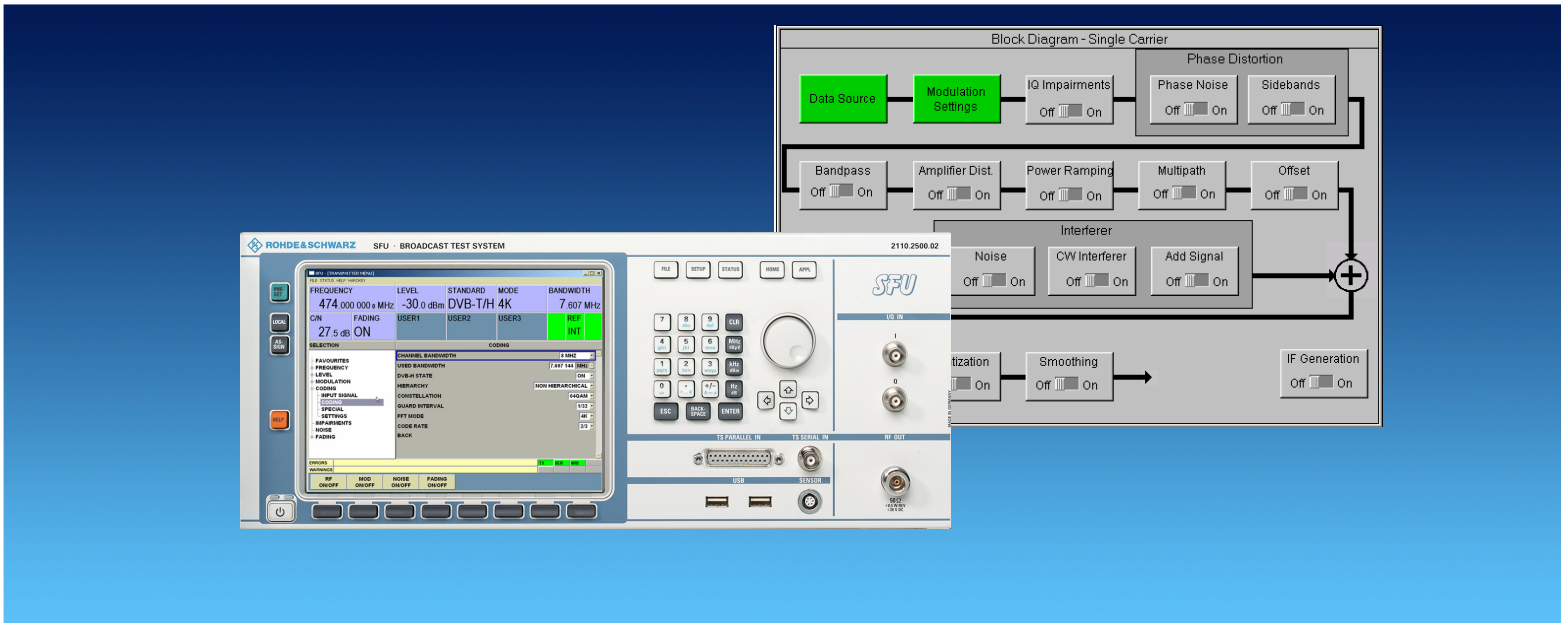

Broadcast Test System: R&S®SFU

R&S®SFU & R&S®WinIQSIM™ Function and Uses of the Arbitrary Waveform Generator (ARB)

Application Note

Arbitrary waveform generator – this term encapsulates the wide-ranging capabilities and applications that can be provided by user-definable I/Q baseband signals and a vector signal generator. Rohde & Schwarz has developed the R&S®WinIQSIM™ software package specifically with this in mind. The first questions a user might ask are: “How do the R&S®SFU and R&S®WinIQSIM™ interwork and what features are available? This Application Note has been produced to answer these questions.

ROHDE&SCHWARZ

Subject to change – H. Gsoedl 12.2006 - 7BM57_1E

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1 Overview

Arbitrary waveform generator – this term encapsulates the wide-ranging capabilities and applications that can be provided by user-definable I/Q baseband signals and a vector signal generator. Rohde & Schwarz has developed the R&S®WinIQSIM™ software package specifically with this in mind.

But, how do the R&S®SFU and R&S®WinIQSIM™ interwork and what features are provided for the user? This Application Note provides the answers to these questions.

This Application Note first outlines the fundamentals of analog and digital modulation. The R&S®SFU's arbitrary waveform generator is then briefly described to lay the groundwork for the more extensive explanation of interworking with the R&S®WinIQSIM™ package.

Note:

In this Application Note, the terms "arbitrary waveform generator", "ARB generator" and "ARB" are synonymous.

2 Requirements

The applications (R&S®WinIQSIM™ + additional applications) described in this Application Note are based on the following requirements:

PC hardware requirements

	Minimum	Recommended
CPU	Pentium 133 MHz	Pentium II 450 MHz or later
RAM	32 Mbytes	128 Mbytes
Hard disk	10 Mbytes	50 Mbytes
Monitor	VGA monitor (640 x 480)	SVGA color monitor, resolution 800 x 600 or later
Remote control	IEC/IEEE bus interface: National Instruments adapters or compatible alternatives	

PC software requirements

	Minimum	Recommended
Operating system	Windows 95 / 98 / NT 4.0 / 2000 / Me / XP	Windows 98 / 2000 / Me / XP
Operating system – expansions	---	Microsoft Internet Explorer 5.0 or later
Remote control	IEC/IEEE bus driver: NI-488.2 V1.7 (or later) Visa driver: NI-VISA V3.0 (or later) Visa remote control of R&S devices: RSIB-PASSPORT V1.4	
Applications	---	R&S®WinIQSIM™ 4.3

See the Rohde & Schwarz website http://www.rohde-schwarz.com for information on R&S®WinIQSIM™ installation, functionality and operation.

R&S®SFU requirements

Hardware options	MEMORY EXTENSION 1	R&S® SFU-B3	2110.7447.02
Software-options	ARB GENERATOR	R&S® SFU-K35	2110.7601.02

3 Modulation

Fundamentals

To make a signal carry information, three signal parameters can be varied as a function of the information.

A sinusoid can be fully described in terms of the parameters amplitude A, phase φ and its period T:

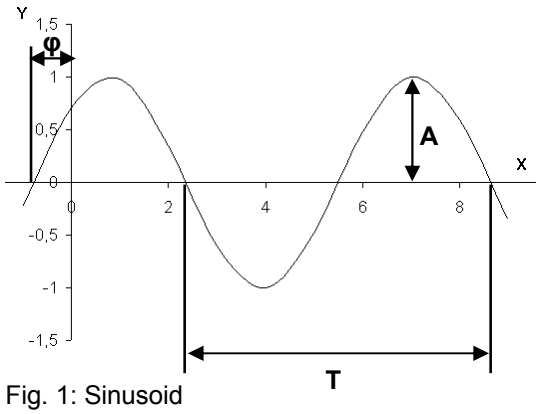
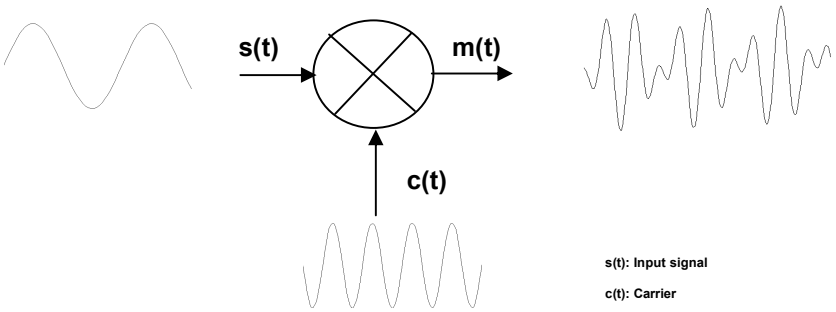


Fig. 1: Sinusoid

A: Amplitude
T: Period
φ: Phase offset

By varying A, φ or T in a specific way, information can be impressed on a signal. This is referred to as amplitude, phase or frequency modulation depending on which parameter is varied. For example, a carrier signal c(t) is amplitude-modulated with an input signal s(t) by multiplying these two signals together in a mixer:



s(t): Input signal
c(t): Carrier
m(t): Modulated signal

Fig. 2: Mixer

Vector modulation

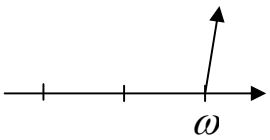
When digital modulation is used, an orthogonality relation makes it possible to maximize information content by allowing two independent data streams to be simultaneously impressed on a single carrier. This form of modulation is commonly referred to as I/Q modulation.

This method works because there is no mutual interference if two signals which are 90° out of phase, i.e. in quadrature, undergo additive superposition. This type of modulation can be mathematically described in steps as follows:

Mathematical intermezzo

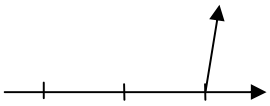
Step 1: Consider a single carrier with frequency ω and phase angle ρ:

$$A(t) = a \cdot \cos[\omega \cdot t + \rho]$$



Step 2: By introducing a frequency offset ω_n, trigonometric addition formulas can be used to obtain a new expression for A(t):

$$A(t) = a \cdot \cos[(\omega_0 + \omega_n) \cdot t + \rho]$$



$\omega_0 - \omega_n \quad \omega_0 \quad \omega_0 + \omega_n$

the identity:

$$\cos(\alpha + \beta) = \frac{1}{2} \cdot \cos(\alpha) \cdot \cos(\beta) - \frac{1}{2} \cdot \sin(\alpha) \cdot \sin(\beta)$$

implies:

$$A(t) = \underbrace{\frac{1}{2} \cdot a \cdot \cos(\omega_n \cdot t + \rho) \cdot \cos(\omega_0 \cdot t)}_{\mathbf{I}} \underbrace{- \frac{1}{2} \cdot a \cdot \sin(\omega_n \cdot t + \rho) \cdot \sin(\omega_0 \cdot t)}_{\mathbf{Q}}$$

As the equation above shows, A(t) is the sum of two signal components in quadrature.

Step 3: The third and last step uses multiplication formulas to manipulate the expression for A(t) to show that I/Q modulation always produces two sidebands:

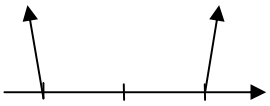
Using the identities:

$$\cos(\alpha)\cdot\cos(\beta)=\frac{1}{2}\cos(\alpha-\beta)+\frac{1}{2}\cos(\alpha+\beta) \text{ und}$$

$$\sin(\alpha)\cdot\sin(\beta)=-\frac{1}{2}\cos(\alpha-\beta)+\frac{1}{2}\cos(\alpha+\beta)$$

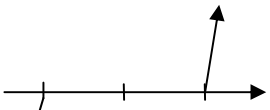
it follows that:

$$I(t)=\frac{1}{2}\cdot a\cdot\cos[(\omega_0-\omega_n)\cdot t-\rho]+\frac{1}{2}\cdot a\cdot\cos[(\omega_0+\omega_n)\cdot t+\rho$$



$\omega_0-\omega_n \quad \omega_0 \quad \omega_0+\omega_n$

$$Q(t)=-\frac{1}{2}\cdot a\cdot\cos[(\omega_0-\omega_n)\cdot t-\rho]+\frac{1}{2}\cdot a\cdot\cos[(\omega_0+\omega_n)\cdot t+\rho]$$



$\omega_0-\omega_n \quad \omega_0 \quad \omega_0+\omega_n$

Phasor diagrams

In mathematics and electrical engineering, the phasor diagram has been adopted as an effective way of visualizing sinusoidal carriers. In other words, a sinusoidal signal is represented by a rotating vector or phasor. The sinusoidal oscillation is described by the amplitude, phase and rotating frequency of the phasor.

I/Q modulation is represented in terms of two phasors. The sine and cosine components of the oscillations give rise to phasors with a specific phase and amplitude. The corresponding symbol can be deduced from this data.

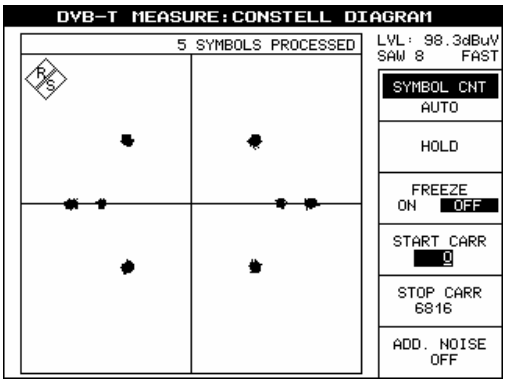


Fig. 3: Constellation diagram, I/Q modulation (COFDM/QPSK)

The figure above is a possible constellation diagram. The horizontal axis represents the in-phase component and the vertical axis the quadrature component (90° phase shift) of the I/Q-modulated carrier.

Vector modulator

The following figure shows how an I/Q modulator could be implemented:

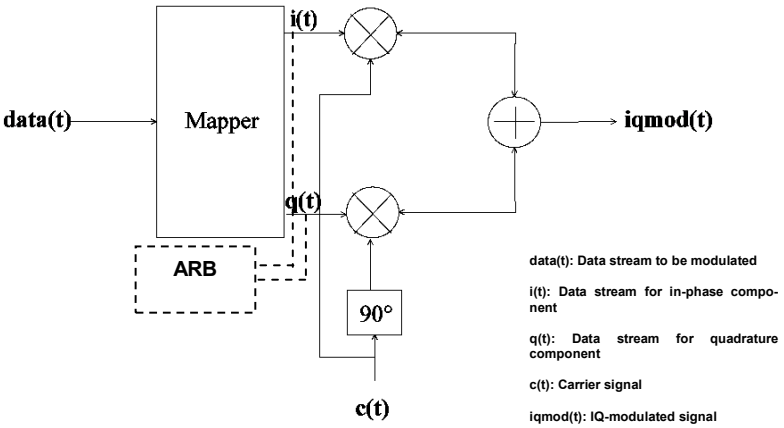


Fig. 4: I/Q modulator

i(t) and q(t) represent the two data streams that are transmitted independently of each other. They are generated from the original data (data(t)) by a mapper. In the Q branch, the oscillator signal c(t) is phase-shifted by 90° before it is fed into the mixer; this is not the case in the I branch.

4 R&S®SFU's Arbitrary Waveform Generator

ARB generators operate on a different principle to hardware-based modulation, which involves applying external data signals in realtime to a modulator, e.g. scramblers, coders, mappers and mixers and outputting a modulated RF signal:

Essentially, an ARB generator is an I/Q-modulation endless loop. In other words, an I/Q-modulation sequence with a specific length, defined and generated beforehand, is stored in memory and read out in a continuous loop as a baseband or IF signal. The baseband I/Q-data which has been obtained in this way is then I/Q modulated using a mixer (see chapter 3 – Vector Modulator).

R&S®SFU-K35 circuit configuration

The R&S®SFU's arbitrary waveform generator can be used as an I/Q data source for a wide range of purposes inside the instrument. The following diagram indicates the possible uses of the ARB in a highly simplified form:

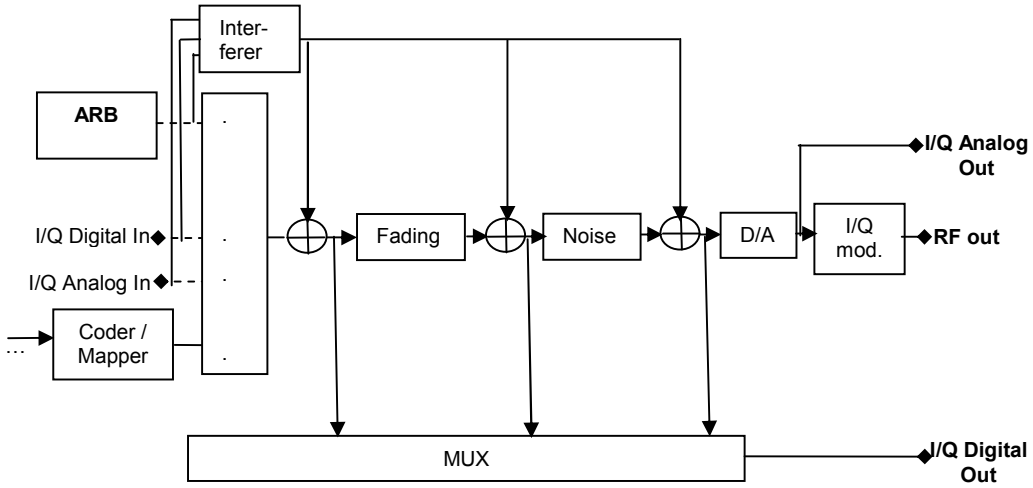


Fig. 5: R&S®SFU/ARB circuit configuration

Possible uses of the ARB generator:

1) Interference source:

The arbitrary waveform generator is used to additively superimpose an interference signal on a signal generated by the internal coder.

2) Source for generating an RF signal from ARB data:

The arbitrary waveform generator outputs baseband I/Q data which, after I/Q modulation, determines the required RF signal at the output.

The I/Q data from the arbitrary waveform generator can be fed to the analog or digital I/Q output. The analog I/Q output is always activated (see

graphics). The digital output is configurable from the tap (tap after baseband impairments not shown).

See the User Manual for a more detailed description of the configuration options.

ARB user interface

The ARB function is implemented in the user interface of the R&S®SFU in the following way:

After <APPL> on the R&S®SFU is pressed, the ARB interface can be selected.

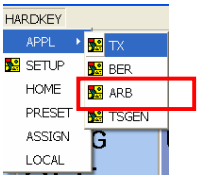


Fig. 6: Selecting the ARB application

The ARB status, waveform file, clock rate, etc, can be selected using the following menu tree.

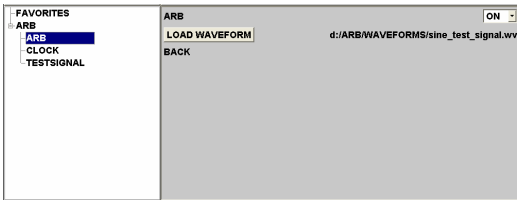


Fig. 7: ARB GUI

See chapter 7 for a detailed example illustrating user prompting.

Data sheet values

Arbitrary waveform generator (option R&S SFU-K35)

Waveform memory	length resolution loading time for 10 Msamples nonvolatile memory	512 samples to 64 Msamples in one-sample steps 16 bit 15 s hard disk
Clock generation	clock rate accuracy operating mode frequency accuracy (internal)	400 Hz to 100 MHz 0.001 Hz internal, external accuracy of reference frequency
Interpolation	bandwidth with clock rate = 100 MHz (no interpolation), roll-off drop to –0.1 dB with clock rate ≤100 MHz, drop to –0.1 dB sampling rate	 40 MHz 0.31 × clock rate automatically interpolated to the internal 100 MHz data rate

Fig. 8: Data sheet values

Different instrument generations may have different memory depths: More recent R&S®SFU-K35 options have memory depths of 128 Msamples rather than 64 Msamples.

The option version can be determined with the “Setup-Hardkey” in “HARDWARE OPTIONS”. If an “SFU-B3” option is listed, it is an ARB for sequence lengths of 128 Msamples.

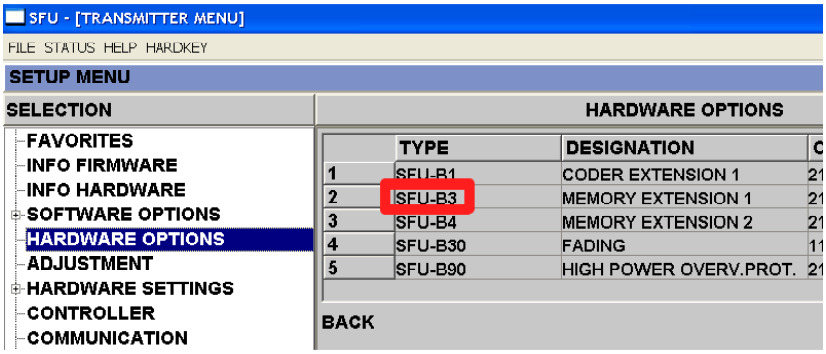


Fig. 9: Hardware options

R&S®SFU-K35 interpolating waveform generator

The following figure shows how the R&S®SFU-K35 arbitrary waveform generator option functions:

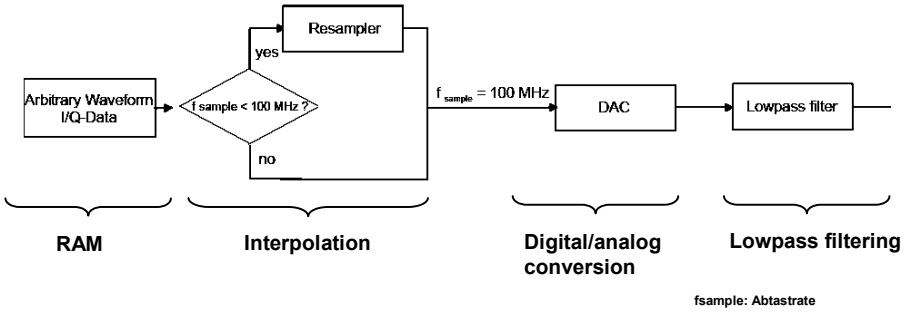


Fig.10: Interpolating arbitrary waveform generator

The great advantage of the interpolating arbitrary waveform generator is that short sequences can be "filled out" with interpolated values (f_{sampl} = 100 MHz) to create long sequences. This makes it possible to significantly reduce any aliasing products.

RAM

The information needed to generate waveforms is stored as a number of samples in the random access memory (RAM). A sample is the amplitude of a signal at a particular instant in time:

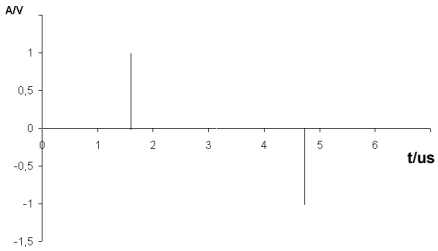


Fig.11: Samples stored in RAM

The Nyquist-Shannon sampling theorem must be used to determine the sampling frequency f_{sampl}. This theorem states that the sampling rate f_{sampl} must be at least twice the frequency of the maximum frequency component in the signal $f_{\max}$:

$$f_{sampl} > 2 \cdot f_{\max}$$

Because of the interpolation filter (see section 4), the formula must be modified in the following way so that filtering does not cut out important regions of the signal:

$$f_{sampl} > 2 \cdot f_{\max} / 0.31$$

The following applies for digital modulation:

$$f_{sampl} > f_{symb} \cdot oversampling$$

where f_{symb} is the symbol rate.

Oversampling obeys the following inequality:

$$oversampling \geq \frac{B_{\mathrm{mod}}}{f_{symb} \cdot 0.31}$$

where B_{mod} is the modulation bandwidth.

Using the sampling rate f_{sampl} that has been obtained, the number of samples N can be determined as a function of the sequence duration t:

$$N = t \cdot f_{sampl}$$

Interpolation

The interpolation filter (f_{sampl} = 100MHz) makes it possible to keep the nominal sampling rate low. Plus, the number of aliasing products, should any occur, is reduced:

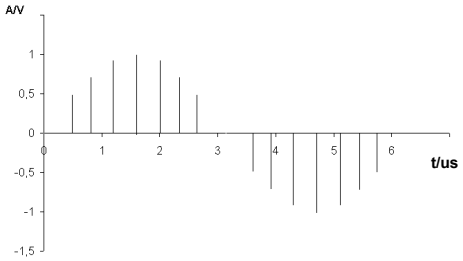


Fig.12: Interpolation filter

Digital/analog conversion

The D/A converter weights the interpolated signals according to the formula $\frac{\sin(f_{sampl})}{f_{sampl}}$. The following signal is created in the time domain:

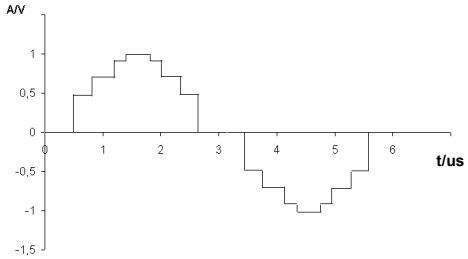


Fig.13: Signal after D/A conversion

Lowpass filtering

The last step, analog lowpass filtering, removes any remaining aliasing products:

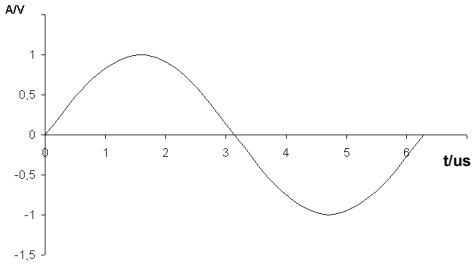


Fig. 14: Output signal after lowpass filtering

Waveform file format

The R&S®SFU processes normalized, binary I/Q data which is contained in specific tags. A tag comprises a name and a data packet, separated by a colon and enclosed in curly braces. Example:

```
{Name: Data}
```

The following procedure must be used to generate waveforms manually:

1st step: binary conversion

To obtain binary data, normalized to -1 - +1 I/Q data from decimal numbers, each decimal number is converted into an unsigned, 16-bit integer. This gives a range, i.e. 65535, that is compatible with the resolution of the D/A converter.

The values which are obtained are then concatenated in the following way: IQIQIQ…IQ.

2nd step: type, clock and samples tag

The following lines are inserted before the actual binary data:

```
{TYPE: SFU-WV, xxxxxxx}
{CLOCK: yyy}
{SAMPLES: zzz}
```

xxxxxxx: Checksum which, however, is not checked by the R&S®SFU and so is set to: 0.

yyy: Clock frequency in Hz at which the waveform is output.

zzz: Number of samples.

The file that has been created now looks like this:

```
{TYPE: SFU-WV, 0}
{CLOCK: 10e6}
{SAMPLES: 20}
IQIQIQIQIQIQIQIQIQI ... IQ
```

3rd step: waveform tag

The last step is inserting the waveform tag which encloses the previously mentioned I/Q data:

```
{WAVEFORM-Length: #IQIQIQIQIQIQIQIQIQI ... IQ}
```

The following entry is for 20 I/Q pairs (80 bytes). The tags which were mentioned previously must be inserted. There is also an optional COMMENT tag which can be used to enter any comments the user wants to make.

```
{TYPE: SFU-WV,0}
{COMMENT: I/Q=sine/cosine, 20 points, clock 10 MHz}
{CLOCK: 10e6}
{SAMPLES: 20}
{WAVEFORM-81: #IQIQIQIQIQIQ ... IQ}
```

5 R&S®WinIQSIM™

R&S®WinIQSIM™ provides the capability for configuring the transmission path from the transmitter to the receiver.

Due to the range of functions provided, it is possible to generate specific types of modulation and then to output them to the R&S®SFU's arbitrary waveform generator. The type of modulation is selected in the System! menu.

System! menu

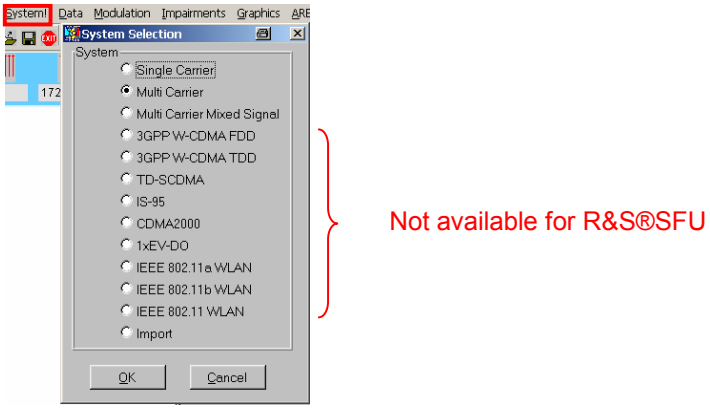


Fig. 15: R&S®WinIQSIM™: System! menu

As the figure above shows, there is a large number of modulation modes to choose from. Ex factory, the R&S®SFU provides the modulation modes: Single Carrier, Multi Carrier, Multi Carrier Mixed Signal and Import.

The blocks shown in the block diagram are modified according to the modulation mode selected in the menu.

Block diagram

The blocks shown in the diagram are the key components of the R&S®WinIQSIM™ application. They are configured to generate the signal that is required:

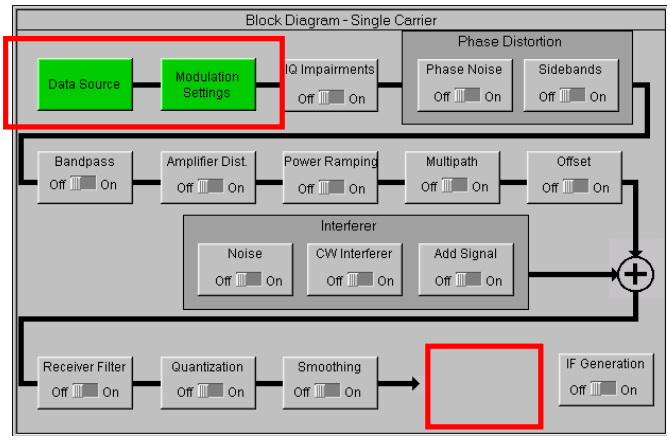
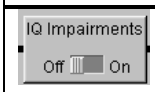
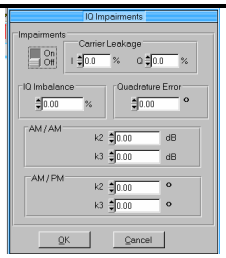
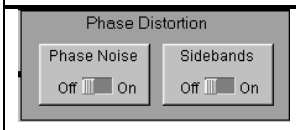
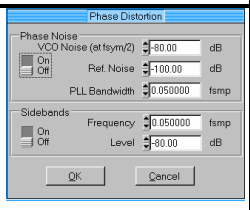
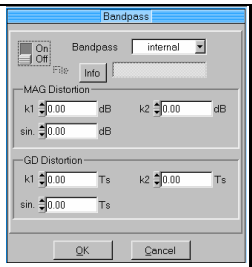
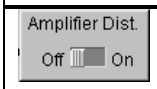
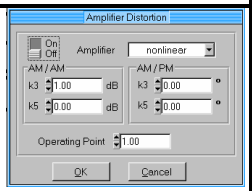
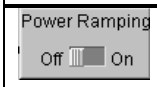
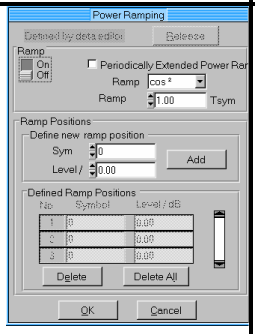
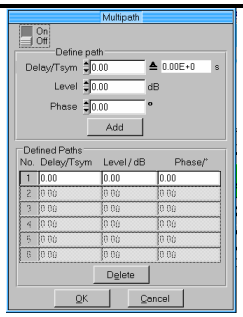
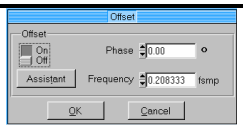
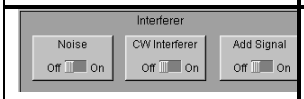
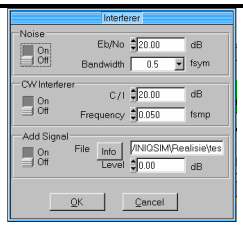


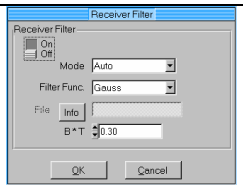
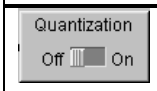
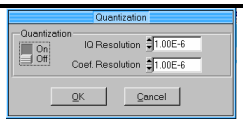
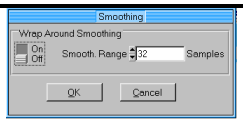
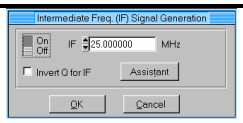
Fig.16: R&S®WinIQSIM™ block diagram

The red sections in the figure above indicate the modulation dependent areas, which can change with different modulation standards.

The table below overviews the functions of the modulation-independent blocks:

Block	Configuration window	Function
		- I/Q offset - I/Q imbalance - Quadrature error
		Phase noise: - VCO noise - Reference noise - PLL bandwidth Sidebands: - Frequency - Level

		- Magnitude distortion - Group delay distortion
		- AM/AM conversion - AM/PM conversion
		Definition of power ramps via: - Ramp functions - Ramp positions
		Insertion of additional propagation paths which can be defined in the following ways: - Path delay - Level - Phase
		- Phase offset - Frequency offset
		The following interferers can be additively superimposed on the transmission path: - Noise - Unmodulated carrier - Imported signal

		Receive filters can be set via: - Filter mode - Filter function - B*T
		Quantization can be set via: - I/Q resolution - Coefficient resolution
		Smoothing can be defined via: - Smoothing range
		Generation of IF signals via: - IF frequency - I/Q polarization change - Additional options

Import

To import user-specific I/Q modulations into R&S®WinIQSIM™, the Import selection option in the Systems! menu can be used to download I/Q data via a TCP/IP connection from Rohde & Schwarz additional applications for R&S®WinIQSIM™.

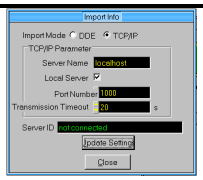
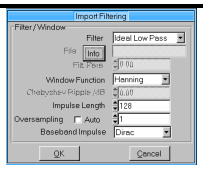
The following programs are available:

- R&S®IQWizard (for importing I/Q data from MATLAB, spectrum analyzers, etc)
- R&S®NPR (generation of noise signals)

Before a connection can be set up between one of the two applications and R&S®WinIQSIM™, both the required additional application and the R&S®WinIQSIM™ must be started. TCP/IP data transmission cannot take place unless the communications port is set both from the additional application and from R&S®WinIQSIM™.

See the next chapter and the references to the Application Notes it contains for a more detailed explanation of this and other functions.

When the import setting has been made on R&S®WinIQSIM™, two specific configuration blocks are available for configuration:

Block	Configuration window	Function
Import		Configuring the network client in R&S®WinIQSIM™: - Port number - Time outs
Filter		Configuring the import filter: - Filter type / parameter - Window function - Pulse length - Oversampling - Baseband pulse

ARB menu

R&S®WinIQSIM™ is a general tool for generating and transmitting I/Q signals. The ARB data that has been generated must therefore be tailored to the ARB generator that is used. This is done in the Target ARB Selection submenu:

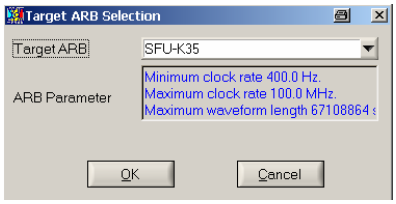


Fig.17: Target ARB Selection

The R&S®SFU-ARB cannot be operated unless “SFU-K35” has been selected.

The “Transmission…” menu item in the “SFU (ARB)” submenu must be selected to actually generate the ARB data:

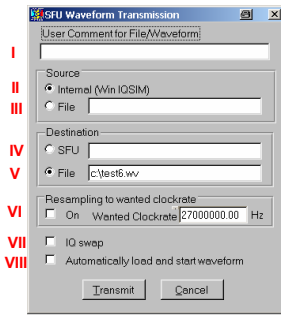


Fig.18: Waveform Transmission

- I: File comment
- II: Currently selected simulation
- III: Previously generated *.ibn file
- IV: File browser for saving directly to the R&S®SFU
- V: Name of the file to be saved locally
- VI: Resetting the clock frequency
- VII: Reversing the polarity of the I/Q modulation
- VIII: With (IV), automatic waveform start after saving on the instrument

Items IV and VIII require R&S®SFU firmware version 1.40 .

See section 7 of this Application Note for an example illustrating the application.

With R&S®WinIQSIM™, the user of the R&S®SFU can automatically generate waveforms which are output in the endless loop mode in the ARB generator.

6 Additional Applications for R&S®WinIQSIM™

R&S®IQWizard

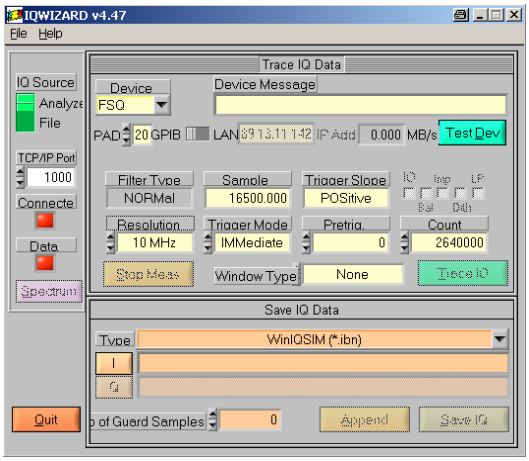


Fig. 19: R&S®IQWizard interface

R&S®IQWizard provides the R&S®SFU user with a wide range of functions for loading I/Q data in many different formats or for recording I/Q data obtained by sampling almost any signal waveform using a spectrum analyzer. The data that has been read can then be saved in any file format or sent to R&S®WinIQSIM™ via a TCP/IP connection.

For more information, see the Rohde & Schwarz Application Note 1MA28_13E[1] at http://www.rohde-schwarz.com.

Importing MATLAB files, ASCII files, etc

The following I/Q data types can be imported:

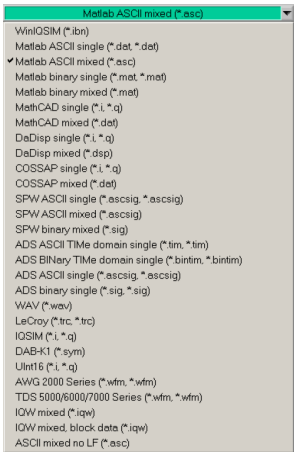


Fig. 20: Importable data types

As indicated above, there is a choice of four different formats for importing user-defined I/Q data from MATLAB. For an in-depth description of the syntax, consult the Application Note referred to above.

Sampling

When connected via an IEC/IEEE interface, the R&S®FSIQ, R&S®FSP, R&S®FSU, R&S®FSQ, R&S®FSL and R&S®EXPI spectrum analyzers from Rohde & Schwarz can be used for signal sampling under R&S®IQWizard control.

To find out how to determine the sampling rate and the number of samples, see the chapter “R&S®SFU’s Arbitrary Waveform Generator”.

Furthermore, it should be noted that the resolution bandwidth (RBW) of the spectrum analyzer must at least equal the bandwidth of the signal to be recorded.

File export

The sampling procedure or the imported files can be exported with “Save IQ Data”. The following target formats can be selected to do this:

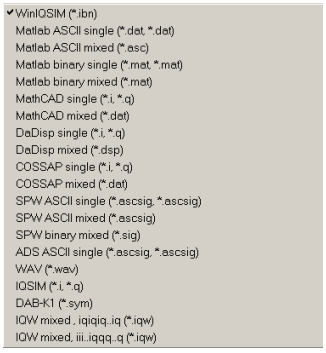


Fig. 21: R&S®IQWizard: exportable data types

R&S®NPR

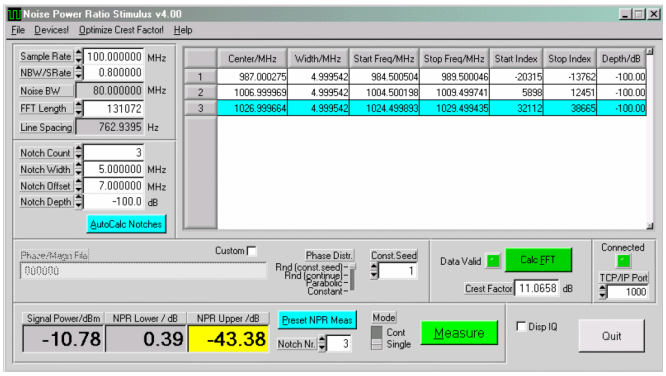


Fig. 22: R&S®NPR interface

When R&S®Noise Power Ratio is directly connected to R&S®WinIQSIM™, it is possible to generate noise power stimulus signals and, using other Rohde & Schwarz instruments connected via the IEC/IEEE bus, to measure the resulting noise power ratio of the DUT.

The test setup to be used is shown below:

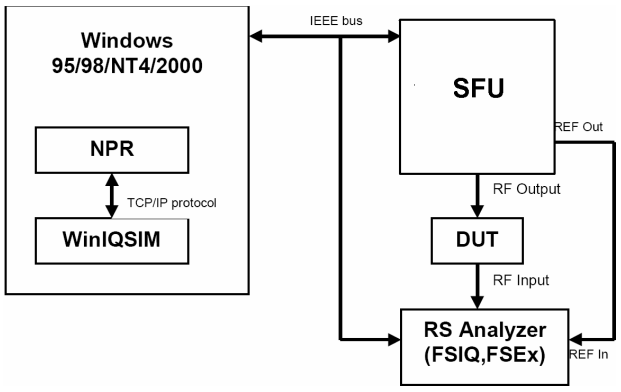


Fig. 23: R&S®NPR test setup

For more information, see the Rohde & Schwarz Application Note 1MA29_4E[2] at http://www.rohde-schwarz.com.

7 Application Example: R&S®WinIQSIM™ and R&S®SFU

GSM signal generation

One of the examples supplied with WinIQSIM will be used as an illustrative signal. Select "File – Open Settings":

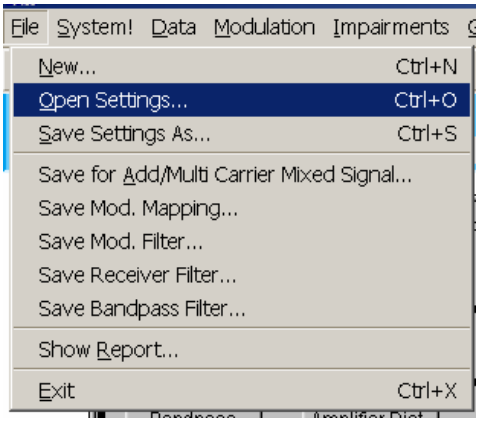


Fig. 24: Open Settings

In the window below, select the "\examples" directory in the applications folder. Select "gsm_slo1.iqs":

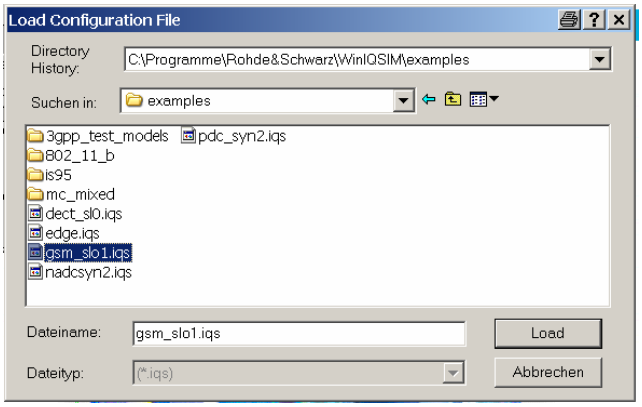


Fig. 25: Open dialog

The configuration for a GSM signal is now displayed in the block diagram.

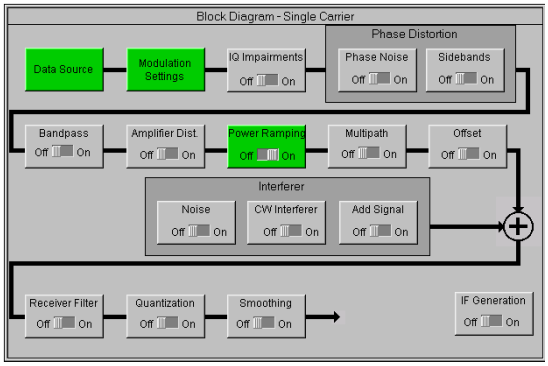


Fig. 26: Block diagram GSM signal

The simulation uses the following settings:

- Data source: example file “GSM_TSC1.DBI” for midamble modulation
- Modulation type: MSK
- Coding: GSM diff.
- Symbol rate: 270.833330 kHz
- Sequence length: 1250 symbols

Filter/Windowing:

- Filter: Gauss
- B*T: 0.30
- Window function: Rect
- Pulse length: 12
- Oversampling: Auto
- Baseband pulse: Rect

Power ramping (symbol/level): (0,-100), (155,0), (157,0), (305,-100), (313,-100), 469,-100), (625,-100), (782,-100), (938,-100), (1094,-100)

*.WV file generation

To transfer the ARB data from R&S®WinIQSIM™ to the R&S®SFU, the following procedure must be performed on R&S®WinIQSIM™ during the 1st step.

1. ARB selection window

After clicking ARB in the main menu, the “Select Target ARB…” menu item is used to select the arbitrary waveform generator:

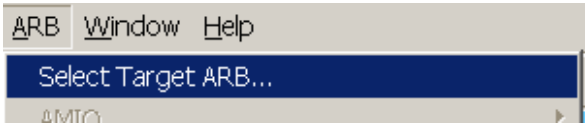


Fig. 27: ARB menu

2. R&S®SFU-K35 selection

Go to Target ARB and select the R&S®SFU option “SFU-K35”. Confirm with OK.

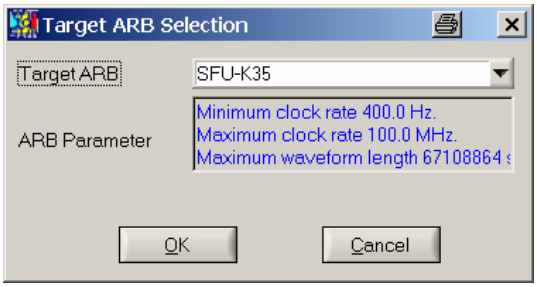


Fig. 28: Target ARB Selection

3. ARB transmission window

Click the ARB area in the main menu so that the submenu items SFU (ARB) and then Transmission can be selected.

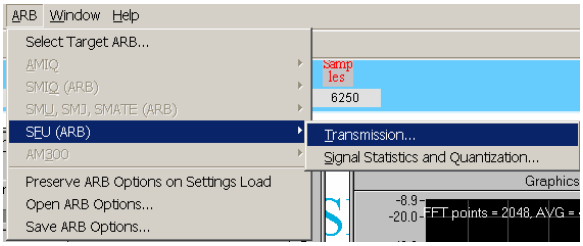


Fig. 29: ARB menu: “Transmission…”

4. ARB transfer specification

To start the generation of an *.WV file for the current R&S®WinIQSIM™ project, “Source” must be selected in “Internal (Win IQSIM)”.

If the file that has been created is to be saved, the storage location must be specified under “Destination” in the “File” or “SFU” menu item.

Note: The “SFU” option in the “Destination” area is available only if the instrument firmware version is 1.40 or later.

To create the ARB file, click Transmit.

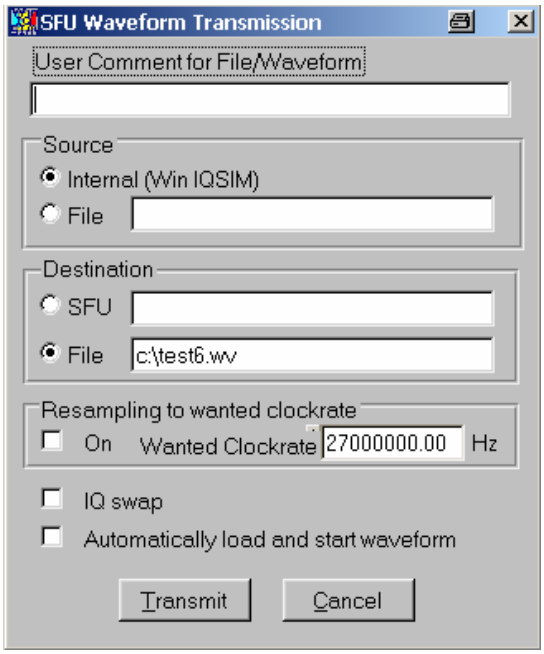


Fig. 30: SFU Waveform Transmission

Automatic transfer of the *.WV file to the R&S®SFU (I)

When you click the text box under (I), a data browser opens. This browser shows the folder structures and contents of R&S®SFU pages. The browser can be used to save R&S®WinIQSIM™ files.

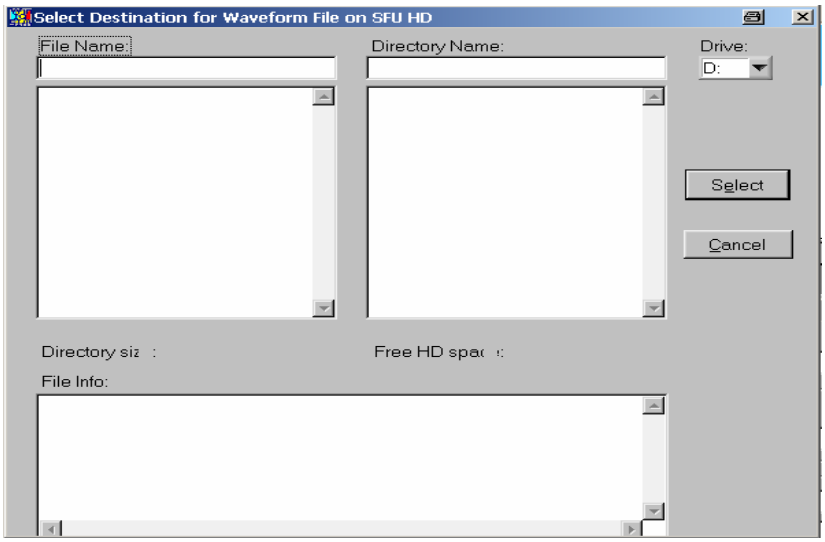


Fig. 31: Saving directly to the R&S®SFU

Manual transfer of the *.WV file to the R&S®SFU (II)

As mentioned some way above, automatic file transfer is not supported by R&S®SFU firmware versions below 1.40. This does not matter as *.WV files can still be transferred manually to the instrument's ARB generator.

Depending on the security context and the network environment, the appropriate alternative can be chosen from the list below.

USB stick

Copy the file from R&S®WinIQSIM™ to a USB memory stick. Use the stick to transfer the file via the R&S®SFU's USB port.

The R&S®WinIQSIM™ file can then be saved to the "D:\ARB\Waveforms" standard folder or to any other directory on the "D:\" drive.

FTP

An FTP server is installed as standard on the R&S®SFU. It can be started by entering “c:\program files\a-ftp”. The FTP server can also be used to transfer the file created by R&S®WinIQSIM™. The FTP client of the DOS command line is used for this example for reasons of availability.

1. Determining the R&S®SFU’s IP address

- Under the instrument’s operating system, select “Run” in the start menu.

Fig. 32: "Run..." start menu

- Enter “cmd” in the entry field and confirm with “OK”.

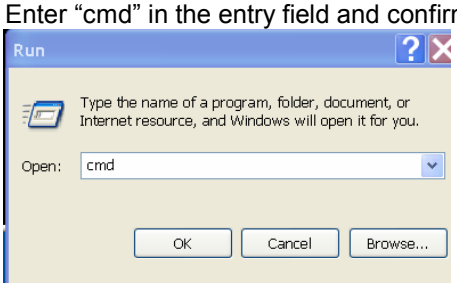


Fig. 33: Run dialog box

- Enter “ipconfig” in the DOS entry mask which now appears. Confirm with ENTER.

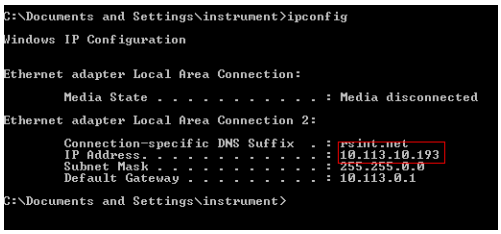


Fig. 34: Displaying the IP address

The IP address is outlined in red.

2. FTP connection on the client

- Enter “ftp” in the DOS command line. Confirm with ENTER.
- Enter “open”. Confirm with ENTER.

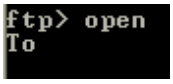


Fig. 35: FTP client

- The IP address obtained above can now be entered. In this example: 10.113.10.193
- When prompted to enter a user and password, do not enter anything; simply confirm with ENTER in each case.
- Select the FTP server directory:
  “cd d:\ARB\Waveforms”

```
ftp> cd d:\ARB\Waveforms
```

Fig. 36: Changing to the FTP directory

- When you enter “put” + <name of file to be transferred>, the file is copied to the current R&S®SFU directory.

```
ftp> put c:\test.txt
200 Command OK.
150 Connection for data test.txt.
226 File ok
FTP: 64d Bytes gesendet in 0,00Sekunden 69000,00KB/s
ftp>
```

Fig. 37: File transfer via FTP

- To terminate the FTP client, enter “quit” and confirm with ENTER.

Shared folders on the R&S®SFU

Alternatively, a folder or drive can be shared via Windows sharing.

1. Opening the sharing menu

Right mouse click the folder to be shared. Select “Sharing and Security”. In the window that appears, click the “Share this folder” item (“D:\ARB\WAVEFORMS”) in the “Sharing” index:

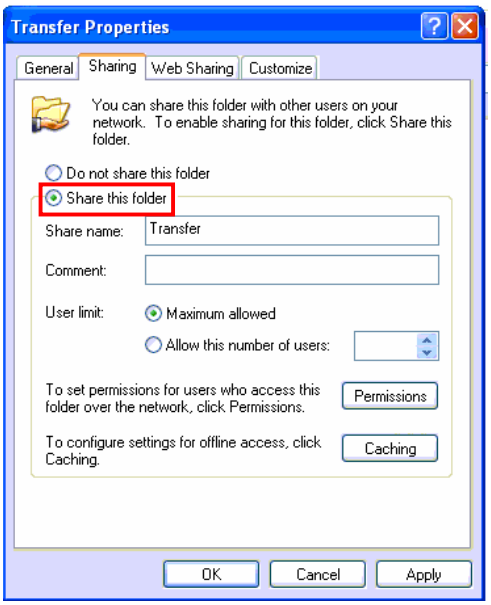


Fig. 38: Sharing menu

2. Setting permissions

Go to “Permissions”.

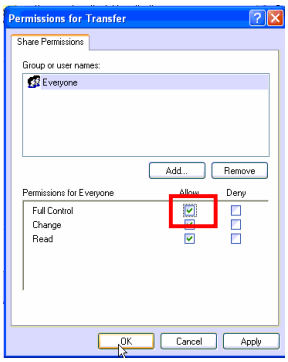


Fig. 39: Setting permissions

Select “Full Control” for “Everyone”. Close the current window and the sharing window with OK.

3. Accessing shared directories

By entering "\\<IP address>\<Shared folder >", this directory can be accessed from the computers in the network. Without the following user account/password, access will be denied:

User: "Instrument"

Password: "Instrument"

Replaying the *.WV file on the R&S®SFU

1. ARB selection window

The ARB interface can be selected by pressing <APPL> on the R&S®SFU .

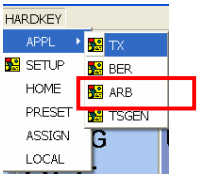


Fig. 40: Selecting the ARB application

2. ARB settings

Set the ARB to “ON”. Then click “LOAD WAVEFORM”.

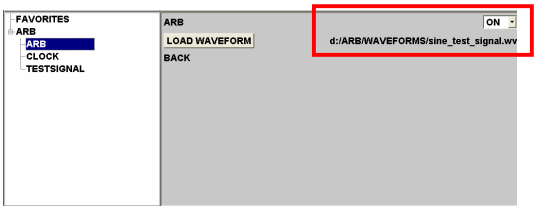


Fig. 41: ARB menu

3. Selecting the *.WV file

Select the directory you want and then the file you require. Confirm your selection.

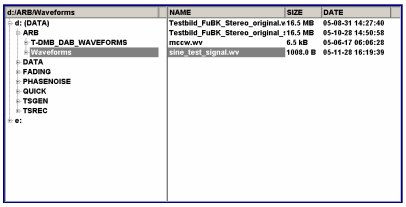


Fig. 42: Loading the waveform

4. Changing to the TX interface

By pressing <APPL> on the R&S®SFU, select the “TX” application.

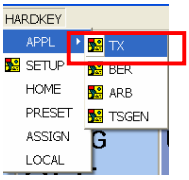


Fig. 43: TX application

5. Selecting the ARB generator as a signal source

Under “SIGNAL SOURCE”, select “ARB”. The ARB signal is then output with modulation on.

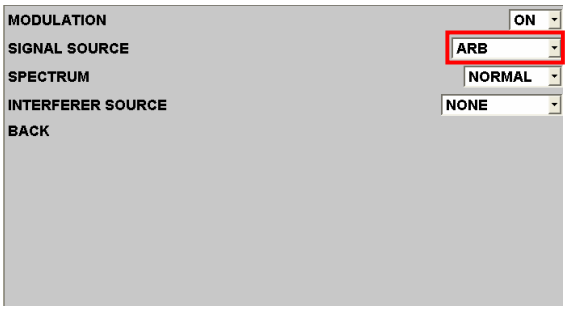


Fig. 44: Signal source selection

A GSM signal is now output at the RF output:

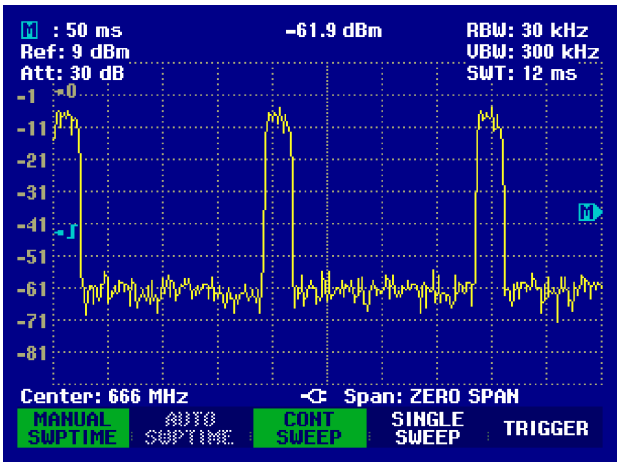


Fig. 45: GSM signal in the time domain

8 References

[1] Gerlach, Ottmar (2005). Application Note 1MA28_13E. I/Q Wizard. I/Q Signal Measurement & Conversion. Munich: Rohde & Schwarz GmbH & Co. KG website: http://www.rohde-schwarz.com.

[2] Gerlach, Ottmar (2001). Application Note 1MA29_4E. NPR – Noise Power Ratio. Signal Generation and Measurement. Munich: Rohde & Schwarz GmbH & Co. KG website: http://www.rohde-schwarz.com.

9 Additional Information

Our Application Note are regularly revised and updated. Check for any changes at http://www.rohde-schwarz.com.

Please send any comments or suggestions about this Application Note to Broadcasting-TM-Applications@rsd.rohde-schwarz.com

10 Ordering Information

Type	Designation	Order no.
R&S SFU	Broadcast Test System	2110.2500.02
R&S SFU-B1	Coder Extension 1	2110.7424.02
R&S SFU-B10	Coder Extension 10	2110.7747.02
R&S SFU-B11	ETI Input/Output	2110.7553.03
R&S SFU-B2	Coder Extension 2	2110.8089.02
R&S SFU-B3	Memory Extension 1	2110.7447.02
R&S SFU-B30	Fading Simulator	2110.7530.02
R&S SFU-B31	Fading Simulator Extension to 40 Paths	2110.7547.02
R&S SFU-B4	Memory Extension 2	2110.7453.02
R&S SFU-B5	User I/O	2110.7460.02
R&S SFU-B6	Additional Hard Disk	2110.7501.02/03
R&S SFU-B90	High Power and Overvoltage Protection	2110.8008.02
R&S SFU-K1	DVB-T/H Coder	2110.7301.02
R&S SFU-K10	MediaFLO Coder	2110.7524.02
R&S SFU-K108	AMC Coder	only on request
R&S SFU-K11	T-DMB/DAB Coder	2110.7518.02
R&S SFU-K120	DMB-TH Coder	2110.7760.02
R&S SFU-K190	ATV Standard B/G Coder	2110.8050.02
R&S SFU-K191	ATV Standard D/K Coder	2110.8037.02
R&S SFU-K192	ATV Standard I	2110.8043.02
R&S SFU-K193	ATV Standard M/N Coder	2110.8066.02
R&S SFU-K194	ATV Standard L Coder	2110.8072.02
R&S SFU-K199	Multi ATV Predefined	2110.8089.02
R&S SFU-K2	DVB-C Coder	2110.7324.02
R&S SFU-K20	TS Generator	2110.7476.02
R&S SFU-K21	TS Recorder	2110.7482.02
R&S SFU-K22	TRP Player	2110.7499.02
R&S SFU-K221	T-DMB/DAB Streams	2110.4348.02
R&S SFU-K23	Video Generator	2110.7799.02
R&S SFU-K3	DVB-S/DSNG Coder	2110.7330.02
R&S SFU-K30	Enhanced Fading	2110.7560.02
R&S SFU-K32	DAB Gaussian Fading	2110.7630.02
R&S SFU-K35	ARB Generator	2110.7601.02
R&S SFU-K351	T-DMB/DAB Waveforms	2110.4277.02
R&S SFU-K352	DVB-H Waveforms	2110.4425.02
R&S SFU-K353	DRM Waveforms	2110.4554.02
R&S SFU-K354	DTV Interferers	2110.4690.02
R&S SFU-K4	ATSC/8VSB Coder	2110.7353.02
R&S SFU-K42	Impulsive Noise	2110.7676.02
R&S SFU-K43	Multinoise Use	2110.7682.02
R&S SFU-K5	J.83/B Coder	2110.7360.02
R&S SFU-K6	ISDB-T Coder	2110.7376.02
R&S SFU-K60	BER Measurements	2110.7782.02
R&S SFU-K7	DMB-T Coder	2110.7382.02
R&S SFU-K8	DVB-S2 Coder	2110.7399.02
R&S SFU-K80	Extended I/Q	2110.7953.02
R&S SFU-K81	Realtime Disabled	2110.7960.02
R&S SFU-K82	Realtime Enabled	2110.7976.02
R&S SFU-K9	DIRECTV	2110.7401.02
R&S SFU-U43	Upgrade Kit for R&S SFU-K43	2110.7699.02
R&S DV-DVBH	DVB-H Stream Library	2085.8704.02
R&S DV-H264	H.264 Stream Library	2085.7650.02
R&S DV-HDTV	HDTV Sequences	2085.7650.02
R&S DV-ISDBT	ISDB-T Stream Library	2085.9146.02
R&S DV-TCM	Test Card M Streams	2085.7708.02

For additional information about measurement equipment, see the Rohde & Schwarz website www.rohde-schwarz.com

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