



Government  
of Canada

Department of Communications

Queen  
TK  
6653  
.T96  
1980

Industry Canada  
Library Queen

SEP 10 1998

Industrie Canada  
Bibliothèque Queen

# DISCUSSION PAPER ON THE NEED FOR IMPROVEMENTS TO TELEVISION RECEIVERS

PREPARED BY:

D. H. TYRIE, P. ENG.

J. SEAL, P. ENG.

MARCH 1980

TELECOMMUNICATION REGULATORY SERVICE

## CONTENTS

## PAGE

INTRODUCTION	1
OBJECTIVES	2
PART A: BACKGROUND INFORMATION ON THE NEED FOR IMPROVEMENTS TO TELEVISION RECEIVERS	5
1. Efficient Spectrum Utilization.	5
2. Demand for TV Channels.	5
3. Spectrum Congestion and Interference to TV Reception.	8
4. Television Receiver Overloading.	12
5. TV Receiver as a Display Device.	14
6. Interconnect Formats for Colour Displays.	15
7. TV Receiver Improvements to Date.	17
PART B: TELEVISION RECEIVER IMPROVEMENTS	22
1. Technical Improvements to TV Receivers.	22
1.1 Taboo-Free Receiver.	22
1.2 Improved Audio Performance.	25
1.3 VIR Colour Correction Circuitry.	26
1.4 Improved Immunity to TV Ghosting.	27
1.5 Improved Vertical Blanking Characteristics.	28
1.6 Electronic Tuning	29
1.7 Visual Display Terminal.	30
2. TV Receiver Grading.	31

COMMUNICATIONS CANADA

JUL 3 1981

LIBRARY - BIBLIOTHÈQUE

<u>CONTENTS</u>	<u>PAGE</u>
3. TV Receiver Standards	33
3.1 Weak Signal Parameters.	33
3.2 Reception Parameters.	34
3.3 Video Quality Parameters.	34
3.4 Audio Quality Parameters.	35
3.5 General Parameters	35
 PART C: INTERFACING OF VIDEOTEXT WITH TELEVISION RECEIVERS	 37
1. Available Vertical Interval Lines.	37
2. Receiver Frequency Response Characteristics for Teletext Reception.	39
3. Interconnect Formats for Colour Displays.	41
4. Multipath Correction Devices and Teletext Reception.	43

COMMUNICATIONS CANADA

JUL 3 1981

LIBRARY - BIBLIOTHÈQUE

Discussion Paper on  
The Need for Improvements  
to Television Receivers

Introduction

Over the past three decades, television broadcasting in Canada has mushroomed into an extensive communications media. Three national and two regional networks are now in operation. In addition, educational networks have developed on a provincial basis and are continuing to expand in many areas. The national CBC service with its twin networks for English and French, the CTV network, the other private networks and the educational stations, plus other independent stations, have created an increased demand for television broadcasting spectrum. Other major radio services such as land mobile and fixed radio service have also created a heavy demand for additional spectrum. Studies indicate that spectrum utilization can be improved for UHF broadcasting by using improved television receivers.

More recently, in data communications, video terminals have gained widespread use for the display of alpha-numeric and graphic data. Video games and home computers are, through special adapters, using television receivers as a display device. This trend in display terminals and devices requiring video displays indicates that the future role of the television set will not be limited to the reception of only broadcast television signals. Indeed, today's technology and development is dealing with data and video processing systems such as videotext, fibre optics, satellite distribution networks, video recording and interactive consumer services. A display device is a key element in all of these systems. To create a

display console with the versatility to accommodate such diverse future services in addition to television broadcasting, improvements and adaptations to present receivers and design changes in future receivers are needed.

### Objectives

The advancement of communication technology and the provision of more and better services to the public are key objectives which the Department is promoting. The spectrum management program is conscious of the needs of users and the need to improve the efficiency of spectrum usage. The continuing research and experimentation in satellite, fibre optics and videotext systems are other programs supporting telecommunications development. Broadcast reception and television receivers are associated with these programs and therefore, the Department is interested in determining what benefits of the advancing technology have been applied to television broadcast receivers. The Department wishes to investigate all aspects of possible improvements to television receivers, to discuss future designs of television receivers and to encourage the development of versatility in future television receivers. The specific objectives to accomplish these aims are as follows:

- to determine what improvements are technically possible for existing and planned designs of television receivers;
- to stimulate investigation of new designs for television receivers which provide improved performance;

- to gather information on the effect of receiver improvement on spectrum planning, frequency allocations, interference ratios and other performance parameters;
- to stimulate discussion and ideas on future television receivers as communications consoles;
- to promote investigation of designs or modifications of television receivers intended to augment their data handling capability;
- to initiate discussion regarding standards for interfacing with television receivers.

This discussion paper is presented to encourage improvements to television receivers and to foster consideration of data display terminals as one of the future roles of television receivers. The paper is divided into three parts: Part A on background information on the need for improvements to television receivers, Part B on television receiver improvements and Part C on interfacing of videotext with television receivers.

Historical background information, included in Part A, may provide the reader with some insight into the reasons which have led the Department to this consideration of the need for improvement in television receivers. Part B of this document deals with television receiver improvements. Short discussions on specific technical changes in receiver design are followed by

questions intended to generate pertinent information on each topic. Part C presents information on receiver compatibility as part of a videotext system or a home entertainment system. Again, the subject matter and questions are to stimulate discussion and technical information exchange.

PART A: BACKGROUND INFORMATION ON THE NEED FOR IMPROVEMENTS  
TO TELEVISION RECEIVERS

1. Efficient Spectrum Utilization

The efficiency of utilization of the television spectrum is mainly governed by the television receiver. Its response determines the number of television channels that can be placed at one location and the distance separation between other channels. The susceptibility of TV receivers to signals, other than the one to which it is tuned, establishes the separation distances required for stations transmitting on other channels. With the increasing demands for radio spectrum, the role of the receiver in spectrum allocation requires examination.

Because the television receiver has become the prime entertainment means in the majority of homes and because of the trend to use the television receiver as a visual display terminal for video games, home computers and data processing, improvements in the television receiver are necessary. Technological advances such as very large scale integrated circuitry, low noise devices and surface acoustic wave filters, can all be used to improve TV receivers.

2. Demand for TV Channels

Prior to 1952, TV broadcasting was restricted to VHF Channels 2-13 inclusive. This number of channels did not provide enough outlets for major networks and educational stations. In 1952, the FCC allotted



70 channels in the 470-890 MHz frequency band, but the lack of TV receivers equipped to tune to these frequencies slowed down the expansion of broadcasting in this UHF-TV band. The All Channel Television Receiver Legislation in the USA in 1962 required that all receivers be equipped to tune all VHF and UHF channels. Even in 1965, the development of improved performance of television receivers was recognized as necessary to achieve efficient use of the radio spectrum. (1)

The demands for TV channels and for additional radio frequency spectrum was demonstrated in the CRTC forecast of television channel requirements (2) and the Department's policy paper on allocation in the 470 to 960 MHz frequency band. (3) The CRTC document states that future channel requirements of important population centers can not be satisfied and concludes that present allocations are not sufficient to meet the future requirements of terrestrial television broadcasting even with the contributions expected from future technological advances. In the Department's policy paper, new allocations in the 470 to 960 MHz frequency band are outlined for the land mobile and broadcasting services. In considering the TV allotment plan, it was determined that the adoption of new more efficient techniques for allotting television channels would:

- (1) The report of Committee 1 of the Committee for the Full Development of All-Channel Broadcasting noted that improvements in sensitivity, noise figure, selectivity and reliability were needed to foster the growth of broadcasting in the UHF portion of the frequency band.
- (2) UHF Broadcasting Spectrum Requirements for Canada: A Long-Range Forecast by CRTC.
- (3) Spectrum Allocation Policy in the 470 to 960 Frequency Band:  
Department of Communications

"enable virtually all forecast television broadcasting requirements to be satisfied within UHF-TV Channels 14 to 69 making possible the re-allocation of the 806 890 MHz band to satisfy the requirements of the mobile service".

The new allotment techniques have been implemented to achieve efficient utilization of the spectrum with today's receivers. However, improved television receivers are a desirable objective for spectrum efficiency and their future introduction, "could result in an even greater availability of channels".

The Department, in the early 1970's, recognized the need to improve the utilization of UHF broadcasting and requested the Canadian Radio Technical Planning Board (CRTPB) to make recommendations on the use of the 470-960 MHz band. A Task Force on UHF-TV Taboos was set up. Part of the report (4) dealing with TV receivers stated the following:

"Present UHF-TV receiver characteristics do not warrant a significant change in taboo restrictions",  
and

"Technically, future television receivers could be designed to improve their performance and reduce, if not delete, certain taboo restrictions such as oscillator radiation and sound and picture image. Whether such

- (4) Report of the Task Force on UHF-TV Taboos submitted to: The CRTPB Ad Hoc Committee on the Band 470-960 MHz, March 1973.

improvements would be economically feasible and what their impact on the manufacturing industry would be should be the subject of a future study".

An objective of the project was to determine if elimination of the UHF taboos would achieve greater spectrum efficiency and allow additional allocations in the UHF-TV spectrum. The study revealed that deletion of most UHF taboos was possible with a technically improved receiver, however, cost would be the limiting factor. Certain improvements in UHF tuner design were considered technically feasible within the following five years (1973-1978). However, a cautionary note was added regarding the significant cost increase associated with manufacturing because of the relatively small volume of UHF tuners for the Canadian market. The study concluded that an improved receiver was technically possible, and recommended that: "The feasibility of future improvements and the question of whether the benefits derived from all these improvements justify the additional cost to the consumer should be subject of a wider study".

3. Spectrum Congestion and Interference to TV Reception

As the number of services using the radio frequency spectrum continues to increase, the resulting congestion produces a greater number of interference complaints. Figures on complaints of television interference in the USA show that 60% of all RFI complaints involved TV

receivers (5), and are due to spurious response in the TV receiver. Existing television receivers are susceptible to interference from various sources such as FM broadcast stations, other TV broadcast stations, land mobile radio systems, general radio services and amateur radio systems.

The interference to TV Channel 6 from FM stations operating on frequencies in the educational FM band has been well documented in reports by the Department (6) and the Federal Communications Commission. (7) Criteria to determine this type of interference are presented in both reports, and factors such as power ratios and separations are given to permit the avoidance of severe picture degradation. More recently, the National Association of Broadcasters, the Association of Maximum Service Telecasters, and the Council for UHF Broadcasting asked the Federal Communications Commission to consider certain standards that would improve the capability of TV receivers to reject interference on TV Channel 6 from educational FM signals on nearby frequencies. (8)

- (5) RFI as it concerns the Radio Operators, the Consumer and the Manufacturer of Home-Entertainment Equipment; T.J. Cohen, IEEE Communications Conference Record, June, 1976.
- (6) Report BTRB-2: Interference Rejection Ratio Measurements on TV Sets Receiving Strong Channel 6 Signals from One and Two Interfering Signals on FM Channels: Department of Communications.
- (7) Report No. R-6702: Calculations for Educational FM Channel Assignments in Areas Served by TV Channel 6: Federal Communications Commission.
- (8) "TV Receiver Standards", Industrial Communications, 8 June 1979, page 21.

The television receiver is susceptible to interference from other TV stations and radio services. The protection ratios necessary to protect the TV service area formed the basis for the development of TV allocation plans and thereby, established the minimum distance separations between frequency related TV channels. If interference to television broadcasting from other radio services is to be avoided, specific separation distances have to be established. The frequencies used by the land mobile service which are adjacent to TV Channels 5 and 7 can cause problems. (9) The general information notes (10) on land mobile frequency assignment caution against assigning land mobile frequencies in areas where TV Channels 4, 5 and 7 are received. The television receiver's susceptibility to interference from other frequencies which are harmonically related to the desired TV channels, is also important and under Broadcast Procedure 1, Rule 4, an analysis of possible cases of interference is requested.

The recent re-allocation of the frequency band 806-890 MHz (Channels 70-83 incl.) from TV broadcasting to the land mobile service has focussed attention on the image response of television receivers with respect to Channels 55 to 69. Previously, the image response at these channel frequencies was prevented by a table of separation distances ("taboos") which included TV Channels 70 to 83. With land mobile operation in the 806-890 MHz band, and given the fact that present TV receivers are designed for operation at these frequencies,

- (9) Report on Investigation of Interference to Channel 7 TV by Land Mobile Transmitters by: G.D. Steeves, Department of Transport, Project No. 1183, June 29, 1966.
- (10) 30-470 MHz Review of Usage: June 15, 1974, Telecommunication Regulatory Service, Department of Communications.

the possibility for image interference to the lower TV channels is great. This fact has been recognized by the Department and the FCC, and studies investigating image interference are presently being conducted. Preliminary findings of these studies indicate that signals at UHF image frequencies present a high probability of interference to existing TV receivers and that additional filtering can reduce the interference susceptibility of these television receivers.

Present television receivers show a disparity of image response between the UHF and VHF bands. A recent comparison of the image response of two TV receivers at Channel 4 and at two UHF Channels 56 and 64, indicates that the VHF channel has 30 dB or better rejection characteristics. The Department has received no known complaints which can be traced to image interference to TV Channel 4 from land mobile operation in the 154 to 160 MHz frequency band. This may be attributed to the superior image rejection performance of VHF channels. Because of this, land mobile users in the USA recommended that the image rejection of UHF tuners be increased to reduce the possibility of interference from land mobile operations above 806 MHz. The American Telephone and Telegraph proposed this to the FCC in response to the TV receiver performance standard inquiry. It was reported that (13):

(13) "TV Receiver Standards", Industrial Communications, 9 June 1979, page 21.

"UHF-TV receivers with image rejection capability "not exceeding 40 dB (AT&T said), "may develop perceptible performance degradation when located in the proximity of land mobile systems operating above 806 MHz.

This results from TV receiver response to signals which lies outside the band assigned to the respective UHF-TV channel. As in the case of interaction between UHF-TV stations, the interference cannot be practically corrected, except by an improvement in UHF-TV receiver image rejection capability".

4. Television Receiver Overloading

The transmitting sites for many TV stations have been surrounded by the rapid growth of suburban population and also, many broadcast antennas are located on high buildings in the central core of cities. This results in a large population located close to a transmitting antenna. More and more television receivers are therefore required to operate in an environment of high-level signal strength. The Department has been receiving an increasing number of complaints of degraded reception of television signals which results from the presence of high field strengths from nearby broadcasting stations. Television receiver susceptibility to high level in-band and out-of-band radiation has been investigated by the Department's EMC Analysis Division (14) and in one conclusion, it was stated:

(14) Report on "Immunity Tests - TV Receiver, EMC Evaluations", Telecommunication Regulatory Service, DOC.

"No set tested was immune to levels of out-of-band input signal such as are likely to be encountered in their normal environment due to emissions of licensed transmitters".

The Department has taken remedial measures to protect TV reception by initiating procedures (15) which require broadcasters to evaluate the potential effects on the nearby receivers because of high field strengths produced by their operations and to commit themselves to resolve any valid cases of interference. An improvement in television receivers allowing satisfactory operation in higher ambient signal levels would help to alleviate this problem.

Signal overloading in the front end of TV receivers has become more common in the past few years due to the rapid expansion of the general radio service. For example, services operating in the 27 MHz frequency band can overload the TV receiver's front end causing second harmonic interference to the reception of TV Channel 2. This and other interference problems have prompted the Department to issue an information brochure (16) intended to assist the consumer in identifying interference and to provide technical information for service representatives to resolve interference.

- (15) The Department has issued Notice to Broadcast Consultants Nos. 51 and 53 and Gazette Notice No. DGTR-008-79 concerning new and renewal applications for broadcasting stations which contain requirements for the control of maximum field strengths.
- (16) Brochure "How to Identify and Resolve Radio-TV Interference Problems" Department of Communications.



5. TV Receiver as a Display Device

The television receiver has been used, until recently, solely as a visual display device for TV programmes distributed through off-air or by cable systems. Technological advances in digital data processing have created new applications for the use of home TV receivers as a display terminal. Video games are already widespread in the consumer market and home computers are fast becoming a reality. These applications and others are identified and discussed in a recent article (17) on home terminals. Videotext systems are being developed and introduced in various parts of the world; Oracle, Ceefax, Prestel and Antiope are some of the systems in use. In the United States, several teletext services similar to the British and French systems are being tested on cable TV and broadcast systems. In Canada, the Department, at its Communications Research Centre, has developed Telidon (18) which represents a technological improvement over the European videotext systems. The development of these videotext systems, is creating a myriad of new uses and services for the TV receiver as a display. Other experimental or development projects are also making use of the television receiver as a display device. Tests of two way cable television services are being conducted at localities in Ontario (19). A field trial for fibre optics as a distribution

(17) Stuart J. Lipoff, "Mass Market Potential for Home Terminals: IEEE Transactions on Consumer Electronics, Vol. Ce-25, No. 2, May 1979, pages 169-184.

(18) Telidon, Government of Canada, Department of Communications.

(19) CRTC Decision 79-266 approved the provision on an experimental basis of communications services of a non-programming nature in Ottawa, Kitchener-Startford area and London Ontario.

medium for TV, information services, computer services and other data services is being set up in Elie, Manitoba (20) by the DOC Research Centre. The television receiver as a display serves as the final link in these experimental systems. To satisfactorily operate as part of these data processing systems, existing television sets required modifications or special interface units such as decoders or radio frequency modulators. The television receiver is being removed from its traditional role of a broadcast entertainment receiver and thrust into the role of a home display terminal for a communication system which includes not only broadcasting, but information services, two way cable TV services, computer services and video games. The expeditious development of the versatility of the television receiver is needed to ensure its ability to accommodate the requirements of these newly developing services.

6. Interconnect Formats for Colour Displays

When colour television was being developed, the National Television Standards Committee standardized the television signal. This 525 line video system has become the North American standard and is known internationally as "NTSC System M". In this standard, the television signal has different formats depending on its location in the transmit-receive system. Two of the common formats in the NTSC standard are the composite video signal and the RF signal.

- (20) CRTC Public Announcement, March 12, 1979 states that: "The Department of Communications, in conjunction with the Manitoba Telephone System and the Canadian Telecommunications Carriers Association, is intending to implement on an experimental basis, a field trial of fibre-optic technology to deliver cable television services to Elie, Manitoba.

Composite video is the format used in broadcasting studios, microwave links and recording equipment for transmission by cable for short distances. Composite video is actually present in every television receiver at one point or another since it is the format where synchronizing and display are most convenient. The benefits in choosing this format for a display terminal are as follows:

- a) there are many trained professionals in Canada who have already worked with this format and understand the operational details;
- b) it is the most common video communication format in North America, except for over the air broadcast situations;
- c) the standard interconnect requirements are a 75 ohm co-axial connector.

When the composite video signal along with the audio signal is modulated onto an RF carrier, the RF signal results. This RF communication technique benefits by frequency division multiplexing which results in the VHF-UHF channeling plans. In the television receiver, the interface terminals are either 300 ohm balanced or 75 ohm unbalanced connections.

The method of encoding the three colour signals into the NTSC format does not allow for displays of higher resolution such as used in

computer graphic displays. These systems use separate Red, Green, and Blue (RGB) signals. This RGB format does not lend itself to mass broadcasting because the separate colour signals are not band limited, however it is efficient for computer to display communication. The advantages of this format are as follows:

- a) maximum resolution for the bandwidth available is possible for the three colours;
- b) higher resolution images are a compromise between the bandwidth generated and the resolution that a display device is capable of.

A RGB format could be considered to be the interconnect format for one-on-one situations where large bandwidths are generated. If the three signals need to be sent over a long distance, then composite video or RF transmission may be required.

#### 7. TV Receiver Improvements to Date

The television receiver is a consumer product and is, therefore subject to highly competitive pricing practices of the consumer market. Because of the need to remain competitive, manufacturers are reluctant to implement major changes to improve television receivers.

Over the past 30 years, the television receiving system has essentially remained unchanged. However, there have been many changes

in the TV receiver: from black and white to colour, from tubes to transistors and finally to integrated circuits. New features have been added such as automatic colour control, push button tuning and memory tuning, etc. These changes were introduced voluntarily by the industry and are known as "visible changes", that is, changes which can be readily demonstrated or shown to the consumer. These features improve the saleability of the television receiver.

Changes to improve TV reception in fringe areas or to increase receiver selectivity to improve the spectrum efficiency are resisted by the manufacturer since these are not marketable improvements and would increase costs. The introduction of such changes generally requires the use of mandatory legislation or regulations. The goal to achieve comparable performance between the VHF and UHF television has required legislation to bring about the introduction of improvements. In 1962, the All Channel Receiver Act, introduced in the United States, required that television receivers, manufactured after 1964, be capable of tuning all UHF as well as the VHF channels. The original UHF tuning system was separate, different and more difficult to use than the VHF system. As a result, the Federal Communications Commission, in 1968, further required that all sets should have comparable ease of tuning for both UHF and VHF. Other legislated improvements to UHF tuners have been the "70 detent (click-stop) tuner with automatic frequency control", a "resettable accuracy not to exceed  $\pm 2$  MHz", an improved noise figure for UHF and a requirement to have an attached antenna for UHF.

Originally, the Federal Communications Commission set a maximum noise figure of 18 dB for UHF tuners. Technological advances permitted improvements to the 18 dB figure, however, there was no incentive not to improve on this performance. Recently, regulations implemented in both Canada (21) and the United States (22) introduced a program to reduce the maximum noise figure to 14 dB then to 12 dB with the possibility that 10 dB may be legislated.

Previous actions taken to upgrade UHF television service were intended to achieve eventual comparability with VHF television. Considering the future need to improve spectrum utilization, the FCC, in 1976, issued a contract for the development of a "high performance television receiver" which would reduce or eliminate the majority of the UHF taboos. The receiver known as the TI receiver was reported on by Texas Instruments in March 1978 (23) and also evaluated by the FCC in a separate report (24). The changes introduced by Texas Instruments were primarily concerned with achieving a reduction of the UHF taboos and therefore were concentrated in the RF and IF sections of the receiver. Their report indicated that improvements in receiver

- (21) "General Radio Regulations, Part II, amendment", Canada Gazette, Part II, Vol. 112, No. 20, November 25, 1978.
- (22) "UHF Television Receiver Noise Figures", Report and Order in Docket 21010, FCC 78-582, 43 FR 36096, August 15, 1978.
- (23) "Final Report for High Performance TV Receiver", D.L. Ash and C.S. Hartman Texas Instruments Inc. FCC/OCE CE 78-01 (March 1978) NTIS No. PB 277196.
- (24) "A Study of the Characteristics of the FCC Prototype TV Receiver Relative to Conventional Receiver UHF Taboos", L.C. Middlekamp et al, FCC/OCE LAB 78-01 (February 1978) NTIS No. PB 277187.

design are possible and their receiver incorporated a new system architecture and several new RF components. The estimated increased cost on a volume production to the consumer would be about \$30. for an average colour television. The evaluation by the FCC laboratory indicated that the performance of the improved receiver was generally better than the stock receiver used for comparison. However, the performance did not achieve all the improvements of parameters originally specified in the contract.

The FCC are continuing their efforts to improve UHF television through several related Notices of Inquiry (25, 26, 27, 28). Questions relating to receiver design dominate these notices and indicate the need for improvements to performance of future TV receivers. Also, further development work has been authorized by the FCC to continue the study and development of the high performance TV receiver.

The Department considers receiver improvements essential for the efficient utilization of the broadcast spectrum, the fulfillment of future channel demands and the achievement of comparability for VHF and UHF television service. In the 1973 report of the Task Force on UHF-TV, certain receiver improvements were judged technically possible

- (25) Notice of Inquiry in General Docket 78-391, "Improvements to UHF Television Reception", FCC 78-864
- (26) Notice of Inquiry in General Docket 78-302 "Technical Improvements to Television Receivers and Certain Transmitter Standards" FCC 78-866.
- (27) Notice of Inquiry in General Docket 78-393 "Television Receiver Performance Standards", FCC 78-868.
- (28) Notice of Inquiry in General Docket 78-307 "Televisin Equipment Grading", FCC 78-665.

and desirable. A survey regarding the implementation of the improved tuner was conducted in 1977. (29) This report revealed that the introduction of an improved tuner only in the Canadian market was not economically viable and could only take place through the imposition of mandatory requirements. The introduction of receiver improvements for all of the North American market was judged viable, however, industry was not willing to take the initiative in this matter. The current action on the investigation of receiver improvements in the United States makes it timely for the Department to also renew its investigation of receiver improvements.

- (29) Harry Dulmage Associates Limited "A Study into the Improvements in Television Tuner Design to Optimize UHF Broadcast Spectrum Utilization" November 1977, for the Department of Communications.



## PART B: TELEVISION RECEIVER IMPROVEMENTS

### 1. Technical Improvements to TV Receivers

Both television broadcasting and land mobile services have an ever increasing need for more spectrum. The Department, therefore, must promote efficient utilization of the available spectrum to maximize the number of allotments. The TV receiver has a primary influence on the efficiency to be achieved in the television broadcasting service. To promote this objective, the Department is instituting an investigation of improvements to TV receivers and their significance in frequency allotment, planning and management, particularly for the UHF frequency band. In addition, there is a need to improve UHF-TV reception to achieve comparability with VHF reception thereby improving the acceptability of UHF channel usage.

#### 1.1 Taboo-Free Receiver

The Department believes that the reduction or elimination of the "taboo" frequencies in the UHF-TV band will lead to better frequency utilization and an increase in the number of available TV channels without reducing the quality of TV reception. Thus, the following series of questions are directed towards improvements in the tuner section of the receiver:

- 1.1a) Considering the performance of contemporary TV receivers, what improvements are still required

to achieve the desirable improvements in UHF tuner design considered technically feasible in the Report of the Task Force on UHF-TV Taboos in 1973?

- 1.1b) Current investigations of possible interference to TV Channels 56 to 69 inclusive from land mobile operation in the frequency band 806-890 MHz indicate that the image rejection of the UHF tuner needs improvements to allow unrestricted land mobile use of the 806-890 MHz band. What technical improvements can be introduced in TV receivers to eliminate or reduce the tuner's susceptibility to this type of interference?
- 1.1c) If the performance objectives of the UHF tuner proposed by the Task Force on UHF-TV taboos and/or the performance achieved by the TI receiver were imposed, what would be the cost to the public?
- 1.1d) Can the performance objectives of c) be individually costed? If so, indicate the improvements which provide good cost-benefit and cost-effective ratios?

- 1.1e) Are there presently available new or modified TV receiver designs that would approach or exceed the performance achieved by Texas Instruments Inc.?
- 1.1f) What effect would the removal of Channels 70 to 83 inclusive from the UHF tuning band have on the cost and performance of UHF tuners?
- 1.1g) Based on the performance objectives achieved by the TI receiver, to what extent could the channel separation distance be reduced to eliminate the following types of interference:
- Intermodulation
  - IF Beat
  - Sound Image
  - Picture Image
  - Local Oscillator Radiation
  - Adjacent Channel (VHF and UHF)

- 1.1h) If the tuner design is based on different local oscillator and intermediate frequencies, what new taboo restrictions would be introduced?

## 1.2 Improved Audio Performance

The present sound channel of TV receivers handle only the broadcast monophonic signal. There is considerable interest in expanding the television sound system to accommodate additional channels for possible stereophonic, or bilingual purposes. Studies of systems for the simultaneous transmission of two sound channels in television have already been conducted in several countries (30) and the analysis and testing of such systems is continuing. Therefore, consideration of changes and improvements to the TV sound system at this time is appropriate and comments on multichannel television sound systems and responses to the following questions are requested:

- 1.2a) Considering present day TV transmitters and receivers, what should be the audio performance of the second TV sound channel and should it be mandatory?

- 1.2b) Can improvements be implemented to achieve performance similar to that of a high quality

(30) CCIR Draft Report 10/436: Transmission of Several Sound Information Channels in Télévision

FM receiver system. If so, what changes would be required and could they be incorporated on a cost effective basis?

1.2c) The provision of a second sound channel should be compatible with the existing system, that is, have comparable performance, not increase television bandwidth and have reception coverage similar to the video signal. Comments and discussions of proposed systems complying with the above requirements are requested.

1.2d) What would be the cost of implementing part or all of the above changes?

### 1.3 VIR Colour Correction Circuitry

The vertical interval reference signal is added to a program signal at its source. Corrections are made at the destination for the deterioration of the colour signal due to the transmission path by restoring the reference signal to its original form. Originally intended for use at the transmitter to correct for any colour degradation due to the network and/or the studio-transmitter link, automatic colour correction is now also available in home television receivers.

1.3a) Should the transmission of the VIR signal, when originated by a network or station, be required for all stations?

1.3b) Should all home receivers be required to incorporate circuitry for the automatic colour correction of the TV signal?

#### 1.4 Improved Immunity to TV Ghosting

Advances in semiconductor technology, multipath and transversal filter designs and digital signal processing have made ghost cancelling in television systems a topic of interest to the consumer electronic engineer. Various methods for ghost reduction are being investigated.

(31) For improved ghosting immunity:

1.4a) Are there circuit designs available which could be presently incorporated into TV receivers to achieve ghost cancellation?

1.4b) What would be the cost to the public of adding these circuits to a TV receiver and would it be more effective if the receiver were redesigned to incorporate this feature?

(31) W. Ciciora et al, "A Tutorial on Ghost Cancelling in Television System", IEEE Trans. on Consumer Electronics, Vol. CE-25, No. 1, pp. 9-44, February 1979.

1.4c) What effect, if any, would deghosting techniques or ghost cancelling circuitry have on other performance parameters of the television system?

1.5 Improved Vertical Blanking Characteristics

The vertical blanking interval can be used for the transmission of signals other than the main video program. Captioning for the deaf, subtitling, program identification, time signals, test signals, transmitter control information, alpha-numeric data and videotext (teletext) signals are some of many uses. The interval is the period in which the electron scanning beam in the TV picture tube is returned from the bottom to the top of the TV screen and contains 21 horizontal lines. Lines 1-9 in the vertical blanking interval of the present NTSC television standards contain equalizing and sync pulses for proper interlaced scanning and synchronization of the TV receiver. This precludes the use of the lines 1-9 for other purposes. Lines 17 to 21 can be used for other signals without any disturbance to normal TV viewing and are presently being used for test and identification signals. The use of lines 10 to 16 inclusive while technically feasible, can cause streaking in the TV picture of some receivers. This streaking is objectionable to TV viewers, and therefore, until receivers have vertical retrace blanking, the use of the vertical interval is limited. To achieve full efficient utilization of the vertical interval lines 10 to 21, the Department is seeking information on the following questions:

- 1.5a) What technical improvements are required in television receivers to allow the full use of lines 10-21 in the vertical blanking interval?
- 1.5b) Could technical improvements to receivers reduce the number of lines for synchronization and thereby free additional lines for other uses?
- 1.5c) What would be the additional costs of TV receivers for these improvements?

#### 1.6 Electronic Tuning

Television tuning is accomplished by two methods, mechanically or electronically. Advances in varactor technology and digital displays have made electronic tuning a viable alternative for both the manufacturer and the consumer. Hence, the number of TV receivers with this method of tuning is increasing. Therefore, information is being sought concerning the effect of electronic tuning in the TV receiver.

- 1.6a) What performance characteristics are most affected by electronic tuning and to what extent?
- 1.6b) Is electronic tuning feasible as a requirement for all television receivers and if so, what would be the costs and implications of such a change?



1.6c) How would the consumer market be affected by electronic tuning for all TV sets?

1.6d) Would electronic tuning benefit UHF reception in regard to comparability with VHF reception?

1.6e) Considering present or planned automatic tuning systems, describe minimum channels provided, channel selection and display mechanisms and other features of the system?

1.6f) What effect would electronic tuning have on TV viewing when received via a cable system?

#### 1.7 Visual Display Terminal

Recently, the role of the television receiver in the home has been augmented by the introduction of other devices such as video cassette recorders, video games and home computers. These new products make use of the television receiver as a visual display terminal. The Department is interested in the future development of the home television set and solicits comments and discussions on how the television receiver may be adaptable to these services. The questions below serve to introduce only some of the topics for discussion:

1.7a) Using the existing television broadcasting and receiving methods, what improvements could be

made to increase the versatility of the television receiver as a visual display for video-text, home computers and other devices requiring a display?

1.7b) Would the public interest be better served if manufacturers were encouraged to adopt a modular television receiving system in the future, i.e. separate units for the video display and the television receiver?

1.7c) What place is foreseen for large screen television in the home consumer market?

1.7d) Since cost in the consumer marketplace is always a prime consideration, what costs are associated with the introduction of these features?

## 2. TV Receiver Grading

Technical improvements to television receivers usually are unnoticed by consumers because there is no technical performance criteria upon which the receiver can be judged. Television sets have been traditionally purchased on the basis of appearance and size with but small attention to the technical performance. A program for grading the performance of television receivers would provide the

consumer with information to permit a choice that best meets his needs. The Department believes that a grading system could result in a benefit to both public and the manufacturer.

Consumers would have better information as to how the television receiver should perform in their homes. Such a system would provide an avenue for manufacturers to document technical improvements and therefore be able to justify cost increases to the consumer. The customer would therefore be encouraged to provide an installation commensurate with the performance that the receiver is capable of.

The Department invites comments on receiver grading and seeks information on the specific questions which follow:

- 2.1 What receiver parameters would provide the most useful information from a consumer standpoint?
- 2.2 What receiver parameters could be most easily documented by the manufacturers?
- 2.3 Of the parameters identified in 2.1 and 2.2, what combination would provide adequate information to the consumer if selection were based on a cost-benefit analysis?
- 2.4 How should this information be made available to the consumer?

2.5 What would be the additional cost for receivers  
if a grading program were implemented?

### 3. TV Receiver Standards

Television receiver performance influences many factors in television broadcasting; however, no performance measurement or standard, except noise figure and tuning requirements, has been included in the regulations. Minimum standards of performance for television receivers would establish a base to use in allocation studies, interference investigations and other broadcasting analyses. The Department, through the following questions, wishes to assess the need for performance standards and to examine the parameters which best indicate the overall performance of television receivers.

#### 3.1 Weak Signal Parameters

Of the listed parameters, which single or combination of parameters could be best used to indicate a receiver's weak signal performance? Analyses of costs, benefits, trade-offs and technical trends are needed to fully evaluate the responses.

- a) Noise figure including bandwidth and impedance match.
- b) Picture sensitivity (relative or absolute).

- c) Signal to noise ratio (S/N) (objective or subjective)..
- d) Other measures of weak signal performance.

### 3.2 Reception Parameters

The following list describes the adequacy of reception of the receiver.

- a) Receiver selectivity, overall and for the RF and IF stages.
- b) Dynamic range including overload protection.
- c) Interference rejection of out of band signals, adjacent channel signals, citizen band channels, image channels and change of rejection ratio with level of desired signal.

### 3.3 Video Quality Parameters

The following parameters are associated with picture quality.

- a) Picture resolution as affected by frequency response, sharpness, focus, interlace, linearity.

- b) Color rendition with and without VIR circuitry.
- c) Receiver transient performance, i.e. smear, overshoot or ringing.

### 3.4 Audio Quality Parameters

The following parameters are associated with sound quality:

- a) Frequency response.
- b) Distortion.
- c) Signal to noise ratio with normal and worst case video present.

### 3.5 General Parameters

These parameters are generally associated with overall performance:

- a) Receiver stability with temperature, voltage, time and vibration or motion.
- b) Circuit effects on performance, e.g. synchronous vs envelope detection, SAW vs LC filters, sensitivity vs noise figure and intermodulation.

- c) Cable service parameters, compatibility of receiver channel selection with cable TV channels, input terminal impedance, local oscillator voltage, etc.
- d) Receiver performance indices based on each of the aforementioned parameters and, in addition, the rating of the comparability between UHF and VHF, the effectiveness of ghost cancellation, the amount of overscan, the vertical retrace blanking, etc.

PART C: INTERFACING OF VIDEOTEXT WITH TELEVISION RECEIVERS

The concept of "Videotext" ancillary broadcast services is becoming well known in the Canadian broadcasting industry. For instance, the Department's Telidon information service could be distributed by ancillary broadcasting. This service is designed to carry consumer oriented information on the currently unused vertical interval lines of a standard broadcast television signal; however, the data rate for this service is not yet established.

The Department is conducting a number of experiments regarding Telidon and its distribution to the consumer (fibre optics and telephone line). Tests involving signal insertion on vertical interval lines and ancillary broadcasting are also intended. Because of these tests, which will involve television receivers, the Department is keenly interested in the compatibility of the Telidon system with the existing broadcasting methods.

1. Available Vertical Interval Lines

The number of vertical interval lines which could be used for data services is currently three and one half lines available per frame. These are lines 15, 16, 20 and part of 21. Some of the TV receiver sets currently in service rely on the composite video signal to blank the beam during vertical flyback. As a result, any information on lines 10 to 15 will appear on the TV screen in the form of a diagonal with line during retrace. Use of lines 10 to 15 will



cause interference to reception on such sets and therefore is presently discouraged.

The use of more vertical lines would be beneficial for the services using the vertical interval. Thus, the Department encourages TV manufacturers to adopt a progressive program of modifying their TV receivers to allow the use of lines 10 through 15. This added capability would permit more time per frame for data transmission and thus more services or more information per service.

With the future of data services in mind, the Department is interested in the possibility of having all TV receivers designed with vertical blanking circuits and seeks answers to the following questions:

- 1) Some television models may have to be re-designed or modified. These modifications may represent a small addition to the cost of the particular receiver. If this is the case, would this cost differential be sufficiently large to make the model less competitive?
- 2) From a consumer's point of view, would it be preferable to be able to send existing television sets somewhere where a retro-fit process can be accomplished? This process could permit an early introduction of new services on lines 10 to 15.

2. Receiver Frequency Response Characteristics for Teletext Reception

A number of TV receiver manufacturers have recently published documents (32, 33) showing how teletext decoder equipment can be incorporated into the TV receiver design. In addition, European and American sources have published documents which show how TV receiver frequency and group delay response is critical to data and error-free teletext reception. In the light of these documents, it appears that a standard TV receiver may not be a convenient receiving device for off-air teletext with high data rates.

It has been shown (34) that synchronous or quasi-synchronous demodulators exhibit improved frequency response, group delay and quadrature distortion characteristics when compared to envelope detectors. The improvement in operating characteristics allows for more accurate reproduction of vertical interval data. Since the difference between synchronous and envelope detectors is quite pronounced it would appear that a "good teletext receiver" would utilize synchronous demodulation techniques.

Therefore, the Department is interested in discussing the following general concepts:

- (32) Television Receiver Design Aspects for Employing Teletext LSI, Tadahiko Suzuki et al, IEEE Transactions on Consumer Electronics, Vol. CE-25, No. 3, July 1979.
- (33) Teletext Field Trails in the United Kingdom, L.A. Sherry, IEEE Transactions on Consumer Electronics, Vol. CE-25, No. 3, July 1979.
- (34) Synchronous Detection Beats Quadrature Distortion in Demodulator Claus Wittrock, Broadcast Engineering, November 1978.

a) Special TV Receivers for Teletext

If a standard TV receiver is not well suited for teletext reception then only those receivers having decoders built-in with adjusted and/or optimized frequency response could be sold on the market as a "special teletext" receiver. What would be the most efficient method of providing decoders for this type of receiver?

b) Standard TV Receivers with Special Decoders

A standard TV receiver may be used with an external decoder to provide the teletext information in a compatible format that requires no adjustment to the TV receiver. What would be the additional requirements for this decoder when compared with the decoder in Part (a)?

c) Adoption of Compatible Teletext Standards

It may be possible to format the data power spectra so that the bandwidth and group delay specifications of standard TV receivers do not seriously affect the data reliability. In this way, the data could be carried over the broadcast system. What would the requirements of such a format be and what performance may be expected?

3. Interconnect Formats for Colour Displays

In North America, there are three common methods of video signal distribution: composite video, RF signal and Red, Green and Blue (RGB) signals. The composite video and RGB signal format are used for distribution by cable on a point-to-point basis. Distribution by RF signal is used in over-the-air broadcast systems.

The Department, through the following questions, wishes to assess the practicality of these various interconnect formats. Moreover, the Department is interested in any other suggested format not listed here:

- 1) Are there any new devices which may become available to the general public and which would not interconnect under any of the three aforementioned interconnect formats?
- 2) Which interconnect format do you feel would be the most practical with current conventional television receiver sets and current home terminal devices?  
Why? What type of plug should be used?
- 3) What would be the preferred method of interconnecting several home terminal devices to single or multiple display devices?

- 4) What resolution should a display device be capable of?
- 5) In the future, higher resolution displays and wider bandwidth interconnect channels may be a reality. Display systems with wider bandwidth and higher resolution than available under the NTSC standard can be achieved, for example, through the RGB, PAL and SECAM concepts. What bandwidth and resolution is required for high definition displays and what is the most practical approach for display terminals in Canada?
- 6) "Hot" chassis display devices may not be suitable for any interconnect format other than the RF signal. Do you feel this will be an important limiting factor if a single interconnect format is to be standardized?
- 7) Are there any other interconnect formats applicable to the home terminal/television interface? Please state in sufficient detail.
- 8) If a standard plug is selected to be employed in any of these aforementioned identified formats, are there any desirable auxiliary functions which could be provided via this plug?

4. Multipath Correction Devices and Teletext Reception

Recent studies (35, 36) have shown that, during multipath transmission conditions, teletext signals degrade somewhat faster than subjective picture quality. This situation can be controlled by the employment of multipath correction devices (normally known as "ghost cancellors") in teletext receivers. A popular approach has been to place a pulse on a current blank line and analyse (via intelligent electronics) the delay, the amplitude and the polarity of any ghosts. The correction electronics then can produce an equal but opposite ghost which effectively cancels the transmission ghost.

The Department wishes to discuss these devices with respect to their applicability and their expected form, keeping the scope of the discussion as wide as possible. The following questions can be used as a basis for discussion:

- 1) Over-the-air mode of television broadcasting is unpopular in metropolitan areas because of ghosting. This conclusion is based on the reported subscriber penetration levels by cable television operators in Canada. Limits on
- 
- (35) A Frequency-Domain Interpretation of Echos and their Effects on Teletext Data Reception, E. Baily Neal, IEEE Transactions on Consumer Electronics, Vol. CE-25, No. 3, July 1979.
  - (36) Reception of Teletext Under Multipath Conditions, S.K. Goyal, S.C. Armfield, IEEE Transactions on Consumer Electronics, Vol. CE-25, No. 3, July 1979.

ghost visibility have been established as operating parameters for cable television systems. Should these limits be maintained as general guidelines for ghost tolerances?

- 2) Ghost cancelling devices can improve teletext and broadcast TV reception under certain conditions. Will the improvements be sufficiently beneficial that enough demand for ghost cancelling devices is created to make them a popular option?
- 3) Circular polarization of antennas may provide improved performance over that of plane polarized antennas in areas where ghosting occurs. Should this type of transmission be studied or developed in order to improve Teletext reception?