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## Chapter 1 : Microwave Transmission Line Impedence Data (): M.A.R. Gunston - BiblioVault

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But what it does, it does well, which is to calculate key parameters for most common microwave transmission lines, including microstrip, stripline, and coplanar-waveguide transmission lines. The software is downloaded as an executable. The simple-to-use software can determine key parameters for a selected transmission-line type and laminate material, such as the conductor width and conductor metal thickness needed to achieve given impedance at a target frequency. The on-screen menus allow a user to select a transmission-line technology and a laminate material. Moving a mouse cursor over any material name reveals additional information about the material. Enter Parameters such as Thickness, Operating Frequency and RF Power Level With a material in place, the next step is to pick a standard dielectric thickness from a menu, or enter a custom thickness. A standard copper cladding thickness must also be selected from a menu, or a custom thickness entered manually. Copper conductor roughness is also accounted for, either selected from a menu as a standard value, or entered manually as a nonstandard value. Similarly, a standard value for copper conductivity can be used in a calculation, or a custom value entered, although any change in the value for copper conductivity will affect all metal layers in a multilayer circuit. The MWI software allows an operator to enter parameters pertinent to a specific application, such as operating frequency and RF power level. Once a user has selected the desired transmission-line type, dielectric material, material thickness, conductor width, thickness of the conductive metal cladding, etc. The software can generate insertion loss tables of data that can be used to create plots of loss versus frequency, and these plots can then be compared to actual measured results from a microwave vector network analyzer VNA. This exact procedure was performed to evaluate the accuracy of the MWI software for calculations of conventional microstrip parameters. MWI calculations performed for conventional microstrip transmission lines have proven to be extremely accurate since they include the effects of dispersion as well as copper roughness. These are ceramic-filled PTFE composite materials with a dielectric constant of 3. ED copper cladding, predicted and measured data matched almost exactly through GHz. The MWI software may not be able to match the accuracy of an EM simulator for a given prediction, but it is considerably faster, providing results almost instantaneously. It has been found to be most accurate for calculations on conventional microstrip and stripline, very accurate with edge-coupled microstrip and offset stripline transmission lines, and fairly accurate with conductor-backed coplanar-waveguide CBCPW transmission lines, although in the case of CBCPW transmission lines, vias must be properly placed to ensure accurate results. Calculating the impedance of transmission lines is not trivial, since a number of factors can affect impedance. In microstrip, the width of the conductor and thickness of the dielectric substrate impact impedance. In CBCPW, not only the conductor width and dielectric thickness, but the spacing on the signal plane between the signal conductor and the adjacent ground planes will affect impedance. The MWI software is free, and provides results fairly quickly that are accurate and can be saved for use in other programs, including in word processors or in spreadsheets for creating x-y plots. It can even calculate the temperature rise above ambient temperature for a selected laminate based on an input RF power level. For anyone needing a quick impedance calculation for designing a filter, coupler, or other high-frequency circuit, the MWI software provides usable results. And the price is right!

## Chapter 2 : Waveguide, Transmission Lines, Cables and Connectors | | Microwave Journal

*A compendium of data for computing the characteristic impedance of transmission lines based on physical dimensions. Covers both conventional structures and unusual geometries, including coaxial, eccentric and elliptic coaxial, twin-wire, wire-above-ground, microstrip and derivatives, stripline, slabline and trough line.*

Overview[ edit ] Ordinary electrical cables suffice to carry low frequency alternating current AC , such as mains power , which reverses direction to times per second, and audio signals. Radio frequency currents also tend to reflect from discontinuities in the cable such as connectors and joints, and travel back down the cable toward the source. Transmission lines use specialized construction, and impedance matching , to carry electromagnetic signals with minimal reflections and power losses. The distinguishing feature of most transmission lines is that they have uniform cross sectional dimensions along their length, giving them a uniform impedance , called the characteristic impedance , [2] [3] [4] to prevent reflections. Types of transmission line include parallel line ladder line , twisted pair , coaxial cable , and planar transmission lines such as stripline and microstrip. At microwave frequencies and above, power losses in transmission lines become excessive, and waveguides are used instead, [1] which function as "pipes" to confine and guide the electromagnetic waves. At even higher frequencies, in the terahertz , infrared and visible ranges, waveguides in turn become lossy, and optical methods, such as lenses and mirrors , are used to guide electromagnetic waves. History[ edit ] Mathematical analysis of the behaviour of electrical transmission lines grew out of the work of James Clerk Maxwell , Lord Kelvin and Oliver Heaviside. In Lord Kelvin formulated a diffusion model of the current in a submarine cable. The model correctly predicted the poor performance of the trans-Atlantic submarine telegraph cable. That is, the voltage on the wire at a given time can be assumed to be the same at all points. However, when the voltage changes in a time interval comparable to the time it takes for the signal to travel down the wire, the length becomes important and the wire must be treated as a transmission line. Stated another way, the length of the wire is important when the signal includes frequency components with corresponding wavelengths comparable to or less than the length of the wire. At this length the phase delay and the interference of any reflections on the line become important and can lead to unpredictable behaviour in systems which have not been carefully designed using transmission line theory. The four terminal model[ edit ] Variations on the schematic electronic symbol for a transmission line. For the purposes of analysis, an electrical transmission line can be modelled as a two-port network also called a quadripole , as follows: In the simplest case, the network is assumed to be linear i. If the transmission line is uniform along its length, then its behaviour is largely described by a single parameter called the characteristic impedance , symbol Z0. This is the ratio of the complex voltage of a given wave to the complex current of the same wave at any point on the line. Typical values of Z0 are 50 or 75 ohms for a coaxial cable , about ohms for a twisted pair of wires, and about ohms for a common type of untwisted pair used in radio transmission. When sending power down a transmission line, it is usually desirable that as much power as possible will be absorbed by the load and as little as possible will be reflected back to the source. This can be ensured by making the load impedance equal to Z0, in which case the transmission line is said to be matched. A transmission line is drawn as two black wires. At a distance x into the line, there is current I x travelling through each wire, and there is a voltage difference V x between the wires. Some of the power that is fed into a transmission line is lost because of its resistance. This effect is called ohmic or resistive loss see ohmic heating. At high frequencies, another effect called dielectric loss becomes significant, adding to the losses caused by resistance. Dielectric loss is caused when the insulating material inside the transmission line absorbs energy from the alternating electric field and converts it to heat see dielectric heating. The transmission line is modelled with a resistance R and inductance L in series with a capacitance C and conductance G in parallel. The resistance and conductance contribute to the loss in a transmission line. High-frequency transmission lines can be defined as those designed to carry electromagnetic waves whose wavelengths are shorter than or comparable to the length of the line. Under these conditions, the approximations useful for calculations at lower frequencies are no longer accurate. This often occurs with radio , microwave and optical signals, metal mesh optical filters , and with the signals found in high-speed digital circuits.

## Chapter 3 : Microwave transmission - Wikipedia

*Get this from a library! Microwave transmission-line impedance data. [M A R Gunston] -- The book reviews developments in the following fields: transmission lines utilizing conductors of circular cross-section; transmission lines utilizing conductors of rectangular cross-section;.*

Uses[ edit ] Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it. A disadvantage is that microwaves are limited to line of sight propagation; they cannot pass around hills or mountains as lower frequency radio waves can. A parabolic satellite antenna for Erdfunkstelle Raisting, based in Raisting , Bavaria , Germany Microwave radio transmission is commonly used in point-to-point communication systems on the surface of the Earth, in satellite communications , and in deep space radio communications. Other parts of the microwave radio band are used for radars , radio navigation systems, sensor systems, and radio astronomy. Radio waves in this band are usually strongly attenuated by the Earthly atmosphere and particles contained in it, especially during wet weather. The electronic technologies needed in the millimeter wave band are also much more difficult to utilize than those of the microwave band. Wireless transmission of information One-way e. In microwave radio relay, microwaves are transmitted on a line of sight path between relay stations using directional antennas , forming a fixed radio connection between the two points. The requirement of a line of sight limits the separation between stations to the visual horizon, about 30 to 50 miles. Before the widespread use of communications satellites , chains of microwave relay stations were used to transmit telecommunication signals over transcontinental distances. Much of the transcontinental traffic is now carried by cheaper optical fibers and communication satellites , but microwave relay remains important for shorter distances. Antennas must be highly directional high gain ; these antennas are installed in elevated locations such as large radio towers in order to be able to transmit across long distances. Typical types of antenna used in radio relay link installations are parabolic antennas , dielectric lens, and horn-reflector antennas , which have a diameter of up to 4 meters. Highly directive antennas permit an economical use of the available frequency spectrum, despite long transmission distances. Danish military radio relay node Because of the high frequencies used, a line-of-sight path between the stations is required. Additionally, in order to avoid attenuation of the beam, an area around the beam called the first Fresnel zone must be free from obstacles. Obstacles in the signal field cause unwanted attenuation. High mountain peak or ridge positions are often ideal. Production truck used for remote broadcasts by television news has a microwave dish on a retractible telescoping mast to transmit live video back to the studio. Obstacles, the curvature of the Earth, the geography of the area and reception issues arising from the use of nearby land such as in manufacturing and forestry are important issues to consider when planning radio links. In the planning process, it is essential that "path profiles" are produced, which provide information about the terrain and Fresnel zones affecting the transmission path. The presence of a water surface, such as a lake or river, along the path also must be taken into consideration since it can reflect the beam, and the direct and reflected beam can interfere at the receiving antenna, causing multipath fading. Rare events of temperature, humidity and pressure profile versus height, may produce large deviations and distortion of the propagation and affect transmission quality. All previous factors, collectively known as path loss , make it necessary to compute suitable power margins, in order to maintain the link operative for a high percentage of time, like the standard  Hop distance is the distance between two microwave stations [2] Previous considerations represent typical problems characterizing terrestrial radio links using microwaves for the so-called backbone networks: During s microwave radio links begun widely to be used for urban links in cellular network. Furthermore, link planning deals more with intense rainfall and less with multipath, so diversity schemes became less used. Another big change that occurred during the last decade was an evolution toward packet radio transmission. Therefore, new countermeasures, such as adaptive modulation , have been adopted. The emitted power is regulated by norms EIRP both for cellular system and microwave. In the last decade the dedicated spectrum for each microwave band reaches an extreme overcrowding, forcing efforts towards techniques for increasing the transmission capacity frequency reuse, Polarization-division multiplexing , XPIC , MIMO. History[ edit ] Antennas of experimental 1. The receiving antenna background, right was located behind the transmitting antenna to avoid interference. US Army Signal Corps portable microwave relay station,  Microwave relay systems were first developed in World War II for secure military communication. The first experiments with radio repeater stations to relay radio signals were done in by Emile Guarini-Foresio. In an Anglo-French consortium headed by Andre C. A military microwave link between airports at St. After the war telephone companies used this technology to build large microwave radio relay networks to carry long distance telephone calls. It was expected at that time that the annual operating costs for microwave radio would be greater than for cable. There were two main reasons that a large capacity had to be introduced suddenly: Pent up demand for long distance telephone service, because of the hiatus during the war years, and the new medium of television, which needed more bandwidth than radio. Military microwave relay systems continued to be used into the s, when many of these systems were supplanted with tropospheric scatter or communication satellite systems. When the NATO military arm was formed, much of this existing equipment was transferred to communications groups. The typical communications systems used by NATO during that time period consisted of the technologies which had been developed for use by the telephone carrier entities in host countries. The typical microwave relay installation or portable van had two radio systems plus backup connecting two line of sight sites. These radios would often carry 24 telephone channels frequency division multiplexed on the microwave carrier i. Any channel could be designated to carry up to 18 teletype communications instead. Similar systems from Germany and other member nations were also in use. Long-distance microwave relay networks were built in many countries until the s, when the technology lost its share of fixed operation to newer technologies such as fiber-optic cable and communication satellites , which offer a lower cost per bit. By positioning a geosynchronous satellite in the path of the beam, the microwave beam can be received. At the turn of the century, microwave radio relay systems are being used increasingly in portable radio applications. The technology is particularly suited to this application because of lower operating costs, a more efficient infrastructure , and provision of direct hardware access to the portable radio operator. Microwave link[ edit ] A microwave link is a communications system that uses a beam of radio waves in the microwave frequency range to transmit video , audio , or data between two locations, which can be from just a few feet or meters to several miles or kilometers apart. Microwave links are commonly used by television broadcasters to transmit programmes across a country, for instance, or from an outside broadcast back to a studio. Mobile units can be camera mounted, allowing cameras the freedom to move around without trailing cables. These are often seen on the touchlines of sports fields on Steadicam systems. Tropospheric scatter "troposcatter" or "scatter" was a technology developed in the s allow microwave communication links beyond the horizon, to a range of several hundred kilometers. The transmitter radiates a beam of microwaves into the sky, at a shallow angle above the horizon toward the receiver. As the beam passes through the troposphere a small fraction of the microwave energy is scattered back toward the ground by water vapor and dust in the air. A sensitive receiver beyond the horizon picks up this reflected signal. Signal clarity obtained by this method depends on the weather and other factors, and as a result a high level of technical difficulty is involved in the creation of a reliable over horizon radio relay link. Troposcatter links are therefore only used in special circumstances where satellites and other long distance communication channels cannot be relied on, such as in military communications.

## Chapter 4 : Read e-book online Microwave Transmission Line Impedence Data PDF - Chiropractic Library

*This software is intended to assist with microwave circuit design in predicting the impedance of a circuit made with Rogers High Frequency circuit materials. The software also has some capabilities for predicting transmission line losses* *as well.*

## Chapter 5 : Transmission line - Wikipedia

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## Chapter 6 : Impedance and Transmission | | Microwave Journal

*A compendium of data for computing the characteristic impedance of transmission lines based on physical dimensions. This book covers both conventional structures and unusual geometries, including coaxial, eccentric and elliptic coaxial, twin-wire, wire-above-ground, microstrip and derivatives, stripline, slabline and trough line.*

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