FSK BERT		ALC-TAB
FREQUENCY BEI LEVEL BLI ANALOG MOD VECTOR MOD DIGITAL MOD	BIT ERROR RATE DATA BITS ERRORS TERMINATED BY STATE CLOCK DETECTED	0 E-15 64 424 0 [] DATA DETECTED SYNCHRONIZED
DIGITAL STD ARB MOD NOISE/DIST FADING SIM BERT LF OUTPUT	MODE TERMINATION ATTRIBUTES DATA BITS ERRORS	ОFF <u>АШТО</u> SINGLE 100 000 100
SWEEP LIST MEM SEQ UTILITIES HELP	PRBS DATA POLARITY CLOCK SLOPE EXTERNAL RESTART DATA ENABLE PATTERN IGNORE UNIT	9 11 15 16 20 21 23 NORM INV POS NEG DISABLED ENABLED NOT_USED LOW HIGH OFF ALLO ALL1 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.



# Contents

1	Overview	2
2	Principle of Operation	2
3	Carrying out the BER Test	3
	With FSP or FSU and SMIQ:	3
	With FSP or FSU and AMIQ:	6
	Setting of FSP or FSU:	6
	Setting of Winigsim:	6
4	Literature	10
5	Additional Information	10
6	Ordering information	10
	-	

# **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<sup>TM</sup> 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<sup>\*\*</sup>) of the SMIQ (Pin 7) using a jack plug<sup>\*</sup>) 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 <b>1.</b> 0	000000000 GH	z LEVEL PEP	+0.1 dBm +0.1 dBm
2FSK			ALC-S&H
FREQUENCY	STATE		OFF ON
LEVEL	SOURCE		PRBS
ANALOG MOD	SELECT STANDARD		USER
VECTOR MOD	MODULATION		2FSK/64.OOkHz
DIGITAL MOD	SYMBOL RATE		16 000.000 sуm/s
DIGITAL STD	FILTER		GAUSS/0.50
ARB MOD	CODING		OFF
NOISE/DIST	TRIGGER MODE		AUTO
FADING SIM			
BERT	TRIGGER		INT
LF OUTPUT	<b>СГОСК</b>	c	OUPLED/SYMBOL

Figure 2: Modulation Setting of SMIQ

#### **BERT Setting of SMIQ:**

**BERT**: Termination Attributes: Data Bits 100 000 Mode Auto

FREQ <b>1.000</b>	000 000 0 GHz	LEVEL O.O dBm PEP O.O dBm
2FSK BERT		ALC-TAB
FREQUENCY LEVEL ANALOG MOD VECTOR MOD DIGITAL MOD DIGITAL STD ARB MOD NOISE/DIST FADING SIM BERT LF OUTPUT SWEEP LIST MEM SEQ UTILITIES HELP	BIT ERROR RATE DATA BITS ERRORS TERMINATED BY STATE CLOCK DETECTED MODE TERMINATION ATTRIBUTES DATA BITS ERRORS PRBS DATA POLARITY CLOCK SLOPE EXTERNAL RESTART DATA ENABLE PATTERN IGNORE UNIT	0 E-15 64 424 0  DATA DETECTED SYNCHRONIZED OFF AUTO SINGLE 100 000 100 9 11 15 16 20 21 23 NORM INV POS NEG DISABLED ENABLED NOT_USED LOW HIGH OFF ALLO ALL1 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<sup>\*\*</sup> of the AMIQ (Pin 7) using a jack plug<sup>\*</sup> 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 WINQISIM setting the file: BERDEMO FSP IF12 5MHz.igs delivered with this Application Note (recommended) or set the WINIQSIM parameters according to the screenshots below. In either cases the AMIQ produces a suitable FSKmodulated 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.

Modulation			
CModulation Modulation Type	2 FSK		
FSK Index	<b>4.0000</b>		
Coding	None		
Symbol Rate	€16.000000 kHz 💌		
Sequence Length	\$511 sym		
Filter / Window			
Filter	Gauss 🗾		
В*Т	0.50		
Window Function	Rect 💌		
Chebyshev Ripple /dB	\$ <u>000</u>		
Impulse Length	10		
Oversampling 🗖 Auto	\$32		
Bb. Impulse 🔽 Auto	Real		
<u>O</u> K <u>C</u> anc	el Advanced		

(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.

Data Source		
Data		
C All 0		
C All 1		
© PRBS PRBS 9		
C Pattern 101010		
C File Info MPLES\DECTSL_0.DBI		
Data <u>E</u> ditor		
<u>Q</u> K <u>C</u> ancel		
<u>QK</u> <u>C</u> ancel Advanced		

Figure 6: Data Source settings

#### Demonstration of BER Test with SMIQ or AMIQ

(3) From the BERT settings menu select BERT Mode On and the marker signals as in Figure 7

BERT Settings		
BERT Mode Off		
BERT PRBS Type PRBS 9 💌		
🔽 Generate Data Signal (available for marker 1 o		
Marker Channel Marker 1 👤		
🔽 Generate Data Enable Signal		
Marker Channel Marker 3 💌		
🔽 Generate Bit Clock Signal		
Marker Channel Marker 2 🗾		
🔽 Generate Restart Signal		
Marker Channel Marker 4 💌		
<u>O</u> K <u>C</u> ancel		

Figure 7: Data Source/Data Editor Bert Settings

(4) From the Block Diagram menu set up IF generation ON.

Block Diagram - Single Carrier			
Data Source Modulation Settings Off III C	Phase Distortion Phase Noise Sidebands On Off I On Off On		
Bandpass Amplifier Dist. Power Off On Off Moise Off On Off On Off Off On Off Off On Off Off	Intermediate Freq. (IF) Signal Generation On IF 12.500000 MHz Invert Q for IF Assistant QK Qancel		
Receiver Filter Quantization Smoothin	g n Off III 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.

MAMIQ Remote Control	
AMIQ Info Rohde&Schwarz,AMIQ04,834170/006,4.	BERT (Bit Error Rate Test)
Interface GPIB address 6	
Loading Waveform File into RAM	Bit Error Rate 0.00 % 🚽
Load HD File Load Floppy File	
bent of Mulli Segmeni Wevelorm 🟮	Clock S Data Changes S Sync S
└────────────────────────────────────	Data Bits 7977 Errors 0
RAM Running 🥥	Total Number (to terminate BEBT):
-Event Control	Data Bits 100000 Errors 10000
Start Stop Execute Batch	
	Terminated by <b>I otal Number of Data Bits</b>
State Shift in Samples	Mode Cont Single Stop
Ch.1 🔽 ON 🏮	Data Polarity
Ch. 2 🔽 ON 🌻0	Clock Slope 💿 high/rising 🔿 low/falling
Ch. 3 🔽 ON 🌻 0	Ext. Restart
Ch. 4 🔽 ON 🌲	Data Enable not used (alwa ▼
Save/Recall	PRBS PRBS 9
Save Recall Delete	Loaded Waveform File: BEBT Info
	DATA BITS: 511
Hardware Setting File Management	BIT CLOCK: MARKER 2
	ENABLE: NOT DEFINED
BERT Test and Adjustment	reomailter benneb
Close	

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<sup>TM</sup> 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.

🎆 AMIQ Rem. Ctrl.: Hardv	ware Settings 🔳 🛛 🗵
Analog Output Type: • Single Output	C Differential Output
Tracking:  Off OI => Q	⊙ Q => I
Channel I: 🔿 Off	C Fix 🔍 Var
Level <b>0.0040</b> V P50	Bies Dû.000 V <sub>DC</sub>
Channel Q: C Off Level © 0.5000 VP50	● Fix ● Var Bies ●0.000 V <sub>DC</sub>
Filter: • Off • 2.5 MH	Hz 🗘 25 MHz 🔿 EXT
Off State: Impedance	🖲 50 Ohm 🕤 High Z
Digital Output State: ● Off ● On	
Output Resolution Quantize to	bit
<u>C</u> lose :	Source, Trigger

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<sup>™</sup>
- [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	4 MSamples Memory	1110.2003.03
AMIQ04 incl. WINIQSIM <sup>™</sup>	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



ROHDE & SCHWARZ GmbH & Co. KG Mühldorfstraße 15 D-81671 München P.O.B 80 14 69 D-81614 München Telephone +49 89 4129 -0 Fax +49 89 4129 - 13777 Internet: http://www.rohde-schwarz.com

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.