EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 473

May 1995

Source: EBU/ETSI JTC

Reference: DE/JTC-DVB-7-1

ICS: 33.160.20, 33.160.40

Key words: Digital television broadcasting by cable, satellite master antenna, cable distribution, equalization

European Broadcasting Union Union Européenne de Radio-Télévision

Digital broadcasting systems for television, sound and data services; Satellite Master Antenna Television (SMATV) distribution systems

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
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

Contents

Blank page

Foreword

This European Telecommunication Standard (ETS) has been produced under the authority of the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of ETS in the specific field of radio, television and data broadcasting.

The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its Members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has Active Members in about 60 countries in the European Broadcasting Area; its headquarters is in Geneva *.

* European Broadcasting Union
Case Postale 67
CH-1218 GRAND SACONNEX (Geneva)
Switzerland

Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

This ETS describes the modulation, channel coding and framing structure for digital multi-programme television for distribution by Satellite Master Antenna Television (SMATV). It has been prepared by the Project Team PT-55V. The work of the Project Team was based on the studies carried out by the European Digital Video Broadcasting (DVB) Project under the auspices of Ad hoc Group for Digital Television by Cable (DTVC). An important input to the DVB project was delivered by the RACE DIGISMATV project which completed the initial phase of its study in Summer 1994.

This ETS is part of the complete "Multivision system" (this name is currently under review) which covers the baseband image coding, baseband sound coding, baseband data service coding, multiplexing, channel coding and modulation for satellite services, channel coding and modulation for cable and Satellite Master Antenna Television (SMATV) distribution and common scrambling system.

Transposition dates	
Date of latest announcement of this ETS (doa):	31 August 1995
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	29 February 1996
Date of withdrawal of any conflicting National Standard (dow):	29 February 1996

Blank page

1 Scope

This European Telecommunication Standard (ETS) describes the transmission system proposal for digital multi-programme television suitable for distribution in Satellite Master Antenna Television (SMATV) systems. This ETS is complementary to the ETS 300 429 [1] and it is aligned with ETS 300 421 [2]. The System described in this ETS is compatible with the modulation and channel coding systems used for digital multi-programme television by cable and satellite transmissions (see ETS 300 429 [1] and ETS 300 421 [2], respectively). The System is based on the MPEG-2 System Layer, see ISO/IEC DIS 13818-1 [3], with the addition of appropriate Forward Error Correction (FEC) technique. The System allows for further evolution as technology advances as described in document ETS 300 429 [1] (see also bibliography in annex D) and is capable of starting a reliable service as of now.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 429 (1994): "Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation - Cable systems".

[2] ETS 300 421 (1994): "Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[3] ISO/IEC DIS 13818-1 (1994): "Coding of moving pictures and associated audio".

[4] Forney, G.D. IEEE Trans. Comm. Tech., COM-19, pp. 772-781, (October 1971): "Burst-correcting codes for the classic bursty channel".

3 Symbols and abbreviations

3.1 Symbols

For the purposes of this ETS, the following symbols apply:

	Roll-off factor
f_0	Channel centre frequency
R_s	Symbol rate corresponding to the bilateral Nyquist bandwidth of the modulated signal
R_u	Useful bit rate after MPEG-2 transport multiplexer
$R_{u'}$	Bit rate after RS outer coder
T	Number of bytes which can be corrected in RS error protected packet
T_s	Symbol period

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

BB	BaseBand
BER	Bit Error Ratio
BW	BandWidth
DTVC	Digital Television by Cable
EBU	European Broadcasting Union
ETS	European Telecommunication Standard
FEC	Forward Error Correction
IF	Intermediate Frequency
IRD	Integrated Receiver Decoder
LSB	Least Significant Bit
MPEG	Moving Pictures Experts Group
MSB	Most Significant Bit
MUX	Multiplex
PDH	Plesiochronous Digital Hierarchy
PRBS	Pseudo Random Binary Sequence
QAM	Quadrature Amplitude Modulation
QEF	Quasi Error Free
QPSK	Quaternary Phase Shift Keying
RF	Radio Frequency
RS	Reed-Solomon
SMATV	Satellite Master Antenna Television (as defined in clause 4)
SMATV-DTM	SMATV system based on Digital TransModulation
SMATV-IF	SMATV system based on distribution at IF
SMATV-S	SMATV system based on distribution at extended Super band
TDL	Tapped Delay Line
TDT	Transparent Digital Transmodulation
TDM	Time Division Multiplex
TV	Television
UHF	Ultra High Frequency
VHF	Very High Frequency

4 SMATV distribution system concepts

A Satellite Master Antenna Television (SMATV) system is defined as a system which is intended for the distribution of television and sound signals to households located in one or more adjacent buildings. These signals are received by a satellite receiving antenna and may be combined with terrestrial TV signals. SMATV distribution systems are also known as community antenna installations or domestic TV cable networks. A SMATV system represents a means for sharing the same resources among several users for satellite and terrestrial reception.

The SMATV System is designed to perform the adaptation of the satellite TV signals to the SMATV channel characteristics. The primary consideration of the SMATV System is the transparency of the SMATV head-end to the digital TV multiplex from a satellite reception without baseband interfacing, delivering that signal to the user home Integrated Receiver Decoder (IRD); thus permitting simple and cost effective head-end as required for the consumer profile of SMATV equipment.

This ETS considers two main SMATV System approaches for distribution of digital TV signals in SMATV installations, as follows:

SMATV System A: this System approach consists of the transmodulation from satellite Quaternary Phase Shift Keying (QPSK) signals as defined in ETS 300 421 [2] to a Quadrature Amplitude Modulation (QAM) scheme (16-QAM, 32-QAM or 64-QAM) using either a full implementation of the System described in ETS 300 429 [1 (see subclause 5.1), or a simplified transmodulation process as described in subclause 5.2. This process of transmodulation without baseband interfacing is also known as Transparent Transmodulation.

The use of one of the System A or System B approaches depends on the technical performance and cost trade-offs in each particular situation.

NOTE: Digital terrestrial specification is not the subject of this ETS.

5 SMATV System A

SMATV System A is based on the use of the transmodulation from satellite QPSK signals to a QAM modulation scheme (see figure 1). This system is also known as SMATV-DTM.

The System comprises the following elements:

- **Head-end transmodulation unit:** this performs the required decoding and adapts the signal modulation coding to the cable distribution network. This unit is also known as the Transparent Digital Transmodulator (TDT).

- **SMATV UHF distribution network:** this is a physical cable structure for distribution of the signal to several users. The reference channel response of SMATV distribution network is given in annex A.

- **User IRD:** this unit performs the required equalization to compensate the channel distortion as well as demodulating and decoding the QAM signal.

5.1 Full implementation of SMATV System A

A full implementation of the QAM System shall be performed according to ETS 300 429 [1] and ETS 300 421 [2] with a transparent interface between them. To this end, the full implementation of SMATV System A shall make use of the MPEG-2 transport layer, the framing structure, the channel coding, the byte-to-symbol mapping and modulation consistent with ETS 300 429 [1] and ETS 300 421 [2]. The channel coding shall include the randomization for spectrum shaping, the Reed-Solomon (RS) coding and the convolutional interleaving according to Forney [4]. This configuration is shown in figure 2.

5.2 Simplified implementation of SMATV System A

In the complete implementation architecture of SMATV System A, outer error protection (i.e. Reed-Solomon and convolutional interleaving) is performed twice, i.e. independently for the satellite link and the cable link. Therefore, the cable link is fed by a Quasi Error Free (QEF) bit stream. In cases when an adequate satellite link margin is achieved, one Reed-Solomon decoder-encoder and deinterleaving-interleaving process could be eliminated from the System. In such cases, a single RS decoder at the user IRD is capable of correcting errors generated in the cable link added to the remaining burstly errors after Viterbi decoding. This configuration is shown in figure 2 when removing the dashed line blocks.

NOTE: This simplified configuration may imply a non-negligible saving in terms of the number of gates and thus in the total equipment cost. Due to consumer type character of SMATV head-ends, this saving is important when an economy of scale is achieved. Consequently, manufacturers could decide whether to adopt the simplified SMATV System A architecture.

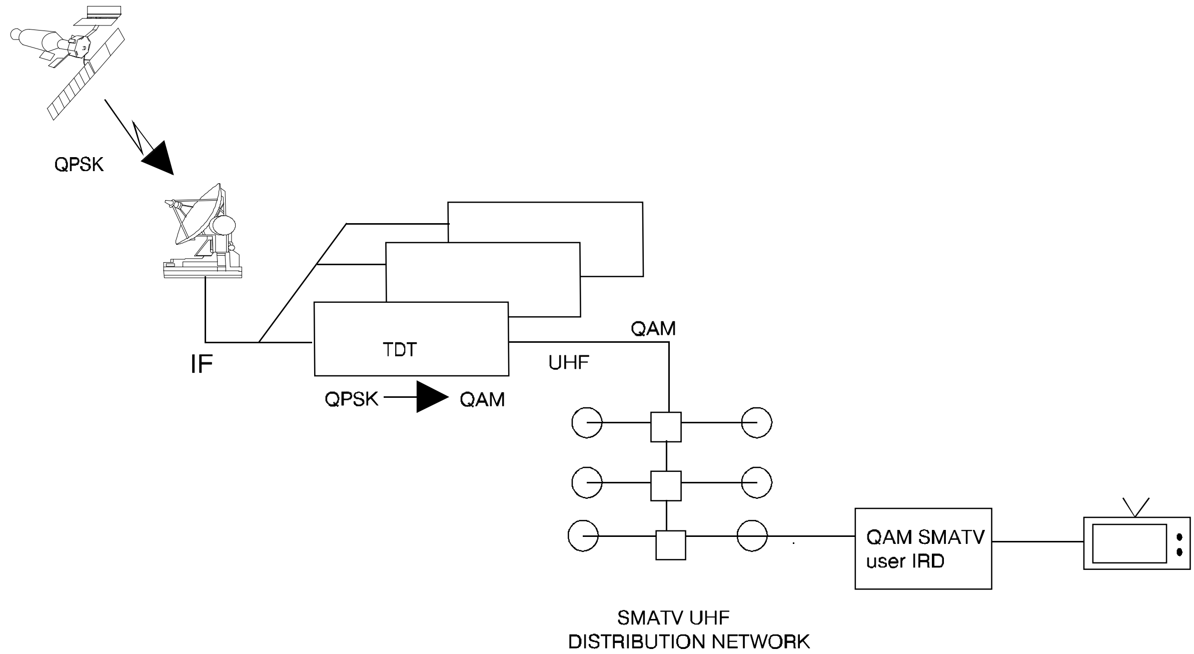

Figure 1: SMATV System A configuration

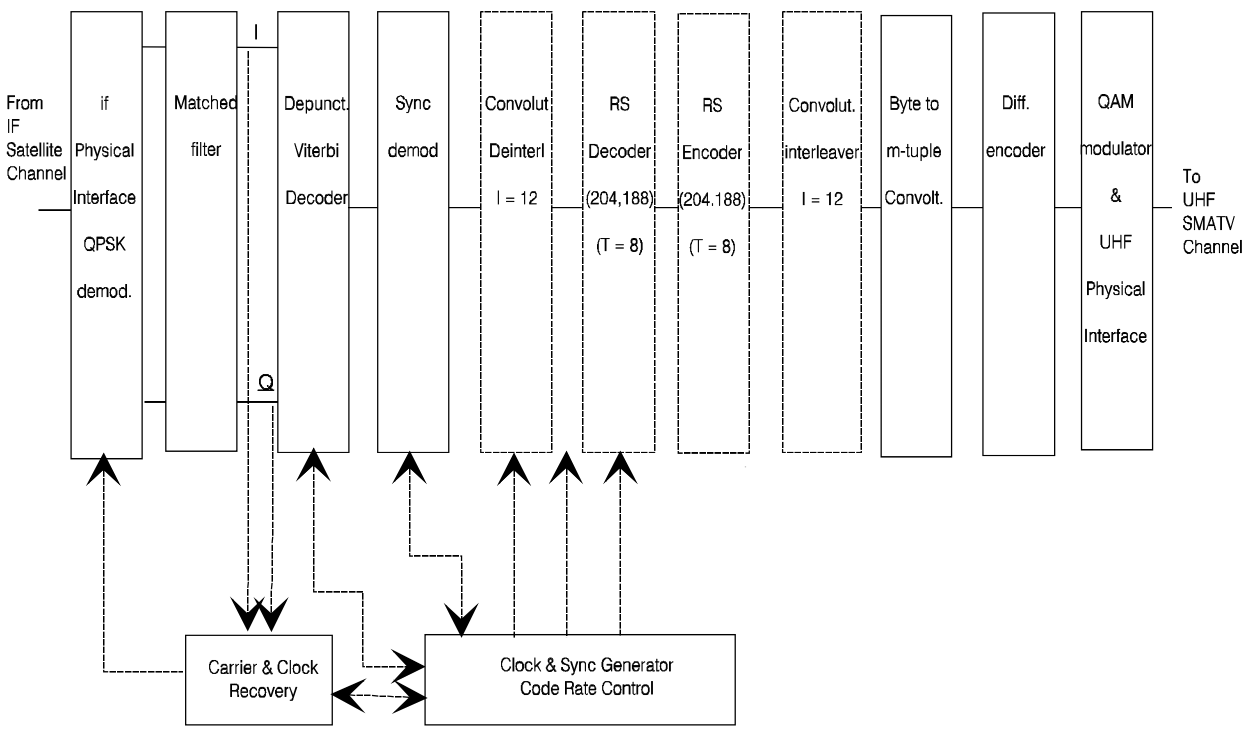

Figure 2: Functional diagram of a SMATV System A

6 SMATV System B

SMATV System B is based on the use of QPSK modulation (see figure 3). The SMATV System B concept allows a direct reception of digital satellite signals by the user IRD connected to a SMATV distribution network. The functional elements of this system are given in the baseline satellite specification ETS 300 421 [2]. Two configurations of SMATV System B are considered as follows:

- SMATV-IF;
- SMATV-S.

In the SMATV-IF configuration, QPSK signals are distributed directly at the Intermediate Frequency (IF) as delivered by the Low Noise Block (LNB) (see figure 3a). In the SMATV-S configuration, QPSK signals are frequency converted to S-band (see figure 3b). In both configurations, the satellite signal reaches the user IRD without being subject to any demodulation and transmodulation process at the head-end. Thus, the modulation characteristics of the satellite link are retained.

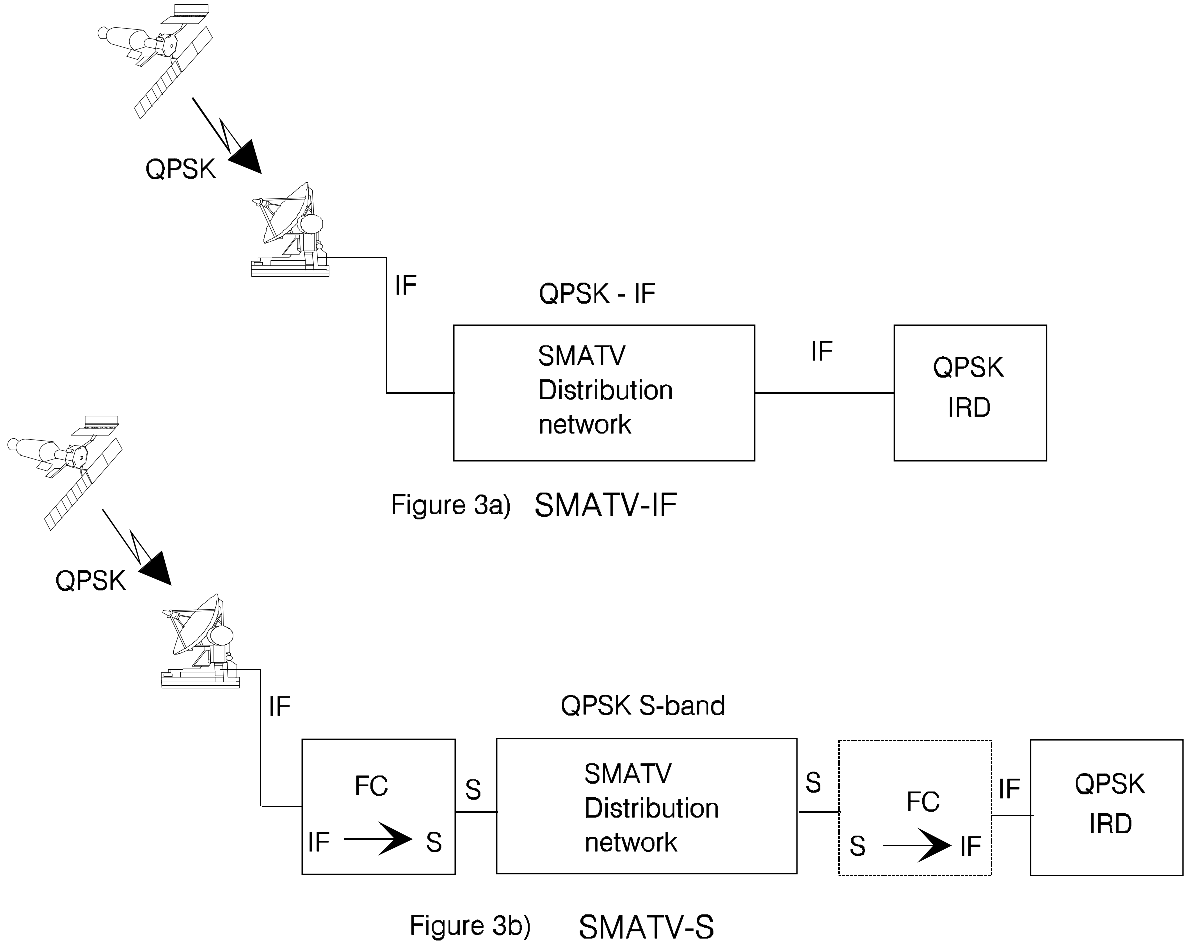

Figure 3: SMATV System B configurations, SMATV-IF and SMATV-S

6.1 SMATV-IF

This configuration allows the direct distribution of the QPSK signal received from the satellite to the SMATV-IF distribution network in the extended IF band (above 950 MHz).

The user IRD should be able to tune all the channels in the extended IF band to demodulate and to decode the signal.

The functional elements of SMATV-IF are given in the satellite specification (see ETS 300 421 [2]).

6.2 SMATV-S

This configuration requires the frequency conversion of the satellite signals from extended IF band (above 950 MHz) to a part of the VHF/UHF band (for example: extended S-band (230 MHz to 470 MHz)).

NOTE: An inverse frequency conversion process (e.g. from extended S-band to IF) may be required at user IRD equipped with IF tuner.

The user IRD performs similar functions as for the satellite reception, see ETS 300 421 [2]. In order to compensate for the channel linear distortions, the matched filter may include equalization capabilities.

The S-band channel model is similar to that of the UHF band; it is given in annex A.

7 MPEG-2 transport layer

The SMATV System shall use the MPEG-2 transport layer which is defined in ISO/IEC CD 13818-1 [3]. The Transport Layer for MPEG-2 data is comprised of packets having 188 bytes, with one byte for synchronization purposes, three bytes of header containing service identification, scrambling and control information, followed by 184 bytes of MPEG-2 or auxiliary data.

8 Framing structure

The framing organization of the SMATV System shall be based on the MPEG-2 transport packet structure (see ETS 300 429 [1], ETS 300 421 [2], ISO/IEC CD 13818-1 [3]).

Annex A (informative): Channel model of SMATV distribution systems

A.1 Channel model response

In order to test SMATV Systems and to evaluate the need for equalization, an RF channel model response has been obtained for SMATV distribution network. The model is based on measurements and computer simulations. The model is significantly simplified in order to take into account only the relevant aspects for the equalization definition. It applies to UHF band as well as S-band SMATV networks.

The RF channel model is split in four models, they are presented in figures A.1 to A.4;

- model A for microreflections between devices in consecutive floors (figure A.1);
- model B for microreflections between head-end and first device (figure A.2);
- model C for microreflections between tap-off and user outlet (figure A.3);
- model D: Combined microreflections model (figure A.4).

Real SMATV networks usually combine features from all models depending on the concrete structure and mainly the cable length and mismatching degree in each connection. It has been concluded that:

- microreflections delay depends on cable lengths;
- microreflections attenuation depends on level of mismatching among components (return losses).

These models are based on assumptions derived from a survey on the most extended SMATV structures, see bibliography DVB-TM 1259. The following configuration has been considered as a reference:

- a range of 3 m to 3,5 m cable length between cascade user outlets;
- a range of 6 m to 12 m cable length between tap-off and user outlet for parallel structures;
- a range of 10 m to 20 m cable length between head-end amplifiers and first passive elements;
- about 10-storey building, in order to include representative echoes generated in several floors.

In figures A.1 to A.4 microreflection distribution can be observed for the 4 models. X-axis in the diagrams represent the microreflection delay in ns. Y-axis gives microreflection attenuation in dB. Taking the above considerations into account, the echo delay ranges can be noted.

The reference channel model for most practical installations is given in figures A.1 to A.4 marked with "3 sigma" and is represented in dark colour. The upper level refers to the worst case.

A.2 Definition of adaptive equalization requirements

QAM demodulator at the user IRD should include an adaptive equalizer to compensate the channel distortion introduced by SMATV in the UHF band. An equalizer may also be included at the user IRD for QPSK demodulation in the S-band. Equalization should be blind, since the baseline systems do not include any training sequence. Referring to the reference RF channel model of figures A.1 to A.4 for the 3 sigma case, state of the art implementations of equalizers can provide less than 1 dB implementation margin at a BER of 2×10^{-4}, and less than 100 ms acquisition time.

MODEL A. Microreflections between devices in consecutive floors

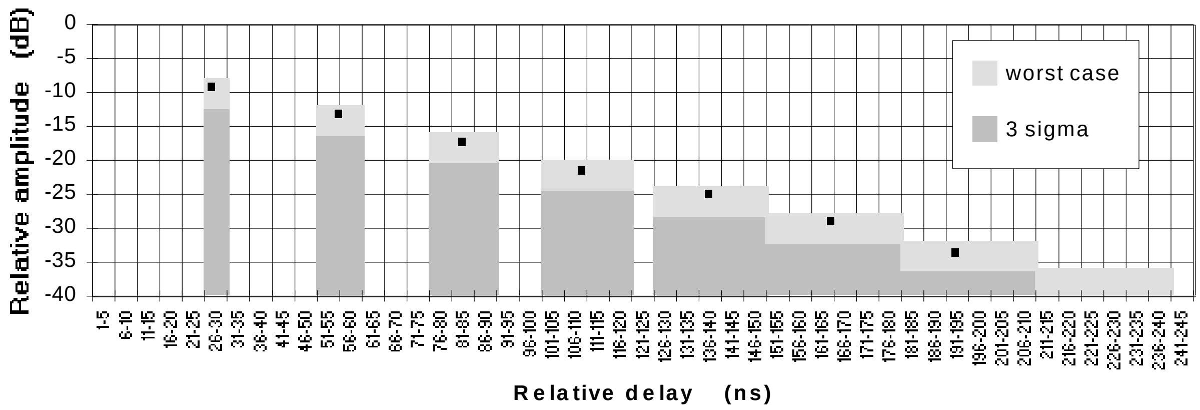

Figure A.1: RF channel model A response of UHF and S bands SMATV distribution network

MODEL B. Microreflections between head-end and 1st device

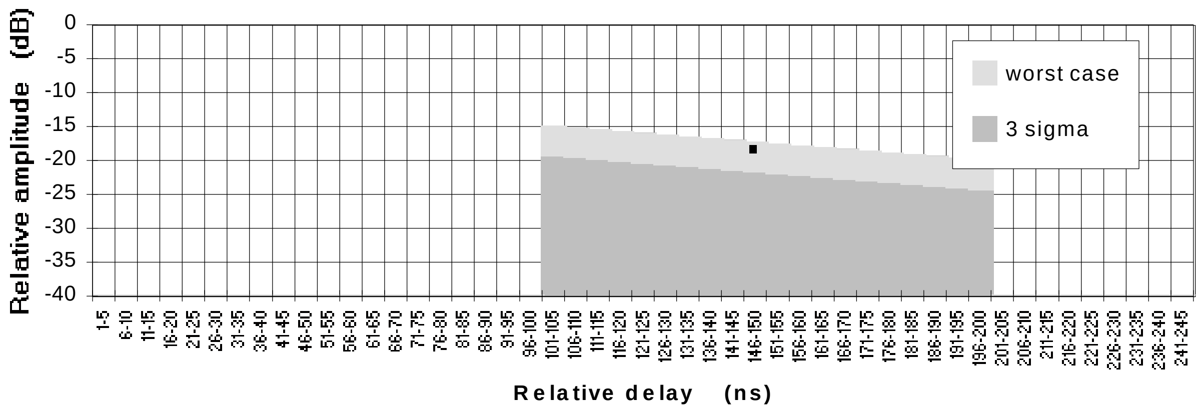

Figure A.2: RF channel model B response of UHF and S bands SMATV distribution network

MODEL C. Microreflections between tap-off and user outlet

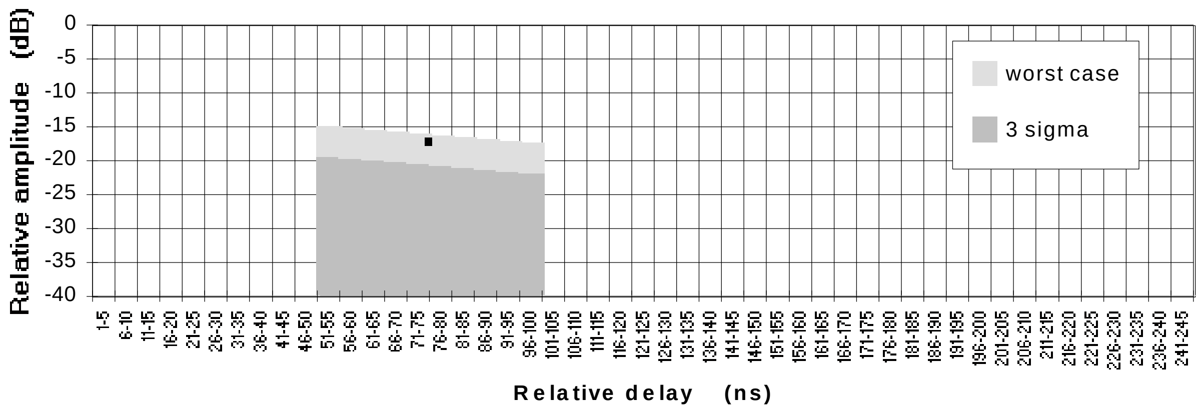

Figure A.3: RF channel model C response of UHF and S bands SMATV distribution network

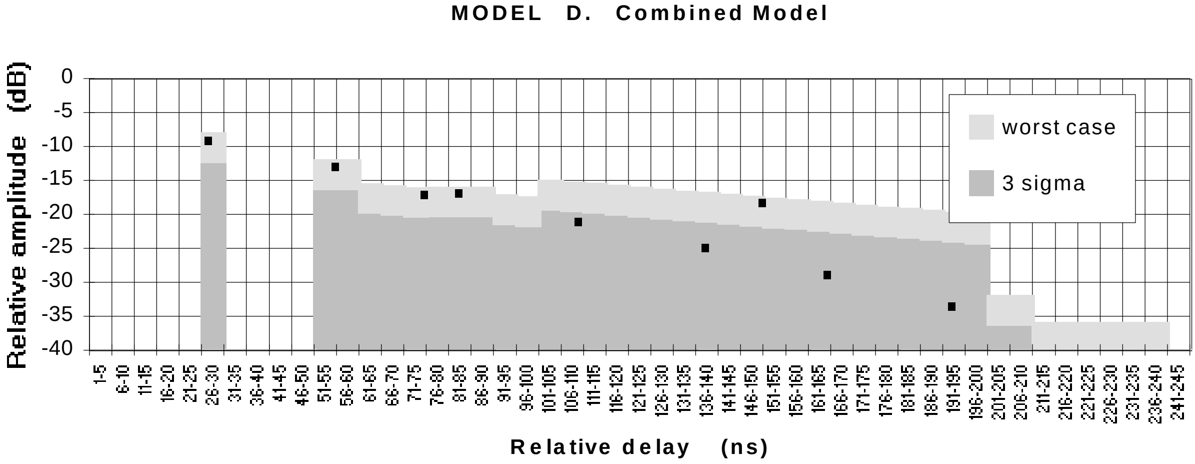

Figure A.4: RF channel model D response of UHF and S bands SMATV distribution network

Annex B (informative): Examples of 64-QAM and QPSK performance with equalizers

In the following, performance of two possible examples of SMATV systems are investigated by computer simulations:

SMATV system A: transmodulation from QPSK to 64-QAM, symbol rate R_S= 6,9 Mbaud in 8 MHz channels, useful bit-rate of 38 Mbit/s at the MPEG multiplex output.

SMATV system B: QPSK modulation with rate 3/4 convolutional coding, symbol rate R_S= 25,8 Mbaud and useful bit-rate of 35,6 Mbit/s at the MPEG multiplex output.

To overcome the linear distortions introduced by the SMATV network, an adaptive “blind” equalizer (see A. Benveniste, M. Goursat in bibliography), composed by a symbol-spaced complex transversal filter (FIR), has been introduced in the receiver. The second tap of the equalizer was set to "1", since the presence of anticipated echoes can generally be excluded in SMATV installations. The results assume steady state of the equalizer, after the end of the blind lock-in phase.

Some critical examples of SMATV channels have been considered in the simulations, as measured on a hardware-simulated SMATV network for a 5-floors building (see G. Garazzino, V. Sardella in bibliography). The channel amplitude and group delay characteristics are reported in figures B.1 to B.6. The first case (Response - 1) refers to a 40 MHz channel, suitable for system B, while the others (i.e., Response-2 , to, Response-6) refer to 8 MHz channels, suitable for system A.

B.1 SMATV System A - Simulation results

With system A the signal is re-generated at the SMATV network input, therefore the noise generator in the simulations was put at the 64-QAM demodulator input, after the SMATV network. Very high degradation levels have been obtained without equalization. In the presence of adaptive equalization with 6 symbol-spaced taps, the signal to noise ratio degradation for BER equal to $2x10^{-4}$ (before Reed-Solomon correction) was lower than 1,5 dB in all the five analyzed network responses 2. These results refer to the value of 23,8 dB in a bandwidth of 7 MHz in an ideal linear Gaussian channel; they do not however include possible additional impairments due to amplifier nonlinearity in the cable head-end.

It is therefore possible to conclude that with SMATV system A (in the 64-QAM configuration) the use of adaptive equalizers is mandatory to overcome typical SMATV network degradations. However in the case of old cable installations with very poor performance (e.g. echo levels of about 8 dB to 12 dB, as given in annex A, figures A.1 to A.4), the use of the equalizer might be insufficient to guarantee 100% service availability when 64-QAM modulation is adopted. Nevertheless, in the case of new installations complying with CENELEC prEN 50083-3 (see bibliography), the service availability with 64-QAM can be guaranteed by a suitable equalizer.

Hardware tests with a 16-QAM modem including blind equalization have demonstrated good performance on the above described SMATV network, see ISO/IEC DIS 13818-1 [3].

As regards the required number of equalization (symbol-spaced) taps N, the echo delay spread T_e to be considered on typical SMATV networks is of the order of 220 ns, as indicated in figures A.1 to A.4 (64-QAM requires C/I levels of the order of 35 dB). Assuming that the second tap of the equalizer is set to "1", to achieve good performance with 64-QAM and high echo levels, N should be larger than $2+2T_e/T_s$. Therefore, for a symbol duration T_s=143 ns, the minimum equalizer length should be of about 6 taps, while 8 to 10 taps could offer an additional margin to cope with longer echoes.

B.2 SMATV System B - Simulation results

Since in a well designed SMATV network, adopting SMATV system B, the main noise source should be in the satellite down-link path, the noise source in the simulations has been put before the SMATV network. The SMATV network transfer function, which has been used in the simulations, is "Resp-1" of figure B.1.

For BER equal to 10^{-4} before Reed-Solomon correction, the SMATV network introduced a degradation on the required C/N (calculated in a bandwidth of 26,8 MHz) for the satellite of about 1,4 dB on the system without equalizer, while the degradation was reduced to 0,4 dB with the equalizer ETS 300 421 [2]. These results refer to the value of 6,1 dB in an ideal linear Gaussian channel; no implementation margin is included. Therefore also for method B, based on the rugged QPSK modulation, the use of an adaptive equalizer in the receiver seems important, allowing to utilise current SMATV installations with very low additional C/N degradation with respect to direct satellite reception.

Hardware tests with a QPSK modulator including rate 3/4 convolutional coding, without equalizer, confirmed the simulation results on the above SMATV network.

As regards the number of equalizer (symbol-spaced) taps N, assuming that the second tap of the equalizer is set to "1", good QPSK performance can be achieved for $N > 2+(T_e/T_s)$, where T_e is the echo delay spread to be considered. For T_e = 220 ns, as indicated in figure A1, and a symbol duration of T_s = 30 ns, the minimum equalizer length should be of about 10 taps.

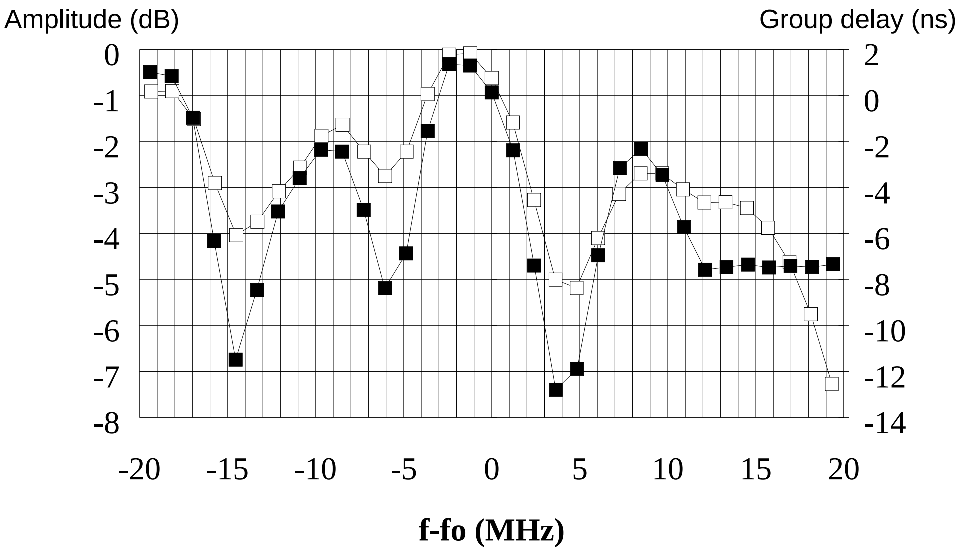

Figure B.: Response 1: Significant example of the measured transfer function for the considered SMATV network (■amplitude, □ group delay)

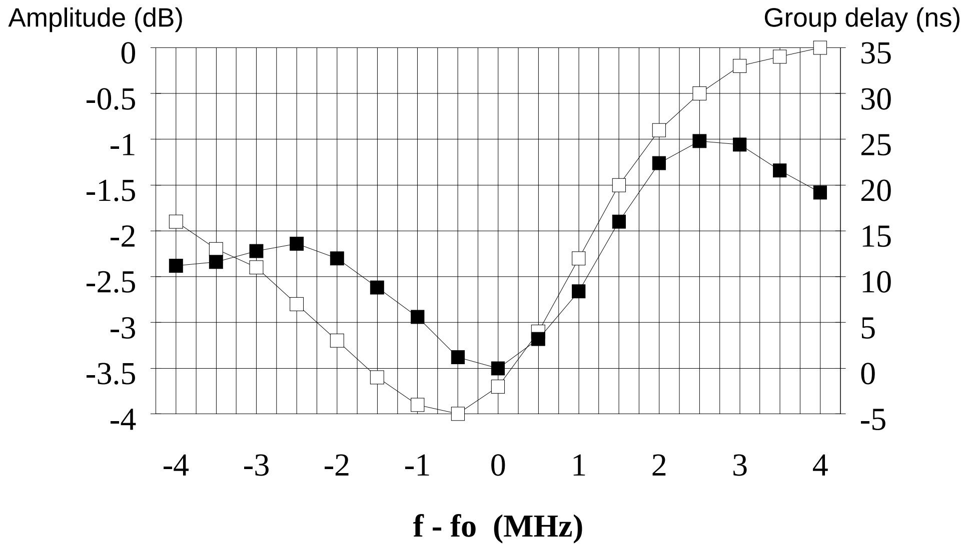

Figure B.2: Response 2: Significant example of the measured transfer function for the considered SMATV network (■ amplitude, □ group delay)

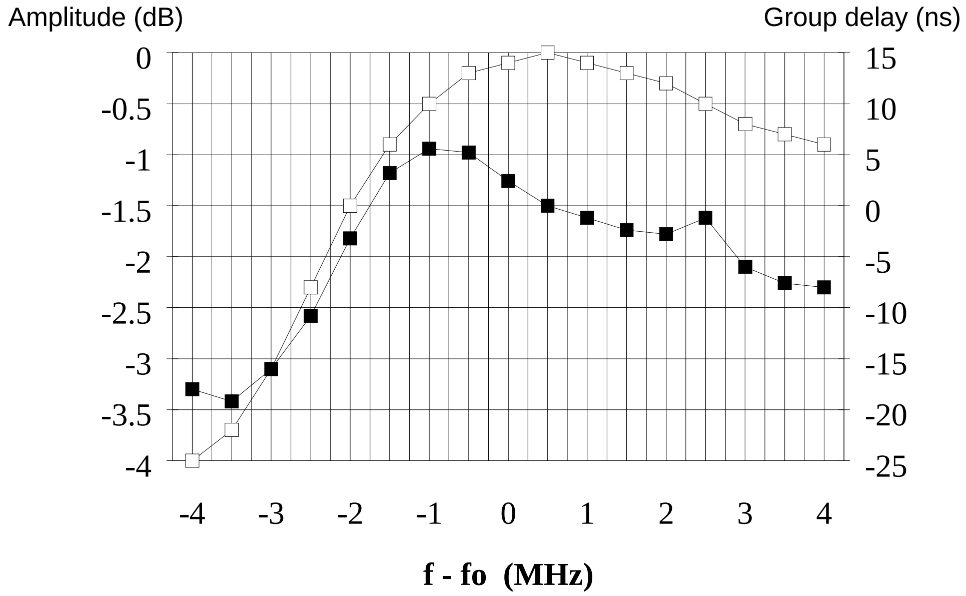

Figure B.3: Response 3: Significant example of the measured transfer function for the considered SMATV network (■ amplitude, □ group delay)

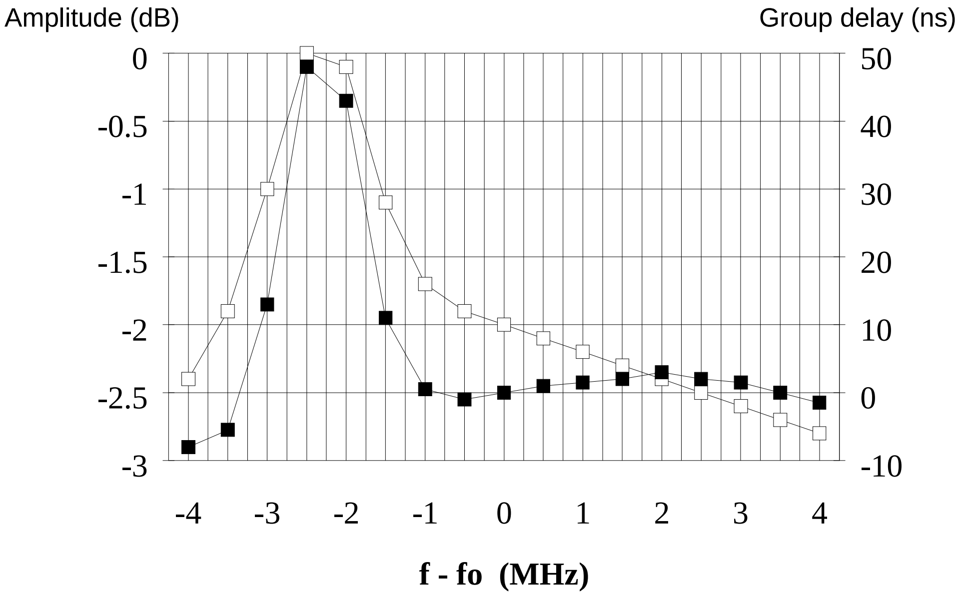

Figure B.4: Response 4: Significant example of the measured transfer function for the considered SMATV network (■ amplitude, □ group delay)

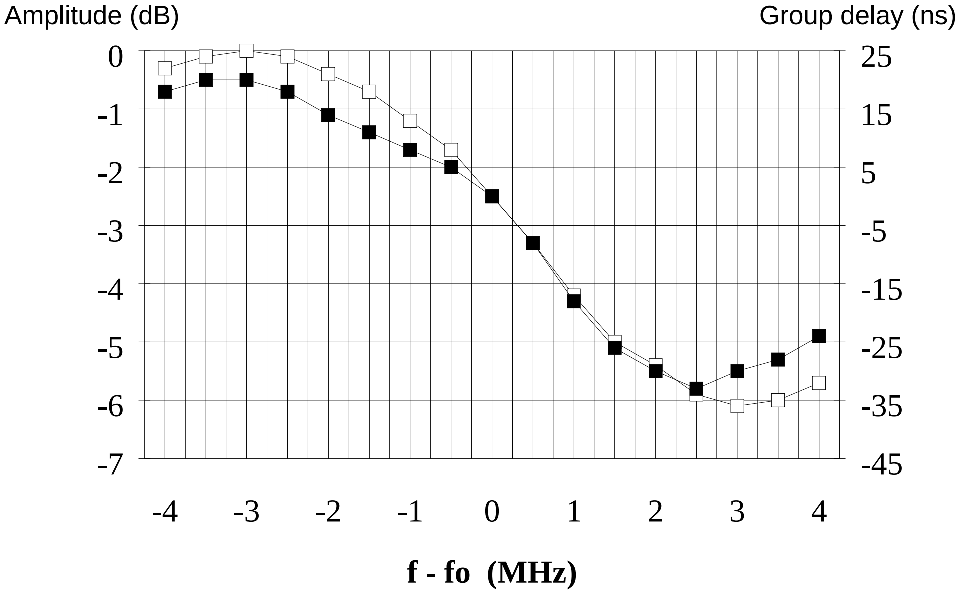

Figure B.5: Response 5: Significant example of the measured transfer function for the considered SMATV network (■ amplitude, □ group delay)

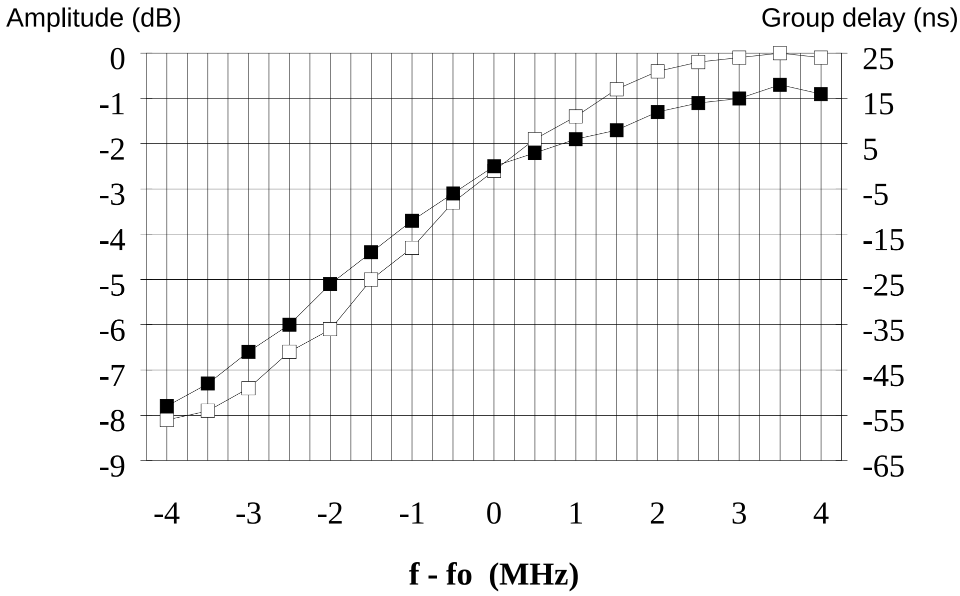

Figure B.6: Response 6: Significant example of the measured transfer function for the considered SMATV network (■ amplitude, □ group delay)

Annex C (informative): Bit rate consideration for SMATV distribution systems

This annex is provided only for comparison purposes with respect to similar annex C of ETS 300 421 [2], and annex B of ETS 300 429 [1].

In order to achieve a transparent re-transmission of satellite services on SMATV systems, it is necessary to take into account the limitations imposed by the SMATV System in the 8 MHz cable channel bandwidth for SMATV System configurations.

Table C.1 gives figures, showing the possible ranges of SMATV symbol rates and occupied bandwidths for different useful bit rates on the satellite. The 16-QAM, 32-QAM and 64-QAM constellations of the SMATV System A are considered.

For full transparency, the same useful bit rate (excluding RS coding) should be used in the satellite and the SMATV cable network.

Referring to annex B of ETS 300 429 [1], the theoretical maximum symbol rate in an 8 MHz SMATV channel is 6,96 MBaud with a roll-off factor of 0.15. In table C.1 indicative useful bit rates are provided.

Channel bandwidth constraints exist in a number of high loaded SMATV networks, which limit the useful bandwidth to 7 MHz. For such existing high loaded networks, transmission of symbol rates about 6 MBaud are feasible with acceptable signal degradation. Symbol rates given above the upper highlighted line support the simplified transparent transmodulation concept, facilitating the satellite link operation at BER ratios above threshold (before RS) for a given antenna size. However, future upgrading of current single channel amplifiers may clear such limitations.

Table C.1: Examples of transparent retransmission of satellite TV on SMATV networks using the same useful bit rate R_u (excluding RS)

	16 - QAM		32 - QAM		64 - QAM	
Examples of satellite R_u for BW (-3dB)/R_S=1,27 (after MPEG-2MUX) (Mbits)	**Symbol rate (Mbaud)**	**Occupied BW. (MHz)**	**Symbol rate (Mbaud)**	**Occupied BW. (MHz)**	**Symbol rate (Mbaud)**	**Occupied BW. (MHz)**
18,9	5,13	5,90	4,10	4,72	3,42	3,93
19,6	5,32	6,11	4,25	4,89	3,54	4,07
21,7	5,88	6,77	4,70	5,41	3,92	4,51
24,0	6,51	7,49	5,21	5,99	4,34	4,99
25,2	6,84	7,86	5,47	6,29	4,56	5,24
26,1			5,66	6,51	4,72	5,43
26,2			5,68	6,54	4,74	5,45
28,3			6,14	7,06	5,12	5,88
29,0			6,29	7,24	5,24	6,03
29,4			6,38	7,34	5,32	6,11
31,5			6,84	7,86	5,70	6,55
31,9			6,92	7,96	5,77	6,63
32,6					5,89	6,78
32,7					5,91	6,80
33,1					5,99	6,88
33,4					6,04	6,95
34,4					6,22	7,15
34,8					6,29	7,24
35,9					6,49	7,47
36,2					6,55	7,53
38,1					6,89	7,92
31,672 (PDH)			6,87	7,90	5,73	6,59

NOTE 1: (thick line) = 7 MHz Cable channel Bandwidth (BW).

NOTE 2: (double line) = 8 MHz Cable channel Bandwidth (BW).

Table C.2 shows the indicative SMATV capacity in case of QPSK channels distributed in the existing extended super-band or in the existing extended IF band for the symbol rates proposed in the satellite ETS 300 421 [2]. Other symbol rates and channel spacing are possible.

Table C.2: SMATV-S and SMATV-IF capacity

		Number of channels		
R_S (Mbaud)	Minimum channel spacing (MHz)	Extended super-band (230 to 470 MHz) NOTE	Satellite first I.F. band (0,95 to 2,05 GHz) NOTE	Total
42,2	57,0	4	19	23
35,9	48,5	4	22	26
31,5	42,5	5	25	30
28,1	37,9	6	28	34
25,8	34,8	6	31	37
23,4	31,6	7	34	41
21,1	28,5	8	38	46
20,3	27,4	8	40	48
NOTE: The frequency ranges in parenthesis are only indicative. Wider ranges may be possible in some circumstances.				

Annex D (Informative): Bibliography

1) Reimers, U. NAB'93, document GT V4/MOD 249: "The European perspectives on Digital Television Broadcasting".

2) A. Masento, V. Mignone, A. Morello: “Performance of 64-QAM and QPSK in SMATV installations - Simulation results”, Report no. 94/xx/E.

3) G. Garazzino, V. Sardella: “Preliminary 16-QAM transmission tests in the UHF Band on a SMATV network”, RAI Technical Report no. 94/28/I.

4) A. Benveniste, M. Goursat, "Blind equalisers", *IEEE Trans. Comm.,* vol.COM-32, pp. 871-883, Aug.1984.

5) DVB-TM 1259 (July 1994): "Satellite digital TV in collective antenna systems - SMATV reference channel model for digital TV, RACE DIGISMATV Project".

6) DTVB 1190/DTVC 38, 3rd revised version, February 1994 (Contribution from DTVC), document: "Specification of modulation, channel coding and framing structure for the Baseline System for digital multi-programme television by cable".

7) DTVB 1110/GT V4/MOD 252/ DTVC 18, 7th revised version, January 1994 (Contribution from V4/MOD-B), document: "Specification of the "Baseline modulation/channel coding system" for digital multi-programme television by satellite".

8) CENELEC prEN 50083-3 (1994): "Cable distribution systems for television and sound signals; Part 3; Active coaxial wideband distribution equipment".

History

Document history	
May 1995	First Edition
December 1995	Converted into Adobe Acrobat Portable Document Format (PDF)

ISBN 2-7437-0149-8
Dépôt légal : Mai 1995