



## **SUMMARY CHARACTERISTICS OF THE HOT BIRD™ SATELLITES**

This document contains information on the mission, communications features, coverage, frequency plans and implementation of the Hot Bird™ satellites.



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## The HOT BIRD™ Satellite Constellation

### A satellite family for entertainment TV Broadcast

#### Introduction

In April 1994, EUTELSAT placed an order with an international consortium led by Matra Marconi Space for the purchase of a high power broadcast satellite with options for additional satellites. Four Hot Bird™ satellites have been ordered and will be used to triple the previous capacity at 13° East, the satellite position of the Hot Bird™ satellites.

All of the new Hot Bird™ satellite series, Hot Bird™ 2, Hot Bird™ 3, Hot Bird™ 4 and Hot Bird™ 5 satellites, have successfully joined EUTELSAT II-F1 and Hot Bird™ 1 satellite at 13° East and are now in full operation. These satellites provide 20 high power transponders with a minimum operational lifetime of 12 years. (Hot Bird™ 5 satellite provides 22 transponders at the beginning of its operational life).

In October 1999, EUTELSAT ordered a new satellite of the series, Hot Bird™ 6, to be manufactured by Alcatel Space. Hot Bird™ 6 will carry 32 active transponders that provide back-up capacity for all of Hot Bird™ 5 channels and for a set of Hot Bird™ 4 channels. Additionally, Hot Bird™ 6 will provide 4 new channels in the Ka-band.

In June 2000, Eutelsat ordered Hot Bird™ 7, to be manufactured by Astrium. The satellite will provide 40 transponders to back-up Hot Bird™ 2 and Hot Bird™ 3 channels.

The launch dates for the Hot Bird™ (HB) satellites are as follows:

<b>Satellite</b>	<b>Launch Date</b>
<b>HB1</b>	March 1995
<b>HB2</b>	November 1996
<b>HB3</b>	September 1997
<b>HB4</b>	February 1998
<b>HB5</b>	October 1998
<b>HB6 / HB7</b>	1 <sup>st</sup> Quarter 2002



The main characteristics of all the Hot Bird™ satellites are given below.

## **The Hot Bird™ Satellite Mission**

The Hot Bird™ satellite mission is primarily to provide high power analogue and digital transmissions over wide geographical areas from a single orbital position dedicated to entertainment programmes and multimedia services. Compared to the EUTELSAT II series, the Hot Bird™ satellites provide higher power, increased capacity, wider coverage, longer lifetime and a lower cost per channel year.

Hot Bird™ 3 and Hot Bird™ 4 satellites also provide a steerable beam to provide broadcast services over selected geographical regions. Hot Bird™ 4, Hot Bird™ 5 and Hot Bird™ 6 satellites will offer Skyplex digital multi-program services to enable the uplinking of different programmes independently from distributed geographical sites while maintaining a single downlink signal from the satellite.

Hot Bird™ 6 will provide back-up capacity for the FSS band channels in the Ku-band and a set of four new Ka-band channels that can be operated in transparent mode or connected to Skyplex units. These channels will allow for the development of new multimedia services such as micro-TV, IP-Broadcasting, interactive networks (with either meshed or star topology), etc, by means of very small transmit/receive terminals on ground.

Hot Bird™ 7 will provide back-up capacity for the BSS band channels of Hot Bird™ 2 and Hot Bird™ 3. Additionally to the Fixed European Coverage, Hot Bird™ 7 incorporates two steerable beams to provide connections both on the uplink and the downlink.

## **Communications Features**

### **Hot Bird™ 1 Satellite (HB1)**

Hot Bird™ 1 satellite (HB1), the last of the EUTELSAT II series, operates 16 transponders each of 36 MHz usable bandwidth for a satellite lifetime of 11 years.

The HB1 frequency plan, given in Figure 1, has been designed to complement that of EUTELSAT II-F1. There are 16 frequencies in the 12.9-13.25 GHz uplink band and in the 11.2-11.55 GHz downlink band. All 16 HB1 channels are connected to an elliptical receive coverage shown in Figure 2 and to a shaped transmit coverage shown in Figure 3. The transmit coverage is well suited for analogue, digital or mixed (Simulcast) use of the capacity.



## **Hot Bird™ 2 (HB2), Hot Bird™ 3 (HB3), Hot Bird™ 4 (HB4) and Hot Bird™ 5 (HB5) satellites**

The four Hot Bird™ satellites, (HB2, HB3, HB4 and HB5) are each designed to provide 20 high power transponders for an operational lifetime of 12 years. (HB5 has enhanced beginning of life capacity.) Most of the channels have a usable bandwidth of 33 MHz although there are also a number of higher bandwidth channels including primarily 36 MHz and 72 MHz channels.

The HB2 frequency plan in Figure 4 shows a total of 26 channels, 20 of 33 MHz usable bandwidth with centre frequencies of the BSS Plan and 6 FSS channels of 36 MHz and 72 MHz bandwidth.

The HB3 frequency plan in Figure 5 contains 32 channels including the remaining 20 channels in the BSS Plan (all of 33 MHz usable bandwidth except for Channel 88 with a 49.5 MHz bandwidth) and 12 FSS channels of 72 MHz bandwidth (except for Channel 45 shown with a 60 MHz bandwidth). HB2 and HB3 both operate their total capacity in the BSS band.

The HB4 frequency plan in Figure 6 provides a total of 28 channels, all of 33 MHz usable bandwidth except for Channels 111 and 113 of 46.5 MHz and 36 MHz bandwidth respectively. In addition to the 8 channels in the BSS band and 7 channels in the 12.5-12.75 GHz downlink band, HB4 provides 13 channels in the 10.7-10.95 GHz downlink frequency band.

With HB4 joining the constellation at 13° East in March 1998, the complete downlink spectrum from 10.7 to 12.75 GHz was filled and a total of 92 channels could be operated, 16 on each of EUTELSAT II-F1 and HB1 and 20 on each of HB2, HB3 and HB4.

HB5 replaced EUTELSAT II-F1 at 13° East in November 1998. Its frequency plan is shown in Figure 7. Thus, its 22 channels occupy the same uplink and downlink bands as the EUTELSAT II satellites. The channels in the 11.45-11.7 GHz and 12.5-12.75 GHz downlink bands are of 33 MHz usable bandwidth while those in the 10.95-11.2 GHz band are of 36 MHz and 72 MHz usable bandwidth.

Pre-assigned channel selectivity, to determine which 20 channels are operated, is used on each of HB2, HB3, and HB4. This enables an identical 14-for-10 channelized section redundancy ring per polarization to be used on these satellites. The HB5 redundancy rings have been slightly modified enabling the operation of all 22 channels at beginning of life and any 10 of 11 channels per polarization thereafter. The HB2, HB3 and HB4 use the same receive coverage shown in Figure 11. Note that this coverage spans the 13.75-18.4 GHz band. The HB5 receive coverage given in Figure 12 offers continuity to EUTELSAT II-F1.



There are two transmit coverages, the higher power Superbeam coverage shown in Figure 13 and the Widebeam coverage given in Figure 14. All channels on each satellite can be connected to either coverage on a channel-by-channel basis.

HB3 and HB4 have a transmit circular steerable beam for which an example coverage is shown in Figure 15. Eight channels on each satellite identified by cross-hatching on their respective frequency plans (Figures 5 and 6) are switchable to the steerable beam on a channel-by-channel basis.

### **Hot Bird™ 6 Satellite (HB6)**

Hot Bird™ 6 satellite (HB6), operates 32 transponders with usable bandwidths of 33, 36 and 72 MHz for a satellite lifetime of 12 years.

The HB6 frequency plan is given in Figure 8 and has been designed with three objectives:

- To provide full back-up capacity of Hot Bird™ 5 frequency plan. Additional capacity has been included splitting the former 72 MHz channels of Hot Bird™ 5 into two 36 MHz channels.
- To provide four additional channels (115, 116, 117 and 118) in the 10.70-10.95 GHz band. The frequency of these channels reuses the corresponding Hot Bird™ 4 channels on the downlink, while the uplink is implemented in the 13.75-14.00 GHz band. Therefore these four channels can be used for two purposes: either as a back-up capacity of the corresponding Hot Bird™ 4 channels over the European coverage, or as an extra capacity that will permit to release channels 115, 116, 117 and 118 of Hot Bird™ 4 from the European coverage to be used through the Hot Bird™ 4 steerable beam. The steerable beam will be used outside the European coverage area on the downlink, while the uplink can still be operated from the European coverage.
- To provide four new Ka-band channels in the band 29.50-30.00 GHz on the uplink and 19.70-20.20 GHz on the downlink. These channels can be operated either in transparent mode or connected to the Skyplex units. In transparent mode the channels offer an usable bandwidth of 72 MHz while when operated with the Skyplex units the downlink bandwidth is 33 MHz. It will be possible to cross-connect the Ka-band channels with channels 153, 154, 158 and 159 in Ku-band, independently on the uplink and the downlink, on a channel by channel basis.

There is one receive coverage and a single transmit coverage in Ku-band, as shown in Figures 16 and 17 respectively. All Ku-band channels are connected to these coverages.



The Ka-band receive coverage is formed by a cluster of four elliptical beams, each one of them connected to one of the four Ka-band channels on the uplink. All four channels are connected to a common downlink coverage. The Ka-band receive and transmit coverages are shown in Figures 18 and 19, respectively. It is possible to cross-connect the Ku-band coverage and the Ka-band coverage by couples of channels as follows: channels 153/K153, 154/K154, 158/K158 and 159/K159. The cross-connection can be established independently on the uplink and the downlink, on a channel by channel basis. The connection of the complementary channel pair will be performed by default.

### **Hot Bird™ 7 Satellite (HB7)**

Hot Bird™ 7 is designed to provide up to 40 high power transponders for an operational lifetime of 12 years. It carries 39 channels with an usable bandwidth of 33 MHz and one channel with an usable band of 49.5 MHz. All channels are allocated in the BSS band. The HB7 frequency plan is shown in Figure 9.

The European Receive Coverage of Hot Bird™ 7 is shown in Figure 20. Figure 21 shows an illustration of the SuperWidebeam coverage in transmission. Additionally, the satellite carries two identical elliptical Steerable beams that can be pointed anywhere over the visible earth from the satellite orbital position. Figure 22 shows an illustration of the Steerable beams coverage.

The channels have the following connectivity:

Channels E21 to E40 shall be connected to the SuperWidebeam Coverage on both uplink and downlink

Channels E1 to E20 shall be connected to two Steerable Beams (1 and 2). Channels E1 to E20 can be switched channel by channel on the uplink between either of the two beams while on the downlink channels E1 to E10 shall be routed via Steerable Beam 1 and channels E11 to E20 shall be routed via Steerable Beam 2.

Following the replacement of Hot Bird™ 5 by Hot Bird™ 6, the planned operated channels will be those shown in Figure 10. A maximum of 104 transponders could be operated in the Ku-band including 16 on HB1, 20 on each of the HB2, HB3 and HB4 as well as 28 on HB6. Additionally four Ka-band channels will be available, which will increase the total Hot Bird™ fleet capacity to 108 transponders.



## **Skyplex**

Skyplex system operation has been demonstrated on Hot Bird™ 4 satellite and the commercial service has been introduced on Hot Bird™ 5 satellite. Eight more Skyplex units will be available with Hot Bird™ 6. Channel 110 on Hot Bird™ 4 satellite and Channels 91 and 92 on Hot Bird™ 5 satellite are configured for Skyplex services.

On Hot Bird™ 6 Channels 91, 92, 93 and 156 will offer Skyplex services in the Ku-band. Additionally, four more units can be used either with the channels K153, K154, K158 and K159 in the Ka-band or with channels 153, 154, 158 and 159 in the Ku-band (see Figure 8). The selectivity of the channels that will be connected to the Skyplex units can be done independently on the uplink and the downlink, on a channel by channel basis.

The Skyplex distributed uplink broadcast service system architecture is shown in Figure 23. Skyplex operation is in accordance with the DVB-S (Digital Video Broadcast - Satellite) standard established by ETSI (European Telecommunications Standards Institute). Basically Skyplex performs various signal processing functions on the satellite, so that for DVB-S compliant IRDs (Integrated Receiver Decoders), the Skyplex downlink signal received from the satellite has an identical format to another DVB multiplex assembled on the ground.

Skyplex signal processing has been optimized for operation with low cost uplink stations compatible with SNG (Satellite News Gathering) equipment. The uplink station performs outer coding, scrambling and QPSK modulation while the on-board Skyplex unit performs demodulation, descrambling, multiplexing, scrambling, interleaving, inner coding and QPSK modulation.

Satellite access can be either in SCPC (Single Channel per Carrier) mode or in TDMA (Time Division Multiple Access) mode. Hot Bird™ 4 satellite carries a single unit which can receive and demodulate 6 independent carriers, each with a useful bit-rate of about 6 Mbit/s. The downlink symbol rate is fixed at 27.5 Msymb/s and saturates the TWTA of Channel 110 whose bandwidth is 33 MHz.

For the Hot Bird™ 4 satellite, three of the six Skyplex channels can be configured by ground command to operate in TDMA mode. Each of these channels can be shared by 2, 3, 4 or 6 uplink stations enabling satellite direct access by stations with capacities as low as about 1 Mbit/s.





The Hot Bird™ 5 satellite carries 3 Skyplex units, each of which may use one of two pre-assigned satellite channels amongst Channels 90, 91 and 92. These Skyplex units have the same basic architecture as those of Hot Bird™ 4 satellite but have increased flexibility. Thus, the Hot Bird™ 5 satellite can receive up to 8 channels and offers lower access rates in both SCPC and TDMA. In TDMA mode, as many as 6 stations can access the 2 Mbit/s carriers resulting in bit rates as low as 350 kbit/s. Hence, applications such as low rate datacasting and sound broadcasting will be feasible with small earth terminals.

The Hot Bird™ 6 satellite carries nine operative Skyplex units (with up to eight active units). The characteristics of the Hot Bird™ 6 Skyplex are similar to the units embarked on Hot Bird™ 5 with the additional capability to receive up to 18x2 Mbit/s channels. The unit operated through channel 156 will have an improved weight and power consumption figures.

Skyplex has been developed by EUTELSAT and ESA and built by Alenia Aerospazio.

## Beacons

The EUTELSAT Satellite Control Centre performs in-orbit operations. Each satellite provides a beacon, B1, which may be used for tracking purposes, on one of two X-polarized frequencies (selectable by ground command) as shown immediately below. The underlined frequency is nominally active. HB3 has a second beacon, B2, at 12500 MHz, X-polarized.

	<b>HB1</b>	<b>HB2</b>	<b>HB3 / HB7</b>	<b>HB4</b>	<b>HB5</b>	<b>HB6</b>
Beacon B1/(TM+RG) (MHz)	11 450.350, <u>11 449.610</u>	<u>11 702.200,</u> 11 703.400	<u>11 702.800,</u> 11 704.000	<u>11704.600,</u> 11705.800	11 699.800, <u>11701.000</u>	<u>11 700.400,</u> 11701.600

Additionally, HB6 will provide a Ka-band beacon at 19.701,00 GHz.

## Satellite Implementation

The Hot Bird™ 1 satellite, the last of the EUTELSAT II series (EUTELSAT II F-6), was produced by a European consortium headed by Aerospatiale of France as prime Contractor,



Matra Marconi UK responsible for the repeater, Alcatel Espace of France responsible for the antennas and DASA of Germany and Alenia Aerospazio of Italy responsible for various platform subsystems.

HB1 uses the same platform as the other EUTELSAT II satellites but with improved repeater technology and simplified repeater and antenna requirements. This enables the operation of higher power TWTAs (70W as against 55W) and provides a significant improvement in estimated stationkeeping lifetime (11 years as against 8.5 to 9 years) compared with previous EUTELSAT II satellites.

The Hot Bird™ 2, Hot Bird™ 3, Hot Bird™ 4 and Hot Bird™ 5 satellites were built by Matra Marconi Space based in France and the UK. The prime interface as well as satellite integration and test is with the Matra Marconi Space based in Toulouse, the communications repeater is delivered by Matra Marconi Space based in Portsmouth while the antennas are built by Matra Marconi Space based in Stevenage. The bus subsystems are furnished by Matra Marconi Space Toulouse and Stevenage. Hot Bird™ 7 is manufactured by Astrium, an industrial consortium joined by MMS and DASA.

The satellite design is compatible with the Ariane 4/5 family launched from Kourou, the Atlas II series launched from Cape Canaveral and Proton launched from Baikonur.

The Hot Bird™ 2, Hot Bird™ 3, Hot Bird™ 4 and Hot Bird™ 5 satellites are based on the three-axis stabilized EUROSTAR 2000 PLUS platform. Typical of the series, the Hot Bird™ 3 satellite is shown in its on-orbit configuration in Figure 24 with solar panels and side-mounted transmit communications antennas deployed. These 2.3 m diameter antennas, which provide the Superbeam and Widebeam coverages, are gridded and shaped. The top-mounted receive antenna also uses gridded and shaped reflectors. The top-mounted transmit steerable antenna uses conventional gridded technology and its circular footprint may be steered anywhere over the visible earth.

The satellite is modular in concept with the service module housing the platform subsystems including the propellant and pressurant tanks, the latter located in the main load-bearing central cylinder. The North/South walls and the earth facing panels constitute the communications module and accommodate the repeater equipment.

The Hot Bird™ 6 satellite is built by an international consortium led by Alcatel Space of France as the prime contractor and includes DASA of Germany and Alenia Aerospazio of Italy as the main subcontractors. Alcatel Space will provide various platform subsystems as well as satellite integration and test and launch site activities. DASA will manufacture the solar array, attitude control and propulsion subsystems. Alenia Aerospazio will deliver the RF



portion of the TCR subsystem and the Skyplex units. Space Systems/Loral will provide the communications repeater.

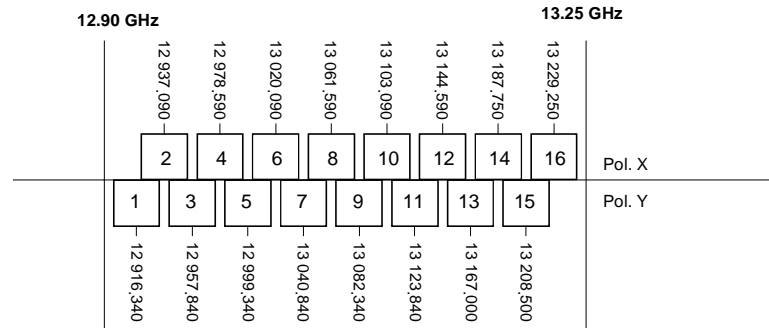
The satellite design is compatible with the Ariane 4/5 family launched from Kourou, the Atlas III series launched from Cape Canaveral, Proton launched from Baikonur and Sea Launch services (maritime platform launcher).

The Hot Bird™ 6 is based on the three axis stabilized SPACEBUS 3000 platform.

The satellite is modular in concept with the service module housing the platform subsystems and the central cylinder accommodating the propellant tanks. The North/South walls and the earth facing panel house the communications equipment. The attitude and orbit control subsystem provides inclined orbit, extended lifetime operation. The EUTELSAT Satellite Control Centre will perform the on-station operations.



UP- LINK



DOWN- LINK

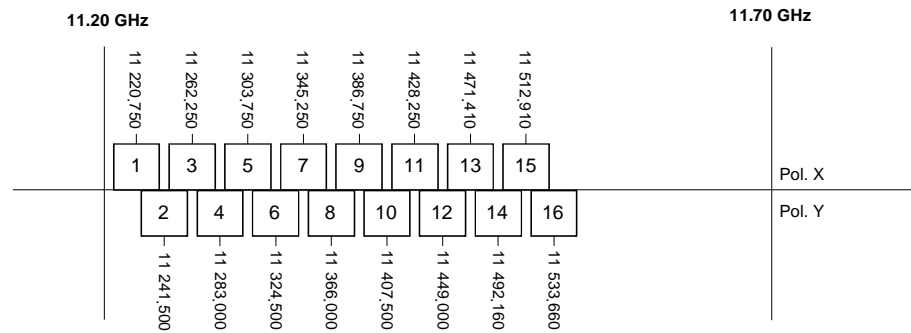
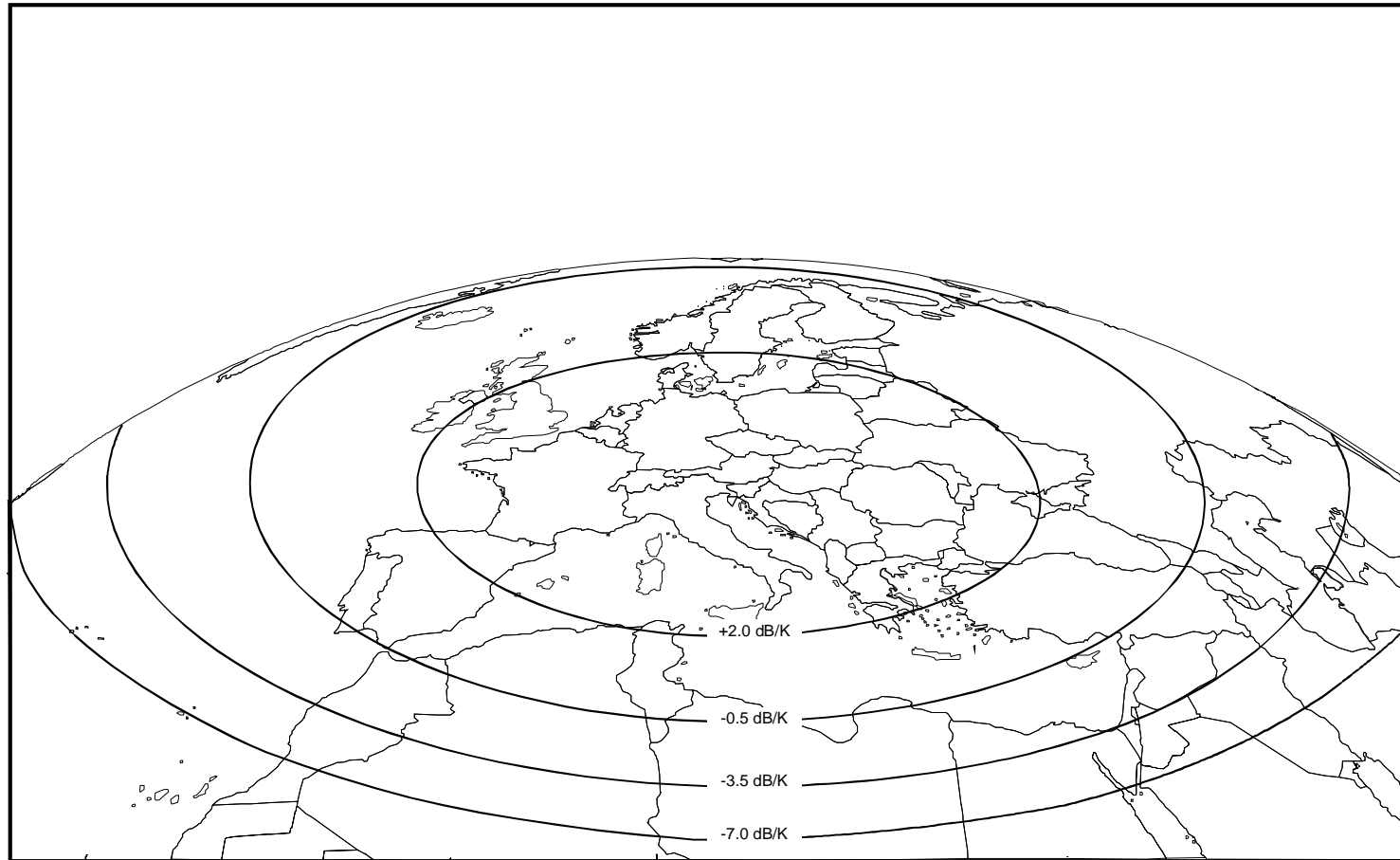
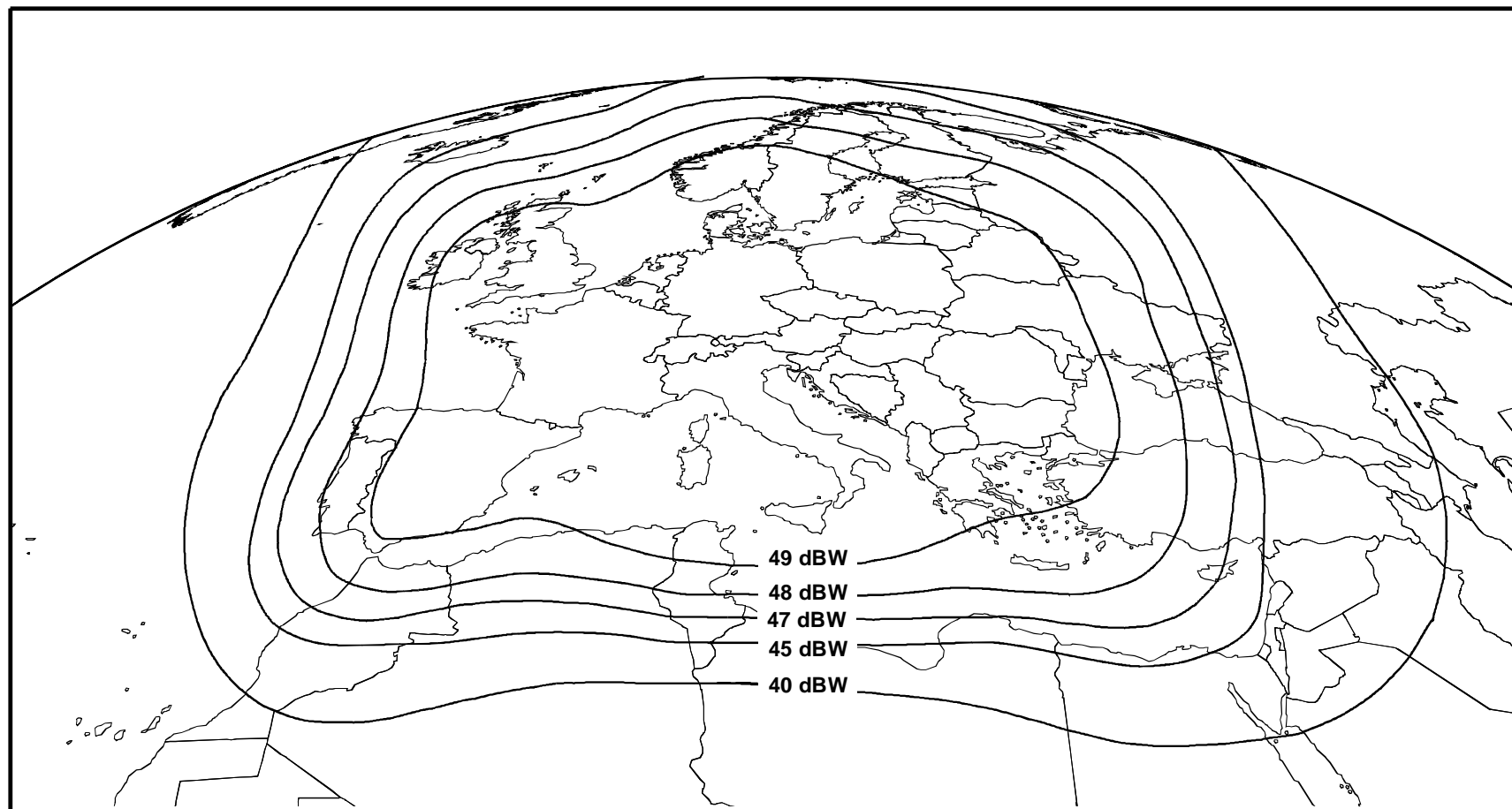


Figure 1. Hot Bird™ 1 Satellite Frequency Plan (Frequencies in MHz)



HB/96/001

Figure 2. Hot Bird™ 1 Satellite Receive Coverage

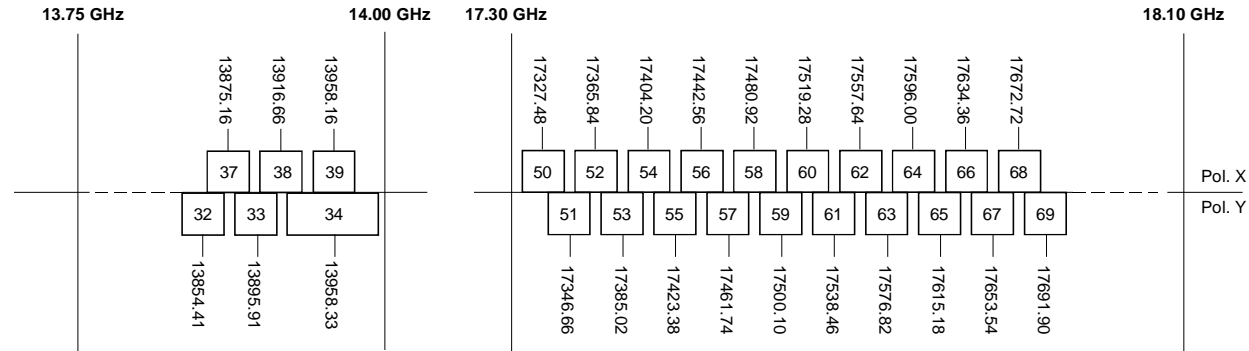


HB/96/002

Figure 3. Hot Bird™ 1 Satellite Transmit Coverage



UPLINK



DOWNLINK

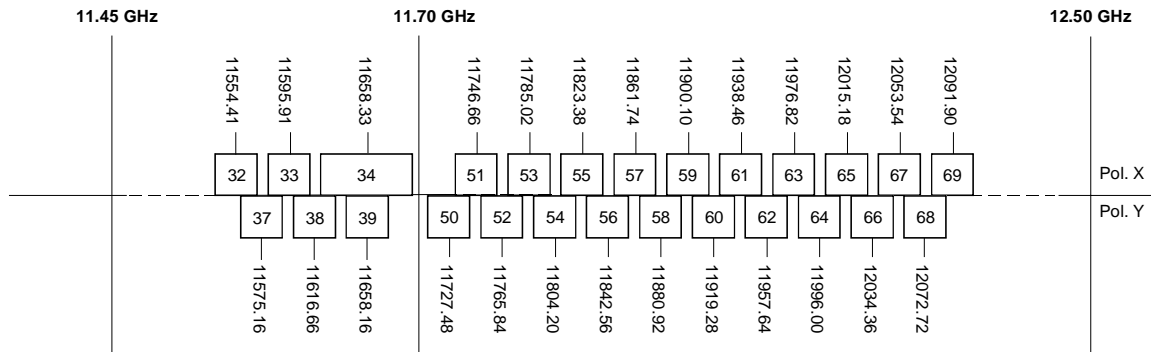
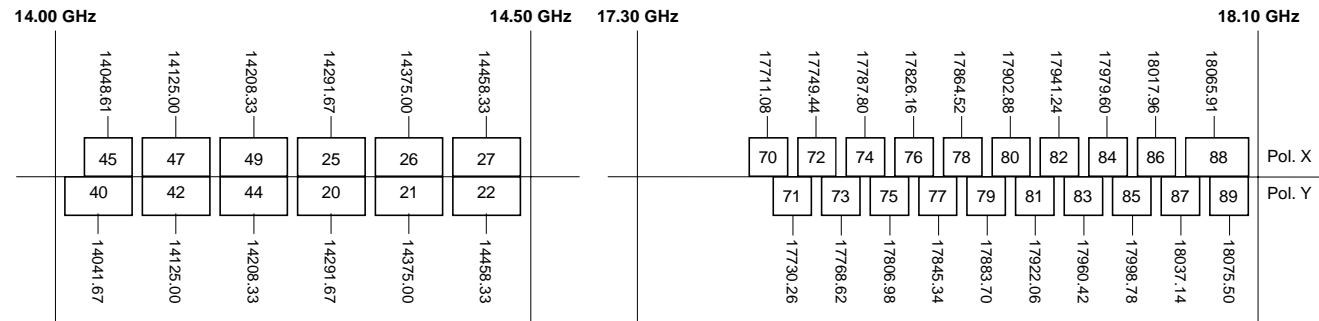


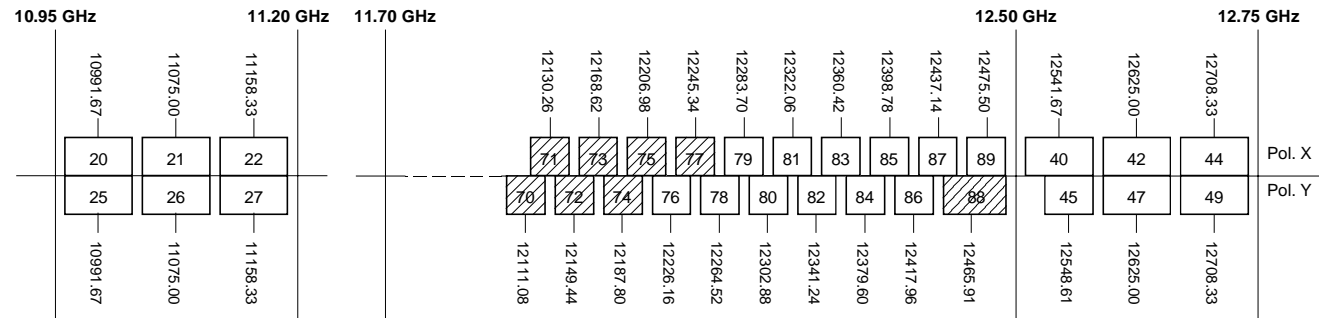
Figure 4. Hot Bird™ 2 Satellite Frequency Plan (Frequencies in MHz)



**UPLINK**



**DOWNLINK**



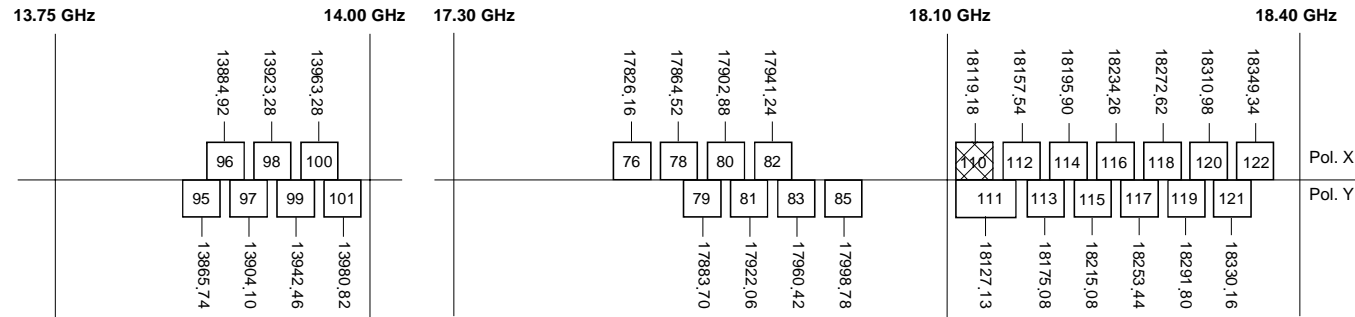
- Widebeam or Superbeam (channel-by-channel)
- Widebeam or Superbeam or Steerable (channel-by-channel)

**Figure 5. Hot Bird™ 3 Satellite Frequency Plan (Frequencies in MHz)**

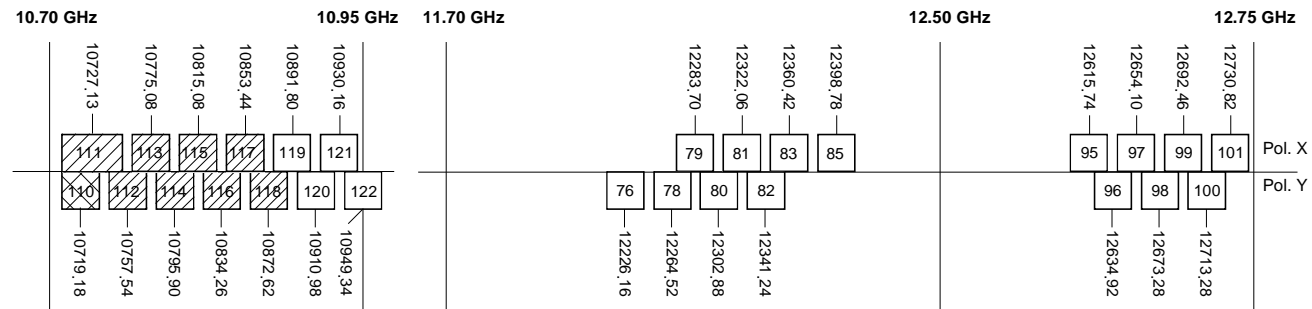







**UPLINK**



**DOWNLINK**

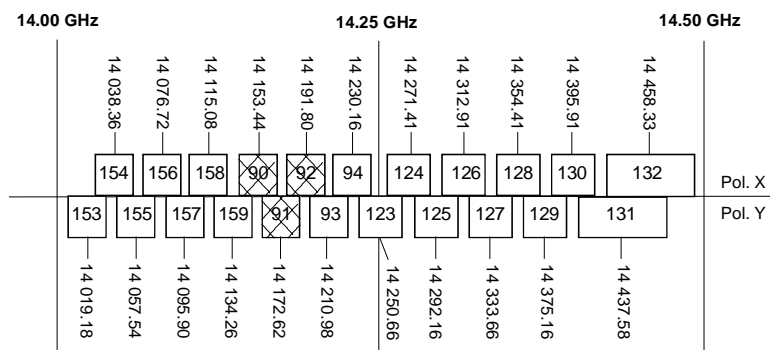


-  Widebeam or Superbeam (channel-by-channel)
-  Widebeam or Superbeam or Steerable (channel-by-channel)
-  Skyplex or transparent operation

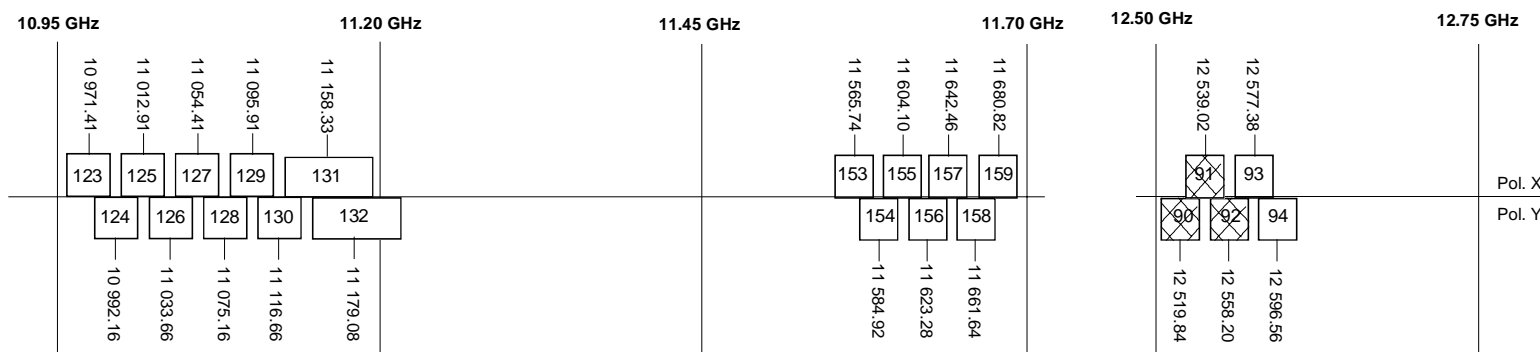
**Figure 6. Hot Bird™ 4 Satellite Frequency Plan (Frequency in MHz)**



UPLINK



DOWNLINK



Skyplex or transparent operation

Figure 7. Hot Bird™ 5 Satellite Frequency Plan (Frequency in MHz)



UPLINK

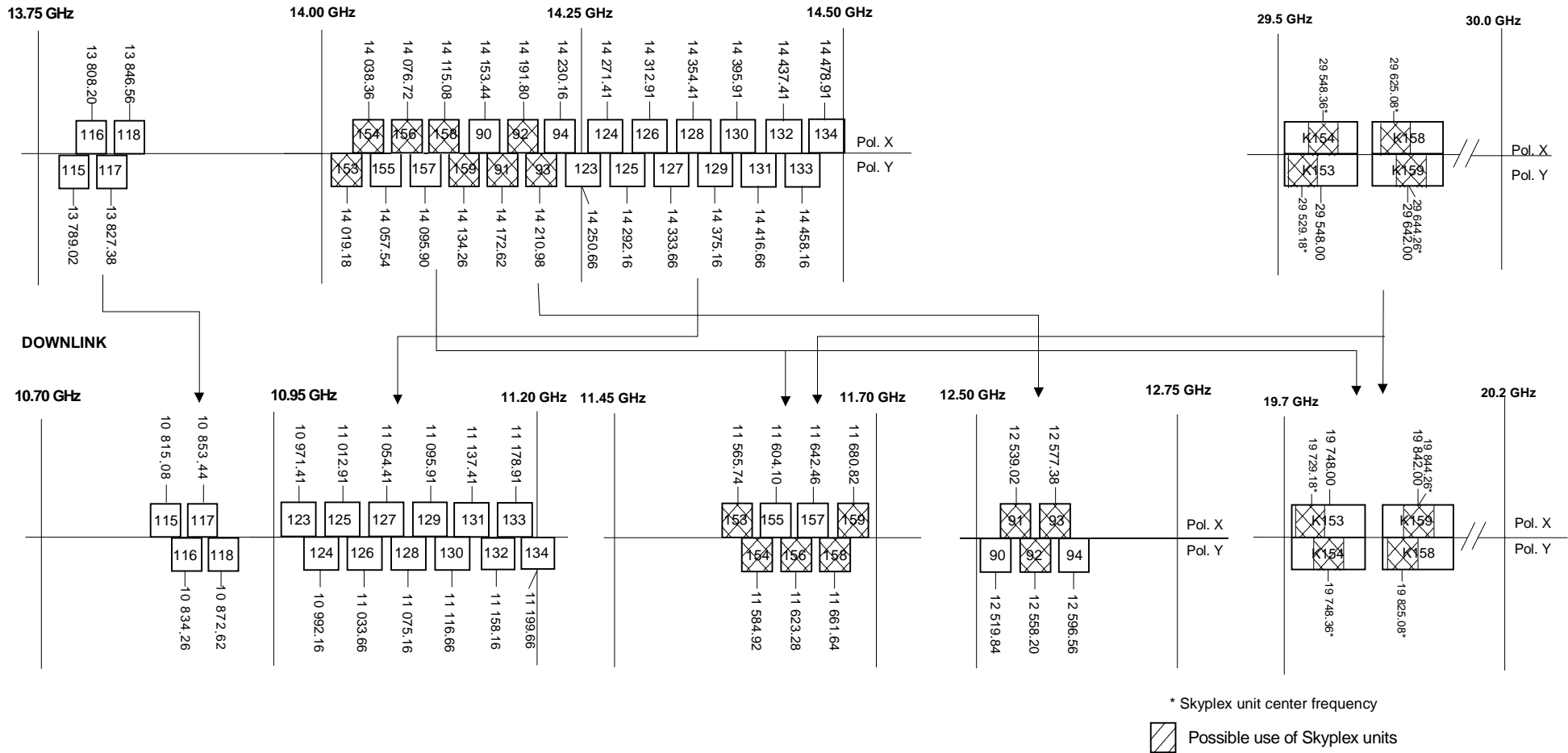
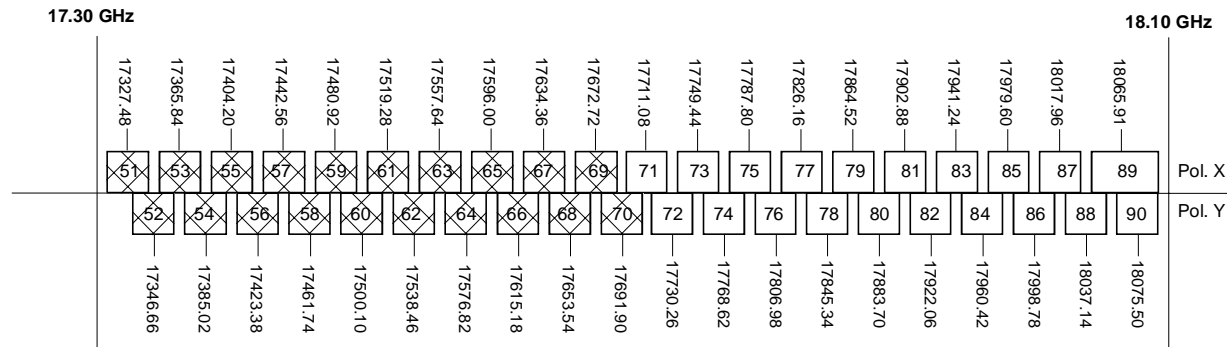


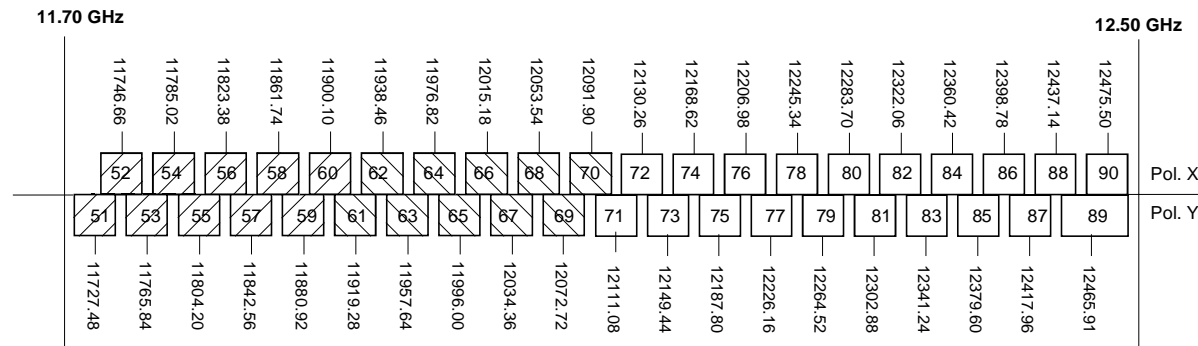
Figure 8 . Hot Bird™ 6 Satellite Frequency Plan (Frequency in MHz)



UPLINK



DOWNLINK



- SuperWidebeam (channels E21 to E40)
- Steerable1 on the downlink, any steerable on the uplink (channel-by-channel)
- Steerable2 on the downlink, any steerable on the uplink (channel-by-channel)

All channels have a 33 MHz bandwidth, except channel 39 (49.5 MHz)

Figure 9 . Hot Bird™ 7 Satellite Frequency Plan (Frequency in MHz)

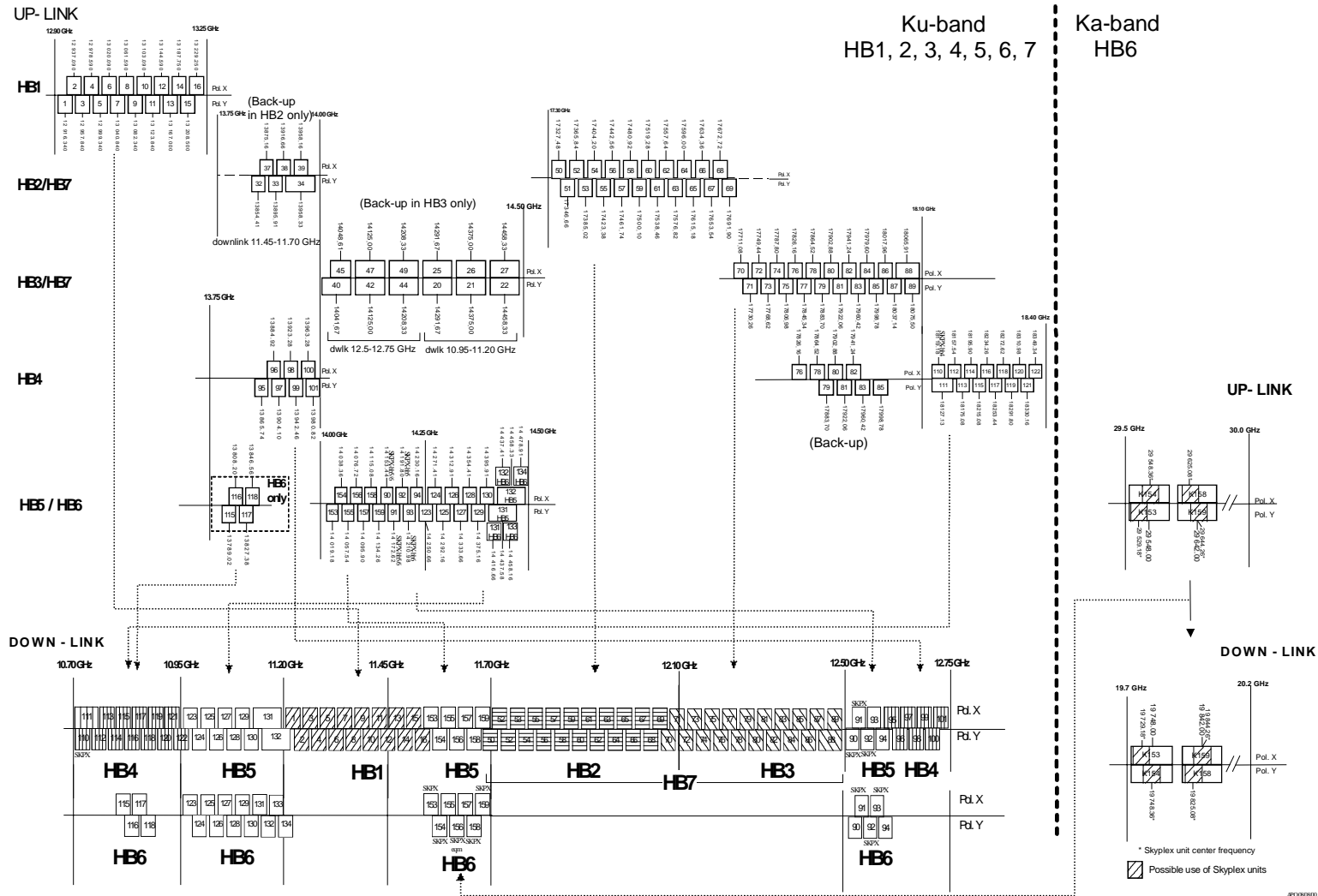
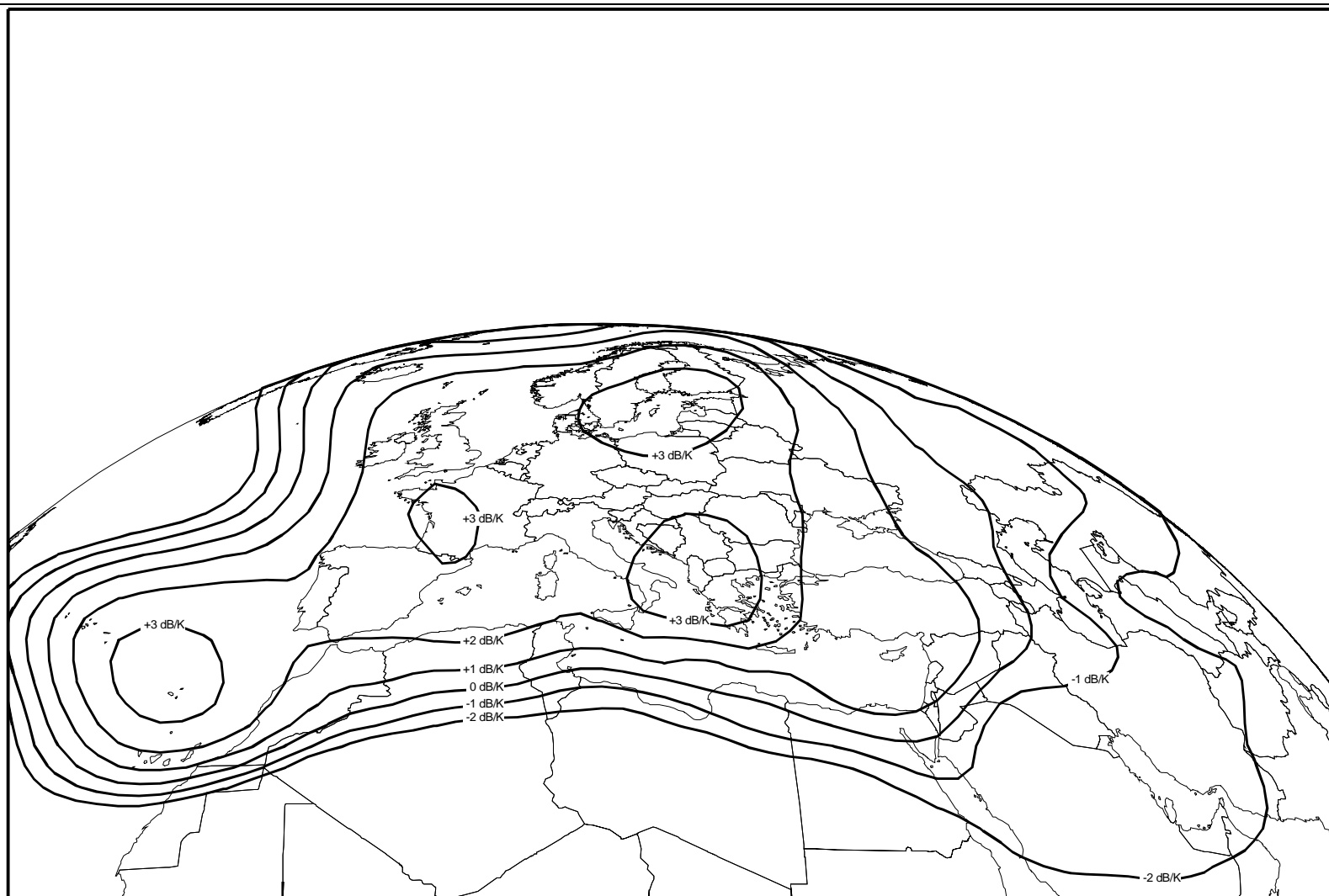
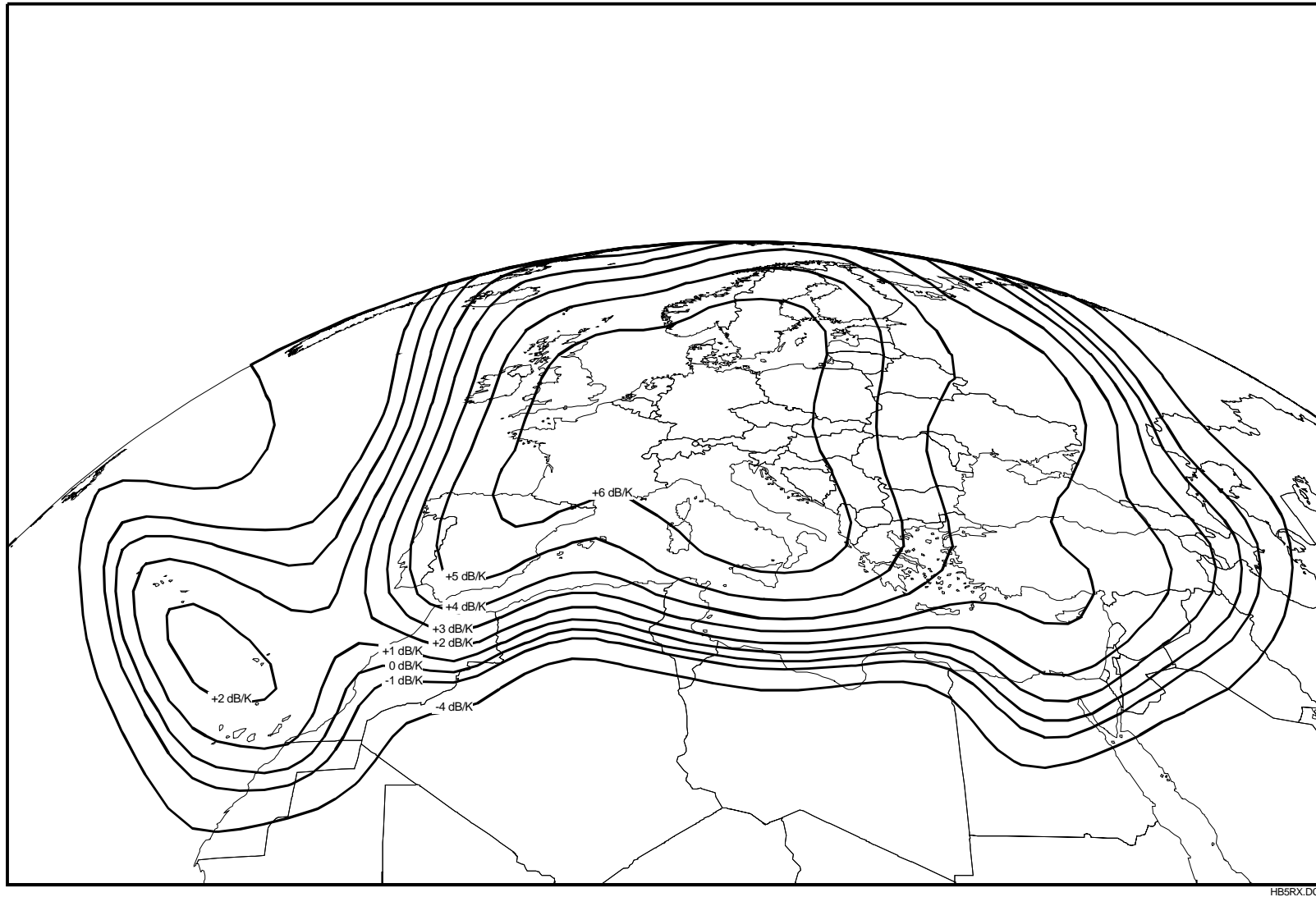


Figure 10 . Frequency Plan for Hot Bird™ 1, Hot Bird™ 2, Hot Bird™ 3, Hot Bird™ 4, Hot Bird™ 5, Hot Bird™ 6 and Hot Bird™ 7 satellites.



HB3RX.DC

Figure 11 . Hot Bird™ 2, Hot Bird™ 3 and Hot Bird™ 4 Satellites Receive Coverage



HB5RX.DOC

Figure 12. Hot Bird™ 5 Satellite Receive Coverage

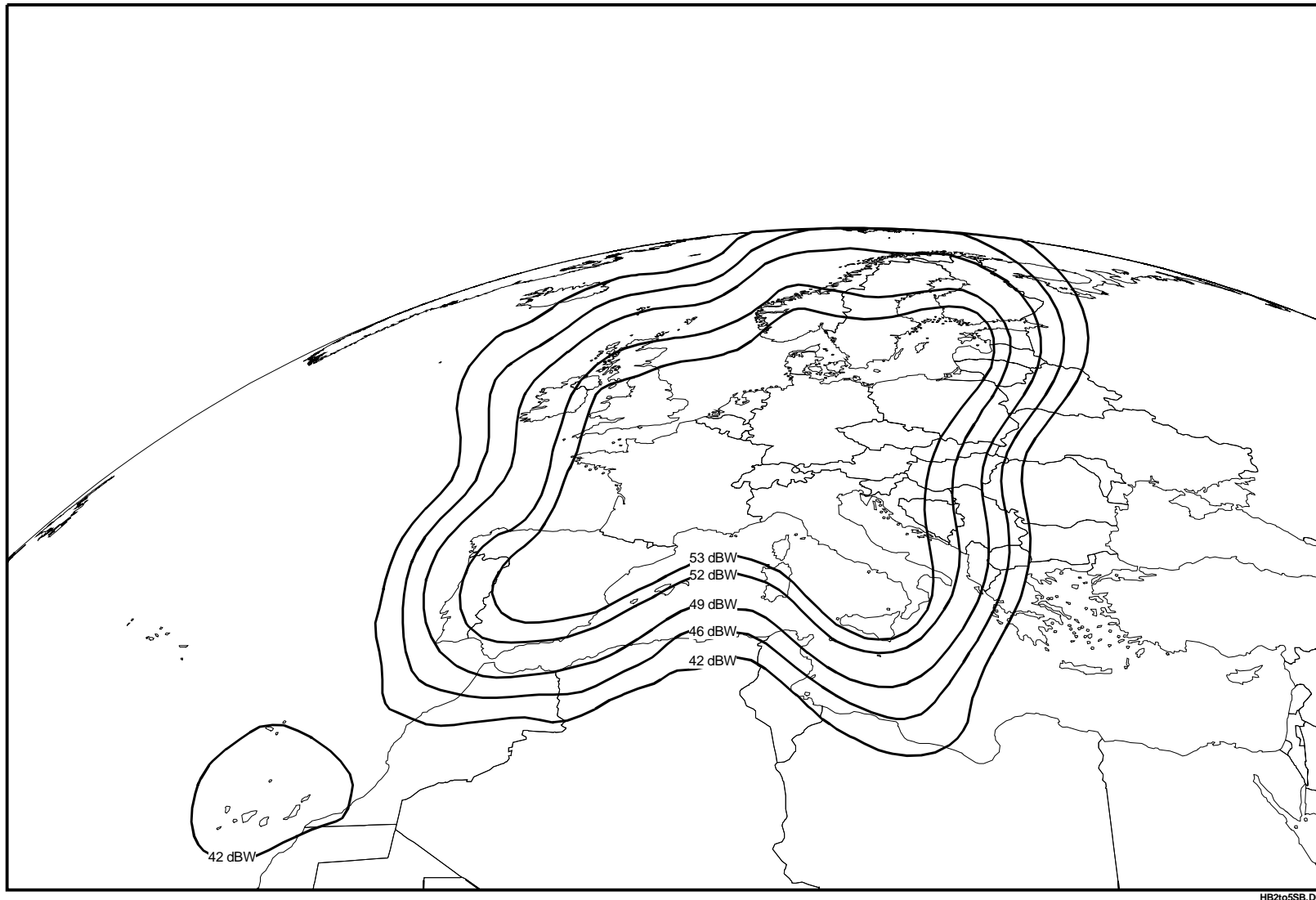


Figure 13. Hot Bird™ 2, Hot Bird™ 3 , Hot Bird™ 4 and Hot Bird™ 5 Satellites Superbeam Transmit Coverage



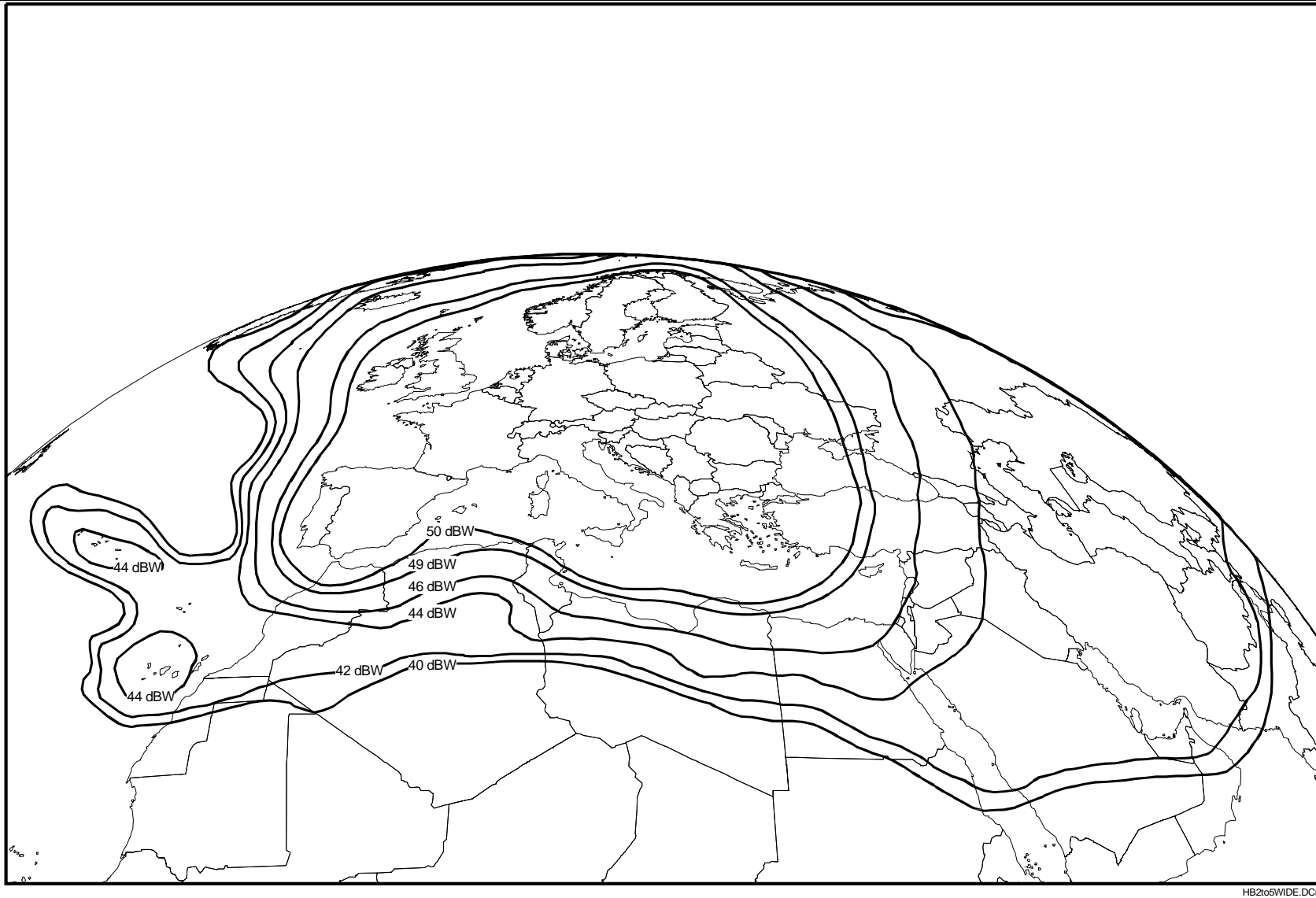


Figure 14. Hot Bird™ 2, Hot Bird™ 3, Hot Bird™ 4 and Hot Bird™ 5 Satellites Widebeam Transmit Coverage

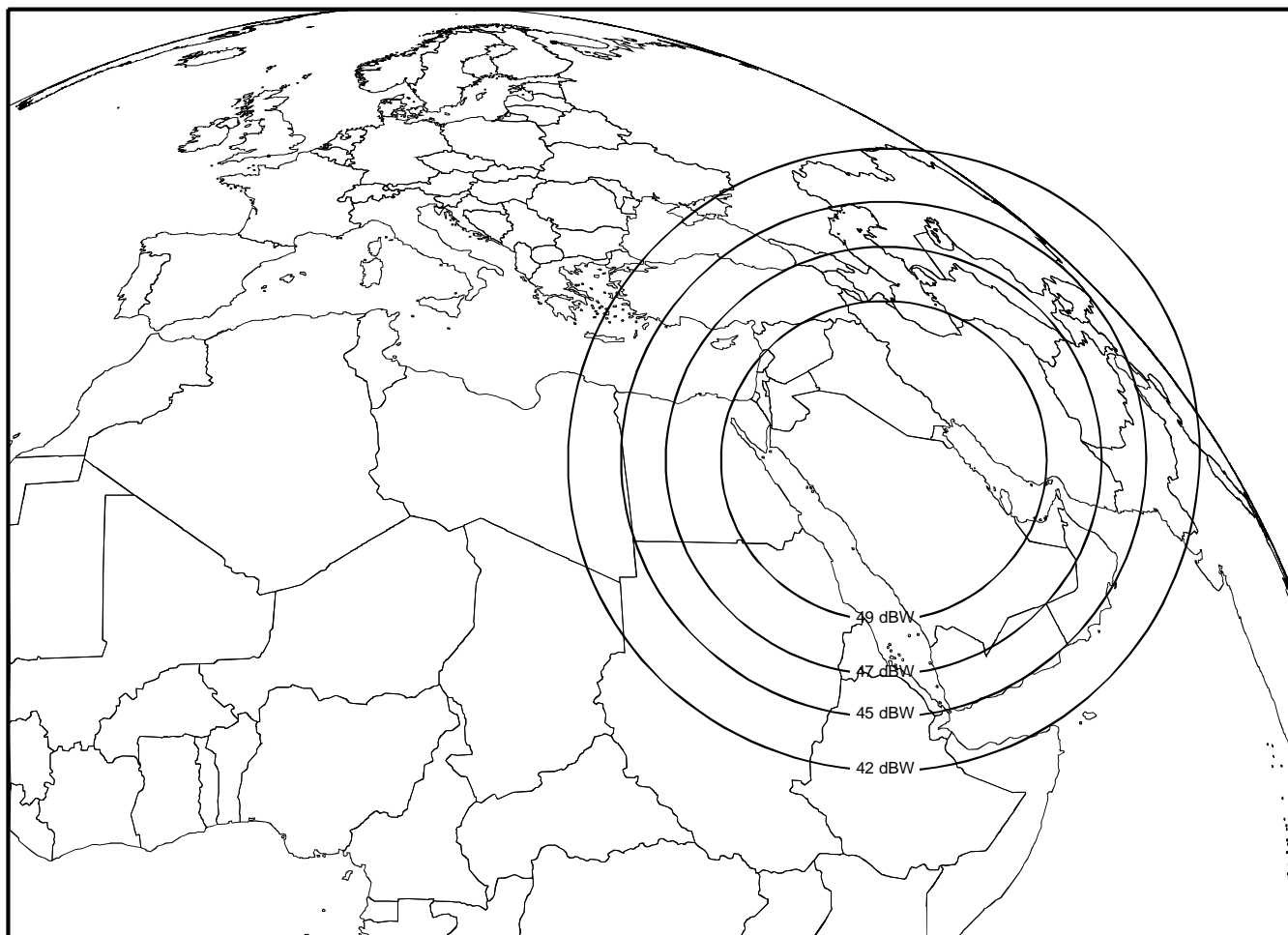


Figure 15. Hot Bird™ 3 and Hot Bird™ 4 Satellites Example Transmit Steerable Beam Coverage

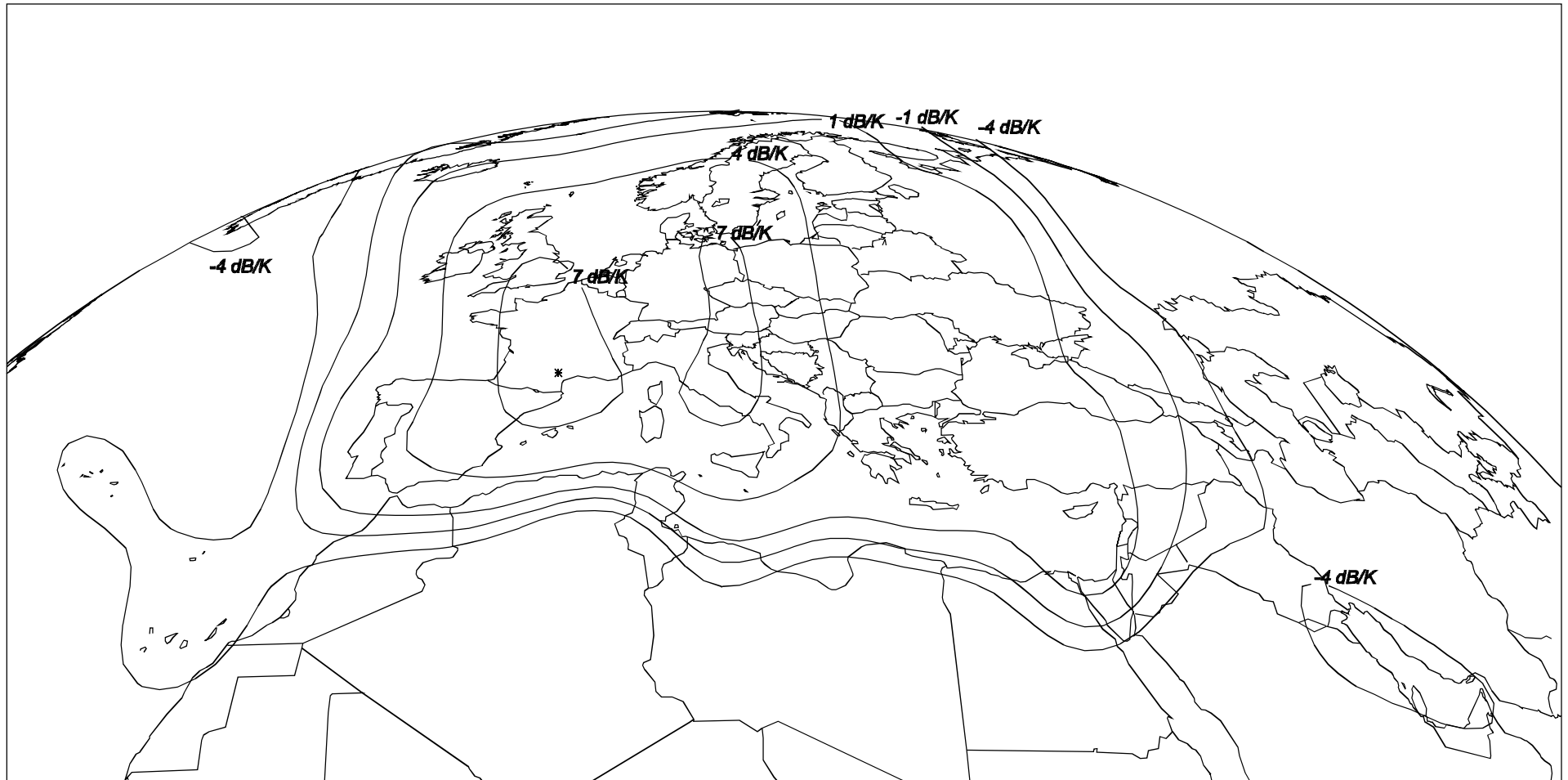


Figure 16 . Hot Bird™ 6 Ku-band Receive Coverage

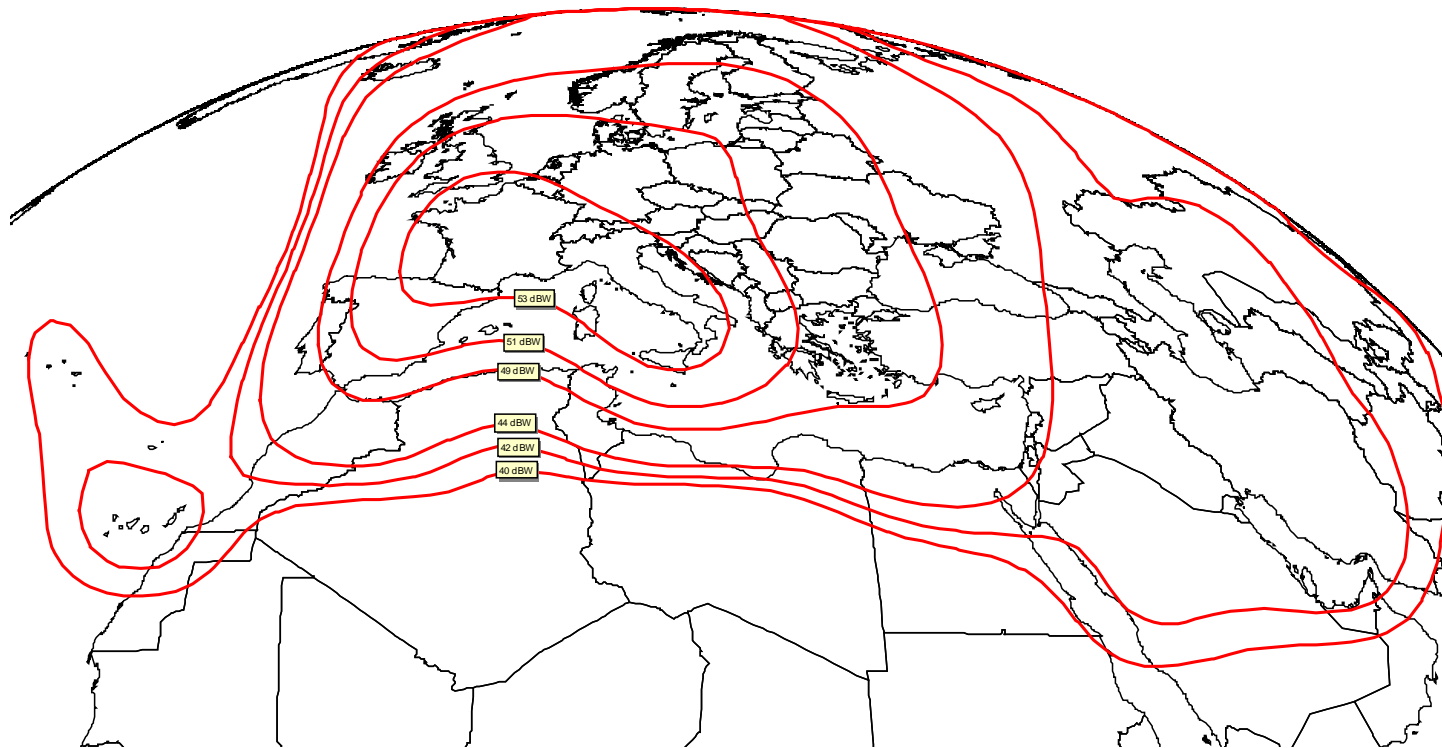


Figure 17 . Hot Bird™ 6 Ku-band Transmit Coverage

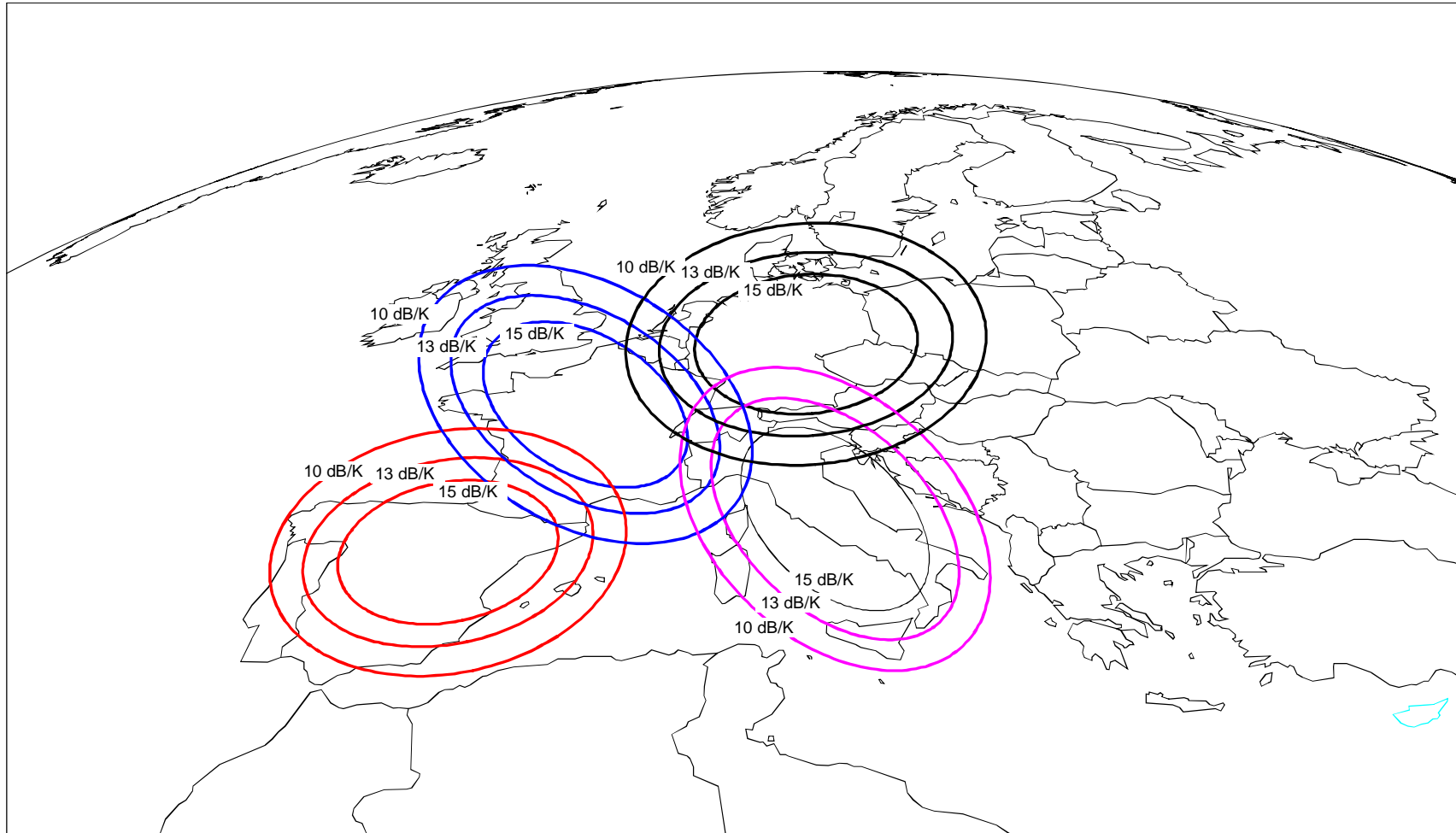


Figure 18 . Hot Bird™ 6 Ka-band Receive Coverage

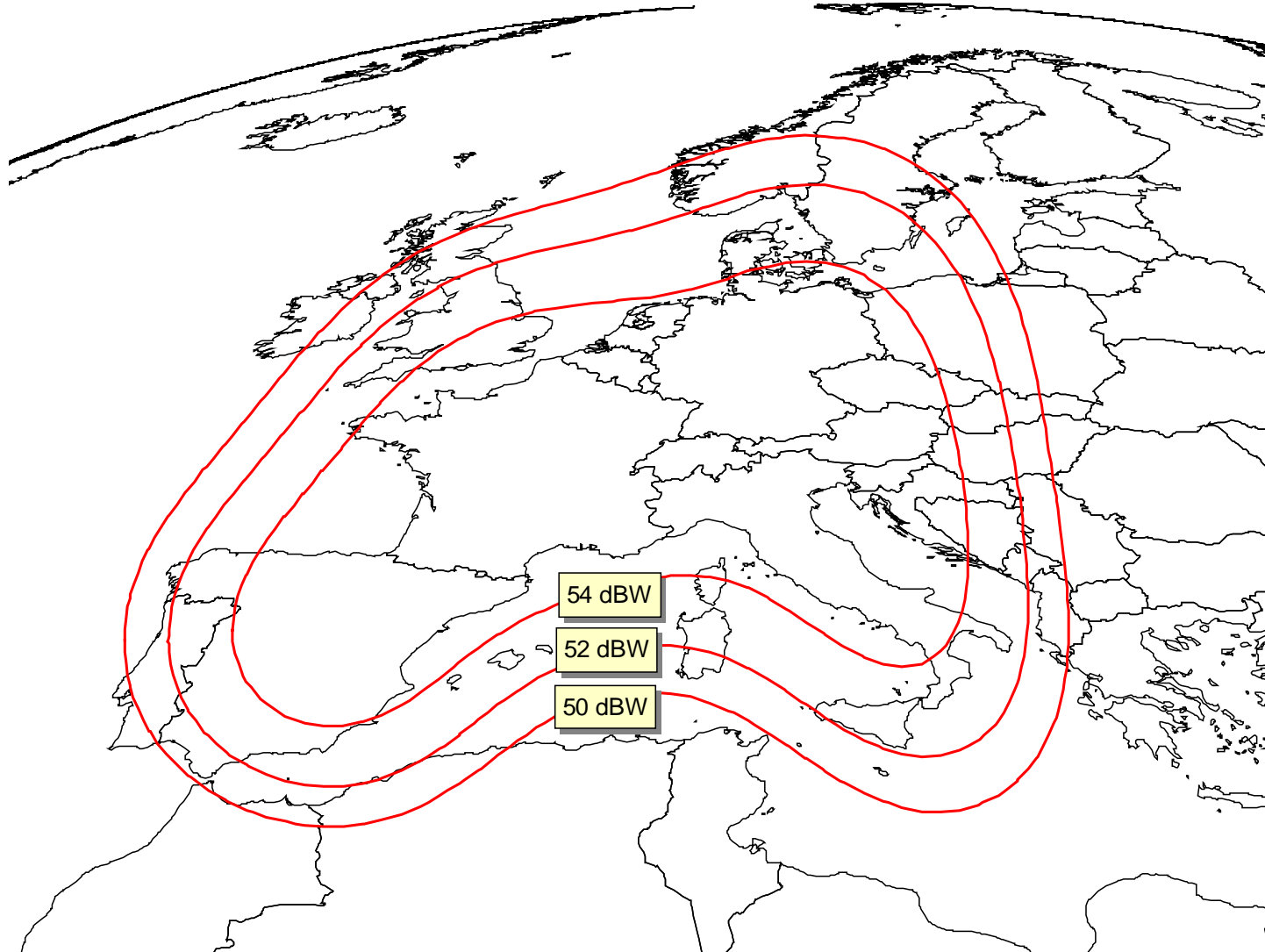


Figure 19 . Hot Bird™ 6 Ka-band Transmit Coverage

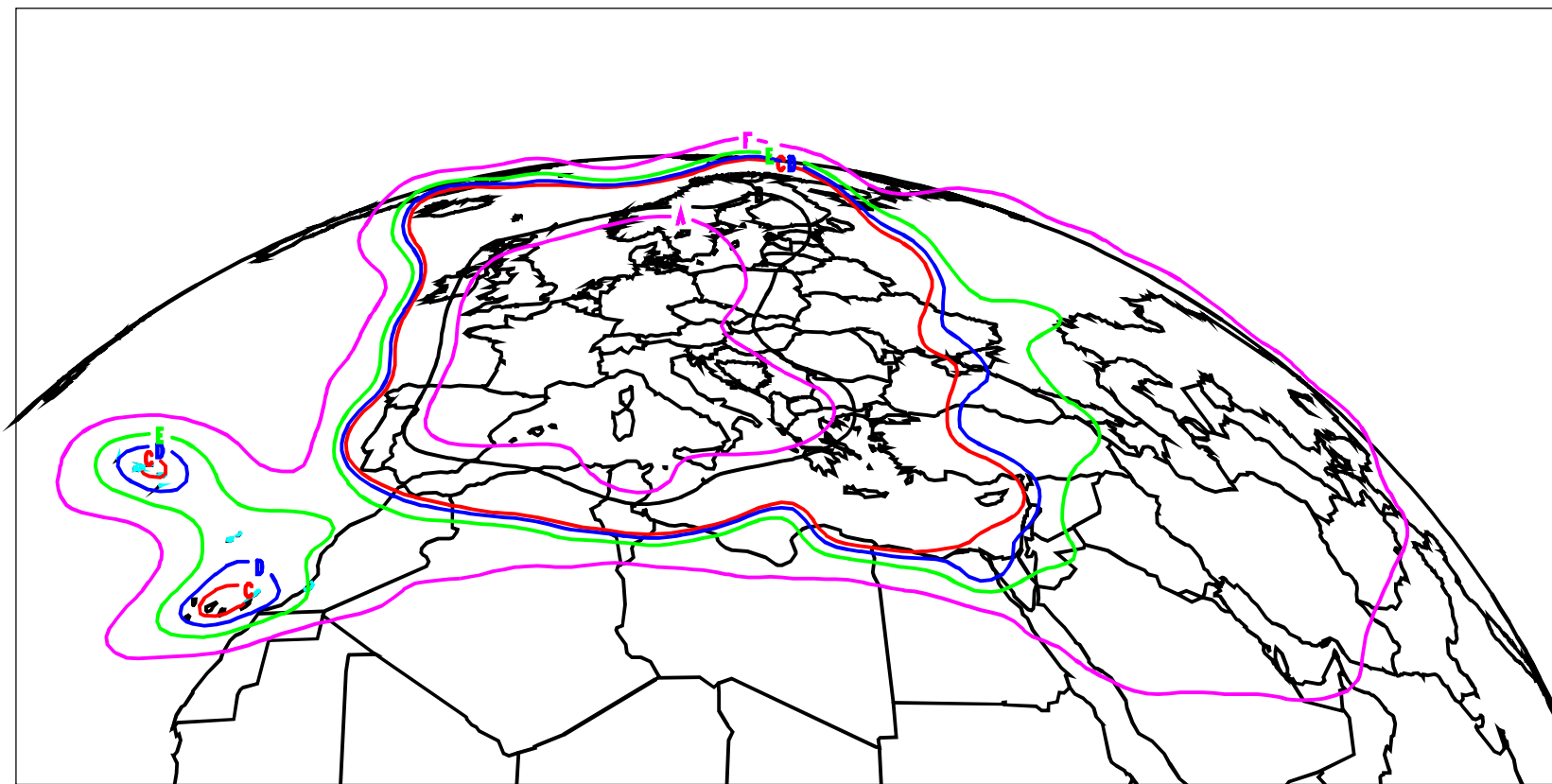


Figure 20 . Hot Bird™ 7 Satellite European Receive Coverage

(Contours A, B, C, D, E, F correspond to 5 dB/K, 4 dB/K, 0 dB/K, -0.5 dB/K, -1.5 dB/K and -4.5 dB/K)

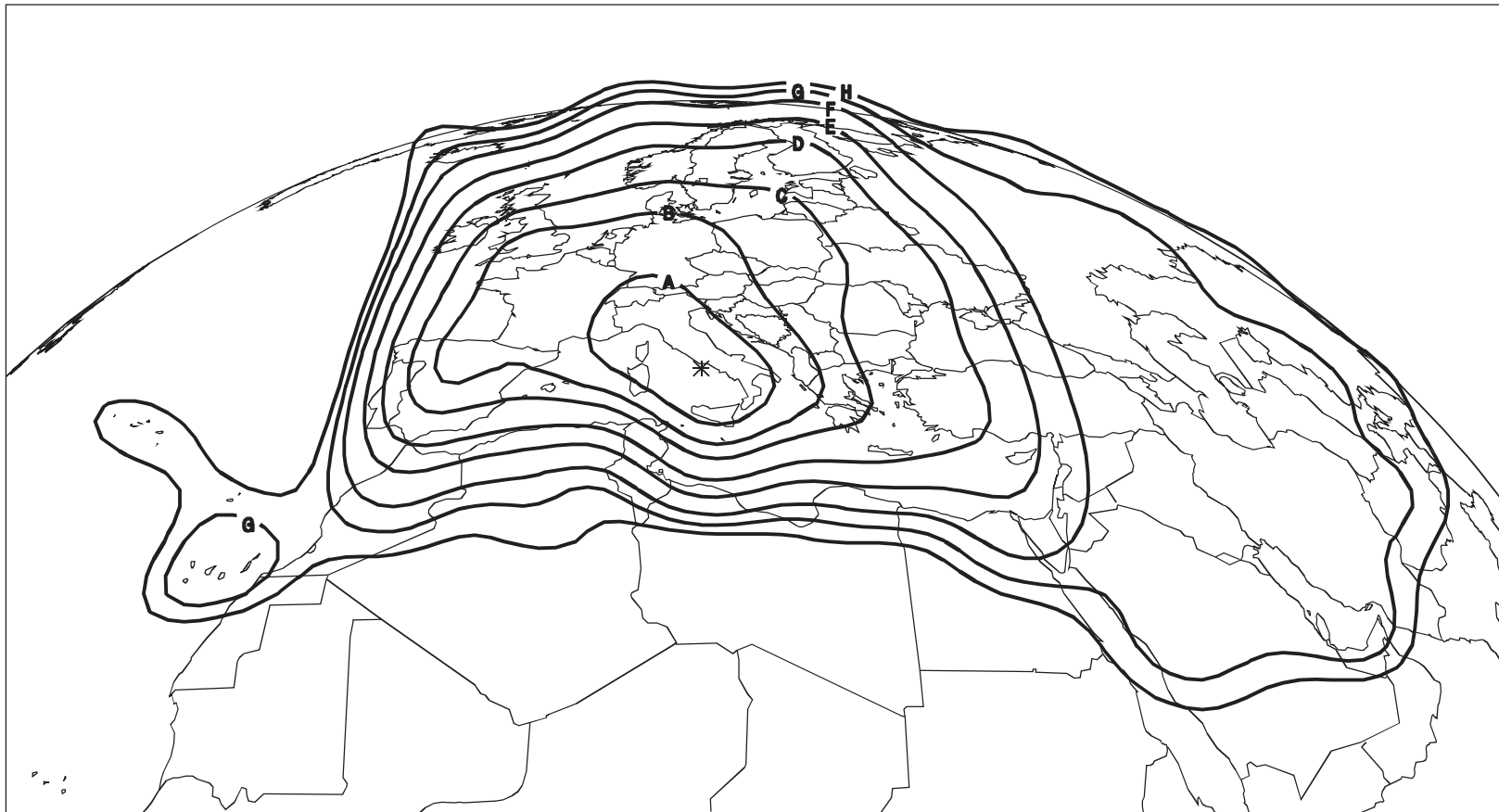


Figure 21 . Hot Bird™ 7 Satellite SuperWidebeam Transmit Coverage

(Contours A, B, C, D, E, F, G and H correspond to 53 dBW, 52 dBW, 51 dBW, 49 dBW, 47 dBW, 43 dBW, 42 dBW and 40 dBW)



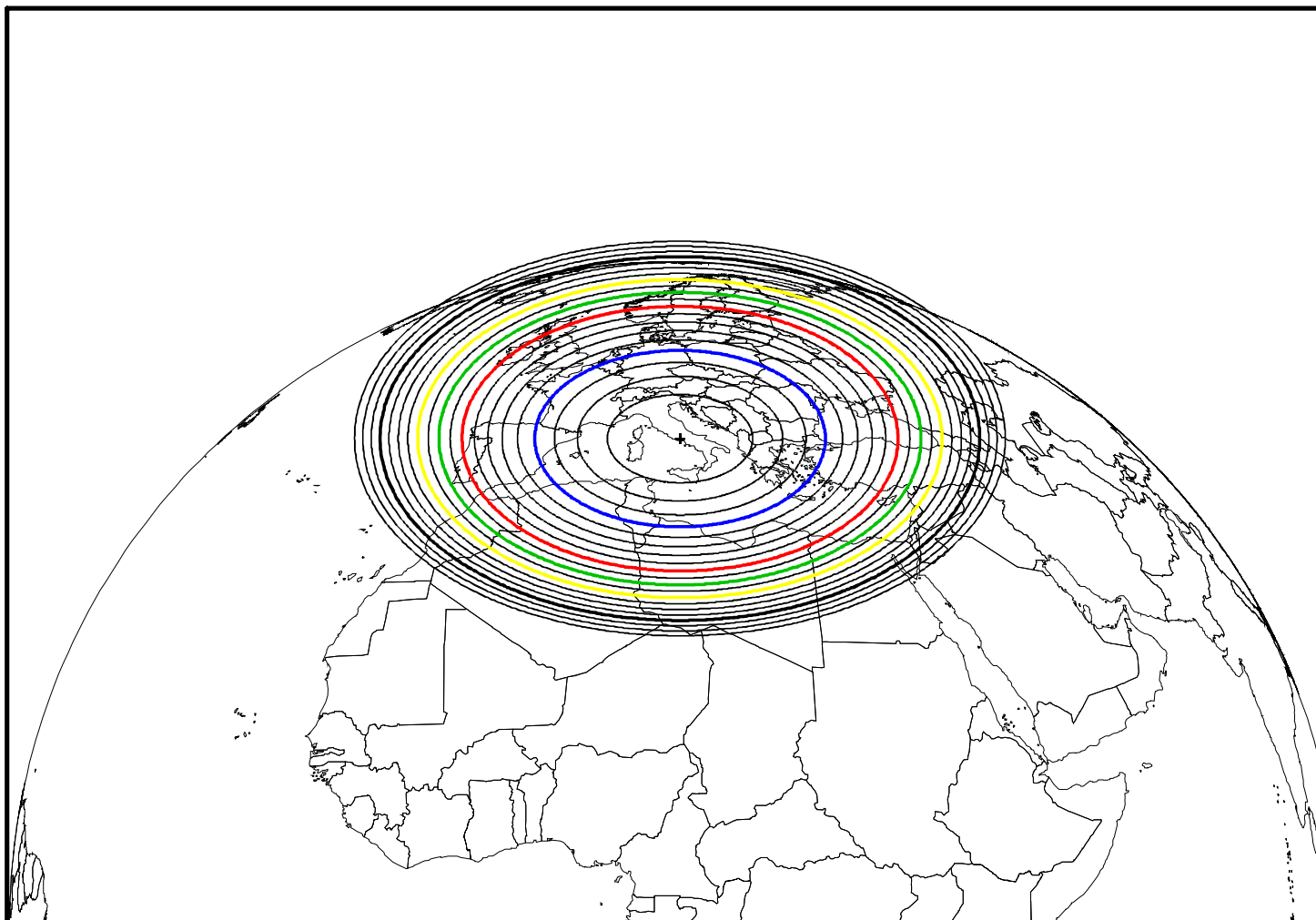


Figure 22 . Illustration of the Hot Bird™ 7 Steerable Beam Transmit Coverage. EIRP levels: 53 to 34 dBW in 1 dB steps.

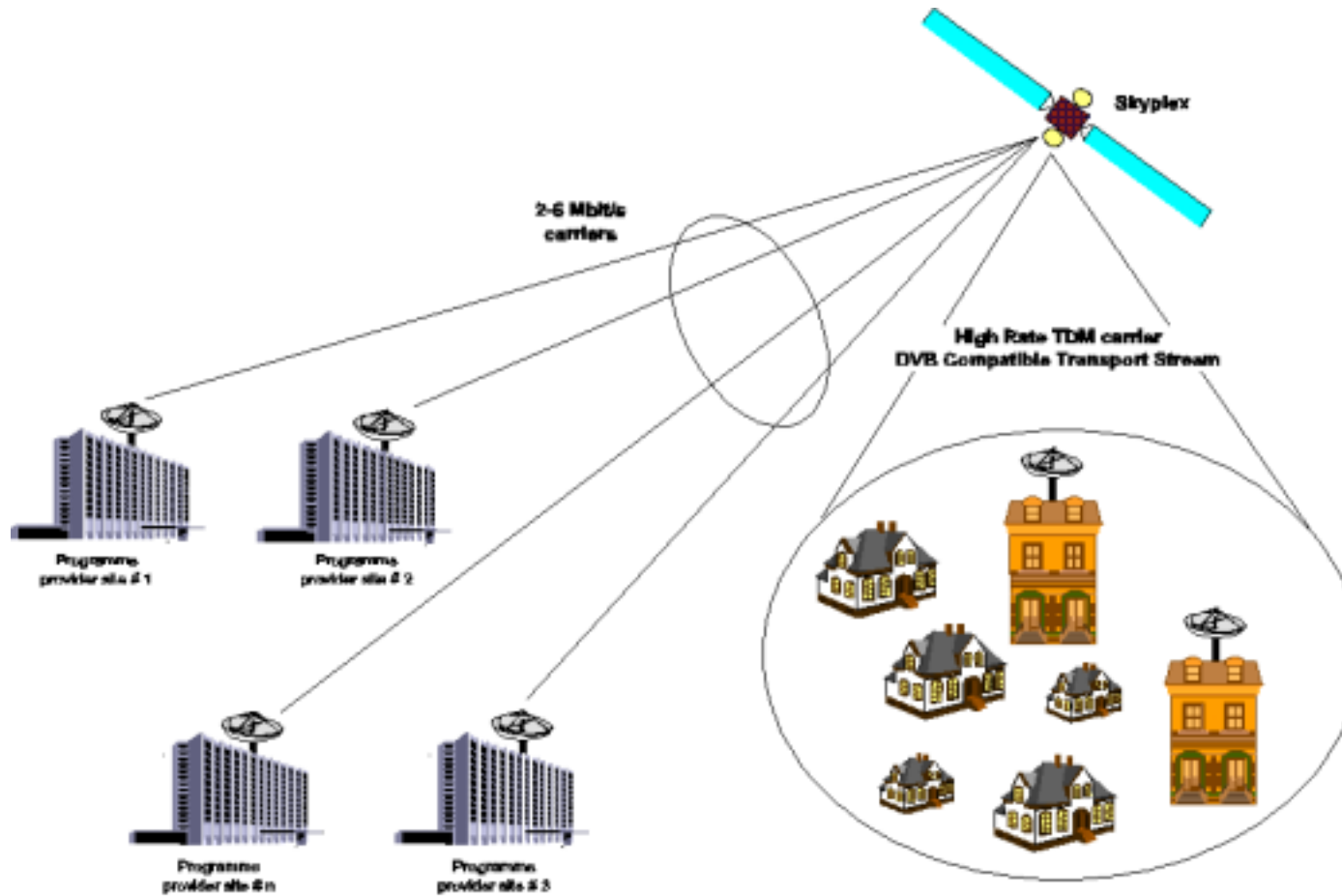


Figure 23. Skyplex System Architecture

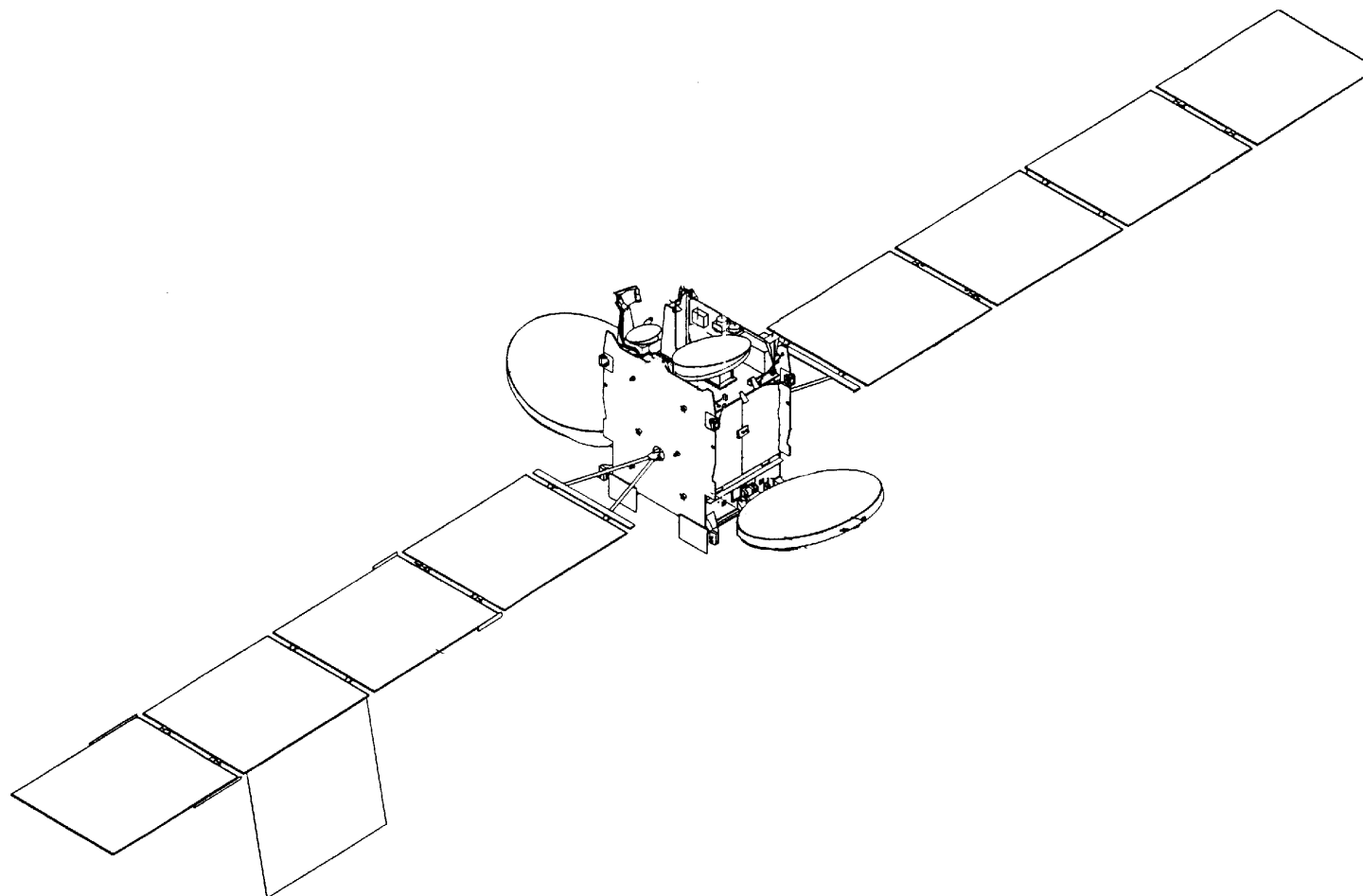


Figure 24. Hot Bird™ 3 Satellite in Orbit