

Nile Global 台達電 (Indoor)

Version: V 2.09

Released Date: 2022/07/20

Test Date: 2022/07/20

Test Personnel: David

Prepared By: David

Reviewed By: Stone



WHA YU INDUSTRIAL CO., LTD.

No. 326, Sec. 2, Gongdao 5th Rd.,

Hsinchu City 300043, Taiwan

TEL: +886-3-5714225 FAX: +886-3-5713853

web: www.whayu.com

Contents

- Revised History
- Conclusion & Comments
- Specification
- Antenna Placement & Solution
- Test Setup for S-parameter Measurement
- Return Loss Results
- Isolation Results
- Test Setup for Radiation Pattern Measurement
- 2D Radiation Pattern Results
- Results Summary (return loss, isolation, peak gain, efficiency)

Revision History

Released Date	Version	Record
2021/06/02	V1.01	Dual Band*4 , Tri Band*2 , 6G*4 , BT*1 antennas first simulated report.
2021/06/10	V1.02	The size of the antenna carrier plate is changed to 240mm*240mm and the Peak Gain needs to be less than 6 dBi.
2021/06/25	V1.03	Change the DB2 antenna position.
2021/07/20	V1.04	Change the antennas cable routing and antennas design.
2021/09/27	V1.05	Customer ID change, antennas re-simulated.
2021/12/23	V2.06	Antennas are redesigned in mockup machine.
2022/01/03	V2.07	Increase 5895MHz testing frequency.
2022/03/23	V2.08	Customer ID change, antennas re-design.
2022/07/20	V2.09	Antennas are designed in machine.

Summary & Comments

Antenna Performance Summary

- Meet specification.

Comments for Further Improvement

- To be confirmed by the customer.

Specification

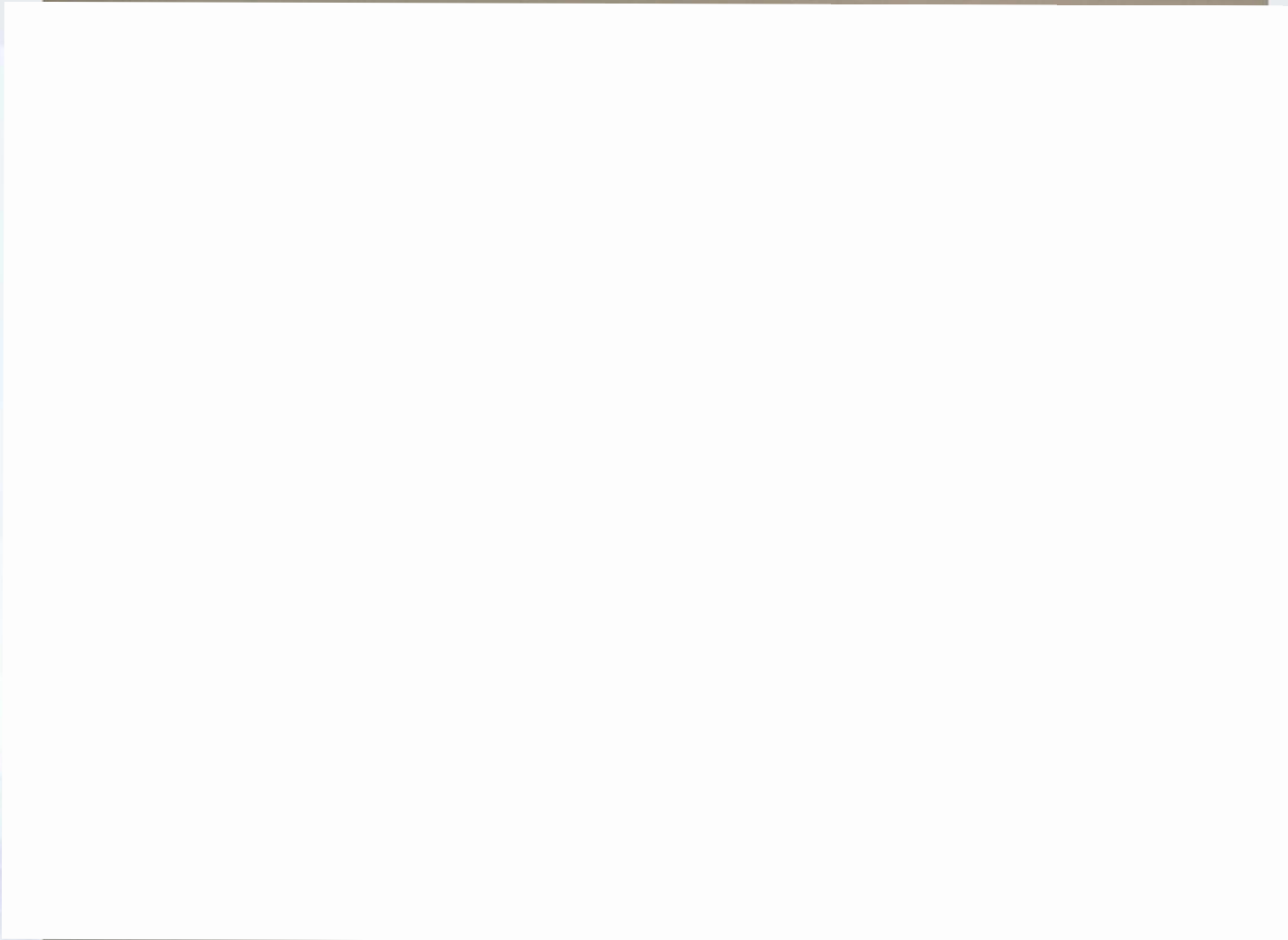
Requirements of Antenna Design

RF Function	Number of ANT	Frequency Band	Remark
Dual Band	4	2G:2400-2500(MHz)/5G:5150-5895(MHz)	
Tri Band	2	2G:2400-2500(MHz)/5G:5150-5895(MHz)/ 6G:5895-7125(MHz)	
6G	4	5895-7125(MHz)	
BT	1	2400-2500(MHz)	

Requirements of Measurement

Test Item	Specification	Remark
Return Loss	> 10dB	
Isolation	2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB	
Peak gain	<7.7dBi for 2.4GHz <7.6dBi for 5GHz <7.5dBi for 6GHz	

Antenna Placement & Solution

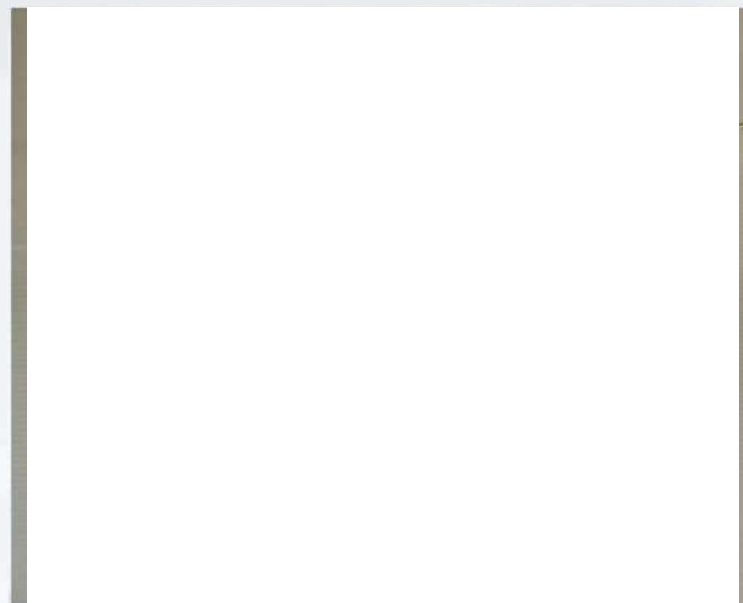


WHA YU INDUSTRIAL CO., LTD.

No. 326, Sec. 2, Gongdao 5th Rd.,
Hsinchu City 300043, Taiwan

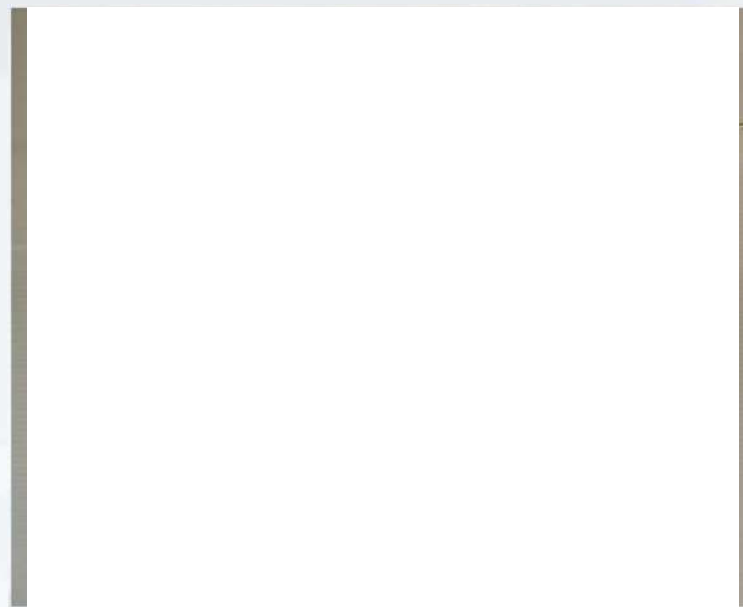
TEL: +886-3-5714225 FAX: +886-3-5713853
web: www.whayu.com

Antenna Placement & Solution



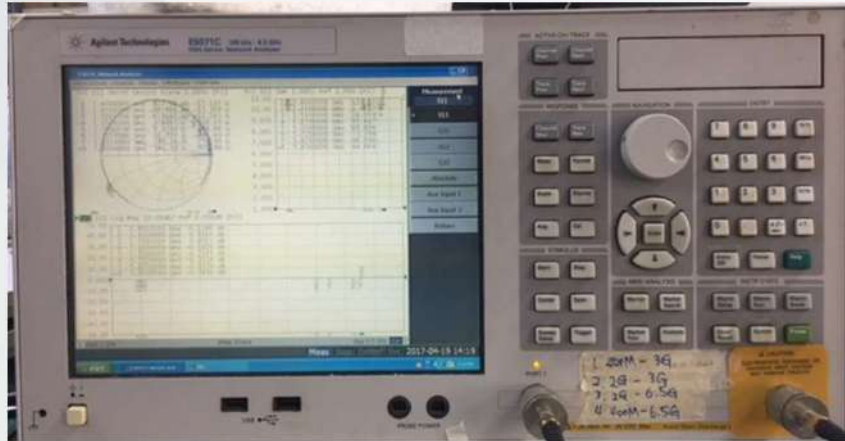
Antenna	ANT Type	Size (L * W * H)	Cable Length (mm)	Cable Type
TB1	Pifa ANT	36.3mm*13mm*13.9mm(T=0.4)	87(Exposed from Antenna : 67)	Φ=1.13 low loss
TB2	Pifa ANT	36.3mm*13mm*13.9mm(T=0.4)	259(Exposed from Antenna : 239)	Φ=1.13 low loss
BT	Pifa ANT	38.2mm*10mm*8.8mm(T=0.4)	167(Exposed from Antenna : 147)	Φ=1.13 low loss
DB1	dipole ANT	52mm*17.3mm*1mm(H=16)	257(Exposed from Antenna : 250)	Φ=1.13 low loss
DB2	dipole ANT	52mm*17.3mm*1mm(H=16)	256(Exposed from Antenna : 249)	Φ=1.13 low loss
DB3	dipole ANT	52mm*17.3mm*1mm(H=16)	77(Exposed from Antenna : 70)	Φ=1.13 low loss
DB4	dipole ANT	52mm*17.3mm*1mm(H=16)	144(Exposed from Antenna : 137)	Φ=1.13 low loss

Antenna Placement & Solution



Antenna	ANT Type	Size (L * W * H)	Cable Length (mm)	Cable Type
6G1	dipole ANT	29.3mm*8.5mm*1mm(H=13)	213(Exposed from Antenna : 209)	$\Phi=1.13$ low loss
6G2	dipole ANT	29.3mm*8.5mm*1mm(H=13)	85(Exposed from Antenna : 81)	$\Phi=1.13$ low loss
6G3	dipole ANT	29.3mm*8.5mm*1mm(H=13)	235(Exposed from Antenna : 231)	$\Phi=1.13$ low loss
6G4	dipole ANT	29.3mm*8.5mm*1mm(H=13)	348(Exposed from Antenna : 344)	$\Phi=1.13$ low loss

Test Setup for S-parameter Measurement



Equipment	Brand	Model	S/N
Network Analyzer	Keysight	E5071C	MY46107744

Calibration date: 2021.11.12

Calibration due date: 2023.11.12

Antenna

RF Cable with I-PEX
conn.

Network Analyzer

Test Setup for S-parameter Measurement

Step 1

Configure the Network Analyzer

- Turn on the network analyzer
- Perform initialization
- Setting the appropriate frequency range and measurement parameters.

Step 2

Calibrate the Network

- Before starting the test, calibrate to eliminate the inherent response of the test system.
- Perform full open, full short, and full load calibration, as well as calibration of the reference plane.

Step 3

Set the Test Parameters

- Set the desired test parameters on the network analyzer. This typically includes selecting the desired S-parameter type (e.g., S11, S21, etc.), frequency range, and power level.

Step 4

Connect the Antenna

- Properly connect the antenna to the test port of the network analyzer.
- Ensure a secure connection and use suitable adapters and cables to minimize signal loss.

Step 5

Perform the Test

- Begin the S-parameter test of the antenna. This will measure the reflection and transmission characteristics of the antenna within the selected frequency range.

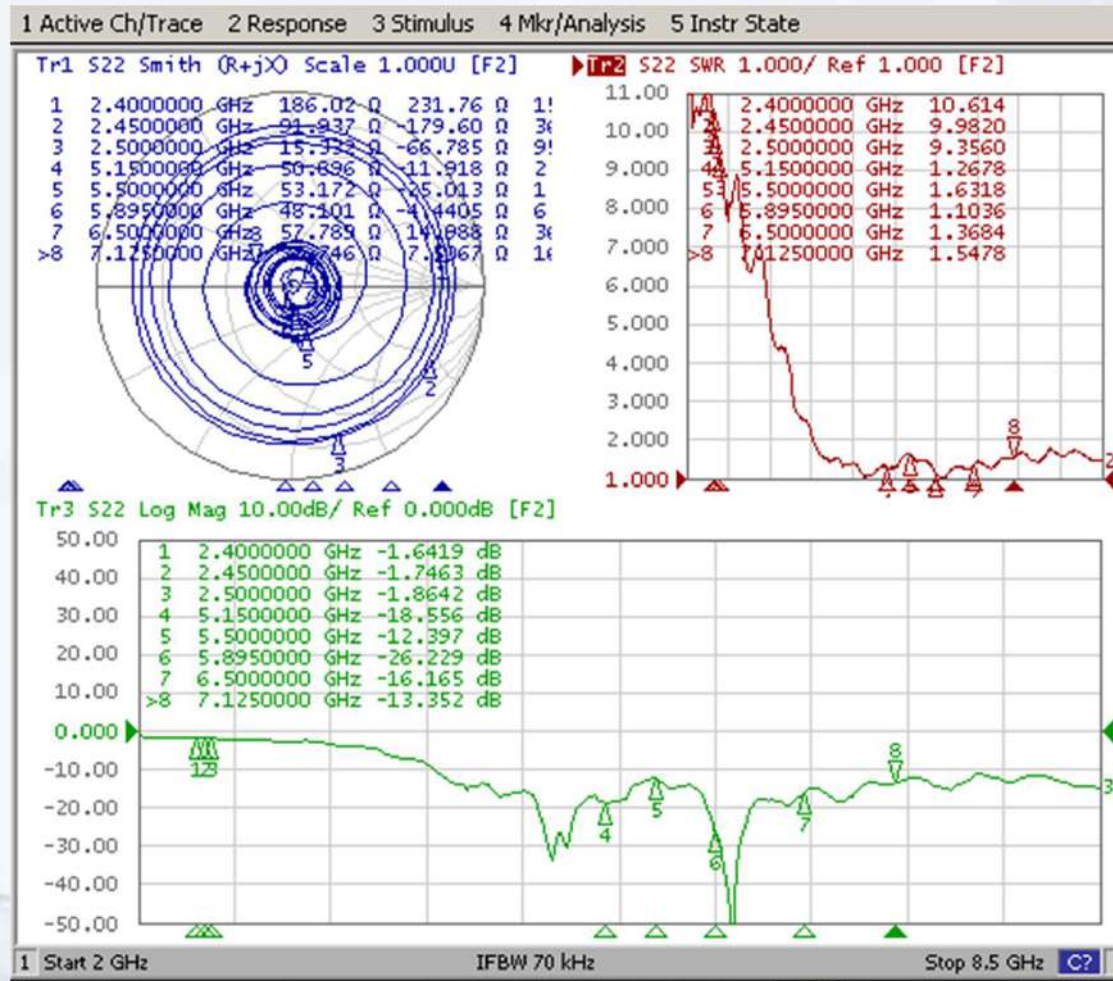
Step 6

Record the Results

- Once the test is completed, record the measurement results. These results are usually presented in the form of graphs or tables for further analysis and comparison.

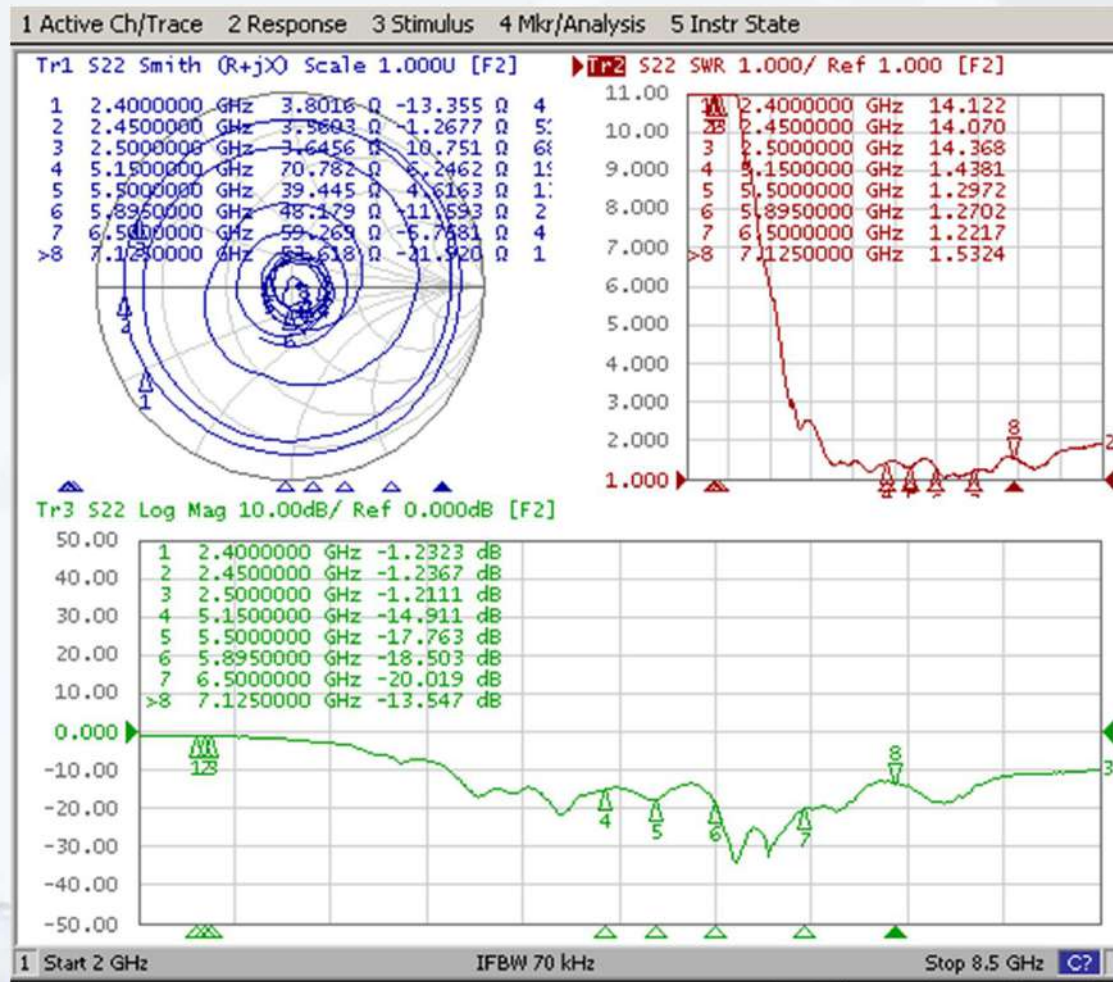
Return Loss Results

6G1(Criterion:>10 dB)



Return Loss Results

6G2(Criterion:>10 dB)



WHA YU INDUSTRIAL CO., LTD.

No. 326, Sec. 2, Gongdao 5th Rd., 12

Hsinchu City 300043, Taiwan

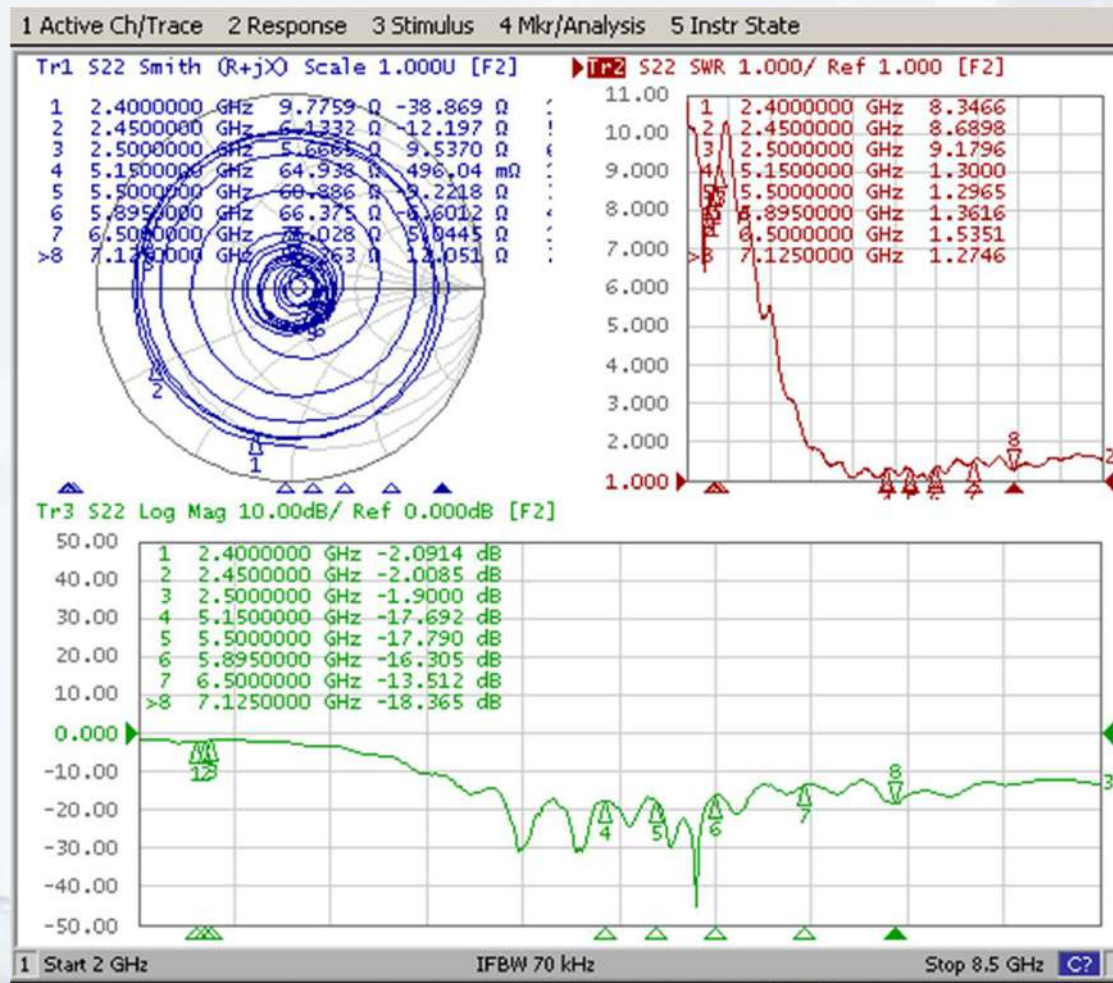
TEL: +886-3-5714225 FAX: +886-3-5713853

web: www.whayu.com



Return Loss Results

6G3(Criterion:>10 dB)



WHA YU INDUSTRIAL CO., LTD.

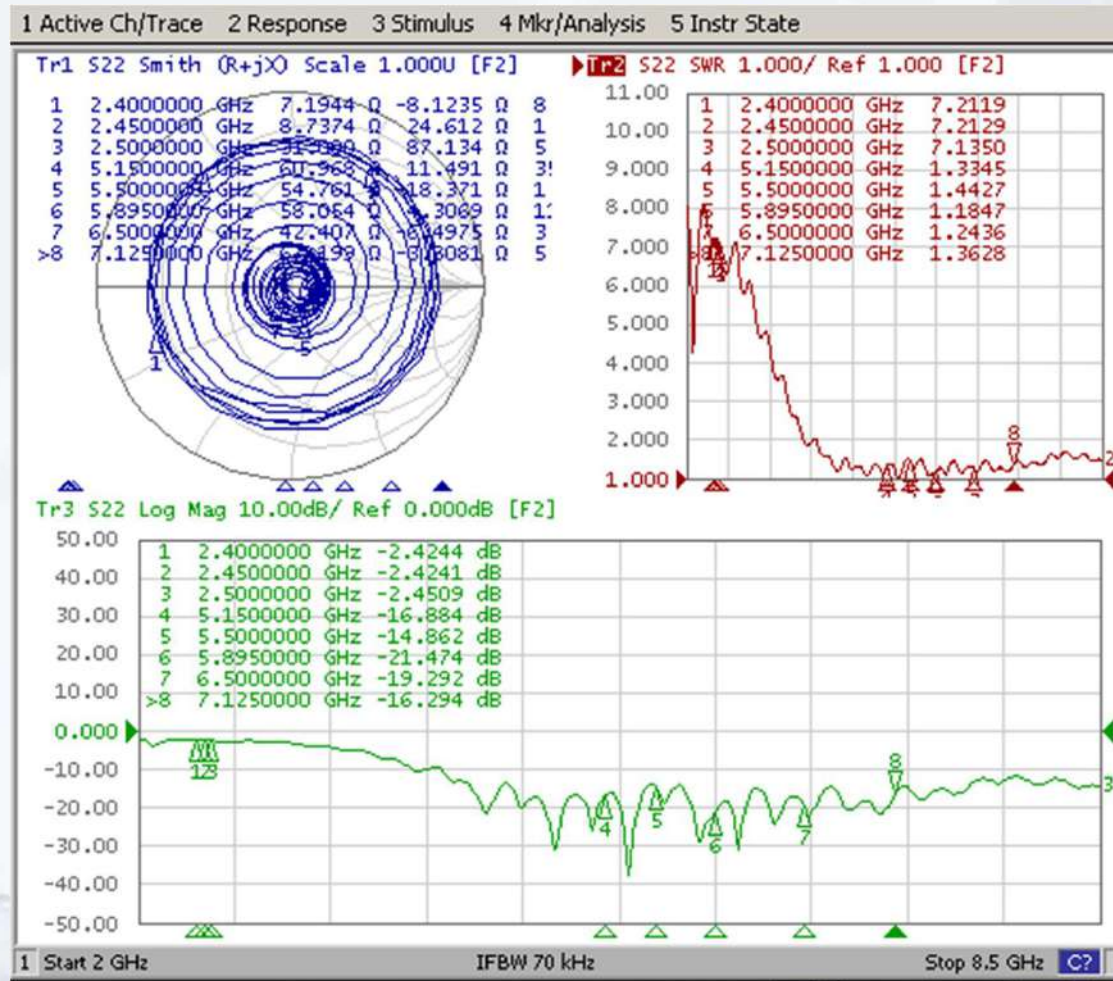
No. 326, Sec. 2, Gongdao 5th Rd., 13
Hsinchu City 300043, Taiwan

TEL: +886-3-5714225 FAX: +886-3-5713853
web: www.whayu.com



Return Loss Results

6G4(Criterion:>10 dB)



WHA YU INDUSTRIAL CO., LTD.

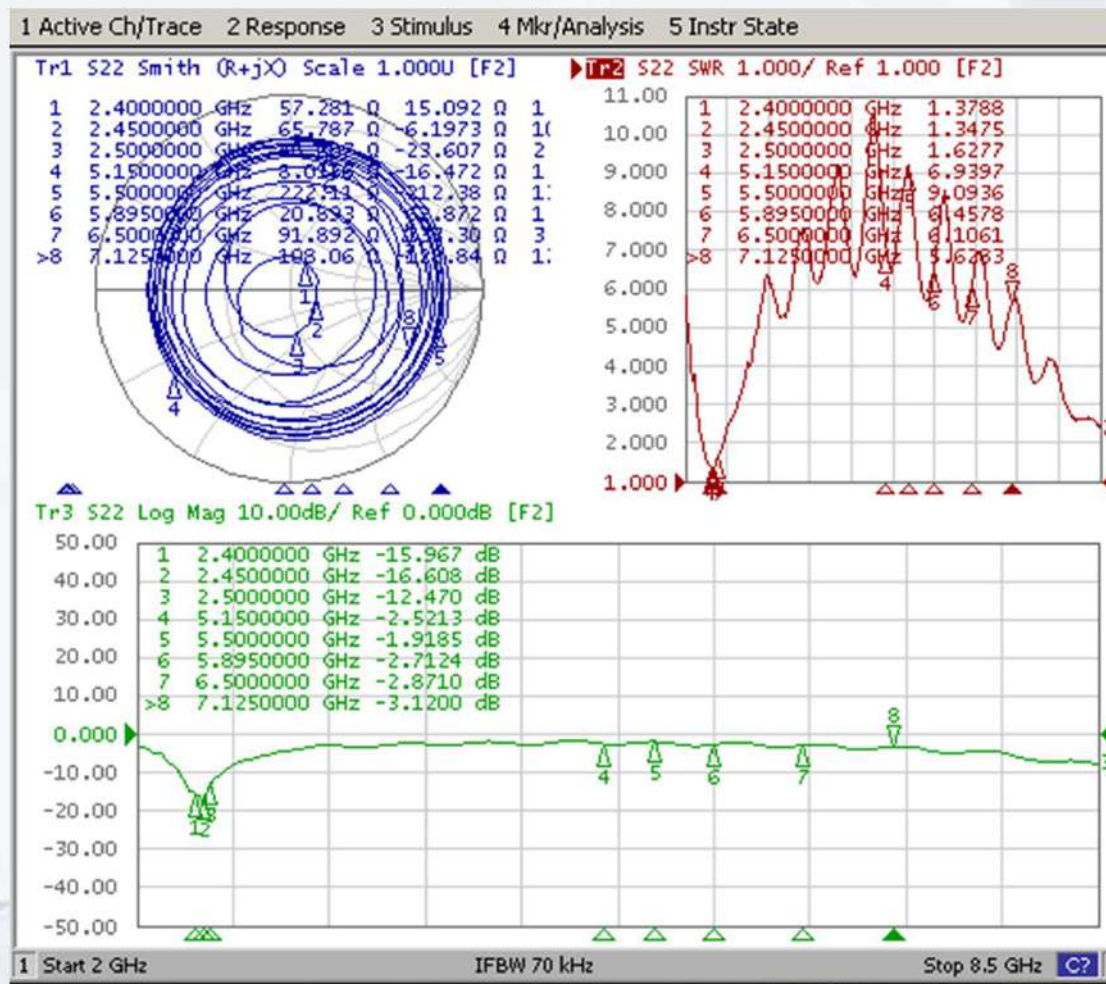
No. 326, Sec. 2, Gongdao 5th Rd., 14
Hsinchu City 300043, Taiwan

TEL: +886-3-5714225 FAX: +886-3-5713853
web: www.whayui.com



Return Loss Results

BT(Criterion:>10 dB)



WHA YU INDUSTRIAL CO., LTD.

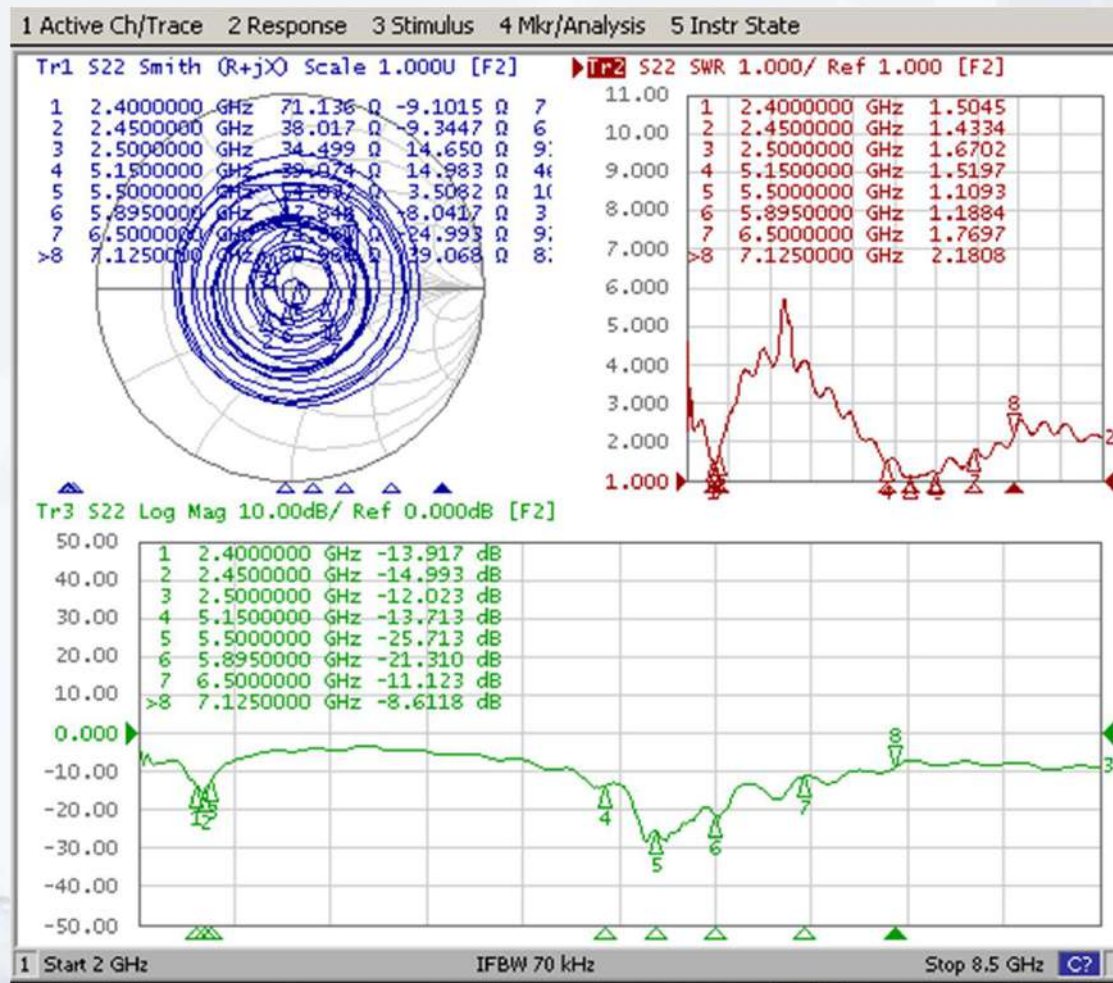
No. 326, Sec. 2, Gongdao 5th Rd., 15
Hsinchu City 300043, Taiwan

TEL: +886-3-5714225 FAX: +886-3-5713853
web: www.whayu.com



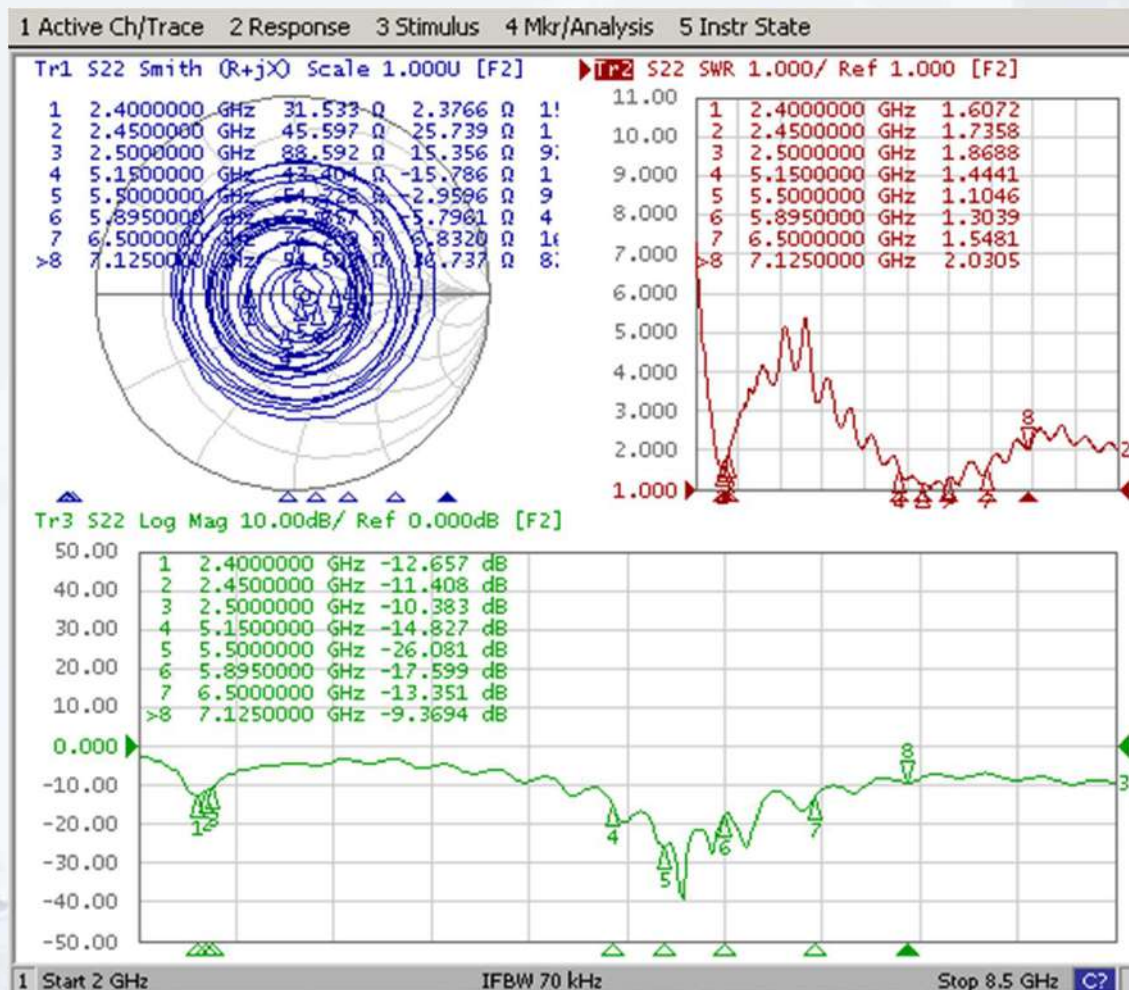
Return Loss Results

DB1(Criterion:>10 dB)



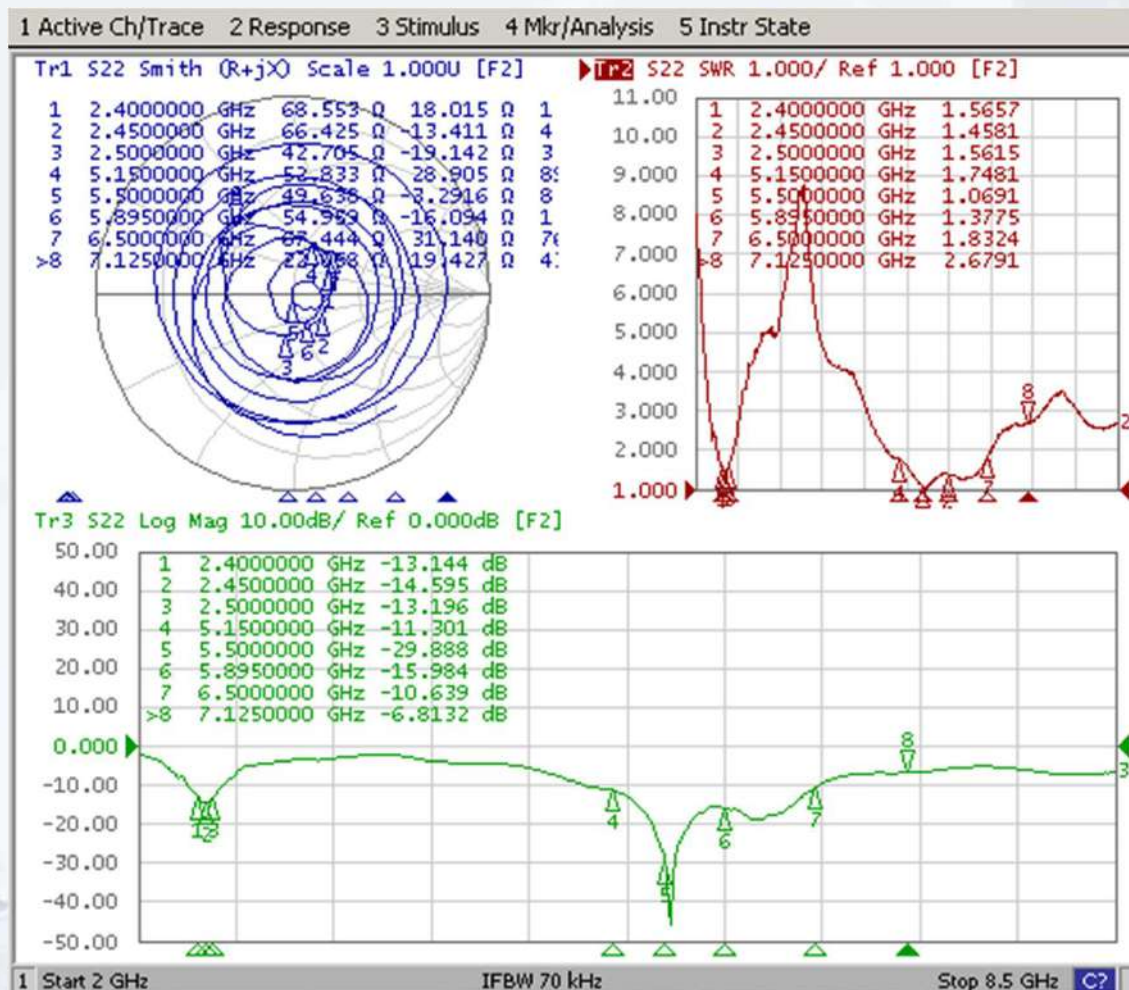
Return Loss Results

DB2(Criterion:>10 dB)



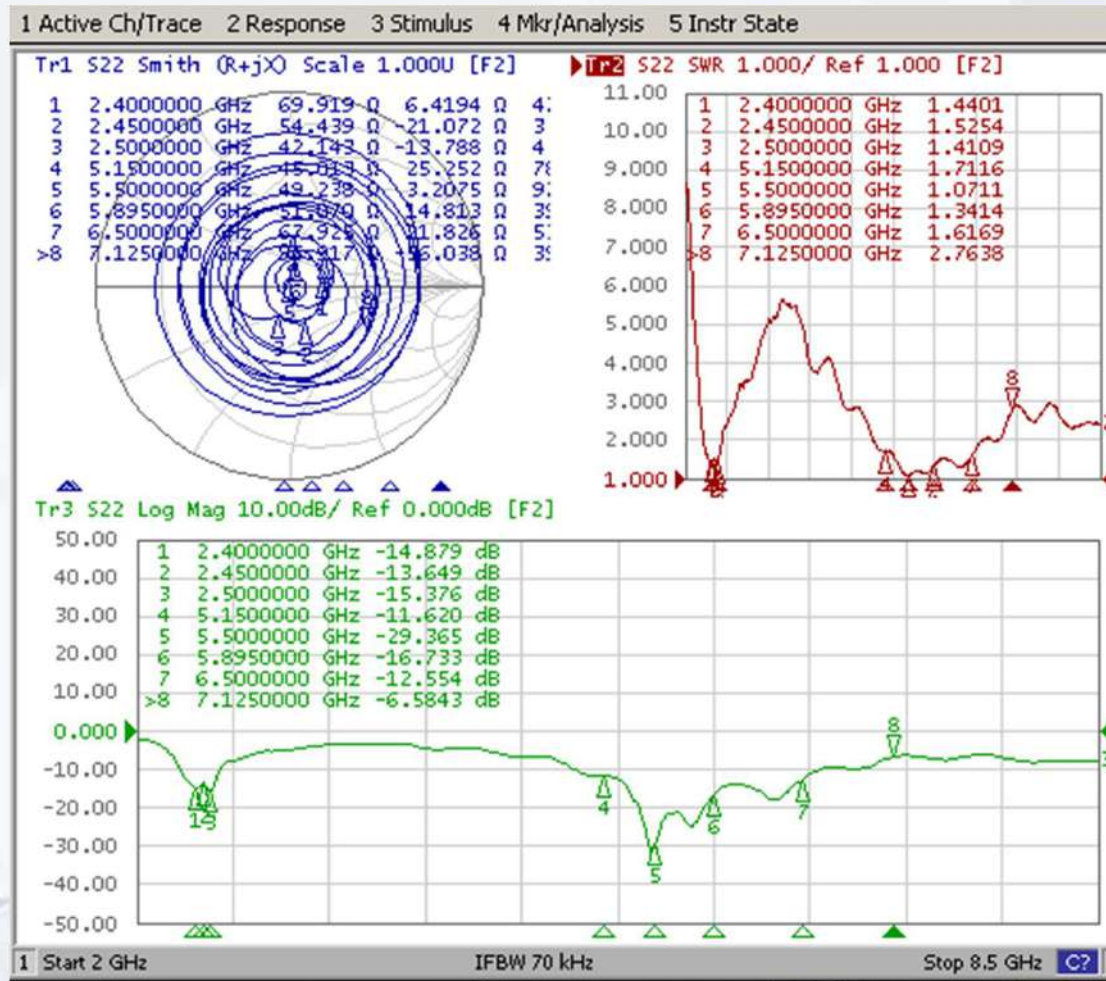
Return Loss Results

DB3(Criterion:>10 dB)



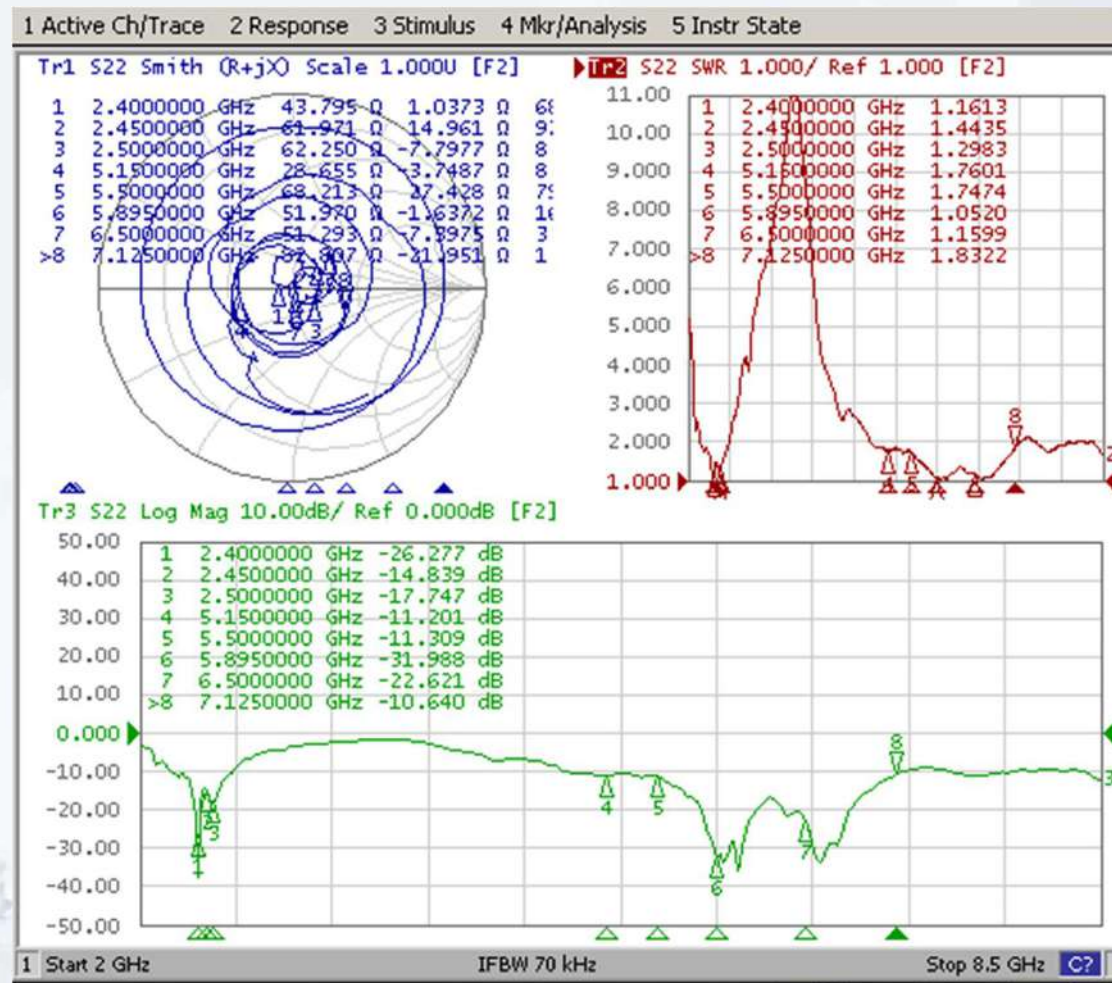
Return Loss Results

DB4(Criterion:>10 dB)



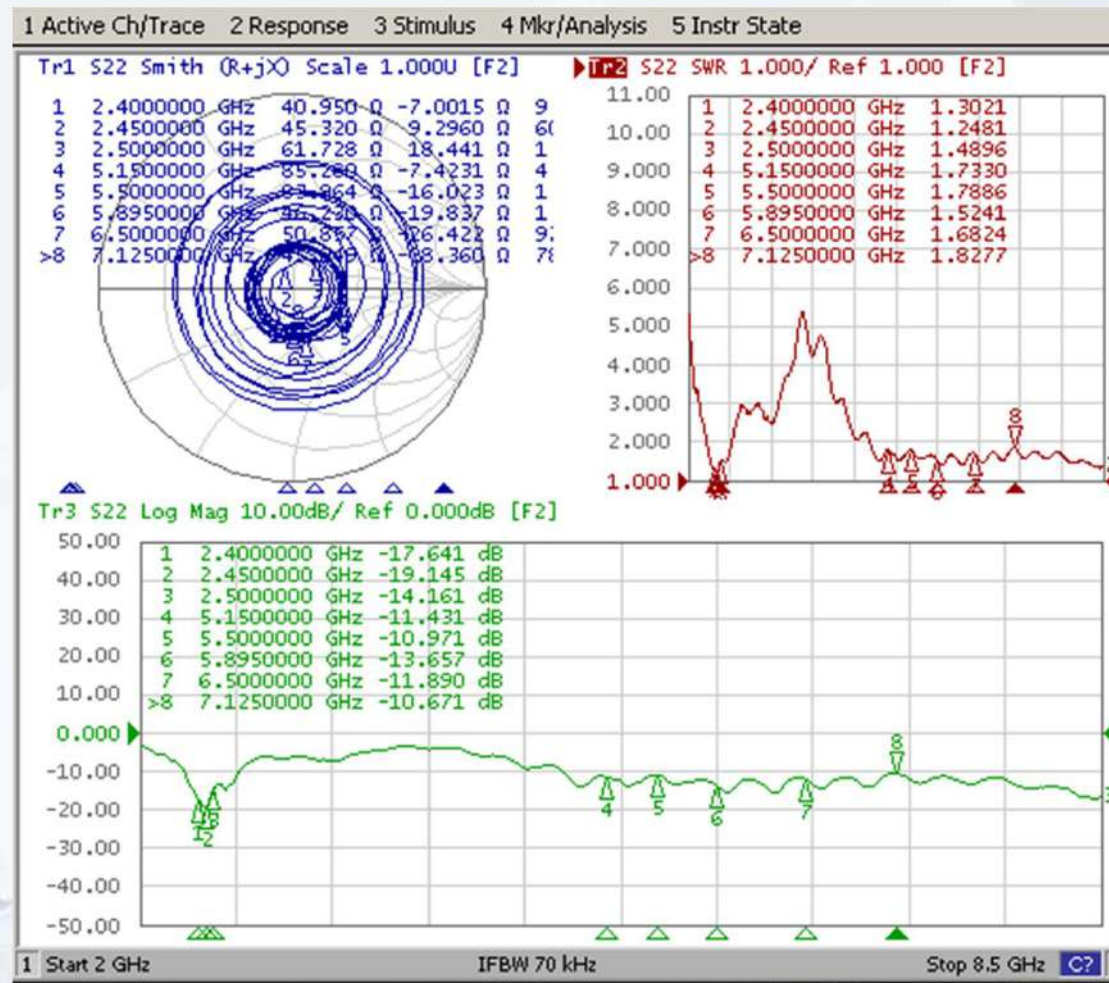
Return Loss Results

TB1(Criterion:>10 dB)



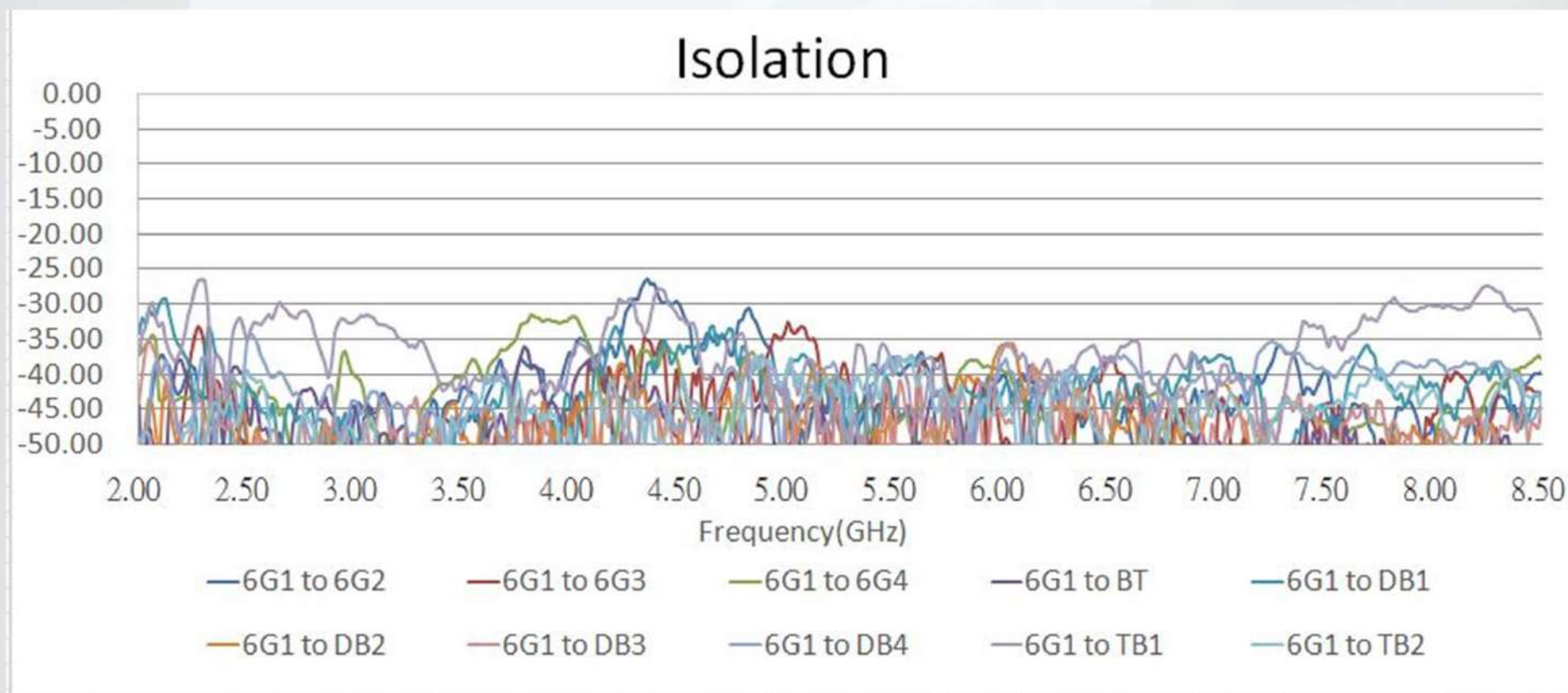
Return Loss Results

TB2(Criterion:>10 dB)



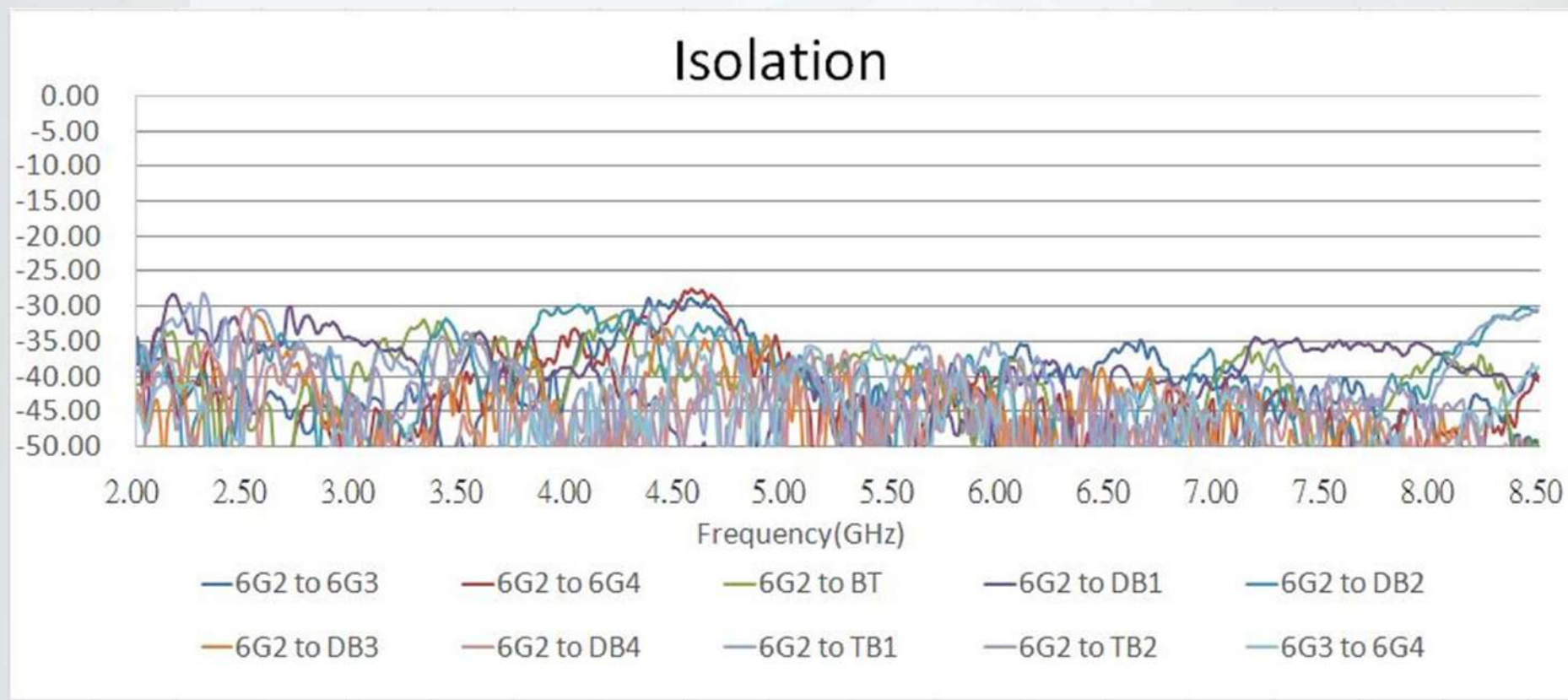
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



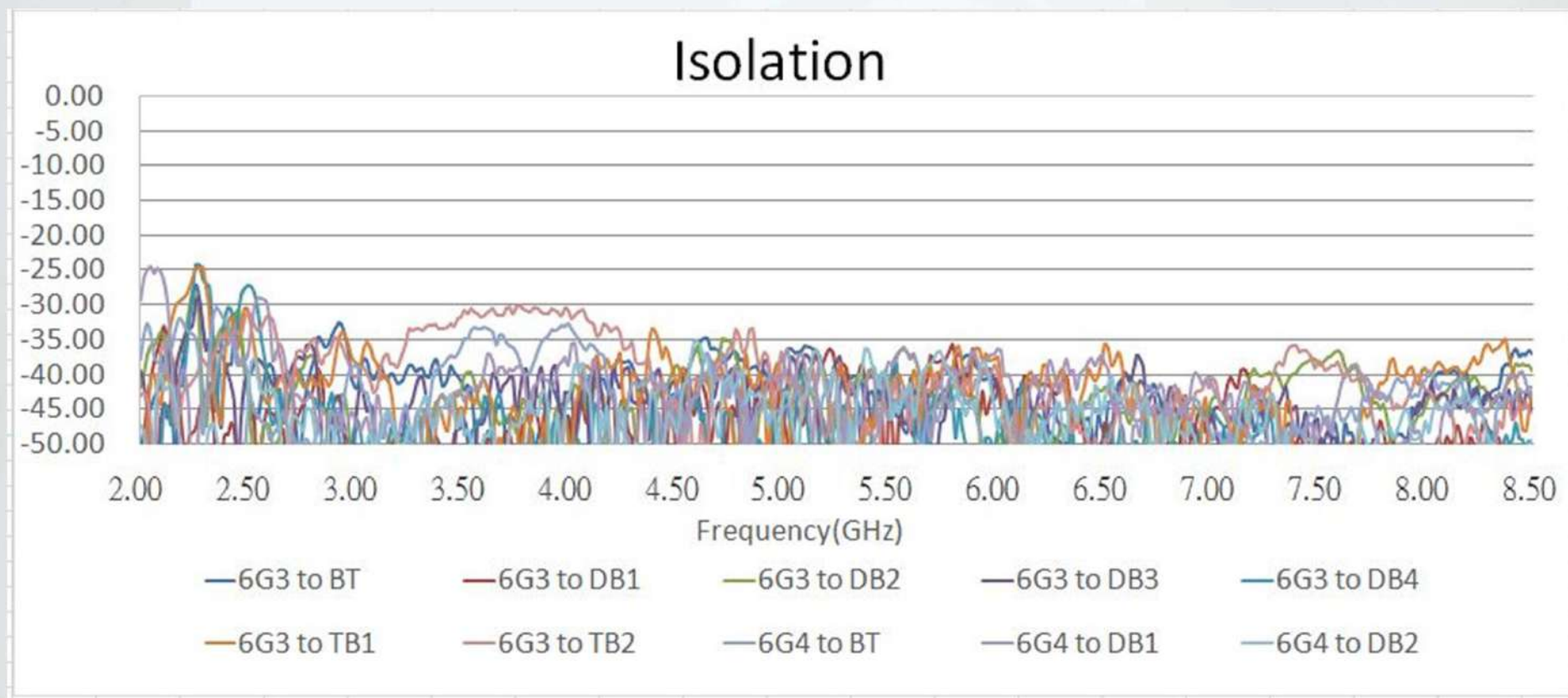
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



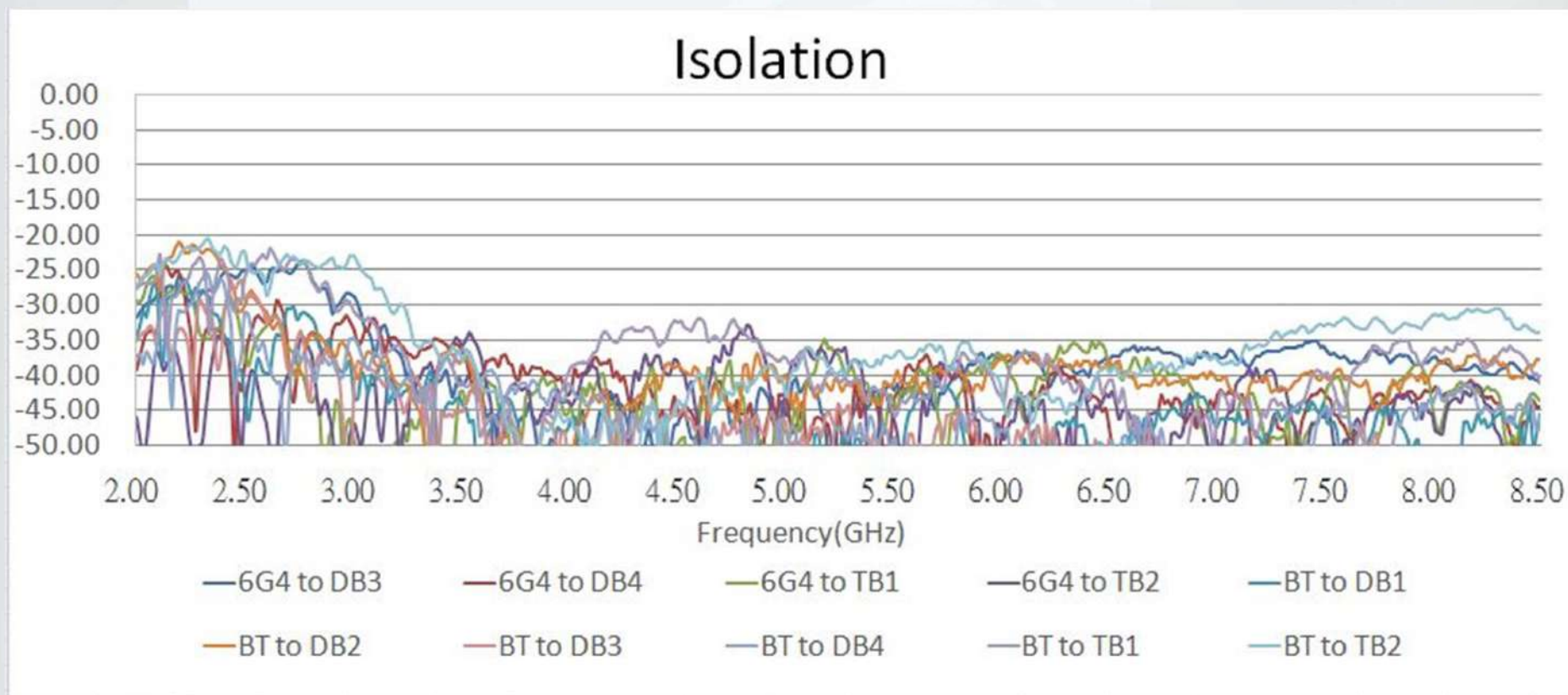
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



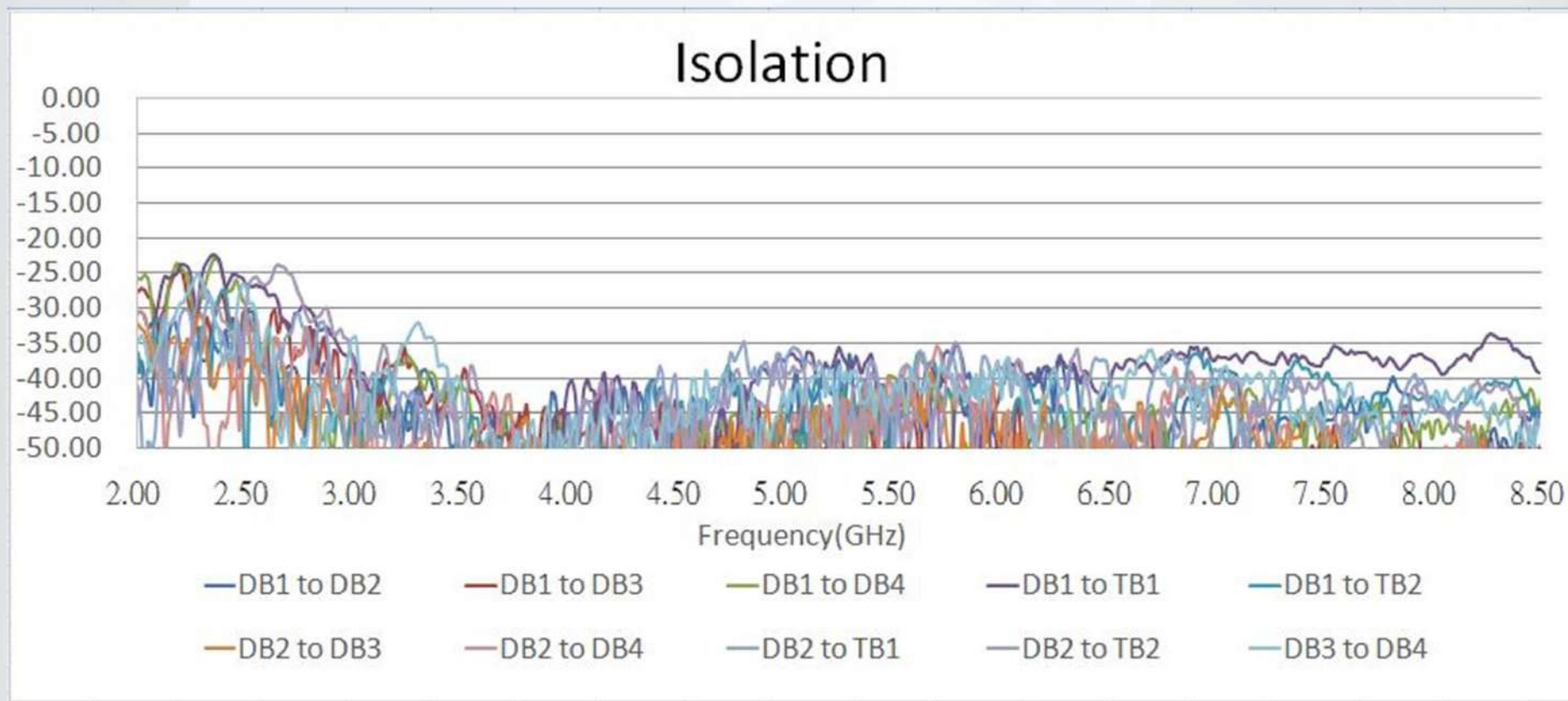
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



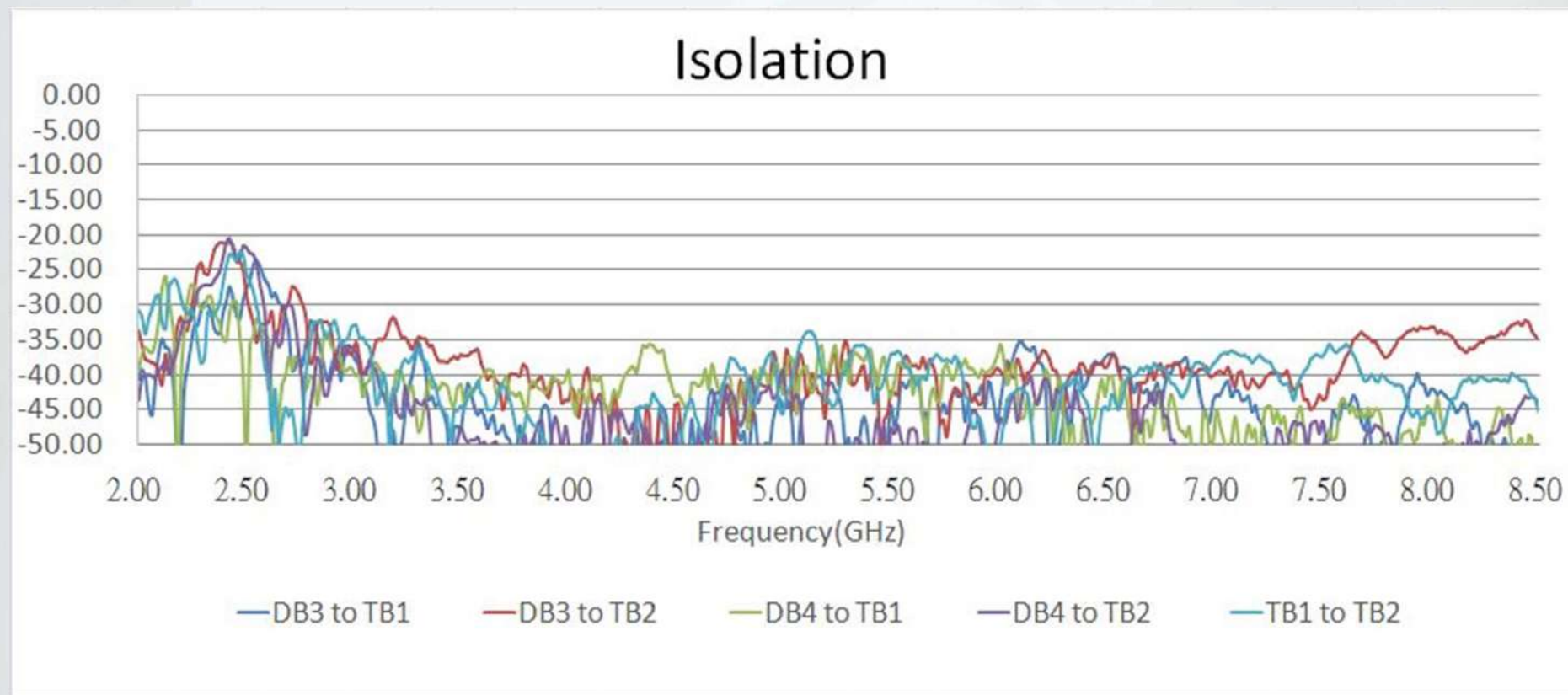
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



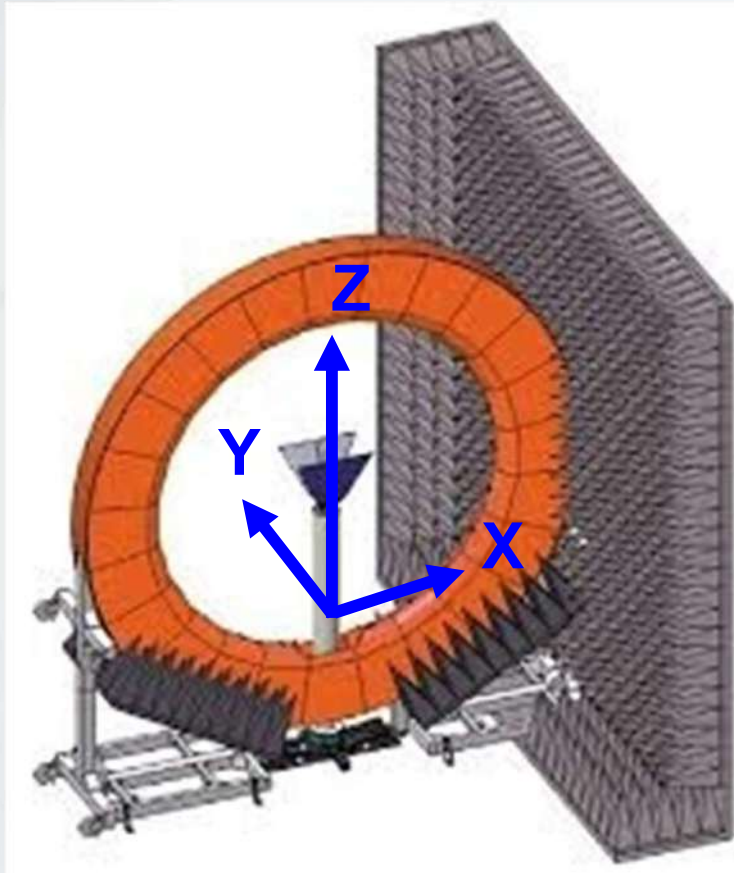
Isolation Results

(Criterion: 2400-2500(MHz)>20dB ; 5150-5895(MHz)/5895-7125(MHz) >35dB)



Test Setup for Radiation Pattern Measurement

Chamber Information



- SATIMO SG-24L Multi-Probe Antenna Measurement System
 - Angle between probes: 15°
 - Frequency range: 400 MHz – 8.5 GHz
 - Chamber Room Size: 5m L x 5m W x 5m H
 - Software: Wave Studio
 - Calibration date: 2021.12.20
 - Calibration due date: 2023.04.28

Test Setup for Radiation Pattern Measurement

Step 1

- Fix the whole antenna unit on the pole in the center of the anechoic chamber.

Step 2

- The whole antenna unit is connected with the coaxial line at the transmitter end of the microwave anechoic chamber.

Step 3

- Close the microwave anechoic chamber door, so that the external signal can not enter the anechoic chamber interior, and then start testing.

Step 4

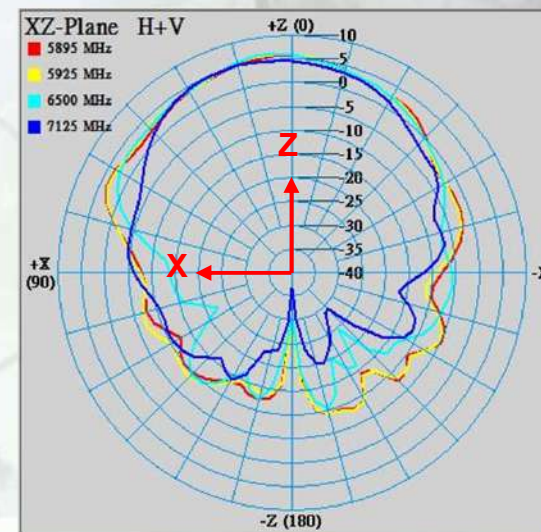
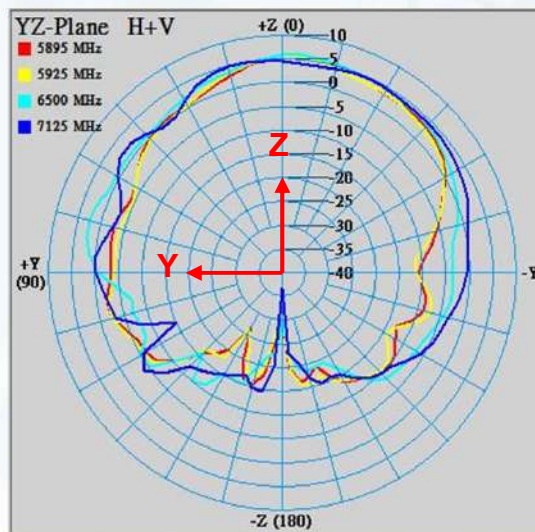
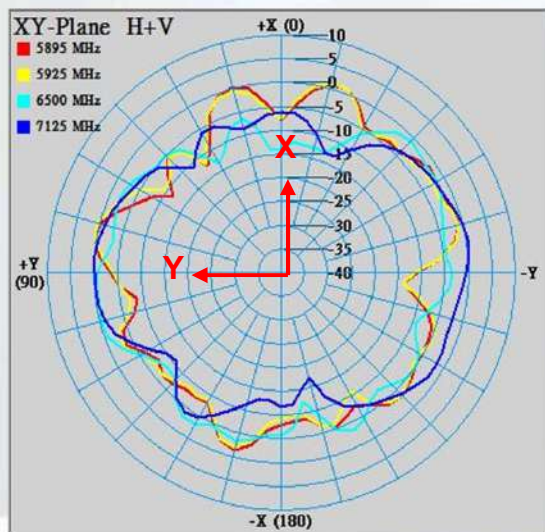
- Open SG-24L the antenna measurement system, can observe the selected frequency, selected angle of the system real-time testing.

Step 5

- After testing, Wave Studio can carry on near and far field data conversion.

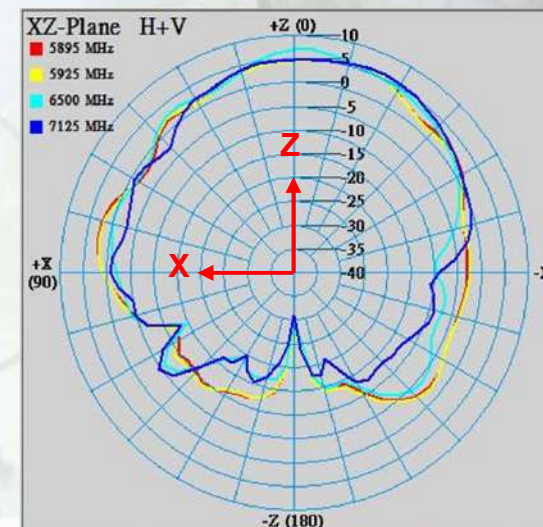
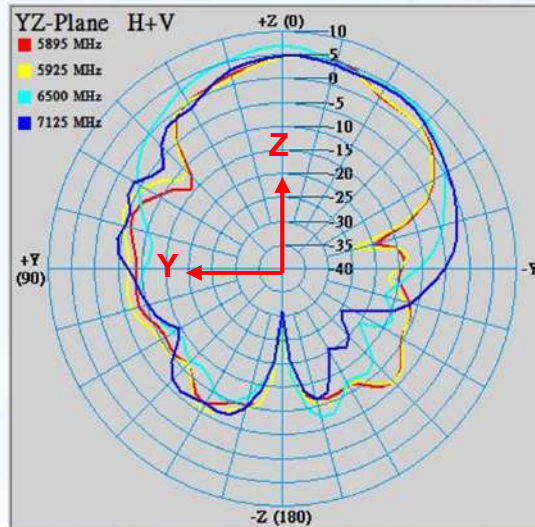
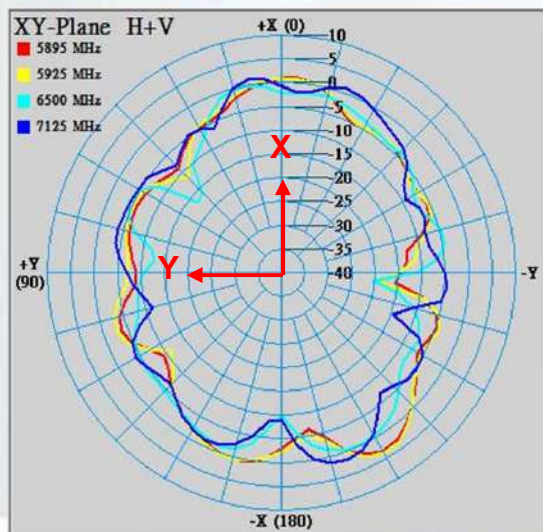
2D Radiation Pattern Results

6G1



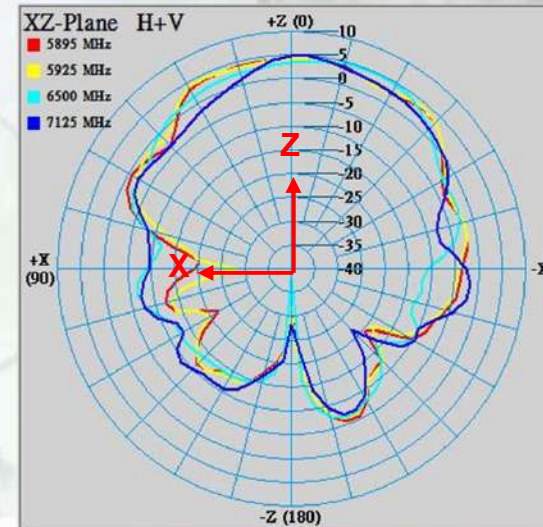
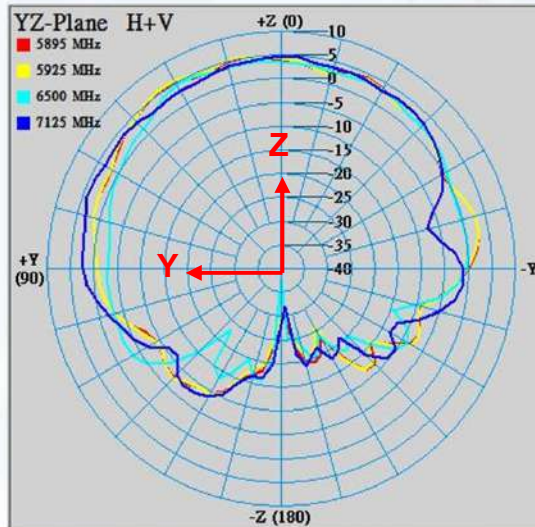
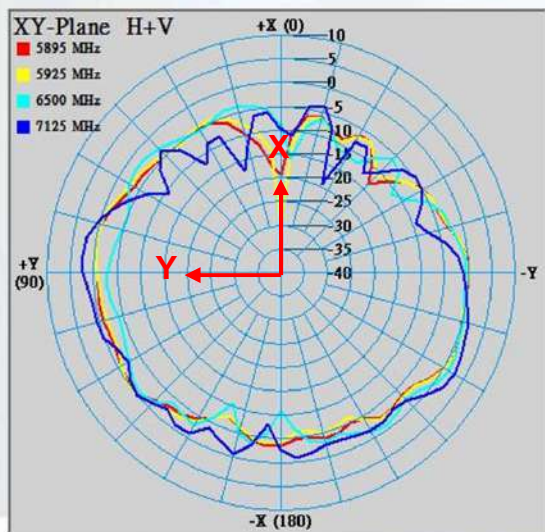
2D Radiation Pattern Results

6G2



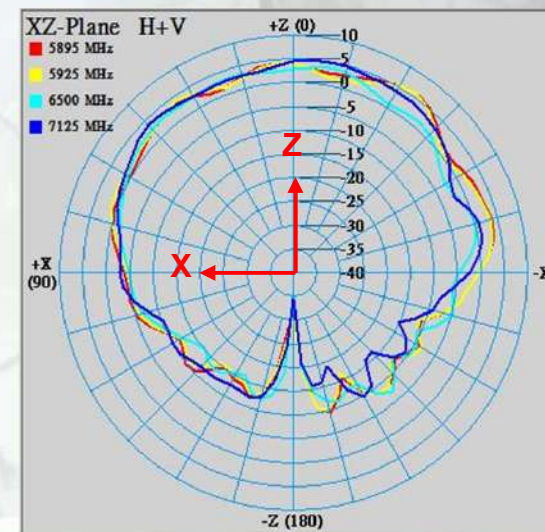
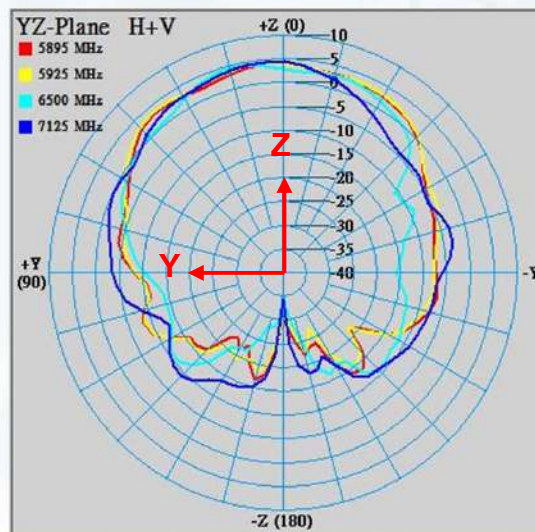
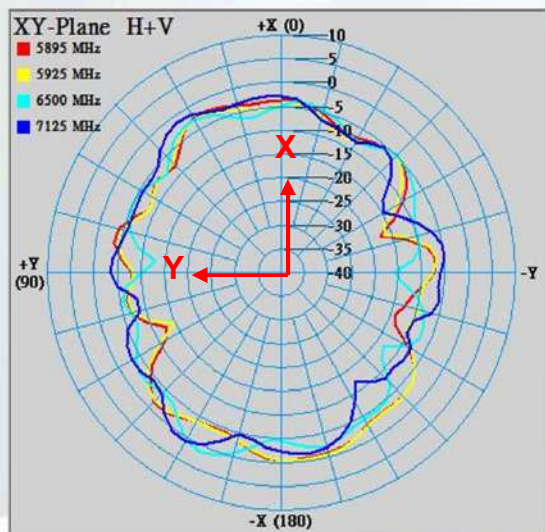
2D Radiation Pattern Results

6G3



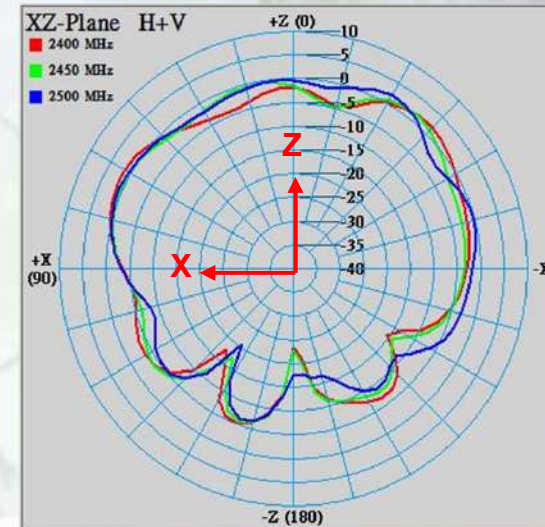
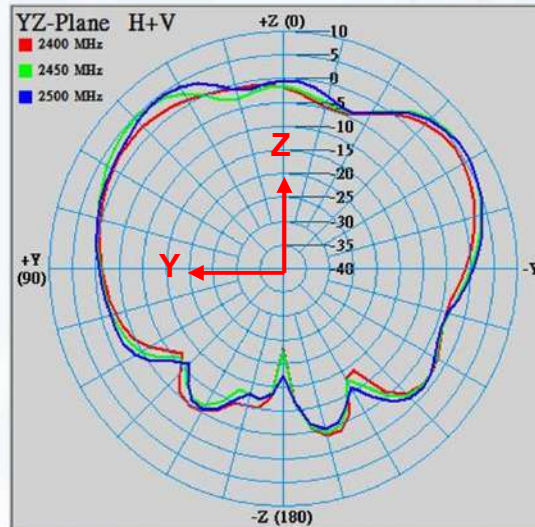
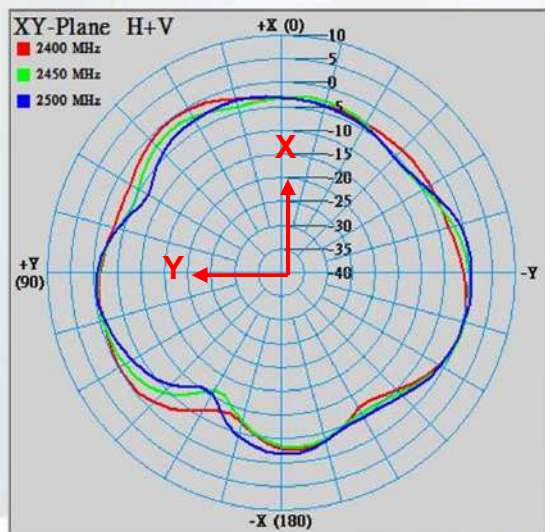
2D Radiation Pattern Results

6G4



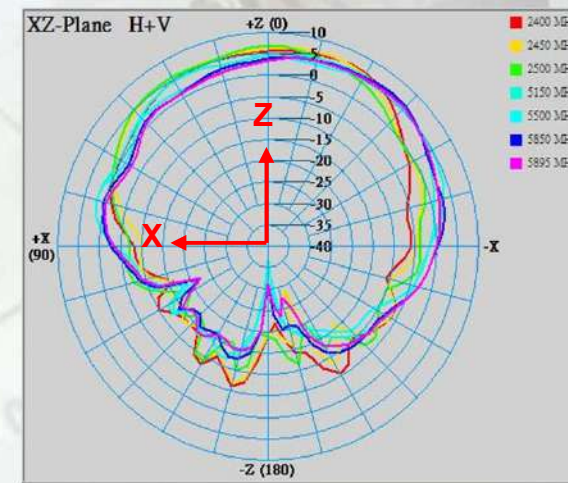
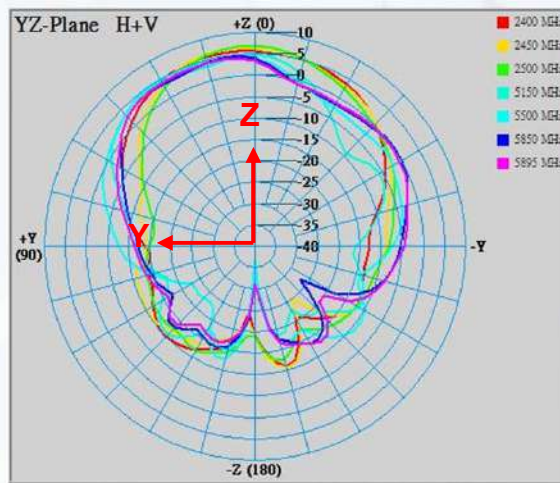
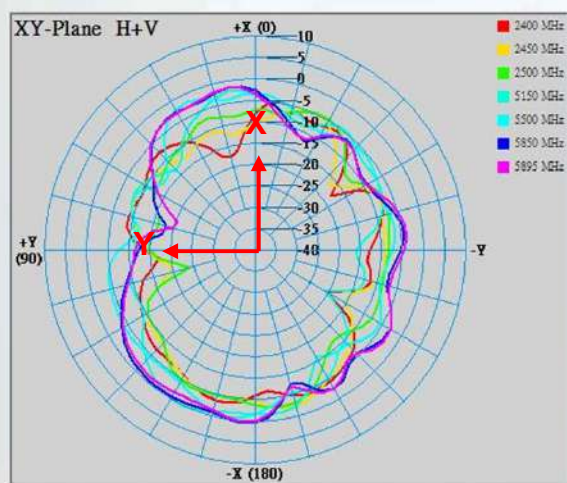
2D Radiation Pattern Results

BT



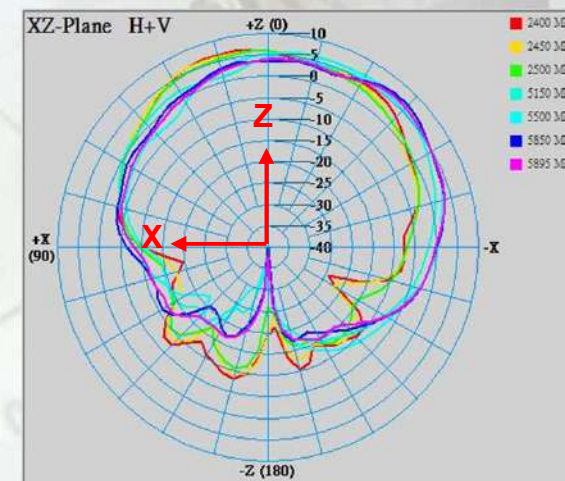
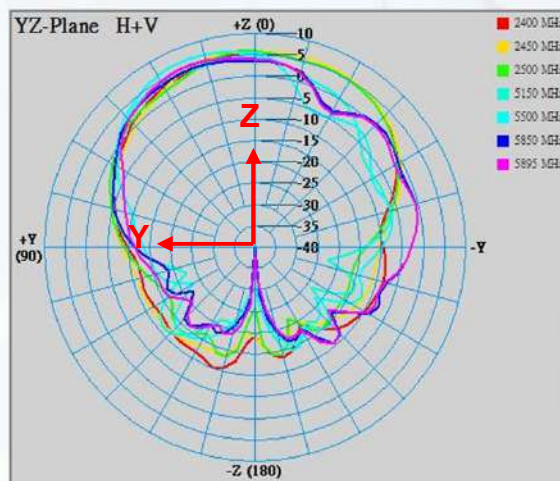
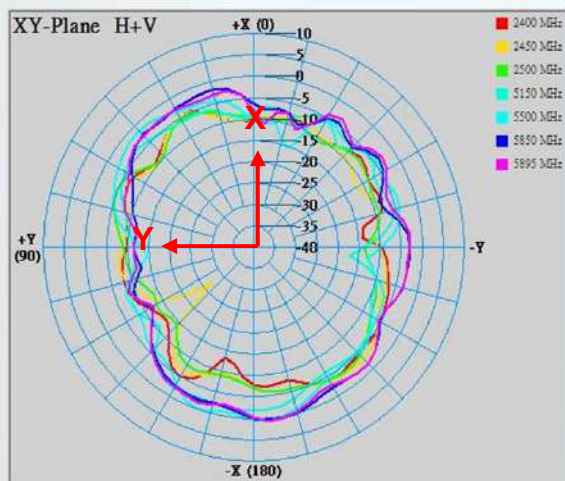
2D Radiation Pattern Results

DB1



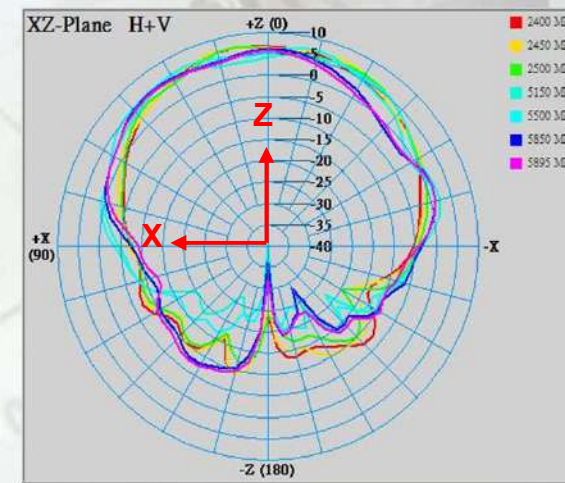
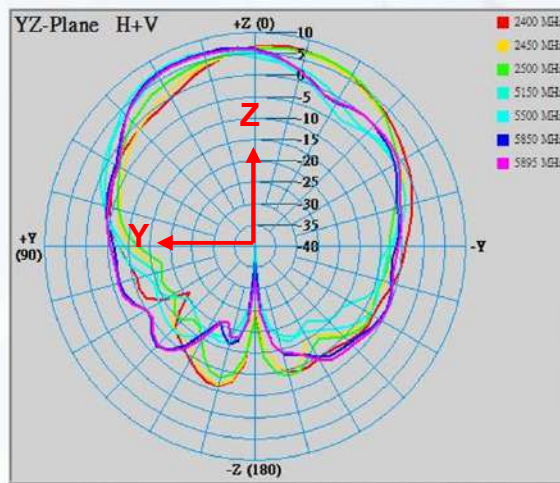
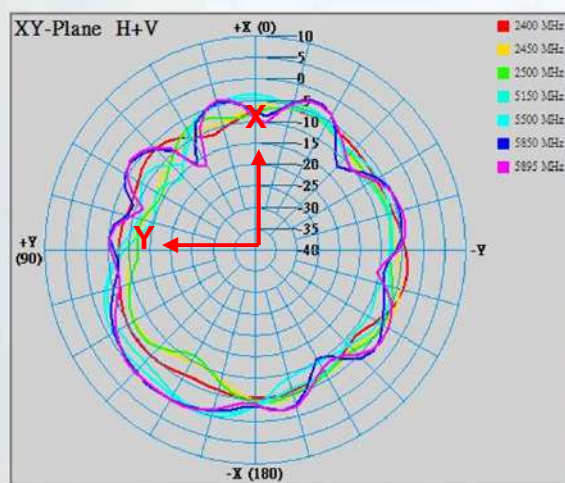
2D Radiation Pattern Results

DB2



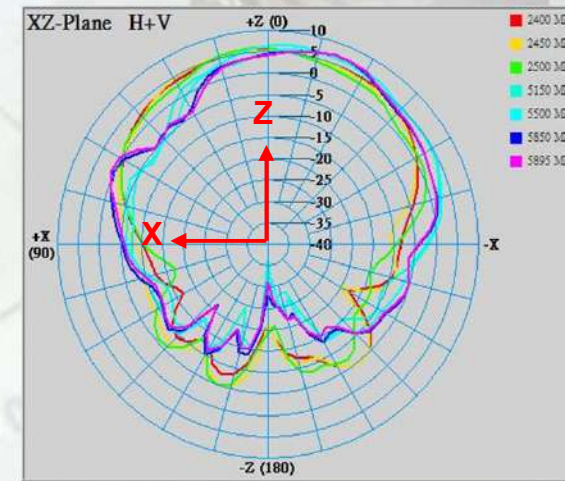
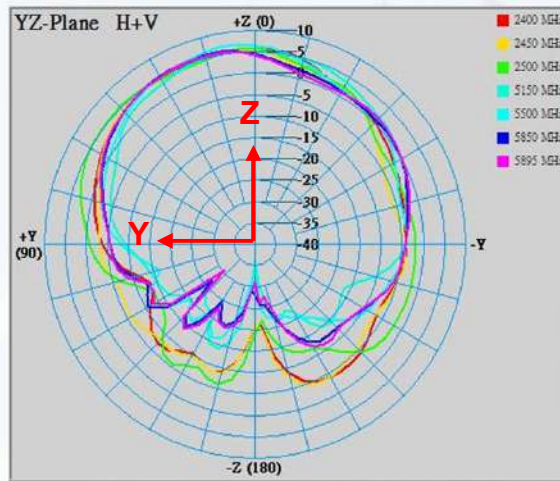
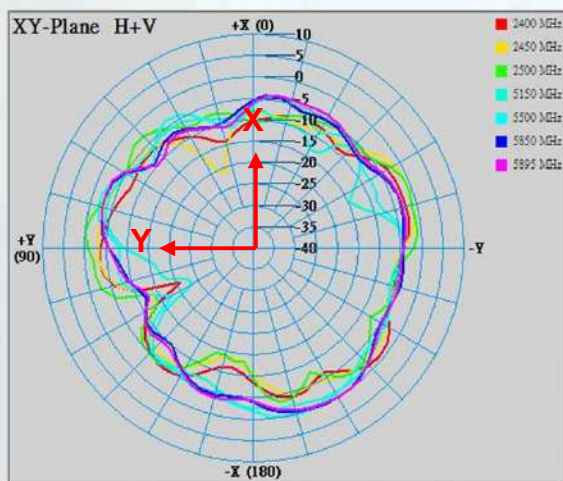
2D Radiation Pattern Results

DB3



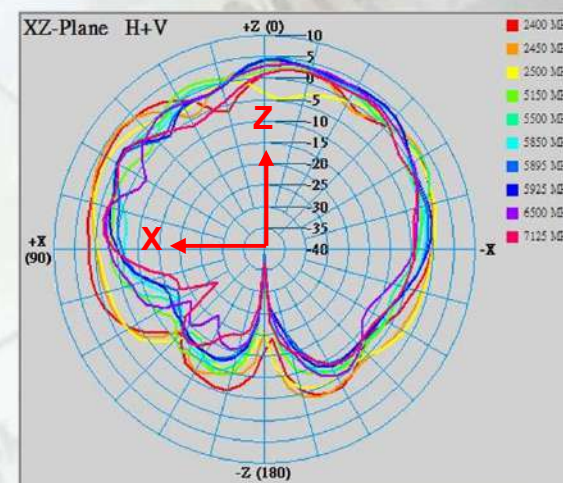
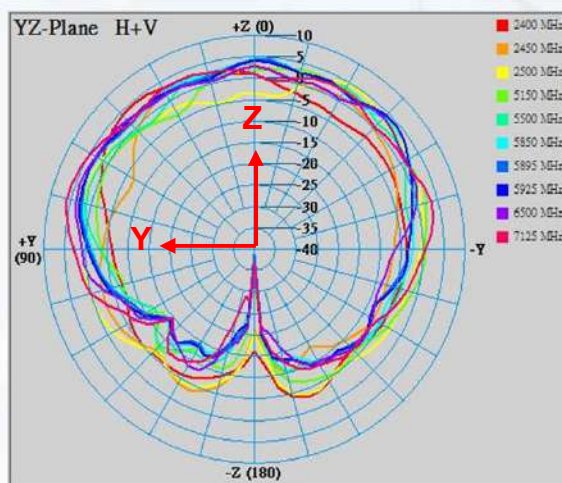
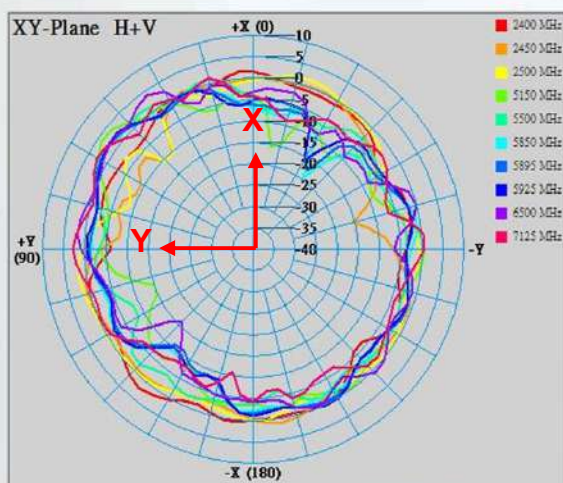
2D Radiation Pattern Results

DB4



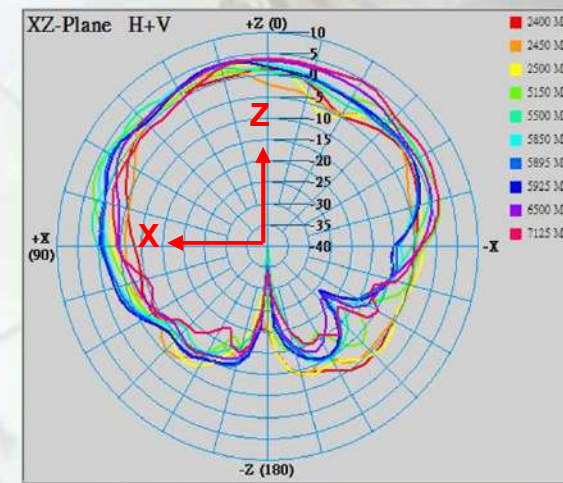
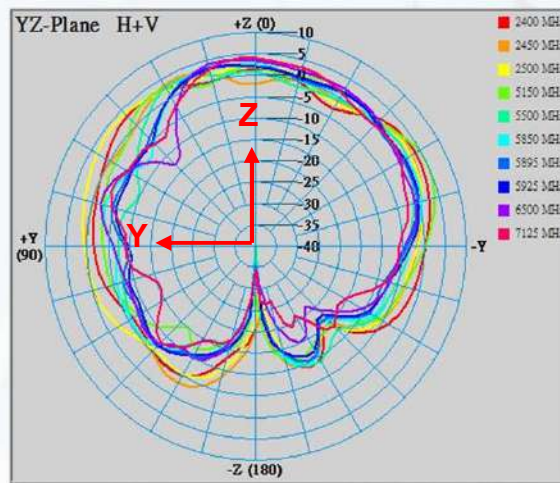
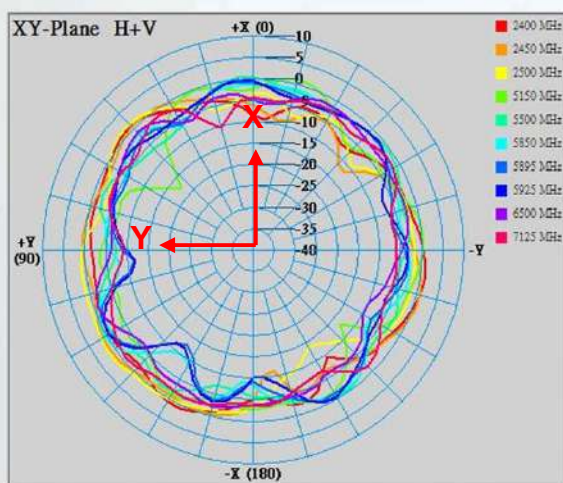
2D Radiation Pattern Results

TB1



2D Radiation Pattern Results

TB2



Results Summary

Return Loss (Criterion: >10dB)

Frequency (MHz)	6G1 (dB)	6G2 (dB)	6G3 (dB)	6G4 (dB)
5895	26	18	16	21
6500	16	20	13	19
7125	13	13	18	16

Results Summary

Return Loss (Criterion: >10dB)

Frequency (MHz)	DB1 (dB)	DB2 (dB)	DB3 (dB)	DB4 (dB)
2400	13	12	13	14
2450	14	11	14	13
2500	12	10	13	15
5150	13	14	11	11
5500	25	26	29	29
5895	21	17	15	16

Results Summary

Return Loss (Criterion: >10dB)

Frequency (MHz)	TB1 (dB)	TB2 (dB)
2400	26	17
2450	14	19
2500	17	14
5150	11	11
5500	11	11
5895	31	13
6500	22	11
7125	10	10

Frequency (MHz)	BT (dB)
2400	15
2450	16
2500	12

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	6G1 to 6G2	6G1 to 6G3	6G1 to 6G4	6G1 to BT	6G1 to DB1	6G1 to DB2	6G1 to DB3	6G1 to DB4	6G1 to TB1	6G1 to TB2
2400	44	44	43	46	42	52	47	42	42	45
2450	44	46	41	38	56	52	50	42	32	46
2500	49	49	41	44	42	48	56	36	34	40
5150	48	39	40	44	41	38	50	39	47	43
5500	38	46	46	52	44	49	50	38	39	38
5895	45	41	38	59	42	41	46	45	42	45
6500	51	37	49	55	42	49	47	38	37	58
7125	44	49	52	53	42	47	48	42	40	44

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	6G2 to 6G3	6G2 to 6G4	6G2 to BT	6G2 to DB1	6G2 to DB2	6G2 to DB3	6G2 to DB4	6G2 to TB1	6G2 to TB2	6G3 to 6G4
2400	42	52	42	31	52	42	40	32	41	55
2450	42	55	40	31	47	56	39	39	35	48
2500	41	51	44	34	38	39	30	44	40	50
5150	42	51	37	41	40	65	49	41	39	36
5500	47	51	37	42	53	41	47	40	42	41
5895	45	40	46	42	39	42	42	38	45	45
6500	37	46	50	43	51	42	64	50	45	55
7125	40	46	36	38	46	42	52	48	42	44

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	6G3 to BT	6G3 to DB1	6G3 to DB2	6G3 to DB3	6G3 to DB4	6G3 to TB1	6G3 to TB2	6G4 to BT	6G4 to DB1	6G4 to DB2
2400	39	48	33	39	31	34	34	32	35	62
2450	31	53	31	51	33	36	33	38	36	61
2500	42	47	41	40	27	30	31	40	37	46
5150	36	37	45	42	55	42	42	42	42	36
5500	42	46	40	43	41	41	41	45	38	43
5895	38	44	43	37	53	41	41	44	37	44
6500	48	47	41	49	50	37	50	44	38	43
7125	46	41	51	45	55	43	64	47	43	46

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	6G4 to DB3	6G4 to DB4	6G4 to TB1	6G4 to TB2	BT to DB1	BT to DB2	BT to DB3	BT to DB4	BT to TB1	BT to TB2
2400	25	34	31	34	33	24	33	26	24	22
2450	25	48	29	38	38	27	27	39	30	24
2500	25	39	36	46	41	30	28	32	26	22
5150	43	46	37	36	48	42	47	58	41	37
5500	41	46	43	45	53	41	54	50	44	37
5895	37	48	39	46	57	41	50	45	37	37
6500	37	46	38	43	51	37	49	52	40	39
7125	38	43	43	40	46	43	57	50	44	36

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	DB1 to DB2	DB1 to DB3	DB1 to DB4	DB1 to TB1	DB1 to TB2	DB2 to DB3	DB2 to DB4	DB2 to TB1	DB2 to TB2	DB3 to DB4
2400	33	29	26	26	27	36	46	34	31	36
2450	34	33	26	25	32	40	37	33	33	33
2500	31	30	29	26	53	37	33	32	30	26
5150	41	47	44	40	40	45	45	37	49	39
5500	43	43	39	46	44	43	42	46	42	41
5895	40	48	55	48	51	44	44	41	46	42
6500	53	54	44	40	49	51	43	39	46	42
7125	49	55	43	37	50	46	43	46	49	40

Results Summary

Isolation (Criterion: 2400-2500(MHz)>20dB ; 5150-5850(MHz)/5925-7125(MHz) >35dB)

Frequen cy (MHz)	DB3 to TB1	DB3 to TB2	DB4 to TB1	DB4 to TB2	TB1 to TB2
2400	30	21	35	22	25
2450	30	23	29	22	23
2500	27	27	49	21	24
5150	40	42	37	62	36
5500	45	42	42	48	37
5895	42	43	40	46	46
6500	37	38	40	53	44
7125	43	40	57	66	37

Results Summary

Peak gain & Efficiency –6G1

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
5895	6.4	72
5925	6.4	72
6500	6.6	69
7125	5.5	66

Results Summary

Peak gain & Efficiency –6G2

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
5895	7.2	74
5925	7.5	75
6500	7.0	76
7125	6.9	72

Results Summary

Peak gain & Efficiency –6G3

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
5895	5.5	75
5925	5.8	76
6500	4.9	69
7125	5.2	72

Results Summary

Peak gain & Efficiency –6G4

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
5895	5.8	63
5925	5.8	64
6500	4.7	60
7125	5.0	61

Results Summary

Peak gain & Efficiency –BT

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	4.5	79
2450	5.9	80
2500	5.9	77

Results Summary

Peak gain & Efficiency –DB1

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	6.8	67
2450	6.9	69
2500	6.8	66
5150	6.7	67
5500	7.2	72
5850	6.6	71
5895	6.6	69

Results Summary

Peak gain & Efficiency –DB2

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	6.7	69
2450	6.9	67
2500	6.5	63
5150	6.7	66
5500	6.7	72
5850	7.1	68
5895	6.5	68

Results Summary

Peak gain & Efficiency –DB3

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	7.7	76
2450	7.3	76
2500	7.6	75
5150	7.2	78
5500	7.6	85
5850	7.1	82
5895	6.9	80

Results Summary

Peak gain & Efficiency –DB4

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	6.1	75
2450	6.4	72
2500	5.9	73
5150	6.6	72
5500	7.3	79
5850	7.0	75
5895	7.1	75

Results Summary

Peak gain & Efficiency –TB1

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	4.5	73
2450	5.1	73
2500	4.8	79
5150	7.2	67
5500	5.9	74
5850	5.9	78
5895	5.7	75
5925	5.8	77
6500	6.8	75
7125	6.2	73

Results Summary

Peak gain & Efficiency –TB2

Frequency (MHz)	Peak Gain (dBi)	Efficiency (%)
2400	4.6	71
2450	4.5	71
2500	4.7	71
5150	5.6	72
5500	5.9	68
5850	6.8	70
5895	6.3	67
5925	6.3	67
6500	5.5	64
7125	5.3	60