A Novel Type N Coaxial Air-line Verification Standard

N. Shoaib*(1) (2), K. Kuhlmann(3), and R. Judaschke (3)
(1) Politecnico di Torino, Italy
(2) Istituto Nazionale di Ricerca Metrologica, Torino, Italy
(3) Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

Vector network analyzers (VNAs) are versatile and complex instruments to characterize devices in the RF and microwave range. After the calibration of a VNA, airlines and attenuators are typically used for the two-port verification in coaxial connector systems. In this paper, a novel type N coaxial verification standard, operating at frequencies up to 18 GHz, based on air-line architecture is designed, fabricated and analyzed. This coaxial architecture is relatively simple compared to already existing attenuation standards which are often based on T- or π-network configurations of lumped elements and it also provides significant transmission losses. The simple approach enables the realization of a calculable standard. Based on electromagnetic simulations, a complete uncertainty budget is presented and compared with the measurement results.

To achieve significant transmission losses, a below cut-off section is used for the design of the coaxial verification standard by cutting the inner cylindrical conductor of the coaxial air-line into two halves. The gap between the halves acts as a below cut-off cylindrical waveguide section. To align the inner conductors, the two halves are connected by a dielectric inset. The complete section can be described as a capacitor acting as a high pass filter. Two different topologies are considered concerning the diameter of the cylindrical dielectric inset. In the first topology, the diameter of the cylindrical inset is equal to the diameter of the inner conductor, while in second topology, the diameter of the cylindrical inset is equal to the outer conductor of the coaxial air-line. The latter configuration is mechanically advantageous because it aligns the two halves with the longitudinal axis of the coaxial standard.

The simulations are performed using *CST Microwave Studio*. The measurement uncertainty of the verification standard is computed by taking into account the tolerances of both mechanical dimensions and dielectric material. The measurement uncertainty due to different error sources is computed according to the *Law of Propagation of Uncertainty*. The data analysis is performed on complex quantities i.e. scattering parameters (S-parameters). The diagrams illustrating the 3D model and the hardware realization for the coaxial verification standard are shown in Fig. 1 and 2, respectively. The measured transmission magnitude and phase agree very well with the simulated values.

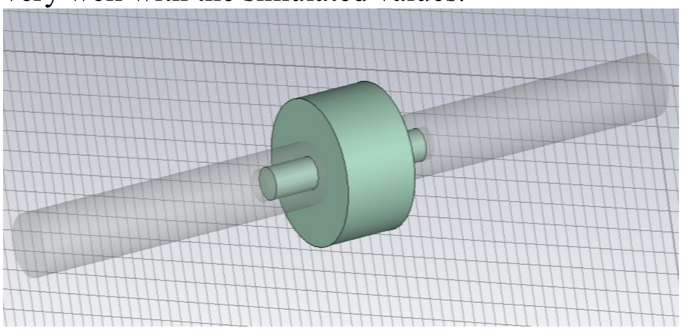

Fig. 1 Inner conductor simulation model of the verification standard

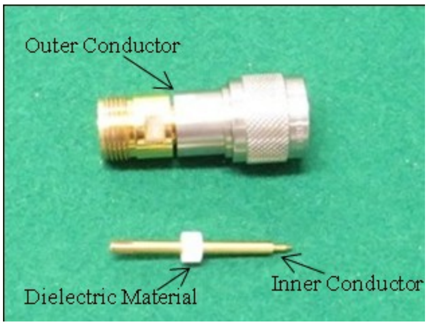

Fig. 2 Photograph of the verification standard