Conversion of C/N or SNR to E_b/N_0 in DVB

Often BER diagrams do not have C/N as abscissa (FIG) but E_b/N_0, which is the energy per information bit E_b referred to the normalized noise power N_0 [1]. C/N describes the ratios in the transmission channel, SNR the signals after the $\sqrt{\cos}$ receive filter. The following applies:

$$C/N = SNR + k_{roll\ off}\ [dB]$$

In converting the two quantities, some factors have to be taken into account as shown by equations 1 and 2 on the right.

To determine C/N [dB] or E_b/N_0 [dB], the logarithmic ratios have to be corrected using the following factors:

- Factor for Reed-Solomon FEC*

$$k_{FEC} = 10 \times \lg \frac{188}{204}$$

$$k_{FEC} = -0.3547\ [dB]$$

- Factors for QPSK/QAM modulation

$$k_{QPSK/QAM} = 10 \times \lg(m)$$

Modulation	m	$k_{QPSK/QAM}$ [dB]
QPSK	2	3.0103
16QAM	4	6.0206
64QAM	6	7.7815
256QAM	8	9.0309

- Factor for coding rate (P = 1 for QAM)*

$$k_P = 10 \times \lg(P)$$

Modulation	P	k_P [dB]
QPSK	1/2	–3.0103
	2/3	–1.7609
	3/4	–1.2494
	5/6	–0.7918
	7/8	–0.5799
QAM	1	0

- Factor for $\sqrt{\cos}$ roll-off filtering in demodulator/receiver

$$k_{roll\ off} = 10 \times \lg\left(1 - \frac{\alpha}{4}\right)$$

Modulation	α	$k_{roll\ off}$ [dB]
DVB-C	0.15	–0.1660
DVB-S	0.35	–0.3977

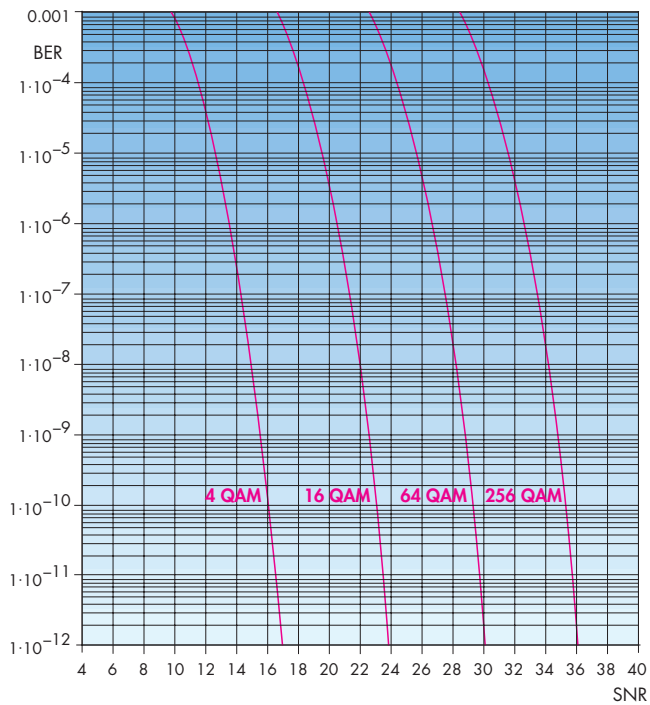
* To be taken into account if E_b only refers to the information bits; not to be taken into account if E_b refers to all bits transmitted (information plus error control bits)

$$C/N = E_b/N_0 + 10 \times \lg\frac{188}{204} + 10 \times \lg(m) + 10 \times \lg(P) - 10 \times \lg\left(1 - \frac{\alpha}{4}\right)[dB]$$

Equation 1

$$E_b/N_0 = C/N - 10 \times \lg\frac{188}{204} - 10 \times \lg(m) - 10 \times \lg(P) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)[dB]$$

Equation 2



BER referred to SNR for 4, 16, 64 and 256QAM

The types of correction factor required depend on whether measurement is made

- in the transmission channel,
- before or after Viterbi correction,
- with QAM or QPSK modulation.

Examples of conversion equations

For **in-channel** measurements with QAM transmission, the following applies:

$$E_b/N_0 = C/N - 10 \times \lg\frac{188}{204} - 10 \times \lg(m)\ [dB]$$

The factors for $\sqrt{\cos}$ roll-off filtering and puncturing rate are not needed.

For measurements in the **QAM demodulator**, $\sqrt{\cos}$ roll-off filtering filtering has to be taken into account.

$$E_b/N_0 = C/N - 10 \times \lg\frac{188}{204} - 10 \times \lg(m) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)\ [dB]$$

For measurements in the **satellite demodulator** with QPSK, the equation for determining the BER as a function of E_b/N_0 after Viterbi FEC is as follows:

$$E_b/N_0 = C/N - 10 \times \lg\frac{188}{204} - 10 \times \lg(m) - 10 \times \lg(P) + 10 \times \lg\left(1 - \frac{\alpha}{4}\right)\ [dB]$$

In the latter case all correction factors are included.

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REFERENCE
[1] ETR 290 Digital Video Broadcasting (DVB); Measurement Guidelines for DVB Systems