Application of the Ansoft Serenade 7.0 PC Software in a Wireless Course

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Abstract

Wireless applications have experienced rapid growth in recent years, resulting in the need for design and analytical tools for practicing engineers that are fast and reliable. This is reflected in the university academic programs where courses in wireless form part of the telecommunications program. The Ansoft Serenade 7.0 PC Software responds to this need as a design and analytical tool in industry and as a teaching aid in the classroom.

I. Introduction

For some years, emphasis on computers and computer applications captured the attention of industry to the point where many other technical areas seemed to take second place in the priority list of many industries. While the focus on computing has not diminished, other technical areas are regaining popularity due to the contributions they make in advancing technology. This is particularly true if the application of the technology is computer-based. An example of this in the field of telecommunications is the resurgence of wireless applications.

Leading up to and during the second world war, radio (wireless applications) played an important part in telecommunications. But post-World War II technological advancement did not occur at the same rate of growth for wireless (RF - radio frequency) applications as it did for areas such as data communications. This situation however has seen some major changes in the recent past since computer applications were incorporated with wireless applications. Factors such as speed of transmission and the ability to transmit vast amounts of information supported the use of computers and equipment that incorporated microprocessors. For some years, the exercise of reducing the size (volume) and weight but at the same time making the equipment more powerful has been the focus of many manufacturers. Another condition that has been a contributing factor to the increase in wireless applications is accessibility to areas that would be problematic for wireline connectivity. Also, the fact that unbounded media does not have the same limitations in terms of bandwidth utilization as do bounded media such as copper makes wireless more attractive.

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** Diagrams used with permission of Ansoft Corporation.

This change in the status of wireless applications has resulted in some universities and colleges incorporating wireless with their programs in telecommunications though some universities are concentrating on data communications. Such is the case at Penn State Wilkes-Barre campus, where wireless forms part of the telecommunications program. This paper discusses the use of the Serenade 7.0 PC Software in the wireless component of the telecommunications program.

II. The Serenade 7.0 PC Software[1]

The University Program of Ansoft Corporation makes the Serenade 7.0 PC software readily available to universities. This software product has proved to be very useful as a teaching aid in the laboratory and serves as a powerful design and analysis tool for RF and microwave systems engineers. It can also be used for optoelectronic design. The analytical capabilities are broadly categorized as linear and nonlinear.

The analytical methods used in this product include noise analysis, stability analysis, digital modulation analysis, statistical analysis, scattering matrix[2] and spectrum analysis to name a few. It has an extensive active and passive library of manufacturer's parts. The design utilities include transmission lines with an extensive media support, filter synthesis and Smith chart. It is capable of optimization and tuning. Possible systems that can be designed are numerous and examples are given below.

As an instructional aid, the user's guide is presented in a step-by-step format which takes the first time user through all the steps essential to becoming competent in its application. The examples manual contain many examples that will give students more than sufficient practice in the topics covered to complement classroom exercises which may be based on student projects. A reference manual effectively completes the supporting documentation, providing detailed information on the analytical methods used.

III. Examples of Utilization in Support of Course Content

Components of the *Wireless Systems* course deal with transmission lines, RF amplifiers and antennas. Some of the examples treated in the section on transmission lines are the wire pair, the twisted pair and the coaxial cable. Various experiments can be performed to give the students a hands-on experience, such as an experiment on characteristic impedance. While all these are still in use, the planar format is mostly used on circuit boards. In microwave applications, edge-coupled microstrip lines[3] can be used to make filters. This configuration finds use in planar and as well, lightweight equipment. In classroom instruction, this forms a useful extension on the application of transmission lines, a lesson which may be started by discussing the wire pair etc. The edge-coupled microstrip lines filter is one of the exercises that can be performed with the Serenade 7.0 PC software. All the examples presented support topics in the course content.

The example in Figure 1 shows a two port four-coupled line sections forming a filter. This figure also shows a Substrate Media control block which gives parameters such as the thickness of the substrate on which the filter is constructed, the dielectric permittivity of the substrate and the height of the cover which indicates the structure is not open to free space. Other details required but not shown are the type of metal used, for example copper, the loss tangent for the material

which indicates that the effective dielectric permittivity is used. Next is the Frequency control block which gives the starting frequency and the final frequency, and the steps in-between. Next is the Variable control block where all the variables are listed. This block is also used for optimization. Figure 2 shows the transmission (S21) and reflection (S11) coefficients of the filter circuit. The analysis is done by use of scattering parameters.

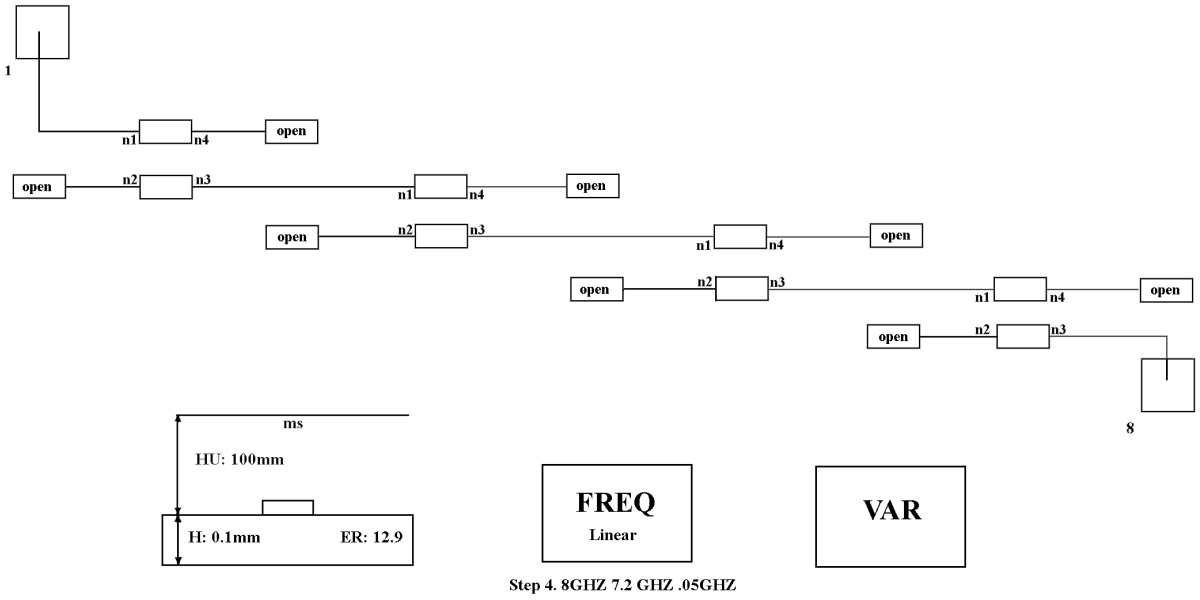

Figure 1. Edge-Coupled Filter

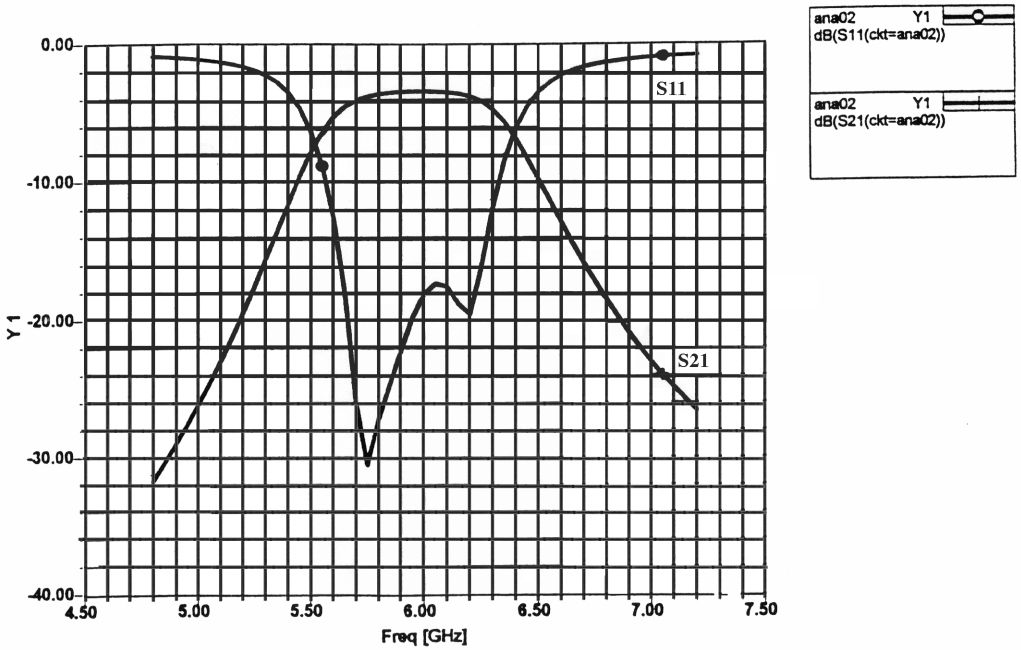

Figure 2. Transmission (S21) and Reflection (S11) Coefficients of the Filter versus Frequency.

The example in Figure 3 is a simple RC circuit to which an impulse is applied. The operating time is set for 32 seconds which is sufficiently long to allow a complete discharge of the capacitor. The analysis is done in the frequency domain and the code does an automatic transformation to time domain to produce a transient response. Figure 4 shows the response (S21) for an impulse of zero rise time. The input impulse (S11) is shown for reference. Figure 5 shows the response when a rise time of 1 second is applied. The ringing can be removed by employing a low pass filter in the measuring device.

A two port travelling wave amplifier is shown in Figure 6, and Figure 7 shows the circuitry in the boxes labeled MFET in Figure 6. The start, stop and steps of frequency should be entered in the Frequency control block, and the variables in the Variable control block. Figure 8 shows the admittance graph for the input (S11) and output (S22) matching of the amplifier using a Smith chart. Figure 9 shows the gain (S21) in dB and the corresponding phase in degrees. Figure 10 shows the gain (S21) in dB of the circuitry contained in the boxes labeled MFET.

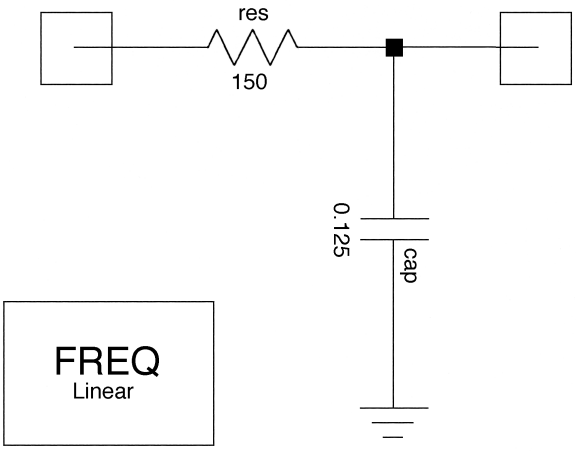

Figure 3. RC Network to Demonstrate Transient Response.

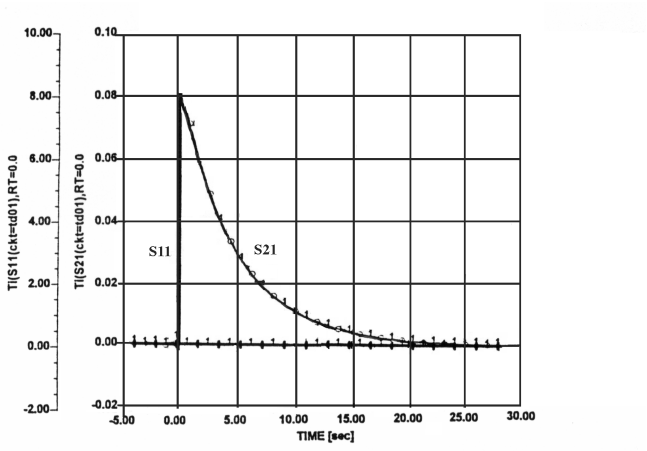

Figure 4. Transient Response (S21) for Rise Time (RT = 0.0) versus Time. Impulse (S11) shows Reference

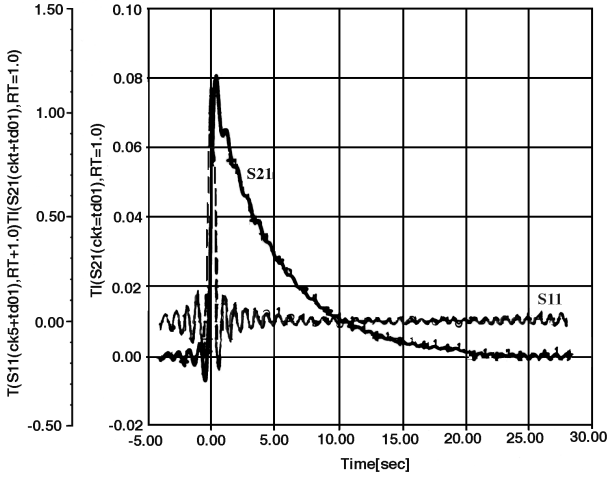

Figure 5. Transient Response (S21) for Rise Time (RT = 1.0) versus Time. (S11) shows Impulse.

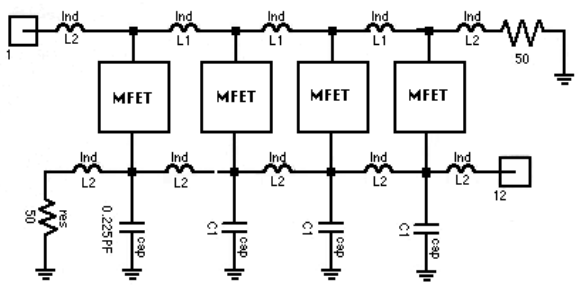

Figure 6. Traveling Wave Amplifier.

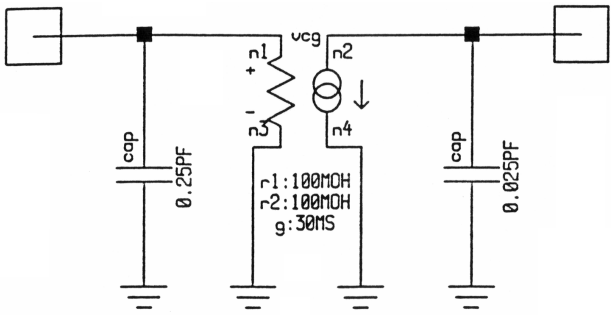

Figure 7. Network Contained in MFET boxes.

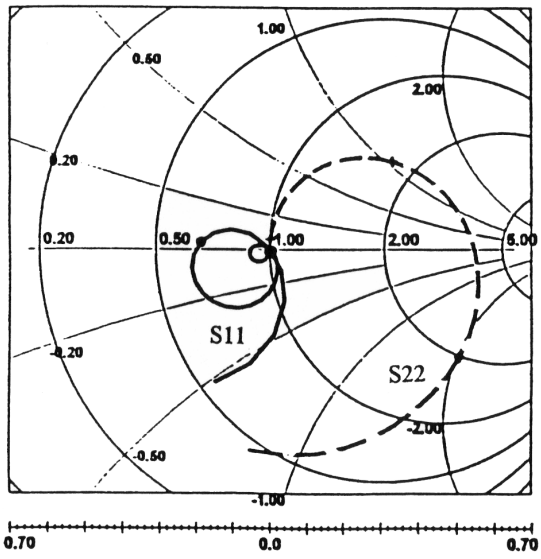

Figure 8. Smith chart showing admittance for the Input (S11) and Output (S22) matching of the amplifier.

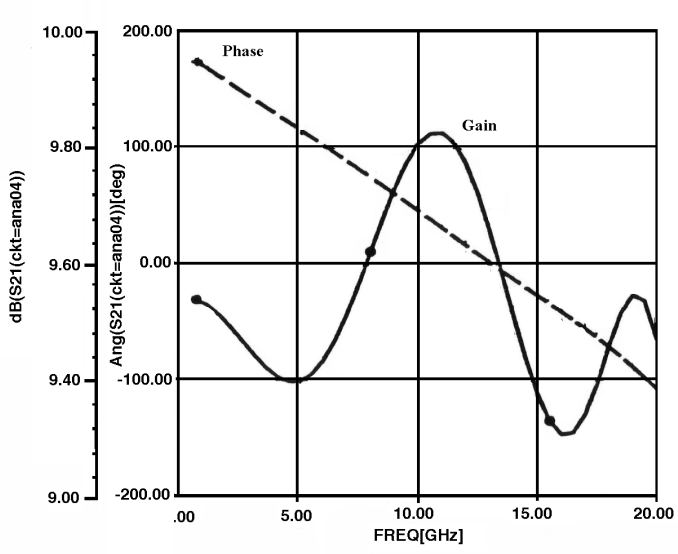

Figure 9. Gain and Phase of the amplifier.

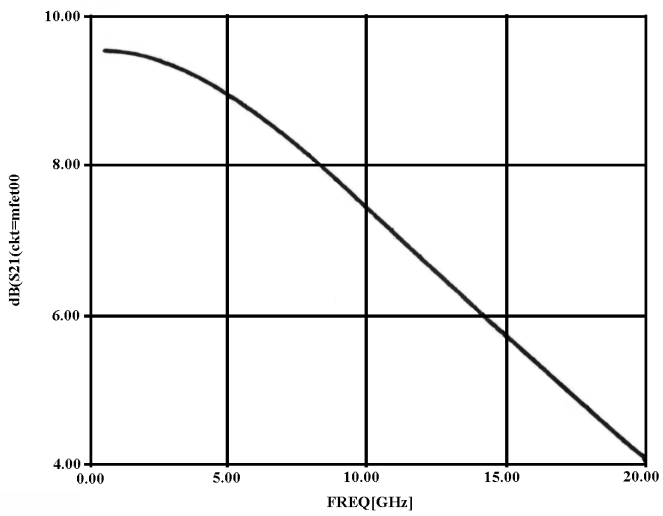

Figure 10. Gain of the circuit contained in MFET.

IV. Conclusion

The growth in wireless applications has resulted in the need for fast and efficient design and analytical tools, a need which has been responded to in the form of the Ansoft Serenade 7.0 PC Software. This software has also proved to be a useful teaching aid in the classroom, giving the students practical experience with the design tools being used by practicing engineers. Another advantage in the classroom is that it helps in students becoming computer literate.

References

[1] Ansoft Serenade 7.0 PC Software Documentation; Ansoft Corporation
[2] Field Theory of Guided Waves; Robert E. Collin; McGraw-Hill Book Company; 1960
[3] Microstrip Lines and Slotlines; K. C. Gupta, R. Garg and I. J. Bahl; Artech House; 1979

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