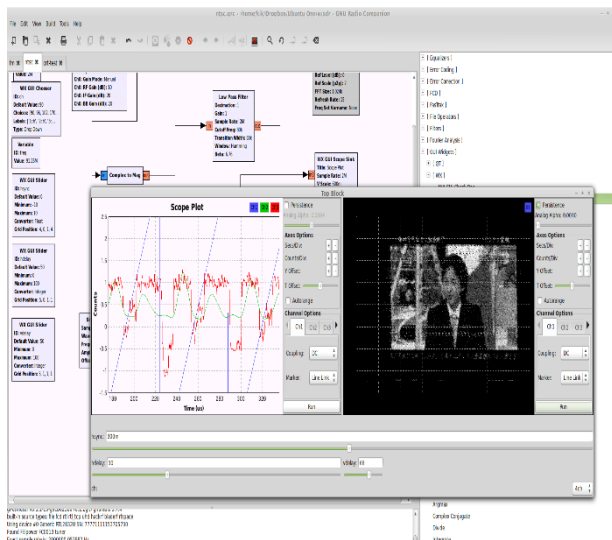
### 2) ORBCOMM Decoder

Orbcomm is a low earth orbit satellite communications system that operates in the 137 - 138 MHz frequency range. The satellites specialize in remote IoT and machine to machine (M2M) connectivity, an example use case being a GPS tracker on a shipping container regularly uploading GPS coordinates from anywhere in the world via the Orbcomm satellites. Orbcomm satellite signals are fairly strong and can easily be received with an RTL-SDR and V-Dipole antenna.

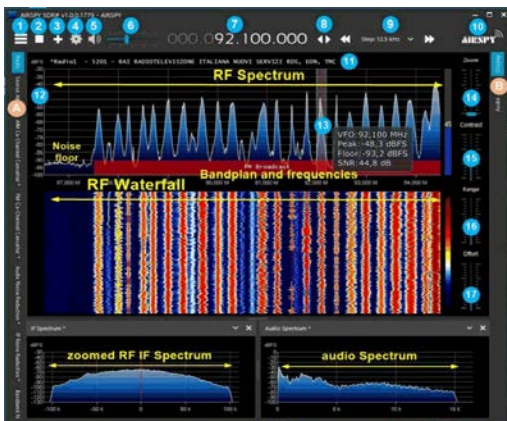
### 3) GNU Radio / TMC Decoder

**GNU Radio** is a free & open-source software development toolkit that provides signal processing blocks to implement software radios.

**TMC Decoder:** A decoder for traffic information sent via RDS. Hardware prerequisites: A RDS receiver that sends the data to the computer, in my case with a serial interface.



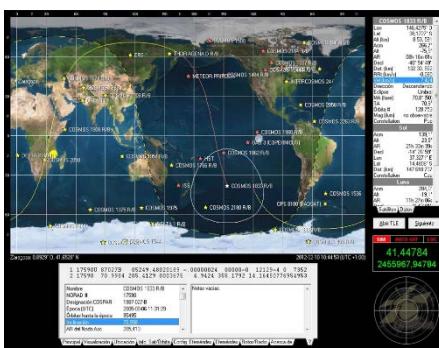
#### 4) SDR# (SDRSharp) - Airspy



Airspy SDR# is a popular Software-Defined Radio (SDR) receiver software developed to achieve High Performance and Affordable Price using innovative combinations of DSP and RF techniques.

Easy to use, advanced Software Defined Radio platform.

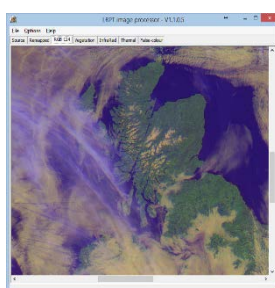
#### 5) Orbitron Software



**Orbitron** is a satellite tracking system for radio amateur and observing purposes. It's also used by weather professionals, satellite communication users, astronomers, UFO hobbyists and even astrologers. Application shows the positions of satellites at any given moment (in real or simulated time).

It tells about the pre-passes, real time passes, and post-passes of the satellites.

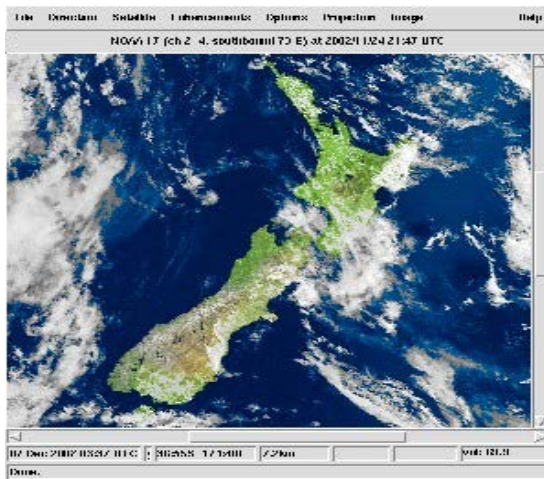
#### 6) LRPT Decoder(Online/Offline)



Application Program Software to add enhancements to Meteor-M N2 images

LRPT Decoder software can also add approximate country boundaries to the image

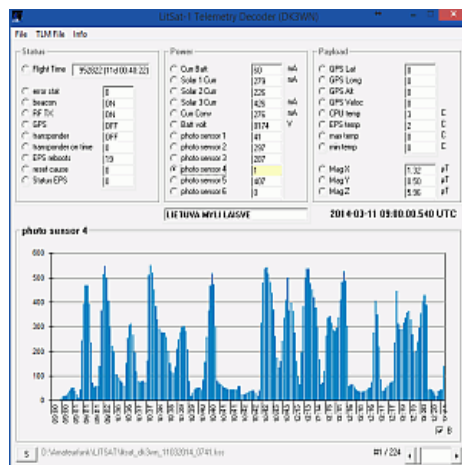
7) WXTIMG



of sound cards to provide better decoding than is possible with expensive purpose-designed hardware decoders.

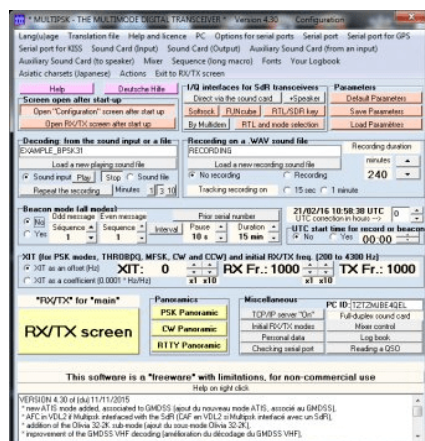
## 8) Telemetry Dashboard

## Specific Decoder Software for Cubesats



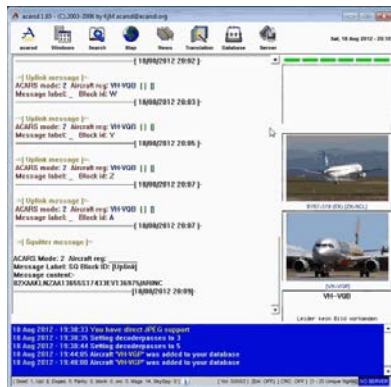
## 9) MULTIPSK

Supports FSK,PSK decoding



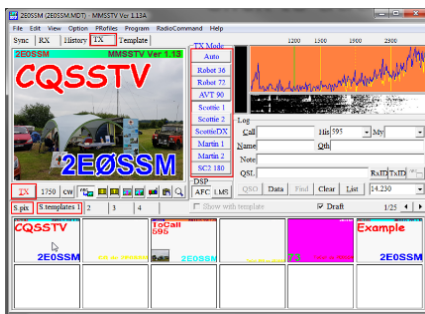


## 10) ACARS DECODER



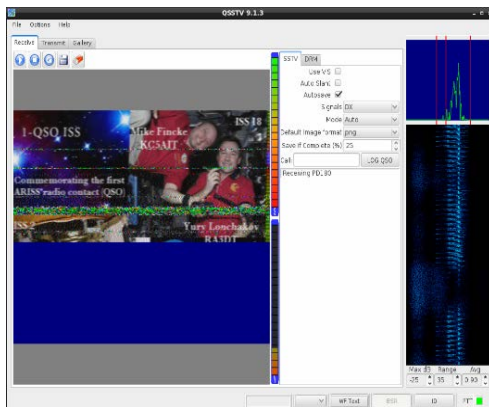
It attempts to decode ACARS transmissions in real-time using up to four Soundcards. acarsd is also a realtime ACARS Server / ACARS webserver, for the worldwide spotter

## 11) MMSSTV



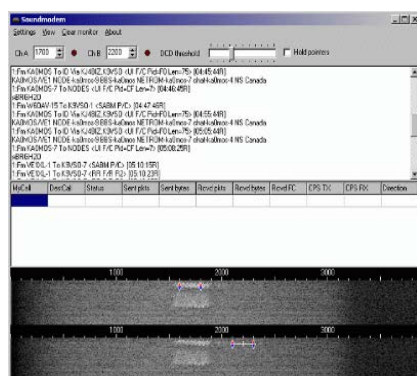
MMSSTV is a popular piece of software used for the sending and receiving of SSTV. For a simple receive setup all you need to do is connect the headphone out of your radio to the input (mic or line) of your PC. For transmission you can get a dedicated data modes cable etc.. made specific for you radio.

## 12) QSSTV



QSSTV is a program for receiving and transmitting SSTV and HAMDRM (sometimes called DSSTV). It is compatible with most of MMSSTV and EasyPal.

## 13) SoundModem and High Speed SoundModem

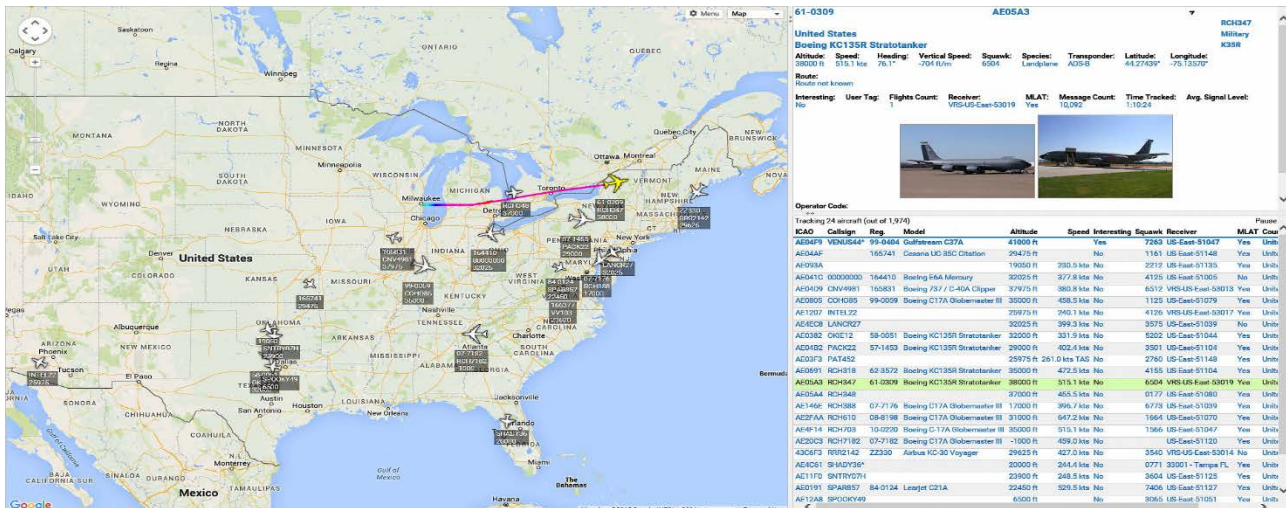


The Soundmodem may be used to build EMCOMM, APRS, BBS, Node station, for satellites etc. It supports such modes. The software uses a soundcard as a modem and supports AX.25 protocol.

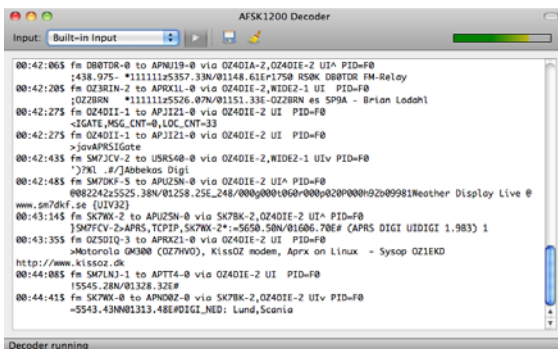


## 14) Virtual Radar Server

Plot aircraft positions on a map

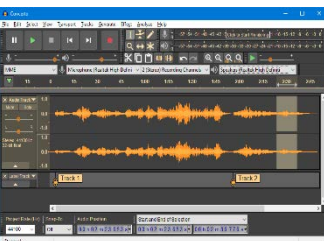


## 15) QTMM



Qtmm is a simple AFSK1200 decoder that uses the computer's sound card for input. It can be used to decode packet radio, APRS and telemetry from OSCAR and Cubesats. Testing shows a good performance in monitoring the International space station APRS Beacon.

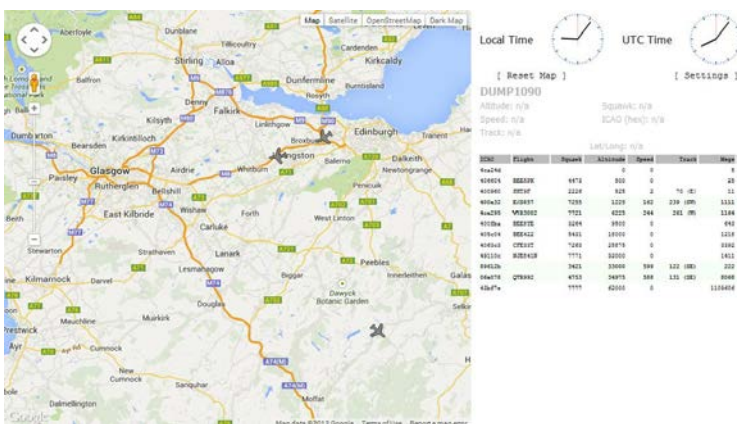
## 16) Audacity



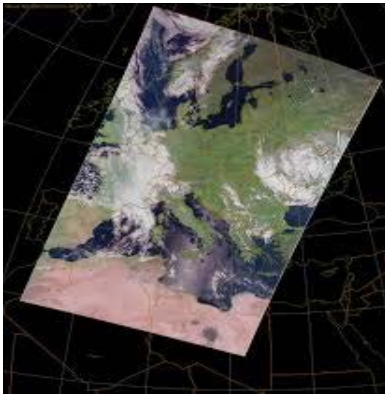
Audacity is a free and open-source digital audio editor and recording application software, available for Windows, macOS, Linux, and other Unix-like operating systems.

## 17) DUMP 1090

For ADS-B decoding, **dump1090** is an RTL-SDR compatible program that is commonly used.



## 18) LRPT IMAGE PROCESSOR



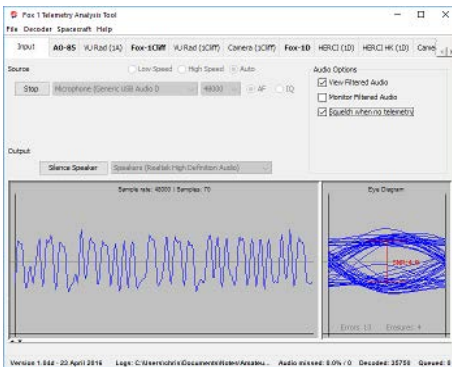
Add enhancements to Meteor-M N2 images. It can remove the edge compression present in the raw scan data from the Meteor-M N2 LRPT data, create a vegetation image, thermal image, and a false-colour image.

## 19) RTL 1090

RTL1090 is a DVB-T dongle to Mode-S converter app



## 20) FOXTELEM



FoxTelem is the program you use to decode the data transmissions from the AMSAT Fox-1 series of spacecraft. It will decode, store and allow analysis of telemetry and onboard experiments.

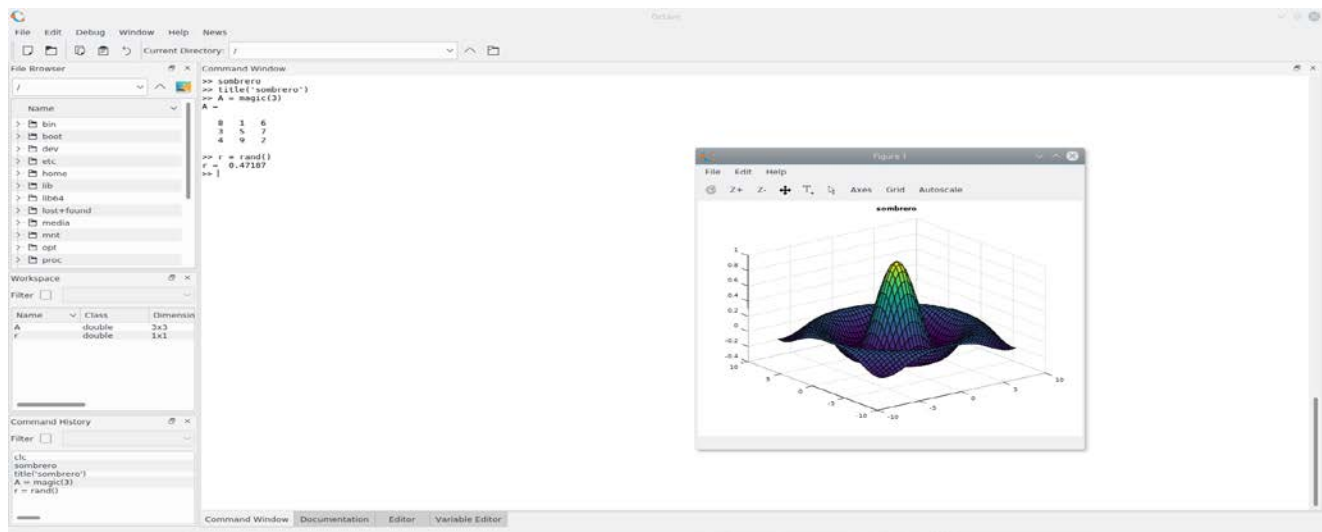
## 21) MRP40 Morse Code Decoder



MRP40 Morse Code Decoder. MRP40 is a powerful and highly-effective ham radio software program that decodes received **CW** audio that has been fed to a computer's sound card. The decoded text is displayed on the computer's monitor. For transmitting **CW**, the program encodes keystrokes from the computer's keyboard.

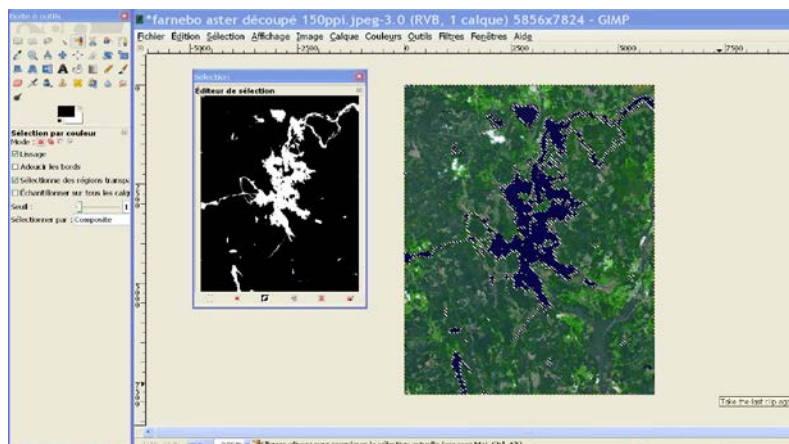
## 22) GNU Octave

GNU Octave is software featuring a high-level programming language, primarily intended for numerical computations. Octave helps in solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with MATLAB.

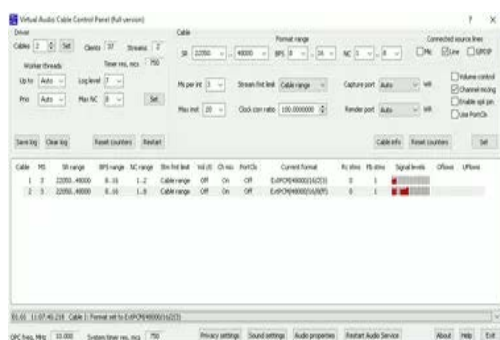


## 23) GIMP

GIMP is a free and open-source raster graphics editor used for image manipulation and image editing, free-form drawing, transcoding between different image file formats, and more specialized tasks.



## 24) Virtual Audio Cable

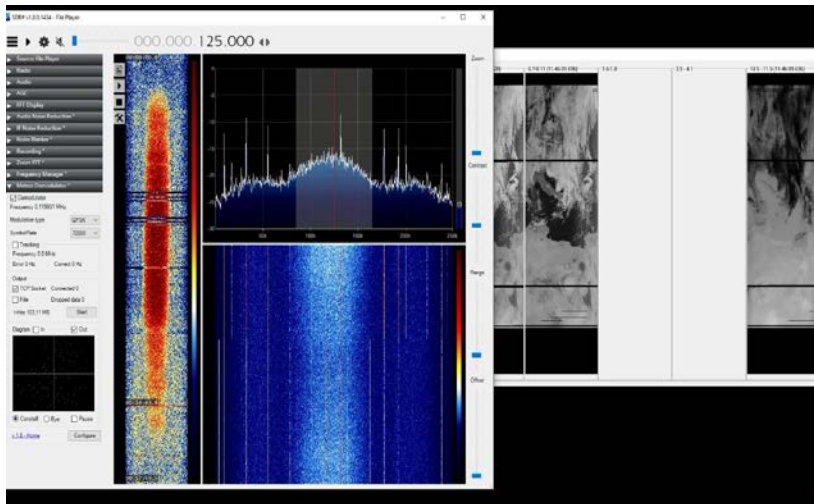


Virtual Audio Cable is a tool that lets you create a number of virtual audio playback or recording devices, so you can use them with any other program without even the slightest loss in audio quality.



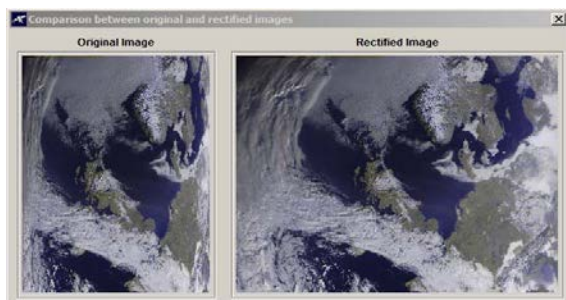
## 25)METEORGIS

**MeteorGIS** is a free program for referencing images send by the Russian weather satellite Meteor MN-2 & MN-2.2.

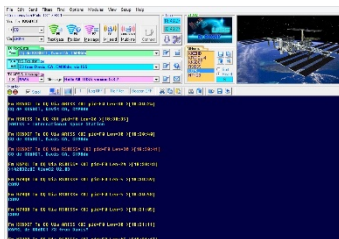


## 26) Smooth Meteor

SmoothMeteor is designed to stretch Meteor 3M N2 images laterally to compensate for foreshortening caused by Earth's curvature. This is useful for people who receive transmissions from Russia's Meteor M2 Oceanographic Satellites. They provide 1 km/pixel resolution images rivalling the HRPT from the NOAA and Metop satellites



## 27) Packet Radio



It has some unique capabilities, such as tracking the positions of nearby stations or sending short messages via the International Space Station (ISS).

## 28) LRPT Rx

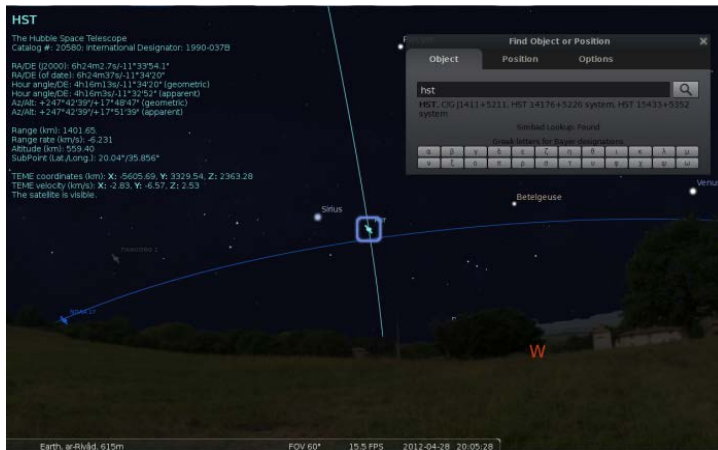
Used for Receiving Images from Geostationary Weather Satellite

## 29)DeJPEGger

The low-rate picture transmission for Meteor Imaging Services.

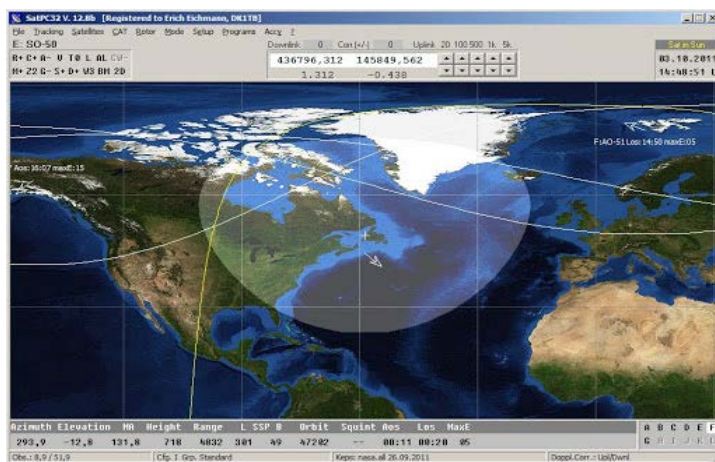
## 30) Stellarium

**Stellarium** is a planetarium software that shows exactly what you see when you look up at the stars and objects in the sky.

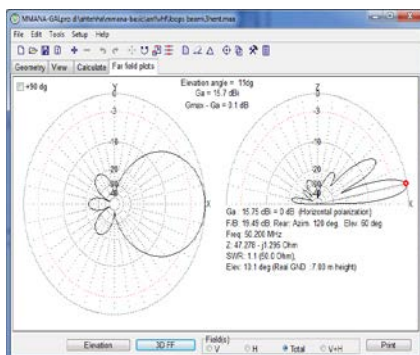


## 31) SATPC32

**SatPC32** is a highly regarded Windows application for amateur radio satellite operations



## 32) MMANA



**MMANA-GAL L** is an antenna-analyzing tool based on the moment method

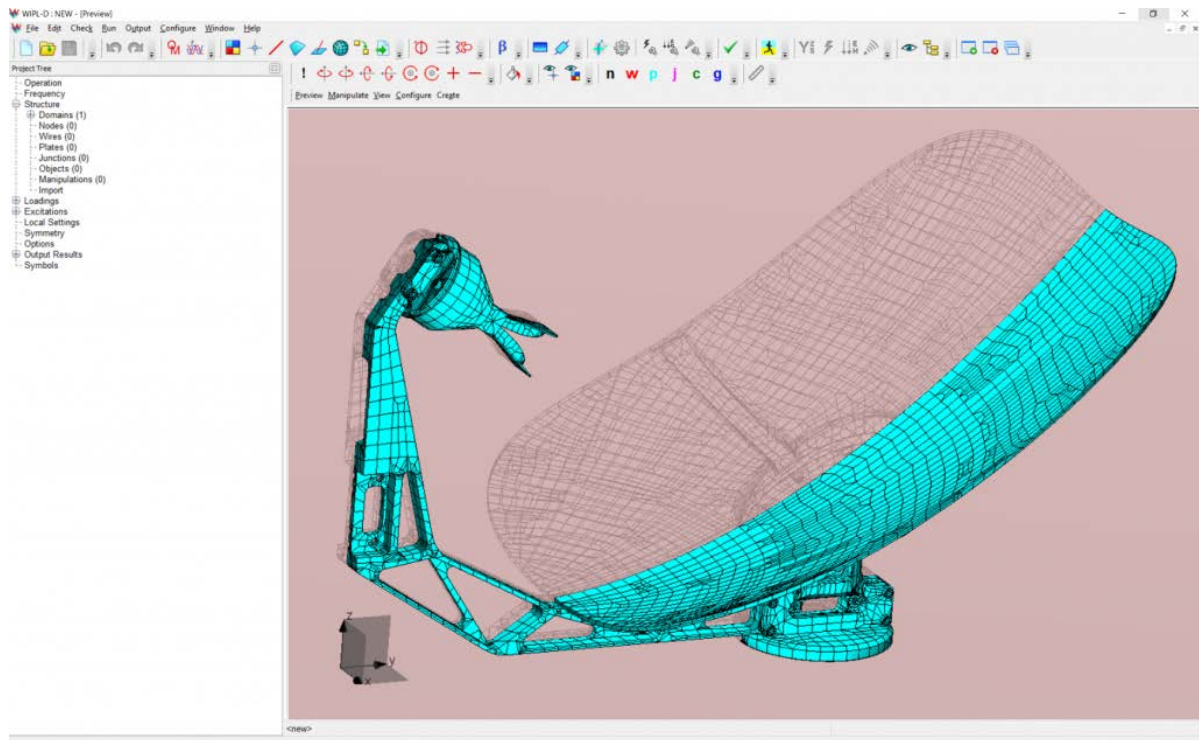
Table-based editor for antenna design and definition

- Graphical antenna viewer
- Viewer for horizontal and vertical beam radiation patterns
- 3D radiation pattern
- Comparator for two or more "calculation" results
- Antenna element editor
- Antenna wire editor
- Tools for defining the combination of elements with different diameters
- Automatic antenna optimizer with respect to jX, SWR, Gain, F/B, Elevation, and Current
- Ability to browse optimized results with manual tuning capability
- Frequency characteristics chart maker



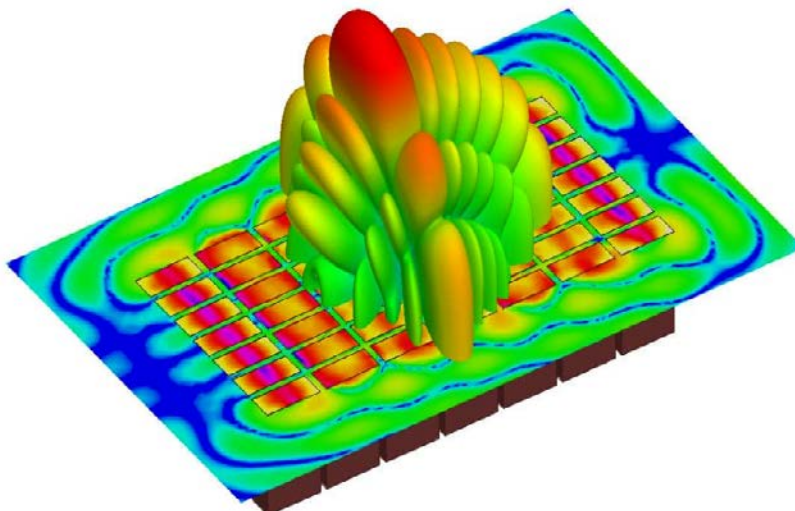
### 33)WIPL-D

**WIPL-D** offers cutting-edge electromagnetic simulation software for fast and accurate electromagnetic and circuit modeling including various application areas: Wire Antennas, Reflector Antennas, Microstrip and others. Planar Antennas, Waveguide Slot Antennas, Antenna Arrays and Radomes, Antenna Placement.



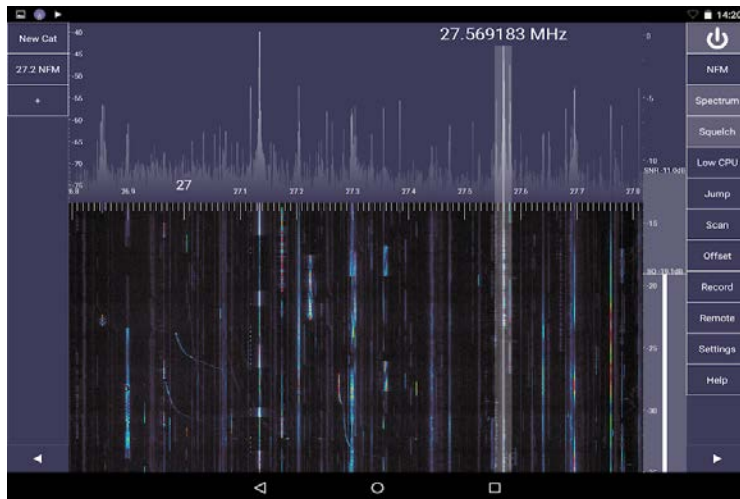
### 34) ANSYS HFSS

Ansys HFSS is a 3D electromagnetic (EM) simulation software for designing and simulating high-frequency electronic products such as antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards. Engineers worldwide use Ansys HFSS to design high-frequency, high-speed electronics found in communications systems, radar systems, advanced driver assistance systems (ADAS), satellites, internet-of-things (IoT) products and other high-speed RF and digital devices.

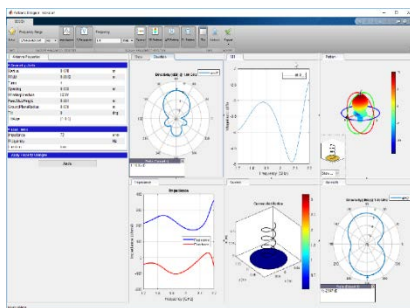


## 35) SDR Touch Android Application

SDR Touch allows connecting hardware SDR receivers to Android via a USB cable. Turn any mobile phone or tablet with USB host/OTG support into a portable software defined radio scanner and a spectrum analyser. Driver support exist for RTL-SDR, NeSDR, SDRplay and HackRF.



## 36) MATLAB



Using **MATLAB** and Simulink we can analyze electromagnetic signals and explore algorithms for antenna simulations.

**Antenna Toolbox** provides functions and apps for the design, analysis, and visualization of antenna elements and arrays.

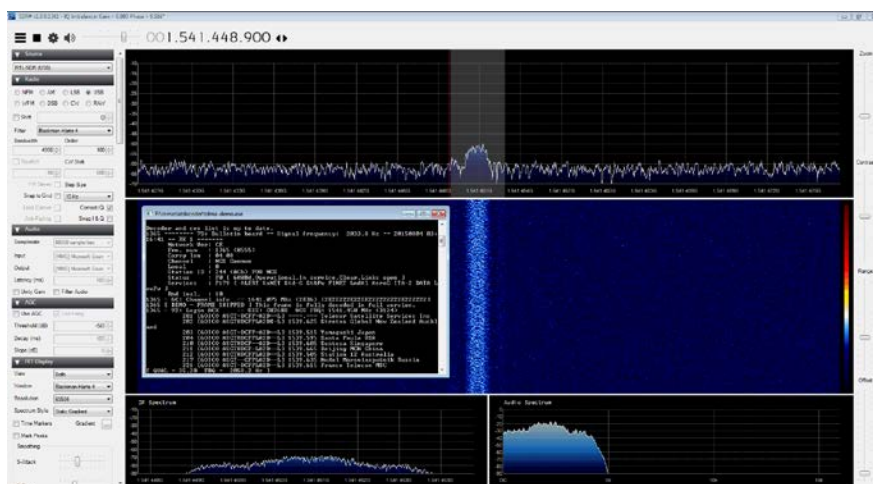
## 37) Zeus Radio

A general-purpose receiver like the others, but has transmit capabilities to for capable radios. Works with various radios like the ZS-1, Hermes, HIQSDR, Odyssey, as well as ExtIO radios like the RTL-SDR. Is one of the few paid options, and costs 2000 RUR (~32 USD) for the RX only version, and 6000 RUR (~96 USD) for the version with transmit capabilities. The trial version allows you to use the software for 10 minutes at a time.



## 38) INMARSAT DECODER

This decoder allows you to fully reconstruct all types of messages, so compressed archives and images can be received. Decoder was designed especially for std-C, fine-tuned and tested, bringing you incomparable performance.



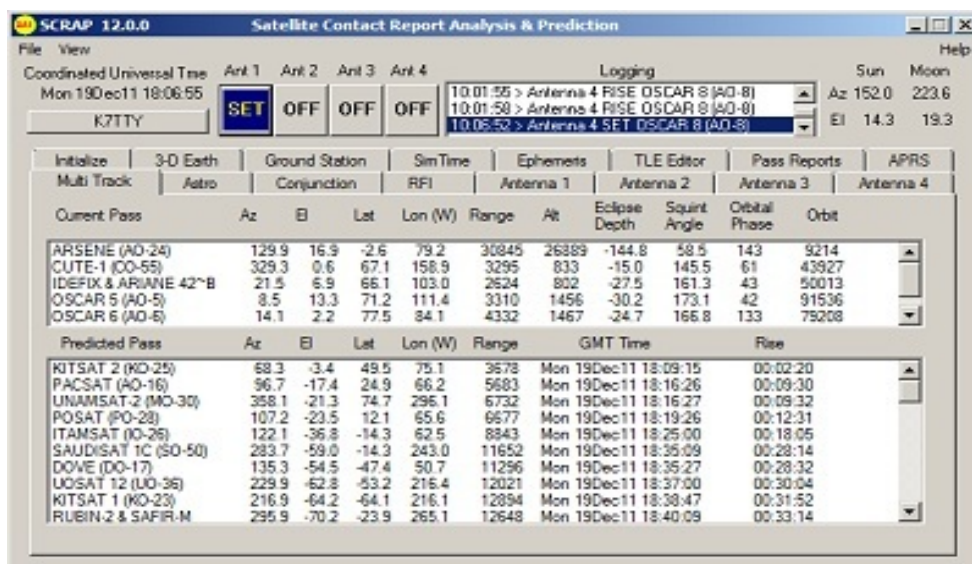
## 39) NOVA for Windows



- Fast, accurate real-time tracking information for an *unlimited* number of Earth-orbiting satellites.
- Full-color 3-D maps.

## 40) SCRAP

**Satellite Contact Report Analysis & Prediction (SCRAP)** is a tracking, report, analysis, prediction and 3-D real time display program.

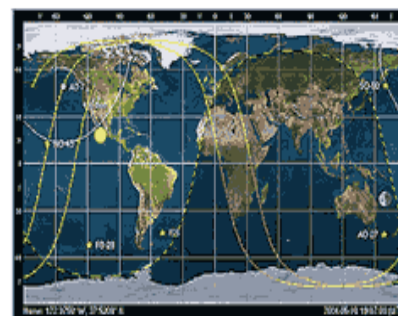




## Tracking Softwares:

### Tracking Programs - Shareware or Open Source

- Features more geared to beginners
- Satellite tracking and prediction
- Simulations and graphical interfaces available
- Generally no antenna steering
- Generally Radio tuning
- Minimal documentation and forum support

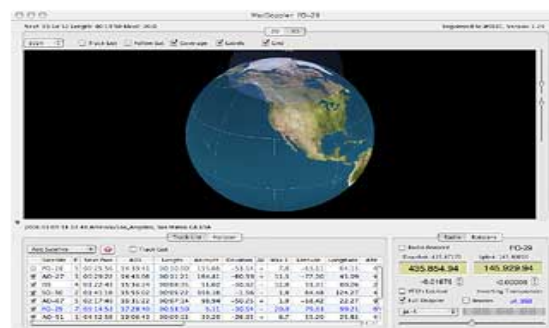


Package	Platform	Publisher	Download	License	Limitation
<a href="#">Orbitron</a>	Windows	Sebastian Stoff	<a href="#">Download</a>	Cardware	None
<a href="#">Predict</a>	OSX, Linux, SunOS and Windows	John A. Magliacane, KD2BD	<a href="#">Linux Windows</a>	GPL	GNU Public License
<a href="#">Portable Predict+</a>	OSX, Linux, SunOS and Windows	John A. Magliacane, KD2BD	<a href="#">Linux Windows</a>	GPL	GNU Public License
<a href="#">PetitTrack</a>	Embedded Linux	Edson Pereira, N1VTN	<a href="#">Download</a>	GPL	GNU Public License
<a href="#">PocketSat+</a>	PalmOS, WindowsCE 3.0	Big Fat Tail Productions	<a href="#">Download</a>	Shareware	3 Second Update
<a href="#">SAT EXPLORER</a>	Windows	Gabriel Rivat F6DQM	<a href="#">Download</a>	Free Software	None
<a href="#">Gpredict</a>	Linux, Mac OS X, Windows	Alexandru Csete, OZ9AEC	<a href="#">Download</a>	GPL	GNU Public License
<a href="#">Pass</a>	Linux, Mac, Windows, PalmOS, WindowsCE, Android, Iphone, iPad	Pedro Converso, LU7ABF & AMSAT-Argentina	<a href="#">Download</a>	Free Software	None

### AMSAT Proprietary Tracking Software's (Paid):

#### Proprietary Tracking Software For Purchase

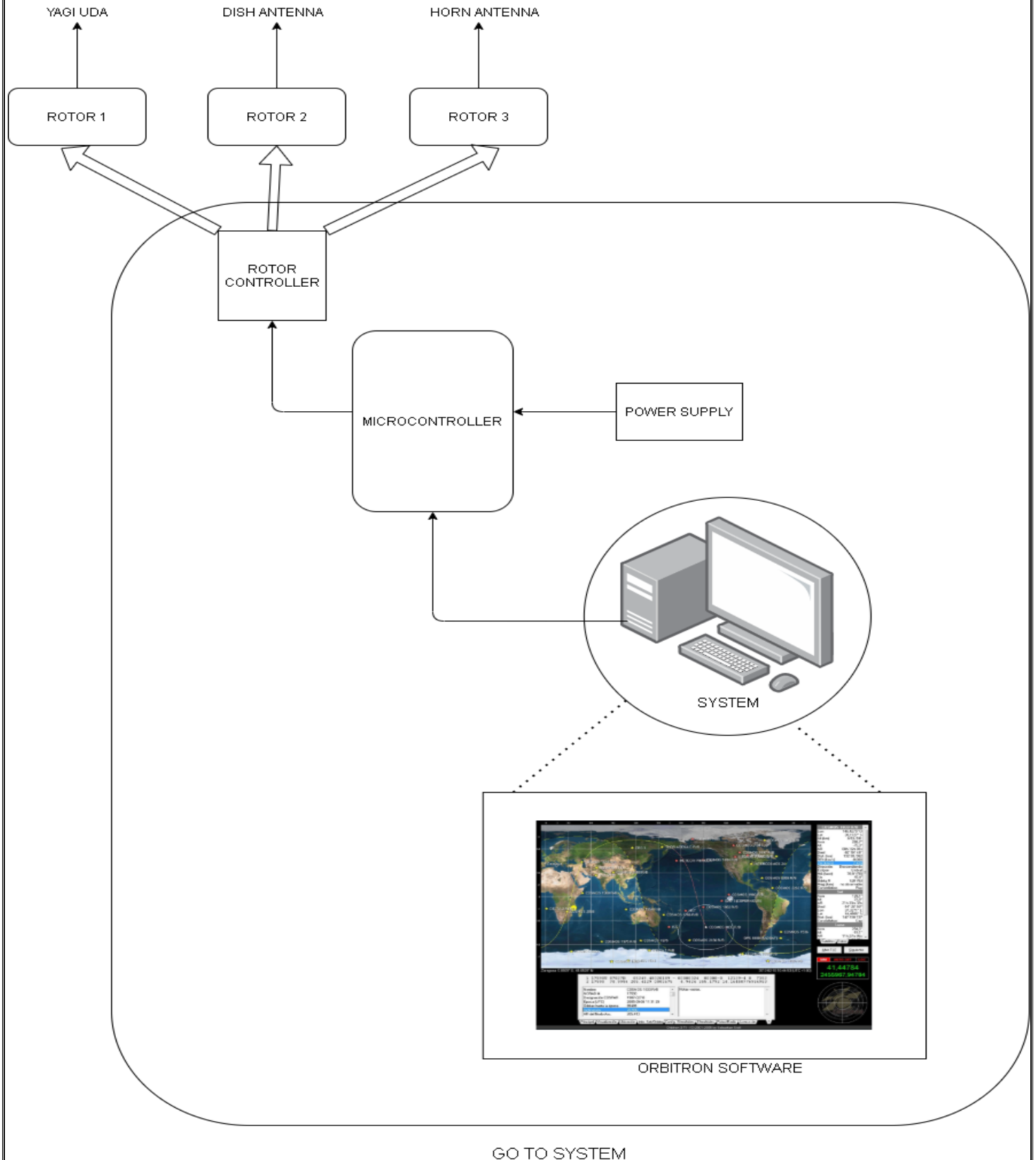
- Advanced features intended for serious satellite users
- Satellite tracking and prediction
- Antenna steering through popular interfaces
- Radio tuning with automatic Doppler correction
- Simulations and graphical interfaces
- Extensive documentation and vendor support



Package	Platform	Publisher	Download	License*	Member Price	Purchase
<a href="#">MacDoppler</a>	Mac OS 10.4, 10.5	Dog Park Software	<a href="#">Demo</a>	\$100	\$80	<a href="#">Purchase</a>
<a href="#">Nova for Windows</a>	Windows	Northern Lights Software Assoc.	<a href="#">Demo</a>	\$60	\$50	<a href="#">Purchase</a>
<a href="#">SatPC32</a>	Windows	DK1TB	<a href="#">Demo</a>	\$50	\$45	<a href="#">Purchase</a>
<a href="#">SCRAP</a>	Windows	Bytheway SDL	<a href="#">Demo</a>	\$60	\$50	<a href="#">Purchase</a>
<a href="#">InstantTrack</a>	DOS	Paul Williamson, KB5MU	<a href="#">Demo</a>	\$50	\$30	<a href="#">Purchase</a>

\*Prices shown are US Dollars. AMSAT members pay the License fee minus the Member Discount. Proof of membership is required..

# GOTO SYSTEM BLOCK DIAGRAM

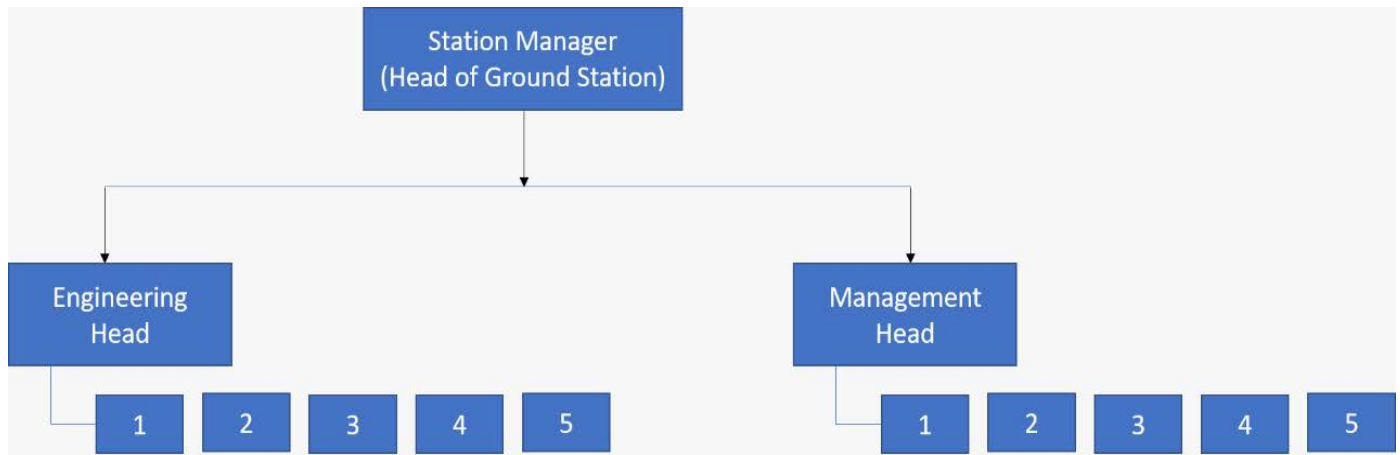


GO TO System is that system which will enable us to point our directional antenna towards the sky for high gain as well as high power transmission capabilities.

Go to system Would essentially have 2 rotors in each directional antenna as shown in the design which will then control the altitude and azimuth of the antenna, this will help the antenna point the Satellite , the rotors would be controlled by A microprocessor which will be interfaced by Orbiton , our satellite tracking software.



## Ground Station Management Planning



10 Student Management, 1- Station Manager, 2 – Heads with team.

Station Manager – All Authority

Engineering Head – Engineering & Technical Changes.

Management Head – Working & Ground Station Mode.

Engineering Team – Breakdown and Technical Upgradation (With Daily Technical Surveillance)

Management Team – Daily Data Collection and Data Processing (With Daily Station Surveillance)

## Future Plans of Ground Station

After every subsystem manufacturing and assembling of our nanosat we will launch an upgrade in our ground station and configure our ground station for receiving the data from the subsystem which will be trial and tested.

After every new technology on soft or hard platform, we will study and incorporate the soft upgrade right away and the hard upgrades would be studied, compared and if required would be incorporated upon conformation of management.

Engineering Head with team would have the responsibility to keep up the ground station updated with latest technology so that it can capture all satellites, latest ones as well as old ones.

Regular maintenance (Monthly as well as Half Yearly) Would be carried out by engineering and management team.

Uninterrupted functioning of ground station would be looked after by management head with team, even under maintenance phase, our ground station would be kept active on other antennas.

Even if there is a need to relocate the Ground station, we still have capability to keep it active in makeshift and Portable state. This is one of the biggest capabilities of ground station which will ensure uninterrupted working of the project in future.

*\*Monthly and Yearly Maintenance Checklist would be made after manufacturing of various stages, it shall be updates as and when required by Station Manager.*

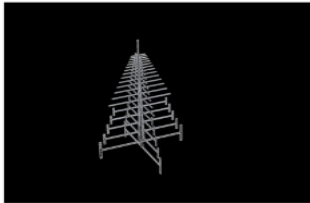
## Documentation & Handbook

Cosmos & Ground Station Management team would be responsible to log all our Reception and Maintain it, Specific Breakdown and Engineering maintenance logging would be done by Engineering Team.

We also would maintain a handbook containing all SOP's (Standard Operating Procedure's) After the Ground station is commissioned to use. This Procedure would be strictly followed under any circumstances and can only be Subjected to change by signed orders of Station Manager only.

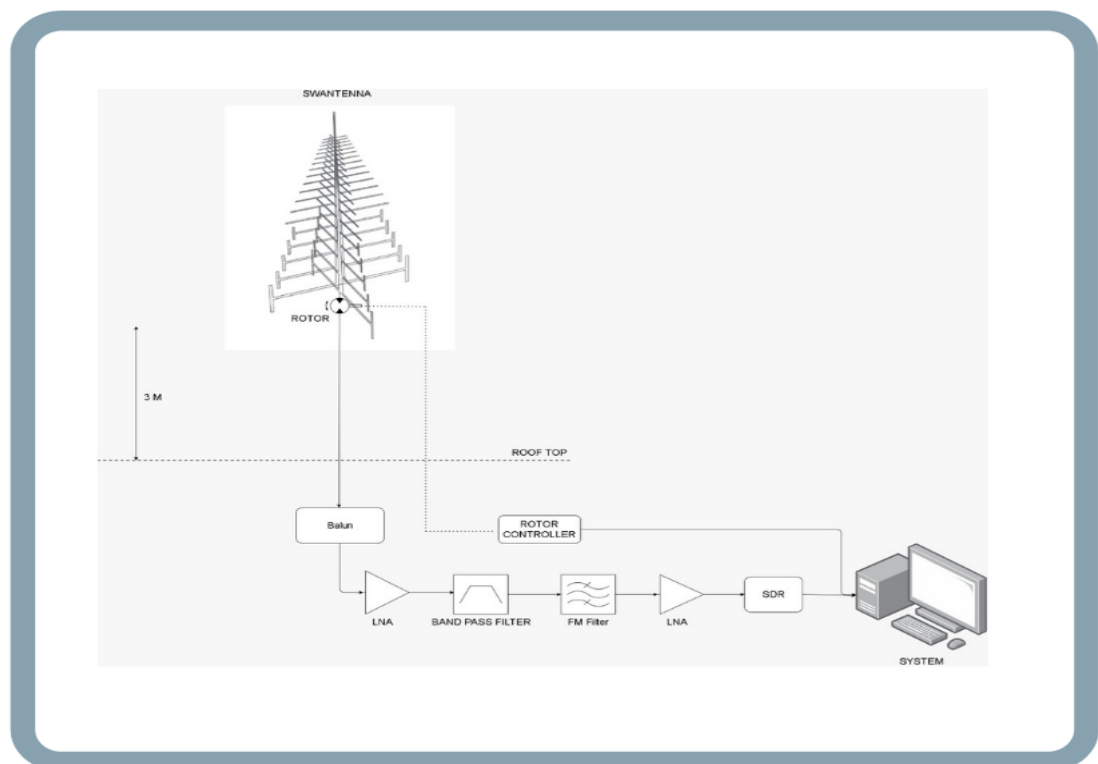
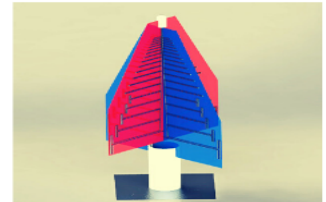


Dr. Vishwanath Karad  
**MIT WORLD PEACE  
UNIVERSITY** | PUNE  
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS



# SWANTENNA

Own researched Antenna



## DESIGN REPORT

**\*The publication of the research in international Journal is under process.**