

ISED CABid: ES1909

Test report No:
NIE: 71605RRF.001A2

Test Report

Reference Standard:
USA FCC Part 22 & Part 90
CANADA IC RSS-132

(*) Identification of item tested	LTE NB-IoT Cellular communication module
(*) Trademark	Sequans Communications
(*) Model and /or type reference	GM02S
Other identification of the product	FCC ID: 2AAGMGM02SA IC: 12732A-GM02SA IMEI TAC: 01577000
(*) Features	LTE-M, NB-IoT (NB1/NB2) Release 14 3GPP HW version: V2 SW version: LR8.1.0.0-55629
Manufacturer	Sequans Communications 55 Boulevard Charles de Gaulle, 92700 Colombes, France
Test method requested, standard	USA FCC Part 22 (10-1-20 Edition). Public Mobile Services. USA FCC Part 90 (10-1-20 Edition). Private Land Mobile Radio Services. CANADA RSS-132 Issue 3, Jan. 2013. ANSI C63.26: 2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López EMC Consumer & RF Lab. Manager  2022.08.11 13:05:04 +02'00'
Date of issue	2022-08-03
Report template No.	FDT08_24 (*) "Data provided by the client"

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Competences and guarantees

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DEKRA Testing and Certification S.A.U. is an FCC-recognized accredited testing laboratory with the appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification S.A.U. is an ISED-recognized accredited testing laboratory, CABid: ES1909, with the appropriate scope of accreditation that covers the performed tests in this report.

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DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

The total uncertainty of the measurement system for the radiated emissions of EUT from 30 MHz to 1 GHz is:
Measurement uncertainty $\leq \pm 5.35$ dB (with factor $k = 2$).

The total uncertainty of the measurement system for the radiated emissions of EUT from 1 GHz to 18 GHz is:
Measurement uncertainty $\leq \pm 4.32$ dB (with factor $k = 2$).

The total uncertainty of the measurement system for the conducted testing of EUT is:

RF Average Output Power: Measurement uncertainty $\leq \pm 0.941$ dB

Frequency Stability: Measurement uncertainty $\leq \pm 249.55$ Hz

Occupied Bandwidth: Measurement uncertainty $\leq \pm 0.81$ kHz

26dB Bandwidth: Measurement uncertainty $\leq \pm 0.81$ kHz

Spurious Emissions at Antenna Terminals: Measurement uncertainty $\leq \pm 2.76$

Spurious Emissions at Antenna Terminals at Block Edges: Measurement uncertainty $\leq \pm 2.76$ dB

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the model GM02S is a multi-band module supporting cellular LTE-M Release 14. It supports HD-FDD.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: the client.

Id	Control Number	Description	Model	Serial No.	Date of Reception	Application
S/01	71605_13.1	LTE Cat-M Cellular communication module	GM02S	G2Q2106160105039	2022-04-04	Element Under Test
S/01	71605_16.1	External Antenna	OmniLOG 90200	--	2022-04-04	Element Under Test
S/01	71605_13.1	NEKTAR-EVK Evaluation Kit	HWPT011B5	58K2131000152	2022-04-04	Auxiliary Element
S/01	71605_14.1	UFL to SMA Cable	--	--	2022-04-04	Auxiliary Element
S/01	71605_15.1	USB Cable	--	--	2022-04-04	Auxiliary Element
S/02	71605_13.1	LTE Cat-M Cellular communication module	GM02S	G2Q2106160105039	2022-04-04	Element Under Test
S/02	71605_13.1	NEKTAR-EVK Evaluation Kit	HWPT011B5	58K2131000152	2022-04-04	Auxiliary Element
S/02	71605_14.1	UFL to SMA Cable	--	--	2022-04-04	Auxiliary Element
S/02	71605_15.1	USB Cable	--	--	2022-04-04	Auxiliary Element

Samples were used for the following test(s):

Id	Type / Comments
S/01	Radiated. / RF output: pin J1.
S/02	Conducted. / RF output: pin J1.

Test sample description

Ports.....:	Port name and description		Cable				
			Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾	
	USB	2	☒	☐	☐		
			☐	☐	☐		
Supplementary information to the ports.....:	--						
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐ AC:	☐	☐	☐	☐	☐	
☒ DC: 3.3 Vdc							
Rated Power	--						
Clock frequencies.....:	--						
Other parameters	--						
Software version	LR8.1.0.0-55629						
Hardware version	V2						
Dimensions in cm (W x H x D)	Not provided data						
Mounting position	☒	Table top equipment					
	☐	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					
	☐	Other:					
Modules/parts.....:	Module/parts of test item		Type		Manufacturer		
	NEKTAR-EVK HWPT011B5		Eval Kit		Sequans		
	USB Cable						
	External antenna				Aaronia AG		
Accessories (not part of the test item)	Description		Type		Manufacturer		
	--						
Documents as provided by the applicant	Description		File name		Issue date		
	--						

(3) Only for Medical Equipment

Identification of the client

SEQUANS COMMUNICATIONS

55 Boulevard Charles de Gaulle, 92700 Colombes, France

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2022-04-08
Date (finish)	2022-05-05

Document history

Report number	Date	Description
71605RRF.001	2022-05-16	First release.
71605RRF.001A1	2022-06-01	Second release. Modification due to typos. This modification of test report cancels and replaces the test report 71605RRF.001.
71605RRF.001A2	2022-08-03	Third release. Inclusion of spectrum analyzer settings in Radiated Emissions section. This modification of test report cancels and replaces the test report 71605RRF.001A1.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the semi-anechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Alfonso Gutiérrez and Miguel Manuel López.

Used instrumentation:

Equipment	Model	Manufacturer	Next Calibration
SEMIANECHOIC ABSORBER LINED CHAMBER IV	FACT 3 200 STP	ETS LINDGREN	2024-06-07
SHIELDED ROOM	S101	ETS LINDGREN	N.A.
EMI TEST RECEIVER 9kHz-7GHz	ESR7	ROHDE AND SCHWARZ	2023-11-08
SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-10-22
HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2023-10-29
HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK	2023-08-24
PRE-AMPLIFIER G>30dB 1GHz-18GHz	BLMA 0118-3A	BONN ELEKTRONIK	2022-12-01
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE AND SCHWARZ	2022-06-04
EMC/RF MEASUREMENT SOFTWARE	EMC32	ROHDE AND SCHWARZ	N.A.
SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-02-26
SIGNAL ANALYZER 20Hz-8GHz	FSQ8	ROHDE AND SCHWARZ	2022-10-06
TEMPERATURE CHAMBER	MK 56	BINDER	2023-03-22
DC POWER SUPPLY 40 V / 40 A	NGPE 40/40	ROHDE AND SCHWARZ	N.A.
DIGITAL MULTIMETER	179	FLUKE	2022-10-19

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

FCC PART 22 / RSS-132		
Requirement – Test case	Verdict	Remark
FCC 22.913 / RSS-132 5.4: RF Output Power	P	
FCC 2.1047 / RSS-132 5.2: Modulation Characteristics	P	
FCC 22.355 / RSS-132 5.3: Frequency Stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 22.917 / RSS-132 5.5: Spurious Emissions at Antenna Terminals	P	
FCC 22.917 / RSS-132 5.5: Radiated Emissions	P	
<u>Supplementary information and remarks:</u>		
None.		

FCC PART 90		
Requirement – Test case	Verdict	Remark
FCC 90.635 (b): RF output power	P	
FCC 2.1047: Modulation characteristics	P	
FCC 90.213: Frequency stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 90.691: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems)	P	
FCC 90.691: Radiated emissions	P	
<u>Supplementary information and remarks:</u>		
None.		

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TEST CONDITIONS

(*): Data provided by the client.

Power supply (V):

$V_n = 3.3 \text{ Vdc}$ (*)

$V_{min} = 2.805 \text{ Vdc}$

$V_{max} = 3.795 \text{ Vdc}$

The subscripts n, min and max indicate voltage test conditions: nominal, minimum and maximum respectively.

Type of power supply: USB powered or DC Voltage from external power supply.

ANTENNA (*):

Device with external and internal antennas.

After a preliminary scan, the determined worst case for the Radiated tests is the external antenna.

For the Conducted tests, the gain of the internal antenna is used.

Declared Gain for antennas:

Low bands	Gain (dBi)	Antenna type
LTE Bands 5 & 26	+1.1	Internal
	+0.17	External

TEST FREQUENCIES:

814 – 824 MHz Band:

NB-IoT. $\pi/2$ - BPSK and $\pi/4$ - QPSK modulations (BAND 26)

Channel (Frequency, MHz)		
Low	Middle	High
26692 (814.2)	26740 (819)	26788 (823.8)

Cross-rule channel (824 MHz):

NB-IoT. $\pi/2$ - BPSK and $\pi/4$ - QPSK modulations (BAND 26)

Channel (Frequency, MHz)
26790 (824)

824 – 849 MHz Band:

NB-IoT. $\pi/2$ - BPSK and $\pi/4$ - QPSK modulations (BAND 5)

Channel (Frequency, MHz)		
Low	Middle	High
20402 (824.2)	20525 (836.5)	20648 (848.8)

NB-IoT. $\pi/2$ - BPSK AND $\pi/4$ - QPSK MODULATION (BAND 26)

Channel (Frequency, MHz)		
Low	Middle	High
26792 (824.2)	26915 (836.5)	27038 (848.8)

NOTE: Sub-block 824 – 849 MHz of band 26 is completely included in band 5, so the channels of band 5 were tested to give conformity to the assigned block.

RF Output Power

Limits

FCC §2.1046 and §22.913. The Effective Radiated Power (E.R.P.) of mobile transmitter and auxiliary test transmitter must not exceed 7 watts (38.45 dBm E.R.P.).

RSS-132. Clause 5.4. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts (38.45 dBm E.R.P.).

In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

FCC §90.635. The maximum output power of the transmitter for mobile stations is 100 watts (20 dBw).

Method

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the maximum declared antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

$$\text{E.R.P.} = \text{E.I.R.P.} - 2.15 \text{ dB}$$

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

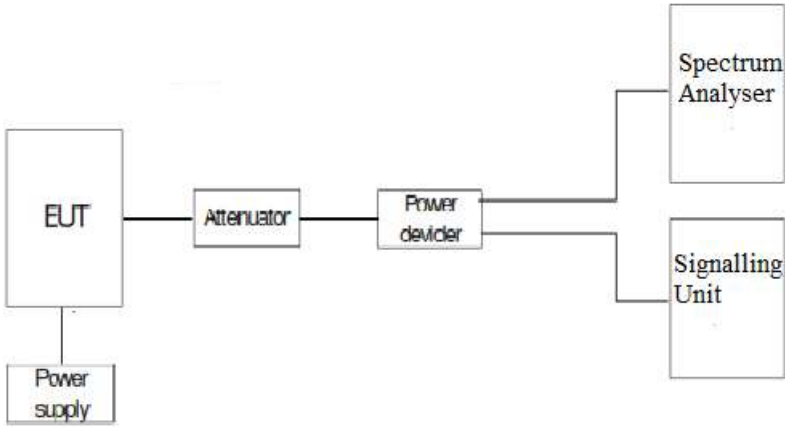
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test setup

Conducted Average Power:



Peak-to-Average Power Ratio (PAPR):



Results

NBLoT 814 – 824 MHz Band:

Channel	Freq. (MHz)	Modulation	BW (kHz)	No. of tones	Offset Tone	Average Power (dBm)	PAPR (dB)
26692	814.2	$\pi/2$ - BPSK	3.75	1	0	22.38	(*)
				1	47	22.40	(*)
			15	1	0	22.52	(*)
				1	11	22.51	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.40	(*)
				1	47	22.43	(*)
			15	1	0	22.47	(*)
				1	11	22.55	(*)
				3	0	22.75	5.33
				3	6	22.95	5.34
				6	0	22.79	4.36
				6	6	22.80	4.42
				12	0	22.86	3.88
26740	819	$\pi/2$ - BPSK	3.75	1	0	22.14	(*)
				1	47	22.16	(*)
			15	1	0	22.35	(*)
				1	11	22.35	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.14	(*)
				1	47	22.17	(*)
			15	1	0	22.35	(*)
				1	11	22.41	(*)
				3	0	22.61	5.47
				3	6	22.76	5.45
				6	0	22.59	4.33
				6	6	22.64	4.33
				12	0	22.65	4.46
26788	823.8	$\pi/2$ - BPSK	3.75	1	0	22.24	(*)
				1	47	22.30	(*)
			15	1	0	22.45	(*)
				1	11	22.48	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.30	(*)
				1	47	22.28	(*)
			15	1	0	22.44	(*)
				1	11	22.47	(*)
				3	0	22.61	5.45
				3	6	22.80	5.37
				6	0	22.71	4.20
				6	6	22.70	4.26
				12	0	22.75	4.57

(*) Preliminary measurements determined QPSK modulation, 3, 6 or 12 tones with 15kHz BW as the worst cases.

Channel	Measured maximum average power at antenna port (dBm)	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power E.I.R.P. (dBm)	Maximum effective radiated power E.R.P. (dBm)	Maximum PAPR (dB)
Low	22.95	1.10	24.05	21.90	5.34
Middle	22.76	1.10	23.86	21.71	5.47
High	22.80	1.10	23.90	21.75	5.45

Verdict

Pass

NB IoT 824 – 849 MHz Band:

Channel	Freq. (MHz)	Modulation	BW (kHz)	No. of tones	Offset Tone	Average Power (dBm)	PAPR (dB)
20402	824.2	$\pi/2$ - BPSK	3.75	1	0	22.27	(*)
				1	47	22.29	(*)
			15	1	0	22.49	(*)
				1	11	22.50	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.32	(*)
				1	47	22.32	(*)
			15	1	0	22.46	(*)
				1	11	22.49	(*)
				3	0	22.66	3.70
				3	6	22.87	3.69
				6	0	22.65	4.55
				6	6	22.69	4.60
				12	0	22.74	6.62
20525	836.5	$\pi/2$ - BPSK	3.75	1	0	22.12	(*)
				1	47	22.20	(*)
			15	1	0	22.37	(*)
				1	11	22.38	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.21	(*)
				1	47	22.22	(*)
			15	1	0	22.36	(*)
				1	11	22.37	(*)
				3	0	22.53	5.72
				3	6	22.75	5.38
				6	0	22.66	4.54
				6	6	22.68	4.65
				12	0	22.70	6.62
20648	848.8	$\pi/2$ - BPSK	3.75	1	0	22.28	(*)
				1	47	22.26	(*)
			15	1	0	22.45	(*)
				1	11	22.44	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.27	(*)
				1	47	22.25	(*)
			15	1	0	22.43	(*)
				1	11	22.47	(*)
				3	0	22.62	5.41
				3	6	22.83	5.33
				6	0	22.72	4.42
				6	6	22.75	4.53
				12	0	22.82	6.44

(*) Preliminary measurements determined QPSK modulation, 3, 6 or 12 tones with 15kHz BW as the worst cases.

Channel	Measured maximum average power at antenna port (dBm)	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power E.I.R.P. (dBm)	Maximum effective radiated power E.R.P. (dBm)	Maximum PAPR (dB)
Low	22.87	1.10	23.97	21.82	6.62
Middle	22.75	1.10	23.85	21.70	6.62
High	22.83	1.10	23.93	21.78	6.44

Verdict

Pass

NBLoT Cross-rule channel (824 MHz):

Channel	Freq. (MHz)	Modulation	BW (kHz)	No. of tones	Offset Tone	Average Power (dBm)	PAPR (dB)
26790	824	$\pi/2$ - BPSK	3.75	1	0	22.31	(*)
				1	47	22.28	(*)
			15	1	0	22.55	(*)
				1	11	22.52	(*)
		$\pi/4$ - QPSK	3.75	1	0	22.33	(*)
				1	47	22.35	(*)
			15	1	0	22.57	(*)
				1	11	22.59	(*)
				3	0	22.74	5.45
				3	6	22.97	5.36
				6	0	22.86	4.27
				6	6	22.91	4.32
				12	0	22.89	4.15

(*) Preliminary measurements determined QPSK modulation, 3, 6 or 12 tones with 15kHz BW as the worst cases.

Channel	Measured maximum average power at antenna port (dBm)	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power E.I.R.P. (dBm)	Maximum effective radiated power E.R.P. (dBm)	Maximum PAPR (dB)
26790 (824 MHz)	22.97	1.10	24.07	21.92	5.45

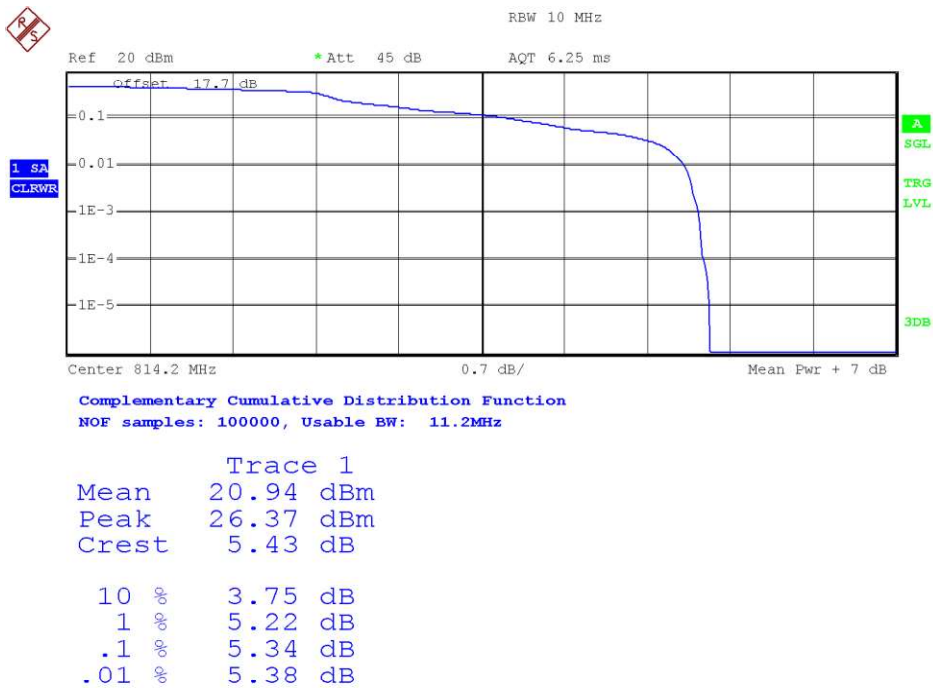
Verdict

Pass

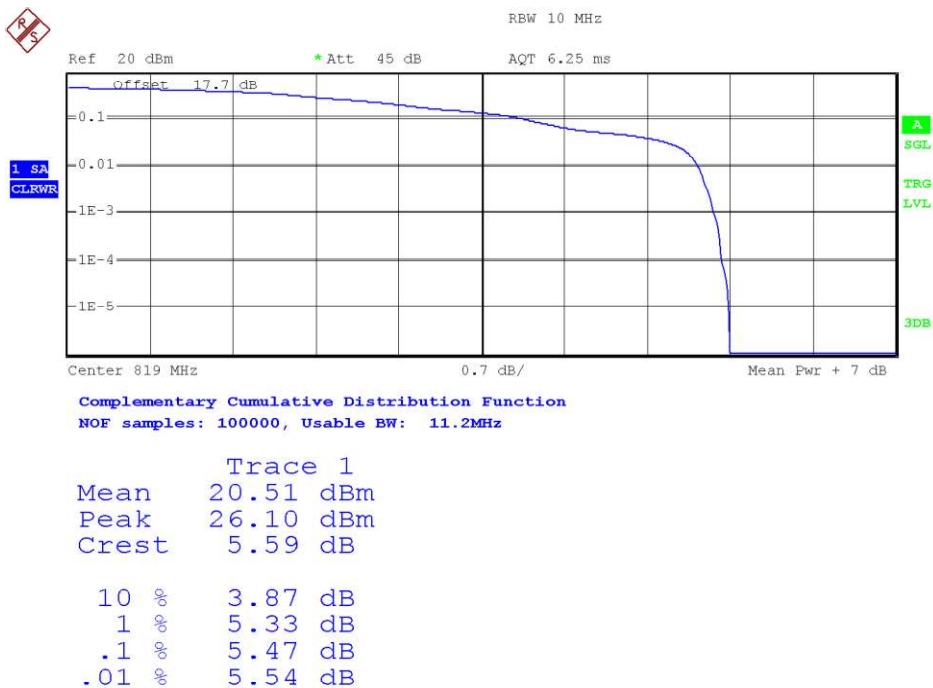
Attachments
Peak-to-Average Power Ratio (PAPR)

NBLoT 814 – 824 MHz Band

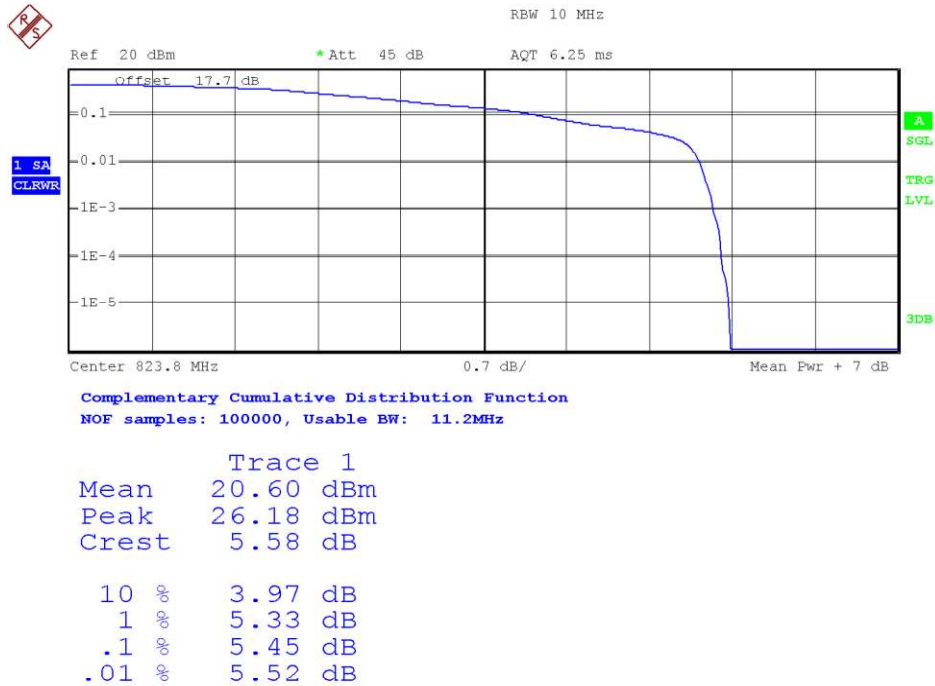
- Low Channel (worst case):



- Middle Channel (worst case):

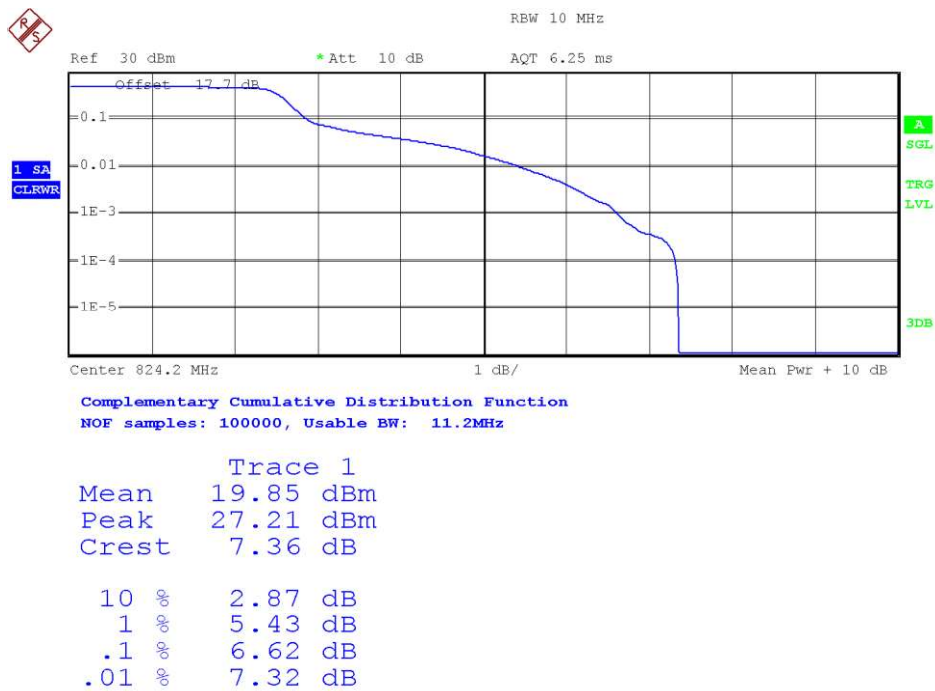


- High Channel (worst case):

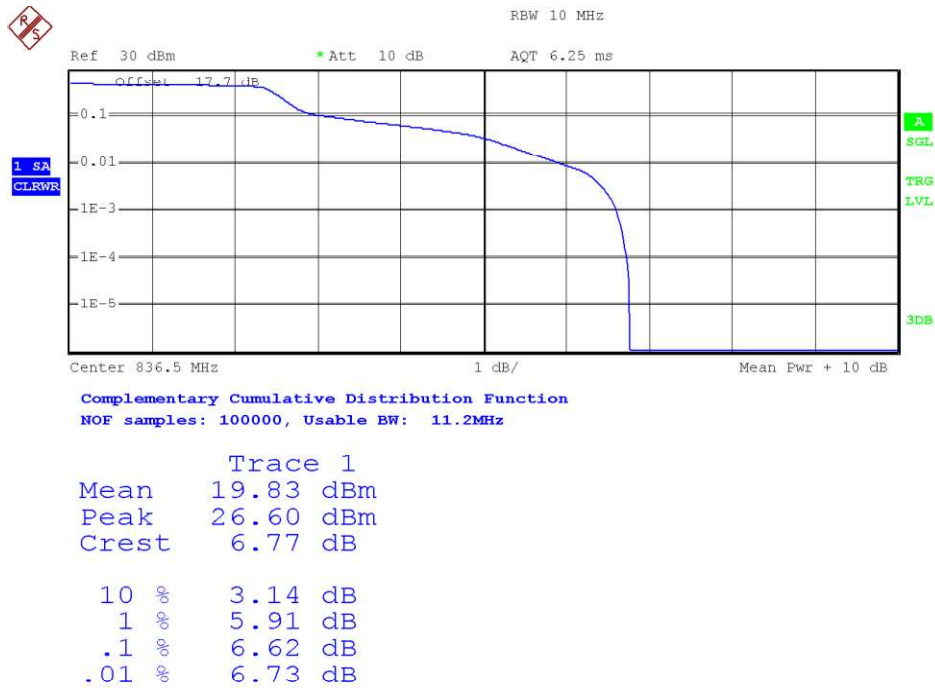


NB IoT 824 – 849 MHz Band

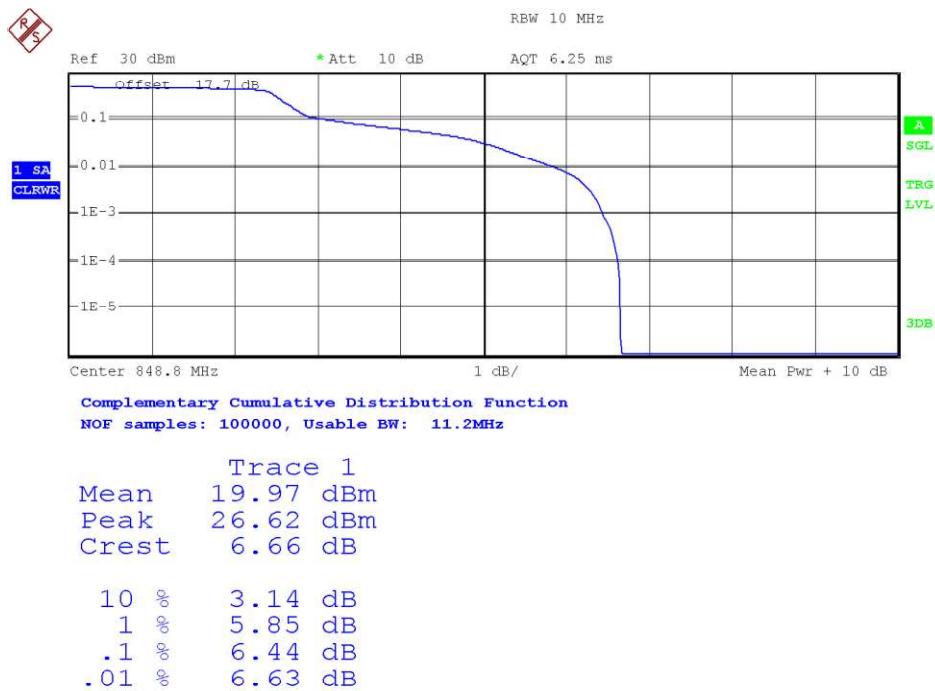
- Low Channel (worst case):



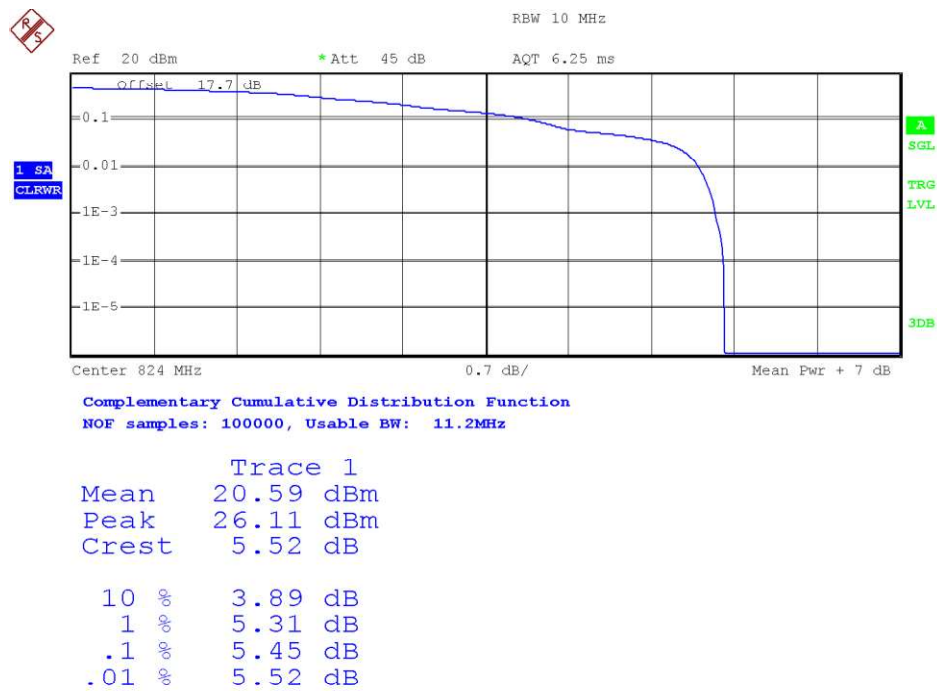
- Middle Channel (worst case):



- High Channel (worst case):



NB-IoT Cross-rule channel 824 MHz (worst case):



Frequency Stability

Limits

FCC §2.1055 and §22.355: ± 2.5 ppm for mobile stations operating in the range 821 to 896 MHz.

RSS-132, Clause 5.3. The carrier frequency shall not depart from the reference frequency in excess of ± 2.5 ppm for mobile stations.

FCC §2.1055 and §90.213: ± 2.5 ppm for mobile stations operating in the range 809 to 824 MHz.

Method

The frequency tolerance measurements over temperature variations were made over the temperature range of -30°C to $+50^{\circ}\text{C}$. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to $+50^{\circ}\text{C}$.

The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set on the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.

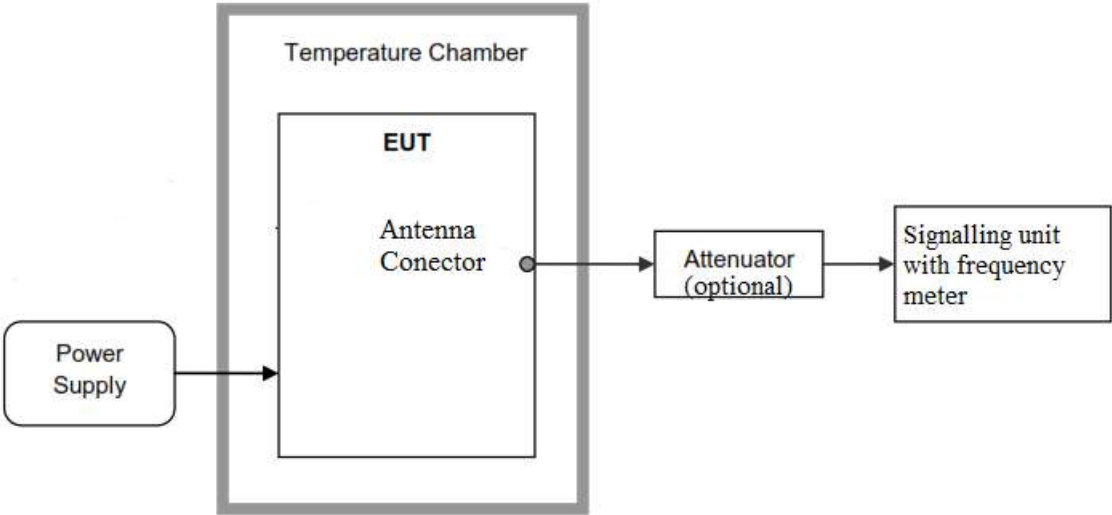
The worst-case NB-IoT mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channels of operation are identified as fL and fH respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

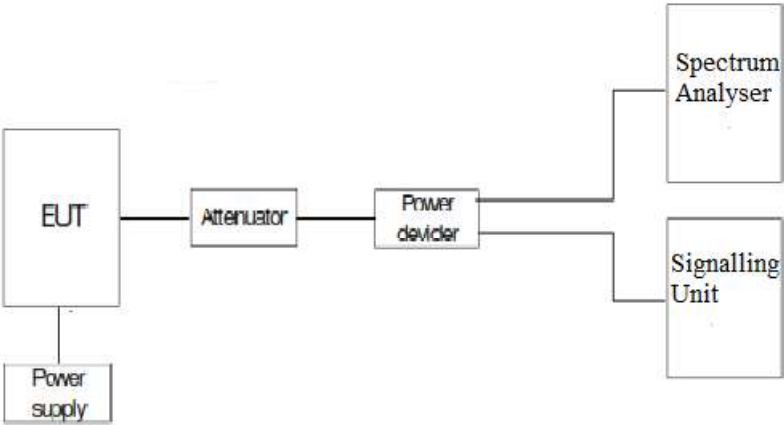
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test setup

Frequency tolerance:



Reference points f_L and f_H :



Results

NBLoT Band 5. $\pi/4$ - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6. Channel: 836.5 MHz.

1. FREQUENCY TOLERANCE

- Frequency stability over temperature variations.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-0.57	-0.000681411
+40	-3.38	-0.004040646
+30	-2.79	-0.003335326
+20	-1.22	-0.001458458
+10	-2.65	-0.003167962
0	-2.46	-0.002940825
-10	-3.92	-0.004686192
-20	-5.36	-0.006407651
-30	-7.84	-0.009372385

- Frequency stability over voltage variations.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3.795	-2.49	-0.002976689
Vmin	2.805	1.77	0.002115959

2. REFERENCE FREQUENCY POINTS f_L AND f_H

Points established at the applicable unwanted emissions limit (worst case):

f_L (MHz)	824.054330
f_H (MHz)	848.946620

The reference frequency points f_L and f_H stay within the authorized blocks.

Verdict

Pass

NBLoT Band 26. $\pi/4$ - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6. Channel: 819 MHz.

1. FREQUENCY TOLERANCE

- Frequency stability over temperature variations.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+50	-15.89	-0.019401709
+40	44.95	0.054884005
+30	1.62	0.001978022
+20	4.55	0.005555556
+10	4.15	0.005067155
0	1.99	0.002429792
-10	1.42	0.001733822
-20	-2.59	-0.003162393
-30	-3.28	-0.004004884

- Frequency stability over voltage variations.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	3.795	3.96	0.004835165
Vmin	2.805	4.15	0.005067155

2. REFERENCE FREQUENCY POINTS fL AND fH

Not Applicable (EA mask applies to Band 26).

Verdict

Pass