Putting Project 25 to the test

To reap the advantages of multiple sourcing under an open standard, public safety systems operators and technicians will require broader testing capabilities.

By Bill Burrows

As the deployment of Project 25 systems gathers momentum, the requirement for system-specific test equipment is becoming apparent. Measurements that need to be made at the air interface during deployment and operation of a Project 25 system require new measurement technology. Additionally, the open standard raises the issue of interoperability among equipment purchased from different sources. Interoperability problems can be minimized with appropriate test strategies.

New testing challenges

Operators and maintenance technicians are focusing considerable attention on the implications of the Project 25 standard for their support and maintenance programs. Because interoperability and maximization of radio spectrum efficiency are fundamental requirements, Phase I of Project 25 uses digital voice encoding to reduce the required bandwidth for speech transmission to 12.5kHz, while simultaneously maintaining backward compatibility and interoperation with the existing 25kHz analog FM systems. Supporting both digital and analog testing, although common in the cellular world, is a new requirement in the public safety communications environment.

Traditional test strategies have primarily focused on the parametric performance of the radio terminal, where measurements such as power, frequency, modulation and sensitivity are the primary indicators of performance. The open-standard concept adopted for Project 25 introduces some new variables into the testing equation that relate to the interoperability of equipment sourced from multiple manufacturers supporting the standard.

The Project 25 standard, like its analog predecessors, is based on a frequency-domain multiple-access (FDMA) system, and it produces continuous signals when the radio is keyed. Therefore, some of the more complex measurement techniques required for time-domain multiple-access (TDMA) systems, such as Terrestrial Trunked Radio (TETRA), are simplified. The significant differences occur in modulation and sensitivity measurements.

Test equipment needs to be easily transportable to a base station site by a lone technician.

A new approach

The modulation selected for Project 25 is *C4FM*, which is a modified, four-level, frequency-shift keying (FSK), with a raised cosine filter for minimizing intersymbol interference. The modulation can be measured using conventional techniques as long as standard test signals are used. These signals are designed to provide a data stream of all low-deviation symbols or all high-deviation symbols, thus enabling the high 61.8kHz and the low 60.6kHz deviations to be measured. This is not practical on a working transmitter because the data content cannot be controlled without removing the transmitter from service, so a new measurement technique has to be used. This requires sampling the transmitted signal and demodulating the data. The demodulated data are used to compute the instantaneous deviation from a "perfect" modulator. This deviation is then compared with the actual measured deviation value, and a root-mean-square (RMS) error magnitude is calculated. This error is expressed as a percentage from the perfect signal. A typical transmitter test screen from a radio test set is shown in Figure 1 on page 57.

Bit-error rate measurement

Receiver sensitivity for digital systems is measured by determining the bit-error rate (BER), which is defined as the number of bits received in error expressed as a percentage of the total number of bits received. This measurement is not quite as simple as it sounds because it depends on *where* the measurement is taken within a given radio system. Of the total throughput of a Project 25 channel of 9,600bps, only 4,400bps are associated with the digital voice. Of the remainder, 2,800bps are used for error correction of the voice signal and 2,400bps are devoted to signaling overhead. The question arises: Do you measure the errors *before* or *after* correction? Obviously, it is the *corrected* performance that is important to the user because this determines the intelligibility of the speech. To overcome the uncertainty of

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Project 25 adoption will require the capability to test equipment from a variety of radio equipment manufacturers.

this measurement, a test signal with a *known* bit pattern is defined. A BER compares the received signal with the expected test signal. Nominal BER for a Project 25 receiver is 5%.

An alternative measurement of receiver sensitivity is a recorded speech pattern, which gives an audible indication. Because of the large amount of error correction used, its failure point occurs abruptly, so sensitivity measurements are accurate.

Additional measurements are specified, such as adjacent channel power and emission spectrum, to ensure that Project 25 equipment does not interfere with, or degrade the performance of, equipment on co-existent analog channels.

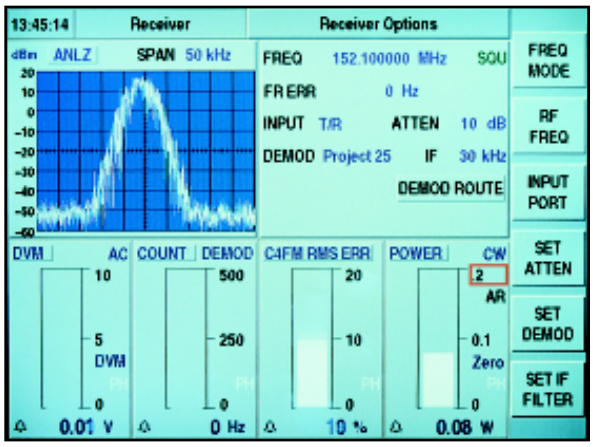
Although these measurements are important to overall system integrity, they are not commonly used for routine system maintenance. They also require performance levels that are only obtainable with specialized test equipment.

How interoperability impacts testing

Although the open standard creates many benefits for the user in the long term (i.e., reduced equipment costs and greater customer choice), it does introduce another uncertainty: Will the equipment from different suppliers work together seamlessly?

The standardization process is designed to create a standard that defines all aspects of the system operation. It is possible however, that equipment suppliers will interpret the standard in differing ways. This may result in a terminal from one manufacturer and a repeater from another not interoperating as expected. Additionally, as new features become available on a system and the equipment is updated, the need to reassess interoperability may occur. This will gain in significance as the number of compliant-equipment manufacturers increases.

Two test strategies can be used to determine interoperability. The first method is to test each new equipment type with all of the existing equipment used in the network. Obviously, not all of the terminal features on all of the user channels can be tested because the testing time would escalate rapidly. If the number of units in a system is large, even basic interoperability tests would



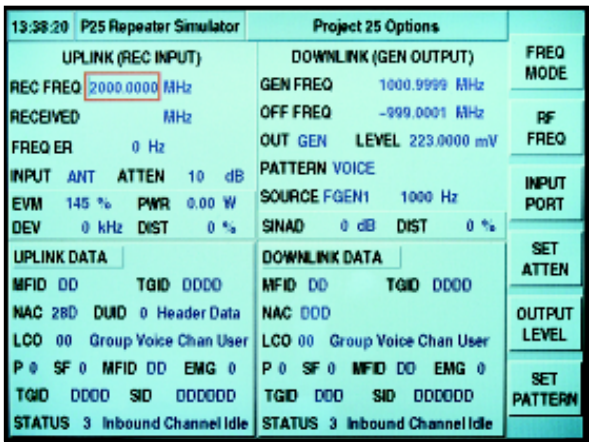


Figure 1 (far left). A typical transmitter test screen from an IFR Systems model 2975 radio test set. Figure 2. (near left). A system parameter measurement screen.

require a tremendous number of combinations. This approach ensures that the equipment will interoperate, but it does not guarantee adherence to the standard—nor does it necessarily indicate which equipment is non-compliant.

An alternative approach is to check all equipment against a reference system or device. If it were practical to use only one reference system for all tests, then this system would itself become the standard. Typically, a radio test set could be used as the reference, but, again, this is based on one manufacturer's interpretation of the standard. Also, the number of functions that can be tested is limited by the reference system capability. This method significantly reduces the number of tests required, but interoperability will only be implied—not guaranteed.

Test equipment for a robust standard

A radio test set provides the tools required to maintain radio systems. Traditionally, these instruments have provided sufficient control of the device-under-test (DUT) for parametric measurements to be made in a normal system environment. Project 25's emphasis on interoperability raises the capability threshold in two significant ways. First, it requires the test set to provide a comprehensive simulation of the radio system and to analyze the data it receives back from the DUT. A system parameter measurement screen is shown in Figure 2 above. Second, the user must be enabled to configure the test set to accurately represent the system being operated.

Reaping the benefits of a standard

Adoption of Project 25 will require radio systems operators and maintenance technicians to revisit their testing capabilities. Accurate testing of equipment offered by a variety of competing manufacturers will enable public safety users to use the open standard to its fullest advantage. ■