



Antenna Composite Gain Test Report

1. Test Information

Report No.	AP181947-01AA
Equipment	Wi-Fi 6E Access Point
Brand Name	Cisco
Model Name	MR57-HW
Applicant	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Manufacturer	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134 USA
Sample Received	Oct. 06, 2021
Start Test Date	Oct. 06, 2021
Final Test Date	Oct. 25, 2021
Issued Date	Feb. 25, 2022

2. Testing Location

Testing Location	
<input checked="" type="checkbox"/>	HWA YA ADD : No.13-1 & 14-1, Ln. 19, Wen 33rd St., Guishan Dist., Taoyuan City 333, Taiwan R.O.C.

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	05CH03-HY	Rex Liao	20.5-24.5 / 40-55	Oct. 06, 2021 ~ Oct. 25, 2021

3. Test Frequency

The middle frequency of each bands are selected to represent each frequency bands.

Band [MHz]	Test Frequency [MHz]
2400-2483.5	2450
5150-5250	5200
5250-5350	5300
5470-5725	5600
5725-5850	5785
5850-5895	5885

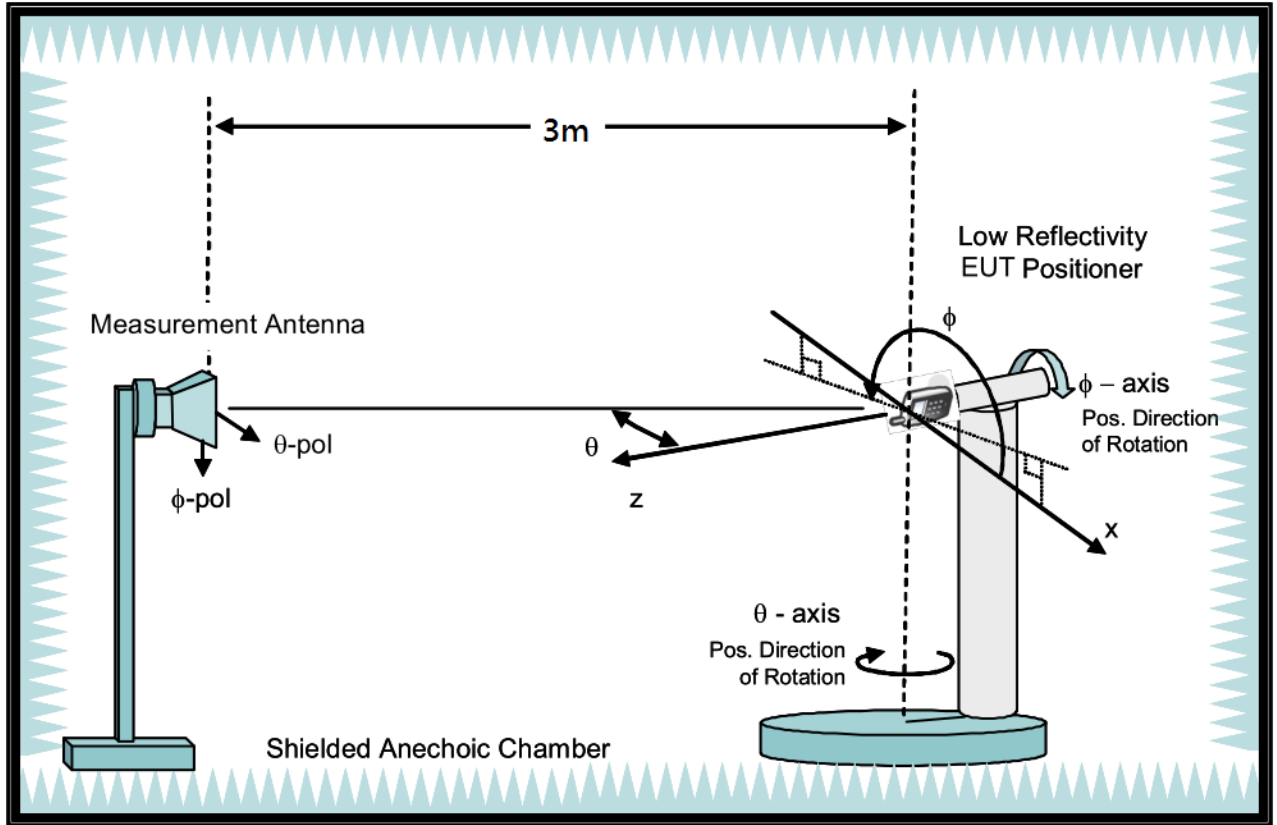
4. Antenna Information

Antenna Position	Brand Name	Model Name	Ant. Type	Connector	Support Function
Antenna 1 (2G5GAnt1)	CISCO	95XKAN15.G42	PIFA	I-PEX	WLAN 2.4GHz & WLAN 5GHz UNII 1~3
Antenna 2 (2G5GAnt2)	CISCO	95XKAN15.G43	PIFA	I-PEX	
Antenna 3 (2G5GAnt3)	CISCO	95XKAN15.G44	PIFA	I-PEX	
Antenna 4 (2G5GAnt4)	CISCO	95XKAN15.G45	PIFA	I-PEX	
Antenna 5 (5GB3B4 5.9GAnt1)	CISCO	95XKAN15.G46	Dipole	I-PEX	WLAN 5GHz UNII 3~4 & WLAN 6GHz UNII 5~8
Antenna 6 (5GB3B4 5.9GAnt2)	CISCO	95XKAN15.G47	Dipole	I-PEX	
Antenna 7 (5GB3B4 5.9GAnt3)	CISCO	95XKAN15.G48	Dipole	I-PEX	
Antenna 8 (5GB3B4 5.9GAnt4)	CISCO	95XKAN15.G49	Dipole	I-PEX	
Antenna 9 (Scanning)	CISCO	95XKAN15.G51	PIFA	I-PEX	WLAN 2.4GHz & WLAN 5GHz UNII 1~3
Antenna 10 (BLE)	CISCO	95XKAN15.G50	PIFA	I-PEX	Bluetooth

Note: The directional gain of the 2G/5GAnt1~4 (2.4GHz/5GHz) and 5GB3B4/5.9GAnt1~4 (only 5GHz) are measured which follows the procedure of KDB 662911 D03.

5. Test Configuration

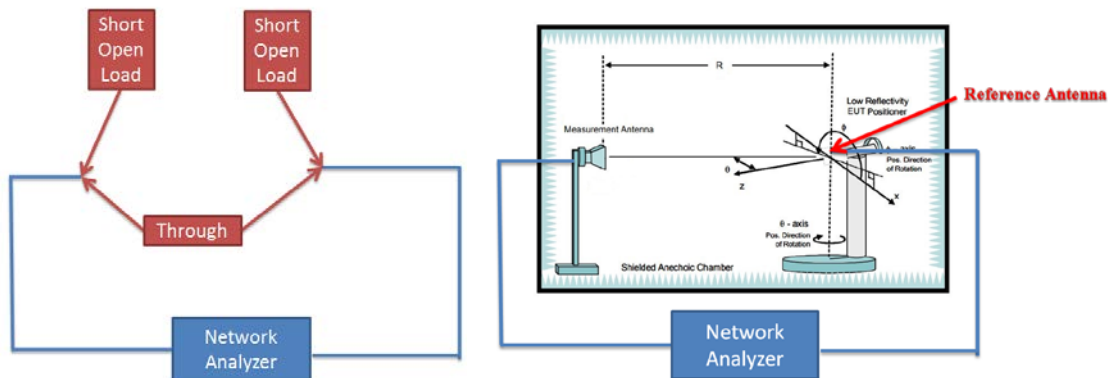
#Reference to CTIA "ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1"



6. Reference Calibration

Connected cables to VNA calibration kit and use network analyzer internal function to do calibration. Do short, open and load to each side. Then connect through to both side and calibrate S21 values and phase. The cable loss and phase reference is calibrated and set inside the network analyzer.

Measurement Antenna is connected to port1 of Network analyzer and reference antenna connected to port 2 of Network Analyzer. Record S21 values and used with reference antenna gain to calculate gain factor.



Frequency (MHz)	2400	2450	2500	5150	5200	5300	5600	5750	5800	5900	6000	6500	7000	7500
S21 values (dBi)	-31.4	-31.4	-31.3	-31.3	-31	-30.7	-30.1	-30.5	-30.5	-30.8	-31.3	-32.8	-34.4	-35.4
Reference gain (dBi)	10.2	10.4	10.6	12.4	12.8	13.4	13.4	13.3	13.3	13.1	13.2	12.3	11.7	11.1
Factor (dB)	41.63	41.81	41.89	43.72	43.78	44.12	43.5	43.78	43.76	43.88	44.45	45.14	46.08	46.51

7. Test Method

EUT set on multi-axis positioner. Measurement antenna set at phi polarization and 1.5 meter height. Port 1 of Network analyzer connect to antenna 1 of EUT. Record S21 value every 15 degree from 0 to 345 degree on Phi angle and 0 to 180 on theta angle of multi-axis positioner. Then set measurement antenna to theta polarization and repeat process. Repeat process to each antenna of EUT.

8. Measured Values and Calculation of Maximum Gain Positions

<Antenna Position: 2G/5GAnt1~4>

For 2TX:

DG_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 3 (S21+iwt)	2.34 +0.32 i	2.37 +0.95 i	2.53 +0.78 i	1.25 -0.85 i	1.48 -1.46 i
Ant. 4 (S21+iwt)	-0.77 +0.34 i	1.67 +0.17 i	1.7 +1.42 i	-0.23 -1.27 i	-0.06 -1.48 i
DG [1SS] (dBi)	3.93	4.36	4.68	3.36	3.75
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	45	45	60	60	75
Φ (°)	105	210	210	210	165

Note: The DG 1SS max value position is the maximum value of section 11 table DG Result (1SS).

DG_1SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 3 [10 [∧] (S21/20) [∧] (cos(wt)+sin(wt) i)]	10 [∧] (2.34/20) [∧] (cos(0.32)+sin(0.32)i)	10 [∧] (2.37/20) [∧] (cos(0.95)+sin(0.95)i)	10 [∧] (2.53/20) [∧] (cos(0.78)+sin(0.78)i)	10 [∧] (1.25/20) [∧] (cos(-0.85)+sin(-0.85)i)	10 [∧] (1.48/20) [∧] (cos(-1.46)+sin(-1.46)i)
Ant. 4 [10 [∧] (S21/20) [∧] (cos(wt)+sin(wt) i)]	10 [∧] (-0.77/20) [∧] (cos(0.34)+sin(0.34)i)	10 [∧] (1.67/20) [∧] (cos(0.17)+sin(0.17)i)	10 [∧] (1.7/20) [∧] (cos(1.42)+sin(1.42)i)	10 [∧] (-0.23/20) [∧] (cos(-1.27)+sin(-1.27)i)	10 [∧] (-0.06/20) [∧] (cos(-1.48)+sin(-1.48)i)
Ant. 3 [Acos(wt)+Asin(wt) i]	1.243 +0.412 i	0.764 +1.069 i	0.951 +0.941 i	0.762 -0.868 i	0.131 -1.178 i
Ant. 4 [Acos(wt)+Asin(wt) i]	0.863 +0.305 i	1.195 +0.205 i	0.183 +1.202 i	0.289 -0.93 i	0.09 -0.989 i
Sum All Antenna [Re+Im]	2.105 +0.717 i	1.959 +1.274 i	1.134 +2.143 i	1.051 -1.798 i	0.221 -2.168 i
Re [∧] 2+Im [∧] 2	4.947	5.459	5.88	4.336	4.747
Amax [(Re [∧] 2+Im [∧] 2) [∧] 0.5]	2.224	2.336	2.425	2.082	2.179
DG [10*log(Amax [∧] 2/Nant)]	3.93	4.36	4.68	3.36	3.75

Note:

1. $A=10^{(S21/20)}$

$$|A\theta^*e^{iwt}|=|A\theta1^*e^{iwt1}+ A\theta2^*e^{iwt2}+ A\theta3^*e^{iwt3}+ A\theta4^*e^{iwt4}+.....|$$

$$|A\varphi^*e^{iwt}|=|A\varphi1^*e^{iwt1}+ A\varphi2^*e^{iwt2}+ A\varphi3^*e^{iwt3}+ A\varphi4^*e^{iwt4}+.....|$$

where

$$e^{iwt}=\cos(wt)+isin(wt)$$

$$|A^*e^{j\omega t}|=\sqrt{Re^2 + Im^2}$$

“Re” is the real part and “Im” is the imaginary part

2. Directional gain (1SS) = 10*log(Amax[∧]2/Nant).

Where Amax is the maximum value of |Aθ| and |Aφ| through all angles.



DG_2SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 3 (S21)	2.3	2.37	2.71	1.04	1.53
Ant. 4 (S21)	0.3	1.67	1.55	1.44	0.65
DG [4SS] (dBi)	1.41	2.03	2.17	1.24	1.11
Polarization	Theta	Theta	Theta	Theta	Theta
θ (°)	45	45	45	75	75
Φ (°)	150	210	210	210	150

Note: The DG 2SS max value position is the maximum DG 2SS value calculated from section 11 table Gain Result.

DG_2SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 3 $((10^{(S21/20)})^2)$	1.6982	1.7258	1.8664	1.2706	1.4223
Ant. 4 $((10^{(S21/20)})^2)$	1.0715	1.4689	1.4289	1.3932	1.1614
Sum All Antenna	2.7698	3.1948	3.2953	2.6637	2.5838
DG $[10*\log(\text{sum all}/Nant)]$	1.41	2.03	2.17	1.24	1.11

Note: Directional Gain (2SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(S21/20)}$$

$$DG(2SS) = 10 * \log(((10^{(S21_{ant1}/20)})^2 + (10^{(S21_{ant2}/20)})^2 + (10^{(S21_{ant3}/20)})^2 + (10^{(S21_{ant4}/20)})^2 + \dots) / Nant)$$

For 4TX:

DG_1SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (S21+iwt)	-2.46 +0.14 i	2.39 +0.92 i	2.18 +0.07 i	2.45 +0.34 i	1.97 -0.81 i
Ant. 2 (S21+iwt)	0.08 +0.03 i	-1.34 +1.34 i	-1.31 +0.97 i	-4.85 +0.34 i	-4.4 +0.14 i
Ant. 3 (S21+iwt)	2.7 +0.48 i	0.85 +0.7 i	0.97 +0.36 i	1.8 +0.12 i	1.53 -0.14 i
Ant. 4 (S21+iwt)	-0.7 -0.36 i	0.47 +1.23 i	0.86 +0.44 i	-0.02 +1.47 i	0.65 +0.48 i
DG [1SS] (dBi)	5.7	6.45	6.36	5.06	5.18
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	45	60	60	75	75
Φ (°)	120	150	150	150	150

Note: The DG 1SS max value position is the maximum value of section 11 table DG Result (1SS).

DG_1SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 [10 [∧] (S21/20)*(cos(wt)+sin(wt) i)]	10 [∧] (-2.46/20)*(cos(0.14)+sin(0.14)i)	10 [∧] (2.39/20)*(cos(0.92)+sin(0.92)i)	10 [∧] (2.18/20)*(cos(0.07)+sin(0.07)i)	10 [∧] (2.45/20)*(cos(0.34)+sin(0.34)i)	10 [∧] (1.97/20)*(cos(-0.81)+sin(-0.81)i)
Ant. 2 [10 [∧] (S21/20)*(cos(wt)+sin(wt) i)]	10 [∧] (0.08/20)*(cos(0.03)+sin(0.03)i)	10 [∧] (-1.34/20)*(cos(1.34)+sin(1.34)i)	10 [∧] (-1.31/20)*(cos(0.97)+sin(0.97)i)	10 [∧] (-4.85/20)*(cos(0.34)+sin(0.34)i)	10 [∧] (-4.4/20)*(cos(0.14)+sin(0.14)i)
Ant. 3 [10 [∧] (S21/20)*(cos(wt)+sin(wt) i)]	10 [∧] (2.7/20)*(cos(0.48)+sin(0.48)i)	10 [∧] (0.85/20)*(cos(0.7)+sin(0.7)i)	10 [∧] (0.97/20)*(cos(0.36)+sin(0.36)i)	10 [∧] (1.8/20)*(cos(0.12)+sin(0.12)i)	10 [∧] (1.53/20)*(cos(-0.14)+sin(-0.14)i)
Ant. 4 [10 [∧] (S21/20)*(cos(wt)+sin(wt) i)]	10 [∧] (-0.7/20)*(cos(-0.36)+sin(-0.36)i)	10 [∧] (0.47/20)*(cos(1.23)+sin(1.23)i)	10 [∧] (0.86/20)*(cos(0.44)+sin(0.44)i)	10 [∧] (-0.02/20)*(cos(1.47)+sin(1.47)i)	10 [∧] (0.65/20)*(cos(0.48)+sin(0.48)i)
Ant. 1 [Acos(wt)+Asin(wt) i]	0.746 +0.105 i	0.798 +1.048 i	1.282 +0.09 i	1.25 +0.442 i	0.865 -0.909 i
Ant. 2 [Acos(wt)+Asin(wt) i]	1.009 +0.03 i	0.196 +0.834 i	0.486 +0.709 i	0.539 +0.191 i	0.597 +0.084 i
Ant. 3 [Acos(wt)+Asin(wt) i]	1.21 +0.63 i	0.843 +0.71 i	1.046 +0.394 i	1.221 +0.147 i	1.181 -0.166 i
Ant. 4 [Acos(wt)+Asin(wt) i]	0.863 -0.325 i	0.353 +0.995 i	0.999 +0.47 i	0.1 +0.993 i	0.956 +0.498 i
Sum All Antenna [Re+Im]	3.829 +0.441 i	2.19 +3.587 i	3.814 +1.663 i	3.111 +1.773 i	3.599 -0.493 i
Re ² +Im ²	14.852	17.665	17.311	12.822	13.193
Amax [(Re ² +Im ²)*0.5]	3.854	4.203	4.161	3.581	3.632
DG [10*log(Amax ² /Nant)]	5.7	6.45	6.36	5.06	5.18

Note:

1. $A=10^{(S21/20)}$

$$|A\theta^*e^{iwt}|=|A\theta1^*e^{iwt1}+ A\theta2^*e^{iwt2}+ A\theta3^*e^{iwt3}+ A\theta4^*e^{iwt4}+.....|$$

$$|A\varphi^*e^{iwt}|=|A\varphi1^*e^{iwt1}+ A\varphi2^*e^{iwt2}+ A\varphi3^*e^{iwt3}+ A\varphi4^*e^{iwt4}+.....|$$

where

$$e^{iwt}=\cos(wt)+isin(wt)$$

$$|A^*e^{jwt}|=\sqrt{Re^2 + Im^2}$$

“Re” is the real part and “Im” is the imaginary part

2. Directional gain (1SS) = 10*log(Amax²/Nant).

Where Amax is the maximum value of |A θ| and |A φ| through all angles.



DG_4SS max value position

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 (S21)	0.43	4.07	-0.74	2.45	0.63
Ant. 2 (S21)	0.54	-3.26	2.38	-4.85	3.84
Ant. 3 (S21)	1.03	0.15	2.71	1.8	-0.53
Ant. 4 (S21)	-0.39	1.72	1.55	-0.02	-4.6
DG [4SS] (dBi)	0.43	1.42	1.66	0.6	0.8
Polarization	Theta	Theta	Theta	Theta	Theta
Θ (°)	60	75	45	75	75
Φ (°)	90	150	210	150	300

Note: The DG 4SS max value position is the maximum DG 4SS value calculated from section 11 table Gain Result.

DG_4SS max value position Calculate

Frequency (Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 $((10^{(S21/20)})^2)$	1.1041	2.5527	0.8433	1.7579	1.1561
Ant. 2 $((10^{(S21/20)})^2)$	1.1324	0.4721	1.7298	0.3273	2.421
Ant. 3 $((10^{(S21/20)})^2)$	1.2677	1.0351	1.8664	1.5136	0.8851
Ant. 4 $((10^{(S21/20)})^2)$	0.9141	1.4859	1.4289	0.9954	0.3467
Sum All Antenna	4.4182	5.5458	5.8684	4.5942	4.809
DG $[10 \cdot \log(\text{sum all}/N_{\text{ant}})]$	0.43	1.42	1.66	0.6	0.8

Note: Directional Gain (4SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(S21/20)}$$

$$DG(4SS) = 10 \cdot \log\left(\frac{(10^{(S21_{\text{ant}1}/20)})^2 + (10^{(S21_{\text{ant}2}/20)})^2 + (10^{(S21_{\text{ant}3}/20)})^2 + (10^{(S21_{\text{ant}4}/20)})^2 + \dots}{N_{\text{ant}}}\right)$$



<Antenna Position: 5GB3B4/5.9GAnt1~4>

For 2TX:

DG_1SS max value position

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (S21+iwt)	2.99 -2.41 i	1.68 -2.03 i	1.08 +2.77 i
Ant. 2 (S21+iwt)	2.03 -2.85 i	4.33 -1.71 i	3.85 +2.89 i
DG [1SS] (dBi)	5.32	6.01	5.57
Polarization	Phi	Phi	Phi
θ (°)	60	60	60
Φ (°)	15	180	180

Note: The DG 1SS max value position is the maximum value of section 11 table DG Result (1SS).

DG_1SS max value position Calculate

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 [10^(S21/20)*(cos(wt)+sin(wt) i)]	10^(2.99/20)*(cos(-2.41)+sin(-2.41)i)	10^(1.68/20)*(cos(-2.03)+sin(-2.03)i)	10^(1.08/20)*(cos(2.77)+sin(2.77)i)
Ant. 2 [10^(S21/20)*(cos(wt)+sin(wt) i)]	10^(2.03/20)*(cos(-2.85)+sin(-2.85)i)	10^(4.33/20)*(cos(-1.71)+sin(-1.71)i)	10^(3.85/20)*(cos(2.89)+sin(2.89)i)
Ant. 1 [Acos(wt)+Asin(wt) i]	-1.05 -0.943 i	-0.538 -1.088 i	-1.055 +0.411 i
Ant. 2 [Acos(wt)+Asin(wt) i]	-1.21 -0.363 i	-0.228 -1.63 i	-1.509 +0.388 i
Sum All Antenna [Re+Im]	-2.26 -1.306 i	-0.766 -2.718 i	-2.564 +0.799 i
Re^2+Im^2	6.812	7.975	7.212
Amax [(Re^2+Im^2)^0.5]	2.61	2.824	2.685
DG [10*log(Amax^2/Nant)]	5.32	6.01	5.57

Note:

1. $A=10^{(S21/20)}$

$$|A\theta e^{iwt}| = |A\theta_1 e^{iwt_1} + A\theta_2 e^{iwt_2} + A\theta_3 e^{iwt_3} + A\theta_4 e^{iwt_4} + \dots|$$

$$|A\varphi e^{iwt}| = |A\varphi_1 e^{iwt_1} + A\varphi_2 e^{iwt_2} + A\varphi_3 e^{iwt_3} + A\varphi_4 e^{iwt_4} + \dots|$$

where

$$e^{iwt} = \cos(wt) + i\sin(wt)$$

$$|A e^{j\omega t}| = \sqrt{Re^2 + Im^2}$$

“Re” is the real part and “Im” is the imaginary part

2. Directional gain (1SS) = $10 \cdot \log(A_{max}^2/N_{ant})$.

Where Amax is the maximum value of |Aθ| and |Aφ| through all angles.



DG_2SS max value position

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (S21)	2.99	1.68	4.84
Ant. 2 (S21)	2.03	4.33	2.96
DG [4SS] (dBi)	2.54	3.2	4
Polarization	Phi	Phi	Phi
Θ (°)	60	60	60
Φ (°)	15	180	345

Note: The DG 2SS max value position is the maximum DG 2SS value calculated from section 11 table Gain Result.

DG_2SS max value position Calculate

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 $((10^{(S21/20)})^2)$	1.9907	1.4723	3.0479
Ant. 2 $((10^{(S21/20)})^2)$	1.5959	2.7102	1.977
Sum All Antenna	3.5866	4.1825	5.0249
DG $[10 \cdot \log(\text{sum all}/N_{\text{ant}})]$	2.54	3.2	4

Note: Directional Gain (2SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(S21/20)}$$

$$DG(2SS) = 10 \cdot \log\left(\frac{(10^{(S21_{\text{ant}1}/20)})^2 + (10^{(S21_{\text{ant}2}/20)})^2 + (10^{(S21_{\text{ant}3}/20)})^2 + (10^{(S21_{\text{ant}4}/20)})^2 + \dots}{N_{\text{ant}}}\right)$$

For 4TX:

DG_1SS max value position

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (S21+iwt)	3.52 -2.11 i	-0.4 +0.53 i	2.73 -1.05 i
Ant. 2 (S21+iwt)	0 -1.31 i	1.74 -0.07 i	2.13 +0.6 i
Ant. 3 (S21+iwt)	-3.51 -2.49 i	2.05 +0.75 i	2.8 -1.1 i
Ant. 4 (S21+iwt)	0.88 -2.52 i	1.65 +0.84 i	3.15 -0.06 i
DG [1SS] (dBi)	5.65	6.75	6.43
Polarization	Phi	Phi	Phi
Θ (°)	60	45	75
Φ (°)	0	270	330

Note: The DG 1SS max value position is the maximum value of section 11 table DG Result (1SS).

DG_1SS max value position Calculate

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 [$10^{(S21/20)} * (\cos(wt) + \sin(wt) i)$]	$10^{(3.52/20)} * (\cos(-2.11) + \sin(-2.11)i)$	$10^{(-0.4/20)} * (\cos(0.53) + \sin(0.53)i)$	$10^{(2.73/20)} * (\cos(-1.05) + \sin(-1.05)i)$
Ant. 2 [$10^{(S21/20)} * (\cos(wt) + \sin(wt) i)$]	$10^{(0/20)} * (\cos(-1.31) + \sin(-1.31)i)$	$10^{(1.74/20)} * (\cos(-0.07) + \sin(-0.07)i)$	$10^{(2.13/20)} * (\cos(0.6) + \sin(0.6)i)$
Ant. 3 [$10^{(S21/20)} * (\cos(wt) + \sin(wt) i)$]	$10^{(-3.51/20)} * (\cos(-2.49) + \sin(-2.49)i)$	$10^{(2.05/20)} * (\cos(0.75) + \sin(0.75)i)$	$10^{(2.8/20)} * (\cos(-1.1) + \sin(-1.1)i)$
Ant. 4 [$10^{(S21/20)} * (\cos(wt) + \sin(wt) i)$]	$10^{(0.88/20)} * (\cos(-2.52) + \sin(-2.52)i)$	$10^{(1.65/20)} * (\cos(0.84) + \sin(0.84)i)$	$10^{(3.15/20)} * (\cos(-0.06) + \sin(-0.06)i)$
Ant. 1 [Acos(wt)+Asin(wt) i]	-0.77 -1.287 i	0.824 +0.483 i	0.681 -1.188 i
Ant. 2 [Acos(wt)+Asin(wt) i]	0.258 -0.966 i	1.219 -0.085 i	1.055 +0.722 i
Ant. 3 [Acos(wt)+Asin(wt) i]	-0.531 -0.405 i	0.926 +0.863 i	0.626 -1.23 i
Ant. 4 [Acos(wt)+Asin(wt) i]	-0.9 -0.644 i	0.807 +0.9 i	1.435 -0.086 i
Sum All Antenna [Re+Im]	-1.943 -3.302 i	3.776 +2.161 i	3.797 -1.783 i
Re ² +Im ²	14.679	18.93	17.593
Amax [(Re ² +Im ²) ^{0.5}]	3.831	4.351	4.194
DG [$10 * \log(Amax^2/Nant)$]	5.65	6.75	6.43

Note:

1. $A = 10^{(S21/20)}$

$$|A\theta * e^{iwt}| = |A\theta_1 * e^{iwt_1} + A\theta_2 * e^{iwt_2} + A\theta_3 * e^{iwt_3} + A\theta_4 * e^{iwt_4} + \dots|$$

$$|A\varphi * e^{iwt}| = |A\varphi_1 * e^{iwt_1} + A\varphi_2 * e^{iwt_2} + A\varphi_3 * e^{iwt_3} + A\varphi_4 * e^{iwt_4} + \dots|$$

where

$$e^{iwt} = \cos(wt) + i\sin(wt)$$

$$|A * e^{j\omega t}| = \sqrt{Re^2 + Im^2}$$

“Re” is the real part and “Im” is the imaginary part

2. Directional gain (1SS) = $10 * \log(Amax^2/Nant)$.

Where Amax is the maximum value of $|A\theta|$ and $|A\varphi|$ through all angles.



DG_4SS max value position

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 (S21)	0.96	1.68	1.08
Ant. 2 (S21)	-0.03	4.33	3.85
Ant. 3 (S21)	0.9	3.73	4.47
Ant. 4 (S21)	3.96	4.39	4.24
DG [4SS] (dBi)	1.73	3.66	3.6
Polarization	Phi	Phi	Phi
θ (°)	60	60	60
Φ (°)	210	180	180

Note: The DG 4SS max value position is the maximum DG 4SS value calculated from section 11 table Gain Result.

DG_4SS max value position Calculate

Frequency (Hz)	5.6G	5.785G	5.885G
Ant. 1 ((10 ^(S21/20))²)	1.2474	1.4723	1.2823
Ant. 2 ((10 ^(S21/20))²)	0.9931	2.7102	2.4266
Ant. 3 ((10 ^(S21/20))²)	1.2303	2.3605	2.799
Ant. 4 ((10 ^(S21/20))²)	2.4889	2.7479	2.6546
Sum All Antenna	5.9596	9.2909	9.1625
DG [10*log(sum all/Nant)]	1.73	3.66	3.6

Note: Directional Gain (4SS) is the max value of all position. Each position value is calculated by KDB662911 D01 (e) (ii).

$$g_{j,k} = 10^{(S21/20)}$$

$$DG(4SS) = 10 \cdot \log\left(\frac{(10^{(S21_{ant1}/20)})^2 + (10^{(S21_{ant2}/20)})^2 + (10^{(S21_{ant3}/20)})^2 + (10^{(S21_{ant4}/20)})^2 + \dots}{N_{ant}}\right)$$



9. Summary of Test Result

<Antenna Position: 2G/5GAnt1~4>

Band (MHz)	2400-2483.5	
Frequency (Hz)	2.45G	
Nant	4TX	2TX
Ant. 1 Max Gain (dBi)	1.87	-
Ant. 2 Max Gain (dBi)	2.68	-
Ant. 3 Max Gain (dBi)	2.7	2.7
Ant. 4 Max Gain (dBi)	1.52	1.52
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/15/300	-
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/15/195	-
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/45/120	Theta/45/120
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/30/15	Theta/30/15
Max Gain (dBi)	2.7	2.7
DG [1SS] (dBi)	5.7	3.93
DG [2SS] (dBi)	2.7	1.41
DG [4SS] (dBi)	0.43	-



Band (MHz)	5150-5250		5250-5350		5470-5725		5725-5850	
Frequency (Hz)	5.2G		5.3G		5.6G		5.785G	
Nant	4TX	2TX	4TX	2TX	4TX	2TX	4TX	2TX
Ant. 1 Max Gain (dBi)	4.07	-	4.09	-	2.45	-	1.97	-
Ant. 2 Max Gain (dBi)	3.7	-	4.21	-	3	-	3.84	-
Ant. 3 Max Gain (dBi)	3.29	3.29	3.51	3.51	2.33	2.33	3.03	3.03
Ant. 4 Max Gain (dBi)	1.8	1.8	1.7	1.7	1.44	1.44	1.61	1.61
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/150	-	Theta/75/150	-	Theta/75/150	-	Theta/75/150	-
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/270	-	Theta/75/270	-	Theta/60/270	-	Theta/75/300	-
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/60/240	Theta/60/240	Theta/45/315	Theta/45/315	Theta/60/180	Theta/60/180	Theta/60/135	Theta/60/135
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Theta/75/90	Theta/75/90	Theta/60/210	Theta/60/210	Theta/75/210	Theta/75/210	Theta/45/75	Theta/45/75
Max Gain (dBi)	4.07	3.29	4.21	3.51	3	2.33	3.84	3.03
DG [1SS] (dBi)	6.45	4.36	6.36	4.68	5.06	3.36	5.18	3.75
DG [2SS] (dBi)	4.07	2.03	4.21	2.17	3	1.24	3.84	1.11
DG [4SS] (dBi)	1.42	-	1.66	-	0.6	-	0.8	-

Note:

1. For 4TX modes, Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
2. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
3. The max gain is the max value of all antennas.



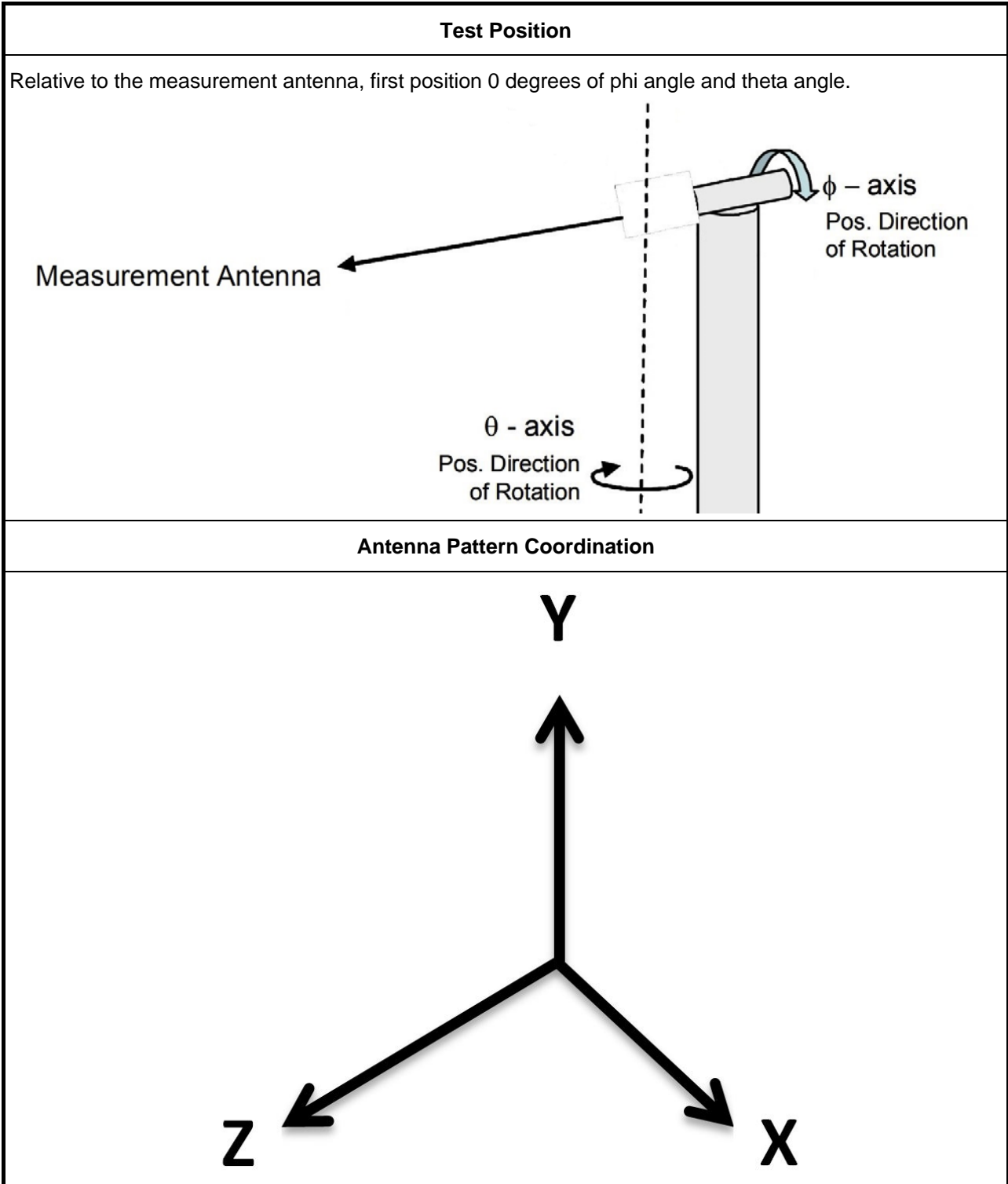
<5GB3B4/5.9GAnt1~4>

Band (MHz)	5470-5725		5725-5850		5850-5895	
Frequency (Hz)	5.6G		5.785G		5.885G	
Nant	4TX	2TX	4TX	2TX	4TX	2TX
Ant. 1 Max Gain (dBi)	3.52	-	3.3	-	4.84	-
Ant. 2 Max Gain (dBi)	3.54	-	4.33	-	4.28	-
Ant. 3 Max Gain (dBi)	4.28	3.52	4.45	3.3	4.6	4.84
Ant. 4 Max Gain (dBi)	4.13	3.54	4.39	4.33	4.75	4.28
Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/0	Phi/60/0	Phi/60/0	Phi/60/0	Phi/60/345	Phi/60/345
Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/150	Phi/60/150	Phi/60/180	Phi/60/180	Phi/75/60	Phi/75/60
Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/165	-	Phi/60/165	-	Phi/60/195	-
Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$	Phi/60/195	-	Phi/60/180	-	Phi/75/105	-
Max Gain (dBi)	4.28	3.54	4.45	4.33	4.84	4.84
DG [1SS] (dBi)	5.65	5.32	6.75	6.01	6.43	5.57
DG [2SS] (dBi)	4.28	2.54	4.45	3.2	4.84	4
DG [4SS] (dBi)	1.73	-	3.66	-	3.6	-

Note:

1. For 4TX modes, Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
2. Each antenna max gain is the max value of measurement S21 of theta and phi through all measurement angles.
3. The max gain is the max value of all antennas.

10. Test Setup



Note:

Photos of Test Position: Please refer to the test photos in the appendix.



11. Test Results

Please refer to the appendix.

Appendix A – Radiated Composite Gain

Appendix B – Antenna Pattern

Appendix C – Test Photos



12. Test Equipment and Calibration Data

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120D-1292	1GHz~18GHz	Aug. 04, 2021	Aug. 03, 2022
Test Software	SPORTON	SENSE-RDG	V1.0.6	-	N.C.R.	N.C.R.

Note: Calibration Interval of instruments listed above is one year.

NCR means Non-Calibration required.



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 1 Max Gain (dBi)	1.87	4.07	4.09	2.45	1.97
Ant. 2 Max Gain (dBi)	2.68	3.7	4.21	3	3.84
Ant. 3 Max Gain (dBi)	2.7	3.29	3.51	2.33	3.03
Ant. 4 Max Gain (dBi)	1.52	1.8	1.7	1.44	1.61
Ant. 1 Polarization/ θ (°)/ ϕ (°)	Theta/15/300	Theta/75/150	Theta/75/150	Theta/75/150	Theta/75/150
Ant. 2 Polarization/ θ (°)/ ϕ (°)	Theta/15/195	Theta/75/270	Theta/75/270	Theta/60/270	Theta/75/300
Ant. 3 Polarization/ θ (°)/ ϕ (°)	Theta/45/120	Theta/60/240	Theta/45/315	Theta/60/180	Theta/60/135
Ant. 4 Polarization/ θ (°)/ ϕ (°)	Theta/30/15	Theta/75/90	Theta/60/210	Theta/75/210	Theta/45/75
Max Gain (dBi)	2.7	4.07	4.21	3	3.84
DG [1SS] (dBi)	5.7	6.45	6.36	5.06	5.18
DG [2SS] (dBi)	2.7	4.07	4.21	3	3.84
DG [4SS] (dBi)	0.43	1.42	1.66	0.6	0.8



DG Result (1SS)

Table with columns for Freq(Hz), DG(dBi), and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, and 5.3G. Each frequency section includes a sub-table for Polarization (Pol.) and Theta angles.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with columns for frequency (5.6G, 5.785G), polarization (Pol.), and various azimuth angles (Theta) and elevation angles (Phi). Rows show DG(dBi) values for each combination.



Gain Result

Table with columns: Freq(Hz), 2.45G, Pol., Phi, Ant. 1, and 24 columns of gain values (Phi(0°) to Phi(345°)). It contains three main sections of data for frequencies 2.45G, 5.2G, and 5.3G.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with 22 columns (Theta, Phi, Re+Im) and 100 rows (Theta 0-180, Freq 5.3G, 5.6G, 5.785G). Each cell contains a complex number representing gain.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with 25 columns (Theta, Phi) and 25 rows (Theta, Phi) for frequencies 5.785G, 2.45G, and 5.2G. Each cell contains a complex number representing gain.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with columns for Freq(Hz), Re+Im, and various Phi angles (0 to 345 degrees) for 5.2G, 5.3G, 5.6G, and 5.8G frequencies. Each cell contains a complex number representing gain.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with columns for Freq(Hz), Re+Im, and various Phi angles (0 to 345 degrees) for Antenna 2 and Antenna 3. The table contains multiple rows of numerical data representing gain values.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with columns for Freq(Hz), Re+Im, and various Phi angles (0 to 345 degrees) for 5.2G, 5.3G, and 5.6G frequencies. Each cell contains a complex number representing gain.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with columns for frequency (5.6G, 5.785G, 2.45G), polarization (Pol), theta angle, antenna number (Ant. 3, 4), and real/imaginary components of gain for various theta angles (0 to 180 degrees).



Radiated Composite Gain (For Antenna Position: 2G5Gant1~4_4TX)

Appendix A.1

Table with columns for frequency (2.45G, 5.2G, 5.3G), polarization (Pol.), and antenna position (Ant. 4). Rows represent elevation angles from 0 to 180 degrees in 15-degree increments. Each cell contains a complex gain value in the form 'Re+Im'.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_4TX)

Appendix A.1

Table with 24 columns representing antenna positions (Theta) and 24 rows representing frequency bands (5.3G, 5.6G, 5.785G). Each cell contains a complex gain value in Re+Im format.

Re+Im	Φ(0°)	Φ(15°)	Φ(30°)	Φ(45°)	Φ(60°)	Φ(75°)	Φ(90°)	Φ(105°)	Φ(120°)	Φ(135°)	Φ(150°)	Φ(165°)	Φ(180°)	Φ(195°)	Φ(210°)	Φ(225°)	Φ(240°)	Φ(255°)	Φ(270°)	Φ(285°)	Φ(300°)	Φ(315°)	Φ(330°)	Φ(345°)
Θ(0°)	-8.2-0.89i	-8.97-1.02i	-10.59-1.04i	-12.48-1.21i	-15.33-1.23i	-23.4+1.49i	-23.71+0.86i	-16.29+0.51i	-12.87+0.32i	-10.67+0.26i	-8.89+0.23i	-8.39+0.23i	-8.01+0.23i	-8.89+0.26i	-9.71+0.29i	-11.14+0.32i	-15.14+0.33i	-24.2+0.13i	-35.2-0.72i	-16.52-0.93i	-11.88-0.96i	-9.93-1i	-9.38-0.96i	-8.59-1.01i
Θ(15°)	-2.27+0.31i	-1.89+0.67i	-2.03+0.84i	-3.6+0.85i	-4.91+0.65i	-7.12+0.36i	-10.88-0.15i	-11.06-1.04i	-10.57+1.44i	-10.25+0.71i	-9.08+0.07i	-9.28-0.36i	-8.21-0.59i	-10.35-0.85i	-8.99-1.11i	-9.52-1.25i	-13.5-1.17i	-13.09-0.74i	-11.35-0.3i	-12.46+0.5i	-6.68+1.17i	-4.5-1.43i	-5.08-0.81i	-4.52-0.25i
Θ(30°)	-3.92+1.55i	-2.76-0.91i	-1.16-0.39i	0.13-0.1i	-1.63-0.22i	-1.51-0.71i	-2.2-1.4i	-3.32+0.78i	-7.31-0.36i	-8.79+1.48i	-12.06+0.15i	-13.54-0.59i	-11.04-1.49i	-3.88+0.85i	-3.21+0.23i	-3.19-0.11i	-6.43-0.18i	-11.11+0.39i	-8+1.23i	-7.41-1i	-4.69+0.14i	-5.81+1.43i	-4.63-0.47i	-4+0.62i
Θ(45°)	-2.14-0.18i	-2.63+0.81i	-1.98+1.53i	0.52-1.18i	0.25-1.35i	1.61+1.23i	1.2+0.33i	-1.02-1.02i	-2.85+0.48i	-3.33-1.14i	-5.13+0.38i	-4.33-0.98i	-3.6+0.76i	-1.09-0.47i	0.15-1.32i	-2.07+1.39i	-5.22-1.53i	-9.4-1.05i	-5.73-0.08i	-6.19+1.27i	-5.97-0.14i	-2.68+1.54i	-3.46+0.11i	-2.88-1.55i
Θ(60°)	-2.39+0.94i	-4.64-0.88i	-2.81-0.04i	-0.17+0.37i	1.21+0.26i	1.18-0.31i	1.3-1.54i	-0.12+0.09i	-2.55+1.33i	-3.68-0.73i	-2.22+0.32i	-1.19-1.4i	-5.13-0.06i	-1.24-1.44i	-0.73+0.69i	-3.15+0.36i	-9.16+0.43i	-11.26+0.91i	-6.73-1.04i	-5.5+0.61i	-6.28-0.54i	-2.11+1.44i	-5.12+0.3i	-2.13-0.67i
Θ(75°)	-2.66-1.44i	-4+0.12i	-2.45+1.15i	-2.13-1.54i	-1.01+1.46i	0.22+0.74i	1.07-0.54i	-0.53+0.95i	-1.5-1.15i	-3.71-0.35i	0.65+0.48i	-0.06-1.48i	-1.44-0.29i	-0.07+1.38i	0.77+0.28i	-4.49-0.33i	-8.07-0.34i	-9.77+0.1i	-4.82-1.55i	-6.7+0.4i	-4.6-0.47i	-4.55-1.56i	-6.66+0.73i	-4.56-0.22i
Θ(90°)	-4.3-1.07i	-3.3+0.55i	-3.79-1.5i	-3.58-1.12i	-2.75-1.25i	-1.53+1.14i	0.42-0.15i	-2.19+1.28i	-2.86-0.95i	-3.78-0.18i	-1.54+0.61i	-3.36-1.54i	-5.91-0.48i	-6.07+1.11i	-3.66-0.02i	-11.29-0.77i	-8.55-0.92i	-6.46-0.48i	-4.46+1.15i	-7.85+0.07i	-5.29-0.59i	-8.42-1.5i	-8.63+0.97i	-7.78+0.17i
Θ(105°)	-10.29-1.12i	-5.23+0.57i	-6.01-1.5i	-5.72-1.24i	-6.11-1.28i	-3.91+1.11i	-3.78-0.27i	-4.09+1.27i	-5.74-0.91i	-6.36-0.09i	-4.33+0.64i	-4.37+1.36i	-5.01-0.77i	-7.57+0.7i	-5.32-0.2i	-13.38-1.19i	-13.78+1.23i	-13.22-0.71i	-10.7+1.14i	-11.8+0.53i	-8.54-0.5i	-11.18+1.52i	-13.88+0.98i	-10.3+0.27i
Θ(120°)	-10.29+1.52i	-8.48-0.18i	-5.97+0.65i	-6.24+1.15i	-7.84+0.82i	-8.47+0.25i	-6.58-1i	-5.62+0.75i	-8.66-1.12i	-9.01-0.33i	-9.19+0.84i	-10.59+1.42i	-14.44-0.31i	-10.65+0.07i	-17.14-0.99i	-17.92+1.38i	-11.26-1.43i	-12.46-0.27i	-19.74+1.4i	-22.8+0.93i	-10.24-0.42i	-12.59-1.39i	-19.48+0.53i	-15.01-0.07i
Θ(135°)	-10.52+0.66i	-9.45-1.24i	-12.69-0.44i	-9.23-0.31i	-9.32-0.39i	-8.36-1.17i	-9.81+0.97i	-8.89-0.09i	-17.58+1.19i	-11.97-0.72i	-12.2+0.75i	-11.45-0.58i	-13.67-1.46i	-14.24-0.06i	-15.6-1.12i	-10.53+0.83i	-21.69+1.35i	-23.11-1.51i	-17.6-0.21i	-19.31+0.9i	-20.37+0.37i	-30.01-0.26i	-16.5+0.92i	-12.32-0.69i
Θ(150°)	-17.26-0.46i	-11.86+0.04i	-11.79+0.67i	-12.47+0.87i	-11.65+0.72i	-11.54+0.27i	-11.55-0.52i	-13.73-1.51i	-15.7+0.54i	-14.51-1.57i	-16.66+0.44i	-13.81-1.05i	-28.92+0.8i	-14.09-1.01i	-16.46+0.69i	-15.76-0.29i	-17.3-1.15i	-22.44-0.2i	-24.07+1.05i	-17.84-1.44i	-23.81+0.3i	-20.04+0.78i	-23.13+0.49i	-25.57-1.3i
Θ(165°)	-13.89+1.46i	-17.78-1.41i	-21.96-1.49i	-16.55+1.39i	-13.04+1.47i	-12.83+1.29i	-17.64+0.7i	-13.57-0.2i	-14.06-0.74i	-20.39+1.53i	-14.82+0.34i	-13.69-0.56i	-12.15-1.1i	-18.82+1.29i	-18.19+1i	-19.7+1.42i	-18.49+1.35i	-23.52+1.14i	-22.58-1.15i	-17.73-1.13i	-16.28-1.04i	-18.34-0.28i	-14.89+0.23i	-16.1+0.67i
Θ(180°)	-12.81-0.72i	-13.39-0.85i	-14.1-0.89i	-14.17-0.93i	-17.63-1.07i	-19.67-1.04i	-27-1.14i	-28.63+1.49i	-19.65+0.75i	-14.58+0.71i	-15.47+0.48i	-21.83+0.32i	-18.54+0.89i	-12.48+0.77i	-13.65+0.67i	-17.07+0.55i	-17.21+0.83i	-22.54+0.78i	-25.3+0.31i	-24.76-0.41i	-24.32-0.53i	-20.64-0.54i	-17.4-0.71i	-15.42-0.71i



Freq(Hz)	2.45G	5.2G	5.3G	5.6G	5.785G
Ant. 3 Max Gain (dBi)	2.7	3.29	3.51	2.33	3.03
Ant. 4 Max Gain (dBi)	1.52	1.8	1.7	1.44	1.61
Ant. 3 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/45/120	Theta/60/240	Theta/45/315	Theta/60/180	Theta/60/135
Ant. 4 Polarization/ $\theta(^{\circ})/\phi(^{\circ})$	Theta/30/15	Theta/75/90	Theta/60/210	Theta/75/210	Theta/45/75
Max Gain (dBi)	2.7	3.29	3.51	2.33	3.03
DG [1SS] (dBi)	3.93	4.36	4.68	3.36	3.75
DG [2SS] (dBi)	1.41	2.03	2.17	1.24	1.11



DG Result (1SS)

Table with columns for Freq(Hz), DG(dB), and various Phi angles (0 to 345 degrees) for frequencies 2.45G, 5.2G, and 5.3G. The table contains multiple rows of data for each frequency, showing gain values in dB.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Table with columns for frequency (5.6G, 5.785G), polarization (Pol.), and various angles (Theta, Phi) from 0 to 180 degrees. Rows show DG(dBi) values for each combination.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Gain Result

Table with columns: Freq(Hz), 2.45G, Pol., Phi, Ant. 3, and 24 columns of gain values (Phi(0°) to Phi(345°)). It contains three main sections of data for 2.45G, 5.2G, and 5.3G frequencies.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Table with columns for frequency (5.3G, 5.6G, 5.785G), polarization (Pol.), theta angle, antenna number (Ant. 3), and real/imaginary components (Re+Im) for various phi angles (0 to 345 degrees) across multiple theta angles (0 to 180 degrees).



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Table with columns for frequency (5.785G, 2.45G, 5.2G), polarization (Pol.), phase (Phi), antenna (Ant. 3, 4), and real/imaginary components (Re+Im) for various angles (Theta) from 0 to 180 degrees. Each angle has 16 columns of data representing different phase values from 0 to 345 degrees.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Table with columns for Frequency (5.2G, 5.3G, 5.6G), Real/Imaginary components, and various angles (Theta, Phi) from 0 to 345 degrees. Each cell contains a complex number representing gain.



Radiated Composite Gain (For Antenna Position: 2G5GAnt1~4_2TX)

Appendix A.2

Table with columns for Azimuth (Theta) and Elevation (Phi) angles, and rows for various frequency and antenna parameters. The table contains numerical gain values for each combination of angles.



Freq(Hz)	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.52	3.3	4.84
Ant. 2 Max Gain (dBi)	3.54	4.33	4.28
Ant. 3 Max Gain (dBi)	4.28	4.45	4.6
Ant. 4 Max Gain (dBi)	4.13	4.39	4.75
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/0	Phi/60/0	Phi/60/345
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/150	Phi/60/180	Phi/75/60
Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/165	Phi/60/165	Phi/60/195
Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/195	Phi/60/180	Phi/75/105
Max Gain (dBi)	4.28	4.45	4.84
DG [1SS] (dBi)	5.65	6.75	6.43
DG [2SS] (dBi)	4.28	4.45	4.84
DG [4SS] (dBi)	1.73	3.66	3.6



DG Result (1SS)

Table with columns for Freq(Hz), Pol., Phi, and DG(dBi) for various angles (0 to 150 degrees) across multiple frequency bands (5.6G, 5.785G, 5.885G).



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

$\Theta(165^\circ)$	-17.44	-22.2	-25.24	-13.24	-14.54	-18.26	-17.77	-27.52	-17.81	-16.09	-17.78	-14.62	-22.16	-13.24	-13.19	-19.58	-20.71	-33.22	-18.36	-11.06	-10.85	-11.32	-21.19	-11.53
$\Theta(180^\circ)$	-23.22	-20.31	-40.05	-25.03	-21.13	-23.91	-23.73	-23.78	-20.64	-18.96	-23.41	-22.86	-18.92	-10.85	-14.88	-17.79	-12.04	-11.82	-15.27	-13.06	-12.37	-13.15	-13.96	-17.98



Gain Result

Table with columns: Freq(Hz), Re+Im, Phi, Ant. 1, and various Phi angles (0 to 345 degrees) for frequencies 5.6G, 5.785G, and 5.885G.



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

Table with columns for Frequency (5.885G, 5.6G, 5.785G), Polarization (Pol.), and various angles (Theta, Phi) from 0 to 135 degrees. Each cell contains a complex gain value in rectangular form (a+bi).



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

Table with columns for frequency (5.785G, 5.885G, 5.6G), polarization (Pol.), antenna position (Ant. 2, Ant. 3), and azimuth angle (Theta). Rows show radiation patterns for various elevation angles (Theta) from 0 to 180 degrees, with values in Re+Im format.



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

Table with 24 columns and 100 rows of data. Columns include frequency (5.785G, 5.885G), polarization (Pol.), phase (Phi), antenna (Ant. 3), and real/imaginary components (Re+Im) for various angles (Theta) from 0 to 180 degrees. Each cell contains a complex number in the form 'a+bi'.



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

Table with columns for frequency (5.6G, 5.785G), real/imaginary components, and gain values for various antenna positions (0 to 135 degrees) and phases (0 to 345 degrees).



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_4TX)

Appendix A.3

Table with columns for frequency (5.885G), polarization (Pol), antenna (Ant. 4), and various azimuth angles (Theta) from 0 to 180 degrees. Each cell contains a complex value (Re+Im) for the radiated composite gain.



Freq(Hz)	5.6G	5.785G	5.885G
Ant. 1 Max Gain (dBi)	3.52	3.3	4.84
Ant. 2 Max Gain (dBi)	3.54	4.33	4.28
Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/0	Phi/60/0	Phi/60/345
Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$	Phi/60/150	Phi/60/180	Phi/75/60
Max Gain (dBi)	3.54	4.33	4.84
DG [1SS] (dBi)	5.32	6.01	5.57
DG [2SS] (dBi)	2.54	3.2	4



DG Result (1SS)

Table with columns for Freq(Hz), Pol., Phi, and DG(dBi) for various angles (0 to 150 degrees) across four frequency bands: 5.6G, 5.785G, 5.885G, and 5.985G.



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_2TX)

Appendix A.4

$\Theta(165^\circ)$	-24.4	-28.41	-21.64	-15.33	-23.19	-25.72	-22.92	-19.31	-16.91	-34.68	-13.9	-12.5	-20.68	-14.82	-17.2	-21.51	-19.59	-16.31	-25.88	-19.51	-17.06	-14.83	-18.56	-22.78
$\Theta(180^\circ)$	-14.91	-14.2	-17.84	-18.39	-19.52	-22.26	-20.01	-16.6	-14.08	-31	-21.25	-20.27	-23.32	-15.49	-25.81	-17.08	-16.96	-15.68	-23.54	-25.74	-27.18	-19.23	-15.8	-17.44



Gain Result

Table with 23 columns (Freq(Hz), 5.6G, Pol., Phi, Ant. 1, etc.) and 23 rows per section. It contains complex gain data for various frequencies (5.6G, 5.785G, 5.885G) and antenna positions.



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_2TX)

Appendix A.4

Table with columns for Frequency (5.885G, 5.6G, 5.785G), Polarization (Pol.), and various angles (Theta, Ant. 1, Ant. 2) and azimuthal angles (Phi(0°) to Phi(345°)).



Radiated Composite Gain (For Antenna Position: 5GB2B3/5.9GAnt1~4_2TX)

Appendix A.4

Table with columns for frequency (5.785G, 5.885G), polarization (Pol, Phi), antenna (Ant. 2), and azimuthal angle (Theta) from 0 to 180 degrees. Each cell contains a complex gain value in Re+Im format.

