



Reference Plane Definition

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10 November 2017

Outline

Introduction

Computing S-Parameters

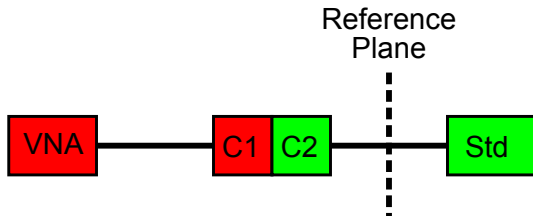
Results



Objective

The objective is to find a way to separate the VNA from the DUT.

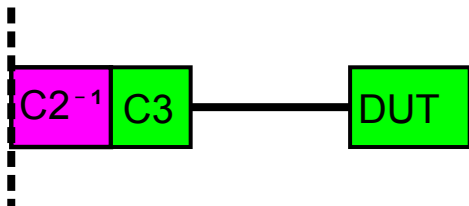
Reference Plane VNA-Connector



- ▶ No need to characterize connectors of standards
- ▶ Condition: all standards must have the same connector

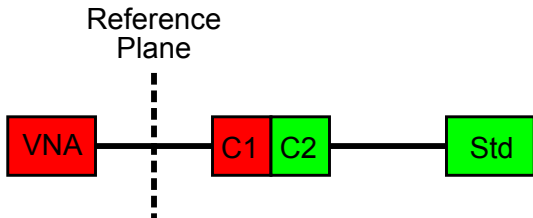
DUT from Refplane VNA-Connector

Reference
Plane



- ▶ $C2^{-1}$ is inverse of connector of standards
- ▶ Reference plane makes sense for DUTs with exactly the same connector as the standards ($C2 = C3$)
- ▶ For comparison between laboratories one needs the same test ports and the same type of connectors on the standards
- ▶ Cascading of results is not possible because connector is missing or mixed with connector of standards

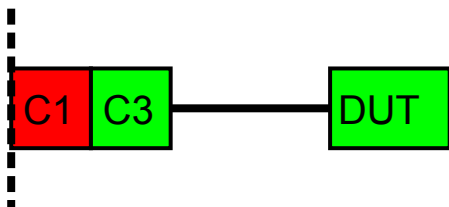
Reference Plane Connector-DUT



- ▶ One has to characterize connectors of standards and test port

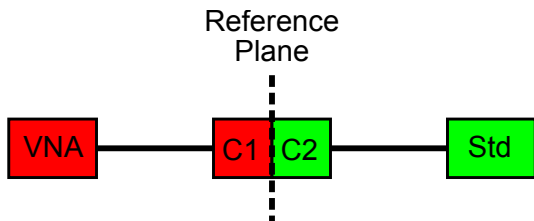
DUT from Refplane Connector-DUT

Reference
Plane



- ▶ C1 is the connector of the test port used during calibration
- ▶ For comparison between laboratories one needs the same test port
- ▶ Cascading of results is not possible because of the connector of the test port.

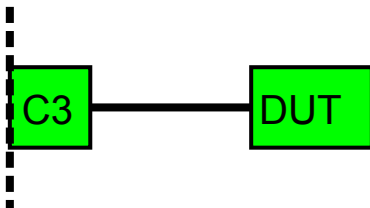
Reference Plane Connector



- ▶ One has to characterize connectors of standards

Reference Plane Connector

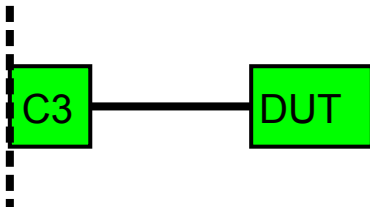
Reference
Plane



- ▶ C3 is the connector of the DUT
- ▶ For comparison between laboratories one needs only the same DUT
- ▶ Cascading of results is possible

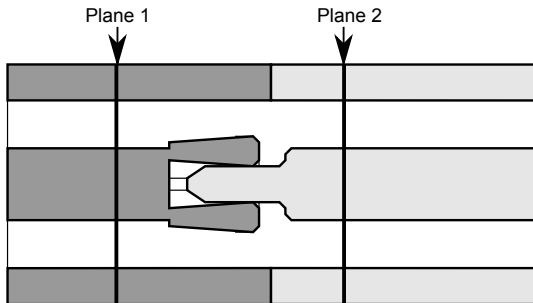
Reference Plane Connector

Reference
Plane



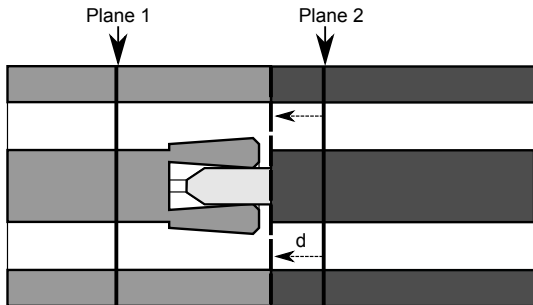
- ▶ C3 is the connector of the DUT
- ▶ For comparison between laboratories one needs only the same DUT
- ▶ Cascading of results is possible
- ▶ **Normal S-parameters can not be defined in this reference plane**

1.85 mm Complete Connector



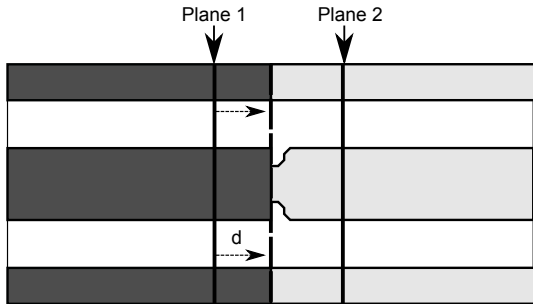
- ▶ The reference planes are in mono-mode regions

1.85 mm Female Connector



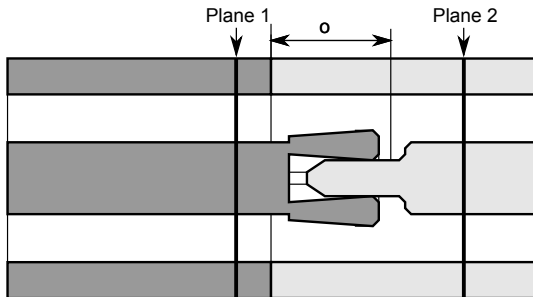
- ▶ The reference planes are in monomode regions
- ▶ The right reference plane is phase-shifted to the center

1.85 mm Male Connector



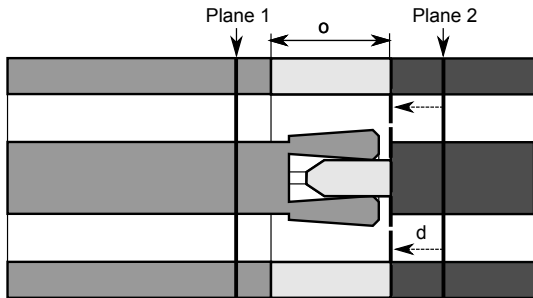
- ▶ The reference planes are in monomode regions
- ▶ The left reference plane is phase-shifted to the center

N-Type Complete Connector



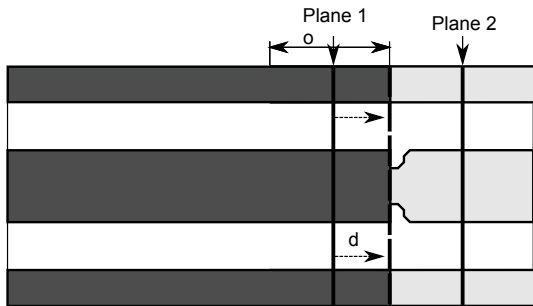
- ▶ The reference planes are in mono-mode regions

N-Type Female Connector



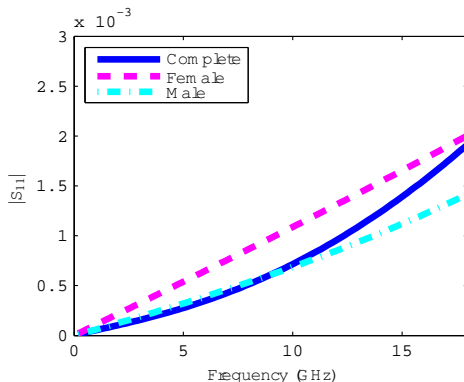
- ▶ The reference planes are in monomode regions
- ▶ The right reference plane is phase-shifted to the center of the center conductor
- ▶ The center of the center conductor is the separation plane

N-Type Male Connector



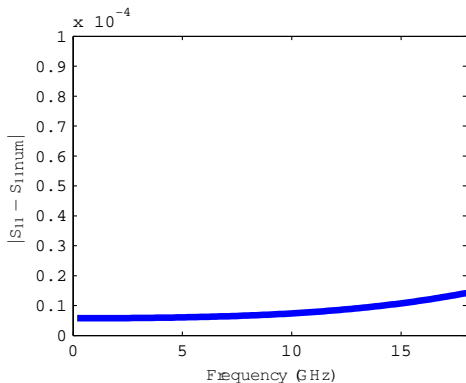
- ▶ The reference planes are in monomode regions
- ▶ The left reference plane is phase-shifted to the center
- ▶ The center of the center conductor is the separation plane

N-Type Reflection Coefficient



- ▶ Reflection of female contact fingers is strong
- ▶ Reflections of male and female do not add up linearly to complete connector

Male-Female Cascaded versus Full Connector



- ▶ The difference between cascading and full connector is 100 times smaller than the connector effect
- ▶ The displayed difference is as well due to the used numerical technique (FDTD)

Conclusion

- ▶ Placement of the reference plane depends on application
- ▶ Reference plane in the middle works fine for coax
- ▶ There is a solid mathematical theory why placing the reference plane in the middle works