

Your new questions on coding

Question 24. What for they enter the new term “efficiency”, if there are already such criteria as the relation signal/noise and a code gain (CG)?

The answer. It is convenient also and it seems to be useful.

Let's try to discuss utility of criterion "signal/noise" all over again. More precisely, we shall consider the relation $\mathbf{a}=\mathbf{E}_b/\mathbf{N}_0$, i.e. the ratio of bit energy of a signal to spectral density of noise power. If it is less, then, naturally, the code and algorithm of its decoding is better. But it is necessary to take into account the code rate and to know extreme possible value for \mathbf{a} , determined by a condition of equality of chosen code rate \mathbf{R} and throughput of channel (capacity) \mathbf{C} . Only in this case it will be clear enough, how much is the characteristics improvement of the decoder possible.

Let's address to code gain (CG). This criterion – is the differential one. We take required reliability of receiver and then we look at the ratio \mathbf{a} corresponding to it. And then we look the same size $\mathbf{a}=\mathbf{E}_b/\mathbf{N}_0$ for concrete algorithm of decoding. Their difference is CG. And it is useful again for understanding of how the CG of the given algorithm is far from extremely possible CG level, to know for concrete code rate \mathbf{R} this extreme CG, determined by condition $\mathbf{R}=\mathbf{C}$. These picture are submitted in our article about new MTD on PLIS Xilinx in "Electrosvjaz" No.2, 2005 (Moscow, Russia).

So considered criteria are useful, but assume knowledge of some additional, extreme possible values.

And concept of efficiency is directly connected to limit values $\mathbf{a}=\mathbf{E}_b/\mathbf{N}_0$ which correspond to equality $\mathbf{R}=\mathbf{C}$. We take the ratio \mathbf{a} for this equality and it is determined working value \mathbf{a} for discussed algorithm. Their difference also is a measure of efficiency of use of the channel in decibels. And if to transform this difference to percents then it will be required efficiency.

For example, let for equality $\mathbf{R}=\mathbf{C}$ corresponds concrete value \mathbf{a}_0 , and the analyzed algorithm of decoding at same code rate \mathbf{R} works at a level \mathbf{a} , on 3 dB higher, than \mathbf{a}_0 . This 3 dB is that size which directly specifies difference of opportunities of the chosen decoder from extreme possible theoretical values \mathbf{a}_0 . But 3 dB is 2 times. So the power of transmission for this decoder is 2 times more large, than it is possible in the theory. But it also means, that usage of the channel, decoder efficiency is 50 %. If there will be a decoder which will work with excess of power from limiting energy level only at 0,5 dB, then for this decoder efficiency is equal 89 %. Is it convenient? Certainly! Also it is not necessary to refuse first two criteria at all. But it is good enough to understand sense of efficiency for the digital channel also.