Abstracts

Low-Frequency Behavior of the Propagation Constant Along a Thin Wire in an Arbitrarily Shaped Mine Tunnel

E.F. Kuester and D.B. Seidel. "Low-Frequency Behavior of the Propagation Constant Along a Thin Wire in an Arbitrarily Shaped Mine Tunnel." 1979 Transactions on Microwave Theory and Techniques 27.8 (Aug. 1979 [T-MTT]): 736-741.

Seidel and Wait have investigated the complex propagation constant (phase and attenuation coefficients) of the fundamental mode of propagation for radio waves along a thin wire or cable, located in an elliptical mine tunnel, and found that the attenuation rate for low frequency is insensitive to the shape of the ellipse if the cable-wall distance and cross-sectional area are kept constant. We consider here tunnels of more general cross section, and obtain a characteristic equation for the propagation constant valid for sufficiently low frequency, by means of a variational formulation of an integral equation. The characteristic equation involves only the electrical parameter of the tunnel walls, the radius of the wire, and the capacitance per unit length that the wire would have if the tunnel walls were perfectly conducting. Agreement with exact calculations for several geometries is found to be excellent below about 100 kHz, and acceptable even up to 1 MHz or more, for typical tunnel parameters. Since the wire capacitance can be shown to depend most importantly on its distance from the wall and on the area of the tunnel, the conclusion of Seidel and Wait can be made more precise and extended to tunnels of arbitrary cross section.

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