



SOLUTIONS FOR 5G WIRELESS TESTING

BEYOND MEASURE.™

 **ETS·LINDGREN**[®]
An ESCO Technologies Company

ETS-LINDGREN IS AN EXPERIENCED PARTNER YOU CAN TRUST

AS THE LEADER IN COMMERCIAL TEST AND MEASUREMENT, ETS-LINDGREN HAS CUSTOM 5G SOLUTIONS TO MEET ALL OF YOUR 5G TESTING NEEDS

Interested in Scheduling a 5G Presentation to Learn More?

ETS-Lindgren engineers have been invited speakers at recent corporate and IEEE sponsored events and webinars. If you would like to schedule a speaker in your area or join a webinar on the topic "RF Measurement Challenges for Emerging 5G and Millimeter Wave Devices", please contact Janet O'Neil at janet.oneil@ets-lindgren.com.

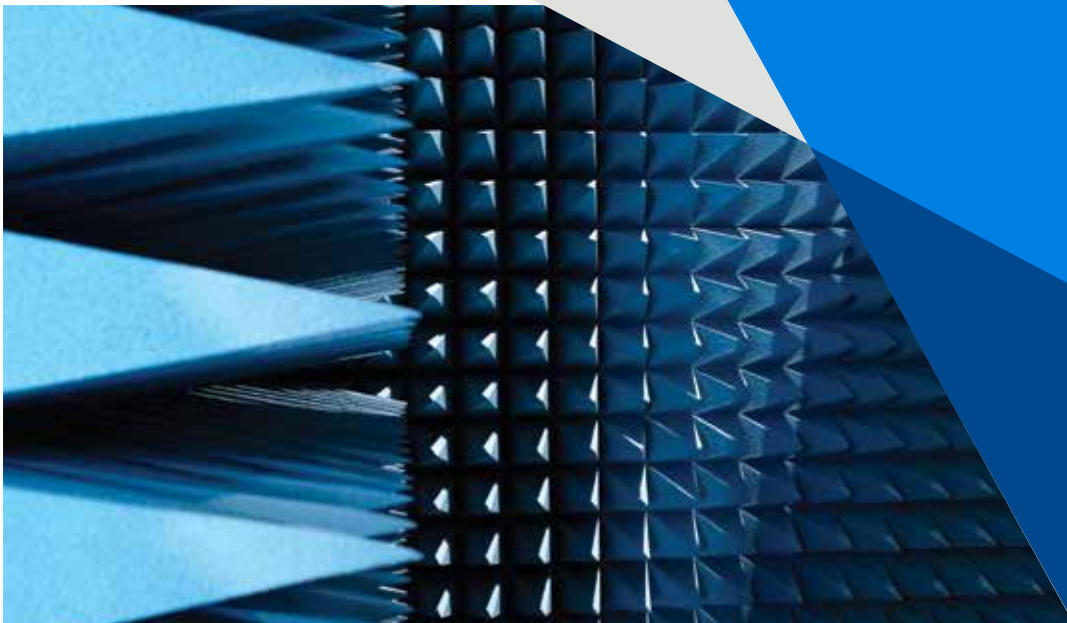
In the never-ending quest for more bandwidth, the wireless industry is moving towards technologies that will drastically alter the relationship between the radio and its antennas.

Existing Over-the-Air (OTA) test techniques were developed to address situations where interactions between the radio, antenna, and their embedded platform prevent their performance from being evaluated independently. However, as we move towards fifth generation (5G) wireless networks, the use of advanced adaptive antenna system (AAS) techniques including beam forming, as well as the expected move to millimeter wave (mmWave) frequencies, will have an unprecedented impact on existing RF testing of wireless devices. Since most of these 5G radio access technologies rely on integrated active antenna elements, the overall radio performance cannot be dissociated from the antenna performance. Thus, while OTA testing will face its own challenges in adapting to new 5G radios and mmWave devices, test techniques that traditionally relied on direct cabled connector access to the radio will now face a complete paradigm shift in the way testing must be performed. Common conformance and production line tests that are normally performed with a direct cable connection become impractical if not impossible when there are possibly hundreds of integrated antenna elements to be tested. Even electromagnetic compatibility (EMC) testing is impacted by the ever present active radio signal.

As the leader in RF, EMC, and OTA test and measurement solutions, with decades of experience in each of these test methodologies, ETS-Lindgren is uniquely qualified to address the emerging 5G and mmWave test requirements. Not only do we have the proven technical depth expected of an industry leader, we also have the capability to work with our customers to provide the optimal test and measurement solution for their specific product application. Since each wireless device manufacturer or carrier will have its own specific performance metrics, ETS-Lindgren offers customized solutions to meet these unique requirements.

ETS-Lindgren is an active contributor to many of the device certification standards for the wireless industry and has first-hand knowledge of the recent changes to the over-the-air performance requirements and standards development work in the 3GPP, CTIA, and Wi-Fi Alliance. This enables ETS-Lindgren to keep abreast of current and future activity on the compliance and regulatory standards generated by these committees. Our customers can be assured that an ETS-Lindgren test and measurement solution will prepare them for meeting current and future requirements.

For more information, please contact your local ETS-Lindgren representative.



5G MEASUREMENT SOLUTIONS: TEST COMPONENTS

ANECHOIC CHAMBERS

ETS-Lindgren is an in-house manufacturer of the shielded enclosures (Series-81 and Series-101) and absorber material (EHP-Series) it uses. This vertically integrated capability guarantees that every performance parameter is optimized to the highest level to meet customer expectations. With decades of experience, ETS-Lindgren can deliver promised performance from small table top test enclosures to very large test facilities. Our materials exceed the performance requirements introduced by the 5G industry moving into the mmWave wave spectrum.

POSITIONING SYSTEMS

With 5G technology moving into the mmWave spectrum and using adaptive antennas that are capable of creating extremely narrow beams, it is critical that the positioning systems are up to the task. With ETS-Lindgren's mmWave/precision positioning systems, the AUT's (Antenna Under Test) can be repeatedly positioned within a fraction of a degree to capture the small intricacies of the antenna patterns. ETS-Lindgren's single axis (2D pattern) and dual axis (3D pattern) positioners are designed to test of a wide range of devices, from small chipset size AUT's to large base station size AUT's. As an option, positioners can be designed to allow control signals to pass through them which allows control of the AUT during the test as needed.

ANTENNAS

ETS-Lindgren has a broad line of antennas suitable for 5G testing from the sub-6 GHz to mmWave spectrum. ETS-Lindgren's antennas are considered the benchmark within the industry. From innovative designs leading to the development of standards to defining the calibration procedures of antennas, measurements performed with ETS-Lindgren antennas can be trusted to be both accurate and repeatable.

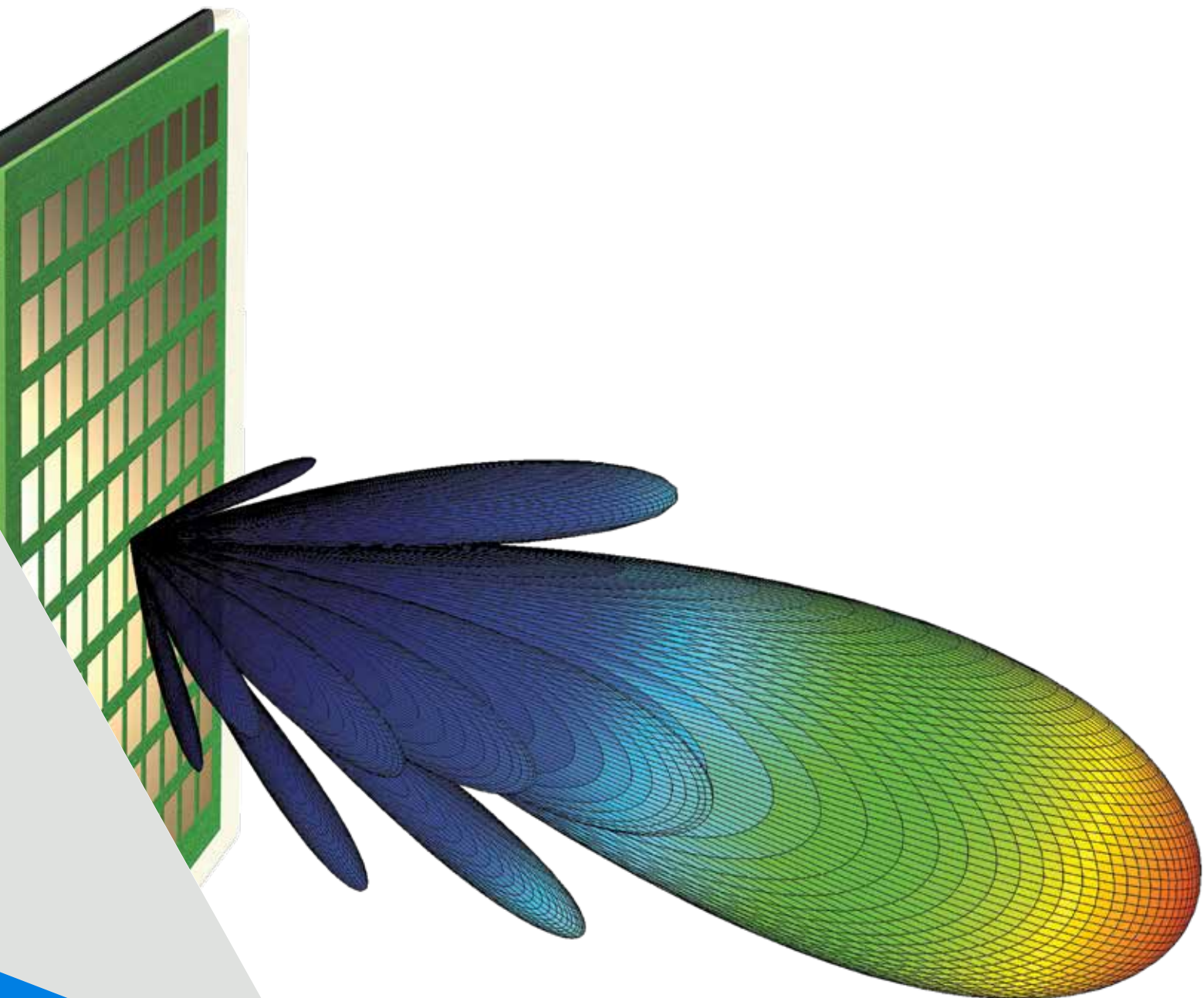
INSTRUMENTATION

Your RF test system can be delivered with carefully selected instrumentation that has been verified to give ideal overall performance for the entire measurement solution. ETS-Lindgren supports all the popular brands of instruments to make the selection process as flexible as possible while keeping in mind any preferences there might be.

5G MEASUREMENT SOLUTIONS: SOFTWARE

EMQUEST™ SOFTWARE

ETS-Lindgren's EMQuest™ EMQ-100 Antenna Measurement Software efficiently pulls together each piece of the hardware to create a powerful test solution. EMQuest EMQ-100 offers a wide range of fully parameterized test methods for measuring basic antenna performance metrics, as well as testing radiated performance of various wireless technology devices, including the different 5G technology variants from mmWave radios to Massive MIMO base stations. Whether you are designing antennas for stand-alone applications or testing an embedded antenna system and radio module against any of the industry standard Over-the-Air (OTA) radiated performance test requirements, EMQuest EMQ-100 provides the flexibility to meet your testing needs.





5G MEASUREMENT SOLUTIONS: TEST CHAMBER SYSTEMS

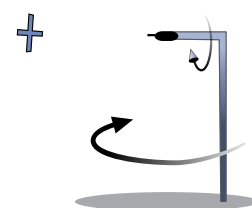
ETS-Lindgren offers a wide range of standard solutions for 5G performance testing whether it is a sub-6 GHz or mmWave device. If a custom solution is required, ETS-Lindgren has the experts to design and manufacture the ideal system for your project.

AMS-8000 SERIES TEST SOLUTIONS

The OTA test systems in the AMS-8000 series are used for 1G to 4G testing, with added capabilities to support other technologies such as Wi-Fi, Bluetooth, and GNSS below the 6 GHz frequency range. This makes them ideal solutions for 5G sub-6 GHz (3GPP FR1) testing requirements as well.

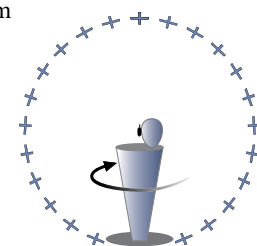
AMS-8500

AMS-8500 is a rectangular chamber with an absorber configuration providing optimal performance for OTA testing. This system is designed to operate down to 690 MHz using the embedded dual-polarized measurement antenna. The standard measurement antenna used in the AMS-8500 has an upper frequency range of 10 GHz, but the frequency range can be extended with different measurement antenna options. The system integrates ETS-Lindgren's Multi-Axis Positioning System (MAPS) to provide spherical positioning of the AUT in two orthogonal axes (theta and phi). Adjustment rails between the theta and phi axis positioners allow the user to position the AUT in the center of rotation for accurate antenna measurements. The MAPS is available with light duty, medium duty, and heavy duty masts, depending on user specific requirements.



AMS-8900

ETS-Lindgren's AMS-8900 series Antenna Measurement System is a high speed, multi-antenna test system designed for fully compliant radiated wireless antenna measurements. The AMS-8900 system includes dual-polarized antennas with either 15° or 7.5° antenna spacing. A high speed switching array integrated into the ring provides real-time swept data acquisition and near instantaneous stepped positioning. Its centralized system configuration ensures easy maintenance and superior reliability. AMS-8900 series chambers support testing from 690 MHz to 6 GHz as standard, or optionally 400 MHz to 6 GHz or 690 MHz to 10 GHz, depending on the antennas used on the ring.



The standard solutions in the AMS-8000 series offering include the AMS-8500 and AMS-8900 series systems. For more information on these and other AMS-8000 series systems, please see our website at ets-lindgren.com.

5G MEASUREMENT SOLUTIONS: TEST CELLS

AMS-5700 SERIES TEST SOLUTIONS

The AMS-5700 series test solutions are designed specifically for 5G testing in the mmWave spectrum (3GPP FR2). There are different test solutions available for 2D and 3D testing, depending upon the test requirements. The basic solutions can characterize the performance of the radio against the 3GPP FR2 test specifications where the antenna pattern is manually locked into a static mode. Traditional AUT manipulation techniques are used to obtain the required test parameters from the resulting pattern.

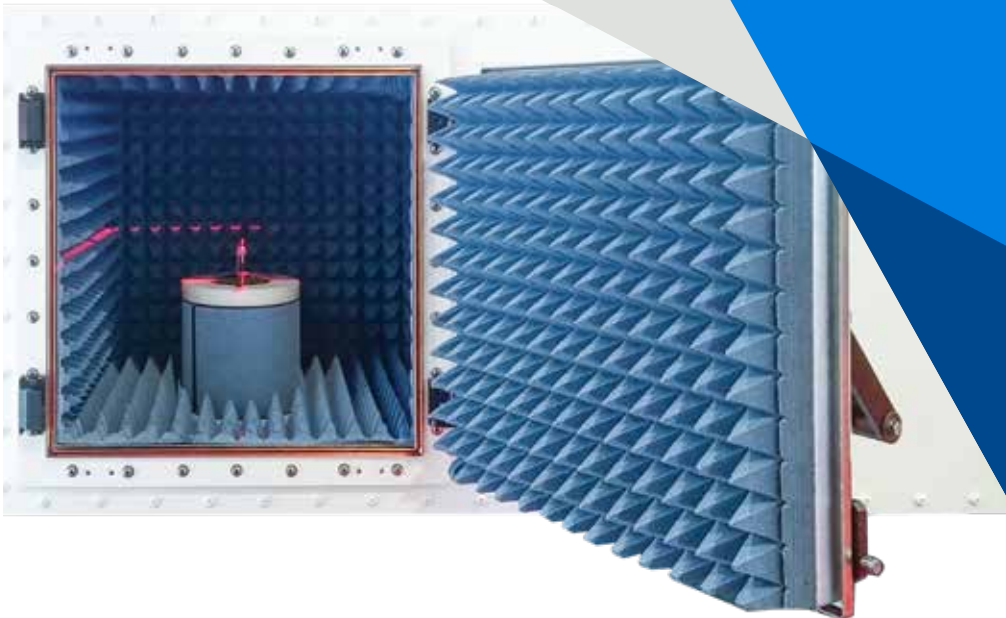
The AMS-5700 series also has solutions to understand the performance of fully implemented beamforming radios that are adapting to their environment. These solutions are available for both UE (User Equipment) and BTS (Base Transceiver Station) testing.

In the UE adaptive systems, the environment will introduce a series of signals-of-interest (SOI) and signals-of-no interest (SNOI) or interference to evaluate how well the device can maintain the connection in the changing environment. The resulting antenna pattern in this adaptive environment can then be probed to understand how high the peaks and how deep the nulls are.

The adaptive test system for 5G BTS or gNodeB (gNB according to the 3GPP New Radio 'NR') is designed to evaluate the Massive MIMO performance in gNB units. In the Massive MIMO test solution the gNB is placed in a controlled test environment containing multiple antennas or antenna arrays emulating multiple UE's active in the gNB field-of-view. In this test solution the UE's can be stationary or moving in accordance with a predetermined path, and the performance of the gNB is measured by its capability to provide a certain level of data throughput for all the different UE's emulated. This test solution can also be equipped with one or more interference or SNOI signals to try to interfere with the gNB's performance.

5G test requirements are still evolving and while we have a number of standard solutions to satisfy multiple levels of testing, we understand that our customers may have unique requirements that are not met by standard solutions. ETS-Lindgren is well equipped to create custom solutions with a unique set of requirements to meet your specific needs.

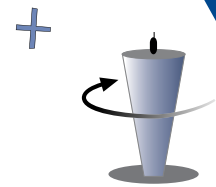




The following are some of our standard 5G/mmWave test cell solutions:

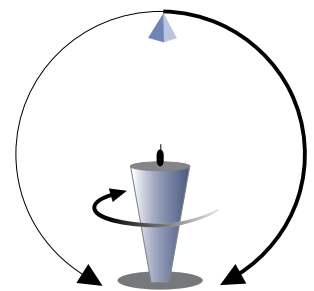
AMS-5700

This table top system was created to allow preliminary R&D level OTA testing where space is limited. The AMS-5700 has a single axis precision azimuth positioner to perform 2D measurements and has a nominal 100 cm (39.4 in) range length. The AUT positioner is equipped with a 50 GHz rotary joint to provide an RF signal to the AUT which, along with AC power and data connectivity via slip ring construction, allows for a continuous rotation of the AUT. The measurement antenna located at the end of the test cell is a dual-polarized antenna with frequency range coverage of the important 24 GHz to 50 GHz spectrum. To assist with the EUT alignment/positioning repeatability, the unit is equipped with a laser alignment system.



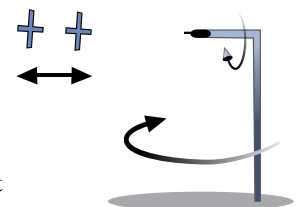
AMS-5701

The AMS-5701 can perform 3D evaluation of small size AUT's. The nominal range length of the solution is 80 cm (31.5 in) and utilizes the distributed axis approach with the measurement antenna mounted to a moving theta positioning arm to obtain spherical pattern information. The AUT phi positioner is equipped with a 50 GHz rotary joint to provide an RF signal to the AUT which, along with AC power and data connectivity via slip ring construction, allows for continuous rotation of the AUT. The measurement antenna located on the theta arm is a dual-polarized antenna with a frequency range coverage of the important 24 GHz to 50 GHz spectrum. To assist with the EUT alignment/positioning repeatability, the unit is equipped with a laser alignment system.



AMS-5702

The AMS-5702 can perform 3D evaluation of small size AUT's. The nominal range length of the solution is variable from 50 cm to 150 cm (19.7 in to 59.1 in) and utilizes a MAPS to obtain spherical pattern information. The AUT positioner is equipped with 50 GHz rotary joints to provide an RF signal to the AUT which, along with AC power and data connectivity via slip ring construction, allows for continuous rotation of the AUT in the theta axis. The measurement antenna located on the linear slide is a dual-polarized antenna with a frequency range coverage of the important 24 GHz to 50 GHz spectrum. To assist with the EUT alignment/positioning repeatability, the unit is equipped with a laser alignment system.



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