RF TEST

Calibrated radio

DEVICE UNDER TEST

Radio transmitter and receiver cards used in wireless communications. The cards, which are placed in an antenna module that mounts on towers, operate at frequencies from 6 GHz to 11 GHz.

THE CHALLENGE

Calibrate transmitters and receivers over three frequency bands to ensure the cards have the correct output power with minimal spurious noise and receive level. Conduct exhaustive performance tests.

THE TOOLS

- Agilent Technologies: digital multimeter, DC power supply, RF spectrum analyzer, RF signal generator. www.tm.agilent.com.
- Averna: test-management software. www.proligent.com.
- Marconi (now Aeroflex): RF signal generator. www.aeroflex.com.
- National Instruments: graphical programming language, test executive. www.ni.com.
- Rohde & Schwarz: RF power meter. www.rohde-schwarz.com.
- Xantrex Technology: DC power supply. www.xantrex.com.

PROJECT DESCRIPTION

A manufacturer of transmitters and receivers of digitally modulated signals needed to reduce test time because the cards require calibration during production test. Test-system integrator Averna (www.averna.com) built eight production test systems for the cards.

RF transmitters require calibration for them to produce specified output power across their frequency range. Prior to implementation of the new test systems, a technician would need 4 to 5 hr to calibrate a transmitter/receiver pair. Now, the calibration and test time is about 20 min.

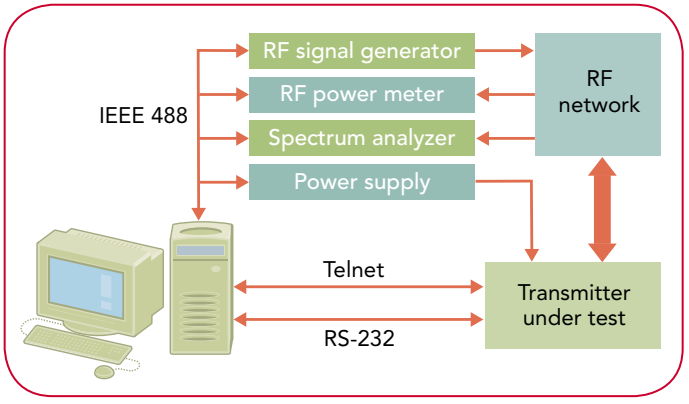
The test stations calibrate transmitter cards for gain, output power, modulation, offset, and balance over the 6–7 GHz, 7–8 GHz, and 10–11 GHz bands. Transmitter frequency and power level is set in software and sent to the transmitter through a Telnet interface.

To calibrate the transmitter's RF power, the software sets the card's signal attenuator to nominal. An RF power meter (**figure**) measures the output power. Based on the measurement, the software adjusts the transmitter's power by changing the output of a digital-to-analog converter (DAC) that drives the transmitter's power amplifier until the power is within tolerance. The DAC's output value must change with frequency to compensate for frequency-dependent losses. The test repeats across the specified frequency band until the output power is within tolerance across the band. (An RF signal generator provides a 19.44-MHz reference frequency.)

The system adjusts the transmitter's gain by adjusting the attenuator—this adjustment prevents overloading of the power amplifier. The final calibration adjusts the transmitter's phase imbalance to minimize spurious noise. Gain and phase-imbalance calibrations minimize signal output errors. The test system stores all settings in the transmitter's flash memory.

The card's receiver needs attenuator calibration, RF and IF filter calibration, and received signal strength indication (RSSI) testing. An RF synthesizer and I/Q modulator provide the input signals to the receiver. Filter calibration ensures that the maximum signal strength reaches the receiver's detector circuits. The software polls each unit under test (UUT) to get RSSI data on received signal power. (The online version of this article contains a diagram of the receiver test station and the software architecture: www.tmworld.com/2008_03.)

A graphical programming language handles all communication among the host PC, the instruments, and the UUT. A test executive lets technicians select tests, and it provides a user interface. A test-management platform works with the test executive to retrieve test results and make them available to engineers and to management.



An automated test system calibrates RF transmitters used in wireless communications.

LESSONS LEARNED

Averna software engineer Alex Pelland likes the Telnet interface because it provides standardized handshaking with the UUT that's built into the protocol. He also prefers a structured approach to software development. "The architecture accelerates and simplifies the introduction of new models or options," he said. "We have implemented generic drivers and we can set each driver to configure the test equipment for a specific UUT. We tried to avoid hardcoded parameters wherever possible."

Martin Rowe, Senior Technical Editor