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Testing GSM-R terminals with the IFR 2935 test set

Jean Jacques Perret



The IFR 2935 test set software has been enhanced to cover the GSM-R frequency bands, therefore giving service companies an economical way of testing the new digital radio system for European Railways.

The "Union Internationale des Chemins de Fer" (UIC) has developed the Project EIRENE, that specifies the functional requirements for a digital radio standard for the European railways. This standard must satisfy the mobile communications needs of the European railways. It encompasses ground-train voice and data communications, together with the ground-based mobile communications needs of trackside workers, station and depot staff and railway administrative and managerial personnel.

This project must provide interoperability for trains and staff crossing national or other borders and offer an appropriate standard for future replacement of national radio systems operating on both important internal routes and low to medium traffic rural areas.

To meet the functionality and performance requirements of EIRENE, the following system services are required:

Voice services

- Point-to-point voice calls
- Public emergency calls
- Broadcast voice calls
- Group voice calls
- Multi-party voice calls

Data Services

- Text message bearer service
- Bearer service for general applications
- Bearer service for automatic fax
- Bearer service for train control applications

Direct mode for local set-to-set operation without network infrastructure

Railway specific applications

Three distinct mobile radio types are required, based on the type of role they will perform and the environment in which they will operate:

Cab radio - for use by the driver of the train

General purpose radio - for general use by railway personnel

Operational radio - for use by railway personnel involved in train operations such as shunting and trackside maintenance.

To reduce the development and deployment costs of such a system, UIC has based its standard on GSM technology , 900 MHz band and modified it to satisfy the railway's requirements while keeping the capacity of connection to GSM public networks. Therefore the radios will be allowed to use channels 1 to 124 and 955 to 1023 of the GSM 900 MHz frequency plan, as well as channels 512 to 885 of the GSM 1800 MHz frequency plan.

This capacity to connect to public networks makes testing EIRENE radio sets using an IFR 2935 test set possible.

IFR 2935 test set description

The IFR 2935 test set is a PC based system that is both easy to use and flexible. The product core is a GSM test head (2935) driven by dedicated software (Phonetest) through an RS232 interface. This system is "Windows" based and accesses all modern PC resources. It has several measurement modes, and can be used as a network simulator to test the mobile in its usual environment, or as a simple test instrument to align mobiles without any protocol emulation.



When used as a network simulator, the "Manual Mode" allows for a mobile to register on a control channel , therefore measuring the access burst parameters to establish a call initiated either from the mobile or from the simulator. The test set displays the standard transmitter measurements (power level, modulation accuracy, etc.) and receiver measurements (sensitivity, etc.). It is also possible to check the capacity of changing the traffic channel while in conversation (handover), the terminal's response to simulator's instructions and the quality of the voice path. SMS transmission and reception capacity can be tested as well.

In automatic mode, the same measurements can be performed under the control of test routines or "Scripts". A script is dedicated to test on several channels and several power levels and to generate a test report, the evidence that the terminal is working well. Therefore a terminal can be checked quickly and returned back to users or routed for repair in case of problems. The test report is useful for the repair shop. Building a new test script is possible starting from an existing script edited as a text file. A script wizard is also provided with the system, allowing for fast and easy generation of new scripts.

The basic way of using the 2935 and Phonetest as a simple terminal test system can be extended as the PC offers storage and communication facilities when used with the Phonetest Manager software option. This is a comprehensive database storing all test

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results and providing a data analysis facility for better quality management.

Operation

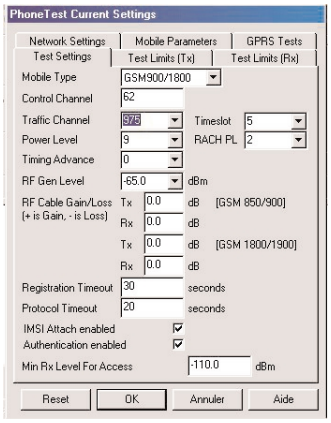
A. Manual Testing

The terminal to test is fitted with a dedicated test SIM card allowing the terminal to register within the test network whose parameters are:

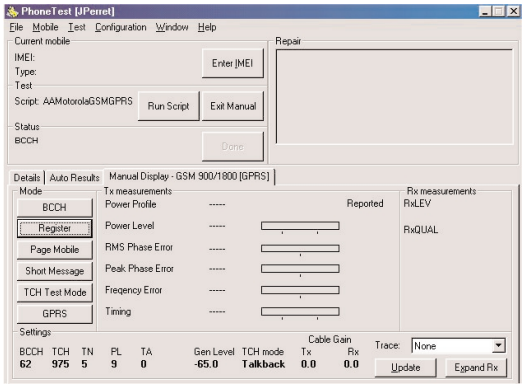
Mobile Country Code MCC 001

Mobile Network Code MNC 01

Also configure the different test set parameters (menu Test/*Settings/Test Settings).



Select the frequency band (**900 or 900/1800**), the traffic channel within the GSM-R specific band, cable gains or losses according to the frequency range and the connection type (direct connection or antenna coupler). Connect the terminal to the test set and run "**Manual Mode**". The lower part of the screen displays the controls, test parameters and test results.

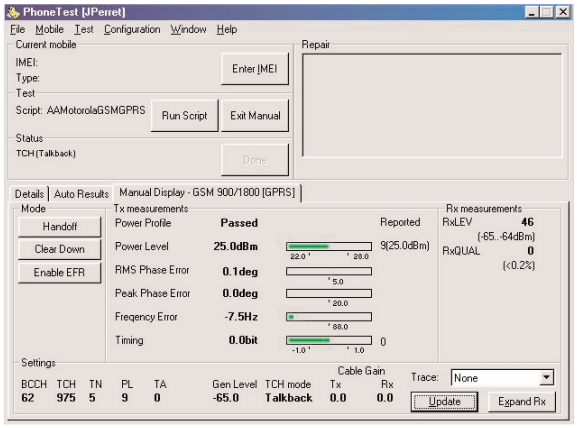


Then proceed as follows:

1. Switch the terminal "**On**". After a few seconds, the terminal registers and terminal information is displayed in a separate window. Please notice that the test set is able to capture and measure the access burst (short burst) of the terminal.

2. Make a call from the terminal or from the test set using the key " **Page Mobile**".

3. As soon as the call is complete, the screen displays repetitive measurements.



a) Transmitter measurements

Power profile : Checking the burst shape

Power level : The value must match the level requested for the mobile and display this on the screen (PL9)

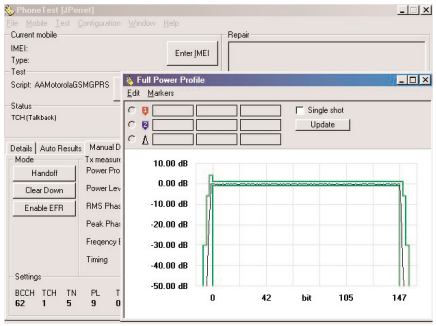
RMS phase error : Modulation measurement quantified in RMS

Peak phase error : Modulation measurement quantified in Peak

Frequency error: Instantaneous value of the frequency difference between the transmitter frequency and the expected value. This result can change but must remain within limits.

Timing advance:The result should equate to the timing advance requested to the phone. This value (TA) is shown at the bottom left of the Phonetest window under the settings information being displayed.

The "**Trace**" window allows for graphical measurements:



Full power profile: Graphical display of the burst profile, useful to check former faulty bursts

Useful part/Ramps : Extends the profile analysis capability

Phase profile : Displays how phase varies during the bursts

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In-channel spectrum: Displays the RF spectrum generated by the mobile

IQ adjustment: Displays the lines relevant for IQ modulator adjustment

b) Receiver measurements

Rx LEV : Displays the RF level measured by the receiver. The value must match the RF generator level, taking into account the connection losses.

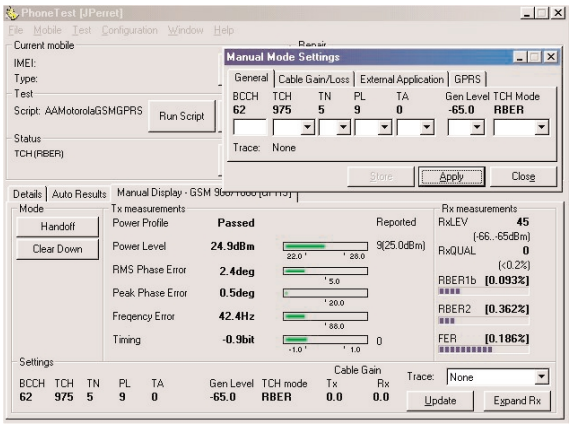
RxQUAL : Displays the quality of reception measured by the receiver. This value is calculated by the phone against known bits within the received frames.

Measuring receiver sensitivity requires other measurement techniques : BER measurement is performed by the test initiating RF loopback within the mobile, i.e. the bits received by the mobiles are transmitted back to the test set and the BER measurement is performed on these. This measurement requires the mobile to be fitted with a test SIM. To select these test functions, click on the "**Update**" key. This opens a window named "**Manual Mode Settings**". Within this window, it is possible to re-configure all the test parameters, introduce cable compensations and select the different test modes for the receiver.

- **Talkback** : The user speaks into the mobile's microphone and this speech is then transmitted to the test set by the mobile . The test set re-transmits the speech to the mobile with a slight delay, providing a simple way of testing both microphone and earphone. If the speech check is unsuccessful then to aid diagnosis "Test tone" can be selected. The test set will send a continuous tone to the earphone only.

- **BER** : The test set puts the mobile into RF loopback and performs the BER measurement on class 1 & class 2 bits (BER1 & BER2).

- **RBER** : The test set puts the mobile into RF loopback and performs the Residual BER measurement on class 1b & class 2 bits (RBER1b & RBER2) together with the frame erasure rate (**FER**). RBER2 is the most sensitive measurement and is used as the reference measurement mode for sensitivity.



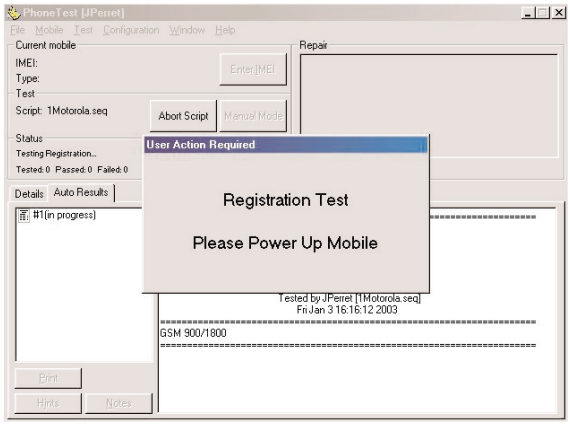
It is therefore possible to check that the terminal sensitivity is better than the minimum required, while setting the RF generator level at the reference value. The bit error rate should be below the specified limit.

Note : Test limits and test conditions are defined inside the "**Test/* Settings/Test Limits(Tx),Test Limits(Rx)**" menus.

Automatic testing

The 2935 test set is fitted with an automatic system able to run complex routines (scripts) including some manual operations.The test engineer will have to switch the terminal on, make or answer a call, check the audio quality or clear the call, following the test routine. Other operations will be fully automatic.

To run an automatic test, select the relevant script using "**File/Load Script**". Then start using "**Run Script**"and follow the instructions appearing on the screen.



At the end of the script, close the session using the "**Done**" key. This opens a window allowing for data recording (if data base options like Phonetest Manager or Phonetest Exchange are available) or/and printing. It is also possible to come back to manual test or re-run the script or another one before closing the session.

The 2935 test set is delivered with a wizard helping to easily create new test scripts. Scripts can be edited and modified, adding, changing or deleting lines and values in order to obtain a test routine perfectly suited for the terminal.

Other tests

GSM-R terminals may also have GPRS packet data transmission mode. The 2935 test set allows to check this mode if fitted with the GPRS test option. SMS transmitted and received can also be tested.

Conclusion

Thanks to the frequency range used by the GSM-R standard, the 2935 test set is perfectly suited for testing GSM-R terminals to ensure terminal operation. Its capability in both manual and automatic test modes gives service centers a solution with adaptability, a simple man/machine interface and good communication capacity with data bases. Therefore the 2935 Phonetest is the perfect tool for GSM-R terminals servicing.

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Part No. 46891/???
Issue ?
02/2003

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