

# R&S iq-tar

# File Format Specification



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The iq-tar file format XML schema definition (<http://www.rohde-schwarz.com/file/RslqTar.xsd>) is released under the Apache License, Version 2.0, <http://www.apache.org/licenses/LICENSE-2.0>.

The iq-tar file format XML stylesheet ([http://www.rohde-schwarz.com/file/open\\_lqTar\\_xml\\_file\\_in\\_web\\_browser.xslt](http://www.rohde-schwarz.com/file/open_lqTar_xml_file_in_web_browser.xslt)) is released under the Apache License, Version 2.0, <http://www.apache.org/licenses/LICENSE-2.0>.

It includes:

**jQuery (JavaScript Library v1.4.2)**

jquery-1.4.2.min.js ( <http://jquery.com/> )

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**explorercanvas HTML5 Canvas for Internet Explorer (r3)**

excanvas.compiled.js ( <http://code.google.com/p/explorercanvas/> )

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## 1 I/Q Data File Format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An iq-tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the iq-tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include user-specific data.

The iq-tar container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see [http://en.wikipedia.org/wiki/Comparison\\_of\\_file\\_archivers](http://en.wikipedia.org/wiki/Comparison_of_file_archivers)) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

### Contained files

An iq-tar file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`  
Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an iq-tar file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`  
Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an iq-tar file.

Optionally, an iq-tar file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`  
Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.  
A sample stylesheet is available at [http://www.rohde-schwarz.com/file/open\\_IqTar\\_xml\\_file\\_in\\_web\\_browser.xslt](http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt).

## 1.1 I/Q Parameter XML File Specification



The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: <http://www.rohde-schwarz.com/file/RsIqTar.xsd>.

In particular, the order of the XML elements must be respected, i.e. iq-tar uses an "ordered XML schema". For your own implementation of the iq-tar file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

### Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>FSV-K10</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
  <DataFilename>xyz.complex.float32</DataFilename>
  <UserData>
    <UserDefinedElement>Example</UserDefinedElement>
  </UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Element	Description
RS_IQ_TAR_FileFormat	The root element of the XML file. It must contain the attribute <code>fileFormatVersion</code> that contains the number of the file format definition. Currently, <code>fileFormatVersion "2"</code> is used.
Name	Optional: describes the device or application that created the file.
Comment	Optional: contains text that further describes the contents of the file.
DateTime	Contains the date and time of the creation of the file. Its type is <code>xs:dateTime</code> (see <code>RsIqTar.xsd</code> ).

Element	Description
Samples	<p>Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be:</p> <ul style="list-style-type: none"> <li>• A complex number represented as a pair of I and Q values</li> <li>• A complex number represented as a pair of magnitude and phase values</li> <li>• A real number represented as a single real value</li> </ul> <p>See also <code>Format</code> element.</p>
Clock	<p>Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute <code>unit</code> must be set to "Hz".</p>
Format	<p>Specifies how the binary data is saved in the I/Q data binary file (see <code>DataFilename</code> element). Every sample must be in the same format. The format can be one of the following:</p> <ul style="list-style-type: none"> <li>• <code>complex</code>: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless</li> <li>• <code>real</code>: Real number (unitless)</li> <li>• <code>polar</code>: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires <code>DataType = float32 or float64</code></li> </ul>
DataType	<p>Specifies the binary format used for samples in the I/Q data binary file (see <code>DataFilename</code> element and <a href="#">chapter 1.2, "I/Q Data Binary File"</a>, on page 7). The following data types are allowed:</p> <ul style="list-style-type: none"> <li>• <code>int8</code>: 8 bit signed integer data</li> <li>• <code>int16</code>: 16 bit signed integer data</li> <li>• <code>int32</code>: 32 bit signed integer data</li> <li>• <code>float32</code>: 32 bit floating point data (IEEE 754)</li> <li>• <code>float64</code>: 64 bit floating point data (IEEE 754)</li> </ul>
ScalingFactor	<p>Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the <code>ScalingFactor</code>. For polar data only the magnitude value has to be multiplied. For multi-channel signals the <code>ScalingFactor</code> must be applied to all channels.</p> <p>The attribute <code>unit</code> must be set to "V".</p> <p>The <code>ScalingFactor</code> must be &gt; 0. If the <code>ScalingFactor</code> element is not defined, a value of 1 V is assumed.</p>
NumberOfChannels	<p>Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see <a href="#">chapter 1.2, "I/Q Data Binary File"</a>, on page 7). If the <code>NumberOfChannels</code> element is not defined, one channel is assumed.</p>
DataFilename	<p>Contains the filename of the I/Q data binary file that is part of the iq-tar file.</p> <p>It is recommended that the filename uses the following convention:  <code>&lt;xyz&gt;.&lt;Format&gt;.&lt;Channels&gt;ch.&lt;Type&gt;</code></p> <ul style="list-style-type: none"> <li>• <code>&lt;xyz&gt;</code> = a valid Windows file name</li> <li>• <code>&lt;Format&gt;</code> = complex, polar or real (see <code>Format</code> element)</li> <li>• <code>&lt;Channels&gt;</code> = Number of channels (see <code>NumberOfChannels</code> element)</li> <li>• <code>&lt;Type&gt;</code> = float32, float64, int8, int16, int32 or int64 (see <code>DataType</code> element)</li> </ul> <p>Examples:</p> <ul style="list-style-type: none"> <li>• <code>xyz.complex.1ch.float32</code></li> <li>• <code>xyz.polar.1ch.float64</code></li> <li>• <code>xyz.real.1ch.int16</code></li> <li>• <code>xyz.complex.16ch.int8</code></li> </ul>

Element	Description
UserData	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
PreviewData	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. iq-tar file format). For the definition of this element refer to the <code>RsIqTar.xsd</code> schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet <code>open_IqTar_xml_file_in_web_browser.xslt</code> is available.

### Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

$\text{ScalingFactor} = 1 \text{ V} / \text{maximum int16 value} = 1 \text{ V} / 2^{15} = 3.0517578125\text{e-}5 \text{ V}$

Scaling Factor	Numerical value	Numerical value x ScalingFactor
Minimum (negative) int16 value	$-2^{15} = -32768$	-1 V
Maximum (positive) int16 value	$2^{15}-1 = 32767$	0.999969482421875 V

### Example: PreviewData in XML

```
<PreviewData>
  <ArrayOfChannel length="1">
    <Channel>
      <PowerVsTime>
        <Min>
          <ArrayOfFloat length="256">
            <float>-134</float>
            <float>-142</float>
            ...
            <float>-140</float>
          </ArrayOfFloat>
        </Min>
        <Max>
          <ArrayOfFloat length="256">
            <float>-70</float>
            <float>-71</float>
            ...
            <float>-69</float>
          </ArrayOfFloat>
        </Max>
      </PowerVsTime>
      <Spectrum>
        <Min>
          <ArrayOfFloat length="256">
            <float>-133</float>
            <float>-111</float>
            ...
            <float>-111</float>
          </ArrayOfFloat>
        </Min>
      </Spectrum>
    </Channel>
  </ArrayOfChannel>
</PreviewData>
```

```

        </ArrayOfFloat>
    </Min>
    <Max>
        <ArrayOfFloat length="256">
            <float>-67</float>
            <float>-69</float>
            ...
            <float>-70</float>
            <float>-69</float>
        </ArrayOfFloat>
    </Max>
</Spectrum>
<IQ>
    <Histogram width="64" height="64">0123456789...0</Histogram>
</IQ>
</Channel>
</ArrayOfChannel>
</PreviewData>

```

## 1.2 I/Q Data Binary File

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `Format` element and `Data Type` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `NumberOfChannels` element is not defined, one channel is presumed.

### Example: Element order for real data (1 channel)

```

I[0],           // Real sample 0
I[1],           // Real sample 1
I[2],           // Real sample 2
...

```

### Example: Element order for complex cartesian data (1 channel)

```

I[0], Q[0],     // Real and imaginary part of complex sample 0
I[1], Q[1],     // Real and imaginary part of complex sample 1
I[2], Q[2],     // Real and imaginary part of complex sample 2
...

```

### Example: Element order for complex polar data (1 channel)

```

Mag[0], Phi[0], // Magnitude and phase part of complex sample 0
Mag[1], Phi[1], // Magnitude and phase part of complex sample 1
Mag[2], Phi[2], // Magnitude and phase part of complex sample 2
...

```

**Example: Element order for complex cartesian data (3 channels)**

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],           // Channel 0, Complex sample 0
I[1][0], Q[1][0],           // Channel 1, Complex sample 0
I[2][0], Q[2][0],           // Channel 2, Complex sample 0

I[0][1], Q[0][1],           // Channel 0, Complex sample 1
I[1][1], Q[1][1],           // Channel 1, Complex sample 1
I[2][1], Q[2][1],           // Channel 2, Complex sample 1

I[0][2], Q[0][2],           // Channel 0, Complex sample 2
I[1][2], Q[1][2],           // Channel 1, Complex sample 2
I[2][2], Q[2][2],           // Channel 2, Complex sample 2
...
```

**Example: Element order for complex cartesian data (1 channel)**

This is an example of how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
    fwrite(fid, single(real(iq(k))), 'float32');
    fwrite(fid, single(imag(iq(k))), 'float32');
end
fclose(fid)
```