AUTOMATIC MEASUREMENT OF RF SIGNAL SPATIAL PROPERTIES AND ANTENNA PATTERNS

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ABSTRACT

Radio frequency signal measurement site is described in the presented paper. It enables direction setting by antenna rotator and signal frequency scanning and consequently measuring the parameters using a receiver. The site has two basic uses: measuring of antenna pattern; scanning and locating of RF signal. The site and its operation are made universally, the accuracy depends of rotator quality and parameter amount depends of receiver type.

1 INTRODUCTION

The current development in wireless communication requires powerful technologies for antenna testing and signal measuring. Sophisticated devices measure plenty signal parameters, but there is not simply site, which combines the use of these devices with antenna rotator system for measuring the spatial properties of signal also.

In this work the site for scanning, locating and measuring of radio frequency signal and measuring and testing the spatial properties of antennas is designed. It consists of antenna system, antenna rotor, receiver and control unit (rotator controller, PC and operating software).

The antenna system and receiver type both has to be chosen depending on the measuring conditions (service, frequency band, bandwidth, polarisation, etc.). The locating accuracy is increased with antenna directivity but the necessary number of measuring directions is also increased.

The antenna rotor quality determines the accuracy of location. The system supports both standard ways to send back information of actual position: resistive feedback and impulse feedback. For both, the initialization process is necessary. It consists of setting the antenna system inertia and the null-azimuth and elevation.

2 IMPULSE FEEDBACK ROTATOR SYSTEM

The rotor CONRAD represents the first group of antenna rotors. It uses impulse feedback, when simultaneously with the rotator work the metal punched wheel moves and it alternately shades the space between photodiode and phototransistor. Its output voltage is converted by MAX-232 to serial interface RS-232 and sent to PC. It enables obtaining the actual rotator position. The control of rotator movement is made by switch relays handled by PC. The impulse feedback rotator system is shown in figure 1.

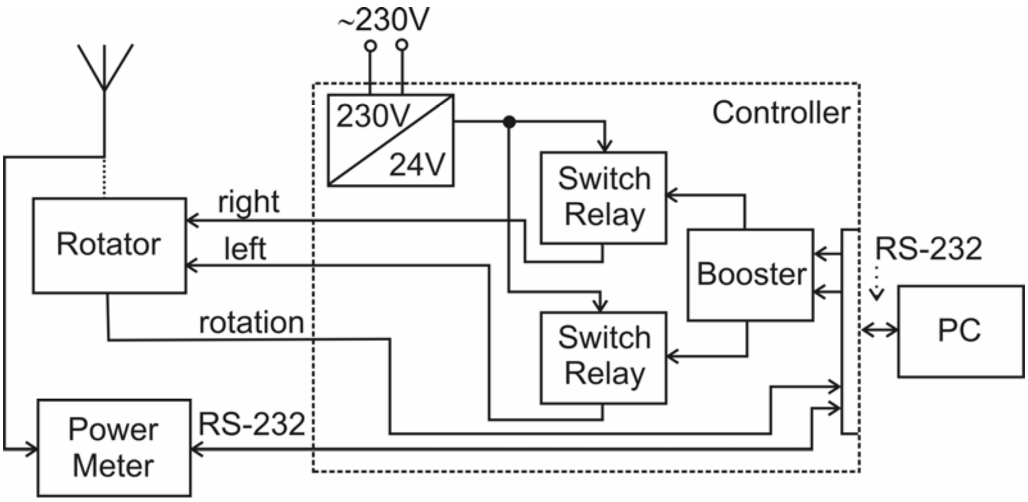

Fig. 1: *Impulse feedback rotator system*

3 RESISTIVE FEEDBACK ROTATOR SYSTEM

The site is also designed for use with KENPRO KR-5400B [1] rotator with independent azimuth and elevation rotator units. The resistive feedback rotator system is shown in figure 2. The actual position is notified by the corresponding voltage, which is converted to digital by A/D converter (TLV2548). This information is compiled by microcontroller (AT89C2051) and sent to PC by serial RS-232. The commanding of rotator is currently made in cooperation with vendor driver KENPRO which uses a pair of switch relay.

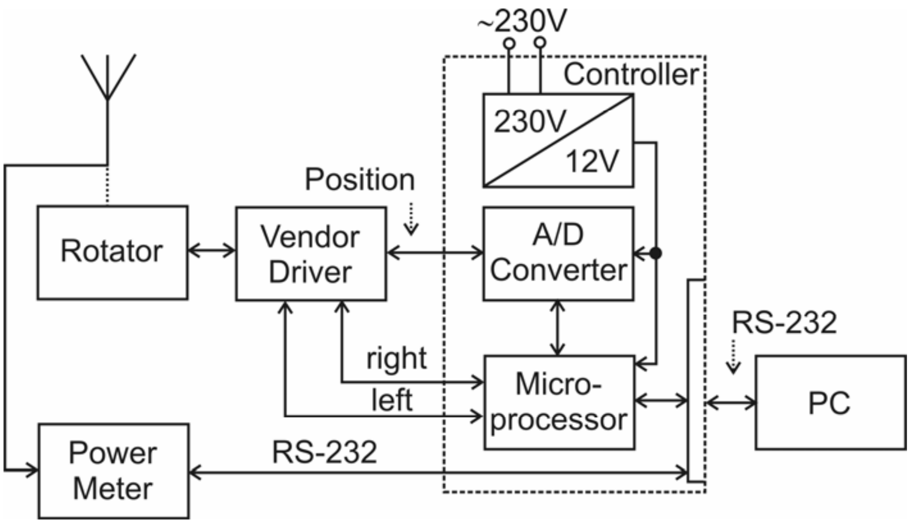

Fig. 2: *Resistive feedback rotator system*

4 CONTROL SOFTWARE

The control software commands the rotator (sets the direction), provides communication with receiver and measuring data management. In the presented site version, the PROLINK 1B [2] is proposed for FM radio and TV application and Rohde & Schwarz ESCS 30 [3] is designed for other services. The control software enables communication with both receivers via GPIB and RS-232 bus and with rotor via RS-232.

The presented software, RF Signal Scanner and Locator, have been designed in Borland Delphi. The basic function for signal locating is a Terrestrial Scan. It enables signal parameters measurement in defined azimuths and frequencies. The measuring data can be displayed for the concrete azimuths or frequencies. In the first situation (figure 3), the spectrum can be shown and the level on each frequency can be read using the markers. The values are also displayed in a table in a separate Results List window. In the second situation, signal level is displayed in a polar graph. The values are also displayed in the Results List window. If a change in elevation is enabled, the elevation rotor unit can set the polarization plane. The system can afterwards measure signal with both horizontal and vertical polarization without the changing the antenna system.

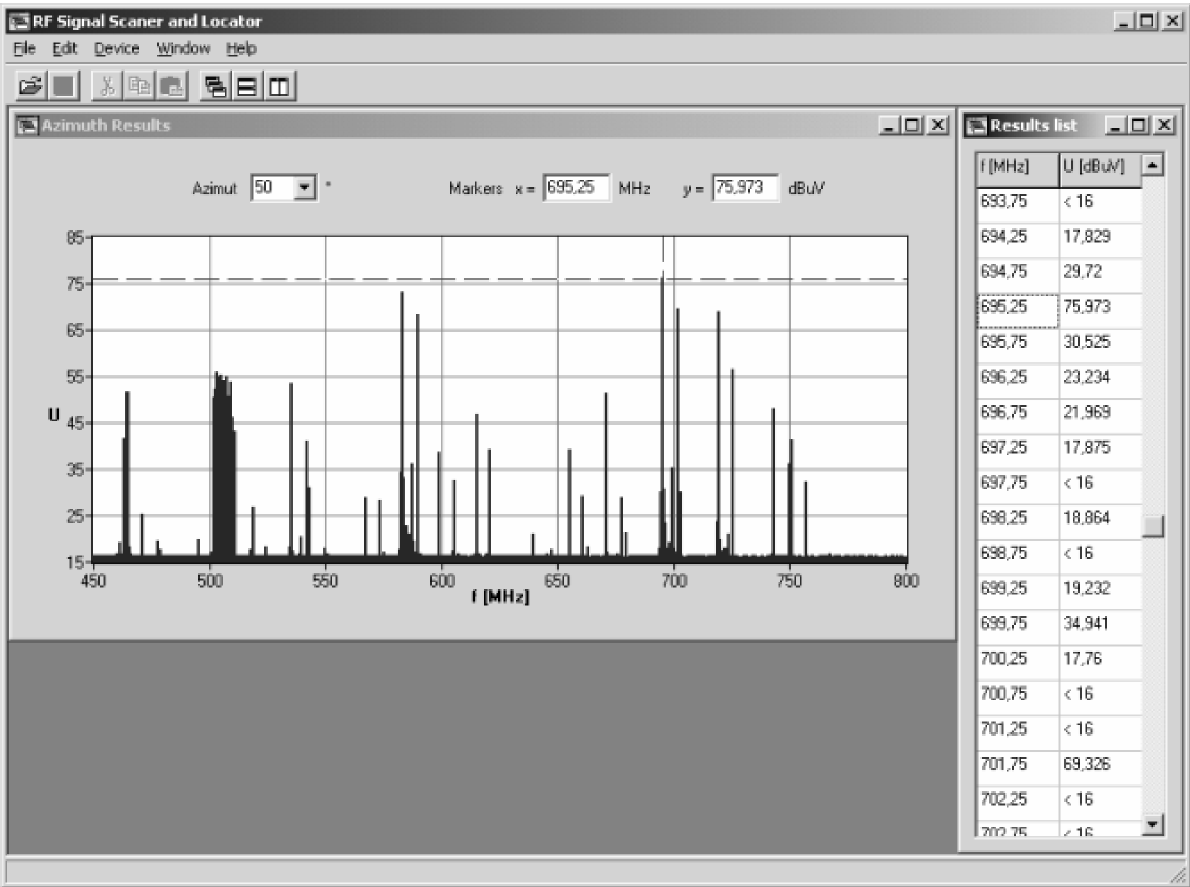

Fig. 3: *Azimuth Results window for Terrestrial Scan*

The Satellite Scan (only with KENPRO KR-5400B) measures the signal parameters in defined azimuths, elevations and frequencies with fixed polarization. Here, the modified circular scanning preventing cable tangle is used [4]. The obtained results are imaged in 3D graph.

The function Terrestrial / Satellite Locator makes the determination of signal source possible by finding the direction with the highest incoming signal level. The control software allows the manual setting of desired space angle accordant with supposed signal direction. In this manner it is possible to reduce the time of location.

The Antenna Pattern Meter function is defined for measuring spatial antenna properties. Here suitable auxiliary antenna and generator HP 8648C is used as a source of reference signal. The system with KENPRO KR-5400B enables the 3D antenna pattern measurement with modified circular scanning utilization. If the system with CONRAD rotator is used, the antenna patterns are possible to measure only in single plane. The manual antenna reconfiguration is necessary for measurement in other planes.

5 REAL MEASUREMENT RESULTS OUTLINE

The presented measuring site is shown in figure 4. The realized controller, power meter PROLINK-1B and computer with control software are shown on the left part. The rotator KENPRO KR-5400B placed on console on the housetop of FEEC building in Purkyňova Street is depicted on right part.

a) b)

Fig. 4: *Realized measuring site: a) measuring workplace; b) antenna rotator*

Some possibilities of the system are demonstrated on the UHF TV scan made in Brno city. In the figure 3 one can clearly see video and audio carrier frequencies for analogue TV and the band occupied by DVB-T. The logarithmic-periodic antenna for UHF band with horizontal polarisation was used for the measurement.

The second possible utilization of presented system is the antenna pattern measurement. The measured antenna pattern is depicted in Antenna Pattern window online during the measurement. The example of measured antenna pattern is shown in figure 5. This measurement was made outdoor on the housetop of FEEC building in Purkyňova Street.

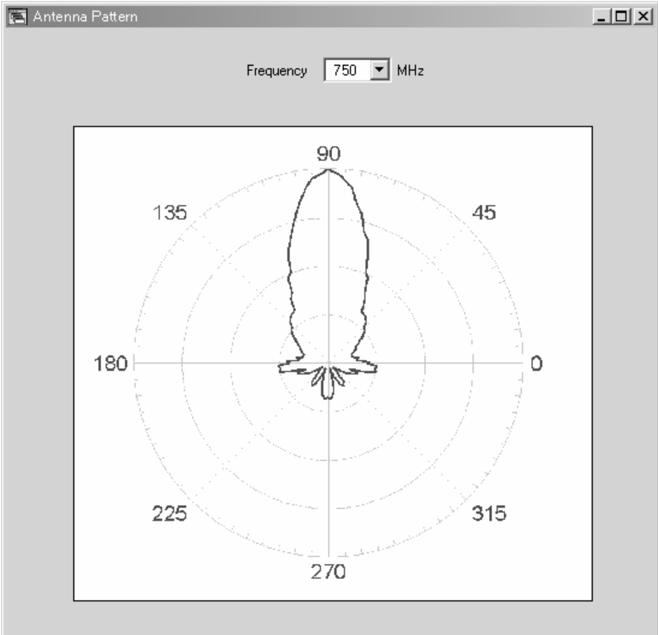

Fig. 5: *Antenna pattern window*

6 CONCLUSIONS

In the presented paper radio frequency signal measurement site is described. It enables signal scanning and locating and antenna patterns measuring using an antenna rotator and receiver. The complete measurement site is full controlled by means of control software. The site and its operation are made universally, the location accuracy depends of rotator quality and parameter amount depends of receiver type. The increasing of the control unit safety is possibly achieved by using the galvanic separation of signal and power systems' parts. The improvement and extension of control software abilities is the goal for further work.

ACKNOWLEDGEMENT

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