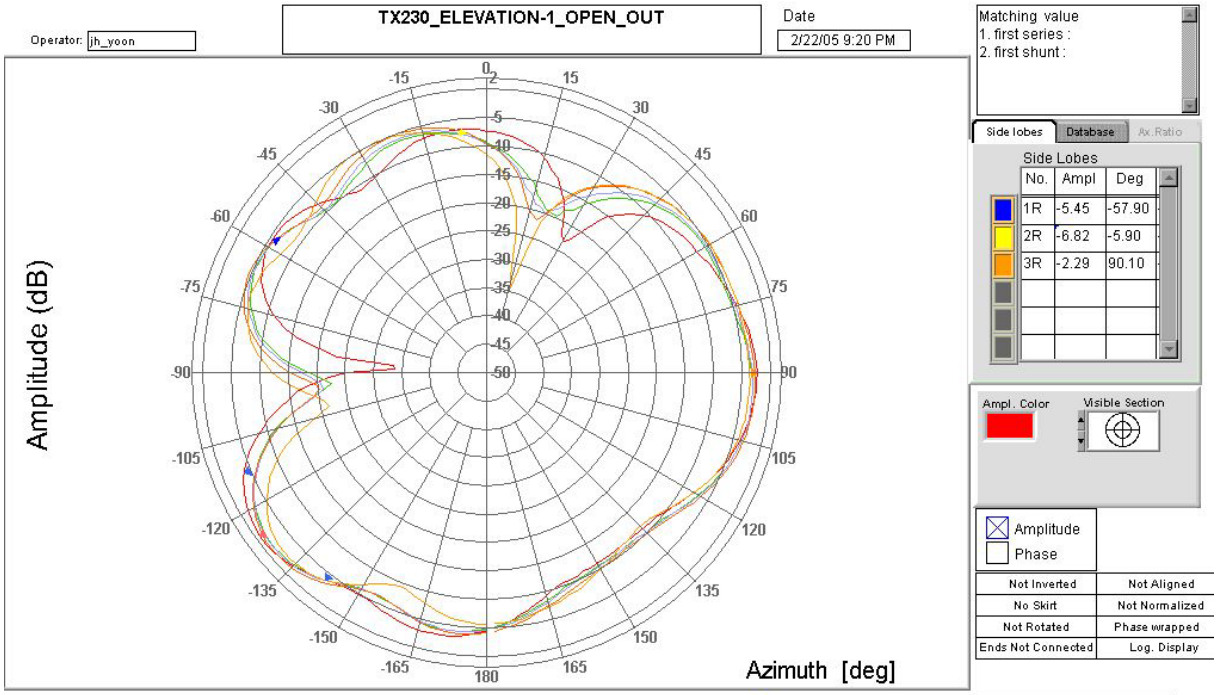
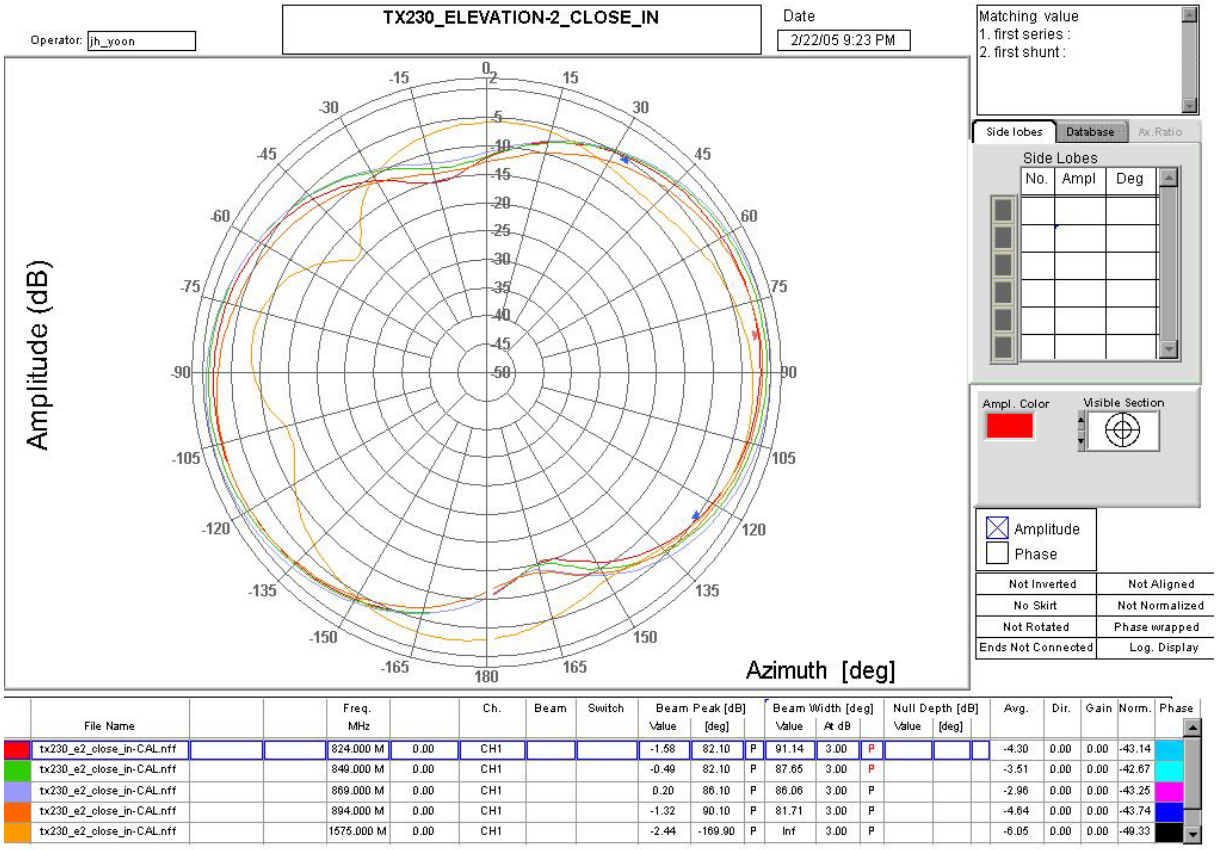
## US-PCS ELEVATION-1 OPEN OUT



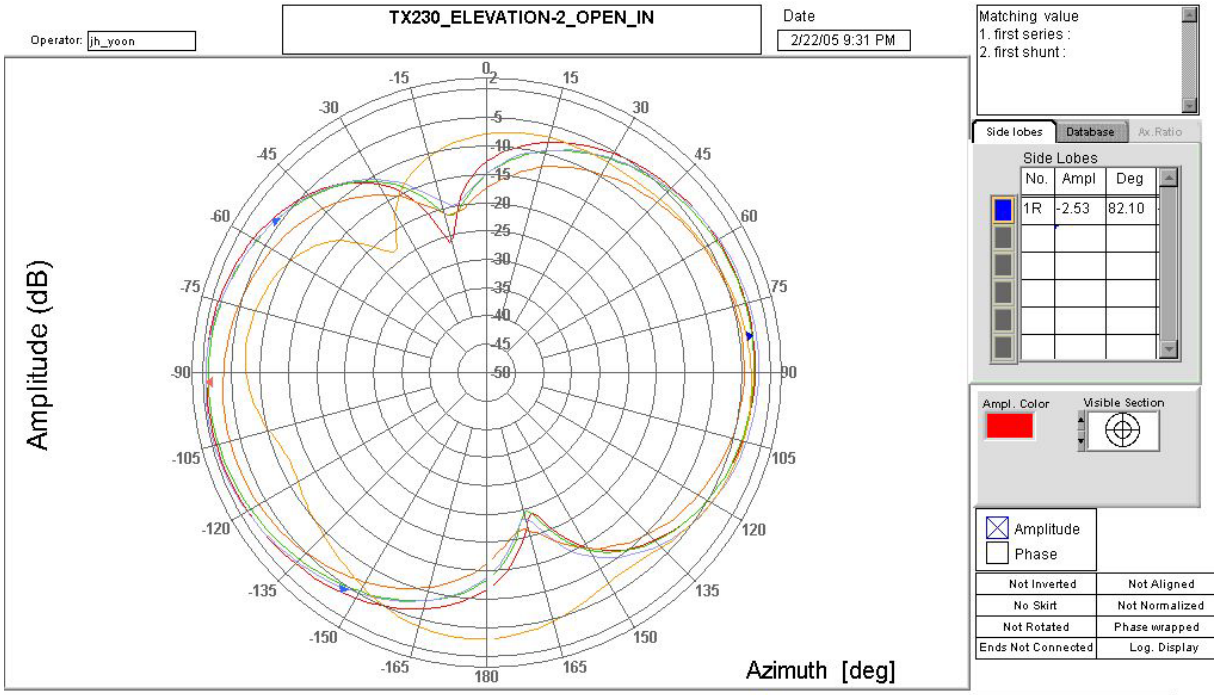

| File Name | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e1_open_out-CAL.nff | 1850.000 M | 0.00 | CH1 | | | -0.67 | -125.90 | P | 29.68 | 3.00 | P | | | | -6.06 | 0.00 | 0.00 | -51.48 | |
| tx230_e1_open_out-CAL.nff | 1910.000 M | 0.00 | CH1 | | | -1.51 | -127.90 | P | 29.20 | 3.00 | P | | | | -6.38 | 0.00 | 0.00 | -50.89 | |
| tx230_e1_open_out-CAL.nff | 1920.000 M | 0.00 | CH1 | | | -1.37 | -127.90 | P | 28.39 | 3.00 | P | | | | -6.20 | 0.00 | 0.00 | -50.90 | |
| tx230_e1_open_out-CAL.nff | 1930.000 M | 0.00 | CH1 | | | -0.98 | -131.90 | P | 28.39 | 3.00 | P | | | | -5.72 | 0.00 | 0.00 | -50.17 | |
| tx230_e1_open_out-CAL.nff | 1990.000 M | 0.00 | CH1 | | | -2.22 | -133.90 | P | 26.76 | 3.00 | P | | | | -6.65 | 0.00 | 0.00 | -50.47 | |

## CELLULAR, GPS ELEVATION-2 CLOSE IN



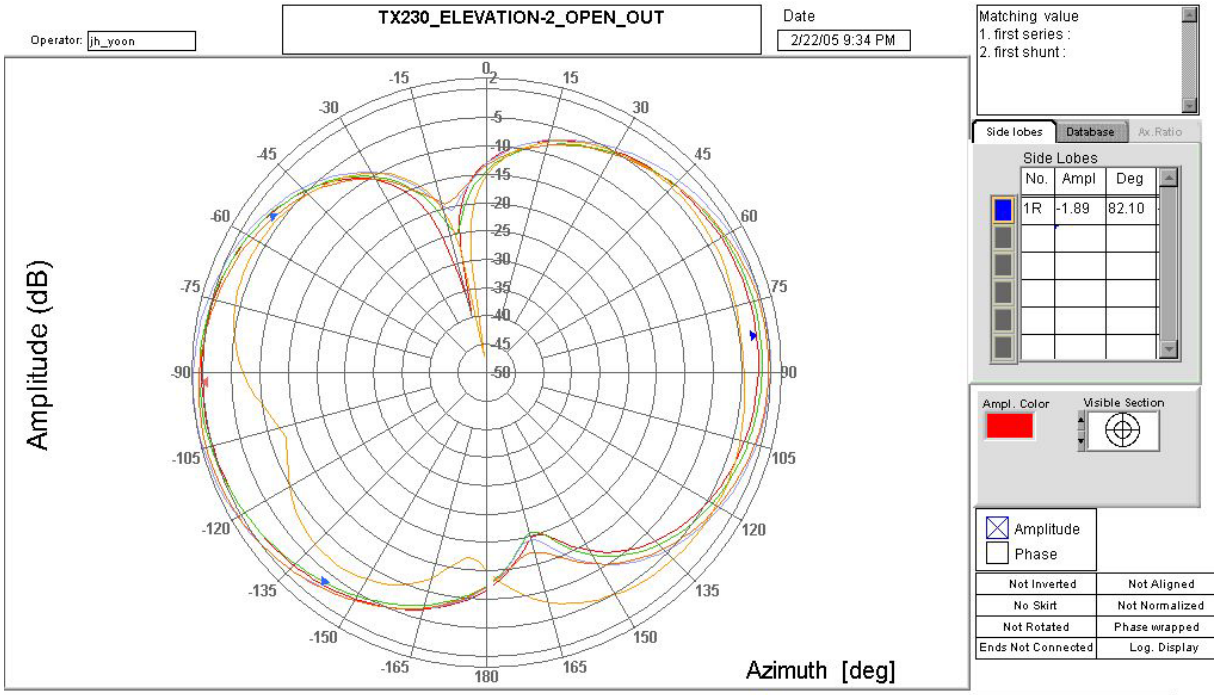

| File Name | | | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_close_in-CAL.nff | | | 824.000 M | 0.00 | CH1 | | | -1.58 | 82.10 | P | 91.14 | 3.00 | P | | | | -4.30 | 0.00 | 0.00 | -43.14 | |
| tx230_e2_close_in-CAL.nff | | | 849.000 M | 0.00 | CH1 | | | -0.49 | 82.10 | P | 87.65 | 3.00 | P | | | | -3.51 | 0.00 | 0.00 | -42.67 | |
| tx230_e2_close_in-CAL.nff | | | 869.000 M | 0.00 | CH1 | | | 0.20 | 86.10 | P | 86.06 | 3.00 | P | | | | -2.96 | 0.00 | 0.00 | -43.25 | |
| tx230_e2_close_in-CAL.nff | | | 894.000 M | 0.00 | CH1 | | | -1.32 | 90.10 | P | 81.71 | 3.00 | P | | | | -4.64 | 0.00 | 0.00 | -43.74 | |
| tx230_e2_close_in-CAL.nff | | | 1575.000 M | 0.00 | CH1 | | | -2.44 | -169.90 | P | Inf | 3.00 | P | | | | -6.05 | 0.00 | 0.00 | -49.33 | |

CELLULAR, GPS ELEVATION-2 OPEN IN



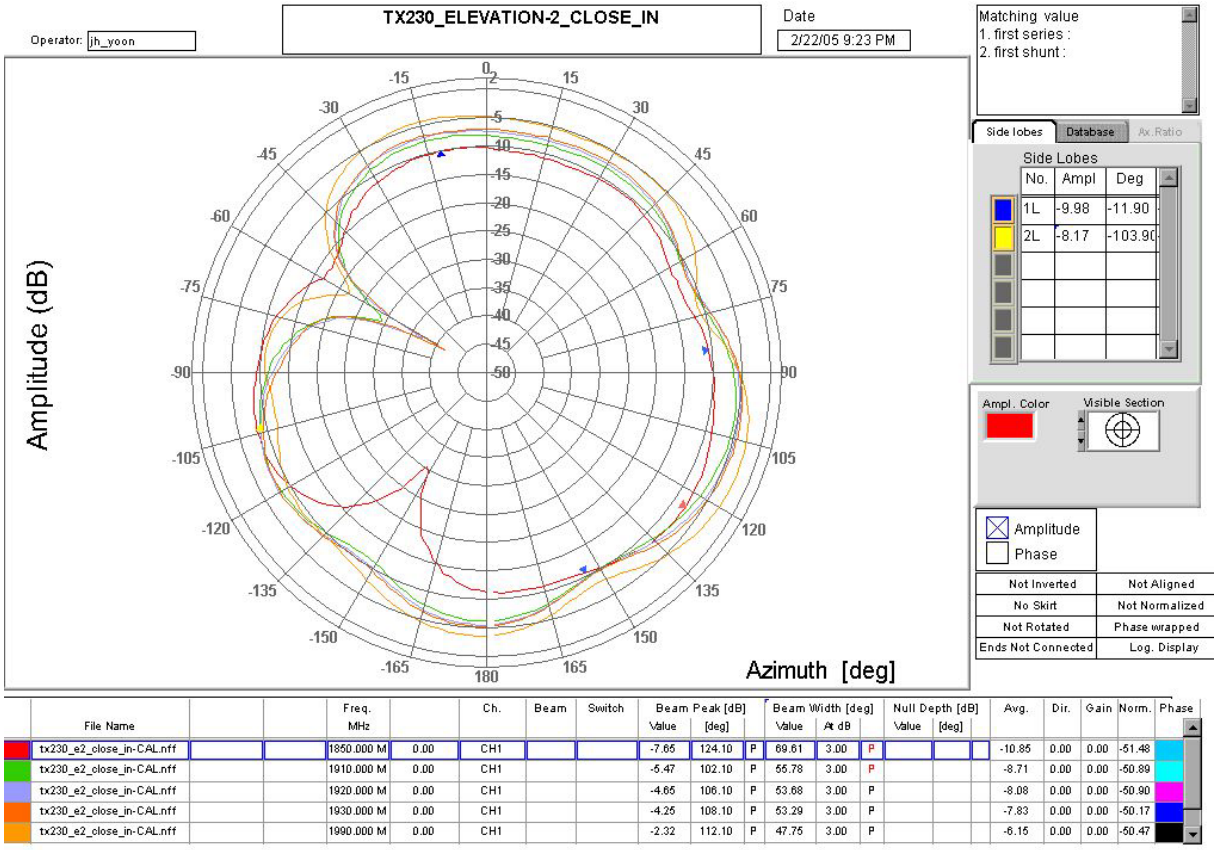

| File Name | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_open_in-CAL.nff | 824.000 M | 0.00 | CH1 | | | -0.52 | -91.90 | P | 92.12 | 3.00 | P | | | -4.29 | 0.00 | 0.00 | -43.14 | |
| tx230_e2_open_in-CAL.nff | 849.000 M | 0.00 | CH1 | | | -0.84 | -93.90 | P | 83.21 | 3.00 | P | | | -4.80 | 0.00 | 0.00 | -42.67 | |
| tx230_e2_open_in-CAL.nff | 869.000 M | 0.00 | CH1 | | | -0.28 | -101.90 | P | 80.18 | 3.00 | P | | | -4.28 | 0.00 | 0.00 | -43.25 | |
| tx230_e2_open_in-CAL.nff | 894.000 M | 0.00 | CH1 | | | -3.09 | -103.90 | P | 80.53 | 3.00 | P | | | -7.08 | 0.00 | 0.00 | -43.74 | |
| tx230_e2_open_in-CAL.nff | 1575.000 M | 0.00 | CH1 | | | -2.97 | -177.90 | P | Inf | 3.00 | P | | | -6.36 | 0.00 | 0.00 | -49.33 | |

## CELLULAR, GPS ELEVATION-2 OPEN OUT



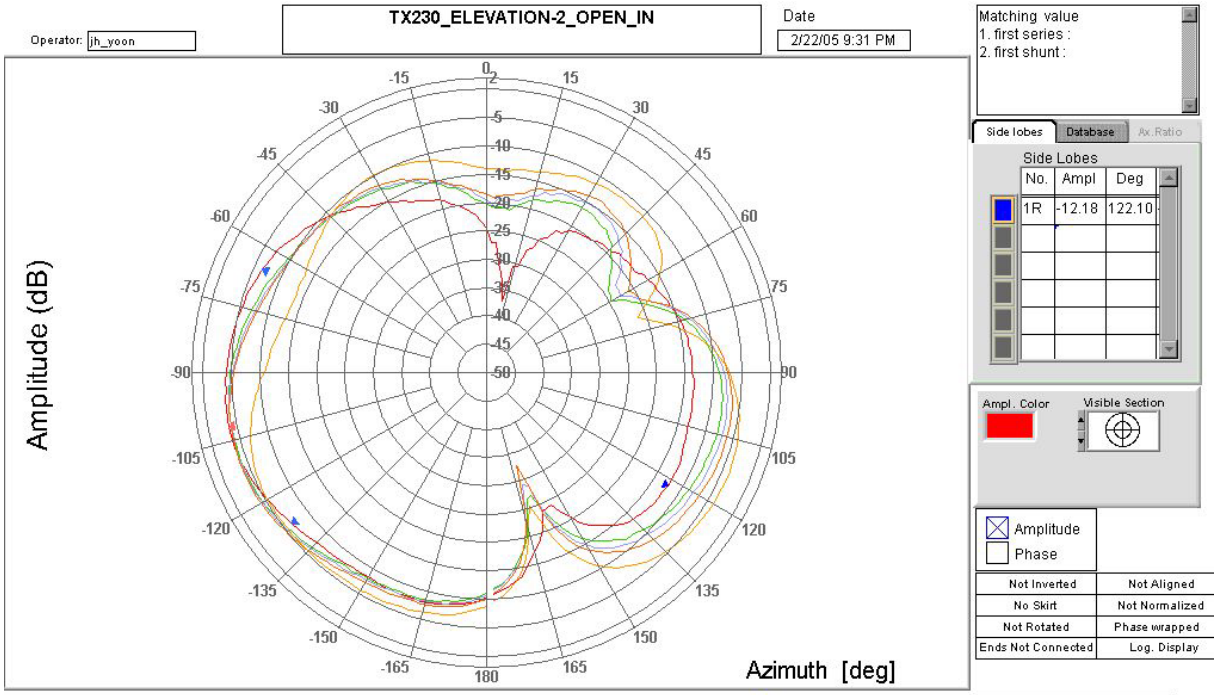

| File Name | | | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_open_out-CAL.nff | | | 824.000 M | 0.00 | CH1 | | | 0.30 | -91.90 | P | 88.48 | 3.00 | P | | | | -3.68 | 0.00 | 0.00 | -43.14 | |
| tx230_e2_open_out-CAL.nff | | | 849.000 M | 0.00 | CH1 | | | 0.67 | -93.90 | P | 79.79 | 3.00 | P | | | | -3.46 | 0.00 | 0.00 | -42.67 | |
| tx230_e2_open_out-CAL.nff | | | 869.000 M | 0.00 | CH1 | | | 1.88 | -97.90 | P | 76.68 | 3.00 | P | | | | -2.29 | 0.00 | 0.00 | -43.25 | |
| tx230_e2_open_out-CAL.nff | | | 894.000 M | 0.00 | CH1 | | | 1.15 | -103.90 | P | 77.24 | 3.00 | P | | | | -2.95 | 0.00 | 0.00 | -43.74 | |
| tx230_e2_open_out-CAL.nff | | | 1575.000 M | 0.00 | CH1 | | | -3.09 | 126.10 | P | 134.87 | 3.00 | P | | | | -6.06 | 0.00 | 0.00 | -49.33 | |

## US-PCS ELEVATION-2 CLOSE IN



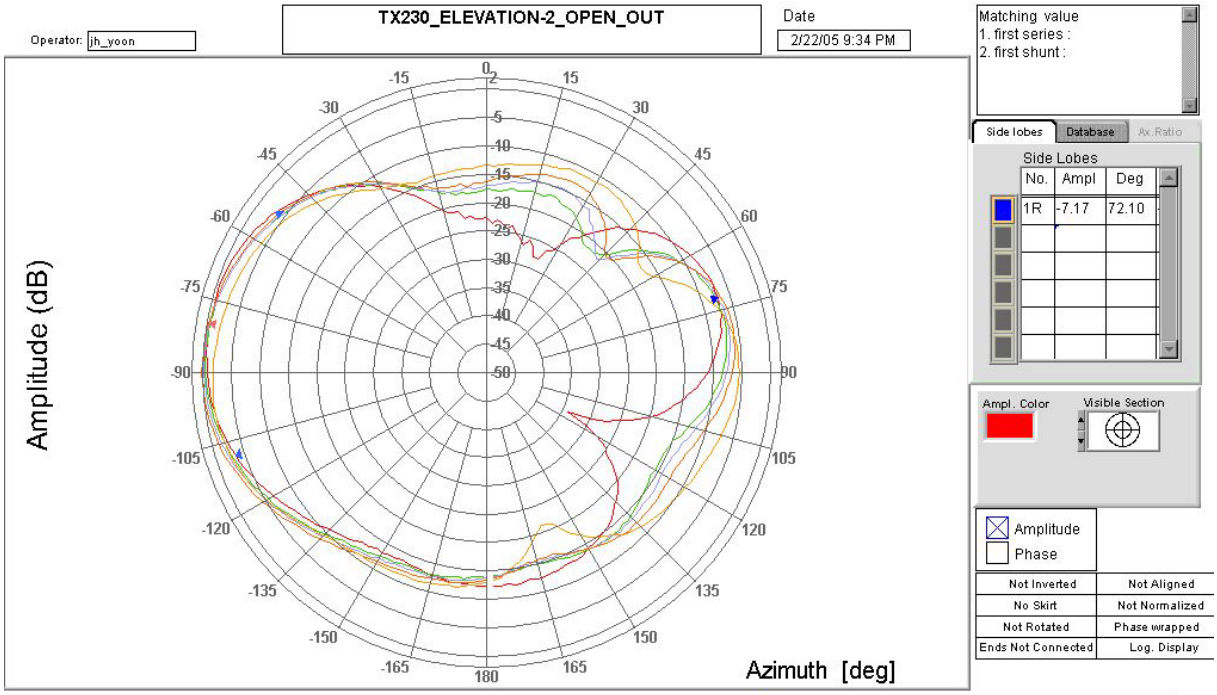

| File Name | Freq. MHz | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | Beam Width [deg] Value | At dB | Null Depth [dB] Value | [deg] | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_close_in-CAL.nff | 1850.000 M | CH1 | | | -7.65 | 124.10 P | 69.61 | 3.00 P | | | -10.85 | 0.00 | 0.00 | -51.48 | |
| tx230_e2_close_in-CAL.nff | 1910.000 M | CH1 | | | -5.47 | 102.10 P | 55.78 | 3.00 P | | | -8.71 | 0.00 | 0.00 | -50.89 | |
| tx230_e2_close_in-CAL.nff | 1920.000 M | CH1 | | | -4.65 | 106.10 P | 53.68 | 3.00 P | | | -8.08 | 0.00 | 0.00 | -50.90 | |
| tx230_e2_close_in-CAL.nff | 1930.000 M | CH1 | | | -4.25 | 108.10 P | 53.29 | 3.00 P | | | -7.83 | 0.00 | 0.00 | -50.17 | |
| tx230_e2_close_in-CAL.nff | 1990.000 M | CH1 | | | -2.32 | 112.10 P | 47.75 | 3.00 P | | | -6.15 | 0.00 | 0.00 | -50.47 | |

US-PCS ELEVATION-2 OPEN IN




| File Name | | | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_open_in-CAL.nff | | | 1850.000 M | 0.00 | CH1 | | | -3.47 | -101.90 | P | 62.63 | 3.00 | P | | | | -9.63 | 0.00 | 0.00 | -51.48 | |
| tx230_e2_open_in-CAL.nff | | | 1910.000 M | 0.00 | CH1 | | | -3.96 | -107.90 | P | 61.97 | 3.00 | P | | | | -9.34 | 0.00 | 0.00 | -50.89 | |
| tx230_e2_open_in-CAL.nff | | | 1920.000 M | 0.00 | CH1 | | | -3.80 | -109.90 | P | 59.62 | 3.00 | P | | | | -9.04 | 0.00 | 0.00 | -50.90 | |
| tx230_e2_open_in-CAL.nff | | | 1930.000 M | 0.00 | CH1 | | | -3.65 | -109.90 | P | 59.86 | 3.00 | P | | | | -8.85 | 0.00 | 0.00 | -50.17 | |
| tx230_e2_open_in-CAL.nff | | | 1990.000 M | 0.00 | CH1 | | | -3.64 | 114.10 | P | 49.06 | 3.00 | P | | | | -8.32 | 0.00 | 0.00 | -50.47 | |

## US-PCS ELEVATION-2 OPEN OUT




| File Name | Freq. MHz | | Ch. | Beam | Switch | Beam Peak [dB] Value | [deg] | | Beam Width [deg] Value | At dB | | Null Depth [dB] Value | [deg] | | Avg. | Dir. | Gain | Norm. | Phase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tx230_e2_open_out-CAL.nff | 1850.000 M | 0.00 | CH1 | | | -0.35 | -79.90 | P | 55.66 | 3.00 | P | | | | -7.42 | 0.00 | 0.00 | -51.48 | |
| tx230_e2_open_out-CAL.nff | 1910.000 M | 0.00 | CH1 | | | -0.24 | -85.90 | P | 52.80 | 3.00 | P | | | | -7.38 | 0.00 | 0.00 | -50.89 | |
| tx230_e2_open_out-CAL.nff | 1920.000 M | 0.00 | CH1 | | | -0.13 | -89.90 | P | 53.64 | 3.00 | P | | | | -7.12 | 0.00 | 0.00 | -50.90 | |
| tx230_e2_open_out-CAL.nff | 1930.000 M | 0.00 | CH1 | | | 0.22 | -89.90 | P | 54.43 | 3.00 | P | | | | -6.65 | 0.00 | 0.00 | -50.17 | |
| tx230_e2_open_out-CAL.nff | 1990.000 M | 0.00 | CH1 | | | -1.61 | -97.90 | P | 60.71 | 3.00 | P | | | | -7.52 | 0.00 | 0.00 | -50.47 | |

### 3.3 Antenna Gain

Antenna gain shall be measured in decibels relative to a standard horn reference antenna (unit : dBi )

The peak gain of the antenna as follows.

| | | |
|---|---|---|
| GAIN(Peak) | CELLULAR CLOSE IN | > 0.21 dBi |
| | CELLULAR OPEN IN | > −0.17 dBi |
| | CELLULAR OPEN OUT | > 1.38 dBi |
| | GPS CLOSE IN | > −2.72 dBi |
| | GPS OPEN IN | > −2.32 dBi |
| | GPS OPEN OUT | > −1.07 dBi |
| | US−PCS CLOSE IN | > −2.72 dBi |
| | US−PCS OPEN IN | > −0.38 dBi |
| | US−PCS OPEN OUT | > 0.3 dBi |

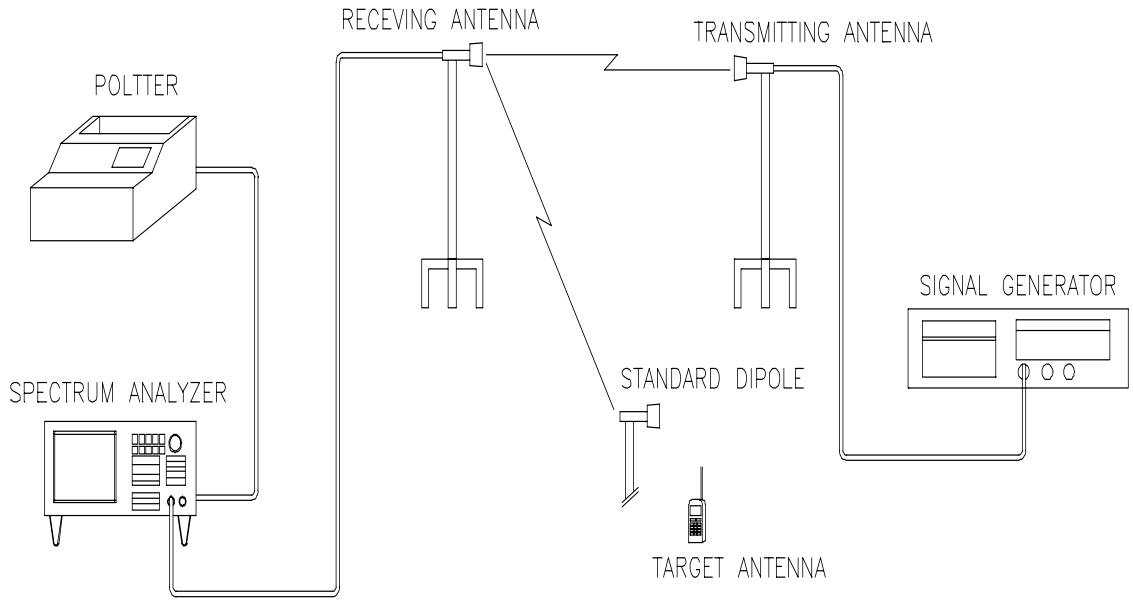
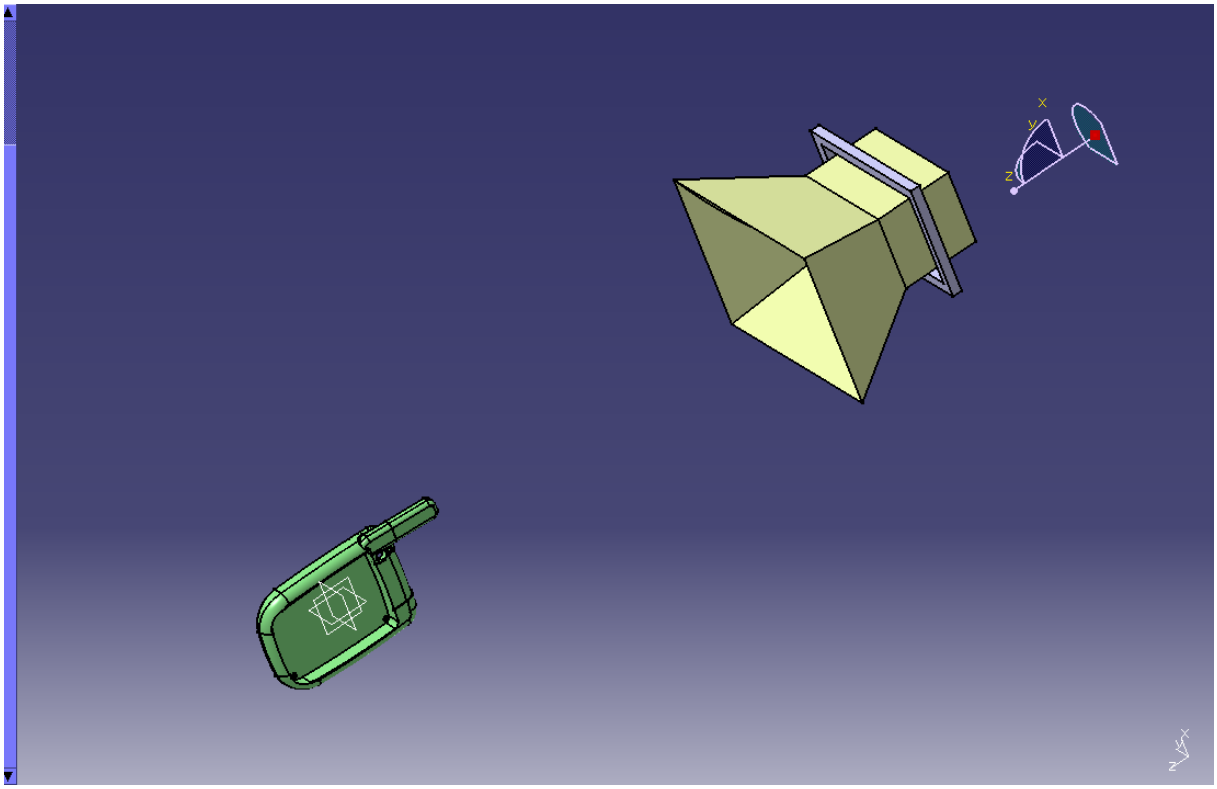
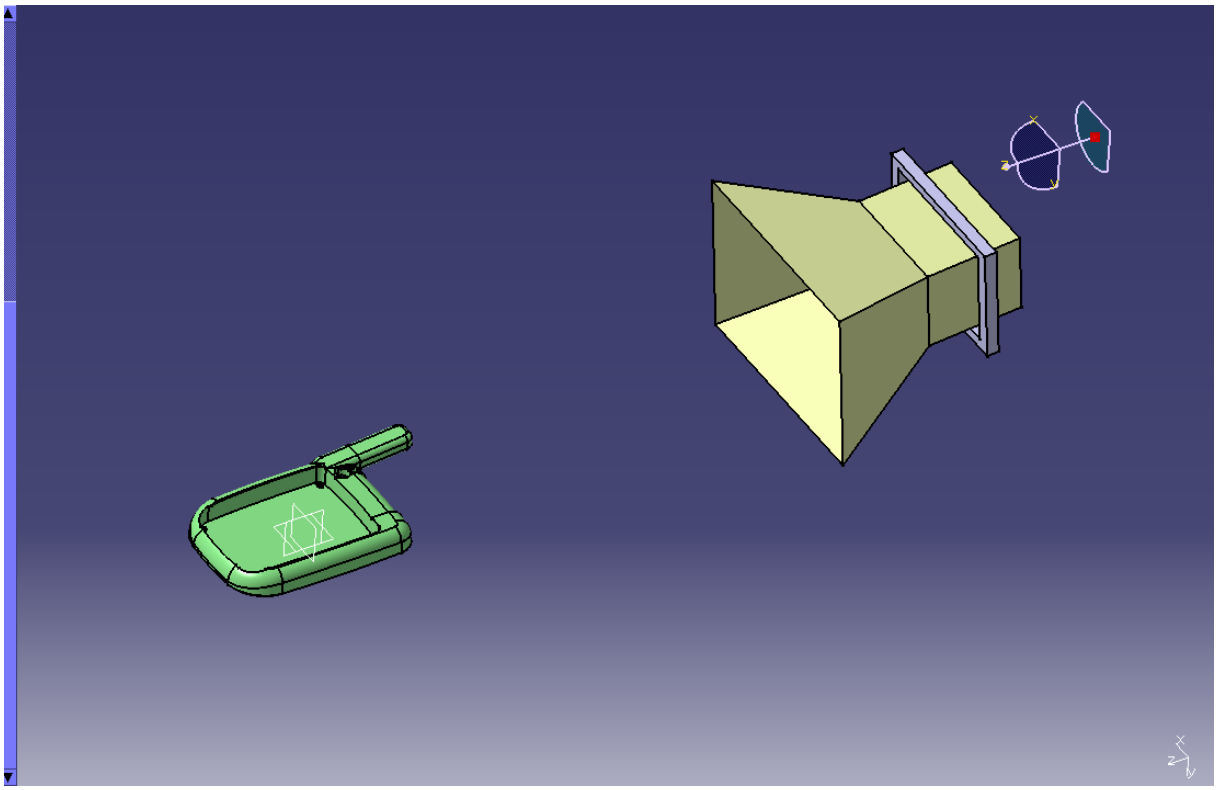



Figure. 2 Antenna Gain Measurement System

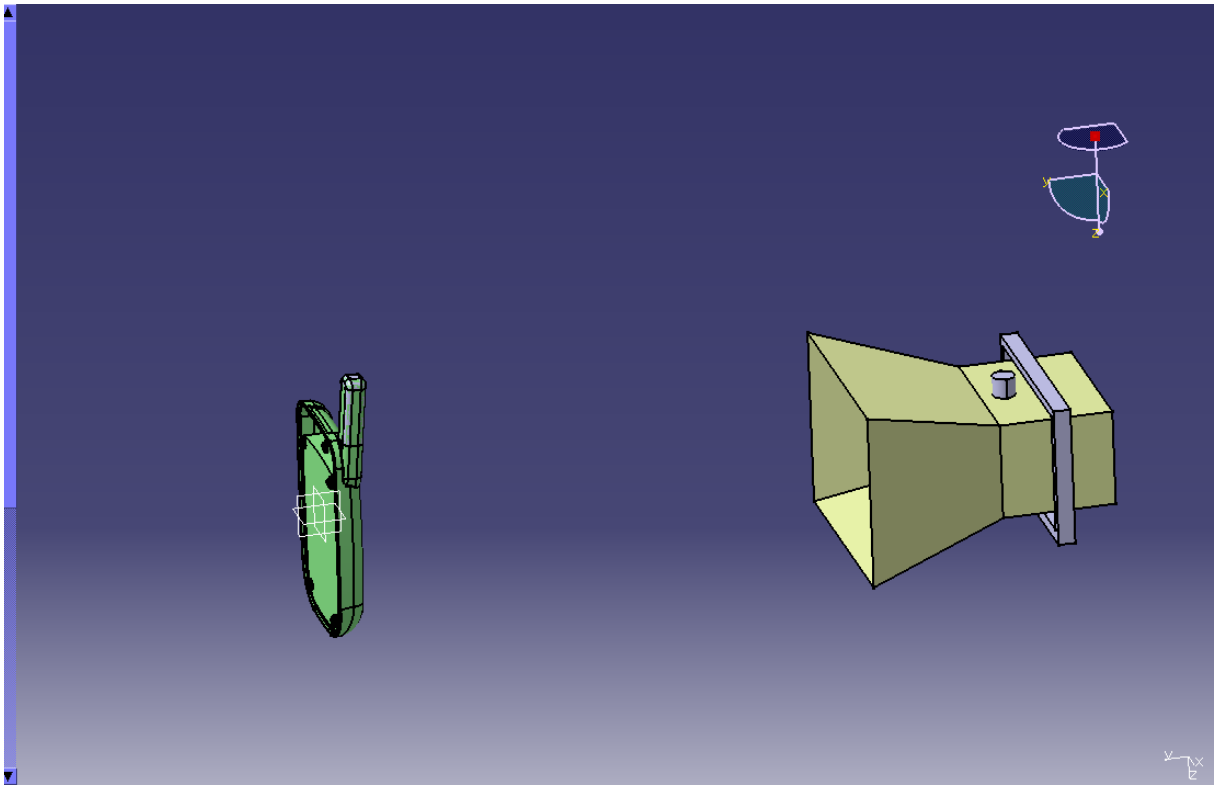
ELEVATION-1 MEASUREMENT



ELEVATION-2 MEASUREMENT

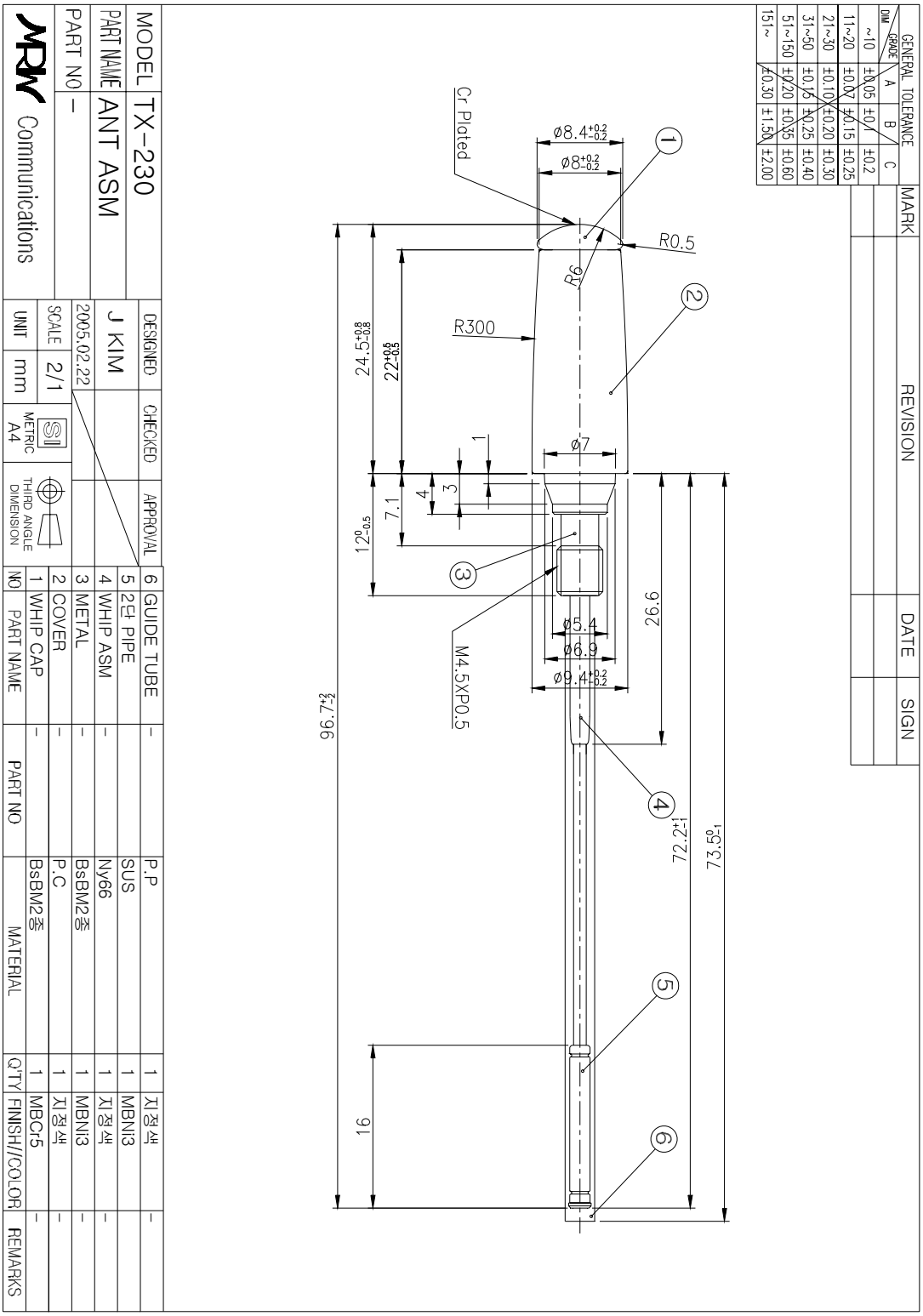


AZIMUTH MEASUREMENT



## 4. Mechanical Specification

### 4.1 Dimension (Refer to the drawing)



### 4.2 Bending Test

There shall not be any visible damage and shall met electrical specification after 1,000 times bending at 90° form side to side.

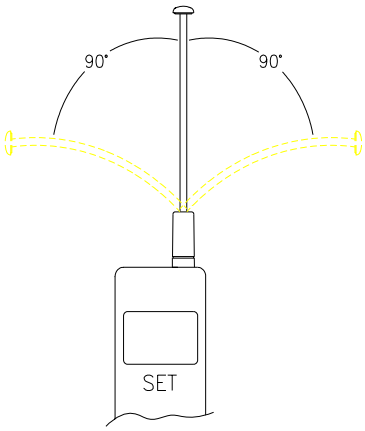



Figure. 3 Bending Test

### 4.3 Extraction / Retraction Test

When the whip of antenna is pulled up for extraction in retracted position, the force should be 100 ~ 350gf and when the whip of antenna is pushed down for retraction, he release force of stopper shall be 100 ~ 350gf.

### 4.4 Drop Test

The handset installed with antenna is dropped from 1.5m onto the concrete bottom for 3 times.

There shall not be any major visible damage and the antenna shall perform normally as defined in this specification after the test.

### 4.5 Pull Test

The antenna is assembled in the test equipment and pulling force with 7kgf is applied to the antenna for 10 seconds.

No visual deterioration shall occur and the antenna shall satisfy the electrical demands after the test.

### 4.6 Torque Test

The antenna is assembled to the test equipment. After applying the torque force with 3kgf in clockwise direction between fitting and plastic, no visual deterioration shall occur, the antenna shall satisfy the electrical demands after the test.

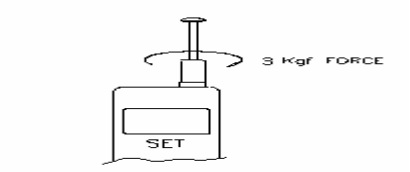



Figure 4. Torque Test

### 4.7 Cycle Test

The antenna is fully extended / retracted ( 1 cycle ) with 10000 times and the extraction / retraction force is measured every 2000 cycles.

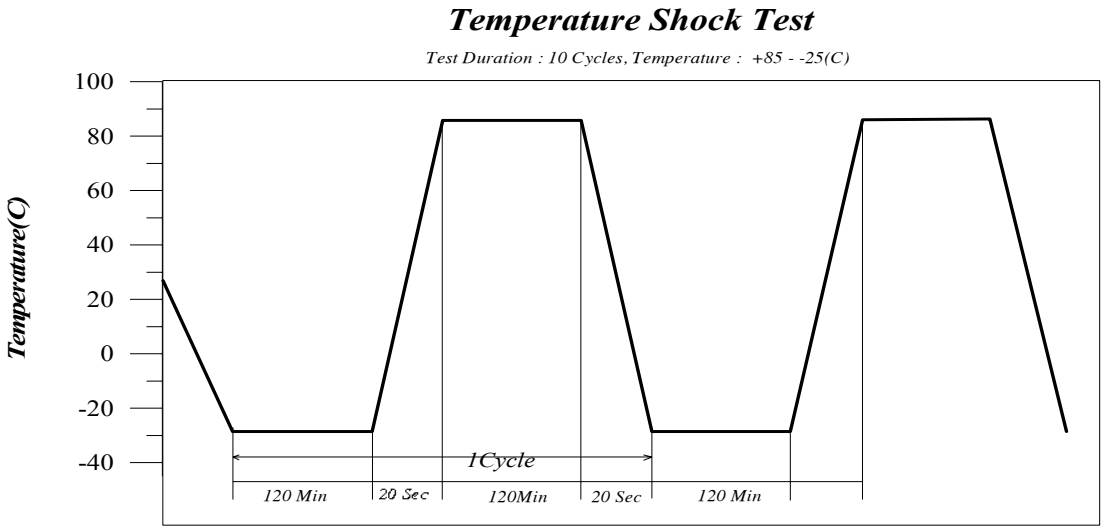
The extraction/retraction force of antenna shall keeps 50 ~ 350gf.

No visual deterioration shall occur and the antenna shall satisfy the electrical demands after the test.

## 5. Environmental Specification

### 5.1 Thermal Shock

The antenna shall withstand 10 repeated cycles of 120 minutes at −25ºC and 120 minutes at +85ºC with a maximum transition time between temperature extremes of 20 seconds. The antenna shall satisfy the electrical specification after the test. The antenna shall have no deterioration after the test.




### 5.2 Temperature Cycling

The antenna is placed in the temperature chamber with −40 for 3 hours and measured after taking out of chamber.

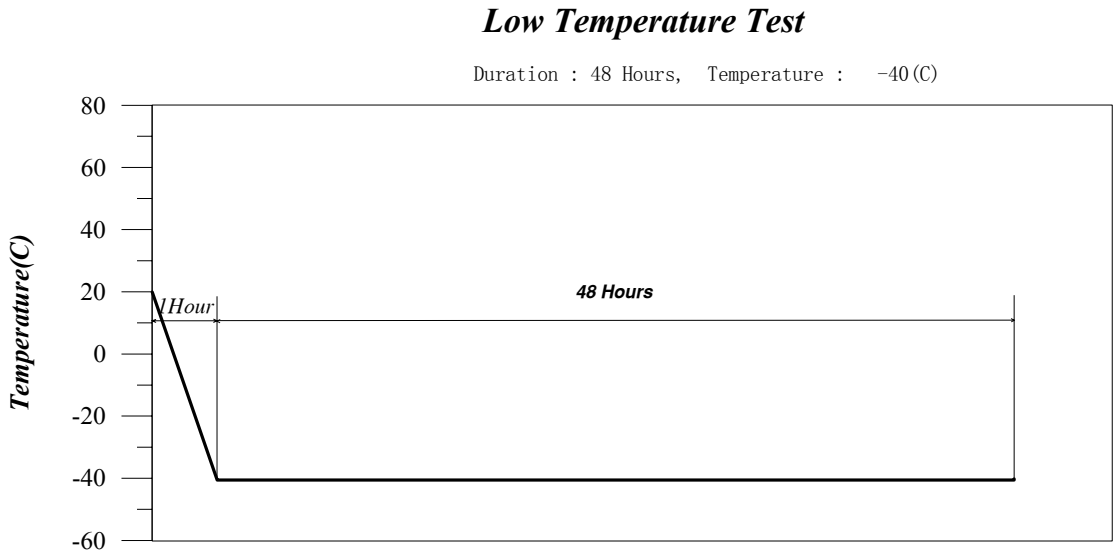
After that, the antenna is again placed in the temperature chamber with +70ºC for 3 hours and measured after taking out of chamber.

The antenna shall not be any visible damage and it shall meet electrical spec.

### 5.3 Low Temperature Test

The antenna is placed in the temperature chamber with −40℃ for 48 hours and measured after taking out of chamber.

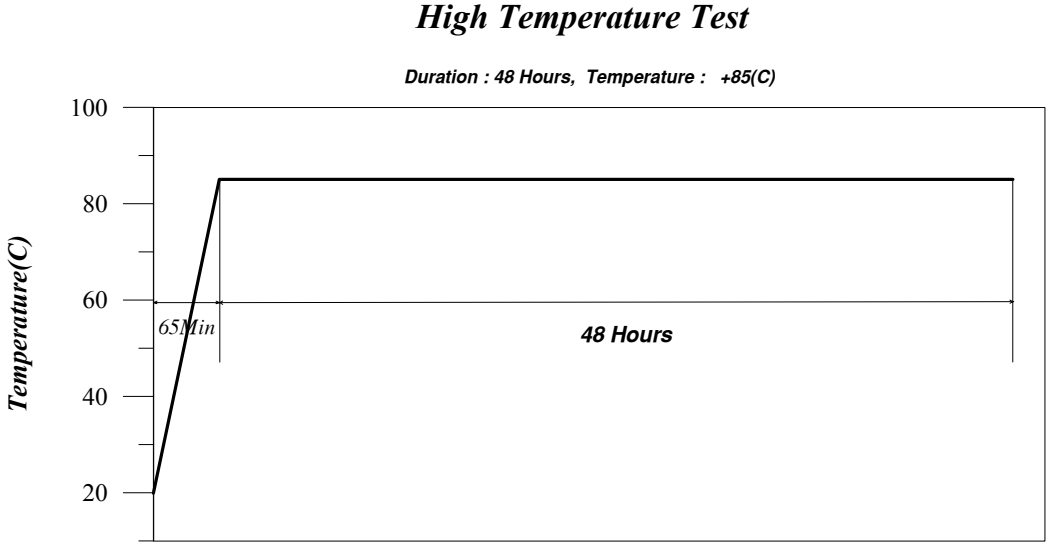
The antenna shall not be any visible damage and it shall meet electrical spec.




### 5.4 High Temperature Test

The antenna is placed in the temperature chamber and test it under below condition and measured it after taking out of chamber.

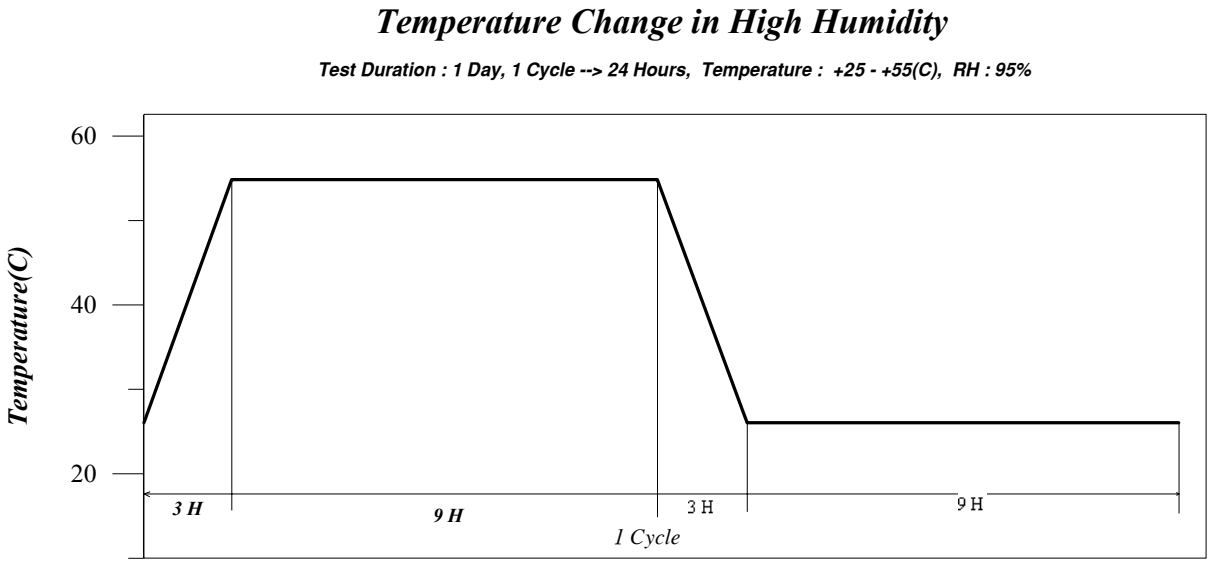
The antenna shall not be any visible damage and it shall meet electrical spec.



## 5.5 Humidity Test

The antenna is placed in the temperature chamber and test it under below condition and measured it after taking out of chamber.

The antenna shall not be any visible damage and it shall meet electrical spec.




## 5.6 Vibration Test

The antenna shall withstand 2G's RMS( 10Hz – 150Hz – 10Hz / 1cycle) with 0.5 octave/min, 12cycles in X,Y,Z direction.

No appearance or function changes shall be found after the test.

## 5.7 Salt Spray Test

The antenna shall be exposed for 48 hours at +35℃ to a 5% Sodium Chloride fog and have no appearance or function changes after the test.

## Appendix A. Reference of TestMethods

| | | Test Items | Reference |
|---|---|---|---|
| Mechanical | MRWS-Ma | Drop Test | IEC 68-2-31 |
| | MRWS-Mb | Insertion/Extraction Test | - |
| | MRWS-Mc | Pulling Test | - |
| | MRWS-Md | Bending Test | - |
| | MRWS-Me | Torsion Test | - |
| | MRWS-Mf | Helix Breaking Test | - |
| | MRWS-Mg | Endurance Test | - |
| Enviromental | MRWES-Na | Temperature Shock Test | IEC 68-2-14 |
| | MRWES-Nb | Temperature Cyclng Test | IEC 68-2-14 |
| | MRWES-Ab | Low Temperature Test | IEC 68-2-1 |
| | MRWES-Bb | Hot Temperature Test | IEC 68-2-2 |
| | MRWES-D | Humidity Test | IEC 68-2-30 |
| | MRWES-Fc | Sinusoidal Vibration Test | IEC 68-2-6 |

*. MRWS-M* : MRW Mechanical Standard

*. MRWES-* : MRW Environmental Standard