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Federal Communications Commission
Office of the Secretary

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of

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| Advanced Television Systems and Their Impact on the Existing Television Broadcast Service | ) ) ) | MM Docket No. 87-268 RM -5811 |
| Review of Technical and Operational Requirements Part 73-E. Television Broadcast Stations | ) ) ) ) | |
| Reevaluation of the UHF Television Channel and Distance Separation Requirements of Part 73 of the Commission's Rules | ) ) ) | |

COMMENTS OF THE CONSUMER ELECTRONICS GROUP
of the
ELECTRONIC INDUSTRIES ASSOCIATION

These comments are submitted by the Consumer Electronics Group of the Electronic Industries Association (EIA/CEG) in response to the August 20, 1987 Notice of Inquiry into advanced television (ATV) systems. EIA/CEG represents manufacturers and marketers of television receivers and VCRs all of whom, have a strong interest in this Inquiry. Consumer use of TV sets could be effected as the Commission is re-examining the extent to which UHF television stations are protected against interference from other television stations.

While TV manufacturers clearly have an important stake and interest in many aspects of the Commission's advanced television system

Count 0+5

proceeding, EIA/CEG's comments at this time are limited to a few narrow technical issues. EIA/CEG comments are confined to the issue of interference and are intended to be consistent with its comments and reply comments file in Docket 20485, Reevaluation revision of the UHF TV "taboo" table, filed October 31, and December 1, 1975, respectively which are attached to this document.

Summary

EIA/CEG views relaxation of the UHF taboos and additional UHF allocations necessary for certain ATV systems as two distinctly separate subjects. The former is based exclusively on NTSC transmissions. The interference potential of the latter signals is not known and may be "tailored" for minimum interference to existing allocations, permitting a higher quality service while at the same time not increasing interference to the existing service.

Relaxation of the taboos would result in increased interference and a reduction in quality of service, (except as related to receiver performance improved over that assumed when the taboos were adopted). TV receivers either in the U.S. or elsewhere demonstrate the potential to improve significantly performance relative to the taboos.

Receiver manufacturers have started an effort to gain an understanding of the interference potential of two-channel ATV

systems based on extension of the work done in the UHF-land mobile proceeding (Gen. Docket 85-172); however, there is insufficient time to include this in an EIA/CEG filing.

Comparison Between UHF Performance and "VHF Reference Performance"

The Commission states that, "In the present re-examination of the UHF taboos there are new elements to be considered, including additional receiver test data and possible reinterpretation of the relationship between the test data and the taboos" (72), and cites a "Technical Memorandum," a study of UHF Television Receiver Interference Immunities, [1] which has been placed in the official docket file in this proceeding. The Commission states that a comparison of the UHF performance with VHF receiver performance has one of three outcomes:

> (a) The UHF performance is better than the VHF performance. This is interpreted as suggesting relaxation of the UHF taboo.
>
> (b) The UHF performance is about the same as the VHF performance. This is interpreted as suggesting modifying the UHF taboo with a prohibited zone stipulation, meaning locating stations adequately close together (almost equal signal levels or adequately far apart (desired signal sufficiently greater than undesired).
>
> (c) The UHF performance is poorer than the VHF performance. This is interpreted as suggesting that the UHF taboo should be maintained.

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[1] FCC/OET TM-1, 08/87

The Commission suggests that on the basis of preliminary results using this new concept, changes to the UHF taboos appear feasible. This conclusion is based on the use of median receiver data. Analysis based on the "median receiver" (or "mean receiver") ignores half the receiver population. For assessing current receiver production (or the receiver population), the lower decile values are a more true measure and reflect the accepted statistical practice. Additionally, there may be no such thing as a "median receiver", as a given receiver may exhibit a wide variation in performance over the tuning range for any taboo.

The co-channel taboo was established in 1952 on the basis of a 28dB desired/undesired signal ratio with a 10kHz offset that produced an "acceptable" television picture. Painstaking testing conducted at the CBS Technology Center has established that viewers expectations are much higher today and that a 28dB D/U ratio produces a picture quality that is unacceptable to both expert and non-expert viewers alike.[2] Today's receivers have much lower noise and better picture performance than those of the era in which the 28dB figure was derived.

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[2] Subjective Assessment of Protection Ratios for UHF Broadcast Signals," B.L. Jones (Apr. 23, 1986), Technical Advisory Committee Working Group Document WG-1.55. Just as receiver design improved, so too has psychophysical science advanced greatly in recent years.

It should be noted that the data in the memorandum are for "just perceptible" interference, not a 28dB D/U ratio. Other taboos have objectionability different from co-channel and change more rapidly as the D/U ratio changes (e.g., the half-IF taboo). The FCC measurements were mainly made between channels 30 and 40 and do not necessarily reflect the performance at either channel 14 or channel 69. Comments follow on specific taboos based on the memorandum and other information.[3]

Comment on Relaxation of Specific Taboos IF Beat (n + 8 channels)

Figure 2 from the memorandum is attached with the VHF and UHF lower decile and UHF lower range performance added. It illustrates that a change in this taboo is not justified. The UHF lower decile performance is not as good as the VHF lower decile performance.

Intermodulation (n + 2, 3, 5 channels) These data are not plotted; however, the lower decile performance is 6 to 10 dB poorer than the mean for n+2 and n+4 (Test No.3). No change appears justified.

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[3] It should be noted that the taboos are all n plus and minus x channels even though the receiver spurious response may be n plus x channels. EIA/CEG views creation of "one-sided" taboos of limited value and administratively unworkable.

The intermodulation taboo is based on the 1952 mechanical tuner that exhibited better selectivity than the varactor tuners found in most color TV receivers today. Today's varactor tuners have RF amplifiers, needed to meet the Commissions 14dB noise figure requirement. As a result there are areas (e.g., California ) where the 20 mile separation between n + 2 stations is marginal. Therefore, revision of this taboo is not considered prudent.

Oscillator Radiation (n + 7 channels) and IF Beats (n + 7 channels).

EIA/CEG concurs with the Technical Memorandum finding that the dominance of local oscillator radiation for a seven channel taboo had diminished. EIA stated in Docket 20485 in 1975: .1m12

> "Oscillator radiation currently is one fourth the value assumed for receivers at the time the taboos were established and the average is expected to decrease with time as a larger proportion of the receiver population has UHF varactor tuners"

The IF beat caused by the n + 7 sound carrier will require the protection similar to the n + 8 IF beat protection of 20 miles.

Half-IF Taboo (n + 4 channels)

This newly named taboo is important because it represents a non-linear type of interference. That is, it more quickly becomes objectionable compared with a linear type of interference such as co-channel or image. It is therefore not considered a good candidate for modification.

Sound Image Taboo( n + 14 channels) and Picture Image Taboo (n + 15 channels)

EIA/CEG sees no benefit in "fine tuning" the sound taboo even though sound power has been reduced 4.5dB compared with that permissible in 1952 when the taboos were established. The spread in receiver performance should also be considered.

Picture image performance, as noted in paragraph 75 of the Inquiry and TM-1, is significantly poorer than that of the VHF reference. The picture image rejection data in TM-1 indicate that EIA/CEG's suggestion in comments filed in Docket 20485 that a "tracking image trap" significantly improves performance and not borne out in practice. The picture image taboo should not be changed.

Adjacent Channel Taboo (n +14 channel)

It should be noted that even the FCC (RFM) advanced technology receiver only shows significant improvement for an n + 1 undesired channel. Being one-sided, it doesn't help if there is an assignment at n +2 channels (i.e., it appears as an n-1 channel). Responses to the questions in paragraph 78 of the Notice follow:

> 16. The present taboos were adopted in 1952 and have remained unchanged since that time. What taboos should be eliminated or modified and what impact would this have on existing television service?

The oscillator taboo could be modified as indicated previously without impacting the existing television service.

> 17. In re-evaluating the effect of taboos generally, what percentage of viewers should be protected?

In terms of television receiver performance, at least 90 percent of the receivers should be protected. Some corrective action should be available to viewers who have the 10% of unprotected receivers.

> 18. Are the conclusions concerning the "VHF reference" criteria described in this proceeding justified? Should the taboos be modified as suggested in this proceeding?

Comparisons should be made, not on median performance, rather on the lower decile of VHF performance versus the lower decile of UHF performance. The data in FCC/OET TM-1 show the performance spreads of VHF cross modulation from median to lower decile is much less than many UHF performance spreads from median to lower decile. In this case, matching medians does not achieve matching lowest decile performance.

The assumption that the absence of complaints means acceptable VHF performance is dubious. A more complete study of the actual problems is needed.

In general the approach used does not provide an accurate evaluation of the possible problems that would be caused by the relaxation of specific taboos. An approach that directly relates taboo relaxation to the potential problems would be a better approach.

Also, to get statistically significant data on lowest decile receiver performance requires sampling much more product, from a wider variety of manufacturers, a wider variety of designs, and both new and old (0-10 years) product.

> 19. Because of the taboos, only 9 (at most) UHF channels can be assigned to any given city.
>
> a. To what extent could broadcasters take advantage of the "gaps" in the allocation table to transmit auxiliary information for advanced TV systems?

The gaps in the existing allocation would seem to represent an opportunity for new systems if proper attention is given to avoiding interference with existing transmissions.

> b. Should new assignments made possible by elimination or modification of taboos be reserved for advanced TV system use, opened for licensing to new full service stations, or used for other purposes?

The key criteria for the new assignments, if possible, should be to have the minimum negative effect on existing services. New full power NTSC TV broadcast stations would have a know negative

effect. Use with an advanced TV system could be defined to have a minimal negative effect.

> 20. a. How might future improvements in television receivers affect susceptibility to taboo frequencies?

Future improvements as demonstrated in the advanced technology receiver must consider the need to tune all VHF, UHF and cable channels. Agreement is needed on a protected first IF frequency. At present this can only be done at a significant cost premium. The customer will not perceive an improvement unless a problem exists. The change cannot be justified from market forces.

Major improvement is difficult for intermodulation, cross modulation or adjacent channels. Only cost effective high performance devices that don't presently exist will result in major improvement. The FCC(RFM) advanced technology receiver is not considered a cost or performance effective design. The concept, as first implemented by Texas Instruments, is ten years old and still cannot be found in the marketplace. It can not accommodate cable channel tuning because of the choice of the first intermediate frequency and the frequency coverage (i.e., broadcast and cable-only channels). VHF noise figures are not as good as current production receivers. And this is "one of a kind" (i.e., a sample "tweeked" for best performance); the data presented in

TM-1 are not "statistical". The industry is trying and is succeeding in improving performance with conventional designs as evidenced by the data for some receivers for some test for some tests in TM-1:

> b. Are advanced TV signals (including any auxiliary signals or augmentation channels) likely to be more, or less,susceptible to current taboo frequencies? Will new taboo frequencies arise?

Auxiliary signals (or augmentation channels) are likely to have much lower interference potential compared with NTSC signals. The developers of any ATV systems are quite aware of the interference problems and will endeavor to "craft" the auxiliary TV signal accordingly. Without knowing the format of such a signal it is not possible to predict if it would be more susceptible to NTSC interference (than another NTSC signal) or whether new taboo frequencies would arise.

> c. Are changes in receiver designs likely to cost effectively reduce the susceptibility of receivers to taboo frequencies for NTSC signals?

The receiver designers consider the taboos along with overall performance and cost in achieving new designs. It is unlikely that future receivers will be designed to eliminate taboo requirements unless new technology makes new compromises possible. New approaches are continually being evaluated.

> d. What are the anticipated costs of taboo-immune TV receivers and the time frame for significant market penetration?

The cost increase with present known approaches would be significant compared to existing tuner costs. The minimum time for real market penetration would be more than ten years from introduction. This does not include the three years necessary for receiver development. EIA Marketing Services Department data [4] indicate that ten years after purchase, 75-80 percent of color TV's are still working and in use. It takes about 15 years for half of all sets to go out of use.

> 21. Should the Commission take action now to encourage reduced generation of and susceptibility to taboos, either on channels used for NTSC or advanced TV signals? Is so, what action is appropriate. e.g., spectrum allocation, interference criteria, or other?

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[4] EIA Color Television Replacement Cycle Study, April 1985. Also referenced in the Technical Advisory Committee Final Report, May 7, 1986, Gen. Docket 85-172

EIA/CEG considers that gathering information on this question falls within the scope of the Advisory Committee on Advanced Television Service. The Commission should wait until interested parties have commented on a Committee report before acting.

Conclusion

EIA/CEG appreciates the Commission's effort to insure the viability of advanced television systems. Television receiver manufacturers ask, however, that the Commission recognize the question of relaxation of taboos and allocation of additional VHF channels are two different issues capable of independent analysis and Commission action.

Respectively submitted,

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C0485 TABOOS

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| In the Matter of | ) | |
| | | DOCKET NO. 20485 |
| RE-EVALUATION AND | ) | |
| REVISION OF THE UHF | ) | |
| TV "TABOO" TABLE. | ) | |

COMMENTS OF THE CONSUMER ELECTRONICS GROUP
of the
ELECTRONIC INDUSTRIES ASSOCIATION

In a Notice released May 22, 1975, the Commission initiated an inquiry into the question of whether the current restrictions on assignment of UHF channels (commonly called the UHF "taboos"), could by various means be reduced or eliminated. The Commission invited comments from interested persons on this question.

These comments are submitted in response to the above Notice of Inquiry by the Consumer Electronics Group of the Electronic Industries Association (EIA/CEG). EIA/CEG represents almost all the major United States Manufacturers of television receivers, including several Japanese companies which have manufacturing facilities in the United States. EIA/CEG has had a long history of working cooperatively and effectively with the Commission to solve common problems, and desires to continue this cooperation with respect to the areas to be examined by the Commission in this proceeding.

Summary

The taboos as they relate to the receiver are primarily a function of the front-end selectivity. Improving selectivity tends to increase receiver noise for a given design. Likewise, changes that decrease the amount of receiver noise degrade selectivity. The performance of all UHF tuners represents a compromise between these two factors. The solution of this dilemma rests on the ability of the industry to exploit new technology.

Relaxation of the oscillator and image taboos, which appear to be the key to additional allocations, is practical. Oscillator radiation currently is one fourth the value assumed for receivers at the time the taboos were established, and the average is expected to decrease with time as a larger proportion of the receiver population has UHF varactor tuners. A "tracking image trap", currently used in Europe and in some U.S. tuners, significantly improves image rejection.

It is not within the scope of this report to predict the number of additional assignments or the frequency spectrum that might be made available by relaxing these two taboos. However, the industry would be motivated by the FCC establishing some objective so that the improved spectrum utilization which could result from relaxation of the taboos could be evaluated from a practical economic and political standpoint.

Introduction

The electronics industry gives every indication of continuing to benefit from the expansion of knowledge that has characterized it in

the past. Television receiver and tuner manufacturers, as active participants, have a management philosophy consistent with a dynamic industry. They have underway a number of proprietary research and development projects. These projects, like many others of interest to the Commission which have already reached the marketplace, are being pursued by manufacturers for reasons beyond the specifics of this Inquiry: aggressive exploitation of new technology yields performance, feature, and cost improvements and the new product image vital to marketing success.

At the same time, the industry has serious concern for the potential economic consequences of involuntary requirements which will raise the cost of television receivers and place it in an unfavorable position in competing for the consumer dollar. Television receivers are one of the consumer items showing the least price inflation at a time when the receiver industry as a whole is experiencing severe financial pressures.

The ability of the industry to recover increased costs of materials and labor has been limited by the effect of price on volume, because the consumer does have other choices in discretionary spending. Significant additional costs resulting from regulatory action in response to this Inquiry, would jeopardize attainment of expanded UHF services by restricting the market for television receivers and inhibit the growth of the television industry.

The taboos were established so the public could receive stations in their area without interference. The public expects and receives both UHF and VHF television service under more adverse conditions than

recognized by the FCC through allocations based on these taboos. The receiver industry has met and fostered this expectation and expanded its market by providing state-of-the-art receivers for operation in the adverse conditions of fringe reception and with indoor antennas lacking in the gain and directivity of the outdoor antennas considered in the allocations. This public expectation and present service must be considered when weighing performance improvements which have been or will be achieved, and their potential effect on taboos.

The Sixth Report and Order in Docket No. 8736, et al, stated some of the receiver performance characteristics which were used in the 1952 UHF channel assignment table. (1) Adjacent channel separation of 55 miles minimum was based on desired to undesired signal ratio of 0dB. (2) Receiver image interference rejection of 30dB provided a basis for picture image signal separation of 75 miles minimum, and a sound image separation of 60 miles to give the same protection to the picture of a desired station as the co-channel separation. (3) Local oscillator radiation was considered, and based on the use of 45 MHz intermediate frequency, assignments on oscillator frequency were not assigned within 60 miles, in order to minimize the potential interference within the desired station grade A service contour. The limit for receiver oscillator radiation was set at 1500 uV/m @ 100 feet. (4) Intermodulation and IF beat types of interference were minimized by assigning channels which could cause these types of interference, 20 miles or more from the desired station.

At the time of adoption of the 1952 UHF allocation plan, commercial TV receivers were VHF monochrome. Knowledge of UHF receiver design

was limited only to laboratory and field test types of receivers. Potential production type UHF tuner performance characteristics were not well defined. Developmental UHF tuners were configured with two mechanically tuned circuits ahead of a solid state diode mixer, no RF amplification, a vacuum tube oscillator, and intended for 45 MHz intermediate frequency. With introduction of commercial UHF broadcasting, UHF tuners developed along these lines, with the use of a solid state oscillator, starting in about 1964, and replacement of mechanically tuned tuners with varactor tuned tuners having solid state RF amplifiers beginning about 1969 in a limited number of receivers.

Approximately 58 million color TV receivers and 63 million black and white receivers were in use at the beginning of 1975. It is estimated that 90% of these are equipped to receive UHF television. Of these receivers equipped for UHF, most have tuners that are similar in configuration and performance to the tuner performance assumed in developing the 1952 UHF allocation table. A small percent of the color receivers and very few of the monochrome receiver population use the newer varactor tupe UHF tuner. Therefore, contemporary UHF receiver performance is similar to that assumed in developing the original allocation plan. Evoluntionary refinements in receiver performance have resulted in lower oscillator radiation, improved UHF noise figure, more stable oscillators, and to a limited extent, better image rejection. Also color receivers, which have increased rapidly in use since adoption of the NTSC color TV system, have better intermediate frequency selectivity characteristics and may have automatic fine tuning, compared with pre-1952 monochrome receivers.

The predominant UHF tuner in current production is the "mechanical" 70-channel detent tuner. While this tuner will continue to be used in a majority of the television receivers marketed in this country for the next few years, varactor tuners and various tuning schemes that offer better equality of tuning between UHF and VHF are being marketed in sharply increasing quantities. It is not considered in the public interest to inhibit the continued penetration of varactor tuners by restrictive changes in the taboos.

Other factors which may bear on the 1952 UHF allocation plan are, (1) increasing the permissible maximum effective radiated power of UHF stations from one to five megawatts, (2) decreasing the sound power from -1.5 to -3dB below picture carrier to -7 to -10dB below picture carrier, and (3) adoption of the NTSC color TV system.

Response to specific questions by paragraph number in the Notice:

Question: 7a. "Considering the performance of contemporary TV receivers, what taboos can be reduced or eliminated without degradation of service?"

Adjacent channel and image taboos were based on 0dB and 30dB, respectively. The FCC limit on oscillator radiation was 1500uV/m at 100 feet at the time the taboos were adopted. The basis for the intermodulation and IF beat taboos is not readily apparent; however, the choices are reasonable in terms of receiver characteristics then and now.

Transmitted sound power has since been reduced 5.4 to 7dB relative to the video power, so some reduction in the sound image mileage separation could be considered.

The oscillator taboo might also be relaxed because of the 6dB reduction in the limit on oscillator radiation from 1500 to 750uV/m. Transistor local oscillators employed for the past several years are typically another 6dB lower, which provides a basis for review.

A review of performance data for contemporary TV receivers, and considering that most of the UHF tuners used in them are the same basic configuration as those in 1952, would support the position that there is little difference in performance that would affect taboos, except as noted for oscillator radiation.

The June 1974 FCC Report Lab. 74-01 showed a very wide spread for important characteristics: Unfortunately, the report did not include measurements taken the same way as those values used to establish the taboos; therefore, interference caused by stations on the taboo channels cannot be directly related to the design parameters of the receivers tested.

Question: 7b. "Should the Commission abolish certain taboos in expectation that receiver performance improvements would ensue to cope with actual interference if it occurs as a result of taboo elimination?" Without such performance improvements, to what extent would service be degraded?"

The Commission should not abolish certain taboos in expectation that receiver performance would ensue to cope with actual interference if it occurs as a result of taboo elimination without determining (a) the need for such action, and (b) that the improved performance required is within the economic and technical capability of the industry. Further, adequate notice and lead time should be given so that the product actually in the field can give acceptable performance.

We estimate the time to accomplish a field changeover to be at least ten years.

Any action taken without a sound technical basis could degrade UHF service on the more than 110 million receivers now in use. The extent of the degraded service would depend on the specific taboos eliminated, actual receiver performance with respect to each taboo (taking into account the reduction in performance during the useful life), and the actual signal condition with respect to signal strength and frequency assignments. Any proposed change in the station assignment plan would require thorough study, including worst case loading of the channels.

Question: 7c. "What TV receiver improvements can be made to improve interference rejection?"

Improved rejection of interference of the type minimized by UHF taboos would be obtained by improved selectivity and linearity of the receiver circuits.

A number of possible design improvements are discussed in the paragraphs that follow; however, these points should be kept in mind:

1. Usually important compromises are involved between parameters of interest to both the FCC and the public.
2. Cost may be a major factor.
3. The design concept may not have reached that phase of its development which merits product or regulatory interest.

Question: 7d. "Comments are requested on at least the following specific receiver improvement possibilities:"

1. Noise figure. Noise is not directly related to the taboos, although it is one factor in determining the interference zone for co-channel spacing. Noise figure is discussed in detail because it is not independent of other tuner characteristics. Known design changes to improve noise figure tend to degrade selectivity, and interference rejection. Likewise, improvements in input selectivity can degrade noise figure.

Increased radiation power, plus antennas with radiation beamed to the horizon, have extended UHF Grade A service virtually to the line of sight, after which attenuation is very rapid and the fringe reception ring relatively narrow.

Improved noise figure would do little to increase the service area achieved with good antenna installations. Such increase would be counter to reduction of taboos since any increase in service radius would require interference protection at that radius.

Noise figure improvement helps when the signal is low, for whatever reason, when other interferences are not present, but the tuner's contribution to picture improvement is relatively small compared with that provided by a good antenna installation. Many installations, including those using built-in or indoor antennas, are less than optimum on both VHF and UHF. UHF is especially vulnerable because typical 300ohm transmission line in good condition has relatively high (6 to 8dB) attenuation per 100 feet. In many cases, inexpensive "flat" twin lead is used, and increased attenuation due to weathering may be critical.

Present situation:

The present FCC Rule specifies 18dB for the maximum receiver noise figure. Tuners purchased by the industry usually have a maximum limit of 14dB. Noise measured at the receiver antenna terminals can be somewhat higher depending on the tuner VSWR, length of lead-in, and in the case of mechanical tuners, the noise figure of the particular VHF tuner usually used as an intermediate frequency amplifier (Channel 1) on UHF. It would appear that an upper limit receiver noise figure at least 3.5dB higher (1.5 dB for VSWR and 2 dB for a limit Channel 1) than the tuner maximum limit must be anticipated with present designs. There is additional variation due to alignment. Receivers typically average under 13dB, with noise figure as low as 8dB measured on some channels. This spread of about ±5dB is reasonable for a mass produced consumer product operating over a continuous two-to-one frequency band, the top of which is almost at a microwave frequency.

Potential improvement-mechanical tuners:

The typical three-circuit tuner used a diode mixer and transistor local oscillator preceded by a double-tuned antenna circuit. A direct practical approach is to use lower noise mixer diodes. The hot carrier diode used in many current receivers typically can give .5 to 1dB lower noise figure at added cost.

Proposed noise figure improvement in a mechanical tuner by the addition of an RF stage is an undesirable alternative. It is discussed in the response to Front-end selectivity on page 12.

Potential improvements in noise figure-varactor tuners:

Tuners in current production are four-circuit tuners with an RF

stage and diode or transistor mixer. The additional tuned circuit has been necessary for performance related to selectivity, (cross modulation and intermodulation) because the Q of current varactor tuned circuits is lower than circuits tuned with conventional capacitors.

UHF tuners for the European market have about 2dB lower noise than U.S. tuners 1/ acheived by using a broadband antenna circuit ahead of a gain-controlled RF amplifier. This design approach has been proposed for the U.S.; however, our market is dominated by multiple Grade A UHF signals. Tuners without preselection are susceptible to interference to an extent that far outweighs the noise figure improvement for typical viewers.

The most pronounced interference observed in tests made on such a broadband input tuner is the ±4 channel cross modulation and ½ IF intermodulation. There is at least 10dB less rejection than a current domestic type. This practical need for selectivity is underscored by the common use of an additional tuned circuit in domestic varactor tuners in order to be comparable with mechanical tuners in field performance.

Another tuner configuration which offers potential noise figure improvement is that of a PIN diode attenuator in a broadband input circuit preceding a fixed gain, low noise RF transistor. Tuner noise figure improvement of 4 - 5dB may be possible and cross modulation can be good because the attenuator protects the RF stage from strong signals,

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1/ See RM-2577, Exhibit #2, Hazeltine Report 3614 and EIA-CEG Opposition to RM-2577.

and the RF transistor is more linear. The performance deficiency of this system is noise in the picture in the mid-to-strong signal strength range. To protect against cross modulation and overload, attenuation must commence at a signal input that is insufficient to give a noise-free picture. Because noise figure is degraded dB for dB with input attenuation, the remaining noise does not reduce with increasing signal strength. Manufacturers do not consider this an acceptable approach in the U.S. In Europe, where UHF assignments are limited, the approach is viable.

2. Front-end selectivity: This affects local oscillator voltage at the antenna terminals, image rejection, cross-modulation and intermodulation. Domestic receivers require good front-end selectivity because input signals may be 0.1V or more, a level at which intermodulation can be a serious problem. Selectivity of current tuners is reasonable as a percent of the signal frequency. It is determined by the number of tuned circuits used and achievable loaded Q.

Selectivity is considered much more important than noise figure in defining UHF picture quality in relation to the taboos. Additional selectivity would improve the interference rejection of both mechanical and varactor tuners, but must be weighed against noise figure and costs.

Present situation:

Contemporary varactor and mechanical tuners have similar selectivity before the mixer, achieved with three and two tuned circuits, respectively. However, varactor designs have an RF stage (necessary for noise figure), which is susceptible to cross modulation. Measurements