

# IQWizard IQ-Signal Measurement & Conversion

## Application Note

### Products:

- R&S®FSW
- R&S®FSVR
- R&S®FSV
- R&S®FSL
- R&S®IQR
- R&S®SMW200A
- R&S®SMBV100A
- R&S®PR100
- R&S®RTO

IQWizard is a tool for loading IQ signal files in various formats and measuring IQ signals with a R&S® spectrum- or network analyzer, test receiver or oscilloscope. The obtained IQ data in memory can be stored in various formats or be transmitted to an R&S® vector signal generator with WinIQSIM™ or WinIQSIM2™.

### Note:

Please find the most up-to-date document on our homepage <http://www.rohde-schwarz.com/appnote/1MA28>.

This document is complemented by software. The software may be updated even if the version of the document remains unchanged

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# 1 Overview

IQWizard is a software tool for loading IQ data files in various formats or measuring IQ signals with a R&S®FSW, R&S®FSVR or R&S®FSL analyzer, R&S®ZVL Vector Network Analyzer, R&S®ETL TV Analyzer or R&S®RTO Digital Oscilloscope. The IQ data may be stored various file formats for further processing with signal analysis, simulation and generation tools such as MathCAD, MatLab and ADS. IQWizard also offers a TCP/IP interface for transmission of the IQ data to WinIQSIM/WinIQSIM2, which can manipulate the data and upload it to an R&S®SMW200A, R&S®SMBV.

The following abbreviations are used in the following text for R&S® test equipment (some products are discontinued, but are mentioned because they are supported by IQWizard):

- The R&S®FSIQ, R&S®FSP, R&S®FSU, R&S®FSQ, R&S®FSL, R&S®FSG, R&S®FSV, R&S®FSVR and R&S®FSW spectrum analyzers are referred to as FSIQ, FSP, FSU, FSQ, FSL, FSG, FSV, FSVR and FSW.
- The R&S®FSUP signal source analyzer is referred to as FSUP.
- The R&S®ESW, R&S®ESPI, R&S®ESU, R&S®ESCI, R&S®ESR and R&S®FSMR test receivers are referred to as ESW, ESPI, ESU, ESCI, ESR and FSMR.
- The R&S®IQR20 and R&S®IQR100 IQ Recorders are referred to as IQR.
- The R&S®ZVL Vector Network Analyzer is referred to as ZVL.
- The R&S®ETL TV Analyzer is referred to as ETL.
- The R&S®PR100 Portable Monitoring Receiver is referred to as PR100.
- The R&S®RTO Digital Oscilloscope is referred to as RTO.
- The R&S®AMU200A and R&S®AMIQ IQ I/Q Modulation Generator are referred to as AMU and AMIQ.
- The R&S®SMW200A Vector Signal Generator is referred to as SMW.
- The R&S®SMU200A Vector Signal Generator is referred to as SMU.
- The R&S®SMJ100A Vector Signal Generator is referred to as SMJ.
- The R&S®SMBV100A Vector Signal Generator is referred to as SMBV.
- R&S® means Rohde & Schwarz GmbH und Co KG

## 2 Hardware and Software Requirements

IQWizard features:

- IQ trace with various R&S® spectrum analyzers, signal source analyzers and test receivers via RF, analog and digital input.
- TCP/IP interface to WinIQSIM / WinIQSIM2™ using one or two separate computers
- Load and save program and device configuration
- Load IQ data in various file formats
- Save IQ data in various file formats
- Store I/Q data up to 5.6 GBytes

### 2.1 Connecting the Computer to the Instrument(s)

You may connect the computer running IQWizard directly to the instrument with a GPIB or LAN cable or establish the connection via Ethernet switch connected to DHCP server.

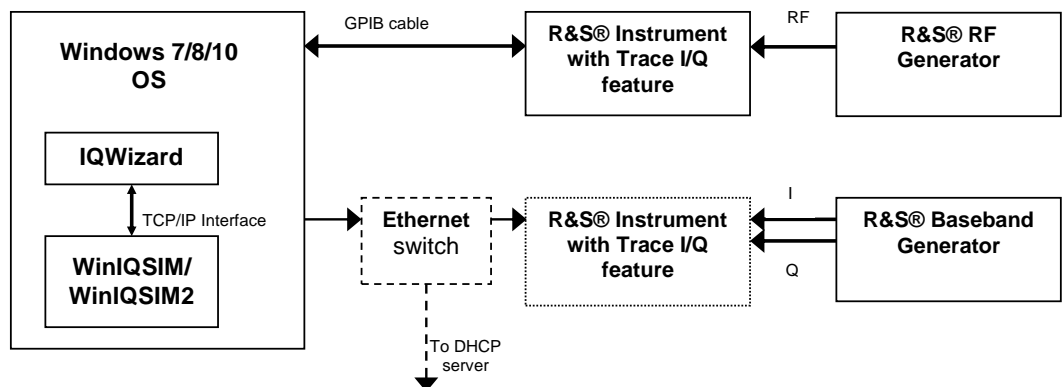


Fig. 2-1: Connecting Instruments

## 2.2 Software Requirements

<b>Windows 7/8/10</b> 32- or 64-Bit Microsoft operating system	
NI-488.2 v15.0 (or above)	IEC/IEEE – bus driver from National Instruments.
NI-VISA v15.0 (or above)	VISA driver from National Instruments.
R&S VISA 5.5.4 (or above)	VISA driver from Rohde & Schwarz
or Agilent I/O Library	GPIO + VISA driver from Agilent
WinIQSIM2 2.xx (or above) (also compatible to WinIQSim v4.4)	This is a software tool capable of receiving IQ data via TCP/IP software interface and calculating and transferring it to an R&S® I/Q modulation generator. IQWizard and WinIQSim or WinIQSIM2 must run simultaneously to enable data transfer. Download latest WinIQSim version from <a href="http://www.rohde-schwarz.com">http://www.rohde-schwarz.com</a> .
<b>Mac OS X 10.x operating system</b>	
NI-488.2 v15.0 (or above)	IEC/IEEE – bus driver from National Instruments.
NI-VISA v15.0 (or above)	VISA driver from National Instruments.
R&S VISA 5.5.4 (or above)	VISA driver from Rohde & Schwarz
or Agilent I/O Library	GPIO + VISA driver from Agilent

## 2.3 Installing the Software

For Windows 7/8/10 execute **1MA028\_IQWIZARD32\_60X.EXE** (32 bit) or **1MA028\_IQWIZARD64\_60X.EXE** (64 bit) that can be downloaded from <http://www.rohde-schwarz.com/appnote/1MA28.html>. The installer uninstalls previous IQWizard versions if present. For MacOSX operating systems use **1MA028\_IQWIZARDMc\_60X.DMG**.

### 3 Starting the Software / Measurement

After executing **IQWIZARD32.EXE** or **IQWIZARD64.EXE** the program will come up with following or similar (depending on **IQWIZARD.CFG** configuration file) start window.

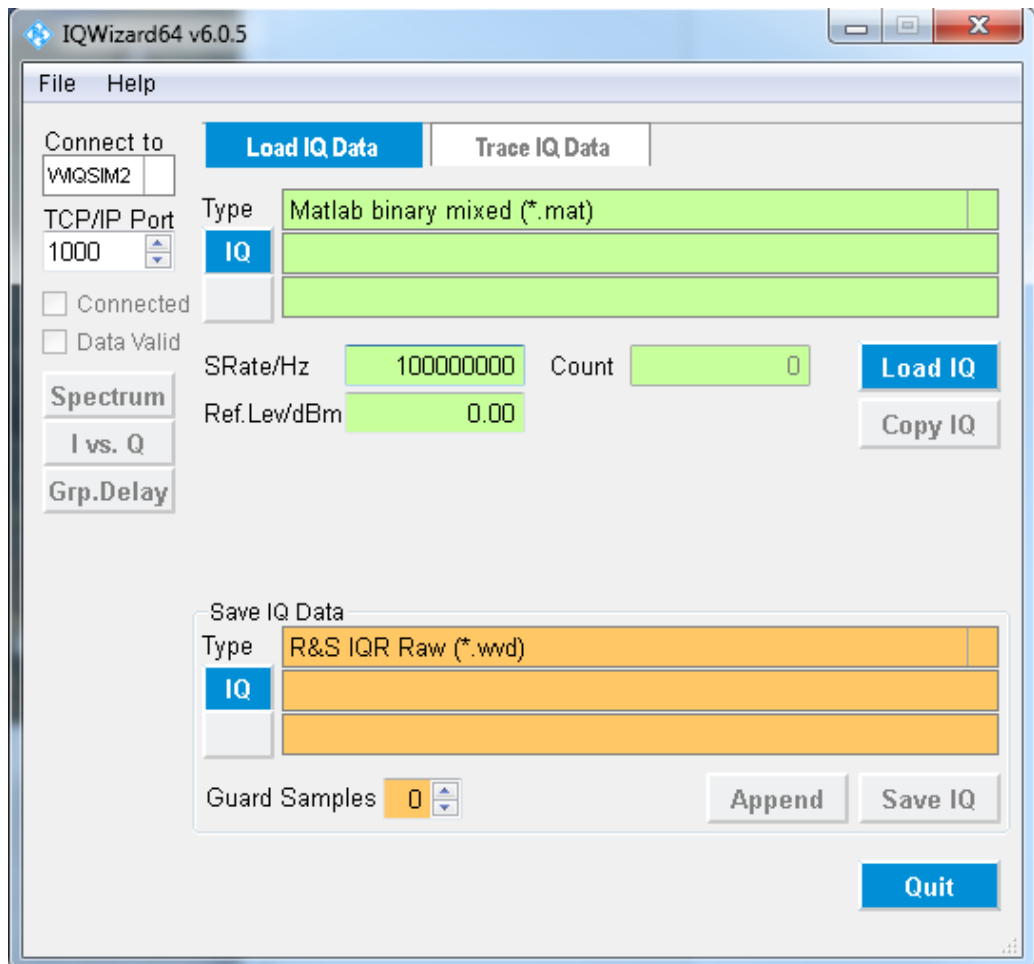


Fig. 3-1: IQWizard with file as IQ source

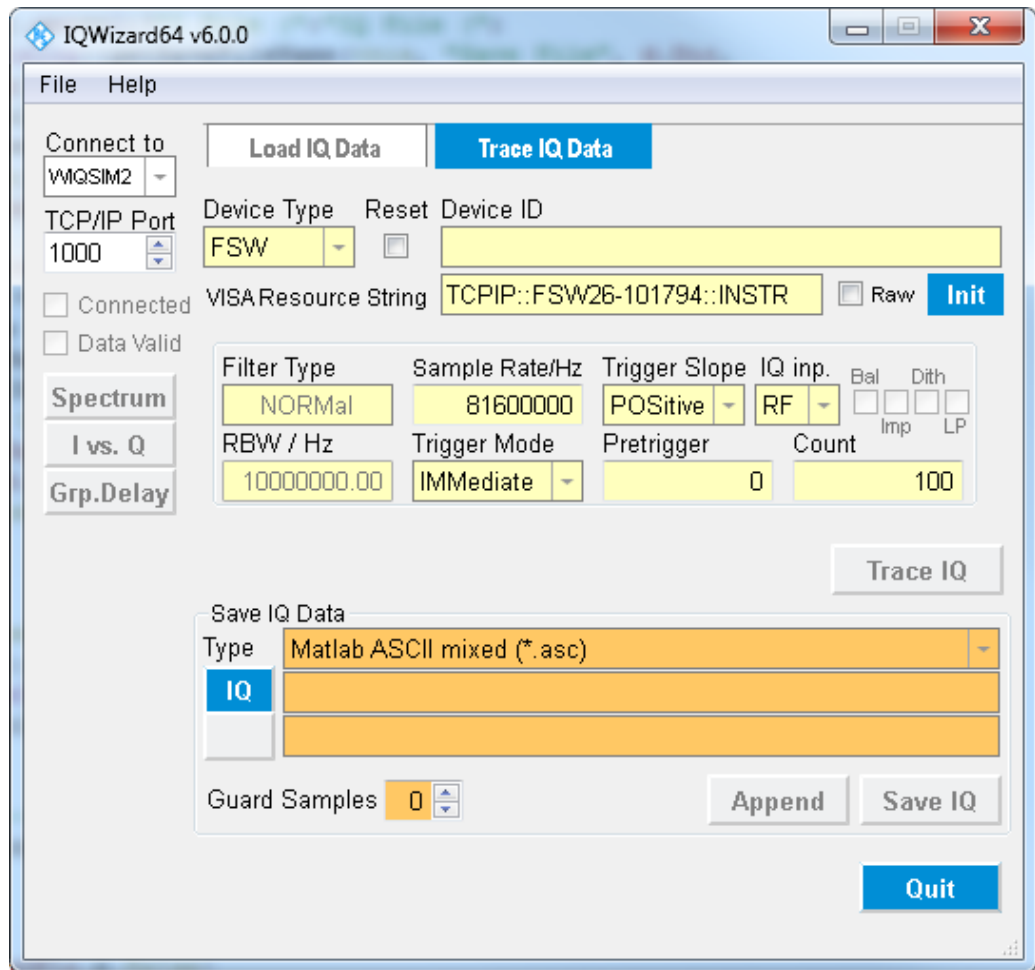


Fig. 3-2: IQWizard with spectrum analyzer as IQ source

- **IQ SOURCE** – IQ data can be loaded from a file (Fig. 3-1) or traced with a spectrum analyzer FSx, test receiver ESx and network analyzer ZVx with spectrum analyzer mode or oscilloscope RTO (Fig. 3-2) or can be loaded from a file with various formats.
- **TCP/IP PORT** – specifies the port number for connecting to WinIQSIM via TCP/IP transfer.
- **CONNECTED** – Checked when link to WinIQSIM is active.
- **DATA VALID** – Checked when valid IQ data traced from an analyzer or read from a file is stored in memory.

## 3.1 Menu

### 3.1.1 File

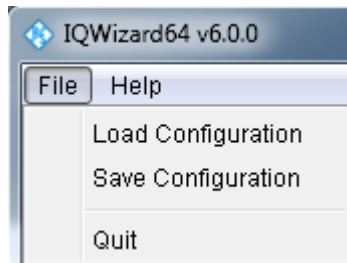


Fig. 3-3: File Menu

### 3.1.2 Load IQ Data

Select the **LOAD IQ DATA** tab to read IQ data from various input file formats into memory and turns active when IQ Source is set to File.

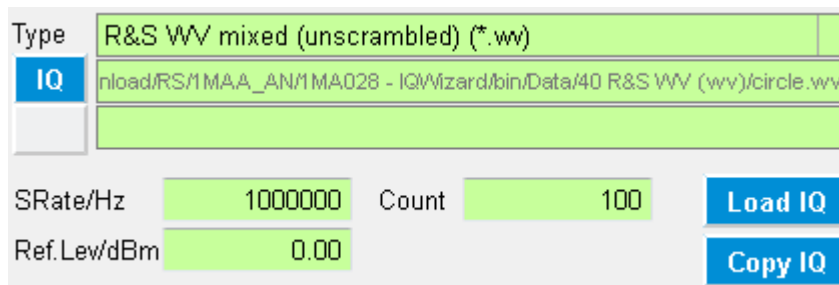


Fig. 3-4: Load IQ Data

#### TYPE

Specifies the file type to load IQ data from. From the 34 possible selections some are shown in the figure below.

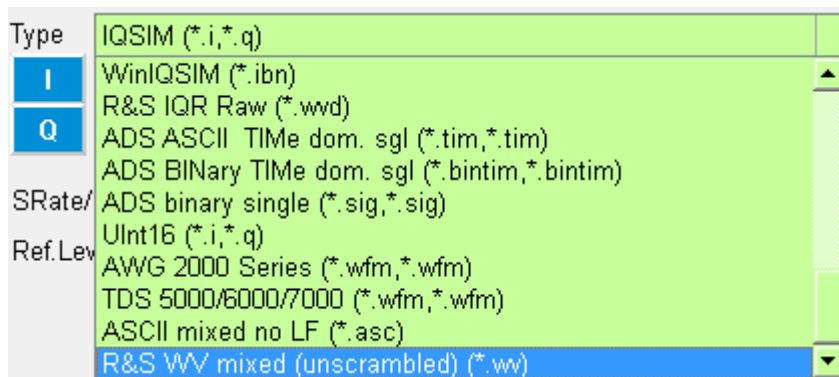


Fig. 3-5: Load IQ File Type



**COPY**

This button allows to become active when **LOAD TYPE WAV MIXED (\*.wav)**, **R&S IQR RAW (\*.wvd)** or **R&S WV (\*.vv)** **and** **Save Type WAV Mixed. R&S IQR Raw** or **R&S VW** are selected. It allows to copy files that cannot be loaded into PC memory due to their size.

- **MatLab Single / IQSim (\*.i, \*.q)** – each file contains n number of rows (= sample count) with values ranging from -1.0 to + 1.0:

```
-1.000000
-0.998123
0.500000
....
```

- **MatLab Binary Mixed (\*.mat)** – file format. The file should contain 2 differently named 32-bit float arrays (i.e. "I" and "Q"). Following C - example code shows how to generate a \*.mat file with MatLAB functions. The C-compiler needs the MATLAB import libraries **LIBMAT.LIB** and **LIBMX.LIB**.

```
#include "mat.h"
#include "matrix.h"
#include "tmwtypes.h"

#define N 1024

Int main(int argc, char *argv[]);
{
    char FNam[256]="C:\MatLabMixed.mat";
    float Iarr[N], Qarr[N];

    MATFile *f;
    mxArray *p;
    mwSize ndim=1, dims[1];

    dims[0]=N;
    p = mxCreateNumericArray (ndim, dims, mxSINGLE_CLASS, mxREAL);
    f = matOpen (d.INam, "w");
    memcpy (mxGetData (p), Iarr, N * sizeof (float));
    matPutVariable (f, "I", p);
    memcpy (mxGetData (p), Qarr, N * sizeof (float));
    matPutVariable (f, "Q", p);
    matClose (f);
    mxDestroyArray (p);
    return 0;
}
```

Note: When generating \*.mat files from the MATLAB environment, use

```
save(filename, '-v6', 'I', 'Q');
```

to avoid compatibility issues.

- MathCAD / COSSAP** single (\*.i, \*.q) – have a dynamic format; integer, float and exponential format; up to 199 characters per line; comment starts with %.

```
1.0 2 3.0 4e0 5e0 6.00000 % Yeah Yeah 1.3
7.0 8 9.0 1e1 1.10e1 12.00000 % No No 1.7
.....
```

- MathCAD / COSSAP** mixed (\*.dat) – same as single, only that consecutive values are an i- and q- pair so the value count must always be even.

```
DaDisp single (*.i, *.q)
DATASET i
VERSION NEXT
NUM SIGS 1
STORAGE MODE INTERLACED
SIGNAL i
DATE 11-29-2000
TIME 14:49:26
INTERVAL 1.000000E+02
VERT_UNITS volt
HORZ_UNITS sec
COMMENT
DATA
1.0000000
2.0000000
3.0000000
4.0000000
.....
```

- DADISP MIXED** (\*.dsp)

```
DATASET i_q
VERSION NEXT
NUM SIGS 2
STORAGE MODE INTERLACED
SIGNAL i, q
DATE 12-27-2000
TIME 14:23:59
INTERVAL 1.000000E-06
VERT_UNITS volt
HORZ_UNITS sec
COMMENT
DATA
0.000000e+00 0.000000e+00
6.278100e-02 0.000000e+00
1.253130e-01 0.000000e+00
1.873750e-01 0.000000e+00
.....
```

- **SPW ASCII single** (\*.ascsig, \*.ascsig) – uses the extension \*.ascsig for i- and q-data files. It is convenient to place this information in the file name, i.e. circle\_i.ascsig.

```

$SIGNAL_FILE 9
$USER_COMMENT

$COMMON_INFO
SPW Version   = 4.70
System Type   = solaris2
Sampling Frequency = 65536000.0
Starting Time = 0.0
$DATA_INFO
Number of points = 20480
Signal Type     = Double
$DATA
0.00427246
0.00476074
0.00299072
.....

```

- **SPW ASCII MIXED** (\*.ascsig)

```

$SIGNAL_FILE 9
$USER_COMMENT

$COMMON_INFO
SPW Version   = 4.70
System Type   = solaris2
Sampling Frequency = 65536000.0
Starting Time = 0
$DATA_INFO
Number of points = 20480
Signal Type     = Double
Complex Format   = Real_Imag
$DATA
0.00427246+j0.06279034
0.00476074-j0.24868988
0.00299072+j0.53582679
.....

```

- SPW BINARY MIXED (\*.sig)**  
 \$SIGNAL\_FILE 9  
 \$USER\_COMMENT  
  
 \$COMMON\_INFO  
 SPW Version = 4.70  
 System Type = solaris2  
 Sampling Frequency = 65536000.0  
 Starting Time = 0  
 \$DATA\_INFO  
 Number of points = 20480  
 Signal Type = Double  
 Complex Format = Real\_Imag  
 \$DATA  
 <I0 64-bit REAL><Q0 64-bit REAL><I1 64-bit REAL> <Q1 64-bit REAL><I2 64-bit REAL><Q2 64-bit REAL><I3 64-bit REAL> <Q3 64-bit REAL>.....  
 ADS ASCII TIME domain Single (\*.tim, \*.tim)  
 BEGIN TIMEDATA  
 # T ( SEC V R xx)  
 % t v  
 <data line>  
 ...  
 <data line>  
 END
- ADS BINARY TIME DOMAIN SINGLE (\*.bintim, \*.bintim)**  
 NUMBER OF DATA XX1  
 BEGIN TIMEDATA  
 # T ( SEC V R XX)  
 % T V  
 <binary data block>
- ADS ASCII SINGLE (\*.ascsig, \*.ascsig)** – see SPW ASCII single
- ADS BINARY SINGLE (\*.sig, \*.sig)** – same as SPW binary mixed, except that instead of <I0><Q0><I1><Q1>...<In><Qn> the data is stored as <I0><I1>...<In> or <Q0><Q1>...<Qn>.
- WAV MIXED (\*.wav)** – binary audio file format, accepts 8- or 16-bit stereo format.
- WAV SINGLE (\*.wav, \*.wav)** – binary audio file format, accepts 8- or 16-bit mono format.
- LECROY (\*.trc)** – binary 8 or 16-bit format containing 2 channels generated with LeCroy's general oscilloscope controlling software Scope Explorer™ available at <http://www.lecroy.com>.
- DAB-K1 (\*.sym)** – binary file format. DAB-K1 is a software for generation of various DAB and DVB signals for spectrum evaluation. DAB-K1 is available at <http://www.rohde-schwarz.com>.

- UINT16** (\*.i, \*.q) – 16-Bit format ranging from 1 to 65535 (0 is internally converted to 1). This format especially supports the AMIQ’s digital IQ output (option AMIQ-B3). Transmitting this format to an AMIQ requires following WinIQSIM configuration (Demo16Bit.iqs):

Import Filter Function	None
AMIQ -> Signal Stat.and Quant	Use Peak Value: OFF Level: 32767.0000 Resolution: 16 Bit
AMIQ Transmission	Comp.Output Signal for sin(x)/x Dist.: OFF

- AWG 2000** (\*.wmf, \*.wmf) – format for Tektronix AWG2000 series arbitrary waveform generators containing frequency and amplitude information in the header. The 12 bit I- and Q-values (0...4095) are normalized to ± amplitude. Wmf demo files are available at <http://www.tektronix.com>.
- TDS 5000 / 6000 / 7000** – Tektronix TDS 5000 / 6000 / 7000 series digital sampling oscilloscopes WFM file format.
- IQW** (\*.iqw) – 4-byte binary float format with alternating I- and Q- values.  
 N = Number of elements = FileSize / 4 (float) / 2 (I & Q)  
 I1,Q1,I2,Q2,...,IN,QN  
 IQW Block Data (\*.iqw) – Same as IQW but with I and Q data blocks.  
 I1,I2,...,IN,Q1,Q2,...,QN  
 ASCII no LF – Alternating I- and Q- ASCII values separated by spaces.
- HEX 16-BIT SIGNED MIXED** – Alternating I- and Q- 16-Bit Hexadecimal values separated by spaces or tabs. The values range from 0 to 0x7FFF → 0.0 to +1.0 and 0x8000 to 0xFFFF → -1.0 to 0.0.

```

0x0000      0xFFFF
0x7FFF      0x8000
0x4000      0xC000
....      ....
  
```

is converted and normalized to

```

+0.00000-0.00000
+1.00000-1.00000
+0.50000-0.50000
....      ....
  
```

When a mixed file type (contains I and Q values) is selected the Q selection button and file name line are dimmed.

- WINIQSIM (\*.ibn)** – This is a mixed (I & Q data) binary file format. \*.ibn files generated with WinIQSIM cannot be loaded into IQWizard because the data is scrambled.

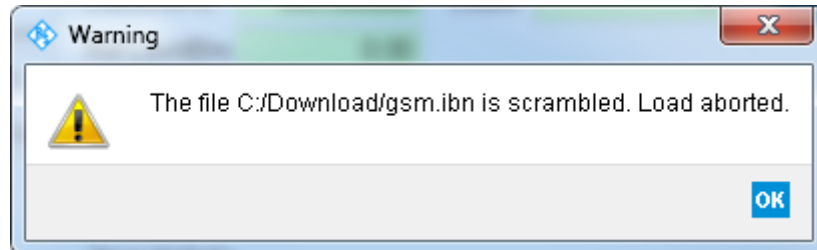


Figure 3-1: Scrambled warning

- PR100 (\*.riq)** – This is a mixed (I & Q data) 16-bit file format generated by the PR100 Portable Monitoring Receiver.  
 <Header 84-bytes><i0 16-bytes><q0 16-bytes><...><...><in><qn>
- R&S WV (\*.wv)** – Unscrambled arbitrary waveform format compatible with all contemporary R&S SMx generators. It contains an ASCII header part and sample count \* I/Q pairs with 16-bit each. See SMW, SMU etc. manual for more details. A warning will pop up in case the file is scrambled (generated with R&S®SMx generator, WinIQSIM or ARB Toolbox).

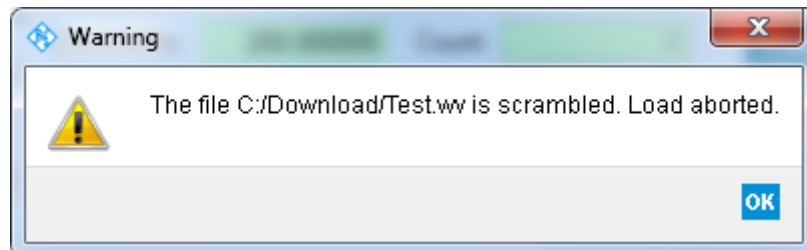


Fig. 3-6: Scramble warning

- R&S IQR RAW (\*.wvd)** – The IQR IQ Recorder can export streamed IQ data to a \*.wvd file on an external USB hard drive, which contains 16-bit binary complementary values. When selected, IQWizard also opens the according \*.wvh (header) file, reads the sample rate and reference level from it and updates the associated **SAMPLE RATE** and **REFLEVEL** controls. If no \*.wvh file is present the sample rate and reference level will not be changed. When IQ data is saved to a \*.wvd (data), a \*.wvh (header) file is additionally created.

I

Starts file load popup with predefined extension (see figure below).

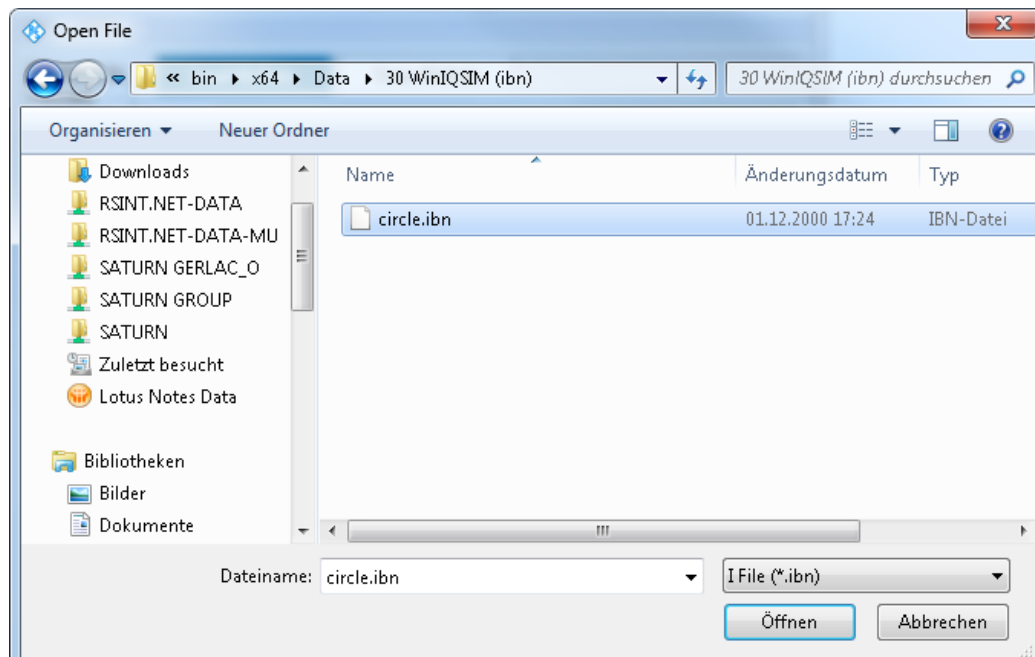


Figure 3-2: Select File

Q

Same as I.

### Load IQ

After necessary files have been selected this button is undimmed and by pressing it the IQ data is loaded from file into memory. When successful, the **DATA VALID** checkbox is turned ON.

*Note:* To avoid an endless loop in case of an incorrect input format for WinIQSIM, SPW and ADS both the Status and Load window allow to abort the load operation with the Abort key, <Alt>A or ESC.

### 3.1.3 Trace IQ Data

IQWizard converts the absolute IQ data provided by the analyzer into relative IQ values corresponding to the analyzer's grid maximum ( $UIQ_{peak} \triangleq 1.00$  at reference level). WinIQSim displays 0dB when the IQ value is equal to the reference level (1.00). Following conversion must be performed manually obtain the absolute level P/dBm.

$$P / dBm = refllevel + 20 * \log\left(\frac{UIqpeak}{1V}\right)$$

Example:  
RefLevel = -10dBm  
UIQpeak = 100mV

$$P = -10dBm + 20 * \log\left(\frac{0.1V}{1V}\right) = -30dBm$$



### 3.1.3.1 FSIQ

The picture below shows the control window for tracing IQ data with an FSIQ with B70 option. It pops up when IQ Source is set to Analyzer and Device Type is set to FSIQ.

Fig. 3-7: Trace IQ FSIQ

- **Device Type** – specifies the analyzer used. Possible selections: FSIQ, FSP, FSU, FSQ, FSG, FSL/ETL/ZVL, ESU, ESPI, ESCI, FSMR, FSUP and RTO.
- **Reset** – Additionally performs an instrument reset ( SCPI command “\*RST”) when **Init** is pressed.
- **VISA Resource String** – sets interface type, address and controller number.  
<Interface>::<Address>::INSTR
  - Interface: TCPIP (LAN), GPIB or GPIB<GPIB controller No> (GPIB), ASRL<Serial interface No>
  - Address: GPIB: 1 to 31, LAN: IP address e.g. 192.168.1.1 or computer name e.g. FSW26-101794 (requires DHCP to be turned ON).
- **Raw** – When OFF the IQ values referenced to the analyzers reference level which shows the correct spectrum level display in WinIQSIM.
- **Init** – Initializes the device and displays its ID in the Device Message box.
- **Data Type** – Always RAW.
- **Resolution BW** – Always 8 MHz.
- **Sample Rate** – specifies the rate in which IQ data is sampled simultaneously. Range: 40 kHz to 32 MHz.
- **Trigger Mode** – selects trigger source to initiate an IQ trace. Possible selections: IMMediate, EXTernal, VIDEo.
- **Trigger Slope** – selects trigger signal slope of EXTernal and VIDEo trigger. Always POSitive.
- **TRIGGER OFFSET** – delay between trigger and start of measurement. A negative value means that the first couple of IQ samples have been taken before the trigger event. Range: -590  $\mu$ s to 2.5ms.

- **RECORD LENGTH** – time period of data trace. Range: 1µs to 20.4ms.
- **COUNT** – is limited to 524200 and in case it is exceeded a foldback of the Record Length takes place. It is calculated as follows:

$$\text{Count} = \text{Sample Rate} * \text{Record Length}$$

- **TRACE IQ** – starts measurement.

### 3.1.3.2 FSP / FSU / ESPI / ESCI / ESR / FSMR

Device Type: FSP    Reset:     Device ID: Rohde&Schwarz,FSP-7,100034/007,4.50

VISA Resource String: TCPIP::RSFSP7100034::INSTR    Raw:     Init:

Filter Type: NORMal    Sample Rate/Hz: 32M    Trigger Slope: POSitive    IQ inp.: RF

RBW / Hz: 10M    Trigger Mode: IMMEDIATE    Pretrigger: 0    Count: 130560

Bal:     Dith:     Imp:     LP:

Trace IQ:

Fig. 3-8: Trace IQ Data FSP

- **DEVICE TYPE, RESET, VISA RESOURCE STRING, RAW, TEST DEVICE, WINDOW TYPE, TRACE IQ** see FSIQ.
- **FILTER TYPE** – Always NORM
- **RESOLUTION BANDWIDTH** – Possible selections are 300 kHz, 1 MHz, 3 MHz or 10 MHz for FSP and additionally 20 MHz and 50 MHz for the FSU, ESPI, ESCI and FSMR.

*Note:* In this particular case the Resolution Bandwidth is the maximum traceable bandwidth and not the smallest frequency resolution.

- **SAMPLE RATE** – possible selections are 15.625 kHz, 31.25 kHz, 62.5 kHz, 125 kHz, 250 kHz, 500 kHz, 1 MHz, 2 MHz, 4 MHz, 8 MHz, 16 MHz or 32 MHz for FSP, FSU and ESPI. 10 kHz for the ESCI and FSMR.
- **TRIGGER MODE** – possible selections are IMMEDIATE or EXTERNAL.
- **TRIGGER SLOPE** – constantly set to POSITIVE.
- **PRETRIG. SAMPLES** – number of samples taken before trigger event. Range 0 to 65023.
- **COUNT** – maximum sample count. Range 1 to 130560 ( $2^{17} - 512$ ) for the FSP and ESPI, 1 to 523776 ( $2^{19} - 512$ ) for the FSU, ESCI and FSMR.

*Note:* If both RSVISA and NI-VISA are installed on your PC it is necessary to make sure that **TCPIP0::INSTR** is set to R&S VISA in **RsVISAConfigure** in order to communicate via LAN with Windows NT based instruments, e.g. 1<sup>st</sup> generation FSP models.



Fig. 3-9: RsVisaConfigure Conflict Manager

In IQWizard use the prefix **RSIB** instead of TCPIP in the VISA resource string.

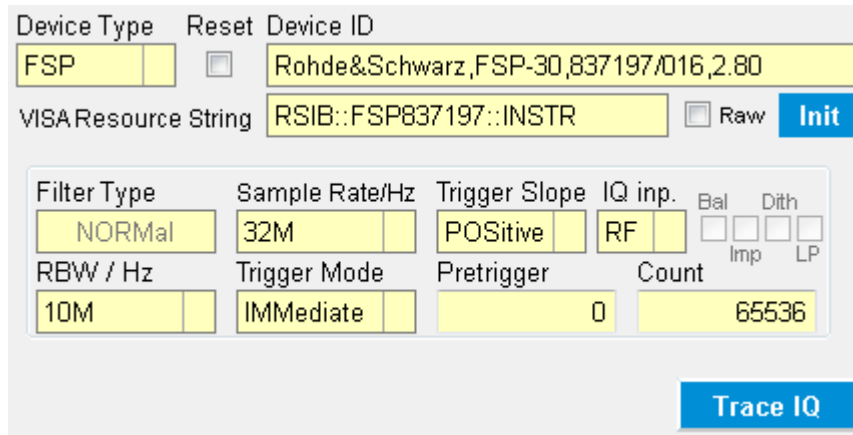


Fig. 3-10: LAN communication with Windows NT based instruments.

### 3.1.3.3 FSW / FSV / FSVR / FSG / FSQ / ESU / FSUP

The screenshot shows the configuration window for the FSW instrument. At the top, there are fields for 'Device Type' (set to FSW), 'Reset' (checkbox), and 'Device ID' (varz,FSW-26,1312.8000K26/101794,2.40 34 Beta). Below this is the 'VISA Resource String' (TCPIP::FSW26-101794::INSTR) and a 'Raw' checkbox. A large blue 'Init' button is on the right. The main configuration area is divided into several sections: 'Filter Type' (NORMal), 'Sample Rate/Hz' (81600000), 'Trigger Slope' (POSitive), and 'IQ inp.' (RF). There are also checkboxes for 'Bal', 'Dith', 'Imp', and 'LP'. Below these are 'RBW / Hz' (10000000.00), 'Trigger Mode' (IMMEDIATE), 'Pretrigger' (0), and 'Count' (100). A large blue 'Trace IQ' button is at the bottom right.

Fig. 3-11: Trace IQ Data FSW

- **DEVICE TYPE, RESET, VISA RESOURCE STRING, RAW, TEST DEVICE, TRACE IQ** see FSIQ.
- **FILTER TYPE** – Always set to NORM.
- **RESOLUTION BANDWIDTH** – Possible selections are 300 kHz / 1 MHz / 3 MHz / 10 MHz / 20 MHz / 50 MHz / 120 MHz (with FSQ-B72). The FSV has a maximum resolution bandwidth of 28 MHz without and 40 MHz with FSV-B70 (IQ bandwidth extension) option. The FSW has a maximum resolution bandwidth of 28 MHz with FSW-B28, 40 MHz with FSW-B40, 80 MHz with FSW-B80 and 160 MHz with FSW-B160 IQ bandwidth extension which is set in the instrument and not in IQWizard. With FSV and FSVR the resolution bandwidth is also set on the instrument and displayed in the Resolution BW indicator.
 

*Note:* In this particular case the Resolution Bandwidth is the maximum traceable bandwidth and not the smallest frequency resolution.
- **SAMPLE RATE** – Range 10 kHz to 81.6 MHz. The FSQ can sample up to 326.4 MHz with the FSQ-B72 bandwidth extension. The FSV has a maximum sample rate of 45 MHz without and 128 MHz with FSV-B70 option. The FSW has a sample rate range of 100 Hz to 200 MHz.
- **TRIGGER MODE, TRIGGER SLOPE, PRETRIG. SAMPLES** – see FSP/FSU/ ESPI/ESU. You can select IMMEDIATE, EXTernal, EXT2, EXT3, IFPower Trigger Mode and POSitive and NEGative Trigger Slope with the FSW. The FSV has -209715199 to 209715199 , and the FSW 0 to 461373339 pre-trigger samples.
- **COUNT** – maximum sample count. Range 1 to 16776704 (224 – 512), 1 to 704642560 (704643072 – 512) with FSQ-B100 + FSQ-B102, 1 to 209715200 with FSV and 1 to 461373339 with FSW.

*Note:* If the used memory exceeds the PCs free memory, an according error message “Insufficient Memory” pops up. Windows XP/Vista/7 with 32 bit can allocate up to 2 GB and Windows 7 64 bit up to 128 GB (!). The FSQ can have up to 705 MSamples IQ data memory which will need  $705 \text{ MS} \cdot 8 (2 \cdot 4 \text{ bit float}) = 5.64 \text{ GS}$  memory in the PC.

- **IQ INP** – Select from RF, AIQ analog baseband input (only FSQ with B71 option) and DIQ digital baseband input (only FSQ or FSG with FSQ-B17 option).

When AIQ is selected a window pops up for setting the IQ Range (31.6 mV to 5.62 V or 31.6 mV to 1.78V with Impedance = 1M $\Omega$ ) and Offset (range: -200 to +200 dB).

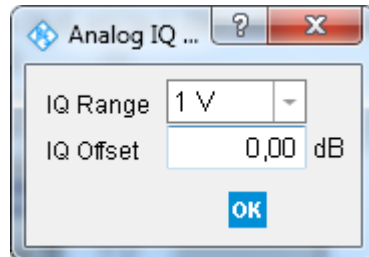


Figure 3-3: Analog Input Parameters

When DIQ is selected a window pops up for setting Range (U<sub>peak</sub>) and digital Sample Rate (range: 0.000001 to 81.6 MHz).

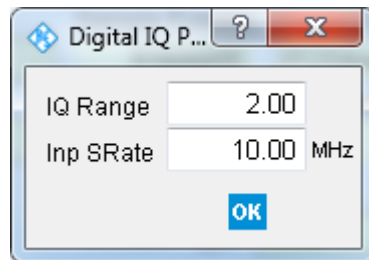


Figure 3-4: Digital IQ Parameters

Note: The R&S®EX-IQ-BOX allows the connection of various digital I/O interfaces to an FSQ and FSG with FSQ-B17 option.

- **BAL** – Baseband input balanced = ON, unbalanced = OFF (only FSQ with B71 option). Available when **IQ INP = AIQ**.
- **IMP** – Input impedance of baseband inputs. OFF = impedance 50  $\Omega$ , ON = impedance high Z (only FSQ with B71 option). Available when **IQ INP = AIQ**.
- **DITH** – Dithering ON/OFF (only FSQ with B71 option). Available when **IQ INP = AIQ**.
- **LP** – Baseband input anti-aliasing low pass ON/OFF (only FSQ with B71 option).

Note: When pressing **TRACE IQ** the instrument will change to spectrum analyzer mode.

## 3.1.3.4 FSL / ETL / ZVL

Device Type	Reset	Device ID	
FSL/ETL/	<input type="checkbox"/>	phde&Schwarz,ZVL-6,1303.6509K06/100014,3.21	
VISA Resource String	TCPIP::ZVL-100001::INSTR <input type="checkbox"/> Raw <b>Init</b>		
Filter Type	Sample Rate/Hz	Trigger Slope	Average
NORMal	65830000	POSitive	1
RBW / Hz	Trigger Mode	Pretrigger	Count
10000000.00	IMMediate	0	523776
			<b>Trace IQ</b>

Fig. 3-12: Trace IQ Data ZVL in spectrum analyzer mode

- **DEVICE TYPE, RESET, VISA RESOURCE STRING, RAW, TEST DEVICE, WINDOW TYPE, TRACE IQ** see FSIQ.
- **FILTER TYPE** – constantly set to NORM
- **RESOLUTION BANDWIDTH** – Indicator for FSL RBW (10Hz to 10 MHz).  
*Note:* In this particular case the Resolution Bandwidth is the maximum traceable bandwidth and not the smallest frequency resolution.
- **SAMPLE RATE** – Range 10 kHz to 65.83 MHz.
- **TRIGGER MODE** – possible selections are IMMEDIATE, EXTERNAL or IFPOWER.
- **TRIGGER SLOPE** – constantly set to POSITIVE.
- **PRETRIG. SAMPLES** – number of samples taken before trigger event. Range : -16253439 to 523775. Negative values correspond to a trigger delay.
- **AVERAGE** – Performs averaging of IQ Data. Range 0 to 32767. Averaging is turned OFF by the program for values  $\leq 1$ .
- **COUNT** – maximum sample count. Range 1 to 523776 ( $2^{19} - 512$ ).

### 3.1.3.5 PR100

Filter Type	Sample Rate/Hz	Trigger Slope	IQ inp.	Bal	Dith
NORMAL	640k	POSitive	RF	<input type="checkbox"/>	<input type="checkbox"/>
RBW / Hz	Trigger Mode	Pretrigger	Count	Imp	LP
500k	IMMEDIATE	0	523776	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 3-13: TracelQ Data PR100

- **DEVICE TYPE, RESET, VISA RESOURCE STRING, RAW, TEST DEVICE, WINDOW TYPE, TRACE IQ** see FSIQ. The PR100 uses a TCP socket connection. The port number is 5555 and must be merged to the IP address →  
TCPIP::::5555::SOCKET
- **FILTER TYPE** – Always set to NORMAL.
- **RESOLUTION BANDWIDTH** – Possible selections are 150 Hz to 500 kHz in 16 steps.
- **SAMPLE RATE** – Always 640 kHz.
- **COUNT** – maximum sample count. Range 1 to 1e9.

The PR100 records IQ data to SD memory (up to 32 GB). The maximum file size is limited to 4 GB (approx. 1 GSample). The file on the PR100 copied to “ReclQ.riq” in the IQWizard working directory and the IQ data imported to a memory array for further processing if the data size does not exceed the computer’s free memory size.



## 3.1.3.6 RTO

The screenshot shows the RTO configuration window with the following settings:

- Device Type: RTO
- Reset:
- Device ID: de&Schwarz,RTO,1316.1000k24/200159,2.80.1.2
- VISA Resource String: TCPIP::RTO-200159::INSTR
- Raw:
- Init:

Ch	Rel BW	Carrier Freq/Hz	Input Type	Input Mode
1	0.80	1000000	REAL	RFIF
	Bandwidth/Hz	Samp. Rate/Hz	IQ Sideband RF	Record Length
	800000000	1000000000	NORMAL	10000000

Fig. 3-14: Trace IQ Data RTO1024

- **DEVICE TYPE, RESET, VISA RESOURCE STRING, RAW, TEST DEVICE, WINDOW TYPE, TRACE IQ** see FSIQ see FSIQ.
- **CHANNEL** – Range 1 to 4 with REAL Input Type, and 1 (=I, 2=Q) and 3 (=I, 4=Q) with COMPLEX Input Type.
- **REL.BW** –  $Bandwidth = Relative\ Bandwidth * Sample\ Rate$
- **INPUT TYPE** – REAL (single input) or COMPLEX (I and Q inputs).
- **INPUT MODE** – RFIF (modulated on Carrier Frequency) and Baseband (I and Q inputs).
- **IQ SIDEBAND RF** – NORMAL or INVERSE (Input Type REAL).
- **IQ SIDEBAND IF** – NUPPER (upper SB, normal), NLOWER (lower SB, normal), IUPPER (upper sideband, inverse) and ILOWER (lower SB, inverse).
- **RECORD LEN** – Maximum sample count. Range 1000 to 10e6 samples.

### 3.1.4 Save IQ Data

This control window allows to store IQ data in various file formats.

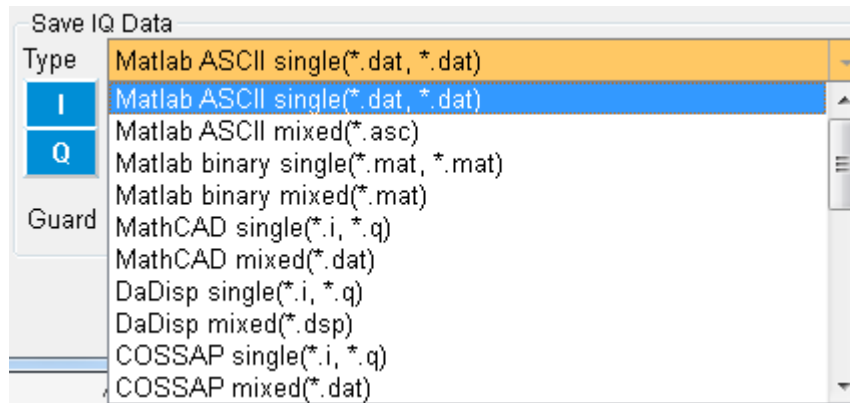


Fig. 3-15: Save file type

With single file types I- and Q- file names need to be entered separately.

I – Starts file save popup with predefined extension (see figure below).

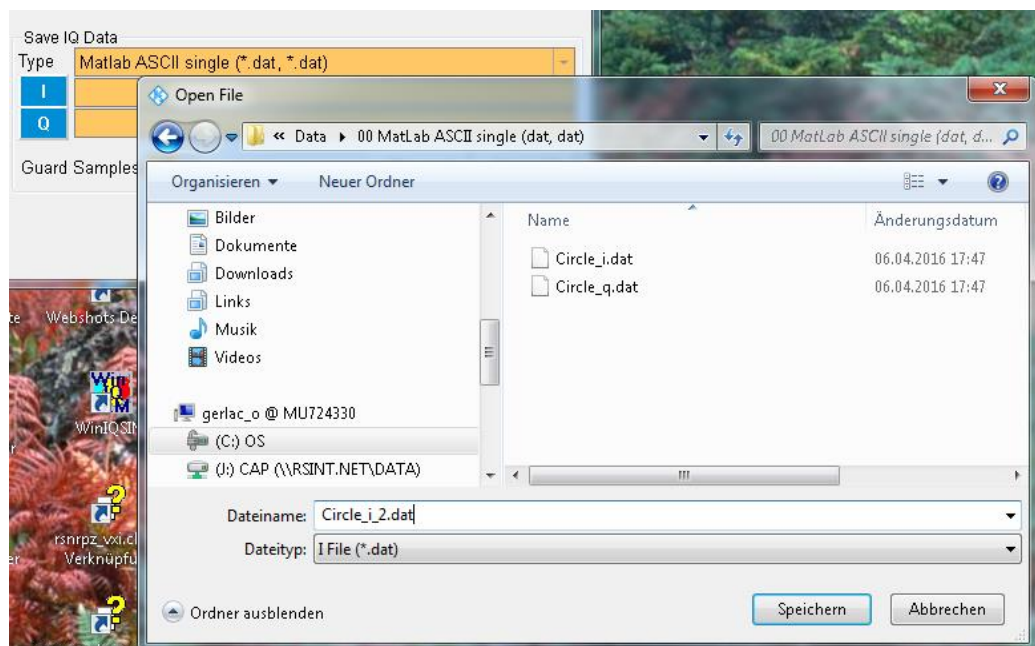


Fig. 3-16: Select I-file

Q – Same as I.

With mixed file types a file is selected by pressing the IQ button.

**IQ** – Starts file save popup with pre-defined extension (see figure below).

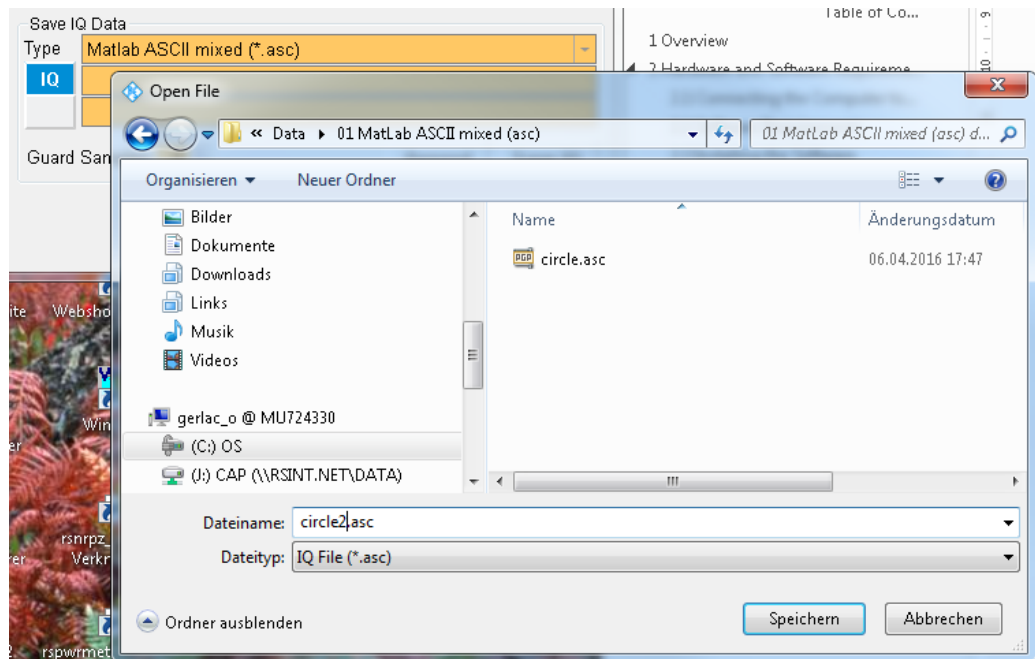


Fig. 3-17: Select IQ File

**GUARD SAMPLES** – The number of GUARD SAMPLES / SAMPLE FREQUENCY = GUARD INTERVAL avoids digital transmissions to from being upset by multipath. The last n-samples of the file are appended to the file.

**APPEND** – Appends the I/Q data in memory to the named file(s).

**SAVE** – Saves the I/Q data in memory to the named file(s).

## 4 Ordering Information

Designation	Type	Order No.
<b>Vector Signal Generator</b>		
<b>R&amp;S®SMW200A</b>		<b>1412.0000.02</b>
SMW-B103	100 kHz – 3 GHz (RF Path A)	1413.0004.02
SMW-B106	100 kHz – 3 GHz (RF Path B)	1413.0104.02
SMW-B203	100 kHz – 3 GHz (RF Path B)	1413.0804.02
SMW-B206	100 kHz – 3 GHz (RF Path B)	1413.0904.02
<b>R&amp;S®SMBV100A</b>	(9 kHz to 6 GHz)	<b>1407.6004.02</b>
SMBV-B1	Reference Oscillator OCSX	1407.9603.02
SMBV-B10	BB Gen, ARB(32MS),120MHz	1407.8607.04
SMBV-B50	ARB (32 MS), 120 MHz RF BW	1407.8907.02
SMBV-B51	ARB (32 MS), 60 MHz RF BW	1407.9003.02
SMBV-B103	9 kHz to 3.2 GHz	1407.9603.02
SMBV-B106	9 kHz to 6 GHz	1407.9703.02
SMBV-K511	ARB Memory Extension 256 MS	1419.2544.xx
SMBV-K512	ARB Memory Extension 1 GS	1419.2567.xx
SMBV-K521	Baseband Extension 120 MHz	1419.2580.xx
SMBV-K522	Baseband Extension 160 MHz	1419.2609.xx
<b>Spectrum Analyzer</b>		
FSLx	(9 kHz to 6 GHz)	1300.2502.xx
FSVRxx	(10 Hz to 40 GHz)	1311.0006.xx
FSV-B70	Extension to 40MHz signal analysis bandwidth	1310.9645.xx
FSWxx	(2 Hz to 85 GHz)	1312.8000.xx
FSW-B28	Extension to 28MHz IQ signal analysis bandwidth	1313-1645-02
FSW-B40	Extension to 40MHz IQ signal analysis bandwidth	1313-0861-02
FSW-B80	Extension to 80MHz IQ signal analysis bandwidth	1313-0878-02
FSW-B160	Extension to 160MHz IQ signal analysis bandwidth	1313-1668-0x
FSW-B320	Extension to 320MHz IQ signal analysis bandwidth	1313-7172-0x

FSW-B500	Extension to 500MHz IQ signal analysis bandwidth	1313.4296.02
FSW-B2000	Extension to 2 GHz IQ signal analysis bandwidth	1325.4750.xx
EX-IQ-BOX	Digital I/O Adapter	1409.5505.02
<b>IQ Recorder</b>		
IQR20	IQ Recorder (HDD) w. 20 MS/s	1530.4600.02
IQR100	IQ Recorder (SSD) w. 99.5 MS/s	1530.4600.10
<b>Test Receiver</b>		
ESU	(20 Hz to 40 GHz)	1302.6005.xx
ESR	(9 kHz to 7 GHz)	1316.3003.xx
<b>Vector Network Analyzer</b>		
ZVLx	(9 kHz to 13.6 GHz)	1303.6509.xx
<b>TV Analyzer</b>		
ETL	(500 kHz to 3 GHz)	2112.0004.13
<b>Portable Monitoring Receiver</b>		
PR100	(9 kHz – 7.5 GHz)	4079.9011.xx
PR100-IR	Internal Recording	4071.9358.02
PR100-ETM	Ext. Triggered Measurement	4071.9458.02
<b>Digital Oscilloscope</b>		
RTO100x	600 MHz, 10 GSa/s	1316.1000.0x
RTO101x	1 GHz, 10 GSa/s	1304.6002.1x
RTO102x	2 GHz, 10 GSa/s	1304.6002.2x
RTO1044	4 GHz, 10 GSa/s	1316.1000.44

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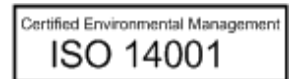
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## Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership



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