Sensormatic LLC, 6600 Congress Ave, Boca Raton, FL 33487, 561.912.6000

Type of assessment:
FCC Part 15 Antenna Assessment

Product:
Beam Forming Antenna

Model:
IDA-3300

IDA-3300 Antenna Specification

Antenna Type	Beam forming Patch
Peak Gain	7.21 dBi
Frequency	902 – 928 MHz

Paul Tervakoski
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Tested by Signature

Mark Alexis
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Reviewed by Signature

Contents

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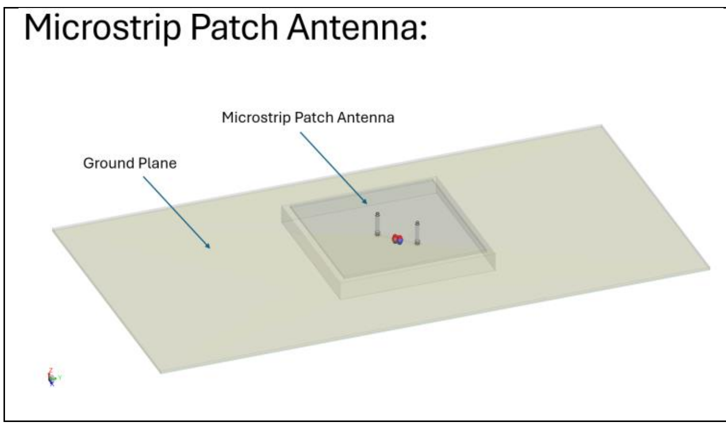
1. Report Summary

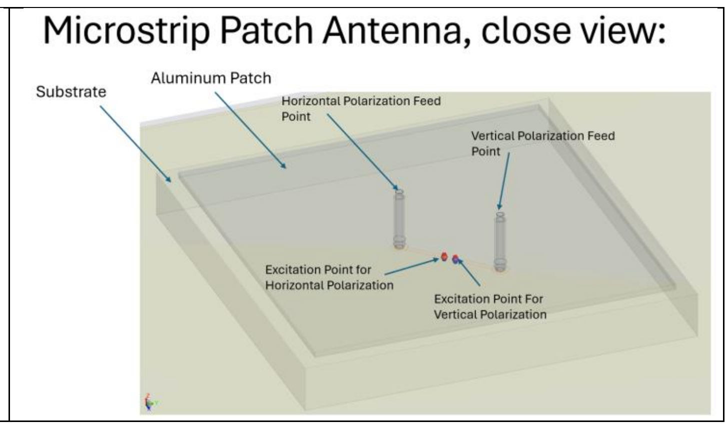
Product	Model	Parameter	Method	Peak Gain
Beam Forming Patch Antenna	IDA-3300	Antenna Gain	Cispr 16-1-6 Three Antenna Method	7.21 dBi

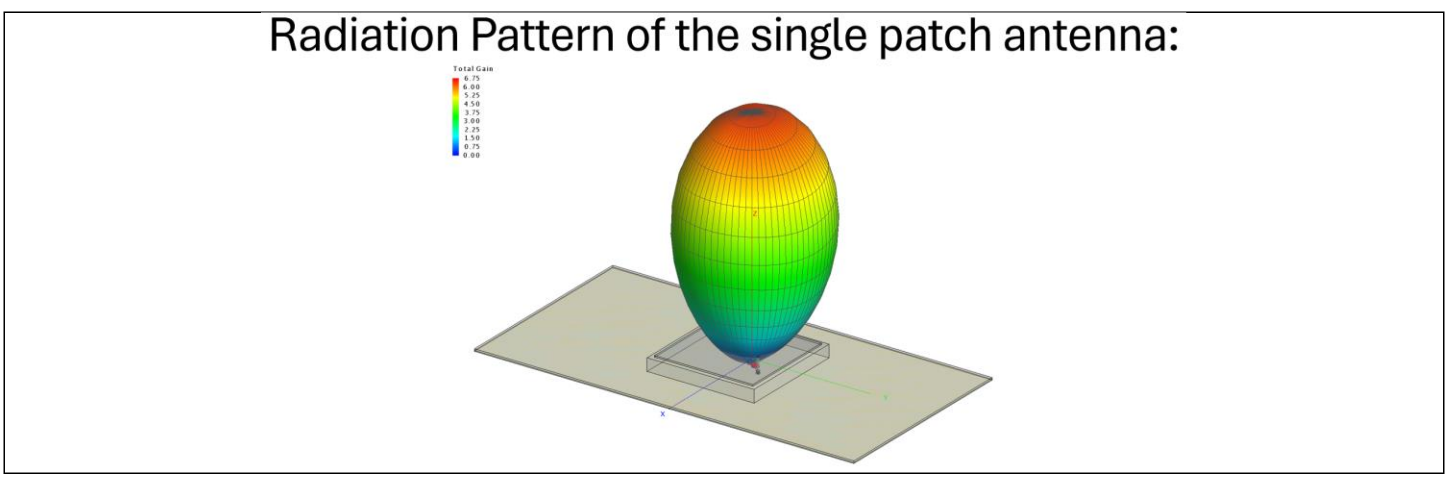
2. AUT Technical Information

Single Patch Antenna design

- A single patch antenna is designed to cover the frequency range of 902-928 MHz, meeting the required specifications for FCC band application.
- The patch has two feed points, allowing for the generation of vertical and horizontal polarizations with good gain, excellent isolation between the polarizations, and good port impedance matching.

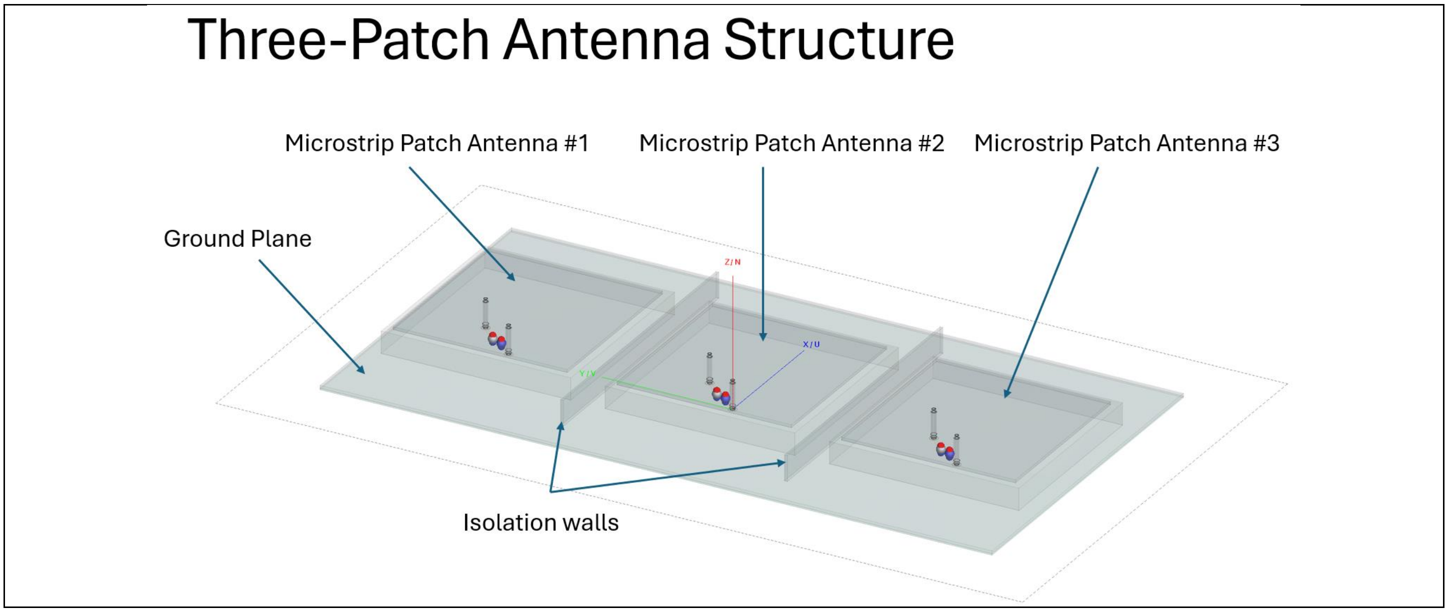


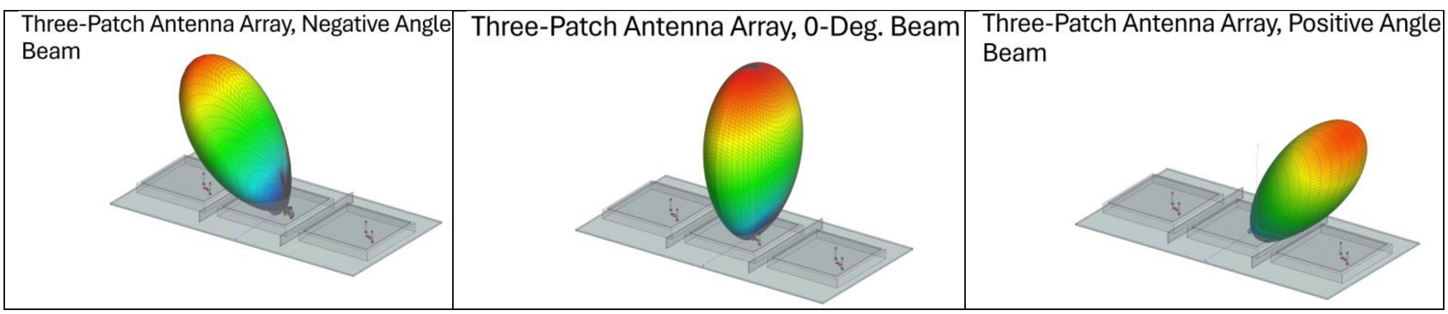




Three Patch Antenna Array Design

- Based on the single-patch antenna, we created an array of three patches capable of generating beam steering in both positive and negative angles, covering a range of -40 to +40 degrees.
- In total, 13 beams are created with the angles:- 40 °,- 35 °,- 30 °,- 25 °,- 20 °,- 10 °, 0 °, +10 °, +20 °, +25 °, +30 °, +35 °, and +40 °.
- By implementing appropriate phase differences between the patches, the beams are formed and steered to meet the project requirements.





3. Measurement Method

Antenna Gain:

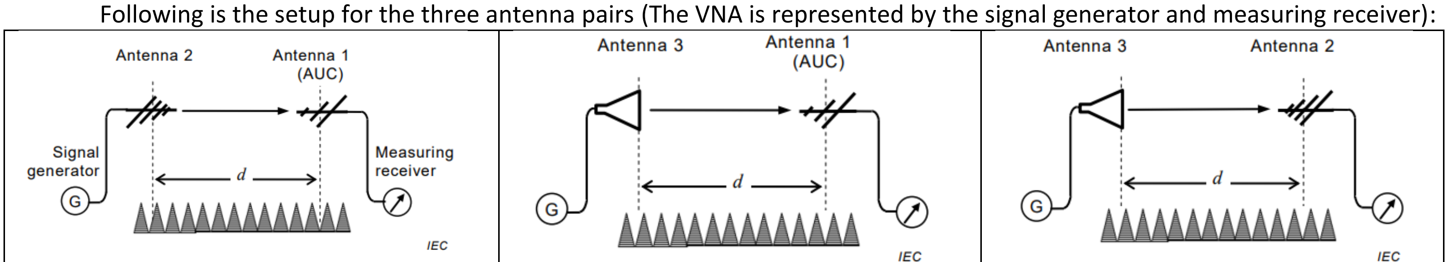
The method of measurement used for the declared peak gain is the Three Antenna Method (TAM) as described in **CISPR16-1-6**. The TAM is a method for which no prior knowledge of the Antenna Factor (AF) of any of the three antennas is needed. It involves the use of three antennas of similar type that cover a common frequency range. Three unique antenna pairs are formed from the three antennas, and the Site Insertion Loss (SIL) of each pair is measured. The result is three equations and three unknowns. Using the three equations, the gain for each antenna can be determined. The test is performed in a fully anechoic room.

In summary:

- **Step 1**: Measure the SIL for each antenna pair in a free-space environment.
- **Step 2**: Calculate the AF for each antenna.
- **Step 3**: Calculate the Antenna gain in dBi for the AUT.

Details of setups, measurements and formulas:

Following is the setup for the three antenna pairs (The VNA is represented by the signal generator and measuring receiver):



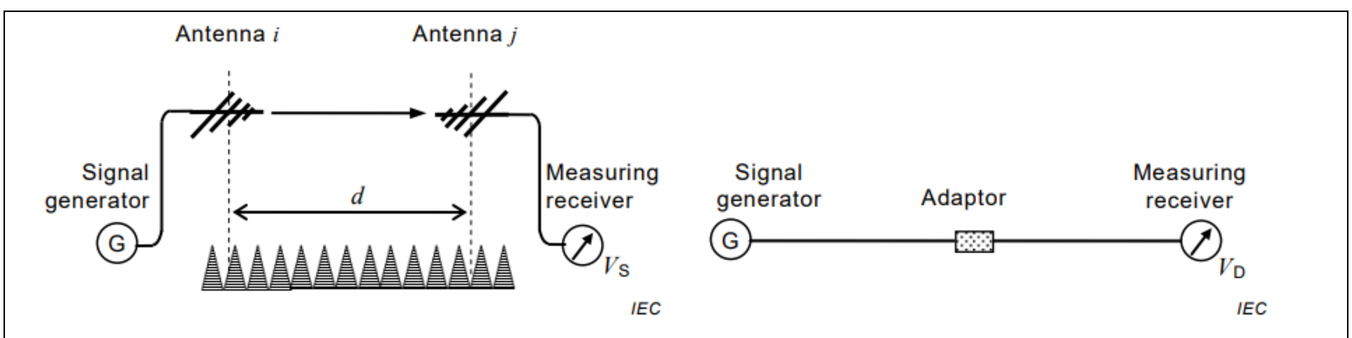
a) Antenna pair (2,1)

b) Antenna pair (3,1)

c) Antenna pair (3,2)

Step 1: Measure the SIL of the three antenna pairs:

The SIL is obtained by subtracting the insertion loss through the antenna pair from the insertion loss with direct connection:



a) Insertion loss through antennas

b) Insertion loss with direct connection

Use the equation:

$$A_i(i,j) = V_D - V_S\,(i,j)$$

Where:

- $A_i(i,j)$ is the SIL for antenna pair (I,j)
- V_D is Insertion loss with direct connection
- $V_S\,(i,j)$ is Insertion loss through antennas

Step 2: Calculate the AF for each antenna:

The following formula expresses the relationship of AF and SIL in a free-space site:

$$A_i(i,j) = F_a(i) + F_a(j) + K(i,j) \text{ in dB} \quad \textbf{(equation 1)}$$

The coefficient $K(i,j)$ is expressed as:

$$K(i,j) = 20\log\left(\frac{39.8}{f(MHz)}\right) - 20\log\left[e_0(\mathrm{I,j})\right] \quad \text{in dB}(m^2)$$

The field strength e_0 is:

$$e^0(i,j) = \frac{1}{d} \quad \text{in } m^{-1}$$

Where:

$F_a(i)$ is the AF in dB(m^{-1}) of antenna *i* in its boresight direction;
$F_a(j)$ is the AF in dB(m^{-1}) of antenna *j* in its boresight direction;
f_{MHz} is the frequency in MHz;
d is the specified separation distance between the antennas, in meters.

Using equation 1, a set of three equations can be obtained from the three measurements of the SIL:

$$A_i(2,1) = F_a(1) + F_a(2) + K(2,1)$$
$$A_i(3,1) = F_a(1) + F_a(3) + K(3,1)$$
$$A_i(3,2) = F_a(2) + F_a(3) + K(3.2)$$

From these three equations, the following equations can be derived to obtain the AF for each antenna:

$$F_a(1) = \frac{1}{2}\left[A_i(2,1) + A_i(3,1) - A_i(3,2) - K(2,1) - K(3,1) + K(3,2)\right]$$

$$F_a(2) = \frac{1}{2}\left[A_i(2,1) - A_i(3,1) + A_i(3,2) - K(2,1) + K(3,1) - K(3,2)\right]$$

$$F_a(3) = \frac{1}{2}\left[-A_i(2,1) + A_i(3,1) + A_i(3,2) + K(2,1) - K(3,1) - K(3,2)\right]$$

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Step 3: Once the AF's are derived the gain of the AUT in dBi can be calculated using the following formulas:

$$Gain_{(num)} \left(\frac{9.73}{\lambda\ 10^{AF/20}}\right)^2$$

$$Gain_{(dBi)} = 10 \log \left(Gain_{(num)}\right)$$

Antenna Pattern:

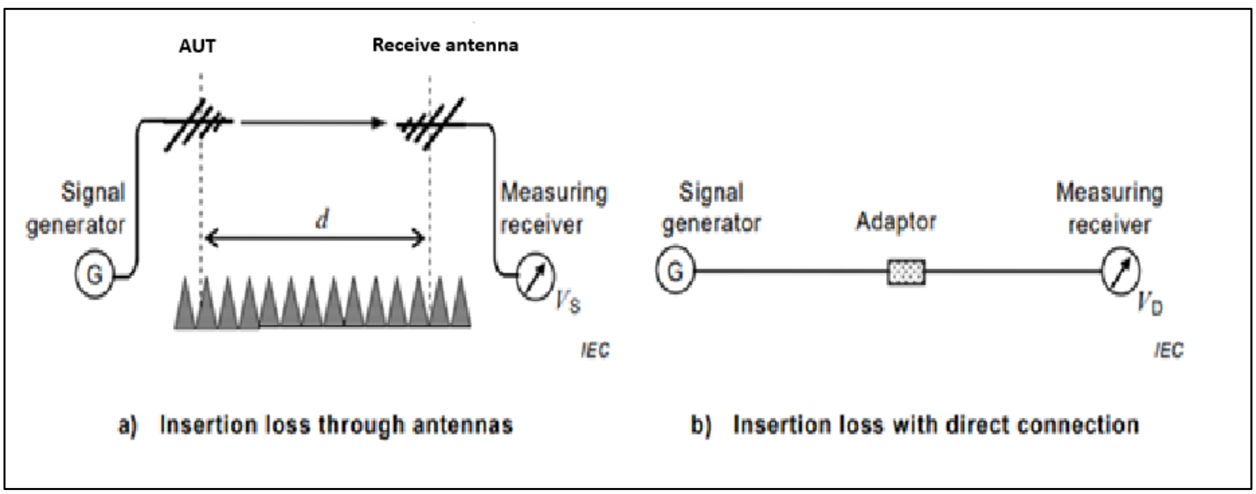
Method used for the pattern measurements:

- **Step 1**: Measure the insertion loss with a direct connection.
- **Step 2**: While rotating the AUT, measure the insertion loss of the AUT and receive antenna.
- **Step 3**: Calculate the Antenna gain in dBi for the AUT using the following formula:

AUT Gain = AUTIL – SIL+ FSPL – Rx ant gain

Where:

- AUTIL is the insertion loss of the AUT and receive antenna (step 2 above)
- SIL is the insertion loss with a direct connection (step 1 above)
- FSLP is the free space path loss
- Rx ant gain is the gain of the receive antenna in dBi which was obtained during the gain measurement above.



The pattern is then plotted using an in-house LabView program.

4. Test Results

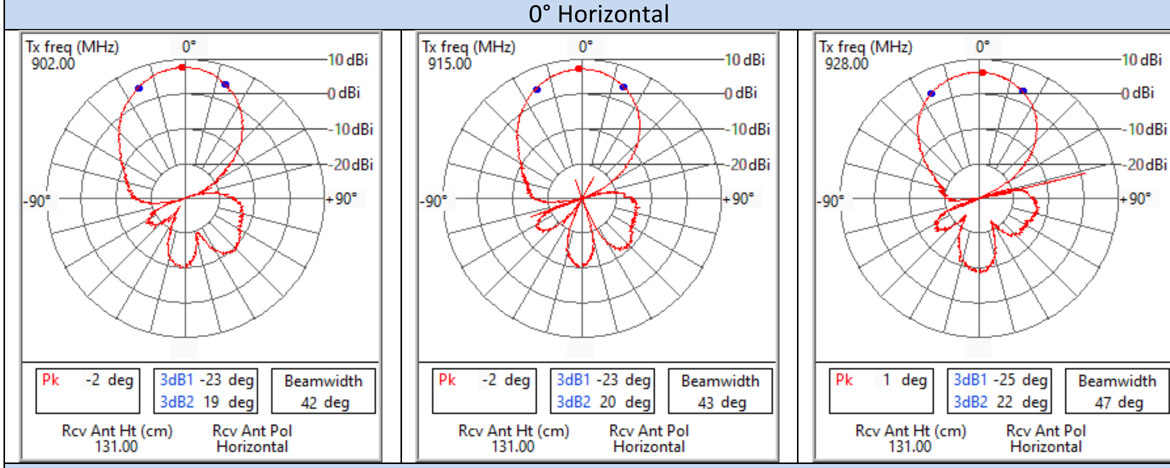
Measured Peak Gain at each angle setting:

Angle	0°	10°	20°	25°	30°	35°	40°	45°
Gain dBi Vert	6.60	6.72	6.90	6.31	5.94	5.34	5.59	4.56
Gain dBi Horz	6.62	7.11	7.21	6.54	6.20	5.98	5.81	4.57

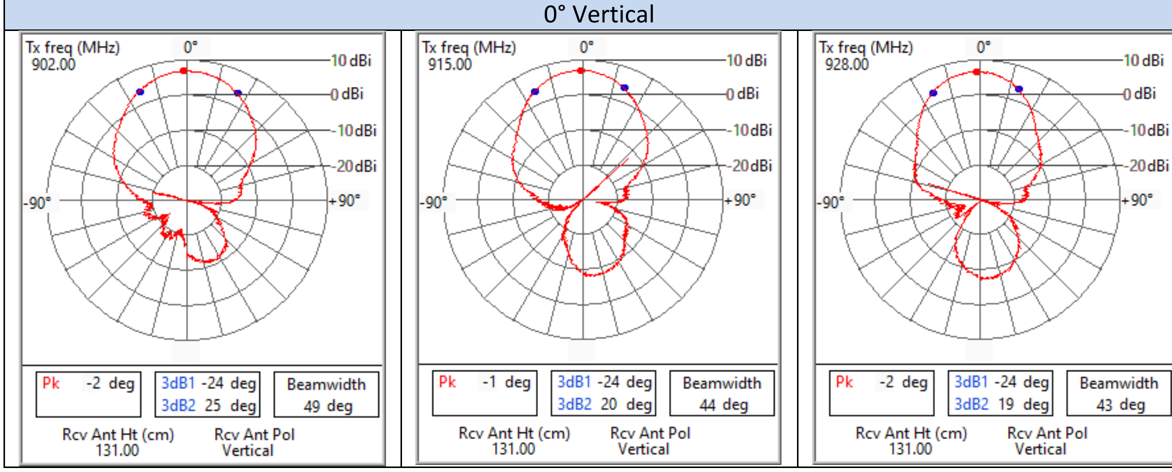
Angle	0°	-10°	-20°	-25°	-30°	-35°	-40°	-45°
Gain dBi Vert	6.60	6.63	7.04	6.26	6.49	6.38	6.56	5.33
Gain dBi Horz	6.62	6.42	6.10	5.61	5.29	4.81	4.96	4.38

Pattern at each angle setting:

0° Horizontal



0° Vertical



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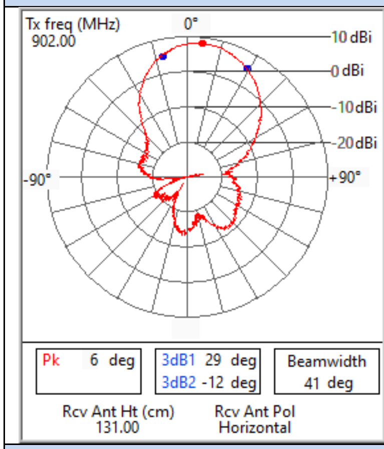
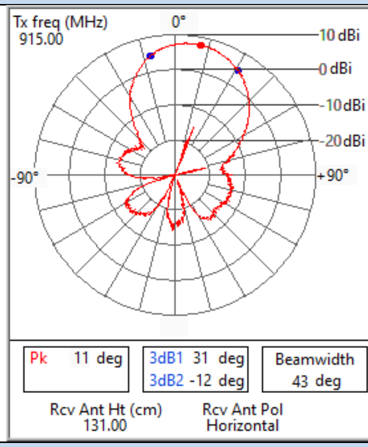
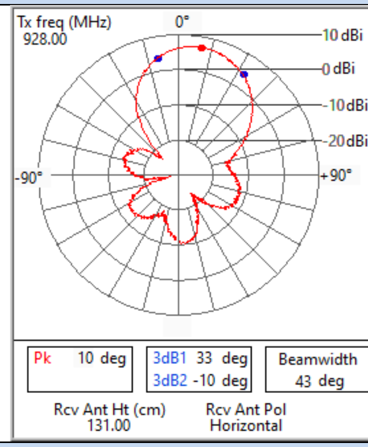
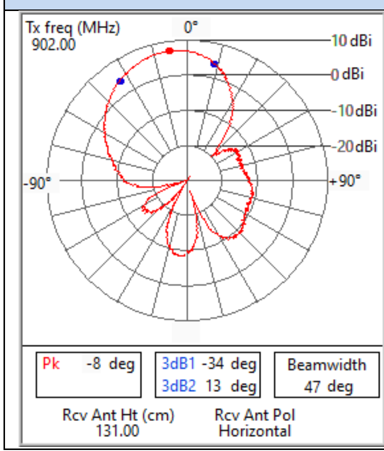
10° Horizontal

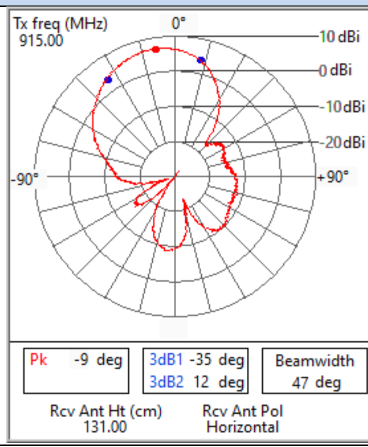


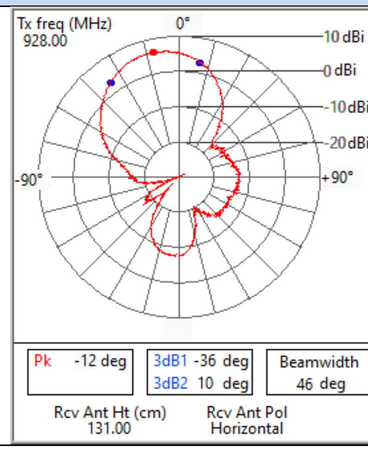




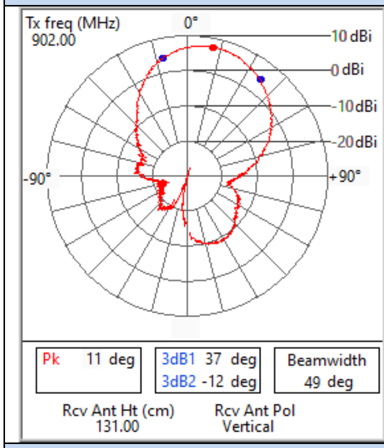
-10° Horizontal

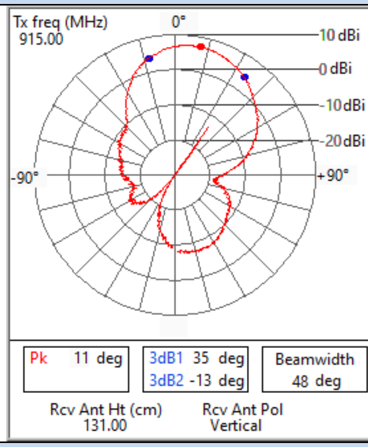


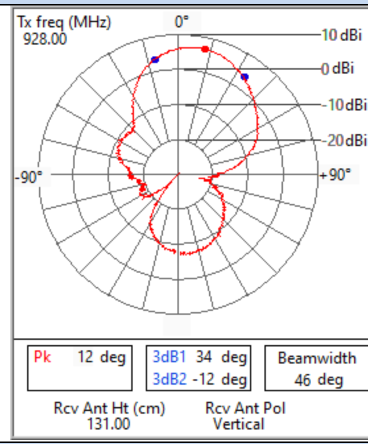




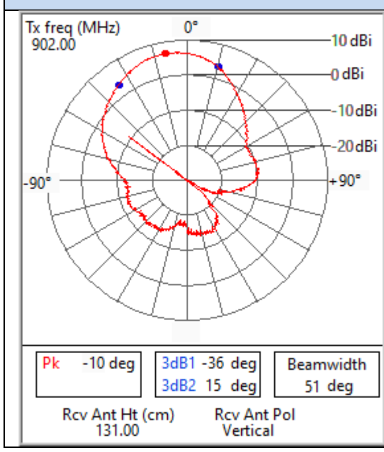
10° Vertical

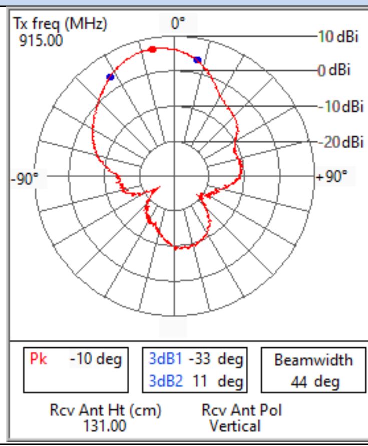


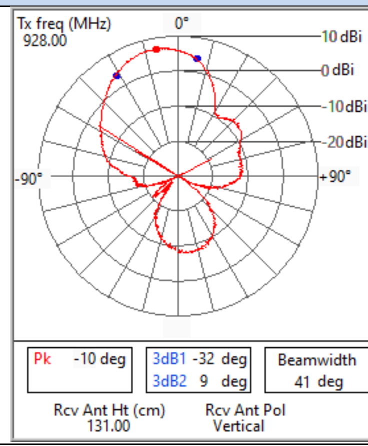




-10° Vertical







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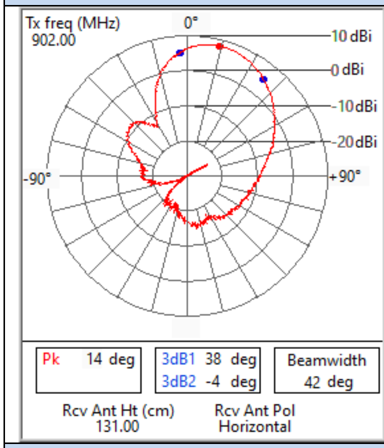
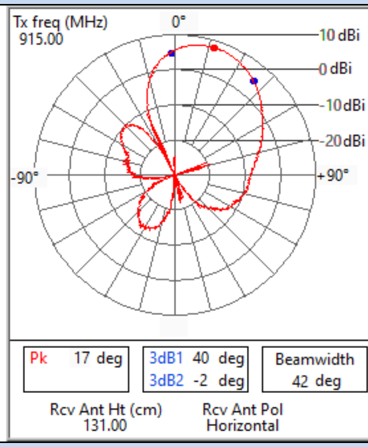
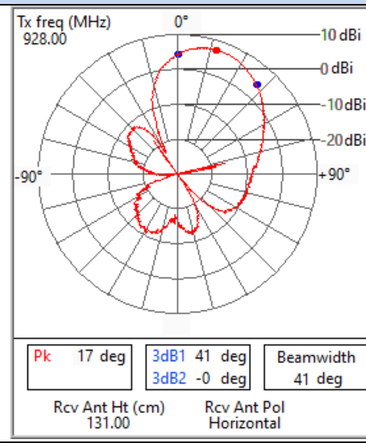
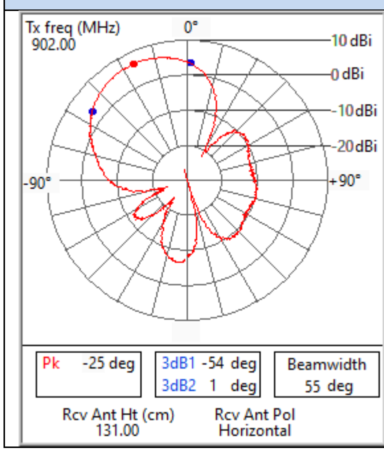
20° Horizontal

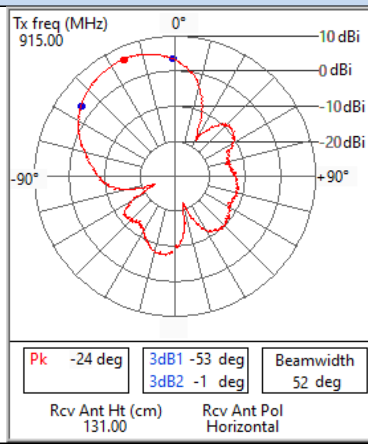


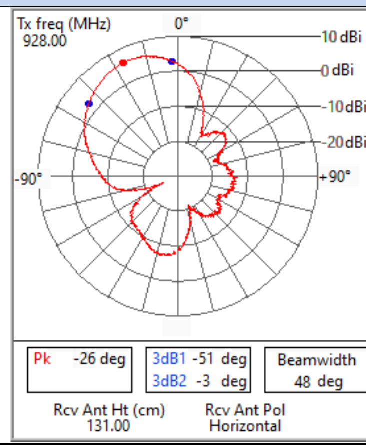




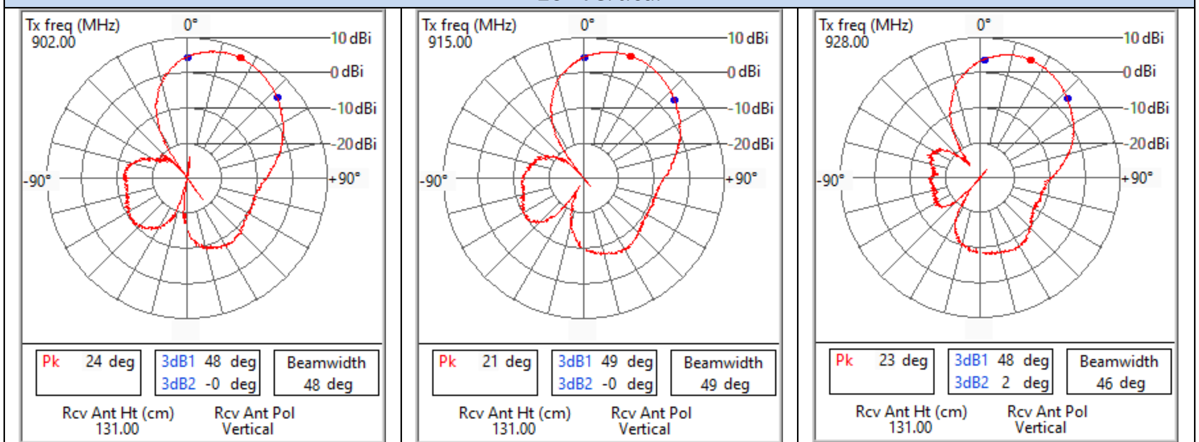
-20° Horizontal



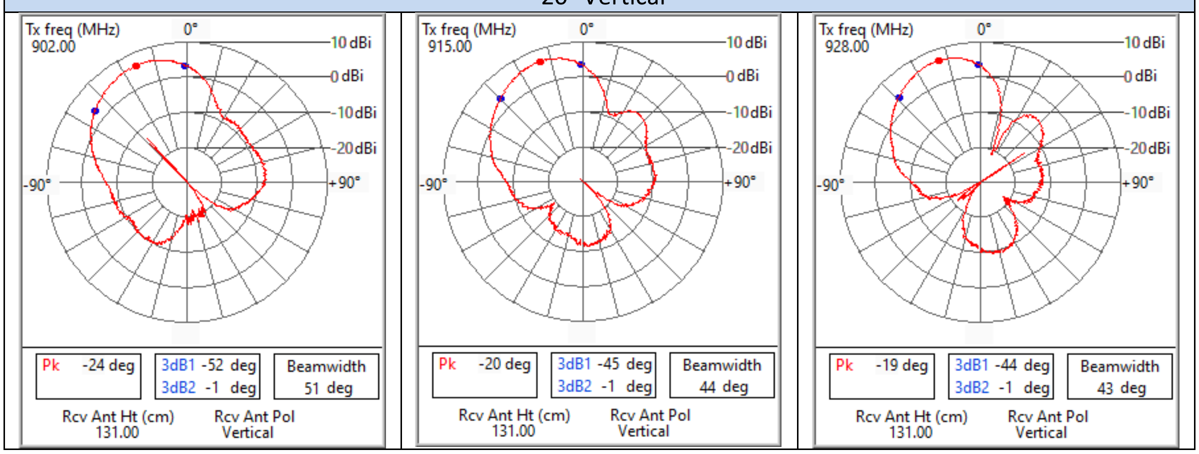




20° Vertical



-20° Vertical



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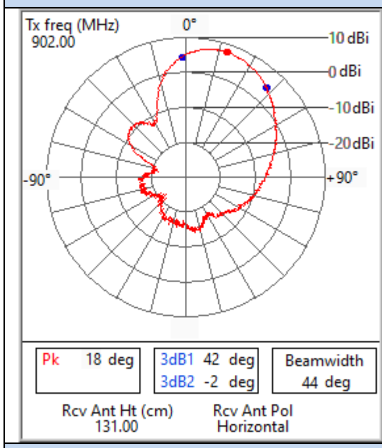

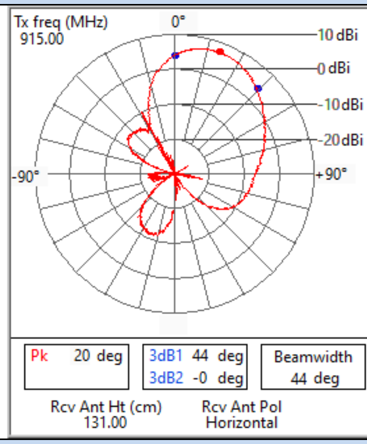

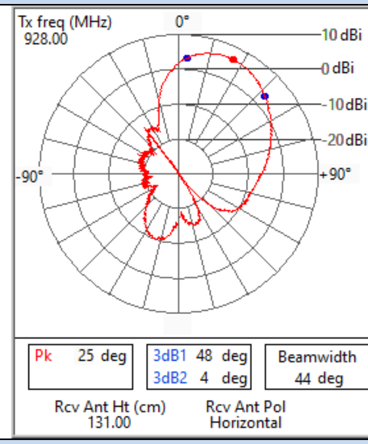

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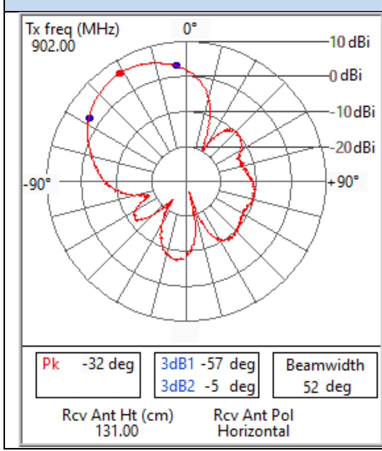

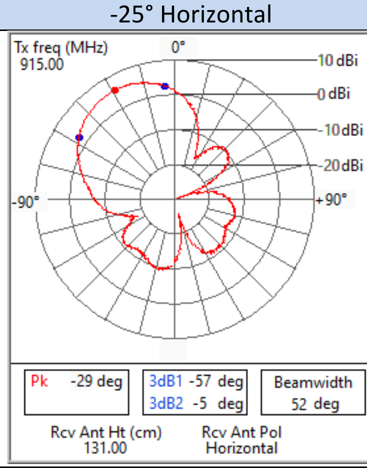

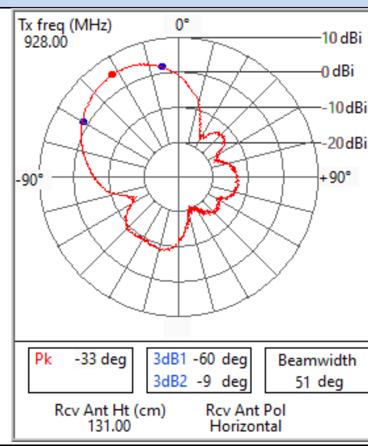

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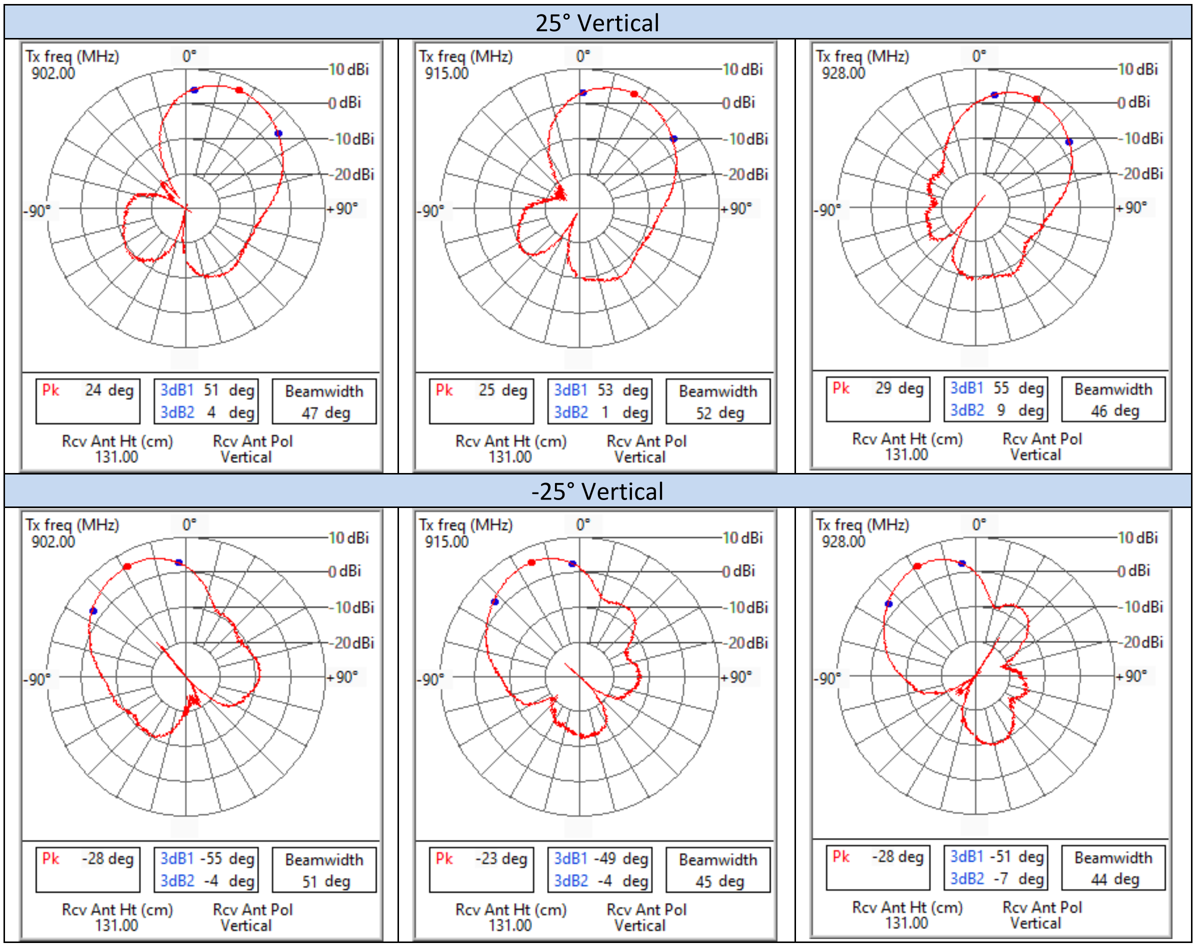

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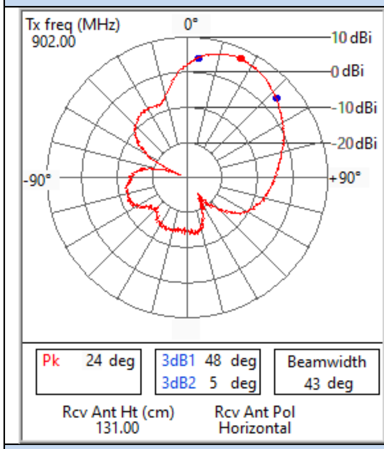

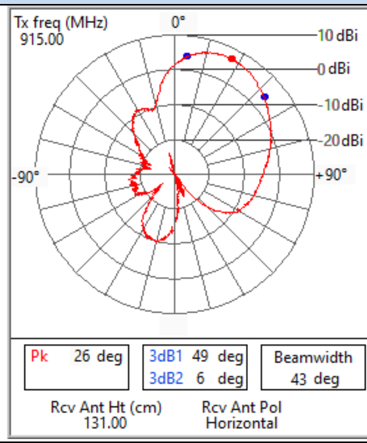

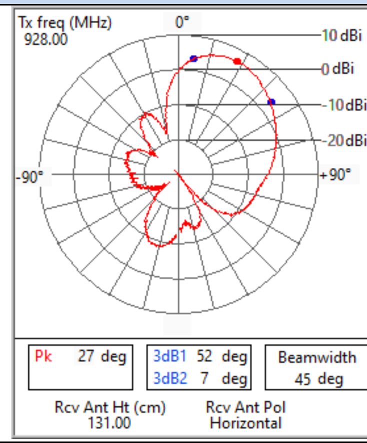

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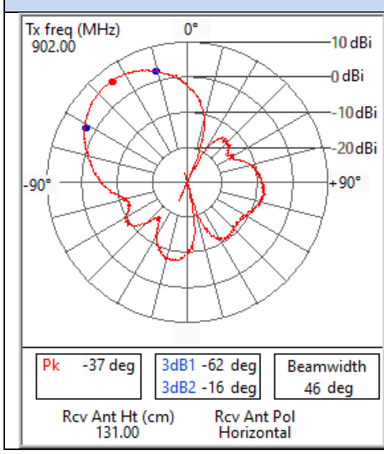

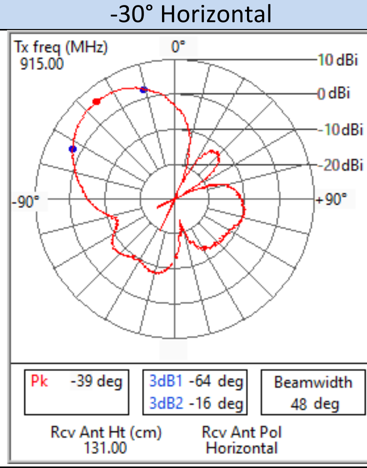

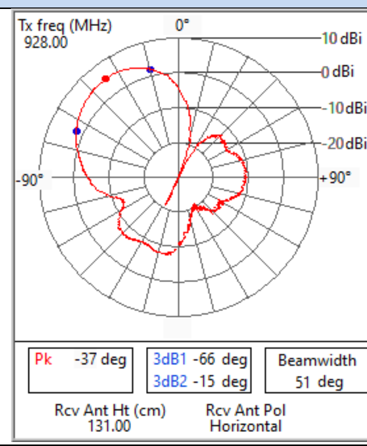

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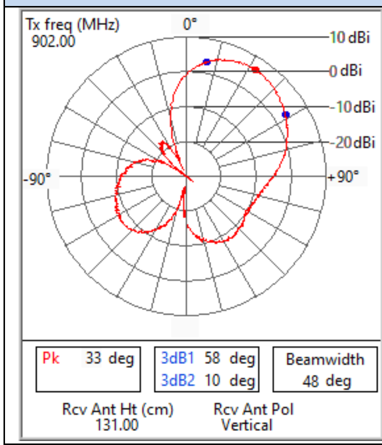

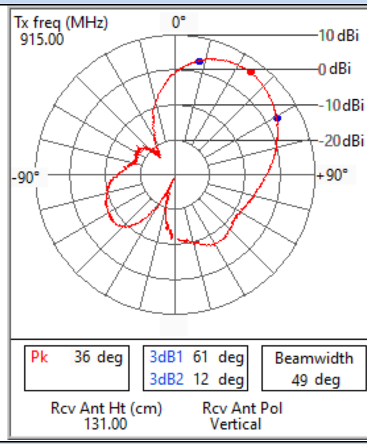

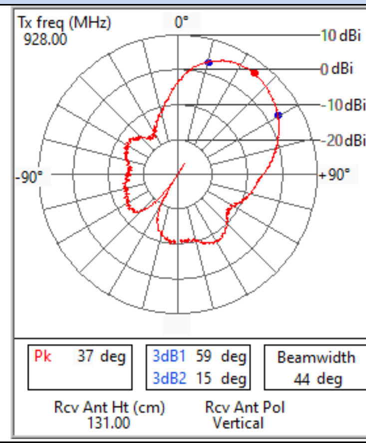

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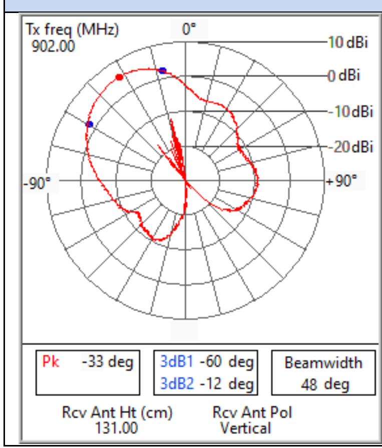

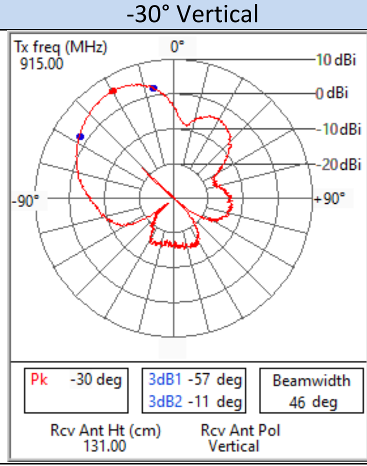

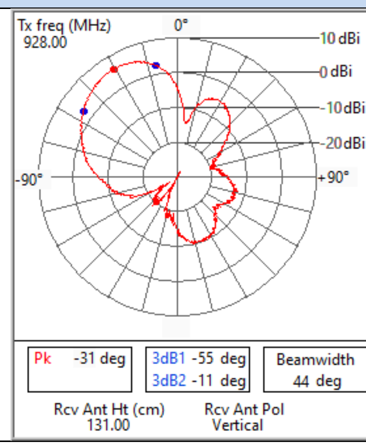

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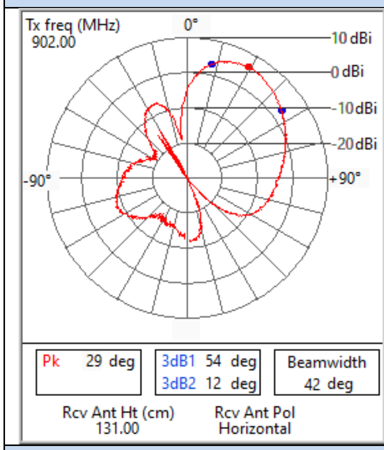

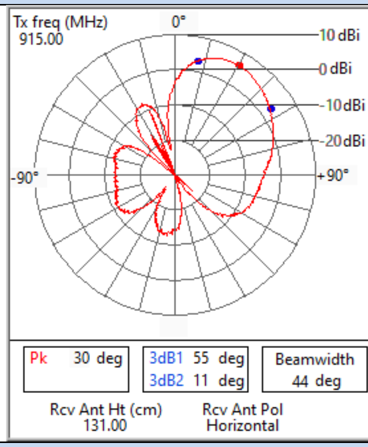

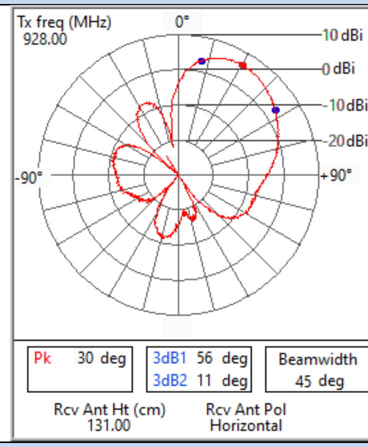

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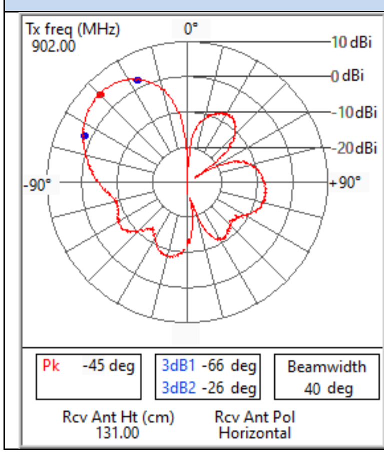

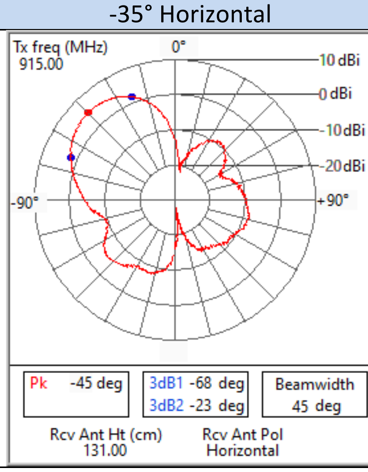

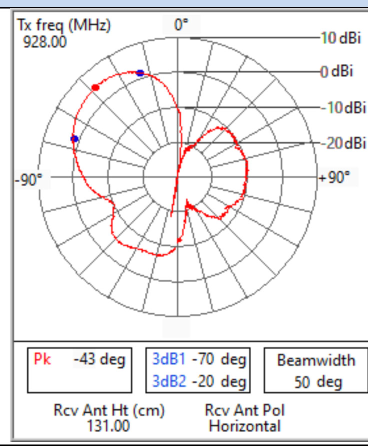

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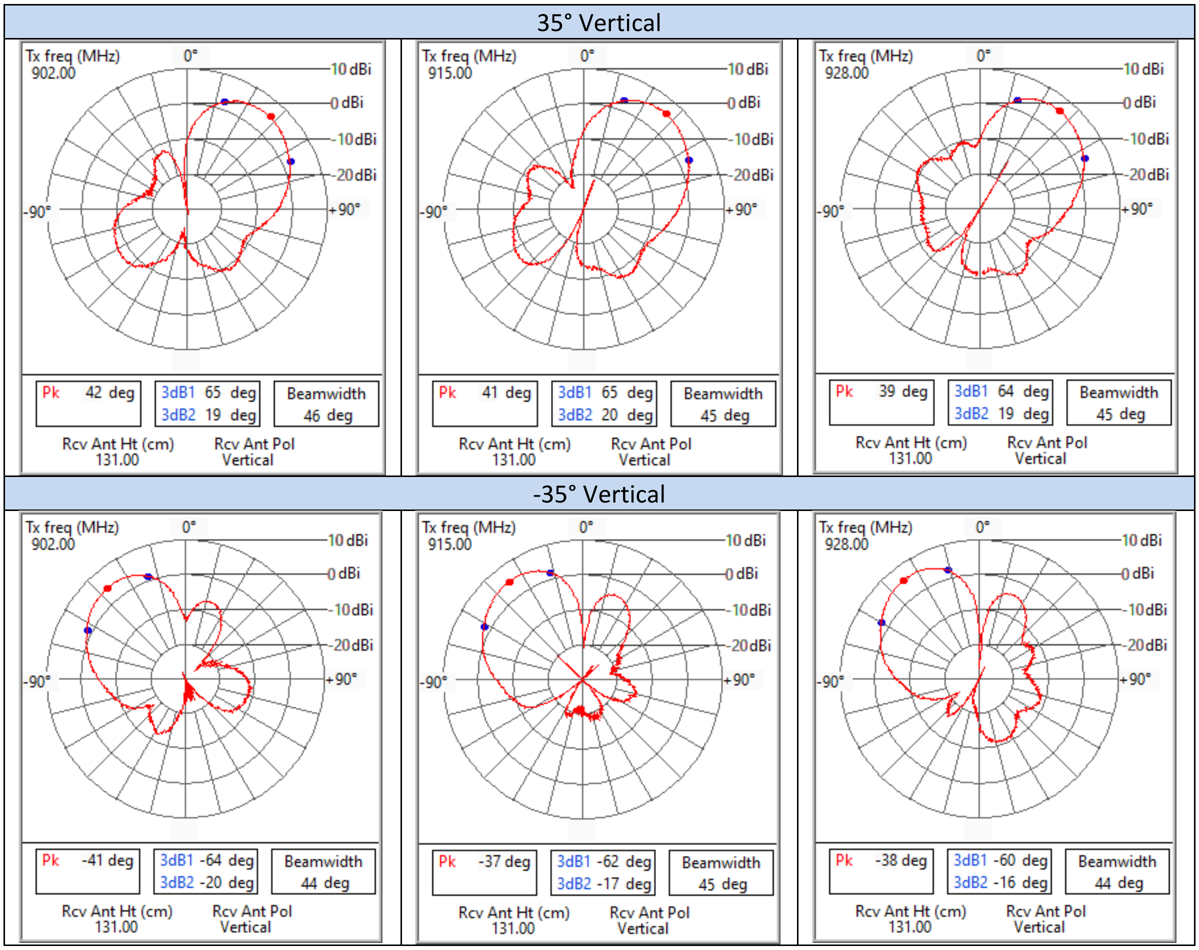

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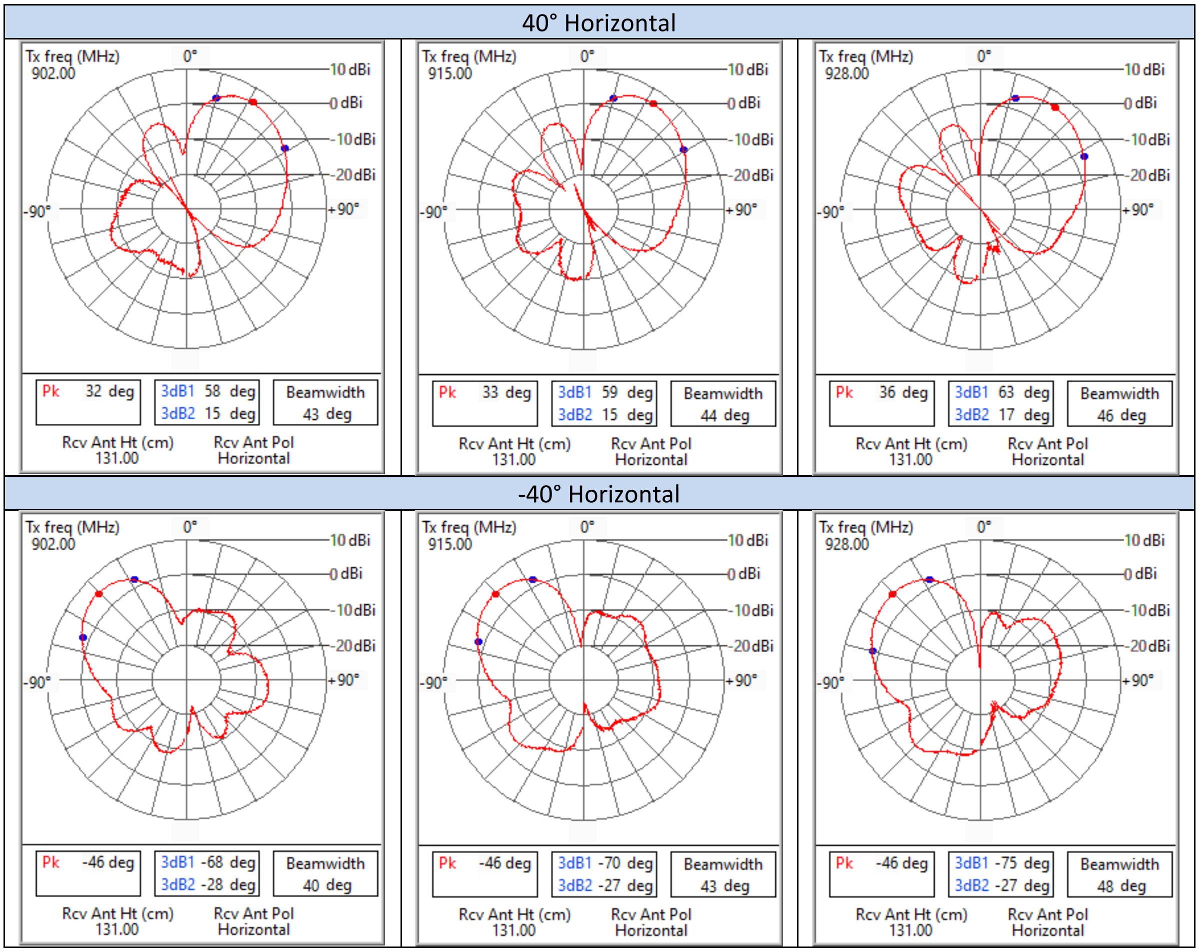
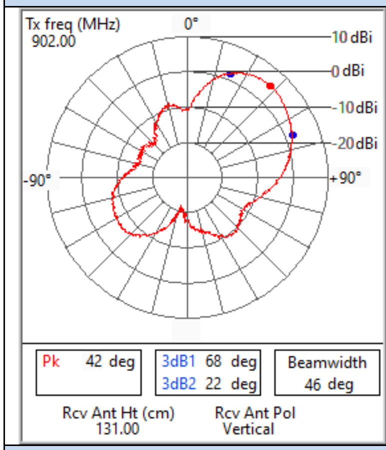
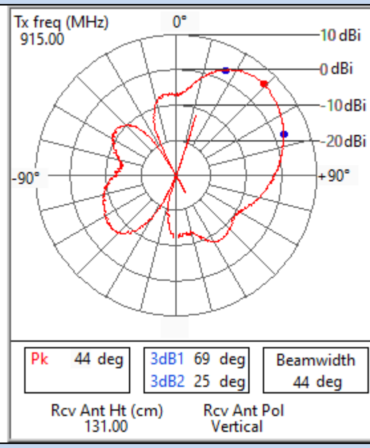
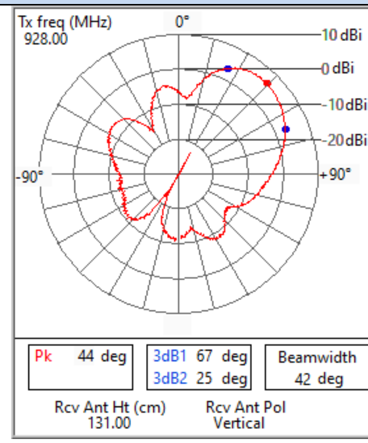


40° Vertical







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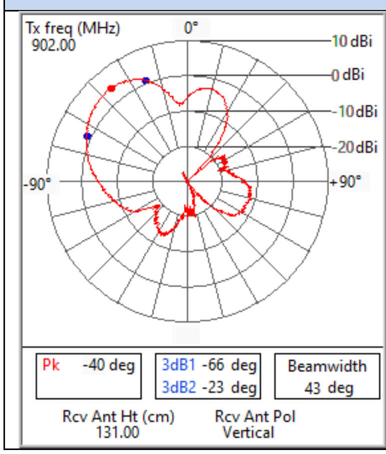
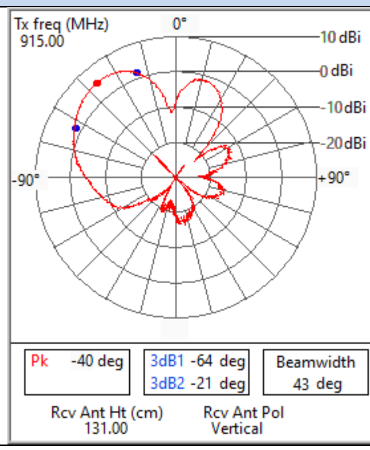
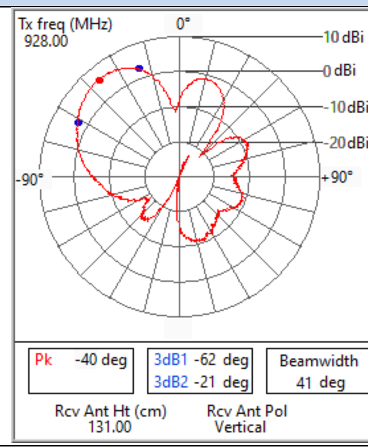
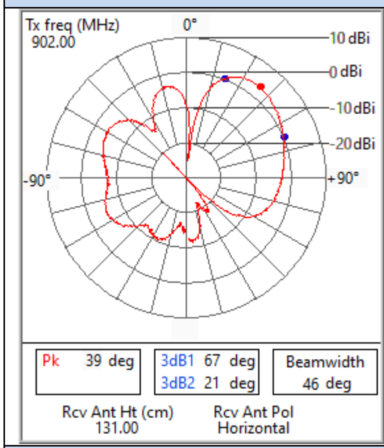
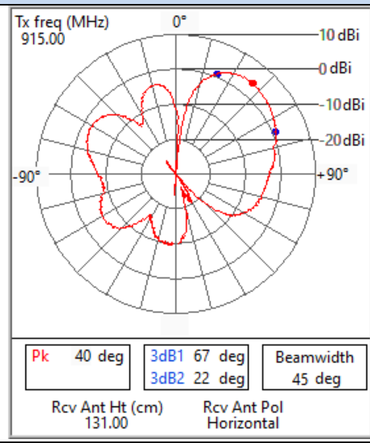


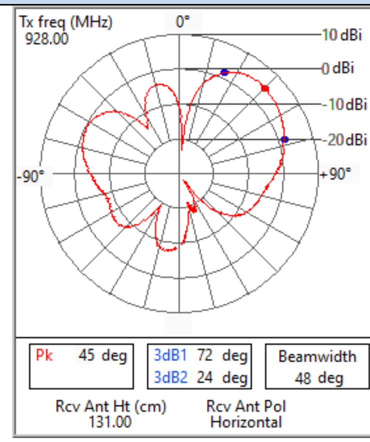




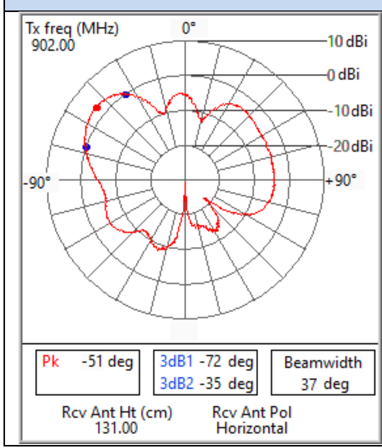
45° Horizontal

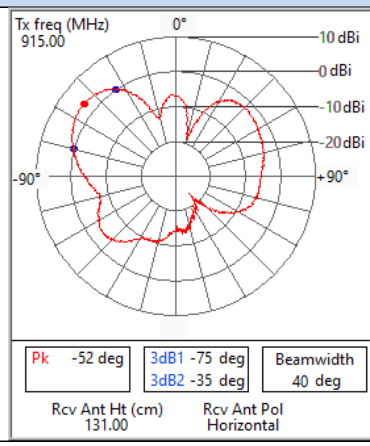


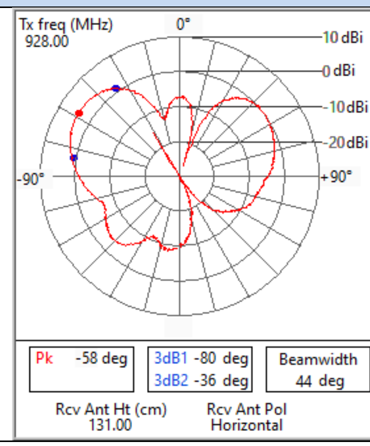




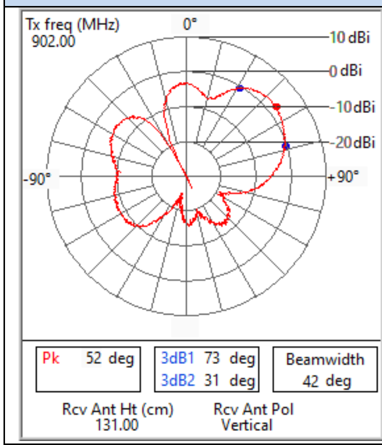
-45° Horizontal

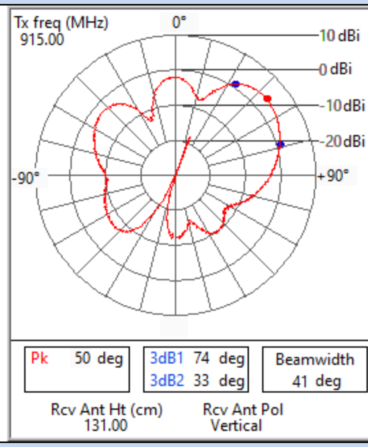


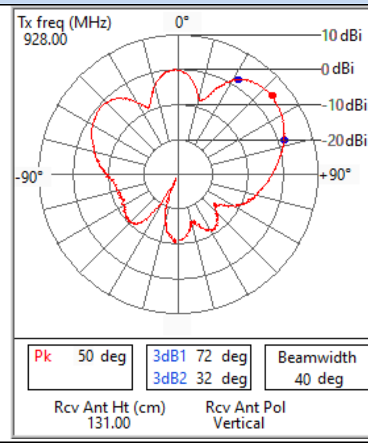




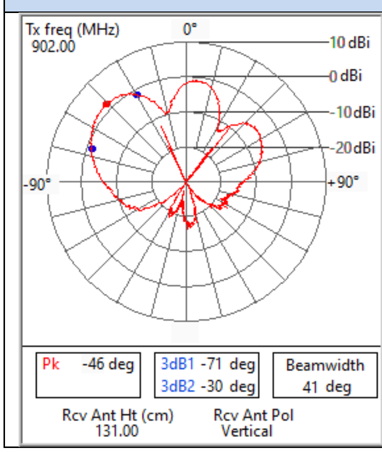
45° Vertical

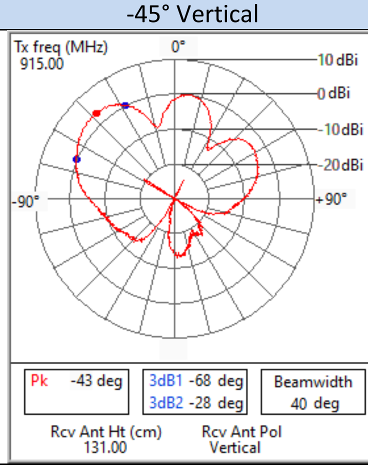


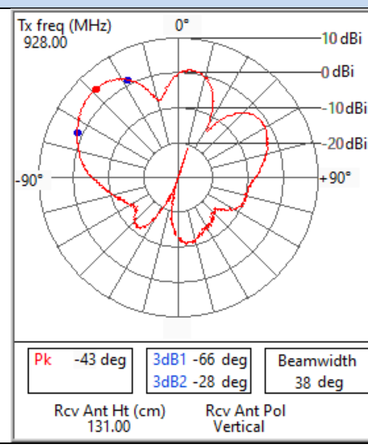




-45° Vertical







5. Test Setup Photos

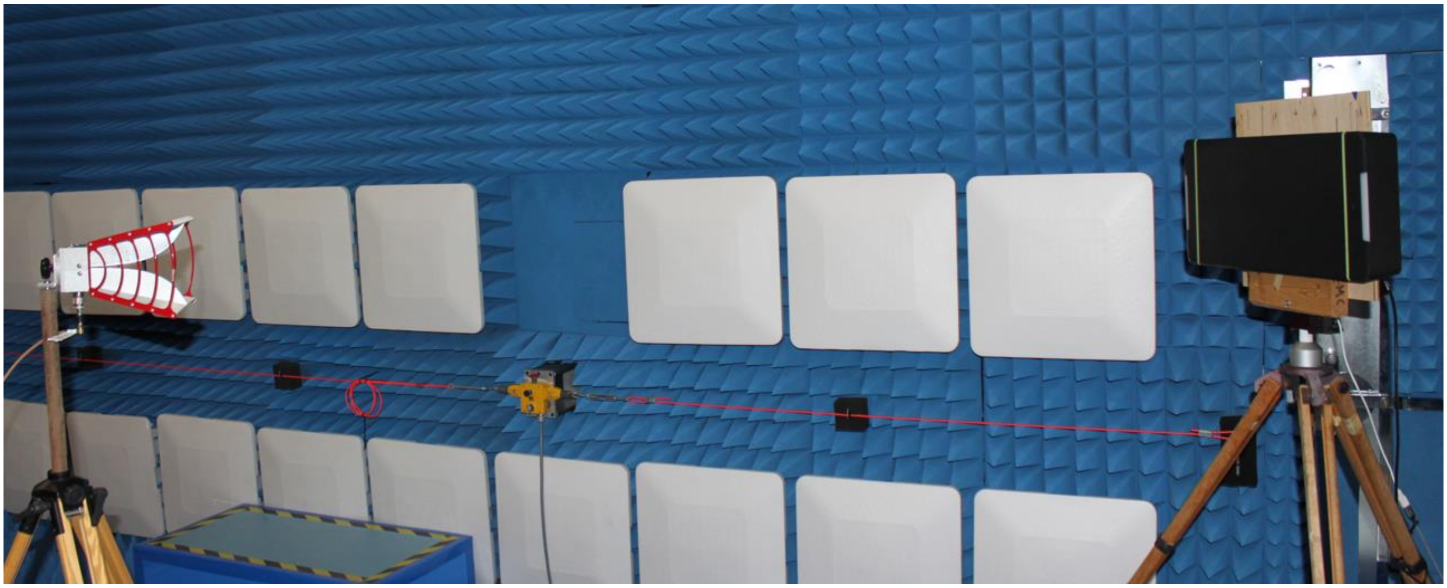


Figure 1. Gain test. Antenna pair (2,1). AUT is on the right

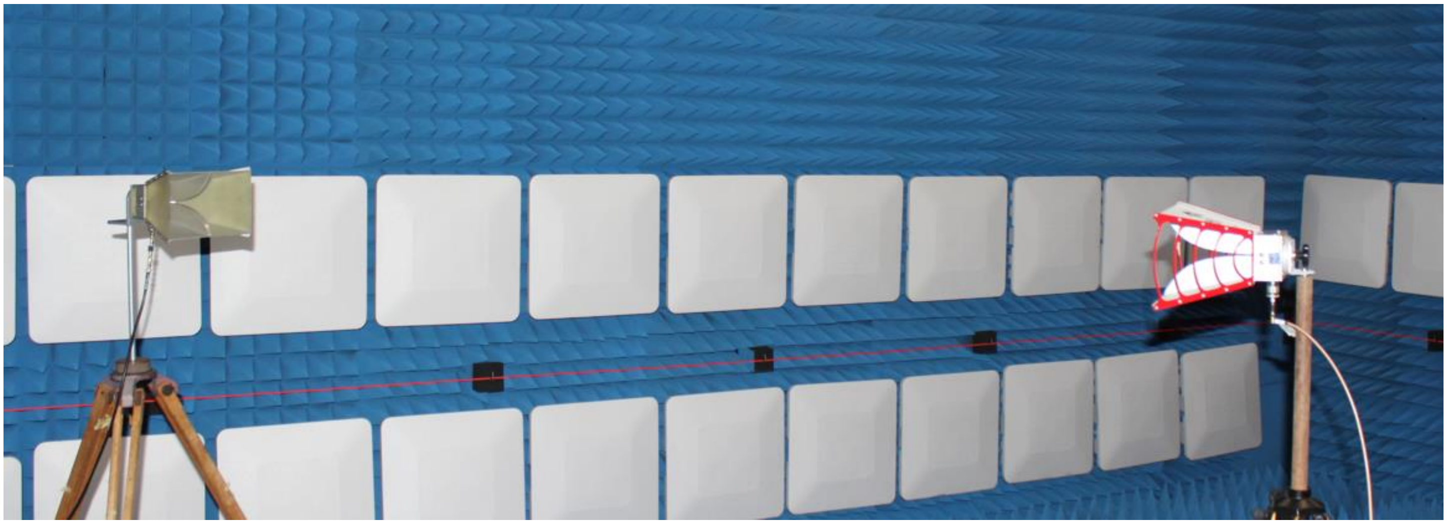


Figure 2. Gain test. Antenna pair (2,3)

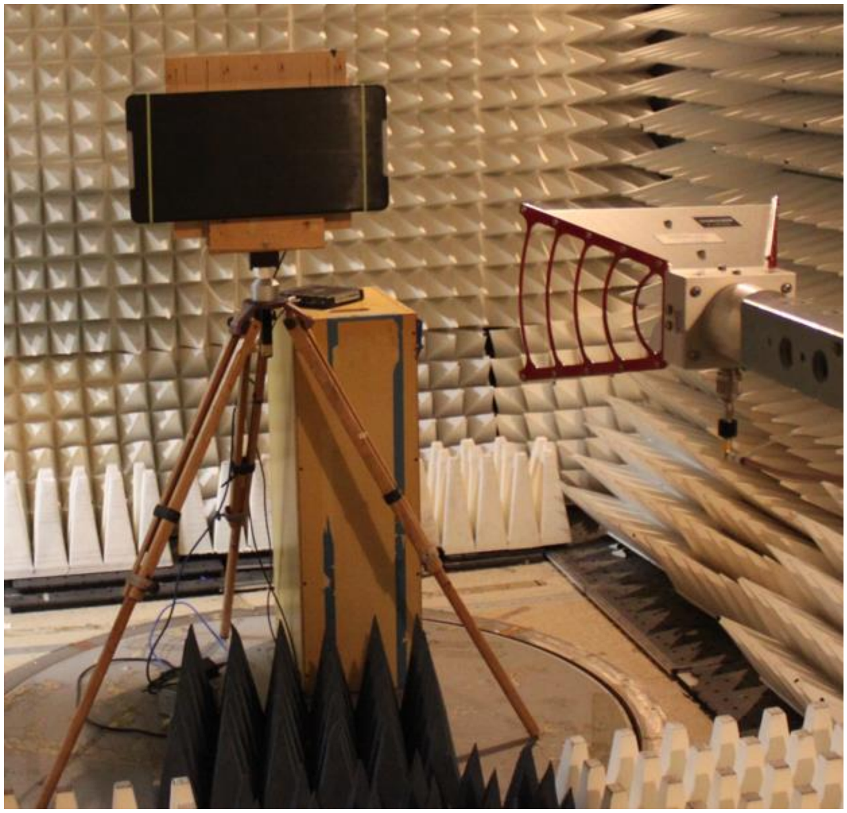


Figure 3. Pattern test

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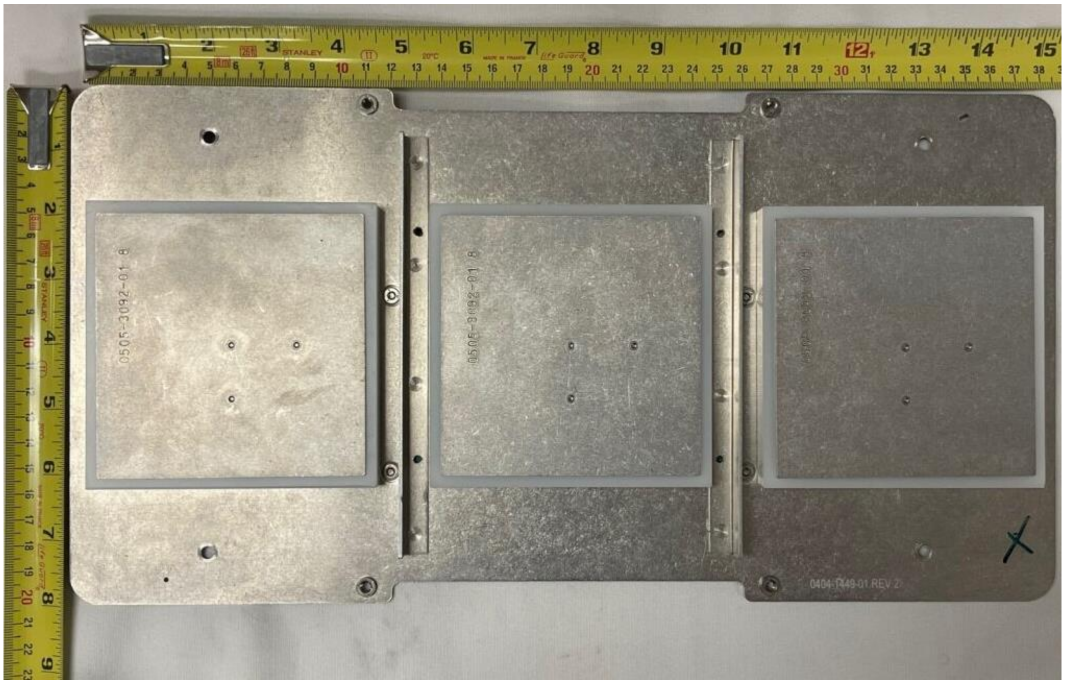
6. Full Electrical Specifications

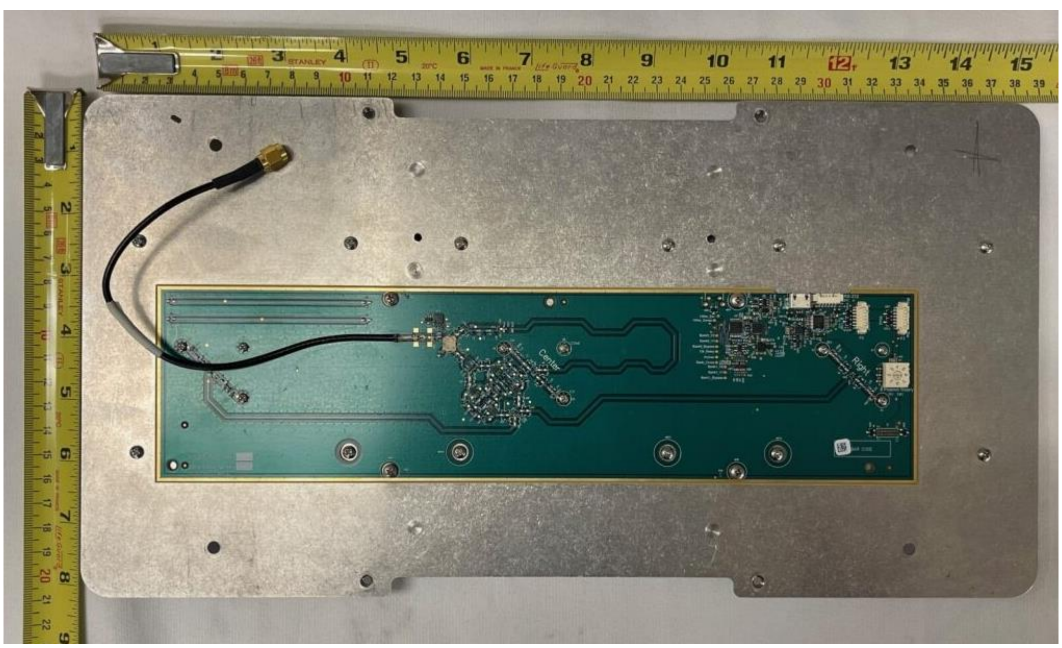
- Antenna Type: Beam forming patch
- Model Number: IDA-3300
- Operating Frequency Range: 902 – 928 MHz
- Impedance: 50 Ω
- Maximum Gain: 7.21 dBi
- Polarization: Linear, Horizontal and Vertical
- Return Loss: Better than 12 dB
- Power Handling Capability: +33 dBm

7. Full Mechanical Specifications

- Physical Dimensions (Length x Width x Height): 15” x 8” x 1”
- Weight: 2.25 lbs.
- Material Construction: Aluminum, HDPE, fiberglass
- Environmental Operating Conditions: -20°C to +50°C
- Connector Type: RP SMA

8. AUT Internal Photos





9. Test Equipment

ISO/IEC 1705-compliant calibrated equipment:

Test Equipment	Manufacturer	Model	Asset #	Cal date	Cal cycle	Next Cal
Vector Network Analyzer	Keysight	E5061B	288	8-19-2025	1 year	8-19-2026

Note: As noted in section 3 above, since the TAM method is used, no prior knowledge of the antennas is needed. They are in fact calibrated, for the frequency range of interest, as part of the gain measurement. Those gain numbers can in turn be used for the pattern measurements.

Test Equipment	Manufacturer	Model	Asset #
Horn Antenna	ETS Lindgren	3115	154
Horn Antenna	EMCO	3115	005
RF cables			
3 dB attenuators	Mini-Circuits	BW-S3W5+	
RF adapters			

10. Revision History

Revision	Revised by:	Revision Date	Sections Affected	Remarks
A	P. Tervakoski	10.30.2025	All	New Document.