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MAIN ELECTRICAL PARAMETERS

Technical information: MAIN ELECTRICAL PARAMETERS

TRANSMISSION LINES

RESISTANCE - R

Measured in Ω/unit of length.
It expresses the passive resistance that slows down the movement of the electrode column along the conductor after applying an electromotive force (voltage) to it.
The higher the resistance, the more the transmitted signal will lose its strength and, therefore, its ability to reach its destination.
The value "R" is given by the ratio between the resistivity of the conductive material and its cross-section.

ATTENUATION - α

Measured in dB/unit of length.
Attenuation determines the quality of a transmission line. It is normally the ratio between the input voltage and the output voltage.
The attenuation of a digital pulse results in degradation and distortion of the signal itself, with a loss in voltage peak and slowing of the pulse. The two main factors causing attenuation are resistive loss in conductors and loss in the dielectric. The sum of these two factors gives the total attenuation.

CHARACTERISTIC IMPEDANCE - Z_0

Expressed in Ω.
The characteristic impedance of a transmission line represents the result of all the passive elements present that oppose the flow of electrons (resistance, capacitance, inductance). In a long-distance or high-frequency transmission system, it is important that the impedance of the cable matches that of the receiving system.
If there is a difference in impedance at the junction, there will be an electrical reflection that will distort both the strength and quality of the signal.
Equally important, particularly in coaxial lines, is impedance uniformity.
If the quality of the conductor, the geometry of the cable, and the uniformity of the dielectric are not constant, internal reflections may occur, causing signal distortion and loss.
Impedance also varies depending on the measurement frequency.

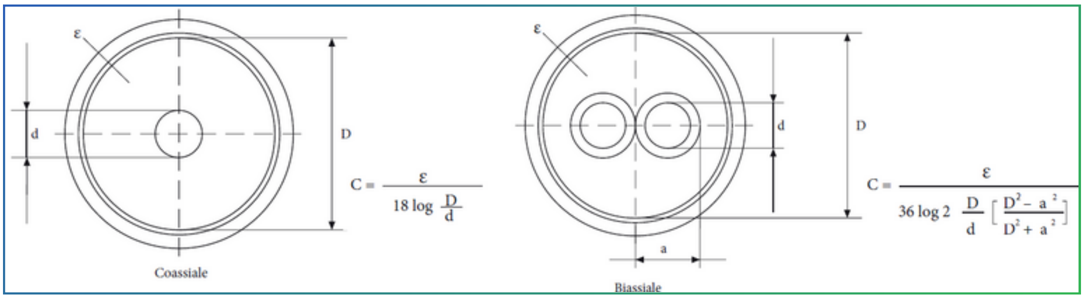
General formula:

$$Z_0 = 1 / (Vr \cdot c \cdot C)\ [\Omega]$$

Vr = relative propagation velocity
c = speed of light [m/sec]
C = capacitance [pF/m]

CAPACITANCE - C

Measured in Farads/unit of length.
It expresses the property of a dielectric material, placed between two conductors, to retain electrical charge when there is a potential difference between the two conductors.
The capacitance value varies depending on the measurement frequency, although in different ways depending on the material used: for example, with PVC the capacitance value changes significantly, while with polyethylene the capacitance value remains almost constant.



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PROPAGATION VELOCITY - VP

Measured in %.
It represents the time required for a signal to travel through a transmission line.
It is defined as the ratio between the speed of the signal in the transmission medium and its speed in air. This value depends on the dielectric constant of the insulation material.

General formula:

$$Z_0 = 1 / \mathcal{E}_r \ [\%]$$

1 = speed of light [m/sec]
$\mathcal{E}_r$ = dielectric constant

INDUCTANCE - L

Expressed in Henry (unit of length).
When two conductors carry equal and opposite currents, a magnetic field is created in the space between the two conductors.
The ratio between the magnetic flux passing through the space between the conductors and the current that reproduces it is called inductance.
This value varies depending on the distance between the two conductors, the diameter of the conductors, and the relative magnetic permeability of the materials constituting the conductors (copper, aluminum permeability = 1).

TRANSMISSIBLE POWER - W

The maximum power that can be transmitted through a cable is limited by the heating of the cable itself and the softening temperature of the dielectric.
The higher the frequency, dielectric constant, and dissipation factor, the greater the heat loss will be.
The transmissible power therefore depends on the materials and dimensions of the cable, as well as, of course, the ambient temperature and reflections.

REFLECTIONS - SWR

Along a coaxial transmission line, any dimensional or material irregularity leads to an uneven characteristic impedance.
With each variation in impedance from the nominal value, part of the signal is reflected, thus increasing losses and reducing the transmissible power.
Reflections increase as the frequency rises, and irregular reflection peaks may be detected during cable testing.
Reflections are expressed by the reflection coefficient, SWR (standing wave ratio), and return loss.