COMAPRISON OF THE DVB-S AND DVB-S2 SATELLITE DIGITAL TELEVISION TRANSMISSION

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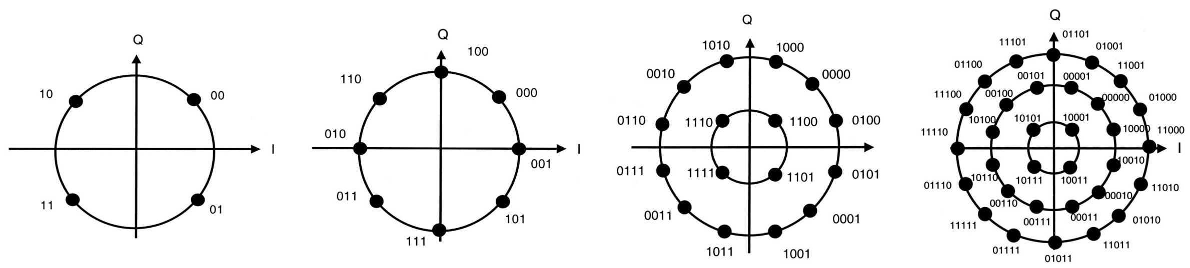
Abstract

The contribution is focused on comparison of the measurements and simulation of the DVB-S (Digital Video Broadcasting - Satellite) and DVB-S2 (Digital Video Broadcasting – Satellite 2nd Generation) digital television transmission. The results of the QPSK (Quadrature Phase Shift Keying) and 8-PSK modulations and their constellation analysis are presented on the case of the various MER (Modulation Error Rate) within the measurements and SNR (Signal-to-Noise Ratio) within the simulation. The results were compared with theoretical values.

The first generation of satellite distribution standard DVB-S standard was defined by ETSI (European Standard Normalization Institute) in 1994 [1]. The second generation of satellite distribution standard DVB-S2 has been defined by in 2005 [2]. First of important differences between generations is the wide variety of input data stream format. The other differences are using more efficient channel coding algorithm and the possibility to use higher modulation technique 8-PSK (Phase Shift Keying) or 16/32APSK (Amplitude Phase Shift Keying) as well as conventional QPSK (Quadrature Phase Shift Keying) as in DVB-S.

1 Modulator in DVB – S/S2 systems

While two of the same size data streams go from convolution coder to the mapper and the mapping is in fact only transposition to Gray's code in DVB-S, the single one from LDPC coder in DVB-S2 system is mapped on two or three-bits symbols (see Fig.1). Digital filtration by filter which reduce ISI (Inter-Symbol Interference) and at once limits modulation signal spectrum follows mapping. Square root raised cosine filter is used on this. Its roll-off factor is fixed $\beta = 0.35$ in DVB-S system, while in DVB–S2 system can the factor β takes the values 0.20, 0.25 or 0.35. Then the signal is modulated by appropriate digital modulation mentioned up above, mixed-up to defined microwave carrier and send to the antenna after power amplification. This way is signal emitted in up-link channel of 11GHz to 19 GHz band to satellite.



a) b) c) d)

Figure 1: Constellation diagrams of digital modulations a) QPSK, b) 8PSK, c) 16APSK, d) 32APSK.

2 Simulation and measurement of channels parameters influence on signal bit error rate after demodulation

For channel noise dependence on achieved signal error rate simulation were applied simplified models in Simulink (see Fig. 2 and Fig. 3). According to the fact that it is direct radio visibility and also it is not so important a form of distortion, but the value of *SNR*, the transmition channel was approximated by AWGN (Additive White Gaussian Channel) channel. MPSK modulators elements from Communication blocks / Digital baseband modulations library where opened in first model, while this library doesn't consist of 16 and 32 APSK modulators. That is why in second model these elements were programmed by standardized parameters. Also demodulators where made with hard decision making.

ETSI standard for DVB-S2 defines energy rates of symbols lying on two (for 16APSK) or three (for 32APSK) power layers. These are marked γ or γ_1 and γ_2 and their values depend on used LDPC (Low Density Parity Check) code rate. For this simulation, it was connected only modulator and none encoder. Values of γ_1 and γ_2 were chosen for lowest code rate (CR = 9/10).

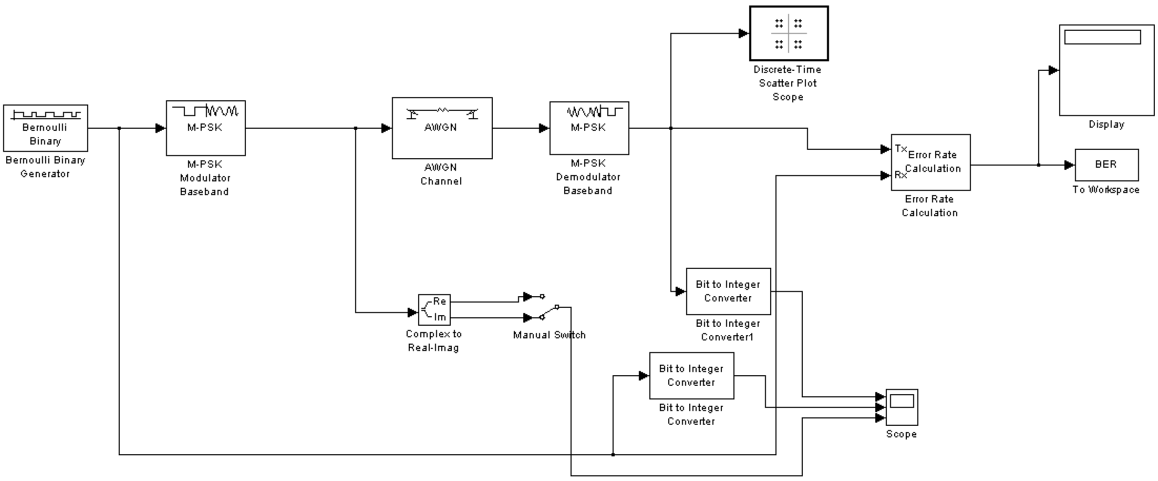


Figure 2: Model used for finding out dependence of *BER* (Bit Error Rate) on *SNR* (Signal-to-Noise Ratio) and constellation analysis assignment for QPSK and 8PSK.

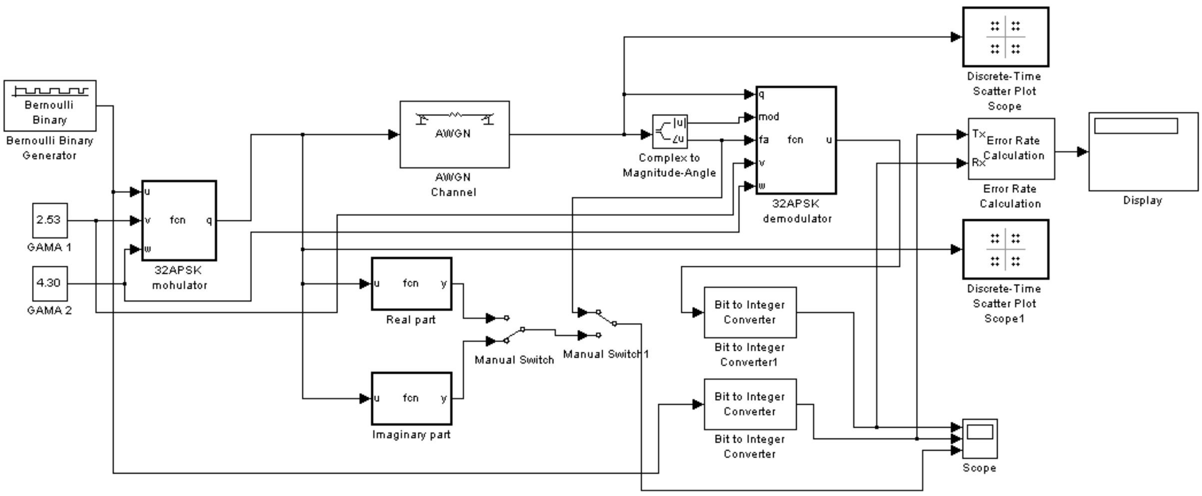


Figure 3: Model used for finding out dependence of *BER* (Bit Error Rate) on *SNR* (Signal-to-Noise Ratio) and constellation analysis assignment for 16APSK and 32APSK.

The simulation outputs are not only data without errors in demodulated signal for input parameters, but also constellation diagrams. It encourages comparison of simulation diagrams with measured diagrams (see Fig. 4).

Beside the constellation analysis, bit error rate of modulations used in satellite broadcasting in mentioned standards (QPSK and 8PSK), that depend on MER (modulation error ratio), were also measured. Measured values of typical waterfall curves were compared with theoretic values. These dependences were found by cyclical run of models in Simulink from m-file, where transmission channel parameters have been changed, for all of modulations.

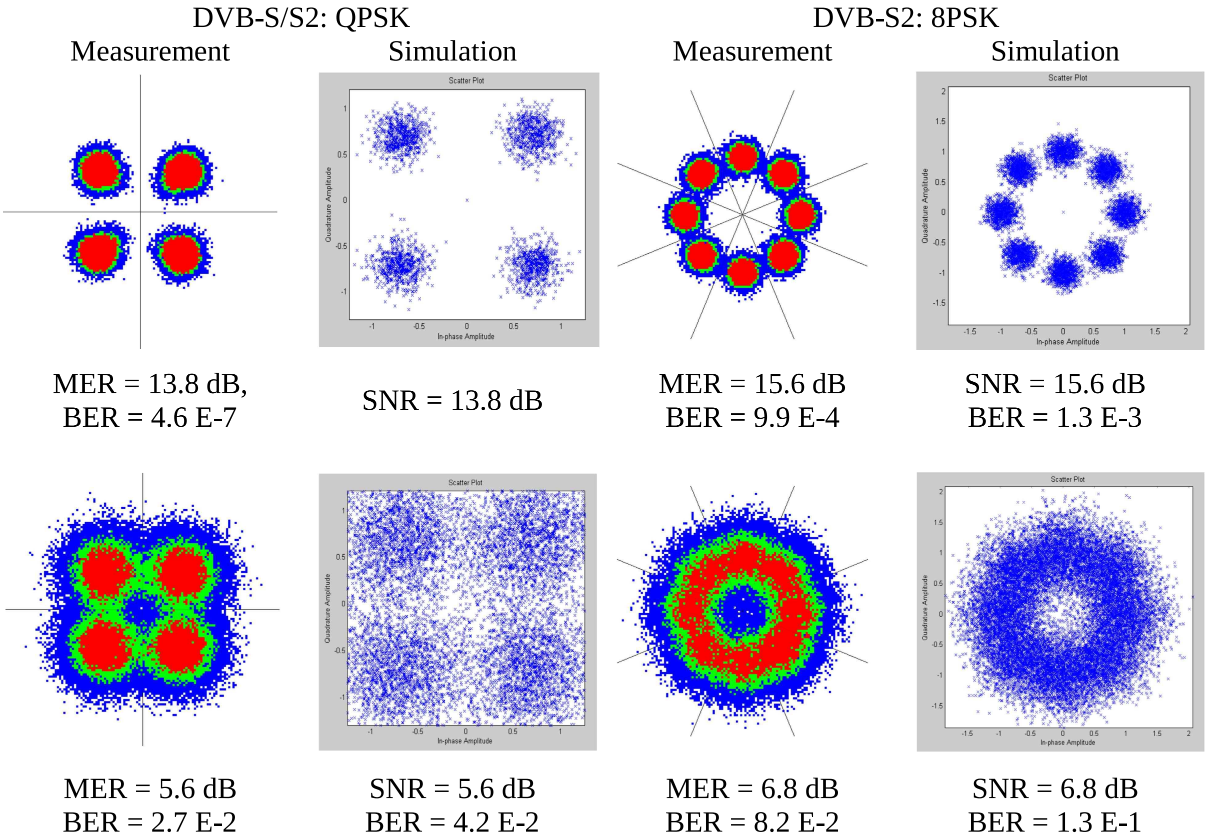


Figure 4: Constellation diagrams of modulations used for broadcasting in DVB-S/S2 systems with two values of *MER* / *SNR* measured and simulated in Matlab.

The theoretical values of dependence have been created by rules [3]. Rule which was applied for MPSK modulation and its symbol error probability is in equation (1):

$$P_S = 2Q\left(\sqrt{\frac{2E}{N_0}}\sin\frac{\pi}{M}\right), \qquad (1)$$

where E is energy of one symbol, N_0 is then AWGN noise energy per one Hz bandwidth.

Then the same for QPSK modulation is in equation (2):

$$P_S = \frac{2Q\left(\sqrt{\frac{2E}{N_0}}\sin\frac{\pi}{4}\right)}{\log_2 4} = Q\left(\sqrt{\frac{E}{N_0}}\right) = Q\left(\sqrt{10^{\frac{S}{N}[dB]/10}}\right). \qquad (2)$$

Then the same for 8PSK modulation is in equation (3):

$$P_S = \frac{2Q\left(\sqrt{\frac{2E}{N_0}}\sin\frac{\pi}{8}\right)}{\log_2 8} = \frac{2Q\left(\sqrt{\frac{2E}{N_0}}0.38268\right)}{3} = \frac{2}{3}Q\left(\sqrt{2.10^{\frac{S}{N}[dB]/10}}0.38268\right) \qquad (3)$$

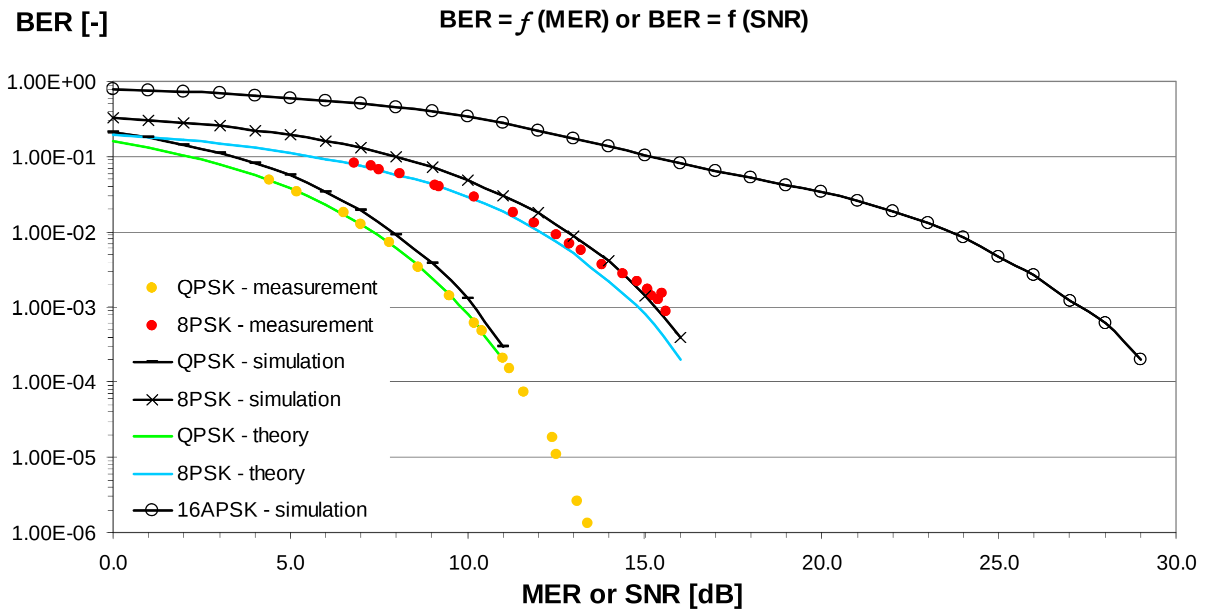


Figure 5: Characteristics of the *BER* (Bit Error Rate) in dependence on *MER* (Modulation Error Rate) in case of the measurements or *SNR* (Signal-to-Noise Ratio) in case of the simulation in Matlab.

3 Conclusion

The measurements and simulations confirmed the theoretical assumptions, that the same channel (*MER* = 14 dB) generates significantly higher channel bit error rate in DVB-S (equal to $3.7.10^{-3}$) than in DVB-S2 (equal to $2.38.10^{-7}$). The reason is in the fact that the higher modulation was used. However, this is reduced by more efficient forward error coding to QEF (quasi error free) value (*BER* < 3.1E-10) which is the same like in the first generation of satellite standard. The second generation satellite television standard implicates an increase of data rate in the same channel and same ground segment with fine factor *G*/*T* up about 30%.

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References

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