

EMC Test Report

According to

Title 47 CFR Part 15 Subpart B

ISED ICES-Gen Issue 2 (February 2024)

ISED ICES-003 Issue 7

ANSI C63.4:2014+A1:2017

DUT Name: In-container sensor
Model No. : 4221
Customer: Treon Oy
Address: Visiokatu 3, 33720 Tampere, Finland
Summary: IN COMPLIANCE
Date of Reception: 9.9.2025
Date(s) of Test(s): 11.9.2025 – 16.9.2025

Tested by (Test Engineer)


Pekka Pulkkinen

Approved by (Technical Manager)


Jukka Rauma

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Document Version History	Date of issue	Comments	Approved by
v0.1	25.9.2025	Initial version	
v1.0	27.10.2025	Approved version	Jukka Rauma
v2.0	29.1.2026	2 nd approved version (A1). Test results up to 1 GHz	Jukka Rauma

1. General Information

Test Engineer(s): Pekka Pulkkinen

Location:

Test Firm Name	Eurofins Electric & Electronics Finland Oy (EEEF)
Test Site	Yrttipellontie, Peltola
Address of Test Site	Yrttipellonte 6, 90230 Oulu, Finland
FCC Designation number	FI0008
FCC site registration number	771880
ISED number	29576
CAB Identifier	T290

Customer: Treon Oy
Mika Sipola
Visiokatu 3, 33720 Tampere, Finland
e-mail: mika.sipola@teon.fi, certification@teon.fi

Climate Conditions: Temperature: 15 - 35 °C
Air pressure: 860 - 1060 hPa
Humidity: 30-60 rH%
These limits were not exceeded during testing.

2. Test Samples

General description:

4221 is a device designed for monitoring conditions inside a confined area such as a trailer or container. 4221 uses several integrated sensors for monitoring environmental conditions as well as changes such as door state and communicates the data using 2.4GHz radio. It has an integrated battery pack (Li-SOCl battery) for energy storage, which is not rechargeable.

Test samples:

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version	Comments
2500291503	SB06a6b437bW000	Treon Oy	In-container sensor	4221	05	0.1.0.4	3 DTM

Accessories / Monitoring devices:

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version	Comments
G4CER061	RR620-010668	Advanced Card System Ltd.	nFC reader	ACR1552	NA	NA	
G4CER049	22-031518	Messtechnik	optoUSB Tranceiver		NA	NA	
G4CER050	22-031517	Messtechnik	optoUSB Tranceiver		NA	NA	

3. Configuration and Operation Modes

Operation Mode	Description
OM1	EUT battery powered, WirepasMesh (BLE) at RX mode at middle channel (2442 MHz), continuous nFC tag reading with ACR1552U nFC reader, 60 GHz radar idle. Power supply: Li-SOCl battery, 3.6 VDC

Test/configuration software

Manufacturer	Name	Version
Rohde & Schwarz	EMC32	10.60.20
Nordic Semiconductor ASA	nRF connect for desktop	V5.2.0

4. Test sample description

Model	4221	
Additional model(s)	-	
Brand name	In-container sensor	
FCC ID	2AR86-AS42	
IC ID	-	
Contains FCC ID	Acconeer A121: 2AQ6KA1201	
Contains IC ID	Acconeer A121: 24388-A121	
Class	Class B	
Radio 1	Type	WirepasMesh (BLE)
	Model	nRF52840
	Manufacturer	Nordic Semiconductor ASA
	FCC-ID	2AR86-AS42
	IC	-
Antenna 1	Type	Internal PCB trace antenna
	Gain	1.1 dBi
	Manufacturer	Treon Oy
Radio module 1	Type	Pulse coherent radar 60 Gz
	Model	A121
	Manufacturer	Acconeer
	FCC-ID	2AQ6KA1201
	IC	24388-A121
Antenna 2	Type	Integral antenna for A121 Radar
Radio module 2	Type	NFC passive tag
	Model	ST25DV04KC-JF6D3
	Manufacturer	STMicroelectronics
	FCC-ID	-
	IC	-
Antenna 2	Type	Internal SMT coil component
	Gain	-
	Manufacturer	Coilcraft
Manufacturer	Treon Oy Visiokatu 3, 33720 Tampere, Finland	

Ports	Port		Cable								
	Name and description		Shielded	Specified max length [m]	Attached during test						
			☐		☐						
			☐		☐						
			☐		☐						
			☐		☐						
Supplementary information to the ports											
Rated power supply	Voltage and Frequency			Reference poles							
				L1	N	PE					
	☐	AC 230 V	☐ 50 Hz ☐ 60 Hz	☐	☐	☐					
	☐	AC 240 V	☐ 50 Hz ☐ 60 Hz	☐	☐	☐					
	☐	AC 110 V	☐ 50 Hz ☐ 60 Hz	☐	☐	☐					
	☐	AC 100 V	☐ 50 Hz ☐ 60 Hz	☐	☐	☐					
	☒	Other: Internal battery only			☐	☐					
	☐	DC:									
Rated Power											
Clock frequencies	Internal XTALs: 32kHz, 32MHz, 27MHz, 24MHz										
Other parameters											
Dimensions in cm (W x H x D)											
Weight											
Mounting position	☐	Table top equipment									
	☒	Wall/Ceiling mounted equipment									
	☐	Floor standing equipment									
	☐	Hand-held equipment									
	☐	Other:									

5. Test description

5.1. FCC subpart 15B and ICES-003, radiated emission test procedure

Radiated tests were performed in a semi-anechoic chamber that has met NSA requirements (4 dB tolerance) according to

- CISPR 16-1-4 Ed. 4.0 2019-01 Validation of a SAC (6.8) using the Reference Site Method (RSM) (6.6);
- ANSI C63.4a -2017 Validation of radiated emission test sites (30MHz – 1 GHz) (Annex D)
- validation date: 7.11.2024

SVSWR requirements (1 -18 GHz) are met according to

- CISPR 16-1-4 Ed. 4.0 2019-01 SVSWR site validation – standard test procedure (7, 7.6)
- validation date: 14.10.2024

2 different measurement antenna was used, located at a distance of 3 m.

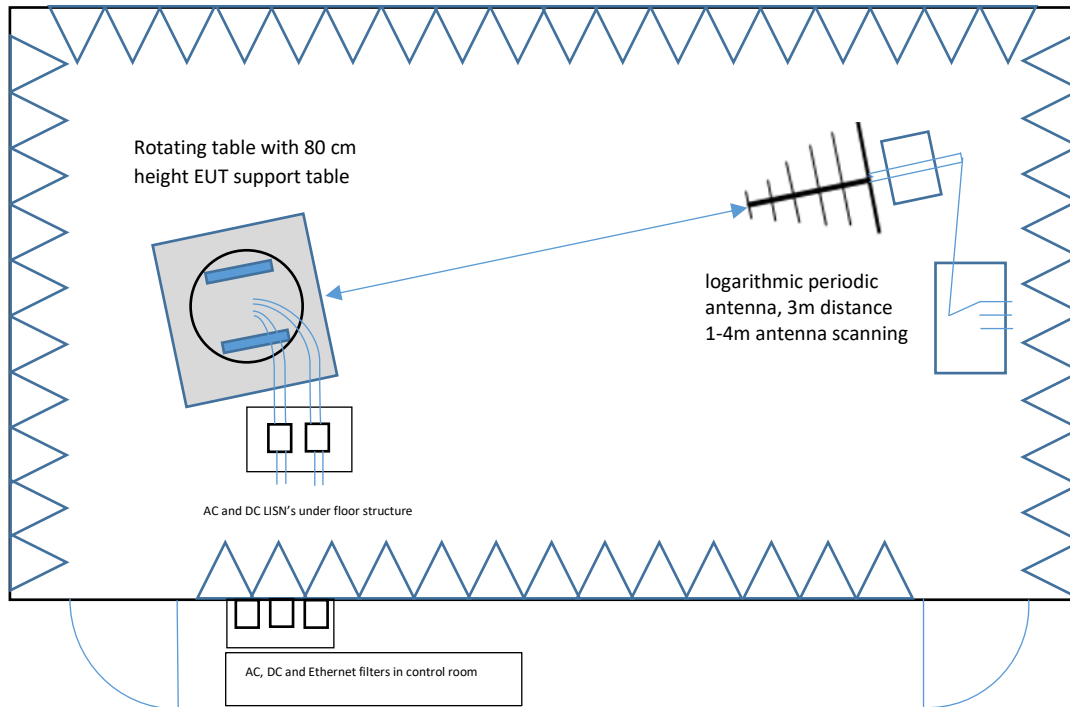
- linear polarized logarithmic periodic antenna for frequency range 30-1000 MHz
- and double-ridged horn antenna for the frequency range 1-18 GHz

The equipment under test was set up on a non-conductive support, 80 cm above the ground plane. EUT power supply LISN's for AC and DC were located under the ground reference plane. The field strength was calculated by adding correction factor to the measured level from the EMI receiver. This correction factor includes antenna factor, cable loss and pre-amplifier gain.

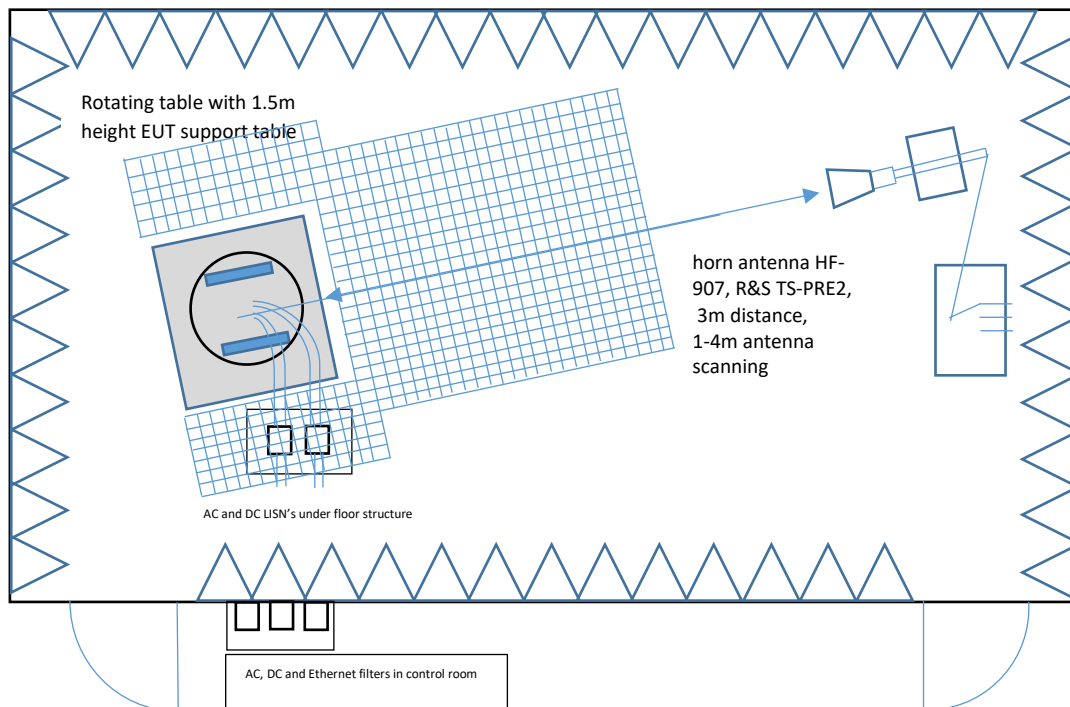
Measurement procedure

- EUT was set in a manner that is most representative of the equipment as typically used (i.e., as specified in the EUT instruction manual)
 - o In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the orientation (attitude) having maximum or near-maximum emission level.
- in exploratory measurements for full frequency range
 - o turntable was rotated with 45° steps (from 0° to 315°)
 - o measurement was done in both vertical and horizontal antenna polarization with antenna height of 1m
 - o measurement was done with peak detector to find the frequencies of maximum emissions and at least six highest peaks related to the limits were chosen
- these peak values were further maximized by scanning the turntable position 0 to 360 degrees and the antenna height 1 to 4m
- for maximized values, final measurement was done with
 - o quasi-peak detector for 30MHz to 1GHz frequency range
 - o with Average detector for 1GHz to 18GHz frequency range

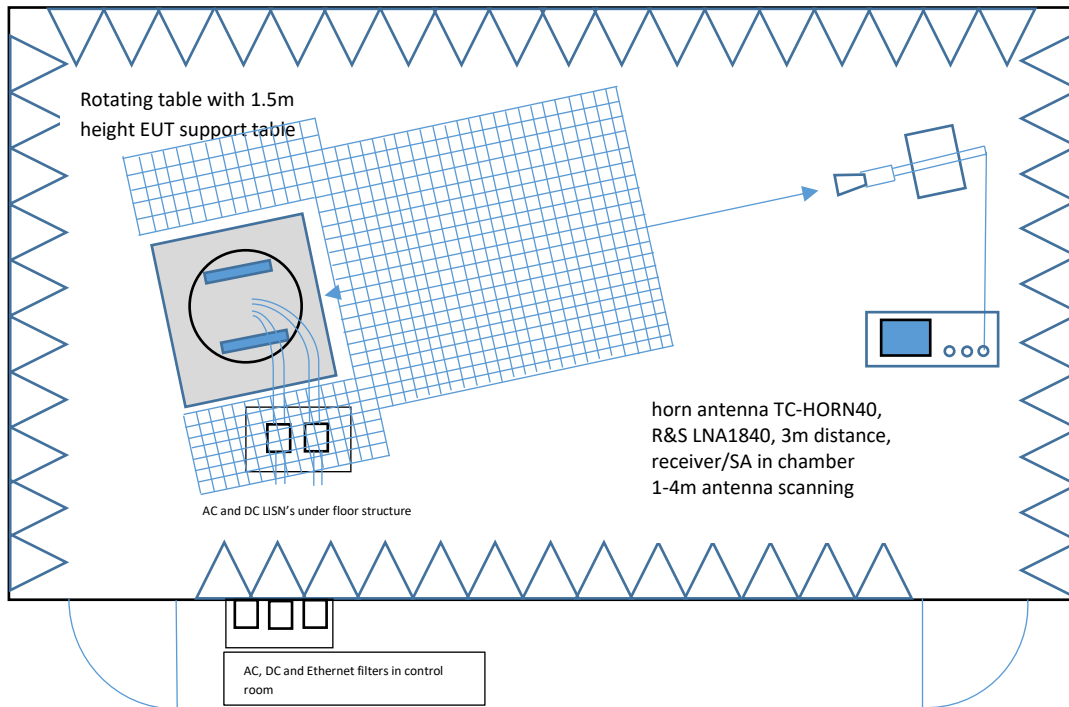
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 18 GHz:



Radiated measurements setup from 18 GHz to 26 / 40 GHz:



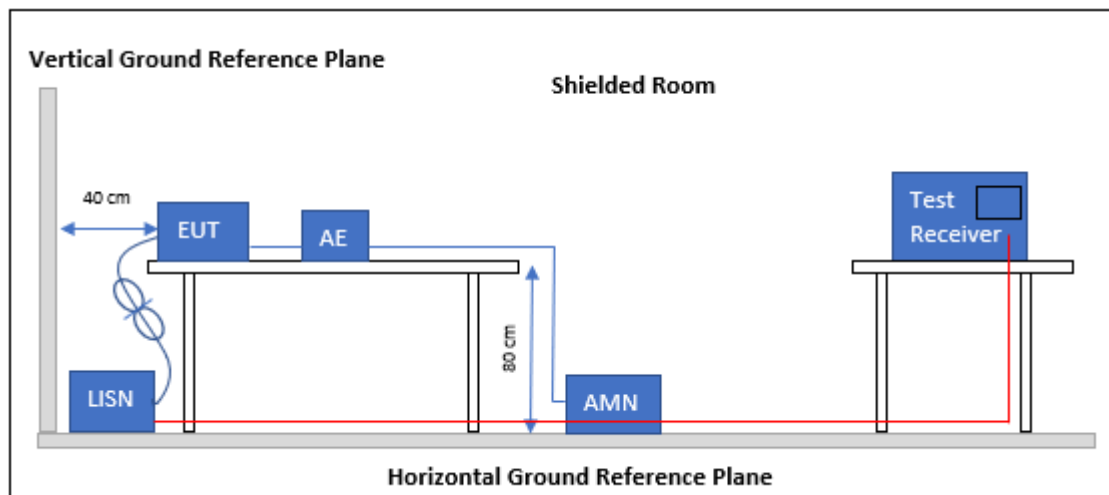
5.2. FCC subpart 15B and ICES-003, conducted emission test procedure

The equipment under test was set up on a non-conductive support, 80 cm above the ground plane and 40 cm distance of vertical ground plane. Test setup is described in pictures below.

Measurement procedure

- EUT was operated in a range of typical modes of operation, with typical cable positions, and with a typical system equipment configuration and arrangement
- in exploratory measurements for full frequency range
 - o measurement was done with peak and average detector to find the frequencies of maximum emissions for each current-carrying conductor of each power cord associated with the EUT and at least six highest peaks related to the limits were chosen per conductor
 - o the one configuration and arrangement and mode of operation that produces the highest emissions related to the limit across all the measured conductors was recorded.
- for this configuration and its maximized values, final measurement for each current-carrying conductor was done with quasi-peak detector and average detector

Conducted emission test setup



6. Uncertainties

6.1. Emission measurement uncertainties

Description	Expanded Uncertainty (k=2)
AC conducted emission	2,24
Radiated emission ≤ 1 GHz	4,62
Radiated emission > 1 GHz	5,72

7. Summary

Title 47 CFR 15B, ISSED ICES-003 Issue 7			
Reference	Requirement – Test case	Verdict	Remark
FCC 15.109 ICES-003, 3.2.2	Radiated emission. Electromagnetic field measure (30 MHz – 1000 MHz)	PASS	
FCC 15.109 ICES-003, 3.2.2	Radiated emission. Electromagnetic field measure (1 GHz – 18 GHz)	N/R	
FCC 15.109 ICES-003, 3.2.2	Radiated emission. Electromagnetic field measure (18 GHz – 40 GHz)		(1)
FCC 15.107 ICES-003, 3.2.1	Continuous conducted emission (150 kHz – 30 MHz)	N/R	(2)
The DUT has been tested and passes the FCC Part 15 Subpart B without any modifications.		Yes	
Supplementary information and remarks: (1) Range: $f > 12.75$ GHz. Test is required only if the 5th harmonics of the EUT's maximum internal work frequency is higher than 12.75GHz. (2) Not applicable according to Clause 15.107 of the standard if battery powered device. Possible test case verdicts PASS = Test object meet the requirements FAIL = Test object does not meet the requirements N/T = Required by standard but not tested N/R = Not required by standard for the test object			

8. Radiated Emissions

Reference: FCC 15.109, ICES-003, 3.2.2
Test method: ANSI C63.4:2014+A1:2017 Section 8

The applied limit for radiated emissions, 3 m distance, according with the requirements of FCC Rules and Regulations 47 CFR Part 15, Subpart B, Secs. 15.109 & ICES-003 Issue 7, section 3.2.2.

FCC part 15, subpart B

Limits, Class B	Quasi-peak Limit for 3m	
Frequency of emission MHz)	(microvolt/meter)	(dBuV/m)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

ICES-003, Issue 7

Limits, Class B	Quasi-peak Limit for 3m	
Frequency of emission MHz)	(microvolt/meter)	(dBuV/m)
30-88	100	40
88-216	150	43.5
216-230	200	46
230-960	223	47
Above 960	500	54

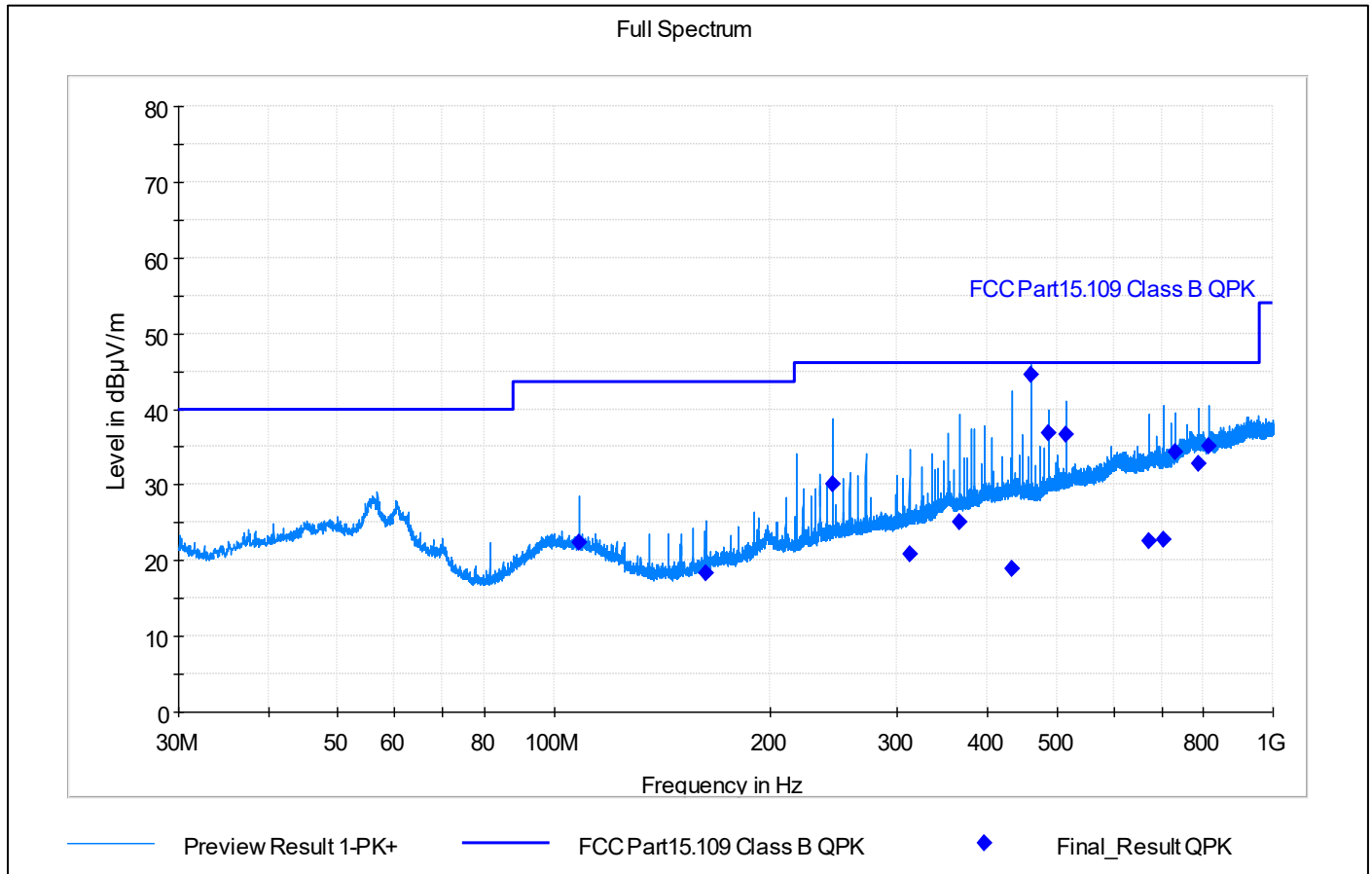
FCC part 15, subpart B and ICES-003, Issue 7

Frequency of emission MHz)	Average Limit for 3m		Peak Limit for 3m
	(microvolt/meter)	(dBuV/m)	(dBuV/m)
Above 1000	500	54	74
Frequencies above 1 GHz, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test, as per §15.35(b)			

Tested sample(s): 2500291503
Operation mode(s) tested: OM1
Test results: PASS
Note:

Test data:

Operation mode(s)	Configuration	Test Verdict
OM1	Worst case, Frequency Range: 30 MHz – 1GHz	PASS

FCC part 15, subpart B and ICES-003 Graph and final result table for 30 MHz – 1 GHz, OM1:

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
108.480	22.29	43.5	21.21	15000	120	141.0	V	283	0	19.3	PASS
162.750	18.41	43.5	25.09	15000	120	170.0	H	41	0	16.9	PASS
244.020	30.08	46.0	15.92	15000	120	102.0	V	331	0	21.1	PASS
312.000	20.74	46.0	25.26	15000	120	100.0	H	263	0	22.6	PASS
366.210	25.03	46.0	20.97	15000	120	100.0	H	71	0	24.0	PASS
433.800	18.93	46.0	27.07	15000	120	260.0	H	286	0	26.0	PASS
461.040	44.55	46.0	1.45	15000	120	125.0	V	42	0	26.2	PASS
488.160	36.84	46.0	9.16	15000	120	102.0	V	113	0	27.0	PASS
515.280	36.71	46.0	9.29	15000	120	101.0	V	117	0	27.6	PASS
671.910	22.55	46.0	23.45	15000	120	356.0	H	106	0	30.3	PASS
703.860	22.75	46.0	23.25	15000	120	379.0	H	97	0	30.6	PASS
732.240	34.26	46.0	11.74	15000	120	98.0	V	326	0	31.3	PASS
786.480	32.69	46.0	13.31	15000	120	154.0	V	127	0	32.0	PASS
813.600	35.10	46.0	10.90	15000	120	152.0	V	67	0	32.2	PASS

9. Test Equipment List

New ID	Manufacturer	Equipment type	Description	Serial	Calibration information	Next calibration
G4C265	Rohde & Schwarz	ESW26	EMI test receiver	101324	15.7.2025	15.7.2026
G4C273	Frankonia	ALX-4000E	Broadband Antenna, 25MHz-4GHz with 6dB (50-A-MFN-06) att.	00816+1531	22.1.2024	22.1.2027
G4C292	Rohde & Schwarz	TS-LNA 1840	RF Preamplifier 18 to 40 GHz	100841	12.8.2024	12.8.2026
G4C294	Rohde & Schwarz	TC-HORN40 + WRD180-2.5	Horn Antenna -> 40GHz	101057 + 100667	4.11.2022	4.11.2025
G4C298	Rohde & Schwarz	CMW500	Wideband radio communication tester	170980	8.7.2025	8.7.2027
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	12.8.2024	12.8.2026
G4C576	Rohde & Schwarz	HF907	Double-Ridged Waveguide Horn Antenna 800MHz-18GHz	100163	8.7.2025	8.7.2028

Appendix A: DUT Photographs

Pictures in separate Annex1

Appendix B: Test Setup Photographs

Pictures in separate Annex1