



# Antenna Composite Gain Test Report

|                 |  |
|-----------------|--|
| FCC ID          | 2AXXQBGW321  |
| Equipment       | BGW320-500 Wireless Integrated ONT Residential Gateway                                     |
| Brand Name      | HUMAX  |
| Model Name      | BGW320-500   |
| Applicant       | Humax Networks, INC.<br>216, Hwangsaetul-ro, Bundang-gu, Seongnam-si, 463-875, South Korea |
| Manufacturer    | Humax Networks, INC.<br>216, Hwangsaetul-ro, Bundang-gu, Seongnam-si, 463-875, South Korea |
| Sample Received | Apr. 25, 2022  |
| Start Test Date | Apr. 25, 2022  |
| Final Test Date | Apr. 25, 2022  |

Approved by: Sam Chen

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## 1. Operation Mode and Antenna Information

| Antenna Position | RF Port |      | Brand Name | Model Name       | Ant. Type | Connector | Modes of Operation         |
|------------------|---------|------|------------|------------------|-----------|-----------|----------------------------|
|                  | 2.4GHz  | 5GHz |            |                  |           |           |                            |
| 2G5GLAnt1        | 1       | 1    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 2.4GHz,<br>5GHz UNII 1, 2A |
| 2G5GLAnt2        | 2       | 2    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 2.4GHz,<br>5GHz UNII 1, 2A |
| 2G5GLAnt3        | 3       | 3    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 2.4GHz,<br>5GHz UNII 1, 2A |
| 2G5GLAnt4        | 4       | 4    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 2.4GHz,<br>5GHz UNII 1, 2A |
| 5G Ant1          | -       | 1    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 5GHz UNII 2C, 3            |
| 5G Ant2          | -       | 2    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 5GHz UNII 2C, 3            |
| 5G Ant3          | -       | 3    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 5GHz UNII 2C, 3            |
| 5G Ant4          | -       | 4    | GALTRONICS | 02102140-06811U1 | PCB       | I-PEX     | 5GHz UNII 2C, 3            |

Note:

2.4GHz and 5GHz UNII 1, 2A Operation Mode (4TX/4RX)

2G5GLAnt1~2G5GLAnt4 can be used as transmitting/receiving antenna.

2G5GLAnt1~2G5GLAnt4 could transmit/receive simultaneously.

5GHz UNII 2C, 3 Operation Mode (4TX/4RX)

5G Ant1~5G Ant4 can be used as transmitting/receiving antenna.

5G Ant1~5G Ant4 could transmit/receive simultaneously.

## 2. Test Frequency

The listed 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                 |



### 3. 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      | 23.5-24.5 / 50-55         | Apr. 25, 2022 |

Note:

Testing Site Information

Brand Name: TDK

Dimension: 11m\*6m\*6m

Characteristic: Fully Anechoic Chamber

#### 4. Test Facility and Configuration

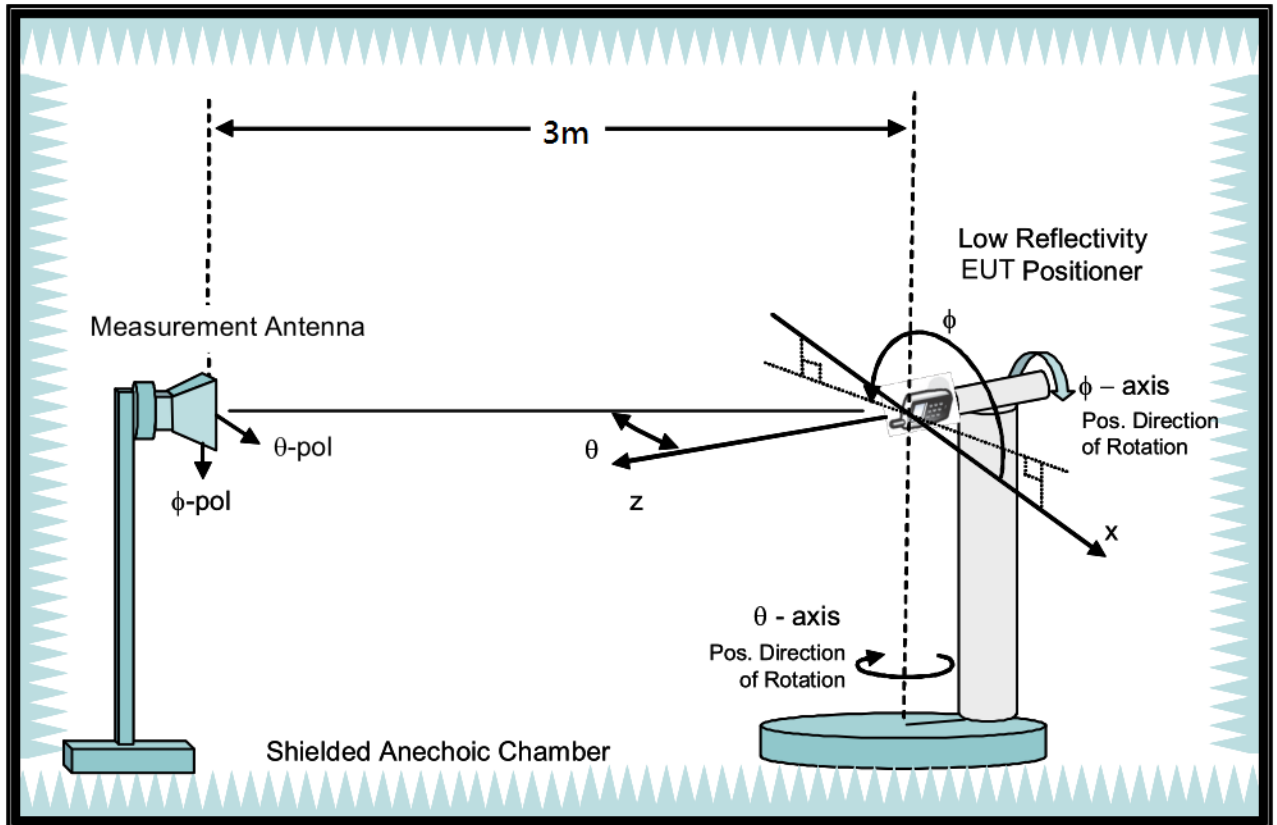
Test configuration: Reference to CITA OTA distributed-axes system configuration.

Chamber: Fully Anechoic Chamber.

Measurement antenna: Dual Polarization Horn antenna

Turntable: Multi-axis positioner (Theta and Phi angle).

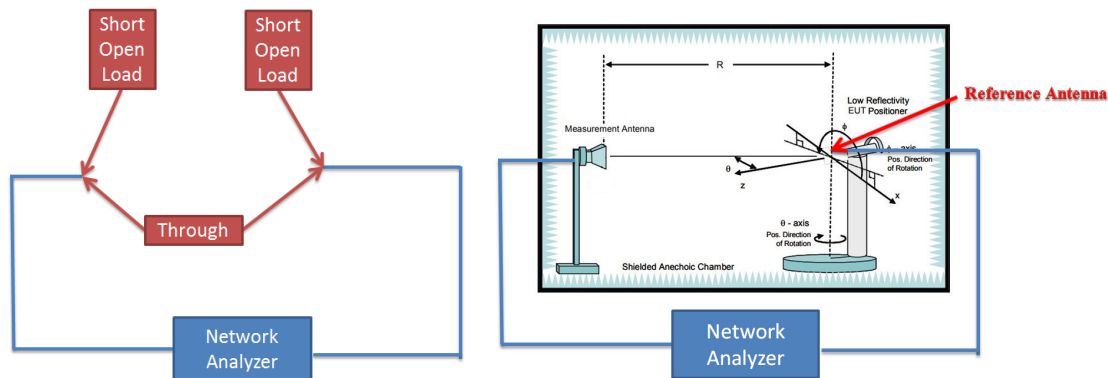
#Reference to CTIA “ctia-test-plan-for-wireless-device-over-the-air-performance-ver-3-7-1”



### 5. 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 G values. The cable loss 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 G 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  |
|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| G reading (dB)       | -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)          | 41.34 | 41.55 | 41.68 | 43.24 | 43.56 | 43.68 | 43.79 | 43.91 | 43.99 | 44.43 | 44.49 | 45.24 | 46.12 | 46.31 |

Note:

$$G \text{ reading (dB)} = 20 \cdot \log(V2/V1) = 10 \cdot \log(P2/P1)$$

V2 is the voltage of VNA port2 is measured, V1 is the voltage of VNA port1 is the reference source.

P2 is the power of VNA port2 is measured, P1 is the power of VNA port1 is the reference source.

$$\text{Factor} = \text{gain factor} + \text{power gain conversion} = (\text{Reference antenna gain}) - (G \text{ reading})$$

## 6. Test Method

EUT set on multi-axis positioner and adjust EUT's physical center to measurement reference center. Measurement antenna set at phi polarization and 1.5 meter height. Port 1 of Network analyzer connect to antenna 1 of EUT. Record G value every 10 degree from 0 to 350 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.

DG steps:

1. Each Phi and Theta polarization antenna gain are measured for all test angles.
2. Composite Phi and Theta antenna gain are computed, using formula in KDB662911 D01 d) (i) and e) (ii), for all angles.
3. Composite antenna gain are examined for all angles to determine max gain and Phi/Theta position. Max gain and phi/theta position are listed in section 7 tables.

Note: Antenna gain = G reading + factor, The factor of chapter five includes reference antenna gain factor and power gain conversion.



## 7. Measured Values and Calculation of Maximum Gain Positions

For 2.4GHz/5GHz UNII 1, 2A

DG\_1SS max value position

| Frequency (Hz) | 2.45G | 5.2G  | 5.3G   |
|----------------|-------|-------|--------|
| Ant. 1 (dBi)   | -7.37 | -1.59 | -1.82  |
| Ant. 2 (dBi)   | 2.89  | -0.06 | 0.22   |
| Ant. 3 (dBi)   | -2.89 | 2.93  | 1.92   |
| Ant. 4 (dBi)   | 3.21  | -19.2 | -19.04 |
| DG [1SS] (dBi) | 5.99  | 4.45  | 4.07   |
| Polarization   | Phi   | Theta | Theta  |
| $\Theta$ (°)   | 30    | 70    | 80     |
| $\Phi$ (°)     | 30    | 230   | 240    |

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

DG\_1SS max value position calculation

| Frequency (Hz)                            | 2.45G             | 5.2G              | 5.3G               |
|---|-------------------|-------------------|--------------------|
| Ant. 1 [ $10^{(G/20)}$ ]                  | $10^{(-7.37/20)}$ | $10^{(-1.59/20)}$ | $10^{(-1.82/20)}$  |
| Ant. 2 [ $10^{(G/20)}$ ]                  | $10^{(2.89/20)}$  | $10^{(-0.06/20)}$ | $10^{(0.22/20)}$   |
| Ant. 3 [ $10^{(G/20)}$ ]                  | $10^{(-2.89/20)}$ | $10^{(2.93/20)}$  | $10^{(1.92/20)}$   |
| Ant. 4 [ $10^{(G/20)}$ ]                  | $10^{(3.21/20)}$  | $10^{(-19.2/20)}$ | $10^{(-19.04/20)}$ |
| Ant. 1 [ $10^{(G/20)}$ ] value            | 0.428             | 0.833             | 0.811              |
| Ant. 2 [ $10^{(G/20)}$ ] value            | 1.395             | 0.993             | 1.026              |
| Ant. 3 [ $10^{(G/20)}$ ] value            | 0.717             | 1.401             | 1.247              |
| Ant. 4 [ $10^{(G/20)}$ ] value            | 1.447             | 0.11              | 0.112              |
| Sum All Antenna [Amax]                    | 3.987             | 3.337             | 3.196              |
| DG [ $10 \cdot \log(A_{max}^2/N_{ant})$ ] | 5.99              | 4.45              | 4.07               |

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

Directional gain (1SS) =  $10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^2 / N_{ant}$



For 5GHz UNII 2C, 3

DG\_1SS max value position

| Frequency (Hz) | 5.6G  | 5.785G |
|----------------|-------|--------|
| Ant. 1 (dBi)   | -5.23 | -5.86  |
| Ant. 2 (dBi)   | -0.9  | -0.75  |
| Ant. 3 (dBi)   | -9.55 | -11.07 |
| Ant. 4 (dBi)   | 3.09  | 4.21   |
| DG [1SS] (dBi) | 4.11  | 4.43   |
| Polarization   | Theta | Theta  |
| $\Theta$ (°)   | 70    | 100    |
| $\Phi$ (°)     | 60    | 50     |

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

DG\_1SS max value position calculation

| Frequency (Hz)                        | 5.6G                      | 5.785G                     |
|---------------------------------------|---------------------------|----------------------------|
| Ant. 1 [10 <sup>^(G/20)</sup> ]       | 10 <sup>^(-5.23/20)</sup> | 10 <sup>^(-5.86/20)</sup>  |
| Ant. 2 [10 <sup>^(G/20)</sup> ]       | 10 <sup>^(-0.9/20)</sup>  | 10 <sup>^(-0.75/20)</sup>  |
| Ant. 3 [10 <sup>^(G/20)</sup> ]       | 10 <sup>^(-9.55/20)</sup> | 10 <sup>^(-11.07/20)</sup> |
| Ant. 4 [10 <sup>^(G/20)</sup> ]       | 10 <sup>^(3.09/20)</sup>  | 10 <sup>^(4.21/20)</sup>   |
| Ant. 1 [10 <sup>^(G/20)</sup> ] value | 0.548                     | 0.509                      |
| Ant. 2 [10 <sup>^(G/20)</sup> ] value | 0.902                     | 0.917                      |
| Ant. 3 [10 <sup>^(G/20)</sup> ] value | 0.333                     | 0.28                       |
| Ant. 4 [10 <sup>^(G/20)</sup> ] value | 1.427                     | 1.624                      |
| Sum All Antenna [Amax]                | 3.21                      | 3.33                       |
| DG [10*log(Amax <sup>2</sup> /Nant)]  | 4.11                      | 4.43                       |

Note:

Directional Gain (1SS) is the max value of every look angle. Each position value is calculated by KDB662911 D01 d) (i).

$$\text{Directional gain (1SS)} = 10 \cdot \log(10^{(G_{ant1}/20)} + 10^{(G_{ant2}/20)} + 10^{(G_{ant3}/20)} + 10^{(G_{ant4}/20)} + \dots)^2 / N_{ant}$$

## 8. Summary of Test Result

| Frequency (Hz)   | 2.45G        | 5.2G          | 5.3G         |
|--|--------------|---------------|--------------|
| Ant. 1 Max Gain (dBi)                                  | 4.3          | 2.43          | 2.5          |
| Ant. 2 Max Gain (dBi)                                  | 3.63         | 2.08          | 2.97         |
| Ant. 3 Max Gain (dBi)                                  | 2.69         | 2.93          | 2.8          |
| Ant. 4 Max Gain (dBi)                                  | 4.67         | 3.28          | 3.24         |
| Ant. 1 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$ | Theta/80/170 | Theta/100/100 | Theta/100/90 |
| Ant. 2 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$ | Phi/10/30    | Phi/120/190   | Phi/120/190  |
| Ant. 3 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$ | Phi/100/80   | Theta/70/230  | Theta/80/230 |
| Ant. 4 Polarization/ $\Theta(^{\circ})/\Phi(^{\circ})$ | Phi/50/20    | Phi/30/190    | Phi/30/200   |
| Max Gain (dBi)   | 4.67         | 3.28          | 3.24         |
| DG [1SS] (dBi)   | 5.99         | 4.45          | 4.07         |
| DG [2SS] (dBi)   | 4.67         | 3.28          | 3.24         |
| DG [4SS] (dBi)   | 4.67         | 3.28          | 3.24         |

Note:

1. Antenna max gain is the max value of each individual antenna through all measurement angles.
2. The max gain is the max value of all antennas.
3. Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. If directional gain is less than max gain, use max gain as directional gain.

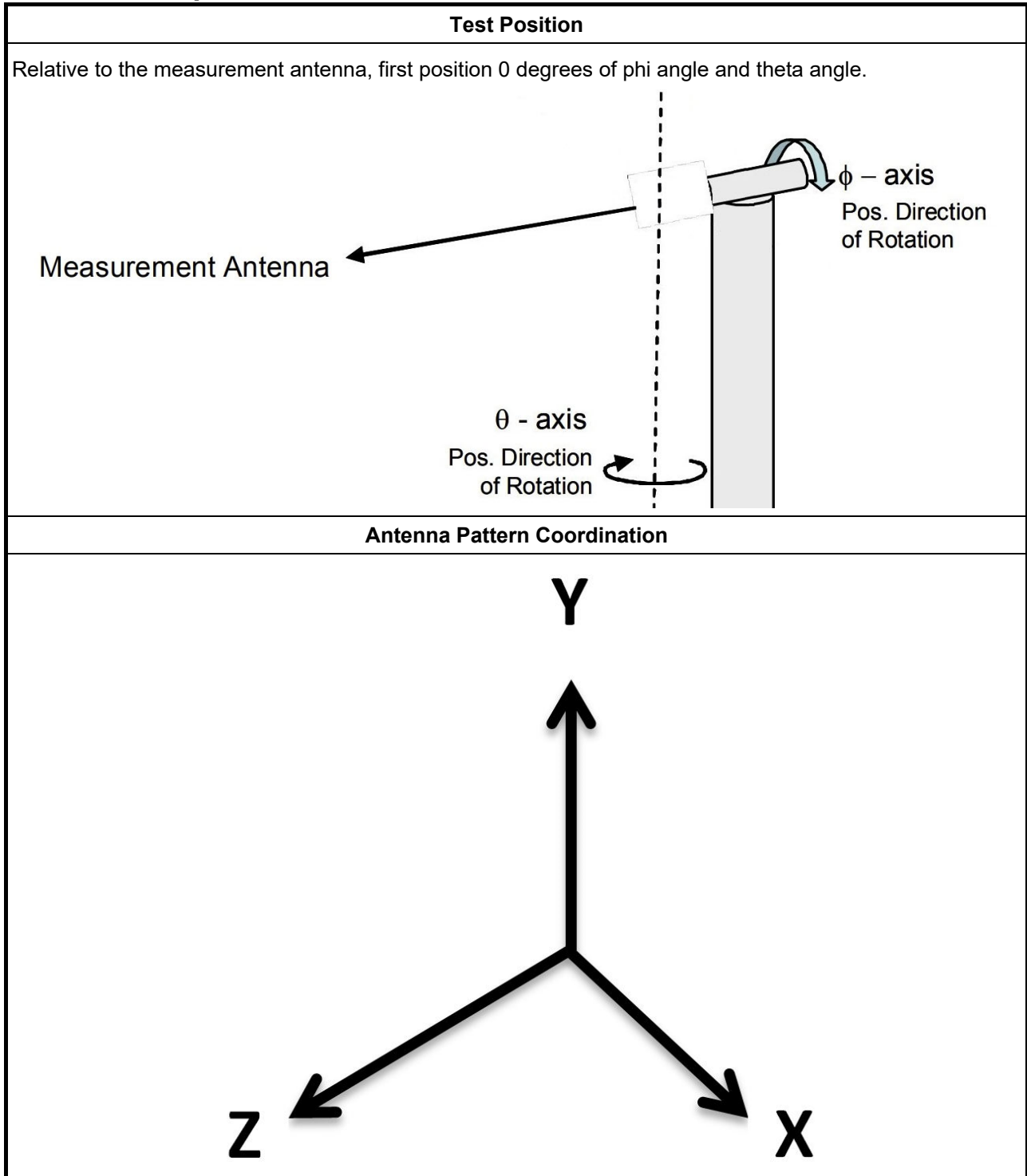


| Frequency (Hz)   | 5.6G         | 5.785G       |
|--|--------------|--------------|
| Ant. 1 Max Gain (dBi)                                  | 2.57         | 2.64         |
| Ant. 2 Max Gain (dBi)                                  | 3.98         | 4.12         |
| Ant. 3 Max Gain (dBi)                                  | 2.29         | 2.9          |
| Ant. 4 Max Gain (dBi)                                  | 3.18         | 4.21         |
| Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Phi/50/280   | Phi/70/190   |
| Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Theta/90/250 | Theta/90/250 |
| Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Phi/40/50    | Phi/80/60    |
| Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Theta/90/60  | Theta/100/50 |
| Max Gain (dBi)   | 3.98         | 4.21         |
| DG [1SS] (dBi)   | 4.11         | 4.43         |
| DG [2SS] (dBi)   | 3.98         | 4.21         |
| DG [4SS] (dBi)   | 3.98         | 4.21         |

Note:

1. Antenna max gain is the max value of each individual antenna through all measurement angles.
2. The max gain is the max value of all antennas.
3. Directional Gain (2SS) = Directional Gain (1SS) – 3dB. If directional gain is less than max gain, use max gain as directional gain.
4. Directional Gain (4SS) = Directional Gain (1SS) – 6dB. If directional gain is less than max gain, use max gain as directional gain.

### 9. Test Setup



Note:

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



### 10. 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        |
| Dual Polarization Horn Antenna | Sporton     | S0209DP    | S0209DP-001     | 2GHz~9GHz        | N.C.R.           | N.C.R.               |
| ENA Series Network Analyzer    | AGILENT     | E5071C     | MY46419201      | 100kHz~8.5GHz    | Feb. 21, 2022    | Feb. 20, 2023        |
| VNA Calibration Kit            | TS RF       | TS85033E-F | -               | DC~9GHz          | N.C.R.           | N.C.R.               |
| Multi-axis positioner          | Sporton     | MAPS01     | MAPS01-001      | Theta / Phi axis | N.C.R.           | N.C.R.               |
| 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.



## 11. Test Results

Please refer to the appendix.

|  |         |
|--|---------|
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| Appendix E – Test Photos.....  | Page 32 |



| Freq(Hz)                                      | 2.45G        | 5.2G          | 5.8G         |
|---|--------------|---------------|--------------|
| Ant. 1 Max Gain (dBi)                         | 4.3          | 2.43          | 2.5          |
| Ant. 2 Max Gain (dBi)                         | 3.63         | 2.08          | 2.97         |
| Ant. 3 Max Gain (dBi)                         | 2.69         | 2.93          | 2.8          |
| Ant. 4 Max Gain (dBi)                         | 4.67         | 3.28          | 3.24         |
| Ant. 1 Polarization/ $\Theta$ (°)/ $\Phi$ (°) | Theta/80/170 | Theta/100/100 | Theta/100/90 |
| Ant. 2 Polarization/ $\Theta$ (°)/ $\Phi$ (°) | Phi/10/30    | Phi/120/190   | Phi/120/190  |
| Ant. 3 Polarization/ $\Theta$ (°)/ $\Phi$ (°) | Phi/100/80   | Theta/70/230  | Theta/80/230 |
| Ant. 4 Polarization/ $\Theta$ (°)/ $\Phi$ (°) | Phi/50/20    | Phi/30/190    | Phi/30/200   |
| Max Gain (dBi)                                | 4.67         | 3.28          | 3.24         |
| DG [1SS] (dBi)                                | 5.99         | 4.45          | 4.07         |
| DG [2SS] (dBi)                                | 4.67         | 3.28          | 3.24         |
| DG [4SS] (dBi)                                | 4.67         | 3.28          | 3.24         |

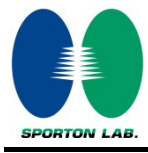












| Freq(Hz)   | 5.6G         | 5.785G       |
|--|--------------|--------------|
| Ant. 1 Max Gain (dBi)                                  | 2.57         | 2.64         |
| Ant. 2 Max Gain (dBi)                                  | 3.98         | 4.12         |
| Ant. 3 Max Gain (dBi)                                  | 2.29         | 2.9          |
| Ant. 4 Max Gain (dBi)                                  | 3.18         | 4.21         |
| Ant. 1 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Phi/50/280   | Phi/70/190   |
| Ant. 2 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Theta/90/250 | Theta/90/250 |
| Ant. 3 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Phi/40/50    | Phi/80/60    |
| Ant. 4 Polarization/ $\theta(^{\circ})/\Phi(^{\circ})$ | Theta/90/60  | Theta/100/50 |
| Max Gain (dBi)   | 3.98         | 4.21         |
| DG [1SS] (dBi)   | 4.11         | 4.43         |
| DG [2SS] (dBi)   | 3.98         | 4.21         |
| DG [4SS] (dBi)   | 3.98         | 4.21         |













# Antenna Pattern of 2.4GHz, 5GHz U-NII 1 and U-NII 2A

# Appendix C

| θ (°)    | -1.170-2.4   | -0.622-2.8   | -0.371-1.99  | -3.39-6.04   | -7.88-8.76   | -9.03-12.55    | -13.43-17.01   | -5.82-5.47     | -5.60-6.75     | -5.92-1.04     | 0.690-27       | 1.452-70       | 1.851-66       | 1.521-89       | -0.171-0.57    | -1.471-3.44    | -2.36-0.77     | 0.24-0.03      |
|----------|--------------|--------------|--------------|--------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Gain     | Φ(0°)Φ(10°)  | Φ(20°)Φ(30°) | Φ(40°)Φ(50°) | Φ(60°)Φ(70°) | Φ(80°)Φ(90°) | Φ(100°)Φ(110°) | Φ(120°)Φ(130°) | Φ(140°)Φ(150°) | Φ(160°)Φ(170°) | Φ(180°)Φ(190°) | Φ(200°)Φ(210°) | Φ(220°)Φ(230°) | Φ(240°)Φ(250°) | Φ(260°)Φ(270°) | Φ(280°)Φ(290°) | Φ(300°)Φ(310°) | Φ(320°)Φ(330°) | Φ(340°)Φ(350°) |
| θ (0°)   | -2.09-1.59   | -1.39-1.55   | -1.71-1.58   | -1.05-1.47   | -1.98-2.75   | -2.87-3.18     | -1.08-1.74     | -1.42-1.70     | -0.33-0.64     | -0.78-0.23     | -1.08-1.31     | -1.42-0.96     | -2.09-2.08     | -2.23-2.72     | -2.41-2.31     | -2.09-2.08     | -2.23-2.72     | -2.84-2.43     |
| θ (10°)  | -2.73-1.88   | -1.42-1.27   | -1.43-1.93   | -1.46-1.99   | -2.93-3.69   | -3.95-3.72     | -3.14-2.23     | -1.29-0.52     | -0.12-0.25     | -0.12-0.26     | -0.39-0.60     | -0.72-0.94     | -1.17-1.62     | -2.46-3.13     | -3.48-3.43     | -3.22-3.31     | -3.53-3.97     | -4.17-3.62     |
| θ (20°)  | -2.99-0.95   | -0.58-0.85   | -0.96-1.74   | -2.55-4.14   | -5.63-5.38   | -4.33-4.00     | -3.66-3.46     | -2.85-2.27     | -1.33-0.60     | -0.01-0.24     | 0.37-0.05      | -0.41-1.00     | -1.92-2.70     | -3.56-3.99     | -4.08-3.80     | -3.52-3.76     | -4.60-5.30     | -5.34-4.25     |
| θ (30°)  | -2.26-1.26   | -1.21-2.06   | -2.13-2.65   | -4.33-4.34   | -3.94-3.06   | -2.23-1.67     | -1.17-0.63     | -2.43-3.35     | -3.96-3.58     | -3.96-3.58     | -1.60-1.23     | -2.53-1.52     | -3.10-2.72     | -2.93-3.56     | -3.10-2.72     | -2.56-2.95     | -3.91-5.21     | -5.91-4.50     |
| θ (40°)  | -1.76-0.24   | -0.75-1.60   | -3.29-3.82   | -3.03-1.82   | -0.80-0.11   | -0.49-2.14     | -4.71-7.03     | -6.99-4.40     | -3.07-3.24     | -4.03-3.85     | -2.92-2.75     | -2.98-3.25     | -4.23-3.74     | -4.14-3.44     | -3.12-2.84     | -3.03-3.33     | -3.98-5.09     | -5.57-4.04     |
| θ (50°)  | -1.90-0.63   | -0.57-1.31   | -3.21-3.31   | -1.69-0.64   | 0.20-0.12    | -1.41-4.00     | -8.04-9.43     | -6.78-3.18     | -1.60-2.19     | -4.26-4.11     | -5.13-6.62     | -4.92-3.90     | -2.56-2.79     | -2.93-2.90     | -2.77-2.46     | -1.97-1.71     | -1.91-2.74     | -4.15-4.04     |
| θ (60°)  | -2.41-0.21   | 0.80-1.36    | -4.15-3.43   | -0.96-0.14   | 0.38-0.99    | -0.87-2.55     | -5.83-2.59     | -8.84-8.93     | -4.59-5.47     | -3.17-5.89     | -5.56-6.92     | -7.39-4.13     | -1.70-1.19     | -1.71-1.07     | -1.17-1.19     | -0.42-1.64     | -3.97-5.48     | -5.08-3.74     |
| θ (70°)  | -2.48-0.08   | 0.35-2.80    | -5.77-3.42   | -0.62-0.44   | -0.81-1.79   | -5.17-8.34     | -13.86-14.12   | -11.09-3.80    | -0.25-0.24     | -3.05-4.19     | -3.26-3.11     | -6.06-6.18     | -3.17-1.88     | -1.76-1.65     | -1.01-0.59     | -0.62-0.61     | -0.97-2.11     | -3.63-4.98     |
| θ (80°)  | -3.60-0.55   | -1.20-4.88   | -6.43-2.29   | 0.87-1.01    | -1.23-7.38   | -5.65-6.28     | -7.91-8.83     | -8.81-6.12     | -0.50-0.75     | -1.67-5.10     | -3.07-0.93     | -4.98-5.19     | -2.73-2.68     | -1.49-1.28     | -1.28-1.52     | -2.07-1.80     | -1.60-2.14     | -3.57-5.64     |
| θ (90°)  | -1.07-1.34   | -0.14-3.54   | -5.51-0.50   | 2.10-2.04    | 1.19-1.18    | 0.36-1.02      | 2.10-2.04      | 0.36-1.02      | 1.19-1.18      | 0.36-1.02      | 2.10-2.04      | 0.36-1.02      | 1.19-1.18      | 0.36-1.02      | 2.10-2.04      | 0.36-1.02      | 1.19-1.18      | 0.36-1.02      |
| θ (100°) | -2.47-1.51   | -2.45-4.53   | -5.33-0.16   | 2.78-3.10    | 3.08-1.43    | 0.68-0.82      | -0.22-1.23     | -0.05-1.46     | 2.52-1.49      | -0.97-4.74     | -3.31-0.62     | -0.10-1.86     | -4.11-3.53     | -1.79-0.56     | -0.27-0.38     | -1.03-2.73     | -3.52-2.82     | -2.61-2.98     |
| θ (110°) | -7.61-2.84   | -1.58-0.51   | -7.94-3.78   | -0.48-0.09   | -0.13-1.02   | 0.06-0.14      | -1.44-2.16     | -0.10-1.75     | 2.38-1.24      | -1.05-2.46     | -3.63-2.27     | 1.93-0.82      | -2.31-3.91     | -3.15-2.00     | -2.16-3.20     | -3.02-3.24     | -4.22-4.24     | -4.56-6.66     |
| θ (120°) | -9.01-4.35   | -3.38-7.46   | -7.02-3.70   | -1.48-0.80   | 1.57-1.48    | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     | 1.57-1.48      | -1.04-1.50     |
| θ (130°) | -6.34-2.58   | -1.19-1.76   | -2.23-3.04   | -1.57-1.71   | -1.22-0.58   | -0.81-1.90     | -3.71-3.01     | -0.97-0.28     | -0.15-0.48     | -1.70-2.90     | -2.94-0.99     | 1.14-1.37      | -0.13-1.68     | -2.55-3.36     | -4.27-5.35     | -6.16-5.38     | -4.38-4.66     | -5.97-8.27     |
| θ (140°) | -5.03-3.19   | -1.47-1.88   | -2.96-7.43   | -7.69-6.91   | -4.87-3.21   | -3.17-4.09     | -4.36-2.43     | -0.63-0.42     | -1.24-3.03     | -5.57-6.96     | -6.32-3.58     | -1.65-0.54     | -0.37-0.15     | 0.09-0.05      | -0.21-0.86     | -1.94-3.66     | -5.19-5.92     | -5.80-5.95     |
| θ (150°) | -3.05-3.19   | -3.23-3.44   | -5.18-7.73   | -7.36-9.32   | -9.57-10.60  | -12.66-12.85   | -1.86-1.74     | -3.24-6.24     | -4.63-4.50     | -4.57-4.16     | -4.83-4.50     | -4.57-4.16     | -4.83-4.50     | -4.57-4.16     | -4.83-4.50     | -4.57-4.16     | -4.83-4.50     | -4.57-4.16     |
| θ (160°) | -5.12-5.85   | -5.80-5.87   | -5.51-4.83   | -4.32-4.66   | -5.09-5.89   | -7.29-8.71     | -9.29-8.64     | -8.50-9.01     | -11.11-10.74   | -8.24-5.89     | -4.41-4.48     | -4.98-5.19     | -5.54-5.46     | -4.71-3.69     | -2.86-2.31     | -1.98-1.77     | -2.23-3.05     | -3.72-4.36     |
| θ (170°) | -6.73-6.67   | -5.72-5.18   | -4.98-4.86   | -5.81-6.90   | -8.08-9.27   | -10.41-11.04   | -12.92-13.97   | -16.23-13.98   | -11.93-9.83    | -8.25-6.95     | -6.44-6.37     | -6.55-6.39     | -6.66-6.46     | -5.65-6.74     | -4.38-4.28     | -4.36-4.48     | -4.76-5.24     | -5.81-6.33     |
| θ (180°) | -7.61-7.17   | -6.73-7.01   | -7.54-8.62   | -10.63-11.94 | -10.25-8.89  | -7.52-6.98     | -6.96-6.81     | -6.71-5.84     | -5.50-5.18     | -5.43-5.73     | -5.83-5.98     | -5.90-6.03     | -6.08-5.44     | -5.35-5.28     | -5.64-6.03     | -6.47-7.03     | -7.52-8.03     | -8.07-8.02     |
| Gain     | Φ(0°)Φ(10°)  | Φ(20°)Φ(30°) | Φ(40°)Φ(50°) | Φ(60°)Φ(70°) | Φ(80°)Φ(90°) | Φ(100°)Φ(110°) | Φ(120°)Φ(130°) | Φ(140°)Φ(150°) | Φ(160°)Φ(170°) | Φ(180°)Φ(190°) | Φ(200°)Φ(210°) | Φ(220°)Φ(230°) | Φ(240°)Φ(250°) | Φ(260°)Φ(270°) | Φ(280°)Φ(290°) | Φ(300°)Φ(310°) | Φ(320°)Φ(330°) | Φ(340°)Φ(350°) |
| θ (0°)   | -9.34-8.60   | -8.61-8.88   | -9.90-10.21  | -10.16-9.93  | -8.48-8.78   | -8.40-8.52     | -8.17-8.75     | -9.18-9.24     | -8.91-8.91     | -8.79-8.90     | -8.54-8.53     | -8.02-9.11     | -9.04-9.16     | -8.20-8.02     | -8.37-8.78     | -9.04-9.16     | -8.20-8.02     | -8.62-8.83     |
| θ (10°)  | -11.72-12.52 | -12.86-11.48 | -12.58-11.82 | -11.98-9.88  | -8.73-8.37   | -8.47-9.47     | -8.13-7.04     | -5.73-6.15     | -6.57-6.83     | -6.61-7.27     | -8.15-7.81     | -8.05-7.45     | -6.96-6.52     | -6.46-6.51     | -8.06-8.15     | -6.88-7.23     | -7.48-9.57     | -11.66-12.68   |
| θ (20°)  | -6.85-8.61   | -13.50-16.85 | -16.94-14.13 | -11.19-9.03  | -8.62-8.04   | -8.00-7.47     | -6.79-7.52     | -8.36-9.20     | -8.12-7.05     | -6.49-6.63     | -6.97-7.38     | -9.13-7.16     | -5.97-5.33     | -4.31-2.47     | -5.26-5.08     | -4.13-3.58     | -3.47-4.61     | -5.10-6.17     |
| θ (30°)  | -6.35-5.76   | -7.16-11.72  | -14.36-12.75 | -10.81-7.27  | -7.91-7.73   | -7.28-5.46     | -5.88-3.89     | -3.67-1.77     | -2.28-2.66     | -2.46-2.67     | -2.36-2.07     | -1.82-1.53     | -3.78-3.09     | -2.86-2.05     | -1.96-4.29     | -2.36-2.07     | -1.96-4.29     | -2.36-2.07     |
| θ (40°)  | -4.42-3.42   | -4.22-8.69   | -11.91-16.90 | -10.94-7.80  | -5.24-5.76   | -4.96-5.09     | -7.15-8.14     | -6.30-6.43     | -2.38-2.50     | -2.44-1.51     | -5.39-4.97     | -2.35-1.72     | -1.81-3.24     | -4.09-3.06     | -2.71-2.77     | -3.17-2.91     | -2.11-2.49     | -3.29-4.41     |
| θ (50°)  | -4.11-2.49   | -3.02-6.56   | -6.88-7.84   | -8.46-6.98   | -4.88-3.47   | -10.51-12.16   | -12.01-10.56   | -5.89-6.71     | -2.49-1.02     | 1.32-1.52      | -1.22-3.61     | -3.50-3.72     | -3.70-1.88     | -1.46-1.50     | -1.76-1.49     | -1.81-2.95     | -3.33-5.20     | -2.47-3.51     |
| θ (60°)  | -3.84-2.17   | -4.70-4.91   | -3.28-4.16   | -2.00-0.65   | -1.29-3.42   | -10.99-10.53   | -5.20-6.93     | -3.63-4.49     | -4.32-3.34     | -0.37-0.92     | -0.96-0.52     | -0.38-0.68     | -1.58-1.29     | -0.84-1.27     | -1.19-0.60     | -0.66-1.62     | -3.28-8.50     | -2.92-3.60     |
| θ (70°)  | -2.84-1.64   | -1.06-3.26   | -2.20-2.10   | -0.40-1.25   | -1.05-4.80   | -1.96-1.10     | -5.12-9.10     | -1.05-4.80     | 1.96-1.10      | -2.57-0.70     | 1.50-0.01      | 0.68-0.15      | 0.40-2.48      | 0.60-0.58      | 0.60-0.58      | 0.60-0.58      | 0.60-0.58      | 0.60-0.58      |
| θ (80°)  | -1.63-0.42   | -0.79-1.91   | -1.09-0.44   | -0.77-2.42   | -1.23-6.64   | -0.97-8.65     | -8.08-7.64     | -4.20-9.29     | -1.23-6.64     | 0.49-0.07      | -2.15-0.91     | 3.13-3.22      | 2.38-0.50      | 0.03-0.09      | 0.82-0.74      | 1.25-3.16      | -2.83-1.37     | -2.83-1.37     |
| θ (90°)  | -2.32-1.11   | -0.21-0.06   | -1.34-0.88   | -0.16-3.71   | -5.30-7.30   | -9.17-6.76     | -7.15-12.56    | -3.73-9.46     | -2.73-3.61     | -0.38-1.57     | -3.56-1.15     | 1.83-0.31      | 0.41-0.59      | 1.22-0.33      | -1.79-1.11     | 0.27-1.08      | -1.40-1.39     | -0.92-2.53     |
| θ (100°) | -0.18-1.72   | 0.89-0.02    | -1.15-3.34   | -3.55-10.58  | -4.46-4.04   | -1.94-13.61    | -0.13-0.64     | -1.61-8.85     | -4.46-4.04     | -0.13-0.64     | -1.61-8.85     | -4.46-4.04     | -0.13-0.64     | -1.61-8.85     | -4.46-4.04     | -0.13-0.64     | -1.61-8.85     | -4.46-4.04     |
| θ (110°) | 0.61-1.10    | -0.32-0.51   | -1.25-9.99   | -6.88-9.09   | -10.49-12.51 | -10.20-10.19   | -12.44-11.05   | -9.99-15.10    | -5.73-5.31     | 0.28-2.25      | -9.66-6.77     | -2.35-0.51     | -2.82-1.09     | 0.71-3.69      | -1.77-1.32     | 1.19-1.13      | -1.98-4.00     | -1.27-0.42     |
| θ (120°) | -3.15-2.07   | -1.15-3.85   | -3.42-7.72   | -13.47-9.98  | -8.62-11.70  | -8.38-5.99     | -12.22-16.28   | -10.54-12.31   | -6.23-10.06    | 0.58-2.80      | -11.44-7.43    | -2.55-0.31     | -9.48-3.37     | 1.35-5.24      | -1.35-3.47     | 1.09-5.40      | -2.44-0.05     | -1.19-1.09     |
| θ (130°) | -6.46-8.26   | -2.97-7.77   | -4.66-8.65   | -11.15-10.35 | -11.04-16.33 | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    | -15.46-15.39   | -10.82-6.12    |
| θ (140°) | -10.43-8.75  | -5.44-6.99   | -6.24-7.24   | -10.08-11.21 | -16.38-15.77 | -16.98-16.55   | -14.51-13.69   | -12.35-7.52    | -8.31-5.83     | -3.15-6.05     | -10.03-13.13   | -11.57-12.30   | -5.90-1.94     | -4.47-1.17     | -10.75-5.82    | -4.77-6.21     | -7.16-5.58     | -4.53-4.42     |
| θ (150°) | -16.04-9.46  | -9.51-10.77  | -8.88-7.81   | -9.94-12.98  | -13.65-13.43 | -13.77-12.50   | -10.94-14.16   | -13.63-8.86    | -6.16-4.93     | -3.21-6.76     | -12.33-11.28   | -14.04-13.28   | -10.00-6.44    | -4.84-5.26     | -8.52-11.02    | -9.70-8.76     | -7.36-8.66     | -12.43-13.98   |
| θ (160°) | -8.71-8.73   | -8.25-8.15   | -11.87-14.33 | -13.45-13.03 | -16.03-16.01 | -10.67-16.27   | -14.77-11.21   | -9.06-9.95     | -12.47-14.43   | -9.96-9.95     | -11.20-12.47   | -9.95-9.92     | -11.20-12.47   | -9.95-9.92     | -11.20-12.47   | -9.95-9.92     | -11.20-12.47   | -9.95-9.92     |
| θ (170°) | -10.07-13.25 | -13.19-13.82 | -13.60-14.61 | -15.17-17.09 | -16.48-15.28 | -14.87-15.49   | -13.93-12.99   | -11.68-11.25   | -10.81-10.95   | -11.68-12.55   | -12.94-12.20   | -11.27-10.61   | -9.70-9.27     | -9.30-10.26    | -10.45-9.29    | -9.99-9.48     | -8.34-8.24     | -8.92-9.63     |
| θ (180°) | -11.80-10.48 | -10.77-10.53 | -12.62-14.31 | -15.24-14.52 | -13.04-10.56 | -10.09-12.85   | -14.65-13.77   | -12.12-12.58   | -13.04-14.16   | -13.40-13.77   | -14.72-14.46   | -14.73-15.20   | -16.29-16.50   | -16.43-16.90   | -15.25-15.66   | -16.56-16.18   | -16.22-17.10   | -15.61-12.06   |
| Gain     | Φ(0°)Φ(10°)  | Φ(20°)Φ(30°) | Φ(40°)Φ(50°) | Φ(6          |              |                |                |                |                |                |                |                |                |                |                |                |                |                |

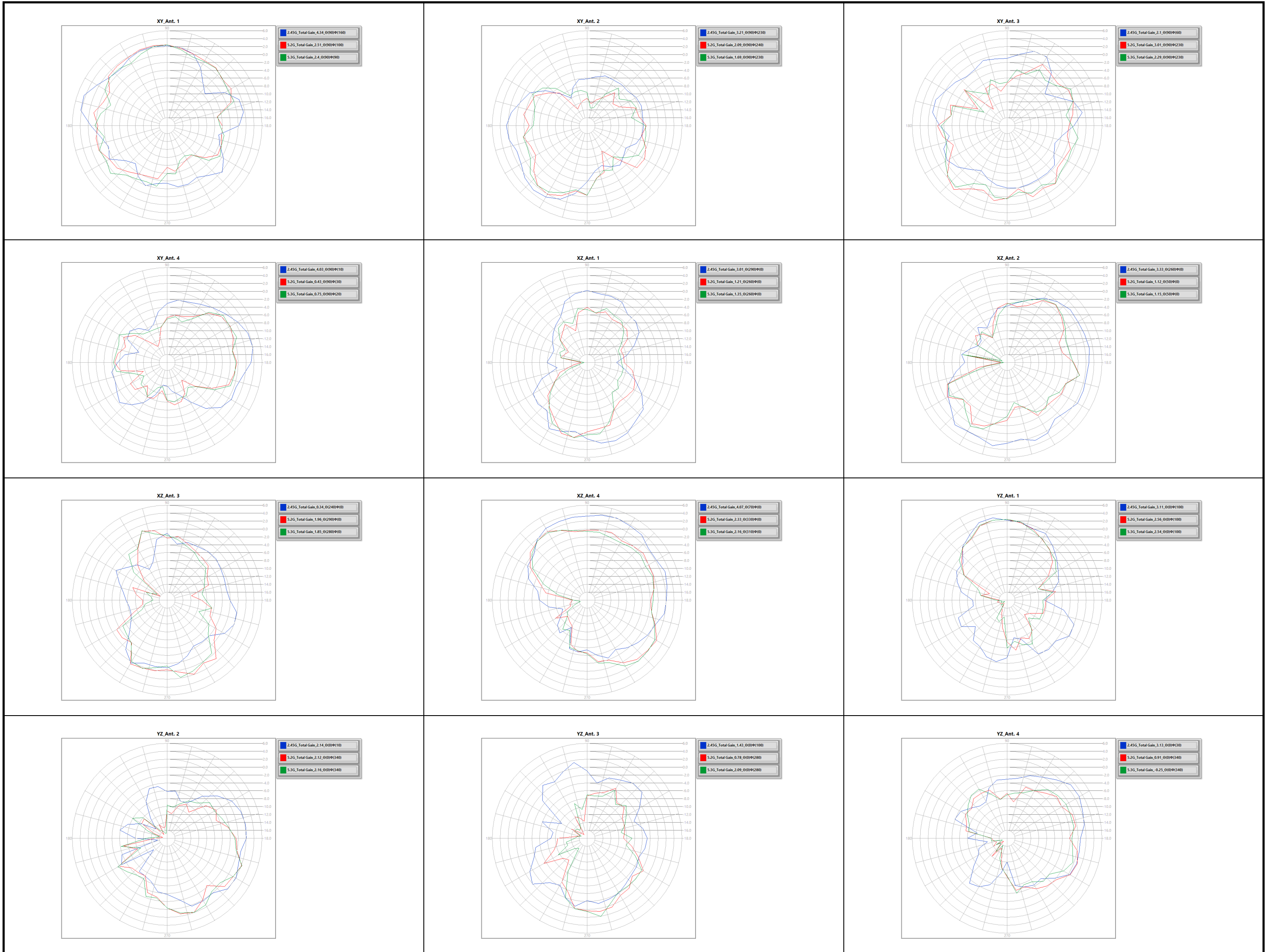


# Antenna Pattern of 2.4GHz, 5GHz U-NII 1 and U-NII 2A

# Appendix C

| Theta (°)    | -7.33/-8.21      | -9.21/-8.88       | -7.34/-6.48       | -6.70/-7.77       | -7.65/-7.42       | -8.84/-11.30        | -12.69/-12.48       | -12.31/-11.77       | -13.15/-14.29       | -13.63/-14.50       | -16.86/-16.50       | -16.45/-15.90       | -16.60/-16.68       | -15.47/-14.46       | -13.71/-12.87       | -13.39/-14.16       | -13.35/-12.30       | -11.26/-8.56        |
|--------------|------------------|-------------------|-------------------|-------------------|-------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Phi (°)      | -14.37/-14.40    | -13.75/-14.56     | -15.89/-15.90     | -14.07/-15.05     | -13.94/-14.17     | -16.31/-17.00       | -16.79/-16.23       | -16.19/-16.90       | -15.68/-16.41       | -16.77/-16.15       | -16.39/-14.52       | -15.02/-16.09       | -14.76/-13.69       | -14.77/-15.75       | -15.03/-14.06       | -16.00/-15.19       | -14.98/-16.19       | -16.50/-14.71       |
| Freq(Hz)     | 5.3G/Pol.        | Total/Ant. 4      | -                 | -                 | -                 | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   |
| Gain         | Phi(0°)/Phi(10°) | Phi(20°)/Phi(30°) | Phi(40°)/Phi(50°) | Phi(60°)/Phi(70°) | Phi(80°)/Phi(90°) | Phi(100°)/Phi(110°) | Phi(120°)/Phi(130°) | Phi(140°)/Phi(150°) | Phi(160°)/Phi(170°) | Phi(180°)/Phi(190°) | Phi(200°)/Phi(210°) | Phi(220°)/Phi(230°) | Phi(240°)/Phi(250°) | Phi(260°)/Phi(270°) | Phi(280°)/Phi(290°) | Phi(300°)/Phi(310°) | Phi(320°)/Phi(330°) | Phi(340°)/Phi(350°) |
| Theta (0°)   | -1.25/-1.13      | -1.15/-1.38       | -1.24/-1.38       | -1.17/-0.93       | -1.15/-1.59       | -1.59/-1.54         | -1.87/-1.94         | -1.84/-1.91         | -1.82/-1.76         | -1.61/-1.41         | -1.34/-1.36         | -1.54/-1.79         | -1.77/-2.14         | -3.02/-3.02         | -2.74/-3.20         | -3.19/-2.90         | -2.75/-2.55         | -2.15/-1.79         |
| Theta (10°)  | -0.87/-0.71      | -0.25/-0.19       | -0.45/-0.87       | -0.83/-0.32       | 0.08/-0.87        | -1.64/-0.93         | -0.70/-1.36         | -1.74/-1.96         | -2.11/-1.93         | -1.51/-1.34         | -1.34/-1.18         | -0.70/-0.58         | -0.52/-0.59         | -1.10/-1.14         | -1.42/-2.02         | -2.66/-3.51         | -3.36/-2.74         | -1.86/-1.25         |
| Theta (20°)  | -0.39/-0.24      | 0.57/0.13         | -0.48/-0.48       | -0.52/-0.93       | -0.98/-0.93       | -0.55/-0.37         | -0.69/-1.17         | -0.46/-0.30         | -0.32/0.09          | 0.12/0.07           | 0.89/1.66           | 2.09/1.70           | 1.53/1.03           | 0.22/-0.25          | -0.54/-1.65         | -2.26/-2.66         | -3.35/-2.88         | -1.70/-0.89         |
| Theta (30°)  | -0.96/-0.48      | 0.13/0.67         | 0.77/0.68         | 0.30/-0.71        | -0.92/-0.75       | -1.91/-1.48         | -0.45/-0.39         | 0.03/0.45           | 0.87/1.45           | 1.86/2.52           | 3.30/3.30           | 2.73/1.66           | 1.28/0.62           | -0.84/-1.47         | -0.66/-0.19         | -0.66/-1.05         | -1.32/-1.63         | -0.65/-0.38         |
| Theta (40°)  | -0.33/-0.04      | 1.09/2.01         | 2.68/2.31         | 1.51/0.53         | -0.49/-1.22       | -2.24/-3.61         | -2.98/-1.08         | 0.94/1.16           | 0.89/1.44           | 2.03/1.92           | 2.77/2.39           | 1.11/-0.52          | -1.37/-1.08         | -2.29/-3.92         | -3.43/-2.73         | -1.37/-0.97         | -1.89/-1.63         | -0.33/-0.17         |
| Theta (50°)  | -0.66/0.83       | 2.35/3.31         | 3.37/2.57         | 1.46/-0.14        | -1.63/-1.88       | -2.84/-4.52         | -4.40/-1.81         | 0.28/0.60           | -0.51/1.49          | 2.16/0.78           | 0.90/-0.59          | -1.85/-0.56         | -2.45/-4.10         | -4.16/-3.79         | -2.83/-2.17         | -1.40/-1.43         | -1.16/-1.81         | -0.32/-0.44         |
| Theta (60°)  | -1.16/0.58       | 2.21/2.53         | 2.06/1.28         | 0.07/-1.86        | -3.85/-4.00       | -4.62/-5.13         | -3.72/-2.02         | 0.32/0.10           | -0.43/1.01          | 1.21/-0.84          | -1.81/-2.31         | -1.97/-3.92         | -3.55/-4.81         | -6.08/-5.30         | -6.26/-5.97         | -4.85/-2.26         | -1.97/-2.41         | -0.36/-0.58         |
| Theta (70°)  | -1.10/-0.01      | 1.82/2.64         | 1.78/0.20         | -1.87/-3.99       | -5.58/-5.73       | -5.16/-4.40         | -4.53/-4.00         | -1.31/-1.43         | -0.94/-0.64         | -1.18/-4.06         | -2.88/-4.45         | -4.63/-4.24         | -6.99/-7.94         | -5.45/-5.52         | -6.70/-6.37         | -6.33/-5.25         | -4.38/-3.37         | -1.54/-0.35         |
| Theta (80°)  | -0.55/-0.45      | 2.12/2.10         | 1.30/-0.02        | -3.28/-5.67       | -5.47/-6.37       | -8.07/-8.19         | -6.10/-5.26         | -2.37/-2.23         | -3.39/-1.91         | -1.84/-3.54         | -4.64/-5.24         | -6.13/-5.70         | -8.97/-11.16        | -7.09/-3.88         | -5.58/-7.73         | -7.52/-5.42         | -5.69/-3.71         | -1.13/-0.45         |
| Theta (90°)  | -0.61/-1.23      | 0.75/0.26         | 0.51/-1.46        | -5.25/-7.07       | -6.22/-6.99       | -8.90/-9.09         | -8.98/-6.58         | -6.57/-3.99         | -4.98/-4.88         | -4.39/-4.96         | -9.61/-11.18        | -9.39/-9.30         | -8.03/-11.29        | -11.71/-8.50        | -7.87/-8.41         | -8.31/-9.75         | -8.47/-4.17         | -0.89/-0.61         |
| Theta (100°) | -0.13/-1.60      | -0.28/-0.53       | -1.64/-2.43       | -3.63/-4.74       | -4.70/-8.01       | -13.68/-12.53       | -9.26/-11.85        | -8.02/-5.05         | -7.44/-7.59         | -5.00/-6.36         | -9.87/-10.09        | -8.61/-9.47         | -9.93/-8.17         | -13.96/-10.32       | -10.77/-7.02        | -7.90/-7.87         | -5.53/-3.99         | -1.49/-0.37         |
| Theta (110°) | 0.83/-0.09       | 0.22/-0.71        | -1.49/-0.45       | -1.36/-2.54       | -3.19/-6.13       | -9.96/-10.74        | -9.24/-9.97         | -15.21/-7.40        | -14.12/-8.16        | -5.29/-10.44        | -10.94/-9.31        | -9.09/-16.21        | -11.96/-15.16       | -16.24/-12.60       | -13.94/-12.27       | -10.49/-11.26       | -3.84/-2.66         | -1.43/-0.30         |
| Theta (120°) | 1.76/0.32        | -0.05/0.20        | -0.61/-1.51       | -1.08/-0.82       | -1.88/-3.66       | -7.57/-10.47        | -11.06/-14.38       | -16.59/-13.82       | -15.14/-9.37        | -9.17/-11.36        | -12.90/-10.31       | -13.76/-11.10       | -12.41/-9.67        | -16.02/-15.97       | -9.09/-10.80        | -11.63/-9.77        | -5.85/-1.26         | -0.37/1.46          |
| Theta (130°) | 1.59/1.18        | 0.45/-0.23        | -0.85/-0.77       | -0.90/-1.41       | -2.18/-3.86       | -7.04/-11.27        | -12.43/-12.63       | -14.08/-13.33       | -9.94/-6.81         | -8.36/-12.82        | -16.71/-12.49       | -9.92/-15.21        | -9.14/-14.94        | -10.67/-13.57       | -12.70/-11.01       | -9.78/-9.87         | -9.60/-5.10         | -1.60/0.20          |
| Theta (140°) | 0.26/1.06        | 1.74/1.18         | -0.13/-1.66       | -2.41/-2.63       | -3.38/-5.11       | -8.01/-9.19         | -11.73/-16.57       | -14.25/-16.55       | -14.50/-10.25       | -11.39/-15.13       | -16.33/-15.88       | -15.89/-10.61       | -11.18/-12.26       | -10.53/-16.01       | -11.90/-5.07        | -7.29/-4.35         | -4.56/-3.20         | -2.11/-1.00         |
| Theta (150°) | -2.16/-2.21      | -1.02/-0.73       | -1.37/-2.72       | -4.33/-4.64       | -5.29/-6.40       | -8.28/-10.93        | -16.45/-16.54       | -13.40/-11.49       | -11.99/-12.00       | -12.33/-12.03       | -14.87/-15.04       | -12.68/-16.07       | -15.86/-17.09       | -17.06/-14.89       | -16.66/-7.50        | -5.19/-3.64         | -3.43/-3.16         | -2.76/-2.09         |
| Theta (160°) | -6.32/-7.16      | -6.31/-4.91       | -4.36/-4.19       | -4.07/-4.24       | -5.68/-7.83       | -9.36/-10.18        | -10.91/-10.84       | -12.24/-13.46       | -15.90/-15.24       | -14.60/-15.82       | -17.00/-15.69       | -14.61/-16.01       | -16.37/-16.10       | -16.98/-11.25       | -10.18/-9.51        | -7.42/-6.93         | -6.73/-6.58         |                     |
| Theta (170°) | -10.50/-11.01    | -11.70/-10.68     | -8.12/-7.10       | -7.07/-7.78       | -8.42/-8.19       | -7.98/-8.51         | -11.00/-14.32       | -15.01/-14.68       | -16.09/-16.84       | -16.23/-15.69       | -15.57/-15.92       | -16.16/-16.87       | -16.13/-15.95       | -16.11/-13.99       | -12.27/-12.18       | -12.56/-14.74       | -14.25/-13.25       | -11.49/-11.05       |
| Theta (180°) | -14.58/-12.52    | -11.33/-12.50     | -13.87/-12.17     | -12.21/-12.36     | -11.57/-13.99     | -16.15/-16.85       | -16.00/-16.44       | -15.80/-16.85       | -16.09/-16.25       | -16.82/-15.96       | -15.82/-13.44       | -12.97/-12.54       | -12.71/-14.28       | -14.47/-14.63       | -15.45/-15.17       | -14.13/-13.06       | -13.13/-14.15       | -14.27/-14.19       |

E1(XY plane) –  $\Theta(90)\Phi(0-360)$   
 E2(XZ plane) –  $\Theta(0-180)\Phi(0)$  and  $\Theta(0-180)\Phi(180)$   
 E3(YZ plane) –  $\Theta(0-180)\Phi(90)$  and  $\Theta(0-180)\Phi(270)$







# Antenna Pattern of 5GHz U-NII 2C and U-NII 3

# Appendix D

| Theta       | Phi(0°)          | Phi(10°)          | Phi(20°)          | Phi(30°)          | Phi(40°)          | Phi(50°)            | Phi(60°)            | Phi(70°)            | Phi(80°)            | Phi(90°)            | Phi(100°)           | Phi(110°)           | Phi(120°)           | Phi(130°)           | Phi(140°)           | Phi(150°)           | Phi(160°)           | Phi(170°)           | Phi(180°)     |
|-------------|------------------|-------------------|-------------------|-------------------|-------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------|
| Theta(60°)  | -2.17/-1.42      | -1.66/-0.95       | -1.00/-2.25       | -1.79/-1.85       | -2.32/-2.50       | -2.46/-1.80         | -1.76/-2.11         | -4.65/-6.15         | -3.90/-0.89         | -0.45/-1.24         | -2.19/-4.38         | -5.19/-2.94         | -3.15/-3.89         | -4.22/-4.34         | -2.71/-1.39         | -2.33/-2.87         | -1.31/0.87          | 0.41/-1.07          |               |
| Theta(70°)  | -3.20/-2.16      | -2.00/-1.30       | -2.87/-2.62       | 0.26/0.57         | -1.43/-2.50       | -3.26/-3.42         | -4.00/-4.78         | -6.78/-8.44         | -4.85/-1.05         | -1.01/-1.85         | -1.04/-2.51         | -1.19/-0.34         | -0.93/-1.61         | -1.09/-2.31         | -1.13/-1.08         | -3.56/-4.75         | -1.68/0.31          | -1.68/0.31          | -0.42/-1.84   |
| Theta(80°)  | -4.43/-3.10      | -1.99/-2.32       | -2.42/0.36        | 2.95/0.35         | -2.21/-2.86       | -4.83/-7.82         | -6.94/-6.75         | -5.17/-5.39         | -5.99/-2.55         | -1.53/-2.31         | -2.24/-3.38         | -0.92/1.02          | -0.12/-2.46         | 0.15/-0.94          | -0.12/0.29          | -1.06/-5.47         | -3.81/-0.27         | -3.81/-0.27         | -2.32/-3.13   |
| Theta(90°)  | -4.19/-2.22      | -3.20/-4.25       | -1.28/0.50        | 0.68/-1.68        | -2.85/-3.87       | -4.87/-8.09         | -6.38/-12.71        | -11.69/-6.78        | -6.29/-2.93         | -1.73/-4.41         | -3.52/-3.44         | -2.47/-0.43         | -1.85/-6.29         | -2.05/-2.96         | -1.66/-0.94         | -2.64/-6.74         | -5.44/-2.96         | -5.44/-2.96         | -3.06/-2.92   |
| Theta(100°) | -3.49/-4.08      | -4.13/-2.90       | -1.49/-1.29       | -0.69/-2.93       | -3.36/-4.01       | -5.68/-8.10         | -6.13/-9.23         | -12.78/-8.46        | -6.43/-5.57         | -4.02/-8.07         | -5.28/-5.38         | -5.07/-1.82         | -3.07/-13.20        | -1.76/-6.33         | -3.28/-2.67         | -4.80/-7.42         | -5.19/-4.55         | -5.19/-4.55         | -5.77/-3.64   |
| Theta(110°) | -3.79/-3.20      | -4.60/-6.29       | -4.67/-3.67       | -1.54/-3.85       | -6.74/-6.11       | -8.07/-11.95        | -11.79/-10.23       | -11.50/-7.41        | -4.86/-7.42         | -6.68/-13.55        | -9.23/-5.18         | -6.13/-4.09         | -3.82/-13.44        | -5.18/-12.10        | -4.51/-3.02         | -2.66/-7.95         | -8.74/-8.80         | -8.74/-8.80         | -6.11/-3.44   |
| Theta(120°) | -1.98/-1.41      | -4.22/-7.79       | -6.64/-6.44       | -6.60/-6.04       | -6.71/-6.98       | -9.80/-11.31        | -13.42/-11.80       | -9.57/-8.32         | -7.67/-11.74        | -12.39/-14.46       | -15.33/-15.84       | -8.04/-4.44         | -5.17/-4.48         | -2.69/-6.34         | -2.95/-2.09         | -2.46/-9.62         | -4.59/-1.44         | -4.59/-1.44         | -4.86/-1.28   |
| Theta(130°) | -0.41/0.16       | -2.35/-4.64       | -5.58/-6.10       | -5.30/-6.42       | -8.81/-10.50      | -9.28/-10.50        | -9.93/-13.99        | -12.12/-13.46       | -10.61/-10.84       | -10.74/-12.92       | -12.80/-11.71       | -7.95/-4.38         | -11.28/-4.04        | -3.52/-8.13         | -4.94/-2.91         | -2.89/-8.59         | -8.64/-1.67         | -8.64/-1.67         | -2.49/-0.94   |
| Theta(140°) | -3.35/-3.12      | -2.63/-2.60       | -5.40/-8.54       | -6.01/-4.55       | -6.01/-4.55       | -11.07/-12.63       | -10.93/-8.34        | -9.61/-15.01        | -12.51/-12.97       | -11.53/-10.69       | -13.33/-15.81       | -15.21/-10.74       | -5.83/-7.56         | -7.30/-9.48         | -8.25/-7.68         | -5.80/-3.96         | -3.00/-3.70         | -3.00/-3.70         | -5.60/-4.95   |
| Theta(150°) | -4.70/-4.02      | -3.98/-4.21       | -5.37/-5.30       | -6.63/-7.36       | -7.03/-7.02       | -8.60/-11.22        | -13.53/-14.63       | -15.05/-12.46       | -13.95/-13.07       | -9.88/-10.64        | -12.31/-14.46       | -9.31/-7.27         | -9.23/-13.00        | -7.90/-8.39         | -10.06/-7.78        | -5.08/-5.17         | -5.60/-5.86         | -5.60/-5.86         | -7.20/-5.99   |
| Theta(160°) | -2.91/-2.60      | -2.48/-4.24       | -6.46/-6.26       | -10.57/-12.94     | -13.86/-14.37     | -13.57/-14.99       | -15.39/-16.05       | -15.96/-15.46       | -15.06/-12.80       | -11.77/-13.97       | -14.90/-12.24       | -9.99/-10.56        | -11.23/-8.81        | -7.90/-9.71         | -11.70/-13.71       | -13.06/-11.01       | -7.79/-5.39         | -7.79/-5.39         | -4.44/-3.88   |
| Theta(170°) | -6.43/-6.74      | -8.59/-9.07       | -9.58/-9.49       | -11.31/-15.28     | -15.77/-15.11     | -10.47/-14.26       | -14.32/-14.90       | -15.06/-12.91       | -10.47/-10.52       | -11.29/-9.37        | -8.21/-7.60         | -7.33/-7.45         | -8.24/-8.67         | -9.90/-11.80        | -15.45/-12.31       | -9.59/-7.99         | -7.46/-6.13         | -7.46/-6.13         |               |
| Theta(180°) | -12.05/-11.24    | -10.47/-10.68     | -10.63/-13.93     | -15.51/-14.37     | -12.75/-11.19     | -11.23/-10.56       | -9.56/-10.29        | -12.63/-14.64       | -14.97/-14.34       | -14.70/-14.27       | -14.34/-14.79       | -14.17/-15.93       | -15.71/-14.39       | -14.61/-15.41       | -15.76/-15.13       | -15.49/-15.08       | -15.95/-15.06       | -15.95/-15.06       | -13.09/-12.87 |
| Freq(Hz)    | 5.65GPol.        | TotalAnt. 4       | -                 | -                 | -                 | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -             |
| Gain        | Phi(0°)/Phi(10°) | Phi(20°)/Phi(30°) | Phi(40°)/Phi(50°) | Phi(60°)/Phi(70°) | Phi(80°)/Phi(90°) | Phi(100°)/Phi(110°) | Phi(120°)/Phi(130°) | Phi(140°)/Phi(150°) | Phi(160°)/Phi(170°) | Phi(180°)/Phi(190°) | Phi(200°)/Phi(210°) | Phi(220°)/Phi(230°) | Phi(240°)/Phi(250°) | Phi(260°)/Phi(270°) | Phi(280°)/Phi(290°) | Phi(300°)/Phi(310°) | Phi(320°)/Phi(330°) | Phi(340°)/Phi(350°) |               |
| Theta(0°)   | -7.10/-5.44      | -4.63/-5.81       | -6.19/-5.98       | -5.92/-5.90       | -6.60/-7.37       | -7.42/-7.17         | -7.52/-7.93         | -8.26/-8.39         | -8.02/-7.51         | -7.55/-6.68         | -5.80/-6.08         | -6.55/-6.70         | -6.76/-6.40         | -6.54/-6.50         | -6.52/-6.54         | -6.39/-6.00         | -6.02/-6.16         | -6.64/-7.34         |               |
| Theta(10°)  | -5.13/-4.55      | -4.31/-4.14       | -3.90/-3.72       | -4.18/-5.44       | -6.21/-5.97       | -5.95/-5.70         | -6.09/-6.07         | -6.54/-7.05         | -6.96/-6.80         | -6.67/-6.88         | -6.06/-5.74         | -6.85/-7.59         | -8.17/-8.64         | -8.85/-8.91         | -7.56/-6.55         | -5.86/-5.04         | -5.14/-5.19         | -5.14/-5.19         | -5.11/-4.88   |
| Theta(20°)  | -6.45/-5.60      | -5.29/-5.19       | -5.30/-5.02       | -5.69/-5.81       | -5.69/-5.81       | -5.99/-6.22         | -7.88/-7.44         | -3.85/-4.48         | -5.48/-4.48         | -6.96/-6.79         | -7.33/-9.73         | -10.40/-10.12       | -10.89/-9.72        | -8.32/-7.44         | -8.32/-7.44         | -8.32/-7.44         | -8.32/-7.44         | -8.32/-7.44         | -5.44/-6.55   |
| Theta(30°)  | -7.38/-8.07      | -7.18/-6.92       | -5.53/-4.47       | -4.41/-3.61       | -3.86/-3.82       | -3.65/-3.72         | -2.42/-1.88         | -3.27/-4.57         | -5.50/-3.84         | -2.93/-4.20         | -9.08/-14.88        | -11.52/-7.22        | -6.28/-6.30         | -4.96/-3.80         | -3.18/-3.91         | -4.87/-5.61         | -4.98/-5.21         | -6.16/-6.64         |               |
| Theta(40°)  | -9.46/-8.50      | -8.74/-8.41       | -3.09/-2.32       | -3.14/-4.09       | -3.72/-3.37       | -2.85/-1.66         | -0.33/-0.12         | 0.52/-1.56          | -2.96/-1.64         | -1.03/-3.78         | -9.21/-13.48        | -11.70/-8.17        | -5.68/-4.00         | -5.11/-5.13         | -3.14/-1.84         | -1.76/-3.57         | -6.43/-8.00         | -7.05/-1.50         |               |
| Theta(50°)  | -7.58/-6.78      | -4.23/-2.06       | -1.17/-1.37       | -1.52/-1.57       | -1.69/-1.90       | -1.09/-0.95         | -0.39/-2.88         | -2.77/-0.09         | 0.05/-3.05          | -4.58/-4.70         | -10.01/-6.82        | -6.42/-6.94         | -5.38/-6.02         | -4.62/-4.58         | -5.90/-11.80        | -15.45/-12.31       | -9.59/-7.99         | -7.46/-6.13         |               |
| Theta(60°)  | -9.53/-6.57      | -4.55/-2.76       | -1.70/-0.09       | 1.05/1.09         | 0.52/0.75         | 0.49/-0.19          | -1.18/-2.84         | -4.48/-6.51         | -4.48/-1.77         | -0.90/-3.29         | -6.89/-8.79         | -6.72/-10.81        | -8.94/-10.52        | -6.65/-6.06         | -5.44/-2.85         | -2.82/-3.50         | -4.08/-5.79         | -7.77/-7.09         |               |
| Theta(70°)  | -6.93/-5.45      | -3.13/-4.04       | 1.15/1.72         | 3.11/2.69         | 1.84/0.48         | -0.95/-0.22         | -0.90/-4.15         | -7.04/-6.49         | -5.03/-4.53         | -2.83/-4.32         | -9.08/-8.74         | -8.45/-9.37         | -9.65/-6.98         | -4.64/-4.15         | -3.06/-1.20         | -0.74/-1.65         | -2.37/-6.88         | -5.06/-7.60         |               |
| Theta(80°)  | -7.04/-7.77      | -0.79/-0.04       | 0.80/1.73         | 2.15/1.56         | 1.25/0.34         | -3.94/-2.67         | -4.29/-6.01         | -3.87/-4.85         | -2.15/-3.21         | -7.62/-11.13        | -9.64/-8.52         | -5.38/-6.30         | -2.12/-1.94         | -2.51/-0.82         | -0.07/-1.94         | -2.47/-1.72         | -2.47/-1.72         | -2.47/-1.72         |               |
| Theta(90°)  | -1.90/-1.23      | -0.90/-1.20       | 0.50/2.16         | 3.31/2.99         | 2.05/0.73         | -1.44/-0.82         | -1.71/-3.17         | -2.83/-4.94         | -5.91/-3.85         | -3.91/-3.87         | -8.46/-12.78        | -9.85/-5.18         | -4.91/-6.85         | -1.61/-3.88         | -2.29/0.14          | 0.08/-2.42          | -2.32/-2.50         | -1.42/-3.92         |               |
| Theta(100°) | -2.11/-1.88      | 0.17/1.93         | 3.16/2.64         | 2.57/0.58         | -0.62/-2.13       | -3.06/-2.65         | -4.90/-7.45         | -3.90/-4.67         | -7.58/-4.41         | -3.96/-7.76         | -11.42/-7.41        | -10.58/-3.76        | -14.50/-8.09        | -6.06/-7.80         | -2.78/-0.01         | -0.29/-1.32         | 1.74/0.43           | 1.50/-1.17          |               |
| Theta(110°) | -2.73/0.74       | 2.03/2.98         | 1.32/-0.72        | 0.12/-0.05        | -2.89/-7.38       | -6.51/3.36          | -9.94/-6.09         | -6.51/4.05          | -15.54/-12.27       | -6.10/-4.52         | -11.20/-6.66        | -4.36/-0.40         | -2.53/-1.90         | 1.00/0.14           | 1.00/0.14           | 1.00/0.14           | 1.00/0.14           | 1.00/0.14           |               |
| Theta(120°) | -0.28/0.12       | 0.67/0.34         | -0.54/-0.24       | -0.21/-0.99       | -2.81/-5.87       | -7.70/-9.90         | -9.19/-7.03         | -7.14/-12.83        | -13.44/-11.52       | -7.31/-7.09         | -10.04/-14.34       | -6.67/-5.33         | -2.54/-7.90         | -9.38/-13.76        | -3.99/-1.26         | -4.17/-7.42         | -1.12/-4.97         | 0.52/1.40           |               |
| Theta(130°) | -1.27/-1.91      | -2.96/-1.16       | -0.38/-0.39       | -0.65/-1.67       | -3.99/-4.74       | -12.77/-11.79       | -8.81/-11.34        | -6.92/-6.67         | -13.13/-11.33       | -9.22/-8.45         | -9.48/-10.24        | -15.45/-9.38        | -5.20/-4.24         | -11.44/-12.66       | -4.15/0.39          | -3.91/-6.16         | -2.89/-7.11         | -3.10/-2.10         |               |
| Theta(140°) | -2.95/-2.09      | -1.22/-1.67       | -1.73/-1.24       | -0.71/-0.99       | -2.58/-6.78       | -8.76/-11.26        | -12.53/-12.59       | -10.37/-10.78       | -10.00/-12.14       | -10.17/-8.25        | -10.92/-9.57        | -12.44/-7.44        | -6.66/-6.78         | -6.33/-9.92         | -7.55/-2.96         | -1.66/-1.57         | -3.11/-4.78         | -5.15/-6.67         |               |
| Theta(150°) | -4.10/-4.34      | -4.47/-4.29       | -4.32/-2.65       | -1.73/-2.13       | -3.21/-4.83       | -7.36/-9.51         | -9.21/-9.27         | -10.96/-12.67       | -12.11/-14.08       | -12.52/-6.16        | -7.84/-10.58        | -10.39/-5.54        | -6.03/-6.60         | -8.89/-14.61        | -9.56/-5.28         | -3.10/-2.91         | -3.92/-5.91         | -5.65/-6.63         |               |
| Theta(160°) | -8.44/-8.83      | -6.17/-5.85       | -6.85/-8.37       | -9.05/-9.94       | -11.37/-11.99     | -11.91/-10.49       | -10.47/-11.71       | -13.72/-12.76       | -11.62/-12.70       | -12.65/-10.12       | -7.71/-7.05         | -7.89/-8.86         | -11.07/-15.02       | -13.98/-12.51       | -10.33/-6.86        | -5.38/-3.99         | -3.05/-3.15         | -4.44/-4.81         |               |
| Theta(170°) | -9.99/-8.21      | -7.55/-9.80       | -9.38/-8.69       | -10.42/-14.67     | -15.58/-14.96     | -15.45/-13.42       | -12.51/-13.12       | -13.81/-13.14       | -13.81/-13.14       | -12.34/-11.32       | -11.04/-11.80       | -11.91/-11.99       | -12.82/-12.84       | -11.49/-9.92        | -10.25/-9.87        | -8.78/-8.91         | -11.52/-12.45       | -11.04/-10.41       |               |
| Theta(180°) | -10.85/-12.24    | -13.50/-13.79     | -14.29/-11.91     | -11.79/-12.15     | -12.16/-11.47     | -10.16/-8.58        | -8.67/-8.88         | -9.44/-10.33        | -11.27/-10.80       | -11.59/-11.62       | -11.93/-12.33       | -11.50/-11.90       | -12.74/-12.97       | -12.78/-12.74       | -12.65/-11.82       | -11.82/-11.55       | -13.82/-15.20       | -12.57/-11.56       |               |
| Freq(Hz)    | 5.785GPol.       | TotalAnt. 4       | -                 | -                 | -                 | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -                   | -             |
| Gain        | Phi(0°)/Phi(10°) | Phi(20°)/Phi(30°) | Phi(40°)/Phi(50°) | Phi(60°)/Phi(70°) | Phi(80°)/Phi(90°) | Phi(100°)/Phi(110°) | Phi(120°)/Phi(130°) | Phi(140°)/Phi(150°) | Phi(160°)/Phi(170°) | Phi(180°)/Phi(190°) | Phi(200°)/Phi(210°) | Phi(220°)/Phi(230°) | Phi(240°)/Phi(250°) | Phi(260°)/Phi(270°) | Phi(280°)/Phi(290°) | Phi(300°)/Phi(310°) | Phi(320°)/Phi(330°) | Phi(340°)/Phi(350°) |               |
| Theta(0°)   | -5.08/-4.89      | -4.59/-4.55       | -4.14/-4.21       | -5.06/-5.20       | -4.54/-5.05       | -5.41/-5.80         | -5.31/-5.14         | -5.35/-5.70         | -5.87/-6.00         | -5.84/-6.21         | -5.82/-6.39         | -5.51/-5.70         | -5.34/-4.98         | -6.19/-6.25         | -5.49/-5.07         | -4.94/-5.21         | -5.04/-4.65         | -4.92/-4.88         |               |
| Theta(10°)  | -2.52/-2.42      | -2.85/-2.84       | -2.44/-2.44       | -2.59/-2.59       | -2.82/-3.39       | -4.29/-4.80         | -4.91/-4.83         | -4.91/-5.41         | -7.50/-9.00         | -9.76/-8.86         | -7.78/-7.60         | -7.41/-6.68         | -6.15/-5.78         | -5.73/-5.27         | -4.28/-3.88         | -3.76/-3.20         | -2.93/-2.59         | -2.26/-2.01         |               |
| Theta(20°)  | -3.50/-3.61      | -3.05/-3.07       | -3.05/-3.51       | -3.78/-4.54       | -4.59/-5.81       | -6.67/-5.74         | -5.65/-5.56         | -5.87/-5.76         | -5.45/-6.12         | -7.58/-8.99         | -9.06/-8.36         | -8.64/-8.58         | -7.90/-6.99         | -6.86/-7.31         | -6.90/-6.31         | -5.34/-4.78         | -4.36/-3.94         | -4.36/-3.94         |               |
| Theta(30°)  | -7.59/-5.18      | -3.26/-2.45       | -2.87/-5.22       | -6.30/-6.02       | -6.83/-8.80       | -9.21/-7.56         | -5.48/-3.56         | -2.59/-3.69         | -4.89/-5.37         | -5.39/-8.19         | -12.16/-12.80       | -10.39/-7.06        | -4.20/-2.89         | -2.09/-1.56         | -2.02/-2.84         | -4.15/-5.85         | -7.19/-7.89         | -8.04/-8.06         |               |
| Theta(40°)  | -8.32/-6.24      | -3.80/-2.35       |                   |                   |                   |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |                     |               |

E1(XY plane) –  $\Theta(90)\Phi(0-360)$   
 E2(XZ plane) –  $\Theta(0-180)\Phi(0)$  and  $\Theta(0-180)\Phi(180)$   
 E3(YZ plane) –  $\Theta(0-180)\Phi(90)$  and  $\Theta(0-180)\Phi(270)$

