Test laboratory accredited according to ISO 17025 by the Swiss Accreditation Service SAS
Laboratoire d'essai accrédité selon ISO 17025 par le Service d'accréditation suisse SAS
Prüflabor akkreditiert nach ISO 17025 durch die Schweizerische Akkreditierungsstelle SAS

Registration number
Numéro d'accréditation
Akkreditierungsnummer
STS 0001
Schweizerischer Prüfstellendienst
Service suisse d'essai
Swiss testing service

Report:	***Electromagnetic compatibility and Radio spectrum Matters***	Report no:	***17-MO-0258.R04***
Product name:	***Roger Select (BT part)***	Mandate no:	***17-MO-0258***
Serial no:	***17XXPM014***	Model number:	***TX27***
Customer:	***Phonak Communications AG*** ***Länggasse 17*** ***3280 Murten*** ***SWITZERLAND***	Date of test:	***December 6 – 15, 2017***

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 without modification of EUT

Test performed by
Mr B. Itzcovich
EMC Test Engineer

Report prepared by
Mr B. Itzcovich
EMC Test Engineer

Report controlled and approved by
Mr T. Houriet
EMC Test Engineer

Rossens, April 10, 2018 (Issue Date)

Main language : *English*

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

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Contents

1. Summary of test results

✓ Pass
✖ Fail
∅ 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 a)	**888 kHz**
6.2	Carrier frequency separation	CFR 47 § 15.247 (a)(1) RSS-247 § 5.1 b)	✓
6.3	Number of hopping channels	CFR 47 § 15.247 (a)(1)(iii) RSS-247 § 5.1 c)	✓
6.4	Time of occupancy (dwell time)	CFR 47 § 15.247 (a)(1)(iii) RSS-247 § 5.1 d)	✓
6.5	Antenna gain & effective radiated power	CFR 47 § 15.247 (b)(4) RSS-247 § 5.4 (2) and (6)	**≤ -0.51 dBi**
6.6	Maximum output power (conducted)	CFR 47 § 15.247 (b)(1) RSS-247 § 5.4 b)	✓
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-Gen Table 6	✓
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	**854KFXD**

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 2, February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3. Client

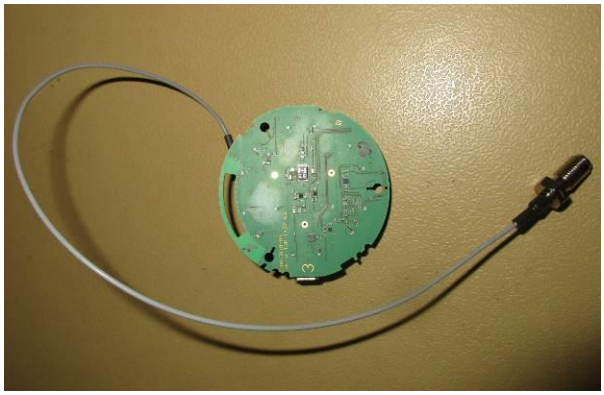
Client name and address	*Phonak Communications AG* *Länggasse 17* *3280 Murten* *SWITZERLAND*
Contact Person	*Mr Josuah Wicht*
Telephone	*+41 26 672 92 78*
Fax	*+41 26 672 93 80*
E-mail	*Josuah.Wicht@phonak.com*
Mandate no	*17-MO-0258*

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 Select (BT part)*
Product description	*Wireless microphone 2.4 GHz*
Model number	*TX27*
Serial no	*17XXPM014*
Software version	*SVN_17000_v.1.0.36358_beta01*
FCC ID IC ID	*FCC: KWCTX27* *IC: 2262A-TX27*
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 = 3.8 V_{DC} / P_{max} = 0.25 W (Lithium Polymer Battery) or* *U = 5 V_{DC} / P_{max} = 2.5 W (USB)*
Dimension	*~55 mm x ~13 mm (Ø 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.*

4.2 Pictures of the EUT



Electronic board with temporary antenna connector

Top view

Bottom view

4.3 Classification

CFR 47 Part 15	☒ Unintentional radiator (Subpart B), Receive 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).

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)	*1 MHz*
Number of channels	*79*
Maximum rated output power	*7.15 dBm (*at transmitter RF output connector)
Variable carrier output	☐ Transmitter carrier output is not variable. RF output: P_{OUT} = ... *mW* ☒ Transmitter carrier output is variable. Max. RF output: $P_{OUT\ MAX}$ = *5.2 mW* Min. RF output: $P_{OUT\ MIN}$ = *0.52 mW* ☐ RF output continuously variable ☒ RF output stepped: *10 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)	*1 MHz*
Number of channels	*79*

4.6 Ports

Port	**Cable**			**Remark**
	Max. length	**Type**	**Screen**	
USB	*≤ 3 m*	*Micro USB*	*Yes*	*Connected to AC adaptor output*
Audio in	*≤ 3 m*	*Jack 3.5 mm stereo*	*Yes*	*External audio input port*

5. Test conditions

5.1 Climatic conditions, location and date

Location	Date	Temp.	Pressure	Rel. humidity
Eurofins Electrosuisse Product Testing AG 1728 Rossens SWITZERLAND	*December 6 - 15, 2017*	*See § 6*		

5.2 Test facility and methodology

The test site is accepted by FCC:
- Test Firm Registration Number: 683197
- Designation Number: CH5001

The test site is accepted by Industry Canada:
- ISED Assigned Code: 3625A
- Ferrite chamber (06-01): 3625A-2
- Foam chamber (06-00): 3625A-3

Conducted and radiated measurements are performed according to the ANSI C63.4-2014 and C63.10-2013 procedures.

5.3 Attendant persons

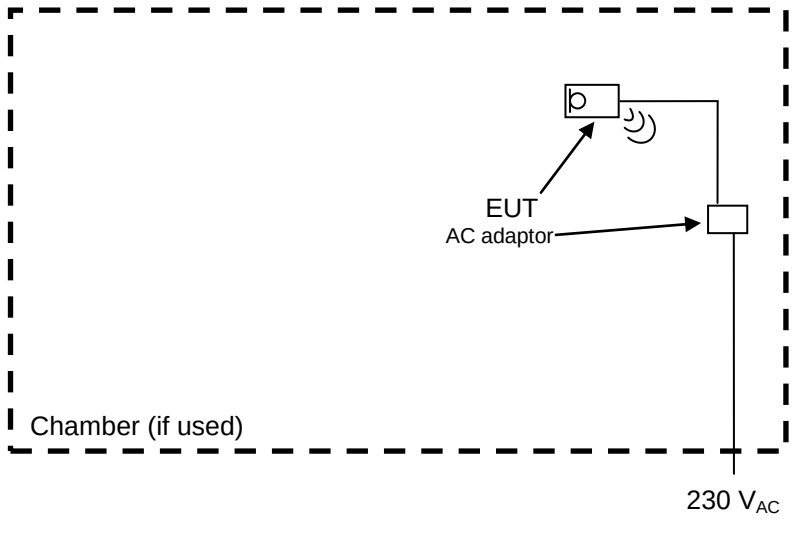
Test Engineer(s):

Mr B. Itzcovich
EMC Test Engineer

Other(s):

Name	Company
Mr Josuah Wicht (partially)	*Phonak Communications AG*

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, 2.441 and 2.480 GHz)*
- *Continuous reception on single frequency (2.44 GHz)*
- *Normal operation: transmission of random data with hopping sequence*

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
AC adaptor	*FLYPOWER*	*PS06H050K 1000EU*	*- - -*	*5 V_{DC} output (USB)*
Cradle	*Phonak*	*Roger Select*	*- - -*	*To provide connectivity with cables*

Cradle + AC Adaptor + cables

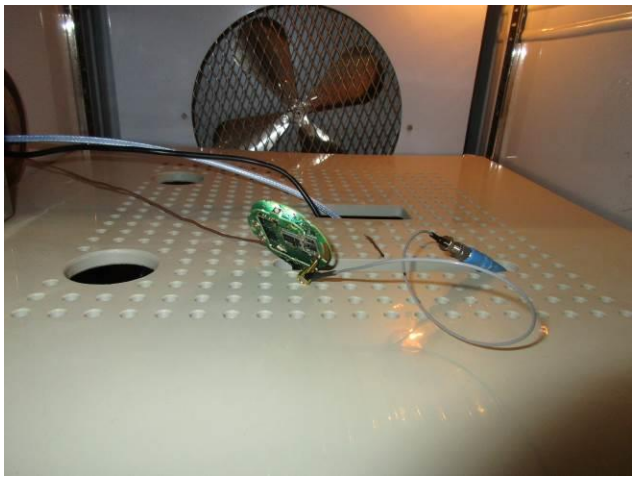
Marking on AC adaptor

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 analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-13					

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Select (BT part), proto 20*

Operating mode: *Single frequencies (2.402, 2.441 and 2.480 GHz), modulated, Pmax*

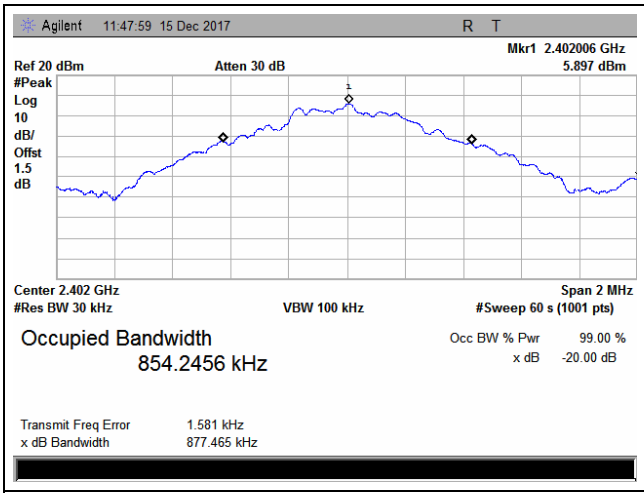
Cables connected to the EUT: *USB and temporary antenna cables*

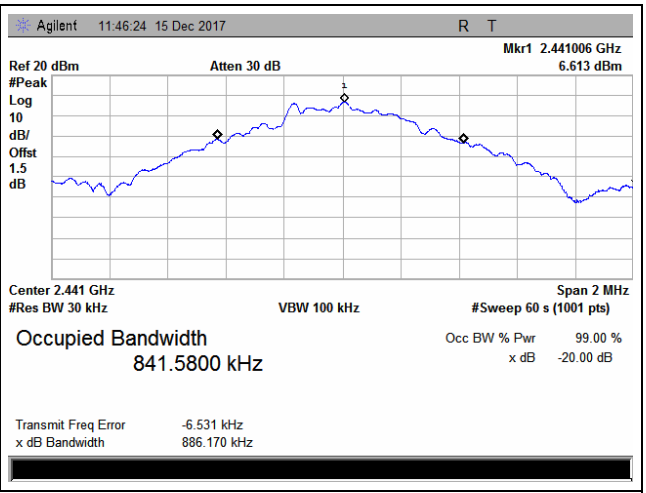
Remarks: *Measured on temporary antenna connector*

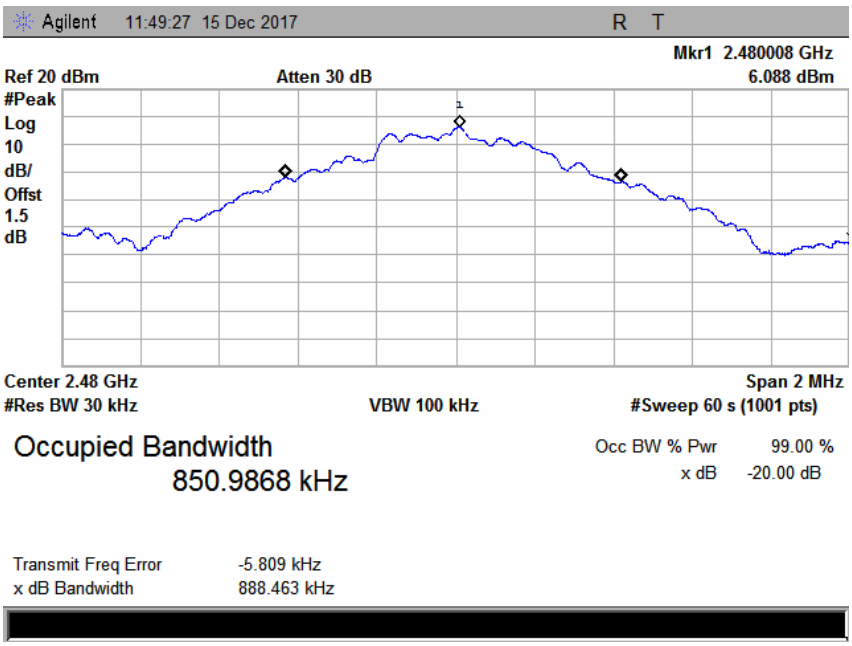
Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 915 - 925 hPa

frequency [GHz]	20 dB bandwidth [kHz]	Remarks
2.402	*877.5*	- - -
2.440	*886.2*	- - -
2.480	*888.5*	- - -





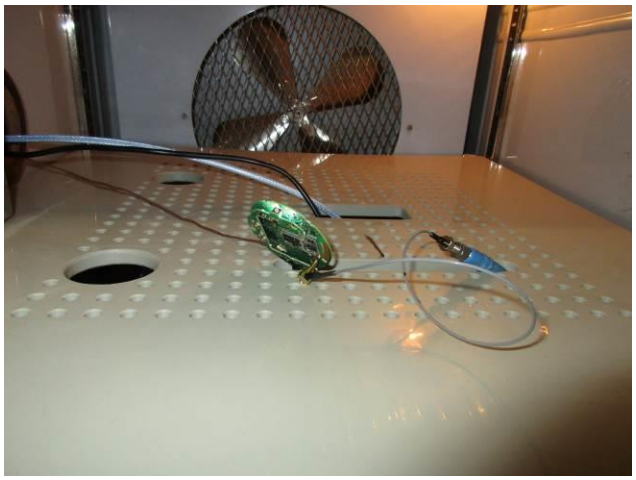


Place and date of test: *Rossens, December 15, 2017*
Operator: *B. Itzcovich*

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:	± 2.6 µHz/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 analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-13					

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

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Select (BT part), proto 20*

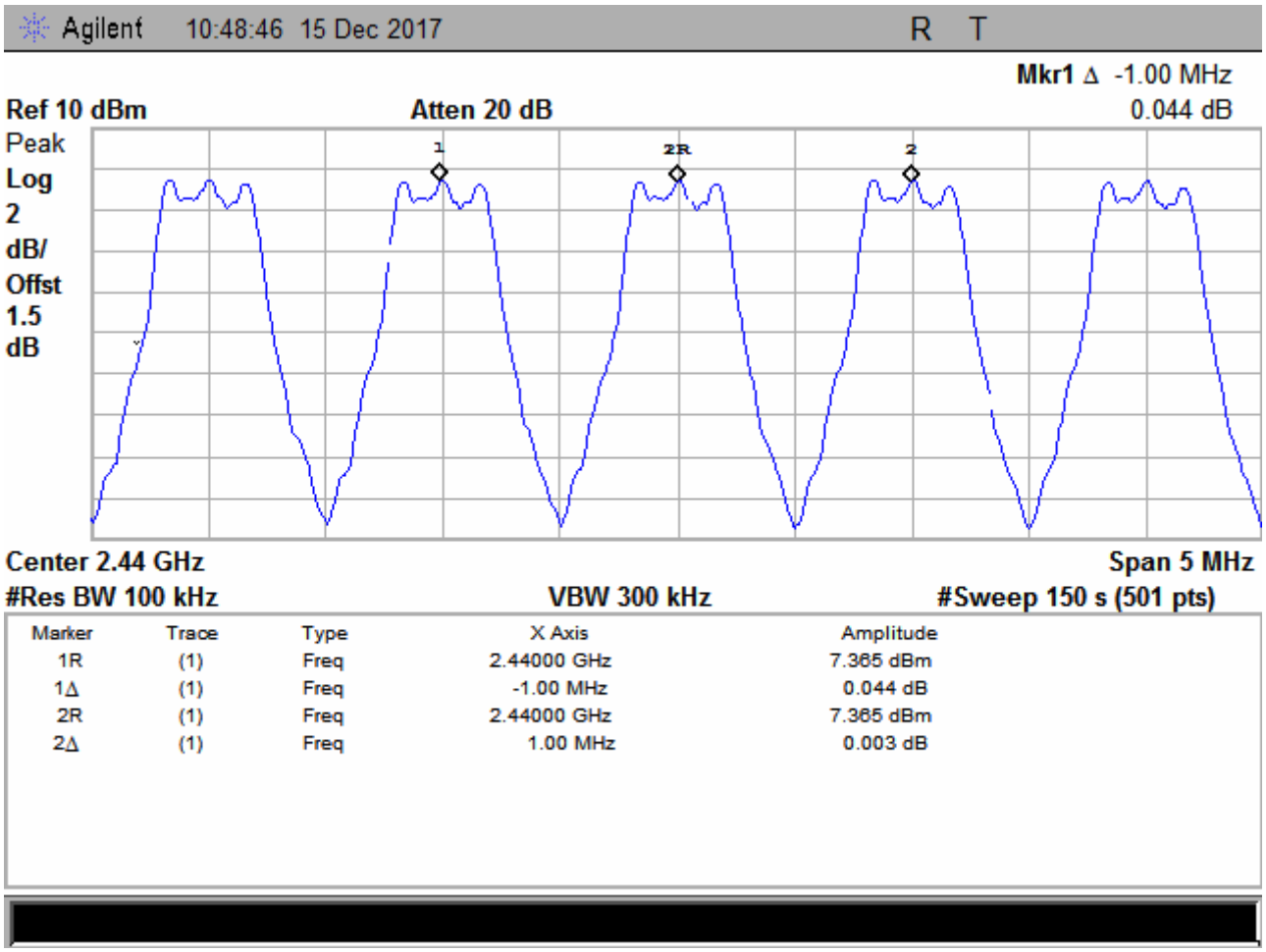
Operating mode: *Continuously hopping on all channels*

Cables connected to the EUT: *USB and temporary antenna cables*

Remarks: *Measured on temporary antenna connector*

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

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 915 - 925 hPa



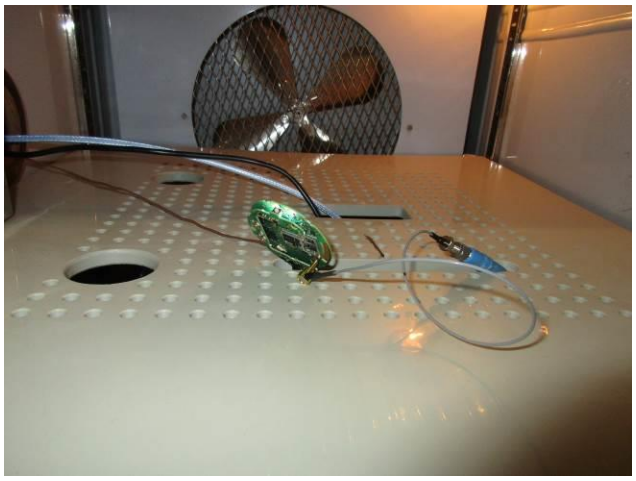
Carrier frequency separation = <u>1.00 MHz</u> > (2/3) x 888 kHz (see § 6.1)

Place and date of test: *Rossens, December 15, 2017*
Operator: *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:	± 2.6 µHz/Hz
Method:	Measurement of the frequency separation on the antenna connector or a test fixture.
Limit:	Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Test set-up:



Remarks:	- - -

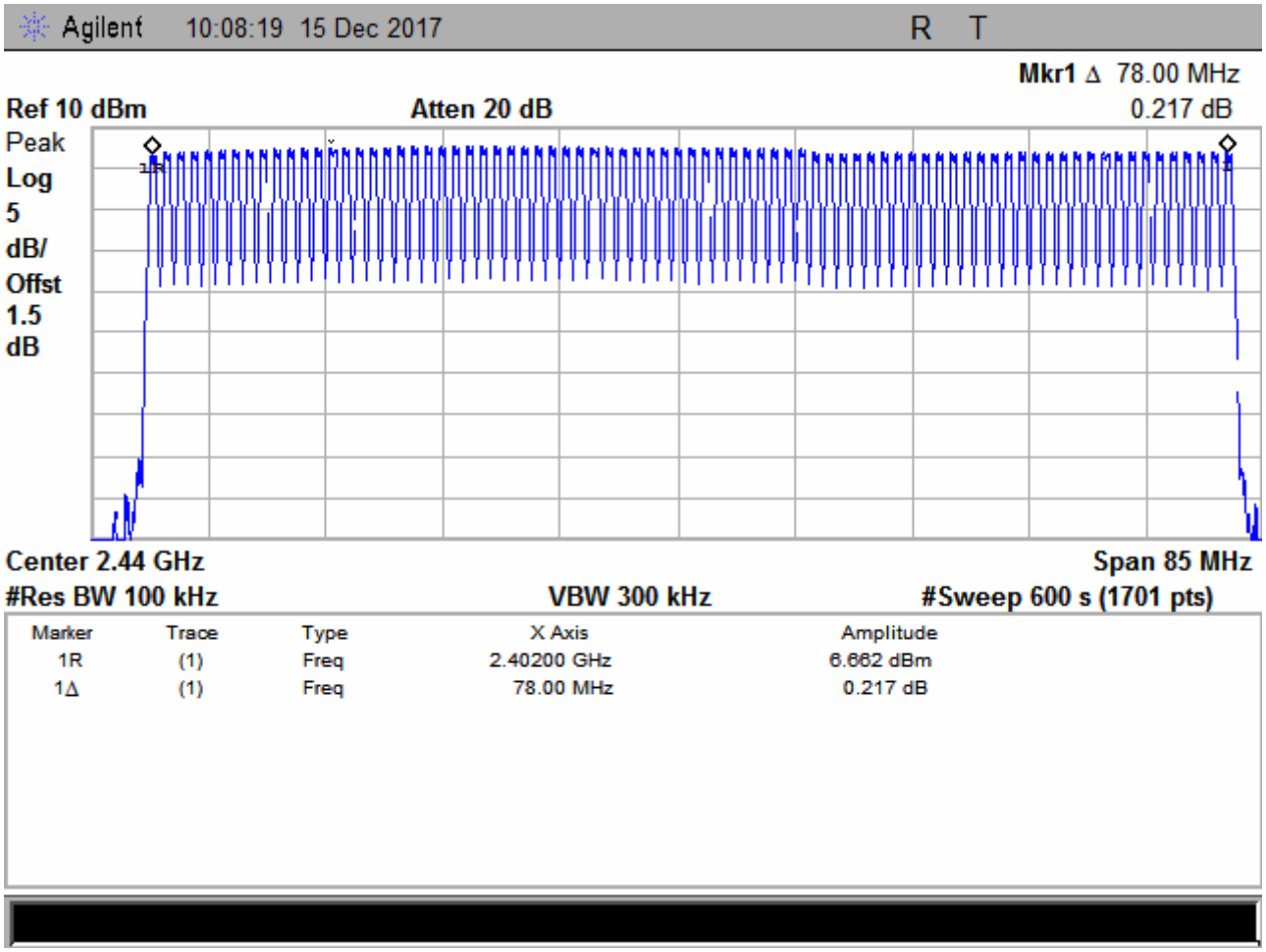
Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-13					

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

Results of the test

Client:	*Phonak Communications AG*
Apparatus:	*Roger Select (BT part), proto 20*
Operating mode:	*Continuously hopping on all channels*
Cables connected to the EUT:	*Temporary supply & antenna cables*
Remarks:	*Measured on temporary antenna connector*
Modifications:	☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Climatic conditions:	Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 915 - 925 hPa



Number of hopping channels = <u>79</u> (≥ 15)

Place and date of test: *Rossens, December 15, 2017*
Operator: *B. Itzcovich*

6.4 Time of occupancy (dwell time)

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

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.

Calculation: According to the Bluetooth core specification V 4.0, all Bluetooth devices comply to the following:

Within a 31.6 second period (= number of hopping channels * 0.4 s = 79 * 0.4 s) in data mode, the dwell time of 0.4 s is independent from the packet type (packet length).

The calculation for a 31.6 second period is as follows:

Dwell time = time slot length * hop rate / number of hopping channels * 31.6 s

Example for a DH1 packet (with a maximum length of one time slot)

Dwell time = 625 µs * 1600 s^{-1} / 79 * 31.6 s = 0.4s (in a 31.6 s period)

For multi-slot packet the hopping is reduced according to the length of the packet. Example for a DH5 packet (with a maximum length of five time slots)

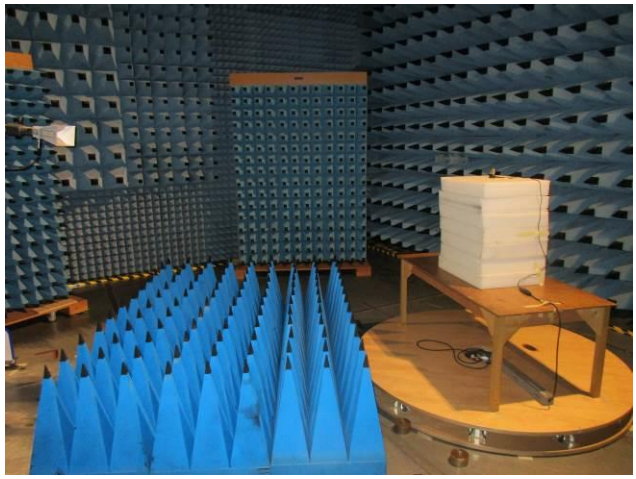
Dwell time = 5 * 625 µs * 1600 * 1/5 *1/s / 79 * 31.6 s = 0.4 s (in a 31.6 s period)

Bluetooth devices comply with the FCC dwell time requirement in the data mode by definition.

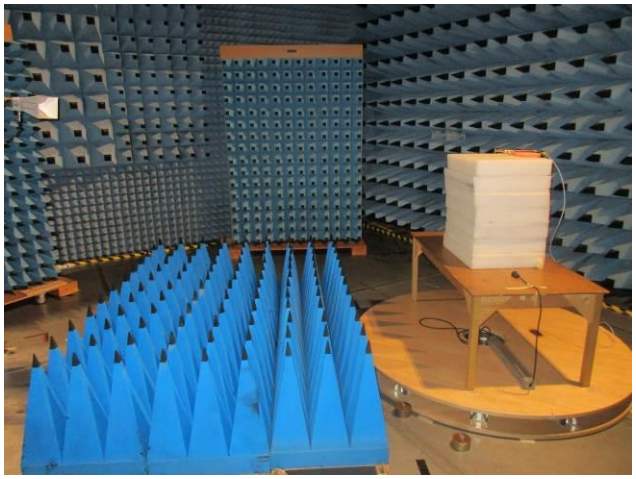
6.5 Antenna gain & effective isotropic radiated power

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:	*1.5 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 analyzer 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:



EUT



Substitution

Remarks:	- - -

Test equipment:

Spectrum analyzer	☐ 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	☒ 03-12	☐ 05-20
Thermocouple detector	☒ 09-04	☐ 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	☒ 15-21	☐ 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 test

Client: *Phonak Communications AG*

Apparatus: *Roger Select (BT part), proto 20*

Operating mode: *Hopping f = 2.402/2.441/2.480 GHz, modulated, max. power*

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

Climatic conditions: Temperature: 21 - 24 °C Humidity: 30 - 35 % Pressure QFE: 920 - 950 hPa

	Measurement with EUT		Power at substitution ant.		Meas. with subst. ant.	Parameters of substitution ant.		Result			Polarisation
f [GHz]	U [dBuV]	preamp [dB]	P [dBm]	factor [dB]	U [dBuV]	gain [dB]	att. Cable [dB]	corr. [dB]	P EIRP [dBm]	P EIRP [W]	
2.402	*66.6*	*0.0*	*10.0*	*0*	*72.8*	*2.15*	*0*	*-60.65*	*5.95*	*3.94 mW*	*Vertical*
2.402	*67.3*	*0.0*	*10.0*	*0*	*73.1*	*2.15*	*0*	*-60.95*	*6.35*	*4.32 mW*	*Horizontal*
2.441	*67.1*	*0.0*	*10.0*	*0*	*73.0*	*2.15*	*0*	*-60.85*	*6.25*	*4.22 mW*	*Vertical*
2.441	*68.2*	*0.0*	*10.0*	*0*	*73.4*	*2.15*	*0*	*-61.25*	*6.95*	*4.95 mW*	*Horizontal*
2.480	*66.2*	*0.0*	*10.0*	*0*	*72.2*	*2.15*	*0*	*-60.05*	*6.15*	*4.12 mW*	*Vertical*
2.480	*66.9*	*0.0*	*10.0*	*0*	*72.5*	*2.15*	*0*	*-60.35*	*6.55*	*4.52 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	*6.86*	*6.35*	*-0.51*	*- - -*
2.440	*7.65*	*6.95*	*-0.70*	*- - -*
2.480	*7.15*	*6.55*	*-0.60*	*- - -*

Place and date of test: *Rossens, December 6 and 14, 2017*
Operator: *B. Itzcovich*

6.6 Maximum output power (conducted)

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

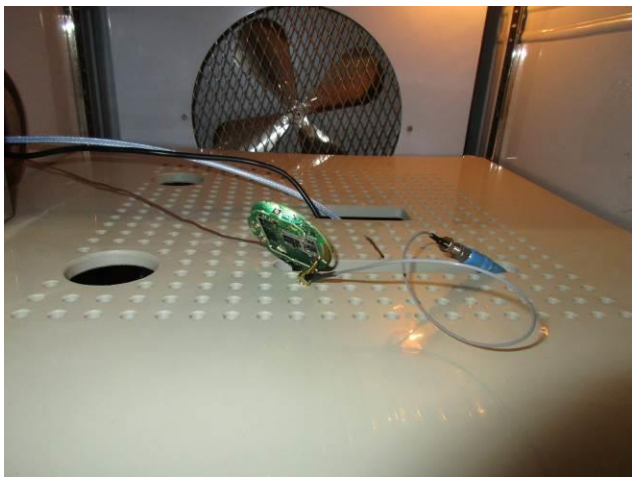
Meas. uncertainty:

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 analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-13					

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

Results of the test

Client: *Phonak Communications AG*

Apparatus: *Roger Select (BT part), proto 20*

Operating mode: *Hopping f = 2.402/2.441/2.480 GHz, modulated, Pmax (05)*

Cables connected to the EUT: *USB and temporary antenna cables*

Remarks: *Measured on temporary antenna connector*

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

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 920 - 930 hPa

f normal [GHz]	Temp [°C]	U [V]	P [dBm]	Limit [dBm]	Remarks	Pass Yes	Pass No
2.402	*22*	*5.0*	*6.86*	*21*	*- - -*	☒	☐
2.440	*22*	*5.0*	*6.75*	*21*	*- - -*	☒	☐
2.480	*22*	*5.0*	*7.15*	*21*	*Maximum conducted emission*	☒	☐

Place and date of test: *Rossens, December 14, 2017*
Operator: *B. Itzcovich*

6.7 Band-edge emission (conducted)

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

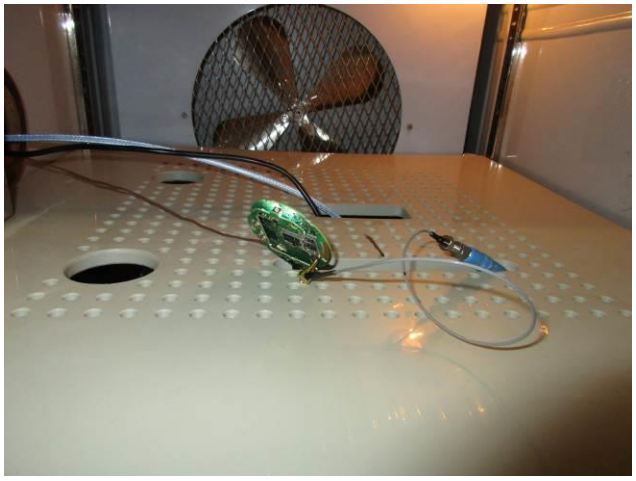
Meas. uncertainty:

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:

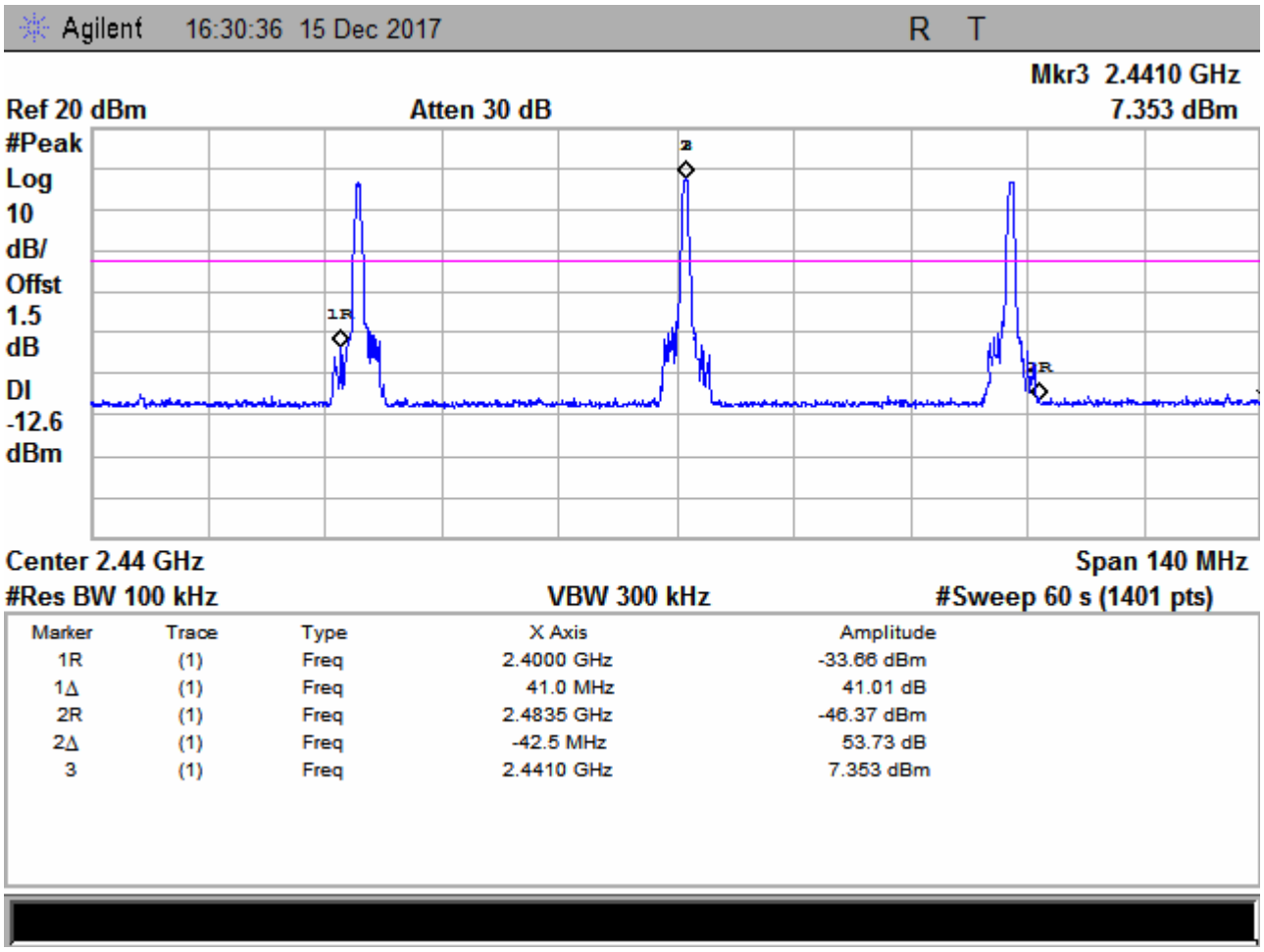
Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☒ 11-13					

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

Results of the test

Client:	*Phonak Communications AG*
Apparatus:	*Roger Select (BT part), proto 20*
Operating mode:	*Hopping f = 2.402/2.441/2.480 GHz, modulated, Pmax (00, 06)*
Cables connected to the EUT:	*USB and temporary antenna cables*
Remarks:	*Measured on temporary antenna connector*
Modifications:	☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 910 - 920 hPa



Place and date of test: *Rossens, December 15, 2017*
Operator: *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

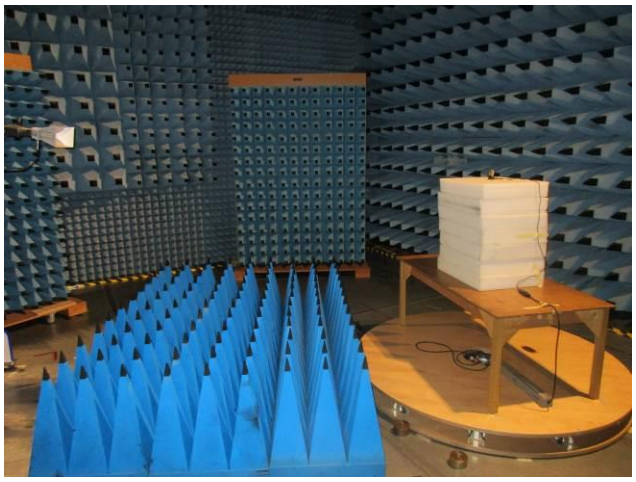
Position of EUT: *1.5 m* (height of the equipment under test above floor)

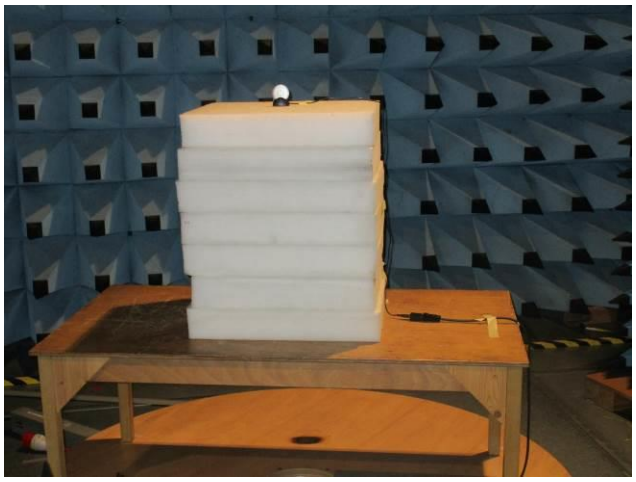
Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyzer and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarizations. 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 dBµV/m and transformed to a measuring distance of 3 m (factor used = 20 dB/decade) if necessary*
e.g.: for f = 40 MHz the limit is 500 µV/m at 3 m;

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

Test equipment:

Spectrum analyzer	☐ 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 test

Client: *Phonak Communications AG*

Apparatus: *Roger Select (BT part)*

Operating mode: *TX (f = 2.402/2.480 GHz), modulated, Pmax, Duty 100%*

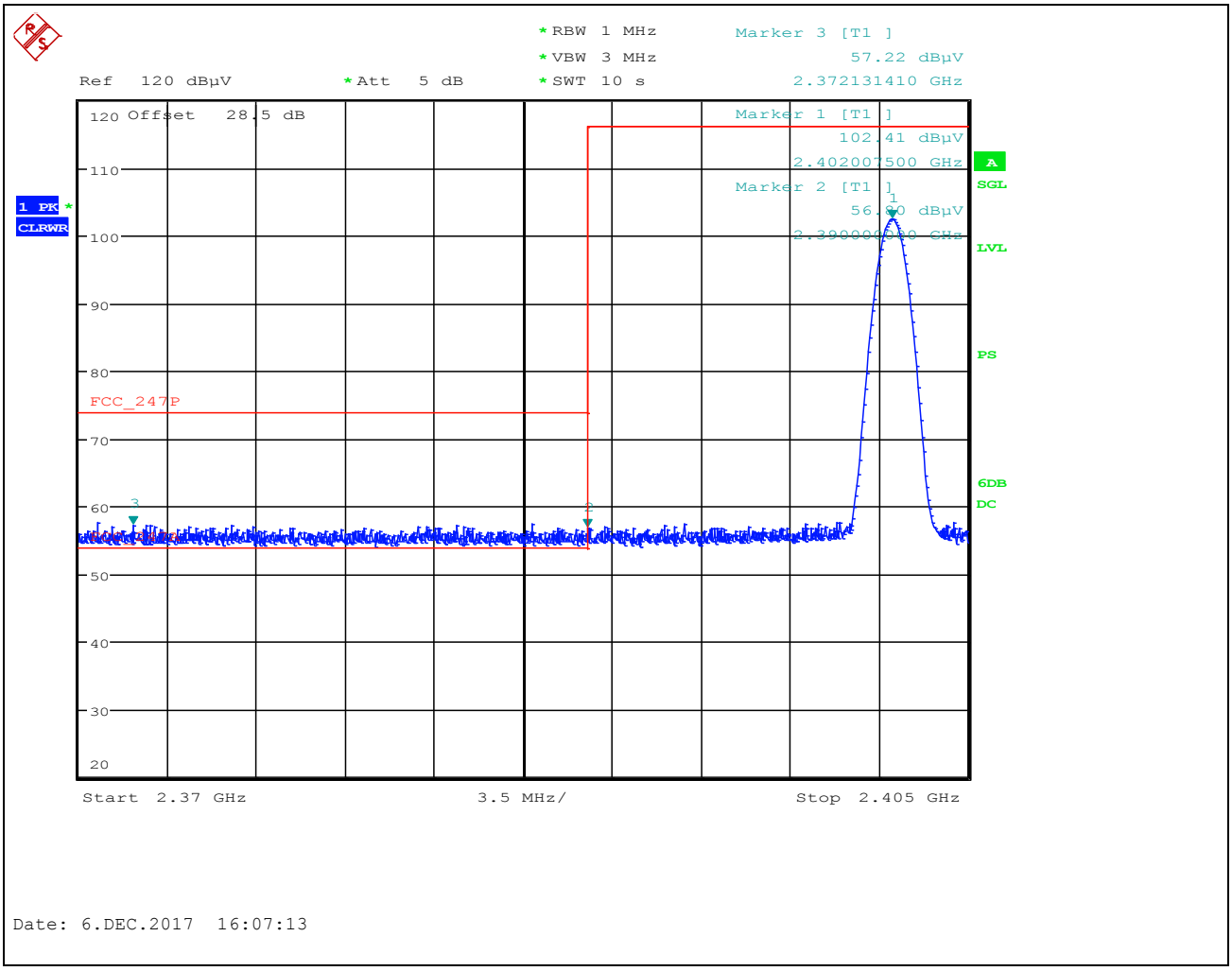
Cables connected to the EUT: *All (see § 4.6 and § 5.4)*

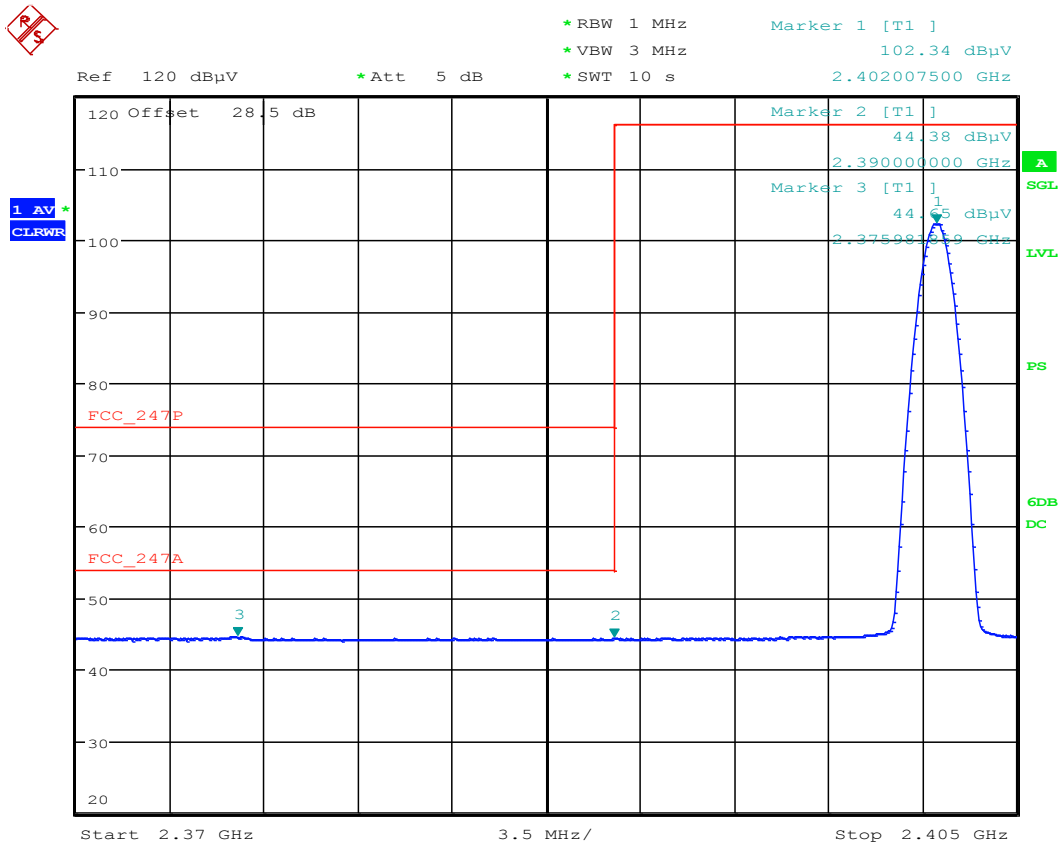
Remarks: - - -

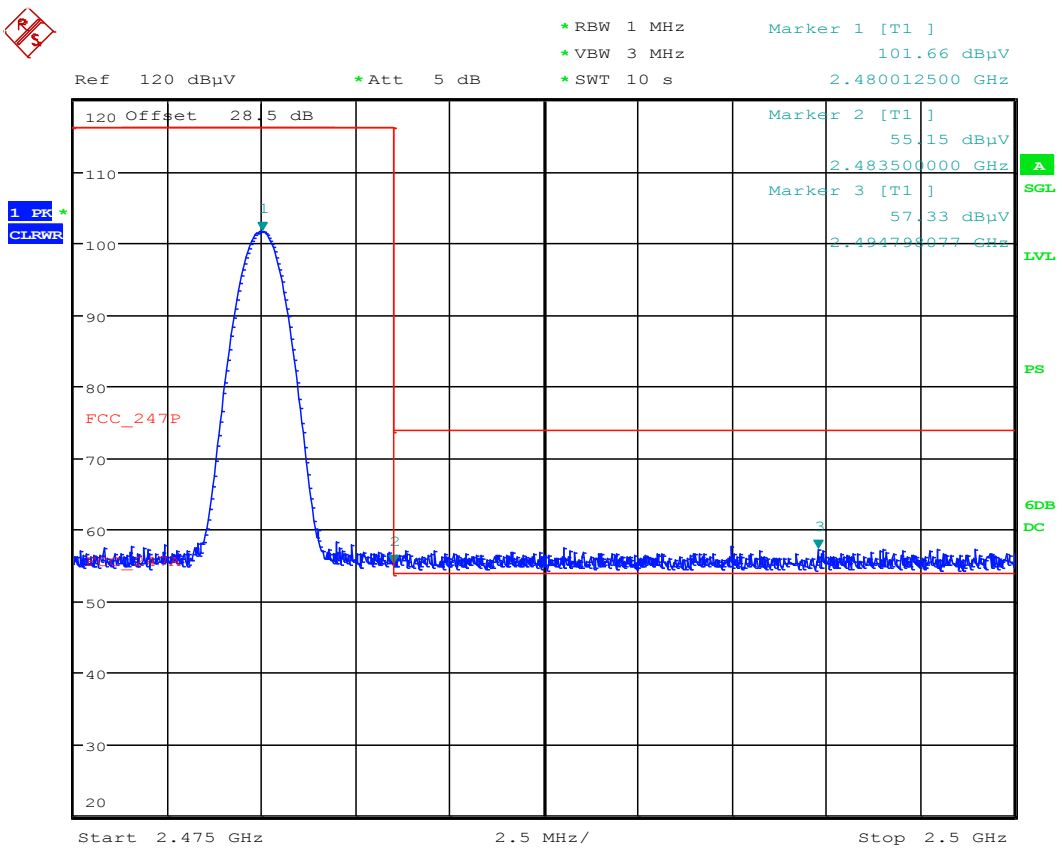
Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

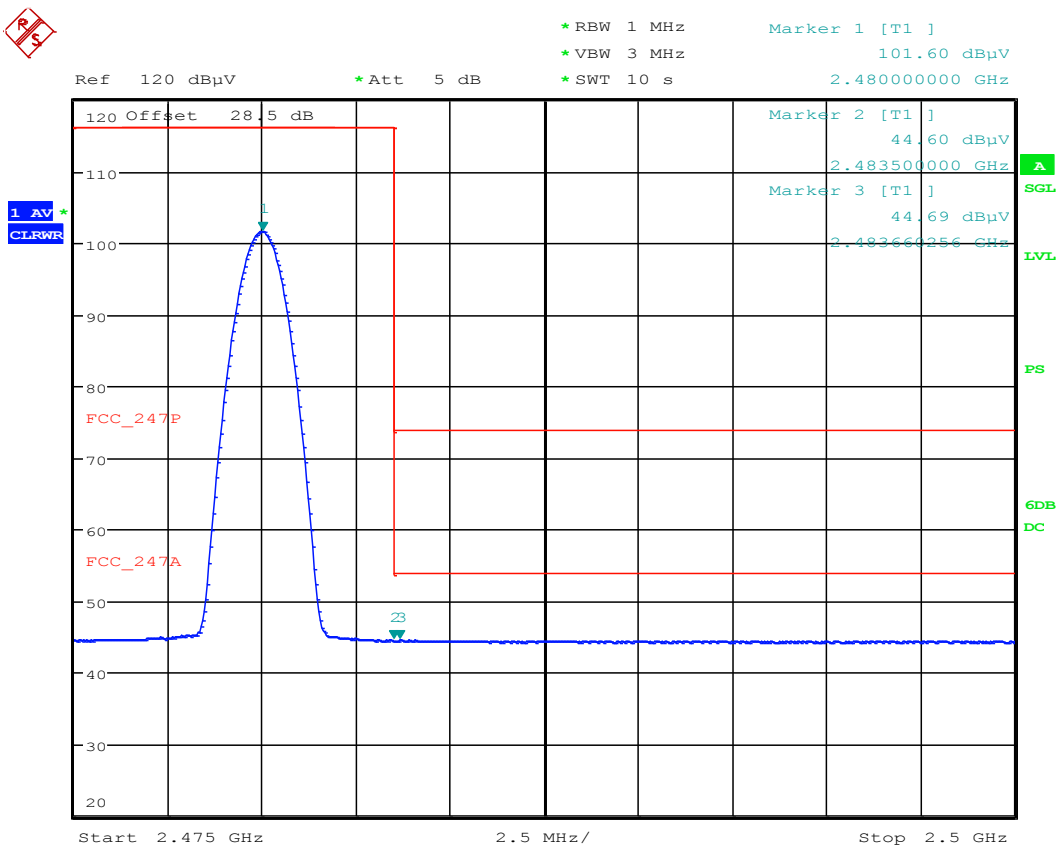
Climatic conditions: Temperature: 22 - 24 °C Humidity: 30 - 35 % Pressure QFE: 940 - 950 hPa

	Measured field strength [dBµV/m]		Limit [dBµV/m]	Margin [dB]		Pass	
	≤2390.0 MHz	≥2483.5 MHz		≤2390.0 MHz	≥2483.5 MHz	Yes	No
Peak detector	*57.22*	*57.33*	*74*	*16.78*	*16.67*	☒	☐
Average RMS detector	*44.65*	*44.69*	*54*	*9.35*	*9.31*	☒	☐




*RBW 1 MHz
*VBW 3 MHz
*SWT 10 s
Marker 1 [T1]
102.34 dBµV
2.402007500 GHz
Ref 120 dBµV
*Att 5 dB
Offset 28.5 dB
Marker 2 [T1]
44.38 dBµV
2.390000000 GHz
Marker 3 [T1]
44.65 dBµV
1 AV
CLRWR
A
SGL
LVL
PS
6DB
DC
FCC_247P
FCC_247A
120
110
100
90
80
70
60
50
40
30
20
Start 2.37 GHz
3.5 MHz/
Stop 2.405 GHz
Date: 6.DEC.2017 16:04:41


RBW 1 MHz
VBW 3 MHz
SWT 10 s
Marker 1 [T1]
101.66 dBµV
2.480012500 GHz
Ref 120 dBµV
Att 5 dB
120 Offset 28.5 dB
Marker 2 [T1]
55.15 dBµV
2.483500000 GHz
Marker 3 [T1]
57.33 dBµV
2.494798077 GHz
1 PK
CLRWR
A
SGL
LVL
PS
6DB
DC
FCC_247P
110
100
90
80
70
60
50
40
30
20
Start 2.475 GHz
2.5 MHz/
Stop 2.5 GHz
Date: 6.DEC.2017 16:13:59



Place and date of test: *Rossens, December 6, 2017*
Operator: *B. Itzcovich*

6.9 Spurious emissions – conducted (transmitter – 9 kHz to 26 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

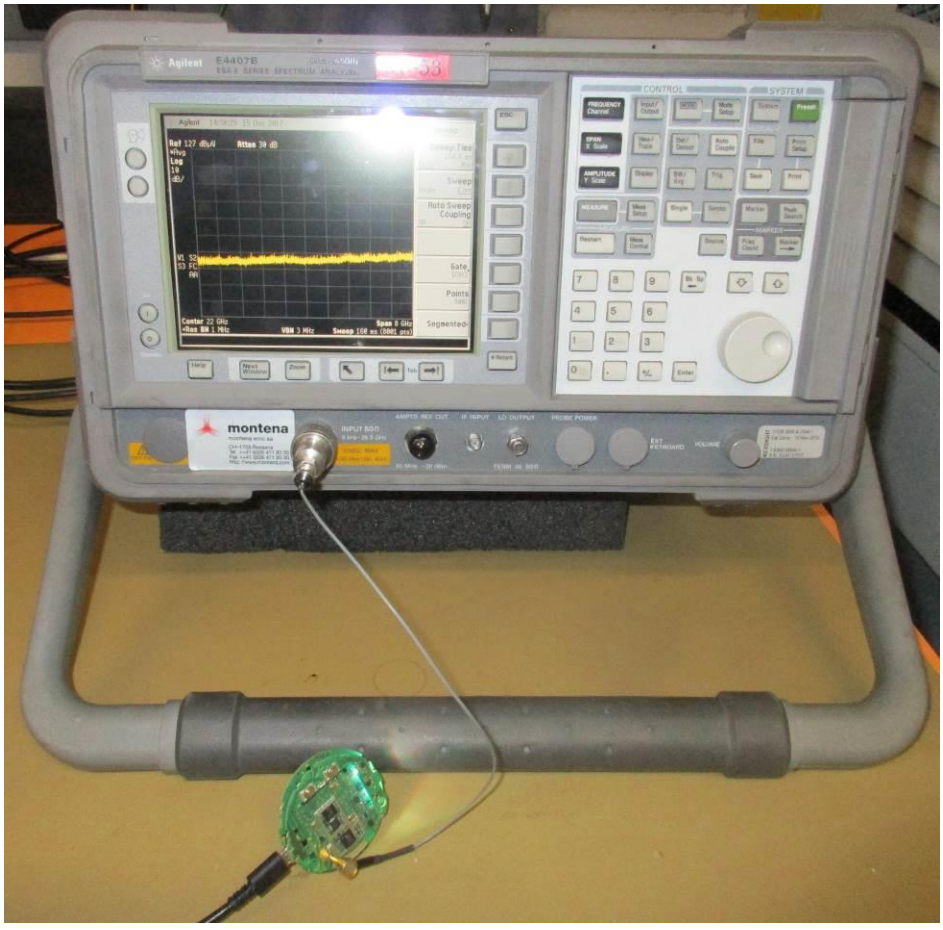
Test method: Measurement of the conducted power on the antenna connector or a test fixture.

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

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 910 - 920 hPa

Test set-up:



Remarks: *Emissions near band-edges are checked under § 6.7*

Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Power supply	☐ 99-07	☐ 04-31				
Cables	☐ 11-13					

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

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

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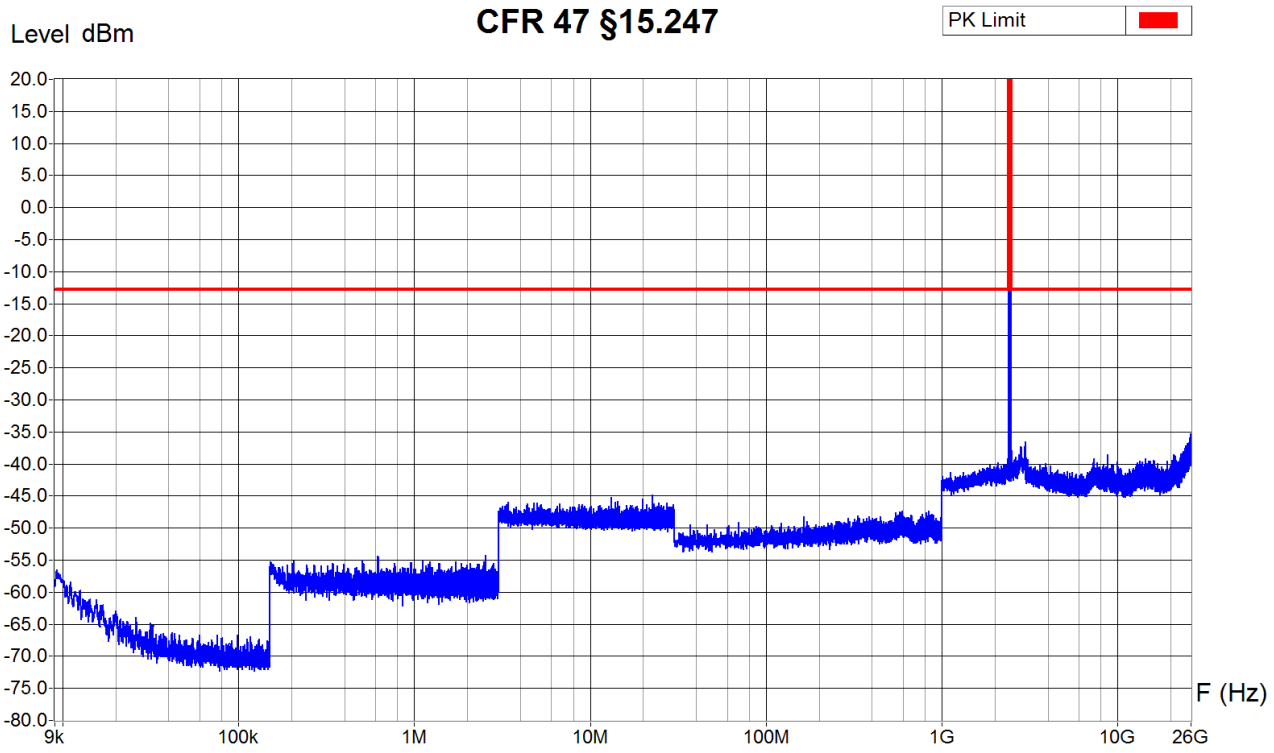
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	Peak detector sweep, 8001 Pts/zone



Operator: B. Itzcovich
Date/Time: 15.12.2017 16:50
Filename: CP_9k-26G_BTTXPmax.png/.txt

6.10 Spurious emissions, 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 analyzer 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

Climatic conditions: Temperature: 21 - 23 °C Humidity: 40 - 50 % Pressure QFE: 925 - 945 hPa

Test set-up:

Parallel

Remarks: *Limit values expressed in dBµV/m and transformed to a measuring distance of 10 m (factor used = 40 dB/decade) if necessary*
e.g.: for f = 10 MHz the limit is 30 µV/m at 30 m;

$$20\log\left(\frac{30\,\frac{\mu V}{m}}{1\,\frac{\mu V}{m}}\right)+40\log\left(\frac{30\,m}{10\,m}\right)=48.6\,\frac{dB\mu V}{m}\;at\;10m$$

Test equipment:

Spectrum analyzer	☐ 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 :	Parallel
Table Angle :	0 - 360°
Antenna Height :	1 m

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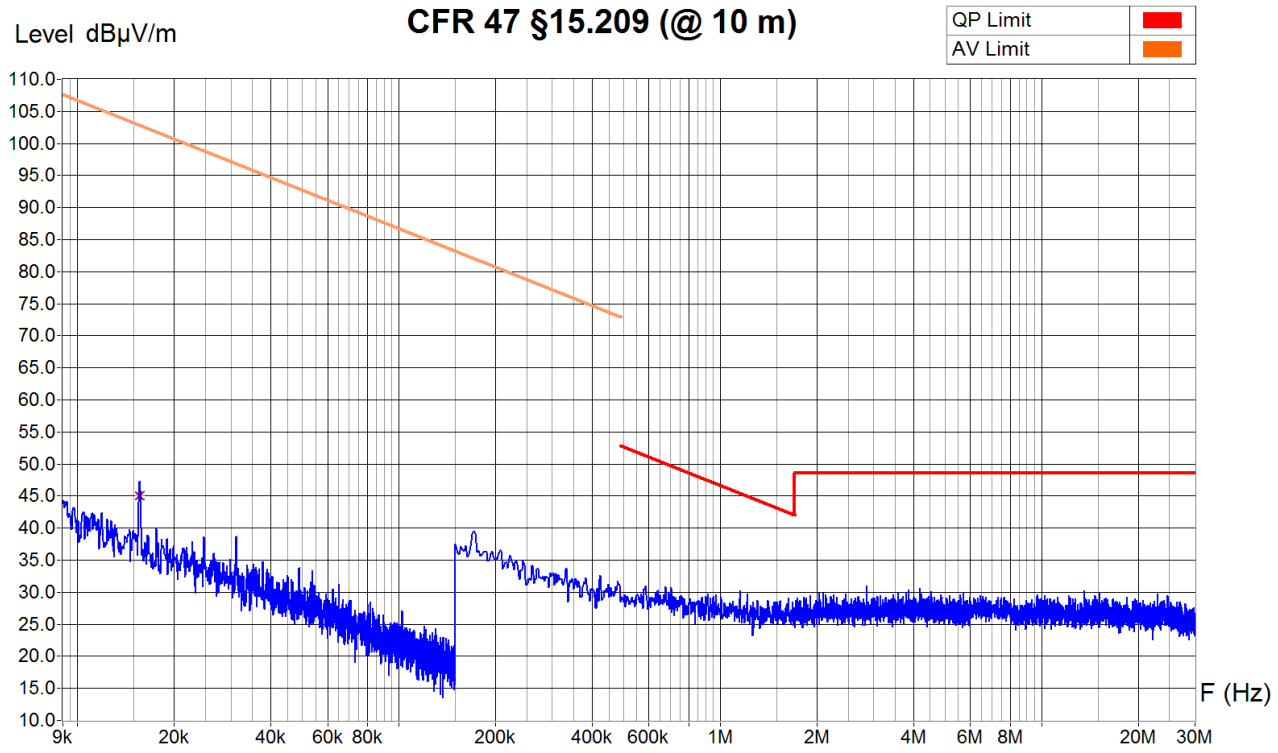
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	"Parallel" means "loop antenna axis towards EUT"
	Peak detector sweep, 9701 Pts/zone



Zone	9 KHz - 150 KHz	150 KHz - 6 MHz	6 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 (+)
15.62 KHz	48.8 dBµV/m	45.1 dBµV/m	45.1 dBµV/m

Sample calculation with all conversion and correction factors used				
Frequency [kHz]	Analyzer Peak value [dBµV]	Cable att. corr. [dB]	Antenna factor corr. [dB]	Peak field [dBµV/m]
15.62	27.3	+0.0	+21.5	= 48.8

Operator: B. Itzcovich
Date/Time: 13.12.2017 14:30
Filename: 65_RE_9k-30M_BTTXPmax_Par.png/.txt

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

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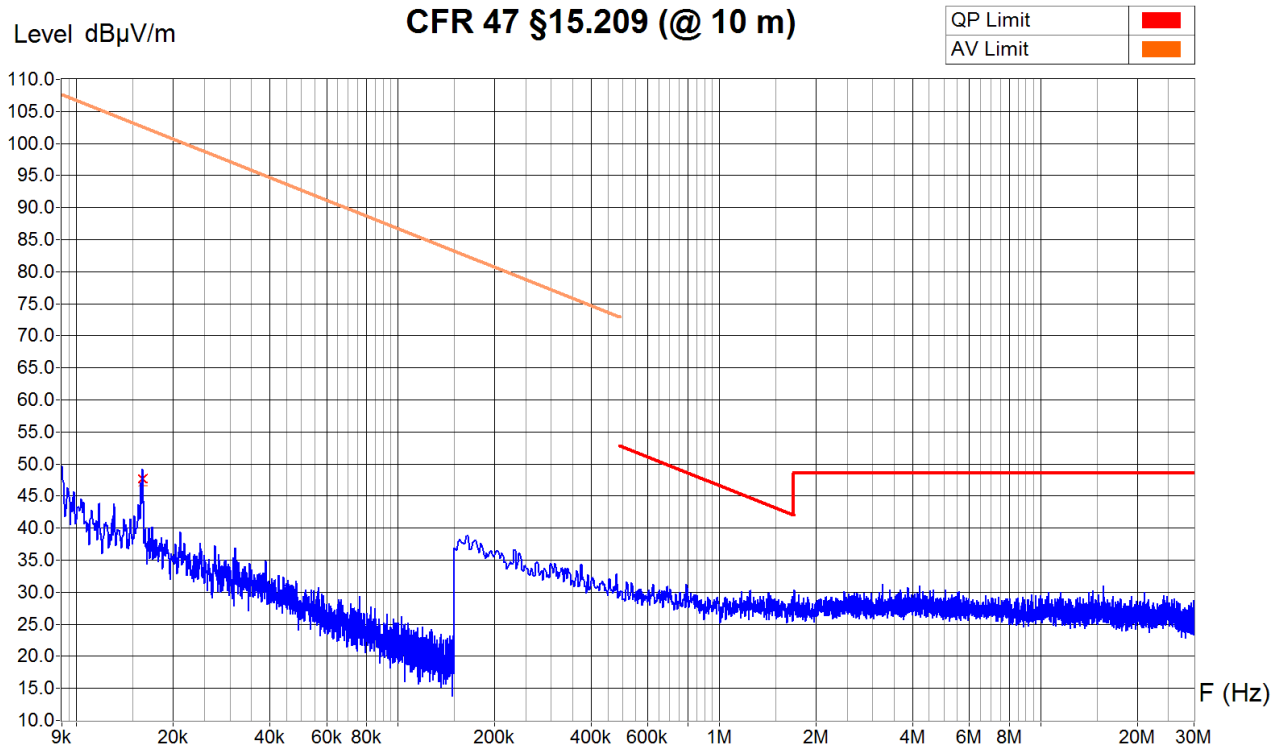
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	"Parallel" means "loop antenna axis towards EUT"
	Peak detector sweep, 9701 Pts/zone



Zone	9 KHz - 150 KHz	150 KHz - 6 MHz	6 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 (+)
16.05 KHz	51.6 dBµV/m	47.6 dBµV/m	46.6 dBµV/m

Frequency	Average RMS detector meas. @ 10m	Average RMS detector meas. corrected for 3m
16.05 kHz	46.6 dBuV/m	67.5 dBuV/m

Operator: B. Itzcovich
Date/Time: 13.12.2017 14:37
Filename: 66_RE_9k-30M_BTTXPmax_Per.png/.txt

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

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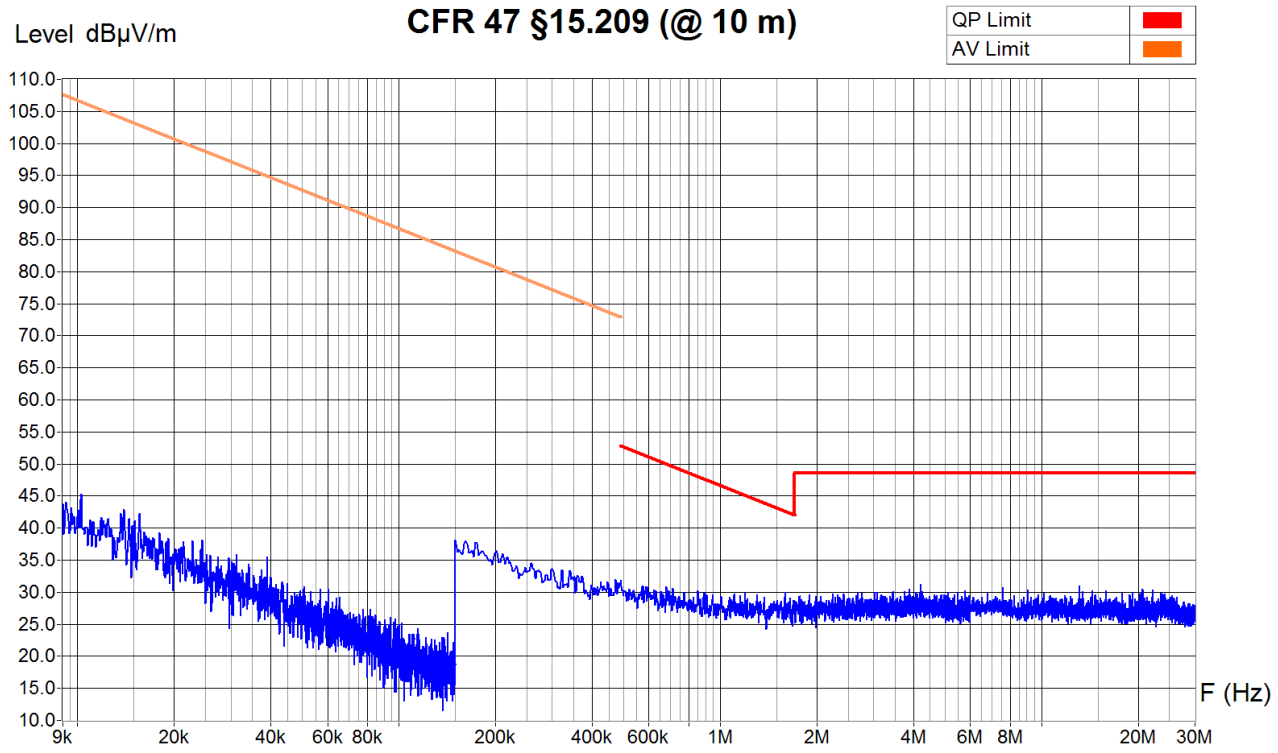
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	"Parallel" means "loop antenna axis towards EUT"
	Peak detector sweep, 9701 Pts/zone



Zone	9 KHz - 150 KHz	150 KHz - 6 MHz	6 MHz - 30 MHz
Video Bandwidth	500 Hz	30 KHz	30 KHz
Resol Bandwidth	200 Hz	9 KHz	9 KHz

Operator: B. Itzcovich
Date/Time: 13.12.2017 15:37
Filename: 67_RE_9k-30M_BTTXPmax_Hor.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 analyzer and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarizations. 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 dBµV/m and transformed to a measuring distance of 10 m (factor used = 20 dB/decade) if necessary*
e.g.: for f = 40 MHz the limit is 100 µV/m at 3 m;

$$20\log\left(\frac{100\,\frac{\mu V}{m}}{1\,\frac{\mu V}{m}}\right)+20\log\left(\frac{3m}{10m}\right)=29.54\,\frac{dB\mu V}{m}\;at\;10m$$

Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☐ 04-29	☒ 10-70	
Preamplifier	☐ 90-01	☐ 95-86	☐ 05-56	☒ 05-59	☐ 05-62	☐ 05-87
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

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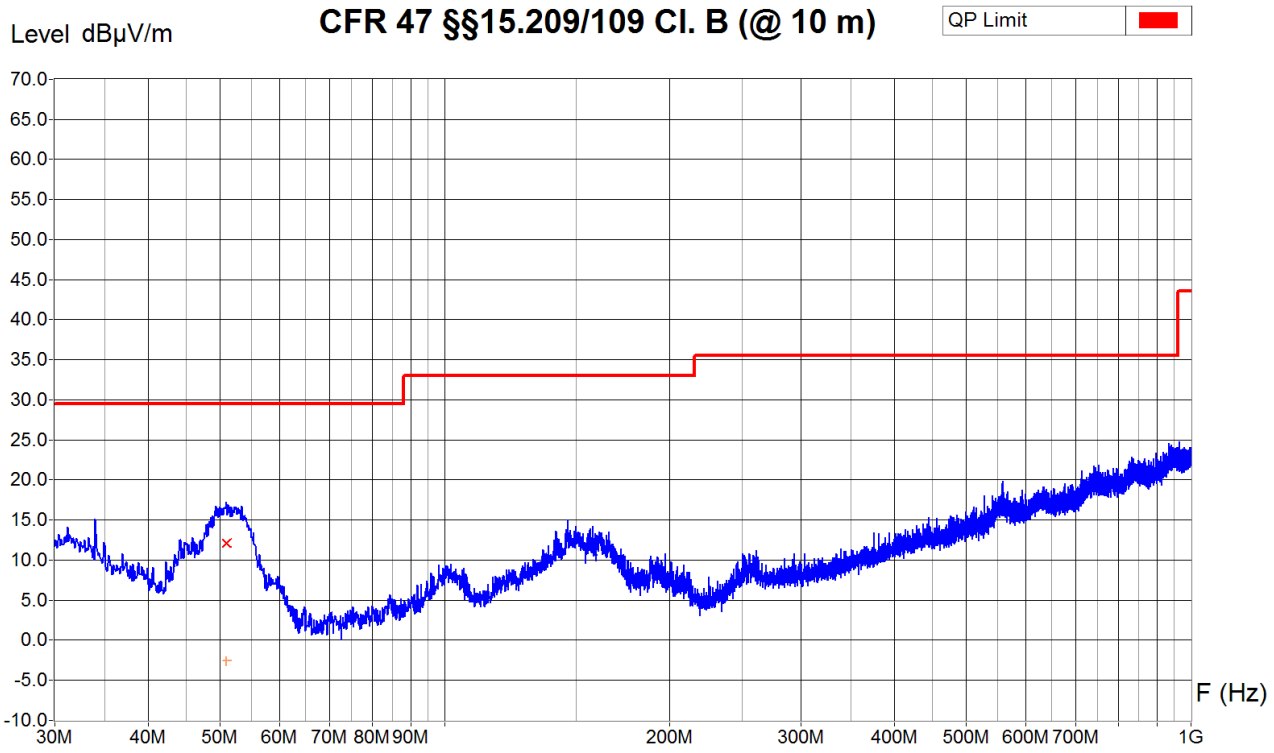
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 9701 Pts/zone



Zone	30 MHz - 1 GHz
Video Bandwidth	500 KHz
Resol Bandwidth	120 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
51 MHz	18.0 dBµV/m	12.2 dBµV/m	-2.6 dBµV/m	17.4 dB

Sample calculation with all conversion and correction factors used					
Frequency [MHz]	Analyzer Peak value [dBµV]	Cable att. corr. [dB]	Preamp. gain corr. [dB]	Antenna factor corr. [dB]	Peak field [dBµV/m]
51.0	39.4	+0.9	-29.1	+6.8	= 18.0

Operator: B. Itzcovich
Date/Time: 13.12.2017 12:09
Filename: 61_RE_30M-1G_BTTXPmax_V_FCC.png/.txt

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

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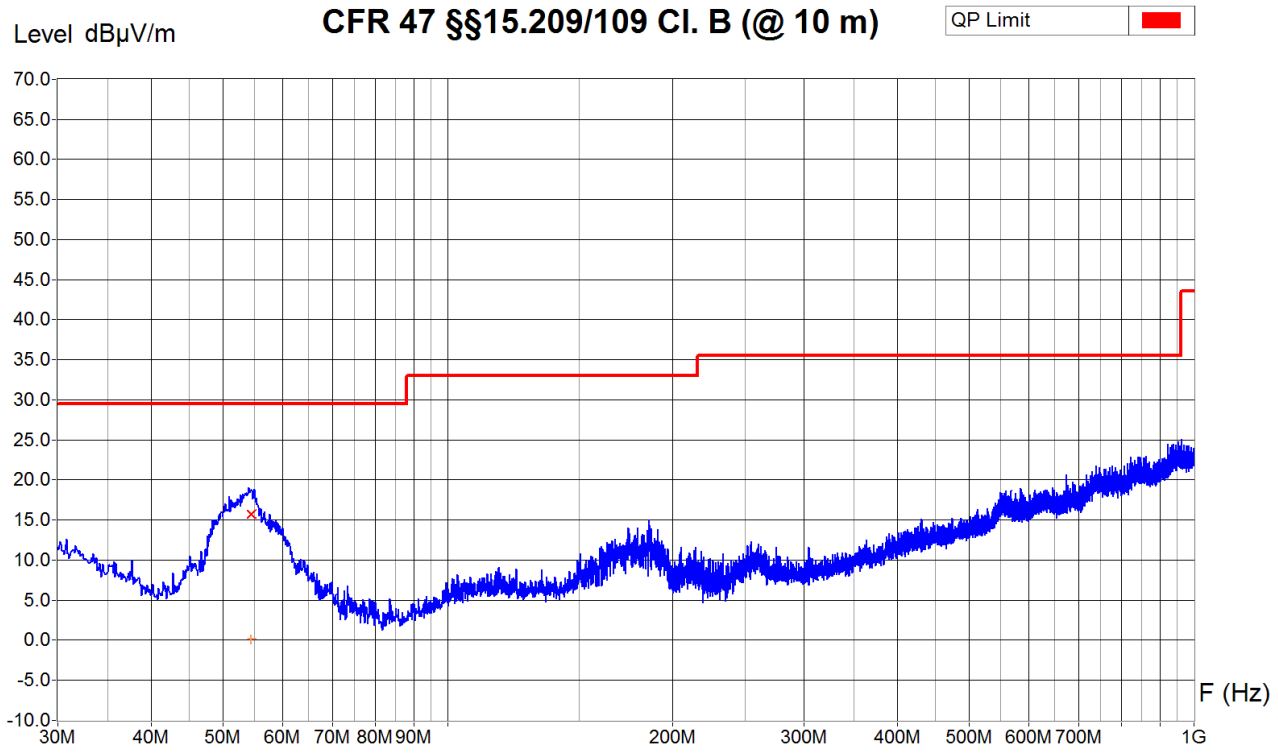
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 9701 Pts/zone



Zone	30 MHz - 1 GHz
Video Bandwidth	500 KHz
Resol Bandwidth	120 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
54.50 MHz	20.4 dBµV/m	15.7 dBµV/m	0.2 dBµV/m	13.9 dB

Operator: B. Itzcovich
Date/Time: 13.12.2017 12:22
Filename: 62_RE_30M-1G_BTTXPmax_H_FCC.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: *1.5 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 analyzer and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarizations, and aimed at the source by tilting. 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

Climatic conditions: Temperature: 22 - 24 °C Humidity: 30 - 35 % Pressure QFE: 935 - 945 hPa

Test set-up:

Remarks:

- *Limit values expressed in dBµV/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 µV/m at 3 m;*

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

- *Average measurement determined from the peak field strength after correcting for the worst-case duty cycle according to § 4.1.4.2.4 of ANSI C63.10:2013. Correction factor: δ(dB) = 20log(Δ) = 20 log (0.1045) = -19.61 dB*

Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Preamplifier	☐ 05-56	☐ 05-87	☒ N967			
Antenna (horn)	☐ 90-24	☒ 07-31				
Cables	☒ 10-75	☒ 10-79				
Filters	☒ 13-14	☒ 12-06	☐ 13-05			
Attenuator 10dB	☒ 11-36					

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

Measurement Type :	Radiated Field
Polarisation :	Vertical
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	Zone 1 - 7 GHz with Notch filter and attenuator 10dB
	Zone 7 - 18 GHz with HP filter
	Peak detector sweep, 3001 Pts/zone

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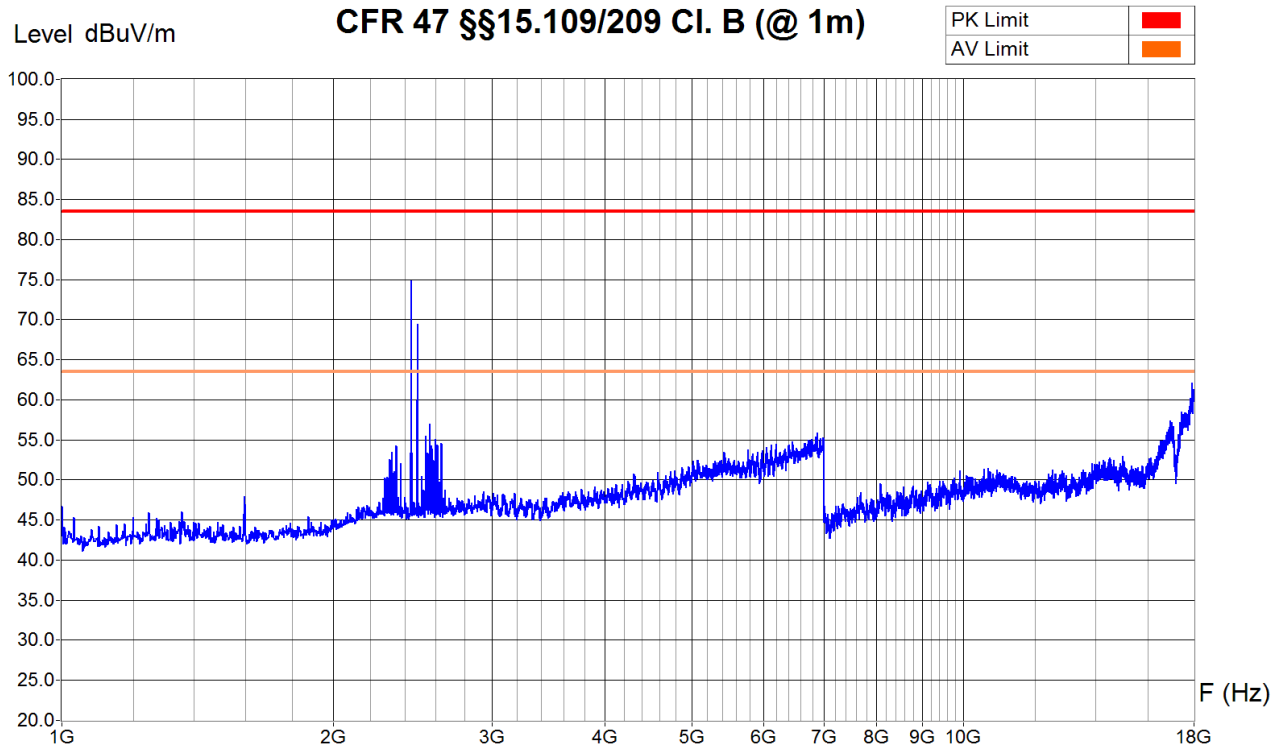
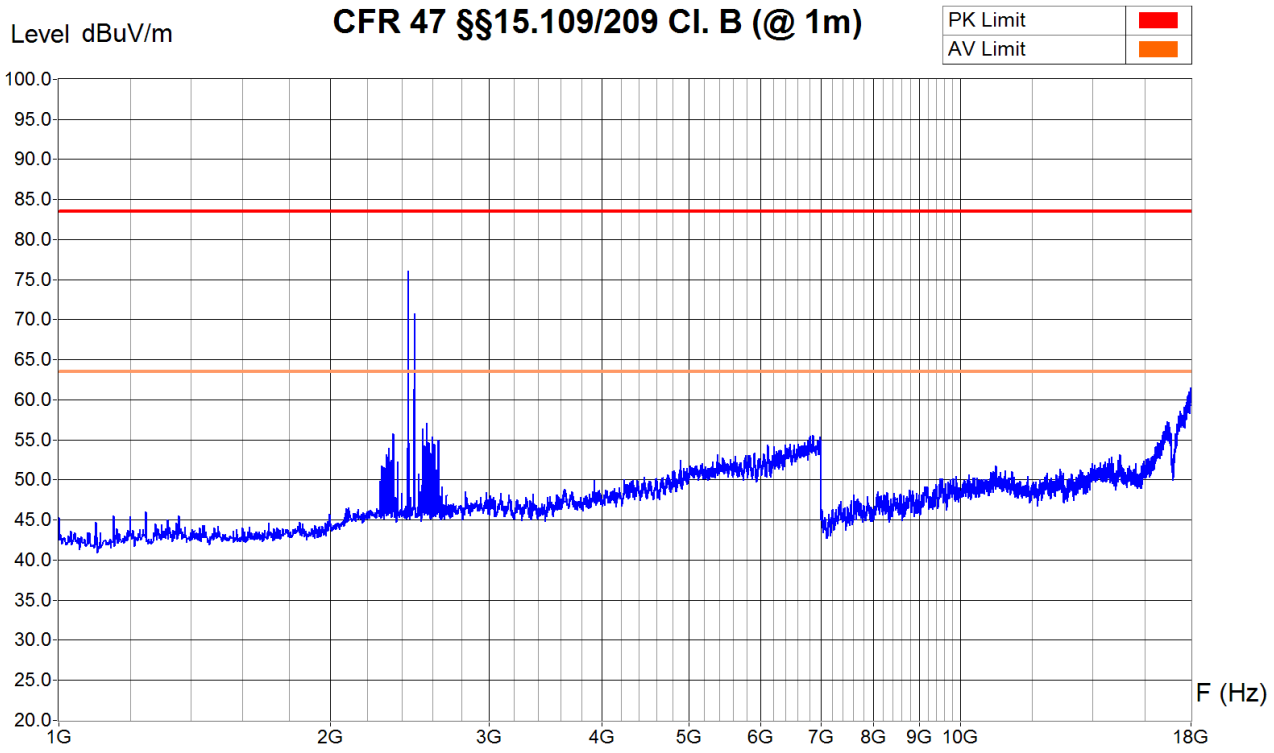


Zone	1 GHz - 7 GHz	7 GHz - 13 GHz	13 GHz - 18 GHz
Video Bandwidth	3 MHz	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Sample calculation with all conversion and correction factors used						
Frequency [GHz]	Analyzer Peak value [dBµV]	Cable att. corr. [dB]	Preamp. gain corr. [dB]	Antenna factor corr. [dB]	Attenuator corr. [dB]	Peak field [dBµV/m]
4.960	48.4	+1.1	-40.1	+32.3	+ 10.00	= 51.7

Operator: B. Itzcovich
Date/Time: 07.12.2017 15:25
Filename: 51_RE_1-18G_BTTXPmax_V_FCC.png/.txt

Measurement Type :	Radiated Field
Polarisation :	Horizontal
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	Zone 1 - 7 GHz with Notch filter and attenuator 10dB
	Zone 7 - 18 GHz with HP filter
	Peak detector sweep, 3001 Pts/zone



Zone	1 GHz - 7 GHz	7 GHz - 13 GHz	13 GHz - 18 GHz
Video Bandwidth	3 MHz	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Operator: B. Itzcovich
Date/Time: 07.12.2017 15:33
Filename: 52_RE_1-18G_BTTXPmax_H_FCC.png/.txt

Measurement Type :	Radiated Field
Polarisation :	Vertical
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)

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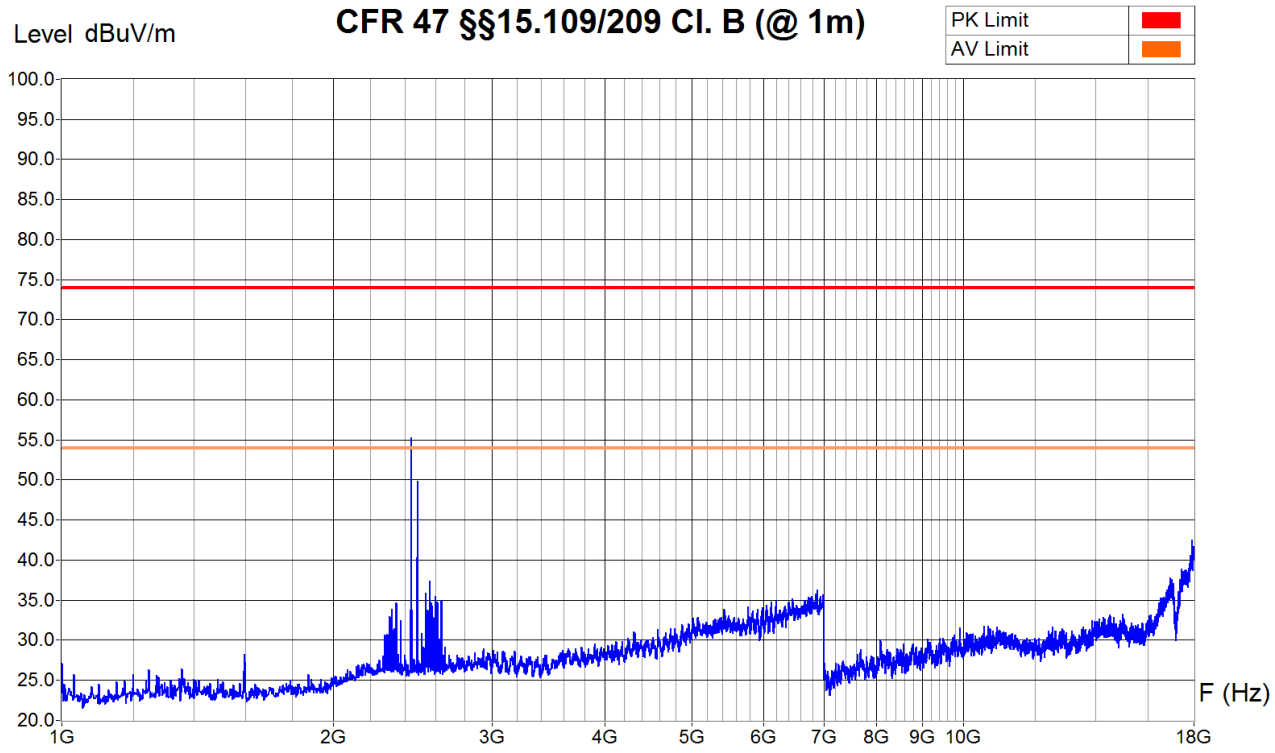
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	Zone 1 - 7 GHz with Notch filter and attenuator 10dB
	Zone 7 - 18 GHz with HP filter
	Average measurement computed from peak values with correction factor -19.6dB



Zone	1 GHz - 7 GHz	7 GHz - 13 GHz	13 GHz - 18 GHz
Video Bandwidth	3 MHz	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Operator: B. Itzcovich
Date/Time: 07.12.2017 15:25
Filename: 51_RE_1-18G_BTTXPmax_V_FCC_AV.png/

Measurement Type :	Radiated Field
Polarisation :	Horizontal
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)

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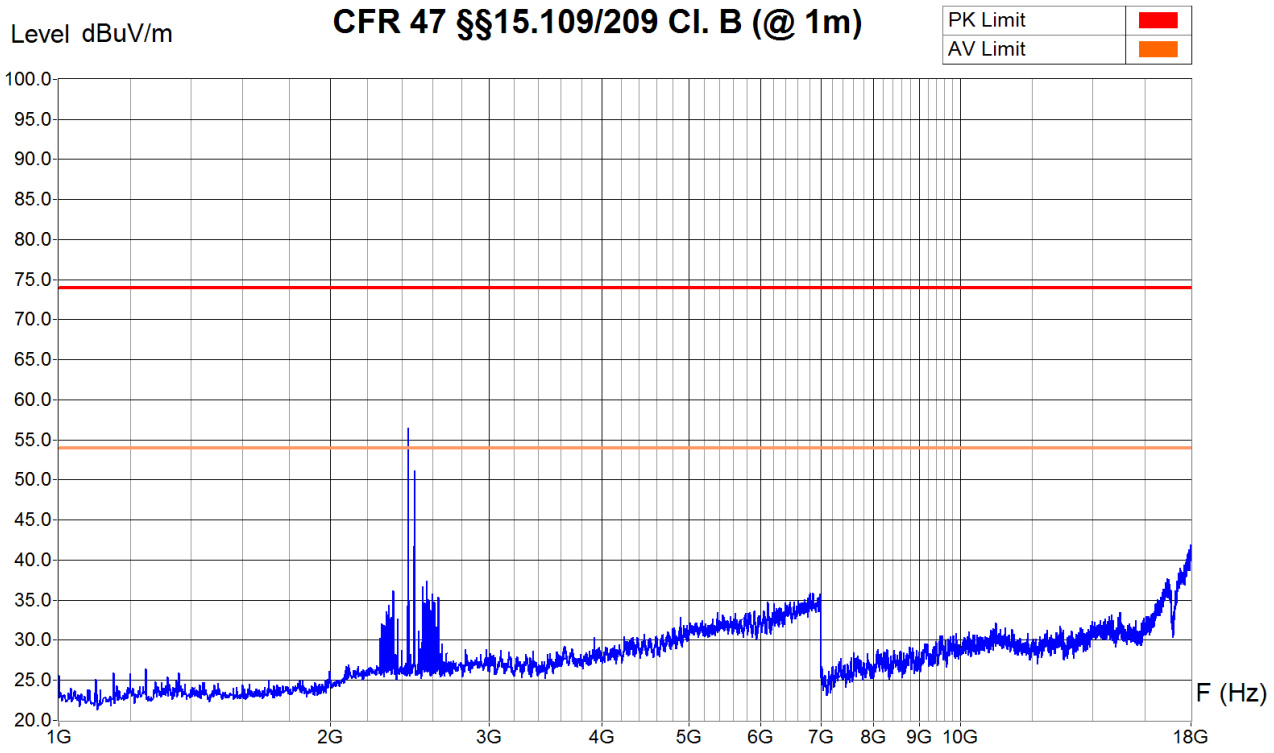
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	Zone 1 - 7 GHz with Notch filter and attenuator 10dB
	Zone 7 - 18 GHz with HP filter
	Average measurement computed from peak values with correction factor -19.6dB



Zone	1 GHz - 7 GHz	7 GHz - 13 GHz	13 GHz - 18 GHz
Video Bandwidth	3 MHz	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz	1 MHz

Frequency	Average RMS detector meas. @ 1m	Average RMS detector meas. corrected for 3m
9.608 GHz	52.8 dBuV/m	43.3 dBuV/m

Operator: B. Itzcovich
Date/Time: 07.12.2017 15:33
Filename: 52_RE_1-18G_BTTXPmax_H_FCC_AV.png

6.10.4 18 GHz to 26 GHz

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

Distance: ☒ 1 m ☐ 3 m ☐ 10 m ☐ 30 m

Position of EUT: *1.5 m* (height of the equipment under test above floor)

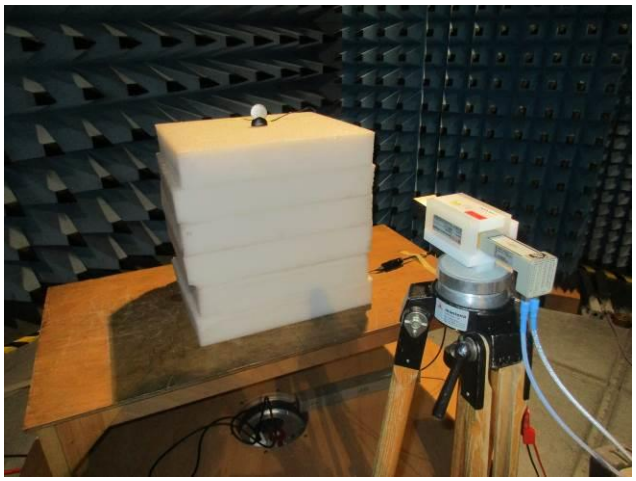
Meas. uncertainty: ± 4.7 dB

Test method: The electromagnetic disturbance radiated by the equipment is measured using a spectrum analyzer and a wide band antenna. The antenna is placed at the same height as the EUT successively with horizontal and vertical polarizations. The EUT is placed successively in standing and lying positions. 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.

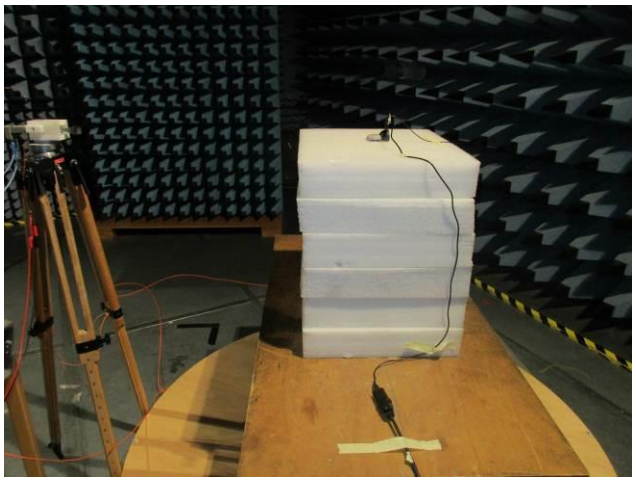
Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Climatic conditions: Temperature: 22 - 24 °C Humidity: 30 - 35 % Pressure QFE: 900 - 910 hPa

Test set-up:



EUT standing



EUT lying

Remarks: *Limit values expressed in dBµV/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 µV/m at 3 m;

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

Test equipment:

Spectrum analyzer	☐ 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					
Multimeter	☒ 09-06					

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

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

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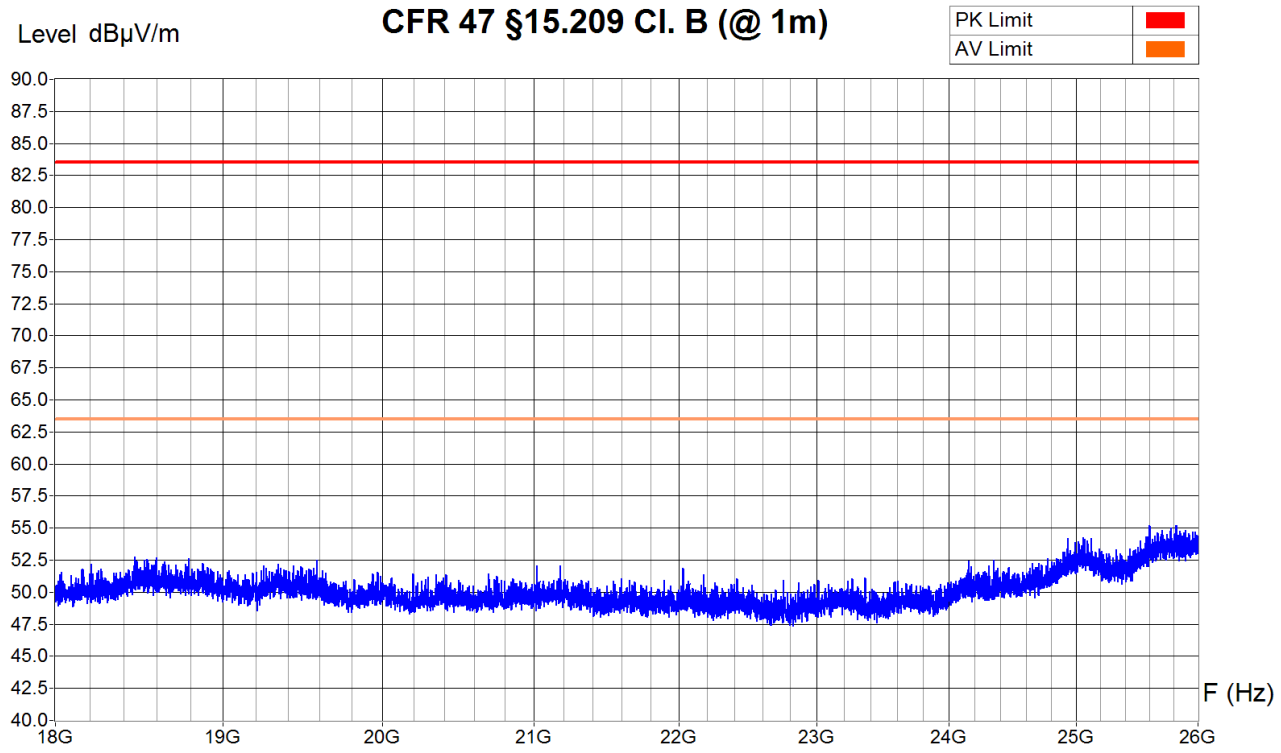
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	EUT standing. With AC adaptor, all cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	
	Peak detector sweep, 8001 Pts/zone



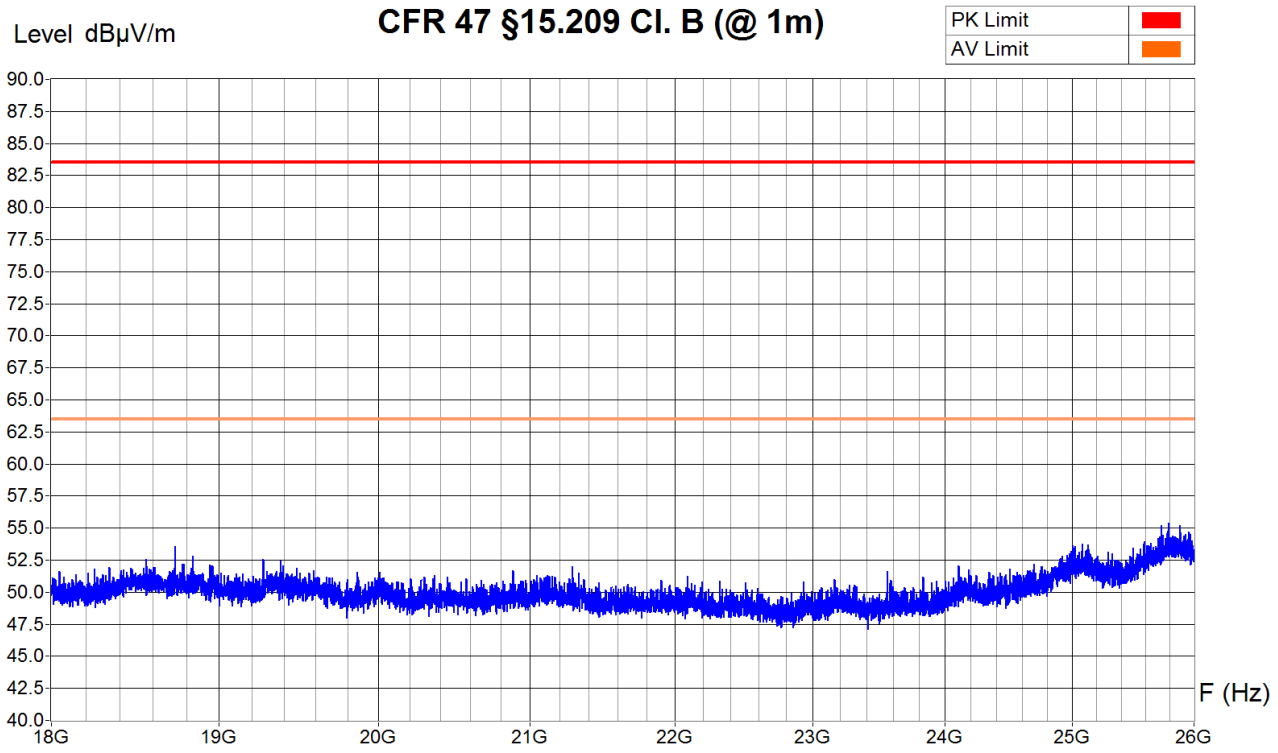
Zone	18 GHz - 26 GHz
Video Bandwidth	3 MHz
Resol Bandwidth	1 MHz

Sample calculation with all conversion and correction factors used			
Frequency [GHz]	Analyzer Peak value [dBµV]	Antenna factor corr. [dB]	Peak field [dBµV/m]
21.367	25.2	+23.7	= 48.9

Operator: B. Itzcovich
Date/Time: 11.12.2017 10:49
Filename: 55_RE_1-18G_BTTXPmax_stand_V.png/.txt

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

Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	EUT standing. With AC adaptor, all cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	
	Peak detector sweep, 8001 Pts/zone

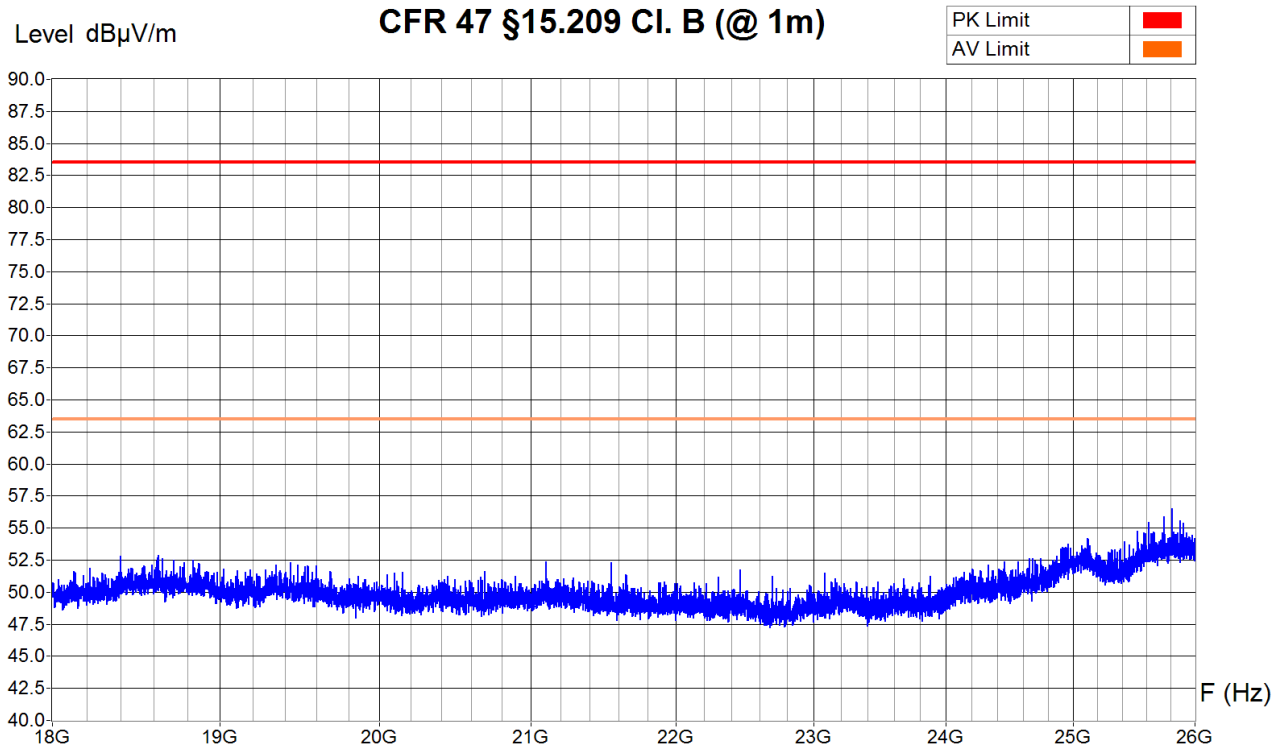


Zone	18 GHz - 26 GHz
Video Bandwidth	3 MHz
Resol Bandwidth	1 MHz

Operator: B. Itzcovich
Date/Time: 11.12.2017 10:58
Filename: 56_RE_1-18G_BTTXPmax_stand_H.png/

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

Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	EUT lying. With AC adaptor, all cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	
	Peak detector sweep, 8001 Pts/zone

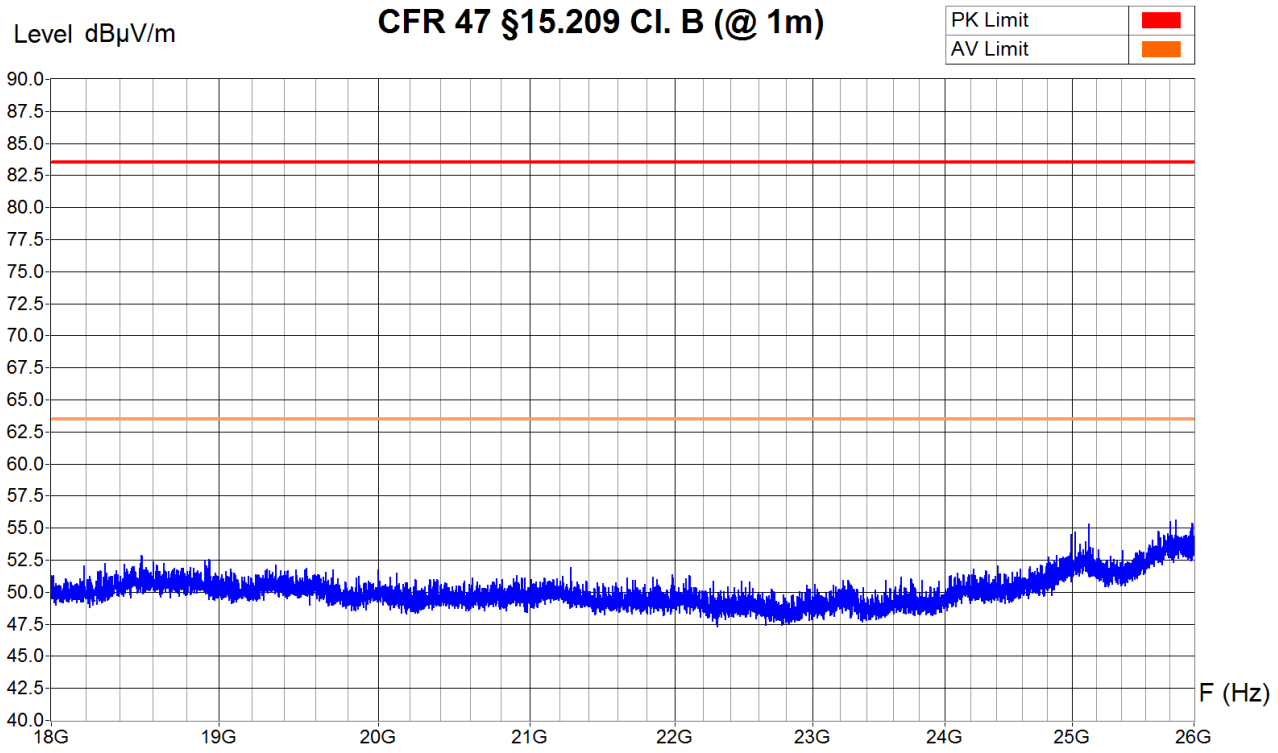


Zone	18 GHz - 26 GHz
Video Bandwidth	3 MHz
Resol Bandwidth	1 MHz

Operator: B. Itzcovich
Date/Time: 11.12.2017 10:46
Filename: 57_RE_1-18G_BTTXPmax_lying_V.png/.txt

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

Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	EUT lying. With AC adaptor, all cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax
Remarks :	
	Peak detector sweep, 8001 Pts/zone



Zone	18 GHz - 26 GHz
Video Bandwidth	3 MHz
Resol Bandwidth	1 MHz

Operator: B. Itzcovich
Date/Time: 11.12.2017 11:01
Filename: 58_RE_1-18G_BTTXPmax_lying_H.png/.txt

6.11 Spurious emissions, receive 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 analyzer and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarizations. 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 dBµV/m and transformed to a measuring distance of 10 m (factor used = 20 dB/decade) if necessary*
e.g.: for f = 40 MHz the limit is 100 µV/m at 3 m;

$$20\log\left(\frac{100\,\frac{\mu V}{m}}{1\,\frac{\mu V}{m}}\right)+20\log\left(\frac{3m}{10m}\right)=29.54\,\frac{dB\mu V}{m}\;at\;10m$$

Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-04	☐ 90-43	☐ 94-35	☐ 04-29	☒ 10-70	
Preamplifier	☐ 90-01	☐ 95-86	☐ 05-56	☒ 05-59	☐ 05-62	☐ 05-87
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

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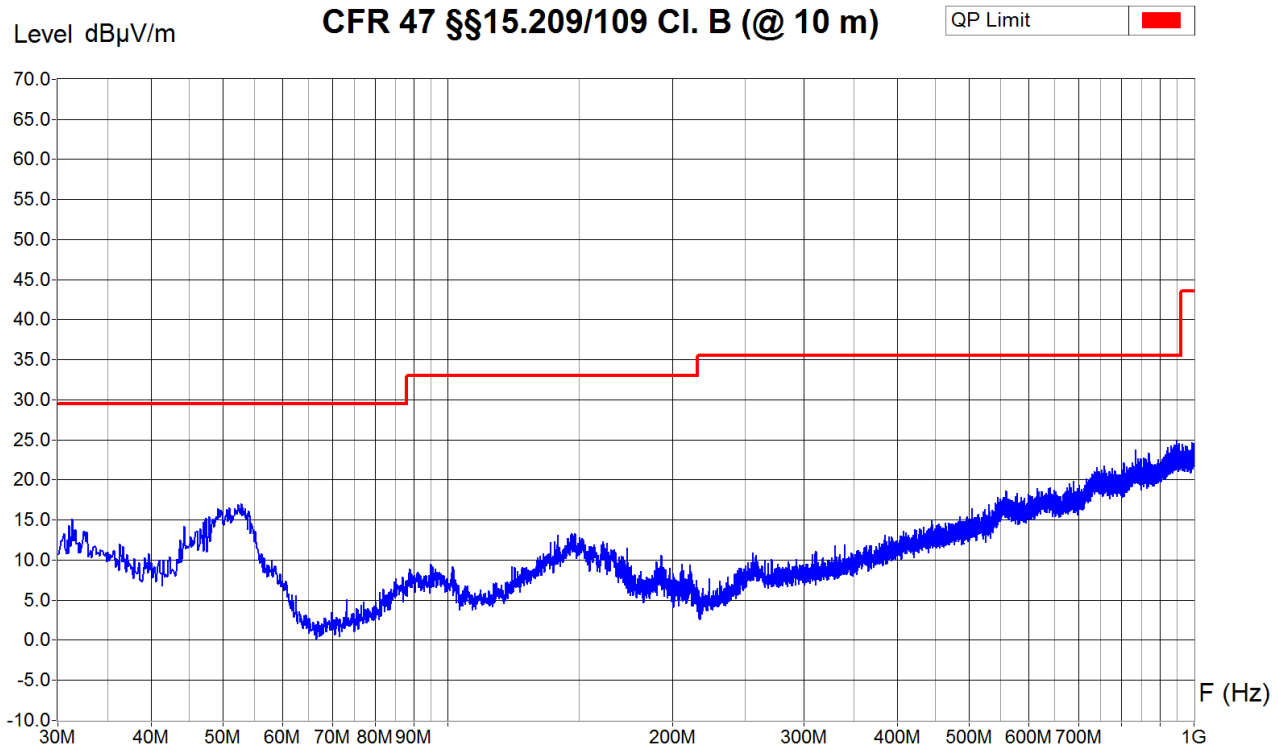
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	RX (f = 2.44 GHz), charging
Remarks :	

Peak detector sweep, 9701 Pts/zone



Zone	30 MHz - 1 GHz
Video Bandwidth	500 KHz
Resol Bandwidth	120 KHz

Operator: B. Itzcovich
Date/Time: 13.12.2017 11:26
Filename: 63_RE_30M-1G_BTRX_V_FCC.png/.txt

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

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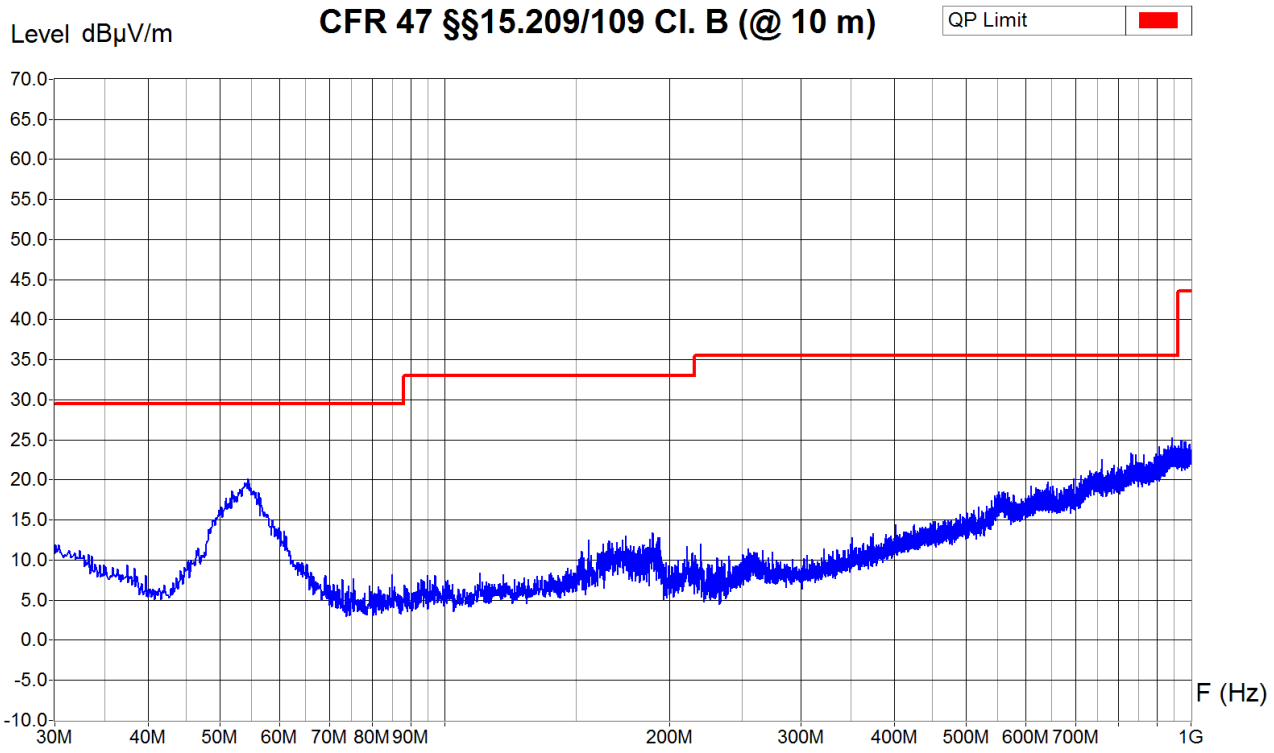
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	RX (f = 2.44 GHz), charging
Remarks :	

Peak detector sweep, 9701 Pts/zone



Zone	30 MHz - 1 GHz
Video Bandwidth	500 KHz
Resol Bandwidth	120 KHz

Operator: B. Itzcovich
Date/Time: 13.12.2017 11:34
Filename: 64_RE_30M-1G_BTRX_H_FCC.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: *1.5 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 analyzer and a wide band antenna. The antenna is moved from 1 to 4 m in height successively with horizontal and vertical polarizations, and aimed at the source by tilting. 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

Climatic conditions: Temperature: 22 - 24 °C Humidity: 30 - 35 % Pressure QFE: 935 - 945 hPa

Test set-up:

Remarks: *Limit values expressed in dBµV/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 µV/m at 3 m;

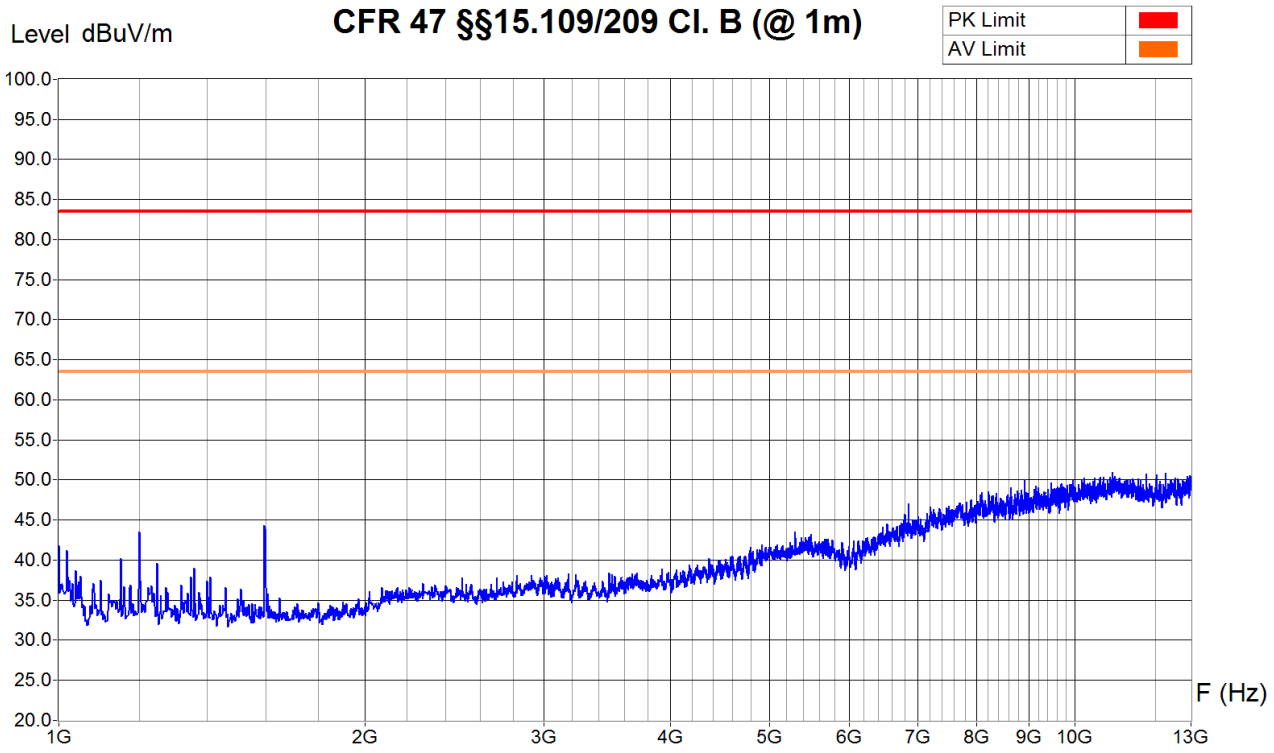
$$20\log\left(\frac{500\,\frac{\mu V}{m}}{1\,\frac{\mu V}{m}}\right)+20\log\left(\frac{3m}{1m}\right)=63.5\,\frac{dB\mu V}{m}\;at\;1m$$

Test equipment:

Spectrum analyzer		☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 07-53
Preamplifier		☐ 05-56	☐ 05-87	☒ N967			
Antenna	(horn)	☐ 90-24	☒ 07-31				
Cables		☒ 10-75	☒ 10-79				
Filters		☐ 13-14	☐ 12-06	☐ 13-05			

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

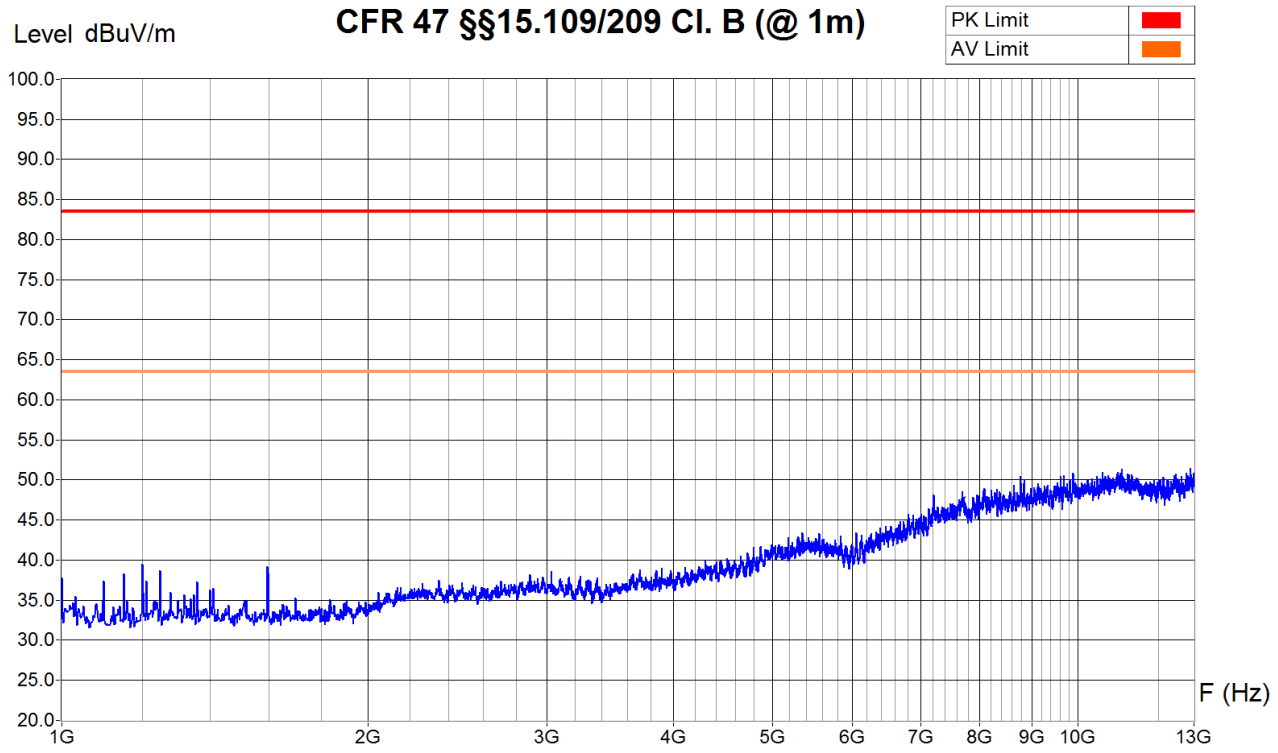
Measurement Type :	Radiated Field
Polarisation :	Vertical
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	RX (f = 2.44 GHz)
Remarks :	
	Peak detector sweep, 3001 Pts/zone



Zone	1 GHz - 7 GHz	7 GHz - 13 GHz
Video Bandwidth	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz

Operator: B. Itzcovich
Date/Time: 07.12.2017 16:05
Filename: 53_RE_1-13G_BTRX_V_FCC.png/.txt

Measurement Type :	Radiated Field
Polarisation :	Horizontal
Table Angle :	0 - 360°
Antenna Height :	1 - 4m (aimed at the source by tilting)
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	RX (f = 2.44 GHz)
Remarks :	
	Peak detector sweep, 3001 Pts/zone



Zone	1 GHz - 7 GHz	7 GHz - 13 GHz
Video Bandwidth	3 MHz	3 MHz
Resol Bandwidth	1 MHz	1 MHz

Operator: B. Itzcovich
Date/Time: 07.12.2017 15:58
Filename: 54_RE_1-13G_BTRX_H_FCC.png/.txt

6.12 Conducted emission - Interference voltage

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

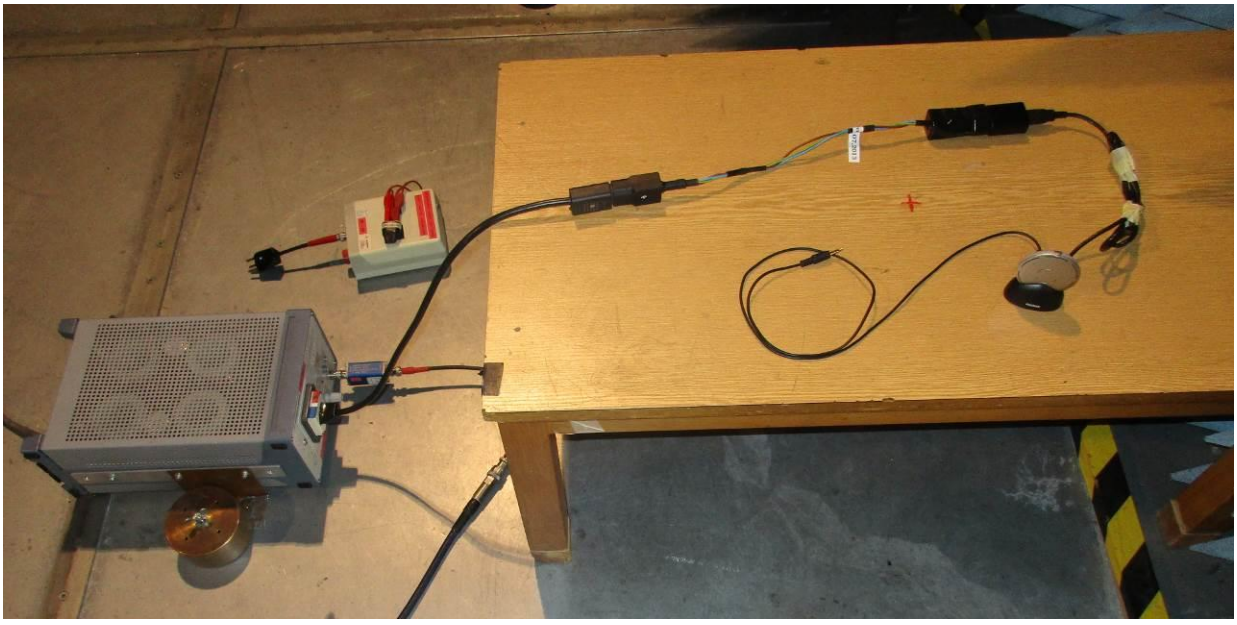
Meas. uncertainty: ± 3.6 dB

Measuring method: The conducted disturbance is measured using a spectrum analyzer 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

Climatic conditions: Temperature: 21 - 23 °C Humidity: 30 - 35 % Pressure QFE: 910 - 920 hPa

Test set-up:



Remarks:	- - -

Test equipment:

Spectrum analyzer	☐ 88-14	☐ 94-24	☐ 02-06	☐ 03-45	☐ 05-39	☒ 10-70
Receiver	☐ 85-12	☐ 90-11	☒ 10-70	☐ 04-28	☐ 06-29	
LISN	☐ 85-13	☐ 90-08	☐ 94-36	☐ 94-40	☐ 95-12	☒ 00-43
Protection 10 dB	☐ 95-33	☐ 95-35	☒ 95-30	☐ 96-38	☐ included in LISN	
Protection 20 dB	☐ 91-46	☐ 95-33	☐ 95-38	☐ included in LISN		
Variable transformer	☒ 75-04					
Multimeter	☒ 09-06					
Cables	☒ 06-00	☐ 10-41				

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

Measurement Type :	Voltage Interference
Supply :	Line 1
Other :	AC adaptor Mains 120 V / 50 Hz
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 14926 Pts/zone

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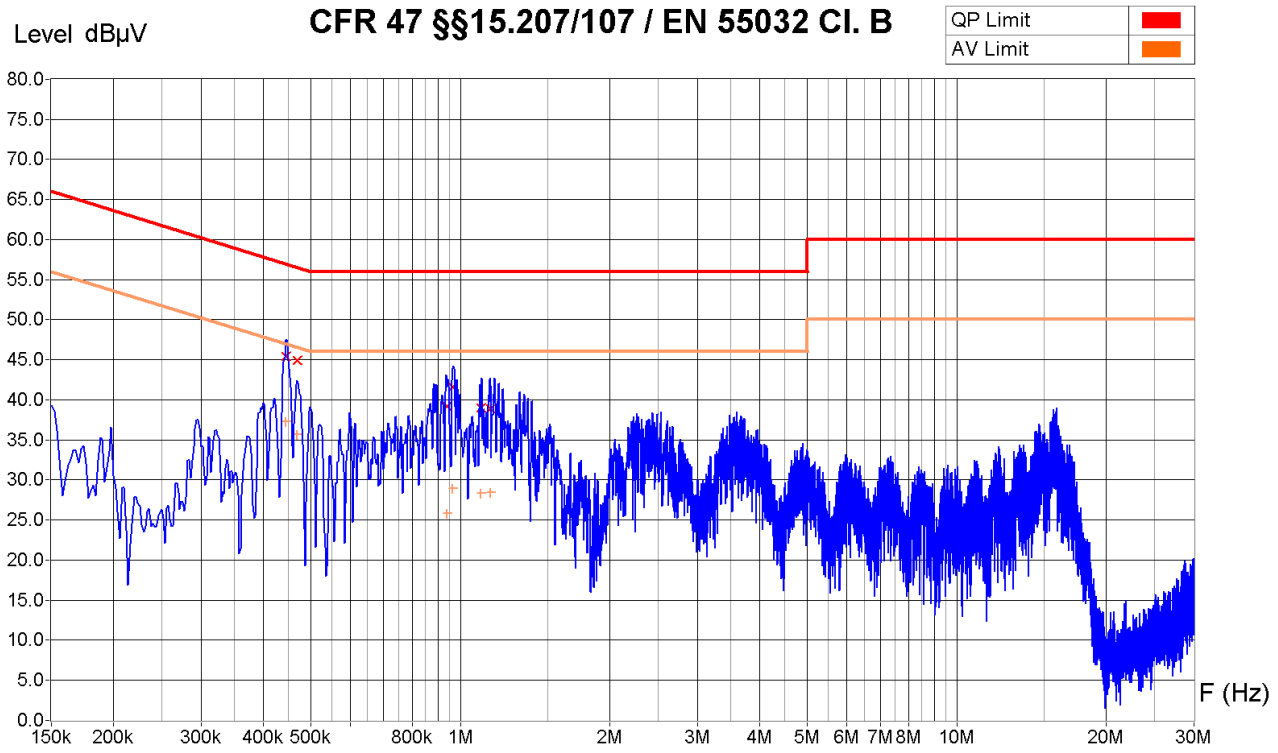

Zone	150 KHz - 30 MHz
Video Bandwidth	300 KHz
Resol Bandwidth	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
445 KHz	47.5 dBµV	45.4 dBµV	37.3 dBµV	11.5 dB
469 KHz	47.6 dBµV	45.0 dBµV	35.7 dBµV	11.6 dB
938 KHz	43.8 dBµV	39.2 dBµV	25.8 dBµV	16.8 dB
966 KHz	44.0 dBµV	41.6 dBµV	28.9 dBµV	14.4 dB
1.10 MHz	43.7 dBµV	39.0 dBµV	28.3 dBµV	17.0 dB
1.15 MHz	43.4 dBµV	38.9 dBµV	28.4 dBµV	17.1 dB

Sample calculation with all conversion and correction factors used				
Frequency [kHz]	Analyzer Peak value [dBµV]	Cable att. corr. [dB]	Attenuator corr. [dB]	Peak voltage [dBµV]
445	37.4	+0.1	+ 10.0	= 47.5

Operator: B. Itzcovich
Date/Time: 15.12.2017 16:08
Filename: 71_CV_150k-30M_BTTXPmax_120V_L.png/.txt

Measurement Type :	Voltage Interference
Supply :	Neutral
Other :	AC adaptor Mains 120 V / 50 Hz

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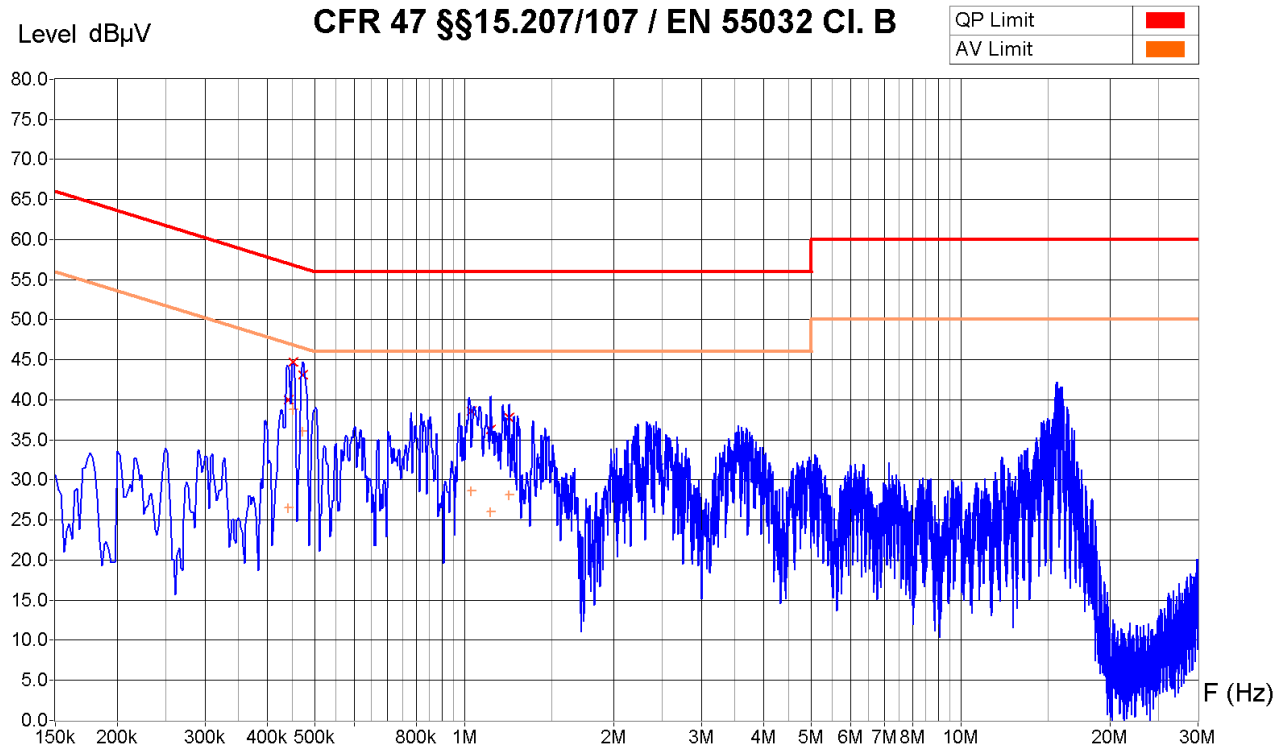
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 14926 Pts/zone



Zone	150 KHz - 30 MHz
Video Bandwidth	300 KHz
Resol Bandwidth	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
441.50 KHz	44.5 dBµV	40.0 dBµV	26.5 dBµV	17.1 dB
451.50 KHz	49.0 dBµV	44.7 dBµV	38.8 dBµV	12.1 dB
472 KHz	48.5 dBµV	43.1 dBµV	36.0 dBµV	13.4 dB
1.03 MHz	42.9 dBµV	38.6 dBµV	28.6 dBµV	17.4 dB
1.13 MHz	42.5 dBµV	36.3 dBµV	26.0 dBµV	19.7 dB
1.23 MHz	42.5 dBµV	37.8 dBµV	28.1 dBµV	18.2 dB

Operator: B. Itzcovich
Date/Time: 15.12.2017 16:04
Filename: 72_CV_150k-30M_BTTXPmax_120V_N.png/.txt

Measurement Type :	Voltage Interference
Supply :	Line 1
Other :	AC adaptor Mains 230 V / 50 Hz
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 14926 Pts/zone

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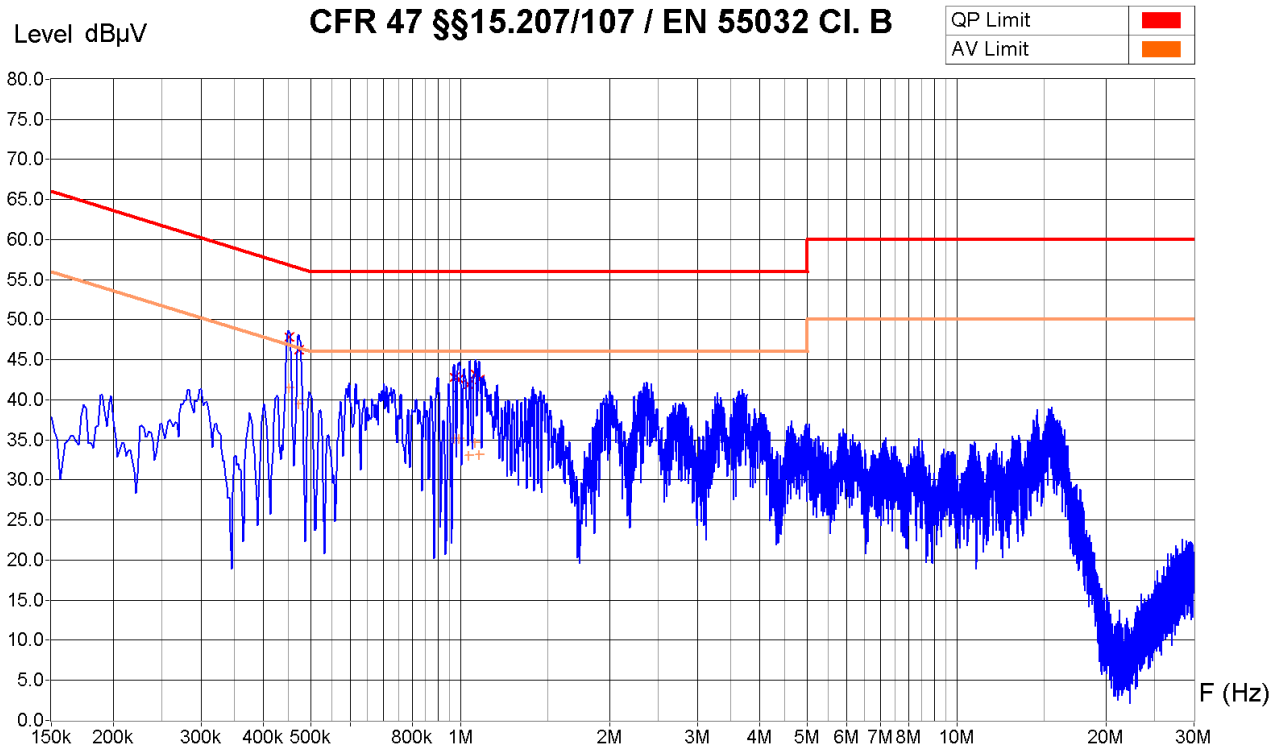

Zone	150 KHz - 30 MHz
Video Bandwidth	300 KHz
Resol Bandwidth	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
451.50 KHz	53.7 dBµV	47.8 dBµV	41.5 dBµV	9.0 dB
472 KHz	48.9 dBµV	46.2 dBµV	39.5 dBµV	10.3 dB
973 KHz	46.0 dBµV	42.8 dBµV	35.1 dBµV	13.2 dB
995 KHz	44.4 dBµV	42.6 dBµV	35.2 dBµV	13.4 dB
1.04 MHz	45.4 dBµV	42.0 dBµV	33.0 dBµV	14.0 dB
1.07 MHz	45.6 dBµV	43.2 dBµV	34.6 dBµV	12.8 dB
1.09 MHz	45.1 dBµV	42.5 dBµV	33.2 dBµV	13.5 dB

Operator: B. Itzcovich
Date/Time: 15.12.2017 15:56
Filename: 73_CV_150k-30M_BTTXPmax_230V_L.png/.txt

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

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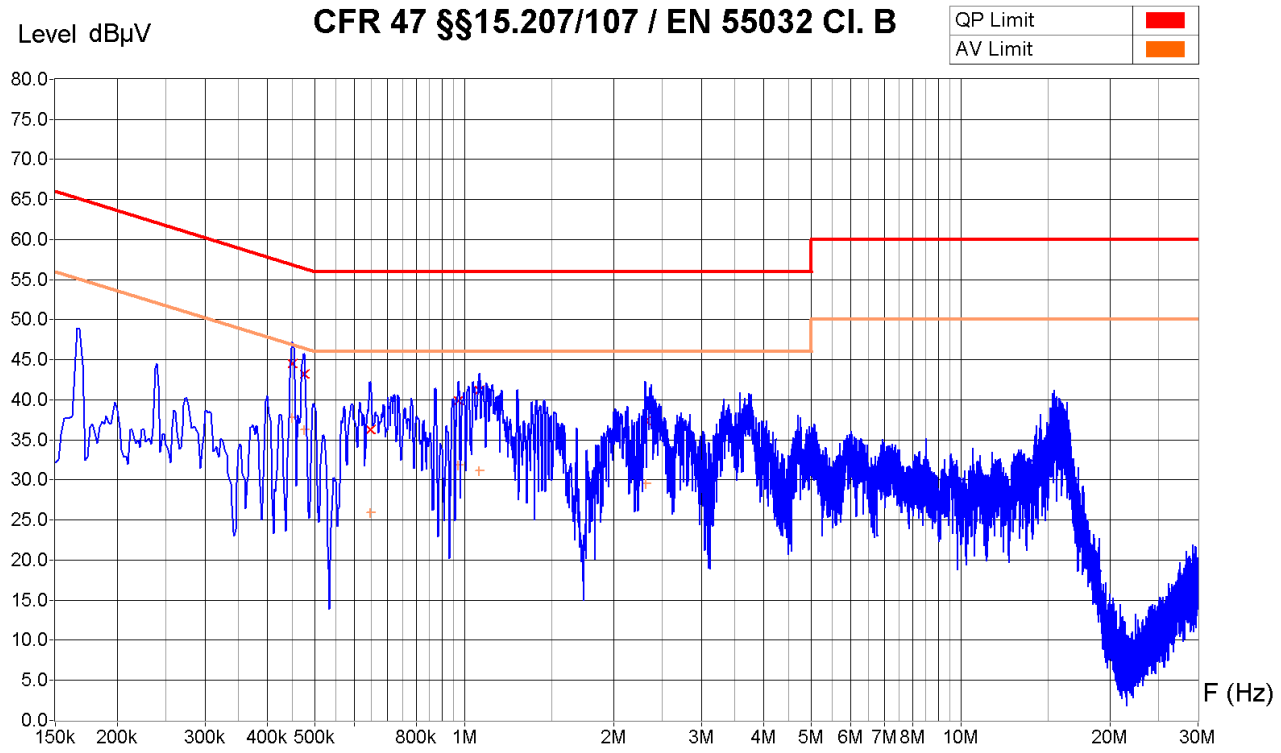
Equipment Under Test :	Roger Select (TX27), BT part
Set-Up :	With AC adaptor, USB and audio cables connected. See photos
Operating Conditions :	Hopping TX (f = 2402 / 2441 / 2480 MHz), modulated, Pmax, charging
Remarks :	
	Peak detector sweep, 14926 Pts/zone



Zone	150 KHz - 30 MHz
Video Bandwidth	300 KHz
Resol Bandwidth	9 KHz

Receiver Measures

Frequency	Peak	QuasiPeak (x)	Average (+)	QP Margin
450 KHz	48.4 dBµV	44.6 dBµV	37.8 dBµV	12.3 dB
476 KHz	48.0 dBµV	43.2 dBµV	36.2 dBµV	13.2 dB
647 KHz	50.3 dBµV	36.3 dBµV	25.9 dBµV	19.7 dB
973 KHz	50.1 dBµV	39.9 dBµV	31.8 dBµV	16.1 dB
1.07 MHz	46.4 dBµV	41.2 dBµV	31.2 dBµV	14.8 dB
2.32 MHz	41.6 dBµV	37.4 dBµV	29.5 dBµV	18.6 dB

Operator: B. Itzcovich
Date/Time: 15.12.2017 15:59
Filename: 74_CV_150k-30M_BTTXPmax_230V_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.

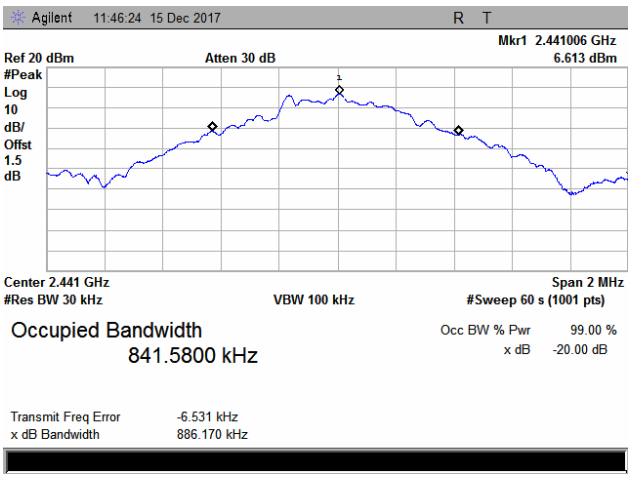
Modifications: ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

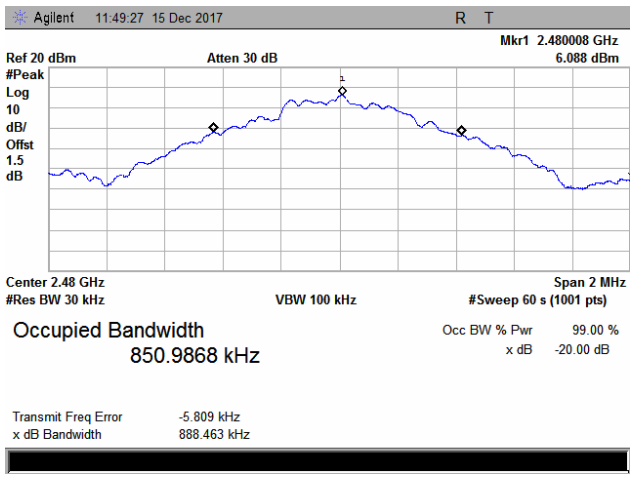
Necessary bandwidth: For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specified conditions.

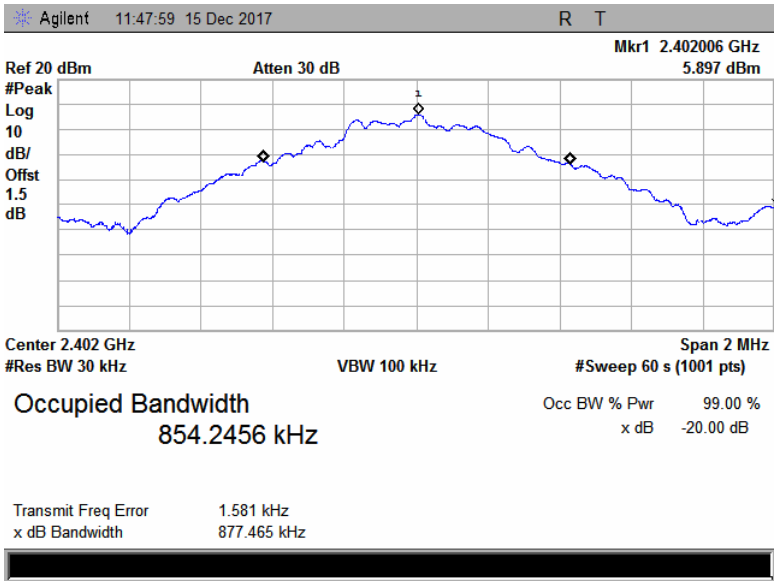
B_n = 854 kHz (occupied bandwidth)

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

Designation of emission: 854KFXD







Place and date of test: *Rossens, December 15, 2017*
Operator: *B. Itzcovich*

7. Appendix

7.1 Test equipment

Inventory No.	Designation	Manufacturer	Type	Serial No.	Cal. date	Next calibr.	Cal. period [year]
04-79	Loop antenna	Rohde&Schwarz	HFH2-Z2	872 177/39	22 Sep. 2015	22 Sep 2018	3
05-38	Bi-Log antenna	Chase	CBL6111	1056	30 Aug 2017	30 Aug 2019	2
07-31	Horn antenna	Schwarzbeck	BBHA 9120 D	9120D-632	30 Aug 2017	30 Aug 2019	2
98-12	Horn Antenna + Preamp + Mixer	Emco + Miteq + Hewlett Packard	3160-09 + JDM2W-18002650-27-10P-R + 11970K	9809-1121 + 1707479 + 2332A01295	01 Jun 2017	01 Jun 2022	5
00-52	Dipole antenna	Schwarzbeck	UHA 9125 D	112	11 May 2017	11 May 2022	5
12-06	HP Filter	BSC	SH 6472	2304801	23 May 2017	23 May 2019	2
13-14	Filter	A-INFOMW	Cavity Band Reject Filter	J10811304070 02	19 Apr 2016	19 Apr 2018	2
11-36	Attenuator	Agilent	8491B 10dB	MY39266234	25 Apr 2016	25 Apr 2018	2
95-30	Attenuator						
05-59	Preamplifier	Montena EMC	AM-1300	432972	22 Mar 2017	22 Mar 2019	2
N967	Preamplifier	Montena EMC	AFS42-00101800-25-S-42	- - -	03 Jul 2017	03 Jul 2018	2
15-21	Signal Generator	Rohde&Schwarz	SML03 (+B3)	102380	16 Dec 2016	16 Dec 2018	2
06-00	Cable	Huber&Suhner	ST18A ST18A SF106PA	6224/18A 8399/18A 463/6PA	02 Jun 2017	02 Jun 2018	1
06-01	Cable	Huber&Suhner	SF106PA SF106PA SF106PA	415/6PA 414/6PA 412/6PA	03 Apr 2017	03 Apr 2018	1
10-75	Cable	Huber&Suhner	ST18A	8385/18A	10 May 2017	10 May 2019	2
10-79	Cable	Huber&Suhner	ST18A	8444/18A	10 May 2017	10 May 2019	2
11-13	Cable	Huber&Suhner	SF104	332033/4	10 May 2017	10 May 2019	2
10-51	Cable	Huber&Suhner	SF104	222093/4	10 May 2017	10 May 2019	2
10-81	Cable	Huber&Suhner	SF104P	44159/4P	01 Jun 2017	01 Jun 2019	2
11-62	Cable	Huber&Suhner	SF104P	51338/4P	01 Jun 2017	01 Jun 2019	2
00-43	LISN	Rohde&Schwarz	ESH3-Z5	890 604/026	12 Oct 2016	12 Oct 2018	2
07-53	Spectr. Analyzer	Hewlett Packard	E4407B	SG45101517	15 Nov 2016	15 Nov 2018	2
10-70	Receiver + Spectr. Analyzer	Rohde&Schwarz	ESU8 1302.6005K08	100231	12 Sep 2017	12 Sep 2019	2
09-04	Power sensor	Agilent	E9304A H19	MY41498789	12 Dec 2016	12 Dec 2020	4
03-12	Wattmeter	Agilent	E4418B	GB40207055	02 Nov 2016	02 Nov 2018	2
09-06	Multimeter	Fluke	87V	96900096	11 Apr 2017	11 Apr 2019	2
06-62	Power supply	Elektro-Automatik	EA-PS 2016-050	2006100338	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.