Comparison of Shielding Effectiveness Measured by Using Absorption Clamp Method and Reverberation Chamber Method

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Introduction

- The shielding effectiveness of the cable can be measured by absorbing clamp method (ACM) and reverberation chamber method (RCM).
- The absorbing clamp can be used to measure the power radiated from the cable under test (CUT). Due to the consistency of electromagnetic environment in reverberation chamber (RC), the power of external environment coupling into CUT power can be received by the reference antenna.
- Due to the difference in characteristic impedance between the cable and the VNA, an impedance adapter is added. Furthermore, for the test conditions without impedance adapter, the final results are corrected by the scattering matrix.
- We compared the results of shielding effectiveness measured in different methods and states.

Measurement Setup

In this part, the schematic and the arrangement of the testing methods are shown in Fig. 1 and Fig. 2. The paired cable and the impedance adapter are shown in Fig. 3.

Theory and Results

- In the absorbing clamp method, the screening effectiveness is defined as:
  \[ a_s = -10 \log_{10} \left( \frac{P_s}{P_m} \right) \]
  where \( P_s \) is the peak power of the near far end test, and \( a_s \) is the attenuation of the measuring device, including part cables, current converter, RF line inside the absorbing clamp and attenuator. \( k_m \) is the voltage gain of impedance adapter.
- In reverberation chamber method, the screening effectiveness is defined as follows:
  \[ a_s = -10 \log_{10} \left( \frac{P_{DUT}}{P_{REF}} \right) \]
  where the \( P_{DUT} \) is the power of external environment coupling into DUT, \( P_{REF} \) is the power received by the reference antenna.
- The detailed formula for calculating SE is expressed as follows:
  \[ a_s = -10 \log_{10} \left( \frac{P_{DUT}}{P_{REF}} \right) - \Delta_{ins} - X_L \]
  where \( \Delta_{ins} \) is the insertion loss of the chamber, \( X_L \) is the insertion loss of all linking devices inside and outside the chamber.
- The voltage gain of the impedance adapter can be expressed as follows:
  \[ k_m = \frac{R_s R_p}{R_s R_p + R_s + R_p} \]
  where \( R_s \) is load resistance, \( R_s \) and \( R_p \) are the resistance of series and parallel resistor respectively.

- When without adding impedance adapter, the scattering matrix simplified by normalized transfer matrix is expressed as follows:
  \[ |S| = \begin{bmatrix} \frac{Z_{101}}{Z_{201}} & \frac{Z_{102}}{Z_{202}} \\ \frac{Z_{211}}{Z_{111}} & \frac{Z_{212}}{Z_{112}} \end{bmatrix} \]

  **Loss** = 20 \* log_{10} |(Z_{212})|

  where \( Z_{01} \) is 50 \( \Omega \), \( Z_{02} \) is the characteristic impedance of the paired cable.

Conclusions

- Under RCM and ACM, the SE calculated with scattering matrix is lower than that calculated with voltage gain in most frequency band. It means that new errors could be introduced for the existence of impedance adapter.
- The SE is insensitive to the polarization of CUT in RC. The difference could be produced through the change of height during movement.
- The shielding effectiveness measured by ACM is higher than that measured by RCM, and the difference between them increases with frequency.
- The ACM could have different coupling mechanism compared with the cable radiation in an RC, which leads different results.