A NOVEL VNA BASED UTILITY TO CREATE “N” PORT S-PARAMETER MATRIXES WITH “M” PHYSICAL PORTS, APPLIED TO ARBITRARY TOPOLOGIES; WHERE M<N

ROHDE&SCHWARZ

Make ideas real

SECTIONS

1. REVIEW THE DEVICE UNDER TEST
2. REVIEW THE TEST STAND
3. UNDERSTAND THE FIXTURE
4. DRIVE THE APPLICATION: TOPOLOGY & MEASUREMENT
5. EXPLORE FIXTURE DESIGN

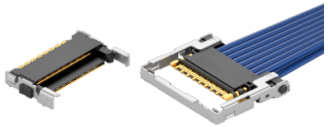
SI-FLY LOW-PROFILE CABLE

PAM4 56 Gbps

PAM4 112 Gbps

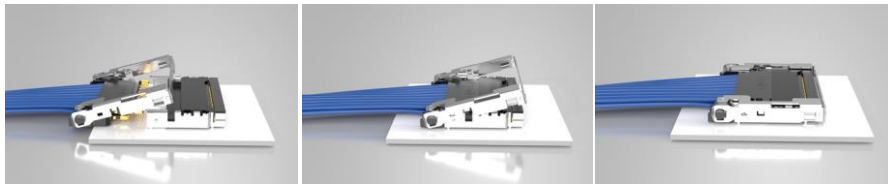
SI-FLY LP

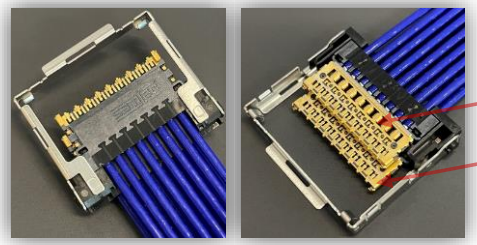
CPC/CPI SERIES



- Low-profile cable system
  - 56G NRZ / 112G PAM4
  - PCIe® Gen 6 capable performance
  - 1-row (8 DP) or 2-row (16 DP) configurations
  - Able to easily fit under heat sinks or other hardware
  - 34 AWG, 92 Ohm ultra-low loss twinax cable
  - BGA attach board connector

SI-FLY™ Mating Step 1, 2, 3

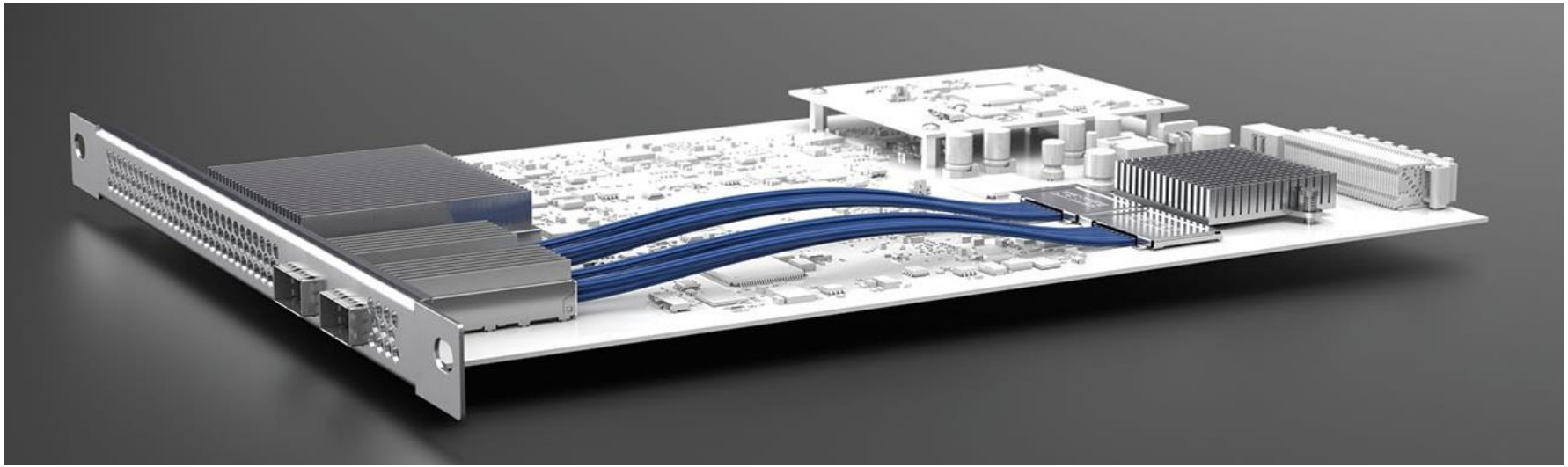




SAMTEC FLYOVER SOLUTIONS

PAM4 56 Gbps

PAM4 112 Gbps



TEST FIXTURE WITH FLYOVER CABLE

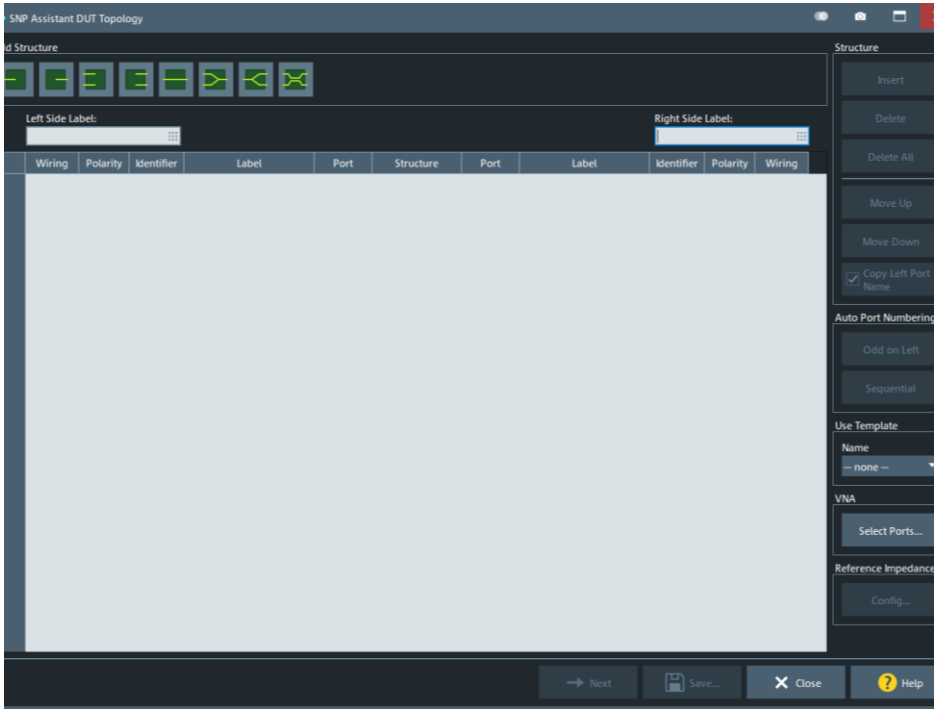
- https://www.samtec.com/kits/si-eval-cable/si-fly-flyover/
- https://www.samtec.com/products/185-cm

TEST EQUIPMENT

1. • R&S®ZNB40 100 KHZ TO 40GHZ NETWORK ANALYZER
2. • FOUR PORTS
3. • 140 DB DYNAMIC RANGE
4. • BRIDGE BASED DIRECTIONAL COUPLER FOR HIGH ACCURACY AT LOW FREQUENCIES
5. • SNP ASSISTANT AND DE-EMBEDDING UTILITY LICENSES

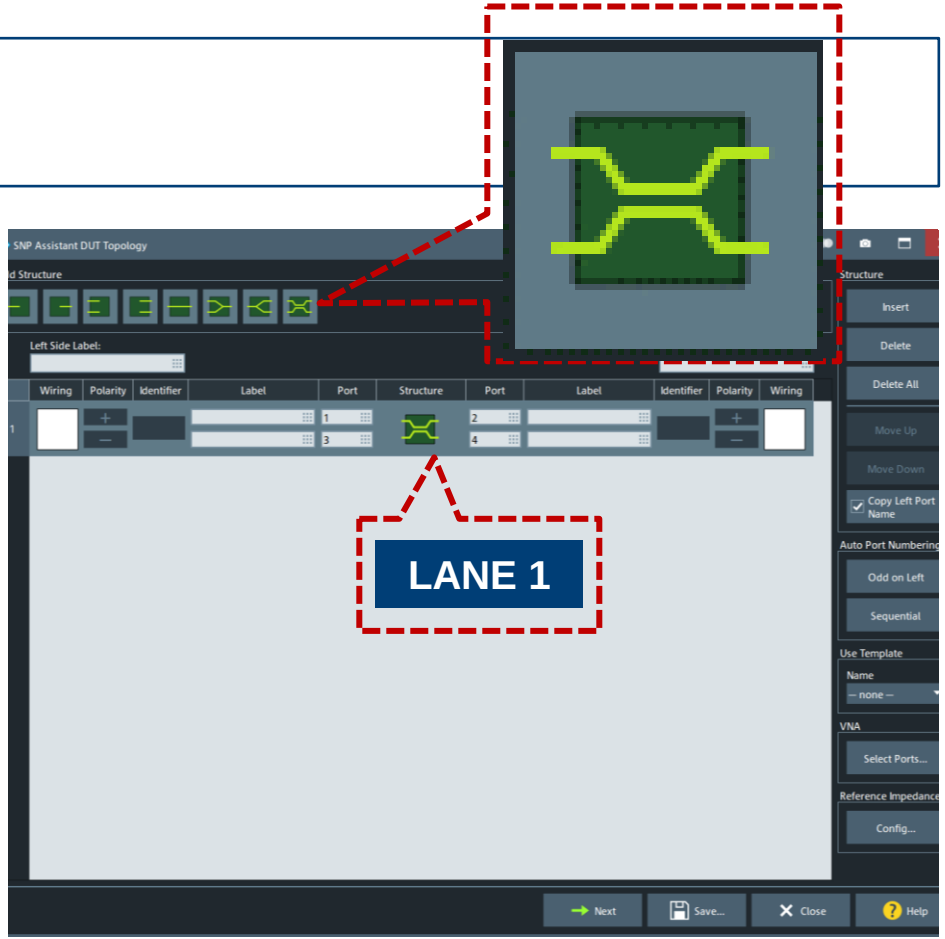
BUILD THE TOPOLOGY

1. • **WE LAUNCH THE UTILITY WHEREIN WE DEFINE AND BUILD THE MULTIPORT DUT TOPOLOGY**
2. • We know that our lanes are differential pairs, so we add a differential lane
3. • WE HAVE DEFINED TWO DIFFERENTIAL PAIRS IN OUR DUT SIMULATION SO WE ADD TWO DIFFERENTIAL PAIRS TO THE GUI



BUILD THE TOPOLOGY

1. WE LAUNCH THE UTILITY WHICH ALLOW US TO DEFINE AND BUILD THE MULTIPORT DUT TOPOLOGY
2. **WE KNOW THAT OUR LANES ARE DIFFERENTIAL PAIRS, SO WE ADD A DIFFERENTIAL LANE**
3. WE HAVE DEFINED TWO DIFFERENTIAL PAIRS IN OUR DUT SIMULATION SO WE ADD TWO DIFFERENTIAL PAIRS TO THE GUI



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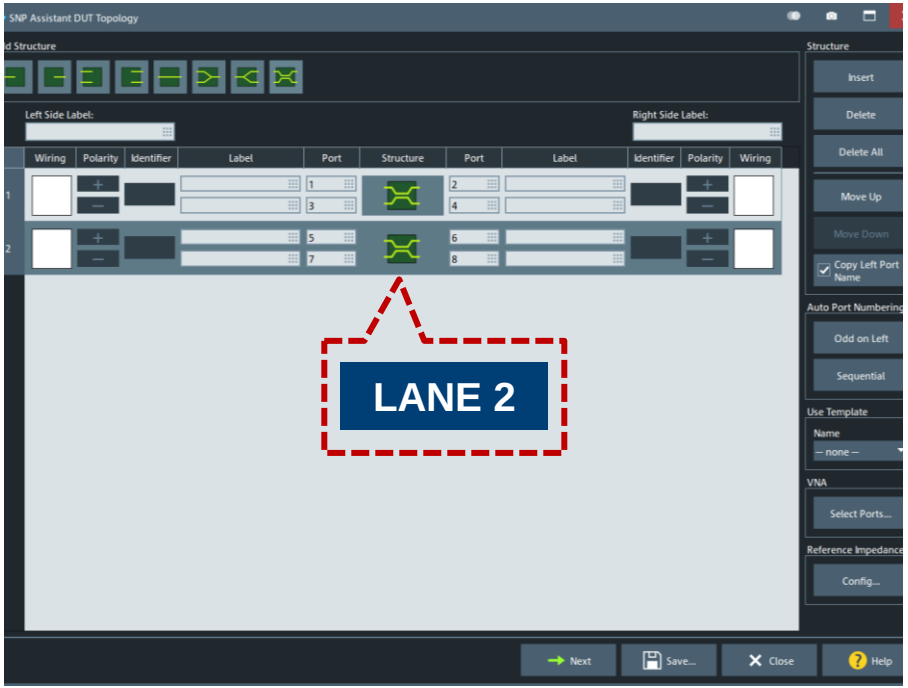
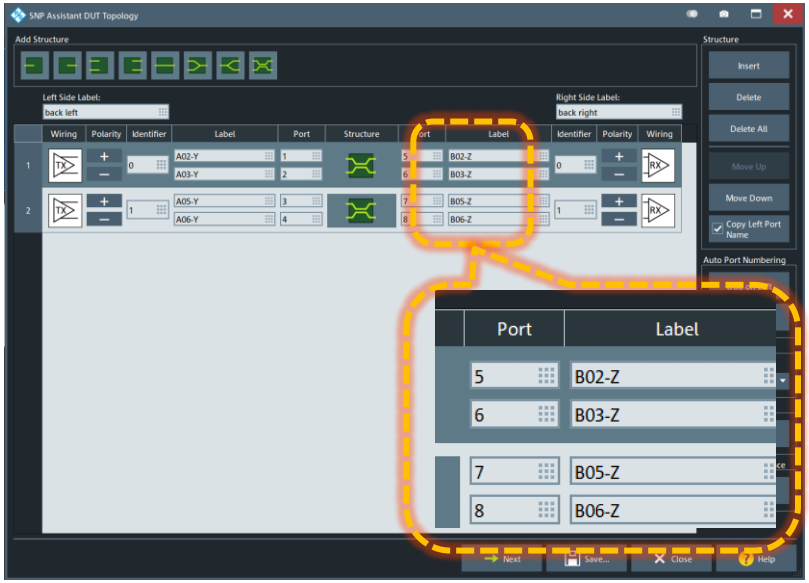
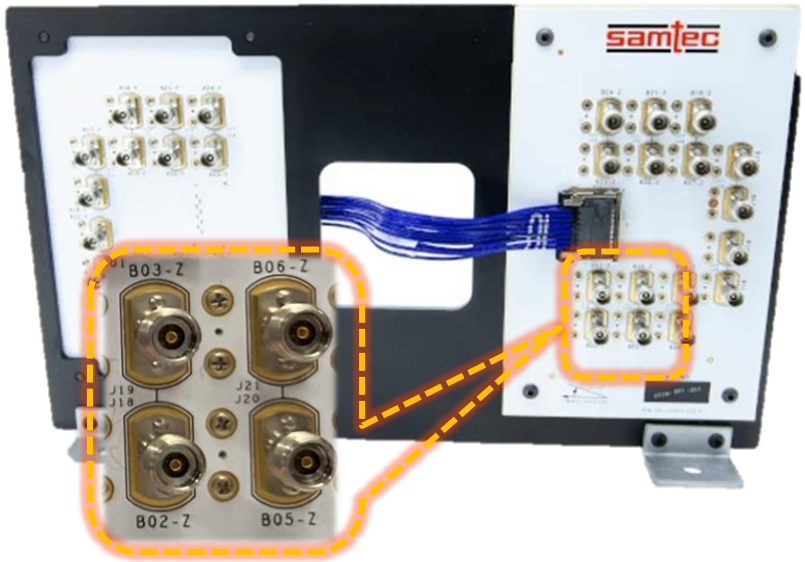


ALIGN THE FIXTURE LABELS WITH THE TOPOLOGY

- We want the tool to reflect the fixture topology.
- Therefore, we add the silk screen labels on the fixture into the label column of the topology

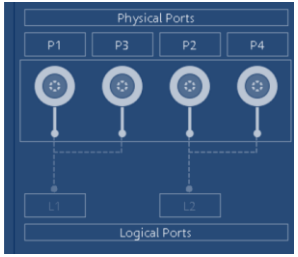


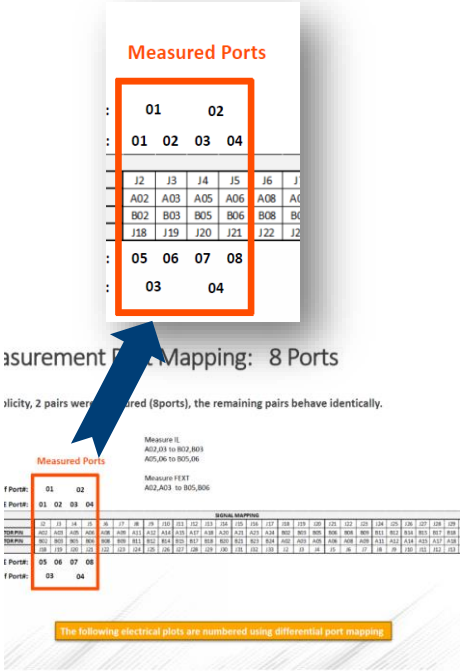


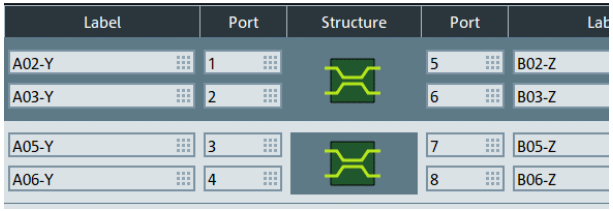
CONFIRM MODELED AND MEASURED PORT MAPS ARE ALIGNED

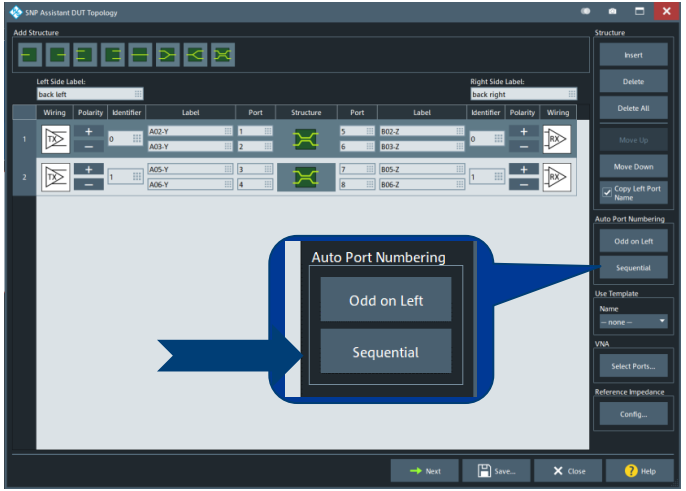
1. THE PORT MAPPING BETWEEN MEASUREMENT AND SIMULATION MUST BE THE SAME TO ENSURE A CORRELATED COMPARE

2. WE NOTE THE PORT MAP IS SEQUENTIAL AND USE THE “SEQUENTIAL FUNCTION”AUTO NUMBER THE PORTS





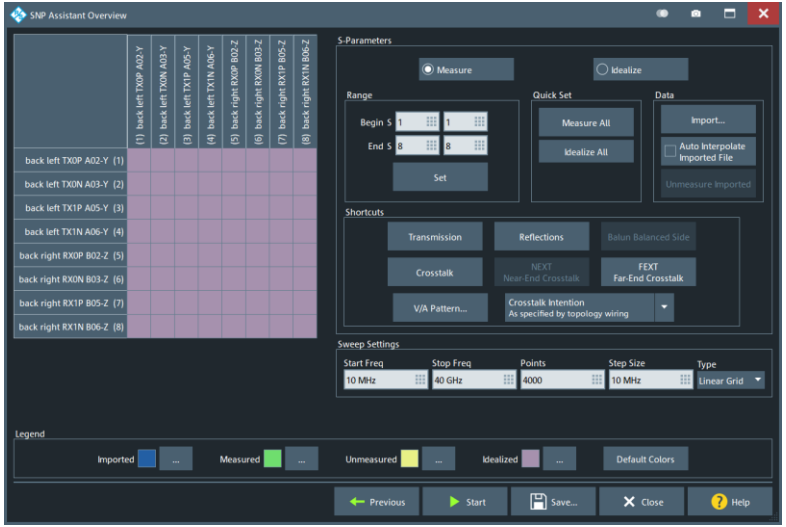




- *Left side is - 1 2 3 4*
- *Right side is - 5 6 7 8*

CREATE THE TEST PLAN

1. • **FIRST, ALL THRUS AND REFLECTS ARE SET TO BE MEASURED - *TRANSMIT & REFLECTION BUTTONS***
2. • NON-STANDARDIZED INTERCONNECTS DO NOT HAVE A FIXED WIRING PATTERN
3. • FOR CORRELATION PURPOSES, WE MUST CONSIDER THE POSSIBILITY THAT ANY PORT CAN BE A TX OR RX
4. • SET VICTIM-AGGRESSOR PATTERN SUCH THAT ALL PAIRS CAN BE CONSIDERED VICTIMS AS WELL AS VICTIMS
5. • NOW WE CAN START THE MEASUREMENTERMINE VIA COUNT



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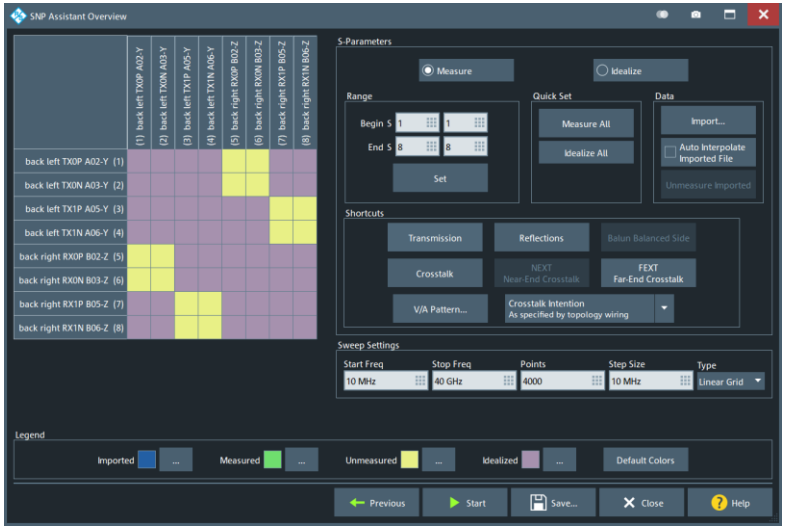

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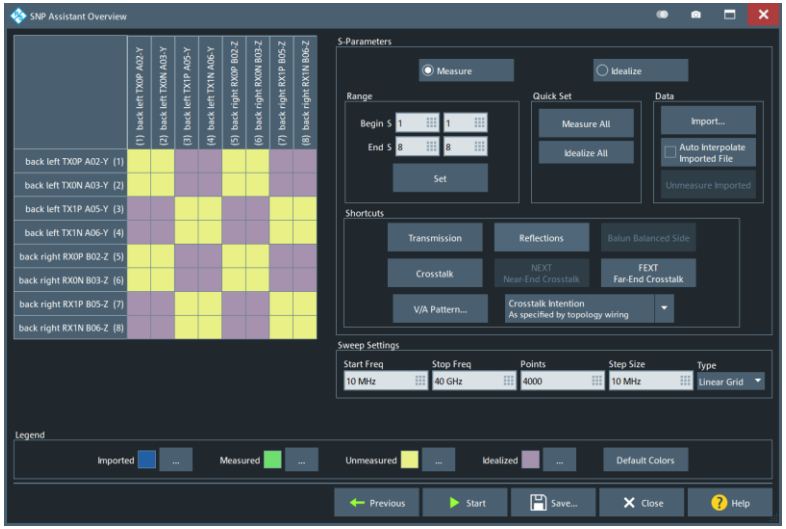
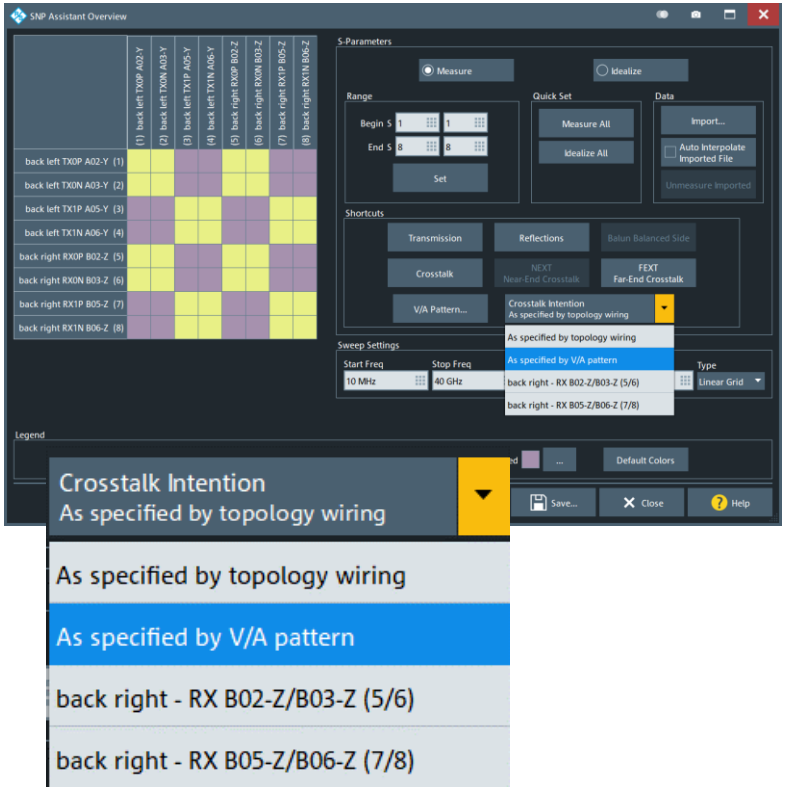


CREATE THE TEST PLAN

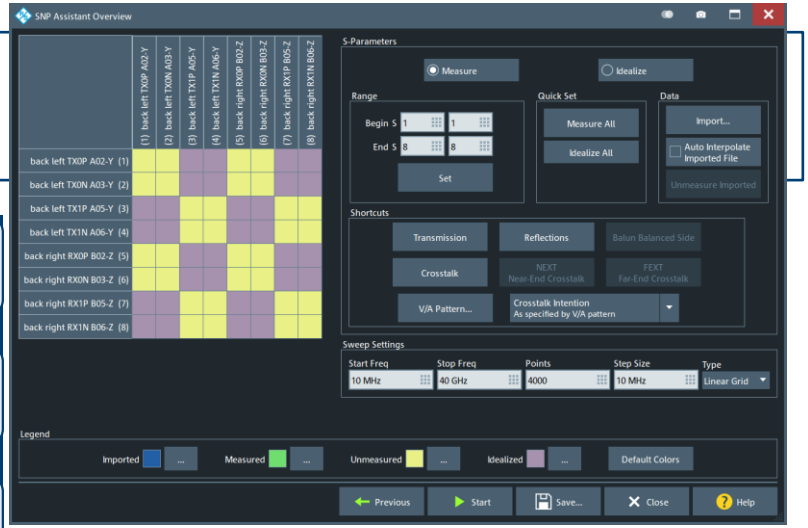
1. • FIRST, ALL THRUS AND REFLECTS ARE SET TO BE MEASURED - *TRANSMIT & REFLECTION BUTTONS*
2. • **NON-STANDARDIZED INTERCONNECTS DO NOT HAVE A FIXED WIRING PATTERN**
3. • FOR CORRE… CONSIDER T… BE A TX OR …
4. • SET VICTIM-AGGRESSOR PATTERN SUCH THAT ALL PAIRS CAN BE CONSIDERED VICTIMS AS WELL AS VICTIMS
5. • NOW WE CAN START THE MEASUREMENTERMINE VIA COUNT

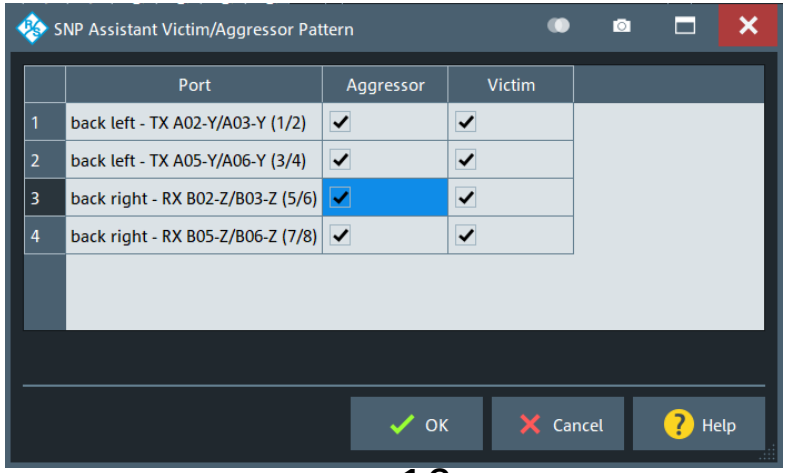
Consider a QSFP standard vs proprietary Backplane connector



CREATE THE TEST PLAN

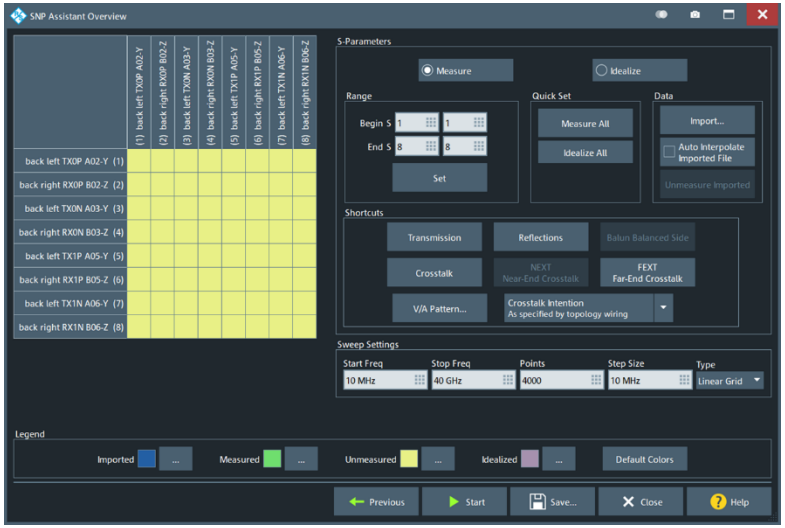
1. FIRST, ALL THRUS AND REFLECTS ARE SET TO BE MEASURED - *TRANSMIT & REFLECTION BUTTONS*
2. NON-STANDARDIZED INTERCONNECTS DO NOT HAVE A FIXED WIRING PATTERN
3. **FOR CORRELATION PURPOSES, WE MUST CONSIDER THAT ANY PORT CAN BE A TX OR RX**
4. SET VICTIM-AGGRESSOR PATTERN SUCH THAT ALL PAIRS CAN BE CONSIDERED VICTIMS AS WELL AS VICTIMS
5. NOW WE CAN START THE MEASUREMENTERMINE VIA COUNT





CREATE THE TEST PLAN

1. FIRST, ALL THRUS AND REFLECTS ARE SET TO BE MEASURED - *TRANSMIT & REFLECTION BUTTONS*
2. NON-STANDARDIZED INTERCONNECTS DO NOT HAVE A FIXED WIRING PATTERN
3. FOR CORRELATION PURPOSES, WE MUST CONSIDER THAT ANY PORT CAN BE A TX OR RX
4. **SET VICTIM - AGGRESSOR PATTERN SUCH THAT ALL PAIRS CAN BE CONSIDERED VICTIMS AND ALSO AS AGGRESSORS**
5. NOW WE CAN START THE MEASUREMENTERMINE VIA COUNT



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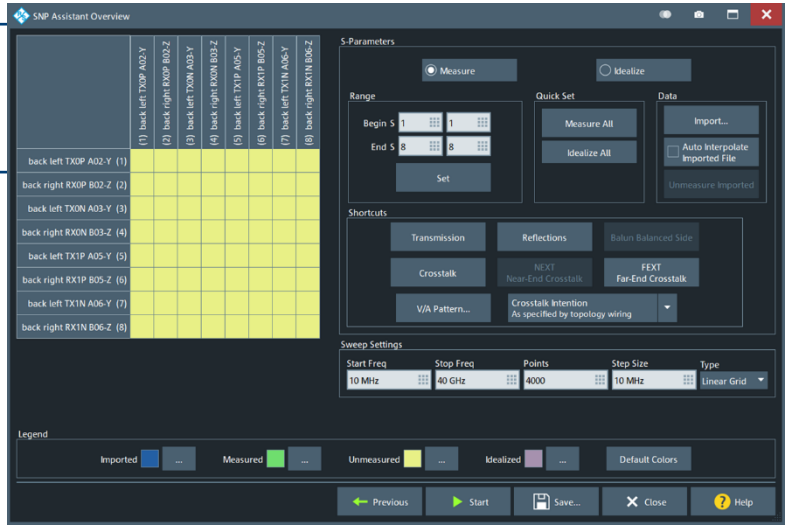
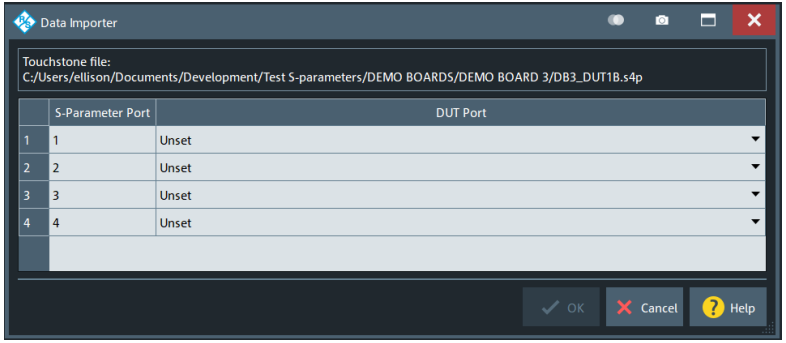
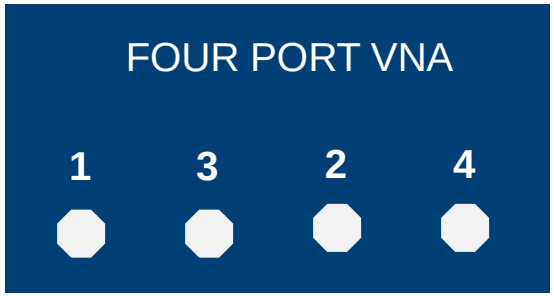
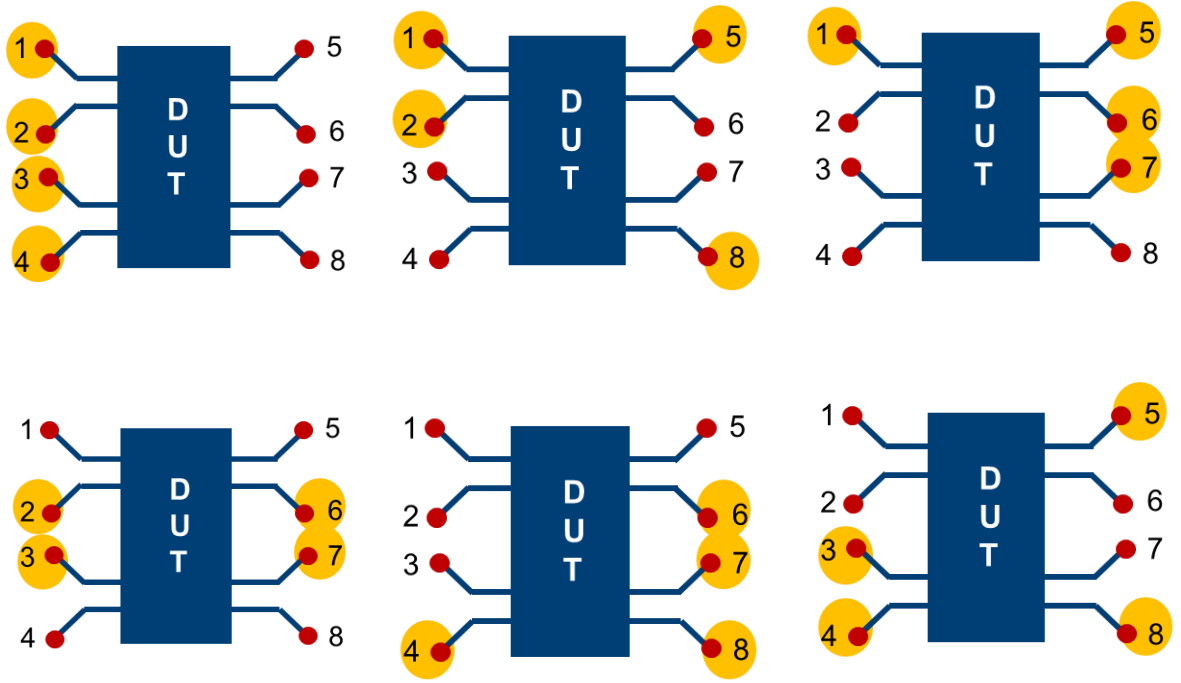
2. NON-STANDARDIZED INTERCONNECTS DO NOT HAVE A FIXED WIRING PATTERN
3. FOR CORRELATION PURPOSES, WE MUST CONSIDER THAT ANY PORT CAN BE A TX OR RX
4. SET VICTIM - AGGRESSOR PATTERN SUCH THAT ALL PAIRS CAN BE CONSIDERED VICTIMS AS WELL AS AGGRESSORS
5. **NOW WE CAN START THE MEASUREMENT**





MEASUREMENTS: VNA 1,2,3,4, TO DUT 1,2,3,4,5,6,7,8






TEST PLAN CREATED
INITIATE MEASUREMENT SEQUENCE
MEASUREMENT COMPLETE – SAVE DATA

MEASUREMENTS: VNA 1,2,3,4, TO DUT 1,2,3,4

1. • THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 1,2,3,4
2. • This makes sure the port map is identical to the simulation and helps prevent mistakes from the person making the measurements
3. • EACH TIME A MEASUREMENT IT TAKEN, THE MEASURED S-PARAMETERS SHOW UP AS GREEN TILES IN THE MATRIX AND NEW PROMPTS ARE PROVIDED TO THE USER.
4. • WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

V...	DUT	Name	DU
1	1	left TX0P A02-Y	
2	2	left TX0N A03-Y	
3	→ 3	left TX1P A05-Y	
4	→ 4	left TX1N A06-Y	

MEASUREMENTS: VNA 1,2,3,4 TO DUT 1,2,5,8

1. • THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 1,2,5,8
2. • This makes sure the port map is identical to the simulation and helps prevent mistakes from the person making the measurements
3. • EACH TIME A MEASUREMENT IT TAKEN, THE MEASURED S-PARAMETERS SHOW UP AS GREEN TILES IN THE MATRIX AND NEW PROMPTS ARE PROVIDED TO THE USER.
4. • WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

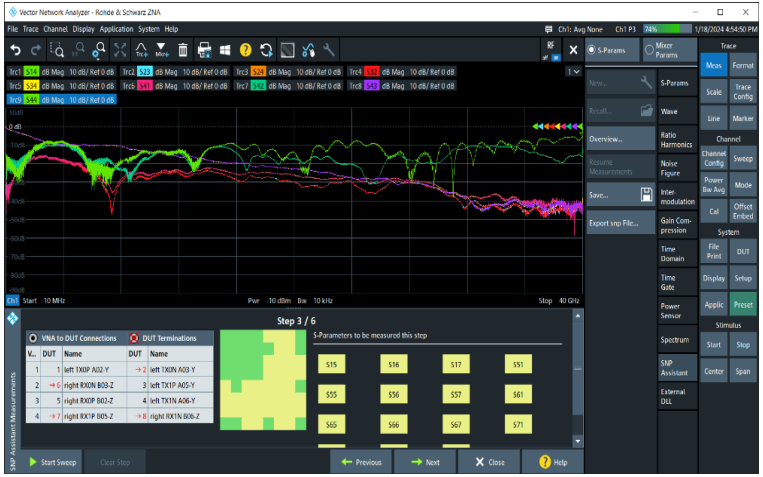
V...	DUT	Name	DU
1	1	left TX0P A02-Y	
2	2	left TX0N A03-Y	
3	→ 5	right RX0P B02-Z	
4	→ 8	right RX1N B06-Z	

MEASUREMENTS: VNA 1,2,3,4 TO DUT 1,6,5,7

1. • THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 1,6,5,7
2. • THIS ENSURES THE PORT MAP IS ALIGNED WITH THE SIMULATION AND PREVENTS OPERATOR CONNECTION ERRORS
3. • EACH MEASUREMENT ITERATION HIGHLIGHTS THE MEASURED PORTS AS GREEN AND REFRESHES USER PROMPT
4. • WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

V...	DUT	Name
1	1	left TX0P A02-Y
2	→ 6	right RX0N B03-Z
3	5	right RX0P B02-Z
4	→ 7	right RX1P B05-Z



MEASUREMENTS: VNA 1,2,3,4 TO DUT 2,6,3,7

1. • THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 2,6,3,7
2. • THIS ENSURES THE PORT MAP IS ALIGNED WITH THE SIMULATION AND PREVENTS OPERATOR CONNECTION ERRORS
3. • EACH MEASUREMENT ITERATION HIGHLIGHTS THE MEASURED PORTS AS GREEN AND REFRESHES USER PROMPT
4. • WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

V...	DUT	Name
1	→ 2	left TX0N A03-Y
2	6	right RX0N B03-Z
3	→ 3	left TX1P A05-Y
4	7	right RX1P B05-Z

MEASUREMENTS: VNA 1,2,3,4 TO DUT 4,6,8,7

1. • THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 4,6,8,7
2. • THIS ENSURES THE PORT MAP IS ALIGNED WITH THE SIMULATION AND PREVENTS OPERATOR CONNECTION ERRORS
3. • EACH MEASUREMENT ITERATION HIGHLIGHTS THE MEASURED PORTS AS GREEN AND REFRESHES USER PROMPT
4. • WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

V...	DUT	Name
1	→ 4	left TX1N A06-Y
2	6	right RX0N B03-Z
3	→ 8	right RX1N B06-Z
4	7	right RX1P B05-Z

MEASUREMENTS: VNA 1,2,3,4 TO DUT 4,3,8,5

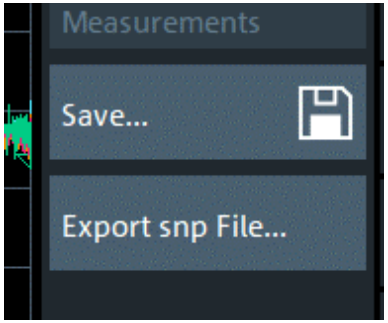
1. THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 4,3,8,5
2. THIS ENSURES THE PORT MAP IS ALIGNED WITH THE SIMULATION AND PREVENTS OPERATOR CONNECTION ERRORS
3. EACH MEASUREMENT ITERATION HIGHLIGHTS THE MEASURED PORTS AS GREEN AND REFRESHES USER PROMPT
4. WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.

VNA to DUT Connections

V...	DUT	Name	DU
1	4	left TX1N A06-Y	
2	→ 3	left TX1P A05-Y	
3	8	right RX1N B06-Z	
4	→ 5	right RX0P B02-Z	

MEASUREMENTS

1. THE TOOL GUIDES THE OPERATOR FOR VNA PORT TO DUT PORT CONNECTION FOR EACH MEASUREMENT STEP – 1,2,3,4 to 4,3,8,5
2. THIS ENSURES THE PORT MAP IS ALIGNED WITH THE SIMULATION AND PREVENTS OPERATOR CONNECTION ERRORS
3. EACH MEASUREMENT ITERATION HIGHLIGHTS THE MEASURED PORTS AS GREEN AND REFRESHES USER PROMPT
4. **WHEN THE MEASUREMENT IS COMPLETE, SAVE THE TOUCHSTONE FILE.**



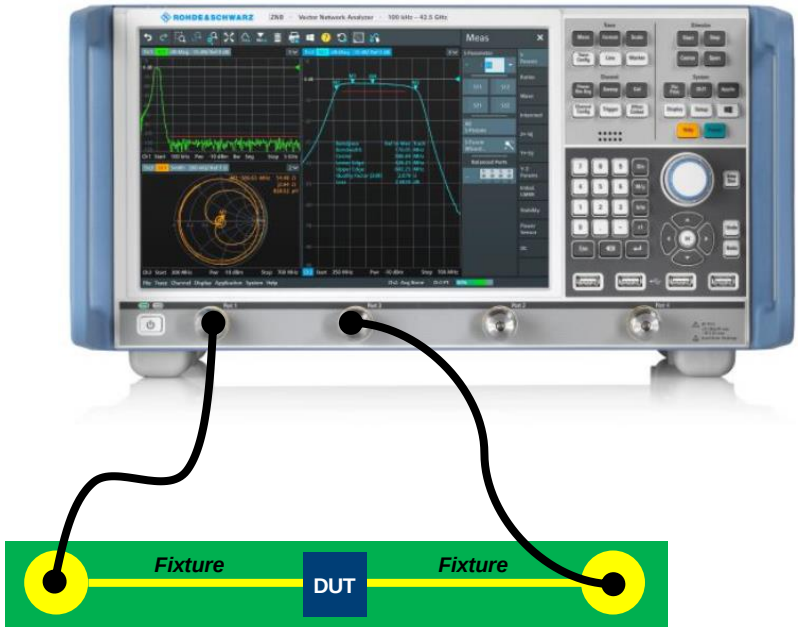
TOUCHSTONE FILE WITH TOPOLOGY

- It is important that the port mapping is not lost when the touchstone file is created.
- Therefore, the tool enters the topology information into the touchstone file so the person making the simulation to measurement correlation can confirm everything is correct.

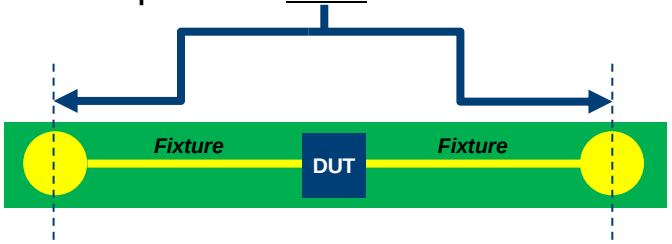
```
#  HZ    S    RI    R      50.00
! Rohde & Schwarz Vector Network Analyzer
! Rohde-Schwarz,ZNA67-4Port,1332450064999999,3.00.1.487-23.09.1.239
! Created: UTC 1/18/2024, 10:02:20 PM
!
  ::MULTI-CHANNEL-INFORMATION::
!
! [SIDE1=left] [SIDE2=right]
! [:] [TX0P] [A02-Y] [1] ->>- [5] [B02-Z] [RX0P] [:]
! [:] [TX0N] [A03-Y] [2] ->>- [6] [B03-Z] [RX0N] [:]
! [:] [TX1P] [A05-Y] [3] ->>- [7] [B05-Z] [RX1P] [:]
! [:] [TX1N] [A06-Y] [4] ->>- [8] [B06-Z] [RX1N] [:]
!
! freq                re:S11              im:S11              r
!                     re:S15              im:S15              r
!                     re:S21              im:S21              r
!                     re:S25              im:S25              r
!                     re:S31              im:S31              r
!                     re:S35              im:S35              r
!                     re:S41              im:S41              r
!                     re:S45              im:S45              r
!                     re:S51              im:S51              r
```


TEST PLAN CREATED
INITIATE MEASUREMENT SEQUENCE
MEASUREMENT COMPLETE – SAVE DATA

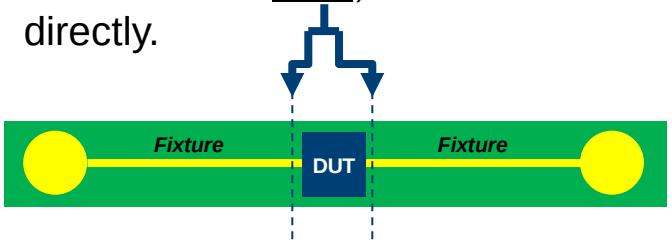
MATCHING REFERENCE PLANES – DEMEBDDING REQUIRED



The calibration plane is here.

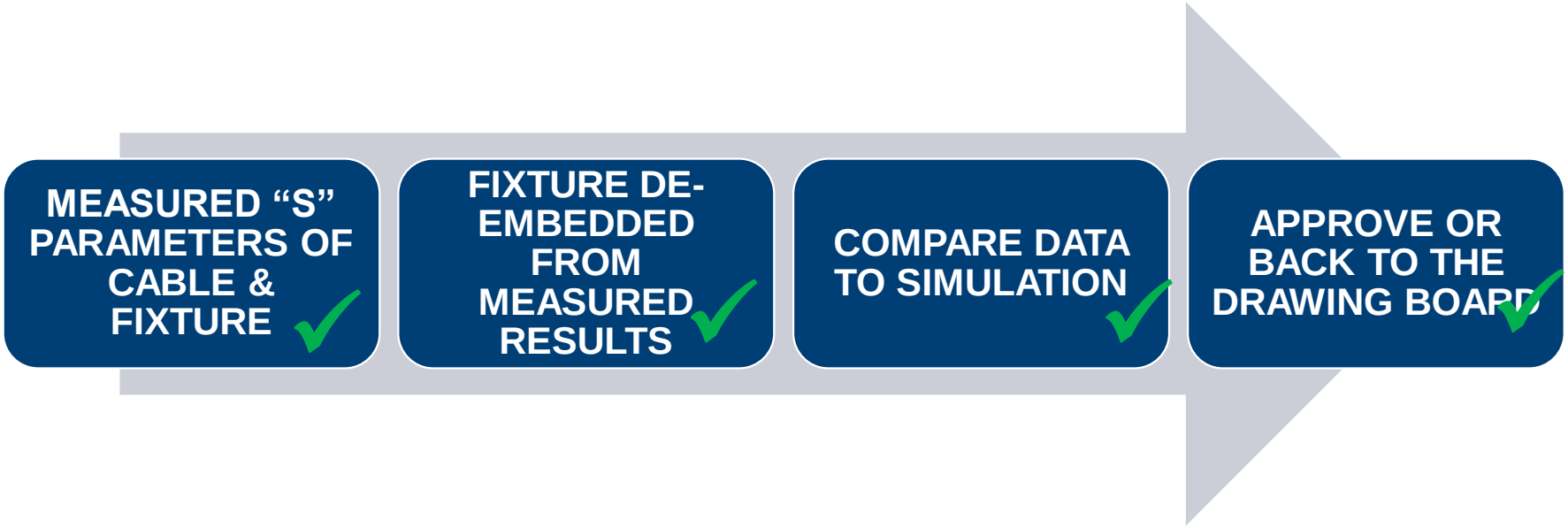


I want it to be here, but I can't measure it directly.



DE-EMBEDDING ASSISTANT

- **De-embedding Assistant walks the user through complex de-embedding tasks.**
- **When the Fixture-DUT-Fixture is greater than four ports, select n x Balanced in the DUT dropdown.**


MEASURED “S” PARAMETERS OF CABLE & FIXTURE
FIXTURE DE-EMBEDDED FROM MEASURED RESULTS
COMPARE DATA TO SIMULATION
APPROVE OR BACK TO THE DRAWING BOARD

Thank you!