UTILIZATION OF MATLAB FOR THE DIGITAL MODULATION METHODS SIMULATION IN DVB AREA

Tomáš Kratochvíl, David Kříž

Institute of Radio Electronics, Brno University of Technology
Faculty of Electrical Engineering and Communication

Abstract: *The contribution deals with the utilization of Matlab for simulation and analysis of digital QPSK and M-QAM modulators and demodulators used in DVB (Digital Video Broadcasting) standard. Presented modulators and demodulators are optional modules of simulation system that can evaluate the influence of transmission errors on transmitted digital signal and according visual information. The system is used for PQ (Picture Quality) and BER (bit-error rate) value evaluation during the DVB transmission in RF band. The modulator and demodulator flowcharts are presented including the simulation example. The conclusion outlines the utilization of the modulator and demodulator and approach to transmission channel model in RF band modeling.*

Keywords: *digital modulation, IQ modulator, IQ demodulator, QPSK, M-QAM*

1 Introduction

There are several transmission systems for the distribution of broadcast signals in DVB (Digital Video Broadcasting) standard area [1]. These include satellite systems (DVB-S), cable networks (DVB-C) and terrestrial channels (DVB-T), which are generally organized as frequency multiplex systems. For the transmission of digital data the available frequency ranges are divided into system-specific channel spacings, which require an adaptation of the baseband signals to the particular channel condition. This takes place by the modulator of a carrier signal in transmitter and the according demodulator in receiver provides the data recovery. This paper presents optional modules of QPSK and M-QAM modulators and demodulators used in developed transmission simulation system that covers also the simulation in RF band.

The grant project[1] "*Simulation and analysis of the digital signal transmission and transmission distortions in DTV and DVB area*" aims are simulation and analysis of the digital signal transmission that corresponds to DVB standards. The transmitted digital signal presents the image data information that is source, channel and link coded, digital modulated and transferred by the digital transmission channel model (in baseband or RF band) with variable parameters.

2 Experimental simulation model of IQ modulator/demodulator

The IQ modulator has I (in-phase) path and Q (quadrature phase) path (see Fig.1) [2]. The I path incorporates a mixer which is driven with 0^{o} carrier phase, the mixer in the Q path is driven with 90^{o} carrier phase and the I and Q are orthogonal to each other. From incoming data stream *data1*(t) the mapper generates two modulation signals $i(t)$ and $q(t)$. The *I* and *Q* modulation products are combined in an adder, so the product *iqmod1*(t) is the sum of the output signals of the mixers (sum of the sine and cosine signals of the same carrier frequency and different only in amplitude and phase). Therefore with the aid of control signals $i(t)$ and $q(t)$ the amplitude and phase of *iqmod1*(t) can vary.

[1] Grant project of the Grant Agency of the Academy of Sciences of the Czech Republic, no. B2813302.

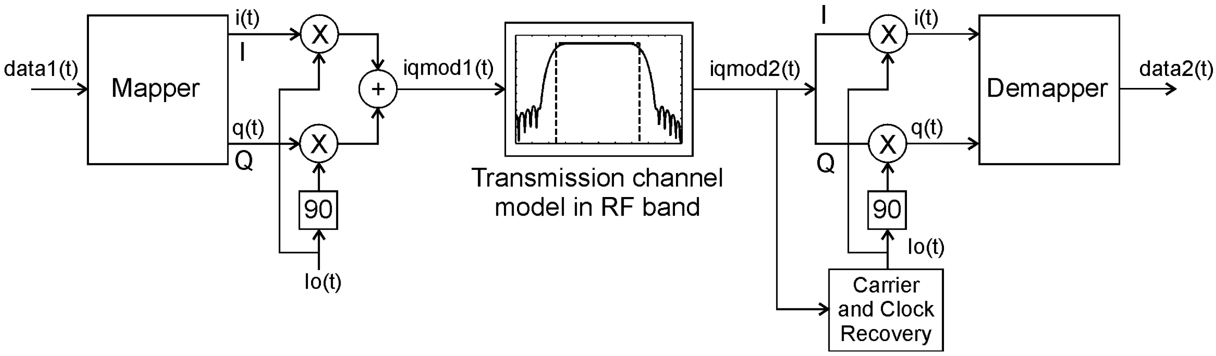

Fig. 1 Simulation model of IQ modulator/demodulator.

The digitally modulated signal *iqmod2*(*t*) is from the transmission channel model in RF band fed to the I mixer, which is driven with 0^{o} carrier phase, and to the Q mixer with the 90^{o} carrier phase. At the same time the carrier and the symbol clock are recovered in a signal processing block. In case of the simulation the task of the carrier phase uncertainty is not important, the feedback to the modulator is ensured. By mixing the baseband *i*(*t*) and *q*(*t*) signals are retrieved. The carrier harmonics superposed on these signals have to be eliminated by low-pass filtering before the demapping.

The task of the transmission channel model is the pertubation of the modulated digital data (random errors, additional noise with variable amplitude, the bandwidth limitation etc.). After the transmission the input *data1*(*t*) and output *data2*(*t*) are compared and the transmission channel model influence on the *BER* can be evaluated [3].

3 Flowcharts of developed modulator and demodulator

IQ modulator and demodulator (QPSK, 16/64/256-QAM) are implemented in Matlab and provides the NRZ data modulation and demodulation (see Fig. 2) [4].

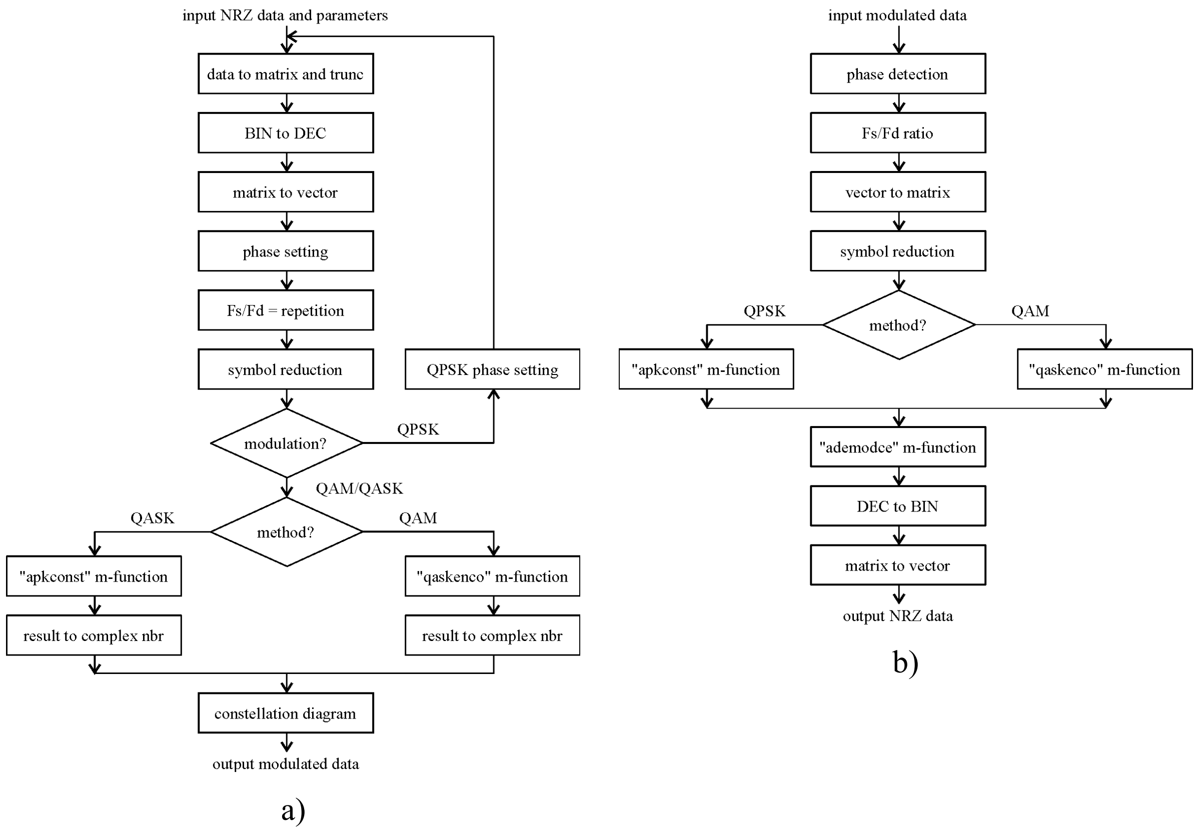

Fig. 2 Flowchart of implemented a) IQ modulator, b) IQ demodulator in Matlab.

4 Simulation example of QPSK and M-QAM constellation diagrams

The example in Fig. 3 presents the ideal case of QPSK and M-QAM constellation diagrams and then in Fig. 4 the influence of additional noise on constellation is present.

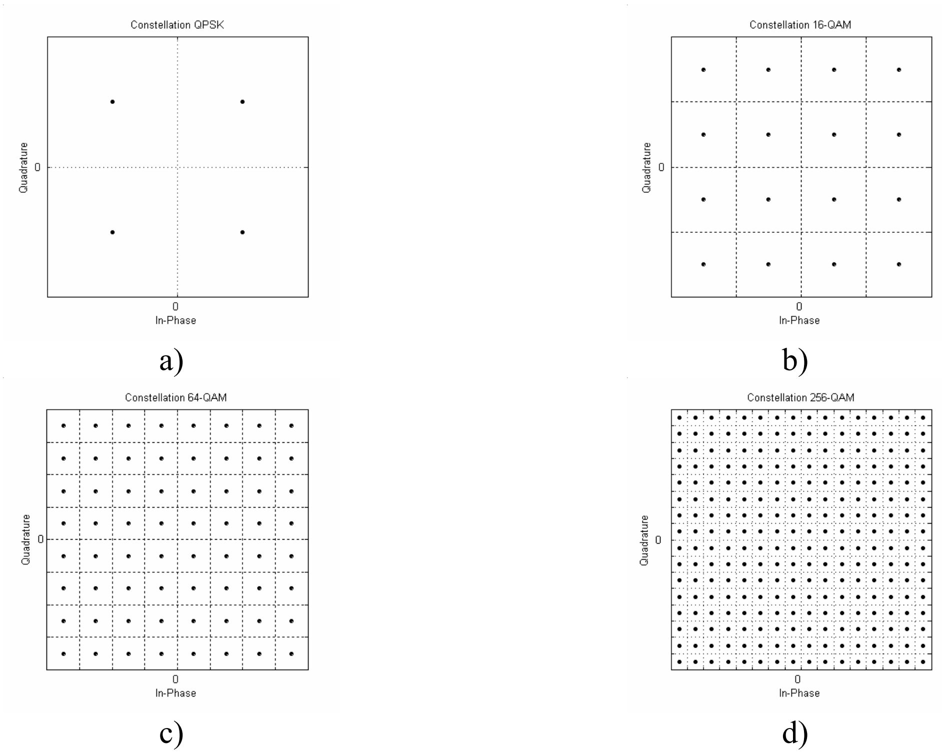

Fig. 3 Examples of created constellation diagrams a) QPSK, b) 16-QAM, c) 64-QAM, d) 256-QAM (ideal case with no pertubation, decision levels are displayed ---).

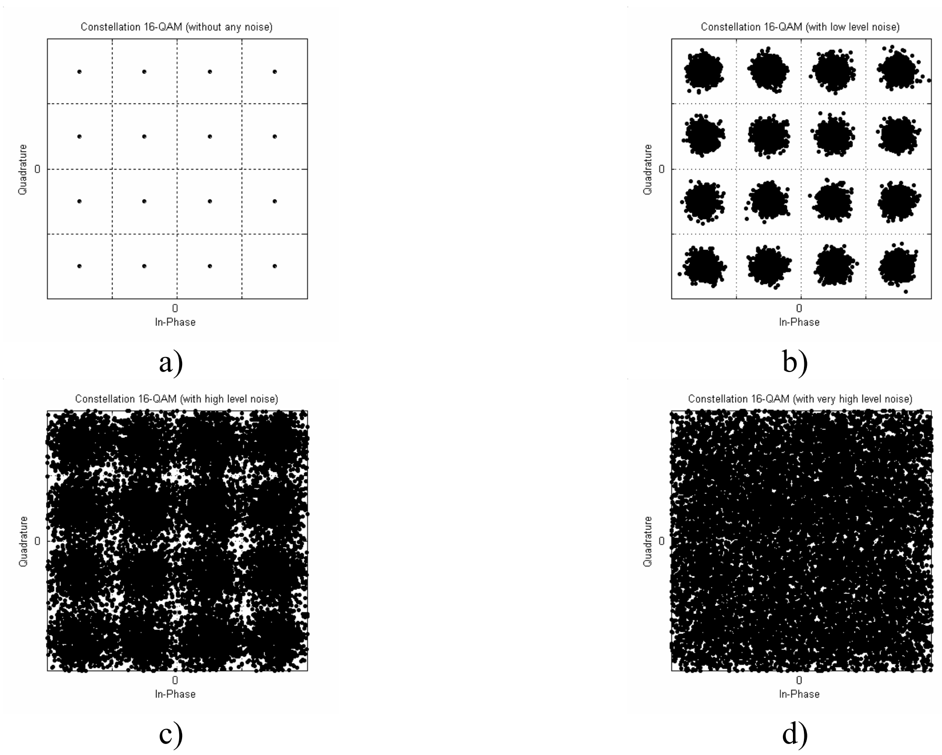

Fig. 4 Influence of the AWGN noise with the % amplitude of transmitted data on 16-QAM constellation a) without any noise, b) 30% noise – $BER = 0$, c) 50% noise – $BER = 1{,}2.10^{-4}$, d) 80% noise – $BER = 4{,}4.10^{-3}$.

5 Conclusion

Presented modulator and demodulator are optional modules of the simulation system that can evaluate the influence of transmission errors on transmitted modulated digital signal and according visual information (according to DVB standard) [5]. The system can setup transmission parameters and model of the transmission channel is included (covers the transmission characteristic model, random errors, additional noise pertubation, reflected signal influence on data etc.) The approach to modeling of the RF transmission channel model appears from the digital filter design (example of the transmission characteristic is in Fig.4). The model is still developed.

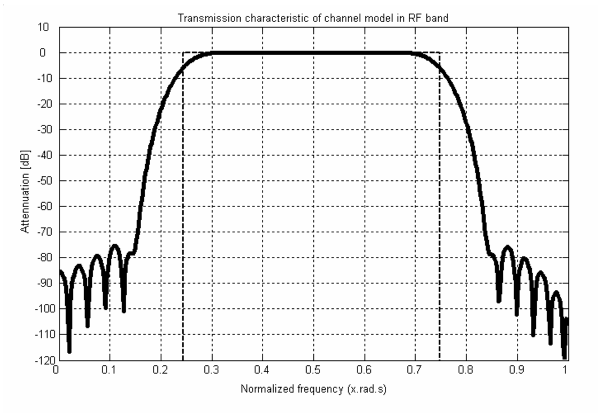

Fig. 4 Transmission channel model in RF band (example of transmission characteristic modeling, band pass digital filter FIR with linear phase, tolerant field ---).

Acknowledgement

The contribution is supported by the grant project of Grant Agency of the Academy of Sciences of the Czech Republic no. B2813302, "*Simulation and analysis of the digital signal transmission and transmission distortions in DTV and DVB area*" and Research programme of Brno University of Technology, Research of electronic communication systems and technologies CEZ MSM 262200011.

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Contact

Tomáš Kratochvíl (assistant professor), David Kříž (magister student)
Institute of Radio Electronics
Faculty of Electrical Engineering and Communication,
Brno University of Technology
Purkyňova 118, 612 00 Brno
Tel: +420 541 149 113, Fax: +420 541 149 244
Email: kratot@feec.vutbr.cz