The purpose of this laboratory task is DVB-S signal parameters measurement, which is received from ASTRA 3A satellite broadcasting, by DVB analyzer Kathrein MSK-33. During measurement you form the idea about received power, signal level, C/N ratio, BER before and after forward error correction (FEC) and about program offer of CS Link provider. You can also try to receive HDTV signal over DVB-S2 broadcasting.

Theoretical background

Satellite receiver consists of inner and outer units. Outer part is includes antenna (offset parabola), which could be equipped with positioner (pom), used for direction choice and Low Noise Block (LNB), referred to as Low Noise Converter (LNC). LNB includes polarization discriminator for polarization choice of electromagnetic wave. The received signal is also amplifed and mixed down from frequencies of tenth GHz to first satellite intermediate frequency interval (0.95 ÷ 2.15) GHz. Signal from LNB comes after coaxial cable to the satellite receiver (inner unit).

DVB-S satellite transmission is characterized by low transmitted power, high bandwidth and marginal multipath propagation. One standard satellite channel can transmit data rate, appropriate to 10 television programs, if main profile/main level of MPEG-2 compress algorithm is used. DVB-S system uses two levels of FEC, except FEC1 (RS code) uses system inner FEC2 realized as convolution code with variable code rate 1/2, 2/3, 3/4, 5/6 or 7/8. This variability can adjust data to the particular satellite transponder and to required type of receive segment. Bit Error Rate (BER) is on receive side is affected by channel parameters. Quadrature Phase Shift Keying (QPSK) with Gray coding is used as a modulation scheme. The satellite transponder, which has one channel bandwidth \( B = 33 \) MHz, can transmit data rate up to 39 Mbit/s, in case of FEC2 code rate 3/4.

CS Link packet is program distribution platform direct to home (DTH), which is broadcasted via Astra 3A satellite. The multiplex consists of majority of Czech nationwide programs, except the others, which has been created for digital distribution purposes. Satellite signal of most TV station is encrypted, opposed to terrestrial broadcasting DVB-T. The encryption is necessary because of restrictions of broadcasting rights on films or sport events, which is located just for Czech Republic territory. The reception of broadcasting from Astra 3A satellite is possible from large place in middle and western Europe.

The satellite parameters, frequency plan, radiation pattern, program structure and technical parameters of CS Link broadcasting is given in Tab. 5.1.
Tab. 5.1: Technical parameters of CS Link packet and Astra 3A satellite  

| Programs in CS Link packet | TV programs - ČT1, ČT2, ČT24, ČT4 Sport, TV Prima, TV Nova, CSFilm, TV Noe, Galaxie Sport a další  
Radio programs - ČRo1-Radiožurnál, ČRo2-Praha, ČRo3-Vltava, ČRo6, ČRo-Region, Čro7-Rádio Praha, D-Dur a další |
|----------------------------|---------------------------------------------------------------------------------------------------------------|
| FEC and broadcasting parameters | Video compression - MPEG-2 MP@ML  
Audio compression - MPEG-1 Layer II  
Frequency of transponder – 12,525 GHz  
Polarization - V / high  
Symbol rate – 27,5 MS/s  
FEC - 3/4  
TID – 3014 (transport stream identifier)  
NID – 3 (network identifier CS Link) |
| Satellite ASTRA 3A parameters | Name of the satellite – ASTRA 3A  
Satellite weight at start - 1500 kg  
Satellite producer - Boeing Satellite Systems Inc.  
Three axes stabilization  
Satellite position – 23.5 degrees east longitude  
Service life - 10 let  
Power consumption - 1550 W  
The number of active transponders - 24 x  
Transponders in bandwidth 11,45 to 11,7 GHz – 12 x  
Transponders in bandwidth 12,5 to 12,75 GHz – 12 x  
Output power TWTA - 30 W  
EIRP in the middle of radiated area - 52 dBW  
Transponder bandwidth - 36 MHz |
| Radiation diagram | Frequency plan |

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3D stereoscopic television transmission by transport stream MPEG-2-TS is described in European standard [7]. It defines where 3D content flags, information about minimal and maximal disparity (video depth range descriptor) are placed in transport stream. It also mentions procedure of switch between 2D-HD and 3D content broadcasting.

The standard defines two forms of stereoscopic broadcasting service. There are “Occasional 3DTV service” and “24/7, Time exclusive and predominant 3DTV service”. It could be generally specified that information about 3D video is included in PES video packets as SEI (H.264/AVC Supplement Enhancement Information). The presence of this information is indicated by Frame_Packing_SEI_not_present_flag in Program Map Table (PMT) [7], [8].

Information about 3D broadcasting is included also in Service Description Table (SDT) and Event Information Table (EIT). SDT table contains two relevant descriptors: Service type (Service descriptor) and Component type (Component descriptor). Service type takes the values 0x1C, 0x1D or 0x1E, in case of regular 3D broadcasting or 0x19, 0x1A, or 0x1B in case of occasional 3D broadcasting, same as in case of classical 2D-HD one. Component type holds information about type of used spatial compression. The value is 0x80 (Side-by-side) or 0x81 (Top-and-bottom).

**Measurements task and procedure**

1. Familiarize yourself with the digital satellite receiver STB and satellite signal analyzer SAT. STB is connected to the HDMI-1 input of television receiver TVP. Manuals of both devices are included.

2. Tune the STB receiver to CS Link signal reception (12525 MHz, vertical polarization, symbol rate 27500 Ms/s, FEC 3/4). Check, receiver had found all the programs, which are in Tab. 1. Note potential differences in program list. Save found television and radio programs to the preselection memory of STB.


3. In satellite receiver STB menu display the bar graphs of received signal level and signal quality (bars are in percentages). Find experimentally the influence of insertion loss ATT on both indicators and measure calibration curve of them.

4. Use SAT analyzer to received signal level measure in [dBµV] without insert loss ATT (0 dB). Find experimentally the influence of insert loss ATT on received signal level. If the decrease of the level in [dBµV] has not linear dependency on insert loss in [dB], you will measure the calibration curve of ATT.

   **Procedure:** Press the button SAT - < > sat frq 1925 MHz – switch to measurement digit. DVBS – SAT MEASURE – ch BW 36 MHz – measure – min/max.

5. Display the content of the transport stream MPEG-2 TS of CS link packet on the SAT analyzer. Switch the receiver to choice program and find experimentally the influence of insertion loss on the video subjective quality. Note the loss value, when the reception starts to be impossible.

6. Simultaneously, when you increase the insertion loss, measure both BERs, BER before FEC and BER after Viterbi and modulation error MER (SNR) on SAT analyzer. Measured dependency of both BERs and MER on insertion loss plot to the joint graph. 

Procedure: Press the button **Mode – CONST. – ch BW 36 MHz.** 

7. Use SAT analyzer to display the spectrum of received signal without insertion loss ATT (0 dB). Find experimentally the influence of insertion loss and antenna deviation on received signal level and C/N. 

Procedure: Press the button **Mode – SPECTR. – span small – marker dig. - max on - ∧ ∨ change the spectrum level reference (display the scale on the screen - min 70 – 30 dBµV, max 130 – 90 dBµV) – cursors control < >.** 

8. Repeat the measurements for choice DVB-S2 channel with 8PSK modulation. Frequency tables with DVB-S2 channels outline are attached. (downloaded from [www.parabola.cz](http://www.parabola.cz)). 

9. **Voluntary task:** Try to tune 3D satellite television broadcasting of ASTRA-3D channel from Astra 1 satellite, which is located at the orbital position 19.2 degrees east. The frequency is 11612 GHz, horizontal polarization, SR 22000, FEC 5/6. Or you can try alternatively BRAVA 3D. Frequency is 10,803 GHz, horizontal polarization, SR 22000, FEC 3/4, DVB-S2/ 8PSK. After you save the preset to the STB memory, the image appears in side-by-side format. You have to switch TVP to the 3D mode by press the 3D button on remote controller and find mentioned spatial compress. To see the 3D perception use circular polarization glasses. 

10. **Voluntary task:** Tune the channel with multiplex that contains 3D program from previous task also on SAT measurement receiver. Transport stream is leaded by TS-ASI interface to the transport stream analyzer DVM 400. Analyze the transport stream and find the information about 3D broadcasting parameters. (see theoretical introduction) Focus on information in PMT (Fig. 5.1), SDT and EIT tables.
Fig. 5.1: PMT table content, (flag Frame_Packing_SEI_not_present_flag).

**Used laboratory facilities**

- **STB** digital television receiver DVB-S/S2 Topfield TF7710HD + RC, CS Link encrypt cart
- **TVP** television receiver LG + remote controller
- **ATT** programmable attenuator Tesla BM577 + 2 x DC component filter
- **SAT** DVB-S satellite broadcasting analyzer Kathrein MSK-33 or alternatives
- **ANT** parabolic offset antenna 90 cm with positioner + LNB (UREL roof)
- Connection cable 3 x BNC-BNC, 2 x F–F, 2 x T reduction BNC, 1 x T reduction F Cable SCART-SCART and HDMI

**Conclusion**

Each student gives here individual measurement evaluation and confirms it by his signature. You have to comment each measurement step in detail, all of outcomes and measured characteristic. Individual conclusion should also contain major technical knowledge from measurement.
Used and recommended literature