THE EFFECTS OF INTERFERENCE ON TV PICTURE AND SOUND

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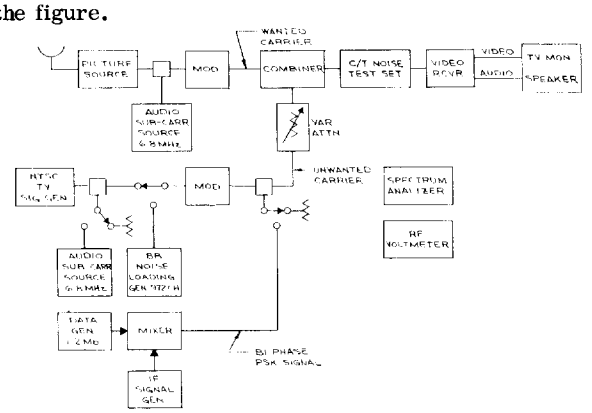
Abstract

A subjective analysis of the effects of different types of interfering carriers on TV picture and sound was conducted. Interference from TV, High Speed Data, and FM/FDM Carriers was evaluated to determine the level at which each interference is first observed, which type produced the worst distortion, and the level at which each type of interference becomes unacceptable. The results indicated that interference from another TV carrier has the worst effect. TV interference was first noticed on the picture at a carrier to interference ratio of 18 dB. A subjective average showed that the picture becomes unacceptable at a carrier to interference ratio of 14 dB. It can be concluded that an earth station operating in an environment where the C/I is greater than 18 dB should have acceptable TV reception.

Subjective Test Evaluation of Interference Model

The effects of different types of interfering carriers on the TV picture and sound were evaluated by subjective testing. An actual TV carrier was processed through a receiver, and the output signal observed and heard on video and sound monitors. Interference from other TV, high speed data, and FM/FDM carriers was simulated and introduced. A group of observers evaluated the effects of different levels of the interfering carriers. The test setup is shown in the figure.



The TV signal was received and reprocessed to have all of the modulation characteristics outlined in the calculations. The carrier to noise (C/N) operating condition was established by an ITT NTS 7040 noise test set, and the TV carrier was fed into an ITT TV receiver. The output video and audio signals were then displayed on a Sony TV picture and sound monitor. A spectrum analyzer was used to set the reference of the wanted carrier to the interfering carriers at 0 frequency separation and 0 dB in the attenuator. Attenuation was added to set the interference 30 dB below the wanted TV carrier. Switches and combiners were used to introduce the different interfering carriers and carrier combinations. Several C/Ns were used in the tests. A standard ITT TV receiver (C/N = 10 dB at threshold) was employed for C/N = 12 dB and 16 dB; an ITT threshold improvement receiver (C/N = 7 dB at threshold) was used for C/N = 9 dB.

A group of subjects was individually asked to observe the monitor and say when the picture became objectionable as attenuation was removed in 1 dB steps. This test was repeated for the various types of interference at different receiver C/Ns. The results were averaged, and the mean at which the carrier to interference (C/I) became unacceptable was recorded. A color bar TV signal replaced the TV picture signal as the wanted carrier, and all tests were repeated. The C/I at which interference was first noted was recorded for all cases.

The results of the subjective tests are shown in the tables. They indicate that TV interference has a worse effect on the received TV signal than either high speed data or FM/FDM interference. TV interference appears as wavy horizontal lines, whereas high speed data appears as random impulses, and FM/FDM shows up as thermal snow.

For any case, it is evident that the general viewer, on a subjective basis, will accept approximately 3 to 4 dB lower C/Is than the ratio measured when interference is first perceived on the picture. No major changes in the quality of the sound were observed, but for C/Is of 12 dB and lower, a notable increase in background noise is heard. It should also be noted that the C/I measured for the condition when interference

TV Signal Interfering with TV Signal

(0 Frequency Separation)

C/N in 36 MHz for wanted TV carrier	C/I for unacceptable picture (subjective average)	C/I for clearly noticeable color bar distortion	C/I when interference first appears on picture
9	14	16	18
12	14	16	18
16	13	16	18

High Speed Data (1.2 Mb) Interfering with TV Signal

(0 Frequency Separation)

C/N in 36 MHz for wanted TV carrier	C/I for unacceptable picture (subjective coverage)	C/I for clearly noticeable color bar distortion	C/I when interference first appears on picture
9	12	15	17
12	12	15	17
16	12	15	17

972 Channels
FM/FDM Signal Interfering with TV Signal

(0 Frequency Separation)

C/N in 36 MHz for wanted TV carrier	C/I for unacceptable picture (subjective average)	C/I for clearly noticeable color bar distortion	C/I when interference first appears on picture
9	12	14	15
12	13	14	15
16	11	13	15

High Speed Data (1.2 Mb) plus TV Signal Interfering with TV Signal

(0 Frequency Separation)

C/N in 36 MHz for wanted TV carrier	C/I for unacceptable picture (subjective coverage)	C/I for clearly noticeable color bar distortion	C/I when interference first appears on picture
9	14	16	18
12	14	16	18
16	14	16	18

Note: All ratios in dB

is first noted on the picture appears to be independent of operating C/N. This indicates that regardless of how much additional operating C/N margin may be added to the station design, the interference will still start to degrade the picture at approximately the same C/I as for a station with a 2 dB operating margin over threshold. However, in the case of TV and FM/FDM interferences, the subjective acceptance C/I tends to improve at high C/N margins since the subjects see less thermal impulse noise. High speed data interference does not seem to share this improvement since it appears as impulse distortion on the picture.

Conclusions

The subjective tests indicate that a TV receiving earth station, operating with a 2 dB C/N margin above fm threshold, in an area where the C/I is greater than 18 dB should have acceptable TV reception.

It should be noted that the testing was conducted in a laboratory environment where the specific effects of only one or two combined interfering carriers could be evaluated. In the field, many interfering carriers at relatively low levels enter the receiving system and add to the overall link noise. This raises the total noise base and thus lowers the system operating C/N. Therefore, for a good earth station design, proper system C/N margin should be included to compensate for the effects of interference at each location.

Reference:

Multiple Satellite Interference Analysis
for 4.5 Meter TVRO Earth Station

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