

## SELF TESTING OF RADIOMONITORING SYSTEM

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*Abstract: System complexity and long time of monitoring of signals in radiomonitoring systems increases fault appearance probability which may have influence on the measurement results. Hence the necessity of built-in self testing algorithms to increase monitoring credibility of radio and TV transmitters. In the paper a testing method based on level measurements of known electromagnetic signals sent near the receiver antenna is presented.*

*Keywords: measuring systems, radiocommunication*

### 1 INTRODUCTION

Monitoring of radio signals in a wide frequency range for checking channels occupation, signal and transmitters' parameters is very important practical problem for government institutions. In 90's fully automatic measurement and control system was designed and implemented in one of the Polish national agencies. The system's hardware consists of a set of antennas and receivers and enables measurement of radiocommunication signals with various types of modulation and polarisation in the 10kHz-18GHz frequency range. A custom designed system's software performs various measurement algorithms (e.g. for various receiver frequencies, various times of measurement or different set-up parameters), measured data collection and visualisation. A hardware part of the system and basic measurement algorithms were presented in [1], [2], a data management software - in [3], [4]. System complexity and long time of monitoring increases fault appearance probability which may have influence on the measurement results. Hence the necessity of built-in self testing algorithms to increase monitoring credibility of radio and TV transmitters.

### 2 DESCRIPTION OF THE SELF-TESTING METHOD

Testing method is based on level measurements of known electromagnetic signals sent near the receiver antenna. Signals are formed in the remote controlled generator HP8646B which is connected to the transmitter antenna. Testing signals are generated and measured during each measurement session. It is important to choose a several test frequencies in each waveband where there are no signals from broadcasting stations, cellular networks, etc. The power of the testing signals is about 20mW and is constant during all measurement time. The carrier frequency of each testing signal is frequency modulated by the audio frequency 1 kHz. The level measurement procedure for testing signals is the same as for broadcasting stations signals.

Test signals results are collected in a database together with broadcasting signals results. For each test signal frequency, a difference between actual measured level of test signal and a standard value of the test level, that is calculated using earlier acquired test signals, was taken as an estimation of radiomonitoring system stability.

There are some problems associated with realisation of this method:

- choice of appropriate number of test signals (too small number - does not assure the accurate checking of the system, too big - extends testing time),
- selection of appropriate frequency values for test signals, which have to be placed in „silent“ areas of monitored band (to minimize influence of other signals upon measurement of test signal levels),
- choice of appropriate methods for determination the standard value of test level, that is calculated using earlier acquired archive test signals levels from the database.

After monitoring all signals in the range 60MHz - 1000MHz and identification all radio and TV carrier frequencies, test signals frequencies were chosen near carrier frequencies of monitored transmitters. The signal from one of TV transmitters and appropriate chosen test frequency is presented in Fig.1. For determination the standard values of test levels a statistic method was applied. For each test frequency, a maximum of histogram of earlier acquired archive test signals levels is calculated.

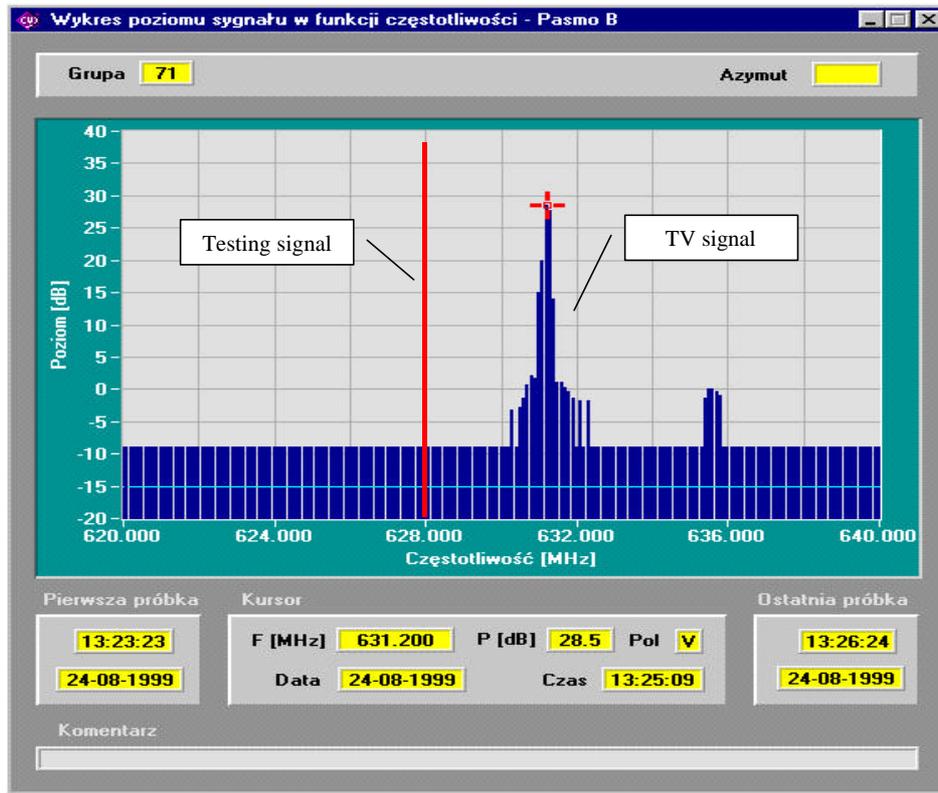


Figure 1. The signal from one of TV transmitters and appropriate chosen test frequency.

### 3 SYSTEM ORGANISATION

The system consists of: PC-type Pentium-based computer, radiocommunication receiver, directional receiver antenna, polarisation control unit, direction control unit, programmable attenuator, generator and transmitter antenna. A block diagram of the system configuration is shown in Fig. 2. A hardware part of the system is based on radiocommunication receiver Anritsu. The whole system is computer controlled to make possible radiocommunication instruments programming and data acquisition, as well as timing of measurements and data storage.

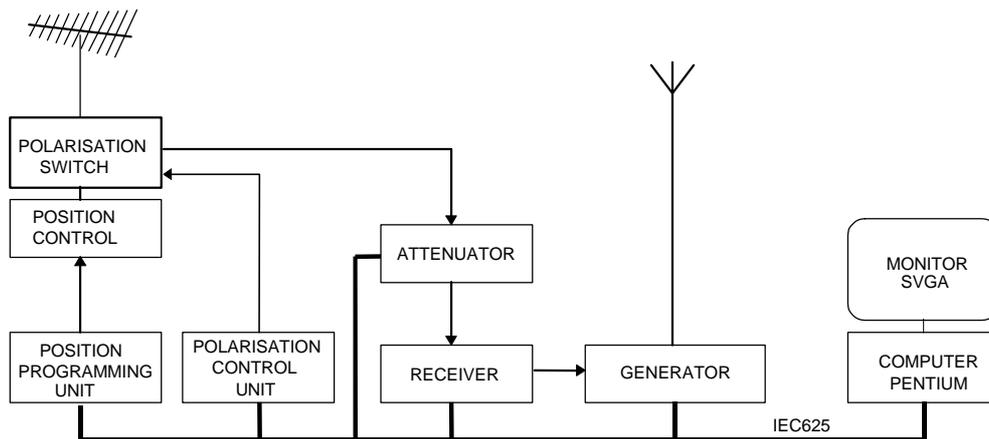


Figure 2. Block diagram of the system configuration.

### 4 SYSTEM SOFTWARE

The software is written in C language with National Instruments LabWindows programming environment. The system was designed for use by operators inexperienced in programming, and a lot of care has been taken to create easy-to-use self-explaining graphical user interface.

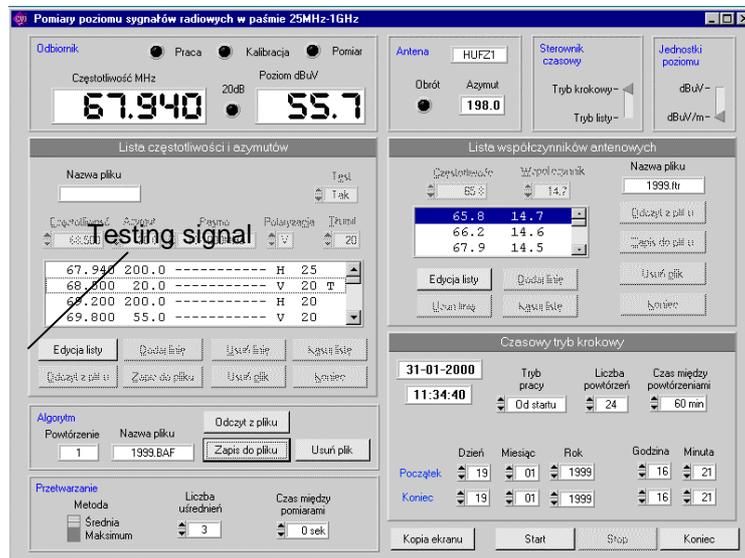
Data acquisition and processing program for estimation of radiomonitoring system stability can be executed from a task list of the full system main program (described in [3],[4]). The program consists of two parts:

- data acquisition,
- estimation of stability.

Graphic user interface was designed as a set of two graphical panels:

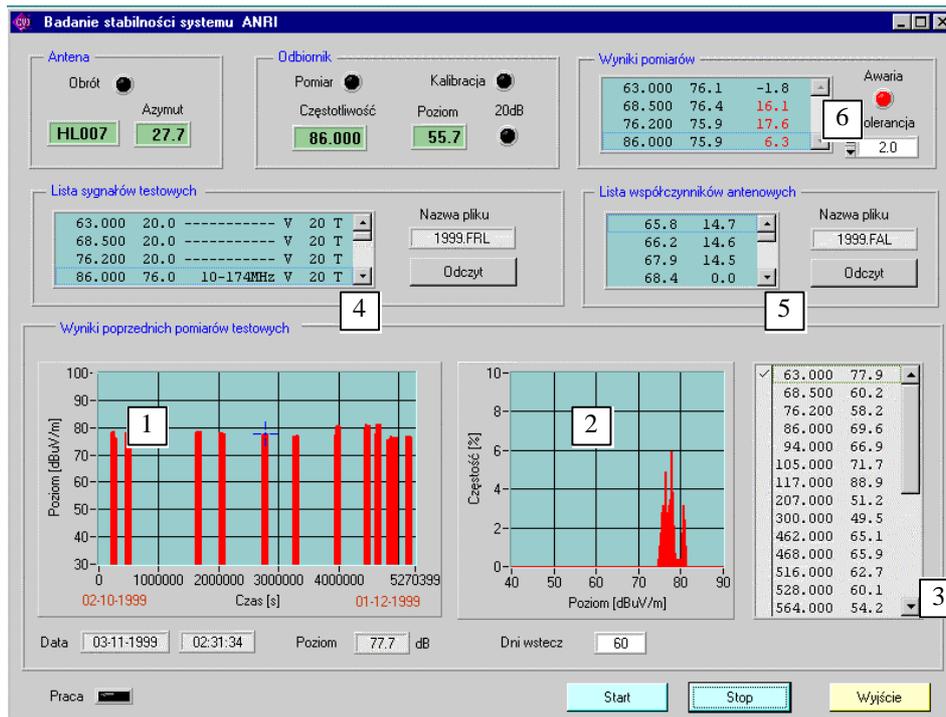
- panel of the Frequency List Mode algorithm for measurement of levels of radio and TV signals and test signals,
- panel for estimation of radiomonitoring system stability.

Data acquisition is performed in the Frequency List Mode. The panel for measurement of levels of radio and TV signals and test signals is shown in Fig.3. An operator chooses required measurement parameters and starts execution of the algorithm. The algorithm can be executed in the instant mode or in the timer mode. There are two timer modes available: timer step mode and timer list mode. In the timer step mode the algorithm is repeatedly executed every "step time" starting at the "on time" until "stop time" is reached. In the timer list mode the algorithm is executed at the time instants contained in a predefined list. The last layer of the parameters change is the change of the frequency sent to the receivers at which the measurement of the signal level takes place. In the Frequency List Mode the receiver is programmed according to the frequencies contained in the predefined list, until the end of the list is reached. The list covers the monitored frequencies and the test frequencies. Each test frequency is followed by character „T“ to differ it from the monitored frequency. For each programmed frequency a level readout from the receiver is performed.



**Figure 3.** Panel of the Frequency List Mode algorithm for measurement of levels of radio and TV signals and test signals.

The program for estimation of radiomonitoring system is executed from the main program task list. A panel for estimation a stability is displayed on a computer screen (Fig.4). Earlier acquired archive test signals levels are readout from the database. For each test frequency, a histogram is calculated and the most frequently appearing signal level is estimated. This level is treated as a standard test level. Results of measurements and processing are presented on the chart (1) - level in function of time, on the chart (2) - levels histogram and in the table (3), where the character „√“ indicates the frequency displayed in the chart (1) and (2). There is a possibility to determine a number of days, that are taken into account to calculate the histogram. Next, a file that contains a list of test signals (4) and a file with antenna coefficients (5) have to be chosen. Then, pushing a button „Start“, automatic measurements of levels for all test signal frequencies from the list (4) is performed. Antenna type, actual antenna azimuth, receiver frequency, actual level value of measured signal and attenuator state in Anritsu receiver are shown in the fields „Antenna“ and „Receiver“ during measurements. After each measurement, the value of measured level and the difference between this value is set to the field „Measurement Results“ (6). If this difference is greater than the declared tolerance value, then a diode „Damage“ is switch on and the difference value is presented in red colour. The default tolerance is set on the value 2, but can be modified.



**Figure 4.** Panel for estimation of radiomonitoring system stability, where:  
1 - level in function of time for one frequency; 2 - levels histogram for one frequency; 3 - table of frequencies and levels; 4 - list of test signals; 5 - list of antenna coefficients; 6 - field „Measurement Results“.

## 5 CONCLUSION

Presented system is an example of a specialised system designed with the use of the advanced software tools such as LabWindows programming environment. The system enables one to automate testing of the radio and TV transmitters monitoring system. The feature of proposed method for estimation of radiomonitoring system stability is its simplicity and taking into account errors of all system units, i.e. directional receiver antenna, polarisation control unit, direction control unit, programmable attenuator and radiocommunication receiver.

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