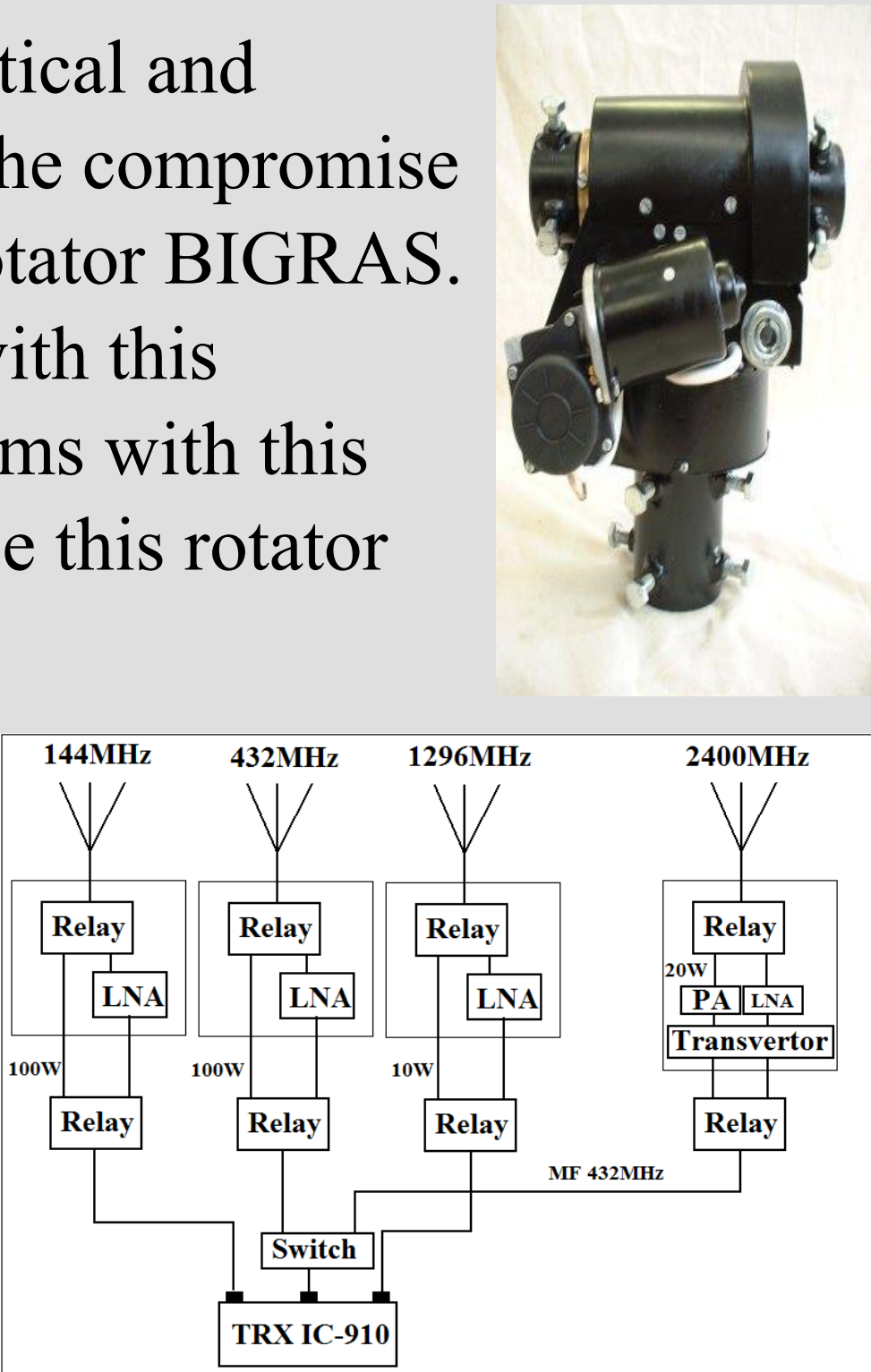


BASIC CONFIGURATION

Basic Configuration and Information

- Satellite and ground segment will be fully operated in the amateur radio segments (144, 432, 1296 and 2400 MHz).
- It has many advantages:
 - 1) We need only the amateur radio licence and two solvers of this project are the amateur radio concession holders.
 - 2) We use the standard equipment commonly used by radio amateurs (transceivers, antennas, software, etc.).
- For rotating antenna system (vertical and horizontal elevation), we chose the compromise solution in the form of a SPID rotator BIGRAS.
- The control unit was included with this rotator, but we had many problems with this unit. In the future we will replace this rotator control unit with our solutions.
- In this picture there is the basic connection of our system.
- We use VHF and UHF amateur radio transceiver from the company Icom, Model IC-910 and in the future we prepare SDR TRX and transverter.



RECEIVERS AND TRANSMITTERS

What do we use for receive and transmit?

- For the bands 144, 432 and 1296 MHz we use a good amateur radio transceiver IC-910 with output power about 100 W at 144 and 432 MHz and 10 W on 1296 MHz.
- This output power should be fully sufficient for these applications. If necessary, we have available power amplifier with output power up to 1 kW from other projects.
- Input sensitivity, selectivity, intercept point, noise figure and other important parameters of this radio are fully adequate and the control is also very good.
- For 2.4 GHz band we develop our own solution. We work simultaneously on two independent versions:



- 1) In the version A with frequency conversion from 1296 MHz to 432 MHz (using transverter) and for the demodulation, we used the standard radio IC - 910 (MF on 432 MHz).
- 2) In the version B (without conversion) we used a proprietary transceiver for 2.4 GHz in the form of an integrated circuit (concrete CC2500 from Texas Instruments).

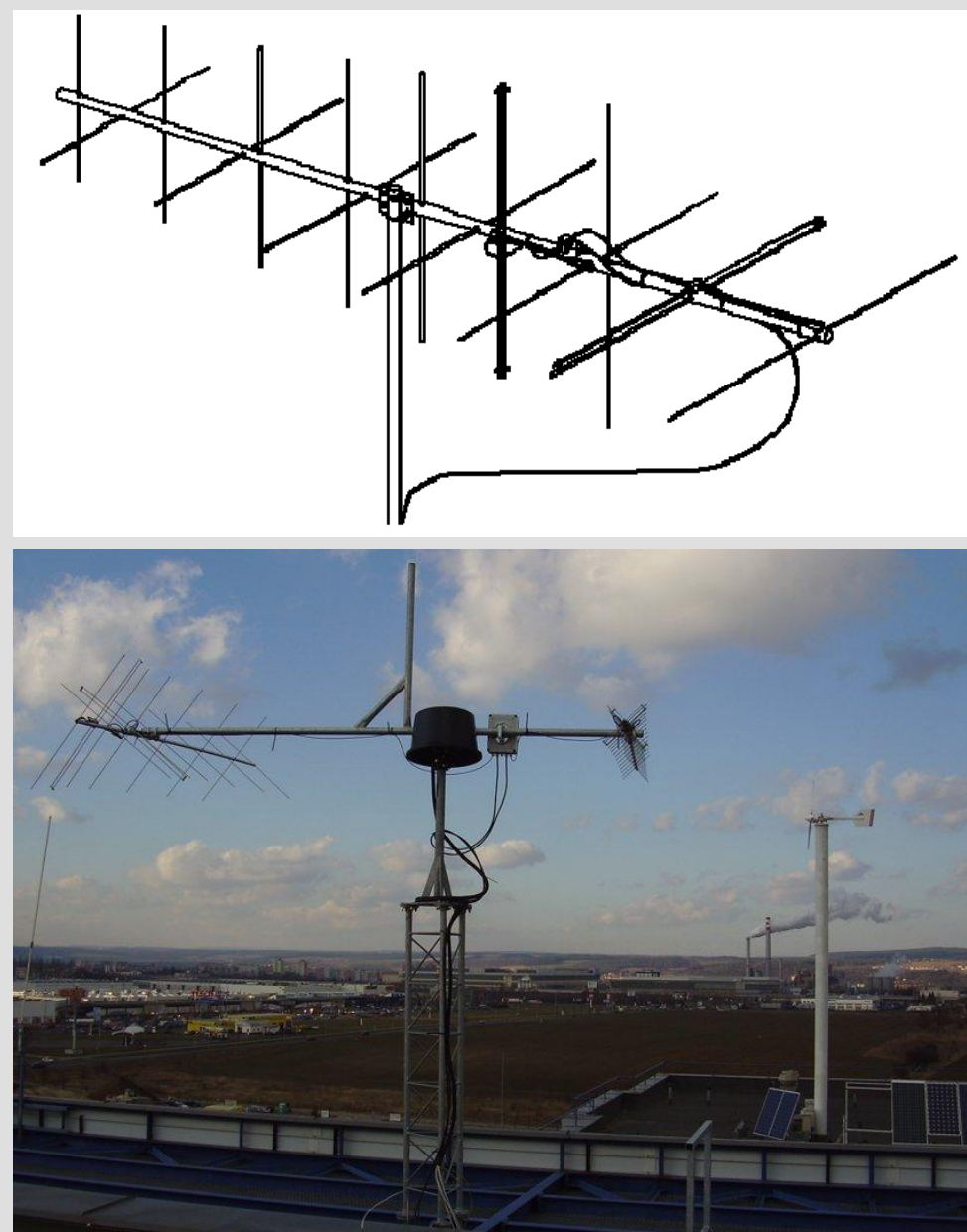
ANTENNA SYSTEM for 144 MHz

Cross YAGI 2mCP14 - manufac. by M2

- We use the special cross-yagi with circular polarization.
- This kind of antennas are the best suited for this application.
- This antenna is designed for the amateur radio segment 144 - 145 MHz (2 m - band).
- We use the low attenuation coax. cable - concrete Ekoflex.
- In this type of antennas it is possible to change the direction of polarization (RHC or LHC) and angle the radiation is 52°.
- Mechanical design is very good and the antenna is designed to wind 150 km per hour.

SPECIFICATIONS:

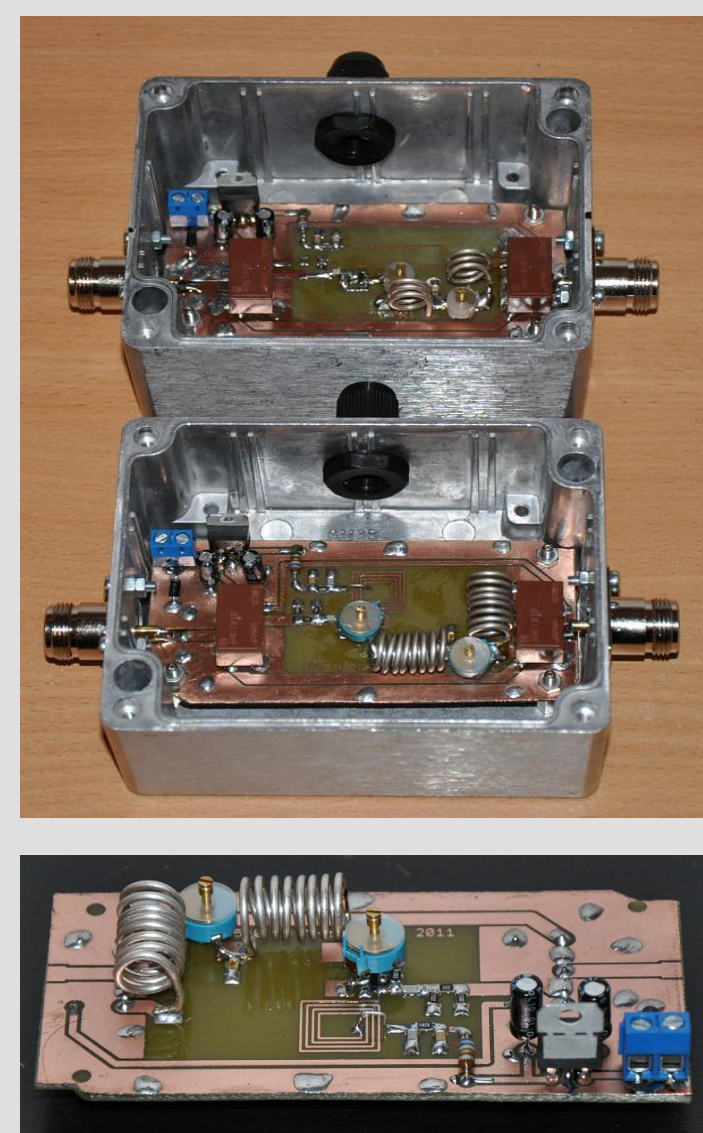
Model: 2M-CP14, M-square
Frequency range: 143-148 MHz
Gain: 10.2 dBd
Front to back ratio: 24 dB
Beamwidth: 52° CIRCULAR
Feed impedance: 50 OHMS
Input VSWR: 1.3:1 TYPICAL
Connector: 'N' FEMALE
Power Handling: 1.5 kW
Boom length: 3.2 m
Number of elements: 14
Weight: 3kg



HIGH IP LNA

Low noise LNA with high IIP and Control Unit

- In our department we have developed the special LNA with filter and the high input intercept point (IIP) about + 6 dB for 144 and 432 MHz.
- These LNA have integrated By-pass relay and can be controlled remotely.
- This LNA are fully waterproof and for the low noise figure they are located on the mast near antennas array.
- Our ground segment is located in areas with high interference and therefore is necessary high IP.



Control Unit

- This device can control up to four independent LNA and all necessary coaxial relays, etc. We used special coaxial relays with different supply voltage (smaller 12 V - larger 20 V).
- It also ensures the required sequence and switching the PAs (TX/RX).
- This device is controlled by the low current interface and is connected with transceivers (IC-910).



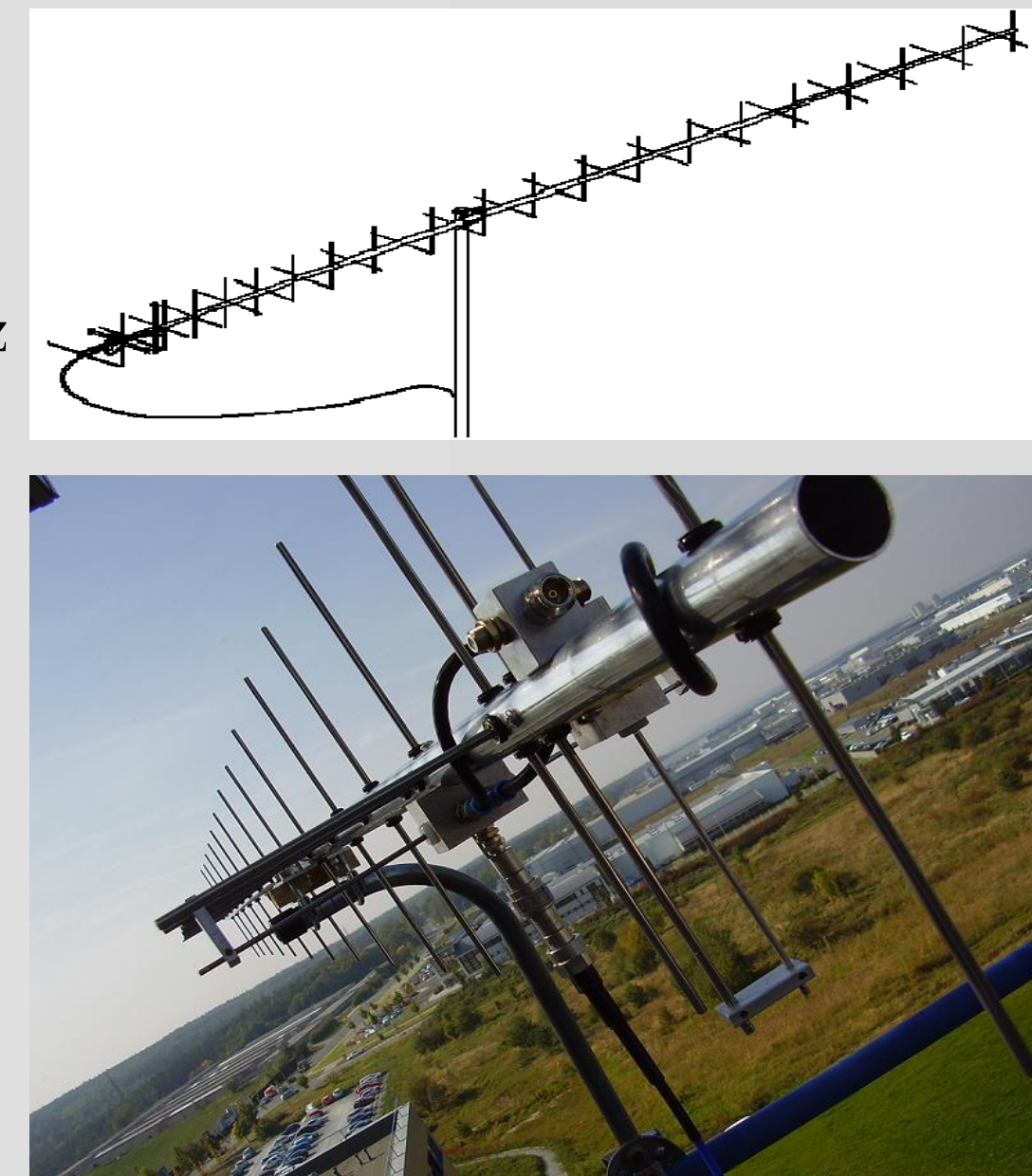
ANTENNA SYSTEM for 432 MHz

Cross YAGI 436CP30 - manufac. by M2

- We use the special cross-yagi with the circular polarization.
- This kind of antennas are the best suited for this application.
- This antenna is designed for the amateur radio segment 432 - 436 MHz (70 cm - band).
- We use the low attenuation coax. cable - concrete Ekoflex.
- In this type of antennas it is possible to change the direction of polarization (RHC or LHC) and angle radiation is 30°.
- Mechanical design is very good and the antenna is designed to wind 150 km per hour.

SPECIFICATIONS:

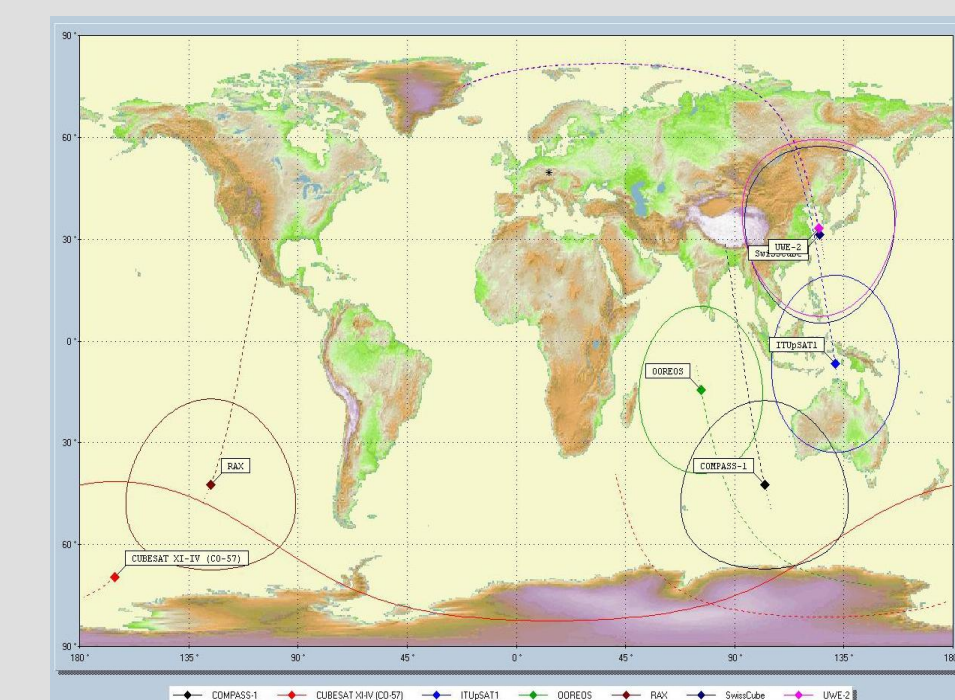
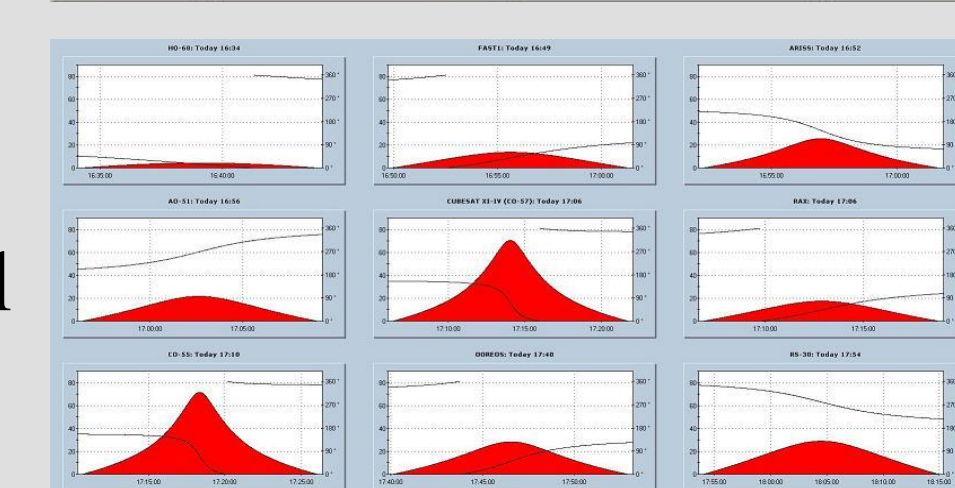
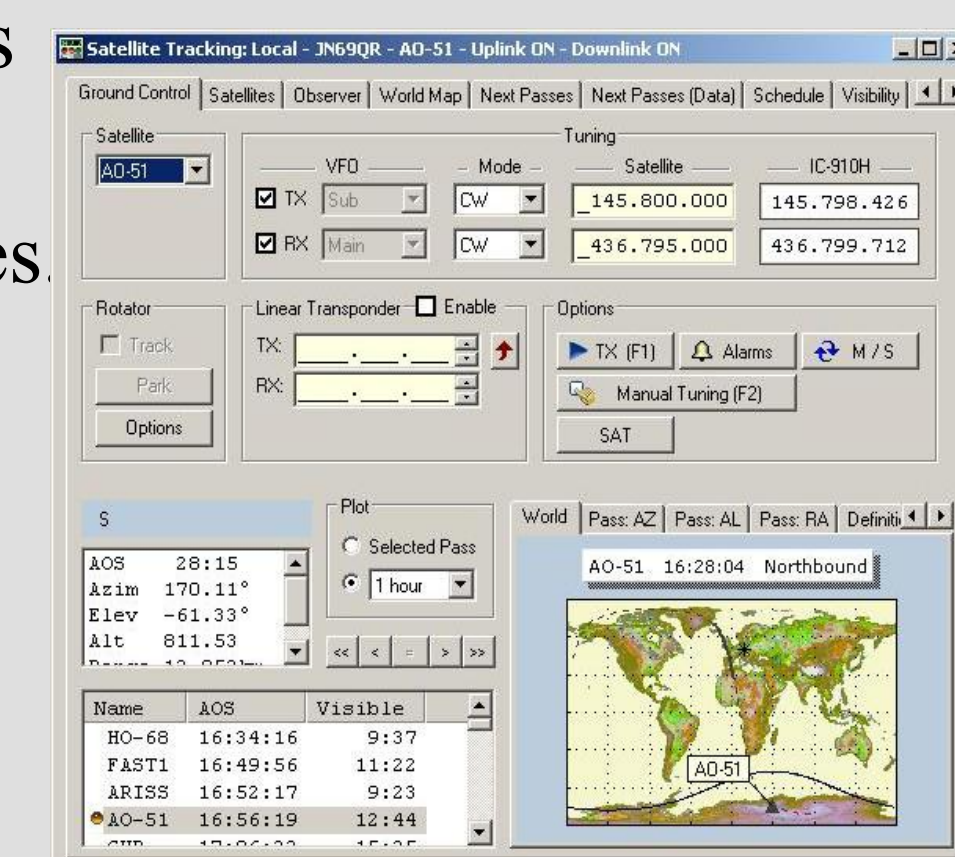
Model: 436CP30, M-square
Frequency range: 430 - 440 MHz
Gain: 14.5 dBd
Front to back ratio: 22 dB
Beamwidth: 30° CIRCULAR
Feed impedance: 50 OHMS
Input VSWR: 1.6 Max. TYPICAL
Connector: 'N' FEMALE
Power Handling: 600W
Boom length: 3 m
Number of elements: 28
Weight: 2,7kg



SOFTWARE

Control software - Ham Radio Deluxe

- The main task of this program is to regulate the rotator unit and to calculate the orbits of satellites.
- The control of this program is simple, easy and it enables the remote control from anywhere with help of auxiliary programs.
- It can import easily Keplerian data of each satellites.
- This program is very universal and we use it also for the control and management of transceiver.



Other Software: SFTP, VoIP and remote control software, etc.

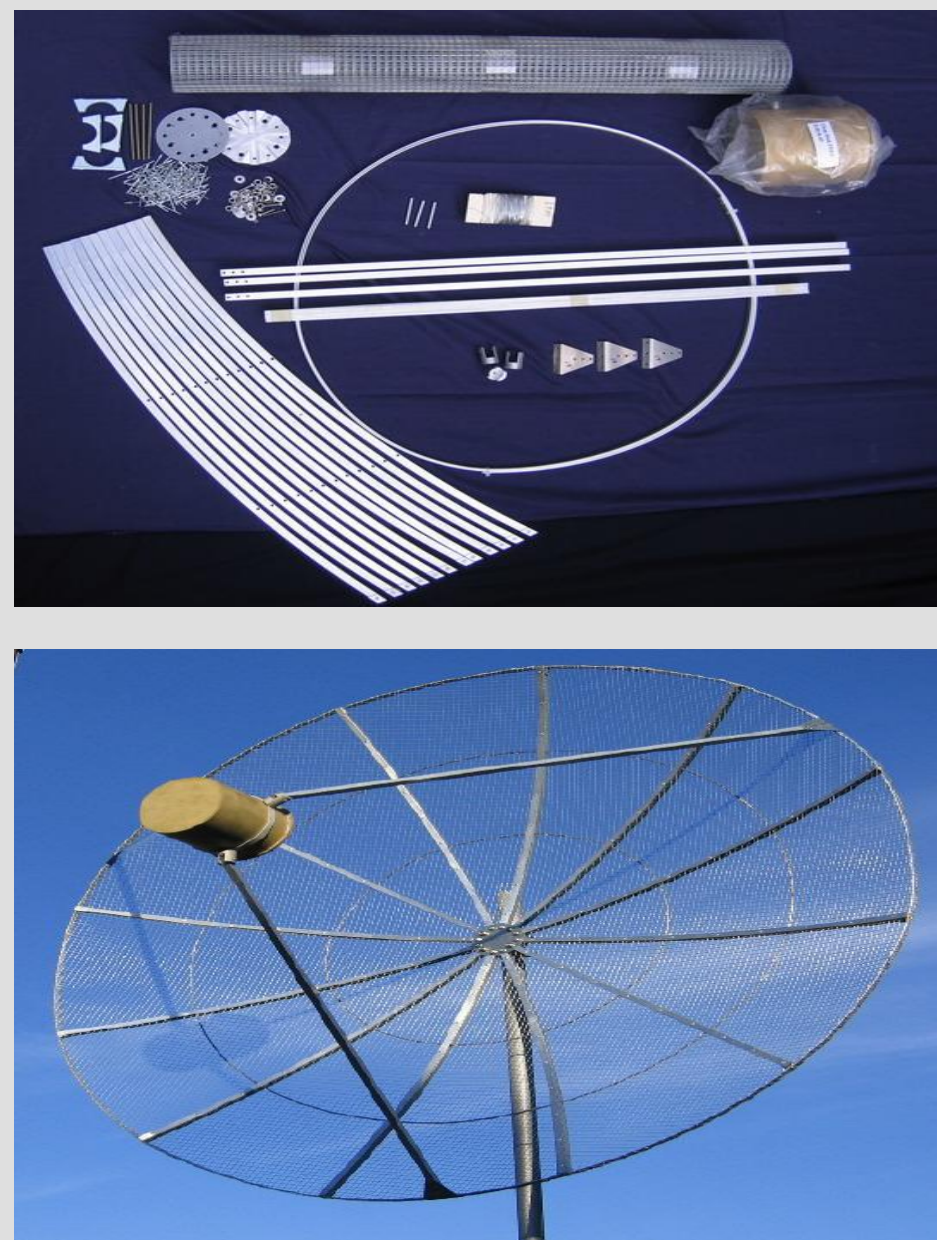
ANTENNA SYSTEM for 2.4 GHz

1.9 meter Mesh Dish - by RF Hamdesign

- We use the special HELIX LHCP dish feed for 2.4 GHz. (Left Hand Circular Polarization feed with F/D = 0.5)
- This kind of antennas are the best suited for this application.
- This Dish antenna is suitable to the frequency 6 GHz and the feed is designed for the amateur radio segment (2.4 GHz) and in the future we add the feed also for 1296 MHz.
- This antenna was supplied as a kit, which we had to build.
- Mechanical design of this kit is good and the benefit for us is the relatively small wind resistance.

SPECIFICATIONS:

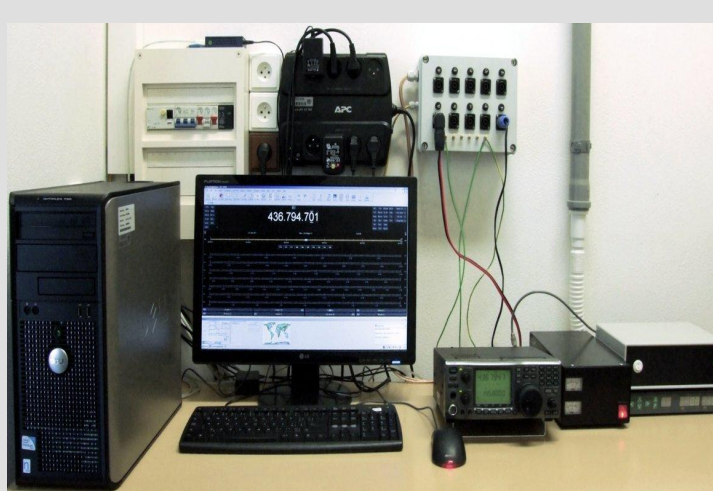
Model: 1.9m Mesh Dish - kit
(LHCP HELIX dish feed 2.1 - 2.7GHz)
Frequency range: 2300 - 2400MHz
Gain: 29.2 dBd
Front to back ratio: > 25 dB
Beamwidth: 5.1°
Feed impedance: 50 OHMS
Input VSWR: 1.2 Max. TYPICAL
Connector: 'N' FEMALE
Power Handling: 1000W
Outside diameter: 1.9m
Weight: 10kg



RESULTS

Current results and future

- Currently we finished completely the mechanical design and mounting mast with rotator and antennas for all bands.
- The ground segment is fully functional for receiving in the band 145 MHz and 435 MHz including LNA..
- We will prepare the completion of the control unit in the future and then it can be used for transmitting.
- The ground segment is now used primarily for receiving and decoding of other satellites. Selected student works, projects and long-term measurements are performed there.
- This project is funded by the Czech Science Foundation and registered as a project number 102/09/0455: Power efficient space probe for experimental research based on picosatellite



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