C# Tools for Communications Engineering

Slavica Cosovic Bajic, Kresimir Kavran
Slavica Cosovic Bajic, Polytechnic of Zagreb,
Vrbik 8,HR-10000 Zagreb, Croatia
Kresimir Kavran, Polytechnic of Zagreb,
Vrbik 8,HR-10000 Zagreb, Croatia
E-mail : *sbajic@tvz.hr, kkavran@tvz.hr*

Abstract - *In this Paper C# programs for Radio Communication are given. This programs is used in teaching students on the Electrical Engineering Department at Polyechnic of Zagreb. The capabilities of the programs are given. Some simulation results for real values of the parameters are given.*

Keywords - *Antenna design and analysis , coupling , intermodulation , phasor calculation , propagation , transmision line , two–part network analysis and matching*

1. INTRODUCTION

C# programs for Radio Communications Engineering is a package directly oriented to radio communication engineering [1]. This programs is used on the Electrical Engineering Department at Polyechnic of Zagreb [2]. It includes the ability to analyze networks, transmission lines, antennas and communication links. Its purpose is in the design and calculation of the communication circuits, where the circuits are not very complex.

2. ANTENNA DESIGN AND ANALYSIS

2.1. Coupling

This program calculates the input admittance , input impedance ,and coupling (power gain)
for two-port network with a given load.The program will also determine the load for maximum coupling. This analysis is useful for calculating coupling between antennas and copling through an electric circuit.

2.2. Impedance of Folded Antenna

This program can be used to design folded dipole antennas. It calculates the input impedance of folded dipoles or monopoles. The folded antenna is a very popular wire antenna with good impedance properties and ease of construction. The equal size conductor, half-wave folded dipole has an input impedance very close to that of a 300 ohm twin-line transmission line.

2.3. Log-Periodic Antenna

This program can be used to design a log-periodic dipole array optimized for maximum directive gain.

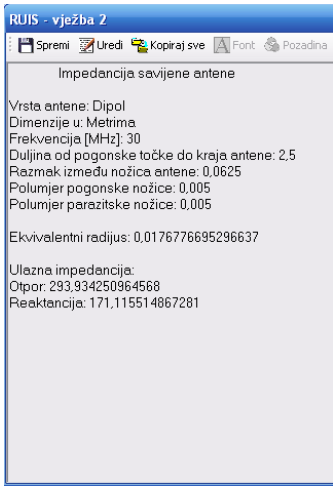

Fig.1 Impedance of Folded Antenna

Input information required is the bandwidth and the desired gain. Output includes the number of dipole elements required, dipole elements length and spacing. And overallarray lengh.The program includes the design of a suitable two-wire feeder line for any specific impedance. Input requirements for the feeder design are the impedance desired and the dipole element length to diameter ratio. The output is the required feeder spacing to diameter ratio. The program is valid for antennas in free space and frequencies at VHF and above. At these frequencies the ground effect can be neglected mounting the antennas high enough above the ground. For lower frequencies this program can be used for a first order estimation.

2.4. Patterns Long-Wire Antennas

This program can be used to design long-wire antennas. It calculates the pattern gain functions for long-wire, traveling wave dipole, VEE, and rhombic

antennas. The effect of a ground plane on the patterns can be included.

2.5. Phasor Calculations

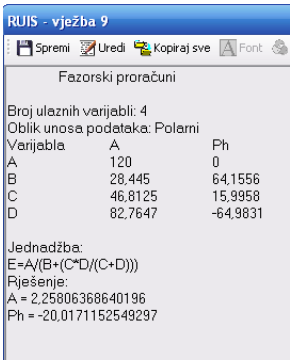

Fig.2. Phasor calculation

This program can be used to perform the complex arithmetic for steady-state ac circuits analysis , or for other calculations requiring complex numbers. In ac circuits, all electrical quantities (e.q., voltage, current, and impedance) can be represented as complex numbers called phasors. This program performs phasor calculations by following the rules of complex algebra. Operatons such as transformations back and forth between polar form and rectangular form, addition, subtraction, multiplication, division, and raising to a power are included. Combinations of these operations may be defined by the user and performd by the program

3. TRANSMISION LINES AND STUB MATCHING

3.1. Transmission Lines

This program calculates the characteristic impedance of different line configurations. It then calculates the input inpedance for a given line length and load at a specified frequency.

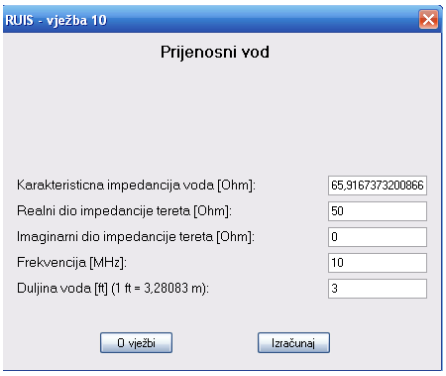

Fig.3 Transmission Lines

3.2. Broadband Matching

This program is a valuable asset for designing a broadband matching network. The performance of a broadband antenna can be improved through the use of a matching network at the antenna feed point.

3.3. Stub Matching

This program is used for a single stub matching of a load to a lossless transmission line. Small lengths of transmission line, short-circuited or open-circuited at one end, are often used as reactances in impedance-matching circuits.

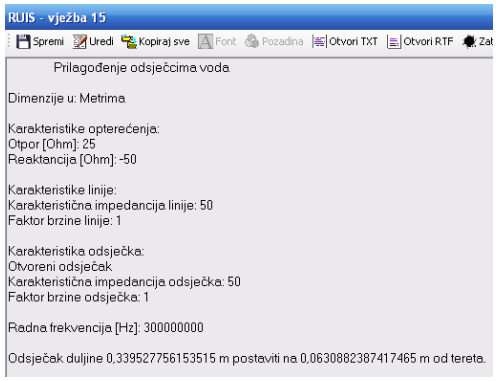

Fig.4. Stub Matching

4. FILTER SYNTHESIS

4.1. Butterworth Filter Synthesis

Fig.5. Butterworth Filter Synthesis

This program calculates the attenuation characteristics and elements of a Butterworth filter.

4.2. Chebyshev Filter Synthesis

This program calculates the attenuation characteristics and elements of a Chebyshev filter.

4.3. Image Parameter Filter Synthesis

This program calculates the attenuation characteristics and elements of a composite image parameter filter.

5. PROPAGATION

5.1. Ground Wave Transmission Loss

This program calculates a basic transmission loss for a given smooth earth distance . The program is applicable to (a) any type of earth surface (planar and spherical) , (b) frequencies between 1 and 1000 MHz and (c) vertical and horizontal polarization.The program is valid for low to medium antenna heights.

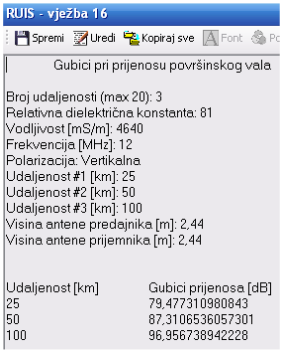

Fig. 6 Ground Wave Transmission Loss

5.2. Skywave Signal and Noise

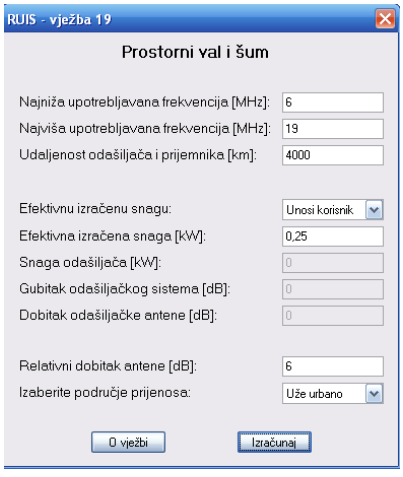

Fig.7 Skywave Signal and Noise

This program calculates received signal strengh over a given skywave propagation path , the field noise intensity for different noise path , and signal to noise ratio at the receiver.

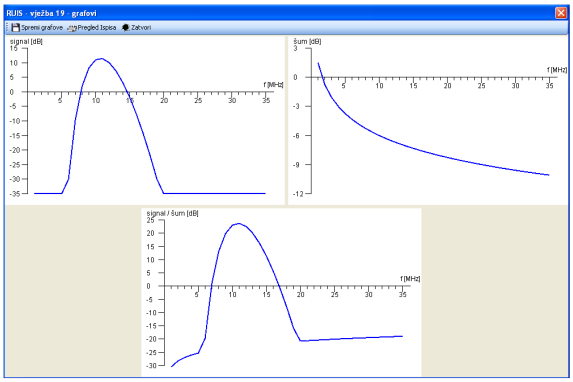

Fig.8 Skywawe Signal and Noise Graphs

5.3. Angle/range

This program calculates the distance between two ponts on the earth's surface and the bearing .In addition the program calculates the distance between a ground station and a satellite , and the zenith and bearing angles at the ground .

6. INTERMODULATION

6.1. Intermodulation Analysis

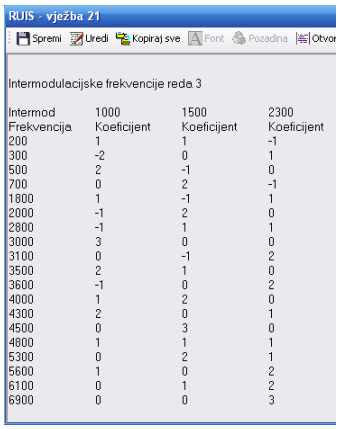

Fig. 9 Intermodulation Frequencies

This program calculates the intermodulation order on a given frequency produced by a set of transmit frequencies. Two or more collocated transmitters tend to produce an interference signal known as intermodulation interference. The order of the intermodulation relates inversely to the effect of the interference. As the order goes down, the number of

intermodulation frequencies goes down but the level of the interference goes up. A capability for finding the lowest order of intermodulation is very useful for evaluation of any frequency plan.

6.2. Intermodulation Frequencies

This program calculates the intermodulation frequencies of a given intermodulation order produced by a maximum of three transmitters.

7. CONCLUSION

The described C# tools are verified through many-years application in the teaching process at the Radiocommunications course for students on the Electrical Engineering Department Polyechnic of Zagreb.

ACKNOWLEDGEMENT

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