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RADIO TEST REPORT – 450027-2TRFWL

Type of assessment:
Final product testing

Applicant:
Sigma SpA

Product:
Ticketing Machine for Outdoor locations

Model:
ETS90-N-CA

Model variant(s):
n/a

FCC ID:
2A9NH-ETS90-N-CA

IC Registration number:
29896-ETS90NCA

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.225
- RSS-210, Issue 10, December 2019, Amendment (April 2020), Annex B.6

Date of issue: July 29, 2022

G. Tepelena, EMC/RF	
Tested by	Signature
P. Barbieri, Wireless/EMC Specialist	
Reviewed by	Signature

Test location(s)

Company name	Nemko Spa
Address	Via del Carroccio, 4
City	Biassono
Province	MB
Postal code	20853
Country	Italy
Telephone	+39 039 220 12 01
Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	FCC: 682159; IC: 9109A (10 m semi anechoic chamber)

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225	Operation within the band 13.110–14.010 MHz.
RSS-210, Issue 10, Dec 2019, Amendment (April 2020), Annex B.6	License-Exempt Radio Apparatus: Category I Equipment. Devices operating in frequency bands for any application Band 13.110–14.010 MHz

1.2 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
450027-2TRFWL	July 29, 2022	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

None

2.3 Model variant declaration

None

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

In the laboratory, the following ambient conditions are respected for each test reported below:

Temperature	18 – 33 °C
Relative humidity	25 – 70 %
Air pressure	860 – 1060 mbar

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model no.	Asset no.	Cal date	Next cal.
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305	2021-12	2022-12
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	2021-12	2022-12
Barometer	Castle	GPB 3300	072015	2022-05	2023-05

3.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 4.1-1: *Measurement uncertainty calculations*

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5 Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant/Manufacturer

Applicant name	Sigma S.p.A
Applicant address	Via Po, 14 – 63824 Altidona (FM) – Italy
Manufacturer name	Sigma S.p.A
Manufacturer address	Via Po, 14 – 63824 Altidona (FM) – Italy

5.3 EUT information

Product	Ticketing Machine for Outdoor locations
Model	ETS90-N-CA
Serial number	4500270001
Power supply	120 Vac
Product description and theory of operation	The device under test is designed for the application of ticketing vending machine; the equipment contains three independent RFIDs, all working at 13.56 MHz in simultaneous transmission.

5.4 Radio technical information

Frequency band	13.553–13.567 MHz
Frequency Min (MHz)	13.56
Frequency Max (MHz)	13.56
RF power Max (W), Conducted	N/A
Field strength, dBµV/m @ 3 m	49.23
Measured BW (kHz), 99% OBW	2.676
Type of modulation	ASK
Emission classification	A1D
Transmitter spurious, dBµV/m @ 3 m	44.38 at 244.080 MHz
Antenna information	Internal, non-detachable antenna

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	The EUT was connected with a laptop via com interface and was controlled to transmit RFID/NFC signal at 13.56 MHz by software.
Transmitter state	Transmitter was set into continuous mode.

5.5.2 EUT setup configuration

Table 5.5-1: *EUT interface ports*

Description	Qty.
Power/data port	1

Table 5.5-2: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	Dell	SN: FA003070, MN: Latitude E6440

Table 5.5-3: *Inter-connection cables*

Cable description	From	To	Length (m)
Power/data cable harness	EUT	DC power source / Laptop	3

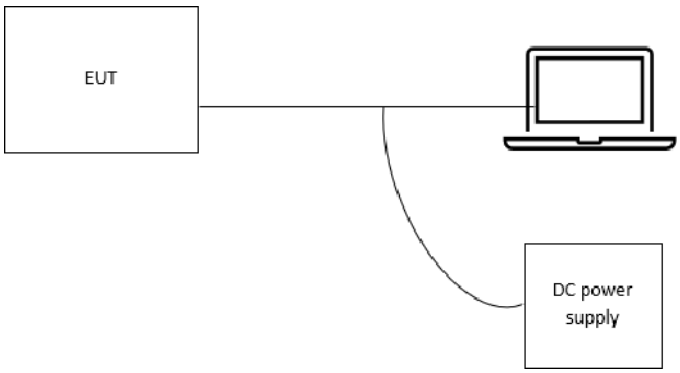


Figure 5.5-1: *Block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Nemko spa

6.2 Testing period

Test start date	June 30, 2022	Test end date	July 29, 2022

6.3 Sample information

Receipt date	June 28, 2022	Nemko sample ID number(s)	1

6.4 FCC Part 15 Subpart A and C, general requirements test results

Table 6.4-1: *FCC general requirements results*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not performed[1]
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: [1] See 450027-1TRFEMC test report.

6.5 FCC Part §15.225 test results

Table 6.5-1: *FCC §15.225 requirements results*

Part	Test description	Verdict
§15.225(a)	Field strength within 13.553–13.567 MHz band	Pass
§15.225(b)	Field strength within 13.410–13.553 MHz and 13.567–13.710 MHz bands	Pass
§15.225(c)	Field strength within 13.110–13.410 MHz and 13.710–14.010 MHz bands	Pass
§15.225(d)	Field strength outside 13.110–14.010 MHz band[2]	Pass
§15.225(e)	Frequency tolerance of carrier signal	Pass

Notes [2]EUT has been tested with all RFIDs in simultaneous transmission and then with each single RFID in transmission alone.
The POS terminal Verifone UX401 (card reader UX301 + contactless antenna UX401) has not been tested alone because already approved (FCC ID: B32UX401CTLS; IC 787C-UX301).

6.6 ISED RSS-Gen, Issue 5, test results

Table 6.6-1: *RSS-Gen requirements results*

Clause	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable[1]
7.4	Receiver conducted emission limits	Not applicable[1]
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Not performed [2]

Notes: [1]According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

[2]See 450027-2TRFEMC test report.

6.7 ISED RSS-210, Issue 10, test results

Table 6.7-1: *ISED RSS-247 requirements results*

Section	Test description	Verdict
Annex B.6 (a)(i)	The field strength within the band 13.553–13.567 MHz	Pass
Annex B.6 (a)(ii)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
Annex B.6 (a)(iii)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz	Pass
Annex B.6 (a)(iv)	The field strength outside the band 13.110–14.010 MHz[3]	Pass
Annex B.6 (b)	Carrier frequency stability	Pass

Notes [3]EUT has been tested with all RFIDs in simultaneous transmission and then with each single RFID in transmission alone.
The POS terminal Verifone UX401 (card reader UX301 + contactless antenna UX401) has not been tested alone because already approved (FCC ID: B32UX401CTLS; IC 787C-UX301).

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	April 12, 2023
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	November 12, 2022
Spectrum analyzer	Rohde & Schwarz	FSP	FA001920	1 year	November 12, 2022
Active loop antenna (0.01–30 MHz)	Com-Power	AL-130R	FA003002	1 year	March 24, 2023
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003010	1 year	April 28, 2023
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	December 17, 2022
50 Ω coax cable	Huber + Suhner	None	FA003043	1 year	December 17, 2022

Note: NCR - no calibration required

Section 8 Testing data

8.1 Variation of power source

8.1.1 References, definitions and limits

FCC §15.31 (e):

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.1.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.1.3 Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

a) Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.
b) For devices, where operating at a supply voltage deviating ±15% from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.
c) For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.
d) For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

8.1.4 Test data

EUT Power requirements:	☐ AC	☒ DC	☐ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☐ YES	☐ NO	☒ N/A

8.2 Number of frequencies

8.2.1 References, definitions and limits

FCC §15.31:

(m) Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.2-1: *Frequency Range of Operation*

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.2.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.2.3 Observations, settings and special notes

ANSI C63.10, Clause 5.6.2.1:

The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

a) For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

b) For multiple-input multiple-output (MIMO) systems, if the measured channel bandwidth on testing the middle channel exceeds the minimum permitted bandwidth by more than 50% on one transmit chain, then it is not necessary to repeat testing on the other chains.

c) If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

ANSI C63.10, Clause 5.6.2.2:

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).

b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

8.2.4 Test data

Table 8.2-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Tx channel, MHz
13.553	13.567	0.014	13.560

8.3 Antenna requirement

8.3.1 References, definitions and limits

FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen, Clause 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.3.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.3.3 Observations, settings and special notes

None

8.3.4 Test data

Must the EUT be professionally installed?	☐ YES	☒ NO	
Does the EUT have detachable antenna(s)?	☐ YES	☒ NO	
If detachable, is the antenna connector(s) non-standard?	☐ YES	☐ NO	☒ N/A

8.4 Occupied bandwidth

8.4.1 References, definitions and limits

FCC Part §15.215:

Additional provisions to the general radiated emission limitations:

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the

ANSI C63.10-2013, Clause 6.9.3:

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

RSS-Gen, Clause 6.7:

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

8.4.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.4.3 Observations, settings and special notes

The emission bandwidth was tested per ANSI C63.10, Clause 6.9.3. Spectrum analyser settings:

Resolution bandwidth:	≥ 1 % of span
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

Table 8.4-1: *99% bandwidth results*

Frequency, MHz	99% bandwidth, Hz
13.560	2676.132

Table 8.4-2: *Lower 20 dBc frequency cross result*

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.559805	13.559886	13.553000	6.886

Table 8.4-3: *Upper 20 dBc frequency cross result*

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.559805	13.5596302	13.567000	6.986

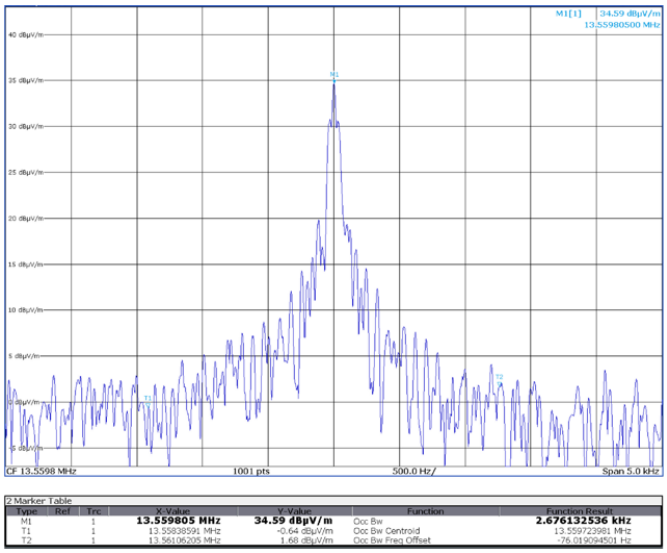


Figure 8.4-1: *99% bandwidth*

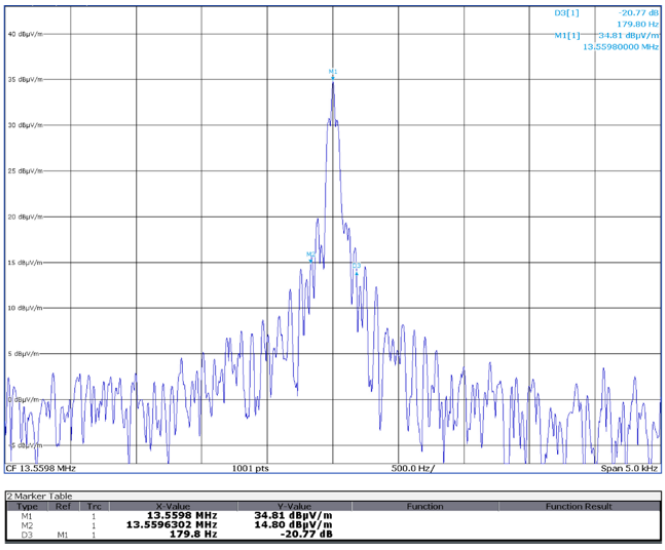


Figure 8.4-2: *20 dB bandwidth*

8.5 Field strength within 13.110–14.010 MHz band

8.5.1 References, definitions and limits

FCC §15.225:

(a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 µV/m (84 dBµV/m) at 30 meters.

(b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m (50.5 dBµV/m) at 30 meters.

(c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 µV/m (40.5 dBµV/m) at 30 meters.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

a. the field strength of any emission shall not exceed the following limits:

i. 15.848 mV/m (84 dBµV/m) at 30 m, within the band 13.553–13.567 MHz

ii. 334 µV/m (50.5 dBµV/m) at 30 m, within the bands 13.410–13.553 MHz and 13.567–13.710 MHz

iii. 106 µV/m (40.5 dBµV/m) at 30 m, within the bands 13.110–13.410 MHz and 13.710–14.010 MHz

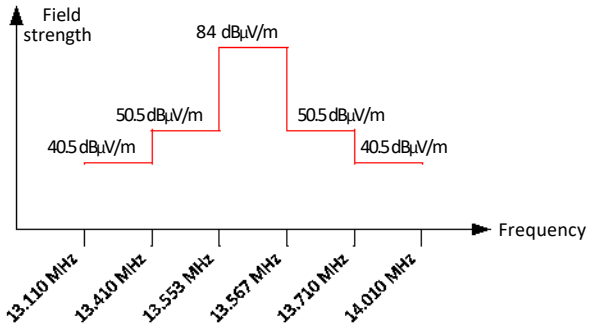


Figure 8.5-1: *In-band spurious emissions limit at 30 m*

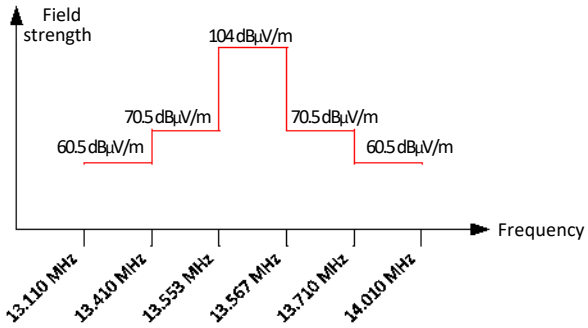


Figure 8.5-2: *In-band spurious emissions limit at 10 m*

8.5.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.5.3 Observations, settings and special notes

The measurements were performed at the distance of 10 m. 20 dB distance correction factor* was applied to the measurement result in order to comply with 30 m limits.
* 30 m to 10 m distance correction factor calculation (for 13 MHz band):

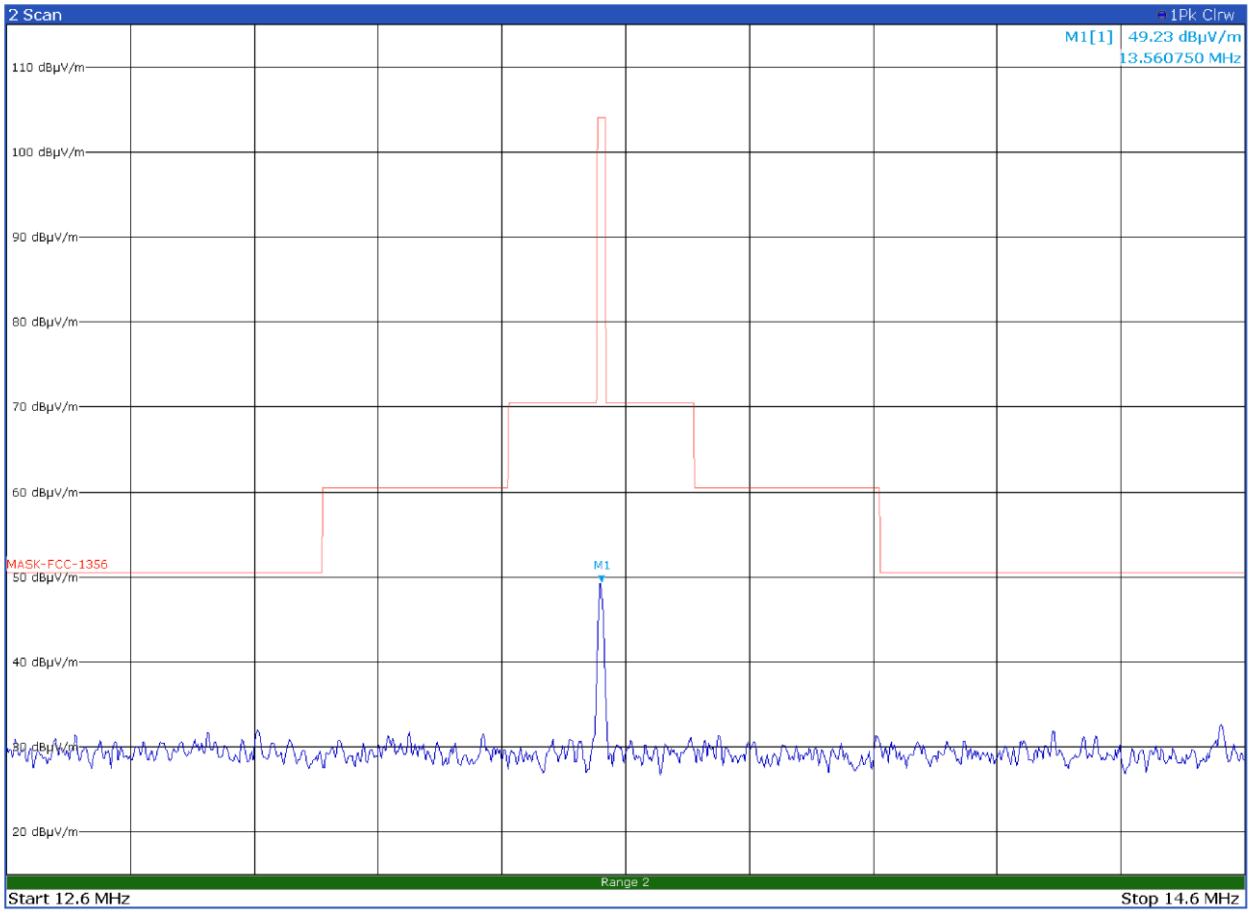
$$40 \times \text{Log}_{10}(10\text{ m}/30\text{ m}) = 40 \times \text{Log}_{10}(0.3) = -20\text{ dB}$$

- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 10 m.
- The spurious emission was tested per ANSI C63.10, Clause 6.4.

Spectrum analyser settings:

Resolution bandwidth:	10 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.5.4 Test data



8.6 Field strength outside 13.110–14.010 MHz band

8.6.1 References, definitions and limits

FCC §15.225:

(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

a. the field strength of any emission shall not exceed the following limits:

iv. RSS-Gen general field strength limits for frequencies outside the band 13.110–14.010 MHz

Table 8.6-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

	Field strength of emissions		
Frequency, MHz	**µV/m**	**dBµV/m**	**Measurement distance, m**
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

References, definitions and limits, continued

Table 8.6-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in this table and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.6-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.6.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.6.3 Observations, settings and special notes

- The spectrum was searched from 9 kHz to 1 GHz.
- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 3 m.
- The spurious emission was tested per ANSI C63.10, Clause 6.4 and 6.5.

Spectrum analyser settings for measurements below 150 kHz:

Resolution bandwidth:	200 Hz
Video bandwidth:	1 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for measurements below 30 MHz:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for measurements below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

All RFIDs in transmission

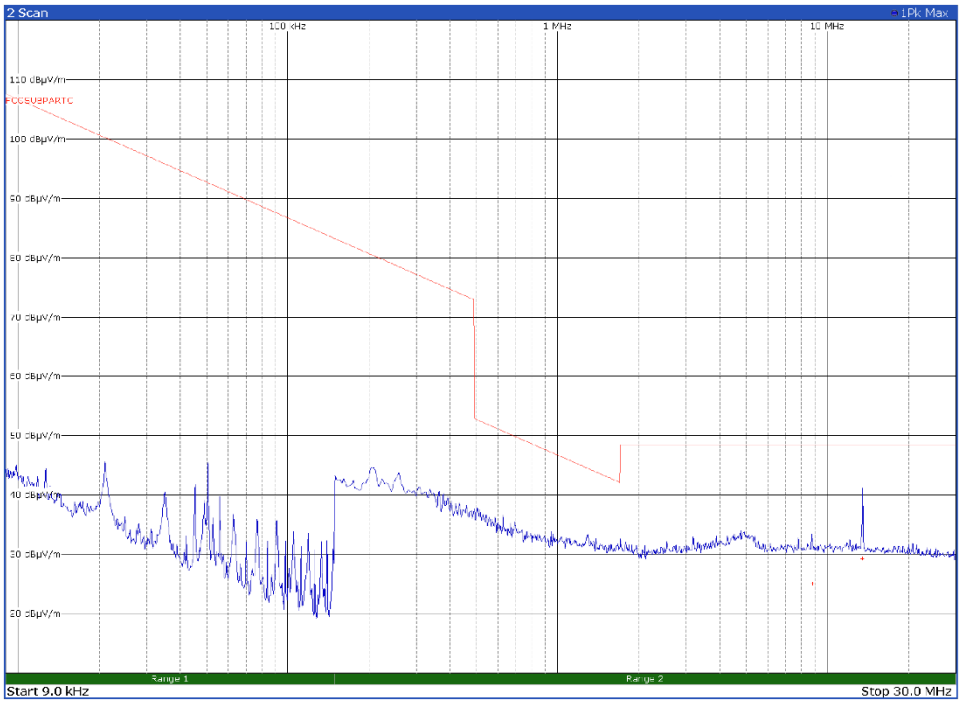


Figure 8.6-1: Field strength of spurious emission 9kHz-30 MHz – Loop antenna facing the EUT and with all RFIDs in simultaneous transmission.

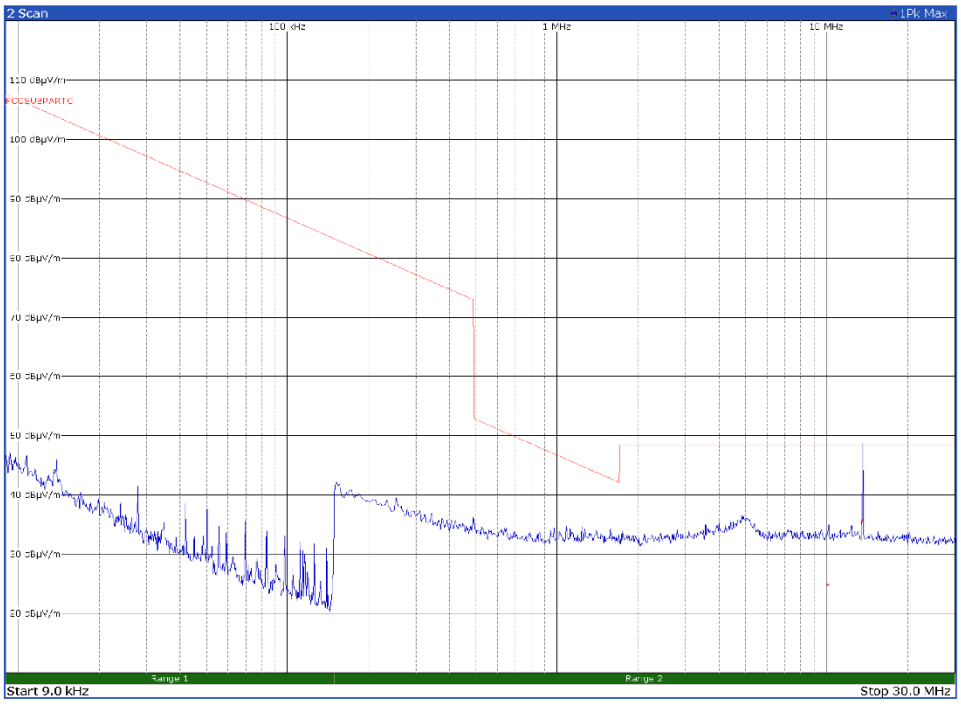


Figure 8.6-2: Field strength of spurious emission 9kHz-30 MHz – Loop antenna orthogonal to the EUT and with all RFIDs in simultaneous transmission.

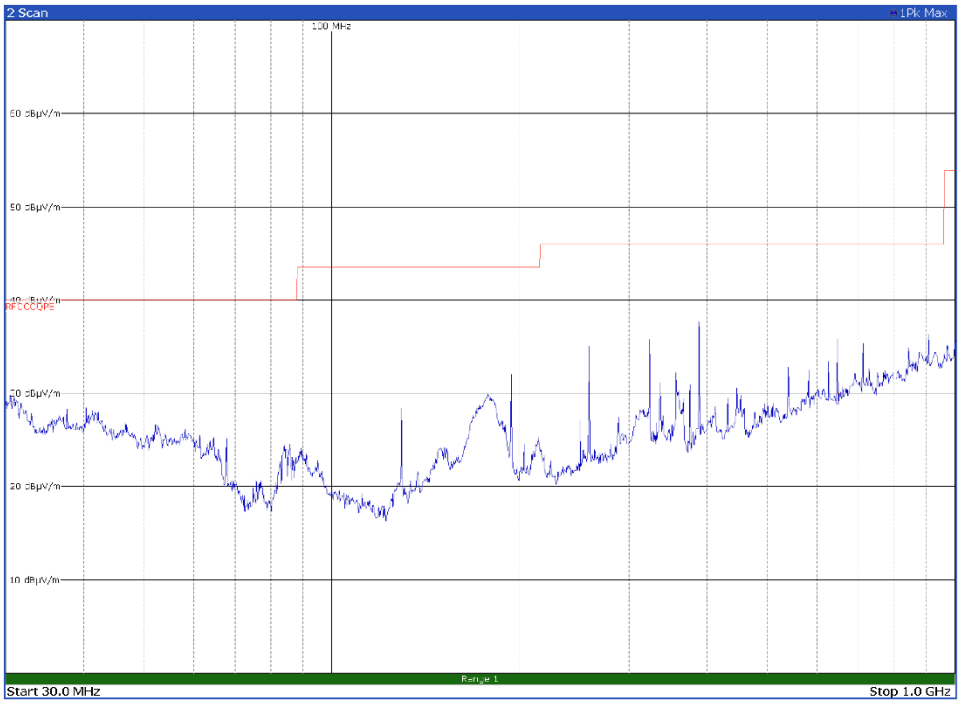


Figure 8.6-3: Field strength of spurious emission 30 MHz – 1 GHz Horizontal pol. and with all RFIDs in simultaneous transmission.

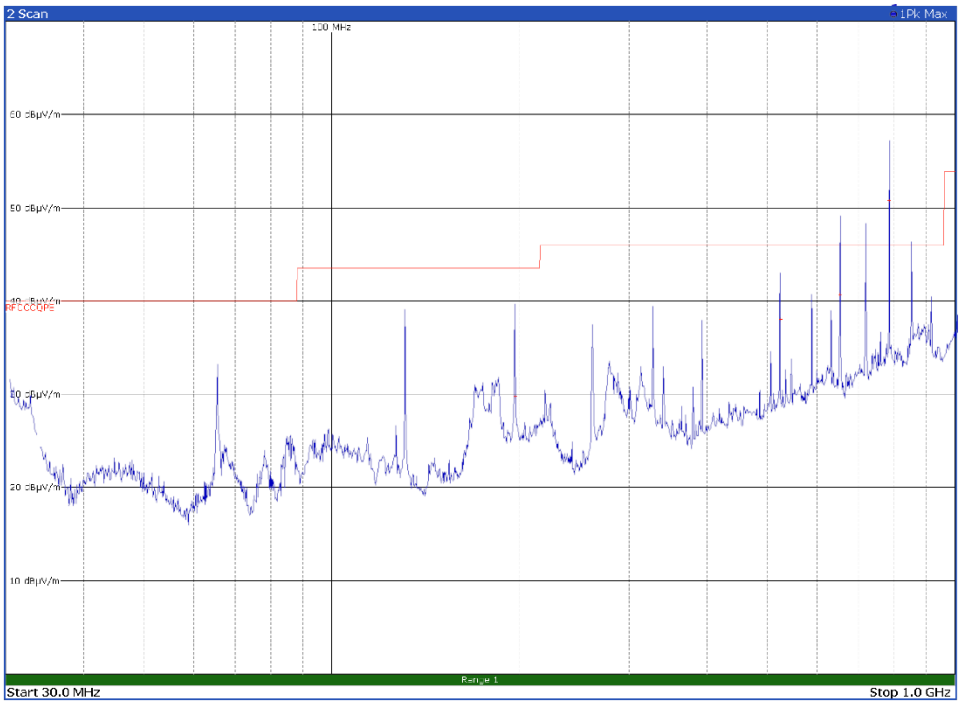


Figure 8.6-4: Field strength of spurious emission 30 MHz – 1 GHz Vertical pol. and with all RFIDs in simultaneous transmission.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
Loop antenna facing the EUT and with all RFIDs in transmission				
8.788	25.27	48.63	-23.36	QP
Loop antenna orthogonal to the EUT and with all RFIDs in transmission				
10.149	25.03	48.63	-23.60	QP
Antenna in horizontal polarization and with all RFIDs in transmission				
646.560	30.01	46.02	-16.01	QP
Antenna in vertical polarization and with all RFIDs in transmission				
194.010	29.67	43.52	-13.85	QP
517.230	37.73	46.02	-5.79	QP
646.530	40.69	46.02	-2.83	QP
775.830	51.25	46.02	7.73(1)	QP

Note (1): spurious emissions over the limit in the 30 MHz – 1 GHz frequency band are generated by the digital circuitry, not by the RFID modules (see test report n. 450027-2TRFEMC issued by Nemko S.p.A., dated 2022-07-29).

Atlantis OEM NFC H11 in transmission

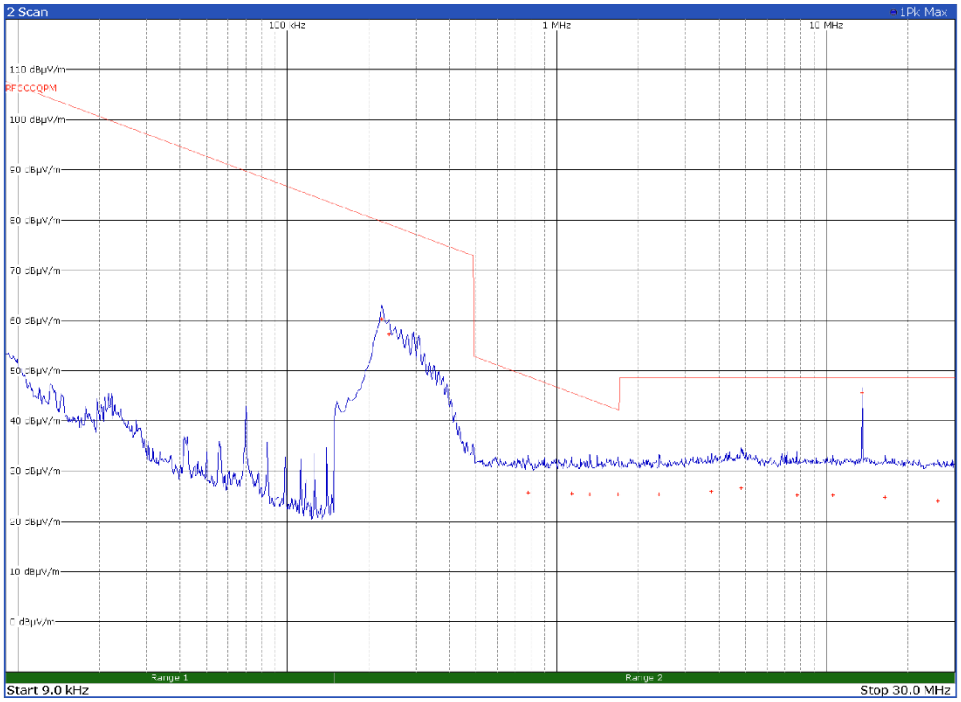


Figure 8.6-5: Field strength of spurious emission 9kHz-30 MHz – Loop antenna facing the EUT and with only Atlantis OEM NFC H11 in transmission.

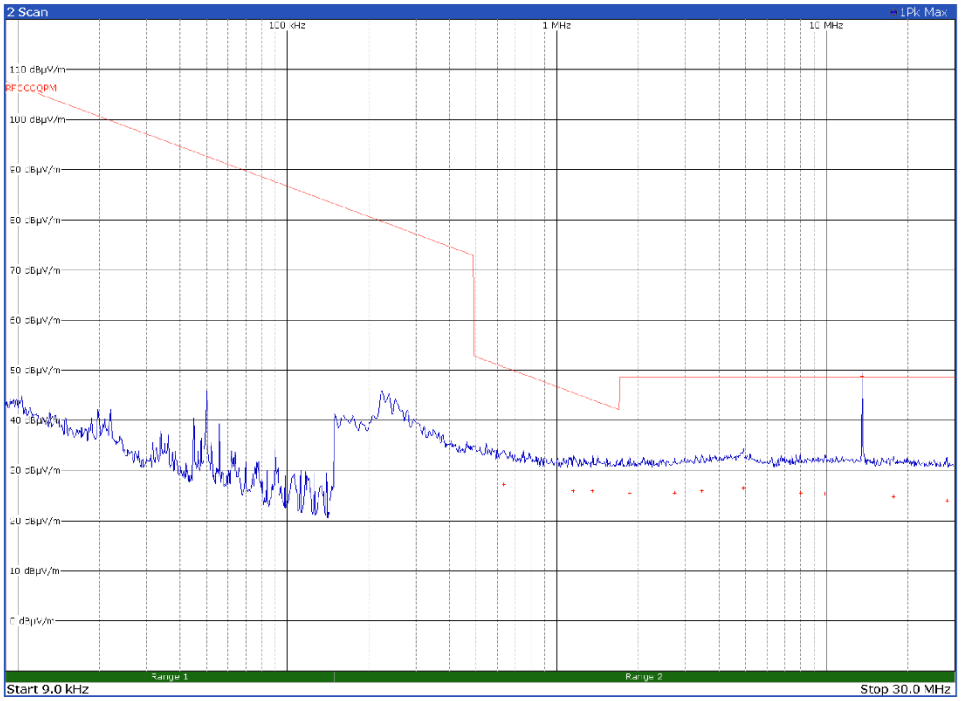


Figure 8.6-6: Field strength of spurious emission 9kHz-30 MHz –Loop antenna orthogonal to the EUT and with only Atlantis OEM NFC H11 in transmission.

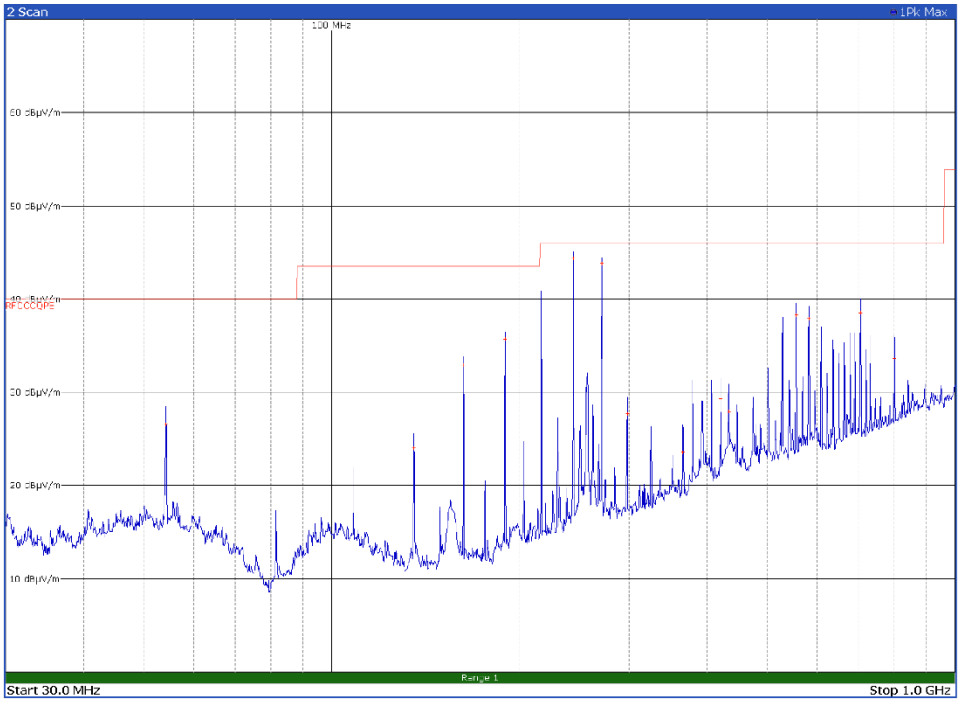


Figure 8.6-7: Field strength of spurious emission 30 MHz – 1 GHz Horizontal pol. and with only Atlantis OEM NFC H11 in transmission.

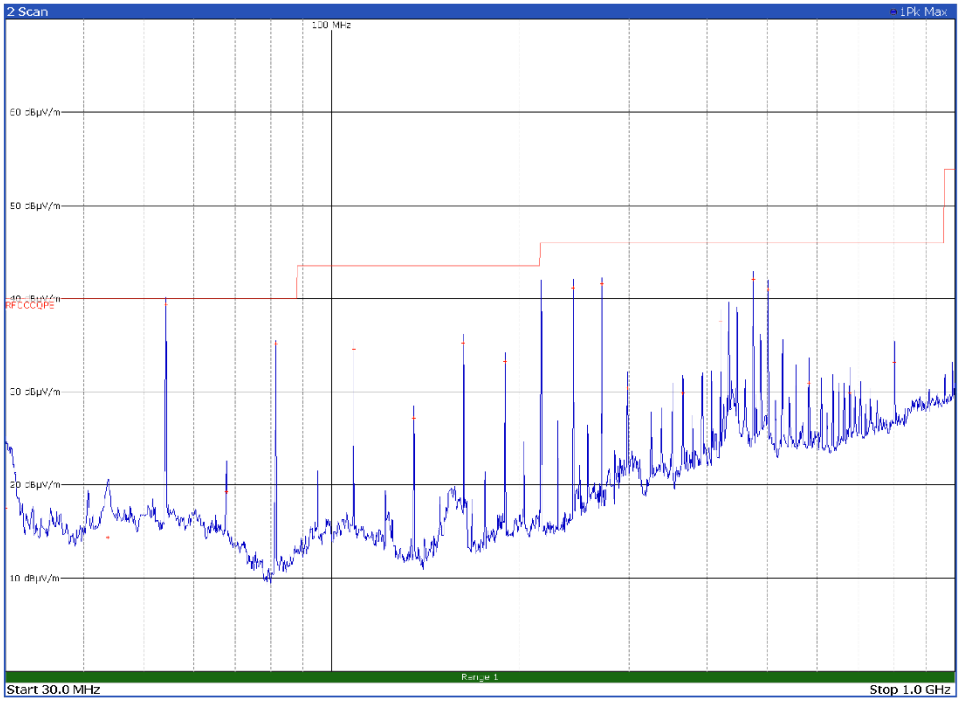


Figure 8.6-8: Field strength of spurious emission 30 MHz – 1 GHz Vertical pol. and with only Atlantis OEM NFC H11 in transmission.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
Loop antenna facing the EUT and with all RFIDs in transmission				
0.22425	60.21	79.67	-19.46	QP
0.23775	57.33	79.17	-21.84	QP
0.78225	25.61	48.82	-23.21	QP
1.13550	25.55	45.59	-20.04	QP
1.32675	25.42	44.23	-18.81	QP
1.68450	25.39	42.16	-16.77	QP
2.39775	25.33	48.63	-23.30	QP
3.74775	25.99	48.63	-22.64	QP
4.84125	26.61	48.63	-22.02	QP
7.77975	25.24	48.63	-23.39	QP
10.563	25.23	48.63	-23.40	QP
16.499	24.74	48.63	-23.89	QP
25.881	24.13	48.63	-24.50	QP
Loop antenna orthogonal to the EUT and with all RFIDs in transmission				
0.63600	27.23	50.62	-23.39	QP
1.15125	25.95	45.47	-19.52	QP
1.35825	25.95	44.03	-18.08	QP
1.86675	25.47	48.63	-23.16	QP
2.73975	25.47	48.63	-23.16	QP
3.45525	25.86	48.63	-22.77	QP
4.92225	26.48	48.63	-22.15	QP
8.00025	25.44	48.63	-23.19	QP
9.8835	25.30	48.63	-23.33	QP
17.790	24.79	48.63	-23.84	QP
27.994	23.90	48.63	-24.73	QP
Antenna in horizontal polarization and with all RFIDs in transmission				
542.400	26.53	46.02	-19.49	QP
135.600	24.03	46.02	-21.99	QP
162.720	32.90	46.02	-13.12	QP
189.840	35.69	46.02	-10.33	QP
244.080	44.38	46.02	-1.64	QP
271.200	43.85	46.02	-2.17	QP
298.320	27.74	46.02	-18.28	QP
366.120	23.57	46.02	-22.45	QP
420.360	29.31	46.02	-22.11	QP
433.920	27.96	46.02	-18.06	QP
555.960	38.32	46.02	-7.70	QP
583.080	37.88	46.02	-8.14	QP
705.090	38.54	46.02	-7.48	QP
800.010	33.62	46.02	-12.40	QP
Antenna in vertical polarization and with all RFIDs in transmission				
30.000	17.52	40.00	-22.48	QP
43.770	14.32	40.00	-25.68	QP
54.240	39.38	40.00	-0.62	QP
67.800	19.27	40.00	-20.73	QP
81.360	35.19	40.00	-4.81	QP
108.480	34.57	43.52	-8.95	QP
135.600	27.19	43.52	-16.33	QP

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
162.720	35.26	43.52	-8.26	QP
189.840	33.24	43.52	-10.28	QP
244.080	41.17	46.02	-4.85	QP
271.200	41.61	46.02	-4.41	QP
298.320	30.39	46.02	-15.63	QP
366.120	29.87	46.02	-16.15	QP
420.360	37.52	46.02	-8.50	QP
474.600	42.07	46.02	-3.95	QP
501.720	40.95	46.02	-5.07	QP
583.080	30.96	46.02	-15.06	QP
677.970	29.87	46.02	-16.15	QP
800.010	33.17	46.02	-12.85	QP

ASK CPL 528 in transmission with ANT550 antenna

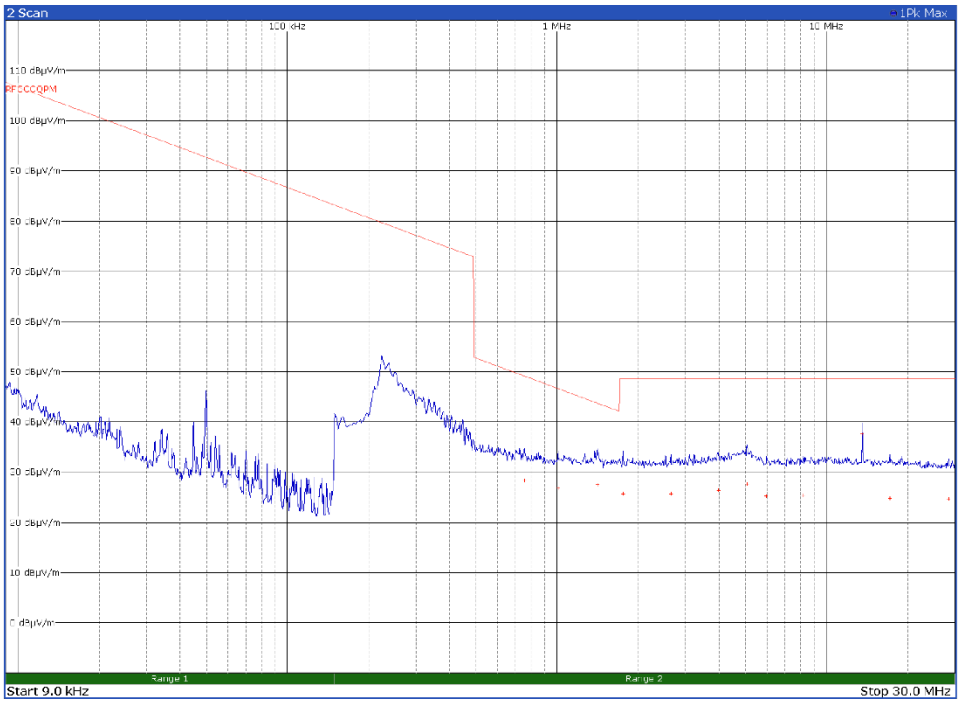


Figure 8.6-9: Field strength of spurious emission 9kHz-30 MHz – Loop antenna facing the EUT and with only ASK CPL 528 in transmission.

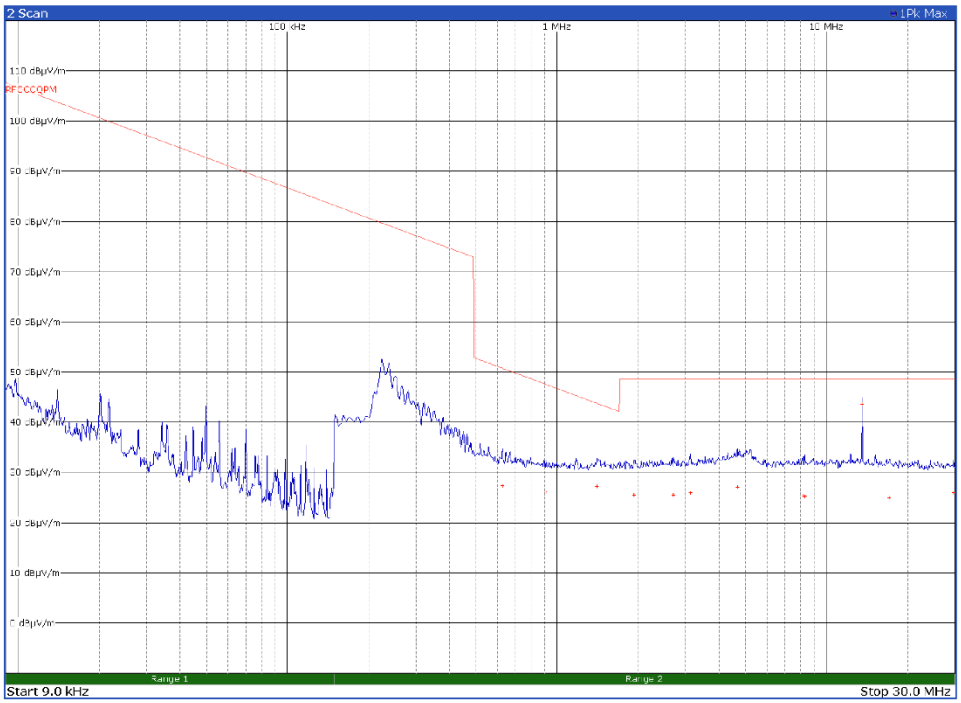


Figure 8.6-10: Field strength of spurious emission 9kHz-30 MHz –Loop antenna orthogonal to the EUT and with only ASK CPL 528 in transmission.

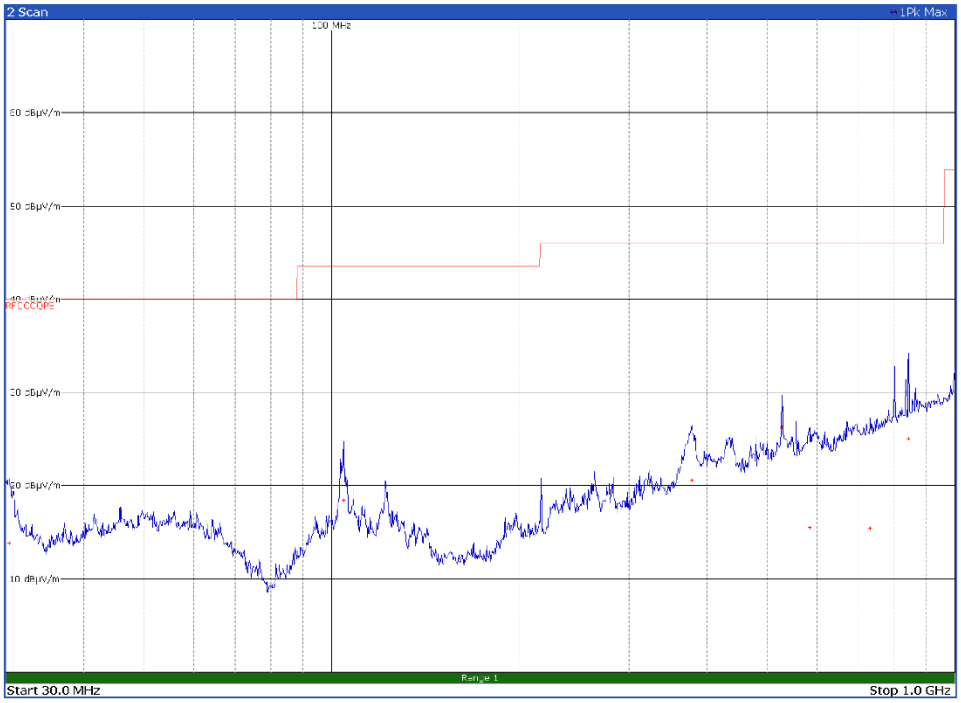


Figure 8.6-11: Field strength of spurious emission 30 MHz – 1 GHz Horizontal pol. and with only ASK CPL 528 in transmission.

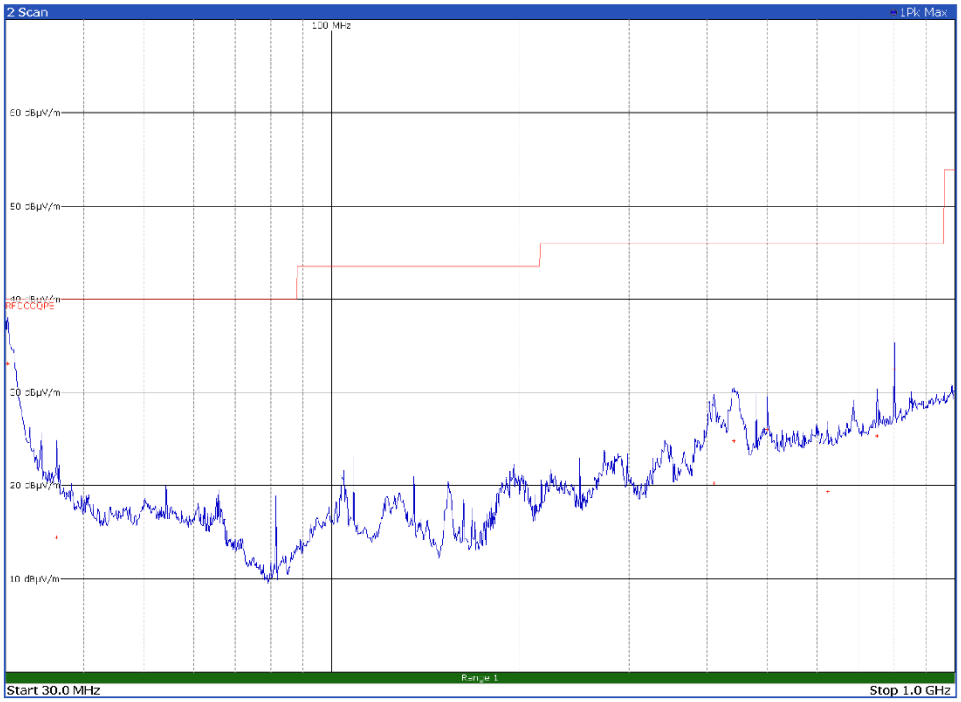


Figure 8.6-12: Field strength of spurious emission 30 MHz – 1 GHz Vertical pol. and with only ASK CPL 528 in transmission.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
Loop antenna facing the EUT and with all RFIDs in transmission				
0.75750	28.28	49.10	-20.82	QP
1.00950	26.83	46.61	-19.78	QP
1.41225	27.51	43.69	-16.18	QP
1.76325	25.70	48.63	-22.93	QP
2.64975	25.64	48.63	-22.99	QP
3.96150	26.28	48.63	-22.35	QP
5.06175	27.61	48.63	-21.02	QP
5.99325	25.20	48.63	-23.43	QP
8.23425	25.39	48.63	-23.24	QP
17.192	24.80	48.63	-23.83	QP
28.366	24.61	48.63	-24.02	QP
Loop antenna orthogonal to the EUT and with all RFIDs in transmission				
0.62700	27.28	50.74	-23.46	QP
0.91275	26.11	47.48	-21.37	QP
1.41000	27.14	43.70	-16.56	QP
1.93425	25.54	48.63	-23.09	QP
2.70150	25.52	48.63	-23.11	QP
3.12675	25.85	48.63	-22.78	QP
4.67475	27.03	48.63	-21.60	QP
8.16225	25.35	48.63	-23.28	QP
8.29500	25.27	48.63	-23.36	QP
17.138	24.94	48.63	-23.69	QP
29.610	25.95	48.63	-22.68	QP
Antenna in horizontal polarization and with all RFIDs in transmission				
30.390	13.82	40.00	-26.18	QP
104.520	18.44	43.52	-25.08	QP
378.030	20.55	46.02	-25.47	QP
528.000	26.27	46.02	-19.75	QP
584.310	15.50	46.02	-30.52	QP
730.710	15.46	46.02	-30.56	QP
841.410	24.99	46.02	-21.03	QP
Antenna in vertical polarization and with all RFIDs in transmission				
302.400	33.02	46.02	-13.00	QP
348.600	15.31	46.02	-30.71	QP
408.000	25.42	46.02	-20.60	QP
440.730	25.26	46.02	-20.76	QP
500.010	26.01	46.02	-20.01	QP
625.020	19.14	46.02	-26.88	QP
750.000	25.32	46.02	-20.70	QP
800.010	32.57	46.02	-13.45	QP

Ksenia Security Volo-in in transmission

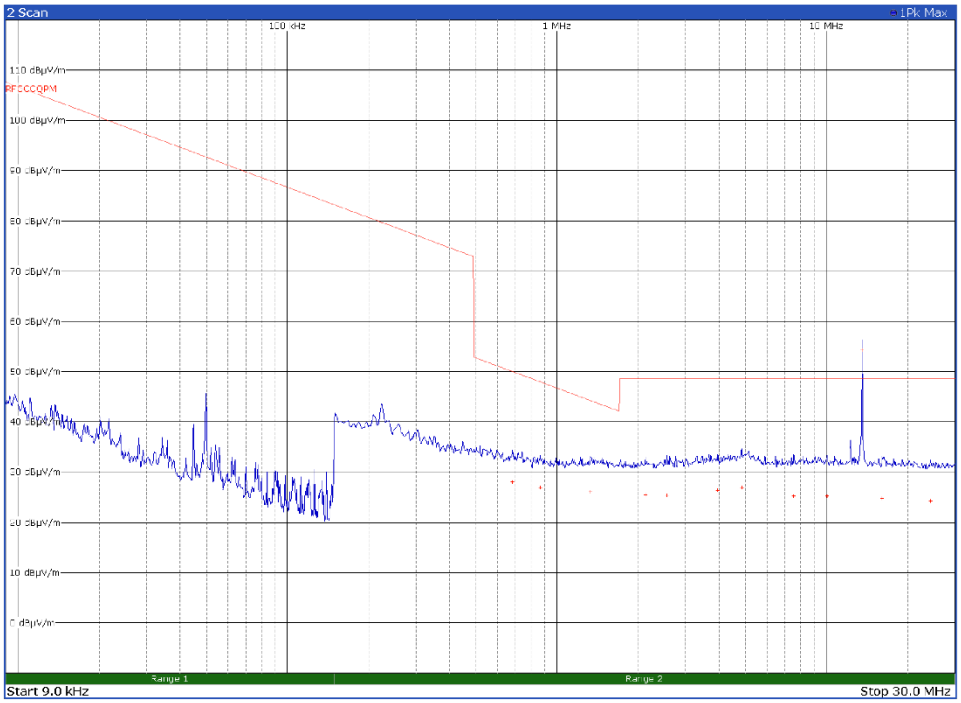


Figure 8.6-13: Field strength of spurious emission 9kHz-30 MHz – Loop antenna facing the EUT and with only Ksenia Security Volo-in in transmission.

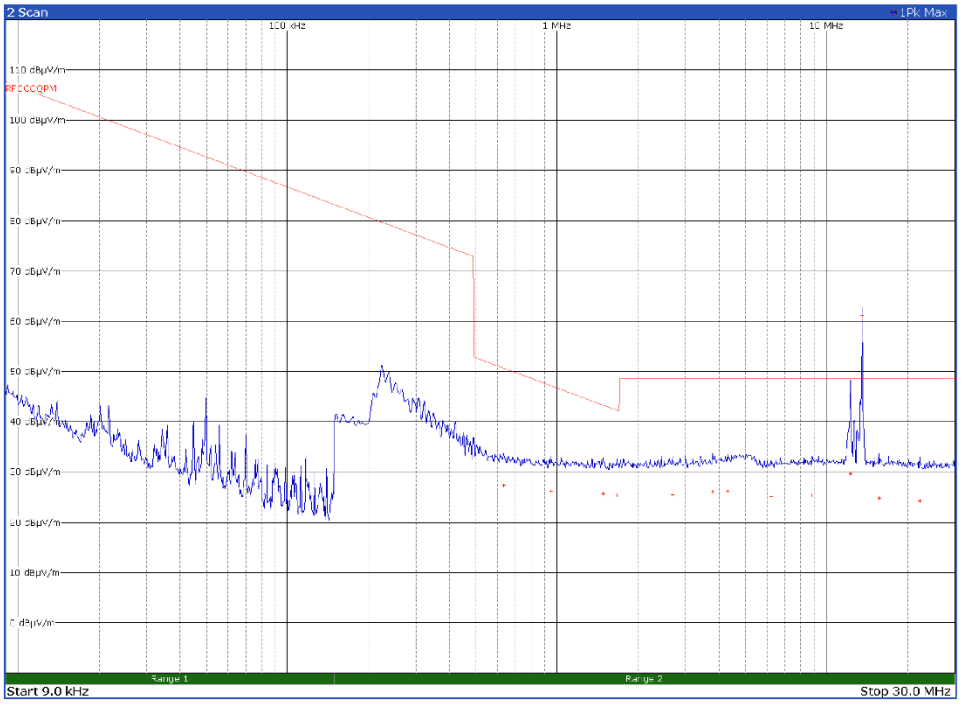


Figure 8.6-14: Field strength of spurious emission 9kHz-30 MHz –Loop antenna orthogonal to the EUT and with only Ksenia Security Volo-in in transmission.

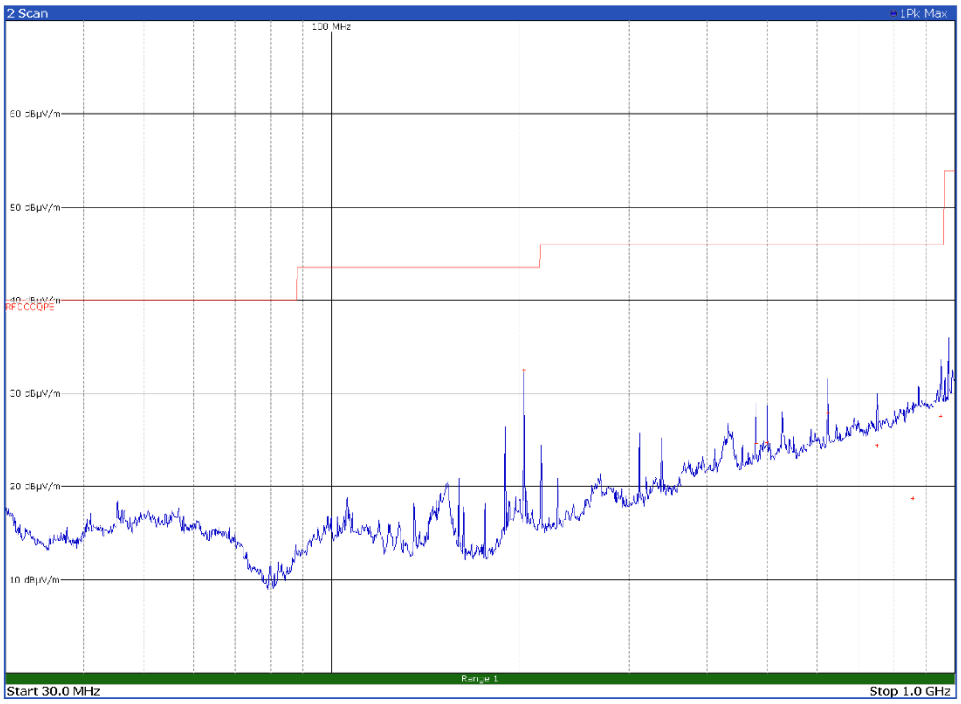


Figure 8.6-15: Field strength of spurious emission 30 MHz – 1 GHz Horizontal pol. and with only Ksenia Security Volo-in in transmission.

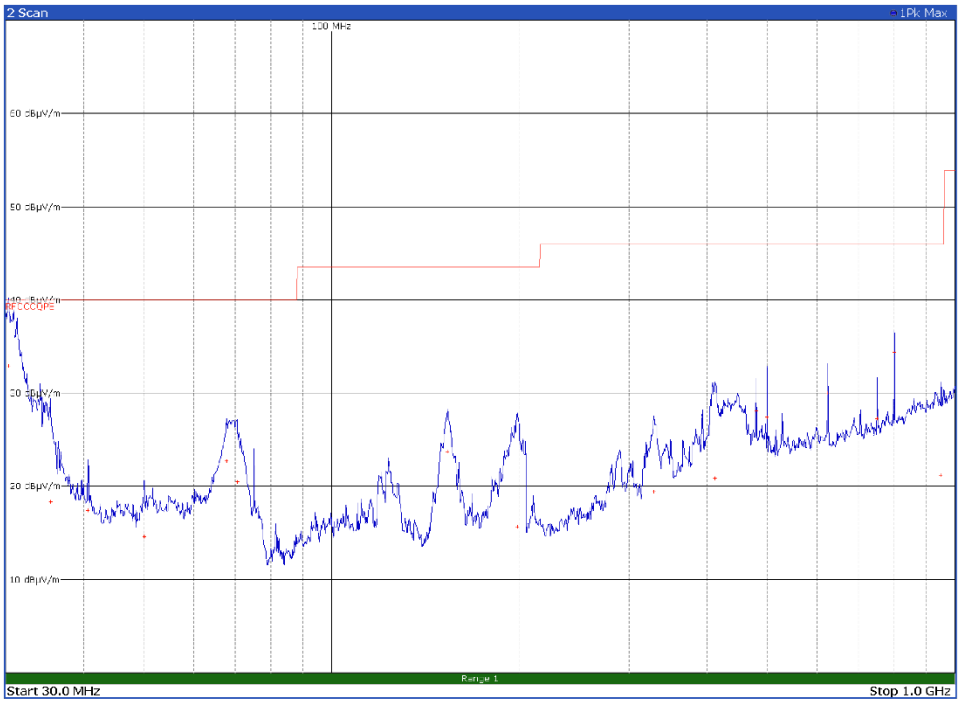


Figure 8.6-16: Field strength of spurious emission 30 MHz – 1 GHz Vertical pol. and with only Ksenia Security Volo-in in transmission.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
Loop antenna facing the EUT and with all RFIDs in transmission				
0.68550	28.04	49.97	-21.93	QP
0.86775	26.94	47.92	-20.98	QP
1.33125	26.04	44.20	-18.16	QP
2.12550	25.49	48.63	-23.14	QP
2.55975	25.41	48.63	-23.22	QP
3.95700	26.35	48.63	-22.28	QP
4.84800	26.90	48.63	-21.73	QP
7.56375	25.26	48.63	-23.37	QP
10.050	25.18	48.63	-23.45	QP
16.103	24.82	48.63	-23.81	QP
24.371	24.16	48.63	-24.47	QP
Loop antenna orthogonal to the EUT and with all RFIDs in transmission				
0.63375	27.31	50.65	-23.34	QP
0.95325	26.27	47.10	-20.83	QP
1.48425	25.62	43.26	-17.64	QP
1.66875	25.42	42.24	-16.82	QP
2.69025	25.46	48.63	-23.17	QP
3.78600	26.09	48.63	-22.54	QP
4.30125	26.23	48.63	-22.40	QP
6.23400	25.07	48.63	-23.56	QP
8.85975	25.40	48.63	-23.23	QP
12.288	29.67	48.63	-18.96	QP
15.680	24.85	48.63	-23.78	QP
22.243	24.17	48.63	-24.46	QP
Antenna in horizontal polarization and with all RFIDs in transmission				
203.400	32.48	43.52	-11.04	QP
480.000	24.67	46.02	-21.35	QP
500.010	24.70	46.02	-21.32	QP
625.020	27.97	46.02	-8.05	QP
750.030	24.40	46.02	-21.62	QP
855.540	18.72	46.02	-27.30	QP
949.230	27.56	46.02	-18.46	QP
Antenna in vertical polarization and with all RFIDs in transmission				
30.300	32.91	40.00	-7.09	QP
35.400	18.32	40.00	-21.68	QP
40.680	17.40	40.00	-22.60	QP
50.010	14.56	40.00	-25.44	QP
67.800	22.73	40.00	-17.27	QP
70.500	20.46	40.00	-19.54	QP
153.510	23.71	43.52	-19.81	QP
198.540	15.66	43.52	-27.86	QP
328.980	19.39	46.02	-26.63	QP
411.900	20.88	46.02	-25.14	QP
480.000	28.09	46.02	-17.93	QP
500.010	27.43	46.02	-18.59	QP
625.050	30.00	46.02	-16.02	QP
750.000	27.22	46.02	-18.80	QP
800.010	34.41	46.02	-11.61	QP
949.290	21.20	46.02	-24.82	QP

8.7 Frequency stability

8.7.1 References, definitions and limits

FCC §15.225:

(e) The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-210, Annex B.6:

Devices shall comply with the following requirements:

b. the carrier frequency stability shall not exceed ±100 ppm

8.7.2 Test summary

Verdict	Pass		
Tested by	G. Tepelena	Test date	July 4, 2022

8.7.3 Observations, settings and special notes

Frequency drift (ppm) = $((F_{measured} - F_{reference}) \div F_{reference}) \times 1 \times 10^6$

Frequency stability test was performed as per ANSI C63.10, Clause 6.8. Spectrum analyser settings:

Resolution bandwidth:	100 Hz
Video bandwidth:	300 Hz
Detector mode:	Peak
Trace mode:	Max Hold

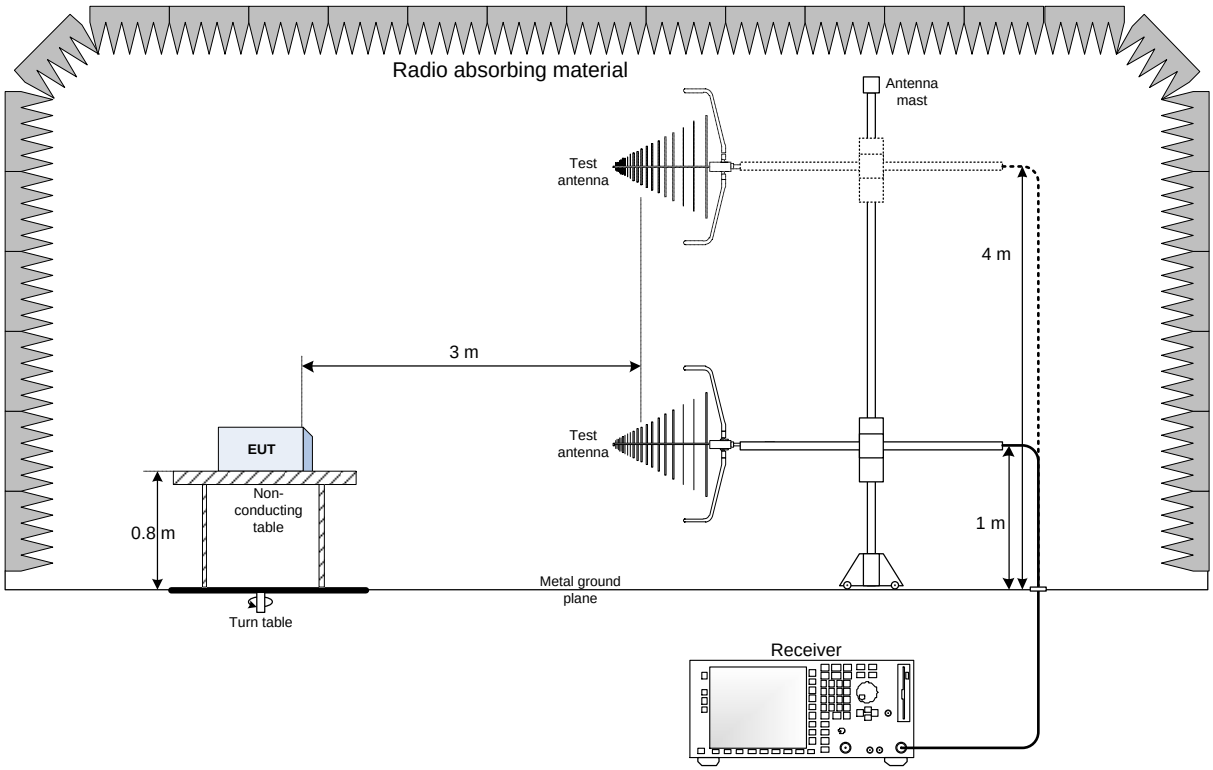
8.7.4 Test data

Table 8.7-1: *Frequency drift measurement*

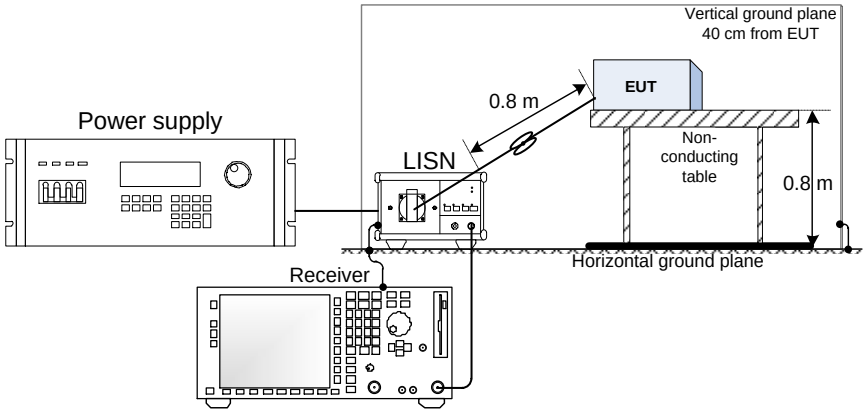
Test conditions	Frequency, MHz	Drift, Hz	Drift, ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	13.559910	−140	10.3	100.0	89.7
+40 °C, Nominal	13.559920	−130	9.6	100.0	90.4
+30 °C, Nominal	13.559960	−90	6.6	100.0	93.4
+20 °C, +15 %	13.560050	0	0	100.0	100.0
+20 °C, Nominal	13.560050		*Reference*		
+20 °C, −15 %	13.560050	0	0	100.0	100.0
+10 °C, Nominal	13.560100	+50	3.7	100.0	96.3
0 °C, Nominal	13.560160	+110	8.1	100.0	91.9
−10 °C, Nominal	13.560200	+150	11.1	100.0	88.9
−20 °C, Nominal	13.560200	+150	11.1	100.0	88.9

Section 9 Block diagrams of test set-ups and EUT photos

9.1 Radiated emissions set-up

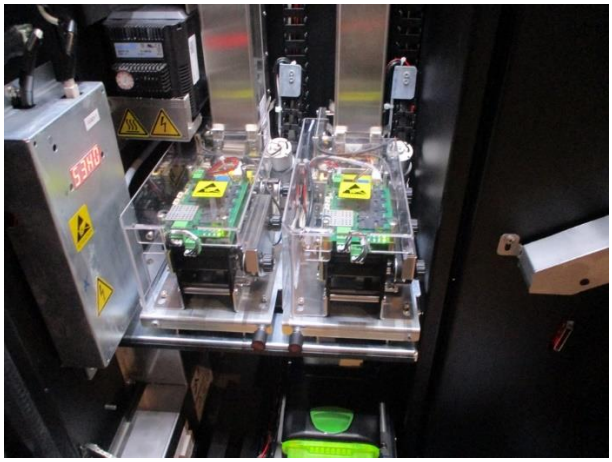


9.2 Conducted emissions set-up

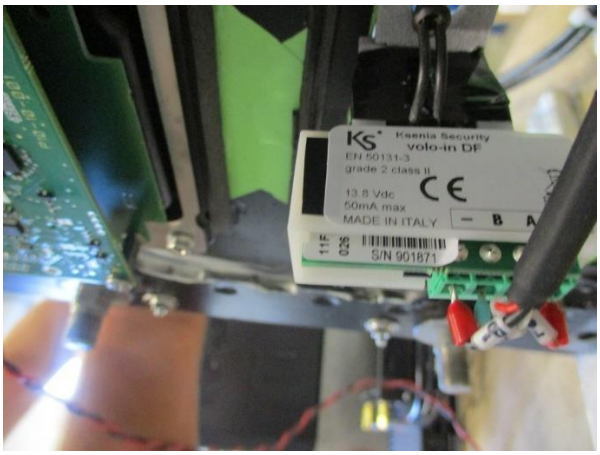


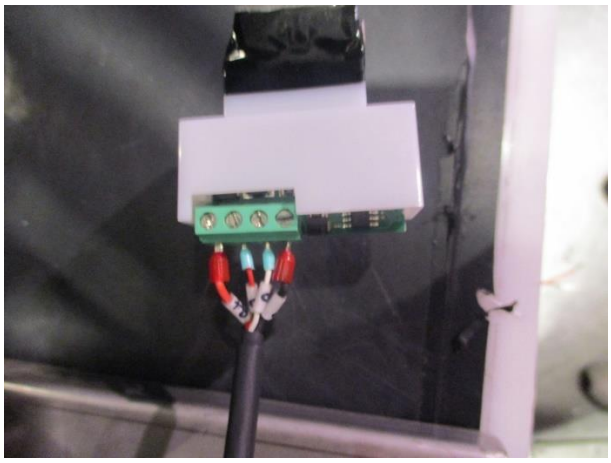
9.3 EUT photos

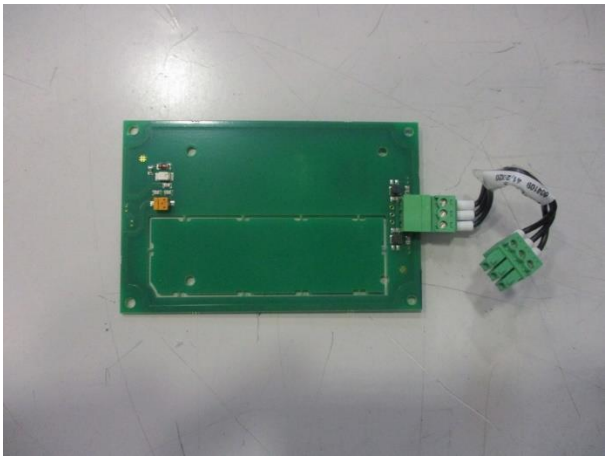
Front, back, lateral photo of EUT

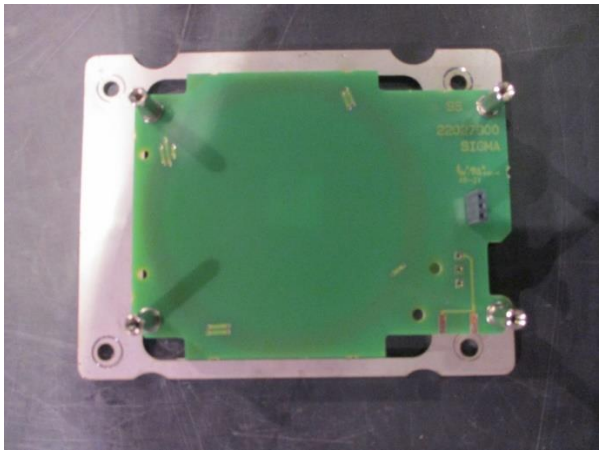


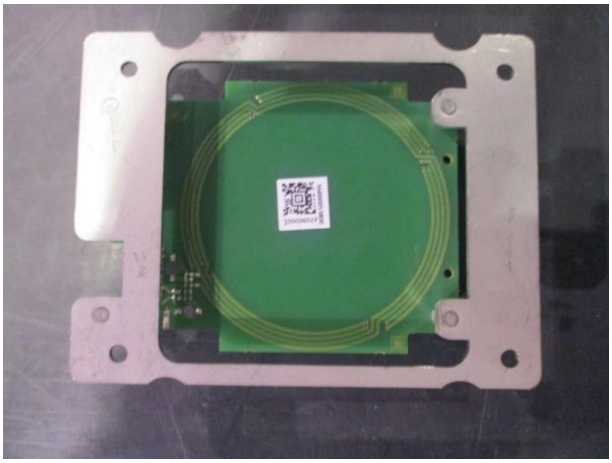

SensorID
Atlantis OEM (5 x 8) - SIGMA_Rev.1
H|1 USB 0|
FD3
FD2
FD4
FD1

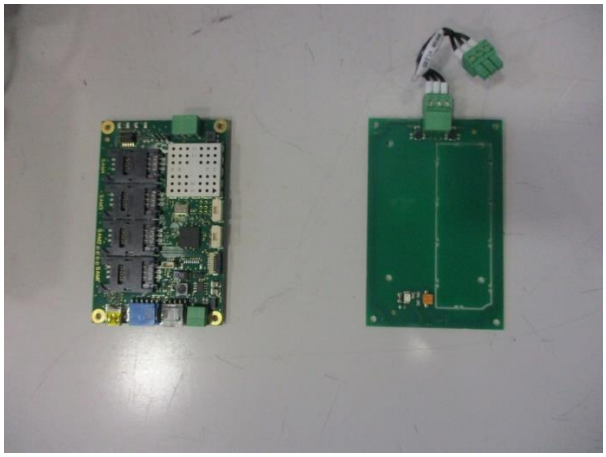

Ksenia Security
volo-in DF
EN 50131-3
grade 2 class II
13.8 Vdc
50mA max
MADE IN ITALY
S/N 901871











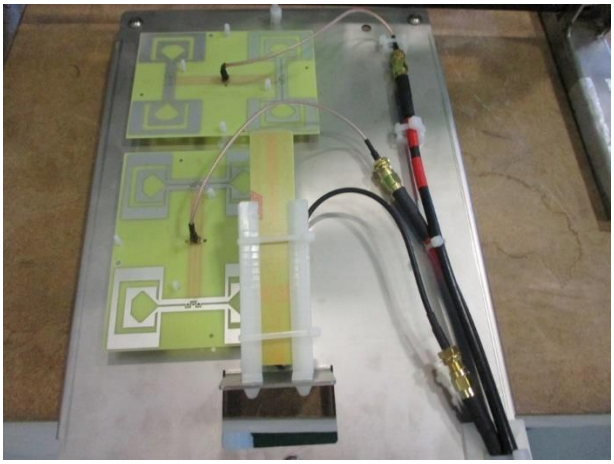


Photo of radio modules and antennas internal of EUT

(End of report)