# LXI Test System Provides Flexibility for Testing Automobile Antenna Amplifiers


## Summary

**LXinstruments**, a system integrator and Agilent Channel Partner located in Böeblingen, Germany, focuses on helping customers build electronic functional test systems. The LXinstruments team recently built a system for testing automotive antenna amplifiers for different German automobile manufacturers using an open LXI (LAN eXtensions for Instrumentation) platform and Agilent test instruments. The LXI-based test system allowed the system integrator to complete the system on time and on budget and gave the customer the flexibility it needs to adapt to changing requirements.


> When we used the LXI functionality, we found the instruments' interactive Web interfaces very helpful.
>
> *Klaus Diederich, LXinstruments general manager*

## Application overview

In today's new cars, antennas are distributed throughout the vehicle. Some cars have as many as 11 antennas to serve the vehicle's AM, FM, digital audio broadcast, GPS, GSM and analog and digital TV signals. Car makers use antenna amplifiers to amplify antenna signals to appropriate levels for the vehicle's audio and video devices. The amplifiers receive inputs from multiple antennas, and provide automatic selection of the highest signal strength input, a feature called "diversity." It is important to locate the amplifiers close to the antennas, so the amplifiers are also distributed throughout the car, and they all provide their signals to a centralized audio/infotainment system

System integrator LXinstruments recently built a functional test system designed to test the antenna amplifiers and verify the diversity feature. The test systems stimulate the different antenna inputs, supply main and phantom power for the DUT and measure the amplification. Although similar systems previously implemented by LXinstruments are based on GPIB, the system discussed here is built on an open LXI (LAN eXtensions for Instrumentation) platform. The new system is used to develop test applications and debug fixtures and software and is seen as the first of a family of future systems that will be operated in an automated manufacturing environment.

The new system includes Agilent LXI power supplies, an Agilent 34980A multifunction switch/measure unit (to switch low-frequency signals, provide automation control and make DMM measurements), and two RF switch boxes designed and integrated by LXinstruments that are controlled by the 34980A. The LXinstruments team uses Agilent VEE Pro graphical language software as the underlying programming environment and runs the systems under Agilent's TestExec SL test executive. The system is designed to handle frequencies from DC to 3 GHz to accommodate the different antenna amplifiers the customer needs to test.

## Key challenges

According to Klaus Diederich, LXinstruments general manager, the biggest challenges for testing his customer's antenna amplifiers involve fixturing, probing and repeatability issues. "We need to make sure all the input and output channels that are multiplexed have the same kind of attenuation, so we get consistent performance on the different signal paths," said Klaus.

Because the antenna amplifiers are manufactured in large volumes, the life cycle rating of the RF switches is important. "With Agilent's excellent RF relays we have found that over multiple years we have very few problems and very good stability and repeatability," said Klaus.

The test system needs close control of RF signal levels, because to test the diversity function, the signals are attenuated significantly (down 70-90 dB) to verify that amplifiers switch to other antenna as expected. This is accomplished by means of a programmable attenuator that allows test engineers to accurately control the attenuation from 0 dB down to -110 dB in 10-dB steps. The range is set with the attenuator, and the exact signal level within the range is set by the RF source.

Because RF signal levels are important in this application, the LXinstruments system performs a calibration once a day using golden devices. Initially, the test system was set up to perform a calibration once every two hours, but because of the repeatability of the test system, the test team found that once-a-day signal level calibration is sufficient.

## Power requirements

The DUT requires two different DC power supplies: a main supply and a second supply to provide a special control voltage called a phantom voltage. The phantom voltage supply is a control source and signals to the DUT to activate the corresponding DUT amplifier channel. As such, it draws very little current. The phantom voltage is applied to the RF output of the antenna amplifier by means of a bias T that separates the DC path from the AC path. This type of testing emulates a situation where someone in the driver's seat wants to listen to the radio and two people in the back seat want to view different TV channels.

Power requirements run from 8-16 volts. The currents run all the way down to 10 micro amps in sleep mode and all the way up to 1 amp


*The LXinstruments system for testing automotive antenna amplifiers*

## Key measurements

The amplifier gain as well as diversity transition thresholds are of primary importance. To verify these features, RF magnitude measurements and accuracy are critical.

Current measurements of the main and phantom supplies are also very important. Sleep mode currents must be low to prevent battery drain, and levels down to 10 µA must be measured. To characterize the individual phantom inputs, and to achieve this dynamic range, external current shunts are used.

In addition to the DC current measurements discussed above, the system measures the color of specific connectors. The different signals are color coded on the connectors, and the system makes sure the right connector color is connected to the right place. A color sensor in the fixture provides analog RGB values, and those are measured with the 34980A DMM to determine the color.

## Switching capabilities

For RF switching, the 34980A multifunction switch/measure unit is equipped with a 34945A microwave switch driver and two 34945EXT modules (extender boards). LXinstruments built an RF switch tray that resides in the system and is controlled by the 34945A. It contains the RF switches as well as RF attenuators.

For signal routing the 34931A multiplexer and 34932A matrix modules are used. And for general purpose switching, the system uses a simple 34937A 32-channel module. A fixture interface (Virginia Panel) acts as the main interface between the system and the fixture.

## Other system instrumentation

LXinstruments makes use of the Agilent 34959A breadboard card to control miscellaneous custom functionality. The test system also includes one 34952A multifunction I/O card for fixture control that is mainly a resource for future requirements.

To keep the new system compatible with older versions still in use, LXinstruments included an Agilent 4402B spectrum analyzer and a Rohde & Schwarz SML03 signal generator. The system also includes an Agilent ENA-L network analyzer and a 33220A arbitrary signal generator that provides a low-frequency data stream that is used as a stimulus for the keyless entry system.

The system includes an Agilent N6700B low-profile modular power system mainframe and two N6734B auto-ranging modules to provide maximal flexibility. LXInstruments engineers chose the N6700B because they needed at least two supply voltages. One supply voltage powers the entire antenna amplifier; the other provides the phantom voltages.

The system uses an industrial PC and Agilent TestExec SL as its test executive.

| Instrument | Quantity | Manufacturer | Description |
|---|---|---|---|
| **34980A** | 1 | Agilent | Multifunction switch/measure mainframe |
| **34921A** | 1 | Agilent | 40-channel armature multiplexer |
| **34937A** | 1 | Agilent | 32-channel Form C |
| **34945A** | 1 | Agilent | Microwave switch driver |
| **34952A** | 1 | Agilent | Multifunction I/O 32 Bit DIO |
| **34932A** | 1 | Agilent | Power supply multiplexer (<1A) |
| **N6710B** | 1 | Agilent | Power supply mainframe |
| **N6734B-ATO** | 2 | Agilent | Power supply module 35 V/1.5 A 50 W |
| **E5062A** | 1 | Agilent | ENA-L network analyzer |
| **85032E** | 1 | Agilent | 50-ohm calibration kit |
| **E4402B** | 1 | Agilent | Spectrum analyzer |
| **33220A** | 1 | Agilent | Arbitrary/function generator 20 MHz |
| **SML03** | 1 | Rohde & Schwarz | 3-GHz signal generator |
| **82357A** | 1 | Agilent | USB/GPIB gateway |
| **7831R** | 1 | NI | PCI DAQ card with FPGA |

***Table 1: Equipment included in the LXinstruments test system***

## I/O

Wherever possible, the test team used the LAN interface to control instruments. "When we used the LXI functionality, we found the interactive Web interfaces of the instruments very helpful," said Klaus. "We used them mainly during software development. For example, we would use the Web browser to monitor the actual relay state on the 34980A as we controlled the instruments."

## Selecting a test solution

The main reason LXinstruments chose the LXI platform instead of a PCI platform for this test system was to ensure it was versatile enough to handle its customer's future needs. Klaus explained that the system will be used for a long period of time for a wide variety of products. "We have found that external instruments are much easier to support than PCI," he said. "And it is much easier to build the same thing again in 5 or 10 years if you are using external instruments rather than PC plug-in cards."

"With earlier systems that were designed purely with GPIB and PC plug-in cards, we found it very hard to support the PC infrastructure. With every new industrial PC we had to take care of everything that might have changed in terms of available slot numbers with PCI and ISA cards and that type of thing. So for this system, wherever possible we have eliminated the PC plug-in cards and used external devices like the USB/GPIB converter. I like controlling all the instruments over Ethernet."

## Open system architecture a big plus

Another important factor for Klaus's team was the "open system" aspect of the LXI platform. "With external instruments, you can control all the instruments through the VISA library, so you don't have to bother with all kinds of card driver software," Klaus said. "You have just one communication path – through the VISA library – and you don't really care if an instrument interface is GPIB or LAN or whatever. Using an open system helps us reduce engineering efforts and engineering costs, because it is a familiar environment and it is very consistent."

## Single-vendor solution offers advantages

Klaus cited Agilent's worldwide support and pricing as key factors in choosing Agilent instruments for the test systems his company builds. He claims the cost of a system based on the 34980A is "very competitive" compared to a PXI or VXI solution.

"Agilent provides a really broad range of instrumentation ranging from basic DC instruments to RF and lightwave. This extensive range, combined with the excellent support and short turnaround times provided by the Agilent Service Center, have been the main reasons for choosing Agilent as our strategic partner. We are even able to offer service agreements guaranteeing a qualified Agilent technician performing repairs at the customer site within 24 hours if an instrument in one of our systems should fail."

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