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OF ITU

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SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Digital transmission of television signals

Use of hybrid cable television links for the secondary distribution of television into the user's premises

ITU-T Recommendation J.87

(Formerly CCITT Recommendation)

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ITU-T Recommendation J.87

Use of hybrid cable television links for the secondary distribution of television into the user's premises

Summary

This Recommendation is limited to rules which facilitate the carriage of both analogue and digital television signals of satisfactory quality on a hybrid link into the user's premises. Digital television signals are referred to in ITU-T J.83, J.84 and ITU-R BT.1306-1.

Source

ITU-T Recommendation J.87 was prepared by ITU-T Study Group 9 (2001-2004) and approved under the WTSA Resolution 1 procedure on 9 March 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation J.87

Use of hybrid cable television links for the secondary distribution of television into the user's premises

1 Background

Converging technologies on multimedia and interactive services associated with the secondary distribution of television services are making it possible for a great deal of information to be accessed through the use of hybrid links into the user's premises. For an undetermined period during the analogue to digital transition, it will be necessary to co-carry both formats using a coaxial cable delivery system into the user's premises.

2 Scope

This Recommendation is limited to rules which facilitate the carriage of both analogue and digital television signals of satisfactory quality on a hybrid link into the user's premises. Digital television signals are referred to in ITU-T J.83, J.84 and ITU-R BT.1306-1.

3 Normative references

The following ITU-T Recommendations, and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU Recommendations is regularly published.

– ITU-T J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.

– ITU-T J.84 (1997), *Distribution of digital multi-programme signals for television, sound and data services through SMATV networks*.

– ITU-R BT.1306-1 (1997), *Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting*.

4 Terms and definitions

This Recommendation defines the following term:

4.1 taboo channel: A channel which coincides with the frequency of the local oscillator in the single super heterodyne receiver which is tuned to an analogue channel.

5 Abbreviations

This Recommendation uses the following abbreviations.

C/N Carrier-to-Noise Ratio

CIN Composite Intermodulation Noise

CSO Composite Second Order

CTB Composite Triple Beat

FDM Frequency Division Multiplexing

IF Intermediate Frequency

OFDM Orthogonal Frequency Division Multiplexing

QAM Quadrature Amplitude Modulation

SMATV Satellite Master Antenna Television

VSB Vestigial Side Band

6 Architecture for hybrid links into the user's premises

Digital signals should be assembled in Frequency Division Multiplexing (FDM) as well as analogue signals in order to assure the gradual transition from analogue to digital signals. Multimedia applications demand bidirectionality for hybrid links. Activation of the upstream facility is recommended on hybrid systems, where appropriate, for the implementation of user requirement for upstream signals, e.g. control functionality and data return.

7 Technical requirement and constraints for hybrid links

The spectrum for residual analogue television should be located where incumbent reception equipment will operate without additional adaptation. This will generally mean that the digital signals are carried on the higher frequency channels. However, digital signals can be transmitted between analogue channels. In this case, especially when digital channels are allocated adjacent to residual analogue channels, the receiving quality of the analogue channels should be maintained.

In general, digital signals have a noise-like spectral energy distribution. When digital signals are impressed upon the analogue signals present, they do not add new Composite Second Order (CSO) or Composite Triple Beat (CTB) products as they would if they were analogue television signals.

They add a new form of impairment called Composite Intermodulation Noise (CIN) instead, which is manifested as a reduction in the video signal-to-noise ratio on the analogue channels.

To minimize the effects of CIN on the co-carried analogue signals, it is desirable to carry QAM, VSB, and OFDM digital signals at an appropriately lower level than the analogue signals, but not so low as to affect the reliability of the digital signal transmissions. It is recommended that QAM, VSB, and OFDM digital video carriers generally be run at levels of eight to ten dB below the co-carried analogue signals and retain adequate operational margins for both analogue and digital signals on the system. In order to retain adequate operational margins for both types of signals assembled in FDM on the system, Carrier-to-Noise Ratio, Distortion, Mutual Interference along with CIN should be considered.

In the case of introducing supplementary digital channels in the cable networks, it is desired that:

– a low bit error rate should be kept for the digital channels;

– disturbances of the conventional analogue channels should be avoided.

Conditions for hybrid digital/analogue transmission should be bounded by:

– the interference from intermodulation distortion;

– the transmission level for digital channels adjacent to an analogue channel;

– the transmission level for digital channels in taboo channels.

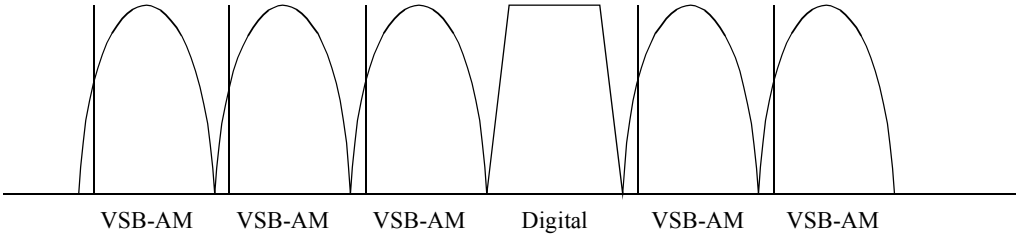
An example for constraints on frequency allocation is provided in Appendix I. In each case, the boundary conditions are related to the type of receiver used in the cable system. The type of receiver means either a general receiver available on the market or a special receiver for the system. In the case of using single super heterodyne receiver, the digital channel which suffers interference from

the local oscillator should have a signal level sufficiently high to maintain signal quality. At the same time, in case of possible interference by the leakage of a local oscillator from a digital receiver, the leakage level of the local oscillator needs to be sufficiently low so as not to disturb the transmitted signals. If these conditions are not met, a double super heterodyne receiver is recommended for use in order to avoid local oscillator interference with the transmission frequencies of the signals. Technical parameters are described in Appendix II for considering the performance of receivers of digital channels.

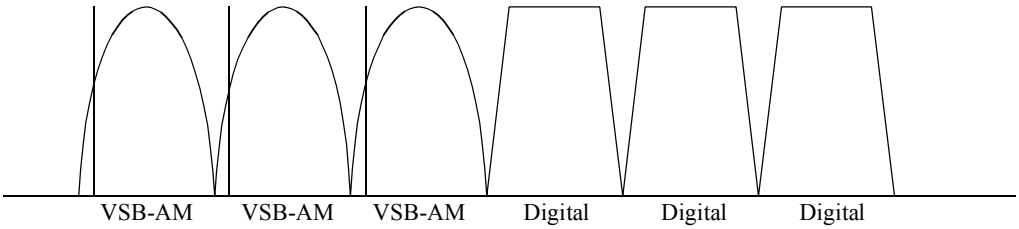
Annex A shows the technical parameters of the hybrid analogue/digital system related to Annex C/J.83 and system C/BT.1306-1.

8 Reference model for the hybrid analogue/digital links

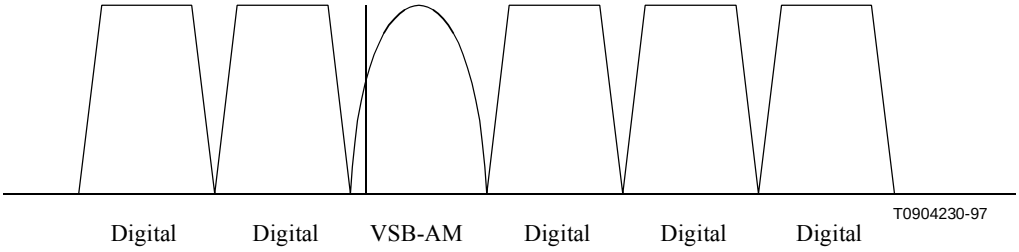
A three-stage reference model for the evolution of hybrid analogue/digital links is shown in Figure 1. In the first stage, analogue signals are dominant. In the second stage, analogue and digital signals are comparable. In the third stage, digital signals are dominant.



a) First stage (a few digital signals among many analogue signals)



b) Second stage (comparable number of analogue and digital signals)



c) Third stage (a few analogue signals among many digital signals)

Figure 1/J.87 – Reference model for evolution of hybrid analogue/digital links

ANNEX A

Technical parameters of the hybrid analogue/digital system

(This Annex relates to Annex C/J.83 and system C/BT.1306-1)

Table A.1 shows a number of technical parameters which may affect the detailed specification for the use of hybrid analogue/digital cable television links for the secondary distribution of television into the user's premises.

Table A.1/J.87 – Technical parameters for digital signal on hybrid analogue/digital cable television links for the secondary distribution of television into the user's premises

Parameters	Specifications
a) Signal level at subscriber's tapoff	53-85 dBμV (75 Ω terminated) (maximum envelope level of modulated signal)
b) Required C/N	31 dB
c1) CTB from many NTSC TV channels	Below −43 dB
c2) CSO from many NTSC TV channels	Under study
d) CIN from many QAM channels	Under study
e) Adjacent interference between a NTSC TV channel and a QAM channel	See Figure A.1
NOTE – Parameters a) to e) are required to attain total system performance. Each parameter should be considered a performance measure of existing cable television systems for analogue service using NTSC system M (video carrier to audio carrier level ratio is 10 dB).	

The range of signal level for adjacent NTSC/QAM signals at subscriber's tapoff is shown in Figure A.1. L_{NTSC} and L_{QAM} are lower bounds for NTSC and QAM signals respectively, determined by required C/N for each signal and system noise. U_{NTSC} and U_{QAM} are upper bounds for NTSC and QAM signals respectively, determined by interference to other telecommunication systems. Lines A and B are upper bounds for QAM signal determined by interference to lower and upper adjacent NTSC signals respectively. Lines C and D are lower bounds for QAM signal determined by interference from lower and upper adjacent NTSC signals respectively. In the cable system using VSB-AM NTSC for analogue signals and system C of ITU-T J.83 for digital signals,

- line A: $E_{QAM} < (E_{NTSC-} - 4)$ dB
- line B: $E_{QAM} < (E_{NTSC+} - 6)$ dB
- line C: $E_{QAM} > (E_{NTSC-} - 18)$ dB
- line D: $E_{QAM} > (E_{NTSC+} - 20)$ dB

Where QAM signal level E_{QAM} is defined by maximum envelope level of modulated signal, and its upper and lower adjacent NTSC signal levels E_{NTSC+} and E_{NTSC-} are defined by unmodulated video carrier levels.

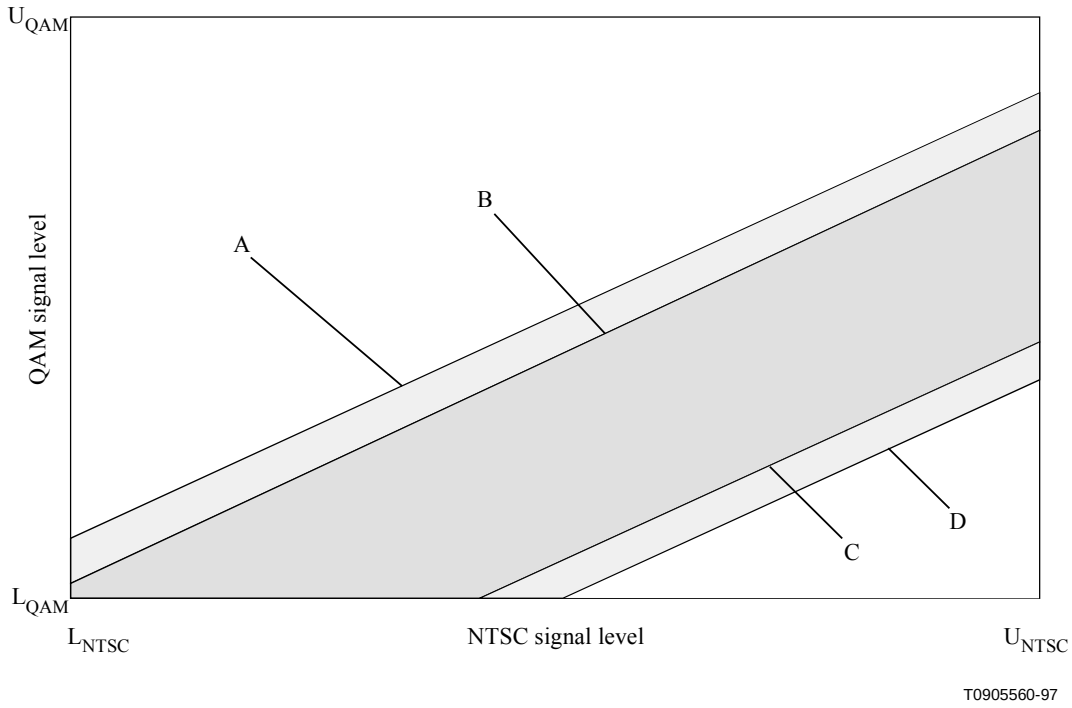


Figure A.1/J.87 – Range of signal level for adjacent NTSC/QAM signals at subscriber's tapoff

Table A.2/J.87 – Technical parameters for digital signal on hybrid analogue/digital cable television links for the secondary distribution of television into the user's premises (NTSC/OFDM)

Parameters	Specifications
a) Signal level at subscriber's tapoff	47-81 dBµV (75 Ω terminated) (average level of modulated signal)
b) Required C/N	24 dB
c1) CTB from many NTSC TV channels	Below –45 dB
c2) CSO from many NTSC TV channels	Under study
d) CIN from many OFDM channels	Under study
e) Adjacent interference between a NTSC TV channel and a OFDM channel	See Figure A.2
NOTE – Parameters a) to e) are required to attain total system performance. Each parameter should be considered a performance measure of existing cable television systems for analogue service using NTSC system M (video carrier to audio carrier level ratio is 10 dB).	

The range of signal level for adjacent NTSC/OFDM signals at subscriber's tapoff is shown in Figure A.2. L_{NTSC} and L_{OFDM} are lower bounds for NTSC and OFDM signals respectively, determined by required C/N for each signal and system noise. U_{NTSC} and U_{OFDM} are upper bounds for NTSC and OFDM signals respectively, determined by interference to other telecommunication systems. Lines A and B are upper bounds for OFDM signal determined by interference to lower and upper adjacent NTSC signals respectively. Lines C and D are lower bounds for OFDM signal determined by interference from lower and upper adjacent NTSC signals respectively. In the cable

system using VSB-AM NTSC for analogue signals and system C of ITU-R BT.1306-1 for digital signals,

- line A: $E_{OFDM} < (E_{NTSC+} - 6)$ dB
- line B: $E_{OFDM} < (E_{NTSC-} - 15)$ dB
- line C: $E_{OFDM} > (E_{NTSC-} - 21)$ dB
- line D: $E_{OFDM} > (E_{NTSC+} - 24)$ dB

Where OFDM signal level E_{OFDM} is defined by average level of modulated signal, and its upper and lower adjacent NTSC signal levels E_{NTSC+} and E_{NTSC-} are defined by unmodulated video carrier levels.

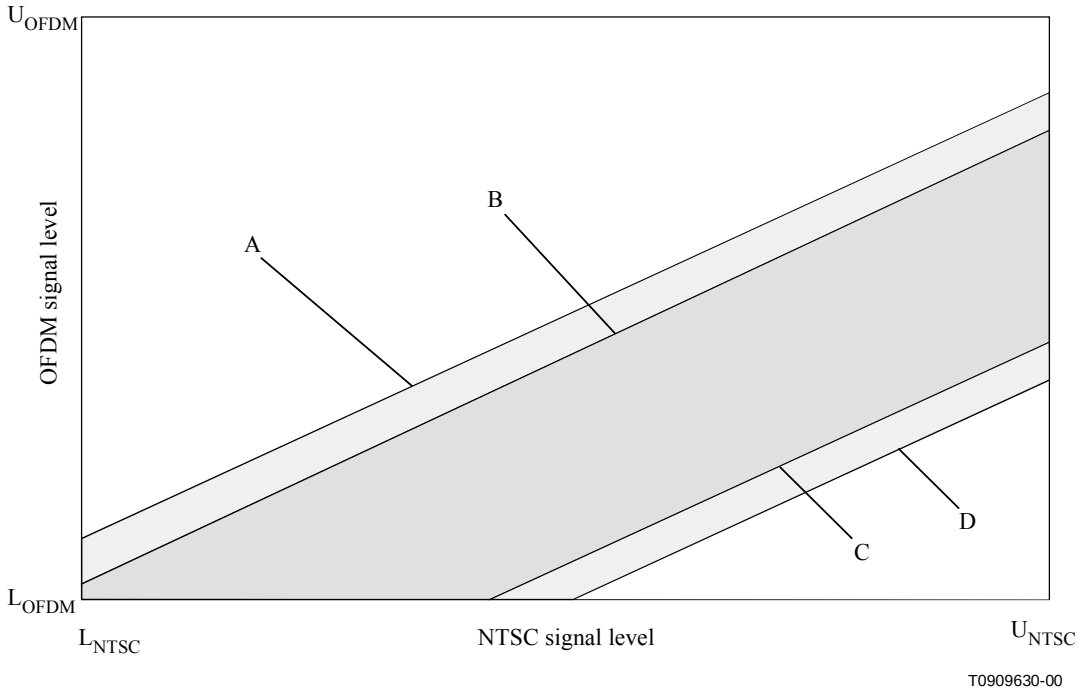


Figure A.2/J.87 – Range of signal level for adjacent NTSC/OFDM signals at subscriber's tapoff

The range of signal level for adjacent QAM/OFDM signals at subscriber's tapoff is shown in Figure A.3. L_{QAM} and L_{OFDM} are lower bounds for QAM and OFDM signals respectively, determined by required C/N for each signal and system noise. U_{QAM} and U_{OFDM} are upper bounds for QAM and OFDM signals respectively, determined by interference to other telecommunication systems. Lines A and B are upper bounds for OFDM signal determined by interference to lower and upper adjacent QAM signals respectively. Lines C and D are lower bounds for OFDM signal determined by interference from lower and upper adjacent QAM signals respectively. In the cable system using Annex C of ITU-T J.83 and system C of ITU-R BT.1306-1 for digital signals,

- line A: $E_{OFDM} < (E_{QAM-} + 18)$ dB
- line B: $E_{OFDM} < (E_{QAM+} + 14)$ dB
- line C: $E_{OFDM} > (E_{QAM+} - 19)$ dB
- line D: $E_{OFDM} > (E_{QAM-} - 20)$ dB

Where OFDM signal levels E_{OFDM} is defined by average level of modulated signal, and its upper and lower adjacent QAM signal level E_{QAM+} and E_{QAM-} are defined by maximum envelope level of modulated signal.

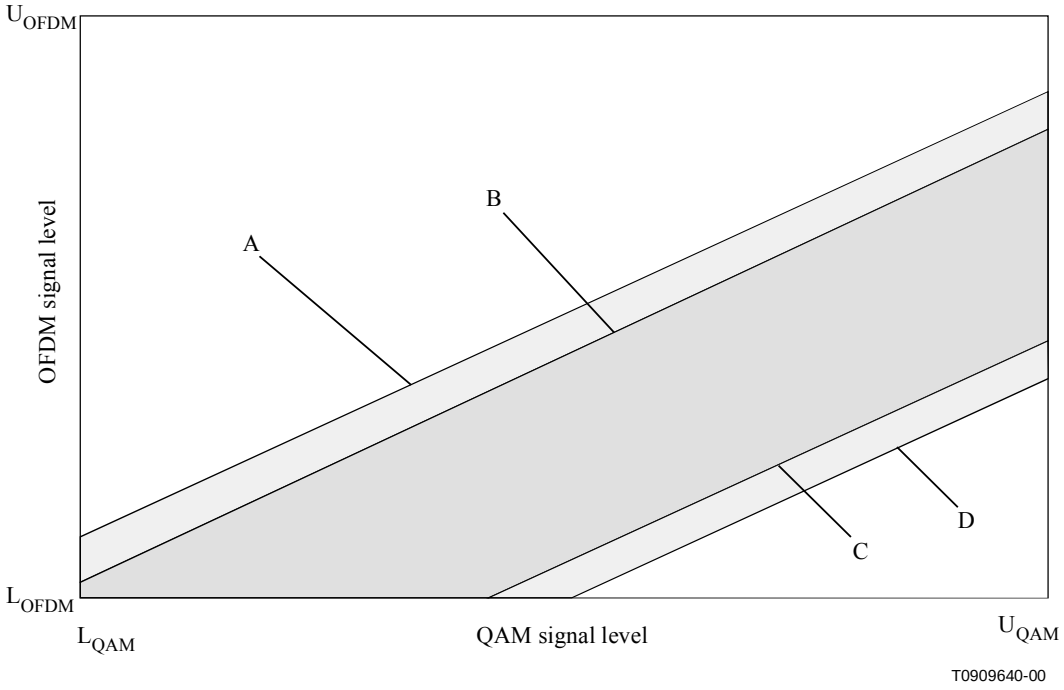


Figure A.3/J.87 – Range of signal level for adjacent QAM/OFDM signals at subscriber's tapoff

APPENDIX I

Constraints on frequency allocation

In some countries such as France and Japan, legislative settings oblige the distribution of a basic service on the cable networks. This service is made up of a multiplex of analogue television programmes.

This appendix describes the French situation where the frequency allocation has to be set in such a way that any television set available on the market can receive and decode the signal properly. This has to be the case whatever the quality of the television receiver.

Because of the features of the analogue television signal (i.e. standard SECAM L in France), this constraint makes the use of taboo channels N ± 1, N ± 4 impossible. The consequence is that more than 200 MHz can be required to deliver only 12 programs in the basic service. Taboo channels may be different because of the Intermediate Frequency (IF) of television receivers. Frequencies of 38 MHz, 45 MHz, 58 MHz, etc. are used for intermediate frequencies. In the case of an intermediate frequency of a television receiver of 38 MHz, the taboo channels are N ± 4.

Many more analogue television programs have been added to the basic service, and the figure of 40 channels is often attained. They often are spread over the entire frequency range, from 120 MHz to the top of the UHF band.

The foregoing does not forbid the introduction of supplementary digital channels in the cable networks. This can be carried out without changing the existing frequency allocation. However, it is

only possible using the taboo channels left vacant by the analogue television channels, and especially the adjacent channels.

APPENDIX II

Technical parameters under study

A number of technical parameters are still under study which may affect the detailed specification for the use of hybrid analogue/digital cable television links for the secondary distribution of television into the user's premises. These parameters are:

a) signal level at subscriber's tapoff;

b) C/N;

c) CTB/CSO from many analogue channels;

d) CIN from many digital channels;

e) adjacent interference between an analogue channel and a digital channel.

NOTE – Parameters a) to e) are required to attain total system performance. Each parameter should be considered a performance measure of existing cable television systems for analogue service using NTSC, PAL and SECAM.

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