R&S®FSW-K70
Analyzing Unknown Signals
Application Sheet

The goal of vector signal analysis is to determine the quality of the measurement signal that is transmitted by the device under test (DUT) by comparing it against an ideal signal, that is: the reference signal. The R&S FSW VSA application tries to reconstruct the ideal signal based on the knowledge about the DUT that you provide. However, what happens if you have no knowledge of the input signal that you could provide to the application?

This application sheet describes the challenge of determining typical signal parameters of an unknown signal from the results of a basic measurement using the R&S FSW VSA application. The focus of the analysis is on signals with linear modulation (PSK/QAM). The application sheet assumes you are familiar with the R&S FSW VSA application in general.

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Test & Measurement
Application Sheet

ROHDE&SCHWARZ

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1 Introduction

In order to analyze an unknown signal, you can perform a basic measurement on the input signal using the default settings in the R&S FSW VSA application. Then investigate the results to obtain information on the most important signal parameters.

The following sections describe how to determine specific parameters from VSA results:

Parameter	Using the results from...
Symbol rate	Spectrum of the signal / spectrum of the magnitude of the capture buffer (coarse estimation) Symbol rate error in result summary (fine-tuning)
Modulation	Constellation diagram
Transmit filter type	Spectrum of measurement and reference signal
Transmit filter roll-off factor	Statistics of EVM (fine-tuning)

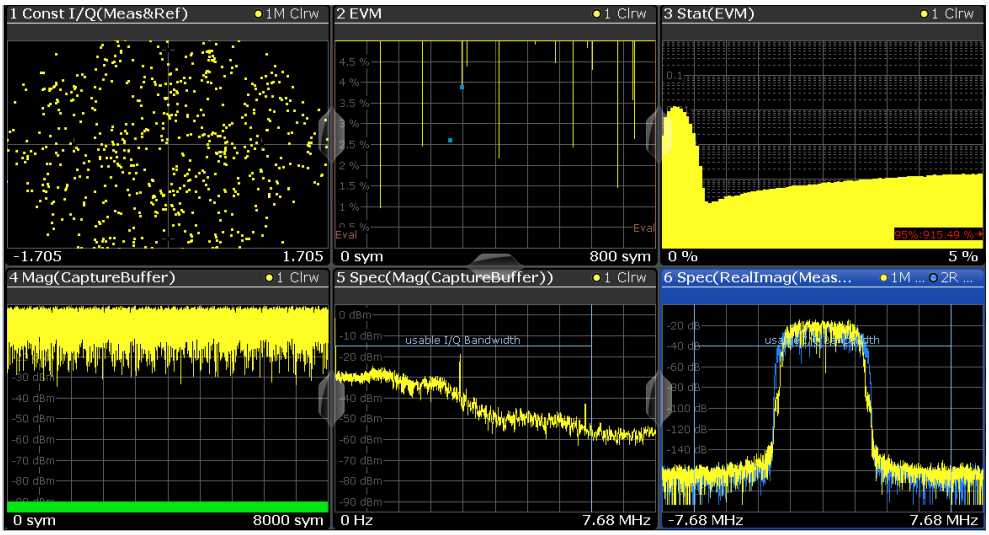
2 Obtaining an Overview of the Signal

The R&S FSW VSA application provides a predefined display configuration for unknown signals. This layout provides useful result displays to obtain an overview and determine the relevant signal characteristics of an unknown signal.

To configure the screen layout using a predefined display configuration

(This function is only available for firmware versions as of 2.50. For earlier versions of the R&S FSW VSA application, configure the shown result displays manually.)

► Select MEAS > "Predefined Display Config" > "Overview: PSK/QAM"



3 Determining the Symbol Rate

You cannot determine the symbol rate simply by looking at the results from one specific display. However, you can obtain a course estimation from the spectrum of the signal, and after determining other signal parameters, fine-tune the estimation using the symbol rate estimation.

3.1 Getting a First Idea

Usually you will have a basic idea of the signal's symbol rate. If you have no idea of the dimension, perform a basic frequency sweep in the R&S FSW Spectrum application. The width of the measured spectrum very roughly corresponds to the symbol rate of the signal.

3.2 Finding a Coarse Estimation

Have a look at the spectrum display of the magnitude of the capture buffer – the symbol rate is a peak in the spectrum.

1. Look at window 5 ("Spec (MagAbs(Capturebuffer)").

2. Select MKR.

   Marker 1 is set to the absolute peak of the measured signal, which is most likely at 0 Hz.

3. Select "Next Peak" to move the marker to the most distinct peak, as shown in Figure 3-1.

   The frequency value of the marker is the approximate symbol rate of the signal.

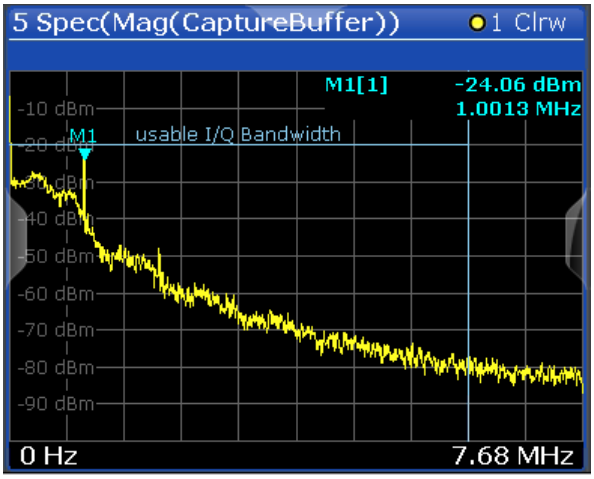


Figure 3-1: Symbol rate as the peak in the spectrum

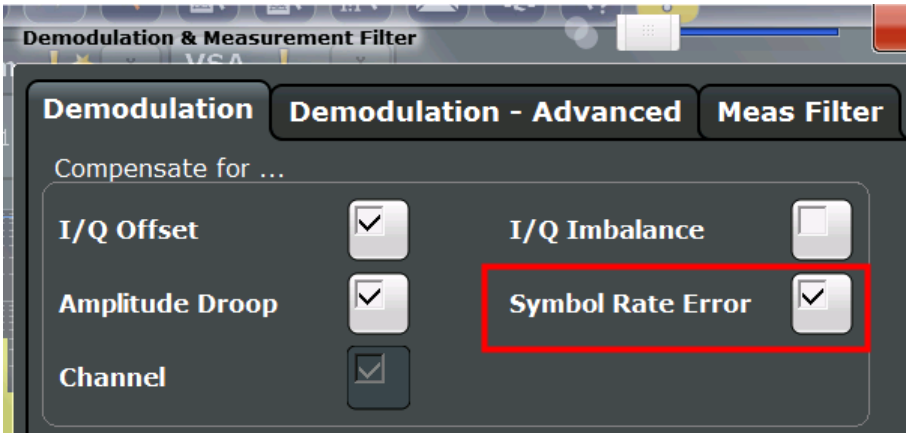
4. Enter the estimated symbol rate in the signal description settings.
   a) From the "Overview", select "Signal Description".
   b) In the "Modulation" tab, enter the "Symbol Rate".

3.3 Refining the Found Symbol Rate

Now that you have a coarse estimation of the symbol rate, you can refine the result. The difference between the currently measured symbol rate and the estimated symbol rate (the *Symbol Rate Error*, or *SRE*) gives the accuracy of the estimated value. The SRE is displayed in the Result Summary display, however only if compensation for SRE is activated in the demodulation settings.

This procedure is best performed with a known modulation and transmit filter. If necessary, repeat this and the following procedures (Identifying the Modulation and Determining the Transmit Filter Type) to improve your results with each cycle.

1. From the "Overview", select "Demodulation".
2. In the "Demodulation" tab, enable "Compensate for": "Symbol Rate Error".



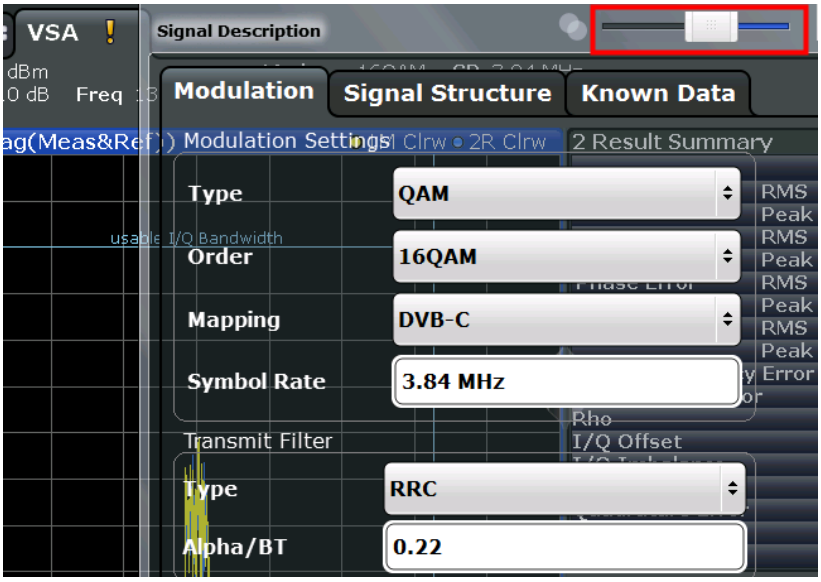
3. Close the "Demodulation" dialog box.
4. From the "Overview", select "Display Config".
5. Add a new window or replace an existing one with the signal source "Modulation Accuracy".
6. Select "Window Config".
7. Select "Result Type": "Result Summary".

   The Result Summary is displayed, including the "Symbol Rate Error".

2 Result Summary

		Current	Peak	Unit
EVM	RMS	35.09	35.09	%
	Peak	105.27	105.27	%
MER	RMS	9.10	9.10	dB
	Peak	-0.45	-0.45	dB
Phase Error	RMS	17.06	17.06	deg
	Peak	46.02	46.02	deg
Magnitude Error	RMS	28.25	28.25	%
	Peak	85.21	85.21	%
Carrier Frequency Error		149115.45	149115.45	Hz
Symbol Rate Error		1084.55	1084.55	ppm
Rho		0.890 858	0.888 341	
I/Q Offset		-34.24	-34.24	dB
I/Q Imbalance		-26.07	-22.24	dB
Gain Imbalance		0.72	1.25	dB
Quadrature Error		3.17	3.17	deg
Amplitude Droop		0.001 868	0.001 868	dB/sym
Power		-72.27	-72.27	dBm

8. From the "Overview", select "Signal Description".
9. Using the slider at the top of the dialog box, increase the transparency of the dialog so you can see the results in the result window(s) behind it.

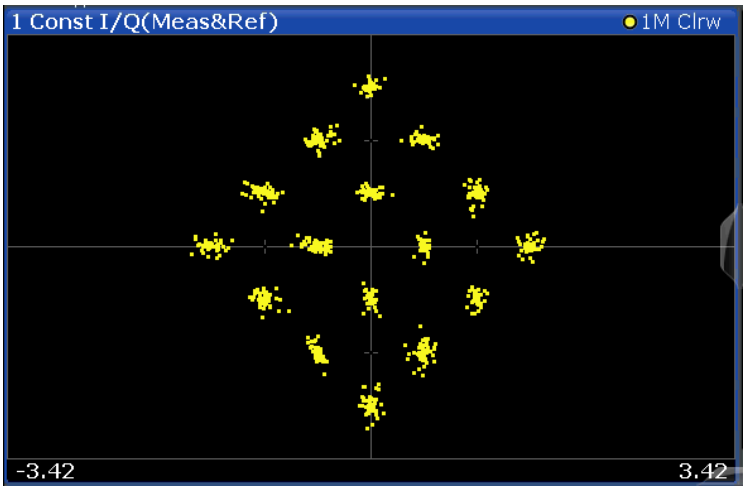


10. In the "Modulation" tab, change the "Symbol Rate", while keeping an eye on the "Symbol Rate Error".
11. Continue changing the settings until the lowest possible SRE is achieved.

4 Identifying the Modulation

The constellation diagram shows the complex input signal as an X/Y plot of the symbol decision instants. You can compare the measured constellation points with the symbol mapping for the various standard modulation modes to determine the closest match.

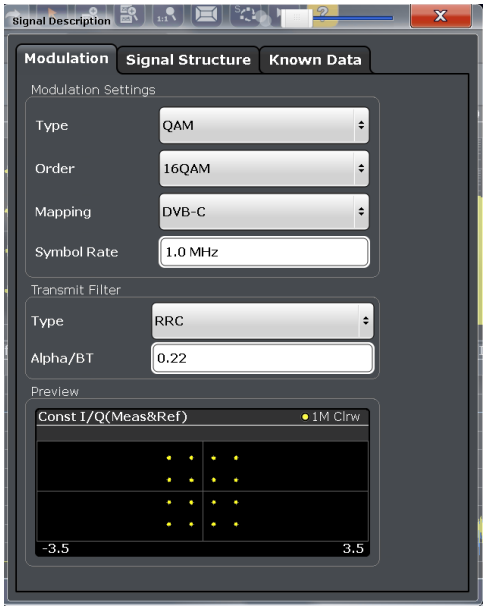
1. Take a look at window 1 ("Const I/Q (Meas&Ref)").



2. Compare the various standard modulation modes described in the R&S FSW VSA application user manual to the constellation in window 1.

Note: Keep in mind that the phase angle is arbitrary at this point, so the constellation may not be absolutely identical to the symbol mapping definition.

3. Enter the most likely modulation settings in the signal description settings.
   a) From the "Overview", select "Signal Description".
   b) In the "Modulation" tab, enter the modulation "Type", "Order", and "Mapping".



5 Deducing the Used Transmit Filter

5.1 Determining the Transmit Filter Type

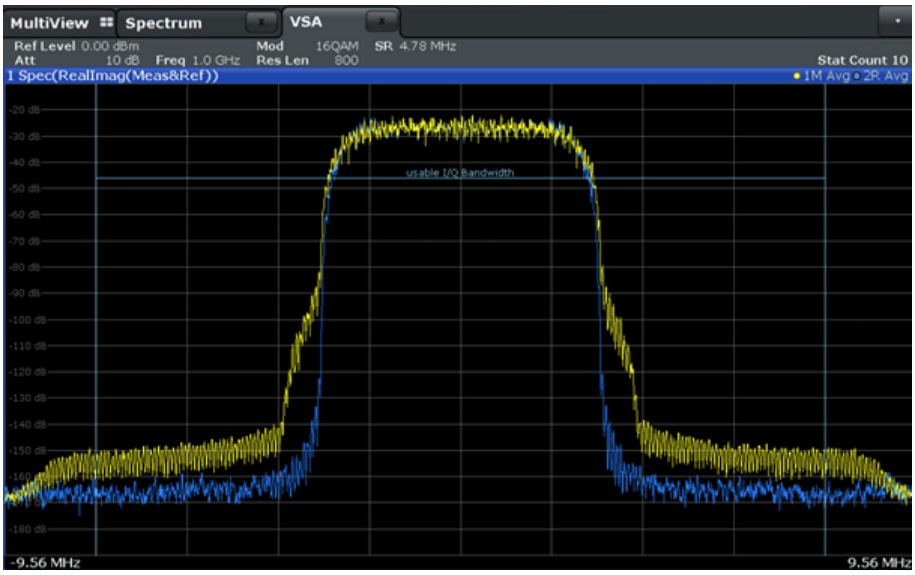
The R&S FSW VSA application uses the transmit filter specified in the signal description to generate the ideal reference signal. If the correct transmit filter is specified, that is: the one actually used by the unknown signal, the measured signal should correspond to the reference signal. Thus, by comparing the two signals and changing the filter settings until the best fit is found, you can deduce the used transmit filter type.

The filter type is best determined from the shape of the signal in a frequency domain display.

One way to compare the reference signal to the measured signal is to select a display that shows both the measurement and the reference signals at the same time, for example "Real/Imag (I/Q)".

1. Take a look at window 6 ("Spec(RealImag(Meas&Ref)").

   The spectrum of both the measurement and the reference signals are displayed in one diagram.



2. From the "Overview", select "Signal Description".
3. Using the slider at the top of the dialog box, increase the transparency of the dialog so you can see the results in the result window(s) behind it.
4. In the "Modulation" tab, change the transmit filter "Type", while comparing the measured signal trace to the reference signal trace.
5. Continue changing the settings until the best match is achieved.

5.2 Concluding the Roll-Off Factor

If you have identified a filter type with a roll-off factor, e.g. RRC, you also have to find the roll-off factor. To do so, analyze the difference between the measured and the reference signal that is provided as an error vector in the EVM result display. Using statistics functions on the EVM results, you can draw conclusions on the likely roll-off factors of the used transmit filter. The lower the EVM, the better the selected roll-off factor matches the measured signal.

1. Have a look at window 2 (EVM) and window 3 ("Stat(EVM)").

   The EVM vector with highlighted symbol instances is displayed in window 2. Window 3 shows the histogram of the EVM.

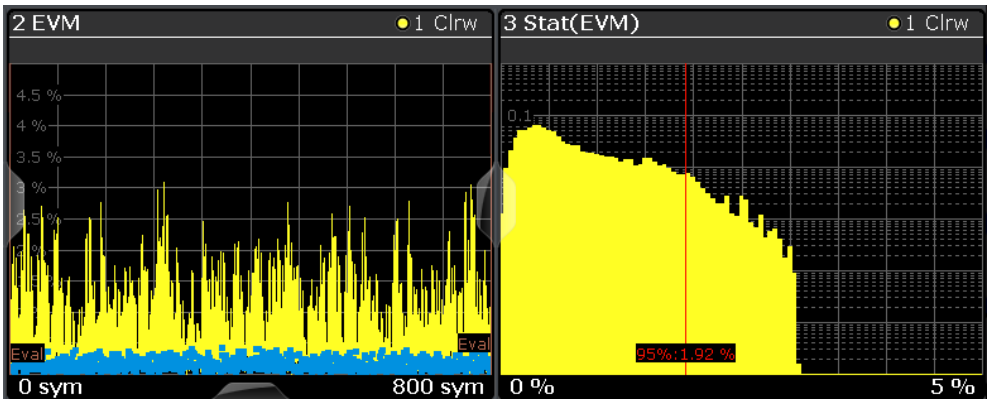


Figure 5-1: EVM results using an incorrect roll-off factor

2. Now change the roll-off factor until both result displays show the fewest error values at all sample instances.

   a) Using the slider at the top of the dialog box, increase the transparency of the dialog so you can see the results in the result window(s) behind it.
   b) Select the "Alpha/BT" input field and scroll through the possible values for that filter type.

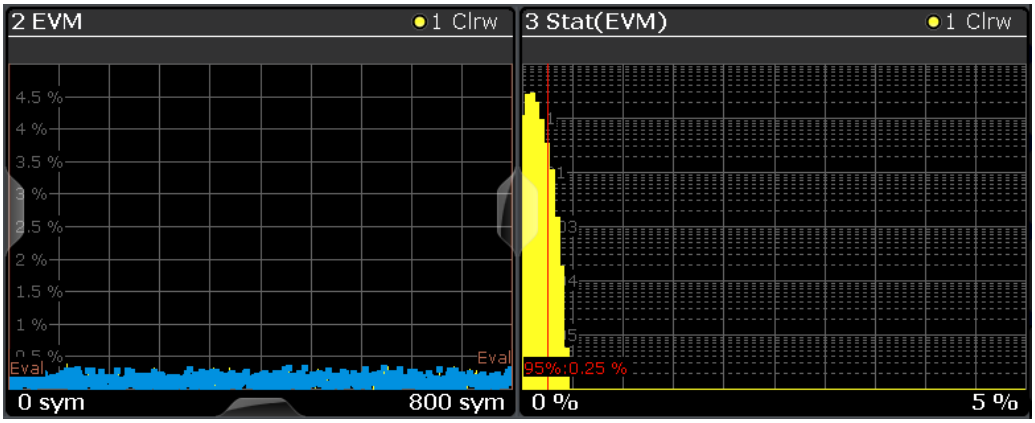


Figure 5-2: EVM results using the correct roll-off factor

If you manage to configure the reference signal such that it matches the measured signal as best as possible, you have determined various important characteristics of the as yet unknown signal.

6 Additional Information

For a comprehensive description of the R&S FSW VSA application functionality, refer to the R&S FSW VSA application user manual. The user manual is available for download at the Rohde & Schwarz product site: http://www.rohde-schwarz.com/product/FSWK70.html > Downloads > Manuals

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The following abbreviations are used throughout this manual: R&S®FSW is abbreviated as R&S FSW.