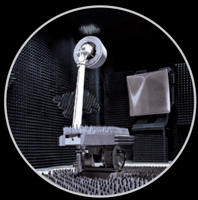
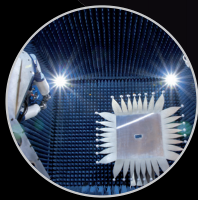
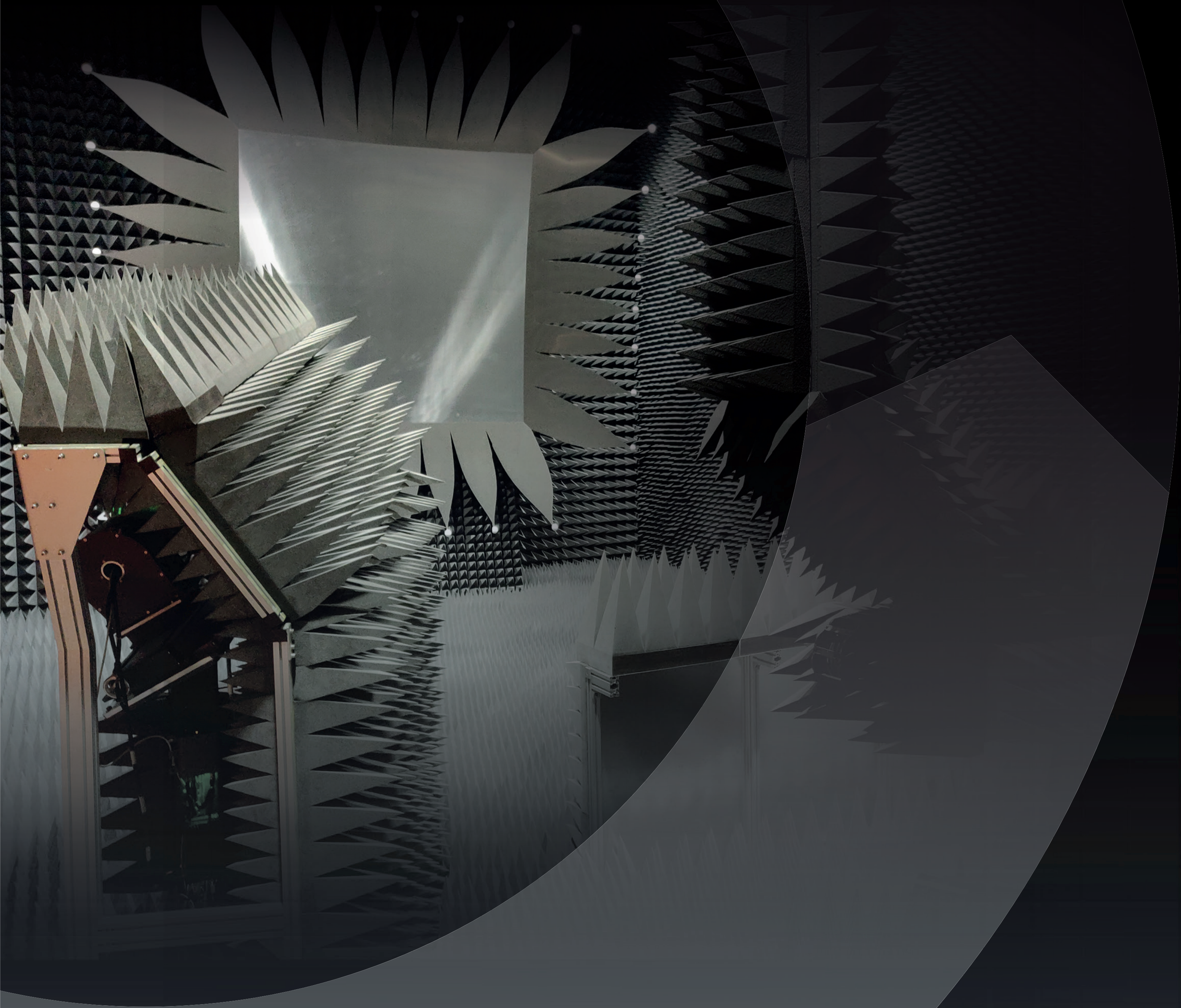
COMPACT RANGE

OVERVIEW

MVG
Microwave Vision Group

TABLE OF CONTENTS

Introduction

Antenna measurements in the far-field require that the antenna under test (AUT) be illuminated by a uniform plane wave. To achieve this uniform plane wave illumination, a very large distance between the antenna and the measurement source antenna is usually required. A **compact antenna test range** creates a plane wave field at distances considerably shorter than those needed under conventional far-field criteria. This shorter distance allows a compact range to be conveniently located near test or integration facilities and by placing it in a shielded anechoic chamber, interferences from external sources can be eliminated. The enclosed system is equally protected from weather conditions, and confidential information is better secured. Careful analysis of requirements and implementation of the appropriate compact range system within an efficiently sized anechoic chamber can result in a high performance test zone and optimized test results.

Over 30 years of engineering know-how goes into the design and manufacturing of compact range systems from MVG-Orbit/FR. This expertise carries through from the project analysis phase to implementation and installation. Precision, accuracy, and state-of-the-art technique are in every piece of equipment we build, with proven results in the numerous systems continuously in use today.

This document presents the **Compact Range Systems and Solutions** offered by MVG. Inside you'll find information on compact range subsystems, advantages of compact ranges, and guidelines for standard compact range solutions. Precision installation, alignment, and field probe verification of quiet zone quality are all services provided as standard elements of compact range systems by MVG-Orbit/FR.The information in this brochure is non-exhaustive. We encourage you to contact our Sales team to discuss options and solutions to best meet your requirements.

mvg.link/compact_ranges

Compact Range Technology

Compact ranges provide an efficient means for obtaining a uniform plane wave illumination over a test object in a distance substantially shorter than in a comparable far-field range. Compact Ranges use a source antenna, which radiates a spherical wave, in conjunction with one or more reflectors to collimate this spherical wave into a plane wave.

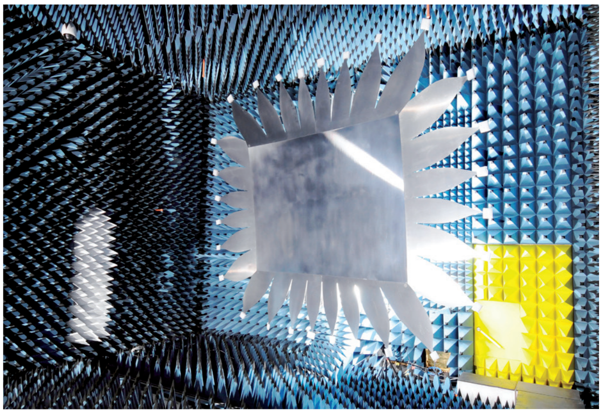
Based on the geometrical-optical principle, the parabolic reflector needs precision in its design to achieve expected performance in a wide frequency range; from low frequencies where the compact range reflector is only a few wavelengths in size, up to very high frequencies where the reflector can reach hundreds of wavelengths. Consideration must also be given to the feed horn, and its positioning in relation to the reflector, as well as the absorber layout and separation distance between the absorbers and the reflector in the anechoic chamber.

Reflectors

One of the most important compact range design goals is to minimize reflector edge diffraction. This is very much the equivalent to designing a low sidelobe antenna. However, the requirements of an ultra-wide frequency range and maintaining a uniform illumination over the largest possible center section of the test zone have resulted in reflector shapes very different from typical antenna reflectors.

Serrated edge

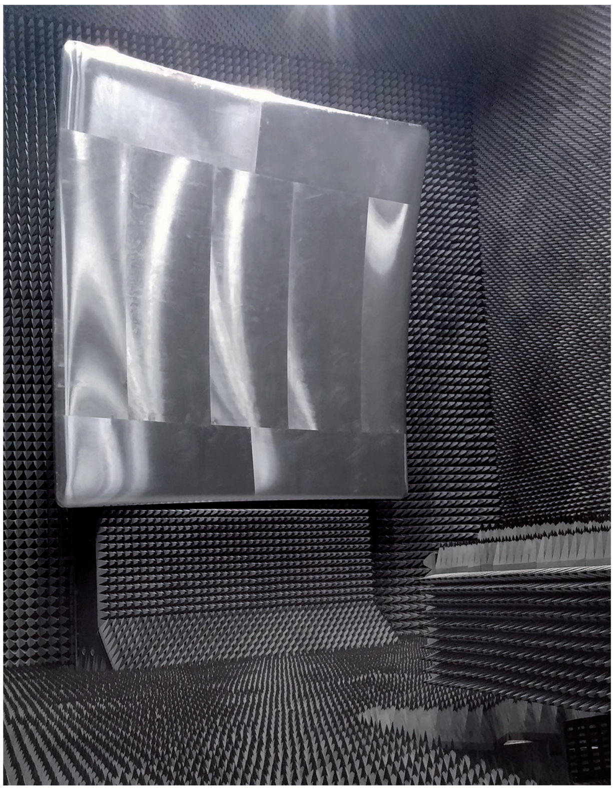
The prevalent compact range reflector shape presents the serrated edge design, where the reflector has sharp indentations all along its rim. These indentations are designed such that the edge diffraction energy is directed away from the test zone. MVG has optimized this design over the years for wide frequency band general purpose use, and can further optimize the serration shape for specific applications and requirements.



A Compact Range facility at the Georgia Tech Research Institute in Atlanta

Rolled edge

A second common compact range reflector shape presents rolled edges. Here the edge of the reflector is designed with a smooth transition in the curvature from the parabolic center section to the convex-shaped rim to direct the energy from the reflector edges away from the test zone. A rolled edge reflector has lower diffraction levels than a serrated edge reflector, making it particularly suited for high accuracy measurements of low side lobe antennas. Through its accurately defined continuous edge it is also especially suited for applications with frequencies above 100 GHz.

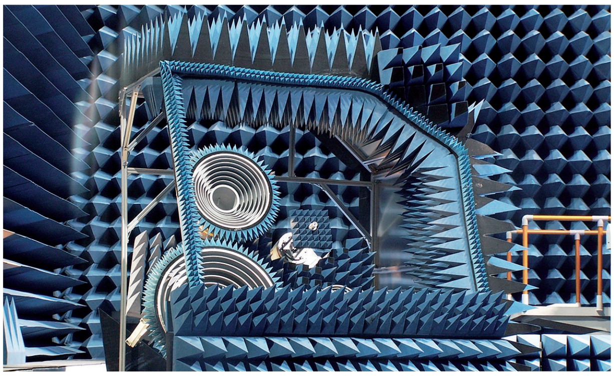


Corner or floor-fed geometries

MVG compact ranges can be configured for corner-fed or floor-fed geometries. These geometries minimize direct feed leakage into the quiet zone for most antenna measurement applications. For special applications, side-fed compact ranges can be designed and manufactured.

Compact range feeds

For the highest test zone performance, a compact range is typically illuminated with a corrugated horn. Several types of corrugated and choked horns are available, offering a choice between amplitude taper and ripple versus quiet zone size. Alternatively broadband horns can be used when a continuous wide frequency range is required.



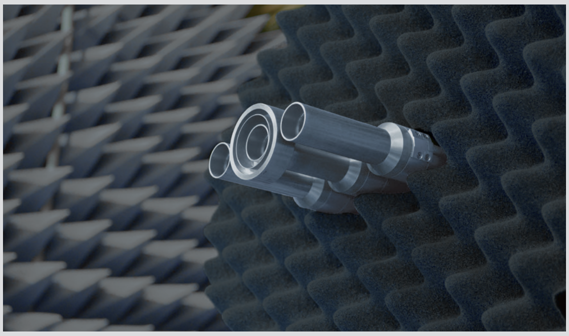
Most horns are available in single and dual linear polarization. Circular polarization is typically calculated from two linear polarizations, but also circular polarized feeds can be used.

Offset system and cross polarization

An offset parabolic reflector system as used for compact ranges has inherent cross-polarization. The MVG standard designs have typically -40 dB cross-polarization in the center of the quiet zone and -30 dB cross-polarization at the edge of the test zone. Several technologies can be offered to improve cross polarization, with various trade-offs in cost, performance and implementation.

INNOVATION

The dual-polarized CXR feed significantly improves the cross-polar performance of single reflector Compact Antenna Test Range (CATR) systems.



In the most common compact range reflector systems, a large reflector is illuminated by a feed to ensure that the amplitude and phase variation is minimal across the Quite Zone (QZ). To avoid obstruction by the feed an offset reflector geometry is used. This offset geometry causes a cross-polarization as a function of position in the QZ.

Accurate testing of low cross-polar antennas in CATR requires a QZ with high polarization purity. It is well known that such a condition is only achieved for testing scenarios where the Antenna Under Test (AUT) only uses the center part of the QZ. Unfortunately, this requirement makes the accurate measurement of cross-polar performance rather difficult for physically large antennas, such as arrays or reflector antennas, or antennas naturally offset in the QZ since they are mounted on a structure, as is the case with satellite antennas.

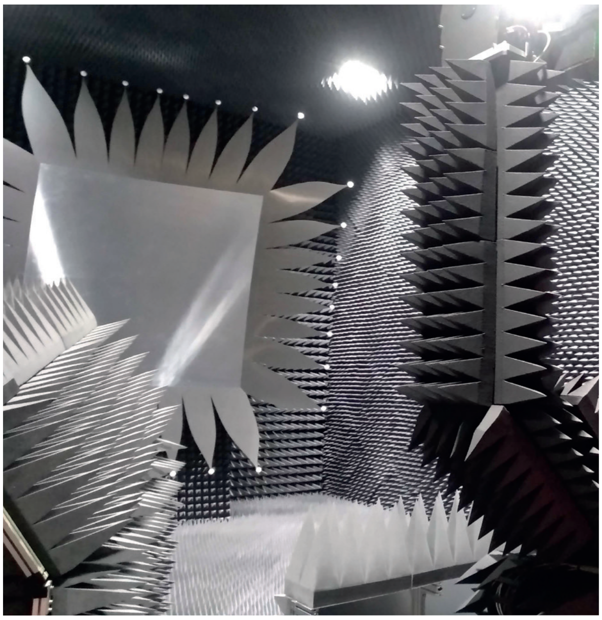
When testing electrically large antennas, the QZ cross-polar performance is often the reason that a more complex and expensive compensated dual reflector CATR, consisting of a hyperbolic and a parabolic reflector, is chosen rather than a single reflector or dual parabolic cylinder reflector CATR. The complexity and cost deterrent is why much research has been done on minimizing the QZ cross-polarization of the single reflector CATR. Solutions such as reflector geometry adjustments, other hardware improvements and post-processing techniques have been proposed over the years, but the drawbacks of these techniques have been a hindrance for their widespread use.

The CXR feed is a plug-and-play component that performs cross-polar reduction, replacing the need for a second reflector as in a compensated CATR reflector system. This feed concept is a breakthrough in compact range systems as it extends their cross-polarization measurement capabilities without any of the traditional limitations and at the affordable cost of a feed replacement. The CXR feed has been conceived to significantly improve the cross-polar accuracy of offset single reflector systems. The concept behind the CXR feed is the cancellation of the Geometrical Optics (GO) cross-polar component induced by an offset reflector by means of an innovative architecture providing conjugate field matching in bandwidth of 1.5:1.

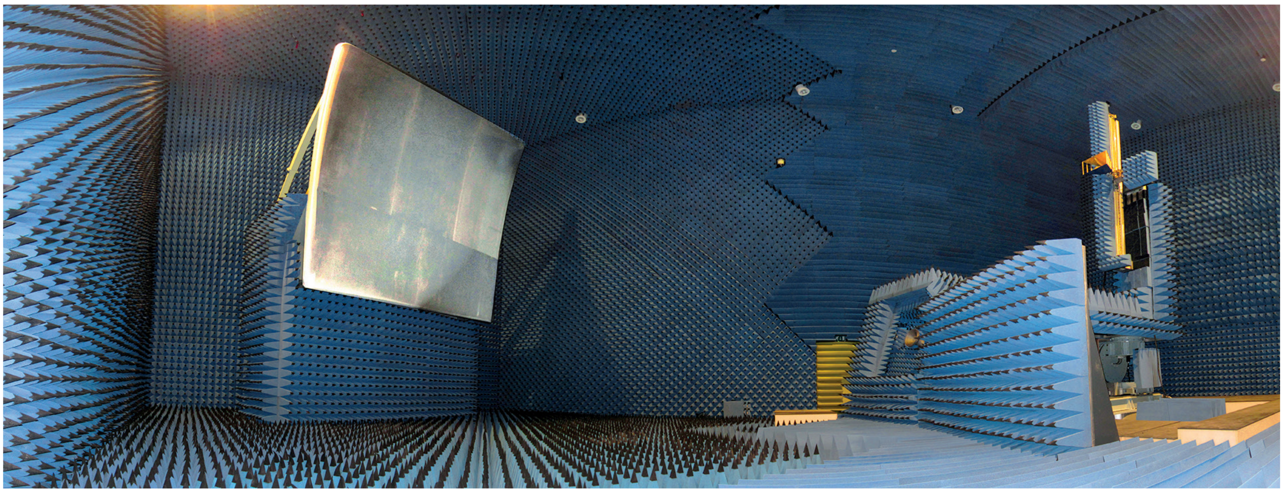
See datasheet @ mvg.link/CXR_feed

Less is more

Particularly suited for the testing of directive antennas, compact ranges offer performance advantages over conventional far-field and near-field ranges, depending on the application. In general, the compact range offers a much smaller overall test facility size than comparable far-field ranges, and provides results with equivalent or better performance indoors than might be achieved on an outdoor range. This has the obvious advantage of high up-time, as logistics and weather are issues that may impede range usage on a long outdoor range. For some applications, the compact range also has several advantages over near-field solutions. Although the DUT is illuminated with a uniform plane wave as in real antenna use, it is not required to collect a complete set of data over the test antenna aperture in order to evaluate a single far-field pattern cut. Using a compact range the desired cut can be measured directly, making the rapid evaluation of antenna performance possible. In addition to antenna measurements, a compact range is also well-suited for radome and radar target measurements, which can be cumbersome and time consuming in traditional near-field. Thirdly, compact ranges enable system level testing, that is, the output of a complete or partial system, including processing electronics, to be evaluated directly as a function of antenna direction. This is frequently not possible with a near-field test scenario.

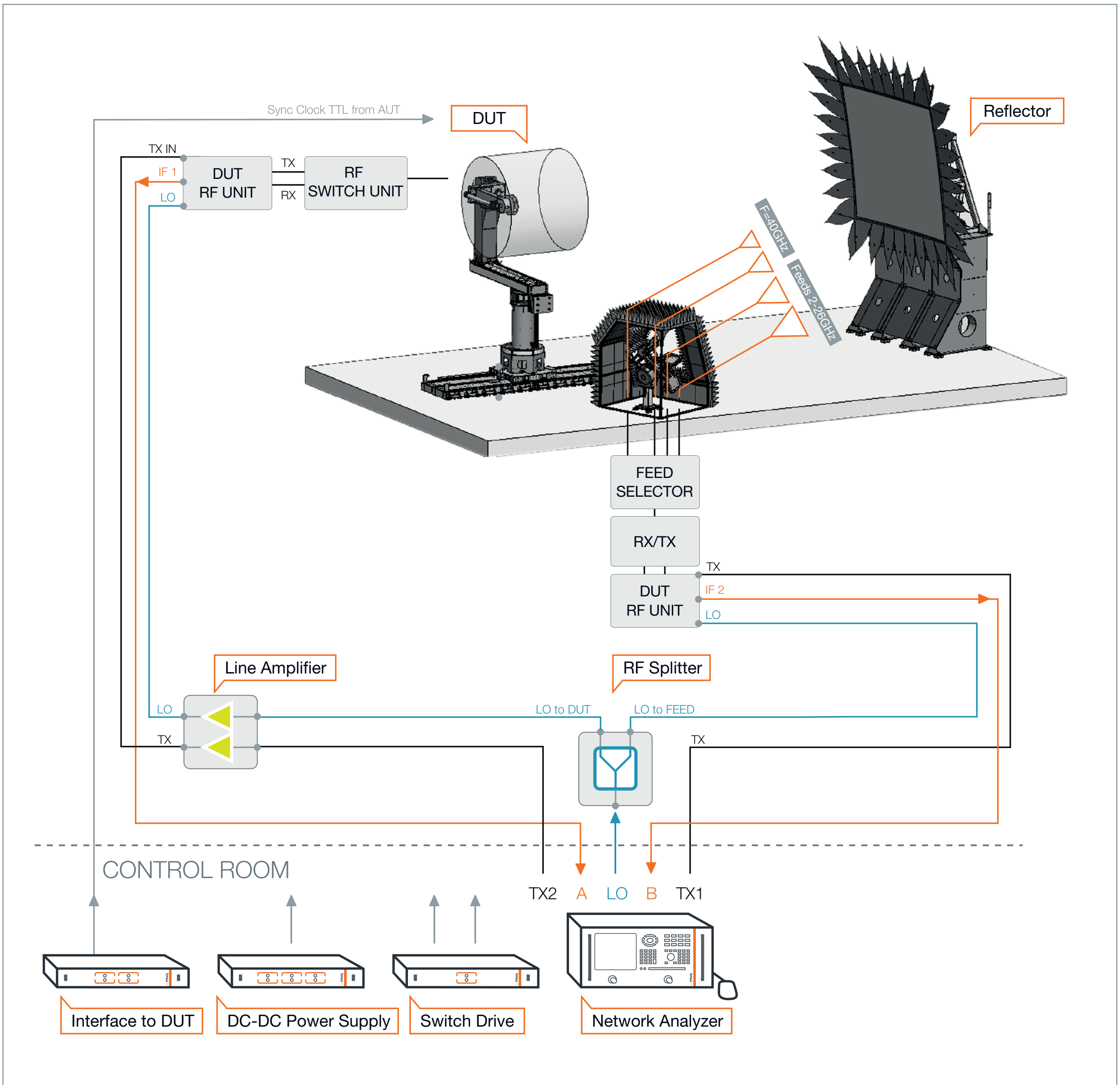


Feed, serrated-edge reflector, and positioner in a compact range



Compact range with a rolled-edge reflector

System overview



The lowest operational frequency of a compact range system is detemined by the size of the reflector, the edge treatment and the absorbers.

The performance of the Compact Range improves in relation to the increase in frequencies to be measured yet is limited to the level determined by the manufacturing accuracy of the reflector. Considering the small sizes of high frequency antennas, the upper frequency can be well above 100 GHz. MVG has already delivered systems for use up to 500 GHz.

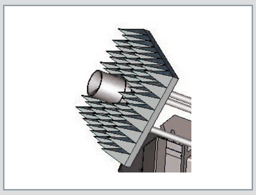
The RF transmit/receive system is supported by a VNA. Depending on the size of the range, amplifiers may be required. Above certain frequencies, a remote mixing configuration is required to avoid high RF cable losses at higher frequencies. Dual polarized feeds and multiple channel DUTs can be handled by optional RF switches and high speed switch controllers.

The data acquisition workstation is equipped with powerful data acquisition and analysis software.

Standard system components

1 Reflector System

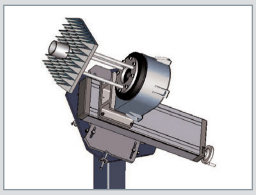
- Parabolic reflector
- Serrated-edge or rolled-edge
- Corner-fed, side-fed, or floor-fed systems
- Optional cross-polarization enhancement solutions



2 Feed Antennas

- A selection of compact range horns utilize a corrugated aperture design producing the rotationally symmetric patterns required for proper illumination of the compact range reflectors
- Optional CXR dual-polarized feed for improved cross polarization

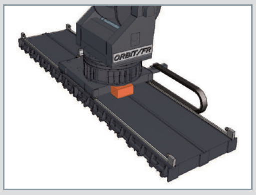
www.mvg-world.com/antennas



3 Feed Positioner

- Consists of a polarization positioner and a linear slide that allows non-standard feeds to be positioned exactly at the focal point
- Feeds for different frequency bands may easily and repeatedly be changed using a standardized mechanical interface
- Multiple feeds can be mounted simultaneously using an optional feed carousel or feed robot. Special feed assemblies are available for improved cross-polarization

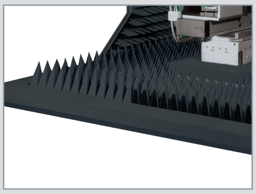
www.mvg-world.com/positioners



4 DUT Positioner

- A typical far-field antenna positioner, generally roll-over-slide-over-azimuth with an optional lower elevation axis for pick-up or an optional upper elevation or squint for boresight alignment.
- A complete range of rotary positioners and model towers

www.mvg-world.com/positioners

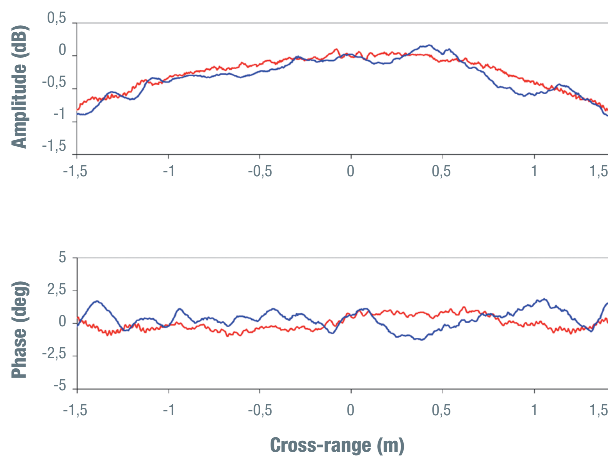


5 Absorbers and Anechoic Chambers

- An optimized combination of standard, adapted and specialty absorbers
- Size of anechoic chamber is based on selected quiet zone size

www.mvg-world.com/absorbers

Typical field probing performance of al–241010



Horizontal and vertical field probe cut, 18 GHz

Main Features

Direct far-field measurement of electrically large antennas

SOLUTION FOR

- **Directive antenna measurements**
- **Radome measurements**
- **RCS measurements**
- **System level measurements**

FEATURES

Technology

- Compact Range

Measurement capabilities

- Gain and directivity
- 2-D and 3-D radiation pattern
- Beamwidth
- Sidelobe levels
- Radiation pattern in any polarization (linear or circular) and cross-polarization
- Radome measurements
- RCS measurements
- EIRP and G/T (requires additional RF instrumentation)

Max. size of DUT

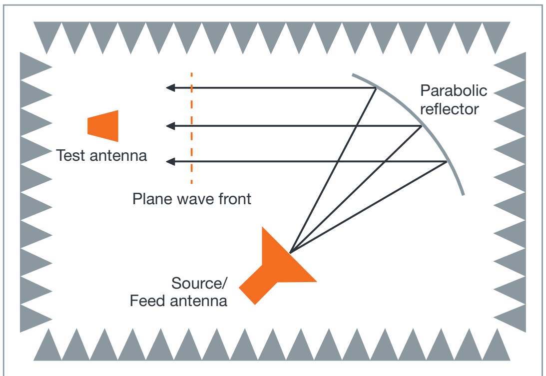
- During a full rotation of the DUT, the radiating parts of the DUT must stay within the quiet zone. If accuracy enhancement methods are desired or required, additional quiet zone space may be needed for the implementation of Antenna Pattern Comparison (APC) and other methods.

Max. weight of DUT

- 10 to 100 kg for small size system
- 100 to 1000 kg for medium size system
- 1000 kg and more for large size system

Typical dynamic range

- 50 to 80 dB, depending on antenna gain, frequency and RF instrumentation



SYSTEM CONFIGURATIONS

Equipment

- ■ Shielded anechoic chamber
- ■ RF absorber
- ■ DUT positioner (roll /tower/slide/azimuth)
- ■ Reflector system: serrated edge or rolled-edge
- ■ Feed horn (one horn, any band from 2 to 40 GHz)
- ■ Feed positioner (polarization positioner / manual slide)
- ■ Data acquisition workstation
- ■ Rotary joints
- ■ RF cables
- □ Real time controller (RTC)
- □ Remote mixing RF equipment
- □ Uninterruptable power supply
- ○ Vector network analyzer

Software

Measurement control, data acquisition and post processing

- ■ Wavestudio suite
- ■ 959 Spectrum (North America only)
- ■ MiDAS

Add-ons

- □ Feed horns (additional bands)
- □ Feed carousels for 3, 4, 5 or more feeds
- □ RF signal switching and conditioning
- □ Elevation squint adjustment
- □ Elevation for pickup

Accessories

- ■ Standard gain horns
- ■ Mounting fixtures

Services

- ■ Installation
- ■ Training
- ■ Warranty
- □ Post warranty service plans*

* go to: www.mvg-world.com/services

■ Included □ Optional ○ Required

Serrated-edge Reflectors

System specifications

	Quiet Zone Shape	Frequency Range	Quiet Zone Dimensions (W x H x L)	Cross Polarization (on-axis)	Amplitude Total Variation	Amplitude Taper	Amplitude Ripple	Phase Total Variation
AL-24404	CC	2-110 GHz	1.2 x 1.2 x 1.2 m 4 x 4 x 4 ft	-30 dB	2.2 dB (2-5 GHz)	1.0 dB (5-40 GHz)	± 0.6 dB (5-12 GHz) ± 0.4 dB (12-18 GHz) ± 0.3 dB (18-40 GHz)	16° (2-4 GHz) 10° (4-40 GHz)
AL-24406	EC	2-110 GHz	1.8 x 1.2 x 1.8 m 6 x 4 x 6 ft	-30 dB	2.2 dB (2-4 GHz)	1.0 dB (4-40 GHz)	± 0.6 dB (4-8 GHz) ± 0.4 dB (8-12 GHz) ± 0.3 dB (12-40 GHz)	16° (2-4 GHz) 10° (4-40 GHz)
AL-24505	CC	2-110 GHz	1.5 x1.5 x 1.5m 5 x 5 x 5 ft	-30 dB	2.2 dB (2-4 GHz)	1.0 dB (4-40 GHz)	± 0.6 dB (4-8 GHz) ± 0.4 dB (8-12 GHz) ± 0.3 dB (12-40 GHz)	16° (2-4 GHz) 10° (4-40 GHz)
AL-24508	EC	2-110 GHz	2.4 x 1.5 x 2.4 m 8 x 6 x 8 ft	-30 dB	2.2 dB (2-4 GHz)	1.0 dB (4-40 GHz)	± 0.6 dB (4-8 GHz) ± 0.4 dB (8-12 GHz) ± 0.3 dB (12-26 GHz) ± 0.4 dB (26-40 GHz)	16° (2-4 GHz) 10° (4-26 GHz) 0.4 * f ° (26-40 GHz)
AL-24606	CC	2-110 GHz	1.8 x 1.8 x 1.8 m 6 x 6 x 6 ft	-30 dB	2.2 dB (2-4 GHz)	1.0 dB (4-40 GHz)	± 0.6 dB (4-8 GHz) ± 0.4 dB (8-12 GHz) ± 0.3 dB (12-26 GHz) ± 0.4 dB (26-40 GHz)	16° (2-4 GHz) 10° (4-26 GHz) 0.4 * f ° (26-40 GHz))
AL-24808	CC	1-110 GHz	2.4 x 2.4 x 2.4 m 8 x 8 x 8 ft	-30 dB	2.2 dB (1-2 GHz)	1.0 dB (2-40 GHz)	± 0.6 dB (4-8 GHz) ± 0.4 dB (8-12 GHz) ± 0.3 dB (12-26 GHz) ± 0.4 dB (26-40 GHz)	16° (2-4 GHz) 10° (4-26 GHz) 0.4 * f ° (26-40 GHz)
AL-241010	CC	0.8-110 GHz	3.0 x 3.0 x 3.0 m 10 x 10 x 10 ft	-30 dB	2.2 dB (0.8-2 GHz)	1.0 dB (2-40 GHz)	± 0.6 dB (2-4 GHz) ± 0.4 dB (4-8 GHz) ± 0.3 dB (8-20 GHz) ± 0.4 dB (20-40 GHz)	16° (0.8 - 2 GHz) 10° (2-20 GHz) 0.5 * f ° (20-40 GHz)
AL-241212	CC	0.8-110 GHz	3.6 x 3.6 x 3.6 m 12 x 12 x 12 ft	-30 dB	2.2 dB (0.8-2 GHz)	1.0 dB (2-40 GHz)	± 0.6 dB (2-4 GHz) ± 0.4 dB (4-8 GHz) ± 0.3 dB (8-20 GHz) ± 0.4 dB (20-40 GHz)	16° (0.8 - 2 GHz) 10° (2-20 GHz) 0.5 * f ° (20-40 GHz)
AL-241618	EC	0.4-110 GHz	5 x 5.5 x 5 m 16 x 18 x 16 ft	-30 dB	2.2 dB (0.6-2 GHz)	1.0 dB (2-40 GHz)	± 0.5 dB (2-40 GHz)	16° (0.6-2 GHz) 10° (2-17 GHz) 0.6 * f ° (17-40 GHz)
AL-244040	CC	0.4-110 GHz	12 x 12 x 12 m 40 x 40 x 40 ft	-30 dB	2.2 dB (0.4-2 GHz)	1.0 dB (2-40 GHz)	± 0.5 dB (2-40 GHz)	16° (0.4-2 GHz) 10° (2-11 GHz) 0.9 * f ° (11-40 GHz)

CC = Circular Cylinder
EC = Elliptical Cylinder

Rolled-edge Reflectors

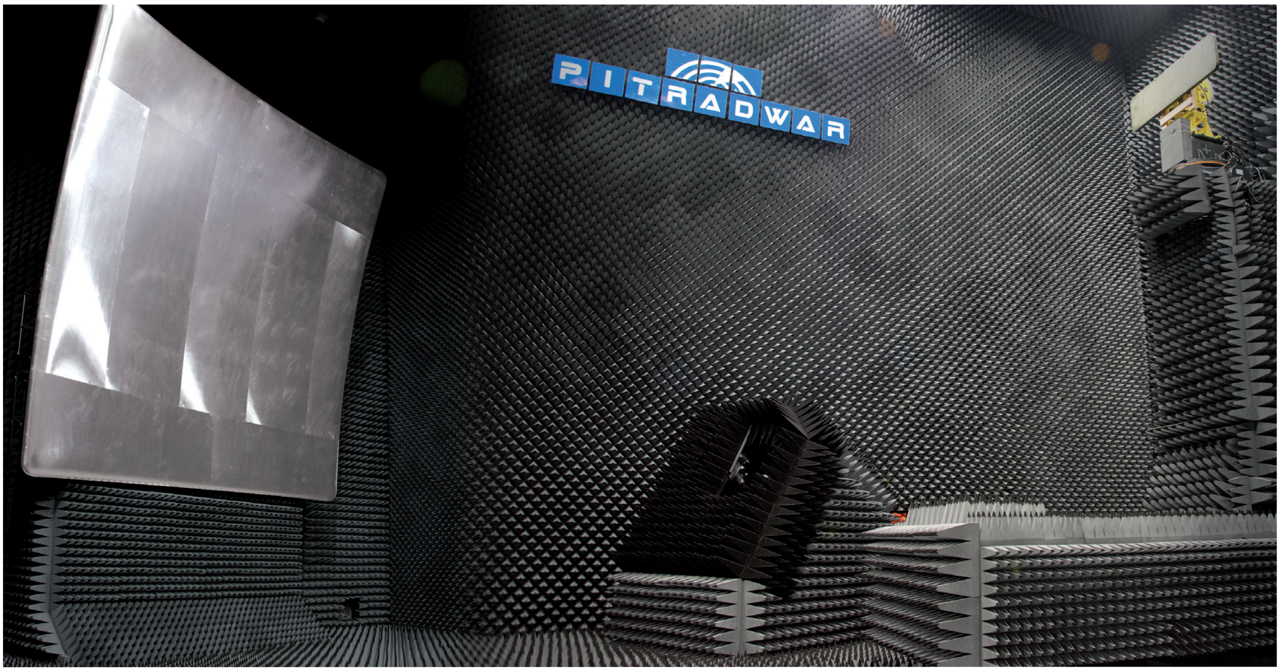
System specifications

	Quiet Zone Shape	Frequency Range	Quiet Zone Dimensions (W x H x L)	Cross Polarization (on-axis)	Amplitude Total Variation	Amplitude Taper	Amplitude Ripple	Phase Total Variation
AL-25202	CC	4-110 GHz	0.6 x 0.6 x 0.6 m 2 x 2 x 2 ft	-30 dB	1.9 dB (4-6 GHz) 1.7 dB (6-8 GHz)	1.0 dB (8-40 GHz)	± 0.4 dB (8-12 GHz) ± 0.3 dB (12-40 GHz)	12° (4-6 GHz) 10° (6-40 GHz)
AL-25303	CC	3-110 GHz	0.9 x 0.9 x 0.9 m 3 x 3 x 3 ft	-30 dB	1.9 dB (3-4 GHz) 1.7 dB (4-6 GHz)	1.0 dB (6-40 GHz)	± 0.4 dB (6-8 GHz) ± 0.3 dB (8-40 GHz)	12° (3-4 GHz) 10° (4-40 GHz)
AL-25404	CC	2-110 GHz	1.2 x 1.2 x 1.2 m 4 x 4 x 4 ft	-30 dB	1.9 dB (2-3 GHz) 1.7 dB (3-4 GHz)	1.0 dB (4-40 GHz)	± 0.4 dB (4-6 GHz) ± 0.3 dB (6-26 GHz) ± 0.4 dB (26-40 GHz)	12° (2-3 GHz) 10° (3-26 GHz) 0.4 * f ° (26-40 GHz)
AL-25606	CC	1.5-110 GHz	1.8 x 1.8 x 1.8 m 6 x 6 x 6 ft	-30 dB	1.9 dB (1.5-2 GHz) 1.7 dB (2-3 GHz)	1.0 dB (3-40 GHz)	± 0.4 dB (3-4 GHz) ± 0.3 dB (4-26 GHz) ± 0.4 dB (26-40 GHz)	12° (1.5-2 GHz) 10° (2-26 GHz) 0.4 * f ° (26-40 GHz)
AL-25808	CC	1-110 GHz	2.4 x 2.4 x 2.4 m 8 x 8 x 8 ft	-30 dB	1.9 dB (1-1.5 GHz) 1.7 dB (1.5-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-3 GHz) ± 0.3 dB (3-20 GHz) ± 0.4 dB (20-40 GHz)	12° (1-1.5 GHz) 10° (1.5-20 GHz) 0.5 * f ° (20-40 GHz)
AL-251010	CC	0.8-110 GHz	3.0 x 3.0 x 3.0 m 10 x 10 x 10 ft	-30 dB	1.9 dB (0.8-1.5 GHz) 1.7 dB (1.5-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-3 GHz) ± 0.3 dB (3-20 GHz) ± 0.4 dB (20-40 GHz)	12° (1-1.5 GHz) 10° (1.5-20 GHz) 0.5 * f ° (20-40 GHz)
AL-251212	CC	0.8-110 GHz	3.6 x 3.6 x 3.6 m 12 x 12 x 12 ft	-30 dB	1.9 dB (0.8-1 GHz) 1.7 dB (1-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-3 GHz) ± 0.3 dB (3-20 GHz) ± 0.4 dB (20-40 GHz)	12° (0.7-1 GHz) 10° (1-20 GHz) 0.5 * f ° (20-40 GHz)
AL-251216	EC	0.8-110 GHz	4.8 x 3.6 x 4.8 m 16 x 12 x 16 ft	-30 dB	1.9 dB (0.8-1 GHz) 1.9 dB (1-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-40 GHz)	12° (1-1.5 GHz) 10° (1.5-20 GHz) 0.5 * f ° (20-40 GHz)
AL-251616	CC	0.8-110 GHz	4.8 x 4.8 x 4.8 m 16 x 16 x 16 ft	-30 dB	1.9 dB (0.8-1 GHz) 1.9 dB (1-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-40 GHz)	12° (1-1.5 GHz) 10° (1.5 -17 GHz) 0.6* f ° (17-40 GHz)
AL-252020	CC	0.5-110 GHz	6.0 x 6.0 x 6.0 m 20 x 20 x 20 ft	-30 dB	1.9 dB (0.5 -1 GHz) 1.9 dB (1-2 GHz)	1.0 dB (2-40 GHz)	± 0.4 dB (2-40 GHz)	12° (1-1.5 GHz) 10° (1.5-17 GHz) 0.6* f ° (17-40 GHz)

CC = Circular Cylinder
EC = Elliptical Cylinder

Notes

1 For the required chamber size, please consult your MVG representative.
2 For performances above 40 GHz, please consult your MVG representative.
3 Specs are defined with compact range corrugated feeds.
4 Specs are defined at 95% confidence level.
5 MVG has already delivered systems for use up to 500 GHz.
6 All products and specifications are subject to change without notice.



Extra Large Compact Range - Pit-Radwar, Poland

MVG compact antenna test ranges are essential tools for antenna design, development, and quality assurance, as they provide controlled and repeatable testing conditions for various applications, including aerospace, telecommunications, and radar systems. The design and construction of these chambers must ensure accurate and reliable results, which is achieved through careful engineering and calibration.

MVG compact ranges are built to customer specifications. Please consult your local MVG representative for further information.

Looking for mini-compact ranges for a minimal footprint and to meet higher frequency challenges? MVG designs and manufactures many sizes of compact ranges. See mvg.link/compact_ranges for more options.

mvg.link/compact_ranges

MVG - Testing Connectivity for a Wireless World

The Microwave Vision Group - MVG offers cutting-edge technologies for the visualization of electromagnetic waves. With advanced test solutions for antenna characterization, radar signature evaluation and electromagnetic measurements, we support company R&D teams in their drive to innovate and boost product development.

WORLDWIDE GROUP, LOCAL SUPPORT

Our teams, in offices around the world, guide and support you from purchase, through design, to 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:
www.mvg-world.com/mvg-offices

Microwave Vision Group

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