RayVerse® 2700/3700

Phased Array Antenna Rapid Calibration and Testing System

PRODUCT BROCHURE

INTRODUCTION

During the development and production of phased array antennas, it is necessary to perform amplitude and phase calibration, as well as testing of the multi-beam patterns. For the most common planar near-field testing, amplitudes and phase calibration require individually calibrating each element in a precision two-dimensional plane, resulting in slow speed.

Additionally, because the scan range cannot exceed 45°, and the probe's cross-polarization will rapidly degrade at large angles, it is challenging to meet the capabilities and accuracy requirements for phased array far-beam testing.

Moreover, the geometrically increasing number of multi-beam patterns for phased array testing also poses a significant challenge.

- Microsecond–level timing control, and calibration efficiency improved by 10 times
- Wide scanning range, high cross–polarization performance
- High testing accuracy, comprehensive testing capabilities
- Fast testing speed, single–point sampling time only 1 - 2 ms
- Convenient installation, no need for precise alignment
- Cutting-edge corrugated horn antenna with wide–angle and low cross–polarization
- Multi–frequency, multi–channel, multi-beam rapid testing

We have innovated a rapid system for phased array calibration and testing; this all-in-one system combines the advantages of compact range and spherical near-field systems, compensating for the shortcomings of planar near-field systems. Its compact range structure enables plane wave radiation, eliminating the need for slow mechanical scanning in amplitude and phase calibration. The microsecond-level channel switching boosts calibration efficiency by more than 10 times.

Figure 1: RayVerse 2700

On the other hand, its spherical scanning system overcomes the limited scanning range and worse cross-polarization of planar scanning systems, enabling high-precision testing of any type of phased array antennas. Additionally, we have invented a multi-beam rapid testing solution, thoroughly addressing the calibration, speed, and accuracy issues of phased array antennas.

Figure 2: RayVerse 10KP Cross-Sectional Diagram

PRODUCT FEATURES

We introduce an advanced and innovative solution (patented technology). By combining the strengths of a compact range and spherical near-field, it conquers the challenges in phased array antenna installation, calibration, and testing.

This solution leverages the benefits of a compact range to improve calibration speed and utilizes spherical near-field technology to address test accuracy and far-beam issues.

Moreover, with the phased-array multi-beam testing method, this solution significantly enhances testing efficiency and effectively resolves challenges across all stages of phased array calibration and testing.

FAST CALIBRATION SPEED

With the compact range method, it enhances calibration speed in the following two aspects.

Electrical Scanning Replacing Mechanical Scanning, Significantly Enhancing Calibration Speed:
In contrast to conventional planar near-field testing systems where mechanical scanning results in slow calibration speeds, this system utilizes the planar wave generated by the compact range to cover the Device Under Test (DUT) in the quiet zone. Calibration can be achieved without moving the DUT and the test probe; instead, it involves switching each array element channel and collecting its phase and amplitude data. For a phased array with 6,000 elements, depending on the parameter settings, each channel's testing time for channel switching plus instrument sampling is around 1-2 ms, and the total calibration time for the entire array is approximately 6-12 minutes.

Dramatic Reduction in Calibration Preparation Time:
Before performing planar near-field amplitude and phase calibration, alignment with the feed antenna requires installing, calibrating, and adjusting the phased array antenna's position using auxiliary methods such as total station and photogrammetry. This process typically takes 1-3 hours or even longer. In contrast, using the compact range for calibration only requires placing the DUT within the quiet zone. Position adjustments are unnecessary, and installation can be completed in just a few minutes.

FAST TESTING SPEED

With the spherical near–field method, testing speed can be improved in the following two aspects.

Frequency Point, Multi-Channel, Wave Quick Test:
Typically, an active phased array antenna consists of multiple frequency points, test channels, and beam directions. Using a conventional measurement system, each antenna state needs to be tested separately, resulting in low testing efficiency. This system achieves high testing efficiency through real-time interaction between testing software and the phased array beam controller, combined with multi-channel switches and multi-frequency sampling of instruments. It realizes full testing automation under microsecond-level timing control. The system can complete testing for thousands of beam directions with just a single 3D scan. Compared to the conventional testing method, its testing efficiency is improved by dozens of times. Assuming the beam switching time is 400 microseconds, performing a single plane scan for 1000 beams within the ±90° range would take less than 6 minutes.

Simplified Setup, No Need for Precise Positioning:
The spherical near–field system utilizes a swing arm to perform spherical scanning, and the Device Under Test (DUT) is only required to be placed on a one-dimensional azimuth positioner. This setup is convenient and can be completed in a few minutes. Additionally, during spherical near-field scanning, the DUT can be roughly placed within the quiet zone, eliminating the need for precise alignment. Estimate a minimum spherical diameter (D) that can enclose the DUT, calculate the required sampling density using the formula λ/D and scan, finally, perform the near-field to far–field transformation. Compared to planar near–field testing, this system's DUT installation process can save several hours.

HIGH TESTING ACCURACY

Sampling accuracy won't deteriorate as the scanning range expands. In a spherical near–field testing system, the test probe maintains alignment with the Device Under Test (DUT) throughout the scanning process. Theoretically, sampling accuracy at any angle remains consistent. Unlike the planar near–field system, where the probe may lose alignment with the DUT as the scanning range expands, leading to changes in the radiation pattern and degradation in cross-polarization, resulting in deteriorated testing accuracy.

Cutting–Edge Corrugated Horn Antenna with Wide–Angle and Low Cross–Polarization. The testing accuracy of a near–field scanning system is significantly influenced by the characteristics of the test probe. Normal dual–polarized horn antennas cannot meet the requirements, so horn antennas with better cross–polarization suppression are usually employed. However, designing a corrugated horn antenna is challenging, and the hardware processing is complex. Typically, satisfactory cross–polarization performance can only be achieved at the apex of the corrugated horn antenna. It is difficult to obtain good cross-polarization performance across a wider angular range. Additionally, in conventional corrugated horn antennas, there exists a phase center offset between the E-plane and H-plane, resulting in a significant difference between horizontal and vertical polarizations.

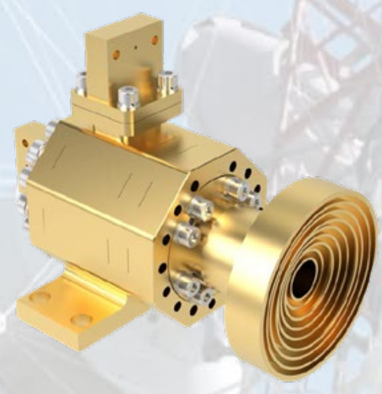

Figure 3: Wide–Angle Low Cross–Polarization Corrugated Horn Antenna

We have developed and designed wide-angle, low cross–polarization corrugated horn feeds (see *figure 3*). Its cross–polarization can maintain -40dB within an angular range of ±20° (see *figure 4*).

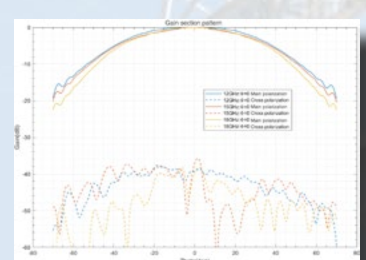

Figure 4: Wide–Angle Low Cross–Polarization Performance

Its phase fluctuations between the E-plane and H-plane are less than 5° within an angular range of ±50°, with excellent symmetry characteristics (see *figure 5*). These two features represent cutting–edge performance. The wide bandwidth and high phase stability ensure minimal phase fluctuations in the quiet zone. The high edge illumination level (wide beamwidth) results in reduced amplitude variations in the quiet zone. The integrated design with absorbers (its outer surface covered by absorbing material) ensures low Radar Cross Section (RCS) characteristics of the feed horn.

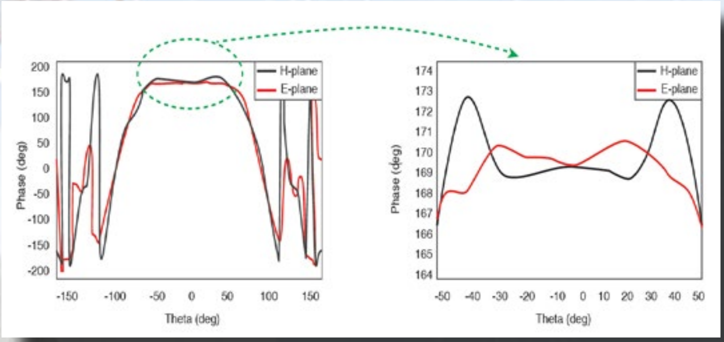

Figure 5: Wide Beamwidth And High Phase Stability Of Corrugated Horn Antenna

STRONG FAR–BEAM TESTING CAPABILITY

A spherical near–field testing system is not restricted by the scanning range; theoretically, it supports scanning across the entire spherical surface. Therefore, it can test antennas of any type and any beam direction. Moreover, its testing accuracy does not deteriorate for far-beam scenarios.

EASY TESTING SETUP

This chamber has the reflector installed on the top, and the system performs spherical scanning with the swing arm. The Device Under Test (DUT) can be easily laid flat on a one–dimensional azimuth positioner. Moreover, unlike planar near-field testing that requires precise positioning of the DUT, this approach significantly reduces pre–test setup time and simplifies the testing procedure.

LARGE–SIZED DUT CAN BE TESTED

For compact range systems, in order to accurately test antenna patterns, the Device Under Test (DUT) size should be smaller than the quiet zone. However, this limitation doesn't apply to amplitudes and phase calibration. When dealing with a larger-sized DUT, it can be divided into multiple parts. Each part can be moved into the quiet zone via the positioner's rotation, and each part's calibration can be performed independently without interference.

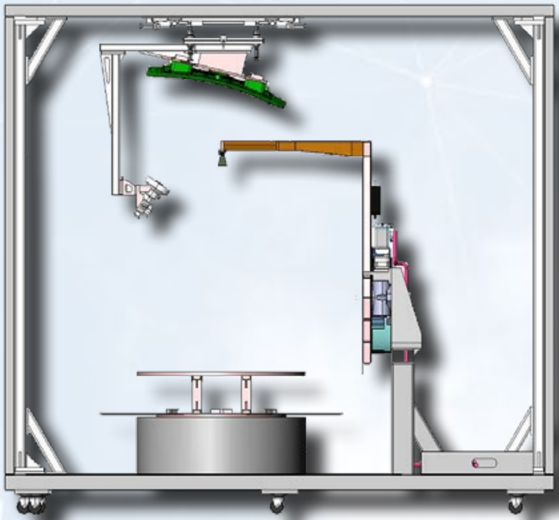

Figure 6: RayVerse® 2700 Cross–Sectional View

With this approach, the larger DUT can be calibrated with a limited-sized reflector (see *figure 6*).

For the spherical near-field testing system, we have specifically designed a wide-beam, low cross-polarization corrugated horn antenna to accommodate testing for large devices, such as antenna patterns. Additionally, according to the formula sampling density=λ/D (where D represents the minimum measurable sphere diameter), it is possible to facilitate a large DUT pattern test by increasing the sampling density.

Item	Planar near-field	Compact Range (two–dimensional positioner)	RayVerse 2700	Notes
Test Setup Time	240 minutes	120 minutes	10 minutes	Estimated average time
Calibration Time	100 minutes	12 minutes	12 minutes	Estimated average time
Test Speed	30 minutes × 1000 (except supporting multi–beam testing)	30 minutes × 1000 (except supporting multi-beam testing)	540minutes	1000 beam states, 2° step, beam state switching time 400us.
Test Range	±30°	±90°	±90°	
Cross-Polarization	-25dB	-25dB	-40dB	
Antenna Pattern Accuracy (Far–Beam)	Poor	Good	Best	
Cost	Fair	Good	Good	

TECHNICAL SPECIFICATIONS

		RayVerse 3700	RayVerse 2700
Measurement Capabilities	Functions	Amplitude & Phase Calibration, Phased–Array antenna (PAA) Multi–Beam Patterns, EIRP, G/T, etc.	
	Application Areas	Basestation, UE, Chip, Radar, Satellite PAA Test	
	Technologies	CATR/Spherical Near–Field test	
	Frequency Range	8 - 40GHz (6 - 110GHz Option)	
	Max. DUT Size	1m	0.6m
System Performance	Signal Type	CW, Pulse (Option)	
	Shielding	≥80dB	
	Dynamic Range	≥60dB (@ IF = 1KHz)	
	Antenna Weight	150kg	50kg
Reflector (Amplitude & Phase Calibration)	Reflector Size	1m	0.6m
	Quiet Zone Dimentions	0.5m	0.3m
	Quiet Zone Properties	Amplitude Variation: 1.5dB	
		Amplitude Taper: 1dB	
		Amplitude Ripple: ±0.5dB	
		Phase Variation: ±4°	
		Cross Polarization: -28dB	
	Test Distance	2m	1.2m
Scan Arm (Antenna Pattern Measurment)	Test Distance	1.6m (Spherical Near–Field)	0.8m (Spherical Near–Field)
	Quiet Zone Dimentions	1m	0.6m
	Quiet Zone Reflection	<-40dB	
	Scanning Range	0° - 90°	
	Scanning Accuracy	≤±0.05°	
	Antenna Cross-Polarization	≤-40dB	
Positioner	Rotation Range	0° - 360°	
	Rotation Accuracy	≤±0.03°	≤±0.05°
Shielding Enclosure	Dimensions (L×W×H)	4.2 × 3.7 × 3.7m	2.7 × 2.7 × 2.7m
	Door Size (W×H)	1 × 2m	
	Shielding	80dB	

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