Application Note

Anritsu Advancing beyond

Receiver Blocking Tests Using Rubidium MG362x1A Signal Generator

What is a Blocking Signal Test?

It is common for today's communication receivers to operate in hostile RF environment where they may have to contend with large unwanted signals whose spectral density is concentrated in narrow frequency band like CW signals. These interfering signals could be within or outside the frequency band in which receiver operates.

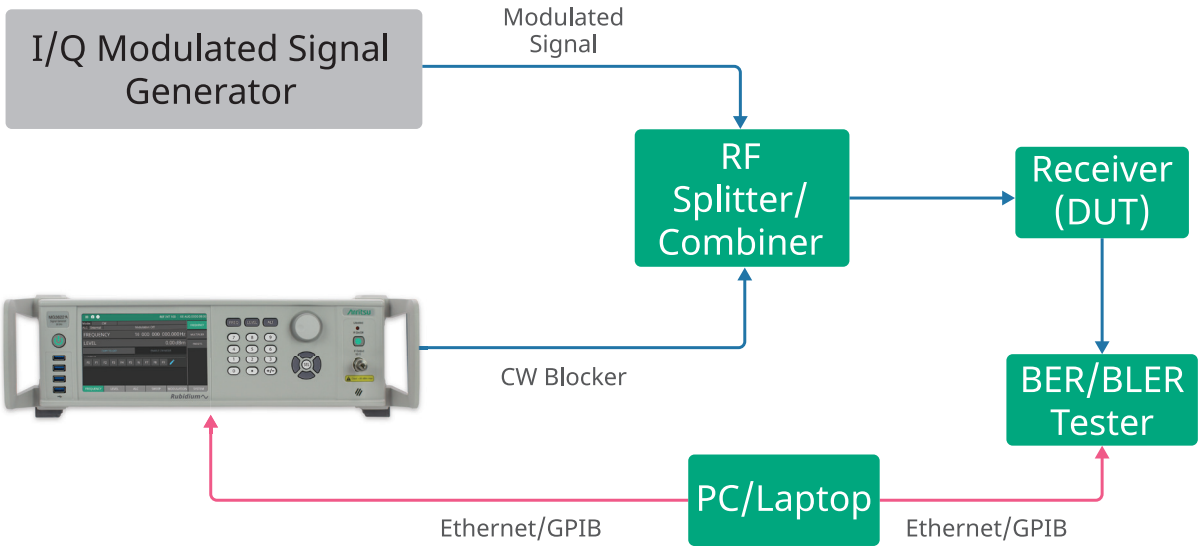
When a small, wanted signal is received along with a large interfering signal at input of the receiver, the interfering signal desensitizes the front-end subsystem which consists typically of a LNA and a mixer or ADC. This happens because the large interfering signal pushes LNA in to compressed region of the gain curve thus reducing the gain of much smaller wanted signal. It results in worsening noise figure of rest of the receiver chain and hence overall sensitivity.

It is desirable that receiver maintain ability to receive and demodulate signals successfully even in the presence of such large interfering signals with highly concentrated spectral energy. Blocking tests are intended to measure receiver's ability to receive, demodulate and decode successfully wanted signals in presence of large interfering signals.

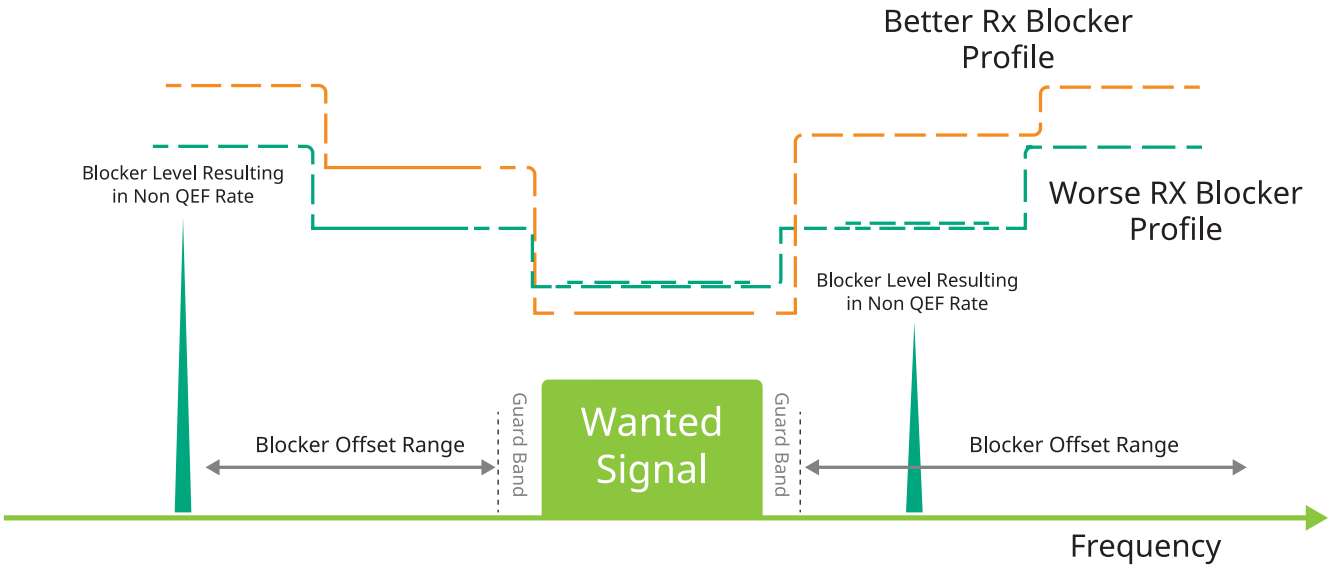
Several communication standards specify blocking test for receivers in their conformance test specifications. 5G NR Base Station Conformance test specification TS 138 141-1, Conformance specification EN 300 328 for equipment operating in 2.4 GHz ISM band which applies to Bluetooth and Wi-Fi are but two examples which specify blocking tests for receivers.

A Generic Receiver Blocking Test Setup

A generic blocking test set up with Rubidium signal generator is shown below. A blocker CW signal from Rubidium is combined with I/Q modulated signal and input into the receiver which is device under test (DUT). Usually, the modulated signal is maintained at a specific level such as 3 dB to 6 dB above the minimum sensitivity of the receiver (DUT). Minimum sensitivity is defined as the signal level at which receiver output has a certain bit error rate (BER) or block error rate (BLER) considered as quasi error free (QEF).



Rubidium, which is acting as the blocker signal generator, is set to a known frequency offset from the modulated signal. The output level of Rubidium is initially set to a low level at which receiver output error rate is not impacted. Then the output level is gradually increased until the receiver output is no longer quasi error free. This level is the max blocker level at which the receiver can output QEF bit rate. Then the output frequency of Rubidium is moved closer to the modulated signal by a specific step size and the whole measurement is repeated at new blocker frequency. In this way Rubidium's output is frequency swept and a graph of blocker frequency vs level is built on either side of the wanted signal for DUT, to assess its robustness against blocker signals.

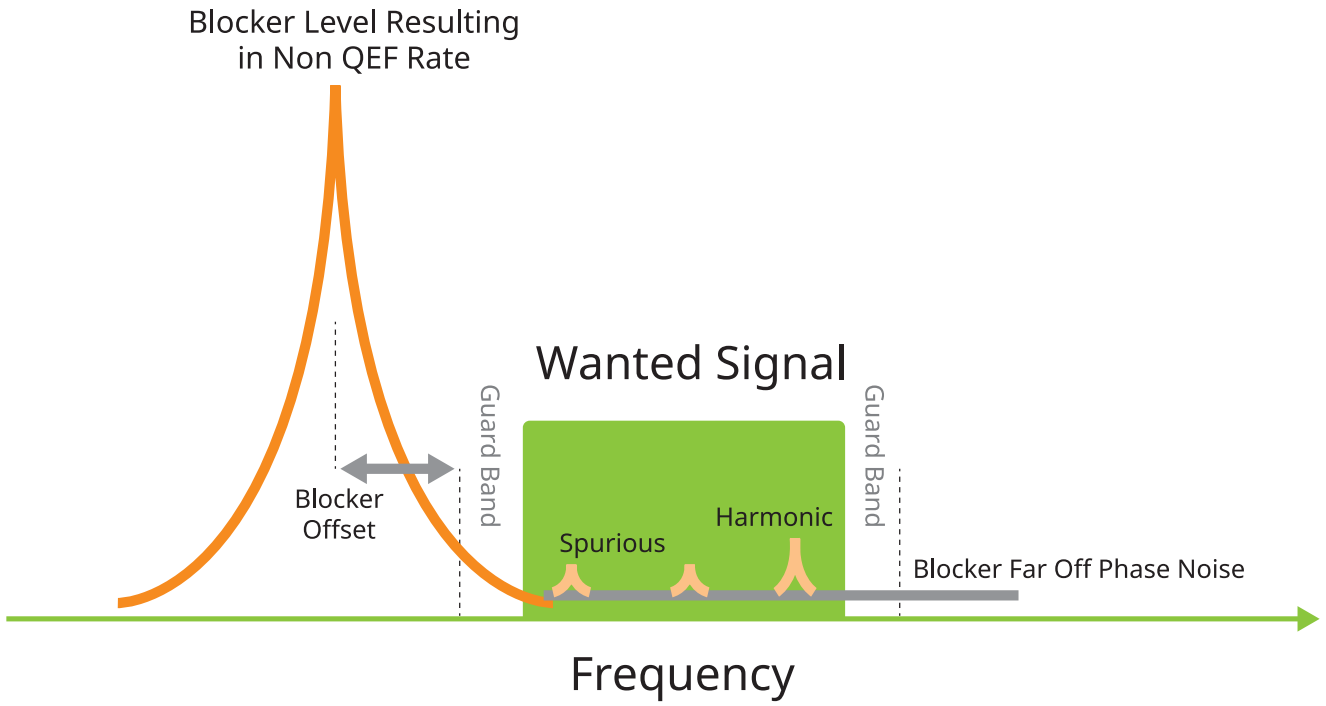


Signal Generator Requirements

Output Power: The larger the offset between wanted and blocking signal in a test, higher is the output power needed of a blocking signal. Hence it is clear that a signal generator used in receiver blocking test should have ability to generate adequately high output power so as to enable blocker measurement even at far away offset from the wanted signal. Rubidium standard output power is +19 dBm for 20 GHz model and +15 dBm for 43.5 GHz model. This output power is more than adequate for blocking tests as specified by almost all LTE/5G, Wi-Fi, WiGig conformance test specifications for receivers.

Harmonic and Spurious: Needless to say Signal generator's harmonic and spurious performance are also important for blocking tests. If a CW signal used as blocking signal has significant second harmonic and if it falls within the wanted signal bandwidth, it will introduce significant error in blocker measurement. The same is true for spurious. Often wanted signal is 50 dB to 60 dB lower than the blocking signal. So even a spurious specification of -75 dBc can result in significant error. Rubidium with industry's best spurious and harmonic performance is well suited for blocking measurements.

Phase Noise: Signal generator phase noise used for generating blocker signal is often overlooked for blocking tests, but it is also important. The far-off phase noise of the signal generator at offsets above 20 MHz contributes to noise within the wanted signal bandwidth, when blocker frequency is close to the signal. The phase noise when integrated over signal bandwidth can adversely impact the overall carrier to noise ratio of wanted signal resulting in inaccurate blocker measurement. The impact is more acute due to worsening of receiver noise figure caused by gain compression. Rubidium's very low phase noise at far off offsets enables users to evaluate receiver's blocking performance better.



5G New Radio Conformance Tests

5G New Radio Conducted Base Station Receiver Tests as per TS 38.141-1 specification address a suite of tests such as reference sensitivity, in band and out of band blocking, intermodulation, dynamic range etc. The out-of-band blocking test measures the receiver's ability to receive a wanted signal at its assigned channel at the antenna connector in the presence of an unwanted interferer out of the operating band, which is a CW signal. Rubidium with its high output power and outstanding harmonic, spurious and phase noise performance is ideally suited for out of band blocking measurements as specified in TS38.141-1.

The test set up needed to measure out of band blocking is very similar to the generic receiver blocking test setup described above in this application note. However, the test process is simpler and requires that CW blocking signal level be fixed at -15 dBm. Wanted signal's power is also fixed to receiver's reference sensitivity specification (REFSENS) + 6 dB. The REFSENS power depends on channel bandwidth and base station type. The frequency of the CW blocker is varied from 1 MHz to 12.75 GHz in 1 MHz steps, excluding the region of wanted signal ± 20 MHz. The throughput of the receiver must be 95% or above for the entire CW blocker sweep. For more details, please refer to TS 38.141-1 specification.

Wi-Fi Receiver Conformance Tests

Conformance specification EN 300 328 is for equipment operating in 2.4 GHz ISM band and applies to Bluetooth and Wi-Fi devices. The specification applies to both FHSS and non FHSS devices and includes conformance test requirements for receiver blocking. Bluetooth and Wi-Fi devices belong to non FHSS category. The blocking test set up is again similar to the generic receiver blocking test set up described above in this application note. The blocking test is carried out with CW blocking signal set at certain set of fixed frequencies in ISM band and level set at -34 dBm. The wanted signal level is also fixed for a given signal bandwidth. With CW blocker set at one of the specified frequencies, the output packet error rate (PER) or frame error rate (FER) is measured and should be less than 10% for test to be considered successful. The blocker is then moved to other specified frequencies and test is repeated.

In summary, receiver blocking tests are an important part of conformance test specifications in many communication standards. All blocking tests require a CW analog signal source to generate blocking signal. Rubidium with its high output power, low harmonic/spurious and ground breaking phase noise performance is ideal choice for receiver blocking tests.

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