Customize Radar Functional Verification Routines to Meet Specific Application Test Needs

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Abstract

As radar sensors continue to increase in design complexity to deliver multiple capabilities for the transportation industry, Tier 1 suppliers continue to innovate on new technology to drive down costs. And as the demand for automotive radar technology and applications continues to increase, their test routines have evolved from simple to complex test protocols in order to adequately verify functional performance of the sensors themselves and for the intended use cases. The combined use of scenario-based testing and RF measurements can be effectively used to verify functional performance of the radar sensors for their specific application use case environment or conditions. This white paper will discuss the changing requirements for radar test and how they can be addressed using the Konrad Technologies Vehicle Radar Test System (KT-VRTS) that is built on the National Instruments platform.

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1 The Challenge: Rapid Changes in Automotive Radar Sensors

The last five years has seen some significant changes in automotive radar sensor designs and feature capabilities.

From 24GHz to 77GHz operating frequencies and up to 1GHz bandwidth on the hardware capability to changes supporting multi-mode operation, multiple chirp patterns and differing modulation schemes (not just FMCW), these changes also create different demands on the sensor test requirements and test methodologies.

As radar technology evolves further into a key automotive sensor for autonomous driving vehicles to understand their surroundings, new test methodologies are required to verify radar sensor performance for their specific application, such as Automated Emergency Braking (AEB) or Adaptive Cruise Control (ACC).

2 The Solution: KT-VRTS Built on a Software-driven, Scalable and Modular Hardware Test Platform

Progressing now and into the future, the advances in automotive radar sensor technology will require flexible and scalable test applications that can be modified to adapt to test requirements for design verification or production test and with Hardware in the Loop (HIL) test. Software-driven hardware platforms can be developed for design verification and then leveraged by scaling as needed for production test needs. For this changing test landscape, the KT-VRTS is a modular test platform that can be deployed as needed by the test application requirements.

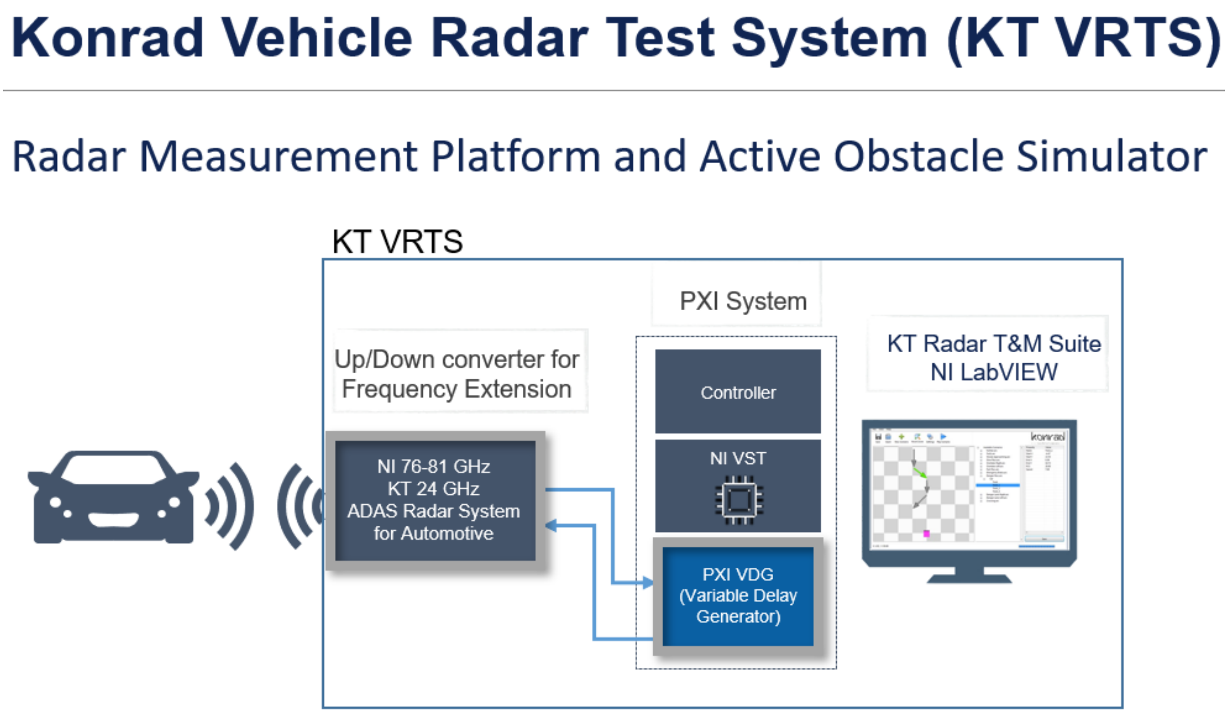


Figure 1: KT-VRTS

Based on the National Instruments Vehicle Radar Test System (NI VRTS), the KT-VRTS (shown in Figure 1) is comprised of either a 24GHz or 76-81GHz mmWave front-end, that is an up/down converter, connected to a calibrated PXI-based RF instrument, the NI Vector Signal Transceiver (VST) and a Variable Delay Generator (VDG) module. The open FPGA in the VST is used for real-time data processing and control of the delay-line based technology in the VDG to implement an active radar simulation application. This hardware framework is configured and controlled by the KT Radar Test & Measurement Suite software to implement RF measurements for radar functional tests, scenario-based obstacle simulation for application-based tests and the connectivity to HIL systems for closed-loop sensor-in-the-loop (SIL) tests.

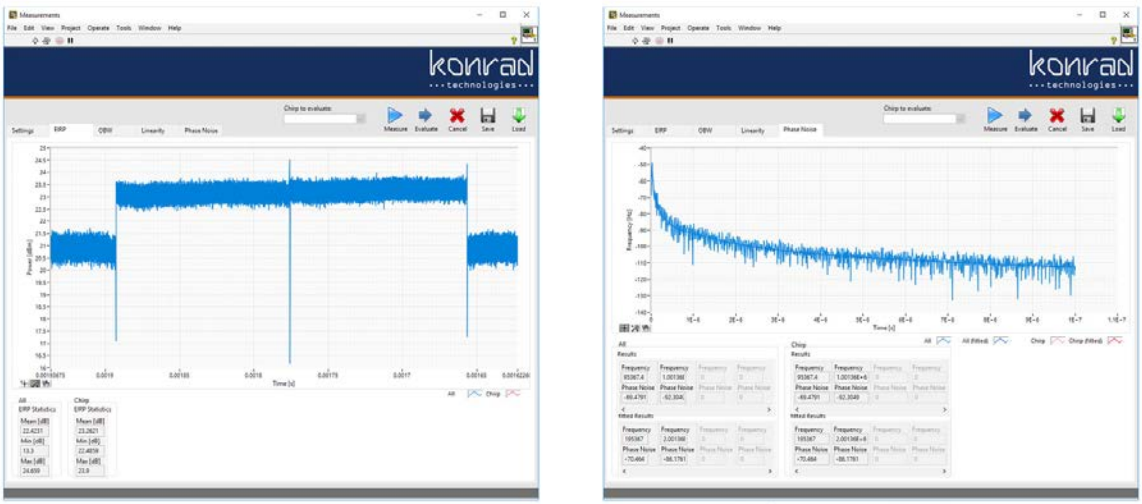
3 Traditional Approach: “Test to Specification” Approach and Drive Test

Typical current test methodologies encompass a phased approach that includes radar calibration verification and radar functional test before a series of drive tests to confirm functionality and finally the 100,000-mile drive test to confirm functional performance. The rapid change of the radar sensor creates a challenge for rapid go-to-market needs to keep up with the market expectations.

4 KT’s Approach: Combine RF Measurements with Scenario-based Object Simulations for Radar Functional AND Application Performance Test

The KT-VRTS enables radar sensor functional and application performance verification with a single test platform.

With the KT-VRTS, key RF measurements like operating frequency and bandwidth, phase noise, Equivalent Isotropically Radiated Power (EIRP) and beam width pattern can be measured to determine the functional performance of a radar sensor according to its listed specifications. Two measurements, EIRP and phase noise, are shown as examples in Figure 2 below.



EIRP　　　　Phase Noise

Figure 2: RF Measurements with KT-VRTS and KT Radar Test & Measurement Suite

The same system can then be used to implement a variety of obstacle simulations to verify the functional performance of the sensor for its application use. Some common examples of such scenarios are shown in Figure 3 below for a lane change or an object moving past the UUT. Several scenarios being discussed by Euro NCAP[1] can be implemented, such as a pedestrian crossing the path of a vehicle.

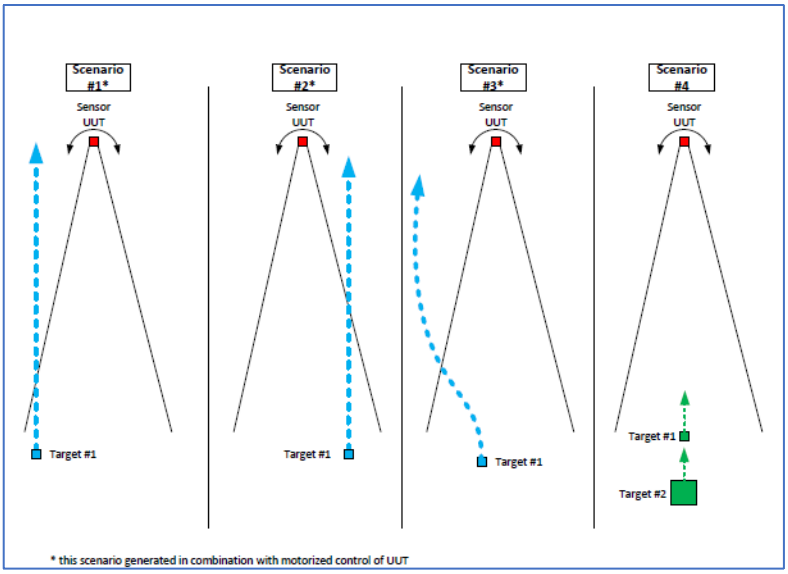


Figure 3: Common obstacle simulation scenarios.

Moving another step further, the same KT-VRTS can be connected to a HIL system for a real-time simulation of vehicle component models with the radar sensor in an open or closed loop operation. With a drive scenario simulator, for example IPG CarMaker, live data streams of object data can be used to implement synchronous real-time object simulations to the radar sensor in a closed loop with the scenario simulation. Figure 4 shows a snapshot of an application with radar, lidar and camera sensors working in real-time with a HIL application. This application-level test can be useful for the Level 3 Autonomous Driving[2] capability.

Figure 4: (From Bottom-Left, Clockwise): Camera sensor output, Radar sensor output, Lidar sensor output, and Scene generator simulator, IPG CarMaker all running in a closed loop for Sensor Fusion HIL test.

5 Solution Benefits: Customize Test According to Specific Radar Application

There are several benefits of the KT-VRTS. One benefit is that radar test methodologies can be customized to confirm radar functional performance for the specific sensor application. For example, test sequences for long range and medium range sensors can be easily customized and configured for different ranges, FOVs, and range resolution. Another benefit is that corner cases for the safety application can be simulated to verify functional performance like in the case of verifying AEB performance for the scenario of an animal suddenly jumping in front of a vehicle. Such inconsistent and rare scenarios in the real world can be configured in the simulation world in the lab for reliability and repeatability tests of the related safety systems. And a final benefit is to reduce the overall cost-of-test since scenario-based HIL test increases the quality of test in the lab which in turn increases functional performance of vehicle sub-systems leading to reduced time needed for costly drive tests.

6 Acknowledgements

1. Euro NCAP; https://www.euroncap.com/en 18.05.2018
2. NHTSA, https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety#issue-road-self-driving 18.05.2018

About Konrad Technologies

Since 1993, Konrad Technologies (www.konrad-technologies.com) has successfully developed, designed and integrated customer-specific test solutions providing customers with R&D, qualification and manufacturing of electronic products with tools to fulfill their quality goals, accelerate engineering and development throughput.

Customers in a wide range of industries from Automotive, Aerospace and Defense, Wireless Communications, Consumer Electronics, Medical, Semiconductor, General Electronic Manufacturing to Industrial Automation use KT's integrated hardware and software platform based solutions to improve their performance worldwide.

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ADAS iiT consortium (ADAS Innovation in Test)

ADAS iiT (www.adas-iit.com) is an amalgamation of four National Instruments partner companies (Konrad Technologies GmbH, SET GmbH, S.E.A. Datentechnik GmbH and measX GmbH & Co. KG) formed with the goal of making autonomous driving even safer. Founded in March 2017, the ADAS iiT group offers a complete test of fully autonomous vehicles in a virtual environment, delivering ADAS turnkey, end-to-end solutions from one single source.

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