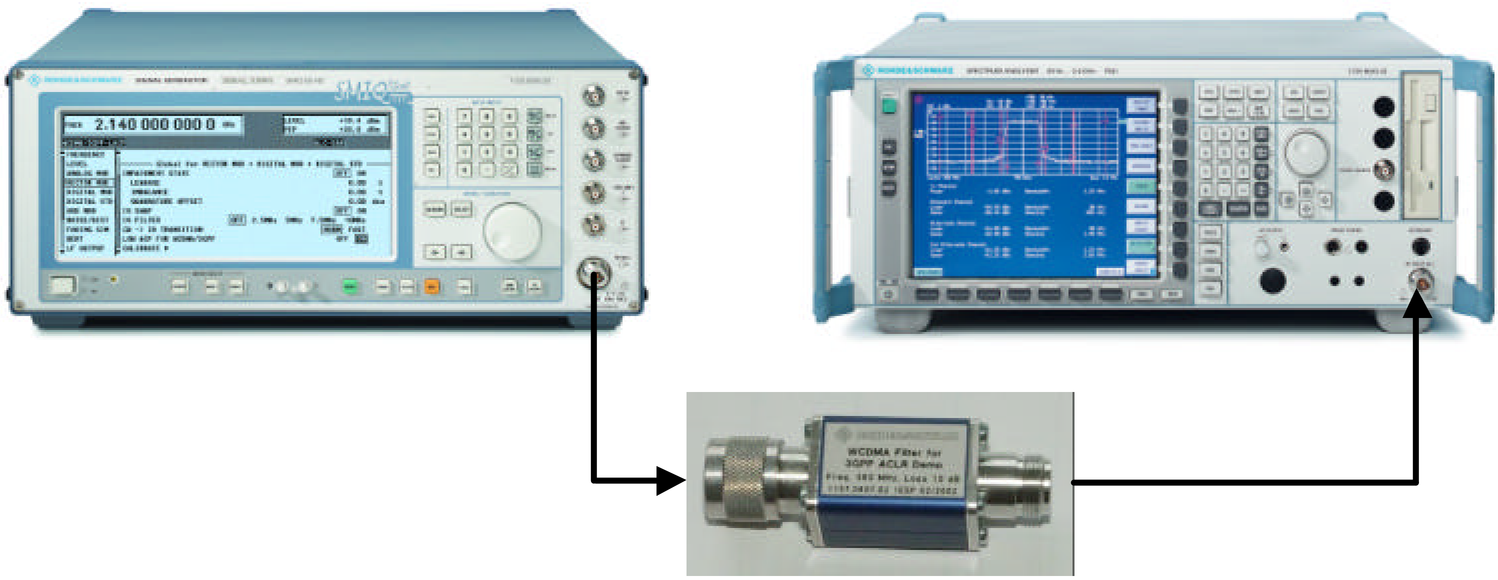

Product: Spectrum Analyzer FSU

How To Demonstrate Improved ACLR Dynamic Range With FSU and Noise Correction

Application Note

This application note provides information about the ACLR measurement with noise correction. The basic requirements and the limiting factors of a spectrum analyzer are explained. Dynamic range improvements by means of a noise correction is presented. Measurement examples show the practical realisation of ACLR measurements.

ROHDE&SCHWARZ

Subject to change – Kay-Uwe Sander/1ESP 05/2002 - 1EF49_0E

Contents

1 Overview

ACLR measurement is one of the most demanding measurement on base stations tranmitter regardless of the technology used. It requires an extremely high dynamic range of the spectrum analyzer.

This application note explains the parameters of the spectrum analyzer defining the ACLR dynamic range. Next the use of smart signal processing routines to improve the ACLR dynamic range are explained. Derived from these parameters recommendations for optimum setup of the analyzer are given. The recommended setups are supported by practical measurements on a WCDMA signal in the last section.

2 Dynamic Range Limitations

The inherent dynamic available for ACLR measurement is an important factor. It must be well below the limits for the device under test. This assures that the test result is minimally affected by the ACLR floor of the spectrum analyzer. The inherent dynamic range of the FSU when measuring power in the adjacent channels is determined by three factors:

- The internal noise floor of the spectrum analyzer
- The phase noise
- The spectral re-growth due to 3rd order intermodulation of the analog signal path in the 5-MHz offset channel.

From these contributions the optimum level settings can be determined taking the internal structure of the spectrum analyzer into account. The following figure shows the contributions of the three limiting factors to the inherent ACLR dynamic range of the FSU spectrum analyzer:

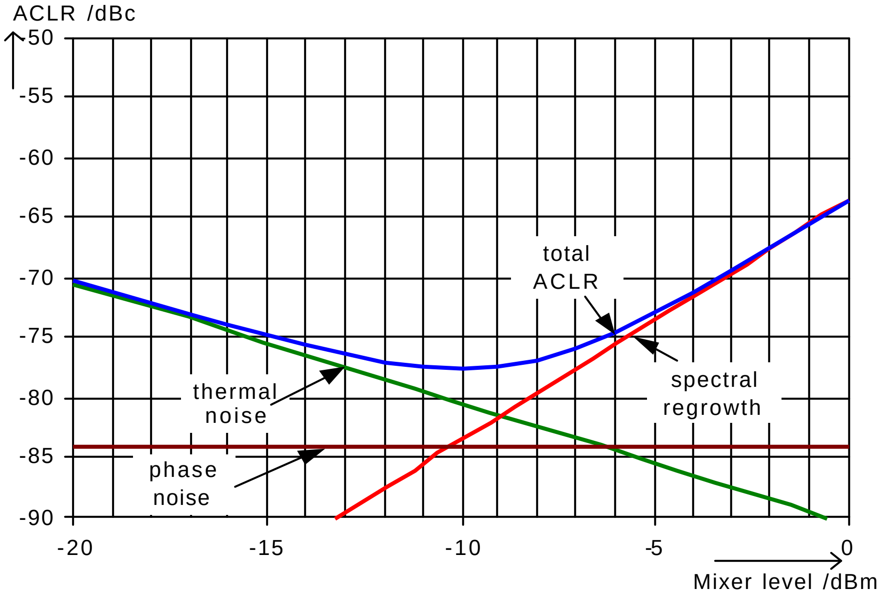

Fig. 1 Inherent dynamic range for 3 GPP ACLR in the 5-MHz offset channels dependent on the level at the input mixer.

3 Signal Processing - Noise Correction

The idea of doing additional signal processing is to compensate for the internal sources of error. There are at least three major error sources:

- The spectral re-growth due to 3rd order intermodulation of the analog signal path.This signal component is hard to compensate due to ist complex structure.
- The phase noise could be measured, but an additional test signal is neccessary to measure the spectrum analyzers contribution to the phase noise at the measurement frequency.
- The internal noise floor of the spectrum analyzer can easily be measured.

Noise correction is a mathematical prodedure to remove the spectrum analyzer inherent noise from the measured signal. The procedure to compensate for the inherent spectrum analyzer noise works in two steps:

- In a first step, the input signal is removed from the spectrum analyzer input and the input is terminated. This is done within the FSU by means of a switch within the RF Attenuator. In this setup, the inherent noise power at the actual frequencies is measured.
- In the second step, the input is switched on again and the input signal is measured. The signal processing calculates the input power by subtracting the inherent noise power from the measured values.

With this procedure, the inherent noise power of the spectrum analyzer is set to a value very close to Zero. The subtraction of the inherent noise from the input signal might generate negative power values, which would cause negative infinite numbers on the typical used LOG scaling. To avoid this, the FSU does not subtract the full amount of inherent noise power from the measured values. This leads to a partly compensated inherent noise display with no infinite numbers.

As a result of this procedure, the noise contribution to the available ACLR dynamic range chart is reduced by 15...20 dB.

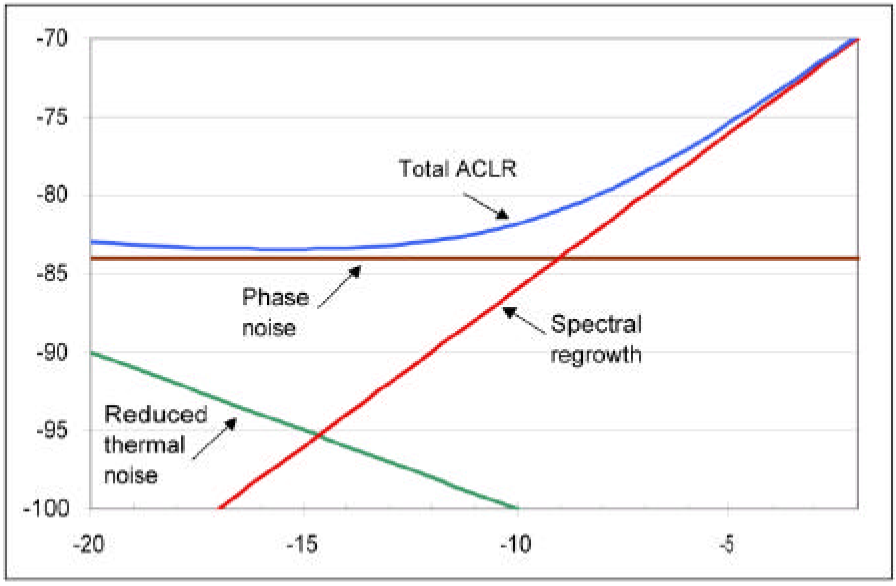

Fig. 2 ACLR dynamic range with reduced noise due to noise correction

It can be derived from the above chart, that the optimum mixer level has moved to a lower value due to the mathematical reduction of the noise power. The optimum mixer level for the FSU spectrum analyzer with active noise correction is about -18 to -13 dBm.

Very important for the successful noise correction is a stable power measurement. The FSU support this requirement:

- The accurate and stable power mesurement is possible by using the RMS detecor. The stability of the power measurement is controlled with the sweep time, since this has a direct influence on the amount of samples available to calculate the average value. A long sweep time will give more stable results and thus leads to better compensation of the inherent noise power.
- The linearity of the receiver has a great impact on the accuracy of the noise power measurement. The FSU is using digital filtering for RBW settings up to 100kHz, thus providing an excellent linearity. This is important because the inherent noise power measurement must be performed with the same instrument setting which is used for the input signal measurement, but only internal noise is measured.

Since the noise compansation measures the inherent noise power of the spectrum analyzer with the actual setting, any change of the spectrum analyzer setting must be avoided (especially settings of Frequency, RF ATT, RBW, ...). Otherwise it requires a re-measurement of the inherent noise by reactivating the Noise Compansation.

4 Setup Procedures

Two parameters must be considered when setting up a spectrum analyzer to achieve the best dynamic range:

- The RF attenuation in order not to generate spectral re-growth in the internal mixer stages.
- The reference level in order not to overdrive the IF path following the internal bandpass filters and the A/D Converter.

Setting of the the input attenuator

The input attenuator has to be set so that the signal path is loaded with optimum mixer level (i.e. level at RF input minus RF attenuation). The optimum mixer level for the FSU is about -13 dBm to -8 dBm dependent on the crest factor of the W-CDMA signal. At -13 to -8 dBm level at the input mixer the FSU provides an ACLR dynamic range of about 77 dBc in the 5-MHz offset channel (see also above figure).

Setting of the the reference level

The reference level can be set independently from the input attenuator in a certain range. The reference level sets the level at the A/D Converter input. It can handle signals up to 2 dB above reference level w/o clipping. For greater signal levels it begins to clip the signal and generates distortion. For 3 GPP W-CDMA signals the reference level (and dynamic range) is optimum when the A/D Converter is driven to full scale to minimize the influence of wideband noise after the IF filters The RF attenuation has to be kept fixed, however. The setting must be done in a way that the overload message of the A/D Converter is just not appearing in the display (Trace about 10..15 dB below reference level).

To free the user from optimum mixer level calculations the FSU provides automatic routines to establish the optimum RF attenuation and reference level. With the signal from the device under test applied to the FSU the user simply activates the soft key ADJUST REF LEVEL in the ACPR menu of the FSU to optimize the dynamic range of the instrument.

5 Performing the Measurements

This section shows how to set up the instruments for ACLR measurement. For the measurement examples the R&S signal generator SMIQ is used. The output signal is a W-CDMA signal according to TS 25.141, test model 1. In order to measure the limits of the FSU the SMIQ output signal is filtered by a bandpass filter with a center frequency of 380 MHz, a bandwidth of ~ 4 MHz and ~ 10 dB insertion loss.

Figure 3 Filter for ACLR demos

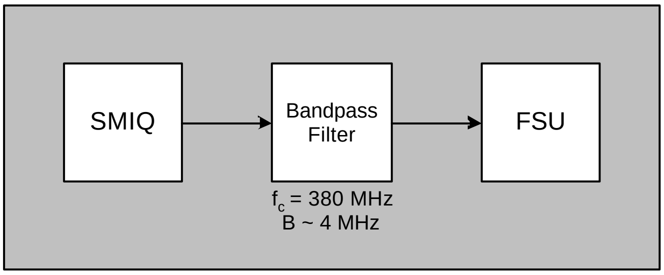

Figure 4 Test setup for the measurement examples

SMIQ setup:

The SMIQ is set to generate the 3GPP ACLR test signal. The following settings have to be performed:

- Preset the SMIQ
- Set the output frequency to 380 MHz
- Set the level to 0 dBm
- Choose Digital Standards - WCDMA/3GPP
- Choose TEST MODELS... - TEST1_64
- Choose FILTER... - set FILTER MODE to LOW_ACP
- Go to STATE and switch the WCDMA modulation ON
- Go to VECTOR DEMOD - IQ FILTER and set to 2.5 MHz

FSU setup (IBW method):

The FSU is set to measure the ACLR. The following settings have to be performed:

- Preset the FSU
- Set the center frequency to 380 MHz
- Set the reference level to 0 dBm
- Presse MEAS - CHAN PWR / ACP - CP/ACP STANDARD,
- Choose WCDMA 3GPP FDD
- Change the sweep time to 1 s
- Adjust SMIQ level to get a channel power reading of about -10dBm
- Press ADJUST REF LEVEL

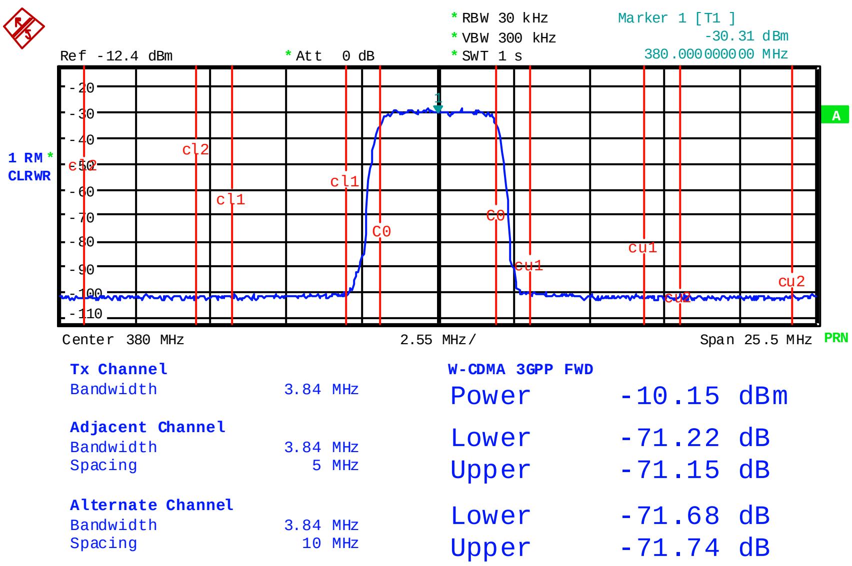

Figure 5 Measurement result with Auto level setting.

The FSU is now set to optimized level settings and shows the ACP measurement (Attenuator is set to 0 dB, reference level is set to ~ -13 dBm). The level setting is done in a way that no overload is displayed under any circumstances. A lower reference level setting will increase the dynamic range furthermore:

- change the reference level in 1 dB steps while observing the channel power, the adjacent channel power and the overload message. A reference level setting of -17 dBm can be reached, while the ACP reading is gaining to about -74dBc. A further decrease will gain more dynamic range, but the overload message will appear. The reference level can be decreased furthermore until the channel power is starting to change. This is a sign of an overloaded IF path.
- Set the reference level to the lowest possible value without overload.

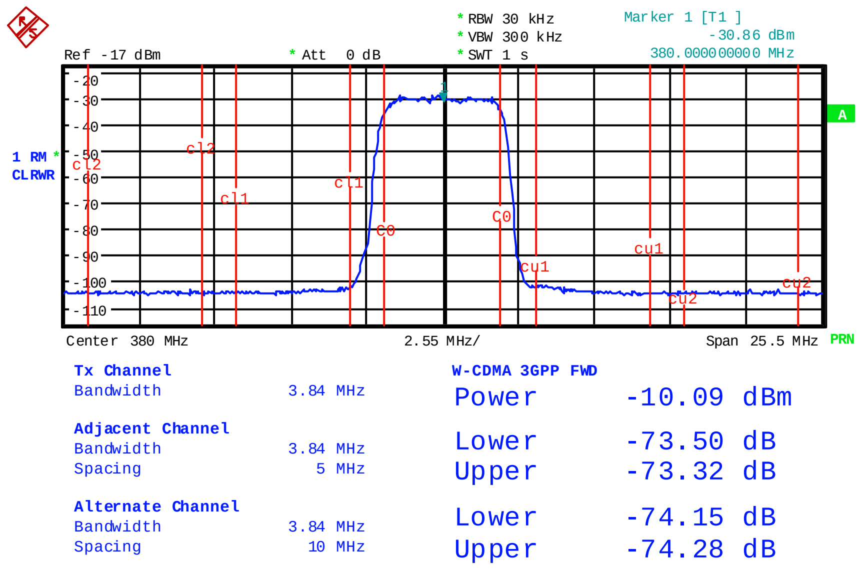

Figure 6 Measurement result with reduced reference level

Activate Noise Correction:

- Change the SWEEP TIME to 10 s
- Presse MEAS - CHAN PWR / ACP - NOISE CORR ON

The FSU will automatically set the RF Attenuator to 5 dB more than the actual value to cover the reduced optimum mixer level.

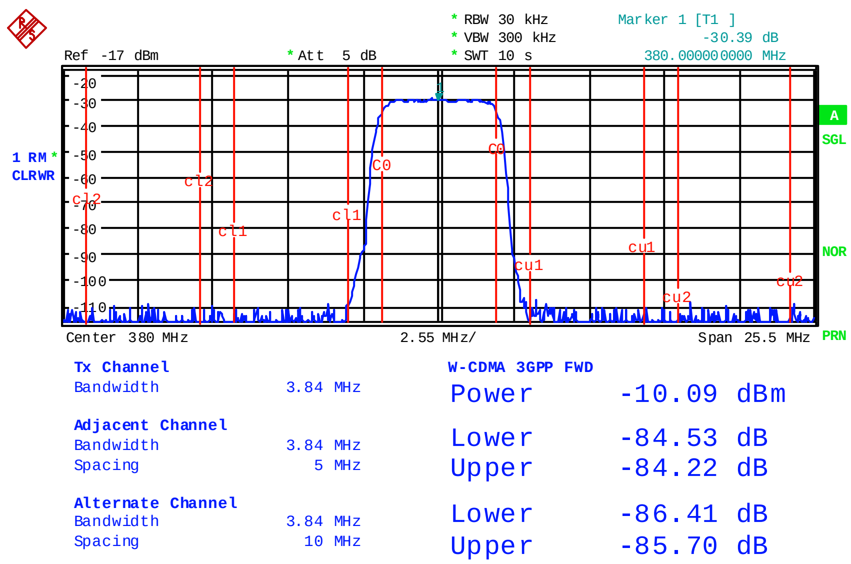

Figure 7 Measurement result with noise coerrection active

FSU setup (Fast ACP method):

The disadvantage of the long sweep time in the IBW mode can be overcome in the Fast ACP mode. In this case the measurement of ACLR is much faster due to the wider RBW used in the power measurement. The following settings have to be performed (starting from the last measurement):

- Preset the FSU
- Change the sweep time to 500 ms
- Presse MEAS - CHAN PWR / ACP - FAST ACP ON
- Press ADJUST REF LEVEL
- Presse MEAS - CHAN PWR / ACP - NOISE CORR ON

In this case the level setting is optimized

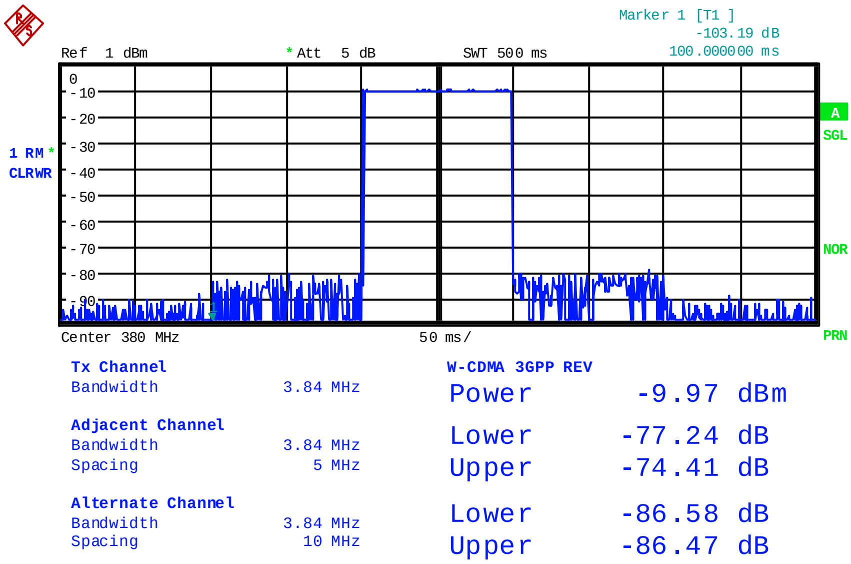

Figure 8 Measurement result in FAST ACP with noise coerrection

6 Literature

[1] Application Note 1EF40_E, Measurement of Adjacent Channel Power on Wideband CDMA Signals

[2] Application Note 1EF41_E, Measurement of Adjacent Channel Leakage Power on 3GPP W-CDMA Signals with the FSP

[3] Application Note 1EF45_E, Spurious Emission Measurement on 3GPP Base Station Transmitters

7 Ordering information

Type of instrument

		Order number
FSU3	20 Hz to 3.6 GHz	1129.9003.03
FSU8	20 Hz to 8 GHz	1129.9003.08
FSU26	20 Hz to 26.5 GHz	1129.9003.26
SMIQ03B	300 kHz to 3.3 GHz	1125.5555.03
SMIQ03HD	300 kHz to 3.3 GHz	1125.5555.33
SMIQB57	High ACLR for WCDMA 3GPP (2110 to 2170 MHz)	1105.1831.02

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