

Virtual networks: new applications for Network Analyzers ZVR and ZVC

Virtual Embedding Networks option ZVR-K9 is a new tool that opens up a whole variety of new applications for Network Analyzers ZVR and ZVC [1]. This software allows so-called virtual networks to be taken into account in S-parameter measurements.

The measurements that can be handled with the aid of ZVR-K9 split into two complementary classes. In the first place, a component may have to be measured as if it were contained in a defined but physically non-existent circuit environment, ie embedding. The other possibility is measurement of a component actually embedded in a real circuit environment but as if the environment did not exist, ie de-embedding [2; 3].

Here is a typical **example of embedding**: a surface-acoustic-wave filter with an impedance of several hundred ohms is to be worked in a $50\ \Omega$ environment. For this purpose the filter has to be embedded in an external matching circuit, eg an RLC combination. To simplify system design for the user,

the manufacturer specifies the filter together with the matching circuit in which it is also tested. This external circuit must be highly stable to minimize measurement uncertainties. If several circuits of the same type are used to increase the testing throughput, the circuits must be reproducible to a high degree. Most real matching circuits fall somewhat short of these two requirements. Option ZVR-K9 allows operation of the filter in a real $50\ \Omega$ environment and consideration of a virtual matching or transforming network in the measurement. This virtual network is a data record, so it is per se stable and reproducible. Consideration of the network in the measurement is possible by appropriate modification of system error-correction data. This means that no extra step is needed in the processing of measured results and the high speed of ZVR is maintained. The two upper diagrams in FIG 1 show the forward S-parameters S_{11} and S_{21} of a through-connection embedded in two (mismatched) Insertion Adapters ZPV-Z1. Each diagram contains two traces, one representing

measurement with a real transforming network and the other a simple through-connection between the $50\ \Omega$ test cables with the network virtual. The two traces are almost identical, which is shown by the vector difference in the diagrams below. Note that the outer circle corresponds to a difference of only 0.02.

In a **de-embedding application**, the DUT ports of interest are not accessible but you know the S-parameters of the network in which the DUT is embedded. This may be a test adapter, for instance, or the package of an MMIC whose inner chip is to be measured. By virtually embedding the DUT with the real transforming network into the corresponding inverse network, the transformation can be neutralized and the de-embedding problem thus turned into one of embedding (FIG 2).

For two-port DUTs the general embedding network is a four-port network. In most practical applications however, it is sufficient to take the special case of a dual two-port. The scattering parameters of the virtual network must be known for both embedding and de-embedding. If they are not known but the network is physically available in the form of a sample circuit, this real network can be measured with ZVR-K9 (unterminating). Or scattering parameters may also be read in from a CAD simulation. The ASCII formats of Ansoft (eg Serenade[®], Super Compact[®]) and HP-EEsof (eg Series IV[®], Touchstone[®]) are supported in this case. Conversely, the measured scattering parameters of a network can also be exported in these data formats.

Option ZVR-K9 comes as a Windows application for ZVR or ZVC with option ZVR-B15 (controller function). It is installed with the aid of a setup program.

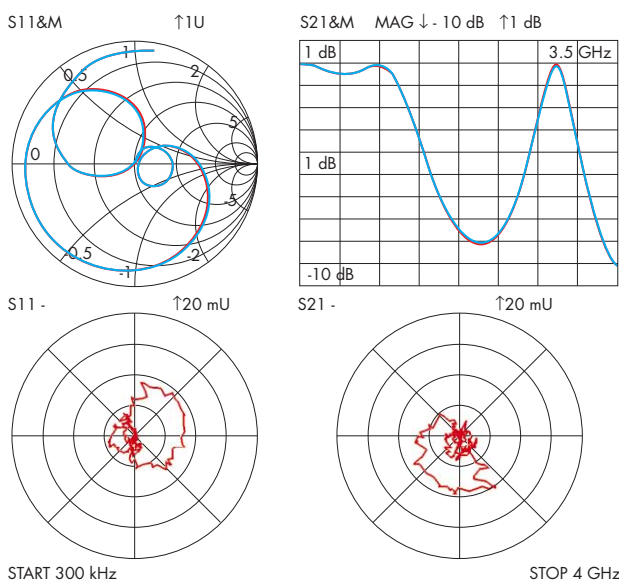


FIG 1 Upper diagrams: S_{11} and S_{21} of through-connection, embedded in physically real Insertion Adapters ZPV-Z1 (red traces) or in virtual ones (blue traces). Vector difference of two traces is shown below each diagram.

ZVR-K9 is controlled by a menu bar and pulldown menus. Functions requiring a lot of user entries, eg measurement of real transforming networks, are organized in successive windows. These contain help graphics in part and are easy to view. User-friendly operation is enhanced by numerous management functions for both the virtual networks and the system error-correction files that are to be modified. Selection of the required virtual network from the program's internal database, for instance, is supported by a list of important parameters such as frequency range, number of points, storage date and an optional comment. With the dis-

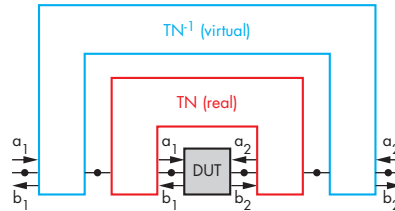


FIG 2 De-embedding solved by embedding real DUT with transforming network in virtual, inverse network

play channels decoupled, an individual virtual network can be selected for each channel.

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REFERENCES

- [1] Ostwald, O.; Evers, C.: Vector Network Analyzer ZVC – Double frequency and benefit. News from Rohde & Schwarz (1998) No. 158, pp 4–6
- [2] Lane, R.: De-Embedding Device Scattering Parameters. Microwave Journal, August 1984, pp 149–156
- [3] Vaitkus, R.L.: Wide-Band De-Embedding with a Short, an Open, and a Through Line. Proc. of the IEEE, Vol. 74, No. 1, Jan. 1986, pp 71–74