

Ka Uplink Station for Skylogic

Design Criteria and Earth Station Engineering

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Abstract

This paper describes the Design Criteria and the Earth Station Engineering for the Provision of a Ka Band Tx/Rx Uplink for Skylogic (company of Eutelsat) in Turin (Italy). The Ka Uplink is provided by Aersat to Skylogic with commissioning phase planned at the end of July 2004. The Aersat is fully responsible for the Project in cooperation with Antech in charge either for the provision of the 5m Ka Tracked Antenna either for the Equipment Integration on site.

The proposed system is constituted by a Ka band Earth Station operating with the Eutelsat W3A satellite located at 7° East. The W3A satellite, besides to constitute the back-up to the Eutelsat W3 satellite for Ku bandwidth, is provided with Ka transponders (H transponders) for European coverage in cross-strapping with Ku transponders (J transponders) covering the south of Africa area.

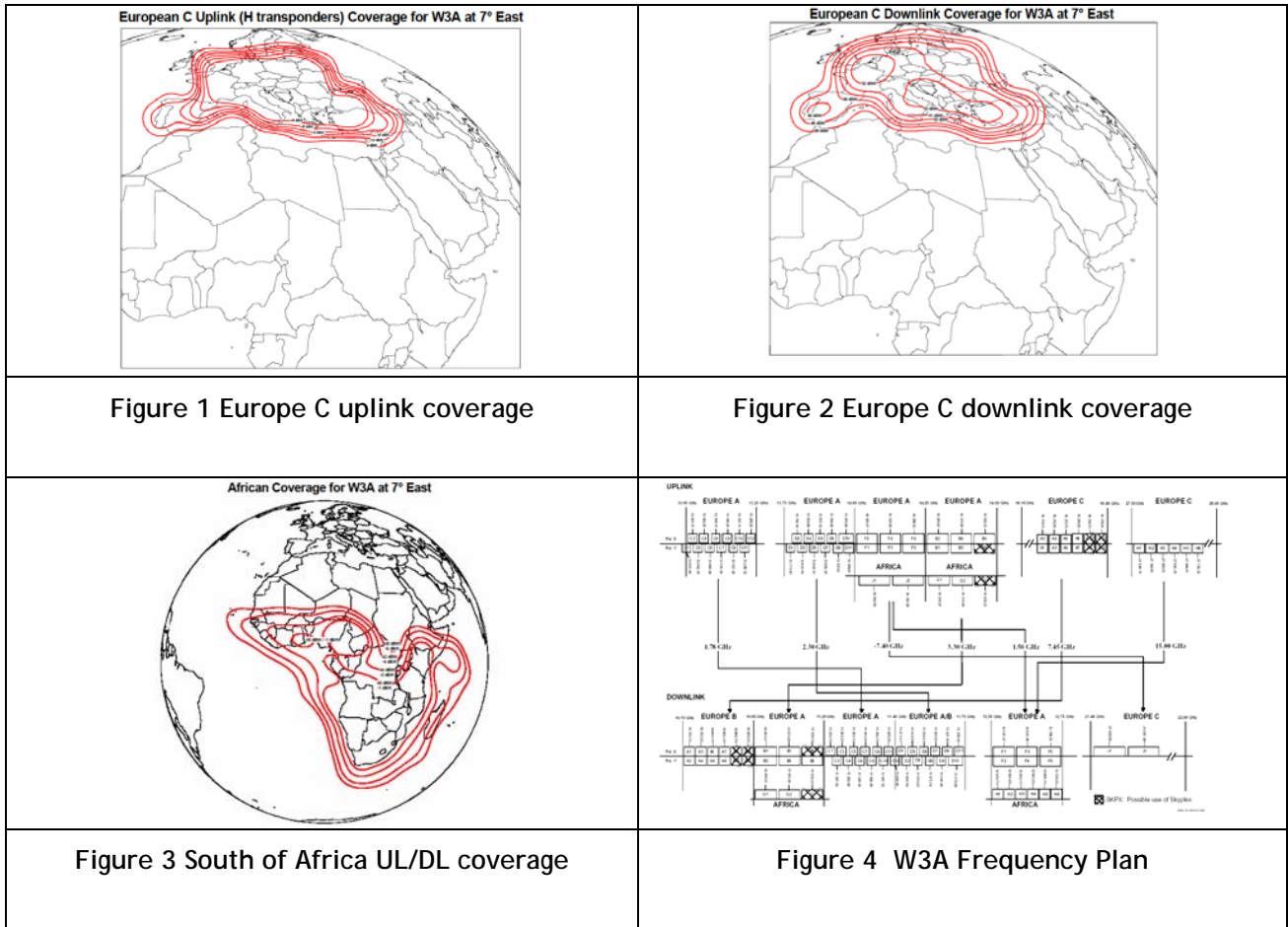
Ka Satellite Coverage of W3A

The specified satellite network, which the Ka Uplink in Turin will operate with, will utilize for transmission from Europe to South of Africa the transponder H (operating in the Ka band from 27.50 GHz to 28.60 GHz in up-link from Europe and in Ku band from 12.50 GHz to 12.75 GHz in down-link to South of Africa) and for reception from South of Africa to Europe the transponder J (operating in the Ka band from 21.40 GHz to 21.65 GHz in down-link to Europe and in Ku band from 14,00 GHz to 14,25 GHz in up-link from South of Africa).

The Eutelsat W3A Ka band coverage on Europe are shown in Figure 1 and Figure 2 respectively for uplink and downlink. The Ku band coverage on South of Africa is shown in Figure 3. The W3A Frequency Plan is shown in Figure 4.

The Ka band Earth Station in Turin will operate on the following frequency bands:

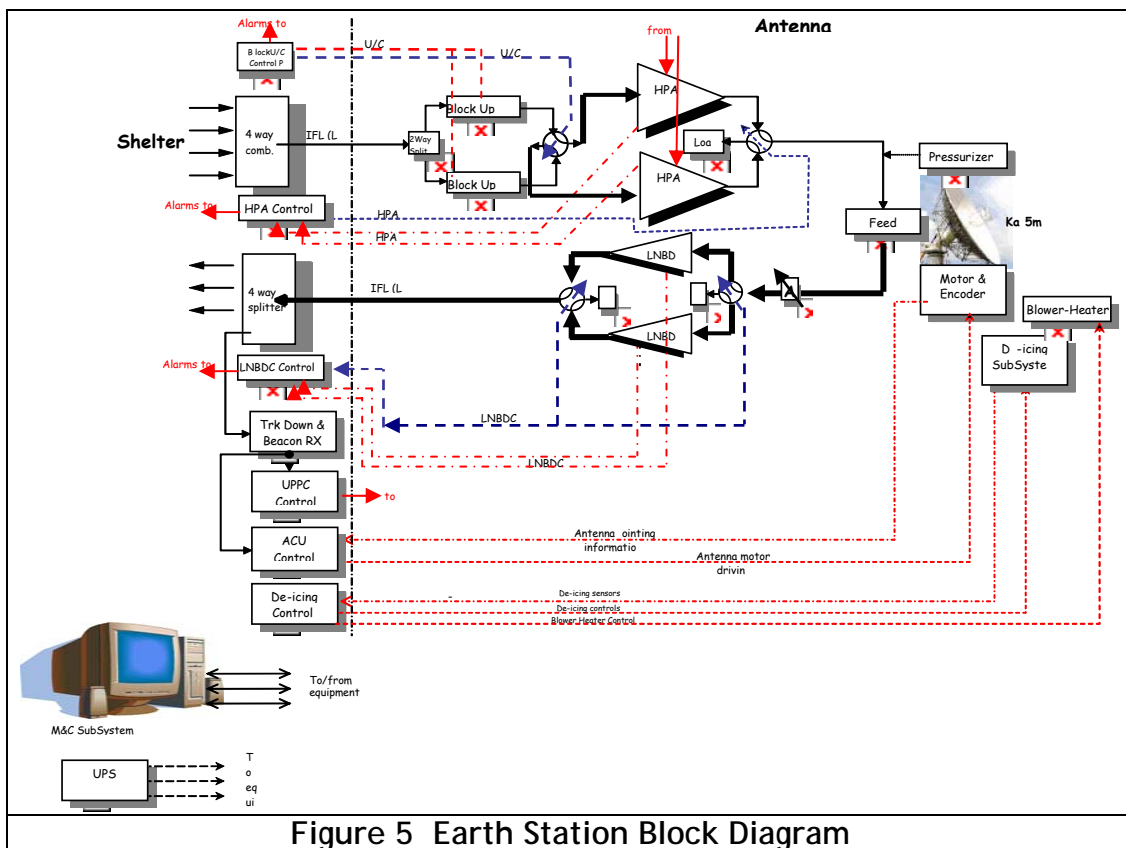
- a. Ka band Up-Link: 27.50 to 28.60 GHz;
- b. Ka band Down-Link: 21.40 to 21.65 GHz.



Earth Station Design

The Earth Station Hub will be able to transmit, in the Ka Tx band operating on W3A satellite, digital DVB Data carriers generated by QPSK modulators in the L band (950 ... 1750 MHz) and to receive digital RCS carriers from remote stations, in Ka Rx band on W3A satellite, down converting these in the receive L band at the demodulator input. The IFL cables runs between Shelter and Indoor Room.

The Earth Station in the baseline configuration will be able to transmit up to three carriers with TWTA equipped with Linearizers. The Block Diagram is shown in Figure 5.



As shown in the blocks diagram, the Tx configuration has been conceived with maximum 4 digital signals to be combined in L band in order to have an input spare in addition to the three which can be up converted and transmitted by the Earth Station. The redundancy configuration is 1+1 either for Block Up Converters and TWTA subsystems in order to increase the earth station flexibility and availability during equipment failures. The TWTA will be able to transmit up to 210 W (rated power) with TWT's of 250 W. This configuration allows the transmission of three simultaneous carriers each one with an EIRP of 74 dBW saturating the relevant transponders. In this manner the provided Earth Station EIRP capability is 82,91 dBW.

As far as the Rx configuration, the Low Noise Block Down Converters subsystem have a redundancy configuration of 1+1 in order to increase the earth station flexibility and availability during equipment failures in the same manner of Tx section. The down converted L band signal, obtained at the output of the redundancy D/C coax switch, will be fed to a 4 way splitter which will provide the connection with 3 L band cables to the RCS Demodulators Subsystems and to the Tracking Down Converter/Beacon Receiver for antenna automatic tracking carried out by the ACU (Antenna Control Unit). The ACU, operating with Step Tracking System algorithm, will drive the antenna motors after having compared the received signals from Beacon Receiver with the data coming from Antenna Encoders.

The proposed Ka antenna is Cassegrain with 5m Reflector. The Feed is a two port Ka band feed provided with a Pressurizer in order to eliminate the possible harmful effects of dampness. The Antenna will be provided with the Hot Air De-Icing.

A 20 dB's UPPC system will compensate in transmission the effects of severe fadings in Ka band in case of rains and atmospheric attenuations.

The Ka Uplink Earth Station can be subdivided in two sections:

- Antenna Section
- Shelter Section

The Antenna Section will host all the RF equipment, as follows:

- Antenna and Feed
- Feed Pressurizer
- Antenna Motors
- Antenna Encoders
- TWTA subsystems
- U/C and Control Logic subsystem
- LNA subsystem
- Waveguide Attenuator
- D/C and Control Logic subsystem

The Shelter Section will will host all the Control equipment, as follows:

- TWTA Control Panel
- LNA Control Panel
- UPPC Control Panel
- Monitor and Control subsystem
- 4 Way L band Combiner
- 4 Way L band Splitter
- Tracking Down Converter and Beacon Receiver
- Antenna Control Unit
- De-Icing Control Panel
- Short Break Panel
- No Break Panel
- UPS 50 KVA subsystem

In the Shelter the UPS and Short/No Break Panels will shielded by the Electronic Equipment.

Design Analyses

Design analyses have been carried out to validate the Earth Station Design and performances, particularly in respect of the following parameters:

EIRP capability:	82,91 dBW
Antenna Gain:	60,95 dB's
TWTA for 3 Carrier Operation:	210 W rated power

Intermodulation. The results of the IM analyses provided compliance for two carrier operation as far as the IM power required for 4 KHZ and 12,5 MHz while for the three carrier operation the IM power required for 12,5 MHz was exceeded.

Link Budget. The calculations have been carried out under the following hypothesis:

- a) Earth Station installed in Turin;
- b) Remote Station (not object of the proposal) in a town of Kenya (Mombasa) covered by the W3A satellite (1,8m and 2W SSPA);
- c) Transmitted Bit Rate by the Earth Station: 36 Mbps with FEC 2/3 and RS (29.5 Msps);
- d) Transmitted Bit Rate by the Remote Station: 384 Kbps with FEC 2/3 and RS (315 Ksps);
- e) Saturation Flux Density - $(80 + G/T) = -86$ dBW/m²;
- f) Transponder Attenuator set at 3 dB;
- g) Earth Station TWTA Out Back Off (OBO) at 4.15 dB's for three carrier transmission.

The link budget calculations have been performed in two directions: Turin - Mombasa and viceversa. The results provided a BER better than 10E-7 for the 99,90% of the time.

Implementation Project

Antenna

The 5m antenna, shown in

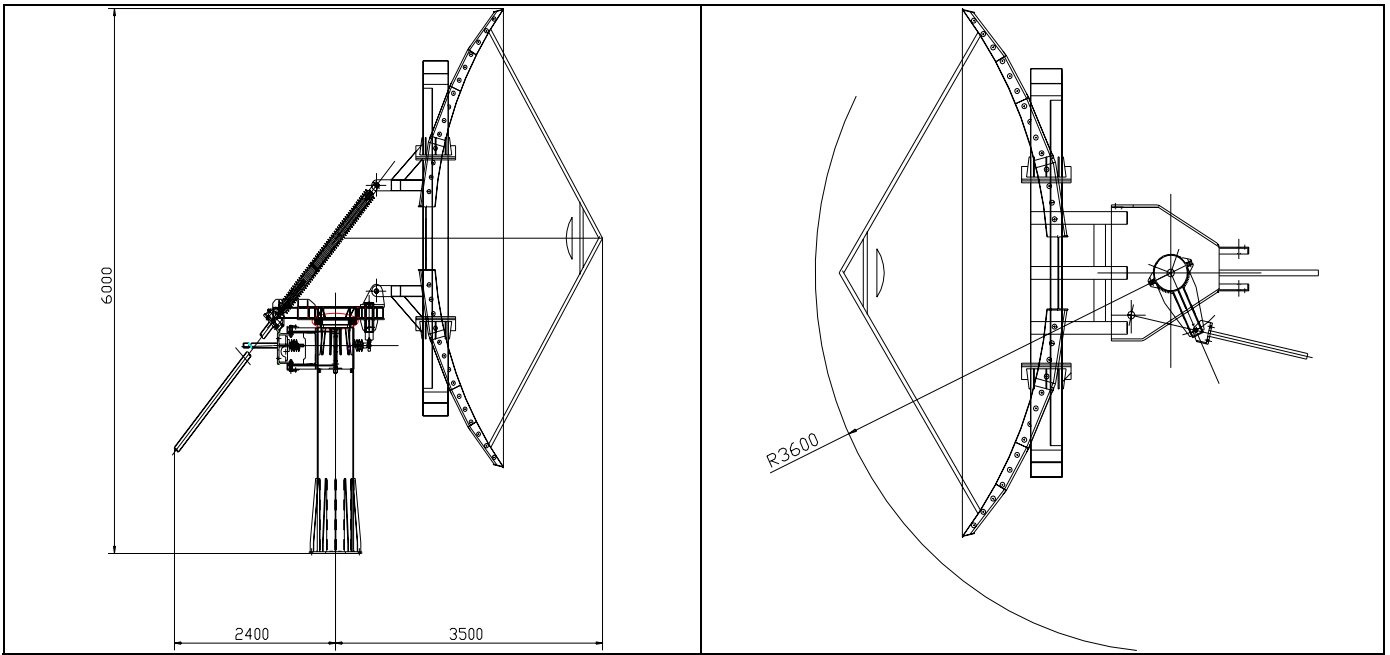


Figure 6 5m Ka Antenna Layout

and Figure 7, is a conventional elevation over azimuth that allows a motion of $\pm 30^\circ$ motorized and from 0° to 360° manual, in azimuth, and from $+5^\circ$ to $+80^\circ$ in elevation. This motion capacity is obtained by means of a double motorization without the necessity of mechanical reconfiguration of the structure.

The antenna is provided with Azimuth and Elevation indicators. Limit and pre-limit Switches are included for the mechanical limits for the Azimuth and Elevation axes. A protected zone is obtained near the center of the main reflector to allow the installation of the LNB and HPA subsystems.

The antenna is provided with lightning protection, adequate connection to independent ground from the grounding system of the same antenna, de-icing system on the reflectors and on the feed.

The electrical performances of the antenna are shown in Table 1 while the Radiation Diagrams are shown in Figure 8.

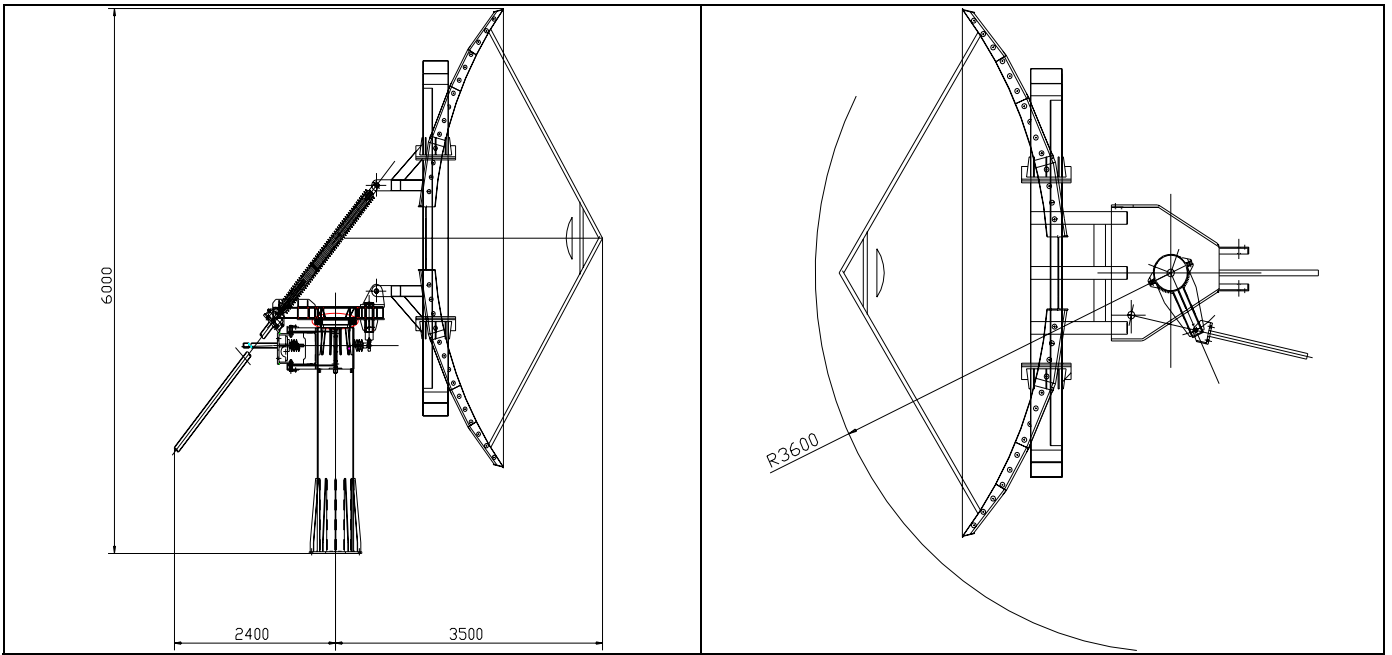


Figure 6 5m Ka Antenna Layout

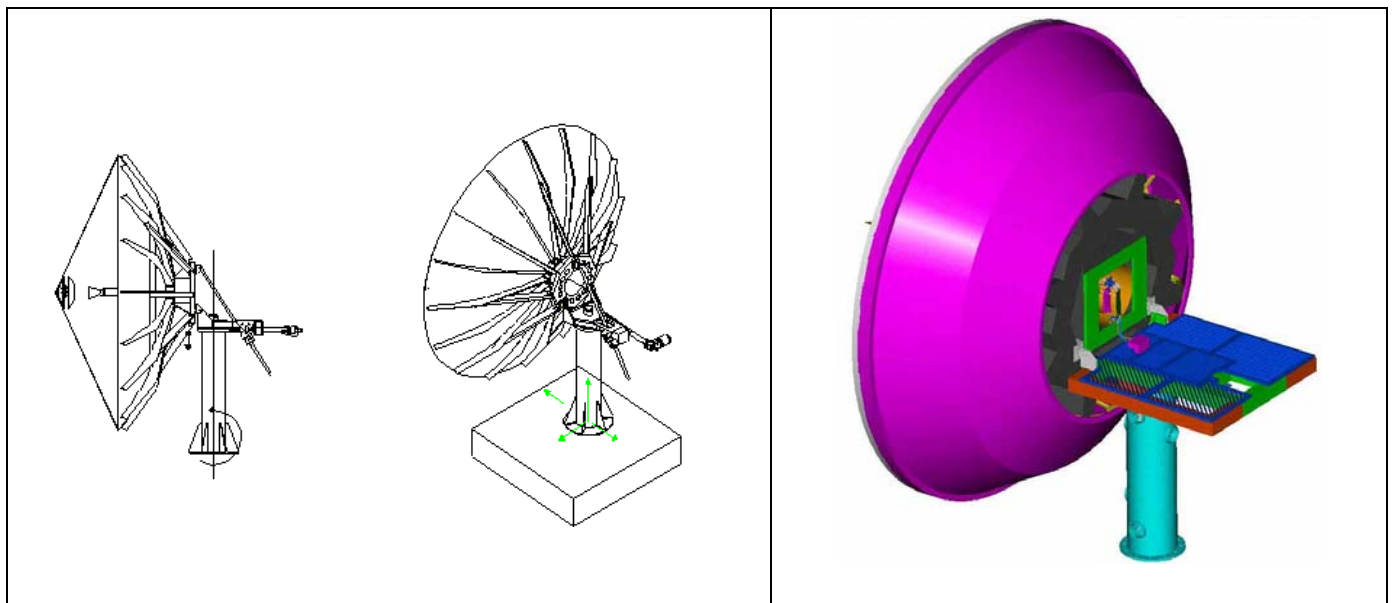
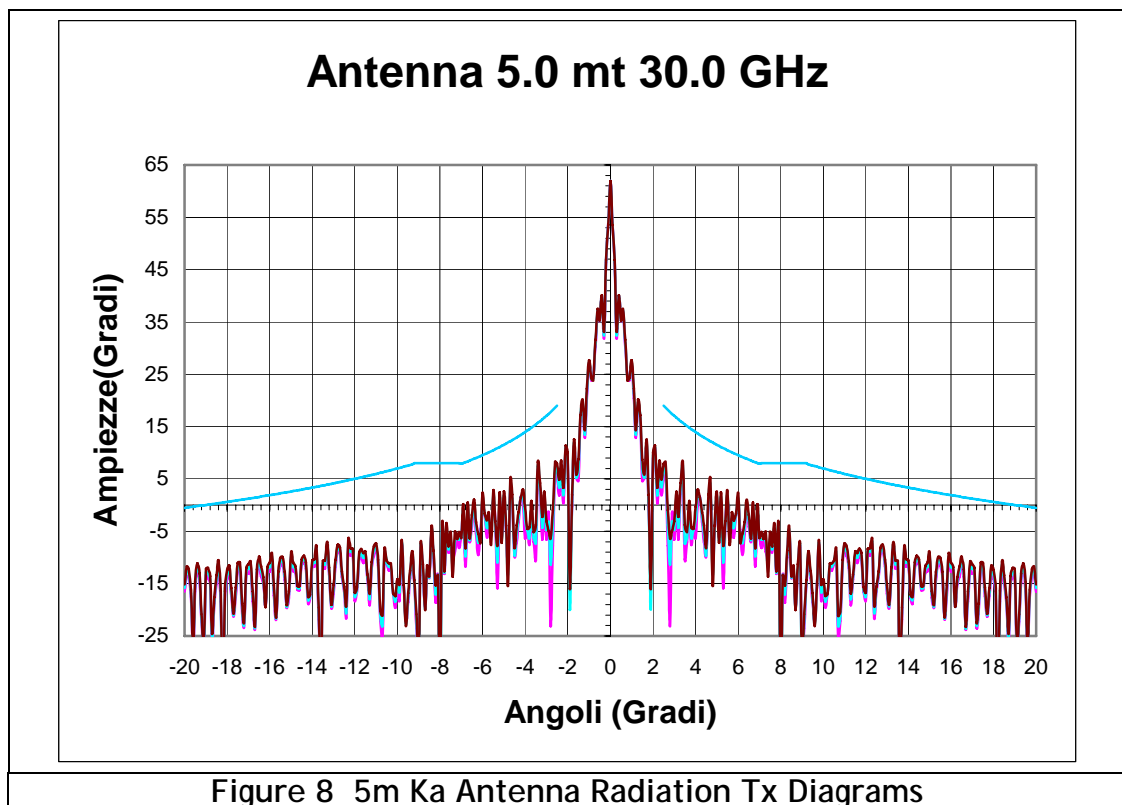


Figure 7 5m Ka Antenna tri-dimensional View

Parameter	Value
❖ Reflector diameter	5 mt
❖ Polarization	dual linear (2 port feed)
❖ Frequency	21.40 - 21.65 GHz (RX Ka) 27.50 - 28.60 GHz (TX Ka)
❖ Gain	RX: 58.81 dBi typ. (@ 21.5 GHz) TX: 61.10 dBi typ. (@ 28.0 GHz)
❖ Antenna Noise Temperature	83.15 K @ 38.1° elevation
❖ G/T	≥ 32.5 dB/°K @ 38.1° elevation
❖ TX/RX Sidelobes	Compliant with EUTELSAT ESS400 for Ka band
❖ XPD a -1 dB di contour plot	27 dB min.
❖ Insertion loss	0.4 dB max (TX) 0.4 dB max (RX)
❖ Return Loss	21 dB min. (TX) 20 dB min. (RX)
❖ Port Isolation	TX/RX 80 dB min (in TX band) TX/RX 70 dB min (in RX band)
❖ Power Handling	500 W CW for TX port
❖ Total loss between TWTA and Horn flange	1.67 dB

Table 1 5m Ka Antenna Main Performances



Shelter

The Shelter will host the UPS system and the control panels of the equipment installed in the Antenna Hub. The shelter Layout is shown in Figure 9.

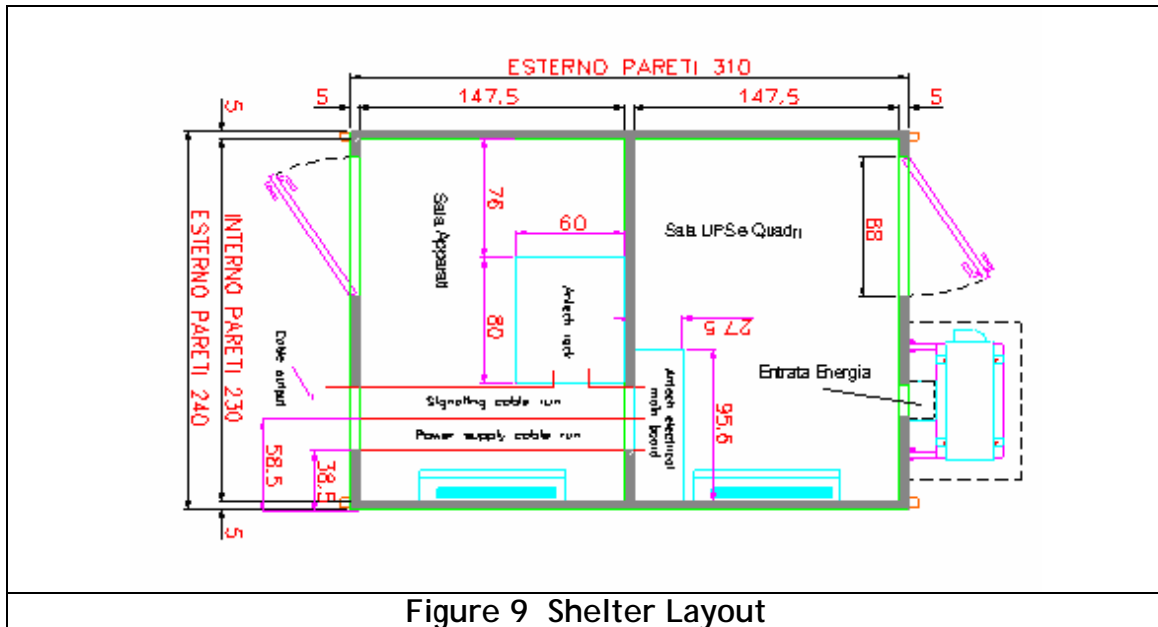


Figure 9 Shelter Layout

Monitor and Control System

M&C is the system devoted for the acquisition/monitoring of all the equipment and subsystem components. It is installed on an industrial PC positioned in the rack and allows the monitoring of the system status, the automatic switching logics for the equipment, and allows the manual switching in case of fault for test and maintenance activities.

N° 2 Ethernet socket type RJ45 will be provided, one inside the shelter near the control panel rack and the other one inside the equipment room where will be installed the remote PC controller.

In order can check and monitoring all the system, should be provided following alarms, dry contact normally close, open in alarm condition:

- detection of RF limit emission exceeding 40V/m;
- detection of RF limit emission exceeding 6V/m;
- Conditioning system;
- UPS system;

Conclusion

The Ka Uplink realized for Skylogic is the first example in Europe for Ka operational services with DVB RCS technologies.