RayVerse® 10KP
Phased Array Rapid Calibration and Testing System

PRODUCT BROCHURE

INTRODUCTION

In the development and production of large-scale phased array antennas, essential tasks include phase and amplitude calibration, as well as measuring multi-beam patterns. RayVerse 10KP (see *figures 1 & 2*) expedites the calibration and testing processes for large-scale phased array antennas across the S-band to W-band.

We are introducing an integrated rapid calibration and testing system for phased arrays, comprising two subsystems.

The first subsystem is the Phased Array Calibration Subsystem (Planar near-field): This involves low-frequency and spread spectrum links on the Device Under Test (DUT) side, as well as low-frequency and frequency conversion links on the planar scanning probe side. The system employs test instruments, frequency converters, switches, amplifiers, etc., to achieve phased array calibration.

The second subsystem is the Phased Array Testing Subsystem (Spherical near-field): This includes the low-frequency and spread spectrum links on the DUT side, as well as low-frequency and frequency conversion links on the arc scanning probe side. The system utilizes test instruments, frequency converters, switches, amplifiers, etc., to perform testing functions such as phased array antenna pattern, EIRP, and G/T value.

- 4m large-aperture mmWave antenna testing system that integrates element calibration and array testing functions.
- High-precision scanning mechanical system capable of meeting testing requirements below 110GHz.
- Utilizes multi-probe continuous triggering technologies to enhance testing speed.
- Active phased array antenna is placed horizontally, facilitating easy AUT (Antenna Under Test) installation.
- Automatic detection of mechanical deformation, ensuring long-term monitoring of hardware stability in the testing system.
- Innovative planar near-field scanning method employed for phased array antenna element calibration

Figure 1: RayVerse 10KP

HIGH CALIBRATION ACCURACY

The compact range method enhances calibration speed in two key aspects.

The first is Consistent Sampling Accuracy. In a spherical near-field testing system using the compact range method, the test probe maintains alignment with the Device Under Test (DUT) throughout the scanning process. This ensures consistent sampling accuracy at any angle, unlike the planar near-field system where probe alignment may be lost as the scanning range expands, leading to changes in the radiation pattern and degradation in cross-polarization.

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

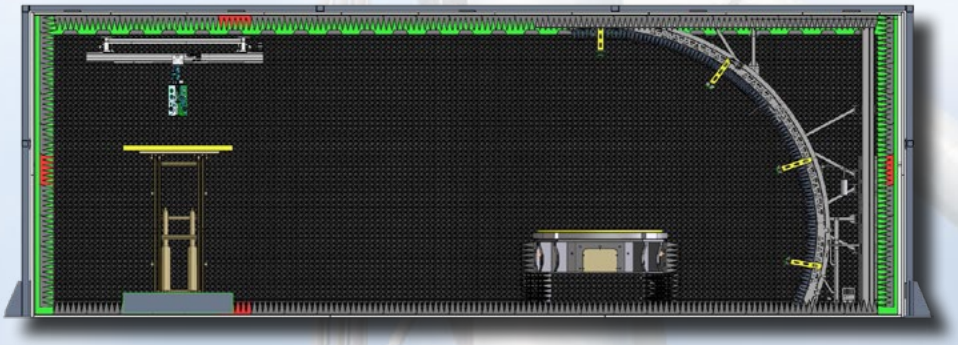

Figure 2: RayVerse 10KP Cross-Sectional Diagram

The second is with the use of a Corrugated Horn Antenna. Testing accuracy in near-field scanning systems is significantly influenced by the characteristics of the test probe. While normal dual-polarized horn antennas may not meet requirements, the design of corrugated horn antennas with better cross-polarization suppression is challenging. We have developed wide-angle, low cross-polarization corrugated horn feeds with cutting-edge performance (see *figure 3*), maintaining

-40dB cross-polarization within an angular range of ±20° (see *figure 4*). These feeds exhibit phase fluctuations of less than 5° within an angular range of ±50°, ensuring excellent symmetry characteristics and representing cutting-edge performance (see *figure 5*). The wide bandwidth and high phase stability minimize phase fluctuations in the quiet zone, and the integrated design with absorbers ensures low Radar Cross Section (RCS) characteristics of the feed horn.

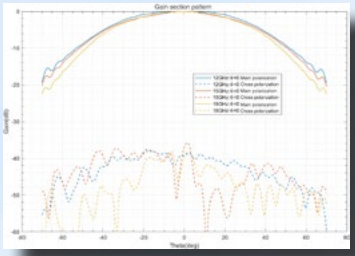

Figure 4: Wide–Angle Low Cross–Polarization Performance

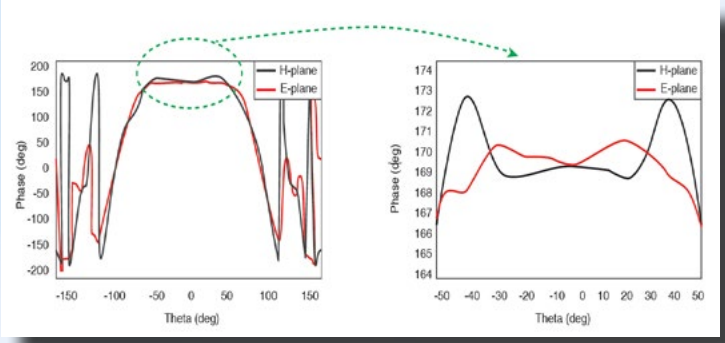

Figure 5: Wide Beamwidth And High Phase Stability Of Corrugated Horn Antenna

FAST CALIBRATION SPEED

Using the spherical near-field method offers improvements in testing speed across two key aspects. The first is Efficient Frequency Point, Multi-Channel, and Rapid Wave Testing. Here active phased array antennas typically consist of multiple frequency points, test channels, and beam directions. Traditional measurement systems require separate testing for each antenna state, resulting in low efficiency. This method enhances testing speed through real-time interaction between testing software and the phased array beam controller. It employs multi-channel switches and multi-frequency sampling of instruments, achieving full testing automation with microsecond-level timing control. The system can efficiently complete testing for thousands of beam directions in a single 3D scan, resulting in a testing efficiency dozens of times higher than conventional methods. For example, with a beam switching time of 400 microseconds, scanning 1000 beams within the ±90° range takes less than 6 minutes.

The second is Simplified Setup with No Precise Positioning Requirement. Here, the spherical near-field system employs a swing arm for spherical scanning, requiring the Device Under Test (DUT) to be placed on a one-dimensional azimuth positioner. This setup is convenient and can be completed within minutes. During spherical near-field scanning, the DUT can be roughly placed within the quiet zone, eliminating the need for precise alignment. By estimating a minimum spherical diameter (D) to enclose the DUT, calculating the required sampling density using the formula λ/D, and performing the near-field to far-field transformation, the system streamlines the DUT installation process, saving several hours compared to planar near-field testing.

Figure 6: Spherical Near–Field Multi–Position Test Time (1000 Beams)

STRONG FAR–BEAM TESTING CAPABILITY

The spherical near-field testing system is unrestricted by scanning range; theoretically, it accommodates scanning across the entire spherical surface. Consequently, it has the capability to test antennas of any type and any beam direction. Furthermore, its testing accuracy remains uncompromised even for far-reaching beams.

EASY TESTING SETUP

The chamber features a top-mounted reflector, and the system conducts spherical scanning using a swing arm. The Device Under Test (DUT) can be conveniently placed flat on a one-dimensional azimuth positioner. In contrast to planar near-field testing, which demands precise DUT positioning, this method substantially cuts down on pre-test setup time and streamlines the testing procedure.

FAILURE DIAGNOSIS CAPABILITY

The system is equipped with array element diagnostic capabilities. Utilizing swift element channel calibration, it can extract amplitude and phase information, enabling the identification and elimination of any pertinent parameters. By creating an array model grounded in phase array element coordinates, the graphical channel information can be visually presented, as depicted below (see *figures 7 & 8*).

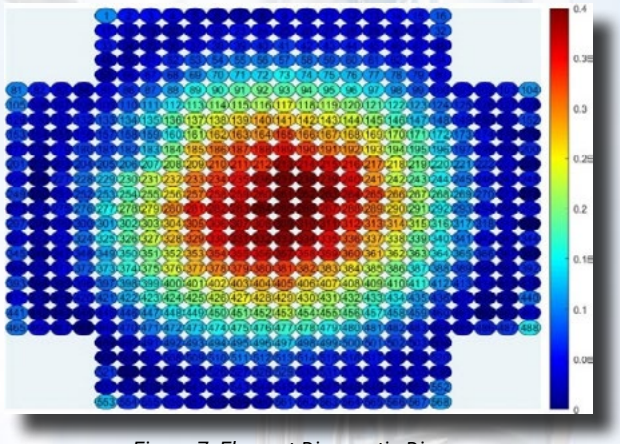

Figure 7: Element Diagnostic Diagram

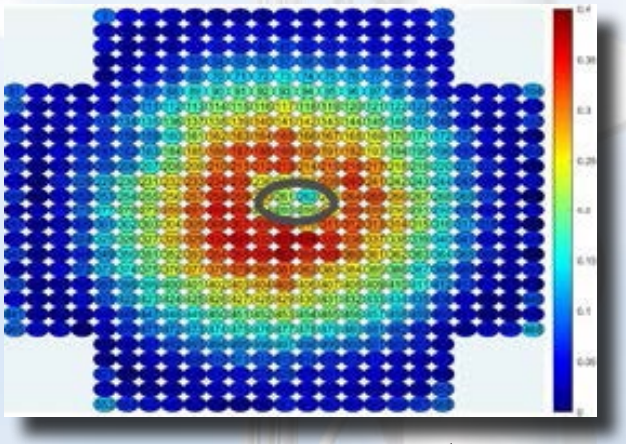

Figure 8: Element Diagnostic Diagram (Partial Elements In The Central Area Are Deactivated)

HIGH SAFETY MARGIN

- All components and materials conform to applicable national standards
- Continuous 24x7 monitoring is conducted using thermal imaging, and real-time monitoring data is uploaded
- The system is equipped with a smoke detector for real-time monitoring of smoke concentration within the system, with data recording. An automatic alarm is triggered if the smoke concentration surpasses the established threshold

TECHNICAL SPECIFICATIONS		
Test Capabilities	Functions	Calibration: P-P (Park&Probe), Near–Field Holographic Imaging, Element Field- Vector Rotation Method Measurement: Antenna Pattern, Efficiency, Gain, H/V Bandwidth, Cross Polarization Ratio, Sidelobe Level, H/V Beam Direction, EIRP
	Applications	Large–sized Radar/Satellite Phased–Array Antenna Test
	Technologies	Planar/Spherical Near–Field Test
	Frequency Range	1 - 110GHz (including S/C/X/Ku/Q/E/W band etc.)
	Max.DUT Size	4.5m
	Quiet Zone Dimentions	4.5 × 4.5m
	Quiet Zone Reflectivity	<-40dB
Planar Scanner	Scanning Dimensions	XY Axis
	Scanning Range	5 × 3m
	Probe Positioning Accuracy	≤0.05mm
	Flatness	≤0.02mm
Scanning Arc	Test Distance	4m (Spherical Near–Field)
	Scanning Range	0° - 90°
	Number of Probes	4
	Scanning Resolution	0.005°
	Scanning Accuracy	≤±0.005°
Positioner	Rotation Range	0° - 360°
	Rotation Accuracy	≤±0.01°
	Rotation Resolution	0.01°
	Rotation Speed	0° - 5° /s
Test Probe	Probe Type	Corrugated Horn/Wideband Horn
	Polarizaion	Dual–Polarized
	Frequency Range	1 - 8GHz; 8 - 12GHz; 12 - 18GHz; 18 - 26.5GHz; 26.5 - 40GHz; 40 - 60GHz; 60 - 90GHz; 90 - 110GHz
Absorber	Substrate	EPP
	Height	300mm
	Absorbing Rate	≥40dB (Option)
Shielding Enclosure	Dimensions (L ×W × H)	10 × 7 × 6m (Customizable)
	Door Size (W × H)	2 × 2m
	Shielding	80dB

TOYO TOYOTech

47623 Lakeview Blvd, Fremont, CA 94538
Phone: 510-438-9548 | E-mail: info@toyotechus.com
http://www.toyotechus.com

03/17/2025 (SCW)