TETRA Test Systems TS8940

Type-approval tests of TETRA base and mobile stations to TBR35

The future of professional mobile radio is digital and the European TETRA standard promises the best of transmission quality, i.e. as long as base and mobile stations pass TBR35 type-approval tests. These can be carried out during development and production with TETRA Test Systems TS8940 comprising a TETRA simulator and a TETRA protocol tester.

The digital European standard TETRA (trans-European trunked radio), currently being finalized by ETSI (European Telecommunication Standards Institute), promises more flexibility, greater frequency economy and better transmission quality in professional mobile communication. TETRA is intended for authorities and organizations in the security sector and also operators of public trunked-radio systems for haulage, the power industry and passenger transport.

TETRA specifications

TETRA uses time-division multiplex with four communication channels on a 25-kHz carrier. The duplex spacing between transmit and receive frequency is 10 MHz. The first TETRA trunked systems will operate in the 380 to 440 MHz frequency band, and later also between 870 and 890 MHz. TETRA compresses the voice signal to 4.8 kbit/s and after error control the gross data rate is 7.2 kbit/s per time slot. If two or four time slots are used for voice and data transmission, data rates of up to 28.8 kbit/s are feasible. If only data are to be transmitted, it is possible to use a mode called packet data optimized. Another special feature of the TETRA standard is the direct mode, where TETRA mobile stations can call another TETRA mobile direct without going through a base station. A further TETRA feature is multi-address call with dynamic group arrangement.

Type-approval tests for TETRA base and mobile stations are outlined in standard TBR35 (technical basis for regulation), which refers to the following ETS specifications: ETS300394-1 (radio), -2 (protocol testing specification voice plus data) and -3 (protocol testing specification packet data optimized). Rohde & Schwarz devised Test Systems TS8940, including the TETRA simulator and TETRA protocol tester, for verification, quality assurance and type approval of TETRA base and mobile stations (FIG 1).

TETRA simulator

The TETRA simulator comprises a control unit, I/Q modem, spectrum analyzer, two RF generators, a power meter and an RF switching matrix (FIG 2).
The correct timed data are sent to the DUT. The sequence controller, which ensures that generates all required call control messages to the I/Q interface card. The RISC processor data buffer, a sequence controller, an basic signalling unit consists of a signalling and measurement unit. The entire system in addition to the basic unit, core of the system is the TETRA control unit, including the controller for the entire system in addition to the basic signalling and measurement unit. The basic signalling unit consists of a data buffer, a sequence controller, an i860-RISC processor and a digital I/Q interface card. The RISC processor generates all required call control messages and forwards them to the sequence controller, which ensures that correctly timed data are sent to the DUT. The I/Q modem modulates the data stream and sends it to the DUT via the switching matrix and, in the reverse direction, demodulates and digitizes the data received from the DUT before forwarding them to the sequence controller. Data are evaluated in the RISC processor and answered as necessary. Special test cases require deliberately distorted test signals (fading). This function is integrated in the TETRA control unit, which distorts the signal in the baseband and transfers it to the I/Q modem.

TBR35 prescribes a second interface in addition to the air interface: the test connector implemented in the TETRA control unit as an RS-232-C interface. With the aid of a respective protocol, bit error rates of different logic channels can be measured to TBR35 on all TETRA mobile and base stations conforming to this protocol.

The system is supported by a signal generator with I/Q modulation that produces the faded TETRA interference signal, and Signal Generator SME 06 to produce the interference signal for testing blocking and immunity to intermodulation. Spectrum Analyzer FSEA30 is used to measure the power ramp, modulation spectrum and spurious emissions.

All signals are amplified and filtered in the RF switching matrix which incorporates relays, mixers, circulators, directional couplers and several customized filters. RF measurement levels have to be highly accurate, so the TETRA simulator uses two high-frequency probes at strategically important test points to minimize frequency response. Channel A of Dual-Channel Power Meter NRVD is used to monitor simulator transmission level, channel B to monitor received level. Any level errors occurring during measurements are automatically corrected with the aid of previously stored reference values.

RF measurements to TBR35
The TETRA simulator uses some 20 programs to measure the RF parameters of TETRA base and mobile stations to TBR35 specifications. Measurements are grouped in transmitter, receiver and transceiver tests.

Transmitter tests check the power ramp characteristic and the quality of the RF output spectrum plus immunity to intermodulation in the transmitter output stage.

In receiver tests the sensitivity of TETRA base and mobile stations is checked as well as their immunity to modulated and unmodulated interference in transmission and adjacent channels.

Transceiver tests check modulation, frequency, synchronization, frame alignment and transmission level matching as a function of received field strength.

Operation
A convenient graphic software interface simplifies operation of the TETRA simulator. Control, Test Cases, Selftest and Path Compensation menus can be selected. Control gives the user access to the PICS (protocol implementation conformance statement) and PIXIT (protocol implementation extra information for testing) files of the DUT. One or more test cases can be selected and executed in the Test Cases menu. Test cases can also be generated with parameters other than those specified in TBR35. If Selftest is selected, the operator can start a complete system test or the selftest of individual system instruments. The Path Compensation menu offers a variety of possibilities to increase the measurement accuracy. Internal path compensation considers all losses of the test system through to the antenna connector. External path compensation makes up for losses outside the test system (e.g., cable loss).

The user may, of course, create his own test programs. Generation of custom programs is easy thanks to the realtime operating system and standard C programming language. A fast C compiler and a variety of debugging procedures
permit efficient and time-saving development of test software.

**TETRA protocol tester**

In addition to measurement of RF characteristics, TBR35 prescribes protocol measurements, for which the TETRA protocol tester is intended. Test cases are currently being created by ETSI using the TTCN (tree and tabular combined notation) specifying language and are expected to be ready this year.

The TETRA protocol tester consists of the TETRA signalling unit and the control unit (FIG 3). The signalling unit comprises the RF frontend, A/D and D/A converters, TETRA filter and DSP cards.

The complete TETRA protocol stack is implemented on the digital signal processors. User interface, TTCN tools (TTCN compiler, target-code generator) and test cases are provided in the control unit. The TETRA signalling unit and the control unit communicate through PCOs (points of control and observation) provided between the individual protocol layers (FIG 4).

The protocol tester as the user sees it is a true representation of the TETRA layer model. A separate window can be opened for each PCO between the layers, in which the uplink and downlink messages are displayed. With the aid of predefined filters, information items of particular interest can be selected and displayed, eg elements violating the protocol or corresponding to an event that is to be triggered. Further menus can be selected to change the basic configuration and other settings.

The TETRA protocol tester not only checks the response of a DUT to a standard protocol, it also investigates DUT behaviour in the case of faults and deviations. The tester supports these investigations by using predefined error types in all protocol layers, which can be activated by the user as required.

The user may integrate his own procedures through the PCOs for executing user-defined tests and test cases as described in TBR35. The same method is used to implement the test cases formulated in TTCN. If the user does not wish TTCN formulation for test cases, he can formulate them direct in C instead. Rohde & Schwarz can supply all protocol test cases to TBR35 as ready implemented and installed turn-key solutions.

Dr. Hans-Jürgen Schneider; Wilfried Tiwald

**Features of TETRA Test Systems TS8940**

**TETRA simulator**
- Graphic user interface
- RF tests executable to TBR35
- Comprehensive system selftest
- Path compensation for increased measurement accuracy
- Simple creation and implementation of user-defined tests

**TETRA protocol tester**
- Graphic user interface
- Complete implementation of TETRA protocol stack
- TTCN test cases executable to TBR35
- All protocol layers software-implemented
- Easy implementation of user-defined TETRA protocol layers
- Predefined error simulation

**Reader service card 153/01**