Sagecom Fast 5298 GFiber EVT2 Antenna Report

Date: 2024.5.20

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Agenda

- Antenna EVT2 Report
- Appendix (1) Antenna raw data

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Requirement of Antenna Design and Measurement

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Requirements of Antenna Design

RF Function	Number of ANT	Frequency Band	Remark
Wi-Fi _ Dual Band	4	2400~2500MHz & 5150~5850MHz	PCB*2 · Printed*2
6G_	4	5925~7125MHz	PCB*2 · Printed*2
BT	1	2400~2500MHz	Printed*1

Requirements of Measurement

Test Item	Specification	Result	
Efficiency	> 75%	75%~77%	**Pass**
Return Loss	< -15 dB	-15.1 dB ~ -40.1 dB	**Pass**
Isolation	2.4G < -20 dB ; 5G&6G < -30 dB	2.4G : -22.9 dB ~ -34.4 dB 5G&6G : -32.0 dB ~ -59.0 dB	**Pass**
Peak Gain	2.4G < 4.5 dBi ; 5G&6G < 5.5 dBi	2.4G < 4.33 dBi 5G&6G < 4.93 dBi	**Pass**
ECC	0.2	MAX: 0.18	**Pass**
Uncorrelated combined gain	Between -7 dB and 1 dB Maximum +/-15° apart vertical directions -3 dB	MAX : 0.48 dB	**Pass**
Correlated combined gain	< 6 dB	MAX: : 5.9 dB	**Pass**

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Conclusions

- Finetune antenna with EVT2 mock up.
- The Return Loss of all antenna are under -15dB.
- The Isolation between all antenna are meet spec.
- The Peak gain & Efficiency of all antenna are all meet spec.
- The ECC are all less than 0.2 between 2G& 5G & 6G, respectively

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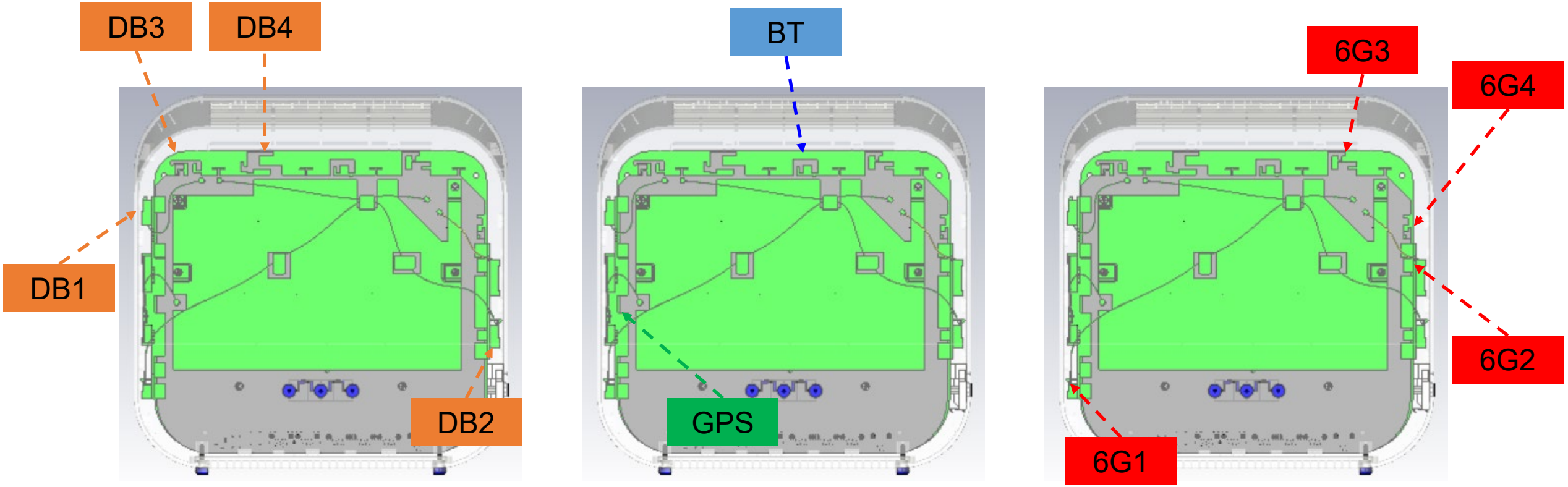
Antenna Placement & Solution



Antenna type	BT on board antenna x1 (BT-1)
	WIFI Dual Band(2G/5G) PCB antenna x2 (DB1, DB2)
	WIFI Dual Band(2G/5G) on board antenna x2 (DB3, DB4)
	WIFI 6G PCB antenna x2 (WIFI 6G1, WIFI 6G2)
	WIFI 6G on board antenna x2 (WIFI 6G3, WIFI 6G4)
	GPS PCB antenna x1 (GPS)

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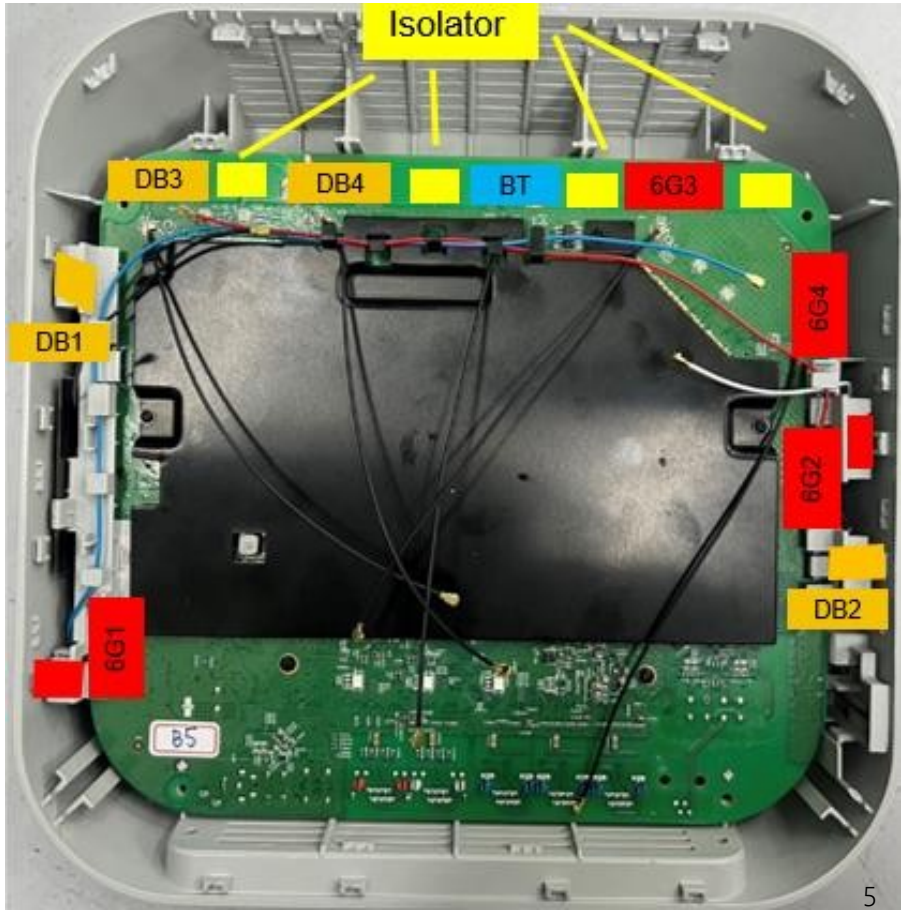
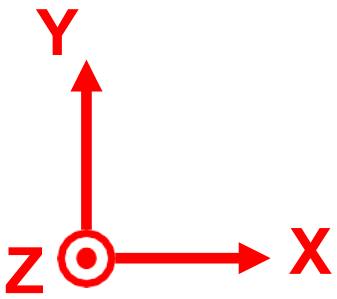
Antenna Placement & Solution



Antenna	ANT Type	Size (L * W * H)	Cable Type
DB1(Dual Band)	PCB	30*15*0.6mm	80.5mm/1.13LLS
DB2(Dual Band)	PCB	30*15*0.6mm	247.5mm/1.13LLS
DB3(Dual Band)	Printed	30*15	150mm/1.13LLS
DB4(Dual Band)	Printed	30*15	150mm/1.13LLS
6G1(WIFI 6E)	PCB	20*10*0.6mm	299mm/1.13LLS
6G2(WIFI 6E)	PCB	20*10*0.6mm	80.5mm/1.13LLS
6G3(WIFI 6E)	Printed	30*15	150mm/1.13LLS
6G4(WIFI 6E)	Printed	15*5	150mm/1.13LLS
BT(2.4G)	Printed	30*15	150mm/1.13LLS



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Antenna Return loss

Frequency (MHz)	DB1	DB2	DB3	DB4
2400	-15.7	-16.9	-25.8	-21.2
2450	-19.7	-19.6	-26.0	-22.7
2500	-15.6	-17.1	-19.3	-23.6
5150	-19.0	-16.6	-16.6	-15.0
5470	-38.0	-20.1	-24.0	-22.5
5850	-20.6	-22.7	-15.4	-15.1

Frequency (MHz)	6G1	6G2	6G3	6G4
5925	-28.2	-19.1	-23.6	-23.5
6525	-40.1	-20.3	-17.8	-17.2
7125	-26.5	-22.0	-15.2	-17.5

Frequency (MHz)	BT
2400	-18.6
2450	-22.4
2500	-20.0

Unit: dB

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Antenna Isolation(1)_2400MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1					NA	NA	NA	NA	NA
DB2	24.1				NA	NA	NA	NA	NA
DB3	24.7	36.2			NA	NA	NA	NA	NA
DB4	27.9	22.5	22.9		NA	NA	NA	NA	NA
6G1	NA	NA	NA	NA		NA	NA	NA	NA
6G2	NA	NA	NA	NA	NA		NA	NA	NA
6G3	NA	NA	NA	NA	NA	NA		NA	NA
6G4	NA	NA	NA	NA	NA	NA			NA
BT	24.6	20.8	29.1	23.0	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(2)_2450MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1					NA	NA	NA	NA	NA
DB2	27.5				NA	NA	NA	NA	NA
DB3	22.6	30.1			NA	NA	NA	NA	NA
DB4	32.6	28.6	23.3		NA	NA	NA	NA	NA
6G1	NA	NA	NA	NA		NA	NA	NA	NA
6G2	NA	NA	NA	NA	NA		NA	NA	NA
6G3	NA	NA	NA	NA	NA	NA		NA	NA
6G4	NA	NA	NA	NA	NA	NA	NA		NA
BT	22.1	22.1	33.4	21.0	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(3)_2500MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1					NA	NA	NA	NA	NA
DB2	29.4				NA	NA	NA	NA	NA
DB3	25.3	29.5			NA	NA	NA	NA	NA
DB4	26.7	34.4	23.4		NA	NA	NA	NA	NA
6G1	NA	NA	NA	NA		NA	NA	NA	NA
6G2	NA	NA	NA	NA	NA		NA	NA	NA
6G3	NA	NA	NA	NA	NA	NA		NA	NA
6G4	NA	NA	NA	NA	NA	NA	NA		NA
BT	21.1	22.9	35.6	21.4	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(4)_5150MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		46.7	27.	33.5	33.6	64.3	41.3	52.1	NA
DB2	46.7		45.3	35.3	32.0	33.6	36.2	34.0	NA
DB3	27.0	45.3		32.7	32.7	46.5	39.9	59.0	NA
DB4	33.5	35.3	32.7		47.5	49.8	37.4	43.8	NA
6G1	33.6	32.0	32.7	47.5		NA	NA	NA	NA
6G2	49.1	33.6	46.5	49.8	NA		NA	NA	NA
6G3	49.1	36.2	39.9	37.4	NA	NA		NA	NA
6G4	46.0	34.0	59.0	43.8	NA	NA	NA		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(5)_5470MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		55.9	28.0	33.8	33.5	51.7	43.7	46.8	NA
DB2	55.9		38.9	44.3	34.0	32.6	42.8	32.5	NA
DB3	28.0	38.9		22.9	32.0	44.9	55.0	42.0	NA
DB4	33.8	44.3	22.9		38.7	42.4	36.9	38.9	NA
6G1	33.5	34.0	32.0	38.7		NA	NA	NA	NA
6G2	51.7	32.6	44.9	42.4	NA		NA	NA	NA
6G3	43.7	42.8	55.0	36.9	NA	NA		NA	NA
6G4	46.8	32.5	42.0	38.9	NA	NA	NA		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(6)_5850MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		45.7	28.1	38.8	33.8	55.5	40.2	44.3	NA
DB2	45.7		44.7	36.4	39.2	36.8	40.3	34.7	NA
DB3	28.1	44.7		25.1	35.0	41.3	45.8	43.4	NA
DB4	38.8	36.4	25.1		37.3	45.3	35.2	38.8	NA
6G1	33.8	39.2	35.0	37.3		NA	NA	NA	NA
6G2	55.5	36.8	41.3	45.3	NA		NA	NA	NA
6G3	40.2	40.3	45.8	35.2	NA	NA		NA	NA
6G4	44.3	34.7	43.4	38.8	NA	NA	NA		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(7)_5925MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		NA	NA	NA	31.4	60.3	42.1	42.3	NA
DB2	NA		NA	NA	41.0	37.4	42.1	35.1	NA
DB3	NA	NA		NA	35.3	39.3	42.3	41.1	NA
DB4	NA	NA	NA		35.9	45.1	36.1	41.5	NA
6G1	31.4	41.0	35.3	35.9		55.8	55.4	57.4	NA
6G2	60.3	37.4	39.3	45.1	55.8		45.4	38.9	NA
6G3	42.1	42.1	42.3	36.1	55.4	45.4		31.9	NA
6G4	42.3	35.1	41.1	41.5	57.4	38.9	31.9		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(8)_6525MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		NA	NA	NA	33.6	54.0	42.9	47.9	NA
DB2	NA		NA	NA	45.3	34.2	36.7	45.7	NA
DB3	NA	NA		NA	**35.0**	53.7	53.5	41.9	NA
DB4	NA	NA	NA		43.9	60.3	38.9	51.3	NA
6G1	33.6	45.3	35.0	43.9		47.8	42.8	42.9	NA
6G2	54.0	34.2	53.7	60.3	47.8		49.1	34.3	NA
6G3	42.9	36.7	53.5	38.9	42.8	49.1		31.3	NA
6G4	47.9	45.7	41.9	51.3	42.9	34.3	31.3		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Antenna Isolation(9)_7125MHz

	DB1	DB2	DB3	DB4	6G1	6G2	6G3	6G4	BT
DB1		NA	NA	NA	55.9	48.9	45.2	49.2	NA
DB2	NA		NA	NA	46.7	32.8	50.3	45.8	NA
DB3	NA	NA		NA	34.8	51.3	38.2	44.6	NA
DB4	NA	NA	NA		43.7	62.3	45.1	49.6	NA
6G1	55.9	46.7	34.8	43.7		42.8	39.9	54.1	NA
6G2	48.9	32.8	51.3	62.3	42.8		43.4	36.4	NA
6G3	45.2	50.3	38.2	45.1	39.9	43.4		35.9	NA
6G4	49.2	45.8	44.6	49.6	54.1	36.4	35.9		NA
BT	NA	NA	NA	NA	NA	NA	NA	NA	

Unit: dB

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Efficiency and Peak Gain(1)

Frequency (MHz)	DB1		DB2		DB3		DB4	
	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)
2400	4.40	76.10	4.34	75.58	4.38	76.26	4.35	75.71
2450	4.42	76.46	4.37	76.07	4.42	76.28	4.40	76.21
2500	4.37	75.93	4.33	75.70	4.34	75.92	4.40	76.30
5150	4.76	76.51	4.72	75.60	4.78	76.10	4.71	75.90
5470	4.86	77.04	4.77	75.87	4.82	76.49	4.80	76.37
5850	4.81	76.83	4.82	76.11	4.73	76.06	4.76	76.14

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Efficiency and Peak Gain(2)

Frequency (MHz)	6G1		6G2		6G3		6G4	
	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)	Peak Gain (dBi)	Efficiency (%)
5925	4.81	75.50	4.80	76.39	4.91	76.80	4.88	75.93
6525	4.90	76.29	4.83	76.60	4.88	76.08	4.90	75.86
7125	4.77	75.38	4.93	76.93	4.84	76.15	4.83	75.67

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Efficiency and Peak Gain(3)

Frequency (MHz)	BT	
	Peak Gain (dBi)	Efficiency (%)
2400	4.28	75.74
2450	4.37	76.13
2500	4.30	75.86

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Results Summary

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Correlation table (ECC) _2G

Frequency (MHz)	DB1&DB2	DB1&DB3	DB1&DB4	DB1&BT
2400	0.0226	0.1654	0.1153	0.0622
2450	0.0251	0.1699	0.1124	0.0591
2500	0.0204	0.1711	0.1192	0.0569

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Results Summary

Correlation table (ECC) _2G

Frequency (MHz)	DB2&DB3	DB2&DB4	DB2&BT	DB3&DB4	DB3&BT	DB4&BT
2400	0.0258	0.0387	0.0435	0.1791	0.1277	0.1815
2450	0.0279	0.0412	0.0510	0.1824	0.1251	0.1844
2500	0.0303	0.0400	0.0466	0.1818	0.1316	0.1795

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Results Summary

Correlation table (ECC) _5G

Frequency (MHz)	DB1&DB2	DB1&DB3	DB1&DB4	DB2&DB3	DB2&DB4	DB3&DB4
5150	0.0183	0.1533	0.1031	0.0262	0.0313	0.1796
5470	0.0166	0.1542	0.1015	0.0241	0.0306	0.1824
5850	0.0179	0.1476	0.0977	0.0285	0.0291	0.1833

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Results Summary

Correlation table (ECC) _6G

Frequency (MHz)	6G1&6G2	6G1&6G3	6G1&6G4	6G2&6G3	6G2&6G4	6G3&6G4
5925	0.0258	0.0204	0.0152	0.0787	0.1392	0.1483
6525	0.0274	0.0206	0.0188	0.0824	0.1419	0.1562
7125	0.0241	0.0183	0.0149	0.0758	0.1411	0.1476

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Results Summary

Uncorrelated gain table

DB1-4

Frequency (MHz)	2D XY plane		2D XZ plane		2D YZ plane	
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)
2450	0.48	-1.10	0.42	-2.32	0.14	-2.30
5470	0.22	-2.74	-0.51	-3.01	0.28	-1.39

6G1-4

Frequency (MHz)	2D XY plane		2D XZ plane		2D YZ plane	
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)
6525	-0.29	-2.76	0.36	-2.75	0.36	-1.79

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Results Summary

Correlated gain table

DB1-4

Frequency (MHz)	2D XY plane		2D XZ plane		2D YZ plane	
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)
2450	5.93	4.55	5.96	3.36	5.95	3.27
5470	5.81	2.89	4.96	2.63	5.97	4.26

6G1-4

Frequency (MHz)	2D XY plane		2D XZ plane		2D YZ plane	
	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)	Peak Gain (dBi)	Average Gain (dBi)
6525	5.41	2.51	5.86	2.59	5.79	3.74

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Correlated Gain and Uncorrelated Gain

Correlated signals

Any transmit beamforming mode, whether fixed or adaptive Examples: Phased arrays, Closed Loop MIMO, Transmitter Adaptive Antenna, Maximum Ratio Transmission (MRT), or Statistical Eigen Beamforming (EBF)

Cyclic Delay Diversity (CDD) modes Example: Legacy modes in 802.11n
Same digital data carried by each Tx antenna, but with different cyclic delays
Signals are highly correlated at any one frequency

Completely uncorrelated signals (if not combined with a correlated mode)

Space Time Block Codes (STBC) or Space Time Codes (STC) for which different digital data is carried by each Tx antenna during any symbol period Example: WiMAX Matrix A (Alamouti coding)

Spatial Multiplexing MIMO (SM-MIMO) Example: WiMAX Matrix B; Matrix C, which adds diversity, is also uncorrelated
Independent data streams sent to each Tx antenna

Unequal antenna gain, equal transmit powers

For antenna gains = G_1 , G_2 , …, G_N dBi

If transmit signals are correlated, thenDirectional gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 /N]$ dBi

If all transmit signals are completely uncorrelated, thenDirectional gain = $10 \log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})/N]$ dBi

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Agenda

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- Appendix (1) Antenna raw data

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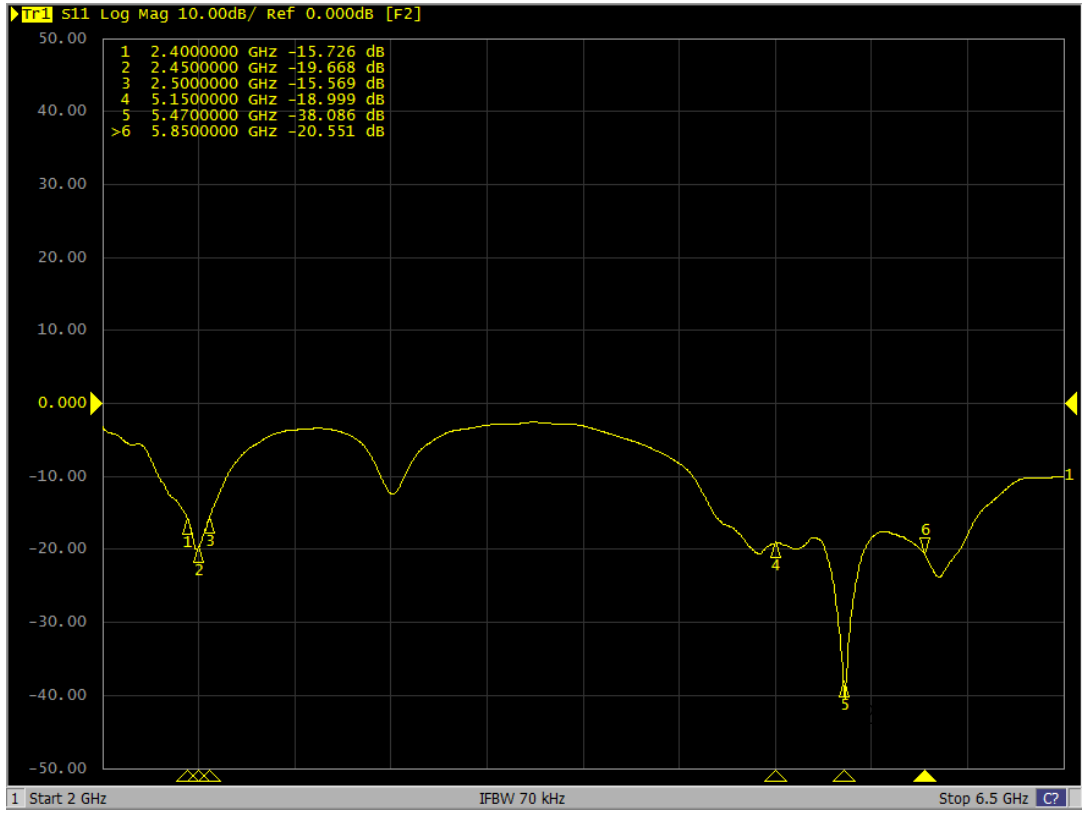
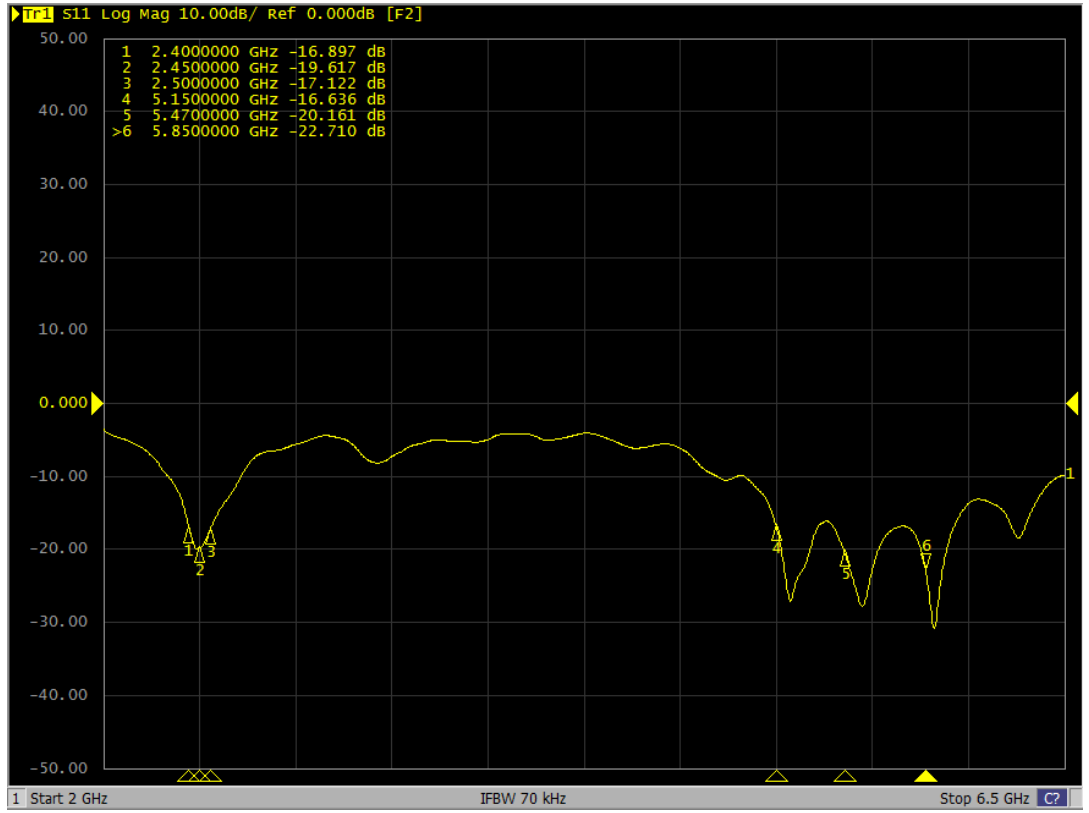
Return Loss

DB1



DB2



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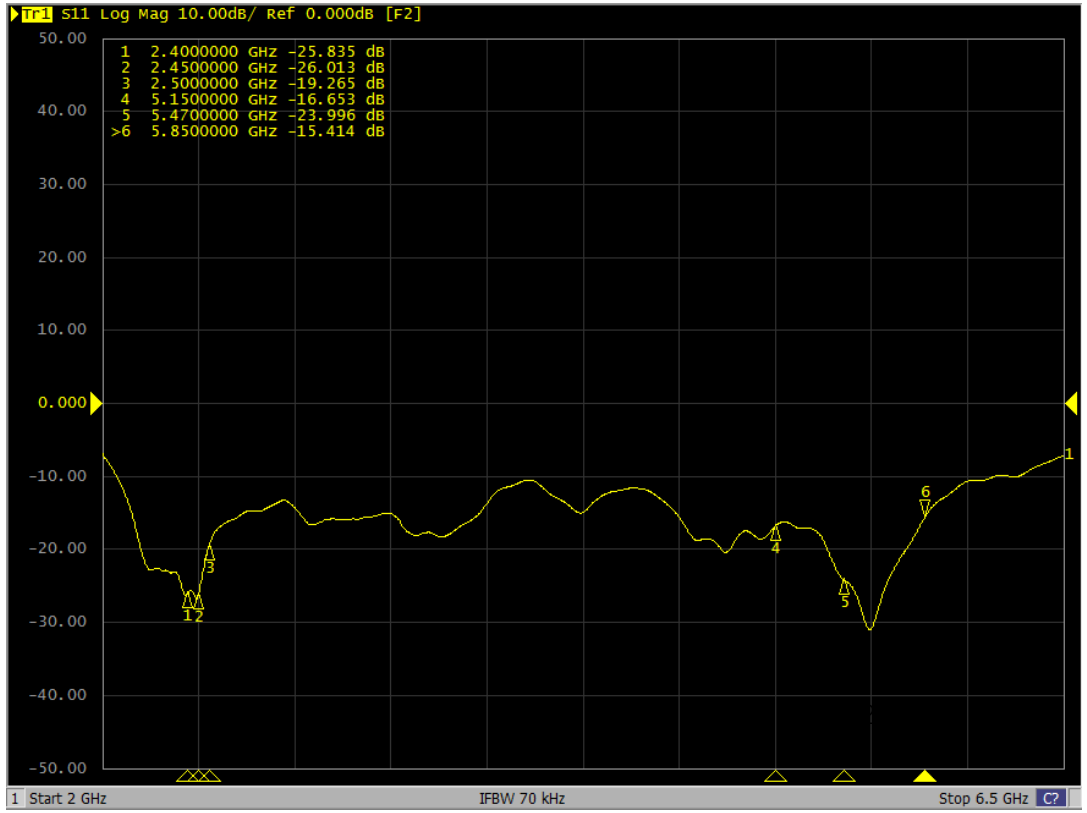
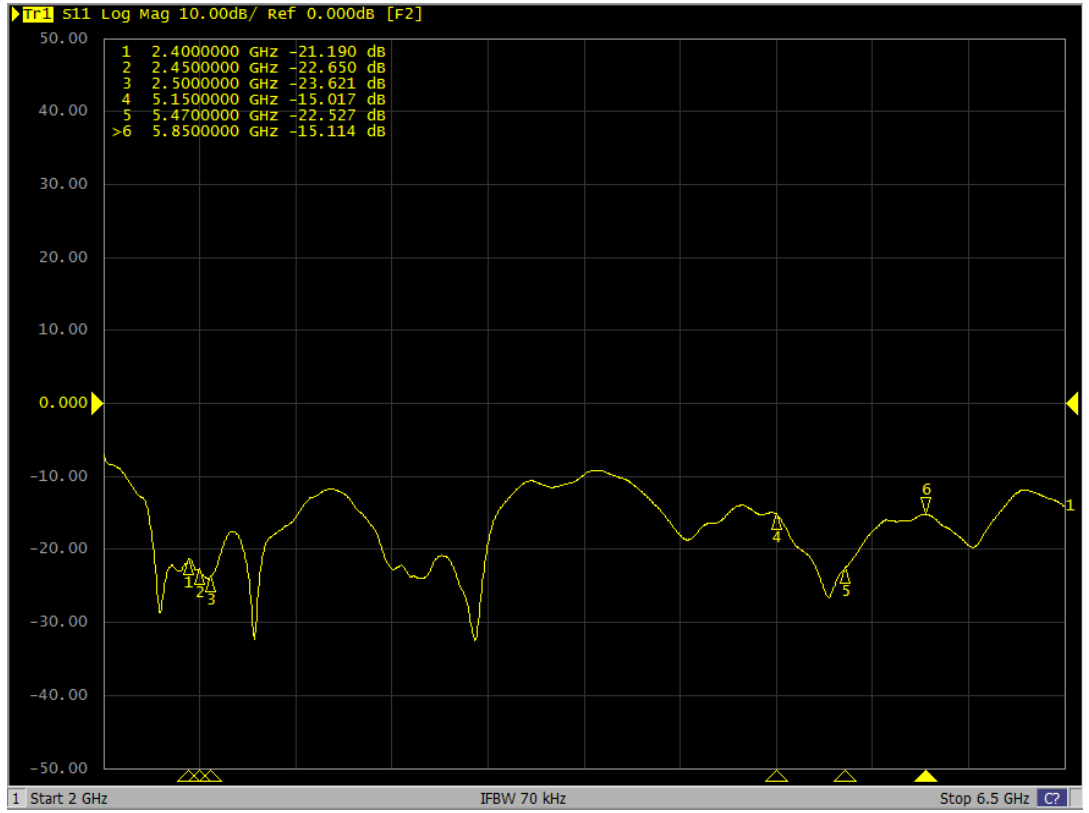
Return Loss

DB3



DB4



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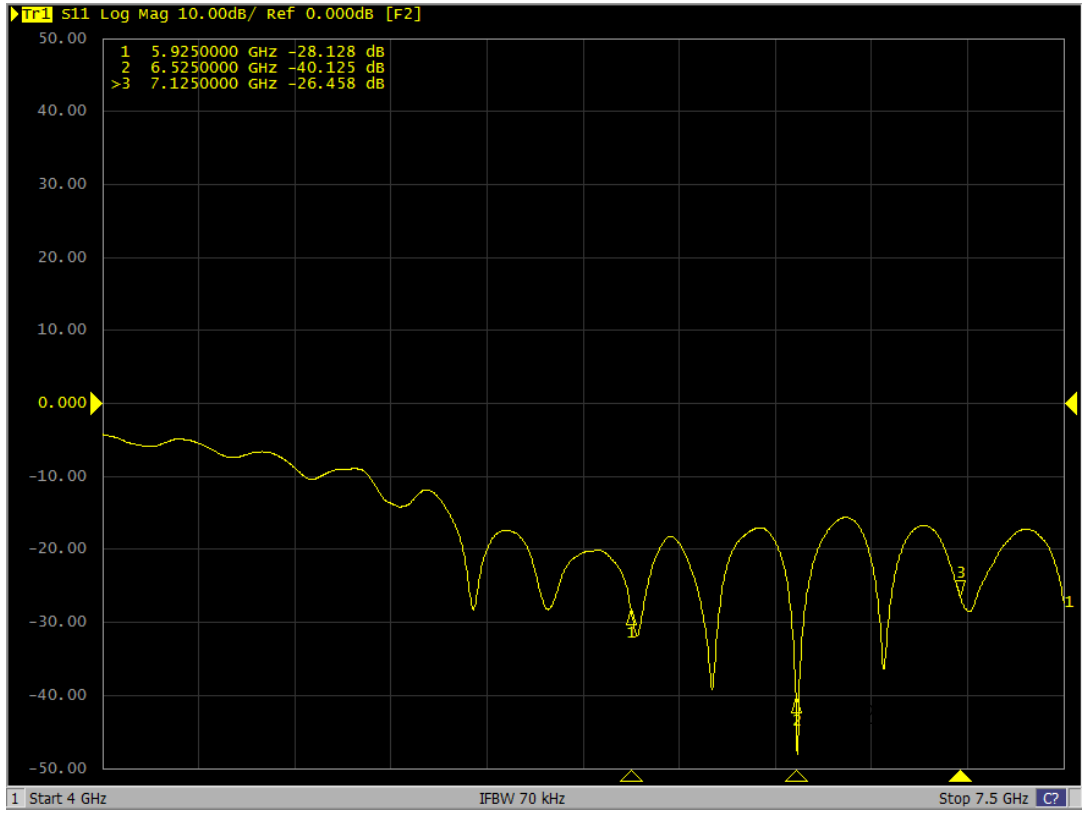
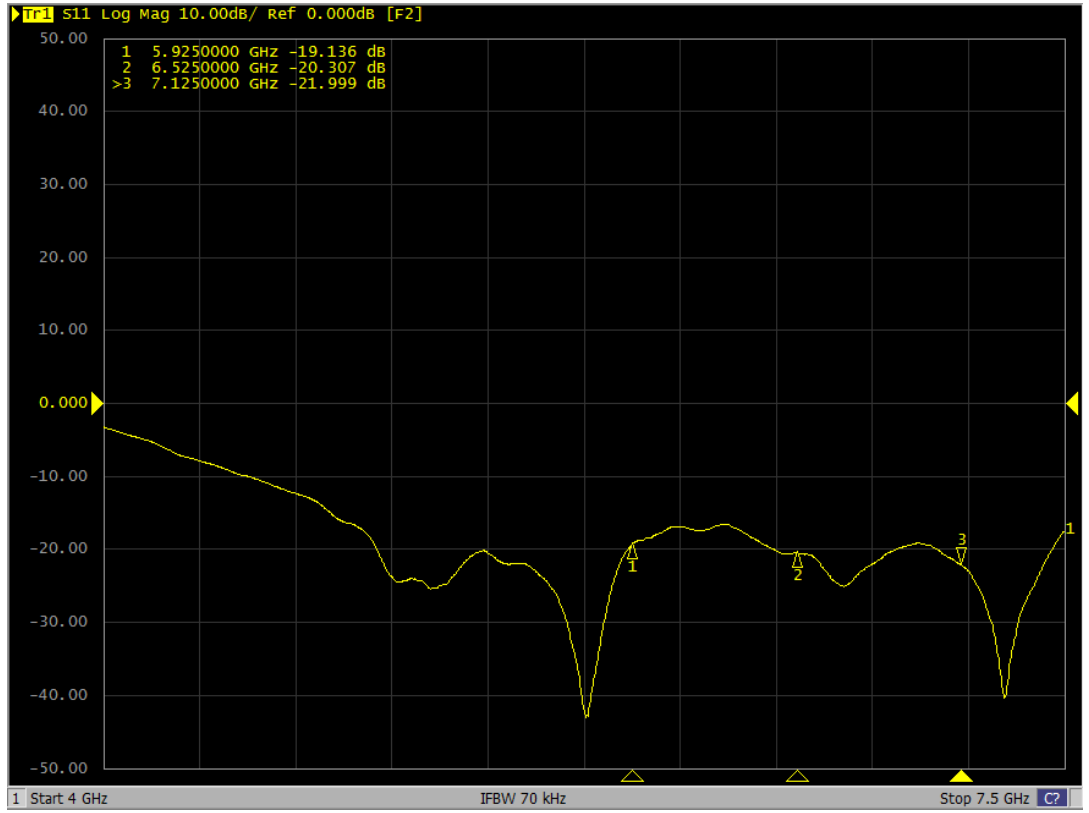
Return Loss

6G1



6G2



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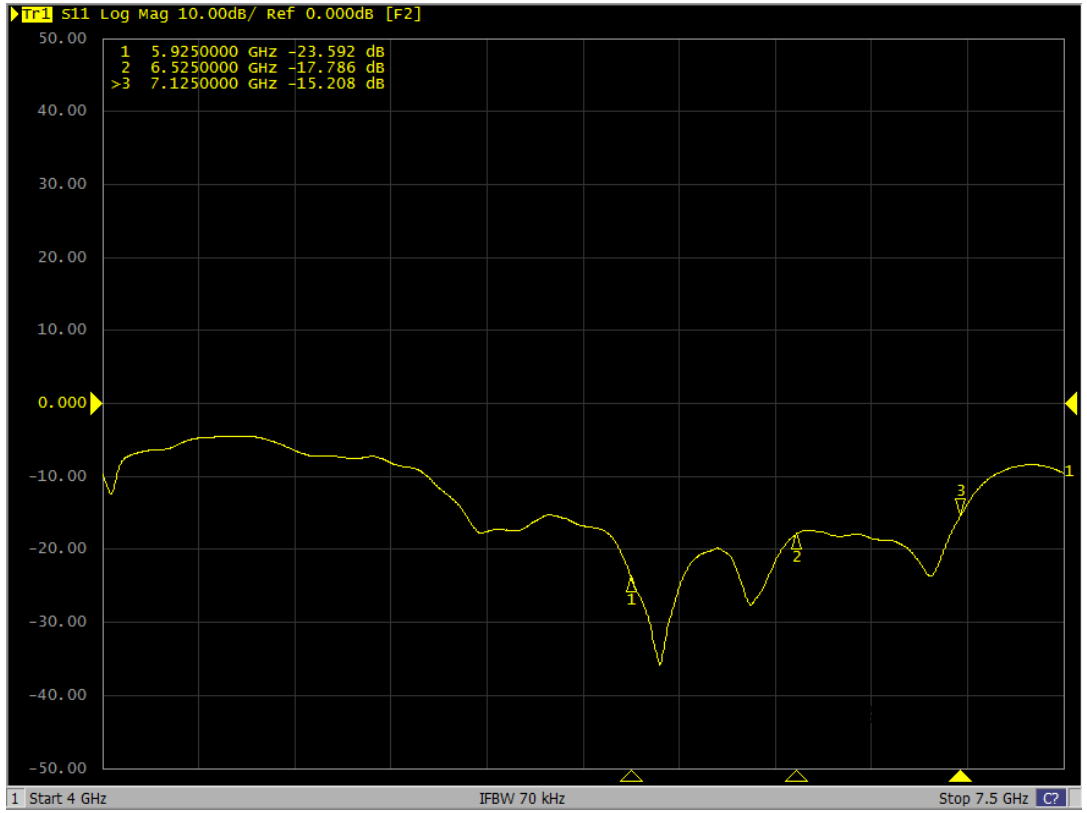
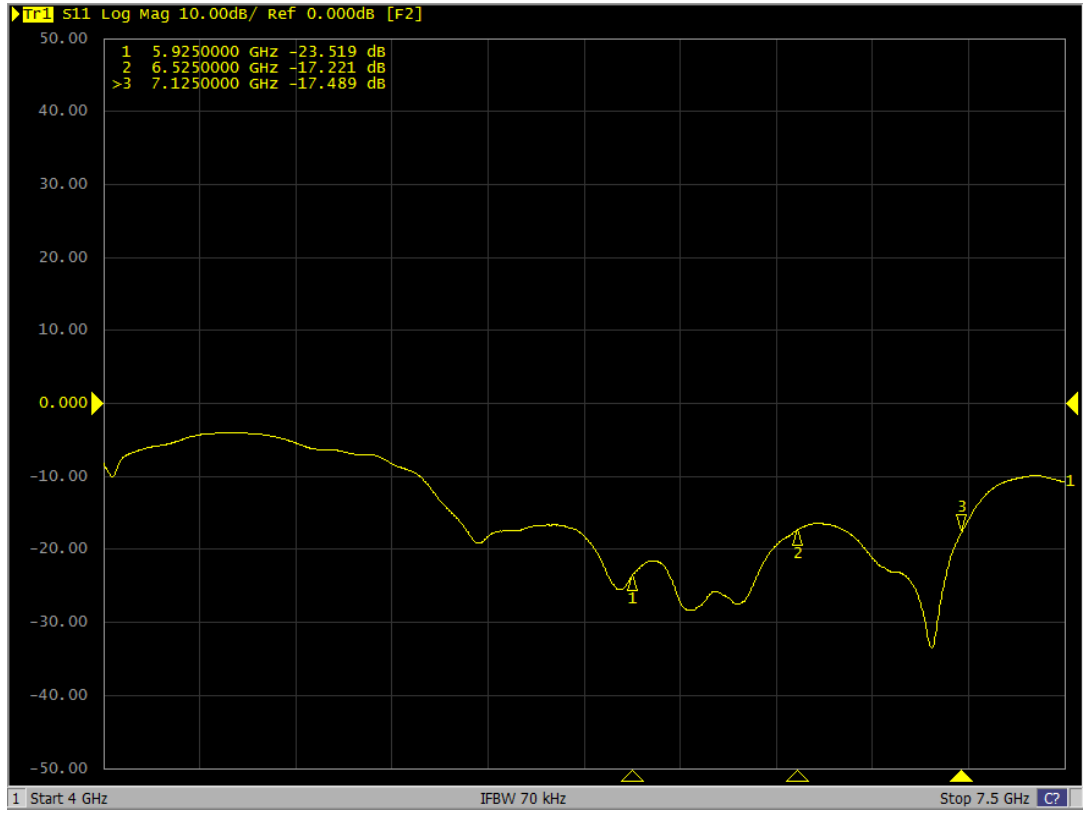
Return Loss

6G3



6G4



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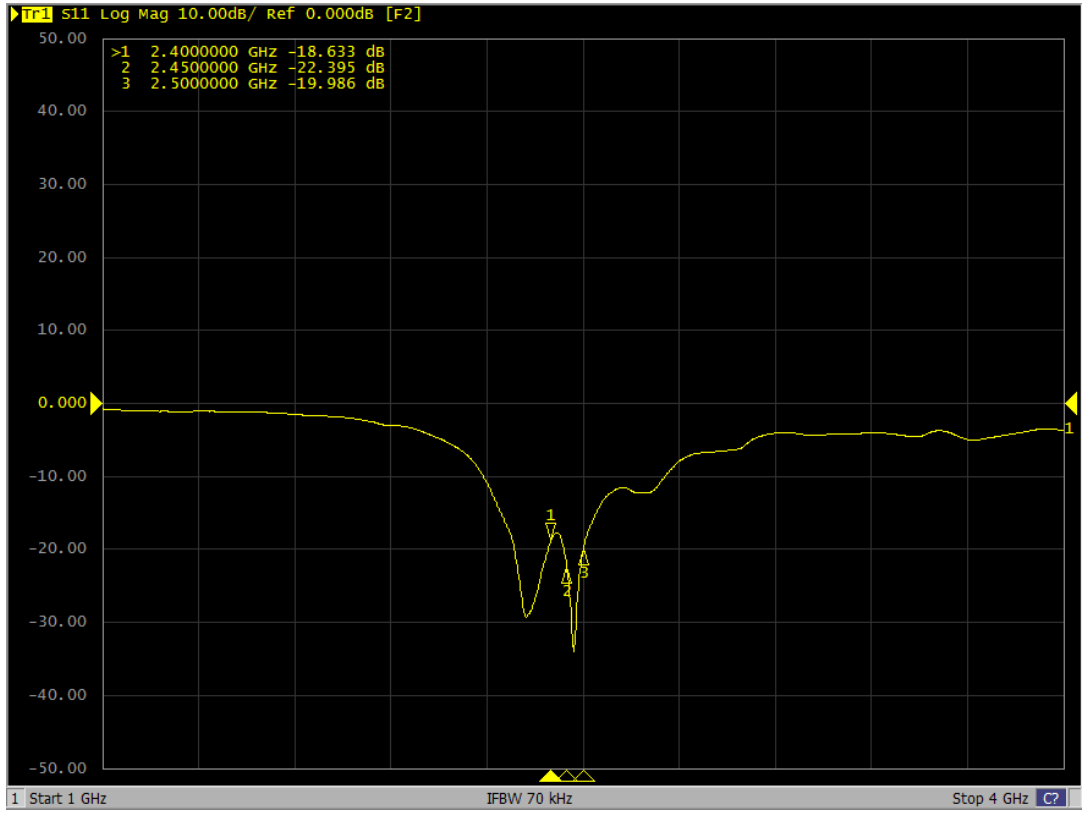
Return Loss

BT



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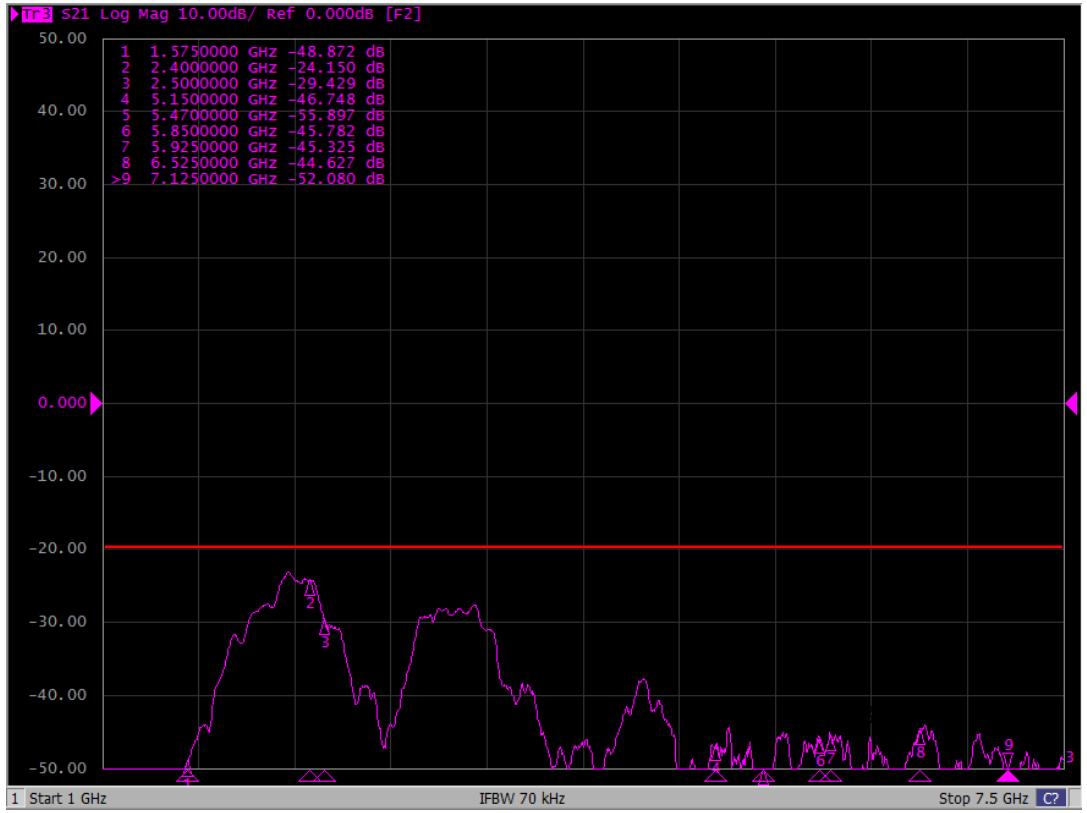
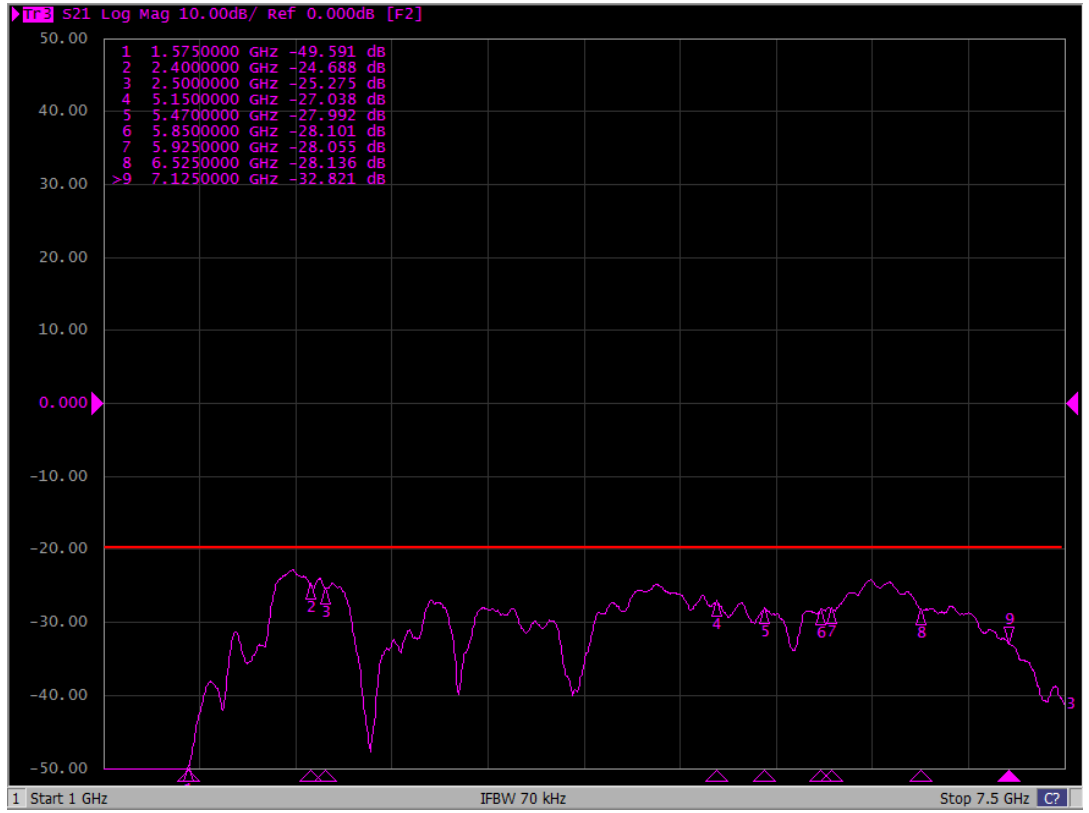
Isolation Results

工业富联

DB1&DB2



DB1&DB3



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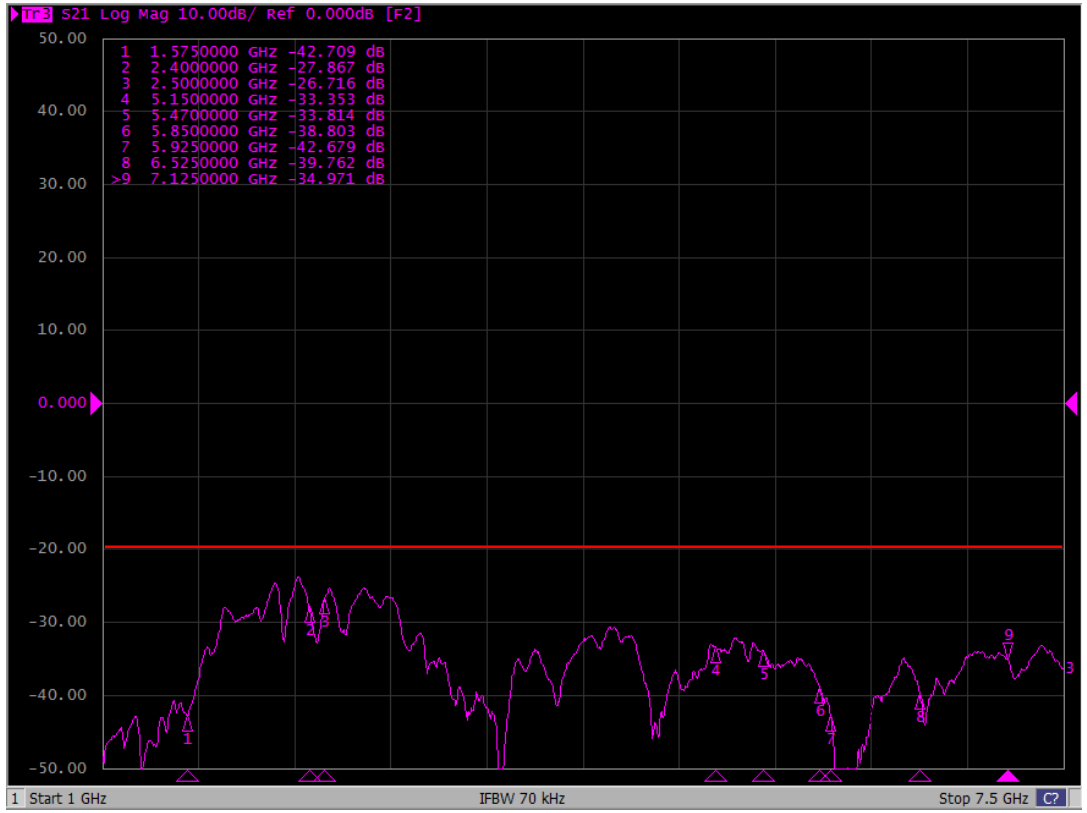
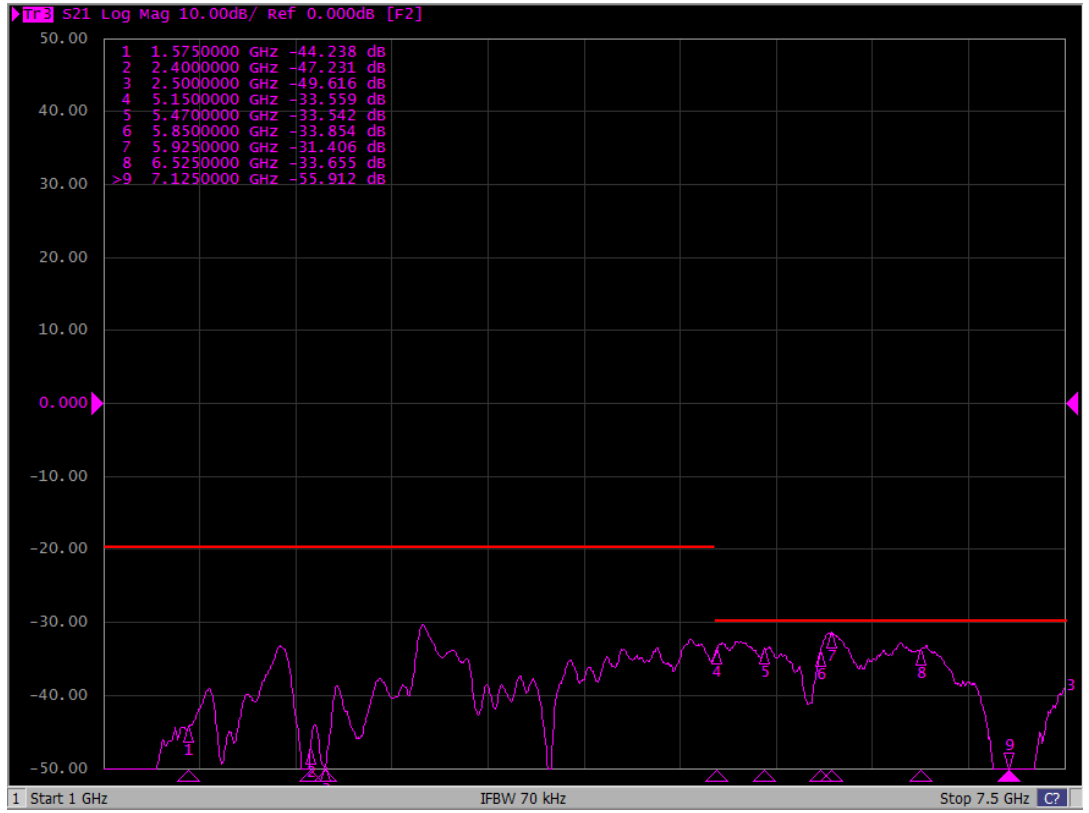
Isolation Results

工业富联

DB1&DB4



DB1&6G1



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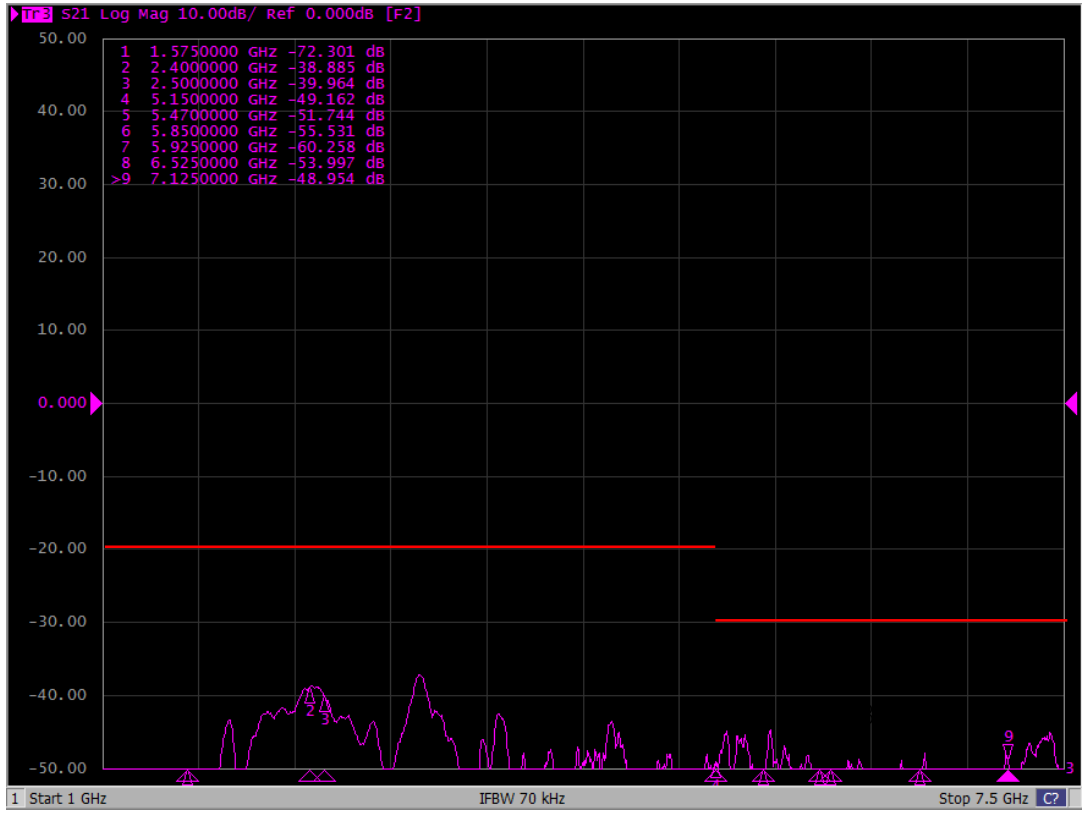
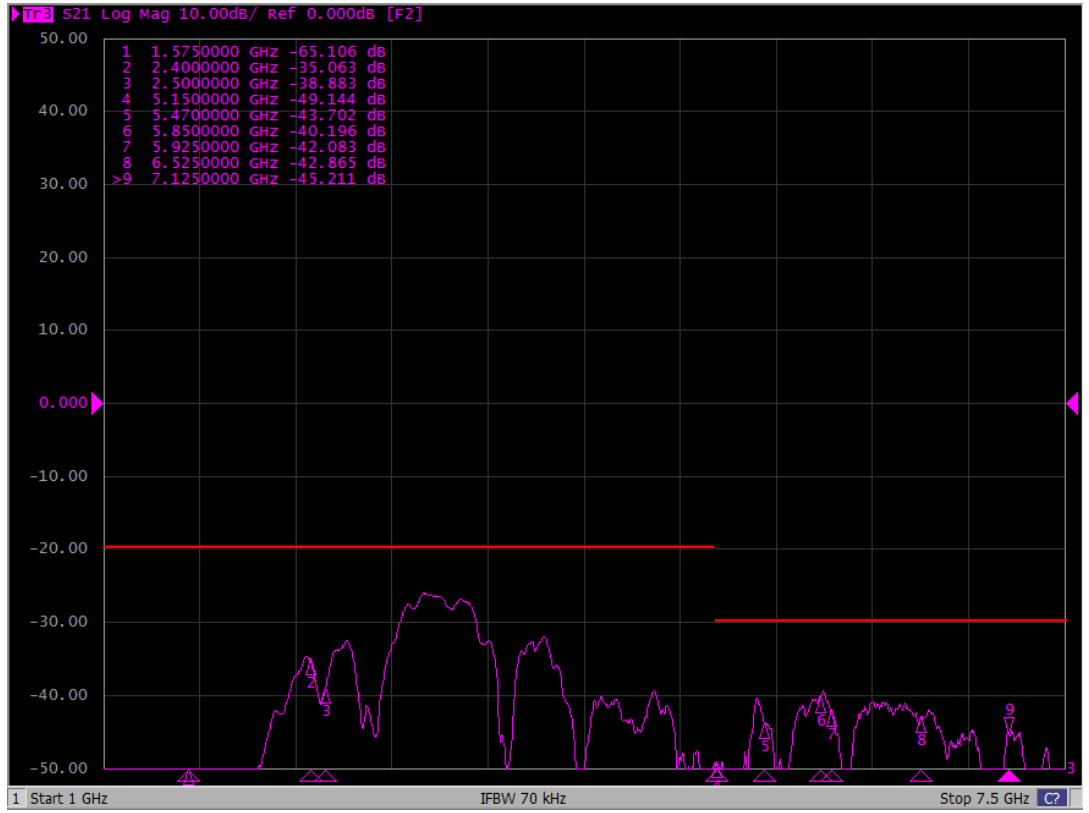
Isolation Results

工业富联

DB1&6G2



DB1&6G3



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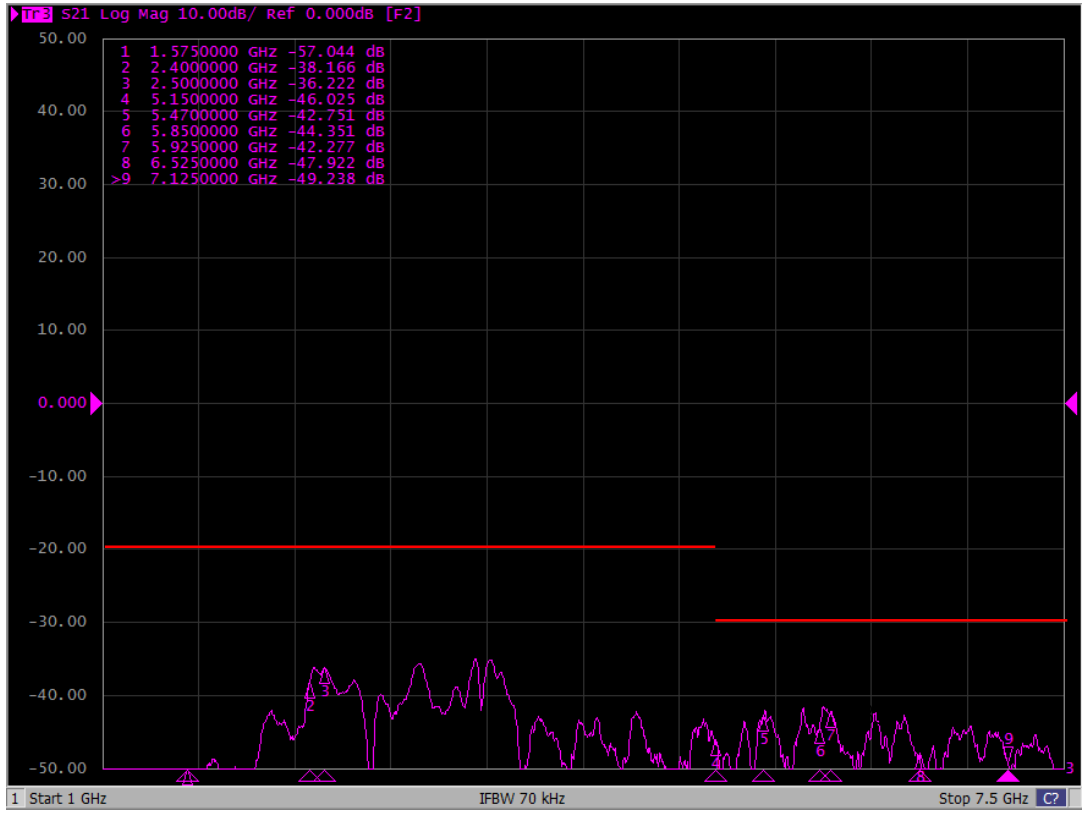
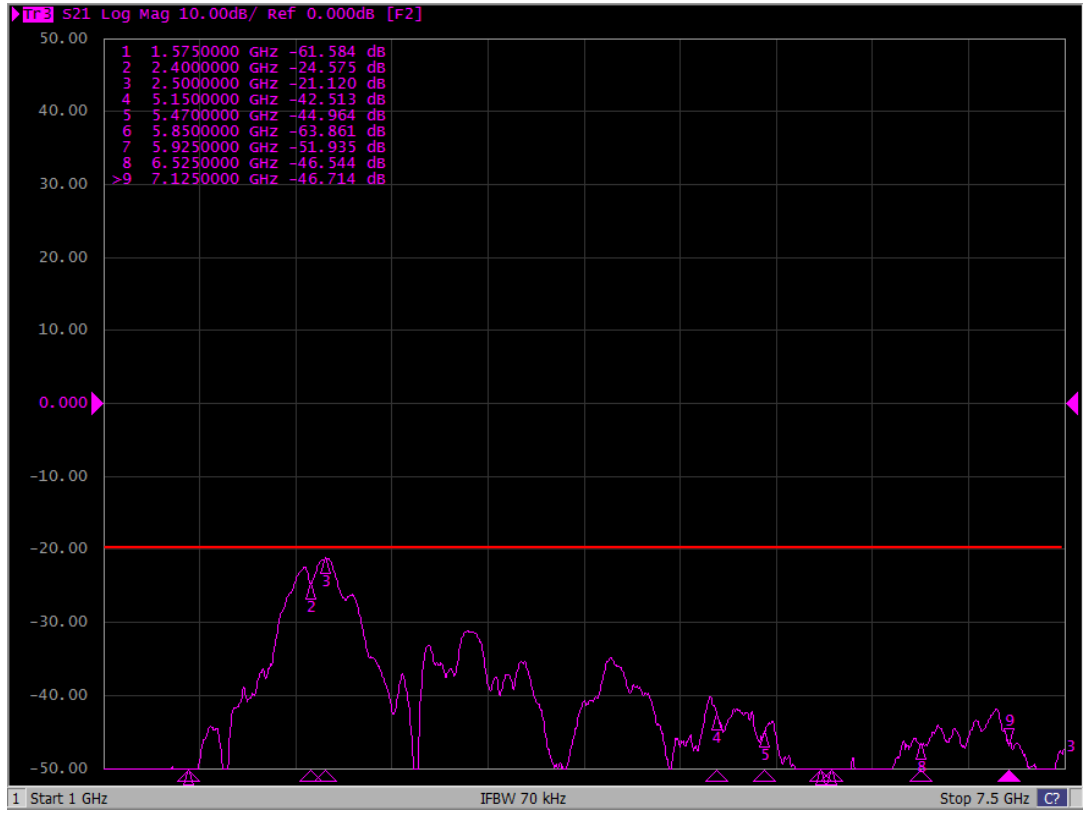
Isolation Results

工业富联

DB1&6G4



DB1&BT



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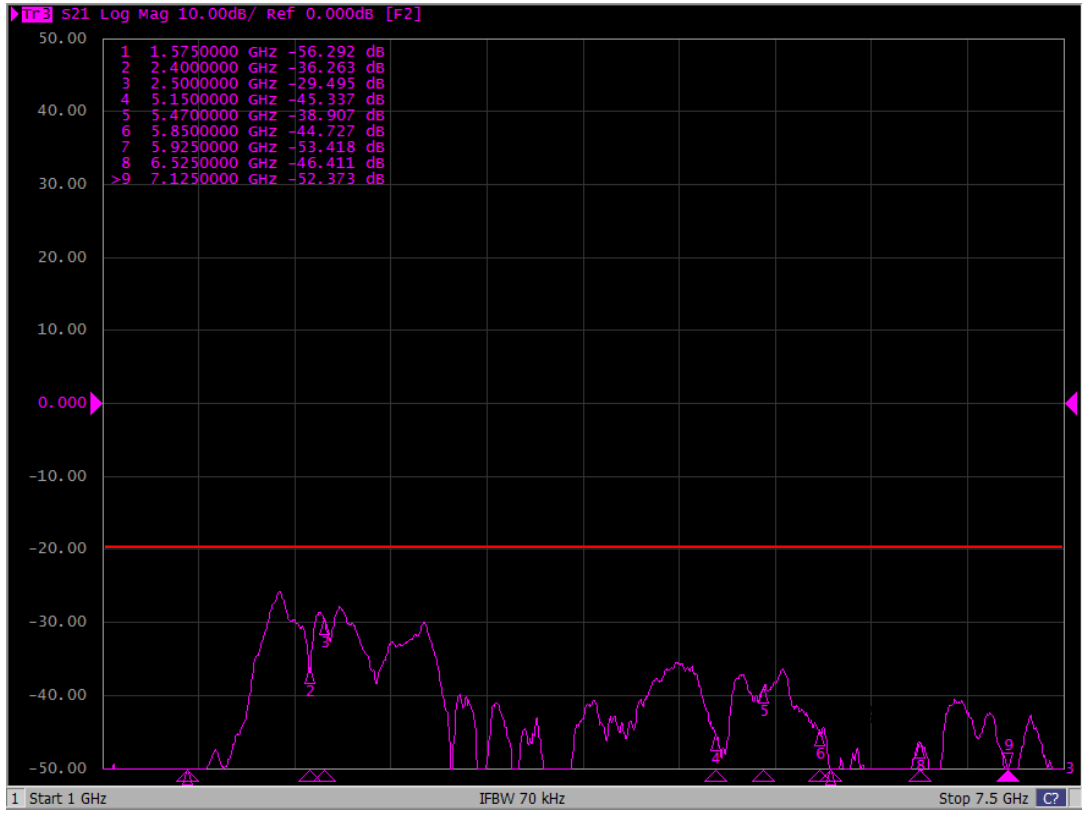
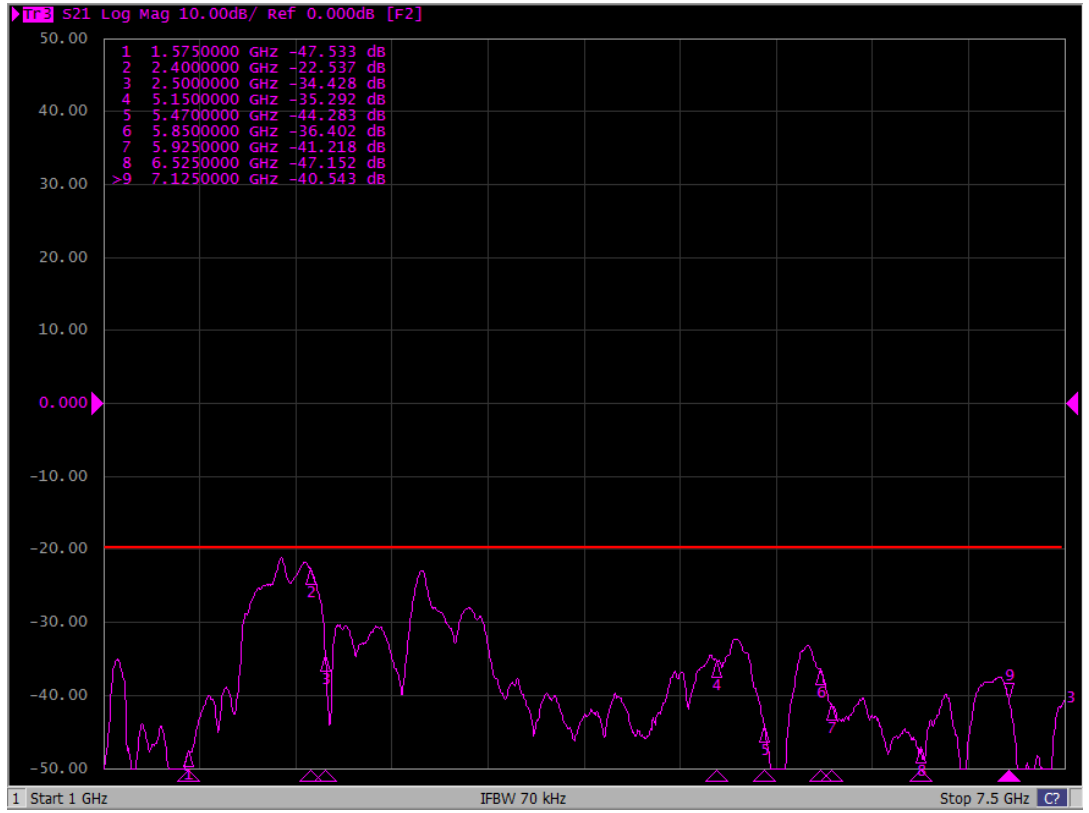
Isolation Results

工业富联

DB2&DB3



DB2&DB4



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Isolation Results

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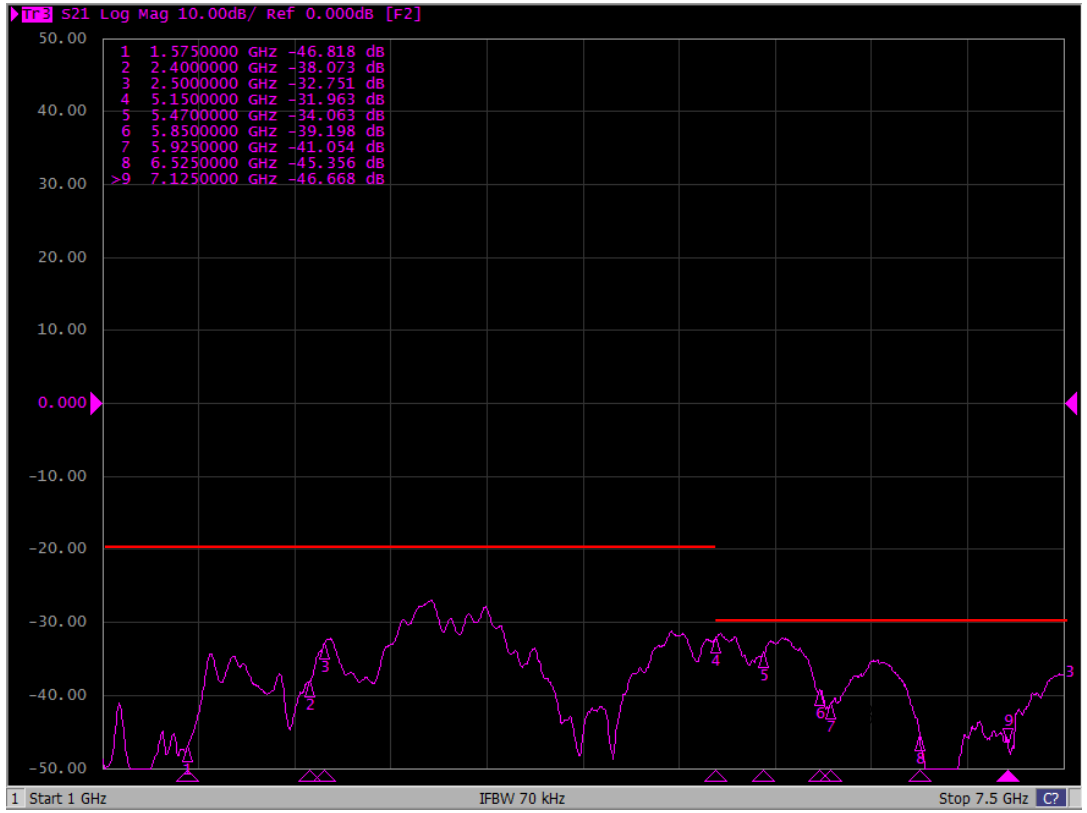
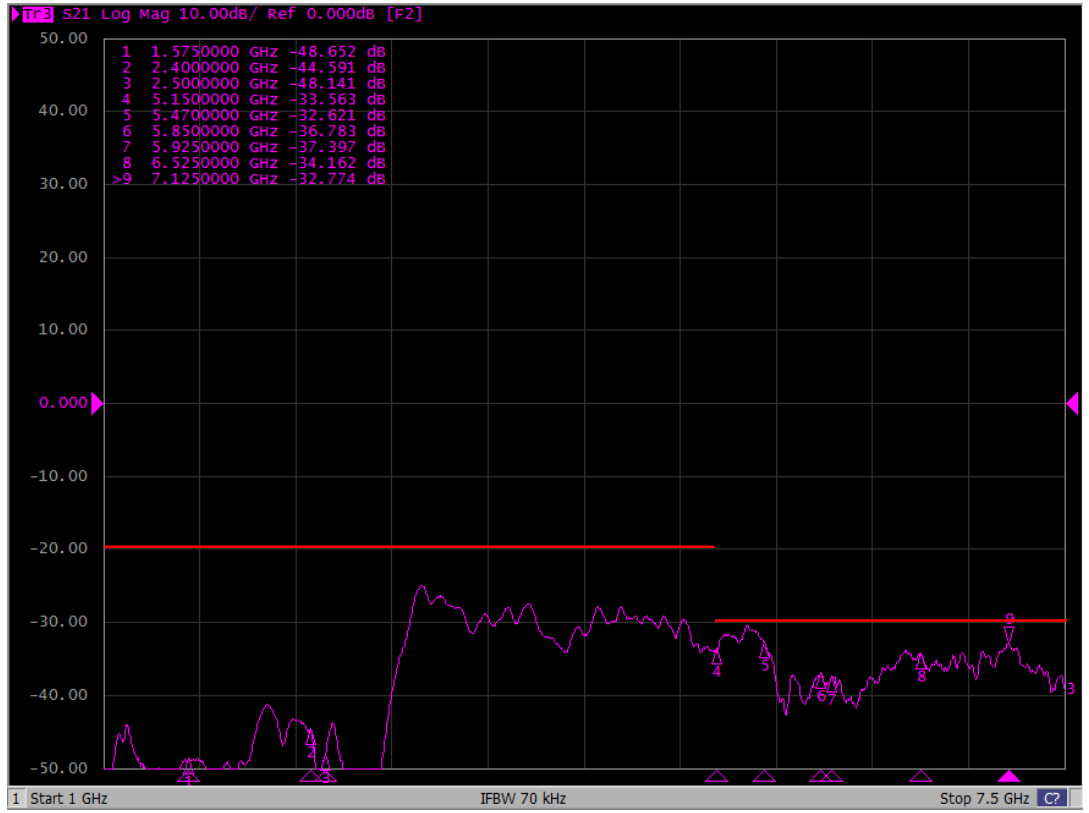
DB2&6G1



DB2&6G2



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Isolation Results

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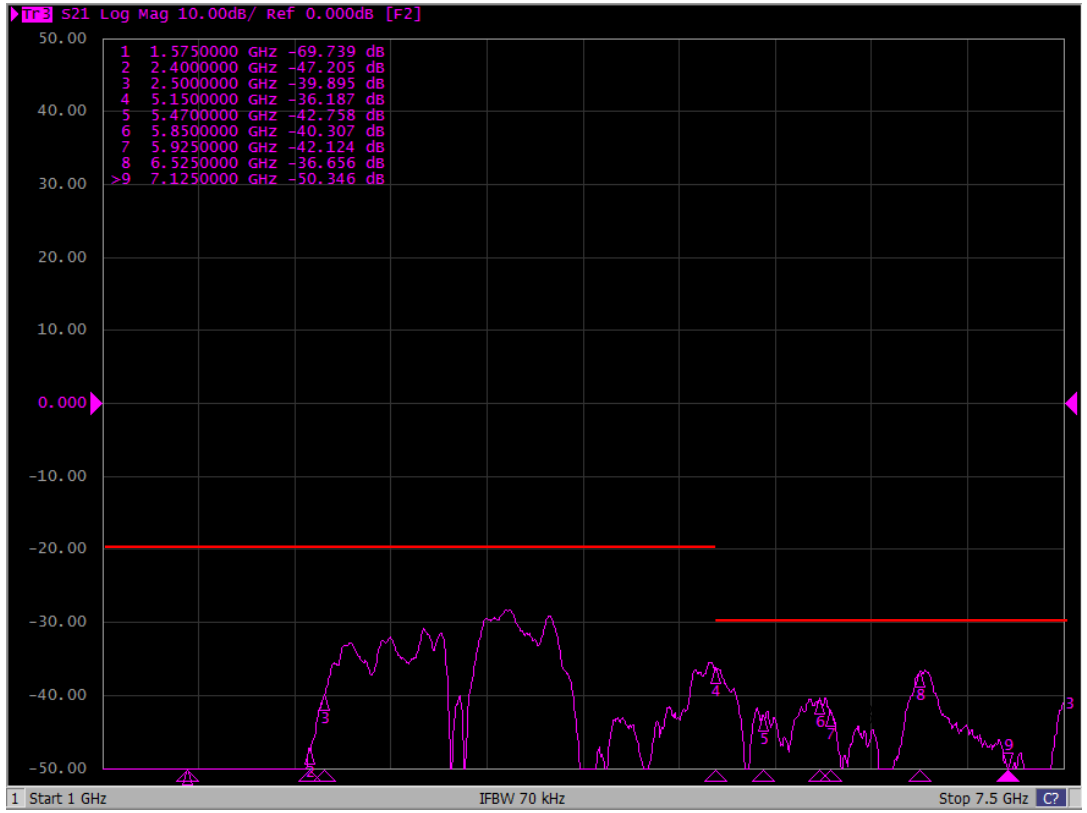
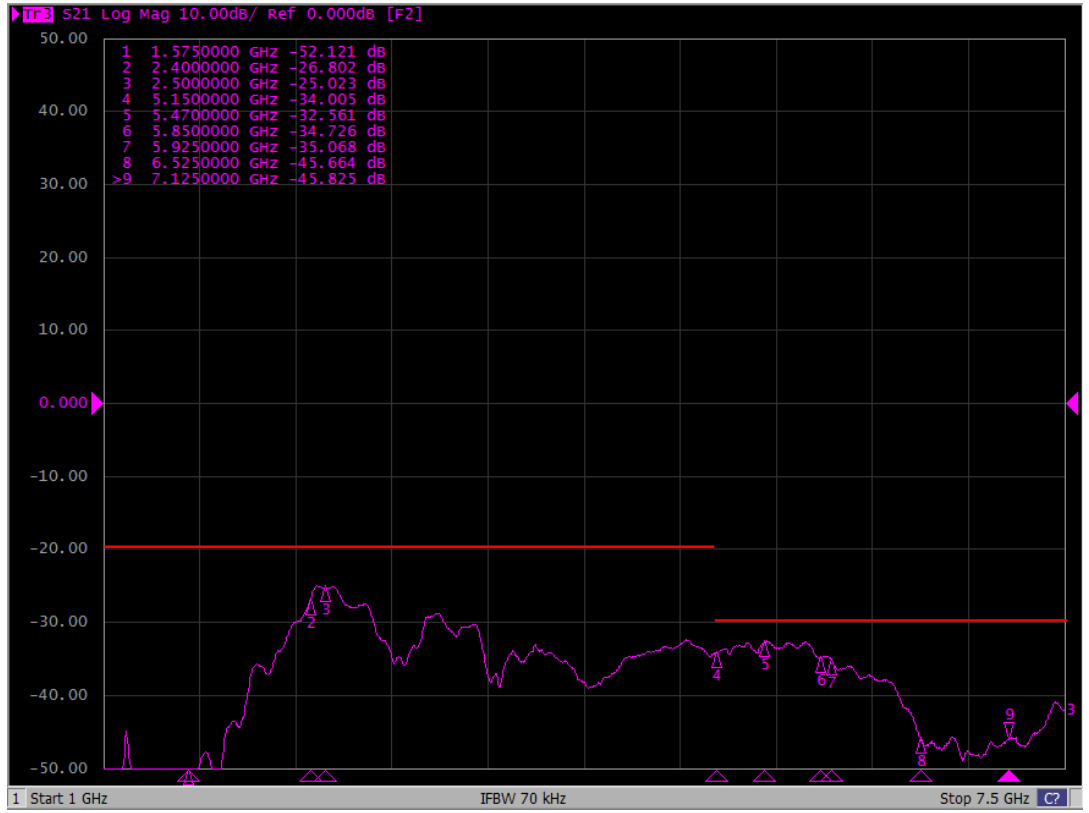
DB2&6G3



DB2&6G4



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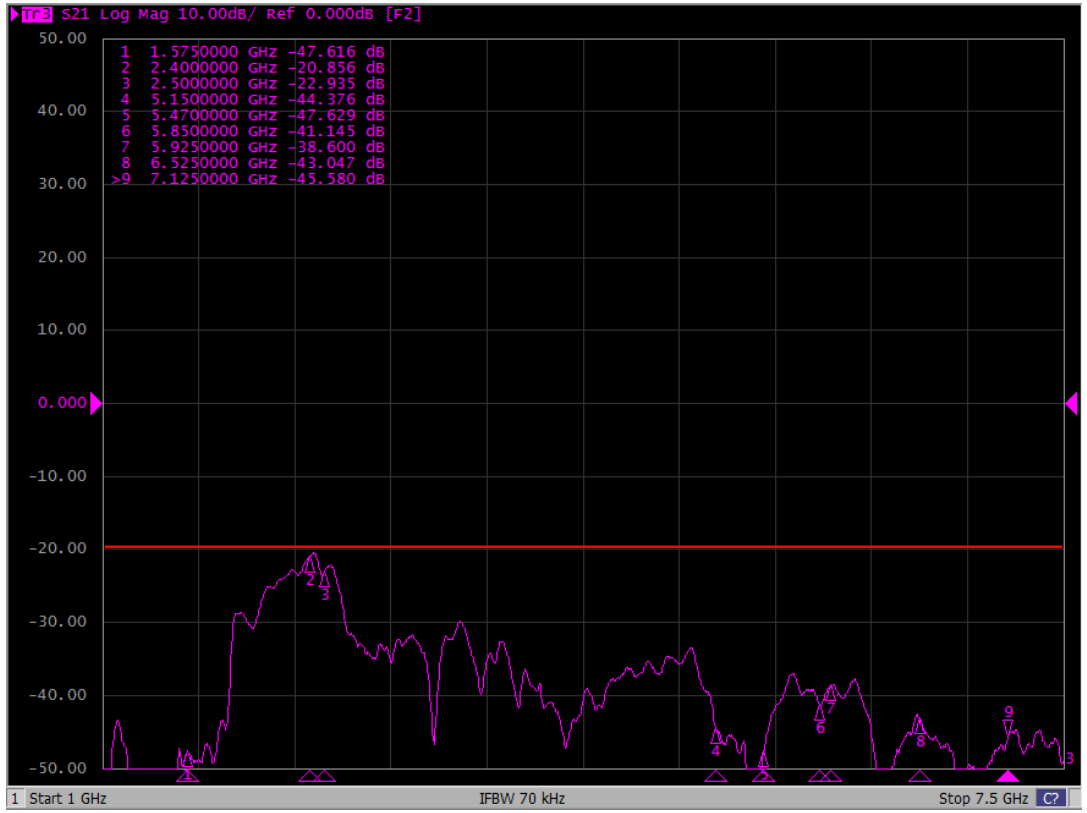
Isolation Results

DB2&BT



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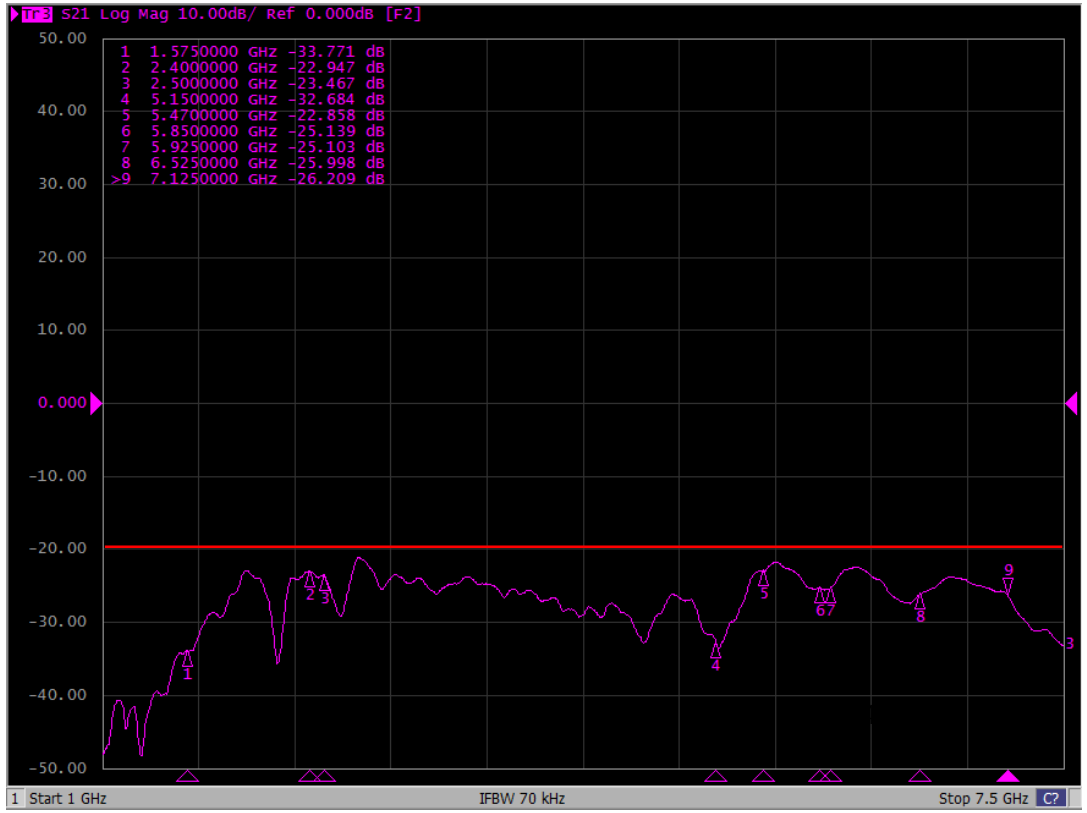
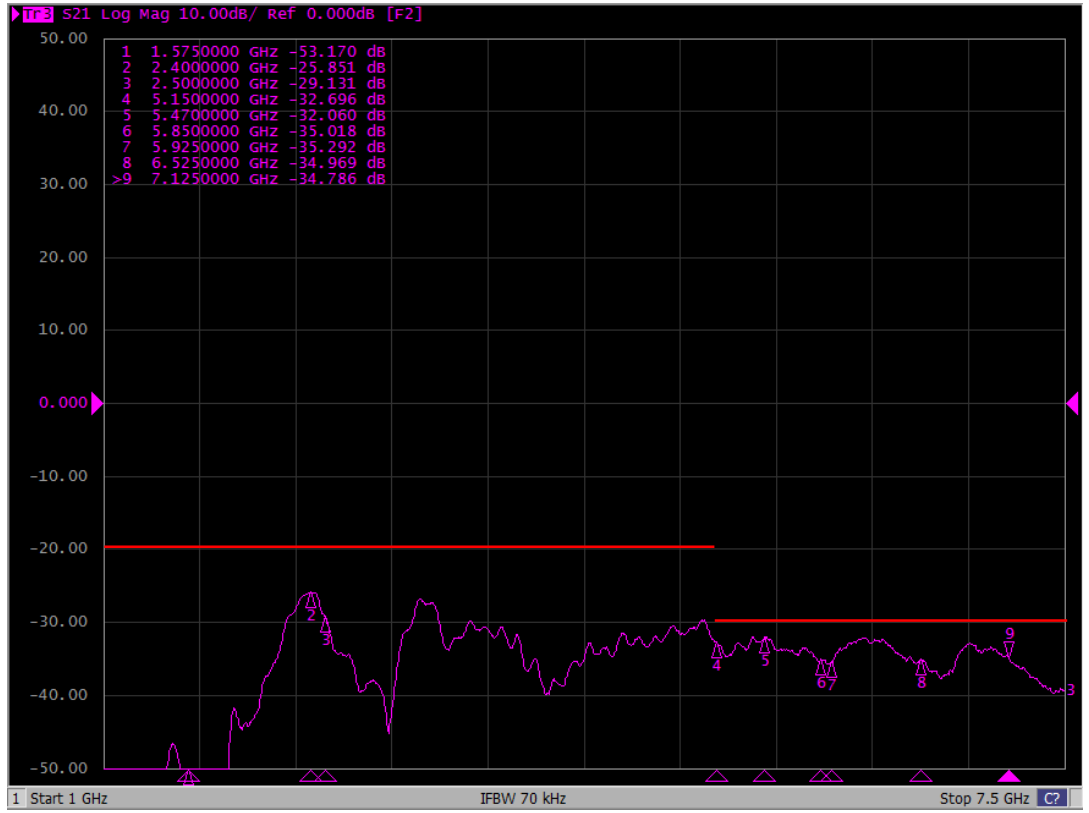
Isolation Results

工业富联

DB3&DB4



DB3&6G1



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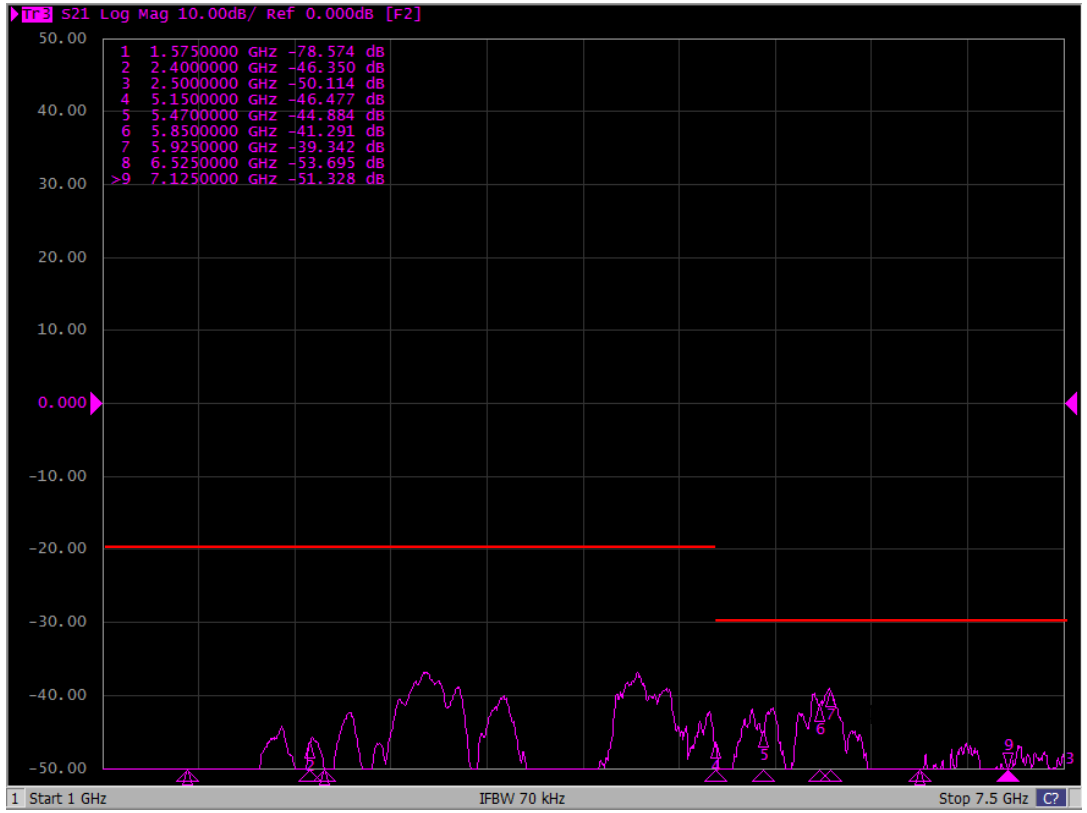
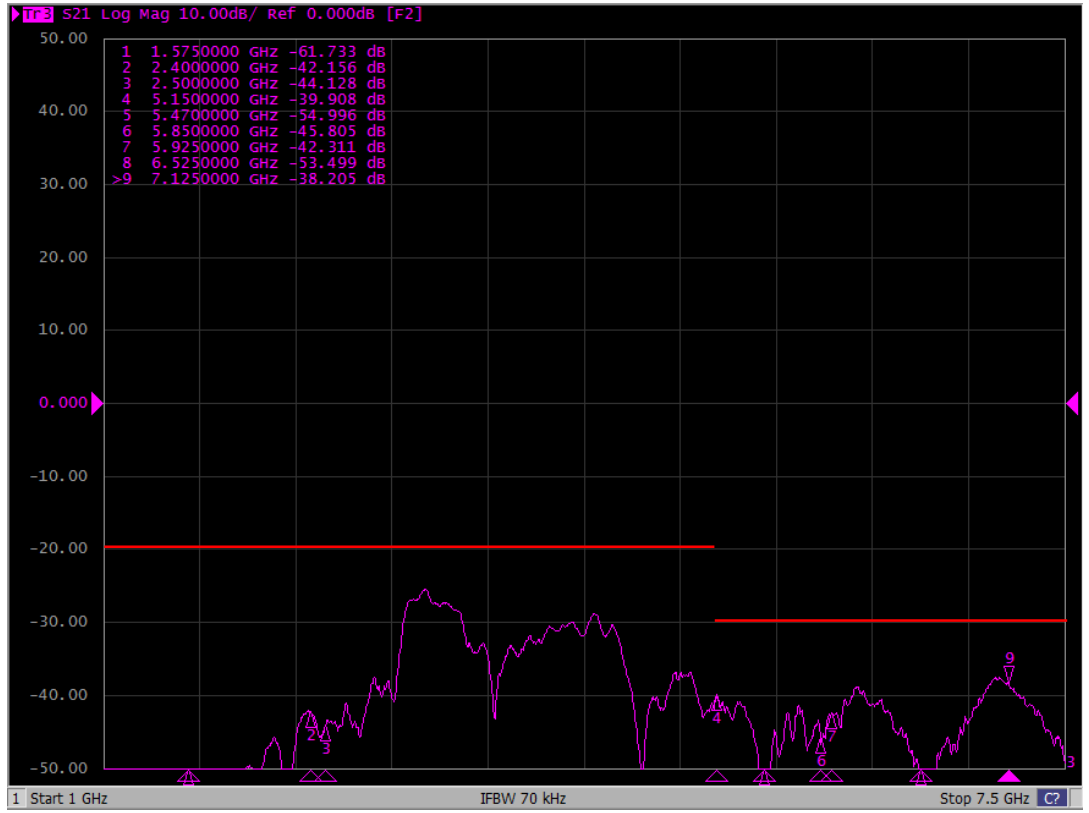
Isolation Results

DB3&6G2



DB3&6G3



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Isolation Results

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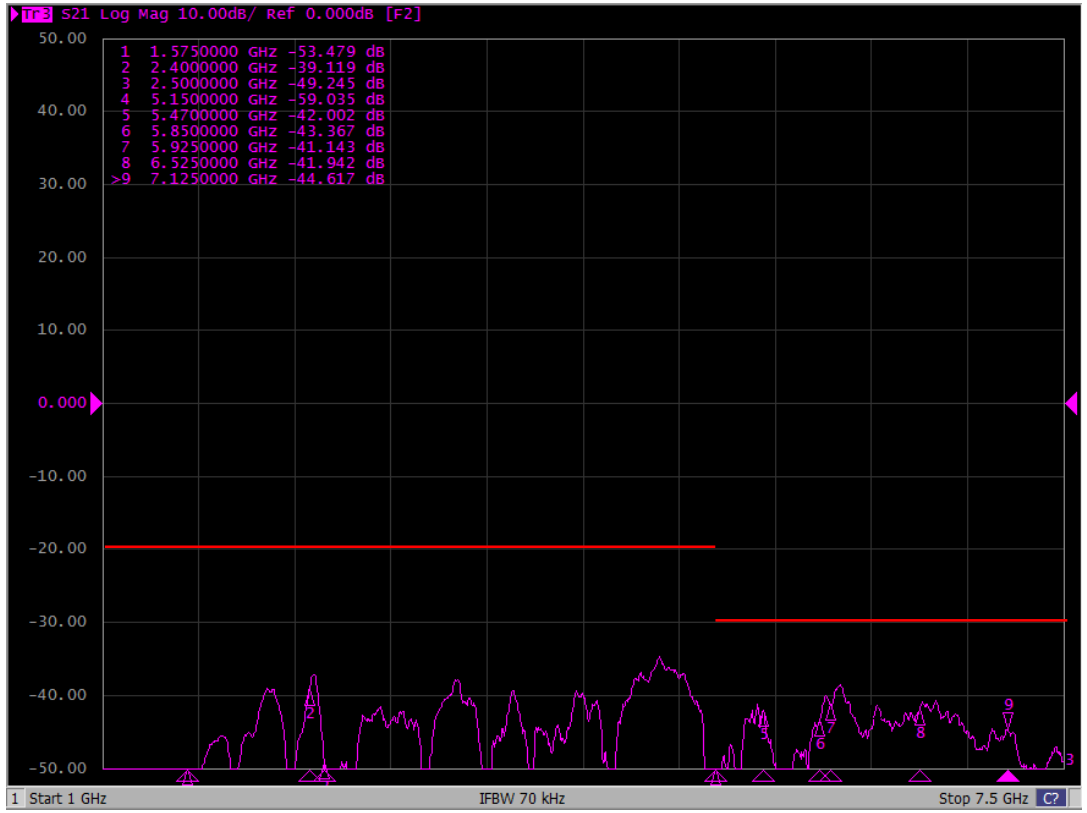
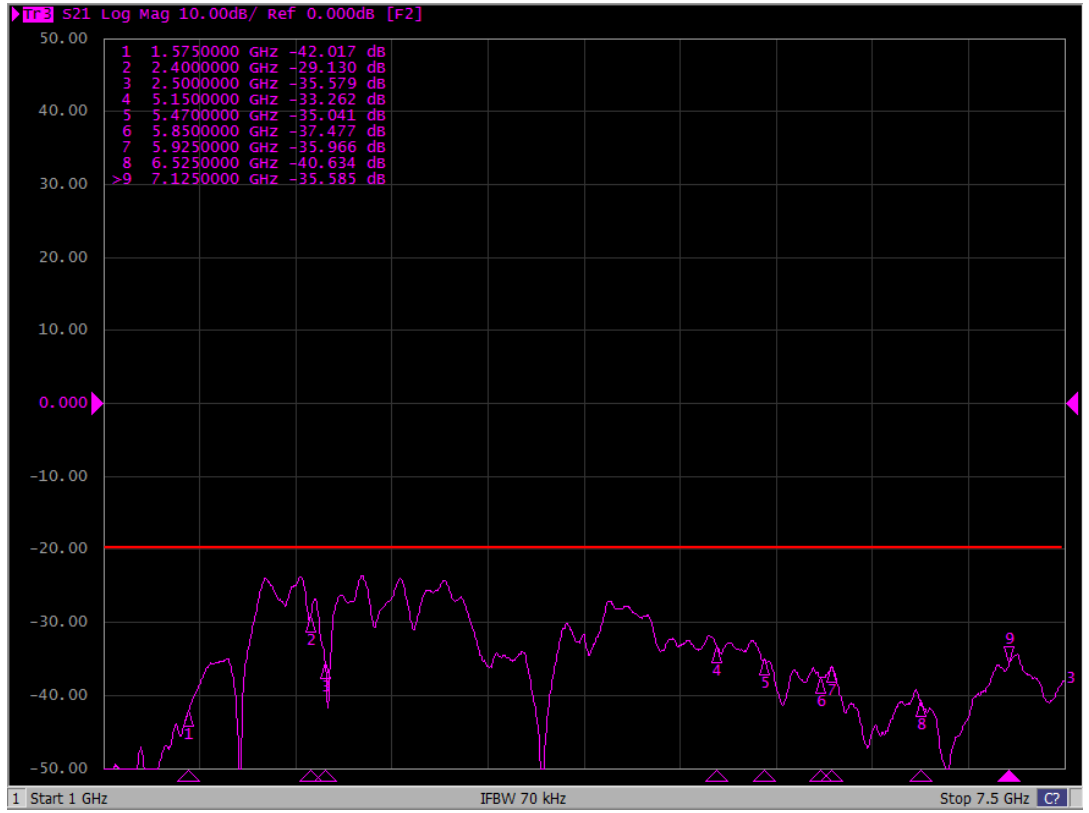
DB3&6G4



DB3&BT



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Isolation Results

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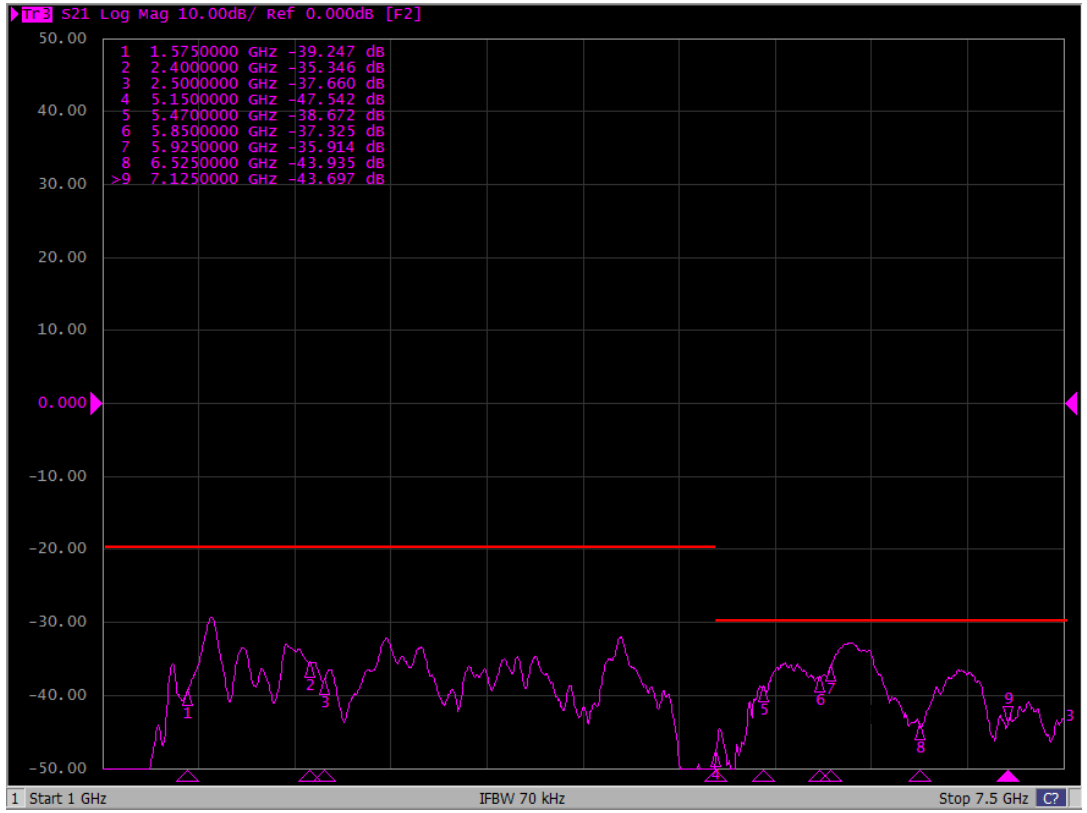
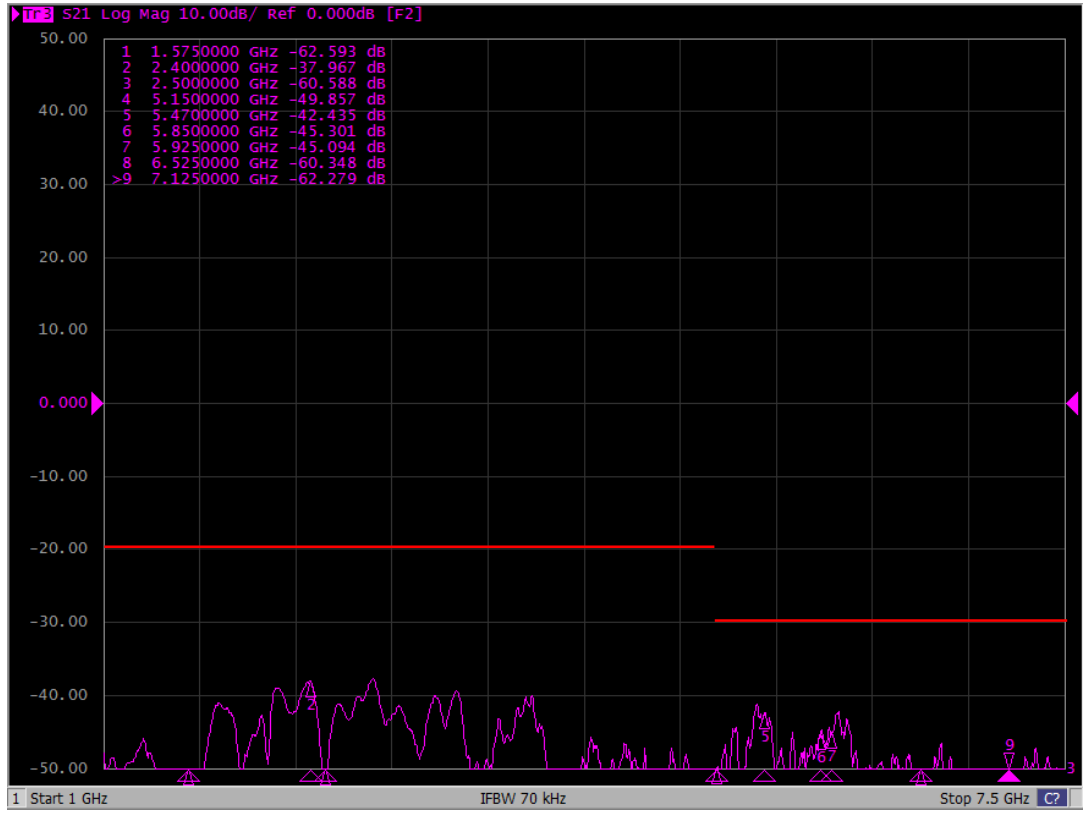
DB4&6G1



DB4&6G2



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Isolation Results

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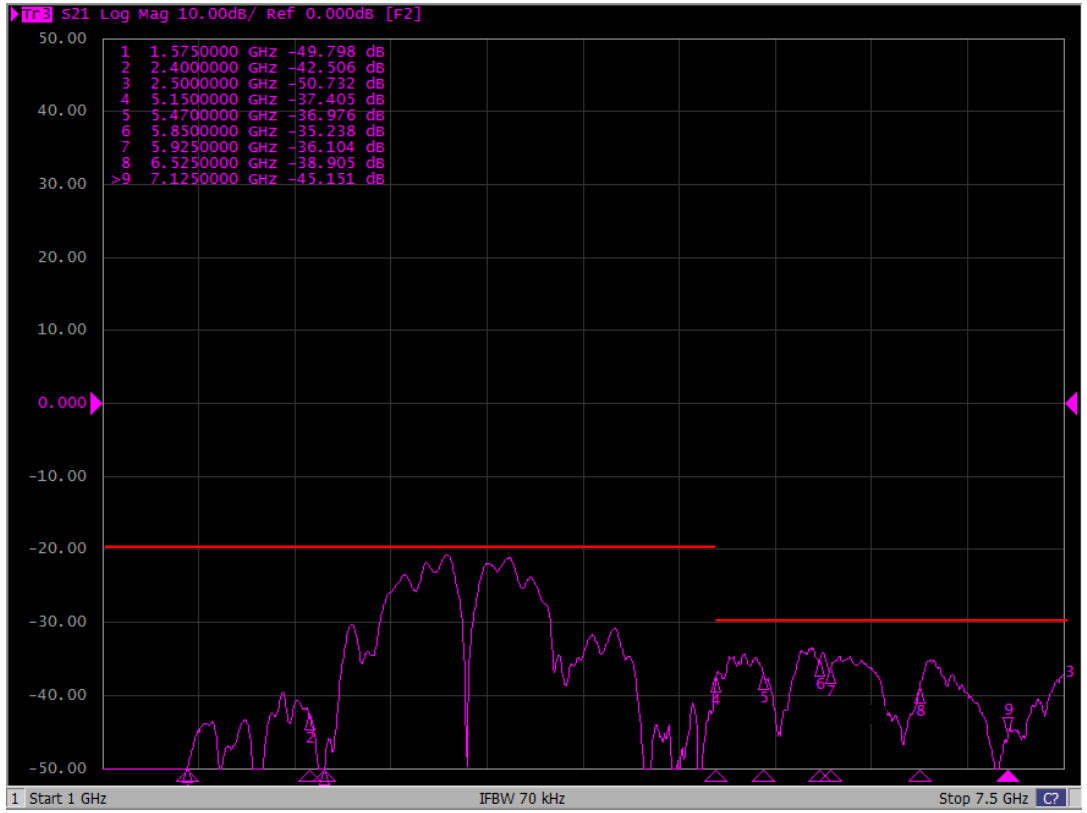
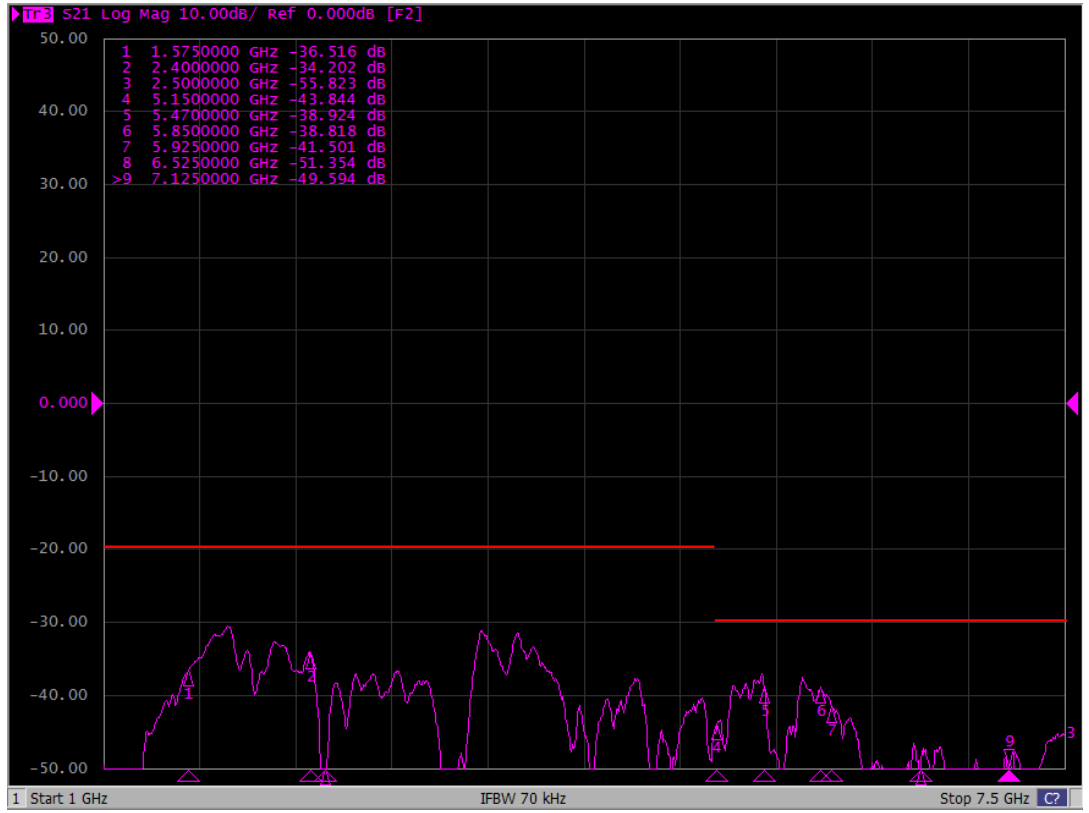
DB4&6G3



DB4&6G4



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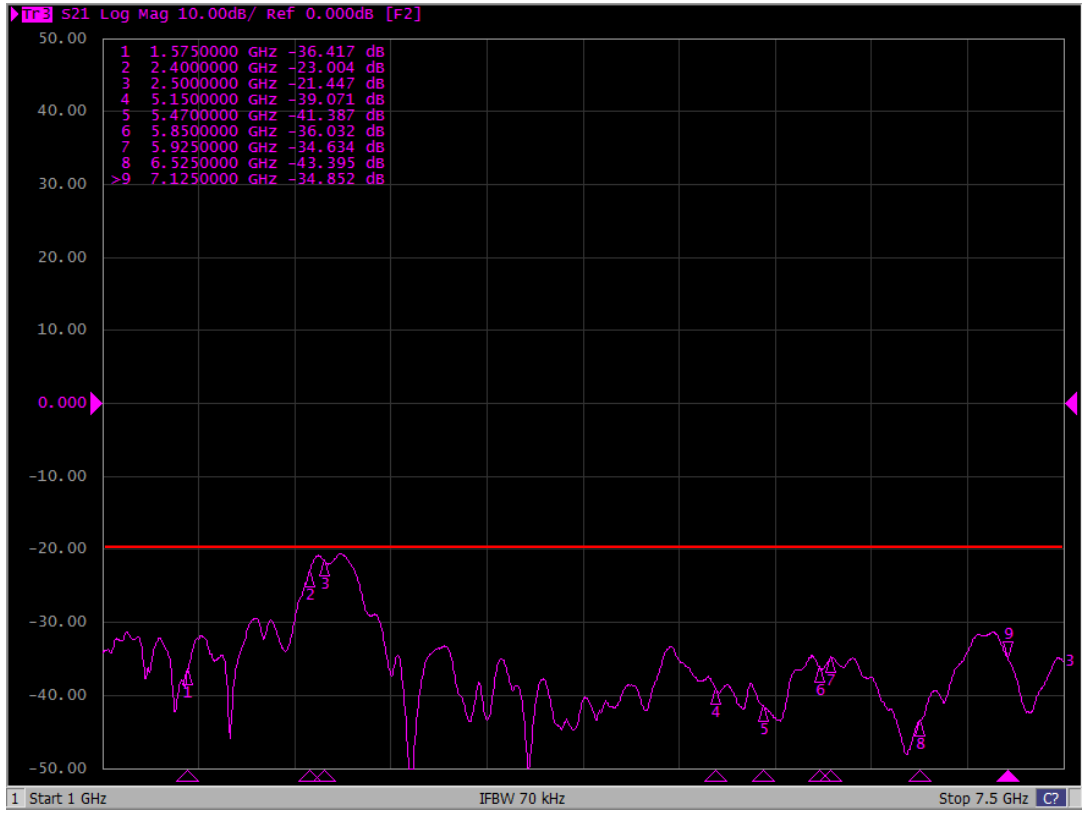
Isolation Results

DB4&BT



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Isolation Results

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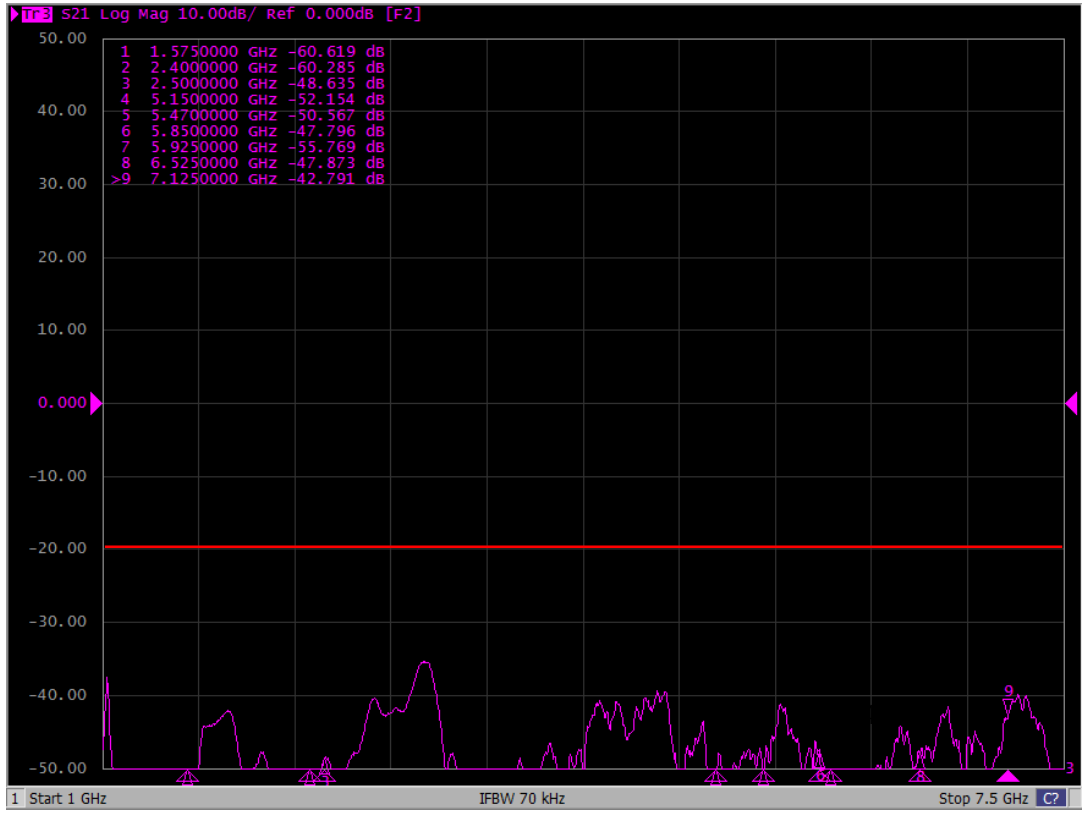
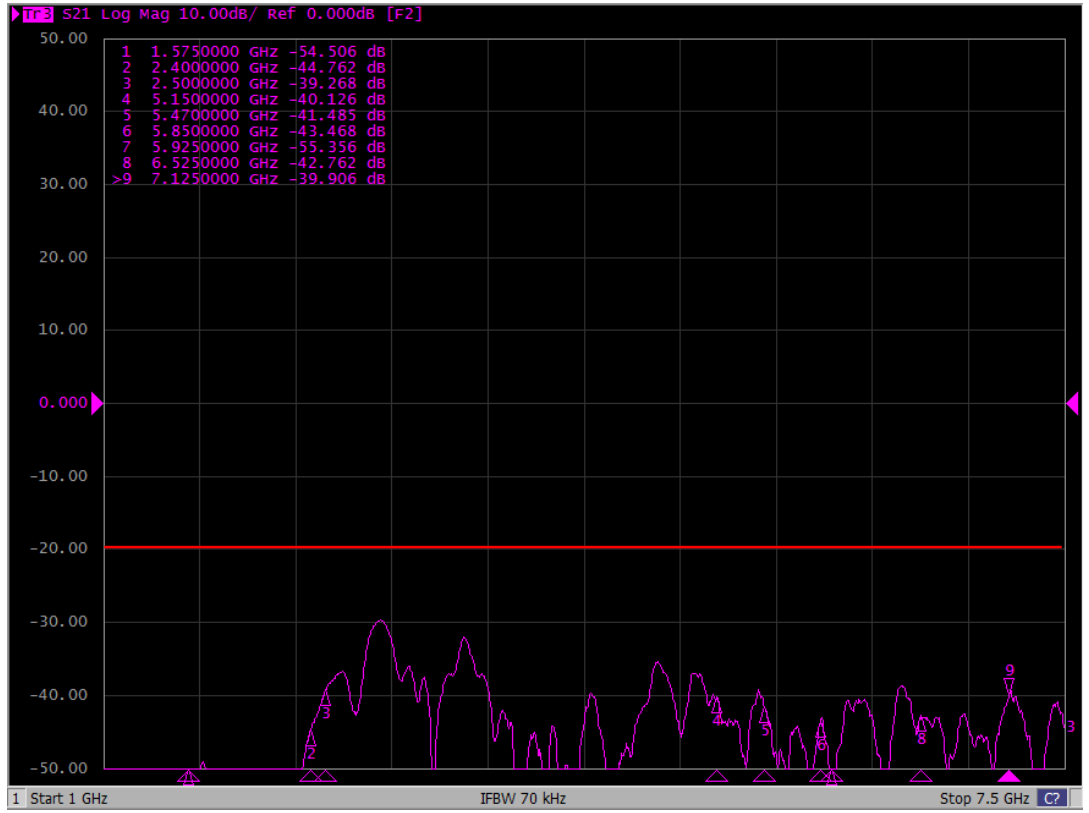
6G1&6G2



6G1&6G3



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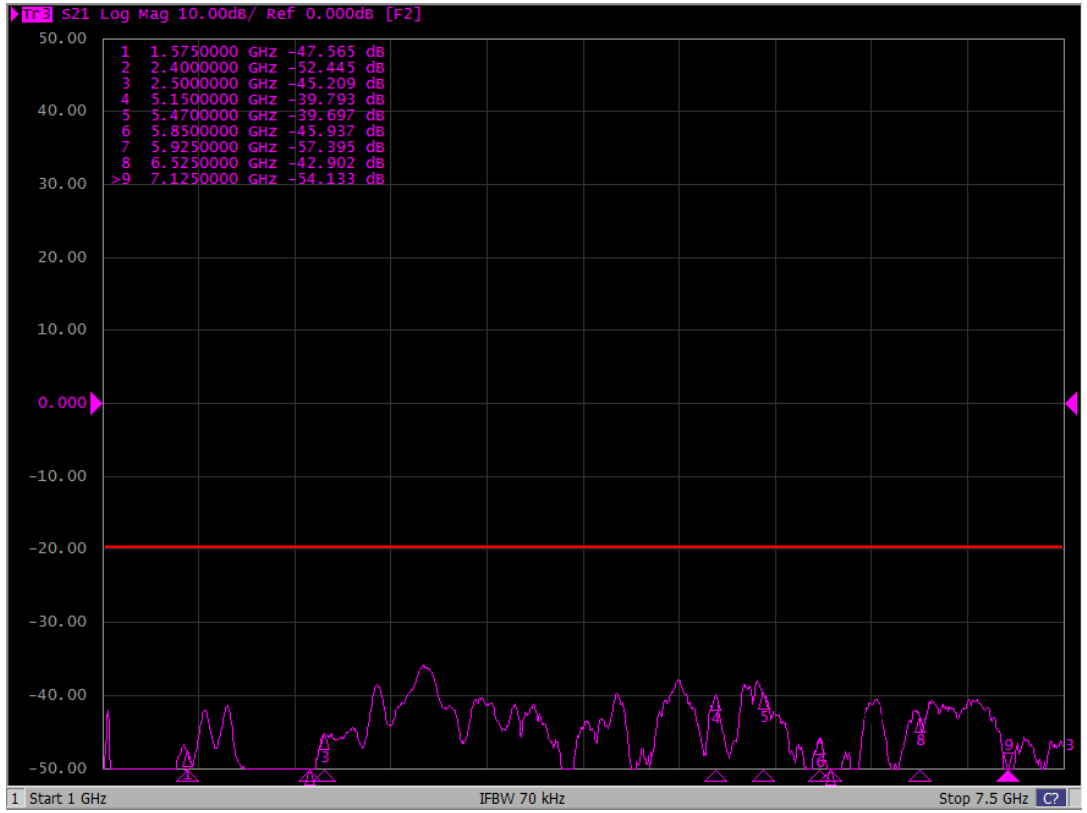
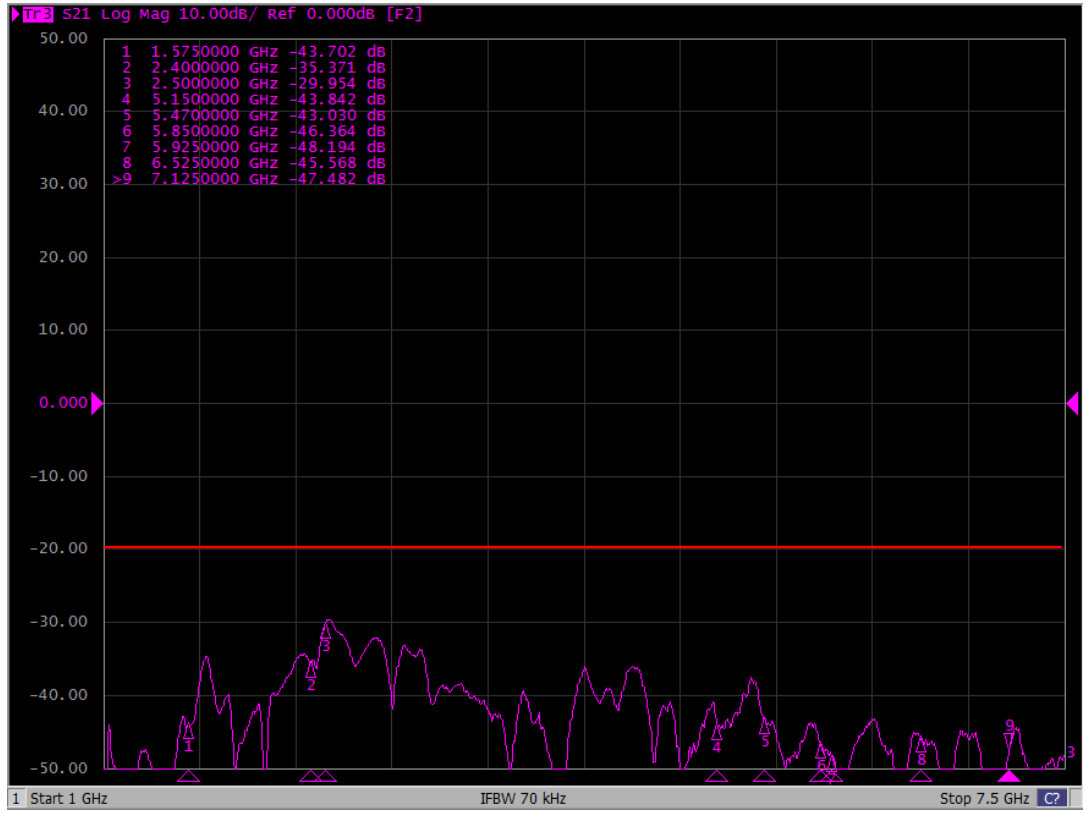
Isolation Results

6G1&6G4



6G1&BT



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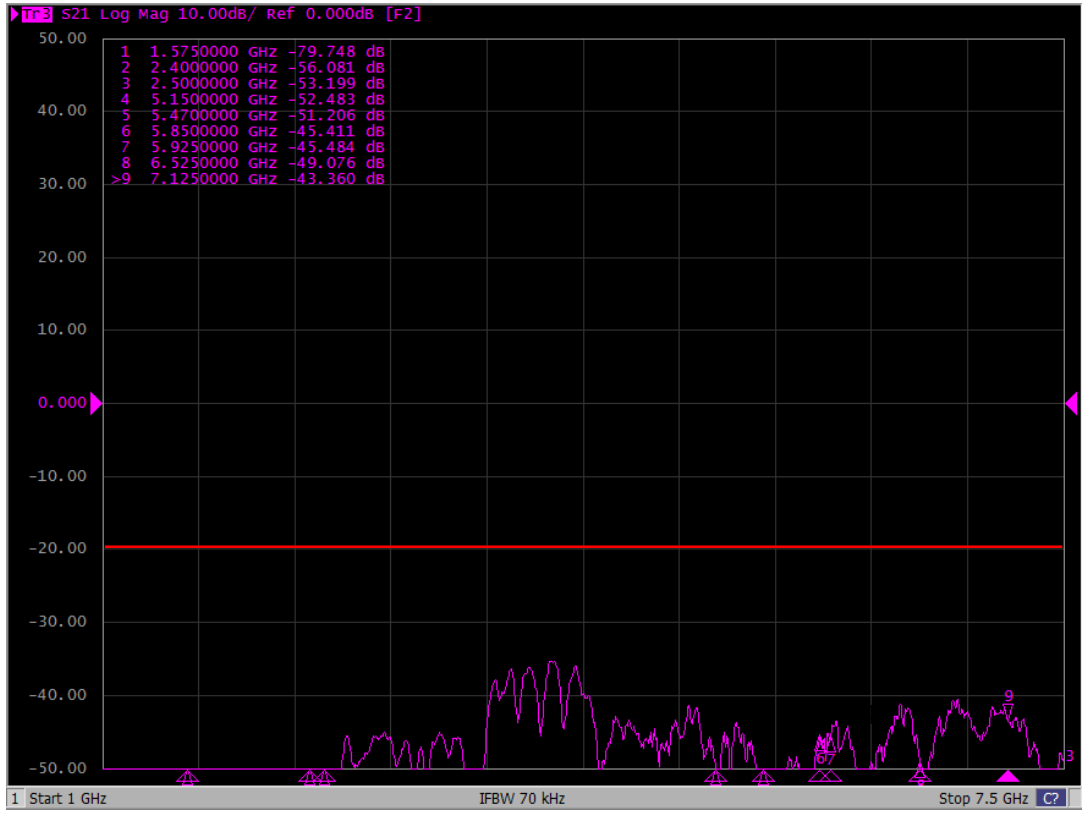
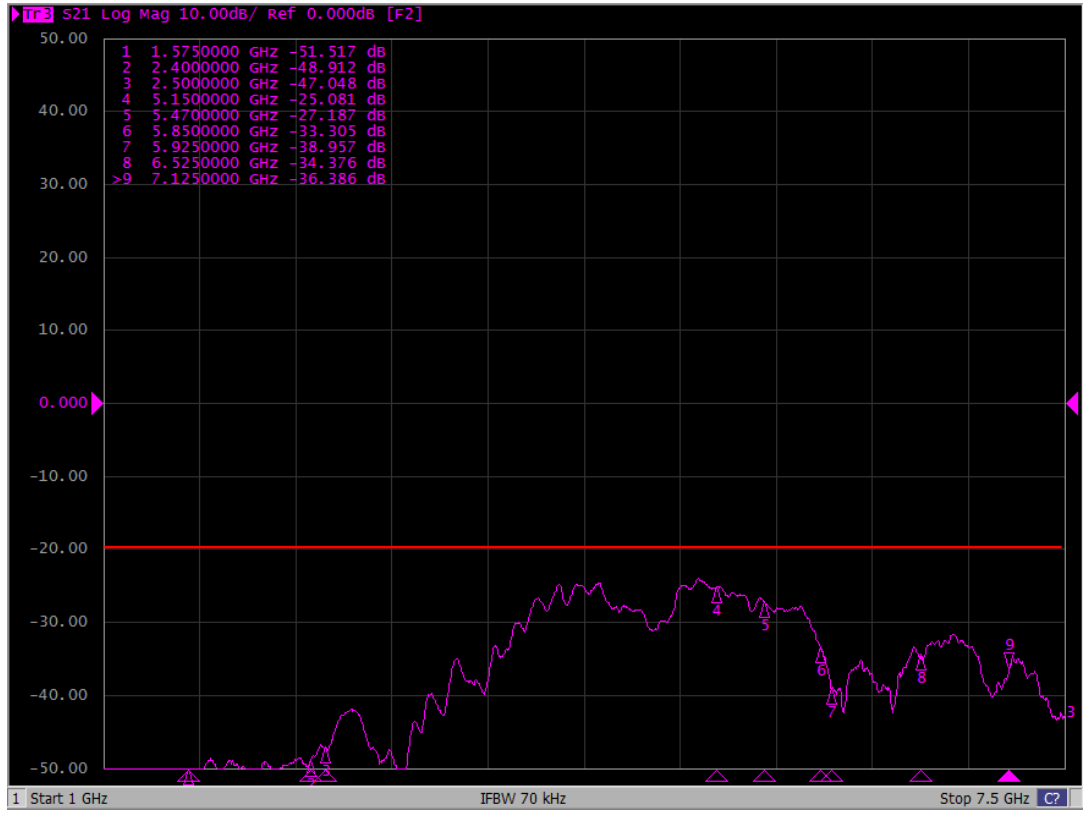
Isolation Results

6G2&6G3



6G2&6G4



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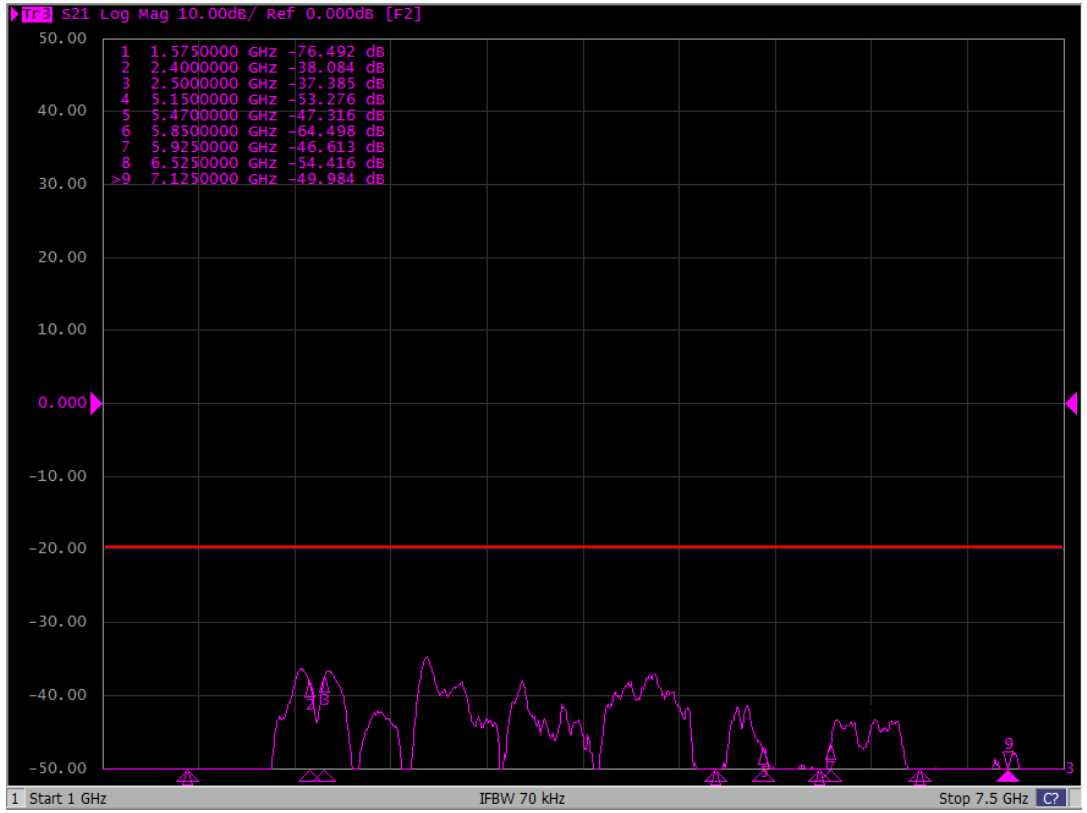
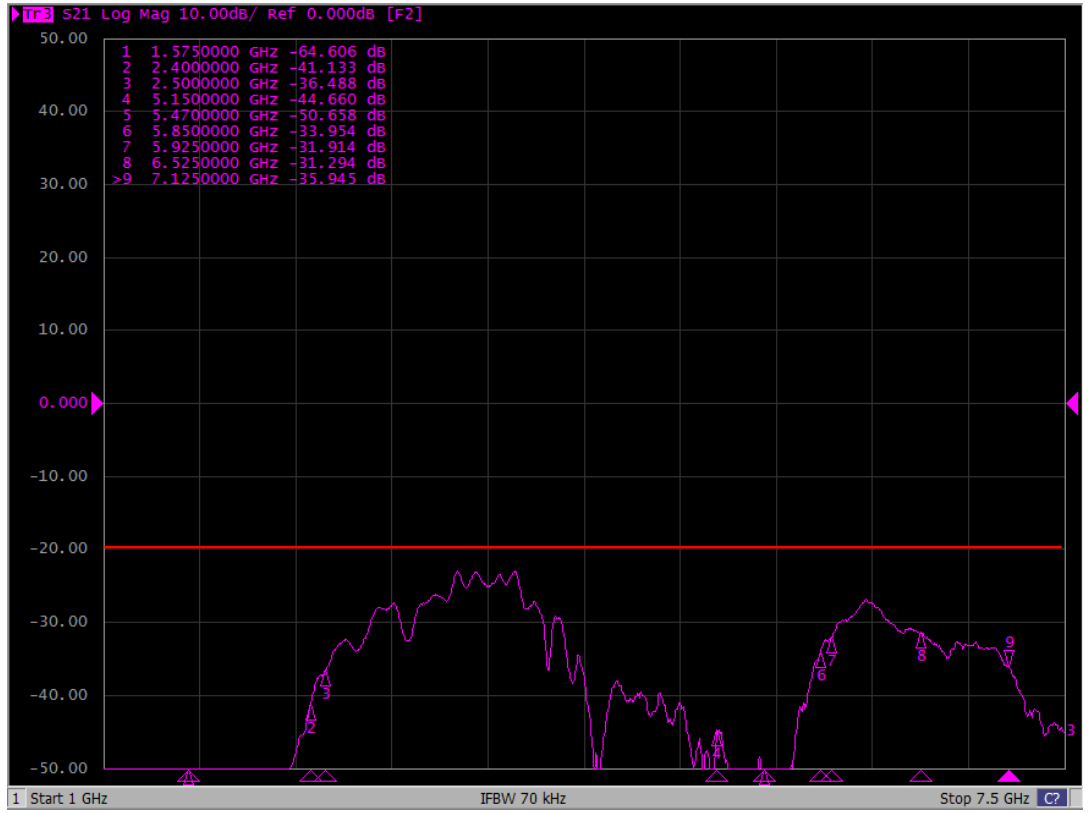
Isolation Results

6G2&BT



6G3&6G4



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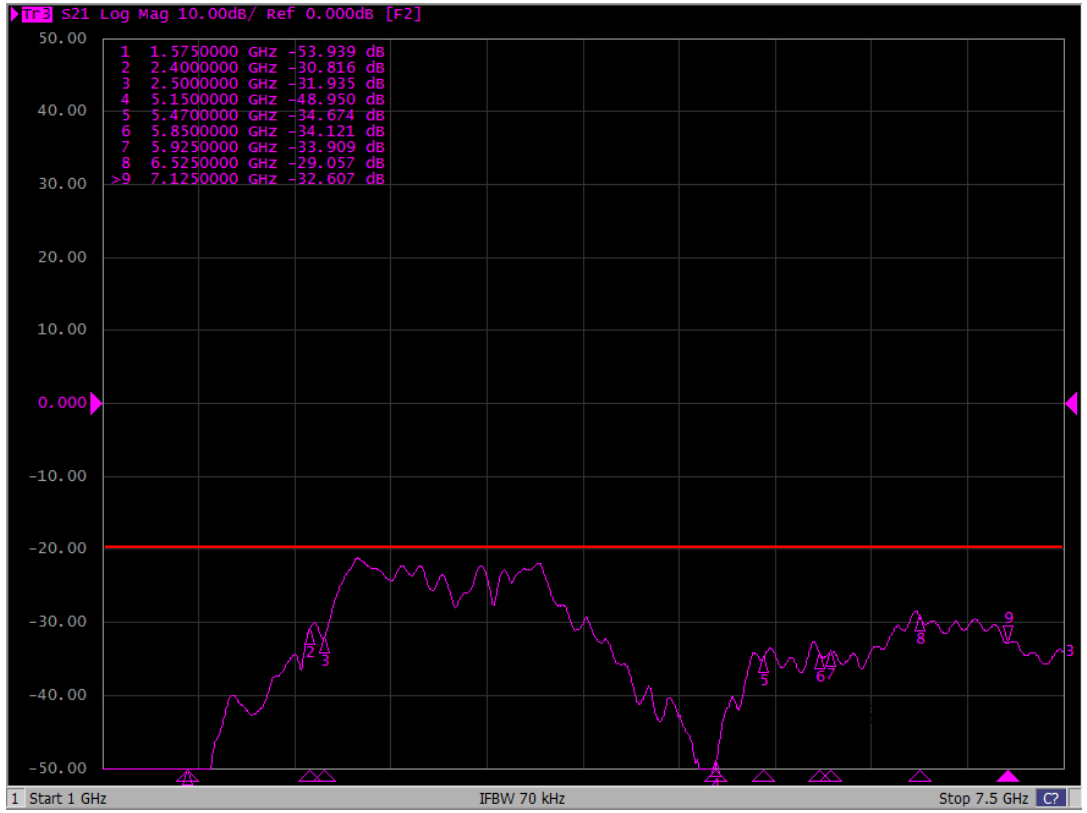
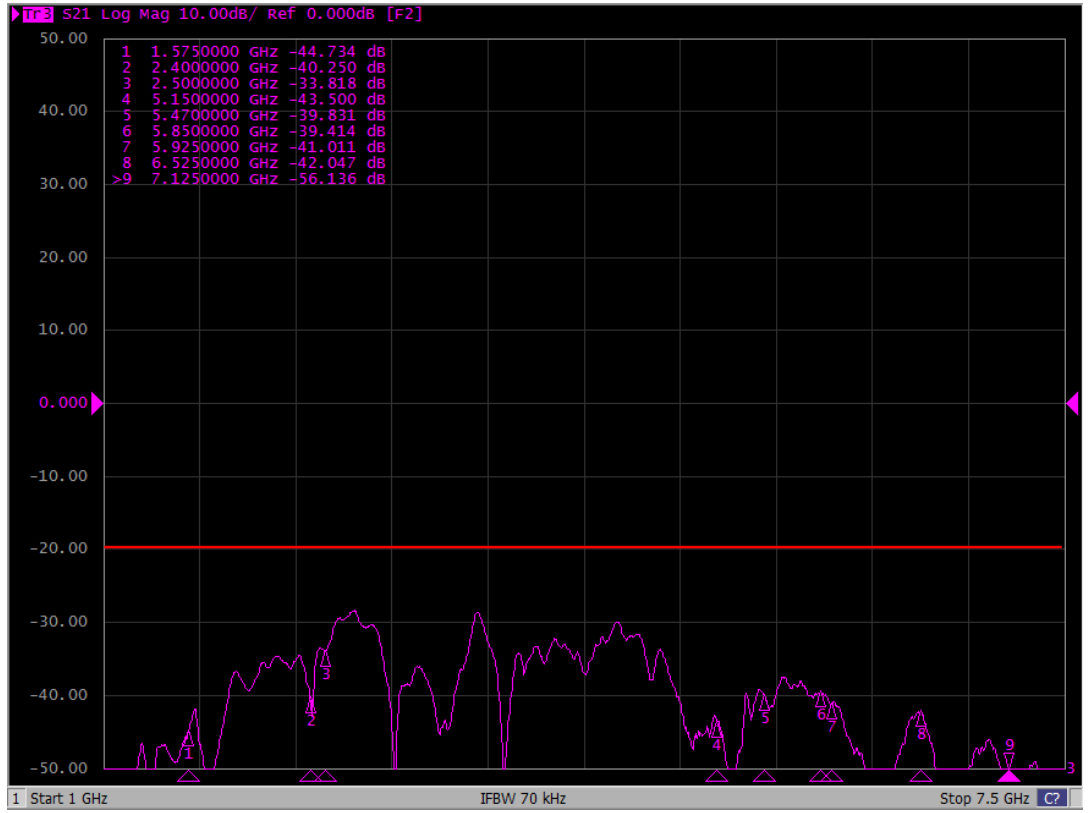
Isolation Results

6G3&BT



6G4&BT



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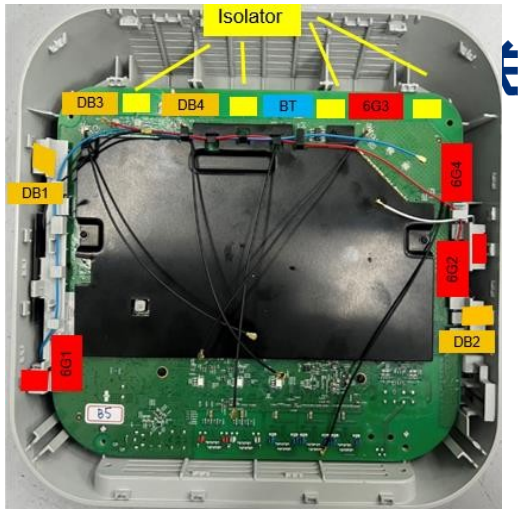
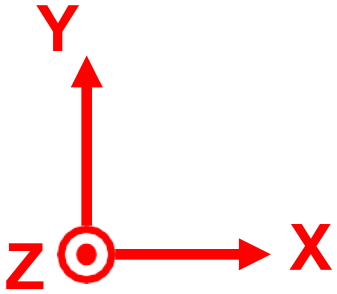
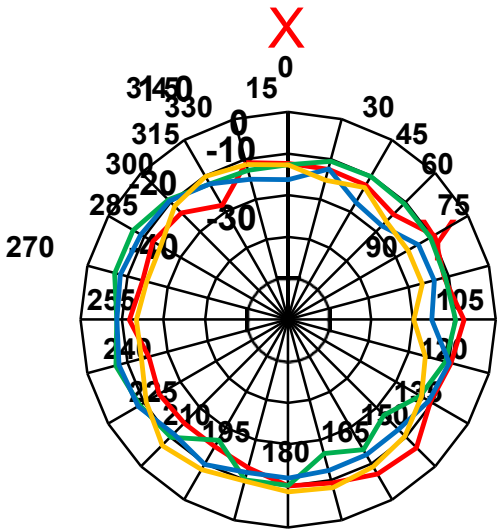
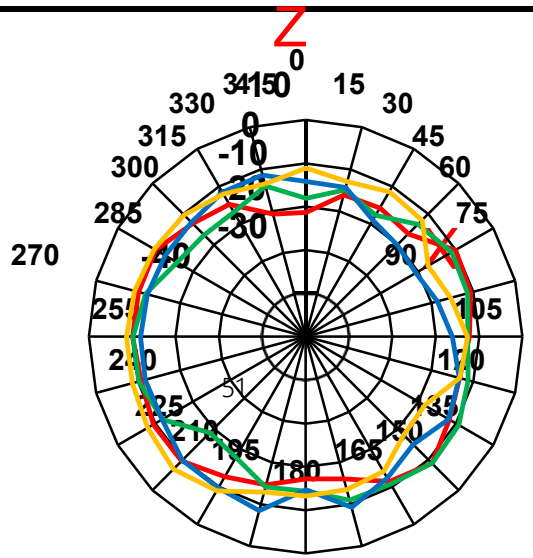
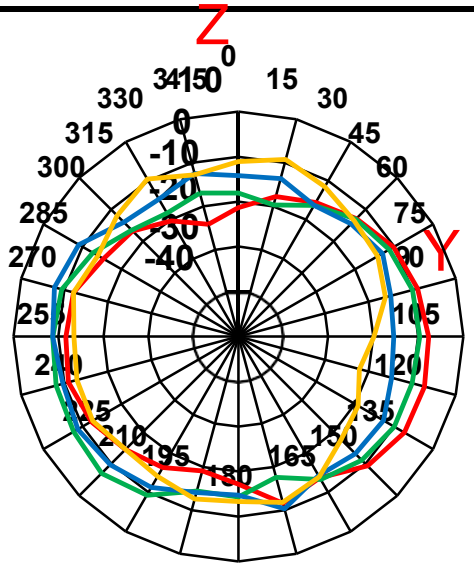
2D Radiation Pattern Results

DB1-4 – 2450MHz





X-Y plane	X-Z plane	YZ plane
		

DB1 DB2 DB3 DB4

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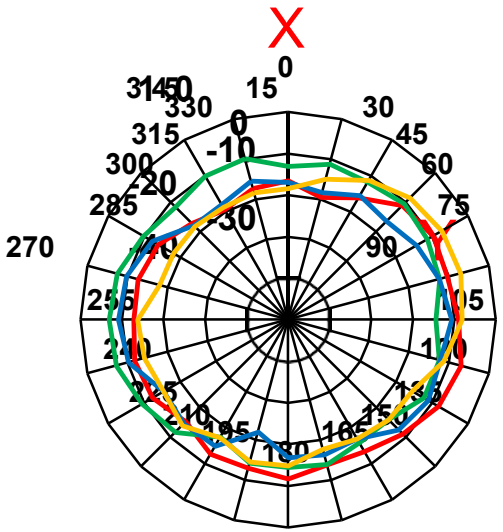
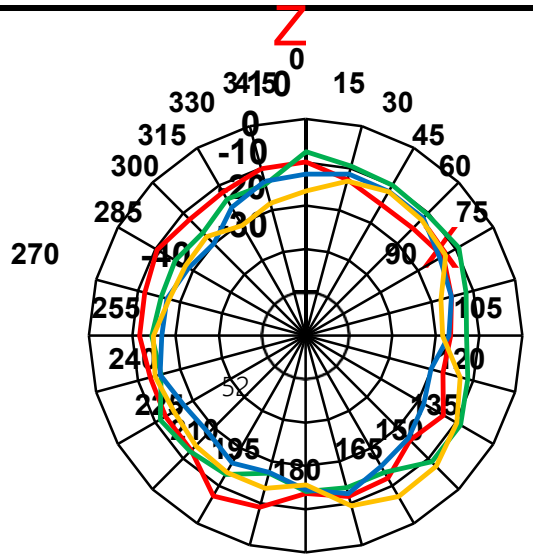
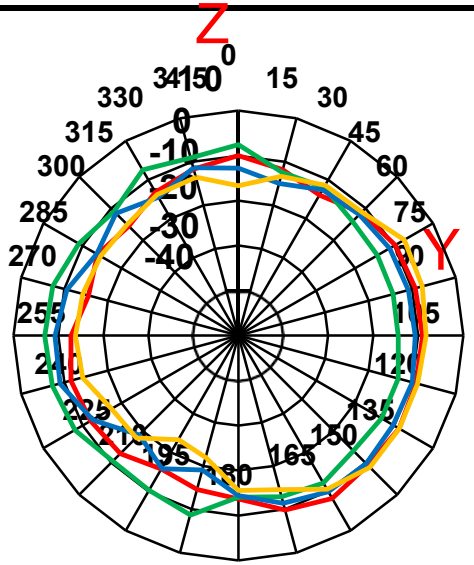
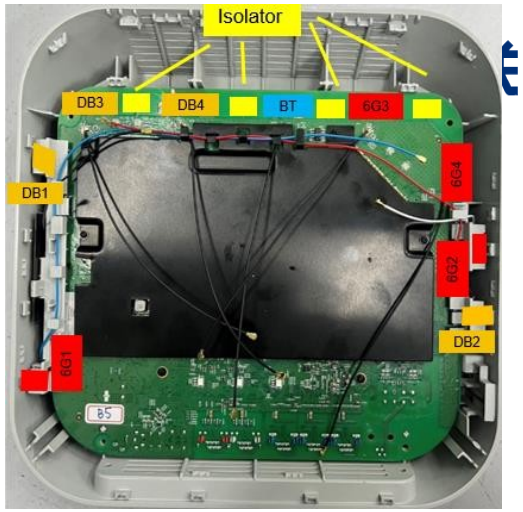
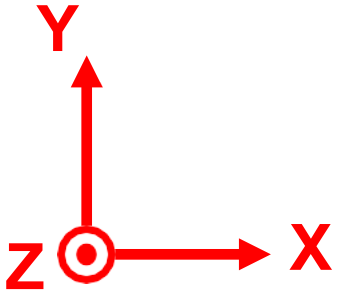
2D Radiation Pattern Results

DB1-4 – 5470MHz

X-Y plane	X-Z plane	YZ plane
		





DB1 DB2 DB3 DB4

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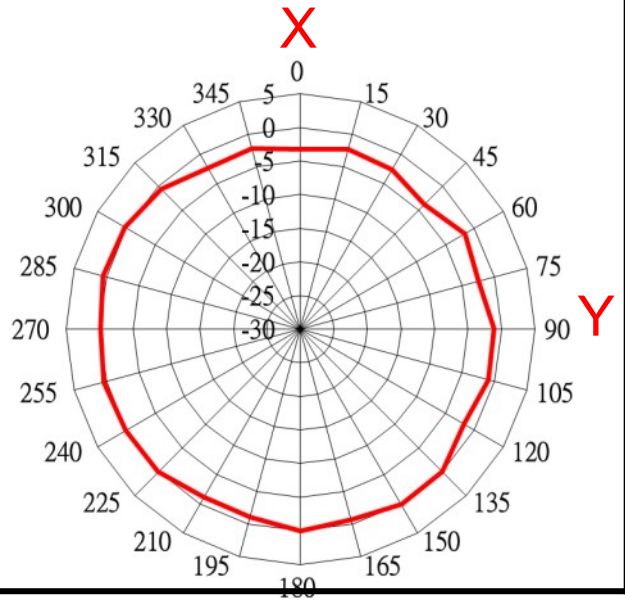
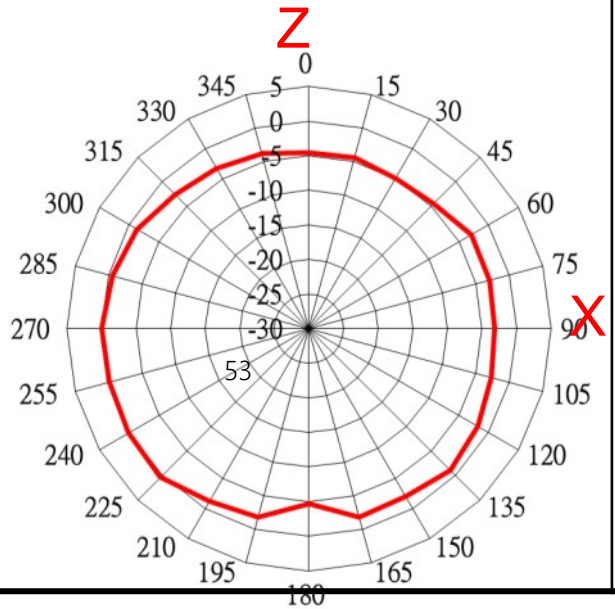
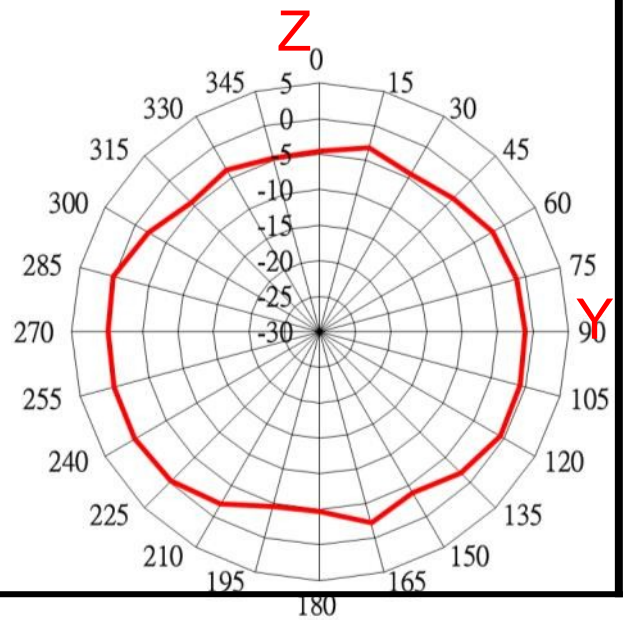
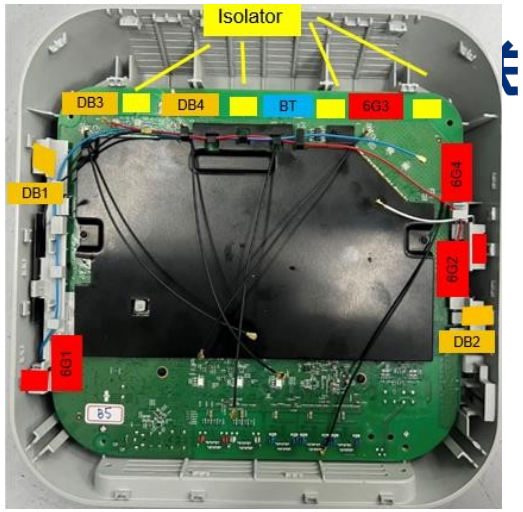
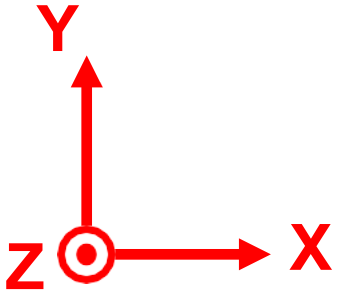
2D Radiation Pattern Results

DB1-4_Uncorrelated – 2450MHz

X-Y plane	X-Z plane	YZ plane
		





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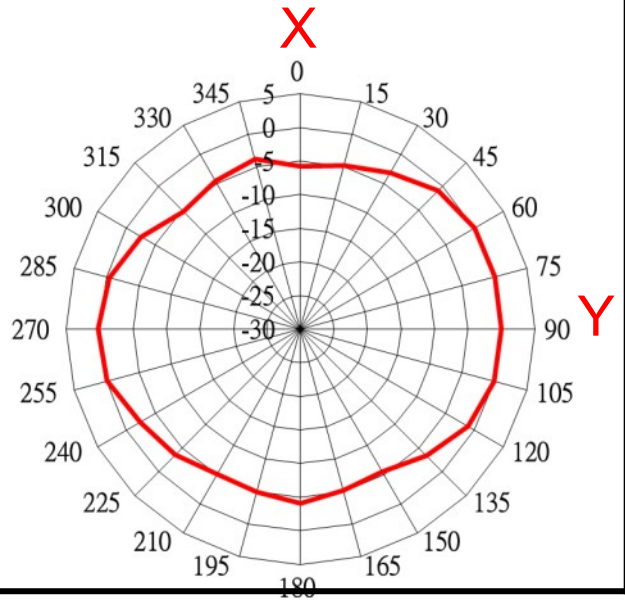
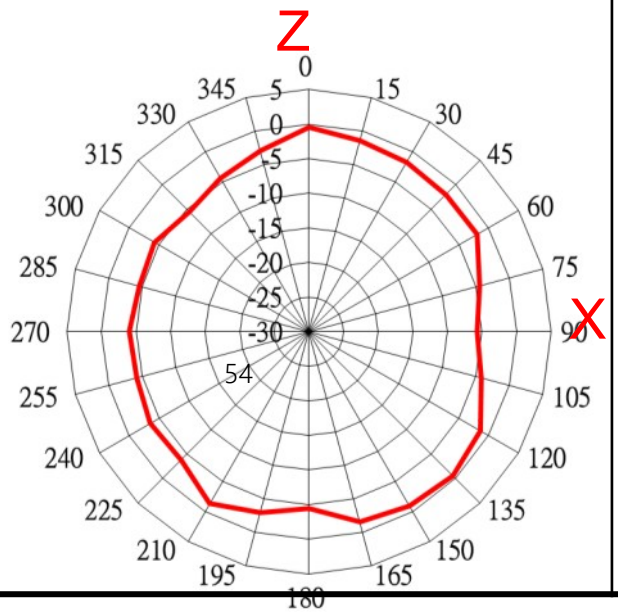
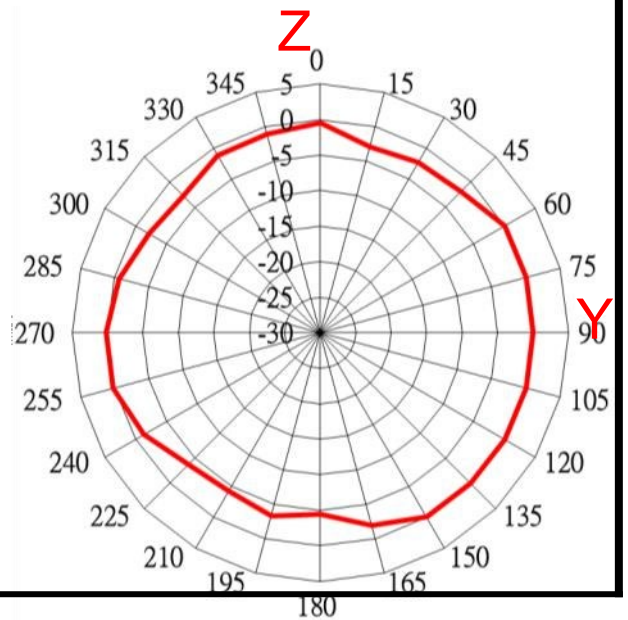
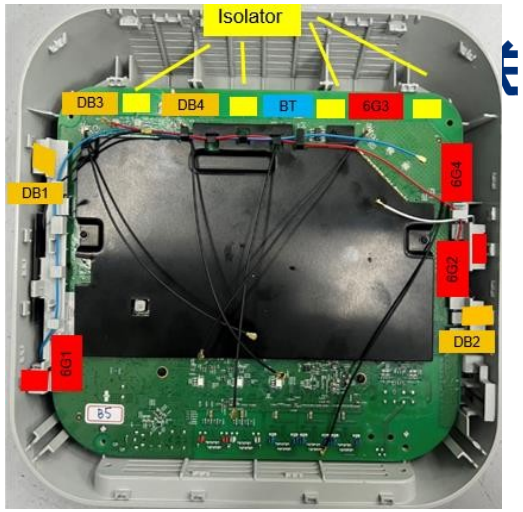
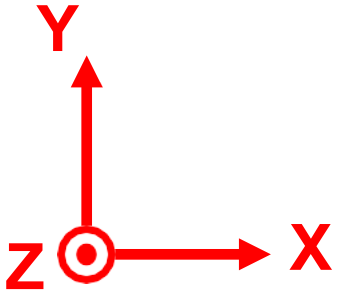
2D Radiation Pattern Results

DB1-4_Uncorrelated – 5470MHz

X-Y plane	X-Z plane	YZ plane
		





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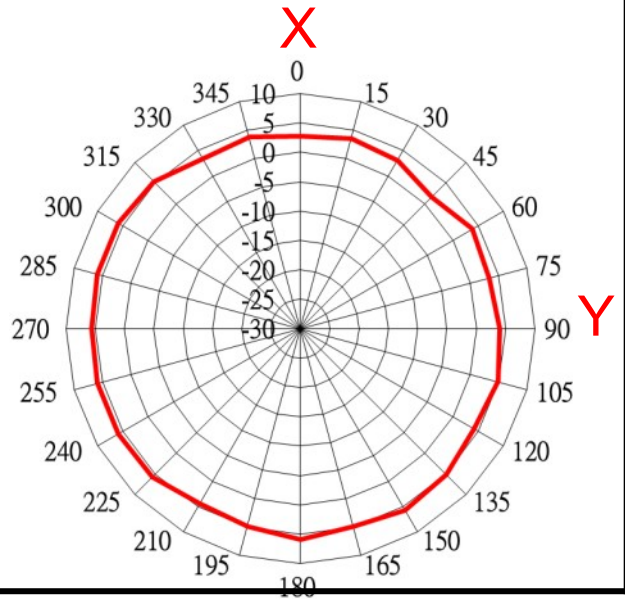
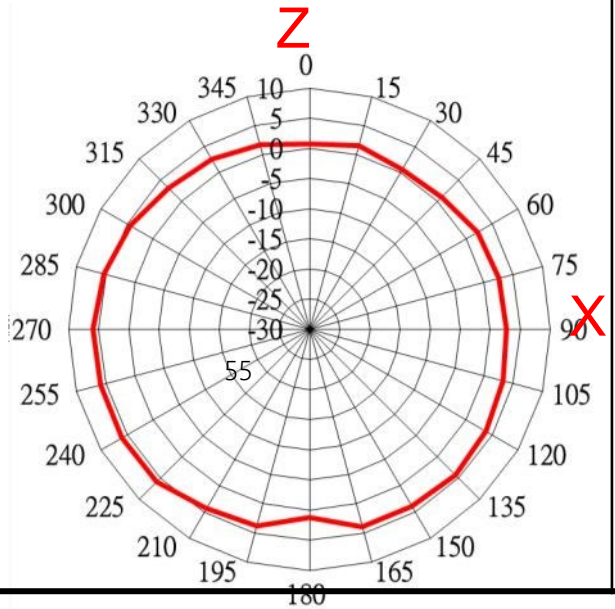
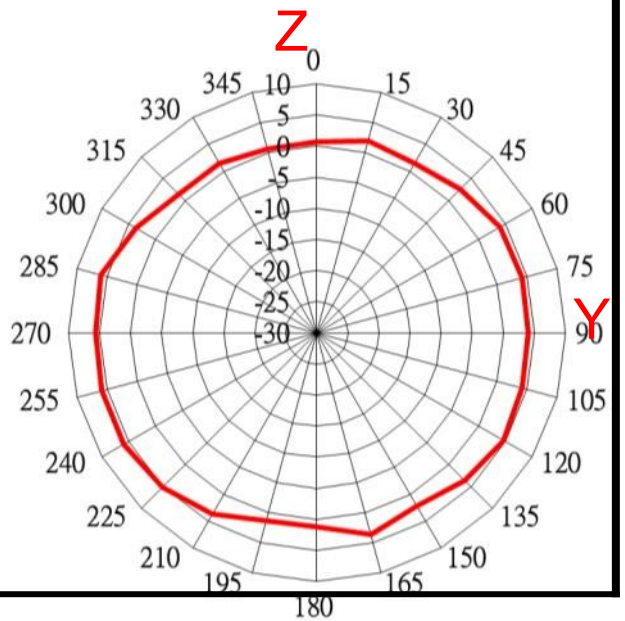
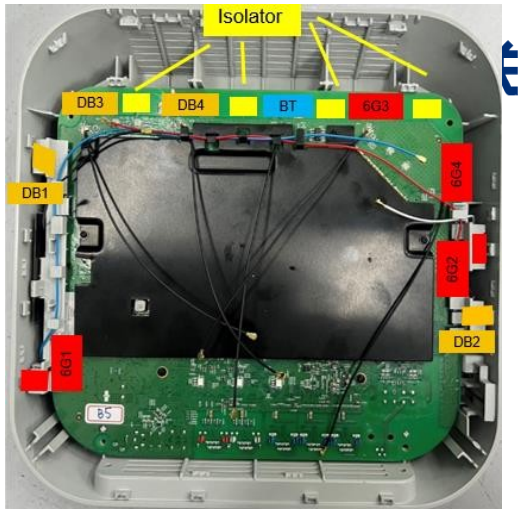
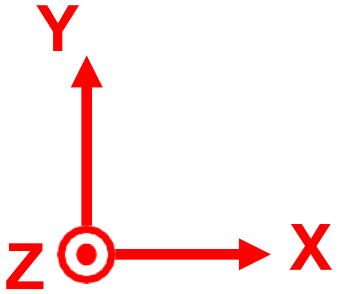
2D Radiation Pattern Results

DB1-4_Correlated – 2450MHz

X-Y plane	X-Z plane	YZ plane
		





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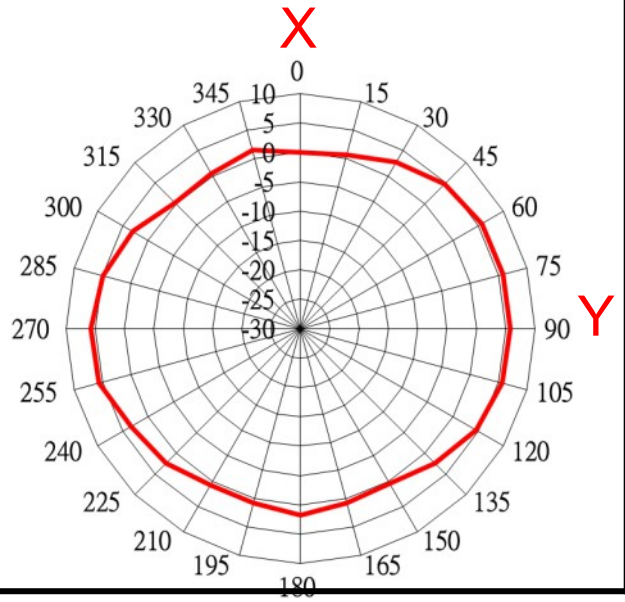
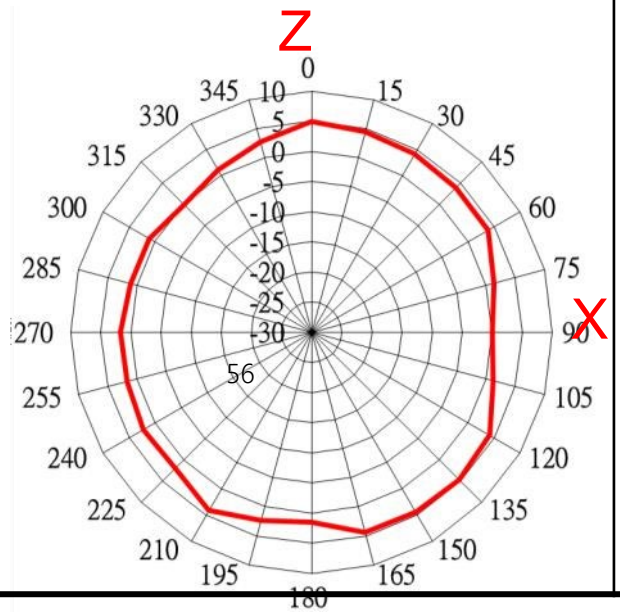
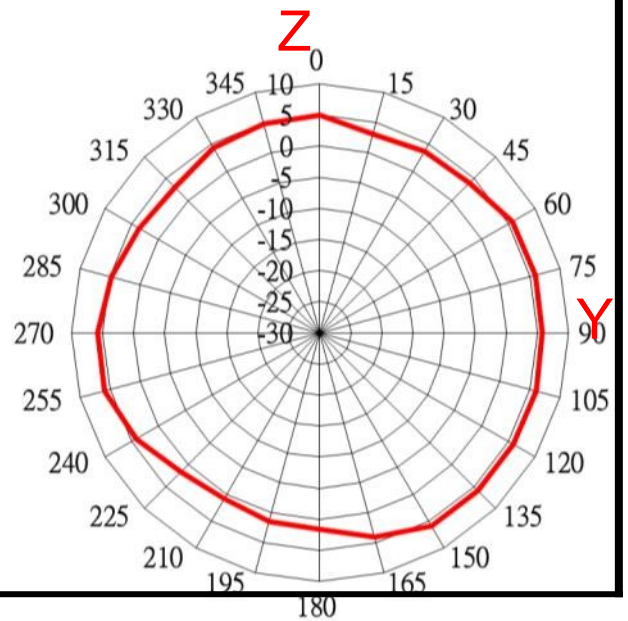
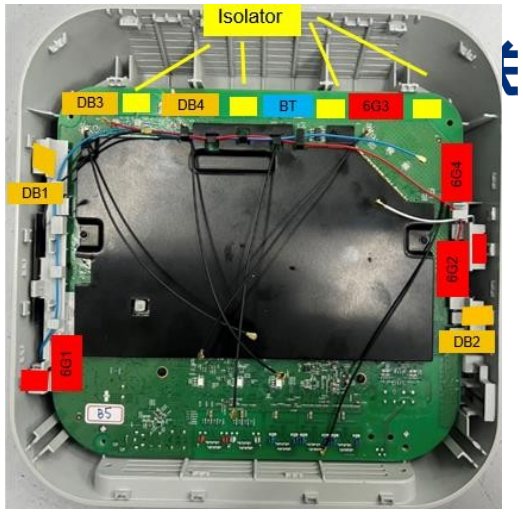
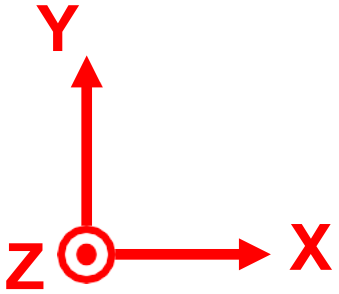
2D Radiation Pattern Results

DB1-4_Correlated – 5470MHz

X-Y plane	X-Z plane	YZ plane
		





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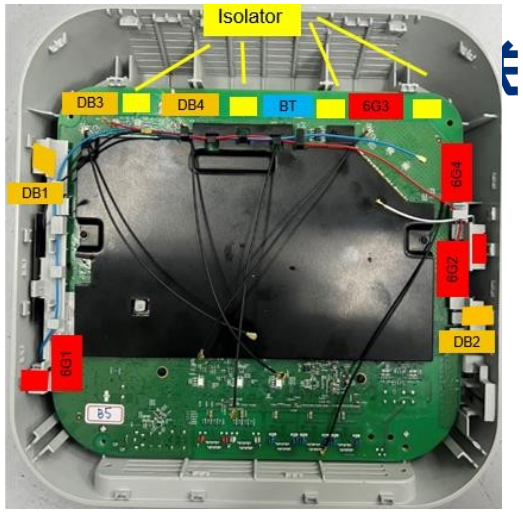
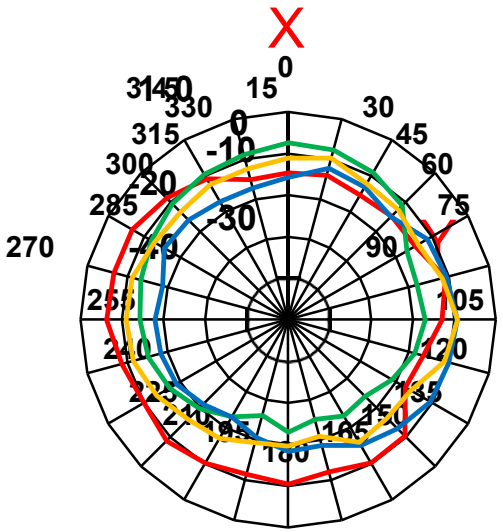
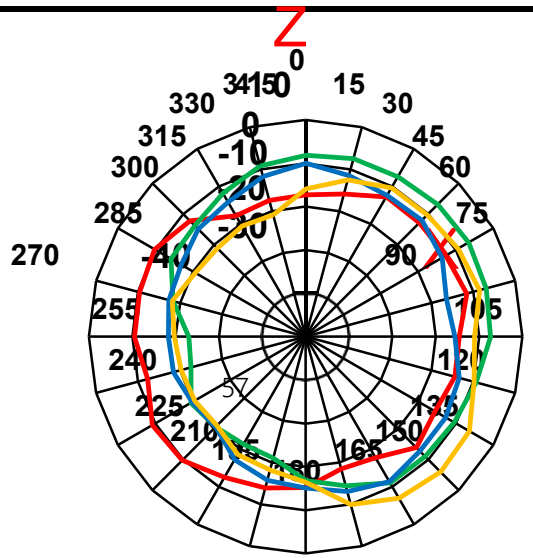
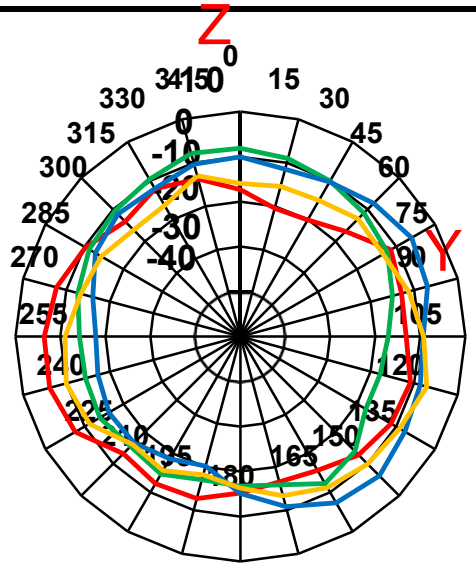
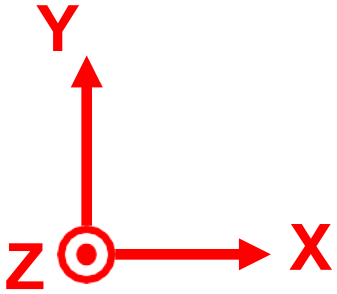
2D Radiation Pattern Results

6G1-4 – 6525MHz



X-Y plane	X-Z plane	YZ plane
		



6G1 6G2 6G3 6G4

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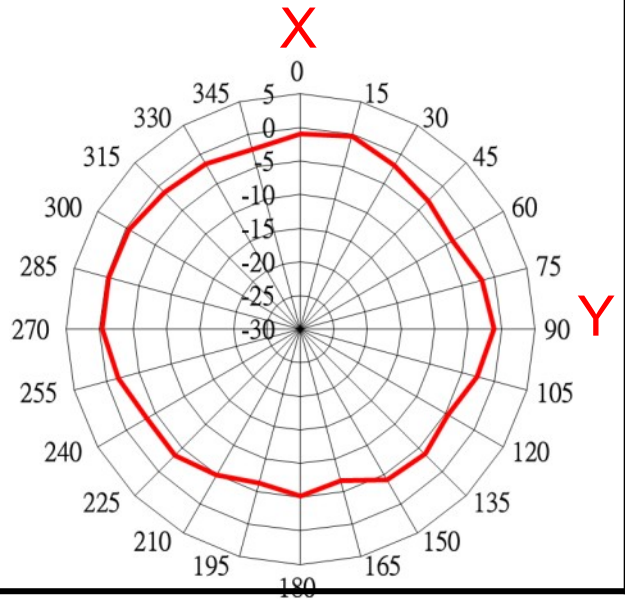
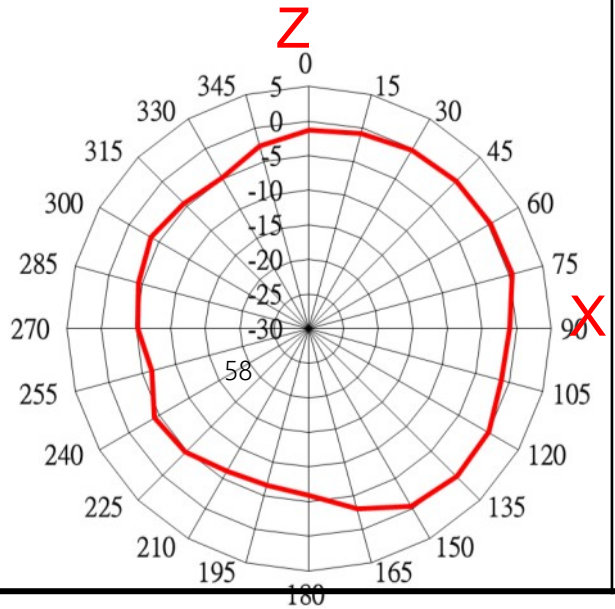
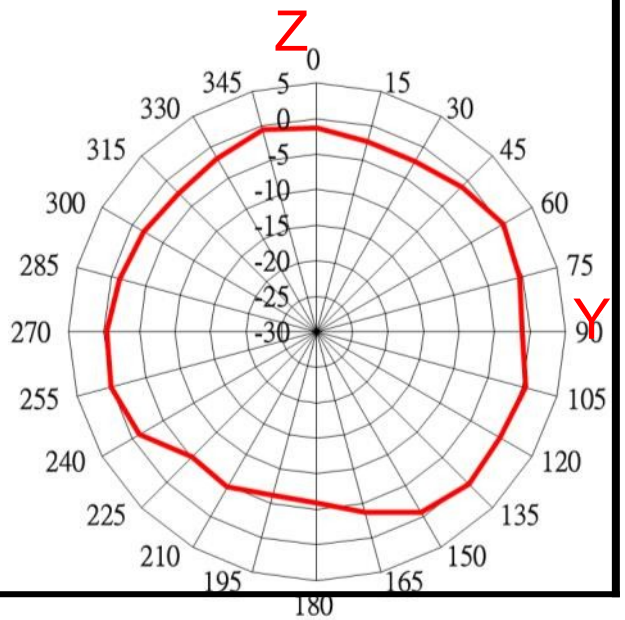
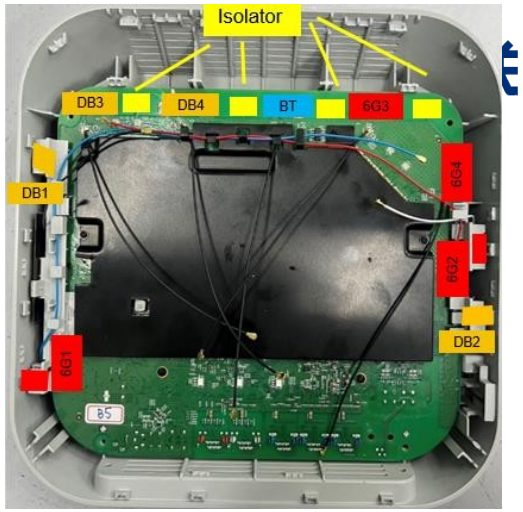
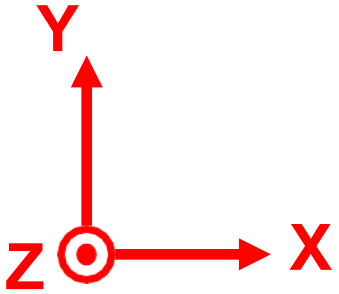
2D Radiation Pattern Results

6G1-4_Uncorrelated – 6525MHz

X-Y plane	X-Z plane	YZ plane
		





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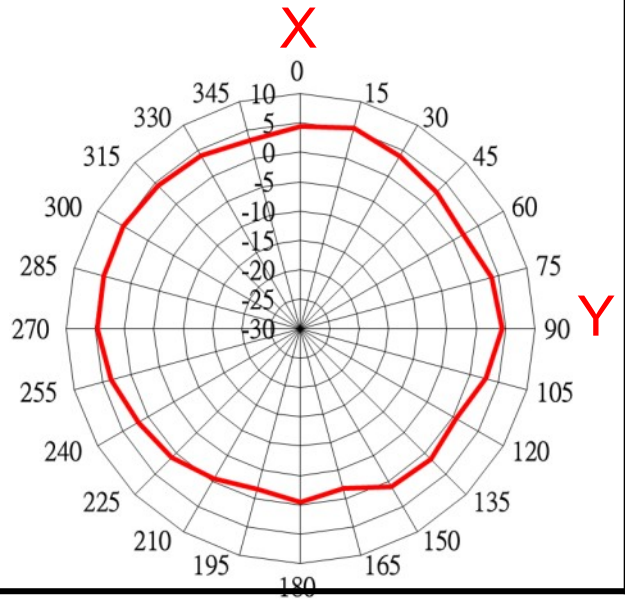
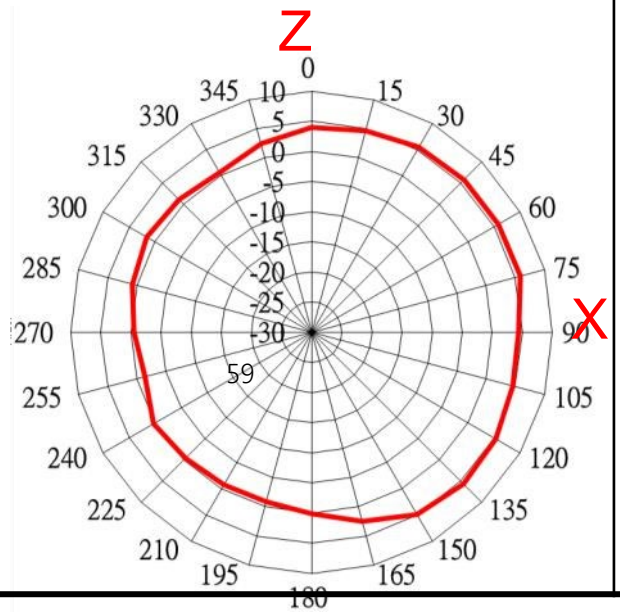
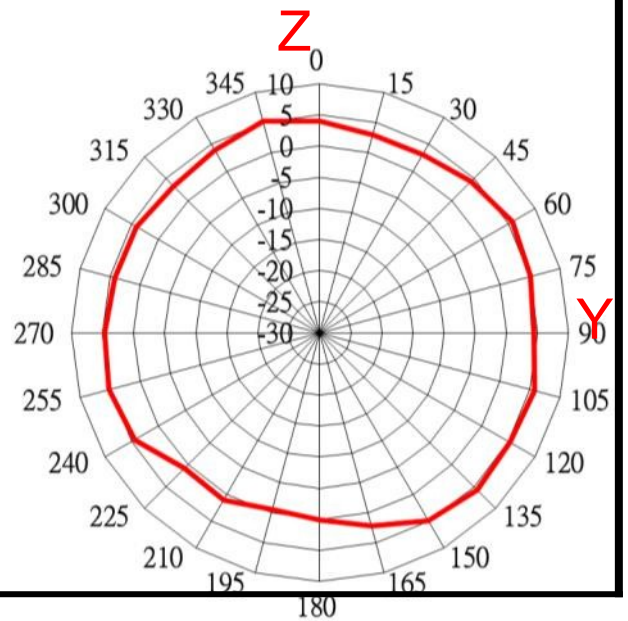
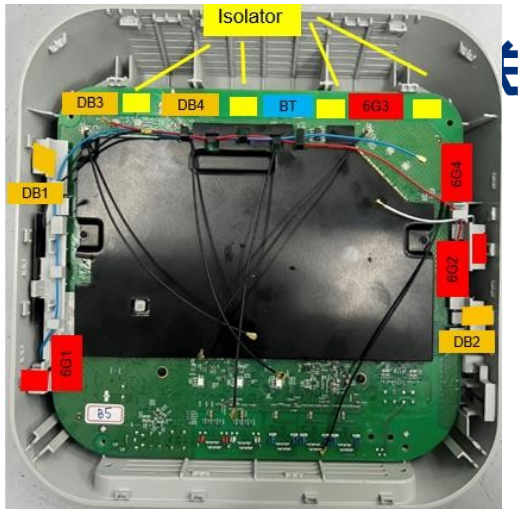
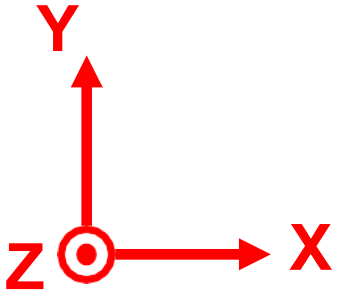
2D Radiation Pattern Results

6G1-4_Correlated – 6525MHz

X-Y plane	X-Z plane	YZ plane
		





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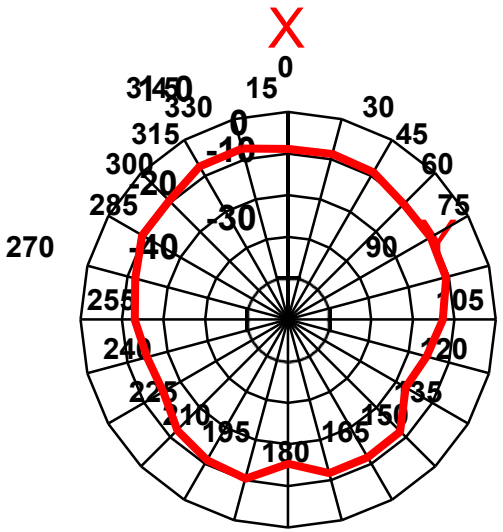
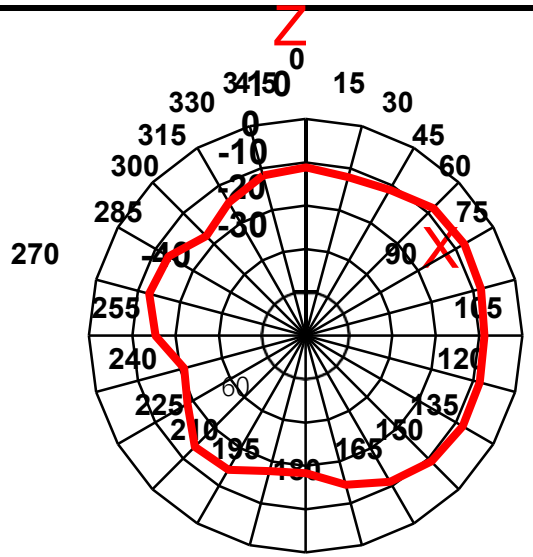
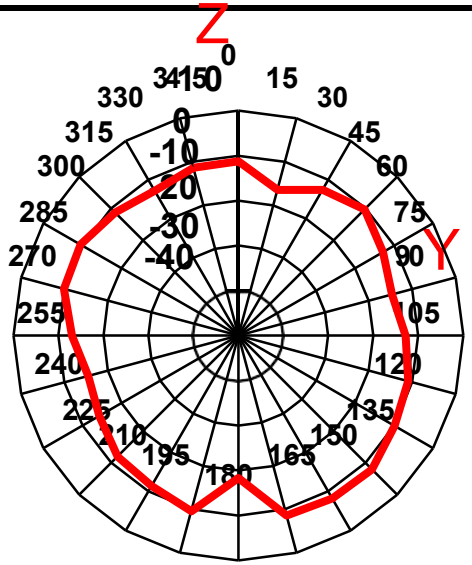
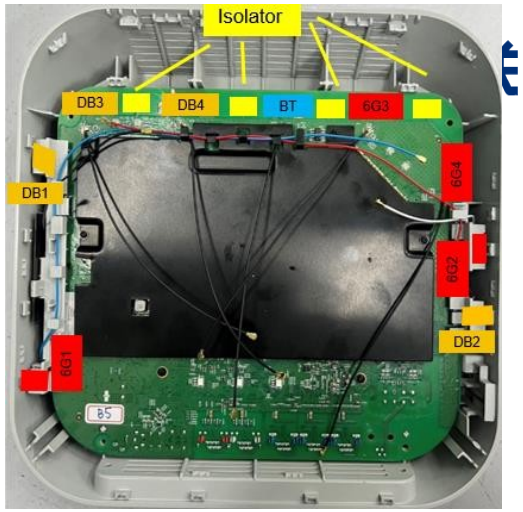
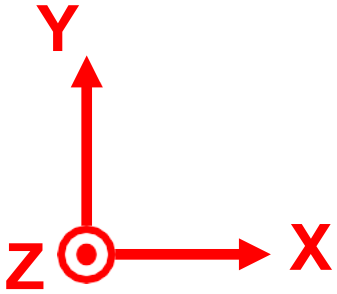
2D Radiation Pattern Results

BT –2450MHz

X-Y plane	X-Z plane	YZ plane
		





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