

INTRODUCTION

With the continuous miniaturization of mobile terminal devices such as cellphones and laptop computers, R&D testing of the built-in low-directionality antennas has become critical. The weaknesses of large far-field chamber are well-known: large size, slow in test, expensive and not cost-effective.

Based on the in-depth study of near-field radiation, we propose an innovative test theory: in the near-field radiation, the indicator that characterizes the overall performance of the mobile terminal such as TRP, TIS and the peak of the antenna pattern are closely related. Through the careful structure design and optimization of the probe antenna, it is possible to make accurate measurements for the DUT's peak value and directionality, and the system measurement uncertainty is similar to the far-field tests. RayZone 1800 5G+ is an excellent implementation of this theory.

The RayZone 1800 5G+ (see *Figures 1 and 2*) employs an innovative asymmetric 13-sided polygon design. Through the 180 degree transformation of some sampling points, with only 12 test antennas, it provides a minimum angle of 15° sampling steps as defined in the CTIA measurement.

The asymmetric shape determines the irregular distribution of the test probes, which maximizes the measurement distance within a small chamber. In addition, matching the antenna quantity with the antenna spacing helps to avoid direct reflection and reduce adjacent coupling between antennas. The RayZone 1800 5G+ achieves the same measurement performance as a large certified chamber in one-fifth of the size.

- Based on the brand-new test theory, it utilizes the effective near-field radiation test, and a unique asymmetric multi-probe system architecture is adopted according to the low directivity physical characteristics of the DUT antenna
- The absorbers are directly adhered to the inner surface, which coincides with the electromagnetic wave propagation end surface. It ingeniously achieves the theoretical maximum-use efficiency of shielding space
- The antennas are isolated from the absorbers to prevent any temperature and humidity changes from affecting the antenna performance and system stability
- All RF cables and controlling mechanisms of the turntable are placed in external trunkings or the chamber base. Together with the wave-transparent fixture, RayZone 1800 5G+ provides a pure test environment

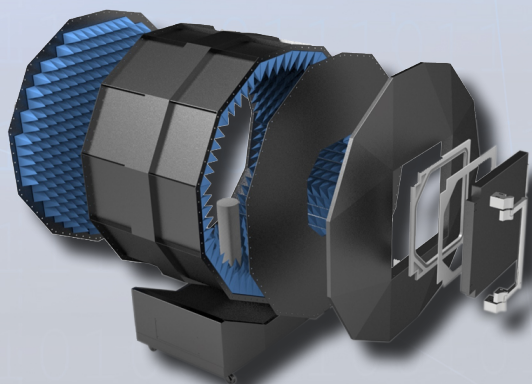


Figure 2: RayZone 1800 5G+ (Exploded View)



Figure 1: RayZone 1800 5G+ (Front View)

- Comprehensive wireless standards: 2G/3G/4G/5G(FR1)/GNSS/A-GNSS/Wi-Fi/Bluetooth/UWB
- IoT standards: LTE Cat NB1 (NB-IoT)/Cat-M1 (e-MTC)
- SISO TRP/TIS/EIRP/EIS testing; 2x2 MIMO throughput testing
- Passive antenna, Desense and ICS testing
- Frequency range: 600MHz-12GHz
- MaxSign software with visual data analysis
- Environment-friendly EPP rigid foam absorbers, low RCS/high gain antennas and customized fixture
- Fast MIMO testing; certified-level accuracy
- Integrated design; plug & play

The RayZone 1800 5G+'s absorbing materials use full-band simulation and optimized designs to obtain the best absorbing performance structure and ensure excellent electromagnetic wave absorption performance (see *Table 1*).

- Electric property: EPP has small dielectric constant, small surface reflection, sufficient internal attenuation, and good absorbing effect in the microwave frequency band
- Fire resistance: meets UL94 HF-1, GB8624 B2 standards
- Limit Oxygen Index: no less than 27%
- Working temperature: long-term -50-100OC (short-term 120OC)
- Environmentally friendly: non-toxic raw materials, odor-free, no harmful gas, and no dust
- Meets RoHS standard
- Physical Appearance: precise size, uniform color

Being a key part of the OTA test system, the customized and low RCS (radar cross section) probe antennas are equipped in the RayZone 1800 5G+ and help to obtain the best system testing accuracy (see *Figure 3*).

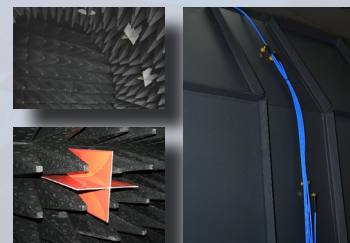


Figure 3: High-Performance Absorbers & Low RCS Antennas

- Working frequency range: 400MHz~12GHz
- Gain flatness within the whole working frequency $\leq \pm 0.25\text{dB}$
- Optimizing the antenna feed to improve the standing-wave-ratio
- Modular design ensures the performance consistency and simple maintenance of the antenna
- Compact size, integrally designed with surrounding absorbers and achieves low RCS characteristics

ABSORBING MATERIALS							
Frequency	400MHz	600MHz	700MHz	1GHz	3GHz	5GHz	12GHz
Absorber Reflection	-28 dB	-28 dB	-42 dB	-45 dB	-50 dB	-55 dB	-55 dB

Table 1: Absorbing Material Performance

A WORLD OF POSSIBILITIES WITH OUR ACCESSORIES

In order to pursue test accuracy, we designed a variety of accessories for use in the test systems.

We recognize the difficulty for engineers to measure and obtain the performance of the AUT itself due to the common current existing in the passive antenna measurement. This has caused the RF connector and test cable to become an undetachable part of the AUT. The common current's side-effect is particularly significant at low frequency.

Therefore, we designed a set of special choke beads for passive antenna measurement which can suppress the common current and reduce the external cable and connector interference to the test result.

The RayZone 1800 5G+ provides a perfect testing environment for antenna engineers, in which engineers can obtain the real and accurate antenna pattern of a small size AUT at very low frequency and in different positions. The figure (see Figure 4) on the right shows a standard passive antenna's patterns from the RayZone 1800 5G+ and software simulation.

From its external shape to the internal parts, the entire design of the RayZone 1800 5G+ went through very strict system-level hardware simulations; it employs customized testing probes which are wide frequency, low RCS and low cross-polarization; new generation EPP absorbers which are in-deformable, durable, moisture-proof, and dust-free; a full wave- transparent and customizable fixture design which reduces signal occlusion and improves test accuracy.

With all efforts on improving the system, the test results of the RayZone 1800 5G+ can be compared with larger far field test systems. It is not only consistent with lab simulations, but also provides the full test capability of even very expensive and large certified chambers. The measured results are as follows on Table 2.

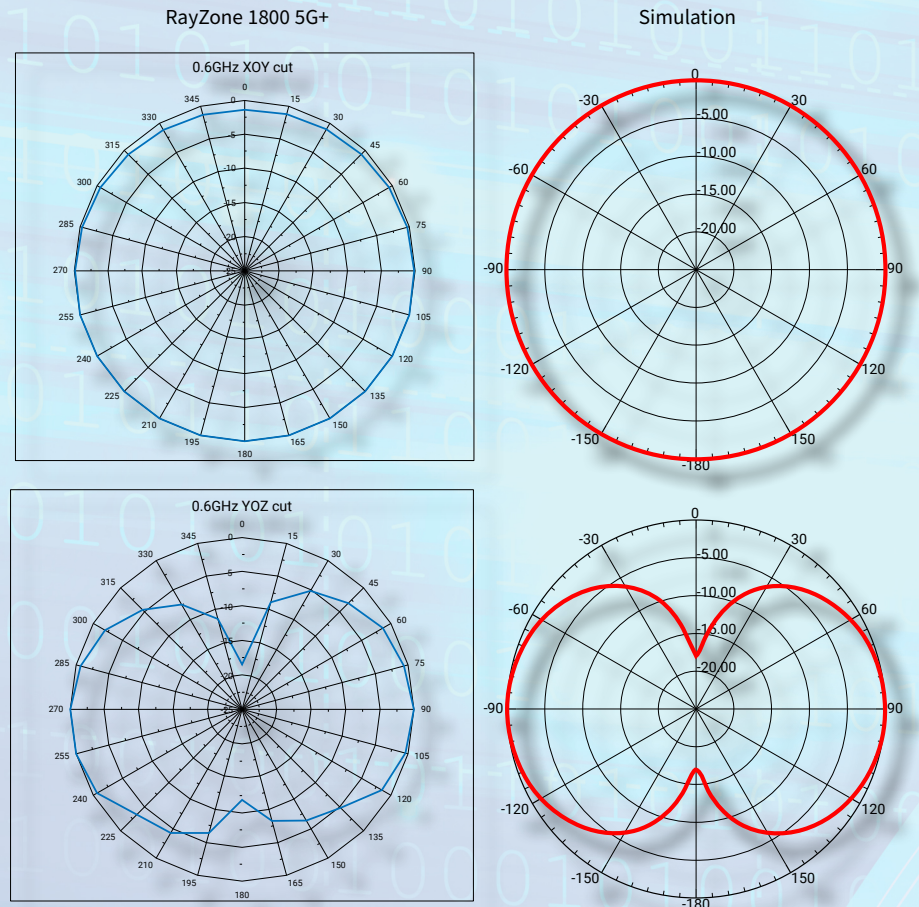


Figure 4: RayZone1800 5G+ Passive Test Result vs. Simulations

TEST RESULT COMPARED WITH LARGER FAR FIELD TEST SYSTEMS

Band	TRP					TIS				
	Channel	Freq	RZ1800	Certified Lab	Difference	Channel	Freq	RZ1800	Certified Lab	Difference
GSM850	251	848.8	26.55	26.7	-0.15	251	893.8	-104.58	-104.6	-0.02
GSM900	124	914.8	26.95	26.4	0.55	124	959.8	-103.16	-102.4	0.76
GSM1800	885	1784.8	26.52	25.9	0.62	885	1879.8	-106.52	-106.3	0.22
GSM1900	810	1909.8	26.38	25.5	0.88	810	1989.8	-105.9	-105.5	0.4
LTE(B3)	19900	1780	20.31	19.9	0.41	1900	1875	-97.5	-97.4	0.1
LTE(B5)	20600	844	19.71	19.9	-0.19	2600	889	-96.52	-97.2	-0.68
LTE(B7)	21350	2560	20.16	20.3	-0.14	3350	2680	-94.74	-94	0.74
LTE(B17)	23800	711	17.14	17.8	-0.66	5800	741	-96.14	-96.8	-0.66
LTE(B40)	39550	2390	18.89	18.7	0.19	39550	2390	-93.25	-93.8	-0.55

Table 2: RayZone 1800 Test Results

MAXSIGN100 PROFESSIONAL ANTENNA/OTA TEST SOFTWARE

The MaxSign100 system's control and test automation software (see *Figures 5 and 6*) is compliant with CTIA test standards and is kept up to date with the latest specifications. The software provides a wide range of applications, flexible configurations, test processes as well as a simple to use but powerful GUI. It meets different test requirements and covers the entire product life cycle from R&D, pre-certification, and conformance to QA manufacturing.

- Supports 3D measurement, cut selectable 2D measurement, and single point measurements
- User-defined test step, test angle, and test configuration
- Arbitrary selection of test point to review all test data of it
- Wide variety of test assistant functions: anti-drop-call, auto-recall, and abnormal situation warnings. Improves the testing processes' reliability and fluency
- Comprehensive raw test data and log files management. Traceable and non-modifiable test process
- Batch processing function supports creating task lists for continuous and auto-mated unattended tests
- Resourceful built-in templates, preconfigured parameters compatible with different instruments and test platforms. Simple manipulations effectively prevent operational errors
- Supports 3D display, antenna pattern arbitrary angle rotation, viewing, and cutting to help R&D engineers to visually analyze and diagnose problems

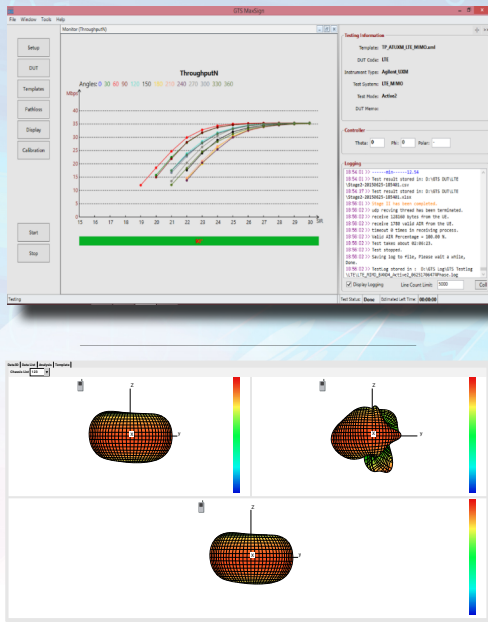


Figure 5: MaxSign Test Software

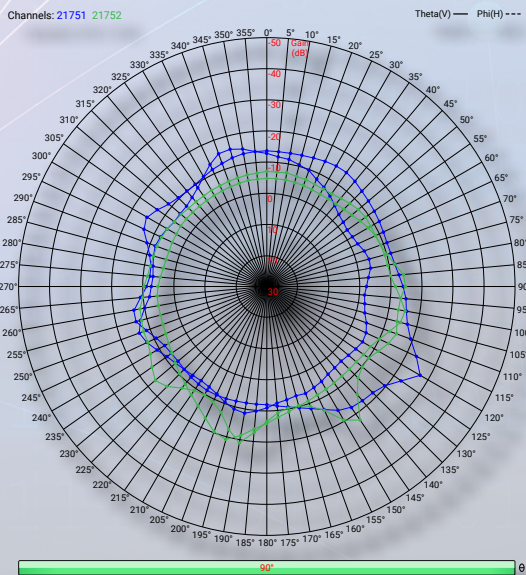


Figure 6: LTE MIMO Band4 Active2

RAYZONE SERIES

The RayZone 1800 5G+ is part of the RayZone series of products, which is a line of electromagnetic environment simulation testing systems. It provides a wide range of applications, powerful functions, and flexible configurations. Compared to a certified chamber, the RayZone 1800 5G+ can achieve the same level of accuracy, but with faster test speed and better test repeatability.

Based on the new testing theory and system design, the RayZone 1800 5G+ (see *Figure 7*) has a unique asymmetric polygon structure which ingeniously multiplies the DUT sampling points, achieving a good balance between compact size and comprehensive functions.

The RayZone 1800 5G+ fully supports SISO OTA throughput test, and RTS (Radiated Two-Stage) MIMO OTA test with only requirement in software upgrades. It is a cost-effective tool for 4G/5G wireless pre-certified tests.

Due to its compact size and flexible mobility, the integrated and calibrated RayZone 1800 5G+ can be transported to customer sites as a whole unit. Without a month-long installation and calibration process needed by conventional chambers, our customers can dramatically save time, space, and effort. To be an accurate, stable, simple, delicate, flexible, convenient, and efficient test solution — the RayZone 1800 5G+ carries out our product philosophies of “Accurate, Simple, Fast, Agile”.

- Full wireless standards
- All standard test items
- Passive/active/phantom test
- 2D/3D pattern display
- Desense test
- Wide instruments selections
- Various debugging information for R&D
- Minimum 15° sampling resolution
- Auxiliary tool for DUT HW optimization

Every innovation comes from our persistence in creating more values for our customers.

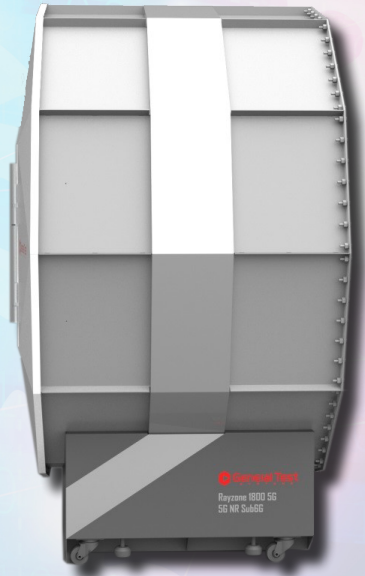


Figure 7: RayZone 1800 5G+ (Side View)

TECHNICAL SPECIFICATIONS

General	Functions	Passive/Active antenna test, OTA test
	Applications	- Antenna R&D test - Wireless terminal R&D test - Desense test - RF pre-certificated test - MIMO throughput test
	DUT types	Antenna, cellphone, tablet, laptop, CPE, etc.
	Test methodologies	Multi-probe, Smart test and RTS method
	Frequency range	600MHz~7.5GHz
	Test items	- Antenna: 2D/3D Antenna pattern(amplitude, phase), Directivity, Gain, Efficiency, Beamwidth, Cross Polar Level, Sidelobe Level - RF: EIRP, EIS, TRP, TIS, NHPRP, NHPIS, ICS, ECC, TWR (two way ranging), AoA (angle of arrival) - Others: Desense
	Shielding	>80dB
	Measurement distance	80cm
DUT	Max. DUT size	25×25×25cm
	Max. DUT weight	20kg
	Com. ports	USB 3.0/RS232
QZ	Size	25cm×25cm×25cm (L×W×H)
	Reflections	<-25dB
Probe Antenna	θ-resolution	15°
	Numbers	12+2
	10dB beam width	~60°
	Cross-polarization ratio	≤-25dB
Absorber	Base material	EPP
	Height	22cm
	Power tolerance	≤0.75 kW/m ²
Turntable	Rotation range	Φ: 0°~360°
	Rotation speed	≤40°/s
	Φ-resolution	0.5°
Chamber	Exterior dimensions	195cm×183cm×110cm (H×W×D)
	Door size	57cm×57cm (W×H)
	Weight	350KG

RAYZONE 1800 5G+ SHIELDING ENCLOSURE

Hardware	Chamber, Shielding Door, Absorber, Dual Polarized Narrow Beam Probe Antennas, RF Switch Box, RF Cable, Positioner, System Controller and Turntable
----------	--

INSTRUMENTS SUPPORTED (OPTIONAL)

Base station Emulator	Keysight UXM E7515A/B, Keysight 8960 (E5515C), R&S CMW500, CMX500, Anritsu MT8820C/8821, MT8862A, MT8000A, StarPoint SP6010
VNA	Keysight, R&S, Anritsu and etc
Signal Generator	Keysight E4438C, Keysight MXG N5182B, Spirent GSS6300/6560/6700/7000
Channel Emulator	Anite F32/F64, Spirent VR5/Vertex

RAYZONE SOFTWARE MODULES

MaxSign V2.1 Base Module	System Control/Instrument Drivers/ Passive Test
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 (802.11 a/b/g/n/ac/ax etc.)	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/FR1 MIMO 2×2	Data Throughput
LTE/FR1 ECC	Passive ECC/Active ECC
GPS/A-GPS	C/No /EIS/TIS
BeiDou	TIS
Desense	Wi-Fi/Cellular/GPS
NB-IoT/Cat-M	TRP/TIS/EIRP/EIS
UWB	TRP/TIS/TWR/AoA

SERVICE & SUPPORT

System calibration	One free calibration at system delivery
Maintenance	Free for the first year
Software upgrade	Free for the first year



TOYO Corporation

Quest for Precision

42840 Christy Street, Suite 110, Fremont, CA 94538

Phone 510-438-9548

web: <http://www.toyotechus.com>

email: info@toyotechus.com