TEST REPORT # EMCC-020548B, 2018-07-20

EQUIPMENT UNDER TEST:

Device:	PIRAMID CONNECT
Serial Number:	n/a
Application:	Movement Detector
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Manufacturer:	SORHEA
Address:	1, rue du Dauphiné 69120 Vaulx-En-Velin France
Phone :	+33 4 78 03 06 10
E-Mail :	a.caradec@sorhea.fr

RELEVANT STANDARD(S) : 47 CFR § 15.245
RSS-210 Issue 9

MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013 ☒ RSS-Gen Issue 4

TEST REPORT PREPARED BY:

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TEST PERSONNEL:

Patrick Reusch

HEAD OF COMMERCIAL EMC AND RADIO DEPT.:

Wolfgang Döring

CONTENTS

1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance with the 47 CFR § 15.245 and RSS-210 Issue 9 requirements for the certification of licence-exempt Intentional Radiator.

1.2 Limits and Reservations

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report. This test report shall not be reproduced except in full without the written permission of EMCCons DR. RAŠEK GmbH & Co. KG.

1.3 Test Location

Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG
DAkkS Accreditation No.:	D-PL-12067-01-02
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Boelwiese 8 91320 Ebermannstadt GERMANY
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter GERMANY
Laboratory:	Test Laboratory IV The 3 m & 10 m semi-anechoic chamber site has been fully described in a report submitted to ISED. This 3m/10m alternative test side is approved by Innovation, Science and Economic Development Canada under file number 3464C-1.
Phone:	+49 9194 7262-0
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E-Mail:	emc.cons@emcc.de
Web:	www.emcc.de

1.4 Customer

Company Name:	S.M.E.E.
Street:	Rue de Taille
City:	38500 Voiron
Country:	France
Name for contact purposes:	Mr Laurent Chapus
Phone:	+33 4 76 65 76 50
Fax:	n/a
E-Mail:	laurent.chapus@smee.fr

1.5 Manufacturer

Company Name:	SORHEA
Street:	1, rue du Dauphiné
City:	69120 Vaulx-En-Velin
Country:	France
Name for contact purposes:	Mr Aymeric CARADEC
Phone:	+33 4 78 03 06 10
E-Mail:	a.caradec@sorhea.fr

1.6 Dates and Test Location

Date of receipt of EUT:	2018-05-02
Test Date:	CW 18-20/2018
Test Location:	Lab IV

1.7 Ordering Information

Purchase Order:	54679 (of 12407)
Date:	2018-04-26
Vendor Number:	n/a

1.8 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2018-05-03	24	36	973	IV	no
2018-05-04	24	36	978	IV	no
2018-05-14	24	45	967	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

The following data is based on customer's information.

Trade Name:	PIRAMID CONNECT
Serial Number:	n/a
No. of Variants:	0
Application:	Movement Detector
Hardware Version:	N/A
Firmware Version:	N/A
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Frequency Range:	10.50 – 10.55 GHz
No. of Channel(s):	1
Tested channel(s):	10.53 GHz
Power Supply:	12 V_{DC}
Ports:	1x 8 wire cable for relay output
Antenna:	Microstrip Array Antenna (10.510GHz)
Gain:	12 dBi
Remarks:	None

2.2 Intended Use

The following information was delivered by the customer:

PIRAMID CONNECT is a dual-technology sensor:
• A passive infrared unit composed of a pyroelectric infrared (PIR) sensor that detects radiation emitted by the human body in the infrared spectrum.
• A Microwave antenna using a 10,510 GHz frequency transmitter and a Doppler Effect receiver detect changes in the state of the radiation field caused by passage of an object or body in the lobe created by the antenna.

The detection zone formed by the lobe of the microwave antenna and the beams from the mirror of the PIR create an invisible detection zone. To trigger an alarm, it is necessary that the object or intruder pass through the detection zone.

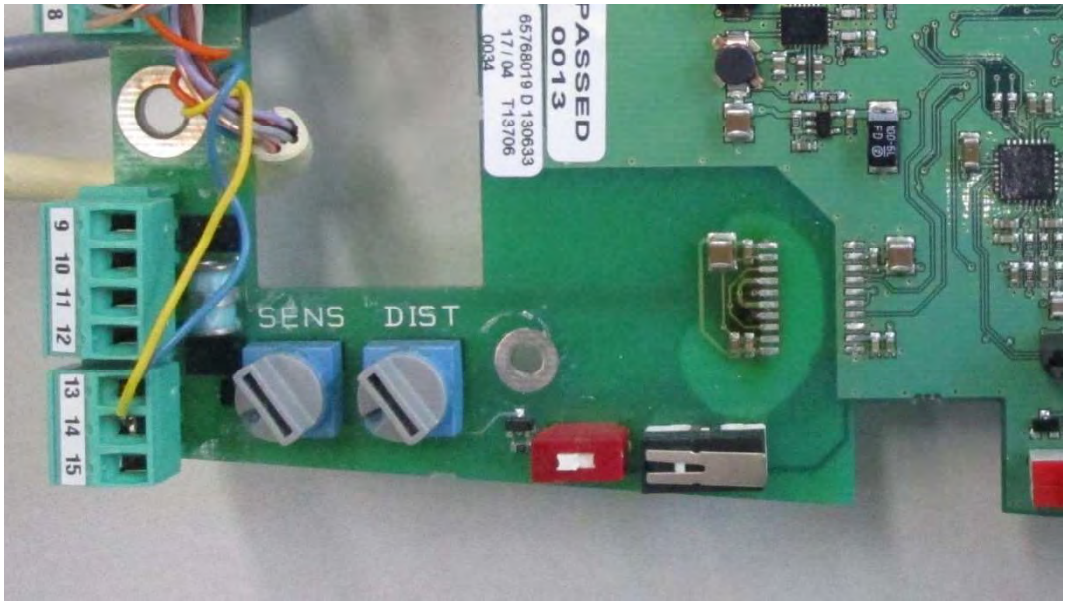
2.3 EUT Peripherals/Simulators

A standard AC/DC adaptor was provided by customer to supply the EUT by 12 V_{DC}.

2.4 Mode of Operation during Testing and Test Set-up

The equipment under test (EUT) was operated during the tests under the following conditions:

Normal Operation:
The EUT was operated with the following settings, which were defined by manufacturer as a worst case mode of operation:
- MODE: down position
- DIST: 9 (MAX)
- SENS: 9 (MAX)



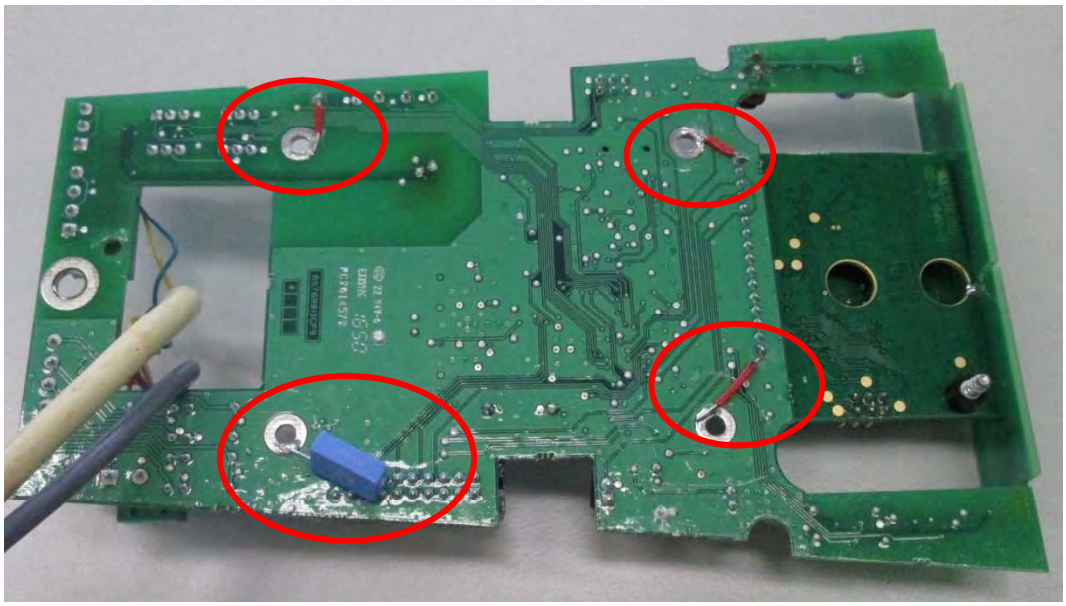
Photograph of settings during testing

According to customer's order, no simulators/dummy loads were attached to the relay's output cable.

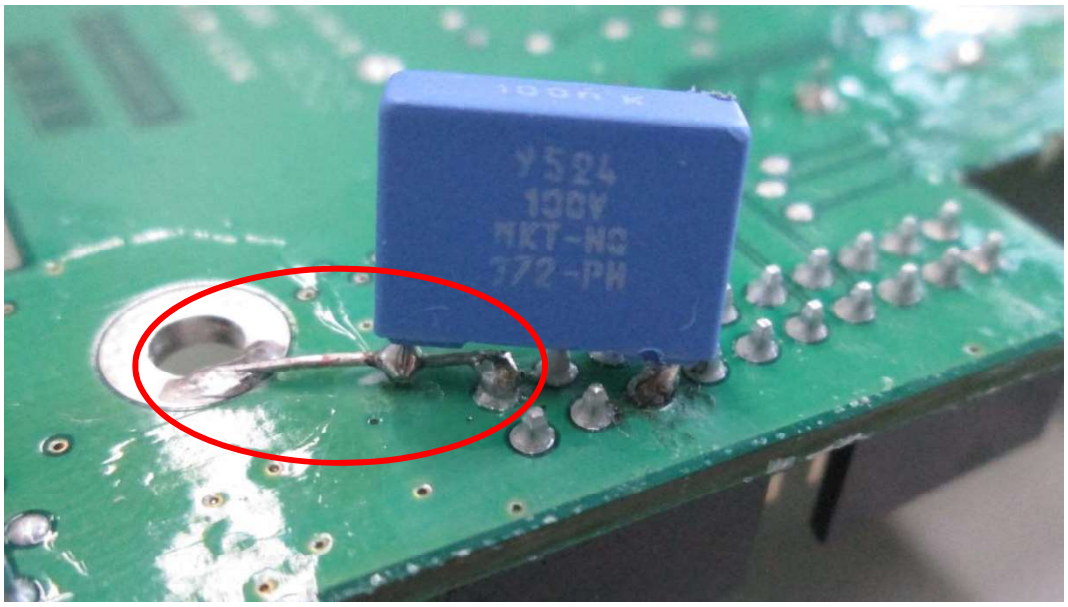
2.5 Modifications Required for Compliance

The sample was not modified after its arrival at EMCCons laboratory.

However, the sample arrived with the following additional four jumpers and one capacitor. All tests were performed in this configuration.



Photograph of modifications



Photograph of capacitor's connection

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: SORHEA
Device: PIRAMID CONNECT
Serial No: n/a

Requirement	47 CFR Section	RSS Section	Report Section	Result
Antenna Requirement	§ 15.203	---	4	Passed
Conducted AC Power Line Emissions 150 kHz - 30 MHz	§ 15.207	RSS-Gen, 8.8	5	Passed
Occupied Bandwidth	§ 15.215	RSS-Gen 6.7	6	Passed
Field Strength of Fundamental	§ 15.245	RSS-210, F.1	7	Passed
Radiated Emissions 9 kHz – 30 MHz	§ 15.245, § 15.209	RSS-210, F.1, RSS-Gen 8.9	8	Passed
Radiated Emissions 30 MHz – 1000 MHz	§ 15.245, § 15.209	RSS-210, F.1, RSS-Gen 8.9	9	Passed
Radiated Emissions 1 GHz – 6 GHz	§ 15.245, § 15.209	RSS-210, F.1, RSS-Gen 8.9	10	Passed
Radiated Emissions 6 GHz – 53 GHz	§ 15.245, § 15.209	RSS-210, F.1, RSS-Gen 8.9	11	Passed

N.A. – not applicable; N.T. – Not tested acc. to applicant's order.

The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units and meet the requirements of the specifications referenced herein.
Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.
The measurements contained in this report were made in accordance with the procedures described in ANSI C63.10-2013 and all applicable Public Notices received prior to the date of testing.All requirements were found to be within the limits outlined in this report.

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report.

Test Personnel: Patrick Reusch
Issuance Date: 2018-07-20

4 ANTENNA REQUIREMENT

Test Requirement: 47 CFR, § 15.203
Test Procedure: none

4.1 Regulation

47 CFR, §15.203 Antenna requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

4.2 Test Equipment

None.

4.3 Test Procedures

None.

4.4 Test Result

The EUT is equipped with a printed patch antenna without any rf connector.

Manufacturer:	SORHEA
Device:	PIRAMID CONNECT
Serial No:	n/a
Test date:	2018-05-14

The EUT meets the requirements of this section.

5 AC POWER LINE CONDUCTED EMISSIONS TEST

Test Requirement: 47 CFR, § 15.207
RSS-Gen, 8.8
Test Procedure: ANSI C63.10-2013

5.1 Regulation

47 CFR, § 15.207 Conducted limits

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission [MHz]	Conducted limit [dBµV]	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5–5	56	46
0.5-30	60	50

*Decreases with the logarithm of the frequency.

RSS-Gen, 8.8 AC power-line conducted emissions limits

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 µH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.
For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

Table 4 – AC power-line conducted emissions limits		
Frequency [MHz]	Conducted limit [dBµV]	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5–5	56	46
0.5-30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

5.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
516	EMI Test Receiver	Rohde & Schwarz	ESIB40	2018-03	2019-03
1890	Shielded Cabinet, SR-ULL-05	EMCC / SIEM / FRANK	SC2-ULL	n/a	n/a
1901	V-LISN 50 ohms (50 uH + 5 ohms)	Rohde & Schwarz	ESH2-Z5	2017-09	2018-10
3184	Pulse Limiter	MTS	MTA-IMP-136	2017-07	2019-07
3662	Digital Multimeter	Agilent	U1241B	2018-02	2019-02
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH	57613 Web-T/Rh/P	2018-01	2020-01
5392	EMC Measurement Software	Rohde & Schwarz	EMC32 (v10.35.01)	n/a	n/a
5551	BNC cable	EMCC	BNC003m0	n/a	n/a

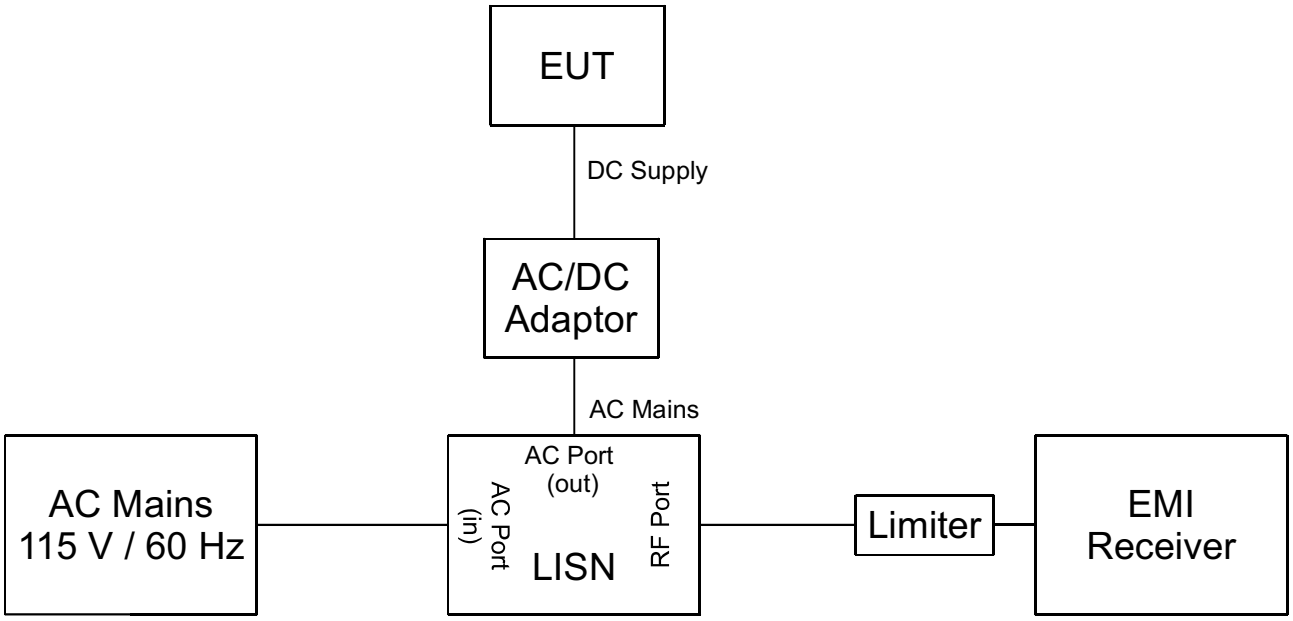
5.3 Test Procedures

ANSI C63.4-2014, 6.2.3.2.2 Placement of tabletop EUTs

A stand-alone EUT shall be placed in the center along the back edge of the tabletop. For multiunit tabletop systems, the EUT shall be centered laterally (left to right facing the tabletop) on the tabletop and its rear shall be flush with the rear of the table.
Accessories that are part of an EUT system tested on a tabletop shall be placed in a test arrangement on one or both sides of the host with a 10 cm separation between the nearest points of the cabinets (see Figure 5). The rear of the host and accessories shall be flush with the back of the supporting tabletop unless that would not be typical of normal use. If more than two accessories are present, then an equipment test arrangement shall be chosen that maintains 10 cm spacing between cabinets unless the equipment is normally located closer together. Multiple accessories (more than two) may be distributed around the table as shown in Figure 5.
Accessories, such as ac power adapters, which are typically table mounted because of cable length, shall be mounted on the tabletop in a typical manner. Accessories, which are typically floor mounted, shall occupy a floor position directly below the portion of the EUT to which they are typically connected.
Power accessories such as ac power adapters (battery eliminators), which power other devices, shall be tested per the following provisions:

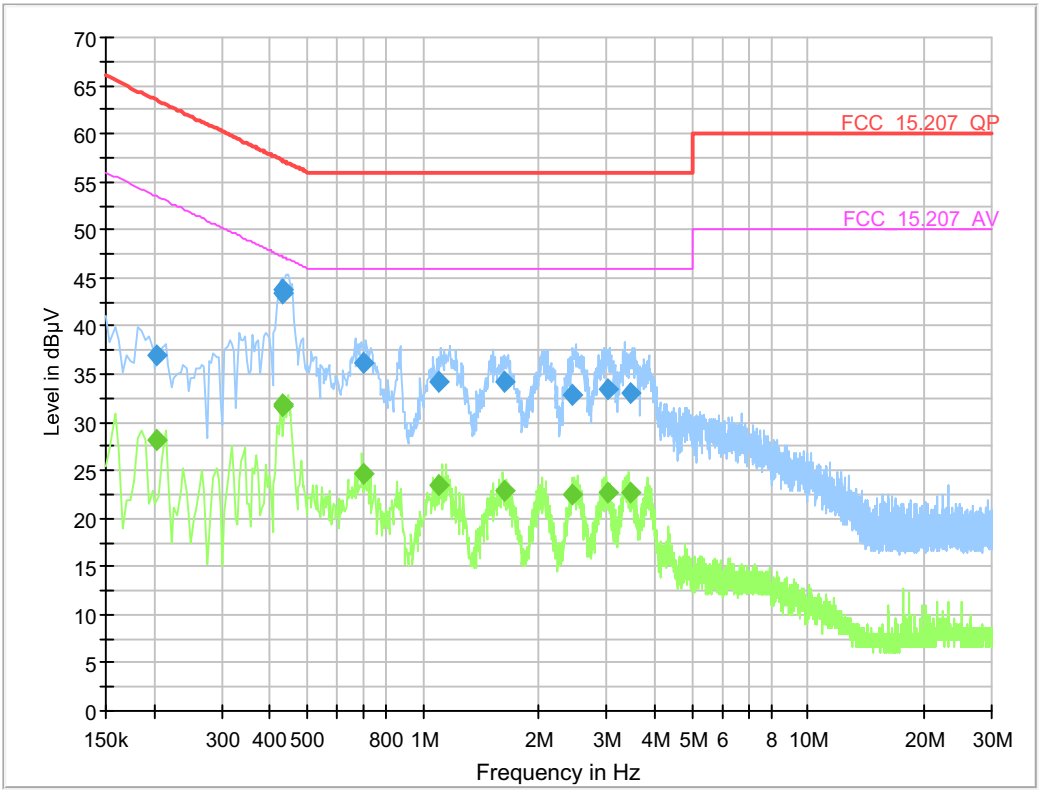
a) Power accessories that are not the EUT are configured as follows:
1) If the power accessory connects to a tabletop EUT having a power cord to the power accessory less than 80 cm in length, then the power accessory is placed on the tabletop. If the length of the EUT power cord to the power accessory is 80 cm or greater, then the power accessory is placed on the floor immediately under the EUT.
2) If the power accessory plugs directly into the wall outlet, then it shall be attached to the source of power on top of the ground plane and directly under the EUT with the EUT connected. If the length of the EUT power cord is less than 80 cm, then a nonconductive support for raising the power accessory is needed, along with a short extension cord from the source of power to the raised power accessory.
b) Power accessories that are part of the EUT are configured as follows:
1) If the input power cord of the power accessory is 80 cm long or greater, then the power accessory shall be placed on the tabletop. If the power accessory has an input power cord that is less than 80 cm long, then the power accessory shall be placed at a height above the ground plane such that its input power cord is fully extended in the vertical direction.

2) If the power accessory plugs directly into the wall outlet, then the power accessory shall be tested on the tabletop using an extension cord between the source of power and the accessory. The extension cord shall be connected in a manner such that it takes the most direct path to the power accessory.



Schematic diagram

5.4 Test Result



Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line
0.203300	---	28.24	53.48	25.23	9.000	L1
0.203300	36.90	---	63.48	26.57	9.000	L1
0.431700	43.76	---	57.22	13.46	9.000	L1
0.431700	---	31.86	47.22	15.36	9.000	L1
0.432700	43.32	---	57.20	13.88	9.000	L1
0.432700	---	31.63	47.20	15.57	9.000	L1
0.703300	---	24.61	46.00	21.39	9.000	L1
0.703300	36.12	---	56.00	19.88	9.000	L1
1.096500	---	23.52	46.00	22.48	9.000	L1
1.096500	34.15	---	56.00	21.85	9.000	L1
1.621100	---	22.92	46.00	23.08	9.000	L1
1.621100	34.23	---	56.00	21.77	9.000	L1
2.439900	---	22.50	46.00	23.50	9.000	L1
2.439900	32.77	---	56.00	23.23	9.000	L1
3.024500	---	22.60	46.00	23.40	9.000	L1
3.024500	33.38	---	56.00	22.62	9.000	L1
3.478900	---	22.60	46.00	23.40	9.000	L1
3.478900	33.00	---	56.00	23.00	9.000	L1

Manufacturer: SORHEA
Device: PIRAMID CONNECT
Serial No: n/a
Test date: 2018-05-18

The EUT meets the requirements of this section.

6 OCCUPIED BANDWIDTH

Test Requirement: 47 CFR, § 15.215
RSS-Gen, 6.7
Test Procedure: ANSI C63.10-2013
RSS-Gen, 6.7

6.1 Regulation

47 CFR, §15.215 Additional provisions to the general radiated emission limitations.
(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. [...]

RSS-Gen, 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

6.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
1294	Multi Device Controller	Frankonia	FC03	n/a	n/a
1868	Anechoic Room FAC	EMCC/Frankonia	n/a	n/a	n/a
3235	Double Ridged Guide Antenna	Schwarzbeck	BBHA 9120D	2017-05	2019-05
3831	Spectrum Analyzer	Rohde & Schwarz	FSU50	2017-09	2018-09
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4524	Notebook	Dell	Latitude E6430	n/a	n/a
4595	USB to GPIB adapter	National Instruments	GPIB-USB-HS	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH	57613 Web-T/Rh/P	2018-01	2020-01
5611	RF cable assembly	Rosenberger	LA1-008-1000	n/a	n/a

6.3 Test Procedures

ANSI C63-10, 6.9.2 Occupied bandwidth—relative measurement procedure

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are −6 dB, −20 dB, and −26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by "−xx dB." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "−xx dB" bandwidth; other requirements might specify that the "−xx dB" bandwidth be entirely contained within the authorized or designated frequency band.53

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

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

RSS-Gen, 6.7 Occupied Bandwidth

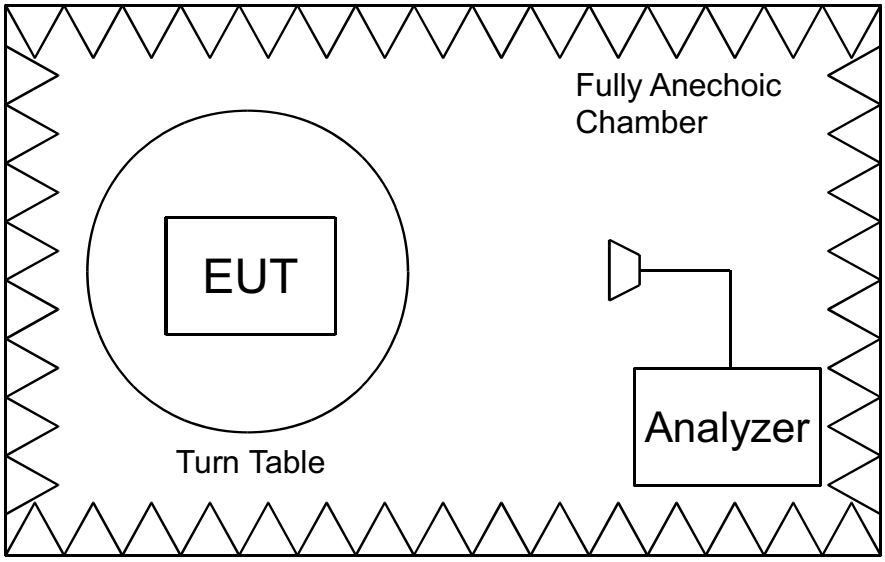
The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.



Schematic diagram

6.4 Test Result

20 dB Bandwidth				
Nominal Tx Frequency [GHz]	**Lower Edge [GHz]**	**Upper Edge [GHz]**	**20 dB Bandwidth [kHz]**	**Limit**
10.53	10.530959631	10.530963349	3.7	within the frequency band 10.50 ... 10.55 GHz

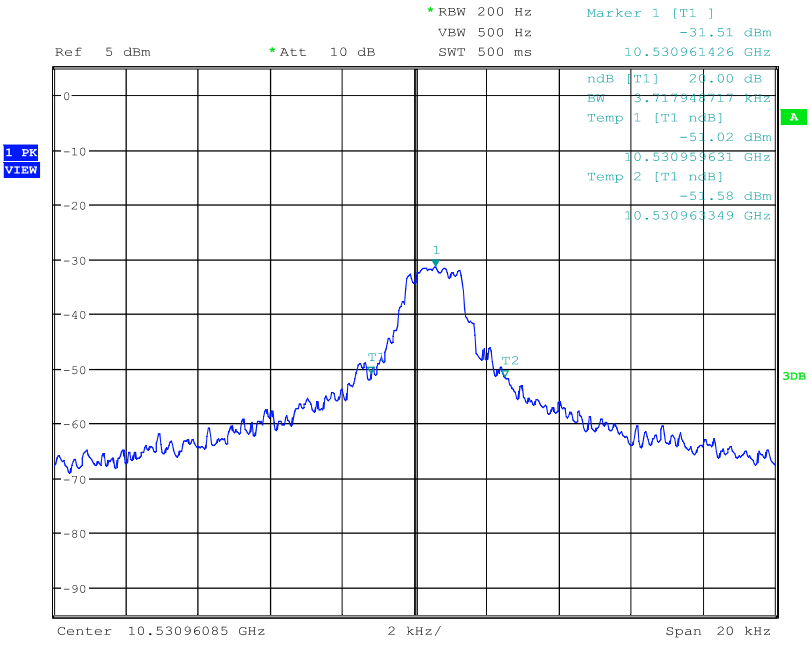
99 % Bandwidth				
Nominal Tx Frequency [GHz]	**Lower Edge [GHz]**	**Upper Edge [GHz]**	**99 % Bandwidth [kHz]**	**Limit**
10.53	10.530958381	10.530964407	6.0	within the frequency band 10.50 ... 10.55 GHz

Manufacturer: SORHEA
Device: PIRAMID CONNECT
Serial No: n/a
Test date: 2018-05-14

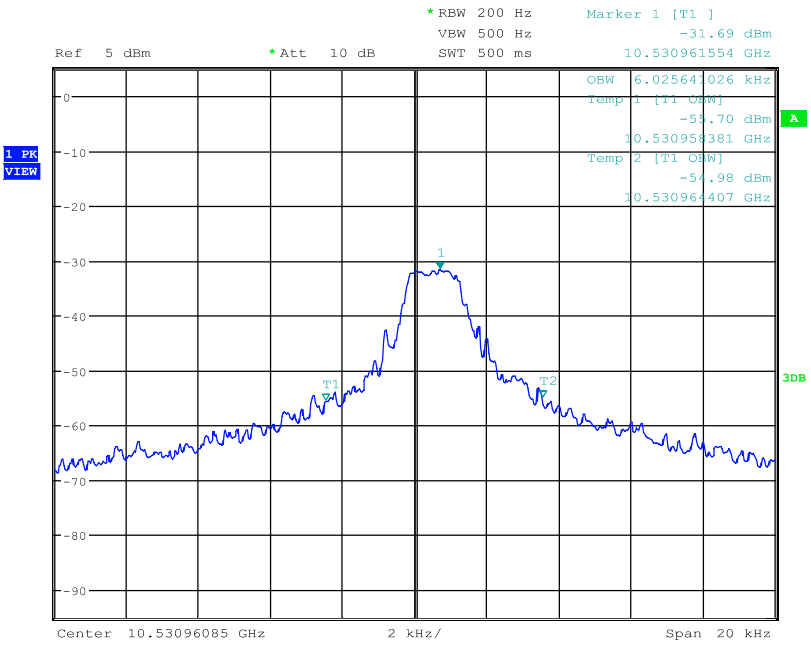
The EUT meets the requirements of this section.

6.5 Detailed Measurement Data

20 dB Bandwidth



99% Bandwidth



7 FIELD STRENGTH OF FUNDAMENTAL

Test Requirement: 47 CFR, § 15.245
RSS-210, F.1
Test Procedure: ANSI C63.10-2013

7.1 Regulation

47 CFR, §15.245 Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.
(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:
(ii) For all other field disturbance sensors, 7.5 mV/m.
(2) Field strength limits are specified at a distance of 3 meters.

RSS-210, F.1 Field Disturbance Sensors
The equipment shall comply with the following emission limits:
a. The average field strength measured at 3 m shall not exceed the limits shown in Table F1:

Table F1 — Field Strengths for Field Disturbance Sensors Operating at Different Frequencies		
Fundamental frequency (MHz)	Field Strength (mV/m)	
	Fundamental Emissions	Harmonic Emissions
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

b. Additionally, harmonic emissions falling into restricted bands listed in RSS-Gen, and which are below 17.7 GHz shall meet the general field strength limits specified in RSS-Gen.
c. Harmonic emissions falling into restricted bands listed in RSS-Gen and which are at and above 17.7 GHz shall not exceed the following field strength limits measured at a distance of 3 m:
ii.7.5 mV/m for all other devices.

7.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
1294	Multi Device Controller	Frankonia	FC03	n/a	n/a
1868	Anechoic Room FAC	EMCC/Frankonia	n/a	n/a	n/a
3235	Double Ridged Guide Antenna	Schwarzbeck	BBHA 9120D	2017-05	2019-05
3831	Spectrum Analyzer	Rohde & Schwarz	FSU50	2017-09	2018-09
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4524	Notebook	Dell	Latitude E6430	n/a	n/a
4595	USB to GPIB adapter	National Instruments	GPIB-USB-HS	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH	57613 Web-T/Rh/P	2018-01	2020-01
5611	RF cable assembly	Rosenberger	LA1-008-1000	n/a	n/a

7.3 Test Procedures

ANSI C63.10, 6.3.1 Test arrangement

[..] Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m (see 6.6.3.1). A method for evaluating the effects of the table on EUT radiated emissions is given in 5.5 of CISPR 16-1-4:2010 for frequencies up to 18 GHz. The EUT shall be set up in its typical configuration and arrangement and operated in its various modes as described in 5.10. An antenna shall be connected to the EUT in accordance with 5.8 and 5.10.4. The EUT and transmitting antenna shall be centered on the turntable. For devices with multiple antennas that are active simultaneously, the EUT shall be positioned, to the extent possible, with the antennas equally distributed around the center of the device. The exact setup shall be documented in the test report.

Any controlling device (e.g., notebook, laptop, or desktop computer) shall be positioned such that it shall not significantly influence the measurement results. No other peripherals are required to be connected to the controlling device for this test unless the radio is being tested as part of the notebook or PDA qualifications.

ANSI C63.10, 6.5.3 Exploratory radiated emission tests

Exploratory measurements are used to identify the frequencies and amplitudes of the emissions while manipulating and rotating the EUT.

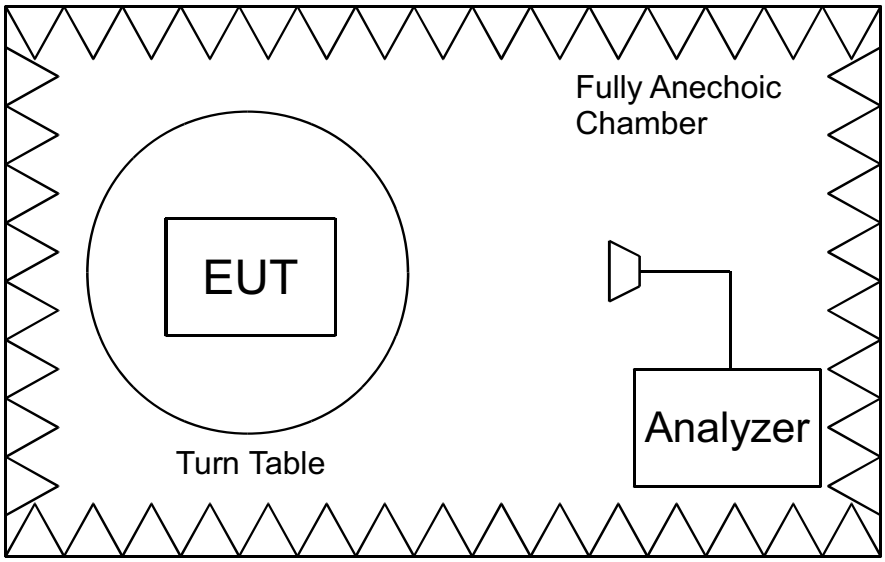
Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. Exploratory measurements shall be made on a test site per 5.2. Shielded rooms, not treated with RF absorption material, shall not be used for exploratory measurements.

For each mode of operation required to be tested, the frequency spectrum shall be monitored. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.

ANSI C63.10, 6.5.4 Final radiated emission tests

Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.



Schematic diagram

7.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB

If the measurement unit is dBm instead of dBµV, the conversation constant of 107 dB has to be added to the reading in dBm.

Assume a receiver reading of -30.1 dBm is obtained. The Antenna Factor of 39.2 dB(1/m) and a Cable Factor of 1.2 dB are added, giving a field strength of 117.3 dBµV/m in the measurement distance. The field strength of 117.3 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = -30.1 + 39.2 + 1.2 + 107 = 117.3 [dBµV/m]
Level in µV/m = Common Antilogarithm (117.3/20) = 732825

If a measurement is performed at a different distance other than specified, the field strength at the specified distance can be obtained by the following equation:

$FS_{Dspecified} = FS_{Dtest} + 20 * LOG (D_{test} / D_{specified})$
where
$FS_{Dspecified}$ = Field Strength at specified distance $D_{specified}$ in dBµV/m
FS_{DTest} = Field Strength at specified distance D_{Test} in dBµV/m
D_{test} = Measurement distance where test was performed in m
$D_{specified}$ = Measurement distance as specified by the rules in m

Assuming a recorded field strength of 117.3 dBµV/m in a distance of 1 m. If the rules are specifying a limit in a distance of 3 m, the field strength recorded in 1 m is corrected by the distance. Therefore, the field strength $FS_{Dspecified}$ is 117.3 dBµV/m + 20 * LOG (1 / 3) = 107.8 dBµV/m.

7.5 Test Result

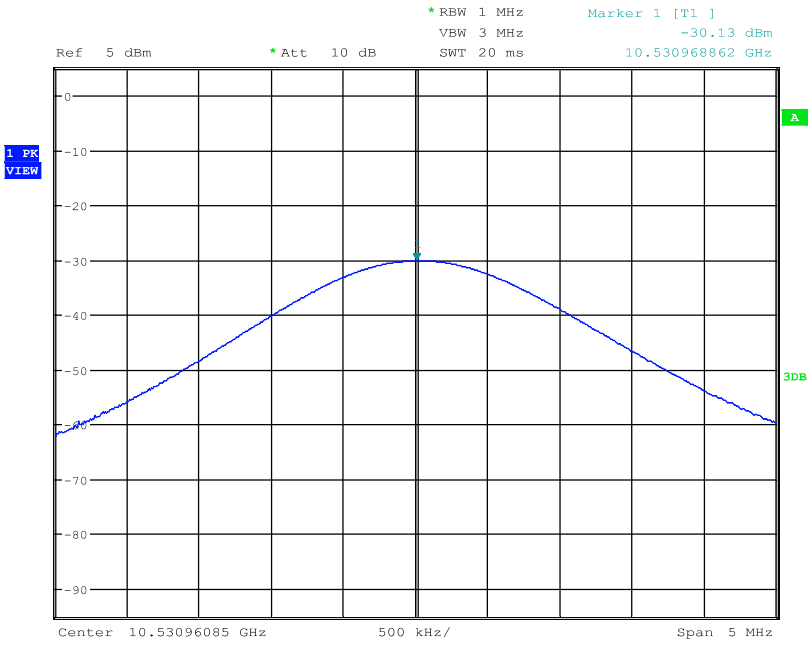
Field Strength of Fundamental						
Frequency [GHz]	**Reading [dBm]**	**AF [dB(1/m)]**	**CF [dB]**	**d [m]**	**FS @ 3m [dBµV/m]**	**Limit [dBµV/m]**
10.53	-30.1	39.2	1.2	1.0	107.8	128

Manufacturer: SORHEA
Device: PIRAMID CONNECT
Serial No: n/a
Test date: 2018-05-14

The EUT meets the requirements of this section.

7.6 Detailed Measurement Data

Field Strength of Fundamental
Pos. Y (worst case)



Note: the plot above is showing the analyzer's reading in a distance of 1 m.

8 RADIATED EMISSIONS 9 kHz – 30 MHz

Test requirement: 47 CFR, §§ 15.245, 15.209
RSS-210, F.1, RSS-Gen 8.9
Test procedure: ANSI C63.10 -2013

8.1 Regulation

47 CFR, §15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

47 CFR, §15.245 Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

47 CFR, §15.209 Radiated emission limits; general requirements
(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength		Measurement distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
0.009–0.490	2400/F[kHz]	67.6 – 20 logF[kHz]	300
0.490–1.705	24000/F[kHz]	87.6 – 20 logF[kHz]	30
1.705–30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

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

(b) In the emission table above, the tighter limit applies at the band-edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

RSS-Gen, 6.13.2 Frequency range for measuring unwanted emission
In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the applicable frequency given below:
b. If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

RSS-210, F.1 Field Disturbance Sensors
e. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

RSS-Gen, 8.9 Transmitter Emission Limits
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz	
Frequency (MHz)	**Field strength (µV/m at 3 m)**
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz		
Frequency	**Magnetic field strength (H-Field) (µA/m)**	**Measurement distance (m)**
9 - 490 kHz Note 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

8.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
374	Loop Antenna	Rohde & Schwarz	HFH 2-Z2	2016-07	2018-10
553	GPIB-140A	National Instruments	186135C-31	n/a	n/a
554	GPIB-140A	National Instruments	186135C-31	n/a	n/a
1292	Multi Device Controller	Frankonia	FC02	n/a	n/a
1416	Isolation Transformer	Daitron	J91097-11	n/a	n/a
1889	Anechoic Room SAC, SR-ULL-01	EMCC/FRANK.	SAC-10	n/a	n/a
2047	USB to GPIB adaptor	National Instruments	0-HS, 187965B-01	n/a	n/a
3846	EMI Test Receiver	Rohde & Schwarz	ESU8	2018-01	2019-01
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4075	Workstation	Dell	Optiplex 7010	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH WUT	57613 Web-T/Rh/P	2018-01	2020-01
5392	EMC Measurement Software	Rohde & Schwarz	EMC32 (v10.35.02)	n/a	n/a

8.3 Test Procedures

ANSI C63.10, 5.3.2 Test distance for frequencies below 30 MHz

Radiated emissions limits are usually defined at a specific distance from the EUT. Where possible, measurements shall be made at the distance specified in the limits. This might not be possible in all cases, however, due to the physical limitations of the test facility, physical access problems at the required distance (especially for measurements that must be made in situ or on-site), or levels of ambient noise or other radiated signals present at the time and location where measurements are made. See 6.4.3 for more information about antenna selection, location, and test distance. If measurements cannot practically be made at the EUT limit distance, then they may be made at a different distance (usually closer) and extrapolated to the limit distance using one of the procedures described in 6.4.4, 6.4.5, or 7.7, depending on the EUT source and size. The test report shall specify the extrapolation method used to determine compliance of the EUT.

ANSI C63.10, 6.4.6 Exploratory radiated emission tests

The tests shall be performed in the frequency range specified in 5.5 and 5.6, using the procedures in Clause 5, applying the appropriate modulating signal to the EUT, to determine cable or wire positions of the EUT system that produce the emission with the highest amplitude relative to the limit.

Exploratory measurements below 30 MHz are useful in determining the maximum level of emissions while manipulating and rotating the EUT; however, exploratory and final measurements may be made concurrently, provided care is taken to determine the maximum level of emissions for all configurations and orientations.

The test arrangement, measuring antenna guidelines and operational configurations in 6.3.1 and 6.3.2, shall be followed. The measurement antenna shall be positioned with its plane perpendicular to the ground at the specified distance. When perpendicular to the ground plane, the lowest height of the magnetic antenna shall be 1 m above the ground and shall be positioned at the specified distance from the EUT. When the EUT contains a loop antenna that can only be placed in a vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, and then orthogonal to the axis. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. When the EUT contains a loop antenna that can be placed in a horizontal or vertical axis, normal measurements shall be made aligning the measurement antenna along the site axis, orthogonal to the axis, and then with the measurement antenna horizontal. For each measurement antenna alignment, the EUT shall be rotated through 0° to 360° on a turntable. The report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB, then the following statement shall be made: “all emissions were greater than 20 dB below the limit.”

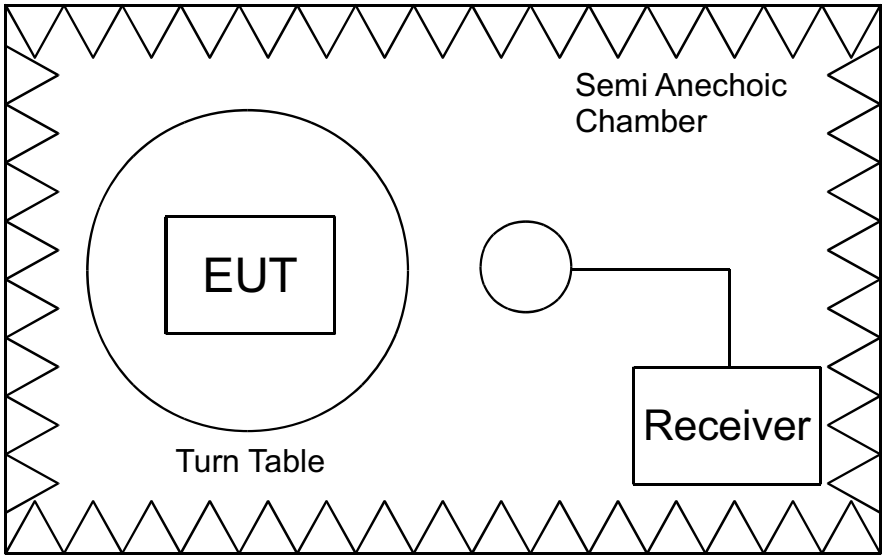
ANSI C63.10, 6.4.7 Final radiated emission tests

Using the orientation and equipment arrangement of the EUT determined in 6.4.6, and applying the appropriate modulating signal to the EUT, perform final radiated emission measurements on the fundamental and highest spurious emissions.

Unless otherwise specified by the regulatory authority, the instrumentation, detector functions, and bandwidths specified in 4.1.4.2.1 shall be used. For pulsed emissions, the procedure in 4.1.4.2.4 shall be used.

Radiated Emissions Test Characteristics	
Frequency range	9 kHz - 30 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	200 Hz (9 kHz - 150 kHz)
	10 kHz (150 kHz - 30 MHz)
Receive antenna height	1 m
Receive antenna polarization	Vertical, two orientations
Measurement location	Semi Anechoic Chamber (SAC)

* According to Section 15.31 (f)(2): At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The 40 dB/decade factor was used.



Schematic diagram

8.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits for the restricted band 2.1735 - 2.1905 MHz:

30 µV/m at 30 meters

Using the equation:

$E_{dB\mu V/m} = 20 * \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (µV/m)

A field strength limit of 30 µV/m corresponds with 29.5 dBµV/m.

8.5 Field Strength Calculation

All emission measurements described in this chapter performed using the EMI test program transducer factor setting capability, i.e. the field strength value at the test distance was measured directly without the necessity of additional correction factors.
For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f)(2) the field strength result is calculated by adding additionally an extrapolation factor of 40 dB/decade (inverse linear-distance for field strength measurements). The basic equation with a sample calculation is as follows:

FS = FST + DF
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
DF = Distance Extrapolation Factor in dB,
where DF = 40 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified distance

Assume the tests performed at a reduced Test Distance of 3 m instead of the Specified Distance of 300 m giving a Distance Extrapolation Factor of DF = 40 log (3 m/300 m) = -80 dB.

Assuming a measured field strength of 55.8 dBµV/m (reading 35.8 dBµV and antenna factor 20 dB(1/m)) is obtained. The Distance Factor of -80 dB is added, giving a field strength of -24.2 dBµV/m. The -24.2 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
FS = 55.8 - 80 = -24.2 [dBµV/m]
Level in µV/m = Common Antilogarithm (-24.2/20) = 0.06

8.6 Final Test Results

Freq. [MHz]	Meas. [PK / QPK]	Reading [dB(µV)]	Ant. factor [dB(1/m)]	DF [dB]	Result [dB(µV/m)]	Limit [dB(µV/m)]	Margin [dB]
		All prescan results more than 20 dB below limit, therefore no final measurement performed.					

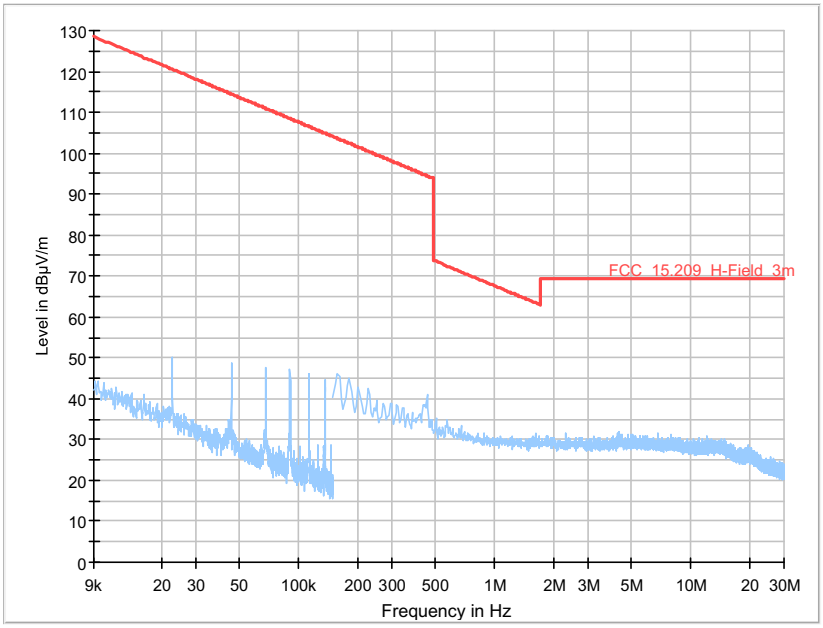
Manufacturer: SORHEA
Device: PIRAMID CONNECT
Serial No: n/a
Test date: 2018-05-03

The EUT meets the requirements of this section.

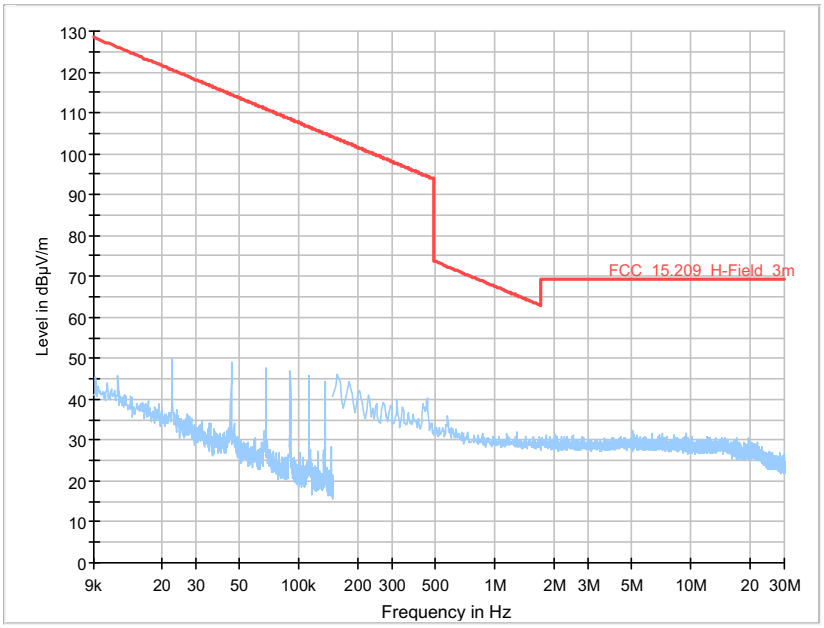
8.7 Detailed Measurement Data

Measurement was performed at 3 m distance. Plots show field strength reading at 3 m distance.
In order to compare the 3 m reading with the specified field strength limits a distance correction as described in 9.5 (40 dB/decade) was applied to the limit (represented by the limit line „FCC_15.209_HField_3m“).

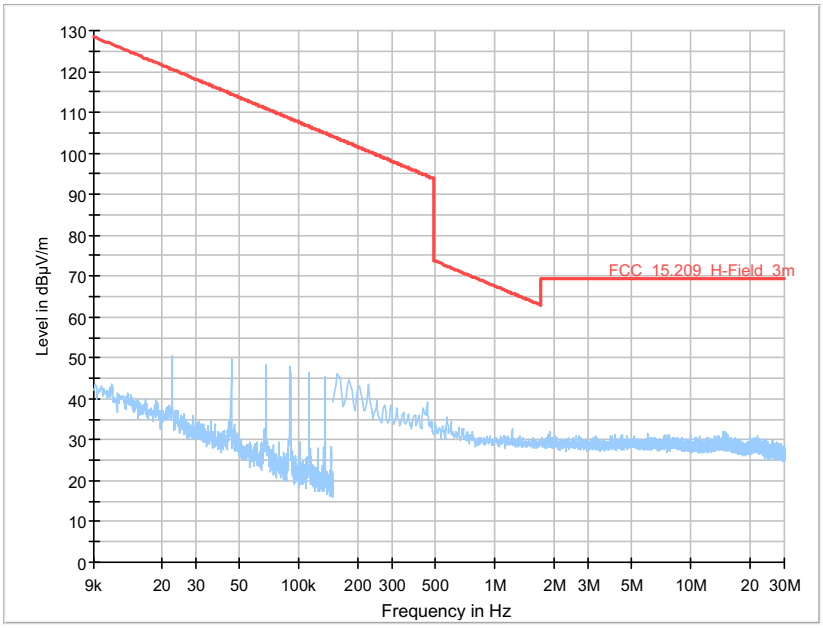
Radiated Emissions 9 kHz – 30 MHz
Pos.: X (refer to Annex 1)



Radiated Emissions 9 kHz – 30 MHz
Pos.: Y (refer to Annex 1)



Radiated Emissions 9 kHz – 30 MHz
Pos.: Z (refer to Annex 1)



9 RADIATED EMISSIONS 30 MHZ – 1000 MHz

Test requirement: 47 CFR, §§ 15.245, 15.209
RSS-210, F.1, RSS-Gen 8.9
Test procedure: ANSI C63.10 -2013

9.1 Regulation

47 CFR, §15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

47 CFR, §15.245 Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

47 CFR, §15.209 Radiated emission limits; general requirements
(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength		Measurement distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
0.009–0.490	2400/F[kHz]	67.6 – 20 logF[kHz]	300
0.490–1.705	24000/F[kHz]	87.6 – 20 logF[kHz]	30
1.705–30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

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

(b) In the emission table above, the tighter limit applies at the band-edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

RSS-Gen, 6.13.2 Frequency range for measuring unwanted emission
In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the applicable frequency given below:
b. If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

RSS-210, F.1 Field Disturbance Sensors
e. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

RSS-Gen, 8.9 Transmitter Emission Limits
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz	
Frequency (MHz)	**Field strength (µV/m at 3 m)**
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz		
Frequency	**Magnetic field strength (H-Field) (µA/m)**	**Measurement distance (m)**
9 - 490 kHz Note 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

9.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
54	N-Cable N/50	Rohde & Schwarz	HFU2-Z5	n/a	n/a
553	GPIB-140A	National Instruments	186135C-31	n/a	n/a
554	GPIB-140A	National Instruments	186135C-31	n/a	n/a
1291	Antenna Mast	Frankonia	FAM4	n/a	n/a
1292	Multi Device Controller	Frankonia	FC02	n/a	n/a
1416	Isolation Transformer	Daitron	J91097-11	n/a	n/a
1889	Anechoic Room SAC, SR-ULL-01	EMCC/FRANK.	SAC-10	n/a	n/a
2047	USB to GPIB adaptor	National Instruments	0-HS, 187965B-01	n/a	n/a
2749	5 W Attenuator 6dB	Weinschel	WA2-6-34	2017-06	2019-06
3846	EMI Test Receiver	Rohde & Schwarz	ESU8	2018-01	2019-01
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4075	Workstation	Dell	Optiplex 7010	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH WUT	57613 Web-T/Rh/P	2018-01	2020-01
5392	EMC Measurement Software	Rohde & Schwarz	EMC32 (v10.35.02)	n/a	n/a
6041	TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	2017-09	2019-09

9.3 Test Procedures

ANSI C63.10, 6.3.1 Test arrangement

[..] Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m (see 6.6.3.1). A method for evaluating the effects of the table on EUT radiated emissions is given in 5.5 of CISPR 16-1-4:2010 for frequencies up to 18 GHz. The EUT shall be set up in its typical configuration and arrangement and operated in its various modes as described in 5.10. An antenna shall be connected to the EUT in accordance with 5.8 and 5.10.4. The EUT and transmitting antenna shall be centered on the turntable. For devices with multiple antennas that are active simultaneously, the EUT shall be positioned, to the extent possible, with the antennas equally distributed around the center of the device. The exact setup shall be documented in the test report.
Any controlling device (e.g., notebook, laptop, or desktop computer) shall be positioned such that it shall not significantly influence the measurement results. No other peripherals are required to be connected to the controlling device for this test unless the radio is being tested as part of the notebook or PDA qualifications.

ANSI C63.10, 6.5.3 Exploratory radiated emission tests

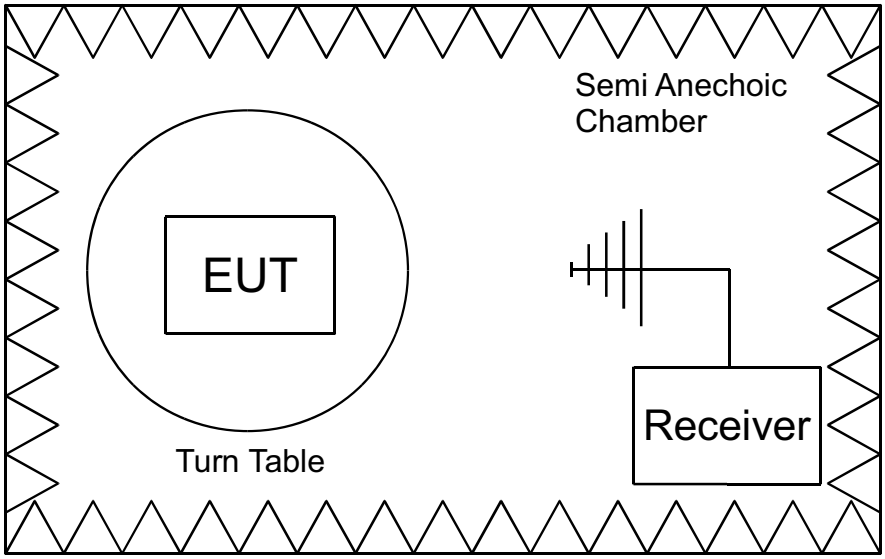
Exploratory measurements are used to identify the frequencies and amplitudes of the emissions while manipulating and rotating the EUT.
Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. Exploratory measurements shall be made on a test site per 5.2. Shielded rooms, not treated with RF absorption material, shall not be used for exploratory measurements.
For each mode of operation required to be tested, the frequency spectrum shall be monitored. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.

ANSI C63.10, 6.5.4 Final radiated emission tests

Using the orientation and equipment arrangement of the EUT, and based on the measurement results found during the exploratory measurement in 6.5.3, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable) and the frequency and amplitude of the six highest spurious emissions relative to the limit; emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz – 1000 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz
Receive antenna height	1 m - 4 m
Receive antenna polarization	Vertical/Horizontal
Measurement location	Semi Anechoic Chamber (SAC)



Schematic diagram

9.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits in restricted bands (e.g. 108 to 121.94 MHz (FCC) or 108 to 138 MHz (ISED)) acc. to §15.209 for the frequency band 88-216 MHz:

150 µV/m at 3 meters

Using the equation:

$E_{dB\mu V/m} = 20 * \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (µV/m)

A field strength limit of 150 µV/m corresponds with 43.5 dBµV/m.

9.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:
FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB
Assume a receiver reading of 23.5 dBµV is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]

Level in µV/m = Common Antilogarithm (32/20) = 39.8

Remark: All emission measurements described in this chapter performed using the EMI test program transducer factor setting capability, i.e. the field strength value at the test distance was measured directly without the necessity of additional correction factors.

9.6 Final Test Results

Frequency [MHz]	Result [dBµV/m]	Limit * [dBµV/m]	Margin [dB]	Remarks
37.14	30.4	40	9.6	Pos. X
40.26	28.2	40	11.8	Pos. Y
204.34	31.8	43.5	11.7	Pos. Y
218.74	34.9	46	11.1	Pos. X
258.46	31.3	46	14.7	Pos. Y
403.54	32.8	46	13.2	Pos. Z

All tests performed at 3 m distance. The table above contains worst-case emissions, only. For further details refer to the detailed measurement data.

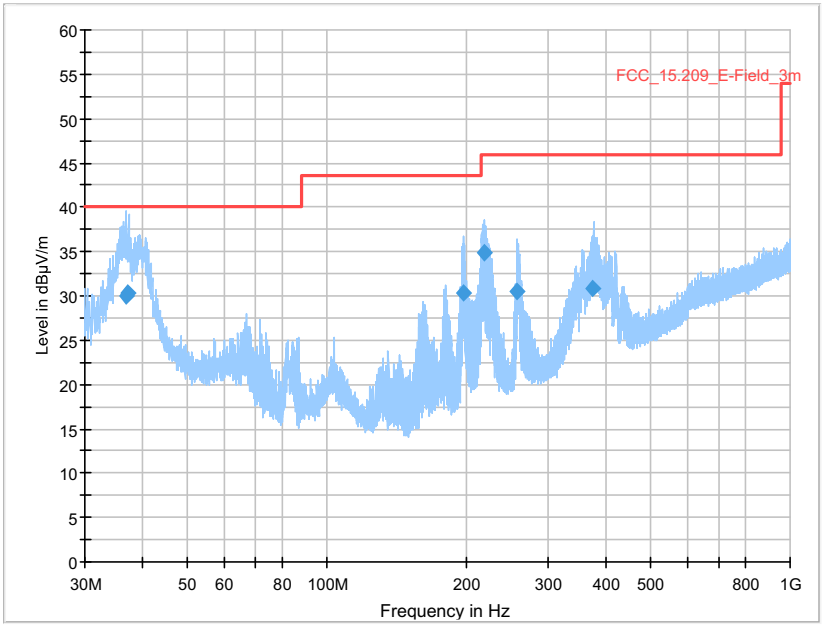
* Note: Limits acc. to 47 CFR §15.209 resp. RSS-Gen 8.9 were used as worst case consideration.

Manufacturer:	SORHEA
Device:	PIRAMID CONNECT
Serial No:	n/a
Test date:	2018-05-03

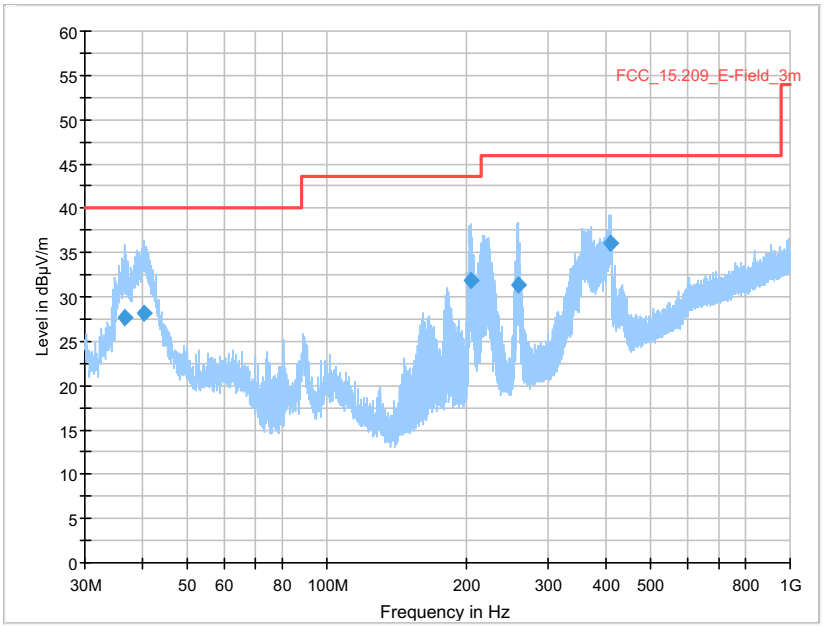
The EUT meets the requirements of this section.

9.7 Detailed Measurement Data

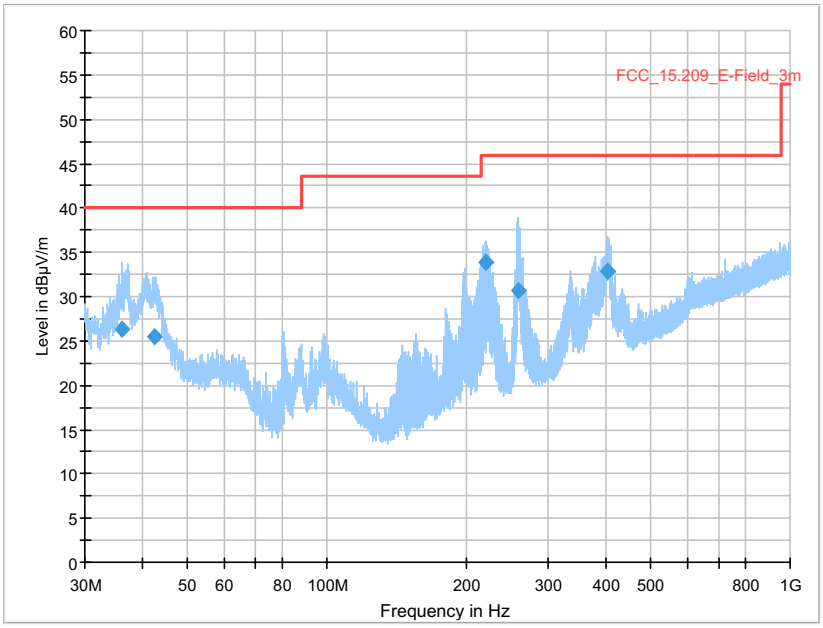
Radiated Emissions 30 MHz – 1000 MHz
Pos.: X (refer to Annex 1)



Radiated Emissions 30 MHz – 1000 MHz
Pos.: Y (refer to Annex 1)



Radiated Emissions 30 MHz – 1000 MHz
Pos.: Z (refer to Annex 1)



10 RADIATED EMISSIONS 1 GHz – 6 GHz

Test requirement: 47 CFR, §§ 15.245, 15.209
RSS-210, F.1, RSS-Gen 8.9
Test procedure: ANSI C63.10 -2013

10.1 Regulation

47 CFR, §15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

47 CFR, §15.245 Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

47 CFR, §15.209 Radiated emission limits; general requirements
(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength		Measurement distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
0.009–0.490	2400/F[kHz]	67.6 – 20 logF[kHz]	300
0.490–1.705	24000/F[kHz]	87.6 – 20 logF[kHz]	30
1.705–30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

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

(b) In the emission table above, the tighter limit applies at the band-edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

RSS-Gen, 6.13.2 Frequency range for measuring unwanted emission
In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the applicable frequency given below:
b. If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

RSS-210, F.1 Field Disturbance Sensors
e. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

RSS-Gen, 8.9 Transmitter Emission Limits
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz	
Frequency (MHz)	**Field strength (µV/m at 3 m)**
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz		
Frequency	**Magnetic field strength (H-Field) (µA/m)**	**Measurement distance (m)**
9 - 490 kHz Note 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

10.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
553	GPIB-140A	National Instruments	186135C-31	n/a	n/a
554	GPIB-140A	National Instruments	186135C-31	n/a	n/a
1016	Lowpass Filter	Microphase	LTP 7000AB	2018-05	2020-05
1416	Isolation Transformer	Daitron	J91097-11	n/a	n/a
1889	Anechoic Room SAC, SR-ULL-01	EMCC/FRANK.	SAC-10	n/a	n/a
2047	USB to GPIB adaptor	National Instruments	0-HS, 187965B-01	n/a	n/a
2749	5 W Attenuator 6dB	Weinschel	WA2-6-34	2017-06	2019-06
3236	Double Ridged Guide Antenna	Schwarzbeck	BBHA 9120D	2017-05	2019-05
3846	EMI Test Receiver	Rohde & Schwarz	ESU8	2018-01	2019-01
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4075	Workstation	Dell	Optiplex 7010	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH WUT	57613 Web-T/Rh/P	2018-01	2020-01
5392	EMC Measurement Software	Rohde & Schwarz	EMC32 (v10.35.02)	n/a	n/a
5535	Positioning controller	Rohde&Schwarz	HCC	n/a	n/a
5536	Rotary table	Rohde&Schwarz	HCT12	n/a	n/a
5544	Antenna Mast	innco systems GmbH	MA 5000-XPET	n/a	n/a
5545	Antenna Mast Controller	innco systems GmbH	CO 3000-1D	n/a	n/a
5616	RF cable assembly	Rosenberger	LA2-025-7000	2017-09	2018-09

10.3 Test Procedures

ANSI C63.10, 6.6.3.1 Tabletop equipment

For emission measurements above 1 GHz, the EUT shall be placed at a height of 1.5 m above the floor on a support that is RF transparent for the frequencies of interest. The 1.5 m height EUT support shall be constructed using a low permittivity and low loss tangent (tanδ) material with a height of 1.5 m, or a low permittivity and low loss tangent (tanδ) material may be placed on top of a typical table with a height of 0.8 m or 1 m. One typical low-permittivity and low-loss tangent material is styrene. Due to its dielectric properties for frequencies above 1 GHz, the use of styrene or building insulation foam is recommended, rather than, for example, wood. Support equipment shall be placed far enough away from the EUT, such that changes in relative position of the EUT and support equipment do not cause changes in measured values. Final measurements for the EUT require a measurement antenna height scan of 1 m to 4 m.

Where possible, the methods for portable, handheld, or body-worn equipment detailed in 6.6.3.3 may be employed for smaller tabletop equipment to allow the use of shorter cabling between measurement antennas and measuring receiver/spectrum analyzer by restricting the upper height of the measurement antenna.

ANSI C63.10, 6.6.4.2 Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of test. If either antenna height or EUT azimuth are not fully measured during exploratory testing, then complete testing can be required at the OATS or semi-anechoic chamber when the final full spectrum testing is performed.

ANSI C63.10, 6.6.4.3 Final radiated emissions measurements

The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

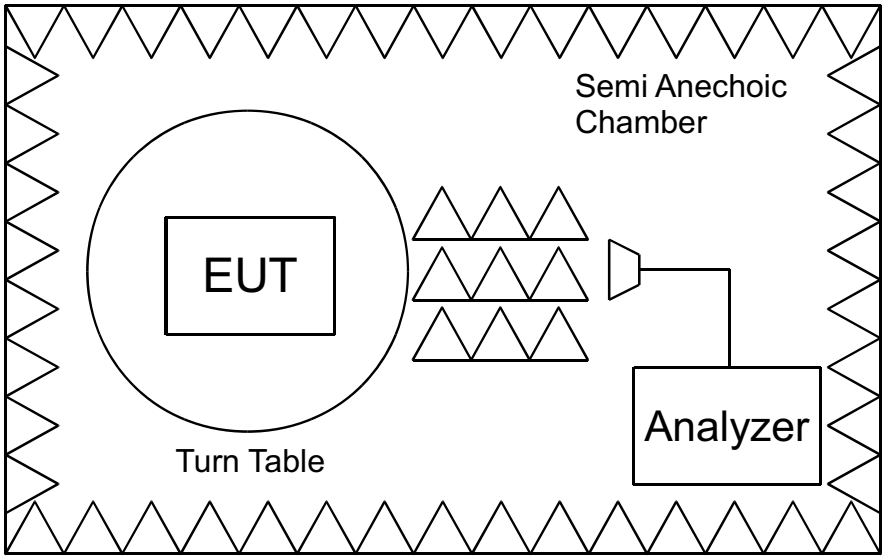
Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.

If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.

As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.

Radiated Emissions Test Characteristics	
Frequency range	1 GHz – 6 GHz
Test distance	3 m
Test instrumentation resolution bandwidth	1 MHz
Receive antenna height	1 m – 4 m
Receive antenna polarization	Vertical/Horizontal
Measurement location	Semi Anechoic Chamber (SAC)



Schematic diagram

10.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits acc. to §15.209 for frequencies above 960 MHz:

500 µV/m at 3 meters

Using the equation:

$E_{dB\mu V/m} = 20 * \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (µV/m)

A field strength limit of 500 µV/m corresponds with 54 dBµV/m.

10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength in dBµV/m

RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB
Assume a receiver reading of 23.5 dBµV is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]
Level in µV/m = Common Antilogarithm (32/20) = 39.8

Remark: All emission measurements described in this chapter performed using the EMI test program transducer factor setting capability, i.e. the field strength value at the test distance was measured directly without the necessity of additional correction factors.

For average measurements, the measured peak field strength is corrected by a Duty Cycle correction factor DCF. Please refer to chapter 2.6 for details.

FS_{AV} = FS + DCF
where
FS_{AV} = Average Field Strength in dBµV/m
FS = Peak Field Strength in dBµV/m
DCF = Correction Factor in dB

Assuming a peak field strength of 57.7 dBµV/m, the value for the average field strength with a Duty Cycle correction factor DCF of -32.8 dB corresponds with 24.9 dBµV/m.

10.6 Final Test Results

Radiated Spurious Emissions 1 – 6 GHz							
		All prescan peak emissions are below limit, therefore no final measurement performed.					

Remark:
The table above contains worst-case emissions, only. For further details refer to the pre-scan test plots.

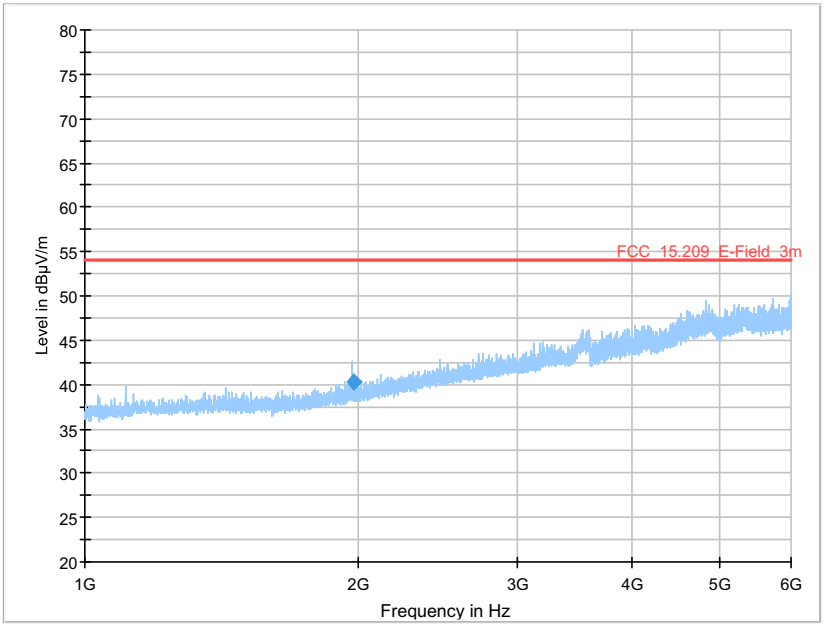
* Note: Limits acc. to 47 CFR §15.209 resp. RSS-Gen 8.9 were used as worst case consideration.

Manufacturer:	SORHEA
Device:	PIRAMID CONNECT
Serial No:	n/a
Test date:	2018-05-04

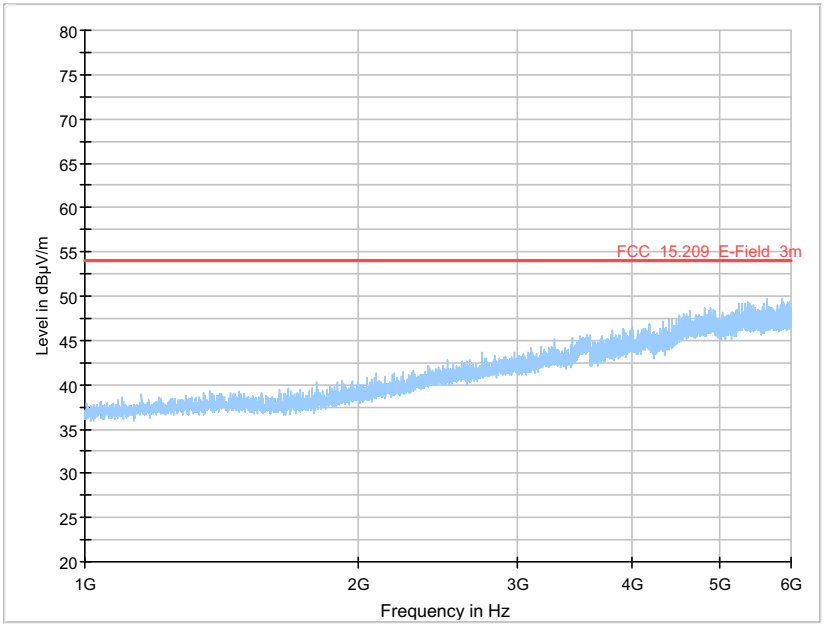
The EUT meets the requirements of this section.

10.7 Detailed Measurement Data

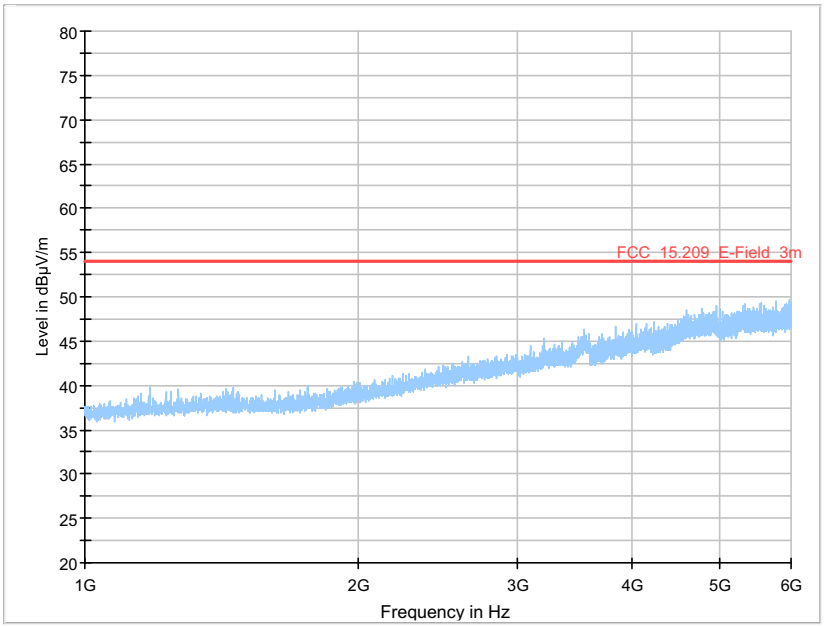
Radiated Emissions 1 – 6 GHz
Pos.: X (refer to Annex 1)



Radiated Emissions 1 – 6 GHz
Pos.: Y (refer to Annex 1)



Radiated Emissions 1 – 6 GHz
Pos.: Z (refer to Annex 1)



11 RADIATED EMISSIONS 6 GHz – 53 GHz

Test requirement: 47 CFR, §§ 15.245, 15.209
RSS-210, F.1, RSS-Gen 8.9
Test procedure: ANSI C63.10 -2013

11.1 Regulation

47 CFR, §15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

47 CFR, §15.245 Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.
(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:
(ii) For all other field disturbance sensors, 7.5 mV/m.
(2) Field strength limits are specified at a distance of 3 meters.
(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

47 CFR, §15.209 Radiated emission limits; general requirements
(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength		Measurement distance
[MHz]	[µV/m]	[dB(µV/m)]	[m]
0.009–0.490	2400/F[kHz]	67.6 – 20 logF[kHz]	300
0.490–1.705	24000/F[kHz]	87.6 – 20 logF[kHz]	30
1.705–30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

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

(b) In the emission table above, the tighter limit applies at the band-edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

RSS-Gen, 6.13.2 Frequency range for measuring unwanted emission
In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated or used in the equipment, whichever is lower, without going below 9 kHz, up to at least the applicable frequency given below:
b. If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

RSS-210, F.1 Field Disturbance Sensors
The equipment shall comply with the following emission limits:
a. The average field strength measured at 3 m shall not exceed the limits shown in Table F1:

Table F1 — Field Strengths for Field Disturbance Sensors Operating at Different Frequencies

Fundamental frequency (MHz)	Field Strength (mV/m)	
	Fundamental Emissions	Harmonic Emissions
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

b. Additionally, harmonic emissions falling into restricted bands listed in RSS-Gen, and which are below 17.7 GHz shall meet the general field strength limits specified in RSS-Gen.
c. Harmonic emissions falling into restricted bands listed in RSS-Gen and which are at and above 17.7 GHz shall not exceed the following field strength limits measured at a distance of 3 m:
ii.7.5 mV/m for all other devices.

e. Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

RSS-Gen, 8.9 Transmitter Emission Limits

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz	
Frequency (MHz)	**Field strength (µV/m at 3 m)**
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz		
Frequency	**Magnetic field strength (H-Field) (µA/m)**	**Measurement distance (m)**
9 - 490 kHz Note 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

11.2 Test Equipment

EMCC Ident No.	Instrument	Manufacturer	Type	Last Calibration	Calibration Valid Until
1	60-Hz-Converter	AEG	DAMK4/DAGK 4	n/a	n/a
516	EMI Test Receiver	Rohde & Schwarz	ESIB40	2018-03	2019-03
1229	Standard Gain Horn Antenna	Mid Century	MC 22/31B	n/a	n/a
1294	Multi Device Controller	Frankonia	FC03	n/a	n/a
1300	Standard Gain Horn Antenna	Mid Century	MC 20/31B	n/a	n/a
1333	Standard Gain Horn Antenna	FMI/Pro NOVA	2424-25	2000-05	n/a
1348	Wav./Kf/SMAf-Adap., R-band	fmi/pro nova	22093-KF20	n/a	n/a
1547	Waveguide Mixer	Rohde & Schwarz Tektronix	FS-Z60/WM782U	n/a	n/a
1800	Doubler 40...60 GHz	Spacek Labs	AU-2X	n/a	n/a
1868	Anechoic Room FAC, SR-ULL-03	EMCC/ FRANKONIA		n/a	n/a
2110	Thermistor Mount	Millitech	THM-22-RF000	2015-08	2020-08
2111	Tapered Transition	FMI/Pro NOVA	23000-24	n/a	n/a
2112	RF Power Meter	Hewlett-Packard	432 A	n/a	n/a
2114	Precis.Var.Waveg.Attn.	FMI/Tho	2411	n/a	n/a
2286	Signal Generator	Wiltron, Anritsu	68369B	2017-08	2019-08
3235	Double Ridged Guide Antenna	Schwarzbeck	BBHA 9120D	2017-05	2019-05
3831	Spectrum Analyzer	Rohde & Schwarz	FSU50	2017-09	2018-09
3880	Digital Multimeter	Agilent	U1241B	2016-05	2018-05
4524	Notebook	Dell	Latitude E6430	n/a	n/a
4595	USB to GPIB adapter	National Instruments	GPIB-USB-HS	n/a	n/a
4689	Digital Camera	Canon	PowerShot A2500	n/a	n/a
4717	Web-Thermo-Hygrobarograph	Wiesemann & Theis GmbH	57613 Web-T/Rh/P	2018-01	2020-01
4808	Waveguide/SMAf-Adapt.	Marconi-Quasar	QRA 20-SMAf	n/a	n/a
4914	Adaptor, Waveguide to Coax	FLANN	23093-TF30 UG-383/U	n/a	n/a
5392	EMC Measurement Software	Rohde & Schwarz	EMC32 (v10.35.01)	n/a	n/a
5611	RF cable assembly	Rosenberger	LA1-008-1000	n/a	n/a
5613	RF cable assembly	Rosenberger	LU8-002-700	n/a	n/a

11.3 Test Procedures

ANSI C63.10, 6.6.3.1 Tabletop equipment

For emission measurements above 1 GHz, the EUT shall be placed at a height of 1.5 m above the floor on a support that is RF transparent for the frequencies of interest. The 1.5 m height EUT support shall be constructed using a low permittivity and low loss tangent (tanδ) material with a height of 1.5 m, or a low permittivity and low loss tangent (tanδ) material may be placed on top of a typical table with a height of 0.8 m or 1 m. One typical low-permittivity and low-loss tangent material is styrene. Due to its dielectric properties for frequencies above 1 GHz, the use of styrene or building insulation foam is recommended, rather than, for example, wood. Support equipment shall be placed far enough away from the EUT, such that changes in relative position of the EUT and support equipment do not cause changes in measured values. Final measurements for the EUT require a measurement antenna height scan of 1 m to 4 m.

Where possible, the methods for portable, handheld, or body-worn equipment detailed in 6.6.3.3 may be employed for smaller tabletop equipment to allow the use of shorter cabling between measurement antennas and measuring receiver/spectrum analyzer by restricting the upper height of the measurement antenna.

ANSI C63.10, 6.6.4.2 Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of test. If either antenna height or EUT azimuth are not fully measured during exploratory testing, then complete testing can be required at the OATS or semi-anechoic chamber when the final full spectrum testing is performed.

ANSI C63.10, 6.6.4.3 Final radiated emissions measurements

The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

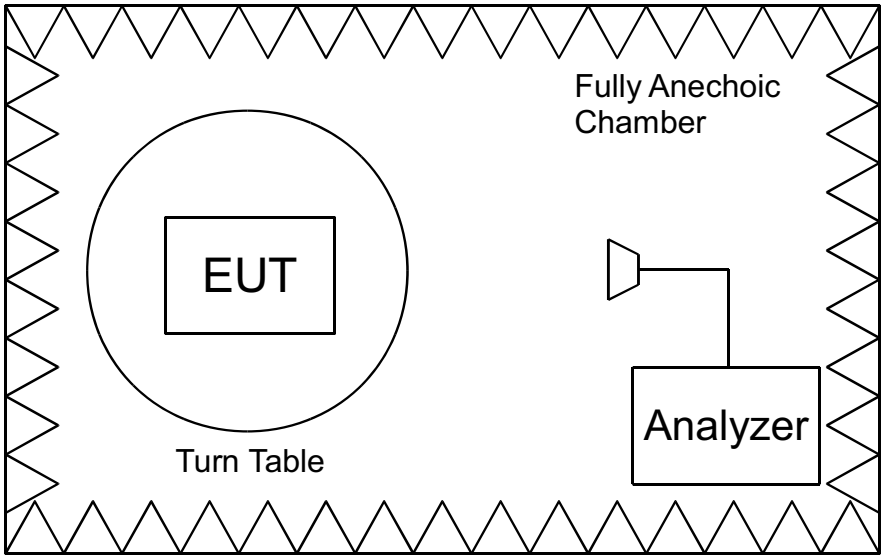
The emission signal shall be kept within the illumination area of the 3 dB beamwidth of the antenna so that the maximum emission from the EUT is measured. This may be achieved by either pointing the antenna at an angle toward the source of the emission or by testing the EUT as described in 6.6.3.3.

If the emission is pulsed, then refer to Annex C for guidelines on selecting bandwidth and determining pulse desensitization factors, as necessary.

As noted in 6.6.4.1, when performing these measurements, the sensitivity of the complete measurement system relative to the limit shall be determined before the test. If the overall measurement sensitivity is inadequate, then low-noise preamplifiers, closer measurement distances, higher gain antennas, or narrower bandwidths may be used. If closer measurement distances or higher gain antennas are used, then the beamwidth of the measurement antenna versus the physical size of the EUT shall be taken into account, so that the physical sizes of the EUT dimensions are encompassed by the beamwidth of the measurement antenna. Also, measurement system overload protection shall be determined to be adequate when preamplifiers are used. The effects on the measured emission value using bandwidths different from those specified shall be determined if such bandwidth changes are made. Any changes from the specific measurement conditions shall be described in the report of the measurements.

Radiated Emissions Test Characteristics	
Frequency range	6 GHz – 53 GHz
Test distance	1 m (6 – 48 GHz) 0.5 m (48 – 53 GHz)
Test instrumentation resolution bandwidth	1 MHz *
Receive antenna height	1.5 m
Receive antenna polarization	Vertical/Horizontal
Measurement location	Fully Anechoic Chamber (FAC)

* Narrower bandwidth (RBW = 100 kHz) was used for measurements in the range of 48 – 53 GHz



Schematic diagram

11.4 Calculation of Field Strength Limits

E.g. radiated spurious emissions field strength limits acc. to §15.209 for frequencies above 960 MHz:

500 µV/m at 3 meters

Using the equation:

$E_{dB\mu V/m} = 20 * \log (E_{\mu V/m})$

where

$E_{dB\mu V/m}$ = Field Strength in logarithmic units (dBµV/m)

$E_{\mu V/m}$ = Field Strength in linear units (µV/m)

A field strength limit of 500 µV/m corresponds with 54 dBµV/m.

11.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB

If the measurement unit is dBm instead of dBµV, the conversation constant of 107 dB has to be added to the reading in dBm.

Assume a receiver reading of −79.9 dBm is obtained. The Antenna Factor of 37.7 dB(1/m) and a Cable Factor of 2.0 dB are added, giving a field strength of 66.8 dBµV/m in the measurement distance. The field strength of 66.8 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = -79.9 + 37.7 + 2.0 + 107 = 66.8 [dBµV/m]
Level in µV/m = Common Antilogarithm (66.8/20) = 2188

If a measurement is performed at a different distance other than specified, the field strength at the specified distance can be obtained by the following equation:

$FS_{Dspecified} = FS_{Dtest} + 20 * LOG (D_{test} / D_{specified})$
where
$FS_{Dspecified}$ = Field Strength at specified distance $D_{specified}$ in dBµV/m
FS_{DTest} = Field Strength at specified distance D_{Test} in dBµV/m
D_{test} = Measurement distance where test was performed in m
$D_{specified}$ = Measurement distance as specified by the rules in m

Assuming a recorded field strength of 66.8 dBµV/m in a distance of 1 m. If the rules are specifying a limit in a distance of 3 m, the field strength recorded in 1 m is corrected by the distance. Therefore, the field strength $FS_{Dspecified}$ is 66.8 dBµV/m + 20 * LOG (1 / 3) = 57.3 dBµV/m.

11.6 Final Test Results

Radiated Spurious Emissions 6 - 40 GHz				
Frequency [MHz]	**Peak Result [dBµV/m]**	**Limit * [dBµV/m]**	**Margin [dB]**	**Remarks**
10531.1	109.4	128	18.6	Pos. Y, Fundamental emission
11993.1	42.8	54	11.2	Pos. X
17804.7	49.8	54	4.2	Pos. Y
21062.0	69.4	77.5	8.1	Pos. Y, Harmonic emission
31593.1	63.8	77.5	13.7	Pos. Z, Harmonic emission

Remark:
The table above contains worst-case emissions, only, measured with peak detection. Hence all peak results are complying with the average limits, no average measurement performed. For further details refer to the pre-scan test plots.

Radiated Spurious Emissions 40 - 53 GHz							
Frequency [MHz]	**Reading [dBm]**	**AF [dB(1/m)]**	**CF [dB]**	**d [m]**	**FS @ 3m [dBµV/m]**	**Limit [dBµV/m]**	**Remarks**
42115.4	-79.9	37.7	2.0	1.0	57.3	77.5	Pos. Y, Harmonic emission
50000.0	≤ -105	39.2	17 **	0.5	43.7	54	Noise floor, RBW = 100 kHz ***

Remark:
The table above contains worst-case emissions, only, measured with peak detection. Hence all peak results are complying with the average limits, no average measurement performed. For further details refer to the pre-scan test plots.

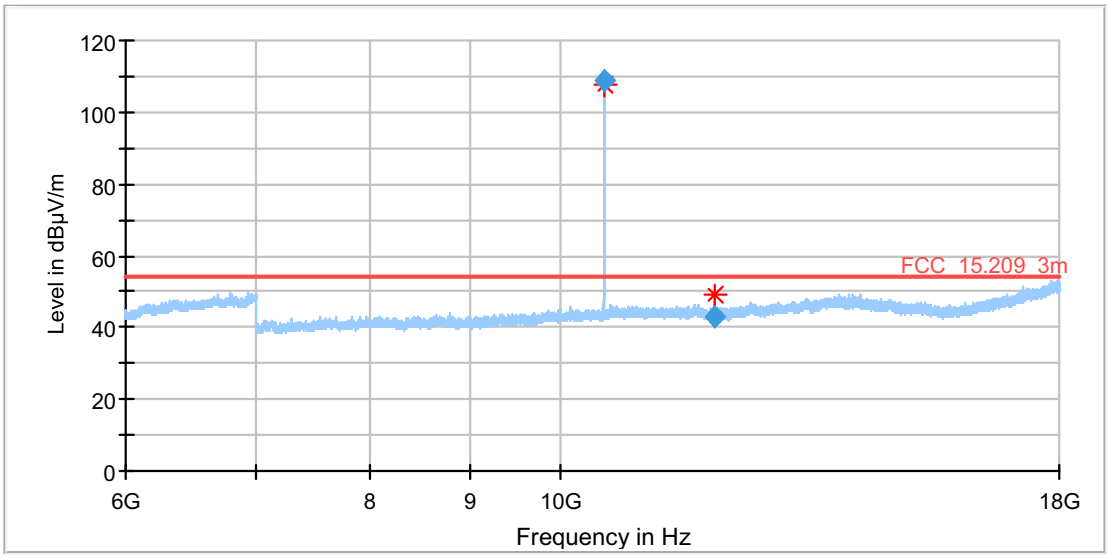
* Note 1: Limits acc. to 47 CFR §15.209 resp. RSS-Gen 8.9 were used as worst case consideration except for the harmonics.
** Note 2: worst case conversation loss of mixer in the frequency range 40 GHz to 60 GHz is approx. 17 dB at 50 GHz. This conversation loss was determined during the measurement by comparison to a reference power meter.
*** Note 3: the spectrum analyzer's resolution bandwidth was reduced to 100 kHz to lower the noise floor below the limits in order to detect emissions. A second measurement was performed with RBW = 1 MHz (as demanded by the rules) but in very close distance to the EUT. The EUT's surface was "scanned" manually with the antenna. No emission was detected. Please refer to the corresponding plot hereafter.

Manufacturer:	SORHEA
Device:	PIRAMID CONNECT
Serial No:	n/a
Test date:	2018-05-04

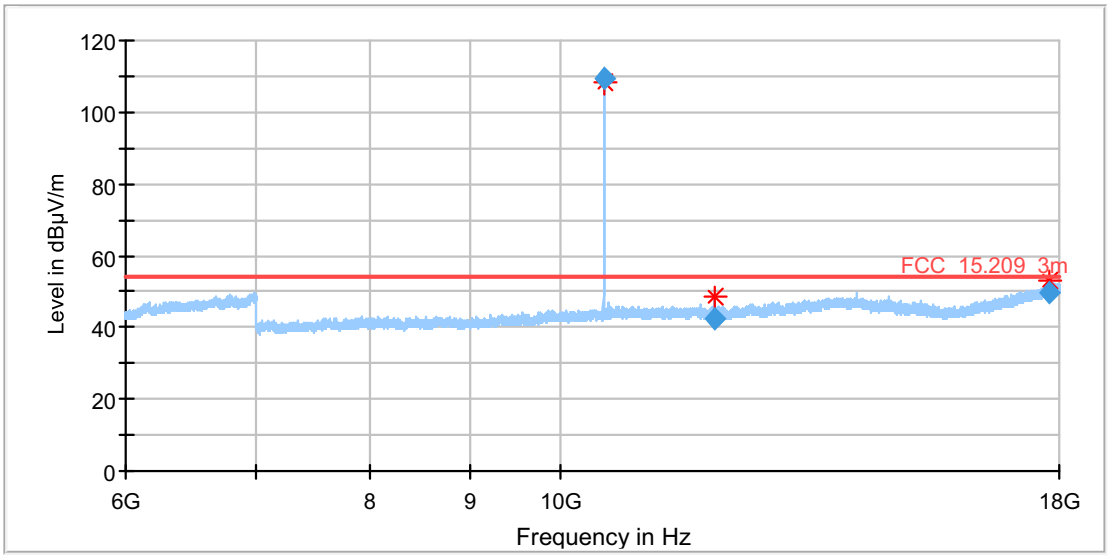
The EUT meets the requirements of this section.

11.7 Detailed Measurement Data

Radiated Emissions 6 – 18 GHz
Pos.: X (refer to Annex 1)

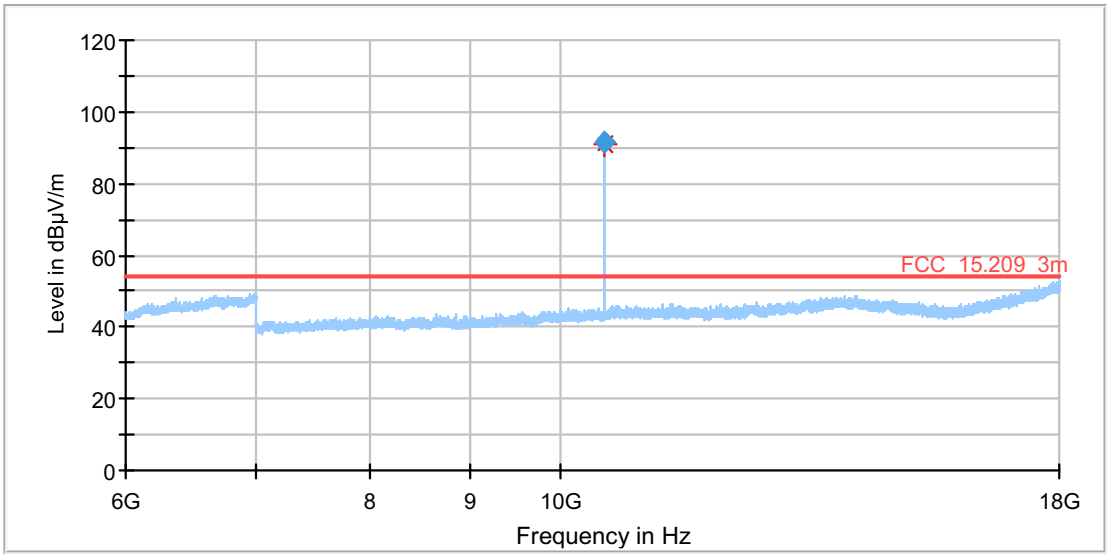


Radiated Emissions 6 – 18 GHz
Pos.: Y (refer to Annex 1)

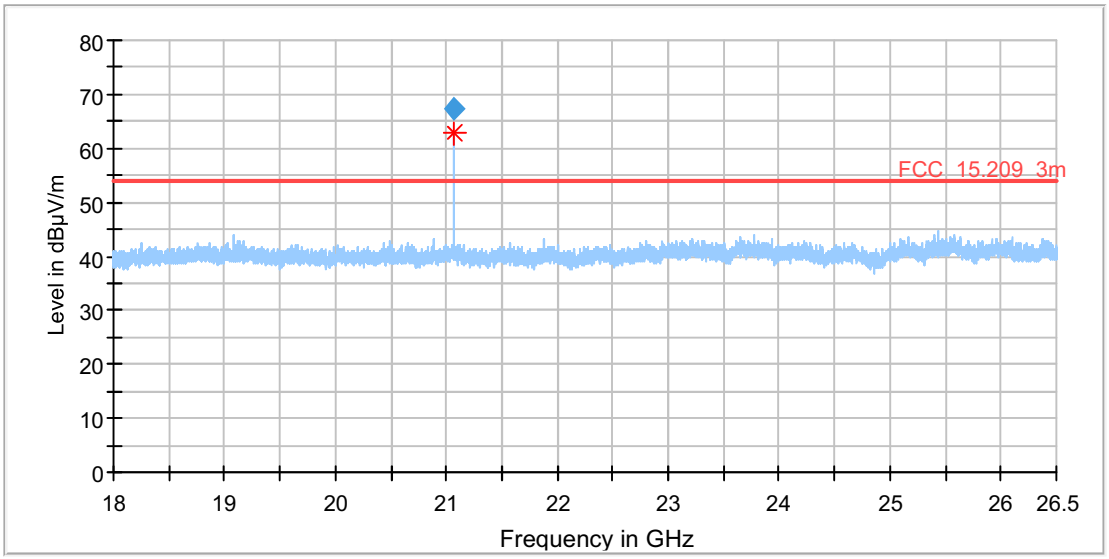


Note: the emission at 10.53 GHz is the fundamental. Therefore, it will not be regarded for further considerations.

Radiated Emissions 6 – 18 GHz
Pos.: Z (refer to Annex 1)

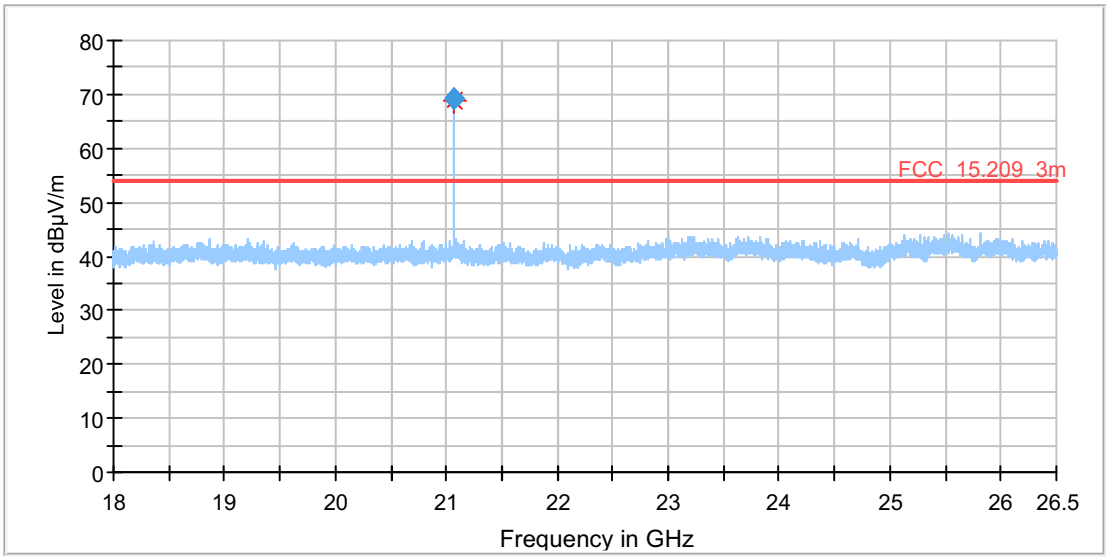


Radiated Emissions 18 – 26.5 GHz
Pos.: X (refer to Annex 1)

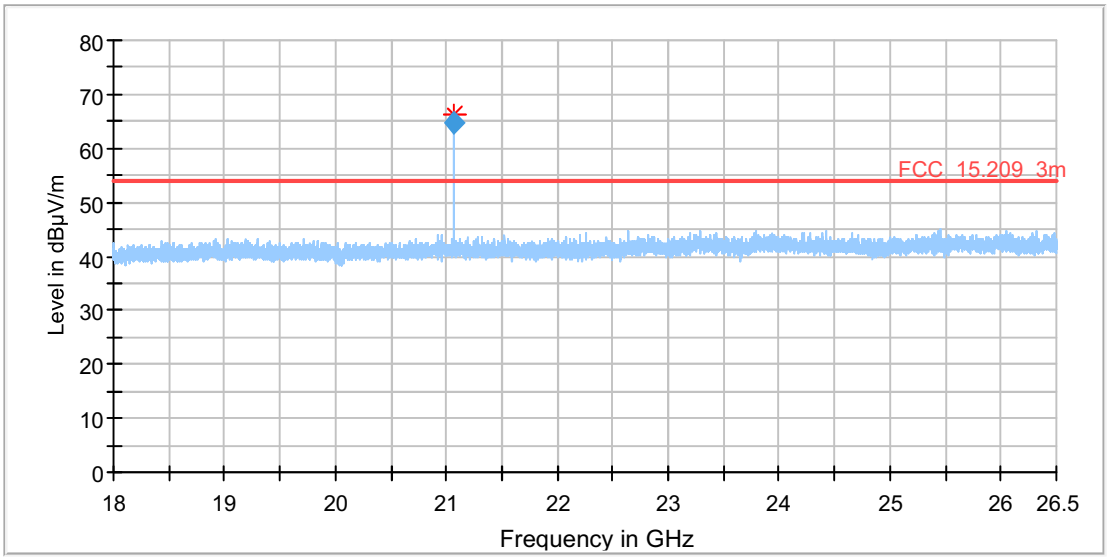


Note: the emission at 10.53 GHz is the fundamental. Therefore, it will not be regarded for further considerations.

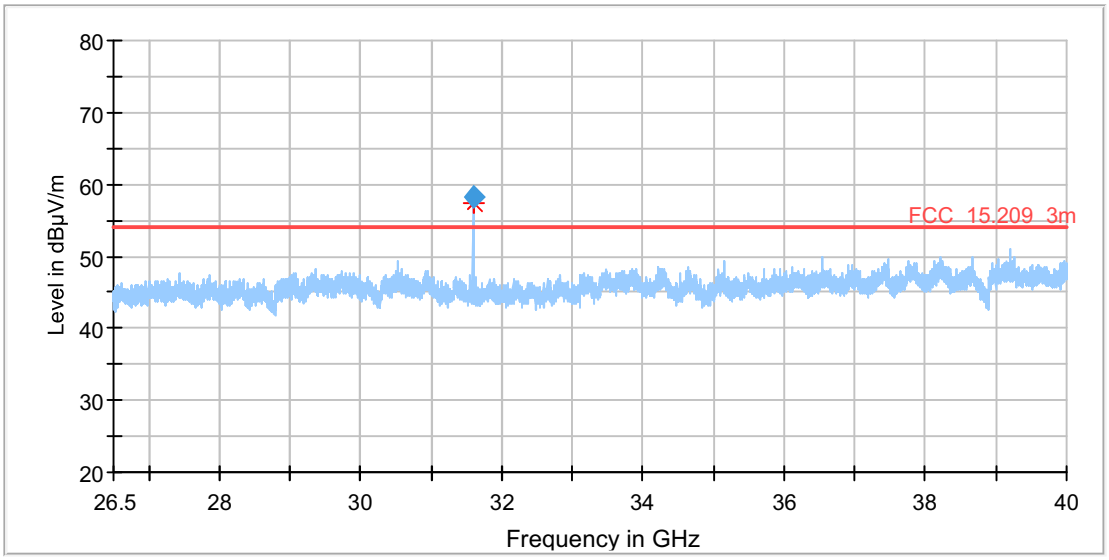
Radiated Emissions 18 – 26.5 GHz
Pos.: Y (refer to Annex 1)



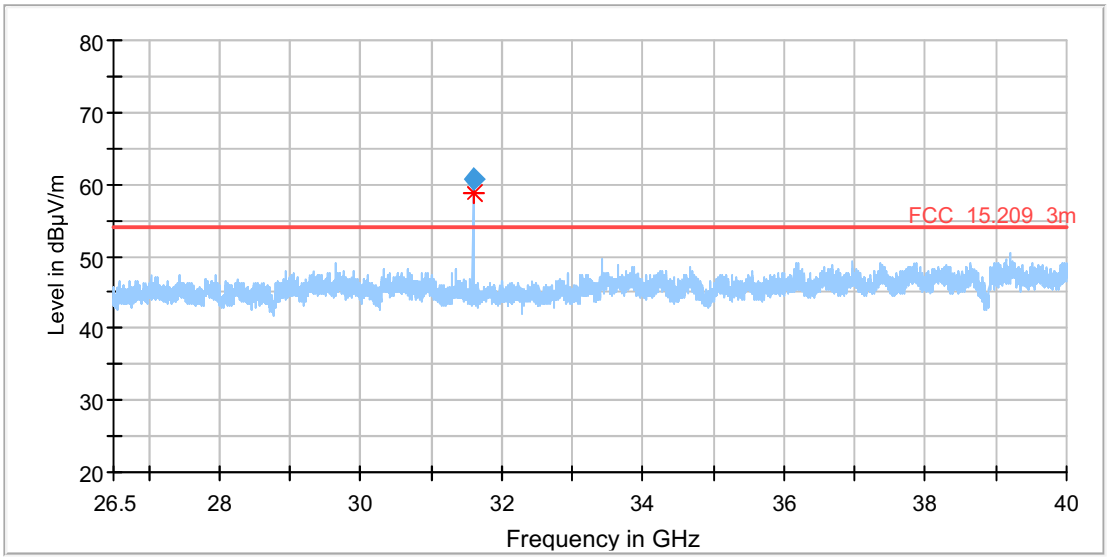
Radiated Emissions 18 – 26.5 GHz
Pos.: Z (refer to Annex 1)



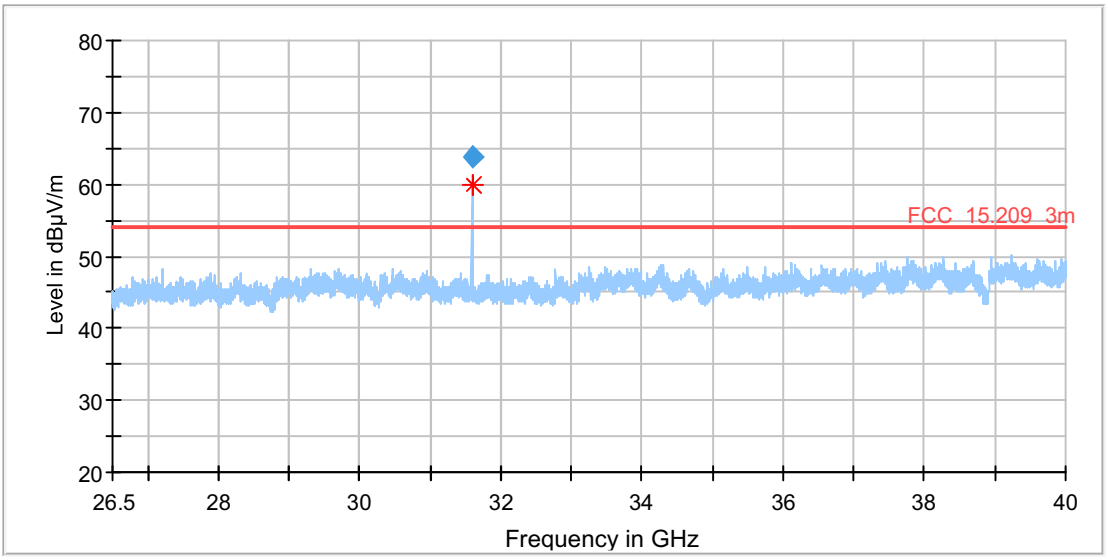
Radiated Emissions 26.5 – 40 GHz
Pos.: X (refer to Annex 1)



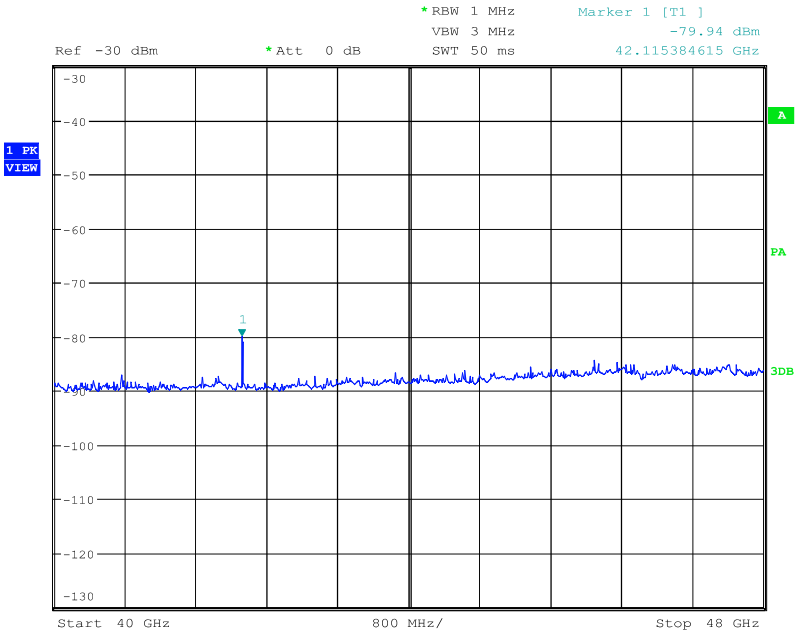
Radiated Emissions 26.5 – 40 GHz
Pos.: Y (refer to Annex 1)



Radiated Emissions 26.5 – 40 GHz
Pos.: Z (refer to Annex 1)

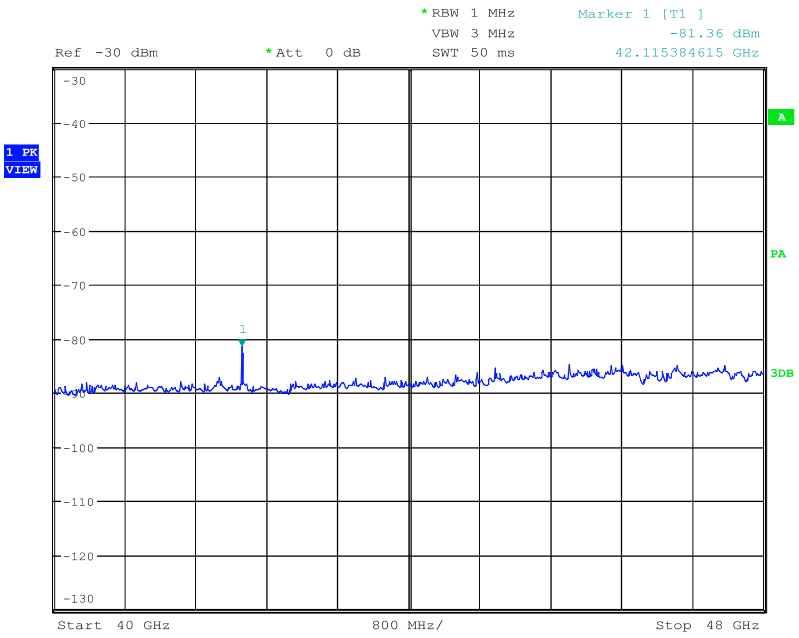


Radiated Emissions 40 – 48 GHz
Pos.: X (refer to Annex 1)

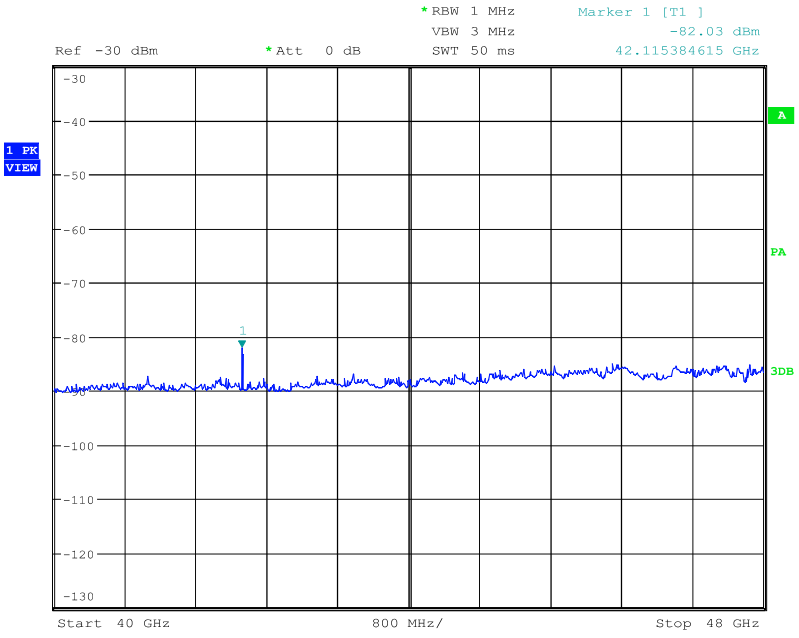


Note: no correction factor was applied in the measurement plots in the frequency range of 40 – 53 GHz.

Radiated Emissions 40 – 48 GHz
Pos.: Y (refer to Annex 1)

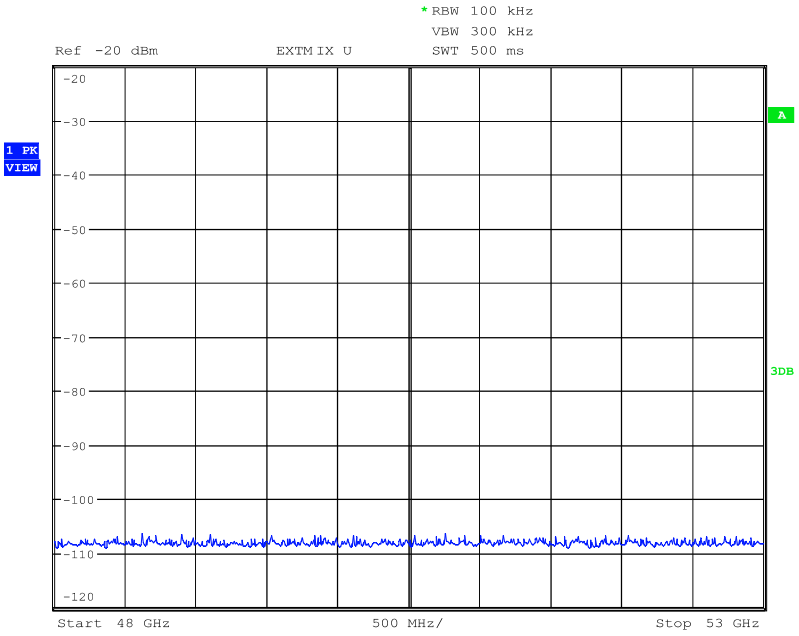


Radiated Emissions 40 – 48 GHz
Pos.: Z (refer to Annex 1)

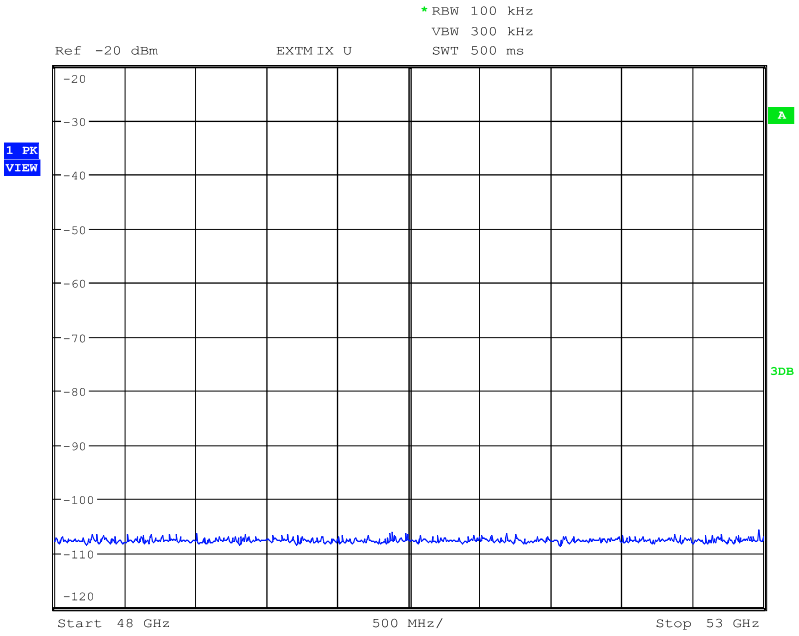


Note: no correction factor was applied in the measurement plots in the frequency range of 40 – 53 GHz.

Radiated Emissions 48 - 53 GHz, reduced RBW
Pos.: X (refer to Annex 1)

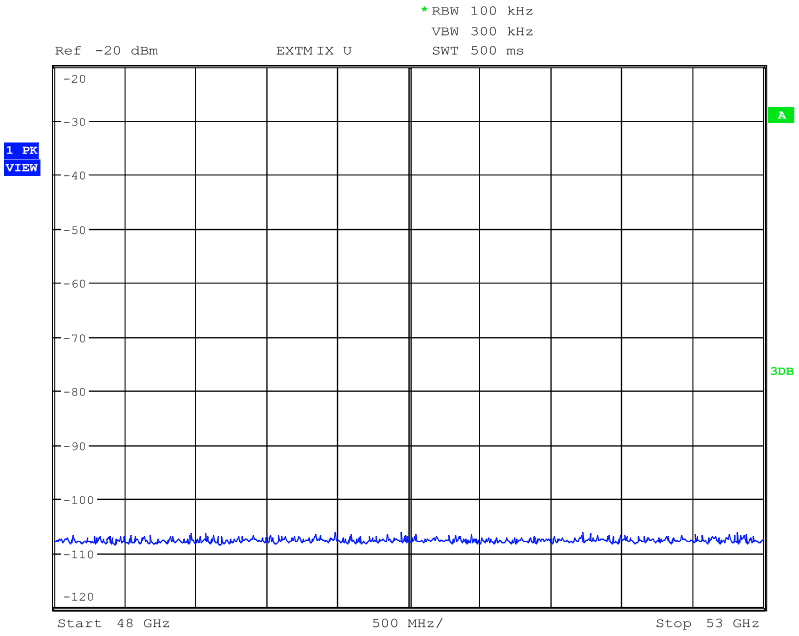


Radiated Emissions 48 – 53 GHz, reduced RBW
Pos.: Y (refer to Annex 1)

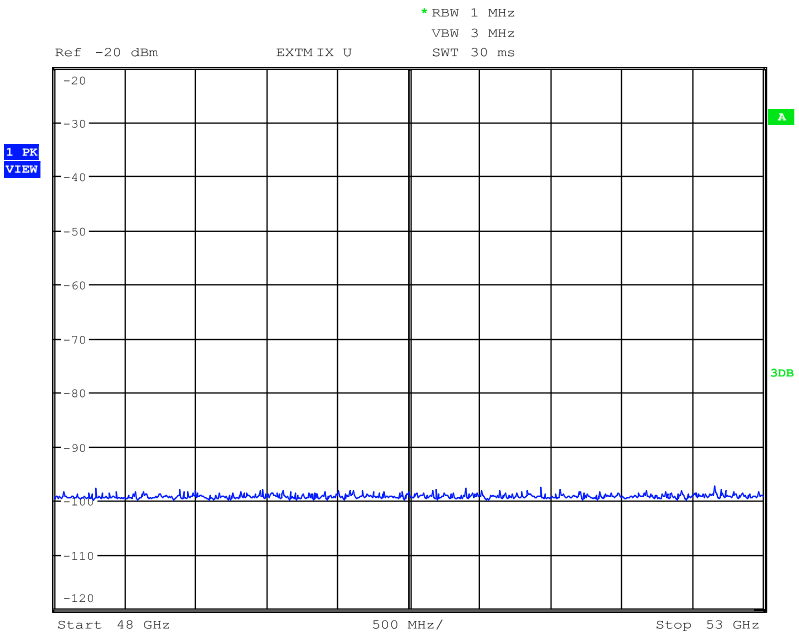


Note: no correction factor was applied in the measurement plots in the frequency range of 40 – 53 GHz.

Radiated Emissions 48 - 53 GHz, reduced RBW
Pos.: Z (refer to Annex 1)



Radiated Emissions 48 - 53 GHz, RBW=1 MHz
Pos.: none – explorative measurement in very close distance



Note: no correction factor was applied in the measurement plots in the frequency range of 40 – 53 GHz.

12 MEASUREMENT UNCERTAINTY

Measurement	Measurement Uncertainty
Radiated emissions, H field (9 kHz – 30 MHz)	± 3.0 dB
Radiated Emissions (30 MHz – 1000 MHz)	± 5.7 dB
Radiated Emissions (Above 1000 MHz)	± 5.3 dB

The reported uncertainty values are based on a standard uncertainty multiplied by a coverage factor of k=2.0, providing a level of confidence of 95 %.

The given values have been calculated on the basis of the following documents:
CISPR 16-4-2: 2014;
UKAS: LAB34, The Expression of Uncertainty in EMC Testing, August 2002;
ISO: Guide to the Expression of Uncertainty in Measurement, 1993.

13 LIST OF ANNEXES

Following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test set-up	7
Annex 2: Internal photographs of equipment under test (EUTs)	4
Annex 3: Internal photographs of equipment under test (EUTs)	5
Annex 4: Photographs of ancillary equipment	2

ANNEX 1 TO TEST REPORT # EMCC-020548B, 2018-07-20

PHOTOGRAPHS OF TEST SET-UP

EQUIPMENT UNDER TEST:

Device:	PIRAMID CONNECT
Serial Number:	n/a
Application:	Movement Detector
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Manufacturer:	SORHEA
Address:	1, rue du Dauphiné 69120 Vaulx-En-Velin France
Phone :	+33 4 78 03 06 10
E-Mail :	a.caradec@sorhea.fr

RELEVANT STANDARD(S) : 47 CFR § 15.245
RSS-210 Issue 9

MEASUREMENT PROCEDURE:

☒ ANSI C63.10-2013 ☒ RSS-Gen Issue 4

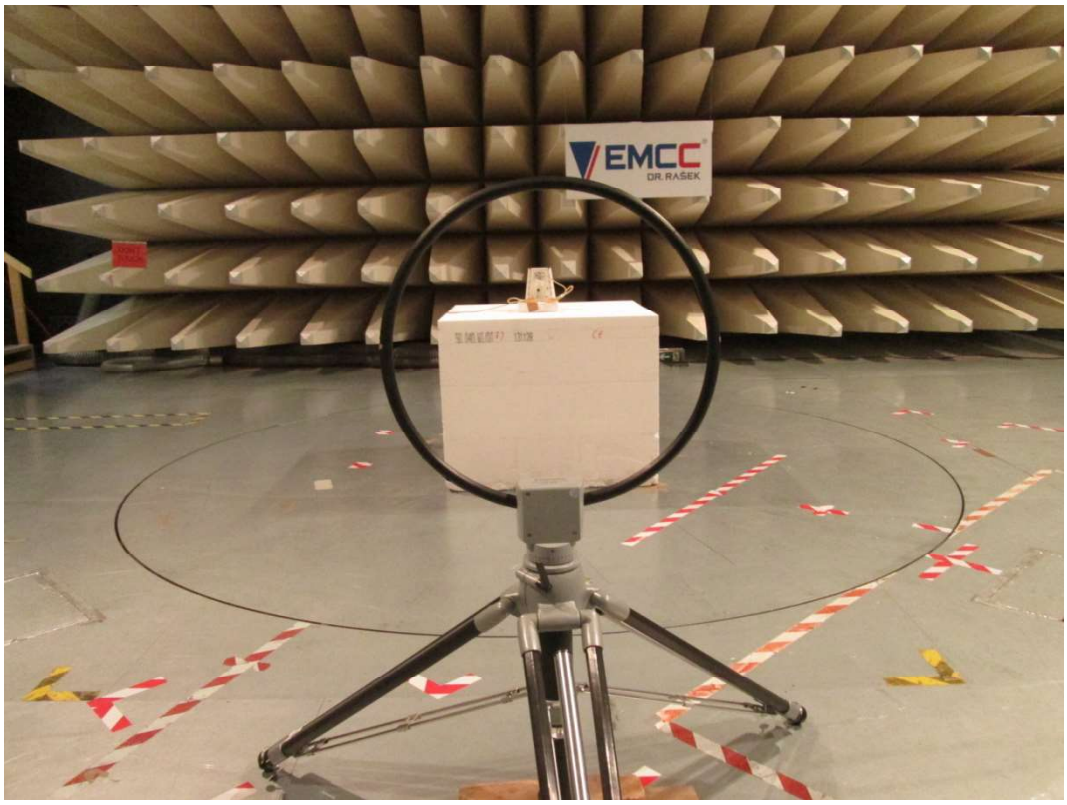


Photo A1-1: Radiated emissions measurement at 3 m distance, 9 kHz – 30 MHz

Photo A1-2: Radiated emissions measurement at 3 m distance, 30 MHz – 1000 MHz

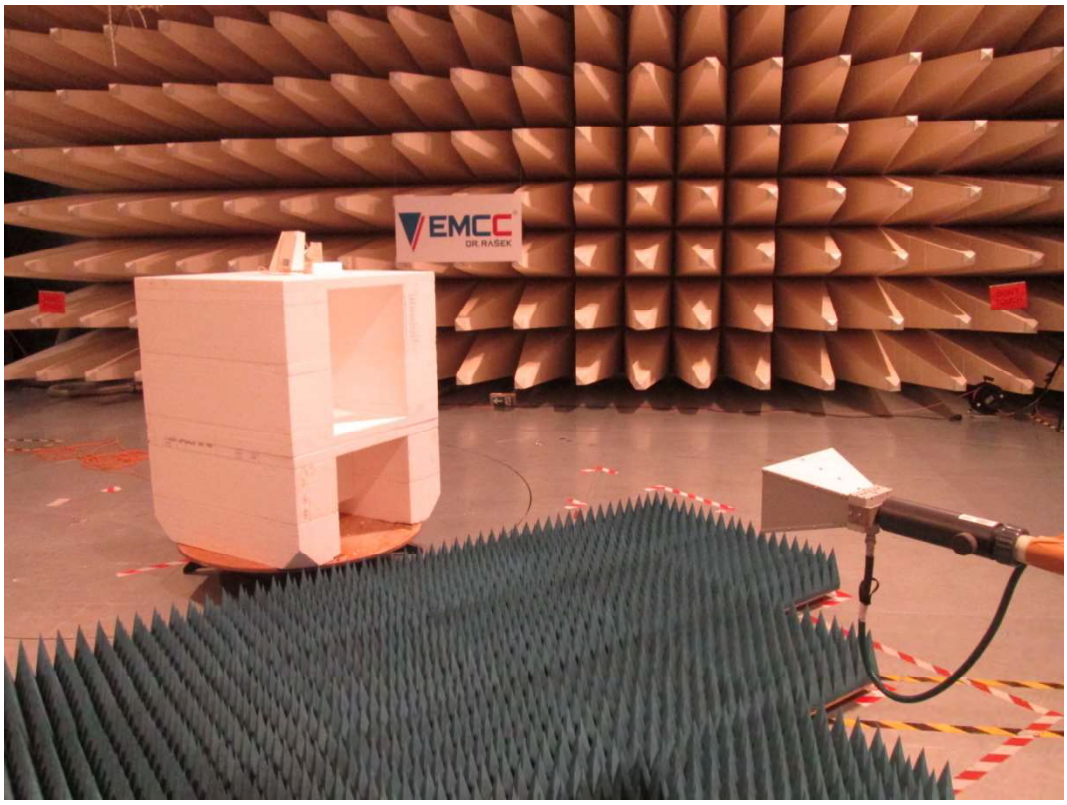


Photo A1-3: Radiated emissions measurement at 3 m distance, 1 GHz – 6 GHz

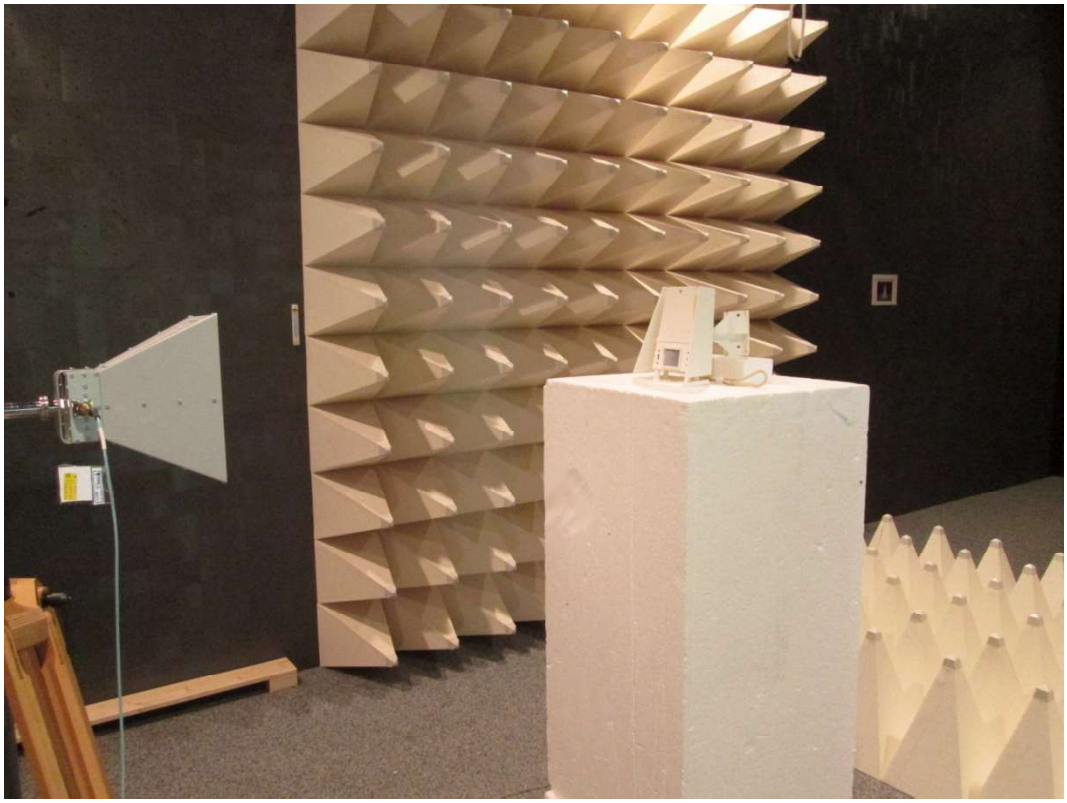


Photo A1-4: Radiated emissions measurement at 1 m distance, 6 GHz – 18 GHz

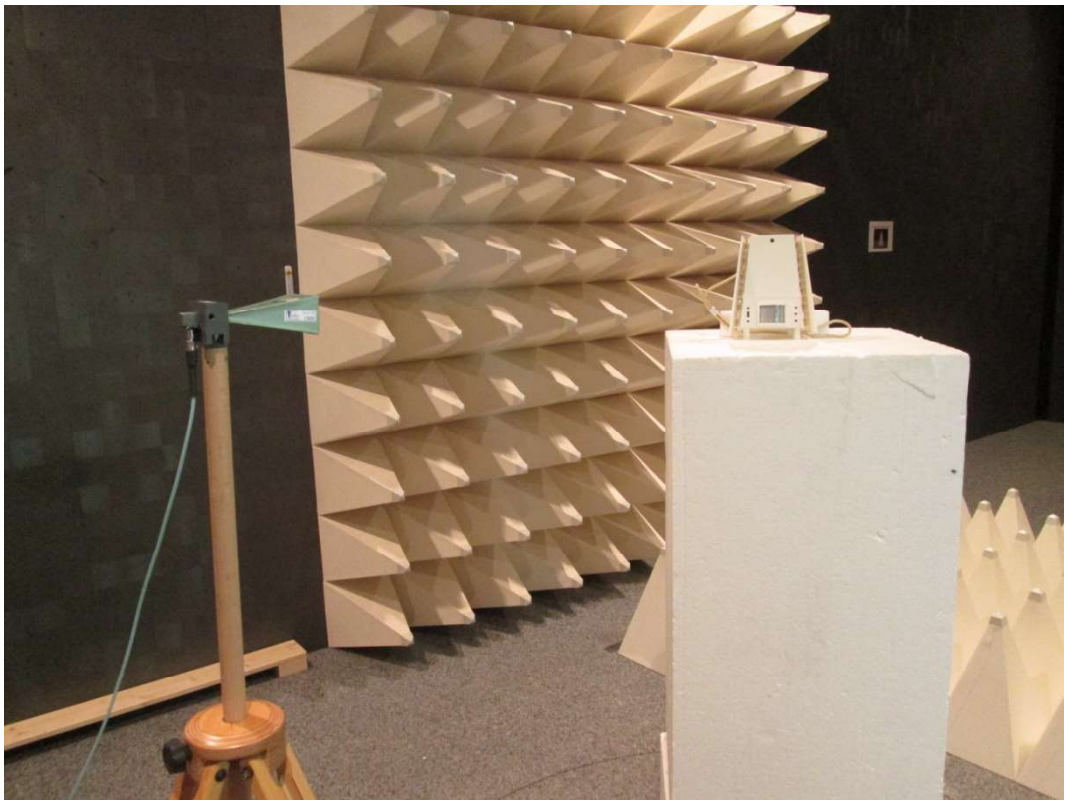


Photo A1-5: Radiated emissions measurement at 1 m distance, 18 GHz – 26.5 GHz

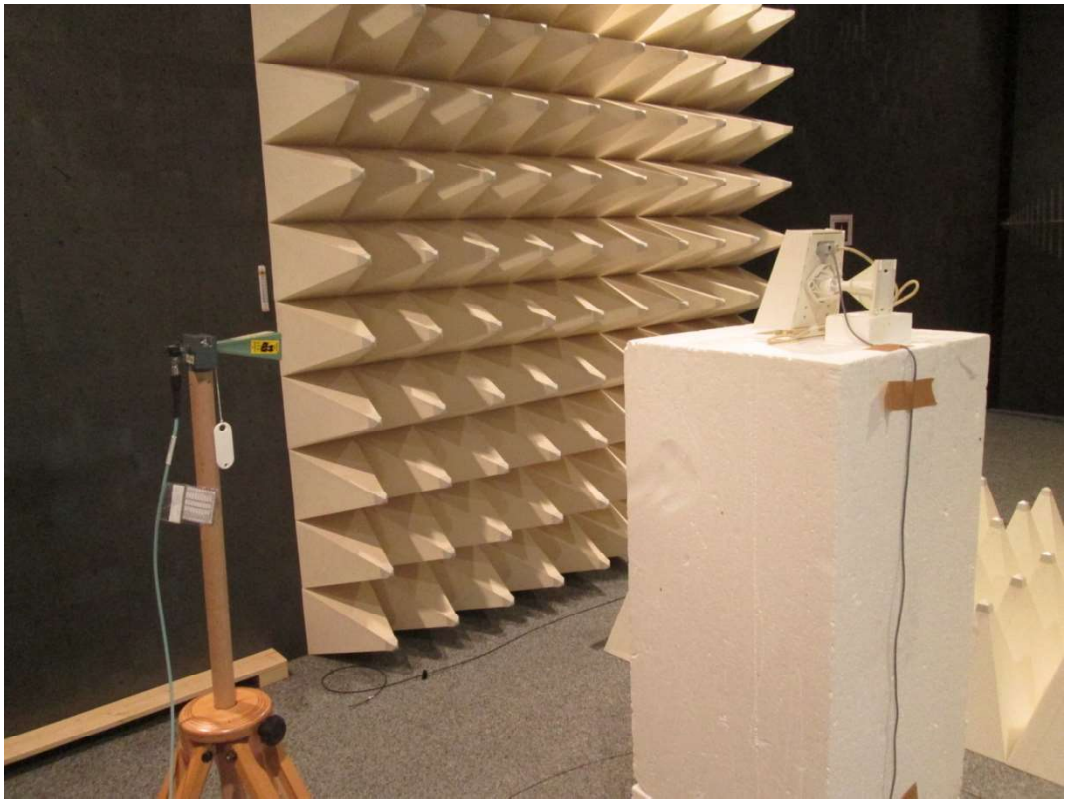


Photo A1-6: Radiated emissions measurement at 1 m distance, 26.5 GHz – 40 GHz

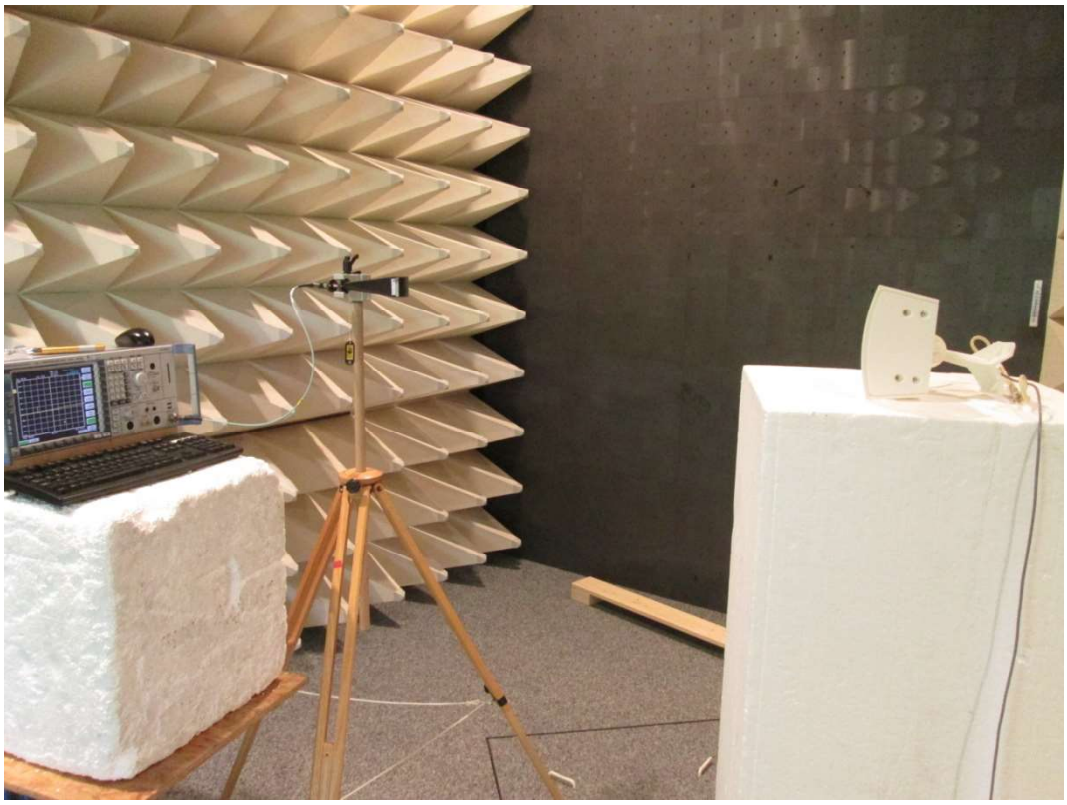


Photo A1-7: Radiated emissions measurement at 1 m distance, 40 GHz – 48 GHz

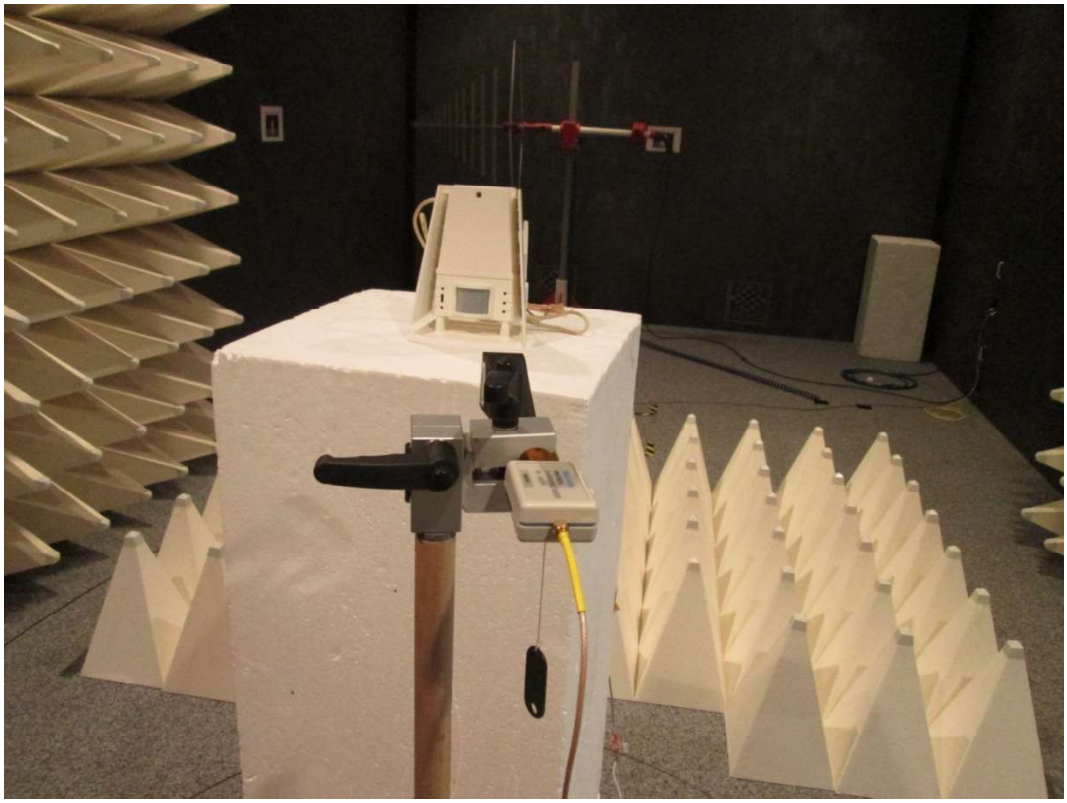


Photo A1-8: Radiated emissions measurement at 0.5 m distance, 48 GHz – 53 GHz

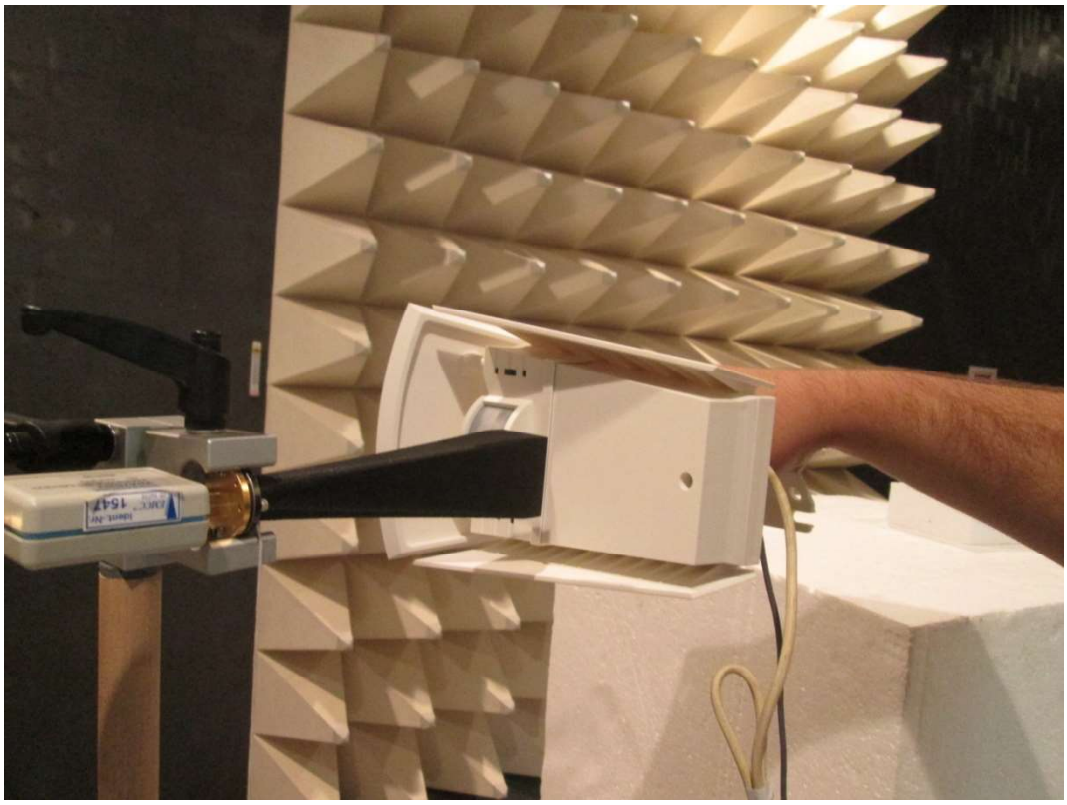


Photo A1-9: Explorative measurement at closer distance, 48 GHz – 53 GHz

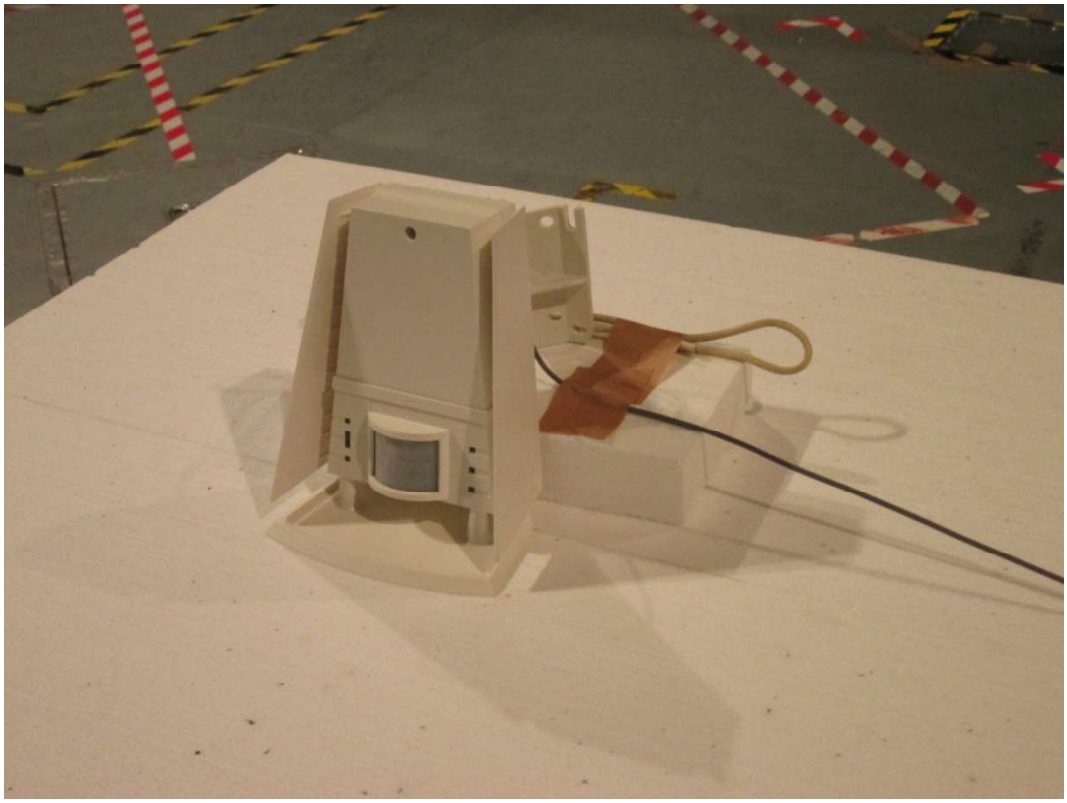


Photo A1-10: EUT Position X

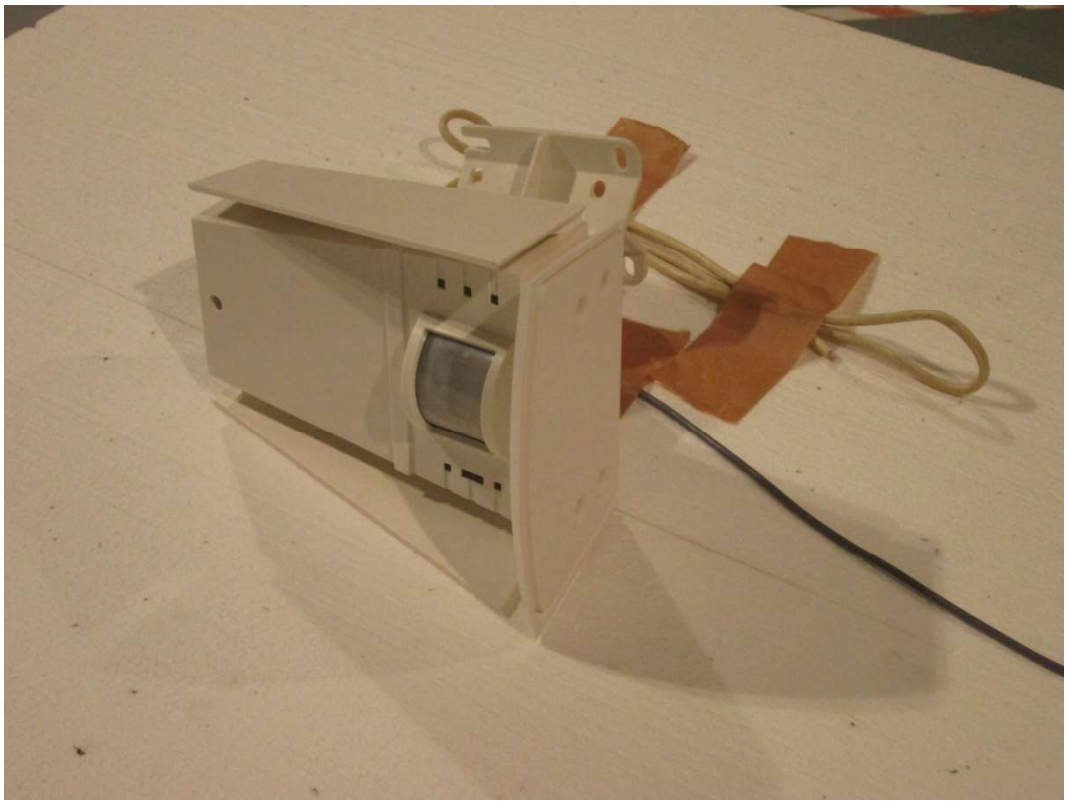


Photo A1-11: EUT Position Y

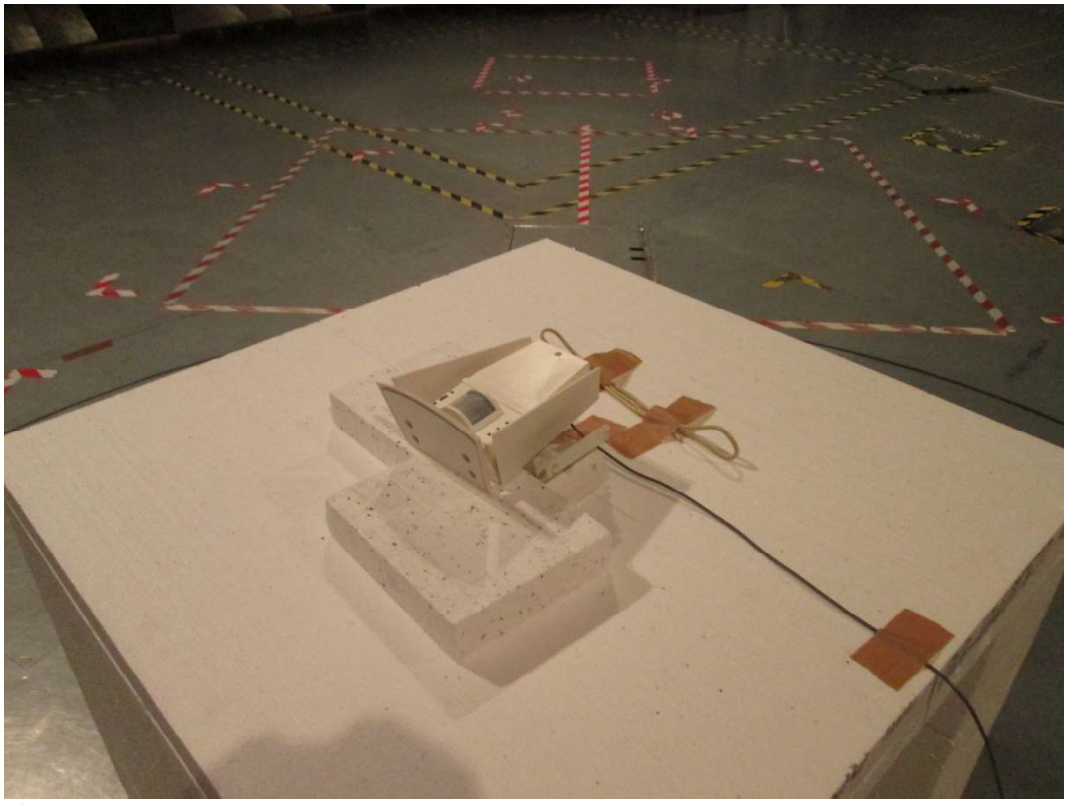


Photo A1-12: EUT Position Z

ANNEX 2 TO TEST REPORT # EMCC-020548B, 2018-07-20

EXTERNAL PHOTOGRAPHS OF EUT

EQUIPMENT UNDER TEST:

Device:	PIRAMID CONNECT
Serial Number:	n/a
Application:	Movement Detector
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Manufacturer:	SORHEA
Address:	1, rue du Dauphiné 69120 Vaulx-En-Velin France
Phone :	+33 4 78 03 06 10
E-Mail :	a.caradec@sorhea.fr

RELEVANT STANDARD(S) : 47 CFR § 15.245
RSS-210 Issue 9

MEASUREMENT PROCEDURE:

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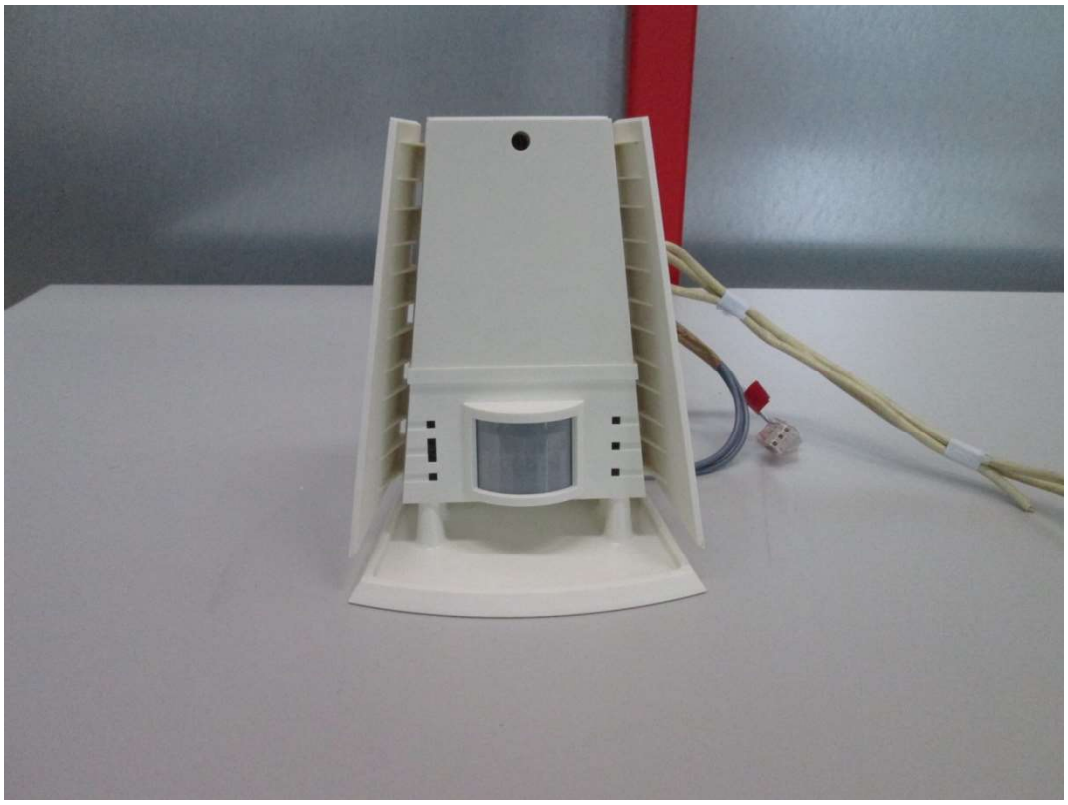

Photo A2-1: Front

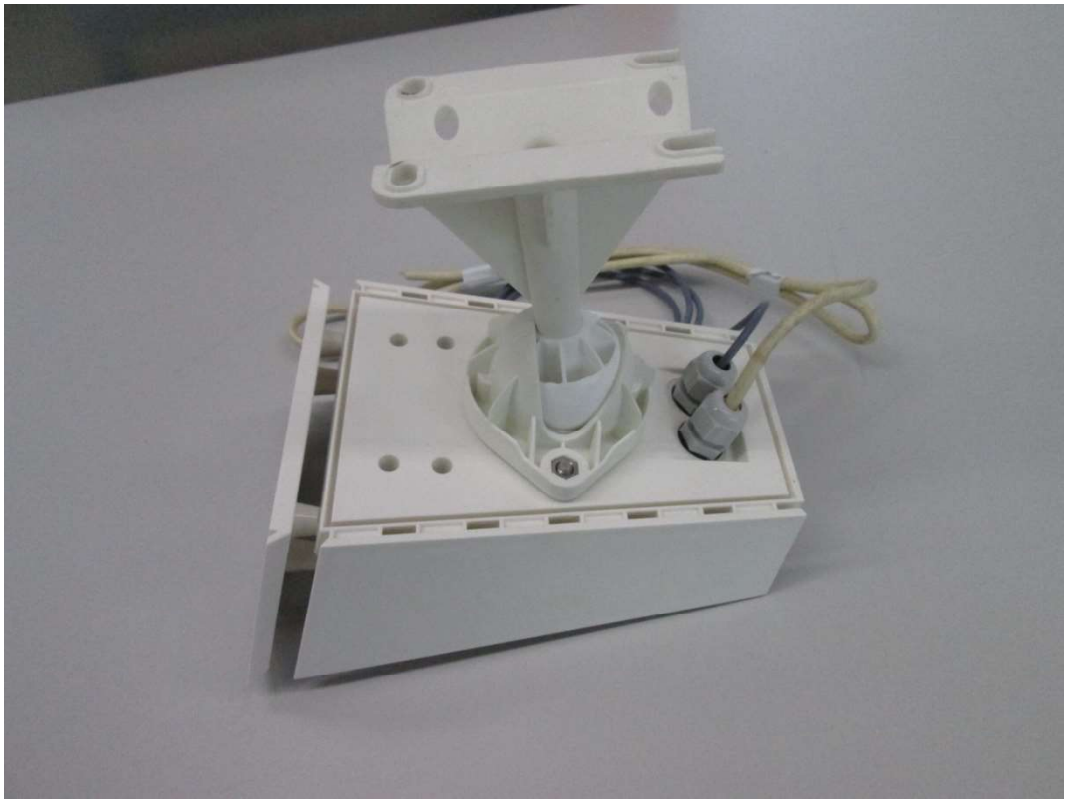

Photo A2-2: Rear

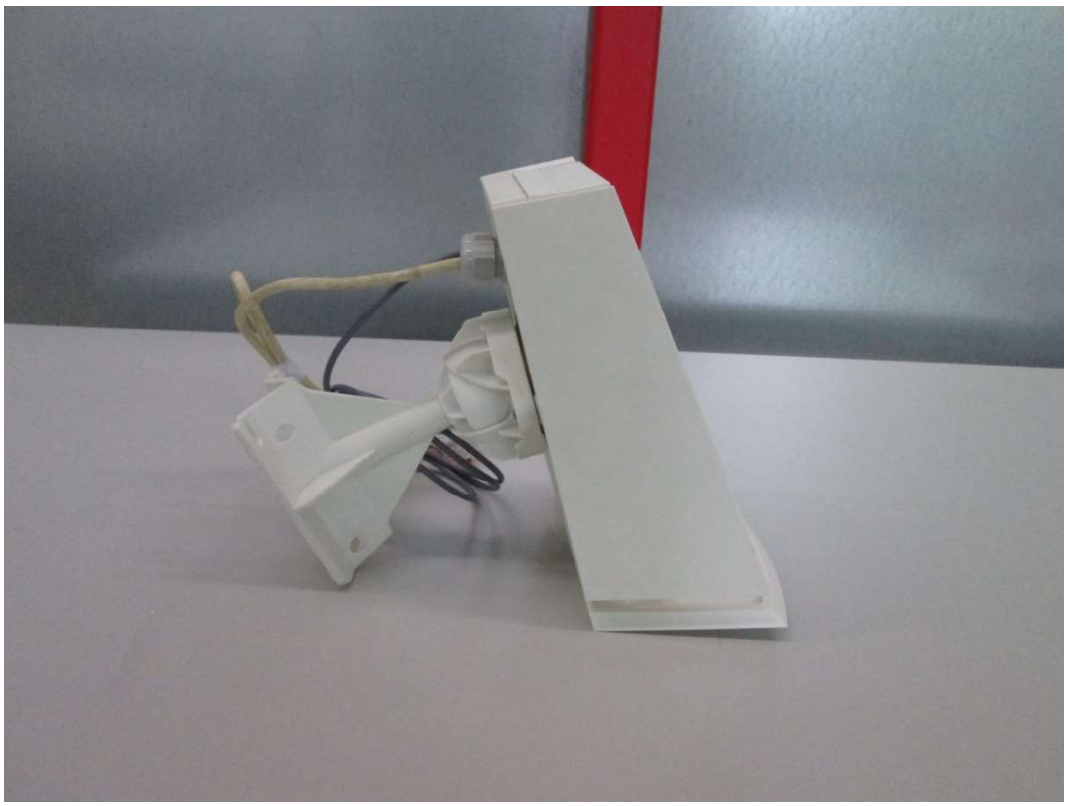

Photo A2-3: Left

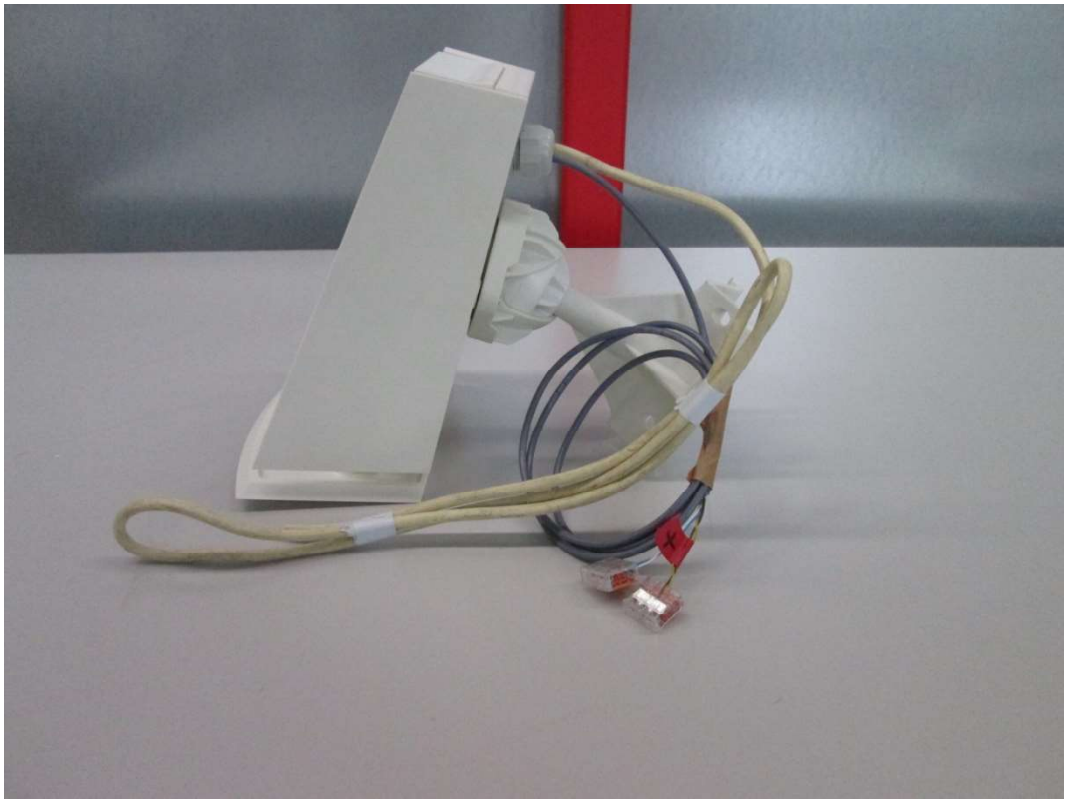

Photo A2-4: Right

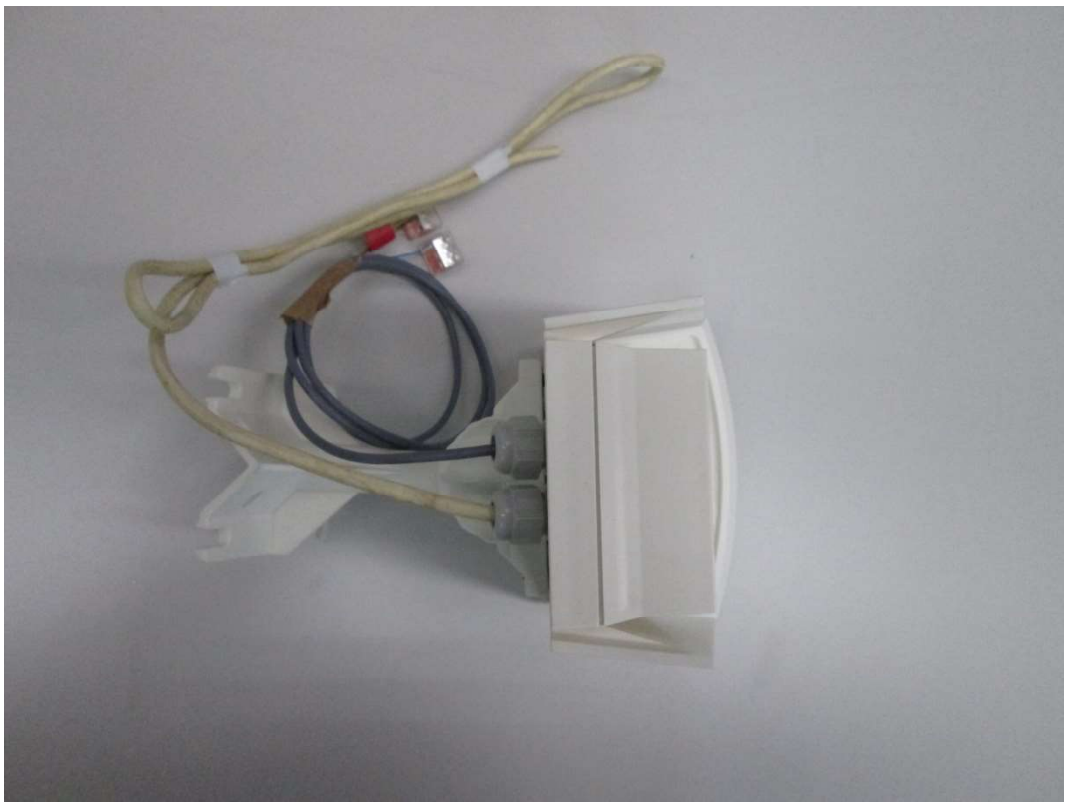

Photo A2-5: Top

Photo A2-6: Bottom

ANNEX 3 TO TEST REPORT # EMCC-020548B, 2018-07-20

INTERNAL PHOTOGRAPHS OF EUT

EQUIPMENT UNDER TEST:

Device:	PIRAMID CONNECT
Serial Number:	n/a
Application:	Movement Detector
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Manufacturer:	SORHEA
Address:	1, rue du Dauphiné 69120 Vaulx-En-Velin France
Phone :	+33 4 78 03 06 10
E-Mail :	a.caradec@sorhea.fr
RELEVANT STANDARD(S) :	47 CFR § 15.245 RSS-210 Issue 9

MEASUREMENT PROCEDURE:

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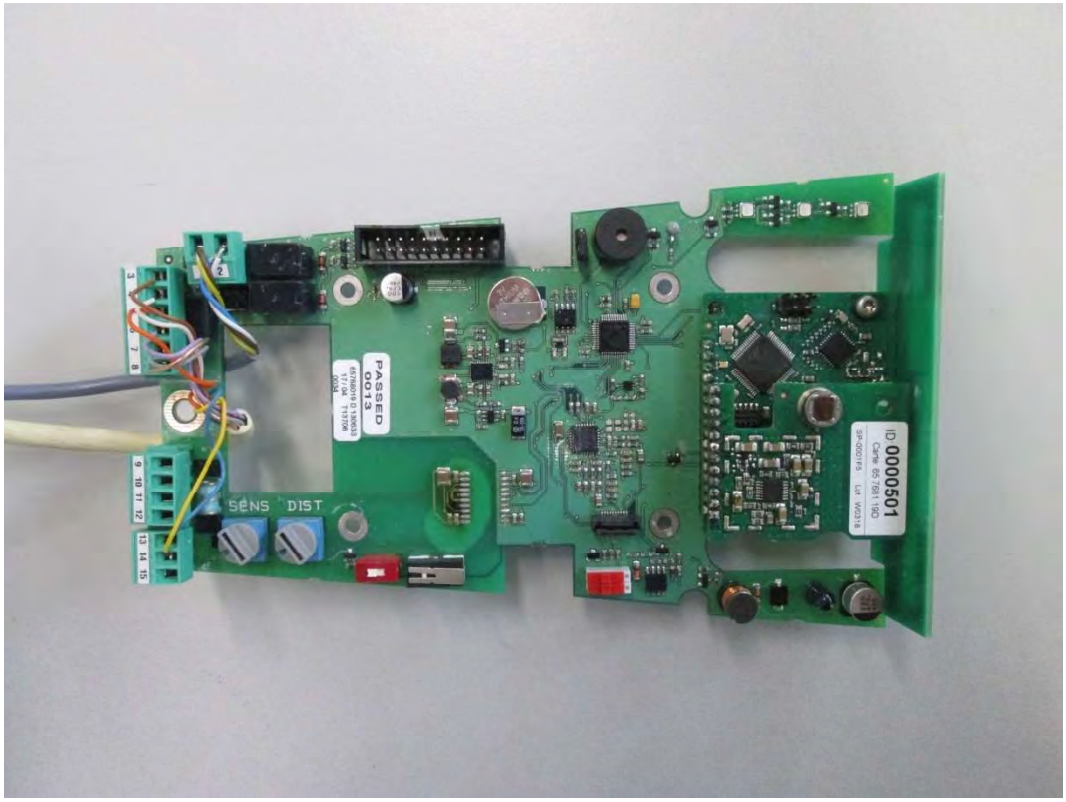

Photo A3-1: Main PCB, Top

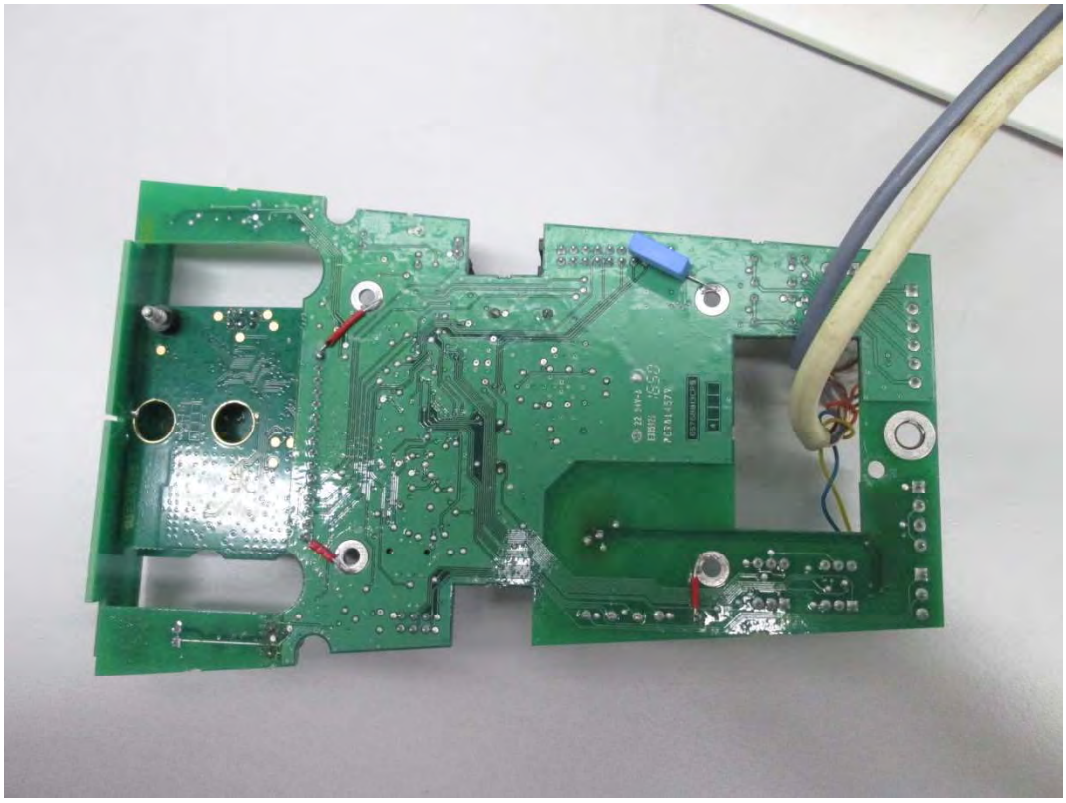

Photo A3-2: Main PCB, Bottom

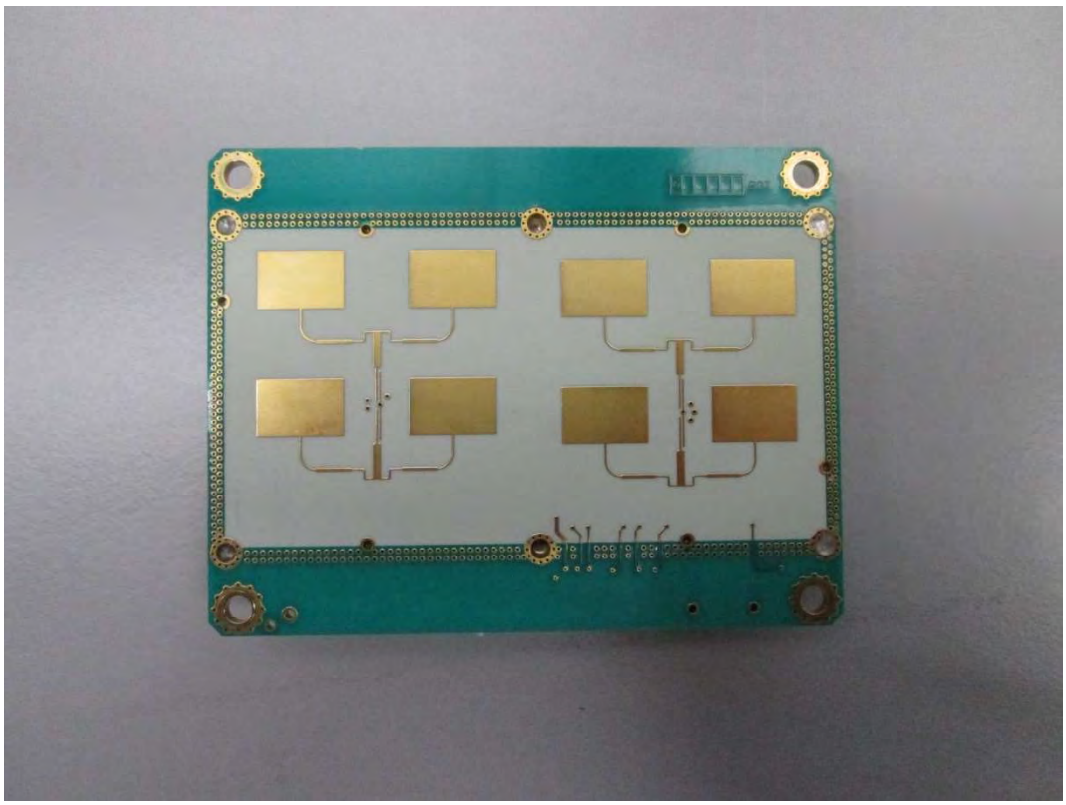

Photo A3-4: Radar Module, Top (Antenna side)

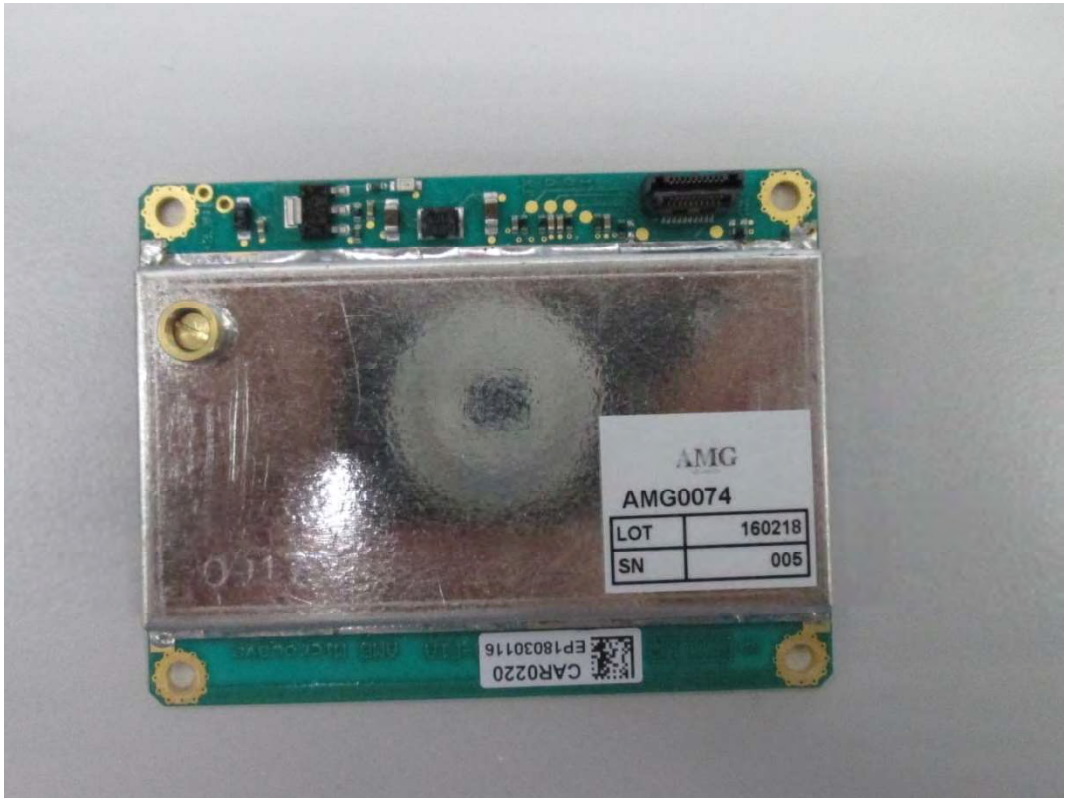

Photo A3-4: Radar Module, Bottom

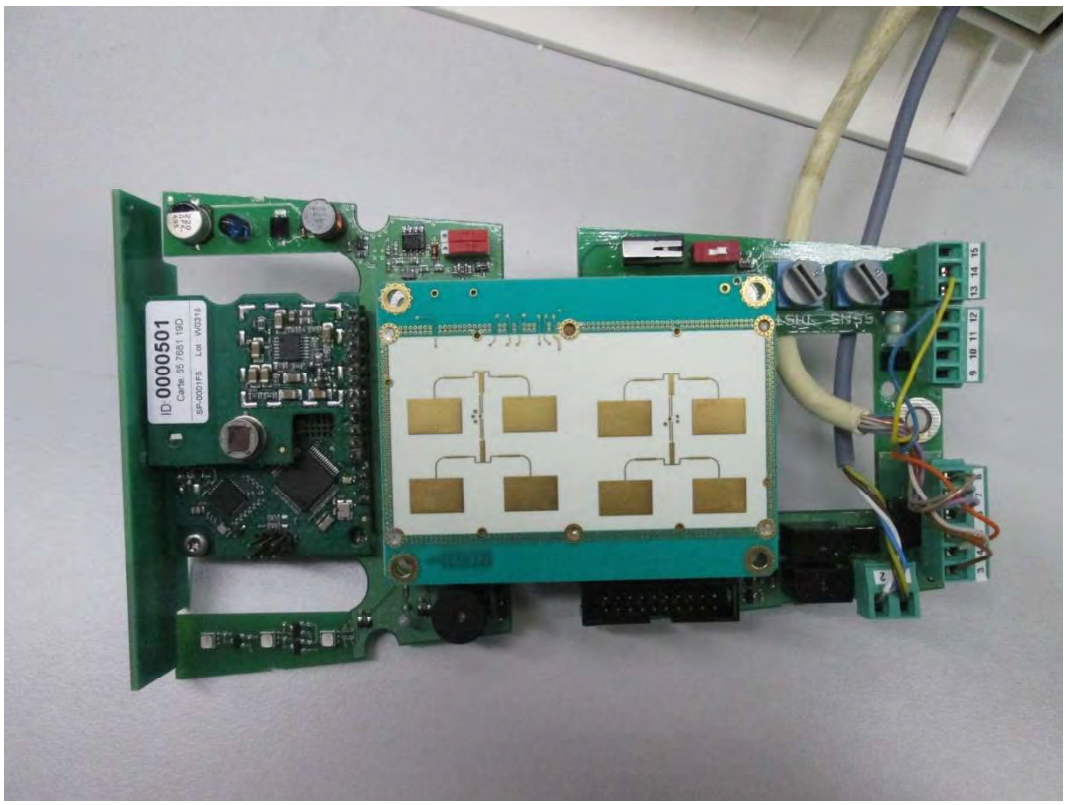

Photo A3-5: Assembled PCBs

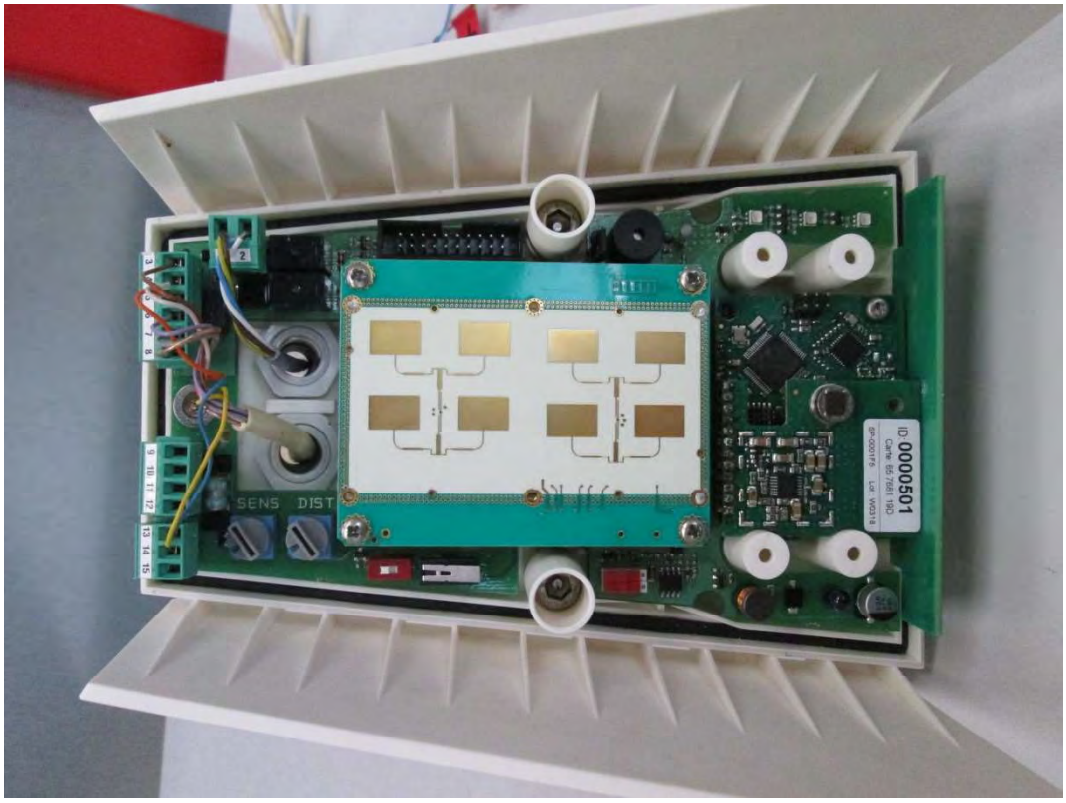

Photo A3-6: Assembled PCBs

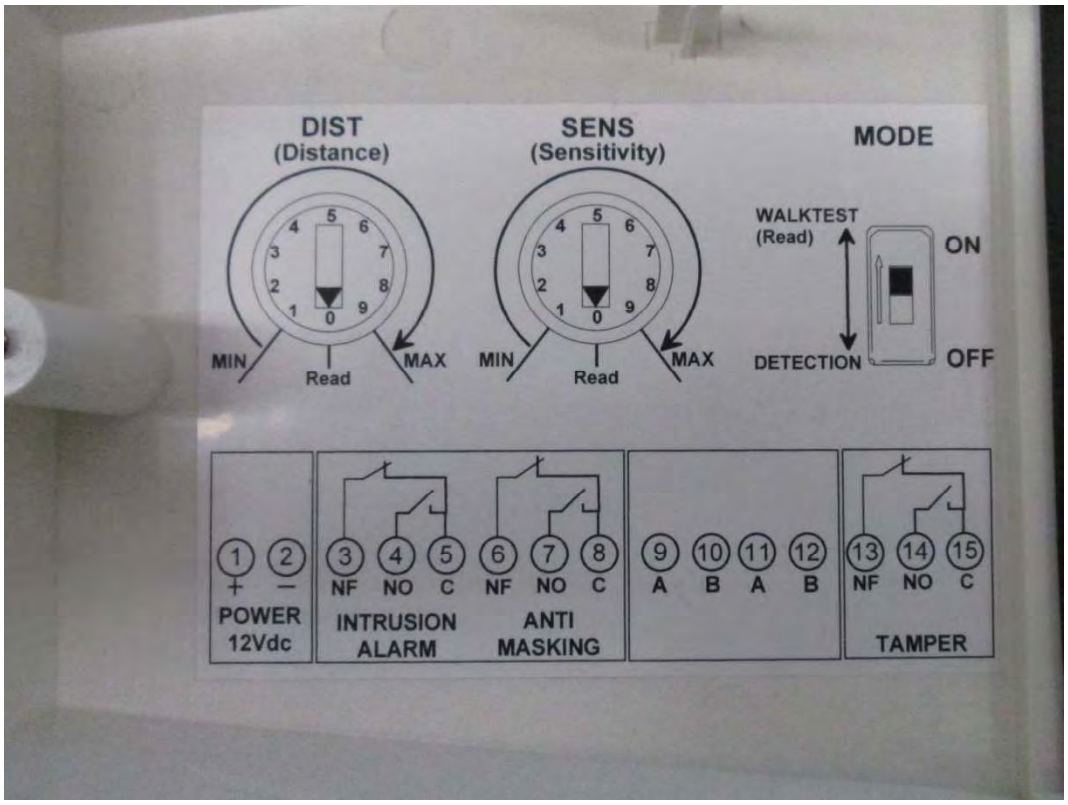

Photo A3-7: Instruction printed inside cover

Photo A3-8: Label

ANNEX 4 TO TEST REPORT # EMCC-020548B, 2018-07-20

PHOTOGRAPHS OF ANCILLARY EQUIPMENT

EQUIPMENT UNDER TEST:

Device:	PIRAMID CONNECT
Serial Number:	n/a
Application:	Movement Detector
FCC ID:	QVA-PIRCONNECT
IC:	11664A- PIRCONNECT
Manufacturer:	SORHEA
Address:	1, rue du Dauphiné 69120 Vaulx-En-Velin France
Phone :	+33 4 78 03 06 10
E-Mail :	a.caradec@sorhea.fr

RELEVANT STANDARD(S) : 47 CFR § 15.245
RSS-210 Issue 9

MEASUREMENT PROCEDURE:

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Photo A4-1: AC/DC Adaptor provided by customer

Photo A4-2: Label of AC/DC Adaptor provided by customer