TMDS: Transition Minimized Differential Signal
CEC: Consumer Electronic Control: Device control function between HDMI Video/audio devices
Hot Plug: Allows to detect the plug of a device.
HEC: HDMI Ethernet Channel: allow to support bidirectional Ethernet communication up to 100 Mb/s
SCL/SDA: I2C serial clock for Display Data Channel (DDC Channel)

2.2.4.8 RF Connectors

Applications and characteristics of coaxial connectors

Line-bound high-frequency signals are susceptible on the one hand to the coupling in of interference signals, and on the other hand to decoupling into the environment. Without appropriate shielding, high-frequency lines therefore act like antennas and emit or receive undesirable electromagnetic waves. For this reason, coaxial lines and connectors have become established in wire-based high-frequency technology. Thanks to their shielding (outer conductor), they attenuate both unwanted signal coupling into and decoupling from the inner conductor to such an extent that they can usually be neglected in applications.

In coaxial connectors, single-ended signals are always transmitted with referenced grounding. The signal-carrying inner conductor is located in the center of a coaxial cable. An insulating dielectric separates it from the outer conductor. This shielding establishes the connection with the ground potential. The inner conductor, dielectric and outer conductor are arranged coaxially, thus giving this type of cable its name (Figure 1.331check number).

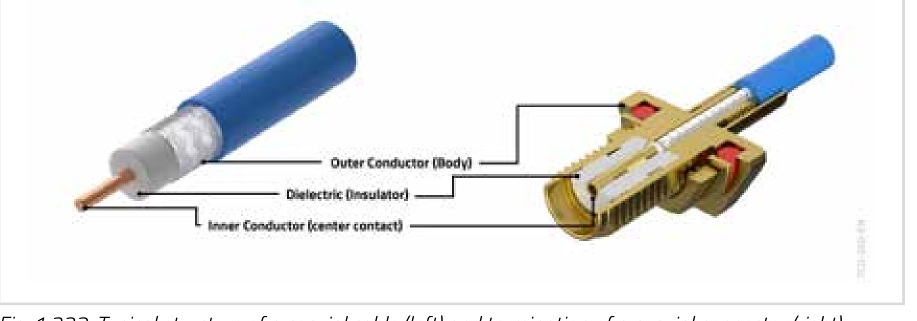

Fig. 1.332: Typical structure of a coaxial cable (left) and termination of a coaxial connector (right).

In the case of coaxial cables, it is precisely the product structure as critical points, since it is important to maintain effective shielding there. While the shielding structure of coaxial cables is usually homogeneous, a discontinuous transition is almost unavoidable when the cable is mostly connected to a coaxial connector. By means of suitable design measures, connectors must also ensure the shielding effect over the entire plug-in connection from cable to plug and socket to another cable or printed circuit board. In addition, changes in the diameter of the inner conductor lead to impedance differences and thus cause signal reflections.

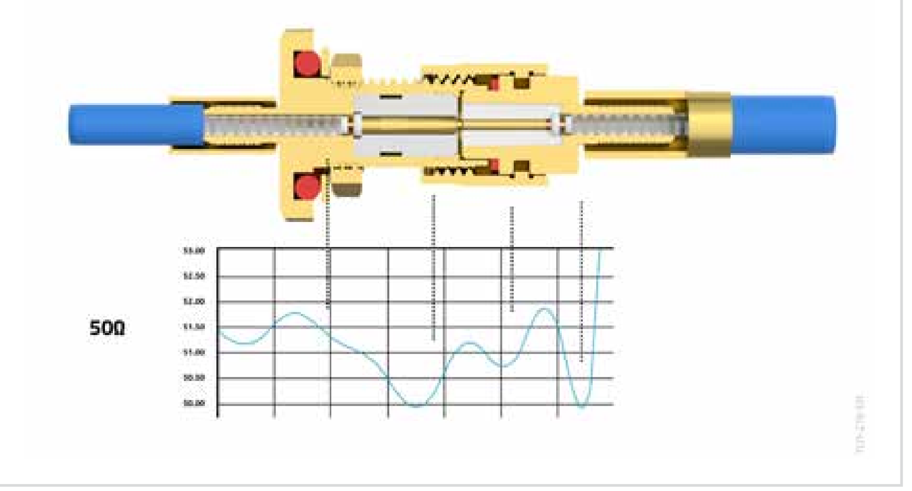

Fig. 1.333: Deviations from the ideal wave impedance of 50 Ω occur at the junctions of the coaxial line and the coaxial connector.

Characteristic impedance and wave propagation

An important parameter for the optimum transmission of high-frequency signals is the characteristic impedance of the RF waveguide, which should have the same value over the entire transmission distance. The characteristic impedance Z_L results from the geometry of the coaxial cable and the impedance of free space Z_0 (376,62 Ω):

$$Z_L = \frac{Z_0}{2\pi\sqrt{\epsilon_r}} \ln\left(\frac{D}{d}\right) \qquad \text{(EQ 24)}$$

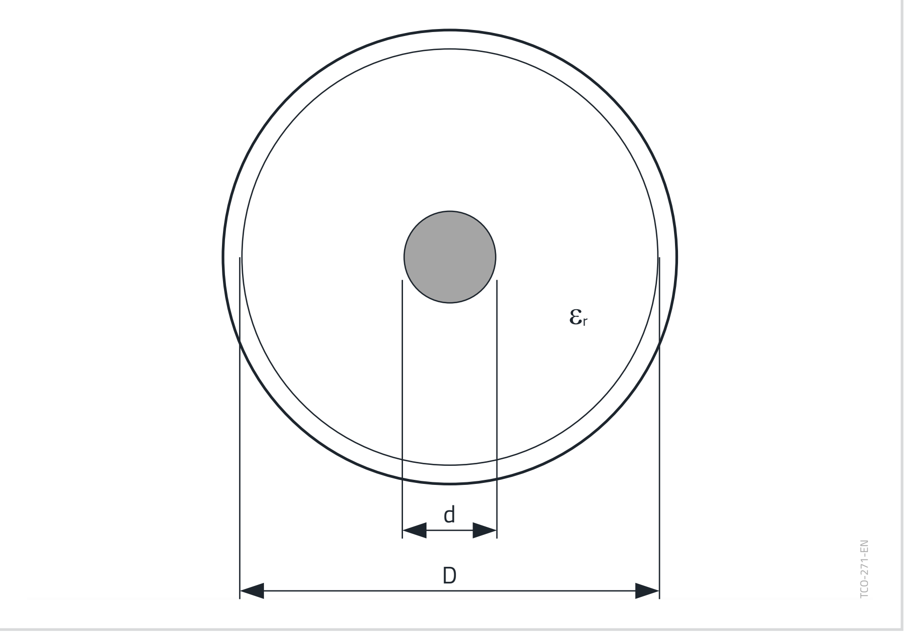

Fig. 1.334: Coaxial line in cross-section. The ratio of the diameters of the inner conductor (d) and outer conductor (D) determines the characteristic impedance.

Typical values for the characteristic impedance of an RF line are 50 and 75 Ω. The diameter of the inner conductor is smaller in the 75 Ω version than in the 50 Ω version.

Typically, transverse electromagnetic waves (TEM) propagate over a coaxial line, where the electric field in the insulating dielectric is radially directed and the magnetic field is concentrically directed. The signal propagation is subject to higher losses with a usually relative permittivity $\varepsilon_r > 1$ of the dielectric compared to air.

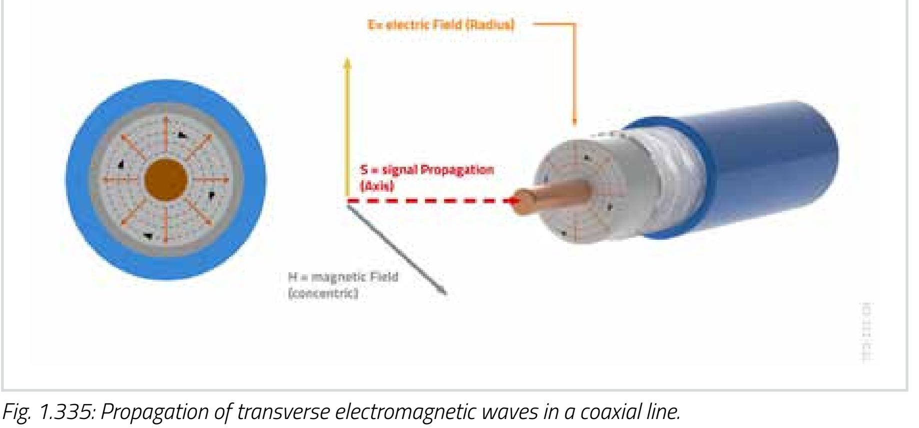

Fig. 1.335: Propagation of transverse electromagnetic waves in a coaxial line.

Impedance mismatches in an RF transmission line cause power losses and reflected energy. Voltage Standing Wave Ratio (VSWR) is a method of measuring such impedance mismatches. VSWR is defined as the ratio between the transmitted and reflected voltage standing waves and is considered an ideal match when VSWR = 1. A common example is an RF power amplifier connected to an antenna via a transmission line. Influencing factors here are the electronics, connectors, jacks, cables, i.e. all RF transmitting components of the system. A high SWR indicates poor efficiency of the transmission line and reflected energy.

Types of coaxial connectors and frequency response

There are numerous types of coaxial connectors, for example N-Type, BNC, TNC, Belling-Lee, F, MCX, MMCX, SMA, SMB, SMP, K, V, W to name just a few de facto standards. Depending on the connector type, the frequency spectrum extends into the one- and two-digit gigahertz range, with the widespread SMA types often specified up to 18 GHz, the more advanced K connectors up to 40 GHz, V connectors up to 70 GHz and W types even up to 110 GHz. The following section explains the coaxial RF connector types SMA, SMB, SMP, UMRF, MCX,MMCX, BNC, TNC and N Type from Würth Elektronik (www.we-online.com/coax) as examples.

Fig. 1.336: The portfolio of Würth Elektronik eiSos includes the coaxial RF connector types UMRF, MMCX, MCX, SMP, SMB, SMA, SMB, BNC, TNC and N-TYPE