



TV Picture Performance related to CNR, CSO, CTB and Spurious signals

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Perception of TV Picture Impairments

The evaluation of TV picture performance is a real tough task, since the visibility of picture degradations is strongly depending on the content of the picture itself and on the subjective feeling of the observer. In order to get a reliable statement on a certain picture quality it is desirable to define objective methods to evaluate the picture quality. For that reason instead of subjective picture investigations objective measurements on CNR and any kind of beat signals like CSO, CTB and spurious signals have been defined.

CCIR Recommendation 500-1 (Kyoto, 1978, Vol.XI) distinguishes between 5 impairment grades of TV pictures:

- 5 – Imperceptible.
- 4 – Perceptible but not annoying
- 3 – Slightly annoying
- 2 – Annoying
- 1 – Very annoying.

CATV systems in general are designed to deliver a picture quality of grade 4 on this impairment scale to the customer. All subsequent statements in this paper therefore refer to a grade 4 picture quality.

Performance Requirements as of IEC 728-1

Global requirements

IEC 728-1 specifies objective a variety of criteria for CATV transmission systems in order to achieve a grade 4 picture quality on the CCIR 500-1 Rec. impairment scale. Some of the global requirements at the customers outlet are:

Impedance	75	Ohms
TV carrier levels	60 ... 83	dB μ V
TV carrier level differences at one outlet for all TV carriers between 30 and 1000 MHz	< 15	dB

CNR requirements

IEC 728-1 gives a minimum specification for the CNR at the customer's outlet: The CNR in any channel should not be below 43 dB for PAL B, D, G, I and 42 dB for NTSC systems.

It is important to note that „in any channel“ means that the frequency response of the transmission system has to be taken into account. If the frequency response of an active (that means optical or coaxial cable) transmission system is defined to be ± 2 dB, the CNR of all TV channels will also vary by ± 2 dB. In order to achieve a CNR of 43 dB for all channels, the transmission system has to be designed to have a nominal CNR of 45 dB to get the 2 dB of headroom for the frequency response ripple.

CSO, CTB and Spurious Signal Requirements

IEC 728-1 defines „Single- and multiple frequency interference to television channels“.

Single-frequency interference to television channels

The single frequency interference specification requires that each unwanted, in the system generated signal (like CSO, CTB and spurious signals) in general has to be 57 dB below the carriers. However, at certain frequencies within a TV channel the sensitivity for picture impairments is different. Appendix 1 gives the so called protection curve for PAL-I systems which is similar to PAL-D systems. IEC 728-1 gives also protection curves for PAL B, G, Secam B, G and L and NTSC.

The horizontal axis of the diagram (referring to landmark paper format), scaled from -3 to $+6$ MHz gives the frequency of interference signals related to the TV picture carrier which is at 0 MHz.

The vertical axis specifies the requested carrier to interference ratio for single-frequency interferences.

The diagram shows that there are some frequencies within a TV channel where unwanted signals do not disturb a picture the same way as signals allocated just at the carrier frequency or up to 1 MHz higher. E.g. Signals at $+3$ MHz could even be tolerated up to -40 dB below the carrier. However, the picture also explains, that regardless what type of unwanted signal, the impact on the picture degradation is only given by the frequency of the unwanted signal related to the carrier frequency. That means a spurious signal of -57 dB e.g. at $+0.6$ MHz has the same impact on the picture as a CTB at 0 MHz or a CSO at $+0.25$ MHz of the same size.

Therefore it is very important to measure all unwanted signal in a TV channel (like spurious signals) and not only those which are very well known like CTBs at 0 MHz.

The single-frequency interference requirement as shown in appendix 1 gives a request for a single interference product in a channel. In practice, however, there are many unwanted signals present in a channel. For that reason IEC 728-1 also specifies a requirement for the total of all unwanted signals in a channel. Obviously, one unwanted signal being at -57 dBc and 0 MHz would meet the single-frequency requirement. However, if there would be e.g. a number of 10 unwanted signals all at -57 dBc, between 0 and 1 MHz the total power would sum up to -47 dBc which would lead to a strong picture impairment. To cover these cases IEC 728-1 also has a requirement for multiple-frequency intermodulation interference.

Multi-frequency interference to television channels

An additional requirement of IEC 728-1 covers multi unwanted signals. The requirement is that multi unwanted signals have to be 54 dB below the carrier in order to achieve grade 4 („perceptible but not annoying“) of the picture impairment scale of CCIR-rec. 500-1. Example: If a transmission system generates a CTB of -57 dBc at 0 MHz and a CSO of -57 dBc at 0.25 MHz, the total interference (logarithmic addition) would be -54 dBc. Any further unwanted signal of the types CSO, CTB and spurious signals would further degrade the -54 dBc and for this reason would cause picture impairment grade 3: Slightly annoying.

Conclusion

Since subjective picture investigations are very time consuming and the results of these are difficult to compare with other picture investigations objective measurements are a good approach to be able to judge the transmission performance of a transmission system. Whereas CNR measurements taking into account the impact of the frequency response of a transmission system are very well understood and standard, measurements of unwanted signals are somewhat more complex. Only a detailed analysis of unwanted signals not only covering the very well known CTB frequency at 0 MHz rel. to the carrier but also other signals like spurious signals will give the guaranty that a transmission system will meet its expectations from the system design.

Appendix 1: Carrier to single-frequency protection ratio for 625 lines system I (PAL).

