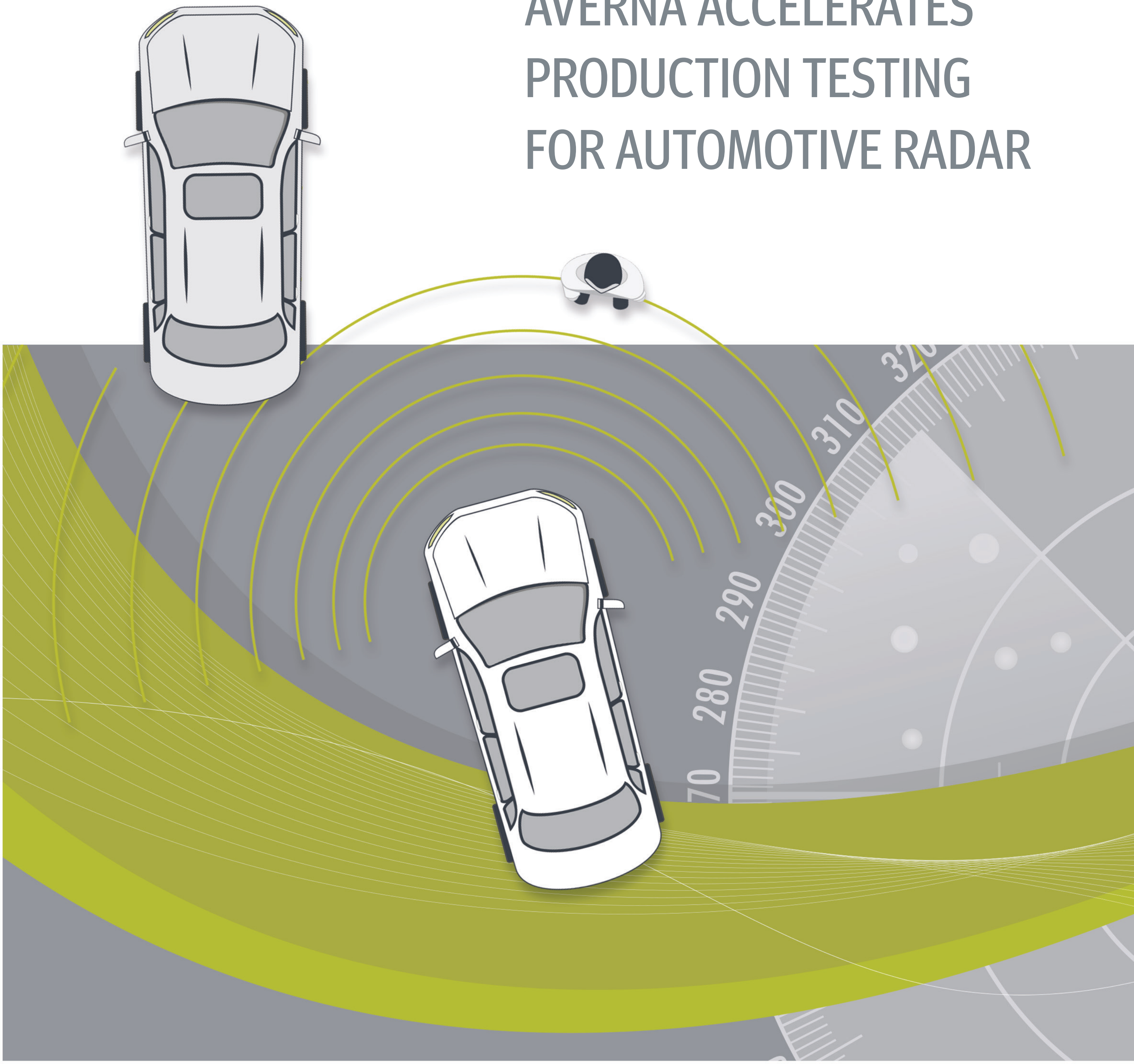
CASE STUDY / Automotive

DESIGN NPI PRODUCTION REPAIR

AVERNA ACCELERATES PRODUCTION TESTING FOR AUTOMOTIVE RADAR



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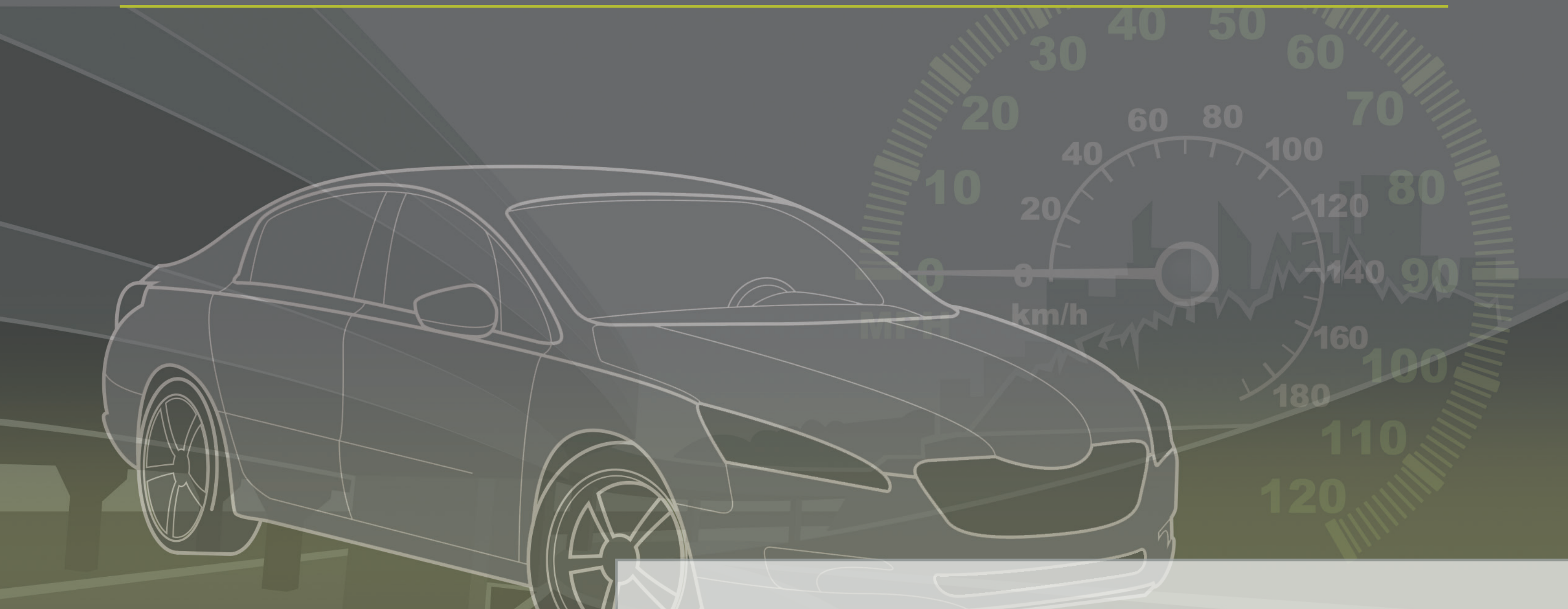


CHALLENGE

Automotive OEMs such as Averna's client must constantly innovate in order to provide comprehensive test coverage, accelerate throughput and extend the value of their test systems.

That's why they contacted Averna. Due to our vast experience in many industries and with numerous technologies, they sought an automated and flexible test system to meet many requirements.

For example, their existing system did not have enough RF bandwidth to perform all the required RF testing in one pass, so each device under test (DUT) required multiple passes.

And even though the system was partially automated, there were many issues with takt time. The system simply was not capable of high throughput, causing regular bottlenecks for the customer.

Other issues they sought to eliminate included dust accumulation and RF leakage within the test chambers, time-consuming manual DUT handling and human errors.

The Averna production-test system would need to:

- Replace a VXI-instrument-based test system with PXI(e) modules
- Feature completely new architecture to reduce test times
- Integrate multiple custom anechoic chambers
- Automate numerous processes and eliminate human errors
- Fully test and label up to 10,000 radar units per chamber per week

Averna's client designs, tests and delivers cutting-edge radar units for automotive OEMs.

Automotive radar systems help drivers avoid collisions and improve passenger safety.

RADAR CONTINUES TO TRANSFORM THE DRIVING EXPERIENCE

Over the past decade, various collision-detection (also called "collision-avoidance") systems have begun appearing in automobiles, primarily luxury vehicles. These systems comprise various technologies such as radar, lasers, cameras, and control systems all designed to improve safety on the road.

Whether driving down the autobahn at top speed, negotiating highly congested urban roadways, or trying to parallel-park in a tight space, today's drivers can have a wealth of powerful on-board systems and alerts to help them get where they are going safely.

Car makers are thus integrating a great deal of advanced RF, microwave, and electronics technology into their vehicles to warn drivers when they risk a collision. In anticipation of an accident, some systems can even apply braking and steering assistance, close windows, tighten seatbelts, raise headrests, etc.

SOLUTION

To solve the client's wide-ranging test needs, Averna proposed, designed and implemented a multi-faceted test solution for the client's production line.

To accomplish this, Averna assembled a team that included HW, SW, and mechatronics engineers, as well as a project manager, to ensure every requirement was met on time and on budget with the utmost quality.

The client was so content with Averna's solution that it ordered a duplicate system for a production line in another country. Both systems are high performance and comprise many automation, flexibility, and expansion features.

Averna's test system deliverables included:

- An NI VST with 200 MHz of bandwidth for RF testing
- A 6 DoF* robot that speeds up production testing
- Anechoic chambers that provide better throughput
- Reduction of DUT takt time and system MTBF**
- A flexible, transportable design for easy expansion/upgrades

RESULTS

THROUGH ITS DEEP TEST ENGINEERING EXPERTISE, AVERNA SIGNIFICANTLY IMPROVED THE CLIENT'S EOL TEST SYSTEM FOR AUTOMOTIVE RADAR UNITS, CUTTING TEST TIMES BY 50% WHILE ENSURING SUBSTANTIAL ONGOING ROI.

* Degrees of Freedom.
** Mean time between failures.

INDUSTRY CHANGES DICTATING TEST SYSTEM EVOLUTION

Automotive is one of the most competitive markets in the world. In dozens of countries, car makers are constantly rolling out new models, special features and tantalizing options. Just a few decades ago, most cars were considered simple conveyances to get you from one place to the next, while today they are marketed as lifestyle choices that provide user experiences.

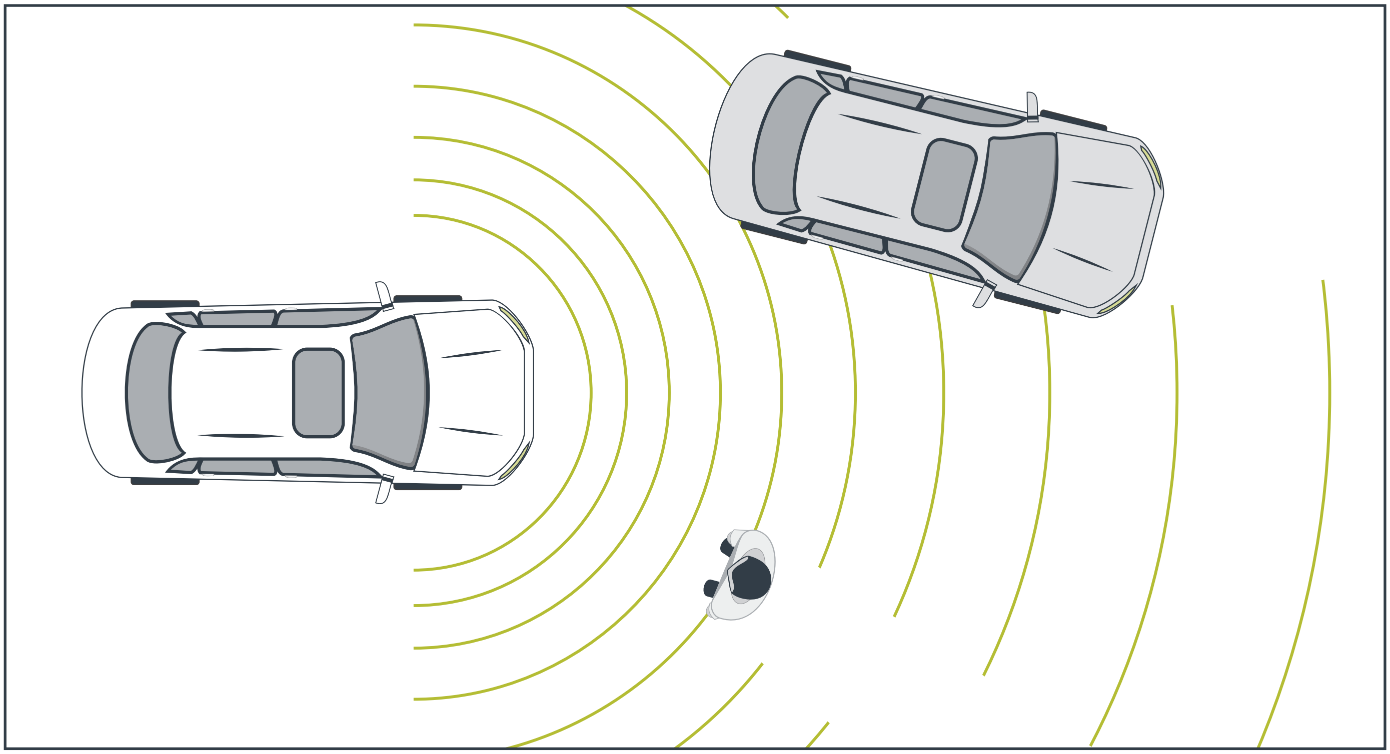
Due to these major changes in the industry, it's no surprise that automotive-component suppliers like Averna's client are constantly looking for ways to optimize their production lines. They need to cater to growing demand, market segmentation and complexity, which requires flexible, high-performance test architecture and systems that can both handle today's challenges and quickly adapt to changing requirements.

Expanding Business Opportunities for Averna's Client

One area that has seen much expansion is automobile safety and sensing mechanisms. With the increasing demand for road and passenger safety components, Averna's client received many repeat orders for multi-beam high-performance (MBH) units, featuring 7-beam, 25-GHz radar.

To handle the increased demand, the client sought a significant upgrade to their end-of-line (EOL) test system. As part of production, they needed to verify all main radar functions at multiple distances, detect any assembly or software-configuration errors, affix labels, and sort the tested units, placing them in the Pass location or into a Fix bin.

Another requirement was to significantly improve takt time – the client simply had to increase throughput. There had been too many manual handling errors and breakdowns with the old test system. The client anticipated needing to test 10,000 units per week per anechoic chamber. That would require full testing to take less than 30 seconds per unit, about half the time that testing took before Averna entered the picture.



OPTIMIZING THE TEST SYSTEM DESIGN

To meet the client's numerous requirements, Averna redesigned each of the major elements of the system. The biggest bottlenecks it detected were in the RF testing and automation realms. Both areas needed significant overhauls.

RF Testing Innovations and Benefits

On the RF test front, Averna introduced several key components. First, it decided to retire a signal analyzer capable of only 80-MHz bandwidth because it had been a real bottleneck. Instead, Averna deployed a National Instruments' Vector Signal Transceiver (VST), so that all RF testing could be handled almost instantaneously by the VST's much wider bandwidth.

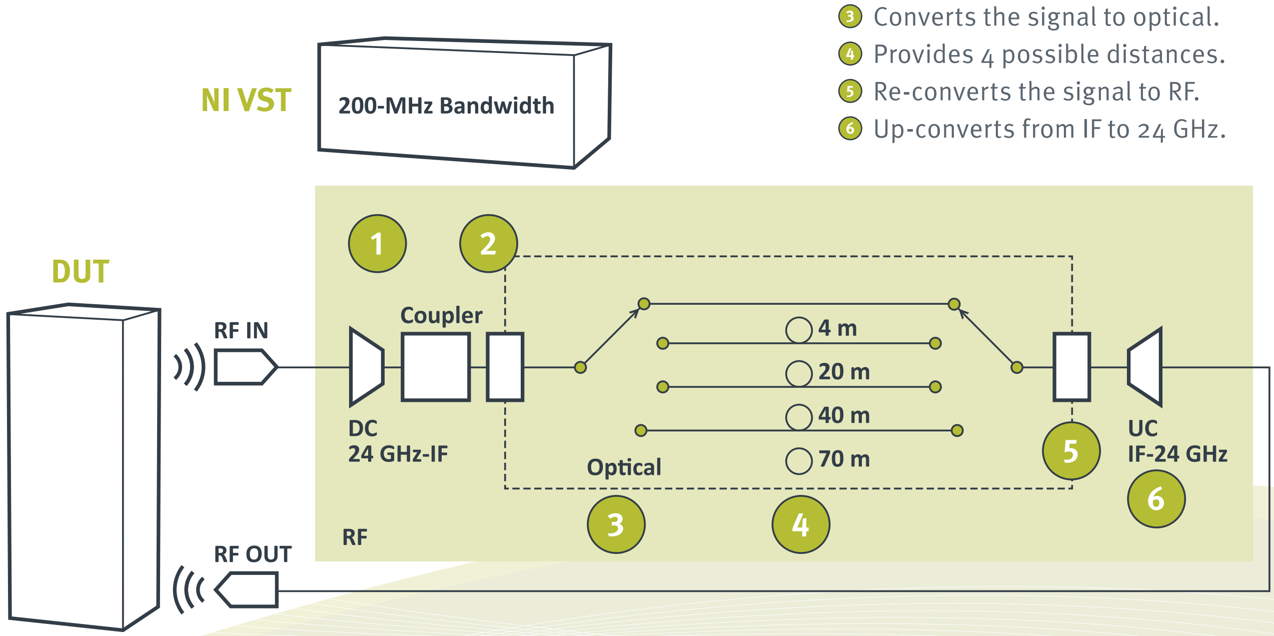
Next, Averna designed a custom anechoic chamber to overcome a number of limitations with the existing one. Using RF shielding with 70-dB effectiveness at 24 GHz, Averna's RF engineers were able to eliminate the pervasive RF noise that had caused downtime for the client's previous chamber.

Averna's engineers also pressurized the chamber so that when the door opens for DUT placement/removal by the robot, no dust can enter to degrade the testing or otherwise affect the DUT.

AUTOMATED RF SIGNAL PROCESSING

Based on the 200-MHz NI VST, Averna's integrated RF test system significantly speeds up testing.

1. Down-converts from 24 GHz to IF.
2. Splits signal to the NI VST.
3. Converts the signal to optical.
4. Provides 4 possible distances.
5. Re-converts the signal to RF.
6. Up-converts from IF to 24 GHz.



Each DUT is quickly loaded, rotated, and fully tested for its ability to detect stationary and moving objects up to 70 metres away.

AUTOMATION INNOVATIONS AND BENEFITS

Using multiple components such as a vision system, a 6-DOF robot, and modular motion fixtures inside the chambers allowed Averna's engineers to streamline processes and speed up the EOL testing.

The vision system detects the DUT on the conveyor, checks the status of the nest in the chamber and assists with the placement of the DUT on the Printing station. Meanwhile the robot rapidly inserts and removes the DUTs from the chambers, greatly speeding up production.

The combination of these redesigned components and better processes led to drastic reduction of takt time, eliminated manipulation errors, made results more repeatable, and increased the EOL test systems' up-time to continuous 24-hour shifts.

KEY RF TESTS AND MEASUREMENTS

In less than 30 seconds per DUT, Averna's system tests and measures these key capabilities:

Effective Isotropic Radiated Power (EIRP)

The system characterizes the Tx antenna in terms of output power, or EIRP. A high EIRP value is important for detecting distant objects.

Power Calibration

The system characterizes radiated power using a pilot tone when the DUT is being rotated, while also programming offset values into the DUT.

Pilot Tone

To improve phase difference calibration, SNR tests are performed while activating the Sensor pilot, which reads amplitudes over difference channels and phase difference.

Calibration Validation

The system repeats the rotation while generating the pilot tone to confirm that the offset values were applied correctly.

Signal-to-Noise Ratio (SNR)

The system validates the FFT-based SNR for different channels for Near and Far range targets, taking noise and signal measurements.

Zero Range Leakage (ZRL)

The system tests for the amount of ZRL leakage – a common issue with frequency modulated continuous wave (FMCW) radar because the Tx and Rx antennas are close to each other.

Two-Way Beam Pattern

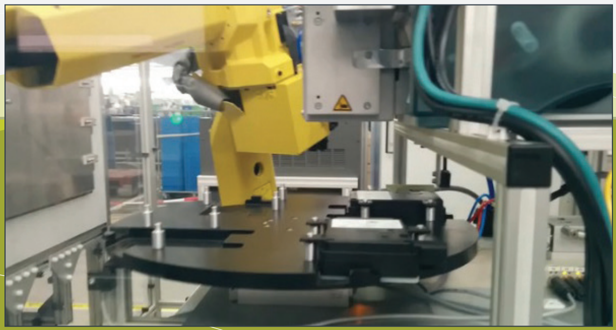
The system measures the radiation pattern of transmitting and receiving beams, as well as the phase difference, including performing side-lobe level analysis.

RF Spectrum

The system measures the transmitted signal (EIRP calibrated) as a function of frequency at ~24 GHz. Bandwidth is determined by measuring the frequency response.

Phase Difference Offset Calibration

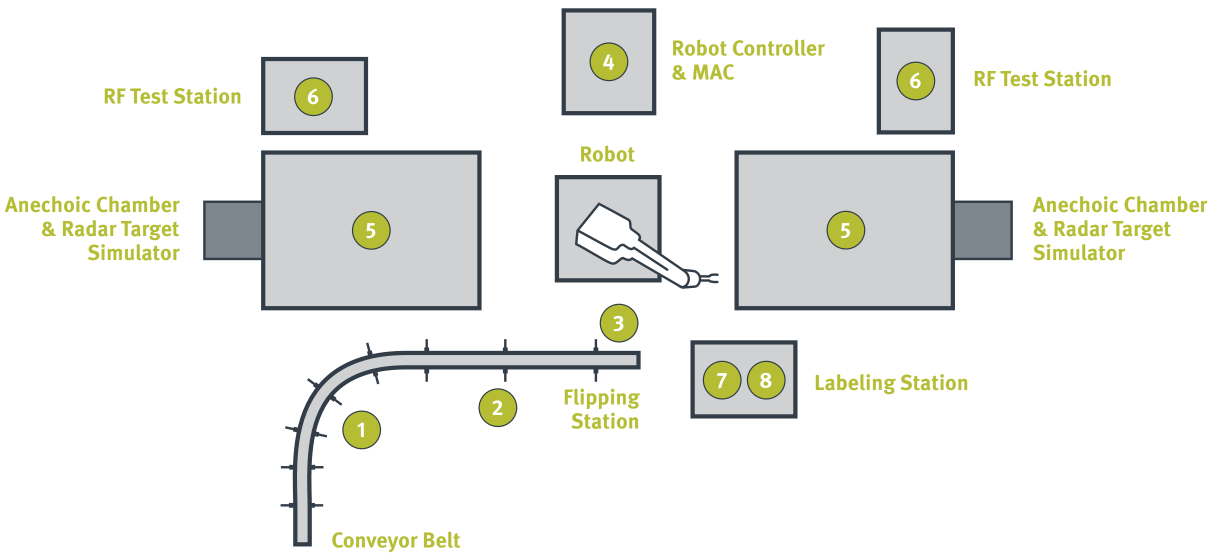
The system moves the sensor at different angles and reads values for different target distances for selected beams.



AUTOMATED EOL TEST SEQUENCE

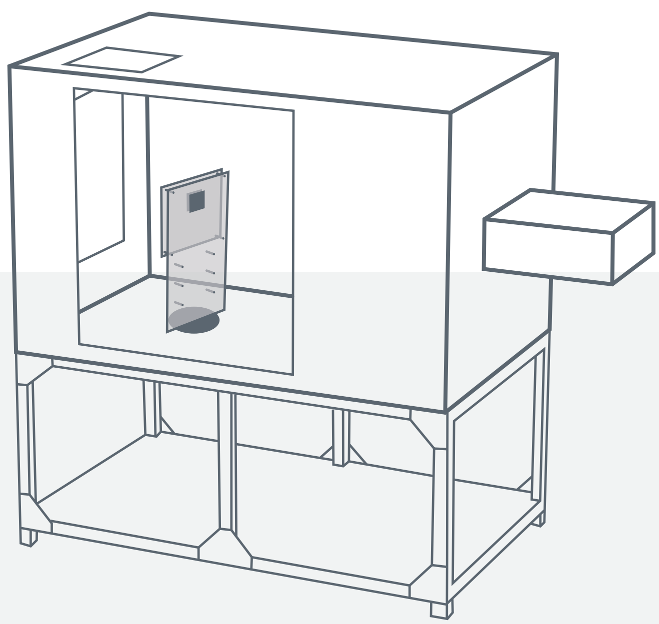
Averna's integrated EOL test system fully processes and tests each radar DUT in less than 30 seconds. Here are the major coordinated steps involving the conveyor belt, vision system, robot, Main Automation Controller (MAC), and RF Test Stations.

1. DUT arrives on conveyor belt.
2. Vision system detects DUT via barcode.
3. Flipping station readies DUT for testing.
4. MAC commands robot to pick up DUT.
5. DUT placed on motion fixture in chamber.
6. Full testing and test results storage.
7. Robot places DUT on Labeling station.
8. Robot places DUT in Pass or Fix location.



Averna employed industry-standard NI TestStand and LabVIEW software for smooth operation and system updates.

Many ergonomic and automation features streamline operation and ensure operator safety.



Each high-throughput anechoic chamber is capable of testing 10,000 radar units per week.

Averna

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SYSTEM INTEGRATION

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