Application Note

NPR MEASUREMENTS ON SATELLITE SIGNALS

Products:

- R&S®FSW
- R&S®SMW200A

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Contents

1 Overview

Noise-Power-Ratio (NPR) measurements are a common procedure and a simple but useful tool to characterize the performance of power amplifiers for satellites or other multi-channel communication systems. The main advantage is the use of wideband signals like noise, multi-carrier CW tones or I/Q modulated signals, which leads to a better simulation of the real environment. This application note provides information how to generate these signals with a vector signal generator and perform NPR measurements with spectrum analyzers. With the R&S®SMW200A vector signal generator any desired test signal can be created. The R&S®FSW spectrum and signal analyzer offers an automated function for NPR measurements. The limiting factors of both a vector signal generator and a spectrum analyzer are explained. Measurement examples show the practical results of NPR measurements.

2 Introduction

Many different methods are available to test the linearity performance of power amplifiers for satellites or other multi-channel communication systems. While some engineers prefer to use very clean two-tone sinewave test signals and measure third-order intermodulation, the use of wideband signals like white noise or multi-carrier CW tones or I/Q modulated signals leads to a better simulation of the real environment. Measuring noise power ratio is popular in the satellite industry as a better way to assess the linearity of high-power amplifiers operating close to maximum output power. The concept of the noise power ratio measurement has been around for a long time and presents a simple but useful tool to characterize the performance of such a system. The wideband noise that is used instead of the sinewave test signals simulates the presence of many single carriers and makes the test conditions more realistic. The intermodulation products generated in the non-linear amplifier will fill up the notch that is placed within the channel bandwidth of interest.

The noise power ratio measurements of high-quality power amplifiers raise requirements on signal generation as well as on signal analysis. The signal generator must be able to generate a test signal with a deep notch. Therefore, contributions from the signal generator's RF section must be well below the intermodulation products generated in the DUT.

Furthermore, it must be sure that the spectrum analyzer is capable of measuring the noise power without generating significant intermodulation distortion itself, or masking the distortion generated by the amplifier with its own amplitude noise floor. With the knowledge of the spectrum analyzer hardware architecture and it´s capabilities, the measurement can be performed with the correct amount of attenuation and level settings in the spectrum analyzer. There are multiple applications for NPR tests, this application note describes NPR measurement techniques for satellite transmissions.

The R&S®FSW offers an automated measurement function for NPR and the R&S®SMW200A provides multiple options to generate high-quality test signals. The combination of both devices makes NPR measurements on high quality power amplifiers or even complete transmit/receive paths easy. The limiting factors of the R&S®FSW and the R&S®SMW200A for this measurement are explained, and measurement examples show the practical results of NPR measurements. The next sections will give further details.

3 NPR Measurement details

3.1 Fundamentals of the NPR measurement

Noise power ratio measurements have been performed since the first release of FDMA systems as a characteristic for the quality of the system. The amount of noise power in a multi-channel system is measured in an unused channel, while all other channels are loaded with signals. Noise and intermodulation distortion will fill up the unused channel, and the measurement of this noise power gives an indication of the system performance.

Practical NPR measurements often use white noise as a test signal. The white noise has similar characteristics as many individual carriers with random distribution of amplitude and phase of each signal. The noise signal passes through a band pass filter to represent a signal with similar bandwidth as used in the real system. A band stop filter (reject filter) simulates the unused channel and creates a deep notch within the band-limited noise signal. Instead of a real white noise signal it is also practical to use multi-carrier CW signals with a high number of tones to simulate the signal. Using notched I/Q modulated signals, the DUT's linearity can be tested with realistic test signals that are similar to the signals the device will see once in operation in the payload.

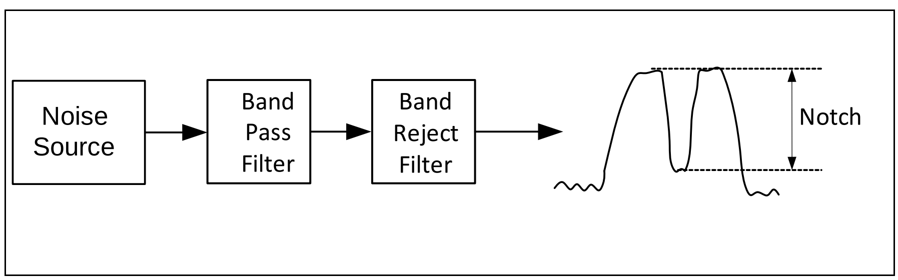


Figure 1: NRP measurement principle

The above figure gives an overview of the traditional way to generate the test signal for NPR measurements. This signal is used to test the power amplifier or transmission system components. The distortion of the amplifier will produce intermodulation products that will be located on both adjacent sides of the band limited signal, but will also fill up the notch. A spectrum analyzer is used to measure the ratio of the signal level (average pedestal level) and the level in the notch. The ratio of these two reading is the noise power ratio (NPR).

The NPR measurement range is limited by two important characteristics: the depth of the test set notch will be an absolute limit that cannot be overcome and must be seen as hard measurement range limit. The other parameter that limits the NPR range is the quality of the spectrum analyzer, as the input mixer and the IF amplifiers will also produce intermodulation that fills up any notch of the measured signal. Testing at these limits of the test setup will lead to systematic errors when the NPR of the DUT is too close to that of the test set.

The test system shall typically have at least 10 dB better performance than the test requirements. The typical requirement for power amplifier tests is 40 to 50 dB NPR, which leads to a requirement of 60 dB for the test system. The next chapter describes a test setup to verify the performance of the R&S®FSW for NPR tests. The corresponding measurement results are presented in chapter 5. In chapter 6, different methods to generate test signals with the R&S®SMW200A are presented and performance of the combined R&S®SMW200A/R&S®FSW setup for NPR measurements is evaluated in chapter 7.

4 Test setup for NPR measurements

The performance of the R&S®FSW noise power ratio measurement is verified with a test setup that is able to generate a very clean signal and reliable notch depth over a wide level range.

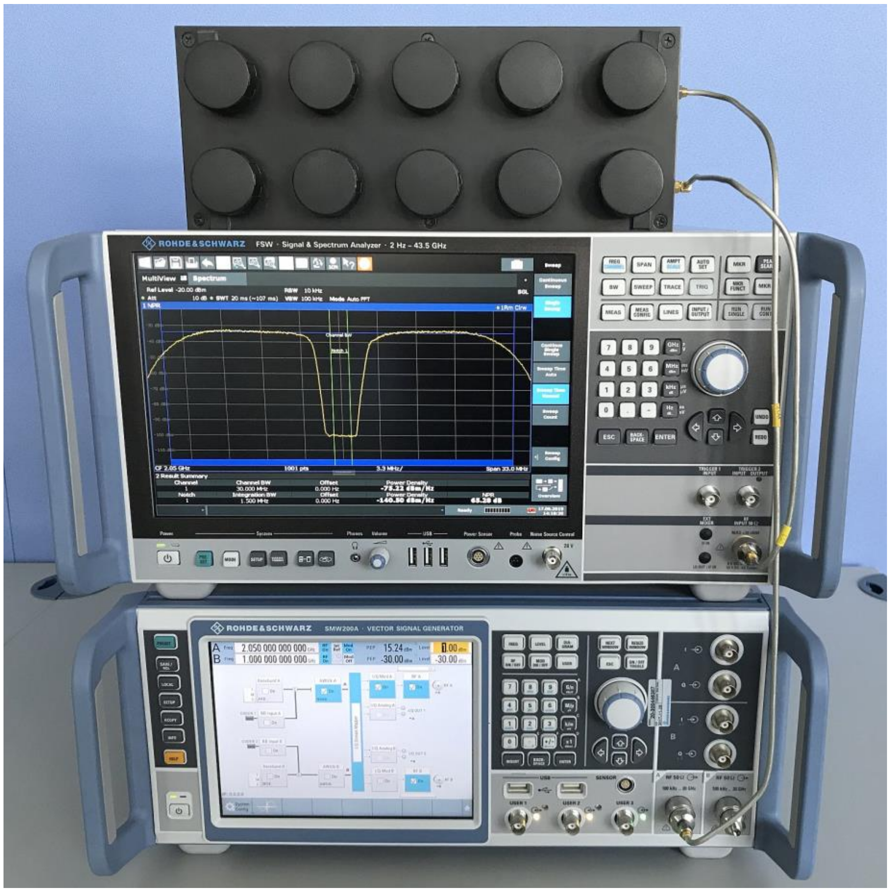


Figure 2: Picture of the test setup for NPR performance verification of the R&S®FSW

The vector signal generator R&S®SMW generates the test signal for the NPR verification of the spectrum analyzer. The generated test signal can be either a band limited noise signal or a user-defined arbitrary waveform file for a test signal. For practical NPR tests on amplifiers, the generator is used to create a NPR test signal with a selectable number of notches. Another possibility for NPR tests is, to use a multi-carrier CW test signal. In this case the notches are a number of disabled tones in the multi-carrier spectrum. More details on signal generation are given in chapter 6.

For the purpose of the verification measurements, the generator provides a band limited noise signal and an external band reject filter is used between the signal generator and the spectrum analyzer.

Figure 3 below shows the block diagram of the test setup:

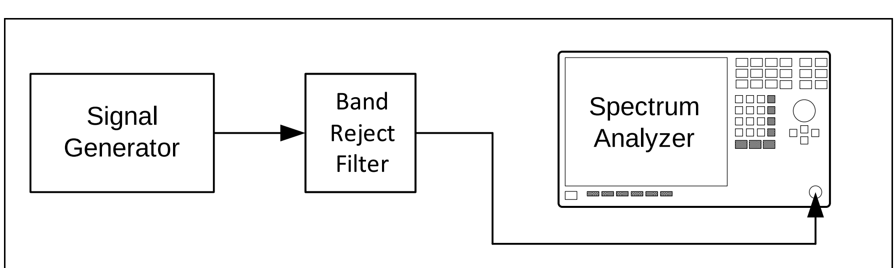


Figure 3: Test setup for NPR measurement performance verification of the R&S®FSW

For the verification of the spectrum analyzer measurement range a very clean signal with a reliable notch is required. For the purpose of this test a band reject filter is used that will suppress all noise and distortion signals from the generator. In order to make accurate tests on the spectrum analyzer the notch depth shall be at least 10 dB more than the required performance for NPR measurements (60 dB).

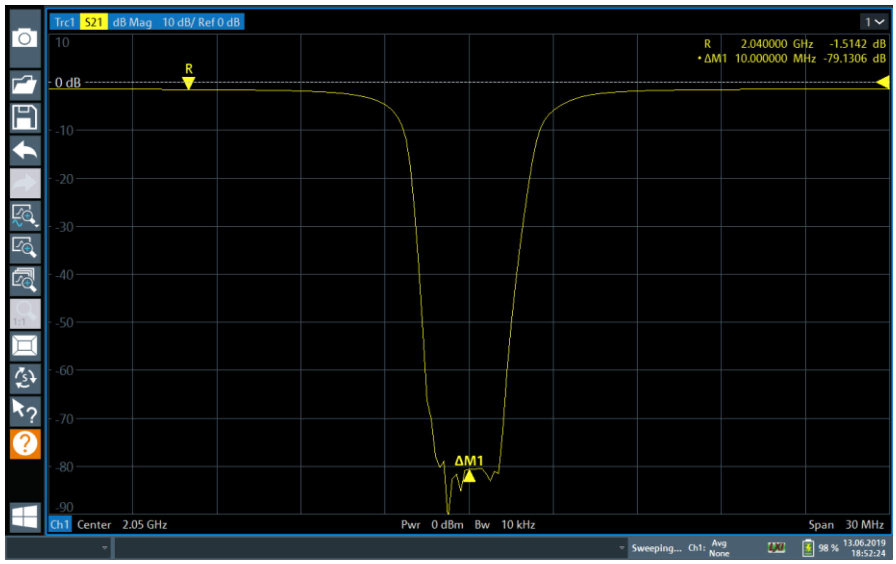


Figure 4: Test result screen display for mean and peak power of a pulsed signal

The above screen shot shows the measurement result for the notch attenuation of the notch filter measured with a network analyzer. The notch depth is the ratio between the pedestal in the passband (marker R) and the attenuation in the notch (marker M1). The notch depth measurement shows about 80 dB of attenuation. This external filter provides a reliable notch (level suppression) which offers sufficient measurement range for the spectrum analyzer verification.

5 NPR Measurement with the R&S®FSW

For the NPR measurement the R&S®FSW spectrum analyzer provides an optional software routine R&S®FSW-K19 Noise Power Ratio (NPR) Measurement.

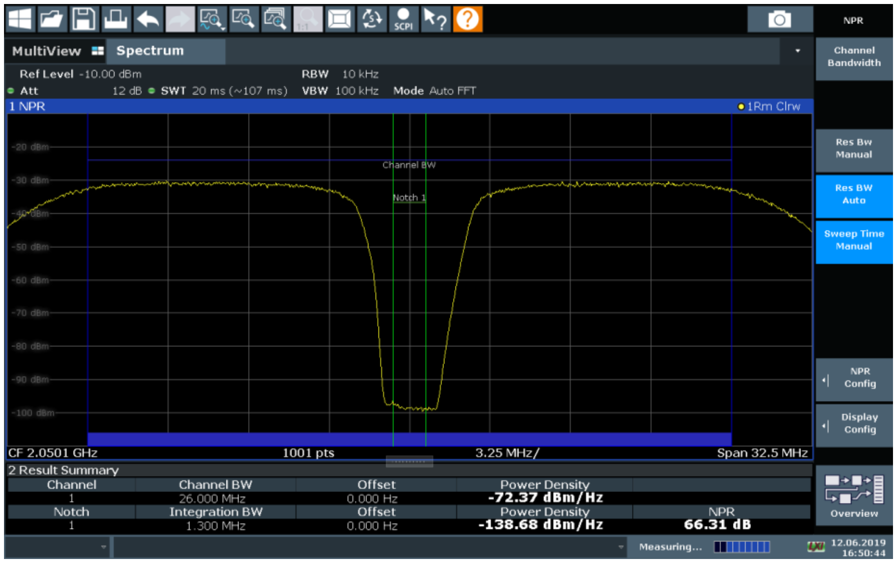


Figure 5: Screen copy of NPR measurement with the R&S®FSW

The screen shot above shows the measurement screen of the NPR measurement. The active channel is marked with the vertical blue lines, the notch is marked with the green lines. The channel power density, the notch power density, and the noise power ratio are calculated and displayed in the table below the spectrum.

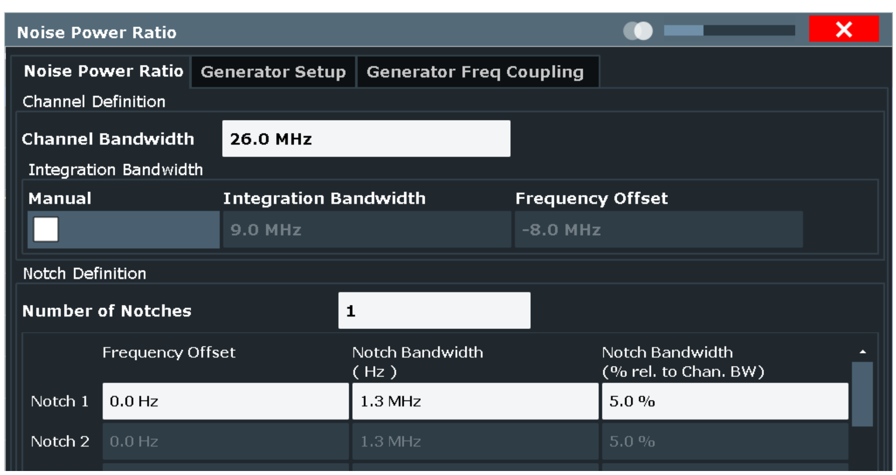


Figure 6: NPR measurement configuration dialog in the R&S®FSW

The noise power ratio measurement allows defining the satellite channel bandwidth and up to 25 notches in the NPR setup. The integration bandwidth that is used to measure the transmit power density can be freely selected within the channel bandwidth.

5.1 NPR measurement range limitations

The inherent NPR measurement range of the R&S®FSW is determined by three factors:

► the thermal noise floor of the spectrum analyzer

► the spectral re-growth due to 3rd order intermodulation of the input mixers

► the spectral re-growth due to 3rd order intermodulation of the A/D converter

The phase noise of the R&S®FSW spectrum analyzer is extremely low and therefore phase noise limitations are omitted for the remainder of the analysis.

The noise floor of the spectrum analyzer places a limit on the lowest level in the notch that can be measured. The available NPR range is hence proportional to the input signal level that reaches the mixer of the analyzer. The dynamic range due to the noise floor increases by 10 dB with each 10 dB increase of the signal level, as the noise floor is constant.

As the input level of the signal increases the inherent distortion of the analyzer appears above the noise floor. Therefore, an optimum mixer level can be found where the maximum dynamic range of the analyzer is achieved, which is the case when the internally generated distortion has the same level as the noise floor. Combining the noise floor and the mixer influence results in the theoretical “V” shape often shown for the achievable dynamic range for third-order intermodulation measurements or adjacent channel power measurements with spectrum analyzers. Similar results can be expected for the NPR measurement.

5.2 NPR measurement results in practice

The described test setup is used to measure the available NPR dynamic range of the R&S®FSW spectrum analyzer. The known high performance of the test signal (after the notch filter) allows the verification of very wide dynamic ranges. The built-in NPR measurement routine of the spectrum analyzer is used to derive the results.

For the following example a band limited noise signal with 26 MHz bandwidth was used. The band-reject filter has an effective notch bandwidth of 3.5 MHz positioned in the center of the signal, and the notch bandwidth in the NPR measurement is set to 2 MHz bandwidth centered in the middle of the notch (see figure 5).

The first measurement shows the dynamic range achievable dependent on the mixer level of the R&S®FSW (mixer level = mean power at the input mixer = mean power at the RF input - RF attenuation). For the purpose of the measurement the analyzer is set to 0 dB RF attenuation and the maximum possible reference level, which is -10 dBm. The input signal level (mean power) is varied between -40 and +10 dBm.

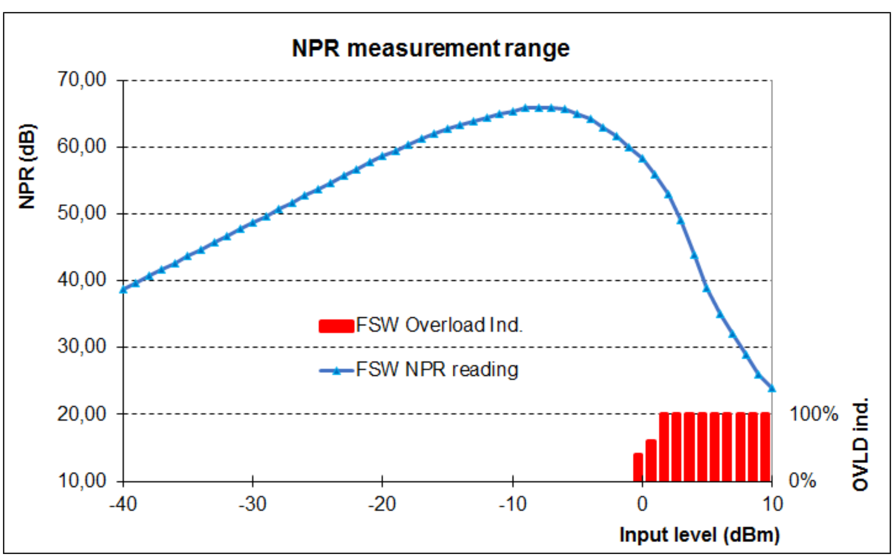


Figure 7: NPR value and Overload indication versus input mixer level

The attainable dynamic range is shown in Figure 7. The curve shows the expected behavior across the input level over a wide level range. At low input levels the noise floor of the spectrum analyzer dominates the available NPR range.

The expected NPR value can be calculated from the input level and the R&S®FSW datasheet value for the noise floor. From 1 to 3 GHz input frequency the specification for the noise floor is -154 dBm/Hz. The minimum input level in the above plot is -40 dBm, this equals -114 dBm/Hz. The NPR is the difference between the noise density in the active part of the signal and the noise density in the notch, the calculated NPR value is 40 dB. The plot shows excellent agreement between the calculation and the measurement.

At high input levels the curve does not strictly follow the expected curve for intermodulation distortion. In the level range above -5 dBm the R&S®FSW is indicating an IF overload condition. The A/D converter in the IF can handle signals up to 2 dB above reference level without clipping. For greater signal levels it starts to clip the signal and generates very high distortion. Measurements in this region must strictly be avoided. From the above plot we can see that the best possible NPR range is at -10 to -8 dBm, slightly below the point when the IF overload starts to warn the user. The NPR value in this level region is about 65 dB, which is much higher than required by most satellite power amplifier measurements (typ. 40 dB). From this measurement we can see that it is important to drive the input mixer of the R&S®FSW with the correct level to obtain the best possible measurement range.

In practice, the linearity of the DUT has to be measured at a fixed level that is applied to the spectrum analyzer, and the analyzer hardware must be set in the right way in order to get the best possible accuracy. Two parameters have to be considered when setting up the optimum dynamic range:

► The RF attenuation, to avoid distortion in the mixer stages

► The reference level, to avoid overdrive of the IF path or A/D converter

In the standard setting of the R&S®FSW the RF attenuation is coupled to the reference level setting to obtain -10 dBm mixer level, which perfectly fits to the optimum level as we have seen in the previous measurement. In other cases, the RF attenuation can also be set independently from the reference level. To obtain the best possible dynamic range the A/D-converter shall be driven to full scale. Dependent on the crest factor of the signal the mean power of the signal is well below the full scale on the screen in this case. The next measurement assumes a fixed level from the DUT with +10 dBm mean power. The reference level on the R&S®FSW is varied to determine the NPR results.

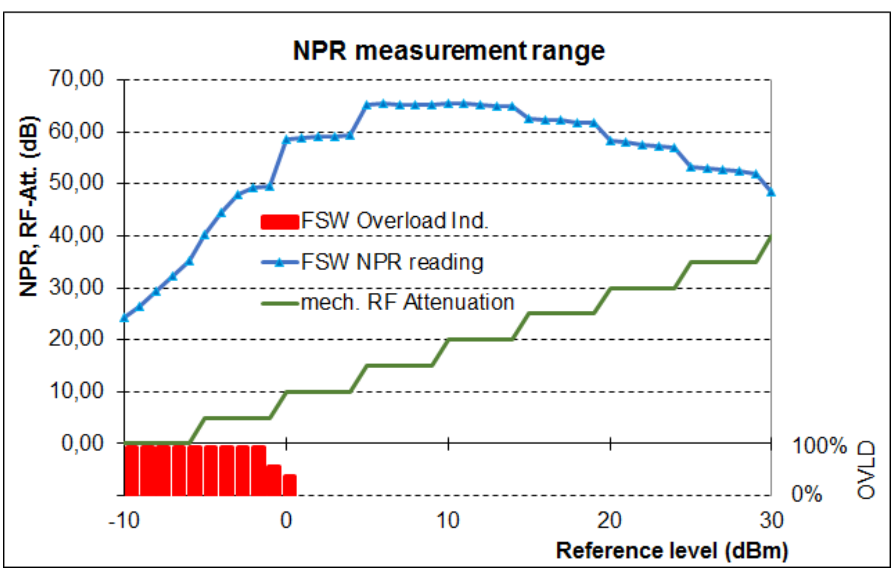


Figure 8: NPR value, RF attenuation and Overload indication versus reference level

The above diagram shows an example of this measurement result for a fixed input signal with +10 dBm mean power. In addition to the NPR reading and the overload indicator there is a curve for the mechanical RF attenuation setting.

The RF attenuator in front of the mixer of the R&S®FSW can be set in 5 dB steps. In addition, the analyzer provides an electronic attenuator in the IF stage in 1 dB steps. In the above measurement the RF attenuation is coupled to the reference level, the attenuation is split between the 5 dB steps before the mixer and the

1 dB steps before the A/D-converter. For a better understanding of the effect only the attenuator in front of the mixer is shown, as this has a direct impact on the spectral regrowth in the mixer.

In the range below 0 dBm reference level the R&S®FSW is fully overloaded. The NPR result is driven by the intermodulation in the A/D converter which is overloaded. No viable measurement is possible in this range.

Above 0 dBm the NPR follows the expected rules for third order intermodulation. The 5 dB-step at 0 dBm reference level leads to a 10 dB improvement in the NPR. The next 5 dB step at +5 dBm does not give another 10 dB improvement as the noise floor prevents such a step. At this point the maximum possible NPR measurement range of 65 dB is reached.

Any further increase of the reference level above 10 dBm leads to a linear loss of NPR measurement range with respect to the RF attenuation setting. Any additional 5 dB step leads to about 5 dB dynamic range loss due to the increased noise floor. The 1 dB steps in the IF (in front of the A/D converter) have very little influence on the noise floor of the R&S®FSW.

6 Test Signal Generation with the R&S®SMW200A

NPR measurements have been difficult in the past as each notch configuration required a band reject filter in the RF path. The band-reject filter is now implemented in the digital baseband of the R&S®SMW to provide notches in all required channels and for all kinds of signals. The baseband signal is I/Q modulated onto an RF carrier. The signal generator output amplifier and the I/Q modulator also contribute to the overall available noise power ratio. Their influence is evaluated in the following.

Test signals for NPR measurements can be band limited noise signals or I/Q modulated test signal. All signals can be easily generated in the R&S®SMW200A. The ARB functionality allows to create noise signals or replay arbitrary waveform files. Additional options allow the real-time generation of OFDM (option R&S®SMW-114), DVB-S2/S2X (option R&S®SMW-116) or OneWeb (option R&S®SMW-130) signals. With the R&S®SMW-K811 notched signals option, up to 25 notches with individual center frequency offset and notch bandwidth are inserted. Alternatively, multi-carrier CW signals can be used in the traditional way. Here, the notch is realized by disabling tones in the multi-carrier spectrum.

6.1 Create notched ARB signals

In the ARB menu, either a user-defined waveform can be loaded or a AWGN test signal can be created (requires option R&S®SMW-K811).

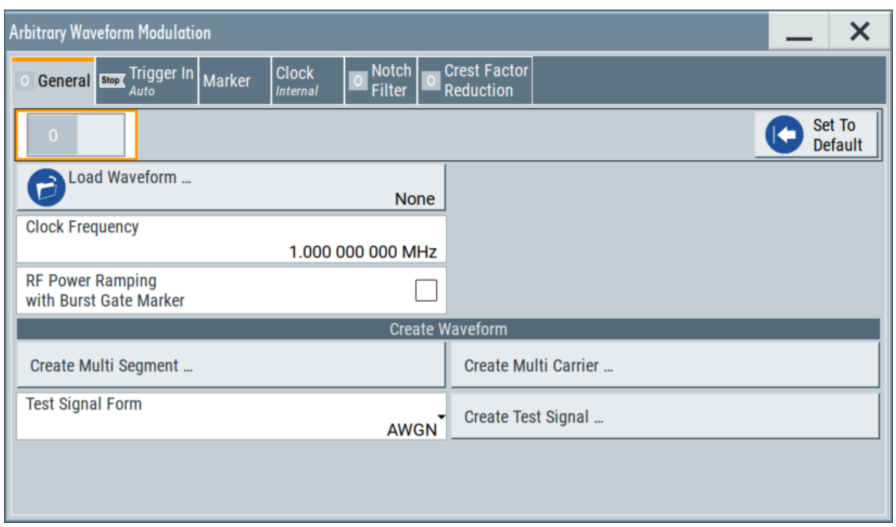


Figure 9: ARB configuration dialog

On creation of an AWGN test signal, the number of samples has to be provided. After clicking on ‘Generate Signal RAM’, the signal is loaded to memory.

Figure 10: AWGN test signal configuration dialog

The noise signal bandwidth can be varied, by adapting the clock frequency parameter.

The next step, adding the notch, is the same irrespective of the using noise or I/Q modulated test signals.

The notched noise option allows definition of up to 25 notches with individual frequency offset and notch bandwidth. The notch bandwidth can be varied between 0 and 10% of the signal sample rate. Separate switching of the notch state (on or off) allows for easy reconfiguration of the test signal.

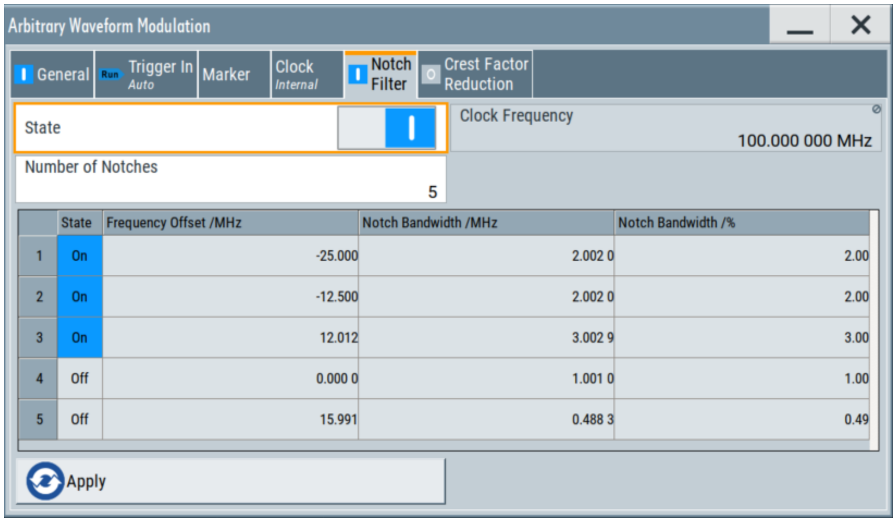


Figure 11: Notch filter configuration dialog (option R&S®SMW-K811)

The notched signals option can also be used in conjunction with internally generated EUTRA/LTE, OFDM, DVB-S2/S2X or OneWeb signals.

Note: The AWGN waveform file generated in the SMW has a definable but finite length of 100 kSa to 1 MSa. When reaching the end of the waveform, the SMW restarts with the first sample, therefore providing a periodic signal to the DUT. With a clock frequency of 500 MHz and a waveform of 1 MSa, the signal has a periodicity of 2 ms. The correspondence of a periodic signal in time domain is a discrete signal in the frequency domain. In other words: our periodic signal corresponds to a discrete frequency domain signal with a line spacing of 500 Hz. This line spacing is clearly smaller than the typical spectrum analyzer RBW setting. Therefore, these lines are not resolved.

Some application software on the market tend to produce very short waveforms (e.g. 10 µs) to produce a wider tone spacing that is easier to resolve. While this approach may be acceptable for some signals, it can be dangerous in other cases, e.g. where signals have a time dependent characteristic, like preamble or bursted signals.

6.2 Create multi-carrier CW signals

Using the multi-carrier CW option (SMW-K61), the user can set number of carriers, carrier spacing and chose a crest factor optimization method. The influence of crest factor optimization is described in section 6.3.

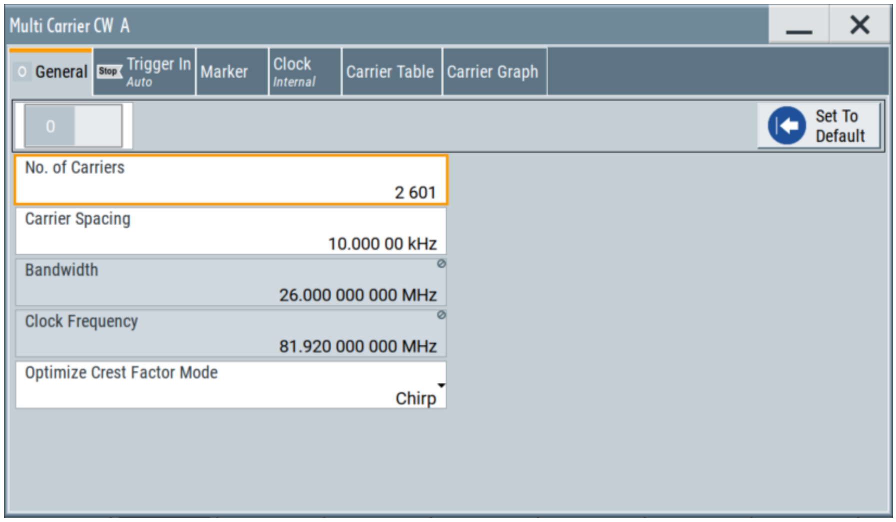


Figure 12: Multi Carrier CW main configuration dialog (option R&S®SMW-K61)

In the tab 'Carrier Table', the required notches can be configured by disabling some carriers. Therefore, a section within the multi-carrier spectrum can be selected by entering the start and stop carrier. This section is then disabled by setting the carrier state to 'Off'.

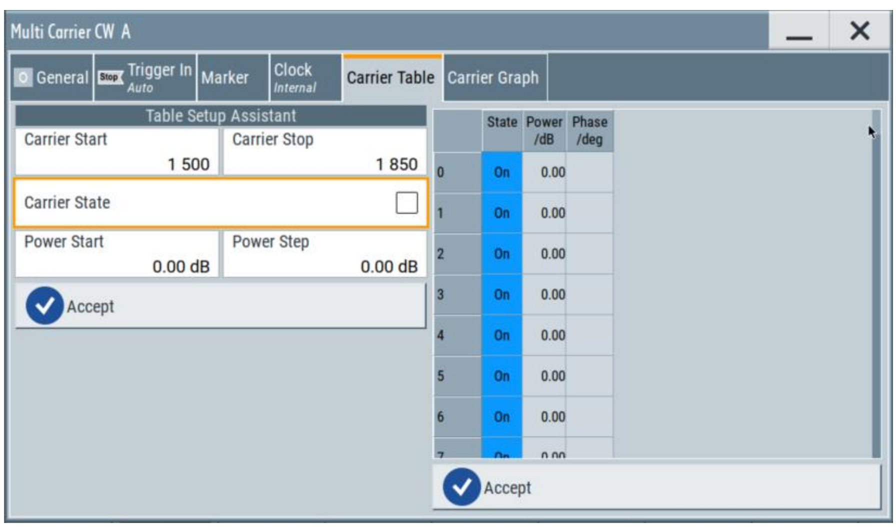


Figure 13: Multi Carrier CW table configuration dialog (option R&S®SMW-K61)

A preview of the configured signal is provided in the 'Carrier Graph' tab.

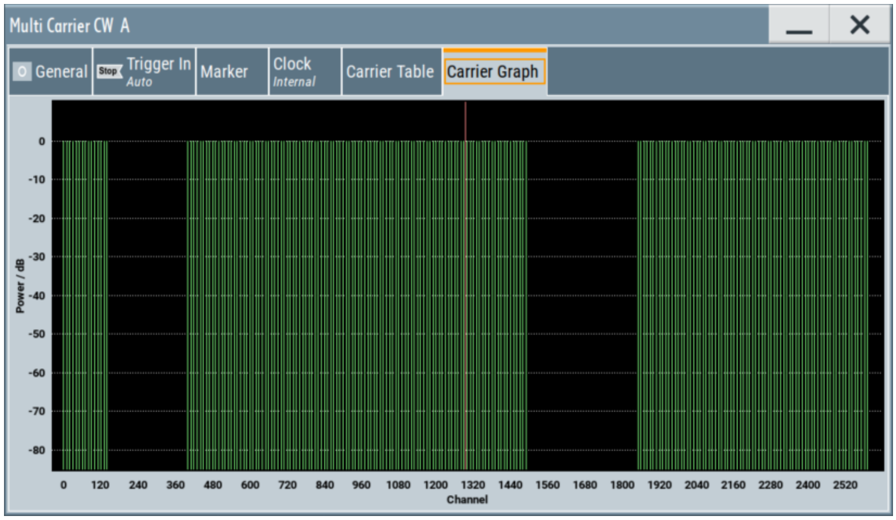


Figure 14: Multi Carrier CW carrier graph (option R&S®SMW-K61)

Hint: When using option R&S®SMW-K61, the notches can be defined without option R&S®SMW-K811

6.3 NPR measurement range limitations

The performance of a vector signal generator for notched signals is limited by the following three main contributions.

- the dynamic range of the digital baseband
- the local oscillator leakage
- the intermodulation products of the RF section (e.g. I/Q modulator, output amplifier)

The R&S®SMW200A offers measures to reduce these impairments to a minimum and provide test signals of highest quality.

The theoretical dynamic range of the internal digital baseband is determined by the resolution of the D/A converter, which is 14 bit for the R&S®SMW200A with R&S®SMW-B9 and 16 bit with R&S®SMW-B10. In practice, the achievable notch depths is reduced by the crest factor of the signal, headroom for frequency response correction and also spurs from the D/A converter.

To maximize the baseband dynamic range, go to **RF → Level…** and set the digital attenuation to -3.5 dB.

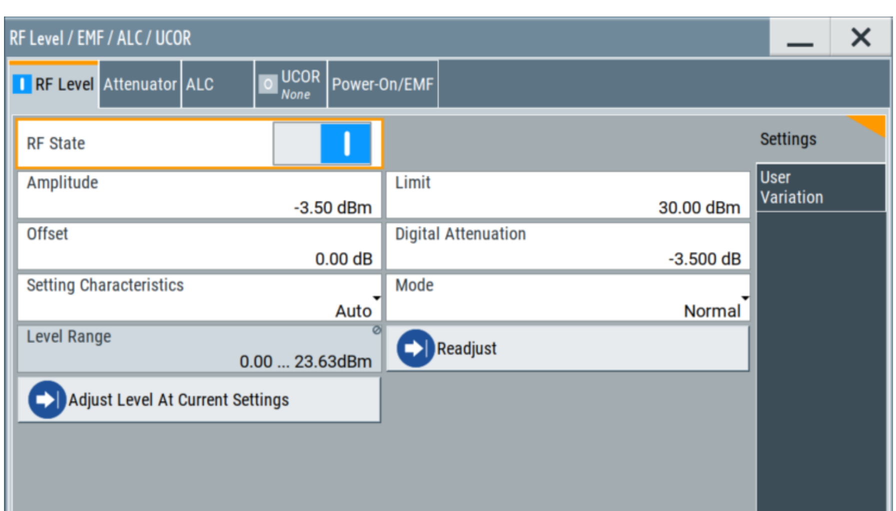


Figure 15: Level configuration dialog

Another factor, which impacts the depths of the notches is the carrier leakage of the LO signal. Due to imperfections in the I/Q modulator a small portion of the unmodulated carrier appears at the output of the modulator. There are two options to eliminate the influence of the local oscillator (LO) on the NPR measurement:

1. Provide a frequency offset to the notches. This way, the leaked LO is still present in the test signal, but does not impair the notch depth.
2. Shift the complete test signal in frequency by providing a baseband frequency offset. E.g. to get a center frequency of 3.5 GHz, the RF frequency is set to 3 GHz and a positive frequency offset of 500 MHz is applied in the digital baseband.

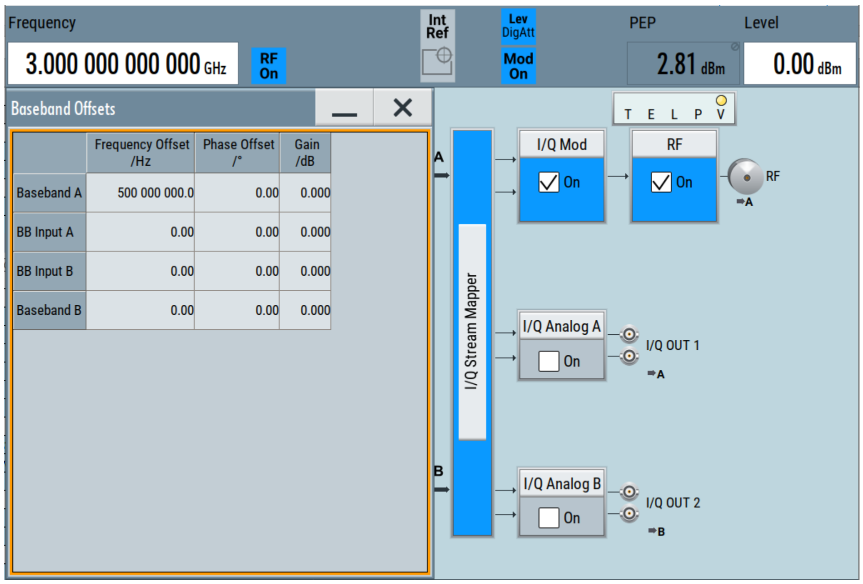


Figure 16: Baseband offsets

As in the spectrum analyzer, also in the signal generator, intermodulation products originating from the RF section can reduce the notch depths. In the R&S®SMW200A the following steps can be performed to optimize the intermodulation characteristics of the test signal:

1. Go to I/Q Mod → I/Q Modulator
2. Monitor the notch depths (without DUT) on the R&S®FSW
3. Vary the value of the parameter "Baseband Gain" until the maximal notch depths is achieved

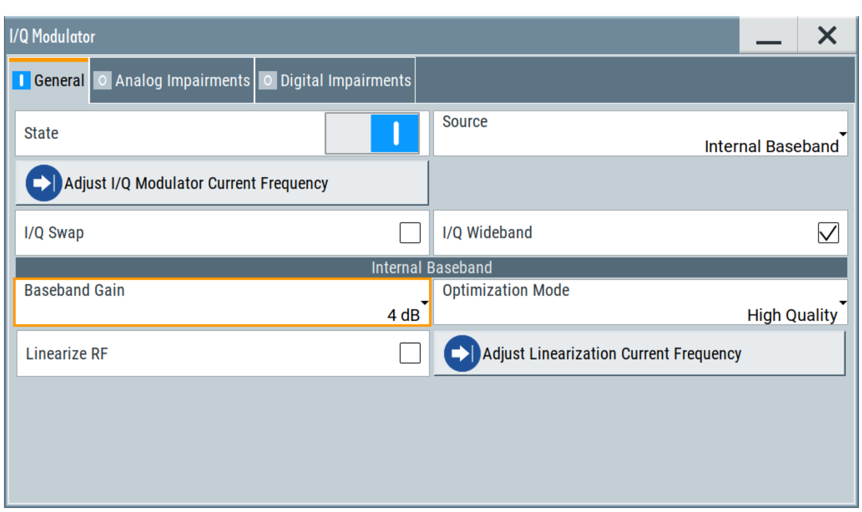
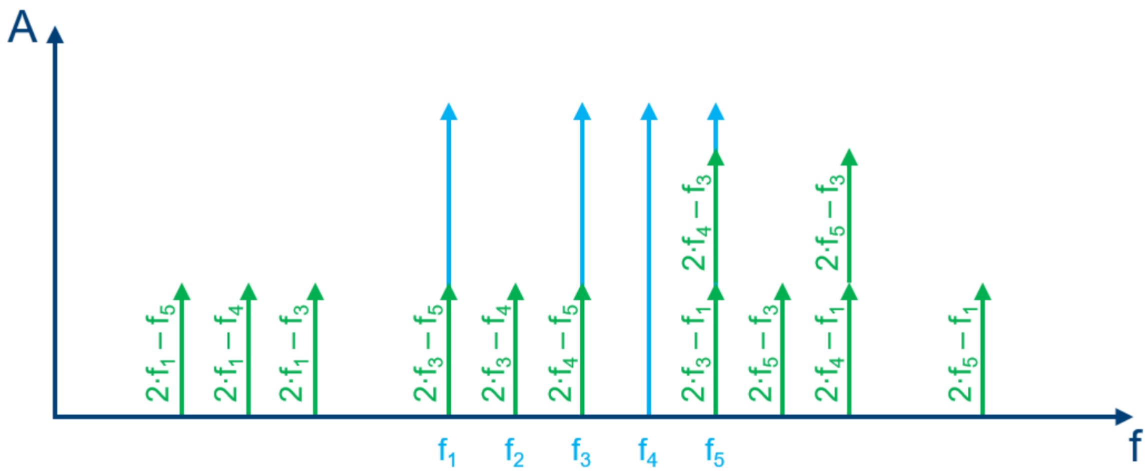


Figure 17: I/Q modulator dialog in R&S□SMW200A

6.4 Dependence on stimulus

As with any intermodulation measurement, the NPR results depend heavily on the input signal (stimulus). To illustrate this, let's have a look at the following multicarrier signal, where a notch was introduced by switching off the carrier at frequency f_2.



In this example, we see that the notch is filled with intermodulation products as expected. Additionally, some intermodulation products coincide with tones of the multicarrier signal. For example, the upper intermodulation product of frequencies f_1 and f_3 has exactly the same frequency as tone f_5. Measuring power on frequency f_5 will give us just about any power reading depending not only on the intermodulation characteristic of the DUT, but also very much on the phases of the three tones. Similarly, there are other intermodulation products that interfere with the tones either constructively or destructively.

Keeping this dependency in mind explains why the result of an NPR measurement depends so much on the stimulus. A measurement result is only meaningful in combination with an accurate description of the stimulus.

Rohde & Schwarz highly recommends to test the DUT with the same signal it faces in real life. Only then the true operational performance can be determined. As an example, for a satellite that was designed to transmit DVB-S2X signals, the ideal stimulus would be a DVB-S2X signal with a notch applied to it.

7 Measurement results with R&S®FSW and R&S®SMW200A

With the following measurements the combined performance of the R&S®SMW200A and the R&S®FSW is evaluated for different test signals. The test signals include a noise signal with 500 MHz bandwidth and a 25 MHz wide notch, a multi-carrier CW signal with 5001 carriers with a spacing of 100 kHz (BW: 500MHz). Carriers 2374 to 2626 are switched off to realize the 25 MHz notch bandwidth. The third test signal is a 500 MHz wide DVB-S2X test signal with 128APSK 3/4 modulation.

The notched noise signal was generated with option R&S®SMW-K811, the notched MCCW signal was generated with option R&S®SMW-K61 and the notched DVB-S2X signal was generated with option R&S®SMW-K116 (DVB-S2X signal) and option R&S®SMW-K811 (notch).

For the purpose of the measurement the spectrum analyzer is set to a fixed reference level of -10 dBm. The RF attenuation is adjusted according to the RMS power of the input signal from the signal generator to keep the mixer input level optimum. Additionally, the baseband gain is varied for optimum intermodulation characteristics in the signal generator.

NPR performance of R&S®FSW and R&S®SMW200A is evaluated at 3.5 GHz, 10 GHz and 32 GHz for a RMS signal power level ranging from -40 dBm to 15 dBm. The LO frequency in the R&S®SMW200A is set 500 MHz below the measured frequency in the R&S®FSW and a baseband offset of 500 MHz is applied. Results are presented in figures 17 to 19.

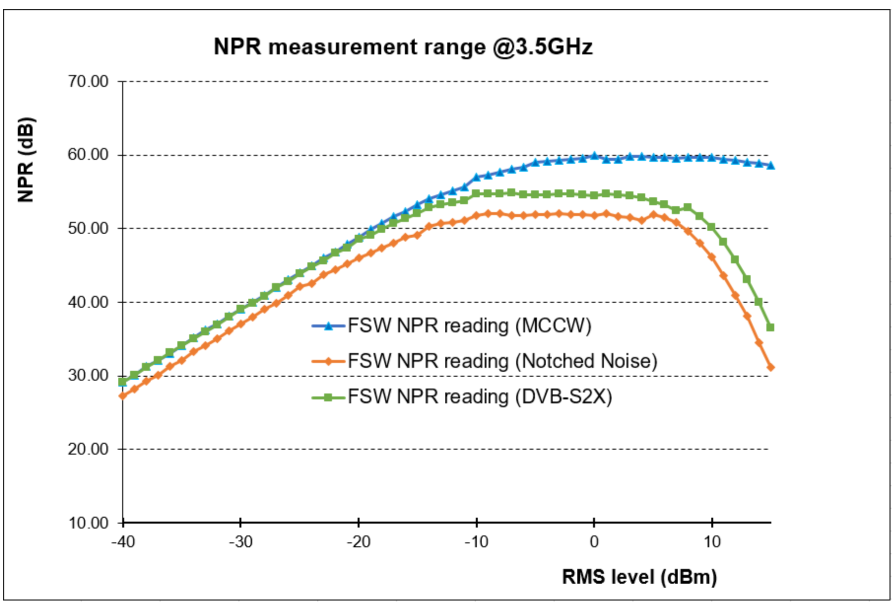


Figure 18: NPR measurement range at 3.5 GHz

As expected, at low input levels the noise floor of the signal generator and spectrum analyzer dominates the available NPR range. With increasing signal level, the available dynamic range increases in both instruments.

The evaluation further shows that the NPR measurement range is dependent on crest factor of test signal. The multicarrier CW signal was generated using crest factor optimization, which yields a crest factor of only 2.8 dB for a signal with 5001 carriers. With this signal the measurement range at 3.5 GHz is up to 60 dB at a signal level of approx. -3 dBm to 12 dBm. With the DVB-S2X test signal with a crest factor of 8.2 dB (incl. notch) the measurement range is up to 55 dB. Even with the noise signal with a crest factor of 11.3 dB (incl. notch), measurements up to 52 dB NPR are possible.

At RMS levels above 6 dBm, the NPR performance decreases for the noise test signal and above 8dBm for the DVB-S2X signal. Considering the crest factor of the signals of 11.3 dB and 8.2 dB, at this RMS level the peak-envelope-power (PEP) of the signals reach the maximum specified output power level of the R&S®SMW200A (17 dBm @3.5 GHz). The output amplifier goes into saturation. This results in increased intermodulation products and reduced NPR measurement range.

Another effect at higher levels, which leads to a degradation of the NPR performance, is the increased noise floor in the R&S®FSW resulting from the increased RF attenuation. This effect is described in chapter 5.2.

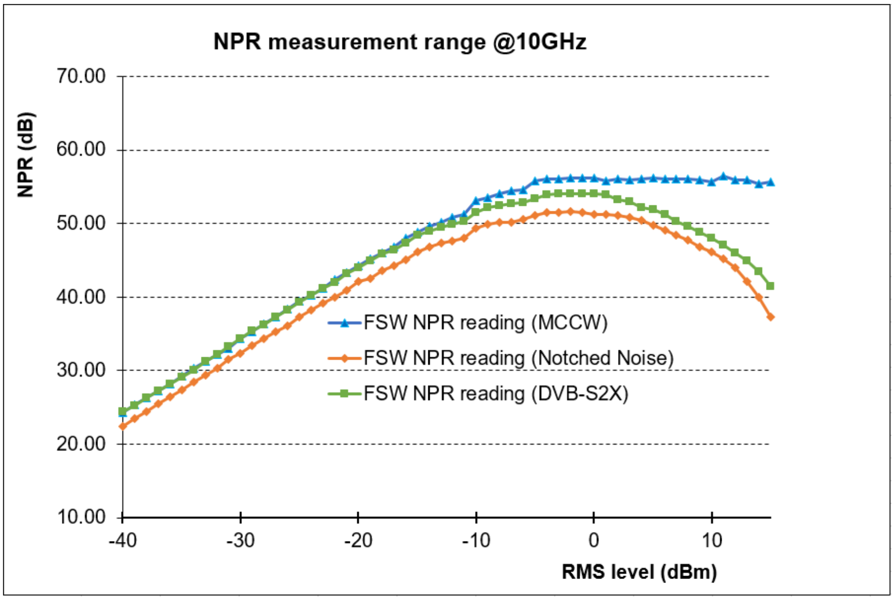


Figure 19: NPR measurement range at 10 GHz

At 10 GHz, the optimum performance is reduced to 56 dB for the MCCW signal, 54 dB for the DVB-S2X signal and 51 dB for the noise signal.

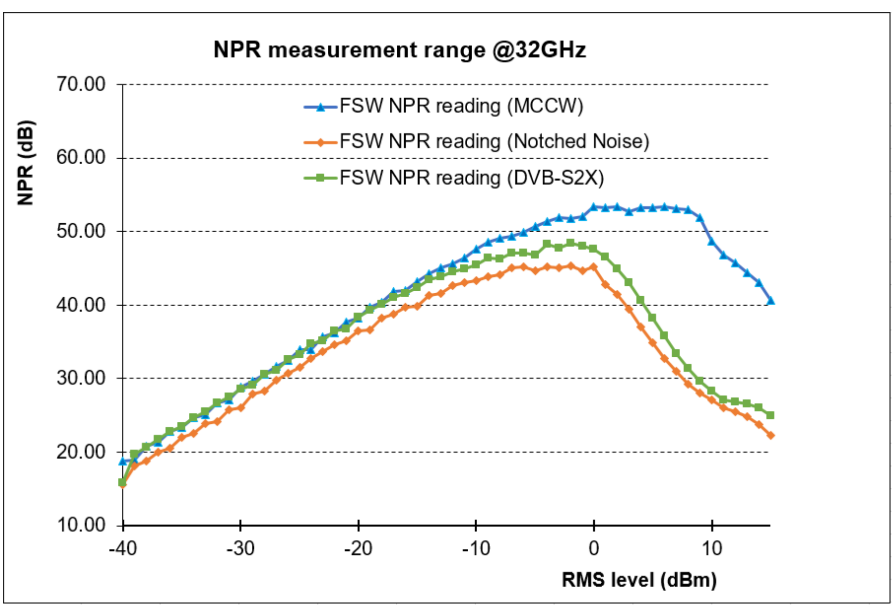


Figure 20: NPR measurement range at 32 GHz

At 32 GHz, NPR measurements up to 53 dB for the MCCW signal, 48 dB for the DVB-S2X signal and 45 dB for the noise signal are possible, depending on the RMS level of the test signal.

Whereas the MCCW test signal provides the deepest notch, most realistic results are obtained with test signals employing the modulation scheme actually used in operation. This way (recommended by R&S®),

the crest factor resulting from the dedicated modulation scheme is already considered in the NPR measurement.

Using AWGN or MCCW test signals with a different crest factor compared to the real I/Q modulated signal used in operation, this difference has to be taken into consideration in the analysis of the NPR measurement results.

8 Combined configuration of R&S®FSW and R&S®SMW200A

NPR measurements require many settings on the generator and the analyzer. Besides setting the frequency and levels, the signal bandwidth and the notch positions must be set. Many of these settings are equal on the signal generator and on the analyzer. The R&S®FSW offers the possibility to take control of the connected generator.

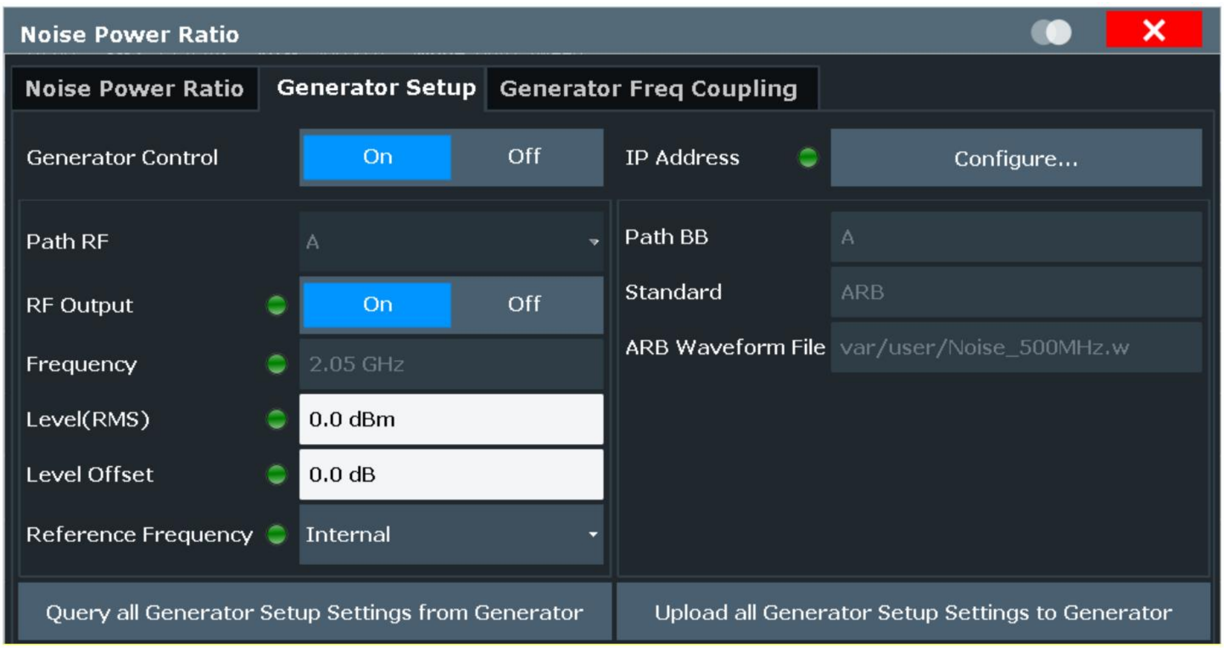


Figure 21: Generator control dialog in the R&S(R)FSW NPR measurement

The generator control configures the connected generator according to the settings in the R&S®FSW-K19 NPR measurement, or the generator settings are loaded into the R&S®FSW.

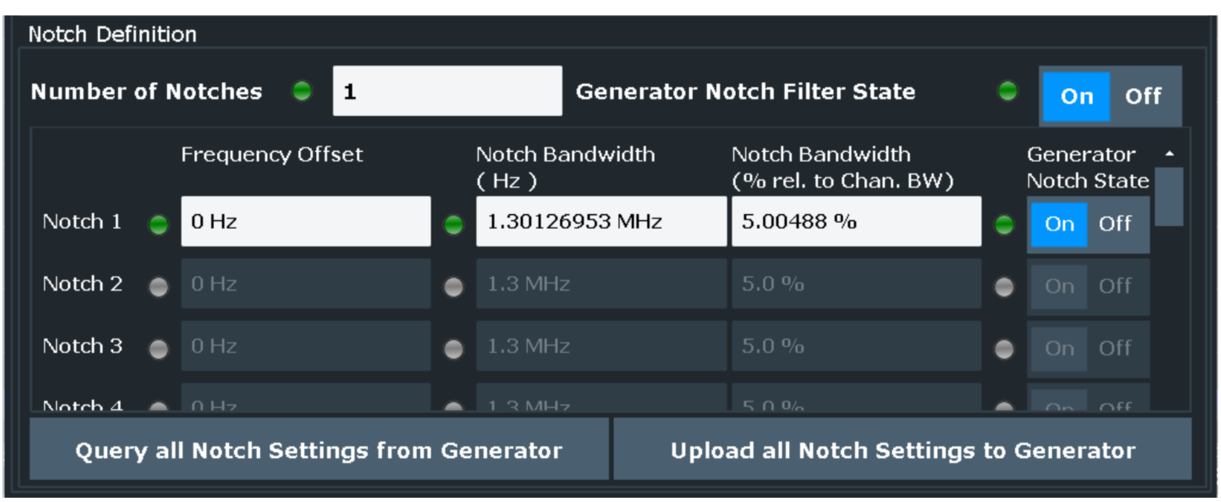


Figure 22: Notch setting dialog in the R&S(R)FSW NPR measurment

Besides the frequency and level settings, the generator control function configures the notch settings of a connected R&S®SMW200A according to the configuration in the R&S®FSW, or the notch settings are loaded from the R&S®SMW-K811. This saves time and efforts and reduces the risk that the settings between the generator and the analyzer do not match.

Note: When using the multicarrier CW option R&S®SMW-K61, combined configuration of R&S®FSW and R&S®SMW200A is not available.

9 Conclusion

The R&S®FSW signal and spectrum analyzer equipped with the option R&S®FSW-K19 forms the basis of a solution for accurate noise power ratio measurements on wideband power amplifiers. The combination with the versatile signal generation capabilities of the R&S®SMW200A makes it the perfect solution to perform NPR measurements under realistic conditions and with a very high dynamic range. Both instruments show excellent RF performance for highest signal quality and measurement accuracy. The integrated automated measurement function in the R&S®FSW makes it easy to use. The 5 d□ step size of the mechanical RF-attenuator offers sufficient resolution of the level setting in order to reach a very high NPR measurement range.

10 Literature

[1] Rohde & Schwarz, *R&S®FSW Signal and Spectrum Analyzer – Product Brochure.*

[2] Rohde & Schwarz, *R&S®FSW Signal and Spectrum Analyzer – Data Sheet.*

[3] Rohde & Schwarz, *R&S®SMW200A Vector Signal Generator – Product Brochure.*

[4] Rohde & Schwarz, *R&S®SMW200A Vector Signal Generator – Data Sheet.*

[5] Analog Devices, *MT-005 TUTORIAL, Noise Power Ratio (NPR) by Walt Kester.*

[6] Rohde & Schwarz, *Application Note 1EF79, Intermodulation Destortion Measurements on the Modern Spectrum Analyzers by Rohde & Schwarz.*

11 Ordering Information

The herein described measurement function for NPR is available in the R&S®FSW equipped with option R&S®FSW-K19 (Noise power ratio measurements).

The herein described signal generation function for notched signals is available in a R&S®SMW200A equipped with option R&S®SMW-K811 (Notched signals). To generate notched DVB-S2X signals additionally R&S®SMW-K116 (DVB-S2/DVB-S2X) is required. For NPR measurements with multicarrier CW signals the R&S®SMW200A must be equipped with option R&S®SMW-K61 (Multicarrier CW Signal Generation).

Please visit the R&S®FSW and the R&S®SMW200A product websites for comprehensive ordering information (“Options”) at www.rohde-schwarz.com.

Designation	Type	Order No.
Vector Signal Generator	R&S®SMW200A	1412.0000.02
Notched Signals for Noise Power Ration Measurements Option, R&S®SMW-B9/B10 required (software license)	R&S®SMW-K811	1414.6364.02
DVB-S2/DVB-S2X Option	R&S®SMW-K116	1414.2630.02
Multicarrier CW Signal Generation Option	R&S®SMW-K61	1413.4280.02
Signal and Spectrum Analyzer	R&S®FSW	1331.5003.xx
Noise Power Ration Measurements Option	R&S®FSW-K19	1331.8283.02

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1EF108 | Version 4e | 03.2022
Application Note | NPR Measurements on satellite signals
Data without tolerance limits is not binding | Subject to change