

GERAN Evolution



Rohde & Schwarz products: R&S[®]SMU200A, R&S[®]SMJ100A, R&S[®]SMATE_200A vector signal generators, R&S[®]FSG, R&S[®]FSU, R&S[®]FSQ signal analyzers

Generating and Analyzing Downlink Signals for Evolved GSM/EDGE Radio Access Network

Application Note 1MA116

This application note describes how to generate and how to analyze the new GERAN Evolution modulation schemes for receiver, power amplifier, and transmitter tests using R&S[®]SMU Vector Signal Generators and R&S[®]FSG / FSU / FSQ Signal Analyzers.



Contents

1	Overview	3
2	Generating Predefined EGPRS2 Signals.....	4
	Loading and Running wv Files	6
	Loading Predefined Settings to WinIQSIM	7
	Transferring WinIQSIM Data to SMU	8
	Transferring User Data to SMU	9
3	Signal Description	10
4	Analyzing EGPRS2 Signals.....	15
	Loading Predefined VSA Standards into the Analyzer.....	15
	Measurements Using the Predefined Setups	17
5	Appendix A: Generating 16 QAM Test Signals with WinIQSIM	20
	Setting up Signals with WinIQSIM	20
	Define Modulation Data for 16 QAM Signal Level A	21
	Modulation Settings.....	26
	WinIQSIM Graphics Functions	28
6	Appendix B: Generating 32 QAM Test Signals with WinIQSIM	29
	Define Modulation Data for 32 QAM Signals Level B	29
	Modulation Settings.....	30
	WinIQSIM Graphics Functions	31
7	Appendix C: Setups of the Analyzer for EGPRS2 Signals	32
8	References.....	36
9	Additional Information	36
10	Ordering Information	37

The following abbreviations are used in this application note for Rohde & Schwarz test equipment:

- The R&S®SMU200A vector signal generator is referred to as the SMU.
- The R&S®SMJ100A vector signal generator is referred to as the SMJ.
- The R&S®SMATE_200A vector signal generator is referred to as the SMATE.
- The R&S®FSQ signal analyzer is referred to as the FSQ.
- The R&S®FSU spectrum analyzer is referred to as the FSU.
- The R&S®FSG signal analyzer is referred to as the FSG.

The R&S logo, Rohde & Schwarz, and R&S are registered trademarks of Rohde & Schwarz GmbH & Co. KG and its subsidiaries.

You can generate all test signals described below with either SMU, SMJ, or SMATE. You can analyze them with either FSQ, FSU, or FSG. To simplify the reading only 'SMU' and 'FSQ' are used on the following pages.

1 Overview

The technical specification TR45.912 [1] issued by the 3rd Generation Partnership Project (3GPP) introduces a feasibility study for evolved GSM/EDGE Radio Access Network. To achieve higher data rates and to improve spectral efficiency the following functions have been specified:

- QPSK, 16 QAM and 32 QAM modulation schemes will be included.
- Turbo coding shall be used in Downlink instead of current convolutional coding.
- Higher symbol rate (325ksps) as additional option instead of 271ksps.

In 3GPP these new signals are referred to as EGPRS2 signals whereas Level A and Level B distinguish between normal and high symbol rate, respectively.

The development of hardware for this evolution has already started, requiring high performance equipment to provide test signals and to analyze downlink transmitter quality.

The application note 1MA116 describes how to generate and analyze these new EGPRS2 modulation schemes for receiver, power amplifier, and transmitter tests using the SMU Vector Signal Generator and the FSQ Signal Analyzer. The high flexibility of the two instruments enable you to dynamically adapt to changes of parameters for experiments and further evolution.

Sections 2 and 3 of this application note show how to generate QPSK, 16 QAM and 32 QAM bursts using the described predefined I/Q settings. In addition information on how to download predefined EGPRS2 signals with this application note is provided.

Sections 4 deals with analyzing these signals. Complete analyzer settings including training sequences and the new user modulation mappings for rotating QPSK, 16QAM and 32QAM can be downloaded together with this application note (please see section 4 for details).

In section 5 and 6 (appendix A and B), you find in detail how to set up your own test signals using the R&S software WinIQSIM, version 4.44 or later. Finally, in section 7 (Appendix C), the various parameters of the attached analyzer setups for the new modulation schemes are documented.

2 Generating Predefined EGPRS2 Signals

The EGPRS2 signals presented in this application note will be generated by the Arbitrary Waveform Generator ARB (SMU-B9, B10, or B11, or SMJ-B50, B51 respectively). Download the predefined files from

<http://www.rohde-schwarz.com/appnote/1MA116.html>

The *.zip files listed below contain files for 8PSK (as reference), QPSK, 16 QAM and 32 QAM for both normal (270,833ksps) and high (325ksps) symbol rate in accordance with 3GPP standardization. For high symbol rate modulation signals with legacy pulse shape as well as new wide pulse shape are included for download (cf section 3 for details). Each package includes signals using the different training sequences (TSC0 – TSC7) as specified by 3GPP TS 45.002 [2]. All signals have 8 slots active with full power throughout the frame. Each signal is 16 frames long, i.e. after 16 frames the random data content is repeated. Unzip the downloaded files on your PC. Depending on the type of data the ARB will be loaded in different ways, see fig. 2_1.

- EGPRS2_A_8PSK.ZIP
- EGPRS2_A_16QAM.ZIP
- EGPRS2_A_32QAM.ZIP
- EGPRS2_B_QPSK_LG.ZIP
- EGPRS2_B_QPSK_WP.ZIP
- EGPRS2_B_16QAM_LG.ZIP
- EGPRS2_B_16QAM_WP.ZIP
- EGPRS2_B_32QAM_LG.ZIP
- EGPRS2_B_32QAM_WP.ZIP

All necessary files in order to generate the above files with WinIQSIM as described in section 5 and section 6 are included in the following file packages (available for download with this application note):

- EGPRS2_A_WinIQSIM.zip
- EGPRS2_B_LG_WinIQSIM.zip
- EGPRS2_B_WP_WinIQSIM.zip

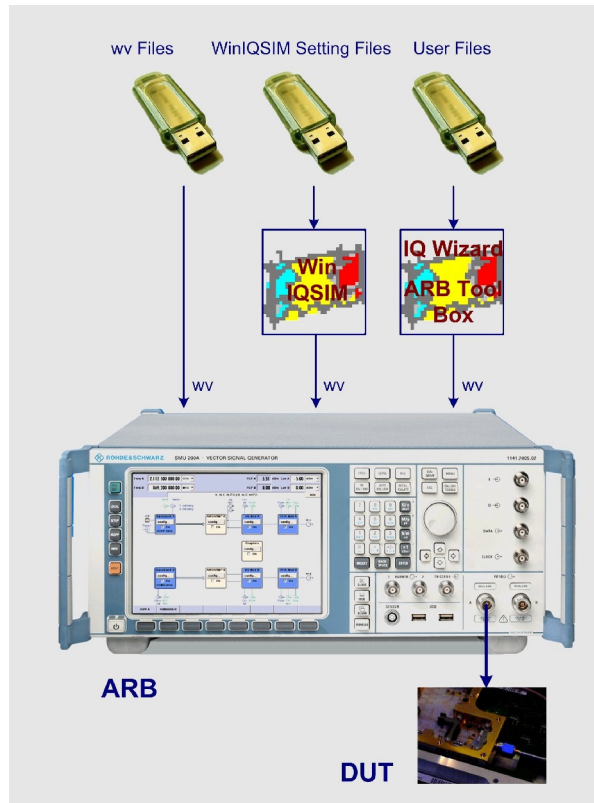


Fig. 2_1: Signal generation for EGPRS2

The file format which runs on the ARB is always waveform (*.wv files). These files cannot be modified.

- Load *.wv files e.g. from USB memory stick directly (or via R&S firmware WinIQSIM) into the SMU.
- Take the R&S firmware WinIQSIM setting files as a starting point to generate your own signals, see sections 5 and 6 of this application note.
- Use the R&S firmware I/Q Wizard or the ARB Tool Box, if you have your own I/Q stream, to convert data into a wv file and to load it into the ARB.

Loading and Running wv Files

- 1) Insert a memory stick containing your wv file(s) into one of the USB sockets of the SMU.
- 2) Click *config* in the *Baseband A* block of the SMU diagram window.

In the list of the standards (fig. 2_2)

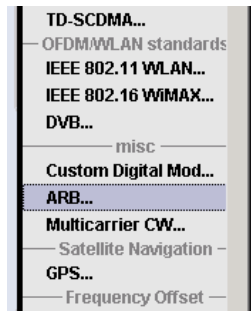


Fig. 2_2: Selecting the ARB

- 3) Choose *ARB*.
The ARB Waveform Modulation menu opens (fig. 2_3).
- 4) Select *Load Waveform...*

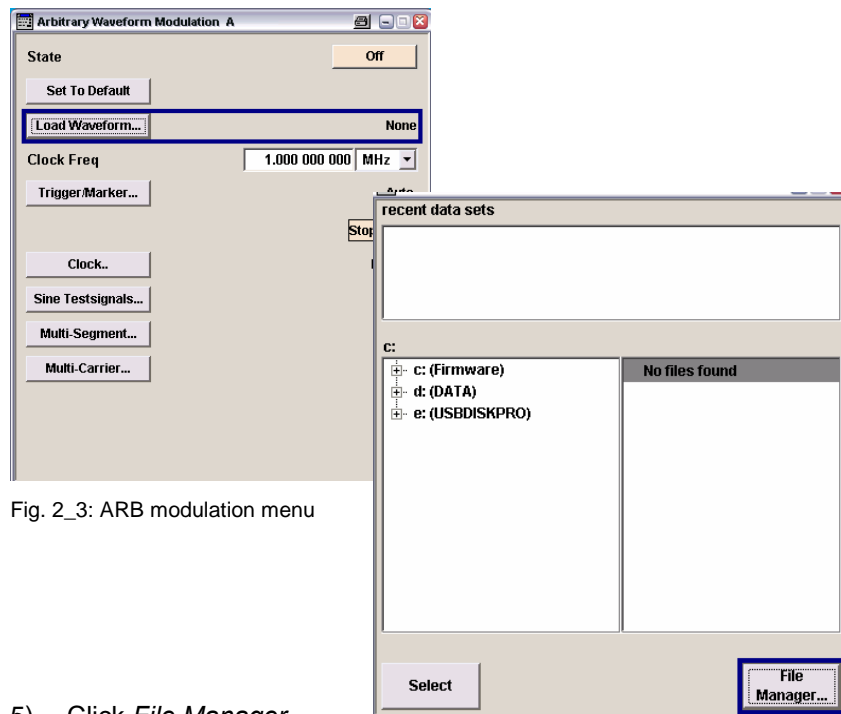


Fig. 2_3: ARB modulation menu

Fig. 2_4: File tree

- 5) Click *File Manager*.
- 6) Copy your wv files from drive e: and paste them to drive d:\

To run a wv file

- 1) Mark the wv file in fig. 2_4 and click the *Select* button.

Go back in the ARB Waveform Modulation menu. The file name and the *Clock Frequency* are indicated:

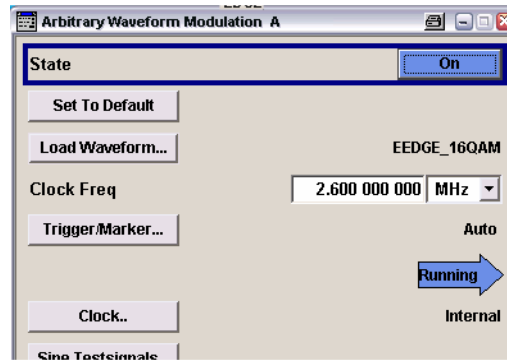


Fig. 2_5: ARB modulation menu

- 2) Start the ARB by switching *State* to *On*.

Note: Do not forget to set frequency and level, and to switch on the RF!

Loading Predefined Settings to WinIQSIM

EGPRS2_*_WinIQSIM.zip contains - for QPSK, 8PSK, 16 QAM and for 32 QAM - the following file types.

- *.iqs WinIQSIM configuration
- *.dbi Modulation and control data
- *.ded Editor settings
- *.imp Modulation Mapping

- 1) Extract the 4 files belonging to the same modulation type to one subdirectory on your PC. Use different subdirectories for the modulation schemes.
- 2) Connect PC and SMU via IEEE-Bus.
- 3) Run WinIQSIM on your PC.
- 4) Click *File, Open Settings*
- 5) Select your iqs file ('iqs' is the extension for I/Q setting files).

WinIQSIM automatically loads the other files when they will be needed.

Transferring WinIQSIM Data to SMU

If this is your first transmission, select the type of the ARB, see step 1). Otherwise proceed with step 3).

1) Click *ARB, Select Target ARB...*, see fig. 2_6 and 2_7.

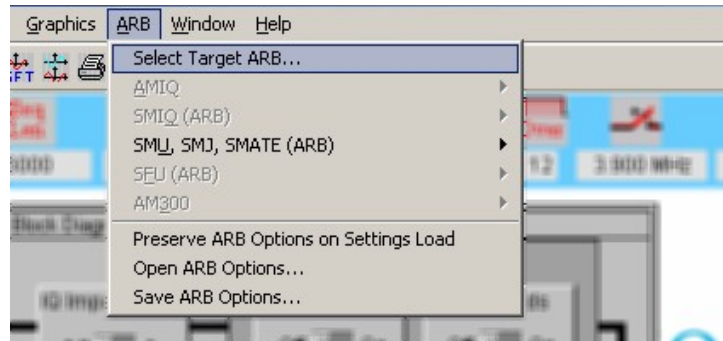


Fig. 2_6: Selecting...

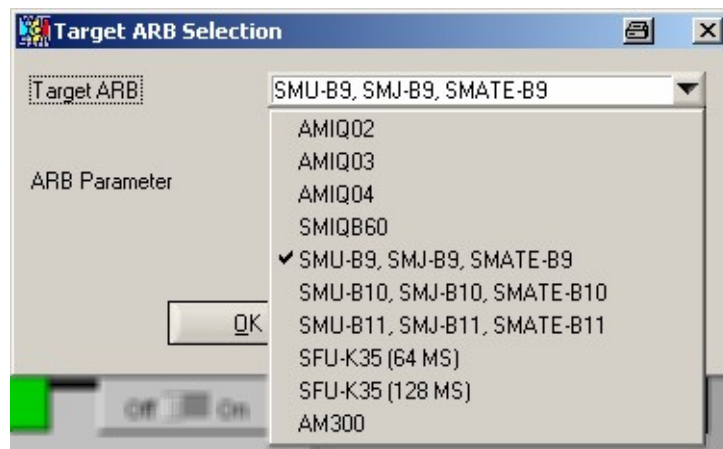


Fig. 2_7: ... your ARB.

2) Select your hardware, click OK.

3) Click *ARB, SMU..., Transmission...*, see fig. 2_8.

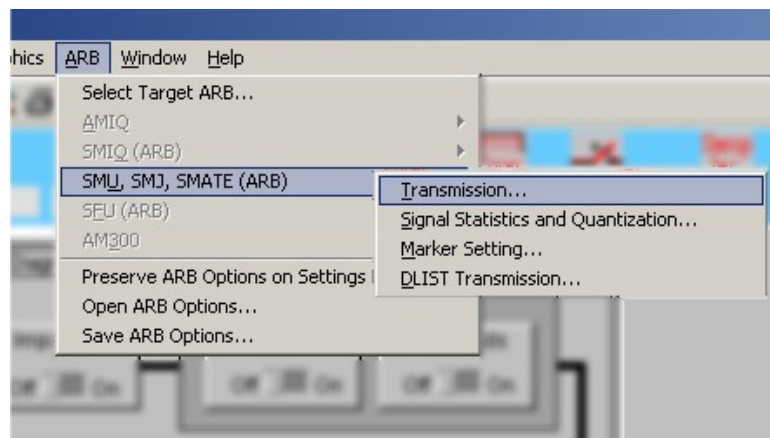


Fig. 2_8: Data transmission to the ARB.

The *Waveform Transmission* panel opens:

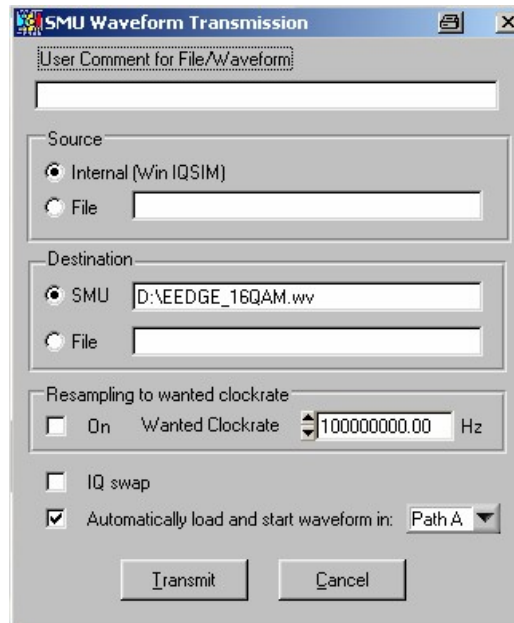


Fig. 2_9: Waveform transmission to the ARB.

4) Add an optional comment.

5) Enter drive D:\ as *Destination* on the SMU:

(The *Clockrate* is set according to the iqs file. You don't need to resample.)

If you activate the checkbox *Automatically load and start waveform* the ARB is started immediately after the data transmission.

6) Click *Transmit*.

Now WinIQSIM calculates the I/Q data, based on the content of the other files, converts it into the waveform format (with extension 'wv') and transmits it to the SMU.

Note: Do not forget to set frequency and level, and to switch on the RF!

Transferring User Data to SMU

IQWizard and the ARB Tool Box convert various I/Q data into wv format.

Download IQ Wizard and a detailed description from

<http://www.rohde-schwarz.com/appnote/1MA28.html>

Download the ARB Tool Box from

<http://www.rohde-schwarz.com/appnote/1GP62.html>

3 Signal Description

Table 3_1 compares the EGPRS Normal Burst with the new evolved EDGE burst structure.

	Normal symbol rate (270.833kps) Level A			High symbol rate (325kps) Level B		
	8PSK (EDGE)	16QAM	32QAM	QPSK	16QAM	32QAM
Tail (left)	3 symbols 9 bits	3 symbols 12 bits	3 symbols 15 bits	4 symbols 8 bits	4 symbols 16 bits	4 symbols 20 bits
PRBS data (left)	58 symbols 174 bits	58 symbols 232 bits	58 symbols 290 bits	69 symbols 138 bits	69 symbols 276 bits	69 symbols 345 bits
Training Sequence	26 symbols 78 bits	26 symbols 104 bits	26 symbols 130 bits	31 symbols 62 bits	31 symbols 124 bits	31 symbols 155 bits
PRBS data (right)	58 symbols 174 bits	58 symbols 232 bits	58 symbols 290 bits	69 symbols 138 bits	69 symbols 276 bits	69 symbols 345 bits
Tail (right)	3 symbols 9 bits	3 symbols 12 bits	3 symbols 15 bits	4 symbols 8 bits	4 symbols 16 bits	4 symbols 20 bits
Guard	8.25 symbols 24.75 bits	8.25 symbols 33 bits	8.25 symbols 41.25 bits	10.5 symbols 21 bits	10.5 symbols 42 bits	10.5 symbols 52.5 bits
Total	156.25 symbols 468.75 bits	156.25 symbols 625 bits	156.25 symbols 781.25 bits	187.5 symbols 375 bits	187.5 symbols 750 bits	187.5 symbols 937.5 bits
Frame (8 bursts)	1250 symbols 3750 bits	1250 symbols 5000 bits	1250 symbols 6250 bits	1500 symbols 3000 bits	1500 symbols 6000 bits	1500 symbols 7500 bits

Table 3_1: Structure of EGPRS and EGPRS2 Bursts

Although the symbol rate is increased from 270.833 kps to 325 kps, the timing of the burst and the frame remains unchanged. Depending on the modulation QPSK, 16QAM or 32QAM at high symbol rate, the total number of bits per slot increases up to 937.5, the number of bits per frame to 7500 respectively.

Fig. 3_2 shows the structure of the high symbol rate QPSK burst, as it is built up in WinIQSIM.

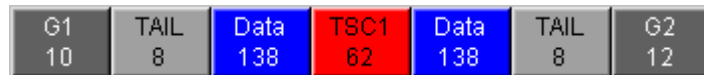


Fig. 3_2: WinIQSIM building blocks and no of bits in the QPSK burst

To facilitate the power ramping, the guard period (G) has been divided into a left part at the beginning of the burst, and a right part at the end. The training sequence has to be divided into two blocks for 16QAM and 32QAM, because the field length of a fixed pattern in WinIQSIM is limited.

We work with two different burst lengths to achieve integer symbol numbers per slot (see Fig. 3_3). In one active slots (N374) the guard period is shortened which is compliant to the standard. Instead of 187.5 symbols one burst consist of only 187 symbols (374 bits). This is compensated by the

following burst with 188 symbols (376 bits), see fig. 3_3. The same principle is used in case of 16QAM and 32QAM modulation.

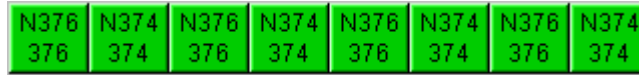


Fig. 3_3: WinIQSIM building blocks and no of bits in the QPSK frame

The burst and frame structure for 16QAM and 32 QAM high symbol rate is shown in figures 3_4 and 3_5:

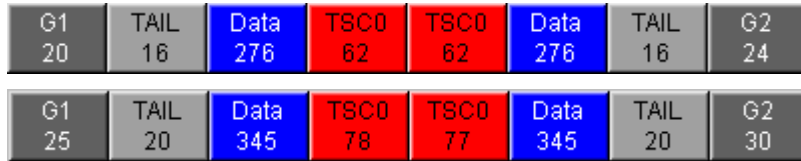


Fig. 3_4: WinIQSIM building blocks and no of bits in the 16QAM and 32 QAM burst

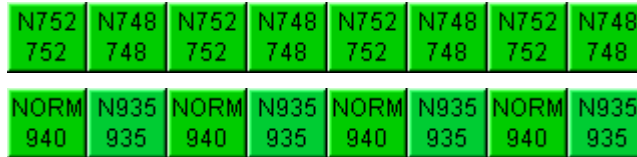


Fig. 3_5: WinIQSIM building blocks and no of bits in the 16QAM and 32 QAM frame

The following figures 3_6, 3_7 and 3_8 show the symbol mapping for QPSK, 16QAM and 32QAM.

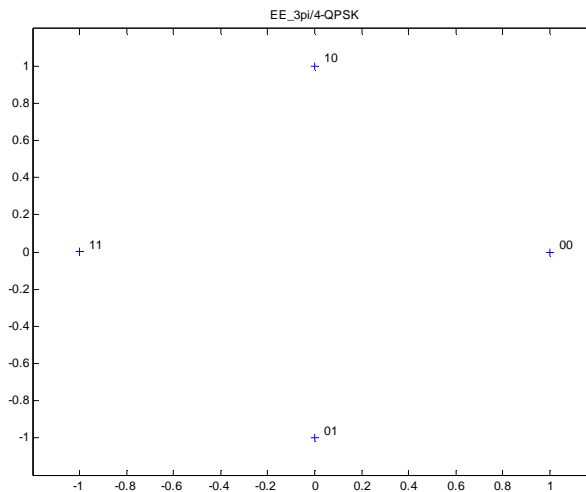


Fig. 3_6: QPSK constellation diagram for EGPRS2

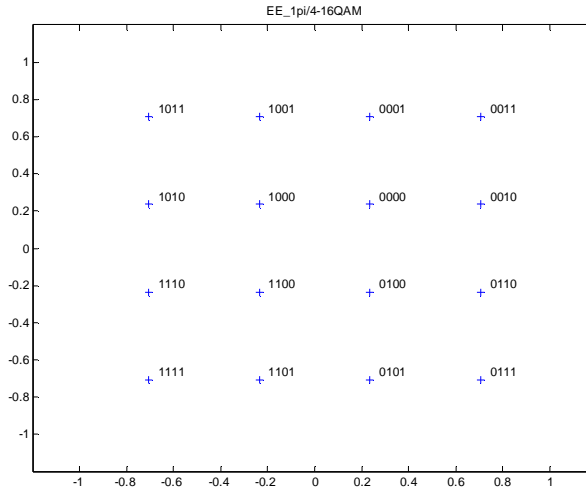


Fig. 3_7: 16 QAM constellation diagram for EGPRS2

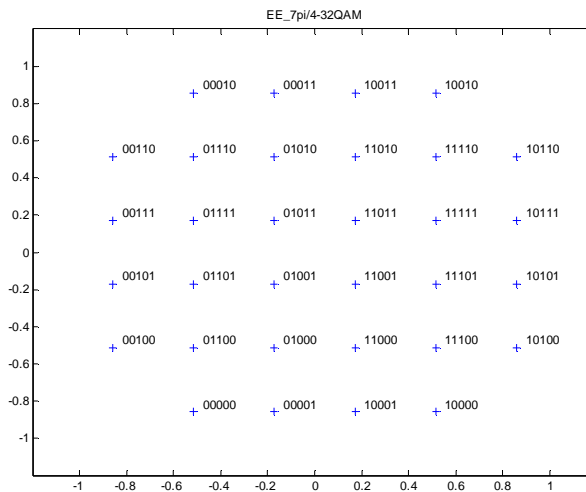


Fig. 3_8: 32 QAM constellation diagram for EGPRS2

Gray-code for transitions between neighboring symbols is applied. The QPSK modulation uses a symbol rotation of $+3\pi/4$, the 16 QAM modulation uses a symbol rotation of $+\pi/4$, and the 32 QAM modulation uses a symbol rotation of $-\pi/4$. (These modulation schemes can be loaded as *USER MODULATION* in the analyzer, see page 15).

The introduction of an increased symbol rate calls for a wider pulse shape filter compared to the legacy GMSK/EDGE filter in order to exploit full performance gain. However a wider pulse shape results into an increased adjacent power leakage, while at the same time co-channel interference is reduced. In 3GPP standardization comprehensive studies were performed investigating in which scenarios a wider pulse shape is acceptable. Results depend significantly on the underlying scenario and/or specific network deployment. On the edge channels in operator allocations where there is no guard channel, or in networks or cells which might exhibit higher levels of adjacent channel interference than normal the use of a wider pulse shape was judged critical. In order to allow flexibility for adaptation to certain

scenarios the following solution was found. For Level A (normal symbol rate) operation the legacy (narrow) pulse shape shall always be used.

For Level B operation (high symbol rate) the modulating symbols as represented by Dirac pulses excite one of the following linear pulse shaping filters:

- a spectrally wide pulse shape $c'(t)$ as described in more detail below or
- a spectrally narrow pulse shape $c_0(t)$ which is the linearized GMSK pulse as defined for GSM/EDGE.

The base band signal is

$$y(t) = \sum_i \hat{s}_i \cdot c'(t' - iT + 2.5T) \text{ for the wide pulse shape and}$$

$$y(t) = \sum_i \hat{s}_i \cdot c_0(t' - iT + 2.5T) \text{ for the narrow pulse shape.}$$

For the wide pulse shape signal $c'(t)$ is the continuous time representation of a discrete pulse shape $c_n = c'(nT_s)$ where T_s is the sampling period equal to $T/16$ and $n = 1, 2, \dots, 97$. A closed form expression of $c'(t)$ is not available because the spectrally wide pulse shape was numerically optimized based on a set of discrete filter coefficients. The continuous time function can be obtained by

- low-pass filtering the discrete time function with a pass-band of 400kHz and a stop-band beginning at 2600 kHz and
- truncating the duration to the time interval $[0, 6T]$.

For the uplink, the pulse shape that shall be used when transmitting a burst is dependent on the parameter 'Pulse format' that is sent to the mobile during assignment of resources. In consequence the choice is left to the operator in which scenarios to use the wide pulse shape filter on a case by case basis. For the downlink the spectrally narrow pulse shape shall always be used avoiding possible critical scenarios at cell borders. The EGPRS2 signals provided with this application note use the legacy (narrow) EDGE pulse for normal symbol rate. For high symbol rate both EGPRS2 signals with legacy narrow pulse and new wide pulse are available for download.

The predefined `wv` and `WinIQSIM` files generate a sequence of 16 frames. This is sufficient e.g. for power amplifier tests. For RX bit error measurements with PRBS9 we recommend a sequence length of 511 frames to have a seamless data flow.

Figure 3_9 displays one 32 QAM burst recorded by the FSQ Signal Analyzer. For this specific example all 31 training sequence symbols have the value 0, which is arbitrary for some examples within this application note. As the symbols of the midamble do not change there is no level change during this period.

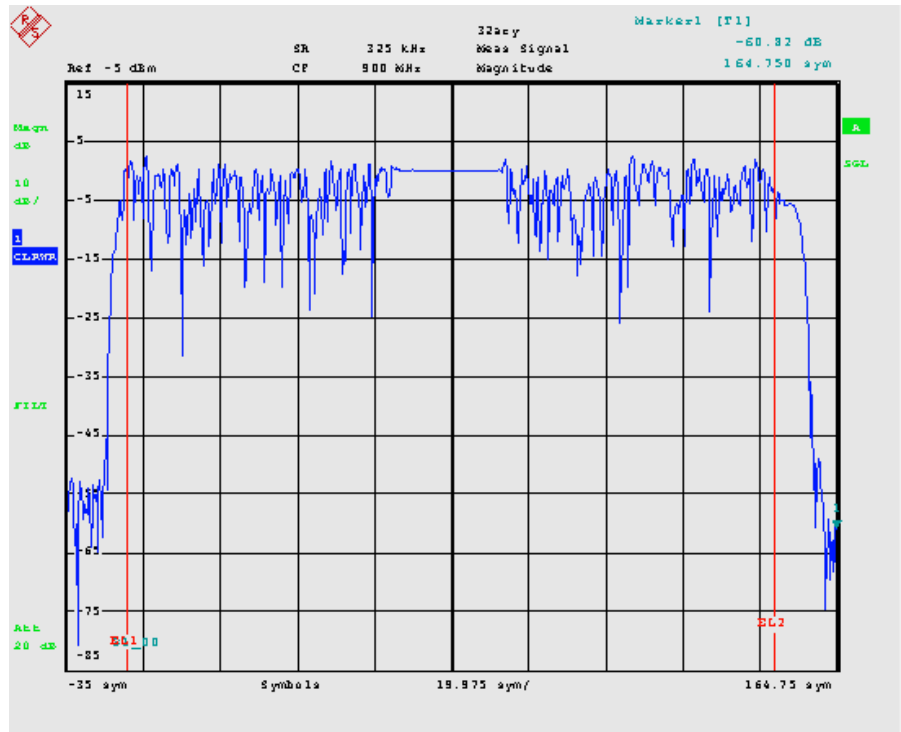
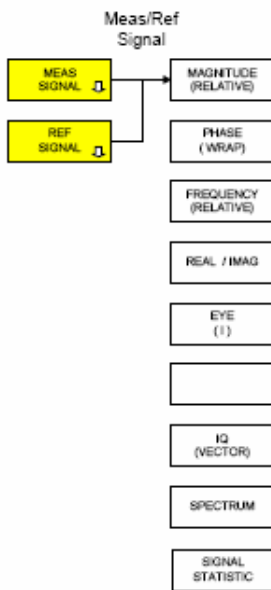


Fig. 3_9: 32 QAM burst: power vs. time

Find more representations of EGPRS2 signals in the following section of this application note.

4 Analyzing EGPRS2 Signals

All following measurements are done using the option *Vector signal analysis VSA* (FSQ-K70 or FSU-B73 resp.) for R&S signal and spectrum analyzers.



Measurements with the VSA include

- Magnitude vs. time
- Phase vs. time
- Real / Imaginary (I/Q) vs. time
- Eye diagram
- I/Q constellation
- Mean power
- EVM
- Magnitude error
- Phase error
- Carrier frequency error
- Origin offset
- Gain imbalance
- Quadrature error
- Rho
- Demodulated bits

Further measurements include:

- Spectrum due to modulation
- Spectrum due to switching

(These measurements can be done without the VSA.)

Loading Predefined VSA Standards into the Analyzer

Complete settings of the VSA can be stored as a *DIGITAL STANDARD* on the analyzer. In particular a VSA standard includes

- symbol mappings,
- patterns, and
- filters.

DIGITAL STANDARDS of the VSA can be exported and imported.

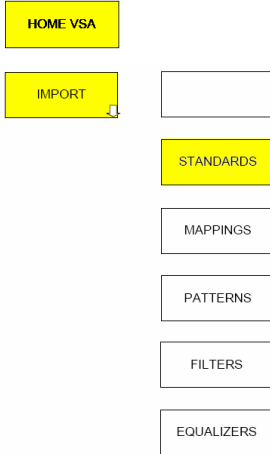
The file *EDGEevo_VSA_Standards.zip* contains a set of digital standards for normal and high symbol rate, for all relevant modulation schemes and for legacy and wide pulse shape signals. A reference setting for demodulation of 8PSK signals is included too.

Download the zip file from

<http://www.rohde-schwarz.com/appnote/1MA116.html>.

To load the setup into the analyzer

- 1) Unzip the files to an USB stick, insert it on the FSQ.

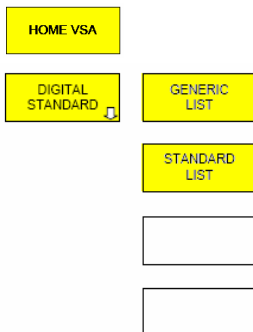


On the analyzer

- 2) Press *HOME VSA*.
- 3) Press *NEXT, IMPORT*.
- 4) Set *PATH* to F:
- 5) Press *STANDARDS*.
- 6) A list of the *DIGITAL STANDARDS* on the USB stick appears.
- 7) Select the first one, press *ENTER*.
- 8) Select the second one, press *ENTER*.
- 9) *etc*
- 10) Press *HOME VSA* to return.

Now the standards are stored on the analyzer. E.g. an entry will appear in the *VSA MODULATION & MAPPING* table as *USER-QAM, PI/4-16ary and 7PI/4-32ary*. Still none of the standards is activated.

To activate the standard



- 11) Press *DIGITAL MODULATION*.
- 12) Press *GENERIC LIST*, select (*ALL*).
- 13) Press *STANDARD LIST*.
- 14) Select an entry, e.g. *EGPRS2_B_32QAM_G*
- 15) Press *ENTER*.

Notes: The *DIGITAL STANDARD* does not include the frequency and level setting of the analyzer. Enter these parameters manually.

As part of the digital standard all training sequences (TSC0-7) specified in 3GPP TS 45.002 (Release 7) [2] have been included.

If one of the corresponding predefined test signals (described in section 3) is applied at the RF input (and frequency and level are adjusted correctly), the analyzer records continuously, synchronizes on the midamble, and presents valid results.

Measurements Using the Predefined Setups

The following screen copies are partly taken from a 16 QAM, partly from a 32 QAM signal. These example screen shots have been created before 3GPP had defined training sequences in detail, i.e. this training sequence has equal symbols. Still these pictures serve illustrative purpose as the used specific training sequence can easily be identified within the burst.

Fig. 4_1 shows the magnitude vs. time of a 16 QAM burst. During the midamble there is no symbol change; thus the power remains constant. Left and right you see PRBS data.

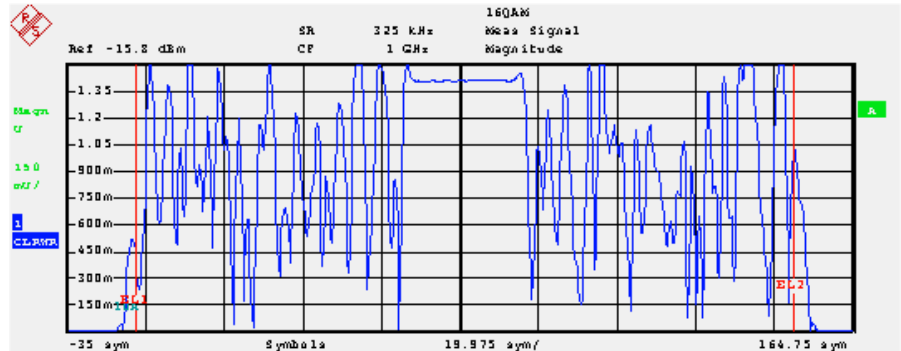


Fig. 4_1: Magnitude vs. time

Fig. 4_2 shows the phase vs. time of a 16 QAM burst, fig. 4_3 the phase versus time of a 32 QAM burst.

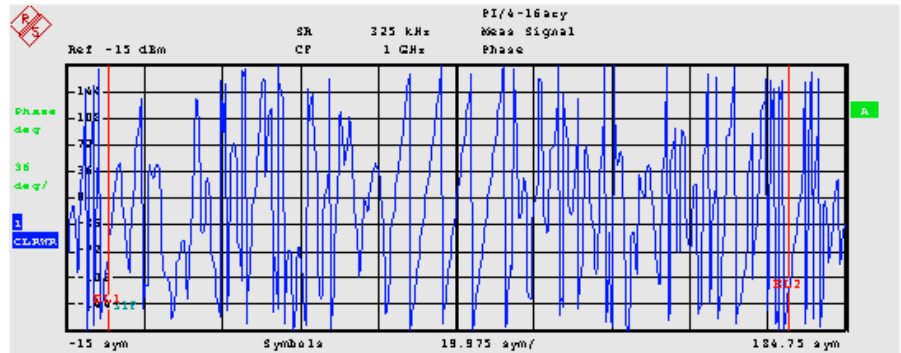


Fig. 4_2: Phase vs. time / 16 QAM

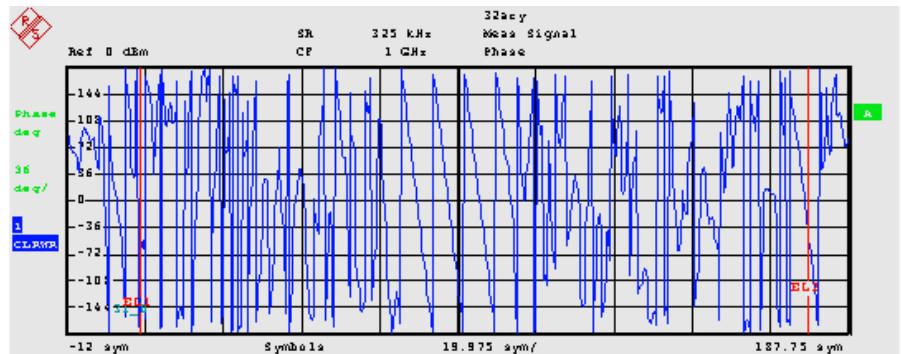


Fig. 4_3: Phase vs. time / 32 QAM

Because the symbols do not change during the midamble, the constant phase shift in this region shows the symbol rotation: $+\pi / 4$ per symbol for 16 QAM, and $-\pi / 4$ per symbol for 32 QAM.

Fig. 4_4 displays the I/Q vector representation of a 16 QAM burst.

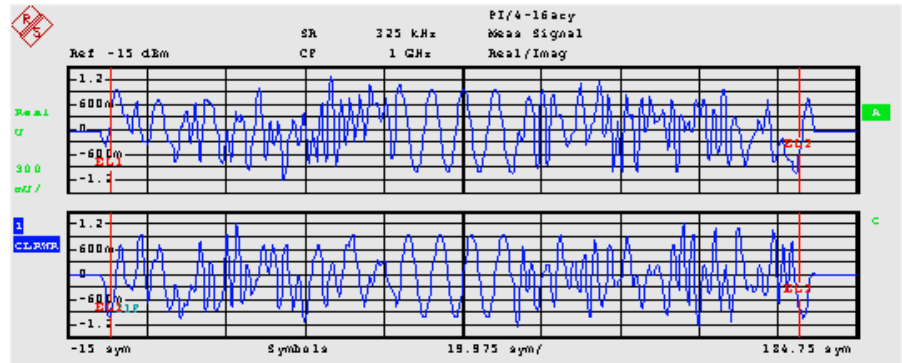


Fig. 4_4: Real / Imag (I/Q) vs. time / 16 QAM

You see the constant phase difference between upper and lower curves during the section of the midamble because the symbols are all the same.

Fig. 4_5 and fig. 4_6 show the rotating constellations:

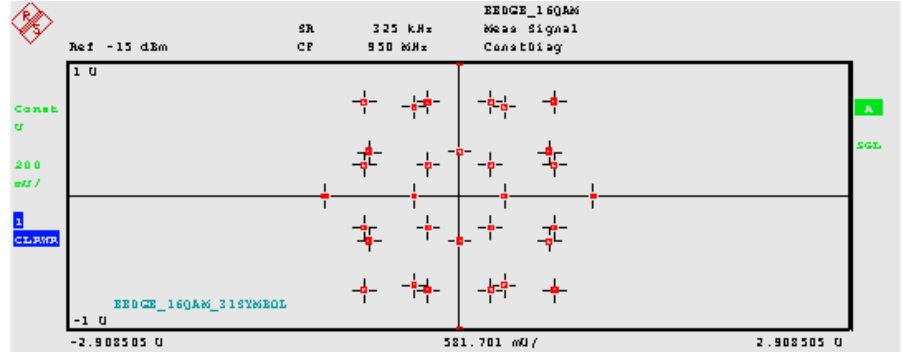


Fig. 4_5: 16 QAM Constellation

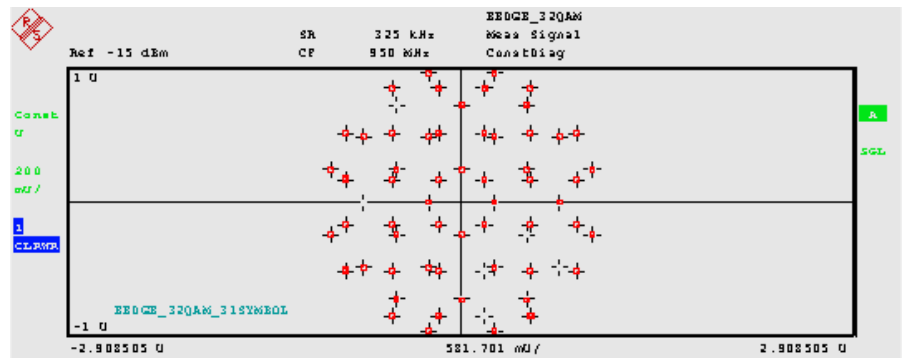


Fig. 4_6: 32 QAM Constellation

Eye diagram:

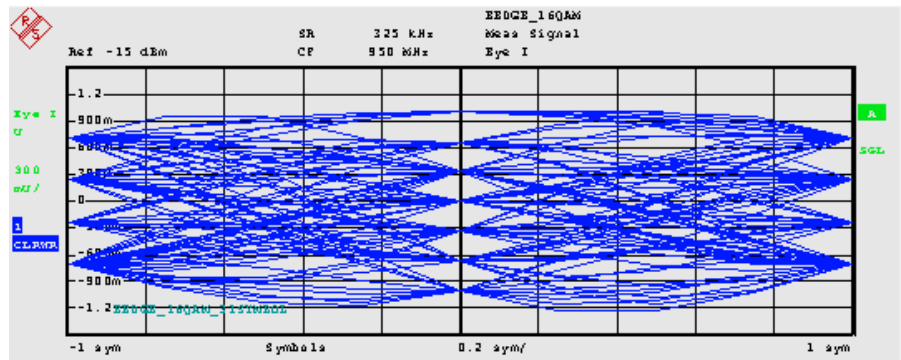


Fig. 4_7: Eye diagram / 16 QAM

The most important signal characteristics are presented as values in the **RESULT SUMMARY**, see fig. 4_8:

MODULATION ACCURACY		SYMBOL TABLE (Hexadecimal)	
EVM	0.170	0.866	-23 %
Magnitude Err	0.060	0.283	-23 %
Phase Error	0.09	0.27	-23 deg
Carrier Freq Err	21.29		Hz
Ampl Delay	-0.00		dB
Origin Offset	-69.22		dB
Gain Imbalance	-0.01		dB
Quadrature Error	-0.01		deg
RHO	0.999997		
Mean Power	-21.57	-17.05	26 dBm
SNR (dB)	55.39		dB

Fig. 4_8: Result summary / 16 QAM

On the left side of the summary table, you find all the important quality characteristics of digital modulated signals such as EVM, Magnitude error, Phase error, Carrier frequency error, Origin offset, Gain imbalance, Quadrature error, Rho, Mean Power, and SNR.

On the right side you see the demodulated bits. The pattern marked green represents the midamble which the analyzer uses to synchronize to the signal.

Figure 4_9 shows a long time analysis of the numerical results:

MODULATION ACCURACY (AVERAGE)		Statistic Count 50 of 50 (std AVG)	
EVM	0.180	0.469	55
Magnitude Err	0.072	0.209	4
Phase Error	0.09	-0.28	51
Carrier Freq Err	26.34		26.64
Ampl Delay	0.01		0.00
Origin Offset	-70.14		-71.28
Gain Imbalance	-0.01		-0.00
Quadrature Error	0.02		0.04
RHO	0.999997		0.999997
Mean Power	-0.19	4.51	31
SNR (dB)	54.88		55.75

Fig. 4_9: Statistics of the numerical results

5 Appendix A: Generating 16 QAM Test Signals with WinIQSIM

Though setup files are provided for download, a detailed description of the signal generation with WinIQSIM is given here, which allows for modifications according to individual needs that may come up during testing. For more details on operating WinIQSIM please consult the WinIQSIM manual.

Setting up Signals with WinIQSIM

WinIQSIM is a powerful tool to generate signals with a wide variety of modulations, coding schemes and modulation data for most communication systems. According to the desired signal structure, data fields, slots and frames must be defined in order to have modulation data for the signal.

WinIQSIM starts with the following screen:

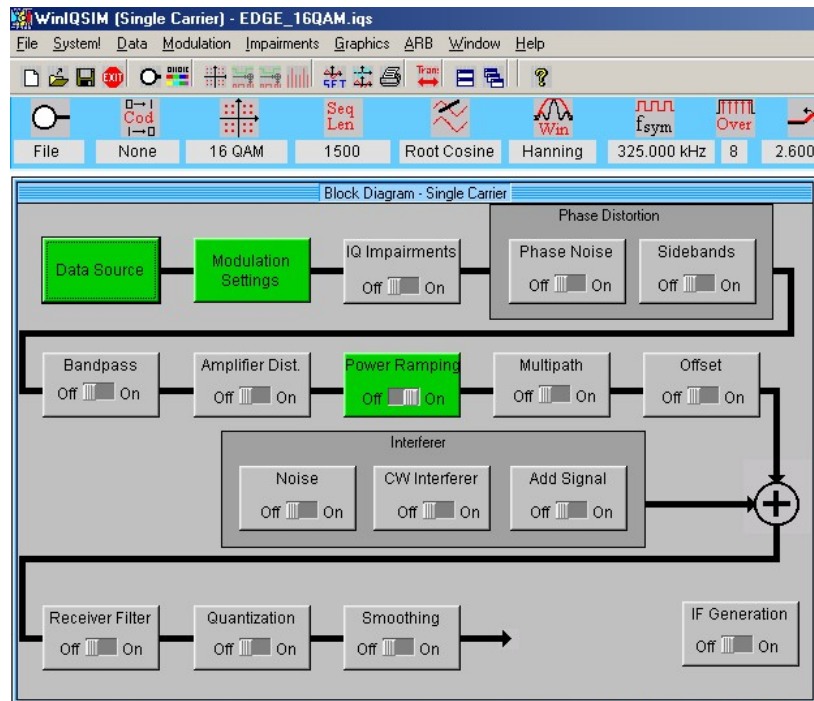


Fig. 5_1: WinIQSIM startup menu

The signal generation is done in following steps:

- Define and calculate the modulation data structure with the WinIQSIM Data Editor (menu *Data Source*), including power ramp settings.
- Set modulation and mapping (menu *Modulation Settings*).
- Transfer signal to arbitrary function generator in Vector Signal Generator SMU.

Use of Predefined Setups

If you decide to use predefined setups for signal generation, e.g. available from: www.rohde-schwarz.com/appnote/1MA116.html, you can skip these steps and open the settings from WinIQSIM *File / Open Settings* menu.

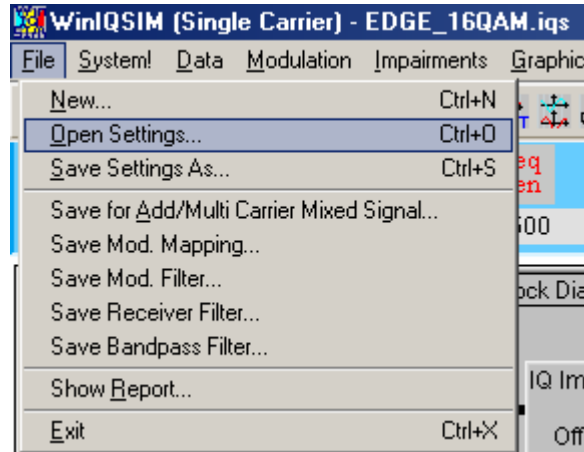


Fig. 5_2: WinIQSIM File Open Settings menu

Define Modulation Data for 16 QAM Signal Level A

WinIQSIM contains a data editor which allows to set up a signal according to the structure specified in 3GPP GERAN standardization.

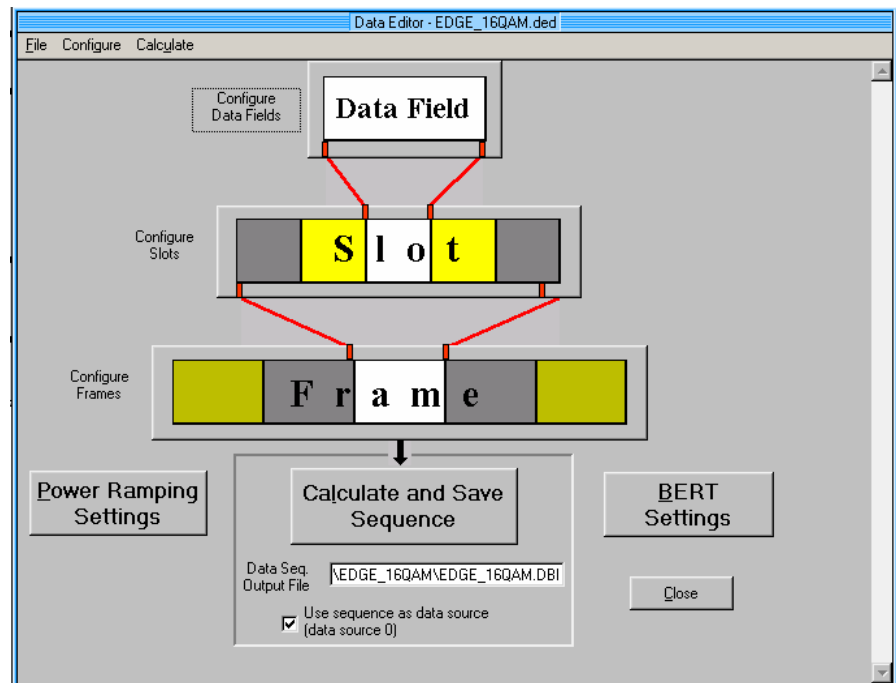


Fig. 5_3: WinIQSIM Data Editor

Data fields form a slot, slots form a frame, and frames form a sequence up to the wanted signal length.

According to the structure given in table 5_4, data fields are set up as follows:

Data Field	Length /Bits	Data
G1	16	Guard (left)
Tail	12	All 1
Data	232	PRBS
TS0a	52	Training Sequence Part 1
TS0b	52	Training Sequence Part 2
G2	20	Guard (right)

Table 5_4: Data fields for 16 QAM used in WinIQSIM Data Editor

All data fields are specified with their length in bits and the appropriate modulation data using the *New* button repeatedly in the menu *Configure Data Fields* of WinIQSIM. They built up a so-called *Data Field Pool*.

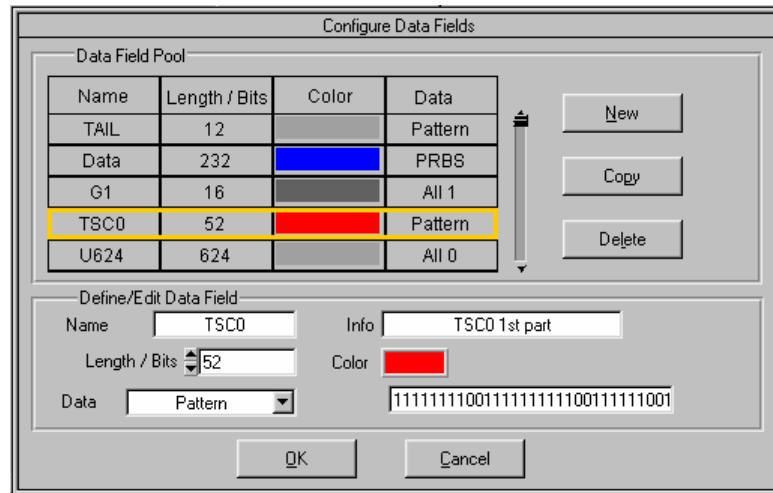


Fig. 5_5: Data Field Pool

The EGPRS2 signals available for download with this application note use PRBS9 data, i.e. pseudo random data is generated for the data field. However the field *Data* contains also a special mode. If the *Data* of a field is set to *BERT-PRBS*, the WinIQSIM PRBS generator will be halted at the end of the field until the next occurrence of this particular field, in the same or in a following slot or frame. There the PRBS sequence will be resumed. This is important for bit error rate testing (BERT). You get a seamless data flow at the demodulator output of a receiver under test.

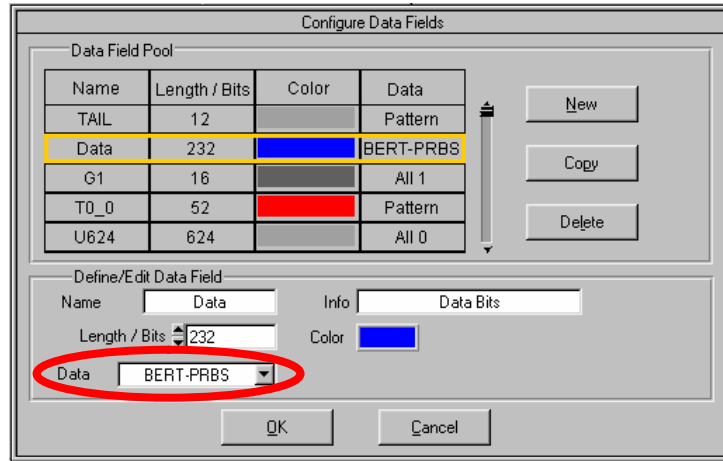


Fig. 5_6: BERT-PRBS data used in field Data

Data field *TAIL* is used for Tail (left) and Tail (right). It is 12 bits long, all bits set to "All 1".

Data field *Data*, 232 bits long, represents the encrypted bits right and left.

The training sequence with 104 bits is split into 2 parts with 52 bits each. Splitting is necessary due to limitations of the pattern editor in WinIQSIM (79 bits maximum). The *Bit Pattern* is set in accordance with training sequences specified in 3GPP TS 45.002 (Release 7) [2].

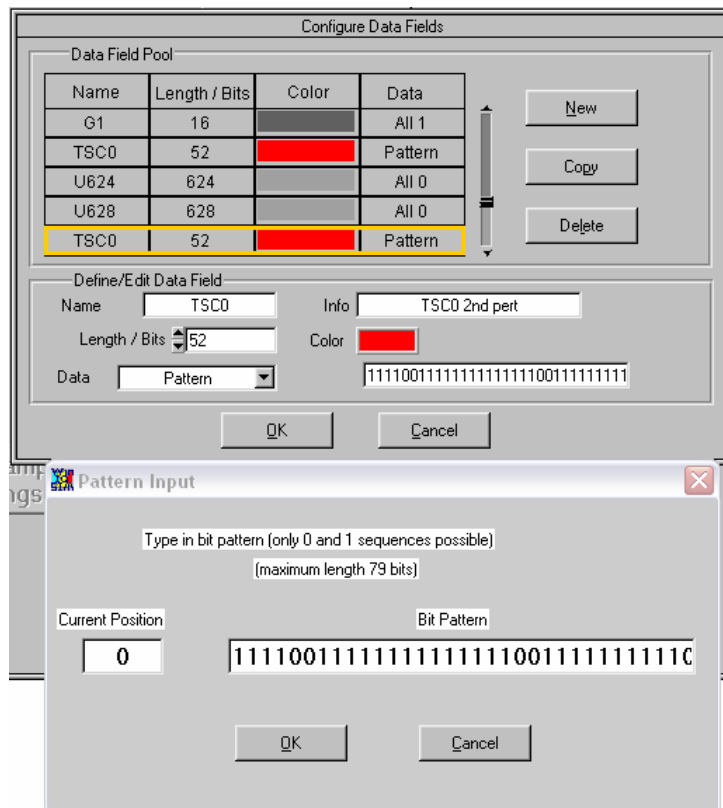


Fig. 5_7: Pattern editor for Training sequence

Different EGPRS2 signals using the specified training sequence TSC0 to TSC7 have been generated.

The Guard part is also split into two halves. One half is put in front of Tail (left), the other half follows Tail (right). This gives the opportunity to easily adjust the appropriate rise and fall times for the total burst.

In case of Level A (normal symbol rate) one burst of EGPRS2 signals contains 156.25 symbols. To achieve an integer number of symbols, the standard allows to vary the length of the guard period *G*. Thus two bursts within the frame are only 156 symbols (624 bits) long. To yield an average of 156.25 symbols they are alternately used with six other burst which are 157 (628 bits) symbols long.

The next figure shows how the active slot is composed from the *Data Pool*.

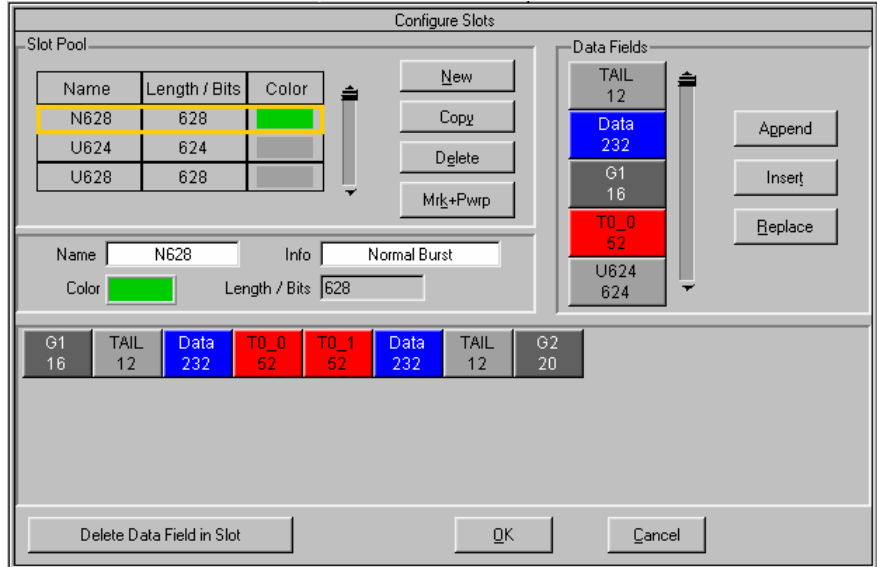


Fig. 5_8: Slot representation of a normal burst for 16 QAM modulation

The position of the power ramping is set by pressing the button *Mrk+Pwrp* in this menu.

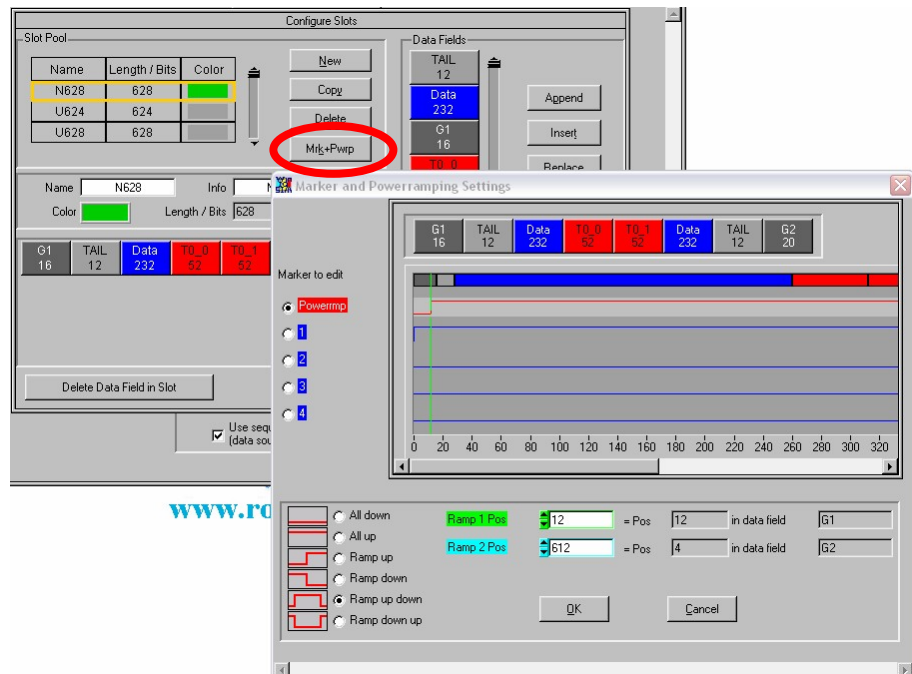


Fig. 5_9: Power ramping for normal burst

Ramp up is set to bit position 12, *Ramp down* to bit position 612. Together with the general ramp settings these positions allow alignment with the power ramp mask.

Note: Bit positions have to be aligned with symbols, since Ramp Time has to be set in symbols.

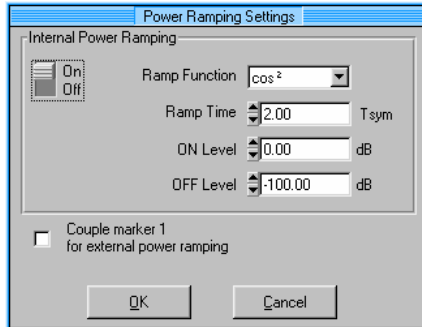


Fig. 5_10: Rise and fall timing for power ramping

The whole frame is created as follows:

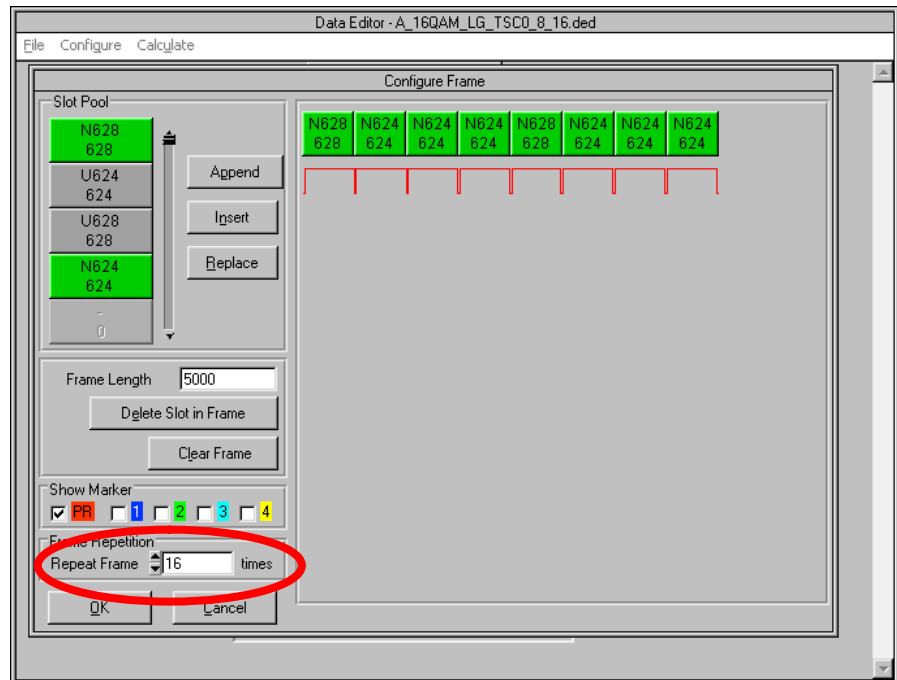


Fig. 5_11: Frame for 16 QAM modulation

This frame can be repeated for BER testing by the settings in the *Repeat Frame* field. The memory size of the installed ARB option limits this parameter.

A click on the *Calculate and Save Sequence* button of WinIQSIM completes the setup of the modulation data.

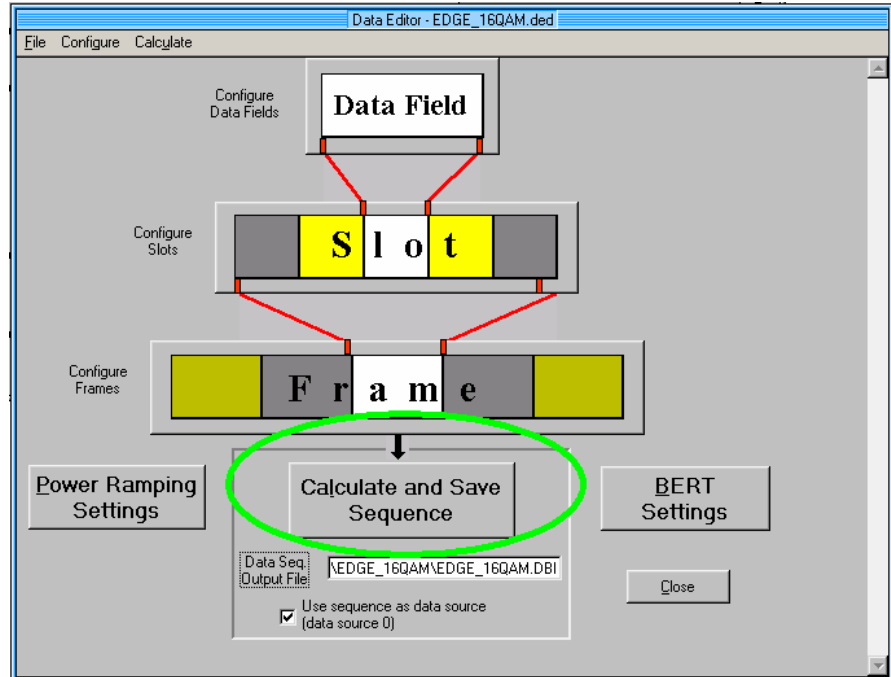


Fig. 5_12: Press Calculate and Save Sequence to complete data generation

Modulation Settings

Menu *Modulation Settings* of WinIQSIM is used to set the parameters for QAM modulation and for the mapping of the test signals.

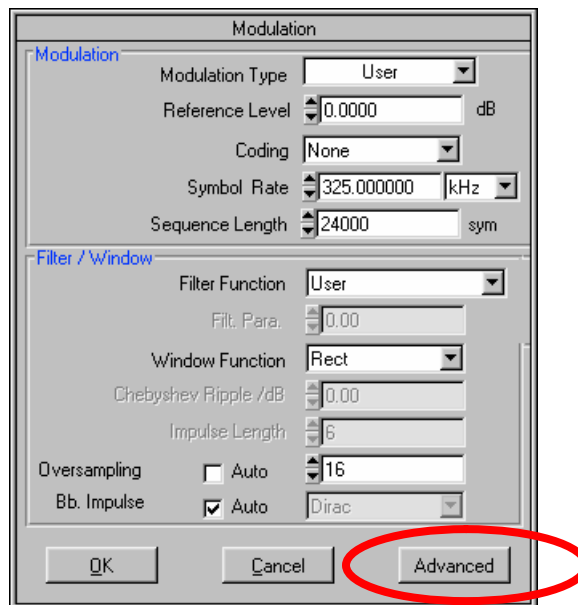


Fig. 5_13: Menu Modulation Settings for standard 16 QAM modulation

Fig. 5_13 shows the settings for a standard 16 QAM modulation Level A signal using the wide pulse shape in WinIQSIM. A specific mapping has

been specified for 16QAM, i.e. *Modulation Type* “User” needs to be selected together with a *User Mod. File* “A_16QAM_LG.imp”. In addition in case of EGPRS2 Level A (normal symbol rate) the known EDGE pulse shape is to be used. Consequently *Filter Function* has to be set to “Gauss EDGE”. The required mapping is included in the WinIQSIM settings file available for download with this application note.

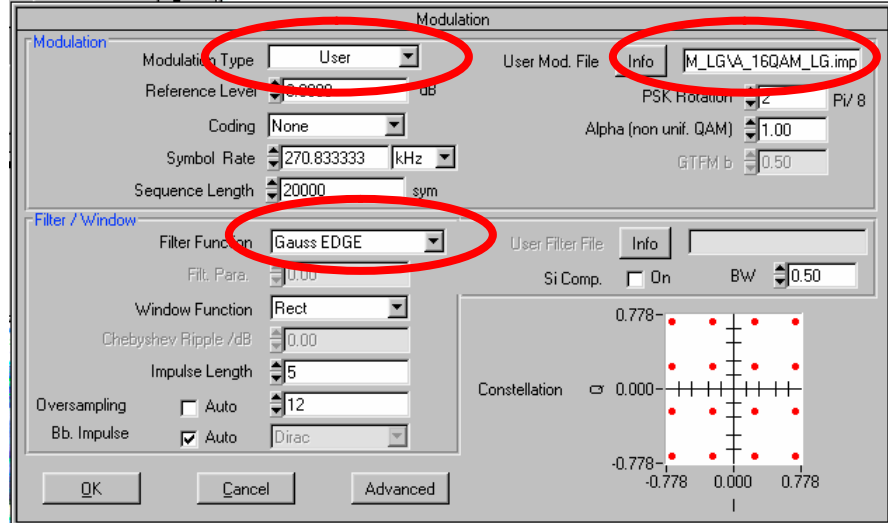


Fig. 5_14: User modulation with EGPRS2 16 QAM mapping

All parameters may be adapted according to individual needs.

WinIQSIM Graphics Functions

The WinIQSIM graphics functions allow a convenient control of the set signal.

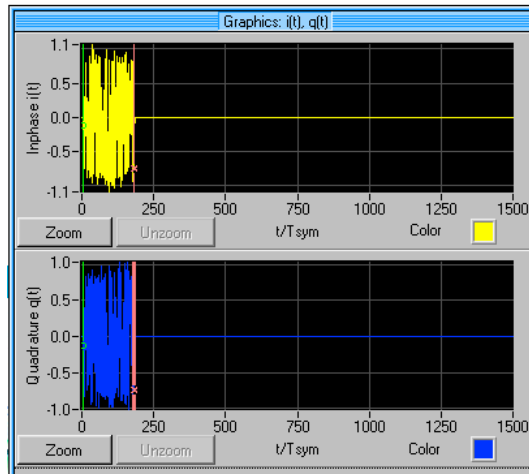


Fig. 5_15: Graphics of I/Q signals generated

In order to display the 16 QAM constellation set the *Filter Function* in menu *Modulation* to *Rect* (rectangular, see fig. 5_13). This should be done only for graphic illustration of the signal in WinIQSIM, do not use this setting for generating test signals. Fig. 5_16 shows the constellation diagram of the signal.

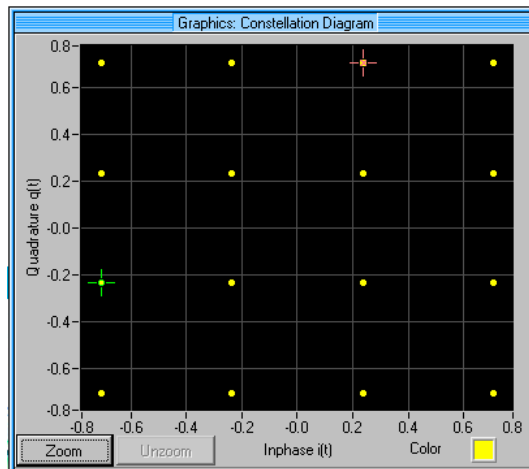


Fig. 5_16: 16 QAM Constellation Diagram (Rect filter used for graphics)

6 Appendix B: Generating 32 QAM Test Signals with WinIQSIM

Setting up 32 QAM signals is very similar to setting up 16 QAM signals. So only a few additional hints are given here for the example of a 32QAM Level B (high symbol rate) signal with narrow pulse shape filter. Predefined settings are available for WinIQSIM.

As 32 QAM modulation transmits 5 bits/symbol instead of 4 bits/symbol at 16 QAM, different data fields have to be defined. Every field now contains 5/4 times the number of bits compared to 16 QAM modulation with the same symbol rate.

Data Field	Length /Bits	Data
G1	25	Guard
Tail	20	All 1
Data	345	PRBS
TSC0	78	Training Sequence Part 1
TSC0	77	Training Sequence Part 2
G2	30	Guard

Table 6_1: Data fields for 32 QAM used in WinIQSIM Data Editor

In the same way as for 16QAM signals the training sequence is split up into 2 parts due to limitation of the maximum numbers of bits for the training sequence field.

Define Modulation Data for 32 QAM Signals Level B

Setup Data Fields with appropriate length according to table 6_1 similar to the instructions given for 16 QAM signals.

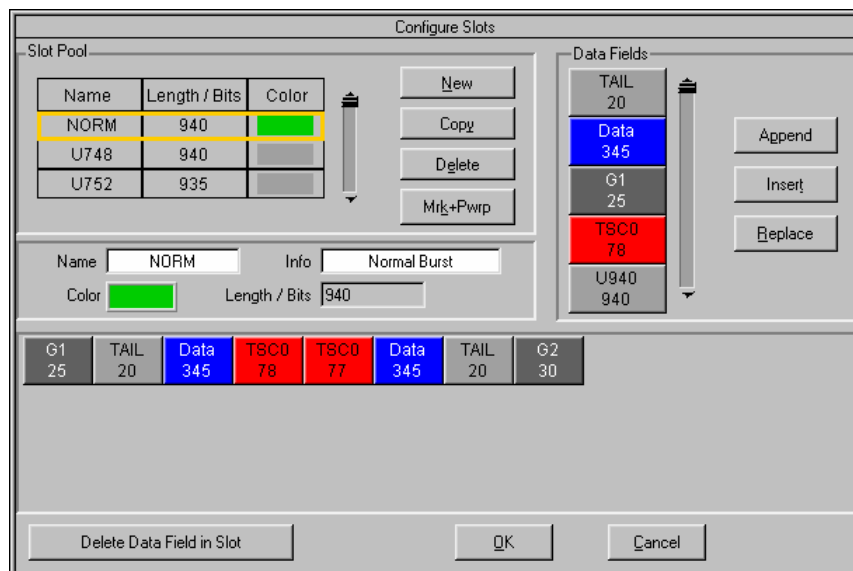


Fig. 6_2: Slot representation of a NORM burst for 32 QAM modulation

Two bursts with different length are used to achieve integer number of symbols per burst.

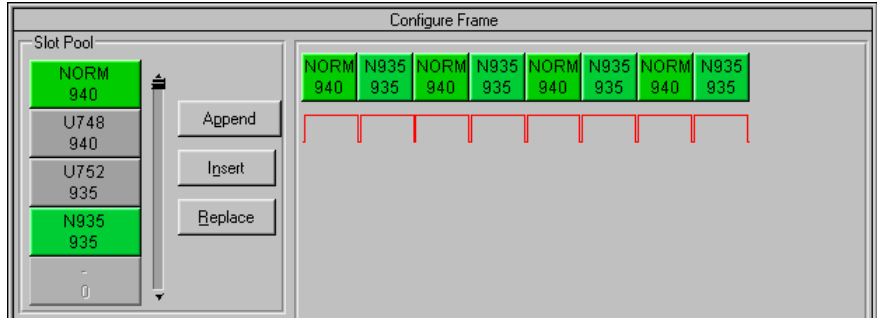


Fig. 6_3: Frame for 32 QAM modulation

Calculate and Save Sequence completes building 32 QAM modulation data.

Modulation Settings

Select *Advanced* in the menu *Modulation Settings* of WinIQSIM. Select *User* in the *Modulation Type* pull down menu to load the specific 32QAM modulation mapping (B_32QAM_LG.imp) as specified in 3GPP TS 45.004 (Release 7) [3]. Accordingly the correct pulse shape filter setting – in this case narrow pulse - is needed, i.e. with *Filter Function* set to *User* the specific *User Filter File* EDGE_NARROW_TX.ifl is required.

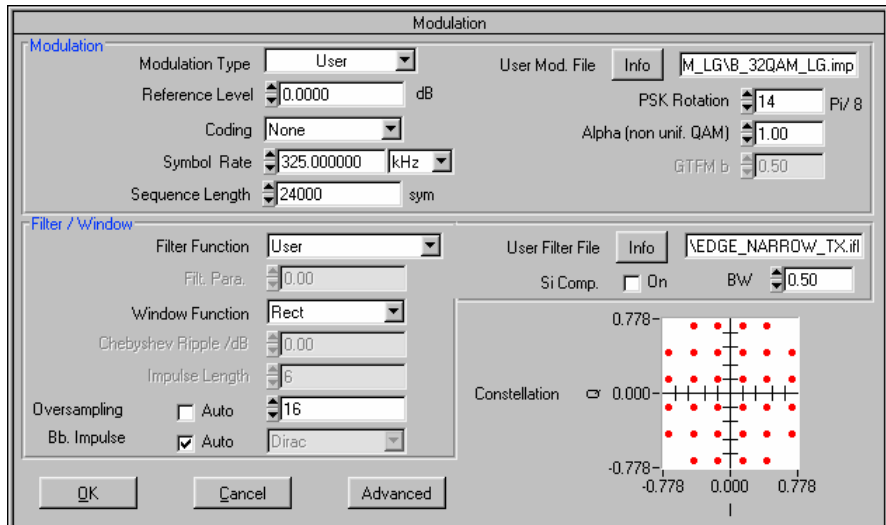


Fig. 6_4: Menu Modulation Settings for standard 32 QAM Level B modulation with narrow pulse shape

WinIQSIM Graphics Functions

Similar as above, WinIQSIM graphics can be used to display the 32 QAM constellation diagram (Use Rect Filter Function).

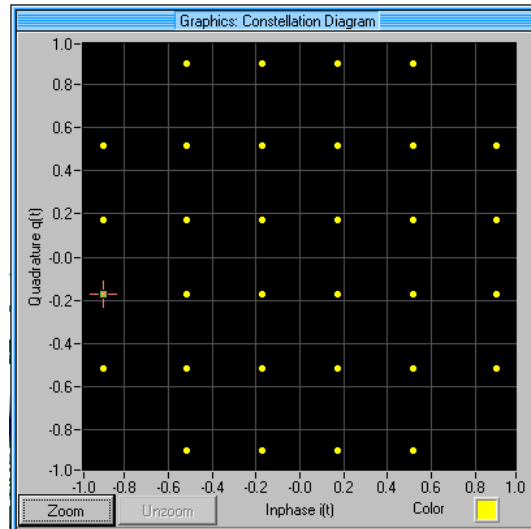


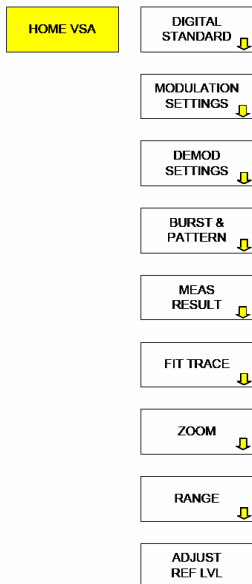
Fig. 6_6: 32 QAM Constellation Diagram (Rect filter used for graphics)

➤ Download Signals to Signal Generator.

Downloading signals to signal generator completes the 32 QAM test signal generation.

7 Appendix C: Setups of the Analyzer for EGPRS2 Signals

The following section shows the parameters of the predefined VSA setups (*DIGITAL STANDARDS*) used in section 4 of this application note. Take these settings as a basic configuration for EGPRS2 which guarantees a valid stable result display. Also use the settings to verify your current configuration in the case of problems. All available settings are included in *EDGEvo_VSA_Standards.zip* available for download with this application note.

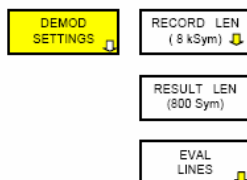


EGPRS2 Level A	8PSK	16 QAM	32 QAM
DIGITAL STANDARD	EGPRS2_A_8PSK	EGPRS2_A_16QAM	EGPRS2_A_32QAM
SYM RATE	270.833 kHz		
MODULATION	8PSK	USER-QAM	USER-QAM
MAPPING	EDGE	EE_1pi/4-16QAM	EE_7pi/4-32QAM
MODULATION FILTER TX RX Meas Filter	GAUSS_LINEARIZED EDGE_ISI EDGE_MEAS		

Table 8_1: Level A (normal symbol rate) modulation parameters

EGPRS2 Level B	QPSK	16 QAM	32 QAM
DIGITAL STANDARD Narrow Pulse Wide Pulse	EGPRS2_B_QPSK_G EGPRS2_B_QPSK_W	EGPRS2_B_16QAM_G EGPRS2_B_16QAM_W	EGPRS2_B_32QAM_G EGPRS2_B_32QAM_W
SYM RATE	325 kHz		
MODULATION	PSK	USER-QAM	USER-QAM
MAPPING	EE_3pi/4-QPSK	EE_1pi/4-16QAM	EE_7pi/4-32QAM
MODULATION FILTER TX RX Meas Filter	Narrow Pulse / Wide Pulse: EDGE_NARROW_TX / EDGE_EVO_TX_WP EDGE_NARROW_100_ISI / EDGE_EVO_ISI_WP EDGE_MEAS_HSR / EDGE_MEAS_HSR		

Table 8_2: Level B (high symbol rate) modulation parameters



	Level A	Level B
DEMO SETTINGS		
RECORD LENGTH	5000 symbols	5000 symbols
RESULT LENGTH	200 symbols	200 symbols

Table 8_3: Demo settings

Fig. 8_1 explains the meaning of the different lengths to specify.

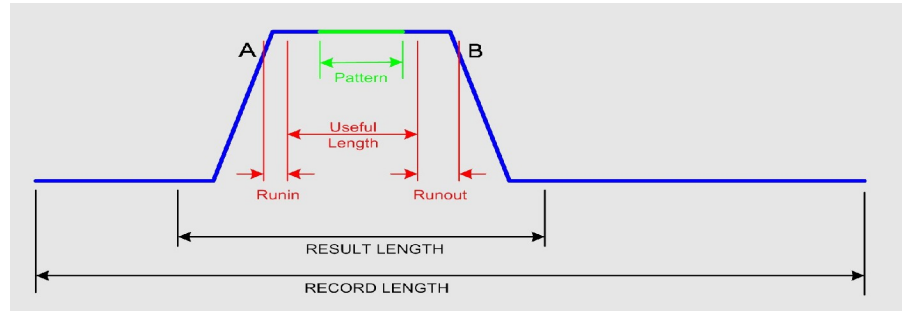


Fig. 8_1: Different lengths in the analyzer.

The *RESULT LENGTH* spans the section which will be displayed for representations vs. time.

In order to evaluate the signal in an area with stable and settled signal conditions the *Useful Length* field has to be specified accordingly. Several internal demodulation and correction parameters are evaluated during the *Useful Length*, and the *Pattern* is searched in this section. Use the parameters *Runin* and *Runout* to skip ranges with potential invalid modulation at the burst edges.

	Level A	Level B
BURST & PATTERN		
BURST SEARCH	ON	ON
EXPERT SETTINGS		
Useful Length	142	169
Max. Length	200	200
Runin	1	1
Runout	1	1
Min. Gap Length	1	1
BURST SEARCH	MEAS ONLY ON BURST	MEAS ONLY ON BURST
PATTERN SEARCH (see below)	ON MEAS ONLY ON PATTERN	ON MEAS ONLY ON PATTERN

Table 8_4: Burst & Pattern

Numeric results such as *EVM*, *Magnitude Error* etc, the *Symbol Table*, and *EYE* and *I/Q* display are derived from the signal between the evaluation lines *EVAL LINES*.

The VSA examines the power ramping to find the burst. A search pattern is necessary to synchronize to the rotating symbol mapping.

The patterns are chosen to correspond to the midamble of the signals described in section 3 of this application note.

HOME VSA

FIT TRACE

FIT TRIGGER

FIT BURST

FIT PATTERN

FIT ALIGN LEFT

FIT ALIGN CENTER

FIT ALIGN RIGHT

FIT ALIGN (50%)

SET SYMB# (0Sym)

Notes:

The patterns included in the predefined DIGITAL STANDARD for EGPRS2 signals are those specified in 3GPP TS 45.002 (Release 7) [2].

- To enable the softkey *PAT SRCH*, select a pattern at first.

Change the *FIT TRACE* default setting:

- Enable *FIT PATTERN*.
- Enable *FIT ALIGN CENTER*.
- Set *SET SYMB#* to 2 symbols.
- Set the pattern position *PAT POS* to 69 symbols.

In fig. 8_2, the analyzer synchronizes. The highlighted green search pattern is stable, but the result quality (e.g. the EVM) is fairly poor.

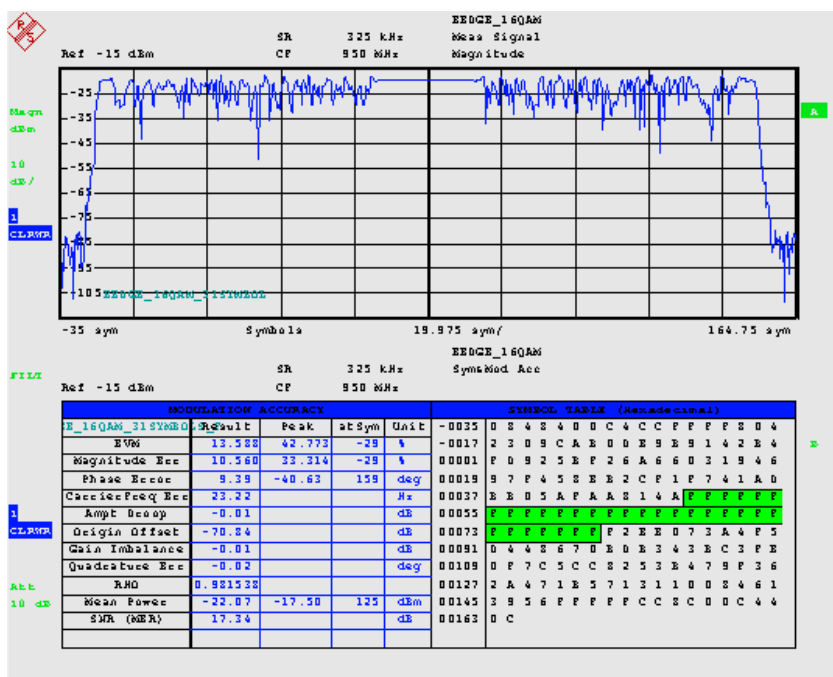


Fig. 8_2: Result display (burst and noise).

DEMOD SETTINGS

RECORD LEN (8 kSym)

RESULT LEN (800 Sym)

EVAL LINES

That's because the evaluation lines are not set correctly: a signal section containing burst and noise is taken for evaluation.

- Select a section within the active part of the burst by the two evaluation lines, see fig. 8_3.

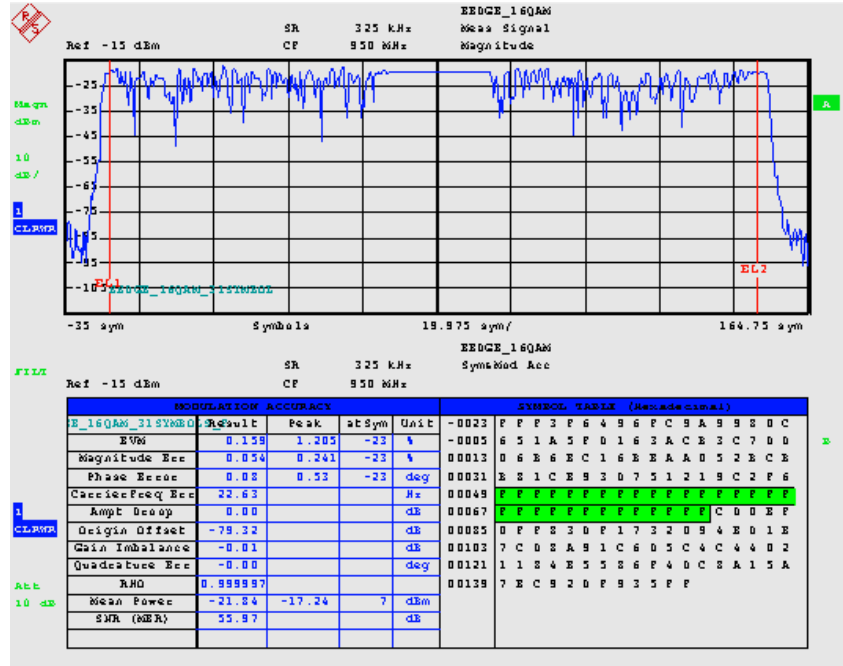


Fig. 8_3: Result display of an active section of the burst

8 References

- [1] 3GPP TR45.912; Feasibility study for evolved GSM/EDGE Radio Access Network (GERAN) (Release 7)
- [2] 3GPP TS45.002; Technical Specification Group GSM/EDGE Radio Access Network; Multiplexing and multiple access on the radio path (Release 7)
- [3] 3GPP TS45.004; Technical Specification Group GSM/EDGE Radio Access Network; Modulation (Release 7)

9 Additional Information

This application note is updated from time to time. Please visit the website [1MA116](#) in order to download new versions.

Please send any comments or suggestions about this application note to TM-Applications@rsd.rohde-schwarz.com.

10 Ordering Information

Signal analyzer, spectrum analyzer, measuring receiver, and options

R&S® FSQx	20 Hz to 40 GHz	1155.5001.x
R&S® FSUx	20 Hz to 50 GHz	1166.1660.x
R&S® FSGx	9 kHz to 8 / 13.6 GHz	1309.0002.x
R&S® FSQ-K70	Vector signal analysis	1161.8038.02
R&S® FSU-B73	Vector signal analysis	1169.5696.03

Vector signal generator and options

R&S® SMU200A	Vector Signal Generator	1141.2005.02
R&S® SMU-B102	Frequency Range 100 kHz to 2.2 GHz	1141.8503.02
R&S® SMU-B103	Frequency Range 100 kHz to 3 GHz	1141.8603.02
R&S® SMU-B104	Frequency Range 100 kHz to 4 GHz	1141.8703.02
R&S® SMU-B106	Frequency Range 100 kHz to 6 GHz	1141.8803.02
R&S® SMU-B9	Baseband with dig. modulation (real time) and ARB (128 Msample)	1404.1501.02
R&S® SMU-B10	Baseband with dig. modulation (real time) and ARB (64 Msample)	1141.7007.02
R&S® SMU-B11	Baseband with dig. modulation (real time) and ARB (16 Msample)	1159.8411.02
R&S® SMU-B13	Baseband Main Module	1141.8003.02
R&S® SMU-B31	High-Power Output	1159.8011.02
R&S® SMJ100A	Vector Signal Generator	1404.4507.02
R&S® SMJ-B103	Frequency Range 100 kHz to 3 GHz	1403.8502.02
R&S® SMJ-B106	Frequency Range 100 kHz to 6 GHz	1403.8502.02
R&S® SMJ-B9	Baseband with dig. modulation (real time) and ARB (128 Msample)	1404.1501.02
R&S® SMJ-B10	Baseband with dig. modulation (real time) and ARB (64 Msample)	1403.8902.02
R&S® SMJ-B11	Baseband with dig. modulation (real time) and ARB (16 Msample)	1403.9009.02
R&S® SMJ-B13	Baseband Main Module	1403.9109.02
R&S® SMJ-B50	Baseband generator, ARB only, 64 Msamples	1410.5505.02
R&S® SMJ-B51	Baseband generator, ARB only, 16 Msamples	1410.5605.02



ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München · Postfach 80 14 69 · D-81614 München ·
Tel (089) 4129-0 · Fax (089) 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.