Products: R&S®FSQ, R&S®FSG, R&S®FMU, R&S®FSU, R&S®FSUP, R&S®FSMR

Using the Equalizer Filter in the VSA Application Firmware for R&S Spectrum Analyzer and Signal Analyzer

Application Note 1EF61

The R&S spectrum analyzers and signal analyzers offer an additional equalizer filter in the Vector Signal Analysis Application Firmware R&S FSQ-K70/FSx-B73, which is a powerful tool for measurement and analysis of vector-modulated signals. This application note describes the functionality of the equalizer filter and how to set the filter parameter manually in an accurate and fast way.

ROHDE&SCHWARZ

Subject to change – D. von Droste, 08.2007 – 1EF61_0E

Contents

1 Overview

The option R&S FSQ-K70/FSx-B73 for vector signal analysis, which is available for the R&S FSQ, FMU, FSU, and FSMR, enables the analysis of analog and digital modulations. A possible source of high modulation errors of the device under test (DUT) is a non-flat frequency response or ripple in frequency response within the modulation bandwidth. An adaptive equalizer filter is able to identify and compensate the distorted frequency response or in general linear distortions from IQ modulated signals (figure 1), which also include group delay distortion and reflections or multipath distortion. This kind of filter is included in the option R&S FSQ-K70/FSx-B73.

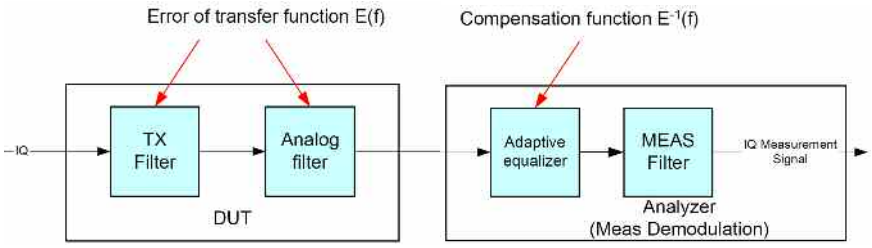

Figure 1: Baseband schematic: compensation of the transfer function's error (caused e.g. by the DUT's analog or digital filter sections) by inserting an adaptive equalizer in the receive path [K70].

The filter coefficients are adapted in such a way that the mean square value of the error vector magnitude (EVM) is minimized. Thus the equalizer filter is limited to PSK and QAM modulation schemes and it cannot be used for MSK, FSK, and VSB schemes [1].

The main purpose of the adaptive equalizer filter in the VSA is to find out if there is a non neglectable frequency response in the DUT. In case of such a frequency response the EVM will improve significantly with the use of the equalizer filter. Additionally nonlinear distortions or spurious errors can be identified more easily if linear distortions are compensated.

2 Adjustment of Filter Length and Step Size

Within the vector signal analysis option two parameters need to be set: Adaptive FIR filter length (softkey 'Equalizer Length') and step size of the implemented algorithm (softkey 'Equalizer Step'). The filter coefficients are calculated automatically according to this algorithm.

If the parameters are set correctly, the linear correction will lead to a low EVM very fast. If the parameters are set in a wrong way, it will take a long time to see improvements and the final value will not be very good. The following sections describe how to adjust the filter length and step size required to train the adaptive equalizer.

Equalizer Length

The equalizer's length L is always given in symbols. The number of taps can be calculated as follows: L*OversamplingFactor + 1. If the length of the filter is chosen too low the filter will never be able to represent the system (under modeling situation). If the length of the filter is chosen too high you will always be able to represent the system, however the converge properties will be poor (due to over modeling) [2]. The aim is to find the one in between.

A good starting length is 10 symbols. To get a first and fast impression of the channel you can also start with 5 symbols. Then the equalizer can be trained (softkey 'Train') while looking at the impulse response of the filter (softkey 'Magnitude (log)'). If the impulse response on the left and right border of the display are almost zero the length can be reduced, otherwise it has to be increased (see figure 2). During training process always watch the EVM or constellation diagram to control the range of improvements.

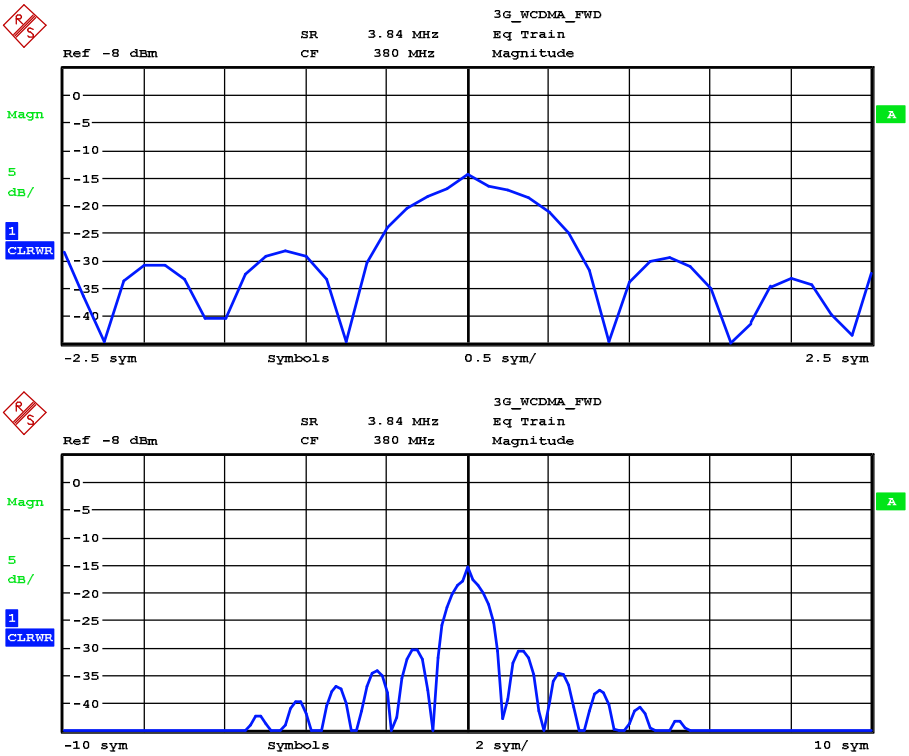

Figure 2: The impulse response of the equalizer filter with an equalizer length of 5 symbols (above) and 20 symbols (below). In this case the impulse response is approx. 12 symbols long and thus a filter length of 12 symbols is needed.

Changing the length during operation of the equalizer is possible in principle. However, it is recommended to preset the coefficients to a neutral filter (softkey 'Equalizer Reset') after changing the length followed by a new learning phase (softkey 'Equalizer Train'). So the equalizers learning process can restart with a defined setting.

Step Size

The softkey 'Equalizer Step' controls the equalizer's learning rate. At the beginning of the equalizer training a step size of 0.25 or 0.1 is favourable for quick improvements of the EVM display. If the EVM is somehow settled and only small improvements are noticeable, the step size can be reduced to 0.05 or less in order to get an even lower EVM. When lowering the step size the learning rate decreases but the accuracy of the compensation increases. At the end of the equalizer training a step size of 0.01 or less is recommended.

Opposed to the equalizer length the stepsize can be altered during operation. This does not reset the equalizer. Finally you can press 'Equalizer Freeze' to use the current settings for the filter. For further information please refer to [K70].

Summary

1. Set Equalizer Length to 10 symbols and Equalizer Step Size to 0.25
2. Train Equalizer
3. Look at the impulse response of the filter and adjust Equalizer Length
4. Reset Equalizer and train it again
5. Look at the EVM and when EVM is somehow settled reduce Equalizer Step Size to 0.05
6. Wait again until EVM is settled and reduce Equalizer Step Size to 0.01
7. Freeze Equalizer

3 References

[K70] Rohde & Schwarz, Application Firmware R&S®FSQ-K70: Software Manual, R&S 2005

[1] Rohde & Schwarz, Spectrum Analyzer R&S®FSQ, Operating Manual, R&S 2005

[2] Christoph Rauscher, Fundamentals of Spectrum Analysis, R & S 2004

4 Additional Information

This application note may be updated from time to time. Please visit the website 1EF61 in order to download new versions.

Please contact TM-Applications@rsd.rohde-schwarz.com for comments and further suggestions.

5 Ordering Information

Signal Analyzer FSQ

R&S FSQ3	20 Hz ... 3.6 GHz	1155.5001.03
R&S FSQ8	20 Hz ... 8 GHz	1155.5001.08
R&S FSQ26	20 Hz ... 26,5 GHz	1155.5001.26
R&S FSQ40	20 Hz ... 40 GHz	1155.5001.40
VSA Option for FSQ		
R&S FSQ-K70	General Purpose Vector Signal Analysis	1161.8038.02

Spectrum Analyzer FSG

R&S FSG8	9 kHz ... 8 GHz	1309.0002.08
R&S FSG13	9 kHz ... 13.6 GHz	1309.0002.13
VSA Option for FSG		
R&S FSQ-K70	General Purpose Vector Signal Analysis	1161.8038.02

Baseband Analyzer FMU

R&S FMU36	DC … 36 MHz	1303.3500.02

General Purpose Vector Signal Analysis included

Spectrum Analyzer FSU

R&S FSU3	20 Hz ... 3.6 GHz	1166.1660.03
R&S FSU8	20 Hz ... 8 GHz	1166.1660.08
R&S FSU26	20 Hz ... 26.5 GHz	1166.1660.26
R&S FSU43	20 Hz ... 43 GHz	1166.1660.43
R&S FSU46	20 Hz ... 46 GHz	1166.1660.46
R&S FSU50	20 Hz ... 50 GHz	1166.1660.50
VSA Option for FSU		
R&S FSU-B73	General Purpose Vector Signal Analysis	1169.5696.03

Signal Source Analyzer FSUP

R&S FSUP8	20 Hz ... 8 GHz	1166.3505.08
R&S FSUP26	20 Hz ... 26.5 GHz	1166.3505.26
R&S FSUP50	20 Hz ... 50 GHz	1166.3505.50
VSA Option for FSUP		
R&S FSQ-K70	General Purpose Vector Signal Analysis	1161.8038.02

Measuring Receiver FSMR

R&S FSMR3	9 kHz ... 3.6 GHz	1166.3311.03
R&S FSMR26	9 kHz ... 26.5 GHz	1166.3311.26
R&S FSMR50	9 kHz ... 50 GHz	1166.3311.50
VSA Option for FSMR		
R&S FSMR-B73	General Purpose Vector Signal Analysis	1169.5696.02

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

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München · Postfach 80 14 69 · D-81614 München ·
Tel (089) 4129 -0 · Fax (089) 4129 - 13777 · Internet: http://www.rohde-schwarz.com