FIG 1 The R&S®CMU 300 now allows RF parameter tests to be combined with layer 1 signaling processes.

The R&S®CMU 300 (FIG 1) now includes a new signaling test mode that combines RF parameter tests with layer 1 signaling processes. Time-critical base station parameters can be thoroughly tested under realistic, dynamic conditions.

Universal Radio Communication Tester R&S®CMU 300

HSDPA measurement solution with realtime functions

When timing is critical

Classic base station measurements – as performed by the R&S®CMU 300 in the tried-and-tested non-signaling test mode – statically measure whether essential base station (BTS) parameters meet technical specifications. However, increasing data throughput rates, such as with HSDPA, mean that mobile radio links must be adapted to available radio channel resources at even shorter intervals. As a result, the time aspect of RF measurements is gaining greater significance. This calls for supplementary tests that check whether all channel parameters are optimally set at the right time.

The R&S®CMU 300 meets these requirements by testing base stations under realistic, dynamic conditions. The tester now includes a new signaling test mode that combines RF parameter tests with layer 1 signaling processes, the first time any compact tester has offered this functionality. The new test mode provides measurement functions that were previously impossible to implement or that required significant technical effort to do so. The R&S®CMU 300 synchro-

nizes to the cell channels (CPICH, BCH) of the base station. An RF connection is sufficient; complex base station trigger interfaces are not required (FIG 2).

The R&S®CMU300 includes a realtime receiver with FEC, a TX tester and a generator and offers the following measurement functions at the best price/performance ratio ever achieved:

- Time-synchronous TX measurements for monitoring critical moments when switching between radio channel parameters (also for HSDPA)
- Special triggers for synchronizing external measuring instruments as well as the above TX measurements (also for HSDPA)
- Data analysis and decoding of DL channels (BCH, transport channels including HSDPA)
- Realtime code domain power measurement
- Analysis of bit and block error ratios of RMC (BER and BLER)
- Random access channel (RACH) preamble tests (including monitoring and evaluation of the acquisition indicator channel (AICH)) as stress test for base stations

and especially for HSDPA:

- Monitoring of max. four HS-SCCHs (from a user-defined set of up to 128 UEs)
- Throughput measurements
- Uplink stimulation for HS-DPCCH
- "Stimulate & Check" tests

New functionalities in detail

Expanded TX measurements

The TX measurements based on the 3GPP specification TS 25.141 (FDD) in the non-signaling test mode [1] are now also available in the signaling test mode:

Power

- Power meter (broadband or frequency-selective)
- Code domain power (CDP)

Modulation

- Error vector magnitude (EVM) including magnitude error / phase error
- Carrier frequency error
- I/Q origin offset
- I/Q imbalance
- Waveform quality
- Peak code domain error power (PCDEP)

Spectrum

- Adjacent channel leakage power ratio (ACLR)
- Occupied bandwidth (OBW)
- Spectrum emission mask (SEM)

An automatic channel-search function is now available and facilitates code domain power and modulation measurements in the non-signaling and signaling ▶

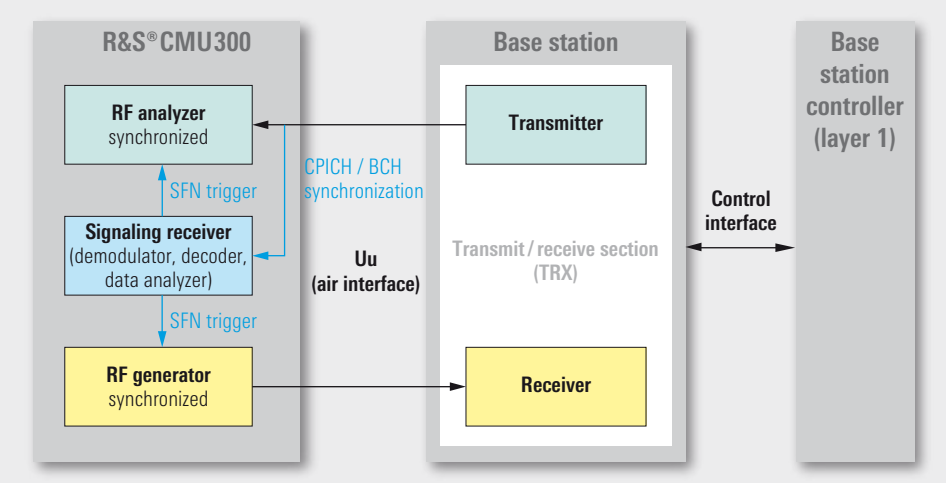


FIG 2 Test setup with the R&S®CMU300 and a base station in signaling test mode.

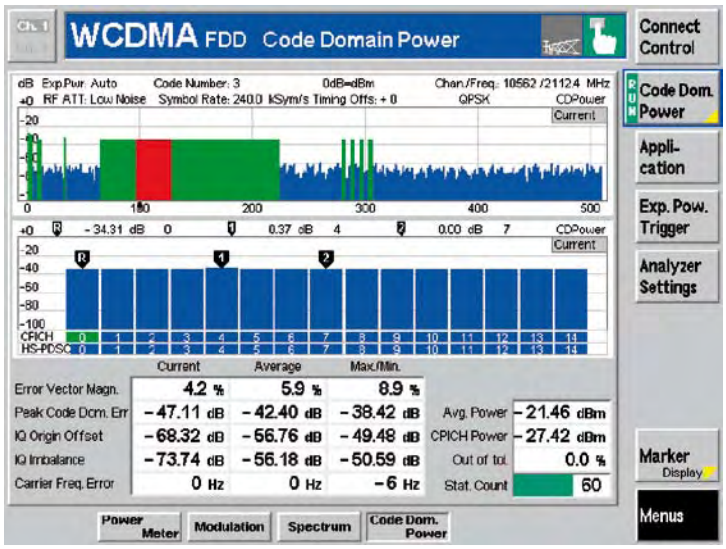


FIG 3 Code domain power measurement with user-defined, static channel combination (four HS-SCCHs, five HS-PDSCHs).

test mode. With this automatic function, you can easily perform measurements in user-defined channel configurations in addition to the channels specified in the 3GPP TS 25.141 FDD R5 test models.

Also, the HSDPA channels can now be configured in the non-signaling and signaling test mode (FIG 3). In the signaling test mode, you can start all measurements at defined times without external triggering.

Trigger

You can trigger time-synchronous measurements as follows:

- **Free Run** The R&S®CMU 300 analyzes the RF signal to define slot timing.
- **Slot Trigger** Trigger signal at the beginning of each DL P-CPICH timeslot.
- **Frame Trigger** Trigger signal at the beginning of each DL P-CPICH frame.
- **Super Frame Trigger** Trigger signal assigned to a settable system frame number. The signal is repeated periodically. It can be set from 2 to 4096 frames.
- **HSFN Trigger** HSDPA trigger signal at the beginning of each HS-SCCH subframe.
- **UE ID Trigger** HSDPA trigger signal at the beginning of each HS-PDSCH subframe assigned to a specific UE ID.

These internally generated trigger signals are also available at an output to trigger further measuring instruments. You can fine-adjust the chip offset of the output triggers. In addition to these internal trigger signals, you can also trigger R&S®CMU 300 measurements with an external signal whose edge and chip offset can be set (FIG 4).

BER measurement

The realtime receiver in the R&S®CMU 300 offers a new approach for analyzing the complete transmit section. The classic method of measuring physical parameters such as modulation quality or code domain power has now been supplemented by the BER measurement. In contrast to pure RF parameter measurements, all of layer 1, including FEC, is tested.

Two different scenarios are possible: **Separate measurement of the BTS downlink (DL) and uplink (UL)**. The BTS DL signal is analyzed and a UL signal, which is evaluated by the BTS, is sent at the same time.

Simultaneous measurement of both links (UL and DL). The BTS sends the UL signal generated by the R&S®CMU 300 back to the tester, where it is evaluated. In addition to the BER (FIG 5) and BLER, the R&S®CMU 300 also calculates the DBLER.

Realtime monitoring and DL channel logging

The R&S®CMU 300 can document and decode DL channels in realtime at the data level, which makes data analysis a lot easier (FIG 6). Since coded data is also available via a COM interface, you can directly evaluate it online on an external PC. The online decoding program supports you in decoding data.

These tools make documenting and evaluating DL transport channel data an easy job. In addition, the system information blocks (SIB) sent by the base station in the BCH/P-CCPCH can be displayed, decoded online and evaluated (FIG 7).

The realtime receiver still ensures the continuous slot-wise measurement of code domain power bits and transmit power control bits (TPC bits). The time reference for all measurements can be determined from system frame numbers (SFN), which are also displayed.

RACH preamble tests including AICH monitoring and evaluation

The RACH preamble test with subsequent AICH monitoring and evaluation is often used to simulate realistic stress scenarios for base stations, e.g. when several mobile phones register in successive access slots. During this test, up to 2^{24} preambles of the RACH – a predefined repeating sequence of up to 64 preambles – are sent. You can set this sequence as needed (FIG 8). For stress tests, you can send preambles at millisecond intervals. Moreover, the R&S®CMU 300 monitors and evaluates the received AICHs for correct data content and correct timing. You can further vary and refine the test conditions by adding additive white Gaussian noise (AWGN) (FIG 9).

HS-SCCH information

The HS-SCCH monitor function can simultaneously analyze a maximum of four HSDPA DL control channels (HS-SCCH) from a user-defined set of up to 128 UEs. The R&S®CMU 300 decodes each frame and lists the detected UEs in a table (FIG 10). Furthermore, it evaluates and displays the HS-SCCH control information, which also contains the modulation type (QPSK / 16QAM), the size of the transport blocks or the number of HSDPA data channels assigned to a UE. The measurement can be triggered by a specific frame (HSFN) or started with a specific UE. During measurements on operating networks, most of the assigned UE IDs are not known. It is also difficult to predict them since they are assigned by a base-station specific algorithm. But the R&S®CMU 300 also offers a solution to this problem: It includes a special UE ID scan mode that scans all HSDPA DL control channels for active UEs and stores the detected UE IDs in a table. This table is used for measuring the HS-SCCH information (or for measuring the HS-PDSCH throughput).

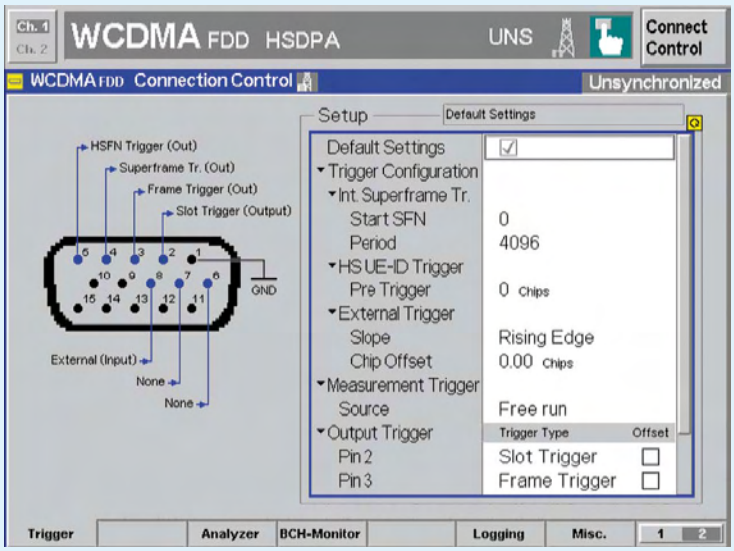


FIG 4 Trigger setup menu.

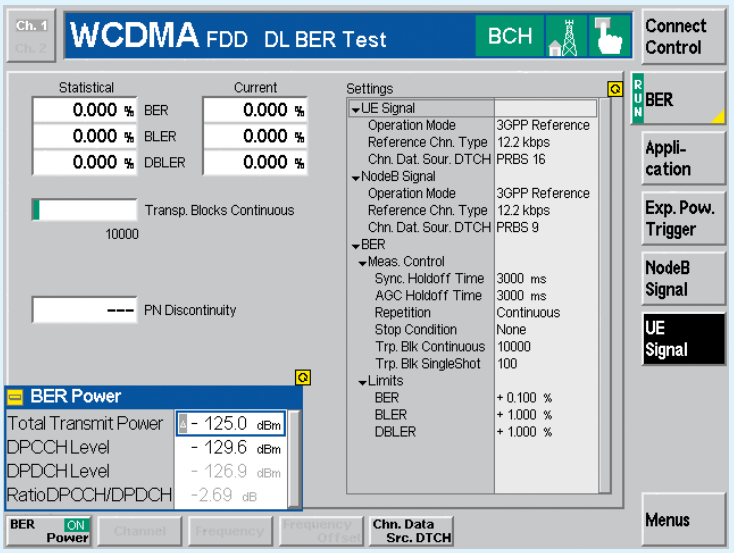


FIG 5 BER measurement.

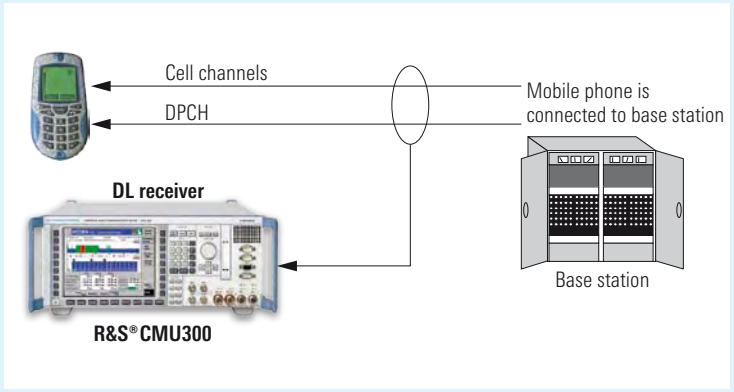


FIG 6 The R&S®CMU 300 can monitor DL channels in realtime and document and decode data.

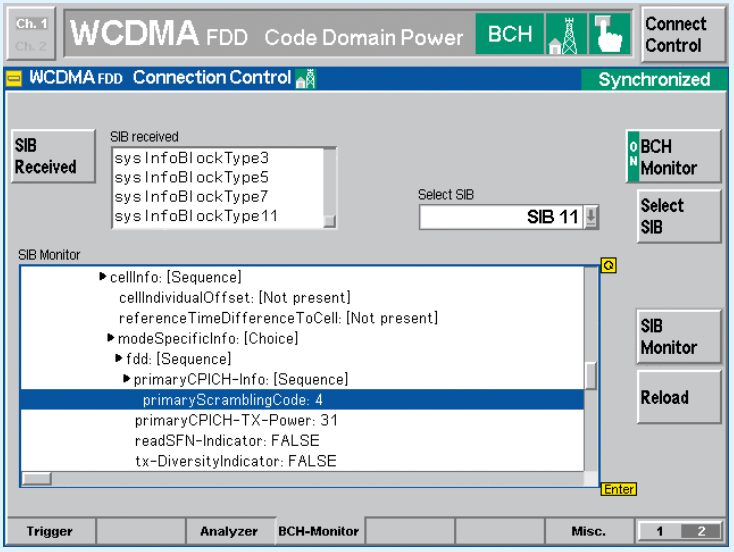


FIG 7 The system information blocks (SIB) sent by the base station in the BCH/P-CCPCH are displayed, decoded online and evaluated.

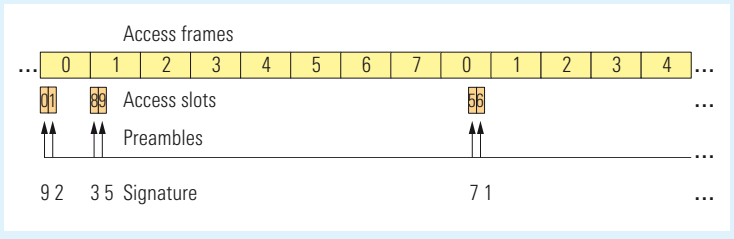
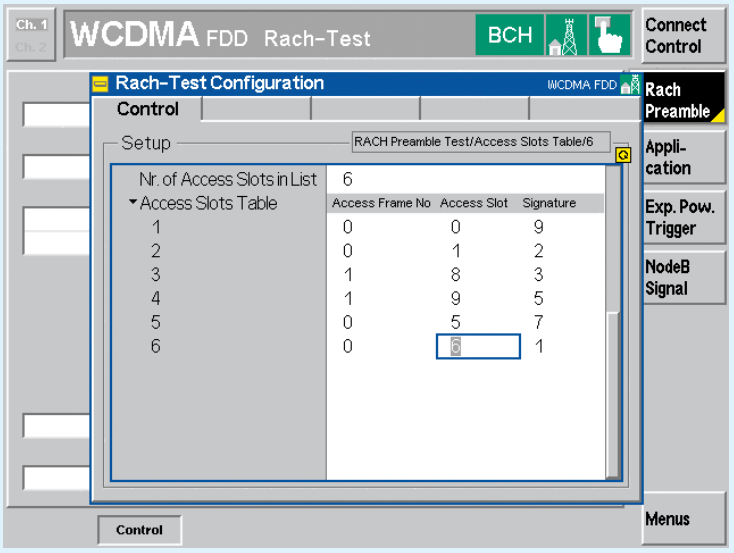


FIG 8 Example of an RACH setup.



Measuring HS-PDSCH throughput

In addition to the HSDPA control channel information, the gross data rate and the effective throughput of the HSDPA DL data channels (HS-PDSCH) are particularly of interest. These two values are calculated for up to 128 UEs based on the evaluated control channel parameters. The current and average data rates, the throughput as well as the minimum and maximum values of each active UE are displayed, and the complete data rate / complete data throughput of all UEs is calculated (FIG 11). The cell data rate or the attained cell throughput is calculated very easily based on the above data. As in the HS-SCCH monitor, this measurement can also be triggered by a specific frame (HSFN) or started with a specific UE ID.

HSDPA UL "stimulate"

The existing R&S®CMU 300 UL generator used in the non-signaling test mode [2] has been expanded in the signaling test mode to include an HSDPA UL function. In addition to the standard function (simulation of a UE by activating reference measurement channels (RMC) or physical channels), an HS-DPCCH with repeating, user-defined ACK / NACK / DTX sequences and / or sequences with channel quality information (CQI) is sent in the HSDPA UL mode. You can configure both sequences independently of each other with up to 64 values. Further user-specific parameters such as transmission time interval (TTI) as well as an independently triggered start (e.g. via HSFN / UE ID trigger) of the CQI or ACK / NACK / DTX sequences open up a variety of realistic ways to stimulate the base station (FIG 12).

HSDPA "stimulate & check"

Another important test, which also allows the time-critical behavior of the MAC-HS to be tested dynamically, is the combination of synchronous HS-DPCCH stimulation of the base station (UL) and HS-SCCH monitoring and evaluation (DL). This test is based on the previously described HSDPA UL generator and the DL HS-SCCH monitoring measurement in the R&S®CMU 300. By configuring a special UE ID trigger, you can simulate a realistic scenario (FIG 13): If the R&S®CMU 300 receives a special UE ID, it sends one element of the user-defined ACK / NACK / DTX sequence to the base station (UL stimulation). You can check the response of the base station (DL check) by using the HS-SCCH monitor.

Summary

The R&S®CMU 300 provides a variety of base station tests. The classic test mode for fast and cost-efficient large-scale tests is the non-signaling mode with vector analysis and signal generator functions. The new signaling test mode functions offer a variety of analysis capabilities for characterizing base stations and thus optimizing networks. Since trigger interfaces are no longer required, the test setup is much easier – a true benefit in production and nano base station tests. The new HSDPA measurements also make the R&S®CMU 300 a popular measuring instrument for testing complex scenarios and for launching HSDPA. A single-box solution featuring such a wide a scope of functions at such an impressive price / performance ratio has never been offered before – making the R&S®CMU 300 truly unique.

Anne Stephan, Daniel Hank

More information and data sheet at www.rohde-schwarz.com (search term: CMU300)

REFERENCES

[1] Universal Radio Communication Tester R&S®CMU 300: Fast transmitter and receiver measurements on WCDMA base stations. News from Rohde & Schwarz (2003) No. 178, pp 25–27

[2] Universal Radio Communication Tester R&S®CMU 300: WCDMA generator for tests on 3GPP base station receivers. News from Rohde & Schwarz (2002) No. 176, pp 17–20

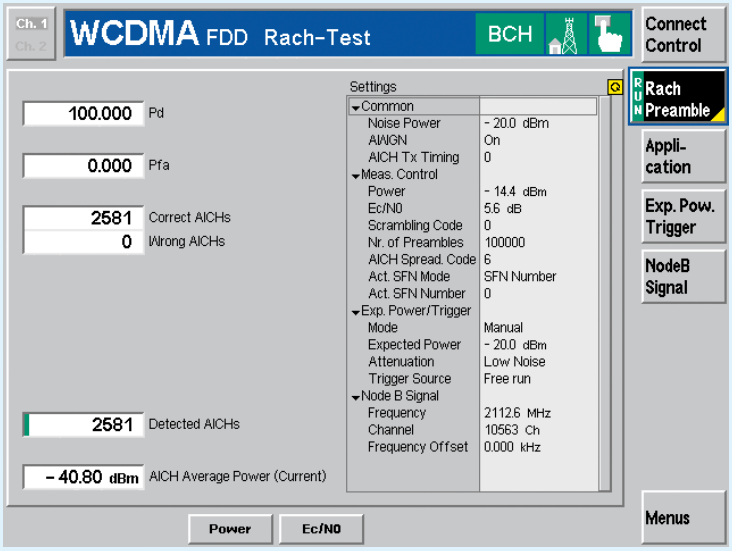


FIG 9 RACH preamble test with AICH monitoring and evaluation. The test conditions can additionally be varied and refined by adding additive white Gaussian noise (AWGN).

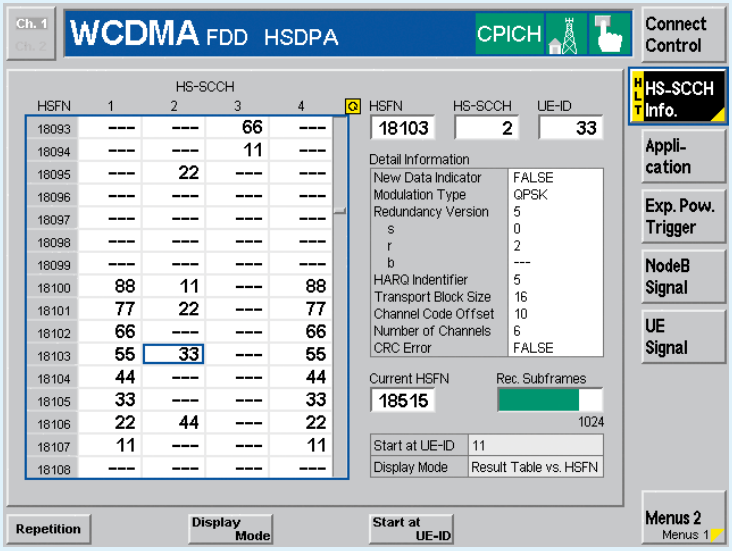


FIG 10 HS-SCCH information and HSDPA control channel information.

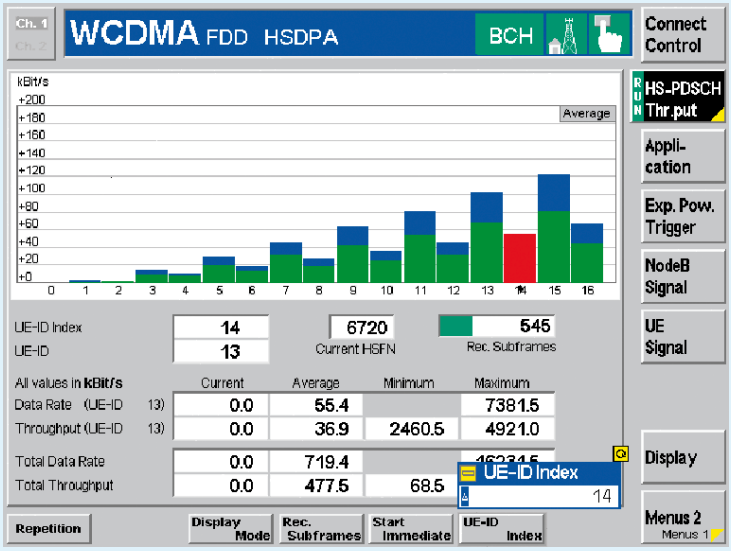


FIG 11 The throughput measurement provides information on cell throughput.

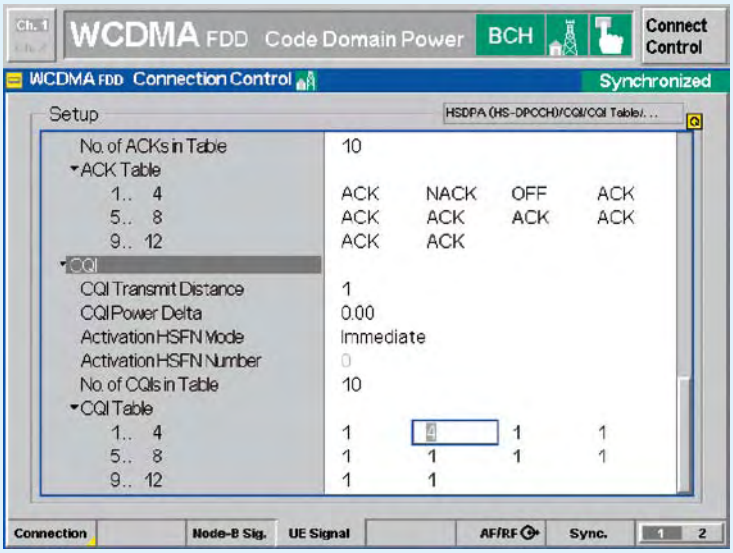


FIG 12 HSDPA UL generator.

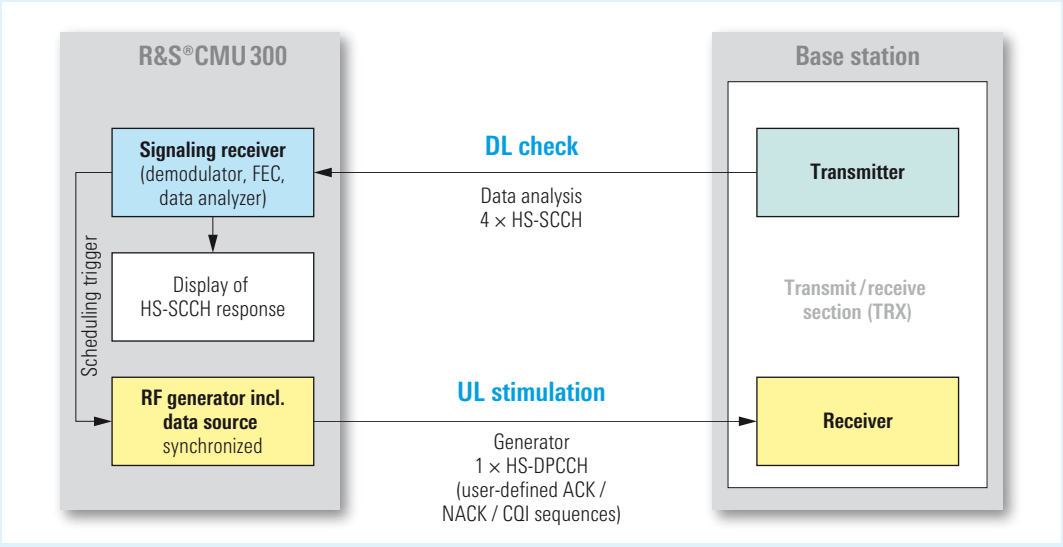


FIG 13
R&S®CMU 300 test setup for HSDPA UL stimulation and DL check.