Effectively characterizing frontend modules during production

Production tests on multiport DUTs, e.g. frontend modules for smartphones, are increasing in complexity. In addition to the traditional RF measurements, T&M equipment must also handle new features and developments, such as DUT configuration via GPIO and handler I/O interfaces and via the MIPI® RFFE interface. Rohde & Schwarz provides unique solutions for these applications with the R&S®ZNrun automated test software and the optional R&S®ZN-B15 MIPI® RFFE interface card.

Fig. 1: The R&S®ZNB vector network analyzer with the R&S®ZN-ZB4 switch matrix during a measurement of a frontend module. With the R&S®ZN-B15 interface card inserted into the analyzer, the module’s MIPI® RFFE interface can be addressed directly via the analyzer firmware.
Increasing complexity for frontend modules

Today’s mobile radio standards are becoming more and more complex and cover an increasingly growing range of functions. This is also reflected by the frontend modules (FEMs) used in smartphones, where the number of integrated components, such as low-noise amplifiers and filters, is on the rise. This diversity also has an impact on T&M equipment, leading to an increase in the number and types of RF measurements required and in the number of ports to be analyzed. FEMs with 16, 20, 23 or more ports are now typical.

Vector network analyzers such as the R&S®ZNB with the R&S®ZN-Z84 switch matrix (Fig. 1), or the R&S®ZNBT multiport vector network analyzer are ideal for these complex RF measurements.

The R&S®ZNB supports the MIPI® RFFE interface

A standardized interface is a key requirement for FEMs in order to ensure interoperability with other components in a mobile phone. For example, other mobile phone components must be able to address the frequency selection filters in a frontend module in order to utilize the more than 12 mobile radio bands plus supplemental services such as WLAN and GPS. A working group within the MIPI® Alliance (see blue box) developed the MIPI® RF frontend (RFFE) interface for this purpose. The new optional R&S®ZN-B15 interface card for the R&S®ZNB supports this interface.

R&S®ZNrun for fast and easy measurements

The large number of test ports and the different characteristics of the components used in FEMs make it difficult to keep an overview of the required measurements. The parameters to be measured at each port must be precisely defined, as well as the appropriate configurations for the T&M equipment.

Rohde & Schwarz developed the R&S®ZNrun software for PCs (see gray box) to make it easier for users to keep track of the large number of measurements to be made – often more than 200 – and to optimize measurement speed. After launching the software, the user selects the type of Rohde & Schwarz network analyzer being used plus any connected switch matrix. The user can then focus on the DUT and enter the number and type of ports. In addition, the individual measurements must be defined. Based on this information, R&S®ZNrun generates a connection plan. As a final step, the user connects the DUT to the T&M equipment as shown in the connection plan, then the software takes over and performs all configurations.

R&S®ZNrun takes into account the characteristic features of the T&M equipment being used, for example the fact that the R&S®ZN-Z84 switch matrix uses switches and therefore cannot measure all ports simultaneously. Ports also have different characteristics as a result of the different switching levels being used. The software optimizes measurement speed by selecting the appropriate sequence of measurements in order to minimize the number of required switching operations. A pass/fail display simplifies sorting of measured FEMs. The software indicates the duration of measurements performed on each DUT and whether all measurements were passed, and it summarizes...
Fast and flexible reconfiguration of test stations
The R&S®ZNrun software was designed with a view to high flexibility in production. For example, exchanging a network analyzer at a fully configured test station, e.g. replacing a four-port analyzer with a two-port instrument, takes just a few mouse clicks. All the user has to do is load the test plan, enter the new analyzer type and save it. The software automatically updates the connection plan, and measurements with the new analyzer can be started. Time-consuming configurations of the individual test steps and of the analyzer are no longer necessary. If additional T&M equipment is needed, such as a power supply unit, it can be integrated in the test sequence by using a plug-in.

Often, settings on the DUT, e.g. the position of an internal switch, must be changed. To handle these tasks, the R&S®ZN-B15 interface card is equipped with two types of interfaces: ten independent general purpose input output (GPIO) interfaces and two MIPI® RFFE interfaces. The GPIOs – which are controlled via the R&S®ZNrun GUI – can be used for powering as well as for addressing FEMs via GPIO pins. The MIPI® RFFE interface can be integrated into the R&S®ZNrun test sequences via a plug-in.

Integrated interface card in place of external modules
The new R&S®ZN-B15 MIPI® RFFE interface card for integration into the R&S®ZNB network analyzer makes it possible to program MIPI® RFFE interfaces on FEMs directly from the analyzer firmware (Fig. 2). This significantly reduces the complexity of test setups compared with solutions using external modules. If an external MIPI® RFFE
control board were used, possibly connected to a controller via USB, it would take considerable effort both to address the control board and to synchronize it with the test system and the DUT.

The R&S®ZN-B15 interface card can be configured via the analyzer GUI (Fig. 3), although all necessary functions are also available as SCPI commands. The card permits programming of the MIPI® RFFE and the GPIO interfaces both for a channel and for a frequency segment. The voltages of the GPIOs can be set independently of one another and also set automatically via a sequencer at the start of the sweep.

With the sequencer, the FEM programming can be incorporated into the sweep sequence and adapted as required for the individual frequency segments (Fig. 4). The segmented sweep function makes it possible to measure a variety of parameters, including insertion loss, isolation or reflection, in a single sweep for various configurations of the FEM. This results in efficient FEM characterization.

The R&S®ZN-B15 interface card can also be used to read the contents of the registers of a frontend module. This information can be used to improve testing, particularly in production applications. For example, a frontend module ID can be read and subsequently made available during the production process. By reading the registers, the FEM programming can also be verified by checking if the registers were set correctly.

**Summary**
The R&S®ZNrun software and the optional R&S®ZN-B15 MIPI® RFFE interface card for the R&S®ZN-B simplify the characterization of FEMs. R&S®ZNrun optimizes test sequences within production environments and offers a high degree of flexibility, while the R&S®ZN-B15 interface card greatly facilitates DUT control.

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