High Performance of the Coaxial Cable Based on Different Dielectrics

Mohammed Q. Taha, Yousif I. Al-Mashhadany and Aymen Lpizra

Abstract—This paper presents the analysis of high performance for coaxial cable with different parameters. The modeling for performance of coaxial cable contains many parameters, in this paper will discuss the more effective parameter is the type of dielectric mediums (Polyimide, Polyethylene, and Teflon). This analysis of the performance related to dielectric mediums with respect to: dielectric losses and its effect upon cable properties, dielectrics versus characteristic impedance, and the attenuation in the coaxial line for different dielectrics. The analysis depends on a simple mathematicalmodel for coaxial cables to test the influence of the insulators (Dielectrics) performance. The simulation of this work is done using Matlab/Simulink and presents the results according to the construction of the coaxial cable with its physical properties, the types of losses in both the cable and the dielectric, and the role of dielectric in the propagation of electromagnetic waves. Satisfied results are obtained that concluded the condition of high performance for coaxial cable.

Index Terms—High performance of coaxial cable, Dielectric mediums, Mathematical model.

1 Introduction

THE coaxial cable has an inner conductor surrounded by a tubular insulating layer, surrounded by a tubular conducting shield. Many coaxial cables also have an insulating outer sheath or jacket. The term coaxial comes from the inner conductor and the outer shield sharing a geometric axis as shown in fig. 1.

Historically, in 1880 an English mathematician Oliver Heaviside studied the so-called skin effect in telegraph transmission lines. He concluded that wrapping an insular casing around a transmission line both increases the clarity of the signal and improves the durability of the cable. He patented the first coaxial cable in England after that year.Four years afterwards (in 1884), the first Coaxial cable was made by an electrical engineering company named Siemens [1-3].

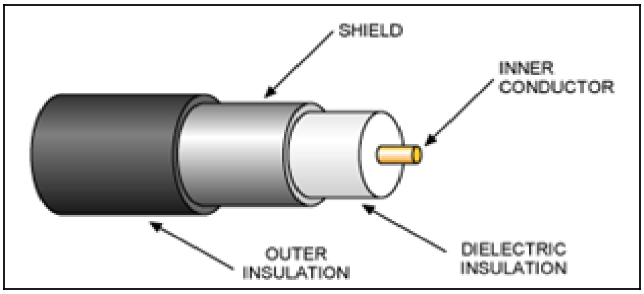

Fig. 1. The cross section of coaxial cable

Coaxial cable virtually keeps all the electromagnetic wave to the area inside it. Due to the mechanical properties, the coaxial cable can be bent or twisted, also it can be strapped to conductive supports without inducing unwanted currents in the cable. In frequency radiation applications up to a few gigahertz, the wave propagation in the transverse electric and magnetic mode only, that means the electric and magnetic fields are both perpendicular to the focal point of propagation.Yet, at frequencies for which the wavelength (in the dielectric) is significantly shorter than the circumference of the transmission line, transverse electric and transverse magnetic waveguide modes can also spread.

Coaxial cable conducts electrical signal using an inner conductor normally a solid copper, stranded copper or copper plated steel wire, surrounded by an insulating layer (dielectric) and all enclosed by a shield. The cable is protected by an outer insulating jacket [4].

The electromagnetic wavescannot propagate through coaxial cable before they are either sucked or reflected because of the effect of the Dielectric Materials. The speed(S)of electromagnetic waves propagating through a dielectric medium is given by

$$S = c / (\mu r\ \varepsilon r)\ \hat{}\ ½.$$

C= 0.3 G (m/s) the velocity of light in a vacuum

μr: Magnetic relative permeability of dielectric medium

εr: Dielectric relative permittivity of the dielectric

Since K>1 for dielectric materials, it is concluded that:The velocity with which electromagnetic waves propagate through a dielectric medium is always less than the velocity with which they propagate through a vacuum.

Common dielectric materials [5-7]. PE-Solid Polyethylene: supports low temperature applications.FPE-Foamed Polyethylene: Provides lower attenuation and capacitance than solid PE.Air Spaced: supports a lower dielectric constant than Polyethylene while allowing for a small diameter cable size.

The function of the dielectric material in the coaxial

- *Mohammed Q. Taha is M.scstudent in the Electrical Engineering Department, Tagliatela College of Engineering, University of New Haven, USA.*
- *Yousif I. Almashhadany is a professor assistant at Electrical Engineering Dept., College of Engineering, University of Al-Anbar, Al-Anbar, Iraq.*
- *Aymen Lpizra is a professor at the Electrical Engineering Department, Tagliatela College of Engineering,University of New Haven, USA.*