Satellite Payload Near-Field Measurement Solutions

Precision Testing of Spaceborne Payloads

MVG
Microwave Vision Group

General Overview

As satellite technology evolves — incorporating increasingly compact and sophisticated RF payloads — the need for precise, reliable, and repeatable test systems becomes fundamental to mission success.

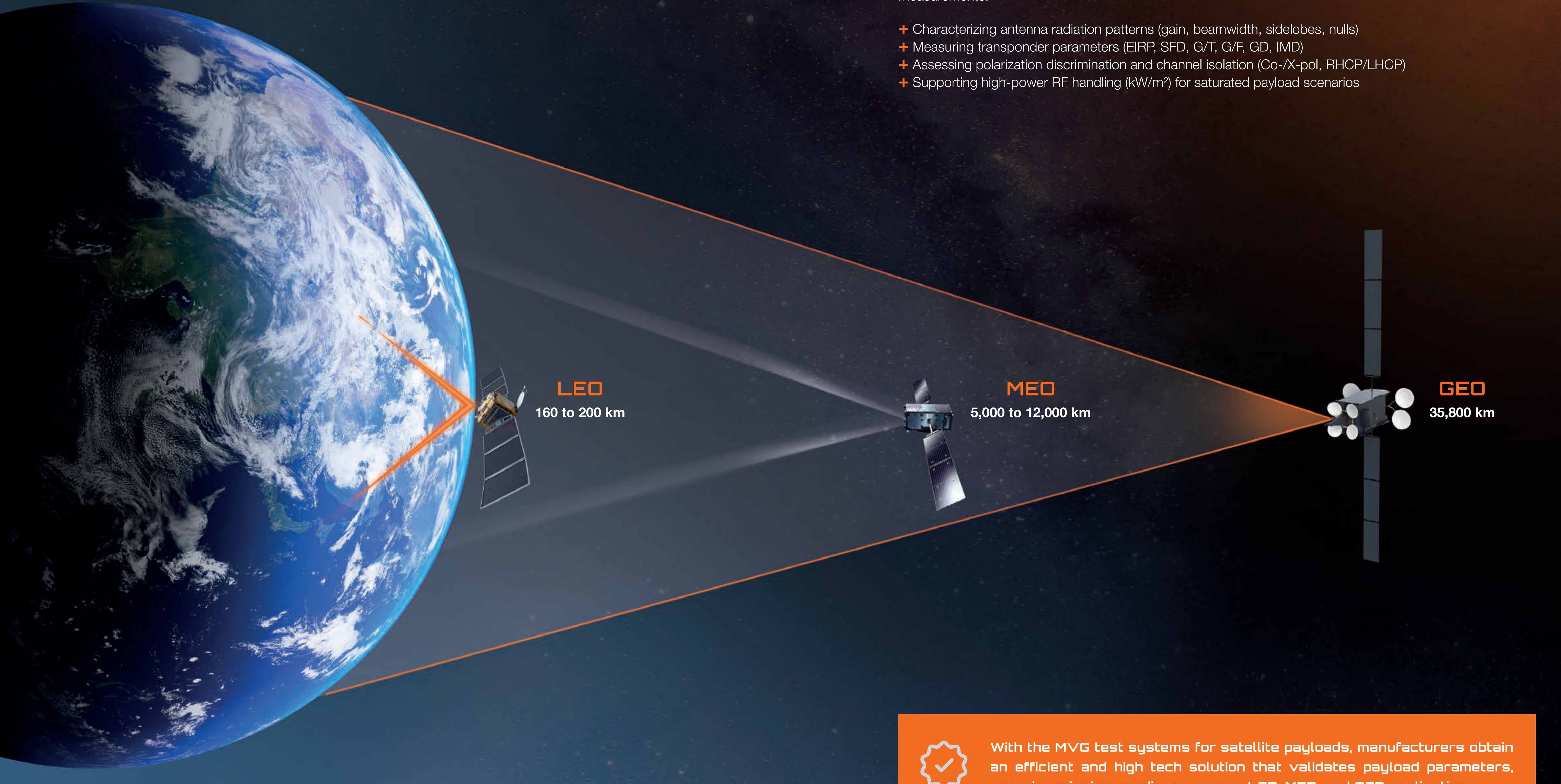
Satellite transceivers serve as the communication lifelines of spacecraft, linking them with ground stations and other orbital assets. Ensuring their optimal performance under mission-specific conditions is essential for both commercial and defense satellite programs.

Measurement Purpose and Testing Needs

Satellite payloads incorporate multiple RF subsystems such as antennas, amplifiers, mixers, filters, and switches that operate across a wide frequency range. To ensure these subsystems meet orbital performance requirements and function reliably, testing is required.

The MVG Planar Near-Field (PNF) systems are designed to support these needs by enabling the following measurements:

+ Characterizing antenna radiation patterns (gain, beamwidth, sidelobes, nulls)
+ Measuring transponder parameters (EIRP, SFD, G/T, G/F, GD, IMD)
+ Assessing polarization discrimination and channel isolation (Co-/X-pol, RHCP/LHCP)
+ Supporting high-power RF handling (kW/m²) for saturated payload scenarios



With the MVG test systems for satellite payloads, manufacturers obtain an efficient and high tech solution that validates payload parameters, ensuring mission-readiness across LEO, MEO, and GEO applications.

Why is Near-Field More Efficient than CATR Testing?

Testing satellite payloads in NF environment offers several key advantages over Compact Antenna Test Range (CATR) methods, both mechanically and in terms of RF performance:

Mechanically

+ NF systems allow horizontal scanning capability that minimizes the need for large and complex structures to support heavy payloads in unusual orientations and measurement of zero gravity antennas

Benefit

Reduces setup time, improves safety, and simplifies mechanical integration within cleanroom environments

+ During NF testing, the satellite remains completely stationary throughout the measurement process, keeping the Device Under Test (DUT) fixed while the probe scans across the defined measurement plane. In contrast, CATR systems typically require payload rotation or movement to achieve the necessary angular coverage

Benefit

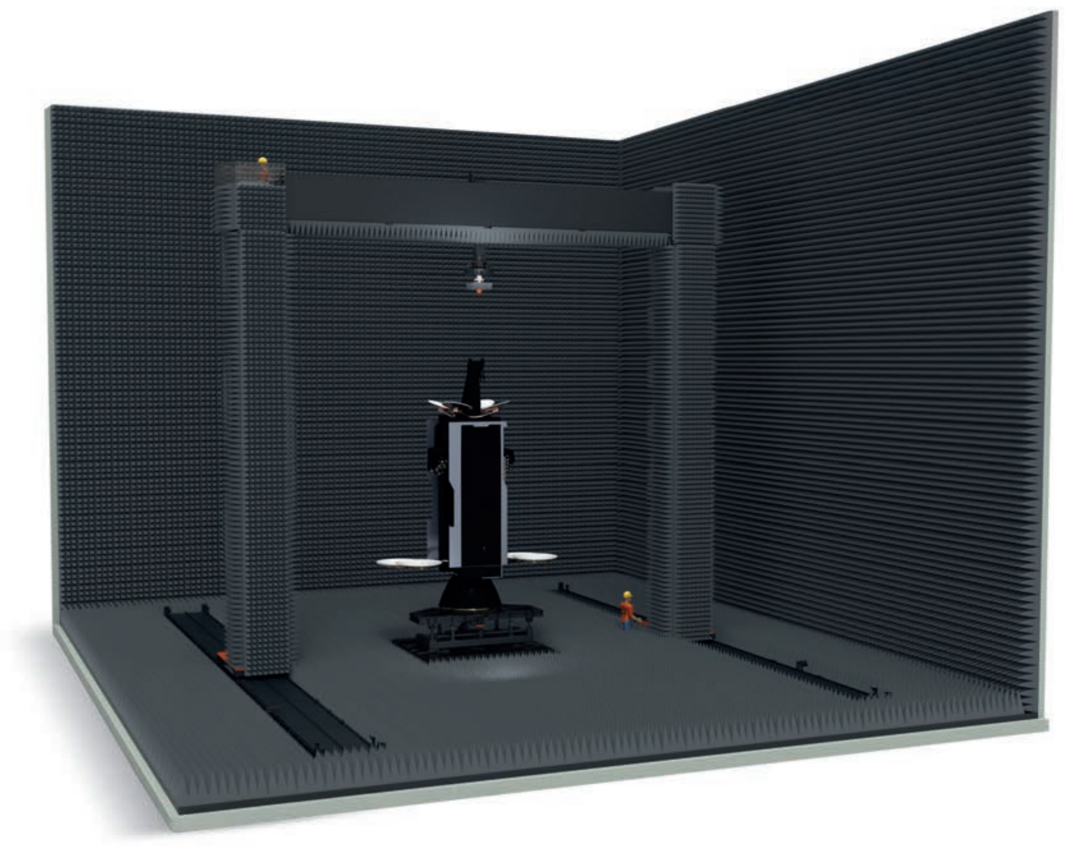
Eliminates the need for complex rotary fixtures, reduces mechanical stress on the structure, and maintains precise alignment in a gravitationally consistent configuration

RF Performance

+ Higher spatial resolution and dynamic range, enabling accurate reconstruction of the far-field pattern through well-established NF-FF transformation algorithms

+ Better control over probe positioning, polarization discrimination, and spatial sampling

+ NF techniques allow the use of probe correction, time-domain gating, and echo suppression techniques to isolate true payload performance with greater accuracy. In contrast to CATR, where residual reflectivity and quiet zone limitations can introduce measurement errors

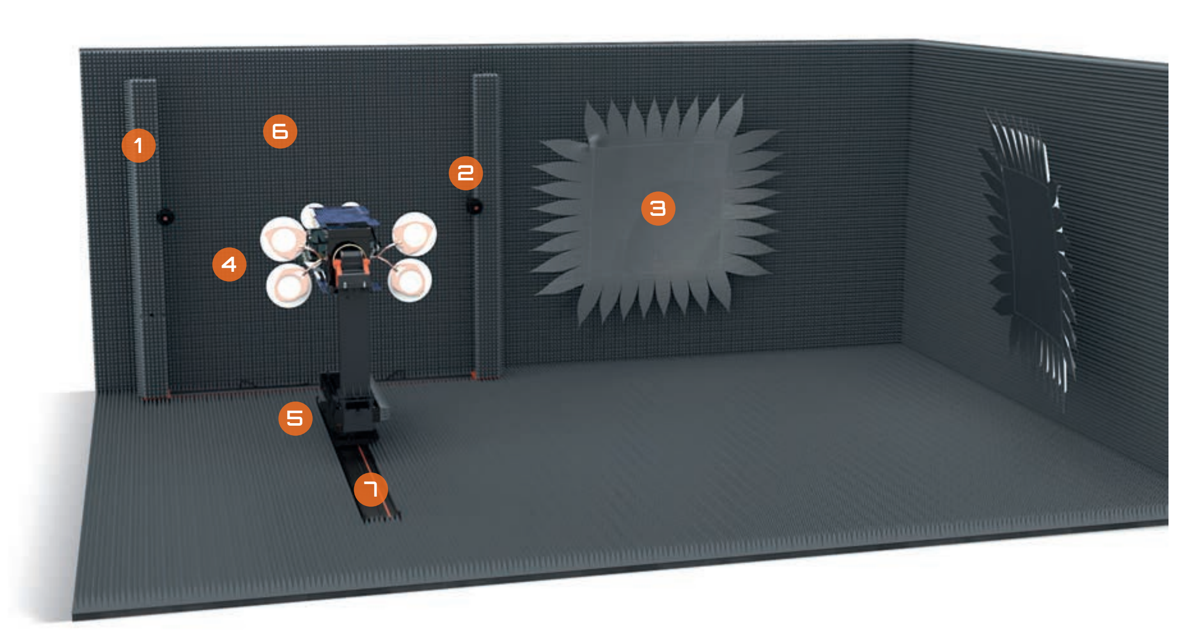


Upgrade an existing CATR System to MVG Dual-Mode Testing

Upgrading a CATR with the MVG planar NF technology enables dual-mode operation, allowing users to maintain their established CATR measurement workflows while also benefiting from wide frequency coverage (1 - 110 Ghz), high accuracy and resolution measurements — **without replacing existing infrastructure.**

The Planar NF scanner can be **seamlessly installed** along the chamber's side or back walls for **non-intrusive integration**, preserving the chamber's original performance. The result is a **flexible, future-proof testing environment** that adapts to evolving payload measurement requirements, **minimizes downtime, avoids costly redesign, and extends the value and capabilities** of existing test assets.

System Overview



1. **Vertical PNF scanner** with dual Y-towers for flexible AUT configurations and co-/cross-polarization acquisition
2. **Dual linear polarized minimum scattering NF probes**
3. **Dual reflector collimation system**
4. **Satellite payload Device Under Test** (characterization at sub system level and spacecraft level)
5. **Heavy duty DUT positioning system**
6. **Modular, shielded, high-power RF** enclosures and ISO 8 cleanroom compliance across all system components
7. **Heavy duty floor slide for relocating DUT from CATR to PNF system**

Main Features

Measurement capabilities

- Up to 64 RF ports for fast TX/RX channel switching
- EIRP, SFD, G/F, G/F, GD, IMD, group delay, and transfer function parameters
- **Antenna characterizations** at the antenna sub-system level and at the spacecraft level
- **Passive and Active (AESA) antenna** measurements
- **High pointing accuracy** for characterizing narrow-beam antennas, ensuring boresight alignment with respect to payload pointing has minimal error
- **High NF dynamic range measurements (> 60 dB)**

SOLUTION FOR

- **GEO, MEO, and LEO satellite payload qualification**
- **Solution for "zero gravity" measurement conditions needs**
- **Active phased array transceiver testing with real-time controller integration**
- **End-to-end system verification using high dynamic range and calibrated probe architectures**

FEATURES

- High-power capable: absorbers, probes, drive system and encoder are designed for Tx saturation radiation testing
- Multi-mode testing: Supports both passive and active antennas including phased-array synchronization
- High beam pointing accuracy for characterizing narrow-beam antennas, ensuring minimal error in boresight alignment with respect to payload pointing

Power Density Handling (DUT)

> 4 kW/m² (high-power handling)

Typical NF Dynamic Range

> 60 dB

Frequency Range

1.0 GHz – 40 GHz (extendable to 110 GHz)

Positioning Accuracy

± 0.02 mm (planarity < 0.05 mm RMS)

RF Port Switching Capability

Up to 64 ports

Calibration Accuracy

18-term uncertainty model (NIST-based)

SYSTEM CONFIGURATIONS

Equipment

- ■ Vertical PNF scanner with dual Y-towers for flexible AUT configurations and simultaneous uplink and downlink measurements
- ■ Horizontal PNF scanner dedicated to applications involving heavy-duty and complex payloads, including dish antenna measurements under zero-gravity conditions
- ■ Dual Linear Polarized Probes (DLP - PNF) with minimal scattering and wideband coverage
- ■ Positioning system designed to align DUT coordinates and boresight with beam pointing using a laser tracker system
- ■ Motion control and positioning systems designed to align to gravity and DUT coordinates via X-Y laser interferometers and laser trackers
- ■ Modular, shielded, high-power RF enclosures and ISO 8 cleanroom compliance across all system components
- ■ Advanced calibration routines and real-time controller synchronization for active antenna measurement modes

Polarization Support

Dual linear / circular (RHCP, LHCP)

Environment Compatibility

ISO 8 cleanroom

Safety Systems

Emergency stops, LiDAR curtains and distance lasers

Services

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

■ Included □ Optional

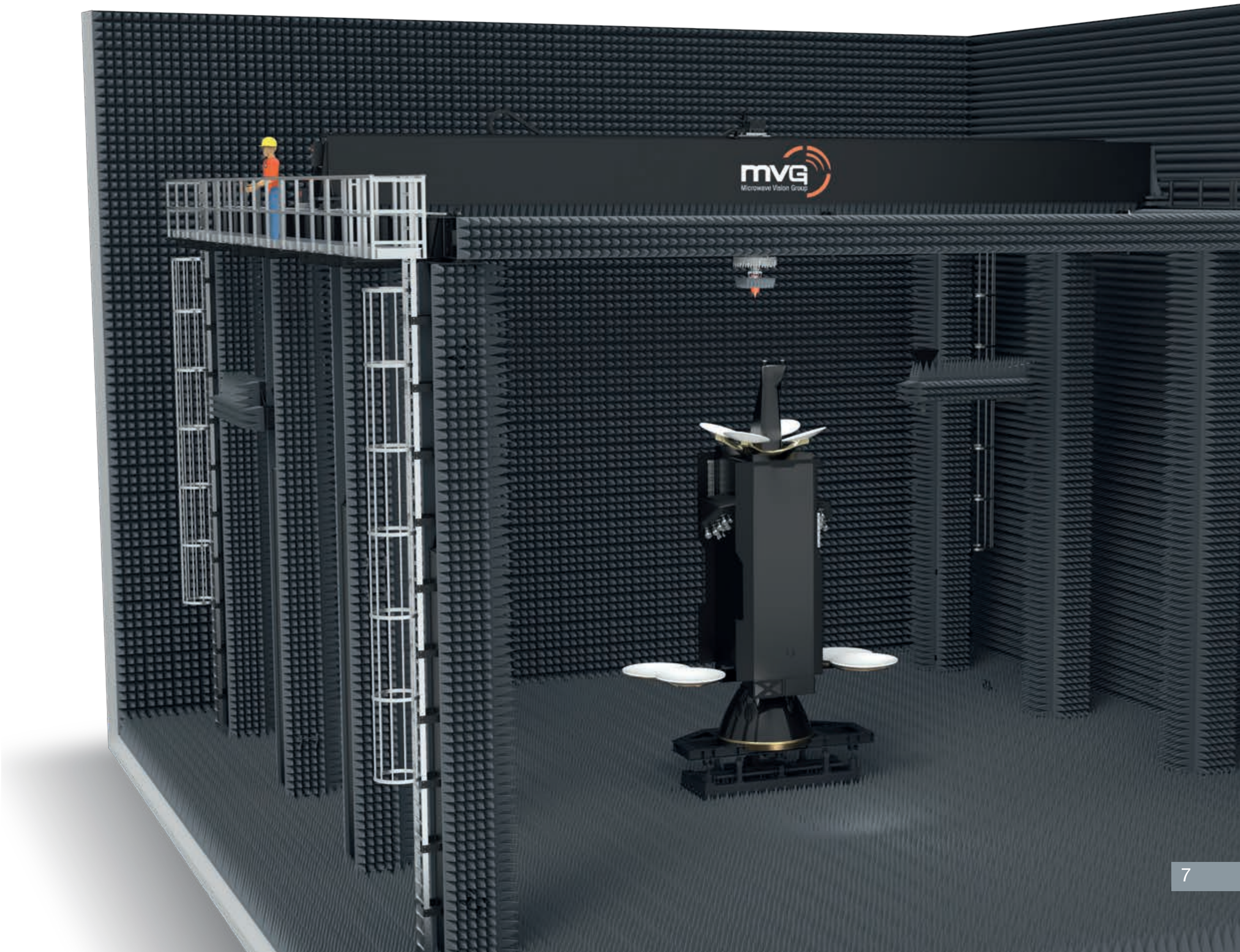
Specifications

Payload Parameter Measurement Accuracy

PARAMETER	ACCURACY
EIRP	± 0.5 dB
SFD	± 0.5 dB
G/T	± 0.7 dB
G/F	± 0.7 dB
Group Delay	± 0.5 ns
IMD	± 1 dB

Antenna Measurement Accuracy

MEASUREMENT PARAMETER	ACCURACY
Peak gain	± 0.3 dB
Side lobe	± 1 dB @ -30 dBc
Cross-Polar Discrimination	> 35 dB
Axial Ratio	± 0.05 dB
Pointing Accuracy	± 0.015 deg



Testing Connectivity for a Wireless World

The Microwave Vision Group 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.

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