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 Akkreditierungsnummer

STS 0024

Schweizerischer Prüfstellendienst
 Service suisse d'essai
 Swiss testing service



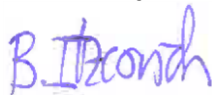
Report:	Electromagnetic compatibility and Radio spectrum Matters		Report no:	14-MO-0234.R16*
Product name:	Roger Multimedia Hub		Mandate no:	14-MO-0234
Serial no:	Proto 2 and 22 (PCB V 3.1)	Model number:	TX21	
Customer:	Phonak Communications AG Länggasse 17 3280 Murten Switzerland	Date of test:	May 27 – 29, 2015 June 10 – 16, 2015 December 4, 2015	

* Replaces report no 14-MO-0234.R06

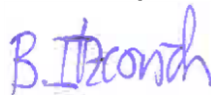
Standards		Result
47 CFR, Part 15	(Subpart C, Intentional radiators: §§ 15.207/209/247)	Pass
	(Subpart B, Class B digital devices: § 15.109)	Pass
Industry Canada	RSS-247, Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices	Pass
	RSS-Gen, General Requirements and Information for the Certification of Radio Apparatus	

These results were achieved with modifications of EUT documented § 7 of this report.

Test performed by
 Mr B. Itzcovich
 EMC Test Engineer



Report prepared by
 Mr B. Itzcovich
 EMC Test Engineer



Report controlled and approved by
 Mr Ch Perrenoud
 Director



Rossens, December 21, 2015

(Issue Date)

2015-04-10_Rev01

Main language : English

The present document results from tests on one specimen and does not prejudice to the conformity of all the manufactured products.

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1. Summary of test results

- ✓ Pass
- ✗ Fail
- Ø Not applicable to this product
- Not tested
- # No requirements / not required

§	Test Type	Result
6	Emission	CFR 47 Part 15 Industry Canada
6.1	Channel 20dB-bandwidth CFR 47 § 15.247 (a)(1) RSS-247 § 5.1 (1)	1.55 MHz
6.2	Carrier frequency separation CFR 47 § 15.247 (a)(1) RSS-247 § 5.1 (2)	✓
6.3	Number of hopping channels CFR 47 § 15.247 (a)(1)(iii) RSS-247 § 5.1 (4)	✓
6.4	Time of occupancy (dwell time) CFR 47 § 15.247 (a)(1)(iii) RSS-247 § 5.1 (4)	✓
6.5	Antenna gain & effective radiated power CFR 47 § 15.247 (b)(4) RSS-247 § 5.4 (2) and (6)	≤ 2.42 dBi
6.6	Maximum output power (conducted) CFR 47 § 15.247 (b)(1) RSS-247 § 5.4 (2)	✓
6.7	Band-edge emission (conducted) CFR 47 § 15.247 (d) RSS-247 § 5.5	✓
6.8	Band-edge emission (radiated) CFR 47 § 15.247 (d) CFR 47 § 15.205 RSS-247 § 5.5	✓
6.9	Spurious emissions – conducted (transmitter) CFR 47 § 15.247 (d) RSS-247 § 5.5	✓
6.10	Spurious emissions – radiated (transmitter) CFR 47 § 15.247 (d) CFR 47 § 15.209 (a) CFR 47 § 15.205 RSS-247 § 5.5 RSS-Gen Tables 4 and 5	✓
6.11	Radiated emission – receiver CFR 47 § 15.109 RSS-Gen Table 2	✓
6.12	Conducted emission CFR 47 § 15.207 RSS-Gen Table 3	✓
6	Emission	CFR 47 Part 2
6.13	Designation of emission FCC 47 §2.201 FCC 47 §2.202	1M73FXD

2. Applied standards

47 CFR Part 15 Subpart C	Code of Federal Regulations - Title 47 - Telecommunication, Part 15, Subpart C: "Intentional Radiators"
47 CFR Part 15 Subpart B	Code of Federal Regulations - Title 47 - Telecommunication, Part 15, Subpart B: "Unintentional Radiators"
RSS-Gen issue 4, November 2014	Spectrum Management and Telecommunications - Radio Standards Specification General Requirements and Information for the Certification of Radio Apparatus
RSS-247 issue 1, May 2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3. Client

Client name and address	Phonak Communications AG Länggasse 17 3280 Murten Switzerland
Contact Person	Mr Josuah Wicht
Telephone	+41 26 672 92 78
Fax	+41 26 672 93 80
E-mail	Josuah.Wicht@phonak.com
Mandate no	14-MO-0234

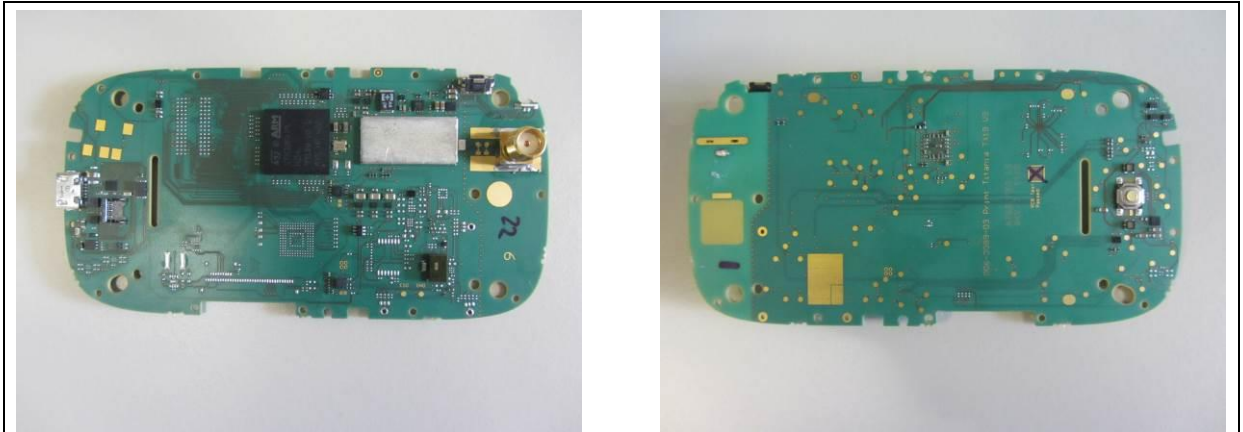
4. Equipment under test

4.1 Identification

Manufacturer name and address	Phonak Communications AG Länggasse 17 3280 Murten Switzerland
Production country	Vietnam
Brand name	Phonak
Product name	Roger Multimedia Hub
Product description	Audio signal transmitter
Model number	TX21
Serial no	Proto 2 and 22 (PCB V 3.1)
FCC ID IC ID	FCC: KWCTX21 IC: 2262A-TX21
Software version	SVN 6716
Lowest Frequency	20 kHz (charge pump for LED driver)
Highest frequency	16 MHz (uC Xtal) / 26 MHz (RF chip) / 2.48 GHz (RF Transmitter carrier)
Supply	$U = 3.7 V_{DC} / P_{max} = 0.5 W$ (Lithium Polymer Battery) or $U = 5 V_{DC} / P_{max} = 5 W$ (DC In USB) *
Dimension	~140 mm x ~55 mm x ~16 mm (l x w x h)
Technical	None. The equipment is completely identified by the above-mentioned information. Phonak Communications AG assures the traceability of the documentation and is responsible for the product identification.

* When the external 5 V_{DC} supply is connected to the EUT, the battery is disconnected from the RF module.

4.2 Pictures of the EUT



Electronic board with temporary antenna connector



EUT (global view)

4.3 Classification

CFR 47 Part 15	☒ Unintentional radiator (Subpart B), Receive and Standby mode ☐ Class A digital device ☒ Class B digital device ☒ The highest frequency of the internal sources of the EUT is less than 108 MHz (measurement shall be made up to 1 GHz). ☐ The highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz (measurement shall be made up to 2 GHz). ☐ The highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz (measurement shall be made up to 5 GHz). ☐ The highest frequency of the internal sources of the EUT is above 1 GHz (measurement shall be made up to 5 times the highest frequency or 40 GHz, whichever is lower). ☒ Intentional radiator (Subpart C), Transmit mode ☒ The highest fundamental frequency of the EUT is less than 10 GHz (measurement shall be made up to the tenth harmonic or 40 GHz, whichever is lower). ☐ The highest fundamental frequency of the EUT is between 10 GHz and 30 GHz (measurement shall be made up to the fifth harmonic or 100 GHz, whichever is lower). ☐ The highest fundamental frequency of the EUT is above 30 GHz (measurement shall be made up to the fifth harmonic or 200 GHz, whichever is lower).
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4.4 Transmitter characteristics (according to Phonak Communications AG)

Method of frequency generation	☒ Crystal ☐ Synthesizer ☐
Transmitter operating frequency range (OFR) The OFR is the total range of frequencies covered by one type, or by a family of equipment. It is noted that a family of equipment may be capable of covering a wider frequency range than the alignment frequency range of one type of equipment.	2.402 GHz to 2.480 GHz.
Channel separation (if applicable)	2 MHz
Number of channels	40
Maximum rated output power	18 dBm (at transmitter RF output connector)
Variable carrier output	☐ Transmitter carrier output is not variable. RF output: $P_{OUT} = \dots mW$ ☒ Transmitter carrier output is variable. Max. RF output: $P_{OUT\ MAX} = 65 mW$ Min. RF output: $P_{OUT\ MIN} = 3.5 mW$ ☐ RF output continuously variable ☒ RF output stepped: 12.5 dB per step
Modulation	☐ Amplitude ☐ Frequency: Deviation kHz ☐ Phase ☐ Pulse Pulse repetition frequency Duty cycle ☒ Other FHSS, GFSK
	☐ Transmitter can be operated without modulation ☒ Transmitter can only be operated with modulation

4.5 Receiver characteristics (according to Phonak Communications AG)

Receiver operating frequency range	2.402 GHz to 2.480 GHz
Channel separation (if applicable)	2 MHz
Number of channels	40

4.6 Ports

Port	Cable			Remark
	Max. length	Type	Screen	
DC 5V in (USB charger)	≤ 3 m	Micro USB	Yes	Connected to Charger
Audio jack	≤ 3 m	Jack 3.5mm 3P	Yes	Analog audio in and out

5. Test conditions

5.1 Climatic conditions, location and date

Location	Date	Temp.	Pressure	Rel. humidity
<i>Electrosuisse Montena EMC 1728 Rossens Switzerland</i>	<i>May 27 – 29, 2015</i>	<i>23 – 26 °C</i>	<i>1015 – 1030 hPa</i>	<i>30 – 55 %</i>
	<i>June 10 – 16, 2015</i>	<i>23 – 26 °C</i>	<i>1015 – 1030 hPa</i>	<i>40 – 50 %</i>
	<i>December 4, 2015</i>	<i>23 – 25 °C</i>	<i>1015 – 1025 hPa</i>	<i>30 – 40 %</i>

5.2 Test facility and methodology

*The alternate test site (ferrite chamber) is accepted by FCC (Reg. No. 90808) and by Industry Canada (Site number 3625A-2).
Conducted and radiated measurements are performed according to the ANSI C63.4-2014 and C63.10-2013 procedures.*

5.3 Attendant persons

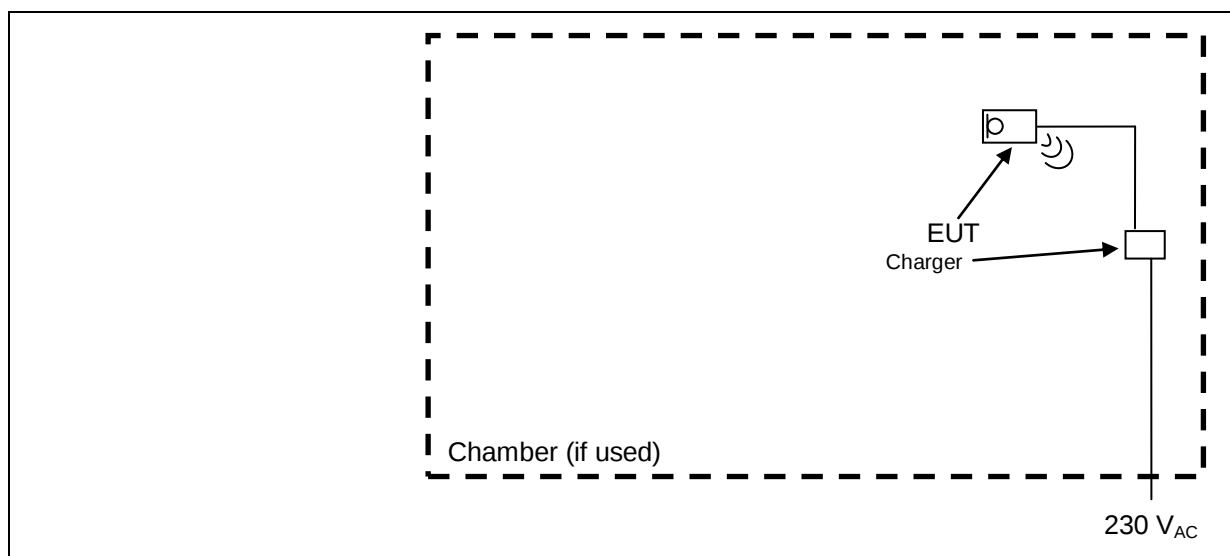
Test Engineer(s):

*Mr B. Itzcovich
EMC Test Engineer*

Other(s):

Name	Company
<i>Mr Olivier Hautier (partially)</i>	<i>Phonak Communications AG</i>
<i>Mr Josuah Wicht (partially)</i>	<i>Phonak Communications AG</i>

5.4 Test configuration



5.5 Operating conditions

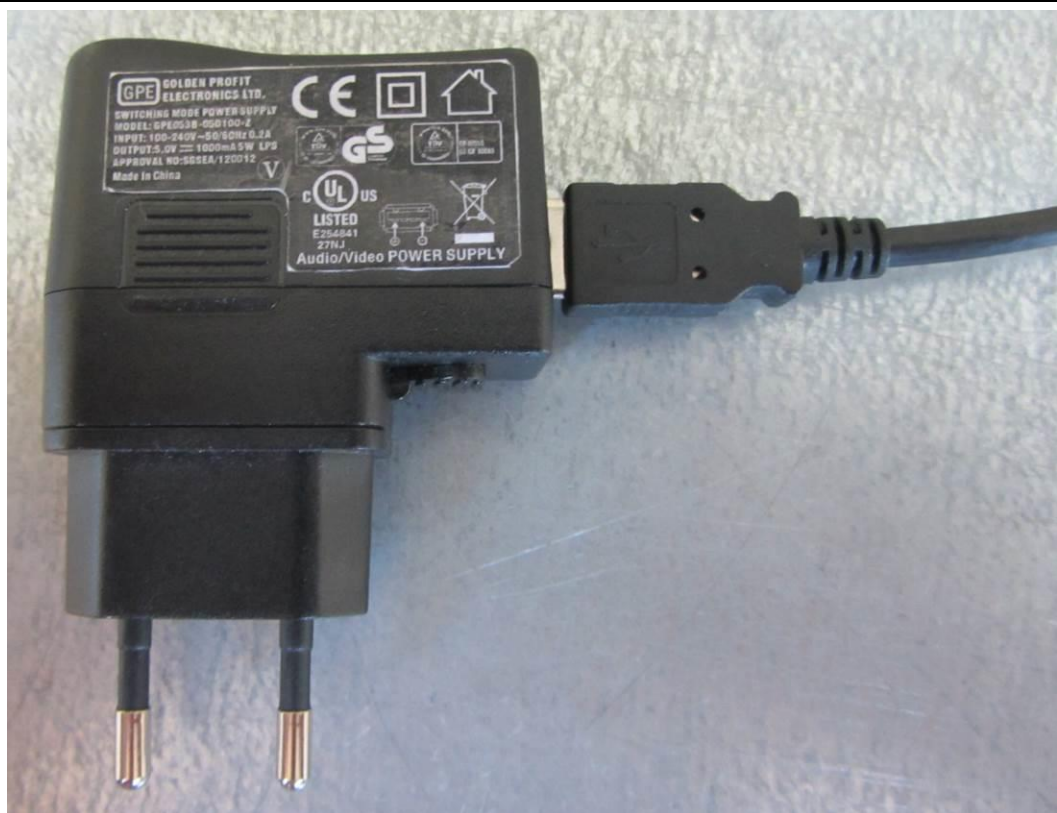
Power supply during tests if not stated otherwise in §6 : 5 V_{DC} (USB)

- Continuous transmission of random data with single frequencies (2.402, 2.440 and GHz and 2.480 GHz)
- Normal operation: transmission of random data with hopping sequence
- Standby: DSP off, controller running, RF module disabled, charging battery

5.6 Auxiliary equipment

The following pieces of equipment are used for the monitoring of the EUT or are necessary for the EUT but they are not part of the EUT

Product	Brand	Model No.	ID	Remark
Charger	Phonak	GPE053B-050100-Z	- - -	100 – 240V _{AC} in / 5 V _{DC} out



Charger

6. Test results

6.1 Channel 20dB-bandwidth

Introduction: Channel-bandwidth measured at -20 dBc.

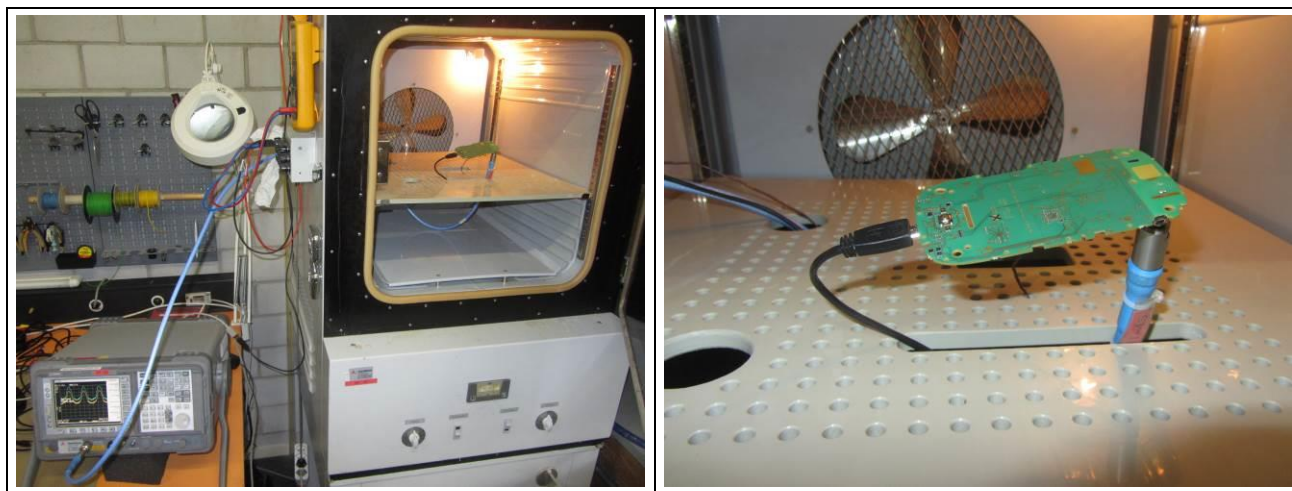
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: 9kHz – 3GHz: ± 1 dB
 3GHz – 6.7GHz: ± 2.1 dB
 6.7GHz – 13.2GHz: ± 2.6 dB
 13.2GHz – 19GHz: ± 2.8 dB
 19GHz – 26.5GHz: ± 3 dB

Method: Measurement of the conducted power on the antenna connector or a test fixture.

Limit: - - -

Test set-up:



Remarks: - - -

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-45					

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Multimedia Hub, proto #22*

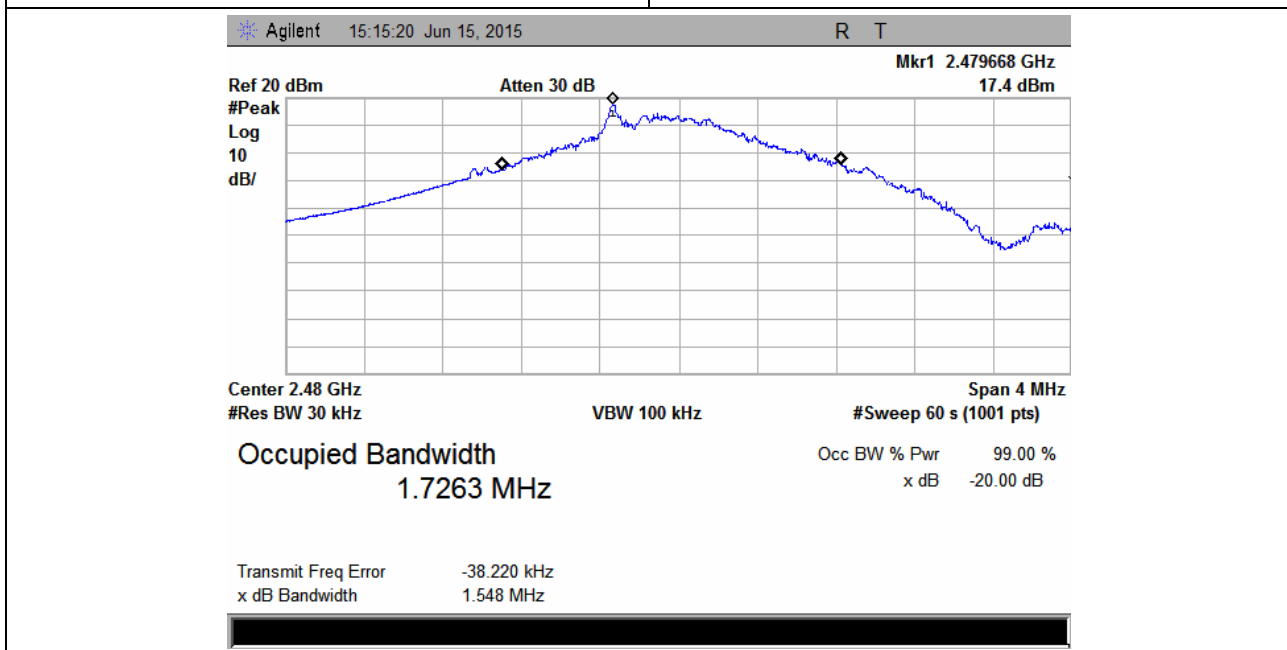
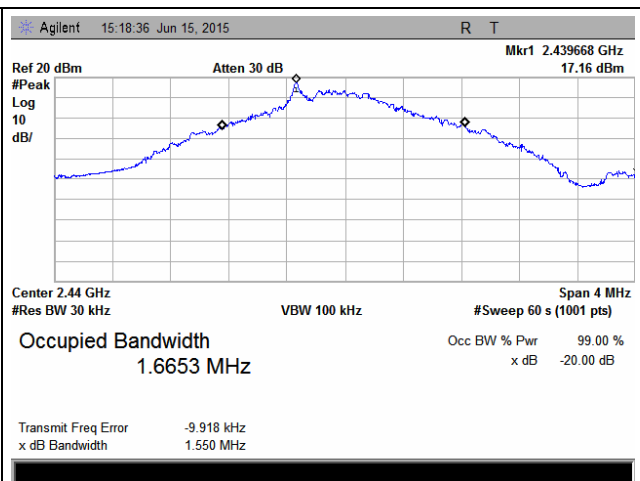
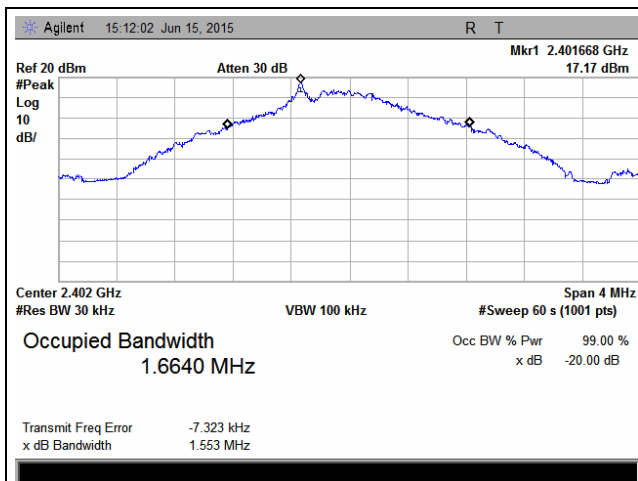
Operating mode: *Single frequencies (2.402, 2.440 and 2.480 GHz), modulated, Pmax (15 dBm)*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

frequency [GHz]	20 dB bandwidth [MHz]	Remarks
2.402	1.553	- - -
2.440	1.550	- - -
2.480	1.548	- - -



Place and date of test:
Operator:

*Rossens, June 15, 2015
B. Itzcovich*

6.2 Carrier frequency separation

Introduction: Determination of the frequency separation of two adjacent channels.

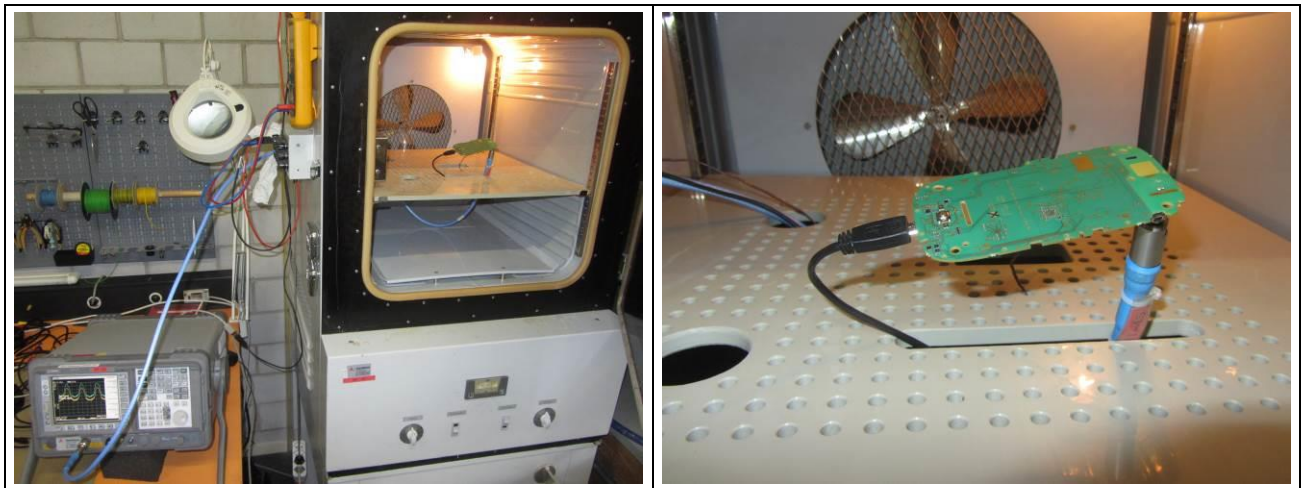
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: $\pm 2.6 \mu\text{Hz/Hz}$

Method: Measurement of the frequency separation on the antenna connector or a test fixture.

Limit: Minimum 25 kHz two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test set-up:



Remarks: ---

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result:	☒ pass	☐ fail	☐ not applicable	☐ not tested
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Results of the test

Client: *Phonak Communications AG*

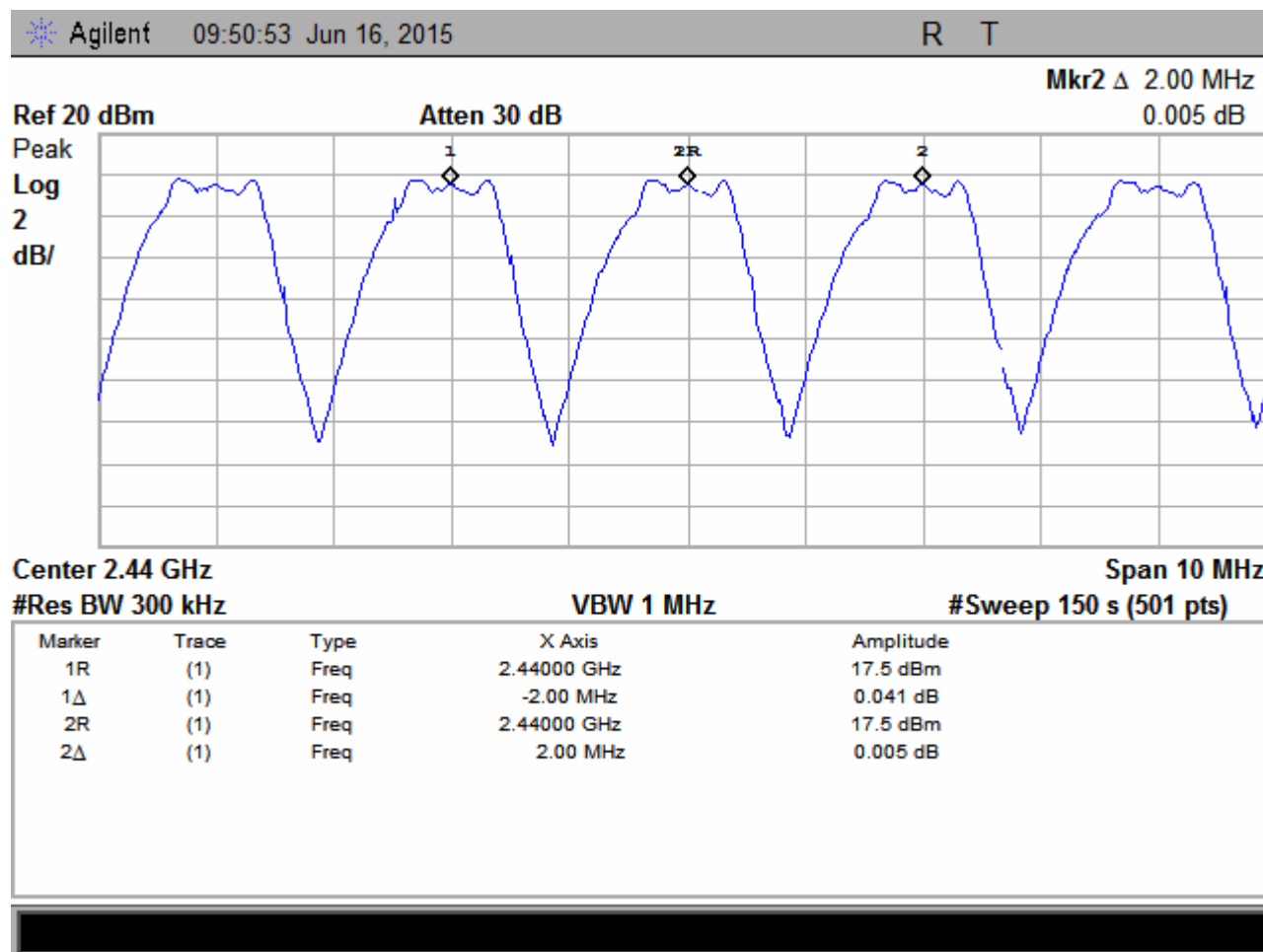
Apparatus: *Roger Multimedia Hub, proto #22*

Operating mode: *Continuously hopping*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5



Carrier frequency separation = 2.00 MHz > (2/3) x 1.55 MHz (see § 6.1)

Place and date of test:
Operator:

Rossens, June 16, 2015
B. Itzcovich

6.3 Number of hopping channels

Introduction: Number of hopping channels used in the frequency hopping system.

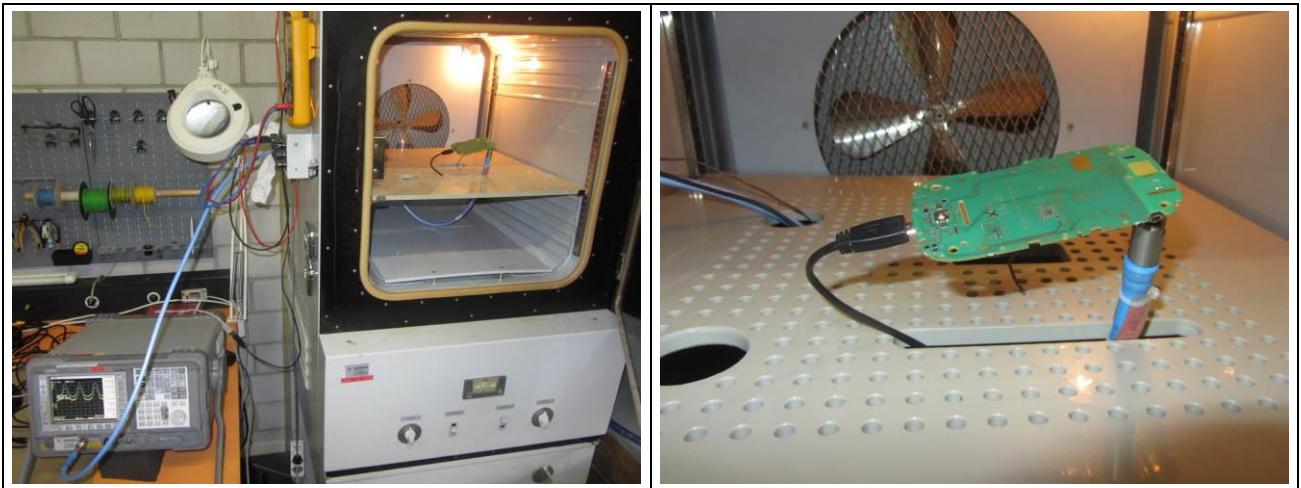
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: $\pm 2.6 \mu\text{Hz/Hz}$

Method: Measurement of the frequency separation on the antenna connector or a test fixture.

Limit: At least 15 channels

Test set-up:



Remarks: ---

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Results of the test

Client: *Phonak Communications AG*

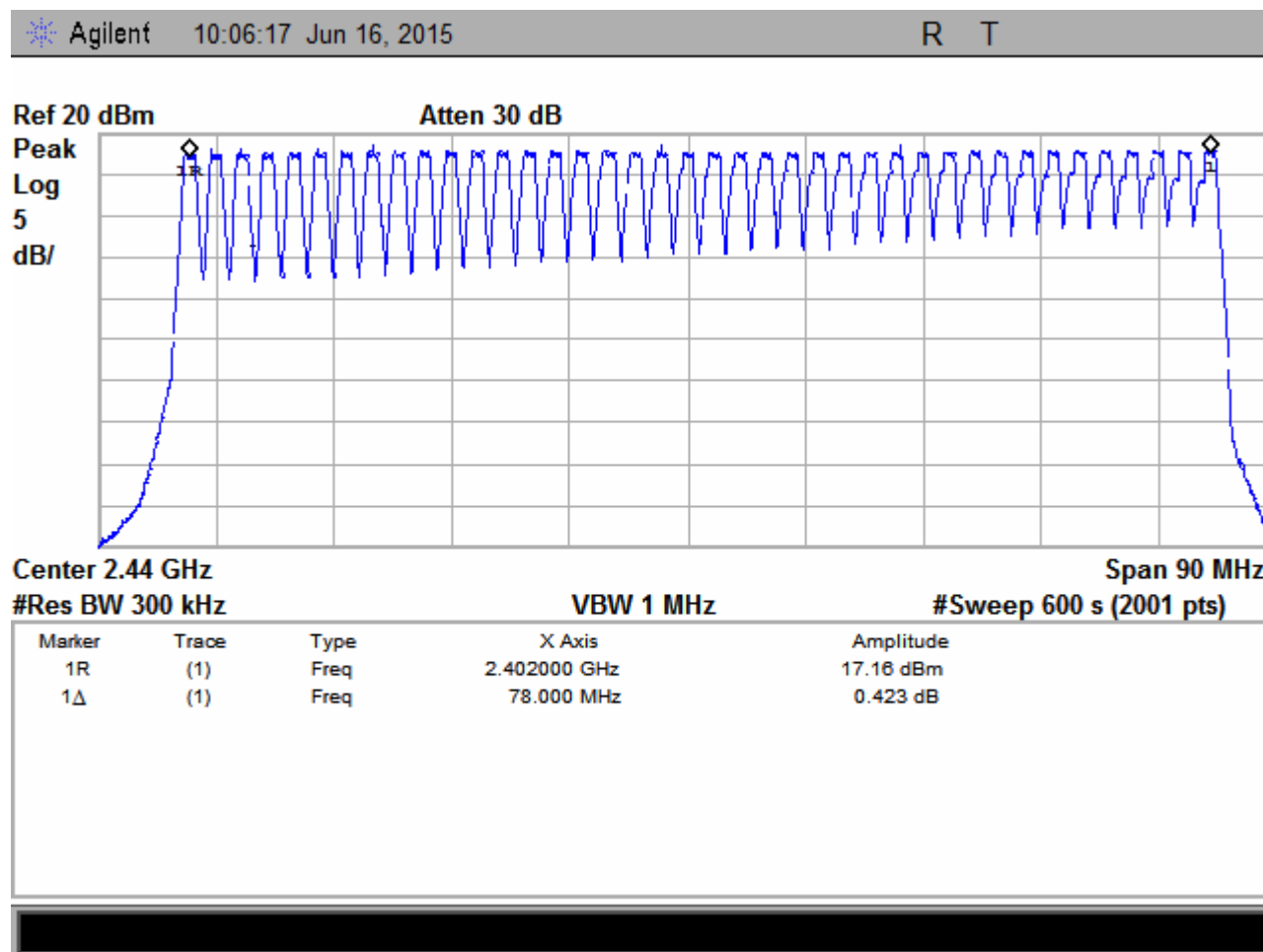
Apparatus: *Roger Multimedia Hub, proto #22*

Operating mode: *Continuously hopping*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5



Number of hopping channels = 40

Place and date of test: *Rossens, June 16, 2015*
 Operator: *B. Itzcovich*

6.4 Time of occupancy (dwell time)

Introduction: Average duration during which the system stays on one channel.

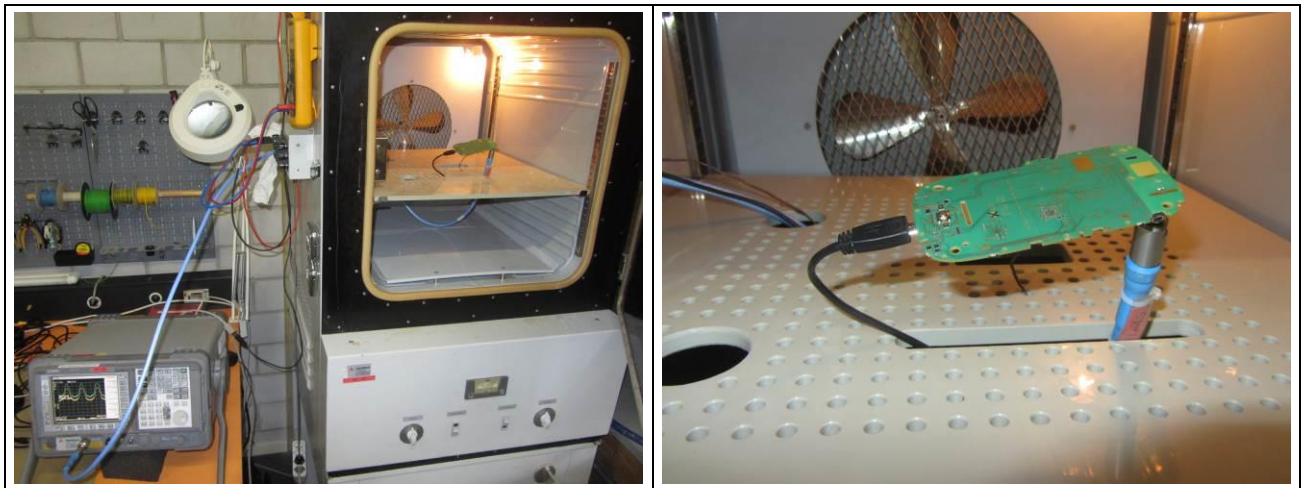
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: $\pm 2.6 \mu\text{s/s}$

Method: Measurement on the antenna connector or a test fixture.

Limit: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test set-up:



Remarks: ---

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☒ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Multimedia Hub, proto #22*

Operating mode: *Continuously hopping*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Calculation based on information from Phonak Communications AG and measurement of the pulse duration

Number of channels: 40

Period of observation: $\text{Number of channels} \times 0.4 \text{ s} = 40 \times 0.4 \text{ s} = 16 \text{ s}$

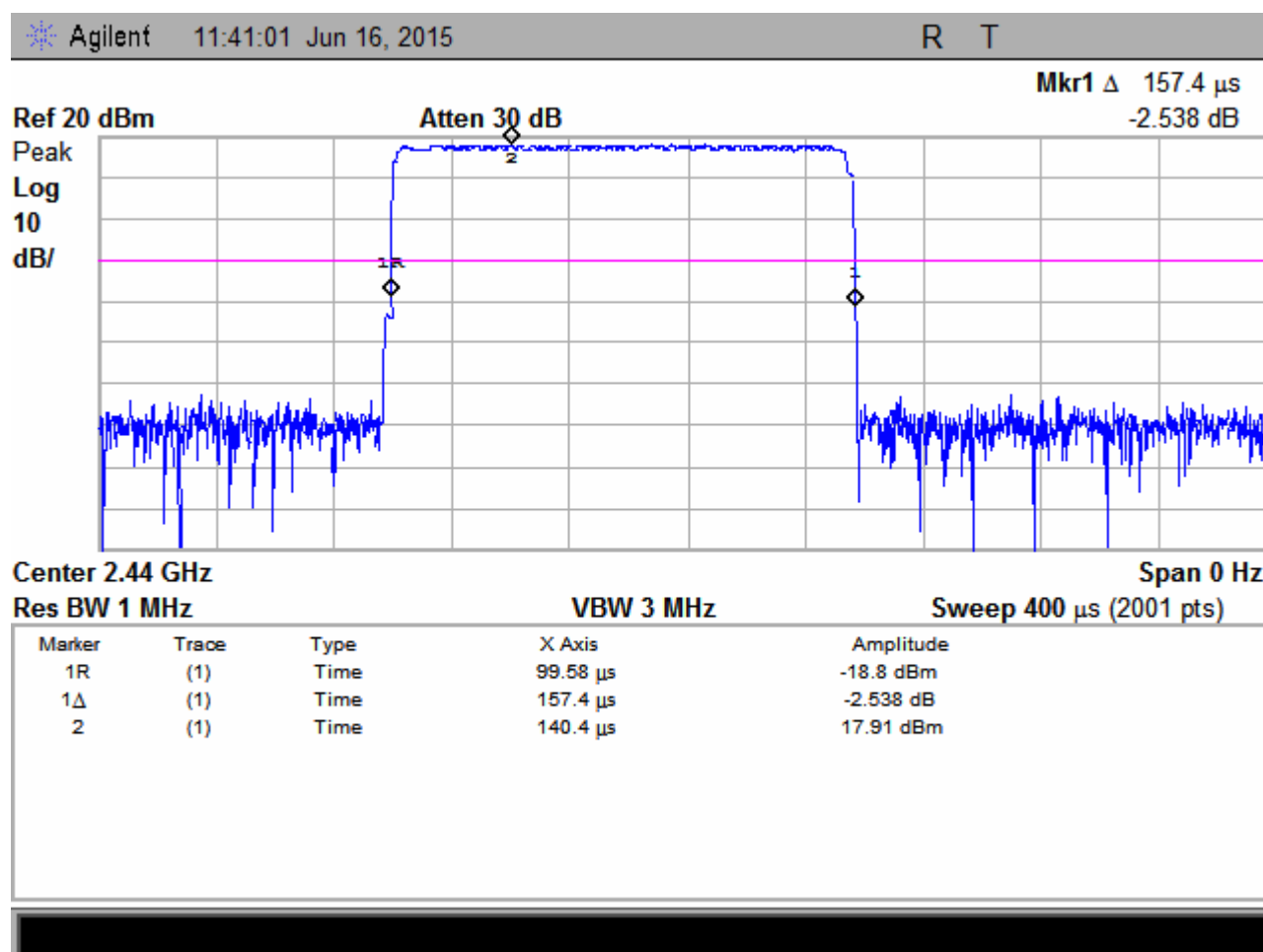
Single occupancy time during one hop (measured): 157 μs

Pulses in 2.9h: $2^6 \times 40 \times 10 = 26'214'400$

Pulses in 16 s: $(\text{Pulses in 2.9h} / 2.9) / 3'600 \times 16 \text{ s} = 40'175.3$

Pulses in 16 s of one channel: $\text{Pulses in 16 s} / \text{Number of channels} = 1004.4$

Time of occupancy: $\text{Pulse in 16 s of one channel} \times \text{occupancy time} = 1004.4 \times 157 \mu\text{s} = 0.158 \text{ s}$

RESULT**0.158 s < 0.4 s => Pass****Example of pulse duration at frequency 2.44 GHz**

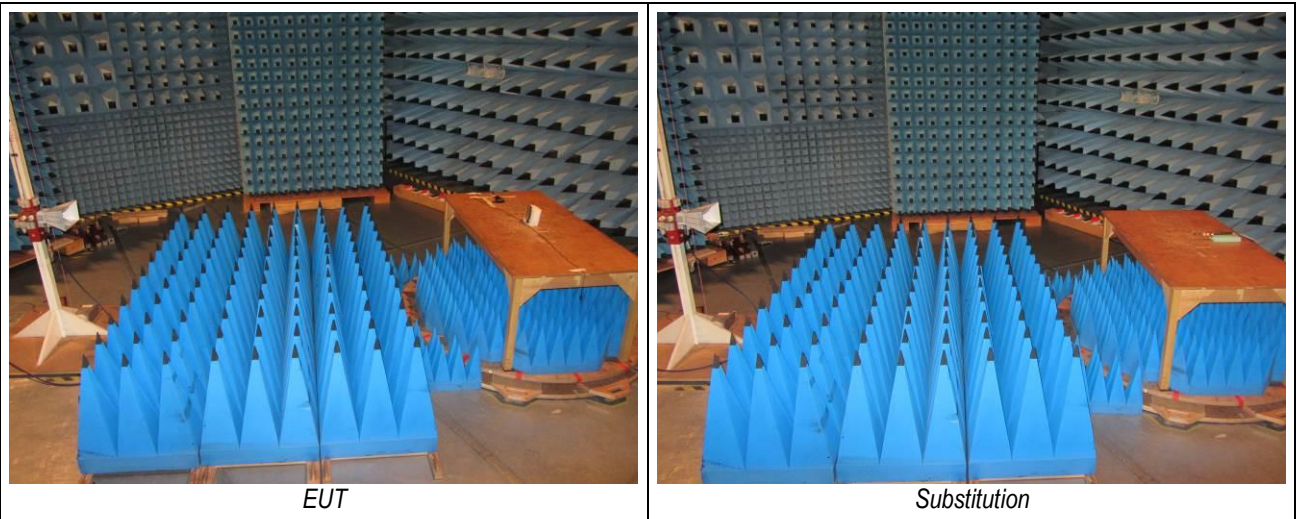
Place and date of test:
Operator:

Rossens, June 16, 2015
B. Itzcovich

6.5 Antenna gain & effective isotropic radiated power

- Introduction:** The effective radiated power is the power radiated by the antenna of an interrogator in its direction of maximum gain under specified conditions of measurement.
- Test site:** ☐ semi-anechoic chamber (ferrites) ☒ semi-anechoic chamber (foam)
- Distance:** ☐ 1 m ☒ 3 m ☐ 10 m ☐ 30 m
- Position of EUT:** 0.8 m (height of the equipment under test above floor)
- Meas. uncertainty:** ± 1.3 dB ($f < 300$ MHz) / ± 1.6 dB ($f > 300$ MHz)
- Test method:** The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The ERP / EIRP values are determined replacing the EUT by a substitution antenna (dipole or other). The limits on the plots represent the equivalent field levels for the required power limits.
- Limit:** Antenna gain 6dBi (for a maximum conducted power of 125 mW = 21 dBm). If antennas with directional gains exceeding 6 dBi are used, the maximum peak output power shall be reduced as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test set-up:



Remarks: Measurement with EUT in position showing maximum emission at 2.44 GHz

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☐ 04-29		
Preamplifier	☐ 11-29	☐ 95-86	☐ 05-56	☐ 05-59	☐ 05-62	☐ 05-87
Antenna (horn)	☐ 90-24	☐ 98-12	☐ 98-13	☒ 07-31		
HF-wattmeter	☐ 95-97	☐ 01-15	☐ 01-17	☐ 03-07	☒ 04-96	☐ 05-20
Thermocouple detector	☒ 07-46	☐ 05-74	☐ 05-88	☐ 07-03	☐ 10-27	☐ 03-14
Substitution antenna	☐ 89-01	☒ 00-52				
Oscilloscope	☐ 90-14	☐ 93-85	☐ 93-86	☐ 01-20	☐ 04-06	☐ 04-50
Multimeter	☐ 03-22	☐ 04-47	☐ 04-104	☐ 04-105	☐ 06-51	☐ 06-52
Frequency generator	☒ 13-16	☐ 00-42	☐ 03-39	☐ 07-02	☐ 04-89	☐ 05-78
Cables	☒ 06-00	☐ 06-01	☒ 10-51	☐ SMK		
Attenuator 10dB	☐ 11-36					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Results of the testClient: *Phonak Communications AG*Apparatus: *Roger Multimedia Hub, proto #02*Operating mode: *Hopping $f = 2.402/2.440/2.480$ GHz, modulated, P_{max} (00, 05)*Cables connected to the EUT: *All (see § 4.6 and § 5.4)*Remarks: *RBW = 5 MHz, VBW = 3 MHz; Peak detector*Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

	Measurement with EUT		Power at substitution ant.		Meas. with subst. ant.	Parameters of substitution ant.		Result			Remarks
f [GHz]	E [dBuV/m]	preamp [dB]	P [dBm]	factor [dB]	E [dBuV/m]	gain [dB]	att. Cable [dB]	corr. [dB]	P EIRP [dBm]	P EIRP [W]	
2.402	108.1	0.0	11.0	0	108.9	2.15	0	-95.78	12.33	17.09 mW	Vertical
2.402	115.5	0.0	11.0	0	109.2	2.15	0	-96.01	19.47	88.59 mW	Horizontal
2.440	108.3	0.0	11.0	0	108.3	2.15	0	-95.14	13.17	20.73 mW	Vertical
2.440	115.7	0.0	11.0	0	109.1	2.15	0	-95.98	19.68	92.83 mW	Horizontal
2.480	107.7	0.0	11.0	0	107.9	2.15	0	-94.70	12.96	19.76 mW	Vertical
2.480	115.2	0.0	11.0	0	108.7	2.15	0	-95.56	19.67	92.77 mW	Horizontal

The antenna gain is the difference (in dB) of the radiated EIRP power and the conducted power of § 6.6 :

frequency [GHz]	Conducted power [dBm]	Radiated power EIRP [dBm]	Antenna gain [dBi]	Remarks
2.402	17.15	19.47	2.32	---
2.440	17.26	19.68	2.42	---
2.480	17.41	19.67	2.26	---

Place and date of test:
Operator:*Rossens, May 29 and June 12, 2015
B. Itzcovich*

6.6 Maximum output power (conducted)

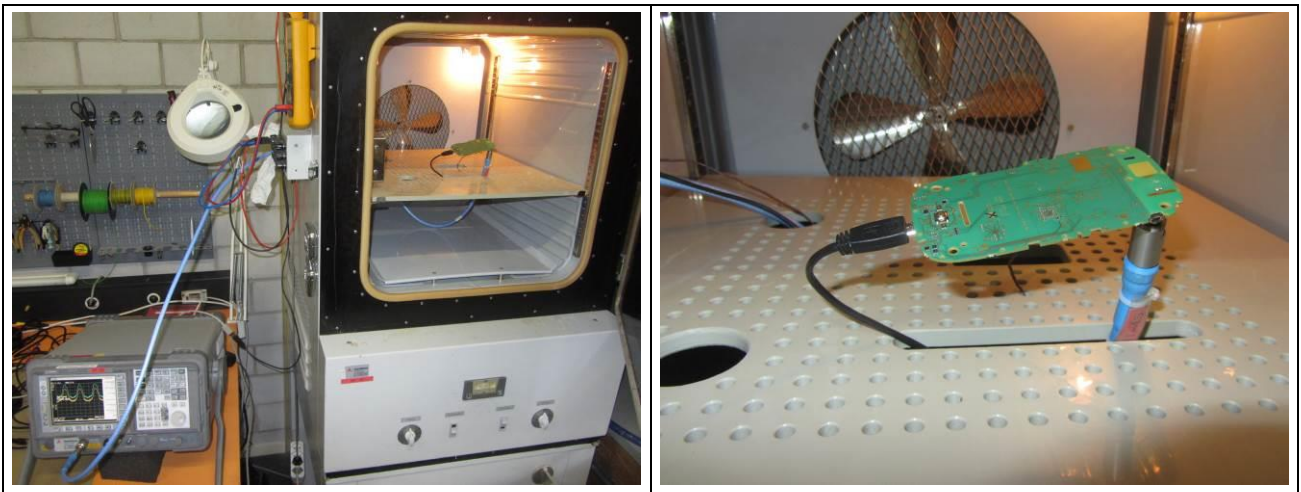
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: 9kHz – 3GHz: ± 1 dB
 3GHz – 6.7GHz: ± 2.1 dB
 6.7GHz – 13.2GHz: ± 2.6 dB
 13.2GHz – 19GHz: ± 2.8 dB
 19GHz – 26.5GHz: ± 3 dB

Test method: Measurement of the conducted power on the antenna connector or a test fixture.

Limit: Maximum 0.125 Watt (= 21 dBm) for systems using antennas with directional gains that do not exceed 6 dBi. If antennas with directional gains exceeding 6 dBi are used, the maximum peak output power shall be reduced as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test set-up:



Remarks: ---

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Multimedia Hub, proto #22*

Operating mode: *Hopping f = 2.402/2.440/2.480 GHz, modulated, max. power (00, 05)*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

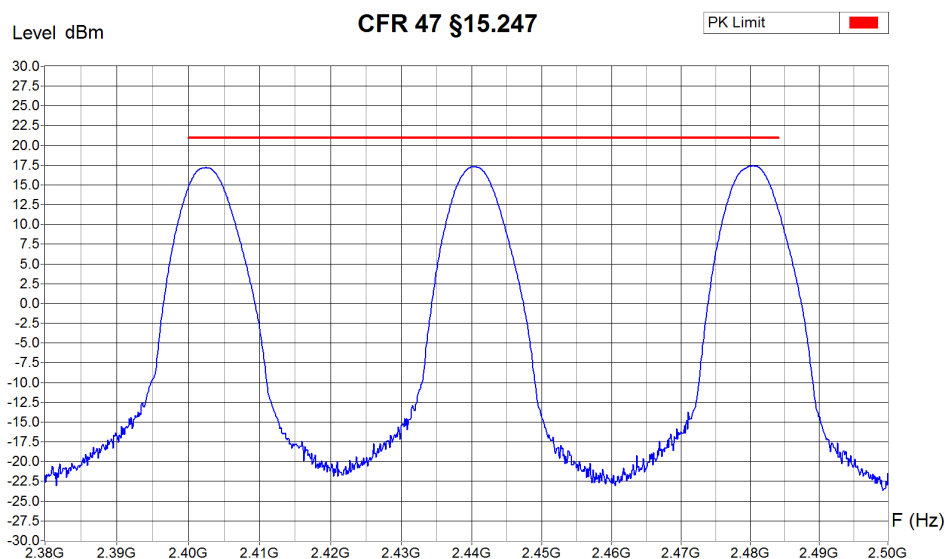
f normal [GHz]	Temp [°C]	U [V]	P [dBm]	Limit [dBm]	Remarks	Pass	
						Yes	No
2.402	26	5.0	17.15	21	- - -	☒	☐
2.440	26	5.0	17.26	21	- - -	☒	☐
2.480	26	5.0	17.41	21	Maximum conducted emission	☒	☐

Equipment Under Test : Titania Hub V3.1 (TX21), Proto #22

Set-Up : See photos

Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Max power (00, 05)

Remarks : Peak detector, 2 sweeps, ST = 10 s, 1001 Pts
Ton = 2x 184 us; T = 3.04 ms
Supply 5VDC (USB), Temp = 26°C



Zone	2.38 GHz - 2.50
Video Bandwidth	3 MHz
Resol Bandwidth	5 MHz

Operator: B. Itzcovich
Date/Time: 12.06.2015 17:03
Filename: 45_CE_2G44_26°C.png/.txt

Place and date of test: *Rossens, June 12, 2015*
Operator: *B. Itzcovich*

6.7 Band-edge emission (conducted)

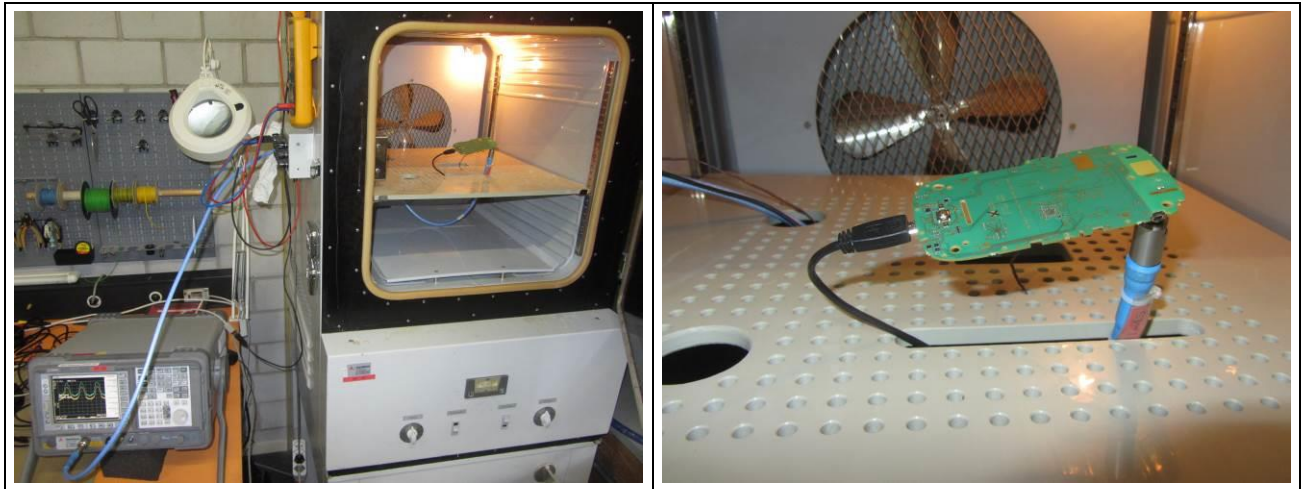
Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

Meas. uncertainty: 9kHz – 3GHz: ± 1 dB
 3GHz – 6.7GHz: ± 2.1 dB
 6.7GHz – 13.2GHz: ± 2.6 dB
 13.2GHz – 19GHz: ± 2.8 dB
 19GHz – 26.5GHz: ± 3 dB

Test method: Measurement of the conducted power on the antenna connector or a test fixture.

Limit: In any 100 kHz bandwidth outside the frequency band, the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

Test set-up:



Remarks: ---

Test equipment:

Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Results of the test

Client: *Phonak Communications AG*

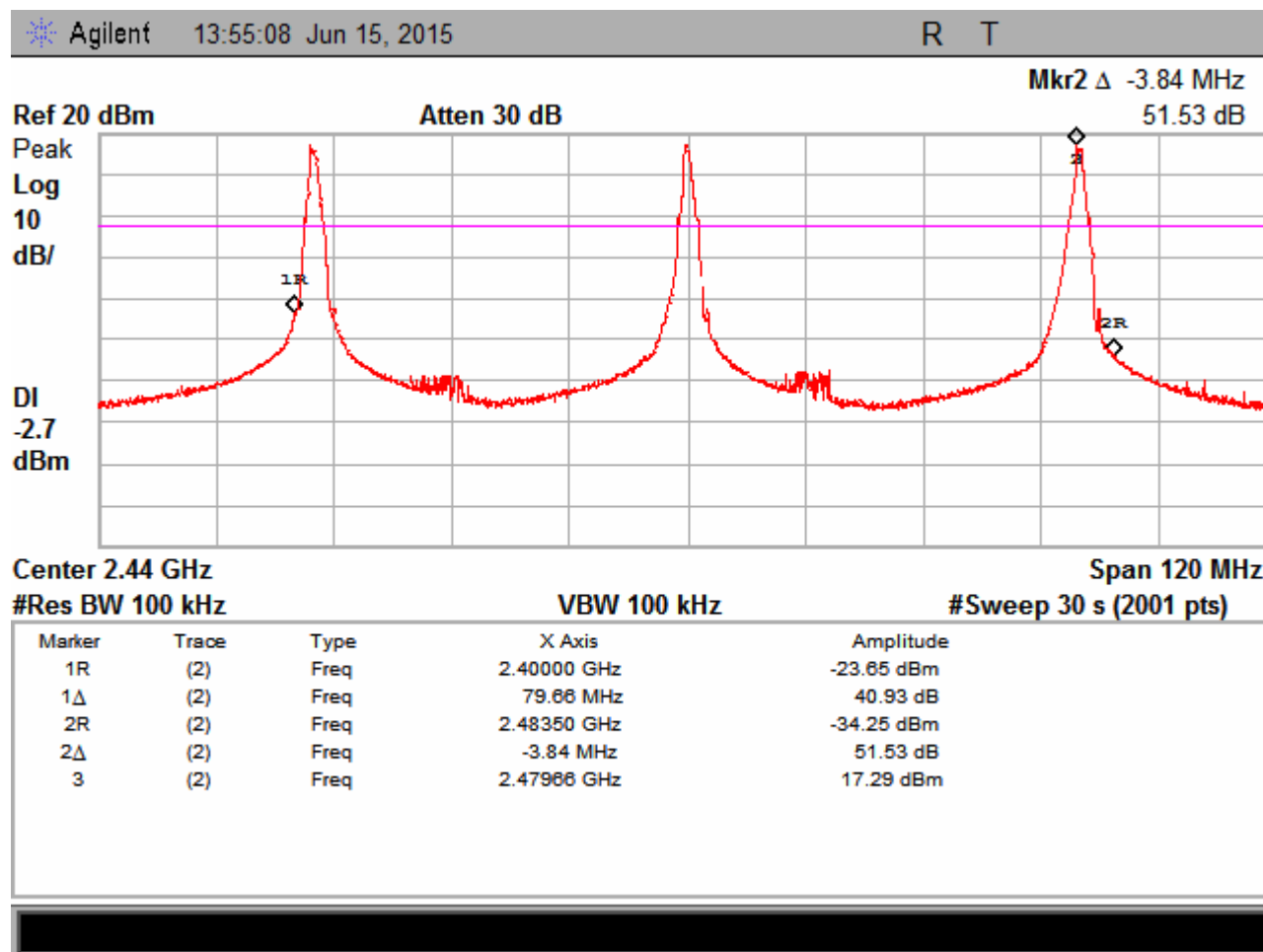
Apparatus: *Roger Multimedia Hub, proto #22*

Operating mode: *Hopping f = 2.402/2.440/2.480 GHz, modulated, max. power (00, 05)*

Cables connected to the EUT: *DC 5V in (USB) & temporary antenna cable*

Remarks: *Measured on temporary antenna connector*

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5



Place and date of test:
Operator:

Rossens, June 15, 2015
B. Itzcovich

6.8 Band-edge emission (radiated)

Test site: ☐ semi-anechoic chamber (ferrites) ☒ semi-anechoic chamber (foam)

Distance: ☐ 1 m ☒ 3 m ☐ 10 m ☐ 30 m

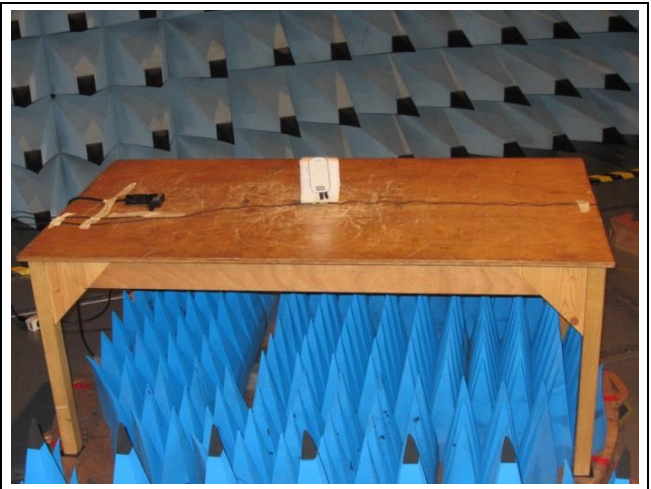
Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value (peak) of all the disturbances appearing while the apparatus is under test.

Limit: Radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a)

Test set-up:



Remarks: Limit values expressed in dB μ V/m and transformed to a measuring distance of 3m
(factor used = 20 dB/decade) if necessary
e.g.: for $f = 40$ MHz the limit is 500 μ V/m at 3 m;

$$20 \log \left(\frac{500 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) = 54 \frac{dB\mu V}{m} \text{ at } 3m$$

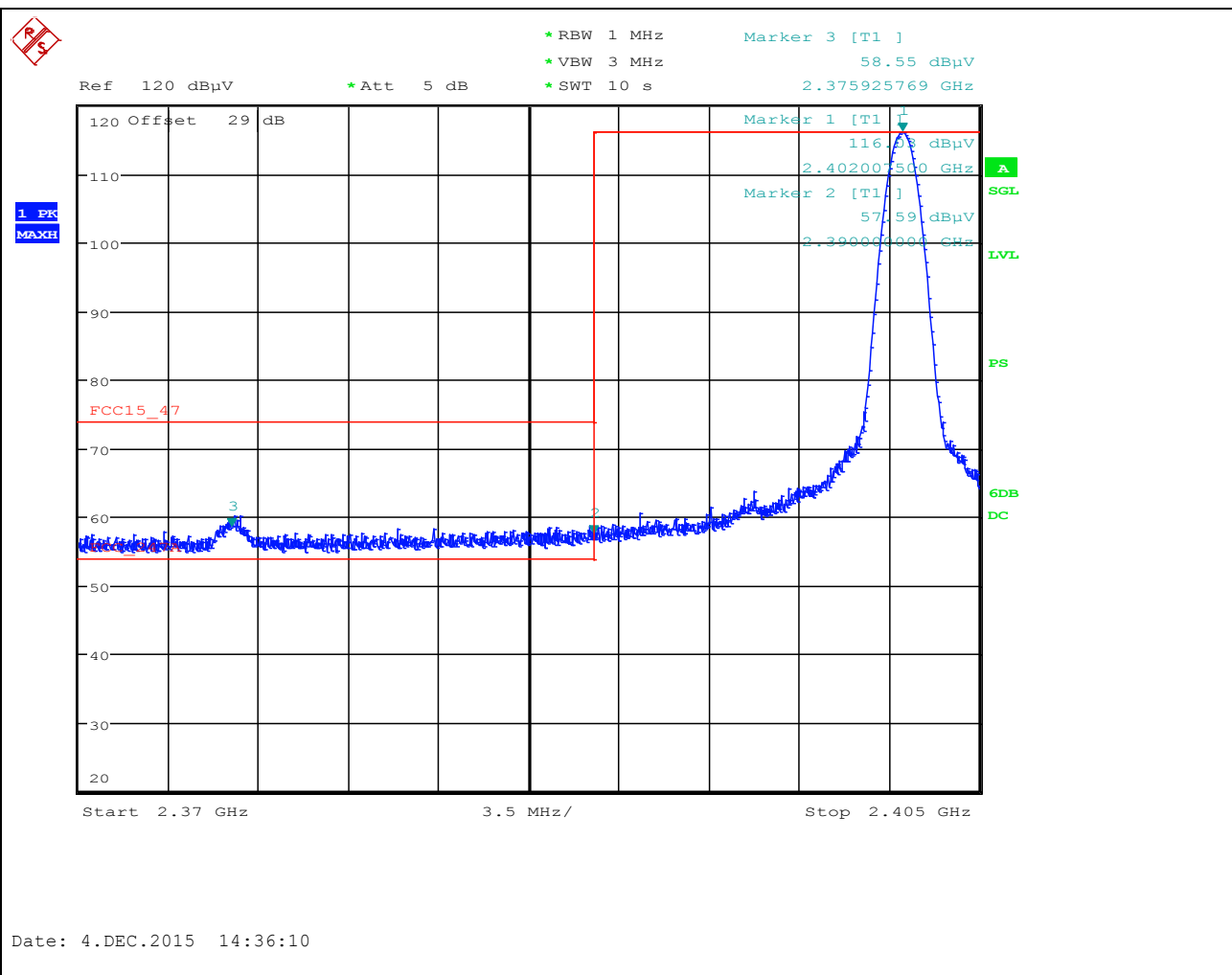
Test equipment:

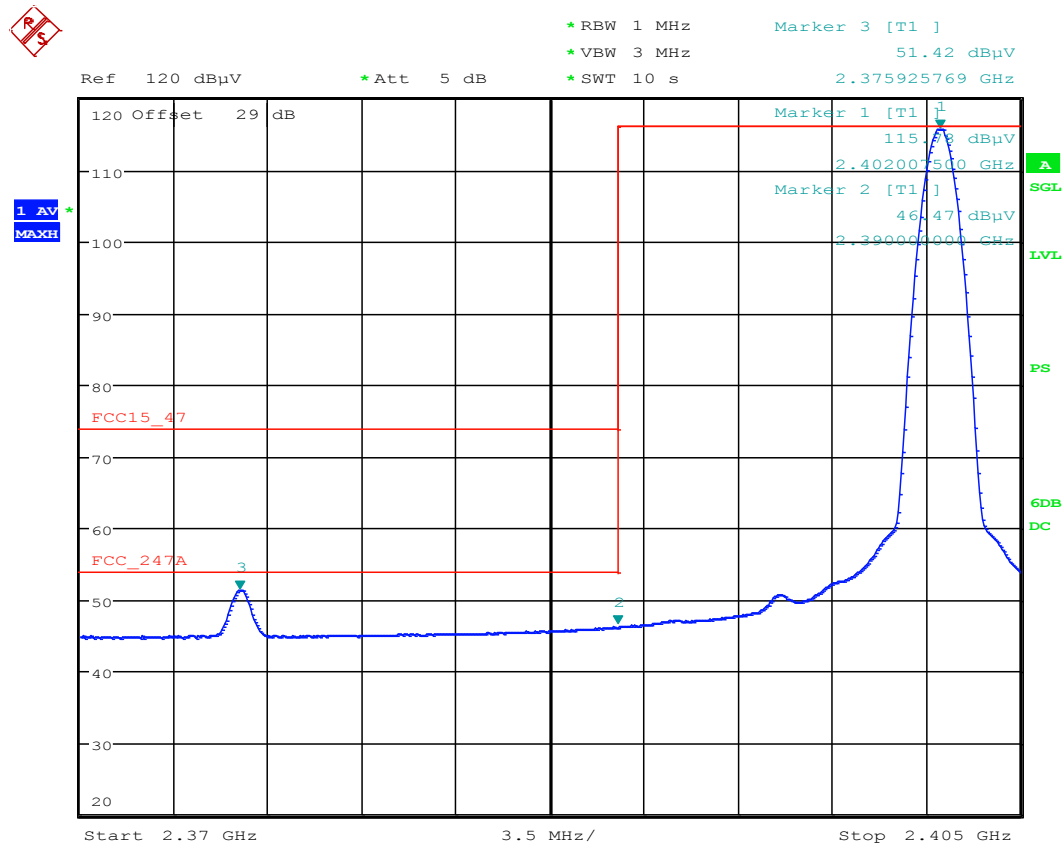
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☒ 10-70	☐ 07-53
Preamplifier	☐ 05-56	☐ 05-87	☐ 11-29			
Antenna (horn)	☒ 90-24	☐ 07-31				
Cables	☐ 06-00	☐ 11-61	☒ 10-75			

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

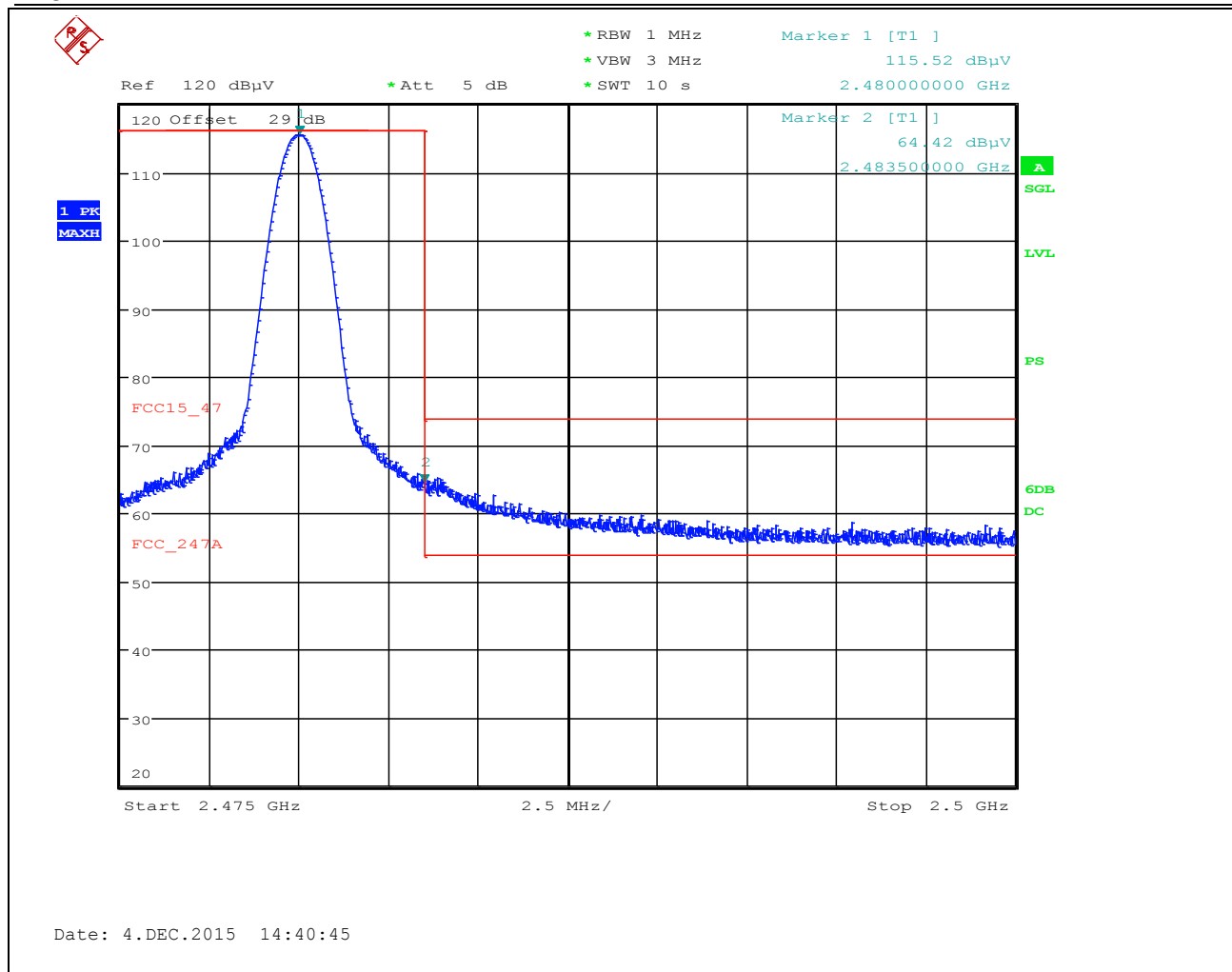
Results of the testClient: *Phonak Communications AG*Apparatus: *Roger Multimedia Hub, proto #04*Operating mode: *TX (f = 2.402/2.480 GHz), modulated, Pmax (00, 05), Duty 100%*Cables connected to the EUT: *All (see § 4.6 and § 5.4)*Remarks: *---*Modifications: ☐ None ☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5

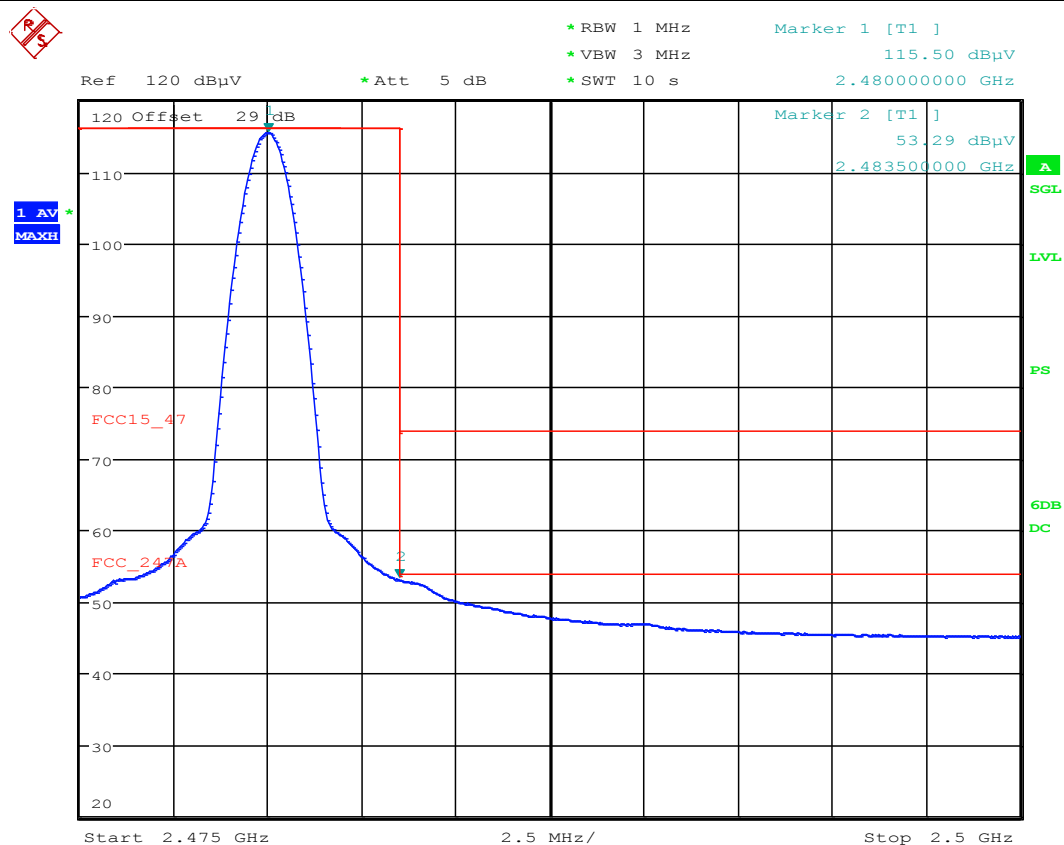
	Measured field strength [dB μ V/m]		Limit [dB μ V/m]	Margin [dB]		Pass	
	≤ 2390.0 MHz	≥ 2483.5 MHz		≤ 2390.0 MHz	≥ 2483.5 MHz	Yes	No
Peak detector	58.55	64.42	74	15.45	9.58	☒	☐
Average RMS detector	51.42	53.29	54	2.58	0.71	☒	☐





Date: 4.DEC.2015 14:37:07





Date: 4.DEC.2015 14:40:00

Place and date of test:
Operator:

Rossens, December 4, 2015
B. Itzcovich

6.9 Spurious emission – conducted (transmitter – 9 kHz to 26.5 GHz)

Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☐ semi-anechoic chamber (ferrites) ☒ laboratory

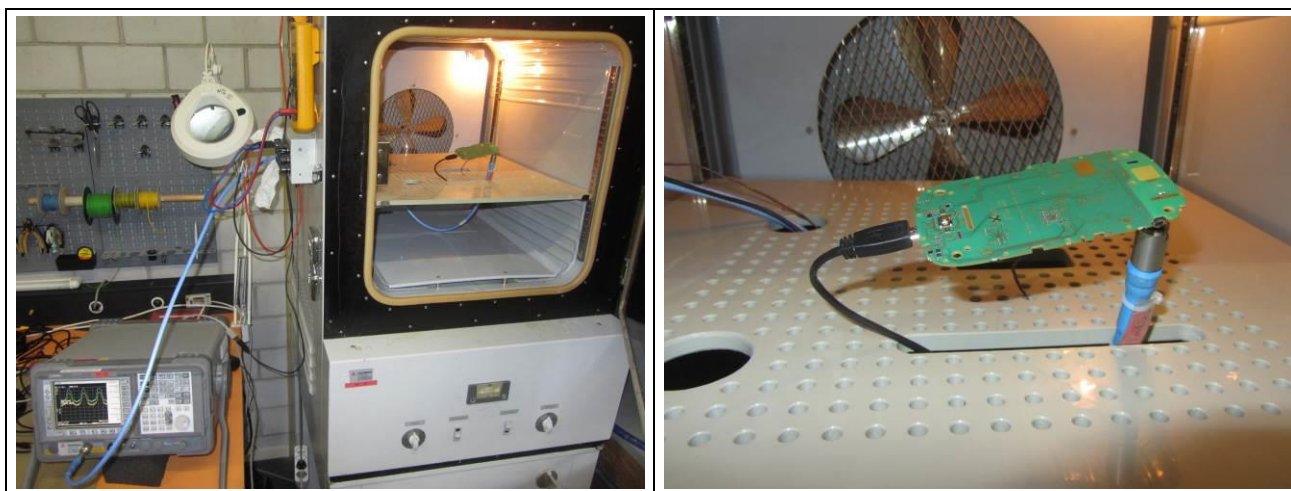
Meas. uncertainty: 9kHz – 3GHz: ± 1 dB
 3GHz – 6.7GHz: ± 2.1 dB
 6.7GHz – 13.2GHz: ± 2.6 dB
 13.2GHz – 19GHz: ± 2.8 dB
 19GHz – 26.5GHz: ± 3 dB

Test method: Measurement of the conducted power on the antenna connector or a test fixture.

Limit: In any 100 kHz bandwidth outside the frequency band, the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: ---

Test equipment:

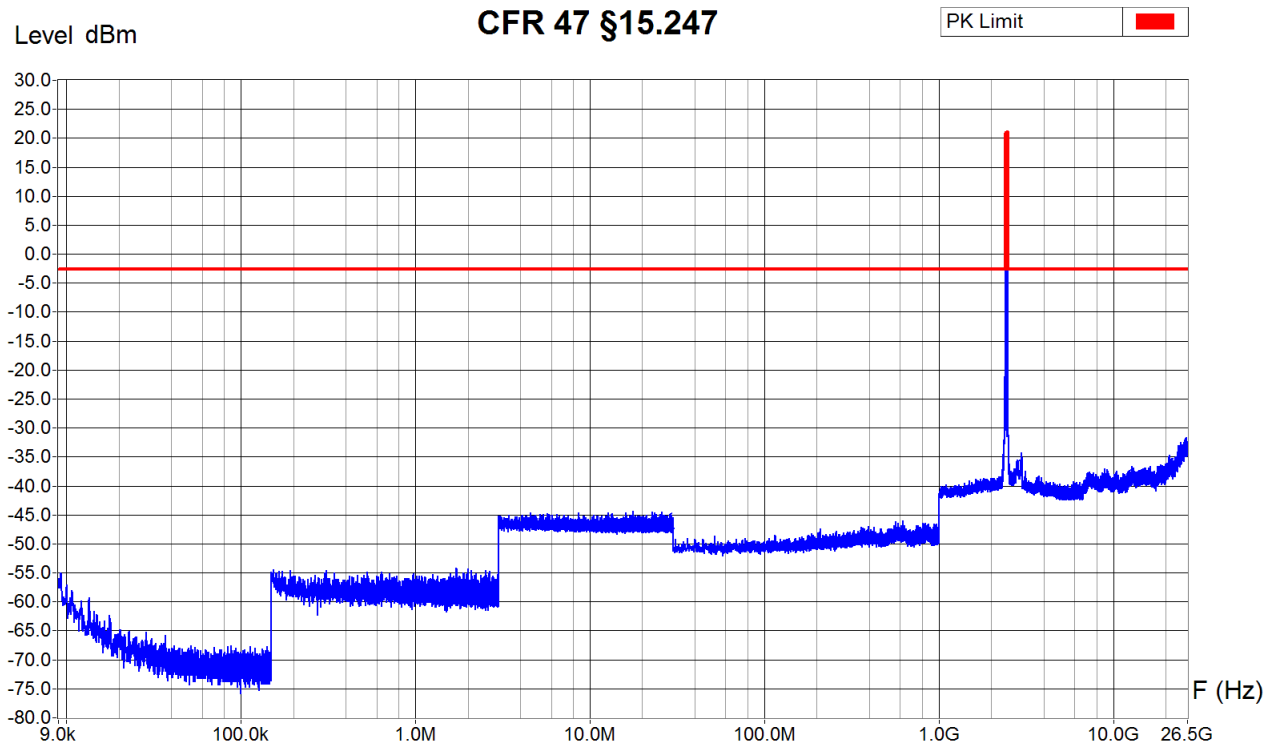
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☒ 99-07	☐ 04-31				
Cables	☒ 11-45					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Power Interference
Port : Temporary antenna connector
Clamp position : -



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #22
Set-Up : See photos
Operating Conditions : Hopping TX, modulated, Max power (00, 05)
Remarks : Peak detector sweep, 8001 Pts



Operator: B. Itzcovich
Date/Time: 15.06.2015 13:00
Filename:
47_CE_150k-26G5.png/.txt

6.10 Spurious emission transmit mode – radiated**6.10.1 9 kHz to 30 MHz**

Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☒ semi-anechoic chamber (ferrites) ☐

Distance: ☒ 3 m ☐ 10 m ☐ 30 m

Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 2.8 dB

Test method: The magnetic disturbance radiated by the equipment under test is measured using a spectrum analyser and a wide band magnetic antenna. The antenna is placed at 1 m height, first in the direction of the apparatus under test, then at 90° to the apparatus and if required also horizontally. If possible the turning table is operated through 360° during the measurement. The recording is carried out taking into account the maximum value of the disturbance appearing during the functioning of the apparatus under test. The peak values are recorded continuously on a graph. The values exceeding the limits are remeasured using a measuring receiver.

Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Perpendicular

Remarks: Limit values expressed in $\text{dB}\mu\text{V}/\text{m}$ and transformed to a measuring distance of 3 m
(factor used = 40 dB/decade) if necessary
e.g.: for $f = 10$ MHz the limit is $30 \mu\text{V}/\text{m}$ at 30 m;

$$20 \log \left(\frac{30 \frac{\mu\text{V}}{\text{m}}}{1 \frac{\mu\text{V}}{\text{m}}} \right) + 40 \log \left(\frac{30 \text{ m}}{3 \text{ m}} \right) = 69.5 \frac{\text{dB}\mu\text{V}}{\text{m}} \text{ at } 3 \text{ m}$$

Test equipment:

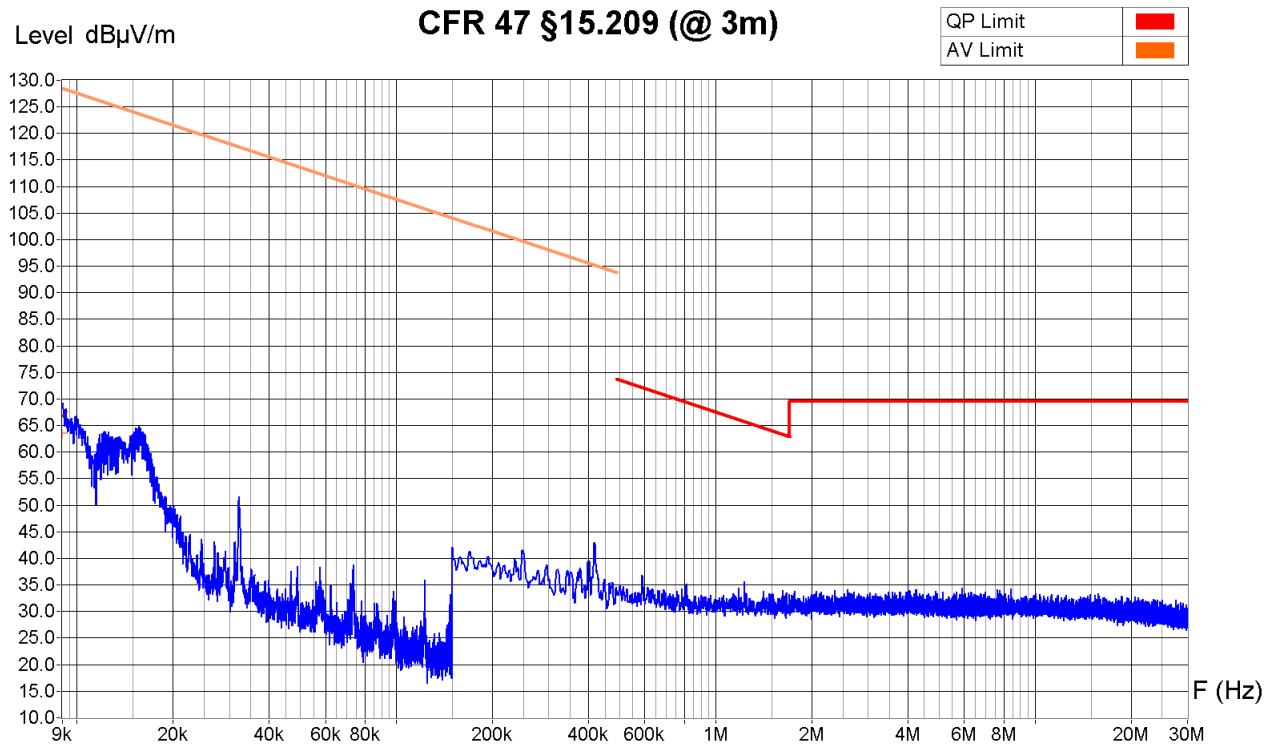
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☒ 10-70		
Preamplifier	☐ 90-01	☐ 95-86	☐ 05-56	☐ 05-59	☐ 05-62	
Antenna (type: magnetic)	☒ 90-25	☐ 90-28	☐ 99-32	☐ 04-79		
Cables	☒ 06-01	☒ 06-206				

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
Polarisation : Perpendicular
Table Angle : 0 - 360°
Antenna Height : 1m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 06), charging
Remarks : Parallel means "antenna centre axis towards EUT"



Zone	9 KHz - 150 KHz	150 KHz - 8 MHz	8 MHz - 30 MHz
Video Bandwidth	500 Hz	30 KHz	30 KHz
Resol Bandwidth	200 Hz	9 KHz	9 KHz

Receiver Measures

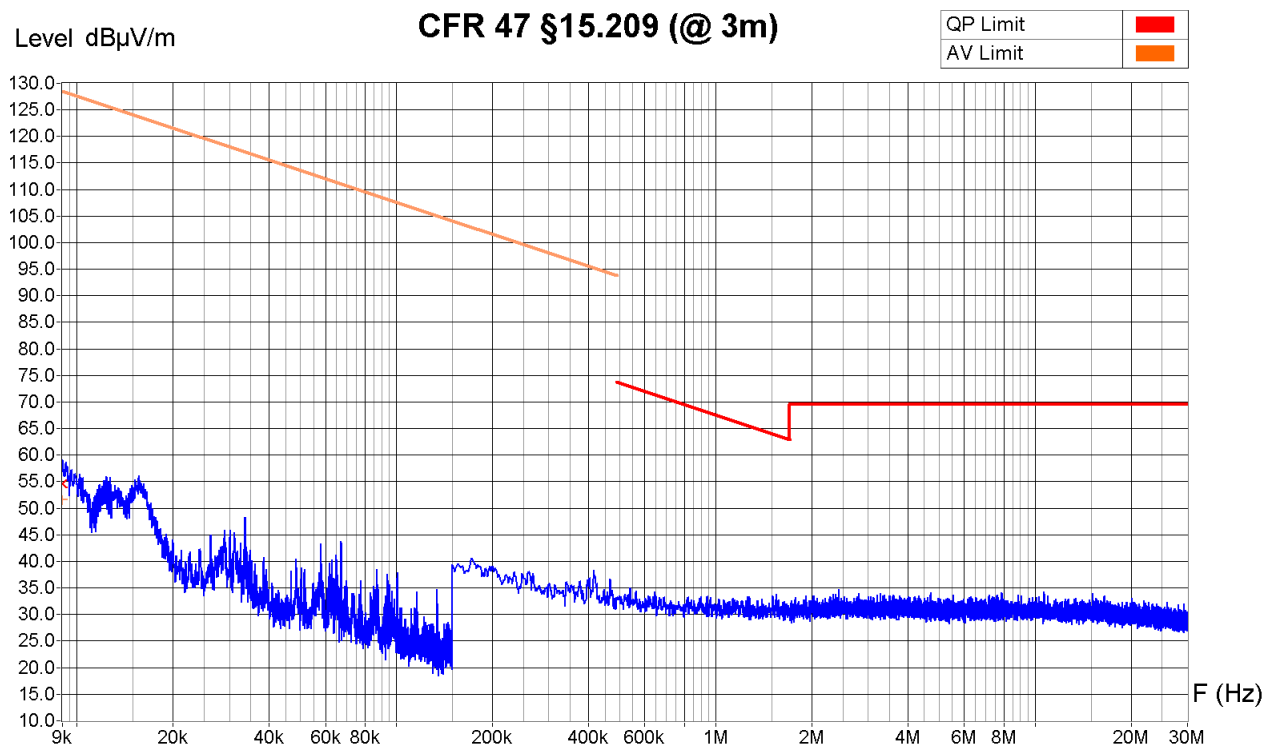
Frequency	Peak	QuasiPeak (x)	Average (+)
9 KHz	72.4 dBμV/m	66.9 dBμV/m	63.5 dBμV/m

Operator: B. Itzcovich
Date/Time: 27.05.2015 16:30
Filename:
07_RE_9k-
30M_Tx3f_Per_FCC.png/.txt

Measurement Type : Radiated Field
 Polarisation : Horizontal
 Table Angle : 0 - 360°
 Antenna Height : 1m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and Audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 06), charging
 Remarks : Parallel means "antenna centre axis towards EUT"



Zone	9 KHz - 150 KHz	150 KHz - 8 MHz	8 MHz - 30 MHz
Video Bandwidth	500 Hz	30 KHz	30 KHz
Resol Bandwidth	200 Hz	9 KHz	9 KHz

Receiver Measures

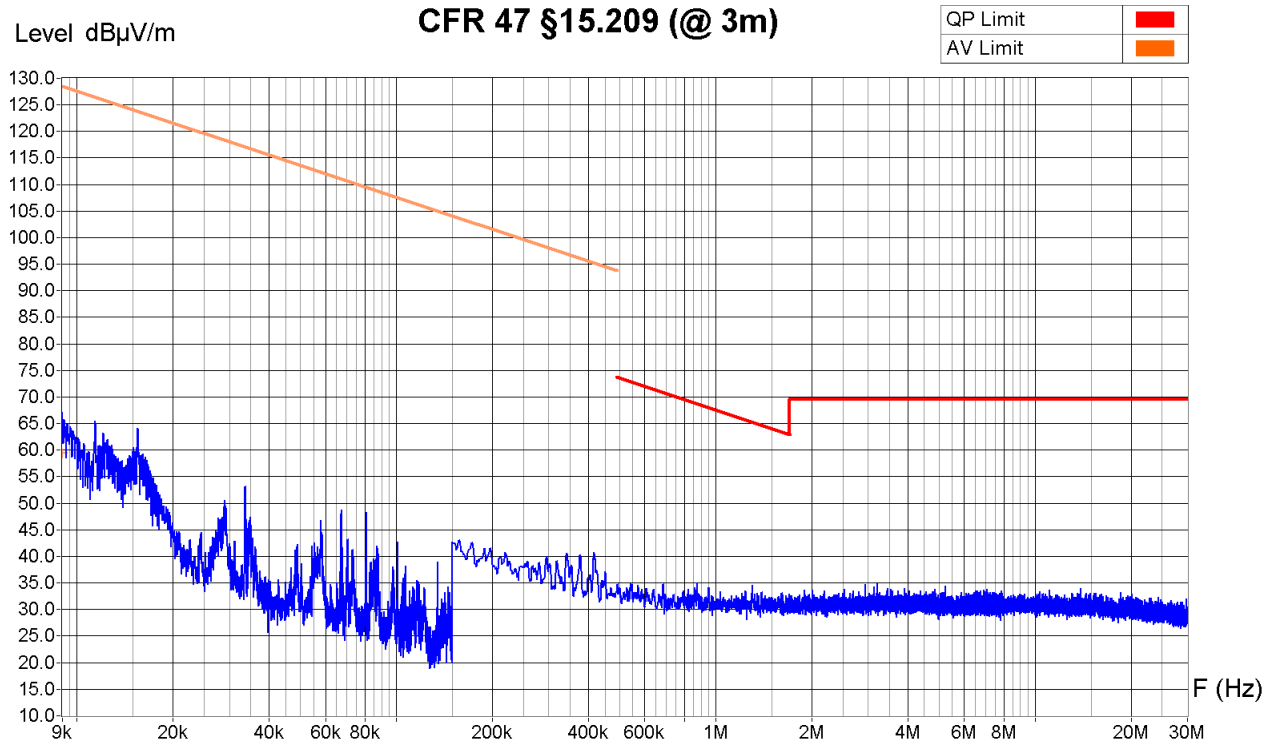
Frequency	Peak	QuasiPeak (x)	Average (+)
9 KHz	60.9 dBμV/m	54.6 dBμV/m	51.7 dBμV/m

Operator: B. Itzcovich
 Date/Time: 27.05.2015 17:21
 Filename:
 08_RE_9k-
 30M_Tx3f_Hor_FCC.png/.txt

Measurement Type : Radiated Field
Polarisation : Parallel
Table Angle : 0 - 360°
Antenna Height : 1m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and Audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 06), charging
Remarks : Parallel means "antenna centre axis towards EUT"



Zone	9 KHz - 150 KHz	150 KHz - 8 MHz	8 MHz - 30 MHz
Video Bandwidth	500 Hz	30 KHz	30 KHz
Resol Bandwidth	200 Hz	9 KHz	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)
9 KHz	68.2 dBμV/m	62.9 dBμV/m	59.4 dBμV/m

Operator: B. Itzcovich
Date/Time: 27.05.2015 17:33
Filename:
09_RE_9k-
30M_Tx3f_Par_FCC.png/.txt

6.10.2 30 MHz to 1 GHz

Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☒ semi-anechoic chamber (ferrites) ☐

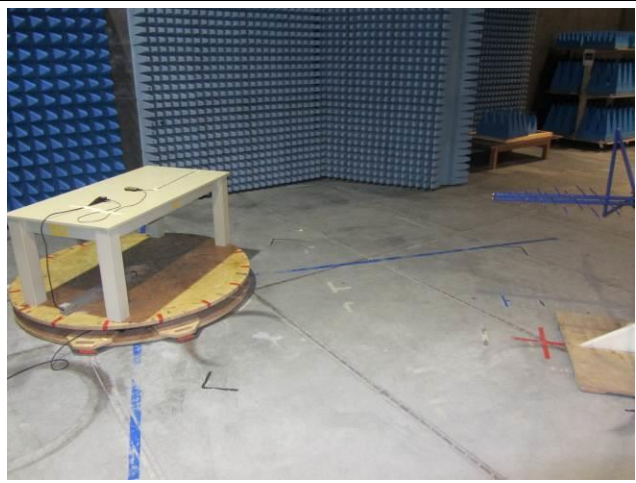
Distance: ☒ 3 m ☐ 10 m ☐ 30 m

Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.6 dB (30 - 300 MHz) / ± 3.7 dB (300 - 1000 MHz)

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value of all the disturbances appearing while the apparatus is under test. The peak values are recorded continuously on the graph. The values exceeding a limit are re-measured manually using a receiver.

Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:

Remarks: Limit values expressed in dB μ V/m and transformed to a measuring distance of 3m
 (factor used = 20 dB/decade) if necessary
 e.g.: for f = 40 MHz the limit is 100 μ V/m at 3 m;

$$20 \log \left(\frac{100 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) = 40 \frac{dB \mu V}{m} \text{ at } 3m$$

Test equipment:

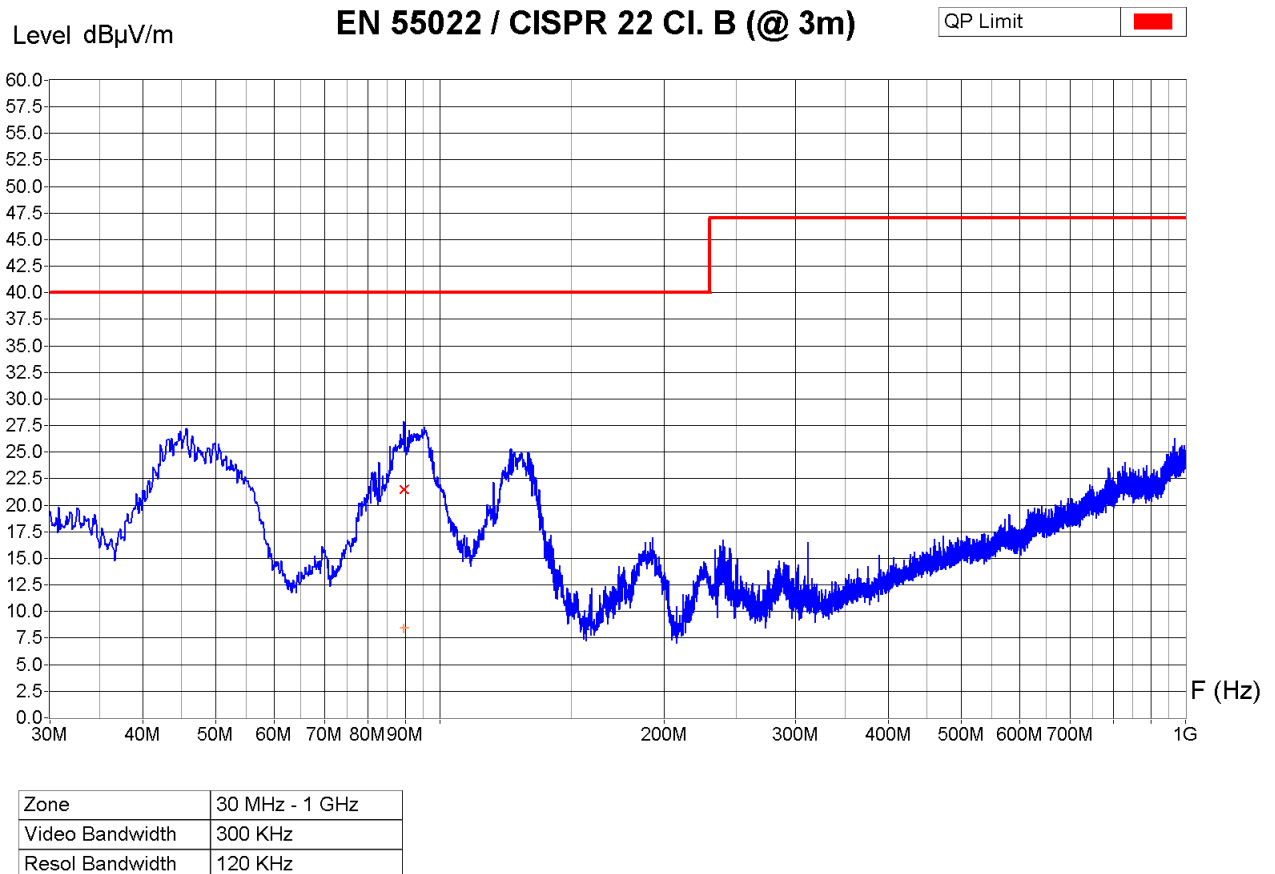
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☒ 10-70		
Preamplifier	☐ 90-01	☐ 95-86	☐ 05-56	☒ 05-59	☐ 05-62	
Antenna (bilog)	☒ 94-03	☐ 05-38				
Cables	☒ 06-01					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
Polarisation : Vertical
Table Angle : 0 - 360°
Antenna Height : 1 - 4m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 06), charging
Remarks : Cage 06-01



Receiver Measures

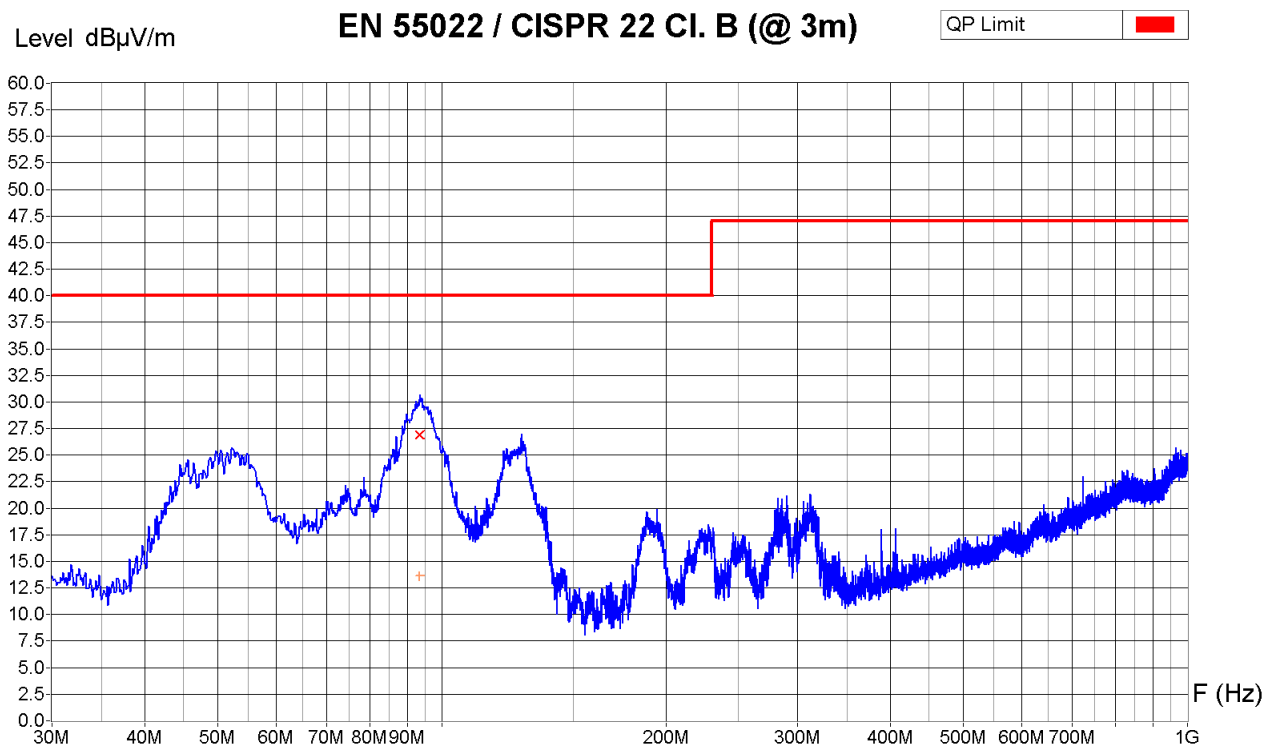
Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
89.40 MHz	28.0 dBμV/m	21.5 dBμV/m	8.4 dBμV/m	18.5 dB

Operator: B. Itzcovich
Date/Time: 27.05.2015 11:05
Filename:
01_RE_30M-
1G_TX3f_V_C22.png/.txt

Measurement Type : Radiated Field
 Polarisation : Horizontal
 Table Angle : 0 - 360°
 Antenna Height : 1 - 4m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 06), charging
 Remarks : Cage 06-01



Zone	30 MHz - 1 GHz
Video Bandwidth	300 KHz
Resol Bandwidth	120 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
93.45 MHz	31.6 dBμV/m	26.9 dBμV/m	13.6 dBμV/m	13.1 dB

Operator: B. Itzcovich
 Date/Time: 27.05.2015 11:20
 Filename:
 02_RE_30M-
 1G_TX3f_H_C22.png/.txt

6.10.3 1 GHz to 18 GHz

Test site: ☐ semi-anechoic chamber (ferrites) ☒ semi-anechoic chamber (foam)

Distance: ☒ 1 m ☐ 3 m ☐ 10 m ☐ 30 m

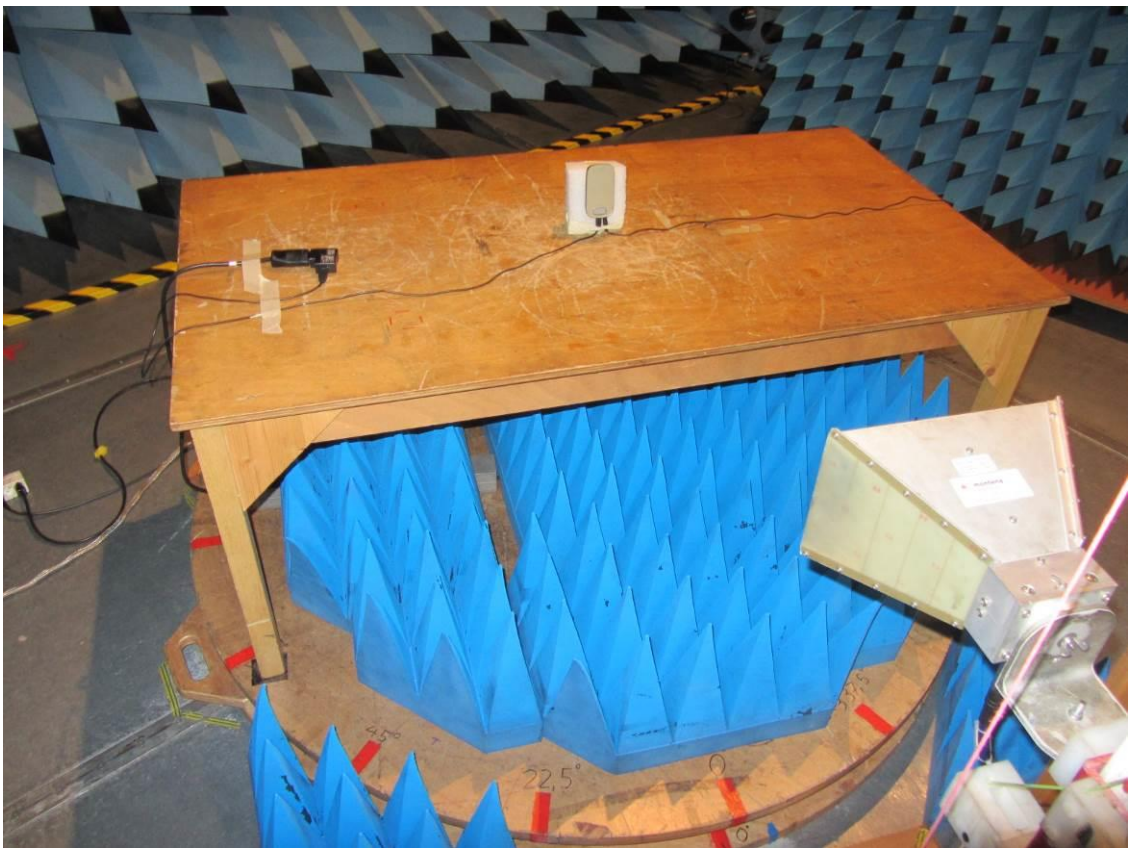
Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value (peak) of all the disturbances appearing while the apparatus is under test.

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: - Limit values expressed in dB μ V/m and transformed to a measuring distance of 1m (factor used = 20 dB/decade) if necessary. E.g.: for f = 1 GHz the limit is 500 μ V/m at 3 m;

$$20 \log \left(\frac{500 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) + 20 \log \left(\frac{3m}{1m} \right) = 63.5 \frac{dB\mu V}{m} \text{ at } 1m$$

- Emissions near band-edges may seem over limits due to poor selectivity of 07-53 Analyser at 1 MHz RBW. They are checked under §§ 6.7 and 6.8

Test equipment:

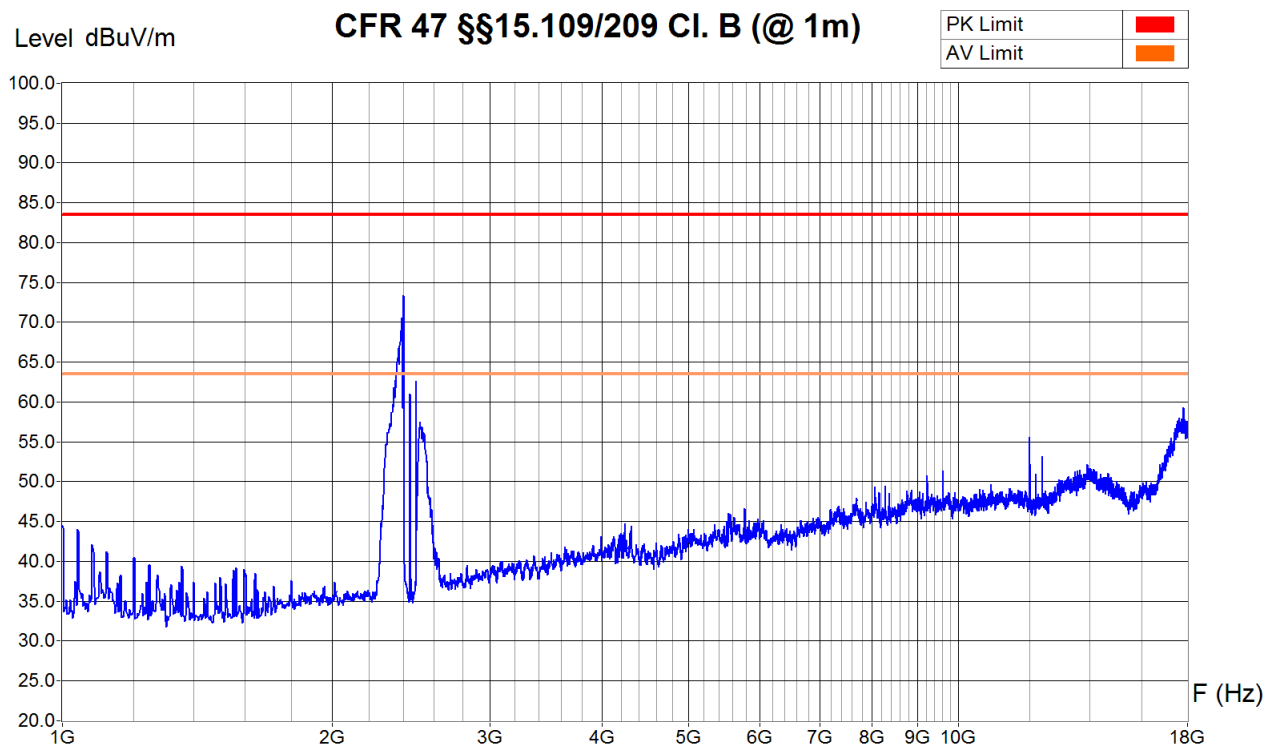
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Preamplifier	☐ 05-56	☐ 05-87	☒ 11-29			
Antenna (horn)	☒ 90-24	☐ 07-31				
Cables	☒ 10-75	☒ 11-61				
Filters	☒ 13-14	☐ 12-06	☒ 13-05			

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
Polarisation : Vertical
Table Angle : 0 - 360°
Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
Remarks : Zone 1 - 6 GHz with notch filter, with preamp.
Zone 6 - 18 GHz with HP filter, with preamp.
Peak detector sweep



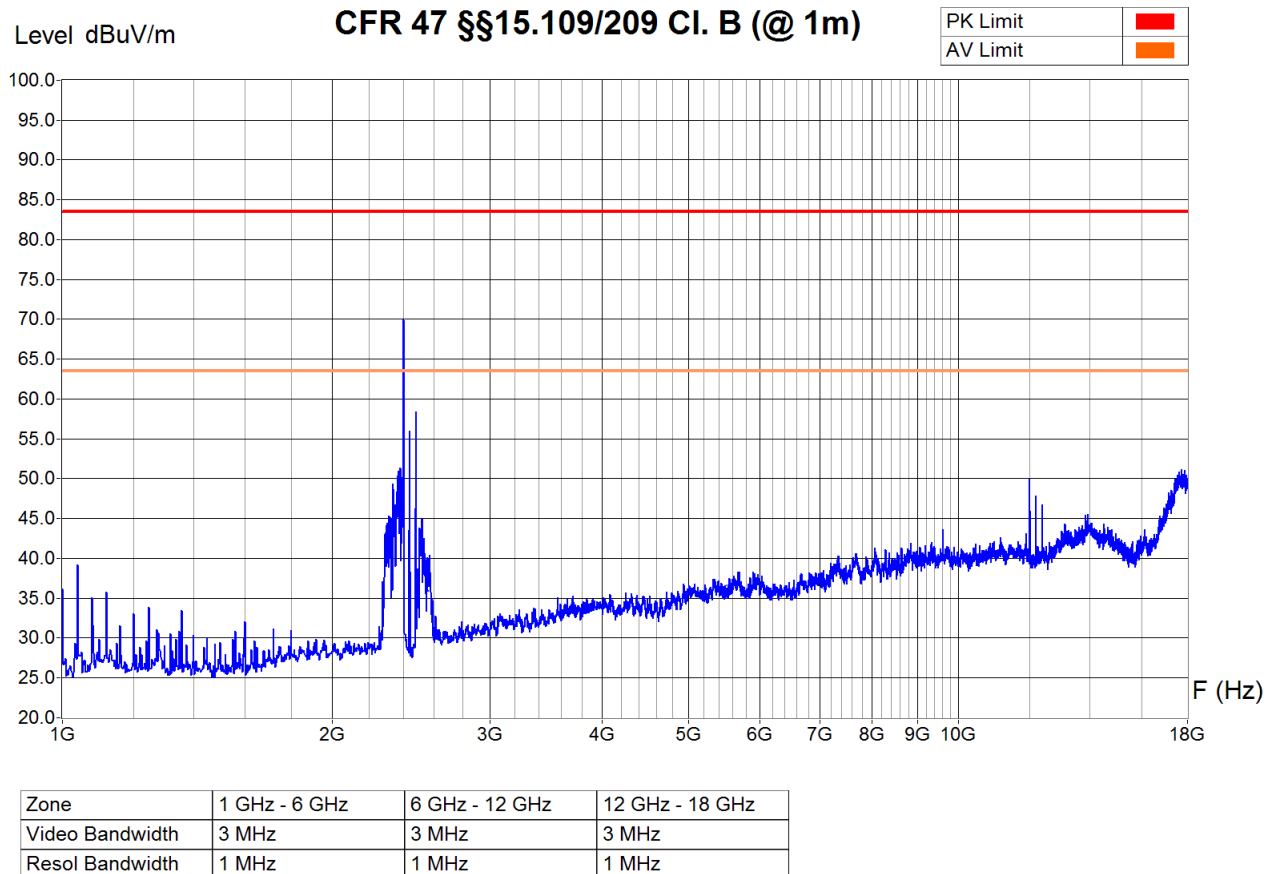
Zone	1 GHz - 6 GHz	6 GHz - 12 GHz	12 GHz - 18 GHz
Video Bandwidth	1 MHz	1 MHz	1 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Operator: B. Itzcovich
Date/Time: 29.05.2015 14:21
Filename:
31_RE_1-
18G_TX3f_0005_V_FCC_PK.png/

Measurement Type : Radiated Field
Polarisation : Vertical
Table Angle : 0 - 360°
Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
Remarks : Zone 1 - 6 GHz with notch filter, with preamp.
Zone 6 - 18 GHz with HP filter, with preamp.
Average RMS detector sweep

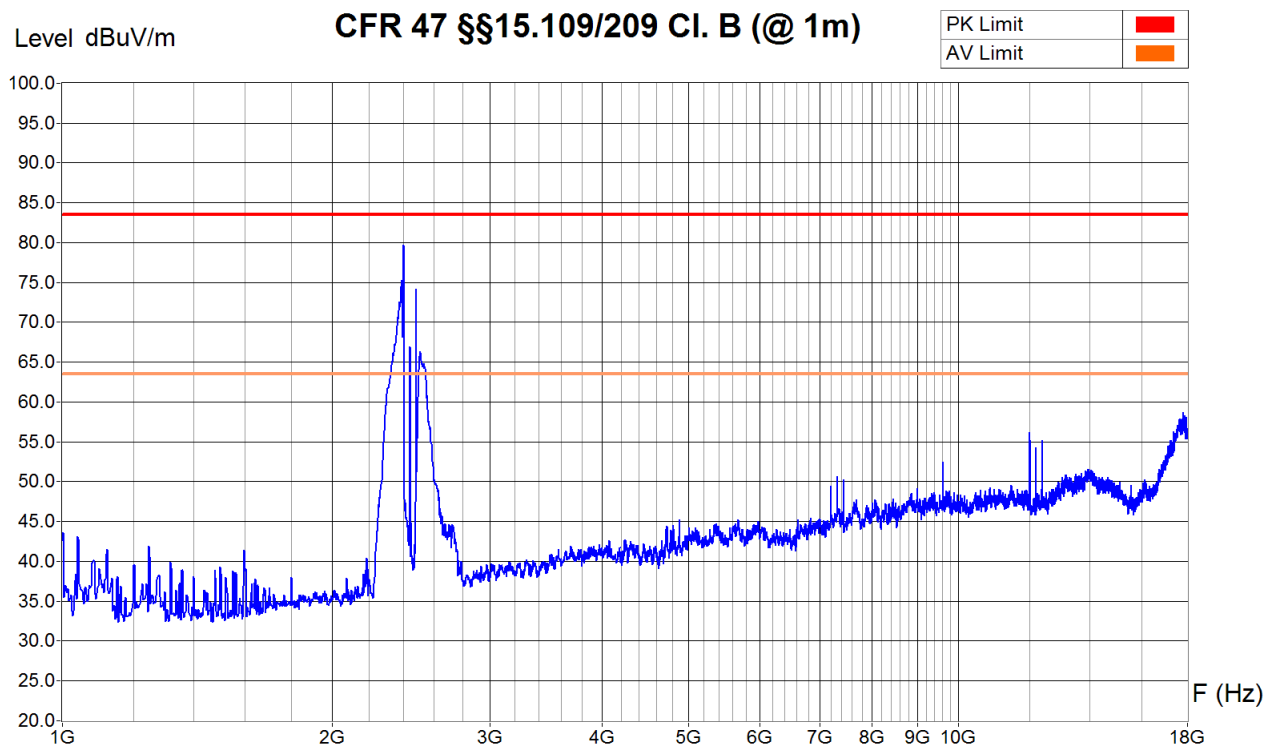


Operator: B. Itzcovich
Date/Time: 29.05.2015 14:33
Filename:
32_RE_1-
18G_TX3f_0005_V_FCC_AVG.pn

Measurement Type : Radiated Field
 Polarisation : Horizontal
 Table Angle : 0 - 360°
 Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
 Remarks : Zone 1 - 6 GHz with notch filter, with preamp.
 Zone 6 - 18 GHz with HP filter, with preamp.
 Peak detector sweep



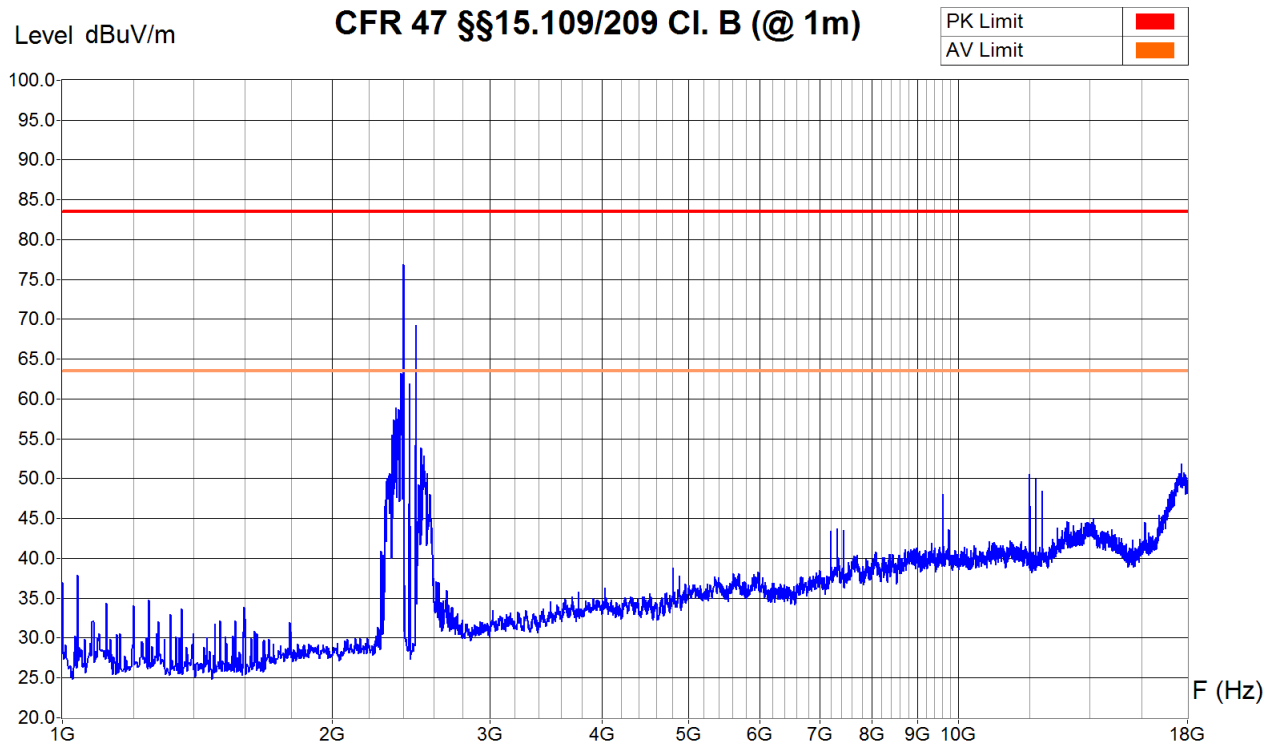
Zone	1 GHz - 6 GHz	6 GHz - 12 GHz	12 GHz - 18 GHz
Video Bandwidth	1 MHz	1 MHz	1 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Operator: B. Itzcovich
 Date/Time: 29.05.2015 14:42
 Filename:
 33_RE_1-
 18G_TX3f_0005_H_FCC_PK.png/

Measurement Type : Radiated Field
Polarisation : Horizontal
Table Angle : 0 - 360°
Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
Remarks : Zone 1 - 6 GHz with notch filter, with preamp.
Zone 6 - 18 GHz with HP filter, with preamp.
Average RMS detector sweep



Zone	1 GHz - 6 GHz	6 GHz - 12 GHz	12 GHz - 18 GHz
Video Bandwidth	3 MHz	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Frequency	Average RMS detector meas.
17.736 GHz	51.8 dBuV/m

Operator: B. Itzcovich
Date/Time: 29.05.2015 14:53
Filename:
34_RE_1-
18G_TX3f_0005_H_FCC_AVG.pn

6.10.4 18 GHz to 26.5 GHzTest site: ☒ semi-anechoic chamber (foam) ☐ semi-anechoic chamber (ferrites)Distance: ☒ 1 m ☐ 3 m ☐ 10 m ☐ 30 m

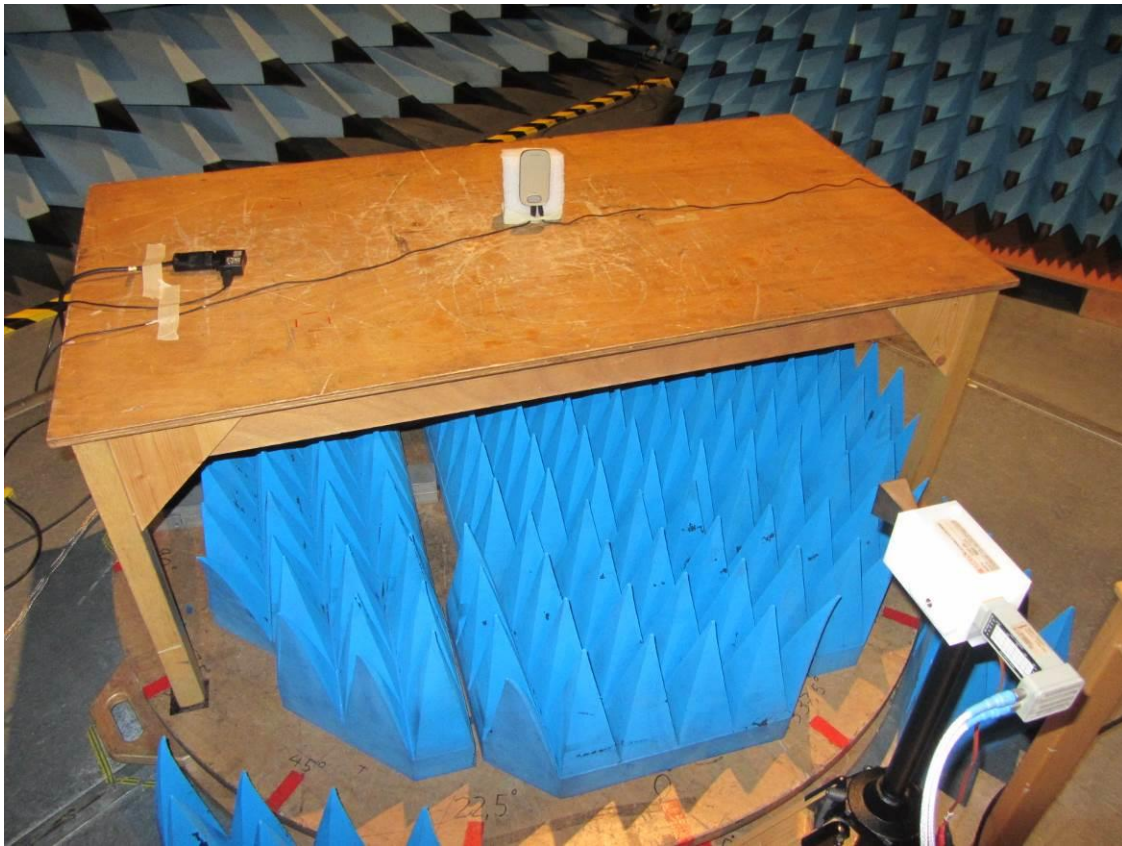
Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value (peak) of all the disturbances appearing while the apparatus is under test.

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: Limit values expressed in dB μ V/m and transformed to a measuring distance of 1m (factor used = 20 dB/decade) if necessary
e.g.: for f = 18 GHz the limit is 500 μ V/m at 3 m;

$$20 \log \left(\frac{500 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) + 20 \log \left(\frac{3m}{1m} \right) = 63.5 \frac{dB\mu V}{m} \text{ at } 1m$$

Test equipment:

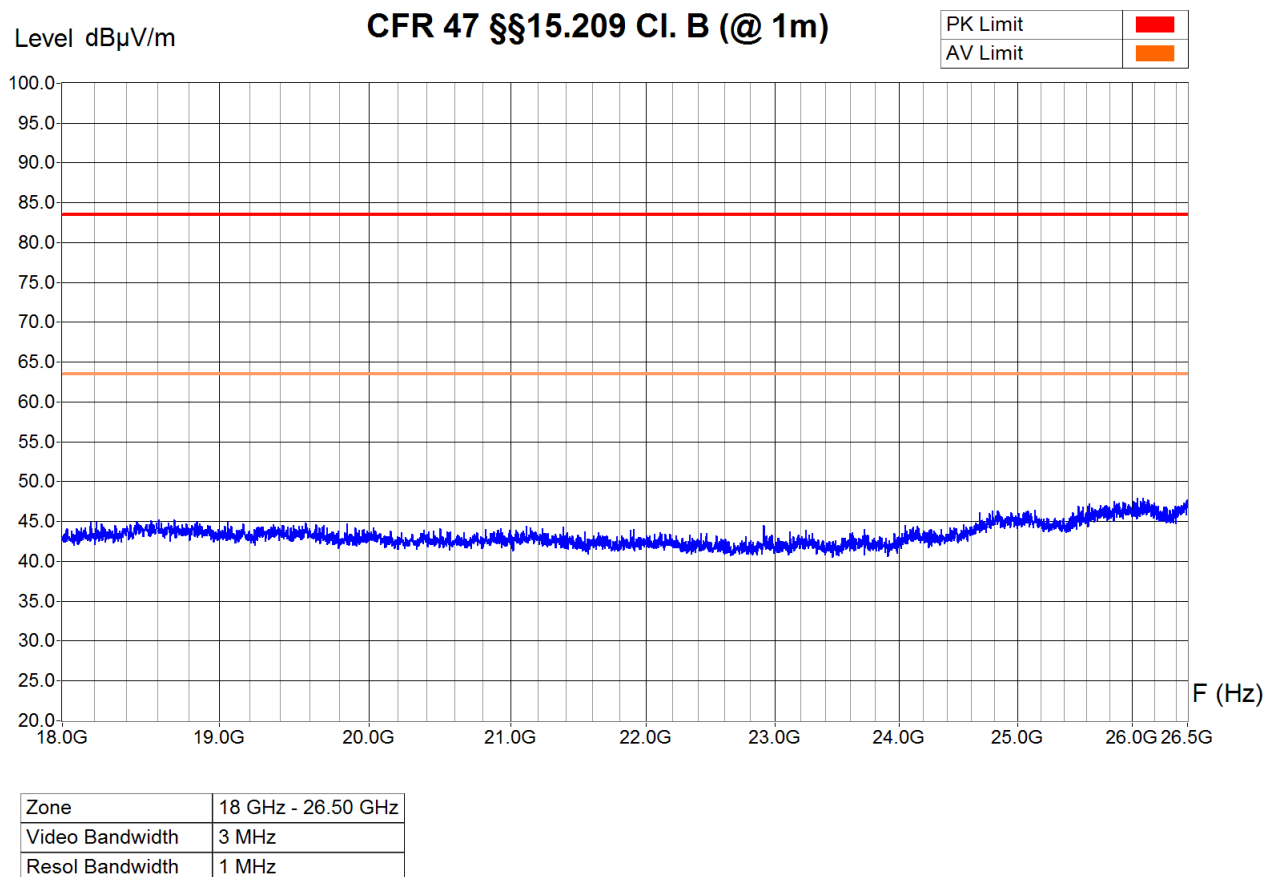
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Antenna with mixer & preamp.	☒ 98-12					
Cables	☒ 11-62	☒ 10-81				
Power supply	☒ 06-62					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
Polarisation : Vertical
Table Angle : 0 - 360°
Antenna Height : 1m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
Remarks : Peak detector sweep

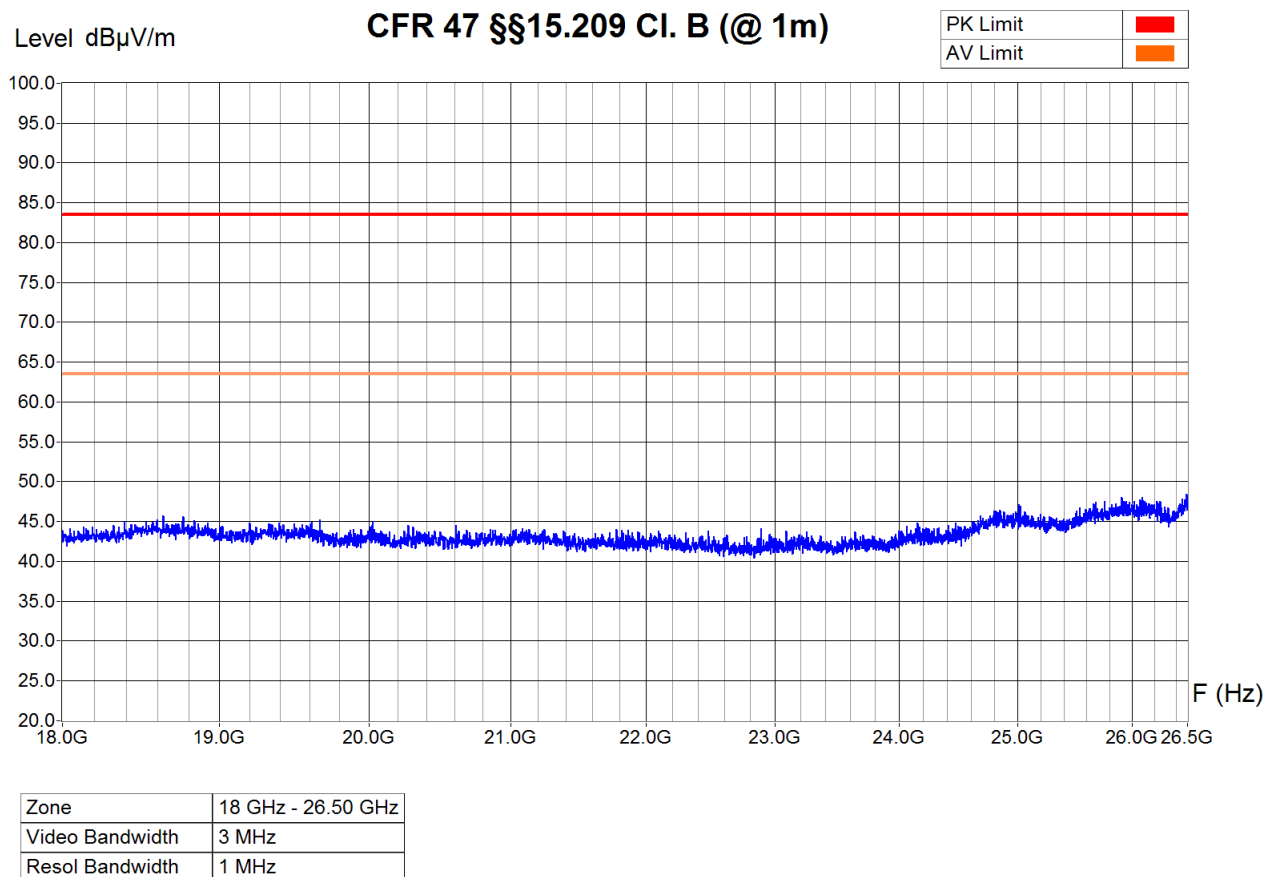


Operator: B. Itzcovich
Date/Time: 29.05.2015 16:48
Filename:
35_RE_18-
26G5_TX3f_0005_V_FCC.png/.txt

Measurement Type : Radiated Field
Polarisation : Horizontal
Table Angle : 0 - 360°
Antenna Height : 1m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05)
Remarks : Peak detector sweep



Operator: B. Itzcovich
Date/Time: 29.05.2015 16:44
Filename:
36_RE_18-
26G5_TX3f_0005_H_FCC.png/.txt

6.11 Spurious emission receive & standby mode - radiated**6.11.1 30 MHz to 1 GHz**

Test site: ☐ semi-anechoic chamber (foam) ☐ open test site
☒ semi-anechoic chamber (ferrites) ☐

Distance: ☒ 3 m ☐ 10 m ☐ 30 m

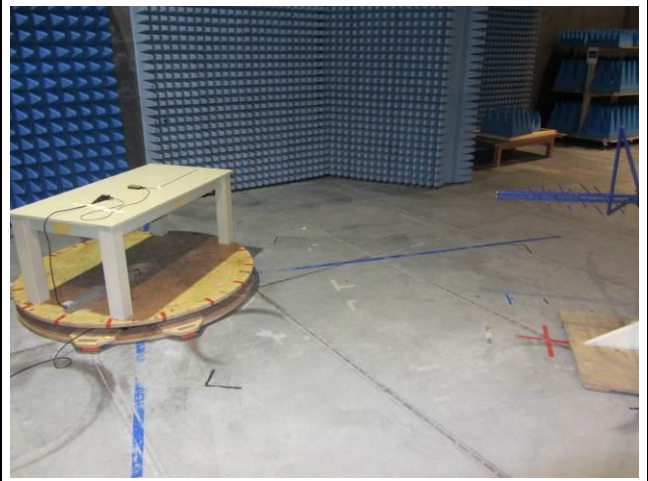
Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.6 dB (30 - 300 MHz) / ± 3.7 dB (300 - 1000 MHz)

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value of all the disturbances appearing while the apparatus is under test. The peak values are recorded continuously on the graph. The values exceeding a limit are re-measured manually using a receiver.

Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: - Limit values expressed in dB μ V/m and transformed to a measuring distance of 3m (factor used = 20 dB/decade) if necessary
 e.g.: for $f = 40$ MHz the limit is 100 μ V/m at 3 m;

$$20 \log \left(\frac{100 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) = 40 \frac{dB\mu V}{m} \text{ at } 3m$$

Test equipment:

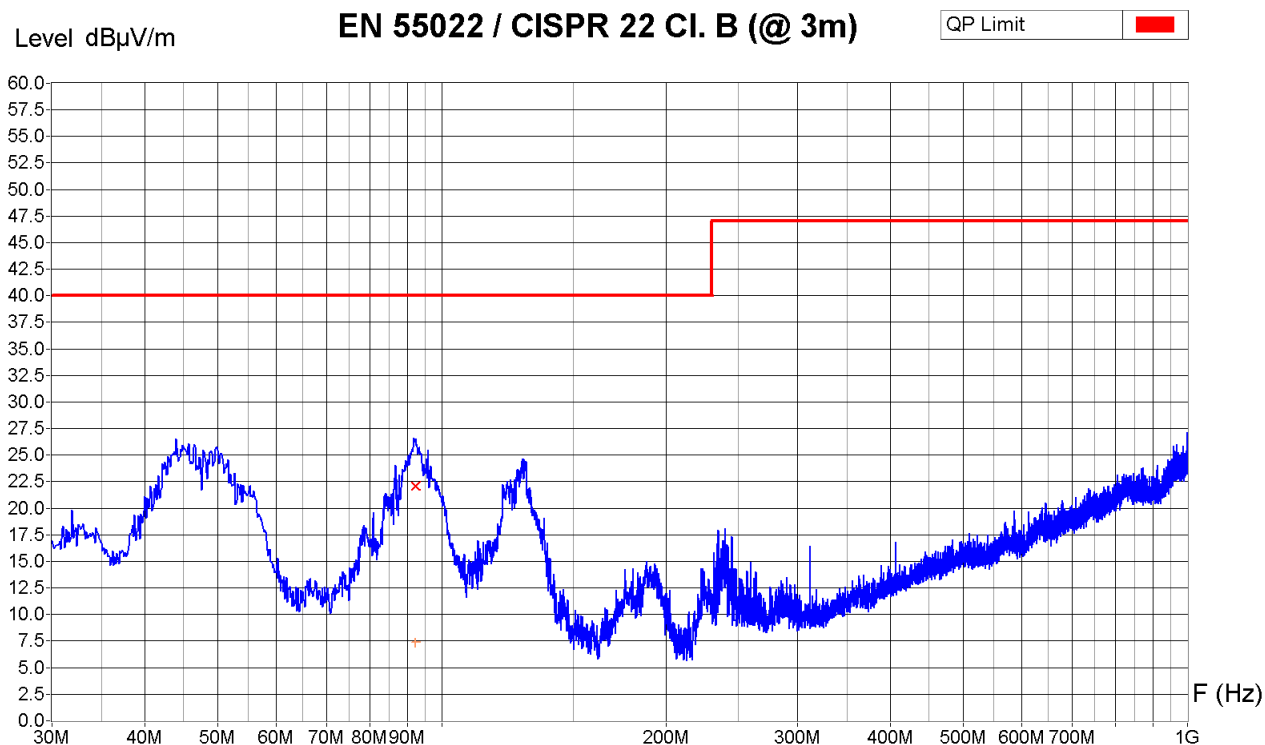
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☒ 10-70		
Preamplifier	☐ 90-01	☐ 95-86	☐ 05-56	☒ 05-59	☐ 05-62	
Antenna (bilog)	☒ 94-03	☐ 05-38				
Cables	☒ 06-01					

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
 Polarisation : Vertical
 Table Angle : 0 - 360°
 Antenna Height : 1 - 4m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : RX (f = 2.440 GHz), charging
 Remarks : Cage 06-01



Zone	30 MHz - 1 GHz
Video Bandwidth	300 KHz
Resol Bandwidth	120 KHz

Receiver Measures

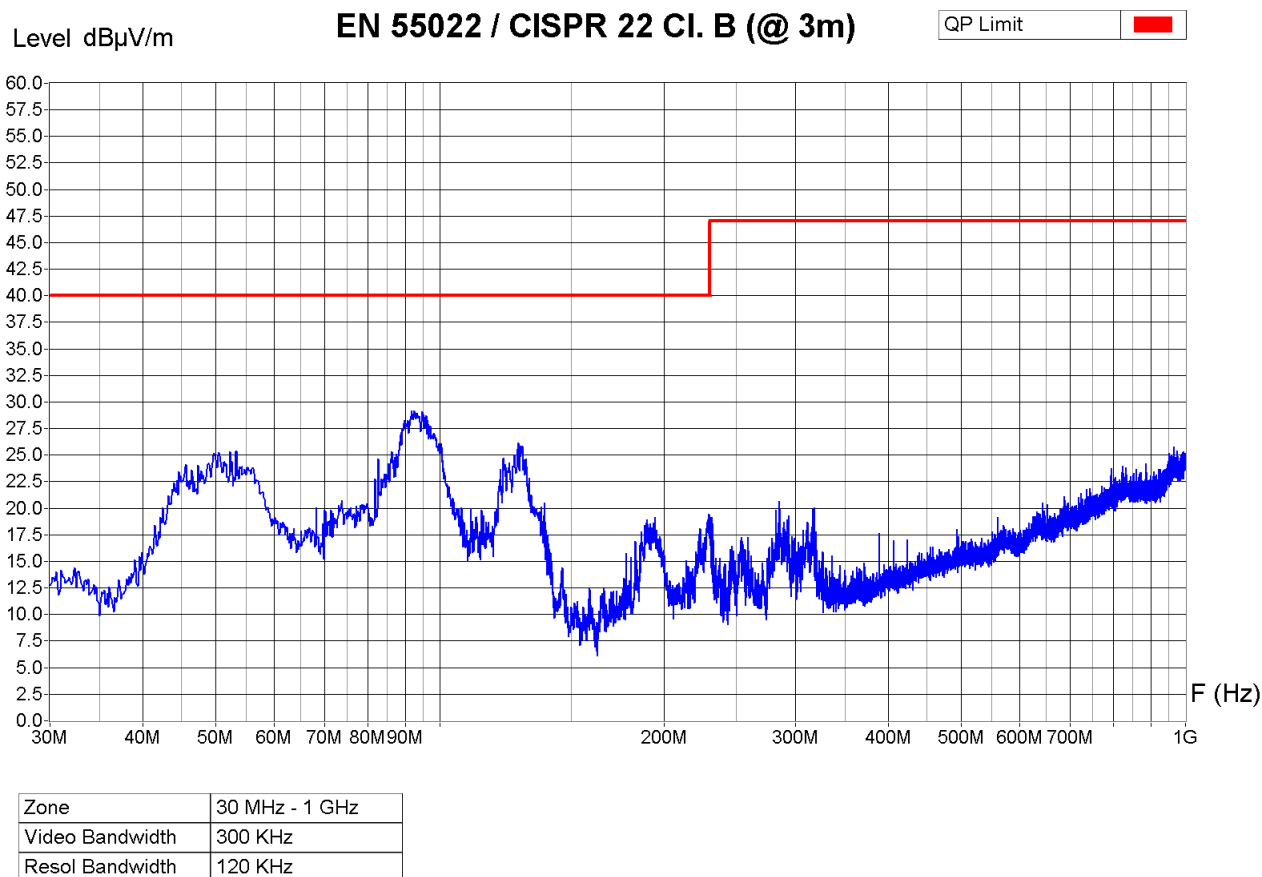
Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
92.15 MHz	29.4 dBμV/m	22.1 dBμV/m	7.4 dBμV/m	17.9 dB

Operator: B. Itzcovich
 Date/Time: 27.05.2015 11:49
 Filename:
 03_RE_30M-1G_RX_V_C22.png/
 .txt

Measurement Type : Radiated Field
Polarisation : Horizontal
Table Angle : 0 - 360°
Antenna Height : 1 - 4m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : RX (f = 2.440 GHz), charging
Remarks : Cage 06-01

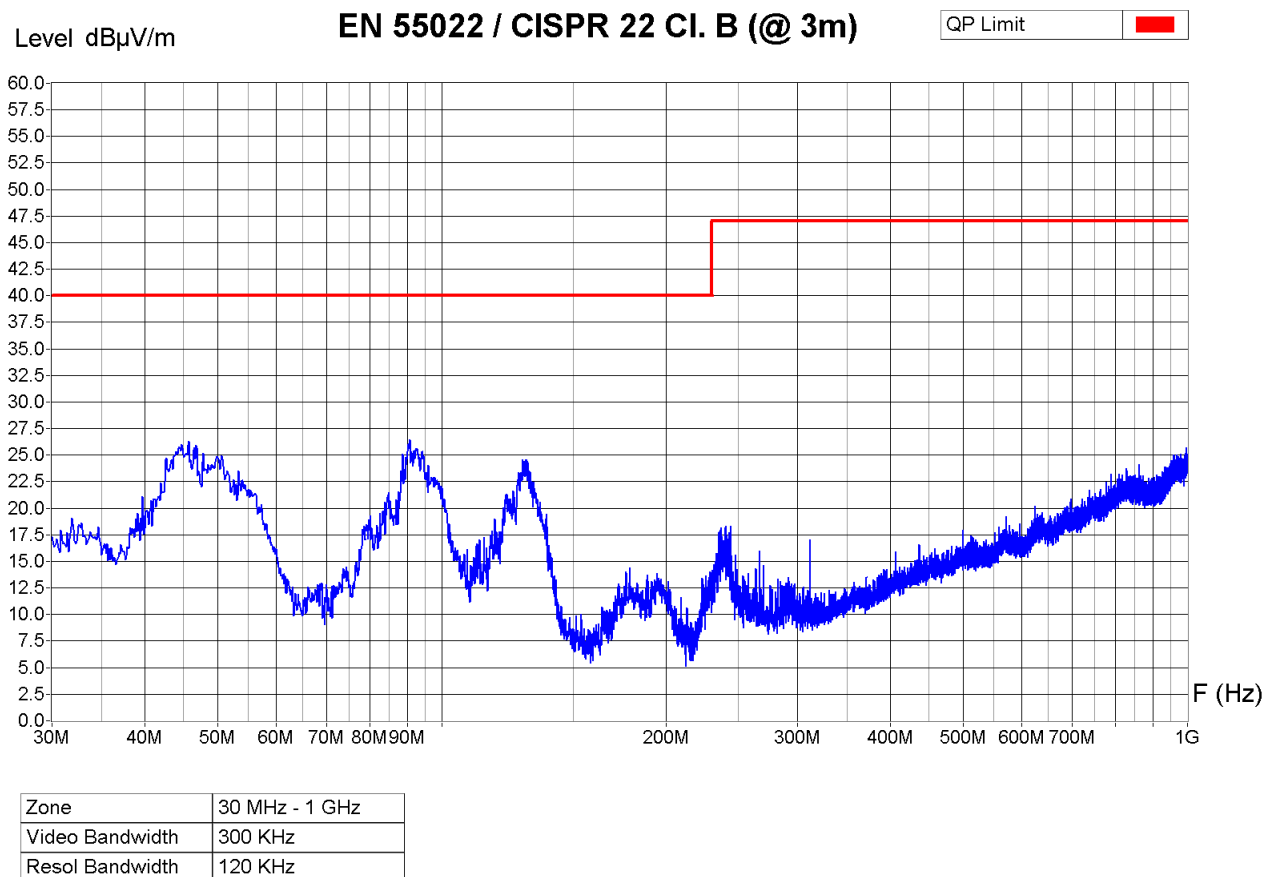


Operator: B. Itzcovich
Date/Time: 27.05.2015 11:41
Filename:
04_RE_30M-1G_RX_H_C22.png/
.txt

Measurement Type : Radiated Field
 Polarisation : Vertical
 Table Angle : 0 - 360°
 Antenna Height : 1 - 4m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Standby, charging
 Remarks : Cage 06-01

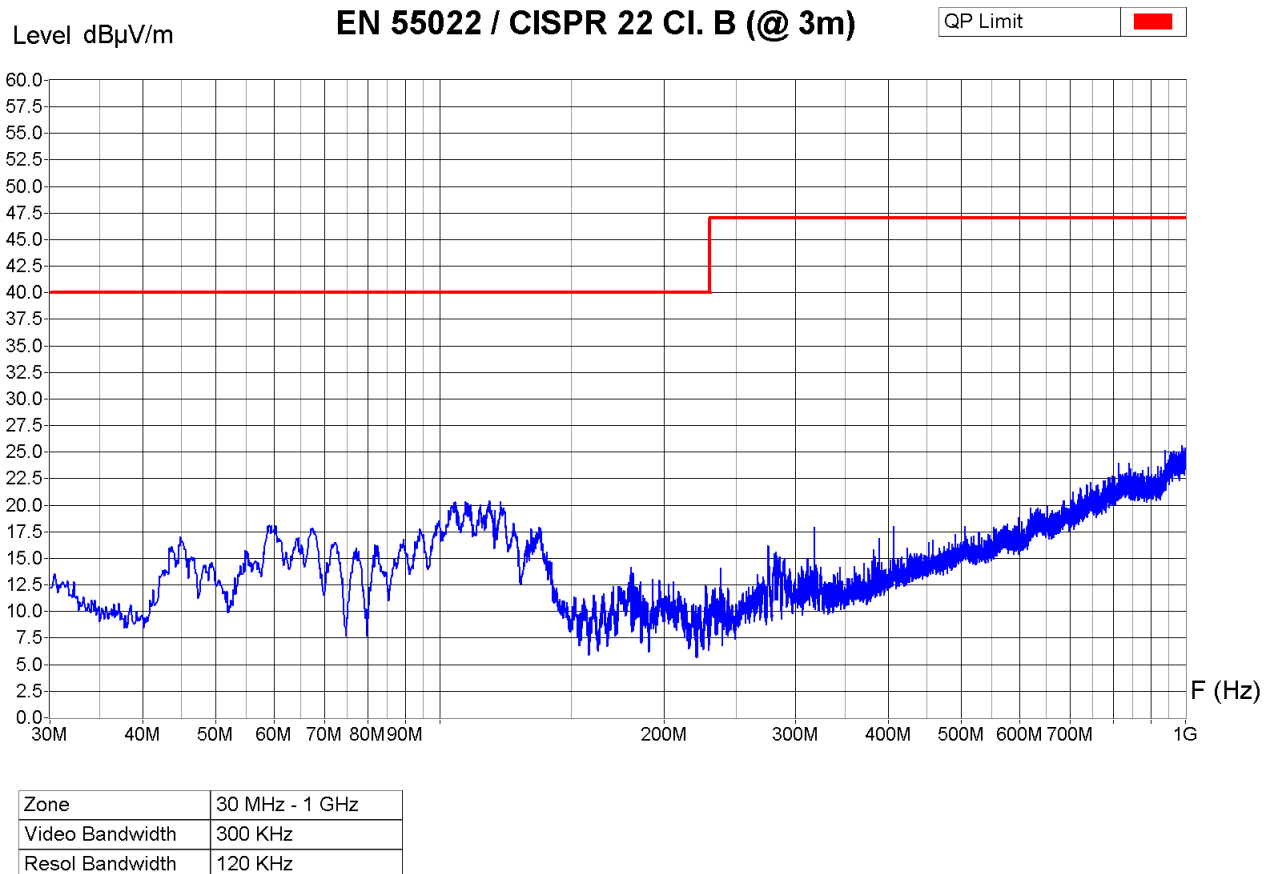


Operator: B. Itzcovich
 Date/Time: 27.05.2015 13:51
 Filename:
 05_RE_30M-
 1G_Stby_V_C22.png/.txt

Measurement Type : Radiated Field
Polarisation : Horizontal
Table Angle : 0 - 360°
Antenna Height : 1 - 4m



Equipment Under Test : Titania Pass-around V3.1 (TX20), Proto #20
Set-Up : With charger and USB cable connected, see photos
Operating Conditions : Standby, charging
Remarks : Cage 06-01



Operator: B. Itzcovich
Date/Time: 27.05.2015 10:25
Filename:
06 RE_30M-
1G_Stby_H_C22.png/.txt

6.11.2 1 GHz to 13 GHz

Test site: ☐ semi-anechoic chamber (ferrites) ☒ semi-anechoic chamber (foam)

Distance: ☒ 1 m ☐ 3 m ☐ 10 m ☐ 30 m

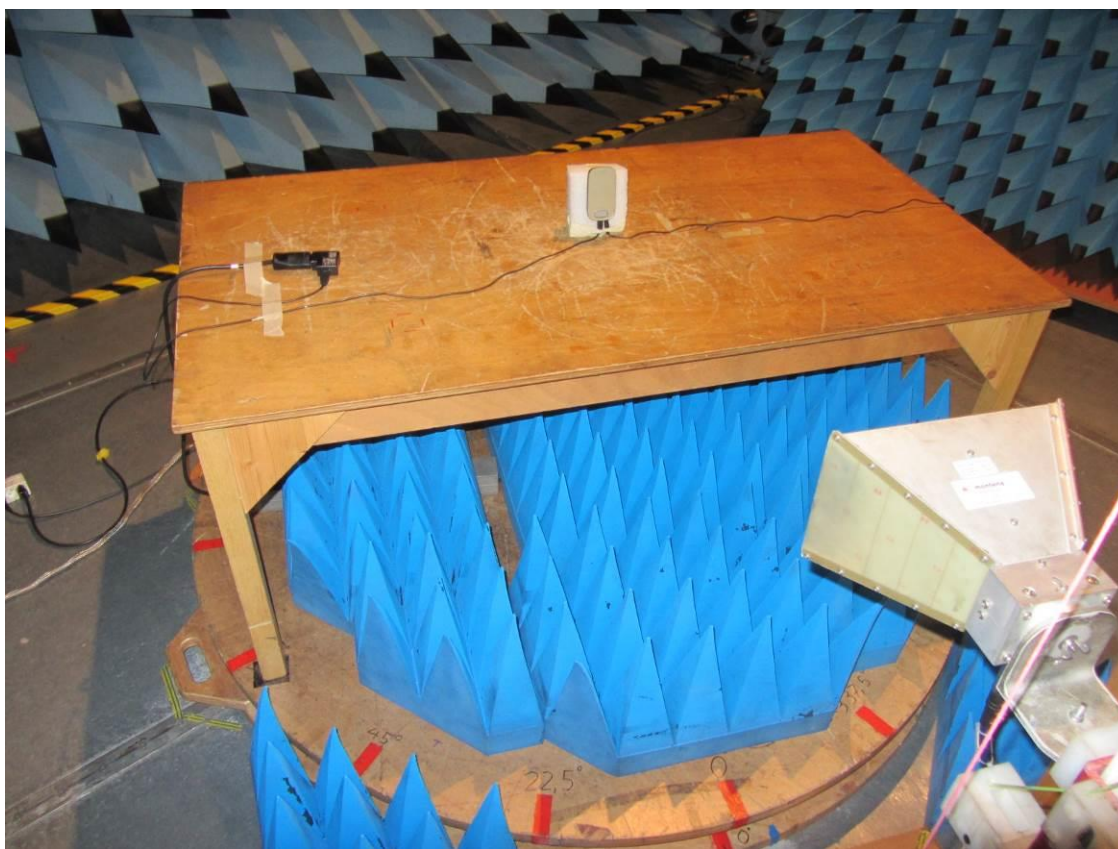
Position of EUT: 0.8 m (height of the equipment under test above floor)

Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyser and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarisations. The turning table is operated through 360° during the measurements. The recordings are carried out taking into account the maximum value (peak) of all the disturbances appearing while the apparatus is under test.

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: Limit values expressed in dB μ V/m and transformed to a measuring distance of 1m (factor used = 20 dB/decade) if necessary
e.g.: for f = 1 GHz the limit is 500 μ V/m at 3 m;

$$20 \log \left(\frac{500 \frac{\mu V}{m}}{1 \frac{\mu V}{m}} \right) + 20 \log \left(\frac{3m}{1m} \right) = 63.5 \frac{dB\mu V}{m} \text{ at } 1m$$

Test equipment:

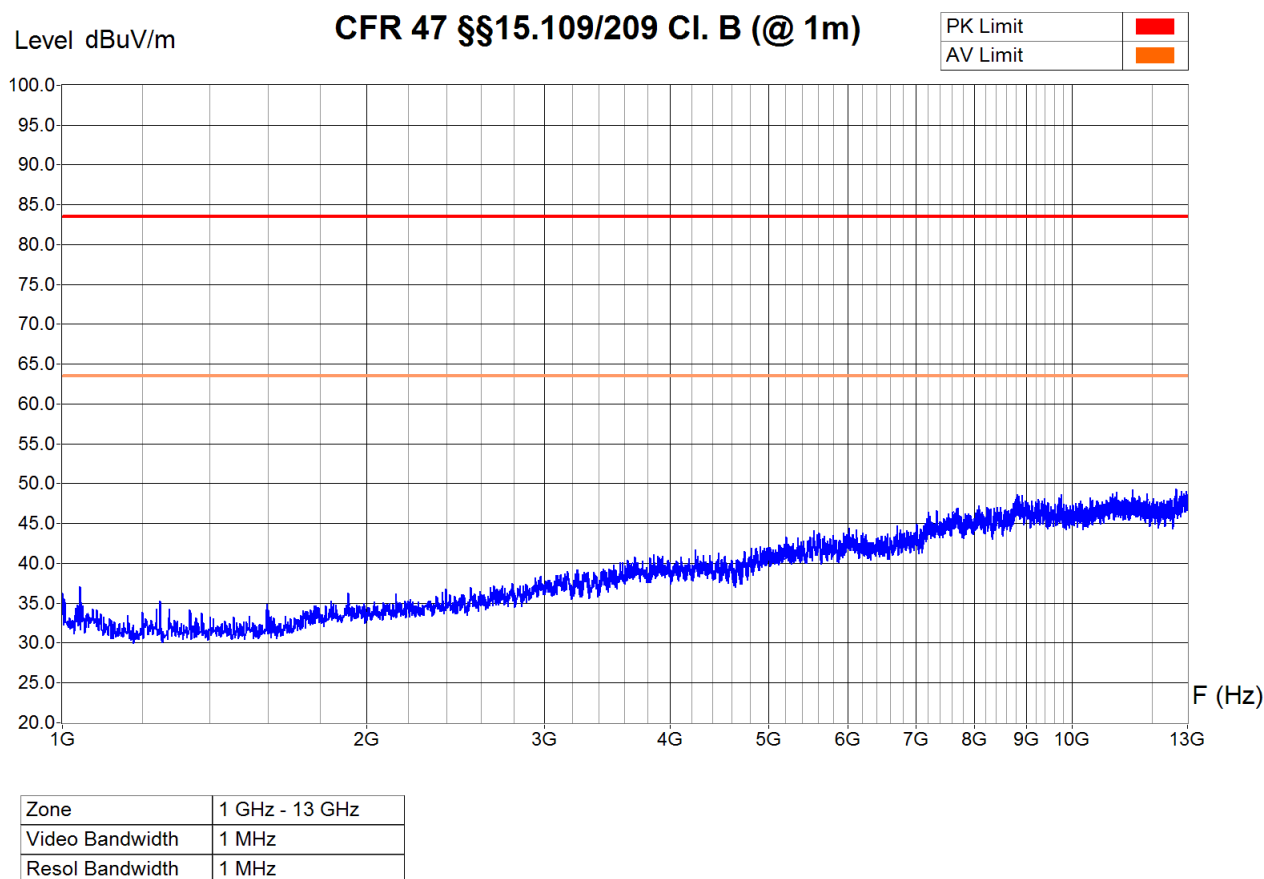
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Preamplifier	☐ 05-56	☐ 05-87	☒ 11-29			
Antenna (horn)	☒ 90-24	☐ 07-31				
Cables	☒ 10-75	☒ 11-61				
Filters	☐ 13-14	☐ 10-66	☐ 11-08	☐ 12-06		

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Radiated Field
Polarisation : Vertical
Table Angle : 0 - 360°
Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : RX (f = 2.44 GHz)
Remarks : Peak detector sweep

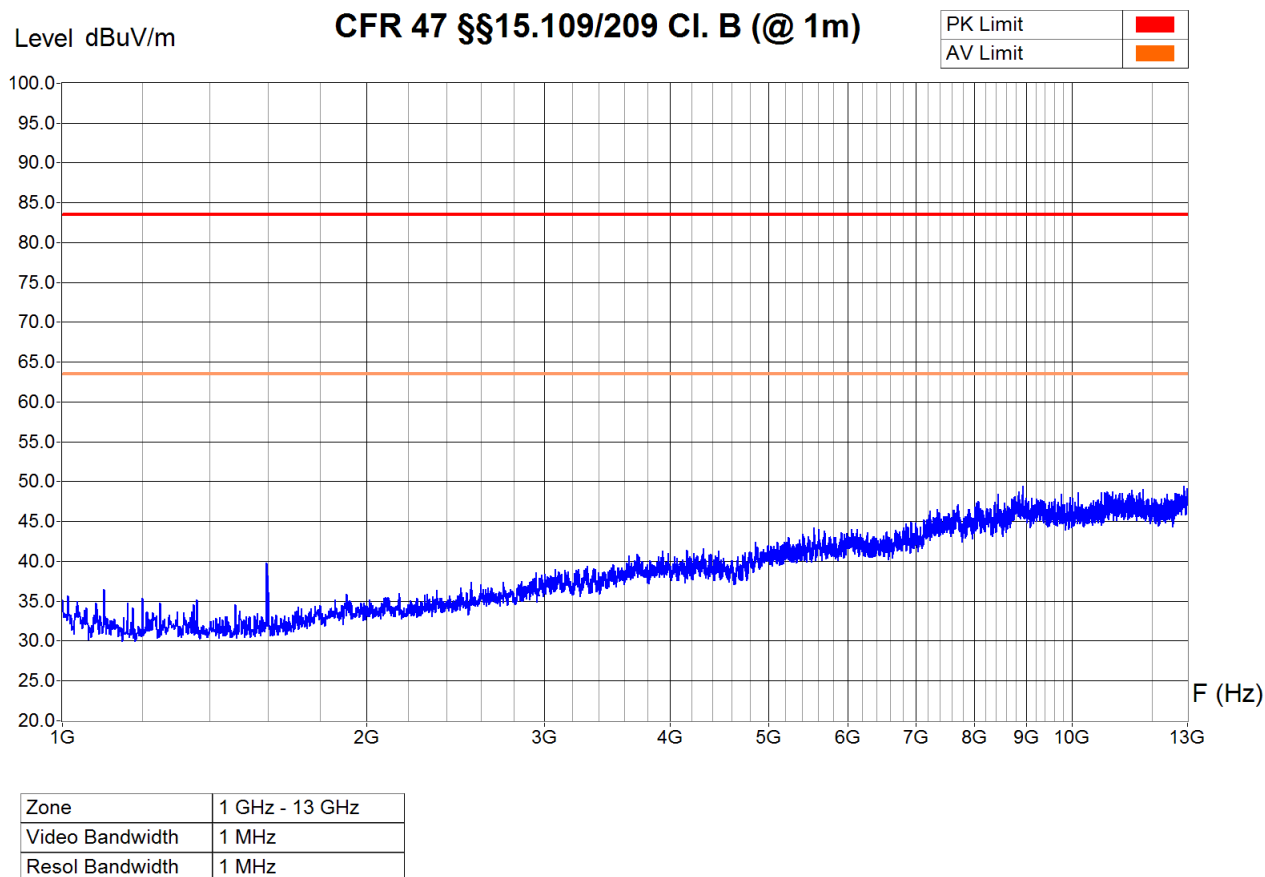


Operator: B. Itzcovich
Date/Time: 10.06.2015 14:17
Filename:
37_RE_1-13G_RX_V_FCC.png/
.txt

Measurement Type : Radiated Field
Polarisation : Horizontal
Table Angle : 0 - 360°
Antenna Height : 1 - 2m



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
Set-Up : With charger, USB and audio cables connected, see photos
Operating Conditions : RX (f = 2.44 GHz)
Remarks : Peak detector sweep



Operator: B. Itzcovich
Date/Time: 10.06.2015 14:22
Filename:
38_RE_1-13G_RX_H_FCC.png/
.txt

6.12 Conducted emission - Interference voltage

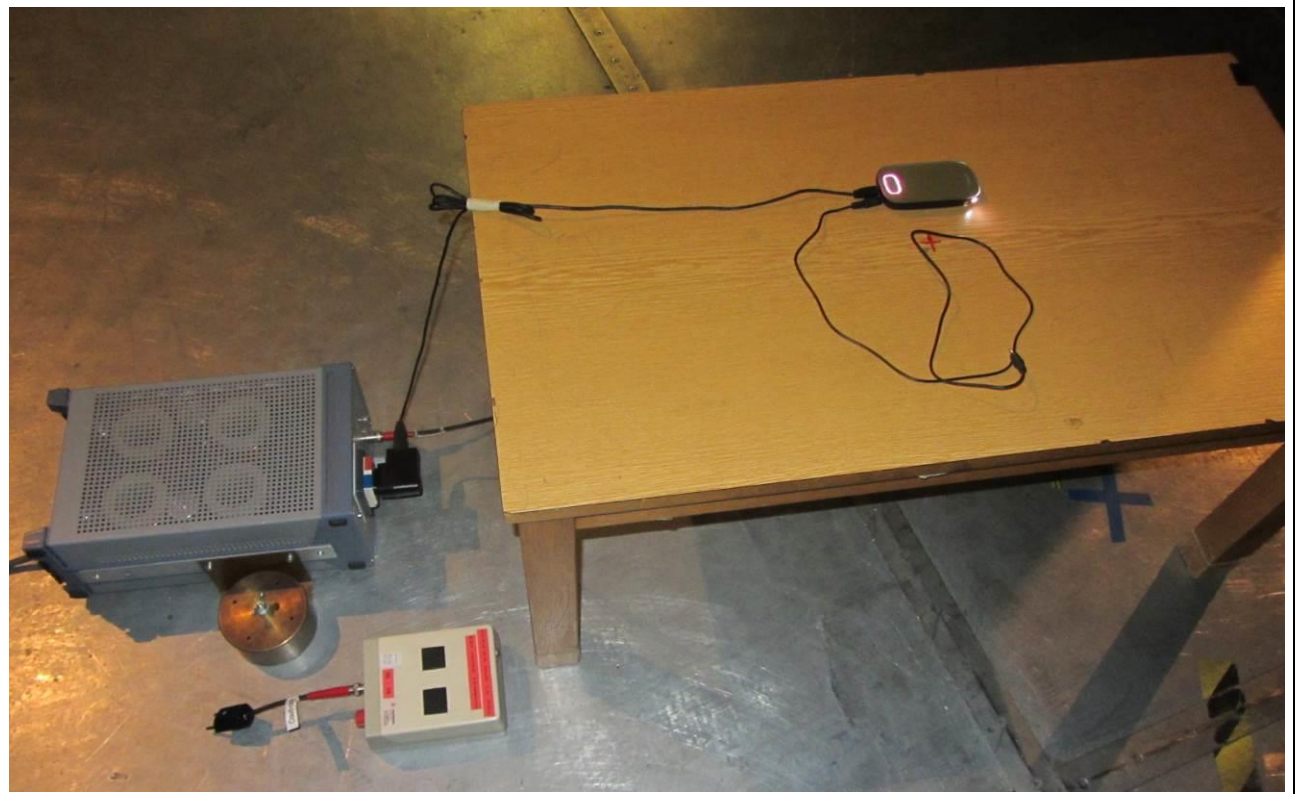
Test site: ☒ semi-anechoic chamber (foam) ☐ shielded room
☐ Semi-anechoic chamber (ferrites) ☐ laboratory

Meas. uncertainty: ± 3.6 dB

Measuring method: The conducted disturbance is measured using a spectrum analyser and a line impedance substitution network (LISN). The measurement of the voltage against the earth is carried out successively. The peak values are recorded continuously on the graph. The values that exceed the limit are re-measured with a measuring receiver.

Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Test set-up:



Remarks: ---

Test equipment:

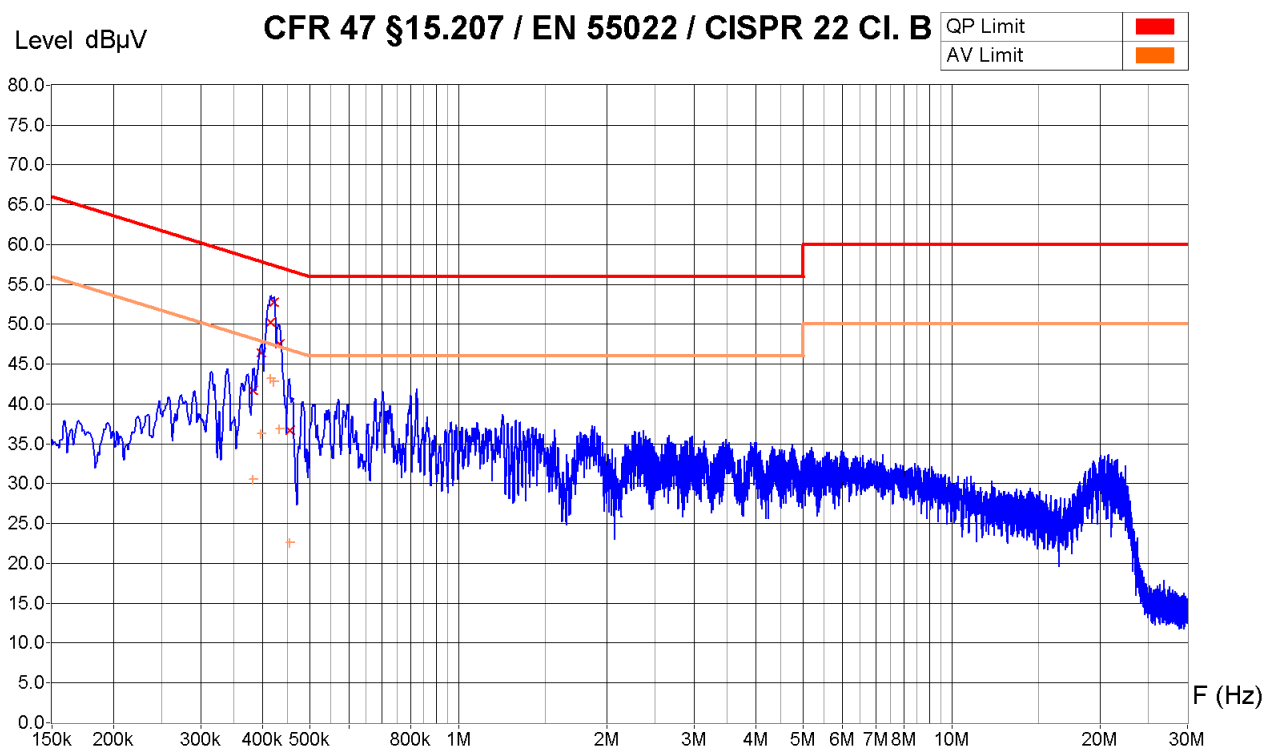
Spectrum analyser	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Receiver	☐ 85-12	☐ 90-11	☒ 94-34	☐ 04-28	☐ 06-29	
LISN	☐ 85-13	☐ 90-08	☐ 94-36	☐ 94-40	☐ 95-12	☒ 00-43
Protection 10 dB	☐ 95-33	☐ 95-35	☐ 95-36	☐ 96-38	☐ included in LISN	
Protection 20 dB	☐ 91-46	☐ 95-33	☐ 95-38	☐ included in LISN		
Variable transformer	☒ 75-04					
Multimeter	☒ 91-40					
Cables	☒ 06-00	☒ 10-41	☒ 06-206			

Result: ☒ pass ☐ fail ☐ not applicable ☐ not tested

Measurement Type : Voltage Interference
 Supply : Line 1
 Other : Charger Mains 115V / 50 Hz



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05), charging
 Remarks :



Zone	150 KHz - 6 MHz	6 MHz - 30 MHz
Video Bandwidth	30 KHz	30 KHz
Resol Bandwidth	9 KHz	9 KHz

Receiver Measures

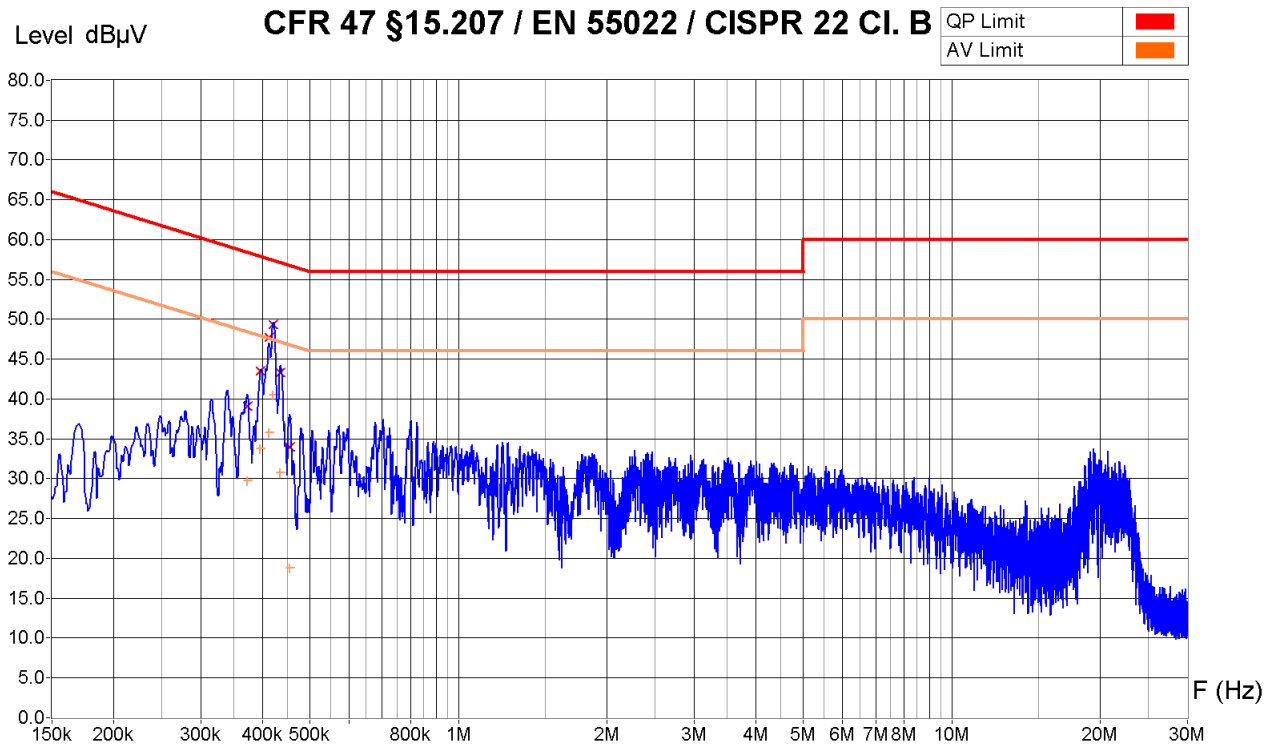
Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
383.50 KHz	45.3 dBμV	41.7 dBμV	30.6 dBμV	16.5 dB
398 KHz	47.9 dBμV	46.4 dBμV	36.3 dBμV	11.5 dB
416.10 KHz	54.2 dBμV	50.2 dBμV	43.2 dBμV	7.3 dB
422.40 KHz	53.5 dBμV	52.7 dBμV	42.8 dBμV	4.7 dB
433.40 KHz	49.7 dBμV	47.5 dBμV	36.9 dBμV	9.7 dB
454.80 KHz	42.5 dBμV	36.7 dBμV	22.6 dBμV	20.1 dB

Operator: B. Itzcovich
 Date/Time: 10.06.2015 09:43
 Filename:
 43_CV_150k-30M_115_L.png/.txt

Measurement Type : Voltage Interference
 Supply : Neutral
 Other : Charger Mains 115V / 50 Hz



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05), charging
 Remarks :



Zone	150 KHz - 6 MHz	6 MHz - 30 MHz
Video Bandwidth	30 KHz	30 KHz
Resol Bandwidth	9 KHz	9 KHz

Receiver Measures

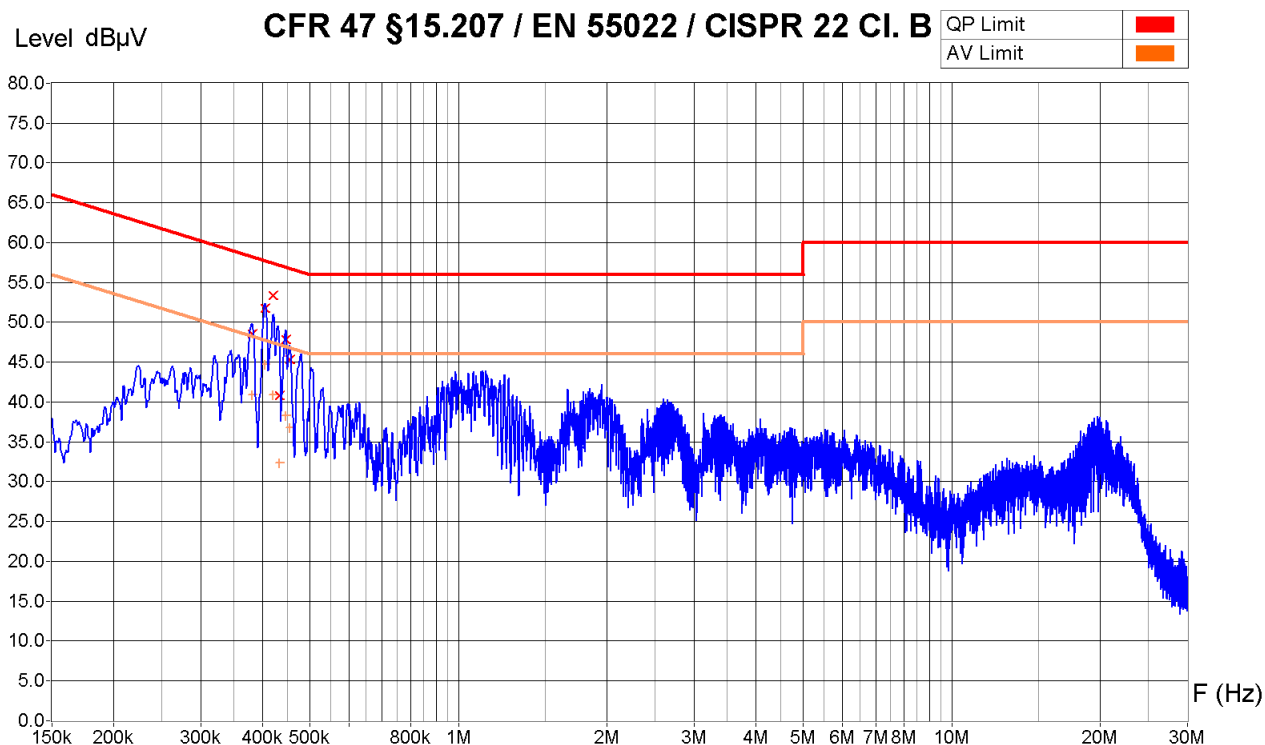
Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
373.70 KHz	41.8 dBμV	39.1 dBμV	29.8 dBμV	19.3 dB
396.50 KHz	45.9 dBμV	43.5 dBμV	33.8 dBμV	14.4 dB
413 KHz	51.1 dBμV	47.7 dBμV	35.8 dBμV	9.9 dB
420.80 KHz	51.6 dBμV	49.4 dBμV	40.5 dBμV	8.1 dB
435 KHz	47.2 dBμV	43.3 dBμV	30.7 dBμV	13.9 dB
454.90 KHz	40.1 dBμV	34.0 dBμV	18.8 dBμV	22.8 dB

Operator: B. Itzcovich
 Date/Time: 10.06.2015 09:34
 Filename:
 44_CV_150k-30M_115_N.png/.txt

Measurement Type : Voltage Interference
 Supply : Line 1
 Other : Charger Mains 230V / 50 Hz



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05), charging
 Remarks :



Zone	150 KHz - 6 MHz	6 MHz - 30 MHz
Video Bandwidth	30 KHz	30 KHz
Resol Bandwidth	9 KHz	9 KHz

Receiver Measures

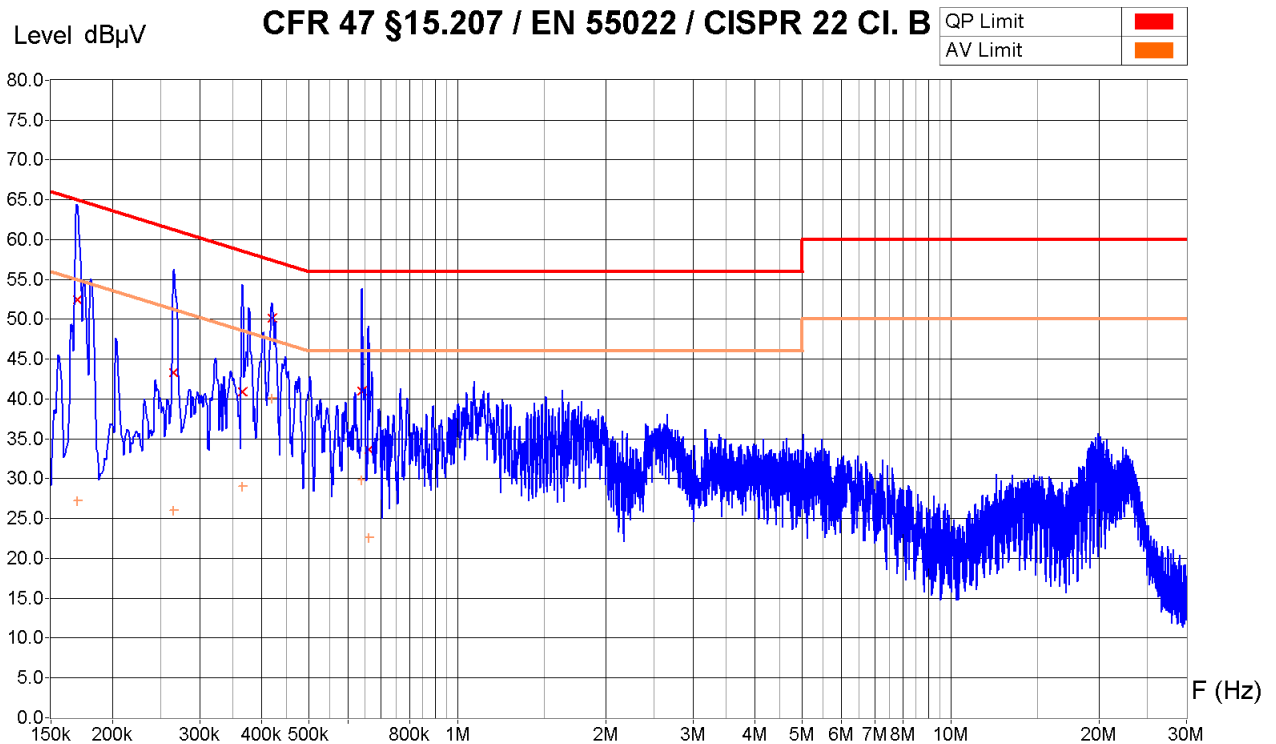
Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
381.70 KHz	50.5 dBμV	48.5 dBμV	40.9 dBμV	9.7 dB
405.50 KHz	53.2 dBμV	51.7 dBμV	44.7 dBμV	6.0 dB
420.80 KHz	55.0 dBμV	53.3 dBμV	40.9 dBμV	4.1 dB
433.40 KHz	52.6 dBμV	40.8 dBμV	32.4 dBμV	16.4 dB
446.50 KHz	62.8 dBμV	47.8 dBμV	38.3 dBμV	9.1 dB
454.90 KHz	50.0 dBμV	45.3 dBμV	36.8 dBμV	11.4 dB

Operator: B. Itzcovich
 Date/Time: 10.06.2015 09:08
 Filename:
 41_CV_150k-30M_230_L.png/.txt

Measurement Type : Voltage Interference
 Supply : Neutral
 Other : Charger Mains 230V / 50 Hz



Equipment Under Test : Titania Hub V3.1 (TX21), Proto #02
 Set-Up : With charger, USB and audio cables connected, see photos
 Operating Conditions : Hopping TX (f = 2.402 / 2.440 / 2.480 GHz), modulated, Pmax (00, 05), charging
 Remarks :



Zone	150 KHz - 6 MHz	6 MHz - 30 MHz
Video Bandwidth	30 KHz	30 KHz
Resol Bandwidth	9 KHz	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
169.50 KHz	73.4 dBμV	52.5 dBμV	27.2 dBμV	12.5 dB
265.60 KHz	69.1 dBμV	43.3 dBμV	26.0 dBμV	17.9 dB
366.80 KHz	56.6 dBμV	40.9 dBμV	29.1 dBμV	17.7 dB
420.80 KHz	64.4 dBμV	50.2 dBμV	40.1 dBμV	7.3 dB
640 KHz	56.9 dBμV	41.0 dBμV	29.8 dBμV	15.0 dB
660 KHz	55.3 dBμV	33.7 dBμV	22.7 dBμV	22.3 dB

Operator: B. Itzcovich
 Date/Time: 10.06.2015 09:18
 Filename:
 42_CV_150k-30M_230_N.png/.txt

6.13 Designation of emission

Standard: United States: 47 CFR "Code of Federal Regulations" – Telecommunication
☒ FCC Part 2, Subpart C: Emission: §2.201 and §2.202

Introduction: A system of designating emission, modulation and transmission characteristics shall be employed.

(a) Emissions are designated according to their classification and their necessary bandwidth.

(b) A minimum of three symbols are used to describe the basic characteristics of radio waves.

(c) Four symbols are used to describe the necessary bandwidth.

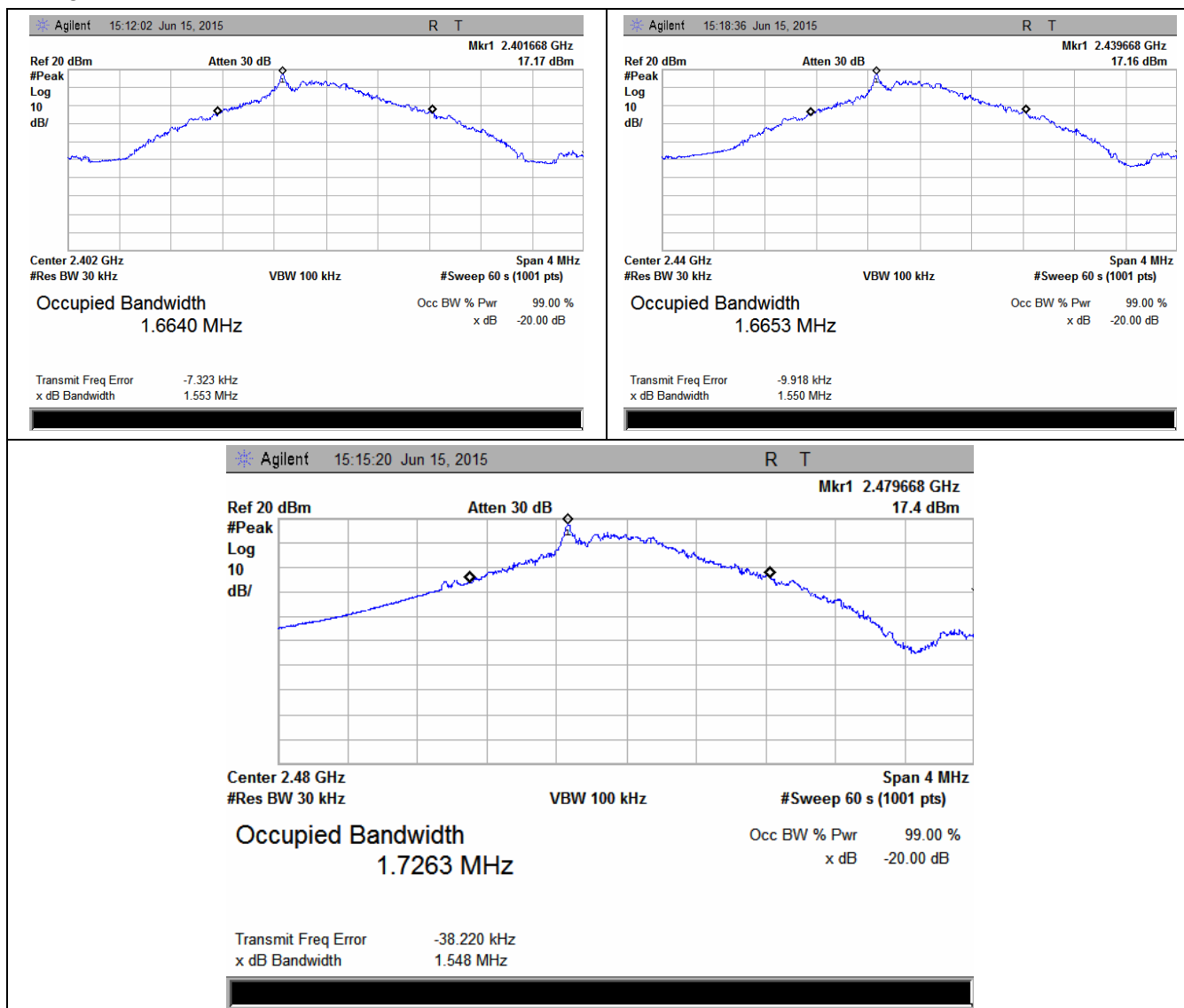
Modifications: ☐ None ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Necessary bandwidth: For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specified conditions.

$B_n = 1.73$ MHz (occupied bandwidth)

Basic characteristics: FXD F : frequency modulation
 X : Cases not otherwise covered
 D : data transmission

Designation of emission: 1M73FXD



Place and date of test:
 Operator:

Rossens, June 15, 2015
 B. Itzcovich

7. Modifications on the EUT

7.1 Level: 1

May 28, 2015 14:00 - change of software settings: max. transmit power decreased by 1 dB

7.2 Level: 2

December 4, 13:00 – software improved (SVN 9293):

To achieve single channel transmit at Duty 100% (max. power) for Restricted Band-Edge (§ 6.8) test

8. Appendix

8.1 Test equipment

Inventory No.	Designation	Manufacturer	Type	Serial No.	Cal. date	Next calibr.	Cal. period [year]
90-25	Loop antenna	Chase	HLA6120	002	11 Mar. 2014	11 Mar. 2016	2
94-03	Bi-Log antenna	Chase	CBL6111	1056	03 Sep. 2014	03 Sep. 2016	2
90-24	Horn antenna	Emco	3115	9008-3514	09 Jul. 2015	09 Jul. 2017	2
90-24	Horn antenna	Schwarzbeck	BBHA 9120 D	9120D-632	29 Aug. 2014	29 Aug. 2016	2
98-12	Horn Antenna + Preamp. + Mixer	Emco + Miteq + Hewlett Packard	3160-09 + JDM2W-18002650- 27-10P-R + 11970K	9809-1121 + 1707479 + 232A01295	17 Aug. 2012	17 Aug. 2017	5
00-52	Dipole antenna	Schwarzbeck	UHA 9125 D	112	28 Feb. 2013	28 Feb. 2018	5
13-05	BP Filter	Telemeter Electronic	11SB10- 12000/T12000-O/O	2	19 Mar. 2015	19 Mar. 2017	2
13-14	Filter	A-INFOMW	Cavity Band Reject Filter	J10811304070 02	25 July 2014	25 July 2016	2
05-59	Preamplifier	Montena EMC	AM-1300	432972	19 Aug. 2014	19 Aug. 2016	2
11-29	Preamplifier	Montena EMC	AFS42-00101800- 25-S-42	1275133	24 Sep. 2014	24 Sep. 2016	2
13-16	Signal Generator	AnaPico AG	APSiN20G-HC	121-21... 0-0096	2 Sep. 2015	2 Sep. 2017	2
06-00	Cable	Huber&Suhner	ST18A ST18A SF106PA	6224/18A 8399/18A 463/6PA	19 Nov. 2014	19 Nov. 2015	1
06-01	Cable	Huber&Suhner	SF106PA SF106PA SF106PA	415/6PA 414/6PA 412/6PA	19 Dec. 2014	19 Dec. 2015	1
06-206	Cable	Huber&Suhner	RG223U	-	18 Dec. 2014	18 Dec. 2016	2
10-41	Cable	Huber&Suhner	RG214U	-	18 Dec. 2014	18 Dec. 2016	2
10-75	Cable	Huber&Suhner	ST18A	8385/18A	19 Dec. 2014	19 Dec. 2016	2
10-79	Cable	Huber&Suhner	ST18A	8444/18A	19 Dec. 2014	19 Dec. 2016	2
10-81	Cable	Huber&Suhner	SF104P	44159/4P	19 Dec. 2014	19 Dec. 2016	2
11-45	Cable	Huber&Suhner	SF106P	3729/6P	19 Dec. 2014	19 Dec. 2016	2
11-61	Cable	Huber&Suhner	SF106PA	413/6PA	19 Dec. 2014	19 Dec. 2016	2
11-62	Cable	Huber&Suhner	SF104P	51338/4P	19 Dec. 2014	19 Dec. 2016	2
00-43	LISN	Rohde&Schwarz	ESH3-Z5	890 604/026	17 Mar. 2015	17 Mar. 2017	2
07-53	Spectr. Analyzer	Hewlett Packard	E4407B	SG45101517	30 Oct. 2014	30 Oct. 2016	2
10-70	Receiver + Spectr. Analyzer	Rohde&Schwarz	ESU8	1302.6005K08	13 Oct. 2014	13 Oct. 2016	2
94-34	Receiver	Rohde&Schwarz	ESHS10	835 499/002-94	17 Jan. 2014	17 Jan. 2016	2
07-46	Power sensor	Hewlett Packard	8481A	1550A11467	24 Oct. 2013	24 Oct. 2017	4
04-96	Wattmeter	Hewlett Packard	437B	2949A02939	10 Sep. 2015	10 Sep. 2017	2
91-40	Multimeter	Fluke	87 True RMS	51300158	5 Mar. 2014	5 Mar. 2016	2
06-62	Power supply	Elektro-Automatik	EA-PS 2016-050	2006100338	NO CAL	NO CAL	-
99-07	Power supply	Coutant Electronics	LA 200.2	-	NO CAL	NO CAL	-
75-04	Transformer	Variac	W10HMT	-	NO CAL	NO CAL	-

Remark: The test equipment for which no calibration date is defined, is controlled during the test by another calibrated equipment. E.g. the output of a power supply with variable transformer is verified by a calibrated multimeter.