XVII A.P.
DÜSSELDORF
21.5-1.6 1990
CCIR

XVIIth PLENARY ASSEMBLY
DÜSSELDORF, 1990

INTERNATIONAL TELECOMMUNICATION UNION

RECOMMENDATIONS OF THE CCIR, 1990

(ALSO RESOLUTIONS AND OPINIONS)

VOLUME XI – PART 1

BROADCASTING SERVICE (TELEVISION)

CCIR INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

Geneva, 1990

CCIR

1. The International Radio Consultative Committee (CCIR) is the permanent organ of the International Telecommunication Union responsible under the International Telecommunication Convention "... to study technical and operating questions relating specifically to radiocommunications without limit of frequency range, and to issue recommendations on them..." (International Telecommunication Convention, Nairobi 1982, First Part, Chapter I, Art. 11, No. 83).*

2. The objectives of the CCIR are in particular:

a) to provide the technical bases for use by administrative radio conferences and radiocommunication services for efficient utilization of the radio-frequency spectrum and the geostationary-satellite orbit, bearing in mind the needs of the various radio services;

b) to recommend performance standards for radio systems and technical arrangements which assure their effective and compatible interworking in international telecommunications;

c) to collect, exchange, analyze and disseminate technical information resulting from studies by the CCIR, and other information available, for the development, planning and operation of radio systems, including any necessary special measures required to facilitate the use of such information in developing countries.

* *See also the Constitution of the ITU, Nice, 1989, Chapter 1, Art. 11, No. 84.*

XVII A.P.
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92-61-04291-0

Geneva, 1990

PLAN OF VOLUMES I TO XV
XVIIth PLENARY ASSEMBLY OF THE CCIR

(Düsseldorf, 1990)

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All references within the texts to CCIR Recommendations, Reports, Resolutions, Opinions, Decisions and Questions refer to the 1990 edition, unless otherwise noted; i.e., only the basic number is shown.

1990
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DISTRIBUTION OF TEXTS OF THE XVIIth PLENARY ASSEMBLY OF THE CCIR IN VOLUMES I TO XV

Volumes and Annexes I to XV, XVIIth Plenary Assembly, contain all the valid texts of the CCIR and succeed those of the XVIth Plenary Assembly, Dubrovnik, 1986.

1. Recommendations, Resolutions, Opinions are given in Volumes I-XIV and Reports, Decisions in the Annexes to Volumes I-XII.

1.1 *Numbering of texts*

When a Recommendation, Report, Resolution or Opinion is modified, it retains its number to which is added a dash and a figure indicating how many revisions have been made. Within the text of Recommendations, Reports, Resolutions, Opinions and Decisions, however, reference is made only to the basic number (for example Recommendation 253). Such a reference should be interpreted as a reference to the latest version of the text, unless otherwise indicated.

The tables which follow show only the original numbering of the current texts, without any indication of successive modifications that may have occurred. For further information about this numbering scheme, please refer to Volume XIV.

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* Not reprinted, see Dubrovnik, 1986.

(1) Published separately.

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* Not reprinted, see Dubrovnik, 1986.

(1) Published separately.

1.3.1 *Note concerning Reports*

The individual footnote "Adopted unanimously" has been dropped from each Report. Reports in Annexes to Volumes have been adopted unanimously except in cases where reservations have been made which will appear as individual footnotes.

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2. **Questions** (Vols. XV-1, XV-2, XV-3, XV-4)

2.1 *Numbering of texts*

Questions are numbered in a different series for each Study Group: where applicable a dash and a figure added after the number of the Question indicate successive modifications. The number of a Question is completed by an *Arabic figure indicating the relevant Study Group.* For example:

- Question 1/10 would indicate a Question of Study Group 10 with its text in the original state;
- Question 1-1/10 would indicate a Question of Study Group 10, whose text has been once modified from the original; Question 1-2/10 would be a Question of Study Group 10, whose text has had two successive modifications.

Note – The numbers of the Questions of Study Groups 7, 9 and 12 start from 101. In the case of Study Groups 7 and 9, this was caused by the need to merge the Questions of former Study Groups 2 and 7 and Study Groups 3 and 9, respectively. In the case of Study Group 12, the renumbering was due to the requirement to transfer Questions from other Study Groups.

2.2 *Assignment of Questions*

In the plan shown on page II, the relevant Volume XV in which Questions of each Study Group can be found is indicated. A summary table of all Questions, with their titles, former and new numbers is to be found in Volume XIV.

2.3 *References to Questions*

As detailed in Resolution 109, the Plenary Assembly approved the Questions and assigned them to the Study Groups for consideration. The Plenary Assembly also decided to discontinue Study Programmes. Resolution 109 therefore identifies those Study Programmes which were approved for conversion into new Questions or for amalgamation with existing Questions. It should be noted that references to Questions and Study Programmes contained in the texts of Recommendations and Reports of Volumes I to XIII are still those which were in force during the study period 1986-1990.

Where appropriate, the Questions give references to the former Study Programmes or Questions from which they have been derived. New numbers have been given to those Questions which have been derived from Study Programmes or transferred to a different Study Group.

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VOLUME XI-1

BROADCASTING SERVICE (TELEVISION)

(Study Group 11)

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STUDY GROUP 11

BROADCASTING SERVICE (TELEVISION)

Terms of reference:

To study:

1. technical aspects of the broadcasting service and the broadcasting-satellite service when these services are used for television;

2. standards for video-frequency equipment, for motion picture films intended for television and for all forms of television recording, to facilitate the international exchange of programmes.

1986-1990	*Chairman:*	M. KRIVOCHEEV (USSR)
	Vice-Chairmen:	S.E. AGUERREVERE R. (Venezuela)
		A. TODOROVIC (Yugoslavia (Socialist Federal Republic of))
		WU XIANLUN (China (People's Republic of))
		R. ZEITOUN (Canada)

As from the next study period, in conformity with Resolution 61 adopted at the XVIIth Plenary Assembly, Düsseldorf (May-June 1990), the scope of the work which will be undertaken and the names of the Chairman and Vice-Chairmen are as follows:

STUDY GROUP 11

BROADCASTING SERVICE (TELEVISION)

Scope:

International exchange of programmes and the technical and operating aspects of the broadcasting and broadcasting-satellite services, including video frequency and recording equipment, as well as the overall performance of the means of delivering signals to the general public when they are used for television, data and associated ancillary services.

1990-1994	*Chairman:*	M. KRIVOCHEEV (USSR)
	Vice-Chairmen:	S.E. AGUERREVERE R. (Venezuela)
		O. MÄKITALO (Sweden)
		T. NISHIZAWA (Japan)
		WU XIANLUN (China (People's Republic of))
		R. ZEITOUN (Canada)

INTRODUCTION BY THE CHAIRMAN, STUDY GROUP 11

PART 1

1. Introduction

Study Group 11 carried out comprehensive studies on the technical aspects of television broadcasting working in compliance with terms of reference adopted at the XVth and confirmed at the XVIth CCIR Plenary Assemblies.

The following revision of these terms of reference was proposed and endorsed at the Final Meeting of the Study Group and is submitted to the XVIIth Plenary Assembly to study:

- technical aspects of the broadcasting service and the broadcasting-satellite service when these services are used for television;
- standards for video-frequency equipment, for motion picture films intended for television and for all forms of television recording, to facilitate the international exchange of programmes;
- the overall performance as well as the methods of assessment of the means of delivering television signals to the general public.

The main questions to be studied are:

- characteristics of television systems;
- auxiliary television services;
- quality of television pictures, its assessment and parameters affecting the quality;
- technical data for planning television broadcasting networks, protection ratios, television receivers and antennas;
- international exchange of television programmes, monitoring and measurement;
- digital coding of television signals;
- recording of television programmes;
- television broadcasting via satellites.

It should be noted that these studies are to a large extent related to future television systems.

In organizing its work, Study Group 11 took into account the proposals of the XVIth CCIR Plenary Assembly as contained in its Resolutions, the reports of the Director, CCIR, and the Organization Committee as well as other advice which was found in the minutes. The Chairman was assisted by four Vice-Chairmen: Messrs. S.E. Aguerrevere R. (Venezuela), A. Todorovic (Yugoslavia (Socialist Federal Republic of)), Wu Xianlun (People's Republic of China) and R. Zeitoun (Canada).

The main activities of the Study Group in the study period from 1986 to 1990 have been the Interim Meeting from 2 to 18 November 1987, the Extraordinary Meeting on High-Definition Television from 10 to 16 May 1989, and the Final Meeting from 9 to 25 October 1989.

Study Group 11 took part in the development of the bases for the World Administrative Radio Conference WARC ORB-88 on satellite communication and in the Second Session of the Regional Administrative Radio Conference AFBC(2) on planning the terrestrial television service in Africa and neighbouring countries.

2. Results of the activity

A brief account of salient results of the activities carried out by Study Group 11 after the conclusion of the Final Meeting is given below along with important tasks to be developed and carried out in the next study period.

A particular acknowledgement is due to the invaluable effort of Study Group 11 Interim Working Parties and to their Chairmen and Vice-Chairmen who have contributed considerably to the outstanding progress of Study Group 11 activities during this study period (see § 3).

2.1 *Summary of the work concerning high-definition television*

2.1.1 *General remarks*

During this study period, Study Group 11 undertook extensive studies on all major aspects of HDTV from the image through production and emission to the display. A total of 5 draft Recommendations concerning HDTV will be presented to the Plenary Assembly for approval, including the draft Recommendation for the HDTV studio standard. Fifteen new or updated Reports were also adopted. They cover the specific requirements related to HDTV matters and in addition, certain other aspects of the interface of HDTV with global television and telecommunications systems, including the very important harmonization question.

The future work of Study Group 11 was also considered, leading to proposed changes to Study Programmes and Decisions and to Report 1217 addressing the strategic aspects of achieving a unified single worldwide standard.

During the Final Meeting, an *ad hoc* Group assisted the Chairman of the Study Group in preparing a detailed summary of the response of the Study Group to Resolution 96 of the XVIth Plenary Assembly (see Part 2 of this Chairman's Report). The resulting progress report supplements the material contained in the Conclusions of the Extraordinary Meeting. It presents in an Annex a bibliography of all CCIR Recommendations and Reports that are related to the development and implementation of HDTV. This material will also be of use in the harmonization activity with the IEC, the ISO and other relevant organs of the ITU including the CCITT.

2.1.2 *Basic parameters of the worldwide HDTV system*

Study Group 11 was specifically charged with considering the progress made in the basic parameters of a worldwide HDTV system. Within this framework, the Final Meeting prepared Report 801 which contains an extensive review of the most important aspects of worldwide HDTV development.

This review is based on the work of the IWPs and JIWPs, especially IWP 11/6 and contributions received. The Report addresses the definition and objectives of HDTV and the rapidly advancing technology.

In the preparation of this Report, Study Group 11 noted the expanding range of application for HDTV and its interrelationship with worldwide development of image communications. Report 1217 examines these issues in more detail.

The measurements of the HDTV system are important to its successful development. Advances in this area are reflected in Recommendation 710 concerning subjective measurements and in Reports 1216 and 1218 concerning, respectively, subjective and objective measurements. The adoption of these represents a major advancement, representing global consensus on the procedures, analysis and context of HDTV measurements.

Study Group 11 placed a high priority on the establishment of a full set of parameter values, both analogue and digital, for the single worldwide HDTV standard. The Study Group examined all aspects of this issue in considerable detail from technical, economic and operational viewpoints.

The current results of this work are outlined in Recommendation 709 and further information concerning these parameter values is included in part 5 of Report 801.

In the preparation of this Recommendation, the Final Meeting took account of many contributions and of particularly valuable information from IWP 11/6. This included an in-depth analysis of the current situation and trends in HDTV development and the implementation of services.

From these analyses, from proposals by administrations, and from the information existing in CCIR texts, the Final Meeting concluded that it would be advantageous to study more carefully the remaining relevant parameter values in a continuation of the work in a special meeting of IWP 11/6 (with the participation of IWP 11/7) scheduled for 22 to 28 March 1990 in Atlanta, United States of America, thus allowing the inclusion of important material anticipated to be then available.

2.1.3 *Methods of emission*

The studies on emission standards and related matters, such as data broadcasting in the HDTV environment in Study Group 11 progressed considerably. Important emphasis was placed on terrestrial broadcasting methods for HDTV. The methods for satellite broadcasting are already well documented in CCIR texts, but additional material was added at the Final Meeting. Part 7 of Report 801 contains the updated information regarding HDTV emission, while Part 8 contains the updated information regarding data broadcasting. With regard to baseband formats for HDTV emission, current HDTV texts, such as Report 1075 and the contents of Part 7 of Report 801 provide much useful information. In addition, a new Report has been created in response to new interest in enhanced television. The technology of HDTV has enabled the development of proposals to add new features, such as wide aspect ratio, and to improve the performance of conventional television systems, thus adding a new dimension to HDTV studies. Reports 1077 and 1220 contain information on this matter.

2.1.4 *International exchange of programmes*

Methods for the international exchange of programmes on transmission links are rapidly developing and this was reflected in the contributions considered by Study Group 11 during this study period. The conclusions are found in Part 9 of Report 801 where the current situation regarding baseband formats is described.

Methods for the international exchange of programmes using recorded media (film, tape, disk) are more advanced and considerable progress was made by the Final Meeting in achieving agreement on several matters.

Recommendation 716 was adopted concerning the scanned area of 35 mm film in the HDTV telecine. This work complements the two draft Recommendations 713 (Recording of HDTV images on film) and 714 (International exchange of HDTV programmes) adopted at the Extraordinary Meeting.

2.1.5 *Future work*

The future work of Study Group 11 concerning HDTV should further extend the results already obtained in order to achieve consistent standards. In particular, a unique studio standard is a clearly identified need and must continue to be the main target.

Recommendation 709 and Report 1217 have laid down a firm basis on HDTV quality assessments and measurements. This should facilitate progress on the establishment of these parameter values as yet uncompleted in Recommendation 709 describing the picture format and other parameters. Further, they make possible the initiation of work in related areas in order to generate subsequent draft Recommendations on these subjects.

The fact that the implementation of HDTV systems and the context of HDTV in general is rapidly changing was initially noted at the Extraordinary Meeting as having a major effect on the general framework of Study Group 11. There have been significant achievements since 1987 and further developments have been achieved with the scheduling of several important events such as the NHK "Open House" (Tokyo), the Second Electronic Cinema Festival in Montreux, the Internationale Funkausstellung (IFA) in Berlin (West), and ITU COM-89.

On the subject of preparations for the 1992 allocation conference, JIWP 10-11/1 has been instructed with the critical matter of examining sharing issues for wideband HDTV emission in the frequency range 12.7-23 GHz.

Considering the results already achieved and the additional information expected, it would appear that the instructions given to the various IWPs and JIWPs as defined by the relevant Decisions are generally satisfactory but some must now reflect consequential changes resulting from Report 1217.

These developments should be considered together with the increasing complexity of the relationship between all sectors of activity. Despite the substantial progress achieved since 1987, not all of the studies on HDTV may be completed before the XVIIth Plenary Assembly. Some administrations request that the completion of certain parameters be extended into the next study period, but all agree effort should be made to specify most of them before the end of this study period.

The complexity of the task to be carried out suggests that great care should be taken to ensure harmonization within Study Group 11, as well as with other closely related organizations to guarantee both consistency and relevancy. The necessity is clearly identified to take adequately into account the increasingly strong relationship between broadcast and non-broadcast activities and particularly their equipment and specifications. This addresses mainly consumer and telecommunications equipment. Study Group 11 therefore invites the relevant organizations involved with standardization activities on aspects of these matters related to HDTV, to continue to cooperate in order to achieve maximum efficiency of the work of all parties and avoid duplication. With the establishment of new IWP 11/9 at the Final Meeting to deal with harmonization matters, it is expected that work within the CCIR on HDTV can be advanced in concert with work being undertaken in the CCITT as well as the IEC and ISO.

2.1.6 *Final remarks concerning HDTV*

In the current study period, Study Group 11 has adopted important Recommendations concerning HDTV. It has in addition adopted a number of Reports, which record the present state of development of HDTV and set out the objectives and strategies for future work. The Study Group was also able to achieve an important milestone in advancing studies leading to global consensus on all aspects of HDTV. This work was only made possible by the collaboration of many administrations and other CCIR participants in IWPs and JIWPs and during the Study Group meetings themselves. The many valuable contributions and the dedicated work of all participants must also be acknowledged as an essential part of the work taking place on HDTV.

An extensive growth in the scope of studies in the field of HDTV and the need to ensure comprehensive examination of complex problems in proper time resulted in the creation of an HDTV Coordinating Group in autumn 1988. This group is responsible for establishing the particular working programme related to HDTV studies and provides for a first assessment of the results achieved.

The group met in January 1989 in order to ensure that there is sufficient progress for holding the Extraordinary Meeting in May. More meetings were held just preceding and immediately after the Extraordinary Meeting and the Final Meeting, respectively.

At the last meeting on 26 October 1989, i.e., immediately after the Final Meeting, the results of the work of the Meeting in the field of HDTV were summarized and tasks defined for discussion at a special meeting of IWP 11/6 with participation of IWP 11/7 (Decision 90) held in March 1990, before the XVIIth Plenary Assembly (see Annex I to this Part of the Chairman's Report).

It was also decided that the HDTV Coordinating Group would meet in March 1990 in Atlanta to discuss coordination matters and to prepare an addendum to this report.

2.2 *Characteristics of existing television systems, the international exchange of television programmes, picture quality, monitoring and measurement*

Considerable progress has been made in the field of existing television systems. Studies on picture quality assessment are in progress to identify alternative methodologies to be applied in specific cases.

Important contributions in this field have been presented at the Final Meeting originated by IWP 11/4. Amendments to existing Reports 1082 and 1206 as well as to Recommendation 500 are proposed. The Report 1222 on the subjective quality of alphanumeric and graphic pictures was prepared to establish the basis for a future Recommendation on the subject.

Current activities also concern operating practices such as standardizing procedures for monitor line-up for subjective assessments.

Assessments intended to establish useful information for determining protection ratio values in the case of BSS services will demand close cooperation between experts of JIWP 10-11/6 and those actively engaged in Joint Interim Working Parties 10-11/1 and 10-11/3 to complement and update Recommendation 600.

Adaptively coded motion pictures will also be discussed in terms of their subjective assessment picture quality, assessment in the case of stereoscope television are considered in the light of Study Programmes 1C/11 and 3A/11. Amendments to Report 624 now include information relevant to television systems used for planning in the African area and neighbouring countries. Report 1077 concerning enhanced quality television systems has been revised in the light of new contributions.

A major part of the work on the subjective assessment of television picture quality is being carried out by IWP 11/4 (JIWP 10-11/6 after the Final Meeting) whose activity is reviewed in § 3.

2.3 *Additional television services*

The broadcasting of data is becoming more and more important on either wideband or narrow-band channels and also in view of a possible integration process at the technical and service level among broadcast and non-broadcast applications.

The broadcasting of data can be of great interest for the developing countries since it is possible to make a better use of the existing infrastructures by providing a large number of new services.

A considerable amount of work in the domain of data broadcasting has been carried out by JIWP 10-11/5 whose activity is referred to in § 3.

Several aspects of these services accompanying either conventional or high definition television systems have been analyzed and substantial revision and/or updating of nearly all the concerned CCIR texts dealing with additional television services has been proposed.

The importance of data broadcasting is reflected in the conspicuous amount of amendments to existing texts and of completely new texts.

Current studies on digital multiplex accompanying the TV programme show the need for equitable balance between video, sound and data in terms of capacity and quality, also in an HDTV environment.

The development of data broadcasting can also favour the existing trend towards the integration at the technical and service levels between interactive and broadcast digital network. In this process the cooperation with the CMTT, the appropriate CCITT Study Groups, the IEC and the ISO is considered more and more important. The future work is directed at formulating a new Recommendation dealing with data broadcasting services for the television systems described in Recommendation 650 and the HDTV systems of Report 1075. This Recommendation should complement Recommendation 653 on teletext systems developed for the television systems complying with Recommendation 470.

Five new Reports have also been prepared during this study period concerning a reference model for data broadcasting (Report 1207), error protection strategies for data broadcasting (Report 1210), telesoftware services (Report 1208), data broadcasting services in an HDTV environment (Report 1225) and a new system for programme delivery control (Report 1226), now industrially developed. This last item will also be considered in the light of proposing a new Recommendation to be finalized in the next study period as suggested by JIWP 10-11/5.

2.4 *Planning of television broadcasting networks, protection ratios, television receivers and antennas*

Considerable activity has taken place in IWP 11/5, as summarized in § 3, for preparing suitable material to be passed to JIWP AFBC(2).

Specific questions related to sharing criteria in the UHF band as well as to emission polarizations were addressed by the WARC AFBC(1) to the CCIR.

The particular environmental planning conditions have been taken into account and the results of recent studies made available for preparing the report of JIWP AFBC(2).

Interesting contributions on antennas and polarization of emissions led to revisions of Report 122 and Recommendation 412, and will finally encourage studies on VHF-UHF antennas for more efficient planning.

Recommendation 655 has been revised at the Final Meeting taking into account the modifications proposed to the protection ratio values necessary to a digital sound multiplex associated to the video carrier. Report 1214 on radio-frequency protection ratios for AM vestigial sideband television systems was prepared at the Interim Meeting and updated at the Final Meeting with reference to the case of synchronized carrier television systems. New information has also been made available to update Report 625.

Another new Report 1215 deals with the use of circular polarization in the planning of television broadcasting services.

2.5 *Digital coding of television signals*

Studies on digital television coding are actively carried out by IWP 11/7 whose activity is covered in § 3.

Much of the work is directed to the selection of standard bit-rate reduction methods for signals conforming with Recommendation 601. Close liaison is being maintained with IWPs CMTT/2 and 11/4.

Further consideration was given to digital encoding parameters for possible additions to Recommendation 601 and to the associated Reports. Similarly, the matter of studio interface standards was reviewed, with the related questions of synchronizing, test and ancillary signals. A number of the coding systems necessary to accommodate digital television signals at the 140 Mbit/s and at the 32-45 Mbit/s hierarchic level have been considered from the user's point of view as described in Report 1211.

On encoding parameters, some further information on the 4 : 4 : 4 and other levels was agreed, together with various additions to associated Reports. As to HDTV, and noting the Report already submitted to the Extraordinary Meeting, the necessary further studies agreed to were listed. In relation to interfaces some new views were stated on ancillary signals which led to Recommendation 711 and the associated Report 1219 on standard synchronizing signals.

More Reports were prepared on a layered model approach for digital television (1223), on measures for the avoidance of possible interference generated by digital television studio equipment (1209), on measurements and test signals for digitally encoded colour television signals (1212) and on test pictures and sequences for subjective assessment of digital codecs. Some further information on BRR methods for HDTV and other applications was assembled.

In this process the cooperation with the CMTT, the appropriate CCITT Study Groups, the IEC and the ISO is considered of fundamental importance.

2.6 *Recording of television programmes*

Most of the work on recording has been actively carried out by JIWP 10-11/4.

Three new Recommendations related to recording contributed considerably to the progress in the field of HDTV. They are dealing with the recording of HDTV images on film (713), the international exchange of programmes electronically produced by means of high-definition television (714) and on the scanned area of 35 mm motion picture film in HDTV telecines (716). In addition, Report 1229 on recording of high definition television programmes on cinematographic film has been prepared.

Recommendation 657 on digital television tape recording has been reviewed to reflect the current position to retain the single time code as the specified approach. Report 630 has also been modified to take into account wider corrections aimed to improve the efficiency of the text.

The Study Group also approved Recommendation 715 on the international exchange of ENG recording.

The proposal for a new Study Programme covering the transfer of television programmes to non-broadcast media for domestic use was discussed.

Future work will mainly be focused on the specifications of analogue HDTV videotape studio recording formats for programme exchange, the harmonization of HDTV interface, for professional and consumer applications (in cooperation with the ISO and IEC), etc.

2.7 *Broadcasting-satellite service (television)*

This subject has been actively studied by the Joint Working Group 10-11S and, in the periods between Study Group meetings, by JIWPs 10-11/1 and 10-11/3.

Information on these studies is presented to the Plenary Assembly in Document 10-11S/1001.

2.8 *Preparation of ITU conferences*

Study Group 11 adopted the report of JIWP 10-11/1 to be transmitted to JIWP ORB, which was charged with the preparation of the technical information necessary to the WARC ORB-88. This work was incorporated in the CCIR report to the conference, which was extensively used for broadcasting satellite feeder-link planning in the 12 GHz band for Regions 1 and 3 and to lay the basis for Resolution No. COM5/1 that invites the CCIR to continue the studies concerning the technical parameters for satellite-sound broadcasting in the range 500-3000 MHz and to develop the necessary systems parameters for wide RF-band high definition television called for in Resolution No. COM5/3, in view of the future WARC on limited frequency allocation, now scheduled in the first quarter of 1992, as decided by the Nice Plenipotentiary Conference.

Study Groups 10 and 11 jointly started preparatory work for the WARC-1992. Administrations and other participants in the work of these Study Groups have been informed on this item by the Secretariat in Circular Letters 10-11S/143 and 10-11S/144 of 15 December 1989. It is stated there that a new Joint Interim Working Party composed of all the Study Groups that are engaged in the task will be formed to deal with multi-Study Group sharing issues and to consolidate the CCIR report to the Conference. The preparatory work carried out within Study Groups and smaller JIWPs such as JIWP 10-11/1 and 10-11/3 will be delivered to the larger IWP.

A substantial contribution was made by IWP 11/5 to JIWP AFBC(2), charged with the preparation of the additional technical information requested by the RARC AFBC(2). Three documents were transmitted to JIWP AFBC(2) containing the latest results on studies on protection ratios and other subjects indispensable for efficient planning.

A considerable amount of work needs to be done for the preparation of the CARR(3), as decided by the Nice Plenipotentiary Conference.

3. Further studies and work of Interim Working Parties

In accordance with the provisions of Resolution 24 (§ 2.3) a number of tasks which could not be dealt with quickly enough or completely during the meetings of Study Group 11 have been entrusted to IWPs functioning between successive meetings of the Study Group. The work of these IWPs and JIWPs is contributing considerably to the success in preparing new texts on important topics.

IWP 11/4 on subjective assessment of television picture quality works under the chairmanship of Mr. D. Wood (EBU) (Vice-Chairman, Mrs. B. Jones (United States of America)). A large part of the work was devoted to HDTV, other subjects having been improved methodologies and methods for assessment of digital transmission codecs in support of IWP 11/7 and IWP CMTT/2.

Following suggestions from Study Group 10, the mandate of the Group was extended to include from now also the assessment of sound quality. The new mandate is given in Decision 95. As a consequence, the group was renamed to JIWP 10-11/6. As far as television is concerned, the JIWP will continue to examine current trends in television systems, e.g. enhanced or high-definition television, and television signal processing, such as digital coding and bit-rate reduction or the use of time-multiplexed components, in order to determine what changes will be required in the methodology of subjective testing to accommodate these trends.

IWP 11/5 on protection ratios for colour television systems (Decision 42) is chaired by Mr. Dinsel (Germany (Federal Republic of)). (Vice-Chairmen: A.H. Fayoumi (Egypt) and S.E. Aguerrevere R. (Venezuela)). In the past study period, the IWP provided information necessary for improved television planning and spectrum utilization.

The future work will include studies on compatibility of new enhanced television systems and HDTV systems with existing terrestrial services and cable distribution and community antenna systems as well as on an introduction strategy for enhanced television and HDTV systems. In accordance with the results of the RARC AFBC(2), investigations in out-of-channel emissions will be necessary in the next study period.

IWP 11/6 on high-definition television standards (Decision 58) is chaired by Mr. Y. Tadokoro (Japan), assisted by two Vice-Chairmen, Mr. R. Green (United States of America) and Mr. W. Habermann (Germany (Federal Republic of)). Following its mandate, the IWP prepared the most important basic documents for the Extraordinary Meeting of Study Group 11 on HDTV, namely a draft Recommendation on a number of basic parameters for the HDTV studio and a status report on HDTV. An Expert Group was established to ensure progress in defining colorimetry for HDTV.

In the next study period, the IWP will continue the work necessary to define a full set of relevant digital (in collaboration with IWP 11/7) and analogue parameters for a single worldwide high definition television standard for programme production and for the international exchange of programmes. It also has to study the subject of emission of HDTV from the point of view of terrestrial broadcasting but with the aim to produce the specification of the baseband signal format, unique if possible, to be used for emission applicable to both satellite and terrestrial broadcasting (see also Part 2, § 6).

IWP 11/7 on digital television standards (Decision 60) works under the chairmanship of Mr. A.N. Heightman (United Kingdom) with two Vice-Chairmen, Mr. K.P. Davies (Canada) and Mr. T. Saito (Japan). Reports were prepared on the bit-rate reduction codec testing project procedures and results, and the existing texts on test pictures and user requirements were appropriately updated. Liaison with IWP CMTT/2 continued to be close and constructive.

Further studies are urgently required on bit rate reduction especially for high-definition television to enable the selection of standard methods. Further studies are also needed to complete the specifications in Recommendation 601 for the various members of the encoding family and for detailed specifications for high-definition and enhanced quality television. The standard synchronizing signals for digital television studios need further specification.

IWP 11/8 on proposals for rearranging Questions and Study Programmes of Study Group 11 was established by Decision 80 under the chairmanship of Mr. Wu Xian Lun (China (People's Republic of)) (Vice-Chairman: Mr. A.N. Heightman (United Kingdom)). The IWP worked mainly by correspondence and at informal gatherings concurrent with other meetings. Although considerable progress was made, the group could not complete the task by the Final Meeting.

IWP 11/9 with R. Bedford (United Kingdom) as its Chairman was established by Decision 91 at the Final Meeting to work on harmonization of HDTV standards between broadcast and non-broadcast applications, i.e. to perform as a link between various standardizing bodies (IEC, ISO, CCITT and CCIR) in the field of HDTV.

JIWP 10-11/1 on the use of the geostationary-satellite orbit and the planning of space services utilizing it (Decision 43, jointly approved with Study Group 10) (Chairman: Mr. D. Sauvet-Goichon (France), Vice-Chairmen: Mr. R.M. Barton (Australia), Mr. W. Richards (United States of America) and Mr. V. Rao (India)) studies aspects of satellite sound broadcasting for individual reception by portable and vehicle receivers in the band 500-3000 MHz. It also undertakes, in consultation with JIWP 10-11/3, studies related to wide RF-band HDTV satellite broadcasting.

Future work of the group will concentrate on tasks identified for the CCIR by the Plenipotentiary Conference, Nice 1989 and WARC ORB-88. Technical studies have to be undertaken for the broadcasting-satellite service (sound) (Resolution No. 520 of WARC ORB-88) on the impact of choice of frequency on system parameters, bandwidth required by such a service and sharing aspects. It is also necessary (Resolution No. 521 of WARC ORB-88) to continue studies on wide RF-band HDTV for satellite broadcasting using a frequency band in the range 12.7-23 GHz and also in the range 11.7-12.7 GHz without prejudice to existing plans.

JIWP 10-11/3 on satellite broadcasting of HDTV signals and on accommodation of several audio and/or data signals and/or picture signals in terrestrial and satellite broadcasting channels (Decision 51, jointly approved with Study Group 10) works under the chairmanship of Mr. O. Mäkitalo (Sweden) (Vice-Chairmen: Mr. T. Nishizawa (Japan), Mr. S. Samnan (Saudi Arabia) and Mr. S.K. Chemai (Kenya)) and undertook comprehensive studies on these subjects in the past study period.

Future work has to be done on radio frequency and emission technical parameters including modulation, channel coding and multiplexing of HDTV broadcasting. In addition, propagation characteristics as they relate to the emission of HDTV are subject of study. Another major item of study concerns broadcasting techniques of several audio signals and/or data signals either associated with television signals or for sound/data broadcasting in terrestrial and satellite channels including suitable modulation standards.

JIWP 10-11/4 on digital television tape recording (Decision 59, approved jointly with Study Group 10) is chaired by Mr. P. Zaccarian (CBS). The studies in the JIWP led to important new Recommendations on HDTV recording and the exchange of electronically produced HDTV programmes. Information was gathered on the release of programmes in a multimedia environment where a new Report identifies areas of action in view of harmonization of standards, notably for signal interconnection.

In the next study period, the JIWP will work on defining the remaining implementation and operating aspects of the single digital recording format specified in Recommendation 657 (D1 format) and on new Recommendations concerning digital recording of HDTV programmes on the one hand and, expecting economies from it, on bit-rate reduced television signals on the other hand.

JIWP 10-11/5 on data broadcasting services works with the mandate given in Decision 72. The Chairman is Prof. F. Cappuccini (Italy). In the past study period, the JIWP was successful in preparing a complete set of basic documents on the various aspects of data broadcasting.

The JIWP will carry out further studies on teletext, particularly on the presentation layer requirements of some non-Latin based alphabets and studies on data coding for services using data broadcasting in television and sound broadcasting channels, whether terrestrial or satellite, to define appropriate service quality criteria and assessment methods. Related to this, requirements for international exchange and system transcoding are also studied.

JIWP AFBC(2) on CCIR preparatory work for the African Television Planning Conference RARC AFBC(2) worked under the chairmanship of Mr. H. Kussmann (Germany (Federal Republic of)) (Vice-Chairmen: Mr. A. El-Fayoumi (Egypt), Mr. J. Edane Nkwele (Gabon) and Mr. S. Samnan (Saudi Arabia)). JIWP AFBC(2) prepared its report to be formally approved at the Final Meeting in view of its submission as the CCIR report to AFBC(2) in response to specific questions related to Recommendations No. 3 to 6 of AFBC(1). This JIWP is now disbanded.

Study Group 11 is also continuing to participate in the work of *JIWP CMTT-4-10-11/1* on satellite news gathering and *JIWP CARR-3* to prepare the technical bases for the establishment of criteria for the shared use of the VHF and UHF bands in Region 3.

4. **Cooperation with other Study Groups**

Close liaison has been maintained with the CMTT and its IWP CMTT/2 in the field of digital television standards for bit-rate reduction methods and transmission parameters of digitally coded TV signals.

The traditional cooperation with Study Group 10 has continued to be quite fruitful through the work of the various JIWPs which shows a deeper integration between the two Study Groups.

Mention should also be made of the cooperation with Study Groups 4, 10 and CMTT in the field of satellite news gathering through JIWP CMTT-4-10-11/1.

Close cooperation in view of the harmonization of the standards is continuously sought and maintained with other standard making organizations, in particular with IEC and ISO.

5. Study Group 11 and matters of interest to developing countries

In accordance with the provisions of Resolution 33, due attention has been given by Study Group 11 and its related IWPs and JIWPs to the specific needs of developing countries.

Report 624 on the characteristics of television systems has been continuously updated bearing in mind the progress of TV services in the developing countries. Wherever possible, the information has been prepared in order to be readily applied in the developing countries. For specific areas of video quality assessment, consideration is being given to the production of standard reference quality material to be used by organizations in developing countries to familiarize staff with generally understood concepts of the quality grades.

Important questions related to protection ratios, antennas and polarization of emissions arising from AFBC(1) and related to TV service planning and efficient spectrum utilization in developing countries have deserved the utmost priority and valuable, timely information has been provided. RARC AFBC(2) has appreciated this work and identified items for further study, part of which will be entrusted to IWP 11/5.

The digital TV studio production standards adopted by Study Group 11 already represent a big step forward to meet the needs of developing countries. The majority of new studio equipment is based on digital techniques and the availability of a reference CCIR standard will surely help in achieving economical performance and quality. Important results have also been achieved in the field of satellite television broadcasting with the Regions 1 and 3 feeder-link plan as approved by the ORB(2) Conference. This plan, largely based on the preparatory work carried out by the CCIR, is the fundamental framework for the implementation of satellite-based new TV services. A larger participation of developing country representatives was warmly encouraged at the Final Meeting of Study Group 11 which would be an ideal forum to collect specific suggestions and proposals for further activities and closer cooperation for the benefits of the broadcasting community.

6. Documents submitted to the XVIIth Plenary Assembly

All the documents approved by Study Group 11 for submission to the XVIIth Plenary Assembly are listed in the usual way in Document 11/1003.

7. Conclusions

The 1986-1990 study period was a very fruitful one. Great progress was achieved in all fields of development of television technologies, in particular, in the studies of future television systems.

Based on the use of new technologies, these systems have had a radical impact on all sections of the television link from programme generation facilities to programme distribution systems including also television receivers. Therefore, the work of Study Group 11 is of complex nature. This can also be concluded from § 3.

It will remain of this type also in the next study period. Hence, still closer cooperation between Study Group 11 and other Study Groups is required and proper organization of all studies to be carried out by Study Group 11 should be ensured taking also into account new procedures which might be adopted by the XVIIth Plenary Assembly.

Progress in the work of Study Group 11 was achieved due to the good work provided within the Interim Working Parties, Joint Interim Parties and Working Groups by all the members. I wish to express my deep respect and gratitude to all of them. It should be also noted, that a great and creative work was carried out by the Chairmen and Vice-Chairmen of these groups.

Valuable assistance was continually provided by the CCIR Secretariat. I feel it my duty to express my gratitude to the Director and his staff.

ANNEX I TO PART 1

MEETING OF THE HDTV COORDINATING GROUP

(Geneva, 26 October 1989)

Conclusions of the meeting

A meeting of the HDTV Coordinating Group was convened to consider the results of the Final Meeting of Study Group 11, as far as HDTV is concerned, as well as the programme of activities to be carried out in view of the Special Meeting concerning the draft Recommendation for the HDTV studio standard.

Chairmen of Working Groups established during the Final Meeting of the Study Group were invited to participate. The list of participants is given on page XXIV.

1. General considerations

Prof. Krivocheev opened the meeting recalling the success of the Study Group 11 Final Meeting in unanimously adopting the Recommendation 709 on HDTV basic parameters for studio standards. He also stressed that this achievement was not only due to the spirit of compromise and cooperation shown by all the participants but also to the engagement of the Chairmen of the Working Groups.

He also mentioned that the activity concerning further progress towards HDTV standardization should not slow down but continue even more intensively in view of the forthcoming CCIR Plenary Assembly. This is, in fact, the content of new Decision 90 to convene a Special Meeting of IWP 11/6 with participation of IWP 11/7 from 22 to 28 March 1990 in Atlanta, United States of America.

2. Preparation of the special meeting

The Chairman suggested that two meetings of the HDTV Coordinating Group could be scheduled on 21 March and on 29 March 1990, respectively, to give guidance to the IWPs and to assess the results of their work. He invited the member of the HDTV Coordinating Group and the Chairmen of Working Groups and *ad hoc* Groups established at the recent Final Meeting (i.e. Mr. G. Waters, Mr. S. Perpar, Mr. H. Yamamoto, Mr. K.P. Davies and Mr. J. Sabatier) to participate in these meetings. This schedule should be mailed as soon as possible to the members of the HDTV Coordinating Group and to the Chairmen of the Working Groups.

The Chairman of IWP 11/6 was also invited to dispatch, as soon as possible, the agenda for the meeting together with a short report summarizing the tasks to be fulfilled. He will also invite the participation of IWP 11/7 members as agreed with the Chairman of IWP 11/7.

As to the next HDTV Coordinating Group meeting, the Chairman suggested that the Chairman of IWP 11/6 should present a report giving an outline on what can be expected as a result of the March meeting of the IWP. He also invited a preliminary report from the Chairman of Interim Working Party 11/9 on harmonization of HDTV standards between broadcasting and non-broadcast applications (Chairman: Mr. R. Bedford (United Kingdom, now also member of the HDTV Coordinating Group) recently set up by the Decision 91 (Doc. 11/724). Mr. Bedford's report should contain information on the organization of work within that IWP and any available results.

A third report will be expected from Mr. R. Zeitoun in his capacities as Vice-Chairman of Study Group 11, Chairman of JWG 10-11S and main coordinator of the CCIR activities for the preparation of the WARC-92. His report to the next HDTV Coordination Meeting should be prepared in consultation with the Chairmen of JIWP 10-11/1 (Mr. Sauvet-Goichon) and JIWP 10-11/3 (Mr. Mäkitalo) on satellite broadcasting of HDTV signals. This report should also cover the accompanying sound aspects.

3. Organization of the work of the special meeting

It was agreed that Mr. Tadokoro, Chairman of the Special Meeting, should organize it by setting up the following Working Groups:

WG-A: Chairman: W. Richards (United States of America)
will deal with the new Recommendation 709;

WG-B: Chairman: K. Davies (Canada)
will deal with colorimetry aspects;

WG-C: Chairman: A. Heightman (UK)
will deal with digital HDTV including bit-rate reduction techniques;

WG-Editorial: Chairman: K. Davies (Canada)
will finalize the output text to be added as supplement to the Chairman's Report to the Plenary Assembly.

Mr. Terzani (Chairman of Study Group 10) announced that an informal group of Study Group 10 will be convened to deal with matters associated with sound broadcasting both in HDTV transmission and direct from satellite in view of the preparation of the forthcoming WARC-92. Messrs. Zeitoun, Mäkitalo, Sauvet-Goichon, and Cappuccini will participate in this group.

Mr. Davies, speaking on behalf of the Chairman of IWP 11/7, announced that the Chairman of IWP 11/7 intends to convene a meeting of his IWP before the Special Meeting in order to present the results of the studies in due time.

The Chairman observed that some informal discussions and preliminary exchanges of view about the results could take place at the next Study Group Chairmen's Meeting (17-19 January 1990).

The Chairman asked the Chairman and participants of IWP 11/6 to assure that all members and participants in the HDTV Coordinating Group receive documents contributed to IWP 11/6 before the Atlanta meeting.

HDTV COORDINATING GROUP MEETING OF 26 OCTOBER 1989

List of participants

Chairman:

Prof. Dr. M. KRIVOCHEEV,	Chairman, Study Group 11
Mr. C. TERZANI	Chairman, Study Group 10
Mr. W. G. SIMPSON	Chairman, CMTT
Mr. R. ZEITOUN	Vice-Chairman, Study Group 11 and Chairman, 10-11S
Mr. WU XIANLUN	Vice-Chairman, Study Group 11 and Chairman, IWP 11/8
Mr. F. CAPPUCCINI	Chairman, JIWP 10-11/5 and Chairman WG 11-B
Mr. K. P. DAVIES	Chairman, *Ad-hoc* Group on HDTV texts
Mr. S. DINSEL	Chairman, IWP 11/5
Mr. S. PERPAR	Chairman, WG 11-C
Mr. D. SAUVET-GOICHON	Chairman, JIWP 10-11/1
Mr. Y. TADOKORO	Chairman, Study Group 11/6
Mr. G. WATERS	Chairman, WG 11-A
Mr. D. WOOD	Chairman, IWP 11/4
Mr. P. ZACCARIAN	Chairman, JIWP 10-11/4

CCIR Secretariat:

Mr. R. L. Nickelson	Senior Counsellor
Mr. G. Rossi	Counsellor
Mr. J. Meyland	Administrator

PART 2

RESPONSE OF THE CHAIRMAN OF STUDY GROUP 11
TO RESOLUTION 96 OF THE XVITH PLENARY ASSEMBLY OF THE CCIR

(Approved by the Study Group as Document 11/730)

The global approach of the CCIR to HDTV standardization

1. Introduction

In Resolution 96, the XVIth Plenary Assembly of the CCIR unanimously stated that it would be appropriate to schedule an Extraordinary Meeting of Study Group 11, lasting not more than one week. It would be confined to HDTV, and subject to confirmation by the Director of the CCIR, on the advice of Study Group 11, after evaluation by the Director of the CCIR, on the advice of Study Group 11, after evaluation during the Interim Meeting of the progress achieved.

The Director of the CCIR, on advice from Study Group 11 and the HDTV Coordination Group, confirmed the need for the Extraordinary Meeting which was held in Geneva, 10-16 May 1989. It made considerable further progress towards the development of a single worldwide HDTV studio standard. At the same time, it forged closer links with other bodies concerned with high definition television, to ensure the global harmonization of both the broadcasting and non-broadcasting application of HDTV.

The Extraordinary Meeting of Study Group 11* successfully completed all items of its agenda and produced four draft Recommendations on HDTV and a total of 11 new or updated Reports. The work of a special *ad hoc* Group set up during the Extraordinary Meeting to produce the "Conclusions of the Extraordinary Meeting of Study Group 11", is particularly noteworthy. This is the first consolidated report that reflects all aspects of the worldwide harmonization taking place in HDTV. This document has subsequently been produced as a CCIR publication.

High-definition television advances rapidly and in the short period between the Extraordinary Meeting and the Final Meeting, considerable progress was made. For this reason, Study Group 11 decided to convene a special one week meeting of IWP 11/6, with representation from IWP 11/7, in March 1990, to take advantage of the developments prior to the XVIIth CCIR Plenary Assembly. The meeting was asked to prepare appropriate supplementary documentation that the Chairman of Study Group 11 shall consider as an addendum to his report to the Plenary Assembly.

The global approach to high-definition television adopted to Study Group 11 has been a driving force in this rapid progress. By means of Decision 74, the global approach of Study Group 11 towards HDTV was emphasized, including the role of high-definition television in the "Information Society" of the next century. A key component of this global emphasis is the harmonization of standards and operating practices for high definition television equipment intended for consumer application. In this regard, the need for coordination of standardization on the international level becomes essential, particularly among organizations concerned with information technology such as the IEC the ISO, and the relevant organs of the ITU.

The current text provides information about the progress achieved between the Extraordinary Meeting of Study Group 11 and the XVIIth Plenary Assembly.

2. The Extraordinary Meeting

The Extraordinary Meeting of Study Group 11 examined contributions concerning all major aspects of HDTV from the image through production, emission and display.

After considering the progress made in the basic parameters for a single worldwide HDTV system, the Extraordinary Meeting prepared Report 1232 which contains a review of the most important aspects of worldwide HDTV development, including reference to the expanding range of applications for HDTV and its interrelationship with worldwide development of image communications.

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* The full texts of the conclusions is contained in Document 11/410. A special publication of the CCIR contains the draft Recommendations and Reports from the conclusions. Some of the draft Recommendations and Reports were subsequently augmented with new information during the Final Meeting. Annex 1 to Part 2 lists the relevant texts of CCIR concerning HDTV.

The XVIth Plenary Assembly of the CCIR placed a high priority on the establishment of a full set of parameter values, both analogue and digital, for the single worldwide HDTV studio standard, taking account of the global approach to HDTV systems. The Extraordinary Meeting examined all aspects of this request in considerable detail from both the technical and operational viewpoints. The results of this work are contained in Recommendation 709. The Extraordinary Meeting concluded that it would be advantageous to study more carefully the remaining relevant parameter values in a continuation of the work.

It found that techniques exist for the broadcasting by satellite of HDTV and that the characteristics of satellite broadcasting systems should not directly restrict the characteristics of the studio standard used as a source of programme material. A new emphasis on terrestrial broadcasting methods for HDTV was also reflected in the conclusions of the Extraordinary Meeting. Updated information about HDTV emission and data broadcasting was incorporated into Report 801.

Methods for the international exchange of programmes on transmission links are rapidly developing and this was reflected in the contributions considered. The conclusions are contained in Report 801. Considerable progress was made by the Extraordinary Meeting in achieving an agreement on methods for the international exchange of programmes using recorded media (film, tape, disc). Recommendation 713 was adopted concerning the recording of HDTV images on film. Recommendation 714 was adopted relating to the exchange of HDTV programmes on tape. The meeting also adopted Reports 1230 and XJ/11 which document aspects of recording of HDTV on tape in the studio and domestic environments respectively.

The measurements of the HDTV system are important to its successful development. Advances in this area were reflected in Recommendation 710 concerning subjective measurements and in Reports 1216 and 1218 concerning subjective and objective measurements, respectively. The adoption of these by the Extraordinary Meeting is a major step forward, representing a worldwide agreement on the procedures, analyses and context of HDTV measurement.

The Extraordinary Meeting also noted that several significant international events where HDTV would be discussed, were scheduled to take place prior to the Final Meeting, and that further work would be needed during, and possibly after, the Final Meeting to update the various documents on HDTV to reflect developments after the Extraordinary Meeting. In particular, it identified colorimetry as a particularly promising subject on which progress was expected during the Final Meeting and noted the formation, by IWP 11/6, of an *ad hoc* Expert Group to examine this subject. Report 1217 sets out details of the strategies to be followed in the light of the Extraordinary Meeting's conclusions.

3. Progress between the Extraordinary and Final Meetings

3.1 *International events demonstrating HDTV development*

The following international events were a driving force in moving HDTV development forward.

NHK "Open House"

The Science and Technical Research Laboratories of NHK (Japan Broadcasting Corporation) held its "Open House" 8-11 June 1989. This is an annual event, which is open to the public, to show the results of the Laboratories research activities. In 1989, demonstrations were given on such subjects as HDTV test pictures, flat panel displays, VLSIs for MUSE decoders and for MUSE-HDTV down-converters, MUSE DPCM codecs and stereoscopic television using HDTV.

Second Electronic Cinema Festival

The Second Electronic Cinema Festival took place in Montreux (Switzerland) from 18-22 June 1989, concurrent with the 16th International Television Symposium and Technical Exhibition. This was the first international event with productions using HDTV production/post-production equipment competed on the grounds of their creative merit.

The Festival was open to productions intended for release by television or in the cinemas, and falling into five programme categories: dramas, documentaries, sports, music, advertisements. Out of 53 productions entered in the Festival, 33 productions were selected to be reviewed by the International Jury which conferred five Astrolabium Awards to the productions of its choice, in the various programme categories.

Internationale Funkausstellung (IFA)

From 25 August until 2 September 1989, the public had the opportunity to witness live HDMAC at the Eureka-95 booth at the Internationale Funkausstellung (IFA) in Berlin (West). The HDMAC signal could also be received by individual dish antennas throughout a large part of Europe, Reception of the HDMAC signal, via both satellite and via cable, and its presentation as the D2MAC compatible picture, were also demonstrated.

The booth contained a fully equipped HDTV studio with four outside broadcast vans operating on the 1250/50/2 system. Using this equipment, a series of HDTV productions were made by leading European broadcasting organizations, and excerpts were shown to the public on HDTV projection displays operating under optimum viewing conditions.

ITU COM-89

ITU COM-89 was held in Geneva from 2-7 October 1989, and considered a wide range of broadcasting and telecommunications matters, both legal and technical. ITU COM-89 included a technical session on HDTV, moderated by the Chairman of Study Group 11. Among the important matters discussed were: the principles of an HDMAC coding system; a proposal for the characteristics of HDTV consumer television receiving systems relative to NTSC in North America; an outline of the current status of the development of HDTV technology for programme production and transmission in Japan; and an examination of the perspectives for digital TV and HDTV via satellite, in the light of actual progress on bit-rate reduction algorithms and on modulation and channel coding techniques. In addition, one paper was presented emphasizing the need for the maximum availability of programming as a precondition to consumer acceptance of an advanced television system. Another paper described the development of HDTV in telecommunications services, in non-broadcasting areas, and methods of delivery using DSB, terrestrial broadcasting, CATV and VCRs.

At the technical equipment exhibition conducted in conjunction with ITU COM-89, HDTV was demonstrated by manufacturers from Japan. The 1125/60/2 system was demonstrated over typical satellite and optical transmissions systems using both the MUSE transmission system and digital codecs. Live pictures for the demonstrations were originated from HDTV cameras and other studio equipment on the stand. The equipment presented included recorders, both studio and semi-professional, a range of HDTV displays, and an HDTV video theatre. A MUSE receiver based on LSI was also demonstrated.

3.2 *CCIR activities*

IWP 11/6 Ad Hoc Expert Group on HDTV Colorimetry

At its meeting held in May 1989, IWP 11/6 established an *Ad Hoc* Expert Group on HDTV Colorimetry charged with preparing a set of parameter values suitable for inclusion in Recommendation 709 for the Studio Production Standard. They included: the opto-electronic transfer characteristics, assumed chromaticity coordinates for primary colours, derivation of luminance signal and the derivation of colour difference signals.

IWP 11/6 Meeting on High Definition Television

In order to improve the contents of the Conclusions of the Extraordinary Meeting of Study Group 11 on High-Definition Television, IWP 11/6 met from 2-6 October 1989, in Geneva, with IWP 11/7 representation. IWP 11/6 considered the report of the *Ad Hoc* Expert Group on Colorimetry and other contributions. It recommended to Study Group 11 that it should make some additions to Recommendation 709, Report 801, and Decision 58, at the Final Meeting.

JIWP 10-11/3

This JIWP met in June 1989, and updated Report 1075 which contains information on satellite HDTV emission and includes characteristics of five HDTV systems plus detailed information on various aspects of HDTV satellite emission such as modulation, multiplexing, quality objectives, propagation factors in the various bands, feeder links and equipment characteristics.

JIWP 10-11/4

The preparatory work performed by JIWP 10-11/4, both at formal meetings and by correspondence was determinant in achieving approval of several texts on HDTV, notably of texts for Recommendations 713, 714 and 716.

JIWP 10-11/5

JIWP 10-11/5 met in Geneva from 14-16 June 1989. On that occasion, the problems related to data broadcasting in an HDTV environment were further reviewed and the Report 1225 on the subject was prepared.

4. Progress on HDTV studies during the Final Meeting of Study Group 11

4.1 *Overview*

The Final Meeting of the 1986-1990 study period of Study Group 11 took place from 9-25 October in Geneva. In the 13 working days allotted, the Study Group was able to consider some 60 contributions concerning HDTV from administrations and a particularly valuable input from IWP 11/6. The Final Meeting was thus able to advance rapidly, taking advantage of the impetus and information generated by several important events (see § 3) adding valuable new data to several Recommendations, many Reports and approving several new Decisions. The results are reported in detail in subsequent parts of this section, but it is clear that CCIR studies of HDTV, have become a major factor in the development of HDTV for both broadcast and non-broadcast uses, and that the broadly based, global approach chosen by Study Group 11 for its work and exemplified in the conclusions of the Extraordinary Meeting on HDTV has proven to be most appropriate.

Future progress, based on this approach, can lead to a convergence of HDTV systems that would be beneficial to all administrations participating in the work of the CCIR and, indeed, to all television users.

Concurrent with the Final Meeting of Study Group 11, Study Group 10 and the CMTT met. This resulted in further advances in CCIR studies concerning the sound aspects of HDTV broadcasting, the emission of HDTV by satellite and the transmission of HDTV. These matters are more fully reported in § 4.3 of this report.

4.2 *Results*

The Final Meeting of the Study Group saw the adoption of one new draft Recommendation and substantial progress in the completion of the HDTV studio standard adopted in its basic form at the Extraordinary Meeting. Three other draft Recommendations adopted at the Extraordinary Meeting remain unchanged. In addition, ten Reports concerning HDTV and related matters were updated and three new Reports were introduced and adopted. Significant changes were made in a number of Questions and Study Programmes to take account of the expanding scope of HDTV in the work, and to reflect the requirement for CCIR participation in the preparations for the WARC-92 and the need for harmonization of the CCIR work in HDTV with that of others studying image-related matters, including the ISO, the IEC and relevant organs of the ITU such as the CCITT.

4.2.1 *Basic parameters and Recommendation 709*

Many contributions were considered concerning basic parameters of the HDTV studio standard and the strategies to be followed. This resulted in substantial improvements in Recommendation 709 and the associated Reports on the current and future work concerning HDTV. Further improvements are anticipated in the near future, reflecting the rapid pace of development in HDTV worldwide, and the Study Group has adopted measures to include these new results rapidly.

Progress was also made in regard to the measurements and assessments of the quality of HDTV, in both its digital and analogue forms, by the adoption of new material, including newly developed test signals and test pictures.

In response to the need to harmonize the parameters of the HDTV broadcast studio with those of other users of HDTV, a new IWP 11/9 has been created to work closely with other organizations to ensure that CCIR activities and results are clearly presented, to ensure that the conclusions and Recommendations of Study Group 11 are convergent with those reached elsewhere and to make the Study Group responsive to the rapidly changing environment for HDTV.

The work of IWP 11/6, assisted by IWP 11/7, has been redirected in an update to Decision 58, which reflects the work accomplished to date and the changing needs of the future activities. Similar considerations have taken place in regard to the activities of other IWPs and JIWPs.

4.2.2 *Methods of emission*

CCIR studies of HDTV emission have, until the Extraordinary Meeting, concentrated on satellite delivery, but there is now a growing interest in studies concerning the delivery of HDTV over terrestrial broadcast facilities and over optical fibres.

At the Final Meeting, JWG 10-11S added significant material to the report concerning BSS delivery, reporting the activities of JIWP 10-11/3 and the several important demonstrations of HDTV emission that have taken place since the Extraordinary Meeting.

Changes to the terms of reference of the IWPs and JIWPs were also made to reflect the new situation and also to expedite the important preparatory work needed for the WARC-92 concerning spectrum allocations for HDTV broadcasting. Reports 1075 and 801 contain the new information concerning both satellite and terrestrial broadcasting of HDTV.

Concerning the terrestrial broadcasting of HDTV, a number of contributions were received and incorporated into the texts regarding the development of coding methods, which will assist further studies on the planning and protection ratios necessary for terrestrial HDTV delivery.

A new Report has been created in response to the new interest in enhanced television. The technology of HDTV has enabled the development of proposals to add new features, such as wide aspect-ratio, and to improve the performance of conventional television systems, thus adding new dimensions to HDTV studies. Reports 1077 and 1220 contain information on this matter.

Report 1225 has been created, based on material from JIWP 10-11/5, concerning the data broadcasting services to accompany HDTV. HDTV offers an attractive prospect for the enhancement of existing data broadcasting services such as teletext and for the development of entirely new services. Development of data broadcasting also acts in favour of the existing trend towards the integration at the technical and service levels between interactive and broadcast digital networks. In this process it is extremely important to maintain close cooperation with the CMTT, the appropriate CCITT Study Groups the IEC and ISO.

4.2.3 *International exchange of programmes*

Since the time of the Extraordinary Meeting, considerable progress has been made in the transmission of HDTV, both by satellite and terrestrial means. A number of important demonstrations have taken place among several countries. A variety of coding techniques, both analogue and digital have been used. This activity has been reported in contributions and included in Report 801 and certain texts of the CMTT.

The future work of Study Group 11 in the area of transmission will be assisted by a significant revision of Decision 18 which creates a new JIWP between the CMTT, Study Groups 10 and 11 that better reflects the global development of HDTV and the need of harmonization of activities with those of the CCITT.

The exchange of programmes on film and on recorded media is studied by JWIP 10-11/14. Based on its input, Recommendation 716 has been adopted concerning the scanned area of 35 mm film in HDTV telecine, complementing the two Recommendations 713 and 714 prepared at the Extraordinary Meeting.

In conjunction with the CMTT and Study Groups 4 and 10, the requirements for Satellite News Gathering in the future HDTV environment were addressed. This has resulted in the introduction of a new draft Study Programme and amendment of Reports concerned with the transmission objectives, equipment requirements, and unique operational requirements for the transmission of portable and transportable satellite earth stations used for HDTV in the "Outside Broadcast" environment and for Satellite News Gathering for HDTV.

4.2.4 *Revisions to Questions, Study Programmes and Decisions*

HDTV will be an increasingly important part of the work of Study Group 11 in the next Study Period. This is reflected in revisions to a number of Decisions concerning IWPs and JIWPs, in changes to Questions and Study Programmes and in the adoption of many texts concerning HDTV. A few particularly significant items are noted:

- Decision 90 established a special meeting to continue development of Recommendation 709 in critical areas, such as colorimetry and digital representation;
- Decision 43 was modified to consolidate the important sharing questions concerning WARC-92 in JIWP 10-11/1;
- Decision 51 was modified to task JIWP 10-11/3 with the critical system parameter questions concerning the WARC-92;
- a new Decision (Decision 93) was adopted relating to the work programme for JIWPs 10-11/1 and 10-11/3 concerning satellite HDTV emission for the WARC-92;

- Decision 91 created an IWP to harmonize HDTV studies and Recommendations with other organizations such as the ISO, the IEC, and with related ITU organs such as CCITT;
- Decision 58 was modified by inclusion of an Annex setting out some specific tasks for IWP 11/6 considered crucial to the further development of HDTV standards;
- major updates were made to Report 1217, the future development of HDTV, setting out clearly the possible strategies to be followed in the achievement of harmonious, coherent and complete HDTV texts.

4.2.5 *Conclusion*

The Final Meeting of Study Group 11 for the 1986-1990 study period continued the pattern of progress in HDTV studies evident at the Extraordinary Meeting and added considerably to its Conclusions (Document 11/410). New Recommendation 716 has been adopted concerning HDTV telecine. There are now five CCIR draft Recommendations on HDTV matters, showing the progress that the Study Group has made and the value of the global approach taken in HDTV studies during the 1986-1990 study period.

The meeting also added new material to seven Reports from the Extraordinary Meeting to include the new contributions, based in large measure on the significant international events that took place between the meetings. Out of the total of the Reports, three remain unchanged.

At the Final Meeting, Study Group 11 also considered the fact that HDTV is now considered in three volumes related to the Study Group and also in the volumes of Study Group 10 and of the CMTT. In order to make this material more accessible, particularly in view of the new harmonization activities, a bibliography of those CCIR texts related to HDTV has been prepared (see Annex I to Part 2).

4.3 *Studies related to HDTV in other Study Groups*

High-quality, multi-channel sound is an important feature of HDTV and Study Group 10 has decided that the subjective assessment of the quality of sound to accompany HDTV should be addressed in conjunction with the subjective assessment of television pictures. As a consequence, Study Groups 10 and 11 have made IWP 11/4 on subjective assessment of television pictures into a Joint Interim Working Party of Study Groups 10 and 11 (JIWP 10-11/6) to address subjective assessment of both picture quality and sound.

Study Group 10 in Decision 94 has formed new IWP 10/12 to expedite the work on suitable sound systems to accompany high-definition and enhanced television systems.

In addition to the satellite studies mentioned earlier, the CMTT is addressing the specific transmission needs of HDTV and extensive amendments have been made to its Reports to incorporate the rapid progress being made on HDTV transmission. By means of new Study Programmes, the studies of CMTT have been extended to include the determination of critical signal characteristics, test signals, measurement methods, performance objectives and other aspects of the transmission of HDTV signals in both analogue and digital form.

5. **Progress between Final Meeting and the Plenary Assembly**

The development of Recommendation 709 and international support for it, is an important step towards international HDTV standardization. The CCIR is the leading organization in the field of HDTV standardization and other organizations are only now becoming fully aware of the national and international importance of worldwide standardization of HDTV.

The parameter values reflected in Recommendation 709, will resolve important HDTV standardization needs, when completed with picture characteristics and scanning parameters. In particular the wide aspect ratio, and interim colorimetric parameters make it possible to formulate general requirements for displays (CRT, projection systems), for optics, image sensors (tube, CCD) and lighting systems. The important concept of "reference system" has been introduced to optimize the transformations between HDTV, film, graphics, and colour printing. In addition the wide aspect ratio can be used in new compatible television systems in the evolutionary approach towards a single worldwide standard for HDTV.

Early achievements of the Final Meeting of Study Group 11 are reflected in Recommendations and Reports concerning both subjective and objective measurements of HDTV. They describe major advances allowing work to commence on the design of HDTV test equipment. Further refinement of the techniques is required in parallel with the advance towards a single worldwide HDTV standard.

Other parts of the Recommendation encourage further studies on bit-rate reduction of the HDTV signal, compliance of the digital HDTV signal with the CCITT hierarchy, on HDTV recording, broadcasting interfaces, etc. The Recommendation will also have special importance in the preparations for WARC-92.

To facilitate the exchange of ideas with other organizations and to further enhance the CCIR's role in this important work, Study Group 11 formed IWP 11/9 to address the harmonization of broadcast and non-broadcast applications of HDTV.

Special Meeting of IWP 11/6 on HDTV

Study Group 11, at its Final Meeting, wished to reinforce its continued progress on HDTV standards development, and to ensure that the Plenary Assembly would have before it the most up-to-date information on the important progress achieved on HDTV standardization between the Final Meeting and the Plenary Assembly. Accordingly, by means of Decision 90, it convened a Special Meeting of IWP 11/6 expressly to consider contributions concerning outstanding parameter values of Recommendation 709 and to prepare appropriate documentation to supplement this Recommendation in certain specific areas. This meeting was held in Atlanta, Georgia, (United States of America), from 22 to 28 March 1990.

This meeting considered 33 new contributions concerning the Recommendation and new approaches that may enhance the prospects for complete harmonization of broadcast and non-broadcast applications of HDTV and may lead more rapidly to consensus on a full set of parameters for a single worldwide standard on HDTV.

Agreement was reached on the colorimetric parameter values for interim systems, contained in Recommendation 709, for which agreement had not been reached at the Final Meeting of Study Group 11. The important concept of a reference system is now introduced in the Recommendation together with the interim parameter values related to current display technology. Guidelines for further work have been agreed to define expeditiously the parameter values for the reference system leading to the possibility of considerable enhancements to picture rendition and reconstruction.

In addition to this important work, IWP 11/6 reviewed new approaches to HDTV standardization with respect to picture characteristics and picture scanning parameters that may assist in converging development towards a single worldwide standard for HDTV studio production and for international programme exchange. Agreement was reached on various approaches and parameter options that need further study. These include not only the already introduced concepts of Common Image Format and Common Date Rate, but also the new concept of Common Image Part and combined CIF/CDR approach.

Administrations and organizations participating in the work of the CCIR have been invited to study these subjects and to contribute reports on the results of their studies for consideration by IWP 11/6 before the Interim Meetings of Study Group 11 in the 1990-1994 study period. Other significant contributions that will assist the work are anticipated from the current work of IWP 11/9 on harmonization and from the WARC-92 preparations of JIWPs 10-11/1 and 10-11/3.

Harmonization activities (Interim Working Party 11/9)

Study Group 11 has established an Interim Working Party (IWP 11/9) to harmonize high-definition television standards taking into account the requirements of the IEC, ISO, CCITT and the CMTT.

The CCIR has been primarily concerned with HDTV studio production standards but has also worked on standards for other parts of the "broadcast chain" from production through to reception. On emission topics, effort has been directed at satellite broadcasting, data broadcasting, terrestrial broadcasting and baseband formats, as well as relationships with enhanced television. On programme exchange topics, work has been done on standards for baseband formats, videodisk, videotape, film and telecine.

It is now considered desirable to coordinate these activities with non-broadcasting HDTV communities of users, mainly represented by industrial, scientific, medical, computer displays, telecommunications and printing/publication interests. This would ensure an indispensable feedback channel through which the various requirements of the non-broadcast applications could be conveyed to the CCIR.

Interim Working Party 11/9 will be meeting in Tokyo, Japan from 3 to 9 October 1990 to review the progress of work and identify what further steps need to be taken by the CCIR, in consultation with other organs of the ITU, such as the CCITT, and international bodies, such as the IEC and the ISO, to reach early decisions on outstanding parameters of HDTV standards.

With these objectives in mind, IWP 11/9 will work to the following agenda:

(a) consider the general problems associated with the harmonization of broadcasting and non-broadcasting applications and develop basic guidelines for joint activities with the ISO, IEC and the CCITT;

(b) take into account the views of the ISO, IEC and the CCITT, to provide information to Study Group 11 concerning:
- harmonization of HDTV Recommendations;
- those parameters of the HDTV studio production standard still under study (see Recommendation 709).

(c) consider the implications of harmonization of HDTV standards on Recommendations being formulated by IWP 11/7, the CMTT, the CCITT, etc., for the transmission of TV programme signals, video conferencing, etc.

Satellite wide RF-band HDTV broadcasting (Joint Interim Working Parties 10-11/1 and 10-11/3)

Among the major topics that are likely to be on the agenda for WARC-92 are the question of a frequency allocation between 12.7 and 23 GHz for satellite wide RF-band HDTV and between 0.5 and 3 GHz for sound broadcasting from satellites to vehicular receivers. Studies should also be continued on the long range future suitability of the band 11.7-12.7 GHz for wide RF-band HDTV without prejudice to the existing plans in this band. JIWP 10-11/1 and JIWP 10-11/3 have been entrusted with the preparations and with coordination by the chairman of JWG 10-11S. Consecutive meetings of these JIWPs are scheduled in Australia in November 1990. The work to be undertaken is outlined in Decision 93 and these include the impact of the choice of frequency on system parameters; emission format, multiplexing and channel coding; satellite power; frequency sharing; system characteristics and spectrum needs for feeder links. The Chairmen of the JIWPs have already distributed the outline of the report and assigned tasks to specific individuals.

Both analogue and digital systems have been under consideration for the broadcasting by satellite of wide RF-band HDTV over a range of frequencies up to 23 GHz. Since each system has its own features in terms of required RF bandwidth, picture quality, etc., the selection of a preferred system should be made after consideration of all factors. At the same time it is indispensable to take into account the harmonization among the various media such as satellite wide RF-band digital HDTV, HDTV distribution systems via cable and B-ISDN over optical fibres, and the interface with the studio output. Since the uncompressed signal bit rate at the output of the HDTV studio is at a level that is too high for the economic transmission over satellite, fibre channels or broadcast emission, techniques will be needed to reduce the bit rate to fit the transmission channels without sacrificing quality. While the channel coding and error coding may differ among the various media, the compression and bit-rate reduction algorithms should have a maximum of commonality in the various applications to allow simple interface between them to achieve economies of scale and make possible receiving equipment adaptable to the different delivery mechanisms. Accordingly, close cooperation among JIWPs 10-11/1, 10-11/3, 10-11/5 and IWPs 11/6, 11/7, CMTT/2 and 11/9 is quite important.

6. Future work

During the current study period, Study Group 11 has achieved considerable progress in the development of HDTV. Its work has resulted in five Recommendations, of which Recommendation 709 is the most important. Significant work remains for the next study period. These studies include: the definition of the colour reference system; picture characteristics and scanning parameters; interfaces and application-specific standards for recording; transmission and emission; and the way in which these might be harmonized with non-broadcasting applications.

Such studies will include, in the area of opto/electronic conversion, approaches to achieving improvements in colour-rendition and signal reconstruction beyond that achieved with the chromaticity coordinates for interim primaries given in Recommendation 709. As far as signal format is concerned, studies will consider such improvements as may be achieved by the use of linear or quasi-linear derivation of luminance and colour-difference signals.

Some important parameters relating to picture characteristics and picture scanning characteristics still remain to be agreed upon. While it is not possible at this time to agree on a single picture characteristics and picture rate, a number of concepts have been established that could lead to a worldwide standard. These include the Common Image Format (CIF) approach and the concept of Common Data Rate (CDR), as well as the new concept of Common Image Part (CIP) introduced at the Special Meeting of IWP 11/6, and the combined CIF/CDR approach. Further studies are required to determine their relative advantages and disadvantages.

It has also been recognized that HDTV discussions should be broadened to include consideration of its potential application in other fields. Consideration of the possible use of HDTV displays for computers leads to an examination of criteria common to both fields of activity. Taking account of these findings could be crucial in the development of a synergy between HDTV production and related computer applications in the medium term, and the HDTV consumer display and computer equipment in the home in the longer term. For example, the concept of common sampling lattice (CSL) could be a possible way to further harmonization of formats between different image applications. The presence of frame buffer memories at a number of points in production-delivery chains could allow a fundamental change in the way the question of standardizing the HDTV picture and scanning parameters is addressed. More work needs to be done on this subject.

Important parameters related to the digital representation of HDTV are still to be determined during the next study period. These parameter categories are related to the picture characteristics and scanning parameters (§ 2 and 3 of Recommendation 709). The degree of bit-rate reduction acceptable for the production environment is a very important consideration. A second category of parameters is related to the relationship between analogue and digital representation (see § 6.6 of Recommendation 709), and in particular the transfer characteristics and the dynamic range. While the specification of satisfactory digital interfaces is already in progress, it can only be completed as the previous two categories of parameters are set.

The digital VTR is an essential part of the HDTV production chain and has important application in non-broadcast and consumer uses. Studies are in progress concerning proposals for full bit rate and reduced bit rate formats and their relationship to HDTV studio parameters and operational requirements.

11/6 and 11/9 and JIWPs 10-11/4 and 10-11/5 to achieve agreement on values for the remaining parameters.

The necessary steps to achieve a complete digital representation of the HDTV studio standard are now well identified. Based on the work already achieved, both on digital television and on high-definition television basic parameters, it is expected that all of the remaining steps can be completed.

The activities described above would encompass examination of the quality achieved with candidate parameters and approches; consideration of near-term and long-term technical and economic feasibility; current and future needs for production, programme exchange, distribution and emission. Special attention will be given to the definition of a programme exchange interface that maintains harmonious relations with conventional television, film, and broadcast and non-broadcast uses of HDTV. The existence, during a transitional stage, of equipment that does not fully meet the interface specification also will be considered.

In conclusion, Study Group 11 recognizes the need to complete these studies as rapidly as possible, and to prepare a report at the Interim Meeting of Study Group 11 in 1991, in accordance with Decision 58.

As it becomes increasingly apparent that applications of HDTV will exist in many areas besides broadcast usages for production, transmission and reception, the need for standards harmonization with other international organizations, both inside and outside the ITU, becomes a pressing necessity. Such harmonization is essential to avoid the proliferation of studies and duplication of effort.

In the IEC, activities are taking place which align closely with work in the CCIR on HDTV on subjects dealing with both professional and consumer equipment. Emphasis is currently being placed in the IEC on work related to the components of a studio recording standard, on measurement methods for satellite up links, on programme delivery via cable distribution systems, on work related to standards for DBS receivers, on matters dealing with display units and consumer video recorders, and on the development of electrical interface standards at the studio, transmitter, consumer receiver and recorder levels.

Regarding activities related to HDTV in ISO, the activities most immediately relevant to HDTV concern work on encoding of audio information and picture encoding, including motion pictures, on access to ISDN networks, work on electronic supports/media, and on colorimetry and graphics. Also under review is a proposal to undertake work on the representation and protocols for the exchange of audiovisual interactive applications.

Concerning activity related to HDTV in the CCITT where the broadband ISDN is under study, the emphasis has been placed on the support of a wide range of services, including audio, video and data applications in the same network. A key element of service integration for an ISDN is the provision of a range of services using a limited set of connection types and multipurpose user-to-network interfaces.

As work progresses in the CCIR, the CCITT, the IEC and ISO, it is anticipated that appropriate liaisons will be established to keep bodies working in areas of mutual interest fully informed of developments in each organization.

7. Conclusion

Study Group 11 is now well prepared to continue studies of HDTV in the widest context to ensure that the initiative CCIR has taken in this critical, worldwide development of HDTV is maintained and enhanced. The next study period will see HDTV moving rapidly from the development and planning stage, to implementation of HDTV broadcast services. The future work of Study Group 11 must reflect this new reality.

The Study Group has now successfully concluded all the tasks assigned to it by the XVIth Plenary Assembly of the CCIR in Resolution 96 and has progressed considerably beyond that point in its studies of HDTV. A good structure has been established also for the future work, recognizing the need for a global approach, taking account of a wide range of applications for HDTV and of the work proceeding in other organizations. The past, the present and the future of HDTV are fully covered in the texts that have been adopted in the Final Meeting.

ANNEX I TO PART 2

A REFERENCE TO THE TEXTS CONCERNING HDTV IN THE VOLUMES OF THE CCIR

Introduction

The CCIR has studied HDTV extensively, particularly in the context of television broadcasting and international programme exchange. At the Extraordinary Meeting of Study Group 11 concerning HDTV, it was also recognized that there existed other organizations such as the IEC and ISO and other parts of the ITU, such as the CCITT, that are already, or will be, concerned in the future with HDTV and that there existed a need to harmonize these studies.

This reference to the texts will be of assistance to those organizations and to others requiring information on the various aspects of HDTV, providing an efficient access to the Recommendations, Reports and other documents that are contained in the Volumes of the CCIR.

1. Recommendations concerning HDTV

		Volume	Page
709	Basic parameter values for the HDTV standard for the studio and for international programme exchange	XI-1	4
710	Subjective assessment methods for image quality in HDTV	XI-1	70
713	Recording of HDTV images on film	X/XI-3	
714	International exchange of programmes electronically produced by means of high-definition television	X/XI-3	
716	Scanned area of 35 mm motion picture film in HDTV telecines (non-anamorphic pictures)	X/XI-3	

2. Reports

2.1 *Basic information*

2.2 *Programme exchange*

2.2.1 *On Videotape*

2.2.2 *On film*

2.2.3 *By transmission links*

2.3 *Emission of HDTV*

2.4 *Industrial and consumer uses*

SECTION 11A: CHARACTERISTICS OF SYSTEMS FOR MONOCHROME AND COLOUR TELEVISION

RECOMMENDATION 470-2*

TELEVISION SYSTEMS

(Question 1/11)

(1970–1974–1986)

The CCIR,

CONSIDERING

(a) that many countries have established satisfactory monochrome television broadcasting services based on either 525-line or 625-line systems;

(b) that a number of countries have established (or are in the process of establishing) satisfactory colour television broadcasting services based on the NTSC, PAL or SECAM systems;

(c) that the use of video component signals, signals consisting of the luminance and two colour difference signals, with time compression and time division multiplexing, may offer picture quality benefits, using new types of television receivers;

(d) that it would add further complications to the interchange of programmes to have a greater multiplicity of systems,

UNANIMOUSLY RECOMMENDS

1. that, for a country wishing to initiate a monochrome television service, a system using 525 or 625 lines as defined in Report 624 is to be preferred;

2. that, for monochrome 625-line systems, the video-frequency characteristic described in Recommendation 472 is to be preferred;

3. that, for a country wishing to initiate a colour television service, one of the systems defined in Report 624, or any compatible improved versions of these systems, is to be preferred. However, other systems based on the use of video components that have been defined in Report 1073 can be considered.

Note – Pre-1986 editions of the CCIR volumes, and in particular that of 1982, contain a complete description of system E used in France until 1984, and system A used in the United Kingdom until 1985.

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* New television systems intended for satellite broadcasting are covered in Recommendation 650 and Report 1073.

RECOMMENDATION 471-1

NOMENCLATURE AND DESCRIPTION OF COLOUR BAR SIGNALS

(Question 1/11)

(1970-1986)

The CCIR,

CONSIDERING

(a) that a number of different colour bar signals used for measurement and adjustment purposes are recorded on magnetic tape, transmitted on national and international circuits or radiated from television transmitters;

(b) that the particular signal in use cannot be readily recognized from the video picture-signal waveform;

(c) that coloured patterns comprising several vertical bars of colour, involving only the primary hues and their complements at particular values of saturation and in descending order of luminance, are frequently used to confirm the correct operation of colour coding, decoding and processing equipment,

UNANIMOUSLY RECOMMENDS

1. that the following nomenclature is used to identify and distinguish between colour bar signals;

1.1 a colour bar generator is assumed to have three outputs corresponding respectively to the red, green and blue primary colour signals, (E'_R, E'_G and E'_B) which are then used as input signals to a colour coder. The signal amplitudes enumerated below refer to these coder input signals expressed as a percentage of the white level (see, for example, Recommendation 567, Part B, § B.1 and Report 624, Fig. 1), taking this as 100% with the blanking level as zero. During the transmission of colour bars the signal levels should be enumerated in the following order, with an oblique stroke between the numbers:

- the primary colour signal level during the transmission of the "white" colour bar, i.e. maximum value of E'_R, E'_G and E'_B;
- the primary colour signal level during the transmission of the "black" colour bar, i.e. minimum value of E'_R, E'_G and E'_B;
- the maximum level of the primary colour signal during transmission of "coloured" colour bars, i.e. maximum value of E'_R or E'_G or E'_B;
- the minimum level of the primary colour signal during transmission of "coloured" colour bars, i.e. minimum value of E'_R or E'_G or E'_B.

Example: Four versions of colour bars are in general use and are illustrated in Fig. 1, which shows the individual components of the red, green and blue primary colour signals as they are generated for four different types of colour bar signal. This data would be expressed as follows:

Colour bars *(a)* 100 / 0 / 100 / 0

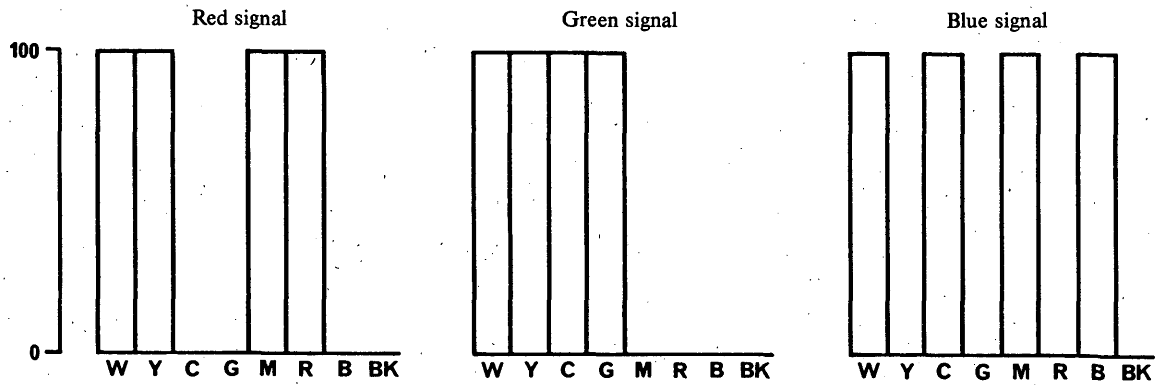
Colour bars *(b)* 100 / 0 / 75 / 0

Colour bars *(c)* 100 / 0 / 100 / 25

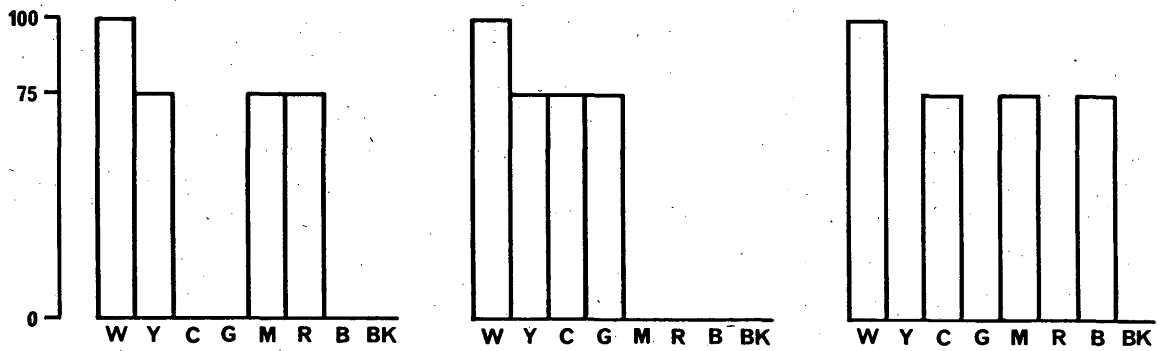
Colour bars *(d)* 75 / 7.5 / 75 / 7.5

2. that the waveforms shown in Fig. 1 be used to ensure conformity between measurements made in different operational environments;

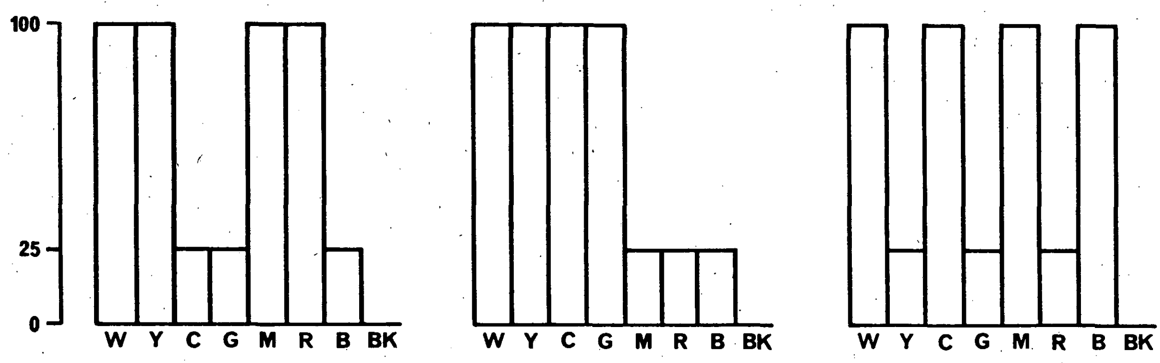
3. that all definitions and calculations relating to descriptions of colour bars shall be consistent with Report 624.



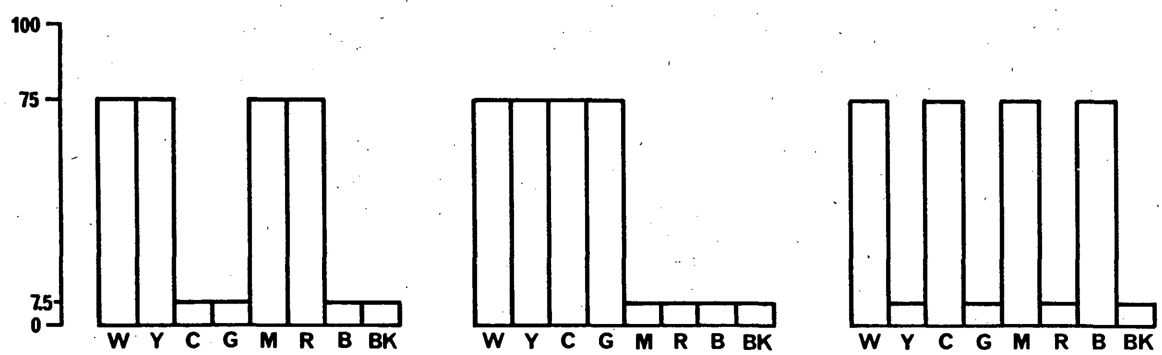
(a) 100/0/100/0 colour bars



(b) 100/0/75/0 colour bars



(c) 100/0/100/25 colour bars



(d) 75/7.5/75/7.5 colour bars

FIGURE 1 – *Relative amplitudes of colour bars for different types of generator*

W: white Y: yellow C: cyan (turquoise) G: green M: magenta (purple) R: red B: blue BK: black

RECOMMENDATION 709

BASIC PARAMETER VALUES FOR THE HDTV STANDARD FOR THE STUDIO AND FOR INTERNATIONAL PROGRAMME EXCHANGE

(Question 27/11)

(1990)

The CCIR,

CONSIDERING

(a) that the parameter values of an HDTV studio standard need to be chosen to facilitate:

- the production of HDTV programmes,
- the international exchange of HDTV programmes,
- the introduction of HDTV broadcasting services, and
- the use of HDTV for non-broadcast purposes;

(b) that this work is the subject of Question 27/11 and the Study Programmes which derive from it;

(c) that there are large benefits to programme producers and broadcasters in the adoption of a single world-wide standard for HDTV programme production and international programme exchange;

(d) that broadcasters and programme producers have a requirement for joint, international production in HDTV;

(e) that the HDTV studio standard must be harmonized with those of current and developing television systems and with those of existing motion-picture film,

UNANIMOUSLY RECOMMENDS

that the following parameters be used in the generation of signals in high-definition television studios and for international exchange of HDTV programmes.

Note – In this Recommendation, the processing model noted below is assumed. The parameters are thus expressed as components using a digital representation concept. Analogue parameters are derived.

Processing model

- Representation of the optical image as a set of three conceptual images in electrical form.
- Sampling of these conceptual images and arrangement of the samples.
- Conversion of the samples into a set of three electrical signals (RGB).
- Formatting of the RGB signal set.
- Analogue scaling, insertion of blanking intervals and addition of sync signals.
- Digital scaling, multiplexing and addition of timing references.

1. Opto-electronic conversion

Item	Characteristics			
	Parameter	Value		
1.1	Opto-electronic transfer characteristics before non-linear precorrection	Assumed linear		
1.2	Overall opto-electronic transfer characteristics at source	$V = 1.099\, L^{0.45} - 0.099$ for $1 \geqslant L \geqslant 0.018$ $V = 4.500\, L$ for $0.018 > L \geqslant 0$ where: L: luminance of the image $0 \leqslant L \leqslant 1$ V: corresponding electrical signal		
1.3	Chromaticity coordinates (CIE 1931)		Coordinates	
	– *For reference primaries, see Note*	Primary	x	y
		red	0.640	0.330
	– For interim primaries related to current display technology	green	0.300	0.600
		blue	0.150	0.060
1.4	Assumed chromaticity for equal primary signals $E_R = E_G = E_B$ (Reference white)	D_{65}		
			x	y
			0.3127	0.3290

Note – Studies to establish the parameter values for the reference primary colours, non-linear video processing and video matrixing are in progress to improve future display colour-rendition and to optimize transformation between HDTV, film, graphics and colour hard-copy (see Annex I). Administrations are urged to present the results of these studies to the Interim Meeting of the 1990-1994 CCIR study period, with the goal of finalizing appropriate values at that time.

2. Picture characteristics

Item	Characteristics	
	Parameter	Value
2.1	Aspect ratio	16 : 9
2.2	Sample per active line	1920
2.3	Sampling lattice	Orthogonal

2.4 The sample distribution and the number of active lines are interrelated and are still under study (see Annex I). The results of this study may also lead to the wish to reconsider the number of samples per active line.

3. Picture scanning characteristics

Item	Characteristics	
	Parameter	Value
3.1	Order of sample scanning	Left to right top to bottom
3.2	Interlace ratio	See below

The objective for the system is defined to be progressive scanning, i.e., 1:1 interlace ratio.

For current implementations, an interlace ratio of 2:1, or an equivalent sample-rate reduction process, may be used.

3.3 The picture rate depends on a number of well-known factors (see Annex I).

4. Signal format

Item	Characteristics	
	Parameter	Value
4.1	Conceptual non-linear precorrection of primary signals	$\gamma = 0.45$ (See complete specification in § 1.2)
4.2	Derivation of luminance signal E'_Y – *Equation for systems related to reference primaries see Note* – Equation for interim systems related to current display technology and conventional coding	$E'_Y = 0.2125\ E'_R + 0.7154\ E'_G + 0.0721\ E'_B$
4.3	Derivation of colour-difference signals (analogue coding) E'_{PB}, E'_{PR} – *Equation for system related to reference primaries, see Note* – Equation for interim systems related to current display technology and conventional coding	$E'_{PB} = 0.5389\ (E'_B - E'_Y)$ $E'_{PR} = 0.6349\ (E'_R - E'_Y)$
4.4	Derivation of colour-difference signals (digital coding) C_1, C_2	Digitally scaled from the values of 4.3

Note – Studies to establish the parameter values for the luminance and colour-difference equations are in progress to improve system performance and optimize transformations between HDTV, film graphics and colour hard-copy (see Annex I). Administrations are urged to present the results of these studies to the Interim Meeting of the 1990-1994 CCIR study period, with the goal of finalizing appropriate values at that time.

5. Analogue representation

Levels are specified in millivolts measured across a matched 75 Ω termination.

Item	Characteristics	
	Parameter	Value
5.1	Nominal level – E'_R, E'_G, E'_B, E'_Y	Ref. Black: 0 Ref. White: 700
5.2	Nominal level – E'_{P_B}, E'_{P_R}	± 350
5.3	Format of synchronizing signals	Tri-level bipolar (see Fig. 1)
5.4	Timing reference	(see Fig. 1)
5.5	Sync level ([1])	± 300 sync on all components (see Fig. 2)

([1]) Some administrations may wish to consider the use of sync on all components as optional.

5.6 The horizontal and vertical blanking intervals will be derived from the studies concerning the parameters in § 2 and 3 (see Annex I).

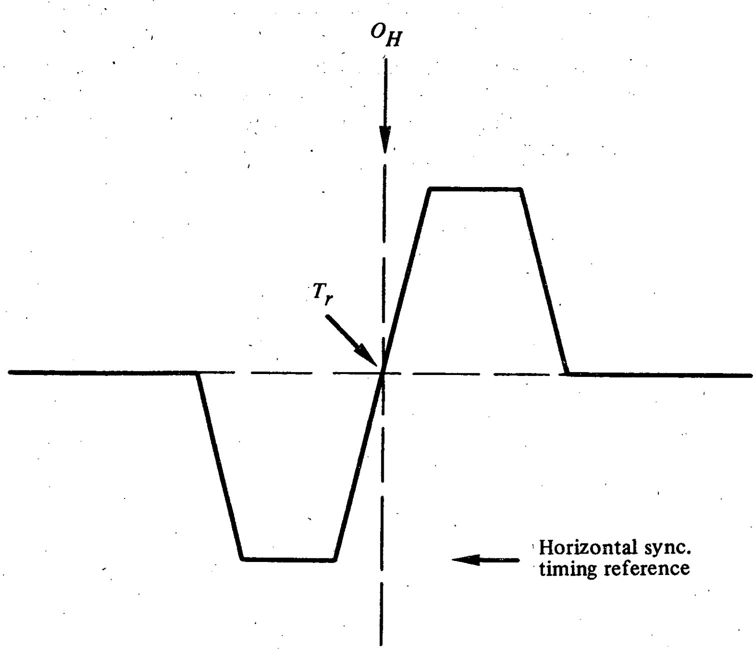


FIGURE 1 – *Format of synchronizing signal*

(The waveform exhibits symmetry with respect to point T_r.)

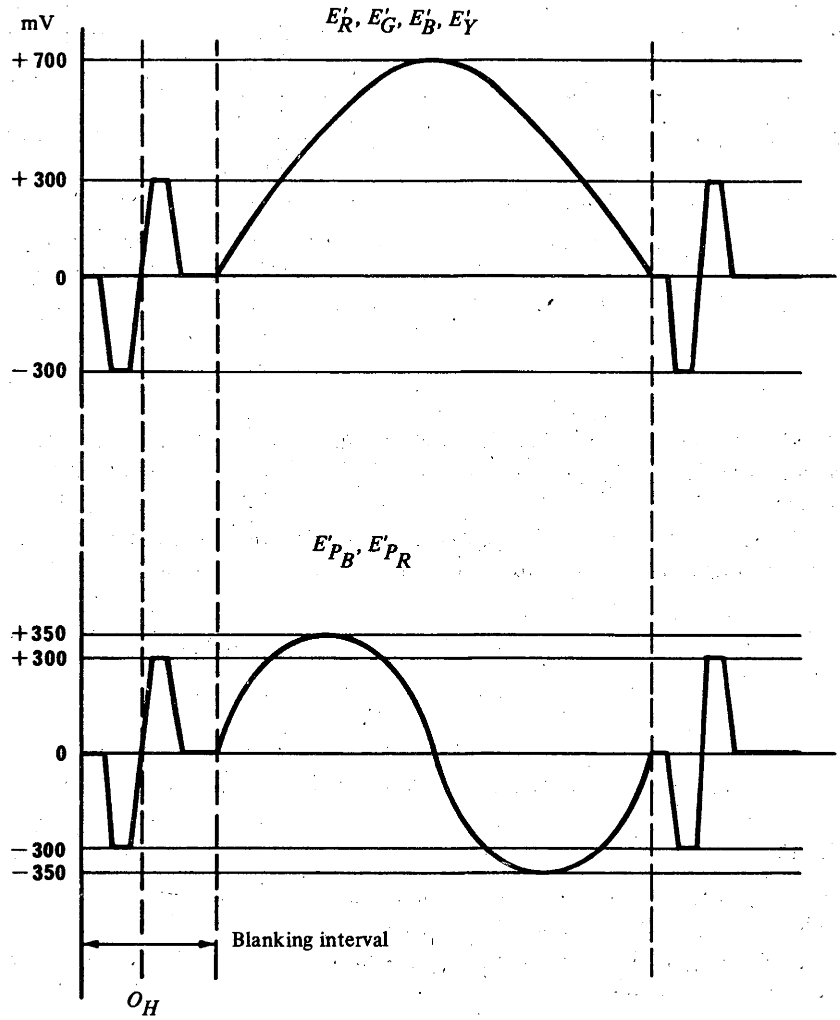


FIGURE 2 – *Sync level on component signals*

6. Digital representation

Item	Characteristics	
	Parameter	Value
6.1	Coded signals	R, G, B or Y, C_1, C_2
6.2	Sampling lattice R, G, B, Y	Orthogonal, line and picture repetitive
6.3	Sampling lattice C_1, C_2	Samples co-sited with each other and with alternate luminance samples
6.4	Sampling frequency R, G, B, Y	Sampling frequency is an integer multiple of 2.25 MHz
6.5	Sampling frequency C_1, C_2	Colour-difference sampling frequency to be 1/2 luminance sampling frequency

6.6 The parameters for the samples per full line for the R, G, B, Y, C_1 and C_2 signals, the signal coding, nominal levels and synchronizing words, possibly together with video related data (video index signal), are still under study (see Annex I).

6.7 The bit rate of the HDTV signal is expected to be in the range 0.8 to 1.2 Gbit/s for current implementations and in the range 2.0 to 3.0 Gbit/s for some future implementations (see Annex I).

ANNEX I

NOTES ON THE OUTSTANDING HDTV STUDIO PARAMETER VALUES

1. Opto-electronic conversion

Three approaches are included in the studies concerning the parameter values for the reference primary colours for the worldwide HDTV studio standard [CCIR, 1986-90a]:

– an extension of the colour gamut based on the values shown in § 1.3, through adjustment of the allowable video-signal ranges [CCIR, 1986-90b];
– adoption of the values shown in Table I [CCIR, 1986-90c];
– adoption of the values shown in Table II [CCIR, 1986-90d].

TABLE I

	Primary	Coordinates	
		x	y
Assumed chromaticity coordinates (CIE 1931) for reference primaries	red green blue	0.6915 0.0000 0.1440	0.3083 1.0000 0.0297

TABLE II

	Primary	Coordinates	
		x	y
Assumed chromaticity coordinates (CIE 1931) for reference primaries	red green blue	0.640 0.168 0.150	0.330 0.731 0.060

2. Picture characteristics

There has been extensive discussion of those aspects of a standard that are related to the way in which the television picture is to be constructed to achieve a single worldwide studio standard as desired by all administrations.

The difficulty lies in a determination as to a means of reaching that goal, particularly because of the problems associated with the field or picture frequency.

In addition to the direct one-step approach to a single standard, contributions have been presented suggesting two conceptual approaches to the above problems. One of these is a "common image format" concept which could be used at a picture or field frequency to suit the application. The other is based on the "common data rate" concept inherent in Recommendation 601. A contribution has also been presented [CCIR, 1986-90e] suggesting a new approach based on the concept of "common image part" whereby a sampling lattice with common sample density is used to define pictures of different sizes, resulting in different numbers of pixels per frame. The two previous approaches can be made special cases of this latter approach.

Further discussion of these matters is found in Reports 801 and 1217.

3. Picture scanning characteristics

There are two major factors to be considered in the selection of a picture rate:

– motion portrayal; and

– the relationship with film and with current and future TV systems.

Motion portrayal is influenced mainly by the picture rate selected and dynamic resolution is improved by the introduction of shuttering in the camera.

Both the picture rate and the interlace ratio are significant for a number of well known reasons.

4. Signal format

The IWP 11/6 Expert Group [CCIR, 1986-90d] suggested that an interim HDTV system should use conventional YC_1C_2 coding which is used in currently available HDTV production systems. In addition, it was suggested that augmented conventional or constant-luminance coding approaches may offer more accurate signal rendition or reconstruction.

Studies are in progress to evaluate more thoroughly possible system performance improvements using constant-luminance coding. A decision then will be made as to whether constant-luminance coding will be included in HDTV system design.

5. Analogue representation

It may be possible to vary the blanking intervals at appropriate interfaces in the overall HDTV system [CCIR, 1986-90f].

6. Digital representation

6.1 *Parameters for the studio standard*

In addition to the number of samples per digital active line, the number of samples per full line, analogue-to-digital horizontal timing relationship, further agreements are being sought on the following items:

6.1.1 Form of coding

6.1.2 Correspondence between video signal levels and quantization levels:

– scale,
– luminance signal,
– each colour-difference signal.

Studies are continuing in this area [CCIR, 1986-90g]. There is agreement that at least 8 bits are required for R, G, B, Y, C_1 and C_2, and that 10 bits will be required for some applications. Therefore, both 8-bit and 10-bit representations are required.

The operational margin of the dynamic range is still subject to further study [CCIR, 1896-90h] even in the case of Recommendation 601 as described in Report 629.

One possible solution is to use the same relationship between video signal levels and quantizing levels as that in Recommendation 601, for 8-bit signals, and for the 10-bit signal, to simply add two bits of lower significance.

Several other proposals are under consideration. One takes the Recommendation 601 approach mentioned above but adds possibilities of variable dynamic range in the case of 10-bit. Another family of proposals [CCIR, 1986-90i] uses part of the 8- or 10-bit dynamic range to extend the permissible signal level above nominal peak white and below normal black level.

6.1.3 *Video index*

The studio standard parameters could embrace the definition of a "video index" signal. Such a signal would include information concerning the origin, coding and prior processing of the signal [CCIR, 1986-90g and j].

To finish § 6.1.1 and 6.1.2 above, further studies are necessary to complete the definition of the form of coding (linear and non-linear). Reaching a conclusion to these studies may be aided if the video index signal included the values of selected parameters.

6.1.4 *Code word usage*

It may be reasonable to reserve some levels when a similar structure of the interface to that described in Recommendation 656 is used, particularly for synchronization data.

6.2 *Some considerations on bit rates*

The source bit rate can be fixed as the result of the choices on relevant parameter values of the studio standard. Transmission of this bit rate in Level 16 of the Synchronous Hierarchy (2488.320 Mbit/s)* appears to be technically feasibly.

Various bit-rate reduction techniques for HDTV signals are being developed, and the quality obtainable with them is under examination in reference to user requirements which are yet to be established. Many workers are interested in a possibility of achieving contribution quality with a bit rate of 140 Mbit/s. Further comparative study with a unified test method is most desirable before method(s) of bit-rate reduction are recommended.

Bit rate reduction techniques may permit use of bit rate for network transmission such as Level 4 (622.080 Mbit/s)* or Level 1 (155.520 Mbit/s)* of the Synchronous Hierarchy or possibly lower bit rates.

REFERENCES

CCIR Documents

[1986-90]: **a.** IWP 11/6-4032 (Denmark, Finland, France, Ireland, Italy, Netherlands, Spain and United Kingdom); **b.** IWP 11/6-4011 (Japan); **c.** IWP 11/6-4023 (Denmark, Finland, France, Ireland, Italy, Netherlands, Spain and United Kingdom); **d.** IWP 11/6-3020 (AHEG-C); **e.** IWP 11/6-4001 (Sweden); **f.** IWP 11/6-3035 (Australia); **g.** IWP 11/6-4008 (IWP 11/7); **h.** IWP 11/6-4015 (Japan); **i.** IWP 11/6-4027 (Thomson-CSF); **j.** IWP 11/6-4004 (Canada).

* See CCITT Recommendation G.707.

SECTION 11B: ANCILLARY TELEVISION SERVICES

RECOMMENDATION 653-1

TELETEXT SYSTEMS *

(Study Programme 29B/11)

(1986–1990)

The CCIR,

CONSIDERING

(a) that several countries have developed and established satisfactory teletext systems;

(b) that it would be highly desirable to assure the compatibility of such systems with the videotex (interactive videography) systems;

(c) that a proliferation of such systems would add further complication to the interconnection of such systems,

UNANIMOUSLY RECOMMENDS

1. that for a country wishing to initiate a teletext service, one of the four systems in Annex I is to be preferred.

ANNEX I

CHARACTERISTICS OF TELETEXT SYSTEMS

1. Introduction

This Annex provides information about the teletext systems, developed for use with television systems of Recommendation 470 whose characteristics are described in Report 624.

An outline description of the essential elements of the teletext systems is given in Table I and the accompanying diagrams (Figs. 6, 7, 8 and 9). The structure of the Table is based, as far as practicable, on the ISO reference model.** For fully detailed specifications of the systems, see [CCIR, 1990].

Table II lists the countries and systems used.

2. Definition of the teletext service

A digital data broadcasting service which may be transmitted either within the structure of an analogue television signal or by using digital modulation systems. The service is primarily intended to display text or pictorial material in two-dimensional form reconstructed from coded data on the screens of suitably equipped television receivers.

Note – At the present time, the field-blanking interval is, in most cases, used for the data broadcasting service, but a possible option exists for extending the data broadcasting service to occupy all active lines in a television signal. The effect on protection ratios for television broadcasting has been studied for 625-line systems and the results published in Recommendation 655.

3. A layered model for describing teletext systems

A hierarchical organization of communication functions for teletext data broadcasting systems is presented in Fig. 1, where the functional items, listed at each hierarchical level, do not refer to specific implementation solutions, but to the overall logical features that are considered sufficient to characterize the service and performance of a typical teletext system.

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* Also referred to as broadcast videography.

** ISO 7498 (1984) "Basic reference model for open systems interconnection".

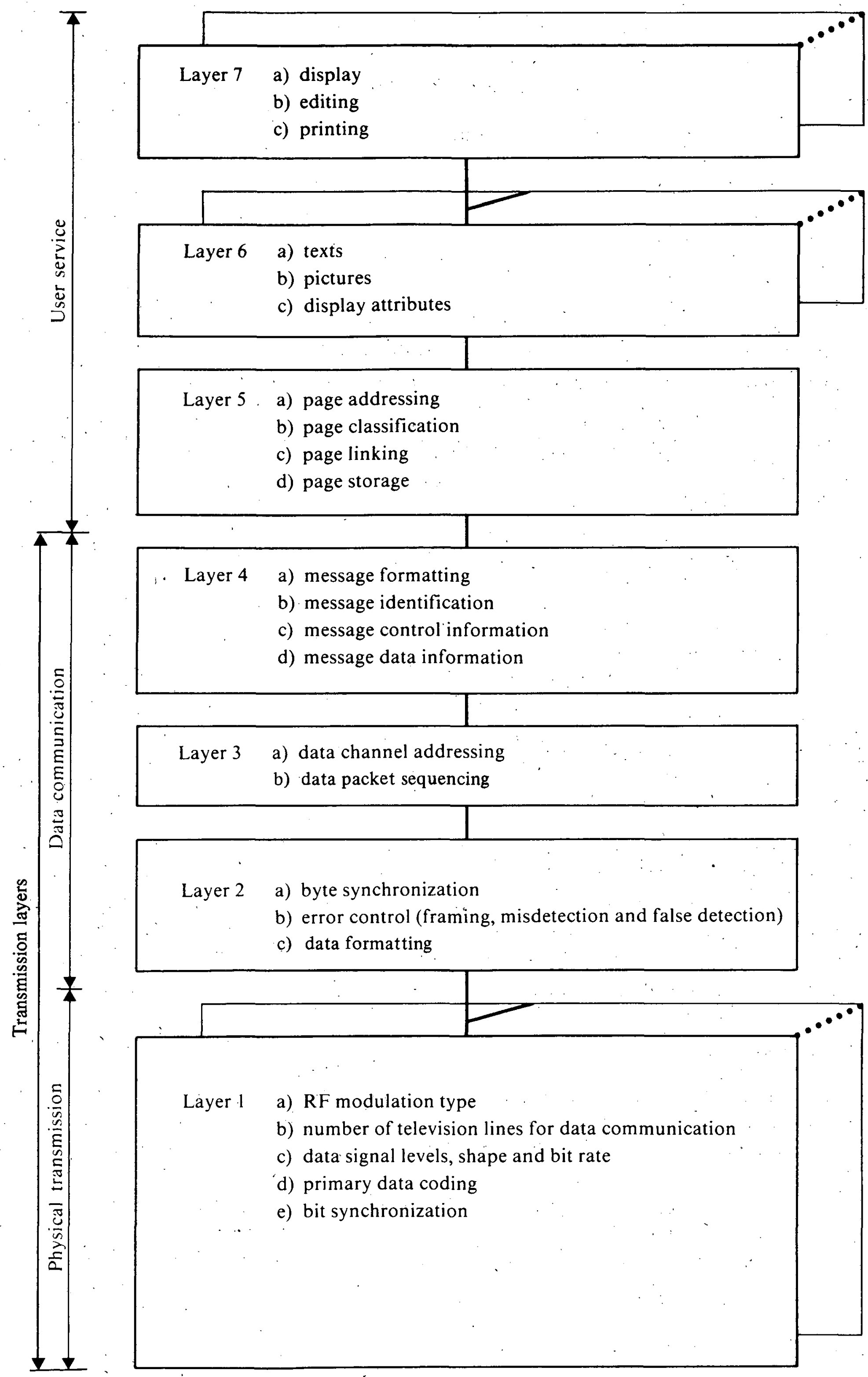


FIGURE 1 – *A functional layered model for the description of teletext systems*

According to this functional model, services may be delivered by arranging the information into logical groupings, delivering them to lower layers for transmission and, after reception, reconstituting the information into the proper form for use by the recipient.

In what follows, the names of the layers are those adopted by the ISO in ISO 7498 (1984) "Basic reference model for open systems interconnection". Some of these names are used in broadcasting technology to express different concepts. This particularly applies to the terms "network" and "link" and care must be taken to avoid confusion.

Layer 1: Physical

Within a given broadcast transmission system this layer relates to the electrical transmission of the data signal and includes such items as bit rate and pulse shaping.

Layer 2: Link

This layer includes logical functions related to the data transmission such as digital frame synchronization techniques, data formatting and error control procedures.

Layer 3: Network

This layer includes logical functions related to multiplexing and demultiplexing of data packets belonging to different communication flows. Examples of such functions are data channel addressing and data packet sequencing.

Layer 4: Transport

This layer provides the function of arranging the data in a way suitable for transfer from one point to another, by such means as segmenting data into groups of information, delivering them to the lower layers for transmission to the distant point and there reconstituting the groups of information and arranging them in a proper sequence.

Layer 5: Session

This layer includes data handling functions which are intended to assist the user to gain access to services. Examples of such functions are access control and page classification.

Layer 6: Presentation

This layer comprises data presentation functions. Examples are the codings used for the presentation of text, pictures and sound.

Layer 7: Application

This layer refers to practical use of the potential facilities provided by the lower layers for a given type of service.

Examples are captioning, telesoftware and cyclic teletext.

4. Transmission characteristics

The logical structure of different elements of the teletext data and their relationship to the television signal are illustrated in Figs. 2, 3, 4 and 5.

4.1 *Data line* (Fig. 2)

A data line is a television line, the active part of which is assigned to digital data. The data content is subdivided into a bit synchronization sequence followed by a *data unit.*

4.2 *Data unit* (Fig. 3)

A data unit is a logical unit of data, subdivided into a byte synchronization sequence and a *data packet.*

4.3 *Data packet* (Fig. 4)

A data packet is an identifiable information package which comprises:

- *a prefix* providing for functions such as addressing, packet size indication, packet continuity indication and designation of packet type;
- *a data block* containing control signals or user information;
- in some systems, a *suffix* to perform the function of error detection or correction at the packet level.

4.4 *Data group* (Fig. 5)

A data group is an identifiable group of data blocks containing information from the same source.

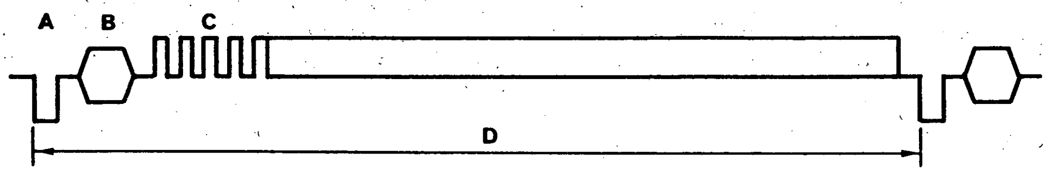


FIGURE 2 – *Data line*

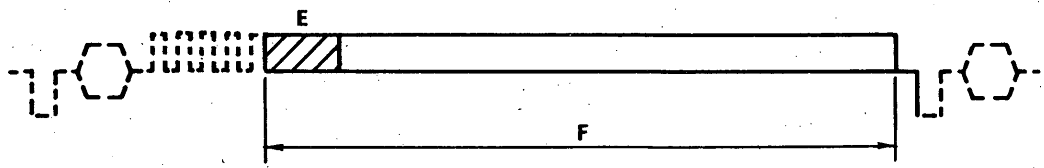


FIGURE 3 – *Data unit*

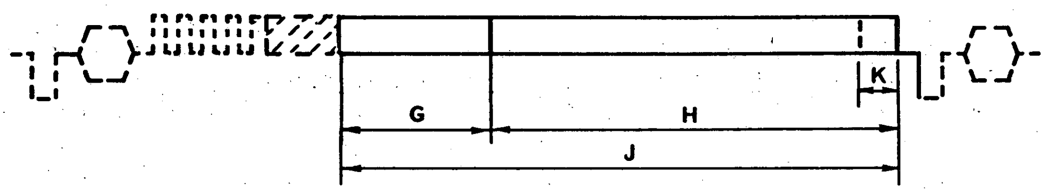


FIGURE 4 – *Data packet*

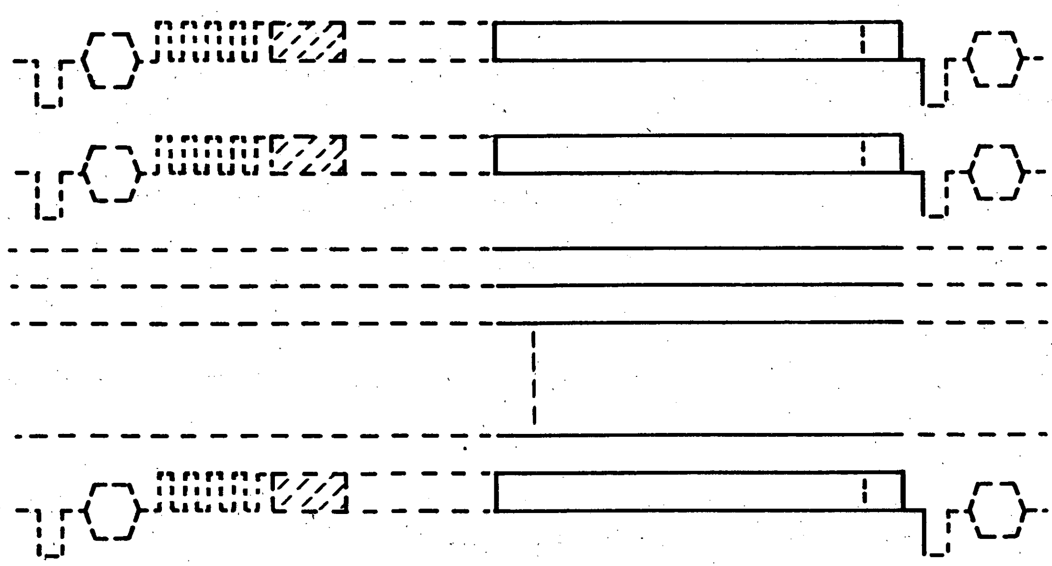


FIGURE 5 – *Data group*

A: line sync.
B: colour burst
C: bit sync.
D: data line
E: byte sync.
F: data unit
G: prefix
H: data block
J: data packet
K: suffix where applicable

5. Presentation layer characteristics

In specifying the presentation layer of teletext systems, substantive account has been taken of the work of the CCITT on videotex systems in its Recommendations T.100 and T.101 (Malaga-Torremolinos, 1984). The work of ISO TC 97/SC2 on character repertoires and coding for all writing systems and languages has also to be taken into account.

5.1 *Repertoires*

5.1.1 *Alphabets and character sets*

a) *Latin alphabet*

The code tables for characters and pictorial commands for the presentation of Latin alphabet based alphanumeric and pictorial information are identical with the respective Videotex code tables of the annexes of CCITT Recommendation T.101 (Malaga-Torremolinos, 1984), with the exception of additional characters as indicated in § 5.1.2. For some coding formats, the controls, commands and instruction sequences are also identical to those of the respective Videotex coding standards. For other formats a precisely equivalent set of controls and description/instruction sequences are defined.

b) *Cyrillic alphabet*

For the Cyrillic alphabet all characters are ISO identified (ISO/DIS 6937-8) with the exception of two symbols [CCIR, 1986-90a].

c) *Chinese character sets*

Chinese characters are very large in number and complicated in form. According to the National Standard of the People's Republic of China GB 2312-80 "Code of Chinese graphic character set for information interchange primary set", the number of the first grade Chinese characters is 3755, and that of the second grade characters is 3008. In the teletext standard of China, the stipulations on encoding and character forms in GB 1988-80 "7-bit encoding character set for information exchange" and GB 2311-80 "7-bit coded character set for information processing exchange methods of extension" will be followed [CCIR, 1986-90b].

d) *Japanese character sets*

The Japanese language is written with mixed use of three types of Japanese characters, and sometimes with the addition of Latin alphabets. They are Katakana, Hiragana and Kanji. The Katakana and Hiragana character sets have a single-byte structure based on ISO standards and respectively contain 86 and 83 Japanese phonetic characters. The Kanji character set has a two-byte structure also based on the ISO standards and contains 2965 characters of level 1 and 3388 characters of level 2 specified in Japanese Industrial Standard (JIS) C 6226. Kanji uses ideographic characters which have a close relation with Chinese characters [CCIR, 1986-90c].

5.1.2 *Special characters*

Certain characters of importance for the captioning functions of teletext services are not included in any of the presentation layer syntaxes defined in Annexes to CCITT Recommendation T.101 Malaga-Torremolinos, 1984). These are:

1 ☎ Telephone

2 ≦ Off-screen indicators

3 ≧

5.2 *Source coding*

5.2.1 *Alphanumeric coding*

These codes are used to display text. Alphanumeric graphic elements include alphabetic letters, syllabic characters and ideographic characters with or without diacritical signs, figures, punctuation marks and special signs.

5.2.2 *Mosaic coding*

These codes are used to construct drawings by means of block mosaic, smooth mosaic and line drawing characters. Each element defines part of a pattern and occupies one character position. Two forms of presentation are defined:

– separated: each element is surrounded by a border of the background colour;
– contiguous: elements adjoin one another.

5.2.3 *Dynamically re-definable character sets (DRCS)*

Character sets in which some, or all, of the characters may be defined at the source and down loaded into the receiver, which can then use them as graphic elements.

5.2.4 *Geometric coding*

These codes are used to construct drawings of various types by a succession of elements such as points, lines and surfaces.

5.2.5 *Photographic coding*

These codes are used to cause the generation of individual picture elements for the display of an image. Continuous tone images as well as pattern oriented displays including graphics characters are included.

5.2.6 *Musical sound data*

These codes are used to cause the generation of musical sounds. Pitch, tone duration, rhythm, timbre and harmonic relationship are defined.

TABLE Ia – *Description of the essential elements of teletext systems specified for 625/50 television systems*

Teletext system	A	B	C	D (1)
Layer 1: Physical				
1.1 Time slot usable for data	Active part of any TV line subject to availability			
1.2 Data positioning (relative to line sync. timing reference (2)	10.5 ± 0.32 μs	Bit 13 is reference plus 12.0 μs (+1.0, −0.4)	10.48 ± 0.34 μs	
1.3 Data amplitude (2) logical 0 logical 1	*S*: sync. *D*: pedestal *A*: data *D*/*S* = 0 (± 3%) *A*/*S* = 7/3(+0, −10%) for positive modulation *A*/*S* = 14/9(−0, +6%) for negative modulation	Black level ± 2% 66% (± 6%) of black-to-white excursion	0 IRE units 70 IRE units for negative modulation 100 IRE units for positive modulation	
1.4 Bit rate	6.203125 Mbit/s ± 0.005%	6.9375 Mbit/s ± 25 × 10^{-6}	5.734375 Mbit/s (3) (367 × line frequency)	
1.5 Data shaping (2)	Sine square	Spectral shaping is skew symmetrical about 0.5 bit rate	Typically a raised cosine 100% roll-off spectrum, followed by a video low pass filter	
1.6 Data coding	Binary NRZ	Binary NRZ	Binary NRZ	
1.7 Data line including clock run-in	320 bits	360 bits	288 bits (The first 16 bits of alternating 1's and 0's constitute the clock run-in)	
Layer 2: Link				
2.1 Digital frame synchronization	Byte 3 = 11100111 [CCIR, 1990; Part 1.1, § 1.3.5]	Byte 3 = 11100100	Byte BS = 11100111	
2.2 Length of data unit	38 bytes	43 bytes	34 bytes (excluding clock run-in)	

Note. – For (1), (2) and (3) see end of Table Ib.

TABLE Ia *(continued)*

Teletext system	A	B	C	D [1]
2.3 Format indicator	Byte 8 (byte 5 in short prefix)	Not required	PS byte	
2.4 Error detection/correction				
2.4.1 Byte error detection – parity	Odd parity on teletext data bytes	Odd parity for bytes 4 to 45 Even parity for bytes 1 to 3	Odd parity	
2.4.2 Byte error detection/correction	8/4 Hamming code on bytes 4 to 8 (4 and 5 in short prefix)	8/4 Hamming code for bytes 4 and 5; 8/4 and 24/18 for extension packets numbers 26, 27, 28 and 29	8/4 Hamming code on all bytes in the prefix, data group header, record header	
2.4.3 Block error detection/correction	No	Bytes 44 and 45 of designated data blocks carry a cyclic redundancy check word (CRC)	Suffix bytes indicated by bits b8b6 of the PS byte	
Layer 3: Network				
3.1 Data channel addressing	Bytes 4, 5 and 6 [CCIR, 1990; Part 1.1, § 1.4]	Bytes 4 and 5 of all packets	Bytes P1, P2, P3	
3.2 Data packet sequencing	Byte 7	Bytes 4 and 5 of all packets	Byte C1	
3.3 Length of prefix	5 bytes (long prefix) or 2 bytes (short prefix)	2 bytes	5 bytes	
3.4 Length of data block	Given by value of byte 8 (byte 5 in short prefix) according to a look-up table [CCIR, 1990; Part 1.1, § 1.4.1.2]	40 bytes	0, 26, 27 or 28 bytes indicated by bits b8b6 of PS byte	

TABLE Ia *(continued)*

Teletext system	A	B	C	D ([1])
Layer 4: Transport				
4.1 Group of data blocks	Start = SOH-RS (0/1-1/14) End = ETX-EOT (0/3-0/4) [CCIR, 1990; Part 1.1, § 4.2.1]	In page-oriented services: – start by page header packet, bytes 4 to 13 – termination by next page header packet For independent data services: – packets 30 and 31. See [CCIR, 1990] for details	Byte GT indentifying 16 types of data group	
4.2 Data group size	1920 bytes max. [CCIR, 1990; Part 1.1, Annex 4.5, § 4.2]	1024 bytes or multiples of 1024 bytes	Bytes S1, S2, and F1, F2	
4.3 Data group integrity				
4.3.1 Continuity	No	Automatic	Byte GC	
4.3.2 Error detection/correction	No	Packet 27, bytes 44 and 45 of designated data blocks carry a cyclic redundancy check word (CRC)	Suffix bytes identified by bits b8b6 of the PS byte	
4.4 Data group sequencing	No	Packets 27, bytes 7 to 42 of designated data blocks	L1, L2 for a given page address	
Layer 5: Session				
5.1 Indicator of type of session				
5.1.1 Cyclic/non-cyclic	Address of data channel (N2 = 96, for example) [CCIR, 1990; Part 1.2, § 3]	Not required	RT = 0/RT = 1	

TABLE Ia *(continued)*

Teletext system	A	B	C	D (1)
5.1.2 Access control	Y16b2b4b6 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.3]	Packet 27 and packet 29 of designated data blocks	Under study	
5.1.3 Terminal facilities	Y15b6b8 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.3]	Display/processable, packet 27, byte 43 of designated data blocks	Basic TTx service recognizes RT = 0, 1, 2 and 3; RT = 4 to 13 are reserved; RT = 14 and 15 are for bradcaster use	
5.1.4 Protocol	Y11b2b4b6b8 [CCIR, 1990; Part 1.1, Annex 4.2, § 1]	Packet 27, byte 43 of designated data blocks		
5.1.5 Batch	No	Packet 27, byte 43 of designated data blocks		
5.1.6 Addressed to user	No	Packet 28, designated data blocks		
5.1.7 Priority	Magazine 0 (N2 = 0)	Not required	RT = 3	
5.1.8 Application	Row 0 (C1 = C2 = C3 = 0 [CCIR, 1990; Part 1.1, Annex 4.1]	Packet 27, byte 43	RT = 2	
5.2 Page classification			Record designator byte, RD, bit 6 = 1 indicates presence of classification sequence	
5.2.1 Normal	C1 C2 C3 E(0...A) except 000	Not required	RT = 0 or 1 and absence of other page classification indicators	
5.2.2 Subtitle	C1 C2 C3 = 10 Y22b8 = 0 [CCIR, 1990; Part 1.2, § 3]	Control bit in page header packet	$Y1_3$ b8 = 1	
5.2.3 Delayed/inhibited display	Y13b8 = 1 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.2]	Control bit in page header packet	$Y1_3$ b6 = 1	
5.2.4 Linked	Y25Y26 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Packet 27, byte 43 of designated data blocks	Header extension bytes (HE)	

TABLE Ia *(continued)*

Teletext system	A	B	C	D [1]
5.2.5 Index	Y12b4 = 1 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.1]	See 5.3	$Y1_3$ b4 = 1	
5.2.6 Alarm	Y12b8 = 1 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.1]	See 5.3	$Y1_5$ b8 = 1, $Y1_5$ b6 = 1 (RT = 3)	
5.2.7 Update	Y13b4b6 Y12b6 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Control bit in page header packet	$Y1_5$ b4 = 1, version # ($Y1_6$) updated	
5.2.8 Priority	C1 = C2 = C3 = A [CCIR, 1990; Part 1.1, Annex 4.1] Y12b2 = 1 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.1]	See 5.3	$Y1_5$ b8 = 1, $Y1_5$ b6 = 0 (RT = 3) (Applies only to television mode)	
5.2.9 Programme related	Y22b8 = 0 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Packet 30, bytes 17 to 25 of designated data blocks	See subtitle and priority page classifications	
5.2.10 Newsflash	Y22b8 = 0 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Control bit in page header packet	Access through data channel B00, page address 0. $Y1_6$ updated	
5.2.11 Support	No	Packet 27, bytes 7 to 42 of designated data blocks	Support record address FFF, $Y1_5$ b2 = 1 Support needed $Y1_4$ b2 = 1	
5.2.12 Scrolling	No	Scrolling region defined by packet 26, bytes 7 to 45 of designated data blocks	See [CCIR, 1990]	
5.2.13 Cover	Y22b4 = 1 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Control bit in page header packet	Data channel 0, page 0 or other page 0 addresses	
5.2.14 Reveal	Y13b8 = 0 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.2]	Control bit in page header packet or user operation	$Y1_5$ b8 = 0, $Y1_5$ b6 = 1 (RT = 3)	

TABLE Ia *(continued)*

Teletext system	A	B	C	D (1)
5.3 Page access information				
5.3.1 Network label	Row 0 (C1 = C2 = C3 = 0) or N2 = (0 or 99)	Packet 30, bytes 13 and 14 of designated data blocks	RT = 2, see [CCIR, 1990]	
5.3.2 Date and time	Row 0 (C1 = C2 = C3 = 0), if any	Packet 30, bytes 15 to 21 of designated data blocks	RT = 2, see [CCIR, 1990]	
5.3.3 Page address	C1 C2 C3 [CCIR, 1990; Part 1.1, Annex 4.1]	Bytes 6 and 7 of page header packet	A_1 A_2 A_3 and RD b2 = 1 for A_4-A_9 (extended address)	
5.3.4 Sub-page address	If Y12b6 = 0, then Y25 Y26, [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	Bytes 8 to 11 of page header packet	$Y1_4$ b8 = 1 (more) and extended address as above	
5.3.5 Logical data delimiter	Not required, see presentation layer	Not required	Not required. Consequence of record header format itself	
5.3.6 Page reconstruction	L [CCIR, 1990; Part 1.1, § 4.2.2.3]	Not required	Update defined by $Y1_5$ b4 = 1 and $Y1_6$ (version #)	
5.3.7 Cyclic marker	No	Not required	$Y1_4$ b6 = 1 (RT = 3) (Subcycle marker if RT = 0 or 1)	
5.3.8 Programme identification	N2 = 0, row 0	Packet 30, bytes 22 to 25 of designated data blocks	RT = 2, see [CCIR, 1990]	
5.3.9 Initial page address	Cover page, Y12b2 [CCIR, 1990; Part 1.1, Annex 4.2, § 1.1]	Packet 30, bytes 7 to 12 of designated data blocks	Data channel 0, page 0	
5.3.10 Search indicator	No	Packet 27, byte 6 of designated data blocks	RT = 2, see [CCIR, 1990]	

TABLE Ia *(continued)*

Teletext system	A	B	C	D [1]
5.3.11 Auto acquisition	If Y12b6 = 0, then Y25 Y26 + C1 C2 C3 [CCIR, 1990; Part 1.1, Annex 4.2, § 2]	As 5.3.9 and 5.3.12	$Y1_4$ b4 = 1	
5.3.12 Page linking	No	Packet 27, bytes 7 to 42 of designated data blocks	Header extension bytes (HE)	
5.4 Conditional access				
5.4.1 Control word synchronization	First US of an article [CCIR, 1990; Part 1.1, § 5.2.3]	Packet 28, bytes 7 to 45 of designated data blocks	Under study	
5.4.2 Initialization complement	C1 C2 C3 L [CCIR, 1990; Part 1.1, § 5.2.3]	Packet 28, bytes 7 to 45 of designated data blocks		
5.4.3 Entitlement checking messages	C1 C2 C3 = FFF, US 3/F 3/F [CCIR, 1990; Part 1.1, § 5.3.1]	Packet 1 to 24 when designated for this function		
5.4.4 Audience segmentation	Y16b2b4b6 [CCIR, 1990; Part 1.1, § 5.3.1]	Packet 28, bytes 7 to 45 of designated data blocks		
5.4.5 Descrambling generator	Pseudo-random generator [CCIR, 1990; Part 1.1, Annex 5.1]	See 5.4.1		
5.4.6 Descrambling procedure	XOR [CCIR, 1990; Part 1.1, § 5.2.3]	See 5.4.1		
Layer 6: Presentation	CCITT Rec. T.101 Syntax 2, Annex C, Profile 2 and [CCIR, 1990]	See [CCIR, 1990] [11]	CCITT Recommendation T.101 [12] (Melbourne 1988), Data Syntax III and [CCIR, 1990]	
Layer 7: Application	Practieal use of the potential facilities provided by the lower layers leads to services such as: access to pages of information, music with text, subtitling, telesoftware, etc. Further information specific to each system is given in [CCIR, 1990]			

TABLE Ib – *Description of the essential elements of teletext systems specified for 525/60 television systems*

Teletext system	A	B	C	D
Layer 1: Physical				
1.1 Time slot usable for data	Active part of any TV line subject to availability			
1.2 Data positioning (relative to line sync. timing reference) (2)		Bit 13 is reference plus 11.7 μs (± 0.175)	10.48 ± 0.34 μs	9.78 ± 0.35 μs
1.3 Data amplitude (2) logical «0» logical «1»		Black level ± 2% 70% (± 6%) of black-to-white excursion	0 IRE units 70 IRE units for negative modulation 100 IRE units for positive modulation	0 ± 2.5 IRE units 70 ± 2.5 IRE units
1.4 Bit rate		5.727272 Mbit/s ± 25 × 10^{-6}	5.727272 Mbit/s (3) (364 × line frequency)	5.727272 Mbit/s ± 3 × 10^{-6} (364 × f_H; 8/5 × f_{sc})
1.5 Data shaping (2)		Spectral shaping is skew symmetrical about 0.5 bit rate	Typically a raised cosine 100% roll-off spectrum, followed by a video low pass filter	Spectrum shaping... Controlled cosine roll-off, roll-off factor 0.6, cut-off frequency 0.5 × bit rate
1.6 Data coding		Binary NRZ	Binary NRZ	Binary NRZ
1.7 Data line including clock run-in		296 bits	288 bits (The first 16 bits of alternating 1's and 0's constitute the clock run-in)	296 bits (bytes (4) 1 to 37. Bytes 1 and 2 comprise clock run-in)
Layer 2: Link				
2.1 Digital frame synchronization		Byte 3 = 11100100	Byte BS = 11100111	Byte 3 = 11100101

TABLE Ib *(continued)*

Teletext system	A	B	C	D
2.2 Length of data unit		35 bytes	34 bytes (excluding clock run-in)	35 bytes
2.3 Format indicator		Not required	PS byte	
2.4 Error detection/correction				
2.4.1 Byte error detection – parity		Odd parity for bytes 4 to 37 Even parity for bytes 1 to 3	Odd parity	
2.4.2 Byte error detection/correction		8/4 Hamming code for bytes 4 and 5; 8/4 and 24/18 for extension packets numbers 26, 27, 28 and 29	8/4 Hamming code on all bytes in the prefix, data group header, record header	
2.4.3 Block error detection/correction		Bytes 7 and 8 of designated data blocks carry a cyclic redundancy check word (CRC)	Suffix bytes indicated by bits b8b6 of the PS byte	(272, 190) majority logic decodable difference set cyclic code on bytes 4 to 37 as a block
Layer 3: Network				
3.1 Data channel addressing		Bytes 4 and 5 of all packets	Bytes P1, P2, P3	Byte 4 and the data line position
3.2 Data packet sequencing		Bytes 4 and 5 of all packets	Byte CI	Byte 5 (bits 1 to 4)
3.3 Length of prefix		2 bytes	5 bytes	14 bits (byte 4 and byte 5, bits 1 to 6)
3.4 Length of data block		32 bytes	0, 26, 27 or 28 bytes indicated by bits b8b6 of PS byte	22 bytes (D-bytes [5] 1 to 22)

TABLE Ib *(continued)*

Teletext system	A	B	C	D
Layer 4: Transport				
4.1 Group of data blocks		In page-oriented services: – start by page header packet, bytes 4 to 13. – termination by next page header packet. For independent data services: – packets 30 and 31. See [CCIR, 1990] for details	Byte GT indentifying 16 types of data group	Byte 5, bit 6 = 1 and D-byte 1 = 00/1 indicate the data block contains a data group header. D-bytes 2 to 7 constitute the data group header.
4.2 Data group size		1024 bytes or multiples of 1024 bytes	Bytes S1, S2 and F1, F2	D-bytes 4 and 5 (6)
4.3 Data group integrity				
4.3.1 Continuity		Automatic	Byte GC	A data group is a series of data blocks sequentially transmitted in a data channel. (See 3.1 and 3.2)
4.3.2 Error detection/correction		Packet 27, bytes 7 and 8 of designated data blocks carry a cyclic redundancy check word (CRC)	Suffix bytes identified by bits b8b6 of the PS byte	D-bytes 21 and 22 carry a cyclic redundancy check (CRC) if D-byte 20 is 01/7, 00/3 or 00/4
4.4 Data group sequencing		Packet 27, bytes 7 to 36 of designated data blocks	L1, L2 for a given page address	D-byte 3 (6); byte 5, bit 5 = 1 delimits transmission units
Layer 5: Session				
5.1 Indicator of type of session				
5.1.1 Cyclic/non-cyclic		Not required	RT = 0/RT = 1	HI (7) = 01/14 02/0 or 01/14 02/1, H-byte (8) 7, bit 1

TABLE Ib *(continued)*

Teletext system	A	B	C	D
5.1.2 Access control		Packet 27 and packet 29 of designated data blocks	Under study	
5.1.3 Terminal facilities		Display/processable, packet 27, byte 37 of designated data blocks	Basic TTx service recognizes RT = 0, 1, 2 and 3; RT = 4 to 13 are reserved; RT = 14 and 15 are for broadcaster use	HI = 01/14 02/0 or 01/14 02/1, H-byte 8
5.1.4 Protocol		Packet 27, byte 37 of designated data blocks		HI = 01/14 02/0 or 01/14 02/1, H-byte 7, bits 5-8
5.1.5 Batch		Packet 27, byte 37 of designated data blocks		HI = 01/14 02/0 or 01/14 02/1, H-byte 7, bit 2 = 1
5.1.6 Addressed to user		Packet 28, designated data blocks		
5.1.7 Priority		Not required	RT = 3	
5.1.8 Application		Packet 27, byte 37	RT = 2	
5.2 Page classification			Record designator byte, RD, bit 6 = 1 indicates presence of classification sequence	
5.2.1 Normal		Not required	RT = 0 or 1 and absence of other page classification indicators	HI = 01/14 02/1 H-byte 7, bit 3 = 0 and bit 4 = 0 and H-byte 9, bit 5 = 0 and bit 6 = 0
5.2.2 Subtitle		Control bit in page header packet	$Y1_3$ b8 = 1	HI = 01/14 02/1, H-byte 7 bit 3 = 1 and bit 4 = 1
5.2.3 Delayed/inhibited display		Control bit in page header packet	$Y1_3$ b6 = 1	

TABLE Ib *(continued)*

Teletext system	A	B	C	D
5.2.4 Linked		Packet 27, byte 37 of designated data blocks	Header extension bytes (HE)	All pages in a batch-type programme are linked (see 5.1.5) HI = 01/14 02/0, H-byte 9, bits 1 to 4 indicate the page linkage structure
5.2.5 Index		See 5.3	$Y1_3$ b4 = 1	
5.2.6 Alarm		See 5.3	$Y1_5$ b8 = 1, $Y1_5$ b6 = 1 (RT = 3)	
5.2.7 Update		Control bit in page header packet	$Y1_5$ b4 = 1, version # ($Y1_6$) updated	HI = 01/14 02/0 or 01/14 02/1, H-byte 10, bit 2
5.2.8 Priority		See 5.3	$Y1_5$ b8 = 1 $Y1_5$ b6 = 0 (RT = 3) (Applies only to television mode)	
5.2.9 Programme related		Packet 30, bytes 17 to 25 of designated data blocks	See subtitle and priority page classifications	HI = 01/14 02/0 or 01/14 02/1, H-byte 7, bit 3 = 1 and bit 4 = 0
5.2.10 Newsflash		Control bit in page header packet	Access through data channel B00, page address 0. $Y1_6$ updated	HI = 01/14 02/1, H-byte 9, bit 5 = 1 and bit 6 = 0 and H-byte 7, bit 3 = 0 and bit 4= 0
5.2.11 Support		Packet 27, bytes 7 to 36 of designated data blocks	Support record address FFF, $Y1_5$ b2 = 1 Support needed $Y1_4$ b2 = 1	HI = 01/14 02/0
5.2.12 Scrolling		Scrolling region defined by packet 26, bytes 7 to 36 of designated data blocks	See [CCIR, 1990]	HI = 01/14 02/1, H-byte 9, bit 6 = 1
5.2.13 Cover		Control bit in page header packet	Data channel 0, page 0 or other page 0 addresses	

TABLE Ib *(continued)*

Teletext system	A	B	C	D
5.2.14 Reveal		Control bit in page header packet or user operation	$Y1_5$ b8 = 0, $Y1_5$ b6 = 1 (RT = 3)	
5.3 Page access information				
5.3.1 Network label		Packet 30, bytes 13 and 14 of designated data blocks	RT = 2, see [CCIR, 1990]	HI = 01/14 02/2, H-bytes 5 to 7
5.3.2 Date and time		Packet 30, bytes 15 to 21 of designated data blocks	RT = 2, see [CCIR, 1990]	
5.3.3 Page address		Bytes 6 and 7 of page header packet	A_1 A_2 A_3 and RD b2 = 1 for A_4-A_9 (extended address)	HI = 01/14 02/0 or 01/14 02/1 or 01/14 02/3, H-byte 4, bits 1 to 4 and H-byte 5 (PR = 000 ~ 999)
5.3.4 Sub-page address		Bytes 8 to 11 of page header packet	$Y1_4$ b8 = 1 (more) and extended address as above	HI = 01/14 02/1, H-byte 6 (PA = 00 ~ 99)
5.3.5 Logical data delimiter		Not required	Not required. Consequence of record header format itself	01/14 N: HI [7] (N: parameter byte) 01/15 N: DI [9] (N: parameter byte)
5.3.6 Page reconstruction		Not required	Update defined by $Y1_5$ b4 = 1 and $Y1_6$ (version #)	HI = 01/14 02/3
5.3.7 Cyclic marker		Not required	$Y1_4$ b6 = 1 (RT = 3) (subcycle marker if RT = 0 or 1)	
5.3.8 Programme identification		Packet 30, bytes 22 to 25 of designated data blocks	RT = 2, see [CCIR, 1990]	HI = 01/14 02/2, DI = 01/15 03/13
5.3.9 Initial page address		Packet 30, bytes 7 to 12 of designated data blocks	Data channel 0, page 0	

TABLE Ib *(continued)*

Teletext system	A'	B	C	D
5.3.10 Search indicator		Packet 27, byte 6 of designated data blocks	RT = 2 see [CCIR, 1990]	
5.3.11 Auto acquisition		As 5.3.9 and 5.3.12	$Y1_4$ b4 = 1	
5.3.12 Page linking		Packet 27, bytes 7 to 36 of designated data blocks	Header extension bytes (HE)	HI = 01/14 02/1 DI = 01/15 03/5 P-byte ([10]) 5 to 9
5.4 Conditional access				
5.4.1 Control word synchronization		Packet 28, bytes 7 to 36 of designated data blocks	Under study	Under study
5.4.2 Initialization complement		Packet 28, bytes 7 to 36 of designated data blocks		
5.4.3 Entitlement checking messages		Packets 1 to 25 when designated for this function		
5.4.4 Audience segmentation		Packet 28, bytes 7 to 36 of designated data blocks		
5.4.5 Descrambling generator		See 5.4.1		
5.4.6 Descrambling procedure		See 5.4.1		
Layer 6: presentation		See [CCIR, 1990]	CCITT Recommendation T.101 ([11]) (Melbourne, 1988), Data Syntax III and [CCIR, 1990]	See [CCIR, 1990] ([12])

TABLE Ib *(continued)*

Teletext system	A	B	C	D
Layer 7: Application	Practical use of the potential facilities provided by the lower layer leads to services such as: access to pages of information, music with text, subtitling, telesoftware, etc. Further information specific to each system is given in [CCIR, 1990].			

(1) Parameters for 625-line 50-field applications are subject to further study.

(2) Parameters for data positioning, amplitude and shaping may be altered to suit particular transmission requirements.

(3) Bit rate parameter may be altered to suit particular transmission requirements.

(4) "Byte" number indicates a byte position in the data line.

(5) "D-byte" number indicates a byte position in the data block.

(6) Data group header bytes (see 4.1).

(7) Data header identifier (see 5.3.5).

(8) "H-byte" number indicates a byte position in a data header.

(9) Protocol data unit identifier.

(10) "P-byte" number indicates a byte position in the protocol data unit.

(11) Latin alphabets based on ISO 6937 with subsets for French, German, Slavic languages, etc., coding for 12 syllabic writing systems in use in the Indian sub-continent and adjacent areas, are specified as are two byte systems for coding idiographic characters used in many languages throughout the world (Kanji, Katakanga, Hiragana, Hangul, etc.).

(12) Caters for all Latin and non-Latin graphic sets such as Greek, Cyrillic, Arabic, Chinese Hanzi, etc., registered in accordance with ISO 2375.

TABLE Ic – *Description of essential elements of teletext systems specified for use with the packet multiplex of the MAC/packet systems*

Teletext system	A	B	C	D
Layer 1: Physical				
1. Data	As MAC/packet data component			
Layer 2: Link				
2.1 Service identification data	MAC/packet address '0'			
2.2 List of services	LISTX parameter '18 in MAC/packet address '0'			
2.3 LISTX item	Teletext coded '03			
2.4 Digital component information parameter DCINF in MAC/packet '0', parameter identifier values		'B0 Teletext 'B1 Teletext subtitles 'B2 Replacement teletext 'B3 Programme delivery control		
2.5 Access coordinates: 16 bits associated with DCINF parameter		4 most significant bits indicate level of error protection '1 First level '2 Second level		
2.6 Complementary access coordinates		Optional 2-byte extension of access coordinates Byte 1, 3 LSBs: magazine number Byte 2: page number		
2.7 Error detection/correction		Level 1: 2 teletext packets in each data block plus a CRC check digit Level 2: 12-bit data words have 11-bit Golay Code and parity bit		
Other layers comprise teletext data as in Table Ia or Ib				

TABLE Id – *Description of essential elements of teletext systems specified for use with the digital multiplex of the NICAM 728 sound system*

Teletext system	A	B	C	D
Layer 1: Physical				
1. Data	As NICAM 728 system data component when signalled as carrying independent data			
Layer 2: Link				
2.1 Data frame		Includes frame alignment word, control data, component information, 88 bytes teletext data		
2.2 Component information		Signals 2 levels of protection as in Table Ic, 2.5		
2.3 Error protection/correction		2 levels of protection similar to that of Table Ic, 2.7		
Other layers comprise teletext data as in Table Ia or Ib				

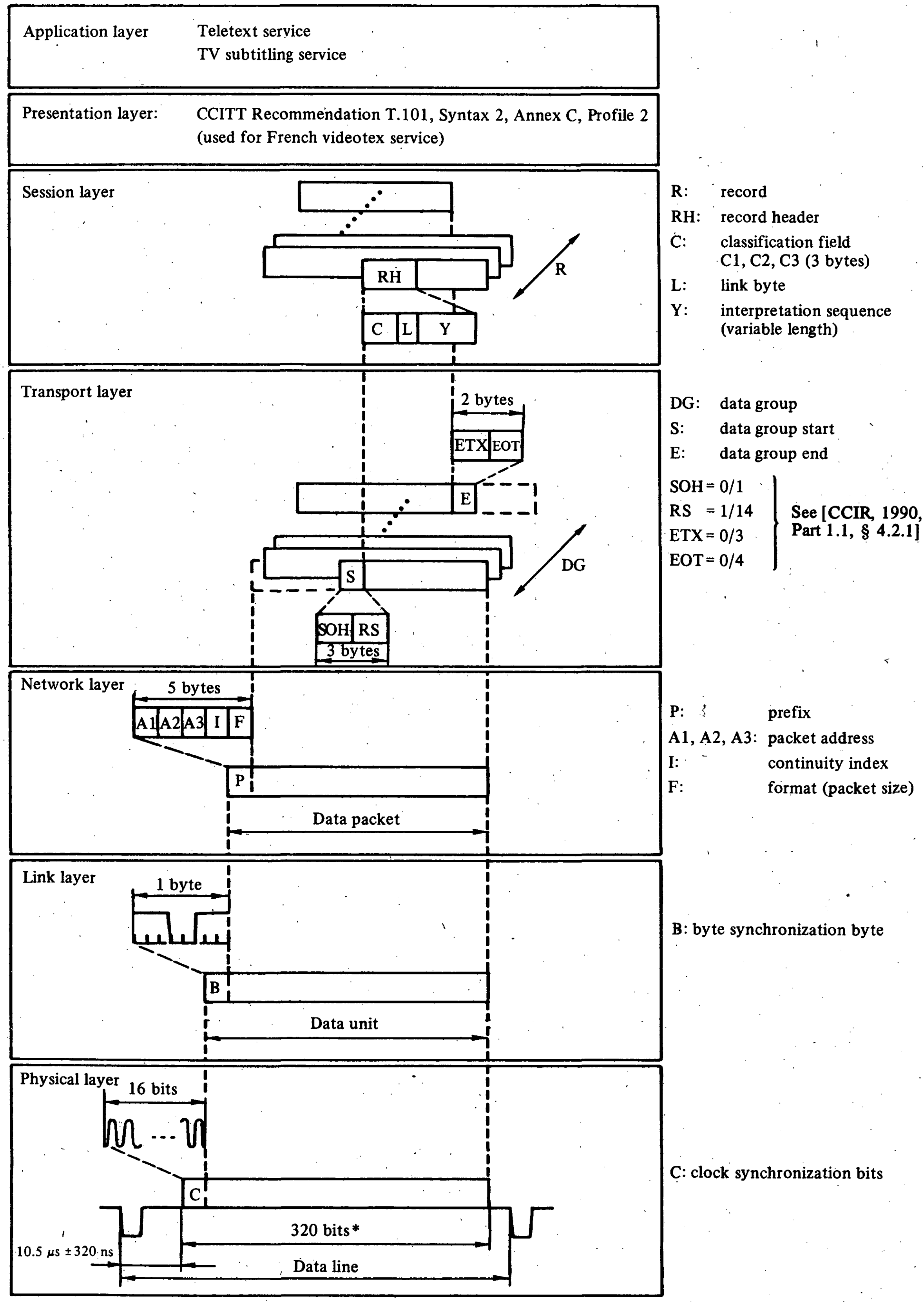


FIGURE 6 – *Layered structure of teletext system A*

* See Note 2 of Table I.

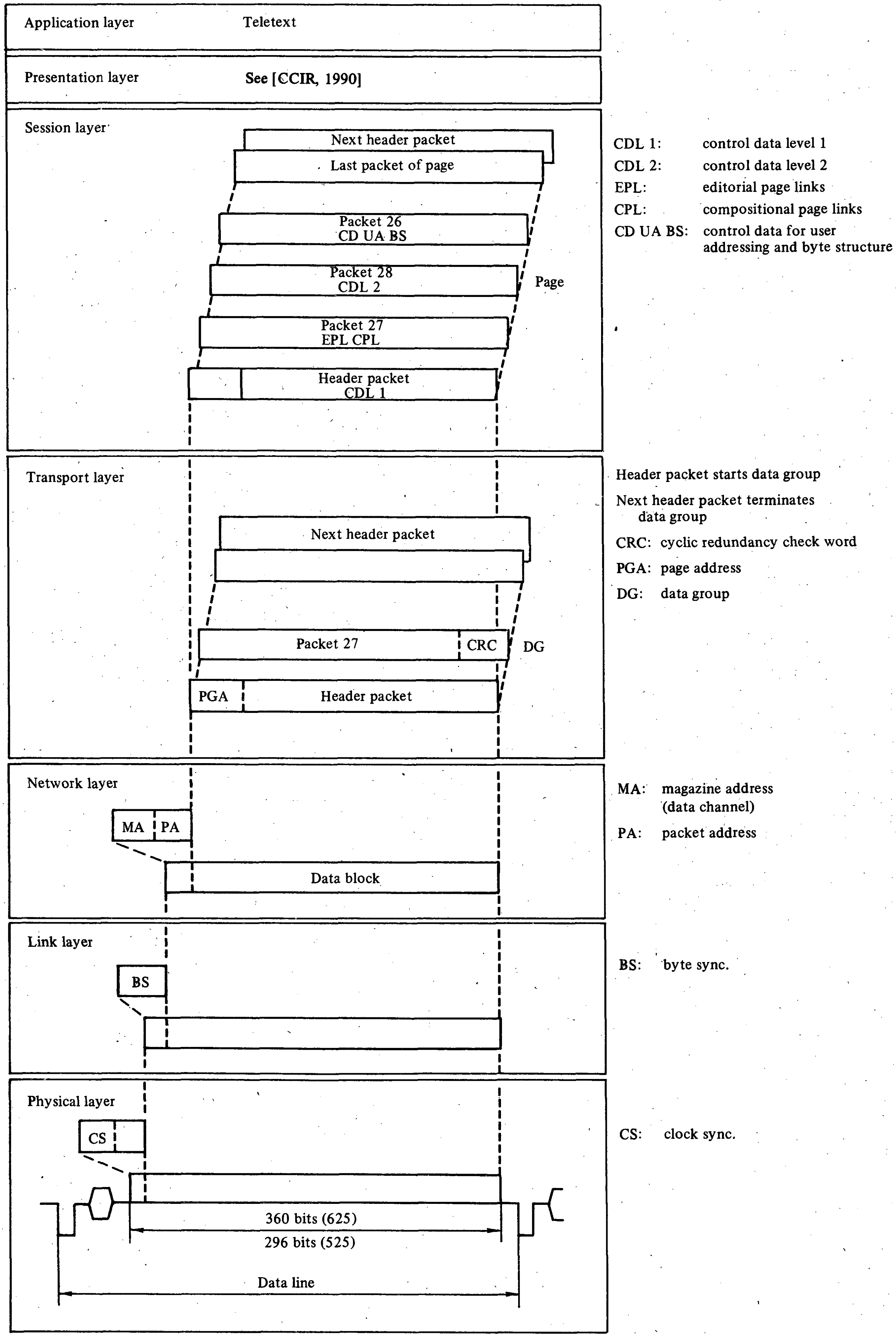
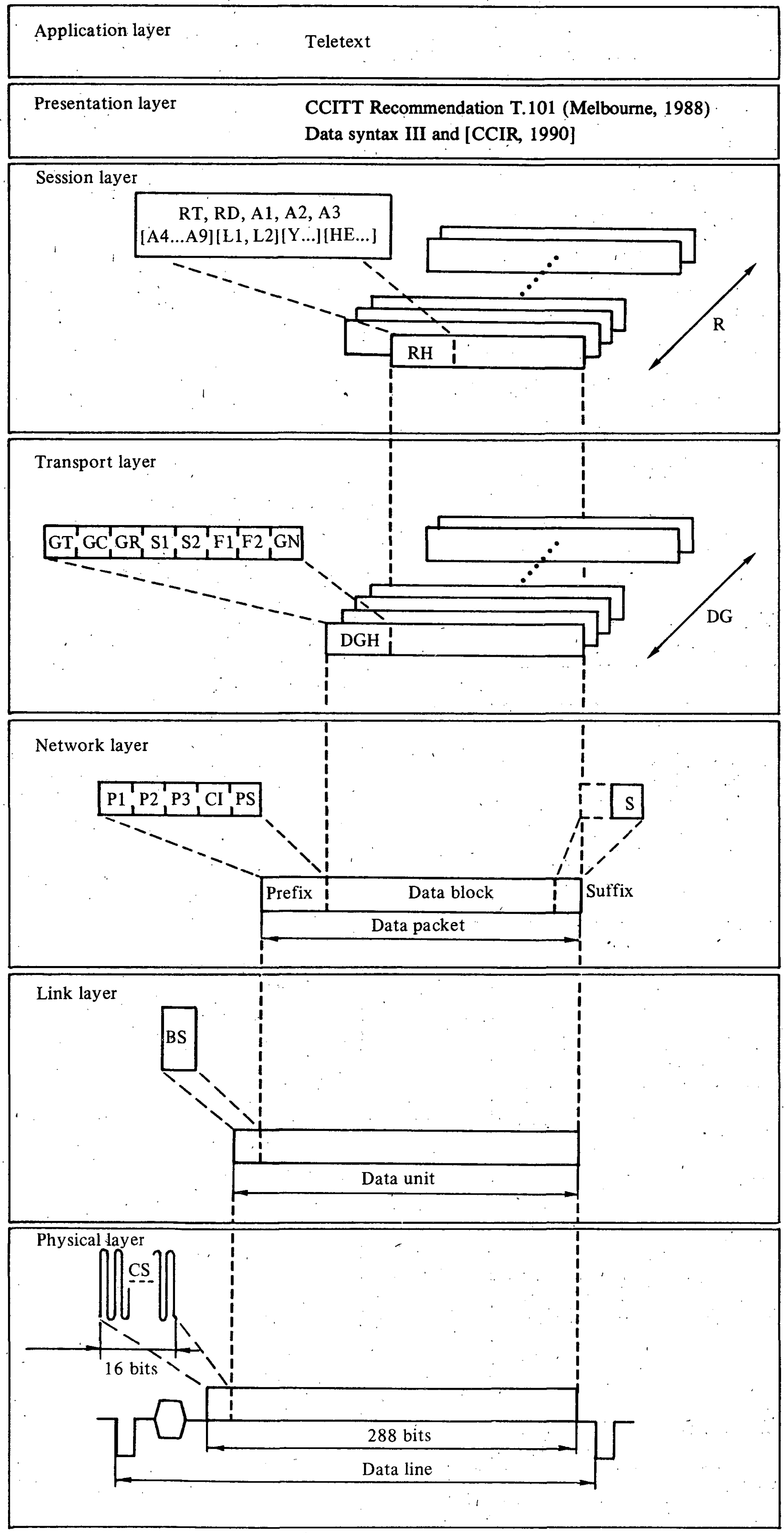


FIGURE 7 – *Layered structure of teletext system B*



R: record
RH: record header
RT: record type
RD: record header designator
A1, A2, A3: record address
A4, A5, A6, A7, A8, A9: optional record address extension
L1, L2: optional record link
Y: optional classification sequence
HE: optional header extension field (5)

DG: data group
DGH: data group header
GT: data group type
GC: data group continuity
GR: data group repetition
S1, S2: data group size
F1, F2: final non-zero block size
GN: data group network routing

P1, P2, P3: packet address bytes
CI: continuity index byte
PS: packet structure byte
S: suffix

BS: byte synchronization byte

CS: clock synchronization bits

FIGURE 8 – *Layered structure of teletext system C*

Layer	Principal function	Processing of data
Layer 7: Application	Programme services	– Subtitle, cyclic, batch and pseudo-interactive programme, etc. – User's programme selection and response.
Layer 6: Presentation	Presentation coding	– Character and DRCS coding – Photographic coding – Geometric coding – Music coding
Layer 5: Session	Identification and control of programme data	PRD: programme data PRCD: programme control data PAD: page data PRCI: programme control information PACI: page control information DU: protocol data unit DI: data unit identifier DL: data unit length DUD: data unit data
Layer 4: Transport	Data transmission control	DG: data group DGH: data group header DB: data block
Layer 3: Network	Multiplexing of data packet	DP: data packet P: prefix (14 bits) DB: data block (176 bits; 22 bytes)
Layer 2: Link	Digital frame sync. and error control	FC: framing code (8 bits) EC: error correcting check bit (82 bits)
Layer 1: Physical	Physical transmission	D: data line (296 bits; 37 bytes) S: line-sync. signal C: colour burst CR: clock run-in (16 bits)

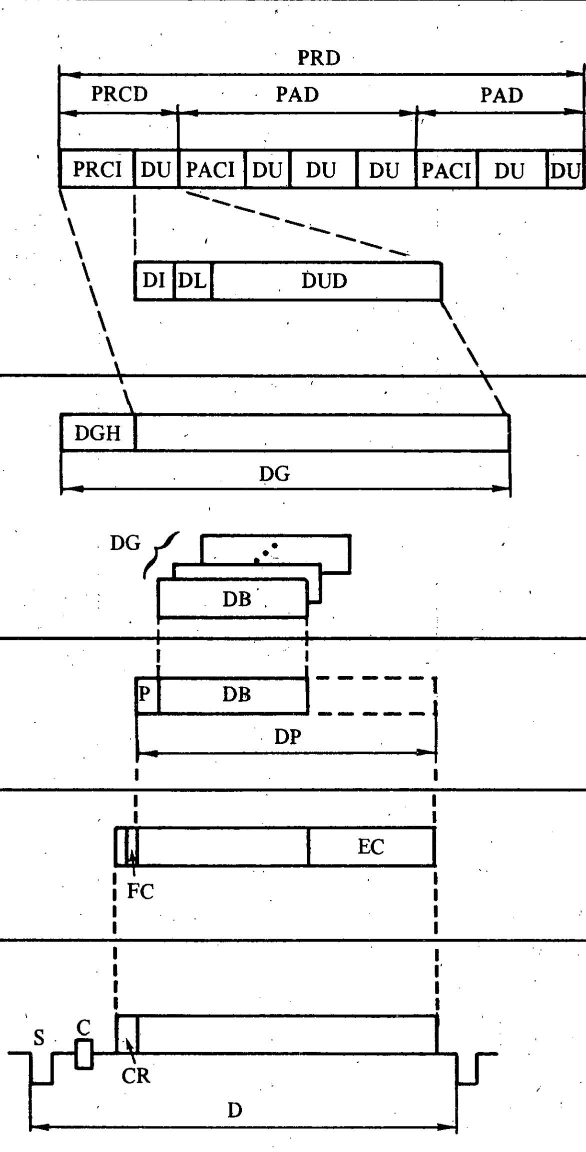


FIGURE 9 – *Layered structure of teletext system D*

TABLE II* – *Teletext systems used in various countries/geographical areas*

Country/geographical area	Teletext system specified	Remarks
Germany (Federal Republic of)	B	
Australia	B	
Belgium	A and B	
Brazil	C	Modified
Burkina Faso	None	
Canada	C	
Cyprus (Republic of)	None	
Colombia (Republic of)	A	
Denmark	B	
Spain	B	Primary character set with national variations to accommodate Basque, Catalan and Galician
United States of America	C	
Finland	B	
France	A	
India (Republic of)	A	
Italy	B	
Japan	D	
Malaysia	B	
Malawi	None	
Maldives (Republic of)	None	
Mexico	None	
Norway	B	
New Zealand	B	
Oman (Sultanate of)	None	
Netherlands (Kingdom of)	B	
Poland (People's Republic of)	B	Experimentally
Syrian Arab Republic	None	
German Democratic Republic	B	Experimentally
United Kingdom of Great Britain and Northern Ireland	B	
South Africa (Republic of)	B	Primary character with national variation to also accommodate the Afrikaans language
Singapore (Republic of)	B	
Sweden	B	
Yugoslavia (Socialist Federal Republic of)	B	Extended character set as specified in [CCIR, 1986-90d]

* Administrations are invited to provide the appropriate entries for Table II.

REFERENCES

[CCIR, 1990]: Specification of teletext systems, Descriptive booklet consisting of: CCIR, 1982-86: 11/422 (Rev.1) (Study Group 11); 11/282 (United Kingdom); 11/345 (France); 11/352, 11/413 (Japan); 11/382 (Canada) and CCIR, 1986-90: 11/107 (Yugoslavia (Socialist Federal Republic of)).

CCIR Documents

[1986-1990]: **a.** JIWP 10-11/5 CP5 (Yugoslavia (Socialist Federal Republic of)); **b.** JIWP 10-11/5 CP13 (China, (People's Republic of)); **c.** 11/149 (Japan); **d.** 11/107 (Yougoslavia (Socialist Federal Republic of)).

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SECTION 11C: CONTROL, MEASUREMENT AND INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES

RECOMMENDATION 472-3*

VIDEO-FREQUENCY CHARACTERISTICS OF A TELEVISION SYSTEM TO BE USED FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES BETWEEN COUNTRIES THAT HAVE ADOPTED 625-LINE COLOUR OR MONOCHROME SYSTEMS

(Questions 1/11, 2/11)

(1970-1974-1986-1990)

The CCIR

UNANIMOUSLY RECOMMENDS

1. the video characteristics, given below, for the international exchange of programmes between countries that have adopted 625-line colour or monochrome television systems. In particular, countries that use Systems B, C, D, G, H, I, K, K1 and L will facilitate programme interchange by adopting these characteristics.

Note 1 – The details concerning the line-blanking and field-blanking intervals are listed in the same order and are designated by the same symbols as in Report 624.

Note 2 – This Recommendation is not intended to apply to Standard N.

2. General characteristics

2.1	Number of lines per picture:	625
2.2	Line frequency and tolerance f_H (Hz) (1)	
	– monochrome transmissions:	15 625 ± 0.02%
	– colour transmissions:	15 625 ± 0.0001%
2.3	Field frequency f_v (Hz):	$(2/625)\ f_H$
2.4	Picture-frame frequency f_p (Hz):	$(1/625)\ f_H$
2.5	Gamma of picture signal:	approx. 0.4
2.6	Nominal video bandwidth (MHz):	5, or 5.5, or 6 (2)
2.7	Nominal difference between black level and blanking level (as a percentage of the luminance amplitude):	0^{+5}_{-0}
2.8	Nominal video level at interfaces (from synchronizing level to peak white-level) (V_{pp}):	1.0 (3)
2.9	Nominal video level at interfaces (from blanking level to peak white-level) (V_{pp}):	0.7 (3)
2.10	Nominal synchronizing level at interfaces (from blanking level to synchronizing level) (V_{pp}):	0.3 (3)

3. Details of line-blanking interval (4)

		(µs)
(H)	Nominal duration of a line:	$H = 64$
(a)	Line-blanking interval:	12 ± 0.3 (5)
(b)	Interval between datum (0_H) and back edge of line-blanking signal (average calculated value for information):	10.5
(c)	Front porch:	1.5 ± 0.3 (5)
(d)	Synchronizing pulse:	4.7 ± 0.2
(e)	Build-up time (10-90%) of line blanking edges:	0.3 ± 0.1
(f)	Build-up time (10-90%) of line-synchronizing pulses:	0.2 ± 0.1

* This Recommendation should be brought to the attention of Study Groups 4 and 9 and the CMTT.

4. Details of the field-blanking interval

(j) Field-blanking period:	$25\ H \pm a$ (6)
(k) Build-up time (10-90%) of field-blanking edges as in *(e)*:	0.3 ± 0.1
(l) Duration of first equalizing pulse sequence:	2.5 *H*, or 3 *H* (7)
(m) Duration of field-synchronizing pulse sequence:	2.5 *H*, or 3 *H* (7)
(n) Duration of second equalizing pulse sequence:	2.5 *H*, or 3 *H* (7)
(p) Duration of equalizing pulse (one half the value given in *(d)*):	2.35 ± 0.1
(q) Duration of field-synchronizing pulse (average calculated value for information):	27.3
(r) Interval between field-synchronizing pulses as in *(d)*:	4.7 ± 0.2
(s) Build-up time (10-90%) of field-synchronizing pulses as in *(f)*:	0.2 ± 0.1

(1) When the reference of synchronism is being changed, the tolerance for colour transmissions may be increased to ± 0.01% (see Report 624). Attention is drawn to the desirability of adding to these characteristics a value for the maximum rate of change of line frequency.

(2) The attention of Study Groups 4 and 9 and the CMTT is drawn to the desirability of subsequently standardizing tolerances for corresponding transmission characteristics applicable to all 625-line systems. For international routine measurements, it is suggested that the test signals be based on a single reference frequency which could be 5 MHz, particularly by countries using systems with nominal video bandwidth of 6 MHz. For example, this suggestion is not contrary to the use of a frequency close to 6 MHz in a multiburst test signal.

(3) When the voltage is measured across a matched 75 Ω termination.

(4) The nominal value of the picture-synchronizing signal ratio is 7/3. For details of permitted tolerances in long-distance transmissions, see Recommendation 567.

(5) In 625-line countries using teletext system B as specified in Annex I to Recommendation 653, to reduce the possibilities of data loss, the following values are preferred [CCIR, 1982-86a, b]:

(a) line-blanking interval: $12^{+0.0}_{-0.3}$ μs

(c) front porch: $1.5^{+0.3}_{-0.0}$ μs

(6) In the blanking interval, lines 16, 17, 18, 19, 20, 21 and 329, 330, 331, 332, 333 and 334 are reserved for the reception of any special signals.

(7) These values may be subject to revision in the case where a single equalizing pulse system might be adopted (see [CCIR, 1963-66] and Report 626).

REFERENCES

CCIR Documents

[1963-66]: XI/115 (United Kingdom).

[1982-86]: **a.** 11/365 (Australia); **b.** 11/376 (Germany (Federal Republic of)).

RECOMMENDATION 722

UNIFORM TECHNICAL STANDARDS AND UNIFORM TECHNICAL PROCEDURES FOR SATELLITE NEWS GATHERING (SNG)

(1990)

The text of this Recommendation as jointly prepared by Study Groups 10, 11 and CMTT can be found in Volume XII (CMTT).

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SECTION 11D: PICTURE QUALITY AND THE PARAMETERS AFFECTING IT

RECOMMENDATION 500-4

METHOD FOR THE SUBJECTIVE ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Question 3/11, Study Programmes 3A/11, 3B/11, 3C/11)

(1974-1978-1982-1986-1990)

The CCIR,

CONSIDERING

(a) that a large amount of information has been collected about the methods used in various laboratories for the assessment of picture quality;

(b) that examination of these methods shows that there exists a considerable measure of agreement between the different laboratories about a number of aspects of the tests;

(c) that the adoption of standardized methods is of importance in the exchange of information between various laboratories;

(d) that routine or operational assessments of picture quality and/or impairments using a five-grade quality and impairment scale made during routine or special operations by certain supervisory engineers, can also make some use of certain aspects of the methods recommended for laboratory assessments;

(e) that the introduction of new kinds of television signal processing such as digital coding and bit-rate reduction, new kinds of television signals using time-multiplexed components and, possibly, new services such as enhanced television and HDTV may require changes in the methods of making subjective assessments,

UNANIMOUSLY RECOMMENDS

1. that the general methods of test, the grading scales and the viewing conditions for the assessment of picture quality, described in the following texts should be used for laboratory experiments and whenever possible for operational assessments;

2. that, in the near future and notwithstanding the existence of alternative methods and the development of new methods, those described in § 2 and 3 of Annex I to this Recommendation should be used when possible; and

3. that, in view of the importance of establishing the basis of subjective assessments, the fullest descriptions possible of test configurations, test materials, observers, and methods should be provided in all test reports.

ANNEX I

1. Introduction

The goal of subjective testing is to establish, by empirical means, a basis for informed decision-making in television design and maintenance. As such, it is essential that the methods and measures used yield results that are both valid (representative of opinions during normal viewing) and reliable (repeatable across viewers and occasions). It should be noted that reliability does not imply validity.

The design of experiments has been well considered and documented; the amount of data which needs to be collected depends upon such interrelated factors as the confidence level which is needed in the answer, the standard deviation in the measurements, and the relative magnitude of the effect which it is required to detect. However, although the purpose of the study constrains the choice of method and of judgement criterion, it may not be obvious which judgement criterion should be measured. In general, however, if an experimenter is causing different amounts of degradation to a picture, the difference between the original (unimpaired) picture and the impaired one is the relevant criterion and, therefore, an impairment scale should be used. Conversely, if an experimenter is not causing a picture to be degraded (e.g. assessments of different scanning algorithms), there is no unimpaired reference, and a quality scale is the relevant criterion.

Nevertheless, it is not inappropriate to use a quality scale when assessing impairments to a picture. Here it is a matter of the question being asked: how annoying?, or, which is better?, or, how *much* better? The question being asked often will determine which scale or method is best suited to the problem.

The following sections summarise recommended methods and the principles of their use.

2. The double-stimulus impairment scale method (the "EBU method")

2.1 *General description*

A typical assessment might call for an evaluation of either a new system, or the effect of a transmission path impairment. The initial steps for the test organizer would include the selection of sufficient test material to allow a meaningful evaluation to be made, and the establishment of which test conditions should be used. If the effect of parameter variation is of interest, it is necessary to choose a set of parameter values which cover the impairment grade range in a small number of roughly equal steps. If a new system, for which the parameter values cannot be so varied, is being evaluated, then either additional, but subjectively similar, impairments need to be added, or another method such as that in § 3 should be used.

The double-stimulus (EBU) method is cyclic in that the assessor is first presented with an unimpaired reference, then with the same picture impaired. Following this, he is asked to vote on the second, keeping in mind the first. In *sessions*, which last up to half an hour, the assessor is presented with a series of pictures or sequences in random order and with random impairments covering all required combinations. The unimpaired picture is included in the pictures or sequences to be assessed. At the end of the series of sessions, the mean score for each test condition and test picture is calculated.

The method uses the impairment scale, for which it is usually found that the stability of the results is greater for small impairments than for large impairments. Although the method sometimes has been used with limited ranges of impairments, it is more properly used with a full range of impairments.

2.2 *General arrangement*

The generalized arrangement for the test system should be as shown in Fig. 1 below.

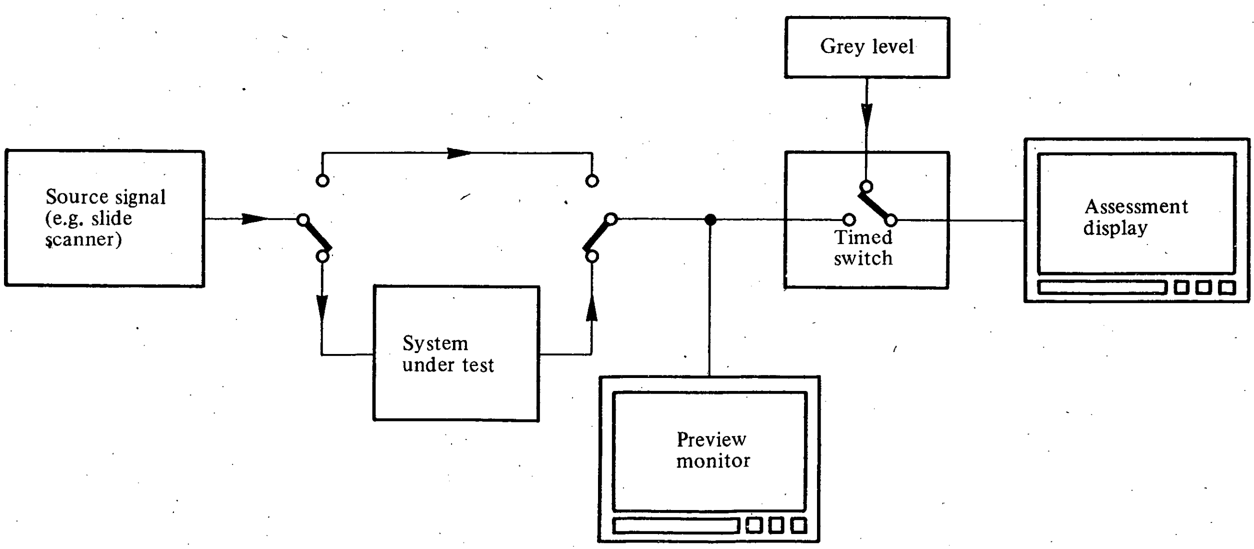

FIGURE 1

The assessors view an assessment display which is supplied with a signal via a timed switch. The signal path to the timed switch can be either directly from the source signal, or indirectly via the system under test. Assessors are presented with a series of test pictures or sequences. They are arranged in pairs such that the first in the pair comes direct from the source, and the second is the same picture via the system under test.

2.3 *Source signals*

The source signal provides the reference picture directly, and the input for the system under test. It should be of optimum quality for the television standard used. The absence of defects in the reference part of the presentation pair is crucial to obtaining stable results.

Digitally stored pictures and sequences are the most reproducible source signals, and these are therefore the preferred type. They can be exchanged between laboratories, to make system comparisons more meaningful. The *D*-1 4 : 2 : 2 tape format (Recommendation 657) should provide a basis for the exchange of source pictures and sequences when such machines are widely and economically available. Computer tape formats are also possible.

In the short term, 35 mm slide-scanners provide a preferred source for still pictures. The resolution available is adequate for evaluation of conventional television. The colorimetry and other characteristics of film may give a different subjective appearance to studio camera pictures. If this affects the results, direct studio sources should be used, although this is often much less convenient. As a general rule, slide-scanners should be adjusted picture by picture for best possible subjective picture quality, since this would be the situation in practice.

Assessments of downstream processing capacity are often made with colour-matte. In studio operations, colour-matte is very sensitive to studio lighting. Assessments should therefore preferably use a special colour-matte slide pair, which will consistently give high-quality results. Movement can be introduced into the foreground slide if needed.

2.4 *Viewing conditions*

The assessors' viewing conditions should be arranged as follows:

2.4.1 *General conditions*

(a)	Ratio of viewing distance to picture height	$4H$ and $6H$*
(b)	Peak luminance	70 cd/m^2
(c)	Ratio of luminance of inactive tube screen to peak luminance	$\leqslant$ 0.02
(d)	Ratio of the luminance of the screen, when displaying only black level in a completely dark room, to that corresponding to peak white	$\simeq$ 0.01
(e)	Ratio of luminance of background behind picture monitor to peak luminance of picture	$\simeq$ 0.15
(f)	Other room illumination	low
(g)	Chromaticity of background	D_{65}
(h)	Ratio of solid angle subtended by that part of the background which satisfies this specification to that subtended by the picture	$\geqslant$ 9

* $6H$ is the preferred distance for assessments of conventional systems (625/50, 525/60), however using assessors at $4H$ also is acceptable, provided either the results are given separately or there is clearly no significant difference in the means obtained.

2.4.2 *Special conditions*

(a)	Typical number of assessors at $4H$ per monitor	2 (for half of the sessions) 3 (for the other half)
(b)	Typical number of assessors at $6H$ per monitor	as above
(c)	Monitor *	high quality 22″-26″ screen size (50 cm-60 cm)
(d)	Display brightness and contrast	set up via PLUGE (see Annex VII to Report 405)
(e)	Typical number of assessors per monitor	5 (2 at $4H$ and 3 at $6H$ for the first session, 3 at $4H$ and 2 at $6H$ for the next session, and so on)
(f)	Nature of viewing room(s)	A room, 3 sides draped in white, 4th side (rear) draped in grey.

2.5 *The test session*

A session should last up to half an hour and include up to about 40 *presentations* (see § 2.6).

The sessions are arranged in groups of two, to allow all assessors to view the pictures or sequences at both $4H$ and $6H$. If there are too many test conditions for a single pair of sessions, further pairs should be arranged. A random order should be used for the presentations (for example, derived from Graeco-Latin squares); but the test condition order should be arranged so that any effects on the grading of tiredness or adaptation are balanced out from session to session. Some of the presentations can be repeated from session to session to check coherence. Each test condition should be shown twice within the same session.

The pictures and impairments should be presented in a pseudo-random sequence and, preferably in a different sequence for each session. In any case, the same test picture or sequences should never be presented on two successive occasions with the same or different levels of impairment.

The range of impairments should be chosen so that all grades are used by the majority of observers; a grand mean score (averaged over all judgements made in the experiment) close to 3 should be aimed at.

A session should not last more than roughly half an hour, including the explanations and preliminaries; the test sequence could begin with a few pictures indicative of the range of impairments; judgements of these pictures would not be taken into account in the final results.

* Where more than one viewing room is used, monitors should be carefully matched.

2.6 *Presentation of the test material*

A test session comprises a number of presentations. The structure of presentations is as shown in Fig. 2 below.

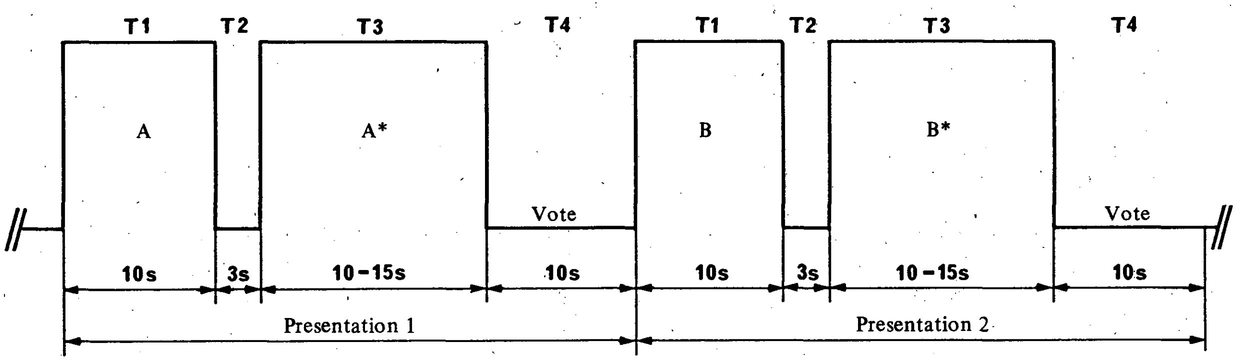

FIGURE 2

A, B: reference picture or sequence
A*, B*: test picture or sequence

Each presentation has four phases:

T1 =	10 s	reference picture
T2 =	3 s	mid-grey produced by a video level of around 200 mV
T3 =	10-15 s	test condition
T4 =	10 s	mid-grey

The duration of T3 can be 10-15 s. Even for moving pictures, evidence suggests that extending the period beyond 15 s does not improve the assessors' ability to grade the pictures.

2.7 *Observers*

At least 15 observers should be used. They should be non-expert, in the sense that they are not directly concerned with television picture quality as part of their normal work, and are not experienced assessors. Prior to a session, the observers should be screened for normal visual acuity or corrected-to-normal acuity, and for normal colour vision using specially selected charts.

2.8 *Grading scales*

The five-grade impairment scale should be used:

5 imperceptible
4 perceptible, but not annoying
3 slightly annoying
2 annoying
1 very annoying.

Assessors should use a form which gives the scale very clearly, and has numbered boxes or some other means to record the gradings.

2.9 *Selection of test material*

Some parameters may give rise to a similar order of impairments for most pictures or sequences. In such cases, results obtained with a very small number of pictures or sequences (e.g. two) may still provide a meaningful evaluation.

However, new systems frequently have an impact which depends heavily on the scene or sequence content. In such cases, there will be, for the totality of programme hours, a statistical distribution of impairment probability and picture or sequence content. Without knowing the form of this distribution, which is usually the case, the selection of test material and the interpretation of results must be done very carefully.

In general, it is essential to include critical material, because it is possible to take this into account when interpreting results, but it is not possible to extrapolate from non-critical material. In cases where scene or sequence content affects results, the material should be chosen to be "critical but not unduly so" for the system under test. The phrase "not unduly so" implies that the pictures could still conceivably form part of normal programme hours. At least four items should, in such cases, be used: for example, half of which are definitely critical, and half of which are moderately critical.

A number of organizations have developed test still pictures and sequences. It is hoped to organize these in the framework of the CCIR in the future.

IWP 11/7 has proposed material for assessing digital systems where bit-rate reduction to 30-33 Mbit/s is applied to Recommendation 601 signals. The evaluation of these systems needs to include the capacity for various downstream processing operations, such as colour-matte. In such cases, the colour-matte system needs to be included in both the direct and test system signal paths. These signals can then be included in the assessment presentations. With this method it is important however to avoid reference pictures or sequences which are in themselves impaired. If it is of interest to evaluate the additional deterioration caused to an already impaired picture, both should be used as test sequences.

2.10 *The introduction to the assessments*

Assessors should be carefully introduced to the method of assessment, and the types of impairment likely to occur. Questions to clarify understanding should be allowed, but instructions must not be changed from one session to another, and care should be taken in answering questions to avoid bias.

At the beginning of each session, an explanation is given to the observers about the type of assessment, the grading scale, the sequence and timing (reference picture, grey, test picture, voting period). The range and type of the impairments to be assessed should be illustrated on pictures other than those used in the tests, but of comparable sensitivity. It must not be implied that the worst quality seen necessarily corresponds to the lowest subjective grade. Observers should be asked to base their judgement on the overall impression given by the picture, and to express these judgements in terms of the wordings used to define the subjective scale.

The observers should be asked to look at the picture for the whole of the durations of T1 and T3. Voting should be permitted only during T4.

2.11 *Presentation of the results*

The coherence of the results should be checked by examining the grades given by the same observer to the same picture in the same session. If the gradings differ by two or more grades, both scores should be eliminated.

For each test parameter, the mean and standard deviation of the statistical distribution of the assessment grades must be given. If the assessment was of the change in impairment with a changing parameter value, curve-fitting techniques should be used. Logistic curve-fitting and logarithmic axis will allow a straight line representation, which is the preferred form of presentation.

The results must be given together with the following information:

A: details of the test configuration

B: details of the test materials

C: type of picture source and display monitors

D: number and type of assessors

E: reference systems used

F: the grand mean score for the experiment.

3. The double-stimulus continuous quality-scale method

3.1 *General description*

A typical assessment might call for evaluation of a new system or of the effects of transmission paths on quality. The double-stimulus method is thought to be especially useful when it is not possible to provide test stimulus test conditions that exhibit the full range of quality.

The method is cyclic in that the assessor is asked to view a pair of pictures, each from the same source, but one via the process under examination, and the other one directly from the source. He is asked to assess the quality of both.

In sessions which last up to half an hour, the assessor is presented with a series of picture pairs (internally random) in random order, and with random impairments covering all required combinations. At the end of the sessions, the mean scores for each test condition and test picture are calculated.

3.2 *General arrangement*

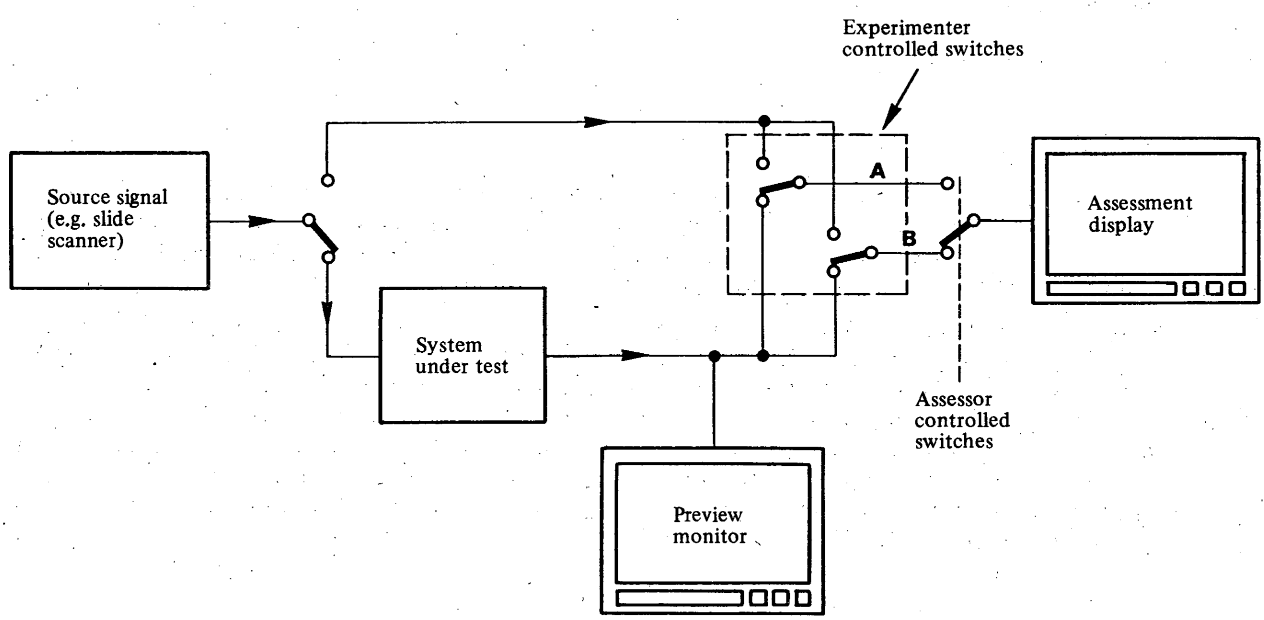

FIGURE 3

There are two variants to this method, (I) and (II), outlined below.

(I) The assessor, who is normally alone, is allowed to switch between two conditions A and B until he is satisfied that he has established his opinion of each. The A and B lines are supplied with the reference direct picture, or the picture via the system under test, but which is fed to which line is randomly varied between one test condition and the next, noted by the experimenter, but not announced.

(II) The assessors are shown consecutively the pictures from the A and B lines, to establish their opinion of each. The A and B lines are fed for each presentation as in variant (I) above. The stability of results of this variant with a limited range of quality is considered to be still under investigation.

3.3 *Source signals*

As for the method in § 2, however, an impaired reference may not have the same effect on stability.

3.4 *Viewing conditions*

As for the method in § 2. However, for variant (I), the number of assessors per monitor is 1.

3.5 *The test session*

As for the method in § 2. For variant (I) at least, it is not necessary to arrange for a grand mean score of 3.

3.6 *Presentation of the test material*

A test session comprises a number of presentations. For variant (I) which has a single observer, for each presentation the assessor is free to switch between the A and B signals until the assessor has the mental measure of the quality associated with each signal. The assessor may typically choose to do this 2 or 3 times for periods of up to 10 s. For variant (II) which uses a number of observers simultaneously, prior to recording results, the pair of conditions is shown one or more times for an equal length of time to allow the assessor to gain the mental measure of the qualities associated with them, then the pair is shown again one or more times while the results are recorded. The number of repetitions depends on the length of the test sequences. For still pictures, a 3-4 s sequence and five repetitions (voting during the last two) may be appropriate. For moving pictures with time-varying artifacts, a 10 s sequence with two repetitions (voting during the second) may be appropriate.

Where practical considerations limit the duration of sequences available to less than 10 s, compositions may be made using these shorter sequences as segments, to extend the display time to 10 s. In order to minimise discontinuity at the joints, successive sequence segments may be reversed in time (sometimes called "palindromic" display). Care must be taken to ensure that test conditions displayed as reverse time segments represent causal processes, that is, they must be obtained by passing the reversed-time source signal through the system under test.

3.7 *Observers*

As for the method in § 2.

3.8 *Grading scale*

The method requires the assessment of two versions of each test picture. One of each pair of test pictures is unimpaired while the other presentation might or might not contain an impairment. The unimpaired picture is included to serve as a reference, but the observers are not told which is the reference picture. In the series of tests, the position of the reference picture is changed in pseudo-random fashion.

The observers are simply asked to assess the overall picture quality of each presentation by inserting a mark on a vertical scale. The vertical scales are printed in pairs to accommodate the double presentation of each test picture. The scales provide a continuous rating system to avoid quantising errors, but they are divided into five equal lengths which correspond to the normal CCIR five-point quality scale. The associated terms categorising the different levels are the same as those normally used; but here they are included for general guidance and are printed only on the left of the first scale in each row of ten double columns on the score sheet. Figure 4 shows a section of a typical score sheet. Any possibility of confusion between the scale divisions and the test results is avoided by printing the scales in blue and recording the results in black.

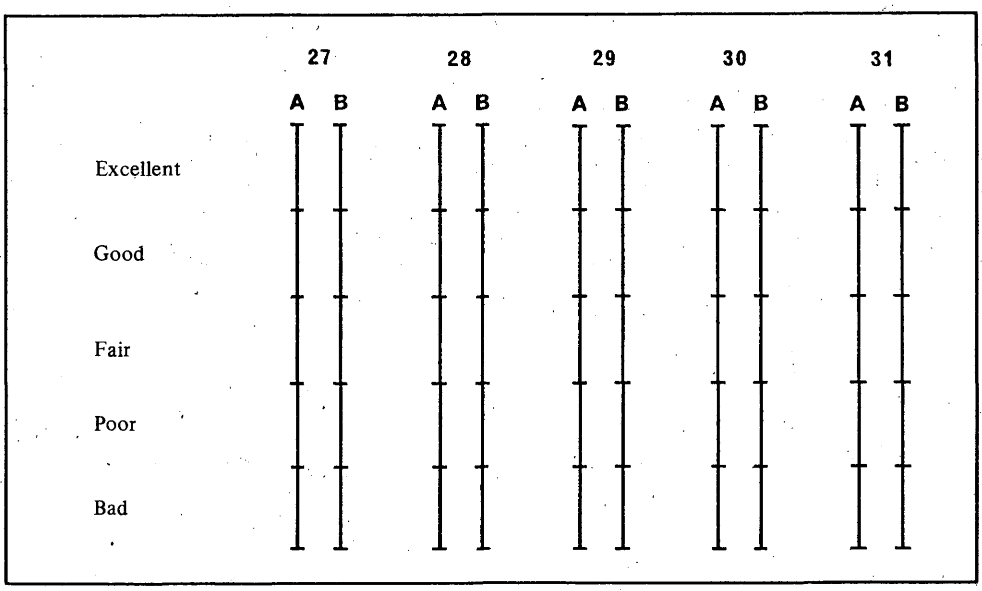

FIGURE 4 – *Portion of quality-rating form using continuous scales*

3.9 *Selection of test material*

As for the method in § 2.

3.10 *The introduction to the assessment*

As for the method in § 2, except for the last paragraph of § 2.10.

3.11 *Presentation of the results*

Two different approaches are possible:

- First, the results can be expressed in the form of a comparison test, i.e. to indicate directly the change in quality from the reference condition. For each test parameter, the mean and standard deviation of the statistical distribution of the measured difference must be given.
- Second (the preferred presentation method), the results can be converted into the terms used to describe an equivalent quality grade. The pairs of assessments (reference and test) for each separate test condition are converted from measurements of length on the score sheet to normalised scores in the range 0 to 100. For each system under test, these scores are then averaged for the different groups of observers, different viewing distances and different test pictures, to give mean scores for reference and test conditions for each combination of the variables.

Because the mean scores for the reference conditions are always less than 1.0, a re-scaling operation on the test scores is necessary. The re-scaling is effected by subtracting residual impairment. The mean score for the reference condition is treated as the residual impairment. The results of the subtraction are expressed in impairment units (imps) but can be transformed back to mean scores if so desired.

The report must include the same additional information as for the method in § 2, except for the mean score.

Fuller details of the data presentation techniques are provided in Report 1205.

4. Alternative methods of assessment

In appropriate circumstances, the single-stimulus and stimulus-comparison methods should be used.

4.1 *Single-stimulus methods*

In single-stimulus methods, a single image or sequence of images is presented and the assessor provides an index of the entire presentation.

4.1.1 *Observers*

For laboratory tests, observers typically are selected as in § 2.7. The number of assessors needed depends upon the sensitivity and reliability of the test procedure adopted and upon the anticipated size of the effect sought. Under normal circumstances, a sample of 10-20 assessors per test is used.

4.1.2 *Test images*

For laboratory tests, the content of the test images should be selected as described in § 2.9.

Once the content is selected, test images are prepared to reflect the design options under consideration or the range(s) of one (or more) factors. When two or more factors are examined, the images can be prepared in two ways. In the first, each image represents one level of one factor only. In the other, each image represents one level of every factor examined but, across images, each level of every factor occurs with every level of all other factors. Both methods permit results to be attributed clearly to specific factors. The latter method also permits the detection of interactions among factors (i.e. non-additive effects).

4.1.3 *Viewing conditions*

Viewing conditions in formal tests typically approximate those described in § 2.4.1 with the exception that assessors are tested individually at constant viewing distance. If the standard conditions poorly approximate the conditions of normal viewing (e.g. viewing distances [Nathan *et al.*, 1985]), it may be appropriate to "validate" any resuls from standard conditions with tests conducted under more representative viewing conditions.

4.1.4 *Test session*

Prior to the assessment session, observers are provided with a description of the viewing task and, usually, with examples of the images or image sequences. Instructions normally are given in written or recorded form. Care is taken to avoid biasing the observers in performance of their task.

The session consists of a series of assessment trials. These should be presented in random sequence and, preferably, in a different random sequence for each observer. When a single random sequence is used, the experimenter normally ensures that the same image is not presented twice in succession with the same kind and level of impairment.

A typical assessment trial consists of three displays: a mid-grey adaptation field, a stimulus field, and a mid-grey post-exposure field. The durations of these displays vary with viewer task, materials (e.g. still vs. moving), and the options or factors considered, but 3, 10 and 10 s respectively, are not uncommon. The viewer index, or indices, may be collected during display of either the stimulus or the post-exposure field.

4.1.5 *Types of single-stimulus methods*

In general, three types of single-stimulus methods have been used in television assessments.

4.1.5.1 *Categorical judgement methods*

In categorical judgements, observers assign an image or image sequence to one of a set of categories that, typically, are defined in semantic terms. The categories may reflect judgements of whether or not an attribute is detected (e.g. to establish the impairment threshold [CCIR, 1974-78]). Categorical scales that assess image quality [Prosser *et al.*, 1964] and image impairment [Allnatt and Corbett, 1974], have been used most often, and the CCIR scales are given in Table I below. In operational monitoring, half grades sometimes are used. Scales that assess text legibility, reading effort, and image usefulness have been used in special cases [Hearty et Treurniet, 1985; CCIR, 1978-82a].

TABLE I

Five-grade scale	
Quality	Impairment
5 Excellent	5 Imperceptible
4 Good	4 Perceptible, but not annoying
3 Fair	3 Slightly annoying
2 Poor	2 Annoying
1 Bad	1 Very annoying

This method yields a distribution of judgements across scale categories for each condition. The way in which responses are analysed depends upon the judgement (detection, etc.) and the information sought (detection threshold, ranks or central tendency of conditions, psychological "distances" among conditions). Many methods of analysis are available (e.g. [Allnatt, 1975; Torgerson, 1958], Report 1205).

4.1.5.2 *Non-categorical judgement methods*

In non-categorical judgements, observers assign a value to each image or image sequence shown. There are two forms of the method.

In continuous scaling, a variant of the categorical method, the assessor assigns each image or image sequence to a point on a line drawn between two semantic labels (e.g. the ends of a categorical scale as in Table I). The scale may include additional labels at intermediate points for reference (see Report 1082). The distance from an end of the scale is taken as the index for each condition.

In numerical scaling, the assessor assigns each image or image sequence a number that reflects its judged level on a specified dimension (e.g. image sharpness). The range of the numbers used may be restricted (e.g. 0-100) or not. Sometimes, the number assigned describes the judged level in "absolute" terms (without direct reference to the level of any other image or image sequence as in some forms of magnitude estimation [Engen, 1971a] (Report 1082)). In other cases, the number describes the judged level relative to that of a previously seen "standard" (e.g. magnitude estimation, fractionation, and ratio estimation [Engen, 1971a]; (Report 1082)).

Both forms result in a distribution of numbers for each condition. The method of analysis used depends upon the type of judgement and the information required (e.g. ranks, central tendency, psychological "distances"). Possible analysis methods are summarised elsewhere [Anderson, 1964; Torgerson, 1958] (Reports 1082 and 1205).

4.1.5.3 *Performance methods*

Some aspects of normal viewing can be expressed in terms of the performance of externally directed tasks (finding targeted information, reading text, identifying objects, etc.). Then, a performance measure, such as the accuracy or speed with which such tasks are performed, may be used as an index of the image or image sequence.

Performance methods result in distributions of accuracy or speed scores for each condition. Analysis concentrates upon establishing relations among conditions in the central tendency (and dispersion) of scores and often uses Analysis of Variance or a similar technique [Hearty and Treurniet, 1985].

4.1.6 *Issues*

4.1.6.1 *Range of conditions and anchoring*

Because the categorical method and some non-categorical methods are sensitive to variations in the range and distribution of conditions seen [Parducci, 1965; CCIR, 1978-82b, c, d], judgement sessions should include the full ranges of the factors varied. However, this may be approximated with a more restricted range, by presenting also some conditions that would fall at the extremes of the scales. These may be represented as examples and identified as most extreme (direct anchoring) or distributed thoughout the session and not identified as most extreme (indirect anchoring).

4.1.6.2 *Meaning of scores*

Because they vary with range, it may be inappropriate to interpret judgements from the categorical method and some non-categorical methods in absolute terms (e.g. the quality of an image or image sequence).

4.2 *Stimulus-comparison methods*

In stimulus-comparison methods, two images or sequences of images are displayed and the viewer provides an index of the *relation* between the two presentations.

4.2.1 *Assessors*

Determination of assessors proceeds in the same fashion as in single-stimulus methods.

4.2.2 *Test images*

The images or image sequences used are generated in the same fashion as in single-stimulus methods. The resulting images or image sequences are then combined to form the pairs that are used in the assessment trials.

4.2.3 *Viewing conditions*

Viewing conditions are determined in the same fashion as in single-stimulus methods.

4.2.4 *Test session*

The assessment trial will use either one monitor or two well-matched monitors and generally proceeds as in single-stimulus cases. If one monitor is used, a trial will involve an additional stimulus field identical in duration to the first. In this case, it is good practice to ensure that, across trials, both members of a pair occur equally often in first and second positions. If two monitors are used, the stimulus fields are shown simultaneously.

4.2.5 *Types of stimulus-comparison methods*

Three types of stimulus-comparison methods have been used in television assessments.

4.2.5.1 *Categorical judgement methods*

In categorical judgement methods, observers assign the relation between members of a pair to one of a set of categories that, typically, are defined in semantic terms. These categories may report the existence of perceptible differences (e.g. SAME, DIFFERENT), the existence and direction of perceptible differences (e.g. LESS, SAME, MORE), or judgements of extent and direction. The CCIR comparison scale is shown in Table II below.

TABLE II – *Comparison scale*

−3	Much worse
−2	Worse
−1	Slightly worse
0	The same
+1	Slightly better
+2	Better
+3	Much better

This method yields a distribution of judgements across scale categories for each condition pair. The way that responses are analysed depends on the judgement made (e.g. difference) and the information required (e.g. just-noticeable differences, ranks of conditions, "distances" among conditions, etc.). Methods of analysis are described elsewhere [Corbett, 1974; Engen, 1971a, b; Torgerson, 1958] (see § 4.2.7.2).

4.2.5.2 *Non-categorical judgement methods*

In non-categorical judgements, observers assign a value to the relation between the members of an assessment pair. There are two forms of this method:

- In continuous scaling, the assessor assigns each relation to a point on a line drawn between two labels (e.g. SAME-DIFFERENT or the ends of a categorical scale as in Table II). Scales may include additional reference labels at intermediate points. The distance from one end of the line is taken as the value for each condition pair.
- In the second form, the assessor assigns each relation a number that reflects its judged level on a specified dimension (e.g. difference in quality). The range of numbers used may be constrained or not. The number assigned may describe the relation in "absolute" terms or in terms of that in a "standard" pair.

Both forms result in a distribution of values for each pair of conditions. The method of analysis depends on the nature of the judgement and the information required. Possible methods of analysis are discussed elsewhere [Torgerson, 1958; Engen, 1971a, b] (see also § 4.2.7.2).

4.2.6 *Performance methods*

In some cases, performance measures can be derived from stimulus-comparison procedures. In the forced-choice method, the pair is prepared such that one member contains a particular level of an attribute (e.g. impairment) while the other contains either a different level or none of the attribute. The observer is asked to decide either which member contains the greater/lesser level of the attribute or which contains any of the attribute; accuracy and speed of performance are taken as indices of the relation between the members of the pair.

4.2.7 *Issues*

4.2.7.1 *Formation of pairs*

Stimulus-comparison methods assess the relations among conditions more fully when judgements compare all possible pairs of conditions. However, if this requires too large a number of observations, it may be possible to divide observations among assessors, or to use a sample of all possible pairs.

4.2.7.2 *Multi-dimensional scaling methods*

Several researchers have used multi-dimensional scaling methods to consider stimulus-comparison judgements of television [Linde *et al.*, 1981; Goodman and Pearson, 1979]. This method and the approach are described in Report 1082.

4.3 *Selection of methods*

All of the methods described so far have strengths and limitations and it is not yet possible to recommend one over the others. Thus, it remains at the discretion of the researcher to select the methods most appropriate to the circumstances at hand.

The limitations of the various methods suggest that it may be unwise to place too much weight on a single method. Thus, it may be appropriate to consider more "complete" approaches such as either the use of several methods or the use of the multi-dimensional approach (Report 1082).

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APPENDIX I

FURTHER GUIDANCE ON THE SELECTION OF METHODOLOGY

1. Introduction

The goal of subjective assessments is usually to establish, by empirical means, a basis for informed decision making in television system design. It is essential that the methods used yield results that are stable, valid (representative of opinions during normal viewing) and reliable (repeatable across viewers and occasions). If results are "reliable" in the above sense, this does not mean they are necessarily also "valid".

The methods outlined in this Recommendation, particularly those in § 2 and 3 of Annex I, are believed to be the most "reliable" and "valid" currently well developed. However, users should always interpret results, keeping in mind, the degree of validity which the particular method used has been shown to exhibit. Assessment methodology is an evolving and improving science. There is no unique method which can be used for all purposes.

Applications currently often fall into the following categories:

(a) assessment of the overall picture quality of a system

(b) assessment of "quality factors". These are constituents of overall quality and may include, but are not restricted to, such factors as the following:

- sharpness (how clearly the assessor can distinguish the boundaries of objects)
- resolution (the amount of fine detail that it is possible to resolve)

(c) assessment of the failure characteristics of a system

(d) assessment of "degradation factors". These are constituents of the overall impairment. They may include, but are not restricted to, the following:

- image blur (how much of a reduction there is in the clarity of object boundaries)
- noise (how much unwanted random signals are in the picture)
- edge busyness (how much jitter there is on edges)
- contouring (how much of a step effect there is on smooth surfaces)

(e) system quality comparisons.

The methods described in Table III are first the two most proven and therefore main methods, for convenience are here called Methods A and E; and secondly, auxiliary methods called N, R and C, which have not yet been subject to such widespread use, but are nevertheless worthy of consideration, and information on which is given in Report 1082.

TABLE III – *Guide to the selection of the different methods for given applications*

	A	E	N	R	C
Overall quality	X		X	X	
Quality factors			X	X	
Failure characteristics	X	X	X		
Degradation factors		X	X		
Comparisons	X				X

A: double-stimulus continuous-quality scale method

E: double-stimulus impairment scale method

N: numerical category scaling

R: ratio scaling/magnitude estimation

C: pair comparing method

Further guidance notes

If a full range of qualities is available or is a requirement for the assessments, then all methods can be considered. If only a limited range of quality is available, method E should not be used.

For system comparisons, in addition to the pair comparing method C, the CCIR seven-point comparison scale is a candidate, but the interval nature of this scale is currently uncertain. Comparison test results using method A may be easier to relate to more familiar quality notions.

Some methods are more complex to organise and process than others, and some are more tiring than others. Method A is more complex and tiring than method E. Thus, if both were equally valid, method E could be the more efficient to use.

RECOMMENDATION 654

SUBJECTIVE QUALITY OF TELEVISION PICTURES IN RELATION TO THE MAIN IMPAIRMENTS OF THE ANALOGUE COMPOSITE TELEVISION SIGNAL

(1986)

The CCIR,

CONSIDERING

(a) that Recommendation 500 specifies the method to be used for the subjective assessment of the quality of television pictures with a view to determining the relationship between that quality and the objective value of the specific distortion;

(b) that Recommendation 567 describes the objective parameters of typical transmission impairment and the corresponding measurement methods and test signals;

(c) that many experimental findings have been published concerning distortion to the composite signal in 525 and 625-line colour-television systems in NTSC, PAL and SECAM coding and that, despite considerable dispersion, those results can be used for determining an impairment characteristic which is representative of an average situation;*

(d) that it would be useful to have impairment characteristics which are accepted as reference values,

UNANIMOUSLY RECOMMENDS

- that, with regard to the transmission characteristics applicable to the composite colour television signal, the impairment characteristics referred to in this Recommendation should be regarded as a particular way of expressing the relationship between the picture quality and the objective value of each of the distortions in question, assuming that only one of them is present at any one time;
- that these impairment characteristics correspond to a viewing distance equal to six times the picture height;
- that the use of these characteristics for $I \geqslant 2$ (see Report 405, Annex III) (represented by a dotted line in Figs. 1 to 6 of this Recommendation) requires great caution.

1. Continuous random noise

The signal-to-noise ratio is measured, unweighted, in accordance with Recommendation 567, Part C, § 3.2.1.

This method is applicable to all 525 and 625-line systems.

The reference impairment characteristic concerns only the impairment due to uniform-spectrum noise (white noise). The correction factors applicable to the different situations are known.

The reference impairment characteristic is shown in Fig. 1. It conforms to the following relations:

- impairment factor: $d = \dfrac{N_{r.m.s.}}{L}$ or $D = \left[\dfrac{L}{N_{r.m.s.}}\right]_{\text{dB}} \doteq 20 \log \dfrac{1}{d}$ (dB)
- mid opinion value ($I = 1$): $d_M = 0.0355$ or $D_M = 29$ dB
- slope: $G = 2.22$

* For the application of this Recommendation to countries using systems D and K, further studies are needed.

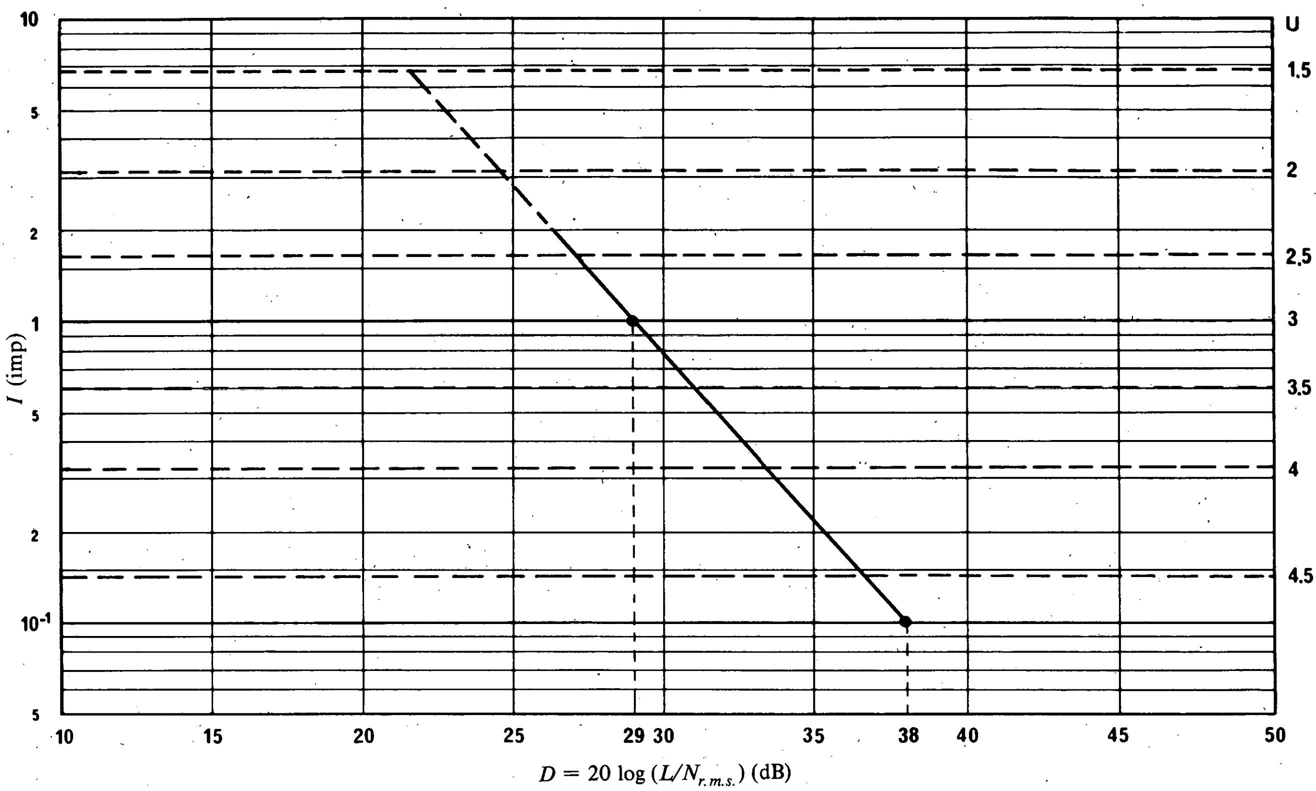

FIGURE 1 – *Impairment characteristic for unweighted white noise*

2. Non-linear distortion

2.1 *Differential gain*

The differential gain is measured in accordance with Recommendation 567, Part C, § 3.4.1.3.

Impairment of the picture depends on the distribution of distortion on the luminance scale. The most critical variation corresponds to an increase in the amplitude of the superimposed colour sub-carrier as the luminance amplitude varies from the black level (A_0) to the white level (A_{max}), which corresponds to distortion measured in terms of value x.

Impairment depends also on the colour coding system.

The reference impairment characteristic is illustrated in Fig. 2 and corresponds to a distortion situation offering the least favourable distribution. It conforms to the following relations:

– impairment factor: $d = x = 100 \left| \dfrac{A_{max} - A_0}{A_0} \right|$

– mid opinion value ($I = 1$):
  NTSC and PAL systems: $d_M = 43\%$
  SECAM system: $d_M = 65\%$

– slope (deviation of d between $I = 1$ and $I = 0.37$):
  NTSC and PAL systems: $S = 15\%$
  SECAM system: $S = 13\%$

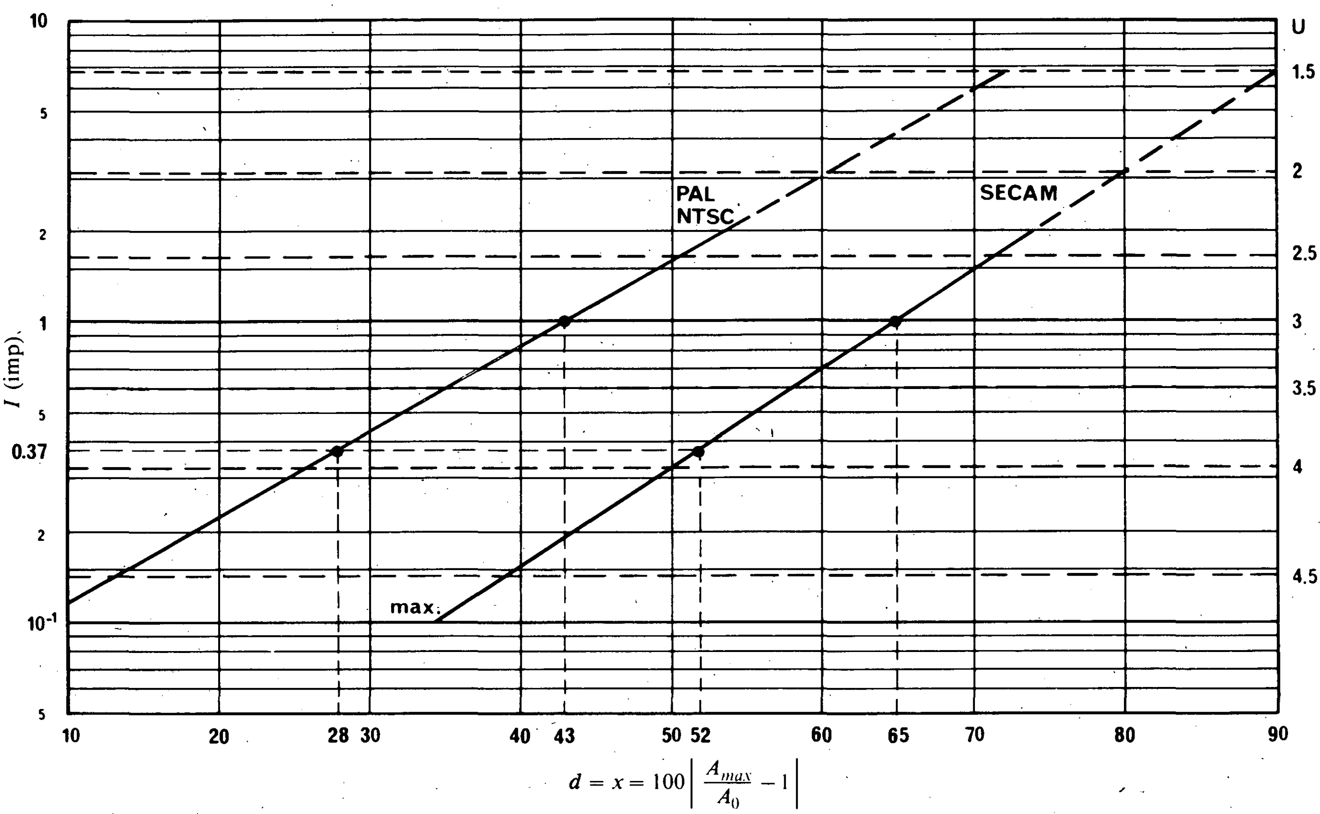

FIGURE 2 – *Impairment characteristic for differentiel gain*

2.2 *Differential phase*

The differential phase is measured in accordance with Recommendation 567, Part C, § 3.4.1.3.

The picture impairment depends on the distribution of distortion on the luminance scale. The most critical variation corresponds to a negative variation in the phase difference from the black level (Φ_0) to the white level (Φ_{min}), which corresponds to a distortion measured in terms of value $-y$.

The impairment depends also on the colour coding system.

The impairment characteristic is illustrated in Fig. 3 and corresponds to a distortion situation offering the least favourable distribution. It conforms to the following relations:

– impairment factor: $d = y = | \Phi_{min} - \Phi_0 |$

  or $D = \log d$

– mid opinion value ($I = 1$):

  NTSC system: $d_M = 10°$

  PAL system: $d_M = 50°$

  SECAM system: $d_M = 65°$

– slope:

  all systems: $G = 2.5$

Note – In the case of the PAL system, the fact that the impairment characteristic is a straight line has not been verified.

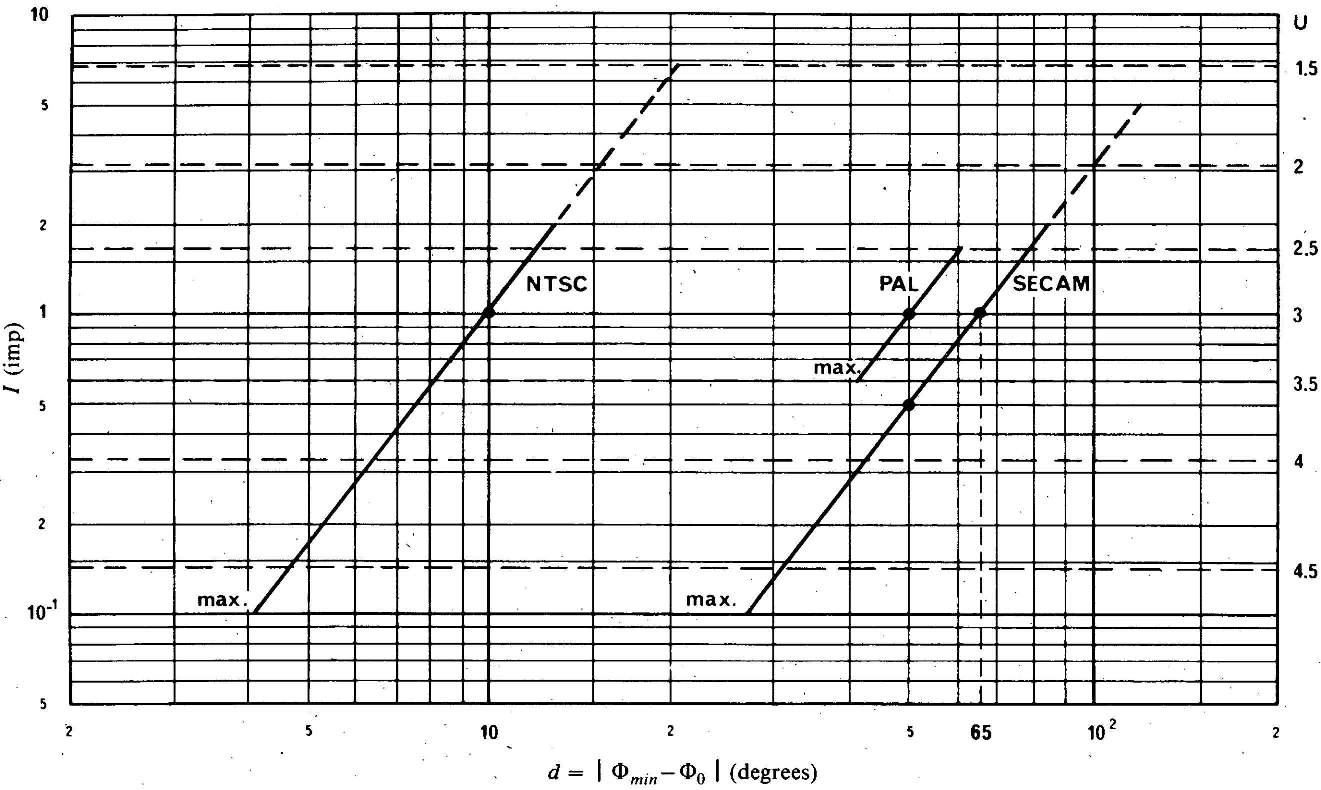

FIGURE 3 – *Impairment characteristic for differential phase*

3. Linear distortion

3.1 *Short-time waveform distortion*

Short-time linear distortion is measured in accordance with Recommendation 567, Part C, § 3.5.1.4, by expressing the difference, as a percentage, between the peak value of the pulse B1, i.e., B_1, and the value of the luminance amplitude, i.e., L. The impairment characteristic value is:

$$d = \left| \frac{L - B_1}{L} \right| \times 100 \qquad (\%)$$

Impairment does not depend on the sign of $L - B_1$.

Impairment does not depend on the colour coding system.

The pulse-to-bar $2T$ ratio, i.e., $\frac{B_1}{L} = 1 - \frac{d}{100}$ can be calculated from the value d.

The impairment characteristic is illustrated in Fig. 4. It corresponds to the following conditions:

– impairment factor: $$d = \left| \frac{L - B_1}{L} \right| \times 100 \qquad (\%)$$

Logarithmic scale in values of d;

– mid opinion value ($I = 1$): $d_M = 40\%$

– slope: $G = 2.32$

Note – Short-time linear distortion is often expressed by the K factor explained in Annex IV to Part C of Recommendation 567.

This factor is such that $K = \frac{d}{4}$.

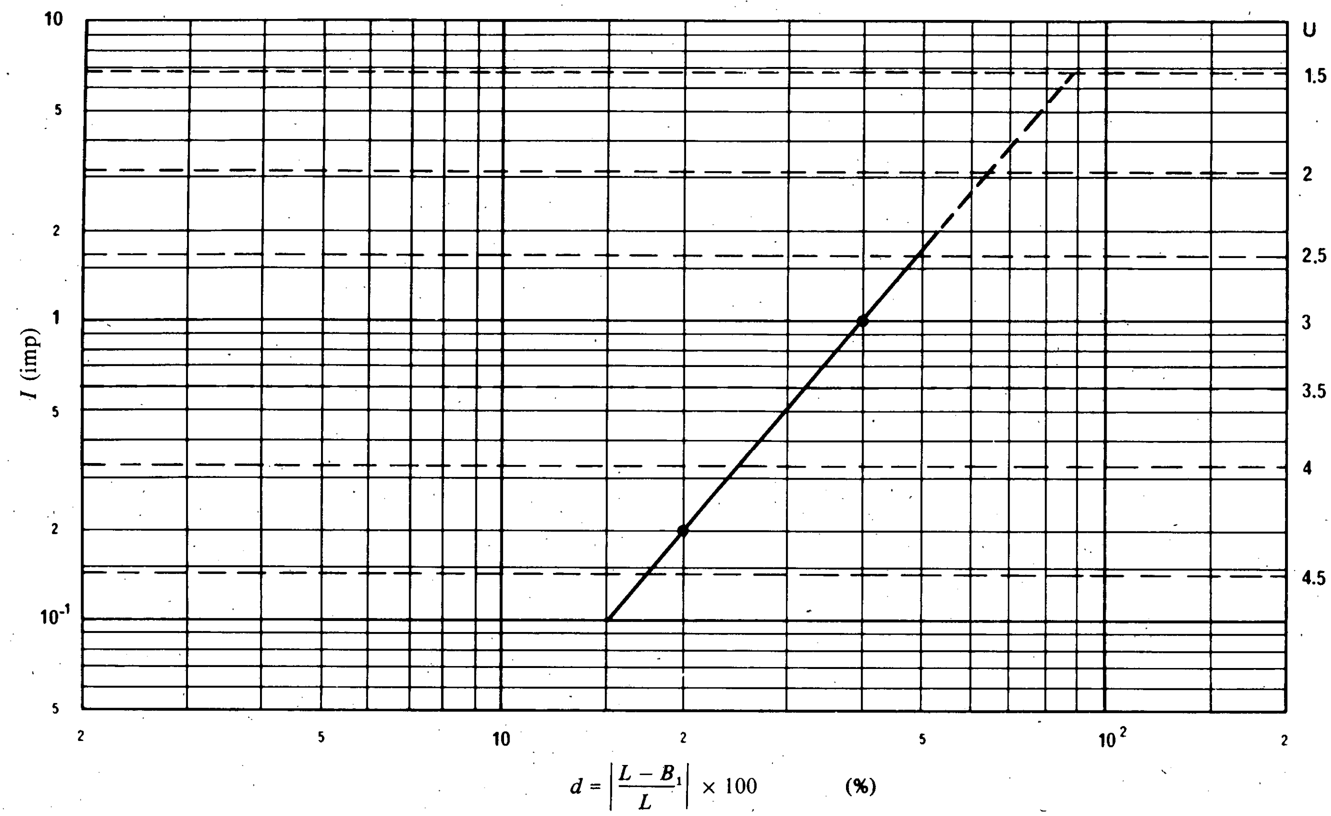

FIGURE 4 – *Impairment characteristic for short-time linear distortion*

3.2 *Chrominance-luminance inequalities*

3.2.1 *Gain inequality*

Chrominance-luminance gain inequality is measured in accordance with Recommendation 567, Part C, § 3.5.3.1, the absence of distortion being expressed by equality between the luminance (E_L) and chrominance (E_C) amplitudes.

Impairment depends on the coding system and the curve is valid only for the NTSC and PAL systems. There is only an indirect effect on the SECAM system.

The impairment characteristic is illustrated in Fig. 5. It conforms to the following relations:

– impairment factor: $d = \frac{E_C - E_L}{E_L}$ (logarithmic scale)

– mid opinion value ($I = 1$): $d_M = 63\%$

– slope: $G = 2.33$

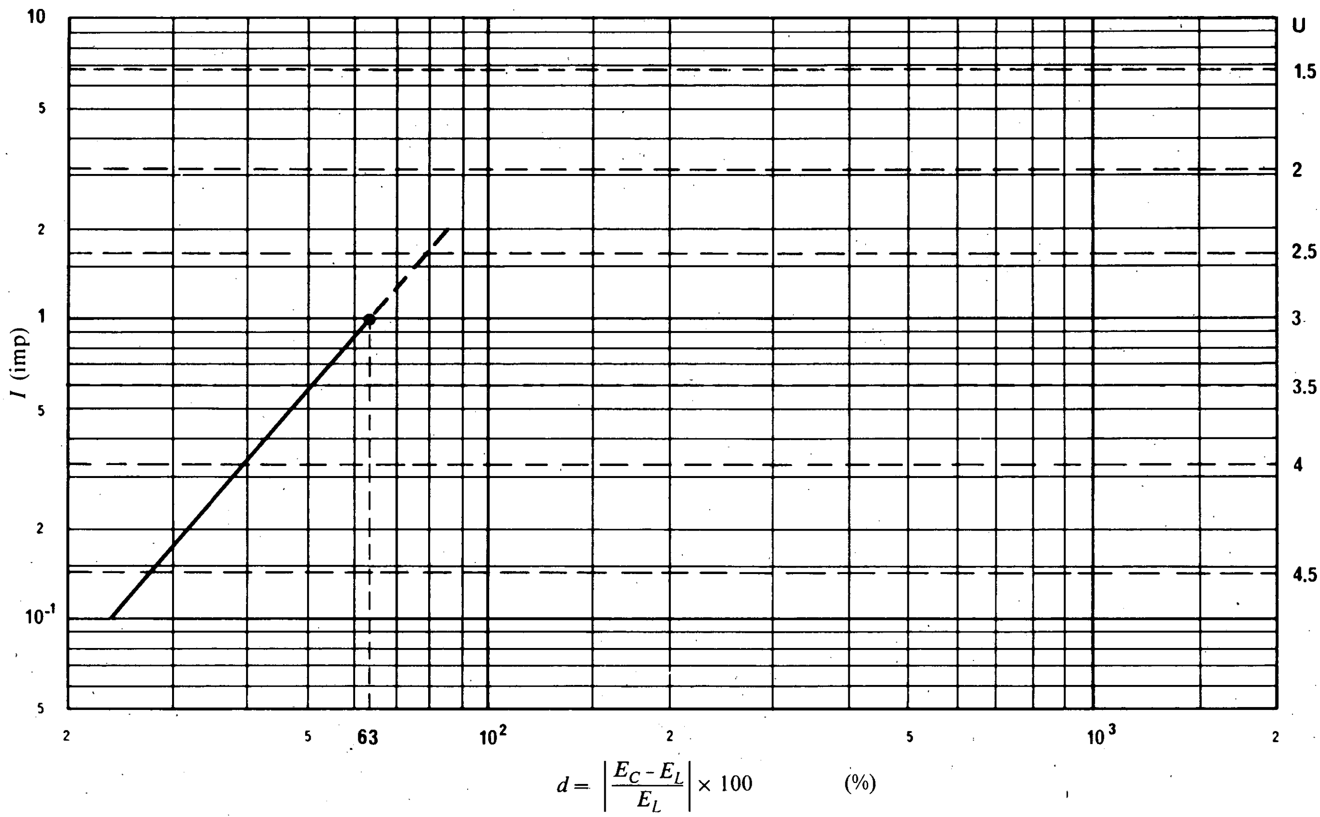

FIGURE 5 – *Impairment characteristic for chrominance-luminance gain inequalities*

3.2.2 *Delay inequality*

Delay inequality is measured in accordance with Recommendation 567, Part C, § 3.5.3.2, using the signal F (modulated $20T$ pulse for 625-line systems and $12.5T$ pulse for 525-line systems).

The value thus measured corresponds closely to that of the group delay of a band-limiting network in which τ_g increases with the frequency. In this case, the value of d corresponds to the value $\Delta\tau_g$ measured at colour sub-carrier frequency.

This value is appreciably different from, and higher than, that obtained by direct measurement of the time separation between a characteristic instant of a steep luminance front and the equivalent characteristic instant of the associated chrominance transition front for the same impairment and therefore the same quality level.

The impairment characteristic meets the following conditions (Fig. 6):

(a) *for the 625-line systems*

– impairment factor: $d = \Delta\tau_g$ at 4.43 MHz

$\Delta\tau_g$ = delay difference

Logarithmic scale in $\Delta\tau$ expressed in ns;

– mid opinion value ($I = 1$): $d_M = 400$ ns

– slope: $G = 2.32$

(b) *for the 525-line systems*

– impairment factor: $d = \Delta\tau_g$ at 3.58 MHz

$\Delta\tau_g$ = delay difference

Logarithmic scale in $\Delta\tau$ expressed in ns;

– mid opinion value ($I = 1$): $d_M = 200$ ns

– slope: $G = 1.76$

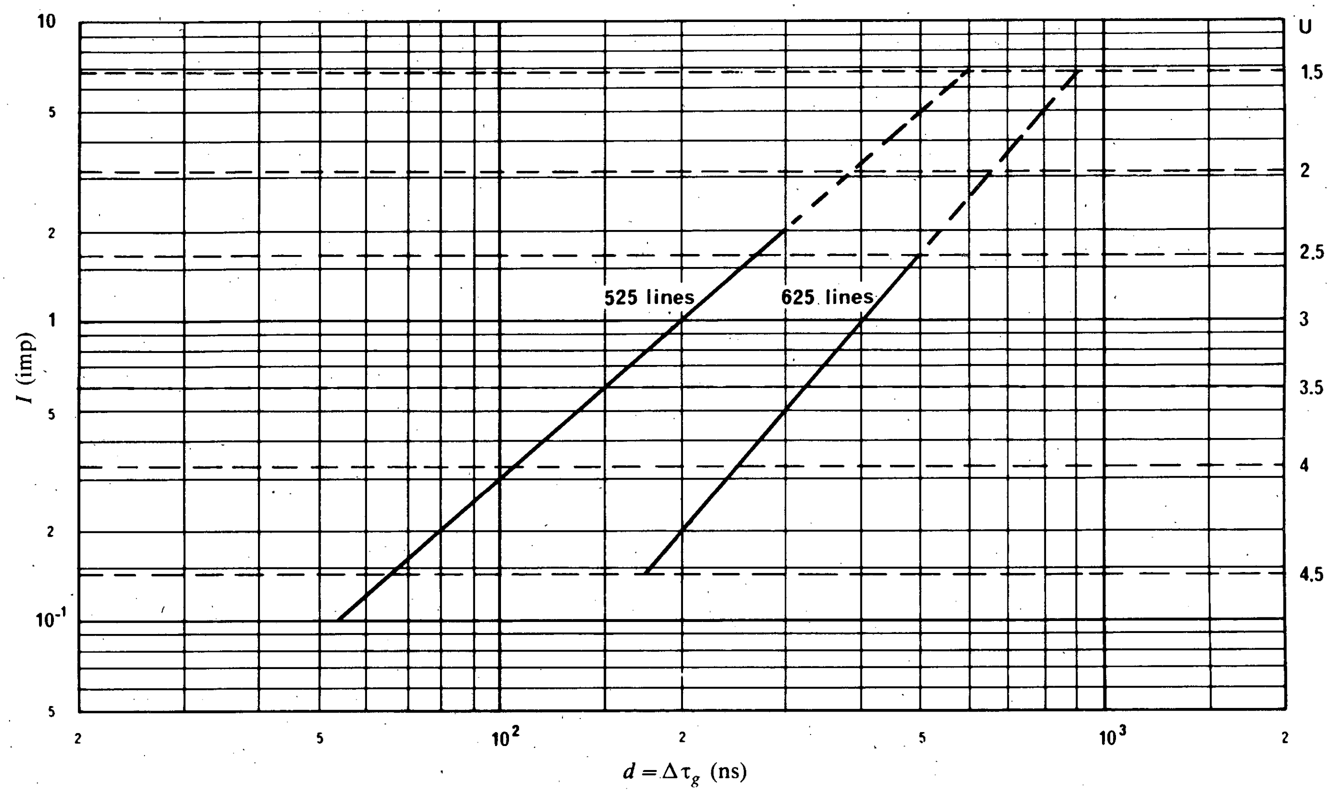

FIGURE 6 – *Impairment characteristic for chrominance-luminance delay inequality*

4. Echo

Consideration is given to the effect of superimposing a direct signal and a reflected signal producing a permanent "ghost" picture, an example of which is described in Report 478.

Impairment depends on:

- the polarity of the echo, and it is noted that maximum impairment occurs with a positive echo;
- the time separation between the direct signal and the echo signal;
- the distortion of the echo signal.

The impairment characteristic illustrated in Fig. 7 corresponds to the case of an undistorted positive echo 1 µs behind the direct signal (E = echo amplitude, S = signal amplitude).

When the echo delay time is less than 1 µs, the following results apply to monochrome television or to the luminance signal in colour television. In the case of colour signals, additional effects occur which, in the PAL and NTSC systems, can be interpreted by using the gain inequality characteristic.

This characteristic meets the following conditions:

- impairment factor: $d = \frac{E}{S}$ or $D = 20 \log \frac{S}{E}$ (dB)
- mean value ($I = 1$): $d_M = 0.126$ or $D_M = 18$ dB
- slope: $G = 2.33$

For time separations other than 1µs, the value D_1 should be corrected as shown in Fig. 8.

Thus the value D_x for $\Delta t = X$ is corrected to $D_1 = D_x - \Delta D$ to obtain the corresponding impairment value in Fig. 7.

The slope of the characteristic is not substantially altered.

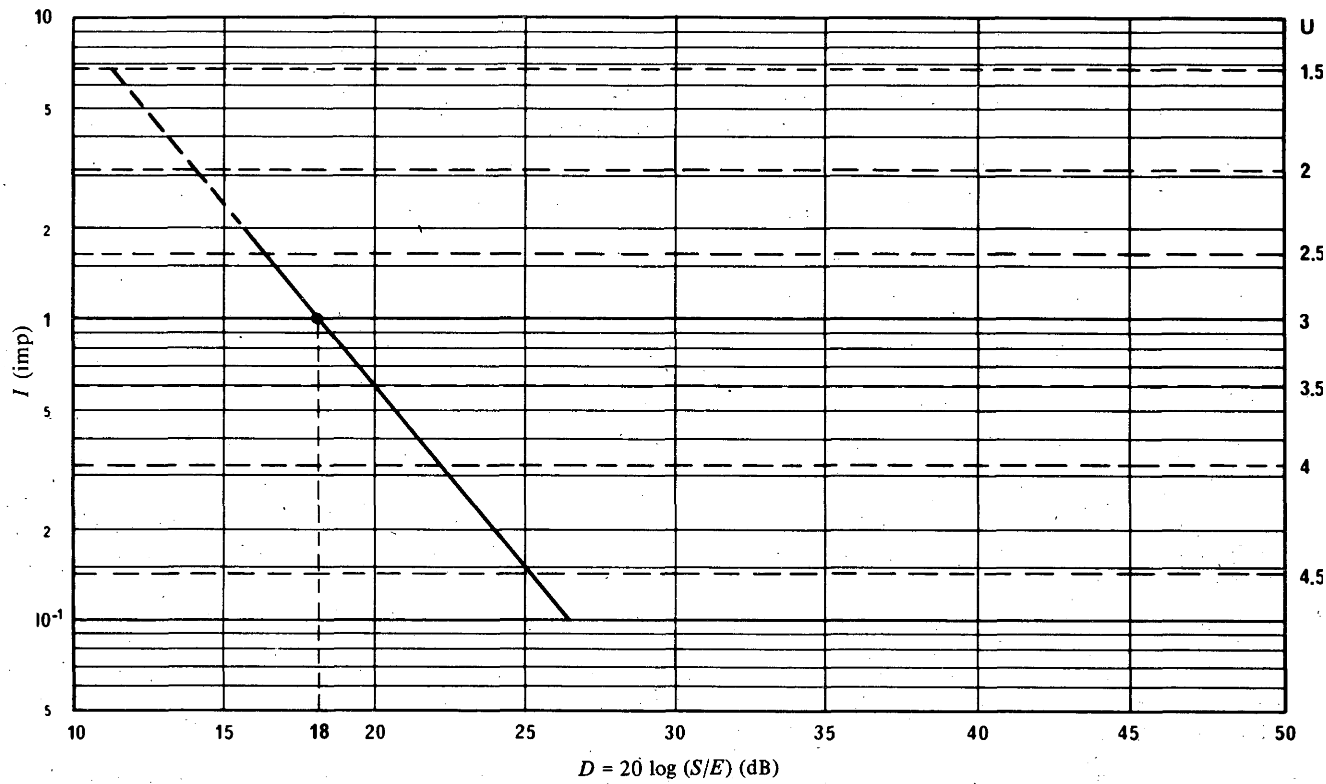

FIGURE 7 – *Impairment characteristic for an undistorted positive echo having a delay of 1 μs*

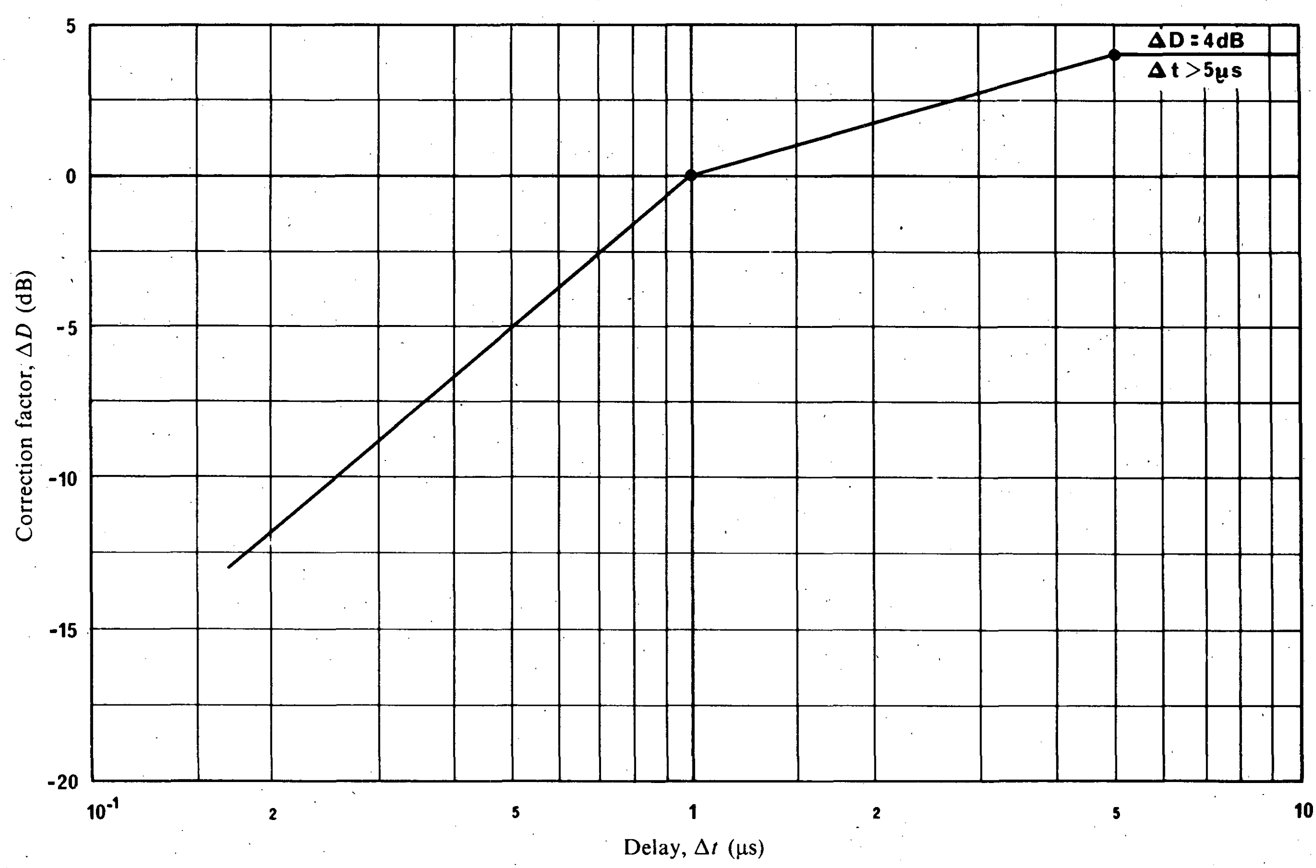

FIGURE 8 – *Correction factor to be applied to the abscissa values of D in Fig. 7 to obtain the signal/echo ratio for other values of delay*

RECOMMENDATION 710

SUBJECTIVE ASSESSMENT METHODS FOR IMAGE QUALITY IN HIGH-DEFINITION TELEVISION

(Questions 3/11 and 27/11)

(1990)

The CCIR,

CONSIDERING

(a) that a number of administrations and organizations throughout the world are currently evaluating high-definition television systems, and that in many parts of the world HDTV broadcasting is likely to become the primary medium of the next century;

(b) that subjective assessments are a vital element in HDTV system design and selection;

(c) that Recommendation 500 outlines a number of preferred subjective assessment methods for conventional television systems (625/50 and 525/60), many of the methodological details of which are also appropriate in the context of HDTV;

(d) that, nevertheless, it may be thought helpful to make clear the assessment methods and viewing conditions appropriate for HDTV, in the key areas currently under study, by a separate Recommendation,

UNANIMOUSLY RECOMMENDS

1. that subjective assessments of image quality of high-definition television systems should be made with the viewing conditions given in Annex I;

2. that subjective assessments of the overall quality of an HDTV image delivered by an emission system should be made using a double-stimulus continuous-quality scale method (Recommendation 500) with the HDTV studio standard as reference (see Note);

3. that assessments of the failure characteristics of an HDTV emission system should be made using a double-stimulus impairment scale method (Recommendation 500) with either the image of the HDTV studio or the image of the unimpaired emission as reference (see Note);

4. that, in the absence of a high-quality reference, the graphic scaling method or the ratio scaling/magnitude estimation method should be considered for assessments of overall quality of the image (before or after processing) provided by an HDTV studio system (see Report 1082);

5. that, when a high-quality reference is available, the double-stimulus continuous quality method (Recommendation 500) should be considered for assessments of overall quality of the image (before, or after processing) provided by an HDTV studio system (see Note);

6. that, in the interpretation of the results of particular studies, due note be taken of any real limitations that current technology may impose upon the results of the study (e.g., bounding effects of pick-up or display devices);

7. that care must be taken to distinguish the influence of the display format from that of the basic system format (e.g. any up-conversion). Assessments may be performed in order to take account of the different formats if applicable and appropriate.

Note – Report 1082 should be consulted for advice on possible linguistic differences in the use of the terms for quality and impairment.

ANNEX I

TABLE I

Condition	Item	Values (1)
a	Ratio of viewing distance to picture height	3
b	Peak luminance on the screen (cd/m^2) (2)	150-250
c	Ratio of luminance of inactive tube screen (beams cut off) to peak luminance (3)	$\leqslant$ 0.02
d	Ratio of the luminance of the screen when displaying only black level in a completely dark room, to that corresponding to peak white (4)	approximately 0.01
e	Ratio of luminance of background behind picture monitor to peak luminance of picture	approximately 0.15
f	Illumination from other sources (5)	low
g	Chromaticity of background	D_{65}
h	Angle subtended by that part of the background which satisfies the specification above (6). This should be preserved for all observers	53° H × 83° W
i	Arrangement of observers	within ± 30° horizontally from the centre of the display. The vertical limit is under study
j	Display size (7)	1.4 m (55 in)

(1) Values b and j are as specified in Report 1216. As it may not be possible currently to achieve these conditions fully for tests, alternative values are given on an interim basis. It should be recognized, however, that the results of tests conducted under the interim conditions may not be, in general, comparable with those obtained in situations in which Report 1216 presentation objectives apply.

(2) Peak luminance on the screen corresponding to the video signal with 100% amplitude. Values $\geqslant$ 70 cd/m^2 should be used until the specified level becomes technically feasible.

(3) This item could be influenced by the room illumination, as well as the contrast range of the display.

(4) Black level corresponds to the video signal with 0% amplitude.

(5) Room illumination should be set in order to make it possible to satisfy the conditions c and e.

(6) A minimum of 28° high × 48° wide is recommended.

(7) Values $\geqslant$ 76.2 cm (30″) should be used if displays of the specified size are not available.

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SECTION 11E: PLANNING OF TELEVISION NETWORKS, PROTECTION RATIOS TELEVISION RECEIVERS AND ANTENNAS

RECOMMENDATION 417-3

MINIMUM FIELD STRENGTHS FOR WHICH PROTECTION MAY BE SOUGHT IN PLANNING A TELEVISION SERVICE

(1963-1966-1970-1986)

The CCIR

UNANIMOUSLY RECOMMENDS

1. that when planning a television service in Bands I, III, IV or V, the median field strength for which protection against interference is planned should never be lower than:

TABLE I

Band	I	III	IV	V
dB (μV/m)	+48	+55	+65([1])	+70([1])

([1]) The values shown for Bands IV and V should be increased by 2 dB for the 625-line (OIRT) system.

These values refer to the field strength at a height of 10 m above ground level;

2. that the percentage of time for which the protection may be sought should lie between 90% and 99%.

Note 1 – In arriving at the figures shown in § 1, it has been assumed that, in the absence of interference from other television transmissions and man-made noise, the minimum field strengths at the receiving antenna that will give a satisfactory grade of picture, taking into consideration receiver noise, cosmic noise, antenna gain and feeder loss, are: +47 dB (μV/m) in Band I, +53 dB in Band III, +62 dB* in Band IV and +67 dB* in Band V.

Note 2 – Further information concerning the planning of television services for sparsely populated regions is contained in Report 409.

Note 3 – In a practical plan, because of interference from other television transmissions, the field strengths that can be protected will generally be higher than those quoted in § 1 and the exact values to be used in the boundary areas between any two countries should be agreed between the Administrations concerned.

Note 4 – The broadcasting band designations I, III, IV and V derive from the European VHF/UHF Broadcasting Conference, Stockholm, 1961 and the African VHF/UHF Broadcasting Conference, Geneva, 1963. The frequency ranges at that time were:

Band I	41- 68 MHz
Band III	162-230 MHz
Band IV	470-582 MHz
Band V	582-960 MHz

According to the Radio Regulations (1982) the bands allocated to the Broadcasting Service start at 47 MHz (Band I) and 174 MHz (Band III) respectively.

* The values shown for Bands IV and V should be increased by 2 dB for the 625-line (OIRT) system.

RECOMMENDATION 655-1

RADIO-FREQUENCY PROTECTION RATIOS FOR AM VESTIGIAL SIDEBAND TELEVISION SYSTEMS

(Question 4/11, Study Programme 4A/11)

(1986-1990)

The CCIR

UNANIMOUSLY RECOMMENDS

that the protection ratios given in this Recommendation should be used for planning purposes.

Studies are still required to allow completion of information on protection ratios applicable to:

- data signals,
- sound signals,
- out-of-channel response,
- within-channel response above the video range,
- 525-line systems,
- system B in the UHF range,
- synchronized carrier operation.

(See Report 1214).

1. Introduction

The RF protection ratio is the minimum value of wanted-to-unwanted signal ratio, usually expressed in decibels at the receiver input, determined under specified conditions such that a specific reception quality is achieved at the receiver output.

1.1 The values of protection ratio quoted apply to interference produced by a single source. Except where otherwise stated, the ratios apply to tropospheric (*T*) interference and correspond closely to a slightly annoying impairment condition. They are considered to be acceptable only if the interference occurs for a small percentage of the time, not precisely defined but generally considered to be between 1% and 10%. For substantially non-fading unwanted signals, it is necessary to provide a higher degree of protection and ratios appropriate to continuous (*C*) interference should be used (see Annex I). If the latter are not known, then the tropospheric (*T*) values increased by 10 dB can be applied.

Values applicable to limit of perceptibility (*LP*) are given for information only.

1.2 Significantly strong wanted input signals can require higher protection ratio because of non-linear effects in the receiver.

1.3 For 625-line systems, the reference impairment levels are those which correspond to co-channel protection ratios of 30 dB and 40 dB with a frequency-offset between vision carriers close to two-thirds of the line frequency but adjusted for maximum impairment, the precise frequency difference being 10.416 kHz. These conditions approximate to impairment grades 3 (slightly annoying) and 4 (perceptible but not annoying) and respectively apply to tropospheric (*T*) and continuous (*C*) interference.

1.4 It should be noted that the amplitude of a vision-modulated signal is defined as the r.m.s. value of the carrier at peaks of the modulation envelope (taking no account of the chrominance signal in positive-modulation systems), while that of a sound-modulated signal is the r.m.s. value of the unmodulated carrier, both for amplitude modulation and for frequency modulation.

For planning purposes it may be assumed that the power in the chrominance channel does not exceed a value which is 16 dB lower than the power in the vision carrier during peaks of the modulation envelope.

1.5 The protection ratio values are not affected if digital data are included in the field-blanking interval of the unwanted television signal. However, certain values are affected in the case of a full-field data unwanted signal; in particular, it is not possible to achieve the full advantages of precision offset operation.

1.6 The relationship between the vision carrier frequencies of the wanted and unwanted signal is as follows (see Annex II):

1.6.1 *Non-controlled condition*

No special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

1.6.2 *Non-precision offset*

Difference between the nominal frequencies of the wanted and unwanted carriers is suitably related to the line frequency, the tolerance of the carrier frequencies being ± 500 Hz.

The line synchronization of television receivers must be sufficiently immune to periodic interference if full advantage of carrier offset operation is to be achieved.

1.6.3 *Precision offset* (see Annex III)

Difference between the nominal frequencies of the wanted and unwanted carriers is suitably related to the line and field frequencies, but with a tolerance of each of the nominal carrier frequencies of the order of ± 1 Hz and stability of the line frequencies equal to or better than 1×10^{-6}. In order to take full advantage of precision offset when the interfering carrier falls in the upper video range (greater than 2 MHz) of the wanted signal, a line-frequency stability of at least 2×10^{-7} is necessary.

2. Co-channel interference

In this section, the protection ratios between two television signals apply only for interference due to the modulated vision carrier of the unwanted signal. Additional protection may be necessary if the wanted sound carrier is affected, or if the unwanted sound carrier lies within the wanted vision channel (e.g. the unwanted sound carrier of system G lies within the vision channel of system K). For all protection ratio figures in this section, the following corrections have to be made:

When the wanted signal is modulated negatively and the unwanted signal is modulated positively (L/SECAM), the values should be increased by 2 dB.

When the wanted signal is modulated positively and the unwanted signal is modulated negatively, the values should be reduced by 2 dB.

Correction is not necessary if the wanted and unwanted signals have the same modulation polarity.

2.1 *Carriers separated by less than 1000 Hz, non-controlled systems having the same or different line-standard*

Protection ratio: 45 dB, tropospheric interference.

2.2 *Carriers separated by parts of the line frequency, systems having the same line-standard, non-precision offset*

TABLE I – *Protection ratio, tropospheric interference carrier separation up to about* $\pm 36/12 f_{line}$ *(about* ± *50 kHz)* where f_{line} = *line frequency*

Offset of line frequency	1/2, 3/2, 5/2, ...	1/3, 2/3, 4/3, ...
625-line system (dB)	27	30
525-line system (dB)	25	28

2.3 *625-line systems, carriers separated by multiples of a twelfth of the line frequency up to about ± 36/12 f_{line} (about ± 50 kHz)*

These protection ratio values do not necessarily apply for greater carrier separations.

TABLE II – *Protection ratio between 625-line systems*

Offset (multiples of 1/12 line-frequency)		0	1	2	3	4	5	6	7	8	9	10	11	12
Non-precision offset Transmitter stability ± 500 Hz	Tropospheric interference	45	44	40	34	30	28	27	28	30	34	40	44	45
	Continuous interference	52	51	48	44	40	36	33	36	40	44	48	51	52
	Limit of perceptibility	61	60	57	54	50	45	42	45	50	54	57	60	61
Precision offset Transmitter stability ± 1 Hz	Tropospheric interference	32	34	30	26	22	22	24	22	22	26	30	34	38
	Continuous interference	36	38	34	30	27	27	30	27	27	30	34	38	42
	Limit of perceptibility	42	44	40	36	36	39	42	39	36	36	40	44	48

Limit of perceptibility – only for information.

(Value in the first column is only valid for the 0/12 case. All other values between 1/12 and 12/12 are the same by addition or subtraction of integral multiples of 12/12 up to ± 36/12.)

3. Adjacent-channel interference

The given protection ratios apply to tropospheric interference and are defined in terms of wanted and unwanted vision carrier levels. For continuous interference, the values should be increased by 10 dB.

Adjacent-channel protection ratios cannot be determined directly from the overlapping channel protection ratio curves shown in § 5 because for certain systems the values may be affected by special measures in the receiver, e.g. sound traps.

3.1 *Lower adjacent-channel interference*

The worst interference on the picture signal from another signal, using the same standard, results from the sound signal in the lower adjacent channel. However, some improvement in protection is achieved if the unwanted sound carrier and the wanted vision carrier are separated by an effective offset in the vicinity of an odd multiple of half line-frequency. This is particularly noticeable during periods without sound modulation when the improvement can be as much as 10 dB; with modulation, the improvement is only 2-3 dB.

Linear correction should be made to take into account vision-to-sound power ratios different from those assumed in the following sub-sections.

3.1.1 *VHF bands*

The figures below relate to the cases where the separation between the wanted vision carrier frequency and the unwanted sound carrier frequency is 1.5 MHz and the ratio between the unwanted vision and unwanted sound powers is 10 dB.

Protection ratio: for frequency-modulated sound carrier

– systems N and M: –13 dB
– all other systems: – 9 dB

for amplitude-modulated sound carrier

– system L (vision-to-sound power ratio 10 dB): – 8 dB

3.1.2 *UHF bands*

Protection ratio: for the 525-line systems in a 6 MHz channel: –13 dB.

For the various 625-line systems for use in 8 MHz channels in the UHF bands, Table III gives the protection required by a signal of any system against a lower adjacent-channel signal of the same or any other standards, assuming a vision-to-sound power ratio of 10 dB for unwanted signals of every standard. A correction must be made for different vision-to-sound power ratios.

TABLE III – *Protection ratio from lower adjacent-channel interference (UHF bands) for 625-line systems*

Wanted signal \ Unwanted signal	Protection ratio (dB)					
	G	H	I	D, K	K1	L
G	–9	–9	–9	–9	–9	–5
H	–9	–9	–9	+13	+13	+17
I	–9	–9	–9	+13	+13	+17
D, K	–9	–9	–9	–9	–9	–5
K1	–9	–9	–9	–9	–9	+17
L	–9	–9	0	–12	–12	–8

3.2 *Upper adjacent-channel interference – VHF and UHF bands*

Protection ratio: for system N: –10 dB
for systems D and K: – 6 dB
for all other systems: –12 dB

4. Image-channel interference

The protection ratio required will depend on the intermediate frequency and image-channel rejection of the receiver, and on the type of unwanted signal falling in the image channel. It can be determined by subtracting the image rejection figure from the required protection ratio for overlapping channels. Table IV shows this situation for the UHF bands. The wanted vision channel can be affected by the unwanted vision carrier, by the unwanted sound carrier, or by both.

Image-channel rejection:

systems D, and K:	30 dB
system I:	50 dB
system M (Japan):	60 dB (VHF) and 45 dB (UHF)
all other systems:	40 dB

TABLE IV – *Protection ratio from image-channel interference 625-line systems (UHF bands)*

Wanted signal \ Unwanted signal	Protection ratio (dB) G, H	I	D, K	K1	L	Image channel	Remarks
G	−1	−4	−11	−11	−7	N + 9	Interference from sound carrier
H	−1	−4	−9	−9	−5	N + 9	
I	−13	−10	−10	−10	−6	N + 9	
D, K	−1	−15	−12	−12	−6	N + 8	Interference from sound carrier
	+13	+13	+13	+13	+15	N + 9	Interference from vision carrier
K1	−1	0	−2	−2	+2	N − 9	Interference from sound carrier
	−1	−4	−5	−5	−1	N + 9	
	+7	+7	+7	+7	+9	N + 10	Interference from vision carrier
L	−2	−2	−4	−13	−9	N − 9	Interference from sound carrier
	< −20	< −20	< −20	< −20	< −20	N − 8	Interference from vision carrier

The image-channel protection ratios in Table IV apply to tropospheric interference, and are defined in terms of wanted and unwanted vision carrier levels assuming a vision-to-sound power ratio of 10 dB for every standard. A correction must be made for different vision-to-sound power ratios. For continuous interference, the values should be increased by 10 dB.

5. Overlapping channel interference

All figures and tables in this section give protection ratios to be applied when a CW signal lies within the vision channel of the wanted transmission, the wanted vision signal being negatively modulated.

Corrections to be made for positively modulated wanted vision signals and for other types of potentially interfering signals are as given in Table V.

TABLE V – *Correction values for different wanted and unwanted signals*

Wanted signal \ Unwanted signal	Correction factors (dB)				
	CW	TV-negative	TV-positive	FM-sound	AM-sound
Vision signal negative modulated	0	−2	0	0	+4
Vision signal positive modulated	−2	−4	−2	−2	+2

When the unwanted signal is a television signal, two calculations of protection ratio are necessary: one for the unwanted vision carrier and one for the unwanted TV sound carrier. The protection ratios shown for unwanted frequency-modulated sound carriers do not apply to non-precision and precision offset conditions. Nevertheless, a reduction of 2 dB relative to the non-controlled condition (curves A and A′) is achieved for non-precision carriers with offsets within the luminance frequency range between 3/12 and 9/12 of the line frequency, and within the chrominance frequency range at 0/12, 1/12, 5/12, 6/12, 7/12, 11/12 and 12/12 of the line frequency.

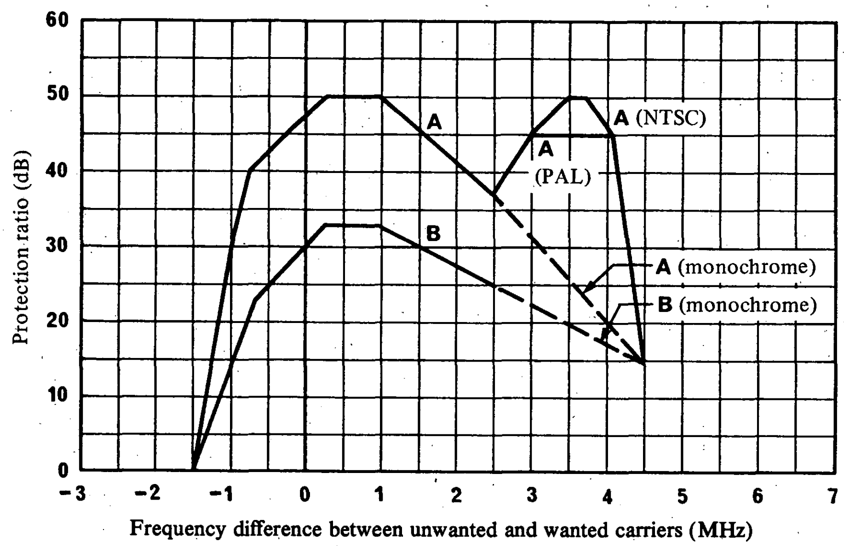
5.1 *525-line systems*

Figure 1 and Table VI show protection ratios for tropospheric interference. For continuous interference, the values should be increased by 10 dB. The unwanted signal is a CW carrier. For other types of unwanted signal, the given correction factors should be applied.

5.2 *625-line systems*

Figures 2 to 4 and Tables VII to IX give protection ratios applicable for tropospheric and continuous interference, and for limit of perceptibility. The values shown refer to the case of a wanted negatively modulated vision signal affected by an unwanted CW signal. The previously indicated corrections apply when considering other combinations of wanted and unwanted signals.

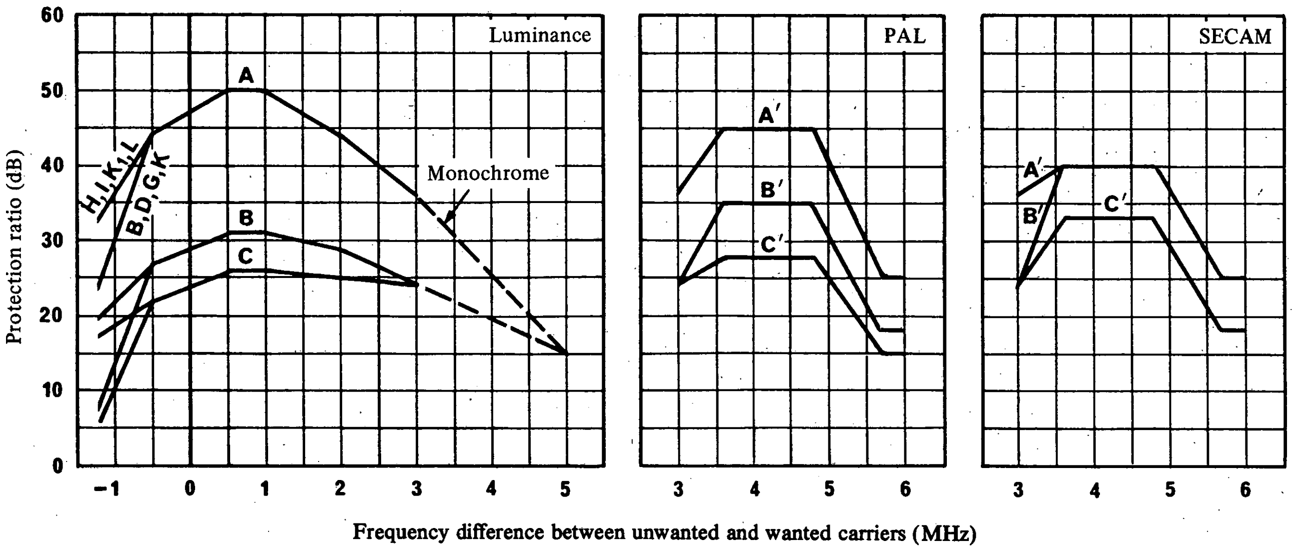
The curves shown in Figs. 2 to 4 are examples that can be derived directly from the associated tables. They illustrate the full range of protection ratio possibilities from the worst case of non-controlled condition (curves A and A′) to the best achievable using either non-precision offset (curves B and B′) or precision offset (curves C and C′). The curves A, B and C are related to the luminance frequency range, the curves A′, B′ and C′ to the chrominance frequency range for the PAL and SECAM systems. For frequency differences below −1.25 MHz or above 6 MHz, the protection ratio can be derived by linear extrapolation to the channel limit.



<table>
<tr><td colspan="2">Frequency difference (MHz)</td><td>−1.5</td><td>−1.0</td><td>−0.75</td><td>0.3</td><td>1.0</td><td>2.5</td><td>3.0</td><td>3.5</td><td>3.7</td><td>4.1</td><td>4.5</td></tr>
<tr><td>A</td><td>NTSC (dB)</td><td rowspan="3">0</td><td rowspan="3">30</td><td rowspan="3">40</td><td rowspan="3">50</td><td rowspan="3">50</td><td rowspan="3">37</td><td rowspan="3">45</td><td>50</td><td>50</td><td rowspan="2">45</td><td rowspan="3">15</td></tr>
<tr><td>A</td><td>PAL (dB)</td><td>45</td><td>45</td></tr>
<tr><td>A</td><td>Monochrome (dB)</td><td></td><td></td><td></td></tr>
<tr><td>B</td><td>Monochrome (dB)</td><td>0</td><td>15</td><td></td><td>33</td><td>33</td><td>25</td><td colspan="4"></td><td>15</td></tr>
</table>

FIGURE 1 and TABLE VI – *525-line systems (M/NTSC and M/PAL)*
Tropospheric interference. Unwanted signal: CW carrier

Curves A: non-controlled condition
B: non-precision offset condition
(1/3, 2/3, 4/3, 5/3, all of the line frequency)

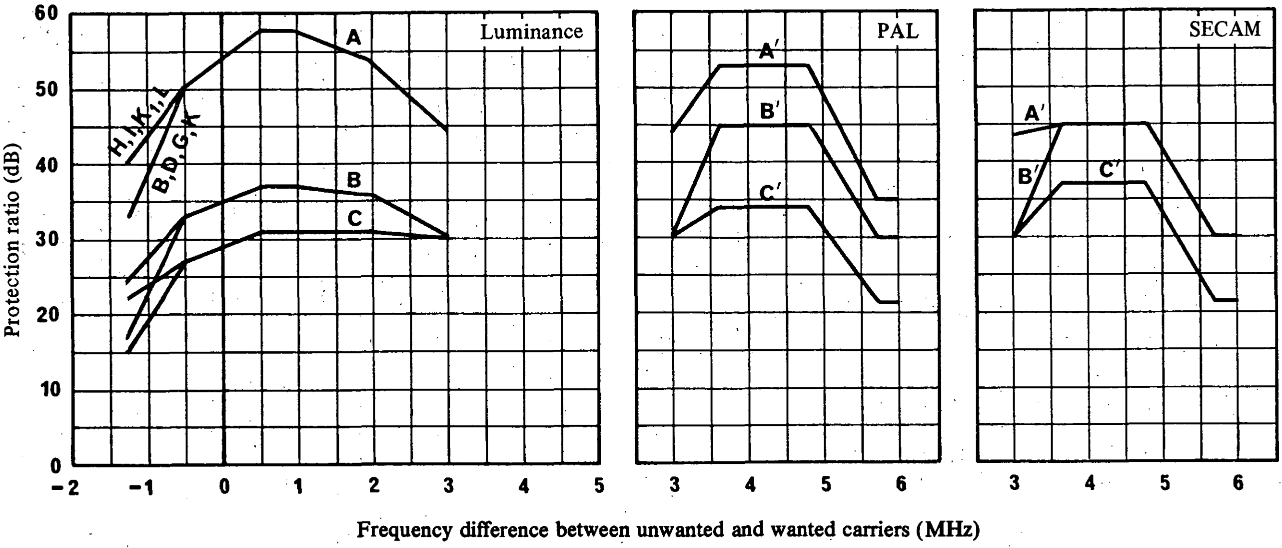


Offset (multiples of 1/12 line-frequency)		Curve	Frequency difference between unwanted and wanted carriers (MHz)											
			Luminance range								PAL		SECAM	
			− 1.25 (1)	− 1.25 (2)	− 0.5	0.0	0.5	1.0	2.0	3.0	3.6-4.8	5.7-6.0 (3)	3.6-4.8 (4)	5.7-6.0 (3)
0	NO	A,B′	**32**	**23**	**44**	**47**	**50**	**50**	**44**	**36**	**35**	**18**	**40**	**25**
	PO	C′	23	11	32	34	40	40	37	31	**28**	**15**	**33**	**18**
1	NO		31	20	43	46	49	49	42	34	39	20	40	25
	PO		23	11	33	36	39	39	36	31	31	16	33	18
2	NO		28	17	39	42	45	45	39	32	42	22	40	25
	PO		21	9	29	32	35	35	33	29	34	17	33	18
3	NO	A′	25	13	34	36	39	39	35	29	**45**	**25**	**40**	**25**
	PO	B′	19	7	25	28	31	31	29	26	**35**	**18**	**33**	**18**
4	NO		22	10	30	32	35	35	32	27	42	22	40	25
	PO	C	**17**	**5**	**22**	**24**	**26**	**26**	**25**	**24**	34	17	33	18
5	NO		20	8	28	30	32	32	30	25	39	20	40	25
	PO	C	**17**	**5**	**22**	**24**	**26**	**26**	**25**	**24**	31	16	33	18
6	NO	B,B′	**19**	**7**	**27**	**29**	**31**	**31**	**29**	**24**	**35**	**18**	**40**	**25**
	PO	C′	17	5	24	26	28	28	26	24	**28**	**15**	**33**	**18**
7	NO	B′	20	8	28	30	32	32	30	25	**35**	**18**	**40**	**25**
	PO	C,C′	**17**	**5**	**22**	**24**	**26**	**26**	**25**	**24**	**28**	**15**	**33**	**18**
8	NO		22	10	30	32	35	35	32	27	39	20	40	25
	PO	C	**17**	**5**	**22**	**24**	**26**	**26**	**25**	**24**	31	16	33	18
9	NO		25	13	34	36	39	39	35	29	42	22	40	25
	PO		19	7	25	28	31	31	29	26	34	17	33	18
10	NO		28	17	39	42	45	45	39	32	39	20	40	25
	PO		21	9	29	32	35	35	33	29	31	16	33	18
11	NO	B′	31	20	43	46	49	49	42	34	**35**	**18**	**40**	**25**
	PO	C′	23	11	33	36	39	39	36	31	**28**	**15**	**33**	**18**
12	NO	A,B′	**32**	**23**	**44**	**47**	**50**	**50**	**44**	**36**	**35**	**18**	**40**	**25**
	PO	C′	23	11	32	40	40	40	37	31	**28**	**15**	**33**	**18**
			Protection ratio (dB)											

FIGURE 2 and TABLE VII – *625-line systems*
Tropospheric interference

(1) H, I, K1, L television systems.
(2) B, D, G, K television systems.
(3) B, G television systems: range is 5.3-6.0 MHz.
(4) D/SECAM and K/SECAM: add 5 dB.

NO: non-precision offset
PO: precision offset



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<tr><th colspan="8">Luminance range</th><th colspan="2">PAL</th><th colspan="2">SECAM</th></tr>
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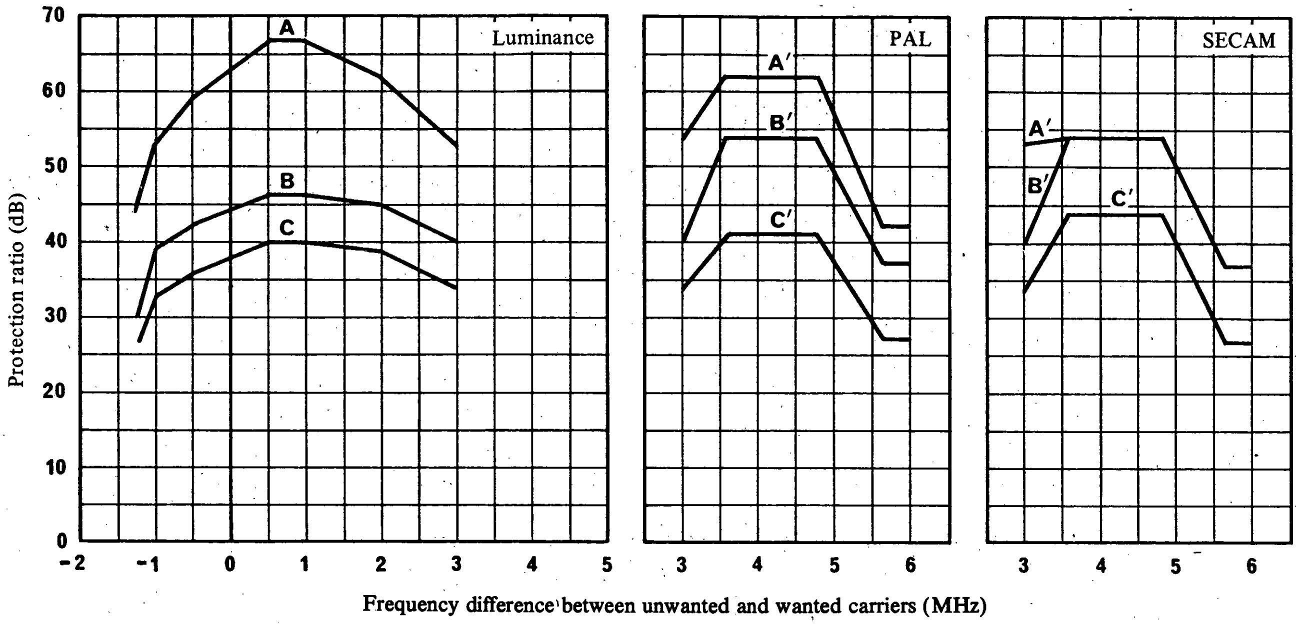
<tr><td colspan="15">Protection ratio (dB)</td></tr>
</table>

FIGURE 3 and TABLE VIII – *625-line systems*
Continuous interference

(1) H, I, K1, L television systems.
(2) B, D, G, K television systems.
(3) B, G television systems: range is 5.3-6.0 MHz.
(4) D/SECAM and K/SECAM: add 8 dB.

NO: non-precision offset
PO: precision offset



<table>
<tr><td colspan="2">Frequency difference (MHz)</td><td>– 1.25</td><td>– 1.0</td><td>– 0.5</td><td>0.0</td><td>0.5</td><td>1.0</td><td>2.0</td><td>3.0</td><td>3.6</td><td>4.8</td><td>5.7</td></tr>
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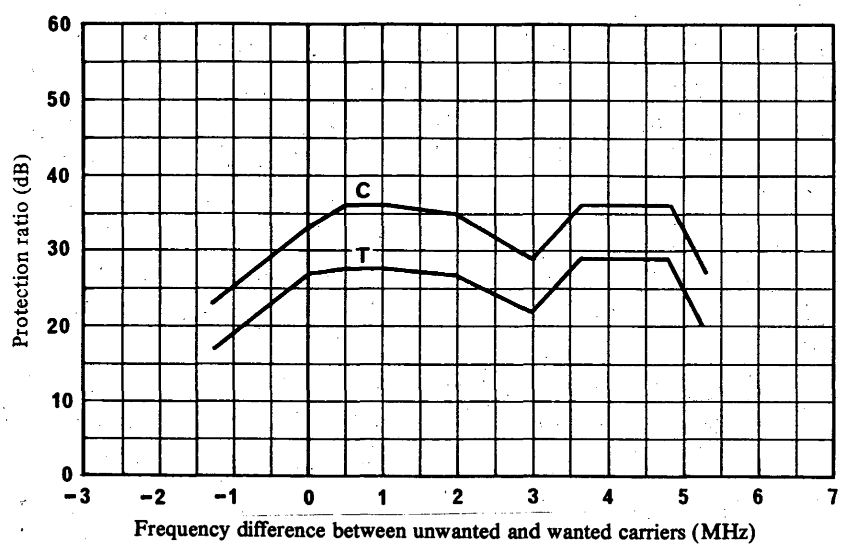
<tr><td>SECAM</td></tr>
<tr><td rowspan="2">C</td><td>PAL</td><td rowspan="2">26</td><td rowspan="2">33</td><td rowspan="2">36</td><td rowspan="2">38</td><td rowspan="2">40</td><td rowspan="2">40</td><td rowspan="2">39</td><td rowspan="2">34</td><td>41</td><td>41</td><td rowspan="2">27</td></tr>
<tr><td>SECAM</td><td>44</td><td>44</td></tr>
</table>

FIGURE 4 and TABLE IX – *625-line systems*
Limit of perceptibility (for information only)

5.3 *Television signal affected by data signals*

The inclusion of digital data such as teletext in the field-blanking interval has no effect on the required protection ratios. However, the full improvement resulting from non-precision or precision offset operation is not achievable when the unwanted signal carries a full-field data signal. In this case, Fig. 5 shows the minimum values for all offset and non-offset conditions given in § 5.2. The curves in Fig. 5 apply to full-field data signals with pulse amplitude at 66% of the peak white-to-blanking level. The values should be increased linearly for higher modulation levels.



Frequency difference (MHz)	−1.25	0.0	0.5	1.0	2.0	3.0	3.6	4.8	5.25
Tropospheric interference (T)	17	27	28	28	27	22	29	29	20
Continuous interference (C)	23	33	36	36	35	29	36	36	27

FIGURE 5 and TABLE X – *625-line systems – B/PAL and G/PAL*
Protection from full-field data signals

6. Protection ratio for sound signals

Protection ratios applicable to the wanted sound signal are given in Table XI for both tropospheric and continuous interference. The values quoted refer to the level of the wanted sound carrier. In the case of a two-sound carrier transmission, each sound carrier must be separately considered. Multiplex modulated sound signals may require higher protection.

For an unwanted vision carrier, subtract 2 dB; for an unwanted amplitude-modulated sound carrier, add 4 dB.

The maximum deviation of the wanted FM sound carrier is assumed to be ± 50 kHz. A linear correction should be made for other deviations.

The weighted signal-to-noise ratio will be improved by approximately 8 dB if, for example, 5/3 line-frequency offset is used instead of 2/3 line-frequency offset.

TABLE XI – *Protection ratio for wanted sound carriers*
Unwanted signal: CW or FM sound carrier

Difference between wanted sound carrier and unwanted carrier (kHz)	Wanted sound signal			
	Tropospheric interference		Continuous interference	
	FM	AM	FM	AM
0	32	40	39	50
15	30	40	35	50
50	22	10	24	15
250	−6	7	−6	12

BIBLIOGRAPHY

DINSEL, S. and SIPEK, E. [April, 1985] Frequency offset in television – theory and application. *EBU Rev. Tech.*, **210**, 64-71.

ANNEX I

TROPOSPHERIC AND CONTINUOUS INTERFERENCE

When using the protection ratios in planning, it is necessary to determine whether, in the particular circumstances, the interference should be considered as tropospheric or continuous. This can be done by comparing the nuisance fields for the two conditions, the nuisance field being defined as the field strength of the interfering transmitter (at its pertinent e.r.p.) enlarged by the relevant protection ratio.

Thus, the nuisance field for continuous interference:

$$E_C = E(50, 50) + P + A_C$$

and the nuisance field for tropospheric interference:

$$E_T = E(50, t) + P + A_T$$

where:

$E(50, t)$: field strength (dB(μV/m)) of the interfering transmitter, normalized to 1 kW, and exceeded during t% of the time;

P: e.r.p. (dB(1 kW)) of the interfering transmitter;

A: protection ratio (dB),

and where the indices C and T indicate continuous and tropospheric interference, respectively.

The protection ratio for continuous interference is applicable when the resulting nuisance field is stronger than that resulting from tropospheric interference, that is, when $E_C > E_T$.

This means that A_C should be used in all cases when:

$$E(50, 50) + A_C > E(50, t) + A_T$$

ANNEX II

DIFFERENT OFFSET CONDITIONS

The required protection ratio varies considerably depending on the frequency relationship between the wanted and the unwanted carriers and their frequency tolerance. The greatest protection is required when the frequency of one or both carriers is "non-controlled".

Less interference is possible and therefore lower protection ratios are required for non-precision offset (line frequency offset). Non-precision offset takes advantage of the line frequency structure of the video signal and, in particular, it is advantageous to offset the carriers by multiples of one-half or one-third of the line frequency. The long-term stability of these favourable protection ratios can only be guaranteed, however, if the frequencies of the wanted and unwanted signals are kept constant within ± 500 Hz.

Precision offset takes further advantage of the field frequency structure of the video spectrum. The least protection is required when both carriers are "precision offset" controlled within a tolerance of ± 1 Hz for the wanted and unwanted carriers.

Figure 6 shows the main characteristics of offset operation and plots in schematic form the protection ratio curves between 0/12 f_{line} and 12/12 f_{line}. These curves are cyclic and their extensions to the left and right are symbolized by broken lines. These various conditions illustrated are similar within the luminance range up to about ± 3 MHz.

The upper and lower curves indicate, respectively, the protection ratios obtained with non-precision and precision offset. More precisely, these two curves trace the envelope of a series of fluctuations in the protection ratio which swings between the two curves at field frequency as represented by the thin line.

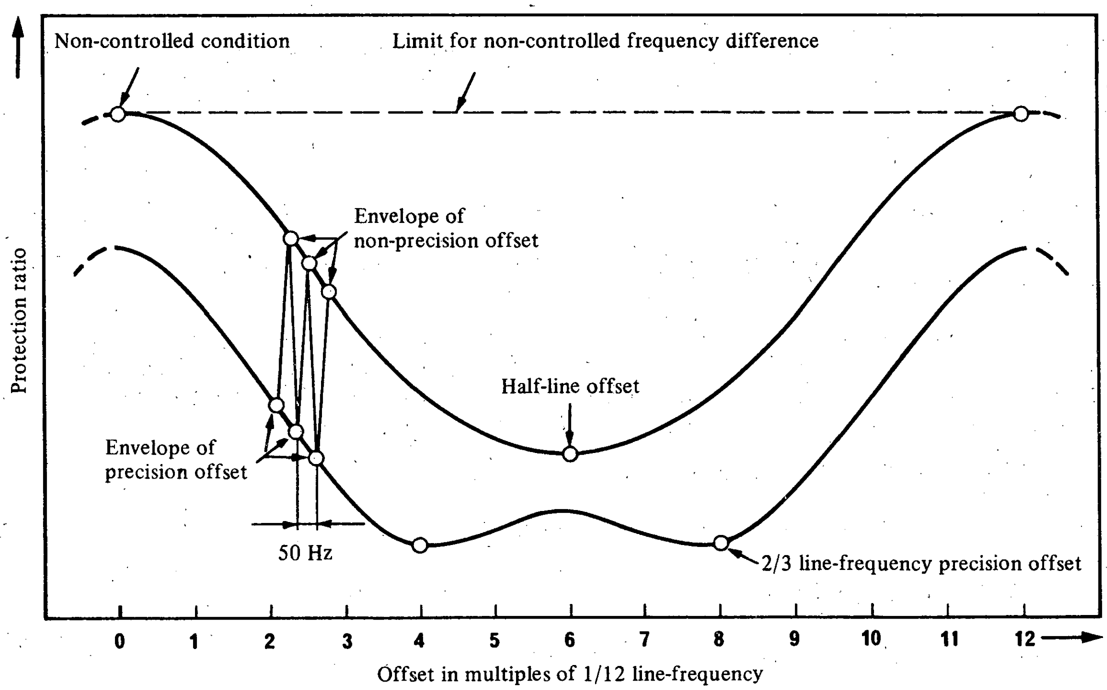


FIGURE 6 – *Schematic protection ratio curves with different offset positions*

Co-channel protection ratio curves in the vicinity of 0/12, 4/12, and 6/12 line frequency (625-line systems)

Figure 7 gives examples of protection ratio curves for the three most important offset positions (0/12, 4/12 and 6/12 f_{line}). The curves in each graph relate to tropospheric interference, continuous interference and the limit of perceptibility.

The white and black points indicate the positions for non-precision and precision offset respectively. The reference impairment points for tropospheric and continuous interference are also indicated in the figure.

When operating TV transmitter networks with synchronized as well as phase-locked carriers, the protection ratio values are slightly reduced.

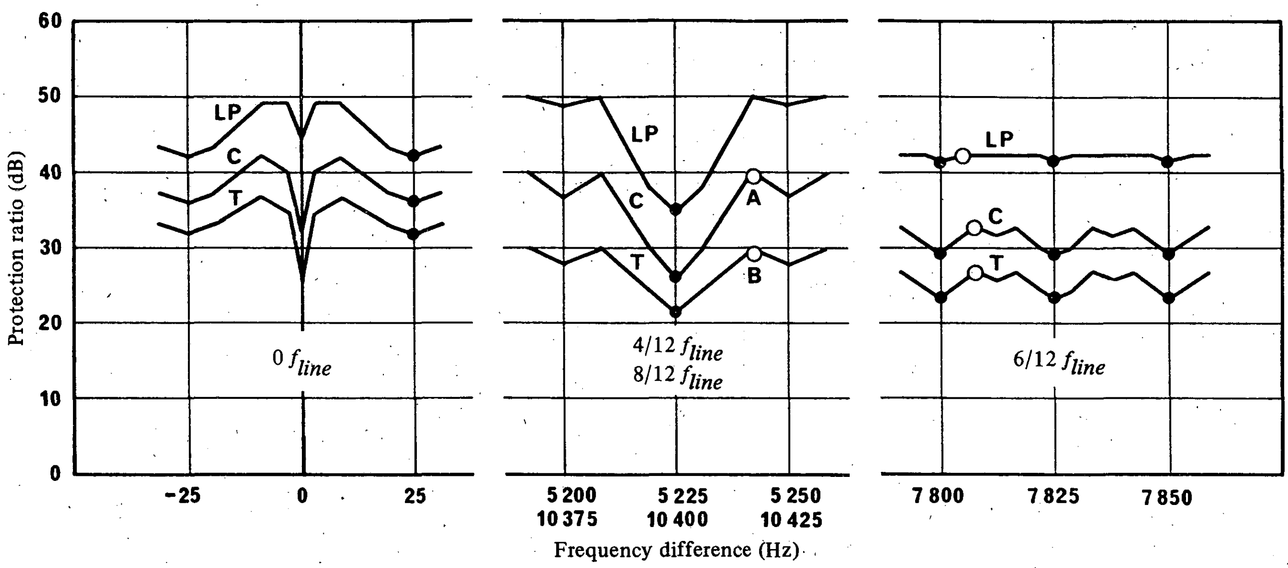


FIGURE 7 – *Precise structure of the protection ratio curves for different offset positions*

Curves T: tropospheric interference
C: continuous interference
LP: limit of perceptibility
A: continuous interference reference point
B: tropospheric interference reference point

○ Non-precision offset
● Precision offset

ANNEX III

FREQUENCIES FOR PRECISION OFFSET

Table XII lists the possible frequencies for precision offset in the vicinity of each twelfth of line frequency. For the luminance frequency range, the frequencies shown in the table end with 25 Hz up to $6/12\ f_{line}$ and with 100 Hz beyond this frequency. Two possibilities are shown for $6/12\ f_{line}$ (7800 and 7825 Hz) because at this point the spectral lines are symmetrical and thus of the same amplitude. The offset frequencies are expressed in twelfths of line frequency.

Alternative frequencies in the vicinity of each offset position, which differ by integer multiples of 50 Hz and by integral multiples of 15 625 Hz from the values given, are possible. The term "precision offset" always refers to a difference between the true frequencies of the wanted and unwanted transmitters, and not to an offset of a transmitter from its nominal carrier frequency.

If the frequency difference between wanted and unwanted carrier exceeds the normalized range specified in Table XII, one has to subtract integral multiples of 15 625 Hz. For computer calculations, formulae are given below for all precision-offset frequency differences in the luminance and in the chrominance range for 625-line systems.

TABLE XII – *Normalized precision offset between 0/12 and 12/12 of line frequency*

Luminance range: for all 625-line systems
Chrominance range: only PAL and SECAM systems

Offset (multiples of 1/12 line-frequency)	Precision offset frequency (Hz)		
	Luminance range	Chrominance range	
		PAL	SECAM
0	25	5	0
1	1 325	1 305	1 302
2	2 625	2 605	2 604
3	3 925	3 905	3 906
4	5 225	5 205	5 208
5	6 525	6 505	6 510
6	7 800 or 7 825	7 810	7 812
7	9 100	9 115	9 115
8	10 400	10 420	10 417
9	11 700	11 720	11 719
10	13 000	13 020	13 021
11	14 300	14 320	14 323
12	15 600	15 630	15 625

Luminance range:

$f_p = m \times 15\,625 \pm (2n + 1) \times 25$
$m \leqslant 192,\ n \leqslant 156$

Chrominance range:

– *PAL systems*

$f_p = m \times 15\,625 \pm (2n + 1) \times 25 + k$
$m \geqslant 216$ and
$k = -20$ for $0 \leqslant n < 143$
$k = -15$ for $143 \leqslant n < 169$
$k = -5$ for $169 \leqslant n < 299$
$k = +5$ for $299 \leqslant n \leqslant 312$

– *SECAM systems*

$$f_p = m \times 15\,625 + 2n \times \left(25 + \frac{25}{624}\right)$$

with m, n, k integers

Computation of operational offset frequencies in a network with transmitter triplets

Precision offset techniques are usually introduced to provide solutions of particular interference problems between two co-channel transmitters. In operational television networks, co-channel transmitters are situated at the corner of a triangle. A typical line offset (non-precision offset) situation for such a transmitter triplet is: nominal vision carrier frequency $-2/3\ f_{line}$, $\pm\ 0\ f_{line}$, and $+2/3\ f_{line}$ or in twelfths: 8M, 0, 8P (M = minus; P = plus). A transmitter triplet A-B-C consists of three transmitter pairs A-B, A-C and B-C. Introduction of precision offset for the above-mentioned example means a possible reduction of interference for all three pairs of the transmitter triplet. In practice, only 35% of all the theoretically possible transmitter triplets have full improvement for all three pairs, the residual 65% triplets have one or two pairs in non-precision offset.

Table XIII shows a complete and normalized list of these 35% possible cases within the range between 0P and 12P which secure an improved interference situation for all three transmitter pairs within a triplet, when precision offset is used.

With a simple rule, determination of precision offset frequencies for transmitter triplets is possible. All transmitter triplets which cannot translate to the normalized cases of Table XIII contain at least one pair without precision offset.

Example

The aim of this calculation is the transformation of all three offset positions into the range between 0P and 12P (see Table XIII). Each single transmitter can be moved by multiples of line frequency, that means by multiples of 12/12 (see Step 2). Moving of any twelfths is allowed, when all transmitters are moved by the same number of twelfths (see Step 1).

		A	B	C	
Given: Transmitter triplet line offset position:		18M	8P	2P	
Step 1					
Set one transmitter to 0 by linear translation:		+18	+18	+18	
	Result:	0	26P	20P	
Step 2					
Translation of transmitter B and C into the range between 0P and 12P by subtracting or adding multiple of the line frequency:			−24	−12	
	Result:	0	2P	8P	
Step 3					
Selection of precision offset frequencies from Table XIII:		0	2 625	10 400	Hz
Step 4					
Step 2 has to be compensated:			+31 250	+15 625	Hz
	Result:	0	+33 875	+26 025	Hz
Step 5					
Step 1 has to be compensated:		−23 400	−23 400	−23 400	Hz
	Result:	−23 400	+10 475	+ 2 625	Hz
	equivalent to	18M	8P*	2P	

TABLE XIII – *Possible offset combinations allowing precision offset for all transmitter pairs in transmitter triplets*

Case	Offset	Frequency (Hz) (625-line systems)
1	0 – 0P – 6P	0 25 7 800
2	0 – 0P – 6P	0 25 7 825
3	0 – 1P – 6P	0 1 325 7 800
4	0 – 1P – 7P	0 1 325 9 100
5	0 – 2P – 6P	0 2 625 7 800
6	0 – 2P – 7P	0 2 625 9 100
7	0 – 2P – 8P	0 2 625 10 400
8	0 – 3P – 6P	0 3 925 7 800
9	0 – 3P – 7P	0 3 925 9 100
10	0 – 3P – 8P	0 3 925 10 400
11	0 – 3P – 9P	0 3 925 11 700
12	0 – 4P – 6P	0 5 225 7 800
13	0 – 4P – 7P	0 5 225 9 100
14	0 – 4P – 8P	0 5 225 10 400
15	0 – 4P – 9P	0 5 225 11 700
16	0 – 4P – 10P	0 5 225 13 000
17	0 – 5P – 6P	0 6 525 7 800
18	0 – 5P – 7P	0 6 525 9 100
19	0 – 5P – 8P	0 6 525 10 400
20	0 – 5P – 9P	0 6 525 11 700
21	0 – 5P – 10P	0 6 525 13 000
22	0 – 5P – 11P	0 6 525 14 300
23	0 – 6P – 6P	0 7 800 7 825
24	0 – 6P – 7P	0 7 825 9 100
25	0 – 6P – 8P	0 7 825 10 400
26	0 – 6P – 9P	0 7 825 11 700
27	0 – 6P – 10P	0 7 825 13 000
28	0 – 6P – 11P	0 7 825 14 300
29	0 – 6P – 12P	0 7 800 15 600
30	0 – 6P – 12P	0 7 825 15 600

* To reduce the sound interference between transmitter B and C, an offset position of 20P = 26 100 Hz (enlarged by 12P = 15 625 Hz) would be preferable. In this case picture interference is unchanged.

RECOMMENDATION 565*

PROTECTION RATIOS FOR 625-LINE TELEVISION AGAINST RADIONAVIGATION TRANSMITTERS OPERATING IN THE SHARED BANDS BETWEEN 582 AND 606 MHz

(Questions 4/11 and 39/11)

(1978)

The CCIR,

CONSIDERING

(a) the Final Acts of the European VHF/UHF Broadcasting Conference, Stockholm, 1961**, and the Special Agreement relating to the use of the band 582-606 MHz by the radionavigation service, Brussels, 1962;

(b) the assumption, which remains to be fully confirmed, that the results of tests carried out with monochrome television signals are also applicable to colour television;

(c) that protection ratios should be such that they are satisfied for 99% of the time;

(d) that values of protection ratios refer to the conditions at the input to the television receiver;

(e) that the level of the television signal is expressed in terms of the power at the peak of the modulation envelope;

(f) that the level of the radionavigation signal is expressed as the power at peak-pulse level,

UNANIMOUSLY RECOMMENDS

that the values of protection ratio given below should be used in determining the protection available to monochrome or colour-television systems operating in the band 582 to 606 MHz:

1. Protection ratios required when the radionavigation signal falls within the passband of the television receiver

When the radionavigation signal falls within the passband of the television receiver, the required signal-to-interference ratio should be:

– 10 dB for systems with negative modulation,

– 15 dB for systems with positive modulation.

The ratio is sensibly constant over the greater part of the passband of the television receiver, but decreases in accordance with the selectivity of the receiver as shown in Fig. 1.

The protection ratios given in Fig. 1 do not relate to interference to the sound channel from signals of the radionavigation services. Further studies should be carried out on this subject.

* This Recommendation constitutes a partial answer to Question 39/11. It should be brought to the attention of Study Group 8.

** However, at the European VHF/UHF Broadcasting Conference, Stockholm, 1961, some delegates made reservations as to the prospect of fulfilling the technical criteria in actual planning.

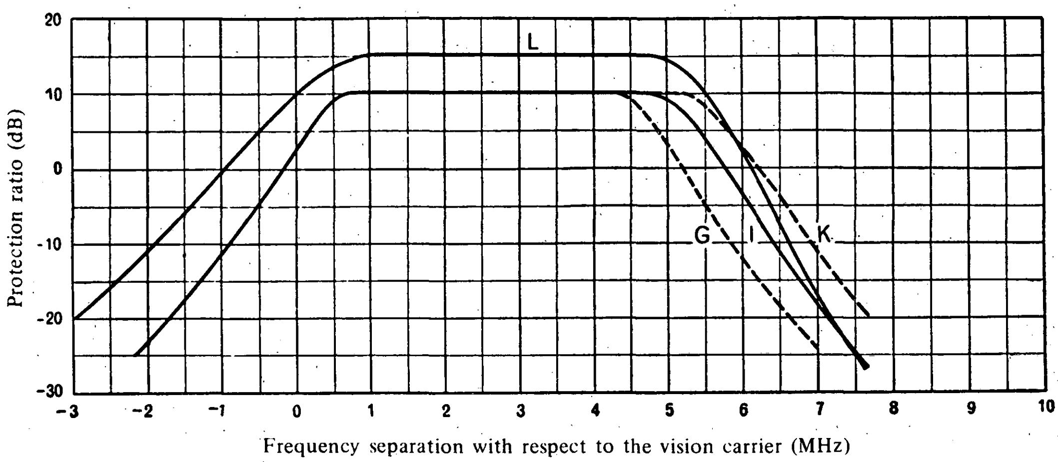


FIGURE 1 – *Protection ratio required by system L, G, I and K picture signals against a radionavigation signal in the band 582 to 606 MHz*

2. Protection ratios required when the radionavigation signal falls outside the passband of the television receiver

Reference should be made to Recommendation 655 for image channel interference.

No information exists at present on adjacent channel interference.

Note – Other interference effects (intermodulation) are likely to occur if radionavigation stations, which in general use high peak powers and highly directional antennas, are situated near receiving locations, especially where the television signal is weak.

RECOMMENDATION 266

PHASE CORRECTION OF TELEVISION TRANSMITTERS NECESSITATED BY THE USE OF VESTIGIAL-SIDEBAND TRANSMISSION

(Study Programme 9A/11)

(1959)

The CCIR,

CONSIDERING

(a) that the transmission of television signals using vestigial-sideband techniques gives rise to distortion;

(b) that this distortion consists of linear distortion (in-phase errors) and non-linear distortion (quadrature errors);

(c) that with average pictures, the depths of modulation are low and thus the non-linear distortion is less than the linear distortion;

(d) that linear distortion arises partly from the transmitter and partly in the receiver;

(e) that due regard has to be paid to future design and development of television receivers as well as to the differing degree of phase errors in existing receivers,

UNANIMOUSLY RECOMMENDS

1. that linear pre-correction shall be introduced into the television picture transmitter, so as to compensate for that part of the linear distortion arising from the errors in the radiated signal;

2. that the television picture transmitter may also introduce a correction to compensate for linear distortions arising in the receiver, but this correction shall not exceed one half of that necessary to compensate a receiver using normal minimum phase-shift networks and with an amplitude characteristic corresponding to the television standard concerned;

3. that the pre-correction allowed in § 2 applies only to frequencies between zero and up to approximately half the video bandwidth.

RECOMMENDATION 419-2

DIRECTIVITY OF ANTENNAS IN THE RECEPTION OF TELEVISION BROADCASTING

(Question 26/11, Study Programme 26A/11)

(1963-1986-1990)

The CCIR

UNANIMOUSLY RECOMMENDS

that the characteristics of directivity of the receiving antennas of Fig. 1 can be used for planning terrestrial television services in broadcasting Bands I, III, IV and V.

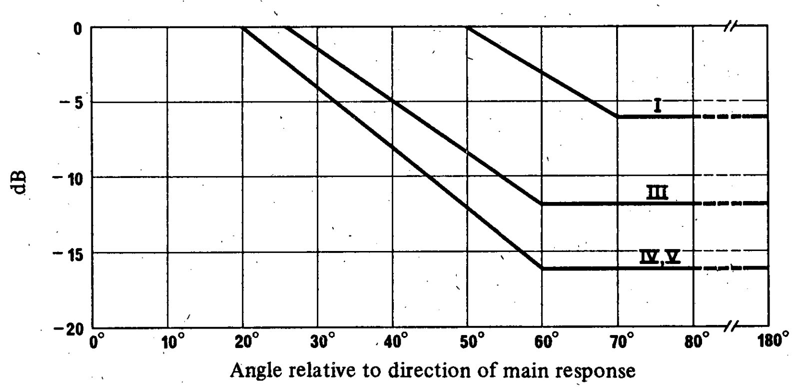


FIGURE 1 – *Discrimination obtained by the use of directional receiving antennas in broadcasting*

(The number of the broadcasting band is shown on the curve)

Note 1 – It is considered that the discrimination shown will be available at the majority of antenna locations in built-up areas. At clear sites in open country, slightly higher values will be obtained.

Note 2 – The curves in Fig. 1 are valid for signals of vertical or horizontal polarization, when both the wanted and the unwanted signals have the same polarization.

Note 3 – In the case of orthogonal polarization the combined discrimination provided by directivity and orthogonality cannot be calculated by adding together the separate discrimination values. However, it has been found in practice that a combined discrimination value of 16 dB may be applied for all angles of azimuth in the terrestrial television Bands I to V. This value could be expected to be exceeded at more than 50% of locations (see Report 122).

Note 4 – Bands I, III, IV and V are defined in Note 4 of Recommendation 417.

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SECTION 11F: DIGITAL METHODS OF TRANSMITTING TELEVISION INFORMATION

RECOMMENDATION 601-2

ENCODING PARAMETERS OF DIGITAL TELEVISION FOR STUDIOS*

(Question 25/11, Study Programmes 25G/11, 25H/11)

(1982–1986–1990)

The CCIR,

CONSIDERING

(a) that there are clear advantages for television broadcasters and programme producers in digital studio standards which have the greatest number of significant parameter values common to 525-line and 625-line systems;

(b) that a world-wide compatible digital approach will permit the development of equipment with many common features, permit operating economies and facilitate the international exchange of programmes;

(c) that an extensible family of compatible digital coding standards is desirable. Members of such a family could correspond to different quality levels, facilitate additional processing required by present production techniques, and cater for future needs;

(d) that a system based on the coding of components is able to meet some, and perhaps all, of these desirable objectives;

(e) that the co-siting of samples representing luminance and colour-difference signals (or, if used, the red, green and blue signals) facilitates the processing of digital component signals, required by present production techniques,

UNANIMOUSLY RECOMMENDS

that the following be used as a basis for digital coding standards for television studios in countries using the 525-line system as well as in those using the 625-line system:

1. Component coding

The digital coding should be based on the use of one luminance and two colour-difference signals (or, if used, the red, green and blue signals).

The spectral characteristics of the signals must be controlled to avoid aliasing whilst preserving the passband response. When using one luminance and two colour-difference signals as defined in Table I of RECOMMENDS 4, suitable filters are defined in Annex III, Figs. 1 and 2. When using the E'_R, E'_G, E'_B signals or luminance and colour-difference signals as defined in Table II of Annex I, a suitable filter characteristic is shown in Fig. 1 of Annex III.

* Main digital television terms used in the Recommendation are defined in Report 629.

2. Extensible family of compatible digital coding standards

The digital coding should allow the establishment and evolution of an extensible family of compatible digital coding standards.

It should be possible to interface simply between any two members of the family.

The member of the family to be used for the standard digital interface between main digital studio equipment, and for international programme exchange (i.e. for the interface with video recording equipment and for the interface with the transmission system) should be that in which the luminance and colour-difference sampling frequencies are related in the ratio 4 : 2 : 2.

In a possible higher member of the family the sampling frequencies of the luminance and colour-difference signals (or, if used, the red, green and blue signals) could be related by the ratio 4 : 4 : 4. Tentative specifications for the 4 : 4 : 4 member are included in Annex I (see Note).

Note – Administrations are urgently requested to conduct further studies in order to specify parameters of the digital standards for other members of the family. Priority should be accorded to the members of the family below 4 : 2 : 2. The number of additional standards specified should be kept to a minimum.

3. Specifications applicable to any member of the family

3.1 Sampling structures should be spatially static. This is the case, for example, for the orthogonal sampling structure specified in § 4 of the present Recommendation for the 4 : 2 : 2 member of the family.

3.2 If the samples represent luminance and two simultaneous colour-difference signals, each pair of colour-difference samples should be spatially co-sited. If samples representing red, green and blue signals are used they should be co-sited.

3.3 The digital standard adopted for each member of the family should permit world-wide acceptance and application in operation; one condition to achieve this goal is that, for each member of the family, the number of samples per line specified for 525-line and 625-line systems shall be compatible (preferably the same number of samples per line).

4. Encoding parameter values for the 4 : 2 : 2 member of the family

The following specification (Table I) applies to the 4 : 2 : 2 member of the family, to be used for the standard digital interface between main digital studio equipment and for international programme exchange.

TABLE I – *Encoding parameter values for the 4 : 2 : 2 member of the family*

Parameters	525-line, 60 field/s (1) systems	625-line, 50 field/s (1) systems
1. Coded signals: Y, C_R, C_B	These signals are obtained from gamma pre-corrected signals, namely: E'_Y, $E'_R - E'_Y$, $E'_B - E'_Y$ (Annex II, § 2 refers)	
2. Number of samples per total line: – luminance signal (Y) – each colour-difference signal (C_R, C_B)	 858 429	 864 432
3. Sampling structure	Orthogonal, line, field and frame repetitive. C_R and C_B samples co-sited with odd (1st, 3rd, 5th, etc.) Y samples in each line	
4. Sampling frequency: – luminance signal – each colour-difference signal	13.5 MHz (2) 6.75 MHz (2) The tolerance for the sampling frequencies should coincide with the tolerance for the line frequency of the relevant colour television standard	
5. Form of coding	Uniformly quantized PCM, 8 bits per sample, for the luminance signal and each colour-difference signal	
6. Number of samples per digital active line: – luminance signal – each colour-difference signal	 720 360	
7. Analogue-to-digital horizontal timing relationship: – from end of digital active line to 0_H	16 luminance clock periods	12 luminance clock periods
8. Correspondence between video signal levels and quantization levels: – scale – luminance signal – each colour-difference signal	 0 to 255 220 quantization levels with the black level corresponding to level 16 and the peak white level corresponding to level 235. The signal level may occasionally excurse beyond level 235 225 quantization levels in the centre part of the quantization scale with zero signal corresponding to level 128	
9. Code-word usage	Code-words corresponding to quantization levels 0 and 255 are used exclusively for synchronization. Levels 1 to 254 are available for video	

(1) See Report 624, Table I.

(2) The sampling frequencies of 13.5 MHz (luminance) and 6.75 MHz (colour-difference) are integer multiples of 2.25 MHz, the lowest common multiple of the line frequencies in 525/60 and 625/50 systems, resulting in a static orthogonal sampling pattern for both.

ANNEX I

TENTATIVE SPECIFICATION OF THE 4 : 4 : 4 MEMBER OF THE FAMILY

This Annex provides for information purposes a tentative specification for the 4 : 4 : 4 member of the family of digital coding standards.

The following specification could apply to the 4 : 4 : 4 member of the family suitable for television source equipment and high quality video signal processing applications.

TABLE II – *A tentative specification for the 4 : 4 : 4 member of the family*

Parameters	525-line, 60 field/s systems	625-line, 50 field/s systems
1. Coded signals: Y, C_R, C_B or R, G, B	These signals are obtained from gamma pre-corrected signals, namely: E'_Y, $E'_R - E'_Y$, $E'_B - E'_Y$ or E'_R, E'_G, E'_B	
2. Number of samples per total line for each signal	858	864
3. Sampling structure	Orthogonal, line, field and frame repetitive. The three sampling structures to be coincident and coincident also with the luminance sampling structure of the 4 : 2 : 2 member	
4. Sampling frequency for each signal	13.5 MHz	
5. Form of coding	Uniformly quantized PCM. At least 8 bits per sample	
6. Duration of the digital active line expressed in number of samples	At least 720	
7. Correspondence between video signal levels and the 8 most significant bits (MBS) of the quantization level for each sample:		
– scale	0 to 255	
– R, G, B or luminance signal (1)	220 quantization levels with the black level corresponding to level 16 and the peak with level corresponding to level 235. The signal level may occasionally excurse beyond level 235	
– each colour-difference signal (1)	225 quantization levels in the centre part of the quantization scale with zero signal corresponding to level 128	

(1) If used.

ANNEX II

DEFINITION OF SIGNALS USED IN THE DIGITAL CODING STANDARDS

1. Relationship of digital active line to analogue sync. reference

The relationship between 720 digital active line luminance samples and the analogue synchronizing references for 625-line and 525-line systems is shown below.

TABLE III

525-line, 60 field/s systems	122 T	720 T	16 T	
0_H (leading edge of line syncs., half-amplitude reference)		Digital active-line period	0_H	Next line
625-line, 50 field/s systems	132 T	720 T	12 T	

T: one luminance sampling clock period (74 ns nominal).

The respective numbers of colour-difference samples can be obtained by dividing the number of luminance samples by two. The (12, 132) and (16, 122) were chosen symmetrically to dispose the digital active line about the permitted variations. They do not form part of the digital line specification and relate only to the analogue interface.

2. Definition of the digital signals Y, C_R, C_B, from the primary (analogue) signals E'_R, E'_G and E'_B

This section describes, with a view to defining the signals Y, C_R, C_B, the rules for construction of these signals from the primary analogue signals E'_R, E'_G and E'_B. The signals are constructed by following the three stages described in § 2.1, 2.2 and 2.3 below. The method is given as an example, and in practice other methods of construction from these primary signals or other analogue or digital signals may produce identical results. An example is given in § 2.4.

2.1 *Construction of luminance (E'_Y) and colour-difference ($E'_R - E'_Y$) and ($E'_B - E'_Y$) signals*

The construction of luminance and colour-difference signals is as follows:

$$E'_Y = 0.299E'_R + 0.587E'_G + 0.114E'_B \qquad \text{(See Note)}$$

whence:

$$\begin{aligned}(E'_R - E'_Y) &= E'_R - 0.299E'_R - 0.587E'_G - 0.114E'_B \\ &= 0.701E'_R - 0.587E'_G - 0.114E'_B\end{aligned}$$

and:

$$\begin{aligned}(E'_B - E'_Y) &= E'_B - 0.299E'_R - 0.587E'_G - 0.114E'_B \\ &= -0.299E'_R - 0.587E'_G + 0.886E'_B\end{aligned}$$

Note. – Report 624 Table II refers.

Taking the signal values as normalized to unity (e.g., 1.0 V maximum levels), the values obtained for white, black and the saturated primary and complementary colours are as follows:

TABLE IV

Condition	E'_R	E'_G	E'_B	E'_Y	$E'_R - E'_Y$	$E'_B - E'_Y$
White	1.0	1.0	1.0	1.0	0	0
Black	0	0	0	0	0	0
Red	1.0	0	0	0.299	0.701	−0.299
Green	0	1.0	0	0.587	−0.587	−0.587
Blue	0	0	1.0	0.114	−0.114	0.886
Yellow	1.0	1.0	0	0.886	0.114	−0.886
Cyan	0	1.0	1.0	0.701	−0.701	0.299
Magenta	1.0	0	1.0	0.413	0.587	0.587

2.2 *Construction of re-normalized colour-difference signals (E'_{C_R} and E'_{C_B})*

Whilst the values for E'_Y have a range of 1.0 to 0, those for $(E'_R - E'_Y)$ have a range of $+0.701$ to -0.701 and for $(E'_B - E'_Y)$ a range of $+0.886$ to -0.886. To restore the signal excursion of the colour-difference signals to unity (i.e. $+0.5$ to -0.5), coefficients can be calculated as follows:

$$K_R = \frac{0.5}{0.701} = 0.713; \; K_B = \frac{0.5}{0.886} = 0.564$$

Then:

$$E'_{C_R} = 0.713\,(E'_R - E'_Y) = 0.500\,E'_R - 0.419\,E'_G - 0.081\,E'_B$$

and:

$$E'_{C_B} = 0.564\,(E'_B - E'_Y) = -0.169\,E'_R - 0.331\,E'_G + 0.500\,E'_B$$

where E'_{C_R} and E'_{C_B} are the re-normalized red and blue colour-difference signals respectively (see Notes 1 and 2).

Note 1 – The symbols E'_{C_R} and E'_{C_B} will be used only to designate re-normalized colour-difference signals, i.e. having the same nominal peak-to-peak amplitude as the luminance signal E'_Y, thus selected as the reference amplitude.

Note 2 – In the circumstances when the component signals are not normalized to a range of 1 to 0, for example, when converting from analogue component signals with unequal luminance and colour-difference amplitudes, an additional gain factor will be necessary and the gain factors K_R, K_B should be modified accordingly.

2.3 *Quantization*

In the case of a uniformly-quantized 8-bit binary encoding, 2^8, i.e. 256, equally spaced quantization levels are specified, so that the range of the binary numbers available is from 0000 0000 to 1111 1111 (00 to FF in hexadecimal notation), the equivalent decimal numbers being 0 to 255, inclusive.

In the case of the 4 : 2 : 2 system described in this Recommendation, levels 0 and 255 are reserved for synchronization data, while levels 1 to 254 are available for video.

Given that the luminance signal is to occupy only 220 levels, to provide working margins, and that black is to be at level 16, the decimal value of the luminance signal, $\overline{Y}$, prior to quantization, is:

$$\overline{Y} = 219\,(E'_Y) + 16,$$

and the corresponding level number after quantization is the nearest integer value.

Similarly, given that the colour-difference signals are to occupy 225 levels and that the zero level is to be level 128, the decimal values of the colour-difference signals, $\overline{C_R}$ and $\overline{C_B}$, prior to quantization are:

$$\overline{C_R} = 224\,[0.713\,(E'_R - E'_Y)] + 128$$

and:

$$\overline{C_B} = 224\,[0.564\,(E'_B - E'_Y)] + 128$$

which simplify to the following:

$$\overline{C_R} = 160\,(E'_R - E'_Y)] + 128$$

and:

$$\overline{C_B} = 126\,(E'_S - E'_Y)] + 128$$

and the corresponding level number, after quantization, is the nearest integer value.

The digital equivalents are termed Y, C_R and C_B.

2.4 *Construction of Y, C_R, C_B via quantization of E'_R, E'_G, E'_B*

In the case where the components are derived directly from the gamma pre-corrected component signals E'_R, E'_G, E'_B, or directly generated in digital form, then the quantization and encoding shall be equivalent to:

$$E'_{R_D} \text{ (in digital form)} = \text{int}\,(219\,E'_R) + 16$$

$$E'_{G_D} \text{ (in digital form)} = \text{int}\,(219\,E'_G) + 16$$

$$E'_{B_D} \text{ (in digital form)} = \text{int}\,(219\,E'_B) + 16$$

Then:

$$Y = \frac{77}{256} E'_{R_D} + \frac{150}{256} E'_{G_D} + \frac{29}{256} E'_{B_D}$$

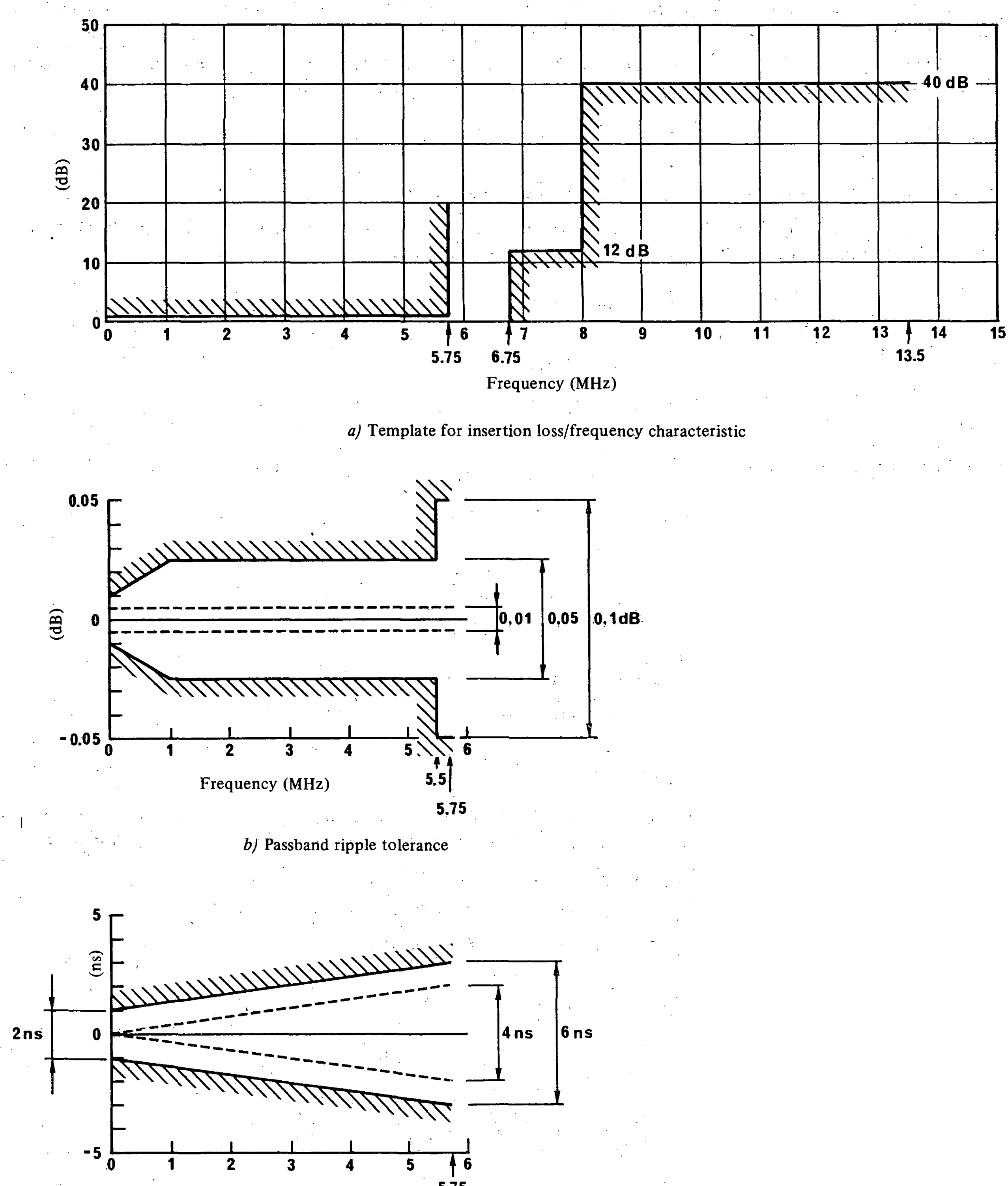
$$C_R = \frac{131}{256} E'_{R_D} - \frac{110}{256} E'_{G_D} - \frac{21}{256} E'_{B_D} + 128$$

$$C_B = -\frac{44}{256} E'_{R_D} - \frac{87}{256} E'_{G_D} + \frac{131}{256} E'_{B_D} + 128$$

taking the nearest integer coefficients, base 256. To obtain the 4 : 2 : 2 components Y, C_R, C_B, low-pass filtering and sub-sampling must be performed on the 4 : 4 : 4 C_R, C_B signals described above. Note should be taken that slight differences could exist between C_R, C_B components derived in this way and those derived by analogue filtering prior to sampling.

ANNEX III

FILTERING CHARACTERISTICS



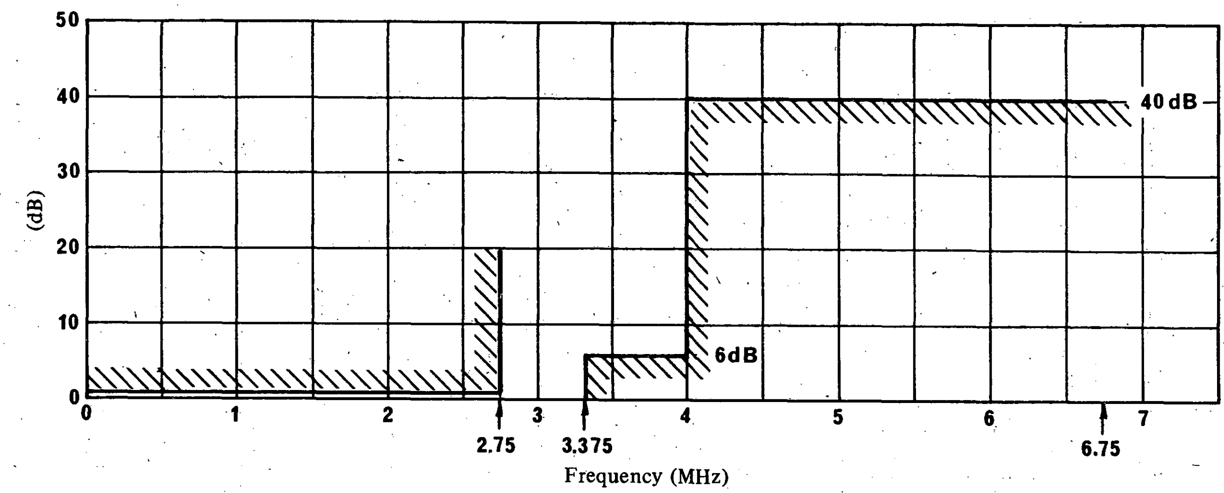
a) Template for insertion loss/frequency characteristic

b) Passband ripple tolerance

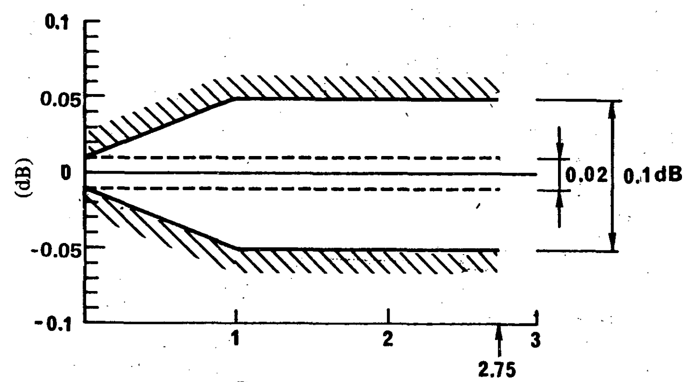
c) Passband group-delay tolerance

FIGURE 1 – *Specification for a luminance or RGB signal filter used when sampling at 13.5 MHz*

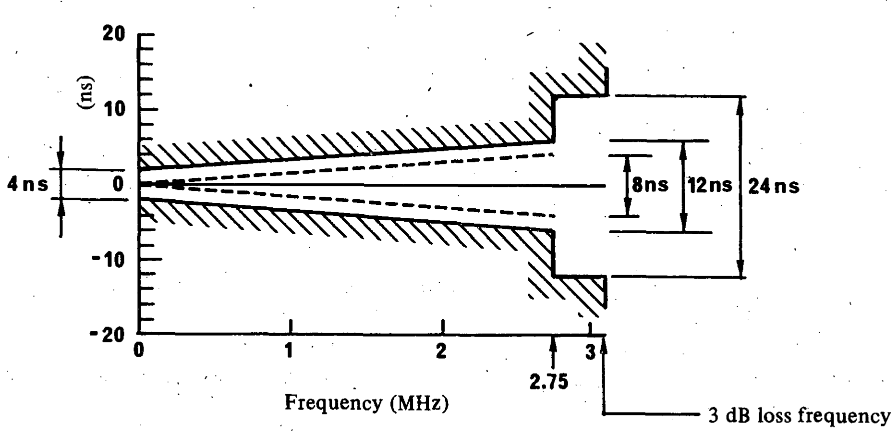
Note – The lowest indicated values in *b)* and *c)* are for 1 kHz (instead of 0 MHz).



a) Template for insertion loss/frequency characteristic



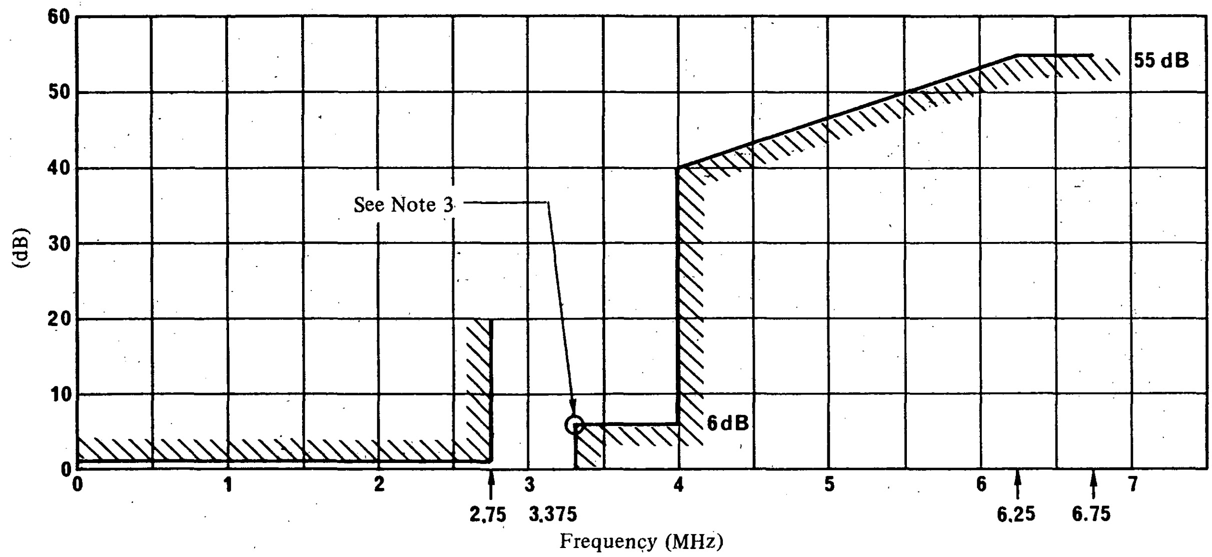
b) Passband ripple tolerance



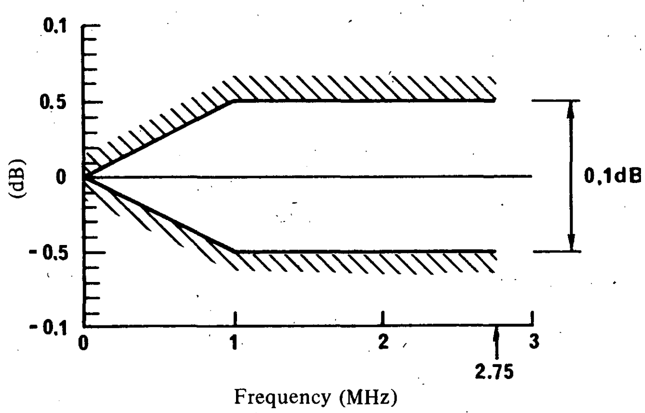
c) Passband group-delay tolerance

FIGURE 2 – *Specification for a colour-difference signal filter used when sampling at 6.75 MHz*

Note. – The lowest indicated values in *b)* and *c)* are for 1 kHz (instead of 0 MHz).



a) Template for insertion loss/frequency characteristic



b) Passband ripple tolerance

FIGURE 3 – *Specification for a digital filter for sampling-rate conversion from 4 : 4 : 4 to 4 : 2 : 2 colour-difference signals*

Notes to Figs. 1, 2 and 3:

Note 1 – Ripple and group delay are specified relative to their values at 1 kHz. The full lines are practical limits and the dashed lines give suggested limits for the theoretical design.

Note 2 – In the digital filter, the practical and design limits are the same. The delay distortion is zero, by design.

Note 3 – In the digital filter (Fig. 3), the amplitude/frequency characteristic (on linear scales) should be skew-symmetrical about the half-amplitude point, which is indicated on the figure.

Note 4 – In the proposals for the filters used in the encoding and decoding processes, it has been assumed that, in the post-filters which follow digital-to-analogue conversion, correction for the (sin x/x) characteristic of the sample-and-hold circuits is provided.

RECOMMENDATION 656

INTERFACES FOR DIGITAL COMPONENT VIDEO SIGNALS IN 525-LINE AND 625-LINE TELEVISION SYSTEMS

(1986)

The CCIR,

CONSIDERING

(a) that there are clear advantages for television broadcasting organizations and programme producers in digital studio standards which have the greatest number of significant parameter values common to 525-line and 625-line systems;

(b) that a world-wide compatible digital approach will permit the development of equipment with many common features, permit operating economies and facilitate the international exchange of programmes;

(c) that to implement the above objectives, agreement has been reached on the fundamental encoding parameters of digital television for studios in the form of Recommendation 601;

(d) that the practical implementation of Recommendation 601 requires definition of details of interfaces and the data streams traversing them;

(e) that such interfaces should have a maximum of commonality between 525-line and 625-line versions;

(f) that in the practical implementation of Recommendation 601 it is desirable that interfaces be defined in both serial and parallel forms;

(g) that digital television signals produced by these interfaces may be a potential source of interference to other services, and due notice must be taken of No. 964 of the Radio Regulations,

UNANIMOUSLY RECOMMENDS

that where interfaces are required for component-coded digital video signals in television studios, the interfaces and the data streams that will traverse them should be in accordance with the following description, defining both bit-parallel and bit-serial implementations.

1. Introduction

This Recommendation describes the means of interconnecting digital television equipment operating on the 525-line or 625-line standards and complying with the 4 : 2 : 2 encoding parameters as defined in Recommendation 601.

Part I describes the signal format common to both interfaces.

Part II describes the particular characteristics of the bit-parallel interface.

Part III describes the particular characteristics of the bit-serial interface.

PART I

COMMON SIGNAL FORMAT OF THE INTERFACES

1. General description of the interfaces

The interfaces provide a unidirectional interconnection between a single source and a single destination.

A signal format common to both parallel and serial interfaces is described in § 2 below.

The data signals are in the form of binary information coded in 8-bit words. These signals are:

- video data;
- timing reference codes;
- ancillary data;
- identification codes.

2. Video data

2.1 *Coding characteristics*

The video data is in compliance with Recommendation 601, and with the field-blanking definition shown in Table I.

TABLE I – *Field interval definitions*

			625	525
V-digital field blanking				
	Field 1	Start (V=1)	Line 624	Line 1
		Finish (V=0)	Line 23	Line 10
	Field 2	Start (V=1)	Line 311	Line 264
		Finish (V=0)	Line 336	Line 273
F-digital field identification				
	Field 1	F=0	Line 1	Line 4
	Field 2	F=1	Line 313	Line 266

Note 1 – Signals F and V change state synchronously with the end of active video timing reference code at the beginning of the digital line.

Note 2 – Definition of line numbers is to be found in Report 624. Note that digital line number changes state prior to 0_H as shown in Fig. 1.

2.2 *Video data format*

The data words 0 and 255 (00 and FF in hexadecimal notation) are reserved for data identification purposes and consequently only 254 of the possible 256 words may be used to express a signal value.

The video data words are conveyed as a 27 Mwords/s multiplex in the following order:

$$C_B,\ Y,\ C_R,\ Y,\ C_B,\ Y,\ C_R,\ \text{etc.}$$

where the word sequence C_B, Y, C_R, refers to co-sited luminance and colour-difference samples and the following word, Y, corresponds to the next luminance sample.

2.3 *Timing relationship between video data and the analogue synchronizing waveform*

2.3.1 *Line interval*

The digital active line begins at 244 words (in the 525-line standard) or at 264 words (in the 625-line standard) after the leading edge of the analogue line synchronization pulse, this time being specified between half-amplitude points.

Figure 1 shows the timing relationship between video and the analogue line synchronization.

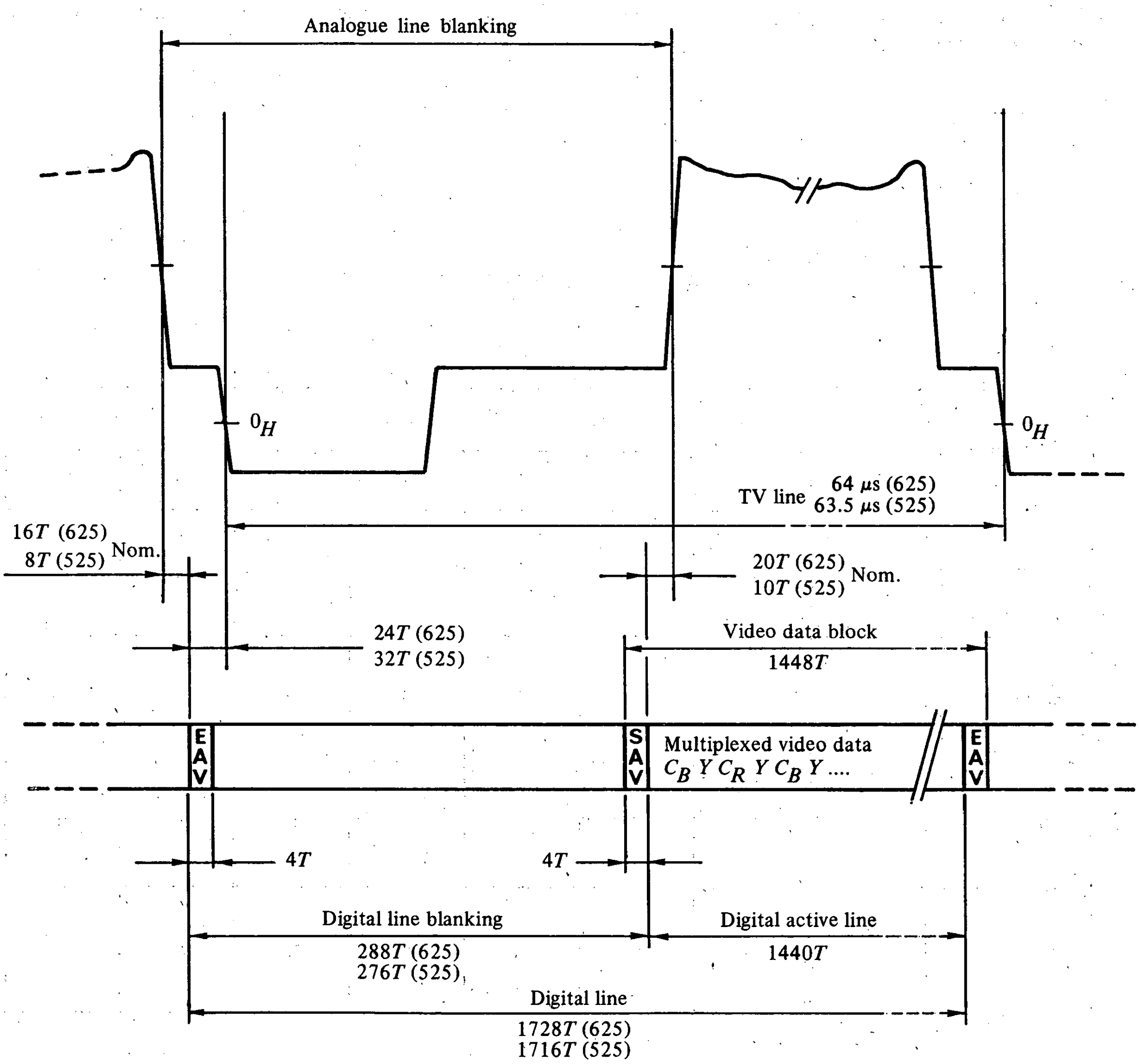


FIGURE 1 – *Data format and timing relationship with the analogue video signal*

T: clock period 37 ns nom.

SAV: start of active video timing reference code

EAV: end of active video timing reference code

2.3.2 *Field interval*

The start of the digital field is fixed by the position specified for the start of the digital line: the digital field starts 32 words (in the 525-line systems) and 24 words (in the 625-line systems) prior to the lines indicated in Table I.

2.4 *Video timing reference codes (SAV, EAV)*

There are two timing reference codes, one at the beginning of each video data block (*S*tart of *A*ctive *V*ideo, SAV) and one at the end of each video data block (*E*nd of *A*ctive *V*ideo, EAV) as shown in Fig. 1.

Each timing reference code consists of a four word sequence in the following format: FF 00 00 XY. (Values are expressed in hexadecimal notation. Codes FF, 00 are reserved for use in timing reference codes.) The first three words are a fixed preamble. The fourth word contains information defining field 2 identification, the state of field blanking, and the state of line blanking. The assignment of bits within the timing reference code is shown below in Table II.

TABLE II – *Video timing reference codes*

Word	Bit No.							
	7 (MSB)	6	5	4	3	2	1	0 (LSB)
First	1	1	1	1	1	1	1	1
Second	0	0	0	0	0	0	0	0
Third	0	0	0	0	0	0	0	0
Fourth	1	F	V	H	P_3	P_2	P_1	P_0

F = 0 during field 1; 1 during field 2

V = 0 elsewhere; 1 during field blanking

H = 0 in SAV; 1 in EAV

P_0, P_1, P_2, P_3: protection bits (see Table III).

MSB: most significant bit.

LSB: least significant bit.

Table I defines the state of the V and F bits.

Bits P_0, P_1, P_2, P_3, have states dependent on the states of the bits F, V and H as shown in Table III. At the receiver this arrangement permits one-bit errors to be corrected and two-bit errors to be detected.

TABLE III – *Protection bits*

Bit No.	7	6	5	4	3	2	1	0
Function	Fixed 1	F	V	H	P_3	P_2	P_1	P_0
0	1	0	0	0	0	0	0	0
1	1	0	0	1	1	1	0	1
2	1	0	1	0	1	0	1	1
3	1	0	1	1	0	1	1	0
4	1	1	0	0	0	1	1	1
5	1	1	0	1	1	0	1	0
6	1	1	1	0	1	1	0	0
7	1	1	1	1	0	0	0	1

2.5 *Ancillary data*

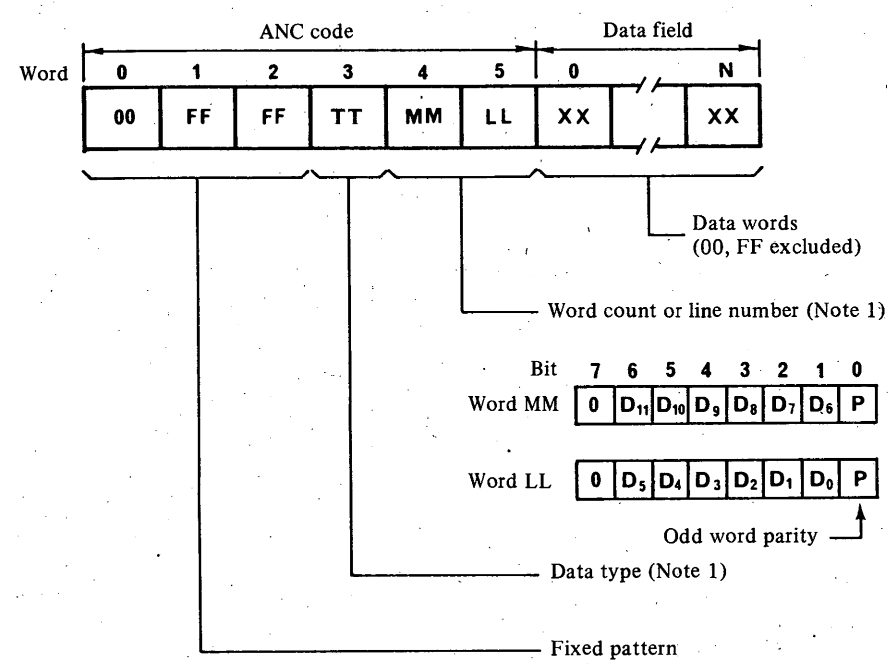
Provision is made for ancillary data to be inserted synchronously into the multiplex during the blanking intervals at a rate of 27 Mwords/s. Such data is conveyed by one or more 7-bit words, each with an additional parity bit (LSB) giving odd parity.

Each ancillary data block, when used, should be constructed as shown in Table IV from the timing reference code ANC and a data field.

2.6 *Data words during blanking*

The data words occurring during digital blanking intervals that are not used for the timing reference code ANC or for ancillary data are filled with the sequence 80, 10, 80, 10, etc. (values are expressed in hexadecimal notation) corresponding to the blanking level of the C_B, Y, C_R, Y signals respectively, appropriately placed in the multiplexed data.

TABLE IV – *Ancillary data block*



"Word count" specifies the length of the data field and lies in the range 1 to 1434. If word TT specifies a line number then D_{11} to D_0 contain the binary equivalent of the line number and the word count is assumed to be zero. The ancillary data block(s) may be transmitted when time is available during horizontal or vertical blanking following the EAV timing reference signal.

Note 1 – The precise location of the ancillary data blocks and the coding of words 3, 4 and 5 require further study.

PART II

BIT-PARALLEL INTERFACE

1. General description of the interface

The bits of the digital code words that describe the video signal are transmitted in parallel by means of eight conductor pairs, where each carries a multiplexed stream of bits (of the same significance) of each of the component signals, C_B, Y, C_R, Y. The eight pairs also carry ancillary data that is time-multiplexed into the data stream during video blanking intervals. A ninth pair provides a synchronous clock at 27 MHz.

The signals on the interface are transmitted using balanced conductor pairs. Cable lengths of up to 50 m ($\simeq$ 160 feet) without equalization and up to 200 m ($\simeq$ 650 feet) with appropriate equalization (see § 6) may be employed.

The interconnection employs a twenty-five pin D-subminiature connector equipped with a locking mechanism (see § 5).

For convenience, the eight bits of the data word are assigned the names DATA 0 to DATA 7. The entire word is designated as DATA (0-7). DATA 7 is the most significant bit.

Video data is transmitted in NRZ form in real time (unbuffered) in blocks, each comprising one active television line.

2. Data signal format

The interface carries data in the form of 8 parallel data bits and a separate synchronous clock. Data is coded in NRZ form. The recommended data format is described in Part I.

3. Clock signal

3.1 *General*

The clock signal is a 27 MHz square wave where the 0-1 transition represents the data transfer time. This signal has the following characteristics:

Width: 18.5 ± 3 ns

Jitter: Less than 3 ns from the average period over one field.

3.2 *Clock-to-data timing relationship*

The positive transition of the clock signal shall occur midway between data transitions as shown in Fig. 2.

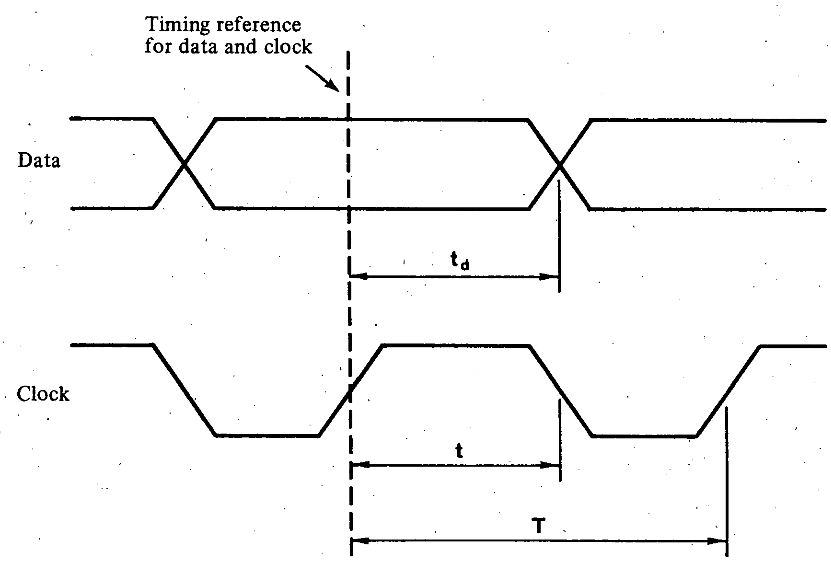


FIGURE 2 – *Clock-to-data timing (at source)*

Clock period (625): $T = \dfrac{1}{1728\, f_H} = 37$ ns

Clock period (525): $T = \dfrac{1}{1716\, f_H} = 37$ ns

Clock pulse width: $t = 18.5 \pm 3$ ns

Data timing – sending end: $t_d = 18.5 \pm 3$ ns

f_H: line frequency

4. Electrical characteristics of the interface

4.1 *General*

The interface employs nine line drivers and nine line receivers.

Each line driver (source) has a balanced output and the corresponding line receiver (destination) a balanced input (see Fig. 3).

Although the use of ECL technology is not specified, the line driver and receiver must be ECL-compatible, i.e. they must permit the use of ECL for either drivers or receivers.

All digital signal time intervals are measured between the half-amplitude points.

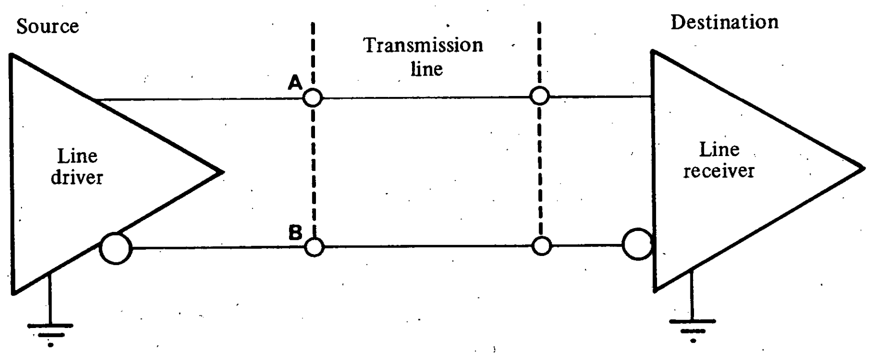


FIGURE 3 – *Line driver and line receiver interconnection*

4.2 *Logic convention*

The A terminal of the line driver is positive with respect to the B terminal for a binary 1 and negative for a binary 0 (see Fig. 3).

4.3 *Line driver characteristics* (source)

4.3.1 *Output impedance:* 110 Ω maximum.

4.3.2 *Common mode voltage:* -1.29 V $\pm$ 15% (both terminals relative to ground).

4.3.3 *Signal amplitude:* 0.8 to 2.0 V peak-to-peak, measured across a 110 Ω resistive load.

4.3.4 *Rise and fall times:* less than 5 ns, measured between the 30% and 80% amplitude points, with a 110 Ω resistive load. The difference between rise and fall times must not exceed 2 ns.

4.4 *Line receiver characteristics* (destination)

4.4.1 *Input impedance:* 110 Ω $\pm$ 10 Ω.

4.4.2 *Maximum input signal:* 2.0 V peak-to-peak.

4.4.3 *Minimum input signal:* 185 mV peak-to-peak.

However, the line receiver must sense correctly the binary data when a random data signal produces the conditions represented by the eye diagram in Fig. 4 at the data detection point.

4.4.4 *Maximum common mode signal:* $\pm$ 0.5 V, comprising interference in the range 0 to 15 kHz (both terminals to ground).

4.4.5 *Differential delay:* Data must be correctly sensed when the clock-to-data differential delay is in the range between $\pm$ 11 ns (see Fig. 4).

5. Mechanical details of the connector

The interface uses the 25 contact type D subminiature connector specified in ISO Document 2110-1980, with the contact assignment shown in Table V.

Connectors are locked together by a one-piece slide lock on the cable connectors and locking posts on the equipment connectors. Cable connectors employ pin contacts and equipment connectors employ socket contacts. Shielding of the interconnecting cable and its connectors must be employed (see Note).

Note – It should be noted that the ninth and eighteenth harmonics of the 13.5 MHz sampling frequency (nominal value) specified in Recommendation 601 fall at the 121.5 and 243 MHz aeronautical emergency channels. Appropriate precautions must therefore be taken in the design and operation of interfaces to ensure that no interference is caused at these frequencies. Emission levels for related equipment are given in CISPR Recommendation: "Information technology equipment – limits of interference and measuring methods" Document CISPR/B (Central Office) 16. Nevertheless, No. 964 of the Radio Regulations prohibits any harmful interference on the emergency frequencies.

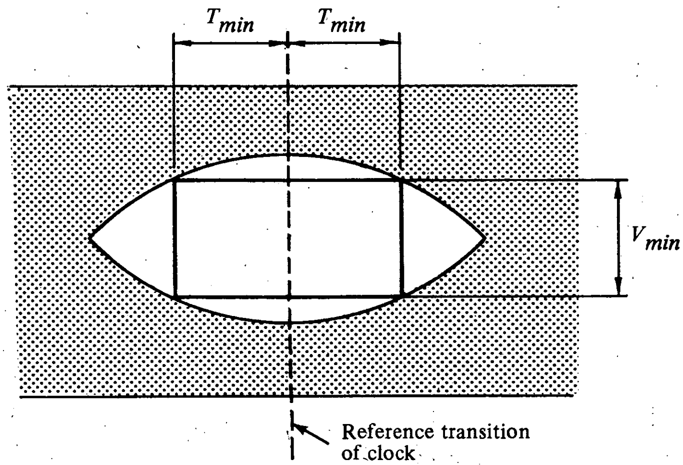


FIGURE 4 – *Idealized eye diagram corresponding to the minimum input signal level*

T_{min} = 11 ns

V_{min} = 100 mV

Note. – The width of the window in the eye diagram, within which data must be correctly detected comprises ±3 ns clock jitter, ±3 ns data timing (see § 3.2), and ±5 ns available for differences in delay between pairs of the cable.

TABLE V – *Contact assignments*

Contact	Signal line	Contact	Signal line
1	Clock A	14	Clock B
2	System ground	15	System ground
3	Data 7A (MSB)	16	Data 7B
4	Data 6A	17	Data 6B
5	Data 5A	18	Data 5B
6	Data 4A	19	Data 4B
7	Data 3A	20	Data 3B
8	Data 2A	21	Data 2B
9	Data 1A	22	Data 1B
10	Data 0A	23	Data 0B
11	Spare A-A	24	Spare A-B
12	Spare B-A	25	Spare B-B
13	Cable shield	–	–

Any spare pairs connected to contacts 11,24 or 12,25 are reserved for bits of lower significance than those carried on contacts 10,23.

6. Line receiver equalization

To permit correct operation with longer interconnection links, the line receiver may incorporate equalization.

When equalization is used, it should conform to the nominal characteristics of Fig. 5. This characteristic permits operation with a range of cable lengths down to zero. The line receiver must satisfy the maximum input signal condition of § 4.4.

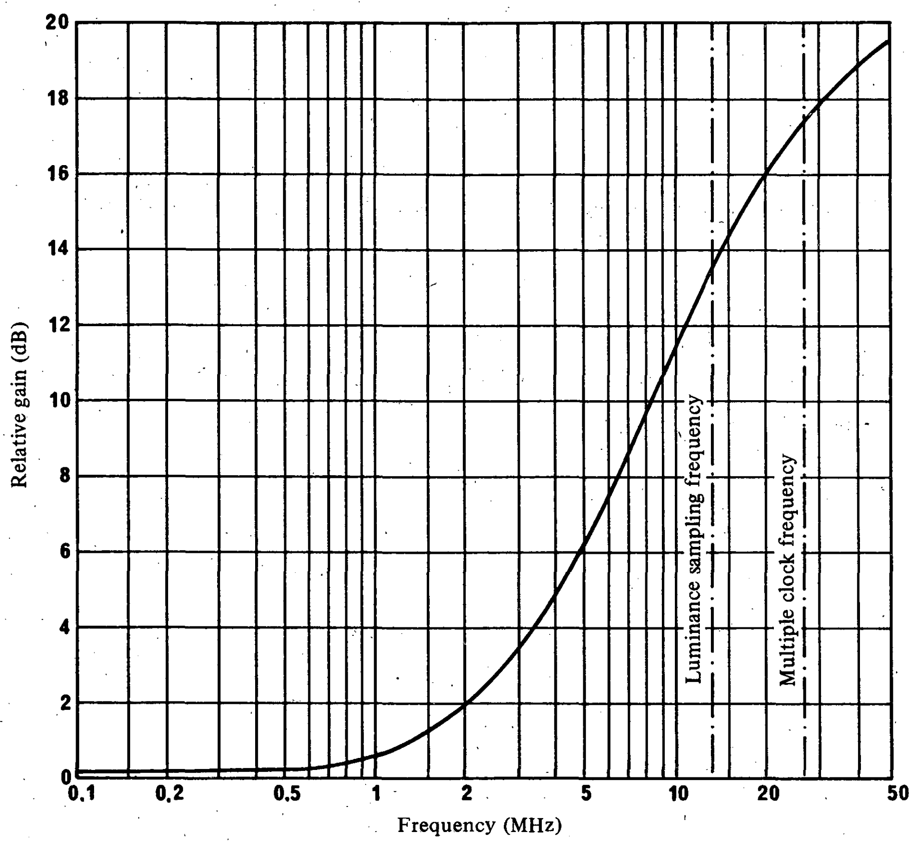


FIGURE 5 – *Line receiver equalization characteristic for small signals*

PART III

BIT-SERIAL INTERFACE

1. General description of the interface

The multiplexed data stream of 8-bit words (as described in Part I) is transmitted over a single channel in bit-serial form. Prior to transmission, additional coding takes place to provide spectral shaping, word synchronization and to facilitate clock recovery.

2. Coding

The 8-bit data words are encoded for transmission into 9-bit words as shown in Table VI.

For some 8-bit data words alternative 9-bit transmission words exist, as shown in columns 9B and $\overline{9B}$, each 9-bit word being the complement of the other. In such cases, the 9-bit word will be selected alternately from columns 9B and $\overline{9B}$ on each successive occasion that *any* such 8-bit word is conveyed. In the decoder, either word must be converted to the corresponding 8-bit data word.

TABLE VI – *Encoding table*

Input	Output		Input	Output		Input	Output		Input	Output		Input	Output		Input	Output	
8B	9B	$\overline{9B}$	8B	9B	$\overline{9B}$	8B	9B	$\overline{9B}$	8B	9B	$\overline{9B}$	8B	9B	$\overline{9B}$	8B	9B	$\overline{9B}$
00	0FE	101	2B	053		56	097		81	0AA		AC	12C		D7	0CC	
01	027		2C	1AC		57	168		82	055		AD	0D9		D8	139	
02	1D8		2D	057		58	099		83	1AA		AE	126		D9	0CE	
03	033		2E	1A8		59	166		84	0D5		AF	0E5		DA	133	
04	1CC		2F	059		5A	09B		85	12A		B0	11A		DB	0D8	
05	037		30	1A6		5B	164		86	095		B1	0E9		DC	131	
06	1C8		31	05B		5C	09D		87	16A		B2	116		DD	0DC	
07	039		32	05D		5D	162		88	0B5		B3	02E		DE	127	
08	1C6		33	1A4		5E	0A3		89	14A		B4	1D1		DF	0E2	
09	03B		34	065		5F	15C		8A	09A		B5	036		E0	123	
0A	1C4		35	19A		60	0A7		8B	165		B6	1C9		E1	0E4	
0B	03D		36	069		61	158		8C	0A6		B7	03A		E2	11D	
0C	1C2		37	196		62	025	1DA	8D	159		B8	1C5		E3	0E6	
0D	14D		38	026	1D9	63	0A1	15E	8E	0AC		B9	04E		E4	11B	
0E	0B4		39	08C	173	64	029	1D6	8F	153		BA	1B1		E5	0E8	
0F	14B		3A	02C	1D3	65	091	16E	90	0AE		BB	05C		E6	119	
10	1A2		3B	098	167	66	045	1BA	91	151		BC	1A3		E7	0EC	
11	0B6		3C	032	1CD	67	089	176	92	02A	1D5	BD	05E		E8	117	
12	149		3D	0BE	141	68	049	1B6	93	092	16D	BE	1A1		E9	0F2	
13	0BA		3E	034	1CB	69	085	17A	94	04A	1B5	BF	066		EA	113	
14	145		3F	0C2	13D	6A	051	1AE	95	094	16B	C0	199		EB	0F4	
15	0CA		40	046	1B9	6B	08A	175	96	0A8	157	C1	06C		EC	10D	
16	135		41	0C4	13B	6C	0A4	15B	97	0B7	148	C2	193		ED	076	
17	0D2		42	04C	1B3	6D	054	1AB	98	0F5	10A	C3	06E		EE	10B	
18	12D		43	0C8	137	6E	0A2	15D	99	0BB	144	C4	191		EF	0C7	
19	0D4		44	058	1A7	6F	052	1AD	9A	0ED	112	C5	072		F0	13C	
1A	129		45	0B1		70	056		9B	0BD	142	C6	18D		F1	047	
1B	0D6		46	14E		71	1A9		9C	0EB	114	C7	074		F2	1B8	
1C	125		47	0B3		72	05A		9D	0D7	128	C8	18B		F3	067	
1D	0DA		48	14C		73	1A5		9E	0DD	122	C9	07A		F4	19C	
1E	115		49	0B9		74	06A		9F	0DB	124	CA	189		F5	071	
1F	0EA		4A	06B		75	195		A0	146		CB	08E		F6	198	
20	0B2		4B	194		76	096		A1	0C5		CC	185		F7	073	
21	02B		4C	06D		77	169		A2	13A		CD	09C		F8	18E	
22	1D4		4D	192		78	0A9		A3	0C9		CE	171		F9	079	
23	02D		4E	075		79	156		A4	136		CF	09E		FA	18C	
24	1D2		4F	18A		7A	0AB		A5	0CB		D0	163		FB	087	
25	035		50	08B		7B	154		A6	134		D1	0B8		FC	186	
26	1CA		51	174		7C	0A5		A7	0CD		D2	161		FD	0C3	
27	04B		52	08D		7D	15A		A8	132		D3	0BC		FE	178	
28	1B4		53	172		7E	0AD		A9	0D1		D4	147		FF	062	19D
29	04D		54	093		7F	152		AA	12E		D5	0C6				
2A	1B2		55	16C		80	155		AB	0D3		D6	143				

3. Order of transmission

The least significant bit of each 9-bit word shall be transmitted first.

4. Logic convention

The signal is conveyed in NRZ form. The voltage at the output terminal of the line driver shall increase on a transition from 0 to 1 (positive logic).

5. Transmission medium

The bit-serial data stream can be conveyed using either a coaxial cable (§ 6) or fibre optic bearer (§ 7).

6. Characteristics of the electrical interface

6.1 *Line driver characteristics* (source)

6.1.1 *Output impedance*

The line driver has an unbalanced output with a source impedance of 75 Ω and a return loss of at least 15 dB over a frequency range of 10 to 243 MHz.

6.1.2 *Signal amplitude*

The peak-to-peak signal amplitude lies between 400 mV and 700 mV measured across a 75 Ω resistive load directly connected to the output terminals without any transmission line.

6.1.3 *DC offset*

The DC offset with reference to the mid amplitude point of the signal lies between +1.0 V and −1.0 V.

6.1.4 *Rise and fall times*

The rise and fall times, determined between the 20% and 80% amplitude points and measured across a 75 Ω resistive load connected directly to the output terminals, shall lie between 0.75 and 1.50 ns and shall not differ by more than 0.40 ns.

6.1.5 *Jitter*

The timing of the rising edges of the data signal shall be within ± 0.10 ns of the average timing of rising edges, as determined over a period of one line.

6.2 *Line receiver characteristics* (destination)

6.2.1 *Terminating impedance*

The cable is terminated by 75 Ω with a return loss of at least 15 dB over a frequency range of 10 to 243 MHz.

6.2.2 *Receiver sensitivity*

The line receiver must sense correctly random binary data either when connected directly to a line driver operating at the extreme voltage limits permitted by § 6.1.2, or when connected via a cable having a loss of 40 dB at 243 MHz and a loss characteristic of $1/\sqrt{f}$.

Over the range 0 to 12 dB no equalization adjustment is required; beyond this range adjustment is permitted.

6.2.3 *Interference rejection*

When connected directly to a line driver operating at the lower limit specified in § 6.1.2, the line receiver must correctly sense the binary data in the presence of a superimposed interfering signal at the following levels:

d.c.	± 2.5 V
Below 1 kHz:	2.5 V peak-to-peak
1 kHz to 5 MHz:	100 mV peak-to-peak
Above 5 MHz:	40 mV peak-to-peak

6.3 *Cables and connectors*

6.3.1 *Cable*

It is recommended that the cable chosen should meet any relevant national standards on electro-magnetic radiation.

Note – It should be noted that the ninth and eighteenth harmonics of the 13.5 MHz sampling frequency (nominal value) specified in Recommendation 601 fall at the 121.5 and 243 MHz aeronautical emergency channels. Appropriate precautions must therefore be taken in the design and operation of interfaces to ensure that no interference is caused at these frequencies. Emission levels for related equipment are given in CISPR Recommendation: "Information technology equipment – limits of interference and measuring methods" (Document CISPR/B (Central Office) 16). Nevertheless, No. 964 of the Radio Regulations prohibits any harmful interference on the emergency frequencies.

6.3.2 *Characteristic impedance*

The cable used shall have a nominal characteristic impedance of 75 Ω.

6.3.3 *Connector characteristics*

The connector shall have mechanical characteristics conforming to the standard BNC type (IEC Publication 169-8), and its electrical characteristics should permit it to be used at frequencies up to 500 MHz in 75 Ω circuits.

7. Characteristics of the optical interface

To be defined.

RECOMMENDATION 711

SYNCHRONIZING REFERENCE SIGNALS FOR THE COMPONENT DIGITAL STUDIO

(Question 25/11 and Study Programme 25N/11)

(1990)

The CCIR,

CONSIDERING

(a) that the definition of synchronizing reference signals for component digital studios would be of benefit in the implementation of equipment operating in accordance with Recommendations 601 and 656;

(b) that such signals should have a maximum of commonality between the 525 line and 625 line versions;

(c) that signals in accordance with Recommendation 656 contain in a conveniently accessible and accurate form all the information required to synchronize digital component equipment;

(d) that the use of digital circuitry introduces the possibility of new techniques in studio synchronization;

(e) that equipment in accordance with Recommendations 601 and 656 may have to operate in a mixed analogue and digital environment for a considerable period;

(f) that compatibility with synchronizing reference signals for component analogue studios would be an advantage;

(g) that signals generated in accordance with Recommendation 470 and Report 624 are widely used for synchronization in studios,

UNANIMOUSLY RECOMMENDS

that the synchronizing reference signals for component digital equipment operating in accordance with Recommendation 601 and Recommendation 656 should be as defined below:

1. Synchronization method

1.1 *Input synchronization*

Input synchronization means the synchronization of the component digital studio or equipment by an input signal.

When synchronizing to an input signal, the equipment has of necessity to derive clock and timing reference information from the input video signal.

1.2 *Output synchronization*

Output synchronization means the synchronization of two or more signal sources.

Equipment requiring a separate reference for output signals should be capable of using either a digital signal in accordance with Recommendation 656 or of deriving clock and timing reference information from a signal of the form defined in Annex I. Equipment requiring such a reference should make provision for analogue and digital signals as alternatives.

Note – In order to provide a reference signal within the specified tolerances, it may be necessary in practice to provide a timing reference generator or a synchronizing pulse generator to serve the local area.

ANNEX I

1. Introduction

This Annex describes an analogue reference signal for the synchronization of component digital video equipment.

2. Analogue synchronizing reference signal

2.1 *Signal characteristics*

The reference signal shall be a 525-line or 625-line signal as defined in Report 624, appropriate to the system, in which the active video information is replaced by blanking level *.

In this application the chrominance subcarrier burst or the unmodulated subcarrier of the SECAM system are optional.

2.2 *Signal amplitude and polarity*

The amplitude of the synchronizing pulses shall be 300 mV nominal.

The amplitude of the optional subcarrier burst shall be 300 mV peak-to-peak nominal.

The polarity of the synchronizing pulses shall be negative.

2.3 *Build-up time of line synchronizing pulses*

The build-up time of the leading (reference) edge of line synchronizing pulses shall not exceed 210 ns, measured between the 10% and 90% amplitude levels.

2.4 *Jitter*

The timing of individual leading edges of line synchronizing pulses shall be within ±2.5 ns of the average timing of leading edges, as determined over at least one field.

2.5 *Impedance*

The reference signal shall operate in a 75 Ω environment.

2.6 *Connector*

The connector shall conform to the standard BNC type (IEC Publication 169-8, 1978).

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* Reference signals of higher constant average picture level (APL) are specifically not recommended because they may cause performance degradation related to APL variations between the vertical interval and other parts of the signal. Furthermore, reference signals with changing APL, such as moving video or switched test signals, are also specifically not recommended because they may cause disturbances to the video signal being processed by the equipment for which they are the reference.

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OPINIONS

OPINION 38*

EXCHANGE OF MONOCHROME AND COLOUR TELEVISION PROGRAMMES VIA SATELLITES

(1970)

The CCIR,

CONSIDERING

(a) the importance of facilitating the exchange of television programmes via satellites;

(b) that, if this exchange is to be made between countries using the same standard or the same system, any conversion or any transcoding at intermediate points could lower the quality of the signal,

IS UNANIMOUSLY OF THE OPINION

that the attention of administrations and organizations responsible for the transmission of international television programmes should be drawn to the desirability of conserving, in the transmission over their networks, the original standard and system, to provide a better quality of service.

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* This Opinion has been brought to the attention of Study Groups 4, 9 and the CMTT.

OPINION 40

SUBJECTIVE ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(1970)

The CCIR,

CONSIDERING

(a) that is has already done considerable work on the subjective assessment of the quality of television pictures (see Report 405);

(b) that the International Electrotechnical Commission (IEC) is also making a similar study with special reference to receivers;

(c) that it is important to develop analogous assessment procedures to obtain consistent results,

IS UNANIMOUSLY OF THE OPINION

that the Director, CCIR, should remain in close contact with the IEC to keep it informed of the wishes of the CCIR and to obtain the results of the work of the IEC with a view to arriving at one or more common methods of assessing picture quality and preventing duplication of work.

OPINION 75-1

SYSTEMS FOR SIGNAL INTERFACE CONNECTION BETWEEN TELEVISION RECEIVERS AND ASSOCIATED EQUIPMENT

(1982–1990)

The CCIR,

CONSIDERING

(a) the importance of facilitating the enhancement and greater efficiency of broadcast systems;

(b) that the introduction of such improvements has heretofore often been delayed by the need to wait until equipment in the hands of the public has become obsolete;

(c) that such delays could be shortened if appropriate means were provided for the connection of associated equipment;

(d) the CCIR studies decided in Study Programme 18U/11,

IS UNANIMOUSLY OF THE OPINION

that the IEC should be invited to study and set standards for signal interface connection between receiving equipment, recorders, teletext decoders and other associated equipment intended for use by the public for conventional television, enhanced television and high-definition television, taking into appropriate account the studies that will be covered by the CCIR on this subject.

Note – The Director, CCIR, is requested to bring this Opinion to the attention of the CCITT and IEC. This Opinion has also been brought to the attention of Study Group 10.

OPINION 83-1

DATA BROADCASTING SERVICES

(1986-1990)

The CCIR,

CONSIDERING

(a) that some data broadcasting services have already been introduced and information is given in Recommendation 653;

(b) that studies within the CCIR on data broadcasting generally are in progress and information is given in Reports 802, 956, 1207 and 1208;

(c) that several administrations are providing a wide range of data services via the public telecommunication networks;

(d) that the use of these complementary delivery facilities can increase the appeal of some of these data services;

(e) that it is desirable to optimize the compatibility of receiving terminals for the two methods of delivery,

IS UNANIMOUSLY OF THE OPINION

that the Director, CCIR, should draw the attention of the Director, CCITT, to the CCIR documentation on data broadcasting services and invite the CCITT to take into account in its studies of data services based on the public telecommunication networks, the desirability for compatibility of the terminal equipment with data broadcasting services. Similarly, the CCIR in its studies of data broadcasting services, should take into account relevant CCITT documentation.

92-61-04291-0