

Test report No:
 NIE: 60982RAN.001

Assessment report

RF EXPOSURE REPORT ACCORDING TO FCC 47 CFR Part 2.1091

Identification of item tested	NB-IOT Module Supporting 2, 4, 5, 12, 13, 66
Trademark	Sequans Communication
Model and /or type reference	NB01Q-1
Other identification of the product	FCC ID: 2AAGMNB01Q1
Features	LTE bands 2, 4, 5, 12, 13, 66
Manufacturer	Sequans Communications S.A. 15-55 Boulevard Charles de Gaulle, Colombes, 92700, France
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. IEEE Std C95.3™ -2002 (R2008). IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager
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Competences and guarantees

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Data provided by the client

The equipment under evaluation consists of a NB-IOT Module Supporting LTE bands 2, 4, 5, 12, 13, 66.

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

Identification of the client

Sequans Communications S.A.

15-55 Boulevard Charles de Gaulle, Colombes, 92700, France

Document history

Report number	Date	Description
60982RAN.001	2019-06-17	First release

General description of the device under evaluation

The equipment under evaluation consists of a NB-IOT Module Supporting LTE bands 2, 4, 5, 12, 13, 66.

As the equipment under evaluation is a module, a conservative evaluation distance of 20 cm has been used to perform the assessment.

The equipment specifications declared by the manufacturer for LTE supported bands are:

Technology / Mode	Band	Frequency (MHz)	Maximum Conducted Output Power (Incl. Tune-Up) (dBm)
LTE	2	1850 - 1910	25.70
LTE	4	1710 - 1755	25.70
LTE	5	824 - 849	25.70
LTE	12	699 - 716	25.70
LTE	13	777 - 787	25.70
LTE	66	1710 - 1780	25.70

Table 1: Equipment specifications

Maximum Antenna Gain determination for RF Exposure compliance

Summary of maximum antenna gain values:

Maximum antenna gain for mobile operation to comply with MPE and EIRP limits (see Appendix A) shall not exceed the following values:

Technology / Mode	Band	Frequency (MHz)	Maximum Gain to comply with:		Maximum Gain (dBi)
			MPE limits (dBi)	EIRP Limits (dBi)	
LTE	2	1850 - 1910	11.3	7.3	7.3
LTE	4	1710 - 1755	11.3	4.3	4.3
LTE	5	824 - 849	8.7	14.9	8.7
LTE	12	699 - 716	7.9	11.2	8.0
LTE	13	777 - 787	8.4	11.2	8.5
LTE	66	1710 - 1780	11.3	4.3	4.3

Table 2: Maximum Antenna Gain values

Maximum Gain to meet FCC Radiofrequency radiation exposure limits:

Technology / Mode	Band	Frequency (MHz)	Distance (cm)	Power density (mW/cm ²)	FCC General Population Limit (mW/cm ²)	Maximum Gain to meet FCC MPE limits (dBi)
LTE	2	1850 - 1910	20	0.07	1.00	11.3
LTE	4	1710 - 1755	20	0.07	1.00	11.3
LTE	5	824 - 849	20	0.07	0.55	8.7
LTE	12	699 - 716	20	0.07	0.47	7.9
LTE	13	777 - 787	20	0.07	0.52	8.4
LTE	66	1710 - 1780	20	0.07	1.00	11.3

Table 3: Maximum Antenna Gain values based on MPE limits

Maximum Gain to meet FCC EIRP limits:

Technology / Mode	Band	Frequency (MHz)	Maximum Output power (dBm)	EIRP Limits (dBm)	Maximum Gain to meet EIRP Limits (dBi)
LTE	2	1850 - 1910	25.70	33.0	7.3
LTE	4	1710 - 1755	25.70	30.0	4.3
LTE	5	824 - 849	25.70	40.6	14.9
LTE	12	699 - 716	25.70	36.9	11.2
LTE	13	777 - 787	25.70	36.9	11.2
LTE	66	1710 - 1780	25.70	30.0	4.3

Table 4: Maximum Antenna Gain values based on EIRP limits

Appendix A: FCC RF Exposure information

FCC RF Exposure evaluation

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	* 100	6
3.0–30	1842/f	4.89/f	* 900/f ²	6
30–300	61.4	0.163	1.0	6
300–1,500			f/300	6
1,500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	* 100	30
1.34–30	824/f	2.19/f	* 180/f ²	30
30–300	27.5	0.073	0.2	30
300–1,500			f/1500	30
1,500–100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

FCC EIRP Limits

Maximum FCC EIRP limits are stated into FCC 47 CFR §22.913, FCC 47 CFR §24.232 and FCC 47 CFR §22.50 standards, these limits are frequency-dependent and are shown in the following table:

Standard	Frequency Band	Technology & Band	EIRP limit (W)	EIRP limit (dBm)
FCC 47 CFR §27.50 (c)	700	LTE 12	4.92	36.92
FCC 47 CFR §27.50 (d)	700	LTE 13	4.92	36.92
FCC 47 CFR §22.913	850	LTE 5	11.48	40.6
FCC 47 CFR §27.50 (d)	1700	LTE 4/66	1.0	30.0
FCC 47 CFR §24.232	1900	LTE 2	2.0	33.0

FCC MPE Evaluation

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

$$\text{Power density: } S[mW/cm^2] = \frac{P_{\max}[mW]}{4\pi R^2[cm]^2}$$

$$\text{Minimum compliance distance: } R_{\min}[cm] = \sqrt{\frac{P_{\max}[mW]}{4\pi S[mW/cm^2]}}$$

$$\text{Maximum gain to meet the MPE limit: } G_{\max}[dBi] = (10 * \log[S[mW/cm^2] * 4\pi R^2[cm]^2] - P_{\max}[dBm])$$

Where:

S = power density

P_{\max} = power input to the antenna

R = distance to the center of radiation of the antenna (evaluation distance)

R_{\min} = distance to the center of radiation of the antenna

G_{\max} = power gain of the antenna in the direction of interest relative to an isotropic radiator