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Test report No:
NIE: 71605RAN.002A1

Assessment report
RF EXPOSURE REPORT ACCORDING TO
FCC 47 CFR Part 2.1091

(*) Identification of item under evaluation	LTE NB-IoT Cellular communication module
(*) Trademark	Sequans Communication
(*) Model and /or type reference	GM02S
(*) Other identification of the product	HW version: V2 SW version: LR8.1.0.0-55629 FCC ID: 2AAGMGM02SA IC: 12732A-GM02SA IMEI TAC: 01577000
(*) Features	NB-IoT (NB1/NB2) Release 14
(*) Manufacturer	SEQUANS COMMUNICATIONS 55 Boulevard Charles de Gaulle, 92700 Colombes France
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael Lopez Martin EMC Consumer & RF Lab. Manager 2022.08.11 08:18:19 +02'00'
Date of issue	2022-08-11
Report template No	FAN36_01 (*) "Data provided by the client"

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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 under evaluation", "Trademark", "Model and/or type reference", “General description of the device”, “Other identification of the product”).
2. Maximum output power and request for evaluation under mobile exposure conditions
3. The device under evaluation consists of a multi-band module supporting cellular NB-IoT (NB1/NB2) Release 14.

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.

Identification of the client

SEQUANS COMMUNICATIONS

55 Boulevard Charles de Gaulle, 92700 Colombes, France

Document history

Report number	Date	Description
71605RAN.002	2022-08-11	First release
71605RAN.002A1	2022-08-11	Second release. LTE 26 band has been included. This modification of test report cancels and replaces the test report 71605RAN.002.

Appendix A: FCC RF Exposure assessment result

General description of the equipment under evaluation

The equipment under evaluation consists of a multi-band module supporting cellular NB-IoT (NB1/NB2) Release 14.

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 each supported technology and band are:

Technology / Mode	Band	Frequency (MHz)	Maximum Conducted Output Power (dBm)
LTE NB-IoT	2	1850 - 1910	25.00
LTE NB-IoT	4	1710 - 1755	25.00
LTE NB-IoT	5	824 - 849	25.00
LTE NB-IoT	12	699 - 716	25.00
LTE NB-IoT	13	777 - 787	25.00
LTE NB-IoT	17	704 - 716	25.00
LTE NB-IoT	25	1850 - 1915	25.00
LTE NB-IoT	26	814 - 849	25.00
LTE NB-IoT	66	1710 - 1780	25.00

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 B) shall not exceed the following values:

Technology / Mode	Band	Frequency (MHz)	Max Gain to comply with RF Exp Limits (dBi)	Max Gain to comply with EIRP Limits (dBi)	Maximum allowed Gain (worst case) (dBi)
LTE NB-IoT	2	1850 - 1910	12.00	8.00	8.00
LTE NB-IoT	4	1710 - 1755	12.00	5.00	5.00
LTE NB-IoT	5	824 - 849	9.40	15.60	9.40
LTE NB-IoT	12	699 - 716	8.60	11.92	8.60
LTE NB-IoT	13	777 - 787	9.10	11.92	9.10
LTE NB-IoT	17	704 - 716	8.70	11.92	8.70
LTE NB-IoT	25	1850 - 1915	12.00	8.00	8.00
LTE NB-IoT	26	814 - 849	9,30	15,60	9,30
LTE NB-IoT	66	1710 - 1780	12.00	5.00	5.00

Table 2: Maximum Antenna Gain values

Maximum Gain to meet FCC Radiofrequency radiation exposure limits:

Technology / Mode	Band	Frequency (MHz)	Distance (cm)	Power density for Gain = 0 dBi (mW/cm²)	FCC General Population Limit (mW/cm²)	Maximum Gain to comply with RF Exposure Limits (dBi)
LTE NB-IoT	2	1850 - 1910	20.00	0.06	1.00	12.00
LTE NB-IoT	4	1710 - 1755	20.00	0.06	1.00	12.00
LTE NB-IoT	5	824 - 849	20.00	0.06	0.55	9.40
LTE NB-IoT	12	699 - 716	20.00	0.06	0.47	8.60
LTE NB-IoT	13	777 - 787	20.00	0.06	0.52	9.10
LTE NB-IoT	17	704 - 716	20.00	0.06	0.47	8.70
LTE NB-IoT	25	1850 - 1915	20.00	0.06	1.00	12.00
LTE NB-IoT	26	814 - 849	20,00	0,06	0,54	9,30
LTE NB-IoT	66	1710 - 1780	20.00	0.06	1.00	12.00

Table 3: Maximum Antenna Gain values based on FCC 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 NB-IoT	2	1850 - 1910	25.00	33.00	8.00
LTE NB-IoT	4	1710 - 1755	25.00	30.00	5.00
LTE NB-IoT	5	824 - 849	25.00	40.60	15.60
LTE NB-IoT	12	699 - 716	25.00	36.92	11.92
LTE NB-IoT	13	777 - 787	25.00	36.92	11.92
LTE NB-IoT	17	704 - 716	25.00	36.92	11.92
LTE NB-IoT	25	1850 - 1915	25.00	33.00	8.00
LTE NB-IoT	26	814 - 849	25,00	40,60	15,60
LTE NB-IoT	66	1710 - 1780	25.00	30.00	5.00

Table 4: Maximum Antenna Gain values based on FCC EIRP limits

Appendix B: 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 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:

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

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

S = power density

P_{max} = power input to the antenna

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

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

FCC Cellular bands limits

Maximum FCC EIRP limits are frequency-dependent and are stated into the FCC standards shown in the following table:

Standard	Frequency Band (MHz)	EIRP limit (W)	EIRP limit (dBm)
FCC 47 CFR §27.50 (c)	600-746	4.92	36.92
FCC 47 CFR §27.50 (b)	776-787	4.92	36.92
FCC Clause 90.542 (a) (7)	788-798	4.92	36.92
FCC 47 CFR §22.913	814-849	11.48	40.6
FCC 47 CFR §27.50 (d)	1710-1780	1.0	30.0
FCC 47 CFR §24.232	1850-1915	2.0	33.0
FCC 47 CFR §27.50 (a)	2305-2315	0.25 (average EIRP)	23.9
FCC 47 CFR §27.50 (h) (2)	2496-2690	2.0	33.0
FCC 47 CFR §96.41 (b)	3550-3700	0.2	23
FCC 47 CFR §27.5 (j)	3700-3980	1	30