Noisecom

Application Note

Calculating the Max Eb/No Ratio You Can Provide with a Noisecom CNG-EbNo Unit

Figure 1: Noisecom CNG-EbNo SNR Noise Generator

Introduction

Eb/No is a very important parameter for those who work with digital communication systems. Usually this term shows up while discussing bit error rate (BER) or modulation methods in a communication system. Eb/No is defined as the ratio of Energy per Bit (Eb) to the Spectral Noise Density (No). It is basically a signal to noise ratio present at the input to a receiver and is used as the basic measure of how strong the signal is. It is very important for any Noisecom CNG-EbNo user to determine the correct Eb/No value and also to be aware of the maximum of that value. Hence, this application note describes how to calculate the maximum Eb/No ratio from a Noisecom CNG-EbNo instrument.

Importance of Eb/No Parameter

It is often said that the Eb/No ratio in digital communication is equivalent to the SNR in analog communication systems. The probability of bit error is proportional to erfc(Eb/No). As the argument of erfc() increases, the probability of error also decreases. Thus it is very important to have either high Eb (Energy per Bit) or low No (Spectral Noise Density) for good quality reception. Eb is the energy per bit for the clean signal and No is the noise PSD (Power Spectral Density) amplitude. Hence Eb/No is of the great importance and all BER and SER (Symbol Error Rate) curves are plotted versus Eb/No.

Eb/No Ratio Calculation

Different forms of modulation like BPSK, QPSK, QAM, etc. have different curves of theoretical bit error rates (BER) versus Eb/No. These curves show the communications engineer the best performance that can be achieved across a digital link with a given amount of RF power and noise level in the system.

Here is an example calculation for the model CNG-EbNo-1550 which has frequency range 950 MHz to 2150 MHz and is generally used for L-band modem tests or Satellite IF loopback testing. So for a receiver bandwidth of 1200 MHz, the noise output power range of CNG-EbNo-1550 is from -55 dBm to +5 dBm. The following formula can be used to convert this to a spectral density value

OUTPUT POWER (dBm) = PSD (dBm/Hz) + 10 LOG (BW)

- 5 dBm = PSD + 10 log (1200 MHz)
- PSD = 5 dBm – 10 log (1200 x 106 Hz)
- PSD = 5 dBm -91 dB
- PSD = - 86 dBm/Hz

Now, assuming fixed carrier power of -10 dBm and data Bit rate of 1, the maximum and minimum Eb/No can be calculated by using the following formula for both minimum and maximum noise power density respectively:

OUTPUT POWER (dBm) = C- Eb/No+10 log (BW/Bit Rate)

- Eb/No= C+10 log (BW/Bit Rate)- Output Power (dBm)

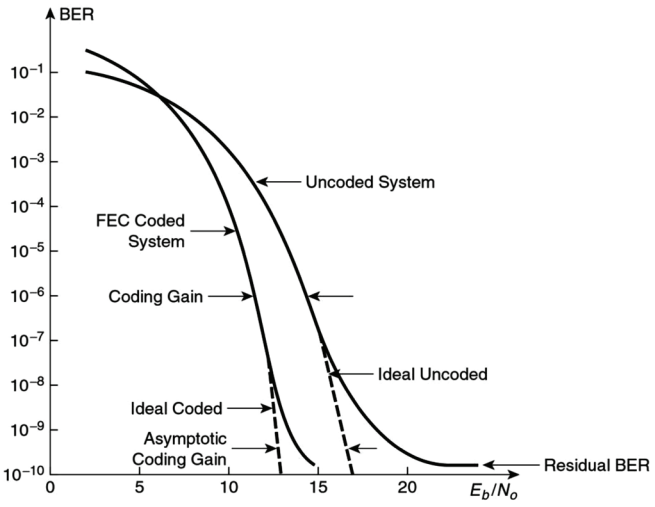

Figure 2: Example of BER, Coding Scheme and Eb/No

What we can observe from the above example table is that the PSD value is only related to the bandwidth and noise output power setting of the instrument. The noise power spectral density is not affected by the selection of carrier power or bit rate.

On the other hand, the Eb/No value is related to carrier power and bit rate settings of the instrument. If we do not change the carrier power but only increase the bit rate then the Eb/No also increases. For the lower value of the carrier power, the Eb/No calculation also decrease for the same receiver bandwidth.

Carrier Power (dBm)	Bandwidth (MHz)	Noise Power (dBm)	Noise PSD (dBm/Hz)	Bit Rate	E_b/N_o
-10	1200	5 (max)	-86	1	76
-10	1200	-55 (min)	-146	1	136
-10	1200	5 (max)	-86	10	85
-10	1200	-55 (min)	-146	10	145
-20	1200	5 (max)	-86	1	66
-20	1200	-55 (min)	-146	1	126
-20	1200	5 (max)	-86	10	84
-20	1200	-55 (min)	-146	10	144

Conclusion

A Noisecom CNG-EbNo series is an example of calculating maximum Eb/No for a digital communication system. So, carrier power and bit rate are the most important parameters which need to be considered in order to calculate the maximum Eb/No ratio for a specific range of power spectral density, noise output power and a fixed bandwidth.

References:

[1] Noisecom CNG- Eb/No Noise Generator: http://noisecom.com/products/instruments/cng-ebno-snr-noise-generator

[2] Data sheet for CNG- Eb/No: http://noisecom.com/~/media/Noisecom/Datasheets/CNG_EbNo_Datasheet_PR3.ashx

[3] Webinar on Signal-to-Noise, Carrier-to-Noise and Eb/No : http://noisecom.com/resource-library/webinars/sn-cn-ebno-webinar

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