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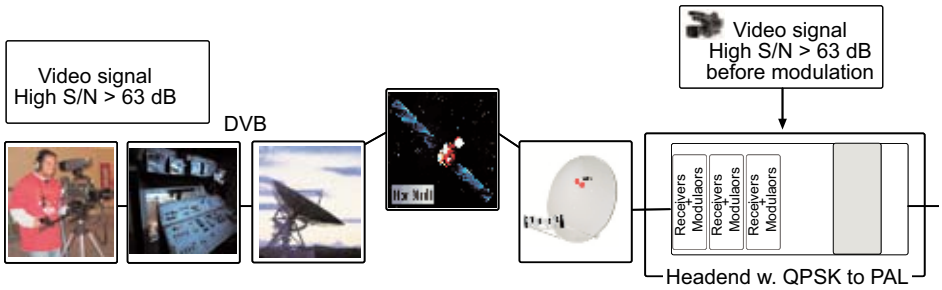
Signal-to-noise. Carrier-to-noise.

- What's the difference?
- What are the practical implications?



Signal-to-Noise (S/N) and Carrier-to-Noise Ratios (C/N) are terms often used to indicate the quality of headend systems and SMATV networks. Although S/N and C/N measure different system properties, the two terms are often used at random and this in turn can lead to wrong conclusions.
This article attempts to explain the difference between the terms and the practical implications in design and installation of TV networks.

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Electronic noise is the enemy to high quality tv-pictures. Noise is to some extent present in all video signals, but the amount has to be kept at levels that are practically invisible to the human eye, and these levels can be expressed in engineering terms.

Signal-to-Noise and Carrier-to-Noise are the terms used to indicate electronic noise levels - that is the ratio between meaningful information and background noise. But why do we use two terms to indicate noise, and what is the difference between S/N and C/N? To understand this, we need first to understand the difference between a signal and a carrier.

A signal is the electromagnetic content of a video signal, and high quality signals are needed to produce high quality pictures and sound on a tv-set. In all distribution systems signals are however modulated into carrier waves and the wave is the carrier or "vehicle" used to distribute the signal.

So, a signal-to-noise ratio is a measurement of electronic noise in the video signal, and it is in practical situations the most meaningful ratio to use. Noise is however introduced, every time a signal is processed, and the carrier-to-noise ratio is an expression of noise added by the modulator and in the distribution system, amplifiers and other active components. Noise inflicted on the carrier will of course also add noise to the signal (and decrease both C/N and S/N ratios), but only the signal-to-noise ratio will include the noise inherited in the signal from the very start and originating from video cameras and other types of recording equipment.

Acceptable levels

The signal-to-noise ratio in the original signal, produced by the video camera, will typically be in the order of 63 dB. Noise will however always be added in the processing and distribution of signals.

The critical value is the S/N ratio of the demodulated signal going into the TV-set, where:

- An S/N ratio of 49 dB is considered excellent
- An S/N ratio of 43 dB is good
- An S/N ratio of 37 dB is acceptable, although noise (fine white grain or snow) at this level is visible
- An S/N ratio of 31 dB or lower must be considered unacceptable and to most people will irritate the eye especially if you have to look at the picture for a lengthy period.
- At S/N ratios below 25 dB colour tv-sets will often be unable to show colours.

Steps of 6 dB are used in the scheme, because a 6 dB step represents a 50% reduction or increase in the amount of noise – and because smaller steps are practically invisible to the human eye.

- continue on page 2

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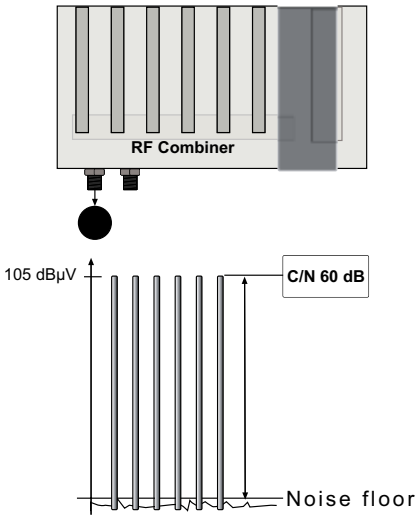
C/N must be higher than the S/N required

Once noise is added to the signals in a distribution system, it won't go away and can only get worse. So, you can't "repair" for noise by adding amplifiers or other types of processing. On the contrary: Each new active component will add noise and reduce the S/N ratio.

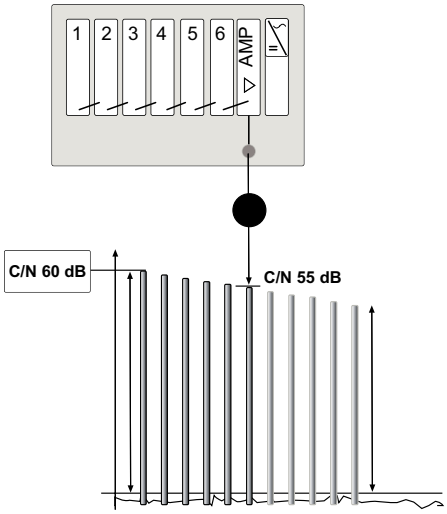
In practice this means that the C/N-ratio of the distribution system (the aggregated C/N-ratio of headend, amplifiers and other active components) has to exceed the S/N-ratio desired at the end of the distribution system, where the signal has been exposed to the maximum of processing. So, if the operator's requirement is an S/N-ratio of 43 dB at all TV-sockets, the distribution system has to be designed with a C/N-ratio exceeding 43 dB.

There is no theoretical formula for calculating the margin needed between system C/N-ratio and desired S/N-ratio. Guidelines derive from tests and practical experience, and you may find different advised margins.

Our experience at Triax is, that the C/N-ratio has to be a least 4 dB higher than the desired S/N-ratio. Most vendors like Triax will help you to calculate the C/N-ratio of a planned system and of course offer advice as to how you can minimize noise at the least costs.



Parallel combined



Serial combined

Minimize noise at the front of the distribution system

As all processing of video signals introduces noise, one of the basic rules is to minimize the number of different processes (active components) needed in a distribution system.

This minimization of processes is logically achieved by investing in quality components at the front end of the system. A quality headend (high C/N-ratio) with a high output level and low noise figures will reduce the number of amplifiers needed - and thus improve the overall C/N-ratio of the whole system.

Using the modulator from set-top boxes and specially cheap boxes, could be an attractive alterative for saving money. With these modulators the most important signal parameters as S/N and C/N ratio are often far below the acceptable level for distribution in a network. Even the best amplifier in the distribution net will not be able to improve or compensate for the low signal quality.

Another point to watch is the combining method used in the headend. In serial combining all signals (channels) except one are processed repeatedly and C/N-ratio is reduced by 1 dB in each loopthrough. In parallel combining all signals (channels) are processed alike and have identical C/N-ratios.

Finally, a lot of attention must be paid to the selection of amplifiers and especially, it is extremely important to avoid excess amplification capacity in the system. Power in terms of an unneeded max amplification capacity will introduce noise and reduce the C/N-ratio.

- continue on page 3

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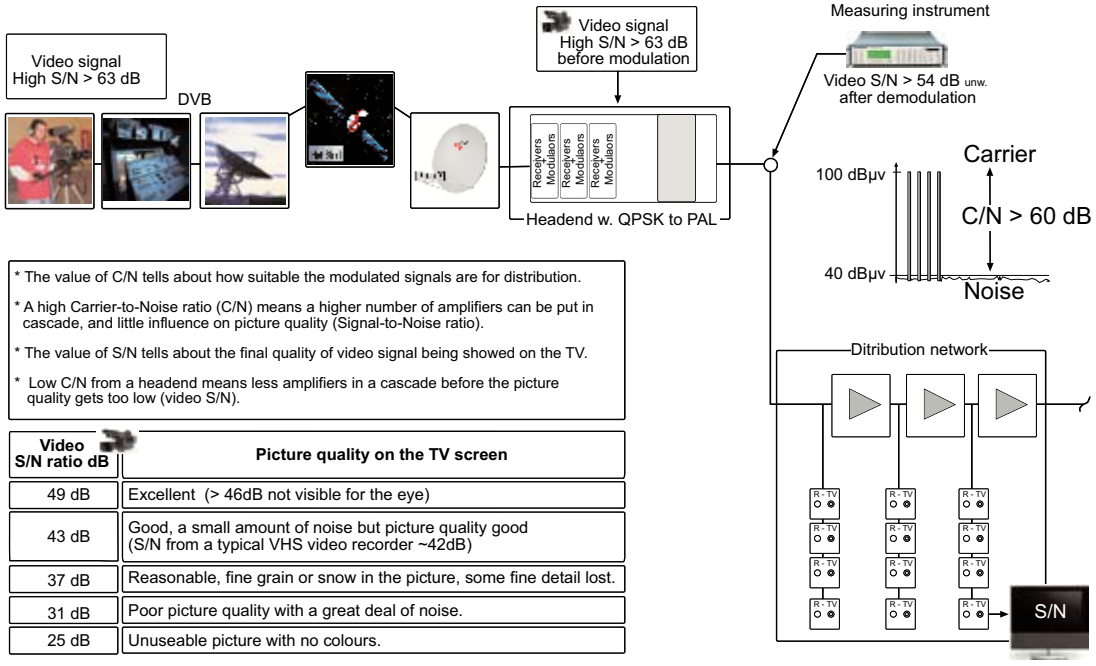
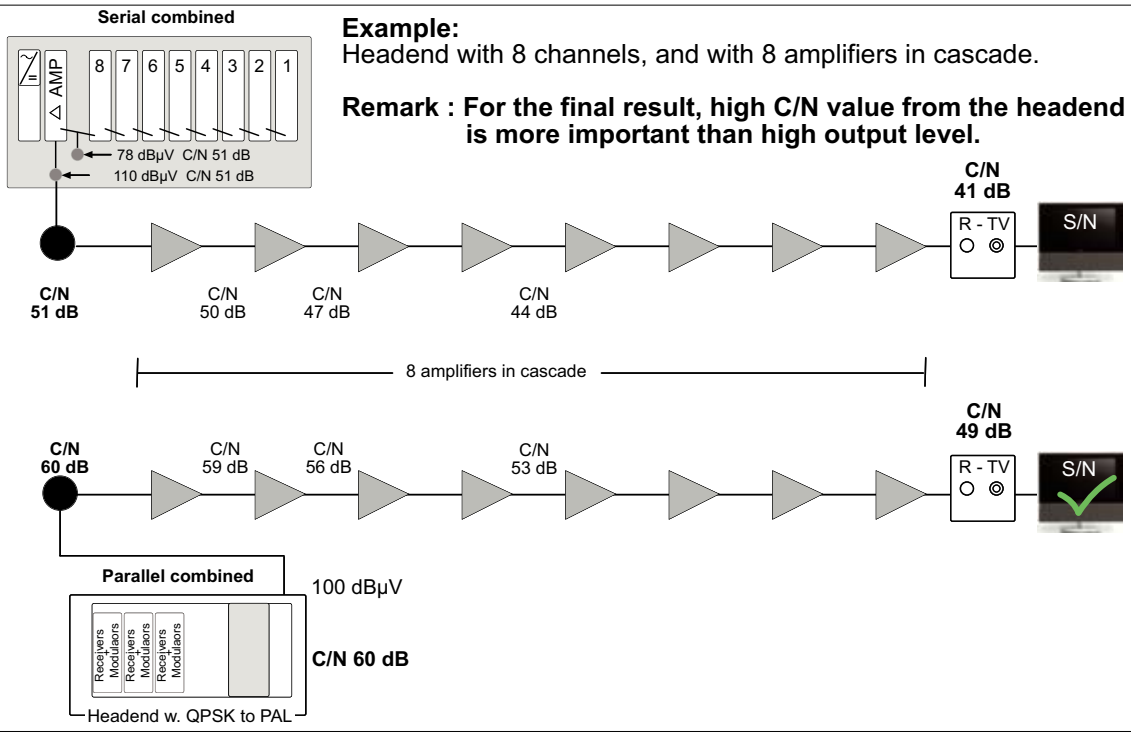
The difference between Signal-to-Noise and Carrier-to-Noise



* The value of C/N tells about how suitable the modulated signals are for distribution.
* A high Carrier-to-Noise ratio (C/N) means a higher number of amplifiers can be put in cascade, and little influence on picture quality (Signal-to-Noise ratio).
* The value of S/N tells about the final quality of video signal being showed on the TV.
* Low C/N from a headend means less amplifiers in a cascade before the picture quality gets too low (video S/N).

Video S/N ratio dB	Picture quality on the TV screen
49 dB	Excellent (> 46dB not visible for the eye)
43 dB	Good, a small amount of noise but picture quality good (S/N from a typical VHS video recorder ~42dB)
37 dB	Reasonable, fine grain or snow in the picture, some fine detail lost.
31 dB	Poor picture quality with a great deal of noise.
25 dB	Unuseable picture with no colours.



Simply more - more simply

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