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佳邦科技股份有限公司

INPAQ TECHNOLOGY CO., LTD.

PASSIVE SYSTEM ALLIANCE

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东软_C928_海外版 LTE/WIFI Antenna Evaluation Report

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INPAQ Technology Co., Ltd.

Last updated in Oct.9th, 2024

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Revision History

Released Date	Version	Record
Oct.9th,2024	V0.0	初版无源调试数据

Requirements of Antenna Design and Measurement

Requirements of Antenna Design

RF Function	Number of ANT	Frequency Band	Remark
WIFI/BT	2	2400-2500MHz,5100-5900MHz	
LTE Main	1	700-960MHz,1710-2690MHz	
LTE DIV	1	1710-2690MHz	

Requirements of Measurement

OTA Test Item	Specification (Free Space)	Remark
WIFI/BT	2400-2500MHz≥50%,5100-5900MHz≥50%	
LTE Main	700-960MHz≥35%,1710-2690MHz≥35%	
LTE DIV	1710-2690MHz≥35%	

Requirements of Antenna Design and Measurement

序号	项目		性能指标要求	备注
1	频率选择性		5G 主/副： 700M∽1000M&1700M∽2700M&3.3G∽5G 5G 分集： 1700M∽2700M&3.3G∽5G 4G 主/副： 700M∽1000M&1700M∽2700M	根据控制器所支持频段作适配
2	阻抗		50Ω	
3	电压驻波比		≤3	
4	天线隔离度	系统内	≥10dB	
		2/3/4/5G -V2X	≥15dB	
		2/3/4/5G –WIFI	≥15dB	
		2/3/4/5G-BT	≥15dB	
		2/3/4/5G -GNSS	≥25dB	
5	天线效率		f<3G 35%以上；3G≤f 40%以上	
6	2D 增益平坦度	θ 取 45°、60°、70°、80°、85°、90°	增益平坦度≤12dB 低于平均增益 10dB 的角度之和＜30°	辐射方向图中截取
7	天线平均增益 (θ 取 60°∽90°)	f＜1GHz	≥-8dBi	
		1≤f＜2.3G	≥-9dBi	
		2.3≤f	≥-10dBi	
8	总全向辐射功率 TRP		f<3G：≥传导实测 Max power-5.5dB 3G≤f：≥传导实测 Max power-4.5dB	5G/4G 频段，需备注测试 BW
9	总全向灵敏度 TIS		≤传导实测 Min sensitivity+6.5dB	

表 9 WiFi 天线标准表

序号	项目		性能指标要求	备注
1	频率选择性		2.4G∽2.5G 5.7G∽5.85G	
2	阻抗		50Ω	
3	电压驻波比		≤2.5	
4	天线隔离度	系统内	≥10dB	
		WiFi-2/3/4/5G	≥15dB	
		WiFi-V2X	≥15dB	
		WiFi-BT	≥15dB	
		WiFi-GNSS	≥25dB	
5	天线效率		≥50%	
6	2D 增益平坦度	θ 取 0°、30°、60°、90°、120°、150°、180°	增益平坦度≤12dB 低于平均增益 10dB 的角度之和＜30°	辐射方向图中截取
7	总全向辐射功率 TRP		≥传导实测 Max power-4.5dB	建议 6M 速率
8	总全向灵敏度 TIS		≤传导实测 Min sensitivity+6.5dB	

终端客户SPEC

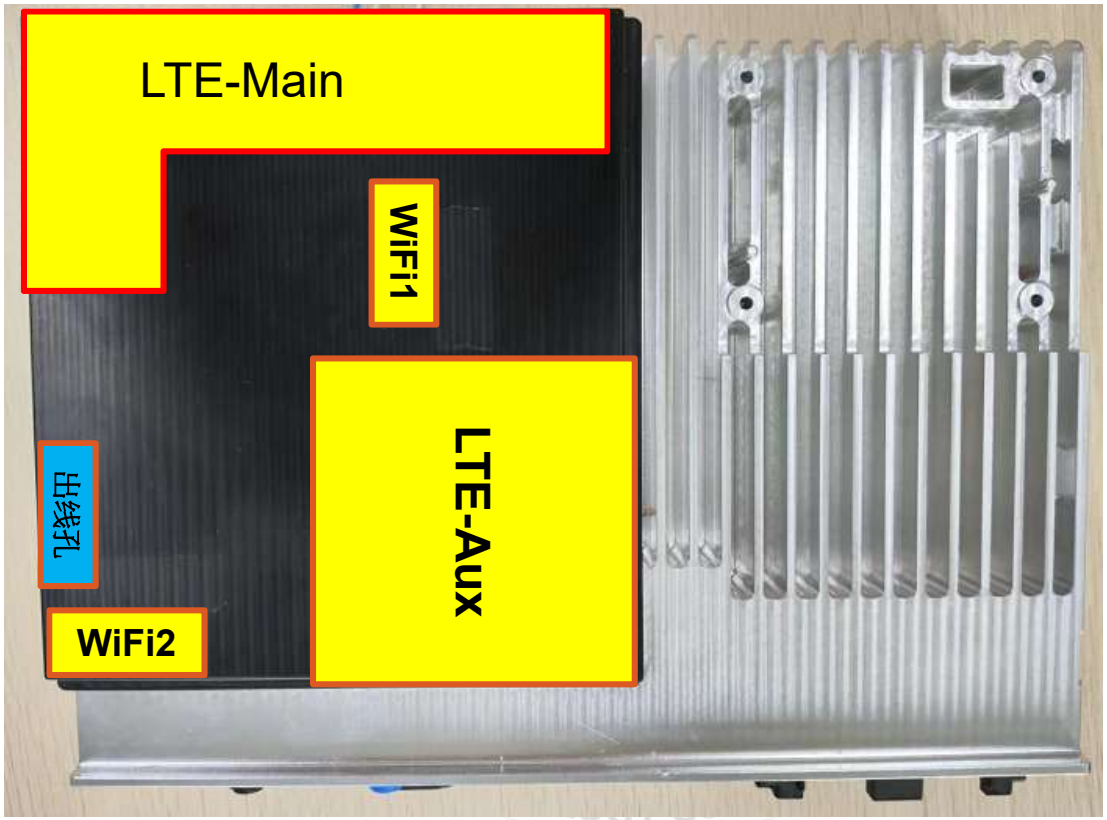
Requirements of Antenna Design and Measurement

BT 天线标准表

序号	项目		性能指标要求	备注
1	频率选择性		2.4G~2.5G	
2	阻抗		50Ω	
3	电压驻波比		≤2.5	
4	天线隔离度	系统内	≥10dB	
		BT-2/3/4/5G	≥15dB	
		BT-V2X	≥15dB	
		BT-WiFi	≥15dB	
		BT-GNSS	≥25dB	
5	天线效率		≥50%	
6	2D 增益平坦度	θ 取 0°、30°、60°、90°、120°、150°、180°	增益平坦度≤12dB 低于平均增益 10dB 的角度之和＜30°	辐射方向图中截取
7	总全向辐射功率 TRP		≥传导实测 Max power-4.5dB	建议 EDR-2DH5
8	总全向灵敏度 TIS		≤传导实测 Min sensitivity+6.5dB	

终端客户SPEC

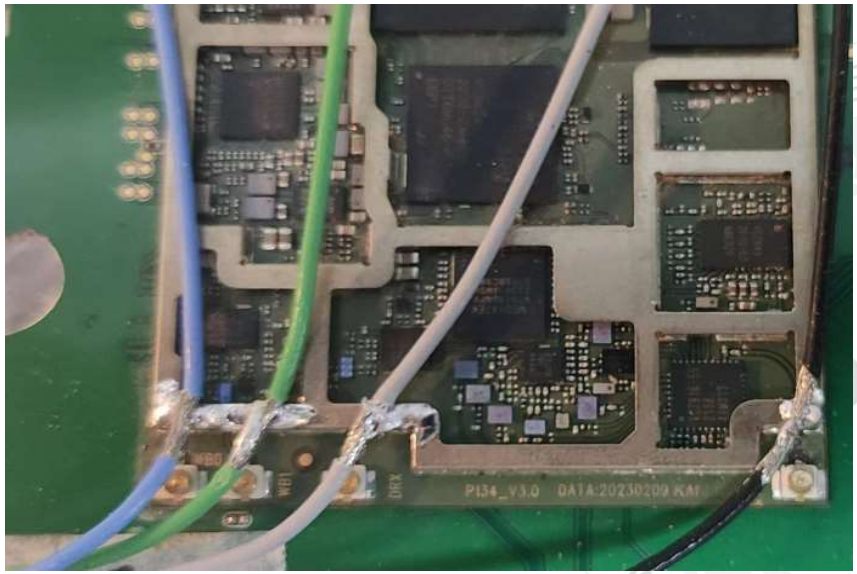
Antenna Placement & Solution



天线布局位置

Antenna Placement & Solution

无源测试接线方式

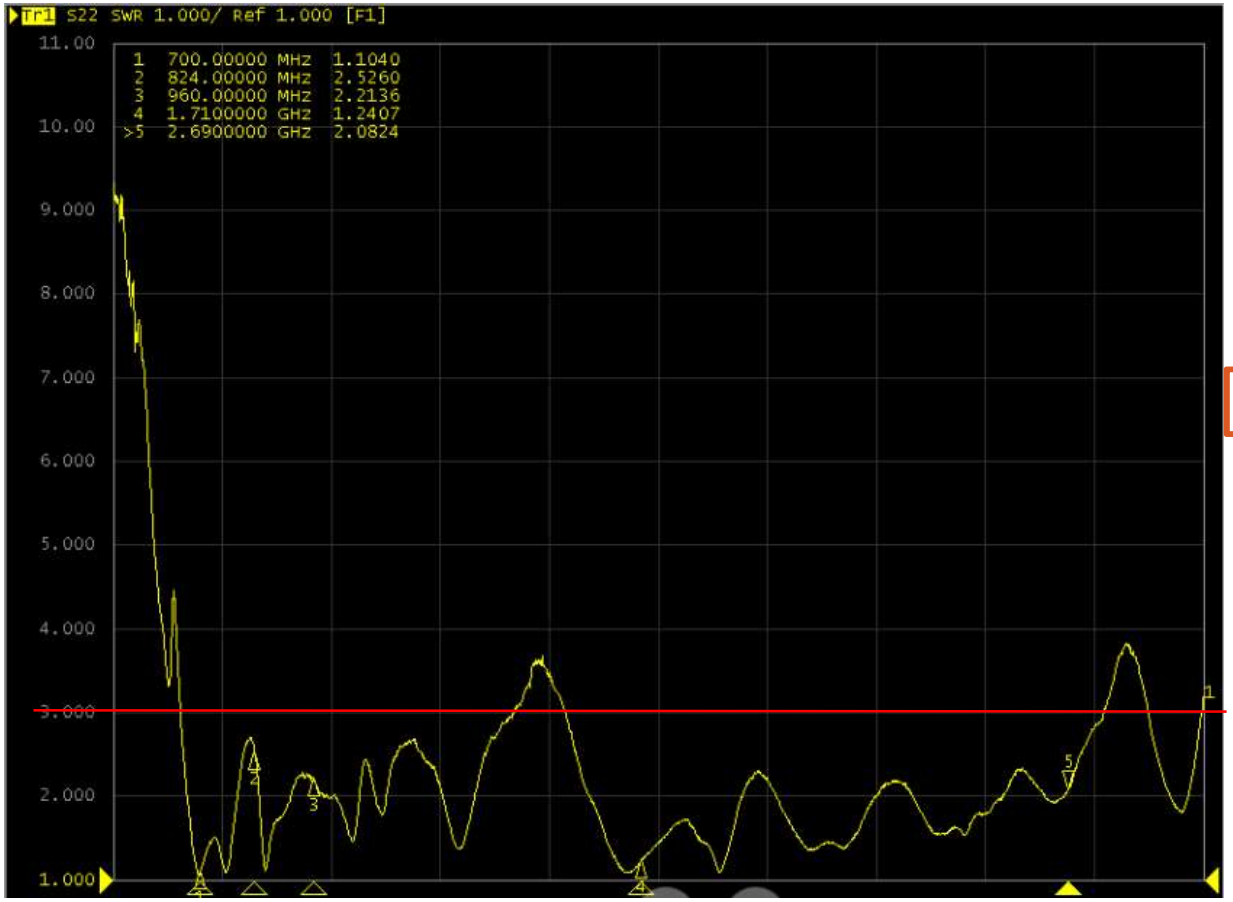


对应各天线座子位子处，线材中剥接地

线材通过SIM卡槽旁边拉出，接网分调试

由于无源调试需要将Cable拉出机壳外，因此需要采用更长的线材，同时为了保持最接近整机状态，在等长于生产定义线长的端子位置中剥并与主板共地。

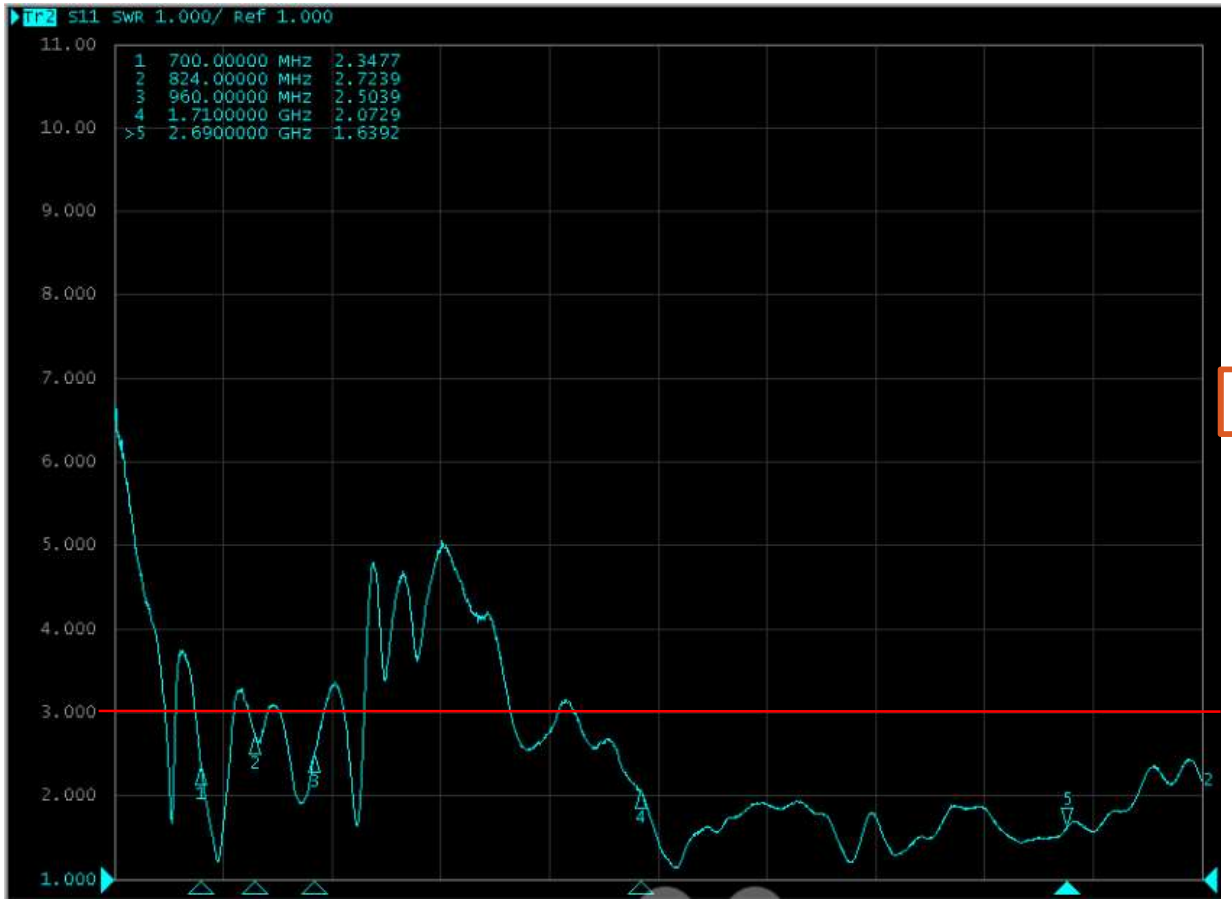
VSWR Results



LTE-Main Antenna

Spec＜3

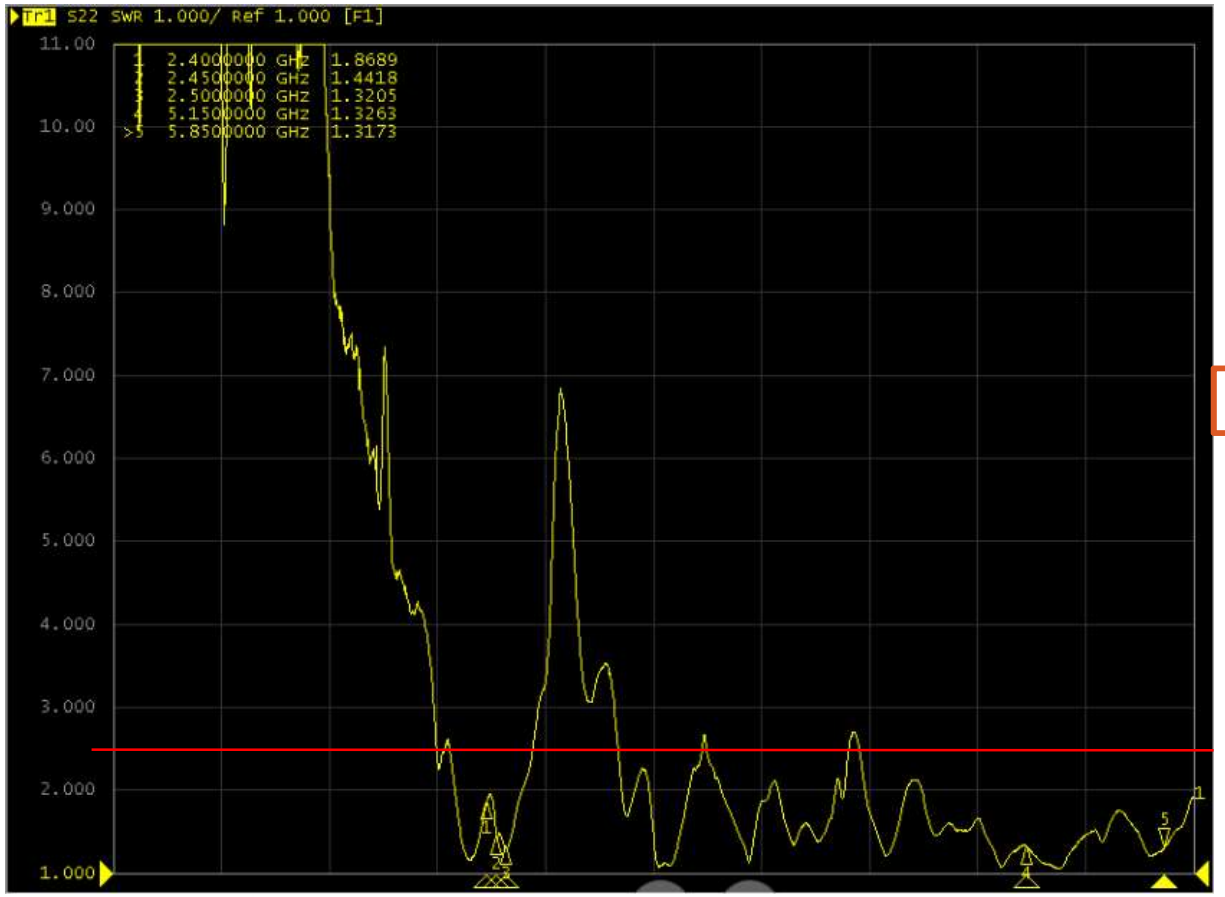
VSWR Results



LTE-DIV Antenna

Spec＜3

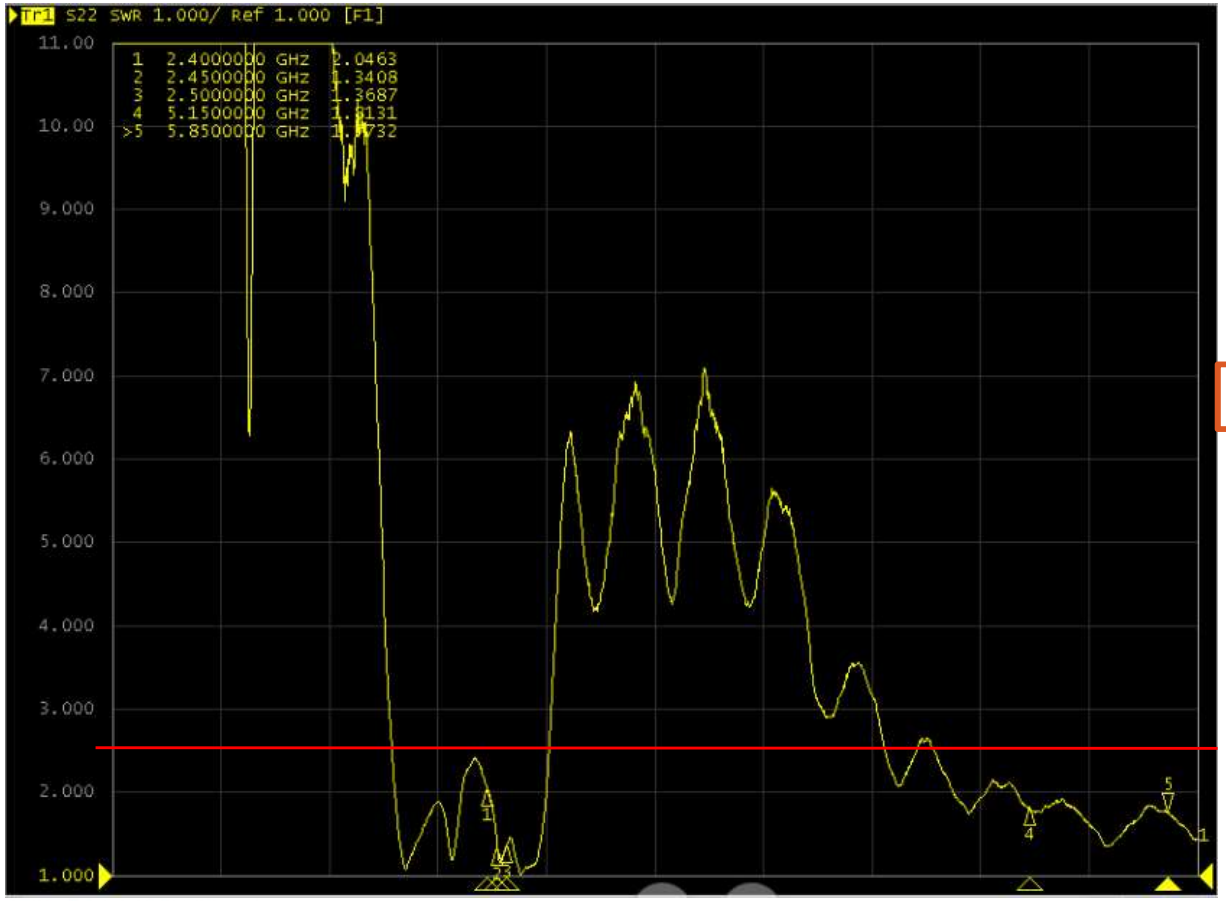
VSWR Results



WIFI-1 Antenna

Spec＜2.5

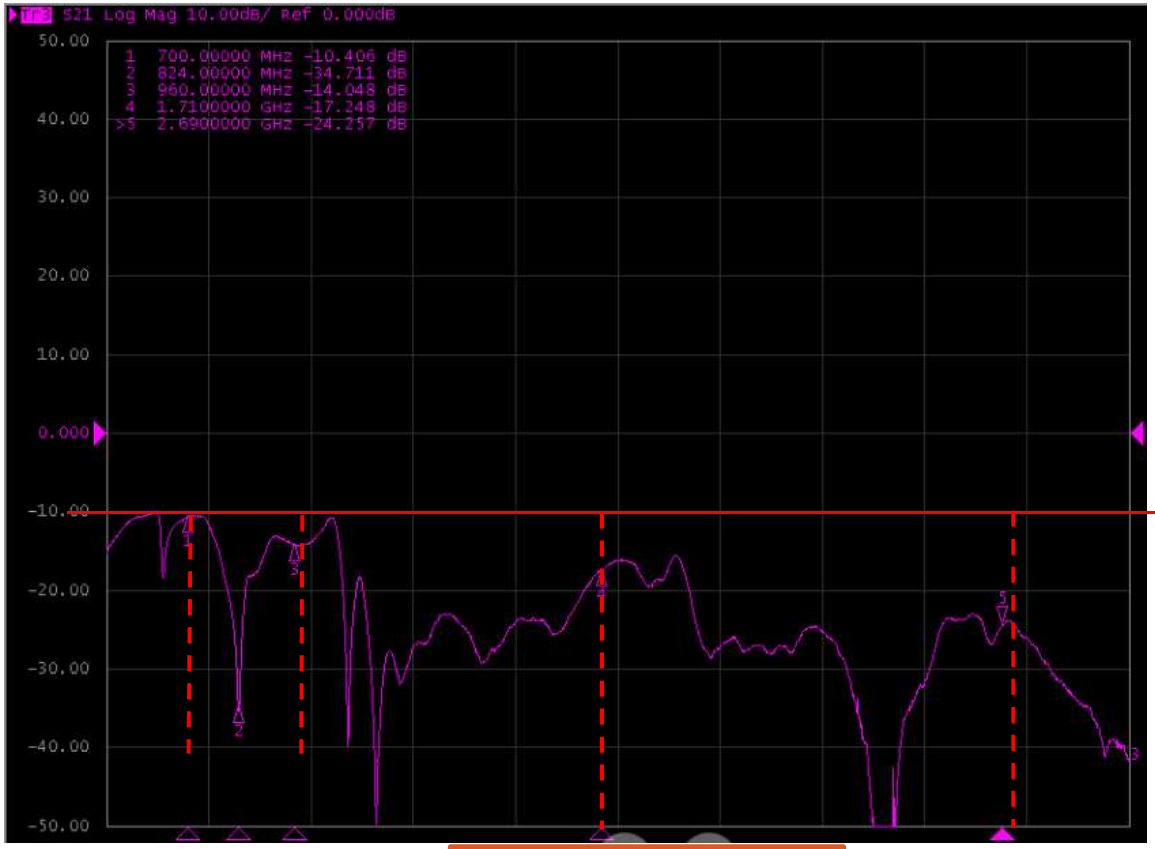
VSWR Results



WIFI-2 Antenna

Spec＜2.5

Isolation Results

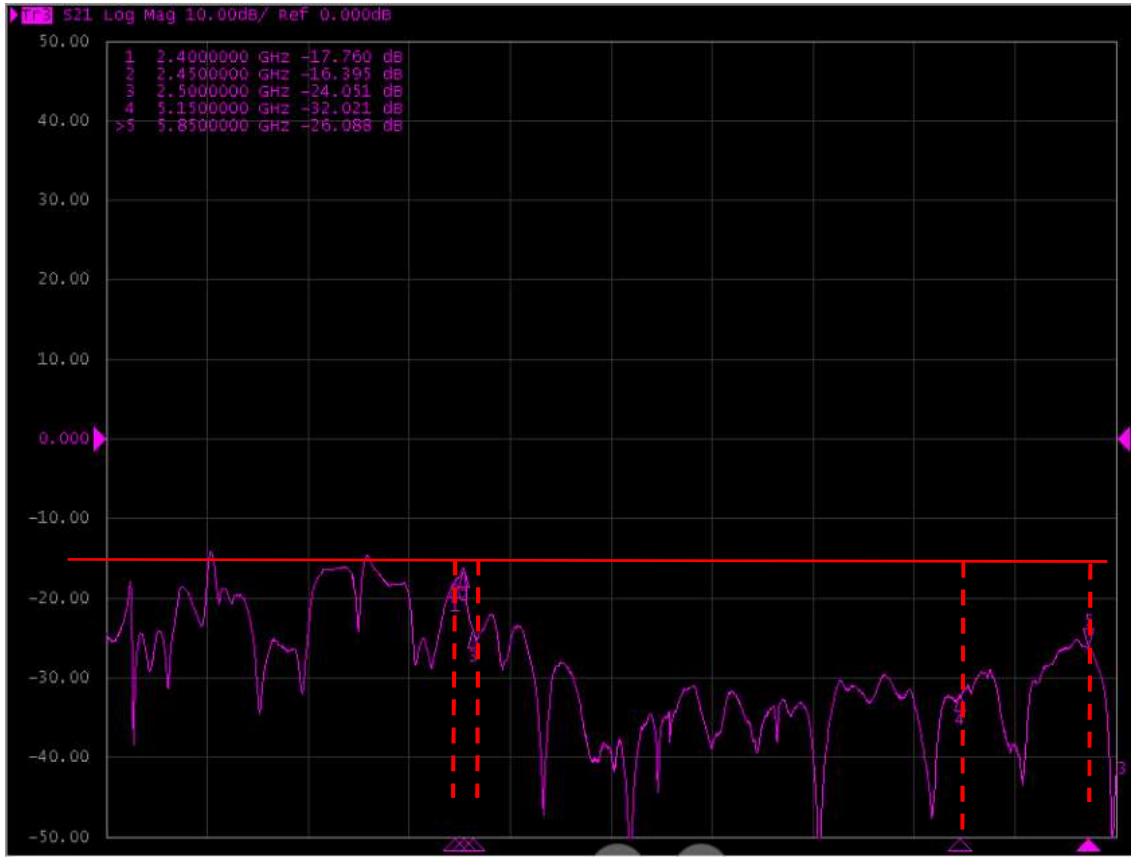


PASS

Spec＜-10

LTE-Main & LTE-Div

Isolation Results

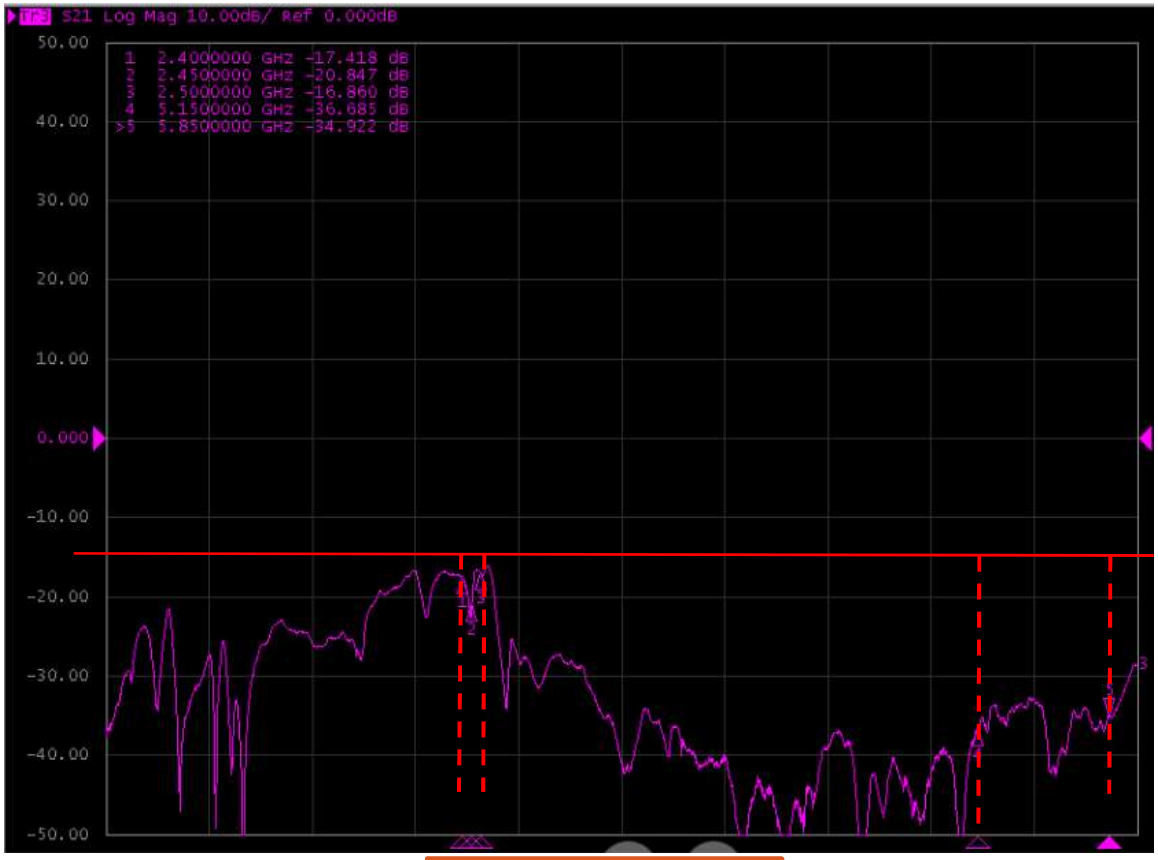


PASS

Spec＜-15

LTE-Main & WIFI1

Isolation Results

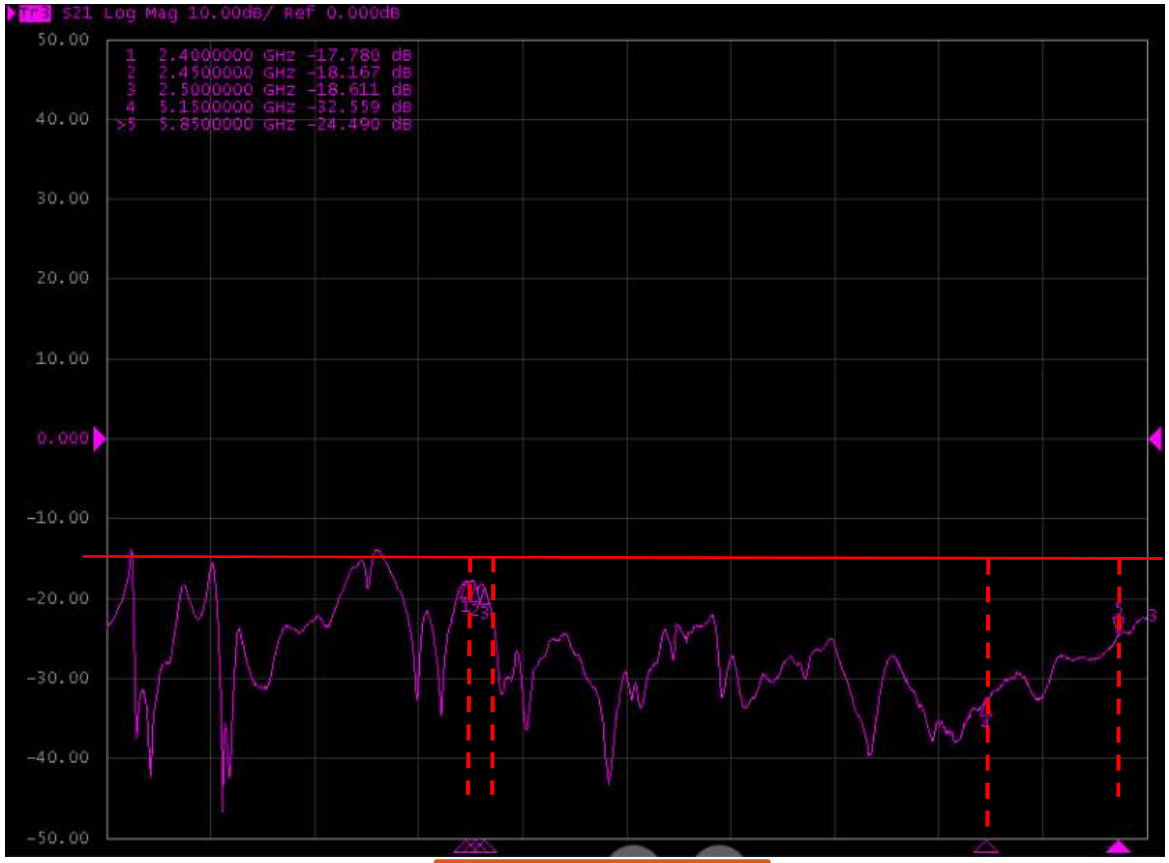


PASS

Spec＜-15

LTE-Main & WIFI2

Isolation Results

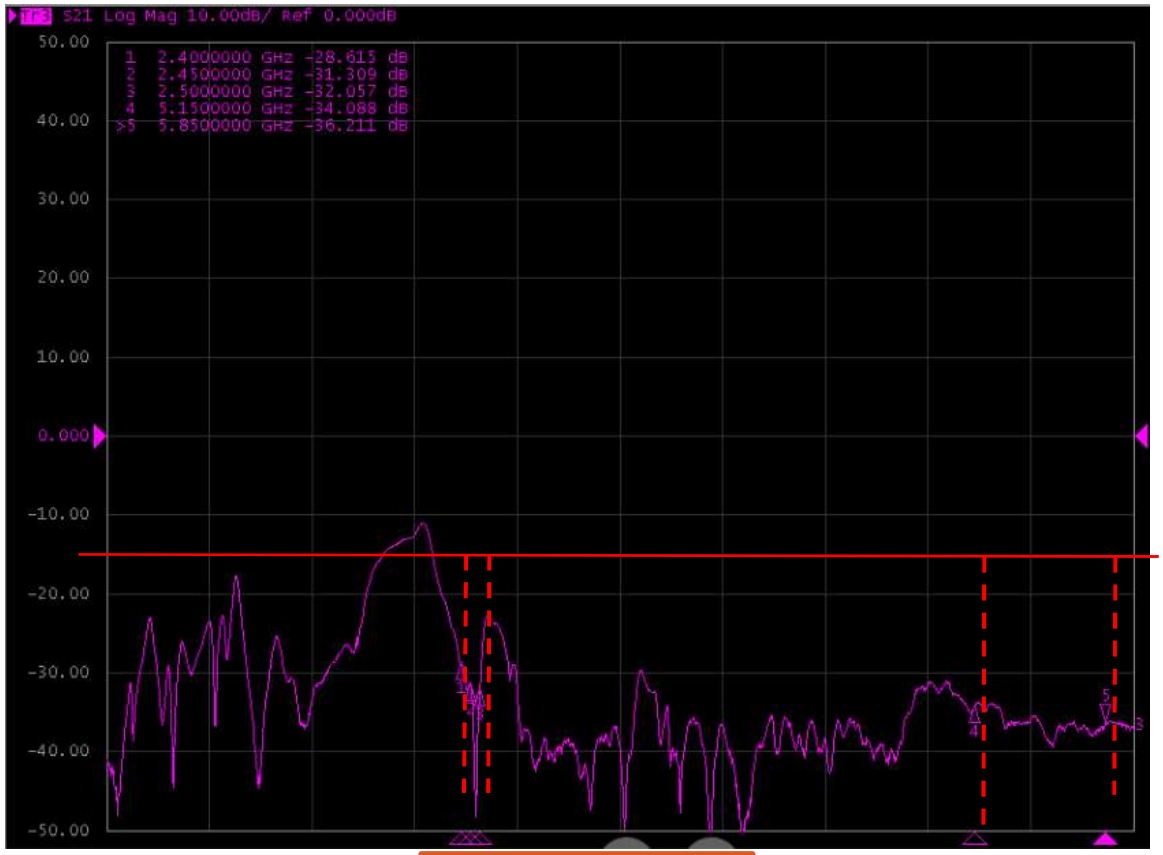


PASS

Spec＜-15

LTE-DIV & WIFI1

Isolation Results

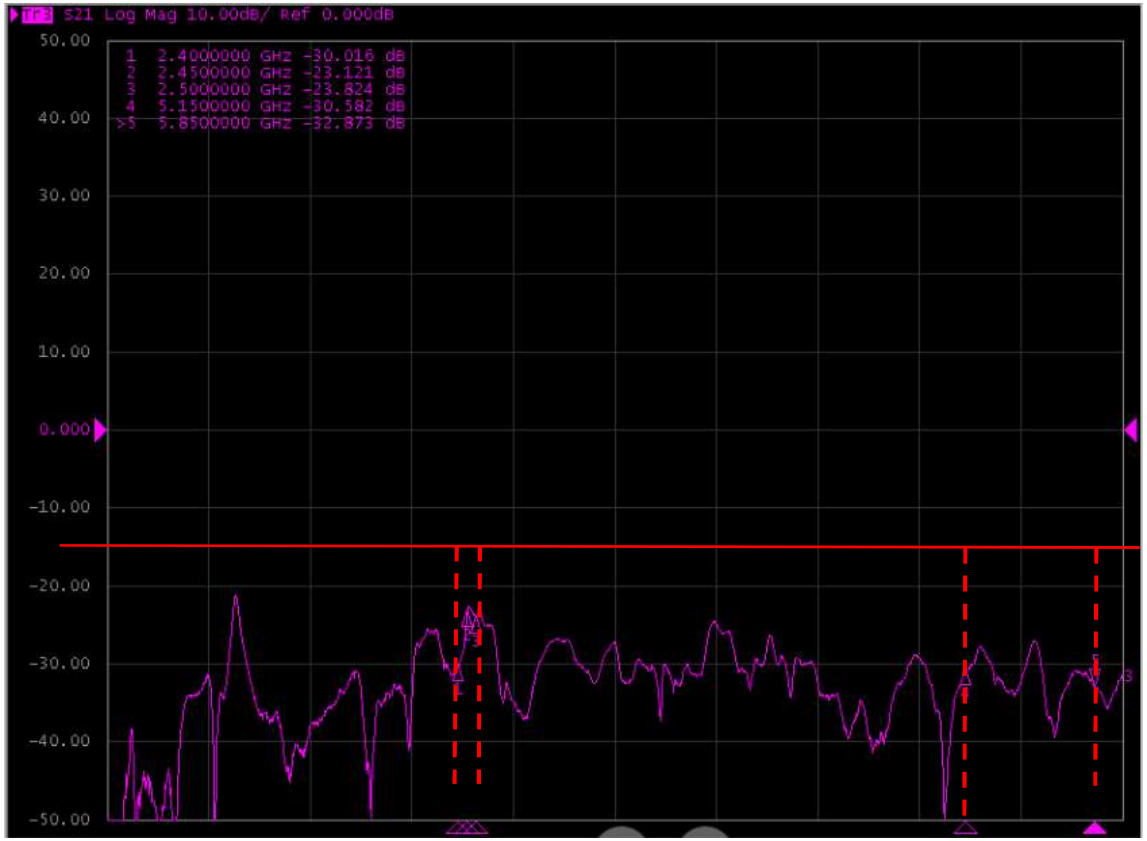


PASS

Spec＜-15

LTE-DIV & WIFI2

Isolation Results

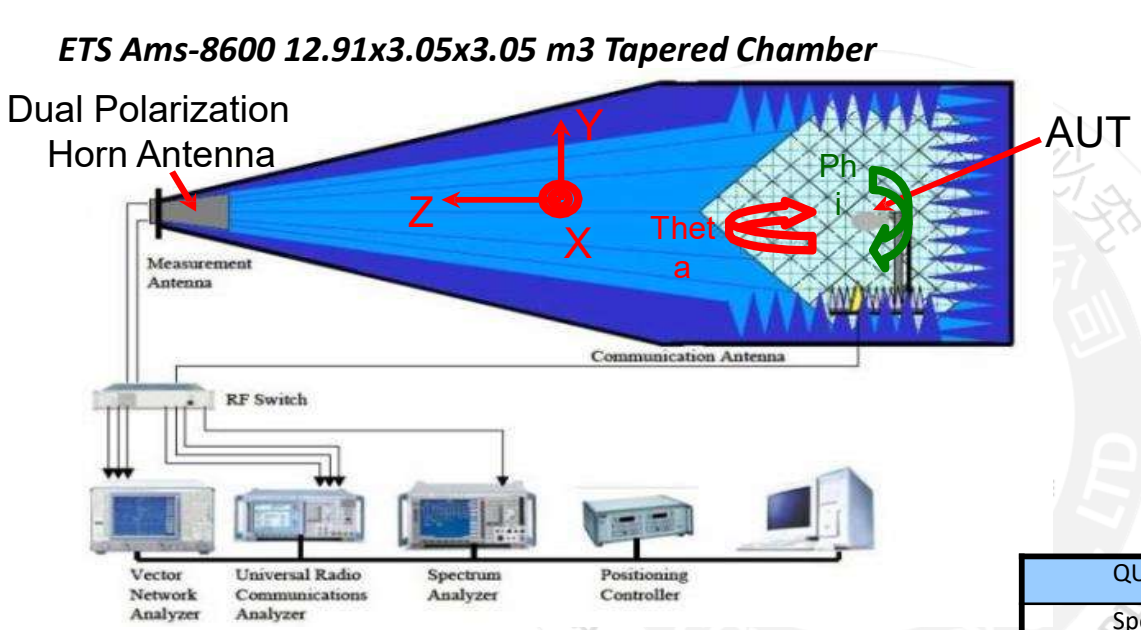


PASS

Spec＜-15

WIFI1 & WIFI2

Test Setup for Radiation Pattern Measurement



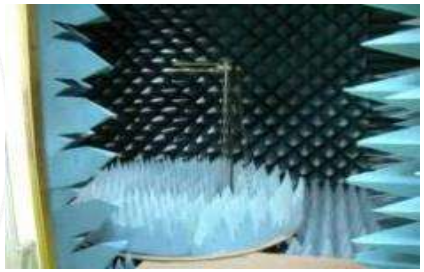
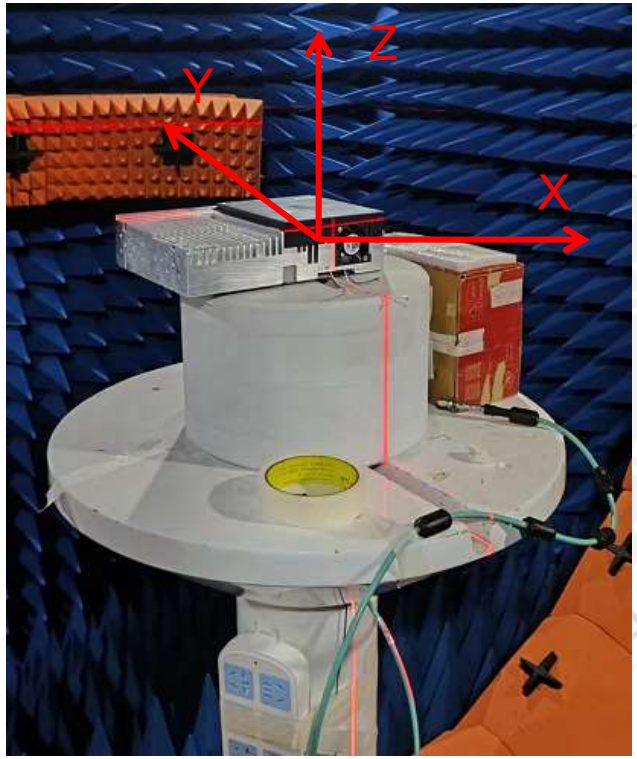


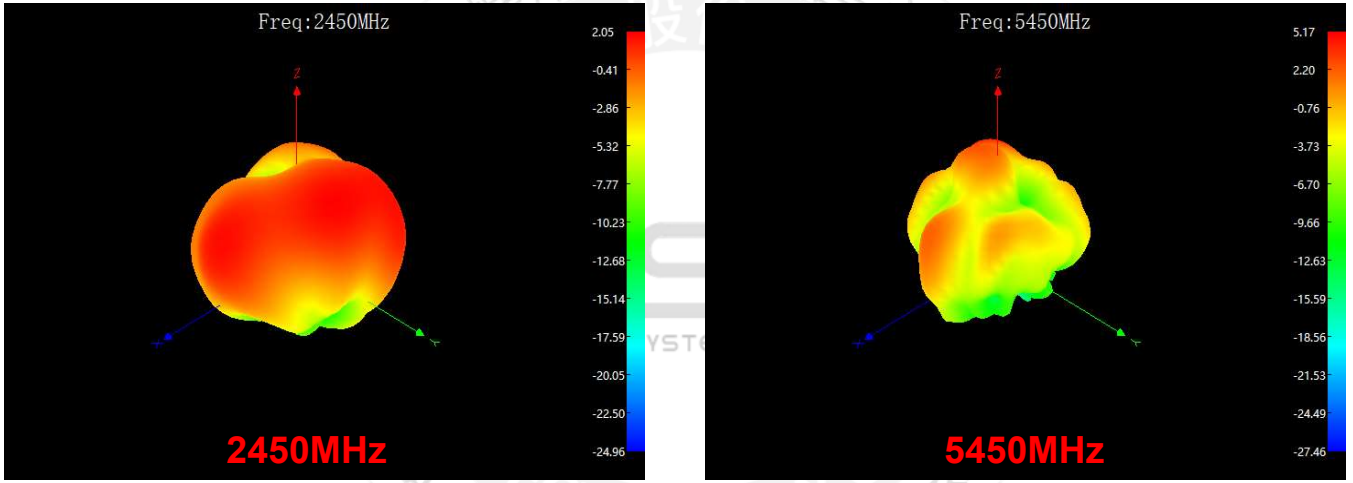
Figure 1: System diagram for test system including compact-size tapered anechoic chamber and optional test instrumentation

QUIPMENT	BRAND	MODULE TYPE
Spectrum	Agilent	E4402B
Signal Generator	Agilent	8960
Switch	Agilent	3499A
Switch	ETS	2090
Network Analyzer	Agilent	N5230A

3D/2D Radiation Pattern Results

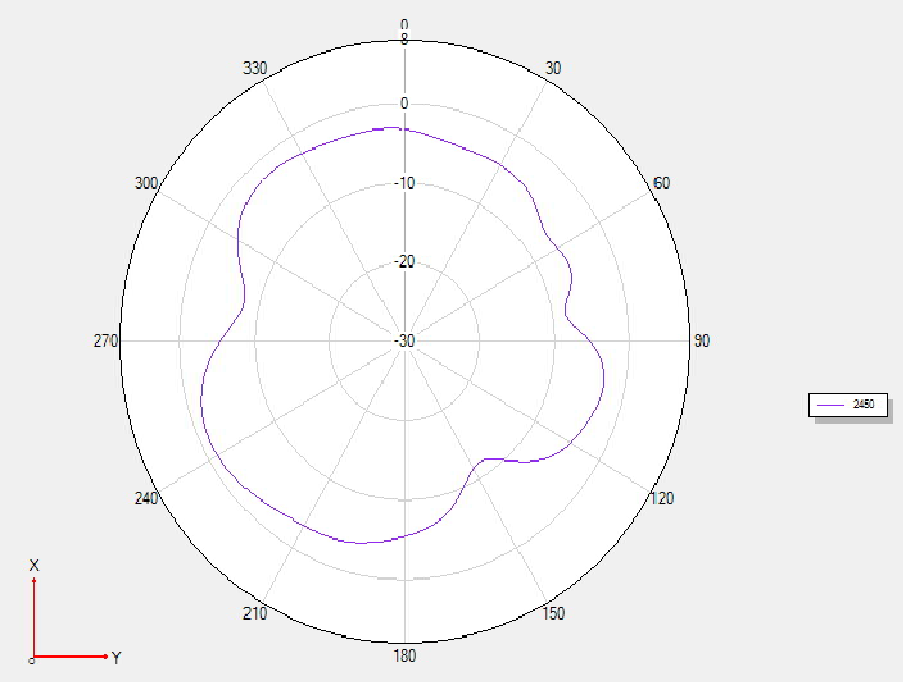


3D/2D Radiation Pattern Results

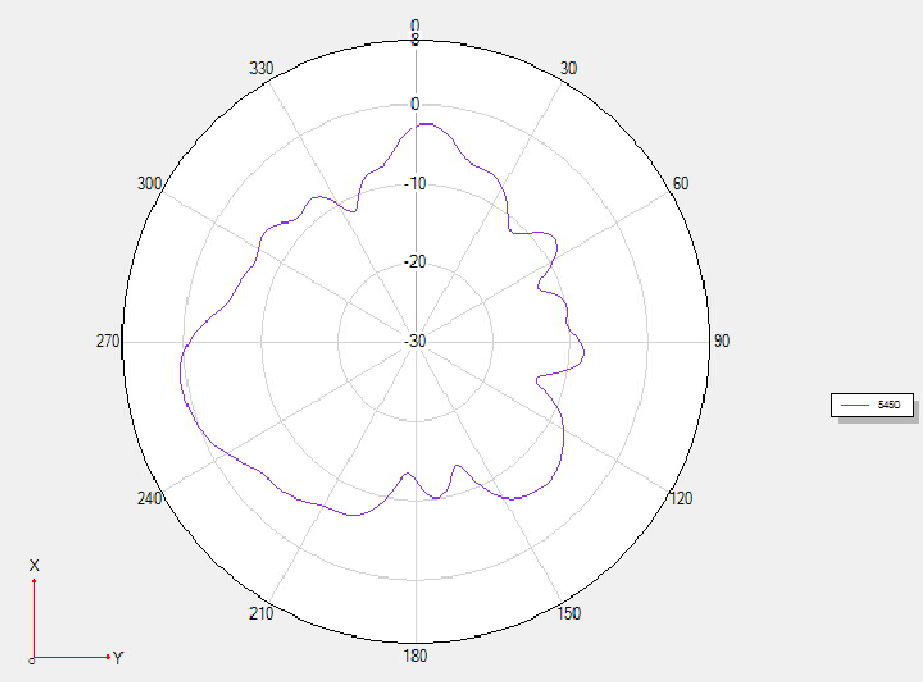


WIFI1

3D/2D Radiation Pattern Results



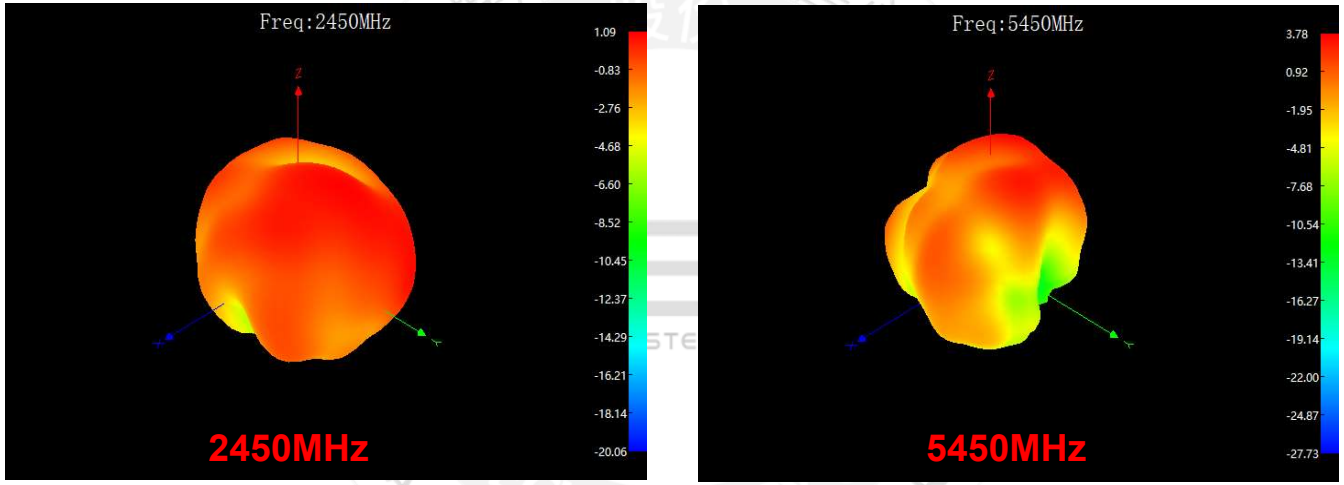
2450MHz @ Θ:90˚



5450MHz @ Θ:90˚

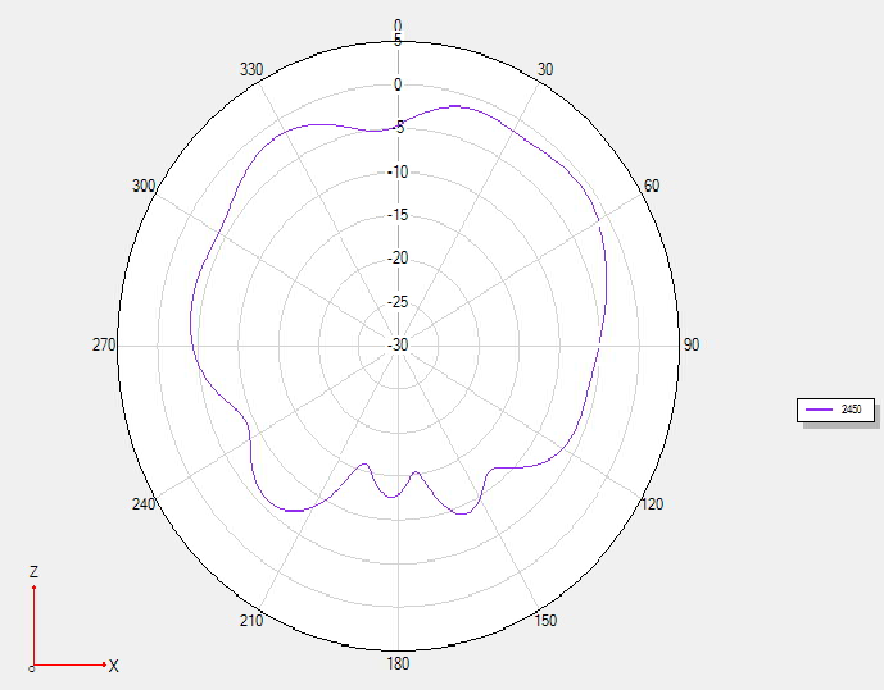
WIFI1

3D/2D Radiation Pattern Results

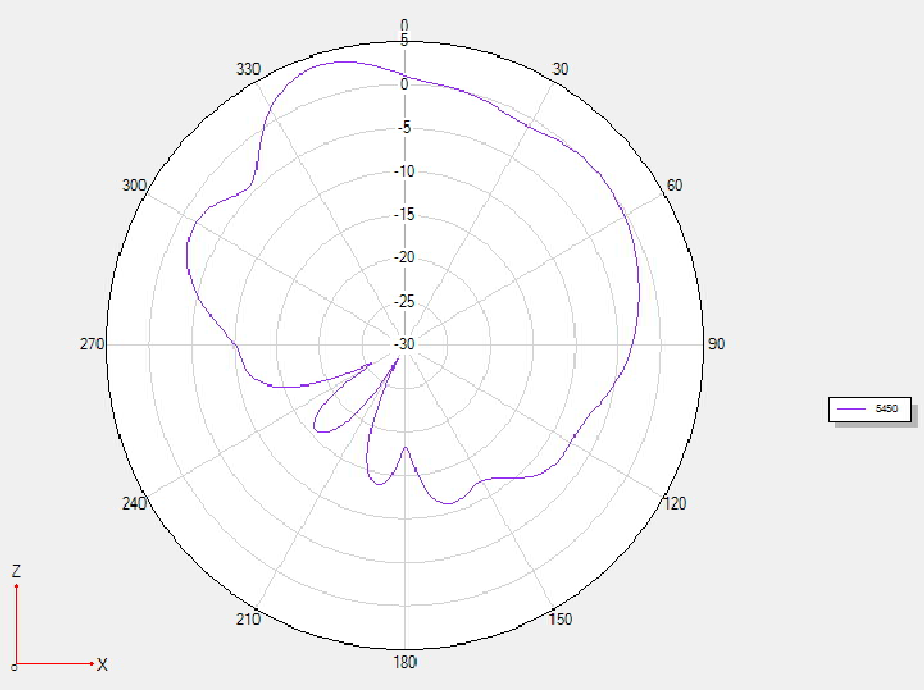


WIFI2

3D/2D Radiation Pattern Results



2450MHz @ Θ:90˚



5450MHz @ Θ:90˚

WIFI2

Results Summary-Peak Gain & Efficiency

LTE-Main Antenna

Frequency / MHz	Efficiency / %	Max Gain/DBi
700	30.49	-0.75
710	30.83	-0.8
720	31.3	-1.08
730	32.2	-1.29
740	34.12	-1.19
750	35.51	-0.48
760	36.08	0.12
770	40.93	0.65
780	44.46	1.39
790	44.26	1.23
800	41.3	0.53
810	40.11	-0.49

Frequency / MHz	Efficiency / %	Max Gain/DBi
820	39.22	-0.78
830	38.65	1.23
840	40.39	0.46
850	42.95	1.17
860	45.29	1.31
870	44.16	0.46
880	41.3	-0.22
890	39.33	-0.91
900	38.06	-0.97
910	39.07	-0.89
920	39.76	0.01
930	40.09	0.87
940	39.63	0.38
950	43.85	1.02
960	46.99	1.12

Results Summary-Peak Gain & Efficiency

LTE-Main Antenna

Frequency / MHz	Efficiency / %	Max Gain/DBi
1700	58.48	4.37
1720	58.34	3.89
1740	55.08	3.17
1760	51.17	3.15
1780	49.89	3
1800	48.19	3.01
1820	46.13	3.58
1840	47.32	2.97
1860	46.13	3.23
1880	46.77	3.22
1900	46.99	3.93
1920	45.92	3.87
1940	45.81	3.35
1960	46.45	3.08
1980	47.86	3.31

Frequency / MHz	Efficiency / %	Max Gain/DBi
2000	48.98	3.36
2020	51.52	3.68
2040	52.72	3.69
2060	54.2	3.26
2080	53.58	2.92
2100	52.84	2.65
2120	46.24	1.96
2140	43.15	1.26
2160	43.05	1.85
2180	46.45	2.07
2200	48.31	2.73
2220	47.42	2.87
2240	45.6	2.44
2260	44.46	2.58
2280	42.76	2.7

Frequency / MHz	Efficiency / %	Max Gain/DBi
2300	43.25	3.14
2320	44.87	2.51
2340	45.5	2.25
2360	43.35	2.02
2380	42.76	2.83
2520	42.17	3
2540	39.72	2.18
2560	37.67	2.71
2580	36.9	3.23
2600	37.33	3.63
2620	37.93	3.89
2640	39.26	4.28
2660	39.63	4.52
2680	37.15	4.34
2700	36.59	3.8

Results Summary-Peak Gain & Efficiency

LTE-DIV Antenna

Frequency / MHz	Efficiency / %	Max Gain/DBi
1700	49.2	4.45
1720	50.47	4.15
1740	49.66	3.4
1760	49.77	3.56
1780	50.58	3.31
1800	47.1	2.12
1820	41.69	2.02
1840	40.18	2.12
1860	37.76	2.98
1880	38.73	2.62
1900	36.51	1.44
1920	36.04	1.57
1940	36.36	2.1
1960	37.81	2.2
1980	8.98	2.29

Frequency / MHz	Efficiency / %	Max Gain/DBi
2000	39.11	2.16
2020	40.17	2.46
2040	40.99	2.54
2060	41.69	2.32
2080	42.66	2.27
2100	42.85	2.2
2120	39.9	2.11
2140	41.78	2.42
2160	41.98	3.03
2180	40.93	2.96
2200	38.37	2.57
2220	38.58	2.38
2240	41.78	3.06
2260	48.08	4.09
2280	52.84	4.23

Frequency / MHz	Efficiency / %	Max Gain/DBi
2300	55.85	4.36
2320	57.28	4.42
2340	55.98	4.54
2360	50.12	4.11
2380	46.34	3.97
2520	44.87	3.72
2540	46.13	3.45
2560	47.75	3.83
2580	50.82	4.14
2600	51.88	3.94
2620	51.88	3.51
2640	51.17	3.28
2660	50.47	3.89
2680	50.82	4.03
2700	49.55	3.52

Results Summary-Peak Gain & Efficiency

WIFI1 Antenna

Frequency / MHz	Efficiency / %	Max Gain/DBi
2400	52.84	4.16
2410	51.17	3.66
2420	51.52	3.21
2430	51.35	2.49
2440	50.32	2
2450	49.75	2.05
2460	48.81	2.46
2470	48.34	2.91
2480	47.16	2.88
2490	47.36	3.14
2500	47.16	3.04

Frequency / MHz	Efficiency / %	Max Gain/DBi
5150	51.76	5.09
5200	51.4	4.87
5250	50.93	5.57
5300	49.75	6.03
5350	48.87	4.87
5400	50.93	4.63
5450	50.82	5.17
5500	48.98	5
5550	49.42	4.88
5600	47.26	3.78
5650	45.95	3.42
5700	45.76	3.69
5750	50.08	4.81
5800	49.86	5.03
5850	48.77	5.12

Results Summary-Peak Gain & Efficiency

WIFI2 Antenna

Frequency / MHz	Efficiency / %	Max Gain/DBi
2400	47.71	0.39
2410	48.13	0.35
2420	50.42	0.91
2430	50.64	0.78
2440	51.32	0.95
2450	52.12	1.09
2460	49.75	1.23
2470	50.31	1.28
2480	48.08	1.04
2490	47.95	1.17
2500	47.36	0.86

Frequency / MHz	Efficiency / %	Max Gain/DBi
5150	50.82	4.42
5200	53.7	4.84
5250	51.76	5.11
5300	47.81	4.74
5350	49.19	4.62
5400	49.42	4.33
5450	50.58	3.78
5500	52.21	3.41
5550	52.94	3.49
5600	51.49	3.96
5650	51.08	3.79
5700	50.12	3.84
5750	51.2	3.96
5800	51.58	4.57
5850	52.75	5.14

Conclusion

1，目前经过初版调试优化，各天线效率可以满足标准要求。
2，天线隔离度，各天线工作频段内隔离度达标。
3，目前仅为无源调试，还需有源机器进行**OTA**测试**TRP/TIS**指标，最终需以有源测试为准。

以上请知悉，感谢！

Thank you