WaveStudio

Microwave Vision Group

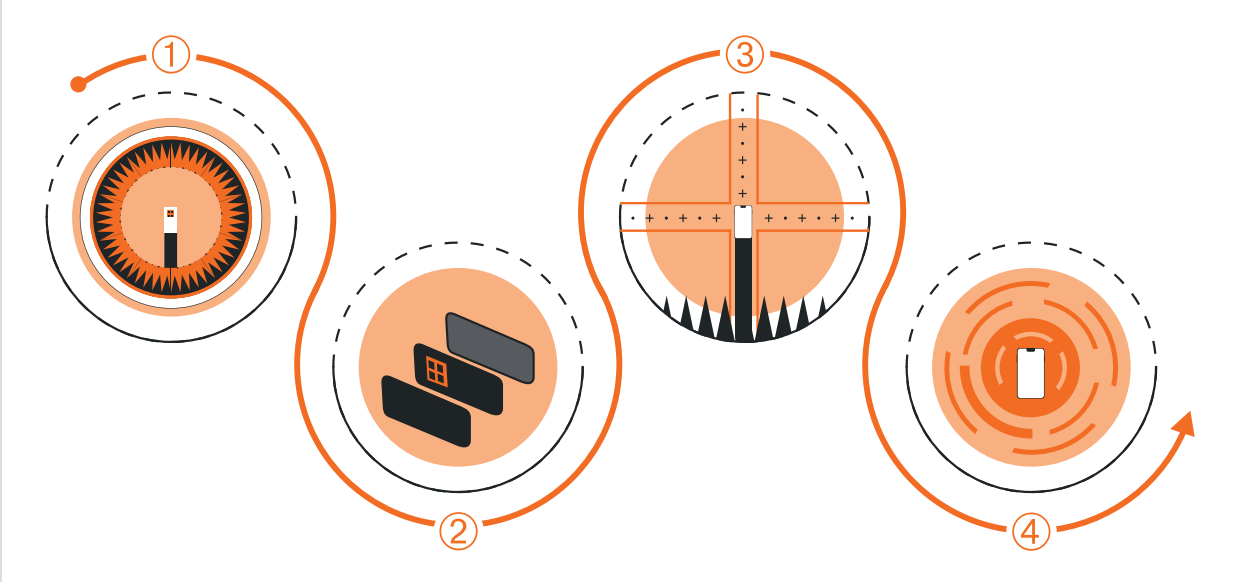
Automated Antenna and OTA Measurement Software Suite

Supporting Wireless Device Design from Start to Finish

Starting from antenna prototyping to fully operational device measurements, WaveStudio Automated Software Suite effectively and efficiently supports the complete design process of wireless devices through its antenna and OTA measurements capabilities.

In the typical design process of a wireless device, antenna and OTA measurements are necessary to ensure that the antenna is working as designed when integrated into the end product. During the design process, there are many prototype iterations and builds which require passive antenna measurements at the start of the project, and active, OTA measurements once the device is capable.

With WaveStudio automated measurement software suite and an MVG system, all antenna measurements and full device testing can be performed quickly and effectively in-house, ensuring that all design iterations meet project milestones.



① ANTENNA MEASUREMENT

Passive measurements are performed when an antenna is designed standalone (to be integrated into system by customer) or when the device under test is inactive.

② INTEGRATION

Integration of developed antennas on a structure, in a mobile, on a car or on a plane require post-processing software and systems specifically designed for integration analysis, coupled with simulation software.

③ OTA MEASUREMENT

Active measurements evaluate the performance of a device Over-The-Air (OTA) and conducted when required. OTA testing allows a new product to be evaluated quickly and effectively and gives the operators an indication of how the device will interact with the network.

④ FUNCTIONAL TESTING

Functional testing determines how a device will react in the real environment. Will its performance be deteriorated by barriers or can it use the multipath propagation to its advantage?

WaveStudio

Antenna Measurement

To minimize gain errors, the environment in which the antenna is tested must be "quiet" (free of noise and unwanted reflections), to obtain an accurate radiation pattern. The standard method used to determine the absolute gain, is gain by substitution, where an antenna with known gain is measured, and the antenna under test is compared. The standard unit for passive antenna measurements is dBi, or decibels relative to an isotropic radiator. In order to obtain this unit, the reference antenna's gain must be known in the same unit, dBi.

GAIN MEASUREMENT

Gain is a fundamental parameter used to quantify antenna performance. During the measurement, the gain is measured at several points around the antenna, from which the antenna pattern is obtained. The antenna pattern is particularly significant when measuring a directional antenna, such as a base transceiver station (BTS) antenna or any antenna array. If the full sphere is measured, the directivity can be calculated using the gain result, point by point, divided by the efficiency measured. Gain is measured in an anechoic chamber, using an external source and receiver. Given the theory of reciprocity, the measurement antenna can be either connected to the source or receiver, depending on the signal direction to the antenna under test.

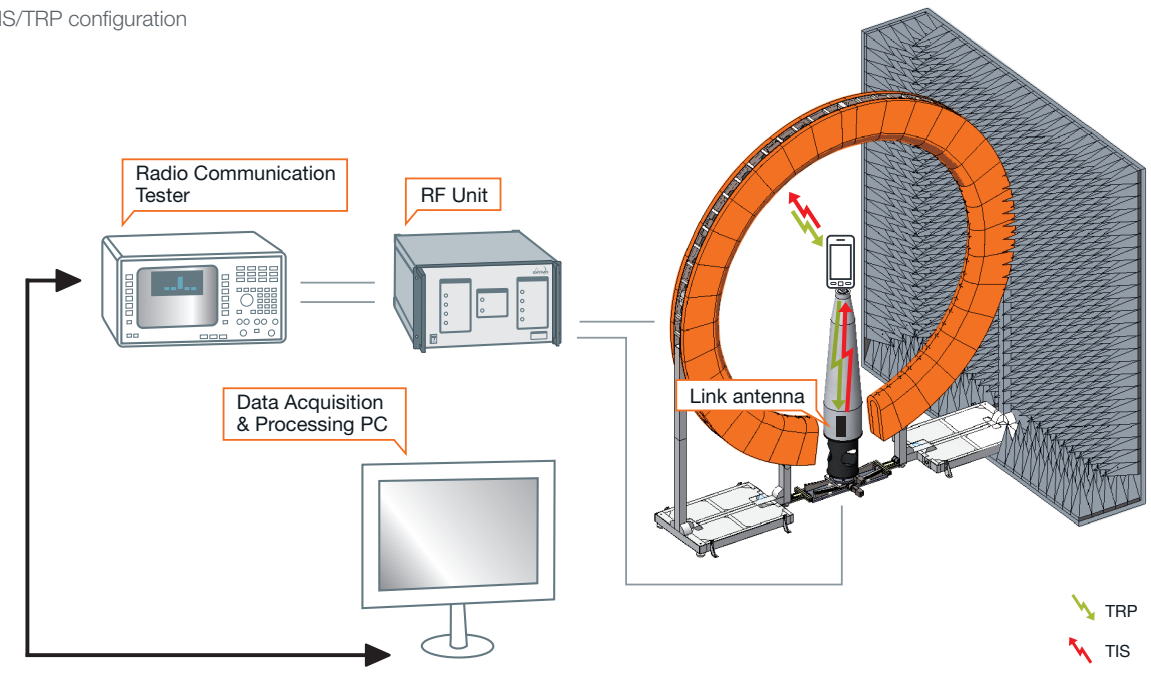
EFFICIENCY MEASUREMENT

Efficiency is the ratio of the power radiated by an antenna to the power input to the antenna. The efficiency provides an estimation of the impedance mismatch loss, the conductive and dielectric loss from the antenna and the structure of the device under test (DUT). The passive efficiency result can be used to estimate the total radiated power TRP of a wireless device knowing the power available at the antenna port. Units used in efficiency measurement are the percentage (%) and the decibel (dB) which is the most widely used unit.

OTA Measurement

When used in conjunction with an anechoic chamber and the required instrumentation, MVG multi-probe systems* are compliant with the standards specified for CTIA certification of wireless devices. Radiated Power and Sensitivity measurement are required to quantify the OTA performance of wireless devices. CTIA, 3GPP and wireless communication standards bodies continue to establish standards using these parameters as their criteria.

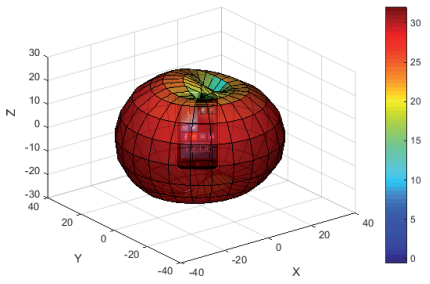
TIS/TRP configuration



* Multi-probe systems with a minimum radius of 1.20m (SG 24 S/L SG 64 C/S/L StarMIMO). Other systems are capable of pre-compliance testing.

RADIATED POWER
EIRP and TRP

Total Radiated Power (TRP) is the total RF channel power radiated by a wireless terminal in an OTA configuration. It is calculated by integrating the measured Effective Isotropic Radiated Power (EIRP) data over the measurement sphere. Measurement time of TRP can be reduced to less than 2 minutes for all 3 channels with WaveStudio, an MVG multi-probe system, and an appropriate radio communications tester. As per the CTIA test plan guidelines, WaveStudio measures the EIRP every 15 degrees in both elevation and azimuth, at a minimum. As an example, a measurement of 1656 points (23 elevations x 12 azimuths, x 2 polarizations x 3 frequencies), could result in a total measurement time of about 2 minutes or less, depending on the protocol measured.



EIRP 3D plot

SENSITIVITY – LINE OF SIGHT (LOS)
EIS and TIS

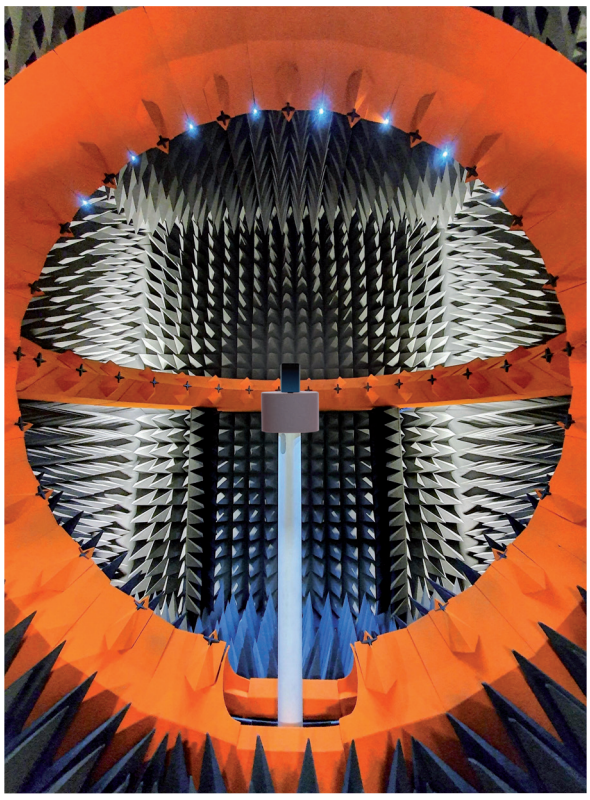
Total Isotropic Sensitivity (TIS) is a figure of merit for the overall radiated sensitivity of a wireless terminal. TIS is the integrated quantity of single point sensitivity (Effective Isotropic Sensitivity - EIS) measurements performed over the full sphere. The sensitivity is defined to be the power at which the device reaches a specified error rate. It helps reveal the effective signal level with which a device would be able to operate if it received the same signal over all directions in a 360-degree sphere. In WaveStudio, the default error rate is set to that defined in the CTIA test plan and can be shifted. As a single metric representing the overall radiated sensitivity performance of the device, TIS is an asset in benchmarking devices.

A method to reduce TIS measurement time is based on the Rx level. This method uses the DUT receiver as a power meter with certain communication protocols (like GSM and WCDMA). From each measurement point on the measurement sphere, a constant power is radiated towards the DUT. The DUT receiver then reports back its received power level and the complete spherical set of power level data can be referenced to a single-point EIS measurement to determine the TIS.

The GPS tracking sensitivity can be obtained using a similar concept. In this case data reported by the GPS receiver in NMEA 0183 format (National Marine Electronics Association) is used. The criteria for the single-point EIS measurement is defined in the CTIA Over the Air Test Plan. This method only requires a GNSS Simulator, a more economical solution to those needing only tracking sensitivity (versus acquisition sensitivity).

SENSITIVITY – Spatial Radio Environment (SPE)
TP versus Power, and TP versus SIR

Throughput (TP) versus Power, and Throughput versus Signal to Interference Ratio (SIR) are used to evaluate the performance of MIMO wireless devices. These measurements evaluate the device's capacity to use spatial multiplexing from two or four independent spatially-diverse data streams.

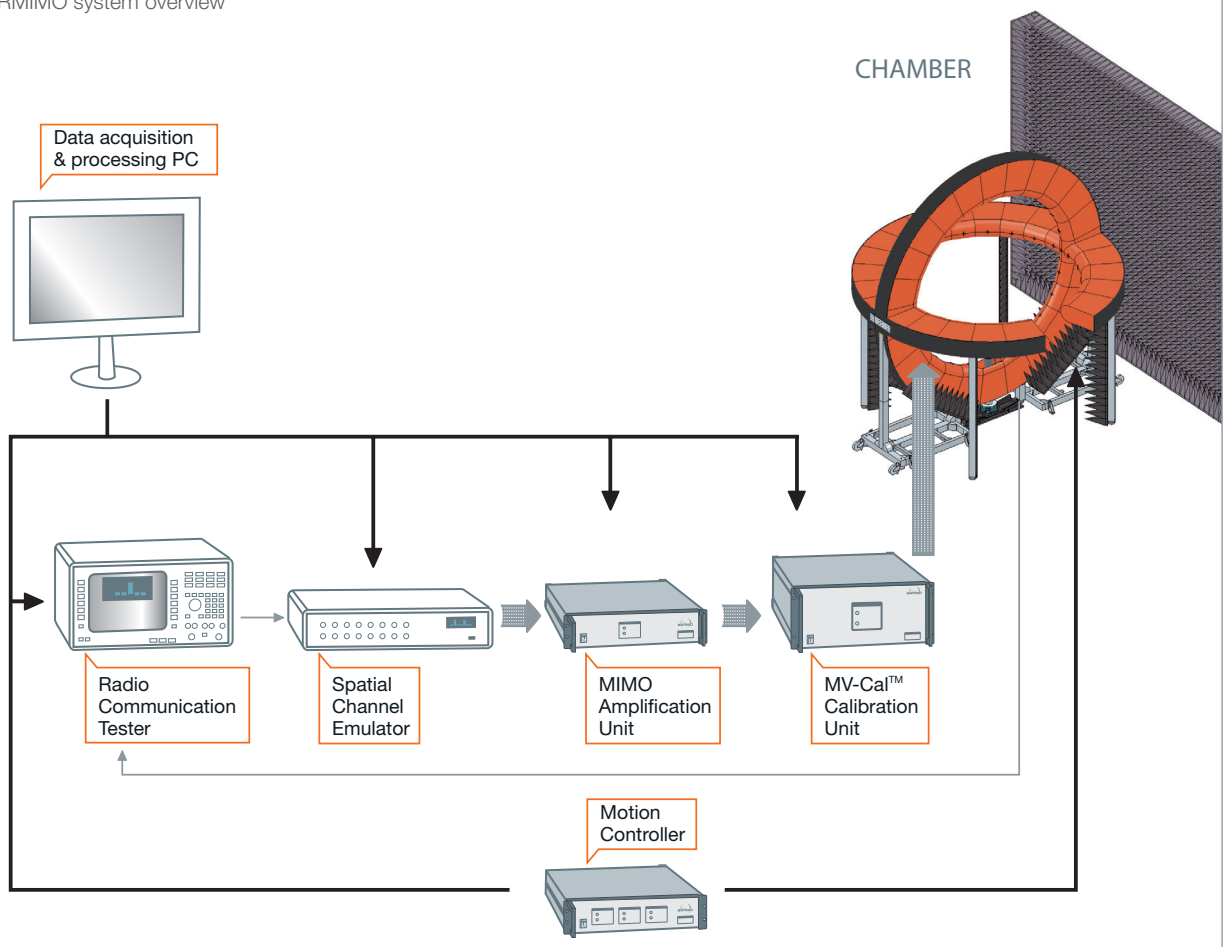


StarMIMO multi-probe measurement system

Using the MIMO[2] multi-probe system, a radio communications tester and a channel emulator, a specific wireless propagation environment can be emulated in the test zone of the system, with variable angles of arrival, angular spread, Cross-Polar Ratio (XPR), Doppler and delay spread. Currently CTIA requires testing with the SCME (Spatial Channel Model Extended) Urban Macro Propagation Channel, and 3GPP with the SCME Urban Micro Propagation Channel. In addition, CTIA requires Throughput versus SIR measurements, whereas 3GPP requires Throughput versus Power. In TP vs Power measurements, the power is reduced until the device reaches the error rate thresholds specified in the Graphical User Interface (GUI), and in TP vs SIR measurements, the interferer level increases until the specified error rate is reached.

For line of sight measurements, only the power accuracy to or from the wireless device is critical. For MIMO measurements, the MIMO receiver is using both the amplitude and phase. The WaveStudio automated patented calibration routine ensures accurate and stable amplitude and phase within the test volume.

STARMIMO system overview



COMPLIANCE WITH CTIA?

WaveStudio's settings for OTA measurements are validated by CTIA for each new protocol released. The software contains presets which configures all the settings to the requirements in the CTIA test plan. Given that the software and the settings are verified, the user is not required to search in the CTIA and 3GPP standards to determine the correct settings.

The MVG multi-probe system is authorized by CTIA for the equipment and software configurations specified on the CTIA website.

[2] StarMIMO-HU or StarMIMO-H

WaveStudio

The WaveStudio automated software suite has been developed to support both antenna measurements and OTA testing of wireless devices. It performs fast and accurate passive and active measurements, includes advanced post-processing capabilities, and generates reports per the requirements set forth by standards bodies such as CTIA & 3GPP.

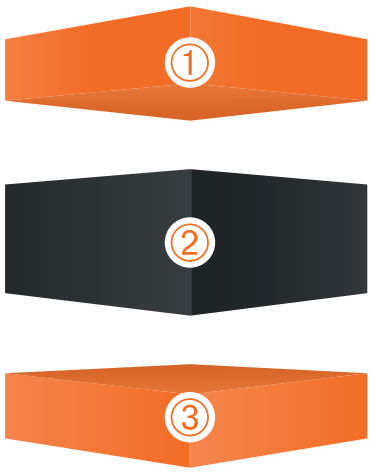
Three modules in one software

One for set up, one for measurements, and one for viewing results. The three modules are separable, yet together form the entire measurement process.

WaveStudio is structured around 3 main modules. The pre-measurement configuration console, the core measurement module, and the results viewer allow you to perform quick and accurate measurements while sharing the results with your team. WaveStudio performs rapid passive and active (power and sensitivity) measurements, and includes advanced post-processing capabilities for both passive and active results.

FLEXIBLE ACCESS RIGHTS

Free pre-measurement configuration console and results viewer for unlimited users.



①

PRE-MEASUREMENT CONFIGURATION CONSOLE (FREE)

Free to download on any PC, this module of WaveStudio allows for the preparation and saving of test batches and projects on simultaneous computers.

②

CORE MEASUREMENT MODULE (LICENSED)

The core measurement module required to perform a measurement is only available in the full-licensed version of WaveStudio. It allows for the comprehensive data acquisition and analysis of automated measurements. The license for this module also includes post-processing capabilities and the possibility to generate reports per the standards body requirements such as CTIA.

③

RESULTS VIEWER (FREE)

This module is also free to download. It allows results to be viewed on any PC, freeing the user to work remotely from the measurement lab, or work as a team.

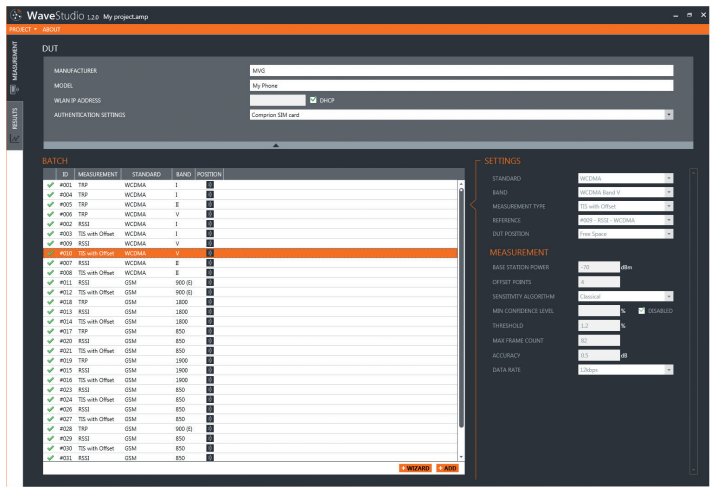
Save time and increase flexibility

Using WaveStudio's automated measurement software suite with an MVG system, tests can be performed quickly and effectively in house, ensuring that the product reaches the market on time.

CORE MEASUREMENT MODULE MADE FOR FASTER MEASUREMENT TIME

WaveStudio's automation capabilities minimize the number of measurement configuration changes necessary, enabling more measurements in a shorter time frame.

New algorithms and technology, as well as the intuitive user-interface, come together to greater more time efficiency in the entire measurement process. Advanced algorithms, such as for offset measurements, allow for fast and repeatable active results by taking advantage of common frequencies among the different protocols, or identical TX/Rx frequencies.



Offset measurement preparation

SAVE TIME WITH OFFSETS

WaveStudio allows you to use offsets for fast, accurate, and repeatable measurements. For example, if you want to test GSM, GPRS or EDGE, these protocols typically use the same antenna and share the same frequencies, so all you have to do is measure the 3D pattern in one of the protocols and then take a few measurement points from this pattern, transfer them into another protocol, and then normalize the data between the two measurements. So, if the TRP test time is 2 minutes for a GSM measurement, you simply need to measure a couple of points from that one measurement for a measurement in EDGE, so the test time for this second TRP comes to somewhere between 0 and 20 seconds. You see that this is a much faster approach than making a completely separate measurement for each protocol. Cumulatively, this methodology can save a lot of time!

MORE FLEXIBILITY WITH PRE-MEASUREMENT AND RESULTS MODULES

WaveStudio adds flexibility to the first and final stages of the measurements process.

Preparation, measurements, and result viewing can take place on separate PCs. Sets of batches can be prepared on an office PC as a sequence of measurements is underway on the lab computer. With the free results viewer, data can be evaluated on different PCs simultaneously as it comes in, allowing for faster review and retesting procedures. Results can be exported in different forms and formats. The user can adjust the file content, separate data according to parameters, or save only a part of the measurement. Reports can be automatically generated in many formats supported by Windows, and the content and lay out of the report can be adapted to specific requirements, such as CTIA certification reports. Data can also be exported to SATENV. All active measurement results are obtained using either fully compliant CTIA methodologies, or MVG's proprietary fast measurement algorithms.

Advanced post-processing

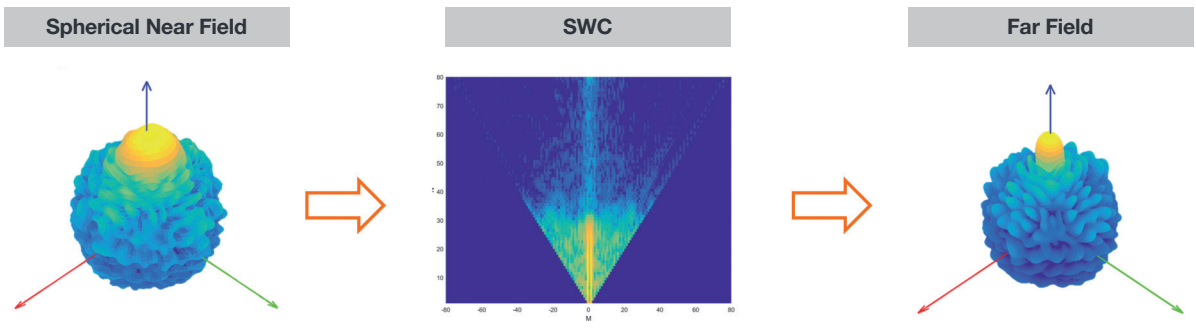
WaveStudio incorporates easy to use post-processing operations such as NF/FF (Near Field to Far Field Transformation), planar back-propagation, and modal filtering. It can automatically compute the Far-Field pattern from the phase and magnitude data obtained in the radiated near field region. Several transformations are possible and correlated to the measurement system and geometry used (Planar, Spherical or Cylindrical transform and Principal-Plane).

MV-Holography performs a planar back-propagation from which the planar field can be displayed at different distances from the antenna under test. Viewing the field at close proximity to the antenna can help trouble shoot an antenna which is not performing as expected.

MV-Translated Spherical Wave Expansion is an advanced NF/FF transformation tool which allows the number of samples to be reduced when the antenna cannot be located at the center of rotation.

For a complete list of MVG's advanced post-processing tools, please contact your local MVG sales representative.

Spherical NF/FF transformation



TESTIMONIALS

"It frees you from having to enter the chamber and making the connection for each single measurement. Now you can prepare several measurements beforehand and with one click on Start, they automatically run one after another, in a row.

Mike, *USA*

"I like the batch capability and the ability to repeat the offset measurement."

Yanli, *China*

"I like the new interface!"

Eivind, *USA*

WaveStudio Technical Specifications

Key features

Measurement types and capabilities
• **Passive radiation pattern measurements: efficiency and gain** • **Active measurements, OTA or conducted, uplink or downlink: TRP, TIS (including A-GPS)**
Gain - Directivity - Efficiency - Half Power Beam Width (HPBW) - Conducted power - Conducted sensitivity - Radiated power - Radiated sensitivity - Radiated receive signal strength - Sensivity sweep - Power sweep - Intermediate Channel Sweep

Wireless communication protocols and test plan compliance
• **Supports wireless communication protocols defined in the CTIA and 3GPP test standards + many others** • **Compliant with CTIA test plan** • **CTIA authorized system***
LTE TDD/FDD - LTE Cat-M1- LTE NB-IoT - GSM, GPRS, EDGE - Wi-Fi 802.11 a/b/g/n/ac - BLUETOOTH 802.15.1.2 - BLUETOOTH LE - CDMA2000, CDMA 1 x RTT, CDMA 1 x EVDO - WCDMA, HSDPA, HSPA, HSPA+, HSUPA - TD-SCDMA, TD-HSDPA - NR (5G) FR1 - A-GPS - GPS via NMEA 0183 (GPS, GLONASS, Galileo, Beidou, QZSS) *(Contact us for the most updated list)*

* see CTIA website for further information

Time saving features
• **Advanced predictive algorithms** • **Batching and batch cloning capabilities** • **Fine search data filters: date, type of measurement, DUT position, standard, band, etc.** • **Advanced backup and recovery process**

Advanced post-processing
• **Post-processing (NF to FF Transformation & more)** • **Advanced mathematical field computations (for passive measurements)** • **Parallel viewing of result plots** • **Results in 1D, 2D & 3D plots** • **Automatic data storage** • **Exporting capabilities**

Accessories
☐ **Instrumentation rack** ☐ **Positioning laser pointer**

Services
■ **Installation** ■ **Warranty** ■ **Training** ☐ **Extended warranty** ☐ **CTIA certification assistance**

■ Included ☐ Optional ⭘ Required

Estimated measurements time

ESTIMATED TIME FOR TRP MEASUREMENTS (one channel with a sampling every 15°)

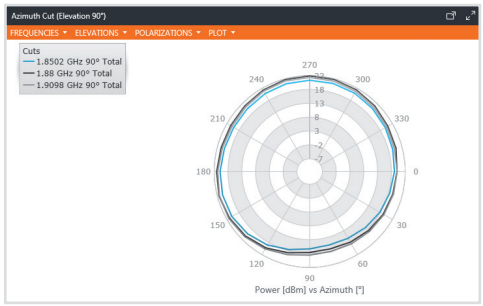
TRP \Standards	GSM GPRS EDGE	CDMA 1xRTT 1xEvDO	WCDMA HSDPA LTE FDD/TDD	Wi-Fi 802.11 a/b/g/n	CTIA Approved Method
Total Radiated Power	30 sec[1]	1 min	30 sec[1]	2 min	Yes

ESTIMATED TIME FOR TIS MEASUREMENTS (one channel with a sampling every 30°)

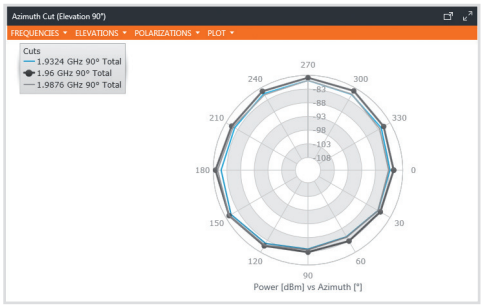
Sensitivity Algorithms / Standards	GSM GPRS EDGE	CDMA 1xRTT 1xEvDO	WCDMA HSDPA LTE FDD/TDD	Wi-Fi 802.11 a/b/g/n	CTIA Approved Method
RSSI pattern + linearization + TIS offset	8 min	-	10 min	-	No
EIS pattern + TIS offset	-	5 min	-	5 min	Yes[2]
Quick CDMA	-	8 min	-	-	No
EIRP pattern + TIS offset	-	-	-	10 min	No

[1] depending on RCT
[2] depending on protocol

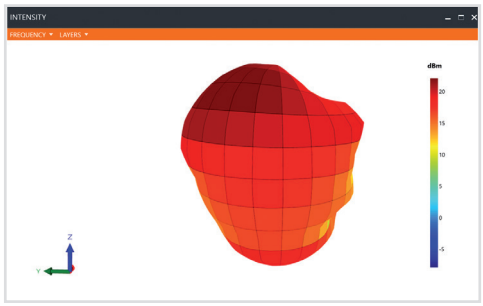
Sensitivity Algorithms / Standards	Estimated time	CTIA Approved Method
A-GPS TIS	120 – 150 min	Yes
TIS – tracking sensitivity based on NMEA data	45 – 60 min	Yes



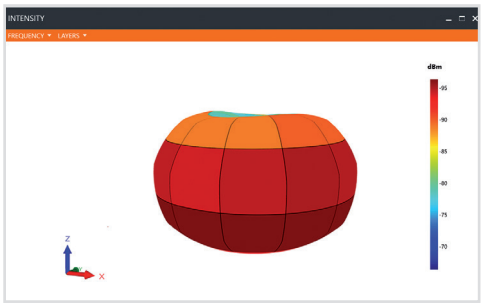
EIRP - Azimuth cut of 3D intensity plot



EIS - Azimuth cut of 3D intensity plot



EIRP - 3D intensity plot



EIS - 3D intensity plot

On-demand software solution

The choice in measurement types and protocol requirements available in WaveStudio broadens the scope of possibilities for an on-demand software offer. MVG will work in cooperation with you and your team to support you in selecting the right license plan for your needs. Your license plan and pricing will be adapted to the selected measurement types and protocols and can be upgraded at any time to catch-up with your future measurements needs. This on-demand delivery model simplifies the implementation, maintenance, and upgrading of your WaveStudio options and features.

ABBREVIATIONS

- A-GLONASS → Global Navigation Satellite System
- A-GNSS → Global Navigation Satellite System
- A-GPS → Assisted Global Positioning System
- CDMA → Code Division Multiple Access
- EDGE → Enhanced Data Rates for GSM Evolution
- EIRP → Effective Isotropic Radiated Power
- EIS → Effective Isotropic Sensitivity
- EvDO → Evolution Data Optimized
- FR1 → Frequency Range 1 (currently defined as 410 - 7 125 MHz)
- GPRS → General Packet Radio Service
- GSM → Global System for Mobile Communications
- GUI → Graphical User Interface
- HSDPA → High Speed Downlink Packet Access
- LOS → Line of Sight
- LTE FDD → Long Term Evolution Frequency Division Duplex
- LTE TDD → Long Term Evolution Time Division Duplex
- MIMO → Multiple-Input Multiple-Output
- NF/FF → Near Field to Far Field Transformation
- NMEA → National Marine Electronics Association
- NR → New Radio
- RSSI → Received Signal Strength Indication
- OTA → Over the Air
- RTT → Radio Transmission Technology
- SPE → Spatial Radio Environment
- TIS → Total Isotropic Sensitivity
- TRP → Total Radiated Power
- TX → Transmitted power
- Wi-Fi → Wireless local area network

MVG - Testing Connectivity for a Wireless World

The Microwave Vision Group offers cutting-edge technologies for the visualisation of electromagnetic waves. Enhancing the speed and accuracy of wireless connectivity testing, as well as the performance and reliability of anechoic and EMC technologies, our systems are integral to meeting the testing challenges of a fully-connected world.

WORLDWIDE GROUP, LOCAL SUPPORT

Our teams, located in offices throughout the world, guide and support you through purchase, design, delivery, and installation. Because we are local, we can assure speed and attention in project follow through. This includes customer support and maintenance, once the system is in place. For the exact addresses and up-to-date contact information, see us at: **www.mvg-world.com/contacts**

Contact your local sales representative for more information
mvg-world.com/wavestudio
salesteam@mvg-world.com