RBW D5011/D6500
Automotive OTA Testing System
PRODUCT BROCHURE

INTRODUCTION

To ensure that an intelligent connected vehicle (ICV) operates reliably and with integrity, it is equipped with multiple wireless systems such as V2X, cellular, Bluetooth, and satellite navigation. However, testing the full communication performance of the vehicle in a real-world environment presents two major challenges. The first challenge is performing a near field antenna and EIRP/EIS test under eccentric conditions. The second challenge is recreating a real-world transmission environment in a lab and conducting MIMO performance tests.

We have overcome these challenges through the application of theoretical methods and engineering solutions. By utilizing the spherical near field (NF) and NF-FF transformation, the issue of severe eccentricity has been resolved. The improved-RTS method has facilitated the simulation of fading environments and MIMO tests. The solution's near field testing system is located at the center of an anechoic chamber, comprising a vehicle turntable, a gantry with a moving probe, test instruments, and software.

TEST TECHNOLOGY: NEW
- Spherical NF scanning + NF-FF transformation

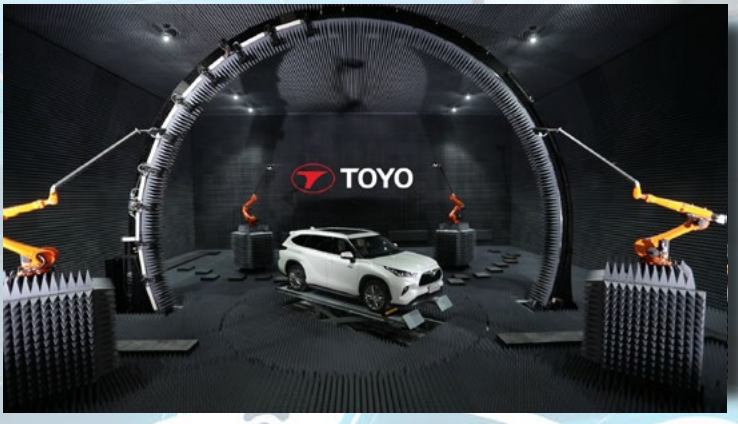
TEST SPEED: FAST
- Passive antenna test (8 antennas): ~5 hours
- Active antenna SISO test: ~10 minutes

TEST PRECISION: HIGH
- System mechanical accuracy: ±0.1°
- Antenna test accuracy: ±0.5dB (typical)
- SISO test accuracy: ±0.8dB (typical)

TEST COVERAGE: WIDE
- Passive antenna test (3D pattern, efficiency, phase center, ECC and self-defined parameters, etc.)
- ICV SISO Test (EIRP, TRP, EIS, TIS, Sensitivity and self-defined parameters, etc.)
- ICV 2×2/4×4 MIMO Test (models of urban, rural, high speed, rain/fog fading and self-defined channel models, etc.)
- Desense Test (test of self-interference, different motion states)

The MIMO testing system comprises of four sets of six-axis robotic arms, each with a test probe at its end, as well as test instruments and software. The spherical NF system and MIMO system can operate simultaneously in the chamber without interfering with one another. During non-MIMO test mode, the robotic arms can retract to the corners of the chamber, away from the turntable, to avoid interference with the antenna and SISO test. When in MIMO test mode, the arms move from the standby area to the working area next to the turntable. With the aid of the test software, the robotic arms can automatically perform the MIMO test by driving the test probes.

This full vehicle C-V2X wireless performance test system can recreate various driving scenarios in a lab and simulate different channel models. It can evaluate both MIMO performance and the overall vehicle's antenna and transceiving performance under different driving conditions. Consequently, this system can serve as a vital test method for the automotive industry to assess the performance and reliability of ICV wireless communication systems.



- Arch + Arms, spherical near field scanning, provides multi-function and wide coverage for full-vehicle wireless performance testing
- Frequency range: 0.6 - 10.3GHz
- Test function:
  - Passive antenna test – V2X , cellular, GNSS etc.
  - Full-vehicle SISO performance test – TRP/TIS of V2X, 2G/3G/4G/5G, (A)GNSS, Wi-Fi, Bluetooth, etc.
  - Full-vehicle MIMO performance test – throughput of 4G/5G 2x2/4x4 MIMO, supports 2D/3D channel models and field test simulation
  - Full-vehicle dynamic performance diagnosis – test and diagnosis for car motion states & self-interference
- DUT sizes supported: 6 × 2.5 × 2.5m and 6 × 2 × 2m
- Flexible configuration: separate SISO/MIMO options, configured independently

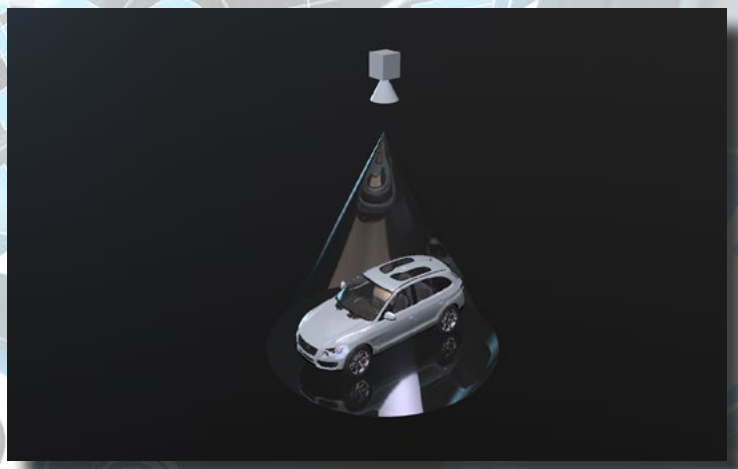


Figure 1: Main-lobe Effective Coverage of Test Probe

WIDE-BEAM, HIGH CROSS-POLARIZED TEST PROBE

Near-field eccentricity is a significant challenge in automotive testing. To ensure precise testing results, the test probe's main lobe must effectively cover the entire radiation area of the AUT (usually the entire vehicle), as depicted in *Figure 1*.

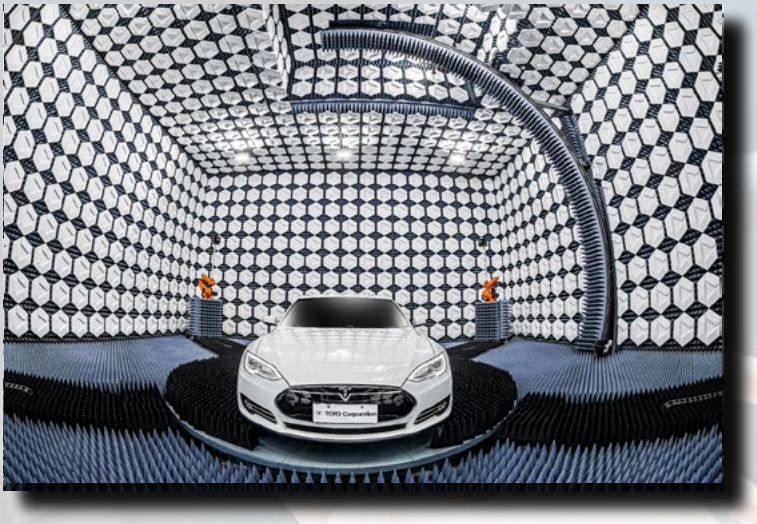
Furthermore, correct NF-FF transformation necessitates high cross-polarization isolation for an eccentric system. Therefore, the cross-polarization of the effective coverage beam is critical. The automotive test requires NF-FF transformation, and an essential precondition for NF-FF transformation is accurately distinguishing the H/V polarization energy.

In practice, the cross-polarization ratio of the entire test probe's main lobe should exceed 18dB to meet the transformation accuracy requirements. We have developed a special probe for automotive testing to achieve high testing precision, with more details provided below:

TEST PROBE SPECIFICATIONS	
Frequency	600MHz - 7.5GHz
Dimensions	300 × 300 × 250mm
VSWR	< 2.4 @600M - 7.5GHz
Beam width	> 60°@600MHz - 3GHz
	> 60°@3GHz - 6GHz
Cross-polarization Isolation	> 25dB @Zenith-angle
	> 18dB @60° Beam-width
Sub 6G in-band flatness	< 0.8dB

Bring Field to Lab

- ✓ Controllable parameters
- ✓ Repeatable scenarios
- ✓ Standard models
- ✓ Efficient test



RTS MIMO TEST

The automotive communication system's reliability in various driving scenarios is directly related to life safety. How to effectively reproduce the vehicle's driving scenario and perform the MIMO test in the lab is the key issue in evaluating the vehicle communication system's reliability under real driving conditions.

Radiated-Two-Stage (RTS) is one of the two approved MIMO test methods of the 3GPP. Another organization CTIA is considering approval of the method as well.

A core RTS patent has been granted. According to the characteristics of automotive testing, we developed a special MIMO test solution. Using the RTS method, we can perform accurate and efficient automotive multi-antenna performance tests in a sophisticated electromagnetic environment. This solution supports 2x2/4x4 MIMO testing of LTE and 5G sub6G (NSA/SA) systems.

With a channel emulator, this system can perform dynamic MIMO testing under standard channel models, and even simulated environments such as rain, fog, terrain, motion state, and road test.

Figure 2: 2-in-1 Configuration/Option

2-in-1 CONFIGURATION

The 2-in-1 configuration enhances performance by providing greater than 180-degree arch coverage. One side of the configuration has 11 multi-probes for efficient testing, while the other side features a single probe with wider frequency coverage.

ERROR-ANALYSIS-BASED NF-FF TRANSFORMATION

The near-field to far-field (NF-FF) transformation algorithm (refer to *Figures 3 to 6*) is at the heart of a spherical NF testing system. GTS has optimized the conventional NF-FF transformation process and designed a unique test probe. We have creatively solved the following three challenges in full vehicle OTA testing::

- The NF eccentricity issue with large device-under-test (DUT)
- The effective radiation coverage, cross-polarization, and beam symmetry issue of the test probe
- The calibration issue of the test probe factor in NF&FF restoration

By addressing these challenges, we can achieve accurate performance evaluation for automotive wireless communication systems.

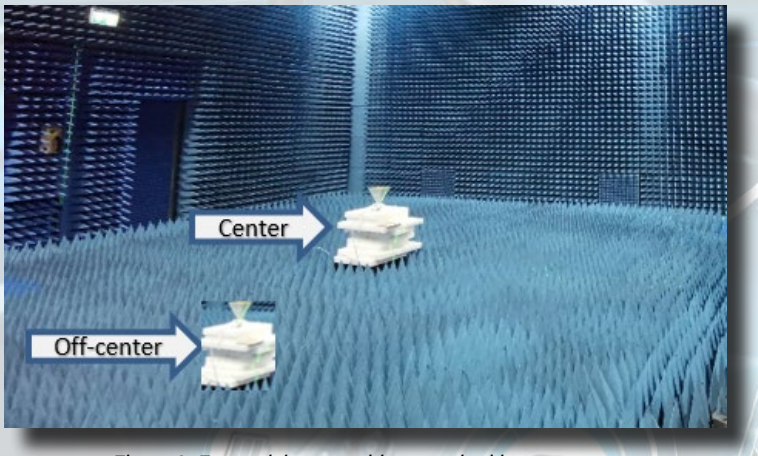


Figure 3: Eccentricity test with a standard horn antenna

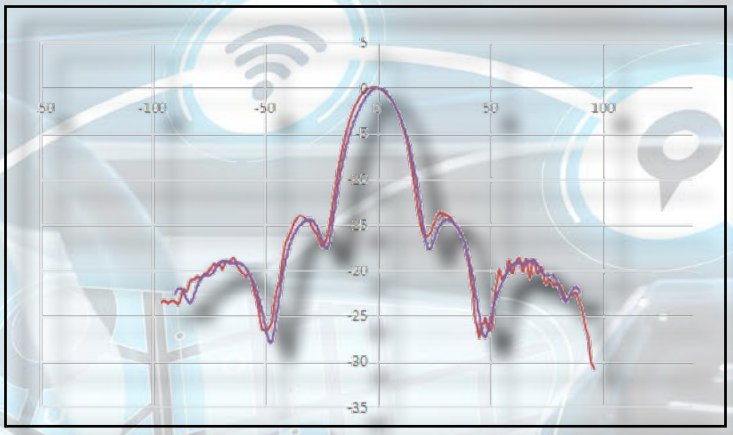


Figure 4: Transformed FF value vs. standard value

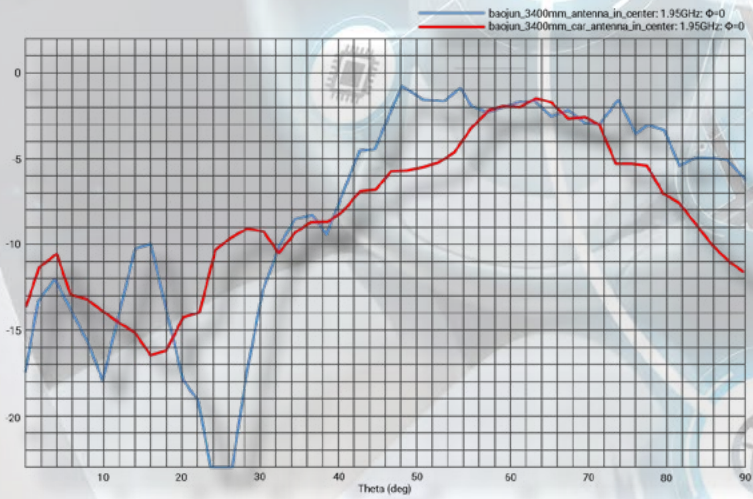


Figure 5: Car antenna@center vs. Car@center large deviation in direct NF results

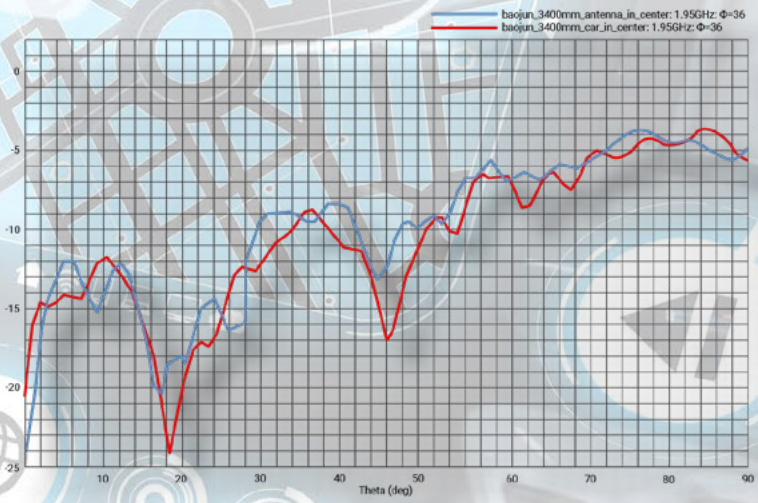


Figure 6: Car antenna@center vs. Car@center (small deviation in transformed FF results)

DESENSE COEXISTENCE TEST

When a vehicle is in motion, its internal subsystems can affect each other, including the wireless communication system's receiving sensitivity which can face various types of interference. To address this issue, the desense test method (as shown in *Figure 7*) can be used for all sensitivity-related tests.

In order to accurately analyze the mutual influence between each module within a vehicle and improve the overall wireless communication performance, desense testing becomes critical in a full vehicle test.

AeroGT Labs has developed a desense test to evaluate the impact of various factors on communication systems, including the vehicle's status, in-vehicle equipment, power supply, and motion. This test can help improve the reliability and performance of automotive wireless communication systems.

SCISSOR LIFT

The scissor lift is a useful tool for extending test coverage. With a load capacity of 10 tons, it can be raised to a height of 250 cm, which in combination with a NCD controller, enables testing of high-mounted devices and systems that are difficult to access.

EPP RIGID FOAM ABSORBER

The performance of an anechoic chamber is directly influenced by its core component, the absorbing material (depicted in *Figure 8*). To ensure optimal system performance, AeroGT Labs exclusively uses 4th generation, high-performance absorbers made of RayBond EPP (Expanded Polypropylene) foam. This environmentally-friendly material offers several advantages over traditional Polyurethane (PU) foams, such as water-resistance, flame-retardancy, stability, and dust-free properties.

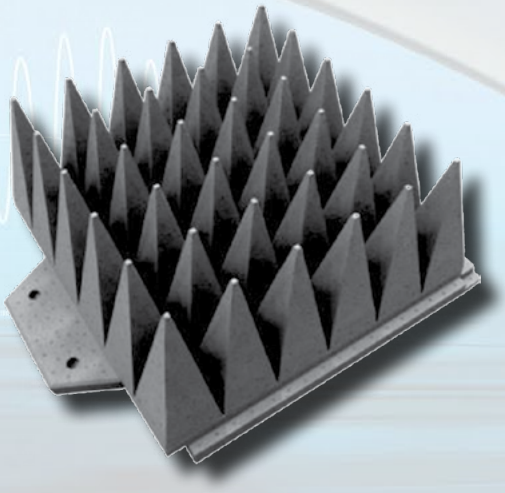


Figure 8: EPP-300 foam absorber

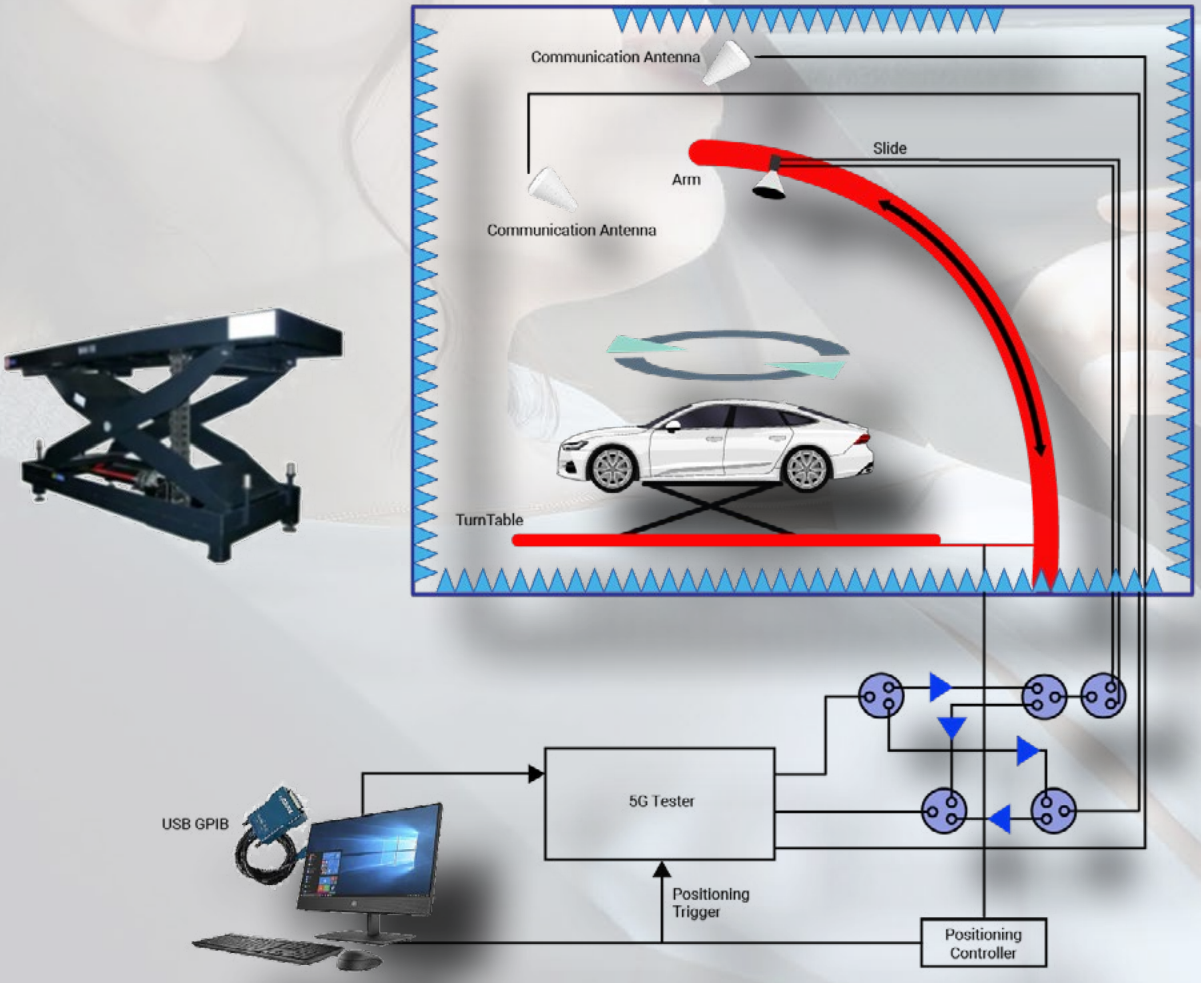


Figure 7: Desense Test Diagram

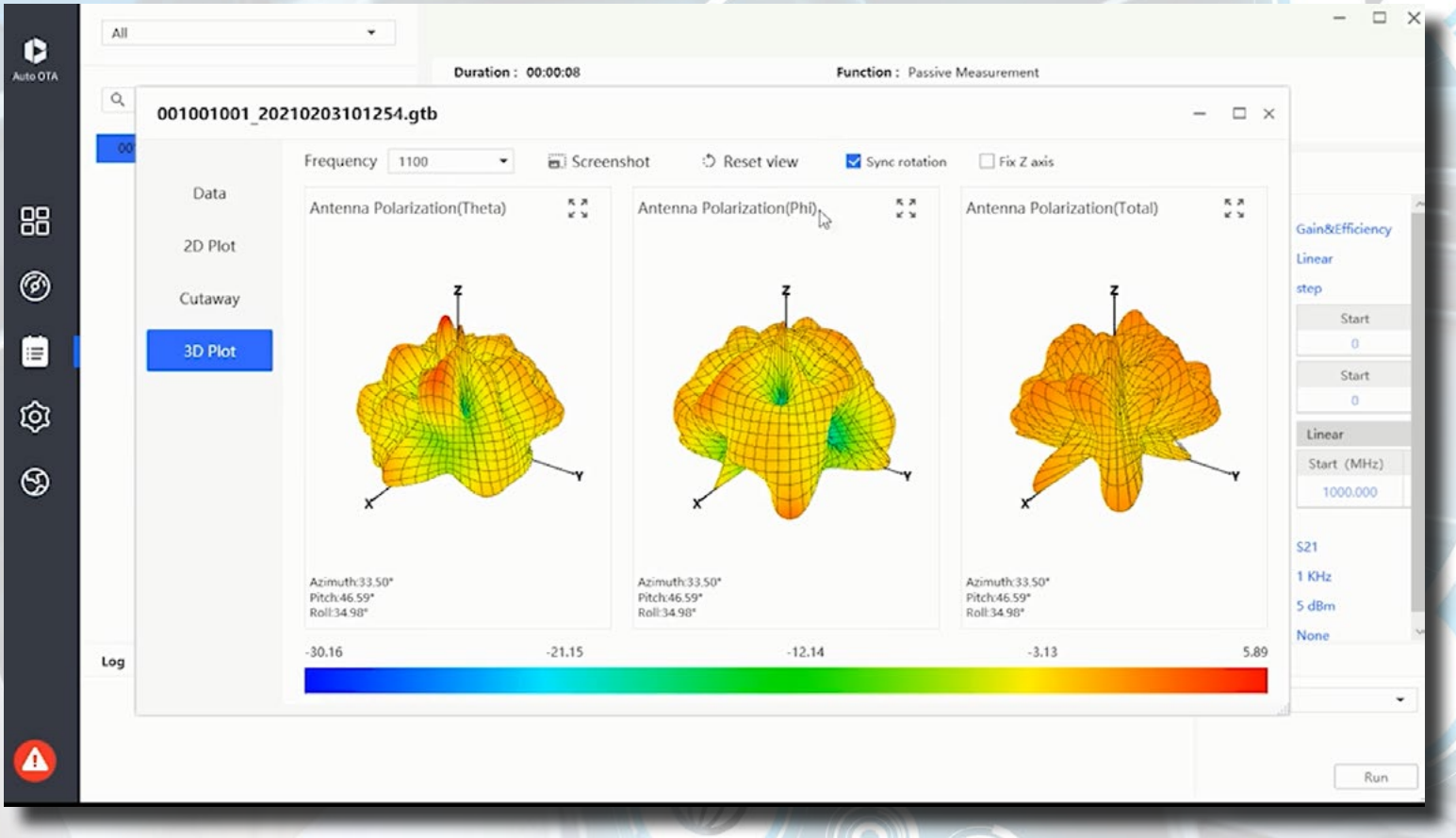
WAVEX® AUTO OTA TESTING SOFTWARE

To perform accurate full-vehicle measurements with a high precision of at least 0.1°, AeroGT Labs has developed a reliable data model that ensures accuracy and stability during measurement. The system also employs a fast-testing algorithm that yields highly reliable test results in the shortest time possible, reducing measurement costs.

The software is designed to provide a user-friendly interface for displaying result data, including 3D/2D polar coordinates, 2D cartesian coordinates, test data, raw data, and test templates. The software adopts a plug-in development model that easily adapts to hardware changes and provides various test instrument drivers with corresponding templates. The system is also equipped with a self-defined task queue, allowing for unattended continuous testing.

The software covers a wide range of tests, including passive antenna, SISO, or MIMO for 3G/4G/5G, Wi-Fi, BT, V2X, and GNSS. In addition, Wavex offers a dedicated result analysis and comparison tool for automotive testing, capable of analyzing and comparing various test results on a common computer. The tool enables analysis and comparison of test results such as:

- NF test data and FF transformed data comparison
- Different vehicles test data comparison
- Simulated data and tested data comparison
- Different angles 2D and 3D comparison
- Multi-angle and multi-frequency data comparison
- Self-defined comparison



TECHNICAL SPECIFICATIONS			
		RBWD5011	RBWD6500
General	Frequency Range	0.6 - 10.3GHz	
	Functions	OTA testing of complete vehicles,Antenna Test: SISO/MIMO Test; Desense Test	
	Technologies	Spherical Near–Field Scanning; RTS MIMO	
	Test Probe	Dual–polarized; Low RCS Vivaldi antenna	
	Dynamic Range	60dB (Typical)	
DUT	Max. Size (L × W × H)	6 × 2.5 × 2.5m	6 × 2 × 2m
Turntable	Diameter	7m	12m
	Rotation Range (Φ)	-10 - 370°	-10 - 370°
	Φ Positioning Precision	±0.1°	±0.1°
	Scissor Lifter Travel	0 - 2.0m	0 - 2.5m
Test Zone Specifications	Positioning System	Slide rail antenna vertical arch + mobile robotic arm	
	Rotation Range (θ)	-110 - 110°	-5 - 111°
	θ Positioning Pecision	±0.1°	±0.1°
	Test Radius	5.5m (Typical)	6.5m (Typical)
	Robotic Arm Size (L × W × H)	2 × 1.6 × 3m (AGV Standby Status)	
Physical Specifications	Exterior Dimensions (L × W × H)	18 × 18 × 9m	20 × 20 × 14m
	Shielding Effectiveness	>100dB	
	Door Size (H × W)	3.6 × 4.2m (Customizable)	4 × 4m (Customizable)
Rigid Absorbers	Base Material	EPP (Expanded Polypropylene)	
	Height	300mm	
	Absorbing Rate	≤-40dB	
	Fire Resistance	Class B1 (Option) (per GB8624–2012 with 3rd party test report)	
	Oxygen Index	> 28% (per GB/T 2406.2–2009 with 3rd party test report)	
	GHS Classifications	Non–hazardous. (per IEC62321 with 3rd party test report)No volatilization, no odor, no toxicity, no harmful gas (formaldehyde etc.) release	

SYSTEM HARDWARE	
Absorber	EPP300: 600 x 600 x 300mm
Test Probe	MA-5000: 0.6~7.5GHz dual-polarized antenna
Communication Antenna	CA-5000: 0.6~7.5GHz
Calibration Kit	AT-5000: 0.6~7.5GHz standard gain horn antenna
RF Unit	Multi-channel switches and amplifiers module
System controller	System synchronization and controlling module

SERVICE & SUPPORT	
System calibration	One free calibration at system delivery
Product warranty	Free for the first year
Software upgrade	Free for the first year

AUTO OTA TEST SOFTWARE	
Wavex Auto OTA test software with basic functions	System Control /Instrument Drivers/ Passive Test/Test Report Generator
3D PatternPad	3D Data Viewer
GSM/GPRS/EGPRS/CDMA/CDMA 1xRTT	TRP/TIS/EIRP/EIS/ICS
WCDMA/CDMA 1xEVDO	TRP/TIS/EIRP/EIS/ICS
TD-SCDMA	TRP/TIS/EIRP/EIS/ICS
Wi-Fi	UE/AP TRP/TIS/Throughput
LTE SISO (FDD/TDD)	TRP/TIS/EIRP/EIS/ICS
5G FR1 SISO(NSA/SA)	TRP/TIS/EIRP/EIS/ICS
LTE/5G FR1	Passive ECC/Active ECC
GNSS/A-GNSS	Cno /EIS/TIS
Desense	Wi-Fi/Cellular/GPS
NB-IoT/Cat-M	TRP/TIS/EIRP/EIS
LTE/5G FR1 RTS MIMO	2x2/4x4 Data Throughput (Android Platform)
V2X	TRP/TIS/EIRP/EIS
NF-FF conversion	Spherical near field to far field transformation with source reconstruction function

INSTRUMENTS SUPPORTED	
Wireless Test Sets	Keysight UXM E7515A/B/E, Keysight 8960 (E5515C), R&S CMW270/500, CMX500, CMU200, Anritsu MT8820C/8821C, MT8860C, MT8000A, StarPoint SP6010/8315/9500
Vector Network Analyzers	Keysight, R&S, Anritsu etc.
Signal Generators	Keysight E4438C, Keysight MXG N5182B, Spirent GSS6100/6300/6560/6700/7000
Channel Emulators	Anite F32/F64/FS16, Spirent VR5/ Vertex

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03/10/2025 (SCW)