PRODUCT FLYER

Vehicle Radar Test System

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- **Software:** NI alliance partners provide customized turn-key software experience based on end-user requirements
- Synchronize with NI PXI modular instruments for complete ADAS test applications
- Supports both obstacle simulation and radar measurements
- 76-81 GHz frequency range
- Minimum obstacle range of 4 m
- Range resolution down to 10 cm
- Simulation of 1 to 4+ radar obstacles
- Measurements include EIRP, phase noise, occupied bandwidth, and more

Built for Automated Design Validation, Test and Measurement

The Vehicle Radar Test System (VRTS) provides automated radar measurement and obstacle simulation capabilities for 76-81 GHz vehicular radar systems. Engineers can use VRTS to test both hardware and software sub-systems of a vehicle, including radar sensors, ADAS sub-systems, and embedded software. The VRTS’s flexible obstacle generation capability allows engineers to test the embedded software of radar and other advanced driver assistance systems (ADAS) through simulation of a wide range of generated scenarios. In addition, the combination of high-performance mmWave Radio Heads and the Vector Signal Transceiver (VST) also allow engineers to conduct precision RF measurements for beam characterization and testing. As a result, engineers can utilize the same measurement hardware for all phases of ADAS and radar system development – from R&D to high-volume manufacturing test.

The VRTS is part of a platform-based approach to test and measurement and it easily integrates with other PXI measurement hardware for as part of a comprehensive automotive test system. In sensor fusion testing applications, engineers can combine and synchronize the VRTS with other measurement...
hardware to simultaneously simulate multiple sensor types. Typical test systems are often configured as part of a hardware-in-the-loop (HIL) simulation in which the test equipment simulates the behavior of the environment to test embedded software.

**VRTS Detailed View**

The VRTS is a modular system capable of providing automotive radar obstacle generation and measurement capabilities in 77 and 79 GHz automotive radar bands. At the heart of the VRTS is a PXI system containing the PXIe-5840 Vector Signal Transceiver (VST) and NI-5692 Variable Delay Generator (VDG). These modules operate in conjunction with a mmRH-3608 or mmRH-3609 mmWave Radio Head - which provides the RF interface to the radar sensor. The mmWave head also features an alignment laser to ensure accurate alignment between the radar DUT and the test system radio head. A block diagram of a typical test configuration is represented in Figure 1.

A key component of the VRTS is the PXIe-5840 vector signal transceiver (VST). This instrument provides two critical functions to the system – including the both calibrated radar measurements and obstacle emulation. Using the VST’s onboard FPGA, engineers can simulate complex movements of a radar obstacle. When performing radar obstacle emulation, engineers can use the VRTS to simulate up to 4 or more objects. Obstacles appear at a range from 4 to 300+ meters with a range resolution of 10 cm to 12 cm, depending on obstacle range. In addition to range, users can dynamically set object radar cross section (RCS) and velocity (Doppler effect) in the software.

The VST’s RF signal generator and analyzer provides calibrated measurement results for automated radar sensor test. Using this instrument, the VRTS allows engineers to perform measurements including antenna beam radiation pattern, effective isotropic radiated power (EIRP), phase noise, spectrum occupancy, beam width, chirp demodulation, and more. The combination of obstacle simulation and
measurements capability can reduce production test floor space and total test time by integrating the functions of two common dedicated test systems.

The modularity of the VRTS enables NI alliance partners to customize the exact hardware configuration in order to best suit the needs of the specific application. However, many VRTS configurations utilize one of the configurations listed below.

9-Slot System for Production Test

For production test applications, the VRTS is configured with one VST and up to two VDGs as illustrated in Figure 2. This configuration supports generation of up to 2 full-range radar obstacles and features the lowest footprint and cost. The production test VRTS is also capable of the full radar measurement suite for beam characterization test, EIRP measurements, and functional test.

Figure 2 – VRTS Configuration for Production Test

System configuration in Figure 2 includes:

- 1x 9-slot PXI-1078 Chassis
- 1x PXIe-8840 Multicore Controller
- 1x PXIe-5840 Vector Signal Transceiver (VST)
- 2x NI-5692 Variable Delay Generator (VDG)

18-Slot System for Validation, Characterization, and Research & Development

For advanced applications, engineers can utilize the PXIe-1085 18-slot chassis to support up to 4 full-range radar obstacles. This configuration includes two VST’s and four VDG’s and is illustrated in Figure 3. Both the production test and advanced VRTS can be expanded to support additional simulated radar obstacles via cabled expansion of the system to additional PXI chassis.
System configuration in Figure 3 includes:

- 1x 18-slot PXI-1085 Chassis
- 1x PXIe-8840 Multicore Controller
- 2x PXIe-5840 Vector Signal Transceiver (VST)
- 4x NI-5692 Variable Delay Generator (VDG)

Note that the configuration in Figure 3 also contains an empty PXI slot which can be used to add additional instrumentation or control additional PXI chassis. Available instrumentation includes power supplies, oscilloscopes, data acquisition modules, CAN/Ethernet interface modules and more.

Milimeterwave Radio Head Options

In addition to multiple PXI configurations, VRTS also features multiple radio head options for both bistatic and monostatic antenna configurations. The bistatic option features independent Tx and Rx ports and up to 50 dB Tx to Rx isolation. By contrast, the monostatic option features a single combined Tx/Rx port with up to 30 dB of Tx to Rx isolation. The bistatic radio head is illustrated in Figure 4.
Radar Obstacle Emulation

The flexibility of the VRTS allows NI alliance partners to configure highly customized software applications that are uniquely tailored to suite the requirements of the specific application. Using the powerful graphical programming environment of LabVIEW and LabVIEW FPGA shown in Figure 5, NI alliance partners are able to develop software applications ranging from stand-alone obstacle simulators to fully-featured hardware-in-the-loop (HIL) simulation systems. With each of these software applications, NI alliance partners build on top of the low-level VRTS hardware API in Figure 5 and augment it with customized software.

One of the benefits of NI’s flexible obstacle generation architecture is that it enables engineers to add new test cases as reliability standards and requirements evolve. For example, in applications involving embedded ADAS software test, engineers can use NI alliance partner software to simulate common driving scenarios, illustrated in Figure 6, including star pattern, lane change, and an object crossing street. The behavior of each of these scenarios can be controlled via three key parameters including range, velocity, and radar cross section.

Engineers using VRTS can configure the system to simulate a wide range of obstacles, and simulated obstacles adhere to the following conditions in Table 1.
### Table 1. VRTS Obstacle Simulation Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Simulated Objects</td>
<td>1 - 4 (full range)</td>
</tr>
<tr>
<td>Range</td>
<td>4 to 300+ m</td>
</tr>
<tr>
<td>Range Resolution</td>
<td>10 cm (near obstacles)</td>
</tr>
<tr>
<td>Distance Accuracy</td>
<td>± 15 cm</td>
</tr>
<tr>
<td>Object Velocity (Doppler Frequency Shift)</td>
<td>0 to ±500+ km/hr (75 kHz)</td>
</tr>
<tr>
<td>Doppler resolution</td>
<td>0.1 km/hour (15 Hz)</td>
</tr>
<tr>
<td>Radar Cross Section Dynamic Range (RCS)</td>
<td>50 dB min</td>
</tr>
<tr>
<td>RCS Resolution</td>
<td>≤ 1 dB</td>
</tr>
<tr>
<td>Distance between VRTS and radar DUT</td>
<td>0.7 – 3.0 m</td>
</tr>
</tbody>
</table>

### Radar Test and Measurement

In addition to obstacle simulation, the VRTS is also designed to perform RF measurements of radar sensors and systems. As part of the low-level hardware control, NI includes measurement science required for typical radar measurements. The measurement science for each of these measurements is based on the NI RFmx measurement API – which delivers extremely fast and accurate measurement results. Typical measurements supported by the VRTS includes:

- Radiation pattern
- Equivalent Isotropically Radiated Power (EIRP)
- Noise
- Spectrum occupancy
- Beam width
- Chirp analysis: linearity, overshoot, recording, tagging

Table 2 illustrates typical RF characteristics of the VRTS hardware. For detailed specifications, view the Vehicle Radar Test System Specifications document at ni.com.

### Table 2. VRTS Hardware Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>76-81 GHz</td>
</tr>
<tr>
<td>Instantaneous Bandwidth</td>
<td>1000 MHz</td>
</tr>
<tr>
<td>Transmit/Receive Isolation</td>
<td>25 dB for monostatic&lt;br&gt;65 dB for bistatic</td>
</tr>
<tr>
<td>Tx Maximum Output Power</td>
<td>0 dBm</td>
</tr>
<tr>
<td>Phase Noise, 77 GHz @ 100 kHz offset</td>
<td>-85 dBc/Hz typical</td>
</tr>
</tbody>
</table>
Platform-Based Approach to Test and Measurement

What Is PXI?
Powered by software, PXI is a rugged PC-based platform for measurement and automation systems. PXI combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features. PXI is both a high-performance and low-cost deployment platform for applications such as manufacturing test, military and aerospace, machine monitoring, automotive, and industrial test. Developed in 1997 and launched in 1998, PXI is an open industry standard governed by the PXI Systems Alliance (PXISA), a group of more than 70 companies chartered to promote the PXI standard, ensure interoperability, and maintain the PXI specification.

Integrating the Latest Commercial Technology
By leveraging the latest commercial technology for our products, we can continually deliver high-performance and high-quality products to our users at a competitive price. The latest PCI Express Gen 3 switches deliver higher data throughput, the latest Intel multicore processors facilitate faster and more efficient parallel (multisite) testing, the latest FPGAs from Xilinx help to push signal processing algorithms to the edge to accelerate measurements, and the latest data converters from TI and ADI continually increase the measurement range and performance of our instrumentation.
NI offers more than 600 different PXI modules ranging from DC to mmWave. Because PXI is an open industry standard, nearly 1,500 products are available from more than 70 different instrument vendors. With standard processing and control functions designated to a controller, PXI instruments need to contain only the actual instrumentation circuitry, which provides effective performance in a small footprint. Combined with a chassis and controller, PXI systems feature high-throughput data movement using PCI Express bus interfaces and sub-nanosecond synchronization with integrated timing and triggering.

### PXI Instrumentation

**Oscilloscopes**
Sample at speeds up to 12.5 GS/s with 5 GHz of analog bandwidth, featuring numerous triggering modes and deep onboard memory

**Digital Multimeters**
Perform voltage (up to 1000 V), current (up to 3A), resistance, inductance, capacitance, and frequency/period measurements, as well as diode tests

**Digital Instruments**
Perform characterization and production test of semiconductor devices with timing sets and per channel pin parametric measurement unit (PPMU)

**Waveform Generators**
Generate standard functions including sine, square, triangle, and ramp as well as user-defined, arbitrary waveforms

**Frequency Counters**
Perform counter timer tasks such as event counting and encoder position, period, pulse, and frequency measurements

**Source Measure Units**
Combine high-precision source and measure capability with high channel density, deterministic hardware sequencing, and SourceAdapt transient optimization

**Power Supplies & Loads**
Supply programmable DC power, with some modules including isolated channels, output disconnect functionality, and remote sense

**FlexRIO Custom Instruments & Processing**
Provide high-performance I/O and powerful FPGAs for applications that require more than standard instruments can offer

**Switches (Matrix & MUX)**
Feature a variety of relay types and row/column configurations to simplify wiring in automated test systems

**Vector Signal Transceivers**
Combine a vector signal generator and vector signal analyzer with FPGA-based, real-time signal processing and control

**GPIB, Serial, & Ethernet**
Integrate non-PXI instruments into a PXI system through various instrument control interfaces

**Data Acquisition Modules**
Provide a mix of analog I/O, digital I/O, counter/timer, and trigger functionality for measuring electrical or physical phenomena
Services and Support

The VRTS is both distributed and supported through select VRTS specialty alliance partners. These partners provide initial consultation, customized system design, and long-term maintenance support. An up to date list of available VRTS partners, contact information, and capabilities is available at www.ni.com/vrtspartners.

All NI hardware includes a one-year warranty for basic repair coverage, and calibration in adherence to NI specifications prior to shipment. PXI Systems also include basic assembly and a functional test. NI offers additional entitlements to improve uptime and lower maintenance costs with service programs for hardware. Learn more at ni.com/services/hardware.

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Premium</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Duration</td>
<td>1, 3, or 5 years</td>
<td>1, 3, or 5 years</td>
<td>Length of service program</td>
</tr>
<tr>
<td>Extended Repair Coverage</td>
<td>●</td>
<td>●</td>
<td>NI restores your device’s functionality and includes firmware updates and factory calibration.</td>
</tr>
<tr>
<td>System Configuration, Assembly, and Test¹</td>
<td>●</td>
<td>●</td>
<td>NI technicians assemble, install software in, and test your system per your custom configuration prior to shipment.</td>
</tr>
<tr>
<td>Advanced Replacement²</td>
<td>●</td>
<td></td>
<td>NI stocks replacement hardware that can be shipped immediately if a repair is needed.</td>
</tr>
<tr>
<td>System Return Material Authorization (RMA)¹</td>
<td></td>
<td>●</td>
<td>NI accepts the delivery of fully assembled systems when performing repair services.</td>
</tr>
<tr>
<td>Calibration Plan (Optional)</td>
<td>Standard</td>
<td>Expedited³</td>
<td>NI performs the requested level of calibration at the specified calibration interval for the duration of the service program.</td>
</tr>
</tbody>
</table>

¹This option is only available for PXI, CompactRIO, and CompactDAQ systems.
²This option is not available for all products in all countries. Contact your local NI sales engineer to confirm availability.
³Expedited calibration only includes traceable levels.

PremiumPlus Service Program

NI can customize the offerings listed above, or offer additional entitlements such as on-site calibration, custom sparing, and life-cycle services through a PremiumPlus Service Program. Contact your NI sales representative to learn more.