

RADIO TEST REPORT – 478882-5TRFWL

Type of assessment:

Final product testing

Applicant:

INPECO SA

Via Torracchia, 26 – 6883 Novazzano – Switzerland

Product:

CANopen Antenna Board single – 13 MHz

Model:

PSI0039

FCC ID:

2BALJ-CAB1C13M01

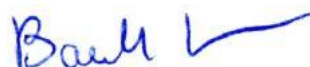
Specifications:

◆ **FCC 47 CFR Part 15 Subpart C, §15.225**

Date of issue: October 21, 2022

P. Barbieri

Tested by



Signature

D. Guarnone

Reviewed by



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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 Spa ISO/IEC 17025 accreditation.

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Table of Contents

Table of Contents	3
Section 1 Report summary	4
1.1 Test specifications	4
1.2 Test methods	4
1.3 Exclusions	4
1.4 Statement of compliance.....	4
1.5 Test report revision history.....	4
Section 2 Engineering considerations	5
2.1 Modifications incorporated in the EUT for compliance	5
2.2 Technical judgment	5
2.3 Deviations from laboratory tests procedures	5
Section 3 Test conditions	6
3.1 Atmospheric conditions.....	6
3.2 Power supply range	6
Section 4 Measurement uncertainty	7
4.1 Uncertainty of measurement	7
Section 5 Information provided by the applicant	8
5.1 Disclaimer	8
5.2 Applicant/Manufacture	8
5.3 EUT information	8
5.4 Radio technical information.....	9
5.5 EUT setup details	10
Section 6 Summary of test results	13
6.1 Testing location	13
6.2 Testing period.....	13
6.3 Sample information	13
6.4 FCC Part 15 Subpart A and C, general requirements test results	13
6.5 FCC Part 15 Subpart C, intentional radiators test results	13
Section 7 Test equipment.....	14
7.1 Test equipment list	14
Section 8 Testing data.....	15
8.1 Variation of power source	15
8.2 AC power line conducted emissions limits.....	16
8.3 Antenna requirement	19
8.4 Occupied bandwidth.....	20
8.5 Field strength within the 13.110–14.010 MHz band.....	23
8.6 Field strength of emissions outside 13.110–14.010 MHz band	25
8.7 Frequency tolerance of the carrier signal	30

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225 Operation in the 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
478882-5TRFWL	October 21, 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 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (1060 mbar)

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

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	2020-12	2022-12
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	2020-12	2022-12
Barometer	Castle	GPB 3300	072015	2022-04	2023-04

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 $\pm 5\%$, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.

The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)

NOTES:

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %

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/Manufacture

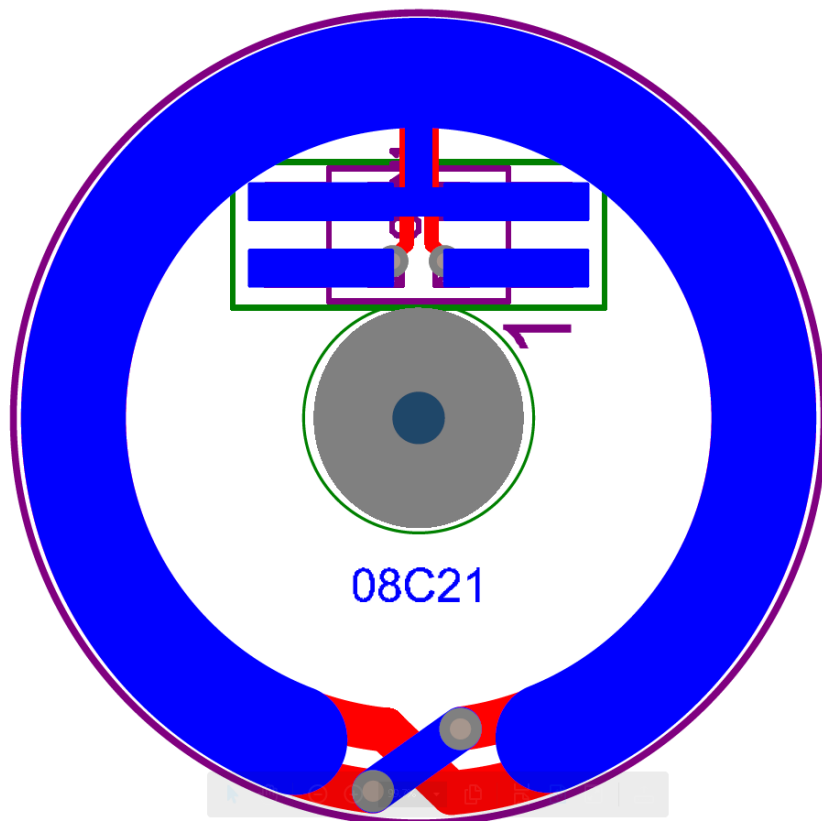
Applicant name	INPECO SA
Applicant address	Via Torraccia, 26 – 6883 Novazzano – Switzerland
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Product	CANopen Antenna Board single – 13 MHz
Model	PSI0039
Serial number	YYMM12345
Power supply requirements	24 V DC
Product description and theory of operation	The EUT is a CAN Antenna board provided with one 13.56 MHz RFID radio module. It's supplied by an external DC power source, and it's provided with a CAN BUS interface for the communication of the hosting device.

5.4 Radio technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Field strength, dB μ V/m @ 3 m	52.7 dB μ V/m
Measured BW (kHz), 99% OBW	0.78 kHz
Type of modulation	ASK
Emission classification	K1D
Transmitter spurious, dB μ V/m @ 3 m	35.8 dB μ V/m Quasi-Peak
Antenna information	The EUT use a customer loop antenna as following:



5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	The EUT has been tested in normal working condition with the antenna working.
Transmitter state	Transmitter set into continuous mode.

5.5.2 EUT setup configuration

Table 5.5-1: EUT sub assemblies

Description	Brand name	Model, Part number, Serial number, Revision level
--	--	--

The EUT is composed by a single unit

Table 5.5-2: EUT interface ports

Description	Qty.
DC power port	1
CAN BUS line	1

Table 5.5-3: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
PC	DELL	Latitude 7480
CAN adapter	IXXAT	USB-to-CAN V2 compact
AC/DC adapter	MW	HDR-60-24

Table 5.5-4: Inter-connection cables

Cable description	From	To	Length (m)
DC power cable	EUT	AC/DC adapter	10
CAN BUS cable	EUT	PC with CAN adapter	10

EUT setup configuration, continued

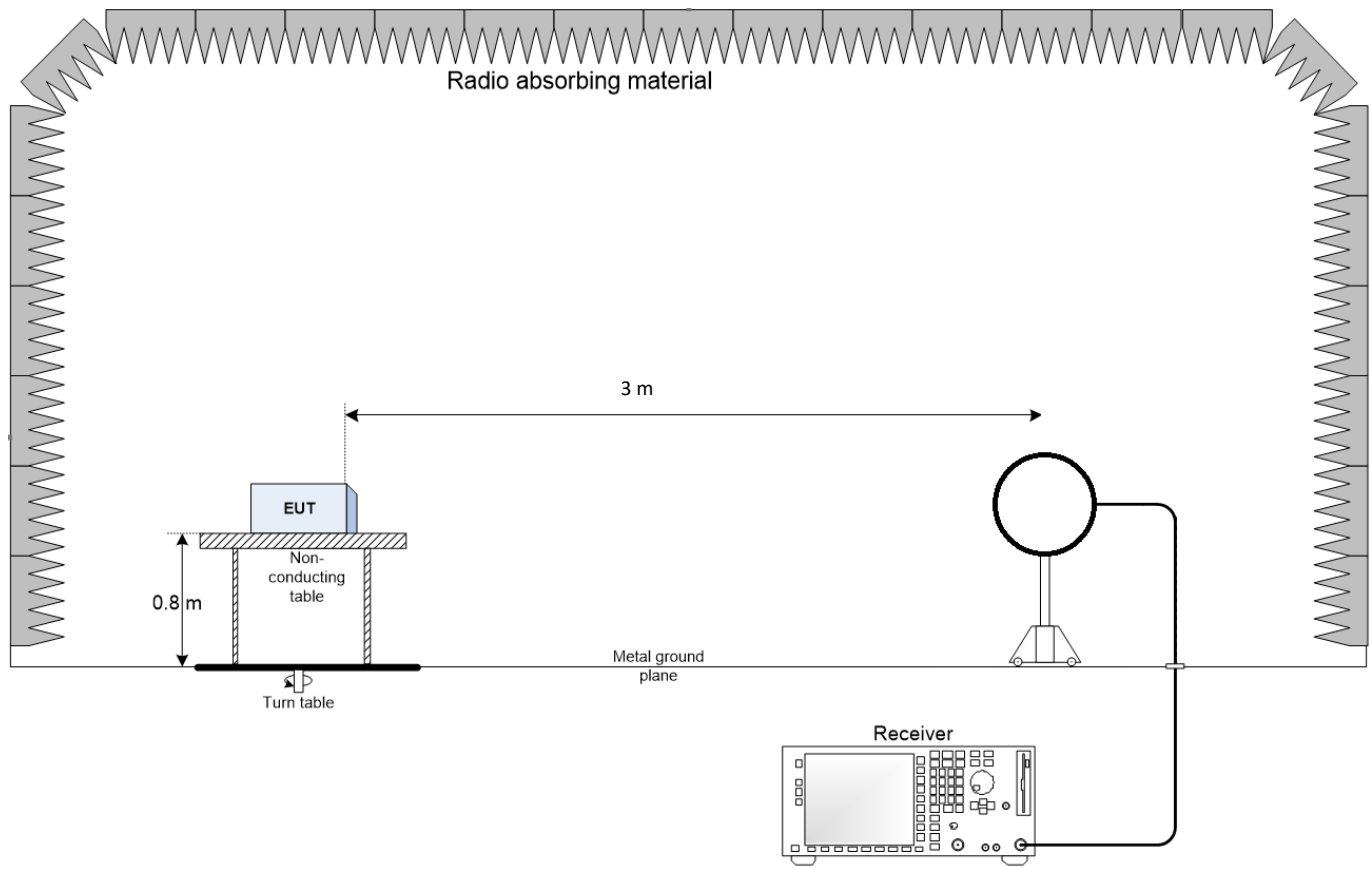


Figure 5.5-1: Radiated testing below 30 MHz block diagram

EUT setup configuration, continued

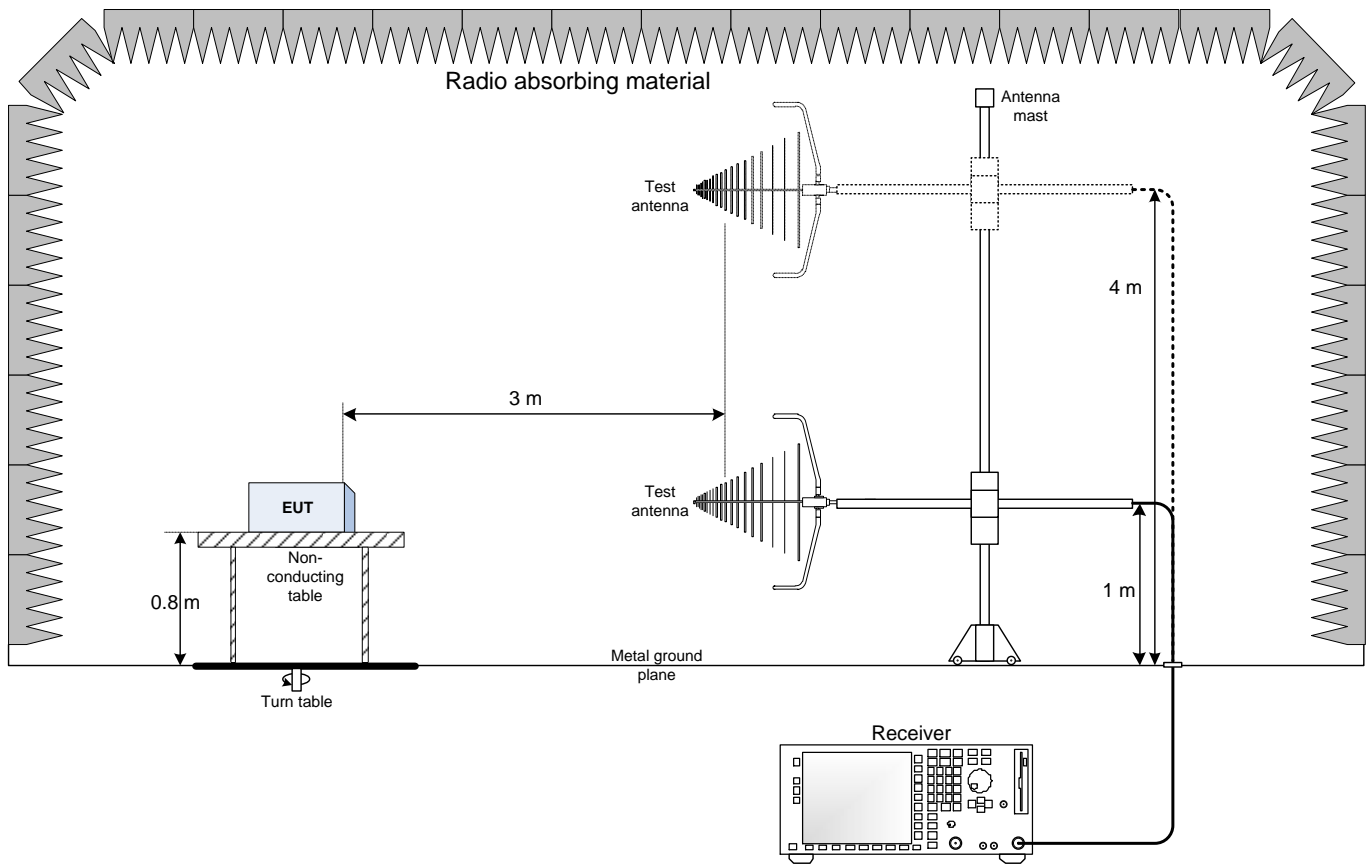


Figure 5.5-2: Radiated testing below 1 GHz block diagram

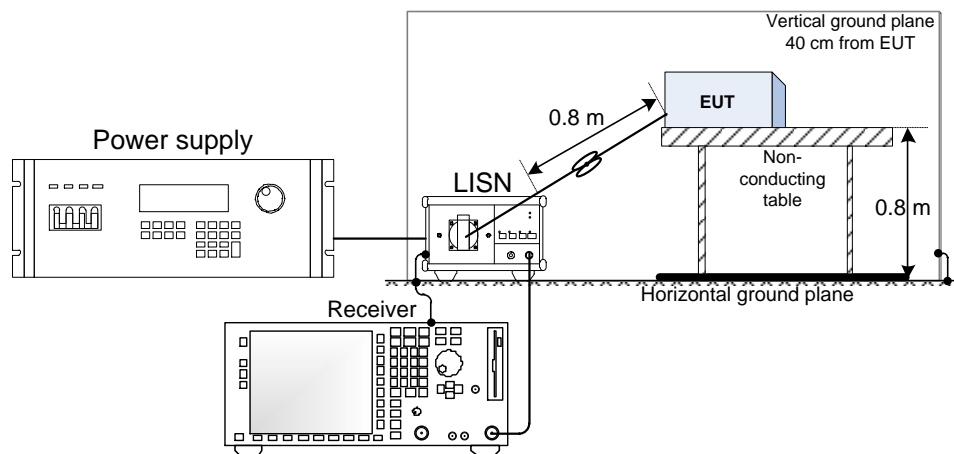


Figure 5.5-3: Conducted emissions block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s) Nemko Spa

6.2 Testing period

Test start date October 17, 2022 Test end date October 21, 2022

6.3 Sample information

Receipt date October 13, 2022 Nemko sample ID number(s) 478882

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	Pass
§15.31l	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass
§15.215(c)	20 dB bandwidth	Pass

Notes: The EUT use only one frequency

6.5 FCC Part 15 Subpart C, intentional radiators test results

Table 6.5-1: FCC 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	Pass
§15.225(e)	Frequency tolerance of carrier signal	Pass

Notes: --

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.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2022-08	2023-08
EMI Receiver	Rohde & Schwarz	ESU8	100202	2022-09	2023-09
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749	2020-07	2023-07
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530	2021-09	2023-09
LISN	Rohde & Schwarz	ENV432	101714	2022-08	2023-08
Climatic Chamber	MSL	EC500DA	15022	2022-02	2023-02

Notes: NCR - no calibration required, VOU - verify on use

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	P. Barbieri	Test date	October 17, 2022

8.1.3 Observations, settings and special notes

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

- 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.
- For devices, where operating at a supply voltage deviating $\pm 15\%$ 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.
- 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.
- 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:

If EUT is an AC or a DC powered, was the noticeable output power variation observed?

If EUT is battery operated, was the testing performed using fresh batteries?

If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?

<input type="checkbox"/> AC	<input checked="" type="checkbox"/> DC	<input type="checkbox"/> Battery
<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO	<input type="checkbox"/> N/A
<input type="checkbox"/> YES	<input type="checkbox"/> NO	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> YES	<input type="checkbox"/> NO	<input checked="" type="checkbox"/> N/A

8.2 AC power line conducted emissions limits

8.2.1 References, definitions and limits

FCC §15.207:

- (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 8.2-1: Conducted emissions limit

Frequency of emission, MHz	Conducted limit, dB μ V	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.

** - A linear average detector is required.

8.2.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 20, 2022

8.2.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

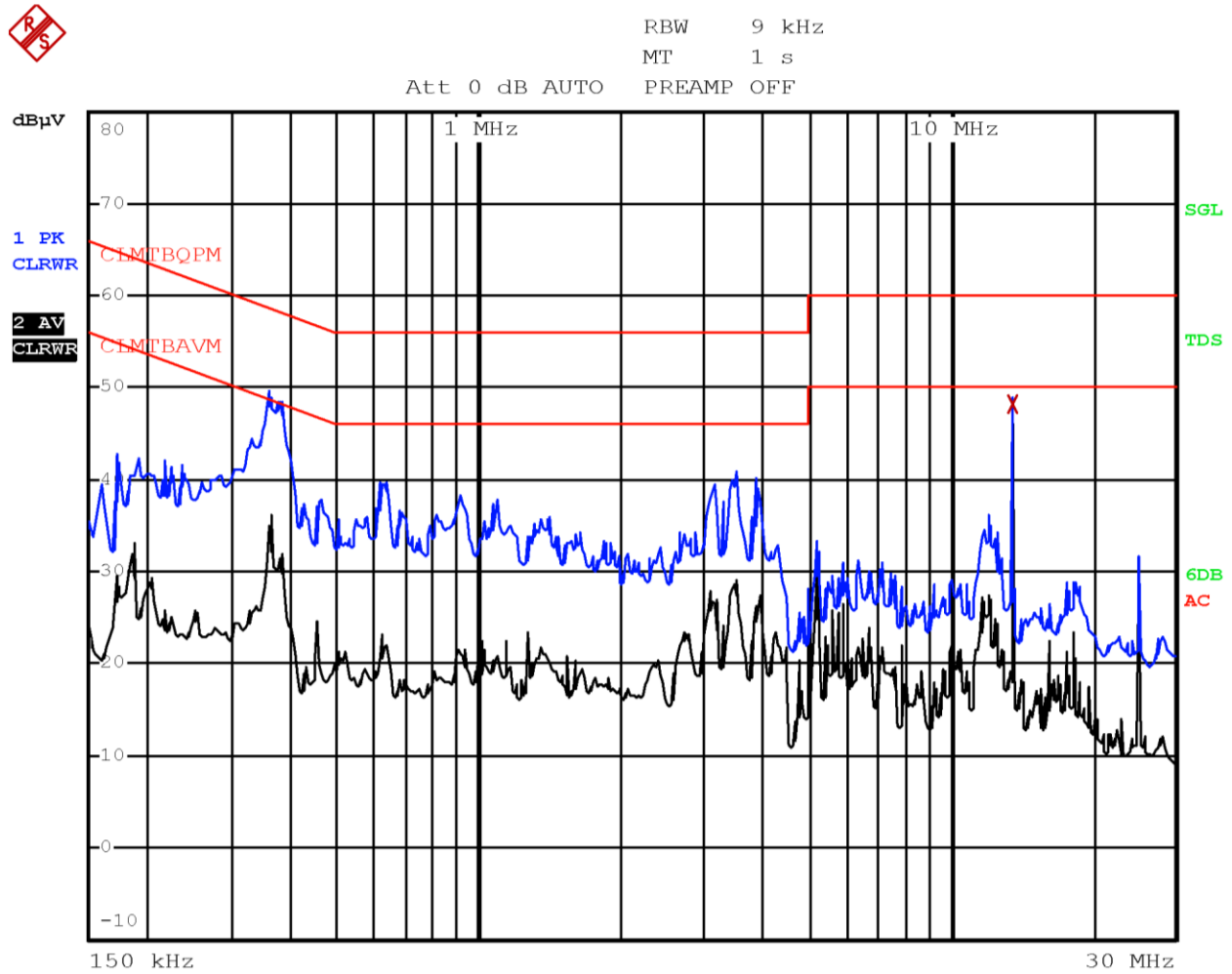
Test receiver settings:

Frequency span	150 kHz to 30 MHz
Detector mode	Peak and Average (preview mode); Quasi-Peak (final measurements)
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	1000 ms

8.2.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESU8	100202
LISN	Rohde & Schwarz	ENV432	101714

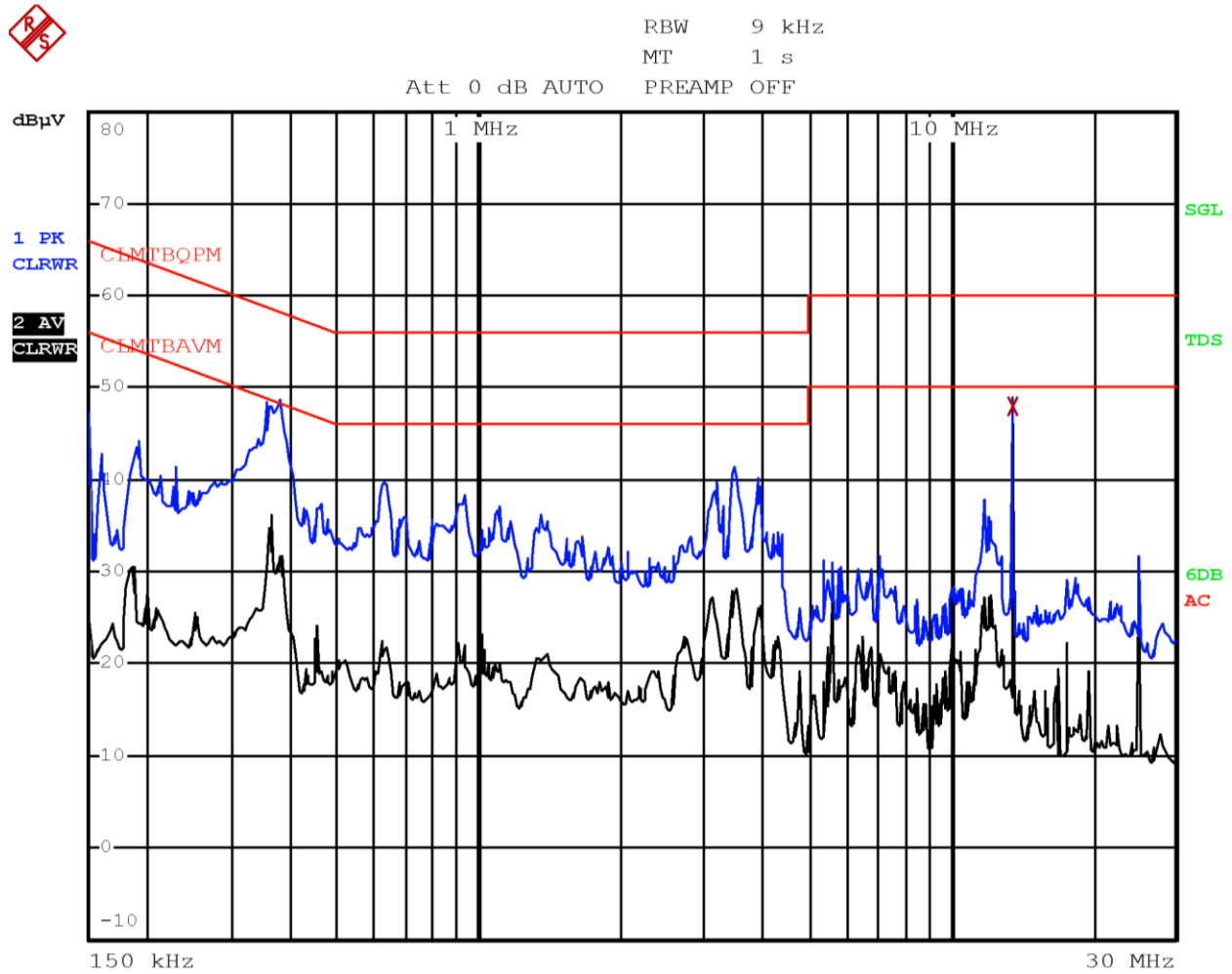
8.2.5 Test data



Plot 8.2-1: Conducted emissions on phase line

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Detector
13.5620	48.2	50.0	-1.8	Av

Test data, continued



Plot 8.2-2: Conducted emissions on neutral line

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Detector
13.5620	48.1	50.0	-1.9	Av

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.

FCC §15.247:

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
- (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

8.3.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 17, 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

Table 8.3-1: Antenna information

Antenna type	Manufacturer	Model number	Average gain	Connector type
Loop antenna	Kronotech	O8C21	--	--

8.4 Occupied bandwidth

8.4.1 References, definitions and limits

FCC §15.215:

- (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 equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80 % of the permitted band in order to minimize the possibility of out-of-band operation.

8.4.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 20, 2022

8.4.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥1 % of span
Video bandwidth	≥3 × RBW
Frequency span	20 kHz
Detector mode	Peak
Trace mode	Max Hold

8.4.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESU8	100202
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

8.4.5 Test data

Table 8.4-1: Lower 20 dBc frequency cross result

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.5602	13.553	-7.2

Table 8.4-2: Upper 20 dBc frequency cross result

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.5611	13.567	-5.9

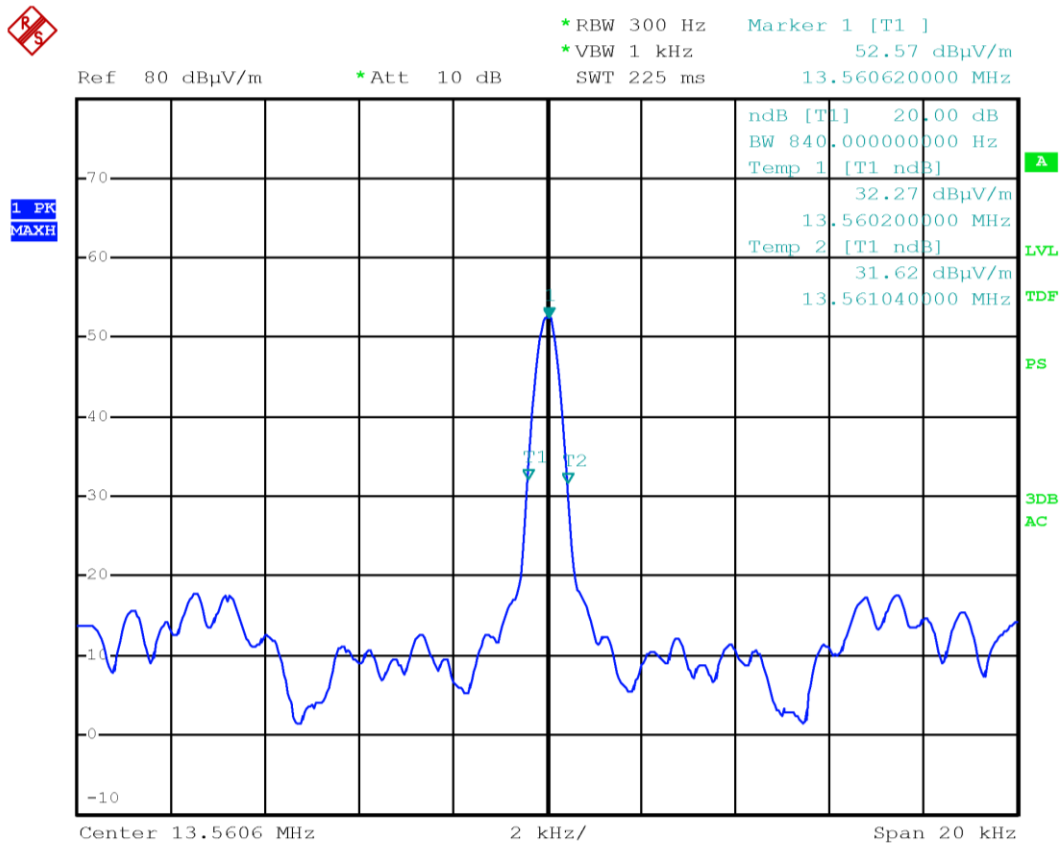


Figure 8.4-1: 20 dB bandwidth

Test data, continued

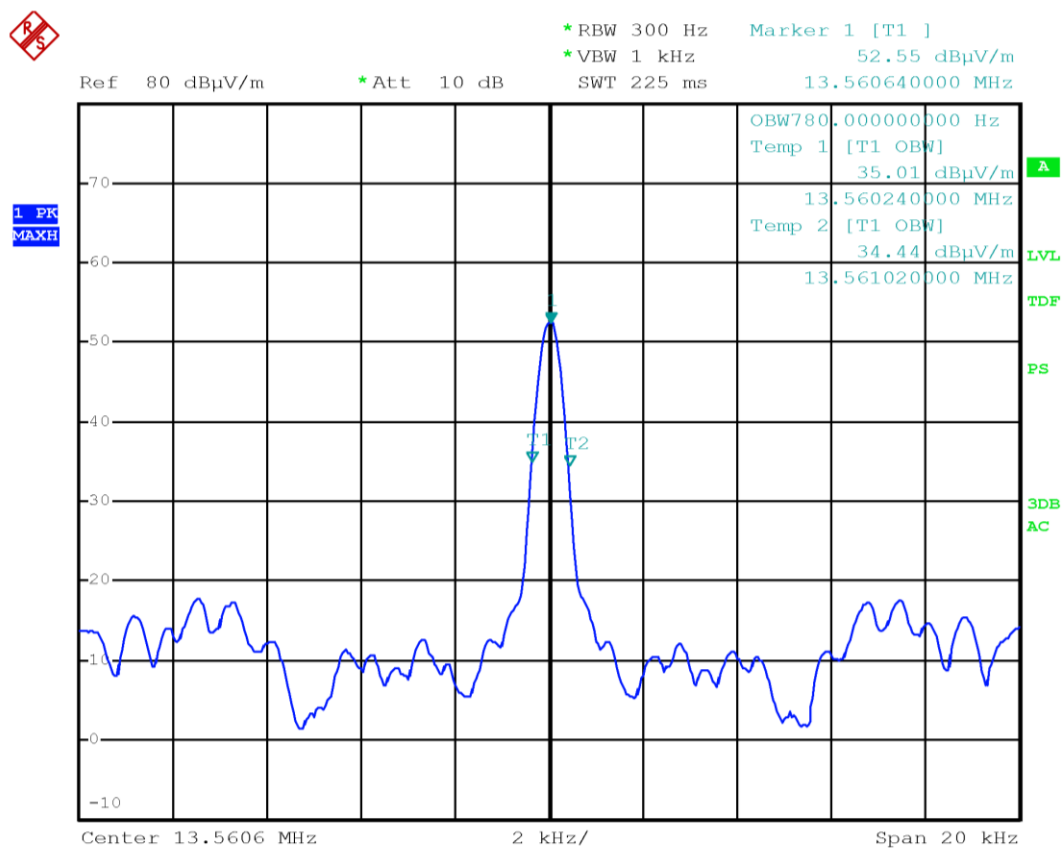


Figure 8.4-2: 99% dB bandwidth

8.5 Field strength within the 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 15,848 microvolts/meter 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 microvolts/meter 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 microvolts/meter at 30 meters.

8.5.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 19, 2022

8.5.3 Observations, settings and special notes

The measurements were performed at the distance of 3 m. 40 dB distance correction factor* was applied to the measurement result in order to comply with 30 m limits.

* 30 m to 3 m distance correction factor calculation (for 13 MHz band):

$$40 \times \text{Log}_{10} (3 \text{ m}/30 \text{ m}) = 40 \times \text{Log}_{10} (0.1) = -40 \text{ dB}$$

Spectrum analyzer settings:

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

8.5.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

8.5.5 Test data

Table 8.5-1: Field strength measurements results

Frequency range, MHz	Frequency, MHz	Field strength at 3 m, dBμV/m	Calculated field strength at 30 m, dBμV/m	Limit, dBμV/m	Margin, dB
13.553–13.567	13.561	52.7	12.7	84.0	-71.3
13.410–13.553	13.551	37.4	-2.6	50.5	-53.1
13.567–13.710	13.577	37.3	-2.7	50.5	-53.2
13.110–13.410	13.371	32.6	-7.4	40.5	-47.9
13.710–14.010	13.830	32.8	-7.2	40.5	-47.7

Note: Calculated field strength at 30 m = Measured field strength at 3 m – 40 dB

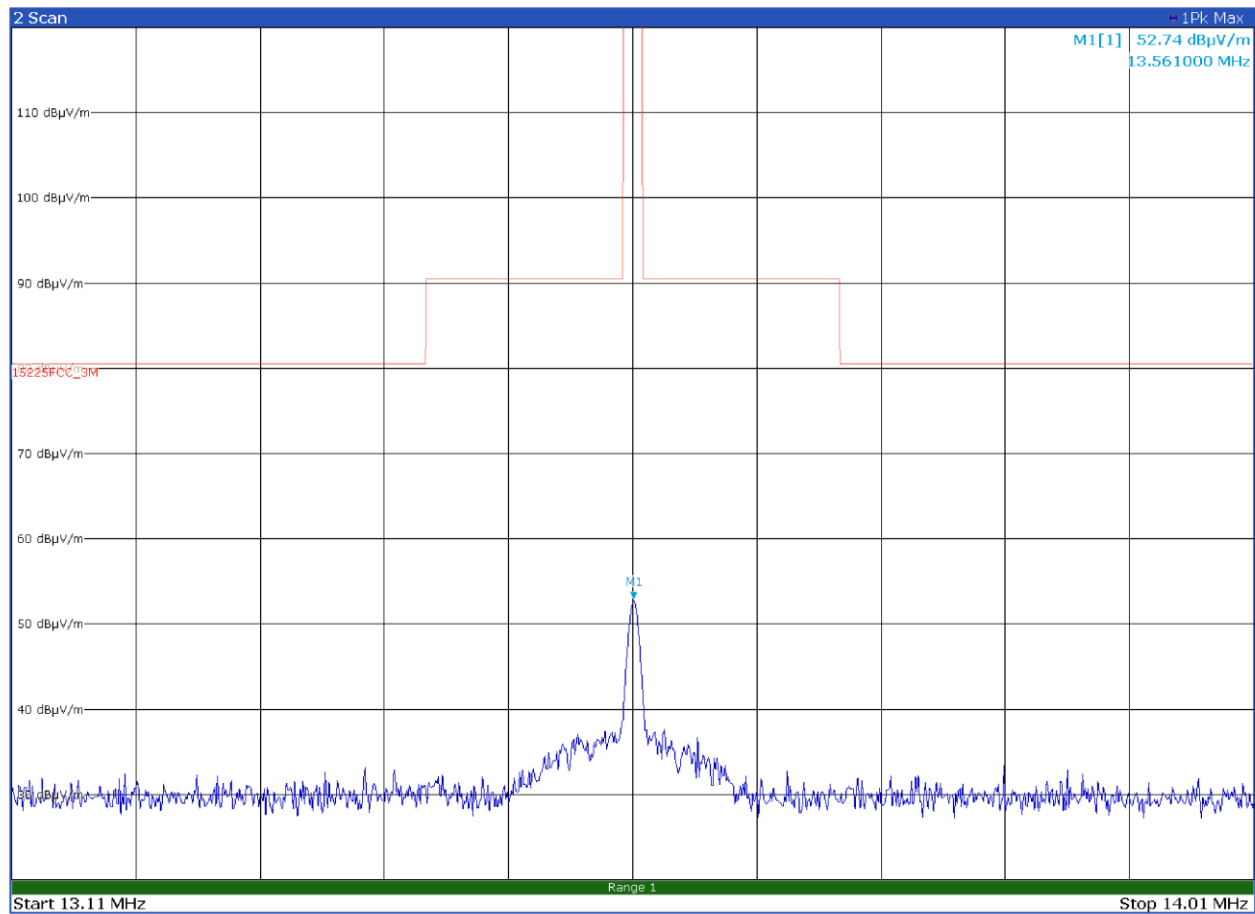


Figure 8.5-1: Field strength plot

8.6 Field strength of emissions 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.

Table 8.6-1: FCC §15.209 – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	
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.

Table 8.6-2: 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	P. Barbieri	Test date	October 19, 2022

8.6.3 Observations, settings and special notes

The spectrum was searched from 9 kHz to 1 GHz.

Radiated measurements were performed at a distance of 3 m.

Spectrum analyzer settings for frequencies below 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	9 kHz
Trace mode	Max Hold
Measurement time	1000 ms

Spectrum analyzer settings for frequencies above 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	120 kHz
Trace mode	Max Hold
Measurement time	1000 ms

8.6.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESW44	101620
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

8.6.5 Test data

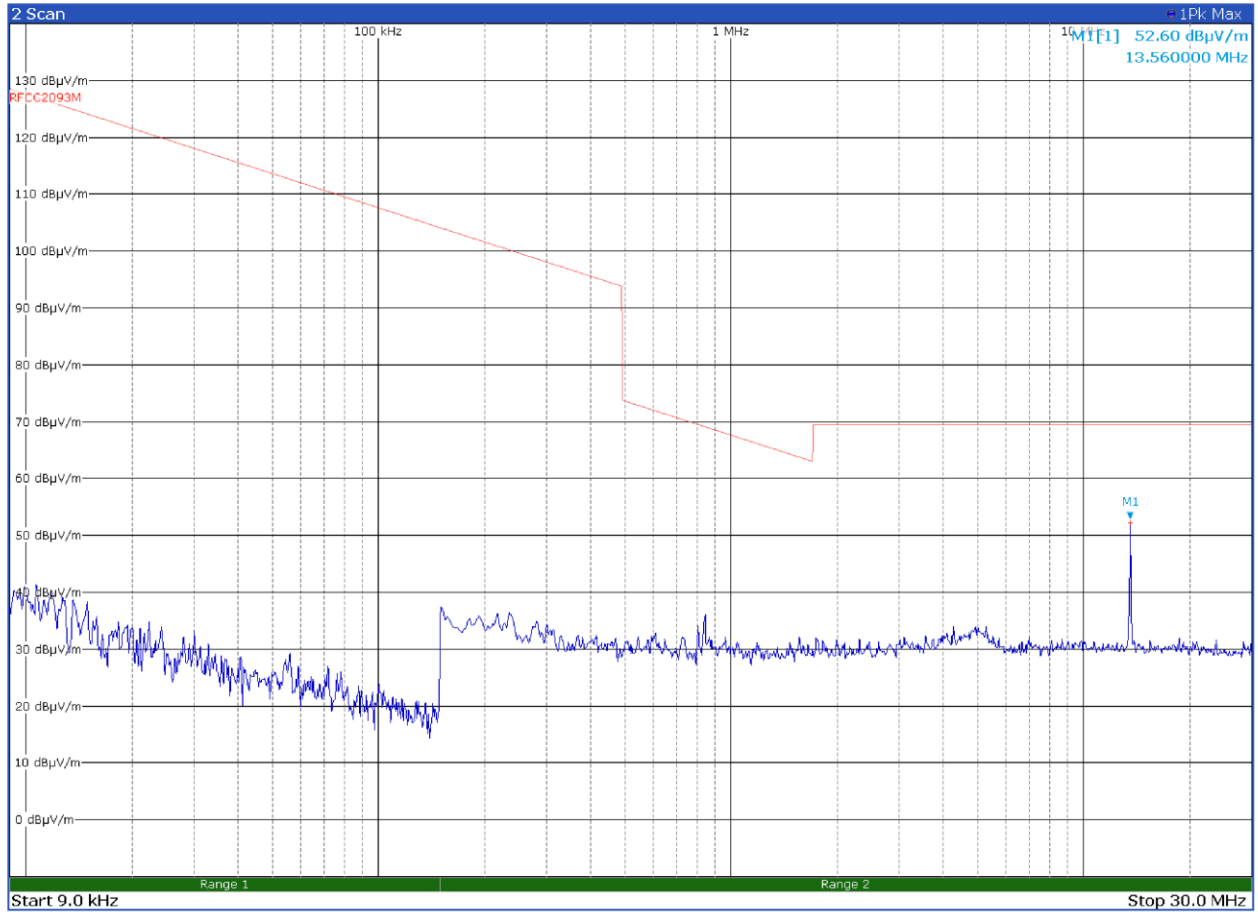


Figure 8.6-1: Field strength of spurious emissions below 30 MHz

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
13.5600	52.2	69.5	-17.3	QP

Test data, continued

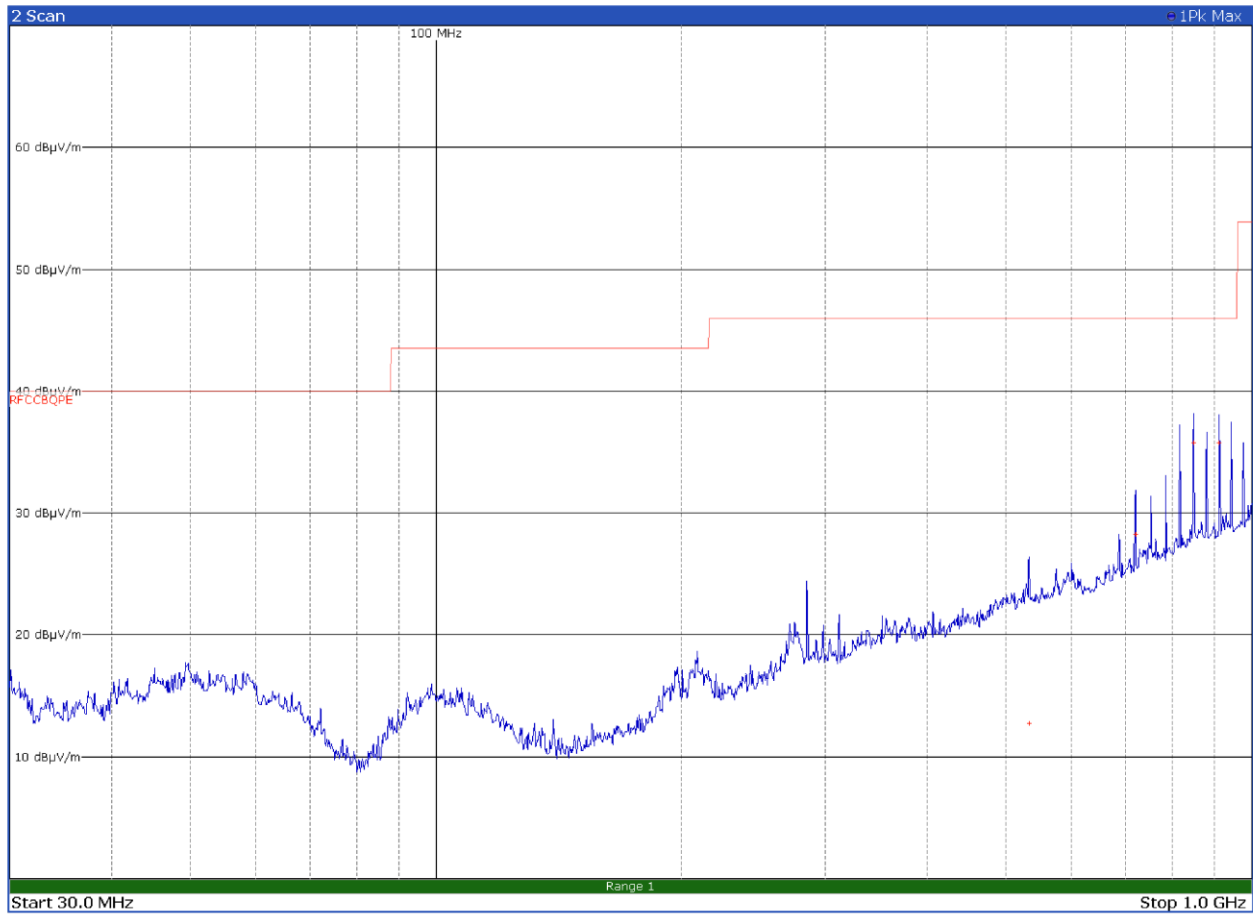


Figure 8.6-2: Field strength of spurious emissions above 30 MHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
532.7700	12.8	46.0	-33.2	QP
720.0000	28.3	46.0	-17.7	QP
848.0100	35.8	46.0	-10.2	QP
912.0000	35.8	46.0	-10.2	QP

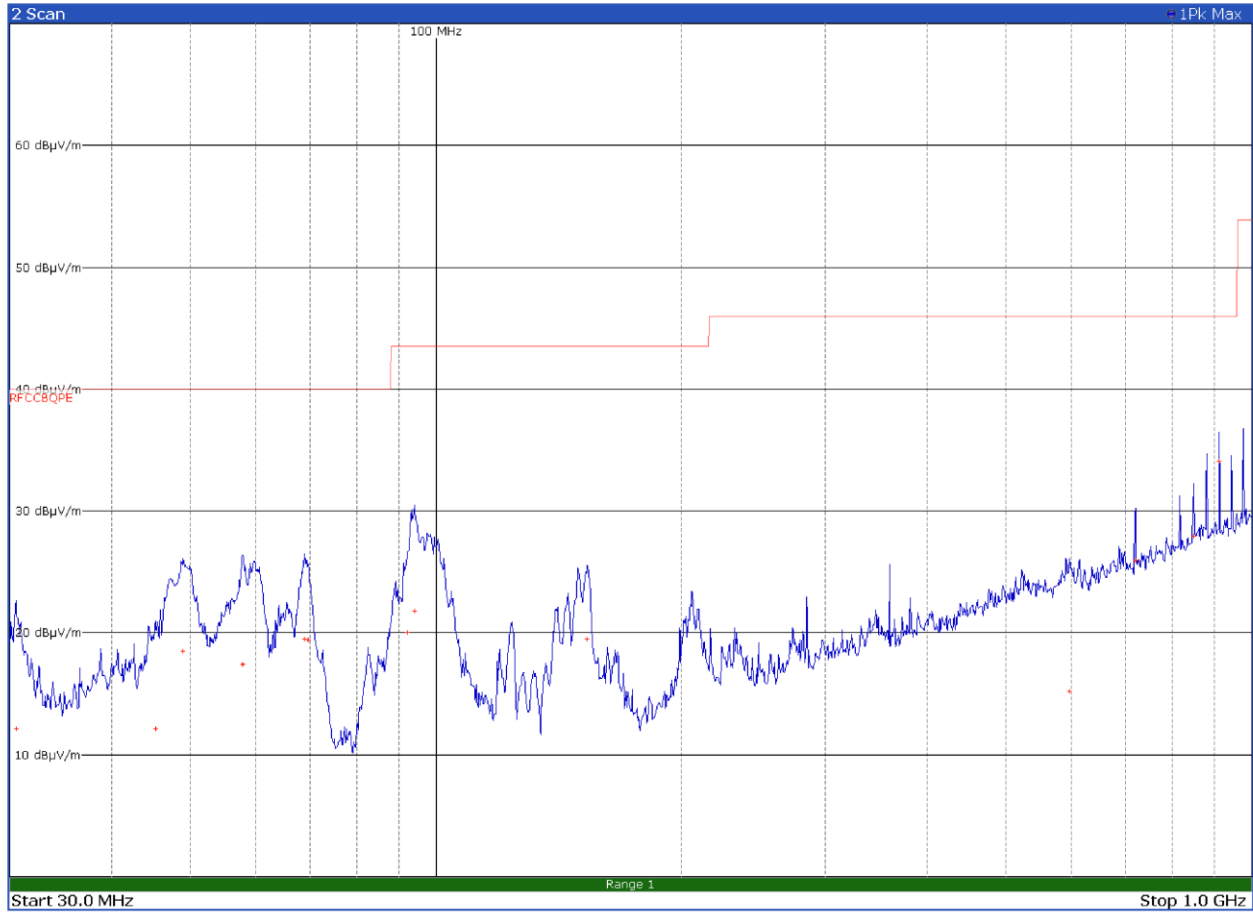
Test data, continued


Figure 8.6-3: Field strength of spurious emissions above 30 MHz with antenna in vertical polarization

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
30.5400	12.2	40.0	-27.8	QP
45.2400	12.2	40.0	-27.8	QP
48.9300	18.6	40.0	-21.4	QP
57.8400	17.5	40.0	-22.5	QP
68.8800	19.5	40.0	-20.5	QP
69.7200	19.5	40.0	-20.5	QP
92.1000	20.1	43.5	-23.4	QP
94.0500	21.8	43.5	-21.7	QP
153.0900	19.5	43.5	-24.0	QP
597.3300	15.3	46.0	-30.7	QP
720.0000	26.0	46.0	-20.0	QP
848.0100	28.0	46.0	-18.0	QP
912.0000	34.2	46.0	-11.8	QP

8.7 Frequency tolerance of the carrier signal

8.7.1 References, definitions and limits

FCC §15.225:

- (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ 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.

8.7.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 21, 2022

8.7.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	$\geq 1\%$ of emission bandwidth
Video bandwidth	RBW $\times 3$
Trace mode	Max Hold

8.7.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESW44	101620
Climatic Chamber	MSL	EC500DA	15022

8.7.5 Test data

Table 8.7-1: Frequency drift measurements results

Test conditions	Frequency, MHz	Frequency drift, \pm ppm	Limit, \pm ppm	Margin, ppm
+50 °C, Nominal	13.560583333	-3.8	100	-96.2
+40 °C, Nominal	13.560586538	-3.5	100	-96.5
+30 °C, Nominal	13.560605769	-2.1	100	-97.9
+20 °C, +15 %	13.560634615	0	100	-100.0
+20 °C, Nominal	13.560634615	Reference	Reference	Reference
+20 °C, -15 %	13.560634615	0	100	-100.0
+10 °C, Nominal	13.560666667	2.4	100	-97.6
-0 °C, Nominal	13.560689103	4.0	100	-96.0
-10 °C, Nominal	13.560701923	5.0	100	-95.0
-20 °C, Nominal	13.560712308	5.7	100	-94.3

Note: frequency drift was calculated as follows:

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

End of the test report