AirBorn	Document Number:	REP0304	Page: 1 of 45
	Document Description:	SInergy™ Signal Integrity Test Report	
	Application: SINERGY	Current Revision: Rev B	Code Identification: 10400

Approved for distribution to all customers

Approvals	Name	Date
Created By	J. BATES	May 23, 2023
Checked By	J. GONZALEZ	May 25, 2023
Approved By	B. RUSSELL	May 26, 2023
Released By	Y. GOLDADE	06/07/23

EC Number	Rev	Submitted By	Date	Approved By	Date
INITIAL RELEASE	-	J. BATES	06/07/23	B. RUSSELL	06/07/23
W67793	A	J. BATES	06/21/23	B. RUSSELL	06/21/23
W67945	B	J. Bates	08/01/23	B. RUSSELL	08/01/23

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1 Introduction

The following measurements pertain to the SInergy™ board mount connectors and cable assembly shown below. The board mount components include a vertical plug, vertical receptacle, and a right angle receptacle. The cable assembly has a plug on one end and a receptacle on the other. All components are 5-bay configurations with four High Density modules and one RF module in the center and the board mount connectors are surface mount. **All s-parameter models referenced in this report can be found on the AirBorn website.**

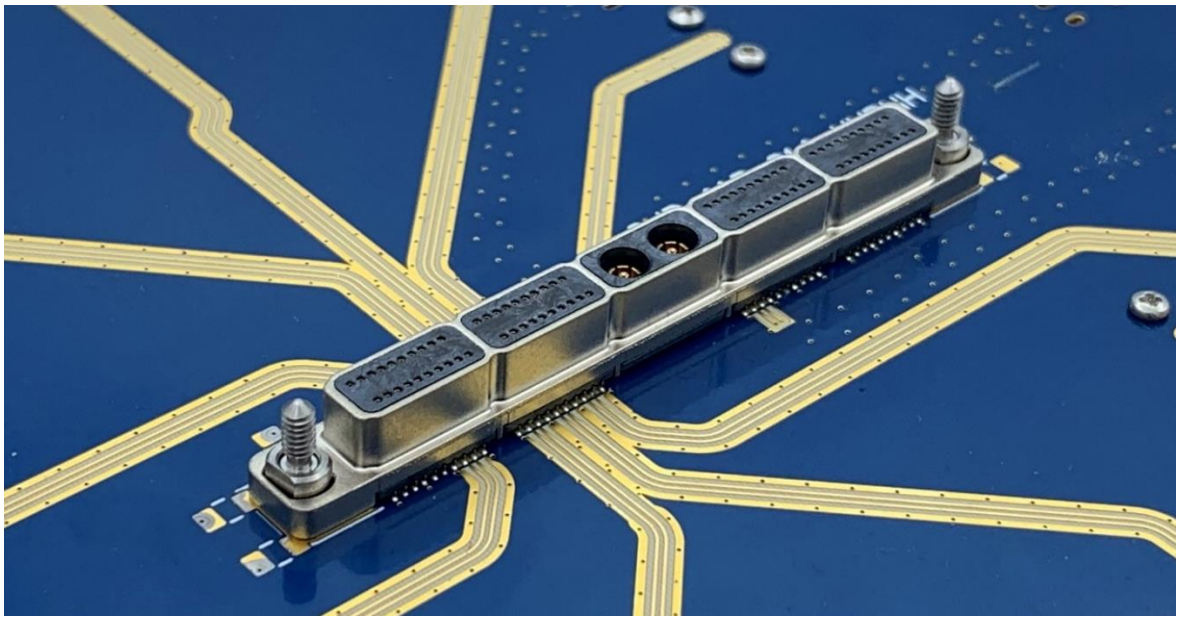


Figure 1 – SVP-A1R-J1A-HHRHH

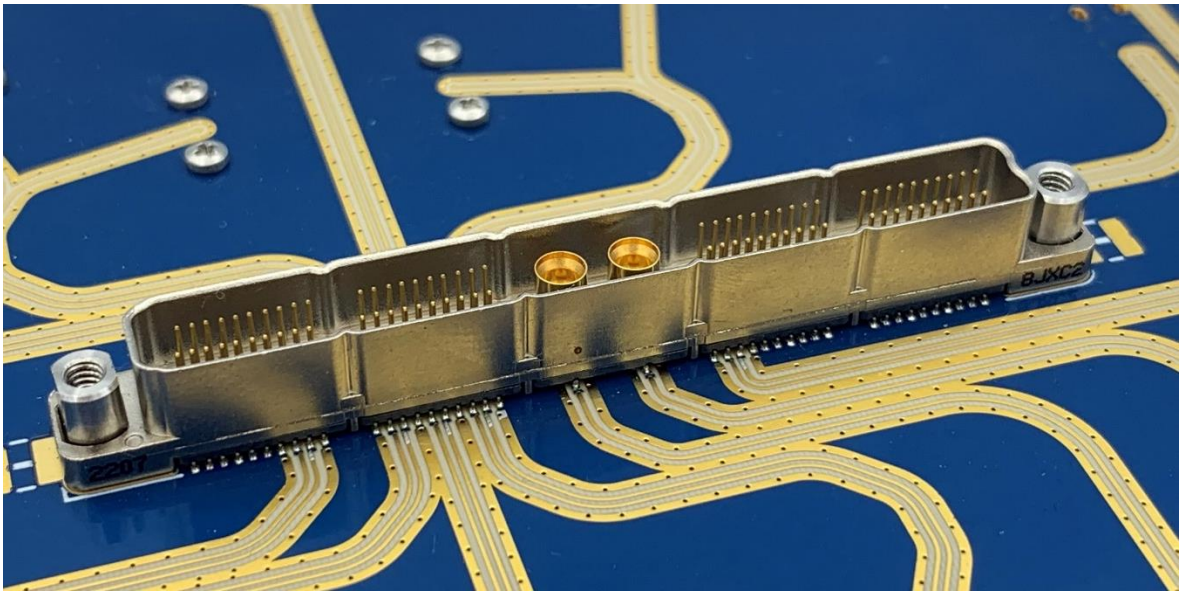


Figure 2 – SVR-B1R-N1A-HHRHH

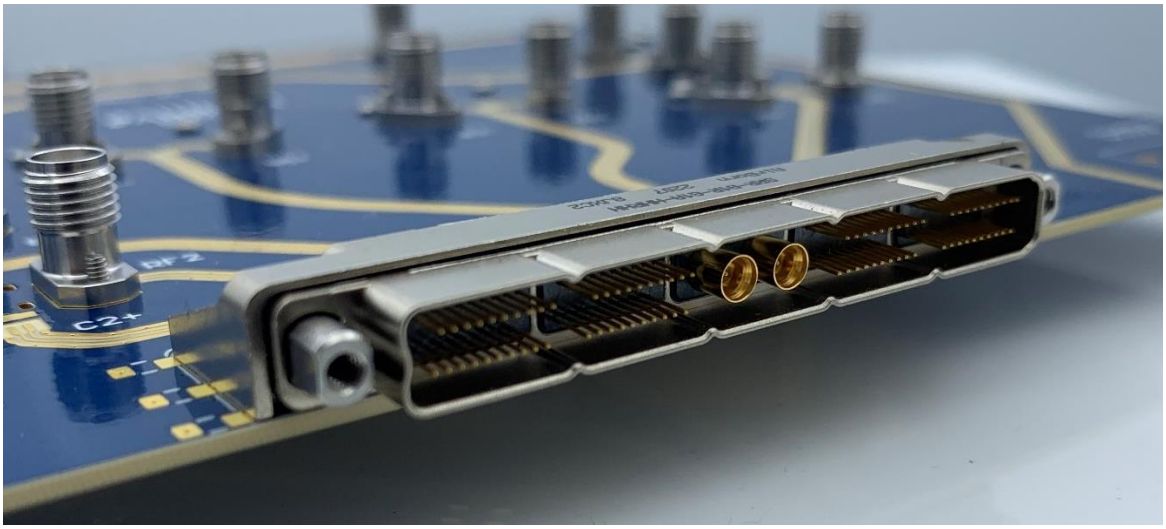


Figure 3 – SRR-A1R-N1A-HHRHH

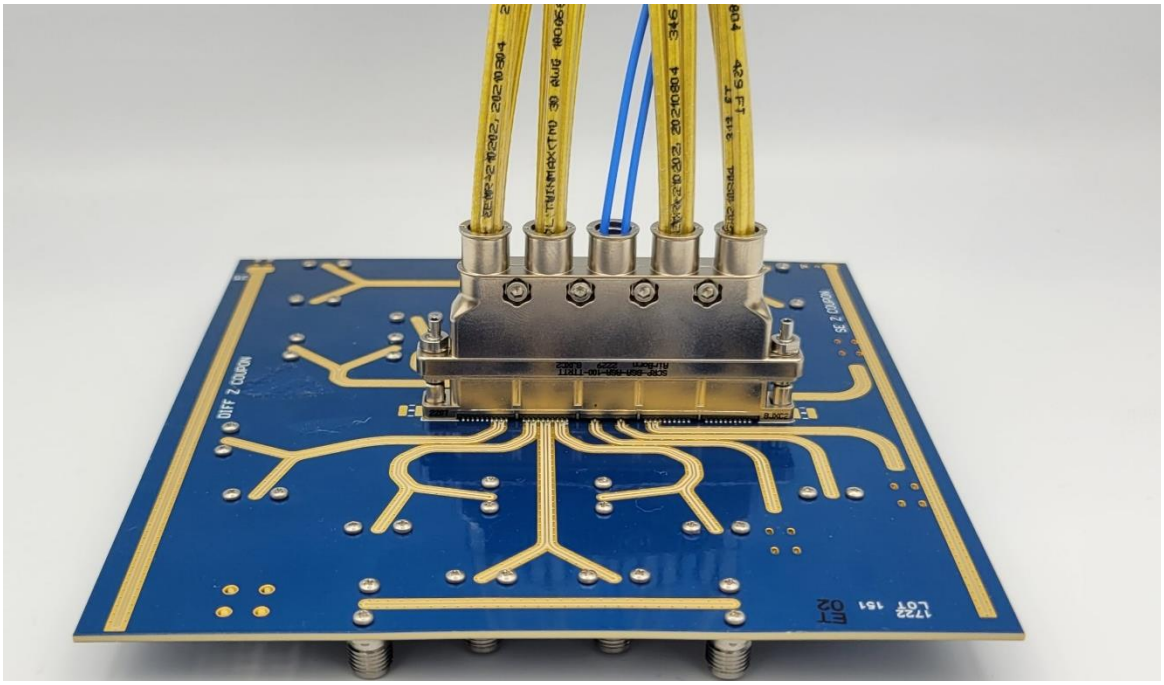
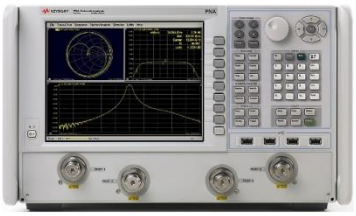


Figure 4 – SCRP-BNA-AJA-100-TTRTT

2 Measurement Equipment and Procedures

- *All s-parameter measurements were performed on Keysight PNA N5225A*



- *All 4 singles ended ports on the PNA were calibrated with the Keysight N4692A Electronic Calibration Module(E-Cal)*

- *All measurements were analyzed with Keysight Physical Layer Test System (PLTS) 2016*
- *Differential logical Port 1 – (Port 1 – Port 3)*
- *Differential logical Port 2 – (Port 2 – Port 4)*
- *The Measurement setup contains an SMA launch and a section of PCB trace with surface mount terminations to the SInergy Connector.*
- *All Test Fixtures include a 1X-Thru Open and 2x-Thru for fixture de-embedding.*
- *PLTS Automatic Fixture Removal (AFR) tool is used to de-embed the SMA connectors and 50 ohm traces up to 40mils from the SMD pad.*
- *The calibration reference plain is then located 1mm away from the pad edge.*
- *All unused links are 50 ohm load terminated on the near and far ends*

3 Measurement Test Fixture Details

All SInergy test fixture designs incorporate a 4-layer PCB with integrated 50 ohm microstrip traces to connect the SInergy connector to SMA 50 Ohm connectors. Each PCB test fixture was optimized using full wave simulation to optimize the signal traces and SMA launch impedances. All test fixtures include fixture de-embedding artifacts that are used with an Automatic Fixture Removal (AFR) application which brings the Vector Network Analyzer (VNA) calibration reference plane to 1mm before the SInergy footprint.

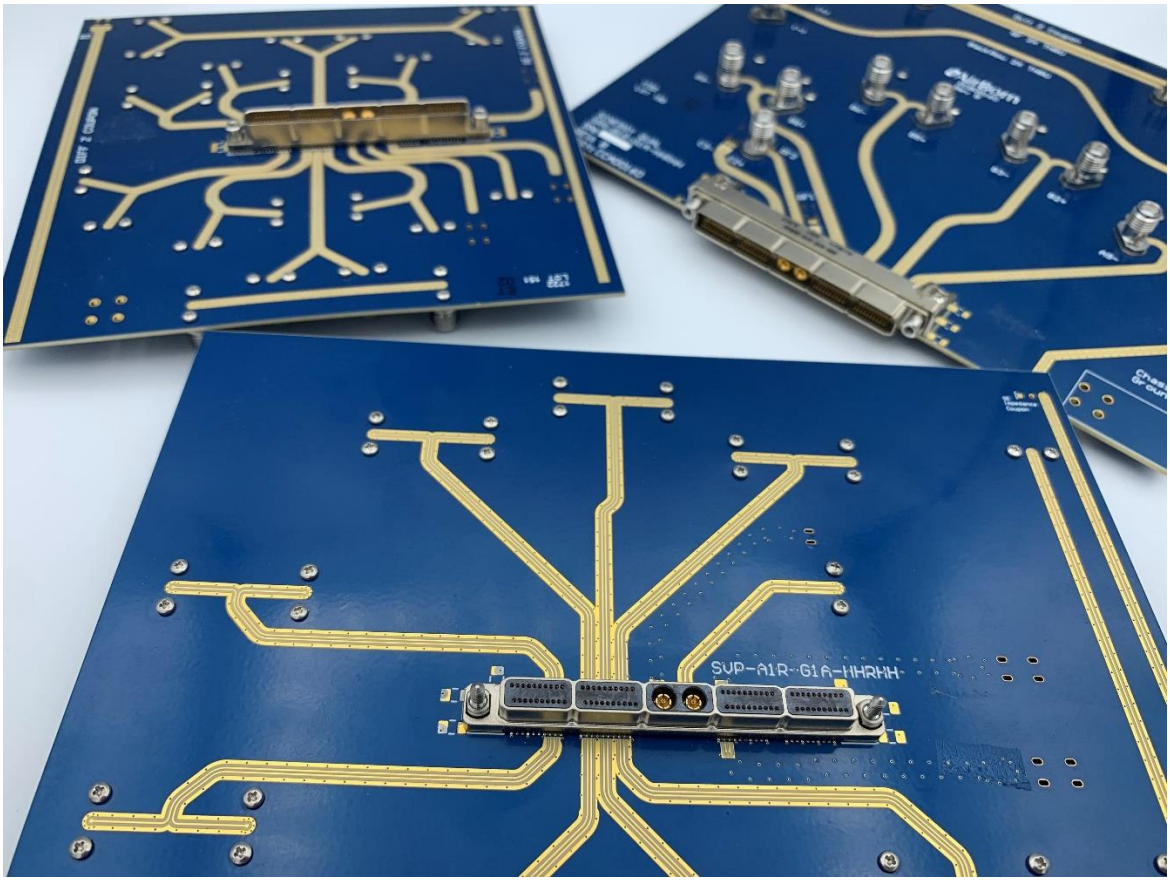


Figure 5 – Measurement Test Fixtures

4 Typical Measurement Test Fixture Setup

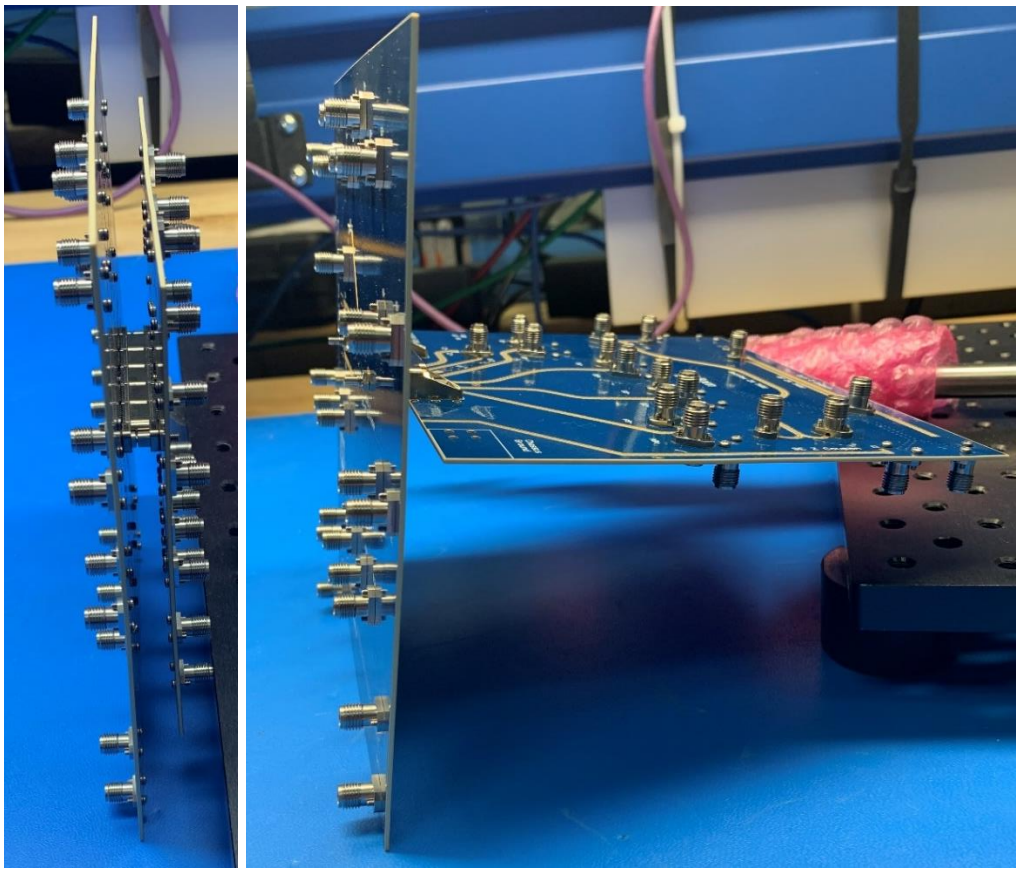


Figure 6 – Board to Board Mated Measurement Test Fixtures

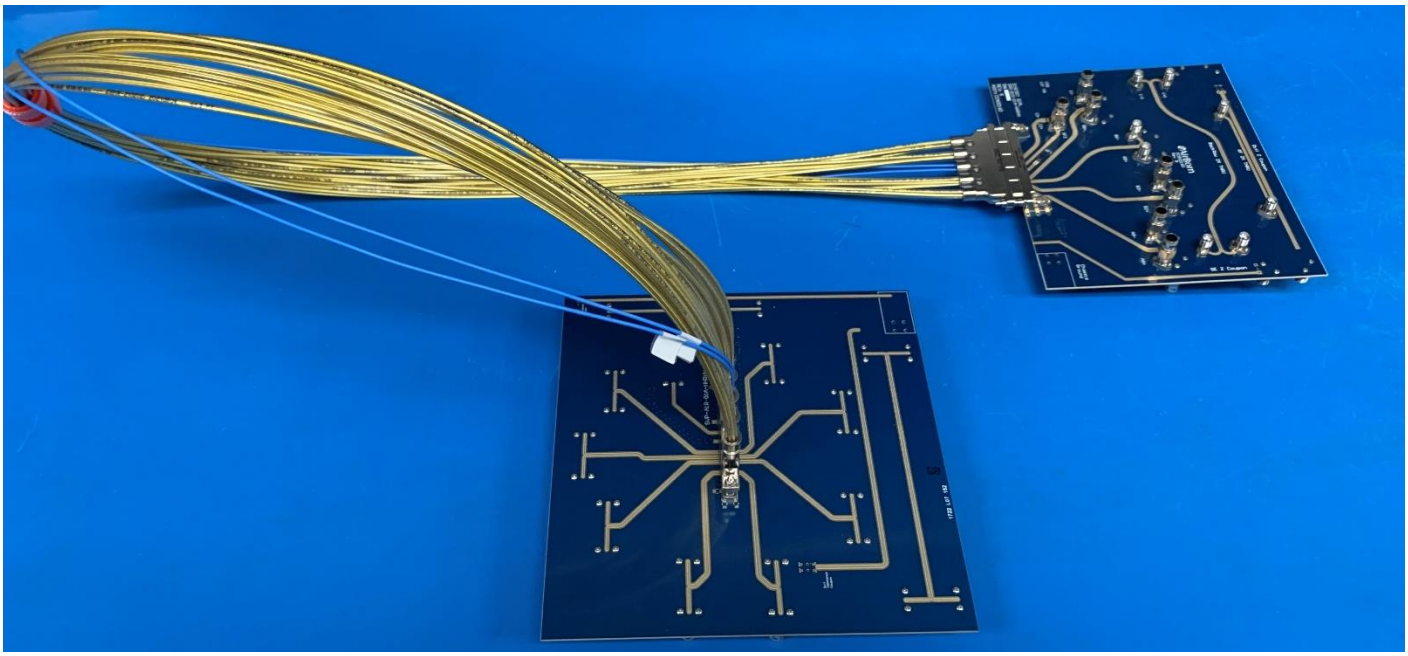


Figure 7– Mated Measurement Test Fixtures with Cable Assembly

5 Sinergy High Density Pinout

Recommended pinout is a G-S-S-G pattern. Recommended Differential Pairs are outlined in red below.

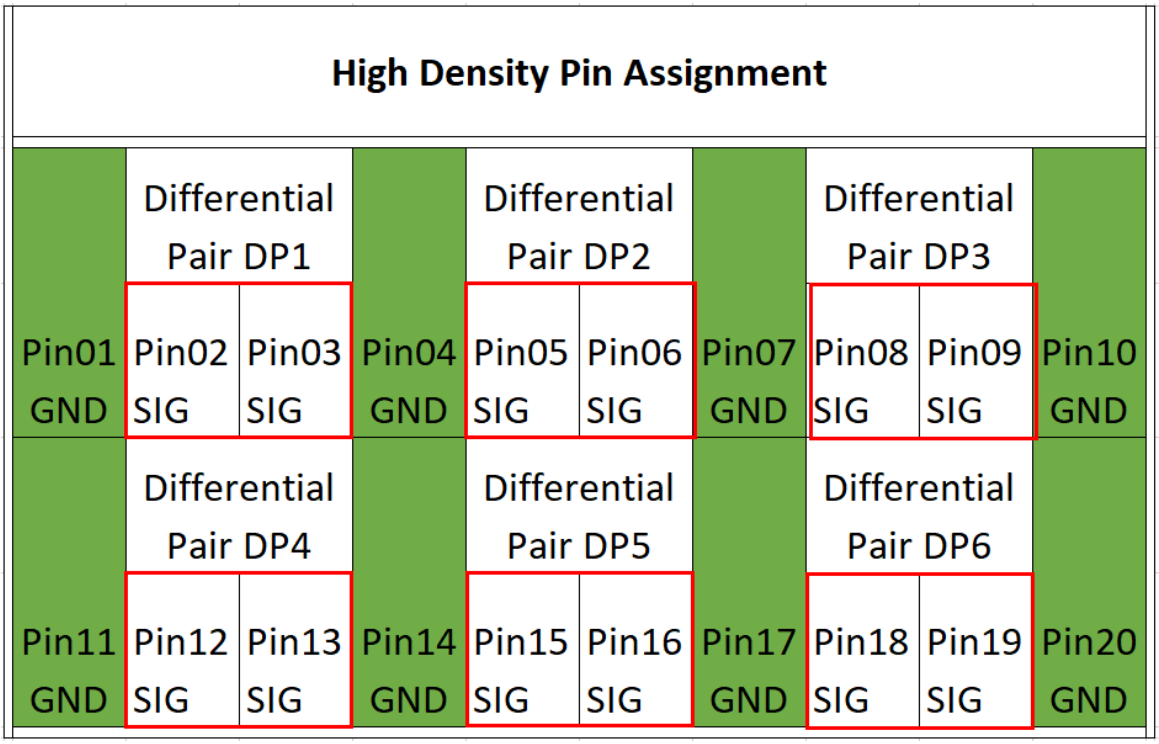


Figure 8 – SInergy HD Module Pin Assignment

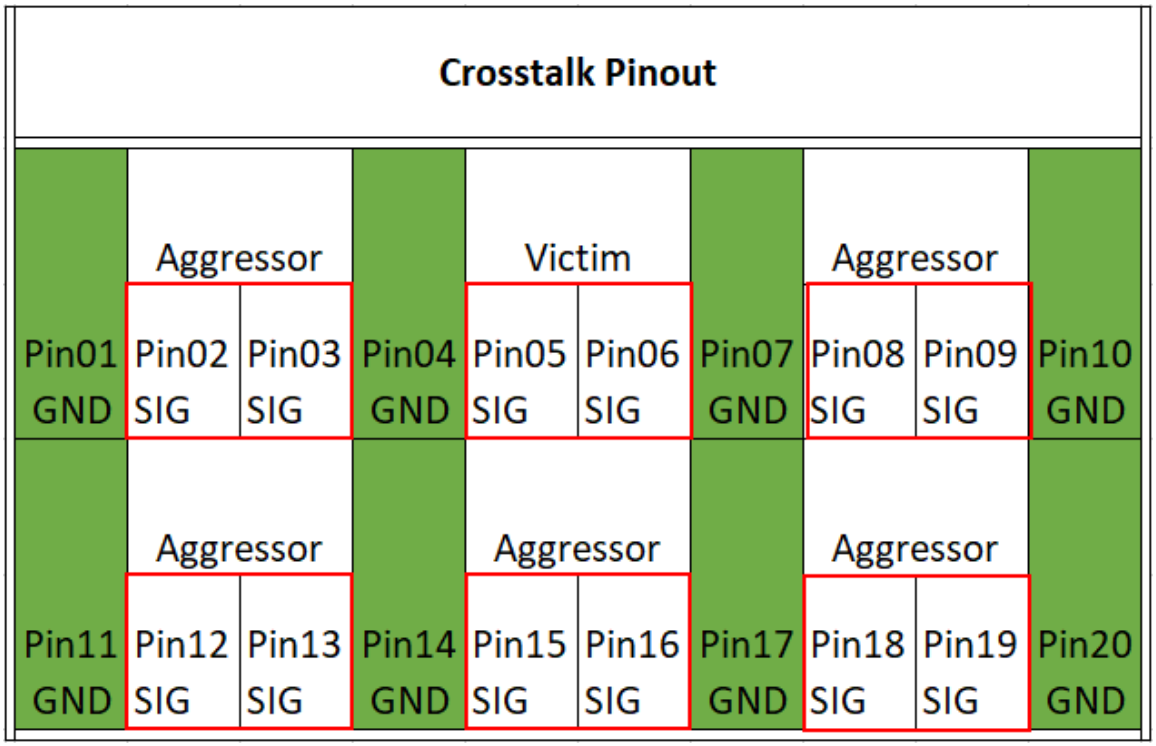


Figure 9 – SInergy HD Module Crosstalk Pinout

6 SI Performance – Board to Board High Density

6.1 Vertical to Vertical

Frequency Domain S-Parameter Summary for differential pair B15/B16. Differential pairs not in this equivalent physical position will have slightly varying bandwidth performance. Table values for Return Loss are pulled from the smoothed RL data, which is the outcome of a 5.05% trace smoothing applied in PLTS. For the Crosstalk Power Sum, the victim is pair B5/B6 and the aggressors are all 5 adjacent differential pairs. For the sake of simplicity and legibility, only one each of the neighboring and diagonal aggressor pairs is shown since the effects of crosstalk are identical across the axis of symmetry.

6.1.1 S-Parameter Summary

Parameter	SVR-B1R-N1A-HHRHH / SVP-A1R-J1A-HHRHH High Density Module Typical Mated Performance		
Insertion Loss	-0.5 dB @ 5 GHz	-1.43 dB @ 12.5 GHz	-3 dB @ 19.4 GHz
Return Loss	-13.2 dB @ 5 GHz	-7.25 dB @ 12.5 GHz	-4.1 dB @ 19.4 GHz
Pair to Pair Near-End Crosstalk	-44.2 dB @ 5 GHz	-45.93 dB @ 12.5 GHz	-37.7 dB @ 19.4 GHz
Pair to Pair Far-End Crosstalk	-55.5 dB @ 5 GHz	-46.46 dB @ 12.5 GHz	-44.9 dB @ 19.4 GHz
Differential Mode to Common Mode Conversion	-37.9 dB @ 5 GHz	-27.88 dB @ 12.5 GHz	-23.21 dB @ 19.4 GHz
Propagation Delay	80 ps		
Differential Skew	1.1 ps		

Table 1 - SVR-B1R-N1A-HHRHH_SVP-A1R-J1A-HHRHH - S-Parameter Pair B15B16 Summary

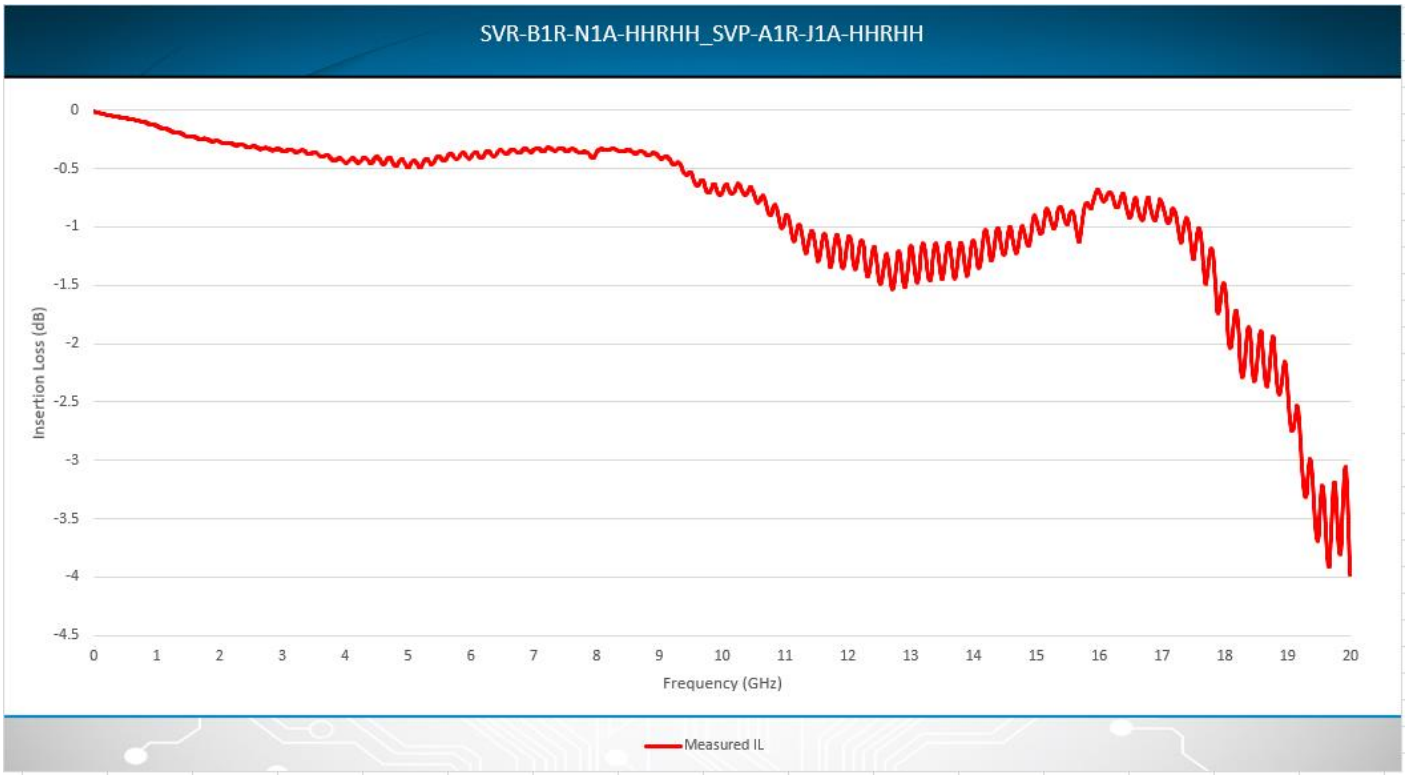


Figure 10 – Vertical to Vertical HD Insertion Loss

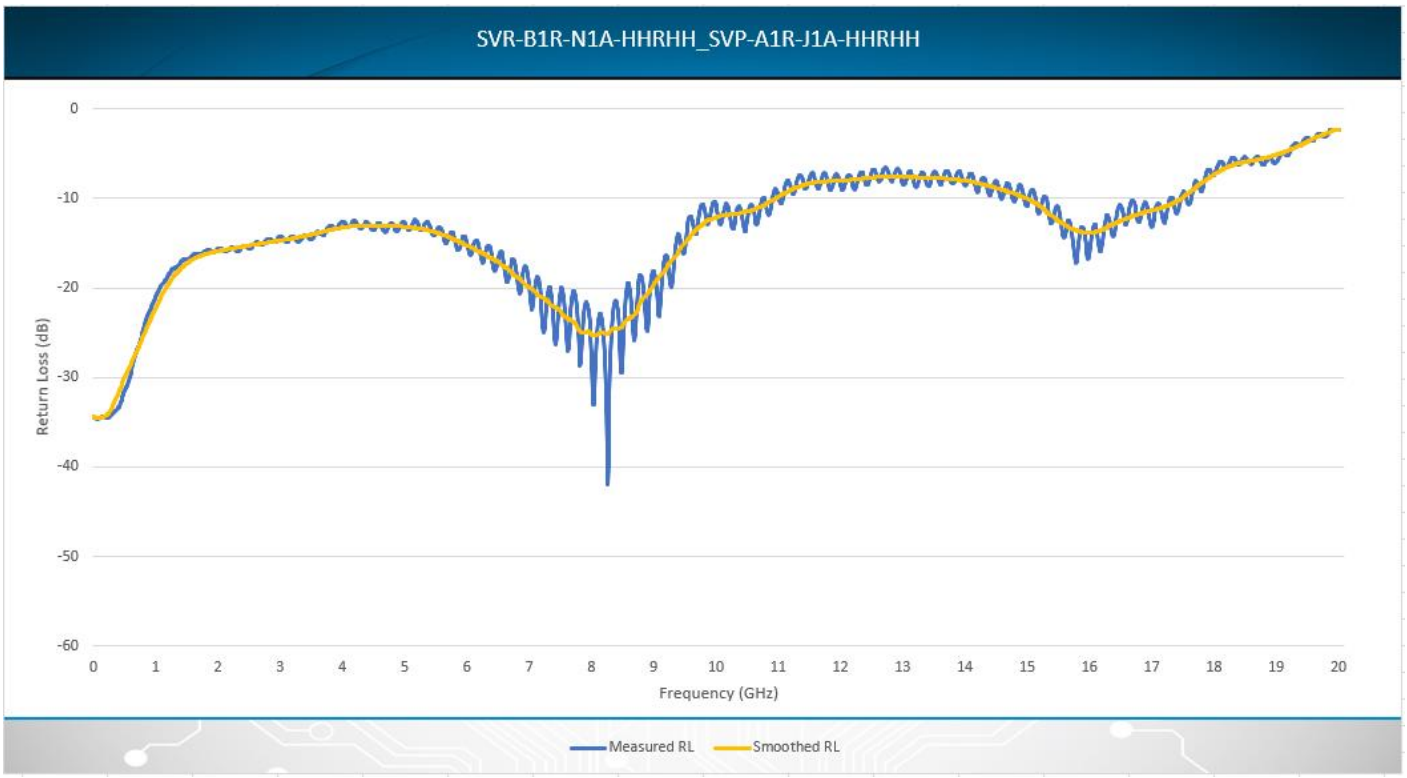


Figure 11 – Vertical to Vertical HD Return Loss

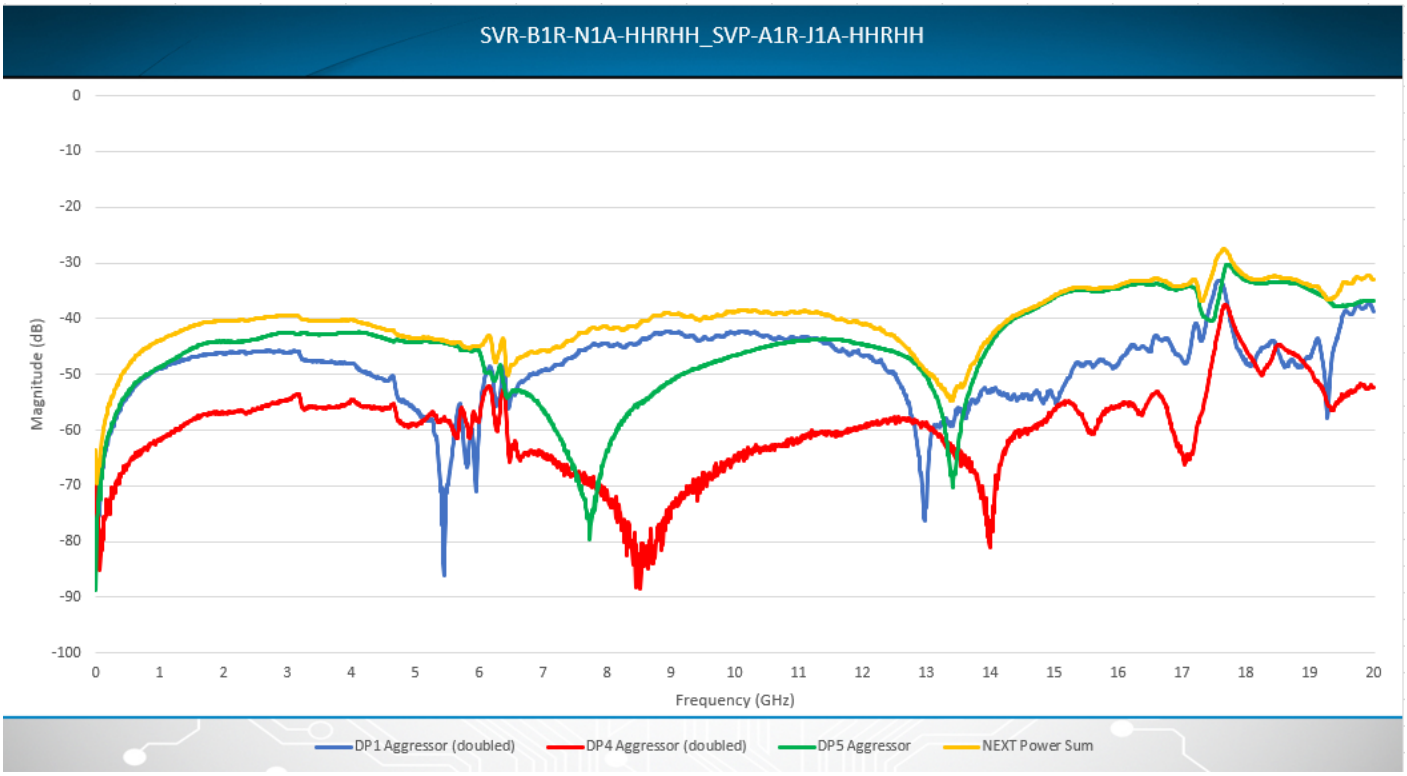


Figure 12 – Vertical to Vertical HD NEXT

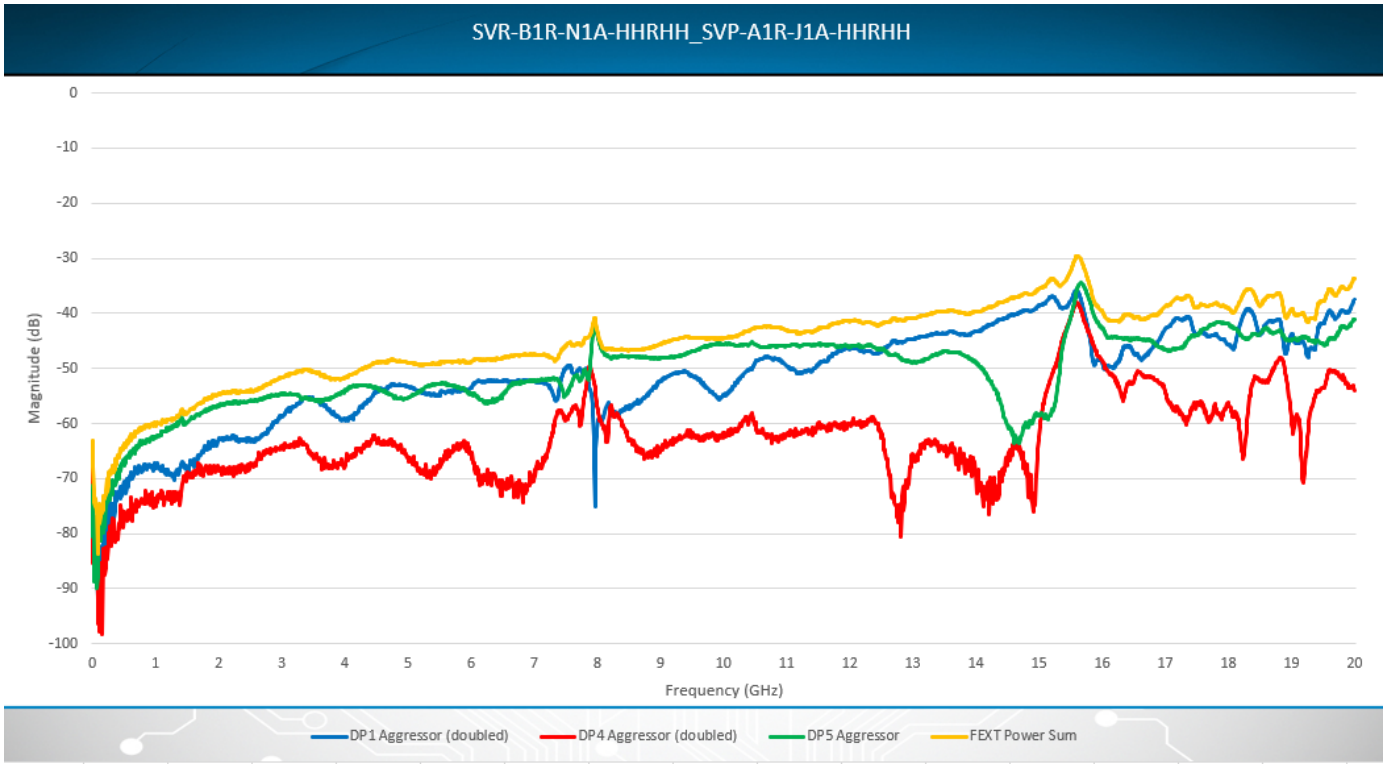


Figure 13 – Vertical to Vertical HD FEXT

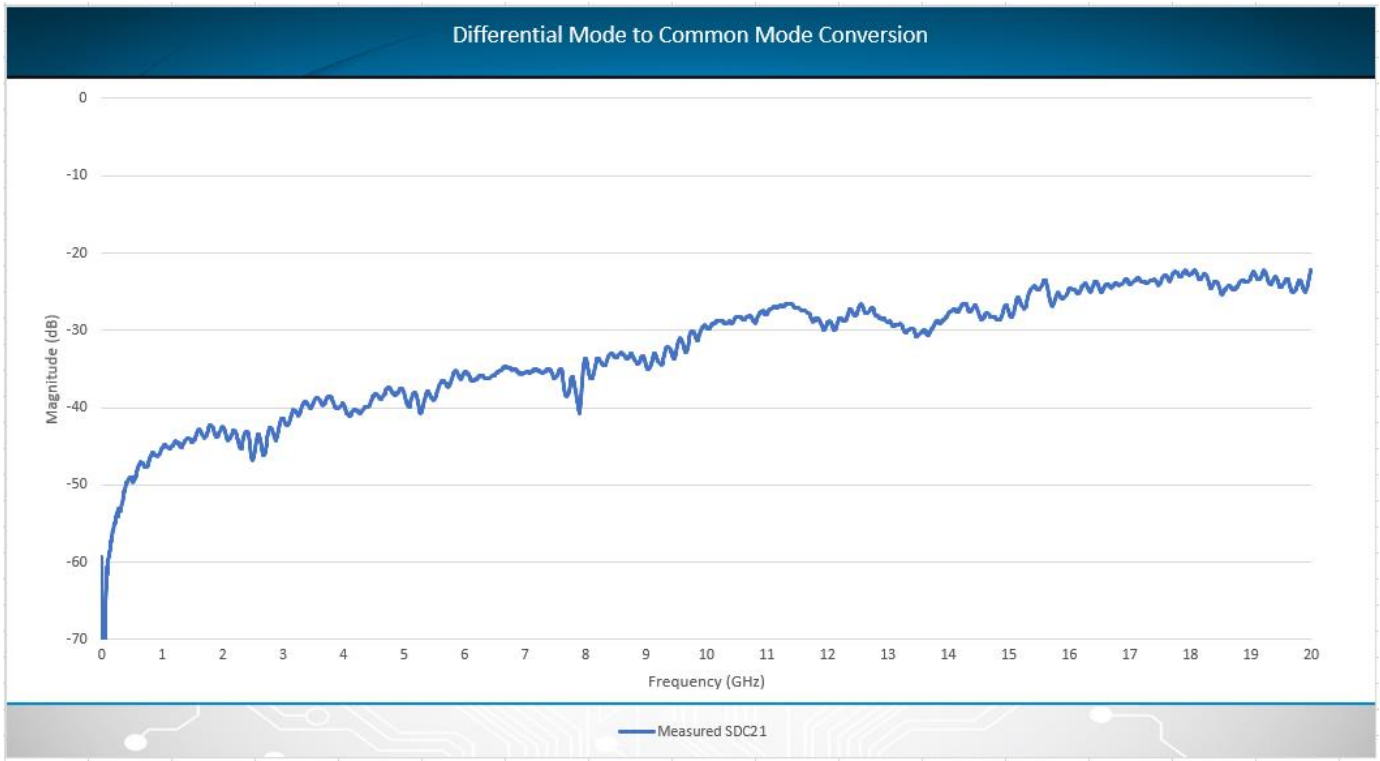


Figure 14 – Vertical to Vertical HD Mode Conversion

6.1.2 Time Domain Impedance Summary

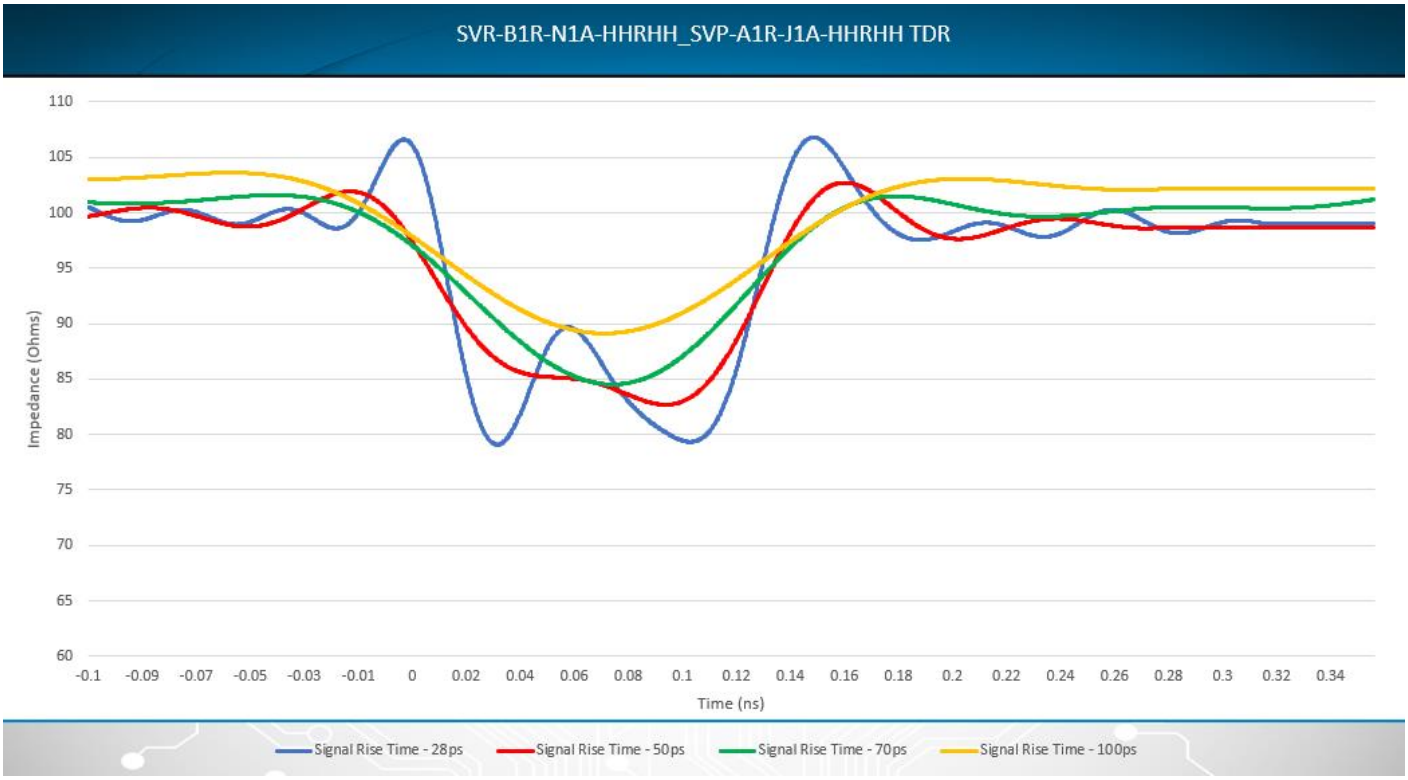


Figure 15 – Vertical to Vertical HD Time Domain Impedance

6.2 Right Angle to Vertical

Frequency Domain S-Parameter Summary for differential pair B15/B16. Differential pairs not in this equivalent physical position will have slightly varying bandwidth performance. Table values for Return Loss are pulled from the smoothed RL data, which is the outcome of a 5.05% trace smoothing applied in PLTS. For the Crosstalk Power Sum, the victim is pair B5/B6 and the aggressors are all 5 adjacent differential pairs. For the sake of simplicity and legibility, only one each of the neighboring and diagonal aggressor pairs is shown since the effects of crosstalk are identical across the axis of symmetry.

6.2.1 S-Parameter Summary

Parameter	SRR-A1R-N1A-HHRHH / SVP-A1R-J1A-HHRHH High Density Module Typical Mated Performance		
Insertion Loss	-0.2 dB @ 5 GHz	-0.62 dB @ 12.5 GHz	-3 dB @ 19.1 GHz
Return Loss	-15.5 dB @ 5 GHz	-12.66 dB @ 12.5 GHz	-5 dB @ 19.1 dB
Pair to Pair Near-End Crosstalk	-49.2 dB @ 5 GHz	-42.68 dB @ 12.5 GHz	-49.7 dB @ 19.1 GHz
Pair to Pair Far-End Crosstalk	-52.8 dB @ 5 GHz	-30.97 dB @ 12.5 GHz	-40.6 dB @ 19.1 GHz
Differential Mode to Common Mode Conversion	-29.4 dB @ 5 GHz	-20.48 dB @ 12.5 GHz	-15.6 dB @ 19.1 GHz
Propagation Delay	98 ps		
Differential Skew	2.5 ps		

Table 2 – SRR-A1R-N1A-HHRHH_SVP-A1R-J1A-HHRHH - S-Parameter Pair B15B16 Summary

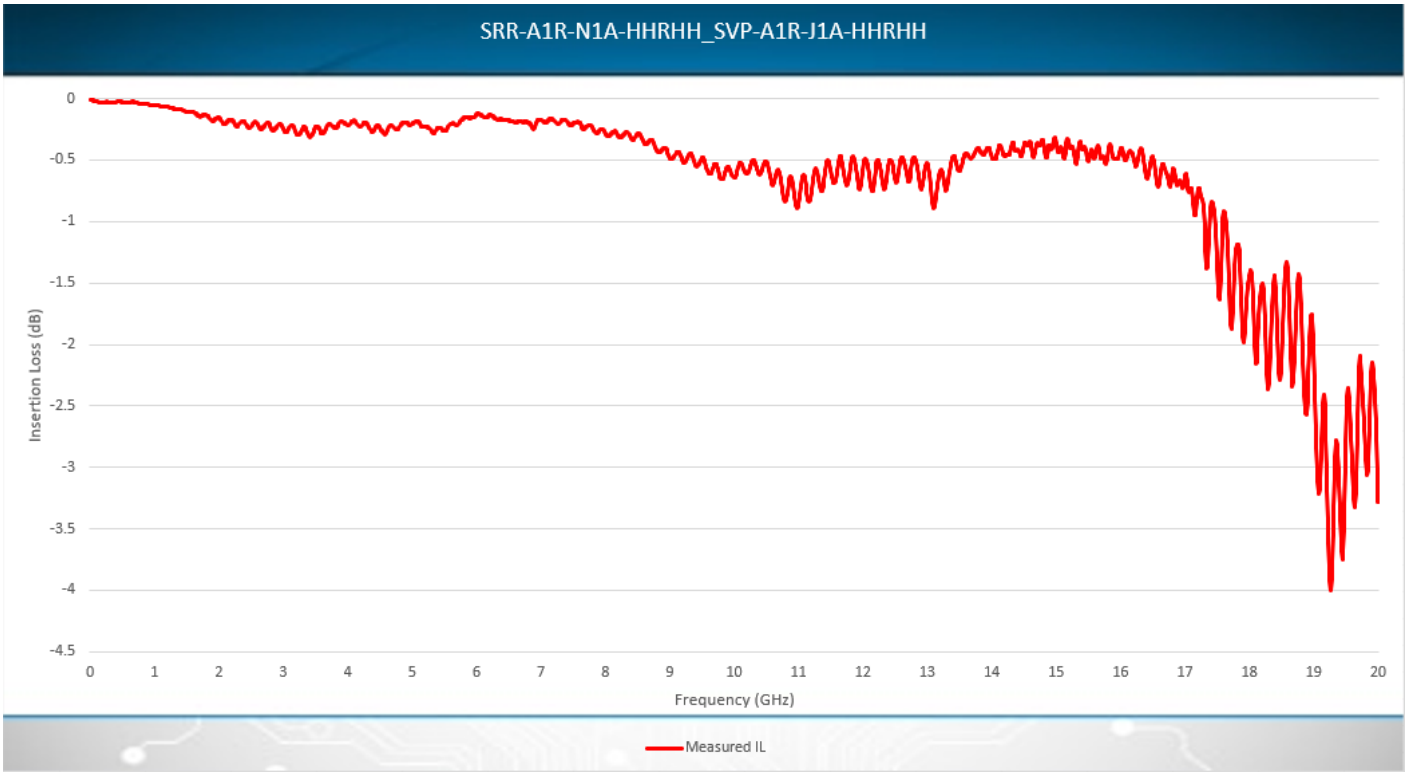


Figure 16 – RA to Vertical HD Insertion Loss

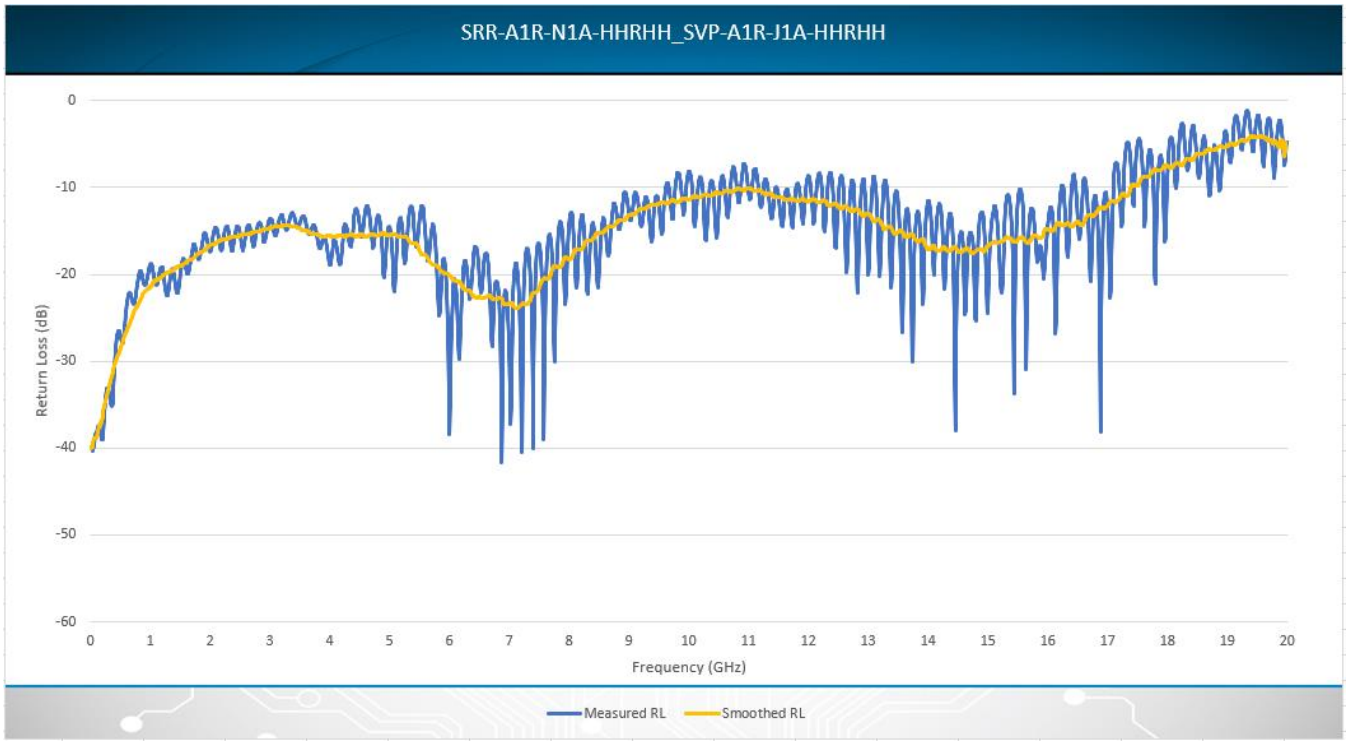


Figure 17 – RA to Vertical HD Return Loss

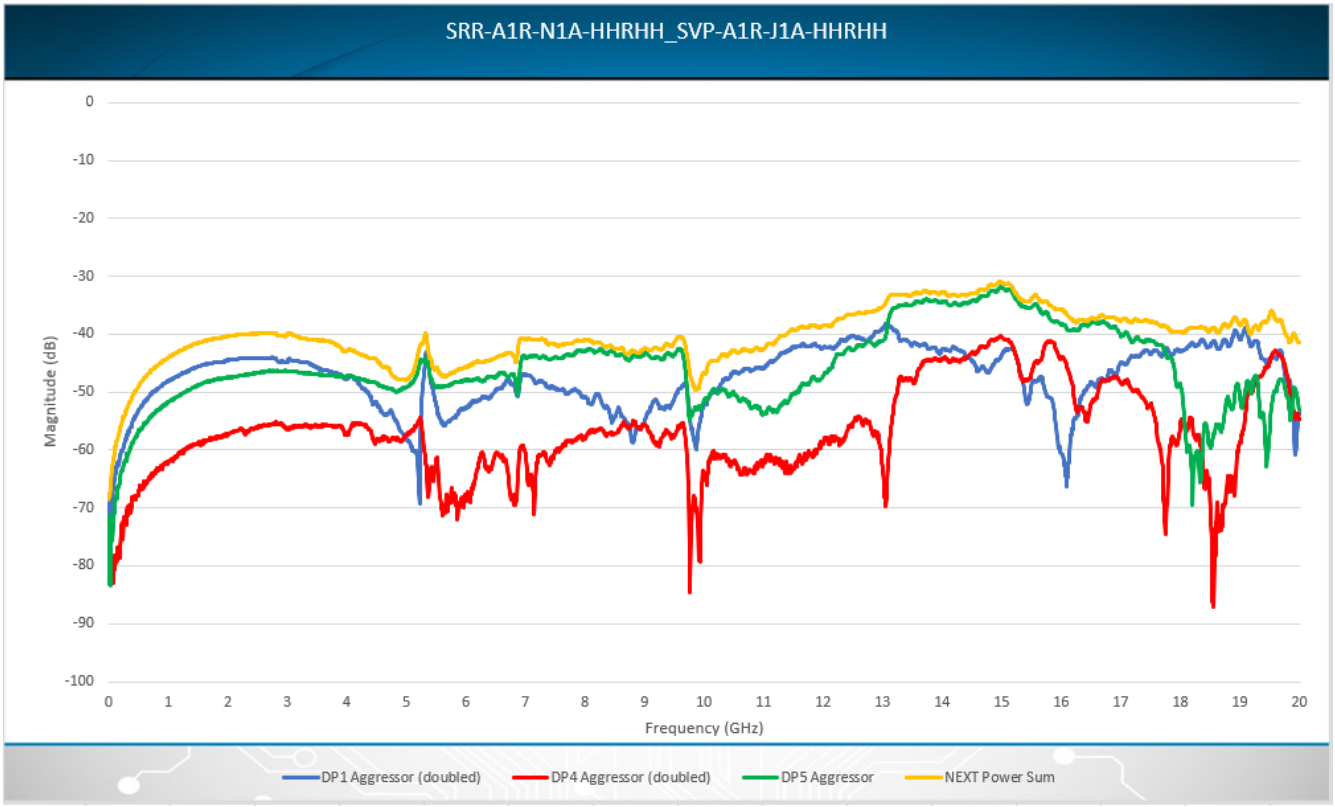


Figure 18 – RA to Vertical HD NEXT

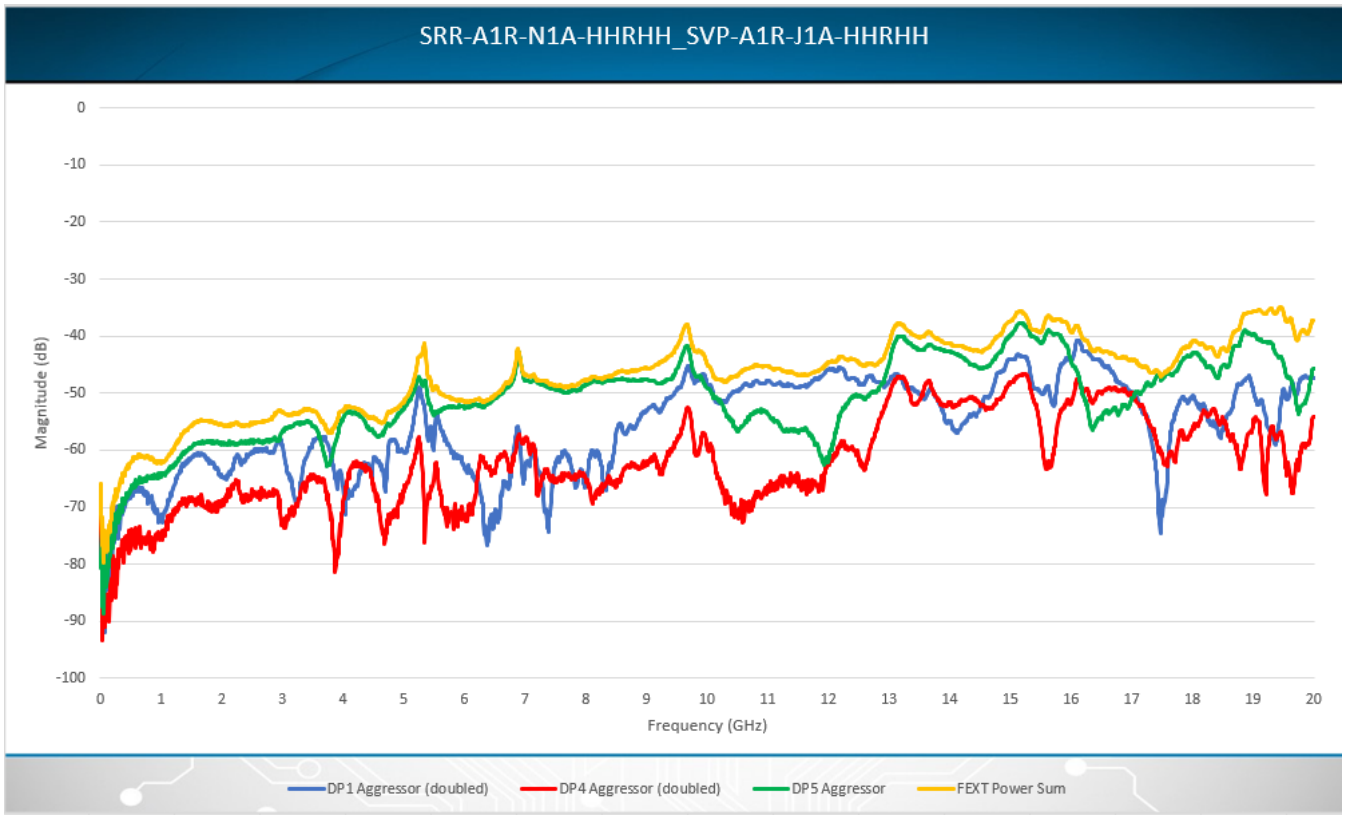


Figure 19 – RA to Vertical HD FEXT

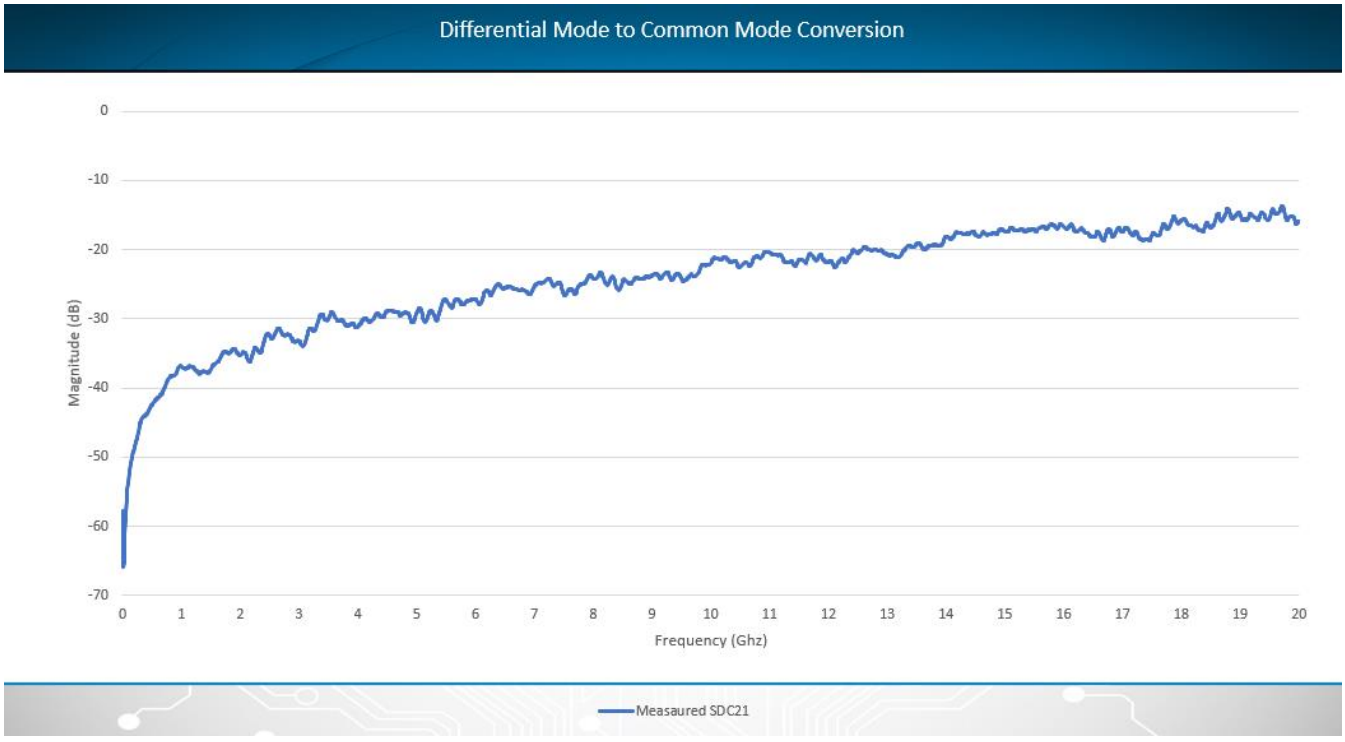


Figure 20 – RA to Vertical HD Mode Conversion

6.2.2 Time Domain Impedance Summary

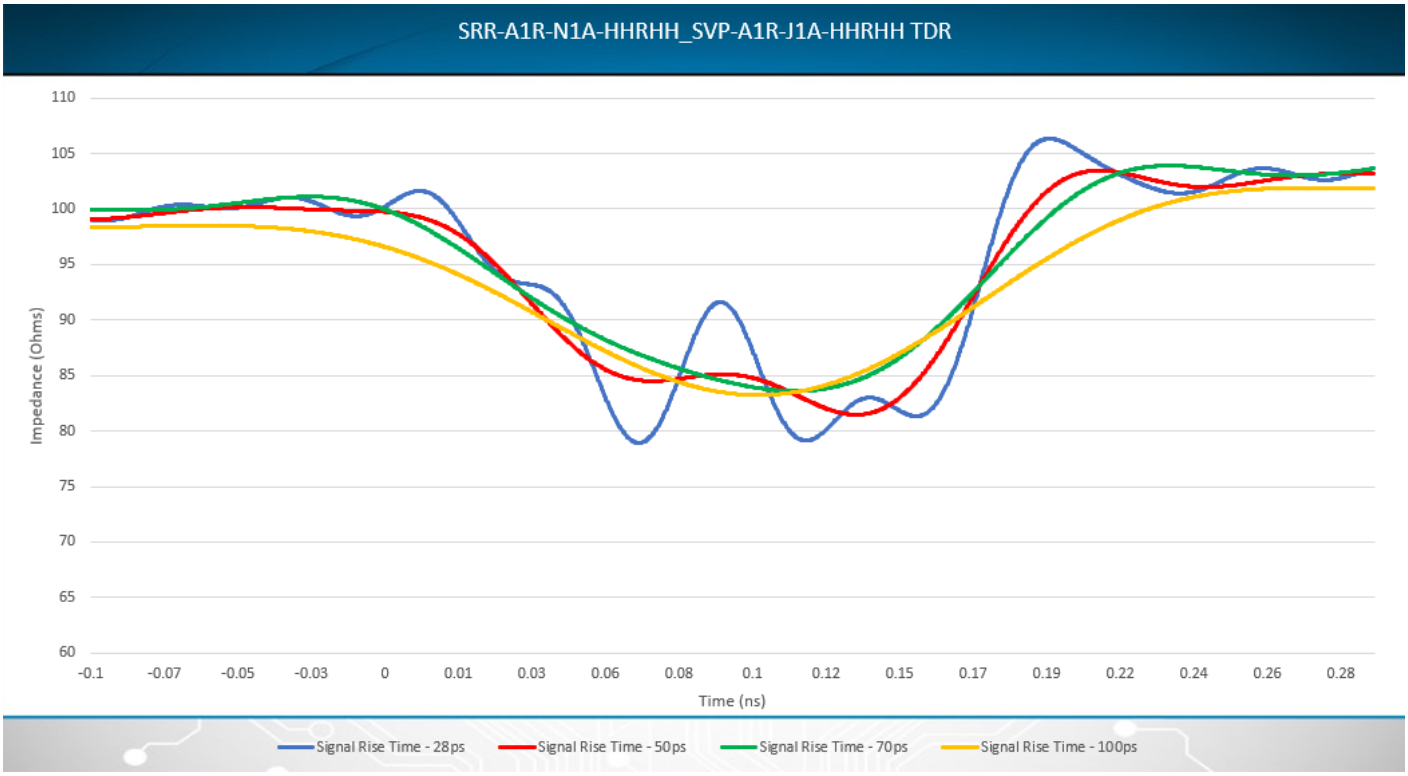


Figure 21 – RA to Vertical HD Time Domain Impedance

7 SI Performance – Cable Assembly High Density

7.1 Vertical to Vertical

Frequency Domain S-Parameter Summary for differential pair B15/B16. Differential pairs not in this equivalent physical position will have slightly varying bandwidth performance. Table values for Return Loss are pulled from the smoothed RL data, which is the outcome of a 5.05% trace smoothing applied in PLTS. For the Crosstalk Power Sum, the victim is pair B5/B6 and the aggressors are all 5 adjacent differential pairs. For the sake of simplicity and legibility, only one each of the neighboring and diagonal aggressor pairs is shown since the effects of crosstalk are identical across the axis of symmetry. The cable assembly is a 1m cable with 30awg Twinax wires.

7.1.1 S-Parameter Summary

Parameter	SCRP-BNA-AJA-100-TTRTT High Density Module Typical Mated Performance		
Insertion Loss	-3 dB @ 3.2 GHz	-3.8 dB @ 5 GHz	-9.3 dB @ 12.5 GHz
Return Loss	-14.5 dB @ 3.2 GHz	-14.3 dB @ 5 GHz	-9.1 dB @ 12.5 GHz
Pair to Pair Near-End Crosstalk	-51.1 dB @ 3.2 GHz	-46.6 dB @ 5 GHz	-43.4 dB @ 12.5 GHz
Pair to Pair Far-End Crosstalk	-59.1 dB @ 3.2 GHz	-59.2 dB @ 5 GHz	-60.9 dB @ 12.5 GHz
Differential Mode to Common Mode Conversion	-36.2 dB @ 3.2 GHz	-31.4 dB @ 5 GHz	-27.3 dB @ 12.5 GHz
Propagation Delay	80 ps		
Differential Skew	1.1 ps		

Table 3 – SCRP-BNA-AJA-100-TTRTT - S-Parameter Pair B15B16 Summary

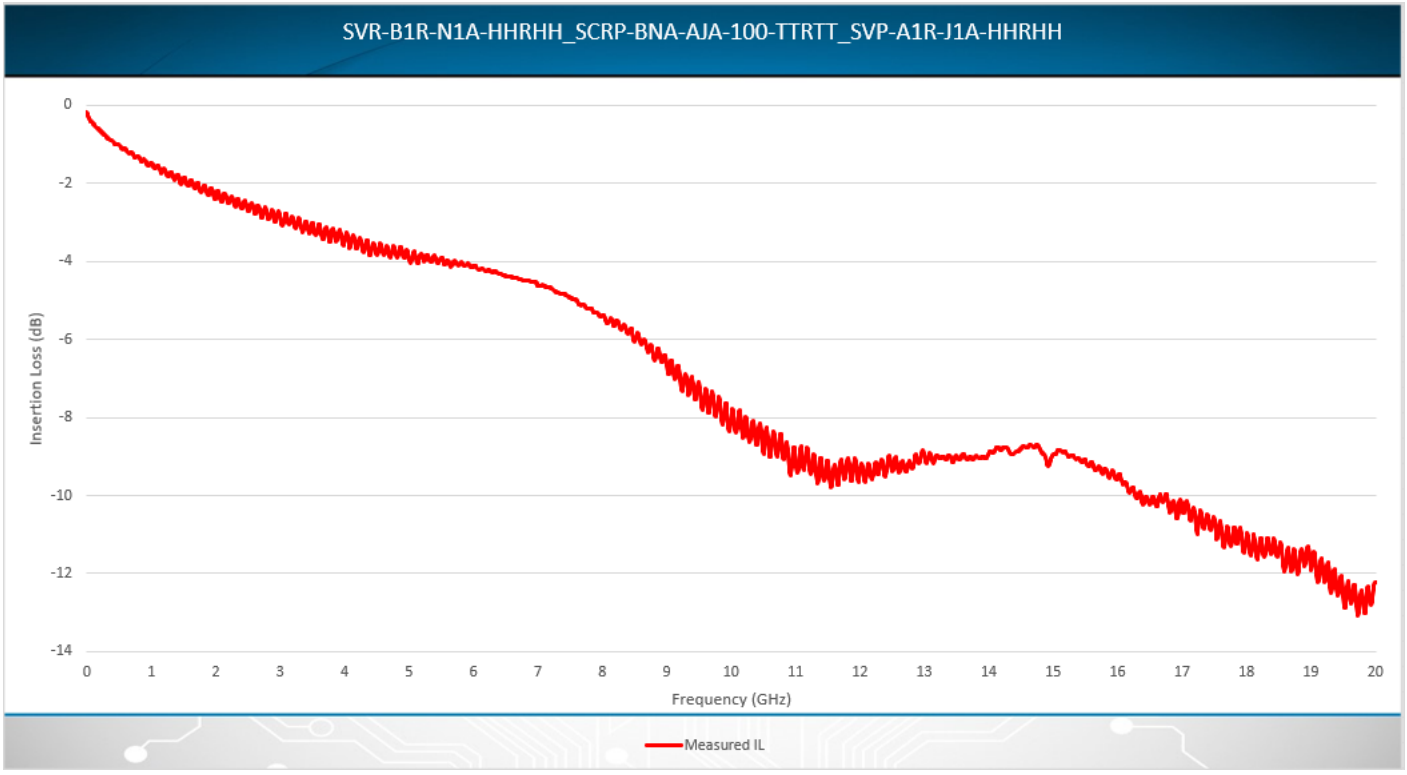


Figure 22 – Cable to Vertical HD Insertion Loss

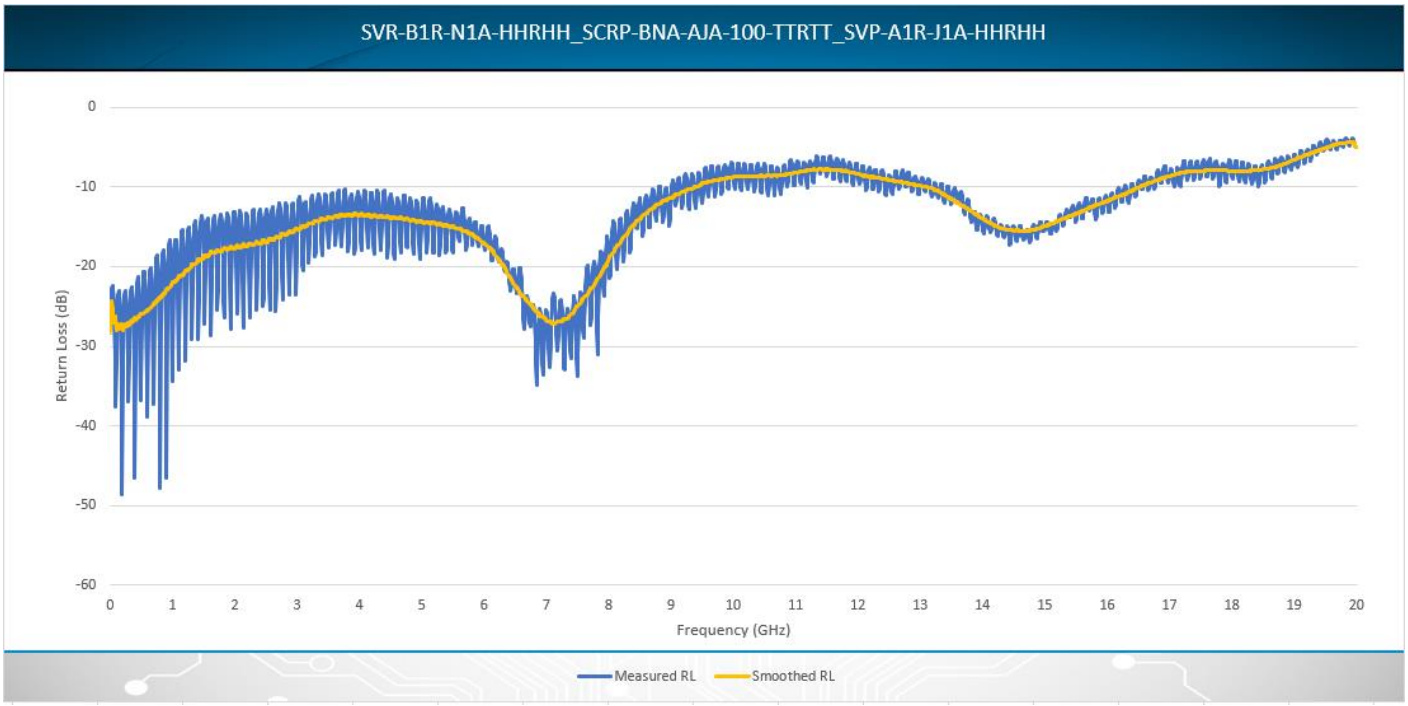


Figure 23 – Cable to Vertical HD Return Loss

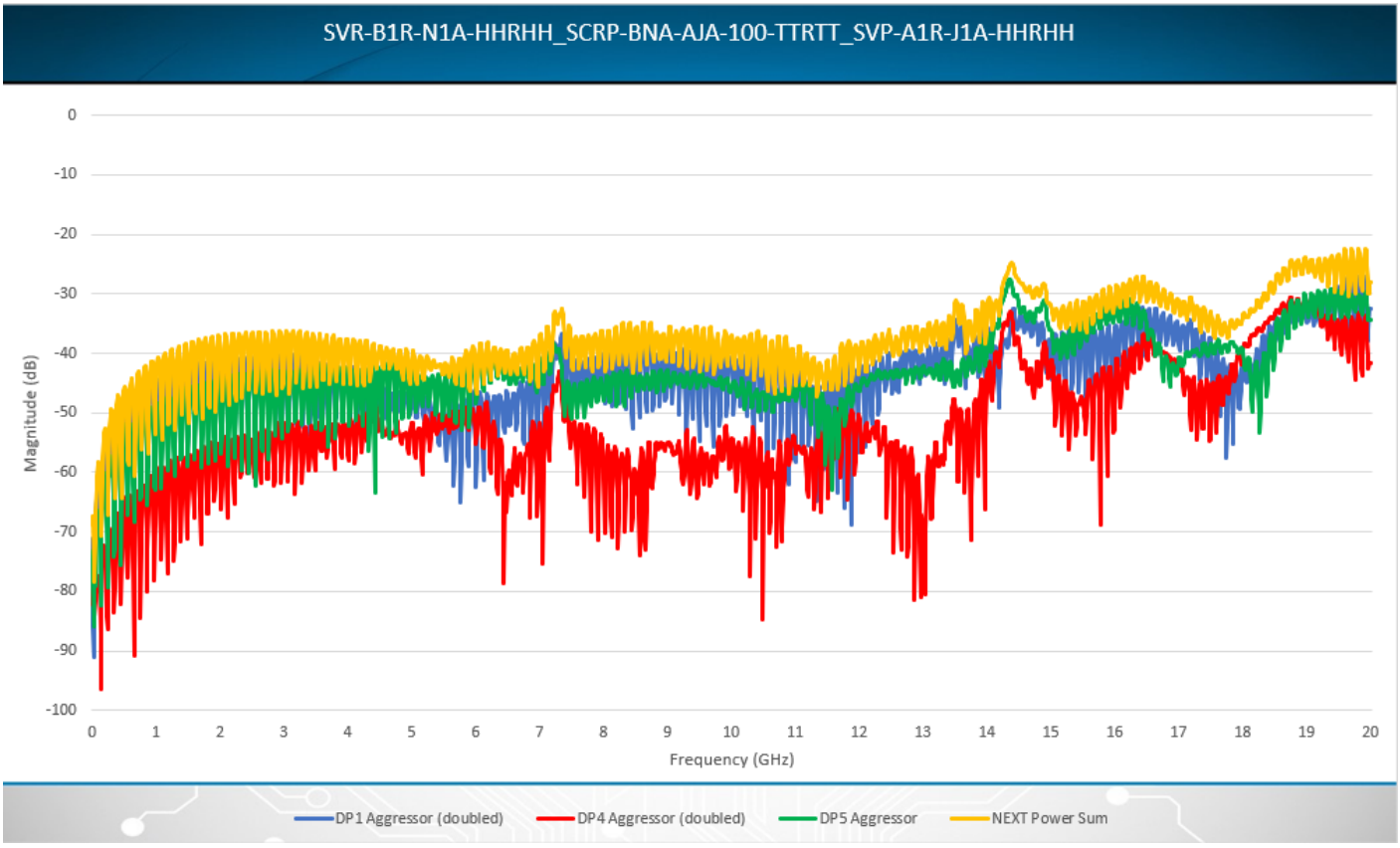


Figure 24 – Cable to Vertical HD NEXT

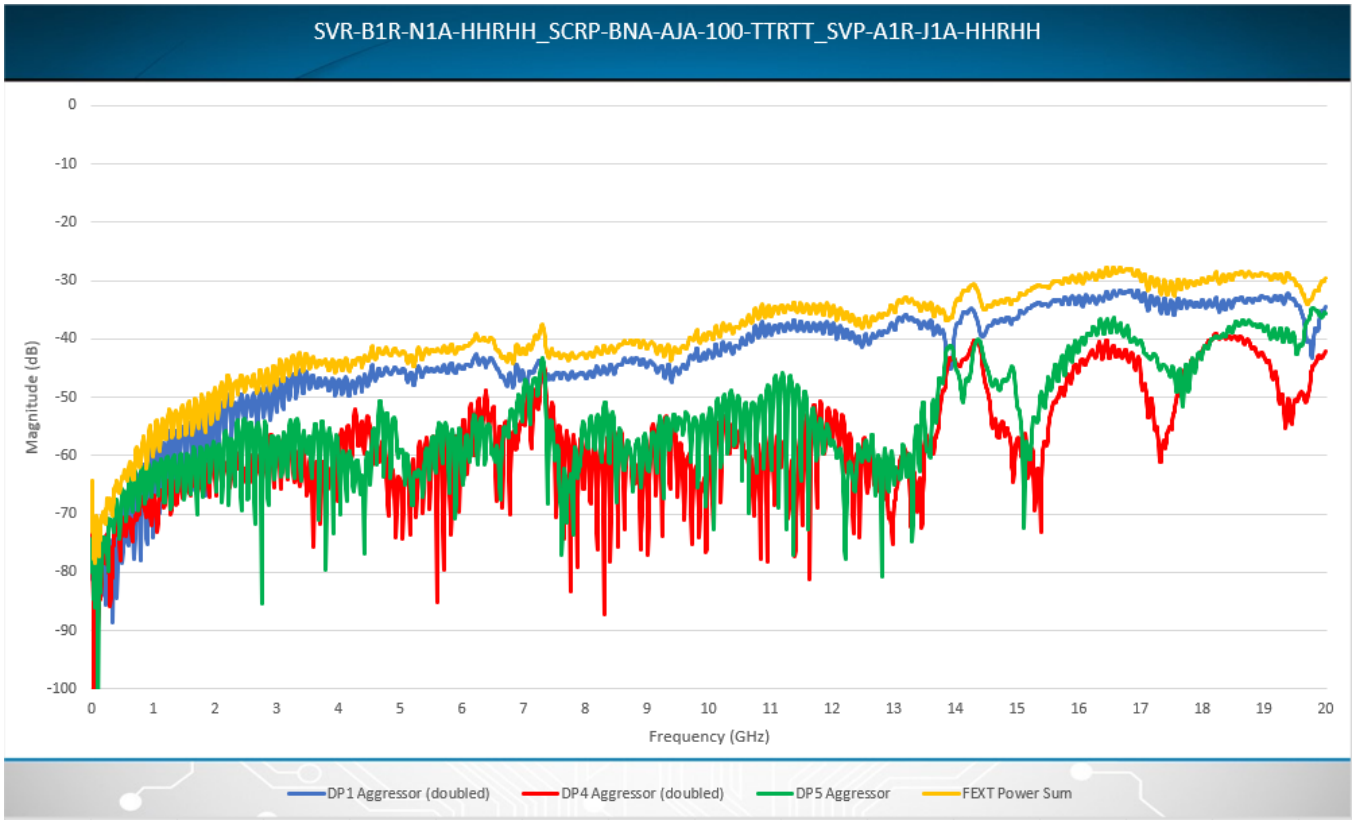


Figure 25 – Cable to Vertical HD FEXT

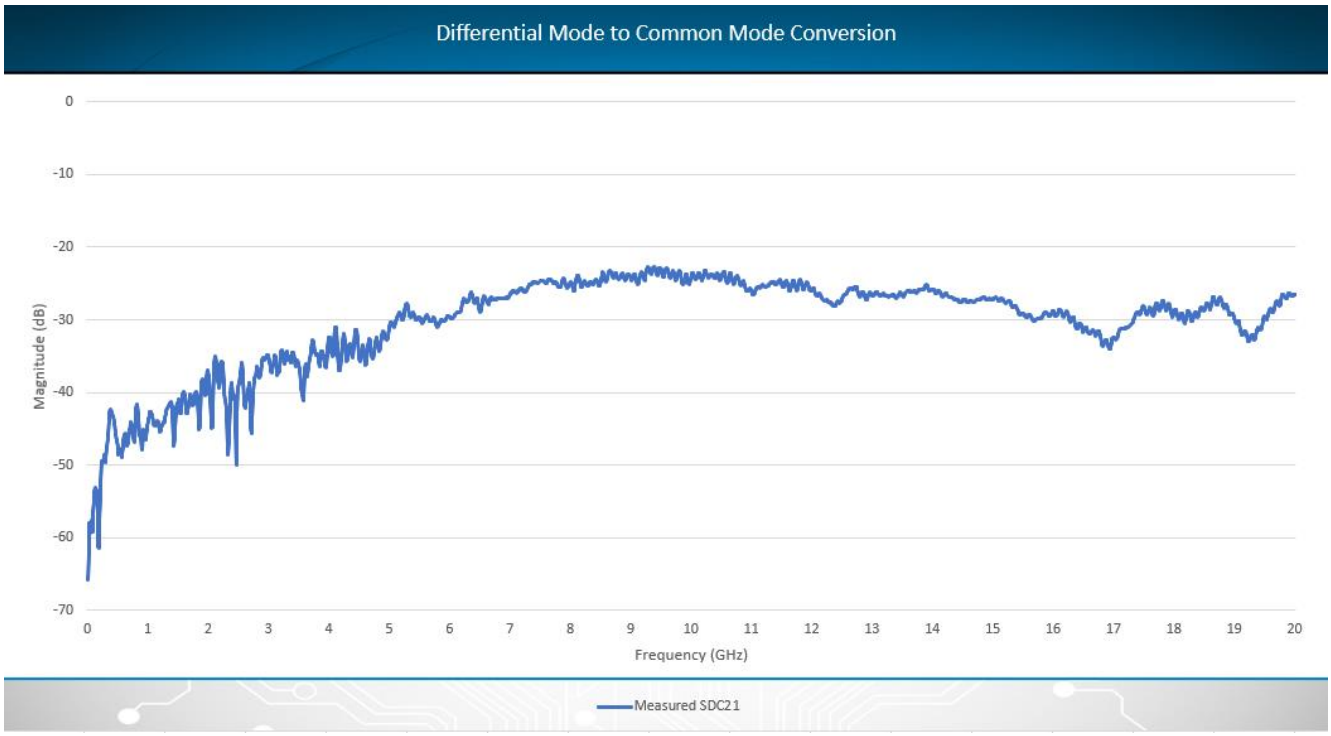


Figure 26 – Cable to Vertical HD Mode Conversion

7.1.2 Time Domain Impedance Summary

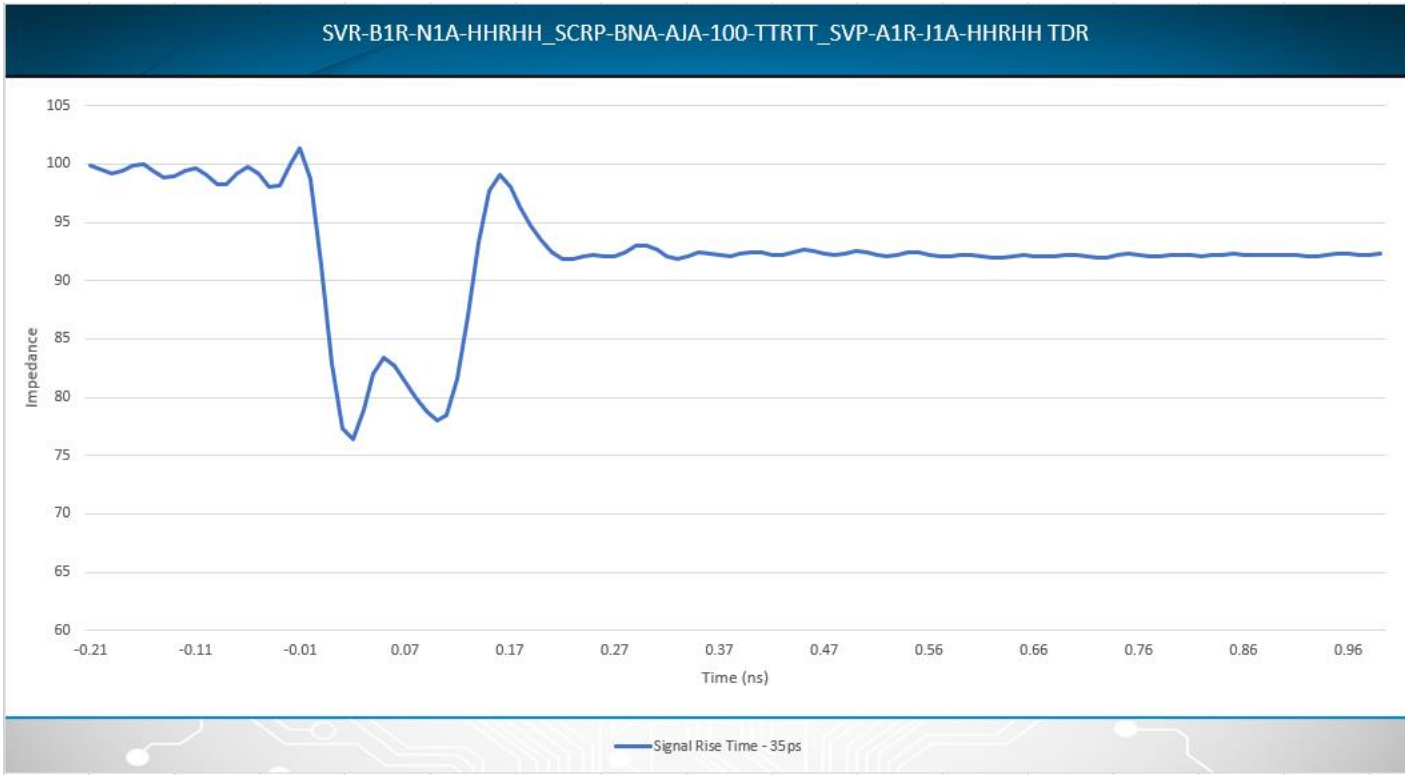


Figure 27 – Cable to Vertical HD Time Domain Impedance

7.2 Right Angle to Vertical

Frequency Domain S-Parameter Summary for differential pair B15/B16. Differential pairs not in this equivalent physical position will have slightly varying bandwidth performance. Table values for Return Loss are pulled from the smoothed RL data, which is the outcome of a 5.05% trace smoothing applied in PLTS. For the Crosstalk Power Sum, the victim is pair B5/B6 and the aggressors are all 5 adjacent differential pairs. For the sake of simplicity and legibility, only o each of the neighboring and diagonal aggressor pairs is shown since the effects of crosstalk are identical across the axis of symmetry. The cable assembly is a 1m cable with 30awg Twinax wires.

7.2.1 S-Parameter Summary

Parameter	SCRP-BNA-AJA-100-TTRTT High Density Module Typical Mated Performance		
Insertion Loss	-3 dB @ 3 GHz	-3.7 dB @ 5 GHz	-7.4 dB @ 12.5 GHz
Return Loss	-16.7 dB @ 3 GHz	-17.3 dB @ 5 GHz	-19.7 dB @ 12.5 GHz
Pair to Pair Near-End Crosstalk	-47.8 dB @ 3 GHz	-65.9 dB @ 5 GHz	-40.5 dB @ 12.5 GHz
Pair to Pair Far-End Crosstalk	-56.8 dB @ 3 GHz	-60.9 dB @ 5 GHz	-51.3 dB @ 12.5 GHz
Differential Mode to Common Mode Conversion	-33.9 dB @ 3 GHz	-34.1 dB @ 5 GHz	-40.3 dB @ 12.5 GHz
Propagation Delay	98 ps		
Differential Skew	2.5 ps		

Table 4 - SCRP-BNA-AJA-100-TTRTT - S-Parameter Pair B15B16 Summary

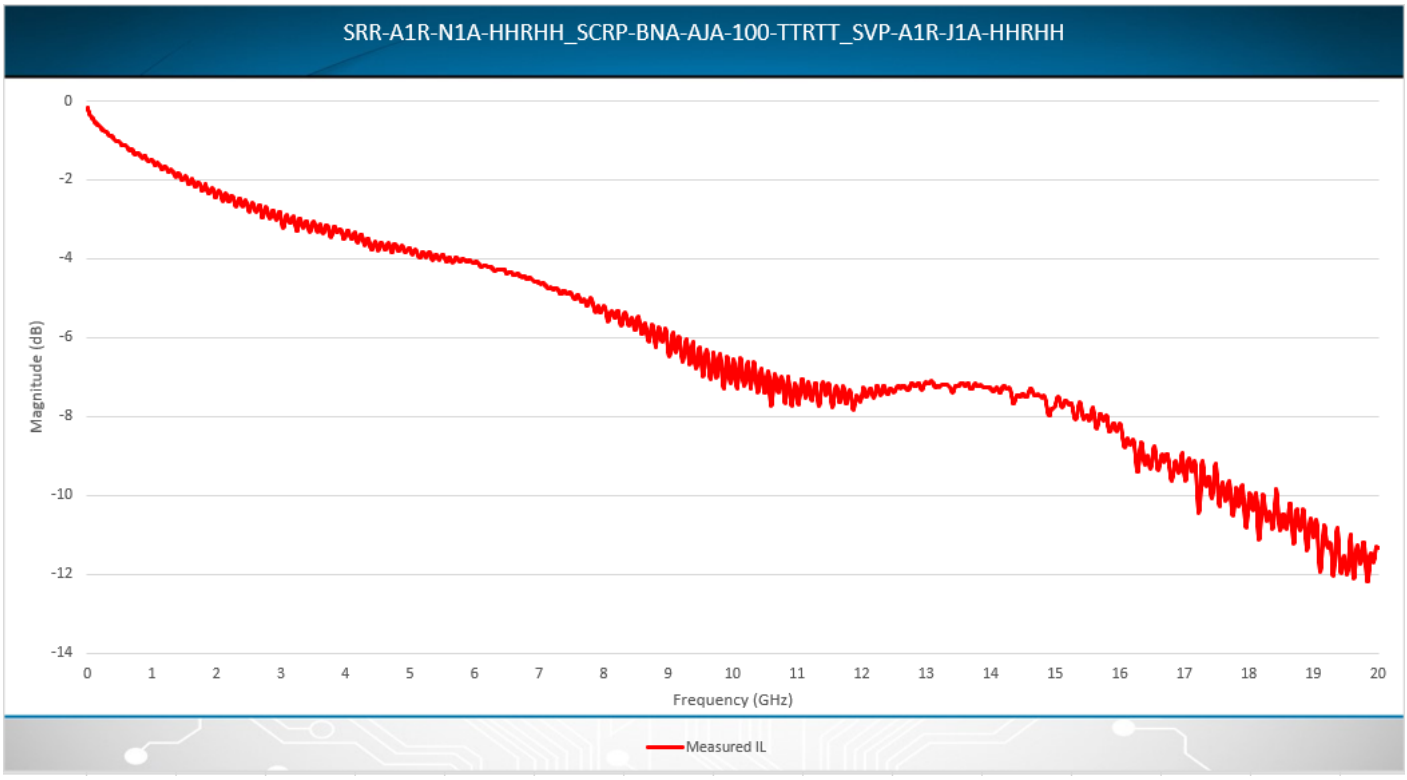


Figure 28 – Cable to RA HD Insertion Loss

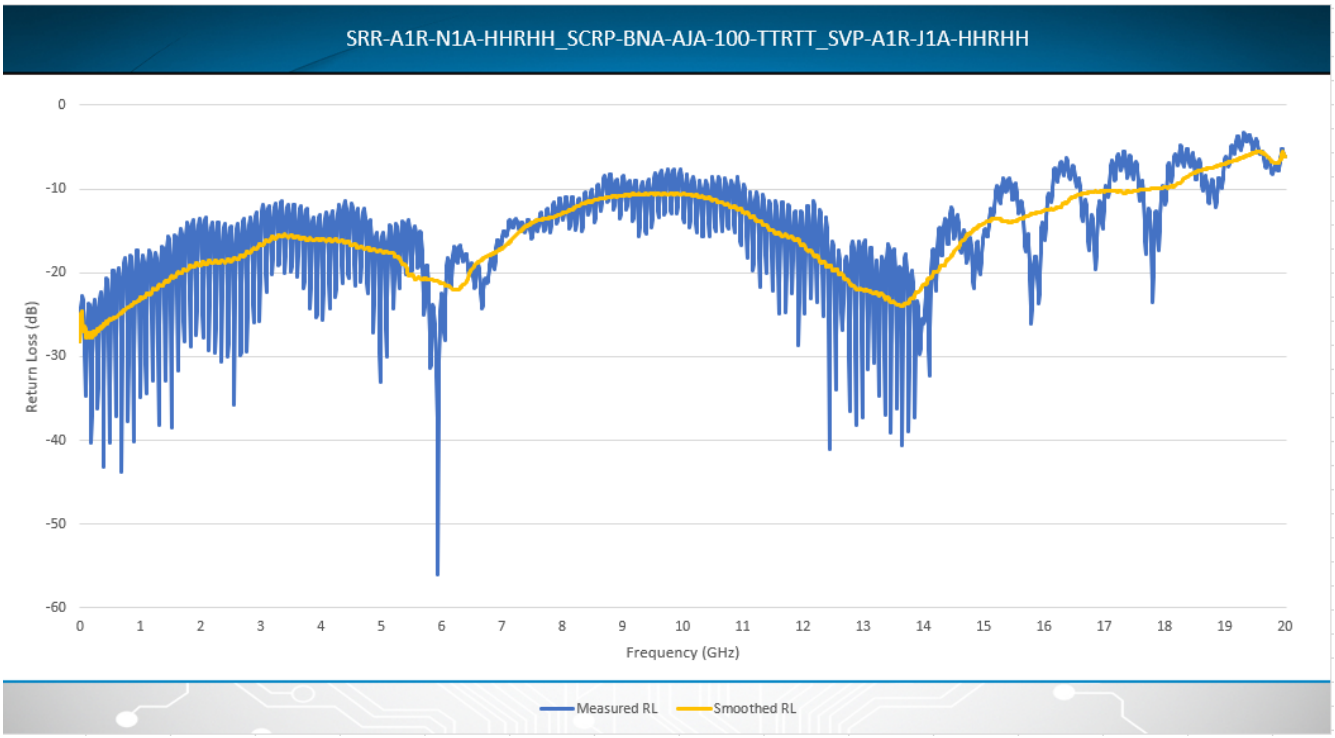


Figure 29 – Cable to RA HD Return Loss

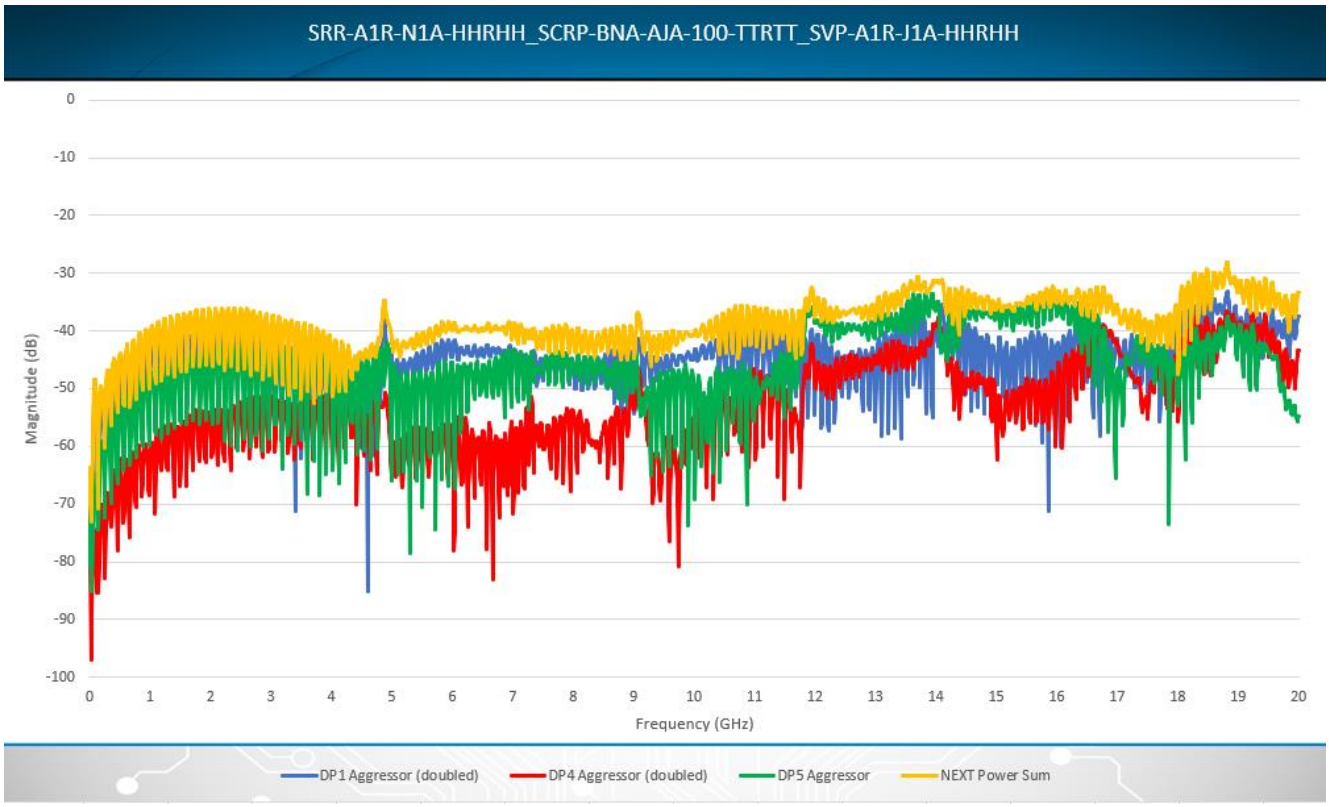


Figure 30 – Cable to RA HD NEXT

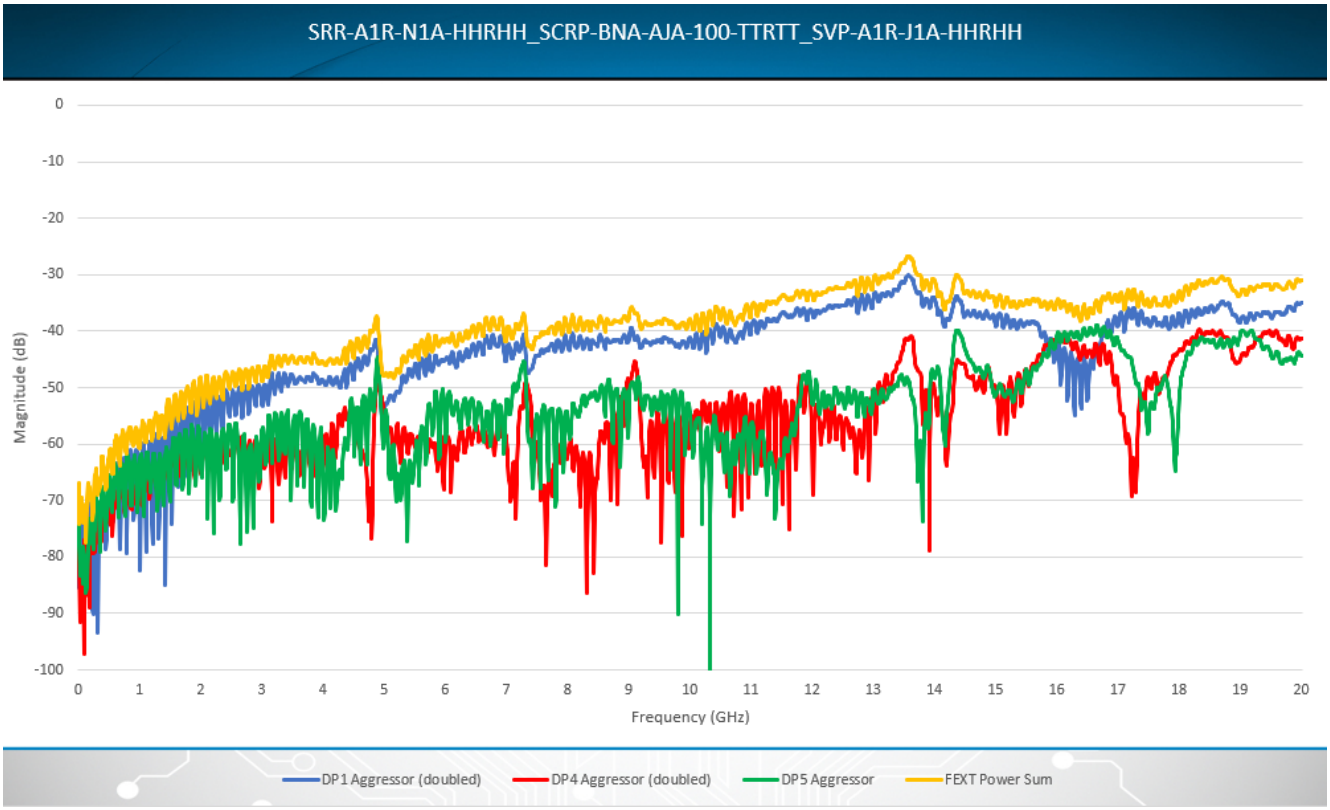


Figure 31 – Cable to RA HD FEXT

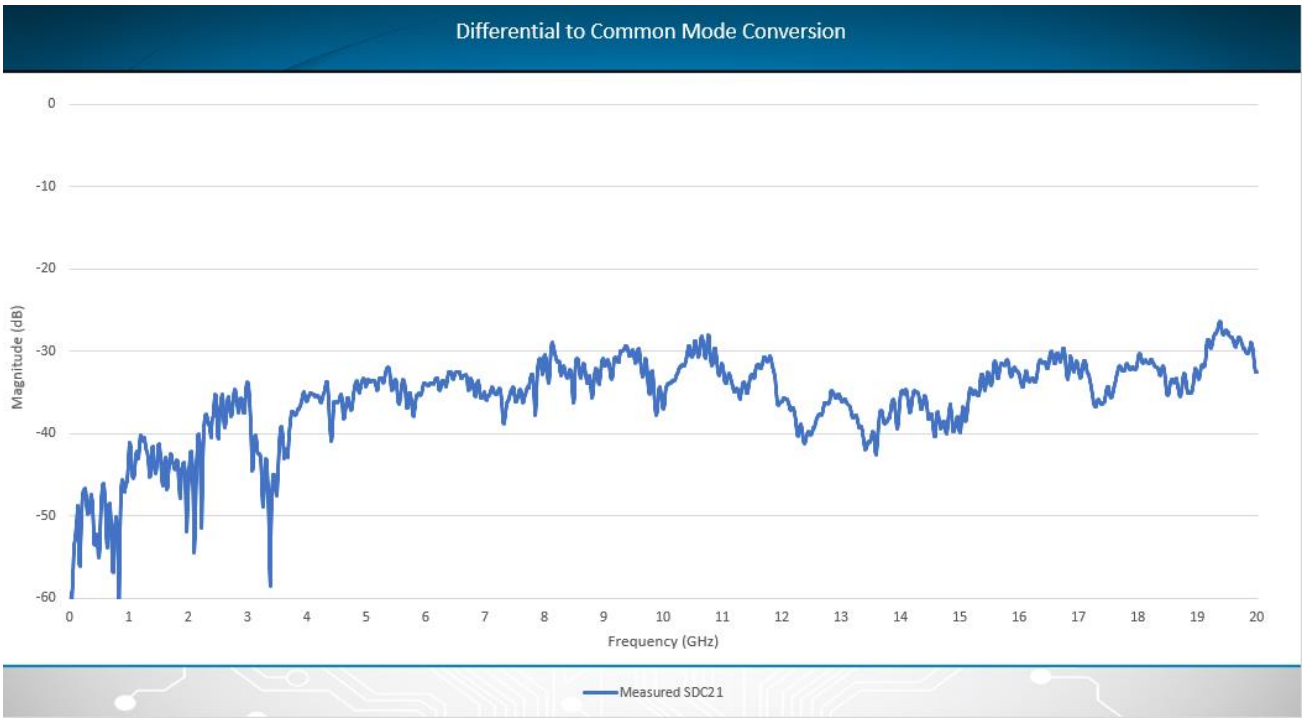


Figure 32 – Cable to RA HD Mode Conversion

7.2.2 Time Domain Impedance Summary

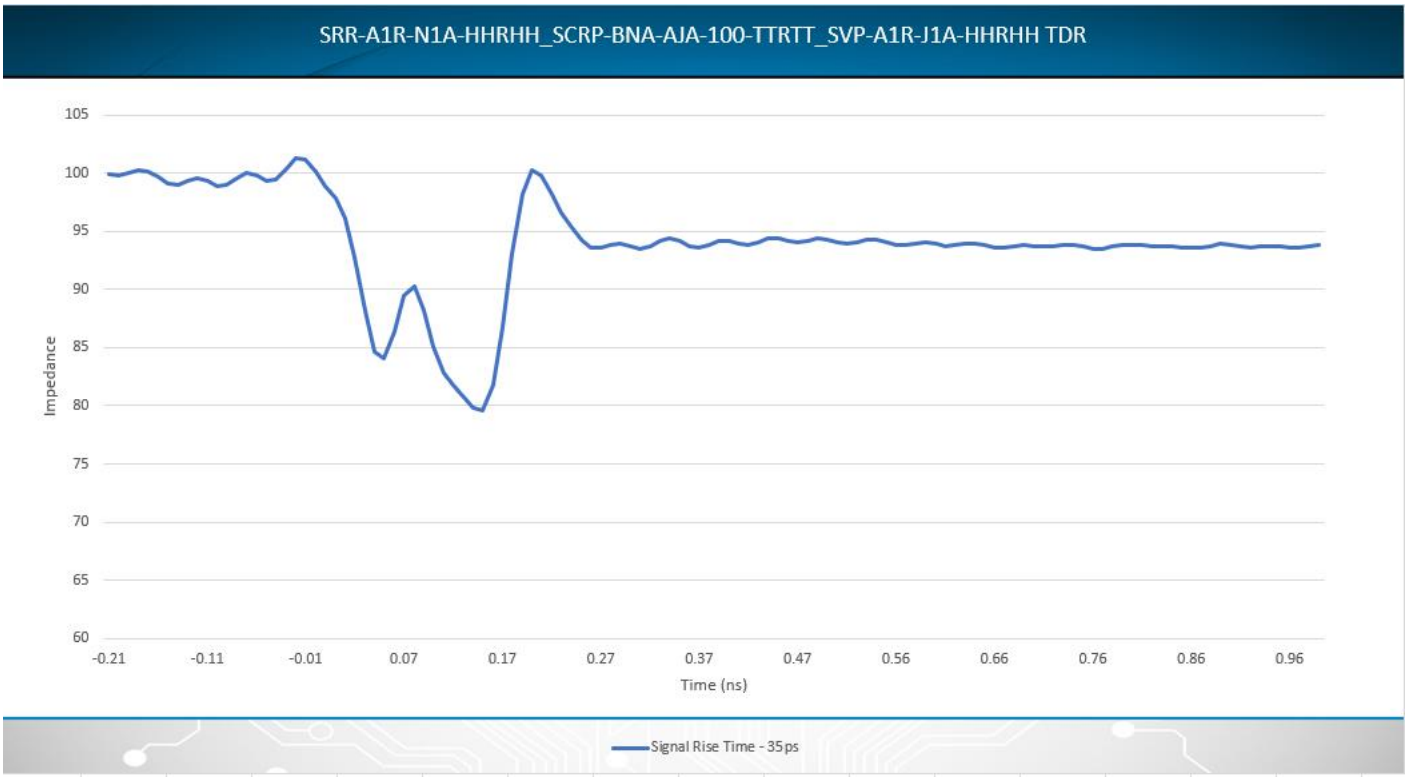


Figure 33 – Cable to RA HD Time Domain Impedance

8 SI Performance – Board to Board RF

8.1 Vertical to Vertical

Vertical to Vertical RF data is de-embedded via gating instead of AFR.

8.1.1 S-Parameter Summary

Parameter	SVR-B1R-N1A-HHRHH / SVP-A1R-J1A-HHRHH RF Module Typical Mated Performance		
Insertion Loss	-0.6 dB @ 5 GHz	-2.08 dB @ 12.5 GHz	-3dB @ 15.6 GHz
Return Loss	-30.7 dB @ 5 GHz	-12.73 dB @ 12.5 GHz	-11.7 dB @ 15.6 GHz
Propagation Delay	206 ps		

Table 5 – SVR-B1R-N1A-HHRHH/SVP-A1R-J1A-HHRHH – RF S-Parameter Summary

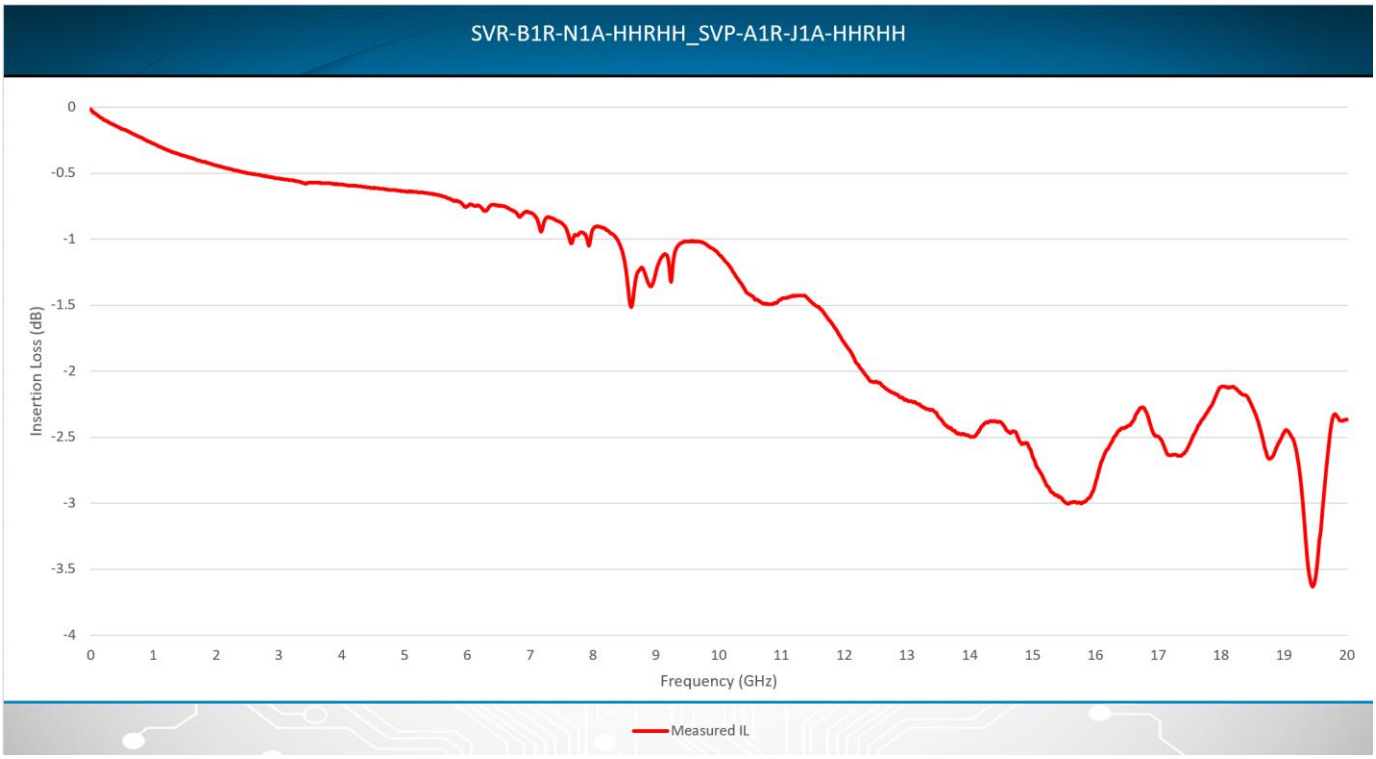


Figure 34 – Vertical to Vertical RF Insertion Loss

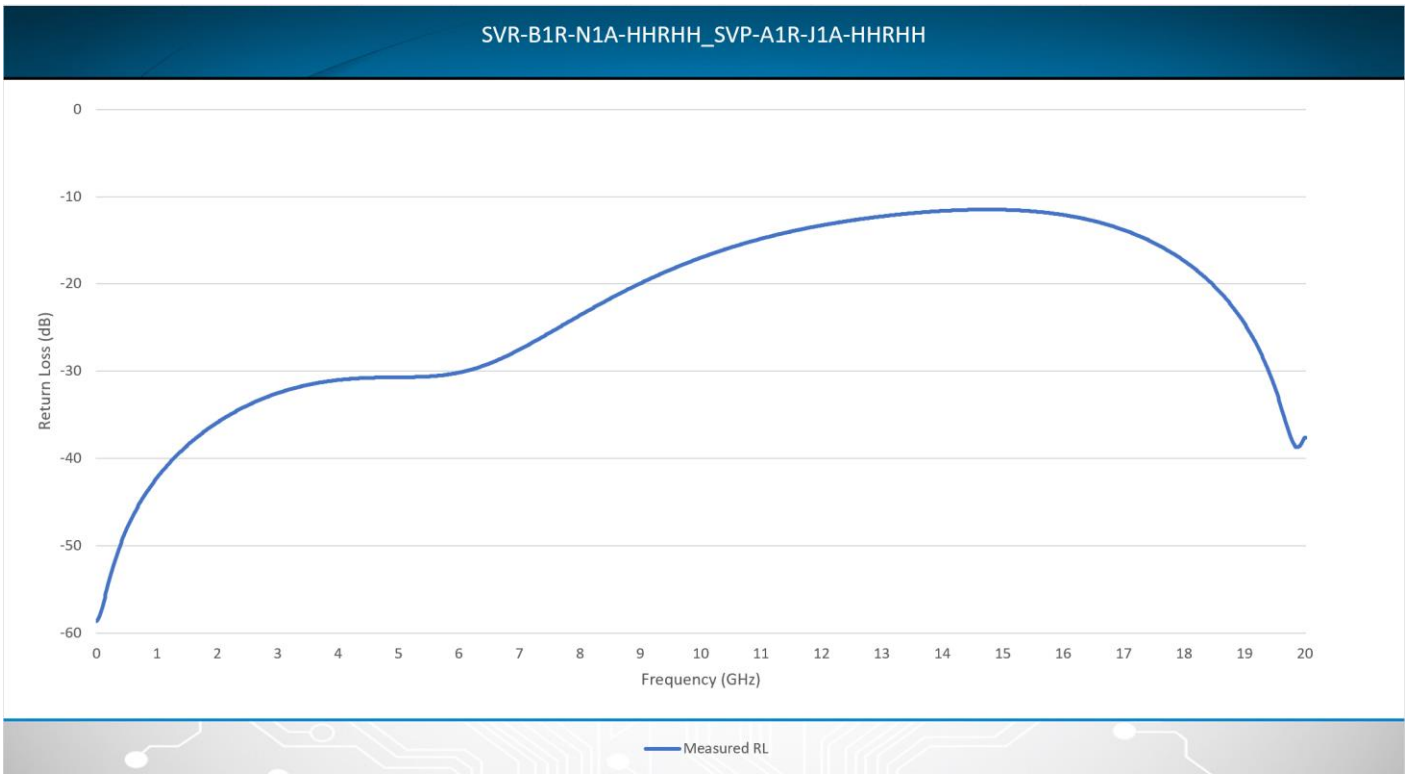


Figure 35 – Vertical to Vertical RF Return Loss

8.1.2 Time Domain Impedance Summary

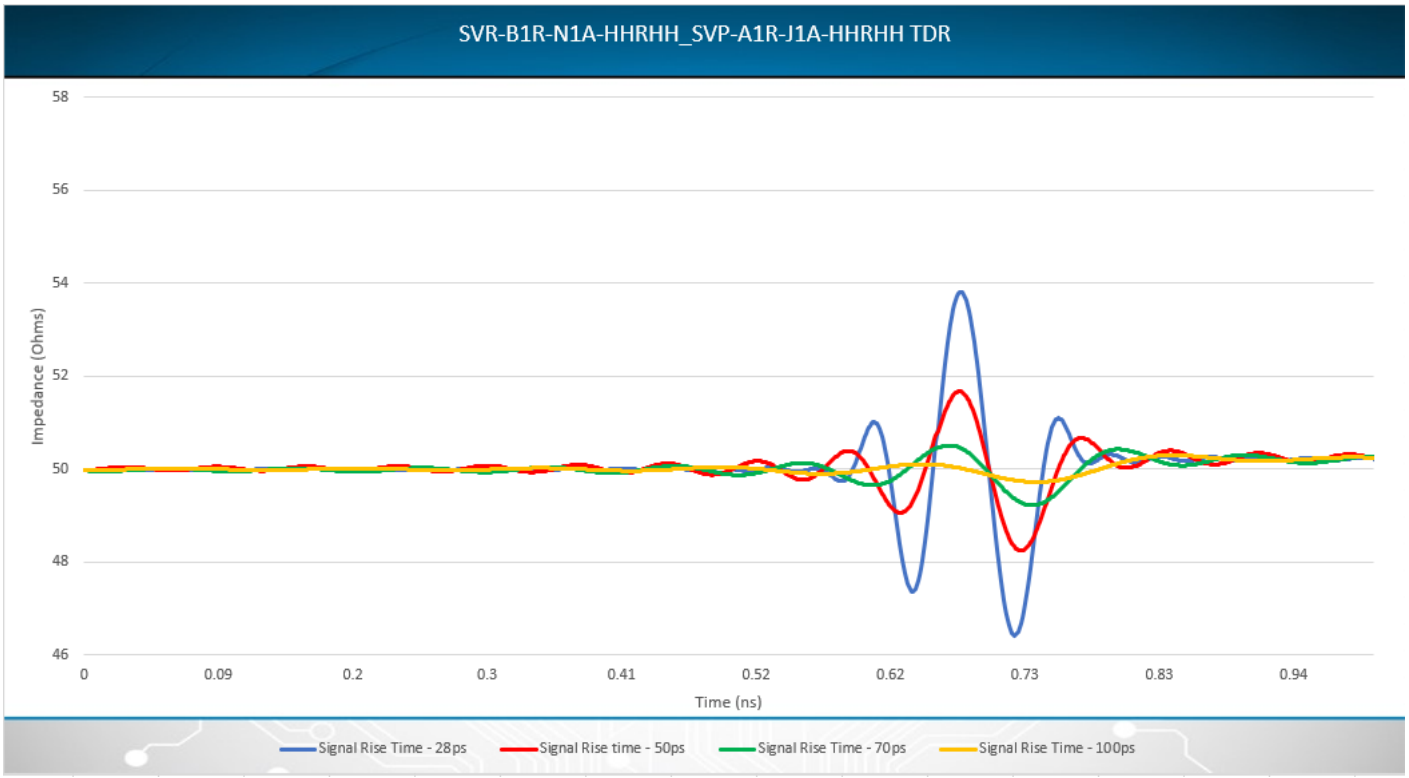


Figure 36 – Vertical to Vertical RF Time Domain Impedance

8.2 Right Angle to Vertical

8.2.1 S-Parameter Summary

Parameter	SRR-A1R-N1A-HHRHH / SVP-A1R-J1A-HHRHH RF Module Typical Mated Performance		
Insertion Loss	-0.3 dB @ 5 GHz	-0.52 dB @ 12.5 GHz	-3 dB @ 19.2 GHz
Return Loss	-29.6 dB @ 5 GHz	-15.16 dB @ 12.5 GHz	-5.1 dB @ 19.2 GHz
Propagation Delay	76 ps		

Table 6 - SRR-A1R-N1A-HHRHH_SVP-A1R-J1A-HHRHH – RF S-Parameter Summary

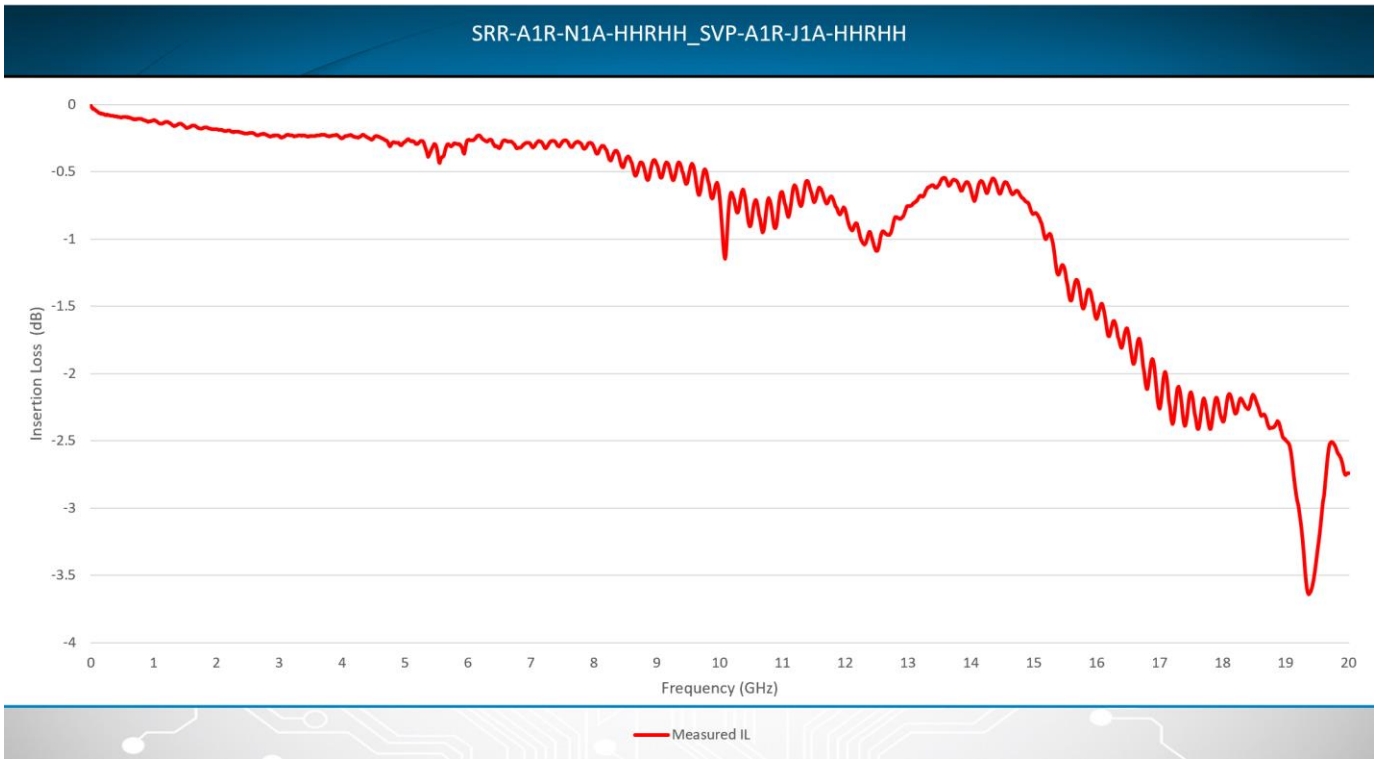


Figure 37 – RA to Vertical RF Insertion Loss

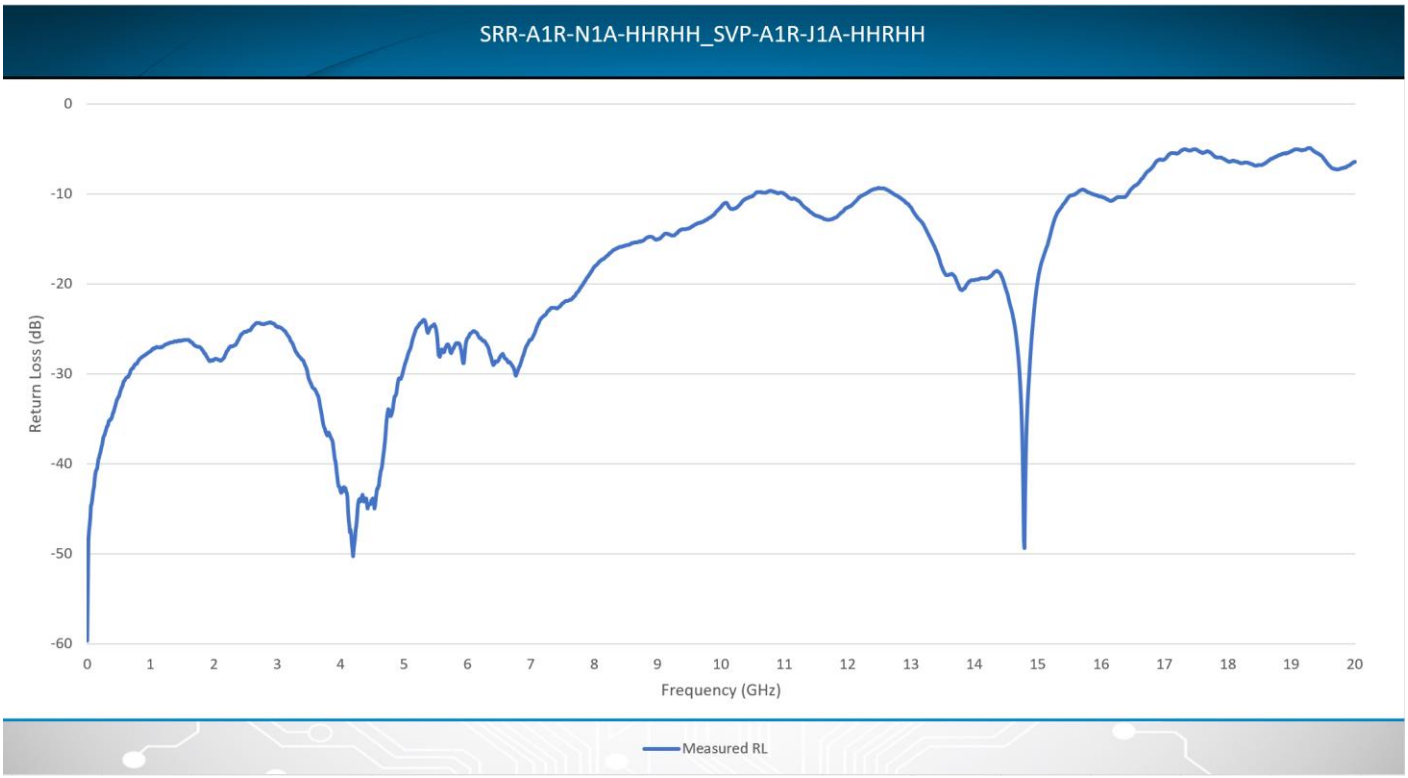


Figure 38 – RA to Vertical RF Return Loss

8.2.2 Time Domain Impedance Summary

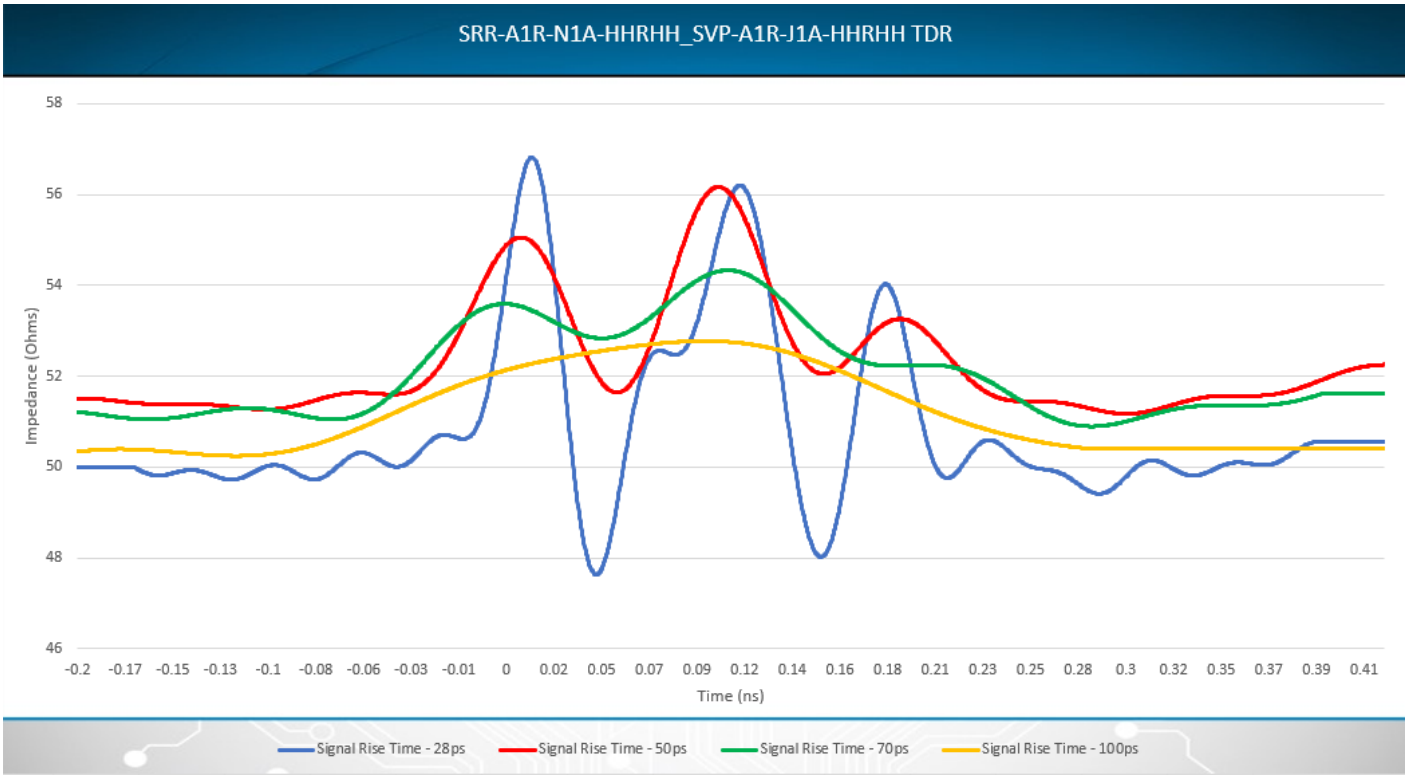


Figure 39 – RA to Vertical RF Time Domain Impedance

9 SI Performance – Cable Assembly RF

9.1 Vertical to Vertical

The cable assembly is a 1m cable with 30awg coax wiring. Vertical to Vertical RF data is de-embedded via gating instead of AFR.

9.1.1 S-Parameter Summary

Parameter	SCRP-BNA-AJA-100-TTRTT RF Module Typical Mated Performance		
Insertion Loss	-3 dB @ 1.7 GHz	-4.9 dB @ 5 GHz	-8.9 dB @ 12.5 GHz
Return Loss	-33.1 dB @ 1.7 GHz	-27.9 dB @ 5 GHz	-15 dB @ 12.5 GHz
Propagation Delay	206 ps		

Table 7 – SCRP-BNA-AJA-100-TTRTT – RF S-Parameter Summary

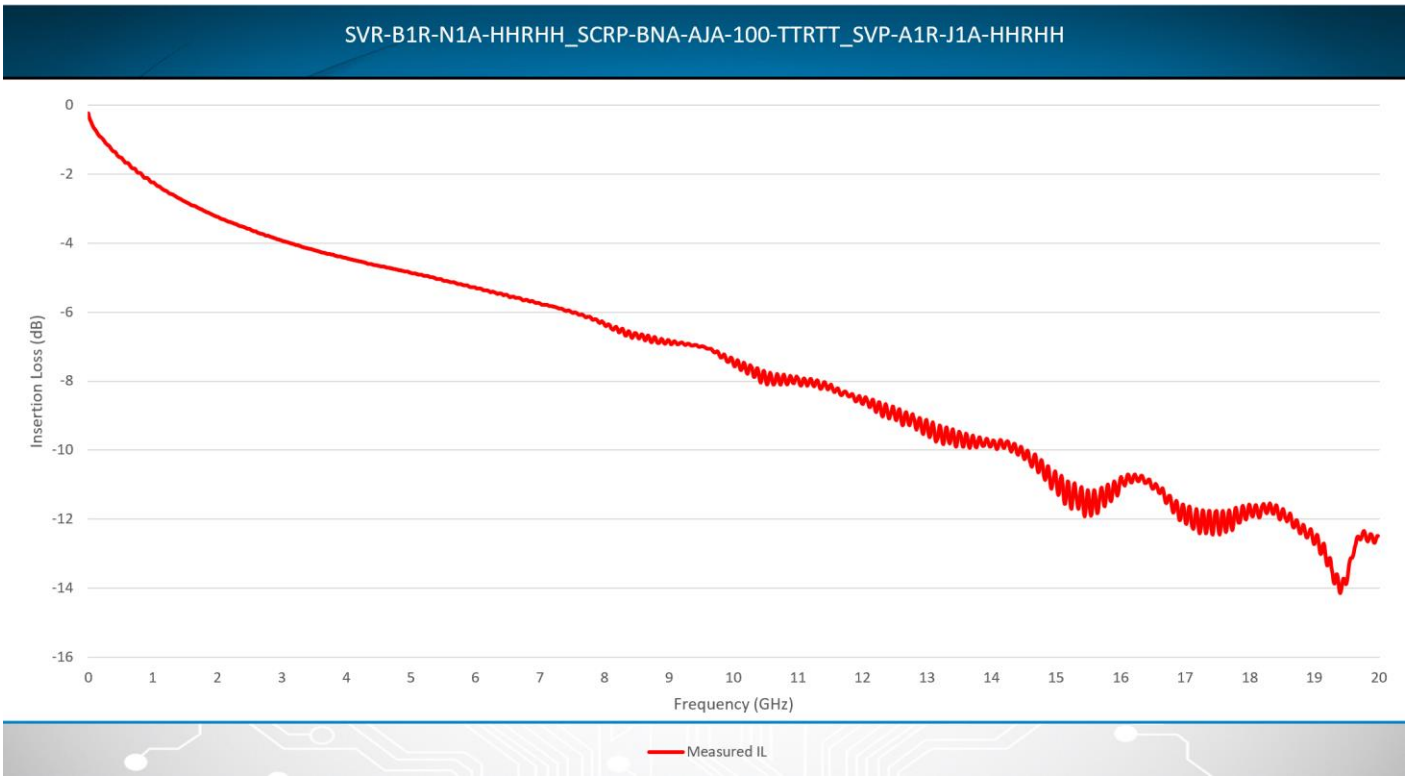


Figure 40 – Cable to Vertical RF Insertion Loss

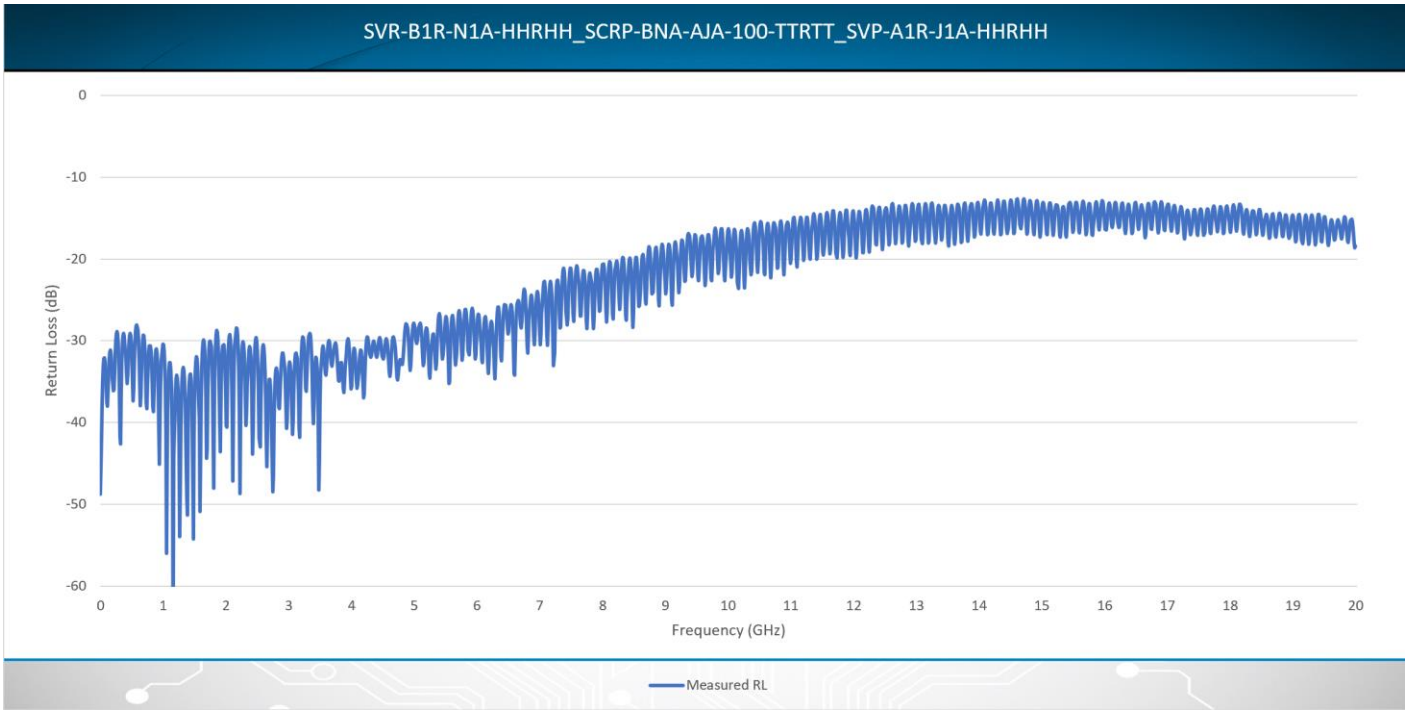


Figure 41 – Cable to Vertical RF Return Loss

9.1.2 Time Domain Impedance Summary

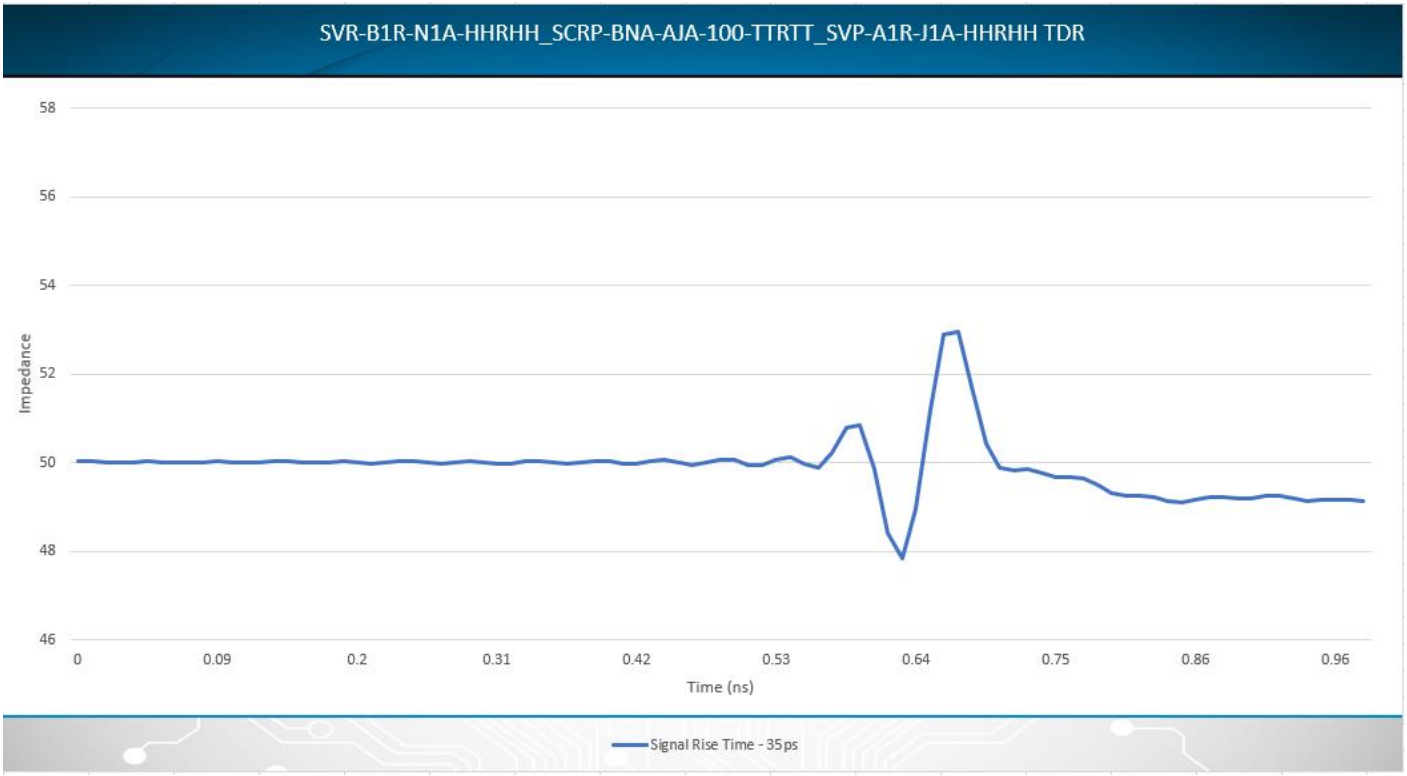


Figure 42 – Cable to Vertical RF Time Domain Impedance

9.2 Right Angle to Vertical

The cable assembly is a 1m cable with 30awg coax wiring.

9.2.1 S-Parameter Summary

Parameter	SCRP-BNA-AJA-100-TTRTT RF Module Typical Mated Performance		
Insertion Loss	-3 dB @ 3.3 GHz	-3.7 dB @ 5 GHz	-6.6 dB @ 12.5 GHz
Return Loss	-34.9 dB @ 3.3 GHz	-22.9 dB @ 5 GHz	-9.7 dB @ 12.5 GHz
Propagation Delay	76 ps		

Table 8 – SCRP-BNA-AJA-100-TTRTT – RF S-Parameter Summary

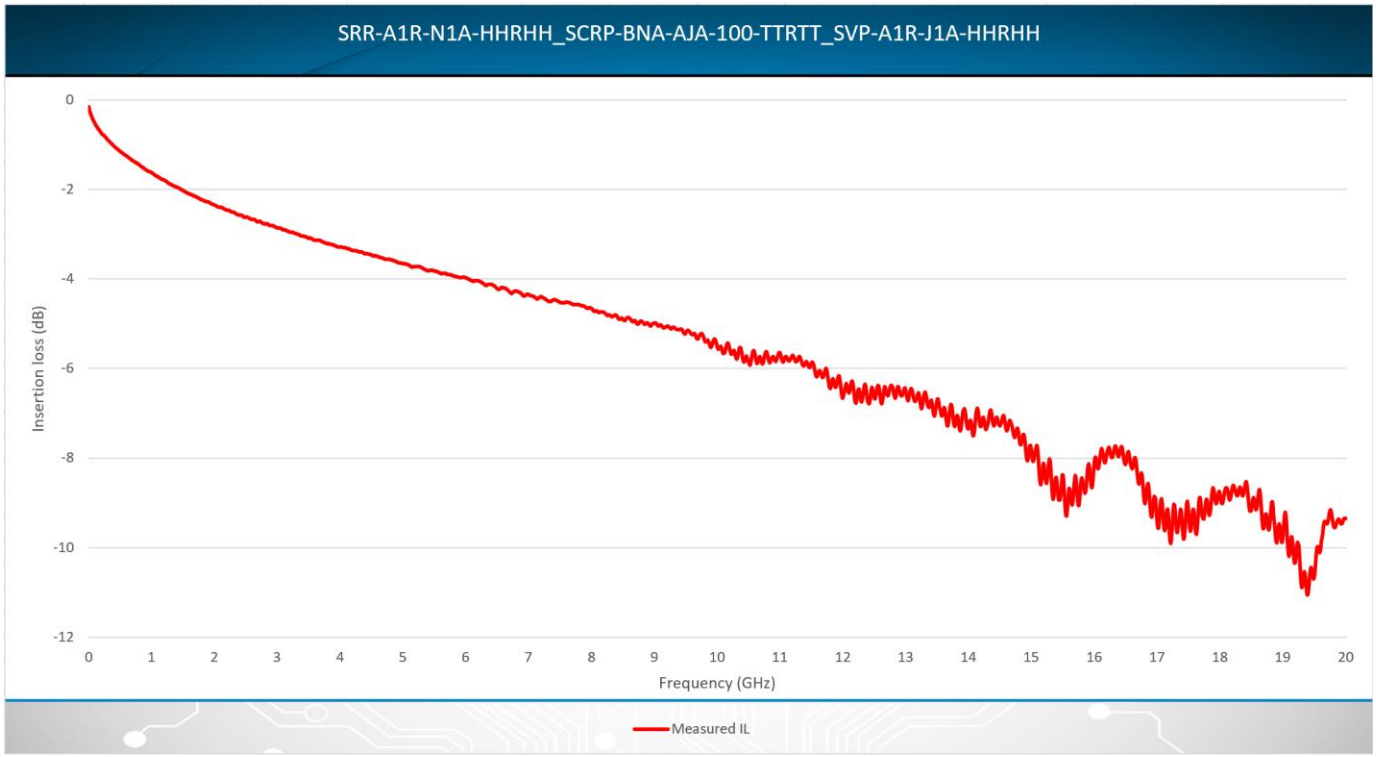


Figure 43 – Cable to RA RF Insertion Loss

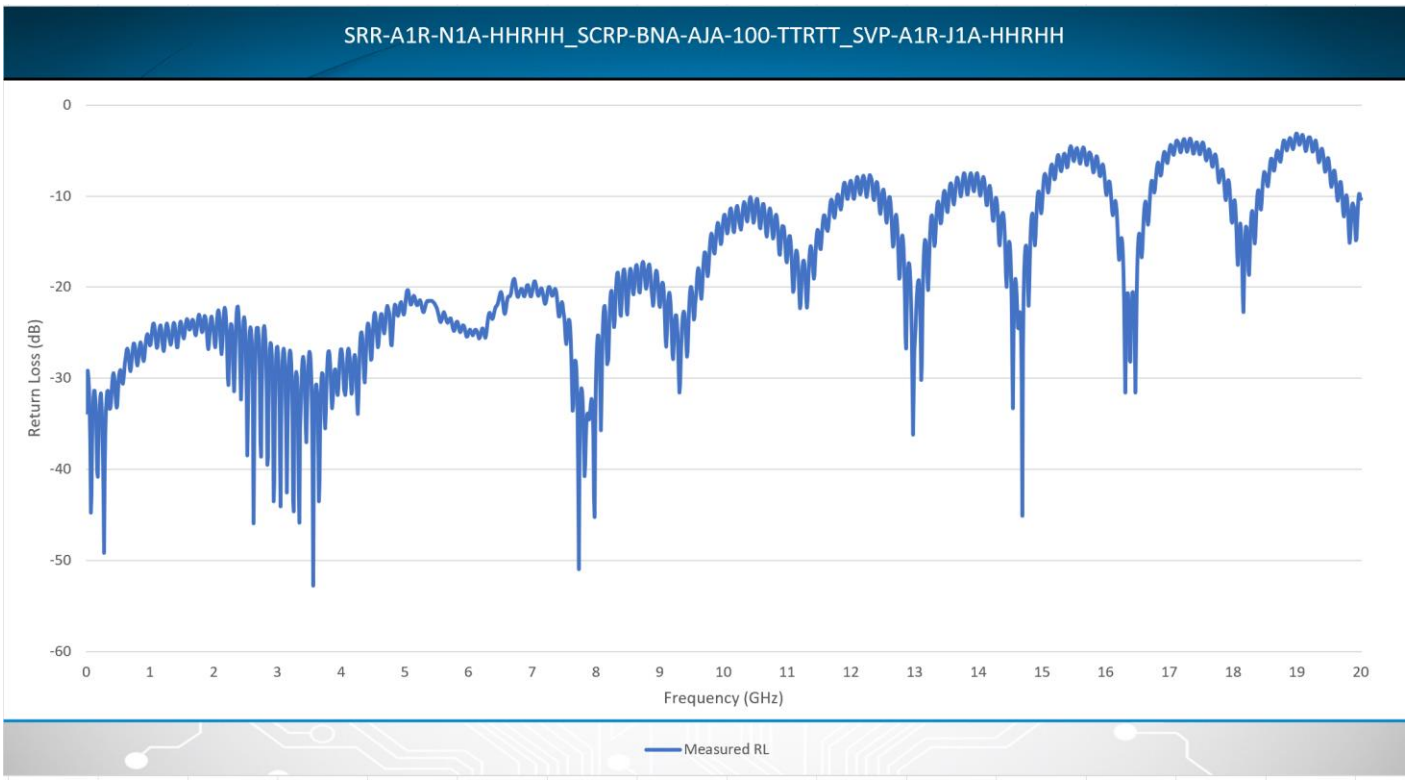


Figure 44 – Cable to RA RF Return Loss

9.2.2 Time Domain Impedance Summary

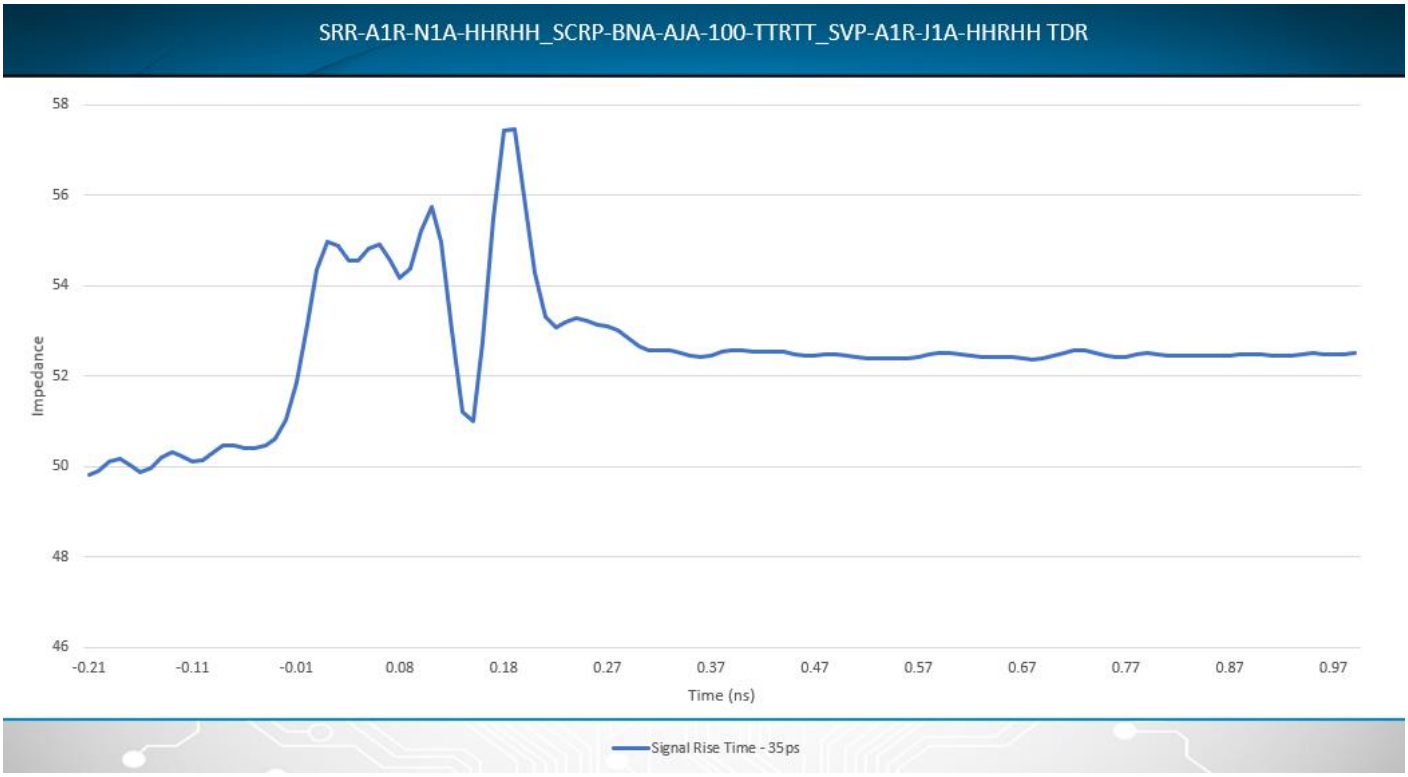


Figure 45 – Cable to RA RF Time Domain Impedance

10 SInergy Connector PCB Layout Recommendation

10.1 Connector Footprint

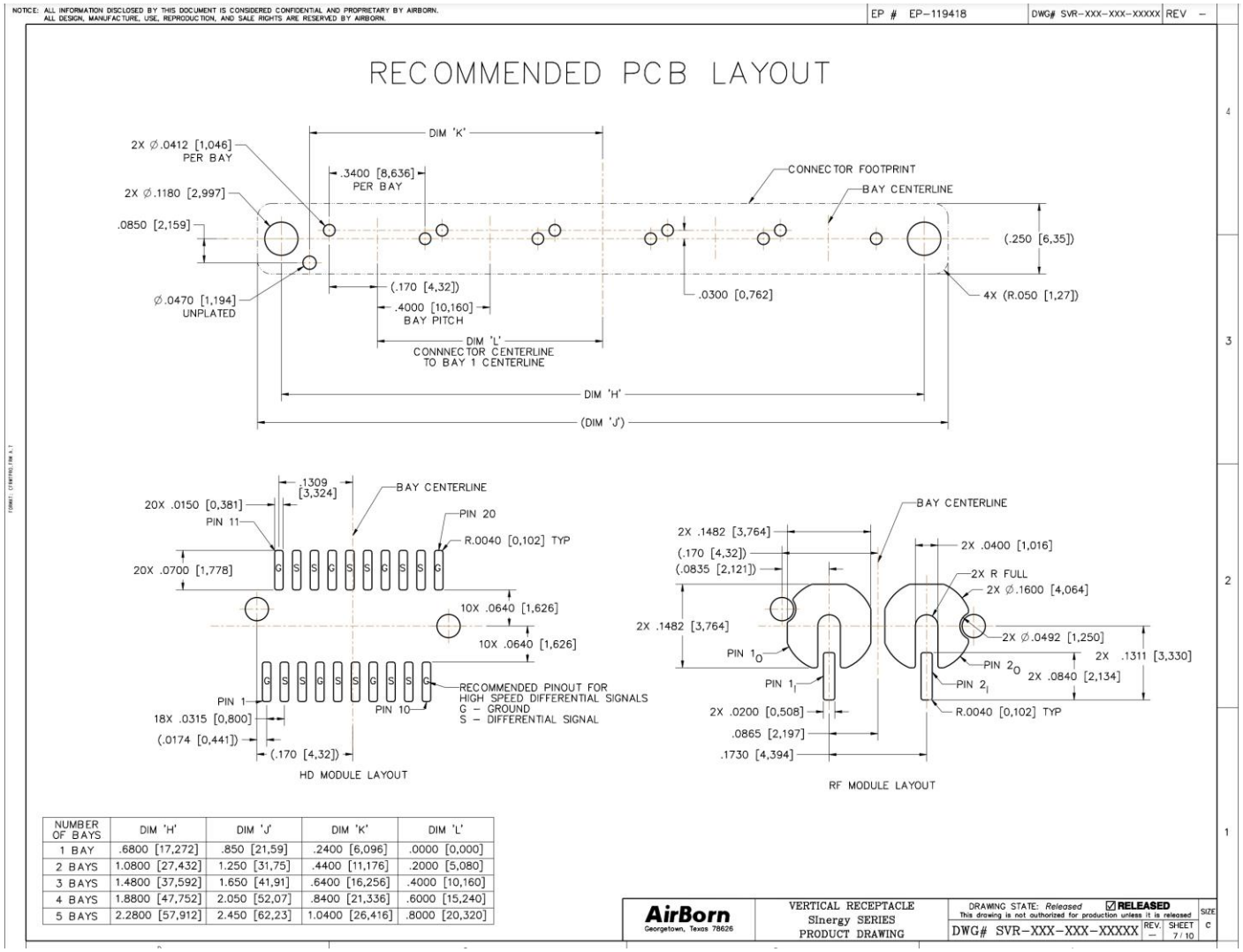


Figure 46 – SInergy Recommended PCB Layout Drawing

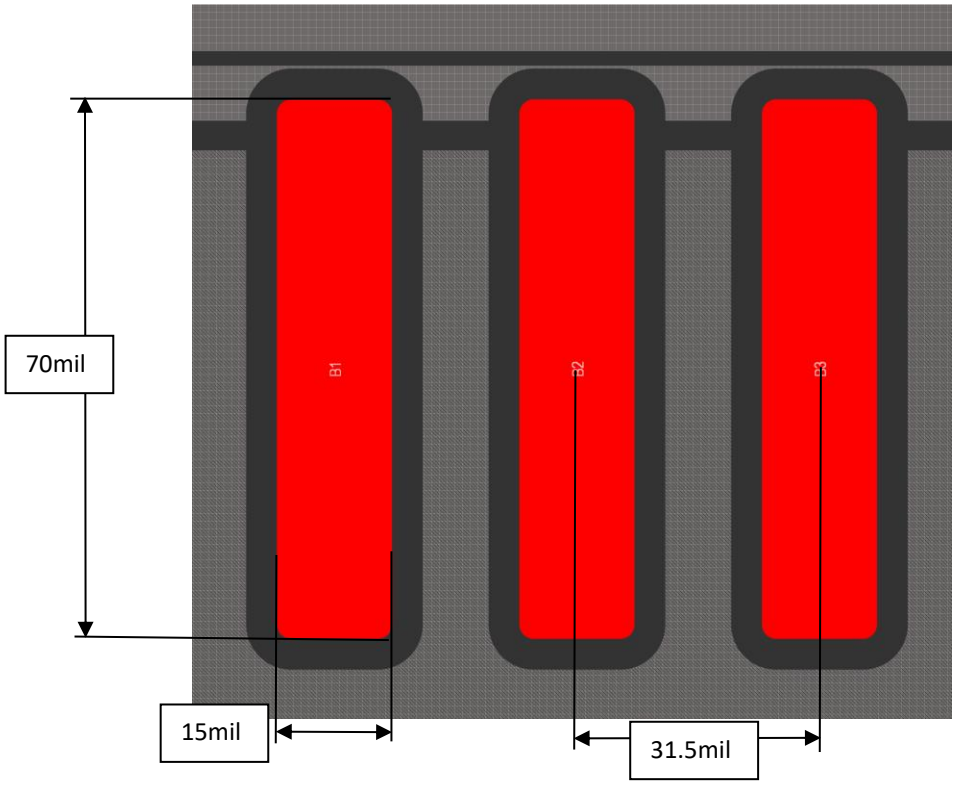


Figure 47 – HD contact optimized footprint

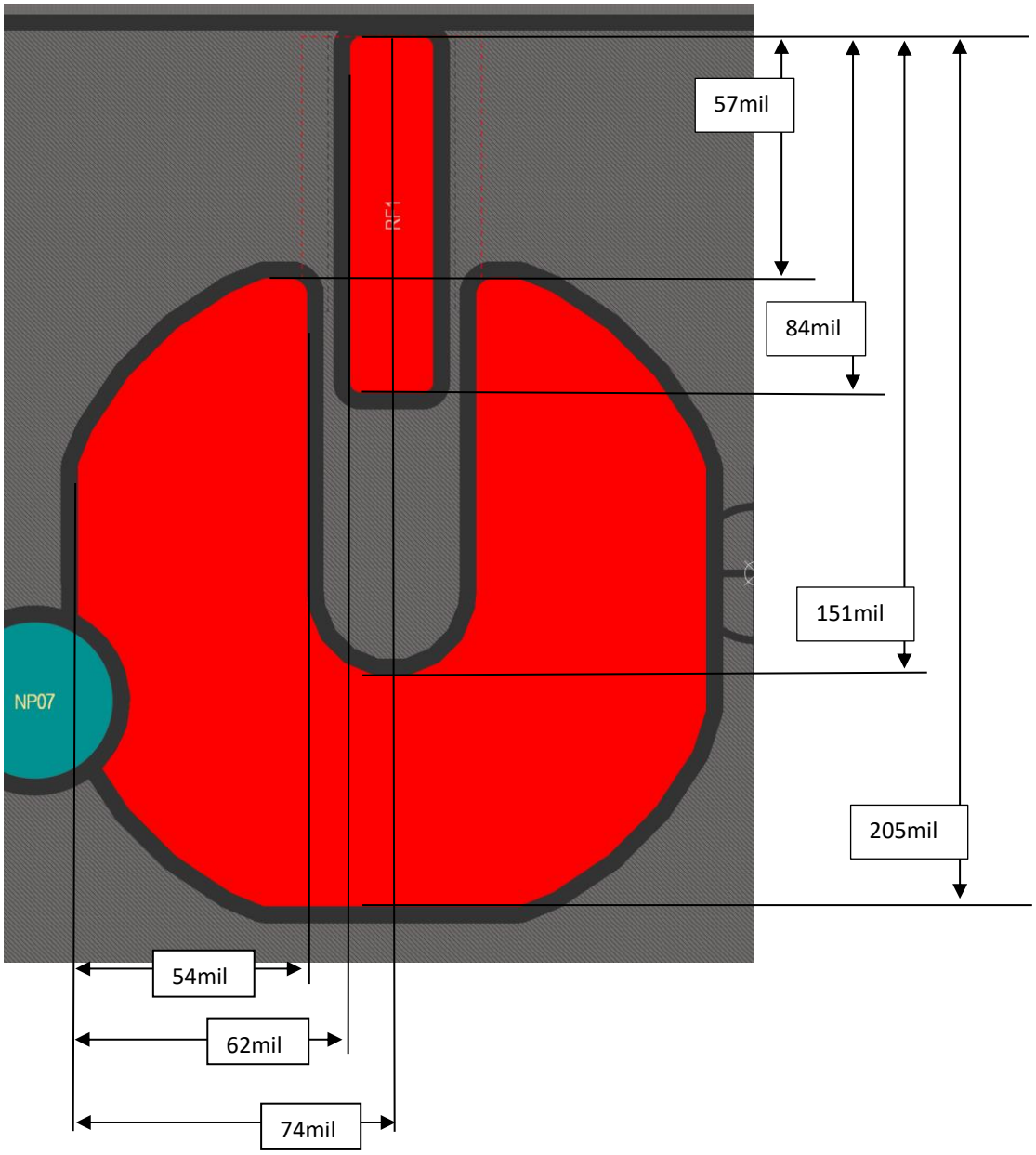


Figure 48 – RF contact optimized footprint

10.2 PCB Design Considerations

10.2.1 PCB Material parameters that will influence high speed connector PCB breakout regain performance

- Dielectric Constant (Dk) - Main contributor to capacitive coupling which contributes to impedance
- Dissipation Factor (Df) – Large contributor to insertion loss. High Speeds need lower Df values
- Typical “Lower Speed” (< 2.5GHz bandwidth), FR-4 material variety
- Typical “High Speed” (< 15GHz bandwidth), Nelco 4000-13EP, Nelco 4000-13EP SI, Megtron6, Tachyon 100G, etc.
- The SInergy test boards were designed for high speed and therefore used Tachyon 100G as the material.

10.2.2 Recommended Antipads in Layer Below SMT Pad

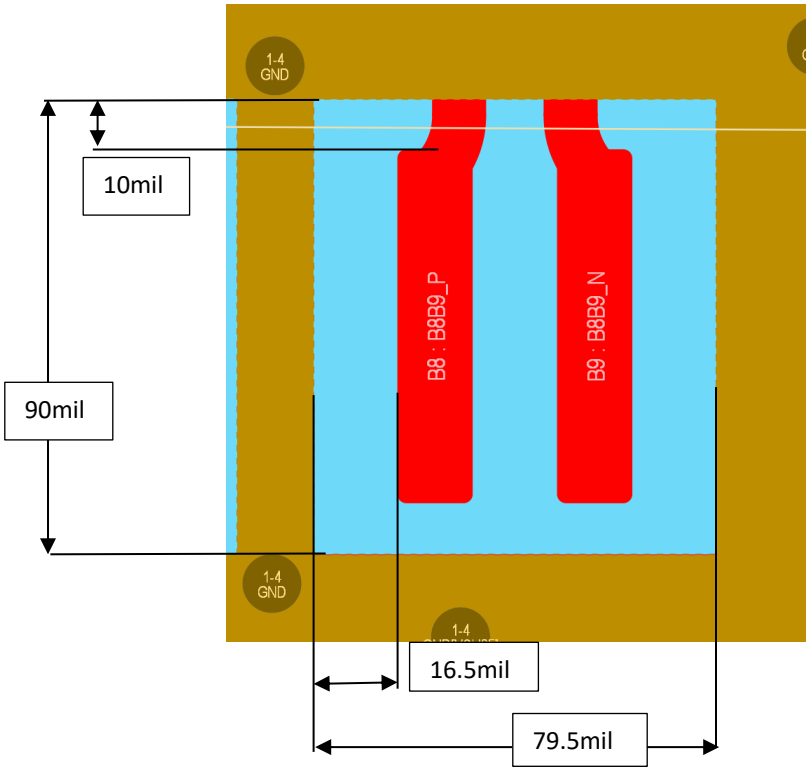


Figure 49 – HD Layer 2 Section Cutout Description

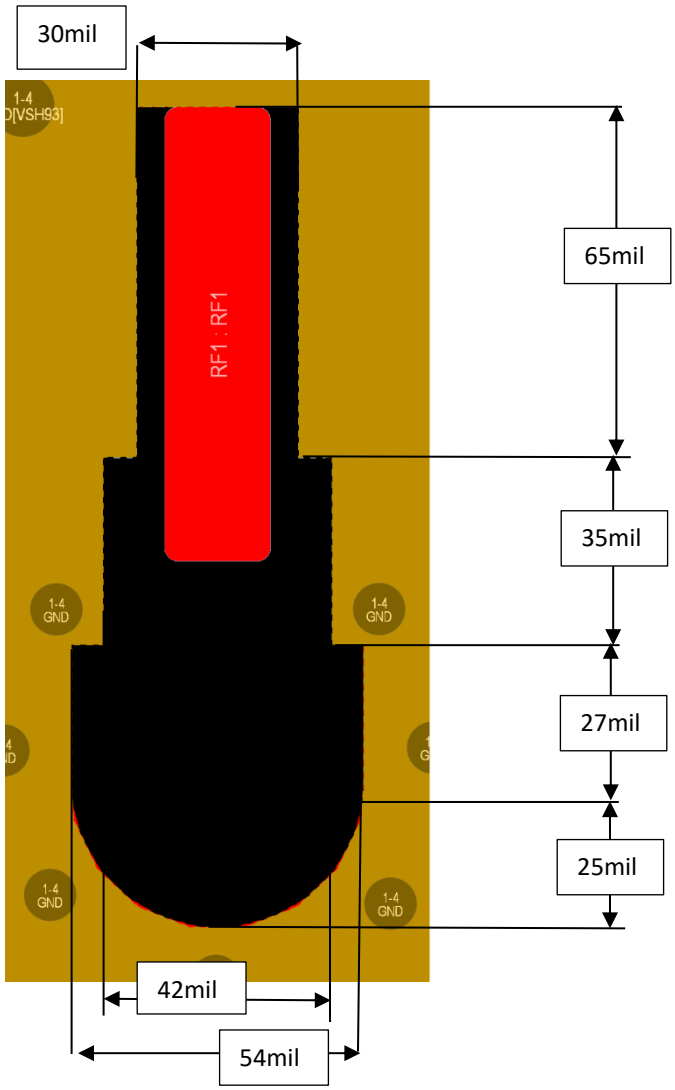


Figure 50 – RF Layer 2 Section Cutout Description

10.2.3 Signal Trace Balance / Return Signal Path

- It is recommended for optimum high speed performance that as many as possible ground return pins are provided around the signal pin
- The ground pins should be symmetrical around differential signal pins to provide a balanced return path within a differential pair
    - An unbalance return path in a differential pair can cause mode conversions leading to intrapair skew issues

10.3 Recommended PCB Stack-Up and Trace Dimensions

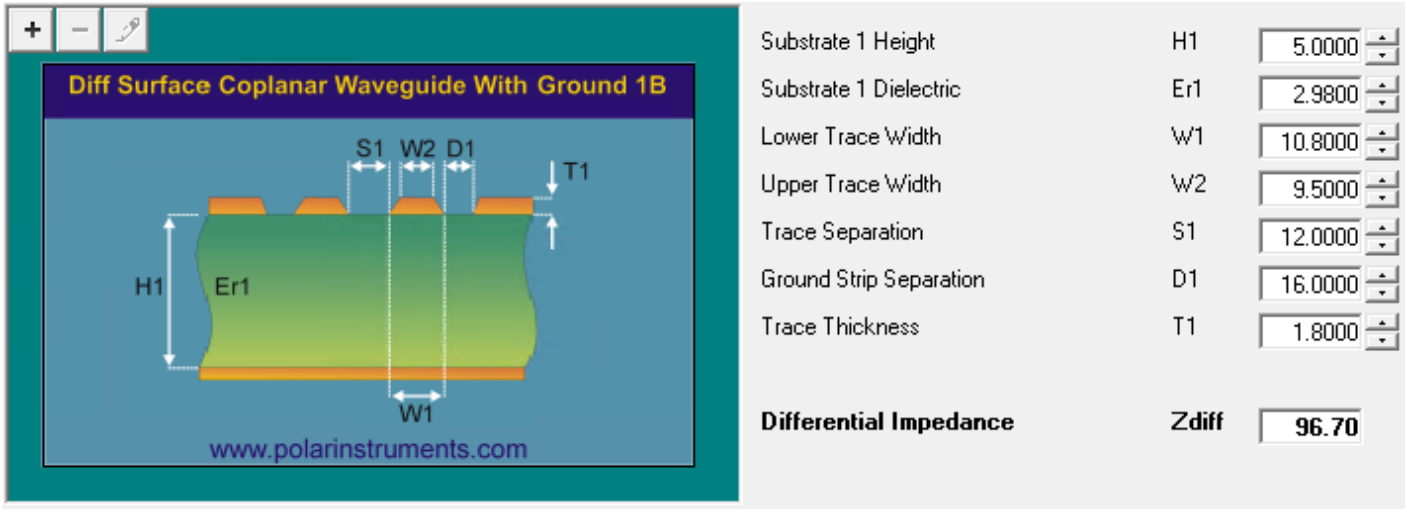


Figure 51 – Example 100 ohm Differential Microstrip

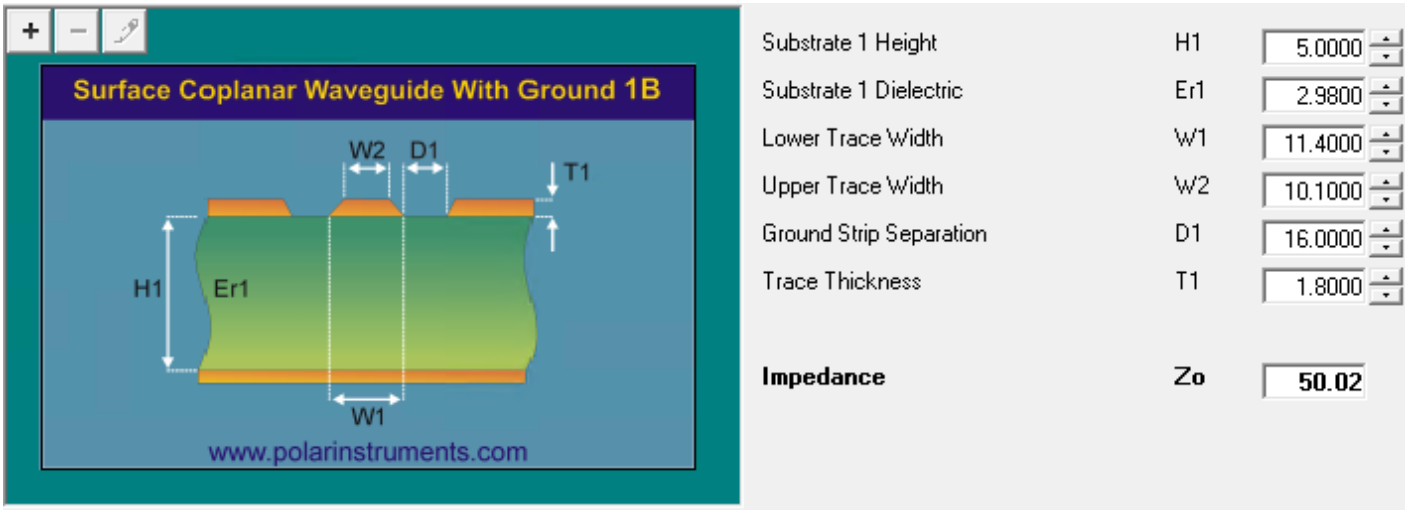


Figure 52 – Example 50 ohm Single Ended Microstrip