

**Test Report acc. to FCC Title 47 CFR Part 15  
relating to  
WERMA Signaltechnik GmbH + Co. KG  
WEA1**

**Title 47 - Telecommunication  
Part 15 - Radio Frequency Devices  
Subpart C – Intentional Radiators  
Measurement Procedure:  
ANSI C63.10-2013**



Deutsche  
Akkreditierungsstelle  
D-PL-12053-01-03

### MANUFACTURER

<b>Manufacturer name</b>	<b>WERMA Signaltechnik GmbH + Co. KG</b>
<b>Manufacturer's grantee code</b>	<b>ZGH</b>
<b>Manufacturer's address</b>	Dürbheimer Str. 15 78604 Rietheim-Weilheim Germany
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<b>Email</b>	Florian.Ott@werma.com

### TESTING LABORATORY

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<b>Testing laboratory name</b>	<b>TÜV NORD Hochfrequenztechnik GmbH &amp; Co. KG</b>
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### RELEVANT STANDARD

<b>Title</b>	<b>47 - Telecommunication</b>
<b>Part</b>	<b>15 - Radio Frequency Devices</b>
<b>Subpart</b>	<b>Subpart C – Intentional Radiators – Section 15.249</b>
<b>Measurement procedure</b>	<b>ANSI C63.10-2013</b>

### EQUIPMENT UNDER TEST (EUT)

<b>Equipment category</b>	Low Power Communication Device Transmitter
<b>Trade name</b>	WERMA
<b>Type designation</b>	WEA1
<b>Serial no.</b>	---
<b>Variants</b>	AndonWireless 2B 921MHz, AndonWireless 5B 921MHz

**Test results**

Clause	Requirements headline	FCC Rule	Test result		
			Pass	Fail	Not*
8.1	Antenna requirement	§15.203	Pass	<del>Fail</del>	<del>Not*</del>
8.2	Restricted bands of operation	§15.205	Pass	<del>Fail</del>	<del>Not*</del>
8.3	AC power line conducted emissions limits	§15.207	Pass	<del>Fail</del>	<del>Not*</del>
8.4	Radiated emission limits, general requirements	§15.209	Pass	<del>Fail</del>	<del>Not*</del>
8.5	Field strength of fundamental and harmonics	§15.249	Pass	<del>Fail</del>	<del>Not*</del>
8.6	Bandwidth	§15.249	Pass	<del>Fail</del>	<del>Not*</del>
8.7	Band edge emissions	§15.249	Pass	<del>Fail</del>	<del>Not*</del>

\* Not tested

As far as in this report statements on conformity are made, decision rules according to DIN EN ISO/IEC 17025:2018, 7.8.6 have been applied. If the report does not state otherwise, procedure 1 according to IEC Guide 115 ed.1.0 2007 (uncertainty of measurement calculated) has been applied on measurement and test procedures which are the base of this report.

<b>The equipment passed all the conducted tests</b>	<b>Yes</b>	<del>No</del>
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<b>Signature</b>		
<b>Name</b>	<b>Mr. Anup Shrestha</b>	<b>Mr. Ralf Trepper</b>
<b>Designation</b>	<b>RF Test Engineer</b>	<b>Deputy Laboratory Manager</b>
<b>Date of issue</b>	<b>2021-05-07</b>	<b>2021-05-07</b>

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Revision	Date of issue	Creator	Content of change
00	25.02.2021	Ralf Trepper	Initial release
01	07.05.2021	Anup Shrestha	Changes in type designation
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Table 0-1: Table of contents

Note: If the document has been changed by revision number, all previous documents are no longer valid and must be destroyed.

## 2. Introduction

This test report is **not an expert opinion** and consists of:

- Test result summary
- List of contents
- Introduction and further information
- Performance assessment
- Detailed test information

All pages have been numbered consecutively and bear the TÜV NORD Hochfrequenztechnik GmbH & Co. KG logo, the test report number, the date, the test specification in its current version as well as the type designation of the EUT. The total numbers of pages in this report is **47**.

The tests were carried out in a representative assembly and in accordance with the test methods and/or requirements stated in:

### **FCC Title 47 CFR Part 15 Subpart C & ANSI C63.10-2013**

The sample of the product was received on:

- **2021-01-15**

The tests were carried out in the following period of time:

- **2021-02-17 - 2021-02-24**

## 3. Testing laboratory

**TÜV NORD Hochfrequenztechnik GmbH & Co. KG,**  
LESKANPARK, Gebäude 10  
Waltherstr. 49-51  
51069 Köln  
Germany

Phone: +49 221 8888950

**FCC Registration Number: 763407**  
**FCC Designation Number: DE0012**

Accredited by:

**DAkKS Deutsche Akkreditierungsstelle GmbH**  
**DAkKS accreditation number: D-PL-12053-01-00**

EUT: WEA1

FCC ID: ZGHWEA1

FCC Title 47 CFR Part 15

Date of issue: 2021-05-07

#### 4. Applicant

Company name : WERMA Signaltechnik GmbH + Co. KG  
 Address : Dürbheimer Str. 15  
 78604 Rietheim-Weilheim  
 Country : Germany  
 Telephone : +49 7424 9557 0  
 Fax : +49 7424 9557 44  
 Email : Florian.Ott@werma.com  
 Date of order : 2021-01-15  
 References : Mr. Florian Ott

#### 5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer : WERMA Signaltechnik GmbH + Co. KG  
 Trademark : WERMA  
 Type designation : WEA1  
 Serial number : ---  
 Hardware versions : WEA1  
 Variants : AndonWireless 2B 921MHz, AndonWireless 5B 921MHz  
 Software release : 00  
 Type of equipment : Low Power Communication Device Transmitter  
 Power used : 4.5 V DC (3x AA batteries)  
 120 V AC 60 Hz (AC / USB adaptor)  
 Frequency used : 921,0 / 921,2 / 921,4 / 921,6 / 921,8 / 922,0 [MHz]  
 Generated or used frequencies : 921,0 / 921,2 / 921,4 / 921,6 / 921,8 / 922,0 [MHz] (carrier frequencies),  
 12 MHz (internal clock oscillator), 8 MHz (ceramic resonator), 50 MHz (crystal)  
 ITU emission class : 116KF1D  
 FCC ID : ZGHWEA1

For issuing this report the following product documentation was used:

Title	Description	Version
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For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the Equipment Under Test (EUT)	2021-02-25	Annex no. 1
Internal photographs of the Equipment Under Test (EUT)	2021-02-25	Annex no. 2
Channel occupancy / bandwidth	2021-02-25	Annex no. 3
Label sample	2021-02-25	Annex no. 4
Functional description / User Manual	2021-02-25	Annex no. 5
Test setup photos	2021-02-25	Annex no. 6
Block diagram	2021-02-25	Annex no. 7
Operational description	2021-02-25	Annex no. 8
Schematics	2021-02-25	Annex no. 9
Parts list	2021-02-25	Annex no. 10
Test result	2021-02-25	Annex no. 11

## 6. Conclusions, observations and comments

The test report will be filed at TÜV NORD Hochfrequenztechnik GmbH & Co. KG for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of TÜV NORD Hochfrequenztechnik GmbH & Co. KG.

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. TÜV NORD Hochfrequenztechnik GmbH & Co. KG cannot be held liable for properties of the EUT that have not been observed during these tests.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15 for the respective test sector, if the test results turn out positive.

**Comments: ---**



## 7. Operational description

### 7.1 EUT details

Remote switch, for a call and reporting system in production lines

### 7.2 EUT configuration

The device must be set in the necessary test modes by software and key press.

### 7.3 EUT measurement description

#### Radiated measurements

The EUT was tested in a typical fashion. During preliminary emission tests the EUT was operated in the continuous measuring mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous measuring mode. All tests were performed with the EUT's typical voltage: 4.5 V DC battery operated / EUT's typical voltage: 120 V AC ext. power supply operated.

In order to establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test samples, secondly the test sample have been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical had been varied.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas, which may have a smaller beamwidth (main lobe) than do the antennas used for frequencies below 1 GHz. The measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal.

#### AC Powerline Conducted measurements

The EUT was directly connected to the artificial mains network. It has been tested with the activated EUT in continuous measuring mode.

The EUT is connected via the USB Port to a laptop with the laptop directly connected to the artificial mains network. It has been tested in two runs: first with Laptop (inactive EUT), second with activated EUT via LAN port of the laptop, third with activated EUT via USB port of the laptop and finally with activated EUT via serial port of the laptop.

## 8. Compliance assessment

### 8.1 Antenna requirement

#### 8.1.1 Regulation

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 carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, 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 Section 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.

#### 8.1.2 Result

Antenna Type	Antenna description	Frequency	Gain	Number of Antennas
<b>Embedded Ceramic Antenna</b>	Ethertronics' series of Ceramic Isolated Magnetic Dipole™ (IMD) antenna Part No. M620720	<b>902 – 928 GHz</b>	<b>0.75 dBi</b>	1

The equipment passed the conducted tests	<b>Yes</b>	<del>No</del>	<del>N/A</del> *
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Test setup photos / test results are attached	<b>Yes</b>	<del>No</del>	Annex no.: 2
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## 8.2 Restricted bands of operation

### 8.2.1 Regulation

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Restricted bands of operation			
Frequency Band	Frequency Band	Frequency Band	Frequency Band
MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
<sup>1</sup> 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	( <sup>2</sup> )
13.36 - 13.41	---	---	---

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.  
<sup>2</sup> Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR Quasi-Peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this Section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a), the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a), and the fundamental emission is outside of the bands listed in paragraph (a) more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

- (2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.
- (3) Cable locating equipment operated pursuant to Section 15.213.
- (4) Any equipment operated under the provisions of § 15.253, § 15.255 or § 15.256 in the frequency band 75-85 GHz, or § 15.257 of this part
- (5) Biomedical telemetry devices operating under the provisions of Section 15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.
- (6) Transmitters operating under the provisions of Subpart D or F of this part.
- (7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.
- (8) Devices operated in the 24.075-24.175 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in § 15.245(b).
- (9) Devices operated in the 24.0-24.25 GHz band under § 15.245 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in § 15.245(b).
- (10) White space devices operating under subpart H of this part are exempt from complying with the requirements of this section for the 608-614 MHz band.

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 15.245 shall not exceed the limits specified in Section 15.245(b).

### 8.2.2 Result

Test Cables used	K60, K101, K119
Test equipment used	23, 406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del> <sup>§</sup>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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## 8.3 Conducted limits

### 8.3.1 Regulation

(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  $\mu$ H /50 ohms 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.

Conducted Limits		
Frequency of Emission	Quasi-Peak (QP)	Average (AV)
MHz	dB $\mu$ V	dB $\mu$ V
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 -30	60	50
*Limit Decreases with the logarithm of the frequency		

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

- 1) For carrier current system containing their fundamental emission within the frequency band 535–1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.
- (2) For all other carrier current systems: 1000  $\mu$ V within the frequency band 535–1705 kHz, as measured using a 50  $\mu$ H /50  $\Omega$  LISN.
- (3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

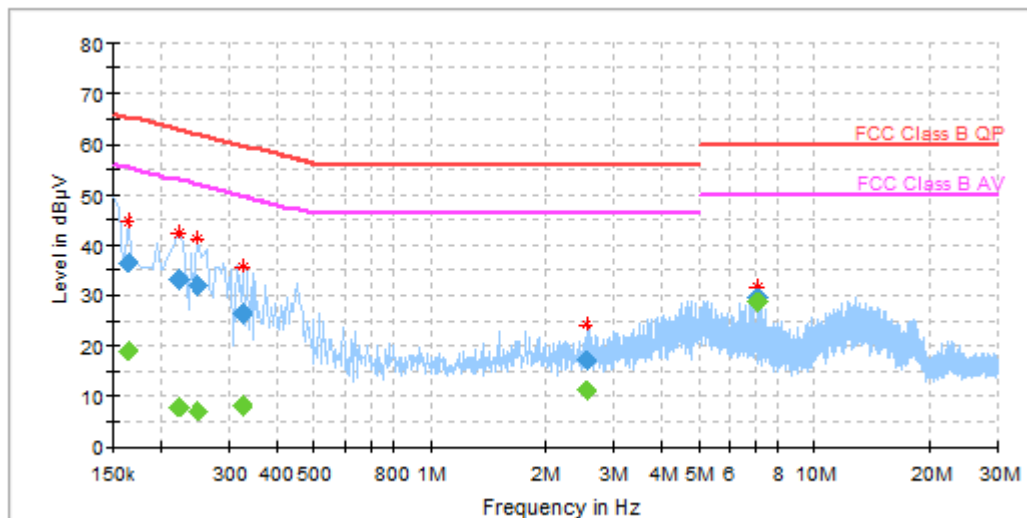
### 8.3.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.10-2013 Section 6. Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

### 8.3.3 Result

#### Conducted emissions (Section 15.207) - Tested with external AC power supply AndonWireless 5B 921MHz

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.163500	36.55	---	65.28	28.74	1000.0	9.000	N	GND
0.163500	---	18.94	55.28	36.34	1000.0	9.000	N	GND
0.222000	---	7.69	52.74	45.06	1000.0	9.000	L1	GND
0.222000	33.07	---	62.74	29.68	1000.0	9.000	L1	GND
0.249000	32.16	---	61.79	29.63	1000.0	9.000	L1	GND
0.249000	---	6.90	51.79	44.89	1000.0	9.000	L1	GND
0.325500	---	8.21	49.57	41.35	1000.0	9.000	N	GND
0.325500	26.59	---	59.57	32.98	1000.0	9.000	N	GND
2.557500	---	11.00	46.00	35.00	1000.0	9.000	N	GND
2.557500	17.30	---	56.00	38.70	1000.0	9.000	N	GND
7.084500	---	28.48	50.00	21.52	1000.0	9.000	N	GND
7.084500	29.53	---	60.00	30.47	1000.0	9.000	N	GND



Measurement uncertainty  $< \pm 2$  dB

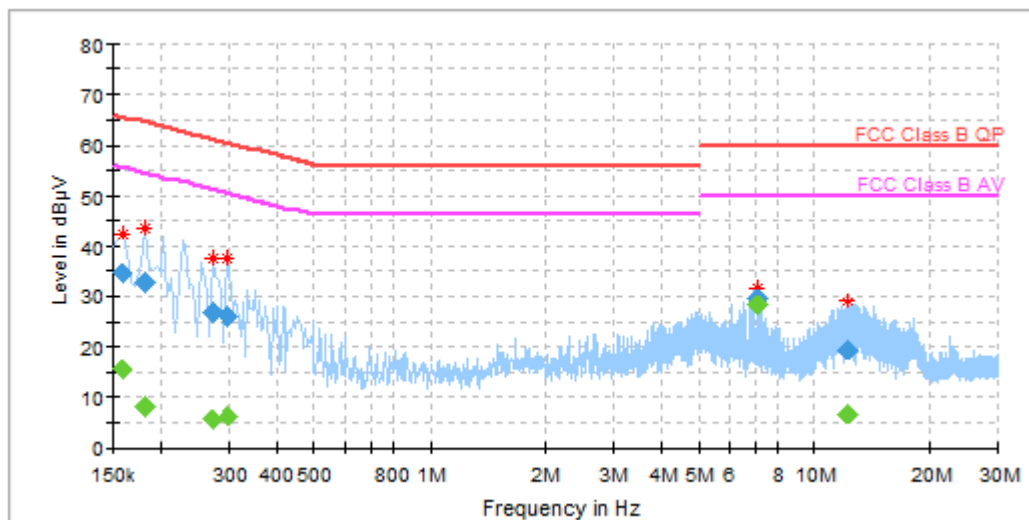
Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

The equipment passed the conducted tests	Yes	No	Not*
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Test setup photos / test results are attached	Yes	No	Annex no.:6, 11
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**Conducted emissions (Section 15.207) - Tested with external AC power supply  
AndonWireless 2B 921MHz**

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.159000	34.63	---	65.52	30.89	1000.0	9.000	N	GND
0.159000	---	15.52	55.52	40.00	1000.0	9.000	N	GND
0.181500	---	8.18	54.42	46.24	1000.0	9.000	L1	GND
0.181500	32.65	---	64.42	31.77	1000.0	9.000	L1	GND
0.271500	---	5.63	51.07	45.45	1000.0	9.000	N	GND
0.271500	26.61	---	61.07	34.46	1000.0	9.000	N	GND
0.298500	26.03	---	60.28	34.26	1000.0	9.000	N	GND
0.298500	---	6.26	50.28	44.02	1000.0	9.000	N	GND
7.080000	---	28.11	50.00	21.89	1000.0	9.000	L1	GND
7.080000	29.54	---	60.00	30.46	1000.0	9.000	L1	GND
12.183000	---	6.60	50.00	43.40	1000.0	9.000	N	GND
12.183000	19.20	---	60.00	40.80	1000.0	9.000	N	GND



Measurement uncertainty  $\pm 2$  dB

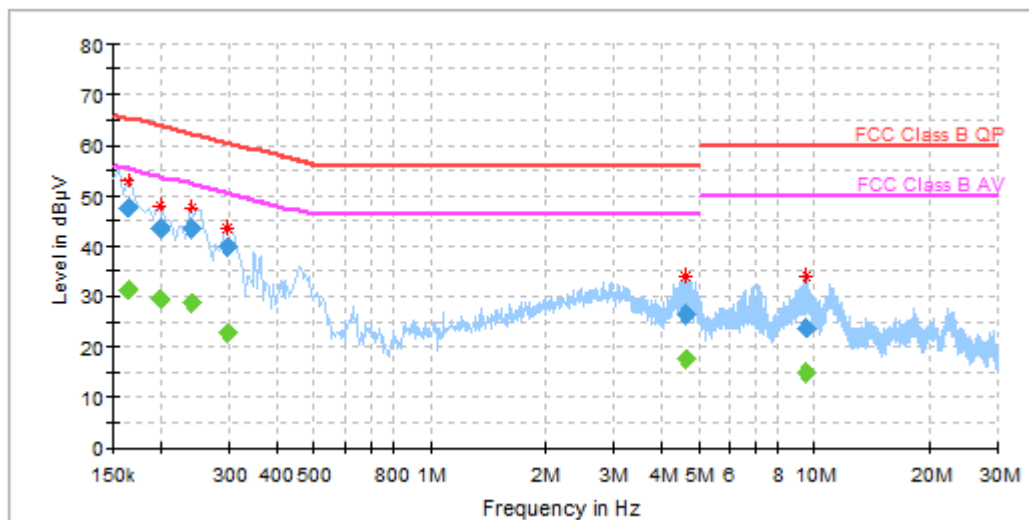
Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

The equipment passed the conducted tests	Yes	No	Not
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Test setup photos / test results are attached	Yes	No	Annex no.:6, 11
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**Conducted emissions (Section 15.207) - Tested with a Laptop over USB port  
Andon Wireless 5B 921MHz (inactive)**

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.163500	---	31.32	55.28	23.97	1000.0	9.000	L1	GND
0.163500	47.67	---	65.28	17.61	1000.0	9.000	L1	GND
0.199500	---	29.57	53.63	24.07	1000.0	9.000	L1	GND
0.199500	43.63	---	63.63	20.00	1000.0	9.000	L1	GND
0.240000	---	28.49	52.10	23.61	1000.0	9.000	L1	GND
0.240000	43.51	---	62.10	18.59	1000.0	9.000	L1	GND
0.298500	39.65	---	60.28	20.63	1000.0	9.000	N	GND
0.298500	---	22.57	50.28	27.71	1000.0	9.000	N	GND
4.614000	26.60	---	56.00	29.40	1000.0	9.000	N	GND
4.614000	---	17.35	46.00	28.65	1000.0	9.000	N	GND
9.492000	---	14.88	50.00	35.12	1000.0	9.000	L1	GND
9.492000	23.81	---	60.00	36.19	1000.0	9.000	L1	GND



Measurement uncertainty  $\pm 2$  dB

Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

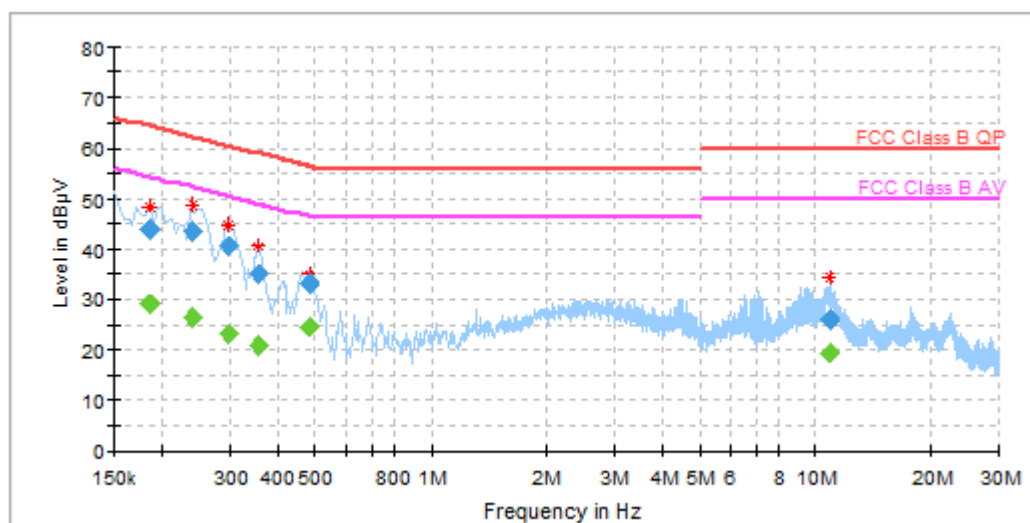
The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.: 6, 11
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**Conducted emissions (Section 15.207) - Tested with a Laptop over USB port  
AndonWireless 5B 921MHz (active)**

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.186000	---	29.17	54.21	25.04	1000.0	9.000	L1	GND
0.186000	43.82	---	64.21	20.39	1000.0	9.000	L1	GND
0.240000	43.58	---	62.10	18.52	1000.0	9.000	N	GND
0.240000	---	26.46	52.10	25.64	1000.0	9.000	N	GND
0.298500	40.40	---	60.28	19.89	1000.0	9.000	N	GND
0.298500	---	23.13	50.28	27.16	1000.0	9.000	N	GND
0.357000	35.12	---	58.80	23.68	1000.0	9.000	L1	GND
0.357000	---	20.95	48.80	27.84	1000.0	9.000	L1	GND
0.483000	33.25	---	56.29	23.04	1000.0	9.000	L1	GND
0.483000	---	24.41	46.29	21.88	1000.0	9.000	L1	GND
10.851000	---	19.21	50.00	30.79	1000.0	9.000	N	GND
10.851000	26.16	---	60.00	33.84	1000.0	9.000	N	GND



Measurement uncertainty  $\pm 2$  dB

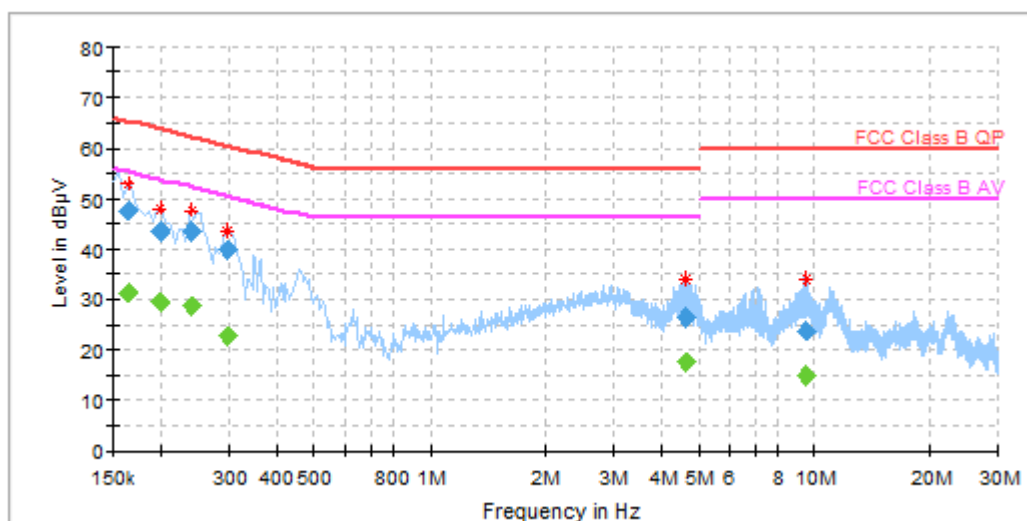
Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Conducted emissions (Section 15.207) - Tested with a Laptop over USB port  
Andon Wireless 2B 921MHz (inactive)**

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.163500	---	<b>31.32</b>	55.28	<b>23.97</b>	1000.0	9.000	L1	GND
0.163500	<b>47.67</b>	---	65.28	<b>17.61</b>	1000.0	9.000	L1	GND
0.199500	---	<b>29.57</b>	53.63	<b>24.07</b>	1000.0	9.000	L1	GND
0.199500	<b>43.63</b>	---	63.63	<b>20.00</b>	1000.0	9.000	L1	GND
0.240000	---	<b>28.49</b>	52.10	<b>23.61</b>	1000.0	9.000	L1	GND
0.240000	<b>43.51</b>	---	62.10	<b>18.59</b>	1000.0	9.000	L1	GND
0.298500	<b>39.65</b>	---	60.28	<b>20.63</b>	1000.0	9.000	N	GND
0.298500	---	<b>22.57</b>	50.28	<b>27.71</b>	1000.0	9.000	N	GND
4.614000	<b>26.60</b>	---	56.00	<b>29.40</b>	1000.0	9.000	N	GND
4.614000	---	<b>17.35</b>	46.00	<b>28.65</b>	1000.0	9.000	N	GND
9.492000	---	<b>14.88</b>	50.00	<b>35.12</b>	1000.0	9.000	L1	GND
9.492000	<b>23.81</b>	---	60.00	<b>36.19</b>	1000.0	9.000	L1	GND



Measurement uncertainty  $\pm 2$  dB

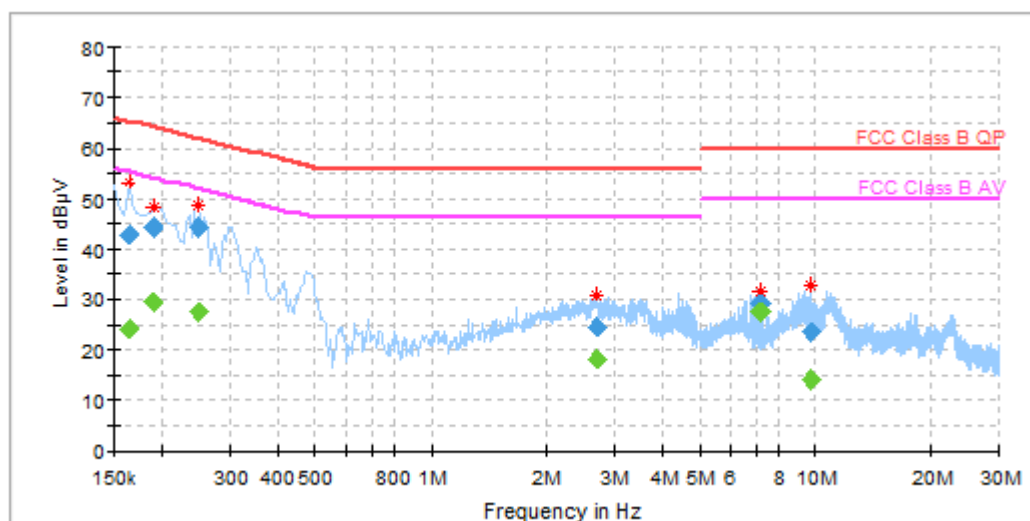
Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.: 6, 11
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**Conducted emissions (Section 15.207) - Tested with a Laptop over USB port  
AndonWireless 2B 921MHz (active)**

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE
0.163500	42.93	---	65.28	22.35	1000.0	9.000	N	GND
0.163500	---	24.09	55.28	31.19	1000.0	9.000	N	GND
0.190500	44.29	---	64.02	19.73	1000.0	9.000	L1	GND
0.190500	---	29.34	54.02	24.68	1000.0	9.000	L1	GND
0.249000	44.16	---	61.79	17.63	1000.0	9.000	L1	GND
0.249000	---	27.39	51.79	24.40	1000.0	9.000	L1	GND
2.701500	24.44	---	56.00	31.56	1000.0	9.000	L1	GND
2.701500	---	18.33	46.00	27.67	1000.0	9.000	L1	GND
7.192500	29.16	---	60.00	30.84	1000.0	9.000	L1	GND
7.192500	---	27.59	50.00	22.41	1000.0	9.000	L1	GND
9.739500	23.50	---	60.00	36.50	1000.0	9.000	L1	GND
9.739500	---	14.18	50.00	35.82	1000.0	9.000	L1	GND



Measurement uncertainty  $\pm 2$  dB

Test Cables used	K ISN2
Test equipment used	60, 272, 551, 665

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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## 8.4 Radiated emission limits, general requirements

### 8.4.1 Regulation

- (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Intentional radiator- radiated emission limits		
Frequency	Field Strength	Measurement distance
MHz	$\mu\text{V} / \text{m}$	m
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
above 960	500	3

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76– 88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

- (b) In the emission table above, the tighter limit applies at the band edges.

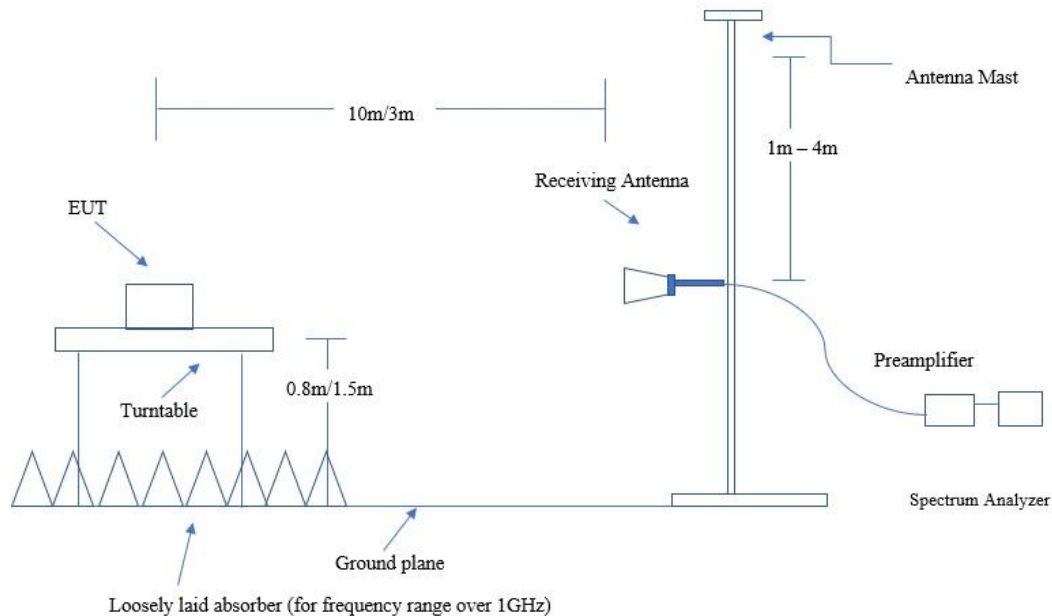
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

(f) In accordance with Section 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in Section 15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in Section 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in Section 15.109 that are applicable to the incorporated digital device.

## 8.4.2 Test setup photo



## 8.4.3 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m turn table. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table would be allowed to rotate 360° to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna is 3m above 30 MHz and is 10m within frequency range 9kHz to 30 MHz. To find the maximum emission, the polarization of the receiving antenna is changed in horizontal and vertical polarization; the position of the EUT was changed in different orthogonal determinations.

Measurement procedures for electric field radiated emissions from frequency range within 9 kHz to 1 GHz & above 1 GHz are consisting of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. The measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

Bore-sighting technique is used for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTs, measuring system sensitivity, etc.

The measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the

EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane

Radiated emissions test characteristics	
Frequency range	9 kHz – 231 GHz
Test distance	10 m (below 30 MHz) 3 m* (above 30 MHz)
Test instrumentation minimum resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Detector Type	Quasi peak and Average based on frequency range
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

\* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

#### 8.4.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors

Correction Factor : Antenna factor + cable loss

For example:

The receiver reading is 32.7 dB $\mu$ V. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dB $\mu$ V/m. The 35.91dB $\mu$ V/m value can be mathematically converted to its corresponding level in  $\mu$ V/m.

Level in  $\mu$ V/m = Common Antilogarithm (35.91/20) = 62.44

At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be

performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

For example: Distance limit ( $d_{\text{limit}}$ ) = 3, Distance measured ( $d_{\text{measured}}$ ) = 1  
Distance Extrapolation Factor (DEF) =  $20 * \log (d_{\text{limit}}/d_{\text{measured}}) = 20 * \log (3/1) = 9.5$

At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

For example: Distance limit ( $d_{\text{limit}}$ ) = 300, Distance measured ( $d_{\text{measured}}$ ) = 10  
Distance Extrapolation Factor (DEF) =  $40 * \log (d_{\text{limit}}/d_{\text{measured}}) = 40 * \log (300/10) = 59.1$

Radiated emissions test characteristics	
Frequency range	9 kHz – Above 960 MHz
Test distance	3 m*
Test instrumentation minimum resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Detector Type	Quasi peak and Average based on frequency range
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

\* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).



### 8.4.5 Result

Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209)										
AndonWireless 2B 921MHz (powered with AC)										
f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dB $\mu$ V	m	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m @ meter	dB $\mu$ V/m	height/m	
---	---	---	---	---	---	---	---	---	---	---
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.										
Measurement uncertainty										$\pm 4$ dB

Blue marked: restricted bands

Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209)										
AndonWireless 5B 921MHz (powered with AC)										
f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dB $\mu$ V	m	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m @ meter	dB $\mu$ V/m	height/m	
---	---	---	---	---	---	---	---	---	---	---
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.										
Measurement uncertainty										$\pm 4$ dB

Blue marked: restricted bands

Test Cables used	K60, K101, K119
Test equipment used	23, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del> <sup>*</sup>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209)**

**AndonWireless 2B 921MHz (Battery powered)**

f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dB $\mu$ V	m	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m @ meter	dB $\mu$ V/m	height/m	
---	---	---	---	---	---	---	---	---	---	---
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.										
Measurement uncertainty										$\pm 4$ dB

Blue marked: restricted bands

**Transmitter spurious radiation below 30 MHz (Section 15.205 and 15.209)**

**AndonWireless 5B 921MHz (Battery powered)**

f	Bandwidth, Type of detector	Noted receiver level	Test distance	Correction factor	Distance extrapol. factor	Level corrected	Limit	Margin	Polaris. EUT / antenna orientation	
MHz		dB $\mu$ V	m	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m @ meter	dB $\mu$ V/m	height/m	
---	---	---	---	---	---	---	---	---	---	---
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.										
Measurement uncertainty										$\pm 4$ dB

Blue marked: restricted bands

Test Cables used	K60, K101, K119
Test equipment used	23, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del> <sup>§</sup>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209)**

**AndonWireless 2B 921MHz (Battery powered)**

f	Detct	BW	Rx Level	M D	CF	DEF	AVC	LC	Limit	Margin	EP	Antenna	
												Pol	H
MHz	Type	kHz	dBμV	m	dB	dB	dB	dBμV/m	dBμV/m	dB	°	H/V	m

The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

Measurement uncertainty: ± 4 dB

**\*\* All other emissions are lower than the noise level of the measuring equipment!**

f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | MD: Measurement distance | CF : Correction factor |

DEF :Distance extrapolation factor | AVC : Averaging Correction factor | LC : Level corrected | EP: EUT Position |

Pol:Antenna polarization | H: Antenna height |

Blue marked: restricted bands

**Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209)**

**AndonWireless 5B 921MHz (Battery powered)**

f	Detct	BW	Rx Level	M D	CF	DEF	AVC	LC	Limit	Margin	EP	Antenna	
												Pol	H
MHz	Type	kHz	dBμV	m	dB	dB	dB	dBμV/m	dBμV/m	dB	°	H/V	m

The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

Measurement uncertainty: ± 4 dB

**\*\* All other emissions are lower than the noise level of the measuring equipment!**

f: Frequency | Detct : Detector type | BW: Bandwidth | Rx Level : Receiver level | MD: Measurement distance | CF : Correction factor |

DEF :Distance extrapolation factor | AVC : Averaging Correction factor | LC : Level corrected | EP: EUT Position |

Pol:Antenna polarization | H: Antenna height |

Blue marked: restricted bands

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Nt</del> *
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209)**

**AndonWireless 2B 921MHz (powered with AC)**

f	Detct	BW	Rx Level	M D	CF	DEF	AVC	LC	Limit	Margin	EP	Antenna	
												Pol	H
MHz	Type	kHz	dBµV	m	dB	dB	dB	dBµV/m	dBµV/m	dB	°	H/V	m
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.													
Measurement uncertainty: ± 4 dB													
<b>** All other emissions are lower than the noise level of the measuring equipment!</b>													
f: Frequency   Detct : Detector type   BW: Bandwidth   Rx Level : Receiver level   MD: Measurement distance   CF : Correction factor   DEF :Distance extrapolation factor   AVC : Averaging Correction factor   LC : Level corrected   EP: EUT Position   Pol:Antenna polarization   H: Antenna height													
Blue marked: restricted bands													

**Transmitter spurious radiation above 30 MHz (Section 15.205, 15.209)**

**AndonWireless 5B 921MHz (powered with AC)**

f	Detct	BW	Rx Level	M D	CF	DEF	AVC	LC	Limit	Margin	EP	Antenna	
												Pol	H
MHz	Type	kHz	dBµV	m	dB	dB	dB	dBµV/m	dBµV/m	dB	°	H/V	m
The amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.													
Measurement uncertainty: ± 4 dB													
<b>** All other emissions are lower than the noise level of the measuring equipment!</b>													
f: Frequency   Detct : Detector type   BW: Bandwidth   Rx Level : Receiver level   MD: Measurement distance   CF : Correction factor   DEF :Distance extrapolation factor   AVC : Averaging Correction factor   LC : Level corrected   EP: EUT Position   Pol:Antenna polarization   H: Antenna height													
Blue marked: restricted bands													

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	No	<del>Not</del> *
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Test setup photos / test results are attached	Yes	No	Annex no.:6, 11
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## 8.5 Field strength limits of fundamental frequencies and harmonics

### 8.5.1 Regulation

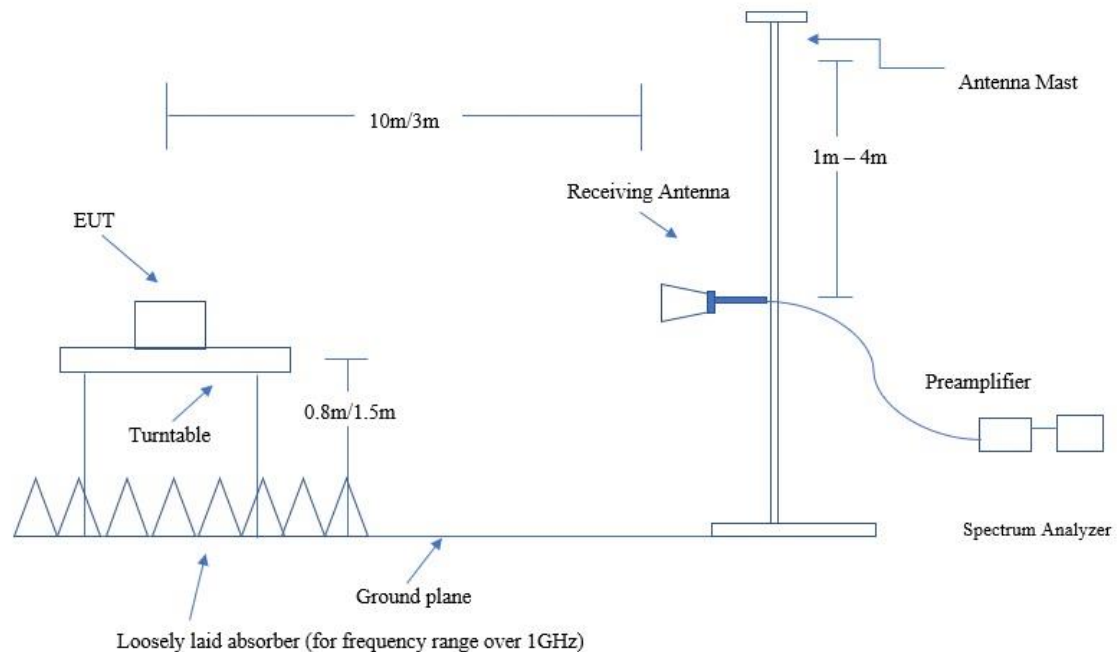
(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Intentional radiator- Fundamental frequencies / Field strength limits		
Frequency	Field strength of fundamental	Field strength of harmonics
MHz	mV / m	$\mu\text{V} / \text{m}$
902-928	50	500
2400-2483.5	50	500
5725-5875	50	500
24.0-24.25	250	2500

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

- (1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.
  - (2) The frequency tolerance of the carrier signal shall be maintained within  $\pm 0.001\%$  of the operating frequency over a temperature variation of  $-20\text{ }^{\circ}\text{C}$  to  $+50\text{ }^{\circ}\text{C}$  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  $20\text{ }^{\circ}\text{C}$ . For battery operated equipment, the equipment tests shall be performed using a new battery.
  - (3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed  $3.5^{\circ}$ . The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than  $3.5^{\circ}$ , power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.
- (c) Field strength limits are specified at a distance of 3 meters.
- (d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.
- (e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

### 8.5.2 Test setup photo



### 8.5.3 Test procedure

The EUT and this peripheral (when additional equipment exists) are placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m turn table. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table would be allowed to rotate 360° to determine the position of the maximum emission level. The test distance between the EUT and the receiving antenna is 3m above 30 MHz and is 10m within frequency range 9kHz to 30 MHz. To find the maximum emission, the polarization of the receiving antenna is changed in horizontal and vertical polarization; the position of the EUT was changed in different orthogonal determinations.

Measurement procedures for electric field radiated emissions from frequency range within 9 kHz to 1 GHz & above 1 GHz are consisting of both an exploratory test and a final measurement. The exploratory test is critical to determine the frequency of all significant emissions. For each mode of operation required to be tested, the frequency spectrum is monitored. Variations in antenna height, antenna orientation, antenna polarization, EUT azimuth, and cable or wire placement is explored to produce the emission that has the highest amplitude relative to the limit.

The final measurements are made based on the findings in the exploratory testing. When making exploratory and final measurements it is necessary to maximize the measured radiated emission. The measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” We consider the “cone of radiation” to be the 3 dB beam width of the measurement antenna.

Bore-sighting technique is used for measurements using a directional antenna, such as a double-ridged waveguide antenna. Several precautions must be observed, including: knowledge of the beam width of the antenna and the resulting illumination area relative to the size of the EUT, estimation for source of the emission and general location within larger EUTs, measuring system sensitivity, etc.

The measurement antenna is kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. That means that if the directional radiation pattern of the EUT results in a maximum emission at an upwards angle from the EUT, when a directional antenna is used to make the measurement it will be necessary for it to be pointed towards the source of the emission within the EUT. This can be done by either pointing the antenna at an angle towards the source of the emission, or by rotating the EUT, in both height and polarization, to maximize the measured emission. The emission must be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured.

Radiated measurement above 1 GHz is made by placing loose-laid RF absorber material on the ground plane

Radiated emissions test characteristics	
Frequency range	9 kHz – 231 GHz
Test distance	10 m (below 30 MHz) 3 m* (above 30 MHz)
Test instrumentation minimum resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Detector Type	Quasi peak and Average based on frequency range
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

\* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

### 8.5.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors

Correction Factor : Antenna factor + cable loss

For example:

The receiver reading is 32.7 dBμV. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dBμV/m. The 35.91dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm (35.91/20) = 62.44

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

For example: Distance limit ( $d_{\text{limit}}$ ) = 3, Distance measured ( $d_{\text{measured}}$ ) = 1  
Distance Extrapolation Factor (DEF) =  $20 * \log (d_{\text{limit}}/d_{\text{measured}}) = 20 * \log (3/1) = 9.5$

If the test distance is taken less than the recommended one, then the minimum distance of the receiving antenna should be calculated according to the  $2D^2/\lambda$ , where D is the antenna length.

At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

For example: Distance limit ( $d_{\text{limit}}$ ) = 300, Distance measured ( $d_{\text{measured}}$ ) = 10  
Distance Extrapolation Factor (DEF) =  $40 * \log (d_{\text{limit}}/d_{\text{measured}}) = 40 * \log (300/10) = 59.1$

### 8.5.5 Result

Field strength of fundamental (Section 15.249)									
AndonWireless 2B 921MHz									
921 MHz Channel 0 (Tested with external AC power supply)									
Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
920.990000	---	<b>89.58</b>	94.00	<b>4.42</b>	26.0	120.000	100.0	V	247.0
920.990000	<b>90.00</b>	---	94.00	<b>4.00</b>	26.0	120.000	100.0	V	247.0
922 MHz Channel 5 (Tested with external AC power supply)									
Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
921.980000	---	<b>87.50</b>	94.00	<b>6.50</b>	26.0	120.000	100.0	V	71.0
921.980000	<b>88.54</b>	---	94.00	<b>5.46</b>	26.0	120.000	100.0	V	71.0
921 MHz Channel 0 (Battery tested)									
Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
921.010000	---	<b>81.53</b>	94.00	<b>12.47</b>	26.0	120.000	100.0	V	50.0
921.010000	<b>82.18</b>	---	94.00	<b>11.82</b>	26.0	120.000	100.0	V	50.0
922 MHz Channel 5 (Battery tested)									
Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
921.980000	---	<b>87.50</b>	94.00	<b>6.50</b>	26.0	120.000	100.0	V	71.0
921.980000	<b>88.54</b>	---	94.00	<b>5.46</b>	26.0	120.000	100.0	V	71.0

Measurement uncertainty: 4 dB

Bandwidth = the measuring receiver bandwidth

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Field strength of fundamental (Section 15.249)**

**AndonWireless 5B 921MHz**

**921 MHz Channel 0 (Tested with external AC power supply)**

Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
920.990000	---	<b>91.88</b>	94.00	<b>2.12</b>	26.0	120.000	100.0	V	313.0
920.990000	<b>92.48</b>	---	94.00	<b>1.52</b>	26.0	120.000	100.0	V	313.0

**922 MHz Channel 5 (Tested with external AC power supply)**

Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
922.020000	---	<b>91.92</b>	94.00	<b>2.08</b>	26.0	120.000	100.0	V	313.0
922.020000	<b>92.40</b>	---	94.00	<b>1.60</b>	26.0	120.000	100.0	V	313.0

**921 MHz Channel 0 (Battery tested)**

Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
920.990000	---	<b>91.45</b>	94.00	<b>2.55</b>	26.0	120.000	100.0	V	291.0
920.990000	<b>92.06</b>	---	94.00	<b>1.94</b>	26.0	120.000	100.0	V	291.0

**922 MHz Channel 5 (Battery tested)**

Frequency (MHz)	QuasiPeak (dBµV/m)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
922.020000	---	<b>91.50</b>	94.00	<b>2.50</b>	26.0	120.000	100.0	V	291.0
922.020000	<b>92.47</b>	---	94.00	<b>1.53</b>	26.0	120.000	100.0	V	291.0

Measurement uncertainty: 4 dB

Bandwidth = the measuring receiver bandwidth

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>N.t.</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Field strength of harmonics (Section 15.249)**

**AndonWireless 2B 921MHz**

**921 MHz Channel 0 (Tested with external AC power supply)**

Frequency (MHz)	Peak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1842.000000	<b>36.28</b>	54.00	<b>17.72</b>	29.1	1000.000	100.0	V	6.0
5526.000000	<b>43.73</b>	54.00	<b>10.27</b>	40.5	1000.000	100.0	H	306.0

**922 MHz Channel 5 (Tested with external AC power supply)**

Frequency (MHz)	Peak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1844.000000	<b>35.02</b>	54.00	<b>18.98</b>	29.0	1000.000	100.0	V	86.0
5532.000000	<b>43.85</b>	54.00	<b>10.15</b>	40.6	1000.000	100.0	H	303.0

**921 MHz Channel 0 (Battery tested)**

Frequency (MHz)	Peak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1842.000000	<b>35.09</b>	54.00	<b>18.91</b>	29.1	1000.000	100.0	V	9.0
5526.000000	<b>43.06</b>	54.00	<b>10.94</b>	40.5	1000.000	100.0	H	6.0

**922 MHz Channel 5 (Battery tested)**

Frequency (MHz)	Peak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1844.000000	<b>33.98</b>	54.00	<b>20.02</b>	29.0	1000.000	161.0	V	38.0
5532.000000	<b>42.49</b>	54.00	<b>11.51</b>	40.6	1000.000	100.0	H	9.0

Measurement uncertainty: 4 dB

Bandwidth = the measuring receiver bandwidth

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>N.t.</del>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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**Field strength of harmonics (Section 15.249)**

**AndonWireless 5B 921MHz**

**921 MHz Channel 0 (Tested with external AC power supply)**

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1842.000000	<b>48.67</b>	54.00	<b>5.33</b>	29.1	1000.000	100.0	V	42.0
5526.000000	<b>46.37</b>	54.00	<b>7.63</b>	40.5	1000.000	185.0	H	306.0

**922 MHz Channel 5 (Tested with external AC power supply)**

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1844.000000	<b>50.20</b>	54.00	<b>3.80</b>	29.0	1000.000	100.0	V	183.0
5532.000000	<b>46.02</b>	54.00	<b>7.98</b>	40.6	1000.000	172.0	H	306.0

**921 MHz Channel 0 (Battery tested)**

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1842.000000	<b>47.14</b>	54.00	<b>6.86</b>	29.1	1000.000	100.0	V	357.0
5526.000000	<b>45.95</b>	54.00	<b>8.05</b>	40.5	1000.000	194.0	H	304.0

**922 MHz Channel 5 (Battery tested)**

Frequency (MHz)	Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB/m)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1844.000000	<b>48.38</b>	54.00	<b>5.62</b>	29.0	1000.000	145.0	V	317.0
5532.000000	<b>43.99</b>	54.00	<b>10.01</b>	40.6	1000.000	115.0	H	299.0

Measurement uncertainty: 4 dB

Bandwidth = the measuring receiver bandwidth

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>N.t.</del> *
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.:6, 11
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## 8.6 Bandwidth (20 dB)

### 8.6.1 Regulation

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. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. 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.

### 8.6.2 Test procedure

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are -6 dB, -20 dB, and -26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this sub-clause, the ratio is designated by “-xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “-xx dB” bandwidth; other requirements might specify that the “-xx dB” bandwidth be entirely contained within the authorized or designated frequency band.

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than  $[10 \log (\text{OBW}/\text{RBW})]$  below the reference level. Specific guidance is given in 4.1.5.2.
- d) Steps a) through c) might require iteration to adjust within the specified tolerances.
- e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “-xx dB down” requirement; that is, if the requirement calls for measuring the -20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
- f) Set detection mode to peak and trace mode to max hold.
- g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

h) Determine the “-xx dB down amplitude” using [(reference value) – xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “- xx dB down amplitude” determined in step h). If a marker is below this “-xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

### 8.6.3 Result

Intentional radiator- Maximum Measured 20 dB Bandwidth		
AndonWireless 2B 921MHz		
Operating Frequency	Maximum Measured 20 dB Bandwidth	20 dB Bandwidth limit
MHz	kHz	kHz
921	115.8	Inside the band
922	114.3	Inside the band

Intentional radiator- Maximum Measured 20 dB Bandwidth		
AndonWireless 5B 921MHz		
Operating Frequency	Maximum Measured 20 dB Bandwidth	20 dB Bandwidth limit
MHz	kHz	kHz
921	114.3	Inside the band
922	114.3	Inside the band

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del> *
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.: 6, 3
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## 8.7 Band edge measurement

### 8.7.1 Regulation

In the emission mentioned in clause 8.2 and 8.4, the tighter limit applies at the band edges.

### 8.7.2 Test procedure

In making radiated band-edge measurements, there can be a problem obtaining meaningful data because a measurement instrument that is tuned to a band-edge frequency might also capture some in-band signals when using the specified RBW. In an effort to compensate for this problem, the following technique (marker-delta method) has been developed for determining band-edge compliance.

a) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured. For example, for a device operating in the 902 MHz to 928 MHz band, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW alternatively may be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 3 MHz VBW, and a peak detector, as required. Repeat the measurement with an average detector (or alternatively, a peak detector and reduced VBW).

b) Choose an EMI receiver or spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the instrument RBW to 1% of the total span (but never less than 30 kHz), with a VBW equal to or greater than three times the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not an absolute field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.

c) Subtract the delta measured in step b) from the field strengths measured in step a). The resulting field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge emissions compliance, where required.

d) This method may be used only when the edge of the occupied bandwidth of the emission falls within two “standard bandwidths” of the restricted-band band-edge frequency, where “standard bandwidth” is the RBW required by the measurement procedure (generally, the “standard bandwidth,” i.e., reference bandwidth, is 10 kHz for measurements below 30 MHz, 100 kHz for measurements between 30 MHz and 1000 MHz, and 1 MHz for measurements above 1 GHz). For this purpose, the occupied bandwidth is based on the 99% power bandwidth. Therefore, you may use the delta technique for measuring emissions up to 2 MHz removed from the band edge. Radiated emissions that are removed by more than two standard bandwidths must be measured in the conventional manner.

### 8.7.3 Result

On each operating frequency measured, band-edge emissions are reported by plots of the measuring instrument display as shown in the following annex.

Test Cables used	K60, K101, K119
Test equipment used	406, 445a, 665, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	<del>No</del>	<del>Not</del> <sup>*</sup>
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Test setup photos / test results are attached	Yes	<del>No</del>	Annex no.: 6, 11
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## 9. Additional information to the test report

Remarks	Description
N.t. <sup>1</sup>	Not tested, because the antenna is part of the PCB
N.t. <sup>2</sup>	Not tested, because the EUT is directly battery powered
N.t. <sup>3</sup>	Not tested, because not applicable to the EUT
N.t. <sup>4</sup>	Not tested, because not ordered



## 10. List of test equipment

State Feb. 17, 2021					
Marking	Manufacturer	SW/Type/Serial-No.	Last Cal./Val.	Next Cal./Val.	No.
<i>I Measuring Instruments</i>					
Attenuator	Radiall	---	Nov 19	Nov 22	62
Attenuator 3dB	Suhner	6803/17	Nov 19	Nov 22	137
Attenuator 3dB / 18 GHz	Suhner	3dB/18GHz	Nov 19	Nov 22	299
Terminator	Texcan	---	Nov 19	Nov 22	304
Attenuator 6dB / 18 GHz	Suhner	6dB/18GHz	Nov 19	Nov 22	344
Attenuator 20dB / 20GHz	Parzich	40AH-20	Nov 19	Nov 22	354
Terminator	KDI	T173CS	Nov 19	Nov 22	490
Variable transformer	RFT	LS 002	---	---	154a
Variable transformer	Schunt+Ben	---	---	---	155
Power sensor	Marconi	6914	Sep 20	Sep 22	258
Power sensor	Marconi	6913	Aug 19	Aug 21	286
Power sensor	Rohde & Schwarz	NRP18SN	Nov 19	Nov 21	651
3-Path Diode Power Sensor 10 MHz to 8 GHz	Rohde & Schwarz	NRP8S	Oct 20	Oct 22	663
3-Path Diode Power Sensor 10 MHz to 18 GHz	Rohde & Schwarz	NRP18S-20	Oct 20	Oct 22	664
Coaxial Directional Coupler	Narda	3003-20	Jan 21	Jan 24	370/342
Coaxial directional coupler	Mini Circuits	ZFDC-20-5	Mar 20	Mar 22	434
Coaxial directional coupler	Narda+Suhner	---	Mar 20	Mar 23	472/492
Coaxial High Pass Filter	Mini circuits	NHP-700	Mai 18	Mai 21	435
Coaxial High Pass Filter	Mini circuits	NHP-200	Mai 18	Mai 21	405
Coaxial High Pass Filter	Mini circuits	NHP-25+	Mai 18	Mai 21	455
High Pass Filter	Mini circuits	VHF-3500+	Mai 18	Mai 21	451
High Pass Filter	Mini circuits	VHF-1200+	Mai 18	Mai 21	452
Bandpass Filter	Schomandl	BN86871	Nov 18	Nov 21	66
Bandpass Filter	Schomandl	BN68673	Nov 18	Nov 21	67
Low Pass Filter	Mini circuits	SLP550	Mai 18	Mai 21	273
Low Pass Filter	Mini circuits	SLP550	Mai 18	Mai 21	274
RF Current Probe 9 kHz – 30 MHz	Rohde & Schwarz	ESH2-Z1	Jun 18	Jun 21	42
VHF- Current Probe 9 kHz – 600 MHz	Rohde & Schwarz	ESV-Z1	Jun 18	Jun 21	43
Passive Test Probe – 9 kHz – 30 MHz	TÜV NORD	VDE 0876	Mai 18	Mai 21	45
Coaxial Fixed Attenuator DC – 1 GHz	Texscan	HFP50/10	Jul 20	Jul 23	60
8 Wire Impedance Stabilisation Network	Schwarzbeck	CAT5 8158	Nov 19	Nov 21	71a
T-Section - 50 W	Rohde & Schwarz	BN 42441/50	Aug 18	Aug 21	93
RF Current Injection Clamp 0.15 – 1GHz	Lüthi GmbH	EM 101	Nov 19	Nov 22	156
Absorbing Clamp MDS 30MHz – 1GHz	Lüthi GmbH	MDS-21	Nov 19	Nov 22	160
Insertion Unit	Rohde & Schwarz	URV5-Z4	Mai 19	Mai 22	162
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 35	Nov 18	Nov 21	164
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 60	Nov 18	Nov 21	165
Fixed Attenuator - DC – 1.5GHz	Bird	Mod/ 8343-060	Apr. 20	Apr. 23	177
Rotary Step Attenuator DC – 2 GHz	Texscan	TA – 50	Mar20	Mar 22	184
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	Nov 19	Nov 21	264
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	Mai 19	Mai 22	272
Fixed Attenuator - DC – 18 GHz   30 dB	MTS	---	Nov 20	Nov 23	275
Fixed Attenuator - DC – 18 GHz   30 dB	MTS	---	Mar 20	Mar 22	276
Passive Probe - 9 kHz – 30 MHz   2.5 kΩ	RFT	TK 121	Jun 20	Jun 23	302
Passive probe 1.5kΩ	Schwarzbeck	TK 9416	Oct 20	Oct 23	621
Termination Resistor 50 W	Radiall	404011	Nov 18	Nov 21	309
Branching device (4x) 50W	Rohde & Schwarz	892228/20	Sep 19	Sep 22	320

Dummy-Load - 2 – 18 GHz	Narda	MODEL 367NF	Nov 19	Nov 22	343
DC Block Adapter - 0.045 – 26.5 GHz	Hewlett-Packard	11742A	Apr 18	Apr 21	356
Insertion Unit 10V   9 kHz 1000 MHz	Rohde & Schwarz	URV 5-Z2	Mai 19	Mai 22	367
RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	395.2680.02	Mai 19	Mai 22	368
150W attenuator	Weinschel	49-20-33	Oct 19	Oct 22	374
Fixed Coaxial Attenuator - DC – 18 GHz	Weinschel	23-6-34	Feb 20	Feb 23	375
Insertion Unit 9 kHz – 2000 MHz	Rohde & Schwarz	URY-Z2	Oct 19	Oct 22	416
Panoramic Adapter (Monitoring)	Schwarzbeck	PAN1550	---	---	429
DC-BLOCK - DC – 6.0 GHz   50 W	Mini Circuits	BLK-6-N+	Aug 18	Aug 21	462
Terminating resistor 50Ω SMA	---	---	Nov 19	Nov 22	493
Terminating resistor 50Ω SMA	---	SC 60-601-0000-31	Nov 19	Nov 22	497
Fixed Attenuator –0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	504
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	505
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-6	Nov 19	Nov 22	506
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-3	Nov 19	Nov 22	507
Electric Dummy Load	RA-NAV Lab.	DA-75U	---	---	526
Power Splitter / Combiner	Mini Circuits	ZESC-2-11	Nov 19	Nov 22	527
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	529
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	530
RF-Attenuator - 6 dB	Haefely	---	Mar 20	Mar 23	540
RF-Attenuator - 1– 120 MHz   12 dB	Haefely	---	Mar 20	Mar 23	541
RF-Attenuator - 1– 120 MHz   39 dB	Haefely	---	Mar 20	Mar 23	542
LISN 9kHz – 30 MHz	Schwarzbeck	NNLA 8120	Aug 20	Aug 22	551
HV Probe P6013A	Tektronix	P6013A	Mai 19	Mai 22	559
VLISN 5μH	Schwarzbeck	8125-1944	Nov 19	Nov 21	585
VLISN 5μH	Schwarzbeck	8125-1945	Nov 19	Nov 21	586
20dB Attenuator, up to 18 GHz	Mini Circuit	BW-N20W5+	Nov 19	Nov 22	594
Step Attenuator - DC-18 GHz   0 to 11 dB	Hewlett-Packard	8494B	Nov 19	Nov 22	604
Analyser Reference System	Spitzenberger & Spies	ARS 16/1	Jan 20	Jan 22	606a/b/c
Capacitive Coupling Clamp 5 kV	Schlöder	SFT 415	Mai 20	Mai 23	608
RF Probes for 50 Ω Receivers	Schwarzbeck	TK 9416	---	---	612
Current probe TRMS	BEHA APROB	CHB35	Oct 19	Oct 22	652
Semi Anechoic Chamber	COMTEST	SAC-3m	Apr 19	Apr 21	660
Maturo Turntable	Maturo	TT2.0SI (SN: TT2.05SI/817 SW: 1.0.0.4473)	---	---	667
Maturo Antenna Mast	Maturo	TAM4.5-E-10kg (SN: 10011/216/2588.01)	---	---	668
Maturo Controller	Maturo	FCU3.0/009/2588.01 (SN: 10014/2019)	---	---	669
Current probe 20 Hz – 100 MHz	Rohde & Schwarz	EZ-17 (0816.2063.03)	Mar 20	Mar 23	670
Coupling Decoupling Network	AMETEK	CDN ST08A	Aug 20	Aug 23	762
BONN HF Switch Matrix DC – 8 GHz	BONN Elektronik	BAS 0080-3	---	---	682
External Directional Coupler	BONN Elektronik	BDC 1060-40/500	Dec 20	Dec 22	683
BI-Directional Coax. Coup. 50-1000 MHz	Narda	3020A	Jan 18	Jan 22	141
<b>2 Generators</b>					
EFT/Burst Generator	Schlöder	SFT 1400	Mai 20	Mai 23	46a
Hybrid Generator	Schlöder	CWG1500	Nov 19	Nov 21	522
ESD Generator	Schlöder	SESD 216	Oct 19	Oct 21	653
Signal Generator	Rohde & Schwarz	SMB100A	Jul 20	Jul 22	571
RF Generator	Rohde & Schwarz	SGT100A	Apr 20	Apr 22	636
Signal Generator	Rohde & Schwarz	SMG	Mai 19	Mai 21	136
Signal Generator	Marconi	2042	Mai 20	Mai 22	6

Signal Generator	Marconi	2024	Mai 20	Mai 22	213
Puls Generator	EM Test	MPG 200	Cal. before use	Cal. before use	181
Surge Generator	H+H	MIG063 IN S-T	Mar. 18	Mar. 21	561
<b>3. Antennas</b>					
Loop Ant. 9kHz-30MHz	Schwarzbeck	FMZB1516	Sep 19	Sep 21	23
Biconical Ant. 30-300 MHz	Schwarzbeck	VHA9103/BBA9106	Apr 20	Apr 22	80/616
Double Ridged Horn	Schwarzbeck	BBHA9120C	Oct 19	Oct 21	169
Double Ridged Horn	Schwarzbeck	BBHA 9120A	Apr 20	Apr 22	284
Tri-Log Broadband	Schwarzbeck	VULB9168	Mai 19	Mai 21	406
Broadband Horn 14-40 GHz	Schwarzbeck	BBHA9170	Nov 19	Nov 21	442
Log Per Antenna 0.7-20 GHz	Schwarzbeck	STLP9148	Mai 19	Mai 21	445a
Bilog Ant.	Schwarzbeck	CBL6111	Cal. before use	Cal. before use	167
Balun with biconical BBA9106 (TX)	Schwarzbeck [only for NSA]	VHBB9124	Nov 19	Nov 21	0796
Balun with biconical BBA9106 (RX)	Schwarzbeck [only for NSA]	VHBA9123	Nov 19	Nov 21	9758
Log periodic Ant (TX)	Schwarzbeck [only for NSA]	UHALP9108	Nov 19	Nov 21	9002
Log periodic Ant (RX)	Schwarzbeck [only for NSA]	UHALP9108	Nov 19	Nov 21	9003
Spectrum analyser Mixer 220 – 325 GHz	Radiometer Physics	SAM325	Aug 19	Aug 21	591
Dual Mode Potter Horn 220-325 GHz	Radiometer Physics	325-WR2	---	---	592
Dual Mode Potter Horn 75-110 GHz	Radiometer Physics	---	---	---	649
Gain Horn Antenna 50-75 GHz	Dorado	GH-15-20	---	---	511
Standard Gain Horn 1.7 – 2.6 GHz	Narda	645	---	---	514
W-band active Sextupler with input drive amplifier	Spacek Labs Inc.	AW-6XW-0	---	---	221a
60 to 65 GHz active frequency quadrupler	Spacek Labs Inc.	A625-4XW-0	---	---	222a
Harmonic Mixer 40-60 GHz	Rohde & Schwarz	FS-Z60	Jul 19	Jul 21	515
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20	---	---	518
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140	Aug 19	Aug 21	545
Dual Mode Potter Horn 90-140 GHz	Radiometer Physics	140-WR8	---	---	547
Spectrum analyser Mixer 140-220GHz	Radiometer Physics	SAM220	Aug 19	Aug 21	450
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	548
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90	Jul 19	Jul 21	501
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	549
Gain Horn 33-55 GHz	Dorado	---	---	---	383
Gain Horn 50-75 GHz	Dorado	---	---	---	384
Gain Horn 75-110 GHz	Dorado	---	---	---	385
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	532/628
Waveguide Harmonic Mixer 50 – 75 GHz	Keysight	M1971V	Oct 19	Oct 21	763
Waveguide Harmonic Mixer 75 – 110 GHz	Keysight	M1971W	Oct 19	Oct 21	764
Stacked Log.-Per. Antenna 70 MHz – 10 GHz	Schwarzbeck	STLP 9129	---	---	662
<b>4. Amplifier</b>					
RF-Power Amplifier 250 kHz – 150 MHz	ENI	3100LA	---	---	---
RF pre-amplifier 100kHz-1.3GHz	HP	8447E	Aug 20	Aug 22	166a
Mitteq amplifier 26.5-40 GHz	Mitteq	---	Mar 20	Mar 22	223a
RF pre-amplifier 1-18GHz	Narda	---	Mar 20	Mar 22	345
Mitteq Amplifier 18-26GHz	Mitteq	---	Apr 20	Apr 22	433
Microwave amplifier 12-18GHz	Schwarzbeck	BBV9719	Mar 20	Mar 22	443
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	Mar 19	Mar 21	444
RF-Power Amplifier 10kHz-1000 MHz	Poetschke	8100 (Band 1) BHED (Band 2) BHED (Band 3)	---	---	684

RF-Power Amplifier 800 MHz – 4,2 GHz	Amplifier Research	10S1G4	---	---	685
RF-Power Amplifier 4 GHz – 8 GHz	Amplifier Research	35S4G8A	---	---	686
<b>5. Power supplies</b>					
Programmable Power Supply	Fluke	PM 2813	---	---	28a
Power Supply	HP	---	---	---	125
Power Supply	Sorensen	LM 30-6	---	---	134a
Power Supply	HP	6034L	---	---	226
Regulated Power Supply	Farnell	AP60-50	---	---	408
Power Supply	EA	PSI 8080-40-DT	---	---	560
Power Supply	HP	6032A	---	---	644
<b>6. Meters</b>					
Microwave Frequency Counter	Hewlett-Packard	5351B	Nov 20	Nov 22	432
Temperature test cabinet	Heraeus Vötsch	VMT04/35	---	---	102a
Temperature test cabinet	Brabender	TTE 32/40 H	---	---	87
Digital-Hygro-Thermometer	Greisinger	GFTH95	Nov 19	Nov 21	57a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Mai 19	Mai 21	161
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	Jul 20	Jul 22	171a
Multimeter	Gossen Metrawatt	Metrahit pro	Nov 19	Nov 21	215a
Humidity/Temperature Measuring device	TESTO	Testo 625	Oct 19	Oct 21	259a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Nov 19	Nov 21	271
Multimeter	Gossen Metrawatt	Metrahit 26S	Sep 20	Sep 22	313
Level and Power Meter - 9 kHz – 3 GHz	Rohde & Schwarz	URY	Mar 20	Mar 22	307
Temperature test device	Ahlhorn	Almemo 2390-5 PT100	Mar 20	Mar 23	401/402
Signal & Spectrum Analyser 10 Hz-30 GHz	Rohde & Schwarz	FSV-30	Jul 19	Jul 21	502
Digital-Vacuum-/Barometer	Greisinger	GDH12AN	Oct 19	Oct 21	558
Temperature test cabinet	Weiß Umwelttechnik	WKL 34/40	Aug 18	Aug 21	562
Digital Storage Oscilloscope	Tektronix	TDS 2012C	Oct 19	Oct 21	568
Miniature Flat, Zero-Biased Schottky Detector -0.1– 18 GHz	Narda	4503A-03	Val. bevor use	Val. bevor use	613
Digital-Vacuum-/Barometer	Greisinger	GDH-200-14	Oct 19	Oct 21	632
EMI Test receiver ESW26	Rohde & Schwarz	R&S ESW26 (SN: 101383/26 SW: R&S ESW1.61))	Nov 19	Mai 21	665
Signal analyser Keysight 50GHz	Keysight	UXA N9040B (SN: MY57213006 SW: A.24.58/2019.0702)	Nov 19	Mai 21	666
<b>7. test/control software</b>					
EMC32	Rohde & Schwarz	V10.60.10 // V10.60.15	---	---	---
Maturo mcApp	Maturo	SW: V3.4.9.4537 (19.04.04)	---	---	---
SPS EMC	Spitzenberger & Spies	SW: V4.1.3	---	---	---
EMV-Soft	Schlöder GmbH	SW: V11.95	---	---	---
ISMISO	EM Test AG	SW:V3.63	---	---	---

## 11. List of test cables

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
3	N	0,5 - 8000	3	Cellflex
4	N	0,5 - 8000	3	Cellflex
4a	BNC	10 – 1500	0.50	Telemeter
14a	BNC	10 – 1000	1.00	Telemeter
17a	APC3.5	10 – 26500	2.13	Huber + Suhner
18a	APC3.5	10 – 26500	2.13	Huber + Suhner
22	BNC	10 – 1000	1.50	---
27	BNC	10 – 1000	1.00	Fabrica Milanese Cond.
40	BNC	---	0.50	Aircell
43	SMA	10 – 18000	0.50	Rosenberger
44	SMA	---	0.50	Huber + Suhner
45	SMA	10 – 18000	0.50	Huber + Suhner
48	SMA	---	0.50	Huber + Suhner
49	N	10 – 18000	1.00	Huber + Suhner
50	N	10 – 18000	1.00	Huber + Suhner
51	N	10 – 18000	1.00	Huber + Suhner
52	N	10 – 18000	1.00	Huber + Suhner
54	BNC	10 – 3500	1.00	Aircell
58	N	10 – 18000	2.00	Huber + Suhner
59	N	10 – 18000	1.00	Huber + Suhner
60	N	10 – 18000	2.00	Huber + Suhner
61	N	10 – 18000	1.00	Huber + Suhner
62	SMA	---	0.50	Huber + Suhner
63	SMA	10 – 18000	0.50	Huber + Suhner
64	SMA	10 – 18000	0.50	Huber + Suhner
65	APC3.5	10 – 26500	0.60	---
66	APC3.5	10 – 26500	0.60	---
67	APC3.5	10 – 26500	0.60	---
68	APC3.5	10 – 26500	0.60	---
72	BNC	---	0.40	---
73	BNC	---	0.40	---
76	SMA	10 – 30000	3.00	Gore
79	BNC/N	10 – 1000	5.00	---
80	SMA	---	0.25	Huber + Suhner
87	SMA	10 – 18000	0.15	Huber + Suhner
88	SMA	10 – 18000	0.15	Huber + Suhner
89	SMA	10 – 18000	0.15	Huber + Suhner
90	SMA	10 – 18000	0.15	Huber + Suhner
91	SMA	---	1.50	Huber + Suhner
94	BNC	---	1.10	---
95	BNC	---	0.80	---
96	BNC	---	0.80	---
100	N	10 – 26500	6.00	Rosenberg
101	N	10 – 18000	2.90	Huber + Suhner
102	SMA	10 – 18000	2.00	Huber + Suhner
111	BNC	10 – 1000	0.50	---
112	BNC	10 – 1000	0.50	---
114	SMA	10 – 18000	0.25	Huber + Suhner
116	SMA	10 – 18000	0.25	Huber + Suhner
119	N	10 – 20000	8.00	Jyebao
121	SMA	10 – 18000	1.50	Huber + Suhner
122	SMA	10 – 18000	2.00	Huber + Suhner
123	SMA	10 – 18000	2.00	Huber + Suhner

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
145	SMA	10 – 26500	8.00	Huber + Suhner
147	APC3.5	10 – 40000	1.50	Jyebao
148	APC3.5	10 – 40000	3.00	Jyebao
151	SMA	10 – 18000	0.50	Rosenberger
152	SMA	10 – 18000	0.50	Rosenberger
154	BNC	10 – 1000	1.00	---
155	N/BNC	---	0.85	---
157	BNC	---	0.50	---
158	SMA	10 – 26500	2.00	Huber + Suhner
160	SMA	10 – 18000	0.40	Nortel Networks
161	SMA	10 – 18000	1.00	Huber + Suhner
162	APC35	10 – 26500	2.00	Huber + Suhner
163	APC3.5	10 – 26500	2.00	Huber + Suhner
164	APC3.5	10 – 26500	2.00	Huber + Suhner
165	APC2.9	10 – 26500	2.00	Huber + Suhner
166	APC3.5	10 – 40000	---	---
167	APC3.5	10 – 40000	1.00	Jyebao
168	APC3.5	10 – 40000	1.00	Jyebao
169	APC3.5	10 – 40000	1.00	Jyebao
170	APC3.5	10 – 40000	1.00	Jyebao
171	APC3.5	10 – 40000	1.00	Jyebao
172	SAM	---	0.90	Huber + Suhner
173	APC	10 – 26500	2.00	Huber + Suhner
174	APC	10 – 26500	---	Huber + Suhner
175	SMA	10 – 18000	0.40	Huber + Suhner
176	N-SMA	10 – 18000	0.50	Huber + Suhner
188	N	10 – 18000	5.00	Huber + Suhner
EMV 1	BNC	---	2.00	Henn
EMV 2	BNC	10 – 1000	2.00	Henn
EMV 4	BNC	---	9.70	Henn
EMV 5	BNC	---	3.80	Henn
EMV 6	BNC/N	10 – 1000	5.00	Lüthi
EMV 7	BNC	10 – 1000	1.50	Henn
EMV 8	BNC	10 – 1500	1.70	Henn
EMV 9	BNC	10 – 1000	1.70	Henn
EMV 11	BNC	---	5.20	Hasselt
EMV 12	BNC	10 – 1000	2.40	Hasselt
EMV 13	BNC	10 – 1000	4.10	Hasselt
EMV 14	BNC	10 – 1000	2.50	Hasselt
EMV 15	BNC	---	0.90	Henn
EMV 16	Fischer	---	2.00	---
EMV 18a	Fischer	---	1.00	---
EMV 19a	Fischer	---	1.50	---
KISN2	BNC	10 – 2000	4.80	---

**End of test report**