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Digital Terrestrial Television

Requirements for Interoperability

DTG
Liss Mill
Hants
GU33 7BD
United Kingdom

Tel: +44 1730 893 144
Fax: +44 1730 895 460
Web: http://www.dtg.org.uk

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1 Document Overview

1.1 Background

The 1996 Broadcasting Act established the legislative framework for the introduction and implementation of digital television in the UK via a network of terrestrial transmitters. The new services share the UHF frequency bands IV and V used by current analogue television services and will co-exist with these services for a number of years until such time that the UK Government decides on the closure of analogue transmissions.

The transmission of digital terrestrial services makes use of channels which could not be used for analogue transmissions because of interference from other transmissions. Using the COFDM coding and modulation system, it has proved possible to construct national networks for six multiplexes, interleaving them with existing analogue transmissions and transmitting from a network of 81 existing transmitter sites which are shown on the map overleaf:

Multiplex 1, which the Broadcasting Act defines as the network with the best population coverage, has been allocated to the BBC and will carry a simulcast of existing analogue services, BBC1 and BBC2, together with new free-to-air services BBC News24, BBC Choice and BBC Inform.

Multiplex 2, the network with the second best coverage, is allocated jointly to ITV and Channel 4 and Teletext Ltd. Again, ITV and Channel 4 must simulcast their existing services but there is excess capacity to allow for at least one new ITV service and one new C4 service. ITV are expected to run a complementary service to the existing analogue service, free-to-air and supported by advertising; Channel 4 have indicated that they expect to start a subscription movie channel as part of their new offering. Teletext Ltd. will offer similar services to their existing teletext services but with greatly improved quality of text and graphics presentation.

Multiplex A is the first of 4 multiplexes which were bid for by commercial companies. It is expected to be operated by SDN, a company with shareholders S4C, United News and Media and NTL. It will carry simulcasts of the analogue Channel 5 and the S4C programme in Wales. Programme plans are not available at the time of writing but the company have given a commitment to offer some Gaelic programming in Scotland.

Multiplexes B, C and D were awarded to British Digital Broadcasting, a joint venture between Carlton Communications and the Granada Group, and together will offer some 15 channels of programmes all available by subscription.

Licenses for multiplexes 2, B, C and D were granted by the ITC in December 1997 with the condition that services start within one year. The license for multiplex A is pending.

Figure 1-1. Location of Main Stations and Relays

1.2 System Overview

A major aim of this introductory chapter of the document is to provide those wishing to 'see the wood for the trees' with an overview that does not require a deep technical understanding. Figure 1-2 shows a block diagram representing a high-level description of the complete digital broadcasting system. More detailed block diagrams of the individual parts of the system are included later in this part, and in subsequent chapters dealing with each area of the broadcasting system.

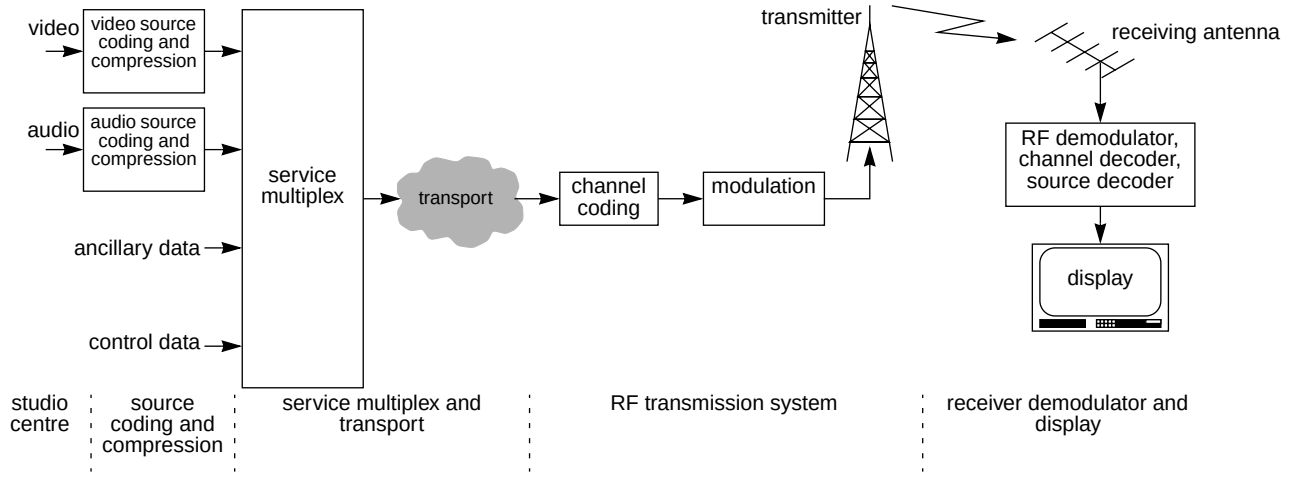

Figure 1-2. Terrestrial System Overview

At its simplest, the digital television system transmits video, audio and various forms of data from one or more broadcasting centres via a network of terrestrial transmitting stations and relays, to receivers in people's homes. The off-air signal fed to the home receiver is collected from either an outdoor antenna mounted so that it has a clear line of sight to the transmitter or from some form of simple indoor antenna. Provision has also been made in the UK terrestrial television broadcasting system for interactivity, allowing viewers to respond to the broadcasting centre via telephone lines or cables.

At its highest level, the system consists of five main processes:

- A broadcasting studio and/or data broadcasting centre.

  This is effectively the basic source of all the signals which are to be transmitted.

- A source coding and compression system.

  This is the area where the high bit rate audio and video signals from the studio undergo bit rate reduction or compression in order to provide signals at data rates low enough to be appropriate for carriage through the subsequent transmission path. In the UK digital terrestrial television system the resulting data will take the form of video, audio, and data streams which comply with the series of MPEG-2 standards ISO/IEC IS 13818-x.

- A data multiplexing (service multiplex) and transport system.

  This part of the overall broadcasting system takes the individual streams of compressed data and assembles them into well defined and identifiable 'packets', which can be multiplexed into a single digital data stream. Ancillary data can be added here including that relating to a common Service Information (SI) system, which can give details of the programmes being broadcast, etc.

  From this point on the transmission system may be regarded as a data container that can contain any kind of data that the broadcaster wishes - it will be flexible enough to carry any combination of MPEG-2 video, audio, or other data, with each packet being coded to identify its type (audio, video, ancillary data, etc.) as well as its position in the bitstream. The 'transport' part of this subsystem assembles the data packets into a transport stream, using the MPEG-2 Transport Stream (TS) multiplex format, which can then be sent over

a range of different data transmission systems, including the various different systems used by telecommunications operators, such as SDH (Synchronous Digital Hierarchy) and ATM (Asynchronous Transfer Mode).

- A channel coding, modulation, and radio frequency transmission section.

  The channel coder processes the digital bitstream into a form suitable for it to be transmitted over the appropriate radio frequency channel, adding extra bits which the receiver can eventually use to detect and correct errors which arise over the transmission path. The encoded signal is then modulated onto a radio frequency carrier in an OFDM (Orthogonal Frequency Division Multiplexing) format, using 1705 carriers, each individual carrier being QAM or QPSK modulated. The UK digital terrestrial broadcasting system must use the ETS 300 744 Specification for Digital Terrestrial Television for the modulation and channel coding of its services.

  It is obviously desirable to co-locate the transmission point of all the digital services in an area irrespective of their location relative to the analogue services. However, in exceptional circumstances, this may not be possible.

- A receiving, decoding, and display system.

  This part of the system includes a radio frequency demodulator, a channel decoder to correct for errors that have occurred along the transmission path, and a source decoder which converts the MPEG-2 signals back into video, audio, and related text, which can then be displayed on a television receiver.

  In addition, the DTG endorses the DVB Common Interface and the DVB Common Scrambling algorithm for conditional access.

1.2.1 Functional Model

When looking at the overall system from the point of view of the functions which will be required at each stage of the broadcasting chain, it is helpful to consider the following diagram, Figure 1-3, and to note that the three dotted vertical lines indicate three of the key interfaces between different parts of the system. To achieve the overall aim of true interoperability, broadcasters and equipment manufacturers must ensure that their signals are in accordance with the appropriate parts of this specification at each of the interfaces shown.

As one example of how important this will be, consider the input on the left hand side of the diagram labelled ‘other bitstreams’. Such bitstreams could be coming from a wide range of programme originators with little knowledge of the complex workings of the digital broadcasting system or its networks. The system has been designed to take account of this, and provided that their bitstreams comply with the requirements specified there should be no problem in ‘plugging in’ such external data streams to the interface at the input to the re-multiplexer.

In a similar manner, the signals labelled as ‘precoded bitstream’ and ‘scrambled bitstream’ can be incorporated into the channel multiplex without changes or re-coding, provided that the bitstreams comply with the interface specifications.

The right-hand side of the diagram gives a simplistic indication of the basic arrangements required for the radio frequency transmission and reception of the digital signals. It is important to note that a co-ordinated transmission plan is being developed, which will ensure that viewers with a single set-top box can receive signals from each of the broadcasters, subject to their having the necessary permissions to view the various services. A major advantage of digital terrestrial transmissions is that they will permit many viewers to use fixed portable receivers with set-top aerials, which will provide high quality pictures. Frequency co-ordination is currently taking place, both nationally and internationally.

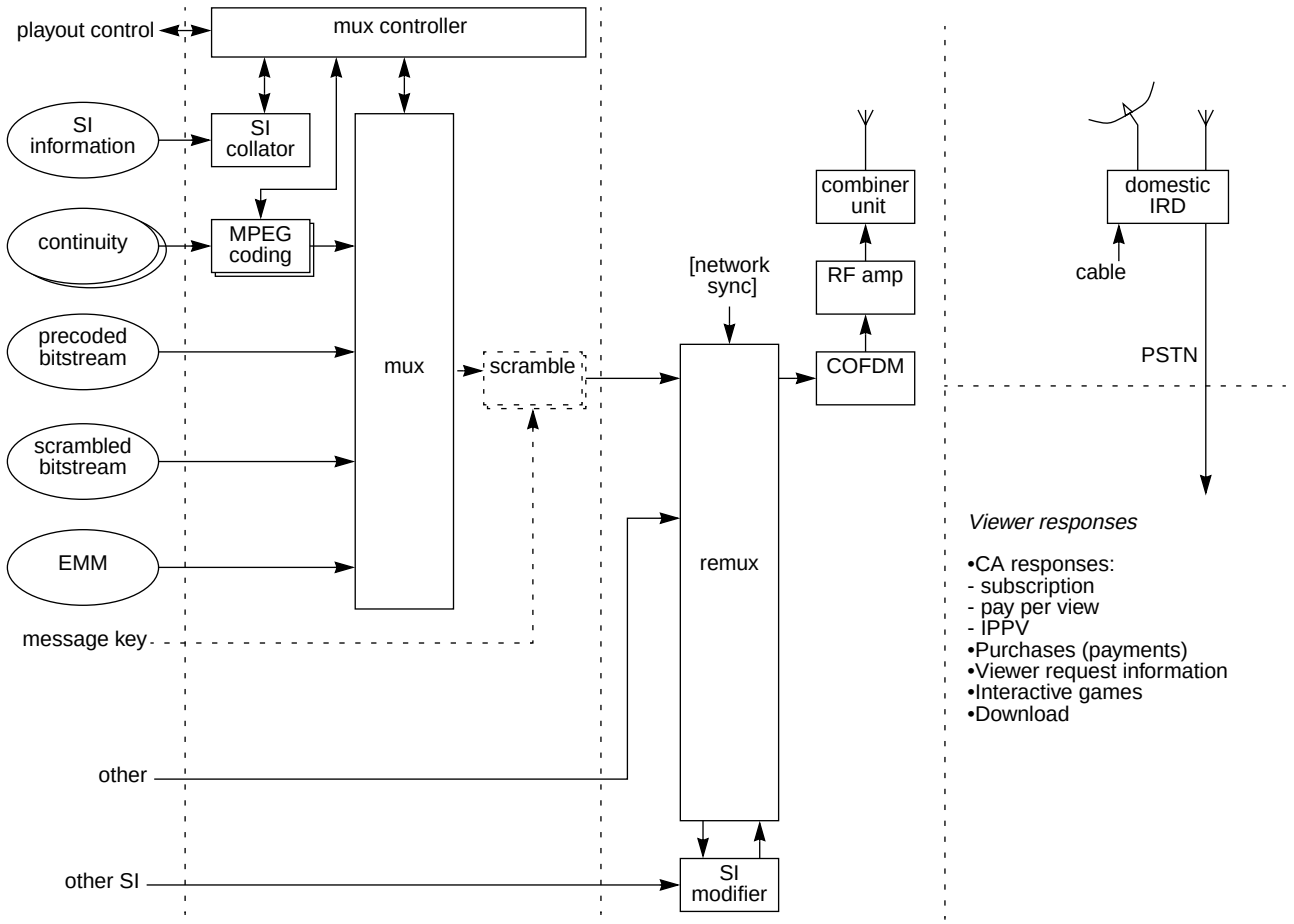

Figure 1-3. Overall Functional System Elements

Figure 1-4 (below) illustrates the individual building blocks of a typical overall system.

Within the individual blocks the links between the typical component parts of the broadcasting chain have been drawn to indicate the most likely scenarios, based on current practice. The playout centre and the network centre follow fairly conventional lines, with the addition of data multiplexing facilities. It is apparent from the diagram of the transmitter area, however, that considerable complexity will be introduced by the necessity to duplicate transmissions at each transmitting site. There is still the need for further discussion on the actual physical location of the 'remultiplexer' function shown at the transmitter site in the diagram, since although it might simplify the distribution system to have these at the transmitter site, in practice there could be problems in putting such key equipment at isolated sites which might be subject to problems due to weather conditions etc. It should be noted that careful adjustment of existing analogue transmitters may be required in order to minimise undesirable intermodulation products due to the addition of extra digital radio frequency transmission signals.

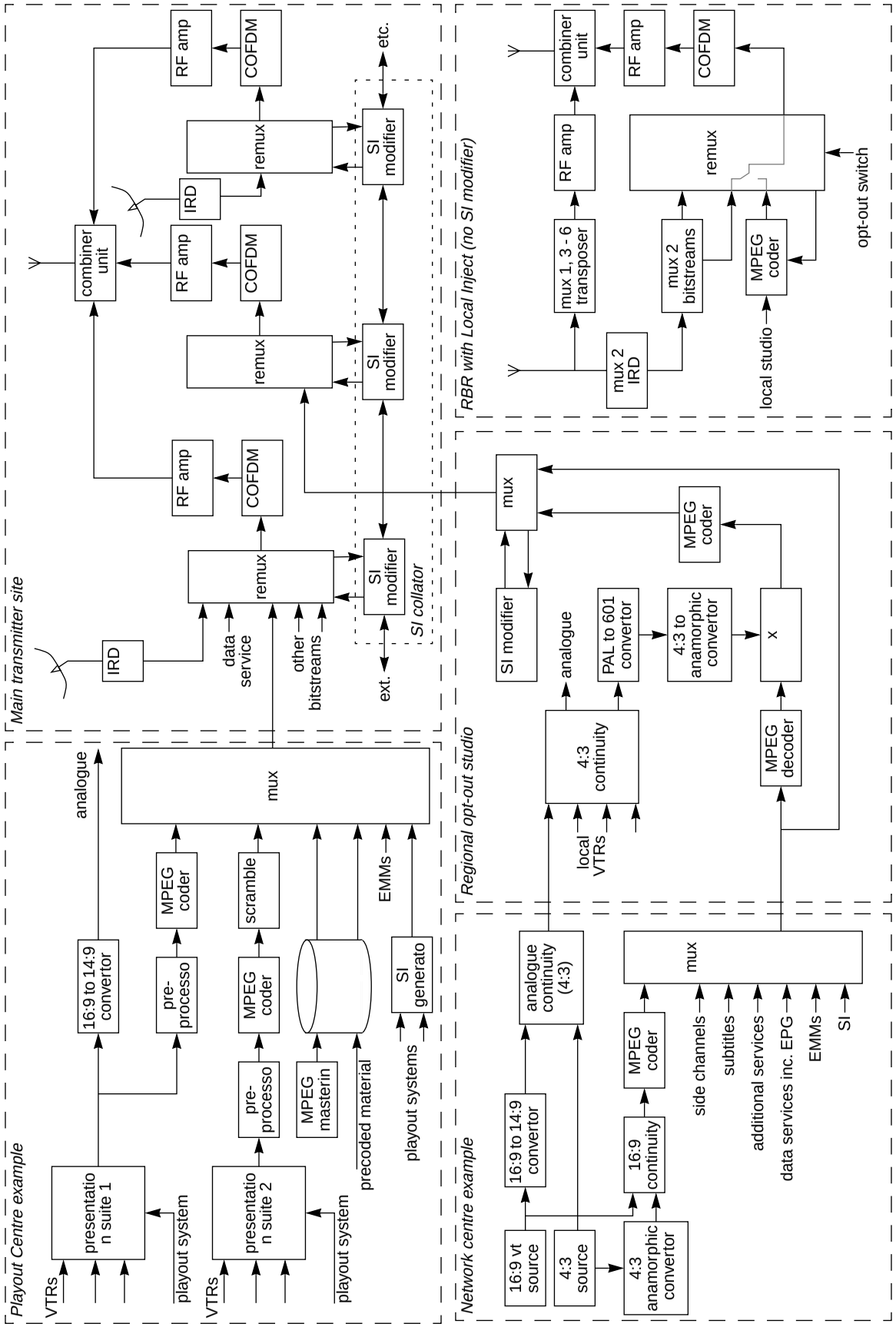

Figure 1-4. Illustrative System Model

1.2.2 The Receiver

Figure 1-5 shows a high-level schematic of a generic digital receiver - a more detailed profile can be found in “Receiver Requirements” in section 23.

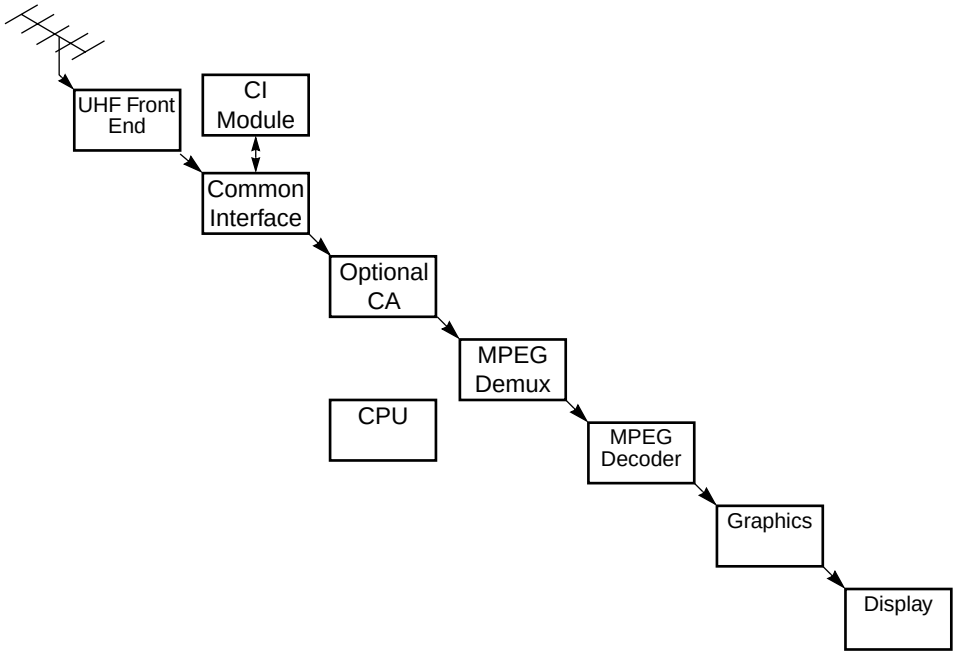

Figure 1-5. Overview of generic receiver.

The key receiver requirement is that any DTT receiver for the UK market must be capable of decoding all UK DTT broadcasts. In the case of pay services the viewer will require the necessary access control entitlements to watch particular programmes. All digital terrestrial receivers will thus offer the viewer access to all available digital terrestrial free-to-air services and to as many pay services as the consumer is willing to pay for. Neither the receiver specification, nor the conditional access arrangements, nor the electronic navigation system must impede this. Collaboration between competing service providers is therefore essential.

The important requirement for all UK DTT receivers to be interoperable renders the UK DTT system different from some existing digital television broadcasting systems, where a single service provider/ transmission operator has specified the complete end-to-end system, including the video and audio coders, modulators and receivers, conditional access system, and the electronic programme guide.

In the UK, however, a free market will operate for the supply of equipment in all parts of the programme chain, including receivers. This will enable the viewer to purchase or rent a receiver from a range of different manufacturers and from high street shops, rather than restricting the choice to equipment made available by a service provider.

The Digital TV Group has developed ‘Receiver Requirements’, details of which are contained within these pages, to enable the retail and rental sector to place orders with a range of manufacturers, without circumscribing different manufacturers’ ability to develop their own distinctive products. Key receiver components such as the digital terrestrial demodulation chip and the tuner, will be commercially available to receiver manufacturers from one or more Digital TV Group member companies.

The new digital receivers will provide a range of attractive features, including:

- high quality picture and sound
- widescreen
- access to new services
- potential for connectivity to cable and satellite
- potential for other ‘pluggable’ features or upgrades and interactivity
- future-proofing

It is expected that digital TV receivers will be available in all shapes and sizes, including ‘home cinema’ large screen receivers, portables TVs with set-top aerials and set-top boxes connected to existing TVs, but whatever type of receiver the customer acquires, it is vital that its ‘front-end’ radio frequency specification (sensitivity, signal to noise ratio, ability to correct errors etc.) enables it to make optimum use of the transmitted digital signals. This book provides full details of the necessary minimum requirements, but manufacturers will remain free to enhance their receiver specifications as they wish.

1.3 Scope of the document

This document provides details of the ‘Requirements for Interoperability’ which are necessary to enable broadcasters and service providers to introduce and implement digital terrestrial television services within the United Kingdom, and gives information about the various national and international technical standards that must be used by all those who have been awarded multiplex service operator Licences by the Independent Television Commission. Adherence to this specification will ensure that there is the maximum possible interoperability between service providers, both in the terrestrial signals transmitted, and in the coverage areas reached by each service.

The document is intended to be read in conjunction with the technical and regulatory specifications issued by the Independent Television Commission.

The document is intended to specify the minimum necessary to ensure interoperability, whilst meeting the requirements of the DTG service providers. It has been written so as to provide the maximum of flexibility to operators, allowing for the introduction and implementation of new services in the future. Wherever possible, technical detail has been kept to a minimum by referring the user to established international standards; a complete listing of the standards referred to is provided.

Detailed references to all national and international technical and operational standards referred to throughout this document are provided in annex B.

1.4 Introduction to 3rd Edition

The second edition of the D-Book was a bible to all those working on the development of DTT in the UK. In this third edition, we have rearranged the sections to bring together normative and informative parts in seven major sections. In this way, we hope to make "navigation" easier and specialists in a particular discipline should now find all the information they want in one place.

- MPEG Transport Stream Characteristics
- Service Information
- RF Transmission and Reception
- Data Services
- Conditional Access and Common Interface
- Receiver Specification
- References and Reference Implementations

The main areas of change from the Second Edition of the D-Book are listed below. However, there are a lot of other refinements and this edition will benefit from careful study.

1.4.1 MPEG Transport Stream Characteristics

A major innovation in the application of DVB standards to UK digital terrestrial has been the definition of an extended means of signalling widescreen formats. The UK broadcasters, many of whom contributed to, or have experience of PALplus widescreen analogue broadcasting, recognised that widescreen can be a 'two edged sword' as a sales feature and that there was a need to define the preferred mode of a television display when faced with various letterbox displays. These are the digital equivalent of the WSS (line 23) signal in analogue (ETS 300 294). This document (see "Video format signalling extensions" in section 3) recommends the display conditions, which should ensure that viewers can easily set zoom functions to their satisfaction. An essential feature is the regeneration of line 23 in the STB or integrated television outputs, so that signals can be recorded on existing analogue VCRs and replayed correctly. This is most important - otherwise the viewer may be faced with a grossly distorted image on replay which may prove hard to restore with the remote control.

1.4.2 Service Information

The section on SI represents a major output of DTG members working to UK multiplex operator requirements. The specification and management of SI in the plurality of UK multiplexes, many of which have regional service requirements, has been a major task and one which has employed the DVB framework to its limits.

1.4.3 RF Transmission and Reception

The opportunity has been taken to reproduce the technical parameters and planning algorithms used by the ITC, NTL and BBC digital television frequency planning project. Also, there is additional material on the choice and use of offsets and the reshaping of the vestigial sideband filters of analogue transmissions where they occupy upper adjacent channels to new digital transmissions. The use of offsets was conditional on digital tuner front end performance and the final decision to use offsets was very much on the critical path

1.4.4 Data Services

One major change to the second edition has been the addition of a full specification for the UK "content decoder," a subset of MHEG-5. The DTG and its members can take great pride in the exhaustive technical evaluation of the available APIs which it carried out during 1996 and which pointed to the technical superiority of MHEG-5. We can be proud, too, that the multiplex operators, who ultimately have the responsibility for the decision taking in complex commercial considerations, saw clearly the need to adopt the emerging open standard which the DTG saw as an essential part of the open market system which the government had defined for UK digital terrestrial television. Credit is due to the small team which then defined the UK 'profile' of MHEG-5. Designed to provide the core needs and, for the time being at least, omitting interactive enhancements which might have added risk to the launch of services, the UK profile is a learned and respected document which is now being referenced in many parts of the world.

In April, the ISO MHEG-7 meeting in Finland adopted the UK profile as a reference implementation for conformance specifications, which indicates the importance of the UK work.

1.4.5 Conditional Access and Common Interface

Another major innovation concerns extensions to the DVB Common Interface specifications. These are:

- Input Modules
- Status Query Functions
- Power Management
- Event Management
- MHEG-5 MMI
- Copy Protection

Concern has been expressed by manufacturers of open standards integrated receivers that these extensions are not yet adopted by DVB and that implementation may delay the availability of Conditional Access modules. The DTG finds itself in a difficult position in balancing these understandable concerns for the short term against the obvious long term benefits. It has therefore recommended that only one extension, Copy Protection, is required at the launch of services and that the others should be prepared for and mandated once they have been accepted by DVB.

Power Consumption is becoming a hot topic in Europe. A UK consumer magazine caused a furore in April when it published an article which asserted that set-top boxes consume nearly 30 W when they are switched off. The stand-by consumption of television equipment has also come to the attention of the European Commission DGXVII who have calculated that equipment in stand-by may account for 10% of all domestic power consumption. By their estimate, the annual power consumed by televisions and VCRs in Europe in stand-by is 15 TWh.

Members of the European Association of Consumer Electronic Manufacturers (EACEM) have given a commitment that, by Jan 2000, no equipment should be sold with a passive stand-by power consumption exceeding 10 W (target value). In *passive stand-by*, the remote control and timer function but it is not possible to receive signals. *Active stand-by* powers the receiver or set-top box sufficiently to receive over-air signals. If a multiplex operator wishes to upgrade the receiver box software by an over-air download, the intention is that its timer should be remotely set during a previous consumer operation so as to bring the unit into an *active stand-by* for the period of the download. In this way, the greater power consumption of active stand-by is only incurred when actually required.

Many consumers currently switch off television equipment at the power socket overnight but this is likely to diminish in the future as data services increasingly deliver content to con-

sumers during the night period. The DTG is therefore recommending that all manufacturers adopt passive-active stand-by in receivers and set-top boxes for use in UK DTT to give flexibility to ensure energy efficient operation in all circumstances.

The Common Interface, together with these extensions will be an essential tool in extending the functionality (and life) of receivers and in the marketing proposition for them.

Concern has been expressed that some functions may be duplicated by the digital home bus IEEE1394-1995 (i.LINK) which is expected to be implemented by manufacturers in the future. However the DTG believes that both will be needed, servicing the separate requirements of module based functionality and the interconnection of equipment around the home.

1.4.6 Services for Disabled Viewers

A DTG Task group has been working in conjunction with the R.N.I.B and produced the definition of a font, Tiresias, for use with DVB subtitles and as a resident font in the STB or receiver. This font is designed for maximum legibility, particularly affecting the visually impaired. It is believed it is the first time such a font has been designed specifically for display on the screen, rather than the printed word.

Another DTG task-group has identified two possible ways of implementing audio description within the digital receiver. The first and simplest is the so-called “cold-cut” method which would switch between the normal audio and a separate bitstream carrying audio description on command of an audio_description_present signal. This could be implemented in the receiver at modest cost and provide a basic service in simpler models.

However, experience suggests that visually impaired viewers normally watch television in the company of others without that impairment, and the DTG task-group concluded that many families which include a visually impaired member would find it desirable to relay the audio description channel onto a separate personal loudspeaker or infrared headset. It should be noted that the use of an infrared connection avoids the possibility of trailing wires which would be particularly dangerous to those with visual impairment. The cost of the necessary processing to decode the additional elementary bitstream carrying audio description is estimated to be in the order of £30, to which the cost of a personal loudspeaker or headset would have to be added. Proposals for the required *“fade”* signal have been submitted to the DVB.

The majority of members, though by no means all, have a primary interest in digital terrestrial television and up to now, this has been the main focus of our work. However, the market will demand interoperability with digital satellite and perhaps cable as well, so we must encompass other platforms in our brief. Also, we cannot ignore the march of convergence with computer technologies. Our service providers are wanting to adopt internet-like data services and manufacturers perceive a demand to bring the internet, or something close to it, to a wider population via future television sets. So, whilst the specifications in this document are complete in all but the finest detail, we have, nevertheless, thought it prudent to adopt a loose-leaf binder format for this document, to allow any future revisions to be issued and inserted in the appropriate place.

The proposition for digital terrestrial is a very simple one – that viewers should be able to plug their existing aerial into a new set-top box or integrated digital receiver and it should work; that it should bring them an attractive range of programme services and that, in terms of the receiver at least, it should be future proof. There is work to be done to ensure that the proposition is substantially achieved but we believe the D-Book specifies the interoperability requirements necessary for success.

Stream Characteristics

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2 Video System Characteristics

2.1 Scope

This section defines the digital video encoding standards that shall be used in all UK UHF terrestrial Television Broadcasts.

2.2 References

- ISO/IEC 11172-2
- ISO/IEC 13818-2
- ETR 154.
- ITU-R BT.470-4 System I

2.3 Essential requirements

Broadcast video shall be encoded according to ISO/IEC 13818-2 constrained according to ETR 154. All receivers should be able to meet the minimum decoding requirements set out in ETR 154.

2.4 DTG Constraints and Extensions

This section sets out the requirements on the broadcast signals and reception equipment to be DTG compliant in addition to the DVB requirements expressed by ETR 154.

2.4.1 Support for rapid channel acquisition

To reduce the typical time taken to start decoding a new service each video elementary stream shall contain a sequence header and associated group of pictures header at an interval no greater than 0.5 seconds[1]. Also, each such sequence header shall be immediately preceded by a PES packet header carrying a PTS.

There is no requirement to set the data alignment indicator flag in the PES packet header or for the broadcast to include a data stream alignment descriptor associated with the video elementary stream in the PMT. If a data stream alignment descriptor is included for a video elementary stream then it shall indicate alignment type ‘04’.

2.4.2 Picture types

Beyond the constraints applied by ISO/IEC 13818-2 and the requirement for periodic I pictures implied by “Support for rapid channel acquisition” no additional constraints are placed on the sequence of coded picture types. Specifically, no additional constraints are placed on the number of B pictures between I and P pictures. As required by the Main Profile of ISO/IEC 13818-2 broadcasts may use I, P, B and dual-prime frame types.

2.4.3 ISO/IEC 11172-2 compatibility

ETR 154 requires that video encoding shall conform to ISO/IEC 13818-2 Main Profile at Main Level. This requires support for ISO/IEC 11172-2 ‘D’ pictures and “constrained parameters” video.

1. ETR 154 recommends but does not mandate this.

DTG conforming broadcasts shall not include ISO/IEC 11172-2 ‘D’ pictures or sequences with a horizontal_size greater than 720.

2.4.4 User data

To ensure good behaviour in current and future receiver video decoder implementations the DTG defines (below) a buffer model for user data within the video elementary stream. This currently proposed use for this data (see Table 3-4) only exploits a small number of the bytes that might be used. Broadcasts are not required to carry this data.

If user data is carried it shall meet the following buffer model:

- All user data bytes enter a single buffer of size 16 bytes (the user data start code is discarded before data is delivered to the buffer).
- All the data delivered at one time is removed from the buffer no later than 40 ms after it was delivered.

If the video elementary stream carries user data then the see “Private Descriptors and User-Defined Values” in section 8.

2.4.5 Video alignment

2.4.5.1 Video with graphics

The graphics system used by applications and subtitling addresses a 720x576 pixel space. The output of the ISO/IEC 13818-2 video decoder is centred vertically and horizontally within this space after upsampling.

If the result of the upsampling process is *less* than 720 pixels wide then the output of the video decoder shall be centred within the region of 720 active digital video pixels. The offset from the start of the active digital video pixel area to the first (left most) pixel of video decoder output is the difference in their widths divided by 2 and truncated towards zero. Equivalent centring should be used to position the video decoder output vertically within the 576 active lines of the analogue display.

If the result of the upsampling process is *greater* than 720 pixels wide then the output of the video decoder shall be cropped symmetrically to fit within the region of 720 active video pixels. The number of pixels cropped from the left hand side of the video decoder output shall be the difference between its width and 720 divided by 2 and truncated towards zero. The remaining difference shall be cropped from the right hand side of the video decoder output.

2.4.5.2 With analogue outputs

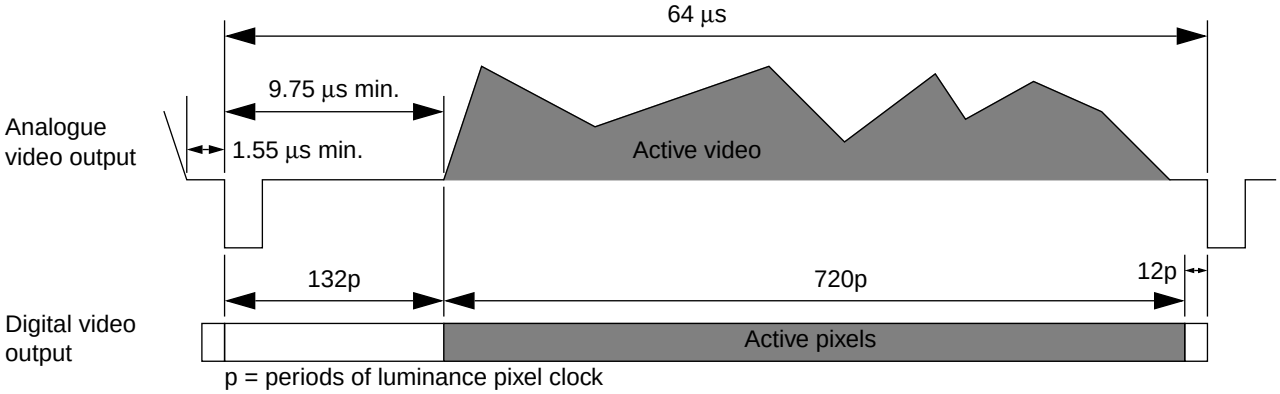


Figure 2-1. Relationship between digital video and analogue video

When presented on the analogue video output of a receiver the digital video output of the receiver's MPEG video decoder and graphics display system shall be aligned to the analogue output signal as is shown in Figure 2-1.

Note:

- The first of the 720 video pixels is output 132 pixel periods (≈9.75 µs) after the falling edge of line sync.
- At least the last 9 of the 720 video pixels should be replaced with blanking level to ensure that the 1.55 µs front porch is achieved.
- Optionally, additional blanking may be applied symmetrically to the start and end of the active video suppressing further active pixels.

2.4.6 Extensions

2.4.6.1 Colorimetry

DTG broadcasts shall use colorimetry as defined by ITU-R BT.470-4 System I.

MPEG-2 Video (ISO/IEC 13818-2), as amended by the corrigendum ISO/IEC JTC1/SC92/WG11 N0930, defines the interpretation of the default condition (when the sequence_display_extension() is not present, or the colour_description flag is set to zero) so that the colour_primaries, transfer_characteristics and matrix_coefficients are implicitly defined by the application.

For the DTG this implicit definition is ITU-R BT.470-4 System I. This has colorimetry which is explicitly the same as ITU-R BT.470-2 System B,G. So, optionally, the use of this colorimetry can be signalled using the value 5 for each of: colour_primaries, transfer_characteristics and matrix_coefficients.

3 Video display formatting

3.1 Scope

This section describes the video format signalling and how it may be used. The receiver response to this signalling is defined in this section.

This section:

- Provides a summary of the “Applicable standards” on page 3-1
- Introduces “Recommendations for signalling in the video stream” on page 3-2

3.2 Applicable standards

- ISO/IEC 13818-1, ISO/IEC 13818-2
- ETS 300 468, ETR 211
- ETR 154.
- ITU-R BT.1119-1, ETS 300 294

The video format shall be encoded as described in ISO/IEC 13818-1, ISO/IEC 13818-2 and ETS 300 468 constrained and interpreted as described in ETR 211 and ETR 154 and as clarified and extended below.

3.2.1 Requirements for DVB compliance

3.2.1.1 Required format information

The following elements must be included for all video services:

- Video sequence header (ISO/IEC 13818-2)

  Restricted to “full screen” luminance pixel resolutions of: 720x576, 544x576, 480x576, 352x576 or 352x288 or “less than full screen” resolutions as described in ETR 154.

- Component descriptor (ETS 300 468)

3.2.1.2 Optional to broadcast, required to decode

All conformant receivers are required to respond to the above mandatory information and shall also respond to the following optionally broadcast information:

- Video sequence display extension (ISO/IEC 13818-2)

  Provided that the display window has an aspect ratio of 4:3 as described in ETR 154.

- Video picture display extension (ISO/IEC 13818-2)

  Provided that the frame centre vertical offset is zero as described in ETR 154.

  It is mandatory to include the video sequence extension in any video sequence that includes the picture display extension (and hence motion vectors).

- Target background grid descriptor (ISO/IEC 13818-1)

  Provided that the display grid is 720 x 576 as described in ETR 154.

- Video window descriptor (ISO/IEC 13818-1)

3.3 Recommendations for signalling in the video stream

DTG compatible broadcasts may use any of the formats permitted by DVB (see ETR 154). This section defines the signalling that must be used when using these formats.

3.3.1 Sequence header

The minimum video format signalling required is the video sequence header. Table 3-1 tabulates the horizontal scaling factors required to restore video to 720 pixel horizontal resolution with the correct aspect ratio. These factors complement the scaling factors employed by the broadcaster when downsampling the video before encoding.

			Source aspect ratio[a]		
horizontal_size	**nominal "full screen" width**	**effective horizontal size[b]**	**4:3**	**16:9**	
545 to 720	720	720	1	4/3[c]	1
481 to 544	544	540	4/3	16/9	4/3
353 to 480	480	480	3/2	2	3/2
1 to 352	352	360	2	8/3	2
			4:3 display		**16:9 display**
			horizontal scaling to fill 720 wide display		

Table 3-1. Horizontal scaling where format is signalled by the sequence header alone

a] From the aspect ratio indication

b] For example, values of horizontal_size from 481 to 544 are treated as 540 when determining the scaling factor to adapt the video for a 720 pixel wide display. I.e. 720/540 = 4/3.

c] These scaling factors apply to a centre cut-out presentation. I.e. the central 3/4 of the coded picture width is scaled by the factor indicated to fill the width of a 4:3 display.

3.3.2 Sequence Display Extension

3.3.2.1 Pan Scan Window

Here the sequence display extension describes a 4:3 aspect ratio window within 16:9 coded frame (the position of this window may be controlled by the picture display extension).

display_horizontal_size			**effective horizontal size[a]**	**horizontal scaling**	
Min.	**Typ.[b]**	**Max.**		**window fills 4:3 display**	**full frame fills 16:9 display**
409	540	540	540	4/3	1
364	408	408	405	16/9	4/3
271	360[c]	363	360	2	3/2
1	264	270	270	8/3	2

Table 3-2.

a] Scaling to make display window fill 4:3 display is 720/effective horizontal size.

b] Recommended to broadcast. Is 3/4 of the nominal "full screen" width.

c] ETR 154 and DAVIC quote 363 as an example of 480x3/4.

3.3.2.2 Non “full screen”

Here the sequence display extension describes a window (4:3 OR 16:9) that surrounds the coded frame.

display_ horizontal_size	effective horizontal size[a]	horizontal scaling to fill display of same aspect ratio[b]	note
720 704	720	1	
544 528	540	4/3	Distinguished from Table 3-2 as display_ horizontal_size ≥ horizontal_size
480	480	3/2	
352	360	2	

Table 3-3.

a] Scaling to make display window fill appropriate display is 720/effective horizontal size.

b] I.e. to fill a 4:3 display if the aspect ratio indication is 0010_2 or 16:9 display if the aspect ratio indication is 0011_2.

3.3.3 Constraints on the use of the picture display extension

The picture display extension may be included in broadcasts to define non-zero valued frame centre horizontal offsets.

When provided, receivers shall use this information ONLY when configured to display a 4:3 cut-out from 16:9 source on a 4:3 display. The horizontal offset should be ignored if the material is displayed in a 14:9 or 16:9 letter box on the 4:3 display.

3.3.3.1 Pan vectors

The term “pan vector” is used in DVB documents (e.g. ETR 154) however, it is not defined. For the purposes of this specification the term is understood to mean an instance of picture display extension with non-zero valued frame centre horizontal offset.

ETR 154 forbids the use of pan vectors with a vertical component (sometimes referred to as “scan”) i.e. picture display extension with non-zero valued frame centre vertical offsets are not permitted.

3.3.4 Format switching

Receivers complying with this specification shall be able to continue outputing decoded video pictures undisturbed by changes in the video format parameters provided that these changes are constrained as follows:

- changes are implemented at a sequence boundary
- vertical_size and display_vertical_size remain unchanged
- the buffer models defined by MPEG are met
- the field parity of the first displayed field of the new sequence complements that of the last displayed field of the preceding sequence.

Specifically, this allows the following parameters to be changed:

- coded picture width (horizontal_size)
- coded pixel aspect ratio (aspect_ratio_indication, display_horizontal_size)

3.4 Video format signalling extensions

DVB requires receivers to support 16:9 and 4:3 coded video (support for 2.21:1 is optional). However, additional origination formats are prevalent in the UK (such as 15:9 format Super 16 film) and invented formats (such as 14:9) may be used to accommodate the delivery mixed formats to a heterogeneous receiver population.

This section describes how these additional formats may be carried compatibly within the standard DVB coded picture formats.

3.4.1 MPEG signalling

The use of the signalling methods within the MPEG video elementary stream is unchanged from that described previously. I.e. the sequence header and sequence display extension parameters describe either a 16:9 or a 4:3 aspect ratio coded frame that is either one of the full screen formats or a cropped version of one of those.

“Pan vectors” may be included in a broadcast that also uses the DTG video format signalling extensions. “Pan vectors”, and the DTG extensions, provide alternative, mutually exclusive, methods of displaying widescreen material on a 4:3 display.

3.4.2 DVB signalling

The ETS 300 368 component descriptor shall be appropriate for the coded frame type of the video, i.e. 4:3 or 16:9 (with or without “Pan vectors”).

3.4.3 Active format description

Active format descriptions may be broadcast to describe the portion of the 16:9 or 4:3 coded frame that is “of interest”. The format descriptions are informative in nature and are provided to assist receivers to optimise their presentation of video.

What follows is the recommended behaviour that all receivers should follow.

Coding

The active format description describes the aspect ratio of the “area of interest” independent of the size and aspect ratio of the coded frame. For example, active_format would be 1 in both fig. 3-1 and fig. 3-2. This indicates that the area of interest has a 4:3 aspect ratio although in the first case the MPEG video frame carrying it has a 16:9 aspect ratio and in the second case the aspect ratio of the video is 4:3.

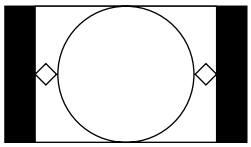


Figure 3-1.

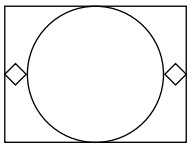


Figure 3-2.

Temporal Scope

After each sequence start (and repeat sequence start) the default aspect ratio of the area of interest is that signalled by the sequence header and sequence display extension parameters. After introduction, an active format specification persists until the next sequence start or until another active format specification is introduced.

3.4.3.1 Syntax

The active format definitions are carried in the user data of the video elementary stream.

Syntax	No. of bits	Identifier
user_data_start_code	32	bslbf
DTG_identifier (set to “DTG1“ = 44544731_{16})	32	bslbf
event_id_flag	1	bslbf
active_format_flag	1	bslbf
reserved (set to 000001_2)	6	bslbf
if(event_id_flag == 1_2) {		
event_id	16	uimsbf
}		
if(active_format_flag == 1_2) {		
reserved (set to 111111_2)	5	bslbf
active_format	3	uimsbf
}		

Table 3-4. DTG use of user data in video elementary streams

3.4.3.2 Semantics

DTG_identifier — A 32 bit value carrying the ascii string “DTG1”.

event_id_flag — A 1 bit flag. A value of ‘1’ indicates that the event_id field is carried in this data structure.

active_format_flag — A 1 bit flag. A value of ‘1’ indicates that an active format is described in this data structure.

event_id — A 16 bit field carrying the value of the current ETS 300 468 event_id.

active_format — A 3 bit integer describing the region of interest in terms of its aspect ratio within the coded frame, based on the effective horizontal size of the frame, and defined in the following table:

active_format	Aspect ration of the active region
0	Active region is the same as the coded frame
1	4:3
2	16:9
3	14:9
4	reserved for future use
5	4:3 (with shoot and protect 14:9 centre)
6	16:9 (with shoot & protect 14:9 centre)
7	Shoot & protect 4:3

Table 3-5. Definition of values of active_format

Where the aspect ratio of the active region differs from that of the coded frame, it is assumed that the active region is the largest that can be fitted within that frame, and is centred within it.

3.4.3.3 Formats illustrated

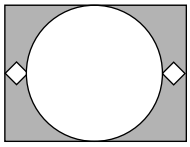
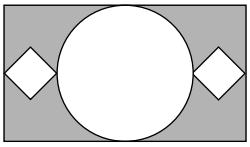
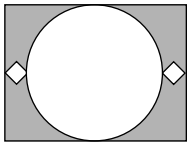
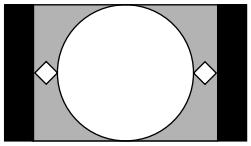
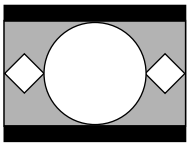
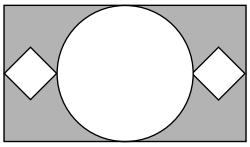
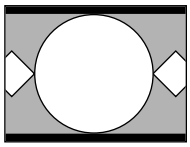
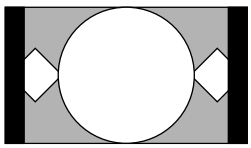
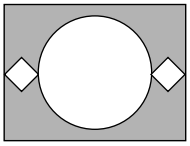
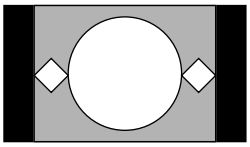
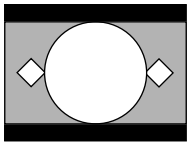
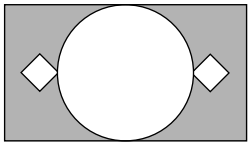
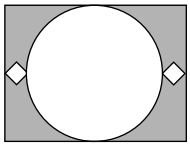
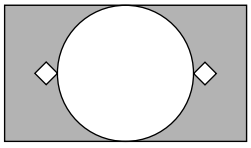
active_format		Full Frame Aspect Ratio	
value	**meaning**	**4:3**	**16:9**
0	As the coded frame		
1	4:3		
2	16:9		
3	14:9		
4	reserved for future use		
5	4:3 (with shoot and protect 14:9 centre)		
6	16:9 (with shoot & protect 14:9 centre)		
7	Shoot & protect 4:3		

Table 3-6. Formats described by the active_format description

3.4.3.4 Receiver Processing

Reference Model

The reference model for the video format processing elements in the Set Top Box, TV and Integrated Digital TV are illustrated in Figure 3-3. The behaviour of the Integrated Digital TV is logically equivalent to that of a Set Top Box attached to a TV. The display format signalling between the Set Top Box and the display is Line 23 WSS (See “Wide Screen Signalling (WSS)” on page 3-10) and/or SCART pin 8. Within an Integrated Digital TV the signalling is logically equivalent to WSS but could be conveyed by other means.

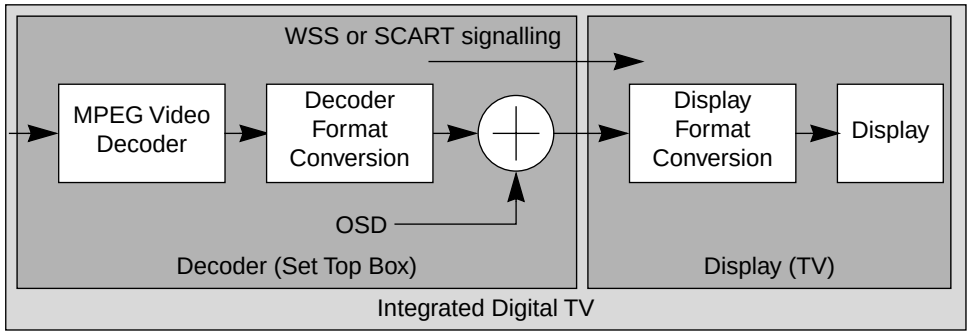


Figure 3-3. Receiver and display format processing reference model

In the reference model the output of the MPEG Video Decoder is logically 720 x 576, the processing applied to this by the Decoder Format Conversion is described in tables 3-7 and 3-9. In many practical implementations the processes in the Decoder Format Conversion are an integral part of the MPEG Video Decoder. This does not affect the logical reference model.

The Display Format Conversion is principally concerned with the processing provided in 16:9 displays to accept 4:3 signals. This is described in “Format processing of a 16:9 TV connected to STB” on page 3-9.

3.4.3.5 Set Top Box (STB)

STB with 4:3 Display

Table 3-7 shows the response of a Set Top Box to all broadcast formats when connected to a 4:3 aspect ratio display.

Broadcast format			**STB into 4:3 display**		
Description of format	**On-air signalling**		**Decoder Format Conversion**	**Signalling to TV**	
	MPEG	**active_ format**		**WSS codes**	**Scart Pin 8**
4:3	4:3	0	FF	0001	12 V
		1			
16:9 LB		2		1101	
14:9 LB		3		1000	
reserved[a]		4		0001	
Full 4:3 S&P 14:9		5		0111	
16:9 LB S&P 14:9		6		1101	
4:3		7		0001	

Table 3-7. Processing by STB connected to 4:3 TV

Broadcast format			STB into 4:3 display		
Description of format	On-air signalling		Decoder Format Conversion	Signalling to TV	
	MPEG	active_ format		WSS codes	Scart Pin 8
16:9	16:9	0	According to user preference. See Table 3-8.		
4:3 PB		1	CCO	0001	12 V
16:9		2	According to user preference. See Table 3-8.		
14:9 PB		3	CCO[b]	0001	12 V
reserved		4	According to user preference. See Table 3-8.		
4:3 PB S&P 14:9		5	CCO	0001	12 V
Full 16:9 S&P 14:9		6	According to user preference. See Table 3-8[c]		
Full 16:9 shoot & protect 4:3		7	According to user preference. See Table 3-8		

Table 3-7. Processing by STB connected to 4:3 TV

a] Where the active_format code is a reserved value, or the active_format code is absent, the behaviour is as if the active_format code was 0.

b] Or 14:9 letter box if available

c] A 14:9 letter box is preferable to 16:9 letter box in this case

User preferences for displaying 16:9

4 user preferences for presentation of widescreen material are defined in Table 3-8. In the first 3 cases the STB provides processing to format 16:9 video for 4:3 display. In the 4th case the STB outputs the 16:9 format signal as if it was addressing a 16:9 display. This mode allows a 4:3 display with special features (such as letter box processing) to format the video to its aspect ratio.

Selected Mode	Decoder Format Conversion	WSS codes	Scart Pin 8
16:9 Letter Box	16:9 LB	1101	12 V
14: 9 Letter Box	14: 9 LB	1000	
Centre Cut-Out	CCO	0001	
Use TV's feature	FF	1110	6 V

Table 3-8. User options for displaying 16:9 on 4:3

Key

FF **Full Frame**
the output of the decoder is the full width & height of the coded frame

LB **Letter Box**
the coded frame is reduced to a 16:9 (or 14:9) letter box and presented within a 4:3 raster.

CCO **Centre Cut-Out**
the central 4:3 aspect ratio region of the 16:9 frame is extracted and output as a 4:3 raster

WSS signalling with 4:3 display

4:3 displays are **not** expected to respond to the WSS codes (see Table 3-12 on page 3-10). This signalling is provided to ensure correct behaviour if the video is recorded and then subsequently displayed on a TV that does support WSS.

3.4.3.6 STB with 16:9 Display

Table 3-9 shows the response of a Set Top Box to all broadcast format when connected to a 16:9 aspect ratio display.

Broadcast format			STB into 16:9 display		
Description of format	On-air signalling		Decoder Format Conversion	Signalling to TV	
	MPEG	active_ format		WSS	Scart Pin 8
4:3	4:3	0	FF	0001	12 V
		1			
16:9 LB		2		1101	
14:9 LB		3		1000	
reserved		4		0001	
Full 4:3 S&P 14:9		5		0111	
16:9 LB S&P 14:9		6		1101	
4:3		7		0001	
16:9	16:9	0		1110	6 V
4:3 PB		1	CCO	0001	12 V
16:9		2	FF	1110	6 V
14:9 PB		3			
reserved		4			
4:3 PB S&P 14:9		5	CCO	0111	12 V
Full 16:9 S&P 14:9		6	FF	1110	6 V
Full 16:9 shoot & protect 4:3		7			

Table 3-9. Processing by STB connected to 16:9 TV

3.4.3.7 Format processing of a 16:9 TV connected to STB

It is recommended that TVs will display the output of the Set Top Box (as described in and 3.4.3.6 above) according to Table 3-10. “User Preference” refers to the option set expected to be provided by the TV and made available to the user.

		Wide Screen Signalling				
		0001 4:3	0111 4:3 S&P	1000 14:9 C LB	1101 16:9 C LB	1110 Full 16:9
User Preference	4:3 Pillar Box	B		D	C	A
	14:9 Pillar Box	D				
	Zoom	C				
	Auto	B	D			
	Wide	A				
	Smart/Panorama	Manufacturer Own				

Table 3-10. TV Processing modes under WSS control

Mode	Scaling		Description
	Horizontal	Vertical	
A	1	1	Makes incoming picture fill the display. Preserves geometry of 16:9, but distorts 4:3 based formats.
B	3/4	1	Makes pillar box of 4:3 signal
C	1	4/3	Expands 4:3 to fill width. Crops top & bottom to preserve geometry
D	7/8	8/7	Expands 14:9 letter box to 14:9 pillar box with correct geometry.

Table 3-11. Mode Definitions

Priority of WSS and Scart Pin 8

- If Scart Pin 8 is at 6 V then the display should behave as if the WSS code is 1110 was present.
- For all other states of Scart Pin 8 the display should follow the WSS code if present.
- If no WSS code is present (and Scart Pin 8 is NOT at 6 V) then the display should behave as if the WSS code 0001 was present.

3.4.3.8 Integrated 16:9 TV

The response of an Integrated 16:9 TV to the broadcast format described in “Video format signalling extensions” on page 3-4 should be equivalent to the combined response of a Set Top Box (“STB with 16:9 Display” on page 3-9) and TV (“Format processing of a 16:9 TV connected to STB” on page 3-9).

3.4.3.9 Wide Screen Signalling (WSS)

Table 3-12 reproduces the Wide Screen Signalling codes from ETS 300 294 / ITU-R BT.1119-1. The shaded rows indicate codes that are not used in this context.

WSS Code[a] bits 0-3	Description
0001	full format 4: 3
1000	box 14:9 centre
0100	box 14:9 top
1101	box 16:9 centre
0010	box 16:9 top
1011	box > 16:9 centre
0111	full format 4:3 (shoot and protect 14:9 centre)
1110	full format 16: 9 anamorphic

Table 3-12. WSS codes

a] This bit ordering follows the ETS specification (i.e. bslbf). The ITU specification writes the bits d_3-d_0. The specifications are identical as in both cases the transmission order is d_0 to d_3.

Additional temporal specification for WSS outputs

- The WSS shall first be output in line 23 of the first frame to which it applies
- The same WSS status bits shall be transmitted in each subsequent frame until the video format changes

3.5 Video Post Processing requirements

The set of scaling factors required in a receiver to reconstruct and present full screen video are evident from the preceding parts of this chapter. The requirements for presenting video in conjunction with an interactive application are addressed in the “Data Services” section and specifically under “Video Scaling” in section 17.

3.6 Recommendations for ISO/IEC 13818-1 signalling

As described in ETR 154 the target background grid descriptor and video window descriptor may be used within broadcasts to position the video output within a 720 x 576 display grid.

Further to this, the position of the video output within the display signalled in DTG broadcasts shall be restricted to even (chroma) pixel and even (field) line ordinates.

4 Audio System Characteristics

4.1 Scope

This section defines the digital audio encoding standards that shall be used in all UK UHF terrestrial Television Broadcasts.

4.2 References

- ISO/IEC 13818-1
- ISO/IEC 13818-3
- ETR 154.
- ITU-R Rec.775

4.3 Essential requirements

All audio components of the broadcast shall be encoded according to ISO/IEC 13818-3 constrained according to ETR 154.

Scope of requirements

These requirements on audio signals apply to applications including, but not limited to, those listed below:

- Primary and other language audio channels for television programmes
- Audio only ‘radio’ services
- Audio description (for the visually impaired)
- Clean dialogue (for the hearing impaired)

Synchronisation

The A/V synchronisation in radiated signals is such that audio is presented to the viewer no more than 20 ms before the video and no more than 40 ms after it when both components are decoded on an ideal decoder at the times indicated by their respective PTSs.

Receivers shall not introduce more than ± 5 ms of additional relative delay between the video and any audio component.

Where additional independent audio components are decoded from the same service (e.g. main programme audio and audio description or main programme and clean commentary) receivers should not introduce more than ± 5 ms of relative delay between the audio components.

Decoding requirements

All receivers shall provide at least one audio decoder able to meet the minimum decoding requirements set out in above. Preferably receivers should implement more than one audio decoder to enable, for example, the concurrent decoding of both the main audio and the audio description for a television programme. See “Receiver implementation minima” on page 4-2.

4.4 Constraints and Extensions

4.4.1 Set-up levels

The level for reference tones for transmission shall be 18 dB below clipping level, in accordance with EBU Recommendation R.68 “Alignment level in digital audio production equipment and in digital audio recorders” as recommended by ETR 154.

4.4.2 Surround Sound

Digitally Coded

Surround sound may optionally be provided as a digital multichannel audio service component, thereby giving freedom of artistic exploitation to the programme makers. The allocation of channels, particularly for a 5.1 digital multichannel service is given in ITU-R Rec.775.

Dolby Prologic™

Multichannel audio signals may optionally be matrixed onto suitably coded MPEG audio stereo signals to generate a service which can be decoded using Dolby Prologic™ decoders. Provision of Dolby Prologic™ compatible decoders in receivers is optional.

4.5 Audio Description

4.5.1 Background (informative)

Audio Description is an “ancillary service” primarily provided for the visual impaired. It provides a spoken description of the video component of a service. Provision of audio description for a proportion of programmes is a licence requirement for digital terrestrial broadcasts in the UK.

The audio description is delivered as a mono audio stream in addition to the main programme audio. This section specifies the coding of this audio stream and provides background on how receiving equipment might operate.

4.5.2 Receiver implementation minima

Receivers shall provide at least one method to deliver audio description to viewers.

The preferred method is to provide two audio decoders, as illustrated in Figure 4-1. These could be implemented on a module connected via the Common Interface (see “Auxiliary decoder” in section 22).

Note: the implementation of the “cold-cut” approach is still under investigation.

An alternative is the “cold-cut” approach illustrated in Figure 4-3.

4.5.3 Signalling

This section is principally concerned with the signalling used to implement the programme provider control of programme volume. Other controls, and the method for presentation of the “described” and/or “standard” sound outputs are addressed for information below.

4.5.3.1 Level control

Three contributions to the “described” output sound level can be identified. These are illustrated in Figure 4-1.

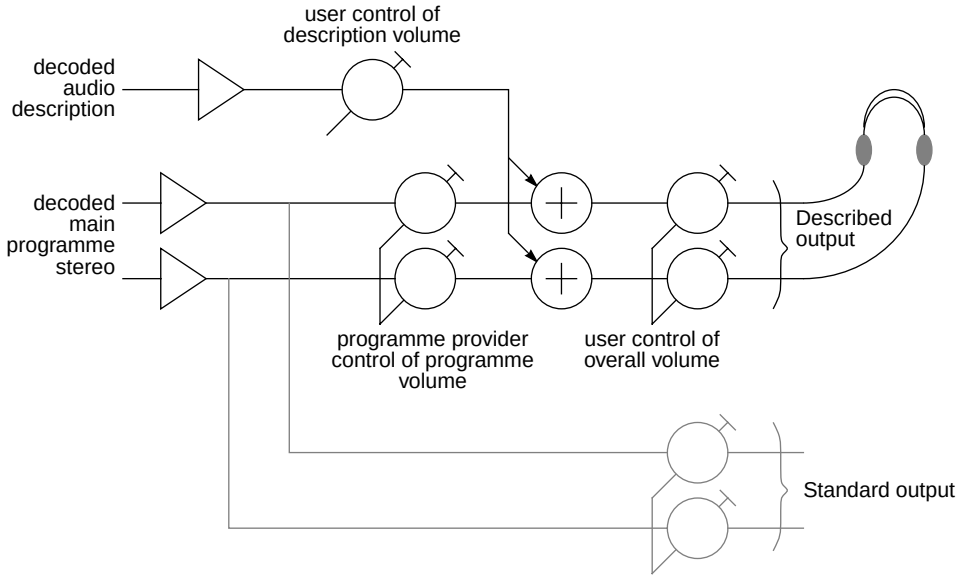


Figure 4-1. Illustration of control of audio level

4.5.3.2 Placement control

Signalling is provided to allow the broadcaster to place the “describer” at any preferred horizontal position within the sound field (speech from out-of-vision commentators is often placed to one side in the stereo image).

4.5.3.3 Syntax & Semantics

Audio description streams shall carry the Audio Description Descriptor defined in Table 4-1 in their PES_private_data field of the PES packet header.

Syntax	Value	Data	Comment
DTG_AD_descriptor(){			
reserved	1111	4 bslbf	
AD_descriptor_length	0100	4 bslbf	this version
DTG_AD_text_tag	"DTGAD"	40 bslbf	6byte string
DTG_AD_revision_tag	“1”	8 bslbf	
AD_fade_byte	0xYY	8 bslbf	FADE byte
AD_pan_byte	0xYY	8 bslbf	PAN byte
reserved	0xFFFFFFFFFFFFFF	56 bslbf	
}			

Table 4-1. Audio Description Descriptor

AD_descriptor_length

The descriptor length gives the number of significant bytes following the length field (i.e. 8).

DTG_AD_text_tag

The tag is a 5 character string of ASCII characters as a simple and unambiguous means of distinguishing this from any other PES_private_data.

If a receiver does not recognise this tag it should ignore the audio description stream carrying it.

DTG_AD_revision_tag	The tag is extended by a 1 byte version designator. Descriptors with the same text tag (“DTGAD”) but a higher revision tag shall be backwards compatible with this specification, i.e. the syntax and semantics of the fade and pan byte fields will be identical but additionally some of the reserved bytes may be used for new signalling. Receivers recognising the main text tag but an earlier revision (lower tag value) should decode the stream based on the fields of the descriptor that it understands and should ignore any additional parameters.
AD_fade_byte	The fade byte takes values between 0x00, representing no fade of the main programme sound, and 0xFF, representing no main programme sound. Over the range 0x00…0xFE one lsb of this field represents an attenuation step of approx. 0.3dB giving a range of about 77 dB. 0xFF represents no main programme sound.
AD_pan_byte	The pan byte takes values between 0x00, representing a central forward presentation of the audio description, and 0xFF, each increment representing a $^{360}/_{256}$ degree (~1.4˚) step clockwise looking down on the listener. See Figure 4-2.
reserved	The remaining 9 bytes of the PES_private_data field are set to 0xFF and reserved for future use.

4.5.3.4 Example

When including this descriptor in an audio stream PES-packet, the PES-packet header syntax will be as follows:

Syntax	Value	Data	Comment
Packet_start_code_prefix	0x000001	24 bslbf	
stream_id	0xYY	8 uimsbf	actually '110ZZZZ'
PES_packet_length	0xYYYY	16 uimsbf	as appropriate
'10'	10	2 bslbf	
PES_scrambling_control	YY	2 bslbf	
PES_priority	Y	1 bslbf	
data_alignment_indicator	Y	1 bslbf	as appropriate
copyright	Y	1 bslbf	
original_or_copy	Y	1 bslbf	
PTS_DTS_flags	10	2 bslbf	if PTS present
ESCR_flag	0	1 bslbf	
ES_rate_flag	Y	1 bslbf	as appropriate
DSM_trick_mode_flag	0	1 bslbf	
additional_copy_info_flag	0	1 bslbf	
PES_CRC_flag	Y	1 bslbf	as appropriate
PES_extension_flag	1	1 bslbf	
PES_header_data_length	0xYY	8 uimsbf	as appropriate
'0010'	0010	4 bslbf	
PTS[32..30]	YYY	3 bslbf	as appropriate
'1'	1	1 bslbf	
PTS[29..15]	YYYYYYYYYYYYYYY	15 bslbf	as appropriate
'1'	1	1 bslbf	
PTS[14..0]	YYYYYYYYYYYYYYY	15 bslbf	as appropriate
'1'	1	1 bslbf	
if (ES_rate_flag ==1'1') {etc.}			
if (PES_CRC_flag ==1'1') {etc.}			
PES_private_data_flag	1	1 bslbf	
pack_header_field_flag	0	1 bslbf	
program_packet_sequence_counter_flag	0	1 bslbf	
P-STD_buffer_flag	0	1 bslbf	
reserved	111	3 bslbf	
PES_extension_flag_2	0	1 bslbf	
DTG_AD_descriptor(){			
reserved	1111	4 bslbf	
AD_descriptor_length	0100	4 bslbf	in version 1
DTG_AD_text_tag	"DTGAD"	40 bslbf	6 byte string
DTG_AD_revision_tag	"1"	8 bslbf	
AD_fade_byte	0xYY	8 bslbf	FADE byte
AD_pan_byte	0xYY	8 bslbf	PAN byte
reserved	0xFFFFFFFFFFFFF	56 bslbf	
}			
for (i=0; i<N1; i++) {			
stuffing_byte			if required
}			
// and now follows the PES data //			

Table 4-2. Illustration of PES packet header

4.5.3.5 Interpretation of pan information

The definition of “pan” is compatible with future systems that might employ digital multi-channel surround sound for main programme audio. Where the main programme audio is stereo the range of values for “pan” are limited to the interval 0xEB…0x00…0x15.

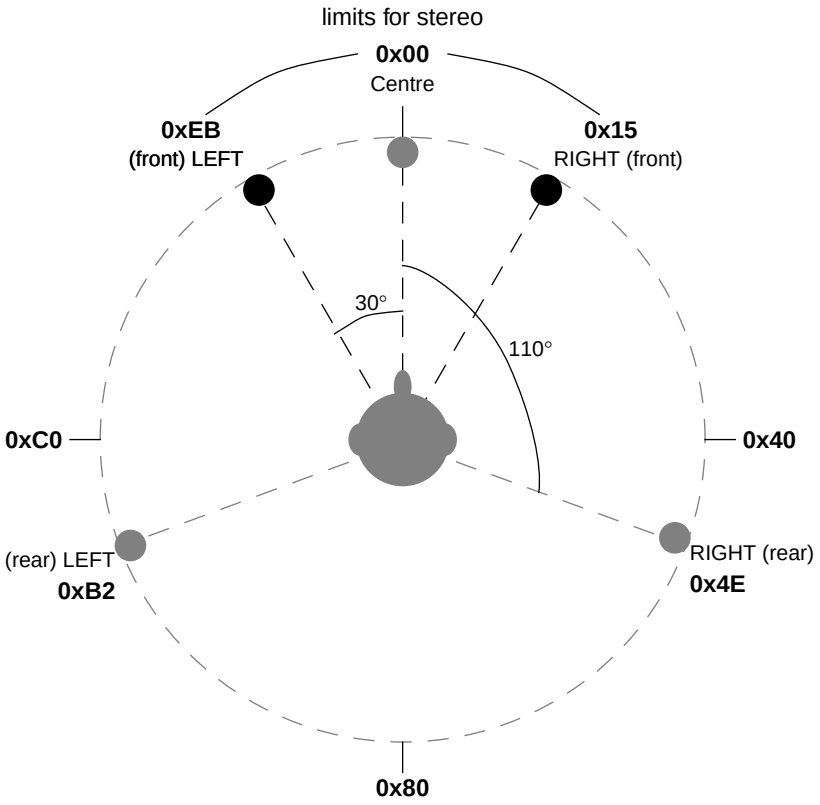


Figure 4-2. Mapping of pan byte onto sound presentation

4.5.4 Constraints on audio description stream coding

The audio description stream shall comply with ETR 154 constrained as follows: it shall be encoded as a mono MPEG-1 layer II audio.

4.5.5 Implementation notes

4.5.5.1 Default states and error conditions

Unless signalling in a selected audio description stream indicates otherwise, the main programme audio should be output without attenuation.

Receivers may ignore the pan information, but if they do so they must position the audio description centrally (i.e. as if pan byte = 0x00).

4.5.5.2 Time of application

All PES packets conveying audio description audio streams shall include an audio description descriptor. The value of fade and pan byte in any PES packet shall apply to all access units commencing within that PES packet.

Error resilience (informative)

If due to some fault or error condition the audio description descriptor is absent or recognisably corrupted, the receiver should revert to the default state (fade = 0x00, pan = 0x00) after a suitable delay.

Attack and decay (informative)

Values for “fade” will be transmitted 5-10 times/second. This allows the service provider to signal gradual changes of “fade”. Receivers should not implement any additional time constants.

4.5.5.3 Approximation of pan and fade (informative)

Pan

Receivers may ignore pan information completely. See “Default states and error conditions” on page 4-6.

Fade

Receivers may treat all non-zero values of fade as 0xFF, i.e. completely replacing the main programme audio with audio description when fade is non-zero. This allows audio description and main programme audio to be decoded with a single audio decoder. However, this is not the preferred implementation.

4.5.5.4 Equalisation of delays (informative)

In certain implementations, for example where the audio description AND main programme audio are decoded and mixed by a decoder additional to the normal decoder of the receiver, the listener may be exposed to main programme audio from two different decoders. It is desirable to minimise or prevent exposing the listener to differential delays of this kind.

4.5.5.5 Implementation routes (informative)

The approach shown in Figure 4-1 uses two audio decoders (either integrated within a receiver or added in an ancillary decoder module). *This is the implementation assumed by service providers*.

Figure 4-3 illustrates an alternative low cost approach where a single decoder can be switched between the main and description audio streams when ‘fade’ is non-zero.

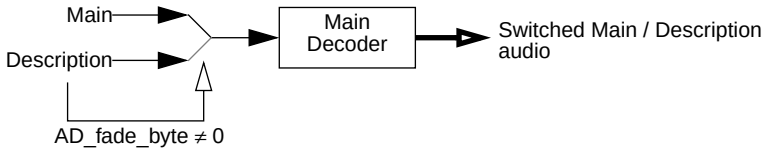


Figure 4-3. The “cold-cut” approach illustrated

Figures 4-4 and 4-5 illustrate a number of alternative approaches where a single decoder in an ancillary decoder module augments the main decoder in the receiver.

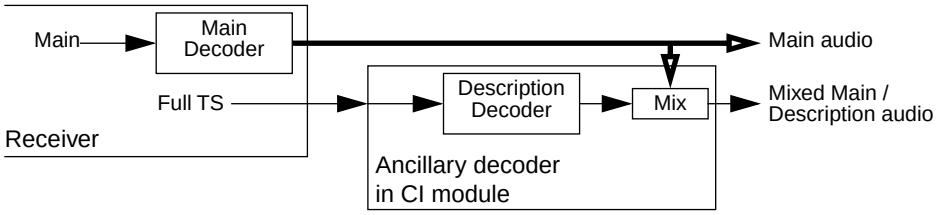


Figure 4-4. Generic single external decoder approach illustrated

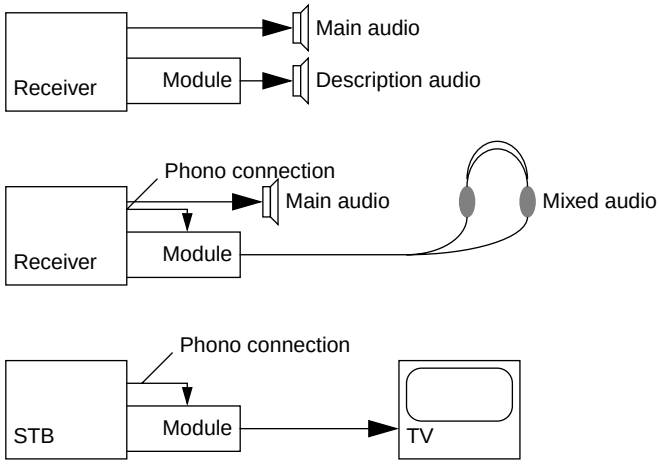


Figure 4-5. Possible single external decoder approaches illustrated

Chapter 5 containing the Subtitling specification will be released shortly

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6 Multiplex and Transport Stream Characteristics

6.1 Scope

This section defines the transport stream standards that shall be used in all UK UHF terrestrial Television Broadcasts.

6.2 References

- ISO/IEC 13818-1, ISO/IEC 13818-2, ISO/IEC 13818-3
- ETR 154
- ETR 289

6.3 Essential requirements

6.3.1 Multiplexing

The multiplexing of baseband signals and associated data conforms to ISO/IEC 13818-1 constrained according to ETR 154.

The PID and section filtering requirements for all UK DTT broadcasts shall be such that they can be received by receivers meeting the requirements set out below.

Multiplex Flexing

UK DTT broadcasts may instantaneously alter the bit rate allocated to program components or services provided that at all times the multiplex, and the streams within it, continue to comply the with the buffer models defined for them in ISO/IEC 13818-1, ISO/IEC 13818-2, ISO/IEC 13818-3 etc.

> *This enables the dynamic allocation of capacity between elementary streams within the transport multiplex. This allows the broadcaster freedom to trade technical quality and quantity of programme services within a multiplex or to use instantaneous "statistical multiplexing" to allow the best use of capacity between multiple programme services by varying the bit-rate occupied by any programme elementary stream to suit instantaneous demand.*

6.3.2 Demultiplexing

All receivers shall be able to meet the minimum demultiplexing requirements set out in ETR 154.

Data rates

A receiver shall be able to demultiplex ISO/IEC 13818-1 transport streams with data rates of at least 58 Mbit/s.

> *While the theoretical maximum payload supported by the DVB Terrestrial Specification is 31.67 Mbit/s, receivers may include the capability to accept transport streams which have higher rates, via other means.*

Errors

Receivers shall implement a suitable error concealment or error recovery mechanism on receipt of transport packet errors.

PID filters	Receivers shall be able to demultiplex at least than 32 different PIDs simultaneously in order to receive any single service.
Section filters	Receivers shall be able to implement at least 32 simultaneous section filters, each applying a filter specification to bytes 1 and 4 to 10 of the section, where each bit in the filter is individually maskable. It shall be possible to apply all 32 section filters to each section.
Burst rate	The throughput of each PID/section filter shall be at least 5 Mbps (peak burst rate measured over 1 ms).
Scrambling control bits	The receiver shall read respond appropriately to the DVB use of the transport scrambling control bits defined in ETR 289.

6.4 Constraints and Extensions

6.4.1 Multicomponent programs

6.4.1.1 Compatible views

Where the PMT carries more than one audio or video elementary stream for a program they shall provide alternative, but compatible, “views” of a single event. For “simple” receivers this presents the viewer with a choice. However, future receivers may have the ability to decode more than one video or audio component for simultaneous presentation to the viewer.

6.4.1.2 Incompatible views

Where a broadcaster wishes to present an “incompatible” viewing alternative this shall be done as a separate program/serviced NOT as alternative “views” within a single program.

6.4.1.3 Ordering the PMT

The ordering of elementary streams within the PMT is not significant. The selection of an appropriate set of components from a program facilitated by descriptors in the PMT and the EIT.

Chapters 7 to 10 containing the SI specification will be released shortly

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RF Transmission & Reception

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11 UHF Transmission and Reception

11.1 Scope

This section defines the modulation parameters that shall be used for all UK UHF digital terrestrial television broadcasts. It provides the spectrum masks for both digital and analogue transmissions necessary to prevent mutual interference and interference to other transmissions.

Much of the section is ‘informative’: it provides recommendations for both transmitter and receiver performance.

11.2 References

- ETS 300 744
- ITC Guidance Note on Picture Quality in Digital Television (31 Oct. 1996)
- draft ETR290
- Final Acts of the World Radiocommunication Conference (WRC-95)
- Current UK Radio Regulations (1990, revised 1994)
- The Chester 1997 Multilateral Coordination Agreement relating to Technical Criteria, Coordination Principles and Procedures for the introduction of Terrestrial Digital Video Broadcasting (DVB-T) (Chester, 25 July 1997)
- BS 6330
- ISO/IEC 13818-1
- AC106 VALIDATE

11.3 Network Design Issues

Note: Informative section

The UK UHF digital terrestrial television network design is based upon the use of the existing national analogue (PAL) transmitting sites. Normally, the mean effective radiated power (ERP) of the digital transmissions will be 20 dB below the vision peak sync ERP of the analogue services. However, in some cases it will be necessary to restrict the power in certain directions, to avoid interference with existing services. The digital network was designed on the assumption that the digital signal would still be receivable at a level of -35 dB relative to the analogue transmissions from the same site. Occasionally, the analogue transmissions use directional antennas when the digital ones do not; then the digital transmissions might have a relative level as great as -10 dB.

The minimum median field strengths associated with a digital network are fully explained in Annex1 of the “Chester Coordination Agreement”. For a carrier-to-noise requirement of 20 dB they are:

Band IV	Band V
44 dBµV/m	48 dBµV/m

Table 11-1. Minimum median field strength for fixed antenna reception

The signal power available at the input of a receiver can be derived using the formula in 11.13.4.

The presence of high relative levels of interfering analogue transmissions places quite severe demands of the receiver selectivity and linearity. BS 6330 quotes a maximum level of 5 mV into 75 W (-35 dBm) at the receiver input for a PAL transmission. Because not all receiver antennas conform to BS 6330, a safety margin is necessary: it is possible for the analogue level to be as great as -25 dBm. Using these figures, as well as those in the above text, results in the following worst case situation where protection is required:

Analogue	Digital
-25 (dBm)	-35 to -60 (dBm)

Table 11-2. Worst case received signal levels for protection

Transmitter performance is another important aspect. It is proposed, later in this section, to quantify the performance in terms of equivalent noise degradation, or END. As an example, suppose a receiver requires a carrier-to-noise ratio (C/N) of 20 dB to provide an error-free output, when the digital transmission is perfect. If the 'real' transmitter introduces distortion such that the required C/N is now 20.5 dB, the END is said to be 0.5 dB.

END is important because its effect is to reduce the service area of a transmitter. 0.5 dB is a realistic and acceptable target for a single transmitter. However, it is possible that some transmitters will make use of rebroadcast links. If the signal is not regenerated before being rebroadcast, the ENDs will accumulate. Thus, if there is a long chain of rebroadcast transmitters, the overall END could be much greater than 0.5 dB. The worst-case acceptable performance limit for a network is still under study. Note that any figures given here should be regarded as 'guidance'; the actual figures form part of the contract between broadcaster and transmission provider.

11.4 Modulation Parameters

Note: these modes are mandated by the ITC

Within the UK all UHF Television Broadcasts shall use the subset of ETS 300 744 tabulated below. All receivers shall implement these modes. Implementation of other modes in receivers is optional.

Modulation parameter	Allowed values
bandwidth	8 MHz only
constellations	All allowed
hierarchy modes	Non-hierarchical only
convolutional code rates (R_c)	All allowed
guard intervals	All allowed
transmission mode	"2K" only

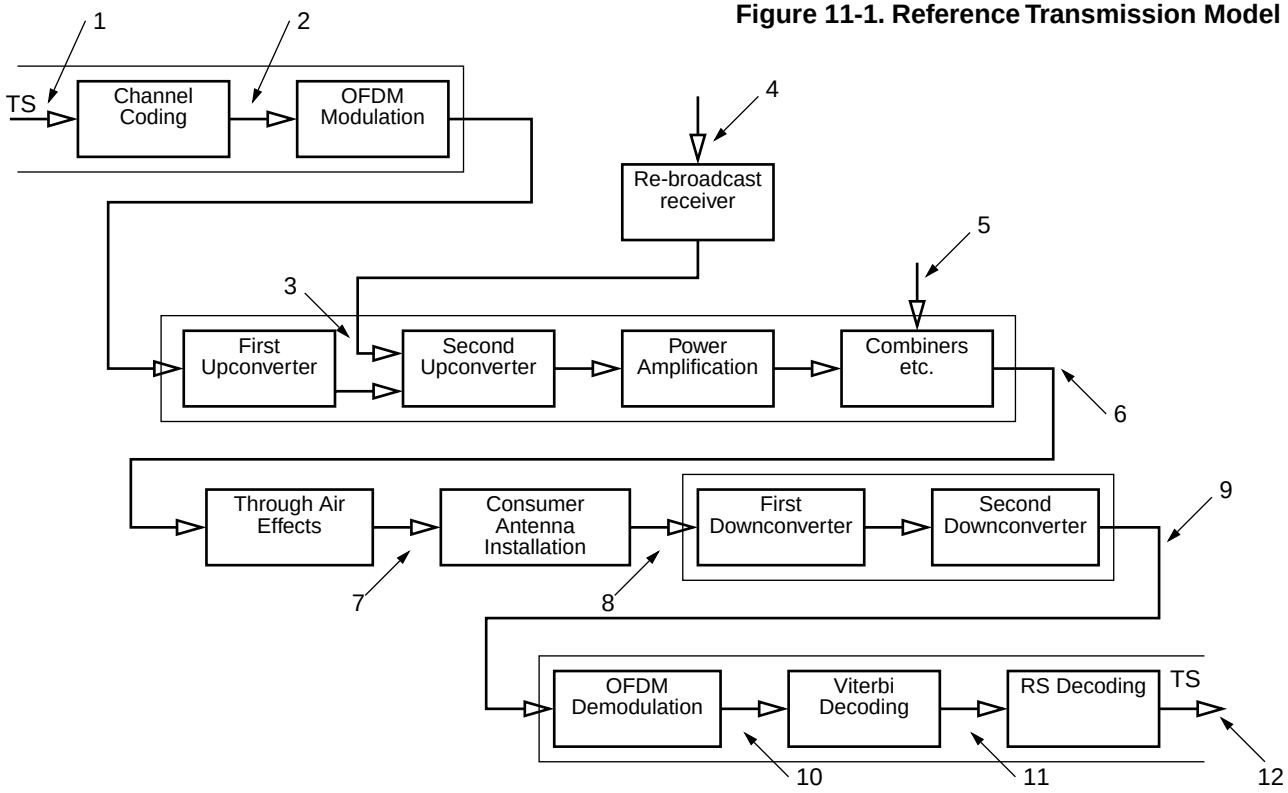
Table 11-3. Allowed terrestrial modulation parameter values

Note that a suggestion has been made that the 8K transmission mode might be used at some smaller sites in the future.

11.5 Example Transmission Chain

The purpose of the transmission system is to deliver ISO/IEC 13818-1 Transport Stream packets from the transmitter input (interface 1) to the receiver output (interface 12) in a quasi-error-free manner. ('Quasi-error-free' may be taken as a bit error ratio of 10^{-11} at the output of the Reed-Solomon decoder, which equates to approximately 1 error per hour for a transport stream of 24 Mbit/s). A typical transmission chain is illustrated below, with the idea of identifying interfaces that might be useful or essential for testing. Although Figure 11-1 is representative of current implementations, advancing technology could result in significant changes; future receivers might use direct conversion techniques, for instance.

Figure 11-1. Reference Transmission Model



1. Transport Stream input
2. Input to OFDM modulator
3. Analogue OFDM modulated signal at IF

   From either first upconverter OR re-broadcast receiver
4. Off-air signal at re-broadcast receiver
5. Interface between power RF stages of different operators
6. Input to antenna feeder
7. "Air Interface" at customer's antenna
8. Input to customer's receiver[1]
9. Output from second down converter, input to OFDM demodulator

1. The effects of passing the UHF signal through VCRs, games machines etc. is not known. The receiver configurations illustrated is "External Interface/Interconnection Requirements" in section 23 suggest that the OFDM receiver is the first device in any UHF chain.

10. Uncorrected symbols
11. Output of Viterbi decoder
12. Transport Stream output

Note that ‘transmission chain’ includes both transmitter and receiver!

11.6 Transmitter Noise-Like Degradations

11.6.1 Noise-like process

Many of the degradations introduced by transmitters are similar in effect to the addition of thermal noise. This is a convenient fact, because it allows the degradations to be measured without the use of specialist test equipment. The degradations considered to be noise-like are:

- Finite precision in the OFDM modulator and other digital processing stages.
- High frequency phase noise introduced by local oscillator and timing references; that is, those phase noise components occurring at offset frequencies greater than the OFDM carrier spacing, or thereabouts.
- Thermal noise.
- Intermodulation products resulting from non-linearity in the power amplifiers.
- Amplitude response ripple.

Degradations that cannot be considered as being similar to the presence of thermal noise are:

- Group delay errors
- Low-frequency phase noise

These will be considered in Section 11.7 on page 11-7.

11.6.2 Measurement of noise-like degradations

These processes are considered together to provide the implementer of the broadcast equipment certain flexibility on the allocation of noise budget between components.

Figure 11-2 below illustrates how noise-like degradations introduced by the transmitter may be measured.

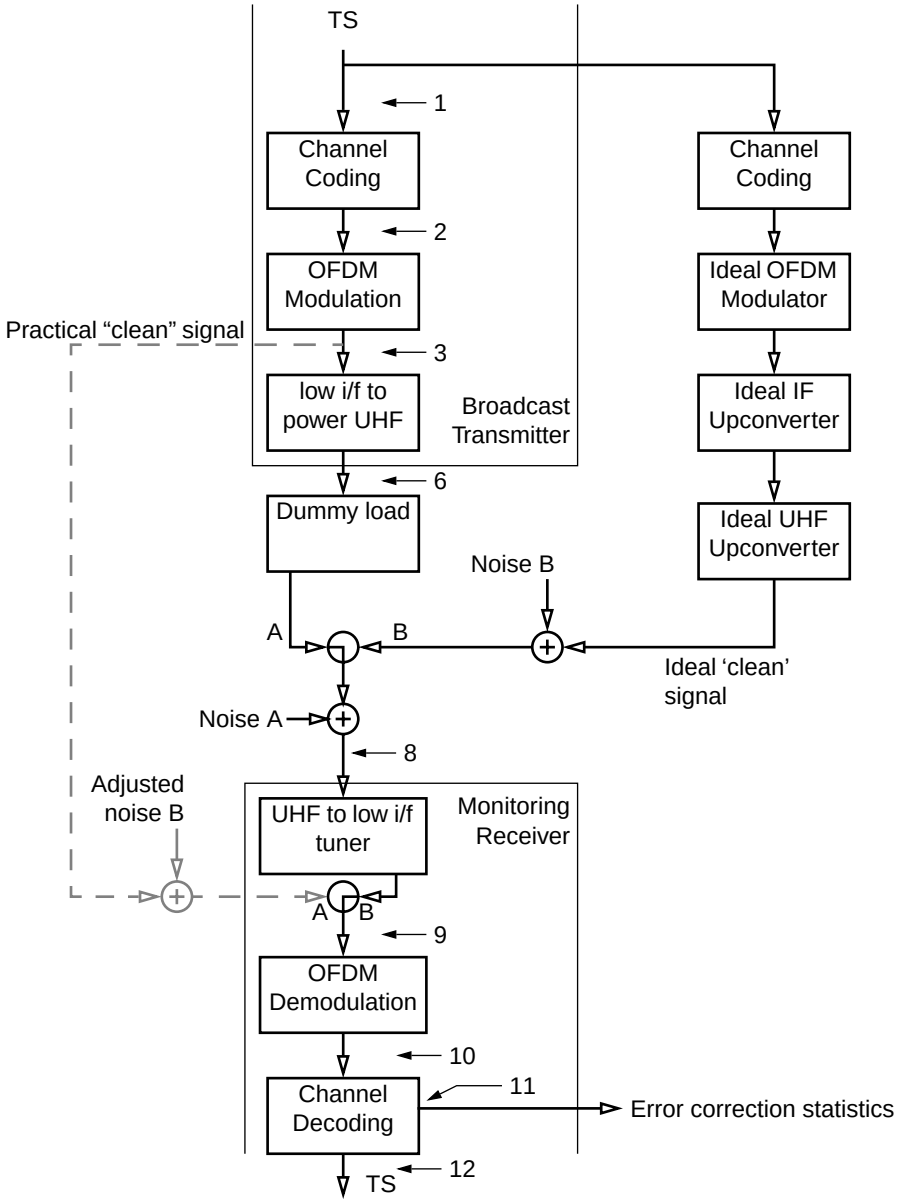


Figure 11-2. Measurement of noise like processes

Note that an ‘ideal’ OFDM modulator and upconverters are shown as the reference chain. In practice high-quality low-power laboratory equipment would be used. Where such a reference chain cannot be provided, the transmitter’s OFDM modulator may be used instead (the dashed path in Figure 11-2), and an allowance - normally very small and measured in the laboratory by comparison with a reference chain - made for its deficiencies.

The requirements for the Monitoring Receiver are as follows:

- The front-end noise must be negligible. Normally this can be ensured by providing sufficient input level.
- The bit error ratio (BER) must be measurable at the output of the Viterbi decoder.
- The implementation margin should be 2 to 3dB. For instance, if an 'ideal' receiver requires 16.5dB carrier-to-noise ratio (C/N) to give an output of acceptable quality, the Monitoring Receiver would require 18.5 - 19.5 dB C/N for an output of the same quality. The 2 - 3dB margin implies the use of a fast-acting channel equaliser.

In principle, the measurement is performed in two stages:

Firstly, a sample of the transmitter's output is passed to the input of the monitoring receiver in the normal way. White noise, 'Noise A', is then added, as shown, and its level increased until a given error rate [2×10^{-4}] is observed at the output of the Viterbi decoder (interface 11).

Secondly, the ideal transmission chain is used in place of the transmitter. 'Noise A' is retained, but a second source of white noise - 'Noise B' - added, as shown, and increased in level until the same error rate as before is noted. When this is true, the level of 'Noise B' must be identical to the equivalent noise floor (ENF) of the transmitter.

Note that it is very important to pay attention to signal levels within the system: the ideal transmission chain and the transmitter must present identical levels to the receiver. Also, the added noise power *within the bandwidth of the OFDM ensemble* must be known.

The ENF just measured is independent of the modulation system. However, the effect of the ENF on the system performance *does* depend on the modulation system; that is, the END will be greater at higher bit-rates. Hence it is necessary to convert ENF to END. Suppose that the carrier-to-noise ratio required to achieve the quasi-error-free point is $(C/N)_{QEF}$. Then

ENF - $(C/N)_{QEF}$	**END**
-6	1.26
-7	0.97
-8	0.75
-9	0.58
-10	0.46
-12	0.28
-14	0.18
-16	0.11
-18	0.07
-20	0.04
-26	0.01

Table 11-4. Conversion of ENF to END

Example The ENF of a transmitter was measured as -35dB. If the modulation mode is 64 QAM, rate 2/3, guard interval 7 µs, what is the END?

Theoretical $(C/N)_{QEF}$ = 16.5 dB

Practical $(C/N)_{QEF}$ = 19 dB (taking into account the 2.5 dB receiver implementation margin)

ENF - $(C/N)_{QEF}$ = -16 dB

Therefore END (from chart) = 0.11dB

11.6.3 Rebroadcast relays

The performance of rebroadcast relays (baseband regenerative and frequency shifting/transposing), if used, will be addressed in a future edition of the 'D Book'.

Note that, where both the parent transmitter and the transposer introduce significant amounts of non-linearity, the overall END could be significantly greater than the sum of the individual ENDs.

11.7 Non-Noise-Like Transmitter Degradations

11.7.1 Group delay errors

At interface 6 (in Figure 11-1), the maximum permitted delay of any carrier relative to that of any other is ± 7.5% of the guard interval (Δ) across the 7.61 MHz ensemble; that is, about ± 500 ns for Δ = 7 µs.

This value may be measured by exciting the first analogue upconverter (interface 3) with a frequency sweep waveform and examining the group delay response into interface 6. Note that the majority of the group delay errors are likely to be introduced by any high-power filters and combiners.

11.7.2 Low-frequency phase noise

Phase noise is introduced by local oscillators and timing references within the transmission chain. The phase noise density generally increases rapidly as the frequency offset from carrier is reduced. How much effect the phase noise has depends on the design of the receiver; wide AFC and channel equaliser loop bandwidths result in a receiver tolerant to low-frequency phase noise. However, the transmitter must not introduce sufficient phase noise to degrade the output of even the least tolerant receiver; thus it is recommended that the following phase noise mask be adopted.

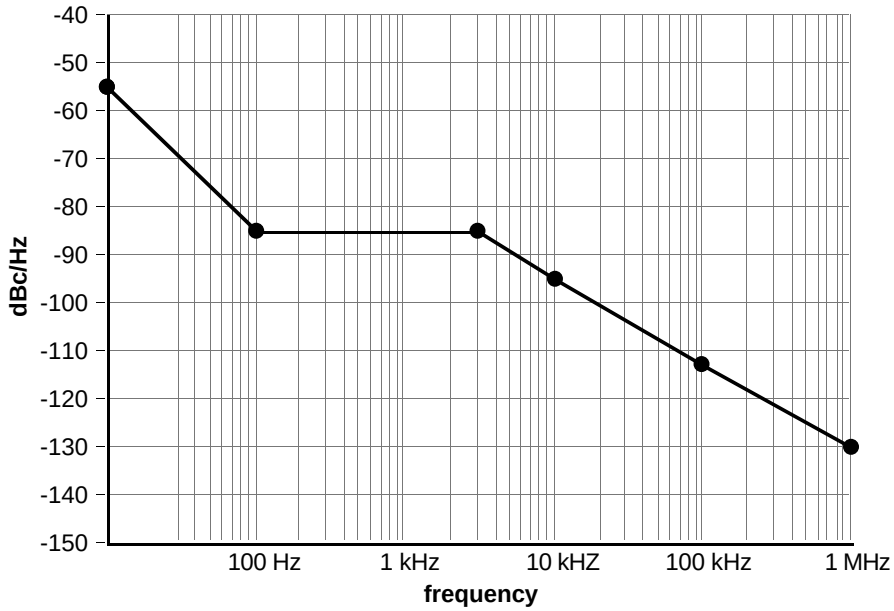


Figure 11-3. Transmitter Phase Noise Mask

Note that this mask is based on a recommendation of the AC106 VALIDATE Project. It represents what is reasonably achievable by commercial broadcast-quality synthesisers. 'Low-frequency' can be taken as 4 kHz, the OFDM carrier spacing. Phase noise components above this frequency can be treated as a contribution to the ENF of the transmitter.

11.8 Channel Frequencies

The channels are identified in the same way as they are for the PAL analogue services; that is, the nominal centre frequency of each channel is given by:

$$f_c = 474\ \text{MHz} + (i\text{-}21) \times 8\ \text{MHz}$$

i is an integer between 21 and 68, corresponding to the channel number.

It is possible that the centre frequency of the digital transmission will be offset by $\pm\frac{1}{6}$MHz (approximately 166.67 kHz) to ease adjacent channel operation. The use of offsets is currently under discussion; they are most likely to be helpful when the digital transmission is in the upper adjacent channel to an existing analogue service.

The error in the centre frequency of the transmitted OFDM ensemble must be within ± 500 Hz.

11.9 Changes in Modulation Parameters

No changes to any of the modulation parameters should take place during normal service hours. However, receivers should adapt to such changes within 5 s.

[Note: Work is currently being carried out to establish the likely capabilities of domestic receivers. It seems that rapid adaptation should be possible, for all but the changes to the guard interval.]

11.10 Single Frequency Networks

The issue of single frequency networks will be addressed in a future edition. Single frequency networks are not planned for the early phases of digital terrestrial television in the UK.

11.11 Spectrum Masks

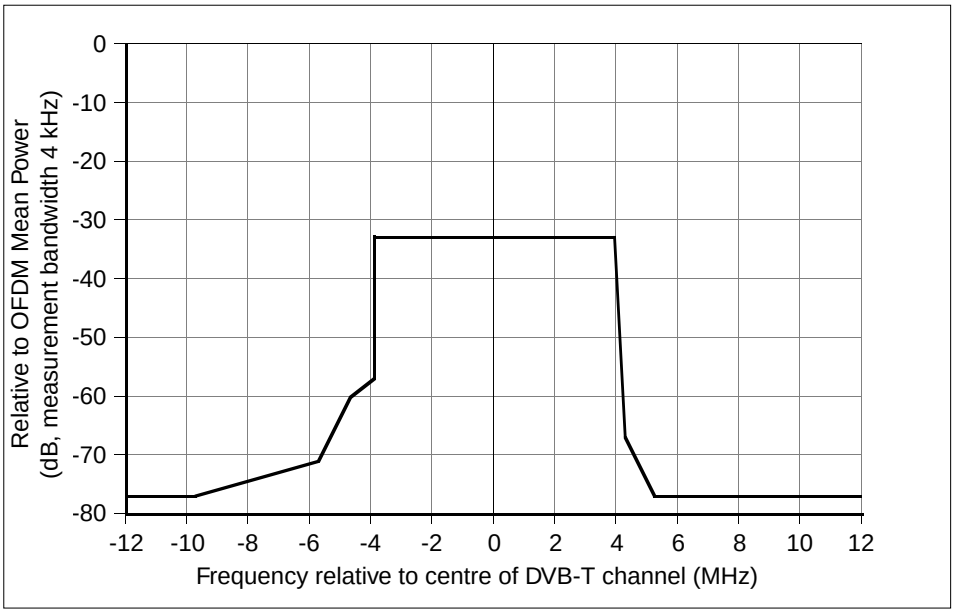
These spectrum masks are designed to prevent interference between digital terrestrial TV transmissions, analogue terrestrial TV transmissions and other transmissions. Transmissions conforming to these masks will not necessarily be acceptable in other respects. For example, the amount of transmitter non-linearity implied by Figure 11-3 could give rise to an excessive END.

11.11.1 DTT Signals

All DTG DVB-T emissions shall at least meet the spectrum mask requirements defined by ETS 300 744 for PAL system I environments. The requirements are reproduced graphically here and tabulated in Table 11-5.

This mask applies in cases where the analogue and digital transmissions are co-sited. Additional restrictions may be necessary where they are not co-sited. This is under study.

Figure 11-4. Spectrum mask to prevent interference to PAL system I signals



relative frequency MHz	-12	-10.75	-9.75	-5.75	-4.685	-3.925	-3.9	3.9	4.25	5.25	6.25	10.25	12
relative level dB	-76.9	-76.9	-76.9	-70.9	-59.9	-56.9	-32.8	-32.8	-66.9	-76.2	-76.9	-76.9	-76.9

Table 11-5. Breakpoints of spectrum mask for use to prevent interference to PAL system I

The above figures apply when the power radiated from the PAL and DTT transmitters are identical.

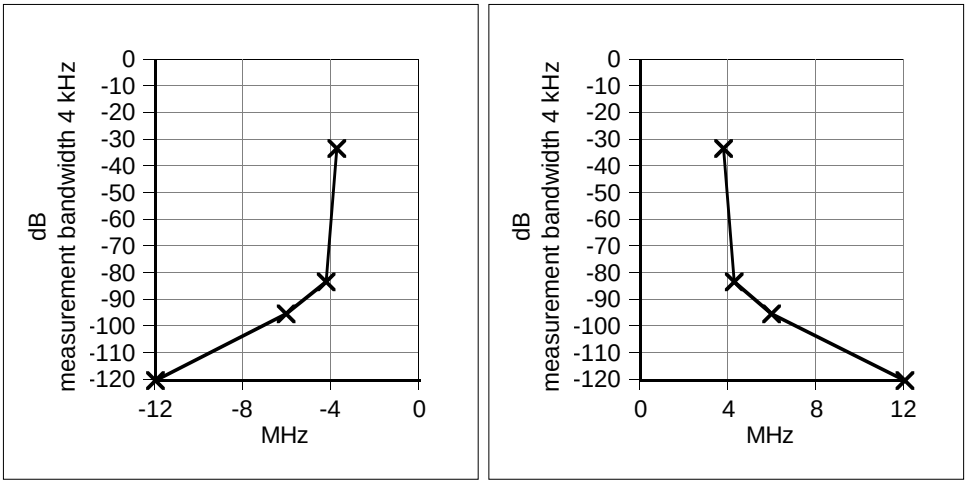
The following proportional correction may be added if the radiated powers from the two transmitters are not identical:

correction = minimum analogue ERP (dB) - maximum digital ERP (dB)

Example: Suppose the minimum analogue ERP is 100 kW, and the maximum digital ERP is 1 kW. The correction factor is then + 20 dB, and the relative level allowed at ± 12 MHz becomes (-76.9 + 20) dB or -56.9 dB.

Where the DVB-T transmission is at the edge of the UHF band, or adjacent to sensitive non-broadcast applications, a second spectrum mask with higher out-of -channel attenuation shall be used. The requirements are given in Figure 11-5 and Table 11-6.

Figure 11-5. ETS 300 744 Spectrum mask for critical cases



Frequency relative to centre of DVB-T channel

relative frequency MHz	-12	-6	-4.2	-3.8	3.8	4.2	6	12
relative level dB	-120	-95	-83	-32.8	-32.8	-83	-95	-120

Table 11-6. Breakpoints of spectrum mask for critical cases

These masks may be changed in a future edition of this specification.

11.11.2 PAL-I Signals

Where the DVB-T transmission is in the lower channel adjacent to a PAL-I transmission, the spectrum mask for the PAL-I emission shall be modified to that represented in Figure 11-6 and tabulated in Table 11-7.

This mask applies in cases where the analogue and digital transmissions are to cover the same service area. The restrictions might not be appropriate where the service areas are different.

.

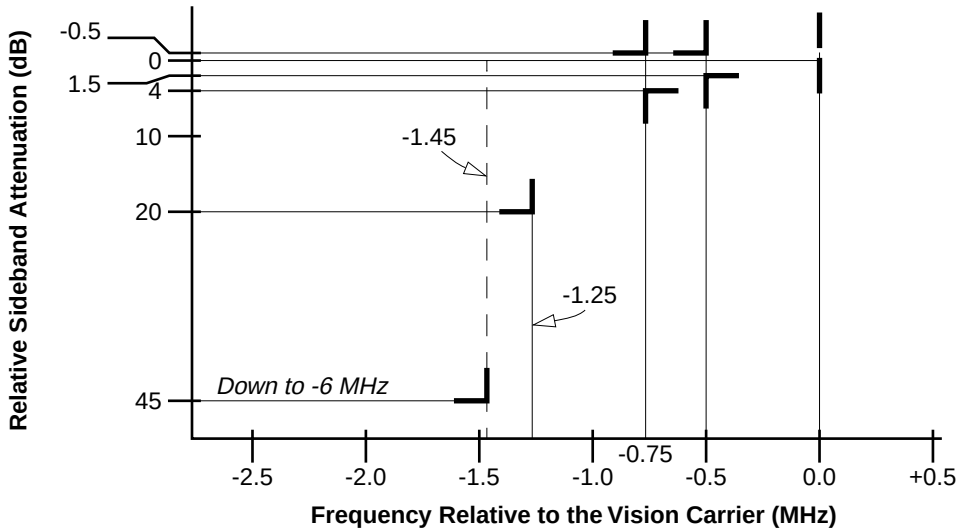


Figure 11-6. System I Sideband Response Mask

f (MHz)	-≤ 1.4	--1.25	-0.75	-0.5	0	+1.5
Limit (dB)	-45	-20	+0.5/-4	+0.5/-1.5	+0.5/-0.5	Reference

Table 11-7. Breakpoints of PAL-I Sideband Response Mask

Note that the requirement is for 45 dB relative sideband attenuation at 1.45 MHz below vision carrier *irrespective of DVB-T offset*.

Current indications are that a similar level of attenuation may be required when the DVB-T emission is in the upper adjacent channel to the PAL-I emission. This remains to be confirmed.

11.12 Minimum Carrier-to-Noise Ratios

Note: Informative Section

A certain minimum carrier-to-noise ration (C/N) is required to ensure near-perfect reception of the ETS 300 744 signal. The actual value depends on both the modulation scheme and the propagation conditions between transmitter and receiver. 'Near-perfect' is taken as a bit error ratio (BER) of 2.10^{-4} following the receiver's Viterbi decoder - a figure that leaves a small safety margin.

A chart of the minimum values of C/N is given below, for all available modulation parameters and for three different channels:

- Gaussian - 'ideal' apart from the addition of white Gaussian noise.
- Ricean - a channel with a prominent direct path between transmitter and receiver, but with a number of echoes present.
- Rayleigh - a channel with no direct path between transmitter and receiver.

These figures are taken from ETS 300 744. They are based on simulations assuming perfect channel estimation. For any practical demodulator there will be an implementation margin of about 2.5 dB, depending on the exact techniques used.

The Ricean and Rayleigh channels for which the figures are quoted are quite complicated; full details may be found in ETS 300 744, the source of Table 11-8.

		Required C/N for BER = 2. 10^{-4} after Viterbi (QEF after Reed-Solomon)			**Bitrate (Mbit/s)**			
Modulation	**Code Rate**	**Gaussian Channel**	**Ricean Channel (F_1)**	**Rayleigh Channel (P_1)**	**D/T_u = 1/4**	**D/T_u = 1/8**	**D/T_u = 1/16**	**D/T_u = 1/32**
QPSK	1/2	3.1	3.6	5.4	4.98	5.53	5.85	6.03
	2/3	4.9	5.7	8.4	6.64	7.37	7.81	8.04
	3/4	5.9	6.8	10.7	7.46	8.29	8.78	9.05
	5/6	6.9	8.0	13.1	8.29	9.22	9.76	10.05
	7/8	7.7	8.7	16.3	8.71	9.68	10.25	10.56
16-QAM	1/2	8.8	9.6	11.2	9.95	11.06	11.71	12.06
	2/3	11.1	11.6	14.2	13.27	14.75	15.61	16.09
	3/4	12.5	13.0	16.7	14.93	16.59	17.56	18.10
	5/6	13.5	14.4	19.3	16.59	18.43	19.52	20.11
	7/8	13.9	15.0	22.8	17.42	19.35	20.49	21.11
64-QAM	1/2	14.4	14.7	16.0	14.93	16.59	17.56	18.10
	2/3	16.5	17.1	19.3	19.91	22.12	23.42	24.13
	3/4	18.0	18.6	21.7	22.39	24.88	26.35	27.14
	5/6	19.3	20.0	25.3	24.88	27.65	29.27	30.16
	7/8	20.1	21.0	27.9	26.13	29.03	30.74	31.67

Table 11-8. Required C/N to achieve a BER of 2 x 10^{-4} after Viterbi decoder

The figures are all the result of early simulation work, and could change as a result of improved simulations.

11.13 Receiver Noise Performance (informative section)

11.13.1 Tuner Noise Model

A useful model for calculating receiver noise performance is illustrated below. The model comprises the following representative components:

- A front-end stage with noise figure F, dB and 'perfect' automatic gain control (AGC).
- An excess noise source of power P_x dBc at a point following the gain-controlled stage.
- A practical but unimpaired demodulator; that is, a demodulator with a fast channel equaliser and a consequent implementation margin of 2-3 dB.

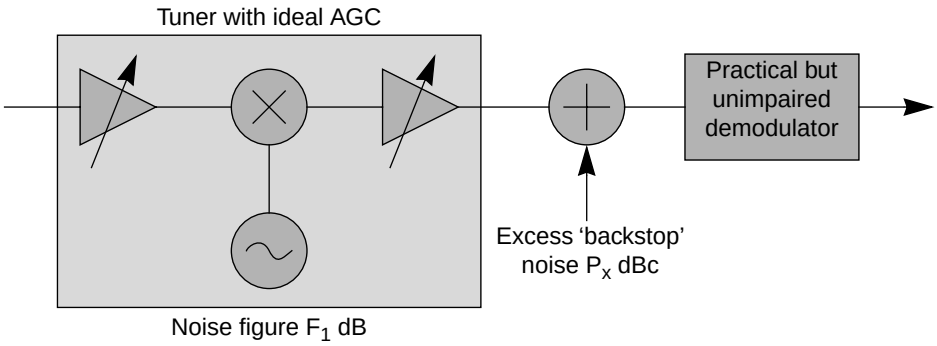


Figure 11-7. Tuner Noise Model

Note that the excess noise source P_x will include contributions from the following:

- Local oscillator phase noise.
- Quantisation noise introduced by the demodulator analogue-to-digital converter.
- Backstop thermal noise.
- Intermodulation products.

The carrier-to-noise ratio at the input to the model is $10\log_{10}$ [C/KTB]

The carrier-to-noise ratio at the input to the 'practical' demodulator is given by:

$$C/N\ (dB) = 10\log_{10}\ [\ C/(KTBF + CPx)\ ]$$

Where:

C = signal input power
K= Boltzmann's constant
T= Reference temperature (290° K)
B= system noise bandwidth (7.61 MHz)

11.13.2 Receiver Input Carrier-to-Noise Requirements

The presence of P_x and the use of a practical demodulator implies that the C/N requirements will be greater than those given in the previous Table 11-8. If it is assumed that P_x = -33 dBc, and that the 'unimpaired' demodulator has an implementation margin of 2.5 dB (to allow for imperfect channel estimation, see section 11.12), the theoretical C/N requirements are as shown below (calculated from the noise model presented in section 11.13.2):

Required C/N (dB) for QEF		
Modulation	**Code Rate**	**Gaussian**
QPSK	1/2	5.6
	2/3	7.4
	3/4	8.4
	5/6	9.4
	7/8	10.2
16-QAM	1/2	11.3
	2/3	13.7
	3/4	15.1
	5/6	16.1
	7/8	16.5
64-QAM	1/2	17.0
	2/3	19.2
	3/4	20.8
	5/6	22.1
	7/8	23.0

Table 11-9. Required C/N for the Various Modulation Scheme

Note that the effect of P_x is greater for the higher transport stream bit-rates. The receiver sensitivity (for a signal from a high quality test source) can be calculated from: Thermal noise floor (-105.2 dBm) + required input C/N (see above table) + receiver noise figure (dB).

11.13.3 Receiver Input Level Requirements

Suppose that the receiver still includes an excess noise source P_x of -33 dBc, and that the demodulator has an implementation margin of 2.5 dB. Suppose, in addition, that the noise figure of the receiver is 8 dB[1], and the noise floor (ENF) of the transmitter is -34 dBc. The minimum receiver input levels for the various channels and modulation schemes are then as below:

		P_x = 33 dBc		
Modulation	**Code Rate**	**Gaussian**	**Ricean***	**Rayleigh***
QPSK	1/2	-91.6	-91.1	-89.3
	2/3	-89.8	-89.0	-86.3
	3/4	-88.8	-87.9	-83.9
	5/6	-87.8	-86.7	-81.5
	7/8	-87.0	-85.9	-78.1
16-QAM	1/2	-85.8	-85.0	-83.4
	2/3	-83.5	-83.0	-80.3
	3/4	-82.1	-81.6	-77.7
	5/6	-81.0	-80.1	-74.8
	7/8	-80.6	-79.5	-70.3
64-QAM	1/2	-80.1	-79.8	-78.4
	2/3	-77.9	-77.2	-74.8
	3/4	-76.2	-75.6	-71.8
	5/6	-74.8	-73.9	-66.0
	7/8	-73.8	-72.7	-48.2

Table 11-10. Minimum Receiver Input Requirement

The figures for the Ricean and Rayleigh channels make use of the information given in ETS 300 744, and duplicated in Table 11-8. Because these particular channels are too complicated for practical implementation, it is proposed that simpler channels be defined and the new figures quoted.

1. Note that the noise figure may be up to 2 dB worse in an installation where the signal from the antenna goes to a ‘loop through’ device such as a VCR or set-top box.

11.13.4 Further Useful Information

The power levels quoted in Table 11-10, for *example*, are in units of dBm; 0 dBm is equivalent to 1 mW. The receiver manufacturing industry commonly uses the unit of dBµV instead Converting between the two quantities is straightforward:

0 dBm is equivalent to 0.274 VRMS across 75 Ω

Therefore 0 dBm is equivalent to 108.75 dBµV

Fundamental theory shows that the signal power available at the input of a receiver is given by:

$$P = \frac{E^2(1.64)G\lambda^2}{480\pi^2} \text{ Watts}$$

Where:

E = field strength (V/m)

G = antenna gain relative to that of a dipole

L = feederloss (note: typically the product GL = 5 (7 dB)

λ = wavelength (m)

If P is to be expressed in dBm,

$$P_{(dBm)} = (10 \log_{10} P - 30) \text{ dBm}$$

If the field strength is to be expressed as *E* dBµV/m

$$E = 20\log_{10}E + 120 \text{ dBµV/m}$$

It is generally agreed that a necessary (but perhaps not sufficient) criterion for adequate performance would be to achieve the following protection ratios for a bit error ratio of $2x10^{-4}$ after Viterbi, in the presence of transmitter noise at –34 dBc:

Unwanted signal	Interferer characteristics	Level relative to wanted carrier (dB)
Co Channel interference	PAL-I, 75% colour bars, FM sound: 1 kHz tone, NICAM	-4
Adjacent Channel	PAL-I, 75% colour bars, FM sound: 1 kHz tone, NICAM	+35
Gaussian Noise		-20
'Typical' Multipath channel		-23
Echo inside the guard band		-8
Echo outside the guard band		-25

Table 11-11. Required Protection Ratios

Note: most of these conditions are taken from the ITC/NTL/BBC Joint Planning study, which assumed a noise figure of 5 dB.

11.14 Receiver Selectivity Requirements

Receiver selectivity is an important issue for the following reasons:

- The aim is to provide six digital transmissions from each transmitting site.
- There will be at least four, and possibly five, existing analogue transmissions from the same site.
- The analogue signal levels received could be 35 dB greater than the wanted digital signal level.
- Approximately half the digital transmissions will be adjacent channel to the analogue transmissions.

Maximum and minimum signal levels were given in Section 11.3, “Network Design Issues,” on page 11-1, but these can be summarised diagrammatically:

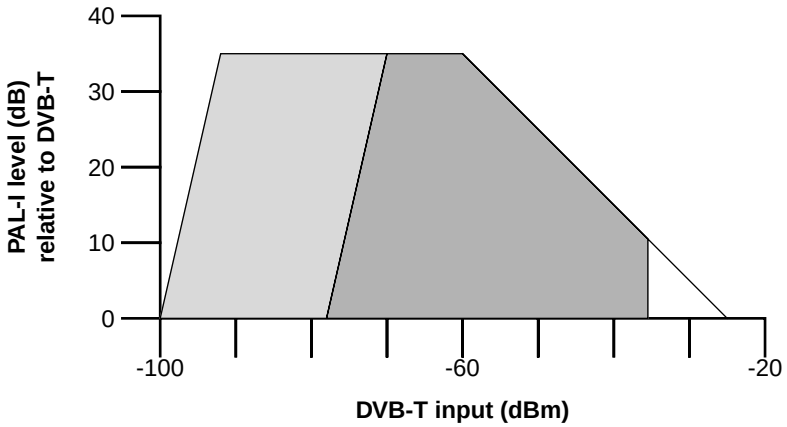


Figure 11-8. Maximum Relative Level of Adjacent Channel PAL Signal

Over the expected range of received signal levels, the diagram shows the maximum relative level of PAL to be +35 dB. (-60 dBm represents a ‘good’ received digital signal level). It is unlikely that very high PAL and digital signal levels will be received simultaneously, and it would be unrealistic to expect a receiver to cater for such circumstances. Hence the diagram shows the maximum digital and PAL signal levels to be -35 dBm and -25 dBm respectively. At very low signal levels, the performance depends on the modulation mode and receiver noise figure.

Note that there are two main mechanisms by which the PAL signal can cause interference:

- inadequate filtering within the receiver; lower adjacent channel NICAM sound is a particular problem.
- intermodulation at a point in the receiver before the IF filtering.

Chapters 12 to 20 containing the MHEG-5 specification will be released shortly

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Conditional Access & Common Interface

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21 Conditional Access

21.1 Scrambling

21.1.1 References

- ETR 289
- Advanced Television Directive (95/47/EC)
- DVB A011

21.1.2 Requirements

Where scrambling is employed in DTG compatible transmissions then the DVB Common Scrambling Algorithm shall be used. It shall be implemented in compliance with ETR 289.

It should be noted that the advanced television directive doesn't forbid the use of other scrambling systems. In the case of DTG transmissions however, the use of the common scrambling algorithm shall be regarded as mandatory for all compliant broadcasts.

21.2 Simulcrypt

21.2.1 References

- SIM 061 [38], Technical Specification of DVB-Simulcrypt

21.2.2 Constraints and Extensions

CA systems and head-end equipment used for DTG broadcasts shall be compliant with the DVB guidelines. These specifications are currently under development. At the time of writing document [38] embodies the current state of this work.

22 Common Interface

22.1 Scope

This section defines the specifications applicable to the common interface in DTG compliant reception equipment.

22.2 References

- EN 50221
- DVB Guidelines on for the implementation of the common interface

22.3 Minimum requirements

Reception equipment that supports the common interface shall implement it to conform to EN 50221 and such guidelines as are developed by the DVB.

The Common Interface extensions specified in this chapter are necessary to enable a full range of module and receiver functions to be implemented to decode all the DTT services which are planned. It is recognised that some decoding functions may be implemented in other ways, without the use of the Common Interface, however receivers should implement the extensions where possible. The DTG proposes to set a suitable timescale, linked to their adoption by the relevant standards bodies, after which certain of these extensions must be implemented in all receivers.

22.4 Numbers of sockets

Receivers shall provide at least 1 PC Card connection for support of the DVB Common Interface to enable use of modules for Conditional Access (CA) OR shall provide an integral CA system. Additionally, receivers shall support at least 1 further DVB Common Interface connection to support multicrypt conditional access and/or other functionality such as decoding of minority services (e.g. audio description).

22.5 Status of Common Interface Extensions

The specifications for extensions to the Common Interface described here are substantially complete in themselves. However, additional extensions are being considered and will be presented in a future revision. This set of extensions is being developed in cooperation with the DVB and will appear in a European standards publication in the future. The registration of resource identifiers will flow from this process.

Command Interface - Session Layer

A method to allow a specific instance of a module to be addressed is under development and will be presented in a future release.

22.6 Input Modules

Two types of input modules are defined ‘A’ and ‘B’. Type ‘A’ is a simple, potentially low-cost module for delivery of broadcast services via DVB-C, DVB-S or DVB-T networks to hosts. Type ‘B’ (See “Type ‘B’ Input Modules” on page 22-10) supports these types of service and in addition allows other types of service and network to be delivered.

22.6.1 Requirements for both input module types

22.6.1.1 TS format

Where the input module delivers a Transport Stream (TS) to the host the TS itself and the data streams within it shall conform to the appropriate DVB specifications for a broadcast TS. In particular:

- TS, PSI, Audio and Video data shall conform to ETR 154
- SI shall conform to ETS 300 468 and ETR 211

22.6.1.2 TS control

Input modules shall continue to pass the host supplied TS from its Transport Stream Input to its Transport Stream Output until the host opens a session to the control resource (e.g. StreamInput or ServiceGateway) of the module and sends a command requesting the module to deliver a stream/service (e.g. TuneTSReq or GetServiceReq).

When the host requests the module to stop providing the stream/service or closes the session to the control resource the TS output by the module shall revert to being that supplied by the host.

This requirement does not preclude the module also including CA functions to descramble some or all of the data passing through the module.

22.6.2 Type ‘A’ Input Modules

22.6.2.1 Introduction (informative)

Module overview

Figure 22-1 illustrates a possible type ‘A’ module. Here a low performance microcontroller provides local intelligence within the module. The functions this is will support are:

- User set-up screens, for example, to allow the user to configure a satellite module with regard to the characteristics of the LNB & dish to which it is connected.[1]
- The ability to search for transport streams.
- The ability to tune to transport streams as directed and then remained locked to them.

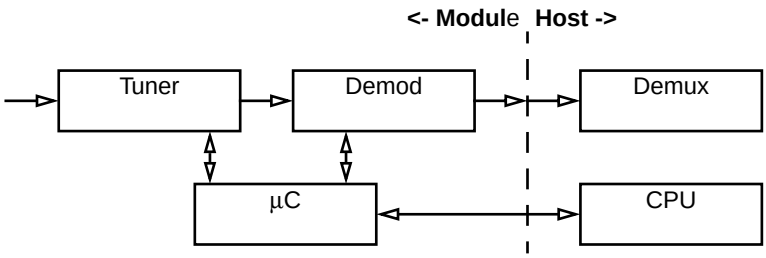

Figure 22-1. Illustrative type ‘A’ module

Software model overview

Module man machine interface

All input modules shall support host-module communications from the Application Information resource. In particular if a module provides set-up screens these shall be accessible at least in response to Enter Menu message from the host.

Hosts supporting input modules shall provide the user with a method to access the top level menu of each module.

Input Set-up

Depending on the delivery system connected to the module it may be appropriate for the module to provide set-up screens, using the normal CI MMI methods, to assist installers set-up the input to the host. For example, these screens might provide display of signal strength to assist antenna pointing etc.

Autoscan set-up

Depending on the delivery system connected to the module it may be appropriate for the module to provide set-up screens to configure its autoscan process. See below.

Host responsibility

The host has no responsibility in these area other than providing a method for the user to activate the top-level user interface screens of the module.

Scanning for TS

The host is responsible for initiating the frequency scanning process. This applies whether module autoscan feature is used or whether the host directs the scanning in a more hands-on way.

Messages are based on delivery system descriptors

The dialogues between the host and the input module are in terms of the payload of DVB SI delivery system descriptors. For all currently defined DVB delivery systems (DVB-T, DVB-S & DVB-C) this payload is the same size (11 byte) but the internal coding varies.

1. This feature is optional but is likely to be a practical requirement of all real modules.

The host is not required to understand this structure to be able to use the module. However, at the host designer's option, enhanced behaviour may be possible where the host does understand it.

Modules must provide autoscan facilities

All low level input modules shall provide an autoscan function that allows them to search for transmissions.

The module is completely responsible for this process. This specification does not limit how this is done. Various approaches can be illustrated that might fit different circumstances:

- The module is initialised by the supplier with a list of frequencies and the attributes of the dish/LNB with which it works.

  This might be appropriate where a service provider or retailer delivers a "shrink wrap" package of module and dish intended to access a particular service provider.

- The module might be supplied pre-initialised with data on the characteristics of various network operators (e.g. Astra and Eutelsat) and various LNB/dishes. The module must then ask the user to tell it about the circumstances in which it is deployed (e.g. an Acme steerable dish with a Bloggs Inc. "Mark III" LNB)

- The module might provide an "advanced user" set-up. For example, this might provide the user with the ability to configure the method the module should use to select polarization on an LNB (e.g. LNB voltage, 22 kHz tone, DiSEqC etc.)

Module controlled scanning

The host instructs the module to autoscan. Each time the module "finds" a TS it stops scanning and delivers TuningInformationMessage (in data equivalent to a DVB SI delivery system descriptor) to the host. The host has an opportunity to store the TuningInformationMessage and to analyse the SI in the TS allowing it to extract service lists etc. Alternatively, the host might just store the TuningInformationMessage and return later to analyse the SI in more detail. The host can tell the module to continue the search. Eventually the module will report "search done".

When the module performs a search for TS the host should not assume that the module has access to the SI within each TS. The host is responsible for analysing the SI in each TS found. For example, in a terrestrial environment the host may be able to get the same TS on more than one frequency. The host is responsible for deciding which set(s[1]) of tuning information to store for each TS.

Host controlled scanning

The host can also construct tuning information to instruct the module to tune. In this way the host can control the search strategy. This gives the host an opportunity to take advantage of any special knowledge it might have. For example, it might "know" about a "barker channel" which provides reliable tuning information. This might allow the host to accelerate tuning.

Features of this type are enabled but not required by this specification. They are therefore an area for product differentiation.

Hosts should be aware that the tuning information provided by the NITs on some delivery systems (e.g. SMATV and Terrestrial) can be unreliable.

Storing tuning information

During the TS scanning process the host will potentially discover many TS and services. It is a host implementation choice to decide how many to remember, and the facilities provided to the user for selecting services.

The minimum information that host needs to retain to be able to return to a TS is the tuning information provided by the module and a reference to the module (to identify it in the case

1. It might be useful to store more than one set of tuning information for a TS to accommodate variable reception conditions!

that there is more than one input module in the host). To be able to return to a service the host must at least store the original network ID, the service ID and a reference to the TS holding that service. The quantity of information involved here is likely to be quite modest.

Optionally hosts might store additional information associated with each service such as the service name.

TS & Service selection

Tuning to TS — **The host can command the input module to tune to a TS**. The TS is specified with the standard 11 byte TuningInformationMessage.

Service Selection — **The host is responsible for accessing services within each TS.** A type 'A' input module is not required to have visibility of the services within a TS.

CA features — Independent of their type 'A' input module functionality, input modules can also provide a Conditional Access Support resource to manage CA access to services within TS. In this case the host communicates independently to the tuning support and the CA support features. Here the host behaviour is almost identical to the case where CA is provided by a separate module down stream of the input module.

22.6.2.2 Type 'A' module command interface

StreamInput

Type 'A' input modules shall present a StreamInput resource to the host. The resource identifier for this resource is <tbd lli>. This resource shall support a single session.

After a session is opened to its StreamInput resource the module shall continue to pass the host supplied TS from its Transport Stream Input to its Transport Stream Output until TuneTSReq is used to tune to a specified TS when the selected TS replaces the one from the host as the output of the module. The TS output of the module reverts to the TS from the host either when the session to the StreamInput is closed or TuneTSReq is used without a TuningInformationMessage.

Table 13-1 summarises the set of stream level module control calls presented by the StreamInput resource.

Call	Direction	Description
DeliverySystemInfoReq	h->m	Requests the module to provide information on its delivery system.
DeliverySystemInfoAck	m->h	Reply describing the type of delivery system connected e.g. (DVB-S, -C, -T)
ScanStartReq	h->m	Instructs the module to start scanning for TS
ScanNextReq	h->m	Instructs the module to continue scanning for TS
ScanAck	m->h	Reply describing the TS found
TuneTSReq	h->m	Instructs the module to tune to a TS
TuneTSAck	m->h	Reports the success or otherwise of the tune

Table 13-1. Overview of the StreamInput **objects**

DeliverySystemInfoReq

Requests the module to report on the delivery system it connects to.

Syntax	No. of bits	Mnemonic

DeliverySystemInfoReq () {
  DeliverySystemInfoReqTag
  length_field()
}
	8	bslbf

Table 13-2. DeliverySystemInfoReq syntax

DeliverySystem-InfoReqTag

This 8 bit field with value 0x80 identifies this message.

DeliverySystemInfoAck

Reply to DeliverySystemInfoReq describing the type of delivery system connected to the module.

Syntax	No. of bits	Mnemonic

DeliverySystemInfoReq () {
  DeliverySystemInfoAckTag
  length_field()
  for(i=0; i<N; i++) {
  SystemIdentifier
  }
}
	8
	
	8
		bslbf
		
		bslbf

Table 13-3. DeliverySystemInfoReq syntax

DeliverySystemInfoAck-Tag

This 8 bit field with value 0x81 identifies this message.

SystemIdentifier

This 8 bit field identifies the delivery system(s) connected by the module. The values defined for this field defined in Table 13-4.

SystemIdentifier value	Delivery system	Tuning information message format
0	“Abstract”	Module specific
1	DVB-C	As DVB SI cable delivery system descriptor
2	DVB-S	As DVB SI satellite delivery system descriptor
3	DVB-T	As DVB SI terrestrial delivery system descriptor
> 3	Reserved for future use	

Table 13-4. Delivery system identification

The TuningInformationMessage format is in all cases 11 bytes long. In cases 1 to 3 the message is the last 11 bytes of the corresponding DVB SI delivery system descriptor (i.e. all bytes after the descriptor tag and length fields). All other delivery systems shall use the same 11 byte format.

Hosts supporting input modules shall be able to work with all delivery systems (even those not yet defined) as there is no requirement for hosts to understand the tuning information message. The purpose in revealing the type of the delivery system is to enable hosts to provide enhanced facilities for delivery systems with which they are “familiar”.

“Abstract” delivery systems

The “abstract” delivery system uses a standard size 11 byte tuning information message. However, the coding of this message is not publicly defined.

Example cases where modules may declare their network as “abstract” include:

- SMATV or small CATV networks where the tuning information delivered by the NIT is not reliable following remodulation of signals from a different delivery system.
- New delivery systems with different modulation parameters

ScanStartReq

Instructs the module to start scanning for TS from some “start point” of its own choosing.

On receiving this the module may open a MMI session to request the user to configure parameters affecting the scope of the search. The host shall be able to let the module open a session to the MMI resource.

Syntax	No. of bits	Mnemonic
`ScanStartReq () {`		
`  ScanStartReqTag`	8	bslbf
`  length_field()`		
`}`		

Table 13-5. ScanStartReq syntax

ScanStartReqTag This 8 bit field with value 0x82 identifies this message.

ScanNextReq

Instructs the module to continue scanning for TS from the “point” achieved when ScanAck last returned.

Syntax	No. of bits	Mnemonic
`ScanNextReq () {`		
`  ScanNextReqTag`	8	bslbf
`  length_field()`		
`}`		

Table 13-6. ScanNextReq syntax

ScanNextReqTag This 8 bit field with value 0x83 identifies this message.

ScanAck

Reply from the module to the host when a broadcast signal is found, or the search is completed.

Syntax	No. of bits	Mnemonic
`ScanAck () {`		
`  ScanAckTag`	8	bslbf
`  length_field()`		
`  TSState`	8	uimsbf
`  TuningInformationMessage`	11x8	bslbf
`  ScanProgress`	8	uimsbf
`}`		

Table 13-7. ScanAck syntax

ScanAckTag This 8 bit field with value 0x84 identifies this message.

TSState This 8 bit field delivers an unsigned integer indicating the availability of the TS. The coding of this field is as follows:

- 0 indicates no signal found.

When auto-scanning for TS ‘0’ indicates that the auto-scan process has searched all possible frequencies.

- 1 to 254 provide a normalised representation of the signal quality (bigger is better) based on the BER at the input to the final RS decoder.

  (detail coding to be provided)

- 255 indicates a ‘perfect’ signal. This is only indicated by an error free network.

TuningInformationMessage This 11 byte field carries a delivery system dependent coding of the tuning information to reacquire the TS found by the module.

The value of this field is not defined if the TSState is ‘0’.

ScanProgress This 8 bit unsigned integer provides an approximate proportional indication of how far through the auto-scanning process the module is. The range of allowed values is 0 to 255. The value increases as the scan progresses.

TuneTSReq

This call requests the module to tune to the TS using the tuning information supplied. If the TuningInformationMessage field is missing (i.e. the length field indicates zero following bytes) then the request is for the module to disconnect from the network.

Syntax	No. of bits	Mnemonic
`TuneTSReq () {`		
`  TuneTSReqTag`	8	bslbf
`  length_field()`		
`  TuningInformationMessage`	11x8	bslbf
`}`		

Table 13-8. TuneTSReq syntax

TuneTSReqTag This 8 bit field with value 0x85 identifies this message.

TuningInformationMessage This 11 byte field carries a delivery system dependent coding of the tuning information to acquire the TS found by the module. The coding is identical to the TuningInformationMessage returned by ScanAck.

TuneTSAck

This reply indicates that the module has tuned to the requested frequency in response to a TuneTSReq. The message is sent when the module is delivering a stable TS.

Syntax	No. of bits	Mnemonic
`TuneTSAck () {`		
`  TuneTSAckTag`	8	bslbf
`  length_field()`		
`  TSState`	8	uimsbf
`}`		

Table 13-9. ScanAck syntax

TuneTSAckTag This 8 bit field with value 0x86 identifies this message.

TSState This 8 bit field has identical coding to the TSState returned value returned by ScanAck.

In the case that TuneTSReq has no TuningInformationMessage (i.e. the message is “network disconnect”) then this field shall have the value ‘0’ (i.e. no signal).

22.6.3 Type ‘B’ Input Modules

22.6.3.1 Introduction (informative)

Module Overview

Figure 22-2 illustrates a possible type ‘B’ module. This example might be suitable for connections to a broadcast network. In this case the module has a demux and a CPU and hence is able to analyse information about the network (in this case DVB SI) and provide service level access (compared to the TS level access provided by the type ‘A’ module - See “Type ‘A’ Input Modules” on page 22-4).

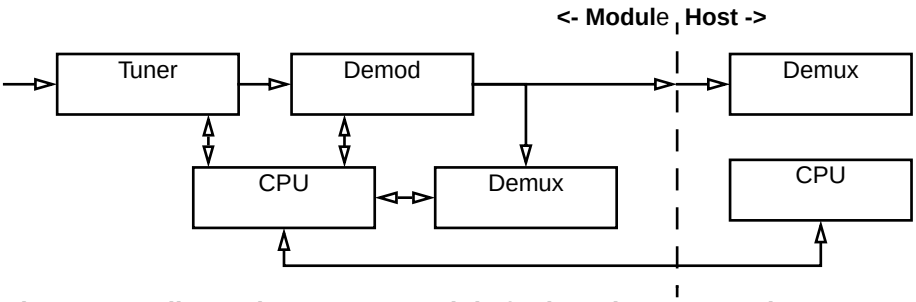

Figure 22-2. Illustrative type ‘B’ module for broadcast networks

Input modules might also integrate CA functions, in which case Figure 22-3 might be representative of the module functions required.

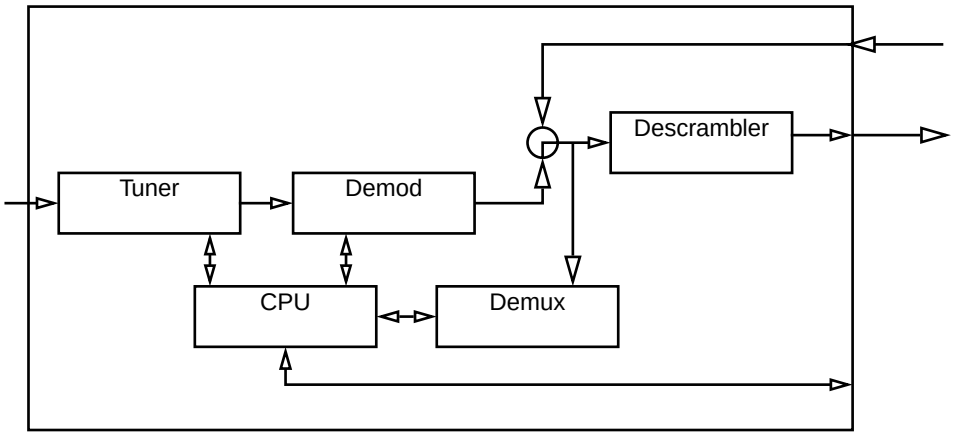

Figure 22-3. Type ‘B’ input Module with CA

Software Model Overview

This section illustrates possible relationships between the type ‘B’ module and a navigation application.

Navigation model

The model assumes that the basic navigation model for hosts with DVB CI is DVB SI. Hence DVB SI service naming concepts are used by the CI to present the list of available services to the host.

This approach can be used to give generic hosts access to a wide range of TV and other services. However, it is envisaged that in the future this module-host API may evolve and provide new methods that allow “aware” hosts to work more directly with novel service types.

Simple TV access

In Figure 22-4 a basic host accesses normal TV services provided by a module. In this case the module provides a list of the services it can provide. The application presents this list to

the user. When the user selects a service the module delivers the service to the host where it is decoded.

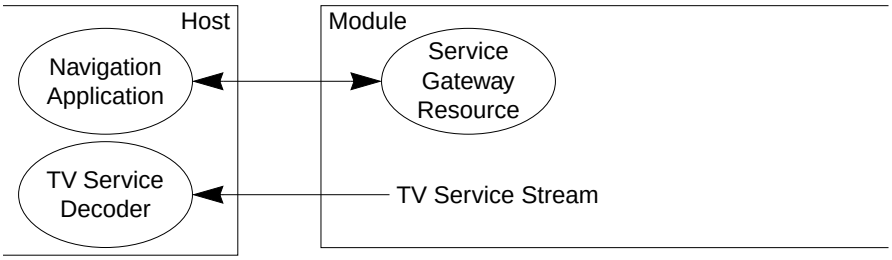

Figure 22-4. The basic host application / gateway resource relationship

The host's "Navigation Application" can be designed to seamlessly integrate the list of module delivered services with the list of "its own" services.

Basic access to new service types

In Figure 22-5 the same basic host is connected to a module that can provide access to new types of service. The module provides a decoder for the service and thus insulates the host from having to "understand" the service. For example, the module might be providing access to a wired VOD service. Here, the module resident "Type Specific Decoder" (TSD) is a "browser" which allows the user to navigate the VOD server. The "browser" is presented to the user via the module-to-host Man Machine Interface routines.

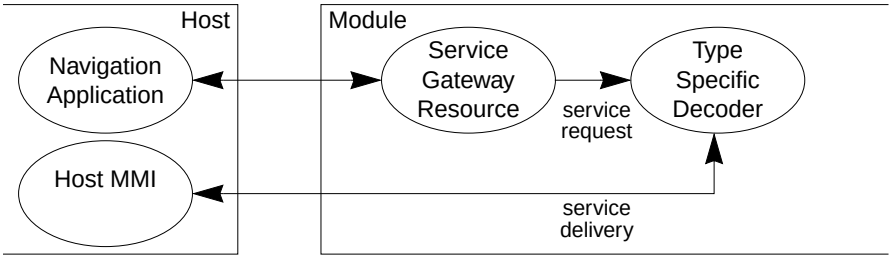

Figure 22-5. A basic host accessing more advanced services

In Figure 22-5 the list of services presented by the module includes a service with a new type "Service Gateway". If the user selects this "Service Gateway" service the module activates the TSD. In some cases (e.g. VOD) the TSD allows the user to browse a catalogue. A catalogue selection may result in an MPEG AV stream being sent from the module to the host. In other cases (e.g. home shopping) catalogue browsing may be the end purpose of the TSD.

Aware hosts

In Figure 22-6 a more advanced host is connected to the module (possibly the same module as in Figure 22-5). Here the host "recognises" new resource types presented by the module and is able to directly take advantage of them.

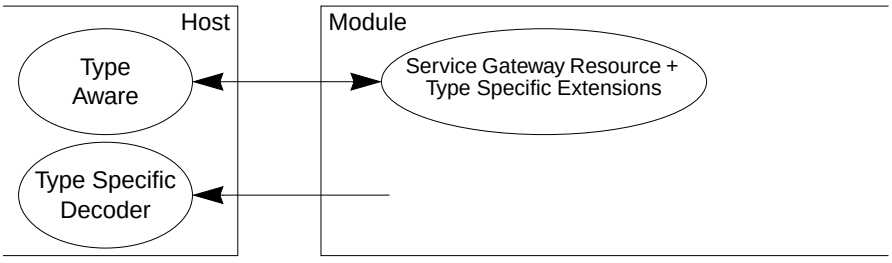

Figure 22-6. An advanced host application accessing advanced services

An example might be where the module provides access to a network file system (implemented using DSM-CC protocols). The Type Specific Extensions in the module could

present the file system by means of the DSM-CC U-U API. The TSD in the host might simple be an MHEG-5/6 engine implemented on top of the DSM-CC U-U API.

Broadcast Type Specific Resource

In this initial proposal the facilities of the basic Service Gateway Resource are outlined (See “Service presentation” on page 22-13). In addition a set of Type Specific Extensions appropriate to broadcast TV services are outlined (See “Event Presentation” on page 22-21). These extensions provide information describing the broadcast events which might be of use to host based TV guide.

Evolution of extensions

Typically[1] Service Gateway Modules will present the Generic Service Gateway Resource on a well known resource ID. In addition, the module can also present a Network Specific Service Gateway Resource which inherits the facilities of the generic resource but extends them with facilities specific to the network.

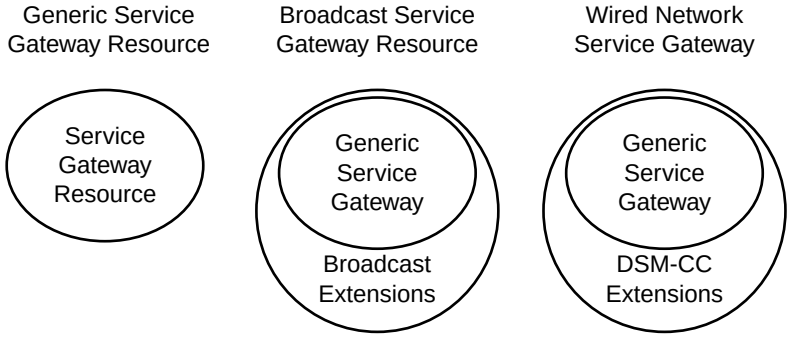

Figure 22-7. Modules presenting Type Specific APIs

For example, a module providing access to DVB-T broadcasts might also present the variant of the Service Gateway Resource with Broadcast Extensions, allowing it to present event information in addition to service lists.

1. This might not be possible where the types of service accessed are not suitable for presentation via a module resident Type Specific Decoder. In this case the module might only present its more specialist resource.

22.6.3.2 Service presentation

ServiceGateway

Table 13-10 summarises the set of “Service Gateway” calls presented by the Generic Service Gateway Resource. These facilities are also inherited by ALL other Network Specific Service Gateway Resources.

After a session is opened to its ServiceGateway resource the module shall continue to pass the host supplied TS from its Transport Stream Input to its Transport Stream Output until GetServiceReq is used to request access to a specified service when a new TS may replace the one from the host as the output of the module. The TS output of the module reverts to the TS from the host either when the session to the ServiceGateway is closed or GetServiceReq is used with no service reference.

Call	Direction[a]	Description
ServiceListReq	A->R	Application requests the resource to provide a list of the services that it can supply.
ServiceListAck	R->A	The resource gives the application a list of the IDs of the services that it can provide.
ServiceListVersionReq	A->R	The application request the version number of the resource’s service list
ServiceListVersionAck	R->A	The resource provides the version number of its service list
ServiceListChanged	R->A	The resource notifies the application that its service list has changed.
ServiceDescReq	A->R	The application requests further information on a particular service.
ServiceDescAck	R->A	The resource supplies further information on a particular service.
GetServiceReq	A->R	The application requests the resource to provide a service.
GetServiceAck	R->A	The resource replies regarding the availability of a service.

Table 13-10. Overview of Application<->Resource service interface calls

a] A=host resident application, R=module resident resource. A->R means from application to resource.

ServiceListReq

The ServiceListReq can be issued by the host to request the list of service references that the module can provide. Typically this is done when a module is first configured or each time the host observes that the version number of the service list has changed, but it might also be done in response to a “ServiceListChanged” message from a module.

Syntax	No. of bits	Mnemonic

`ServiceListReq () {`
`  ServiceListReqTag`
`  length_field()`
`}`
	8	bslbf

Table 13-11. ServiceListReq syntax

ServiceListReqTag This 8 bit field with value 0x80 identifies this message.

ServiceListAck

In response to “ServiceListReq” a module returns a service list version number followed by a list of the service references that the module can support. These references are persistent as they are either the “real” DVB SI reference to DVB broadcast service or represent a “logical” service that the module can provide.

Changes in the service list presented should represent “significant changes” in the service offering as the host is encouraged to respond by drawing the user’s attention to the change.

Syntax	No. of bits	Mnemonic
ServiceListReq () {		
ServiceListAckTag	8	bslbf
length_field()		
VersionNumber	8	uimsbf
NumberOfServices	16	uimsbf
for(i=0; i<NumberOfServices; i++) {		
OriginalNetworkID	16	bslbf
ServiceID	16	bslbf
}		
}		

Table 13-12. ServiceListAck syntax

ServiceListAckTag This 8 bit field with value 0x81 identifies this message.

VersionNumber This 8 bit integer increments each time the service list is updated.

NumberOfServices This 16 bit integer giving the number of service references (the value may be 0 if there are no service references).

OriginalNetworkID This 16 bit field is an original network ID allocated within ETR 162 [11].

ServiceID This 16 bit field uniquely identifies the service within the original network.

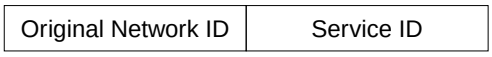

Figure 22-8. service reference

A transport stream ID is NOT required to uniquely identify a service as is indicated in this extract from section 4.1.1 of ETR 211 [12]:

> A service can be uniquely referenced through the path original_network_id / transport_stream_id / service_id. The network_id, thus, is not part of this path. In addition each service_id shall be unique within each original_network_id.

Host use of service references (informative) The host use of the “service reference” is not prescribed. However, it is likely that a host that implements concepts such as “favourite channels” will store the “service reference” in non-volatile memory. This allows the host to bind the “service reference” to RCU keys or to organise it into navigator lists according to the user preference.

Hosts might also store other characteristics of the service (e.g. its name) in non-volatile memory. However, this is a optional as the additional data can be requested from the module when required once the host has the “service reference” as an index.

ServiceListVersionReq The host requests the version number of the service list held by the module. If the version number returned by the module is different from that which the host remembers the host should normally request the service list to investigate the service changes.

This method is provided to give the host an alternative to requesting the full service list each time it is activated.

Syntax	No. of bits	Mnemonic
`ServiceListVersionReq () {`		
`  ServiceListVersionReqTag`	8	bslbf
`  length_field()`		
`}`		

Table 13-13. ServiceListVersionReq syntax

ServiceListVersionReqTag This 8 bit field with value 0x82 identifies this message.

ServiceListVersionAck Returns the current version number of the module's list of services in response to ServiceListVersionReq.

Syntax	No. of bits	Mnemonic
`ServiceListVersionAck () {`		
`  ServiceListVersionAckTag`	8	bslbf
`  length_field()`		
`  VersionNumber`	8	uimsbf
`}`		

Table 13-14. ServiceListVersionAck syntax

ServiceListVersionAckTag This 8 bit field with value 0x83 identifies this message.

VersionNumber This 8 bit integer increments each time the service list is updated.

ServiceListChanged Typically the service list presented by a module will be static. A host may scan the list on each activation, this will generally be invisible to the user. The ServiceListChanged message enables the module to inform the host of changes while activated.

For example, this enables module-side service book marks established by the user while interacting with a service gateway to propagate rapidly to the host's navigator service lists (See "Book marks (informative)" on page 22-19).

Syntax	No. of bits	Mnemonic
`ServiceListChanged () {`		
`  ServiceListChangedTag`	8	bslbf
`  length_field()`		
`  VersionNumber`	8	uimsbf
`}`		

Table 13-15. ServiceListChanged syntax

ServiceListChangedTag This 8 bit field with value 0x84 identifies this message.

VersionNumber This 8 bit integer increments each time the service list is updated.

ServiceDescReq

The ServiceDescReq allows the host to request the module to provide more detailed information describing a particular service.

Syntax	No. of bits	Mnemonic
ServiceDescReq () {		
ServiceDescReqTag	8	bslbf
length_field()		
OriginalNetworkID	16	bslbf
ServiceID	16	bslbf
}		

Table 13-16. ServiceDescReq syntax

ServiceDescReqTag This 8 bit field with value 0x85 identifies this message.

ServiceDescAck

This message carries the module's reply to ServiceDescReq. The payload is modelled on the parameters of the SDT and the descriptors from the descriptor loop of the SDT of a DVB broadcast service.

Syntax	No. of bits	Mnemonic
ServiceDescAck () {		
ServiceDescAckTag	8	bslbf
length_field()		
OriginalNetworkID	16	bslbf
ServiceID	16	bslbf
reserved_future_use	6	bslbf
EIT_schedule_flag	1	bslbf
EIT_present_following_flag	1	bslbf
running_status	3	bslbf
free_CA_mode	1	bslbf
descriptors_loop_length	12	uimsbf
for(j<0; j<descriptors_loop_length; j++) {		
descriptor()		
}		
}		

Table 13-17. ServiceDescReq syntax

ServiceDescAckTag This 8 bit field with value 0x86 identifies this message.

reserved_future_use This 6 bit field has identical meaning to that within the SDT defined in ETS 300 468 [4].

EIT_schedule_flag This 1 bit field has identical meaning to that within the SDT defined in ETS 300 468 [4].

EIT_present_following_flag This 1 bit field has identical meaning to that within the SDT defined in ETS 300 468 [4].

running_status This 6 bit field has identical meaning to that within the SDT defined in ETS 300 468 [4].

free_CA_mode This 1 bit field has identical meaning to that within the SDT defined in ETS 300 468 [4].

descriptors_loop_length This 12 bit integer has identical meaning to that within the SDT defined in ETS 300 468 [4].

descriptor() A descriptor defined for use in the SDT in ETS 300 468 [4] or a private descriptor in the scope of a private_data_specifier_descriptor.

Where the service is a DVB broadcast service the payload shall be the descriptors from its SDT. The minimum requirements for this are described in ETR 211 [12] and ETS 300 468 [4]. Operator's private descriptors may be included using the normal DVB SI methods.

Where the service is **not** a DVB broadcast service at least the mandatory minimum set of SI descriptors shall be used to provide a description of the service. Specifically, these shall convey at least the following:

- CA identifier descriptor (if some part of the service is scrambled)
- Data broadcast descriptor (when required by ETR 211 [12])
- service name (and optionally service provider name) within the service descriptor

Service gateway type

The service type indicated in the service descriptor shall reflect the service type of the broadcast. In addition it is proposed that a "service gateway" service type be introduced (either as a DTG private service type or, following DVB agreement, an official DVB service type).

Presenting service choices (informative)

As the service description is provided in the same terms as a DVB broadcast service a DVB host should be able to integrate its presentation of the list of service provided by the module with the list of services that the host can provide from its own RF inputs. Hosts can choose whether to cache the module's set of service descriptions into its own RAM (which will make sorting the service lists easier) or whether to request service descriptions from the module as it needs them (which offers a different RAM/processing balance).

Hosts can use the "service gateway" service type information to provide a visual indication that a service gateway is provided. However, it is not essential for hosts to do this.

GetServiceReq

The GetServiceReq requests a module to provide a service. The message payload is service reference. If the service reference is missing (i.e. the length field indicates zero following bytes) then the request is for the module to disconnect from the network.

Syntax	No. of bits	Mnemonic
`GetServiceReq () {`		
`  GetServiceReqTag`	8	bslbf
`  length_field()`		
`  OriginalNetworkID`	16	bslbf
`  ServiceID`	16	bslbf
`}`		

Table 13-18. GetServiceReq syntax

GetServiceReqTag

This 8 bit field with value 0x87 identifies this message.

GetServiceAck

The GetServiceAck message is a response from the module to the host. It informs the host of the progress towards delivering the service and may provide information on which to act.

Syntax	No. of bits	Mnemonic
GetServiceAck () {		
GetServiceAckTag	8	bslbf
length_field()		
OriginalNetworkID	16	bslbf
ServiceID	16	bslbf
Reserved	5	bslbf
ServiceTerminated	1	bslbf
ServiceNotAvailable	1	bslbf
CAServiceFlag	1	bslbf
ActualService	16	bslbf
}		

Table 13-19. GetServiceAck syntax

GetServiceAckTag This 8 bit field with value 0x88 identifies this message.

Reserved These 5 bits are reserved for future use and shall be set to ‘0’.

ServiceTerminated This 1 bit field, when set to ‘1’ informs the host that the service has finished (e.g. a VOD film has finished or the user has finished with navigating an information service).

Responsibility for service navigation reverts to the host after this message.

In the case that GetServiceReq has no service reference (i.e. the message is “network disconnect”) then GetServiceAck shall return with this field set to ‘1’.

ServiceNotAvailable This 1 bit field, when set to ‘1’ informs the host that the service requested is not available. Responsibility for service navigation reverts to the host after this message.

The non-availability of the service may be short-term (i.e. the service is not a full time service and just is not running at the present time) or it may indicate that the service has been deleted. It is the module’s responsibility to delete services from its service list if it determines that the service is permanently unavailable.

Depending on the network there may be a concept of “replacement” services. The module is responsible for replacing the requested service with a “replacement” service if this is appropriate for the network.

CAServiceFlag This 1 bit field, when set to ‘1’ informs the host that conditional access restrictions apply to the service that is being delivered. The host is responsible for using calls such as CA PMT to obtain access to the service.

This approach will work whether the CA facilities are built into the host, provided in a second CI module (downstream of the input module) or provided by the input module itself. However, in the last case the module may provide a purchasing interface as well as a navigation interface. So, the service may already have been “purchased” by the time it reaches the host. Here the module will NOT indicate that it is delivering a CA service and thus the host won’t have to have a CA PMT dialogue with the module

Allowed flag combinations

Attribute	Allowed combinations		
ServiceTerminated	1	0	0
ServiceNotAvailable	0	1	0
CAServiceFlag	0	0	x
ActualService	0	0	>0

Table 13-20. Allowed combinations

ActualService This 16 bit field carries the actual service id of the service being delivered. This allows the module to map “logical” to “actual” services. The value also indicates if the module is delivering a TS/service that the host should decode.

The purpose of the “logical” to “actual” mapping is network dependant, possible uses include:

- Delivering a replacement service when the requested service is not running
- Delivering a replacement service when entitlements for the requested service are not available (CA replacement)
- Translation of a logical “bookmark” service to an actual service (see “Book marks (informative)”)
- Indicating the “actual” service selected from a “navigator” service

Where no TS (or an incorrect TS) is being delivered to the host (e.g. when the service has terminated, the service is not available or the user is still interacting with a navigator provided by the module) the value of actual service shall be zero. This informs the host that it should not attempt to decode a service from the TS.

A non-zero value of actual service indicates that a valid TS is being delivered AND the service ID (MPEG program number) of the service that the host should decode from the TS.

Multiple acknowledges

An input module may generate more than one GetServiceAck in response to a single GetServiceReq. For example, there may be a response with ActualService=0 as the user starts to navigate a service gateway followed by a series of messages with ActualService≠0 as the user selects different service offerings.

The host should assume that the user is interacting with the module until a GetServiceAck message carrying ServiceNotAvailable or ServiceTerminated are set to ‘1’ or the user uses the ‘ESC’ function on the RCU to terminate interaction with the module.

Book marks (informative)

Service lists may exist in several forms, including:

- The list presented by the host navigator to the user
- The list presented by the module to the host
- The list presented by a module’s service gateway to the user while they navigate the service gateway.

Bookmarking (or other methods of identifying a favourite service) are an optional feature of a host service navigator. This document does not seek to comment on how these might be implemented. However, the method by which these might be connected to a module delivered service is described.

The module service gateway may present the user with a service list (as is illustrated in (A) of Figure 22-9). Alternatively (e.g. in the case of accessing a service server such as VOD) the user may navigate a catalogue of services. In either case the module can provide facilities (such as bookmarks) to allow favourite services to be recalled easily. The set of services pre-

sented by the module to the host might be the service gateway and the set of favourite services (as is illustrated in (B) of Figure 22-9). The host service navigator can then integrate the module service list with its own service list (as is illustrated in (C) of Figure 22-9).

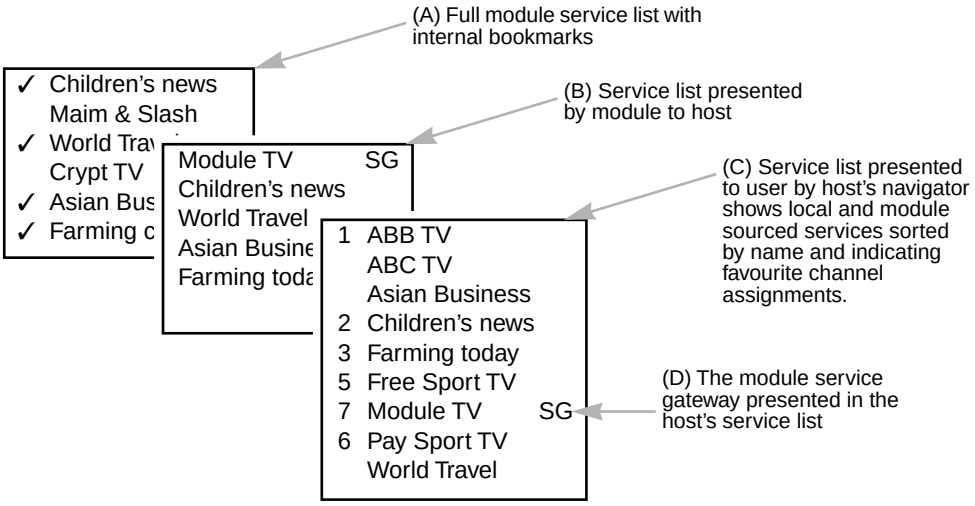

Figure 22-9. Propagation of module service "book marks" to host lists

The module can issue ServiceListChanged to inform the host of the addition to its service list. The host on discovering this new service should add it to its service lists and could provide the user with a method to "book mark" the service, such as associating it with a key on the RCU.

Peripheral access (informative)

The service access metaphor has a wide range of application. For example, it could be used to provide access to peripherals connected to the host by a digital network such as 1394. The "service gateway" in this case might provide an interface to control devices such as DVD or DVC. The approach described for Book marks (informative) could be used to allow direct access to DVD discs held in a changer (or "juke box").

22.6.3.3 Event Presentation

In the previous section (“Service presentation” on page 22-13) the protocols for presenting information on services from a module were described. This approach was generic and so can be applied to many different types of network. This section describes the protocols for presenting information on broadcast events from a module. Events are not a concept that fits all types of network or service. For example, VOD services may have no concept of “next event” or “schedule”. Also, even for simple TV services, there may be significant variations in the use of SI between service providers. These will inevitably be reflected in the data that the module can provide to the host.

EITSectionReq

The EITSectionReq requests the module to deliver a specified DVB SI EIT section.

Syntax	No. of bits	Mnemonic
EITSectionReq () {		
EITSectionReqTag	8	bslbf
length_field()		
TableID	16	uimsbf
ServiceID	16	uimsbf
SectionNumber	8	uimsbf
OriginalNetworkID	16	uimsbf
Reserved	7	bslbf
OKToDisruptService	1	bslbf
}		

Table 13-21. EITSectionReq syntax

EITSectionReqTag This 8 bit field with value 0x90 identifies this message.

TableID This 16 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4]. The set of allowed values, and their definition, are those defined for the EIT (i.e. 0x4E to 0x6F).

ServiceID This 16 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

SectionNumber This 8 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

OriginalNetworkID This 16 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

Reserved These 7 bits shall be set to ‘0’.

OKToDisruptService This 1 bit field, when set to ‘1’, indicates to the module that it is acceptable to disrupt delivery of a current service to obtain the requested event information. If this bit is set to ‘0’ service delivery shall not be disrupted (but the module may not be able to deliver the requested information with this constraint).

EITSectionAck

This returns the parameters of the EIT section requested by EITSectionReq (or an explanation of why it hasn't been provided).

Syntax	No. of bits	Mnemonic
EITSectionAck () {		
EITSectionAckTag	8	bslbf
length_field()		
Reserved	2	bslbf
ResponseCode	2	bslbf
Length	12	uimsbf
for(i=0; i<Length; i++) {		
event_id	16	uimsbf
start_time	40	bslbf
duration	24	uimsbf
running_status	3	uimsbf
free_CA_mode	1	bslbf
descriptors_loop_length	12	uimsbf
for(j=0; j<descriptors_loop_length; j++) {		
descriptor()		
}		
}		
}		

Table 13-22. EITSectionAck syntax

EITSectionAckTag This 8 bit field with value 0x91 identifies this message.

Reserved These reserved bits shall be set to '0'.

ResponseCode This 2 bit field identifies the status of the response:

value	meaning
00	Section not on this TS (but might be available on another TS)
01	Section not available
10	Section found
11	reserved

Table 13-23. EIT Section response codes

Length This 12 bit integer specifies the number of bytes following it. This may be zero, see ETR 211 [12].

event_id This 16 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

start_time This 40 bit field has identical meaning to that within the EIT defined in ETS 300 468 [4].

duration This 24 bit field has identical meaning to that within the EIT defined in ETS 300 468 [4].

running_status This 3 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

free_CA_mode This 1 bit flag has identical meaning to that within the EIT defined in ETS 300 468 [4].

descriptors_loop_length This 12 bit integer has identical meaning to that within the EIT defined in ETS 300 468 [4].

descriptor() Bytes of zero or more descriptors associated with this event.

22.7 Status Query Functions

22.7.1 Generic Status Queries

Described here is a facility provided by hosts to provide status information to modules. A generic approach has been taken as it is expected that the set of status items available for interrogation will grow with time.

Status Query

The host provides a StatusQuery resource which is able to support a session on each of the host-module transport connections. The set of messages for this resource is listed in Table 13-24.

Message	Direction[a]	Description
StatusQuery(N)	M->H	Requests the host to return the status of status item N.
Trap(N)	M->H	Requests the host to return the status of status item N whenever its value changes.
GetNextItemReq	M->H	The dialogue supported by these calls can be used by the module to explore the set of status items that the host supports.
GetNextItemAck	H->M	
StatusAck	H->M	Returns the status of requested status item as a variable length array of bytes. The format of these bytes will depend on the status item.

Table 13-24. Messages of the status query resource

a] M=module resident process, H=host's status query resource. M->H means from module to host.

The set of status items that can be interrogated are listed in Table 13-25.

Status Item Number	Name	Description
0	Reserved	
1	Selection Information	Used to provide Audience Metering Information by describing the inputs and outputs of the host. See "Selection information" on page 22-26.
2	Port Profile	Also used in Audience Metering, provides a description of the various host ports. See "Port profile" on page 22-29.
3	Viewed Service	Used to allow an auxiliary decoder (e.g. Audio Description) to track the service being viewed on the host. See "Port profile" on page 22-29.
4	Activation Status	Describes the power status of the host to the module. See "Activation status" on page 22-30.

Table 13-25. List of status items that can be interrogated

22.7.1.1 StatusQuery

Requests the host to report on an item of its status.

Syntax	No. of bits	Mnemonic
StatusQueryReq() {		
StatusQueryReqTag	8	bslbf
length_field()		
StatusItem	32	uimsbf
}		

Table 13-26. StatusQueryReq syntax

StatusQueryReqTag This 8 bit field with value 0x80 identifies this message.

StatusItem This 32 bit unsigned integer identifies the status item queried. The allowed values, and their definitions are listed in Table 13-25.

22.7.1.2 Trap

Requests the host to report on changes to the value of a particular status item until the module's session to the StatusQuery resource is closed.

Syntax	No. of bits	Mnemonic
TrapReq() {		
TrapReqTag	8	bslbf
length_field()		
StatusItem	32	uimsbf
}		

Table 13-27. TrapReq syntax

TrapReqTag This 8 bit field with value 0x81 identifies this message.

StatusItem This 32 bit unsigned integer identifies the status item to be monitored. The allowed values, and their definitions are listed in Table 13-25.

22.7.1.3 GetNextItemReq

Requests the host to return the StatusItem number of the next status item supported by the host after the specified StartStatusItem.

Syntax	No. of bits	Mnemonic
GetNextItemReq() {		
GetNextItemReqTag	8	bslbf
length_field()		
StartStatusItem	32	uimsbf
}		

Table 13-28. GetNextItemReq syntax

GetNextItemReqTag This 8 bit field with value 0x82 identifies this message.

StartStatusItem This 32 bit unsigned integer identifies a start point for a search through the set of supported status items. This value is not required to be one of the status items supported by the host. Typically a module will use the value zero will be used when starting a search.

22.7.1.4 GetNextItemAck

Reply from the host to the module in response to a GetNextItemReq.

Syntax	No. of bits	Mnemonic
GetNextItemAck() {		
GetNextItemAckTag	8	bslbf
length_field()		
NextStatusItem	32	uimsbf
}		

Table 13-29. GetNextItemAck syntax

GetNextItemAckTag This 8 bit field with value 0x83 identifies this message.

NextStatusItem This 32 bit unsigned integer identifies status item number of the first supported status item greater than the StartStatusItem specified in the request.

The value 0 is returned if StartStatusItem is greater than or equal to the status item number of the highest numbered item supported by the host.

22.7.1.5 StatusAck

Reply (from host to module) resulting from a StatusQuery or Trap request from a module. There shall be exactly one StatusAck in response to each StatusQuery. Following a Trap request there shall be a StatusAck in response delivering the current value of the status item, there shall also be a further StatusAck each time the value of the status item changes until the module's session to the StatusQuery resource is closed.

Syntax	No. of bits	Mnemonic
StatusAck () {		
StatusAckTag	8	bslbf
length_field()		
StatusItem	32	uimsbf
for(i=0; i<N; i++) {		
StatusBytes	8	bslbf
}		
}		

Table 13-30. DeliverySystemInfoReq syntax

StatusAckTag This 8 bit field with value 0x84 identifies this message.

StatusItem This 32 bit unsigned integer is the StatusItem value from the a StatusQuery or Trap request that lead to this reply.

StatusBytes This set of bytes conveys the status information corresponding to the StatusItem. The coding of this information will depend on the status item interrogated.

If the host does not support the status item requested in the StatusQuery or Trap request there shall be an immediate reply with no status byte information.

Table 13-31 identifies the set of formats for status information defined at the time of writing.

Status Item Number	Definition of status bytes
0	None allowed
1	See Table 13-32, “Selection information status data,” on page 22-26
2	See Table 13-37, “Port profile status data,” on page 22-29
3	See Table 13-38, “Viewed service status data,” on page 22-30
4	See Table 13-39, “Activation status data,” on page 22-30

Table 13-31. List of status items that can be interrogated

22.7.2 Audience metering

To support *Audience Metering* for the purpose of market analysis hosts support the following status items:

- Selection information
- Port profile

22.7.2.1 Protecting consumer privacy

Some of the data provided by this status enquiry is private to the consumer. As in normal operation it will not be apparent to the consumer that this data is being collected the host shall ensure that the consumer is aware of, authorises and can discontinue the data collection. The exact method employed is outside the scope of this specification. The method described here is presented as an informative example.

Authorising a module (informative)

The host maintains in non-volatile memory a list of authorised modules. The module identification can be the non-volatile *module ID* allocated to the module by the host.

When a module not previously authorised first attempts to perform StatusQuery or Trap on the Selection Information status item the host initiates a dialogue with the consumer to establish their willingness for data to be collected before allowing the session to open. Once a particular module is authorised the host does not interrogate the consumer again.

Consumer control (informative)

A user interface method should be provided by the host which identifies the modules that are authorised and allows the user to deauthorise them.

22.7.2.2 Selection information

The *Selection Information* status data is a list of descriptions of signal sources with their associated destinations. Each input may go to zero or more destinations. The set of input ports shall be complete and shall list each input port only once. If an input port is not connected to an output zero destinations shall be specified.

If Trap() is used to interrogate the selection information a reply will be issued each time the user alters the configuration of the host. The host should only report configuration changes that last for at least 1 second.

Syntax	No. of bits	Mnemonic
`time`	40	bslbf
`while( there is data in the object ) {`		
`  in_port_id`	8	bslbf
`  length_in_signal_desc`	8	uimsbf
`  for( i=0; i<length_in_signal_desc; i++) {`		
`    in_signal_desc`	8	bslbf

Table 13-32. Selection information status data (Sheet 1 of 2)

Syntax	No. of bits	Mnemonic
}		
reserved	4	bslbf
length_outputs	12	uimsbf
for(i=0; i<length_outputs; i++) {		
out_port_id	8	bslbf
length_out_signal_desc	8	uimsbf
for(i=0; i<length_out_signal_desc; i++) {		
out_signal_desc	8	bslbf
}		
}		
}		

Table 13-32. Selection information status data (Sheet 2 of 2)

time time encoded as in the UTC_time field of the DVB SI Time and Data Table.

in_port_id identifier of the source of a signal.

in_port_id	description
0 - 7	RF Modulated digital source 0 to 7
8 - 15	IEEE 1394 port 0 to 7
16 - 23	SCART port 0 to 7
24 - 126	Reserved for future use
127	No source
128 - 255	Manufacturer specific ports

Table 13-33. In port values

length_in_signal_desc the number of bytes in the description of the input signal.

in_signal_desc a block of bytes describing the input signal. The format of this block depends on the input port.

in_port_id	signal source description		
		no bits	mnemonic
0 - 7	DVB SI style delivery system description: original_network_id network_id transport_stream_id service_id Video component tag (0xFF if not found) Audio component tag (0xFF if not found)	 16 16 16 16 8 8	 uimsbf uimsbf uimsbf uimsbf uimsbf uimsbf
8 - 15	<TBD>		
16 - 23	Empty		
24 - 127	Reserved for future use		
128 - 255	Manufacturer specific string of bytes		

Table 13-34. In signal description blocks

reserved this 4 bit field should be set to ‘0’.

length_outputs the number of bytes in the description of the output signal(s).

out_port_id identifier of the destination of the signal.

out_port_id	description
0 - 7	Display 0 to 7
8 - 15	IEEE 1394 port 0 to 7
16 - 23	SCART port 0 to 7
24 - 31	RF Modulator 0 to 7
32 - 126	Reserved for future use
127	No output
128 - 255	Manufacturer specific ports

Table 13-35. Out port values

length_out_signal_desc the number of bytes in the description of the input signal.

out_signal_desc a block of bytes describing the output signal. The format of this block depends on the output port.

out_port_id	signal destination description		
		no bits	mnemonic
0 - 7	Visibility measure 0 -> obscured 1 -> partially obscured 2 -> fully visible >2 reserved	8	bslbf
8 - 15	<TBD>		
16 - 23	Empty		
24 - 127	Reserved for future use		
128 - 255	Manufacturer specific string of bytes		

Table 13-36. Out signal description blocks

22.7.2.3 Port profile

The *Port Profile* status data provides a textual definition of the host and each input and output port.

Syntax	No. of bits	Mnemonic
`receiver_identification_length`	8	uimsbf
`for(i=0; i< receiver_identification_length; i++){`		
`  receiver_identification_char`	8	uimsbf
`}`		
`for(j=0; j<N; j++){`		
`  in_port_id`	8	bslbf
`  length_in_port_desc`	8	uimsbf
`  for( i=0; i< length_in_port_desc; i++) {`		
`    in_port_desc`	8	bslbf
`  }`		
`  out_port_id`	8	bslbf
`  length_out_port_desc`	8	uimsbf
`  for( i=0; i< length_out_port_desc; i++) {`		
`    out_signal_desc`	8	bslbf
`  }`		
`}`		

Table 13-37. Port profile status data

receiver_identification_length length of the following string in bytes.

receiver_identification_char a string of characters (coded according to annex A of DVB SI) uniquely describing the receiver manufacturer, model and version.

in_port_id see above.

length_in_port_desc length of the following string in bytes.

in_port_desc a string of characters (coded according to annex A of DVB SI) describing the input port.

out_port_id see above.

length_out_port_desc length of the following string in bytes.

out_signal_desc a string of characters (coded according to annex A of DVB SI) describing the output port.

22.7.2.4 Auxiliary decoder

The *Viewed Service* status item allows a module to implement a decoders in addition to those provided by the host. Typically this might allow modules to implement additional audio decoders to allow the decoding of an audio description stream concurrently with the main programme audio.

Ensuring consumer permission

See “Protecting consumer privacy” on page 22-26.

Viewed Service

The *Viewed Service* status data indicates the program or components selected by the consumer to be most significant on the display of the host[1].

If Trap() is used to interrogate the viewed service a reply will be issued each time the user changes channel.

Syntax	No. of bits	Mnemonic
service_id	16	bslbf
number_components	8	uimsbf
for(i=0; i<number_components; i++) {		
component_tag	8	uimsbf
}		
}		

Table 13-38. Viewed service status data

service_id corresponds to the service_id/program_number of the program currently selected for display by the host. The program number 0x0000 should be used to indicate that the source of the signal applied to the display is not in the Transport Stream available to the module (e.g. the signal source is an analogue VCR connected to a SCART interface).

number_components number of components tags that follow.

component_tag the component tag of the component currently selected for decoding by the consumer if a component tag is provided for this component in the PMT by a stream identifier descriptor.

Informative note

Auxiliary decoder modules are expected to be able to parse the PMT of the currently selected service and possibly also certain SI tables. For example, if a service provides soundtracks in more than one language the component tag will identify the audio component currently selected by the consumer. By examining the PMT a module should be able to identify the language of the selected audio stream. An audio description module could then analyse the ISO 639 Language descriptors in the PMT to determine the stream (if any) providing audio description in that language.

22.7.3 Activation status

The *Activation* status data describes the power status of the host.

Syntax	No. of bits	Mnemonic
reserved	4	bslbf
event_activated	1	bslbf
activation_state	3	bslbf

Table 13-39. Activation status data

reserved These 4 bits are reserved for future use and shall be set to ‘0’.

event_activated This 1 bit field, when set to ‘1’ indicates that the host was activated by an event from the event manager (See “Event Management” on page 22-34) rather than by user action (which is indicated when this bit is set to ‘0’).

When the host has been event activated it is likely that a user is available to respond to dialogues generated by the module.

1. I.e. the host implements picture-in-picture the dominant window should be considered. If an information service conceals most of the display area the service ID of the information service should be indicated.

activation_state this value identifies the power-up state of the host.

activation state	current power mode
0	Reserved
1	Standby-active[a]
2	On[b]
2 - 7	Reserved for future use

Table 13-40. Activation state status values

a] Corresponds to the EACEM defined power mode “Standby-active”

b] Corresponds to the EACEM defined power modes “On (play)” and “On (record)”

22.8 Power manager

The Power manager resource, with ID <tbd pmm>, allows a module to indicate to the host that it is engaged in a task that should be allowed to complete.

When one or more modules present the Power manager resource, the host may interrogate each instance of this resource before deactivating the power supply to the modules. If any module is busy the deactivation shall be postponed.

Modules shall continue to operate

Modules shall continue to operate after they have indicated that it is OK for the host to shut-down. For example, a CA module shall continue to descramble data, an input module shall continue to deliver data etc. This operation continues until explicitly stopped by the host (e.g. by the host closing sessions).

Modules may “change their mind”

If, after a module has indicated that it is OK for the host to shutdown, there is session traffic between the module and the host (either module or host initiated) the host shall ignore any previous indication from the module that it is ready to shutdown. The host should therefore re-interrogate the module before shutting down.

22.8.1 Activation state change request

The Activation state change request object from the host to the module “asks” the module if it is “occupied” with a task that should be allowed to complete before powering-down the host.

Syntax	No. of bits	Mnemonic
`activation_state_change_request() {`		
`  activation_status_change_request_tag`	8	uimsbf
`  length_field()`		
`  reserved`	4	bslbf
`  activation_state`	4	bslbf
`  }`		

Table 13-41. Activation status state change request object

activation_status_change_request_tag This 8 bit field with value 0x80 identifies this message.

reserved These 4 bits are reserved for future use and shall be set to ‘0’.

activation_state this value identifies the requested new activation state.

activation state	requested power mode
0	Standby-passive[a]
1 - 15	Reserved for future use

Table 13-42. Activation state request values

a] Corresponds to the EACEM defined power mode “Standby-passive”

Minimum repetition interval

Hosts should not send Activation state change requests to a module more often than once each minute.

22.8.2 Activation state change acknowledge

The Activation state change acknowledge object is sent in response to a Activation state change request object. It provides an opportunity for the module to indicate that it is performing a task. If any module provides this indication the host shall defer the process of changing the activation state (i.e. it should defer the shutdown). However, modules should not delay the removal of power without good reason.

If a module does not reply within 1 second of an Activation state change request the host can assume that the module assents to the state change.

Syntax	No. of bits	Mnemonic
`activation_state_change_ack() {`		
`  activation_status_change_ack_tag`	8	uimsbf
`  length_field()`		
`  reply_code`	8	bslbf
`  }`		

Table 13-43. Activation status change reply object

activation_status_change_ack_tag This 8 bit field with value 0x81 identifies this message.

reply_code this value identifies the modules response to the requested state change.

reply_code	description
0	OK to change state
1	Module busy, don't change state
2 - 255	Reserved for future use

Table 13-44. Activation status change acknowledge values

22.8.2.1 Overview of dialogues (informative)

Figure 22-10 illustrates a possible host/module dialogue sequence to show the use of some of the power management resource calls.

First some event, possibly a timer event, activates the host. This is followed by the host's normal initialisation of its CI. All installed modules can then start work. In this example we focus on module 'A', but module 'B' could also perform some tasks.

As the host was "woken" by a timer event it is "trying to get back to sleep" so, periodically (See "Minimum repetition interval" on page 22-32) the host polls all modules to see if it can shut down. While module 'A' performs its task(s) it replies "Module busy" when asked, module 'B' replies "OK to change state". As one or more of the modules is busy the host defers going to sleep.

After a period module 'A' completes its work and, like 'B', replies "OK to change state". At this point the host can shut down.

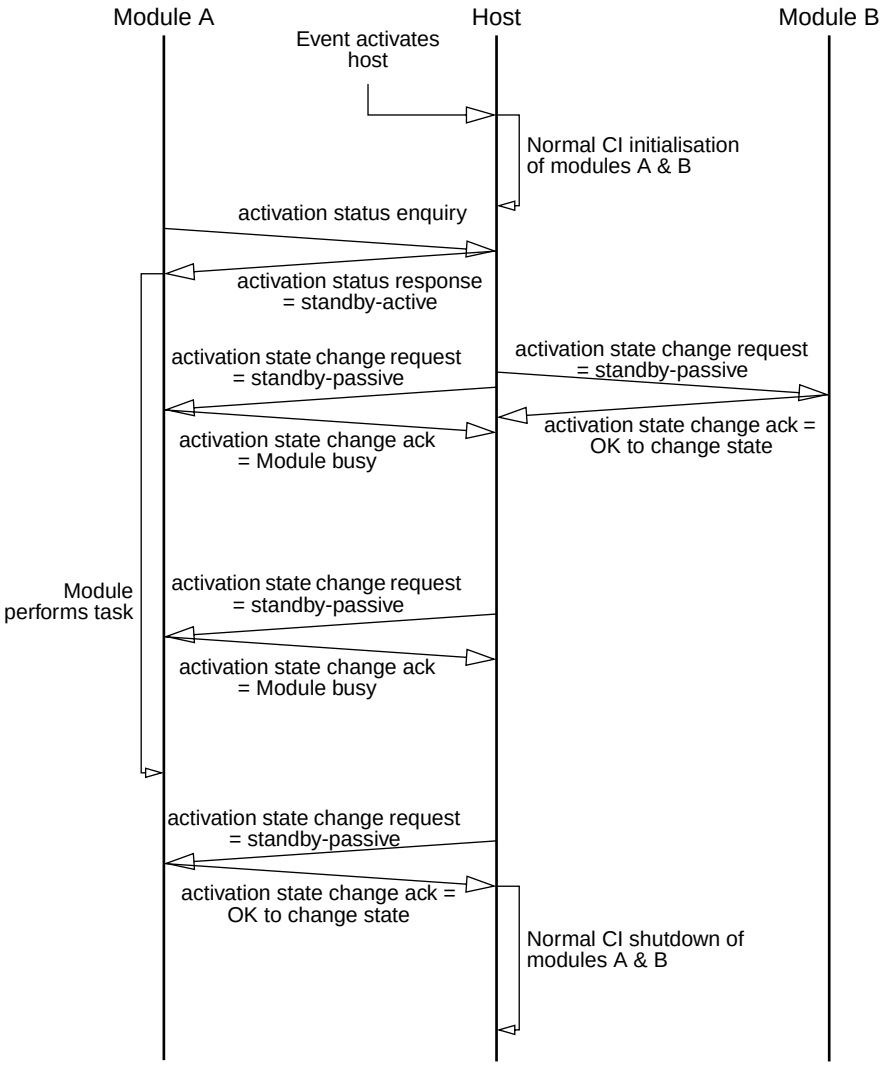

Figure 22-10. Module to host dialogues illustrated

22.9 Event Management

Event Manager

The *Event Manager Resource* allows modules to define events which should be signalled to the module. If the host is in standby-passive mode when the event is detected the activation state will be raised to standby-active and the module will be notified of the event.

22.9.1 Event resources

Number of events

The *Event Manager* shall provide sufficient resources to retain one timer event for each transport connection provided by the host.

Module Connection

If a module has a an event pending it shall open a session to the Event Manager each time it is activated. This enables it to receive messages from the Event Manager.

Retention of events

The host shall associate each timer event with the identity of the module. The scheduled event shall be retained until one of the following conditions:

- the scheduled event occurs
- the same module requests a new event (which replaces the current one)

Host's should also handle unusual conditions such as when a module reserves a timer event a long time in the future and is then removed.

Time range

The host shall be able to accept timer events scheduled anywhere in the future time range that can be encoded by the event request message.

Resource priorities

When the event is requested resource contentions at the time the event occurs cannot be predicted. The host is responsible for arbitrating the resource requirements of the module over other demands on the host. Direct[1] or indirect[2] use of the host's resources by the consumer shall have priority over demands from a module.

The system design of the module and any services associated with it are responsible for tolerating the non-availability of resources.

Power-up timing

The time specified by a module is the time at which it requires the host to be functioning. The host design is responsible for starting the activation process suitably before the scheduled time.

Energy conservation

When a module completes the task for which it booked the timer event it shall use the power management facilities (See 22.8 on page 22-31) to notify the host that it can return to a low power state.

1. E.g. the consumer has directly selected a service or is interacting with a host resident application such as a programme guide.
2. E.g. the host is recording an event "booked" by the consumer via a programme guide

22.9.2 Event request

The event request is a message sent by a module to the host to request activation of the host in response to a specified event.

Syntax	No. of bits	Mnemonic
`event_request_tag {`	8	uimsbf
`  length_field()`		
`  event_type`	8	bslbf
`  for( i=0; i<N; i++) {`		
`    event_desc`	8	bslbf
`  }`		
`}`		

Table 13-45. Event request object

event_request_tag This 8 bit field with value 0x80 identifies this message.

event_type identifier of the type of event.

event_type	description
0	Timer
1 - 255	Reserved for future use

Table 13-46. Coding of event types

event_desc a block of bytes defining the event. The format of this block depends on the event type. If there are no event_desc bytes this cancels any event of this event type previously booked by this module.

event_type	Event description bytes		
		no bits	mnemonic
0	Start time (like DVB SI EIT start_time)	40	bslbf
1 - 255	Reserved for future use		

Table 13-47. Coding of the event description bytes for each event type

22.9.3 Event request acknowledge

The event request reply message is sent by the host to the module in response to “Event request”.

Syntax	No. of bits	Mnemonic
`event_request_ack() {`		
`  event_request_ack_tag`	8	uimsbf
`  length_field()`		
`  event_type`	8	bslbf
`  reply`	8	bslbf
`}`		

Table 13-48. Event

event_request_ack_tag This 8 bit field with value 0x81 identifies this message.

event_type identifier of the type of event as described in Table 13-46.

reply identifier of the type of the reply.

event_type	description
0	Event booked OK
1	Event type not supported
2	Event resources consumed
3 - 255	Reserved for future use

Table 13-49. Definition of event request reply codes

22.9.4 Event notification

The event notification message is sent by the host to the module when an event requested by the module occurs.

Syntax	No. of bits	Mnemonic
`event_notification() {`		
`  event_notification_tag`	8	uimsbf
`  length_field()`		
`  event_type`	8	bslbf
`}`		

Table 13-50. Event notification object

event_notification_tag This 8 bit field with value 0x82 identifies this message.

event_type identifier of the type of event as described in Table 13-46 on page 22-35.

22.10 MHEG-5 MMI

MHEG-5 MMI

The host provides an MHEG-5 MMI resource with resource identifier <tbd mmi>. When the module opens a session to this resource the host requests the file “~/startup” from the module by using FileRequest. The module delivers this file using FileAcknowledge. This file is the application object for the MHEG-5 application that the module wants to run in this MMI session. The MHEG-5 engine in the host launches “startup”.

File Naming

The file naming convention is based on the UK MHEG profile (see “Mapping Rules for GroupIdentifier” in section 19) which is itself based on DAVIC. This identifies 4 components to the file name (Source, Path Origin, Path and Filename) and a short form (see “Shorthand Notation” in section 19).

For an MHEG-5 application delivered by a module the default Source is the session from the module to the MHEG-5 MMI resource in host. So, MHEG-5 GroupIdentifiers of the form “~/<file name>” lead to a FileRequest with the FileNameBytes “~/<file name>”. The file name may include a Path (directories, subdirectories etc.) However, these are invisible to the host.

The MHEG-5 application may also use GroupIdentifiers referring to files delivered via other means (such as a broadcast object carousel). The format for GroupIdentifiers in these cases will depend on the MHEG-5 application domain definition of the host. In the UK a GroupIdentifier starting “DSM:/” is the broadcast object carousel. “CI:/” is reserved to indicate the Common Interface as a file source.

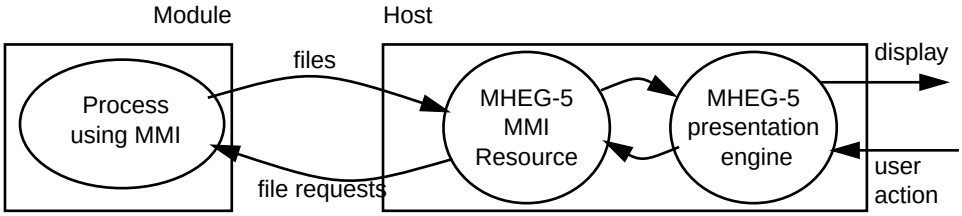

Figure 22-11. Overview of the operation of a MHEG-5 MMI resource

22.10.1 Resource Contention

The module is not guaranteed access to the MHEG-5 MMI resource. For example, if the user is interacting with a broadcast MHEG-5 application this application has priority. Therefore there are cases (e.g. associated to a CA_PMT dialogue) where the module cannot rely on the use of this MMI method and shall be able to provide its function using another MMI method.

Cases that can be identified where a module can rely on opening a session to the MHEG-5 MMI resource are:

- When responding to an EnterMenu from the host.

  (the host may need to kill an executing broadcast MHEG-5 application - but the user focus is not on the application at the time)

- When responding to a GetServiceReq

  (as this is part of a channel change which will kill any broadcast MHEG-5 application associated with the service selected by the user)

22.10.2 FileRequest

This message from the host requests the module to deliver the named file.

Syntax	No. of bits	Mnemonic
`FileReq () {`		
`  FileReqTag`	8	uimsbf
`  length_field()`		
`  for( i=0; i<N; i++) {`		
`    FileNameByte`	8	bslbf
`  }`		
`}`		

Table 13-51. File request message

FileReqTag This 8 bit field with value 0x80 identifies this message.

FileNameByte A byte of the filename requested.

22.10.3 FileAcknowledge

This message from the host requests the module to deliver the named file.

Syntax	No. of bits	Mnemonic
FileAck () {		
FileAckTag	8	uimsbf
length_field()		
Reserved	7	bslbf
FileOK	1	bslbf
for(i=0; i<N; i++) {		
FileByte	8	bslbf
}		
}		

Table 13-52. File request object

FileAckTag This 8 bit field with value 0x81 identifies this message.

Reserved These 7 bits are reserved for future use and shall be set to ‘0’

FileOK This 1 bit field is set to ‘1’ if the file is available and ‘0’ otherwise.

FileByte A byte of the file requested.

22.11 Copy protection

This optional resource (with resource identifier <tbd cpr>) is included in hosts which support copy protection, that is, a means of controlling the content outputs from a host - audio, video and/or data - to allow or disallow recording or copying of the content. The resource provides a generic means of communicating with the copy protection function with a generalised set of objects, but the detailed content of the object will be specific to the particular copy protection system(s) implemented.

The resource consists of four objects, CP_query, CP_reply, CP_command, and CP_response. CP_query queries information and status of the resource, with the reply returned in CP_reply. CP_command sends data to the resource and CP_response sends data from the resource. The first pair of objects are specified with standard queries and replies. The second pair just pass data opaquely between application and resource, with the specific format and semantics of the data defined by the particular copy control mechanism implemented in the host.

The CopyProtectionID field contains a value unique to a particular type of copy control mechanism used. This shall be a company_id allocated by the IEEE.

Minimum repetition interval

Copy protection systems shall not require communication between the module and the host more than once per second.

22.11.1 CP_query and CP_reply

CP_query

CP_query asks for the current status of the copy protection resource.

Syntax	No. of bits	Mnemonic
cp_query() {		
CopyProtectionQueryTag	8	uimsbf
length_field()		
CopyProtectionID	24	uimsbf
}		

Table 13-53. Copy protection query syntax

CopyProtectionQueryTag This 8 bit integer with value 0x80 identifies this message.

CopyProtectionID This 24 bit value identifies the copy protection system that is to be interrogated.

CP_reply

Syntax	No. of bits	Mnemonic
cp_reply() {		
CPReplyTag	8	uimsbf
length_field()		
CopyProtectionID	24	uimsbf
Status	8	uimsbf
}		

Table 13-54. Copy protection reply syntax

CPReplyTag This 8 bit integer with value 0x81 identifies this message.

CopyProtectionID As above. This field contains the true ID value for the copy protection mechanism implemented by the resource, even when the status reply is ID mismatch.

Status

status	status value
Copy Protection Inactive	01
Copy Protection Active	02
ID mismatch	FF
reserved	other values

Table 13-55.

22.11.2 CP_command and CP_response

These objects are identical except for the tag value.

CP_command

Syntax	No. of bits	Mnemonic
cp_command () {		
CPCommandTag	8	uimsbf
length_field()		
CopyProtectionID	24	uimsbf
for (i=0; i<n; i++) {		
CPCommandByte	8	uimsbf
}		
}		

Table 13-56. Copy protection command syntax

CPCommandTag This 8 bit integer with value 0x82 identifies this message.

CopyProtectionID As defined above.

CPCommandByte Bytes forming a command message from the application to the resource. The coding of this message is specific to the copy control technology.

CP_response

Syntax	No. of bits	Mnemonic
cp_response () {		
CPResponseTag	8	uimsbf
length_field()		
CopyProtectionID	24	uimsbf
for (i=0; i<n; i++) {		
cp_response_byte	8	uimsbf
}		
}		

Table 13-57. Copy protection response syntax

CPResponseTag This 8 bit integer with value 0x83 identifies this message.

CopyProtectionID As defined above. If CP_command is sent to the resource with an invalid ID then the response is a CP_reply message with a status of ID mismatch.

CPResponseByte Bytes forming a response message from the resource to the application. The coding of this message is specific to the copy control technology.

22.12 Module Identification

Proposal to be added.

22.13 Resource identifiers and application object tags

The private_resource_definer 0x??? is registered with CENELEC in to designate resources defined by DTG.

Resource					Application Objects		To Resource	From Resource
Name	Identifier Value							
	class	type	vers.	identifier	APDU Name	Tag Value		
StreamInput	tbd	1	1	<tbd lli>	DeliverySystemInfoReq	0x80	✓	
					DeliverySystemInfoAck	0x81		✓
					ScanStartReq	0x82	✓	
					ScanNextReq	0x83	✓	
					ScanAck	0x84		✓
					TuneTSReq	0x85	✓	
					TuneTSAck	0x86		✓
ServiceGateway					ServiceListReq	0x80	✓	
					ServiceListAck	0x81		✓
					ServiceListVersionReq	0x82	✓	
					ServiceListVersionAck	0x83		✓
					ServiceListChanged	0x84		✓
					ServiceDescReq	0x85	✓	
					ServiceDescAck	0x86		✓
					GetServiceReq	0x87	✓	
					GetServiceAck	0x88		✓
	tbd	1	1		EITSectionReq	0x90	✓	
					EITSectionAck	0x91		✓
Status Query	tbd	1	1	<tbd sq>	StatusQuery	0x80	✓	
					Trap	0x81	✓	
					GetNextItemReq	0x82	✓	
					GetNextItemAck	0x83		✓
					StatusAck	0x84		✓
Power manager	tbd	1	1	<tbd pmm>	Activation state change request	0x80	✓	
					Activation state change acknowledge	0x81		✓
Event Manager	tbd	1	1	<tbd evm>	Event request	0x80	✓	
					Event request acknowledge	0x81		✓
					Event notification	0x82		✓
MHEG-5 MMI	tbd	1	1	<tbd mmi>	FileRequest	0x80		✓
					FileAcknowledge	0x81	✓	
Copy protection	tbd	1	1	<tbd cpr>	CP_query	0x80	✓	
					CP_reply	0x81		✓
					CP_command	0x82	✓	
					CP_response	0x83		✓

Table 13-58. DTG defined common interface resources

Receiver Specification

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23 Receiver Requirements

23.1 Introduction

23.1.1 Scope

The section describes the receiver requirements.

23.1.2 Outline of target system

An overall block diagram of an example receiver is shown in Fig.23-1. The main input comprises the off-air UHF signal from the roof-top or indoor aerial system. Its outputs comprise video, audio and data signals which are connected to the display, audio amplifier, VCR, and computer systems. The receiver is controlled by a remote control system, and has a return path provided by the public switched network telephone line which connects via a built-in telephone modem to support transactions between the receiver and a remote server.

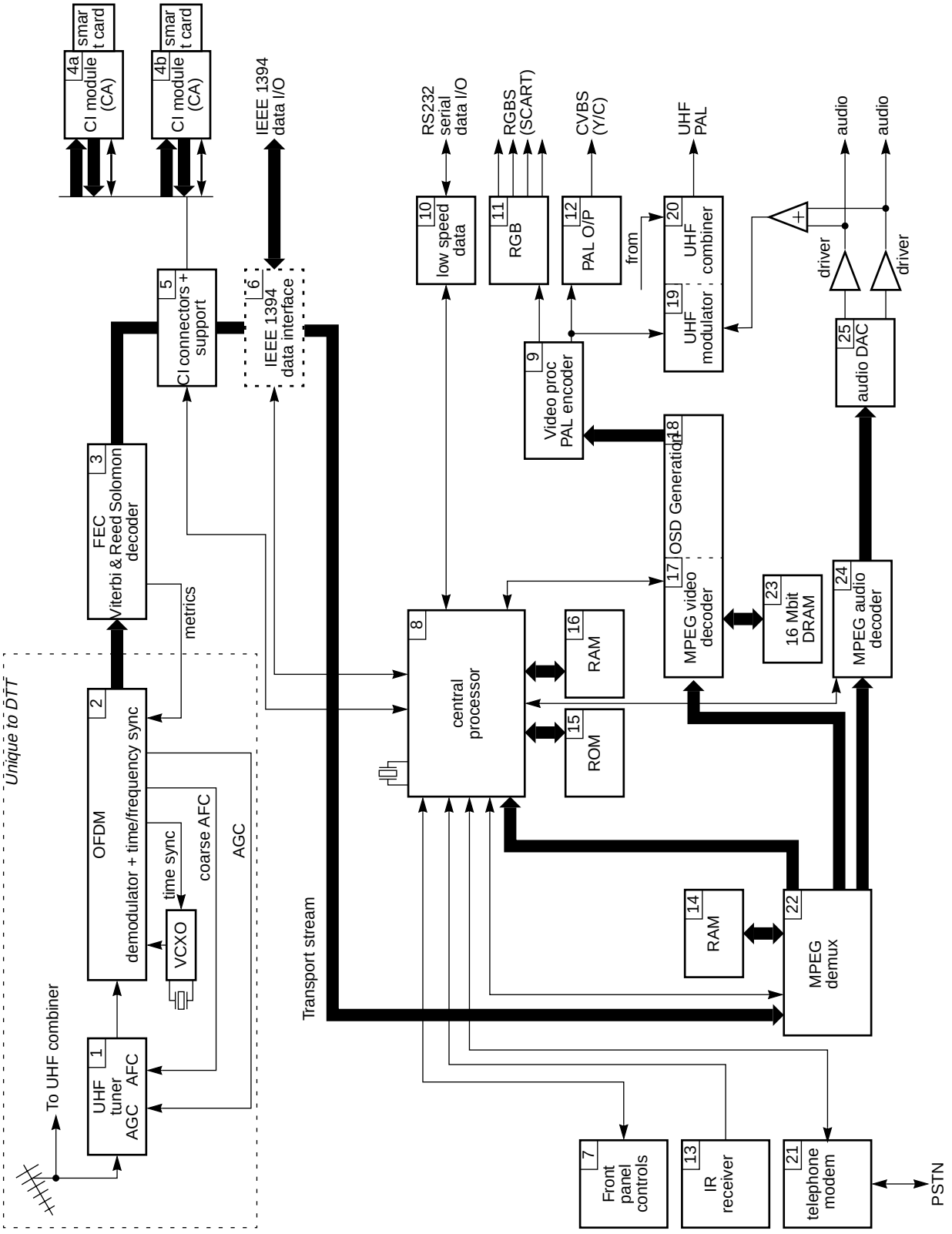

Figure 23-1. Illustrative example of a Digital Terrestrial Television Set-top Box architecture

23.1.3 Compatibility

This definition is based on standards published by CENELEC, ETSI, ISO and others. In general, a subset of these specifications is identified enabling simplification of receivers. However, in a few cases, extensions to these standards are made to meet the requirements of service providers.

The response of receivers to signals outside this agreed gamut is not specified by this specification, but so far as is practical receivers should be capable of decoding any signal which conforms to the specification.

Any receiver should be capable of decoding any UK DTT broadcast, and vice-versa, it should be possible for any UK DTT broadcast to be received (subject to any necessary access control (CA) entitlements being obtained) by any receiver.

This principle of interoperability makes UK DTT significantly different from some existing digital television broadcasting systems, where one service provider / transmission operator has specified the complete end-to-end system, including video/audio coders, modulators and receivers, conditional access system and electronic programme guide. In contrast, for UK DTT, it is proposed that a free market will operate for the supply of equipment in all parts of the programme chain, including receivers.

23.2 Requirements Summary

COFDM	Multiplex	Video	Video Post Processing	Audio	Data	Service Information	Conditional Access	Return Channel	Graphics	External Connections
DVB-T All profiles 2K FFT non-hierarchical (section 11)	DVB TS> 58 Mbps Demux ≥ 32 PIDS simultaneously ≥ 32 section filters, of 8 bytes. (section 6)	DVB MPEG-2 MP/ML I,P, & B frames Aspect ratios 4:3, 16:9 and 2.21:1 Constrained parameters MPEG-1 limited to 720 pixels. (section 2)	Aspect ratio conversion 16:9 → 4:3 centre cut-out, letterbox 16:9 (section 3) Video scaling of 2.0 and 0.5. (section 3) Decoding of colour descriptor, scene analysis, source video processing parameters	DVB MPEG-2 all mono & stereo modes AV synch. ± 5 ms (section 4) Dolby Pro-Logic™ ≥ 224 kb/s rates only Optional supplementary audio components (section 4)	DVB subtitling (section 5) MHEG-5 applications (“Data Services” section)	DVB All SI tables (section 8)	DVB 2 x Common Interface (section 22)	PSTN telephone modem minimum V22bis 2400 bit/s	4:2:2 output resolution 720 pixels by 576 lines @256 colours (section 15) ≥ 8 regions, 1 CLUT/region DVB subtitling system compatible (section 5) OSD Memory > 60 kbytes	RJ11 - PSTN modem 2 x PCMCIA - DVB CI TV Peritelevision RS232 at > 64 kbps for data ---------- *Optional* VCR Peritelevision with AV link. Auxiliary Peritelevision. VCR S-VHS. Dual audio phono. Digital Audio IEEE 1284 IEEE 1394

Table 14-1. Requirement summary

23.3 Front End

"UHF Transmission and Reception" in section 11.

23.4 Signal Decoding

See:

- "Video System Characteristics" in section 2
- "Video display formatting" in section 3
- "Audio System Characteristics" in section 4
- "Subtitling" in section 5
- "Multiplex and Transport Stream Characteristics" in section 6
- "Rules of Operation for Mandatory SI" in section 8

23.5 Return Channel

23.5.1 PSTN Modem

The interactive system shall meet the requirements for interactive services specified in DVB 'Commercial Requirements' document DVB A008. The return shall be implemented using a PSTN modem with associated procedures and protocols as defined in References prETS 300801 and prETS 300802.

The receiver shall include an integral PSTN modem (at least V22 bis operating at 2400 bit/s or higher).

The modem shall be identified as a resource available to the DVB Common Interface and the Conditional Access system (if present).

Line Sensing

Line sensing shall cause the receiver to drop a call within one second of a user attempting to make a call with any phone connected to the same line. The receiver shall use line sensing to prevent the receiver from seizing the line if a phone on the same line is in use.

The receiver shall use line sensing to detect whether the receiver is connected to the telephone line, and shall be capable of differentiating this state from use of the line by other telecommunications devices.

The modem shall disconnect the line on loss of carrier, DTR or software command.

The modem shall be BABT approved.

23.6 External Interface/Interconnection Requirements

The connections to the set top box or integrated television receiver should wherever possible follow the connector and connection guidelines as laid down in DVB Interfaces for DVB-IRD prEN 50201. For specification of the physical connections listed below also refer to DVB-IRD prEN 50201.

Typical connections to the receiver are shown in Figures 23-2 to 23-5 for cases of both Digital IRD and integrated Digital TV.

23.6.1 RF Input /Output Connections

A receiver should be capable of connection in line with an existing analogue TV or VCR. This requires that there is an RF loop through path, with optional re-modulated PAL output in the range of channels E21 to E69.

23.6.2 Analogue Video and Audio Connections

All set top box receivers shall include a Peritelevision EN50049-1 connector with CVBS, RGB and audio output to a television receiver or monitor.

In addition, set top box and integrated TV receivers may include the following optional connections:

1. A Peritelevision connector to provide input / output CVBS (or Y/C) and audio to a VCR. This shall include the AV link VCR Control Protocol.
2. A Peritelevision connector to provide input RGB, CVBS and audio for connection of an analogue or digital satellite receiver.
3. A dual phono socket to provide left and right audio for connection to a hi-fi or Dolby surround processor.
4. SVHS connector to provide input / output Y/C for a VCR.

The inclusion of Y/C in the Peritelevision connector increases the number of routing possibilities which may require re-matrixing or decomposition of the PAL signal when several pieces of equipment are connected together.

The receiver may generate analogue signalling such as WSS ITU-R BT.1119-1 and PDC EBU Tech.3262 (1990) from broadcast information such as the active format description (see “Active format description” in section 3) and the SI to provide control of external devices.

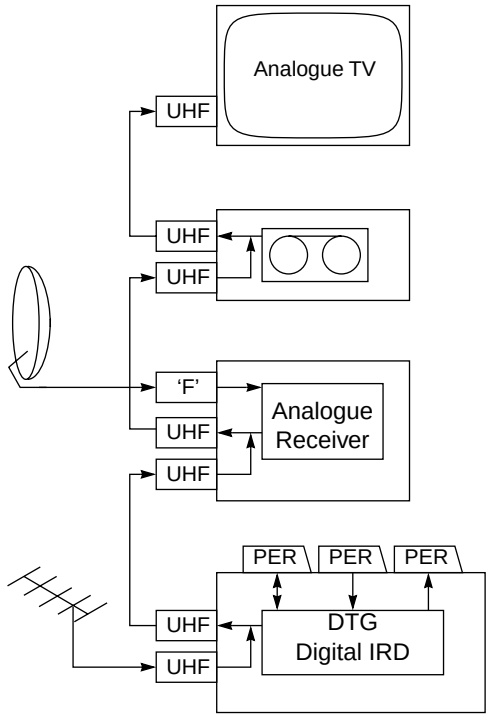

Figure 23-2. Set top unit + VCR + Satellite Receiver: 'RF' routing

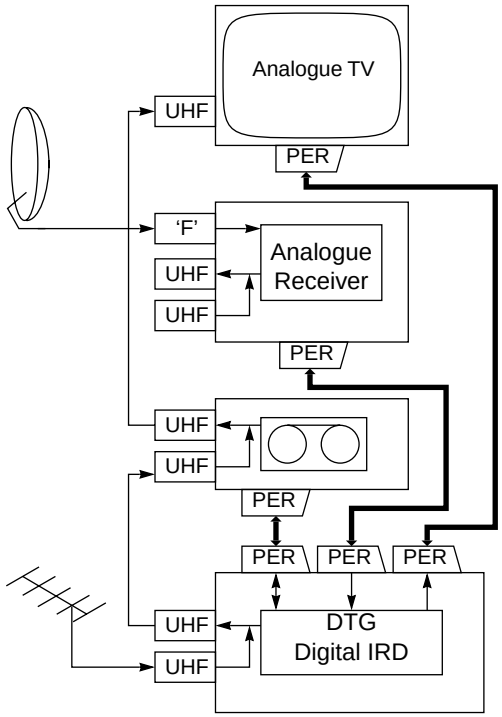

Figure 23-3. Set top unit + VCR + Satellite Receiver: 'PERI' signal routing

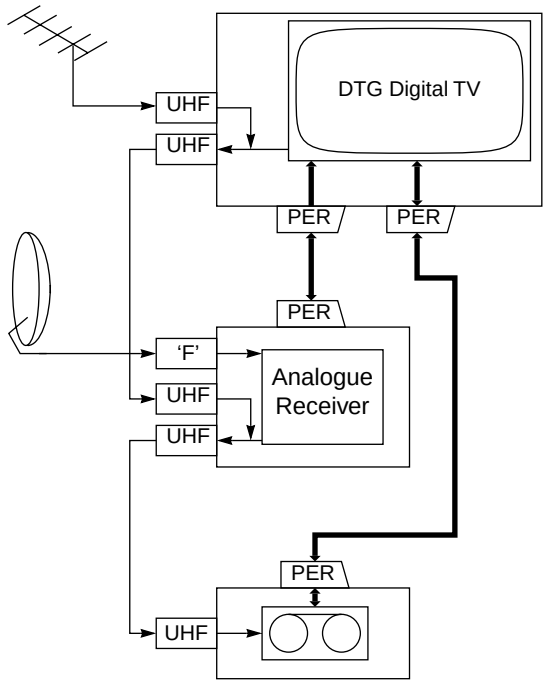

Figure 23-4. Integrated Digital TV + VCR + Satellite Receiver: VCR or Satellite to TV by 'PERI' connection only

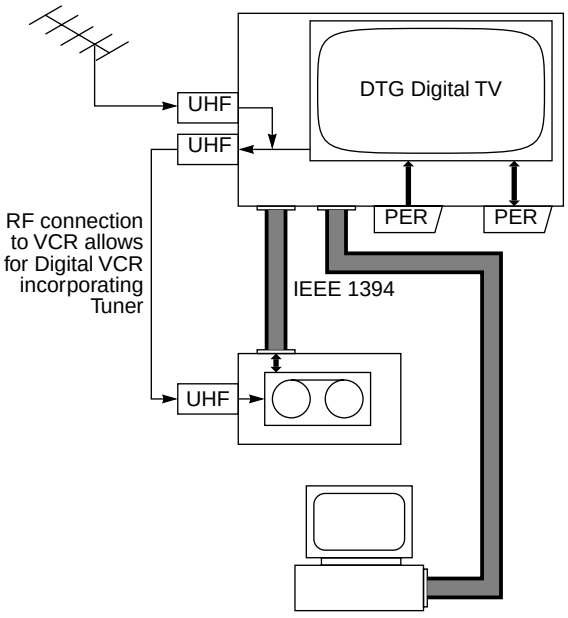

Figure 23-5. Integrated Digital TV + VCR + Computer: IEEE 1394 digital connection

23.6.2.1 Digital Connections

To allow for connection to external devices or other delivery media such as digital VCRs, PCs, printers and digital hi-fi, the following connections shall be included:

1. RS 232C connector with the receiver being seen as a DCE for connection to a PC.
2. RJ11 socket for connection of the integral modem to the user's telephone line.
3. 1 PC Card connection for support of the DVB Common Interface to enable use of modules for conditional access EN 50221.

In addition the following connections are optional:

4. Digital audio connection, IEC 985:1989, for PCM coded audio.
5. High speed parallel interface, IEEE 1284 (1994), primarily for bi-directional transfer of data information with a computer or printer.
6. High speed serial interface, IEEE 1394 (1995), for input and output of transport streams. Anticipated uses include:

   • connection to digital storage media such as digital VCRs, DVDs etc.

   • upgrading the modem capability to higher rate PSTN, ISDN and, in the future, ATM.

   • in-home distribution of MPEG streams between receivers, digital storage media, other delivery media, etc.
7. 1 or more additional DVB Common Interface connections to support multicrypt conditional access and/or other functionality such as decoding of minority services (e.g. audio description) as described in "Numbers of sockets" in section 22.

23.6.3 VCR Control

The connection of digital receivers to VCRs allows the recording and playback of digitally broadcast programmes. The ability of receivers to control VCR operations will allow the user to program the digital receiver to automatically record present and future events. To support this the receiver should include the following facilities:

1. A method of signalling between receiver and VCR

   Signalling between receiver and VCR shall use AV link prEN50157. In addition receivers may also support VCR signalling by IR link or IEEE 1394 (1995).
2. A means of converting user commands and programme event information into VCR signalling information.
3. A timer and wake-up facility.

23.6.4 User Control

It is not necessary to specify the means of user control of the receiver for the purposes of interoperability. Specification of any user device is therefore left open except that it must support the functionality required by DVB CI and the content decoder (see "Data Services").

23.7 Power Operating Modes

Receiver power consumption shall be in accordance with the “Commitment made by the consumer electronics industry on reducing energy consumption in stand-by Televisions & Video Recorders” (EACEM ref. AR17-G97-5051-009).

Table 14-2 defines, for digital appliances, the recommended functions that should be implemented in each of the power modes defined by EACEM when connected to a power supply. The power consumption of appliances in each of the different power modes shall be no more than that required by EACEM’s schedule.

Mode	Digital TV	Digital STB
Off[a]	The appliance is connected to a power source, produces no output, performs no processing functions and cannot be switched to any other mode with the remote control unit or other signal.	
Stand-by-passive	The appliance is connected to a power source, produces no output, performs no processing functions and is waiting to be switched into one of its other modes on receipt of a signal. Appliances may operate circuits to maintain the network in which they are placed. For example, appliances may maintain an RF feed-through. Possible signal sources include an internally generated timer event, an external remote control unit and buttons on the appliance.	
Stand-by-active	The appliance is connected to a power source, presents no output directly to the consumer. The appliance is in an active mode communicating for part or all of the time with an external or internal signal. The appliance is able to decode a broadcast and then supply it to an external device. It can perform internal tasks such as operating a CA system. However, tasks that require interaction with the consumer will not be possible.	
On	In addition to the facilities provided in stand-by-active the appliance is able to present an output directly to the consumer this allows the CA system and other applications to interact with the consumer.	In addition to the facilities provided in stand-by-active the appliance may be able to interact with the consumer.

Table 14-2. Power state definitions

a] Appliances that provide an active UHF feed-through may not have an “off” mode.

24 Receiver Software Upgrading

24.1 Status

This sections presents an analysis of possible methods for downloading firmware to receivers. A more complete specification is under development.

24.2 Introduction

The need has been identified to download software from an external source to the TV (IDTV) or digital set-top box (DSTB). This chapter defines the mechanisms for the downloading of software to replace sections of the main operating code of receivers after manufacture and point of sale.

It is not intended that the protocols defined in this chapter are the same as those protocols proposed for:

- Loading the initial production software at the time of manufacture (boot loading) which will be specific to each manufacturer and will be hardware dependent. The initial method of loading the code to the on-board non-volatile memory (normally flash ROM) associated with the CPU must be an issue for the equipment manufacturer only.
- Downloading higher level applications, e.g. MHEG applications.

Primarily there are two reasons for software replacement which have been considered. These are:

- Manufacturer specific download to fix bugs which have been found.
- Manufacturer specific download to update the receiver software features.

Protocols for downloading through locally connected devices as well as the broadcast channel have been considered.

One prime consideration is to ensure the upgrade is fast and reliable, and to prevent data aimed for any receiver, whatever manufacturer or model, corrupting any other receiver as a result of the download. As a result manufacturer, software-version number and model number identification is needed.

24.2.1 References

For the purposes of this document, the following references apply:

[1] IEEE Manufacturer registration coding, IN3001.DOC, Dec1997

[2] Addition CI objects required for data download through CI command interface, IN3002.DOC, Dec. 1997

[3] An extract from ISO 7816-3 standard for Smart card, IN3003.DOC, Dec 1997

[4] Implementation Guidelines for Data broadcasting, TM1847 Rev 1

[5] EN....: “DVB specification for Data Broadcasting” SI-DAT 360 rev. 4

[6] ISO/IEC 13818-1: “Information technology - Generic coding of moving pictures and associated audio information - Part 1: Systems - International Standard (IS)”

[7] ISO/IEC 13818-6: “Information technology - Generic coding of moving pictures and associated audio information - Part 6: Extension for Digital Storage Media Command and Control (DSM-CC) - International Standard (IS)”

[8] RFC 791 (IP): “Internet Protocol”, J. Postel, 01.09.1981

[9] ETS 300 468: “Digital broadcasting systems for television, sound and data services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems”

[10] MPEG2 DSM-CC Extension User-to-user Client- Server Ad Hoc group, Rev 3.2, MPEG 95/087

[11] RFC 1590, J. Postel, “Media Type Registration Procedure”, 03/02/1994, (Updates RFC 1521)

[12] OMT: James Rumbaugh, OMT: The Object Model, JOOP, 21-27 January 1995.

24.3 Authorisation and security

24.3.1 Identification

All manufacturers using software download shall register their organisation with IEEE to receive an ‘Organisationally Unique Identifier’ number (OUI).

Many companies will already be registered by virtue of existing products and this system is already used by various world-wide standards. This is compatible with the DSM-CC ‘User Compatibility Descriptor’ coding.

The details are given in [1].

The following items must be specified by unique codes, which with the exception of the ‘Organisationally Unique Identifier’ can be allocated by the manufacturer:

- Manufacturer - given by IEEE in the OUI code
- ‘Model Number.’
- ‘Software Version’

Beyond this the manufacturer is free to extend the definition associated with the firmware using sub descriptors.

24.3.2 Data Verification

The minimum data verification which should be used is a CRC on each data packet.

The manufacturer is able to use any further verification methods thought appropriate.

24.4 Download Authorisation

Download shall not require the use of any Conditional Access System, but shall use a secure software downloading protocol with the following characteristics:

- Data authentication to ensure the validity of the origin of the software, be it service provider and/or manufacturer.
- Data integrity checking to prevent the downloading of a wrong version of the software
- Ability to recover from failure during downloading.

  For example, if the Set Top Box is switched off during the downloading, it should restart with the downloading when switched on later. This means that a bootstrap has to be implemented in a non-modifiable and secure memory. This bootstrap must contain the Set Top Box downloading software.
- Independence from any Conditional Access system, to allow improvements in, or replacement of the conditional access system, and download in the absence of a conditional access system.

Confidentiality of the downloaded application is not required. The software itself can always be recovered from a Set Top Box, so it does not need to be encrypted over the air.

Protection against error transmissions is ensured by the downloading protocol itself, DVB SI-DAT Object Carrousel. The secure downloading gives a second level of error detection.

24.4.0.1 A method for Data Origin Authentication

The protocol when used with one key level allows source identification based on single control by manufacturer or service provider. When used with two keys it allows control by both parties.

Principles of the secure downloading protocol with one key level

The secure downloading protocol relies on:

- hashing of the code by a Hash algorithm, such as RIPE-MD160
- RSA signature of the hashed code
- download of the code + the RSA signature to the Set Top Box.

The service provider or the manufacturer owns an RSA key pair (P, S). This key is composed of a secret part S and a public part P. The service provider or the manufacturer uses the hash algorithm and the secret part S of the key to calculate the signature.

The code and the signature are carried by the downloading protocol. The detailed operation of the Hash function and the method for carrying the signature depend on the downloading protocol.

This public part P of the key and the hash algorithms are stored in each decoder to check the hash algorithm.

The code to be signed must contain a field which identifies the manufacturer, hardware platform, software version. This avoids a receiver downloading the wrong software version. This field can be short (e. g. 32 bits) or can be a standard format such as provided by IEEE.

Principles of the secure downloading protocol with two key levels

The first key pair (P1, S1) belongs to the manufacturer. He uses his key secret key S1 to sign the code and provides the service provider with the code, his public key P1 and the signature.

The second key pair (P2, S2) belongs to the service provider. The secret key S2 is used to certify the manufacturer public key P1.

The set Top Box contains the service provider public key P2. This key P2 is used to reveal the manufacturer public key P1. P1 is then used to verify the signature.

This two key level scenario gives more flexibility to the service provider:

- the generation of the signature is delegated to the manufacturer, the service provider keeping control of the security
- different RSA keys can be used for different manufacturers, the service provider having to manage only his own RSA key.

24.5 Transfer Mechanism

24.5.1 Data Compression

The form of data compression to be used by any specific manufacturer for receiver specific data will be decided by that manufacturer, and the decompression algorithms must be supported by the receiver software.

24.5.2 Methods of Download

24.5.2.1 Preferred methods

The preferred methods use the DSM-CC Object Carousel.

Stream based download

DSM-CC is a necessary component of the MHEG based receiver and is thus the preferred handling protocol for extracting data objects carried in transport stream format. Reference [2], [3].

In order for it to operate transparently the download data could be carried in:

- The over-air transport stream from the broadcast signal
- A simulated transport stream from a CI module from memory on the module
- A transport stream from an external source using as the CI module as a port, e.g. conversion from IEEE1394, etc.
- IEEE1394 port on the receiver

The profile of the DSM-CC Object Carousel should be compatible with that used by the MHEG-5 content decoder.

Methods using data carousels could also be considered.

Data based download using Command Interface of CI

The Command Interface protocol is a specified section of the software of the receiver.

The preferred physical layer solution is the Common Interface command interface (PCMCIA form), which can provide a convenient and relatively fast local method of transferring parallel data to the CPU using a self-contained device. Since all other applications will be disabled when download is in progress the full bandwidth capability of the 8 bit data bus could be used to maximise the data rate.

Although it is not necessary to use the object carousel on top of the Command Interface of CI, because the CI-stack provides a complete flow control system, it is reasonable to encapsulate the manufacturer-code-binaries into DSMCC-Descriptors due to the portability of the download methods. Therefore the usage of object carousel is preferred.

For more information see the CI extensions....

24.5.2.2 Non-preferred interfaces for software download

Other methods for software download are possible but less suitable.

- IEEE1394
- Modem
- RS232

24.6 Guidelines for Implementation

24.6.1 Verification before writing to Flash

The software loading process should verify any new software before programming it into FLASH and linking it to the normal receiver boot process.

At minimum the receiver shall:

- Have its download software in a protected area of memory that cannot be modified.
- Load new software to an area of RAM to allow verification before programming into FLASH.

Ideally, the receiver should have two banks of FLASH so new software can be completely programmed into FLASH before previous software is deleted.

Annexes

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A Definitions and Abbreviations

access unit
A coded representation of a presentation unit. In the case of audio, an access unit is the coded representation of an audio frame.

In the case of video, an access unit includes all the coded data for a picture, and any stuffing that follows it, up to but not including the start of the next access unit. If a picture is not preceded by a group_start_code or a sequence_header_code, the access unit begins with the picture start code. If a picture is preceded by a group_start_code and/or a sequence_header_code, the access unit begins with the first byte of the first of these start codes. If it is the last picture preceding a sequence_end_code in the bit-stream all bytes between the last byte of the coded picture and the sequence_end_ code (including the sequence_end_code) belong to the access unit.

ATSC

bitrate
The rate at which the compressed bit stream is delivered from the channel to the input of a decoder.

bouquet
A collection of services marketed as a single entity. Defined in ETS 300 468.

bouquet_id
Defined in ETS 300 468.

Bouquet Association Table
Defined in ETS 300 468.

BAT

BER
Bit Error Ratio

broadcaster
An organisation which assembles a sequence of events or programmes to be delivered to the viewer based upon a schedule.

byte aligned
A bit in a coded bit stream is byte-aligned if its position is a multiple of 8-bits from the first bit in the stream.

Conditional Access
CA
A system to control subscriber access to services, programmes and events e.g. Videoguard, Eurocrypt.

CENELEC
European Committee for Electrotechnical Standardisation. Central Secretariat: rue de Stassart 35, B - 1050 Brussels.

'D' picture
ISO/IEC 13818-2

delivery system
The physical medium by which one or more multiplexes are transmitted e.g. satellite transponder, wide-band coaxial cable, fibre optics.

descriptor

descriptor_tag

DTG
Digital Television Group

DTT
Digital Terrestrial Television

DVB
Digital Video Broadcasting
DVB Project Office, c/o European Broadcasting Union, 17 A Ancienne Route, CH-1218 Grand-Saconnex, Geneva, Switzerland.

Phone: +41 22 717 27 19. Fax: +41 22 717 27 27. Email: dvb@ebu.ch

ERP
Effective Radiated Power

EPG
Electronic Program Guide

elementary stream **ES**	ISO/IEC 13818-1 A generic term for one of the coded video, coded audio or other coded bit streams in PES packets. One elementary stream is carried in a sequence of PES packets with one and only one stream_id.
END	Equivalent Noise Degradation
ENF	Equivalent Noise Floor
Entitlement Control Message **ECM**	Entitlement Control Messages are private conditional access information which specify control words and possibly other, typically stream-specific, scrambling and/or control parameters.
Entitlement Management Message **EMM**	Are private Conditional Access information which specify the authorization levels or the services of specific decoders. They may be addressed to individual decoder or groups of decoders.
ETSI **European Telecommunications Standards Institute**	ETSI Secretariat. Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE. Internet: secretariat@etsi.fr. Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16
event	A grouping of elementary broadcast data streams with a defined start and end time belonging to a common service, e.g. first half of a football match, News Flash, first part of an entertainment show
event_id	Defined in ETS 300 468.
Event Information Table **EIT**	Defined in ETS 300 468.
EIT_{pf}	Event Information Table, present/following
EIT_{pfo}	Event Information Table, present/following (other)
Event Schedule Guide **ESG**	
extended event descriptor	Defined in ETS 300 468.
FTA **Free To Air**	
forbidden	The term “forbidden” when used in the clauses defining the coded bit stream, indicates that the value shall never be used.
horizontal_size	ISO/IEC 13818-2
ID	Identifier
ITC	Independant Television Commision
Man Machine Interface **MMI**	
MHEG	Multimedia and Hypermedia Experts Group. ISO/IEC 13522-5 [32].
MPEG	Motion Picture Experts Group
MPEG-2	Refers to the standard ISO/IEC 13818. Systems coding is defined in part 1. Video coding is defined in part 2. Audio coding is defined in part 3.
MTBF	Mean Time Between Failures
multiplex	A stream of all the digital data carrying one or more services within a single physical channel.

network	A collection of MPEG-2 Transport Stream multiplexes transmitted on a single delivery system, e.g. all digital channels on a specific cable system.
network_id	Defined in ETS 300 468.
Network Information Table **NIT**	Defined in ETS 300 468.
Non-scheduled service	A data or other service which is not scheduled, and for which the concept of an 'event' therefore has no meaning.
NVoD	Near Video on Demand
On Screen Display **OSD**	
original_network_id	A unique identifier of a network. Defined in ETS 300 468.
Packet Identifier **PID**	A unique integer value used to associate elementary streams of a program in a single or multi-program
PES	ISO/IEC 13818-1 An abbreviation for Packetized Elementary Stream.
PES packet	ISO/IEC 13818-1 The data structure used to carry elementary stream data. It consists of a PES packet header followed by PES packet payload.
PES packet header	ISO/IEC 13818-1 The leading fields in a PES packet up to and not including the PES_packet_data_byte fields, where the stream is not a padding stream. In the case of a padding stream the PES packet header is similarly defined as the leading fields in a PES packet up to and not including padding_byte fields.
PES Stream	ISO/IEC 13818-1 A PES Stream consists of PES packets, all of whose payloads consist of data from a single elementary stream, and all of which have the same stream_id. Specific semantic constraints apply.
presentation time-stamp **PTS**	ISO/IEC 13818-1 A field that may be present in a PES packet header that indicates the time that a presentation unit is presented in the system target decoder.
presentation unit **PU**	ISO/IEC 13818-1 A decoded Audio Access Unit or a decoded picture.
program	A program is a collection of program elements. Program elements may be elementary streams. Program elements need not have any defined time base; those that do, have a common time base and are intended for synchronized presentation.
PAT	Program Association Table, ISO/IEC 13818-1
programme	A concatenation of one or more events under the control of a broadcaster e.g. news show, entertainment show
PMT	Program Map Table
program_number	
PSI	Program Specific Information
RCU	Remote Control Unit
reserved	The term "reserved" when used in the clause defining the coded bit stream, indicates that the value may be used in the future for ISO defined extensions. Unless otherwise specified within this ETS all "reserved" bits shall be set to "1".

reserved_future_use	The term “reserved_future_use”, when used in the clause defining the coded bit stream, indicates that the value may be used in the future for ETSI defined extensions. Unless otherwise specified within this ETS all “reserved_future_use” bits shall be set to “1”.
Running Status Table	Defined in ETS 300 468.
RST	
SDT	Service Description Table, defined in ETS 300 468.
SDT_o	Service Description Table (other)
section	A section is a syntactic structure used for mapping all service information defined in this ETS into ISO/IEC 13818 [1] Transport Stream packets.
segment	Defined in ETR 211.
service	A sequence of programmes under the control of a broadcaster which can be broadcast as part of a schedule.
service_id	A unique identifier of a service within a transport stream. Defined in ETS 300 468.
service provider	See broadcaster.
short event descriptor	
SI	Service Information Digital data describing the delivery system, content and scheduling/timing of broadcast data streams etc. It includes MPEG-2 PSI together with independently defined extensions.
SIP	Service Insertion Point: A logical entity, the output of which is a set of co-operating multiplexes with consistent cross-carried SI as defined by this document.
sub_table	From ETS 300 468 sub_table is collection of sections with the same value of table_id and: for a NIT: the same table_id_extension (network_id) and version_number; for a BAT: the same table_id_extension (bouquet_id) and version_number; for a SDT: the same table_id_extension (transport_stream_id), the same original_network_id and version_number; for a EIT: the same table_id_extension (service_id), the same transport_stream_id, the same original_network_id and version_number The table_id_extension field is equivalent to the fourth and fifth byte of a section when the section_syntax_indicator is set to a value of “1”.
table	A table is comprised of a number of sub_tables with the same value of table_id.
table_id	
table_id_extension	
TDT	Time and Date Table, defined in ETS 300 468.
TOT	Time Offset Table, Defined in ETS 300 468.
Transport Stream	A Transport Stream is a data structure defined in ISO/IEC 13818 1 [1] It is the basis
transport_stream_id	A unique identifier of a transport stream within an original network. Defined in ETS 300 468.
Tx	Transmitter
UK DTT	Digital Terrestrial Television within the UK

B Normative References

[1]	ETS 300 294	Television Systems; 625-line television Wide Screen Signalling (WSS). Equivalent to ITU-R BT.1119-1.
[2]	ETS 300 421	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for *11/12 GHz satellite services*. December 1994.
[3]	ETS 300 429	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for *cable systems*. December 1994.
[4]	ETS 300 468	Draft EN 300 468 v1.3.1 (1997-09): “Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems”
[5]	ETS 300 743	Digital broadcasting systems for television, sound and data services; *Subtitling systems*.
[6]	ETS 300 744	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for *digital terrestrial television*.
[7]	prETS 300801	Digital Video Broadcasting (DVB); DVB interaction channel through the Public Switched Telecommunications System (PSTN) / Integrated Services Digital Network (ISDN). Equivalent to DVB TM 1582.
[8]	prETS 300802	Digital Video Broadcasting (DVB); Network Independent Protocols for DVB Interactive Services. Equivalent to DVB TM 1594.
[9]	Draft EN 301 192	Digital Video Broadcasting (DVB); DVB specification for data broadcasting
[10]	ETR 154	Digital broadcasting systems for television; Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Satellite and Cable Broadcasting Applications. As described in TM 1214 r9 September 1996 expected to replace ETSI edition 2 May 1996.
[11]	ETR 162	Digital broadcasting systems for television, sound and data services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems.
[12]	ETR 211	ETR 211 (Second Edition, August 1997): “Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)”
[13]	ETR 289	Digital Video Broadcasting (DVB); Support for use of scrambling and Conditional Access (CA) within digital broadcasting systems.
[14]	draft ETR290	Measurement guidelines for DVB systems
[15]	prEN 50201	Interfaces for DVB-IRDs
[16]	EN 50221	Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications
[17]	prEN50157	AV Link
[18]	EN50049-1	Peritelevision Connector

[19]	ITU-R BT.470-4 System I	Television Systems
[20]	ITU-R BT.1119-1	Wide Screen Signalling for Broadcasting. Equivalent to ETS 300 294.
[21]	ITU-R Rec.775	Rec. ITU-R BS 775 rev.1. Multi-channel stereophonic sound system with or without accompanying picture.
[22]	ITU-T X.680	INFORMATION TECHNOLOGY – ABSTRACT SYNTAX NOTATION ONE (ASN.1): SPECIFICATION OF BASIC NOTATION Also published as ISO/IEC International Standard 8824-1. ASN.1
[23]	ITU-T X.690	INFORMATION TECHNOLOGY – ASN.1 ENCODING RULES: SPECIFICATION OF BASIC ENCODING RULES (BER), CANONICAL ENCODING RULES (CER) AND DISTINGUISHED ENCODING RULES (DER) Also published as ISO/IEC International Standard 8825-1. DER
[24]	ISO/IEC 11172-2	MPEG 1 video
[25]	ISO/IEC 11172-3	MPEG 1 audio
[26]	ISO/IEC 13818-1	Information technology - Generic coding of moving pictures and associated audio information: Systems. ISO/IEC 13818-1:1996(E)
[27]	ISO/IEC 13818-2	Information technology - Generic coding of moving pictures and associated audio information: Video.
[28]	ISO/IEC 13818-3	Information technology - Generic coding of moving pictures and associated audio information: Audio.
[29]	ISO/IEC 13818-6	Information technology - Generic coding of moving pictures and associated audio information: Extensions for Digital Storage Media Command and Control.
[30]	ISO/IEC 6937	ISO/IEC 6937: “Information Technology - Coded graphic character set for text communication - Latin alphabet”
[31]	ISO 10646-1	“Unicode”
[32]	ISO/IEC 13522-5	MHEG-5 Information technology - Coding of multimedia and hypermedia information: Support for Base-Level Interactive Applications.
[33]	DVB A011	DVB Common scrambling algorithm - distribution agreements
[34]	DVB User Requirements for Terrestrial Digital Broadcasting Services.	
[35]	DVB A008	DVB Commercial requirements for asymmetric interactive services supporting broadcast to the home with narrow band return channels.
[36]	DVB V2 SI 244	DVB Data Broadcasting Services - Commercial Requirements.
[37]	SI-DAT 360	DVB specification for Data Broadcasting
[38]	SIM 061	Technical Specification of DVB-Simulcrypt Part 1 - Head-end Architecture and Synchronisation Part 2 - Extended Interoperability and Control (under development)
[39]	SI-DAT 382 Rev. 4	Implementation Guidelines for Databroadcasting

[40]	Advanced Television Directive (95/47/EC)	Directive 95/47/EC Directive of the European parliament and of the Council of 24 October 1995 on the use of standards for the transmission of television signals.
[41]	UK Frequency Plan for Digital Television Broadcasting being developed by ITC, BBC and NTL in collaboration with UK regulatory authorities.	
[42]	IEC 985:1989	Digital Audio Interface.
[43]	IEEE 1394 (1995)	High Performance Serial Bus.
[44]	IEEE 1284 (1994)	Signalling Method for a Bi-Directional Parallel Peripheral Interface for Personal Computers.
[45]	EBU Tech.3262 (1990)	Specification of the domestic video programme delivery control system (PDC).
[46]	ITC Guidance Note on Picture Quality in Digital Television (31 Oct. 1996)	
[47]	ITC (Rev. 2.0, 2nd January 1998): “Draft ITC Rules of Operation on the use of the DVB-T Specification”	
[48]	Final Acts of the World Radiocommunication Conference (WRC-95)	
[49]	Current UK Radio Regulations (1990, revised 1994)	
[50]	AIFF-C	AIFF-C Audio Interchange File Format, version C, allowing for Compression.
[51]	DAVIC 1.3 Part 09	DAVIC 1.3 Specification Part 09, Information Representation, Revision 6.1
[52]	DAVIC 14B94R10	DAVIC 1.4 Baseline document 94, Revision 1.0, “MHEG-5 Resident Programs to access SI.”
[53]	HTML 3.2	HyperText Mark-up Language reference specification, by Dave Raggett, 14-Jan-1997 available at http://www.w3.org/TR/REC-html32.html
[54]	PNG	Portable Network Graphics Specification, Version 1.0, 01-October-1996 available at http://www.w3.org/TR/REC-png.html
[55]	BS 6330	Britsh Standard Code of Practice for Reception of sound and television broadcasting BS 6330 1983
[56]	AC106 VALIDATE	Digital TV transmitter performance specification. Submitted to DVB as TM1925

C ITC / NTL and BBC Digital TV Frequency Planning Project: Technical Parameters and Planning Algorithms

ITC / NTL and BBC Digital TV Frequency Planning Project

Technical Parameters and Planning Algorithms

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Written by Mark Maddocks (BBC), Brian Tait (NTL), Philip Brown (NTL),
Graham Plumb (BBC) and Mark Lee (BBC)

NTL Project Manager approval: . . . . . .

Brian Tait

BBC Project Manager approval: . . . . . .

Graham Plumb

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ITC / NTL and BBC Digital TV Frequency Planning Project

Technical Parameters and Planning Algorithms

1 Introduction

The purpose of this document is to summarise the planning parameters and algorithms which are being used by both BBC R&D and NTL in the joint planning study for digital terrestrial television. This document forms the first deliverable of the project. However, subject to agreement by the clients, the parameters and algorithms described in the document may be updated or modified in the light of new information becoming available in the study. This has occurred with Version 2.1 of the document which contains the following changes;

- the algorithm used for calculating net coverages is described.
- the method used to allocate channels to multiplexes has been included.

2 Planning Parameters

2.1 COFDM System Parameters

Three COFDM systems will be considered in the planning study. For the purposes of the study only their failure C/N and C/I are important. However the following COFDM systems are the basis for the values used:

Table 1: COFDM System Parameters

Modulation	16 QAM	16DAPSK	64 QAM
Error Coding Rate	1/2	3/4	2/3
Guard Interval (µs)	28	7	28
Data rate (Mbit/s)	12.2	19.5	24.4
System C/N (dB)	12	16.5	20
C/N in multipath conditions (dB)	15	19	23

The quoted C/N ratios are based on measurements, or simulations including an implementation margin, and are therefore comparable. This value is applicable in a Gaussian or Ricean propagation channel. The noise performance of the system may be worse in the presence of strong echoes and stringent multipath conditions; this is reflected in the bottom line of Table 1 where an additional 2.5 dB to 3 dB has been added. As there is uncertainty about which system within a family of systems will be used (or indeed the performance of domestic equipment) the coverage of all three systems will be calculated.

2.2 Minimum Wanted Field Strengths

Table 2, shows the parameters for fixed rooftop reception via a directional receiving antennas and is calculated for three frequencies, one in each of Band IV, lower Band V and upper Band V. The parameters marked with a '*' are taken from Reference 1.

Table 2: Derivation of minimum field strength

Noise bandwidth	(MHz)	7.5		
Rx input impedance	(Ω)	75		
Thermal noise	(dBµV)	3.5		
Receiver noise figure*	(dB)	5		
Minimum C/N	(dB)	see Section 1.1		
Receiver input voltage	(dBµV)	8.5 + minimum C/N		
Frequency	(MHz)	500	650	800
Receiver antenna gain*	(dBd)	10	11	12
Feeder loss*	(dB)	3	4	5
Dipole factor	(dB)	20.5	22.5	24.5
Field strength - C/N	(dBµV/m)	22	24	26

This calculation gives the minimum field strength required at the receiving antenna at each location for each of the systems described in Section 2.1. Further correction factors for location and time variation are required for planning purposes. The resulting minimum field strengths are summarised in Table 3.

Table 3: Minimum field strengths (dBµV/m)

failure C/N (dB)	Band IV	lower Band V	upper Band V
15	37	39	41
19	41	43	45
23	45	47	49

2.3 Location variation

A standard deviation of 5.5 dB is assumed for the log-normal distribution of field strengths with location. This is lower than the value of 8 dB given in ITU-Recommendation 370 [3]. However the former value includes only the local variation and not the additional prediction error included in the value in Reference 3.

The distribution of the composite field strength which occurs when more than one interfering signal is present is calculated by an algorithm given in Section 3. In this calculation a correlation coefficient of zero will be assumed.

2.4 Percentage of Time for Protection from Interference

The interference predictions assume the following time percentage protection:

(i) 95% time to UK and Irish domestic receiving locations for analogue services.
(ii) 99% time to UK and Irish RBL receiving antennas for analogue services.
(iii) 99% time to Continental analogue transmissions.
(iv) 99% time to UK digital TV domestic receiving locations.

2.5 Protection Ratios

The protection ratios which will be used for the study are shown in Table 4.

Table 4: Protection Ratios (dB)

	Interfering Signal						
Wanted Signal	Analogue Lower-adjacent	Analogue Co-channel	Analogue Upper-adjacent	OFDM Lower-adjacent	OFDM Co-channel		OFDM Upper-adjacent
Channel n	n-1	n	n+1	n-1	n		n+1
OFDM	-35**	System C/N* - 16 dB	-35**	-40**	System C/N*		-40**
Analogue PAL-I SECAM-L				0** ****	41 (C) 42	37 (T) 37	0** ****

* See the penultimate line of Table 1
** Values for adjacent channel interference are subject to review
(C) Continuous interference (impairment grade 4)
(T) Tropospheric interference (impairment grade 3)

2.6 Receiving antenna discrimination

A domestic antenna directivity and cross-polar discrimination will be used in accordance with Reference 5.

3 Planning Algorithms

Algorithms are needed to cover the following stages in the development of a plan:

- The initial calculation of the predicted field strength of a single transmitter in a target area.
- The calculation of the e.r.p. restrictions needed to ensure compatibility.
- The calculation of the anticipated coverage of the digital television signal from that single transmitter, which comprises various topics; the methods of combining wanted and interfering signals, the coverage criteria and the method of counting population and generating maps of coverage.
- The calculation of the overall coverage of a network of transmitters from the coverage of the individual transmitters, allowing for areas of overlap.
- The calculation of the net coverages of single transmitters, where coverage in the overlap regions needs to be divided between the available transmitters.
- The allocation of channels to multiplexes, based on population coverages served and a number of other factors.

The algorithms covering these areas are described below.

3.1 Field strength calculations from individual transmitters in the UK

BBC and NTL have for many years used a field strength prediction method for the VHF and UHF bands based on propagation over terrain profiles derived from a terrain database of at least 0.5 km resolution [4]. This method will be used to calculate the wanted and interfering field strength distributions to and from each UK transmitting site. These field strengths will be calculated for all cases at a single frequency around the bottom of Band V. The difference in actual frequency chosen will not have a significant effect (compared with the prediction error) on the results. This method will yield more detail in the field strength distributions than is possible using the ITU-R Rec. 370 curves [3]. Some difference between the BBC and NTL algorithms for predicting field strength have been found. As there is insufficient time within the Planning Project to evaluate these differences and come up with a unified method, each organisation will use its current method, and in cases where there are significant differences in coverage, this should be taken to indicate an area of uncertainty that cannot be resolved by prediction.

To evaluate the effect of these differences on the overall coverage of an 80-station digital television plan the BBC and NTL will exchange transmitter parameters on completion of station designs which will allow each organisation to predict the coverage of all of the 80 stations.

Out-going co- and adjacent channel interference to UK analogue TV transmitters will be calculated using the above method. The method for calculating the compatibility with non-UK and Irish analogue TV transmitters is described separately in Section 3.2.

3.2 Out-going interference to continental transmitters

Out-going adjacent channel interference to continental analogue TV transmitters will not be considered.

Out-going co-channel interference to continental analogue TV transmitters will be assessed initially using a method based on ITU-R Recommendation 370. The predictions assume reception at 10m above ground level. The values for protection ratio and other planning parameters which are incorporated in the software are given in Section 2, 'Planning Parameters'.

Restrictions to protect continental transmitters will be calculated in the following way:

- An initial calculation using Recommendation 370 would be made to the transmitter site using no Delta H and no terrain clearance angle correction.
- The protection ratios from Table 4 will be used.
- The minimum field strength to be protected will be 65 dBµV/m in Band IV and 70 dBµV/m at Band V.
- Where this procedure generated restrictions which significantly affected the ability for the digital service to cover its target area the situation would be investigated for various extenuating circumstances such as terrain shielding, receive antenna discrimination and the presence of other analogue broadcast interferers at a higher level. These factors would be used as the basis for an additional relaxation of the restriction. To allow the study to produce an indicative coverage quickly and also to provide detailed information to assist in the international coordination process, a two level approach will be used.

The first level approach would use ITU-R Recommendation 370 (without terrain clearance angle correction) to determine the required restrictions. The ERPs determined in this way may not be highest achievable, but this approach will provide indicative coverages for the full network in the original timescale. To prevent a large amount of re-design of transmitting antennas, a representative antenna template will be generated using the EBU method, which permits the radiation pattern to change by a maximum of 5 dB every 10°.

In parallel a second level approach would be used to determine the optimum plan and generate the level of detail requested to support the co-ordination process. This will examine the existing levels of analogue interference, possible terrain protection and the benefits and receiving antenna discrimination.

3.3 Signal combination

A method of assessing the combined effects of multiple interferers is needed for computing digital TV coverage. The log-normal location variation of field strength must be taken into account. The combined effect of noise, co-channel and adjacent-channel

incoming interference to digital TV signals will be assessed using the following method except in the case where the two sites are within 10 km of each other where the correlation between the signals will be assumed to be 1. This case encompasses several complex issues which can only be resolved by further fieldwork.

The distribution of the power sum of a number of log-normally distributed signals can be approximated to a sufficient degree of accuracy by another log-normal distribution function. Various methods have been developed for estimating the mean and standard deviation of this log-normal distribution; a simple method is presented in ITU-R Report 945-2. A more accurate method has been developed by Schwartz and Yeh [2]; this will be used for field strength combination.

The field combination routine will apply the appropriate receiver antenna pattern or polarisation corrections to each mean field strength. This produces an array of mean interfering field strengths. Small interfering field strengths may then be discarded by selecting those more than a user-specified filter range below the wanted field strength. This is done both to speed up the field strength combination and to reduce the possibility of errors arising from the combination of a very large number of individual sources. A suitable filter range is between 20 dB and 25 dB.

The log-normal method requires a value for the standard deviation of the location variation of each individual signal. The standard deviation for each individual signal is given in Section 2.3. A correlation of zero is assumed between all signals.

In calculating the interfering fields, 1% of time field strengths will be used to ensure protection for 99% of time. 50% of time fields are used in calculating the contributing fields. This effectively assumes that the fields from all the interfering transmitters are at their 1% of time values for the same 1% of time.

The effect of noise can also be taken into account using this method. The standard deviation of the noise is zero because it is assumed to be constant over all locations. The mean field strength used for the noise is the field strength which would produce the receiver noise voltage. This is given in the bottom line of Table 2. With these values the effect of noise can be combined with the interfering field strengths using the Schwartz and Yeh method.

Different types of interference will be subject to different protection ratios. The mean field strengths need to be scaled before combination so that a single protection ratio can be used. An offset can be calculated between the minimum C/N and the appropriate protection ratio for the interfering transmitter. The offset should then be added to all the mean field strengths from that transmitter. This will scale all field strengths in the interference power sum to have a protection ratio equal to the minimum C/N.

3.4 Coverage Criteria

Given values for the mean and standard deviation of the wanted and interference fields in a coverage cell, it is possible to calculate the mean and standard deviation of their ratio. The probability of a receiver in the cell being served can then be determined.

The location variation in the ratio of wanted and unwanted power will be log-normally distributed. The mean and standard deviation of this distribution are given by:

$$m_{R_{dB}} = m_{C_{dB}} - m_{(N+I)_{dB}}$$

$$\sigma_{R_{dB}} = \sqrt{\sigma^2_{C_{dB}} + \sigma^2_{(N+I)_{dB}}}$$

where:

$m_{R_{dB}}$ is the mean of the ratio (dB),

$m_{C_{dB}}$ is the mean field strength from the wanted transmitter (dBµV/m),

$m_{(N+I)_{dB}}$ is the mean effective field strength due to noise and interference (dBµV/m),

$\sigma_{R_{dB}}$ is the standard deviation of the location variation in the ratio (dB),

$\sigma_{C_{dB}}$ is the standard deviation of the location variation in the field strength from the wanted transmitter (dB),

$\sigma_{(N+I)_{dB}}$ is the standard deviation of the location variation in the effective field strength due to noise and interference (dB).

The proportional coverage is the proportion of points in this distribution where the ratio is greater than required. This can be calculated using standard methods from the normal distribution for each cell.

The ‘area’ will be produced by plotting the covered area based on the 90% locations ‘cut-off’ decision criteria (see Section 3.7).

3.5 Co-sited Interference

Adjacent channel interference from analogue services which are co-sited with the wanted digital transmitter must be treated differently. The correlation coefficient between the wanted and interference location variation is then assumed to be one.

The proportion of locations served is calculated taking into account all interferers except the co-sited interference. The mean wanted power is then compared with a simple power

sum of the co-sited interference with the appropriate protection ratio. If this test is passed then co-sited interference is assumed to have no effect. If the test is failed then the proportion of locations served is set to zero.

Treating co-sited interference separately in this way assumes that co-sited adjacent channel interference does not add with other interference sources and that there is perfect correlation between the wanted and co-sited interference location variation. Further study is required to determine if these assumptions are realistic.

3.6 Proportional Coverage In Overlap Areas

There will be many transmitters in a network and service will be possible from more than one transmitter at many locations. The coverage proportions of all significant transmitters need to be combined.

The location variation from different transmitters is assumed have a correlation coefficient of zero (see section 2.3). Therefore the probability of service from different transmitters is independent. The proportion of locations where service is available from at least one transmitter is then:

$$p_s = 1 - \prod_{i=1}^{I} \overline{p_i}$$

where:

I is the number of transmitters,

$\overline{p_i}$ is the proportion of locations which are unserved from transmitter i.

3.7 Population Counting

Population coverage assessments are based on the predicted field strength level in each 1 km square. The population coverage estimates are based on two methods:

(i) all population within areas where at least 90% of the locations are predicted to be served. This is referred to as the 'cut-off' method.

(ii) the proportion of the population which is predicted to receive the minimum field strength level, in those areas where at least 50% of the locations are predicted to be served. This is referred to as the 'proportional' method.

The population in each 1km square is derived from the Post Office Address file (PAF). A processed version of the PAF provides the number of domestic residences in each 1 km square. A multiplying factor representing the average number of people per domestic residence is applied to this figure to give the population in each 1 km square.

3.8 Calculation of Net Coverages

This section outlines the method for calculation of net coverages for each multiplex from each transmitter and the rationale used in the selection of the proposed method. **Net** coverage figures for each multiplex from each transmitter are required for the C/N = 20 dB (24 Mbit/s) option.

3.8.1 Conditions

The method meets the following conditions:

(1) The sum of the net coverages equals the total coverage.
(2) Net coverage areas of different transmitters are allowed to overlap.
(3) Division of coverage in these overlap areas is biased towards the dominant transmitter.
(4) There are no abrupt thresholds in the apportionment of the coverages between transmitters in the overlap areas.
(5) The method is simple to implement.
(6) The method is quick to calculate.

3.8.2 Calculation Method

The following simple net coverage calculation method satisfies the above conditions. First, the total coverage in each small square is calculated from the individual coverages of each of the transmitters that have coverage in the square. The total coverage in the square is given by:

$$p_s = 1 - \prod_{i=1}^{n} (1 - p_i)$$

where p_i = coverage from transmitter i.
n = number of transmitters serving the square.

In order to ensure that condition (1) is met, the two alternative population counting rules described in Section 3.7 are then applied to the total coverage:

Cut-off method: $$p_c = \begin{cases} 1, & p_s \geq 0.9 \\ 0, & p_s < 0.9 \end{cases}$$

Proportional method: $$p_p = \begin{cases} p_s, & p_s \geq 0.5 \\ 0, & p_s < 0.5 \end{cases}$$

The modified total coverages for the square are then apportioned between the transmitters serving the square to give the net coverages for each transmitter as follows:

$$p_{ni} = p_t \frac{p_i^2}{\sum_{j=1}^{n} p_j^2}$$

where p_t = p_c or p_p = total coverage in square.

Taking squares in the fraction causes more weight to be given to the dominant transmitter or transmitters, to satisfy condition (3). The sum of all the net coverages in the square will be equal to the total coverage in the square, thus satisfying condition (1).

3.8.3 Overall Net Coverages

The overall net coverage of a transmitter is the sum of the net coverages in each square. Note that the population counting rules are not applied in calculating this sum, as they have already been applied to the total coverage in each square.

Note that the net coverage of a transmitter will be affected by the selection of transmitters to be included in the set of transmitters for which the calculation is to be performed. As transmitters are added to the set, the net coverage of the transmitters already in the set will reduce slightly due to the presence of overlaps.

The overall net coverages as calculated by the BBC and by NTL differ slightly. The average of the two values for each transmitter is taken as the net coverage of the transmitter.

3.8.4 Illustrative Example

Consider a square served by two transmitters. Transmitter 1 serves 80% of the square ($p_1 = 0.8$) and transmitter 2 serves 50% ($p_2 = 0.5$). The total coverage p_s in the square is then $1-(1-0.8)(1-0.5) = 0.9$. Applying the population counting rules gives p_c = 1.0 and p_p = 0.9.

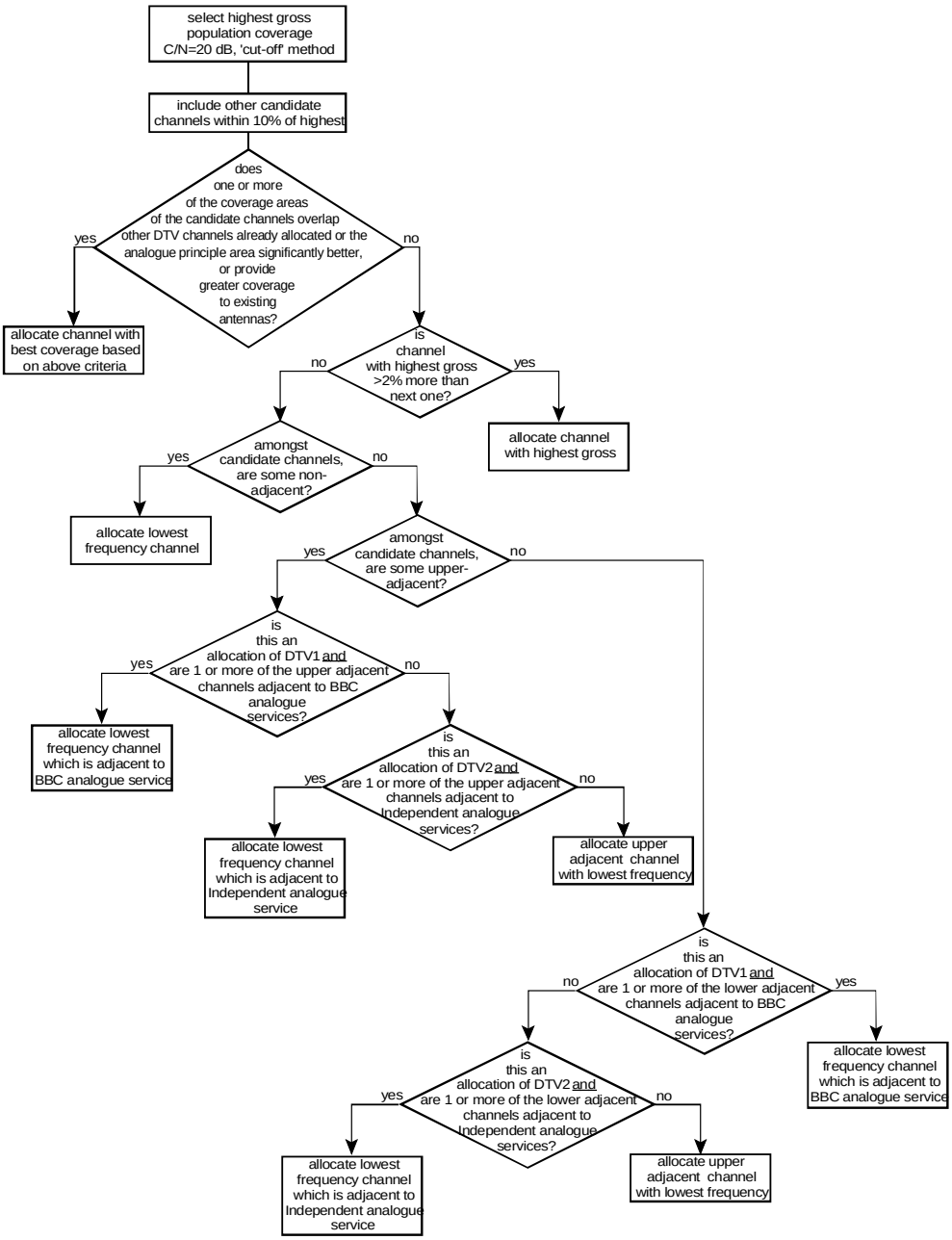
The net coverages are then as shown in the table below.

Rule	p_1	p_2	p_t	net p_1	net p_2	sum of nets
Cut-off	0.8	0.5	1.0	0.72	0.28	1.0
Proportional	0.8	0.5	0.9	0.65	0.25	0.9

3.9 Allocation of Channels to Multiplexes

Following is the flowchart which shows the procedure used when allocating DTV channels to multiplexes.

Flowchart of algorithm for allocation of DTV channel to multiplex



(In cases where this algorithm produces technically-unsound results exceptions will be made and documented)

4 References

1. Technical Basis for Planning Digital Terrestrial Television Services. EBU B/TVP Document Number 028.
2. Schwartz S. C. and Yeh Y. S., 1982, “On the Distribution Function and Moments of Power Sums with Log-Normal Components”, Bell System Technical Journal, September 1982.
3. ITU-R Recommendation 370-5, 1990, “VHF and UHF propagation curves for the frequency range from 30 MHz to 1000 MHz.”, Documents of the XVIIIth Plenary Assembly, Dusseldorf 1990, Volume V.
4. Causebrook J. H. et al., 1982, “Computer Prediction of Field Strength: A Manual on Methods Developed by the BBC for the LF, MF, VHF and UHF Bands.”, BBC Research Department.
5. ITU-R Recommendation 419-3.

D Digital Network Group Receiver specification issue 1.0

This annex contains issue 1.0 of the D-Mux Group “Digital Terrestrial Television Receiver Specification” from November 1997.

This document is an example of a receiver specification based on edition 2 of these “Requirements for Interoperability”.

The reader should note that:

- the references in the document relate to edition 2 of the “Requirements for Interoperability” which has significantly different heading numbering to that in this edition.
- in a number of areas issue 1.0 of the D-Mux Group specification introduced matter that is now a standard feature of the “Requirements for Interoperability”.
- the D-Mux Group is now called the Digital Network Group.

Digital Terrestrial Television Receiver Specification

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DOCUMENT HISTORY

Rev.	Date	Changes	Author	Status
Issue1.0	30 October 1997	First Issue	BDB	First Issue

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1. Introduction

Background

UK digital television broadcasters (the DMUX group) plan to launch Digital Terrestrial Television services during the second half of 1998. These will comprise of Free to Air, subscription and interactive services. An area of significant risk to a successful launch is the availability of domestic receivers. In order to reduce this risk to an acceptable level the DMUX group has decided to define a minimum level of service they guarantee to support.

This specification describes the mandatory features a receiver is required to have for correct operation with UK DTT broadcasts. In preparing this specification the DMUX group have paid particular attention to maintaining as much future service flexibility as possible by avoiding long term legacy issues and reducing the cost of an entry level DTT Set Top Box. The DMUX group have also taken into account their obligations as a result of the ITC licence awards of UK Digital Terrestrial Television operating licences.

The principle audience for this specification is manufacturers who intend to make Digital Terrestrial television receivers to support launch of services. This specification is written from a Set Top Box perspective but may also be used as a basis for manufacturers who wish to integrate the functionality into television sets.

Structure of this Document

This specification is organised to describe major functional areas of the receiver. It makes extensive use of the work done by the UK Digital Television Group (DTG) and refers to the DTG document entitled Digital Terrestrial Television, Requirements for Interoperability Version 2, June 1997 (the D-Book) as a means of enabling interoperability across all multiplexes.

It also refers directly or indirectly to many other standards, including those published by Cenelec, ETSI and ISO. In general a subset of these specifications is identified enabling simplification of receivers. However in a few cases these standards are clarified in this specification.

A Standards Reference table is provided at the end of this document. In this specification the use of 'shall' indicates a mandatory requirement.

2. Overview

The Digital Terrestrial Television Receiver (DTT Rx), in either Set Top or Integrated form, shall be compliant with MPEG-2 standards and European DVB specifications where appropriate. The DTT Rx shall be compliant with the DTG D-Book version 2 where indicated. The DTT Rx shall be capable of reception, processing, and display of any service to which the user is entitled and for which the DTT Rx is functionally equipped. This will include scrambled and unscrambled services from a number of broadcasters.

The DTT Rx shall process SI present / following, actual and other event information.

The DTT Rx shall include a V.22 bis, 2400 baud modem for the return path.

The DTT Rx shall support a range of video formatting; including the presentation of center cut out and letterbox presentation of 16:9 services on a 4:3 television display. Decoding of MPEG, GIF and PNG formatted stills shall be supported.

Two video planes shall be supported (video and OSD). The OSD shall be provided as solid, translucent or clear.

The DTT Rx shall support DVB subtitles. DVB Teletext (ETS 300 472) shall be supported by the reinsertion of data into the VBI of the video output.

The DTT Rx shall include a content decoder based on MHEG 5 specifications and the resident programmes defined in this specification.

In order to provide for software download the DTT Rx software shall be stored in Flash memory, with the exception of essential boot software and the software controlling code download which may be stored in protected Flash or ROM.

Macrovision [7.x] copy protect technology shall be supported.

The DDT Rx shall bear a conformance mark, on the front panel, as defined by the DMUX group to indicate compliance with this specification.

The DTT Rx shall support at least one DVB common interface connector. External Conditional Access modules shall be supported through the DVB Common Interface specification. An RS 232 serial port shall be provided.

3. Receiver Operation

3.1 Receiver Set Up

Instructions and help screens (or aids) to allow the user to install and configure the DTT Rx shall be provided as a stored application in the DTT Rx. These should also be described in the user manual. These configuration details shall be set by the user on first time power-up and shall be accessed for future use through the remote control. The DTT Rx configuration details shall be stored in non-volatile memory. It is not expected that the full user manual be stored electronically.

It shall be possible to force a guaranteed hardware reset from the front panel.

3.2 Actions on Initial Service Selection

The DTT Rx shall operate according to the general principles stated in section 30 of the D-Book.

The management of user preferences and favourite service preferences shall be further specified within the DTT SI Code of Practice and shall override the D-Book recommendations.

3.3 Remote control

The remote control, shall have, at least, the following functions:

Mandatory	Description	Optional	Description
On/standby	To toggle the DTT Rx between active (on) and standby mode.	Subtitles	Display subtitles over current video
Numerals 0, 1 thru 9	For numeric entry	16:9 output	Switch between 4:3 and 16:9 video display modes
Up, Down, Left, Right	Cursor movement control		
Select	To select a screen item		
Cancel	To cancel a previous action		
I(nfo)	To display present / following event banner		
Text	Access to the content decoder		
Guide	To display present / following event information for all services		
Red, Green, Blue, Yellow	Hot buttons to allow fast selection of options displayed through the OSD		
Volume Up / Down	Adjust audio level		
Sound Mute	Mute the audio output		
Programme Up	Step up to the next programme service		
Programme Down	Step down to the previous programme service		

Table 1

Receiver manufacturers have the option of providing a remote control that is universal (TV + DTT Rx) remote control with buttons to control the day to day functions of TV sets.

3.4 Front panel

The following front panel buttons shall be provided:

- On / Standby, Guide, Select, Left, Right, Up, Down, I(nfo)

The following front panel indicators shall be provided as separate lamps or a single display:

- Mains On / Standby
- Online (telephone)
- 4 digit numeric display

4. RF

4.1 RF Input / Digital Terrestrial UHF Reception

RF input shall be as specified in D-Book section 29.3.1.1, providing for RF bypass of analogue TV channels.

The DTT Rx shall comply with section 29.3.1.1 (UHF terrestrial) of the D-Book and be capable of receiving Digital Terrestrial Television transmissions as described in section 16 of the D-Book. Valid transport streams shall be acquired:

In less than 200ms after channel change;

In less than 100ms after a channel fade of less than 2 seconds.

The tuner shall not support UHF channel offsets.[1]

4.2 RF Output

The DTT Rx, in Set Top Box form, shall be equipped with a modulator. The output shall meet the ETSI standard for PAL-I. The output frequency range shall be adjustable PAL I, CH21-CH69. The modulator shall be a Mixer-Booster type modulator, which adds the output of the DTT Rx via the mixer to the buffered local RF signals. The frequency of the output channel shall be configurable by software and the default agreed prior to the start of manufacture. The DTT Rx shall not cause interference to TV signals when the RF signal is looped through the DTT Rx

It is not a mandatory requirement for Integrated DTT Rx to be fitted with a RF Modulator.

5. MPEG De-Multiplexing

The DTT Rx shall support the multiplexing requirements specified in the D-Book sections 5 and 29.3.2 and the following additional requirements where they exceed those specified in the D-Book. Particular attention is drawn to section 5.3 of the D-book, essential requirements. The following additional requirements are specified.

DTT Rx shall implement a suitable error concealment or error recovery mechanism on receipt of transport packet errors.

The DTT Rx shall read the transport scrambling control bits and respond in accordance with specification DVB TM 1244 Rev. 6.

Each section filter shall apply to bytes 1 and 4 to 10 of the section. Each bit in the filter shall be individually maskable. For each filtered transport packet stream, it shall be possible to apply all 32 section filters.

The burst rate per channel filter shall not exceed 5 Mbps, where a channel filter is the combination of a PID filter and a section filter.

It shall be possible to select one or several section based data streams, demultiplex them and output them, as low rate data, on either the Common Interface or RS 232 port.

[1] Offsets are currently under review by DMUX operators.

6. Service Information

The DTT Rx shall process the mandatory minimum set of PSI and SI defined by ISO/IEC 13818-1 and ETR 211. The DTT Rx shall decode SI and PSI transmitted according to sections 8.1, 8.2, 8.3, 8.4 of the D-Book with the following exclusions: Sections, 8.4.1, 8.4.2.2 (Schedule), 8.4.3 and 8.4.5 (NVOD), 8.4.8.1 (content descriptors), 8.4.7 (storage media) and 8.4.8 (use of descriptors). SI interpretation, including the BAT, shall be according to the draft DTT SI Code of Practice published by the DMUX group.

The DTT Rx shall display present / following event information for all services and shall enable the selections of any component associated with one or more services. It shall not be necessary to have a smart card to view or access in the clear (unscrambled) event information.

A banner shall be briefly displayed on service change. The banner shall be displayed on the screen showing present / following service information. The banner shall also be displayed on user selection. The user shall be able to scroll through present / following information on other services, one service at a time without a service change.

Schedule information e.g. ESG (schedule) shall not be supported at this stage.

6.1 DTG Proposed Extensions to DVB SI

The use of the proposed DTG private descriptors is under review.

7. PSTN Modem

The DTT Rx shall include, as a minimum, an embedded modem conforming to all rates up to and including V22 bis, 2400 baud.

The modem shall be identified as a resource available to the DVB Common Interface and the Conditional Access system (if present).

Line sensing shall cause the DTT Rx to drop a call within one second of a user attempting to make a call with any phone connected to the same line.

The DTT Rx shall use line sensing to prevent the DTT Rx from seizing the line if a phone on the same line is in use.

The DTT Rx shall use line sensing to detect whether the DTT Rx is connected to the telephone line, and shall be capable of differentiating this state from use of the line by other telecommunications devices.

The modem shall disconnect the line on loss of carrier, DTR or software command.

The modem shall be BABT or CE approved.

8. Video Decoding Requirements

8.1 Moving Video

Subject to the limitations of the MPEG Video Decoding integrated circuits that will be available in time for integration into first generation DTT Rx, the DTT Rx shall support section 2 and 3, section 29.3.3 and section 32 of the D-BOOK and the following requirements where specified below. See also the display requirements defined under On Screen Display. This includes the management of wide screen presentation on 4:3 and 16:9 TV sets.

It is expected that the DTT Rx shall not be able to support the full range of video scaling described in the D-Book. The DTT Rx shall support center cut out and letterbox presentation of 16:9 broadcasts on 4:3 television sets.

DTT Rx manufacturers should note that the UK DMUX group has agreed not to transmit WSS signaling (Line 23).

Scaling by 0.5, 1.0 and 2.0 shall be supported.

All screen resolutions defined in the D-Book shall be supported with and without B-frames.

Support for the specified resolutions shall include the ability for the display size to be increased; allowing decoded pictures to be displayed at full screen size. In this case upsampling shall be applied. It shall be possible to disable the re-sizing of the picture under application control in order to support less than full screen display of video.

It is not required for the DTT Rx to support the manipulation of video objects while simultaneously processing MPEG video and audio.

The DTT Rx shall implement a simplified Active Format as described in the table below:

Syntax	**No. of bits**	**Identifier**
user_data_start_code	32	bslbf
DTG_identifier (set to DTG1 = 44544731 $_{16}$)	32	bslbf
event_id_flag	1	bslbf
active_format_flag	1	bslbf
reserved (set to 000001_2)	6	bslbf
if (event_id_flag == 1_2) {		
event_id	16	uimsbf
}		
if (active_format_flag == 1_2) {		
reserved (set to 11111_2)	5	bslbf
active_format	3	uimsbf
}		

Table 2

Additional semantics are:

Active_format flag: A 1 bit flag. A value of 1 indicates that an active_format is described in this data structure.

Active_format: a 3 bit integer describing the region in terms of its aspect ratio within the coded frame, based on the effective horizontal size of the frame, and defined in the following table:

Active_format	Aspect ration of active region
0	Active region is the same as the coded frame
1	4:3
2	16:9
3	14:9
4	20:9
5	4:3 (with shoot and protect 14:9 centre)
68	reserved

Table 3

Where the aspect ratio of the active region differs from that of the coded frame, it is assumed that the active region is the largest that can be fitted within that frame, and is centred within it.

8.2 Video Stills

8.2.1 MPEG Stills

The DTT Rx shall be capable of decoding and presenting MPEG stills at a minimum format of 4:2:0, in the video plane, assuming MPEG video is not being decoded.

8.2.2 Other

Support for the decoding of other application related image formats is to be defined.

9. On Screen Display (OSD)

The DTT Rx shall support the specifications defined in section 29.3.10 of the D-Book. Limitations to this are to be defined.

The DTT Rx shall support two display planes: one for active video and one for OSD.

The DTT Rx OSD layer shall be able to apply a partial screen refresh.

Using translucency or transparency effects it must be possible to merge the graphics into a video or stills background. The DTT Rx shall support at least opaque, clear and a single level of translucent (50%) OSD.

A minimum of 8 bit per pixel colour shall be supported.

The DTT Rx shall support 100% OSD area overlaid on active video when in either 4:3 or 16:9 display modes.

The DTT RX shall support at least 60% OSD area overlaid on 16:9 letterbox presentation on 4:3 output.

The DTT Rx shall support 100% OSD area overlaid on active video with 4:3 picture scaled to 1/4 screen. In the event that a 16:9 picture can not be scaled the DTT Rx shall default to a 4:3 center cut out.

9.1 Text

The range of supported fonts will be defined.

9.2 Teletext & Subtitles.

The DTT Rx shall be capable of decoding a DVB subtitles transmitted in the conformance with ETS 300 743, with the defined font and in accordance with the DTT SI Code of Practice, and displayed using the OSD capabilities of the DTT Rx whilst decoding the full television, video and audio, service to which it is associated.

The DTT Rx shall be capable of decoding a DVB subtitling service compliant with ETS 300 743 whilst decoding the full television (video + audio) service with which it is associated. Both bit mapped graphics and character reference mode shall be supported.

The enabling and disabling of subtitles shall be controlled through the DTT Rx user interface, both as a default option and as an option for single programmes.

DVB Teletext (ETS 300 472) shall be supported by the reinsertion of data into the VBI of the video output. There is no requirement for the support of local decoding for presentation by a set-top box. It shall be possible for this functionality to be disabled prior to shipment in the event that UK multiplex operators decide not to broadcast DVB Teletext.

9.3 Performance

The DTT Rx shall be capable of simultaneous decoding:

- MPEG Video or MPEG I-Frames
- MPEG audio
- Sections at the maximum burst rate defined in section 3.1
- Section based data streams at the maximum rate supported by the RS232 data port.

The time take by the DTT Rx to realise a full screen containing the supported video objects shall be less than 500ms.

The DTT Rx shall support pixel for pixel registration, or equivalent, between layers such that objects in the OSD layer can be accurately located with respect to images displayed in the MPEG layer.

10. Audio

The DTT Rx shall support the D-Book, section 4 and section 29.3.4, except where the following requirements exceed those specified.

- MPEG-1 layer and layer2
- Single channel
- Dual Channel (one channel played at any one time)
- Joint Stereo
- Stereo

Stereo information from an MPEG-2 compatible multiservice audio bit stream.

The DTT Rx shall be capable of decoding at least the basic stereo information from an MPEG-2 compatible multiservice audio bit stream.

The DTT Rx shall be capable of decoding audio with sampling rates of 32 kHz, 44.1 kHz or 48 kHz.

The DTT Rx shall be capable of decoding audio that was not emphasised on encoding.

The DTT Rx shall detect errors and shall subsequently invoke concealment or muting mechanisms.

Dolby ProLogic™ sound encoded in MPEG-2 Musicam streams, subject to the limitations of the MPEG coding, shall be presented correctly to the listener without any degradation arising from the MPEG decoding process.

The DTT Rx shall support the fade in or out of audio under user control.

The DTT Rx shall provide support for audio muting under user control.

The audio description channel shall be supported by an external module via the Common Interface.

11. Content Decoder

11.1 MHEG5 Engine

The DTT Rx shall provide a content decoder based on a profile of MHEG5. No manufacturer specific extensions to MHEG5 shall be supported.

11.1.1 Text Class

The content decoder shall support 2 embedded fonts, one with proportional spacing the second with fixed spacing (to be defined).

Up to seven font sizes shall be supported (to be defined).

Text formatting outside of the capabilities of the MHEG5 Text class shall be provided by the use of escape sequences within the text itself. This will necessitate supporting a small set of standard HTML tags (to be defined).

Character set ISO 8859-1 (Information Processing — 8 bit single byte coded graphic character sets, Latin alphabet) shall be supported.

11.1.2 Hypertext Class

The hypertext class will map directly onto the Text class.

The AnchorFired event shall not be supported.

11.1.3 Bitmap Class

Support shall be provided for the following:

Bitmaps coded as 256 colour GIF shall be rendered in the OSD plane. Bitmaps coded as 256 colour PNG shall be rendered in the OSD plane.

Bitmaps encoded as MPEG-2 I-Frame shall be rendered in the video plane.

It shall be possible to place graphics precisely at any point on the screen.

11.2 Resident Programmes

The DTT Rx shall include a number of resident programmes.

1. It shall be possible to navigate between scenes delivered through the content decoder using user variable input data from the remote handset (e.g. manual input of Teletext page numbers to select pages at random.).
2. It shall be possible for the content decoder to select a new event from a service within the current or a different multiplex. When this action is invoked the content decoder shall return control to the core receiver software. All other resident programmes that are active shall also be terminated on change of service. By way of example: if the content decoder displays a program listing, the viewer may be able to select, subject to the content, the program and the receiver will automatically tune to the appropriate service.

3. It shall be possible for the content decoder to invoke the video scaling function of the core receiver. When the viewer turns off the content decoder any control taken by the decoder shall be released. By way of example this will allow a viewer to select a content page and if that content page is related to the program the video may reduced the picture to a _ size for display within the OSD.

11.3 Caching

It is not a requirement for cached scenes to be retained on change of service.

Other requirements are to be defined.

11.4 Content Delivery Protocol

Data for the Content Decoder shall be delivered using the DVB data carousel.

12. Memory

The DTT Rx shall be manufactured with adequate memory to support the features and functions defined in this specification. Specifically to support MHEG applications and to allow for caching of multimedia objects.

The DTT Rx shall be manufactured with Video DRAM to support the video decoding, scaling and OSD requirements of this specification. In the event that demand for memory from video and OSD exceeds the resources available the DTT Rx shall not lock up but continue to decode transport streams correctly. The DTT Rx shall prioritise the use of memory in favour of the OSD (when active), either by:

Not displaying moving video, or;

Reducing the resolution of the moving video by 50%.

When the demand for memory drops back within the available resource the DTT Rx shall resume normal operation. This may happen as a result of a user action or it may happen as a result of a change in broadcast content. A [ten] second hysteresis will be built in to any self recovery to avoid rapid switching between preferred and fallback display modes.

The DTT Rx shall be manufactured with adequate NVRAM to support the essential functions of the receiver. The NVRAM shall support 100,000 write cycles per byte without failure (4 sigma).

The DTT Rx shall provide costed options for 1, 2 and 4 Mbytes FLASH (as a manufacturing option), with erase sector size of 32kwords.

If the receiver supports the down load of software, then the DTT Rx shall have the facility to be able to be manufactured such that it shall 'boot', from power up, from either the 'failsafe' loader in ROM or the hardware protected boot section of FLASH depending on decoder memory architecture. It shall be possible through a special sequence of front panel key presses to force the decoder to run the loader software on power up. The manufacturers shall be responsible for managing this process. The intended purpose of this function is to allow bugs that become apparent during service to rectified. It is not intended to be used as a means to enhance the features of the receiver. In the event that the receiver has an embedded Conditional Access module the software download shall be under the control of the CA system.

13. Conditional Access

The DTT Rx shall be supplied with a DVB compliant conditional access system chosen by Pay TV operators. The Conditional Access system shall be implemented either as an external module connected to the receiver through the DVB Common Interface or as an embedded module. The embedded Conditional Access system shall use a detachable smartcard (based on the ISO7816 smart card interface). The subscriber access card complies fully with ISO-7816 standards, including authentication procedures that prevent the use of unauthorised cards.

A method shall be provided for controlling Macrovision [7.x] copy protect technology through the Common Interface or embedded Conditional Access system.

14. Peripheral Interfaces & Connectors

Manufacturers shall position all connectors such that standard commercially available leads may be used in all sockets without leads interfering with each other.

14.1 Mandatory Connectors

The DTT Rx shall have the following peripheral interfaces.

14.1.1 RF Interfaces

UHF input as specified in D-Book section 29.3.1.1, providing for RF bypass of analogue TV channels.

The DTT Rx shall have a Modulator output: IEC 169-2 male connector, 75 ohm impedance.

The DTT Rx may provide an additional RF output: IEC 169-2 male connector, 75 ohm impedance.

14.1.2 SCART Connector

The SCART shall comply with the EN 50049-1 specification.

The TV SCART shall provide: CVBS, RGB or Y/C, blanking/fast switch, audio L&R, slow switch/4:3 & 16:9.

14.1.3 Modem Connector

A RJ 11 socket shall be provided for connection to the PSTN. A captive stranded line cord of 3 meters shall be provided with a jack to suit BS 6312 plug. Pins 2 and 5 of the BS 6312 jack shall be connected through to the modem.

14.1.4 Conditional Access Smart Card Slot

For receivers that have an embedded Conditional Access system, the smart card slot shall be located on the front of the DTT Rx.

14.1.5 DVB Common Interface

For receivers that do not contain an embedded Conditional Access system two DVB Common Interface sockets shall be provided. One of these sockets shall support a DVB compliant Conditional Access module. The second shall be for general peripherals as described below. At least on of these sockets shall be Type 2 PCMCIA format.

14.1.6 Peripherals Interface

The peripherals interface shall conform to the DVB common interface standard and will support external modules, for example: Satellite Sidecar, IEEE 1394 interface adapter, and audio description channel module. Power for a satellite sidecar (tuner, demodulator and LNB) shall not be provided through this interface.

The location of this interface should take account of the need to accommodate cable entry.

14.1.7 EIA-232-E (RS232)

The DTT Rx shall include a 9-pin female D-type complying with EIA/TIA-232-E levels.

It shall be possible to connect either an external modem or an external data processing device (e.g. PC) to the serial port.

The pin allocation shall be as follows:

PIN	Name	Source if PC connection
1	DCD	Not used
2	RXD	DTT Rx
3	TXD	PC
4	DTR	Not used
5	GND	N/A
6	DSR	Not used
7	RTS	Not used
8	CTS	Not used
9	RI	Not used

The DTT Rx shall provide software flow control and support standard baud rates from 300 to 19,200 bps inclusive. The DTT Rx manufacturer shall demonstrate that throughput rates equal baud rates.

parity:	none
character length:	8
number of stop bits:	1

14.2 Recommended Connectors

The following connectors may be provided at the manufacturer's discretion.

14.2.1 Audio Connectors

The audio output shall be provided by L&R phono connectors as specified by IEC48B sec3l6

The DTT Rx shall provide full volume adjustment from the norm, which shall be set, under application or user control.

14.2.2 Second SCART Connector

The SCART shall comply with the EN 50049-1 specification.

The TV SCART shall provide: CVBS, RGB or Y/C, blanking/fast switch, audio L&R, slow switch/4:3 & 16:9.

15. Homologation, Shipping and Packaging

Digital Terrestrial Television receivers, Set Top Boxes or Integrated televisions, meeting this specification shall carry a conformance mark, as defined by the DMUX group. The DMUX group intends to operate a self-certification scheme similar to that operated by the DVB.

The DTT Rx shall be UK mains powered in the voltage range of 230V +/- 10% AC and frequency 50Hz.

The DTT Rx shall comply with all relevant European and UK statutory requirements for domestic electrical equipment, including but not limited to: safety, power and EMC.

The DTT Rx shall meet the requirements for European CE marking directive and carry the mark.

Connection to the mains supply shall be via either a fixed lead of 2 meters minimum length, with adequate strain relief, or by detachable lead which connects with the DTT Rx using an "IEC" socket specified in BS4491. The DTT Rx shall be fitted with a plug to BS1363 and shall be fused appropriately.

The DTT Rx shall include an off mode.

The DTT Rx power consumption shall be less than 40 Watts (VA).

The workmanship shall be of a quality consistent with comparable domestic equipment with an expectation that it shall exhibit similar standards of reliability.

The DTT Rx shall be shipped with the following accessories included:

- Full operating instructions in languages required by EU directives;
- Relevant DTT promotional material;
- A remote control handset with batteries;
- A double screened RF lead 1.5 meters long with a male connector at one end and a female connector at the other;
- A mains lead 2 meters ling fitted with a UK mains plug;
- DTT Rx serial number

15.1 Standby Condition

The DTT Rx shall have two powered operational modes:

- a standby condition where the DTT Rx shall be capable of receiving and processing user input (from the remote handset or front panel); EMM and ECM data streams, reception and processing of broadcast data streams, and initialising a session across the Common Interface;
- fully powered mode, when all functionality is active.

16. References

The following documents are referred to directly or indirectly.

16.1 DTG

Digital Terrestrial Television Requirements for Interoperability, Version 2, June 1997

16.2 ETSI

ETS 300 421	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12 GHz satellite services. December 1994.
ETS 300 429	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for cable systems. December 1994.
prETS 300 468	Digital broadcasting systems for television, sound and data services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems. Edition 2. Vote V 113. 16 October 1996 as augmented by DVB TM1701.
ETS 300 472	Digital broadcasting systems for television, sound and data services; Specification for conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) bit streams.
prETS 300 743	Digital broadcasting systems for television, sound and data services; subtitling systems. Equivalent to DVB TM 1398.
ETS 300 744	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for digital terrestrial television.
prETS 300801	Digital Video Broadcasting (DVB); DVB interaction channel through the Public Switched Telecommunications System (PSTN) / Integrated Services Digital Network (ISDN). Equivalent to DVB TM 1582.
prETS 300802	Digital Video Broadcasting (DVB); Network Independent Protocols for DVB Interactive Services. Equivalent to DVB TM 1594.
ETR 154	Digital broadcasting systems for television; Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Satellite and Cable Broadcasting Applications. As described in TM 1214 r9 September 1996 expected to replace ETSI edition 2 May 1996.
ETR 162	Digital broadcasting systems for television, sound and data services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems.
ETR 211	Digital broadcasting systems for television, sound and data services; Guidelines on the implementation and usage Service Information (SI). May 1996.
prETR 289	Digital Video Broadcasting (DVB); Common Scrambling (CS) system description.

16.3 CENELEC

prEN 50201	Interfaces for DVB-IRDs
prEN50157	AV Link
EN50049-1	Peritelevision Connector
prEN 50221	Common interface for conditional access and other digital video broadcasting decoder applications

16.4 ITU

ITU-R BT.470-4	System I Television Systems
ITU-R BT.1119-1	Wide Screen Signalling for Broadcasting.

16.5 ISO

ISO/IEC 11172-2	MPEG 1 video
ISO/IEC 11172-3	MPEG 1 audio

ISO/IEC 13818-1 Information technology - Generic coding of moving pictures and associated audio information: Systems. ISO/IEC 13818-1:1996(E)

ISO/IEC 13818-2 Information technology - Generic coding of moving pictures and associated audio information: Video.

ISO/IEC 13818-3 Information technology - Generic coding of moving pictures and associated audio information: Audio.

ISO/IEC 13818-6 Information technology - Generic coding of moving pictures and associated audio information: Extensions for Digital Storage Media Command and Control.

ISO 8859 Information Processing — 8 bit single byte coded graphic character sets, Latin alphabet.

16.6 DVB

DVB TM1701 Progress Report on DVB-TM Ad-hoc Group SI-DAT. 9 th July 1996

DVB SI-DAT 327 Report by SI-DAT Drafting Group on PDSDs and Guidelines Clarification (18/19 September 96) as ratified by the September 1996 meeting of the DVB TM.

DVB A011 DVB Common scrambling algorithm - distribution agreements

DVB User Requirements for Terrestrial Digital Broadcasting Services.

16.7 IEE/IEEE

IEC 985:1989 Digital Audio Interface.

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DTG
Liss Mill
Hants
GU33 7BD
United Kingdom

Tel: +44 1730 893 144
Fax: +44 1730 895 460
Web: http://www.dtg.org.uk