# Verification of Circuit Signal Detection Method for Non-contact Measurement System

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***Abstract* — With the size of electronics products becoming smaller, the EMC issue is more important. The common use of analysis technique in EMC issues is contact-measurement technology. However, the high circuit density in package, it's hard to make sure every single trace design with test point for contact-measurement. Non-contact technique such as nearfield measurement become popular with the advantage that it doesn't require test point. Nearfield-measurement is usually used to find hot spots of the electromagnetic field and realized which region is the main noise location. To realize the reason for noise, coupling loss between probe and DUT should be de-embed.**

***Keywords—De-embedding Technique, Equivalent Circuit Model, Near Field Measurement, Non-contact Signal Excite***

## I. Introduction

With the application trend of high frequency and high speed of the circuit, the measurement technology is driven to evolve. In the literature [1], the evolution of the measurement technology of the high-frequency probe is mentioned. However, due to the miniaturization of hand-held electronic products, the circuit may have no extra space to design test points, so it is impossible to use the traditional contact measurement interface such as high-frequency probes or SMA(Sub Miniature Version A) connectors to check the interference effect of the signal transmission path affecting the circuit operation. This paper is based on the near-field measurement system. The rise of operating frequency and the development of high density of signal traces, the reduction of the chip spacing in the product, and the resulting many electromagnetic compatibility problems, are easily affected by the surrounding electromagnetic fields. Therefore, the near-field measurement system is used to analyze and detect electromagnetic interference problems. The paper is based on the IEC-61967-3 specification for near-field measurement systems set by the IEC (International Electrotechnical Commission).

## II. Measurement Architecture

The frequency-domain near-field measurement architecture is shown in Figure 1. The excitation end in the measurement system is a network analyzer, which can output a frequency range of 300kHz~20GHz, and the receiving end is a spectrum analyzer with a receiving range of 1Hz~26.5GHz. The magnetic field probe is 300kHz~6GHz, so the frequency range that the system can support is 300kHz~6GHz.

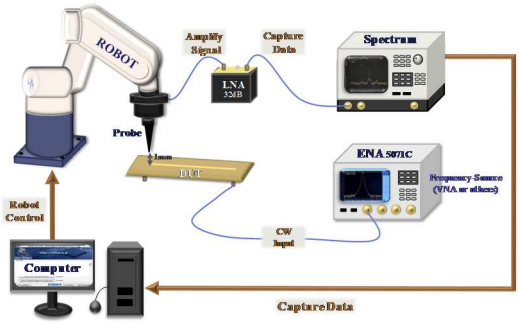


Fig. 1. Frequency Domain Near-field Measurement Architecture

## III. Non-contact Equivalent Model

Combined with the equivalent electric field probe model established in sections, the coupling amount of the electric field probe to the transmission line can be gradually analyzed, as shown in Figure 2 for the coupling equivalent model. To simplify the complexity of de-embedding, one port is added with load to change the measurement structure from three ports to two ports shown as in figure 3.

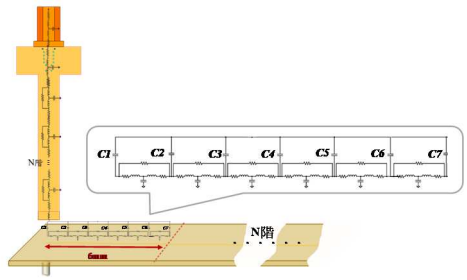


Fig. 2. Coupled Equivalent Model

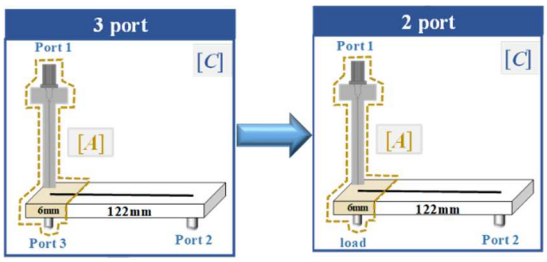

Fig. 3. Schematic diagram of electric field probe coupling transmission line 3port measurement and 2port measurement

## IV. Verification of Transmission Line De-embedding

Figure 4 is a schematic diagram of De-embedding restoring DUT characteristics.

The subscript table is the source of scattering parameters. There are three sources of [C], namely HFSS simulation, the table is [C]_HFSS; the measurement is [C]_meas; the model establishment is [C]_model, and [A] is also divided into three types: [A]_HFSS, [A]_meas, and [A]_model, so there will be nine kinds of De-embedding verification results. As a result, only the [C]_model De-embedding [A]_model succeeded.

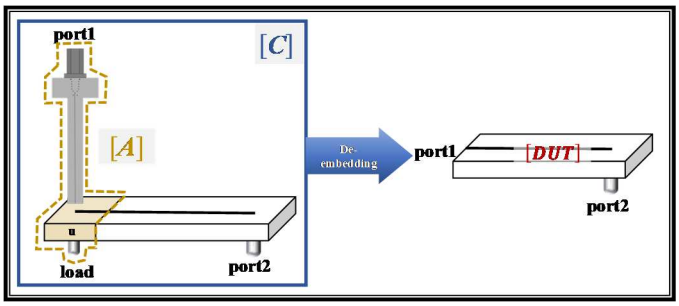


Fig.4. Schematic diagram of De-embedding restoring DUT

De-embedding restores DUT characteristic results almost invalid, In order to analyze the cause of failure, first, confirm whether the scattering parameters [A]_HFSS and [A]_model have the same characteristics as [A]_meas. The verification results show that the difference in the reflection loss is large, as shown in Figure 5.

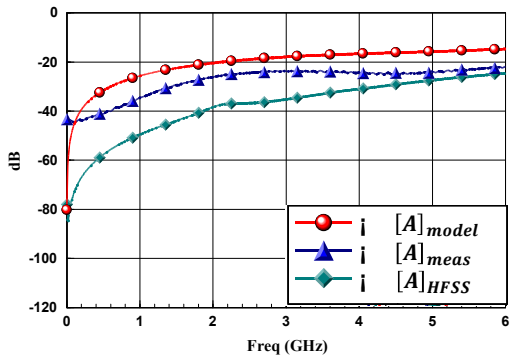


Fig. 5. Return loss_S22

After confirming [A]_HFSS, [A]_model, and [A]_meas, add the simulated [DUT]_HFSS as shown in Figure 6, check whether it can be restored to [C], and compare it with the measurement, as shown in Figure 7 is the verification result of [A]+[DUT] being the reflection loss, which may cause different resonance points due to the impedance mismatch of the junction.

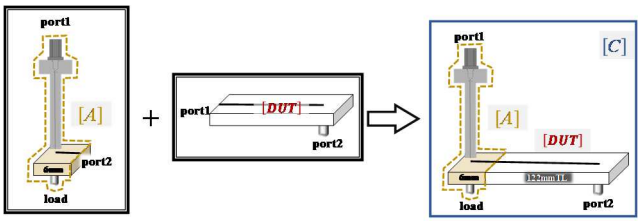


Fig. 6. [A]+ [DUT] Validation Schematic

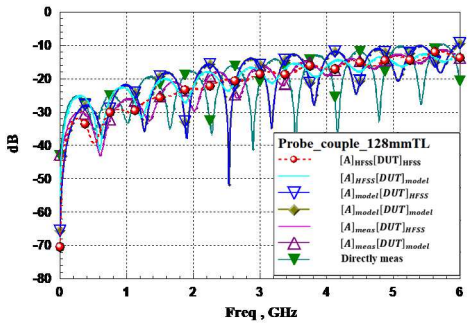


Fig. 7. [A]+ [DUT] Validation Schematic _Return loss_S22

## V. Conclusion

In order to simplify the complex effect of De-embedding, the original three-port measurement is simplified to two ports, so that the part of the probe radiation coupled to the DUT is deducted to restore the DUT characteristics. In addition to using the transmission line as the verification benchmark, first, verify the accuracy of the electric field probe coupled to the 6mm transmission line [A] and the electric field probe coupled to the object to be tested [C], and then [C]-[A] to check whether the object to be tested can be restored characteristic, it was found that the restoration could not be expected. Therefore, [A]+[DUT] is verified to be able to restore [C], so it is preliminarily judged that the junction impedance of its De-embedding does not match and the result of [C]-[A] has a gain, and also causes [A] +[DUT] has different resonant points of reflection loss. Therefore, it is confirmed by [C]-[DUT] and [C]-([C]-[DUT]) that the junction impedance does not match and the characteristics of the DUT cannot be restored.

## References

[1] Han-Hsiang Shih, Meng-Hua Tu and Sung-Mao Wu, " Non-exchanging structure calibration kit for double-side direct contact measurement," 2015 Asia-Pacific Microwave Conference (APMC), Dec 2015