TEMPEST TROUBLE-SHOOTING USING A DIFFERENTIAL MODE REJECTION NETWORK

The DMRN solves the problems of getting fast, accurate, and reliable data on common mode emissions.

Mark J. Nave, EMC Services, Inc., Seminole, FL

BACKGROUND

When TEMPEST, FCC, and VDE measurements are made, testing for conducted emissions is performed with a LISN and a receiver. The total noise, comprised of common mode and differential mode components, is measured by this setup. While total noise is the only test that is of interest for compliance measurements, any troubleshooting method to suppress the source of the emissions will normally begin with the identification of the conduction mode, and hence the coupling path.

In the past, a current probe was used to separate common mode from differential mode. The disadvantages of the current probe technique are:

- The current probe output is a voltage signal proportional to the current through the probe. For the user to relate this measurement to the LISN voltage measurement, the current must be multiplied by the LISN impedance. This is an additional step for the user.
- The current probe typically has amplitude and phase (or time) distortion of the signal which varies with frequency. Thus the current correction factor is varying with frequency and even more effort is required by the user.

Typically, both components of noise exist at the same frequency. Both components may be approximately the same amplitude or one may dominate. To relate the current probe measurement to the LISN data, one must use the correction factors. These time consuming inconveniences were the reasons the Differential Mode Rejection Network (DMRN) was developed.

THE NEW METHOD

With the DMRN, the problems of getting fast, accurate, reliable data on common mode emissions have been solved. The DMRN connects to the actual LISNs being used, so no modifications to the test setup are required. The DMRN attenuates the differential mode emissions by 50 dB minimum from dc to 30 MHz. The common mode emissions are attenuated by less than 4 dB. The DMRN performance is depicted in Figure 1. Specifications are given in Table 1. Note that almost no amplitude or phase distortion results, and direct measurement of the common mode emissions is possible.

USE OF THE DMRN

When all source suppression techniques have been used and the EUT still generates conducted emissions above the allowable limits, a filter must be designed to reduce the emissions. Filter design separately incorporates common mode and differential mode filtering; however, there is no method to determine the required amount of filtering for each type of EMI other than trial and error. This is another use of the Differential Mode Rejection Network. To design a filter for an EUT one would then use the DMRN and the following procedure:

- A set of measurements are made on the EUT using the DMRN. This measures only the common mode conducted emissions.
- A common mode filter is designed for the EUT and the EUT is retested to ensure that conducted emissions are within specified limits.
- With the common mode filter in place, measurements are taken on the EUT without the DMRN. This measures the total emissions. Since all common mode emissions are beneath the specified limit, all emissions above the limit are differential mode.
- A differential mode filter is designed for the EUT, and the EUT is retested to ensure that it meets all conducted emissions requirements.

The DMRN thus is used as a tool to aid the designer or EMI engineer in identifying the specific mode of conducted emissions and to aid in the development of a suitable filter.

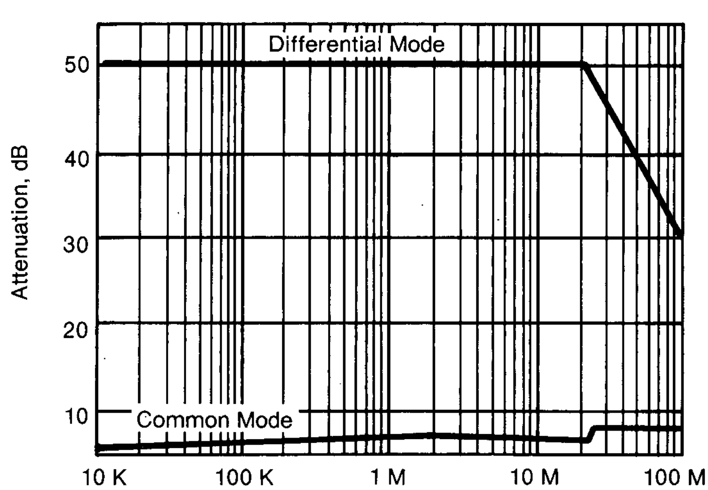

Figure 1. DMRN

Frequency Range	DC to 30 MHz
Impedance	50 Ohm at all ports
Differential Mode Rejection	50 dB minimum
Common Mode Attenuation	< 4dB
Maximum Power Input	33 dBm (140 dBµV)
Input and Output Connections Made via BNC Connectors	
Cabinet Dimensions	3"H x 4"W x 3"D

Table 1. DMRN Specifications.

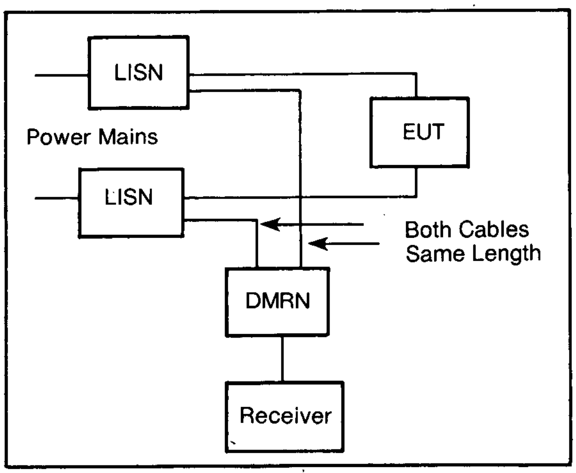

Figure 2. Block Diagram of Test Setup With DMRN.

DMRN IN THE LAB

The DMRN is connected as shown in Figure 2. One of the DMRN inputs is connected to the phase LISN, and the other is connected to the neutral LISN. The DMRN properly terminates the LISNs and provides a matched 50-ohm output for the receiver. The connections should be made by coaxial cables of exactly the same length. As short a length as possible should be used to connect the DMRN to the LISNs.

The case of the DMRN should be grounded directly to the reference ground plane. Note that a ground loop is formed by the DMRN case, the coaxial cable shield, the LISN case, and the reference ground plane. It is unlikely that the ground loop formed by the two cases and the short cable shield will present a problem, except in the presence of a very strong magnetic field. Grounding the DMRN as close as possible to the LISNs is therefore normally recommended.

The guidelines given above enable the engineer to utilize the DMRN, an important unit that can save valuable time and yield more precise test results. ■