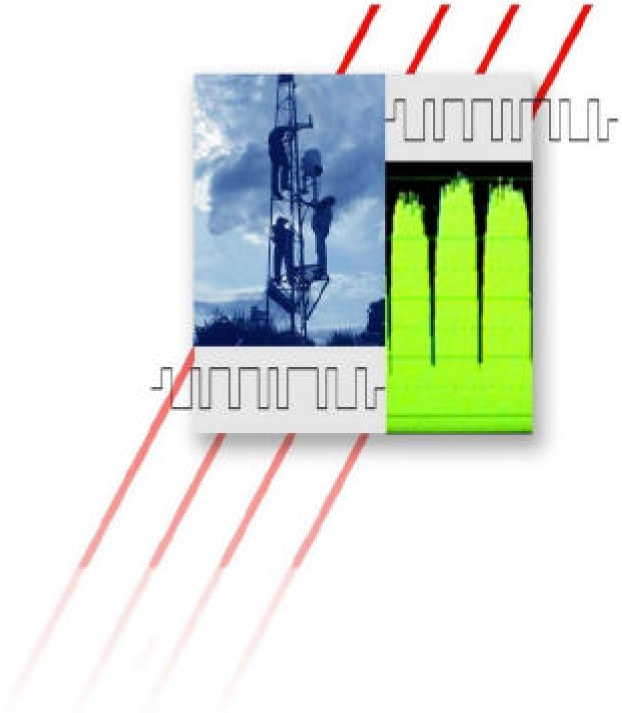
/M/D/S/i TECHNICAL GUIDE

INFORMATION FOR INSTALLERS

OF ***Hypercable*** BWA SYSTEMS

Compliant with DVB-MC/S ETSi EN 300-748



***Hypercable*™ System Overview V 3.0**

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1.INTRODUCTION

This document provides recommendations for the use and installation of equipment for the reception and distribution of BWA Hypercable DVB-MC/S transmissions from terrestrial transmitters (Horizontal Satellite).

The main body of the document includes:

- Information on the characteristics of DVB-MC/S signals and systems.
- Information on the effects of the climate on signal reception quality.
- Recommendations concerning the reception system architecture.
- Specifications for reception equipment.
- Recommended antenna sizes and installation procedures.

This information should be used in conjunction with ***Annex A and Annex B*** to this document, which provides the technical characteristics of Hypercable transmitters and **RECOMMENDATIONS FOR MOUNTING AND CARE ABOUT THE FRESNEL ZONE CLEARANCE**

2. DVB-MC/STRANSMISSIONS

2.1. CHARACTERISTICS OF THE HYPERCABLE BWA DELIVERY NETWORK

Annex A provides the technical characteristics of standard Hypercable BWA in C band KU Band and Q band.

The technical characteristics of Hypercable BWA networks in various countries are available from MDSi or from the operator on request. A MDSi contact point is given in *Section 7* on page 54.

2.2. CHARACTERISTICS OF DVB-MC/S CARRIERS

2.2.1. Hypercable BWA Access Mode

Transmissions from the Hypercable are high rate (50-100 Mbit/s) broadcast multiplexes, each conveying a number of different digital television programmes (typically 10 to 20 standard definition programmes). This mode of operation is commonly referred to as Multiple Channel (Programme) Per Carrier (MCPC). Each transmission of this type uses a dedicated transponder (i.e. single carrier transponder access). This provides the best possible signal strength at the reception point.

Other Hypercable BWA access modes are possible. These include Single Carrier (Programme) per Carrier (SCPC) access, and Myriaplex™ full duplex Hyperlink P to P solutions to provide the DVB-T backbone.

2.2.2. Symbol Rate

Digital transmissions from the Hypercable BWA have various symbol rate in the range: 2 to 60 Msymbol/s, depending upon the transmission mode. This range is compatible with each 40 Mhz transponder in the 1 GHz Hypercable bandwidth.

In order to maintain operational flexibility, and for compatibility with future services, it is recommended that all reception equipment is capable of operating over a wider range of symbol rates from 2 to 60 Msymbol/s (see *Section 4.4.2* on page 26). The MDSi available reception equipment has this capability.

2.2.3. Radiated Power Levels

Hypercable BWA digital television transmissions essentially employ of the available SSPA power with little "backoff"[1]. The radiated power level of each digital multiplex is therefore little less to the saturated EIRP capability of the transponder that it occupies. No saturated field level coverage are available for each Hypercable BWA deployment, but the field level increase or decrease by the square of the distance from the Hypercable BWA transmitter and require

[1] *Operation of the Hypercable high power amplifier below its maximum output level in order to reduce the adverse effects of channel nonlinearities on the transmission quality*

the use of the HyCAnC™ system to prevent the LNA saturation, the DRO "pulling" and the LNB intermodulation and transmodulation.

➢ 2.2.4. Forward Error Correction (FEC)

Digital television transmissions from the Hypercable BWA typically employ an FEC rate of 3/4 or 7/8 but are not constrained to do so. They may employ any one of the FEC rates specified in the DVB-MC/S standard (i.e. rates 1/2, 2/3, 3/4, 5/6 and 7/8).

➢ 2.2.5. Frequency Stability Phase Noise and Near to Far level management

The frequency stability and phase noise performance of outdoor reception systems designed for FM (analogue) or satellite Digital TV services **are not** adequate for the reception of digital TV transmissions from the Hypercable BWA system. Consequently, outdoor units originally intended for satellite reception cannot be used to receive DVB-MC/S MCPC transmissions by the addition of a suitable IRD [2]. This, because digital Terrestrial BWA transmissions at high symbol rates are relatively sensitive to Multipath, Raleigh fading ice depolarization rain attenuation occurring frequency instabilities and phase noise. And much more because the user can be located **near** the transmitter (0.5 km) or **Far** the transmitter (100 km) and the field level can vary about 60 dB.

Nevertheless, use of a usual Satellite LNB will guarantee reception of all transmissions. The recommended technical characteristics of the HyCAnC™ antenna LNB system are given in *Section 4.3* on page 23.

➢ 2.2.6. System Criterion for terrestrial Hypercable BWA and MVDS

The criterion for terrestrial Hypercable BWA and MVDS systems links is often based upon interference. One of the preferred methods uses the threshold to Interference (T/I) ratio, per Telecommunications Systems Bulletin TIA TSB 10-F "Interference Criteria for Microwave Systems".

/M/D/S/I Hypercable LDQPSK modulation system, take care about the capability to receive the anted signal between two unwanted signals transmitted by two adjacent channels. The two adjacent unwanted channels can have a level 10 dB more than the wanted channel with any effect on the reception quality of the Wanted channel.

[2] *Integrated Receiver-Decoder*

BANDWIDTH OF MODULATED CARRIER

The spectral occupancy of the IF signal out of the modulator is:

$$BW_{3dB} = SR = \frac{DR}{m \times CRv \times CRrs},$$

BW_{3dB} = 3 dB Bandwidth
SR = Symbol Rate (sym/s)
DR = Data Rate
m = Modulation factor (order of modulation)
= 2 QPSK, 3 8PSK, 4 16QAM
CRv = Viterbi code rate (i.e. 5/6)
CRrs = Reed Solomon code rate (i.e. 188/204, 187/204, etc.)

The symbol rate is also the 3 dB bandwidth (BW3dB) of the IF spectrum, and the spectral occupancy at 20 dB down is BW20 = BW3dB x 1.38 times the 3 dB bandwidth. For QPSK carrier at 19.39 Mbit/s data rate with R3/4 + RS 188/204 the symbol rate is 14.0 Mbit/s so BW3 = 14.0 MHz and BW20dB = 19.3 MHz.

Normal carrier spacing is 1.3 x SR for multiple carriers. Figure 1 is a plot of the spectrum for a 37.5 Msymbol/s carrier. The modulator output plot also shows the spectral mask for DVB-MC/S microwave terrestrial transmission.

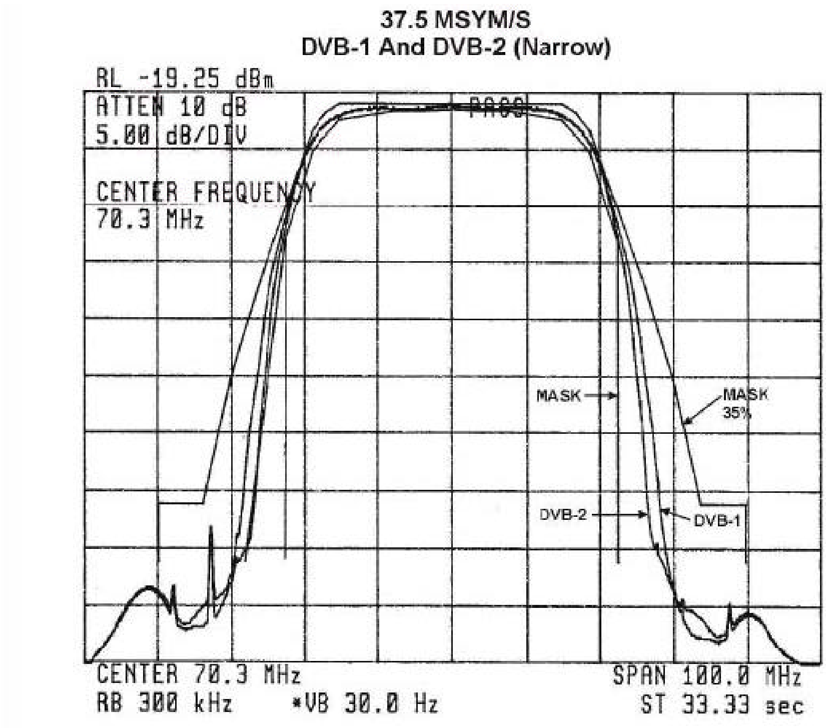


Figure 1. Modulator Output: Typical Spectral Occupancy

ADJACENT CARRIERS

➢ Carrier Spacing

Figure 2 illustrates how adjacent carriers are usually shown in on MVDDS transponder:

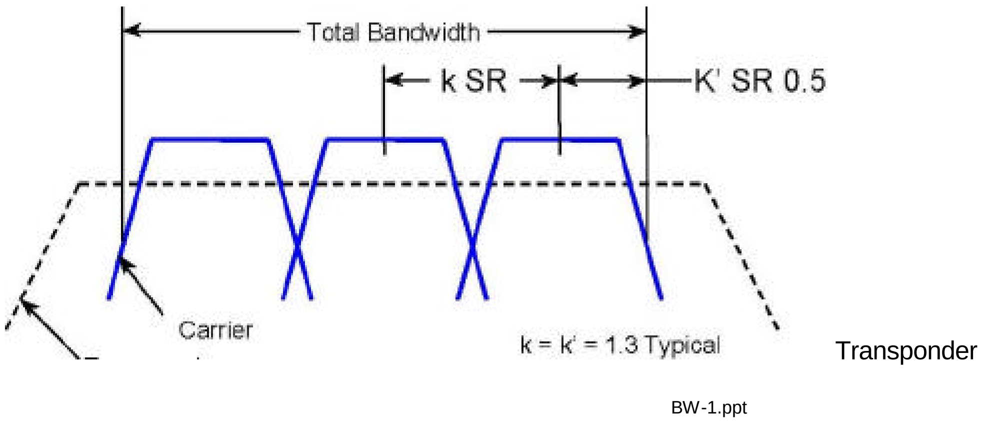


Figure 2. Carrier Spacing

The spacing between carriers is normally 1.3SR, where SR is the symbol rate defined earlier.

➢ Adjacent Carrier Performance – Satellite Link

The adjacent carrier performance of the MDS 240 is specified for the terrestrial MVDDS environment. Adjacent carrier performance is normally specified in the following way:

> BER performance (usually 10-6 to 10-9) of the desired carrier is met in the presence of two like modulated carriers on either side of the carrier spaced at 1.3 times the symbol rate each Y dB (Y = 10 dB for the MDS 240) higher than the desired carrier.

Although the performance is specified with the desired carrier in the presence of two adjacent carriers, testing is conducted with a single adjacent carrier whose power is equal to the power of the two adjacent carriers. Using a single adjacent carrier in place of two carriers is valid and shown to be equivalent to two carriers numerous times. It is also easier to conduct a controlled test with a single adjacent carrier and in cases where the carriers are broadband it is the only way to test because the total bandwidth required for three carriers will exceed the bandwidth of the test setup. The equivalent power for testing with one carrier (P1C) equivalent to two carriers (P2C) is:

$$P1C = P2C + 3\ dB$$

The Figure 3 below shows how the desired and test carriers are set up for testing. The relative spacing of the carrier is given as:

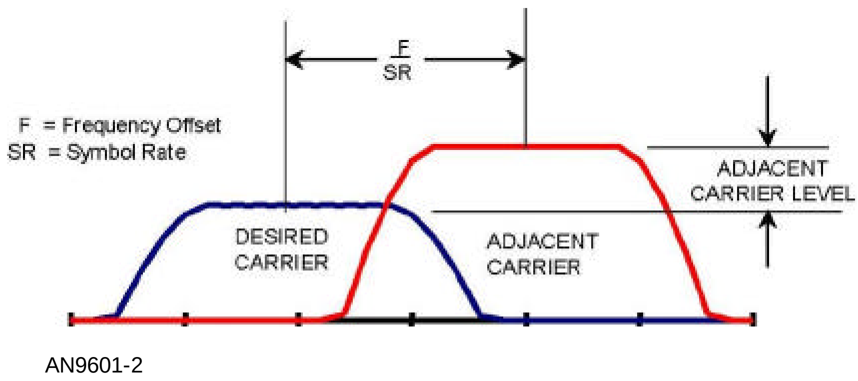
$$F/SR$$

Where,

F = the measured separation of the carriers
SR = symbol rate

Equivalent testing with one carrier is performed to verify performance to this requirement.

Normalized Adjacent Carrier Spacing And Level



Frequency

Figure 3 Adjacent Carrier Testing for MVDDS

➢ Adjacent Carrier Performance – for Hypercable MVDDS

The criterion for terrestrial links is often based upon interference. One of the preferred methods uses the threshold to Interference (T/I) ratio, per Telecommunications Systems Bulletin TIA TSB 10-F "Interference Criteria for Microwave Systems." The starting point to establish T/I is to establish the minimum operating threshold level, Ts, followed by injecting a like modulated carrier to determine the T/I level. The preferred approach is to generate a plot of T/I versus frequency starting with the interfering carrier at zero frequency offset from the desired carrier then progressively increase the offset until the carriers are well separated. It is then possible to use this information for frequency coordination. The acceptable level of interference is:

Icoord = Tx -TIsp(fd) - 5

Where,

Icoord = Acceptable level of interference, dBm

Ts = Threshold power level of receiver (demodulator) at BER = 10^{-6}, dBm

TIsp(fd) = Value of T/I from T/I curve based upon separation of interfering carrier from the desired

fd = Separation between centre frequencies of interfering and desired carriers

5 = This is the "usual" value for multiple exposure allowance to account for interference from multiple adjacent carriers in a high usage density areas

Figure 4 shows a plot of T/I versus frequency for the MDS 240 Demodulator based upon measured data when the interfering signal is a like modulated carrier. In this case, the frequency offset is normalized to symbol rate to simplify estimating T/I performance for any modem symbol rate, SR. The level used for Ts is the minimum input signal level from the demodulator specification and the reference BER is 10^{-8} for the test. The plot includes QPSK, 8PSK and 16QAM.

For terrestrial transmission C/N is used. The C/N is found from the Eb/No as:

$$C/N = Eb/No + 10 \text{ Log } (m*CR),$$

The parameters m and CR were previously defined in the section covering spectral occupancy and symbol rate (SR and BW3dB). Eb/No is taken from the modem specification.

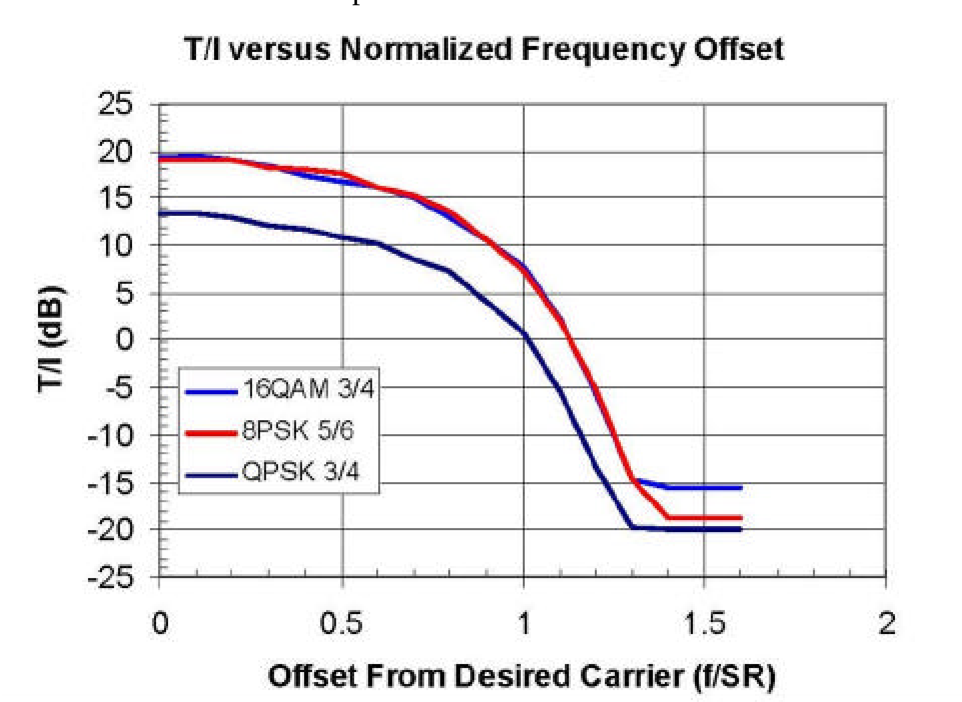


Figure 4. T/I versus Normalized Frequency Offset

3. RECEPTION SYSTEM ARCHITECTURES

3.1. General

Reception system architectures fall into two categories: individual reception systems and collective reception systems.

- Individual reception systems will be referred to as "DTH"[3] systems.
- Collective reception systems are often referred to as "Terrestrial Master Antenna Television" (TMATV) systems.

The purpose of this section is to briefly review the different possible system architectures and to help installers choose the most appropriate system architecture for reception of the services delivered by the Hypercable BWA. In particular, it is recommended that:

- New installations of any type (individual or collective) are capable of receiving over the frequency range 3.4 - 4.2 GHz 10.7 -12.75 GHz 40.5 – 42.5 GHz and on both linear polarisations ("X" and "Y").
- Collective reception systems are implemented using the "switched IF" architecture (see *Section 3.4* on page 15) with a four-cable backbone.
- Installers consider the use of DiSEqC™-compatible equipment to ensure that newly-installed reception systems have maximum configuration flexibility, regardless of their architecture. Further information on DiSEqC™ is given in *Section 3.5.1.c* on page 20.

Each of these points is discussed further in the following sections.

3.2. Orbital and terrestrial Location(s)

As a minimum, direct-to-home (DTH) and terrestrial master antenna television (TMATV) reception systems should be capable of receiving from the Hypercable BWA transmitter position. (Or another local transposer or relay)

Television services of interest to the general public exist also by satellite at orbital positions. In recognition of this fact, installers may wish to consider the installation of DTH TMATV and SMATV reception systems that allow simultaneous reception from two or more terrestrial and also some orbital positions. Reception systems of this type are briefly mentioned in the following sections. They are described in more detail in *Reference 1*.

[3] *Direct-To-Home*

3.3. INDIVIDUAL RECEPTION SYSTEMS

Figure 5 is a single-feed system for reception from one Hypercable BWA transmitter. It utilises a single HyCAnC™ LNB antenna to receive all signals in the frequency range 10.7 to 12.75 GHz, (or 3.4 to 4.2 and 40.5 to 42.5 Ghz) on any one of two orthogonal linear polarisations. Frequency band switching, polarisation switching, Near to Far switching is performed within the HyCAnC™ LNB.

This is the minimum configuration recommended for individual reception systems.

The capabilities of the reception system shown in *Figure 5* complies most of the specific requirements of the Hypercable BWA, which operates over a wide frequency range (10.7 -12.7 GHz) and on two linear polarisation.

***Figure 5**: DTH Receive System Architecture*
Single-Feed System:
1 cable, single-input receiver,
Planar Space Diversity
DiSEqC™ and HyCAnC™ band /
Polarisation / Near To Far managing method.

Other system architectures apply if reception is required from two or more terrestrial and also orbital positions. Systems of this type are often referred to as "multi-feed" systems and are quite common in Europe.

There are several possible multi-feed reception system architectures. These are described and compared in *Reference 1*. Installers who wish to implement multi-feed individual reception systems should heed the recommendations given in the referenced document concerning the preferred system architecture and the use of DiSEqC™ and HyCAnC™ technology.

3.4. Collective Reception Systems

➢ 3.4.1. Possible Architectures

Collective reception systems are installed for a number of reasons. A relatively simple system could just to provide multiple reception points within the home, allowing independent programme selection at each reception point. More extensive systems could serve a block of apartments, where limited line of sight, local regulations or physical limitations on the number of antennas that can be installed preclude the installation of multiple individual reception systems. The cost to the viewer is potentially lower with collective reception systems, since the cost of equipment is shared amongst all users. Service availability will also be enhanced with a single, relatively large antenna for collective reception with respect to HyCAnC™ for Near to Far and fading management.

Collective reception systems can be implemented in a number of different ways. These include:

- Switched IF systems.
- QPSK to AM re-modulation.
- IF-IF conversion.
- IF-RF-IF conversion.
- Remote controlled head-ends.
- QPSK-to-QAM transmodulation.

These system architectures are described and compared in *Reference 1*.
In this document only the switched IF system architecture is considered. Since switched IF systems simply route the signals received from the Hypercable BWA to the user's IRD, they are generally less complex and less expensive than alternative systems that modify the signal format (e.g. QPSK-to-QAM transmodulation).
The switched IF system architecture described below is the recommended architecture for collective reception of DVB-MC/S services from the Hypercable BWA.

➢ 3.4.2. Recommended Architecture: Switched IF System

Switched IF systems distribute the Hypercable BWA Intermediate Frequency (IF) signal supplied by the HyCAnC™ Antenna directly to each user. They require multiple cables, each having sufficient bandwidth to deliver both the full satellite IF range (950 – 2150 MHz) and the terrestrial frequency range (50 – 850 MHz). The number of cables depends upon the number of terrestrial and orbital positions, polarisations and frequency bands to be supported.
The system architecture for a single user is illustrated in *Figure 6*. In this example, reception is from a single Terrestrial position.

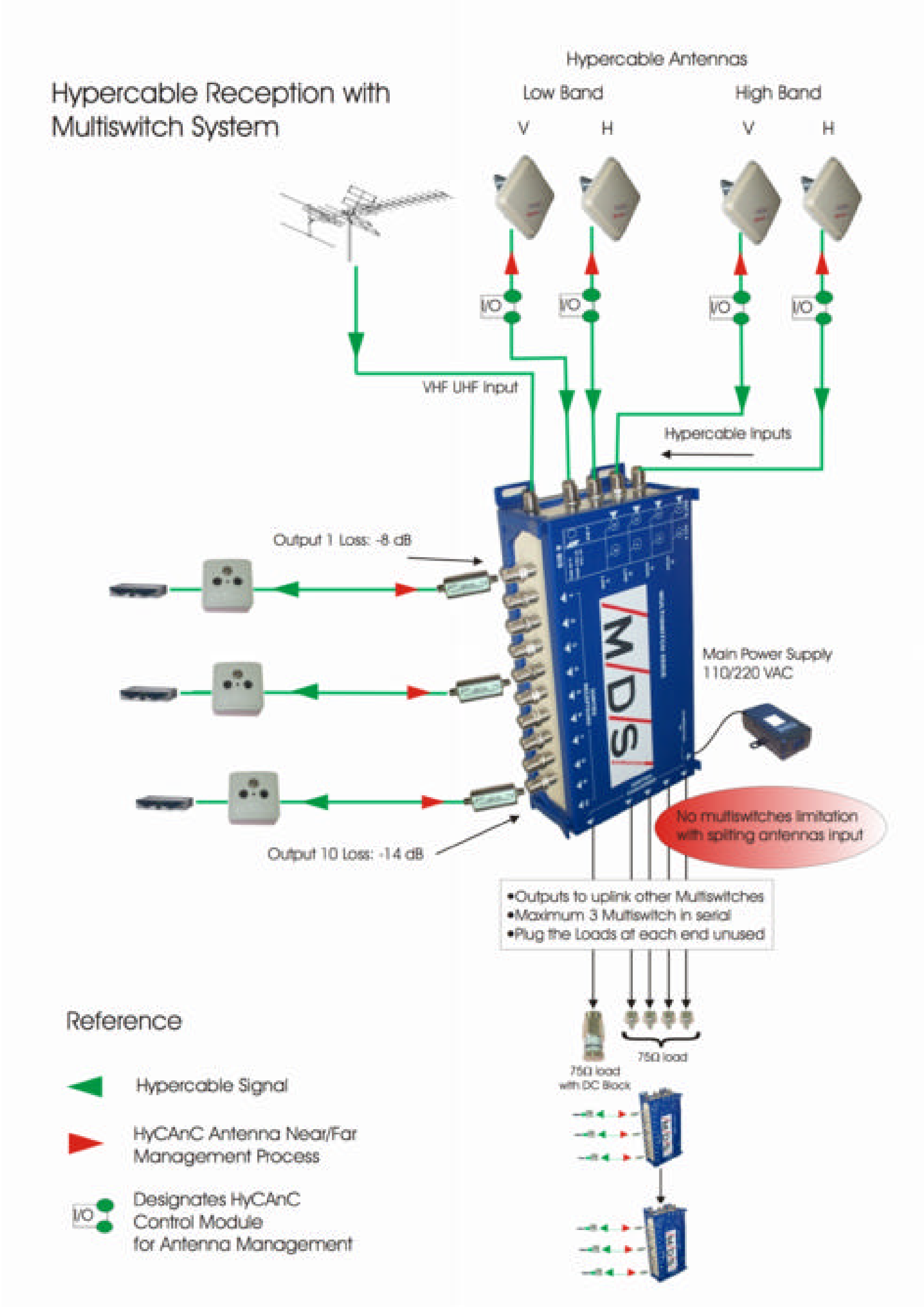


Figure 6 – Hypercable reception with Multiswitch system

A "quad" HyCAnC™ providing four outputs is used to deliver signals received on both polarisations (X and Y) and in both frequency bands (lower and upper)[4]. Each output delivers the signals received on one polarisation and in one frequency band.

Each user is equipped with a "multi-switch" that provides a number of outlets. The purpose of the switch is to select the correct polarisation and frequency band for the programme of interest. In other words, it switches between the signals delivered by the four outputs of the quad HyCAnC™. Polarisation/band switching for one outlet is independent of the switching for all other outlets. Terrestrial signals are added to the IF signal delivered by the Hypercable BWA and are distributed via the same cable network.

The domestic distribution network is flexible in that it supports a variety of different equipment (satellite FM TV receivers, digital satellite and Terrestrial IRDs and conventional television sets), each having the capability for independent programme selection. As far as the user is concerned, the system is equivalent to having a dedicated DTH reception system. Switched IF distribution systems thus create a "virtual" antenna for each user.

[4] *Lower band: 10.7 -11.7 Ghz or 40.5 - 41.5 GHz. Upper band: 11.7 -12.75 GHz or 41.5 - 42.5 GHz*

One difference with DTH installations is that the STB IRD may require an equaliser to compensate for distortions introduced by the distribution network. The equaliser compensates for the fact that the attenuation of the network is not constant across the frequency band used to distribute the TV signals. This variation in attenuation (gain) is often referred to as the "gain slope".

The equaliser is sometimes built into the cable distribution amplifiers. This distribution method has the important advantage that it conveys all of the digital information that is available in the DVB-MC/S multiplex directly to each user's IRD. The IRD is identical to that used in DTH systems and the user is provided with all the services that a DTH viewer would enjoy. Furthermore, the system is transparent to any system used for conditional access (pay TV).

The general architecture of a switched IF distribution system, can be extended to support more than one terrestrial and more than one orbital position. The backbone now contains additional cables, the total number depending upon the number of orbital positions to be supported. The multi-switches must also provide a greater number of inputs to provide full flexibility to each user. Please refer to various MDU company suppliers.

➢ 3.4.3. Recommended Configuration for Switched IF Systems

The collective reception system architecture shown in *Figure 6* has the same reception capabilities as the individual reception system shown previously in *Figure 5*. It can receive over the full frequency range from 10.7 to 12.75 GHz or 3.4 to 4.2 GHz and 40.5 to 42.5 GHz and on both linear polarisations.
As stated previously, in a switched IF system this full-bandwidth, dual-polarisation capability requires the installation of a four-cable backbone to distribute the four Hypercable BWA IF signals to each multi-switch.

In order to receive services from the Emirates Hypercable BWA only, it would be possible to install a system with only two cable backbone, since only two Hypercable IF signal needs to be distributed to the users (10.7 -11.7 GHz, V and H polarisation). In this architecture still a multi-switches are required, since there is no requirement to switch between frequency bands.

It is strongly recommended that switched IF collective reception systems are installed with full-bandwidth, dual-polarisation capability for compatibility with future services in the upper band 11.7 to 12.7 Ghz. As a minimum, all new installations should include a four-cable backbone, since upgrading a twice-cable network at a later date to receive new services is costly and often impractical or impossible.

➢ 3.4.4. Standards

The European Telecommunications Standards Institute (ETSI) has standardised a number of architectures for collective reception systems. These are described in EN 300 473.

There are two basic system architectures defined in the standard: System A and System B:

- System A is a QPSK-to-QAM transmodulation system, known as "SMATV-DTM". Further information on this standard and the system architecture can be found in *Reference 1*.
- System B is based on the direct distribution of DVB-MC/S or DVB-S IF signals. It has two variants, known as "T(S)MATV-IF" and "T(S)MATV-S".

The T(S)MATV-IF standard is applicable to the switched TMATV-IF collective reception system architecture that is recommended in this document.

➢ 3.4.5. Interaction Channels in T(S)MATV Systems

ETSI has published guidelines for implementing "interaction" channels in SMATV distribution systems via two-way satellite links. (Applicable for Hypercable TMATV DVB-MC/S)

Interaction is accommodated in the distribution network by allocating portions of the spectrum to "forward" and "return" channels (70 to 130 MHz for the forward channel and 15 to 35 MHz for the return channel). Each channel accommodates a 3 Mbit/s QPSK carrier that is shared by all users. TMATV networks can be thus adapted to provide interactive services with a return path via Hypercable BWA.

The reader is referred to the relevant ETSI document, TR 101 201, for further information.

➢ 3.4.6. Hypercable BWA IF Distribution Network Characteristics

TMATV networks that are based on the distribution of Hypercable BWA IF signals should be capable of delivering signals over the frequency range 47 MHz -2150 MHz to allow for the distribution of terrestrial AM/VSB transmissions in addition to digital Hypercable MVDS transmissions. All passive distribution components (splitters, cables, taps, etc.) should be designed for this frequency range and should allow the passage of control signals from each receiver to the appropriate matrix switch (see *Section 3.5.3* on page 22).

The matrix switches should provide the possibility of combining the Hypercable MVDS IF signals with signals received on the terrestrial frequencies (47 – 862 MHz). The input and output isolations of such switches should be at least 26 dB.

➢ 3.4.7. Transparency

Digital television distribution systems should be transparent to Conditional Access (CA) systems that are used to implement, for example, pay-TV services. They should also be transparent, as far as possible, to the service information that is transmitted in the DVB-MC/S multiplexes (such as, for example, tuning information).

This transparency is guaranteed with the switched IF system architecture that is recommended in this document. In other architectures it may not be possible, or may not be economically viable.

3.5. Reception System Control Capabilities

➢ 3.5.1. Signalling Methods

3.5.1.a Conventional Signalling Method

Receiving systems, regardless of their architecture, need to be able to operate over the full frequency range from 10.7 GHz to 12.75 GHz and on both linear polarisations in order to be physically capable of receiving all of the services that can be delivered from the Hypercable BWA (or any other MVDS and orbital position).

The simplest form of receive architecture consists of a Planar Space Diversity antenna equipped with a single feed (HyCAnC™ LNB) and connected by a single cable to an IRD (i.e. the DTH reception architecture of *Figure 1*). In this architecture the single HyCAnC™ LNB needs to be capable of working over the full frequency range and on both polarisations.

The bandwidth employed by the Hypercable BWA broadcasting system is too large to be directly implemented in the LNB. Conventional practice is to receive in one of two frequency bands: in the “low” frequency band (10.7 – 11.7 GHz, or 40.5 – 41.5 GHz) or in the “high” frequency band (11.7 – 12.75 GHz or 41.5 – 42.5 GHz). The LNB is switched to receive in the frequency band that is appropriate for the desired Hypercable BWA channel.

The HyCAnC™ LNB also receives on one of two linear polarisations: V or H. The LNB is switched to receive in the polarisation that is appropriate for the desired Hypercable channel.

The HyCAnC™ LNB also manage the Near to Far and the fading by the mean of another DiSEqC™ commands send by the STB with a dedicated software or elaborate inside the LNB when the HyCAnC™ embedded version is used.

Consequently, the simplest reception architecture requires many signalling states to be communicated from the IRD to the antenna subsystem:

- Low band, V polarisation.
- Low band, H polarisation.
- High band, V polarisation.
- High band, H polarisation.
- High Gain 60 dB
- Medium Gain 45 dB
- Low Gain 30 dB
- Continuous gain adjustment 33 dB (60 to 27 dB gain)

The Hypercable HyCAnC™ solution is to use DiSEqC™ commands and variation of the LNB power supply voltage for this purpose. The cable that conveys the received satellite signals to the IRD also carries these control signals.

3.5.1.b The Need for an Advanced Signalling Method

The tone/voltage signalling method is adequate for systems that require four or less signalling states.

However, HyCAnC™ systems require more signalling states. The simplest example are described before for the Near to Far and fading control and management.. Additional signalling states are therefore required.

The number of additional states depends upon the complexity of the HyCAnC™ and receive system. In general, TMATV systems require more complex signalling than DTH systems.

It is also desirable to have two-way communication, so that the IRD can obtain feedback on the settings of remotely configured equipment, and a means for proprietary signalling between the outdoor and indoor units. This greatly simplifies installation, re-configuration and fault-finding procedures.

3.5.1.c The DiSEqC™ and HyCAnC™ System

EUTELSAT has developed a switching method that is fully compliant with, and indeed greatly exceeds, the requirements of dual satellite DTH reception.

The resulting bus control system, known as DiSEqC™ (**Di**gital **S**atellite **Eq**uipment **C**ontrol), provides a means for communication between satellite receivers/IRDs and peripheral equipment, using only a single coaxial cable. DiSEqC™ is an open system that has been adopted as an international standard by CENELEC.

The relevant specifications for the DiSEqC™ communication protocol are available on request from EUTELSAT, or from EUTELSAT's Web site (http://www.eutelsat.com).

A number of stages of DiSEqC™ implementation have been proposed, known generically as one-way and two-way DiSEqC™. This has been done to allow the standard to be introduced in an evolutionary manner.

The DiSEqC™ system uses the satellite receiver (IRD) as a single master terminal controlling a number of remote devices such as LNBs.

One-way DiSEqC™ (DiSEqC™ 1.0) is a preparative, or intermediate, standard. It allows for the switching and control of compatible units such as LNBs, switches and positioners, without confirmation from the remote slave devices.

Two-way DiSEqC™ (DiSEqC™ 2.0/2.1) further enhances the standard by allowing remote units to report their possible and actual configurations. Combined with appropriate control software in the receiver, DiSEqC™ 2.0 will greatly assist in simplifying the set-up and configuration of complex reception systems.

The DiSEqC™ standard is also compatible with existing tone and voltage switching techniques, thereby allowing for a simple upgrade path. Indeed, as an initial implementation, a DiSEqC™ Tone Burst standard has been defined which provides the minimum signalling necessary for dual-feed reception systems.

Since the DiSEqC™ system is relatively simple to implement, and in view of the potential it offers for sophisticated and intelligent reception systems, EUTELSAT recommends that installers employ equipment that is compatible with the DiSEqC™ 2.0 standard, or higher, as soon as possible. If an evolutionary path is required, then interim solutions should be based on the DiSEqC™ 1.0 standard.

/M/D/S/i has developed HyCAnC™ a control method to manage the fading and the Near to Far problems and to use only one size Space Diversity Planar antenna from Near the transmitter up to Far… the maximum coverage.

HyCAnC™1.1 use the standard DiSEqC™ system with a special algorithm embedded in the STB and for HyCAnC™1.2 and 1.3 version the software is also embedded in the LNB.

➢ 3.5.2. Individual Reception Systems

In the reception system architecture of ***Figure 5***, the DiSEqC™ communication protocol could be used to control all LNB antenna parameters.

➢ 3.5.3. Collective Reception Systems

The switched IF reception system architecture recommended previously in ***Section 3.4.2*** requires communication from the IRD to the multi-switch that delivers its programmes. When the TMATV system is designed to receive from one Hypercable BWA location, as illustrated in ***Figure 6***, or if it is designed to receive from two or more Hypercable transmitters positions then DiSEqC™ signalling may be employed.

The advantages of two-way DiSEqC™ are particularly apparent in TMATV distribution networks, where the number of devices and switching states to control may be large. DiSEqC™ also allows the receiver to automatically detect that it is operating in a TMATV system and to adjust its configuration accordingly. DiSEqC™ is recommended for all TMATV and SMATV installations for these reasons.

4. RECEPTION EQUIPMENT

4.1. General Requirements

DVB-MC/S reception systems should comply with the appropriate ETSI standards and implementation guidelines. These include, but are not limited to:

- ETR 154 (implementation guidelines for the use of the MPEG-2 Systems, Video and Audio standards).
- **EN 300 748** (framing structure, channel coding and modulation for **Terrestrial DVB-MC/S** services).
- EN 300 468 and ETR 211 (specification for service information in DVB systems and related implementation guidelines).
- EN 50221 (common interface specification for conditional access).
- EN 50256 (characteristics of DVB receivers).
- EN 50201 (interfaces for DVB-IRDs).

Installers should check with their equipment suppliers the extent of compatibility with the above standards.

Installers are invited to consider using equipment that is also compatible with MDSi's recommendations as given in the following subjections.

4.2. Carrier Types and ODU

It is recommended that, as a minimum, all receive installations should be capable of receiving MCPC transmissions.

The performance of most Analogue or Digital DTH satellite antenna systems (outdoor units) is inadequate for digital MCPC Hypercable BWA MVDS programme reception. (Space and Angular Diversity Near to Far and fading Management is not implemented in usual Satellite DTH products)

HyCAnC™ antenna LNB System is required for reliable service

4.3. Antenna Subsystem for the band 10.7-12.7 GHz

The antenna subsystem, or outdoor unit, comprises the Planar Space and Angular Diversity antenna, one or more HyCAnC™ low noise block down converters (LNBs), polarizer's and external component(s), if any, associated with LNB switching.

/M/D/S/i, compatible DTH and TMATV reception systems, unless otherwise indicated, should comply with the requirements given in the relevant ETSI DVB-MC/S standard, which is ETS 300 748.

It is recommended that all reception equipment be capable of operation over the whole of the 10.7 – 12.75 GHz 3.4-42 GHz 40.5-42.5 GHz frequency band.

The recommended characteristics for the antenna System are based on MDSi specifications and are summarised in the next pages.

4.3.1. Planar Hypercable Antenna

H and V Linear Polarization, or
RHCP and LHCP Circular Polarization
High Directivity – High front to back ratio.
Ultra wide band 10.7 to 12.7 GHz

Fig. 7: Planar Hypercable Antenna Front View

Fig 8: Planar Hypercable Antenna Side View

➢ 4.3.2 Specifications for the Active Planar Antenna 10.7 – 12.7 GHz

4.3.2 .a Electrical

Frequency range:..10.7 - 12.7 GHz.
Gain typical: 200mm-360mm-540mm..24 dB. 31dB. 34 dB
3 dB Beam width (AZ/El) ....8.5°.
Polarization:...Dual H-V or Circular L and R.
VSWR:... 1.6/1
Cross Polarization:..25 dB.
Front to Back Ratio (from 90° to 270°) ....30 dB.

Global gain with HyCAnC™ programmable LNB..54 dB to 80 dB
Global gain with HyCAnC™ programmable LNB
and coaxial attenuators:..14 dB to 55 dB or 33 to 77 dB.

2. Frequency Range	10.7 GHz - 12.7 GHz
GAIN for 200, 360 and 540 mm	21/24 dB 30/31 dB 34/35 dB
3 dB BEAM width (Az/El)	9.3 – 6.2 – 3.5 deg
Polarization	Dual
VSWR	1.5:1 max
Cross Polarization	22 dB to 30 dB
Front to Back Ratio (from 90 to 270)	30 to 45 dB
Side lobes	ETSI EN3012-2 Range4, Cat. 2, Class 2

4.3.2 b Mechanical

Dimensions:......................................220x75 or 360x75 or 540x75 inclusive Radome Mount and LNB
Input RF Interface ....Rounded C120 Waveguide compliant with Hypercable attenuators.
Back Plane:..Aluminium (coated).

Dimensions	200-360-540 mm Inclusive of radome & connector
Input/RF Interface	WR42
Backplane	Aluminium (coated)
Flange	UG-595/U

4.3.2 .c Optional coaxial attenuator

Optional coaxial attenuators 17 dB or 29dB.
The attenuators are inserted in the C120 Wave Guide in radio fields with levels more than 70 dBm.

Regulatory Compliance: ETSI EN 301 215 - TS1

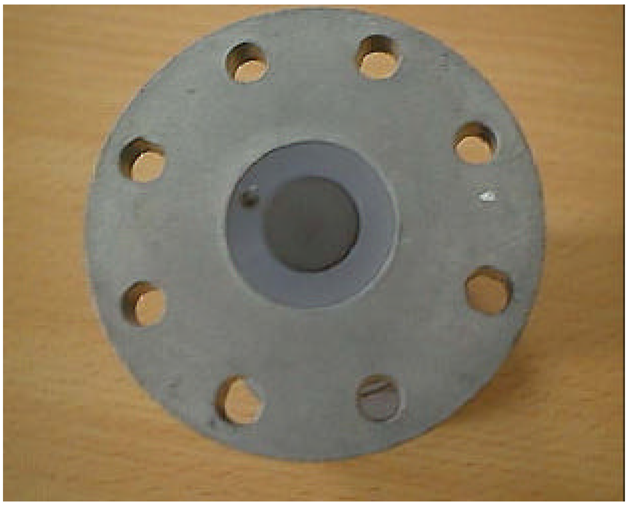


Fig 9. Coaxial attenuator

4.4. INTEGRATED RECEIVER-DECODER

4.4.1. General

The IRD behaviour should be consistent with the recommendations given in ETR 154.

Digital IRDs should comply with the framing structure, channel coding and modulation requirements of EN 300 421. and EN 300 748.

4.4.2. Symbol Rates

All reception equipment should be capable of operating over the full range of symbol rates identified previously in ***Section 2.2.2*** for MCPC transmissions (i.e. 2 to 30 Msymbol/s).

4.4.3. FEC Rates

All receivers should be capable of operating over the full range of FEC rates specified by the DVB-MC/S standard (i.e. 1/2, 2/3, 3/4, 5/6 and 7/8).

In addition, it is recommended that a facility be provided to automatically detect the FEC rate and to configure the receiver for proper reception without the need for user intervention.

➢ 4.4.4. Equalisation

Installers may wish to consider the use of receivers equipped with an equaliser for improved performance in TMATV IF distribution systems. Information on the typical channel response for an TMATV network and the potential performance gain can be found in EN 300 473 and compliant with the DVB-MC/S terrestrial specifications EN 300-748 extended by /M/D/S/i.

➢ 4.4.5. Firmware

In order to guard against obsolescence of reception equipment, installers should consider the use of IRDs whose firmware can be updated over the air. (Including HyCAnC™ protocol)

➢ 4.4.6. Number of Transport Streams and Services

The IRD should be capable of accommodating at least 100 transport streams (DVB carriers) and at least 1000 services (programmes).

➢ 4.4.7. Wanted to Unwanted carrier (Information about EN 300 748 extended)

See section 2.2.6 page 9.

➢ 4.4.8. Hypercable MVDS service information

Each DVB carrier conveys “service information” (SI) that allows the IRD to properly decode the services it carries. It is possible for a DVB carrier to convey information on services provided by other carriers, although this is not mandatory and cannot be guaranteed in all cases.

It is Operators intention to provide a common access channel that will convey service information for the whole of the Hypercable BWA network. This network-wide service information will be derived from the various services delivered by the Operator. IRDs that are intended for reception from the Hypercable BWA system should include a facility to automatically tune to this channel during set-up and should use the information conveyed by this channel for IRD configuration. This will ensure that the information presented to the viewer is up-to-date and complete for the whole of the Hypercable BWA system.

4.4.9. Conditional Access

It is recognised that programme encryption is one area where implementation decisions by broadcasters may not be made solely on the basis of conformance with other broadcasting groups. Hence /M/D/S/i makes no specific recommendations on the conditional access system to be employed.

/M/D/S/i does, however, recommend that broadcasters/service providers consider the use of CA systems that support the DVB Common Interface (EN 50221). Practically, this means that CA systems that are available on a PCMCIA module may be used to upgrade existing IRDs that make use of the common interface. Different conditional access systems are accommodated through the insertion of an appropriate conditional access module (PCMCIA card).

/M/D/S/i can provide an efficient low cost CA system for small terrestrial Hypercable network.

/M/D/S/i recommends that installer’s consider the use of such IRDs in order to ensure that reception systems are as “open” as possible and provide the maximum of flexibility and programme choice to the user.

➢ 4.4.10. Physical Interfaces

The IRD shall comply with the EN 50201 standard, DVB-MC/S specifications and HyCAnC™ LNB antenna management.

4.4.10.a IF Connections

The recommended characteristics for the IF interface (with the LNB) are given in ***Table 1***.

4.4.10.b Control of Peripheral Devices

It is recommended that the DiSEqC™ 2.0 or higher be implemented in the IRD.

When used with DiSEqC™-enabled peripheral devices, such as LNBs, this will facilitate automatic equipment set-up, adjustment and monitoring. It will also ensure compatibility with modern TMATV networks that employ DiSEqC™ signalling.

4.4.10.c Conditional Access Interface

See ***Section 4.4.8*** on page 27.

Parameter	Value
Input frequency range:	950 - 2150 MHz (minimum)
Number of LNB inputs:	1
Input connector:	IEC 169-24, type F, female
Characteristic impedance:	75 Ω
Input return loss (over input frequency range):	≥ 8 dB
Nominal (-3 dB) bandwidth:	Adaptable, depending upon bit rate
LNB isolation [a]	> 26 dB
LNB Switching Control signals:	DiSEqC™ Level 2.0 or higher
Maximum AFC pull-in range:	± 5 MHz
Maximum group delay variation over the IF frequency range:	20 ns (within any 36 MHz bandwidth)

a. Applicable to dual input receivers where both LNBs are simultaneously powered.

Table 1: IF Interface Characteristics

4.4.10.d VHF/UHF Connections

The IRD should provide a VHF/UHF output for compatibility with VCR and television equipment that is not equipped with video and audio base band inputs. This output would carry the demodulated, decoded and re-modulated video, audio and teletext information of the selected digital programme.

If provided, it should be possible to combine normal VHF/UHF terrestrial signals with the re-modulated signal generated by the digital IRD. The IRD would thus provide a VHF/UHF input for the terrestrial signals and a VHF/UHF output for the combination of these signals and the signal generated by the IRD.

It should be possible to adjust the frequency of the VHF/UHF signal generated by the digital IRD.

4.4.10.e Base band Connections

All IRDs should include at least two Peritelevision (SCART) connectors for connection to a TV and a VCR.
Note that there are two common types of SCART arrangement, one with composite and RGB input/output and one with composite and luminance/chrominance (S-Video) input/output. The inclusion of luminance/chrominance in the Peritelevision connector increases the flexibility in routing when several pieces of equipment are connected together.
Peritelevision connectors may include an audio-video link control protocol such as, for example, the Programme Delivery Control system specified in ETS 300 231. This may be used to generate VCR/TV control signals based on the IRD's interpretation of the SI contained in the digital multiplex. A typical application would be automatic programme recording based on the event information contained in the SI (programme start and stop times).
An S-Video (S-VHS / Hi-8) connector may be provided in order to supply a high quality[5] luminance/chrominance pair to a VCR, a television set or other equipment. Its implementation is optional.

4.4.10.f Analogue Audio Outputs

As a minimum, Left and Right audio sockets should be provided for audio connection to a hi-fi system.

4.4.10.g Digital Interfaces

As a minimum, receivers should implement an RS232-compliant serial port or a parallel port (IEEE 1284) in the IRD. The purpose of this digital interface is to facilitate the transfer of data conveyed in a DVB multiplex to a PC (for example, software downloading).

Manufacturers may wish to also consider the use of high performance interfaces such as IEEE 1394.

4.4.10.h Telephone Connection

A "return channel" from the IRD to the broadcaster/service provider is commonly implemented via the public telephone network. Alternative solutions are possible, as discussed previously in ***Section 3.4.5.***

Receivers containing an integral modem should incorporate an RJ11 socket with a suitable local-end connector on an adapter cable to connect the modem to the user's telephone line. All modem equipment should correspond to the requirements of the telecommunications licensing authority of the country in which the equipment is to be used. The modem should implement line sensing to avoid use of the interaction channel when the line is in an off-hook or busy state. Implementation of a return channel via the telephone network is optional. If this facility is provided it should conform to ETS 300 801.

[5] *Reduced luminance/chrominance cross-talk and increased luminance bandwidth*

5. INFLUENCE OF THE CLIMATE

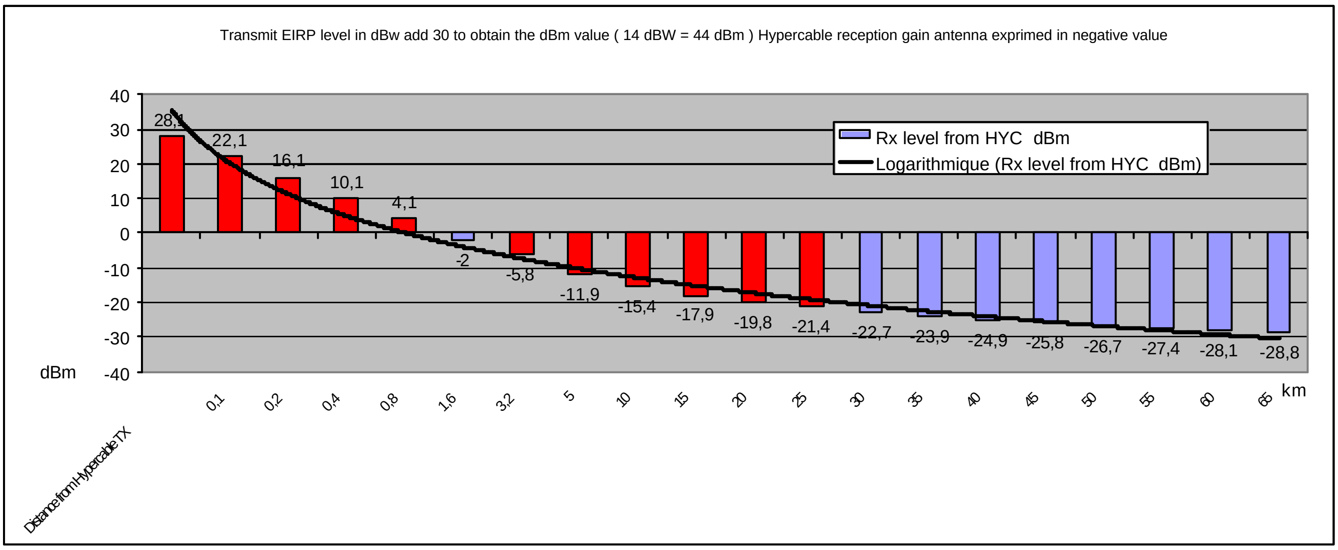
5.1 Hypercable BWA MVDS Reception characteristics

The Hypercable terrestrial transmission is broadcasting a signal horizontally.

The main characteristic of horizontal broadcasting is that the signal level is very dependent of the distance of the client from the transmitter.
The signal will be very high when the client is close to the transmitter and very low when the client is far from the transmitter.

Due to these specifications and due to the reception decoder limitations (chapter 2), it becomes impossible to receive the signal when the client is located outside the reception level limits, (Limits which are matching with the reception decoder limits - maximum and minimum). This means that when the client is living inside the area, which is receiving the signal above the decoder's limits or bellow the decoder's limits, the decoder won't be able to receive the signal correctly.

Figure 10



The **figure 10** shows a typical terrestrial broadcast network, carrier level at the STB input without HyCAnC antenna Near to Far management.
EIRP is 14 dBw (44 dBm) ant total Planar LNB gain is 80 dB. The signal level in this case are not processed by HyCAnC same if standard Antenna LNB System are in use.
The STB cannot receive and the Antenna LNB is saturated up to 30 km away the transmitter location.
The signal is only available above 30 kilometers from the transmitter (decoder limits –70dBm to –25dBm).
No signal can be received bellow 30 km from the transmitter (too strong signal).

5.2 Differences between Satellite and Terrestrial reception

The Hypercable reception (or any terrestrial network) reception has totally different characteristics than satellite reception.

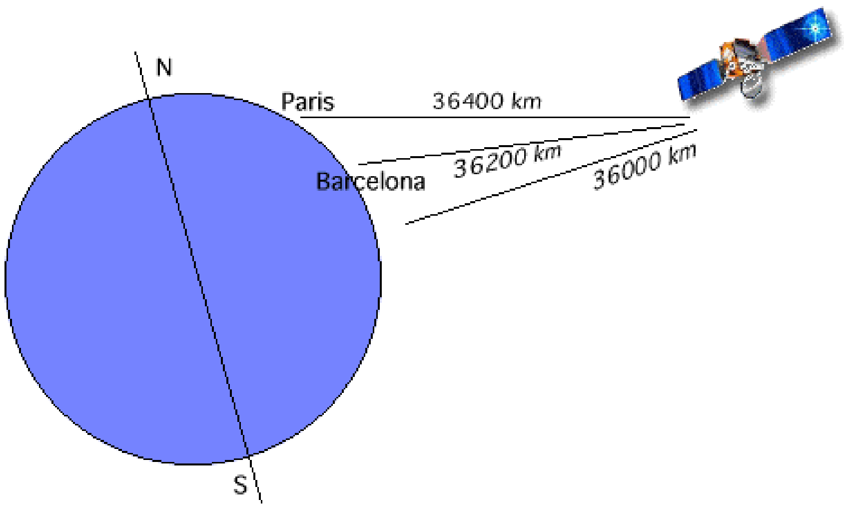
Satellite reception signal level is usually uniform inside a quite large area.
The signal is quite the same for an entire continent (or country) and there is no chance for the client to receive too much of satellite signal wherever he is located inside the satellite footprint (excepted if the client is using a too big satellite dish).

<u>Example of satellite reception:</u>

Satellite Reception Field Levels -150 dBw (-120 dBm):

- Paris = -120 dBm dist from Satellite= 36,400km
- Barcelona = -120 dBm dist from Satellite= 36,200km

Figure 11: Example of satellite reception



5.3. Various Fading And The Effects of Rain

Hypercable fading characteristics:

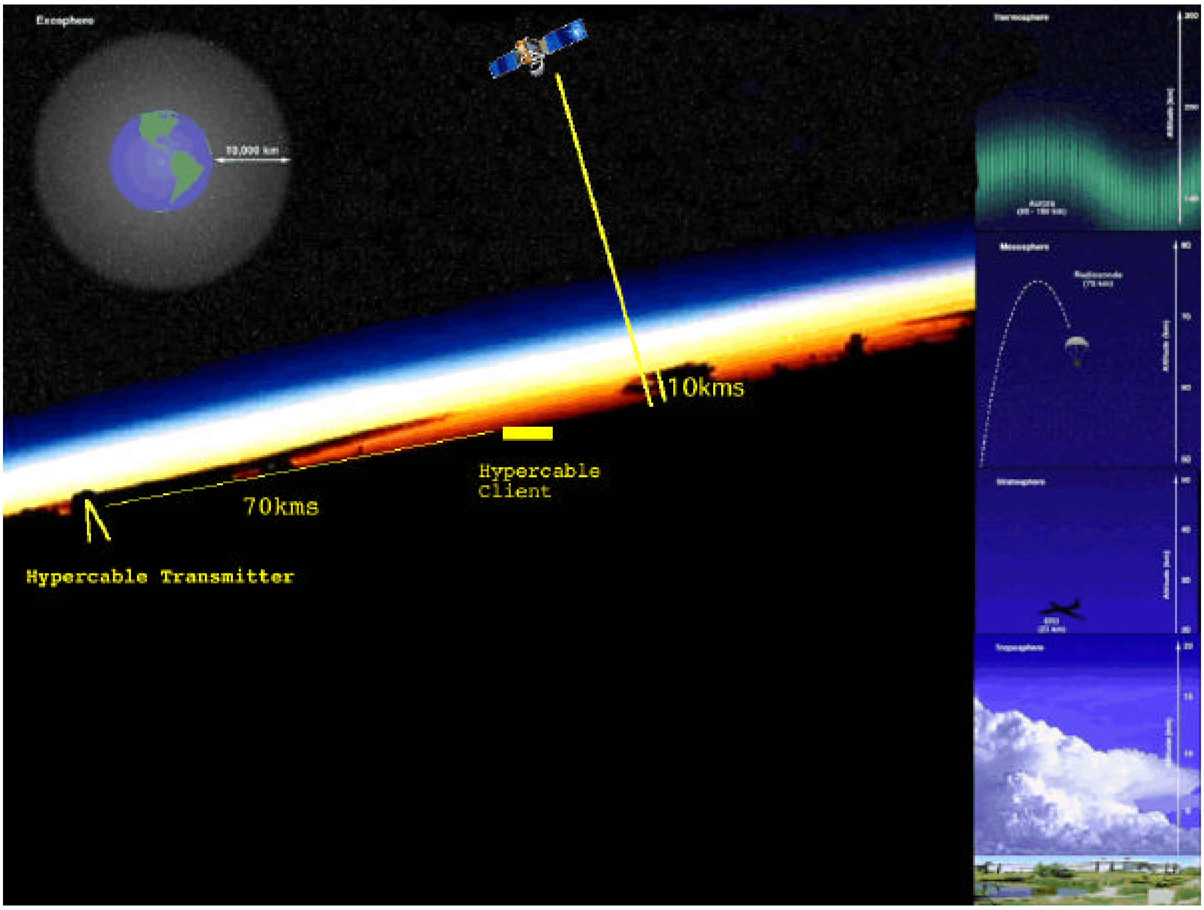
Operating Hypercable terrestrial network is imposing different constraints than satellite.
Fading is much more sensitive when doing Hypercable terrestrial broadcast than doing Satellite reception.

Signal levels are very dependent of the atmosphere conditions and the distance of the atmosphere that they go through. The most disturbing area of the Atmosphere is found between the ground level and 5,000 meters altitude, where the clouds and weather are to be found.

Satellite signals are crossing the Atmosphere layer vertically and therefore a very small part of the disturbing areas (3 km).

HyperCable signals are found ONLY inside the lower atmosphere layer, which is the most disturbing area for the signal levels (Rain, Snow, Sand Storms, Pollution dust, ducts, Raleigh fading, multipath …)

Figure 12: Hypercable signal



The Worldwide Hypercable Deployment area includes regions where the quality of the received signal is heavily influenced by rainfall.

There are two effects:

- A reduction in the received signal strength due to absorption of the signal by raindrops as it passes through the rainy atmosphere.
- An increase in the electrical noise received by the antenna.

Each of these effects is briefly discussed in the following sections.

The antenna size in an individual or collective reception system is chosen to provide a margin against the combined effects of rain attenuation and thermal noise increase. This margin and its implications are considered in ***Section 5.5***.

➢ 5.4.1 Rain Attenuation

The amount by which the signal is attenuated by rain depends upon the rainfall rate. Prolonged periods of light rain will cause some attenuation, but usually not enough to disrupt the service (provided that the receiving system is sized and installed correctly). However, short periods of heavy rain produce high levels of attenuation that may cause loss of reception (an “outage”).
Severe rainstorms are far less common than longer periods of light rain.

Consequently, outage events occur relatively infrequently. It is not possible to design an economically viable satellite system that eliminates the risk of rain-induced outages entirely. Instead, the system is designed so that signal can be received with good quality for the vast majority of time.

The services delivered by the Hypercable BWA are designed for a minimum availability of 99.5% of the average year at those receive locations that are worst affected by rain. This availability or better should be achieved by all receive installations, provided that the recommendations given in this document are respected. In particular, the minimum antenna HyCAnC™ gain guidelines of ***Section 6.3*** and the installation procedures of ***Section 6.4*** should be observed.

➢ 5.4.2 Moisture

Because Hypercable BWA signals travel through the atmosphere, a rain cell anywhere in the signal path will cause some reduction in the strength of a transmission. Satellites are located in the a geostationary orbit 35,800 km above the earth, and since rain only forms in the troposphere which extends 10 km above the earth, a signal travelling through a rain cell will experience attenuation during only a small portion of its transmission path.

Terrestrial microwave transmissions are more susceptible to the effects of rain attenuation because their signal paths are entirely in the troposphere, and the signal may pass through an entire rain cell. For terrestrial Hypercable BWA the cell portion increase by the travel in a full cell and more than one rain cell (***Figure 12***)

➢ 5.4.3 Frequency

Generally, rain attenuation increases as the signal frequency increases. Therefore, transmissions at 4 GHz will experience insignificant attenuation, while transmissions at 12 GHz will experience greater attenuation. For 4 GHz signals to be affected would require rainstorms approaching hurricane conditions. Signals at higher frequencies can be affected by less severe storms.

This is due to the wavelength of each frequency and the size of the raindrop through which the signal has to pass. Transmissions at 4 GHz have a longer wavelength than transmissions at 12 GHz, and are less susceptible to rain attenuation. For example, a 4 GHz frequency has a wave-length of approximately 7 cm, and a 12 GHz frequency has a wavelength of approximately 2 cm. Any raindrop in the path of either signal which approached half the wavelength in diameter, will cause attenuation.

➢ 5.4.4 Time

How long a transmission will be affected by rain attenuation and how deep the attenuation will be is determined by the amount of rainfall. Generally, signal strength can be affected for two to three minutes during an average rainfall, and up to 15 minutes for extremely heavy rain periods. However, attenuation periods of up to 15 minutes are extremely rare, and although signal strength may be affected, there will be no noticeable effect on transmission as long as the attenuation does not exceed the allocated rain fade margin.

Figure 13 shows the level of rain attenuation in Europe and Africa.

Note: For area E please consider if at 25 km from the Hypercable transmitter your system design give you 20 dB of FADE MARGIN the losses for Rain at 0.01% of the time (52 minutes) in one year are 22 mm by hour, the table give in 11 GHz a losses level of 0.5 dB by km the sum is 0.5 x 25 = 12.5 dB, the system is still reliable at 25 km for a rain at 22 mm/h.

➢ 5.4.5 HyCAnC™ the Absolute Necessity

The Existing Physical Limitations in the receiver system.

For example a satellite decoder can't receive a signal above –25 dBm and lower than –75dBm this in the L Band (950-2150 MHz for a full L band with 24 transponders 40 MHz each) the decoder can work only inside these limitations (-70 to –20dBm). But in fact with the maximum antenna LNB performances if the signal is maximum –25 dBm the Thermal earth Noise is from –58 to –50 dBm the STB margin work is only 10 dB high than the noise.

The antenna is made with a passive device (offset - dish – array – dipoles…) and an active device, which amplify the signal given by the Passive device (LNA Low Noise Amplifier).

The Active device is made of several amplification stages LO and Mixer. These amplifiers have got similar limitations as the Receiver (Maximum and Minimum). If the Amplifier is getting too much signal from the antenna then it will saturate and won't work properly. (Transmodulation, Frequency Pulling, Intermodulation …etc).

To summarize, both of the Receiver and the Antenna have limitations (maximum and minimum), which are restricting the area where a signal can be received. This is not a problem for the satellite reception because the signal level is usually uniform inside a quite large area.

The signal is the quite the same for an entire continent (or country) and there is no chance for the client to receive too much of satellite signal wherever he is located inside the satellite footprint, (excepted if the client is using a to big satellite dish), also the fade margin is calculated for a maximum of 10 dB and never occur to change this rules.

For terrestrial Hypercable BWA systems the problem is another, the client can be located from 200 meters or at 20 km from the transmitter and to use the same antenna receiver System this require to manage no less than 40 dB of Near to Far Fading more the rain fading (Also Raleigh fading, Sand Storm fading, Ducts positive or negative selective fading…etc) near 12 dB at 20 km in area E. The HyCAnC™ antenna receiver System require to still provide a valuable signal at 20 km with 52 dB fading, to solve this problem it is required to use HyCAnC™ full Embedded in the antenna or spread inside the antenna system and inside the STB reception software for a maximum of QOS.[6]

[6] Thomson and Pace STB are Hypercable HyCAnC certified.

Fiaure 13 :

Rain Climatic Zones of Europe and Africa

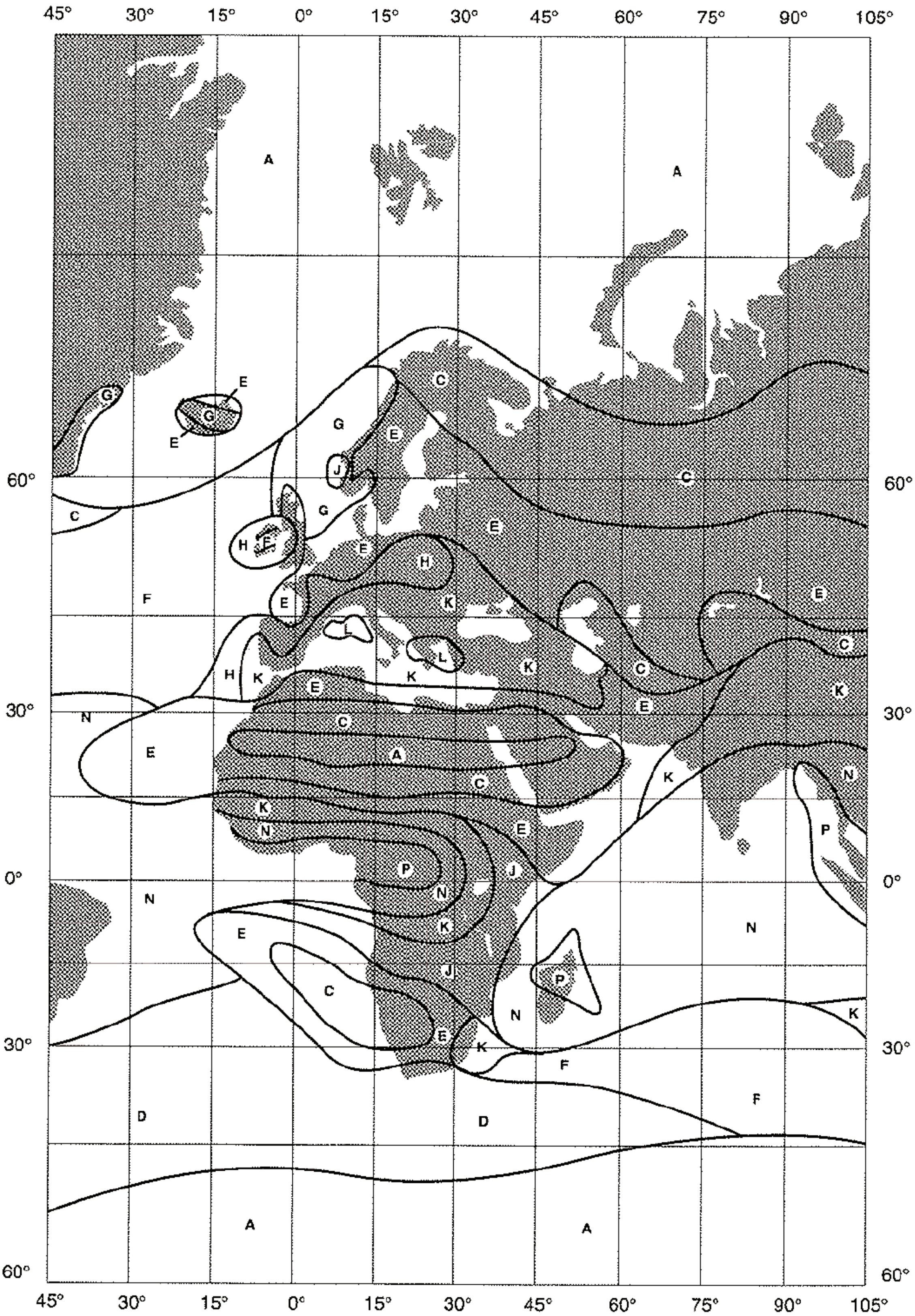
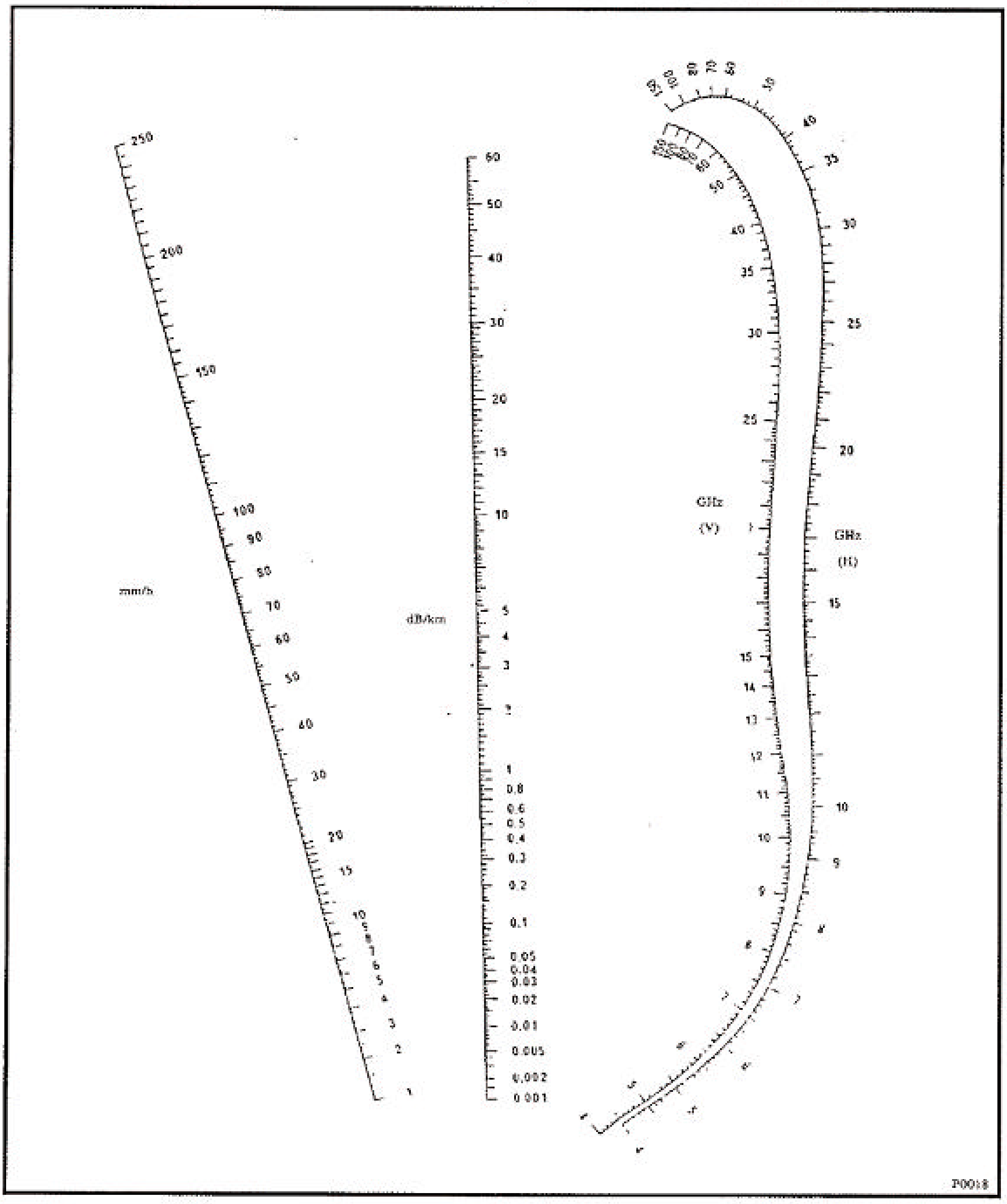


Table 2 : Rain Climate Zones
Rainfall Intensity Exceeded (mm/h)

Percentage of time (%)	A	B	C	D	E	F	G	H	J	K	L	M	N	P
1.0	<0.5	1	2	3	1	2	3	2	8	2	2	4	5	12
0.3	1	2	3	5	3	4	7	4	13	6	7	11	15	34
0.1	2	3	5	8	6	8	12	10	20	12	15	22	35	65
0.03	5	6	9	13	12	15	20	18	28	23	33	40	65	105
0.01 4 [illegible]	8	12	15	19	22	28	30	32	35	42	60	63	95	145
0.003	14	21	26	29	41	54	45	55	45	70	105	95	140	200
0.001 5 minuts	22	32	42	42	70	78	65	83	55	100	150	120	180	250

Fig. 14 – Specific Attenuation due to Rain

(V): Vertical Polarisation (H): Horizontal Polarisation



5.5. SKY NOISE INCREASE AND THERMAL EARTH NOISE (G/T DEGRADATION)

Every object radiates a certain amount of electrical noise, which increases with the physical temperature of the object.

The receiving antenna collects unwanted noise energy along with the signal energy. Since it is pointed at a location in space, it "sees" a very cold object (space) under clear sky conditions (little or no cloud). Since it is pointed at a location on the earth, it "sees" a very hot object.

During rainfall, it sees a rainy atmosphere at a much higher physical temperature than space. Consequently, the level of electrical noise received by the antenna increases when it rains. The magnitude of this increase depends upon the rainfall rate and hence, indirectly, on the level of rain attenuation.

This effect is sometimes referred to as the "sky noise increase". It is also referred to as "G/T degradation", because it causes the receiving system noise temperature ("T") to increase, which reduces the earth station's figure of merit (G/T).

Currently in clear conditions the antenna pointed at a location on the earth receive 6 to 12 dB of more noise than an antenna pointed at a location in the space. The rain or the snow are colder than the Earth and the Noise reduce when snow or rainfall. For this reasons G/T are not degraded and the system noise temperature decrease increasing the figure of merit (G/T), Only the rain attenuation level can be considered.

Figure 15 shows the variation of the sky noise increase with rain attenuation. Precise values depend upon the elevation angle of the receive antenna, as well as the characteristics of the LNB. These characteristics include the feed loss and the noise figure. ***Figure 15*** provides curves for typical noise figures of 0.8, 1 and 1.2 dB.

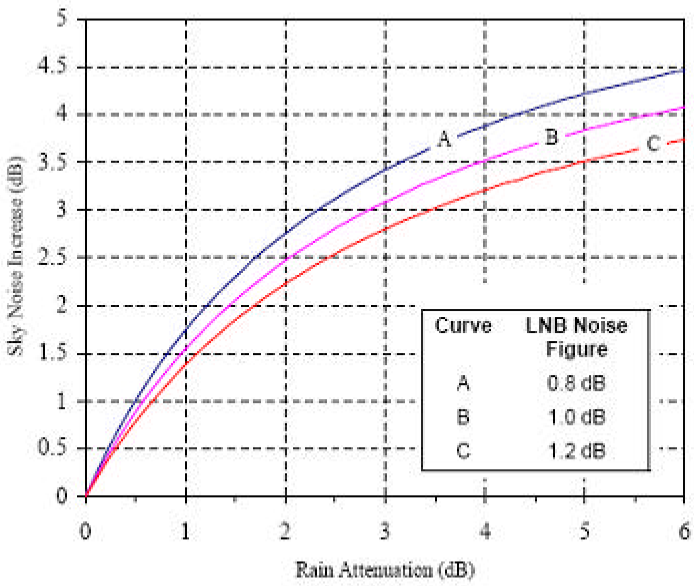


Fig 15: Sky Noise Increase as a Function of Rain Attenuation

5.6. Fade Margin, Clear Sky Margin

All reception systems must provide sufficient power margin to compensate for field level attenuation during rainfall. The magnitude of this margin is determined by the combined effects of rain attenuation and Multipath (Also Ice depolarisation).

The minimum HyCAnC™ antenna performance recommendations are based on a clear sky, Multipath, Raleigh fading, rain fading cumulated …margin of 20 dB, which is sufficient to provide a service availability of at least 99.9% of the average year everywhere within the Hypercable BWA coverage service area. This margin comprises approximately equal levels of rain attenuation and various terrestrial fading. Using a larger antenna would provide a greater margin but with care and in the limit of the HyCAnC™ LNB saturation and, consequently, improved service availability, Operating with a large clear sky margin of 20 dB or more requires special attention to be paid when installing the antenna to ensure that the antenna is correctly pointed towards the Hypercable BWA Transmitter. This very and essential important subject is considered in ***Section 6.4***.

6. INSTALLATION GUIDELINES

6.1. DVB TRANSMISSION FREQUENCIES

Each DVB-MC/S carrier (digital multiplex) is transmitted via a dedicated Hypercable carrier but in one transponder only, one transponder can broadcast up to 32 carriers. The frequency of each carrier is selected by each LDQPSK Digital Signal Processor Modulator inside the limit (1 GHz bandwidth) of the transponder in which it is conveyed. Usual KU Band frequencies are listed in ***Table 2*** of ***Annex A***.

6.2. CARRIER EIRP

Each carrier EIRP in Hypercable MVDS BWA systems can be adjusted for the required coverage, or imposed by the local regulator. For example in USA the FCC give 14 dBm by carrier in 24 MHz bandwidth in the band 12.2 to 12.75 GHz, In Ireland the regulator give power up to 42 dBm but need a field of 48dBuv. Most of others countries such as Slovenia, Vietnam, Algeria allocate EIRP up to 43 dBm by carrier.

6.3. GUIDELINES ON HYCANC™ ANTENNA GAIN

The recommend HyCAnC™ antenna size depends of the field level produced by the Hypercable Transmitter. The field level depends of the transmitter EIRP and depends of the distance of the user from this transmitter; by the mean of the coverage survey the Hypercable operator knows the field at +-3 dBm.

- From -60 to –105 dBm the Planar 200 is recommended
- From –105 to –115 dBm the Planar 36 or Inverted Offset is recommended or Planar 540
- From –115 to – 125 dBm the Planar 540 is recommended
- From -125 to – 135 dBm the Hycospa semi parabolic inverted Offset is recommended.

But to have high reliability and because the transmitter is not in most of the cases located on a very elevated mountain, the medium coverage of a cell is up to 25 km LOS and the field for 42 dBm EIRP is not less than –102 dBm. The HyCAnC™ Planar 200 can be used for all the area.

For community reception systems (TMATV), a little more gain is recommended to provide an additional margin for losses during fading events[7]. A larger antenna gain will also increase the C/N ratio.

The final decision on antenna size should be based on local experience, taking into account the specific equipment used, as well as the required clear sky margin. The EIRP maps given in ***Annex A*** can be used as a basis for dimensioning collective reception systems for particular geographic regions.

[7] *Taking care to not exceed a total LNB level of –8 dBm DCP for the full 1 Gigahertz capacity 24 carriers at –25 dBm DCP level for each carrier*

6.4. ANTENNA POINTING

➢ 6.4.1. Obtaining the Correct Clear Sky Margin

It is strongly recommended that all antennas are precisely pointed to obtain the maximum receive signal strength and the highest possible service availability. DVB-MC/S reception will degrade extremely quickly once the threshold bit error rate (BER) has been reached.

The picture and sound quality of a digital television signal is a poor indicator of the installation quality of a reception system. Under clear sky conditions, the picture and sound quality obtained with a well-pointed antenna is perceived to be exactly the same as that obtained from a badly mispointed antenna. However, when it begins to have Multipath, Raleigh fading rain the mispointed antenna will quickly lose the service, whereas a high-quality installation will only lose the service under extreme and infrequent weather conditions (e.g. during thunderstorms) and will achieve the minimum service availability target (good quality reception for at least 99.5% of the year).

Figure 16 shows the reduction in the clear sky margin that occurs when the antenna is mispointed. If, for example, a 90 cm antenna were badly pointed by only 1° is azimuth or elevation, then the clear sky margin would be reduced by more than 3 dB to around one-half of its target value. During installation, this reduction in the received signal level may go unnoticed because it does not affect the picture and sound quality. Furthermore, since the margin is still reasonably high, it cannot be detected by observing the BER indication provided by the IRD (if any).

In Terrestrial microwave mode the badly pointed effect is strongly devastating for the C/N and the BER than in satellite mode due to Multipath effects. For this reason the usual Satellite Dishes 45 or 60 or 90 or 120 cm are strongly inadvisable because of the effects of the side lobes; the regular Offsets are more inadvisable increasing the Earth noise by 6 dB (the lower side lobe se the ground and the Multipath coming from the ground).

For this reasons and to have a minimum of Multipath, Planar Space and angular Diversity are Highly recommended and also Inverted Offset semi parabolic antennas or full Shielded center feed parabolic antenna for Hypercable repeater use or a strong TMATV equipment.

Please see:

ANNEX B FOR MOUNTING AND FRESNEL ZONE CLEARANCE

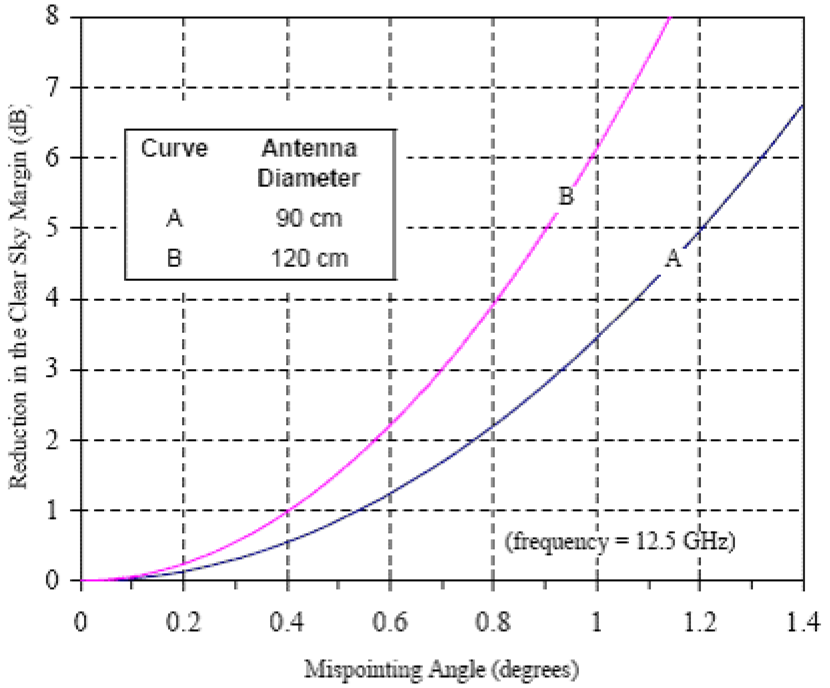


Fig 16. Variation of Clear Sky Margin with Mispointing Angle

A 1.2 m antenna is more sensitive to mispointing errors, as can be seen by comparing curves A and B in ***Figure 16***.

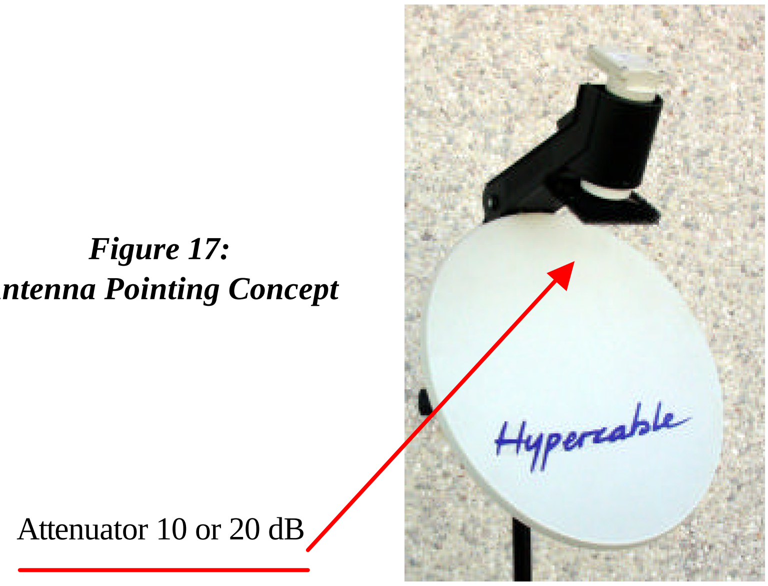
Special installation procedures are recommended in the following sections for precision dish alignment. It is strongly recommended that installers follow these guidelines to ensure the long-term satisfaction of their customers and to minimise the risk of having to re-visit existing installations in order to improve their tolerance to rain fading.

➢ 6.4.2. Antenna Pointing Concept

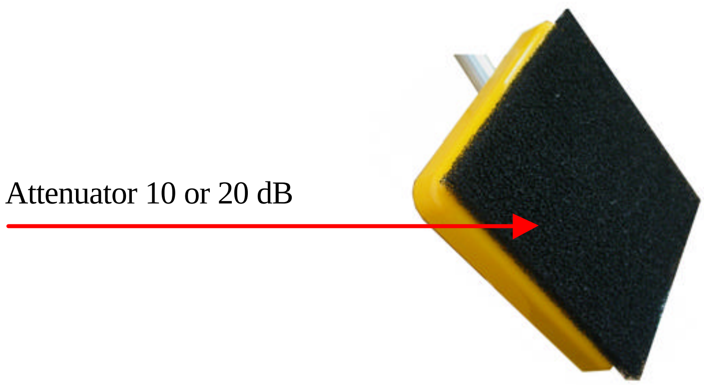
Wherever possible, precise antenna pointing should be carried out with a signal strength meter. Nevertheless, recognising that this equipment can be expensive and may not always be readily available, an alternative method has been developed which is described in this section.

The basic concept is to introduce a calibrated attenuator between the antenna's reflector or the antenna Space Diversity array and the source, as illustrated in ***Figure 17***. This device is fabricated by MDSi to also simulate fading.

Figure 17:
Antenna Pointing Concept



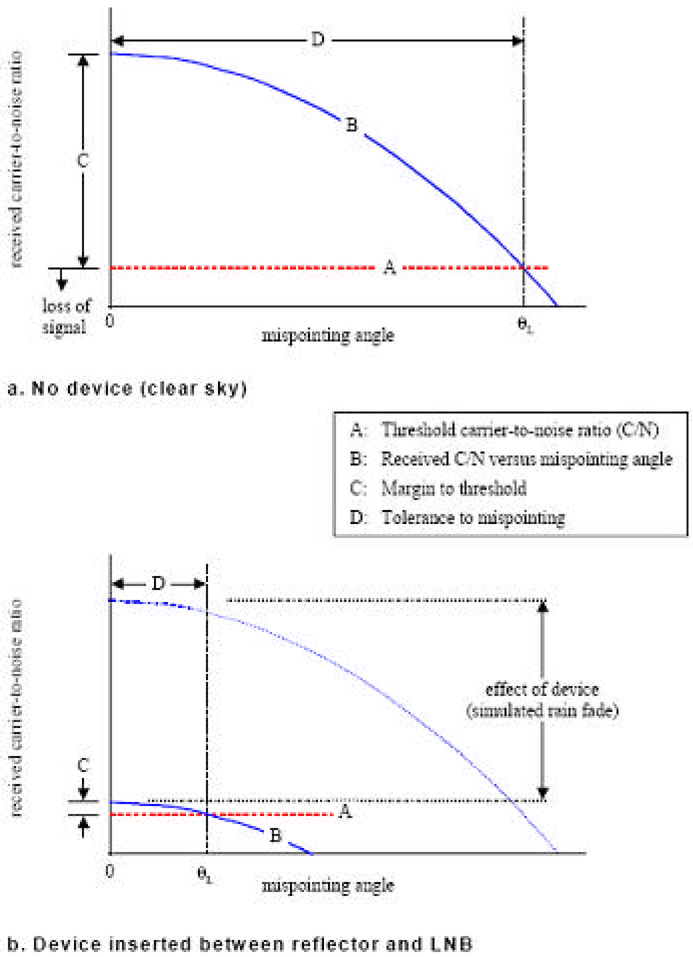
The purpose of the device is to simulate the effects of various fading and rain (attenuation and noise increase) when the antenna is installed under clear sky conditions. The antenna can then be pointed whilst it is operating with a small margin, which allows mispointing errors to be more readily detected and hence the antenna to be installed with maximum precision. Once the device is removed, the desired minimum clear sky margin of 20dB is obtained without the need for expensive test equipment.



The basic principle of operation is illustrated in ***Figure 18***.

Figure 18a shows the variation of the carrier-to-noise ratio (C/N) of the received signal with the antenna-mispointing angle under clear sky reception conditions and with no device inserted between the reflector and the LNB. The C/N is maximised with a mispointing angle of zero (perfect antenna alignment). This gives the maximum possible rain fade margin (labelled "C" in the figure).

Figure 18. Principle of operation of the Antenna Pointing Concept



As the mispointing angle is increased, the C/N reduces until it falls below the threshold C/N (curve “A”) at an offset angle of θ_L, at which point the service is lost. Since it is difficult to detect antenna alignment errors until the mispointing angle approaches θ_L (until the system is operating close to threshold), the receiving system is tolerant to mispointing errors over the approximate angular range 0 to θ_L degrees. In the case of clear sky reception with a margin of 20 dB, the value of θ_L is rather large (approximately 3° for a Planar 200 cm antenna and 1° for a planar 540 antenna).

Figure 18*b* shows the effect of inserting the device between the reflector and the LNB under clear sky conditions. The device degrades the C/N so that, with perfect antenna pointing, the C/N is slightly above the threshold value. The antenna then has to be very precisely pointed for the signal to be correctly received. The consequential reduction in the tolerance to mispointing is illustrated in the figure (labelled “D”). Put another way, the device significantly reduces the maximum possible mispointing error, leading to a far more precise installation than would otherwise be the case.

➢ 6.4.3. Attenuating Device for Accurate Antenna Pointing

The device to be inserted between the LNB and the antenna reflector during installation is available on request near MDSi. It will have the following basic characteristics:

- Simple, low cost fabrication from an inexpensive, readily available material.
- Robust (tolerance to mishandling, wear and tear).
- Simple to use.
- Flexible, offering a range of different attenuation values (e.g. by thickness of material).

➢ 6.4.4. Recommended Antenna Pointing Procedure

6.4.4.a Azimuth and Elevation Angle Charts

Azimuth angle and elevation angle are calculated before each client installation with the Hypercable Mapper Software supplied by MDSi to the Operator.

The azimuth angle is measured in the local horizontal plane and is positive in a clockwise direction from true north.

Note that local magnetic north may deviate from true north at the receive location. Consequently, if a magnetic compass is used for azimuth alignment, the antenna may not be properly pointed in azimuth. The azimuth angle can be corrected by the value of local magnetic deviation if this is known. The azimuth elevation chart are provided by the local Hypercable MVDDS BWA local operator for each Transmitter, Transposer and local repeater for each location to each user and includes corrections for the variation between true north and magnetic north, but does not include the effects of local magnetic anomalies.

Elevation angle is measured in the local vertical plane that contains the transmitter and is expressed relative to the local horizontal. An antenna pointed at the local horizon would thus have an elevation angle of zero degrees. Standard elevation angle depend of the location of each transmitter for 99% of the case this angle is comprise from 0° up to 5°.

The azimuth and elevation information should be sufficient for initial pointing of the antenna and initial acquisition of the desired signals. After coarse antenna pointing, fine azimuth and elevation adjustment should be carried out using the procedures described below.

6.4.4.b Instrumentation

Antenna installation should be carried out using frequency-selective signal strength DCP measurement, BER measurement and HyCAnC™ software and commands. In any case a minimum of hand-held BER meter is preferred to the BER indication provided by the IRD (if any), since it provides a direct reading of the BER at the location of the outdoor unit.

Where necessary, the BER indication provided by the IRD should be used in preference to a subjective assessment of the picture and sound quality since, as explained previously, the latter is a very poor indicator of the accuracy of antenna alignment.

Regardless of the instrumentation used, antennas should always be pointed using the method described below to obtain the highest possible clear sky margin (Fade Margin) and service availability.

6.4.4.c Recommended Antenna Pointing Procedure

The antenna alignment procedure described in this section assumes the insertion of an attenuating device between the Array signal collector or antenna's reflector and the LNB in order to allow the antenna to be aligned as precisely as possible. This concept has been described previously in ***Section 6.4.2***.

This procedure is absolutely necessary to prevent Multipath Fading and cannot be revised for any reason.

Antenna alignment should be carried out using the weakest digital emission in the direction of the intended reception point (the one with the lowest carrier EIRP in fact the carrier of the beacon transmitter 10 dBm lower in power than the service carriers). The Operator give the information can be used for the purposes of identifying the most appropriate beacon transmitter for antenna alignment. Frequently the Beacon transmit a narrow band carrier that's indicate the Hypercable transmitter name and location and others useful information such as channels in use and carriers specifications, also sometime one analogue FM stereo local program is broadcasted by the Beacon.

Figure 19 shows the recommended antenna pointing procedure.

The antenna is coarsely pointed in azimuth and elevation and the LNB polarisation 90° angle is set with the assistance of the information supplied by the local Hypercable Operator. The azimuth, elevation and LNB H/V angles are then adjusted iteratively until the signal is received and the pointing and polarisation angles have been optimised as far as practicable. Take care about the LNB skew angle still absolutely vertical no tilt right or left are permitted because Hypercable is a terrestrial system still perpendicular to the Earth surface.

The next step is the fine pointing sequence, which may need to be performed once or repeated several times, depending upon the initial (coarse) pointing accuracy. The purpose of this sequence of events is to adjust the antenna pointing as accurately as possible using the attenuating device. This device allows attenuation to be introduced into the receiving system in stages[8].

[8] *Details of how this is implemented are available with the HyCAnC antenna manuals. It could be implemented, for example, by progressively introducing 10 dB or 20 dB or twice in front of the antenna Array or the antenna source before the HyCAnC LNB.*

The fine pointing sequence is as follows.

The attenuation is progressively increased until the signal is lost. The last incremental attenuator is then removed, which should cause the signal to be re-acquired.

At this point, the receiving system should be operating close to threshold and will be sensitive to mispointing errors.

Once the receiving system is in this condition, the azimuth and elevation angles should be iteratively adjusted for the best reception quality. Wherever possible, the quality should be measured by a hand-held BER meter or, if this is not available, using the BARLED indication provided by the HyCAnC™ LNB.

Once fine azimuth and elevation adjustment has been made, the attenuator that was previously removed is replaced.

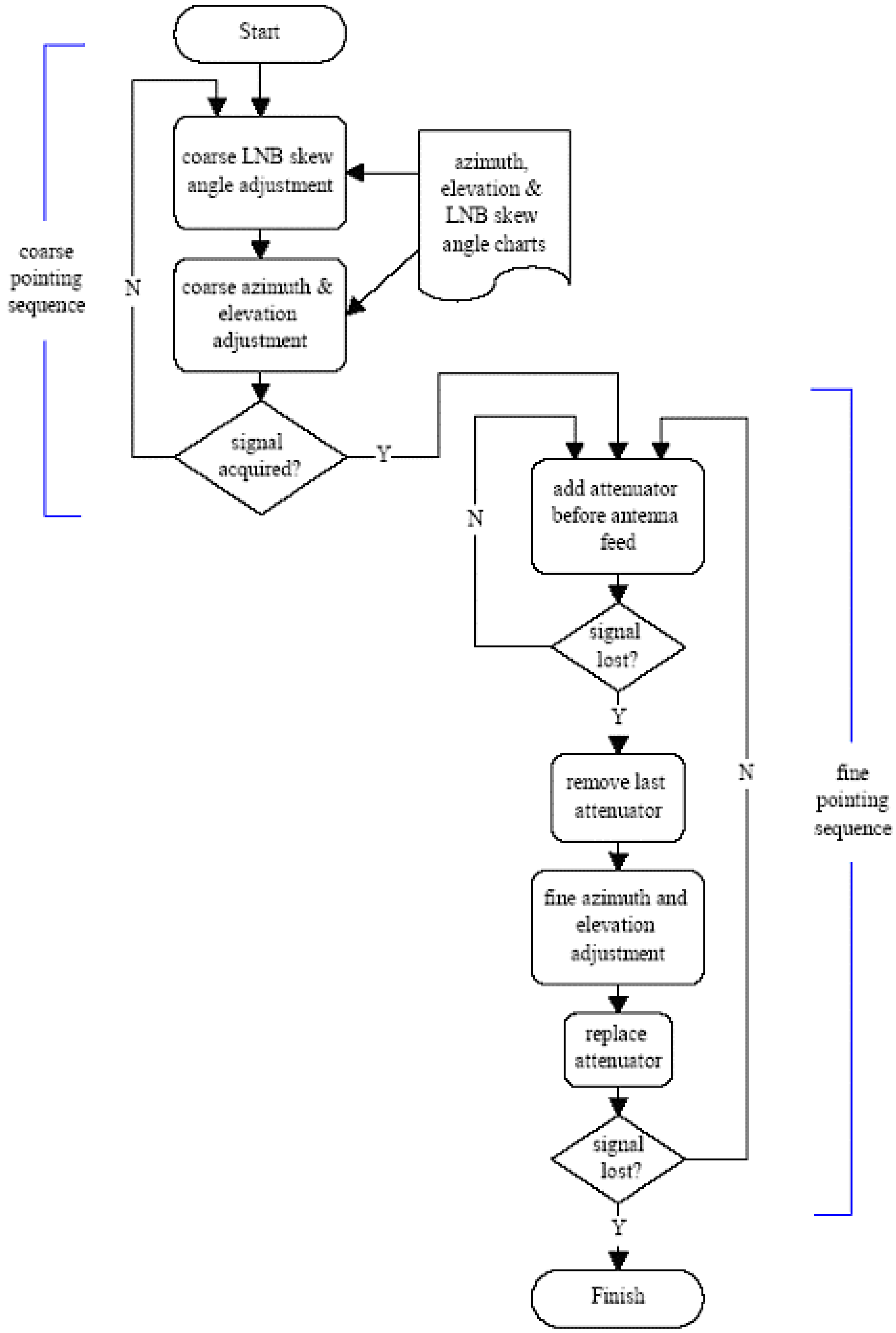


Figure 19 Recommended Antenna Pointing Procedure

If the signal is lost after the attenuator has been replaced, then the antenna is pointed as accurately as possible and the installation is finished. Removing the attenuator from in front of the feed will produce the desired clear sky margin.

If the signal can still be received after the attenuation has been replaced, then the fine pointing sequence should be repeated until the maximum pointing accuracy is obtained.

6.5. Polarisation Alignment

➢ 6.5.1. The Importance of Accurate LNB Skew Angle Adjustment

Good polarisation alignment is important to ensure that transmissions on one polarisation (e.g. X) do not interfere with transmissions from the same Hypercable Transmitter on the other polarisation (e.g. Y).

Usually the Hypercable system transmits on the two polarisations H and V (X and Y). This means that the receiving systems can be exposed to potential interference from transmissions on the opposite polarisation and vice versa. It is very important that the polarisation alignment is made as accurately as possible so that services delivered from the Hypercable transmitter at a later date for Hypercable starting the service in only one polarisation plane, which may use the opposite (Y) polarisation, do not degrade the reception quality of existing receivers. Also in another configurations opposite polarisation can be used for repeaters or Transposer covering shadow areas

Raindrops and Ice also cause a fraction of the X-polarised signal energy to be transferred to the opposite (Y) polarisation. This causes a degree of self-interference when it rains. If the skew angle of the LNB is not accurately adjusted for maximum rejection of this unwanted interference, then the margin of the receive installation will be degraded even in the absence of transmissions on the Y polarisation.

➢ 6.5.2. LNB Skew Angle Chart

The LNB skew angle is measured with respect to the local vertical. Any other position than vertical can be use if this is not specified by the Operator for particular Hypercable transmitter broadcasting in circular or with a special 45° polarisation skew angle.

The Hypercable regular system assumes that the polarisation offset is zero when the LNB is positioned vertically in its clamping bracket. Installers should be take care should therefore be taken when interpreting the LNB skew angle position to ensure that the correct polarisation adjustment is made. The manufacturer’s documentation and recommendations should be referred to in all cases.

➢ 6.5.3. Fine Polarisation Adjustment

Sometime in no Line Of Sight reception configuration (Reception by Reflection or Diffraction) the Polarisation plane can rotate; the LNB skew require a fine adjustment but based on received signal strength or BER measurement is difficult because the measurement is not very sensitive to the LNB skew angle. An alternative method is required to ensure that the skew angle can be set as accurately as possible. This method is to use the attenuator device to have a low BER quality and to adjust the skew to obtain the better BER indication.

6.6. CONNECTIONS

➢ 6.6.1. Interconnection Between the LNB and the IRD

For digital signals, poor connections can often lead to high VSWR and poor or unreliable reception and are the main source of installation faults. Always use good quality F-connectors, making sure they are correctly matched to the size (diameter) of the cable. Usually, crimped type connectors are more reliable, as long as the correct crimping tool is employed.

Always remember to adequately waterproof all externals connections as soon as the installation is operating correctly.

In addition, it is vital to use a High quality coaxial cable for outdoor use.
Digital, Class A is required with 90 dB susceptibility and losses less than 24dB/100 metres at 2200 MHz.
For the right HyCAnC™ 1.11 management by the STB it is required to not use more of 30 meters of cable (more than 8 dB losses) without the use of an L Band amplifier with a slope curve gain.

For the HyCAnC™ versions 1.2 or 1.3 with HyCAnC™ software embedded inside the LNB the previous recommendation is cancelled and 20 dB of losses can be accepted for STB capable to run at –75 dBm.

Also it is vital that the outer shield of the cable is properly connected to the F-connector at both ends of the cable. This will ensure that the communications signals are correctly shielded from interference and that there is an adequate DC path for the LNB power. The antenna and the LNB need to be separately earthed to protect against the possibility of a lightning strike (see below).

➢ 6.6.2. Earthing for Lightning Protection

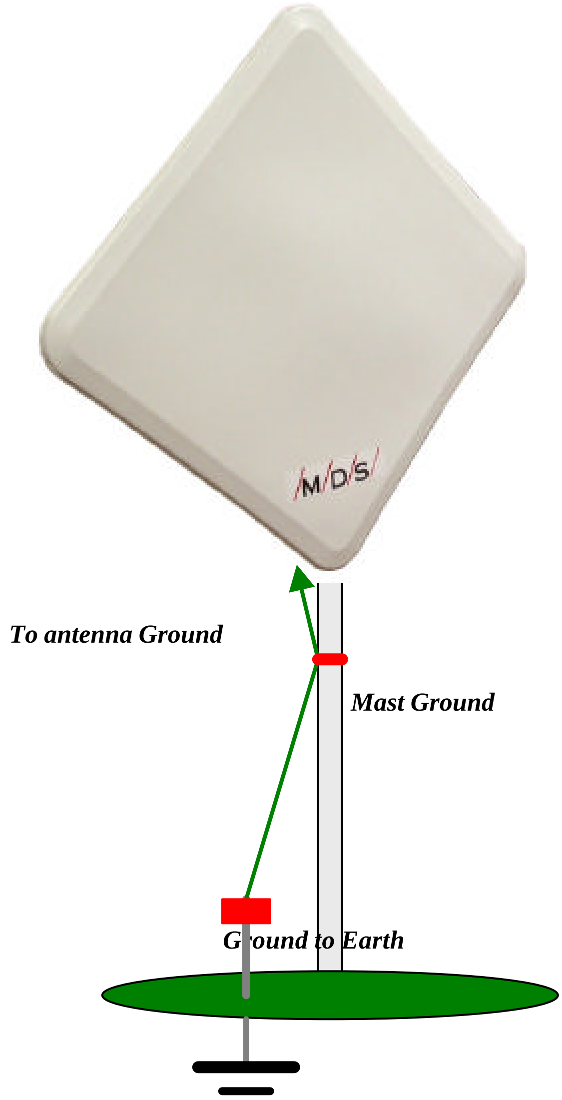
For safety reasons, a lightning conductor must be installed between the outdoor unit and ground, as illustrated in ***Figure 16***.

The earthing strap used for this purpose should be of a sufficient size to safely conduct the current generated by a lightning strike to ground. Hypercable HyCAnC™ antenna is provided with a grounding connection.

The LNB and the antenna are often coated in a non-conducting material for protection against the weather. Earthing connections should be made to exposed metallic areas (antenna mount system and mast) to provide a good conducting path to ground. This can be achieved at the LNB using a metal tag attached to the cable connector. (Cable ground kit)

* Convenient earthing points on the antenna are usually provided by the mounting bolts.

Figure 20: Lightning conductor



6.7. Planar Antenna or Dish Drainage

Any special care are required for antenna drainage or antenna LNB protection for rain and snow; the system antenna LNB design take care about all of this problems.

Only The LNB F plug require a very good waterproof protection (Silicon paste cylindrical "instant clip" system are the better solution) Please see antenna manual installation for this purpose.

6.8. Considerations for TMATV SMATV Installations

Below are some practical points to bear in mind:

- Use a sufficiently Fade Margin antenna system with HyCAnC™ embedded version 1.2 or 1.3 for small TMATV. And use also the MA 3020 L Band Processor C/N increaser for large TMATV

- In IF distribution systems, **never use 90° F-connectors or F-F connectors** (to extend cables) in the main trunk or backbone. A small loss of signal here, due to increased VSWR, can be very difficult to recover in other parts of the network.

- Make sure that the HyCAnC™ antenna LNB system is as flat as possible across the frequency band, particularly at the highest frequencies above 2 GHz. In fact, all components should ideally be rated well above the 2,150 MHz limit that is required for satisfactory distribution of the highest frequencies.

- Make sure that the coaxial cable response is as flat as possible across the frequency band, particularly at the highest frequencies above 2 GHz. In fact, all components should ideally be rated well above the 2,150 MHz limit that is required for satisfactory distribution of the highest frequencies.

- Only use amplification when required and do not overload the inputs to multi-switches or tuners.

- Do not over equalise, HyCAnC™ embedded and MA 3020 are managing the band and the levels. Also DVB-MC/S tuners are designed to accept a flat or falling frequency response. If there is a positive frequency slope (i.e. the higher frequency signals have a higher level), then this may upset the sensitivity of the tuner and cause reception problems.

6.9. BWA Beacon

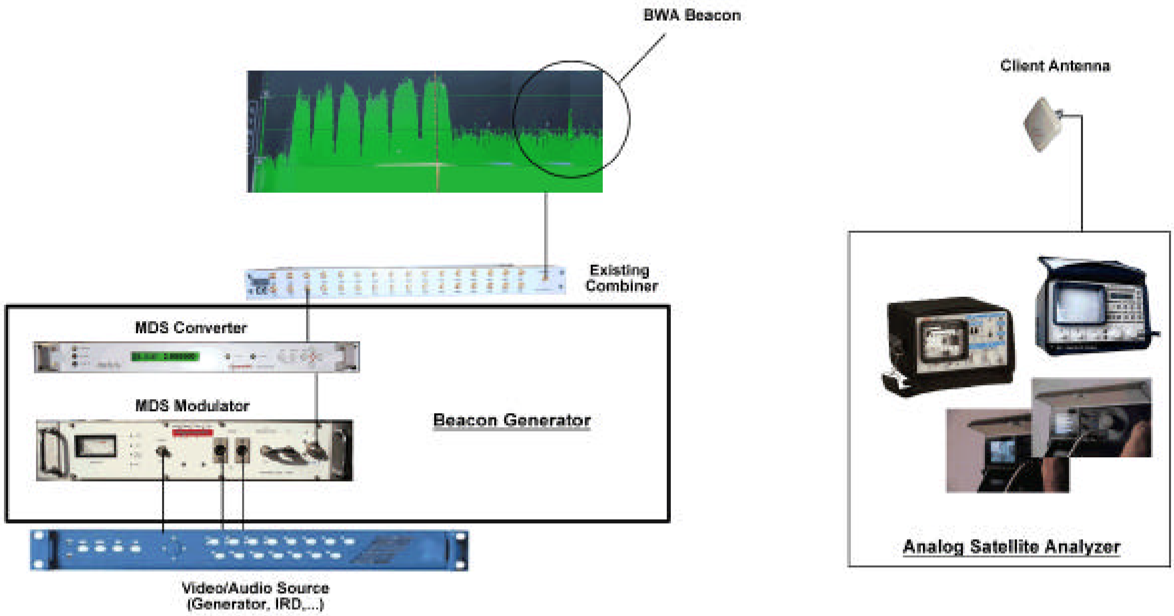


Figure 21

- **Function:**

- **Generate a Radio frequency signals Beacon**
- **Insertion into one polarization of an existing transmission Head End**
- **Identification of the BWA station**

- **Objective:**

This Beacon is allowing the client installer to use any type of Analog Satellite Analyzer for pointing the Hypercable client antennas and keeping the highest quality of service as possible.

Any client that will be installed using this beacon will be insured to have around 10-20dB of quality of service margin.

As the Beacon is locally inserted into the BWA Head End, a specific call sign can be used in the video and audio signal, so that the identification of the BWA to receive will be easy when there are several BWA cells that are overlapping together.

7. CONTACT DETAILS

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Hypercable **® The Wireless Broadband ®**

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