APP NOTES

5G FR1 Base Station Receiver Test

LITEPOINT

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Background

3GPP TS 38.141-1 spec defines variety of receiver testing to check the base station receiver performance. The test cases include reference sensitivity, which is a pure FRC signal without interference, dynamic range with AWGN interference and also other complicated test cases with UL signals as interference.

This application note will guide the users to start receiver test with LitePoint solution and device setup.

1.1 Setup

IQxstream-5G+ supports 4x4 MIMO capability base station device test setup, Figure 1. Physical Setup. The recommended setup is to connect the DUT four antenna ports to tester port with the same module: RF1A, RF2A, RF3A and RF4A. On the backplane s ide of the tester, EXT1 can be connected to DUT trigger output signal for 1PPS timing alignment during the test. 10 MHz reference clock in or out port from the tester can be connected to the DUT 10 MHz clock depends on the DUT 10 MHz port design, either input or output.

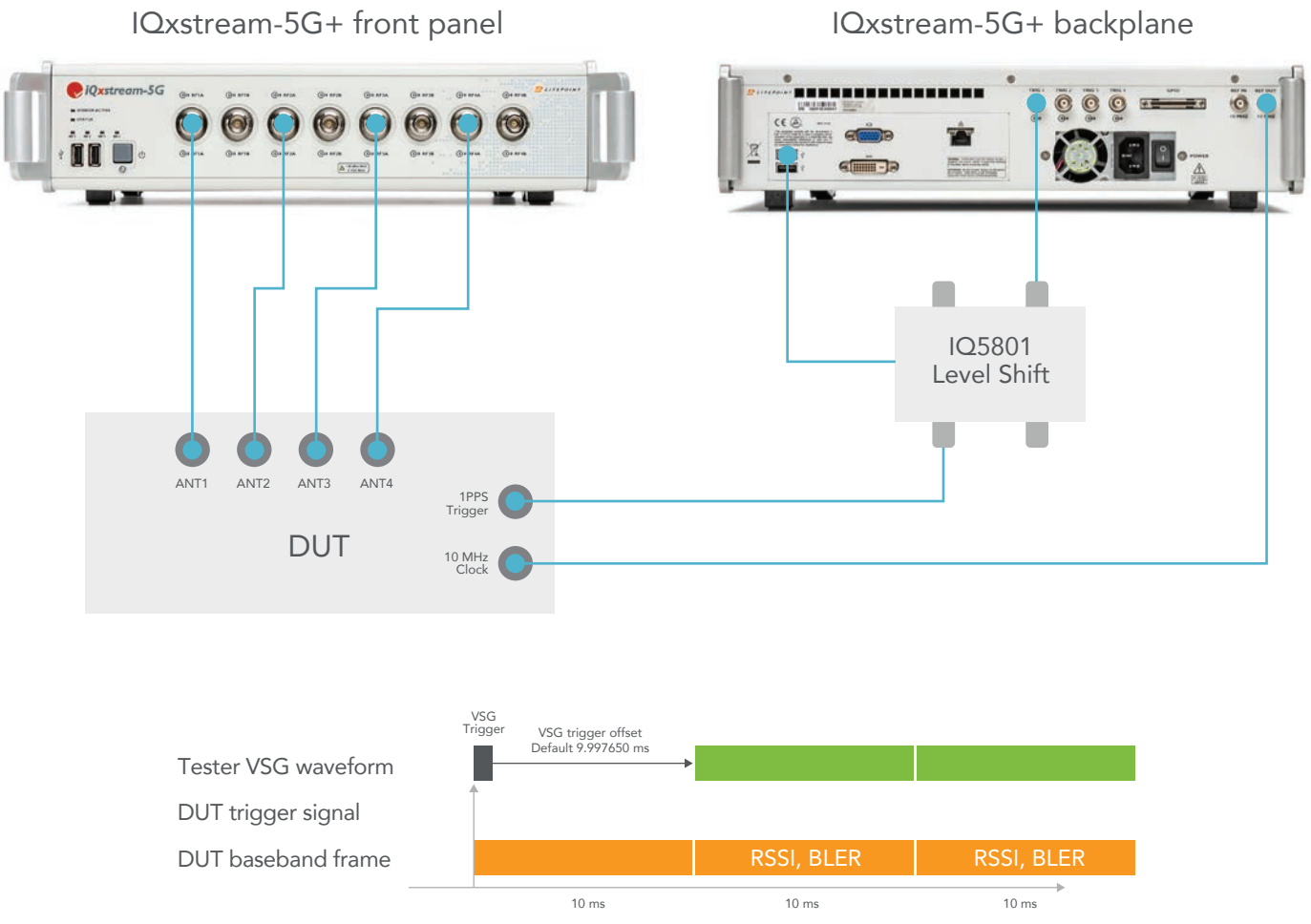

Figure 1. Physical Setup

1.2. Software application

To run the receiver test with IQxstream-5G+, the user requires below applications:

- 0300-5G_MIMO software license, mandatory
- IQmi package on the tester, mandatory
- IQfact5G, optional

IQmi (IQ Measurement Interface) is a simplified interface running in the tester to helps the users configure the test condition more friendly. LitePoint provides a series of IQmi user guide in the IQmi installation package that helps the users to get start with it. IQmi it's a test case based command design, a single test condition could be generated by sending the commands to the tester. For example, a wanted signal level for the desired SCS, BW combination and the test case selection of reference sensitivity/dynamic range/IBB/NBB/ACS/ICS. This is usually for manual test or for the users who want to develop an ATE tool.

IQfact5G is a turnkey application solution. It integrates tester control, DUT control and the sensitivity level searching. A test flow to edit the test cases and a test log, test report will be generated.

Figure 2. IQmi commands interface

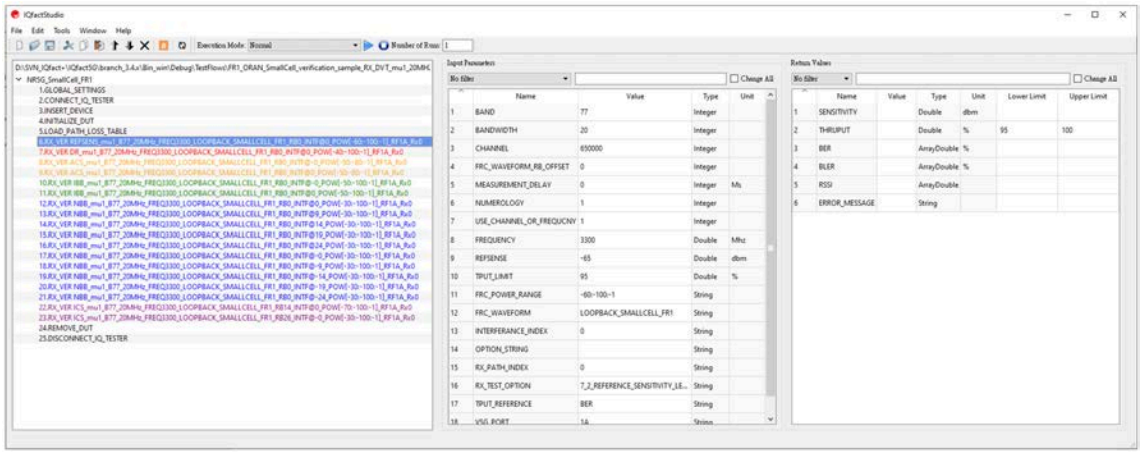

Figure 3. IQfact5G GUI IQfactStudio

All the Receiver Tests sections will have IQmi and IQfact5G examples.

2. Receiver Tests

TS 38.141-1 A.1 and A.2 sections define the FRC fixed reference channels for the receiver test. The parameters for the reference measurement channels are specified in table A.1-1 for FR1 reference sensitivity level, ACS, in-band blocking, out-of-band blocking, receiver intermodulation and in-channel selectivity. Table A.2-1 defines FRC waveforms parameters for dynamic range test.

The A.1-1 waveforms are QPSK while waveforms in A.2-1 for dynamic range test are 16QAM, code rate is the major difference between these two FRC waveform parameters.

Reference Channel	G-FR1-A1-1	G-FR1-A1-2	G-FR1-A1-3	G-FR1-A1-4	G-FR1-A1-5	G-FR1-A1-6	G-FR1-A1-7	G-FR1-A1-8	G-FR1-A1-9	G-FR1-A1-10	G-FR1-A1-11
Subcarrier spacing (kHz)	15	30	60	15	30	60	15	30	60	15	15
Allocated resource blocks	25	11	11	106	51	24	15	6	6	24	105
CP-OFDM Symbols per slot (Note 1)	12	12	12	12	12	12	12	12	12	12	12
Modulation	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Code rate (Note 2)	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3
Payload size (bits)	2152	984	984	9224	4352	2088	1320	528	528	[2088]	[8968]
Transport block CRC (bits)	16	16	16	24	24	16	16	16	16	16	24
Code block CRC size (bits)	-	-	-	24	-	-	-	-	-	-	24
Number of code blocks - C	1	1	1	2	1	1	1	1	1	1	2
Code block size including CRC (bits) (Note 3)	2168	1000	1000	4648	4376	2104	1336	544	544	[2104]	[4520]
Total number of bits per slot	7200	3168	3168	30528	14688	6912	4320	1728	1728	[6912]	[30240]
Total symbols per slot	3600	1584	1584	15264	7344	3456	2160	864	864	[3456]	[15120]

Table 1. FRC parameters for FR1 reference sensitivity level, ACS, IBB, IMD

Reference channel	G-FR1-A2-1	G-FR1-A2-2	G-FR1-A2-3	G-FR1-A2-4	G-FR1-A2-5	G-FR1-A2-6
Subcarrier spacing (kHz)	15	30	60	15	30	60
Allocated resource blocks	25	11	11	106	51	24
CP-OFDM Symbols per slot (Note 1)	12	12	12	12	12	12
Modulation	16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Code rate (Note 2)	2/3	2/3	2/3	2/3	2/3	2/3
Payload size (bits)	9224	4032	4032	38936	18960	8968
Transport block CRC (bits)	24	24	24	24	24	24
Code block CRC size (bits)	24	-	-	24	24	24
Number of code blocks - C	2	1	1	5	3	2
Code block size including CRC (bits) (Note 3)	4648	4056	4056	7816	6352	4520
Total number of bits per slot	14400	6336	6336	61056	29376	13824
Total symbols per slot	3600	1584	1584	15264	7344	3456

Table 2. FRC parameters for FR1 dynamic range

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50MHz	60 MHz	80 MHz	90 MHz	100 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}
15	25	52	79	106	133	160	216	270	N/A	N/A	N/A	N/A
30	11	24	38	51	65	78	106	133	162	217	245	273
60	N/A	11	18	24	31	38	51	65	79	107	121	135

Table 3. NRB for SCS and channel BW configuration

2.1. Reference Sensitivity Level (3GPP TS 38.141-1 Ch.7.2)

The reference sensitivity level is the minimum receiving power level that the base station can keep throughput greater than 95% of its maximum throughput, or in non-signaling test it's usually mapping to 5% BLER or a mapping method to 5% BER. Physically this can be considered as the base station coverage range with 95% maximum throughput.

The reference sensitivity level test condition has different test limits according to the base station class. The wider coverage range base station class requires lower reference sensitivity level to cover wider range UE UL signal. The Medium range base station requires 3 dB lower reference sensitivity power than Local area to support wider distributed UEs, while Wide Area class base station reference power requires 5 dB lower than Medium Range base station.

Bandwidth (MHz)	Sub-carrier Spacing (kHz)	Reference Measurement channel	Wide Area $P_{REFSENS}$ (dBm)			Medium Range $P_{REFSENS}$ (dBm)			Local Area $P_{REFSENS}$ (dBm)		
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz	f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz	f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
5, 10, 15	15	G-FR1-A1-1	-101	-100.7	-100.5	-96	-95.7	-95.5	-93	-92.7	-92.5
10, 15	30	G-FR1-A1-2	-101.1	-100.8	-100.6	-96.1	-95.8	-95.6	-93.1	-92.8	-92.6
10, 15	60	G-FR1-A1-3	-98.2	-97.9	-97.7	-93.2	-92.9	-92.7	-90.2	-89.9	-89.7
20, 25, 30, 35, 40, 45,	15	G-FR1-A1-4	-94.6	-94.3	-94.1	-89.6	-89.3	-89.1	-86.6	-86.3	-86.1
20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-94.9	-94.6	-94.4	-89.9	-89.6	-89.4	-86.9	-86.6	-86.4
20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-95	-94.7	-94.5	-90	-89.7	-89.5	-87	-86.7	-86.5

Table 4. Sensitivity levels test conditions

The TS 38.141-1 spec also defines different FRC parameters for the different numerology and channel BW combinations, due to the FRC waveform occupied RB difference. The FRC waveform is a partial RB configured waveform or a full RB configured waveform to that numerology and BW configure. When the FRC waveform is partial RB configured waveform to a numerology and channel BW, it introduces another test condition FRC RB offset.

Figure 4. shows an example of the numerology 0, channel BW 5 MHz, 10 MHz and 15 MHz. In these three numerology and BW combinations, FRC waveform is G-FR1-A1-1 which is a SCS=15 kHz and 25 RB waveforms. The test conditions for these three combinations could be:

Numerology 0, BW=5 MHz: NRB=25, there is only G-FR1-A1-1 with RB offset 0.

Numerology 0, BW=10 MHz: NRB=52, the interested FRC waveform sensitivity test condition could be the most left RB location or the most right RB location, that is RB offset 0 and RB offset 27.

Numerology 0, BW=15 MHz: NRB=79, the interested FRC waveform sensitivity test condition could be the most left RB location, center RB location and the rightest RB location, that is RB offset 0, RB offset 27 and RB offset 54.

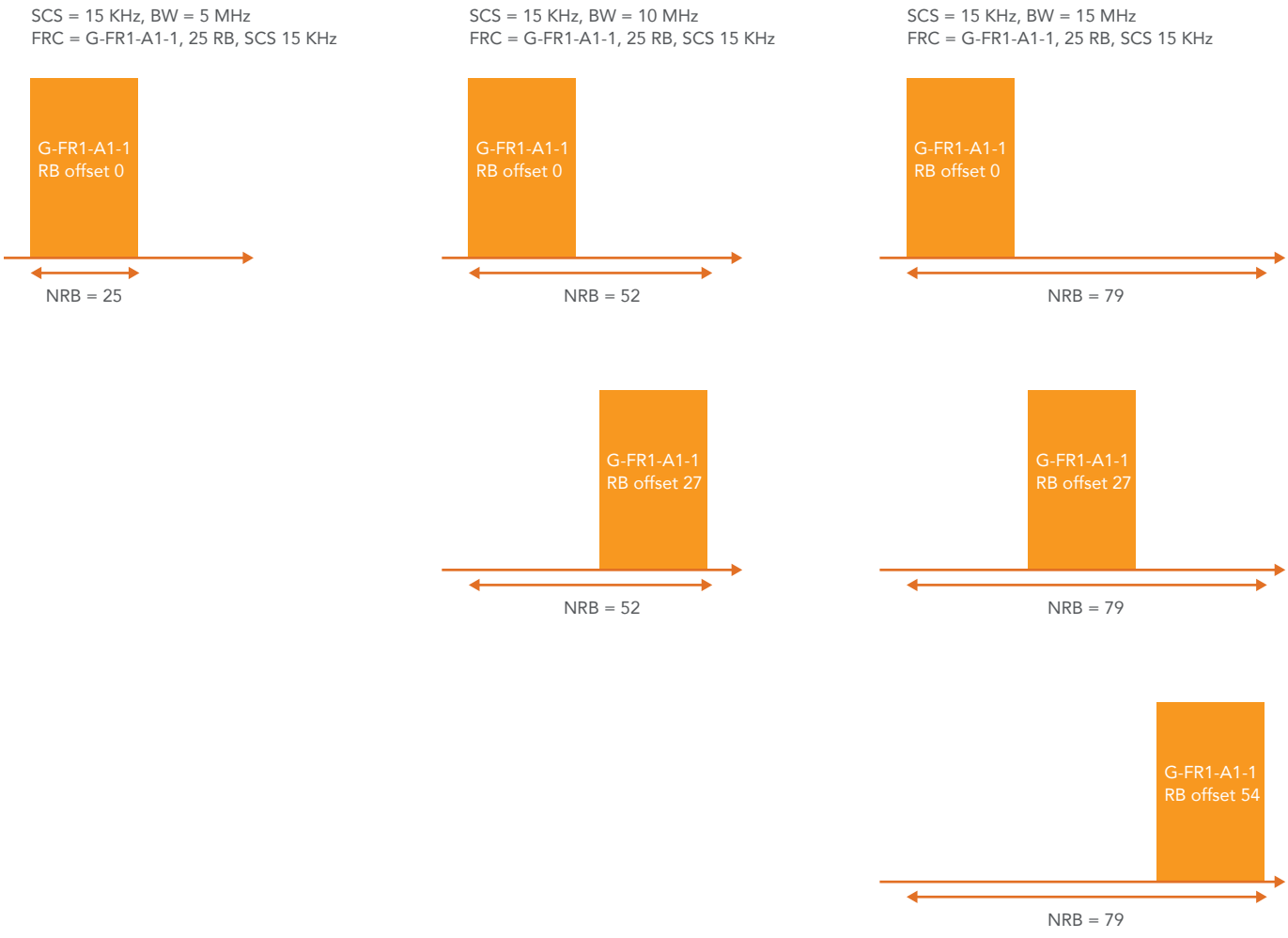

Figure 4. FRC waveform RB offset in a channel BW

2.1.1. Reference Sensitivity Level test with IQmi

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 0.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000"
;
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:CONF SEGMENT_TYPE, RX_START;
IQMI:CELL:CONF RX_TEST_CASE, SENSITIVITY;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_START;
IQMI:CELL:CONF RX_SELECT, PATH_RX_VSG_M1_RF1A;
IQMI:CELL:CONF POWER_DBM, -65;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF RX_TEST_CASE, SENSITIVITY;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

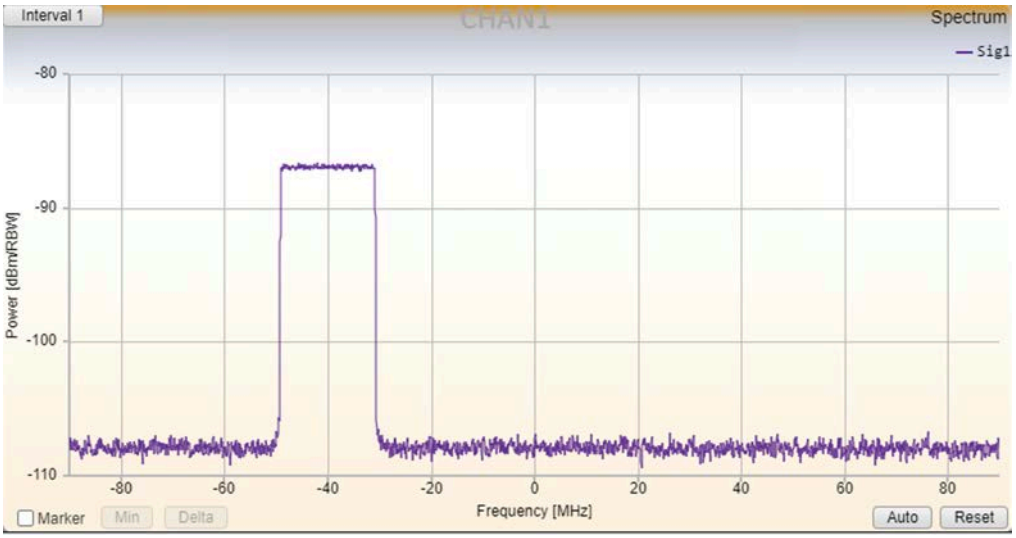

Figure 5. A1-5 waveform RB offset 0 for SCS30 KHz BW100 MHz

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 222.

```
IQMI:CELL:CONF SEGMENT_TYPE, RX_START;
IQMI:CELL:CONF RX_TEST_CASE, SENSITIVITY;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;

IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_START;
IQMI:CELL:CONF RX_SELECT, PATH_RX_VSG_M1_RF1A;
IQMI:CELL:CONF POWER_DBM, -65;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF RX_TEST_CASE, SENSITIVITY;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

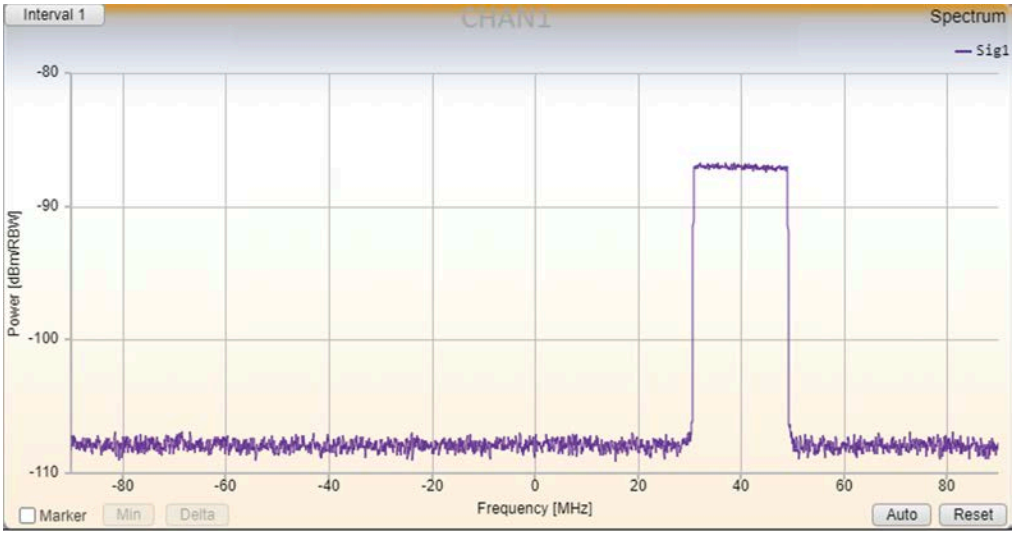

Figure 6. FRC A1-5 waveform RB offset 222 for SCS30KHz BW100 MHz

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.1.2. Reference Sensitivity Level test with IQfact5G

In each IQfact5G NBB test node, it will do sensitivity level searching for the assigned FRC waveform and interference location. To get all interference frequency offset results, the user just need to duplicate the test nodes and change the INTERFERENCE_INDEX value.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_2_REFERENCE_SENSITIVITY_LEVEL

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

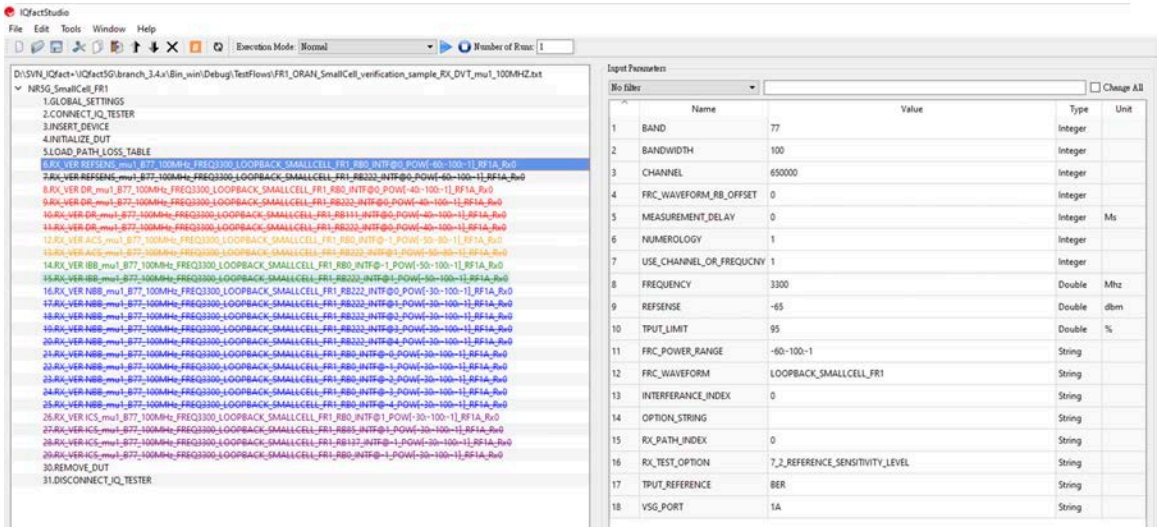

Figure 7. IQfact5G Reference Sensitivity Level test node

Example test log and report from IQfact5G

6.RX_VER REFSENS_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB0_INTF@0_POW[-60:-100:-1]_RF1A_Rx0

SENSITIVITY : -80.00 dbm (,)
THRUPUT : 97.37 % (95, 100)
BER : 2.63 % (,)
BLER : 2.63 % (,)
RSSI : -74.71 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER REFSENS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-60:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-80			PASS
FR1_RX_VER REFSENS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-60:-100:-1]_RF1A_ Rx0_THRUPUT	%	97.37	95	100	PASS
FR1_RX_VER REFSENS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-60:-100:-1]_RF1A_ Rx0_BLER	%	2.634804			PASS
FR1_RX_VER REFSENS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-60:-100:-1]_RF1A_ Rx0_RSSI		-74.713753			PASS

Table 5. IQfact5G Reference Sensitivity Level test result

2.2. Dynamic Range (3GPP TS 38.141-1 Ch.7.3)

AWGN (adaptive white Gaussian noise) is a noise with noise power spectrum density uniform distributed over the visible spectrum. The AWGN is added to any signal or noise in a receiver system. With a AWGN signal input to the receiver the receiver system visible noise floor is raised and the dynamic range compressed.

In this test a FRC waveform with higher modulation QAM than reference level sensitivity is used, 16QAM in Table 2. FRC parameters for FR1 dynamic range. The tester needs to generate the FRC waveform with AWGN added and input the test receiver.

The wanted signal power and AWGN interference power are different for each BW and SCS combination in Table 6. Dynamic Range test conditions. The interference power level in the test condition is defined with the unit dBm/BWconfig because the AWGN is a non-bandlimited signal and must define the power level with a limited bandwidth, that is BWconfig where the actual RB configured in a channel BW. In general the test condition is to give the (wanted signal)/(Interference dBm/BWconfig) the same level over all combinations.

During the test, a AWGN with interference power in this table is generated and the FRC wanted signal power level has to be lower than the wanted signal power level in this table and keep the receiver throughput 95% to its maximum throughput or keeps 5% BLER.

BW (MHz)	SCS (kHz)	FRC	Wide Area Wanted signal power (dBm)	Wide Area Interference power (dBm) / BWConfig	Mid Range Wanted signal power (dBm)	Mid Range Interference power (dBm) / BWConfig	Local Area Wanted signal power (dBm)	Local Area Interference power (dBm) / BWConfig
5	15	G-FR1-A2-1	-70.7	-82.5	-65.7	-77.5	-62.7	-74.5
	30	G-FR1-A2-2	-71.4		-66.4		-63.4	
10	15	G-FR1-A2-1	-70.7	-79.3	-65.7	-74.3	-62.7	-71.3
	30	G-FR1-A2-2	-71.4		-66.4		-63.4	
	60	G-FR1-A2-3	-68.4		-63.4		-60.4	
15	15	G-FR1-A2-1	-70.7	-77.5	-65.7	-72.5	-62.7	-69.5
	30	G-FR1-A2-2	-71.4		-66.4		-63.4	
	60	G-FR1-A2-3	-68.4		-63.4		-60.4	
20	15	G-FR1-A2-4	-64.5	-76.2	-59.5	-71.2	-56.5	-68.2
	30	G-FR1-A2-5	-64.5		-59.5		-56.5	
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
25	15	G-FR1-A2-4	-64.5	-75.2	-59.5	-70.2	-56.5	-67.2
	30	G-FR1-A2-5	-64.5		-59.5		-56.5	
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
30	15	G-FR1-A2-4	-64.5	-74.4	-59.5	-69.4	-56.5	-66.4
	30	G-FR1-A2-5	-64.5		-59.5		-56.5	
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
40	15	G-FR1-A2-4	-64.5	-73.1	-59.5	-68.1	-56.5	-65.1
	30	G-FR1-A2-5	-64.5		-59.5		-56.5	
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
50	15	G-FR1-A2-4	-64.5	-72.1	-59.5	-67.1	-56.5	-64.1
	30	G-FR1-A2-5	-64.5		59.5		-56.5	
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
60	30	G-FR1-A2-5	-64.5	-71.3	-59.5	-66.3	-56.5	-63.3
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
70	30	G-FR1-A2-5	-64.5	-70.7	-59.5	-65.7	-56.5	-62.7
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
80	30	G-FR1-A2-5	-64.5	-70.1	-59.5	-65.1	-56.5	-62.1
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
90	30	G-FR1-A2-5	-64.5	-69.5	-59.5	-64.5	-56.5	-61.5
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	
100	30	G-FR1-A2-5	-64.5	-69.1	-59.5	-64.1	-56.5	-61.1
	60	G-FR1-A2-6	-64.8		-59.8		-56.8	

Table 6. Dynamic Range test conditions

Like reference sensitivity level testing, the FRC waveform is not full RB configured to some channel BW, in that case the FRC waveform RB allocation is another test condition to be considered.

Figure 8. Dynamic range test with FRC waveform RB offset

2.2.1. Dynamic range test with IQmi

Example of dynamic range testing with numerology 1, 100 MHz BW. FRC RB offset 0

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_
VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -43;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 0;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, DYNAMIC_RANGE;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

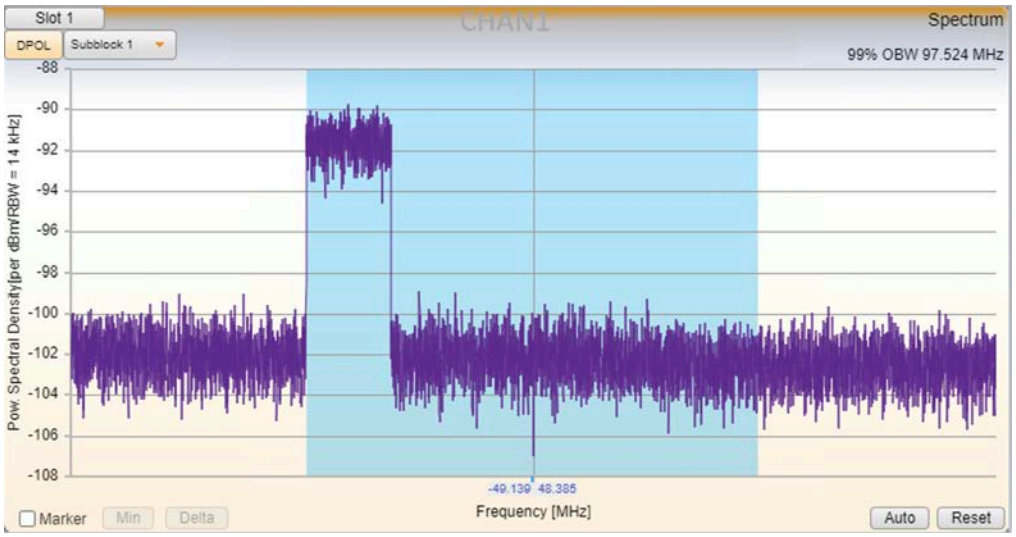

Figure 9. Numerology 1 100 MHz Dynamic range, FRC RB offset

Example of dynamic range testing with numerology 1, 100 MHz BW. FRC RB offset 222

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -43;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 0;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, DYNAMIC_RANGE;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

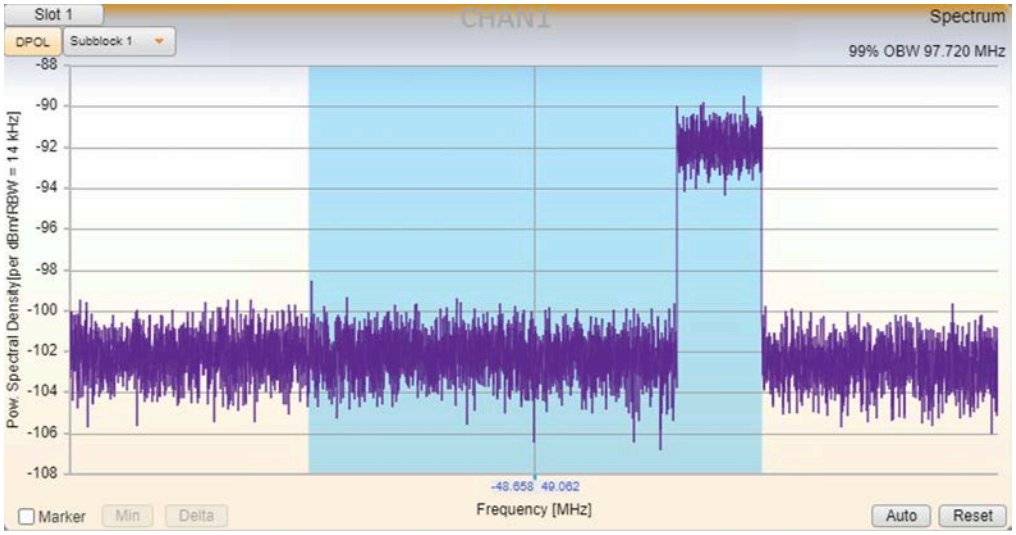

Figure 10. Numerology 1 100 MHz Dynamic range, FRC RB offset 22

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.2.2. Dynamic range test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_3_DYNAMIC_RANGE

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

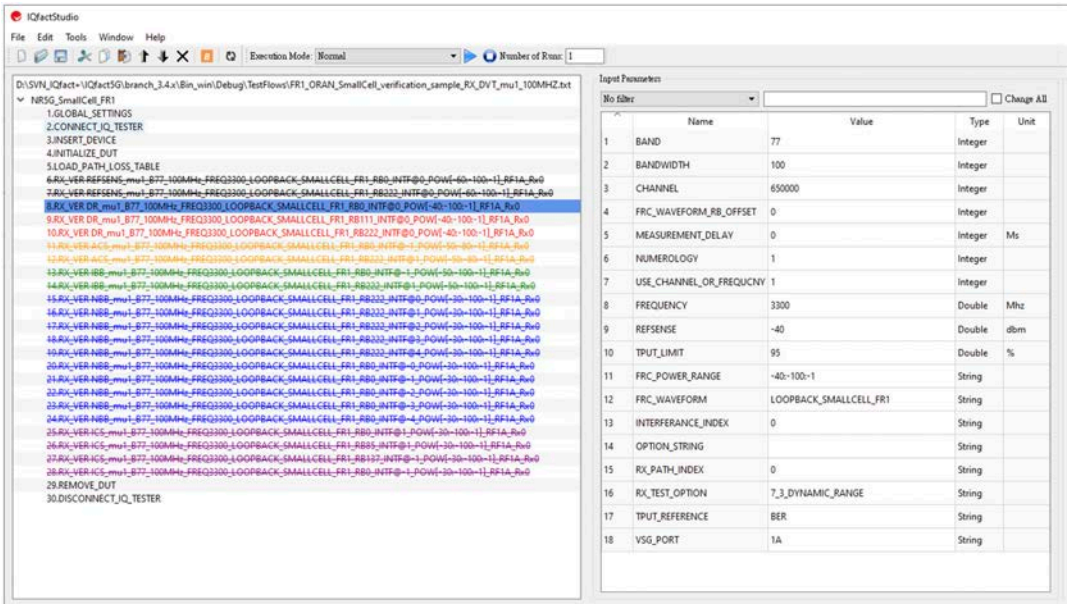

Figure 11. IQfact5G Dynamic range test node

Example test log and report from IQfact5G

10.RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB222_INTF@0_POW[-40:-100:-1]_RF1A_Rx0

SENSITIVITY : -60.00 dbm (,)
THRUPUT : 95.95 % (95, 100)
BER : 4.05 % (,)
BLER : 4.05 % (,)
RSSI : -58.58 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-60			PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_THRUPUT	%	96.11	95	100	PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_BLER	%	3.890931			PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_RSSI		-58.4271			PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-60			PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_THRUPUT	%	95.95	95	100	PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_BLER	%	4.050926			PASS
FR1_RX_VER DR_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@0_POW[-40:-100:-1]_RF1A_ Rx0_RSSI		-58.5815			PASS

2.3. Adjacent Channel Selectivity (3GPP TS 38.141-1 Ch.7.4.1)

Adjacent channel selectivity (ACS) is to test the receiver performance when there is a UE transmitting UL signal just adjacent to the base station serving UE UL channel, the interference and wanted signal test condition is listed in Table 7. Adjacent channel selectivity test condition. Channel BW below 20 MHz are tested with 5 MHz UL interference channel while channel BW above 20 MHz tested with 20 MHz UL interference.

The interference frequency center is located about half of the interference channel BW to the wanted signal channel edge. The wanted signal is same as reference sensitivity test FRC waveform which is either full RB to channel BW or partial allocated RB to the channel BW that means the wanted signal RB offset is also a test condition, Figure 12. FRC waveform RB offset in adjacent channel selectivity test.

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of interfering signal
5	±2.5025	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
10	±2.5075	
15	±2.5125	
20	±2.5025	
25	±9.4675	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
30	±9.4725	
35	±9.4625	
40	±9.4675	
45	±9.4725	
50	±9.4625	
60	±9.4725	
70	±9.4675	
80	±9.4625	
90	±9.4725	
100	±9.4675	

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)	Interfering signal mean power (dBm)
5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100	$P_{REFSENS}$ + 6 dB	Wide Area BS: -52 Medium Range BS: -47 Local Area BS: -44

Table 7. Adjacent channel selectivity test condition

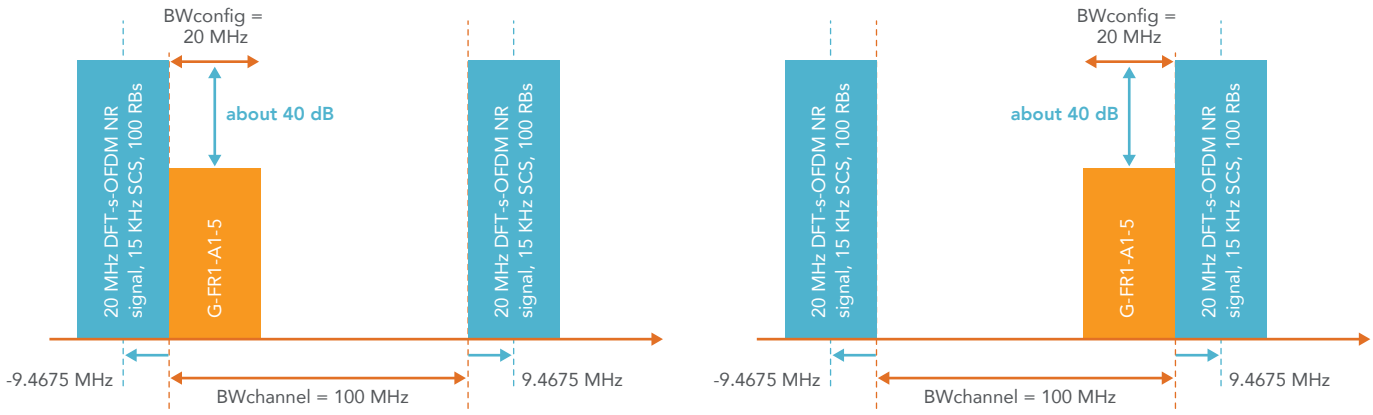

Figure 12. FRC waveform RB offset in adjacent channel selectivity test

When the receive signal level is low the received usually likes to have a higher LNA gain to amplify the signal to have a better SNR, however the adjacent channel interference signal level is about 40 dB higher than the PSENSE, it's a RF component nature that setting a high gain to a high power signal could bring signal nonlinearity that increase the spectrum side lope and contribute noise to wanted signal, Figure 13. Adjacent channel interference impact.

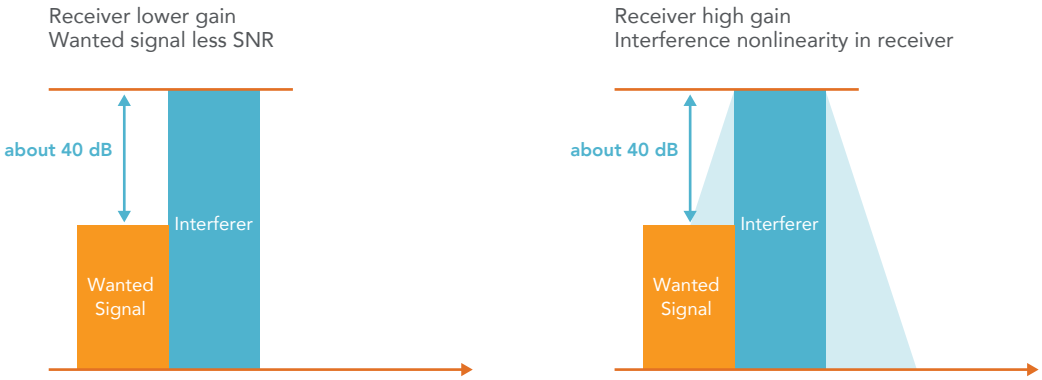

Figure 13. Adjacent channel interference impact

2.3.1. Adjacent channel selectivity test with IQmi

Example of adjacent channel selectivity testing with numerology 1, 100 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX -1

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -65;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, ACS;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

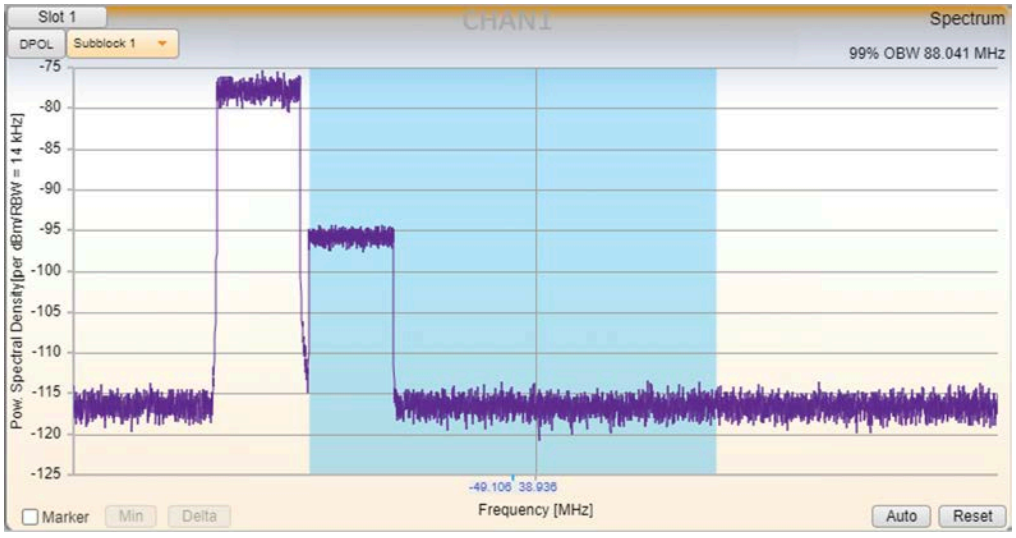

Figure 14. Numerology 1 100 MHz Dynamic range, FRC RB offset 0, INTERFERENCE_INDEX -1

Example of dynamic range testing with numerology 1, 100 MHz BW. FRC RB offset 222, INTERFERENCE_INDEX 1

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -65;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, ACS;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

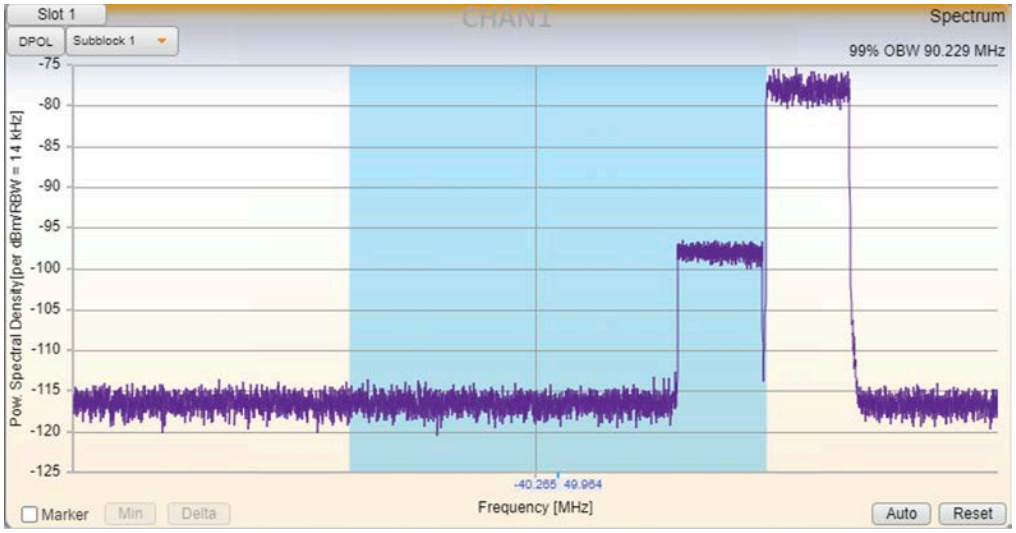

Figure 15. Numerology 1 100 MHz Dynamic range, FRC RB offset 222, INTERFERENCE_INDEX 1

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.3.2. Adjacent channel selectivity test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_4_1_ADJACENT_CHANNEL_SELECTIVITY

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency location.
INTERFERENCE_INDEX > 0, the interference will locate at the right side of the channel
INTERFERENCE_INDEX < 0, the interference will locate at the right side of the channel

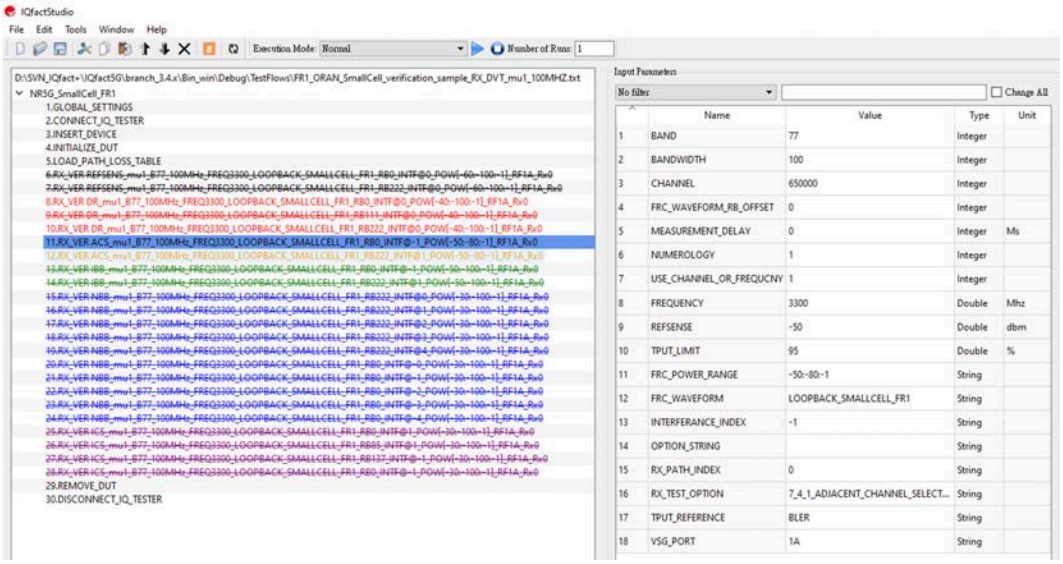

Figure 16. IQfact5G Adjacent channel selectivity test node

Example test log and report from IQfact5G

12.RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB222_INTF@1_POW[-50:-80:-1]_RF1A_Rx0

SENSITIVITY : -60.00 dbm (,)
THRUPUT : 100.00 % (95, 100)
BER : 0.00 % (,)
BLER : 0.00 % (,)
RSSI : -59.72 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-80:-1]_RF1A_Rx0_ SENSITIVITY	dbm	-69			PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-80:-1]_RF1A_Rx0_ THRUPUT	%	99.99	95	100	PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-80:-1]_RF1A_Rx0_ BLER	%	0.006808			PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-80:-1]_RF1A_Rx0_ RSSI		-68.2995			PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-80:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-60			PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-80:-1]_RF1A_ Rx0_THRUPUT	%	100	95	100	PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-80:-1]_RF1A_ Rx0_BLER	%	0			PASS
FR1_RX_VER ACS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-80:-1]_RF1A_ Rx0_RSSI		-59.724			PASS

2.4. In-band Blocking (3GPP TS 38.141-1 Ch.7.4.2)

In-band blocking is to test receiver performance when there is an UL interference signal adjacent to the wanted signal 2 times the UL interference signal BW away from the wanted signal frequency center. The UL interference signal and the wanted signal are in the same operation band so it's known as In-band blocking.

The in-band blocking wanted signal is FRC waveform same as the reference sensitivity test, Table 1. FRC parameters for FR1 reference sensitivity level, ACS, IBB, IMD, ACS. While the FRC waveform is not full RB allocated to all channel BW, the FRC waveform RB offset is also one test condition, Figure 17. In--band blocking.

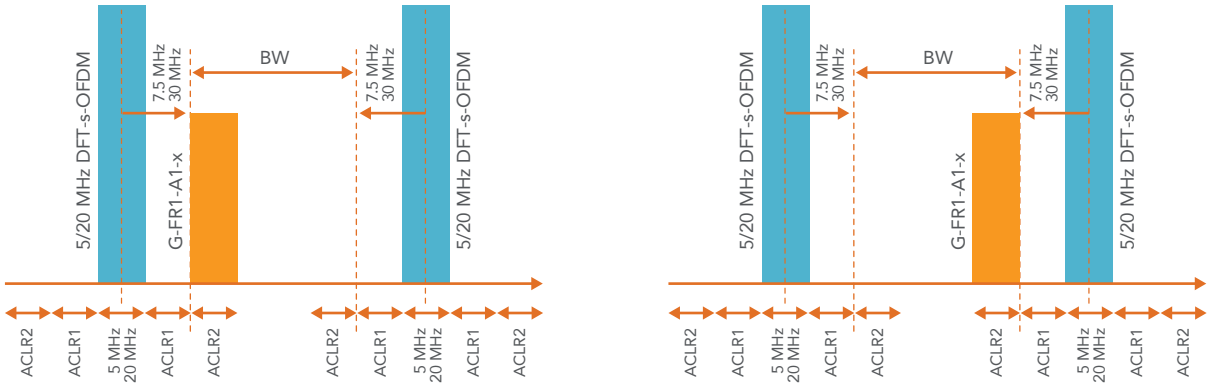

Figure 17. In-band blocking

The test requirement is to have UL interference signal level generated at -43 dBm for wide area BS, -38 dBm for medium range BS and -35 dBm for local area BS. While the wanted signal level has to be lower than PREFERENCE + 6 dB and still gives the throughput more than 95% of the maximum throughput, or BLER less than 5%.

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm) (Note 2)	Interfering signal mean power (dBm)	Interfering signal centre frequency minimum offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap (MHz)	Type of interfering signal
5, 10, 15, 20	$P_{REFSENS}$ + 6 dB	Wide Area BS: -43 Medium Range BS: -38 Local Area BS: -35	±7.5	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	$P_{REFSENS}$ + 6 dB	Wide Area BS: -43 Medium Range BS: -38 Local Area BS: -35	±30	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs

Table 8. Inband blocking test requirement

2.4.1. In-band blocking test with IQmi

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX -1.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -82;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, IBB;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

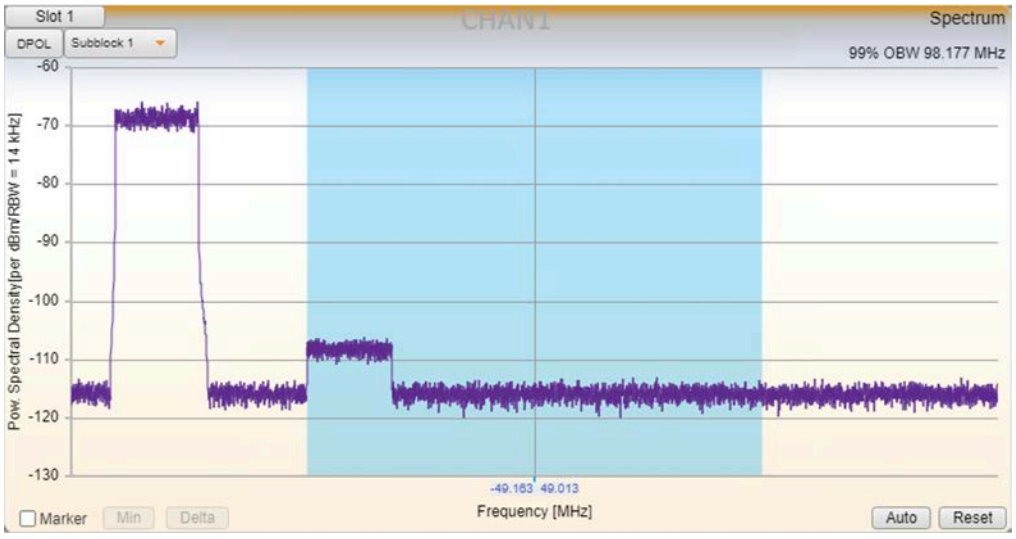

Figure 18. Numerology 1 100 MHz IBB, INTERFERENCE_INDEX -1

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 222, INTERFERENCE_INDEX 1

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -82;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, IBB;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

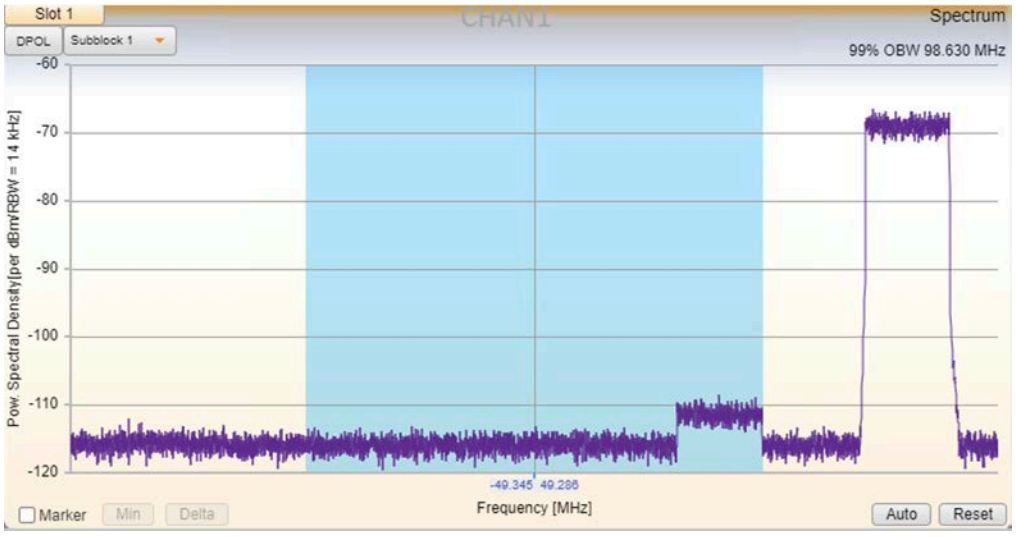

Figure 19. Numerology 1 100 MHz NBB, INTERFERENCE_INDEX 1

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.4.2. In-band blocking test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_4_2_INBAND_BLOCKING

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency offset. With a negative value it gives the blocking interference at the left side while with a positive INTERFERENCE_INDEX it gives the blocking interference locates at the right side.

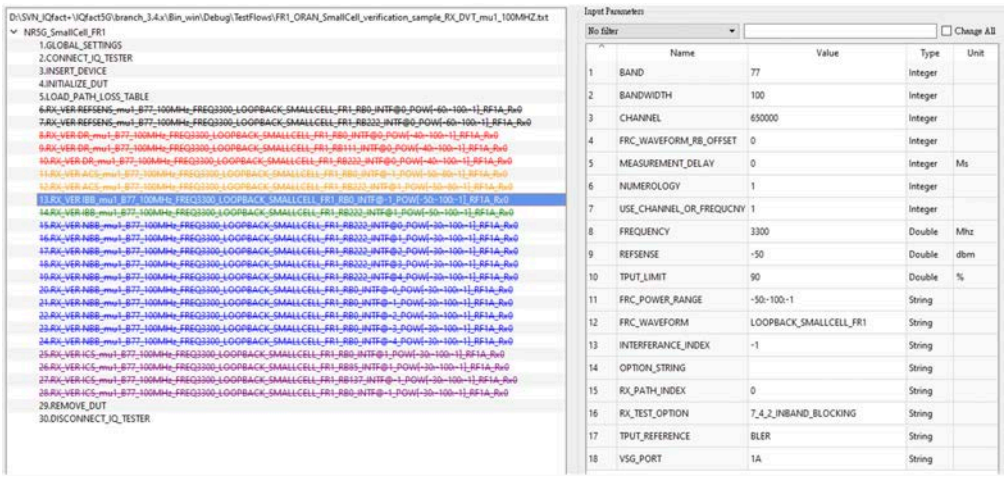

Figure 20. IQfact5G Narrowband blocking test node

Example test log and report from IQfact5G

14.RX_VER IBB_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_RF1A_Rx0

SENSITIVITY : -81.00 dbm (,)
THRUPUT : 92.93 % (95, 100)
BER : 7.07 % (,)
BLER : 7.07 % (,)
RSSI : -76.01 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER IBB_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-81			PASS
FR1_RX_VER IBB_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_RF1A_ Rx0_THRUPUT	%	92.93	90	100	PASS
FR1_RX_VER IBB_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_RF1A_ Rx0_BLER	%	7.073802			PASS
FR1_RX_VER IBB_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_RF1A_ Rx0_RSSI		-76.0077			PASS

Table 9. IQfact5G Narrowband blocking test result

2.5. Narrowband Blocking (3GPP TS 38.141-1 Ch.7.4.2)

Narrowband blocking is to have a 1RB UL signal as the interference signal adjacent to the channel bandwidth edge, Figure 21. Narrowband blocking. The whole interference power distributed on the single RB therefore the power spectrum density of the interference is much higher than the wanted signal. This could be challenging when the interference close to wanted signal.

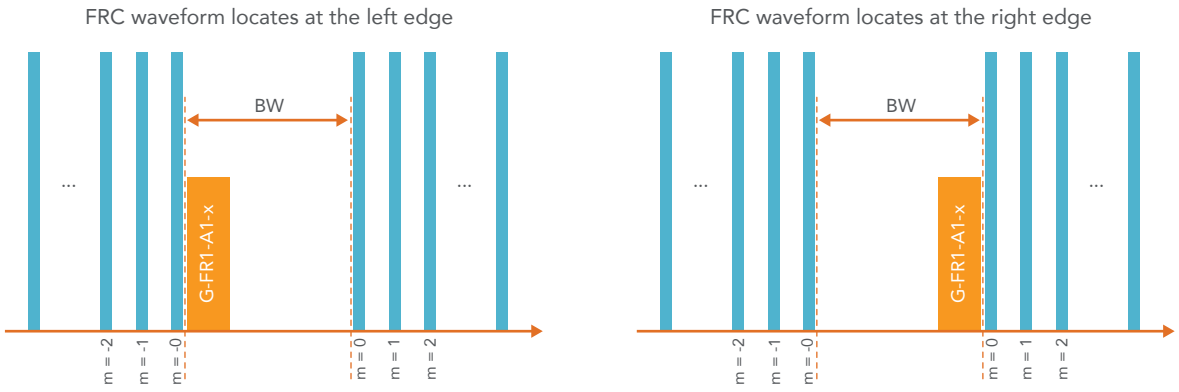

Figure 21. Narrowband blocking

According to the base station class, the 1RB interference power level is different. A wide Area class BS has to be tested with -49 dBm interference power level, while Medium Range BS and Local Area BS are tested with -44 dBm and -41 dBm. The wider the coverage of the base station, the lower interference level since the UEs are more far away from the base station and gives a lower interference power level.

The FRC waveform to narrowband blocking is same as reference sensitivity level test, Table 1. FRC parameters for FR1 reference sensitivity level, ACS, IBB, IMD, ACS. While testing the FRC waveform is possible to be a partial RB to the full channel BW, in this case the FRC waveform RB offset is a test condition to be tested. When FRC waveform locates at the left side channel edge, it is sensitive to the left side interference while when it locates at the right side it is sensitive to the interference at the right side.

Multiple interference frequency offset to the channel edge has to be tested, Table 11. Narrowband blocking interference frequency offset.

The minimum requirement is having the wanted signal power level lower than $P_{REFSENS}$ + 6 dB but still can have 95% maximum throughput, for each FRC waveform location and each interference frequency offset. The PREFSENS is the minimum requirement in Table 4. Sensitivity levels test conditions.

BS channel bandwidth (MHz)	Wanted signal power (dBm)	UL 1RB Interfering power (dBm)
5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	$P_{REFSENS}$ + 6 dB	Wide Area BS: -49 Medium Range BS: -44 Local Area BS: -41

BS channel bandwidth (MHz)	Interfering RB centre frequency offset (kHz)	Interfering signal
5	±(350+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB
10	±(355+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
15	±(360+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
20	±(350+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
25	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	20 MHz DFT-s-OFDM NR signal, 15 kHz SCS, 1 RB
30	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
35	±(560+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
40	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
45	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
50	±(560+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
60	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
70	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
80	±(560+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
90	±(570+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	
100	±(565+m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 99	

Table 11. Narrowband blocking interference frequency offset

2.5.1. Narrowband blocking test with IQmi

Example of reference level testing with numerology 1, 20 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX -14.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -44;
IQMI:CELL:CONF CBW_HZ, 20e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -14;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, NBB;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

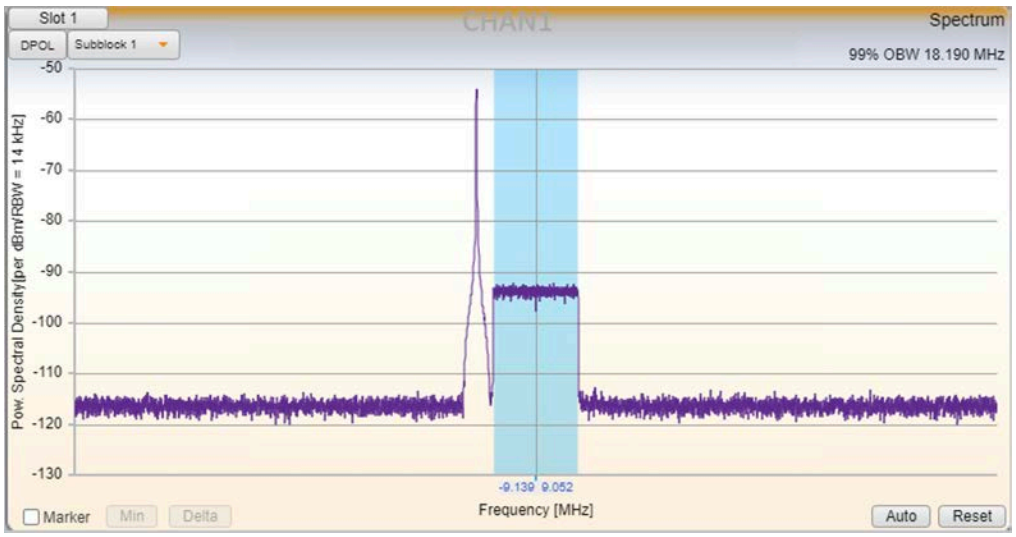

Figure 22. Numerology 1 20 MHz NBB, INTERFERENCE_INDEX -14

Example of reference level testing with numerology 1, 20 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX 14

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -44;
IQMI:CELL:CONF CBW_HZ, 20e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 14;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, NBB;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

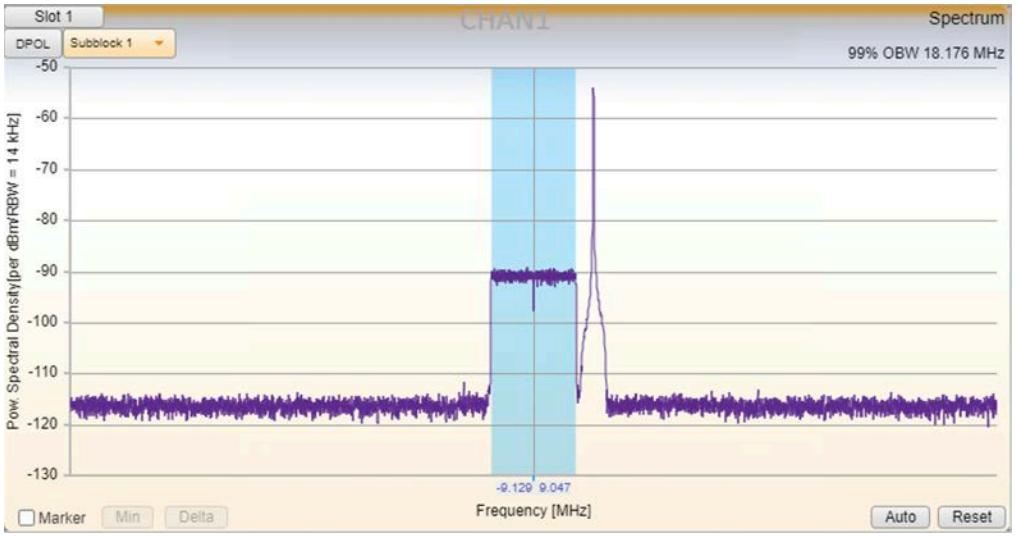

Figure 23. Numerology 1 20 MHz NBB, INTERFERENCE_INDEX 14

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.5.2. Narrowband blocking test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_4_2_NARROW_BAND_BLOCKING

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency offset, value m in Table 7. Narrowband blocking interference frequency offset. When a positive value assigned, a positive frequency offset applied to the interference. Please note that 0 and -0 means different interference frequency offset.

Example: 20MHz
INTERFERENCE_INDEX 0, interference frequency offset is + 350 khz to the channel right edge
INTERFERENCE_INDEX 14, interference frequency offset is + (350+14*180) khz to the channel right edge
INTERFERENCE_INDEX -0, interference frequency offset is - 350 khz to the channel right edge
INTERFERENCE_INDEX -14, interference frequency offset is - (350+14*180) khz to the channel right edge

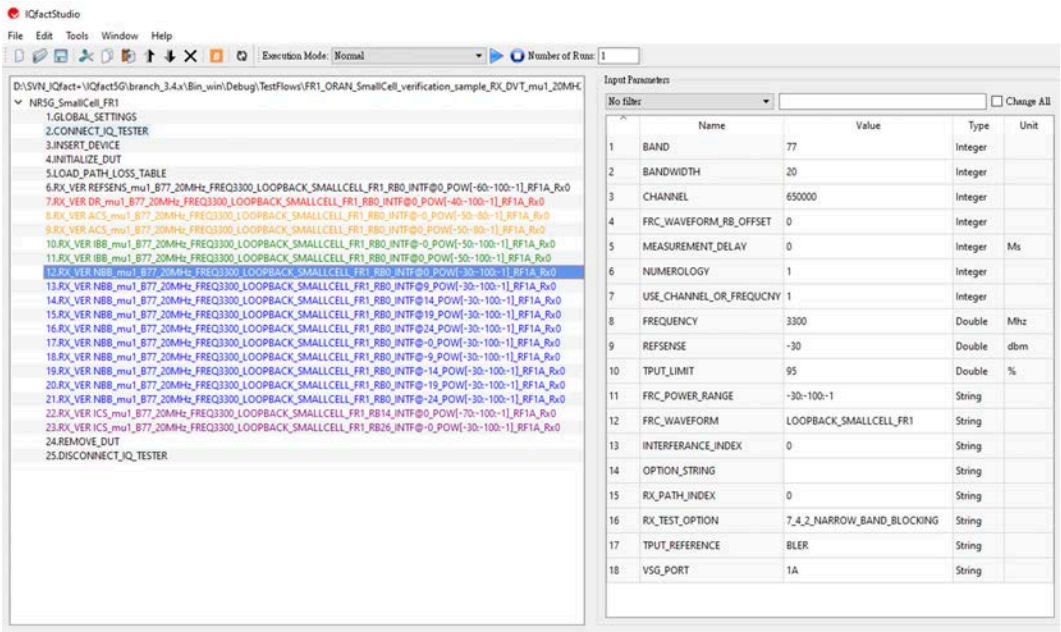

Figure 24. IQfact5G Narrowband blocking test node

Example test log and report from IQfact5G

12.RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB0_INTF@0_POW[-30:-100:-1]_RF1A_Rx0

BER : 0.07 % (,)
BLER : 0.07 % (,)
RSSI : -51.94 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-30:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-52			PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-30:-100:-1]_RF1A_ Rx0_THRUPUT	%	99.93	95	100	PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-30:-100:-1]_RF1A_ Rx0_BLER	%	0.074891068			PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@0_POW[-30:-100:-1]_RF1A_ Rx0_RSSI		-51.937416			PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@14_POW[-30:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-72			PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@14_POW[-30:-100:-1]_RF1A_ Rx0_THRUPUT	%	95.53	95	100	PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@14_POW[-30:-100:-1]_RF1A_ Rx0_BLER	%	4.4730392			PASS
FR1_RX_VER NBB_mu1_B77_20MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@14_POW[-30:-100:-1]_RF1A_ Rx0_RSSI		-71.691765			PASS

Table 12. IQfact5G Narrowband blocking test result

2.6. Receiver Intermodulation (3GPP TS 38.141-1 Ch.7.7)

Intermodulation distortion is a common front-end performance measurement item. With intermodulation distortion the signal quality degrades and signal distorted. Receiver internally has some low noise amplifier that can have intermodulation. In this test a FRC wanted waveform is generated and a UL interference signal are generated from VSG.

Also, a CW tone is generated from VSG and locates between wanted signal and the interference signal, so that when these three signals come into the receiver side intermodulation could be tested. Figure 25. Receiver Intermodulation test shows how the intermodulation contributed from the interference.

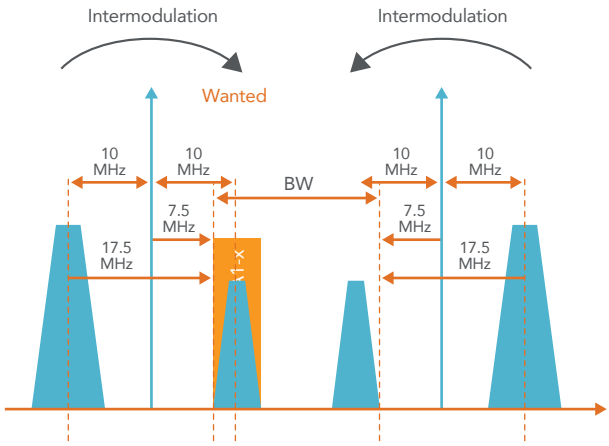

Figure 25. Receiver Intermodulation test

The wanted signal FRC waveform and interference power level is defined in Table 13. Receiver Intermodulation test condition. The requirement is to have the receiver throughput higher than 95% of maximum throughput when the wanted signal level lower than the level in this table, or BLER less than 5%.

Base Station type	Wanted signal power (dBm)	Mean power of interfering signals (dBm)
Wide Area BS	$P_{REFSENS}$ + 6 dB	-52
Medium Range BS	$P_{REFSENS}$ + 6 dB	-47
Local Area BS	$P_{REFSENS}$ + 6 dB	-44

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge (MHz)	Type of interfering signal (Note 3)
5	±7.5	CW
	±17.5	5 MHz DFT-s-OFDM NR signal (Note 1)
10	±7.465	CW
	±17.5	5 MHz DFT-s-OFDM NR signal (Note 1)
15	±7.43	CW
	±17.5	5 MHz DFT-s-OFDM NR signal (Note 1)
20	±7.395	CW
	±17.5	5 MHz DFT-s-OFDM NR signal (Note 1)
25	±7.465	CW
	±25	20MHz DFT-s-OFDM NR signal (Note 2)
30	±7.43	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
40	±7.45	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
50	±7.35	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
60	±7.49	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
70	±7.42	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
80	±7.44	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
90	±7.46	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)
100	±7.48	CW
	±25	20 MHz DFT-s-OFDM NR signal (Note 2)

Table 13. Receiver Intermodulation test condition

NOTE 1: Number of RBs is 25 for 15 kHz subcarrier spacing and 10 for 30 kHz subcarrier spacing.
NOTE 2: Number of RBs is 100 for 15 kHz subcarrier spacing, 50 for 30 kHz subcarrier spacing and 24 for 60 kHz subcarrier spacing.
NOTE 3: The RBs shall be placed adjacent to the transmission bandwidth configuration edge which is closer to the Base Station RF Bandwidth edge.

2.6.1. Receiver Intermodulation test with IQmi

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX -1.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -66;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, INTERMOD;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
```

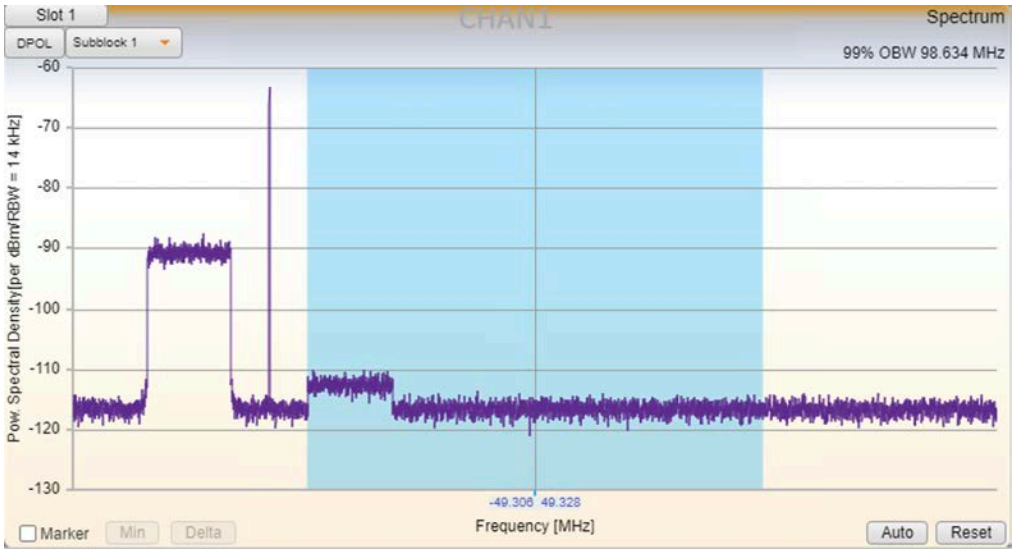

Figure 26. Numerology 1 100 MHz RxIMD, FRC RB@0 INTERFERENCE_INDEX -1

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 222, INTERFERENCE_INDEX 1

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -66;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, INTERMOD;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

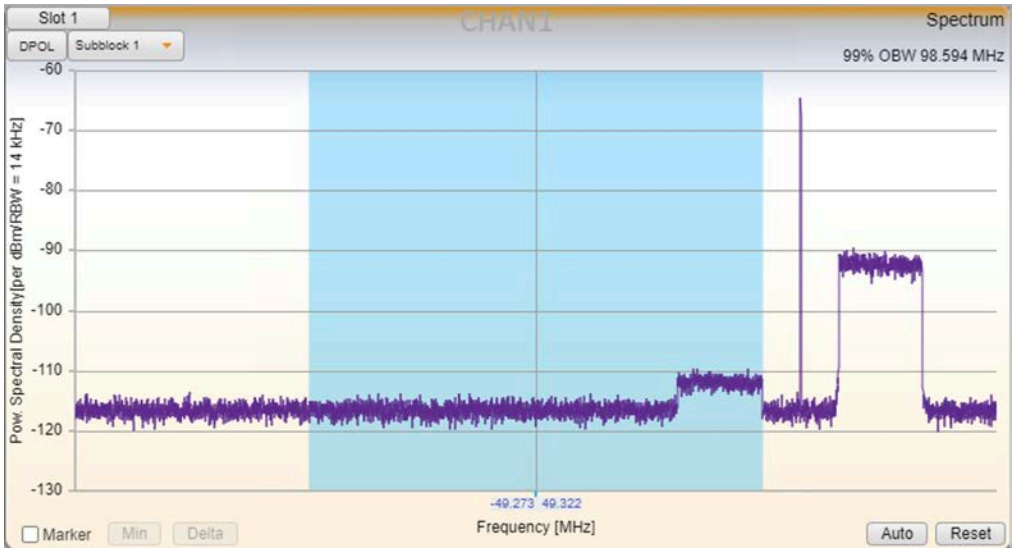

Figure 27. Numerology 1 100 MHz RxIMD, FRC RB@222 INTERFERENCE_INDEX 1

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.6.2. Receiver Intermodulation test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_7_RECEIVER_INTERMODULATION

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency offset. With a negative value it gives the blocking interference at the left side while with a positive INTERFERENCE_INDEX it gives the blocking interference locates at the right side.

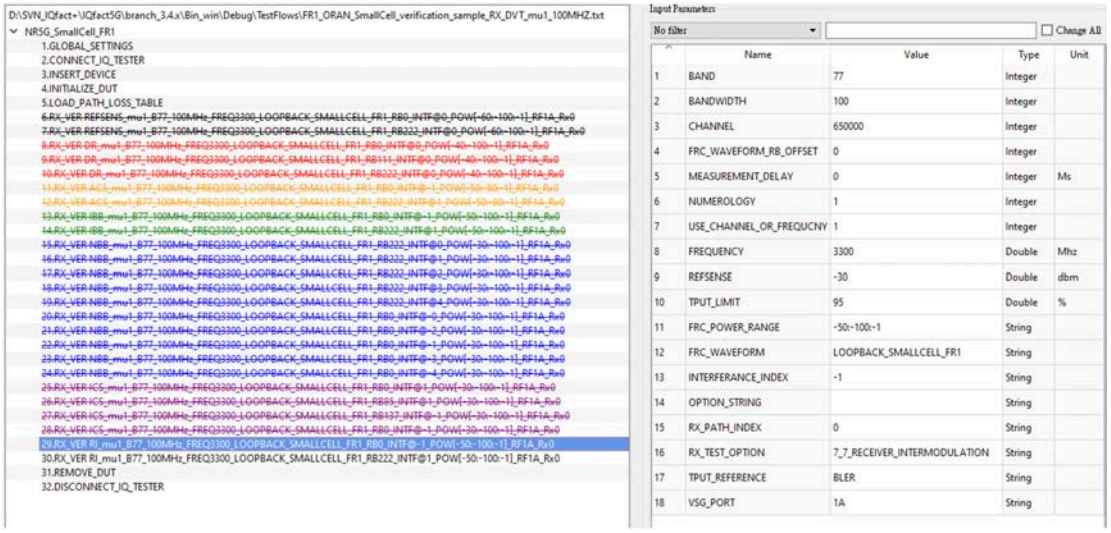

Figure 28. IQfact5G RxIMD test node

Example test log and report from IQfact5G

29.RX_VER IMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-100:-1]_RF1A_Rx0

SENSITIVITY : -70.00 dbm (,)
THRUPUT : 95.18 % (,)
BER : 4.82 % (,)
BLER : 4.82 % (,)
RSSI : -76.32 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-70			PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-100:-1]_RF1A_ Rx0_THRUPUT	%	97.01	95	100	PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-100:-1]_RF1A_ Rx0_BLER	%	2.9888344			PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-50:-100:-1]_RF1A_ Rx0_RSSI		-75.916145			PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_ RF1A_Rx0_SENSITIVITY	dbm	-70			PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_ RF1A_Rx0_THRUPUT	%	95.18	95	100	PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_ RF1A_Rx0_BLER	%	4.8202615			PASS
FR1_RX_VER RI_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-50:-100:-1]_ RF1A_Rx0_RSSI		-76.317825			PASS

Table 14. IQfact5G Narrowband blocking test result

2.7. Narrowband Intermodulation (3GPP TS 38.141-1 Ch.7.7)

Similar to Receiver Intermodulation, Narrowband Intermodulation, this test is also to verify the receiver low noise amplifier and front-end performance to overcome the IMD. The difference is the interference here become a single RB UL signal, which has higher spectrum density than a multiple RB signal, that means the intermodulation spectrum density could also be higher.

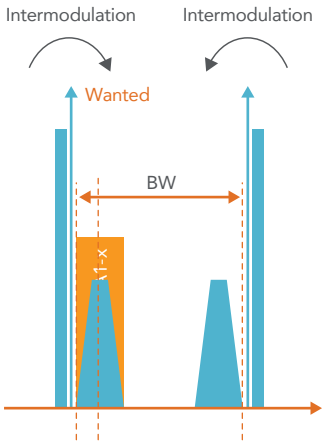

Figure 29. Narrowband Intermodulation test

The wanted signal FRC waveform and interference power level is defined in Table 15. Narrowband Intermodulation test condition. The requirement is to have the receiver throughput higher than 95% of maximum throughput when the wanted signal level lower than the level in this table, or BLER less than 5%.

Base Station type	Wanted signal power (dBm)	Mean power of interfering signals (dBm)
Wide Area BS	$P_{REFSENS}$ + 6 dB	-52
Medium Range BS	$P_{REFSENS}$ + 6 dB	-47
Local Area BS	$P_{REFSENS}$ + 6 dB	-44

BS channel bandwidth of the lowest/highest carrier received (MHz)	Interfering RB centre frequency offset to channel edge	Type of interfering signals
5	±360	CW
	±1420	5 MHz DFT-s-OFDM NR signal, 1 RB
10	±370	CW
	±1960	5 MHz DFT-s-OFDM NR signal, 1 RB
15 (Note 2)	±380	CW
	±1960	5 MHz DFT-s-OFDM NR signal, 1 RB
20 (Note 2)	±390	CW
	±2320	5 MHz DFT-s-OFDM NR signal, 1 RB
25 (Note 2)	±325	CW
	±2350	20 MHz DFT-s-OFDM NR signal, 1 RB
30 (Note 2)	±335	CW
	±2350	20 MHz DFT-s-OFDM NR signal, 1 RB
34 (Note 2)	±345	CW
	±2350	20MHz DFT-s-OFDM NR signal, 1 RB
40 (Note 2)	±355	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB
45 (Note 2)	±365	CW
	±2710	20MHz DFT-s-OFDM NR signal, 1 RB
50 (Note 2)	±375	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB
60 (Note 2)	±395	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB
70 (Note 2)	±415	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB
80 (Note 2)	±435	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB
90 (Note 2)	±365	CW
	±2530	20 MHz DFT-s-OFDM NR signal, 1 RB
100 (Note 2)	±385	CW
	±2530	20 MHz DFT-s-OFDM NR signal, 1 RB

Table 15. Narrowband Intermodulation test condition

2.7.1. Narrowband Intermodulation test with IQmi

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 0, INTERFERENCE_INDEX -1.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -48;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 0;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, NBINTERMOD;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
```

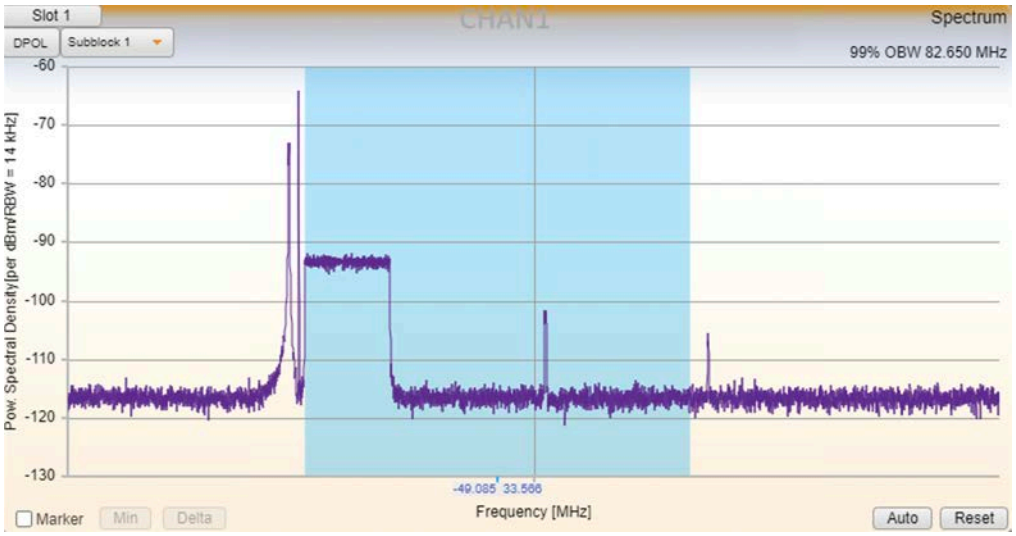

Figure 30. Numerology 1 100 MHz NBIMD, FRC RB@0 INTERFERENCE_INDEX -1

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 222, INTERFERENCE_INDEX 1

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -48;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 222;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, NBINTERMOD;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
```

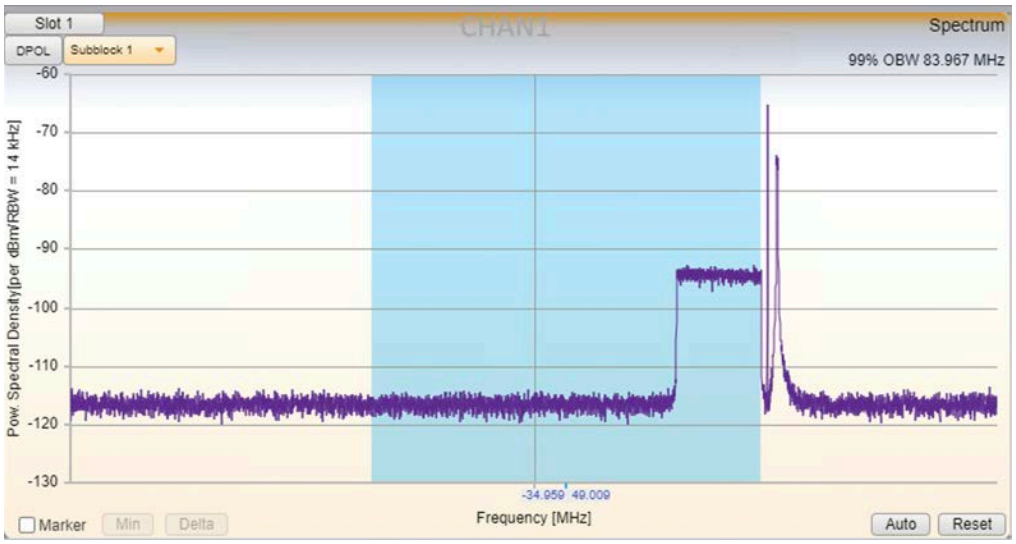

Figure 31. Numerology 1 100 MHz NBIMD, FRC RB@222 INTERFERENCE_INDEX 1

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.7.2. Narrowband Intermodulation test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_7_NARROW_BAND_INTERMODULATION

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency offset. With a negative value it gives the blocking interference at the left side while with a positive INTERFERENCE_INDEX it gives the blocking interference locates at the right side.

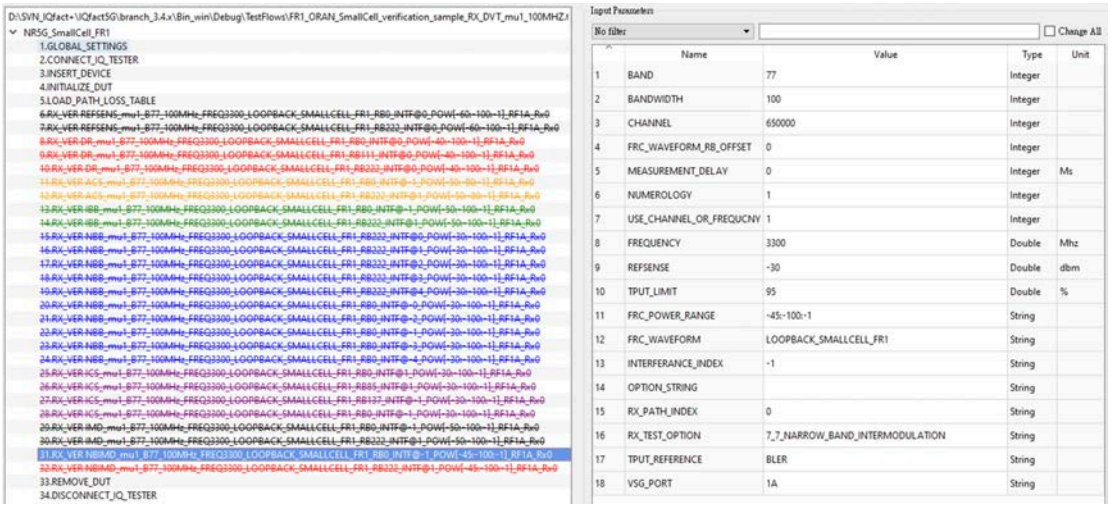

Figure 32. IQfact5G NBIMD test node

Example test log and report from IQfact5G

32.RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB222_INTF@1_POW[-45:-100:-1]_RF1A_Rx0

SENSITIVITY : -51.00 dbm (,)
THRUPUT : 100.00 % (,)
BER : 0.00 % (,)
BLER : 0.00 % (,)
RSSI : -62.32 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-45:-100:-1]_RF1A_ Rx0_SENSITIVITY	dbm	-52			PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-45:-100:-1]_RF1A_ Rx0_THRUPUT	%	100	95	100	PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-45:-100:-1]_RF1A_ Rx0_BLER	%	0			PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB0_INTF@-1_POW[-45:-100:-1]_RF1A_ Rx0_RSSI		-62.2475			PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-45:-100:-1]_ RF1A_Rx0_SENSITIVITY	dbm	-51			PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-45:-100:-1]_ RF1A_Rx0_THRUPUT	%	100	95	100	PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-45:-100:-1]_ RF1A_Rx0_BLER	%	0			PASS
FR1_RX_VER NBIMD_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB222_INTF@1_POW[-45:-100:-1]_ RF1A_Rx0_RSSI		-62.3175			PASS

Table 16. IQfact5G Narrowband blocking test result

2.8. In-Channel Selectivity (3GPP TS 38.141-1 Ch.7.8)

In-channel selectivity is to test the receiver performance when there is an UL interference just locates adjacent to the wanted signal, both the wanted signal and the interference are in the same channel adjacent to the channel center frequency. The FRC waveform is must partial RB is this test case, it can locate at either right side of the channel center frequency or the left side of the channel frequency. Figure 33. In-channel selectivity test.

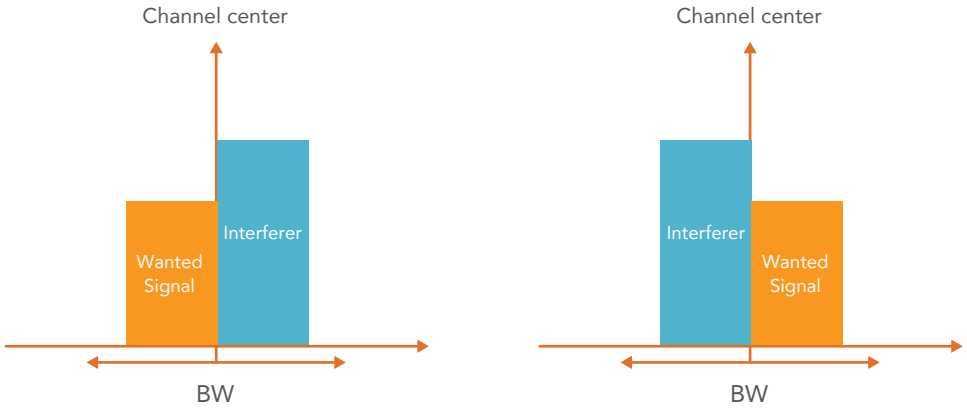

Figure 33. Inchannel selectivity test

The wanted signal FRC waveform and interference power level is defined in Table 17. In-channel selectivity test requirement. The requirement is to have the receiver throughput higher than 95% of maximum throughput when the wanted signal level lower than the level in this table, or BLER less than 5%.

NR channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)			Interfering signal mean power (dBm)	Type of interfering signal
			f ≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz		
5	15	G-FR1-A1-7	-99.2	-98.8	-98.5	-81.4	DFT-s-OFDM NR signal, 15 kHz SCS, 10 RBs
10, 15, 20, 25, 30,35	15	G-FR1-A1-1	-97.3	-96.9	-96.6	-77.4	DFT-s-OFDM NR signal, 15 kHz SCS, 25 RBs
40, 45, 50	15	G-FR1-A1-4	-90.9	-90.5	-90.2	-71.4	DFT-s-OFDM NR signal, 15 kHz SCS, 100 RBs
5	30	G-FR1-A1-8	-99.9	-99.5	-99.2	-81.4	DFT-s-OFDM NR signal, 30 kHz SCS, 5 RBs
10, 15, 20, 25, 30,35	30	G-FR1-A1-2	-97.4	-97	-96.7	-78.4	DFT-s-OFDM NR signal, 30 kHz SCS, 10 RBs
40, 45, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	-91.2	-90.8	-90.5	-71.4	DFT-s-OFDM NR signal, 30 kHz SCS, 50 RBs
10, 15, 20, 25, 30, 35	60	G-FR1-A1-9	-96.8	-96.4	-96.1	-78.4	DFT-s-OFDM NR signal, 60 kHz SCS, 5 RBs
40, 45, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	-91.3	-90.9	-90.6	-71.6	DFT-s-OFDM NR signal, 60 kHz SCS, 24 RBs

Table 17. In-channel selectivity test requirement

2.8.1. In-channel Selectivity test with IQmi

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 85, INTERFERENCE_INDEX 1.

```
IQMI:CELL:INIT;
IQMI:CELL:CONF DISABLE_EXT_RCLOCK, 1;
IQMI:CELL:VERS?
IQMI:CELL:CONF MODULE, SMALLCELL;

IQMI:CELL:PORT "PATH_RX_VSG_M1_RF1A,RF1A,
RX,1000.000000,1.000000,3000.000000,1.000000";
IQMI:CELL:PORT "PATH_RX_VSG_M2_RF1A,RF1B,
RX,1000.000000,1.000000,3000.000000,1.000000";

IQMI:CELL:CONF MODULE, SMALLCELL;
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
```

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,
  PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -64;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 85;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, 1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, ICS;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

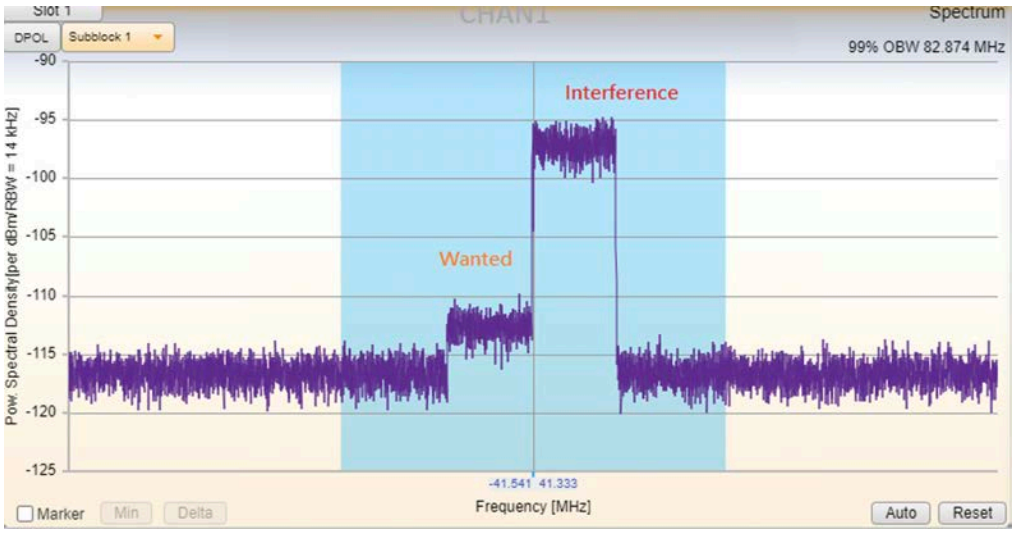

Figure 34. Numerology 1 100 MHz ICS, FRC RB@85 INTERFERENCE_INDEX 1

Example of reference level testing with numerology 1, 100 MHz BW. FRC RB offset 137, INTERFERENCE_INDEX -1

```
IQMI:CELL:CONF TECH, NRSUB6_5GBS;
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_INTERFERENCE;
IQMI:CELL:CONF RX_SELECT, (PATH_RX_VSG_M1_RF1A,PATH_RX_VSG_M2_RF1A);
IQMI:CELL:CONF POWER_DBM, -82;
IQMI:CELL:CONF CBW_HZ, 100e6;
IQMI:CELL:CONF RBOFFS, 137;
IQMI:CELL:CONF NUMEROLOGY, 1;
IQMI:CELL:CONF INTERFERENCE_INDEX, -1;
IQMI:CELL:CONF BS_CLASS, MEDIUM;
IQMI:CELL:CONF RX_TEST_CASE, ICS;
IQMI:CELL:CONF FREQ_MHZ, 3300.000000;
IQMI:CELL:CONF WAVEFORM, LOOPBACK_SMALLCELL_FR1;
IQMI:CELL:CONF BAND, 77;
IQMI:CELL:CONF TIMEOUT_S, 5;
IQMI:CELL:CONF TRIG_SOURCE, IMM;
IQMI:CELL:CONF TRIG_OFFSET_US, 0;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;

IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

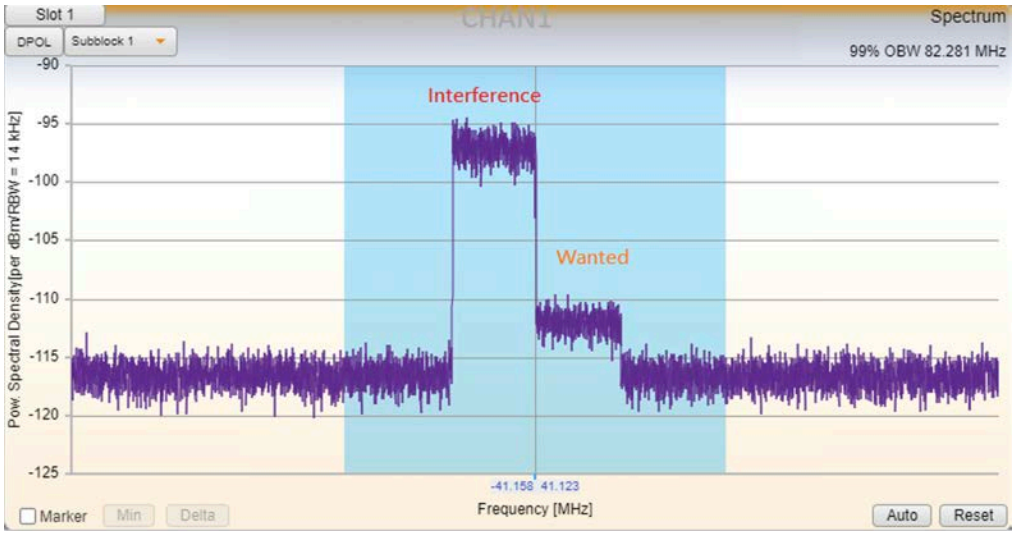

Figure 35. Numerology 1 100 MHz ICS, FRC RB@137 INTERFERENCE_INDEX -1

To stop the VSG waveform playing to below commands with RX_STOP segment type.

```
IQMI:CELL:TEST:BLOC1:STAR;
IQMI:CELL:CONF SEGMENT_TYPE, RX_STOP;
IQMI:CELL:TEST:CRE;
IQMI:CELL:TEST:BLOC1:STOP;
IQMI:CELL:TEST:BLOC1:RUN:HSN?
```

2.8.2. In-channel Selectivity test with IQfact5G

Unlike IQmi which is a single test condition test, IQfact5G it searches the sensitivity level for BLER or BER user defined limit in the test flow.

Some key parameters to run a reference sensitivity level search test:

RX_TEST_OPTION:
7_8_IN_CHANNEL_SELECTIVITY

FRC_WAVEFORM_RB_OFFSET:
to assign the FRC waveform RB location

REFSENSE:
The initial reference sensitivity search level

FRC_POWER_RANGE:
the reference sensitivity search range

INTERFERENCE_INDEX:
The interference frequency offset. With a negative value it gives the blocking interference at the left side while with a positive INTERFERENCE_INDEX it gives the blocking interference locates at the right side.

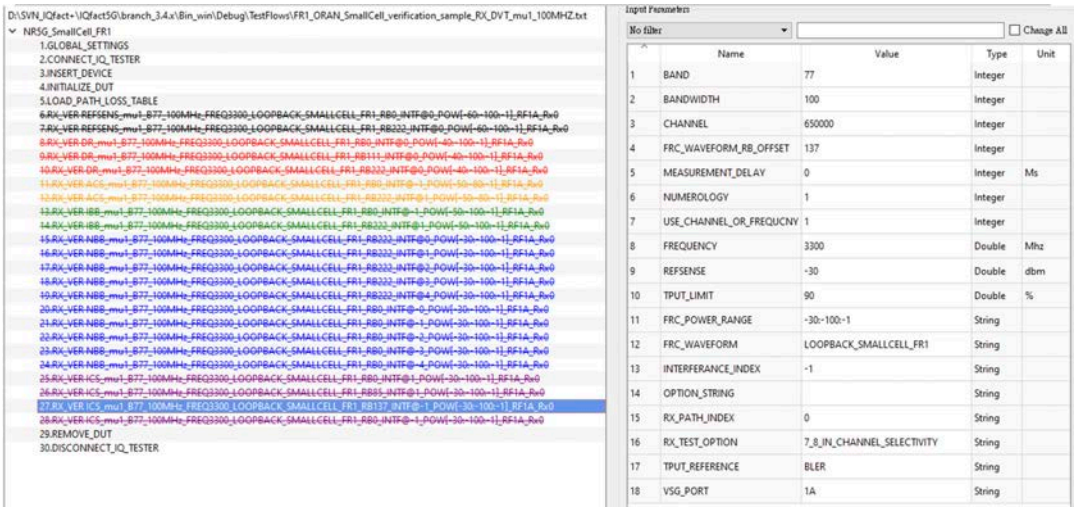

Figure 36. IQfact5G Inchannel selectivity test node

Example test log and report from IQfact5G

27.RX_VER ICS_mu1_B77_100MHz_FREQ3300_LOOPBACK_SMALLCELL_FR1_RB137_INTF@-1_POW[-30:-100:-1]_RF1A_Rx0

SENSITIVITY : -82.00 dbm (,)
THRUPUT : 92.76 % (,)
BER : 7.24 % (,)
BLER : 7.24 % (,)
RSSI : -65.77 (,)

Test Item	Unit	Measure Value	Lower Limit	Upper Limit	Test Result
FR1_RX_VER ICS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB137_INTF@-1_POW[-30:-100:-1]_ RF1A_Rx0_SENSITIVITY	dbm	-82			PASS
FR1_RX_VER ICS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB137_INTF@-1_POW[-30:-100:-1]_ RF1A_Rx0_THRUPUT	%	92.76	90	100	PASS
FR1_RX_VER ICS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB137_INTF@-1_POW[-30:-100:-1]_ RF1A_Rx0_BLER	%	7.244009			PASS
FR1_RX_VER ICS_mu1_B77_100MHz_FREQ3300_LOOPBACK_ SMALLCELL_FR1_RB137_INTF@-1_POW[-30:-100:-1]_ RF1A_Rx0_RSSI		-65.7712			PASS

Table 18. IQfact5G Inchannel selectivity test result

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