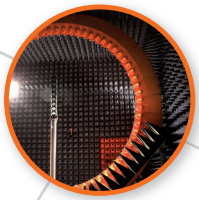


5G by MVG

5G FR1 AND FR2 ANTENNA MEASUREMENT AND OTA TESTING SOLUTIONS OVERVIEW

mvg
Microwave Vision Group

SHAPING THE FUTURE OF 5G OTA TESTING

VISION – The connected society enabled by 5G

5G lays the foundation for a connected society in the near future. A world where everything that benefits from being connected will be connected. The Internet will shift from computer screens and smartphones into the physical world, where objects will communicate directly with each other. Examples range from automated factories with production and logistics efficiencies reaching new heights to self-driving cars and services, farming, medical services, consumer electronics, wearables, smart homes, smart cities etc. In short, this is the next digitalization phase of the world. Completely new businesses will be built on this opportunity. It is a movement that will impact all industries, across all markets around the world.

At the Microwave Vision Group (MVG), our ambition is to be at the leading edge of what the market needs in terms of 5G testing. As 5G is emerging into new industries and applications, we need to be flexible to rapidly respond to what would be beneficial for the markets. We work closely together with customers across the world to align our product roadmap with their product visions and needs, proactively driving the development of competitive test solutions.

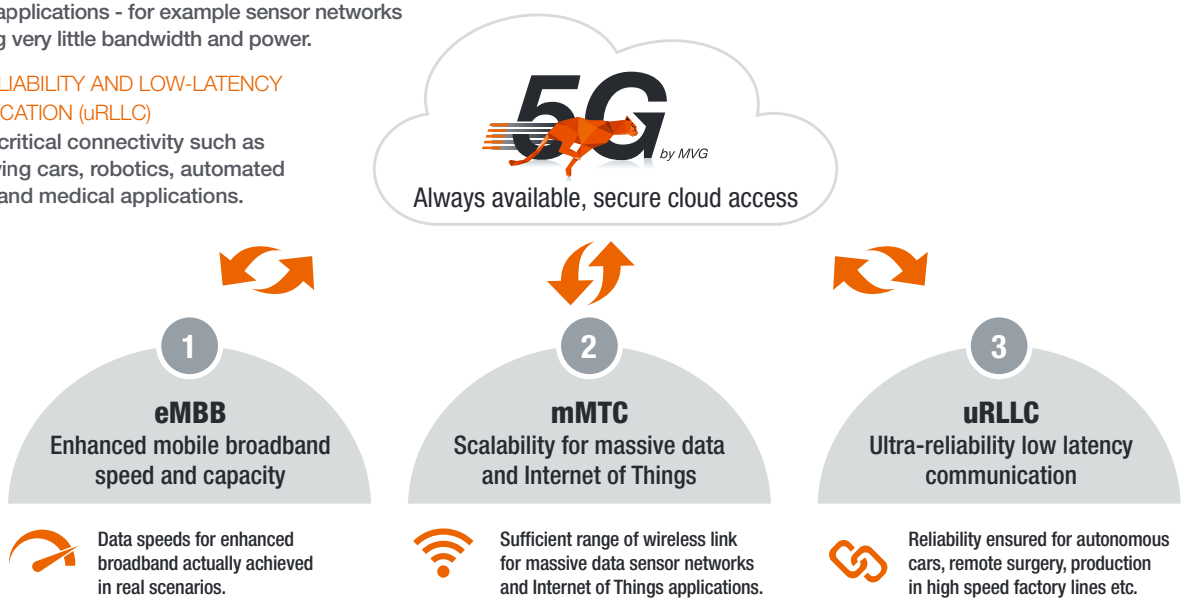
We believe that with MVG as a one-stop shop for wireless connectivity testing products and services, we enable customers to improve their competitiveness. In delivering turn-key systems, our customers can focus on their core competencies. The scope of the MVG product portfolio and technologies allows us to flexibly handle changing needs of customers both today and in the future.

CHALLENGE – Technological requirements that pave the way to 5G

What is 5G?

5G is the first-generation of wireless mobile standard developed for more than voice and data use. 5G networks will allow ten times higher bandwidth, manage a very large number of connection and ensure quick and reliable transmissions. Based on user experience, system performance, enhanced services, business models and management operations 5G connections will depends on the development of three cornerstones:

1. ENHANCED MOBILE BROADBAND SPEED AND CAPACITY (eMBB)
   Increased bandwidth and capacity for mobile data able to handle the ever-increasing amounts of wireless data traffic.
2. MASSIVE MACHINE TYPE COMMUNICATION (mMTC)
   Reduced overhead for massive scale Internet of Things applications - for example sensor networks consuming very little bandwidth and power.
3. ULTRA-RELIABILITY AND LOW-LATENCY COMMUNICATION (uRLLC)
   Real time critical connectivity such as in self-driving cars, robotics, automated factories, and medical applications.



All this backed up by central and local Clouds through the 5G networks, enabling a multitude of services to be efficiently rolled out. There is a broad spectrum of ways the 5G standard can be adapted to handle all the application cases of the connected world.

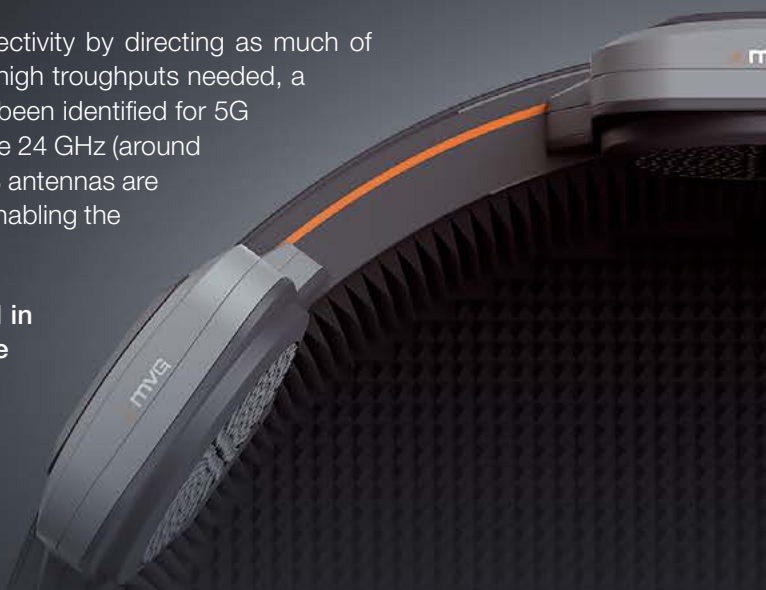
Ensuring the wireless connectivity performance is fundamental for realizing the vision of 5G

What is critical for enabling all of this to work as expected is the wireless link. Radio performance is the parameter that is most difficult to control, as this performance is heavily device and installation dependent. It is of paramount importance to be able to accurately secure the desired wireless performance in the products and services rolled out on the market, in order to fulfill the expectations of the service. The promise of 5G is based on lab results in ideal conditions, while the performance achieved in real life will depend on how well the radio performance actually works. This needs to be tested for each device and application.

Over-The-Air (OTA) testing challenges for the 5G network

Tests and measurements of 5G enabled devices and base transceiver stations (BTS) differ significantly from what was done before. From a technical perspective, introducing mmWaves devices into our telecommunications network poses a number of testing challenges. The RF architecture in 5G devices and the higher frequencies used will require tests traditionally performed through coaxial cables in RF labs to be tested OTA, as there won't be any physical connectors available in the devices. In addition to antenna testing, all other RF system performance and radio resource management parameters need to be tested OTA instead of through cables.

5G uses dynamically steerable beams to maximize connectivity by directing as much of the signal towards the devices as possible. To handle the high troughputs needed, a much larger and widely available contigous spectrum has been identified for 5G evolution in the centimeter and milimeter-wave bands above 24 GHz (around 28 GHz and 39 GHz). With a frequency up to 100 GHz BTS antennas are evolving from passive antenna to active antenna systems enabling the implementation of Massive MIMO.



As a result, 5G devices and network have to be tested in different configuration at the system level and over the air (OTA). To date, three OTA testing methodologies have been approved by 3GPP for conformance testing of mmWave user equipment and base station: direct far-field, indirect far-field and near-field to far-field transformation.

Innovator's DNA

Innovative solutions serving present & future customer testing needs.

ENERGY

Measure the amount of energy emitted by antennas

This measurement quantifies the efficiency of the conversion.

An antenna converts existing electrical quantities in a conductor or a transmission line to electromagnetic quantities in space (electric and magnetic fields), either in transmission or in reception.

SPACE

Determine in which directions energy is radiated

This involves determining the radiation pattern of the antenna.

In a smartphone, for example, the manufacturer seeks a radiating pattern that is well distributed throughout all directions in space, because it is not possible to predict from the phone's direction given by the user. However, in the case of a radar, the manufacturer aims to focus maximum energy in one direction in space to measure with the utmost precision where detected devices may be located.

INTEGRATION

Integrate the antenna into structure

This involves integrating developed antennas into a structure, such as a mobile phone, a car, or aircraft.

To this end, MVG has developed a line of high-value-added post-processing software and systems specifically designed for integration analysis, coupled with simulation software, enabling this detailed, essential study.

IMPACT – Product development towards the 5G era

5G is an evolving standard, and most importantly, the amount of applications and use cases are expected to increase over time as 5G is deployed in new industries and markets. This will drive a continuous need for new test solutions, as well as adaptations of existing solutions to be introduced.

One of the bigger challenges in the 5G markets is the test capacity increase needed for 5G product development, as most tests will be done OTA instead of through cables. We can see already now that companies are starting to transform their labs from purely conducted test labs to OTA-based test labs. Those tests will include the agility of the devices to network communication, including handovers in dynamic RF environment scenarios representing real environments.

Another challenge on the market is that companies that never have created wireless products before now need to become capable of performing wireless testing. In order to stay competitive, adding wireless connectivity to products that in the past were not connected is needed. Wireless connectivity will be as natural as the Internet is today, and this is a big change.

INFORMATION

Monitor the information carried by the signal

This involves transmitting data from several directions in space and reducing the level of energy emitted until communication with the device is no longer possible.

Innovation ++

FUNCTIONAL TESTING

Test the device in real conditions

These tests determine how a device will react in its real environment.

Will its performance be deteriorated by or can it take advantage of the barriers and disruptive objects that separate it from emission sources?

SOLUTION – Portfolio of test solutions for 5G

MVG offers a wide selection of solutions based on near-field, far-field and compact range measurement techniques for Antenna, EMC, RCS, and Radome testing. Our solutions support the measurement needs of the Aerospace & Defense, Telecommunications, and Automotive industries, as well as Academic and Research institutes.

MVG will benefit from 5G technology as our technological expertise is a trusted asset to both the Telecom and Aerospace & Defense markets. Technologies traditionally applied in our products mainly used in A&D markets can be used for high frequency 5G applications, bringing efficiency and fast time-to-market for customers. In combination with state-of-the-art multi-probe technology and advanced software applications for data processing and analysis, we are optimizing our technologies for 5G applications.

Little Big Lab systems

Large anechoic chambers traditionally need dedicated infrastructure, with extensive real estate and building construction requirements. As a convenient and flexible alternative, MVG created a series of compact and portable, all-in-one antenna measurement tools, called **“Little Big Lab” – *Little in size, BIG in performance.***

Multi-probe systems

As a testing technology, the highly effective multi-probe systems have evolved with the development of cellular and connectivity technologies in the last 25 years. They are today a reference for OTA testing of wireless devices. While concepts such as testing in near- and far-field (NF, FF) is less critical in current 1-4G standardization, OTA testing and performances of devices is likely to be a critical issue for 5G, including the necessity to test at system level the devices in electromagnetic dynamic environments created by a set of probes. Our multi-probe systems utilize MV-Scan™ technology to conduct fast, accurate, and smart antenna measurements and Radome tests. MV-Scan™ Technology is integrated in all multi-probe systems, allowing major improvements in terms of measurement speed.

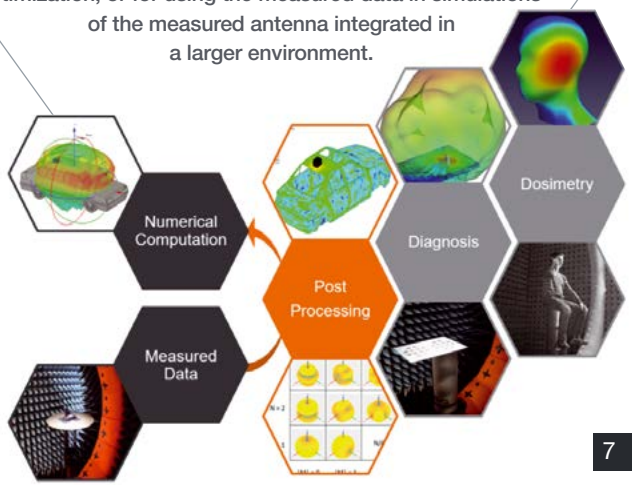
Assessing FF performance and performing direct FF testing can now be done in a compact environment by combining Plane Wave Generator (PWG) to a smart mechanical positioners. StarWaveTM Technology is offering a 5G FR1 and FR2 OTA testing solution creating an accurate indirect far-field conditions coupled with the possibility of live end-to-end testing.

Single-probe systems

MVG's single-probe systems are able to control in real-time up to four axes in parallel in near-field and far-field measurements. The systems utilize our MV-Cor™ correction table feature and high-speed linear motors to improve accuracy and measurement speed. Our single-probe systems are the solution for measurement of high frequency bands - above 50 GHz.

Advanced post-processing techniques

The NF-FF transformation produces mathematical expressions of measured antennas in the form of spherical, planar or cylindrical wave functions or equivalent currents. From these expressions, a large range of post-processing techniques, that bring more detailed information about the antennas are available. These insights can be used for diagnostic analysis in R&D or production, for performance optimization, or for using the measured data in simulations of the measured antenna integrated in a larger environment.



QUICK GUIDE – MVG 5G Antenna Measurement Solutions

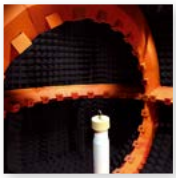
Little Big Lab





System name	StarLab 50 GHz	µ-Lab	Mini-Compact Range	Mini-TScan	MiniLab
Applications	• mm-Wave Antenna Measurement • mm-Wave OTA Testing • BTS antenna testing	• Chip measurements • Miniature connectorized antenna measurements • Measurements of laptops and other devices	• mm-Wave Antenna Measurement • mm-Wave OTA Testing	• Phased-array antenna testing • High-gain antenna testing • Near-field focused antenna testing • Array illumination assessment • Array element failure analysis	• IoT measurement • M2M • Smartphone • Radiation visualization • Active OTA measurements • Passive antenna efficiency
Technology	• Near-field / Spherical	• Near-field / Spherical • Far-field / Spherical	• Compact Range	• Near-field / Planar • Optional: Near-field / Spherical Near-field / Cylindrical	• Near-field / Spherical
Frequency bands	• 18 GHz to 50 GHz	• 50 - 110 GHz • 18 - 50 GHz optional • Other bands possible upon request	• CR-M12: 8 - 110 GHz • CR-M20: 4 - 110 GHz	• 1 GHz to 110 GHz	• 650 MHz to 6 Ghz
Max size of DUT	• 45 cm for spherical set-up	• On centered support column: as large as a standard laptop • On offset column for chip measurements: 5 cm x 5 cm (chipset)	• CR-M12: 30 x 30 cm • CR-M20: 50 x 50 cm	• Depending on the scan length and antenna length	• Up to 40 cm
Antenna directivity	• Low to High	• Low to High	• Medium to High	• High	• Low
Measurement speed	• 10 times faster than standard	• Standard	• Standard	• Standard	• 10 times faster than standard
Industries	• Aerospace & Defense • Telecom • Automotive • Academic & Research institutes	• Telecom • Academic & Research institutes	• Aerospace & Defense • Telecom • Automotive	• Aerospace & Defense • Telecom • Automotive	• IoT • Telecom
Website product page	https://www.mvg-world.com/Starlab50ghz	https://www.mvg-world.com/Microlab	https://www.mvg-world.com/CR-M	https://www.mvg-world.com/Minitscan	https://www.mvg-world.com/Minilab

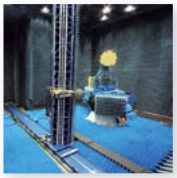
Multi-Probe






System name	StarMIMO	StarWave NEW	SG 24	SG 64	SG 128	SG 3000 F
Applications	• MIMO, diversity and beam-forming OTA testing • Virtual drive testing • End-to-end performance testing • Massive MIMO testing	• Antenna Measurement • OTA Testing • BTS antenna testing	• Antenna measurement • OTA testing • MIMO measurement • Linear array antenna measurement • CTIA certifiable measurement	• Antenna measurement • OTA testing • MIMO measurement • Linear array antenna measurement • CTIA certifiable measurement	• Antenna measurement • Linear array antenna measurement • Sub-system antenna measurement	• Vehicle testing
Technology	• Near-field/Spherical • Far-field • Spatial radio channel emulation of real world environments	• Full spherical measurement system in indirect Far-field condition according to 3GPP IFF specification	• Near-field / Spherical • Far-field	• Near-field / Spherical • Far-field	• Near-field / Spherical • Far-field	• Near-field / Spherical
Frequency bands	• 400 MHz to 6 GHz (depending on the specification of the spatial channel emulator) • 28 GHz	• 5G FR1 and FR2 are covered PWG6: 600 MHz – 6 GHz *(coming soon)* / PWG28: 24.25 GHz – 29.GHz *(available)* / PWG39: around 39 GHz - tbd *(under development)*	• SG 24 - Compact: 650 MHz to 6 GHz • SG 24 - Standard: 400 MHz to 6 GHz • SG 24 - Large: 400 MHz to 6 GHz	• SG 64 - Compact, SG 64 - Standard and SG 64 - Large: 400 MHz to 6 GHz • SG 64 - 18 GHz: 400 MHz to 18 GHz • SG 64 - LF: 70 MHz to 6 GHz	• SG128 - 6 GHz: 400 MHz to 6 GHz • SG 128 - 18 GHz: 400 MHz to 18 GHz	• 70 MHz to 6 GHz
Max size of DUT	• Depending on the number of probes / channels	• 35 cm (size of the QZ)	• 1.79 m for SG 24 - L	• 2.73 m for SG 64 - L	• 4.16 m	• 2.4 m x 6 m (W x L)
Antenna directivity	• Low to High	• Low to High	• Low to High	• Low to High	• Low to High	• Low to High
Measurement speed	• 10 times faster than traditional	• TBD	• 10 times faster than standard	• 10 times faster than standard	• 10 times faster than standard	• 10 times faster than standard
Industries	• Telecom • Aerospace & Defense • Automotive • Academic and research center	• Aerospace & Defense • IoT • Telecom • Academic & Researche institutes	• Aerospace & Defense • Telecom • Automotive • Academic & Research institutes	• Aerospace & Defense • Telecom • Automotive	• Aerospace & Defense • Telecom • Automotive	• Aerospace & Defense • Automotive
Website product page	https://www.mvg-world.com/StarMIMO	https://www.mvg-world.com/Starwave	https://www.mvg-world.com/SG_24	https://www.mvg-world.com/SG_64	https://www.mvg-world.com/SG_128	https://www.mvg-world.com/SG_3000F

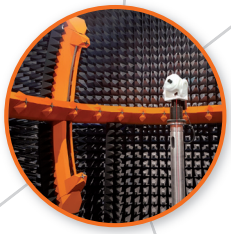
Single-Probe


System name	Compact Range	TScan	HScan
Applications	• Antenna measurement • Radome measurement • RCS measurement	• Phased-array antenna testing • High-gain antenna testing • Near-field focused antenna testing • Array illumination assessment • Array element failure analysis	• Space-borne antenna measurements • Payload testing • Phased-array antenna testing • High-gain antenna testing • Array illumination assessment • Array element failure
Technology	• Compact Range	• Near-field / Planar • Optional: Near-field / Spherical Near-field / Cylindrical	• Near-field / Planar • Near-field / cylindrical or Spherical - optional
Frequency bands	• Small: 2 - 110 GHz* • Medium: 700 MHz - 110 GHz* • Large: 700 MHz - 110 GHz*	• 100 MHz - 110 GHz	• 100 MHz - 110 GHz
Max size of DUT	• During full rotation of the DUT, the radiating parts of the DUT must stay within the quiet zone	• Depending on the scan length and antenna length	• Depending on the scan length and antenna length
Antenna directivity	• Medium to High	• High	• High
Measurement speed	• Standard	• Standard	• Standard
Industries	• Aerospace & Defense • Telecom • Automotive	• Aerospace & Defense • Telecom • Automotive	• Aerospace & Defense • Telecom • Research institutes
Website product page	https://www.mvg-world.com/Compact_Range	https://www.mvg-world.com/TScan	https://www.mvg-world.com/HScan

Hybrid

System name	T-DualScan	G-DualScan
Applications	• Antenna measurement • Pulsed measurement • Phased-array antenna measurement	• Antenna measurement • Pulsed measurement • Phased-array antenna measurement
Technology	• Near-field / Planar • Near-field / Cylindrical	• Near-field / Spherical • Far-field / Spherical
Frequency bands	• Single-probe: 800 MHz - 110 GHz • Multi-probe: 800 MHz - 18 GHz • Multi-probe: 70 - 800 MHz upon request	• Single-probe: 200 MHz - 18 GHz, divided in sub-bands (up to 40 GHz upon request) • Multi-probe: 400 MHz - 6 GHz (400 MHz - 18 GHz or 70 - 400 MHz upon request)
Max size of DUT	• Depending on the scan length and antenna length	• 7 m diameter
Antenna directivity	• High	• Low to High
Measurement speed	• Multi-Probe: 10 times faster than standard • Single-probe: Standard	• Multi-Probe: 10 times faster than standard • Single-probe: Standard
Industries	• Aerospace & Defense • Telecom	• Aerospace & Defense • Telecom
Website product page	https://www.mvg-world.com/T-DualScan	https://www.mvg-world.com/G-DualScan



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Learn more:
www.mvg-world.com/5G
salesteam@mvg-world.com

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