Passive Antenna Radiation Pattern Test Report

Prepared in accordance with IEEE std 149

Customer:	Xylem PO Box 30160 College Station, TX 77842	Kimberly Francisco 919-424-8963 Kimberly.Francisco@xylem.com	
EUT Make & Model:	Sensus 525M SmartPoint	Serial #:	GOR2526_071
Date Tested:	05 November 2025		
Testing Location:	Wireless Research Center of NC 3331 Heritage Trade Drive, Suite 101 Wake Forest, NC 27587, USA	Tel: 919-435-1051 Alt: 919-435-1173	
Tested By: Jordan Stearns		Reviewed By: Koichiro Takamizawa	
Jordan Stearns Signature / Date 11/14/2025		Ko Takamizawa Signature / Date 11/14/2025	

A2LA ACCREDITED
Testing Cert #3518.01

Contents

1 Introduction

1.1 Product Description

AUT is an omni-directional PCB antenna, operating from 902.4 to 915.1 MHz within a Sensus 525M SmartPoint.

1.2 Test Description

The antenna test was performed in the Satimo SG-64 chamber at Wireless Research Center of North Carolina according to IEEE Standard 149, "*IEEE Standard Test Procedures for Antennas*", "*WRC 08 SG64 Satimo Passive Testing Procedures*", "*WRC 20 SG64 Passive Gain Cal Procedures".*

1.3 Test Setup and Alignment

The AUT was placed on WRC's Styrofoam mast, using rf transparent foam to raise the unit vertically such that the center (width) of the AUT is in line with the X axis of the WRC antenna test chamber. The RF port was oriented in the chamber's -Z axis.

1.4 Antenna Pattern Measurements

The antenna patterns, peak gain and antenna efficiencies were measured using the Satimo SG-64 chamber which is a multi-probe spherical near-field antenna test chamber. The antenna patterns were measured from 600 MHz to1050 MHz, and 1600 MHz to 2300 MHz in 10 MHz steps as well as the 3 discreet frequencies of 902.4MHz, 908.75MHz, 915.1MHz. The testing was conducted using a Keysight E8257D Signal Generator to generate CW signals of interest and routing the signal through the AUT. The radiated signals are received by one of the 63 probes within the Satimo SG-64's arch that is 1.61 m in radius from the center of the chamber. The received signal's amplitude and phase were recorded using Satimo NPAC receiver. The far-field radiation patterns were calculated mathematically from the measured complex near-field patterns using Near-to-Far Field transform implemented in Satimo's SatEnv software. The peak gains of the radiation patterns were determined using the gain substitution method defined in IEEE 149 using WRC's SH400 horn for frequencies between 400 MHz to 790 MHz, and SH800 horn for frequencies above 800 MHz as the gain references.

1.5 Coordinate Systems

Several coordinate systems are used in the test reports to represent various antenna pattern plots. The DUT antenna was tested, and raw data is stored in theta dominant spherical coordinate system as shown in Figure 1(a) In the theta dominant spherical coordinate system which follows the right-hand rule, theta angle in the vertical planes goes from -180 degrees at -Z axis to 0 degree at +Z axis to + 180 degrees at -Z axis, and phi angle in XY plane goes from 0 degree at +X axis to 180 degree at -X axis.

During the testing, the antenna was oriented in the chamber vertically with the antenna's port aligned with -Z axis of the chamber while the top of the antenna was facing toward +Z axis.

The antenna pattern polar plots presented in Section 2.2.4 show 3 principal axis. The elevation cuts at phi=0 degree and phi=90 degrees show the antenna pattern in XZ plane and YZ plane as indicated in Figure 1(b) and (c). The azimuth cut at theta=90 degree shows the antenna pattern in XY plane as indicated in Figure 1(d).

The contour plots in Section 2.2.4 are a 2D projection of the 3D antenna pattern similar to the equirectangular projection of the world map. The horizontal axis of the contour plots represents phi angle from 0 degree at +X axis to +180 degree at -X axis to +360 degree at +X axis and the vertical axis of the contour plots represent 0 degree at +Z axis to +180 degrees at -Z axis as shown in Figure 1(e). The contour plot with corresponding spherical coordinate points are shown in Figure 1(f). At the +Z (theta=0 degree) and -Z axis (theta=180 degrees) on the spherical coordinate, the phi angle becomes ambiguous, and thus the points on the north pole and south pole of the spherical coordinate maps to lines on the contour plot. The average gain and average cross-pol discrimination plots are generated based on the azimuth and elevation coordinate system as indicated in Figure 1 (g). The azimuth and elevation angles are defined based on compass heading which follows the left-hand rule.

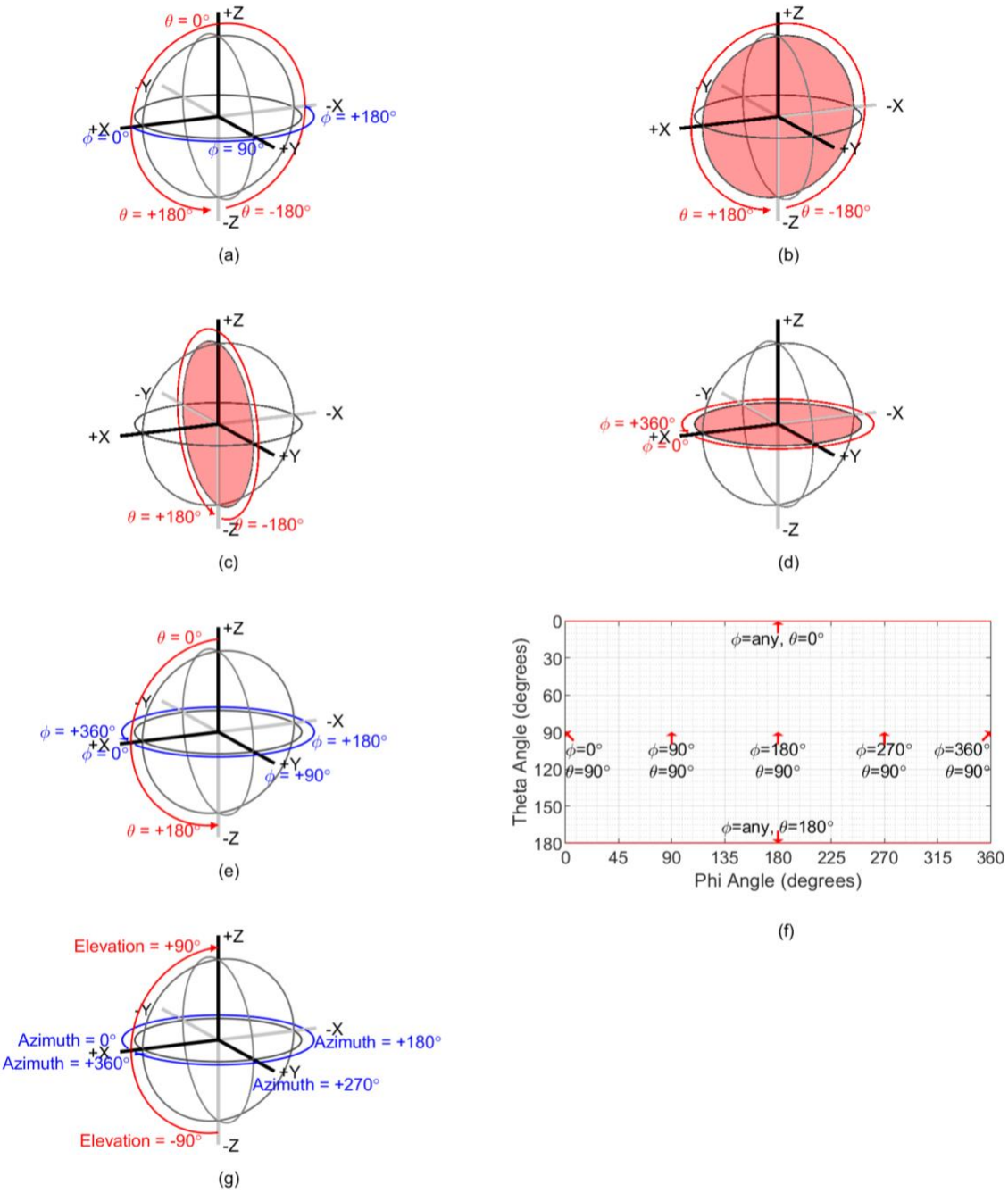


Figure 1. Coordinate systems used in the measurements and the report (a) Theta/Phi spherical coordinate system, (b) phi=0 degree cut (XZ plane), (c) phi=90 degree cut (YZ plane), (d) theta=90 degree cut (XY plane), (e) spherical coordinate projected to a rectangul

1.6 Contact Information

Any questions, comments or concerns relating to the report should be directed to:

Jordan Stearns, Operations Manager
Wireless Research Center of North Carolina
3331 Heritage Trade Drive, Suite 101
Wake Forest, NC 27587, USA
Phone: 919-435-1051

1.7 Testing Facilities

All tests were performed at Wireless Research Center of North Carolina (USA) Inc., in Wake Forest, NC.
All tests were performed, and results recorded by Jordan Stearns on 11/05/2025.

2 Test Results

2.1 Summary Tables

2.1.1 Measured Gain and Efficiency

Frequency (MHz)	Peak Gain (dBi)	Efficiency (dB)	Efficiency (%)
902.4	-0.22	-2.54	55.7
908.75	-0.21	-2.51	56.0
915.1	-0.16	-2.51	56.1

2.1.2 Measured Return Loss and VSWR

Frequency (MHz)	Return Loss (dB)	VSWR
902.4	9.61	1.99
908.75	9.62	1.99
915.1	9.96	1.93

2.2 Plots of Measured Results

2.2.1 Measured peak gain

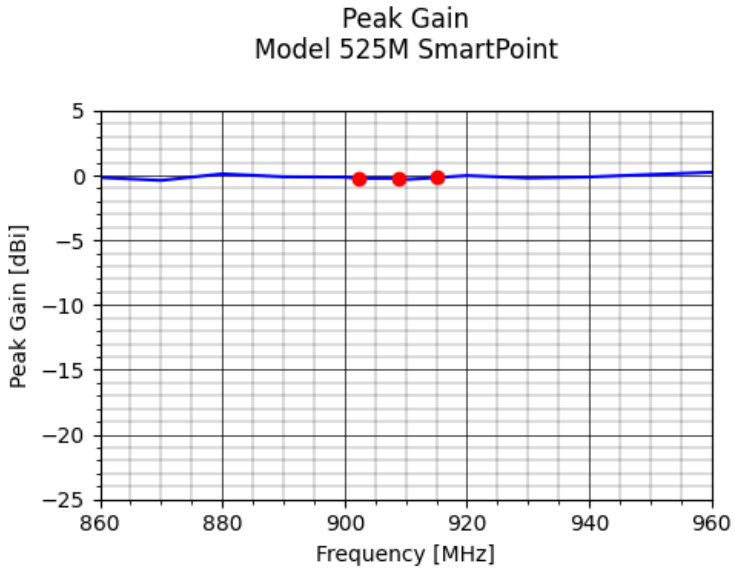


Figure 2 Peak Gain of Model 525M SmartPoint.

2.2.2 Measured radiation efficiency

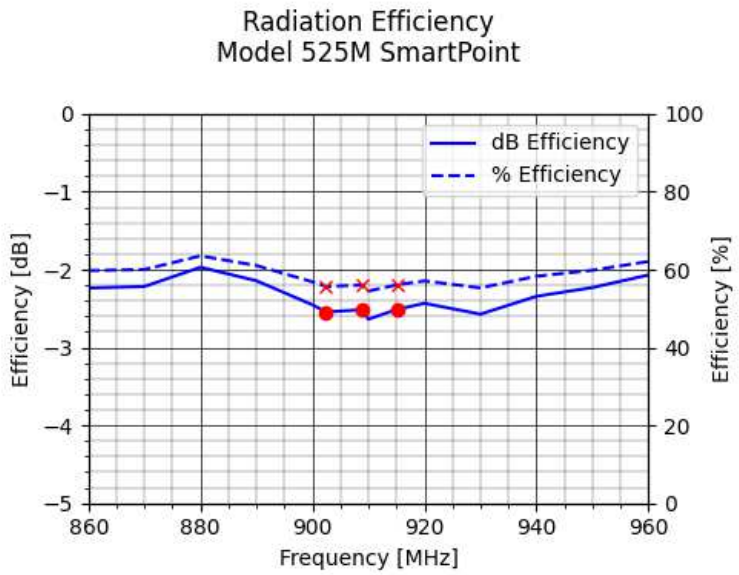


Figure 3 Radiation efficiency of Model 525M SmartPoint.

2.2.3 Measured return loss plot

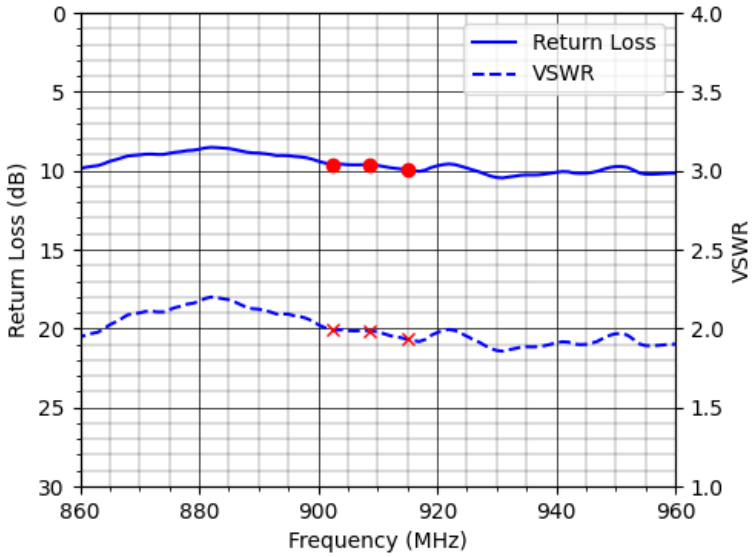
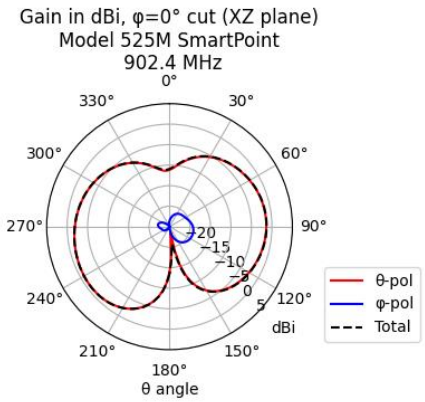
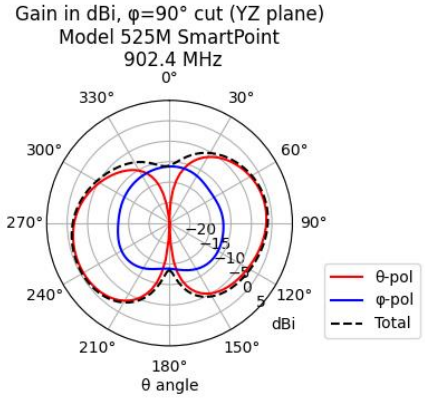


Figure 4 Return Loss of Model 525M SmartPoint.

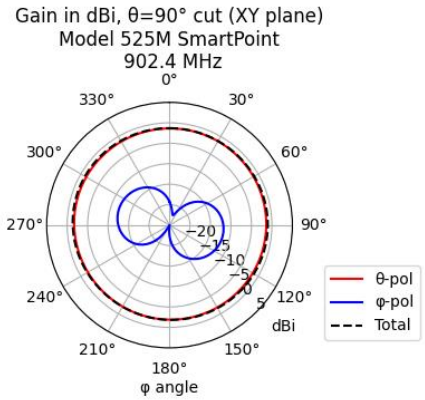
2.2.4 Measured patterns



(a) Phi=0 degree cut (XZ-plane).

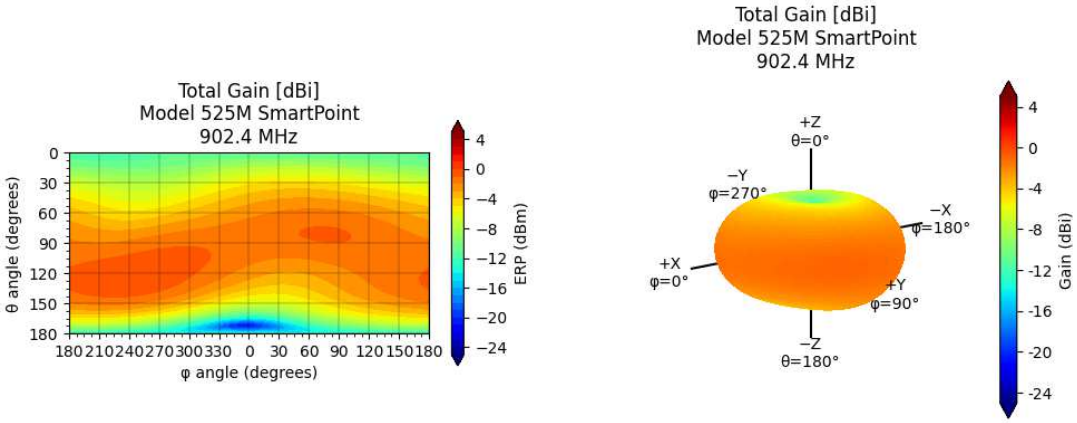


(b) Phi=90 degree cut (YZ-plane).

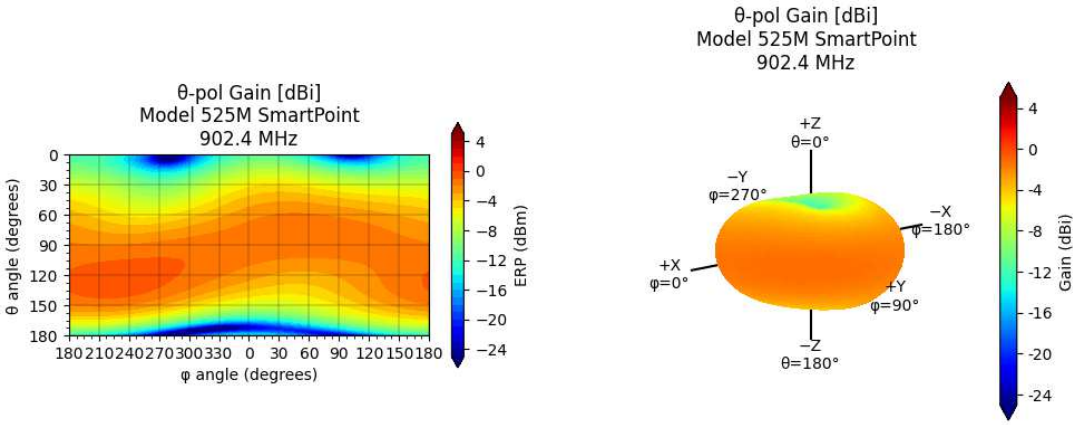


(c) Theta=90 degree cut (XY-plane).

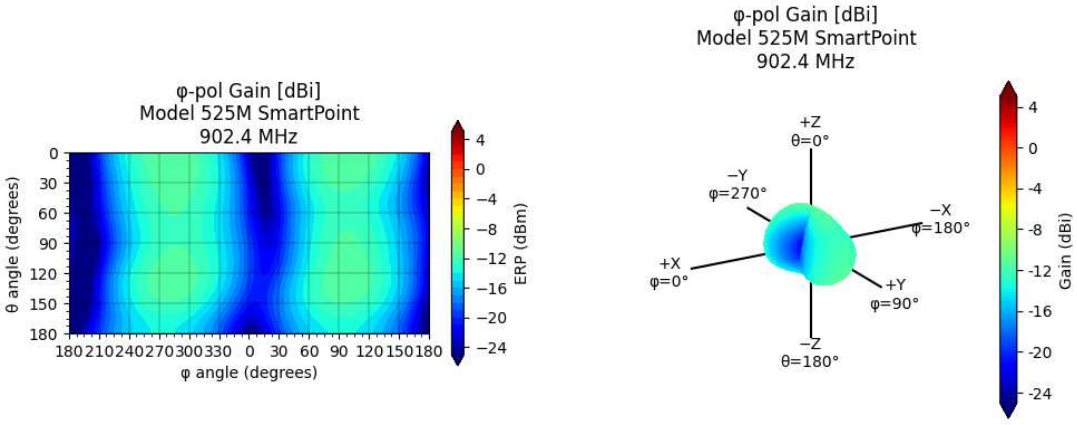
Figure 5 Gain pattern cuts of Model 525M SmartPoint 20251105 at 902.4 MHz.



(a) Total gain contour and 3d plots.

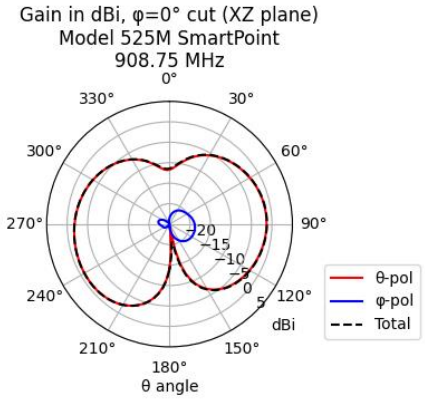


(b) Theta-pol gain contour and 3d plots.

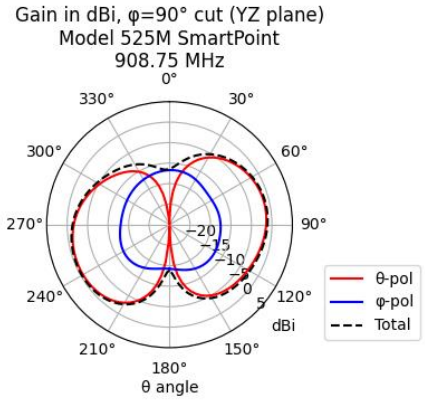


(c) Phi-pol gain contour and 3d plots.

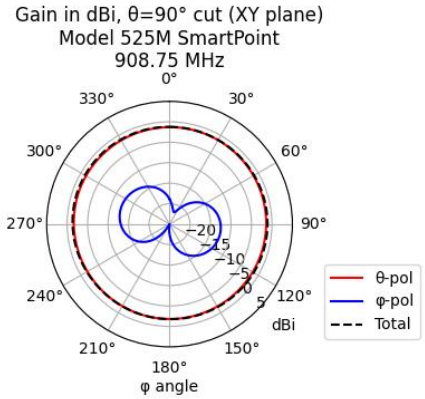
Figure 6 Gain contour and 3d patterns of Model 525M SmartPoint 20251105 at 902.4 MHz.



(a) Phi=0 degree cut (XZ-plane).

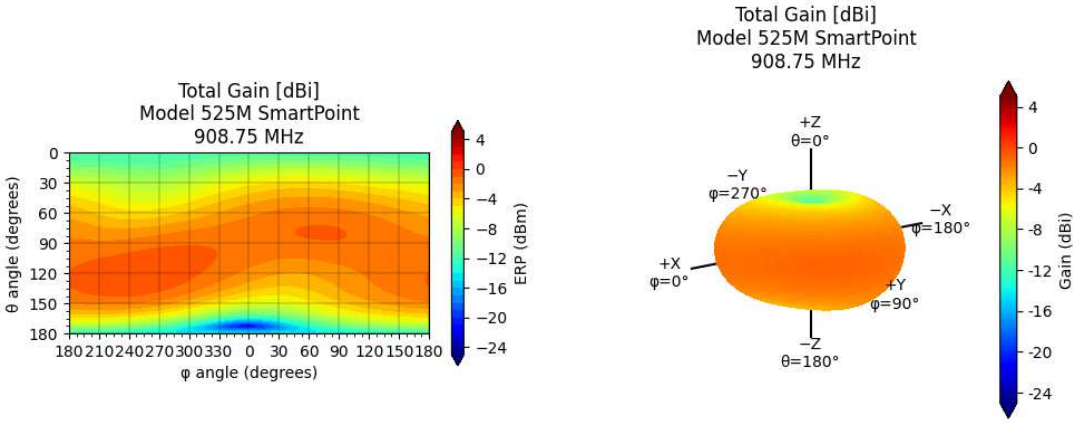


(b) Phi=90 degree cut (YZ-plane).

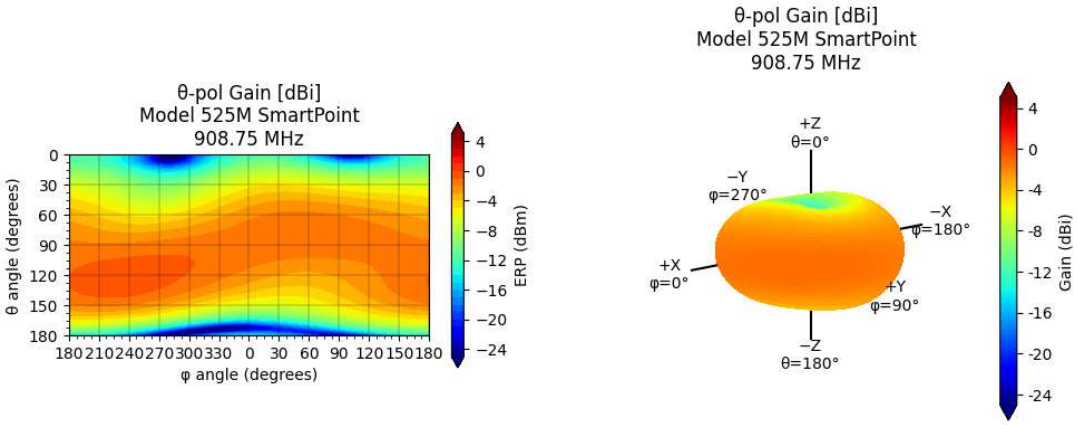


(c) Theta=90 degree cut (XY-plane).

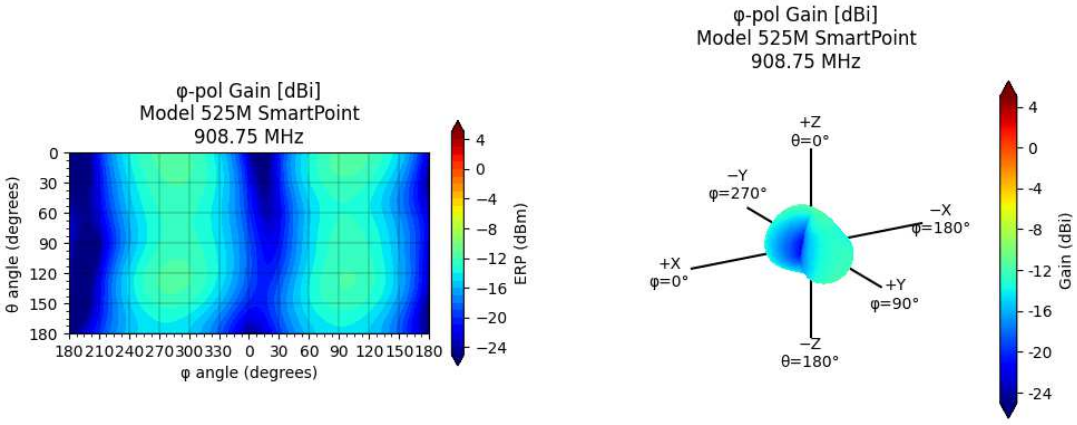
Figure 7 Gain pattern cuts of Model 525M SmartPoint 20251105 at 908.75 MHz.



(a) Total gain contour and 3d plots.

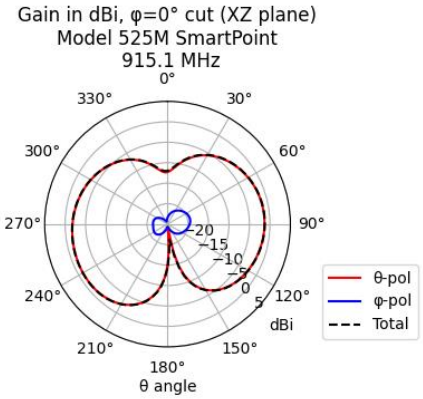


(b) Theta-pol gain contour and 3d plots.

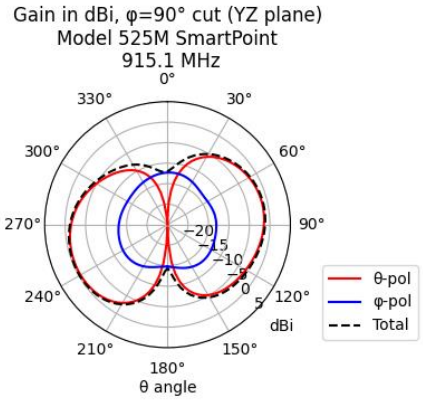


(c) Phi-pol gain contour and 3d plots.

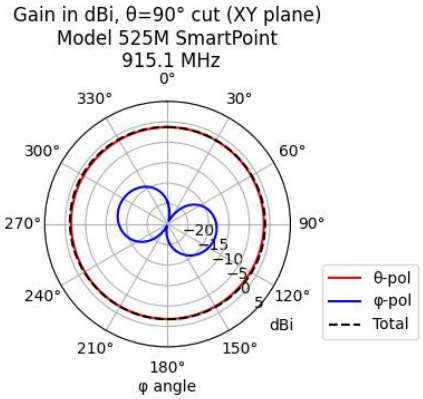
Figure 8 Gain contour and 3d patterns of Model 525M SmartPoint 20251105 at 908.75 MHz.



(a) Phi=0 degree cut (XZ-plane).

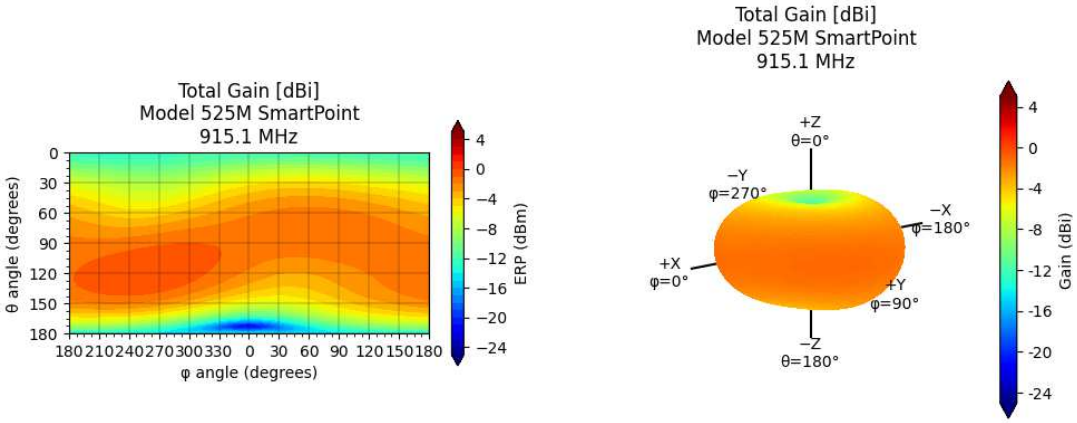


(b) Phi=90 degree cut (YZ-plane).

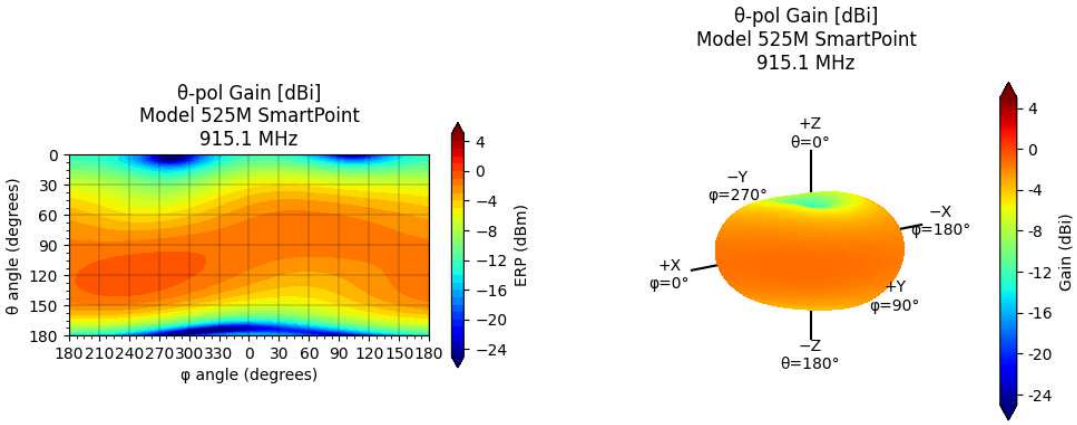


(c) Theta=90 degree cut (XY-plane).

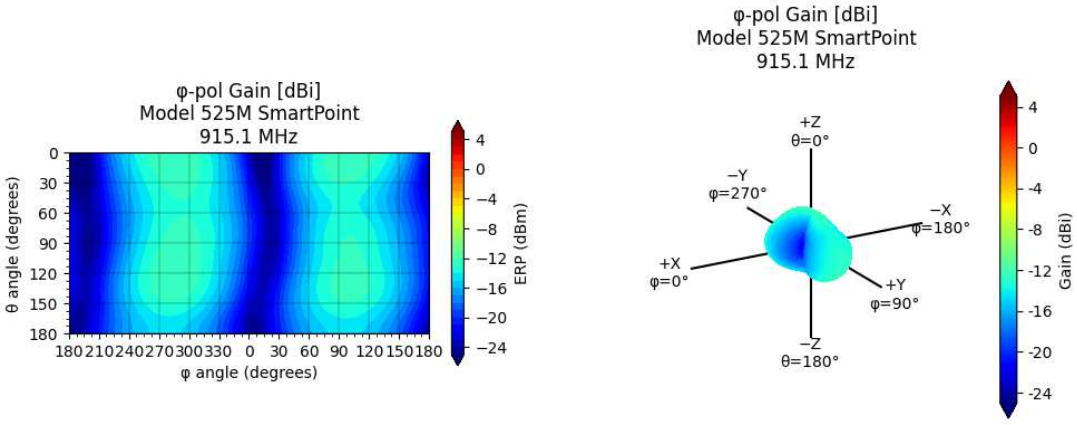
Figure 9 Gain pattern cuts of Model 525M SmartPoint 20251105 at 915.1 MHz.



(a) Total gain contour and 3d plots.



(b) Theta-pol gain contour and 3d plots.



(c) Phi-pol gain contour and 3d plots.

Figure 10 Gain contour and 3d patterns of Model 525M SmartPoint 20251105 at 908.75 MHz

3 Raw Data

Raw data is provided in the following file formats.

{AUT}-F{XXXX}.txt	Full 3D pattern data at a single frequency: {XXXX} MHz
{AUT}-phi=0.txt	2D cut data at ϕ=0°, all frequencies
{AUT}-phi=90.txt	2D cut data at ϕ=90°, all frequencies
{AUT}-theta=90.txt	2D cut data at θ=90°, all frequencies
{AUT}-efficiency.txt	Efficiency, all frequencies
{AUT}-gain.txt	Peak Gain, all frequencie

4 Test Setup and Equipment

4.1 Test Set-up Photos

4.1.1 Antennas

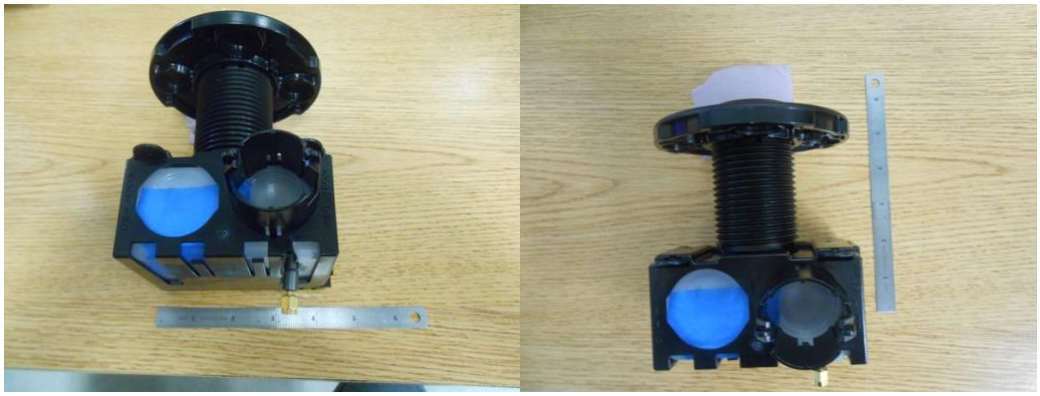


Figure 11 AUT

4.1.2 DUT antenna facing -Y Axis

Figure 12 DUT Antenna in SG-64 facing -Y axis

4.1.3 DUT antenna facing X axis

Figure 13 DUT Antenna in SG-64 facing -X axis

4.2 Chamber Equipment

Figure 14 WRC workstation

Figure 15 SG-64 chamber equipment

4.3 Test Equipment

Equipment Type	Model Number	Manufacturer	Serial Number	Calibration Due Date
Antenna Test Chamber	SG-64	MVG	ATL0169S	04/11/2026
Signal Generator	E8257D	Keysight	MY51110555	12/05/2025
Signal Generator	E8257D	Keysight	MY51110603	12/22/2025
Torque Wrench	74 Z-0-0-21/Ncm100	Huber-Suhner	19298	06/30/2026
Dual Ridge Horn	SH-400	MVG	114	Calibrated on 05/07/2012. Validated by Satimo on 1/13/2020. No Expiration Date
Dual Ridge Horn	SH-800	MVG	253	Calibrated on 5/14/2012. Validated by Satimo on 1/13/2020. No Expiration Date

4.4 Gain Measurement Uncertainty

Frequency Range	Measurement Uncertainty
400 MHz to 800 MHz	± 1.25 dB
800 MHz to 1000 MHz	± 1.01 dB
1000 MHz to 6000 MHz	± 0.66 dB

Progress | RightSignature

SIGNATURE CERTIFICATE

REFERENCE NUMBER
BB6A28D2-7FCD-4D18-B91F-11CE5CE3CB66

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	Signature Reference ID 3C3B0061	
Name Jordan Stearns	**Status** signed	**Viewed At** 11/14/2025 14:41:53 EST
Email jordan.stearns@wrc-nc.org	**Multi-factor Digital Fingerprint Checksum** 4f53cda18c2baa0c0354bb5f9a3ecbe5ed12ab4d8e11ba873c2f11161202b945	**Identity Authenticated At** 11/14/2025 14:43:03 EST
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11/14/2025 14:43:04 EST	Ko Takamizawa (ko.takamizawa@wrc-nc.org) was emailed a link to sign.

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