



Antenna Test Report for 8x8 Wi-Fi 6 AP (M/N:MR56-HW)



Contents

- **General Information**
- **Test Setup**
 - Diagram
 - Equipment
 - Procedure
- **Test Result**
 - Summary
 - Performance

General Information

■ Antenna Information:

- Brand: WNC

20 Park Ave. II, Hsinchu Science Park, Hsinchu 308, Taiwan

■ Antenna Type:

– Wi-Fi 2/5G: PIFA (95XKAA15.GJ1)

– Wi-Fi 5G: PIFA (95XKAA15.GJ1)

– BLE: PIFA (95XKAA15.GJ3)

– Scanning: PIFA (95XKAA15.GJ2)

■ Test Date and Member

Date: 2020/ 04/27

Member: Gary

General Information

■ Radio information:

– About 2.4G operation

- MR56 is 4 x 4 multiple input, multiple output (MIMO) with four spatial streams on 2.4 GHz.
- And it offers MU-MIMO and OFDMA for more efficient transmission to multiple clients.
- Supported modes are listed below:

2.4GHz Band		
MODULATION MODE	TX & RX CONFIGURATION	
802.11b	4TX	4RX
802.11g	4TX	4RX
802.11n (HT20)	4TX	4RX
802.11n (HT40)	4TX	4RX
VHT20	4TX	4RX
VHT40	4TX	4RX
802.11ax (HE20)	4TX	4RX
802.11ax (HE40)	4TX	4RX

Note:

1. All of modulation mode support beamforming function except 802.11b/g modulation mode.
2. The EUT support Beamforming and CDD mode, therefore both mode were investigated and the worst case scenario was identified. The worst case data were presented in test report.

- Note: The worst-case spatial stream configuration for 2.4G operation is $N_{ss}=1$.

General Information

■ Radio information:

– About 5G operation

- MR56 is 8 x 8 multiple input, multiple output (MIMO) with eight spatial streams on 5 GHz.
- And it offers MU-MIMO and OFDMA for more efficient transmission to multiple clients.
- Supported modes are listed below:

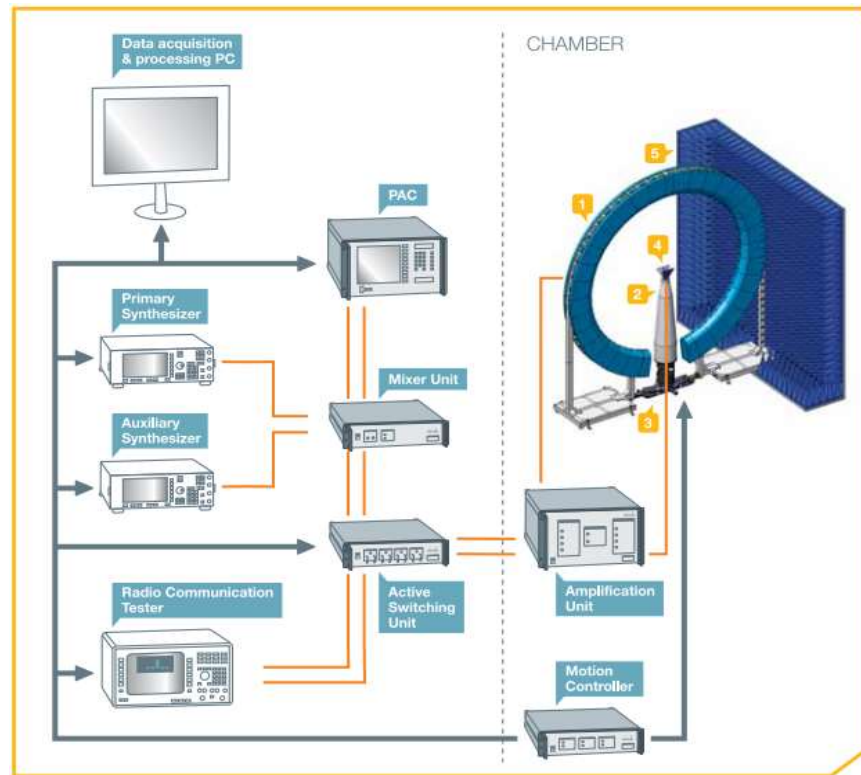
5GHz Band		
MODULATION MODE	TX & RX CONFIGURATION	
802.11a	8TX	8RX
802.11n (HT20)	8TX	8RX
802.11n (HT40)	8TX	8RX
802.11ac (VHT20)	8TX	8RX
802.11ac (VHT40)	8TX	8RX
802.11ac (VHT80)	8TX	8RX
802.11ac (VHT80+VHT80)	4TX+4TX	4RX +4RX
802.11ax (HE20)	8TX	8RX
802.11ax (HE40)	8TX	8RX
802.11ax (HE80)	8TX	8RX
802.11ax (HE80+HE80)	4TX+4TX	4RX +4RX

Note:

1. All of modulation mode support beamforming function except 802.11a modulation mode.
2. The EUT support Beamforming and Non-Beamforming mode, therefore both mode were investigated and the worst case scenario was identified. The worst case data were presented in test report.

- Note: The worst-case spatial stream configuration for 5G operation is $N_{ss}=1$.

Test Setup and Diagram



SG 64 uses analog RF signal generators to emit EM waves from the probe array to the antenna under test (AUT) or vice versa.

It uses the NPAC as an RF receiver for antenna measurements. The NPAC also drives the electronic scanning of the probe array.

The NPAC includes the fastest and most accurate sources and receivers on the market.

Equipment

Device	Type/Model	Serial#	Manufacturer	Calibrated Date	Calibrated Until
SG64 Chamber	Standard	SG64	MVG	2020/03/30	2024/03/30
Turn Table	Customization	-	Machinery Dept.	2020/03/30	2024/03/30
New Probe Array Controller	N/A	1102341-4535	MVG	2020/03/30	2024/03/30
Power Supply Unit	N/A	1103211-13204	MVG	2020/03/30	2024/03/30
Active Switching Unit	N/A	1102347-7214	MVG	2020/03/30	2024/03/30
TX Amplification Unit	N/A	1102527-5909	MVG	2020/03/30	2024/03/30
RX Amplification Unit	N/A	1102536-3823	MVG	2020/03/30	2024/03/30
Transfer Swittching Unit	N/A	1102183-3351	MVG	2020/03/30	2024/03/30
Mixer Unit	N/A	1102545-7208	MVG	2020/03/30	2024/03/30
Power And Control Unit	N/A	1102706-7209	MVG	2020/03/30	2024/03/30
Antenna Probe	DP 400-6000	-	MVG	2020/03/30	2024/03/30
Cable 13.7m - 400MHz to 18GHz	SS402	00100A1F5A1XXS	Woken	2020/03/30	2024/03/30
Temperature & Humidity Meter	HTC-01	-	Metravi	2020/03/30	2024/03/30

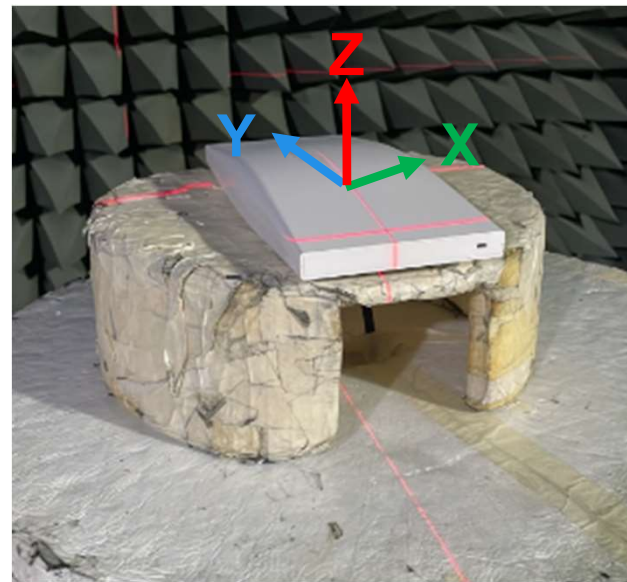
Note:

1. There are 63 set ANT probes in WNC's SG64 Chamber.

Test Setup and Procedure



- Place the device at the center of the chamber.
- Connect the antenna cable to RF cable of the chamber
- Run Satimo test SW (**NPAC Spherical Measurement, v1.5.4 (GIT-E6965664)**)
- Get 3D data in 2.8125 degree step from phi 0° ~ 360° and theta -90° ~ $+90^{\circ}$, including efficiency, peak gain, 2D & 3D radiation pattern.
- This is far field test for **MR56-HW** antenna verification.
- This is passive measurement, which means the device is off and not in any operating mode.



Summary

– **VSWR**

- *Under 2 for 2.4GHz and 5GHz application*

– **Isolation**

- *Above 20dB for all antennas*

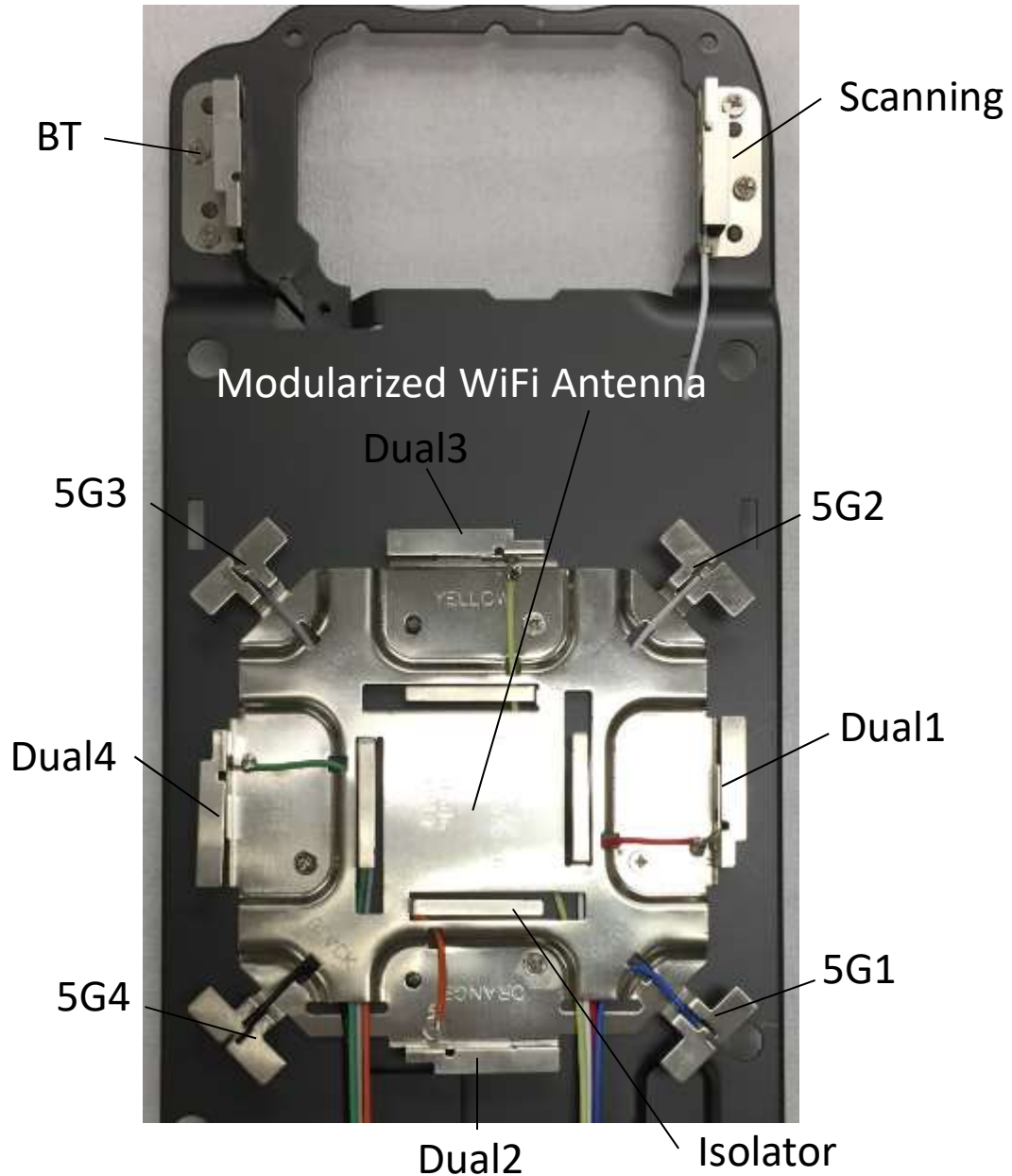
– **Average Radiation efficiency (excluding cable length loss)**

- *70% for dual-band 2.4GHz antenna ; 81% for dual-band 5GHz antenna*
- *80% for 5GH antenna*
- *75% for Scanning 2.4GHz antenna ; 79% for Scanning 5GHz antenna*
- *68% for BT antenna*

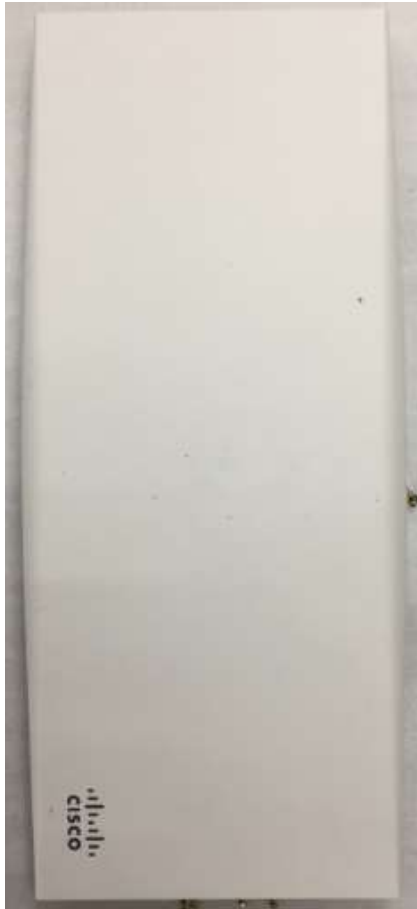
– **Peak gain**

- *5.5dBi for dual-band 2.4GHz antenna ; 6.4dBi for dual-band 5G antenna*
- *5.9dBi for 5GH antenna*
- *3.6dBi for Scanning 2.4GHz antenna ; 5.4dBi for Scanning 5G antenna*
- *3.6dBi for BT antenna*

Antenna Placement



Test Product Specification



Top cover



Main-Board



Chassis-Bottom



Bottom cover

Antenna Efficiency and Peak Gain

	Frequency (MHz)	2400	2450	2500	Avg.	5150	5350	5550	5750	5850	Avg.
Dual1	Eff. (%)	58%	64%	61%	61%	66%	69%	68%	68%	63%	67%
	Avg. Gain (dB)	-2.4	-1.95	-2.18		-1.79	-1.62	-1.67	-1.68	-2.01	
	w/o cable loss Eff. (%)	65%	72%	68%	69%	81%	84%	83%	83%	77%	81%
	Peak Gain (dBi)	4.64	5.44	5.28		4.88	5.45	5.54	5.87	5.50	
Dual2	Eff. (%)	59%	64%	62%	62%	62%	68%	63%	69%	66%	66%
	Avg. Gain (dB)	-2.28	-1.91	-2.07		-2.07	-1.68	-2	-1.59	-1.81	
	w/o cable loss Eff. (%)	67%	72%	70%	70%	75%	82%	77%	84%	80%	80%
	Peak Gain (dBi)	4.09	4.48	4.67		6.20	6.44	5.69	6.39	5.74	
Dual3	Eff. (%)	61%	65%	60%	62%	63%	69%	65%	68%	66%	66%
	Avg. Gain (dB)	-2.12	-1.84	-2.19		-2	-1.62	-1.88	-1.69	-1.78	
	w/o cable loss Eff. (%)	70%	75%	69%	71%	79%	86%	81%	85%	83%	83%
	Peak Gain (dBi)	4.90	4.63	4.82		5.18	5.94	5.34	5.58	5.38	
Dual4	Eff. (%)	58%	65%	59%	61%	72%	69%	63%	63%	61%	65%
	Avg. Gain (dB)	-2.36	-1.89	-2.29		-1.45	-1.62	-1.99	-2.01	-2.16	
	w/o cable loss Eff. (%)	66%	73%	67%	69%	88%	84%	77%	77%	74%	80%
	Peak Gain (dBi)	4.10	5.01	5.54		5.25	5.50	4.27	5.16	4.79	

Antenna Efficiency and Peak Gain

	Frequency (MHz)	5150	5350	5550	5750	5850	Avg.
5G1	Eff. (%)	69%	69%	64%	60%	64%	65%
	Avg. Gain (dB)	-1.6	-1.62	-1.93	-2.21	-1.92	
	w/o cable loss Eff. (%)	82%	82%	76%	71%	76%	78%
	Peak Gain (dBi)	5.35	5.28	4.96	5.40	5.66	
5G2	Eff. (%)	65%	69%	62%	68%	64%	66%
	Avg. Gain (dB)	-1.86	-1.58	-2.06	-1.68	-1.96	
	w/o cable loss Eff. (%)	82%	88%	79%	86%	81%	83%
	Peak Gain (dBi)	5.95	5.81	5.29	5.57	5.08	
5G3	Eff. (%)	58%	67%	67%	60%	61%	63%
	Avg. Gain (dB)	-2.35	-1.76	-1.73	-2.19	-2.18	
	w/o cable loss Eff. (%)	74%	85%	85%	77%	77%	79%
	Peak Gain (dBi)	4.65	5.40	4.92	4.27	4.24	
5G4	Eff. (%)	66%	65%	67%	72%	68%	68%
	Avg. Gain (dB)	-1.80	-1.89	-1.76	-1.41	-1.67	
	w/o cable loss Eff. (%)	78%	77%	79%	86%	81%	80%
	Peak Gain (dBi)	5.67	5.19	5.80	5.70	5.50	

Antenna Efficiency and Peak Gain

	Frequency (MHz)	2400	2450	2500	Avg.	5150	5350	5550	5750	5850	Avg.
Scanning	Eff. (%)	63%	71%	69%	68%	69%	67%	64%	69%	66%	67%
	Avg. Gain (dB)	-2.03	-1.51	-1.63		-1.62	-1.73	-1.93	-1.63	-1.81	
	w/o cable loss Eff. (%)	69%	78%	76%	75%	81%	79%	76%	81%	78%	79%
	Peak Gain (dBi)	3.18	3.69	3.10		5.43	4.97	4.71	5.01	4.72	

	Frequency (MHz)	2400	2450	2500	Avg.
BT	Eff. (%)	64%	67%	67%	66%
	Avg. Gain (dB)	-1.95	-1.77	-1.76	
	w/o cable loss Eff. (%)	66%	69%	69%	68%
	Peak Gain (dBi)	3.51	3.58	3.61	

Antenna Composite gain- calculated Method



Directional Gain Calculations (co-pol)

In-Band Measurement, Unequal Antenna Gains

- If Any Transmit Signals Are Correlated:

- Directional Gain= $10\log[(10^{\frac{G_1}{20}}+10^{\frac{G_2}{20}}+\dots+10^{\frac{G_n}{20}})^2 / N_{ant}] \text{ dBi}$

- If All Transmit Signals Are Completely Uncorrelated:

- Directional Gain= $10\log[(10^{\frac{G_1}{10}}+10^{\frac{G_2}{10}}+\dots+10^{\frac{G_n}{10}})/N_{ant}] \text{ dBi}$

N_{ant} : Number of Transmit Antennas

G_1, G_2, \dots, G_n : Gain of Individual Antennas

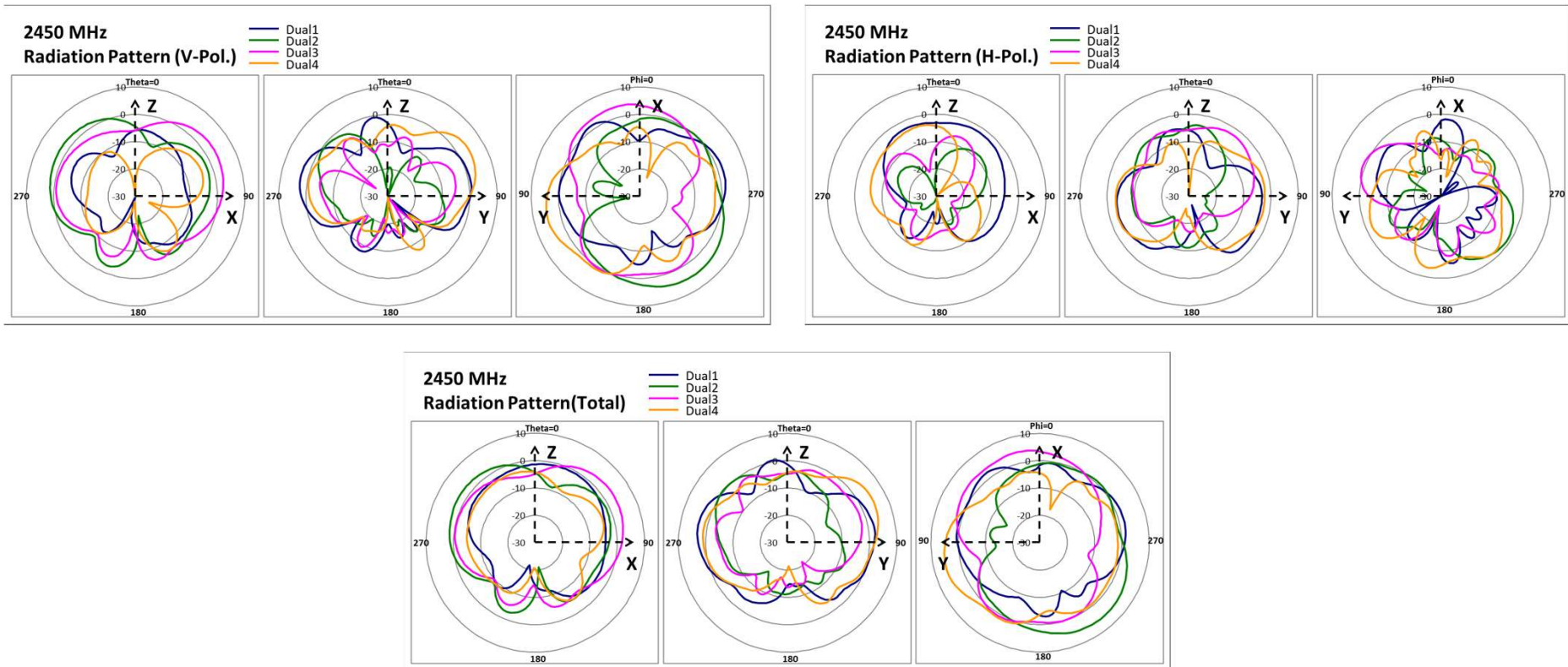
April 13, 2016

TCB Workshop

7

Antenna Composite gain- data calculated explain

1. Measure 4 antennas and output V-pol.(Gain theta), H-pol.(Gain phi) and total radiation pattern.



Antenna Composite gain- data calculated explain

- Calculate with four antennas pattern by page13 formula.
 - Below table(circled in red) is four antennas XZ cut plane in V-pol.(gain theta) data, these data by using formula to calculation and output directional gain.
 - Use same method to get YZ / XY plane directional gain data.

Example:

● If Any Transmit Signals Are Correlated:

$$\text{Directional Gain} = 10 \log \left[\left(10^{\frac{G_1}{20}} + 10^{\frac{G_2}{20}} + \dots + 10^{\frac{G_n}{20}} \right)^2 / N_{ant} \right] \text{ dBi}$$

v-pol	XZ cut								
Ant1		-3.76814	-4.19292	-4.66602	-5.19607	-5.78957	-6.44544	-7.16206	-7.93125
Ant2		-0.75284	-0.25145	0.18119	0.547973	0.859547	1.103471	1.295622	1.418946
Ant3		-5.25615	-4.41829	-3.67379	-3.01051	-2.41228	-1.87137	-1.38116	-0.93979
Ant4		-2.01204	-3.31614	-4.92656	-6.97685	-9.72533	-13.788	-21.2627	-25.473

correlated									
calculated									
directional gain	3.88	3.24	3.14	3.01	2.83	2.61	2.35	2.07	2.04
uncorrelated									
calculated									
directional gain	-1.38	-2.62	-2.69	-2.73	-2.72	-2.67	-2.58	-2.45	-2.30

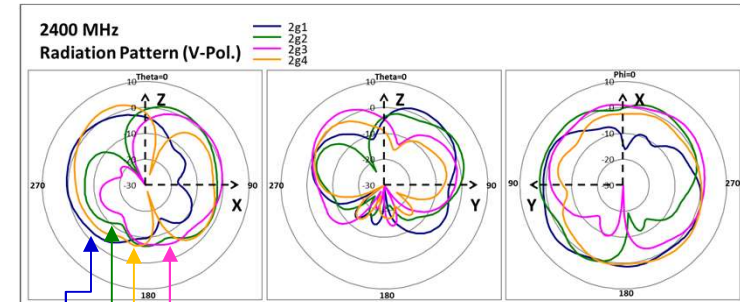
Max. directional gain in XZ cut

● If All Transmit Signals Are Completely Uncorrelated:

$$\text{Directional Gain} = 10 \log \left[\left(10^{\frac{G_1}{10}} + 10^{\frac{G_2}{10}} + \dots + 10^{\frac{G_n}{10}} \right) / N_{ant} \right] \text{ dBi}$$



Using same calculation method output XZ, YZ and XY cut in v-pol. , h-pol. and total directional gain



Antenna Composite gain- data calculated explain

3. Calculate three cut planes(XZ/YZ/XY) and find maximum value of three planes. This maximum value will be this frequency directional gain. , Example for 2.4GHz :

XZ-plane		Frequency	2400	2450	2500
Dual1	Total	PeakGain	-2.67	-0.78	-1.02
Dual2	Total	PeakGain	0.44	2.61	4.12
Dual3	Total	PeakGain	2.04	3.53	2.74
Dual4	Total	PeakGain	-0.64	-3.42	-2.48
Corr. Composite	Total	Peak Gain	5.37	5.46	5.40
UnCorr. Composite	Total	Peak Gain	-0.44	-0.03	0.13

YZ-plane		Frequency	2400	2450	2500
Dual1	Total	PeakGain	4.48	3.42	5.22
Dual2	Total	PeakGain	0.09	0.46	-0.93
Dual3	Total	PeakGain	-0.07	-1.76	-0.78
Dual4	Total	PeakGain	3.77	4.89	4.99
Corr. Composite	Total	Peak Gain	6.57	6.01	5.15
UnCorr. Composite	Total	Peak Gain	0.97	1.03	0.59

XY-plane		Frequency	2400	2450	2500
Dual1	Total	PeakGain	3.36	2.19	3.99
Dual2	Total	PeakGain	4.09	5.70	4.40
Dual3	Total	PeakGain	4.90	4.15	4.82
Dual4	Total	PeakGain	3.67	5.57	5.08
Corr. Composite	Total	Peak Gain	5.99	6.53	6.26
UnCorr. Composite	Total	Peak Gain	0.72	1.44	1.09

Corr. Composite	Total	Peak Gain	6.57	6.53	6.26
UnCorr. Composite	Total	Peak Gain	0.97	1.44	1.09

Antenna Composite gain- data calculated explain

Calculate three cut planes(XZ/YZ/XY) and find maximum value of three planes. This maximum value will be this frequency directional gain. Example for 5GHz :

XZ-plane		Frequency	5150	5350	5550	5750	5850
5G1	Total	PeakGain	4.42	4.60	4.07	3.88	4.53
5G2	Total	PeakGain	5.26	5.65	4.99	5.18	4.69
5G3	Total	PeakGain	4.71	5.31	4.70	4.87	4.73
5G4	Total	PeakGain	4.66	5.68	4.31	5.18	4.87
Corr. Composite	Total	Peak Gain	10.58	10.71	10.21	10.68	10.30
UnCorr. Composite	Total	Peak Gain	4.57	4.70	4.19	4.67	4.29

YZ-plane		Frequency	5150	5350	5550	5750	5850
5G1	Total	PeakGain	5.23	4.91	4.25	4.14	4.34
5G2	Total	PeakGain	5.20	4.98	5.28	5.41	4.90
5G3	Total	PeakGain	5.19	5.33	4.76	5.13	4.86
5G4	Total	PeakGain	5.17	5.51	4.85	5.62	5.04
Corr. Composite	Total	Peak Gain	10.73	10.71	10.33	10.54	10.15
UnCorr. Composite	Total	Peak Gain	4.72	4.70	4.32	4.53	4.16

XY-plane		Frequency	5150	5350	5550	5750	5850
5G1	Total	PeakGain	4.60	4.39	4.85	5.67	4.68
5G2	Total	PeakGain	2.98	3.62	4.06	4.77	4.70
5G3	Total	PeakGain	2.42	3.86	3.54	4.71	4.51
5G4	Total	PeakGain	4.15	3.78	4.58	4.84	4.47
Corr. Composite	Total	Peak Gain	7.30	7.18	7.60	7.82	7.52
UnCorr. Composite	Total	Peak Gain	1.72	1.60	1.97	2.11	1.60

Corr. Composite		10.73	10.71	10.33	10.68	10.30
UnCorr. Composite		4.72	4.70	4.32	4.67	4.29

Antenna Composite gain- data calculated explain

Calculate three cut planes(XZ/YZ/XY) and find maximum value of three planes. This maximum value will be this frequency directional gain. Example for 8x8 5GHz

XZ-plane		Frequency	5150	5350	5550	5750
Dual1	H-Pol.	PeakGain	3.64	3.16	2.89	1.70
	V-Pol.	PeakGain	1.27	2.85	2.67	1.96
Dual2	H-Pol.	PeakGain	-3.32	-8.21	-11.76	-5.16
	V-Pol.	PeakGain	1.86	1.46	1.51	2.17
Dual3	H-Pol.	PeakGain	-6.14	-7.34	-7.52	-5.78
	V-Pol.	PeakGain	2.34	1.77	1.80	2.13
Dual4	H-Pol.	PeakGain	3.94	3.52	2.94	3.49
	V-Pol.	PeakGain	2.67	3.15	1.65	3.73
5G1	H-Pol.	PeakGain	1.19	1.55	-0.31	-0.27
	V-Pol.	PeakGain	2.11	1.75	2.20	2.23
5G2	H-Pol.	PeakGain	2.24	3.26	1.35	2.34
	V-Pol.	PeakGain	3.08	2.05	3.37	3.07
5G3	H-Pol.	PeakGain	1.50	2.03	1.49	1.84
	V-Pol.	PeakGain	2.37	2.71	2.22	2.08
5G4	H-Pol.	PeakGain	1.95	2.16	2.48	2.47
	V-Pol.	PeakGain	2.35	3.12	2.32	3.61
Corr. Composite	H-Pol.	Peak Gain	8.67	8.91	7.80	8.70
	V-Pol.	Peak Gain	8.77	8.69	8.75	9.09
UnCorr. Composite	H-Pol.	Peak Gain	0.43	0.60	-0.28	0.39
	V-Pol.	Peak Gain	0.54	0.43	0.48	0.53

YZ-plane		Frequency	5150	5350	5550	5750
Dual1	H-Pol.	PeakGain	-5.99	-7.45	-7.81	-4.53
	V-Pol.	PeakGain	3.30	2.60	3.02	1.69
Dual2	H-Pol.	PeakGain	5.29	5.58	5.05	5.05
	V-Pol.	PeakGain	1.55	1.85	0.70	1.51
Dual3	H-Pol.	PeakGain	3.95	3.89	4.14	4.21
	V-Pol.	PeakGain	1.62	2.62	2.49	3.46
Dual4	H-Pol.	PeakGain	-6.47	-7.83	-4.93	-6.85
	V-Pol.	PeakGain	3.29	2.51	1.28	2.91
5G1	H-Pol.	PeakGain	1.82	2.02	2.50	1.37
	V-Pol.	PeakGain	2.58	2.40	0.98	1.08
5G2	H-Pol.	PeakGain	2.57	2.48	2.38	2.14
	V-Pol.	PeakGain	2.34	2.44	2.64	3.02
5G3	H-Pol.	PeakGain	2.75	2.93	2.27	2.39
	V-Pol.	PeakGain	2.32	2.26	2.21	1.82
5G4	H-Pol.	PeakGain	3.00	2.97	2.24	3.90
	V-Pol.	PeakGain	1.97	2.23	2.07	2.77
Corr. Composite	H-Pol.	Peak Gain	8.93	9.02	8.84	9.20
	V-Pol.	Peak Gain	9.29	9.34	8.88	9.20
UnCorr. Composite	H-Pol.	Peak Gain	0.83	1.05	0.75	0.56
	V-Pol.	Peak Gain	0.69	0.74	0.19	0.40

XY-plane		Frequency	5150	5350	5550	5750
Dual1	H-Pol.	PeakGain	3.32	3.21	3.69	2.56
	V-Pol.	PeakGain	2.14	3.29	3.48	3.50
Dual2	H-Pol.	PeakGain	3.18	4.22	4.19	3.85
	V-Pol.	PeakGain	2.48	2.83	3.52	4.70
Dual3	H-Pol.	PeakGain	3.71	3.52	2.76	2.63
	V-Pol.	PeakGain	2.12	3.07	2.88	3.18
Dual4	H-Pol.	PeakGain	3.05	2.53	1.91	2.31
	V-Pol.	PeakGain	3.19	3.80	1.95	3.61
5G1	H-Pol.	PeakGain	4.20	4.04	4.81	5.47
	V-Pol.	PeakGain	-2.17	-0.95	-1.64	0.21
5G2	H-Pol.	PeakGain	2.86	3.33	3.59	4.24
	V-Pol.	PeakGain	-3.88	-3.10	-3.08	-2.49
5G3	H-Pol.	PeakGain	2.37	3.77	3.46	4.56
	V-Pol.	PeakGain	-3.16	-3.92	-2.74	-3.59
5G4	H-Pol.	PeakGain	3.99	3.56	4.33	4.45
	V-Pol.	PeakGain	-3.25	-2.51	-1.86	-2.30
Corr. Composite	H-Pol.	Peak Gain	8.84	8.60	8.59	8.76
	V-Pol.	Peak Gain	5.59	5.98	6.24	6.63
UnCorr. Composite	H-Pol.	Peak Gain	0.53	0.36	0.37	0.40
	V-Pol.	Peak Gain	-2.67	-1.92	-1.91	-1.24

Antenna Composite gain

	Composite Gain	2.4 ~ 2.4835
2G	Correlated	6.57
4x4	Un-Correlated	0.97

	Composite Gain	5.15 ~ 5.25	5.25 ~ 5.35	5.47 ~ 5.725	5.725 ~ 5.85
5G	Correlated	10.73	10.71	10.33	10.68
4x4	Un-Correlated	4.72	4.70	4.32	4.67

Frequency	Position (θ, ϕ) of directional gain	Polarization	Antenna gain (dBi)				Calculated Directional Gain (dBi) Correlated
			ANT 0	ANT 1	ANT 2	ANT 3	
2.4 ~ 2.4835	($\theta=250, \phi=90$)	V-pol.	1.06	-4.37	-0.07	3.72	6.57
5.15 ~ 5.25	($\theta=197, \phi=90$)	V-pol.	4.53	5.12	5.08	4.07	10.73
5.25 ~ 5.35	($\theta=180, \phi=90$)	V-pol.	4.58	4.84	5.30	3.96	10.71
5.47 ~ 5.725	($\theta=191, \phi=90$)	V-pol.	3.45	4.93	4.67	4.11	10.33
5.725 ~ 5.85	($\theta=169, \phi=0$)	V-pol.	3.85	5.04	4.82	4.86	10.68

Antenna Composite gain

	Composite Gain	5.15 ~ 5.25	5.25 ~ 5.35	5.47 ~ 5.725	5.725 ~ 5.85
5G	Correlated	9.29	9.34	8.88	9.20
8x8	Un-Correlated	0.83	1.05	0.75	0.56

		Frequency			
		5.15 ~ 5.25	5.25 ~ 5.35	5.47 ~ 5.725	5.725 ~ 5.85
Antenna gain (dBi)	Antenna				
	Dual1	0.68	1.27	0.00	0.22
	Dual2	-6.28	-7.65	-3.55	-3.94
	Dual3	-4.02	-5.70	-5.62	-3.81
	Dual4	2.49	1.93	0.58	-0.10
	5G1	1.21	2.12	-0.18	1.08
	5G2	2.13	2.17	2.40	2.60
	5G3	1.15	1.25	1.48	1.32
	5G4	1.16	1.86	0.95	1.69
Polarization		V-pol.	V-pol.	V-pol.	V-pol.
Position (θ, ϕ) of directional gain		($\theta=191, \phi=90$)	($\theta=191, \phi=90$)	($\theta=194, \phi=90$)	($\theta=197, \phi=90$)
Calculated Directional Gain (dBi) Correlated		9.29	9.34	8.88	9.20

Antenna Composite gain

	Composite Gain	2.4 ~ 2.4835
2G 2x2 Dual_1+Dual_3	Correlated	6.33
	Un-Correlated	3.47

2G, 2x2, Dual_1+Dual_3			Antenna gain (dBi)		Calculated Directional Gain (dBi) Correlated
Frequency	Position (θ, ϕ) of directional gain	Polarization	ANT 1	ANT 3	
2.4 ~ 2.4835	($\theta=60, \phi=318$)	V-pol.	1.52	4.81	6.33

	Composite Gain	5.15 ~ 5.25	5.25 ~ 5.35	5.47 ~ 5.725	5.725 ~ 5.85
5G 2x2 Dual_2+Dual_3	Correlated	8.47	8.92	8.16	8.59
	Un-Correlated	5.47	5.91	5.17	5.58

5G, 2x2, Dual_2+Dual_3			Antenna gain (dBi)		Calculated Directional Gain (dBi) Correlated
Frequency	Position (θ, ϕ) of directional gain	Polarization	ANT 2	ANT 3	
5.15 ~ 5.25	($\theta=129, \phi=90$)	V-pol.	5.79	5.13	8.47
5.25 ~ 5.35	($\theta=129, \phi=90$)	V-pol.	6.10	5.72	8.92
5.47 ~ 5.725	($\theta=129, \phi=90$)	V-pol.	5.68	4.60	8.16
5.725 ~ 5.85	($\theta=60, \phi=98$)	V-pol.	5.66	5.51	8.59

Antenna Composite gain

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
1-2	Correlated	5.41	5.43	4.78		6.07	6.17	5.87	6.16	5.75
	Un-Correlated	2.70	3.21	2.62		3.64	3.81	3.34	3.50	3.13

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
1-3	Correlated	4.81	5.97	6.33		5.92	6.07	6.05	5.93	5.98
	Un-Correlated	2.44	3.05	3.47		3.10	3.57	3.36	3.53	3.12

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
1-4	Correlated	5.52	6.14	6.09		7.41	7.63	7.61	7.68	6.88
	Un-Correlated	2.62	3.60	3.33		4.41	4.65	4.62	4.76	4.01

Antenna Composite gain

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
2-3	Correlated	5.22	6.01	5.30		8.47	8.92	8.16	8.59	8.13
	Un-Correlated	2.71	3.49	2.58		5.47	5.91	5.17	5.58	5.12

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
2-4	Correlated	4.47	6.11	5.03		5.84	5.68	5.43	5.97	5.23
	Un-Correlated	1.97	3.60	2.41		3.44	3.37	3.13	3.09	2.68

Dual band	Composite Gain	2400	2450	2500		5150	5350	5550	5750	5850
3-4	Correlated	5.72	5.18	4.34		6.07	5.55	5.63	5.65	5.53
	Un-Correlated	2.87	2.82	2.31		3.06	3.16	2.98	2.75	2.75

Antenna Composite gain

Single – 5G	Composite Gain	5150	5350	5550	5750	5850
1-2	Correlated	7.85	8.03	7.35	7.52	7.57
	Un-Correlated	4.85	5.03	4.35	4.54	4.56

Single – 5G	Composite Gain	5150	5350	5550	5750	5850
1-3	Correlated	7.85	8.10	7.22	7.56	7.21
	Un-Correlated	4.84	5.09	4.21	4.63	4.21

Single – 5G	Composite Gain	5150	5350	5550	5750	5850
1-4	Correlated	7.98	7.99	7.45	7.38	7.50
	Un-Correlated	4.97	5.00	4.44	4.39	4.49

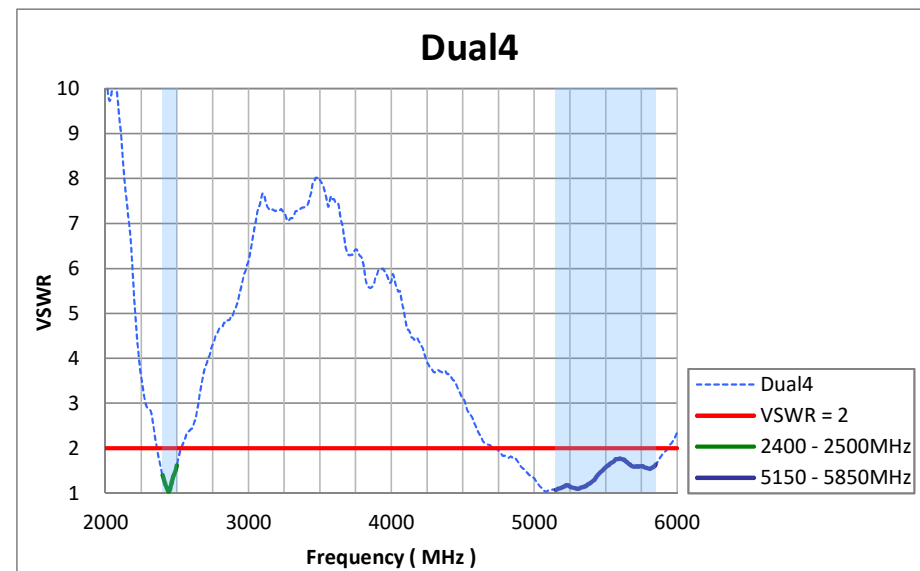
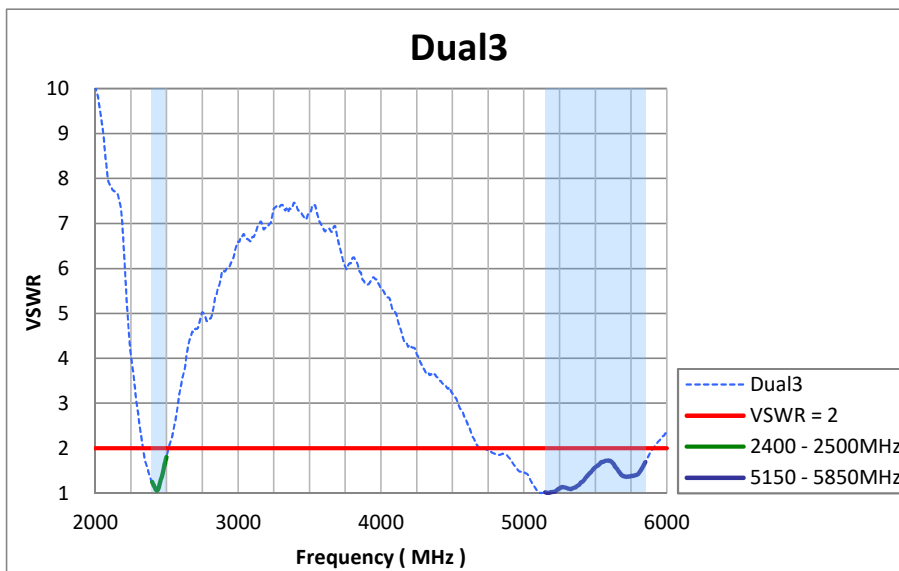
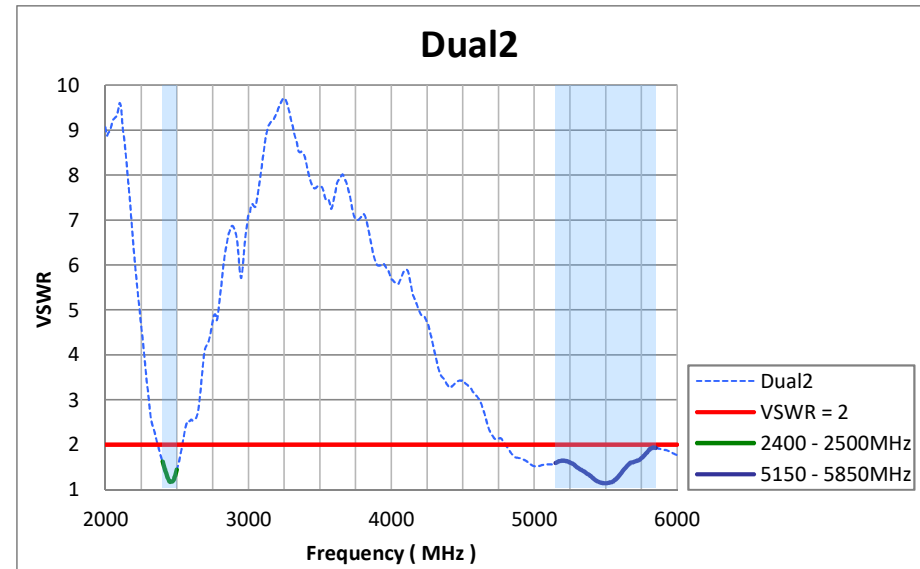
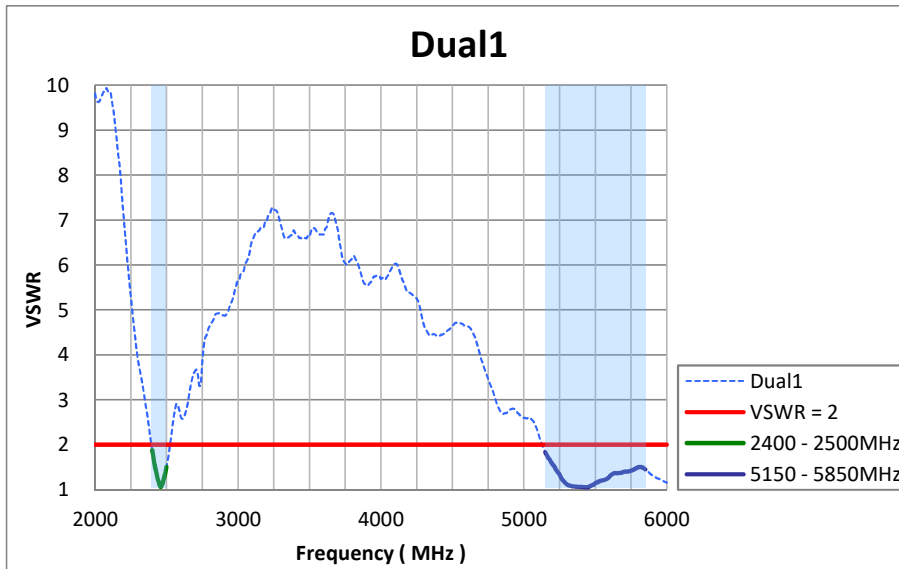
Antenna Composite gain

Single – 5G	Composite Gain	5150	5350	5550	5750	5850
2-3	Correlated	8.11	8.33	8.04	8.11	7.78
	Un-Correlated	5.10	5.32	5.03	5.10	4.77

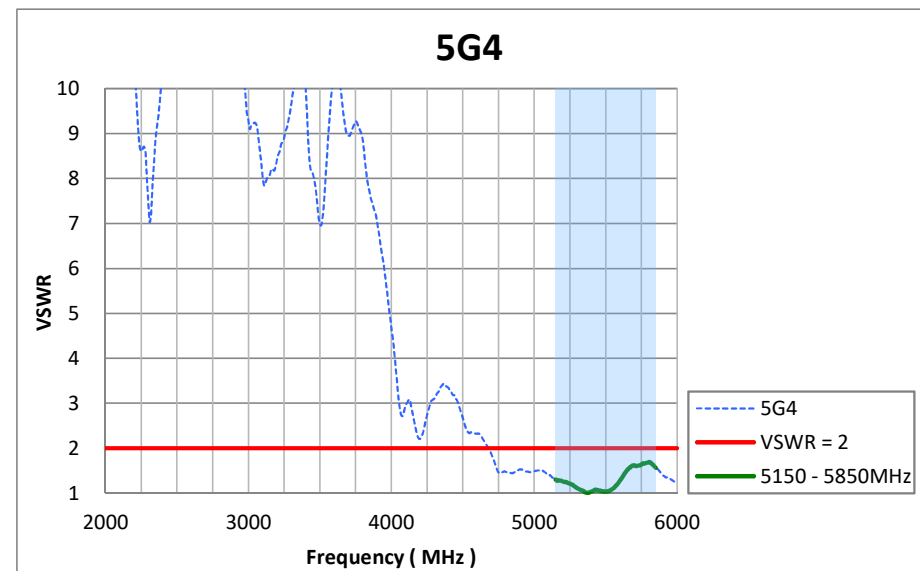
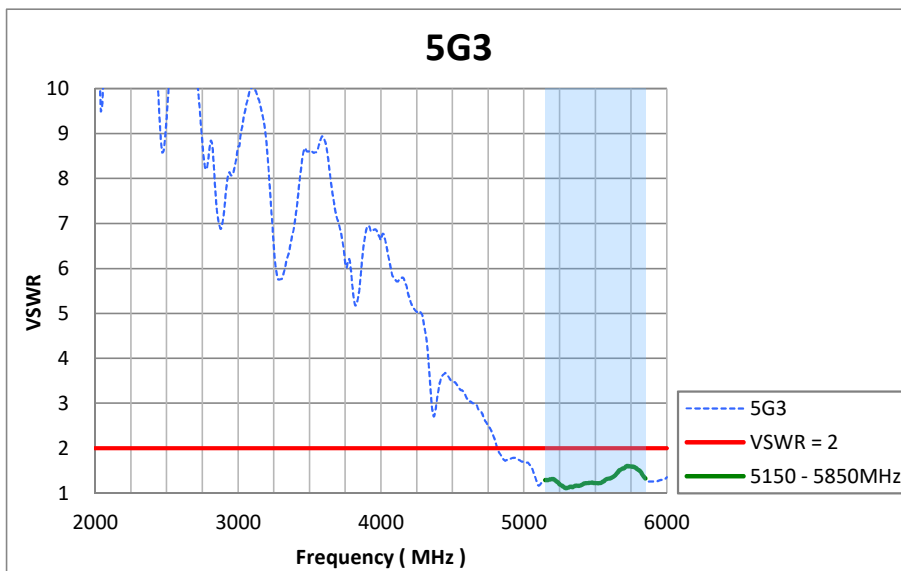
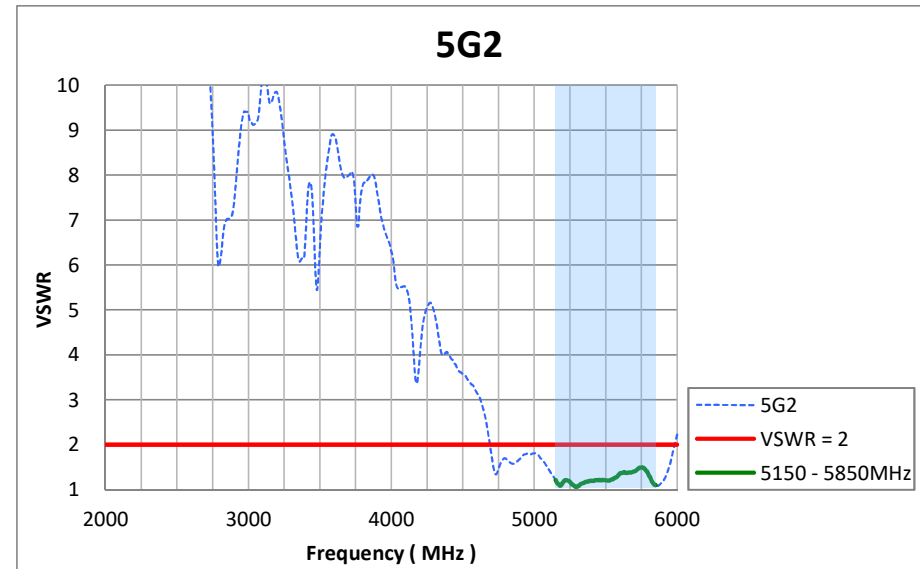
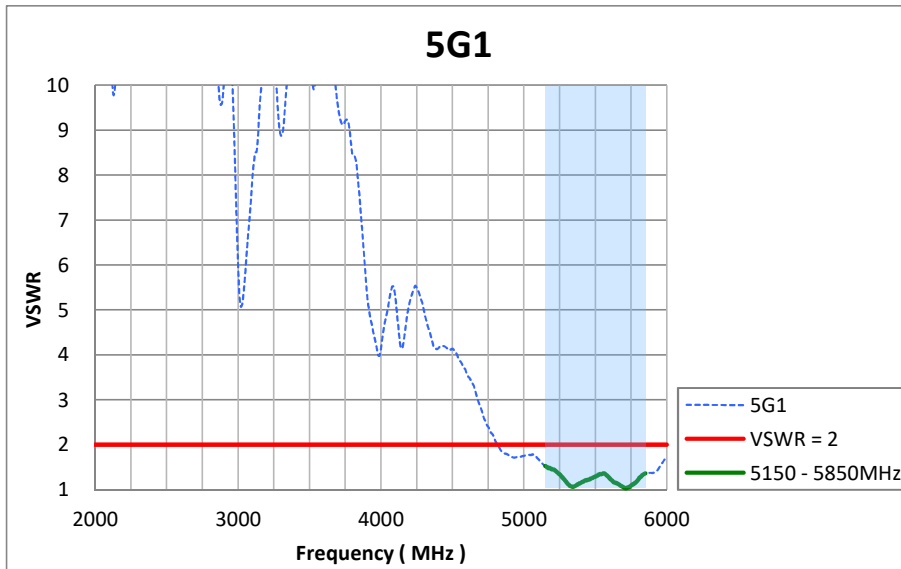
Single – 5G	Composite Gain	5150	5350	5550	5750	5850
2-4	Correlated	7.91	7.94	7.67	7.96	7.62
	Un-Correlated	4.90	4.95	4.67	4.95	4.62

Single – 5G	Composite Gain	5150	5350	5550	5750	5850
3-4	Correlated	7.68	8.27	7.67	7.91	7.81
	Un-Correlated	4.68	5.26	4.67	4.93	4.80

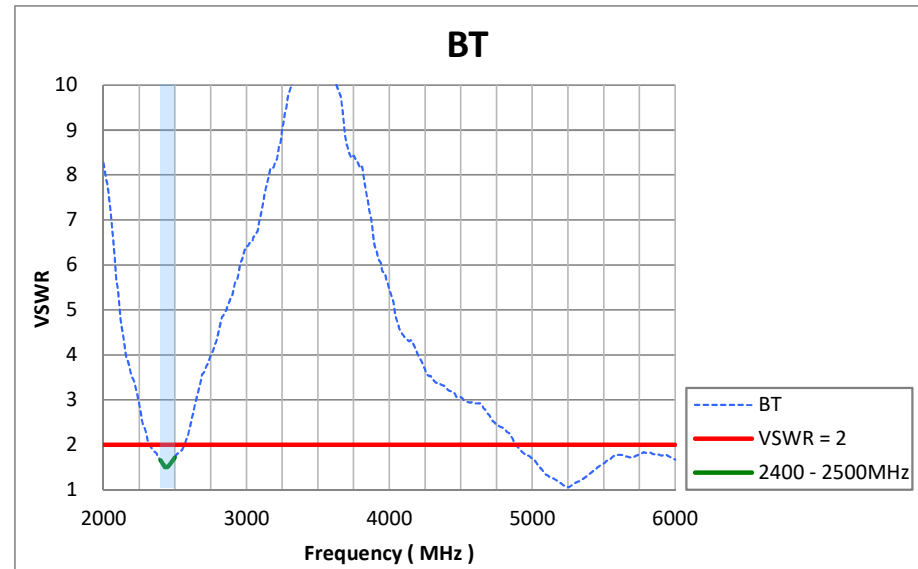
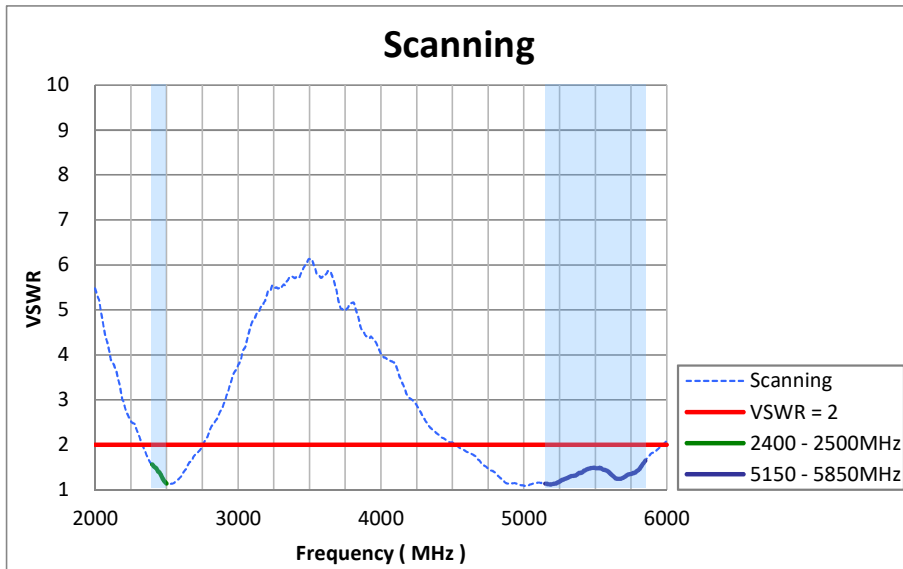
VSWR for Dual Band



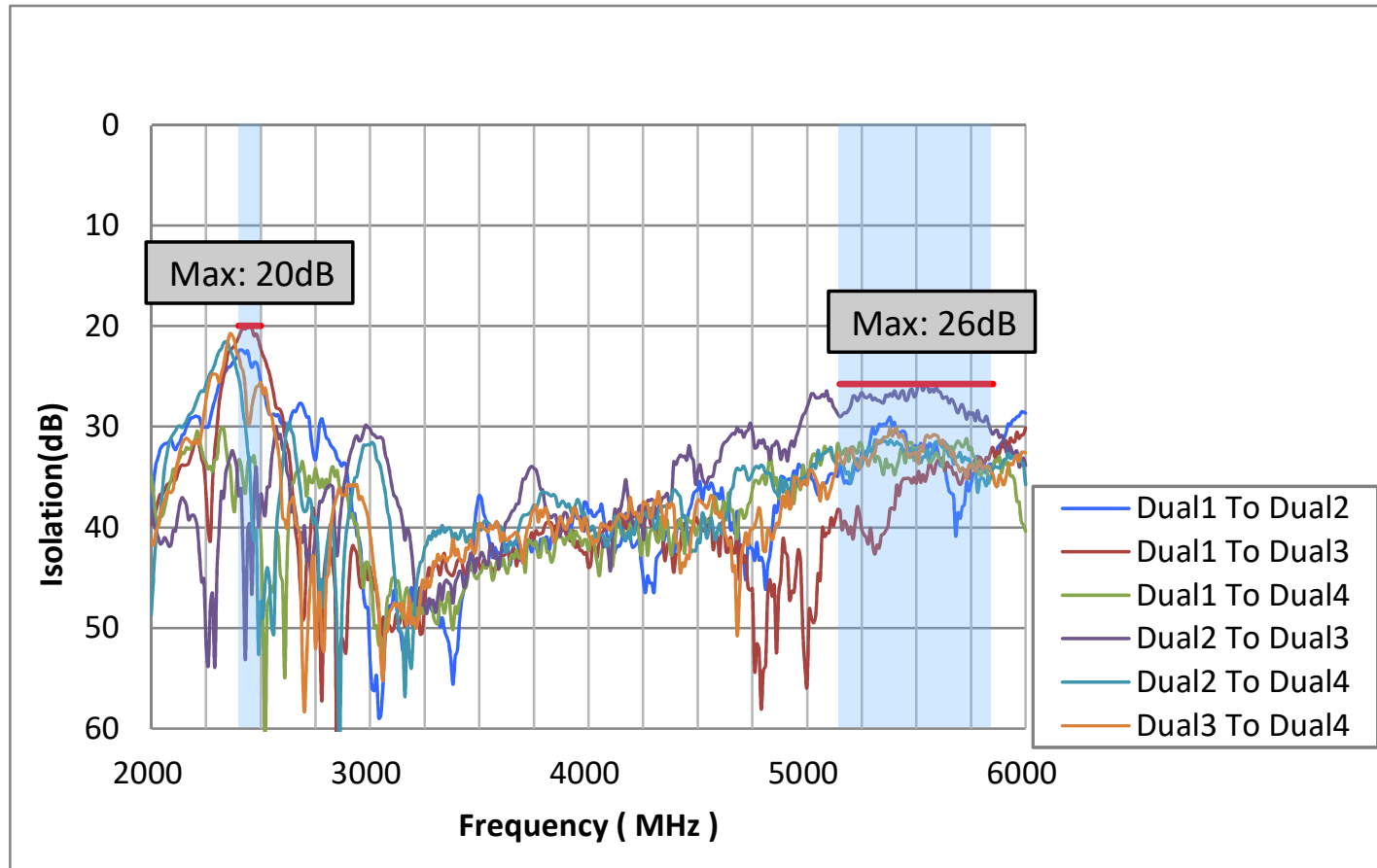
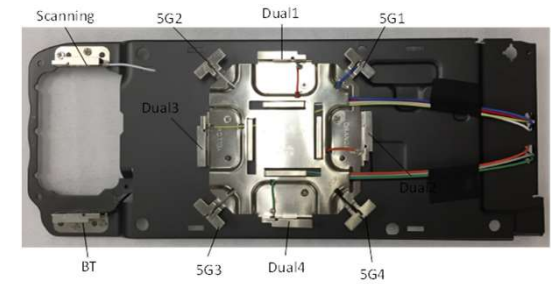
VSWR for 5G



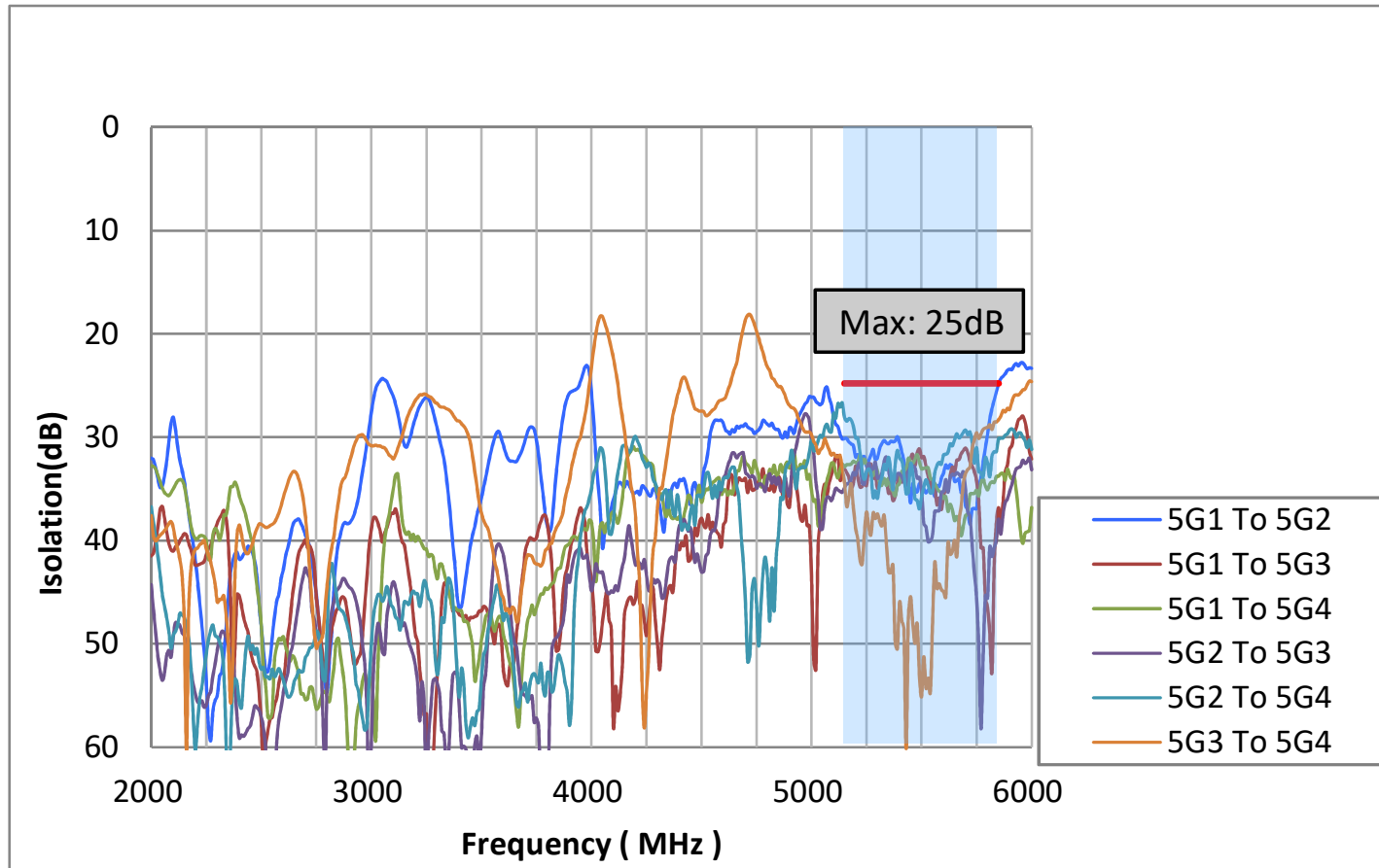
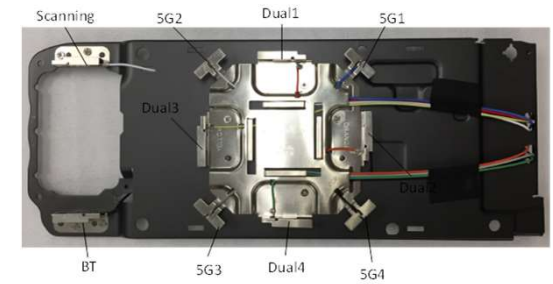
VSWR for Scanning / BT



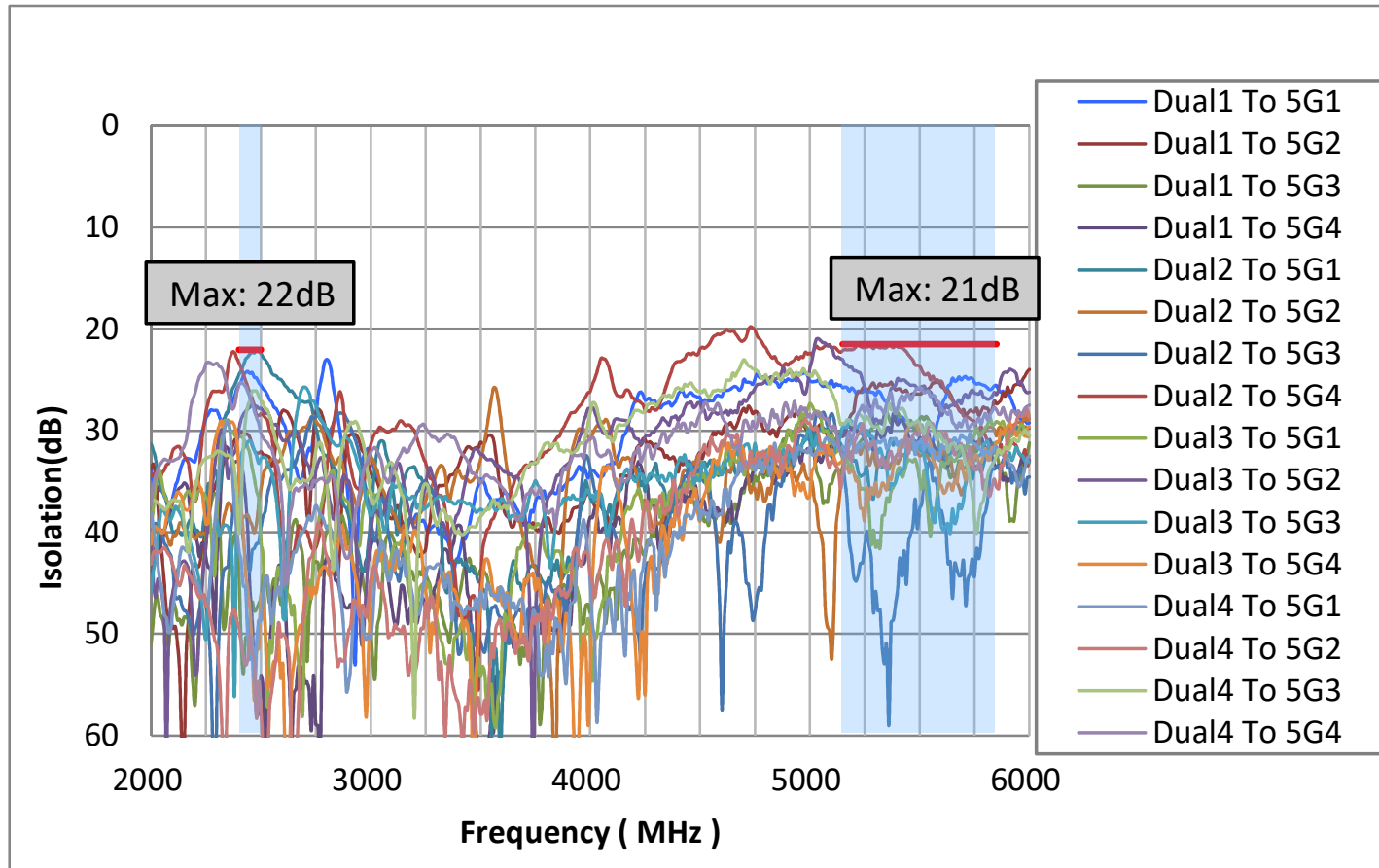
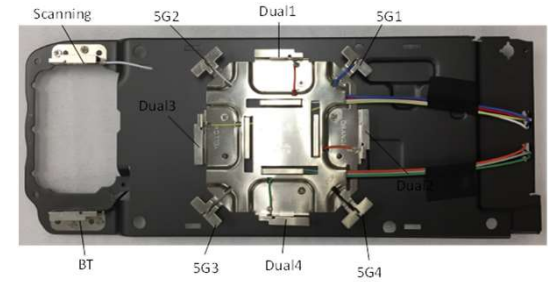
Isolation for Dual-Band ANTs



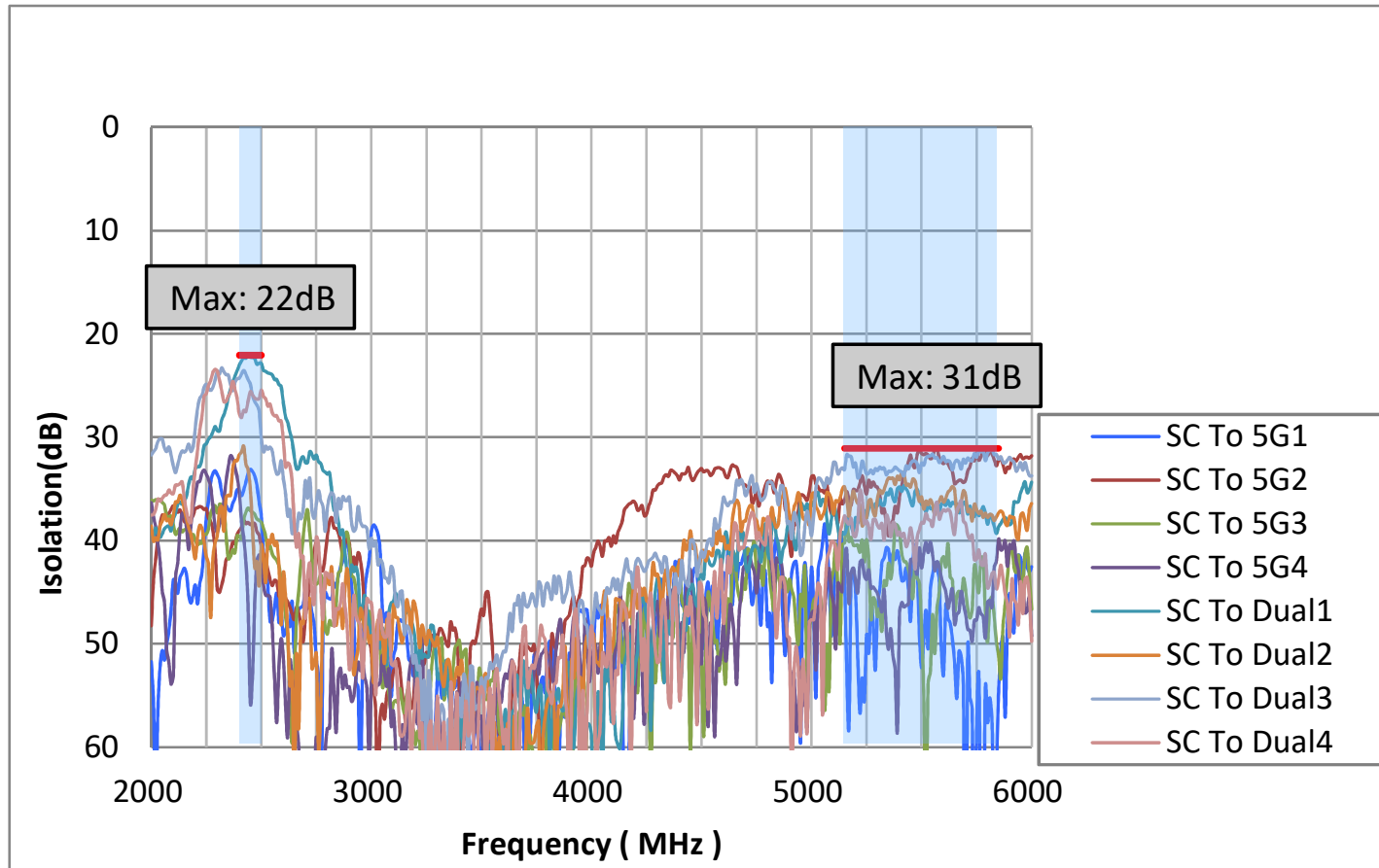
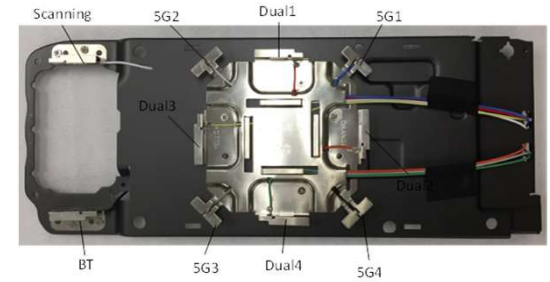
Isolation for 5G ANTs



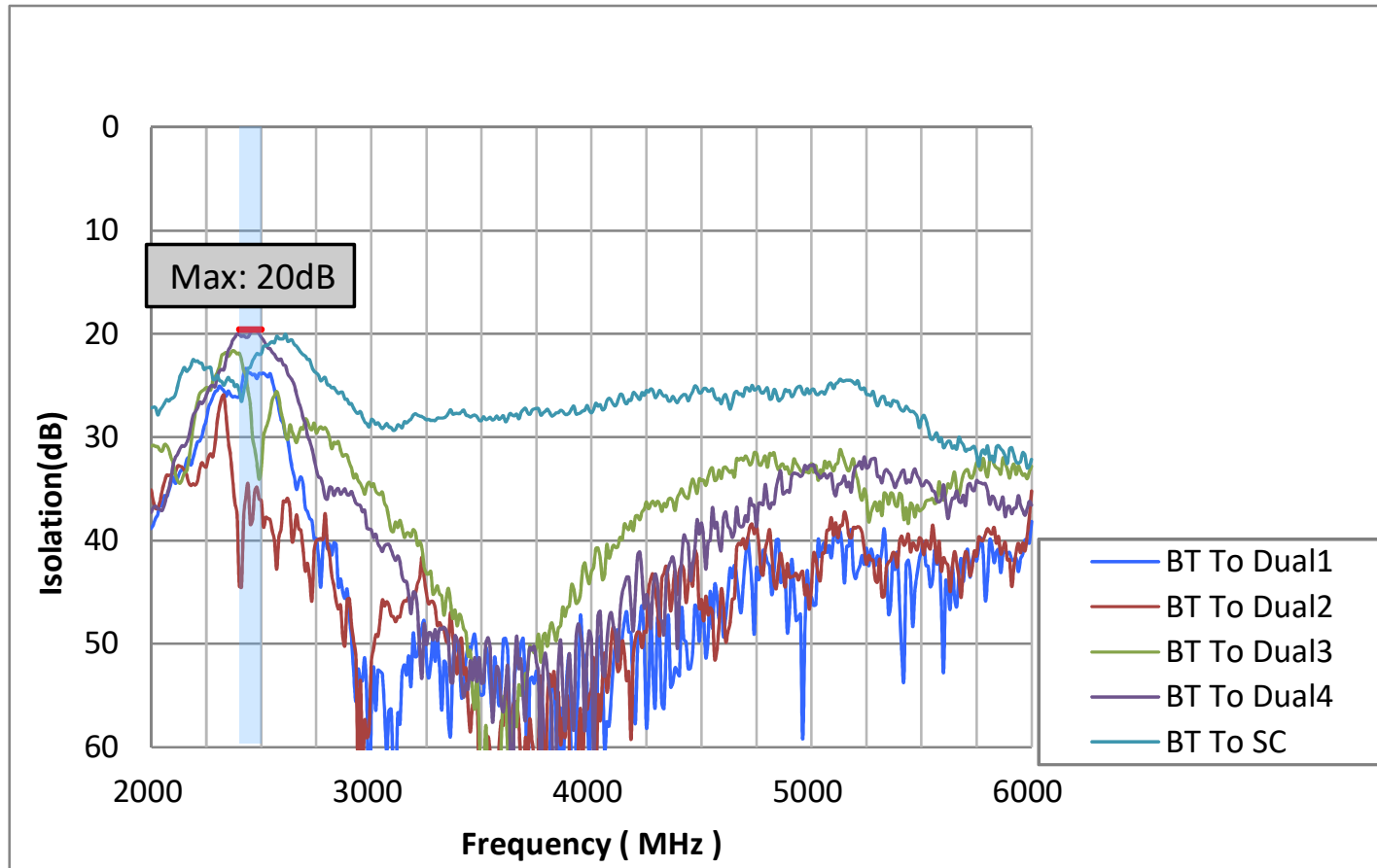
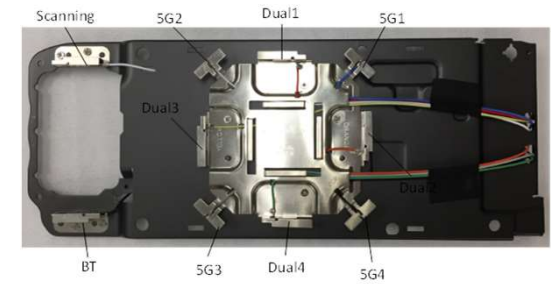
Isolation for Dual-Band to 5G ANTs



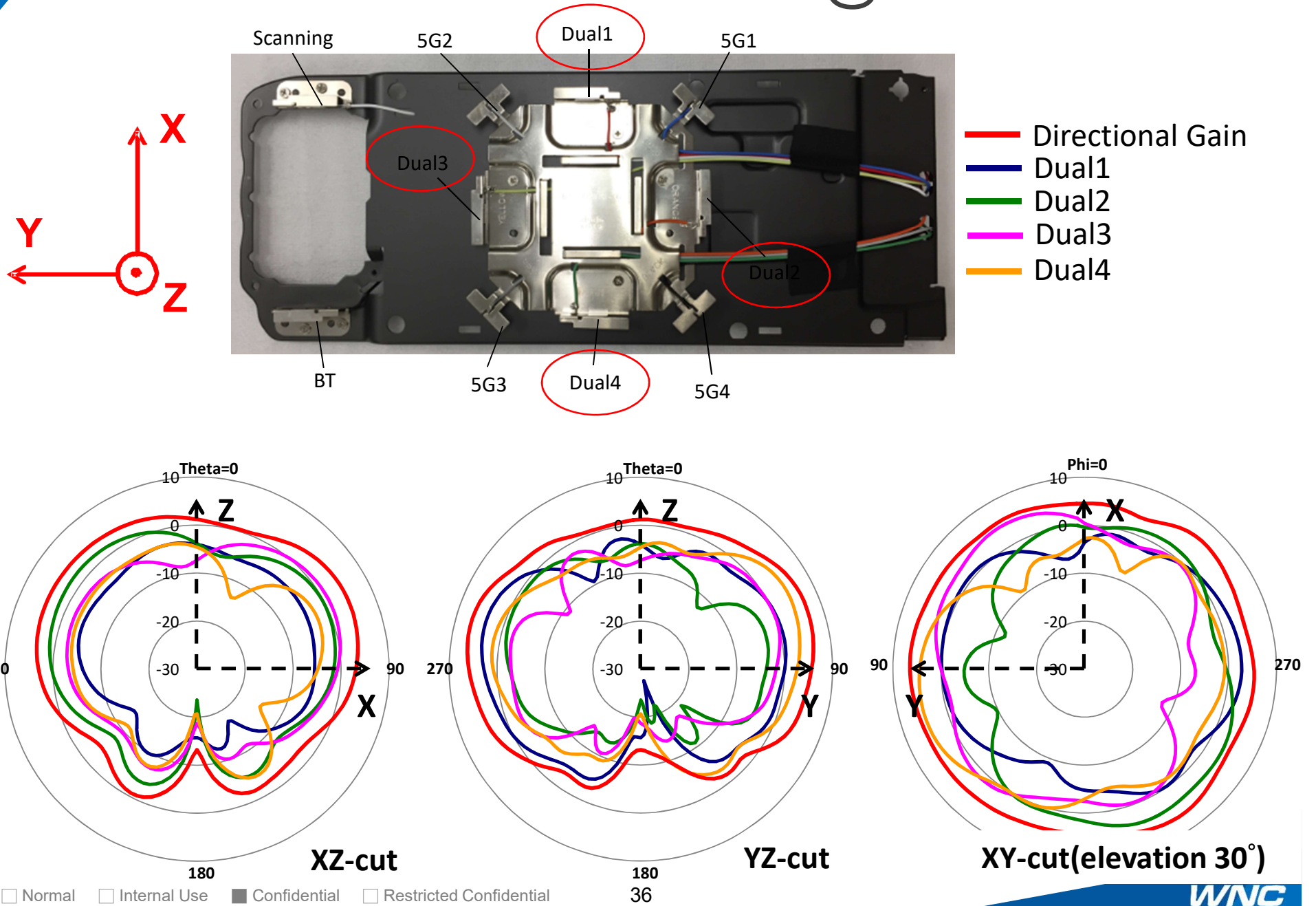
Isolation for Scanning to others



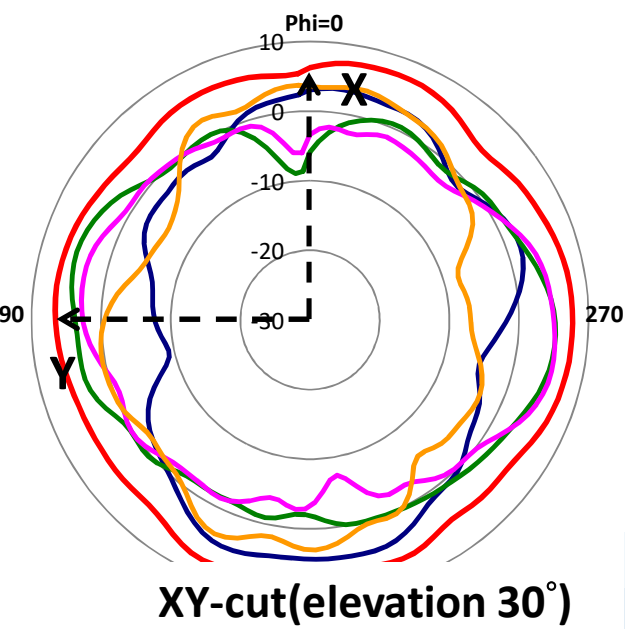
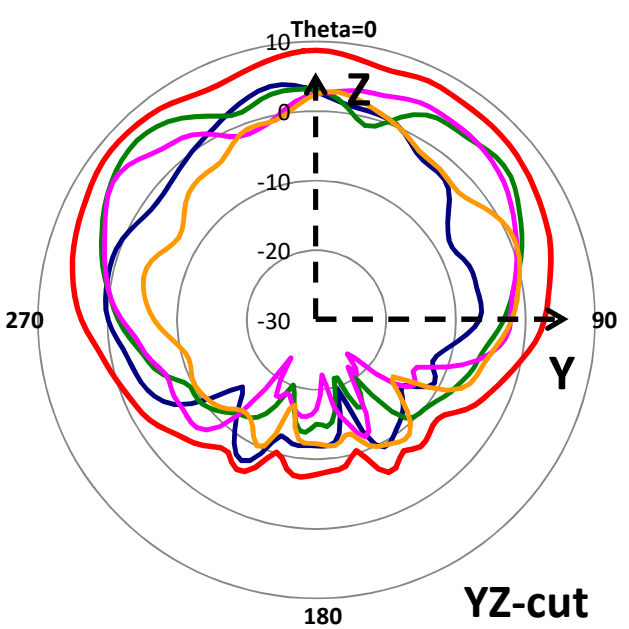
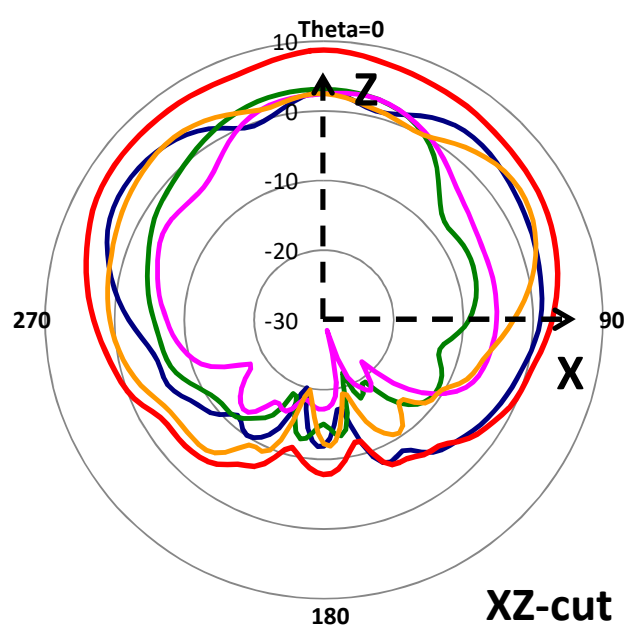
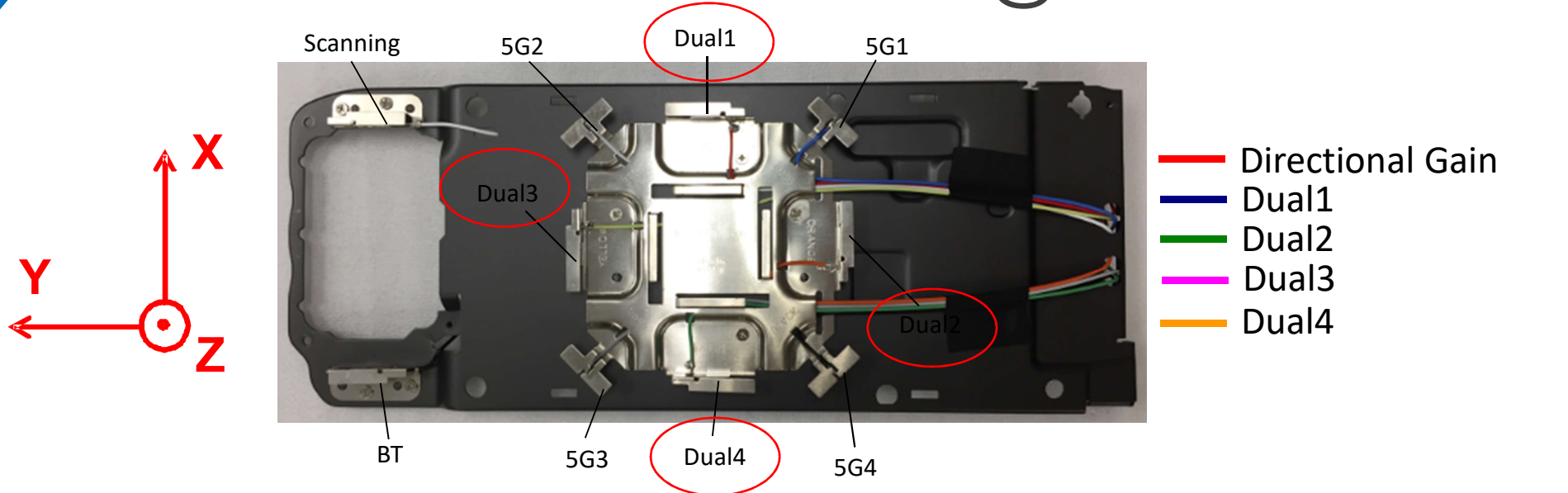
Isolation for BT to others



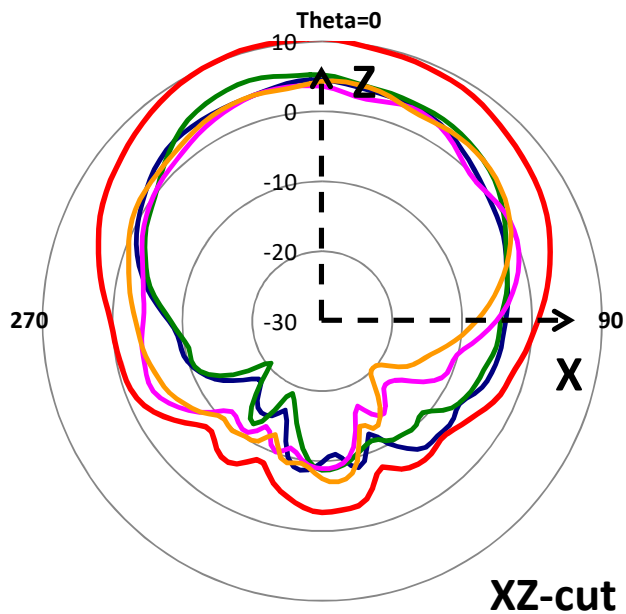
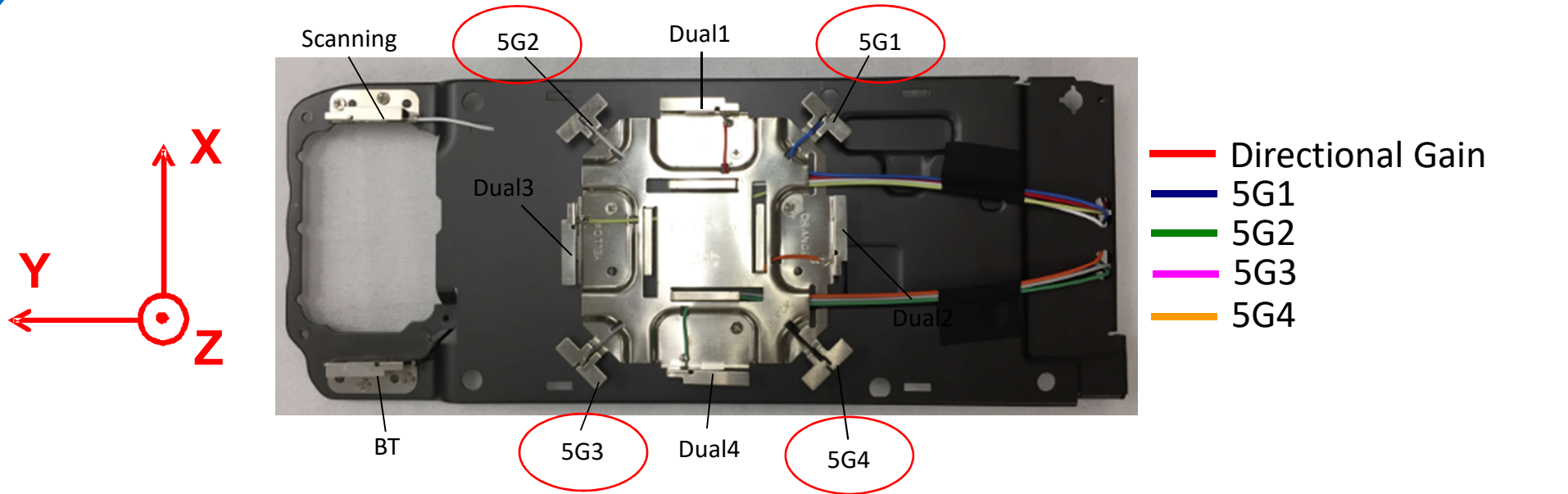
Radiation Pattern for Dual-Band @ 2.4GHz



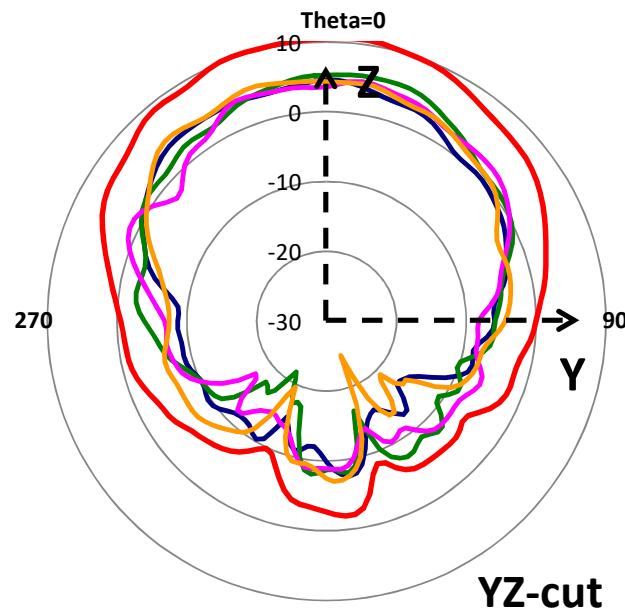
Radiation Pattern for Dual-Band @ 5GHz



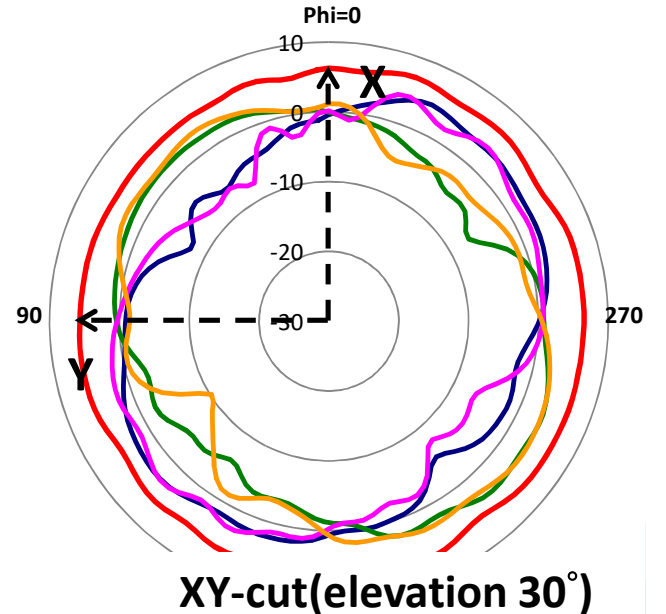
Radiation Pattern for 5G



XZ-cut

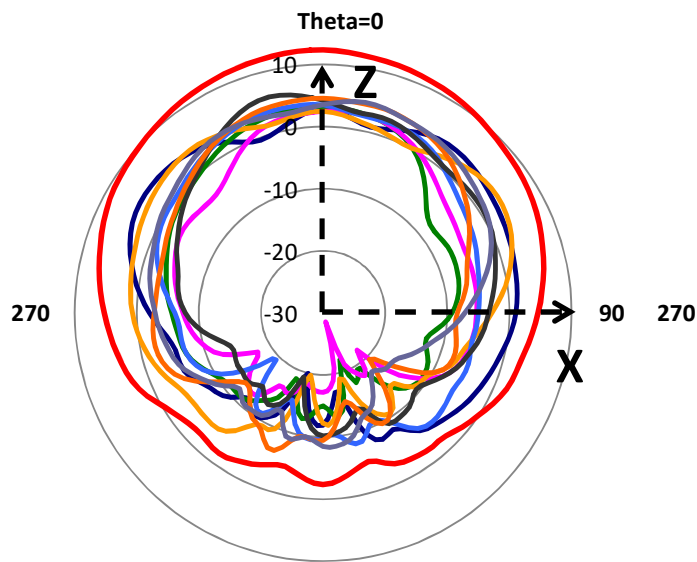
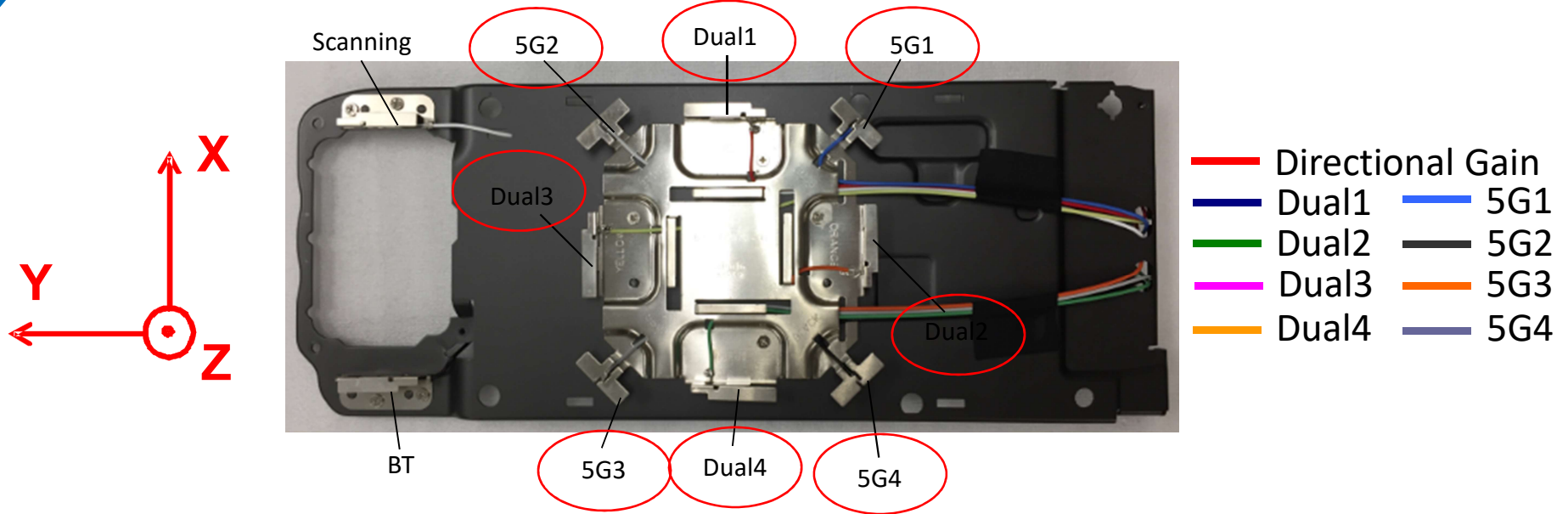


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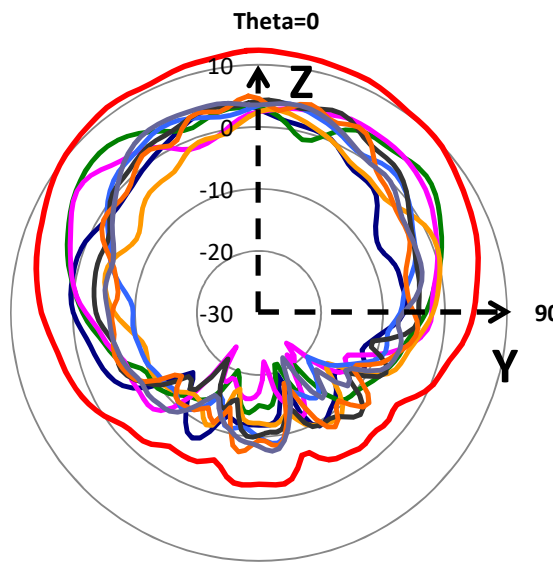


XY-cut(elevation 30°)

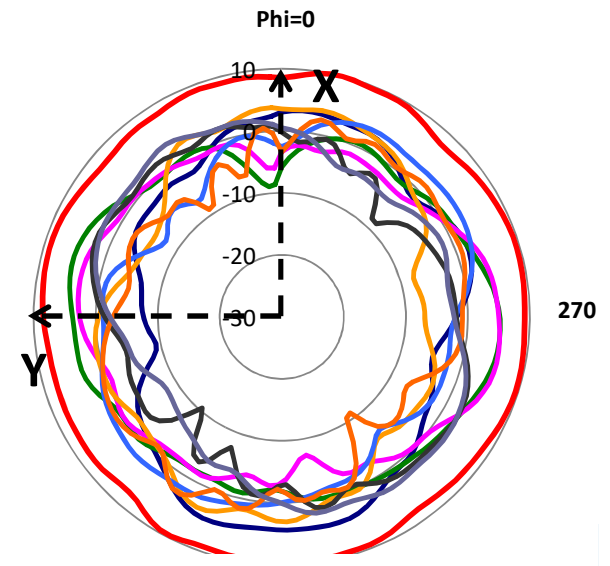
Radiation Pattern for 8x8 5G



XZ-cut

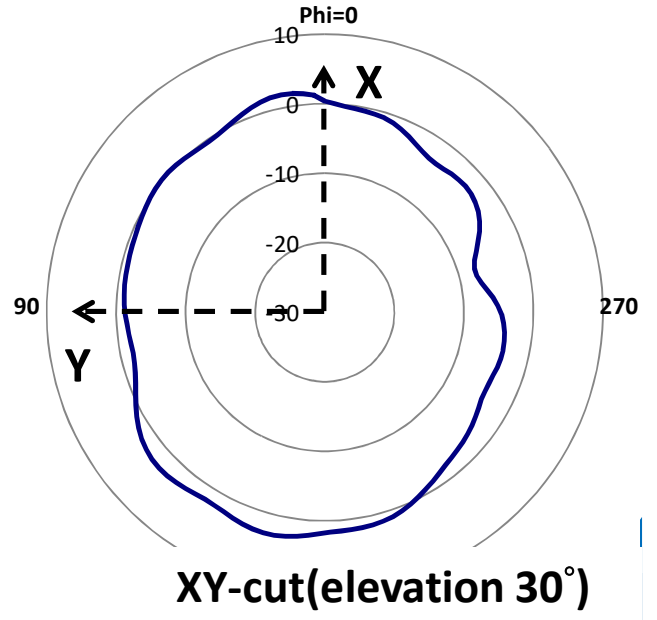
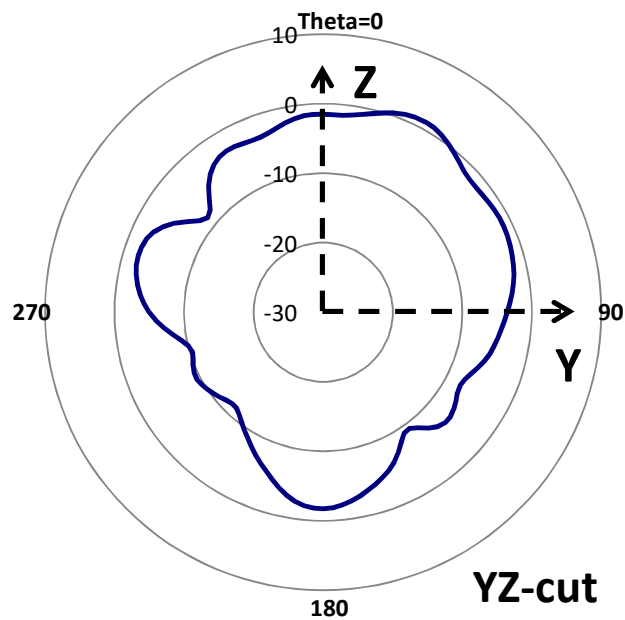
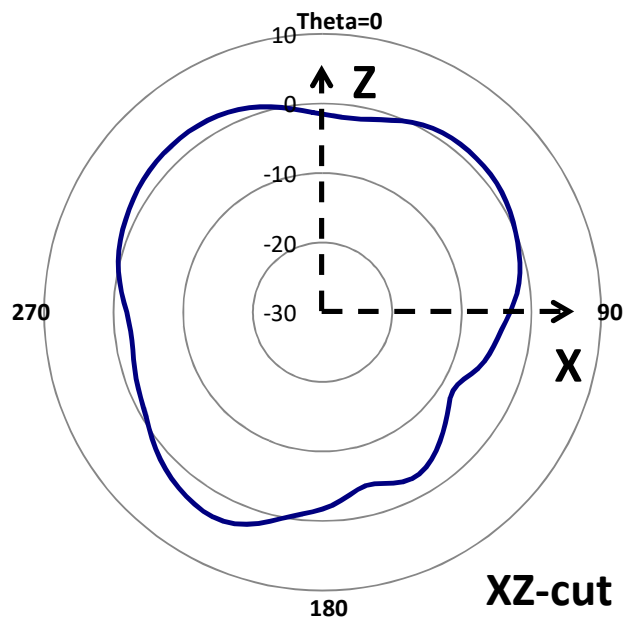
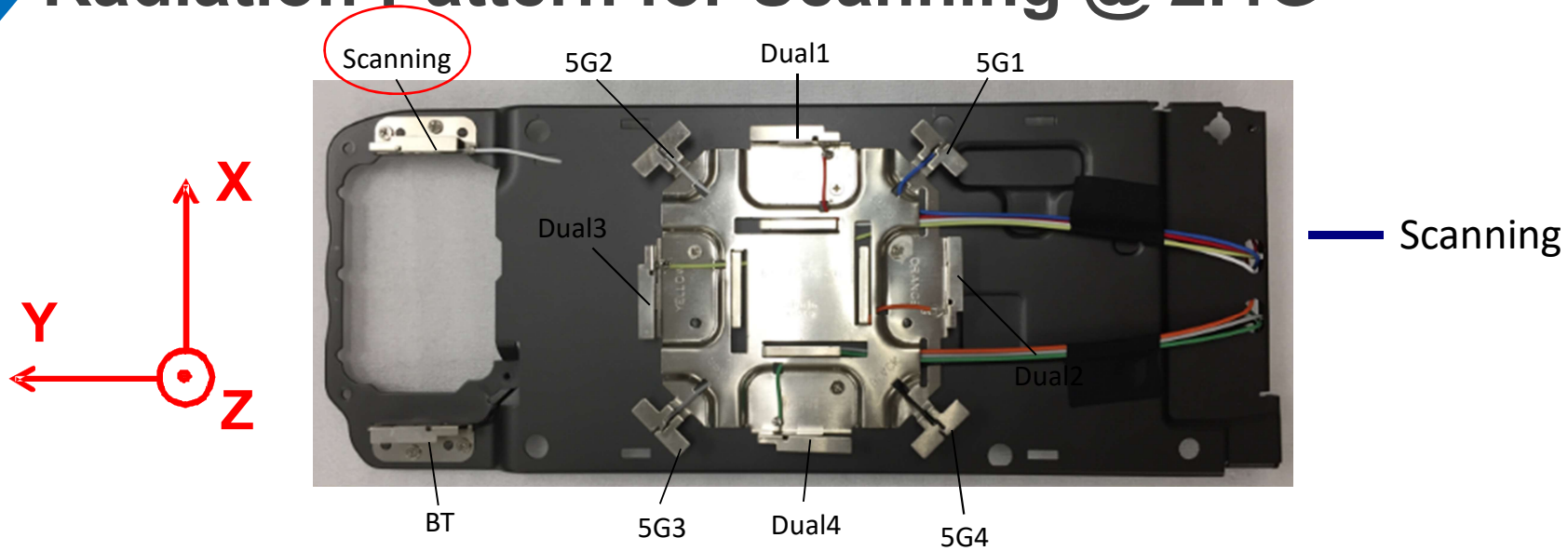


YZ-cut

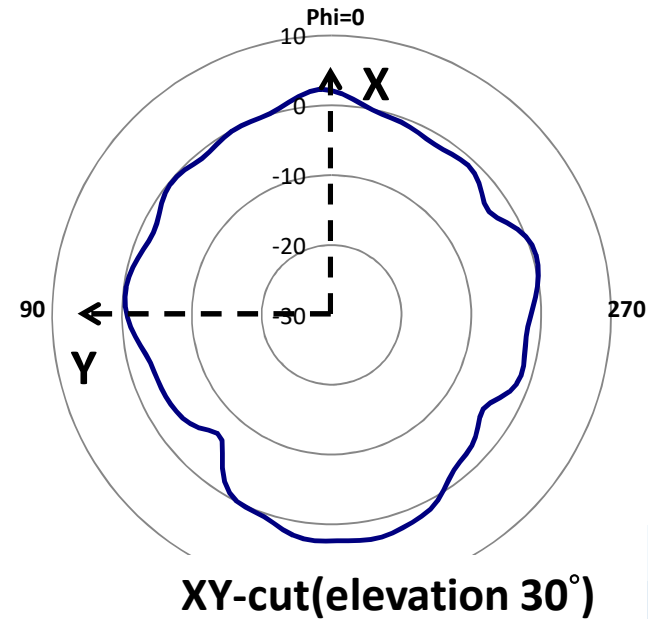
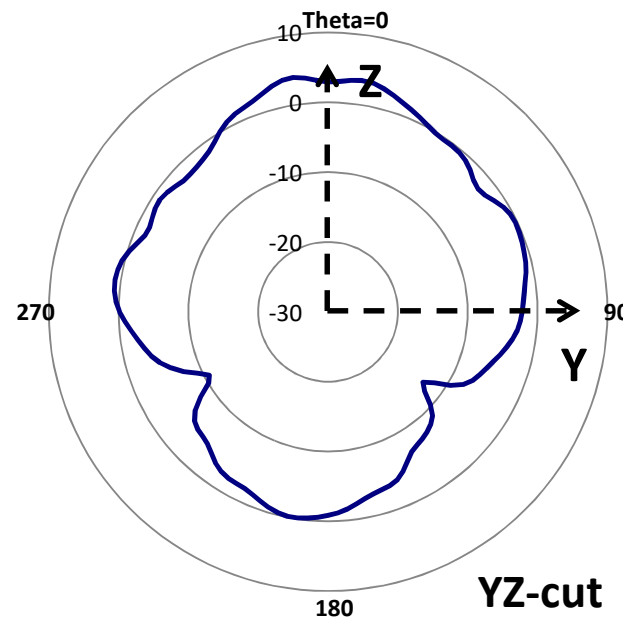
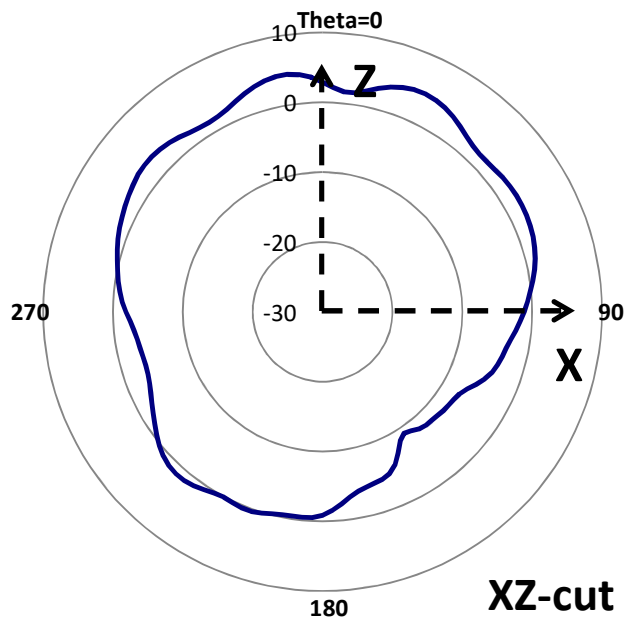
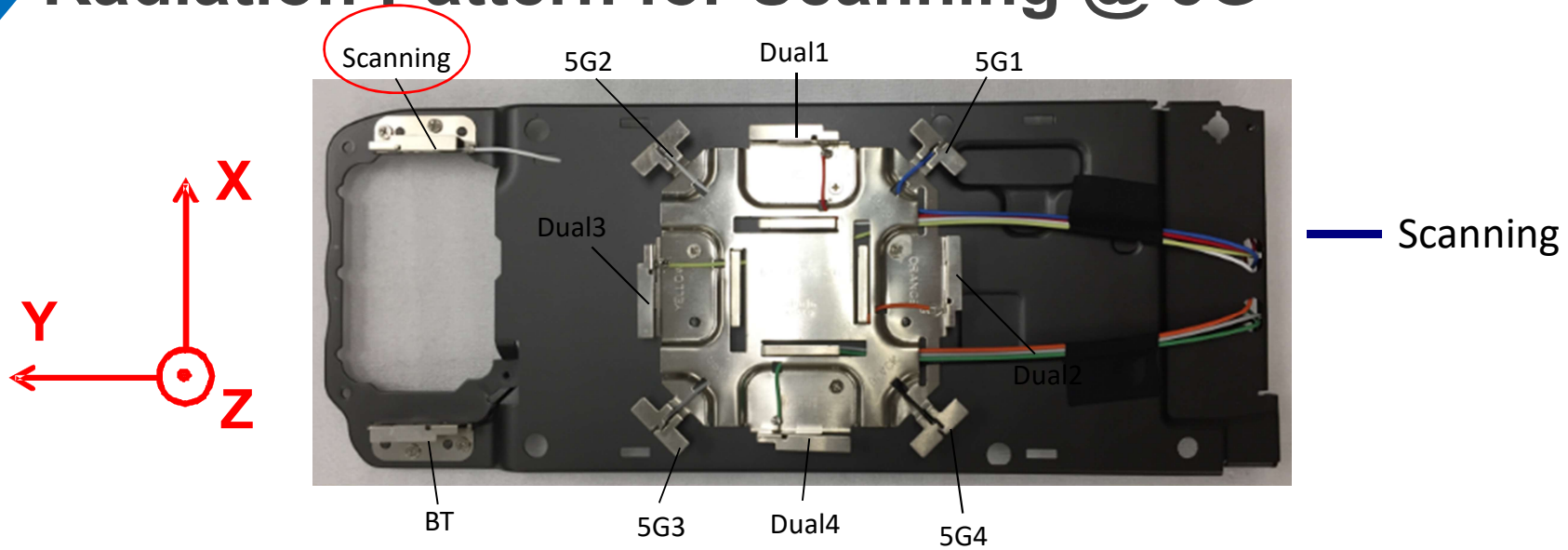


XY-cut(elevation 30°)

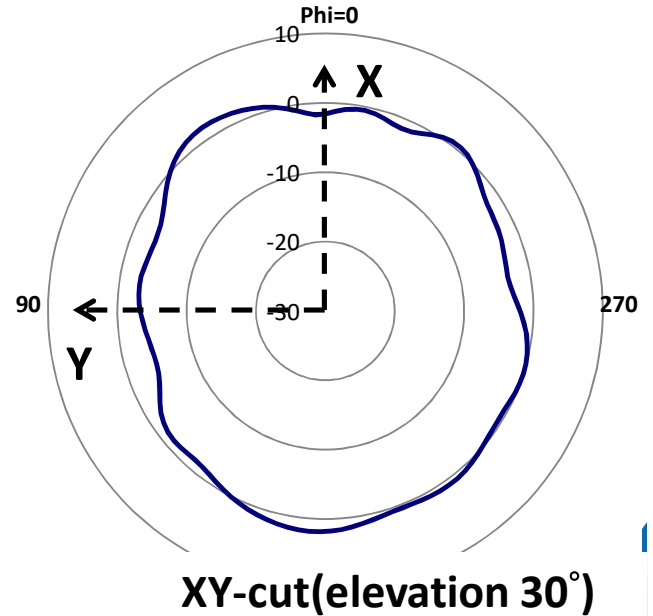
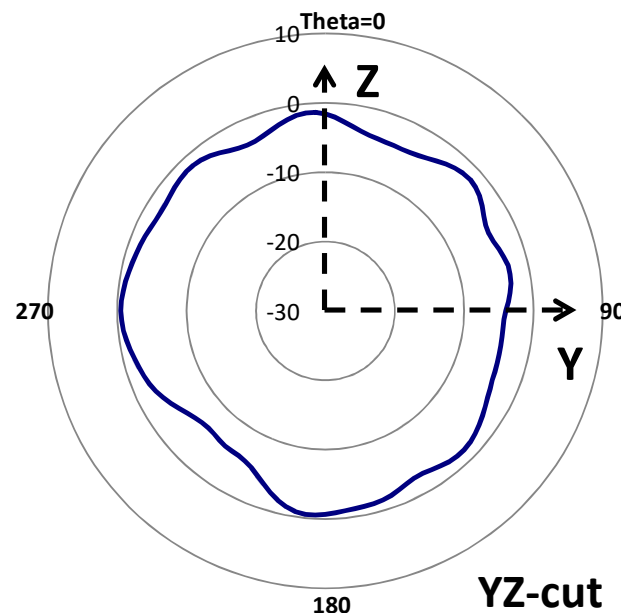
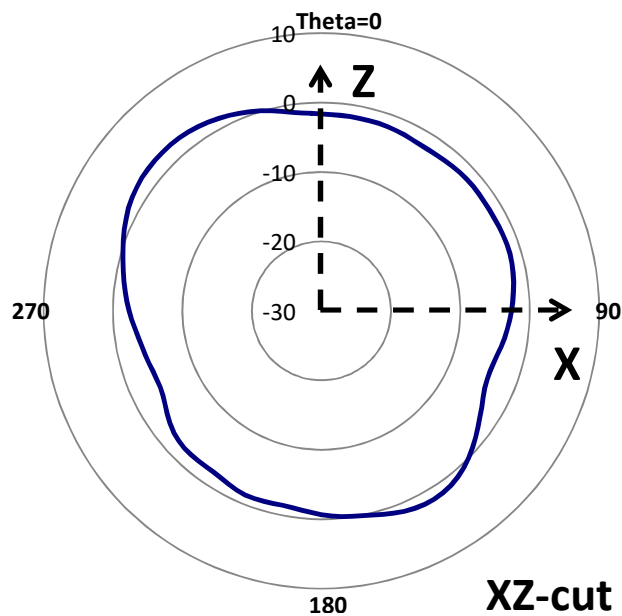
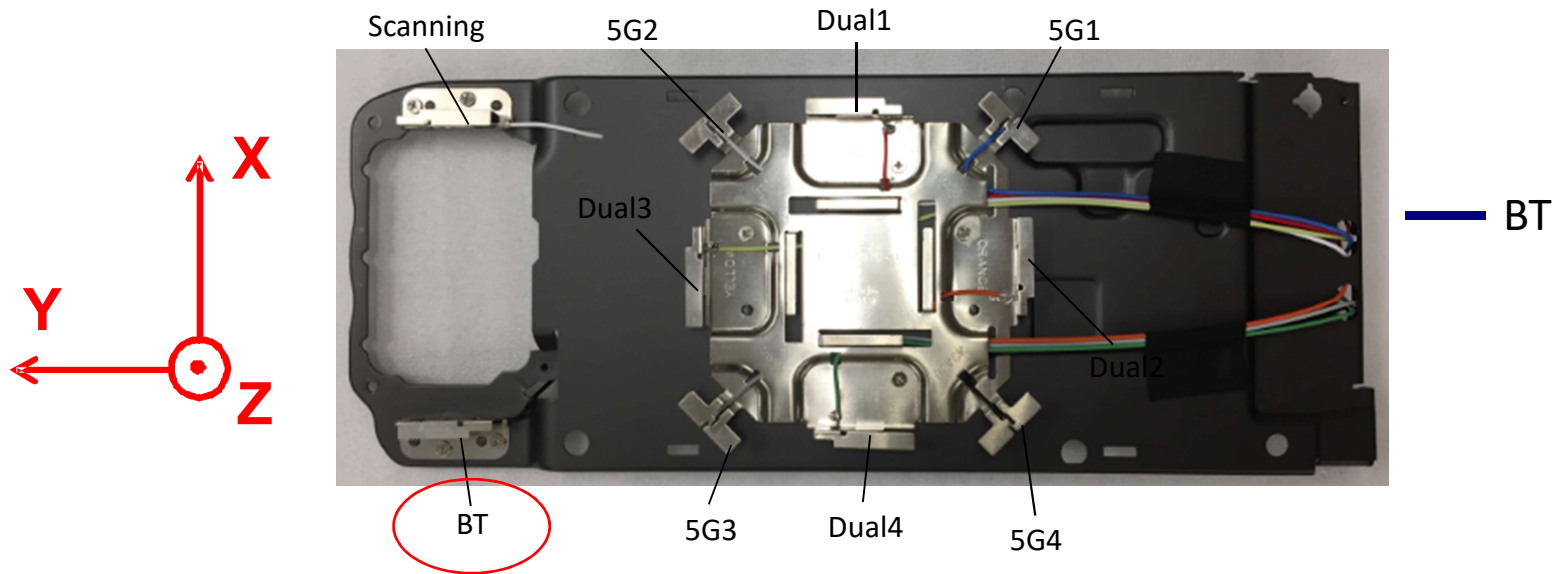
Radiation Pattern for Scanning @ 2.4G



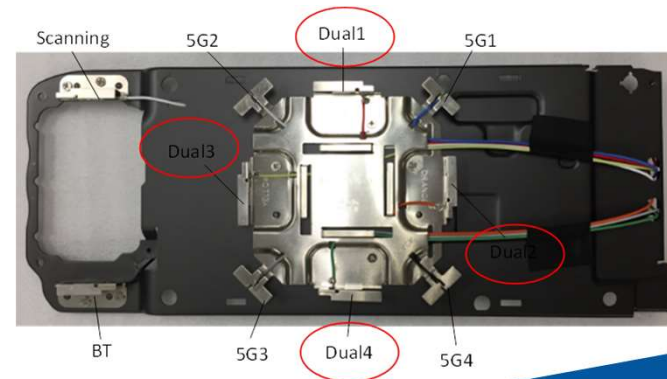
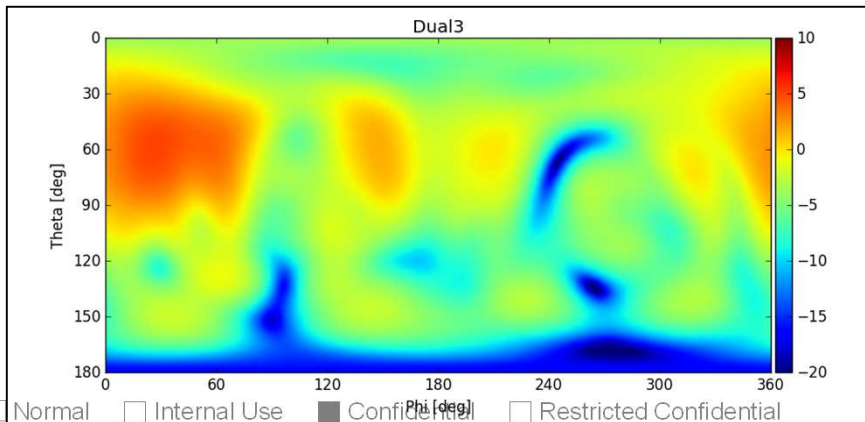
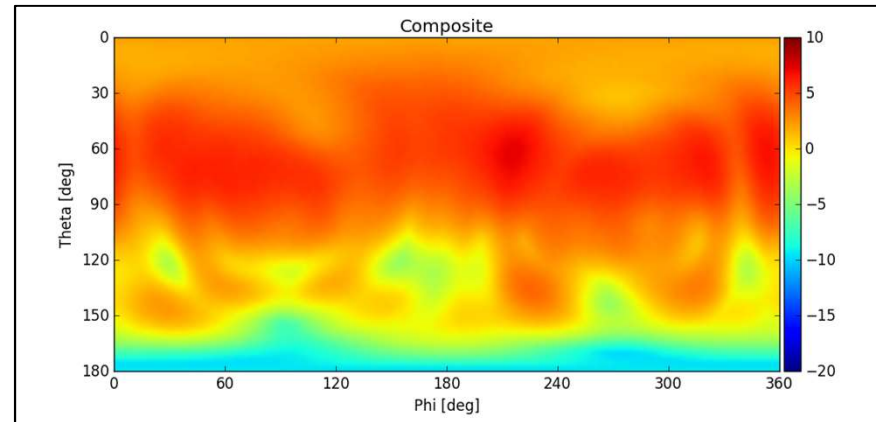
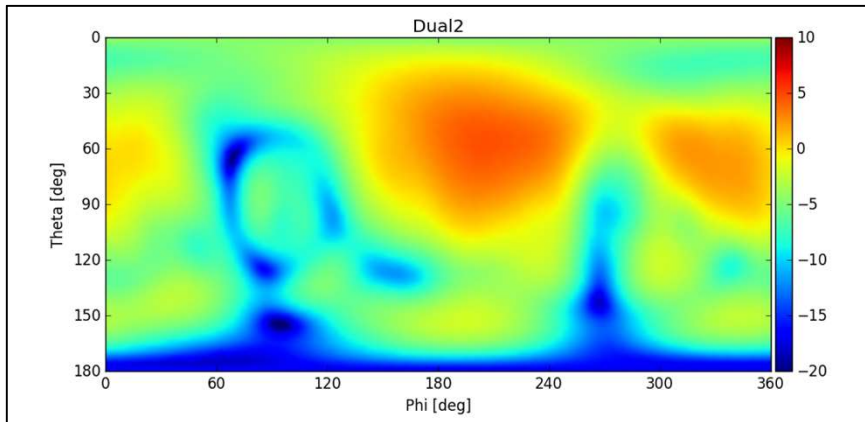
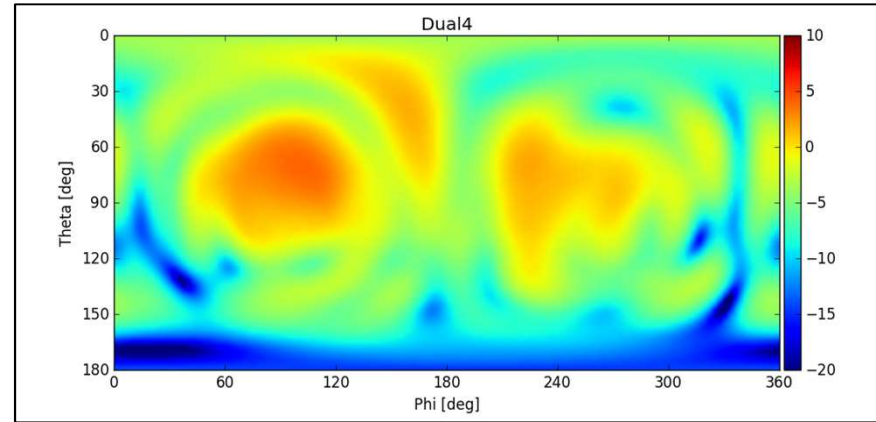
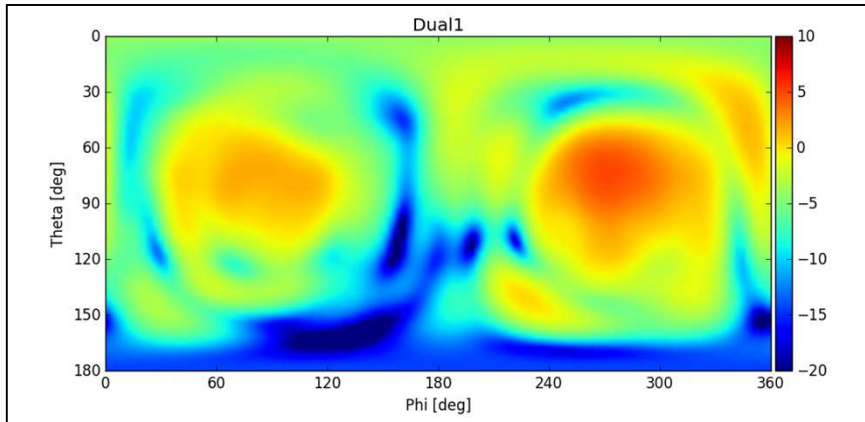
Radiation Pattern for Scanning @ 5G



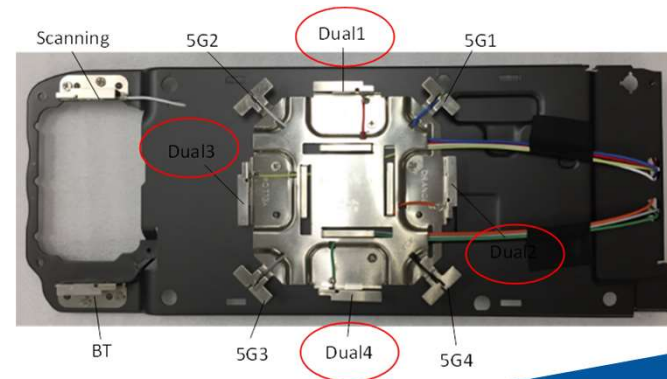
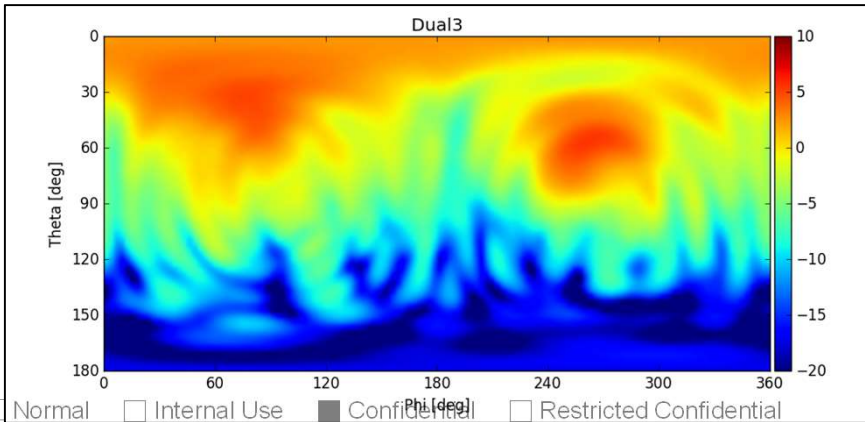
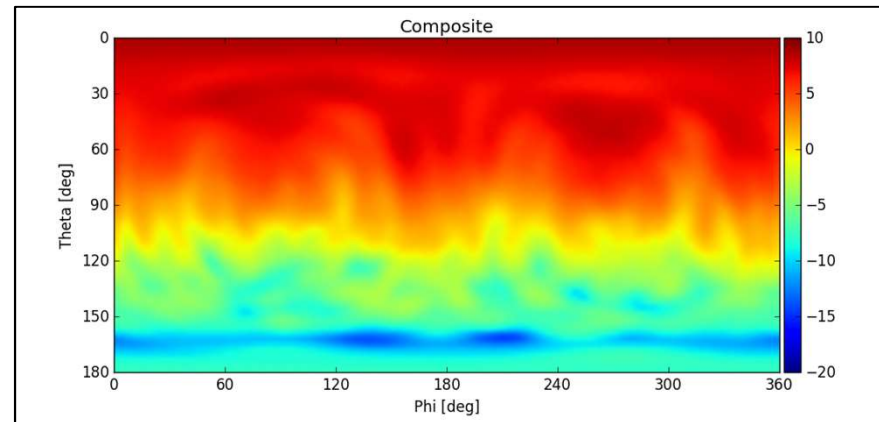
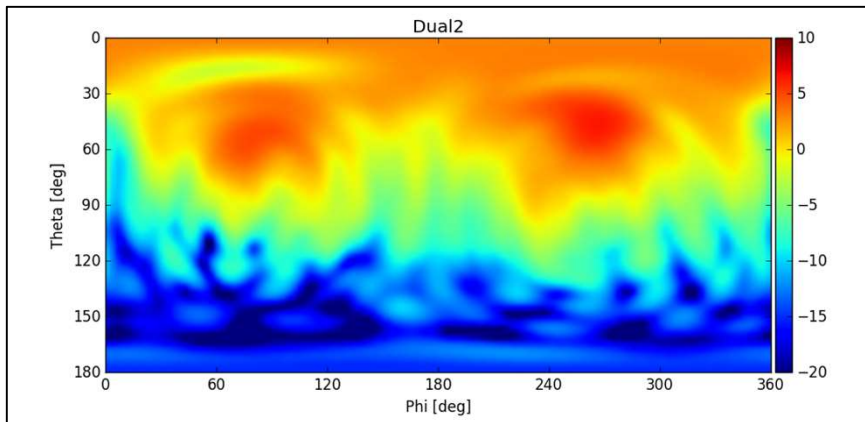
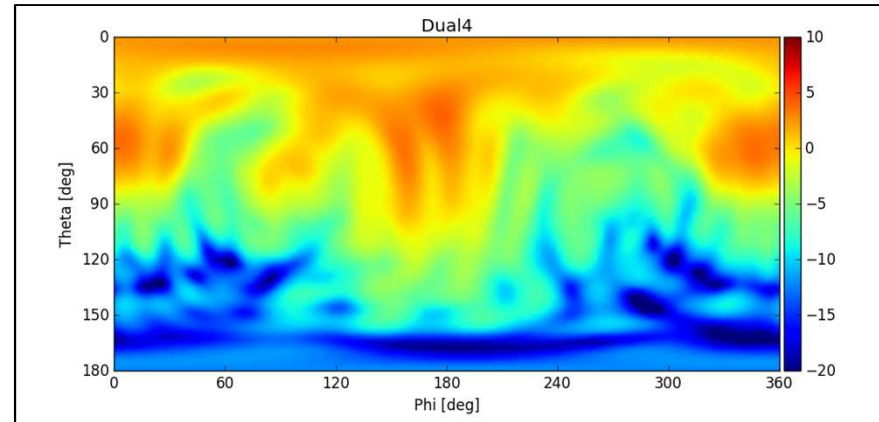
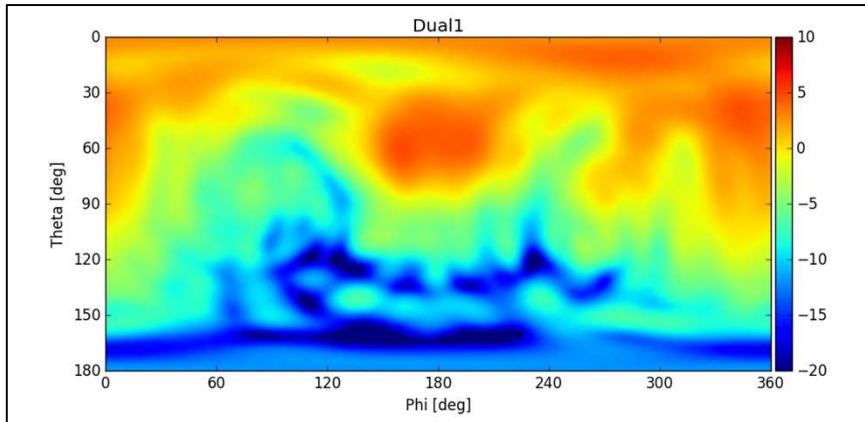
Radiation Pattern for BT



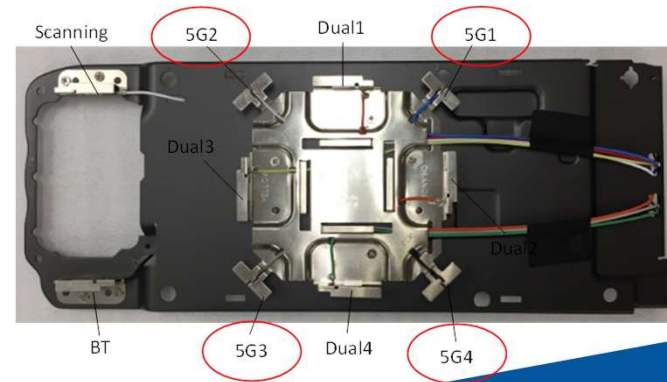
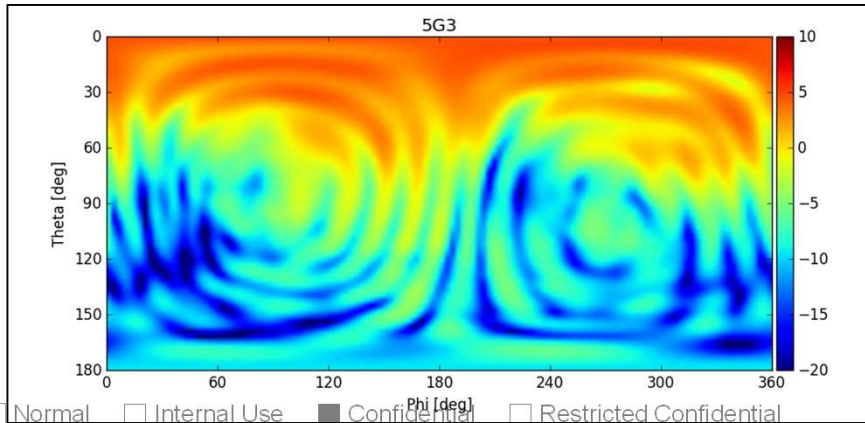
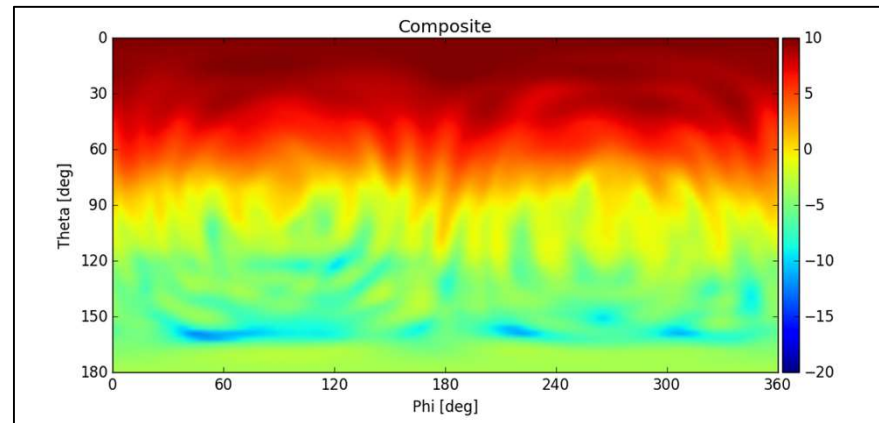
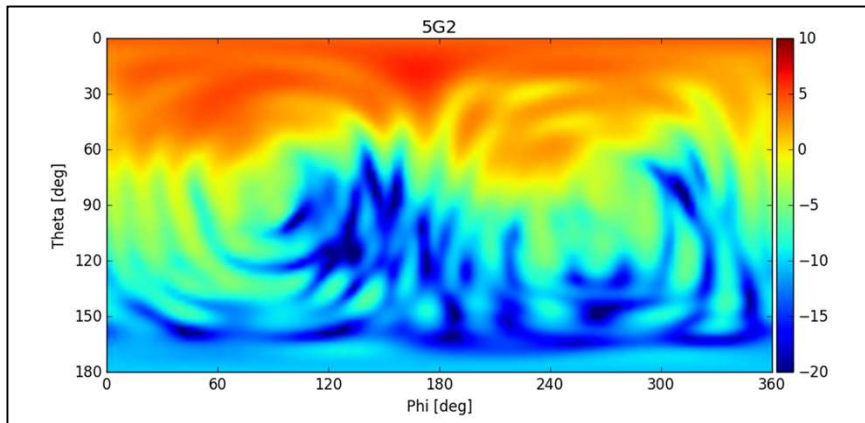
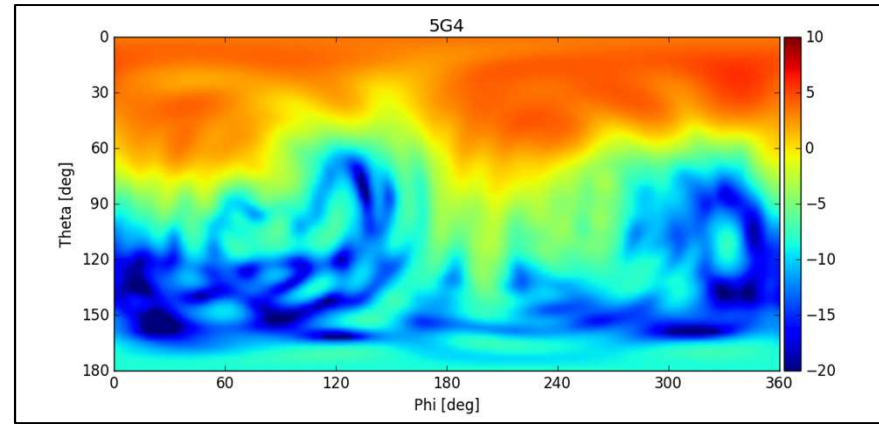
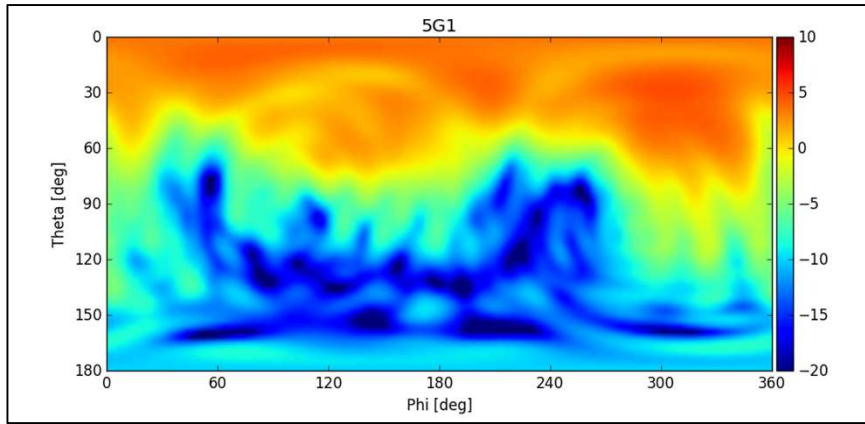
3D Radiation Pattern for Dual-Band @ 2.4GHz



3D Radiation Pattern for Dual-Band @ 5GHz

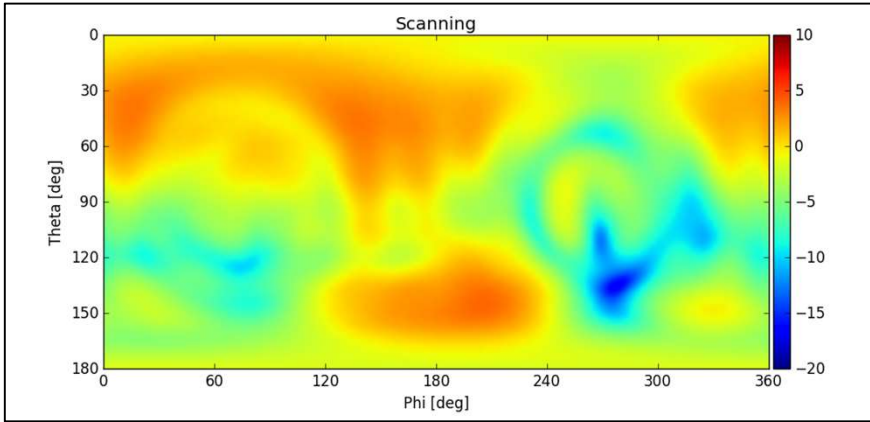


3D Radiation Pattern for 5G

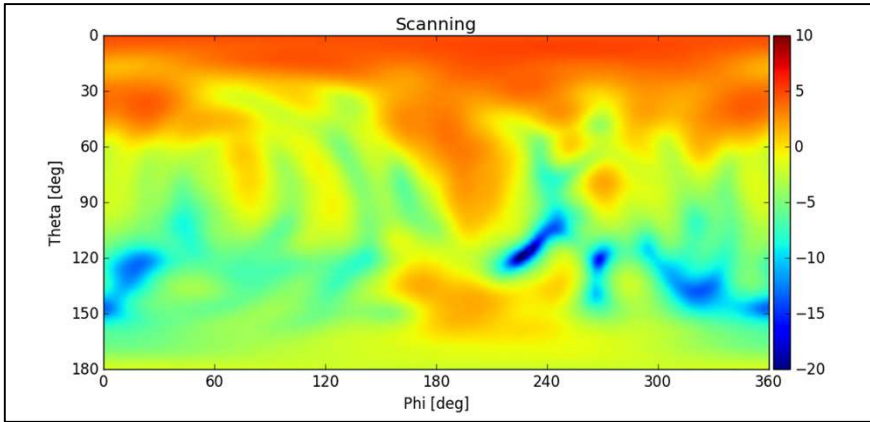
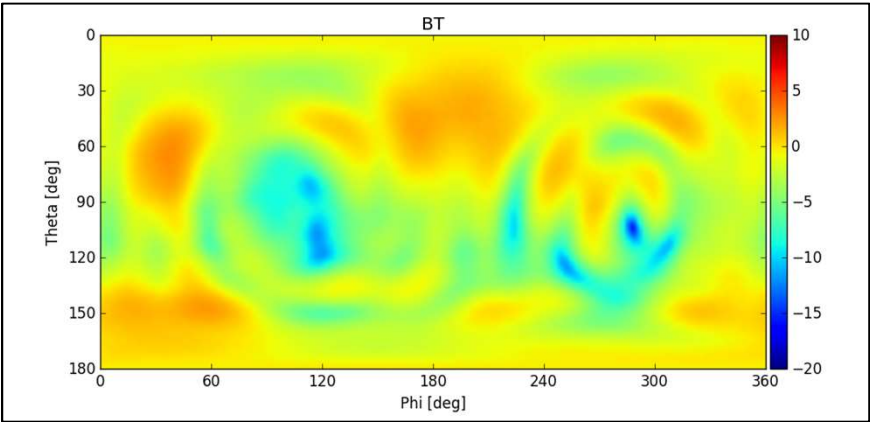


Normal
 Internal Use
 Confidential
 Restricted Confidential

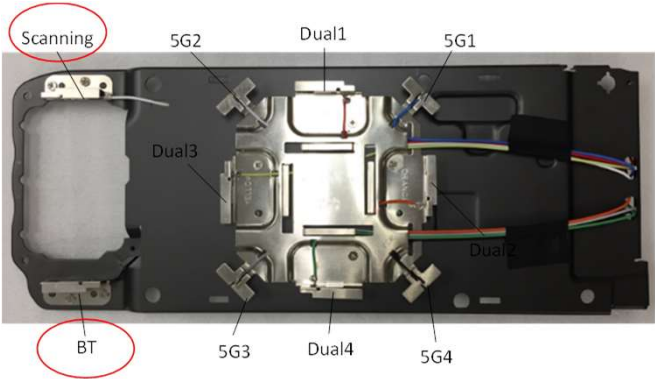
3D Radiation Pattern for Scanning / BT



2.4G



5G



WNC

Wistron NeWeb Corp.

