How to Run WCDMA BER/ BLER Tests Using R&S Vector Signal Generators

Application Note

Products:

| R&S®SMBV100A | R&S®SMU200A

| R&S®SMJ100A

This application note shows how to run 3GPP WCDMA BER and BLER tests according to standard TS 25.141 with the Vector Signal Generators R&S®SMBV100A, R&S®SMJ100A, or R&S®SMU200A.
The description of hardware test setup is followed by detailed instructions on how to configure the R&S® generators and how to run a BER or BLER test step by step.
Remote control commands for the generators are included, to simplify integrating the BER/BLER tests into your proprietary test suite.

The procedures described in this application note are independent of the type of Device Under Test. Only an external synchronisation signal is required as well as reference frequency input or output.

Application Note
Detlev Liebl
03.2009-1MA144_3E

ROHDE&SCHWARZ

Table of Contents

1 Overview

This application note shows how to run BER and BLER tests according to standard TS 25.141 with the Vector Signal Generators R&S®SMBV100A, R&S®SMJ100A, or R&S®SMU200A on 3GPP WCDMA NodeBs.

A description of the recommended hardware test setup in chapter 2 is followed by detailed instructions on how to configure the R&S® generators (chapter 3). Remote control commands are included to simplify integrating the BER/BLER tests into your proprietary test suite. In chapter 4 you find instructions on how to run a BER or BLER test step by step.

Unlike User Equipment, NodeBs calculate the BER and the BLER internally or by means of an external device. The BER and BLER are not evaluated inside the tester; it only provides an uplink reference channel with PRBS data. This method is often called the "single ended BER / BLER test". User Equipment on the other hand provides an internal loop to send back the decoded receive data via the uplink: the calculation is done inside the tester. This method is called the "loopback BER / BLER test".

The single ended NodeB BER / BLER tests described here can be executed with either an R&S®SMBV100A, or an R&S®SMJ100A, or an R&S®SMU200A. To improve the readability, only a "signal generator" is mentioned in the following text. For the reminder of this application note, a reference to this signal generator could equally apply to an SMBV, an SMJ, or an SMU.

Benefits of the Rohde & Schwarz solution:

- Real-time test signals for 3GPP up- and downlink
- Additional White Gaussian Noise AWGN provided for receiver tests
- Remote control via IEEE488 and LAN
- Dual independent baseband and RF channels provided by SMU200A
- Dual baseband faders for optimum signal quality inside the SMU200A

The following abbreviations are used in this application note for R&S® test equipment:

- The R&S®SMBV100A Vector Signal Generator is referred to as SMBV.
- The R&S®SMJ100A Vector Signal Generator is referred to as SMJ.
- The R&S®SMU200A Vector Signal Generator is referred to as SMU.

2 BER / BLER Test Hardware Configuration

Requirements:

- Test controller (PC) with software to setup the Device Under Test (DUT), to run the test suite, and to generate and store the test protocols.
- Rohde & Schwarz® SMBV100A, SMJ100A, or SMU200A generator with the appropriate hardware and software options, see table 8_1 on page 18.
- Power supply for the DUT.

The DUT shall provide:

- Sync pulse to synchronize up- and downlink. This could be a Start of Frame Number signal (SFN) which indicates when the frame counter wraps from 4095 to 0 or a Transmission Time Interval signal (TTI).
- 10 MHz reference input or output at the DUT. Some NodeBs can also use other frequencies, e.g. 19.2 MHz.

Hardware Setup:

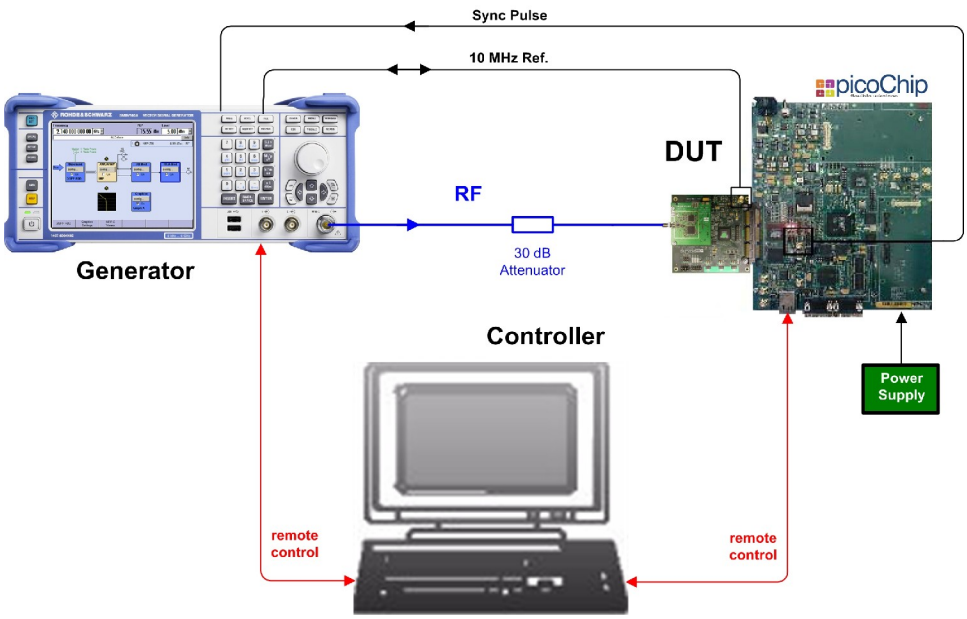


Figure 2_1: Hardware test setup for BER / BLER measurements

The DUT used in Figure 2_1 that supports this methodology (single ended BER/BLER) is the picoChip WCDMA Femtocell reference design and development platform.

Note: A 19.2 MHz reference clock output could also be provided on this product.

More information for picoChip customers on configuring this reference design for BER/BLER testing is found on the site https://support.picochip.com.

Preparations:

- Measure the RF path loss (RF cable including attenuator) for the test frequencies.
- Connect the:
  - Antenna port of the DUT via a 30 dB attenuator to the generator RF output. This improves the impedance matching between generator and DUT increasing level accuracy.

    Some base stations provide a DC bias at the RX connector to supply an external amplifier. Make sure that the bias is disabled, or use a DC blocking circuit between the DUT and signal generator.
  - 10 MHz Reference input of the DUT to the REF OUT connector of the R&S® generator if DUT is set to external reference.
    If the DUT does not have the possibility to receive a reference input, connect the 10 MHz reference port of the DUT to the *REF IN* connector of the R&S® generator.
  - Sync pulse output of the DUT to the TRIGGER1 input of the SMU and SMJ generators or to the TRIG input of the SMBV.
  - Remote control cables between the Controller, the DUT and the R&S® generator if the generator shall be remote controlled. Use the IEEE488 or the LAN interface either.

3 Generator Configuration

Manual Operation:

1. Reset the R&S® signal generator (press the hardkey *PRESET*).

2. Press hardkey *SETUP*; set 10 MHz *Reference Oscillator* to *Internal* or *External Source* as required by your DUT.

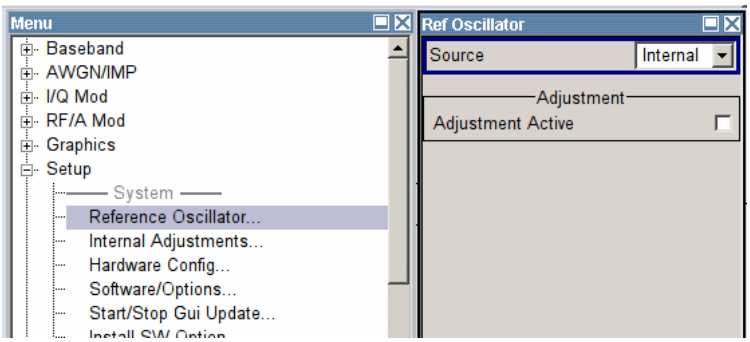


Figure 3_1: Reference oscillator setting.

3. Set the test frequency.

4. In the signal generator *DIAGRAM* select *RF/A Mod* and click *config...*

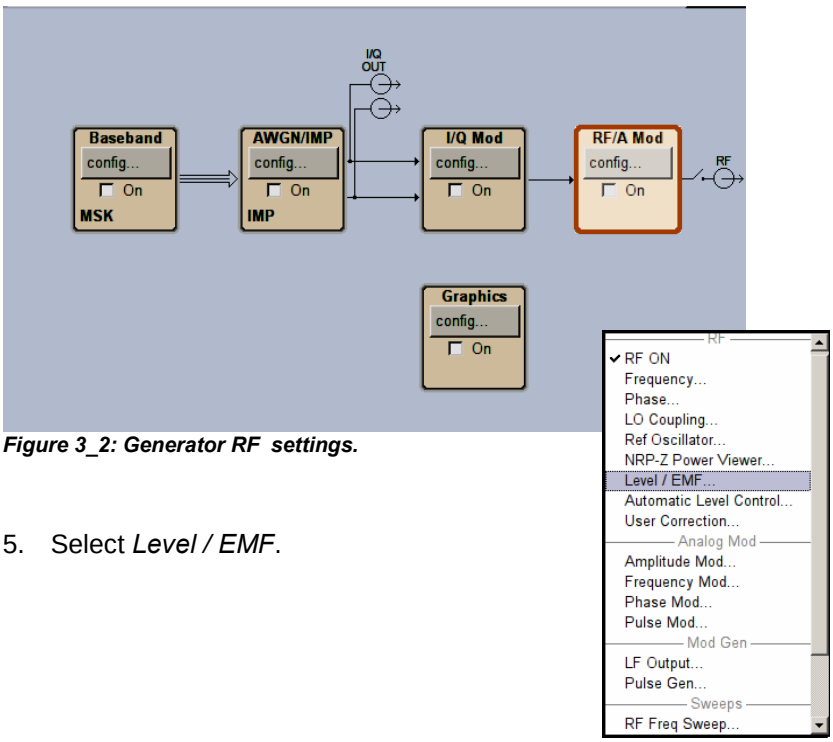


Figure 3_2: Generator RF settings.

5. Select *Level / EMF*.

The RF level panel opens:

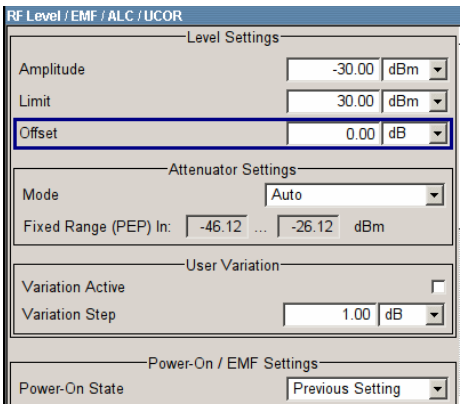


Figure 3_3: RF Level Offset input.

6. Enter your RF loss as a negative *Offset* (e.g. -30.7 dB)

7. Press hardkey *LEVEL*, enter the value required in the testplan, e.g. -98.7 dBm:

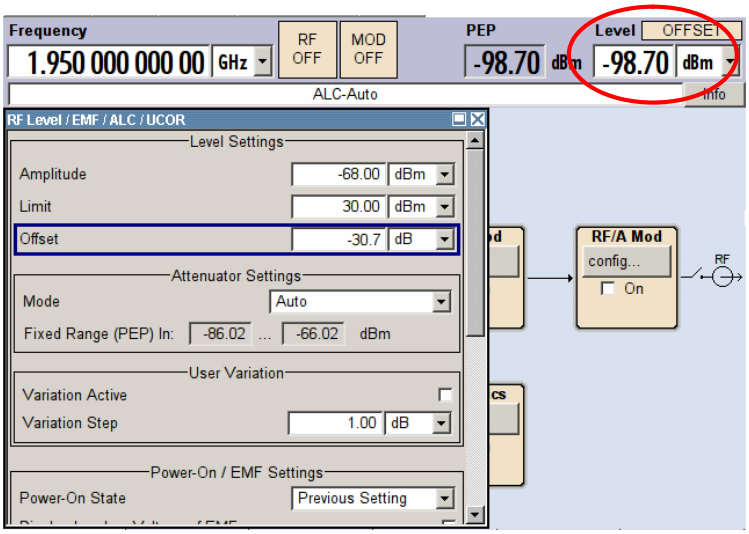


Figure 3_4: RF Level at the DUT.

Glossary of *Level Settings*:

Level:	power at the DUT (if RF is switched on).
Amplitude:	power at the generator RF port (if RF is switched on).
Offset:	negative value of the insertion loss of the RF path.

Level = Amplitude + Offset

8. Press the *hardkey ESC* to return to the *DIAGRAM*.

9. In the signal generator *DIAGRAM* select *Baseband* and click *config...*

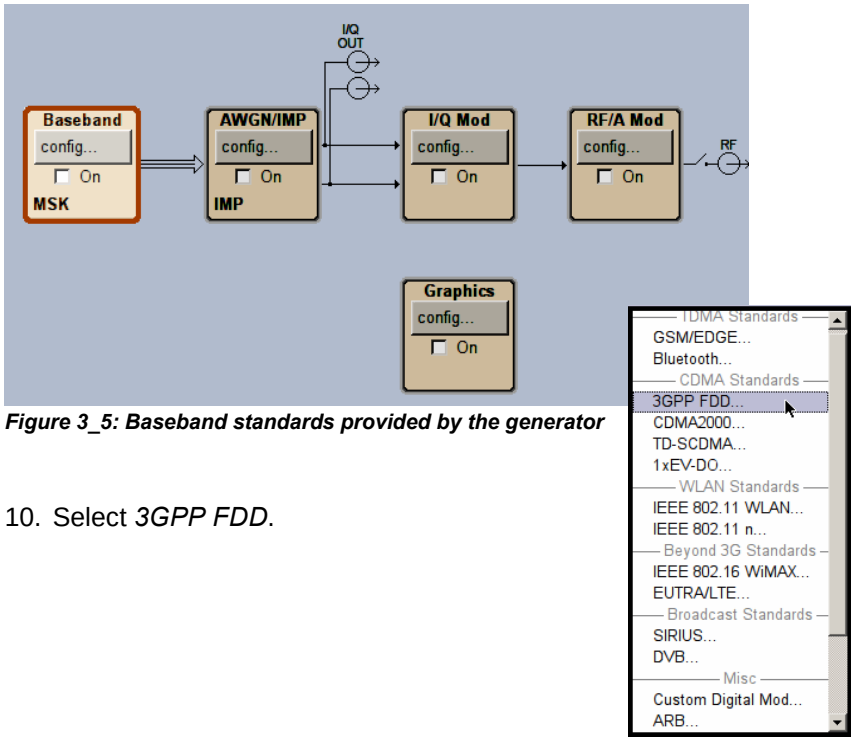


Figure 3_5: Baseband standards provided by the generator

10. Select *3GPP FDD*.

The 3GPP FDD main panel opens:

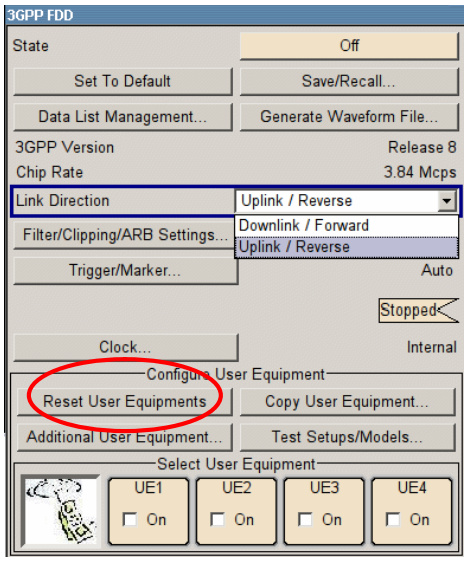
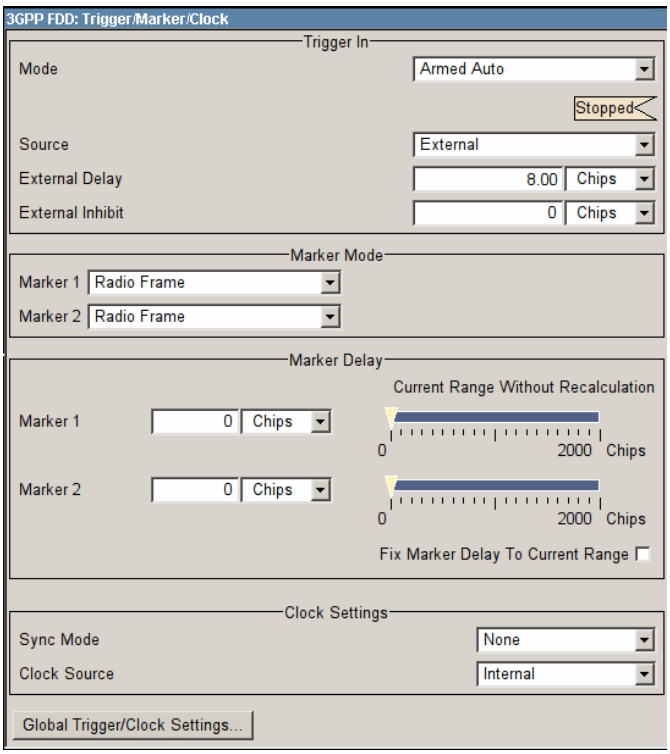


Figure 3_6: 3GPP FDD main panel

11. Set *Link Direction* to *Uplink / Reverse*

12. To clear previous settings click *Reset User Equipments*.

13. Click button *Trigger / Marker*

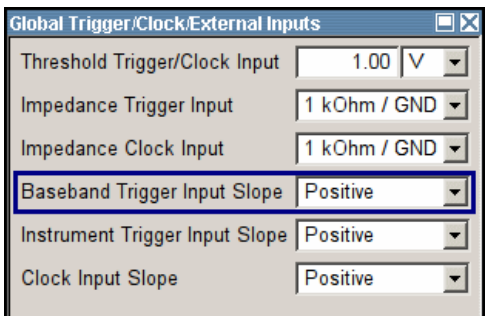


14. Select Armed Auto.
15. Select *Source External*. This makes the *Delay* and *Inhibit* fields visible.

Figure 3_7: Trigger settings for BER / BLER tests.

The *External Delay* depends on the type of NodeB. Wide Area NodeBs need a higher delay than Medium Range NodeBs; Medium Range NodeBs need a higher delay than Local Area NodeBs, and so on.

16. For optimum value ask the radio vendor.
17. Set (Trigger) *Source* back to *Internal*. This halts the generator even if external trigger signals are applied. So the generator doesn't disturb the initialization of the DUT.
18. Click Global Trigger/Clock Settings.



19. Modify the default settings if necessary.

Figure 3_8: The Baseband Trigger is used.

20. Press *the hardkey ESC* twice to return to the *3GPP FDD* main panel.

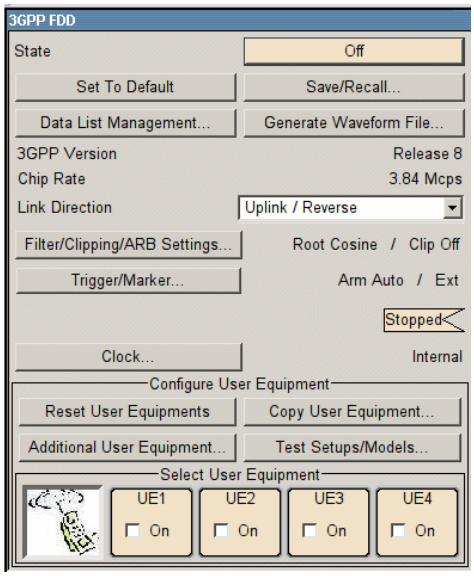


Figure 3_9: 3GPP FDD main panel / Uplink

21. Select and click *UE1*.

The configuration panel for UE1 opens.

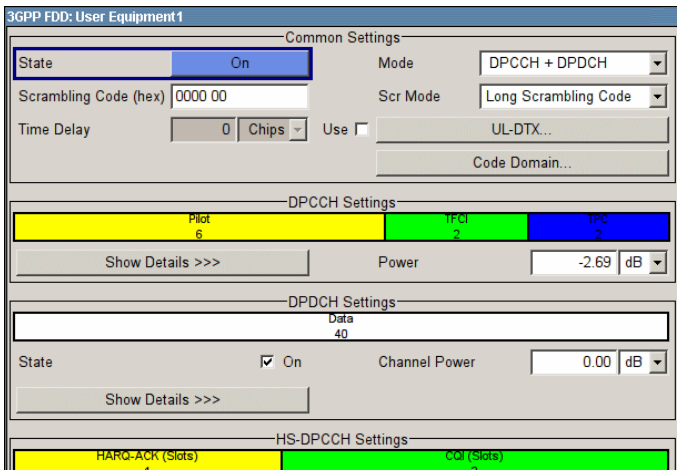
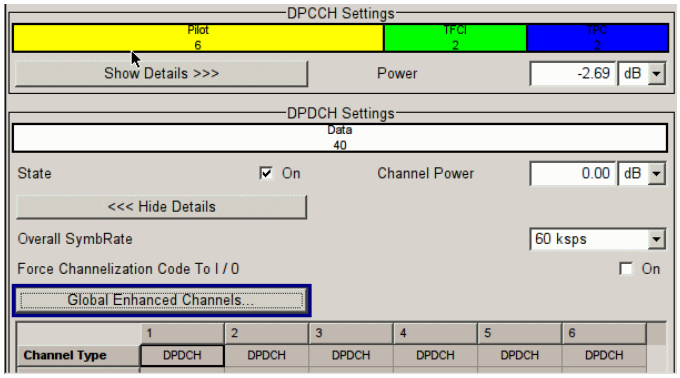


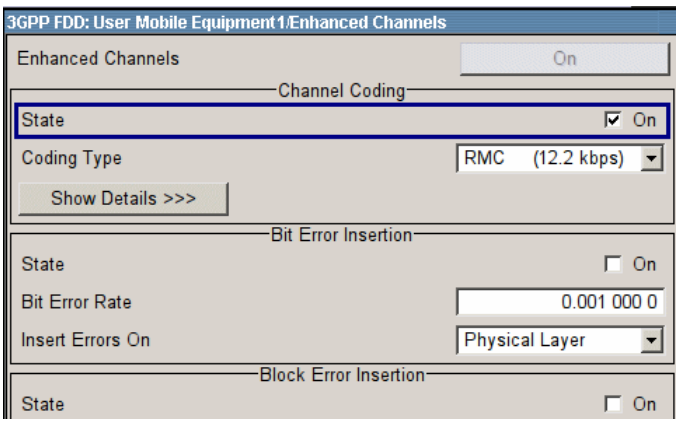
Figure 3_10: Panel of UE1

22. Switch *State on*.
23. Enter the *Scrambling Code*.
24. Set *DPCCH Power* to -2.69 dB
25. Click *Show Details*.



26. Click *Global Enhanced Channels*.

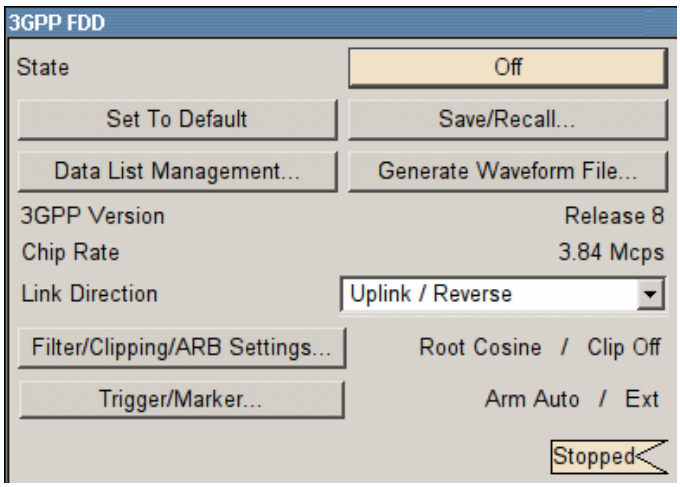
Figure 3_11: Panel of UE1 / details



27. Click *Channel Coding State On*.

Figure 3_12: UE1 to generate a real-time RMC 12.2

28. Press the hardkey *ESC* twice to return to the *3GPP FDD* main panel.



29. Click *State on.*

Figure 3_13: 3GPP FDD main panel

30. Press hardkey *RF on.*

Without a trigger signal, the generator remains stopped. There is no RF output.

31. Click button *Trigger / Marker...*

32. Set (Trigger) *Source* to *External.*

Now the generator starts running after the trigger event, delayed by the *External Delay*, see fig. 3_7.

Once running the *ARM* button appears in the 3GPP and the trigger panel:

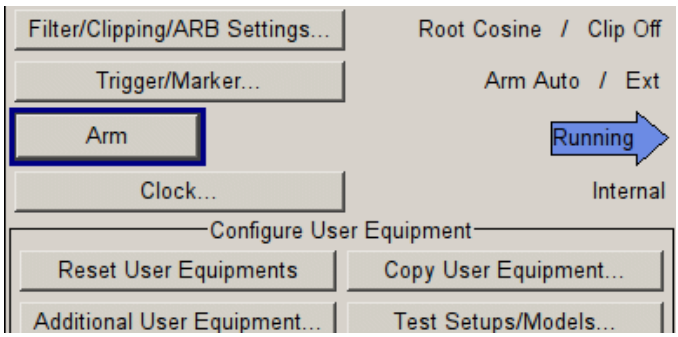


Figure 3_14: ARM button in the 3GPP FDD main panel

Click *ARM* to stop the generator (until the next trigger event).

Remote Control / SCPI Commands (example values are shaded):

Basic settings:

```
*RST                                        //    reset
ROSC:SOUR INT                               //    10 MHz ref. int
SOUR:FREQ:CW 1950 MHz                       //    test frequency
SOUR:POW:OFFS -30.7 dB                      //    level offset
SOUR:POW:LEV:IMM:AMPL -98.7 dBm             //    level
```

Generate uplink RMC 12.2:

```
SOUR:BB:W3GP:PRES                           //    reset 3G settings
SOUR:BB:W3GP:LINK UP                        //    uplink
SOUR:BB:W3GP:SEQ AAUT                       //    trig. armed auto
SOUR:BB:W3GP:TRIG:SOUR INT                  //    trig. internal
SOUR:BB:W3GP:TRIG:EXT:DEL 2                 //    2 chips delay
SOUR:BB:W3GP:MST1:ENH:DPDC:CCOD:STAT ON     //    enhanced on
SOUR:BB:W3GP:MST:ENH:DPDC:CCOD:TYPE M12K2   //    RMC 12.2
SOUR:BB:W3GP:MST1:ENH:DPDC:TCH1:DATA PN9    //    data PN9
SOUR:BB:W3GP:MST1:ENH:DPDC:TCH1:INT1 ON     //    interleaver 1 on
SOUR:BB:W3GP:MST1:ENH:DPDC:INT2 ON          //    interleaver 2 on
SOUR:BB:W3GP:MST:DPCC:SFOR 0                //    slot format 0
SOUR:BB:W3GP:MST:DPCC:POW -2.69             //    DPCCH/DPDCH
SOUR:BB:W3GP:MST1:SCOD #H1A                 //    scrambl. code 1A
SOUR:BB:W3GP:MST1:STAT ON                   //    UE on
SOUR:BB:W3GP:STAT ON                        //    3GPP on
OUTP:STAT ON                                //    RF on
```

To start the uplink signal at the next trigger event set trigger to external:

```
SOUR:BB:W3GP:TRIG:SOUR EXT
```

4 Test Steps

The order of the test steps may vary for different NodeBs, in particular at which point in time the generator and the measurement have to be started (steps 7 and 8 below). Ask your radio vendor for the correct order.

1. Connect the DUT, power supply, controller PC and generator as shown in fig. 2_1 on page 5.

---

2. Power up the signal generator.

3. If the DUT is set to internal 10 MHz reference, configure the signal generator to external reference (and vice versa).

4. Configure the signal generator as described in section 3 *Generator Configuration*, steps 1 to 31. The trigger *Source* should still be set to *Internal*.
   At the first time it could be helpful to use a fairly high generator power level (-70 dBm at the DUT RF port).

---

5. Power up the DUT.

6. Configure the DUT to generate sync pulses.

7. Set the generator trigger *Source* to *External*. This starts the uplink signal after the next sync pulse. Check whether the signal generator is running.

8. Configure the uplink channel on the DUT and start the test.

If the DUT does not receive the uplink signal correctly, click *Arm* on the generator to resync up- and downlink.
If this does not help, abort the test program, stop the generator (set it to internal trigger), reset the DUT and restart from step 6.

► Consider that the trigger delay set in section 3 step 16 may have been set incorrectly.

5 Conclusion

BER and BLER receiver tests are required in R&D, for conformance testing and in production. For all receiver sensitivity and performance measurements, the R&S® generators provide the test signals as stipulated by the standard TS 25.141. The insertion of bit errors, applying signal impairments, or Additional White Gaussian Noise requires only a few keystrokes.
The R&S® generators SMU, SMJ, and SMBV are remote compatible, and can be controlled via LAN or IEEE.
For transmitter tests to TS25.141 as well as for classical spectrum measurements in R&D and production Rohde & Schwarz® recommends the R&S®FSQ, R&S®FSL, and R&S®FSV Signal Analyzers.

6 Literature

[1] 3GPP TS25.141; Base Station (BS) conformance testing (FDD) V 8.4.0, 2008-09

[2] 3GPP TS25.104; Base Station (BS) radio transmission and reception (FDD) V 8.4.0, 2008-09

[3] 3GPP TR25.820; 3G Home NodeB Study Item Technical Report V 8.0.2, 2008-09

[4] Tests on 3GPP WCDMA FDD NodeBs in Accordance with Standard TS25.141, Application Note 1MA67, Rohde&Schwarz®, 2005

[5] picoChip support site https://support.picochip.com/

7 Additional Information

Please contact **tm-applications@rohde-schwarz.com** for comments and further suggestions.

For additional information on picoChip, mail to **info@picochip.com**.

8 Ordering Information

SMBV100A VECTOR SIGNAL GENERATOR		
Type	**Designation**	**Order No**
SMBV100A	Vector Signal Generator	1407.6004.02
SMBV-B103 or SMBV-B106	9 kHz to 3.2 GHz 9 kHz to 6 GHz	1407.9603.02 1407.9703.02
SMBV-B10	Baseband Generator with Digital Modulation (realtime) and ARB (32 MSample), 120 MHz RF Bandwidth	1407.8607.02
SMBV-K42	Digital Standard 3GPP FDD	1415.8048.02

SMJ100A VECTOR SIGNAL GENERATOR		
Type	**Designation**	**Order No**
SMJ100A	Vector Signal Generator	1403.4507.02
SMJ-B103 or SMJ-B106	Frequ. range 100 kHz - 3 GHz Frequ. range 100 kHz - 6 GHz	1403.8502.02 1403.8702.02
SMJ-B9 or SMJ-B10 or SMJ-B11	Basebandgenerator with dig. modulation (real time) and ARB 128 / 64 / 16 MSamples	1404.1501.02 1403.8902.02 1403.9009.02
SMJ-B13	Baseband main module	1403.9109.02
SMJ-K42	Digital Standard 3GPP FDD	1404.0405.02

SMBV100A VECTOR SIGNAL GENERATOR		
Type	**Designation**	**Order No**
SMU200A	Vector Signal Generator	1141.2005.02
SMU-B102 or SMU-B103 or SMU-B104 or SMU-B106	Frequ. range 100 kHz - 2.2 GHz Frequ. range 100 kHz - 3 GHz Frequ. range 100 kHz - 4 GHz Frequ. range 100 kHz - 6 GHz	1141.8503.02 1141.8603.02 1141.8703.02 1141.8803.02
SMU-B9 or SMU-B10 or SMU-B11	Basebandgenerator with dig. modulation (real time) and ARB 128 / 64 / 16 MSamples	1161.0766.02 1141.7007.02 1159.8411.02
SMU-B13	Baseband main module	1141.8003.02
SMU-K42	Digital standard 3GPP FDD	1160.7909.02

Table 8_1: Instruments and instrument options for BER / BLER tests

About Rohde & Schwarz
Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Regional contact
Europe, Africa, Middle East
+49 1805 12 42 42* or +49 89 4129 137 74
customersupport@rohde-schwarz.com

North America
1-888-TEST-RSA (1-888-837-8772)
customer.support@rsa.rohde-schwarz.com

Latin America
+1-410-910-7988
customersupport.la@rohde-schwarz.com

Asia/Pacific
+65 65 13 04 88
customersupport.asia@rohde-schwarz.com

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15 | D - 81671 München
Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com