```
FREQ  1.000 000 000 0  GHz          LEVEL        0.0  dBm
                                     PEP          0.0  dBm
2FSK BERT                                              ALC-TAB
FREQUENCY   BER    BIT ERROR RATE                      0 E-15
LEVEL       BLER   DATA BITS                           64 424
ANALOG MOD         ERRORS                              0
VECTOR MOD         TERMINATED BY                      ----
DIGITAL MOD        STATE      CLOCK DETECTED  DATA DETECTED  SYNCHRONIZED
DIGITAL STD
ARB MOD            MODE                      OFF  AUTO  SINGLE
NOISE/DIST
FADING SIM         TERMINATION ATTRIBUTES
BERT                DATA BITS                          100 000
LF OUTPUT           ERRORS                             100
SWEEP              PRBS              9  11  15  16  20  21  23
LIST              DATA POLARITY                   NORM   INV
MEM SEQ           CLOCK SLOPE                     POS    NEG
UTILITIES         EXTERNAL RESTART          DISABLED  ENABLED
HELP              DATA ENABLE           NOT_USED  LOW  HIGH
                  PATTERN IGNORE             OFF  ALL0  ALL1
                  UNIT                      ENG  SCI  %  PPM
```

Products: AMIQ or SMIQ and FSP or FSU

Demonstration of BER Test with SMIQ or AMIQ and FSP or FSU

Application Note

Two test setups which demonstrate the Bit Error Rate (BER) test function of either an SMIQ (with option B21) or an AMIQ (with option B1) are described. The tester generates the FSK modulated RF or IF signal as well as carries out the BER test. The analog Marker FM Demodulator from an FSP/FSU spectrum analyzer is used as an online FSK demodulator.

ROHDE & SCHWARZ

Contents

1   Overview

Two test setups are described to demonstrate easily the Bit Error Rate (BER) test function of either AMIQ/AMIQ-B1 or SMIQ/SMIQB21 as desired.

The test setups contain either SMIQ with SMIQB21 or, as an alternative I/Q Modulation Generator AMIQ/AMIQ-B1 controlled by I/Q Simulation Software WINIQSIM^{TM} for signal generation and BER measurement. In both cases the analog Marker FM Demodulator of an FSP or FSU spectrum analyzer is used as an online FSK demodulator to demodulate the FSK modulated IF or RF signal, generated by the AMIQ or SMIQ. The AF output from the spectrum analyzer is fed to the AMIQ or SMIQ BER data input.

2   Principle of Operation

Uncoded 2-FSK modulation is a rather simple digital modulation. An oscillator is switched between two frequencies: The high frequency normally indicates a digital "1" and the low frequency a digital "0". In many cases an analog FM demodulator with sufficient demodulation bandwidth can be used to demodulate the 2-FSK signal. The digital datastream is produced by feeding the demodulated AF voltage to a suitable comparator which may be a simple TTL input if the AF voltage exceeds a peak voltage of 2 V.

The analog FM marker demodulator of the FSP or FSU can under certain circumstances be used as an FSK online demodulator and is therefore useable for demonstrating the BER measurement capability of either SMIQ/SMIQ-B21 or AMIQ/AMIQ-B1. (The FM demodulator function of either spectrum analyzer cannot be used for this purpose because it is an offline demodulator which cannot deliver a continous data stream). FM deviation and gain of the FM marker demodulator must be high enough to exceed the TTL "high" threshold for the BER data input to the SMIQ or AMIQ.

3   Carrying out the BER Test

With FSP or FSU and SMIQ:

Figure 1 shows the test setup using FSP or FSU and SMIQ. Connect the FSP/FSU AF output to the BER data input of the rear side 9-pin sub-D connector[**)] of the SMIQ (Pin 7) using a jack plug[*)] stereo 3.5 mm. The clock signal of the SMIQ (front side BNC connector) is fed to the BER Clock input of the same SMIQ connector (pin 6).

[*)] R&S part number: 1015.1585.00, both connectors of the jack plug tied together.

[**)] Use R&S part numbers 0434.9362.00 (female connector), 0704.1414.00 (shielding) and 0704.1495.00 (screws, 2x). Connect shielding to pin 1 to 5 (ground pins).
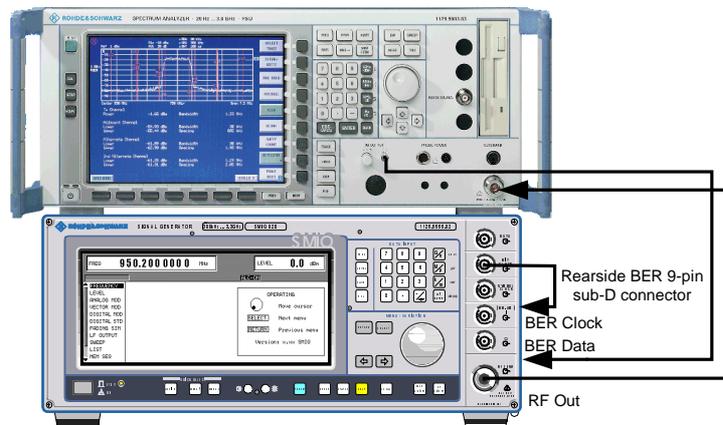
Figure 1: Test setup with FSP or FSU and SMIQ

Setting the FSP/FSU (identical in both setups):

PRESET

CENTER 1 GHz

AMPT: REF LEVEL 5 dBm

Span: Zero Span

BW: Res BW Manual 300 kHz

MKR FNCT: Marker Demod: FM

Turn AF volume knob clockwise for at least 2 complete turns (AF Volume is thus set to maximum).

Demonstration of BER Test with SMIQ or AMIQ

Setting the SMIQ:

PRESET

FREQ *1 GHz*

LEVEL *0 dBm*

DIGITAL MOD: STATE ON

SOURCE: PRBS

PRBS LENGTH 9

MODULATION: TYPE 2FSK

FSK DEV: 64 kHz

SYMBOL RATE: 16 kHz

FILTER TYPE: GAUSS

FILTER PARAMETER: 0.5

```
FREQ   1.000 000 000 0  GHz        LEVEL        +0.1  dBm
                                   PEP          +0.1  dBm
2FSK                                                  ALC-S&H
FREQUENCY    STATE                                OFF  ON
LEVEL        SOURCE...                                PRBS
ANALOG MOD   SELECT STANDARD...                       USER
VECTOR MOD   MODULATION...                    2FSK/64.00kHz
DIGITAL MOD  SYMBOL RATE                    16 000.000 sym/s
DIGITAL STD  FILTER...                           GAUSS/0.50
ARB MOD      CODING...                                  OFF
NOISE/DIST   TRIGGER MODE...                          AUTO
FADING SIM
BERT         TRIGGER...                                INT
LF OUTPUT    CLOCK...                      COUPLED/SYMBOL
```

Figure 2: Modulation Setting of SMIQ

BERT Setting of SMIQ:

BERT:Termination Attributes: Data Bits 100 000

Mode Auto

```
┌─────────────────────────────────────────────────────────────────────────┐
│ FREQ   1.000 000 000 0  GHz                    LEVEL          0.0  dBm     │
│                                                PEP            0.0  dBm     │
│ 2FSK BERT                                              ALC-TAB             │
│ FREQUENCY    BER   BIT ERROR RATE                              0 E-15     │
│ LEVEL        BLER  DATA BITS                             64 424           │
│ ANALOG MOD         ERRORS                                     0           │
│ VECTOR MOD         TERMINATED BY                          ┌────┐          │
│ DIGITAL MOD        STATE      CLOCK DETECTED  DATA DETECTED  SYNCHRONIZED │
│ DIGITAL STD                                                               │
│ ARB MOD            MODE                       OFF  │AUTO│  SINGLE         │
│ NOISE/DIST                                                                │
│ FADING SIM         TERMINATION ATTRIBUTES                                 │
│ ┌────┐             DATA BITS                            100 000           │
│ │BERT│               ERRORS                                 100           │
│ LF OUTPUT                                                                 │
│ SWEEP              PRBS                    │9│ 11  15  16  20  21  23     │
│ LIST               DATA POLARITY                        │NORM│ INV        │
│ MEM SEQ            CLOCK SLOPE                            │POS│ NEG       │
│ UTILITIES          EXTERNAL RESTART              │DISABLED│ ENABLED       │
│ HELP               DATA ENABLE                 │NOT_USED│ LOW  HIGH       │
│                    PATTERN IGNORE                │OFF│ ALL0  ALL1        │
│                    UNIT                         │ENG│ SCI  %  PPM         │
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 3: BERT Setting of SMIQ

A continuous BER measurement will start. The SMIQ should display 0.00 % BER if everything is set correctly.

Lower the level of SMIQ by about 40 dB (-40 dBm) to achieve a BER of some percent (Signal to Noise ratio will decrease). Restart measurement after changing the level.

With FSP or FSU and AMIQ:

Figure 4 shows the test setup using and AMIQ. Connect the FSP or FSU AF output to the BER data input of the rear side 9-pin sub-D connector[**] of the AMIQ (Pin 7) using a jack plug[*] stereo 3.5 mm. The clock signal (Mark 2 output) of the AMIQ (rear side BNC connector) is fed to the BER Clock input of the same AMIQ connector (pin 6).

[*] R&S part number: 1015.1585.00, both connectors of the jack plug tied together.

[**] Use R&S part numbers 0434.9362.00 (female connector), 0704.1414.00 (shielding) and 0704.1495.00 (screws, 2x). Connect shielding to pin 1 to 5 (ground pins).
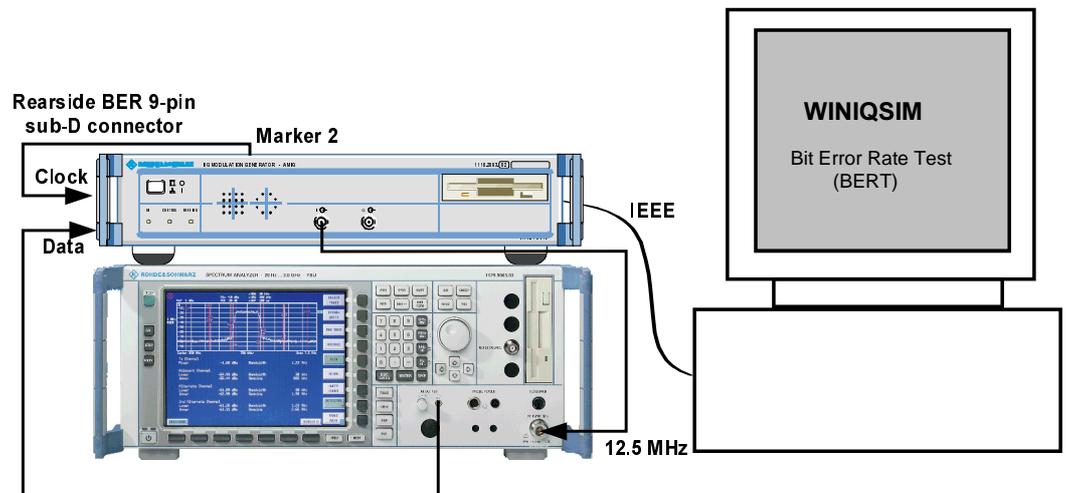
Figure 4: Setup with FSP/FSU and AMIQ

Setting of FSP or FSU:

As above but Frequency: Center 12.5 MHz

Setting of Winiqsim:

You can either use the WINQISIM setting file: *BERDEMO_FSP_IF12_5MHz.iqs* delivered with this Application Note (recommended) or set the WINIQSIM parameters according to the screenshots below. In either cases the AMIQ produces a suitable FSK-modulated IF Signal at 12.5 MHz. A symbol rate of 16 kHz and an FSK index of 4 gives sufficient deviation and a suitable level of AF voltage from the FSP/FSU FM Marker demodulator. Because of the IF generation about 1.6 Msamples have to be calculated by WINIQSIM. Calculation and transmission of the IQ waveform files to the AMIQ lasts therefore some 1 – 4 minutes depending on the performance of the PC used.

(1) From the modulation menu setup the modulation parameters
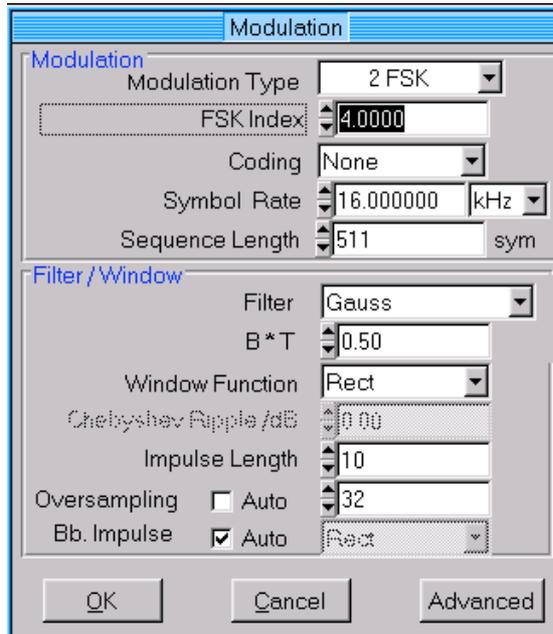
Figure 5: Modulation Settings of Winiqsim

(2) From the data source menu, select the source as PRBS 9.
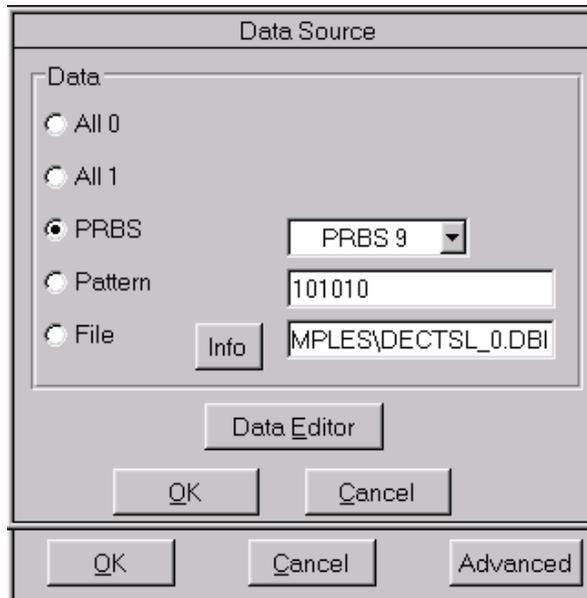
Figure 6: Data Source settings

(3) From the BERT settings menu select BERT Mode On and the marker signals as in Figure 7
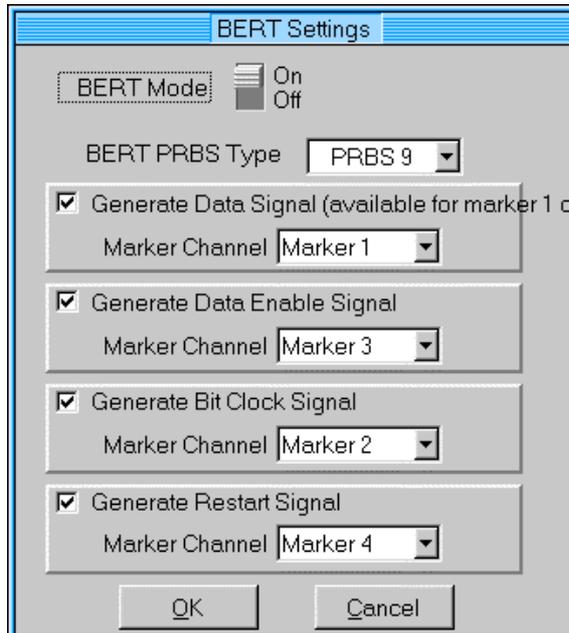
Figure 7: Data Source/Data Editor Bert Settings

(4) From the Block Diagram menu set up IF generation ON.
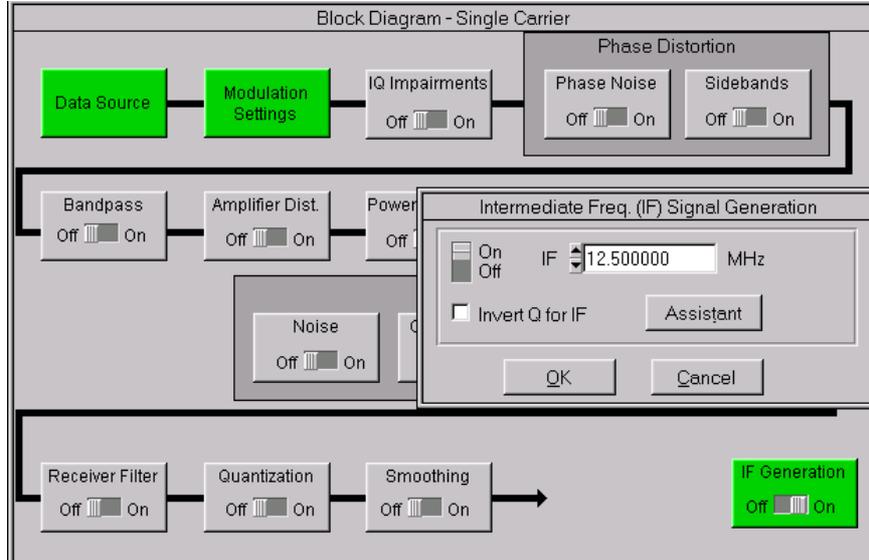
Figure 8: IF Generation Setting

(5) Transmit the Settings to AMIQ

(6) From the AMIQ Remote Control/BERT menu setup parameters as: Data Bits, Errors, Data Polarity, Clock Slope, Ext Restart, Data Enable and PRBS as set in Figure 9.
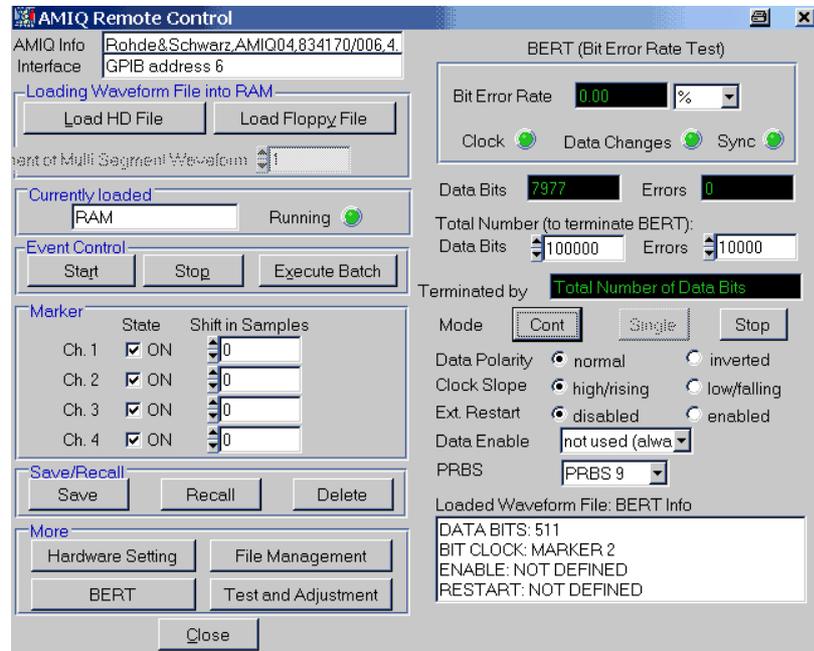
Figure 9: AMIQ Remote Control/BERT Settings

(7) Start the Bit Error Rate Test with:

Mode Cont.

A continuous BER measurement will start. The WINIQSIM™ software should display 0.00 % BER if everything is set correctly.

Lower level of AMIQ at I output from default setting 0.5V to about 0.004V.
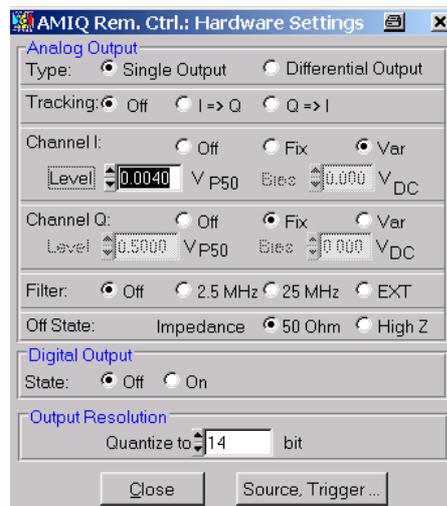
Figure 10: Level Setting of I Channel (Hardware Settings Menu)

A BER of some percent will occur because the Signal to Noise ratio is thus decreased. Restart measurement when changing the level.

4   Literature

[1]   Application Note 1MA16_0E "Demonstration of BER Test with AMIQ controlled by WinIQSim"

[2]   Software Manual WINQSIM^{TM}

[3]   Operating Manual SMIQ

[4]   Application Note 1GP36 "Bit Error Rate Measurements with AMIQ and WinIQSIM"

5   Additional Information

Please contact **TM-Applications@rsd.rohde-schwarz.com** for comments and further suggestions.

6   Ordering information

Name of instrument	range	Ordering number
Vector Signal Generator		
SMIQ02B	300 kHz to 2.2 GHz	1125.5555.02
SMIQ03B	300 kHz to 3.3 GHz	1125.5555.03
SMIQ04B	300 kHz to 4.4 GHz	1125.5555.04
SMIQ06B	300 kHz to 6.4 GHz	1125.5555.06
SMIQ03HD	300kHz to 3.3 GHz	1125.5555.33
Options		
SMIQB11	Data Generator	1085.4502.04
SMIQB20	Modulation Coder	1125.5190.02
SMIQB21	BER Measurement	1125.5490.02
I/Q Modulation Generator		
AMIQ03 incl. WINIQSIM^{TM}	4 MSamples Memory	1110.2003.03
AMIQ04 incl. WINIQSIM^{TM}	16 MSamples Memory	1110.2003.04
AMIQ-B1	Option BER Measurement	1110.3500.02
Spectrum Analyzer		
FSP3	9 kHz to 3 GHz	1093.4495.03
FSP7	9 kHz to 7 GHz	1093.4495.07
FSP13	9kHz to 13.6 GHz	1093.4495.07
FSP30	9 kHz to 30 GHz	1093.4495.30
FSU3	20 Hz to 3.6 GHz	1129.9003.03
FSU8	20 Hz to 8 GHz	1129.9003.08

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