



## Utilization of LabVIEW for Measurement of Selected Parameters of VHF Transceivers

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### **Abstract:**

*The article deals with the problems of the measurement of VHF transceivers with frequency hopping. A variant of the measuring workplace which was proposed on the basis of LabVIEW program is described. The emphasis is laid on a connecting through the virtual measuring blocks with the real instruments and also on the presentation of the measured results.*

### **Keywords:**

*Measurement of Transceivers, LabVIEW, Frequency Hopping, Spread Spectrum*

### **1. Introduction**

Modern VHF transceivers provide the connection either to one carrier frequency (single channel) or to  $N$  gradually switched carrying frequencies (frequency hopping – FH). The second way is technically more difficult but more advantageous from a military point of view for two main reasons. First, the switching occurs relatively quickly. Second, the sequence of the used carrying frequencies is pseudorandom and unknown to a foreign participant in advance; therefore it is difficult to receive by his or her receiver.

The article describes the possibilities of measuring the parameters of transceivers that operate with the slow frequency hopping (SFH). This work is focused on the acquiring of knowledge about the initial phase of their connection – in concrete terms synchronization which must take place between (mutually remote) transmitters and receivers and which is used to “coordinate” their pseudorandom sequences generators. Although these problems are generally described in the literature, for example in [1],

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the producers do not publish the specific technical solution for obvious reasons. In an effort to better understand these problems and to use knowledge gained in the Communication and Information Systems (CIS), we focused mainly on the following issues:

- How long does the synchronization process last?
- How much do the transmitter and the receiver participate in it?
- How many  $n$  channels from the total number of  $N$  channels are used in this process?
- Is this number of the channels  $n$  constant or dependent on  $N$ ?
- How long does the transmitter stay on one carrying frequency (the hop length) during synchronization?

To answer these questions, we had to select the appropriate type of transceiver and propose the corresponding measuring system.

The selection of a specific type of a transceiver was mainly influenced by the availability of this technology in our workplace. We have chosen the portable transceiver of a type TRC 9100-3 [2] with a frequency range of 30-87.975 MHz and with the possibility of setting up to 2320 channels in 25 kHz steps. In the FH mode it is possible to adjust the frequency band and the step of frequency hopping, which enables to select the number of used frequencies  $N$ .

The described problems are a part of a research project FVT0000403 that has been worked on at our department.

## 2. The Design of the Workplace

The measuring workplace was designed according to Fig.1. Our analysis is based on the assumption that the synchronization works in two phases. In the first phase, the subordinate transceiver sends a request for synchronization as a sequence  $n \in N$  of carrying frequencies modulated by FSK. The pilot transceiver catches the signal and, after a certain delay, the synchronization signal is sent (again by frequency hopping). According to the used algorithm, the subordinate transceiver consequently searches for the right moment to run its pseudorandom sequences generator. It is a moment when the party is ready to launch. For this reason, the workplace must contain not only two transceivers, but also the transmission channel formed by a pair of attenuators JFW of a type 50DR-063 and a combiner JFW of a type 50PD-135.

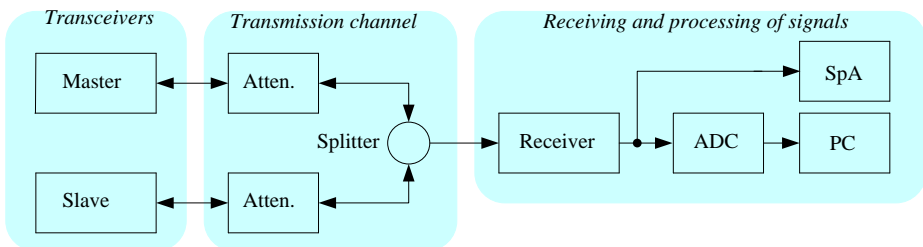


Fig.1 Block diagram of a workplace

The choice of radio receiver was a key question. Taking into consideration the character of this type of the connection, it is not possible to use a usual (narrowband) receiver. That is why the broadband receiver with a frequency detector was used, specifically UKZ-M [3] with an adjustable frequency band from 100 to 200 MHz. This

band is out of the range of the band of the transceiver TRC 9100, but if we use the IF input ( $f_{if} = 30$  MHz with a bandwidth of 8 MHz), we are under certain circumstances (by setting the band for frequency hopping from 30 to 34 MHz) able to capture and demodulate its signal. Even though it presents only a certain part of the frequency range of the transceiver, we can still observe and measure all the necessary parameters of the synchronization signal because of the sufficient number of adjustable channels in this range (up to  $N = 80$ ).

The signal from the demodulator output is processed either in the digital or analog mode. The 16-bit A/D converter of the type NI PCI 6221 [4] was used for the digital processing. The converter is controlled by a personal computer and has the maximal sampling rate  $f_{s \max} = 250$  kHz.

The obtained samples are used to measure all the required time parameters and they can also be used to calculate the frequency spectrum. In analog processing, for example a spectral analyzer Rohde & Schwarz type FSE [5] can be used.

### 3. Measuring Methods Used

All the required quantities were possible to gain from the time course of the signal at the output of frequency detector. The scanning of the time course was taken by the A/D converter and the obtained samples were saved in the computer memory for further numeric processing.

The function of A/D converter was software-controlled through a personal computer. The program LabVIEW version 8.5 [6], which provides the necessary control functions and also offers its computing and graphics capabilities, was selected for that purpose. By the means of graphic possibilities of the program, two simulation models shown in Fig. 2 have been designed. The model for A/D converter controlling is shown in the left part of the picture. Its basic block is the “DAQ Assistant”, which is used to set all the parameters of the converter. The next two blocks are used to display the time course and to save the obtained samples to a file.

There is a model for digital processing of the received signal in the right part of the picture. The block “Read from Measurement File” provides the reading of the samples from the file; the other blocks are used to filter, form and display the signal according to requirements using the time course.

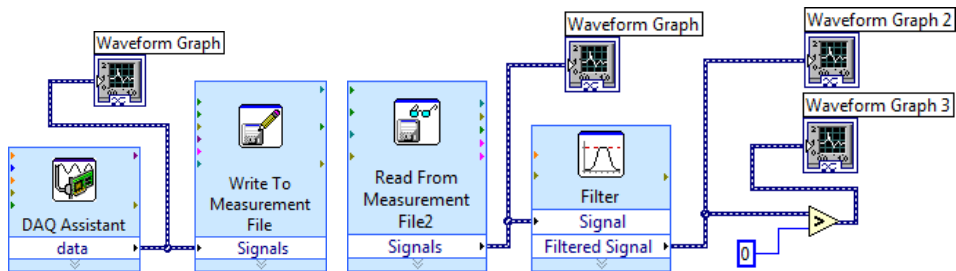
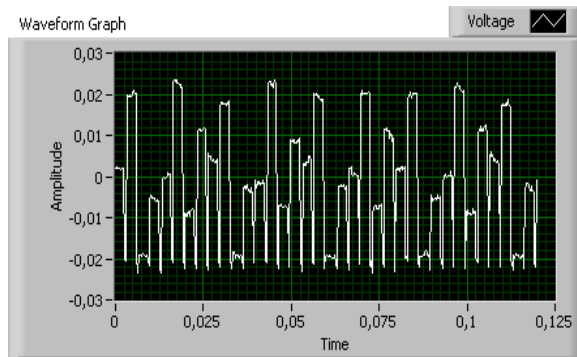


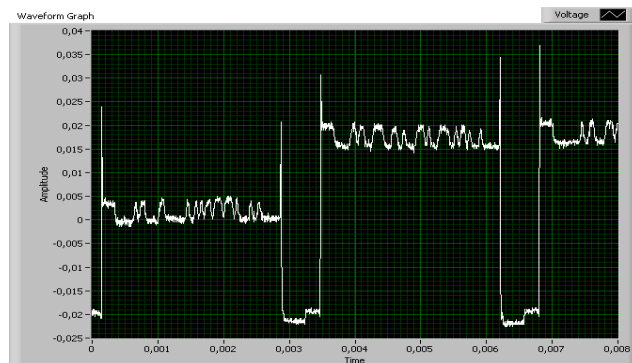
Fig.2 Models for A/D converter controlling and for the processing of obtained samples.



synchronization, what type of keying is used here and how the transmission rate is set. There is an example of one measurement of these parameters in the Fig. 5.



*Fig. 4 Measurement of  $n$  channels used in the application of synchronization  
Set  $f_s = 4$  kHz,  $N = 20$  channels,  $\Delta f = 200$  kHz, band 30.2-34 MHz*



*Fig. 5 Measurement of the length of a “hop” during synchronization  
Set  $f_s = 250$  kHz, recorded in 2000 samples.*

Using the samples saved in a file, it is possible to determine the length of a hop to 2.75 ms and the length of the delay between two hops 0.375 ms. In the figure we can see that the signal transmitted during one hop is frequency-keyed (FSK). By his consequent shaping (in the system according to the Fig. 3), we can determine the transmission rate to  $v_p = 17$  kb/s.

## 5. Conclusion

The results have confirmed that the LabVIEW environment is suitable for the described kind of measurement. Using the LabVIEW the control of A/D converter NI PCI-6221 is simple and accurate. The possibility to record the samples to a file provides the possibility of consequent digital processing by other virtual blocks to the user. The procedure of measurement is also very clear in the LabVIEW. The obtained results can be used, apart from other things, to teach the students with the specialization of CIS.

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