Hellas-Sat 2 Satellite

USER's MANUAL

September 2005

INTRODUCTION

The HELLAS SAT User'sl Manual gives a short description of the Hellas- Sat 2 satellite system and sets the procedures and calculations required for the user in order to access the satellite. It is offered to the service providers and potential users of the system with the aim to provide all necessary information for their systems planning and implementation of satellite services.

However, depending on the case, the information and guidance provided cannot be considered as a specification but only as a reference tool.

DOCUMENT STRUCTURE

This document is divided into 3 sections. On section 1 all technical characteristics of the Hellas-Sat 2 satellite are described. In section 2 the reader is introduced to the procedures and access conditions of the satellite. Finally section 3 provides all necessary contact details for customer's technically related issues.

1. SATELLITE TECHNICAL CHARACTERISTICS

1.1 INTRODUCTION

This Section contains general information on the multi-region geostationary Hellas-Sat 2 satellite.

1.2 GENERAL CHARACTERISTICS

The Hellas- Sat 2 satellite is designed for a minimum operational lifetime of 15 years and its orbital position can be controlled with ±0.09º East/West and ± 0.05º North/South accuracy over at least 12 years. In order to enable the pointing of manually adjusted or program-tracked antennas, HELLAS SAT provides, on request, the data for orbit determination to the Earth Station operators. Up to thirty (30) transponders of 36 MHz bandwidth each are available for simultaneous operation, in eclipse as well as in sunlight.
Reception and transmission take place via four dual polarized beam antennas. Two of them (F1 & F2) are fixed, with a 2.5m main reflector each and dual offset Gregorian configuration of single feed with numerically shaped main reflector to provide complex beam shape for efficient illumination of Europe, and part of Middle East and N. Africa. The other two antennas (S1&S2) also Gregorian, are steerable with a shaped parabolic reflector of 1.3m to provide spot coverage and can be pointed anywhere over the surface of the visible Earth, currently pointing M. East (S2) and S. Africa (S1).

1.3 FREQUENCY PLAN

The frequencies and polarization arrangement of the Hellas-Sat 2 satellite transponders are shown in Figure 1.

The fixed coverage antenna F1 receives signals in the band 13.75-14.00 GHz whilst the fixed coverage antenna F2 receives signals in the band 14.00-14.25 GHz. The steerable antenna S1 receives signals in the band of 13.75-14.00 GHz.
The steerable antenna S2 receives signals in the band 14.00-14.25 GHz on the horizontal uplink polarization and in band 14.00-14.50 GHz on the vertical uplink polarization. There are two types of receivers/downconverters.

Type 1 receiver provides frequency translation of either uplink band 13.75-14.00 GHz or 14.00-14.25 GHz to downlink band 12.50-12.75 GHz using two switchable local oscillators (1.244GHz and 1.5GHz respectively). These receivers are connected in a 8/6 redundancy scheme.

Type 2 receiver provides frequency translation of uplink band 14.00 to 14.25GHz, to downlink band 10.95 to 11.20 GHz using a 3.050 GHz local oscillator.These receivers are connected in a 2/1 redundancy scheme.

There are also two downconverter assemblies that provide frequency translation of the S2 uplink band 14.25-14.50 GHz to downlink band 11.45 to 11.70 GHz using a 2.8 GHz local oscillator and connected in a 2/1 redundancy scheme.

It is noted that, due to switching capabilities, channels 13-24(F1 antenna) or channels 37-48 (S2 antenna) may be downlinked in the band 12.50 to 12.75 GHz via the F1 antenna, selectable on a channel by channel basis. It is also possible to downlink S2 channels of the 14.25-14.50 GHz band via the F2 antenna in the 11.45-11.70 GHz band but in this case the F2 channels have to be downlinked via the S2 antenna in the 10.95-11.20 GHz band.

Moreover, there is the possibility to uplink in channels 14 of F1 and downlink in channels 32 of S1 on a channel basis thus connecting Europe with areas outside F1 coverage.

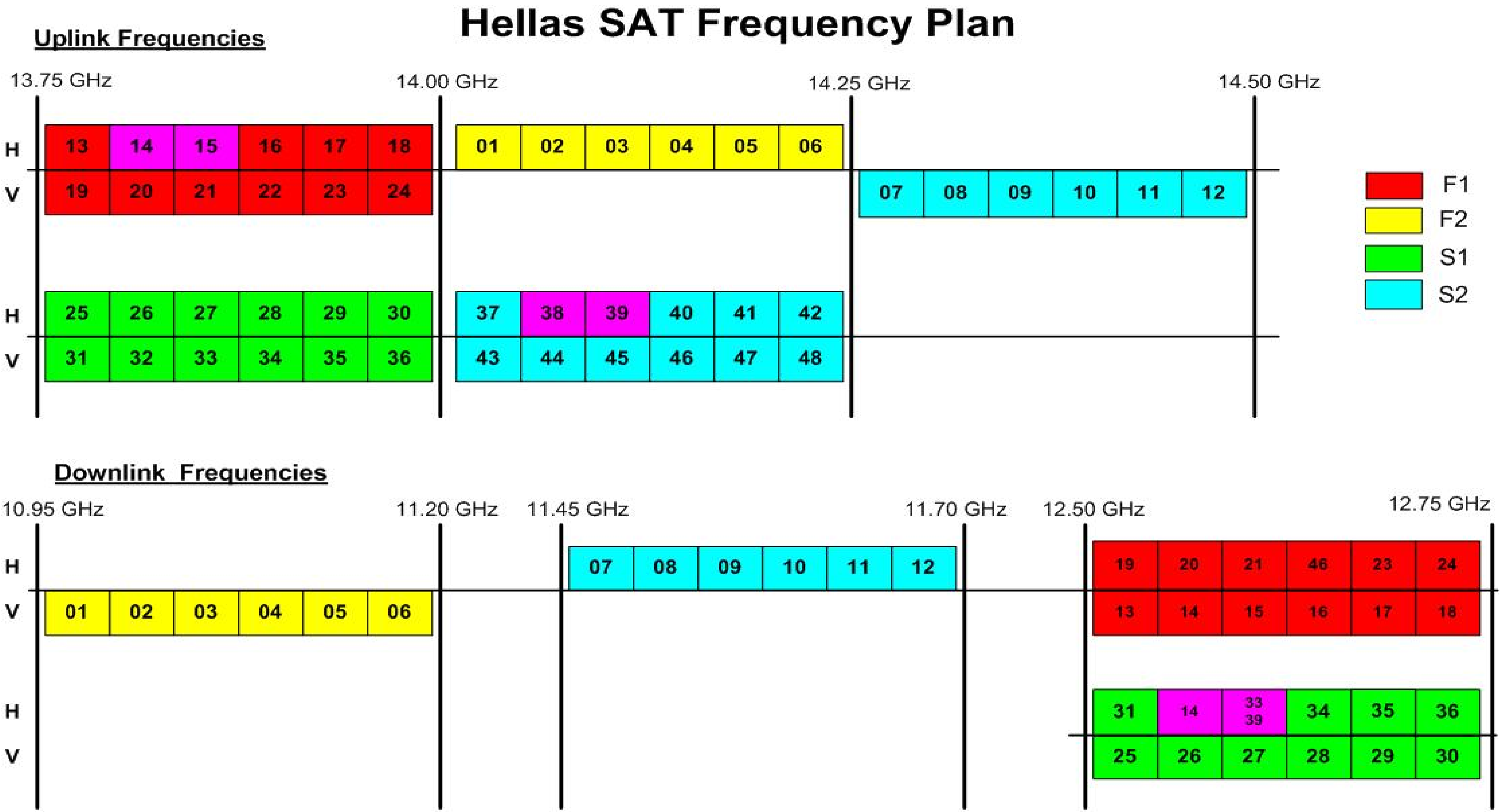


Figure 1. Hellas SAT frequency Plan

1.4 COVERAGE MAPS

Hellas–Sat 2 satellite provides four antennas for reception. The fixed coverage F1 and F2 antennas differ only in the shaping of the main reflectors. In practice they provide almost the same coverage over Europe, N.Africa and Middle East.

Annex C provides the receive coverage areas in terms of G/T contours for F1, F2, S1 and S2.

The steerable antennas S1 and S2 are currently pointed to cover S.Africa and M.East/Eastern Europe region respectively. S1 and S2 are of identical design.

Hellas- Sat 2 provides four antennas for transmission. The fixed transmit coverage of F1 and F2 as well as those of the S1 and S2 are presented in Annex C in terms of EIRP contours.

1.5 TRANSPONDER GAIN ADJUSTMENT

Each transponder can be adjusted in terms of its gain. The adjustment is performed by a channel amplifier (Camp) which is located before the TWTA. The Hellas- Sat 2 payload has 38 channel amplifiers. The Camp is a variable gain preamplifier for each individual TWTA and its prime function is to limit the effects of rain fade. The Camp can be operated in two modes selectable by ground command; Fixed Gain Mode (FGM) and Automatic Level Control (ALC) mode.
In FGM, the gain of the Camp is selectable by telecommand. In this mode of operation, the Camp has 27 gain steps (step 0 to 26), with a step size of 1.5 ± 0.3 dB.

In ALC mode, the Camp output signal power is set by telecommand to the required level while the input power may vary over a specified dynamic range. In this mode of operation the Camp has 17 gain steps (0-16), with a step size of 1±0.25 dB

From the operational point of view, the above arrangement provides flexibility to the earth station operators in cases where the uplink station is power-limited and/or where power compensation is required to cater for unpredictable link fade (rain etc.).

1.5.1 Saturation Flux Density (SFD)

The input power flux density for saturation of each channel is calculated at peak satellite antenna gain. The peak saturated flux density is used in relation with the antenna G/T contours relative to peak antenna gain and the sensitivity (gain step) of the transponder. The sensitivity of each transponder may be adjusted independently from the others.

The SFD for transponder saturation at peak satellite antenna gain (at the maximum satellite G/T point) ranges from about – 75 to – 115dBW/m^2 depending on the transponder gain step, the antenna each transponder is connected to, and the particular TWTA.

Operationally, three gain modes are used; Low (L), Medium (M) and High (H). However, there is the possibility to use other gain steps depending on the earth station EIRP capability, the receive earth station G/T, earth stations location, the desired quality etc.

In Table 1 below, the SFD values are presented for the above mentioned gain settings and for each particular satellite antenna.

The quoted figures, based on the less sensitive transponder at nominal configuration, represent average values for all transponders. This means that a difference of 1 or 2 dB from the specified values is expected. Moreover, the peak gain values correspond to the minimum available values. However, the quoted figures can be used in link budget calculations for planning purposes.

A simplified link budget example is presented in Annex A to show how IPFD for saturation is employed in link budget calculations.

Gain Step	**F1 antenna**		**F2 antenna**		**S1 antenna**		**S2 antenna**	
	Peak Gain +8.37 dB/K	Satellite Contour 0 dB/K	Peak Gain +11.10 dB/K	Satellite Contour 0 dB/K	Peak Gain +5.94 dB/K	Satellite Contour 0 dB/K	Peak Gain +5.65 dB/K	Satellite Contour 0 dB/K
5(L)	-82.20	-73.83	-84.9	-73.80	-80.90	-74.96	-76.80	-71.15
9(M)	-88.32	-79.95	-91.12	-80.02	-87.16	-81.22	-82.95	-77.3
13(H)	-94.66	-86.29	-97.37	-86.27	-93.44	-87.50	-89.16	-83.51

Table 1: Average SFD values for transponder saturation versus sensitivity

Using values from Table 1 and the G/T maps it is easy to calculate the SFD on a specific location. The required SFD calculation formula is shown below.

SFD calculation formula:

$$SFD_L = SFD_{Peak} + Aspect\_Correction \Rightarrow$$
$$SFD_L = SFD_{Peak} + (G/T_{Peak} - G/T_L)$$
(Equation 1)

An appropriate example for the calculation of the SFD and all necessary parameters for a link budget can be seen in Annex C.

1.6 BEACONS

A Ku- band beacon generator on board of the satellite provides a signal to a dedicated global horn antenna. The Ku-band beacon transmits a single right hand circular polarized unmodulated frequency of 11.4515 GHz with a maximum EIRP of 12 dBW within the whole visible area from the satellite. A 3 dB loss of power level is expected if linear polarization reception system is used by the station. This beacon is a two for one redundant unit and is used by the earth stations operators to track the Hellas-Sat 2 satellite.

1.7 TWTA TRANSFER CHARACTERISTICS

All TWTA which are employed on Hellas- Sat 2 transponders provide a maximum output power of 105W.
The OBO denotes the power level available at the output of the TWTA relative to that when the transponder is saturated. The OBO is therefore very important for link budget calculations as it provides the available power per carrier for one or more carriers in the down link.

Operation of the TWTA at saturation means that the maximum output power is obtained in the down link which in turn directly affects the design of the terrestrial receive equipment.

When a number of carriers are simultaneously amplified at different frequencies by the power amplifier of a satellite transponder or of a transmit E/S, non-linearities of the amplifiers cause intermodulation, i.e produce unwanted signals, called intermodulation products.

The number of intermodulation products increases very quickly with the number of input carriers (for example, for 3 carriers, there are 9 products and for 5 carriers there are 50). However, in most cases only the third-order intermodulation products falling within the frequency band of the wanted carriers are considered.

To reduce intermodulation products in multicarrier operation (FDMA mode) the TWTA needs to be driven with a sufficient back-off: i.e an input back-off of about 9 dB corresponding to an output back-off of about 4.1 dB. In the case of earth station HPAs, an output back-off is usually required (3 to 8 dB). However the situation can be improved by the utilization of linearizers.
Above limitations do not apply in the case of a single carrier occupying the whole transponder bandwidth and therefore the TWTA can be driven almost to saturation.
For a Hellas-Sat 2 TWTA, in different operational modes, the following total IBO/OBO values may be employed:

		No of Carriers				
		1	**2**	**3**	**4**	**MultiCarrier**
Trp 1-12, Beams F2, S2	**IBO**	0	-5	-7.5	-7	-9
	OBO	0	-2	-3.1	-3.9	-4.1
	C/IM	-	27.7	18.5	18	18
		No of Carriers				
		1	**2**	**3**	**4**	**MultiCarrier**
Trp 13-24 & 25-48 Beams F1, S1, S2/F1	**IBO**	0	-5	-8.5	-8	-10.5
	OBO	0	-2	-3.5	-3.4	-4.9
	C/IM	-	26.5	18	18	18

Table 2: IBO vs. OBO for multi-carrier operation

2. LEASED TRANSPONDER UTILIZATION CONDITIONS

The lessee is free to set his own transmission parameters (type of carrier, bandwidth, modulation, quality etc), provided that this does not lead to unacceptable levels of interference of any kind into the same or on adjacent satellites.

HELLAS SAT does not allow Power Limited links unless agreed otherwise between the two parties.
Before any carrier activation, HELLAS SAT will prepare a link budget analysis and the lessee will be asked to agree upon the operational parameters for the particular applications. Alternatively the lessee can submit to the planning department for approval its own calculations. In either way the operational parameters shall be included in an approved Transmission Plan. Any deviation from the approved transmission parameters requires special coordination and agreement by HELLAS SAT.

Prior to accessing the Hellas-Sat 2 space segment capacity all transmit Earth Station operators have to submit to HELLAS SAT Operations Department Earth Stations approvals (Eutelsat, Intelsat, PanAmSat etc). In case there is no such document, The Earth Station operator should co-ordinate XPOL, frequency & power stability tests with HELLAS SAT NOC in advance.

All transmit Earth Station operators should strictly follow the HELLAS SAT Line-Up procedures. The appropriate document is provided in Annex A.

3. CONTACT HELLAS SAT

HELLAS SAT can be reached at:
Tel: +30 210 6100600.
Fax:+30 210 6111545
http://www.hellas-sat.net

The HELLAS SAT Booking Office is manned on a 24 hour basis. For capacity reservations and technical matters are contact the following number:
Tel: +30 210 6100701/+30 210 6100702
Fax: +30 210 6100700

The HELLAS SAT NOC is manned on a 24 hour basis. For line-up procedures or emergency issues, contact the following numbers:
Tel: +30 210 6116090 (primary),
Tel: +30 210 6116091 (secondary)

ANNEX A

HELLAS SAT NETWORK OPERATIONS CONTROL

Satellite Access Procedures

Purpose :

This document defines the procedures all Earth Stations must follow in order to access Hellas Sat 2 Space Segment.

Customer Access :

In order to transmit to Hellas Sat 2 satellite, an authorization procedure should firstly take place. Customers should originally contact Hellas Sat planning department (planning@hellas-sat.net). After getting authorized, the Network Operations Control can be reached by contacting the Shift Engineer (+302106116090).

Line-Up Procedure :

There is a 10 minute Line-Up time that precedes the start of the booked time. During the access procedure the customer must be ready to go behind specific steps. Particularly, the Shift Engineer will require the following step-by-step sequence to be precisely tagged along:

A) *CHECK-IN :*

1) Check the antenna registration.
2) Check the carrier ID.
3) Confirm the uplink frequency.
4) Confirm the uplink polarization.
5) Confirm the start and finish transmission time (in case of permanent carriers this is not required).

B) *C/W CARRIER TRANSMISSION :*

6) Check that a clean and power reduced carrier is transmitted.
7) Check the correct downlink frequency.
8) Confirm good cross-polarization isolation.

C) *MODULATED CARRIER TRANSMISSION :*

9) Check that a modulated carrier has been rapidly transmitted.
10) Adjust and confirm the level (C/N, EIRP) of the modulated carrier.

D) *CHECK-OUT:*

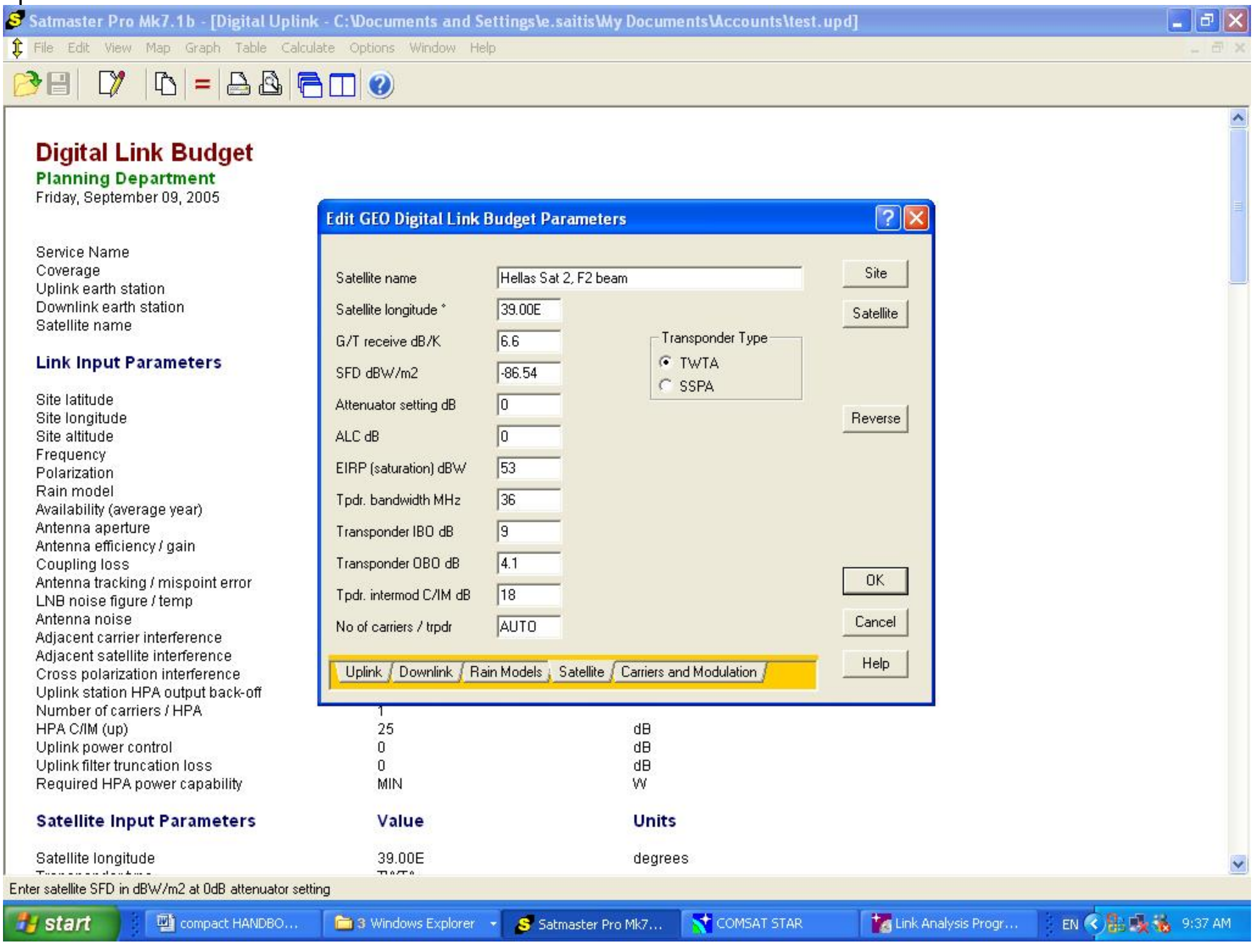
11) Request customer's engineer mobile number.
12) Ask for a "good night" call that indicates the end of the transmission.

ANNEX B

LINK BUDGET EXAMPLE

Example: Link between Athens and London on beam F2 transponder 03, multicarrier operation. Transponder is set on FGM 09.

Picture 2 shows a snapshot from Satmaster indicating the required fields needed from the satellite operator.



G/T and EIRP can be extracted from the coverages provided in Annex C

G/T_{Athens}=6.6dB/K

$EIRP_{London}$=53dBW

SFD can be extracted using equation 1 as follows:

$$SFD_{Athens} = SFD_{Peak} + Aspect\_Correction \Rightarrow$$

$$SFD_{Athens} = SFD_{Peak} + (G/T_{Peak} - G/T_{athens}) \Rightarrow$$

$$SFD_{Athens} = -91.12 + (11.18 - 6.6) \Rightarrow$$

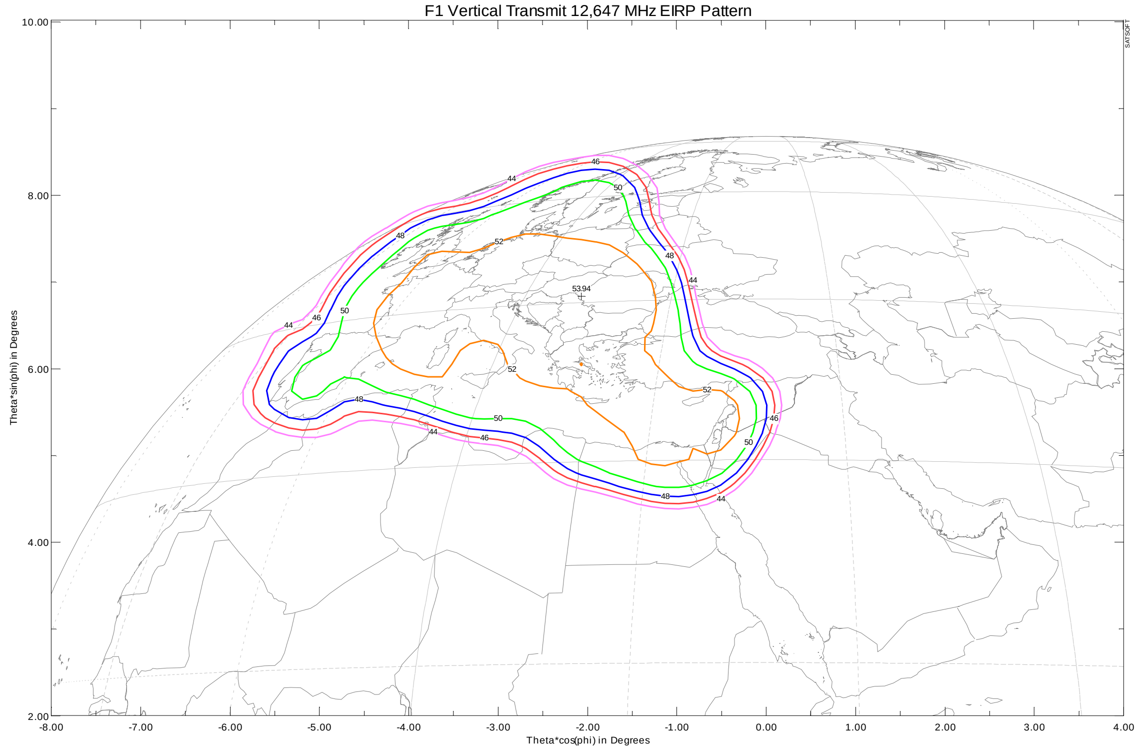
$$SFD_{Athens} = -91.12 + 4.58 = -86.54 \Rightarrow$$

$$SFD_{Athens} = -86.54 dBW / m^2$$

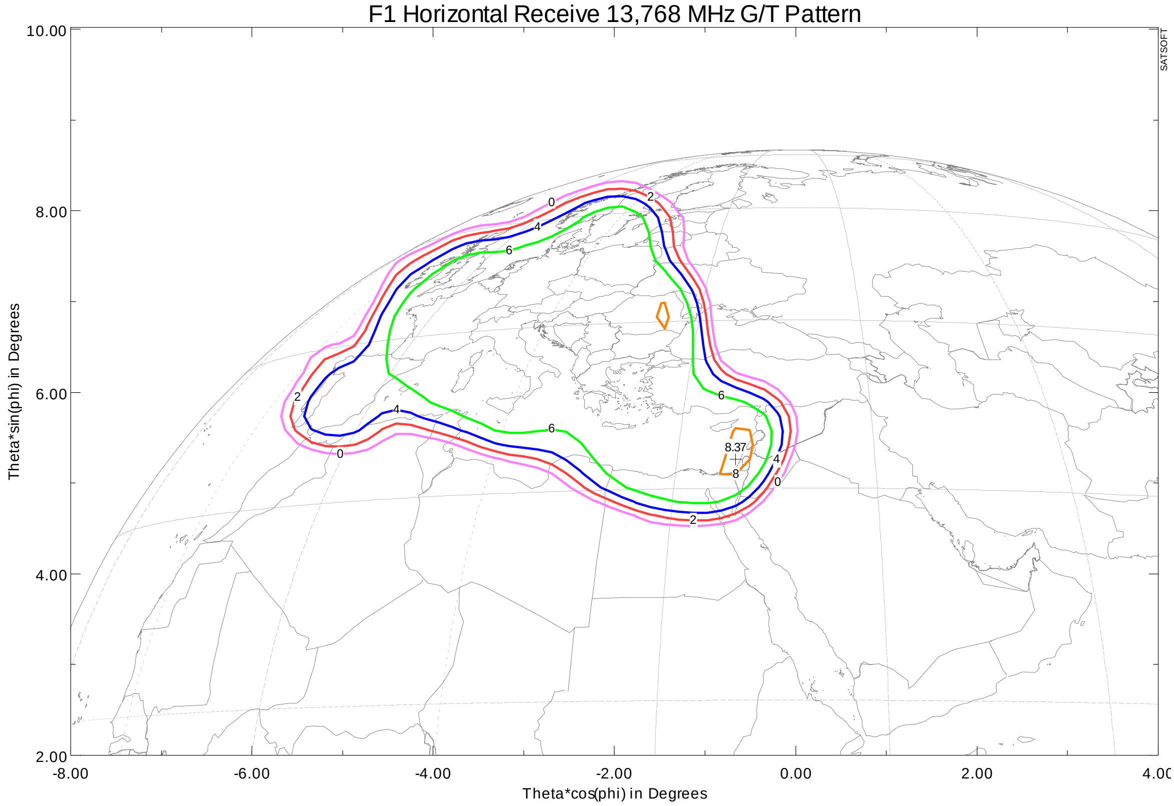
ANNEX C

COVERAGE MAPS

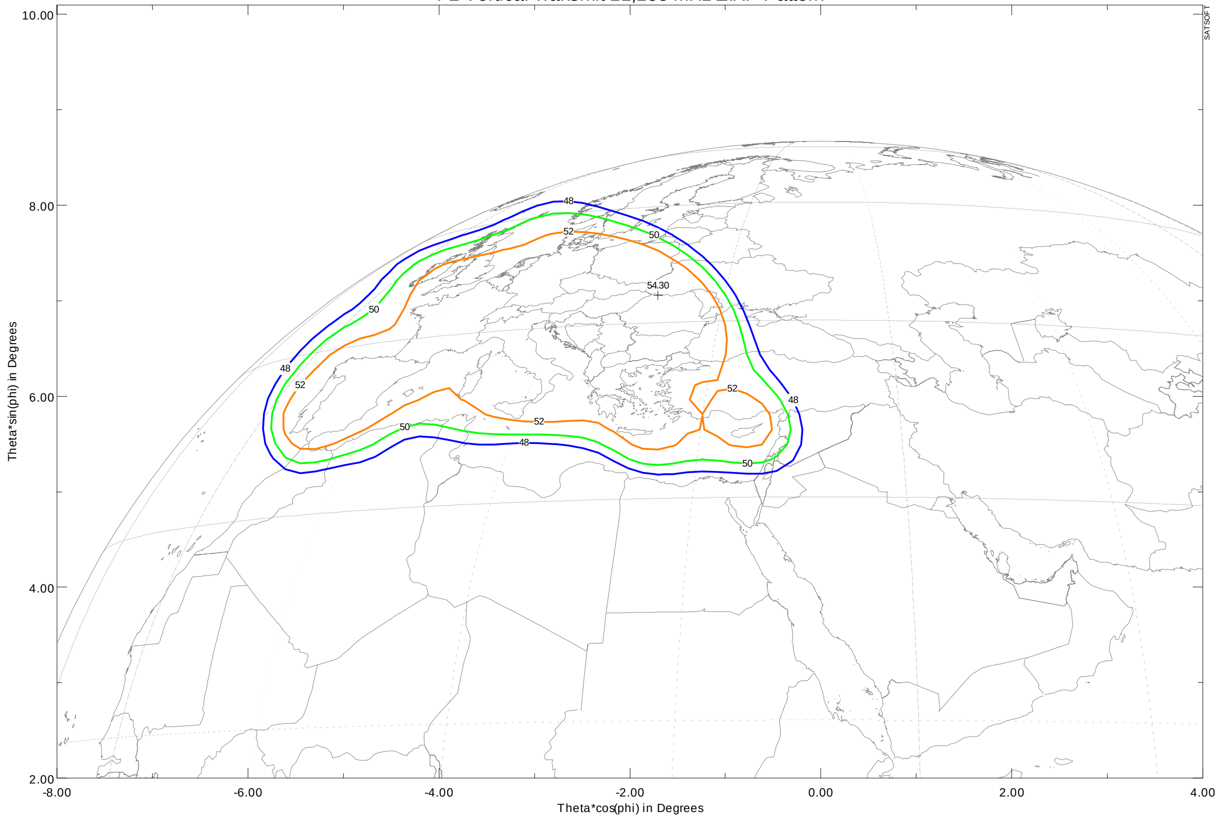
F1 Vertical Transmit 12,647 MHz EIRP Pattern



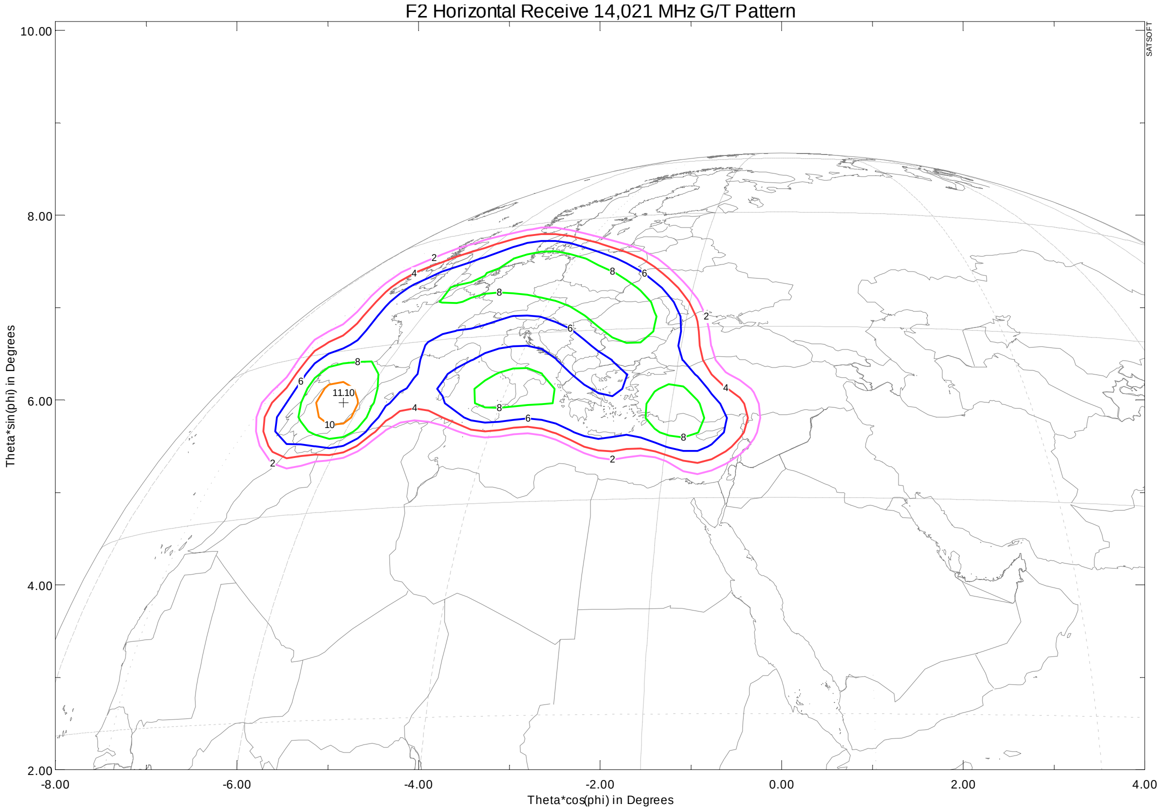
F1 Horizontal Receive 13,768 MHz G/T Pattern



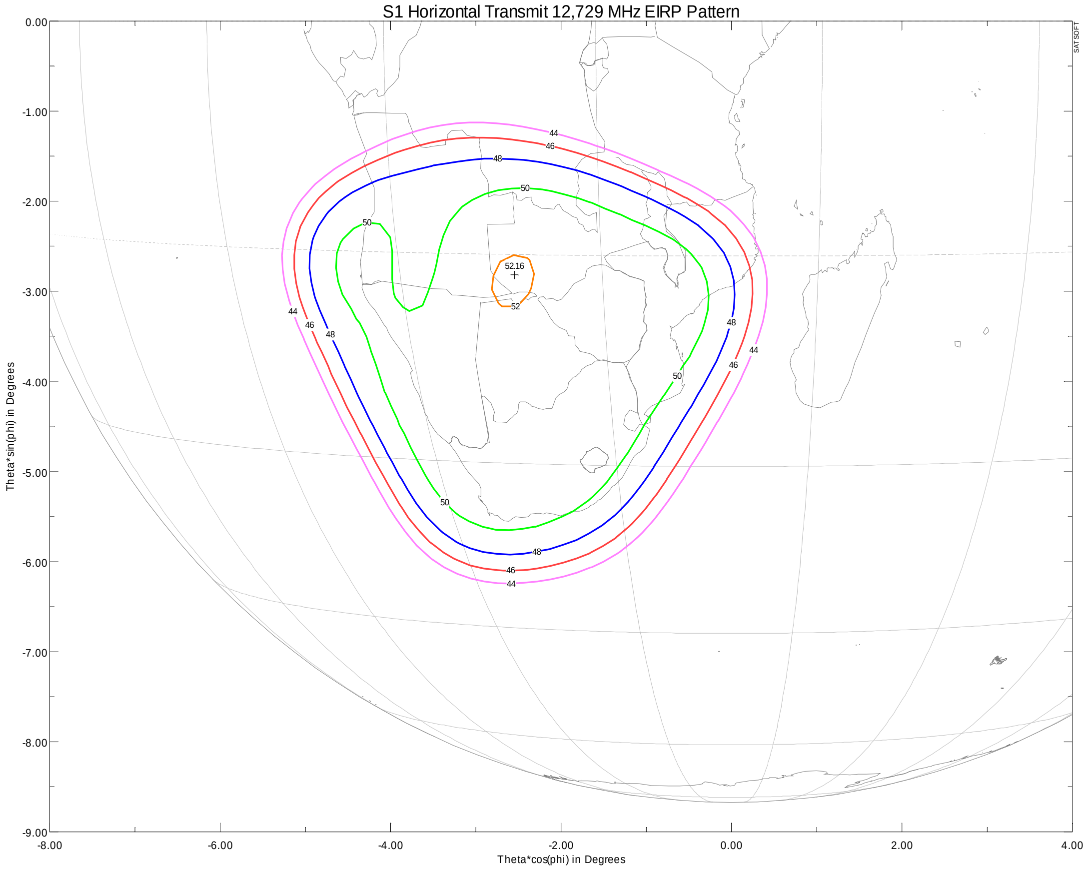
F2 Vertical Transmit 11,135 MHz EIRP Pattern



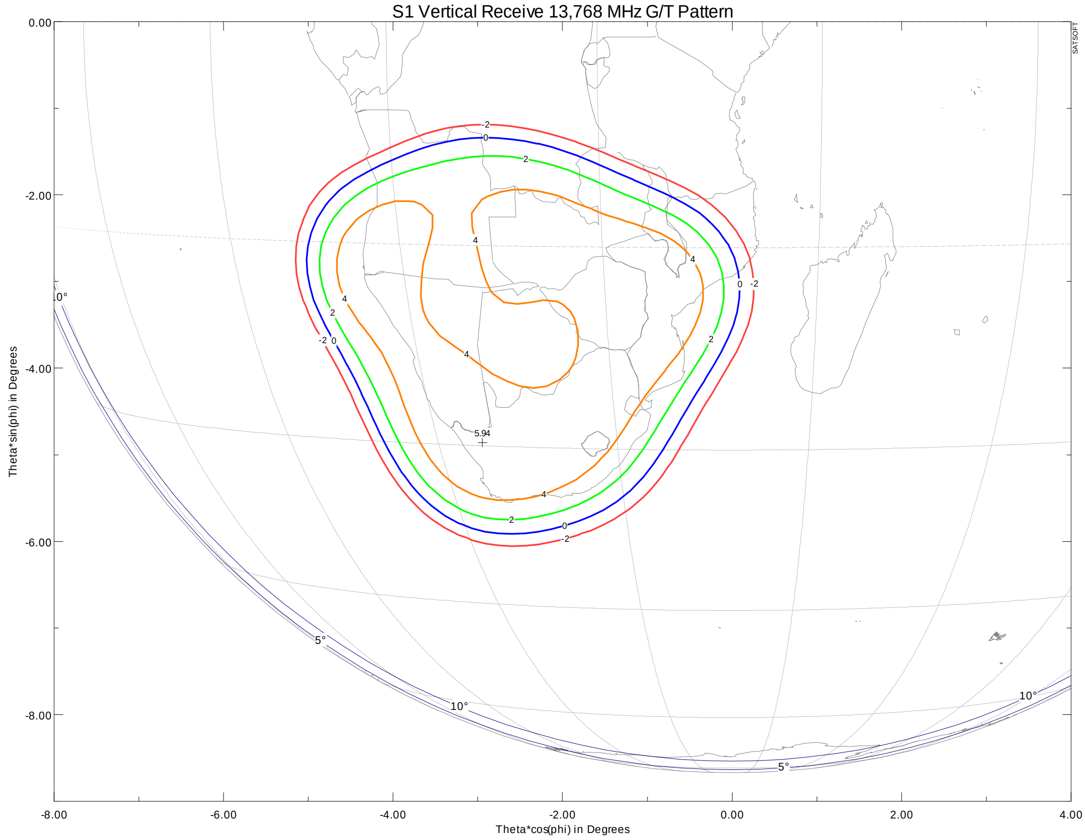
F2 Horizontal Receive 14,021 MHz G/T Pattern

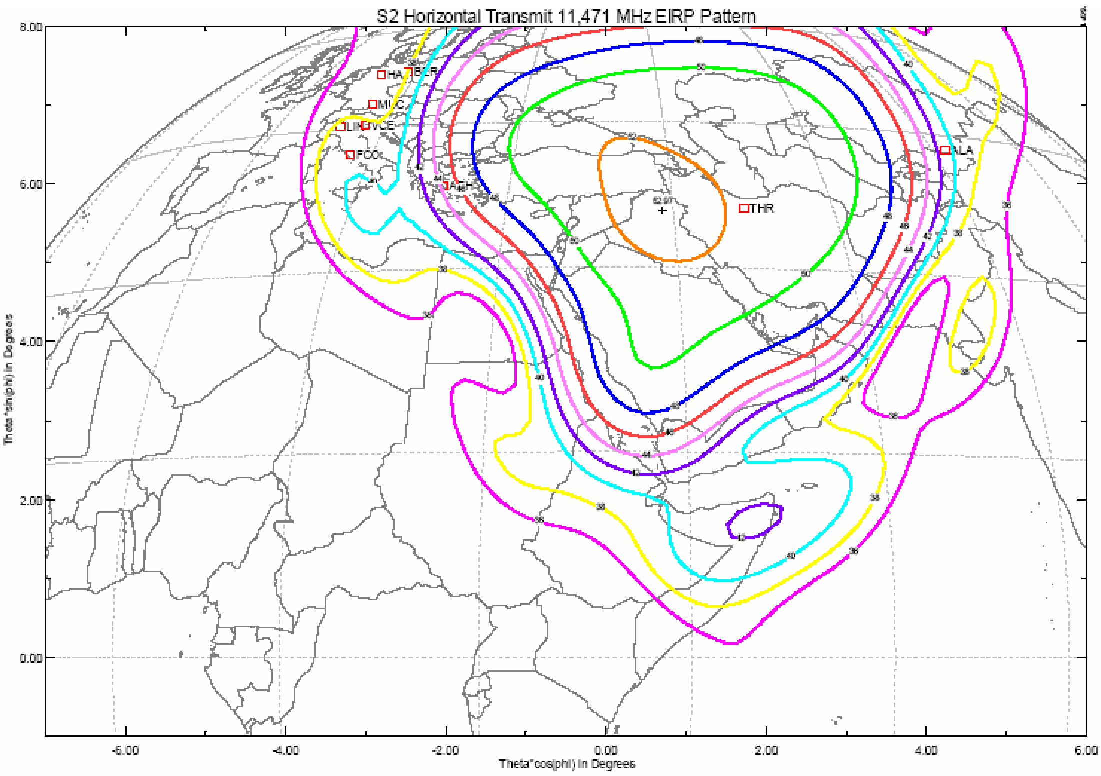


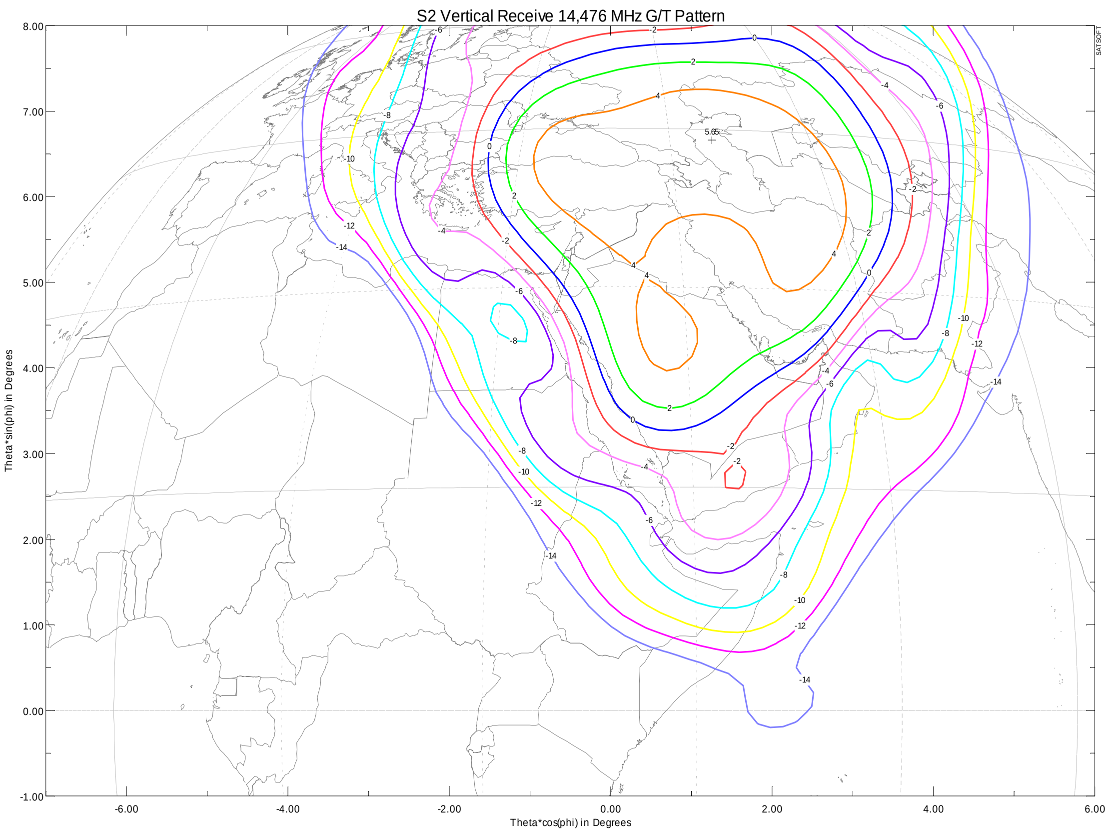
S1 Horizontal Transmit 12,729 MHz EIRP Pattern



S1 Vertical Receive 13,768 MHz G/T Pattern




S2 Horizontal Transmit 11,471 MHz EIRP Pattern
Theta*sin(phi) in Degrees
Theta*cos(phi) in Degrees
THR
ALA


S2 Vertical Receive 14,476 MHz G/T Pattern
Theta*sin(phi) in Degrees
Theta*cos(phi) in Degrees