

TEST REPORT

Electromagnetic Compatibility

Report Reference No. : **REP020952**

Date of issue : 2023-12-12

Test Report Verdict : **PASS**

Testing Laboratory..... : **Nemko S.p.A.**

Address..... : Via Del Carroccio, 4

City : 20853 Biassono (MB)

Country : Italy

Testing location..... : Described at clause 1.4

Customer name..... : **2hire S.r.l.**

Customer information..... : Via Mantova 52, 00198 Roma - Italy

Reference standards..... : FCC CFR 47 Part 15 Subpart B

Standard application : Full application

Equipment under test : **Automotive Telematics Unit**

Trademark(s) : **2hire**

Manufacturer..... : 2hire S.r.l.

Model/Type reference : Described at clause 4.1

Tests performed by : D. Guarnone



Report approved by..... : P. Barbieri



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1. GENERAL INFORMATION

1.1 Project history

Report number	Modification to the report / comments	Date
REP020952	First release	2023-12-12
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1.2 Symbol used in the report

<input checked="" type="checkbox"/>	: The crossed square indicates that the listed condition, standard or equipment is applicable for this report.
<input type="checkbox"/>	: The empty square indicates that the listed condition, standard or equipment is not applicable for this report.
NP (Not performed)	: Test case not performed according to customer request
N (Not applicable)	: Test case does not apply to the test object
P (Pass)	: Test object does meet the requirement
F (Fail)	: Test object does not meet the requirement
<input type="checkbox"/> Comma (,) / <input checked="" type="checkbox"/> Dot (.)	: Symbol used as decimal separator throughout this report
Asterisk (*)	: Symbol used to indicate a standard or a test not accredited by ACCREDIA
EUT	: Equipment Under Test

The results contained in this report reflect the results for this particular model(s) and serial number(s) and apply to the sample(s) as received. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

1.3 Date of sample(s) reception and tests

Date of receipt of test sample(s)	: 2023-12-12
Testing start date	: 2023-12-12
Testing termination date	: 2023-12-12

1.4 Testing location

The tests have been performed in the place indicated below:

Nemko premises location: Nemko S.p.A.
Via Del Carroccio, 4
20853 Biassono (MB) - Italy
FCC site number: 682159

Other location: --
--
--

1.5 Environmental conditions

The tests were carried out in the ranges of environmental conditions specified below:

Ambient temperature: 18-33 °C ¹

Relative Humidity: 25-70 % ²

Atmospheric pressure: 860-1060 hPa

Notes:
¹ For luminaire, temperature during tests was verified to be within 18 ÷ 30 °C
² During ESD test, humidity was verified to be within 30 ÷ 60 %

The following instruments are used to monitor the environmental conditions:

Equipment	Trademark	Model	Serial No.
Thermo-hygrometer	Testo	175-H2	20012380/305
Thermo-hygrometer	Testo	175-H2	38203337/703
Barometer	Castle	GPB 3300	072015

1.6 Measurement uncertainty and assessment of conformity

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:

Test	Range	Measurement Uncertainty	Notes
Radiated Disturbance	Antenna distance 1 m, 3 m, 10 m 0.009 ÷ 200 MHz	5.0 dB	(1)
	Antenna distance 1 m, 3 m, 10 m 200 ÷ 1000 MHz	5.2 dB	(1)
	Antenna distance 1 m, 3 m, 10 m 1 ÷ 6 GHz	5.2 dB	(1)
	Antenna distance 1 m, 3 m 6 ÷ 18 GHz	5.5 dB	(1)
	Antenna distance 1 m, 3 m 18 ÷ 40 GHz	7.2 dB	(1)
Radiated Disturbance with large loop antenna system (LLAS)	0.009 ÷ 30 MHz	3.3 dB	(1)
Conducted Disturbance	0.02 ÷ 150 kHz with AMN	3.8 dB	(1)
	150 kHz ÷ 30 MHz with AMN	3.4 dB	(1)
	150 kHz ÷ 30 MHz with AAN	4.6 dB	(1)
	9 kHz ÷ 30 MHz with voltage probe	2.9 dB	(1)
	150 kHz ÷ 30 MHz with current probe	2.9 dB	(1)
Frequency	10 Hz ÷ 1 kHz	0.2 %	(1)
	1 kHz ÷ 40 GHz	10 ⁻⁶	(1)
Electromagnetic fields (EMF)	Magnetic, Electric and Electromagnetic fields: 0 Hz ÷ 40 GHz	25 %	(1)
Electrical quantities (voltage, current, resistance)	AC/DC Voltage 10 mV ÷ 1000 V 0÷100 kHz AC/DC Current 0.1 mA ÷ 400 A 0÷1 kHz Resistance 100 mΩ ÷ 10 MΩ	2.5 %	(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 % (2) The instruments used for this immunity test is according to the tolerances requested by the applicable standard (3) The reported expanded uncertainty of measurement is related to the stimulus quantity			

1.7 Instruments calibration table

Instrument cited in the report and not listed in this paragraph are not subject to calibration. The calibration is valid up to the last day of the due date month.

Description	Manufacturer	Model	Identifier	Cal Date	Due Date
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
EMI Receiver	Rohde & Schwarz	ESU8	100202	2023-09	2024-09
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Antenna Trilog 25-2000 MHz	Schwarzbeck Mess-Elektronik	VULB9168	9168-242	2021-06	2024-06
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09	2024-09
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2021-06	2024-06
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40	2023-05	2026-05
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01	2023-05	2024-05
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718C	00121	2023-03	2024-03
Preamplifier	Schwarzbeck Mess-Elektronik	BBV9718	BBV9718-137	2023-05	2024-05
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530	2023-09	2025-09
Common Mode Absorption Device	Schwarzbeck Mess-Elektronik	CMAD1614	00041	2022-05	2025-05
LISN	Rohde & Schwarz	ENV432	101714	2023-09	2024-09
LISN	Rohde & Schwarz	ESH2-Z5	872 460/041	2023-08	2024-08
V-network	Rohde & Schwarz	ESH3-Z5	840 731/004	2023-08	2024-08
Oscilloscopio	Agilent	54846A	MY40000254	2023-08	2024-08
Multimeter	Rohde & Schwarz	HMC8012	101577	2023-05	2024-05
Barometer	Castle	GBP 3300	072015	2023-05	2024-05
Data logger con diagnosi in campo	Testo	175-H2	20012380/305	2022-12	2024-12
Data logger con diagnosi in campo	Testo	175-H2	38203337/703	2022-12	2024-12
Attenuator	Aeroflex / Weinschel	2	CC8577	2023-08	2024-08
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

2. PRODUCT STANDARDS, TEST METHODS AND TECHNICAL PROCEDURES

2.1 Standard(s) applied

The following standard(s) or specifications, accredited by ACCREDIA, were applied:

FCC CFR 47 Part 15 Subpart B

Code of Federal Regulations – Title 47 – Part 15 Radio Frequency Devices – Subpart B
Unintentional radiators

2.2 Test method(s) applied

The following documents are referred to in the standard(s) in such a way that some or all of their content constitutes requirements for the standard itself.

ANSI C63.4 (2014)

American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

2.3 Nemko technical procedures

WM L0177: General routines for using instruments at Nemko

WM L1002: Measurement Uncertainty - Policy and Statement

WM L0077: General procedure for conducting EMC tests

3. SUMMARY OF TEST RESULTS AND VERDICTS

3.1 Measurement of electromagnetic disturbances emitted by the equipment under test

Emission Tests		
Requirement / test	Method Standard	Verdict
Part §15.107 – Conducted emission	ANSI C63.4	N
Part §15.109 – Radiated emission	ANSI C63.4	P
Notes: Vehicular equipment, test not applicable		

4. EQUIPMENT UNDER TEST

4.1 EUT Identification

<p>Short description of the EUT</p> <p>2hire Box 2.0 is an innovative IoT device designed by the 2hire team. Improve monitoring capabilities and vehicle management by connecting to the vehicle's OBD-II port, CAN-bus or internal connectors of the actuator. This connection allows you to retrieve data and enables various interactions with the vehicle, such as closing and opening doors. The device has cellular connectivity with global coverage across all 4G/3G/2G networks, secure communication protocols, Bluetooth technology for offline commands and profiles customizable for different makes and models of vehicles. Thanks to the dedicated GPS module, it is possible to have a vehicle tracking with high precision</p>	
<p>Copy of marking plate(s) (if present)</p> <div style="text-align: center;"> </div>	
<p>Sample ID</p> <p>Model/Type</p> <p>Ratings</p> <p>Equipment installation</p> <p>Accessories and detachable parts included</p> <p>Test performed.....</p>	<p>PRJ00459760003 assigned by Nemko S.p.A</p> <p>2hire box V2.0</p> <p>12 V</p> <p>-</p> <p>None</p> <p>All tests were performed on this sample</p>
<p>Software and/or firmware information</p>	<p>-</p>
<p>Product variants not tested:</p>	
<p>Opinions and interpretations - not subject to ACCREDIA accreditation:</p>	

4.2 EUT Power Supply

Used ¹	N° ²	Type	Supply Voltage	Phases N°	Supplementary Information
<input checked="" type="checkbox"/>	1	DC	12 V	L+N	Vehicle battery
Notes: ¹ The crossed square indicates that the supply voltage is used in at least one test. ² This number will be used all over the report to identify the supply voltage(s) used for each test.					

4.3 EUT Information declared by the Customer ¹

Information	Declaration
EUT highest frequency ²	f _c = 2700 MHz
Environment intended use.....	Other
Equipment classification ³	B
Notes: ¹ Nemko S.p.A. declines all responsibility for the information above declared by the customer that may influence the validity of the results contained in this test report. ² For host products with certified modular transmitter, the frequency range of investigation of the composite system is specified by rule in Sections 15.33(a)(1) through (a)(3), or the range applicable to the digital device, as shown in Section 15.33(b)(1), whichever is the higher frequency range of investigation. ³ Equipment class and category definitions are specified in the standard used.	

4.4 EUT Operation Modes

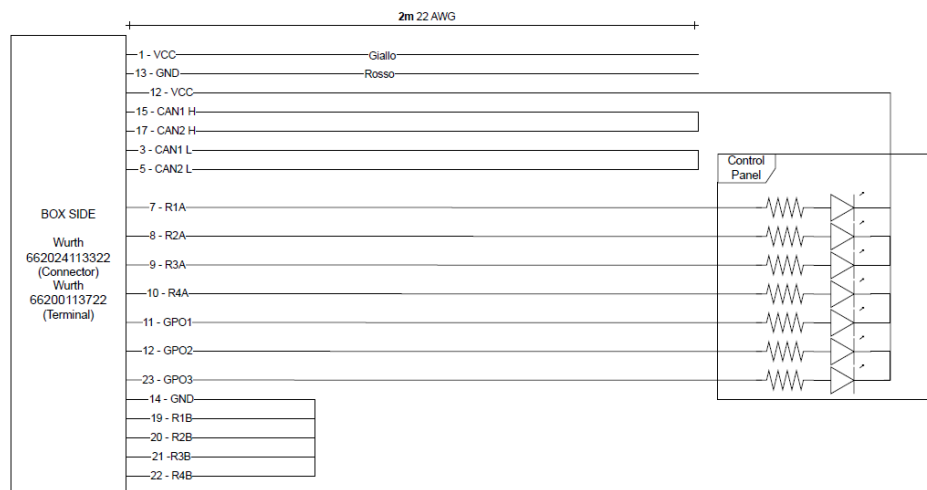
N°	Description
1	E.U.T. powered, Can Bus 1 and Can Bus 2 closed in loop; radio modules disabled.
Notes:	

4.5 EUT Configuration Modes

The EUT was configured to measure its highest possible radiation level. The test modes selected are according to EUT instruction manual.

N°	Description
1	
Notes:	

4.6 EUT Input/Output Ports



Port	Name	Type ¹	Cable Max. >3m	Cable Shielded	Description
0	Enclosure	N/E	—	—	—
1	DC	DC	<input type="checkbox"/>	<input type="checkbox"/>	
2	Can Bus 1	I/O	<input type="checkbox"/>	<input type="checkbox"/>	
3	Can Bus 2	I/O	<input type="checkbox"/>	<input type="checkbox"/>	

Notes:

¹ Port type:

AC = AC Power Port

DC = DC Power Port

N/E = Non-Electrical

ANT = Antenna Port

I/O = Signal/Control Input or Output Port

TP = Wired network or telecommunication Port

4.7 EUT and Equipment Used During Test

Use ¹	Product Type	Manufacturer	Model	Comments
--	--	--	--	--
Notes: ¹ Use EUT - Equipment Under Test SIM - Simulator (Not Subjected to Test) AE - Auxiliary/Associated Equipment (Not Subjected to Test)				

4.8 EUT Electric/Block Diagram

<p>Not applicable</p>

4.9 Information about radio module(s)

Radio module 1	
Description	Information
Identification:	Model: EG21-G Trademark: Quectel Wireless Solutions Company Limited
Frequency band (MHz):	700–960 MHz & 1710–2170 MHz & 2300–2690 MHz
Modulation type:	Standard
Antenna information:	Two antennas Quectel LTE Full-Band PCB antenna type YF0022AA, one as main antenna and one as Rx-diversity antenna
Other information:	FCC ID: XMR201906EG21G, issued date: 06/07/2019
Notes:	

Radio module 2	
Description	Information
Identification:	Model: ESP32-C3-MINI-1 Trademark: 2hire s.r.l.
Frequency band (MHz):	2400 MHz 2483.5 MHz
Modulation type:	GFSK
Antenna information:	Integral (as per original)
Other information:	FCC ID: 2BDMD-2HBM2
Notes:	

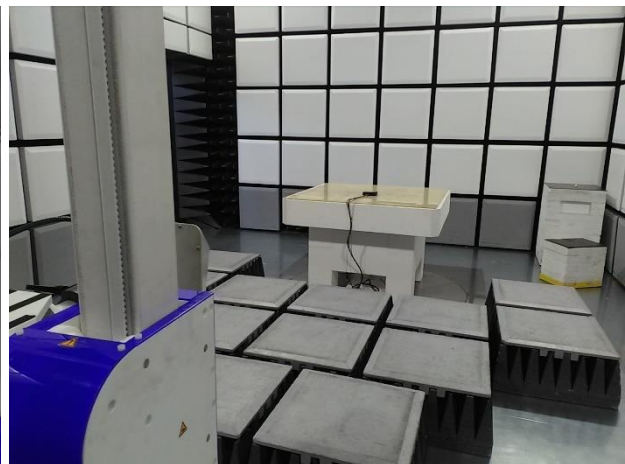
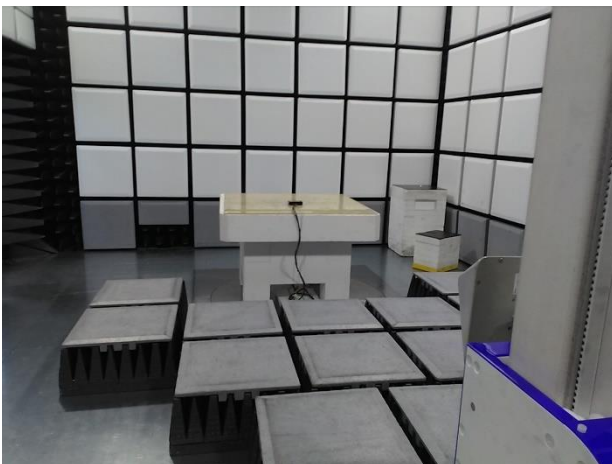
5 TEST RESULTS

5.1 Radiated Emission

5.1.1 Test result

Verdict:	<input checked="" type="checkbox"/> P <input type="checkbox"/> F <input type="checkbox"/> N ¹ <input type="checkbox"/> NP
Frequency range:	30 MHz – 40000 MHz ²
Test site:	Semi anechoic chamber
Measurement distance:	3 m or 10 m ³
Notes:	
<p>¹ If marked, the test is not applicable for the EUT.</p> <p>² For host products with certified modular transmitter, the frequency range of investigation of the composite system is specified by rule in Sections 15.33(a)(1) through (a)(3), or the range applicable to the digital device, as shown in Section 15.33(b)(1), whichever is the higher frequency range of investigation.</p> <p>³ Test was performed at 10 m measurement distance for class A EUT in the frequency range from 30 to 1000 MHz; test was performed at 3 m measurement distance in all other cases.</p>	

5.1.2 Photo documentation of the test set-up



5.1.3 Test method

Method standard is reported at par. 3.1. Measurements were made on a semi anechoic chamber. Preliminary measurements were performed at an antenna to EUT separation distance of 3 or 10 meters with the receive antenna located at a fixed height (from 1 to 4 meter) in both horizontal and vertical polarizations. Final measurements were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 meters. All frequencies were investigated in both horizontal and vertical antenna polarization, where applicable.

Receiver reading P_R , reported in tables at clause 5.1.6, was achieved adjusting the input signal P_{IN} by a correction factor CF , to take into account of the insertion loss due to cables and attenuators, the antenna factor, the external preamplifier gain. This correction factor was pre-inserted in the firmware of the receiver and was applied by the instrument during the test. The relationship between P_R and P_{IN} , expressed in dB, is:

$$P_R = P_{IN} + CF$$

5.1.4 Limits for enclosure

Radiated emission ¹				
Frequency (MHz)	Limit for Class A EUT		Limit for Class B EUT	
	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$
30 to 88	90	39.0	100	40.0
88 to 216	150	43.5	150	43.5
216 to 960	210	46.4	200	46.0
960 to 1000	300 ²	49.5 ²	500 ²	54.0 ²
Above 1000 ³	1000 ²	59.5 ²	500 ²	54.0 ²

Notes:

¹ For frequency range between 30 to 1000 MHz Quasi-Peak detector is used. For frequency range above 1000 MHz Average and Peak detector are used.

² Above 1000 MHz, the limit reported refers to measurement s performed with Average detector. For measurements performed with Peak detector the limit is 20 dB greater.

³ For Class A radiated emission above 1 GHz, a measurement distance of 3 m can be used, with the limits increased by 10 dB.

5.1.5 Test equipment used¹

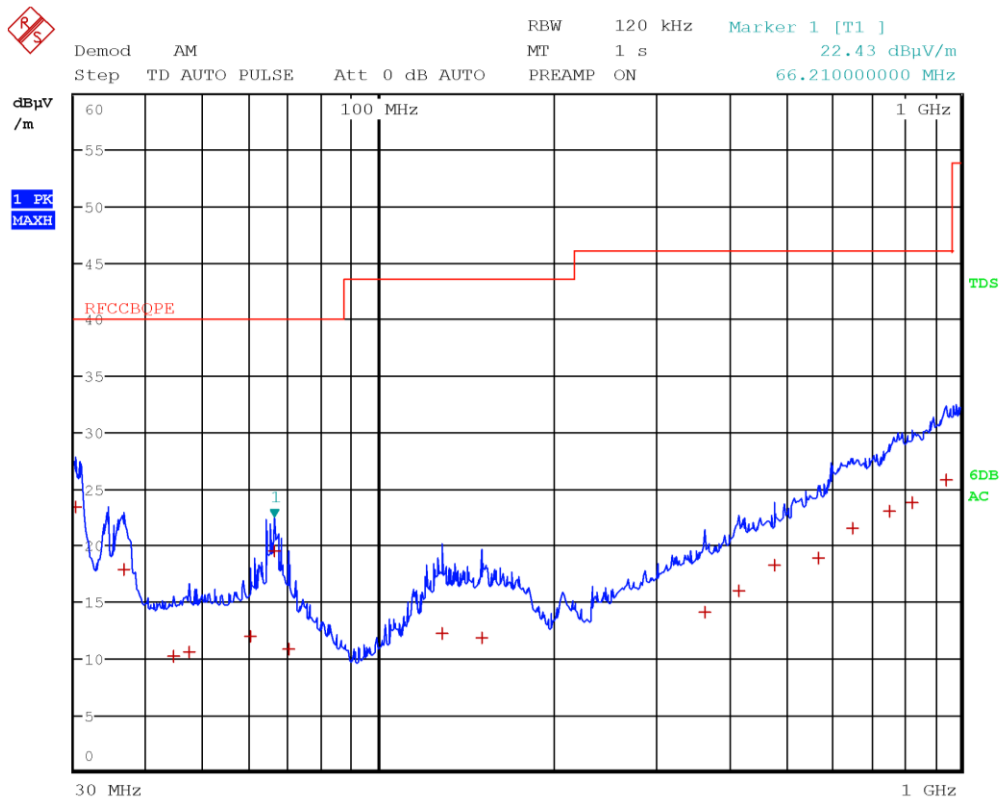
Used ²	Description	Manufacturer	Model	Identifier
<input checked="" type="checkbox"/>	SAC	Nemko Spa	10m SAC	530
<input checked="" type="checkbox"/>	SAC	Comtest	3m SAC	1711-150
<input checked="" type="checkbox"/>	EMI receiver	Rohde & Schwarz	ESW44	101620
<input type="checkbox"/>	EMI receiver	R&S	ESU8	100202
<input checked="" type="checkbox"/>	Common mode absorption device	Schwarzbeck	CMAD1614	00041
<input checked="" type="checkbox"/>	Antenna	Schwarzbeck	VULB9162	VULB9162-025
<input type="checkbox"/>	Antenna	Schwarzbeck	VULB9168	VULB9168-242
<input checked="" type="checkbox"/>	Antenna	Schwarzbeck	STLP9148	STLP9148-123
<input type="checkbox"/>	Antenna	Schwarzbeck	STLP9148	STLP9148-152
<input type="checkbox"/>	Antenna	RF Spin	DRH40	061106A40
<input type="checkbox"/>	Preamplifier	Schwarzbeck	BBV9718	BBV9718-137
<input checked="" type="checkbox"/>	Preamplifier	Schwarzbeck	BBV9718C	00121
<input checked="" type="checkbox"/>	Preamplifier	Sage	STB-1834034030-	18490-01
<input checked="" type="checkbox"/>	Controller for turntable and antenna mast	Maturo	FCU3.0	10041
<input checked="" type="checkbox"/>	Tilt antenna mast	Maturo	TAM4.0-E	10042
<input checked="" type="checkbox"/>	Turntable 4.5 t	Maturo	TT4.0-5T	2.527
<input checked="" type="checkbox"/>	Cable set	Rosenberger and Huber + Suhner	RE01+RE02	1.654+1.655
<input checked="" type="checkbox"/>	Cable set	Rosenberger and Huber + Suhner	RE03+RE04	1.510+1.511
<input checked="" type="checkbox"/>	Cable set	Rosenberger and Huber + Suhner	RE04+RE05	1.511+1.512
<input checked="" type="checkbox"/>	Software for table and mast	Maturo	mcApp	-

Notes:
¹ See clause 1.7 for calibration information.
² If crossed, the instrument was used during tests.

5.1.7 Test protocol

Antenna Polarization	Supply Voltage ¹	Test Mode		Remarks	Verdict
		Operation ²	Configuration ³		
Vertical	1	1	1		P

Notes:
¹ See clause 4.2 EUT Power Supply
² See clause 4.4 EUT Operation Modes
³ See clause 4.5 EUT Configuration Modes



Date: 12.DEC.2023 11:35:00

Antenna Polarization	Supply Voltage ¹	Test Mode		Remarks	Verdict
		Operation ²	Configuration ³		
Vertical	1	1	1		P

Notes:

¹ See clause 4.2 EUT Power Supply

² See clause 4.4 EUT Operation Modes

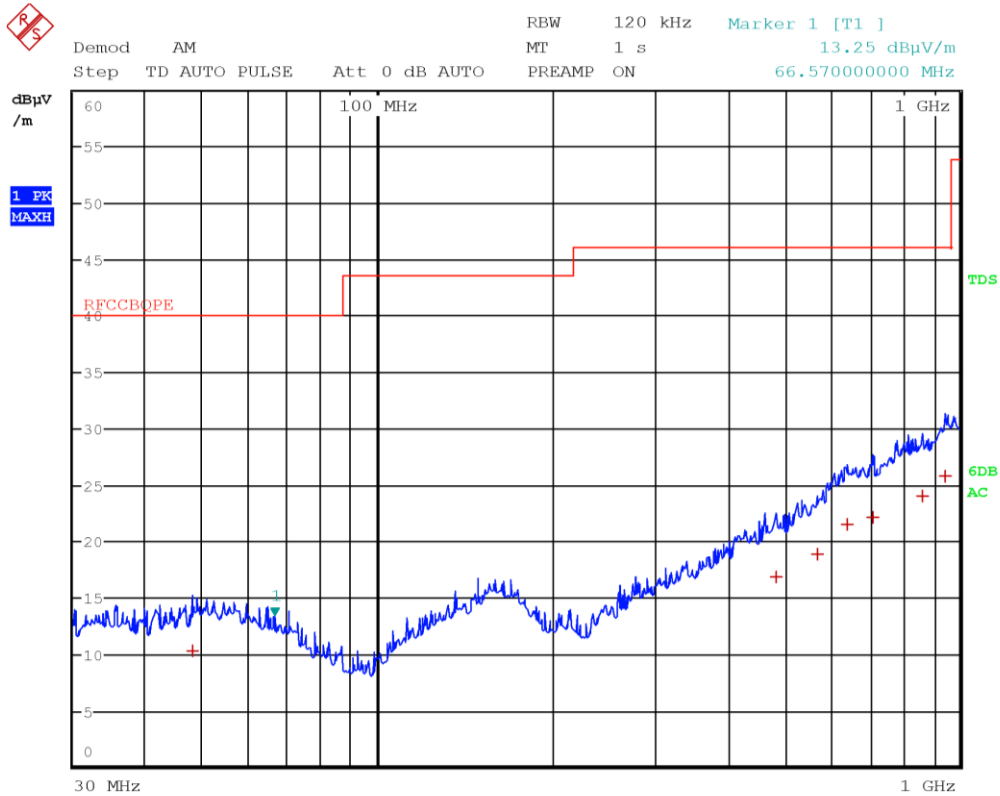
³ See clause 4.5 EUT Configuration Modes

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Detector
30.0900	23.4	40.0	-16.6	QP
36.5100	17.9	40.0	-22.1	QP
44.4900	10.2	40.0	-29.8	QP
47.3400	10.6	40.0	-29.4	QP
60.2100	12.0	40.0	-28.0	QP
66.2100	19.6	40.0	-20.4	QP
70.2000	10.8	40.0	-29.2	QP
128.2500	12.2	43.5	-31.3	QP
150.4500	11.8	43.5	-31.7	QP
363.6900	14.1	46.0	-31.9	QP
416.8800	16.0	46.0	-30.0	QP
479.9700	18.3	46.0	-27.7	QP
569.4900	19.0	46.0	-27.0	QP
653.3700	21.5	46.0	-24.5	QP
753.5400	23.1	46.0	-22.9	QP
823.9800	23.8	46.0	-22.2	QP
943.5600	25.8	46.0	-20.2	QP

Antenna Polarization	Supply Voltage ¹	Test Mode		Remarks	Verdict
		Operation ²	Configuration ³		
Horizontal	1	1	1		P

Notes:
¹ See clause 4.2 EUT Power Supply

² See clause 4.4 EUT Operation Modes

³ See clause 4.5 EUT Configuration Modes


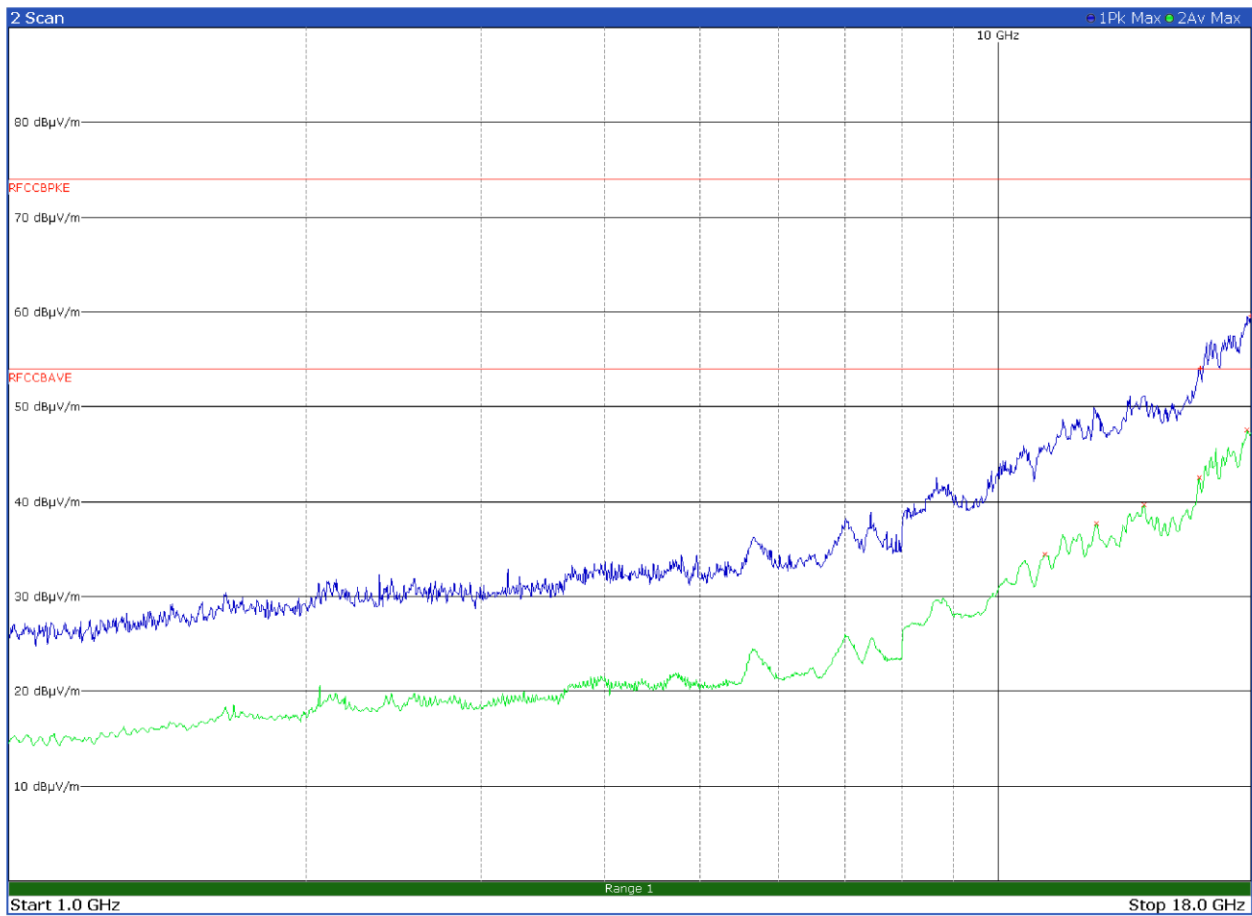
Date: 12.DEC.2023 11:43:16

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
48.0000	10.3	40.0	-29.7	QP
484.6200	16.9	46.0	-29.1	QP
570.3300	18.9	46.0	-27.1	QP
642.9000	21.6	46.0	-24.4	QP
708.4200	22.2	46.0	-23.8	QP
864.4800	24.1	46.0	-21.9	QP
942.9600	25.8	46.0	-20.2	QP

Antenna Polarization	Supply Voltage ¹	Test Mode		Remarks	Verdict
		Operation ²	Configuration ³		
Horizontal	1	1	1		P

Notes:
¹ See clause 4.2 EUT Power Supply

² See clause 4.4 EUT Operation Modes

³ See clause 4.5 EUT Configuration Modes


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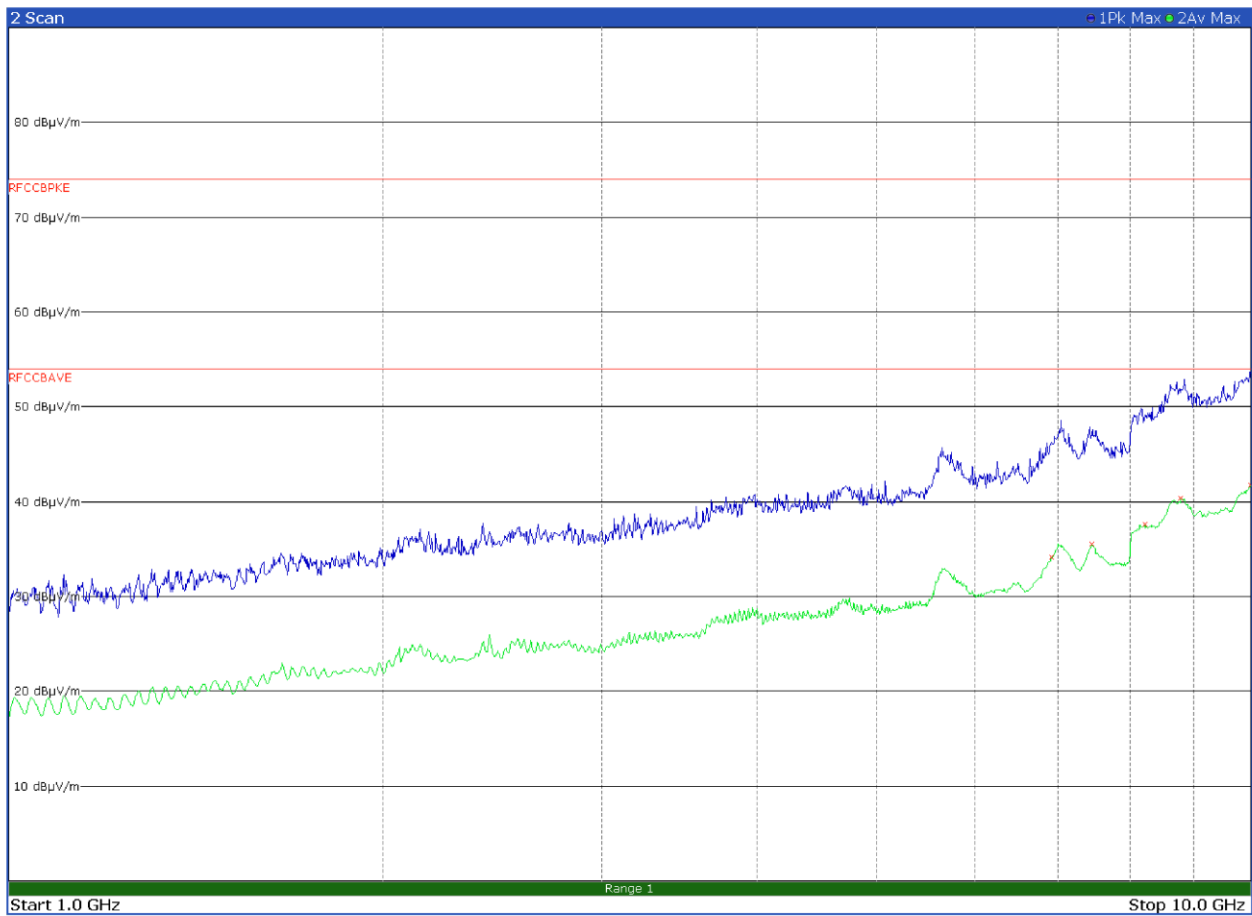
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Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
11161.7500	34.5	54.0	-19.5	Av
12581.0000	37.7	54.0	-16.3	Av
14032.5000	39.8	54.0	-14.2	Av
15959.7500	42.6	54.0	-11.4	Av
15989.7500	54.1	74.0	-19.9	Pk
17859.0000	47.6	54.0	-6.4	Av
17998.2500	59.7	74.0	-14.3	Pk

Antenna Polarization	Supply Voltage ¹	Test Mode		Remarks	Verdict
		Operation ²	Configuration ³		
Vertical	1	1	1		P

Notes:
¹ See clause 4.2 EUT Power Supply

² See clause 4.4 EUT Operation Modes

³ See clause 4.5 EUT Configuration Modes


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Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
6914.5000	34.2	54.0	-19.8	Av
7447.2500	35.6	54.0	-18.4	Av
8221.2500	37.7	54.0	-16.3	Av
8782.0000	40.4	54.0	-13.6	Av
9998.2500	41.8	54.0	-12.2	Av

6 EUT PHOTOS







End of report