RADIO REPORT

FCC 47 CFR Part 15C
ISED Canada RSS-247

Digital transmission systems operating within the 902.0 MHz - 928.0 MHz band

Report Reference No	G0M-2008-9229-TFC247DT-V02
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	DAkkS - Registration number : D-PL-12092-01-03 (ISED) ISED Testing Laboratory site: 3470A-2 DAkkS - Registration number : D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant	Hempel A/S
Address	Lundtoftegaardsvej 91 2800 Kgs. Lyngby Denmark
Test Specification	47 CFR Part 15C RSS-247, Issue 2, 2017-02 RSS-Gen, Issue 5, Amendment 1, 2019-03
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	Temperature and humidity logger with BLE and LoRa communication
Model(s)	915 MHz
Additional Model(s)	None
Brand Name(s)	None
Hardware Version(s)	1.3.0
Software Version(s)	BLE v1.0.0, LoRa v1.4.0
FCC-ID	2AXRV-HT915
IC	-/-
Test Result	**PASSED**

Possible test case verdicts:		
Required by standard but not tested	N/T	
Not required by standard	N/R	
Not applicable to EUT	N/A	
Test object does meet the requirement	P(PASS)	
Test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of receipt of test item	2020-09-09	
Report:		
Compiled by	Wilfried Treffke	
Tested by (+ signature) (Responsible for Test)	Wilfried Treffke	W. Treffke .....
Approved by (+ signature) (Deputy Head of Lab)	Toralf Jahn	.....
Date of Issue	2021-02-19	
Total number of pages	106	
General Remarks:		
The test results presented in this report relate only to the object tested. **The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.** This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
The device has 64 Tx channels starting 902.3MHz - 914.9MHz with 200kHz spacing and 8 Tx channels 903MHz-914.2MHz with 1.6MHz spacing. The device receiver has 8 Rx channels starting 923.3MHz – 927.5 MHz with 0.6MHz spacing The device is capable of working with all gateways without hardware modifications. However, due to gateway limitations the device uses only 8x125kHz channels and 1x500kHz in real life. Which channels will be in use is decided by gateway.		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2020-12-21	Initial Release	
02	2021-02-19	Replaced document: G0M-2008-9229-TFC247DT-V01 Replaced by: G0M-2008-9229-TFC247DT-V02 Reason: Typo because of channel frequencies on page 35 and 43	W.Treffke

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EUT	Equipment Under Test
FCC	Federal Communications Commission
ISED	Innovation, Science and Economic Development Canada
RBW	Resolution bandwidth
RMS	Root mean square
VBW	Video bandwidth
V_{NOM}	Nominal supply voltage

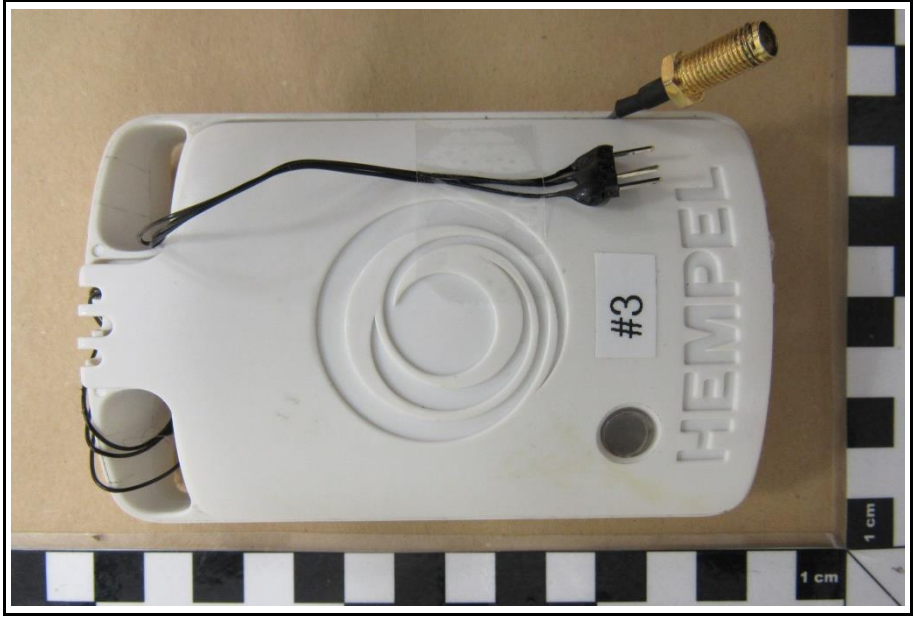
REPORT INDEX

1 Equipment (Test Item) Under Test

Description	Temperature and humidity logger with BLE and LoRa communication	
Model	915 MHz	
Additional Model(s)	None	
Brand Name(s)	None	
Serial Number(s)	None	Sample ID 32168 conducted Sample ID 32167 radiated
Hardware Version(s)	1.3.0	
Software Version(s)	BLE v1.0.0, LoRa v1.4.0	
PMN	-/-	
HVIN	-/-	
FVIN	-/-	
HMN	-/-	
FCC-ID	2AXRV-HT915	
IC	-/-	
Equipment type	End Product	
Radio type	Transceiver	
Assigned frequency bands	902.0 MHz - 928.0 MHz	
Radio technology	Hybide System	
Modulation	LoRa	
Number of antenna ports	1	
Antenna	Type	Integrated PCB
	Model	None
	Manufacturer	GRINN
	Gain	0 dBi
Supply Voltage	V_{NOM}	3.6 VDC battery
Operating Temperature	T_{NOM}	25 °C
AC/DC-Adaptor	Model	None
	Vendor	None
	Input	None
	Output	None
Manufacturer	Hempel A/S Lundtoftegaardsvej 91 2800 Kgs. Lyngby Denmark	

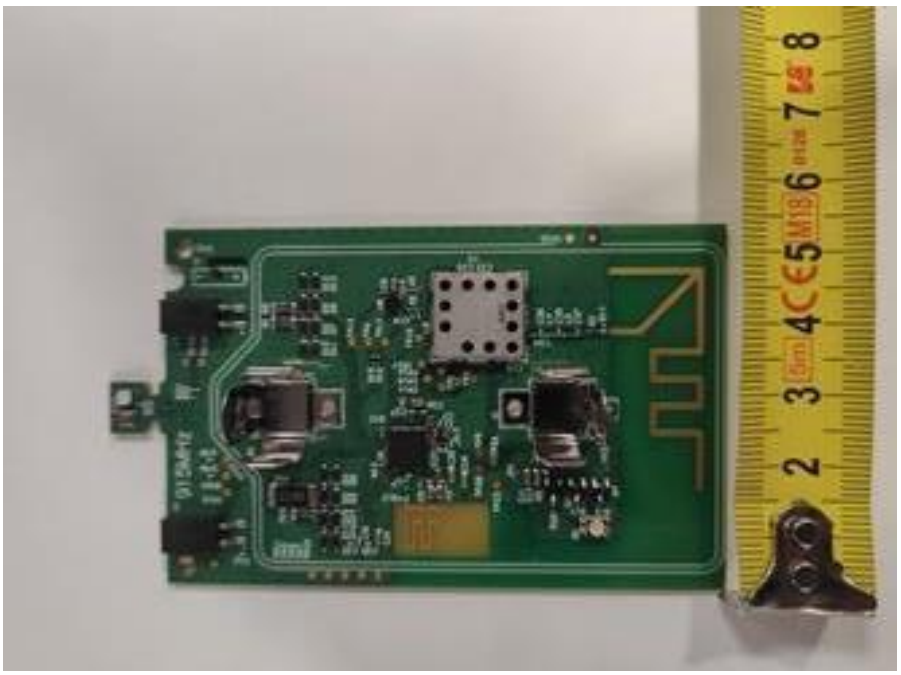
1.1 Photos – Equipment External

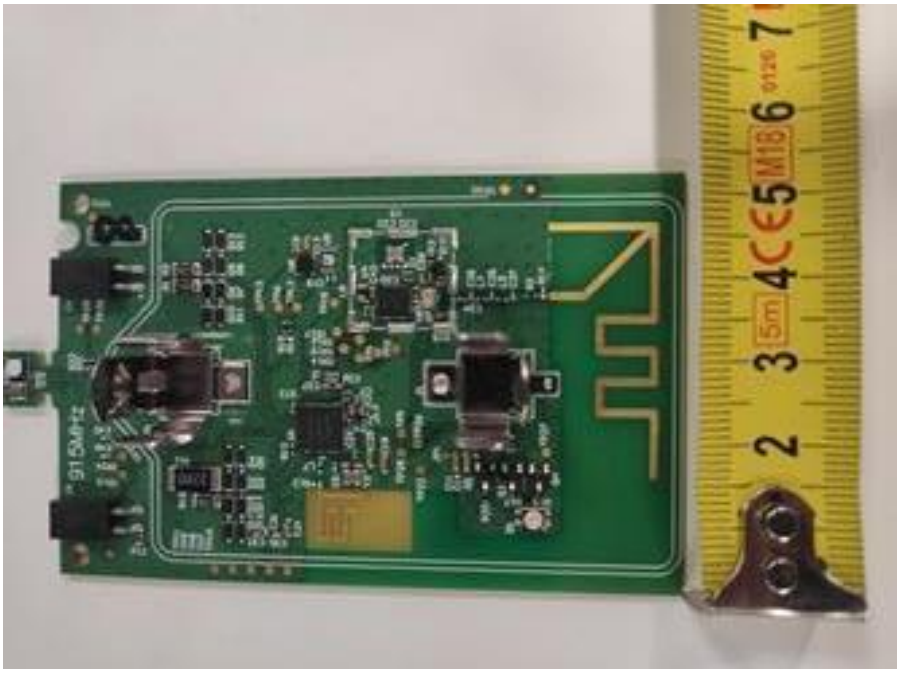
EUT LoRa Radiated Sample Top View


EUT LoRa Conducted Sample Top View


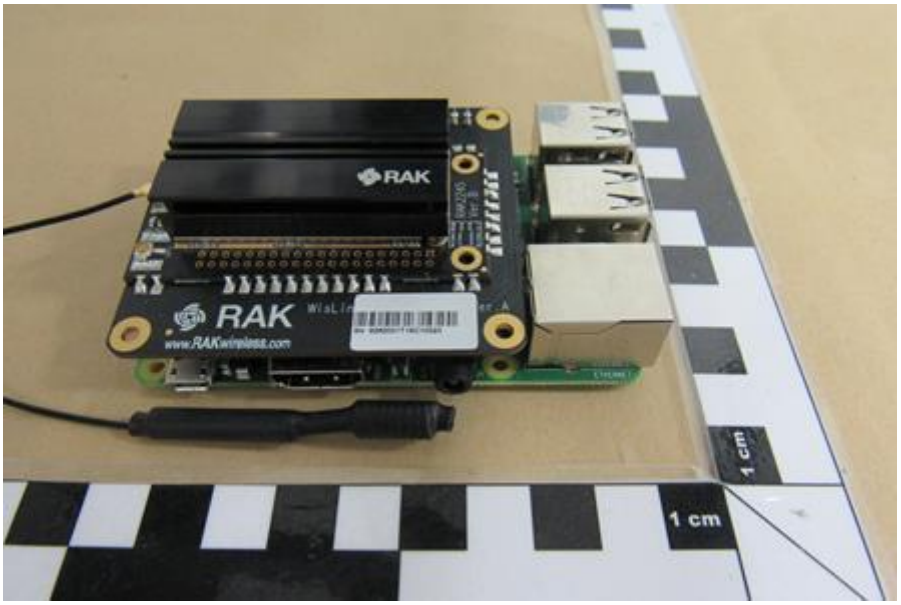
1.2 Photos – Equipment Internal

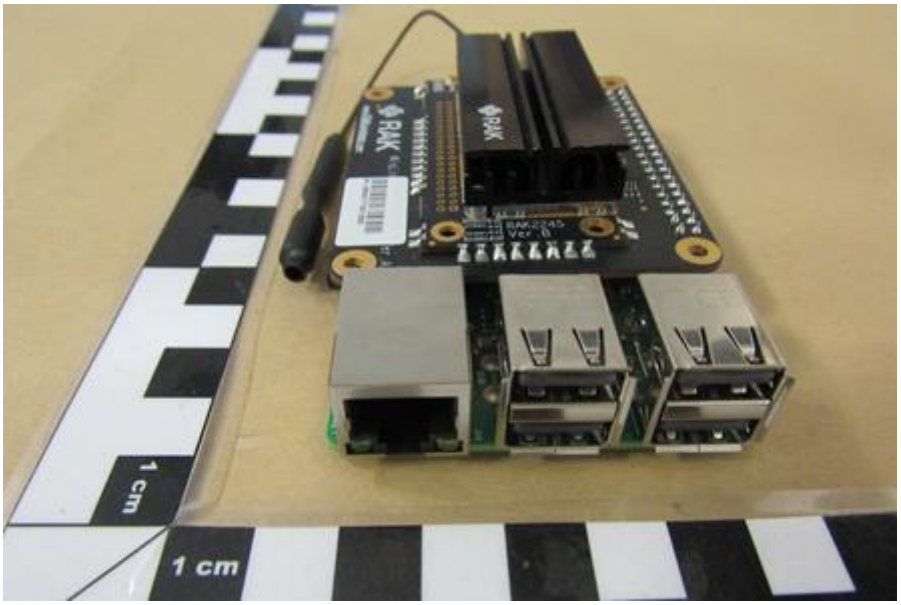
EUT Housing Opened View


PCB Top View Without Potting Compound


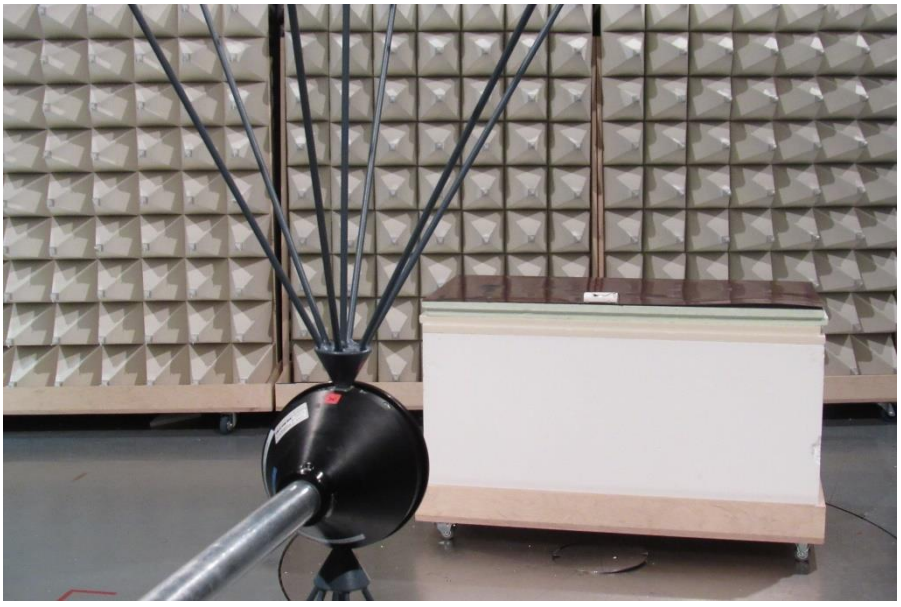
PCB Without Shielding View


LoRa Module Without Shielding

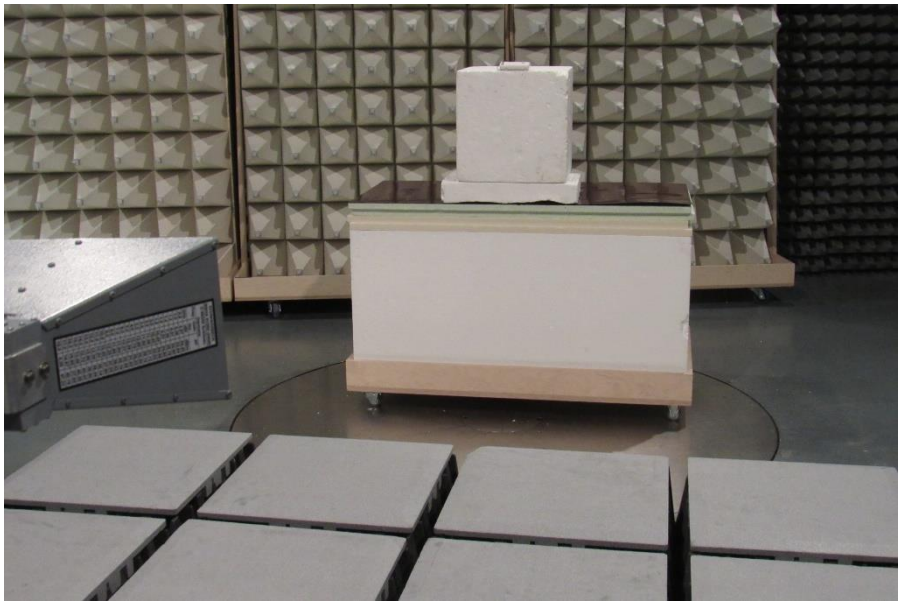

AE: LoRa Gateway View A


AE: LoRa Gateway View B


1.3 Photos – Test Setup

Radiated Setup View A


Radiated Setup View B


Radiated Setup View C


1.4 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE 1	LoRa gateway	RAKWireless	RAK2245	LoRa Gateway used to communicate with the device hopping mode
AE 2	USB-UART converter	-	-	Converter is used to communicate with the device under test
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
CBL	Connecting Cable			
SFT	Software			
Comment:				

1.5 Test mode duty cycle

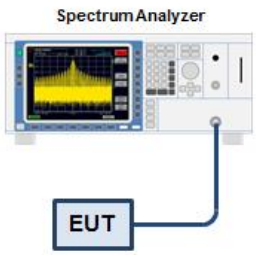
1.5.1 Information

Test Information	
Measurement Method	ANSI C63.10 11.6

1.5.2 Requirements

Requirements	
Duty cycle	Duty cycle correction
≥ 98 %	No correction required
< 98 %	Correction required (10 x Log_{10}(1/DC)

1.5.3 Setup

Test Setup


1.5.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 3	EF00241	2019-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

1.5.5 Procedure

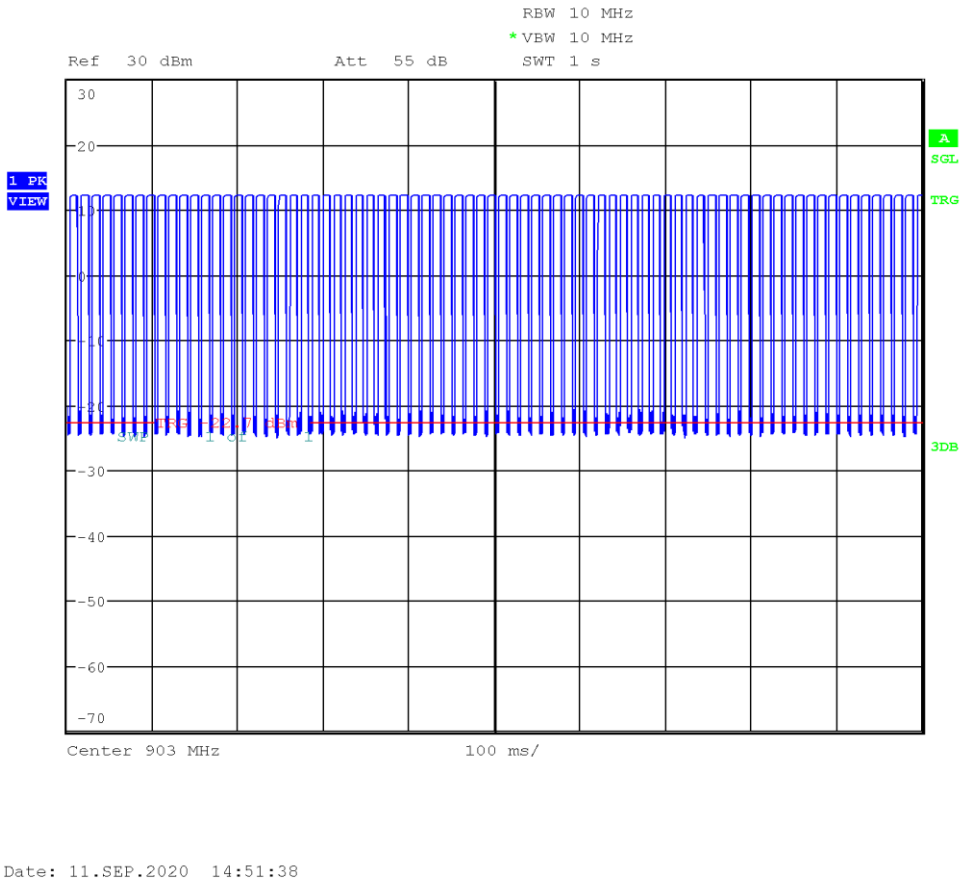
Test Procedure
1. EUT set to test mode 2. Span is set to zero span 3. Detector set to peak 4. Sweep time is set long enough to capture at least 5 bursts 5. Envelope peak value of emission spectrum is selected 6. The maximum burst duration T_{ON} is measured using two markers set to the start and the end of the longest burst 7. The minimum idle duration T_{OFF} is measured using two markers set to the start and the end of the shortest idle period 8. The duty cycle is calculated by DC = T_{ON} / (T_{ON} + T_{OFF}) 9. The duty cycle correction is calculated by DC = 10 x Log_{10}(T_{ON} / (T_{ON} + T_{OFF}))

1.5.6 Results

Duty Cycle Results		
Mode	Duty Cycle	Correction Factor [dB]
SF7	0.73	-2.73
SF8	0.82	-1.72
SF9	0.93	-0.63
SF10	0.96	-0.35
SF11	0.97	-0.26
SF12	0.99	0.00
Comment	DTS mode (500 kHz). SF12 is used for all power based measurements.	

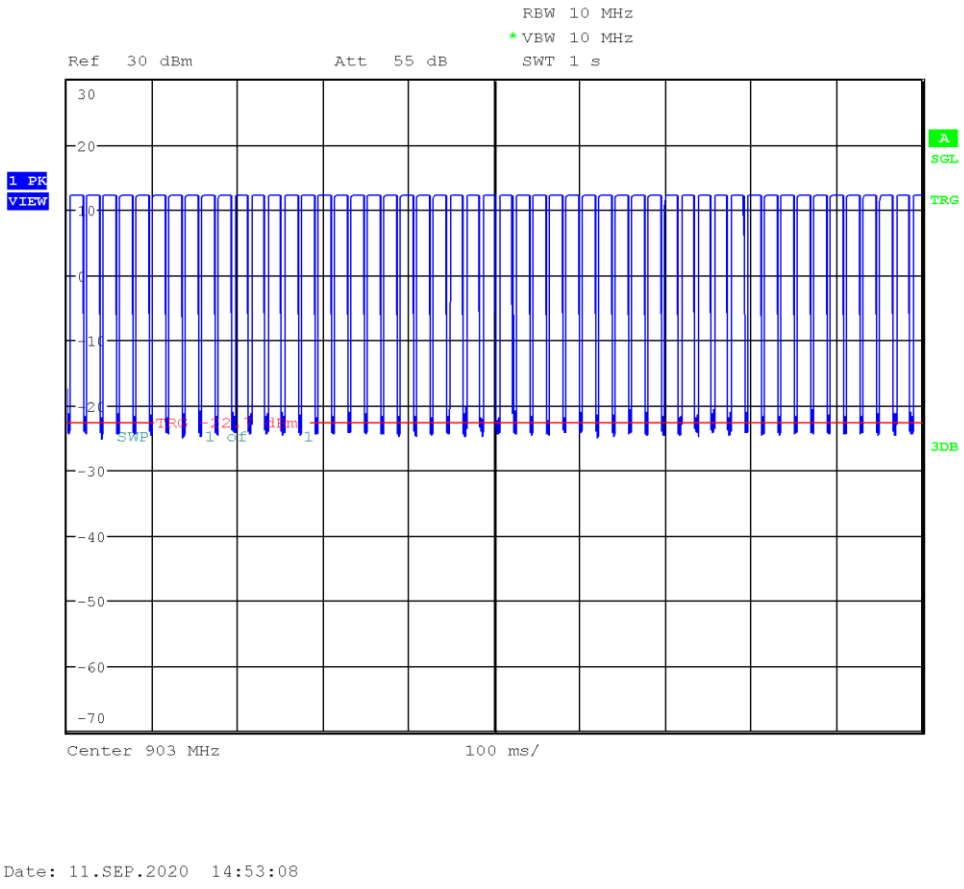
Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-11
Note:	SF7
Duty Cycle Period:	100
Maximum Duty Cycle:	0.73
Maximum Duty Cycle [%]:	73
Duty Cycle Correction [dB]:	-2.73



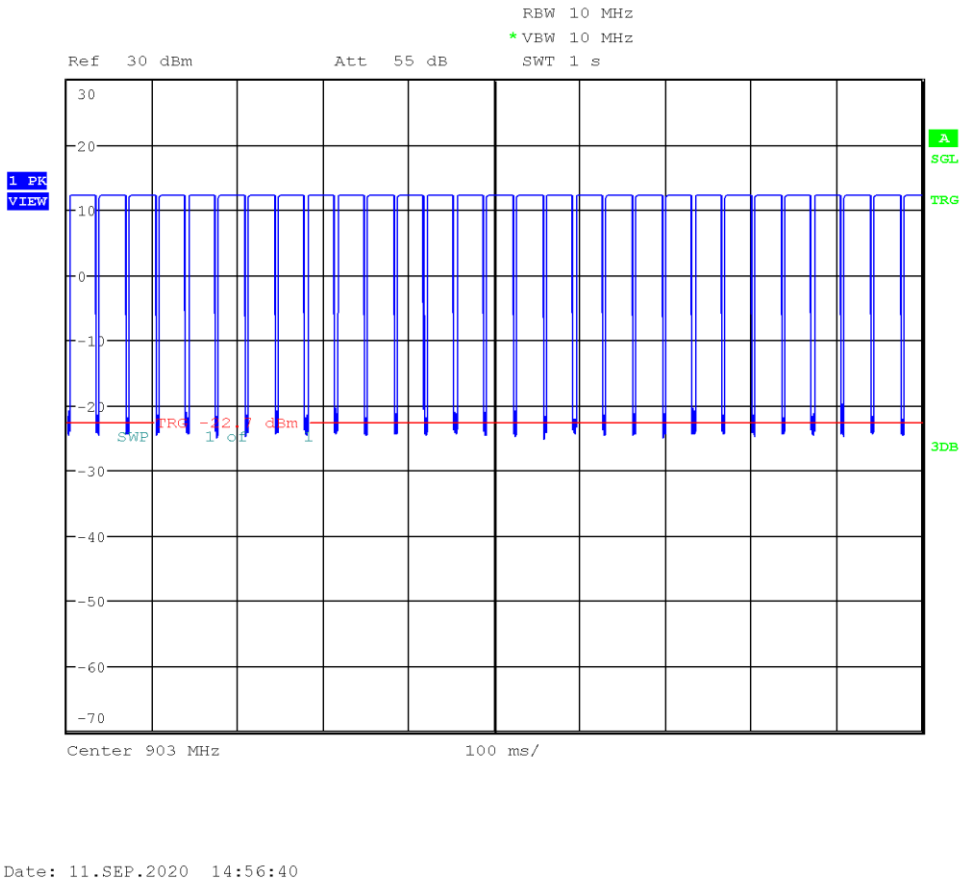
Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-11
Note:	SF8
Duty Cycle Period:	100
Maximum Duty Cycle:	0.82
Maximum Duty Cycle [%]:	82
Duty Cycle Correction [dB]:	-1.72



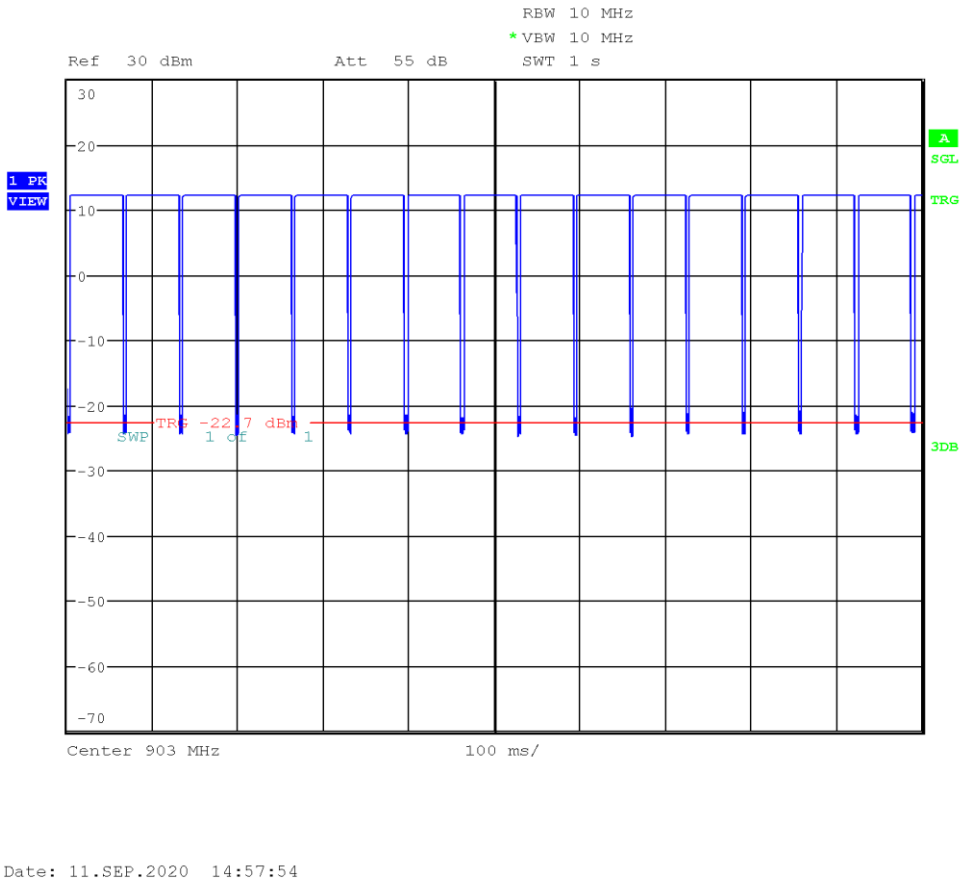
Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-11
Note:	SF9
Duty Cycle Period:	100
Maximum Duty Cycle:	0.93
Maximum Duty Cycle [%]:	93
Duty Cycle Correction [dB]:	-0.63



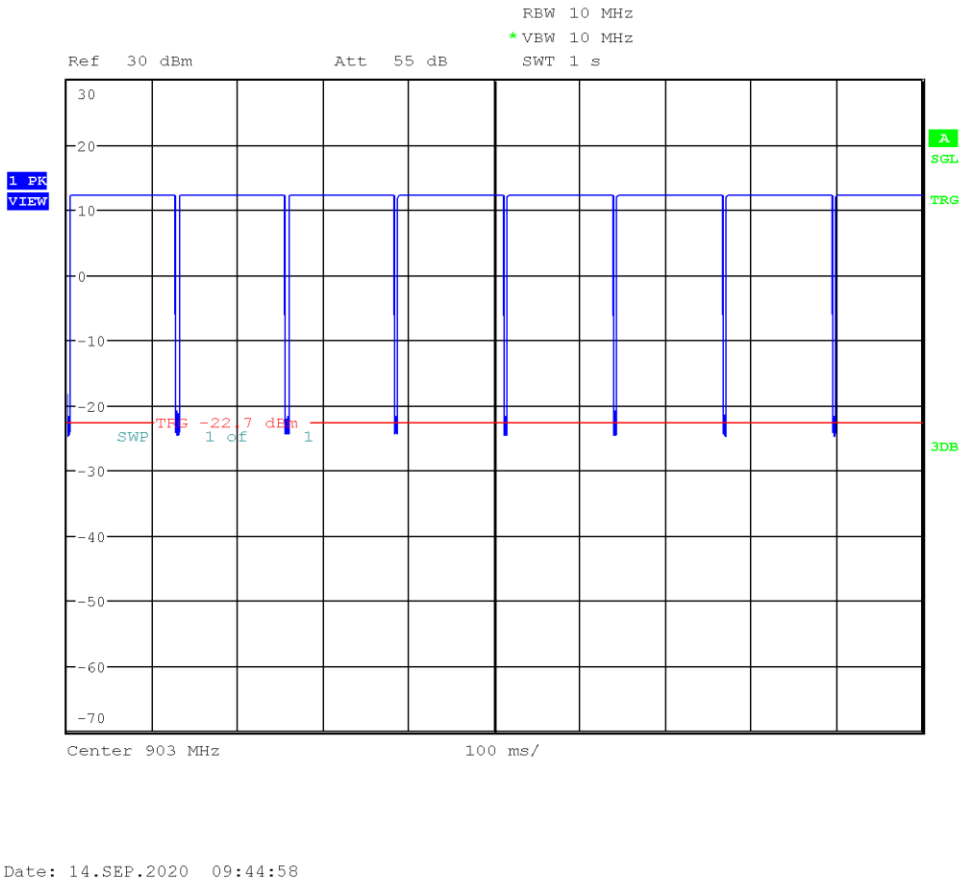
Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-11
Note:	SF10
Duty Cycle Period:	100
Maximum Duty Cycle:	0.96
Maximum Duty Cycle [%]:	96
Duty Cycle Correction [dB]:	-0.35



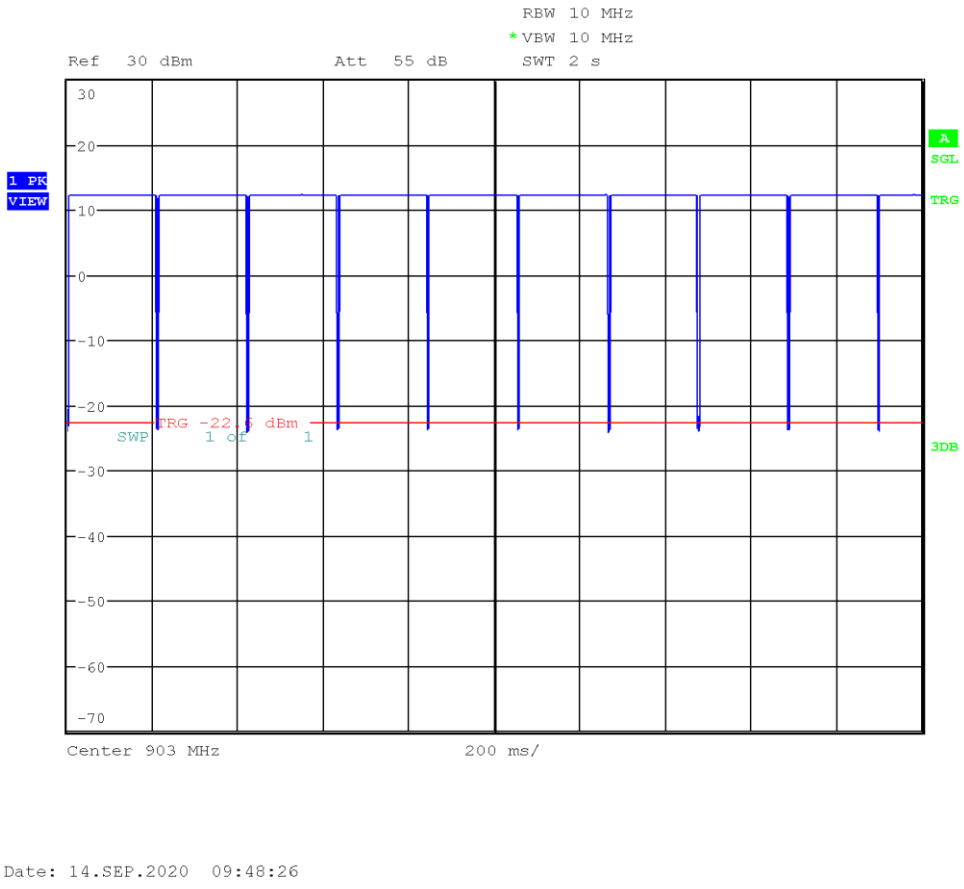
Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-14
Note:	SF11
Duty Cycle Period:	1000
Maximum Duty Cycle:	0.97
Maximum Duty Cycle [%]:	97
Duty Cycle Correction [dB]:	-0.26



Duty Cycle

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	30959
Reference Standards:	ANSI C63.10:2013
Reference Method:	ANSI C63.10:2013, Section 7.5
Operating Frequency:	903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-09-14
Note:	SF12
Duty Cycle Period:	1000
Maximum Duty Cycle:	0.99
Maximum Duty Cycle [%]:	99
Duty Cycle Correction [dB]:	-0.09



1.6 Test Modes

Mode	Description
Mode 1	Mode = Transmit single frequency Modulation = LORA Bandwidth = 500 kHz (software setting) Power = 15 (software setting) Coding rate = 1 (software setting) Delay = unused (software setting) Spreading Factor = 7 (software setting) Duty cycle = 73 %
Mode 2	Mode = Transmit single frequency Modulation = LORA Bandwidth = 500 kHz (software setting) Power = 15 (software setting) Coding rate = 1 (software setting) Delay = unused (software setting) Spreading Factor = 12 (software setting) Duty cycle = 99 %
Mode 3	Mode = Transmit single frequency Modulation = LORA Bandwidth = 125 kHz (software setting) Power = 15 (software setting) Coding rate = 1 (software setting) Delay = unused (software setting) Spreading Factor = 7 (software setting) Duty cycle = 73 %
Mode 4	Mode = Transmit single frequency Modulation = LORA Bandwidth = 125 kHz (software setting) Power = 15 (software setting) Coding rate = 1 (software setting) Delay = unused (software setting) Spreading Factor = 12 (software setting) Duty cycle = 99 %
Mode 5	Mode = Transmit hopping mode Modulation = LORA Bandwidth = 125 kHz (software setting) Power = 15 (software setting) Coding rate = 1 (software setting) Delay = unused (software setting) Spreading Factor = 12 (software setting) Duty cycle = 9 %
Receive	Mode = Receive Modulation = LORA Bandwidth = 500 kHz (software setting) Coding rate = 1 (software setting) Spreading Factor = 7 (software setting)
Comment: Test mode selection was based on pre-compliance measurement of all operational modes. The operational Mode 1 and Mode 3 with spreading factor 7 were selected for bandwidth based compliance tests. The Mode 2, 4 were selected for power based compliance tests because of the max. output power and the max. duty cycle.	

1.7 Test Frequencies

Designator	LoRa 500kHz	Channel	Frequency [MHz]
F1	Tx	0	903.0
F2	Tx	4	909.4
F3	Tx	7	914.2
F4	Rx	3	925.1

Designator	LoRa 125kHz	Channel	Frequency [MHz]
F5	Tx	0	902.3
F6	Tx	32	908.7
F7	Tx	64	914.9

1.8 Sample emission level calculation

The following is a description of terms and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBµV. Any external preamplifiers used are taken into account through internal analyzer settings.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strengths to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. Cable losses have been included with the A.F. to simplify the calculations. The antenna factor is used in calculations as follows:

Reading on Analyzer (dBµV) + A.F. (dB/m) = Net field strength (dBµV/m)

Net:

This is the net field strength measurement (as shown above).

Limit:

This is the FCC Class B radiated emission limit (in units of dBµV/m). The FCC limits are given in units of µV/m. The following formula is used to convert the units of µV/m to dBµV/m:

Limit (dBµV/m) = 20*log (µV/m)

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example only:

Reading + AF	= Net Reading	:	Net reading - FCC limit	= Margin
+21.5 dBµV + 26 dB/m	= 47.5 dBµV/m	:	47.5 dBµV/m - 57.0 dBµV/m	= -9.5 dB

2 Result Summary

FCC 47 CFR Part 15C, ISED RSS-247				
Product Standard Reference	**Requirement**	**Reference Method**	**Result**	**Remarks**
ISED RSS-Gen, Issue 5 (section 6.6)	Occupied Bandwidth	ANSI C63.10-2013	N/R	Informational only
FCC § 15.247(a)(2) ISED RSS-247, Issue 2 (section 5.2)	6 dB Bandwidth	ANSI C63.10-2013	N/R	No requirement for hybrid systems
FCC § 15.247(b)(3) ISED RSS-247, Issue 2 (section 5.4)	Maximum average conducted power	ANSI C63.10-2013	PASS	
FCC § 15.247(e) ISED RSS-247, Issue 2 (section 5.2)	Power spectral density	ANSI C63.10-2013	PASS	
FCC § 15.247(a)(1) ISED RSS-247 § 5.1 Issue 2	20 dB Bandwidth	ANSI C63.10-2013	PASS	
FCC § 15.247(a)(1)(i) ISED RSS-247, Issue 2 (section 5.1)	Number of hopping frequencies	ANSI C63.10-2013	N/R	No requirement for hybrid systems
FCC § 15.247(a)(1) ISED RSS-247, Issue 2 (section 5.1)	Frequency hopping channel separation	ANSI C63.10-2013	PASS	
FCC § 15.247(a)(1)(i) ISED RSS-247, Issue 2 (section 5.1)	Time of occupancy (Dwell time)	ANSI C63.10-2013	PASS	
FCC § 15.207 ISED RSS-247, Issue 2 (section 3.1)	AC power line conducted emissions	ANSI C63.10-2013	N/R	Not powered (directly or indirectly) via AC-Mains
FCC § 15.247(d) ISED RSS-247, Issue 2 (section 5.5)	Band edge compliance	ANSI C63.10-2013	PASS	
FCC § 15.247(d) ISED RSS-247, Issue 2 (section 5.5)	Conducted spurious emissions	ANSI C63.10-2013	PASS	
FCC § 15.247(d) FCC § 15.209 ISED RSS-Gen, Issue 5 (section 6.13)	Transmitter radiated spurious emissions	ANSI C63.10-2013	PASS	
ISED RSS-247, Issue 2 (section 3.1)	Receiver radiated spurious emissions	ANSI C63.10-2013	PASS	
Comment:				

Possible Test Case Verdicts	
PASS	Test object does meet the requirements
FAIL	Test object does not meet the requirements
N/T	Required by standard but not tested
N/R	Not required by standard for the test object

3 Test Conditions and Results

3.1 Test Conditions and Results - Occupied bandwidth

3.1.1 Information

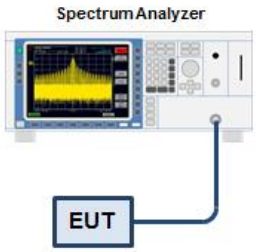
Test Information	
Reference	ISED RSS-Gen, Issue 5 (section 6.6)
Measurement Method	ANSI C63.10 6.9.3
Measurement Uncertainty:	± 1.26 %
Operator	Wilfried Treffke
Date	2020-12-15

3.1.2 Limits

Limits
None (Informational only)

3.1.3 Setup

Test Setup



3.1.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 3	EF00241	2019-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.1.5 Procedure

Test Procedure

1. EUT transmitter is activated in test mode under normal conditions
2. The spectrum analyzer is set to peak detection and maximum hold with a span twice the emission spectrum
3. The resolution bandwidth is set to the range of 1 % to 5 % of the occupied bandwidth
4. The occupied bandwidth is measured with the build-in analyzer function

3.1.6 Results

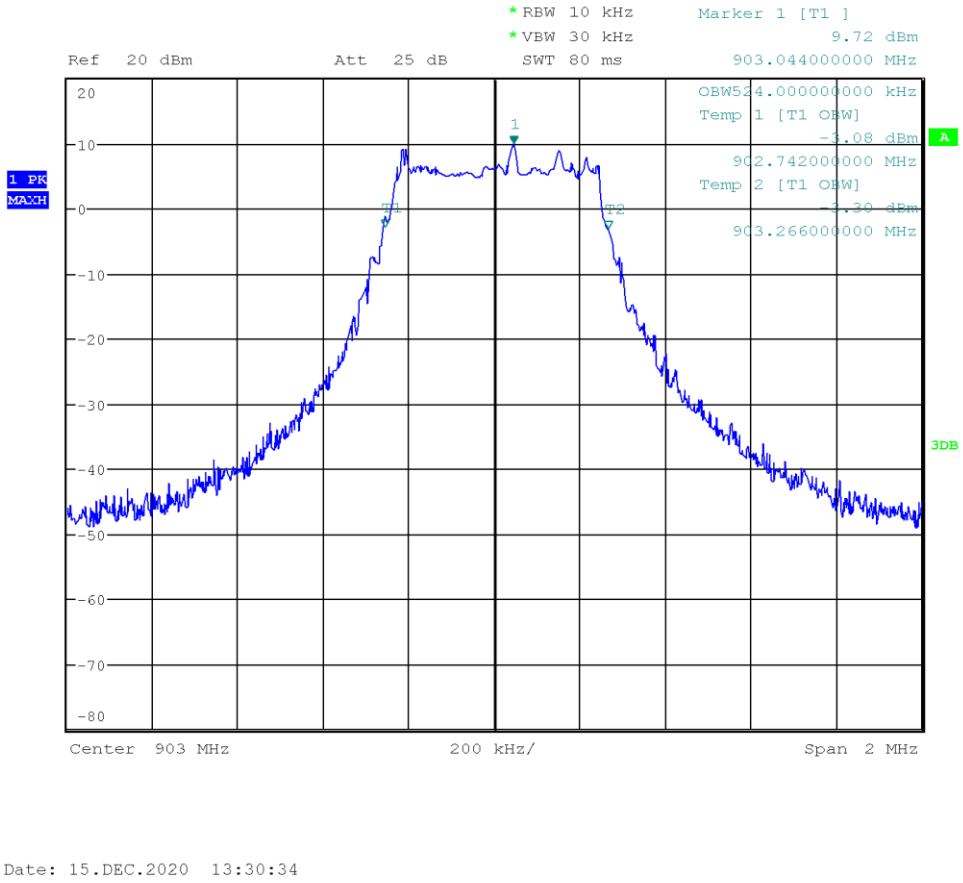
Test Results various Spreading Factors (preselection test mode)		
Mode	Frequency [MHz]	Bandwidth [MHz]
SF7	903.0	**0.524**
SF8	903.0	0.504
SF9	903.0	0.504
SF10	903.0	0.501
SF11	903.0	0.504
SF12	903.0	0.507

Test Results – Mode 1		
Mode	Frequency [MHz]	Bandwidth [MHz]
Transmit	903.0	**0.524**
Transmit	909.4	0.514
Transmit	914.2	0.516

Test Results – Mode 3		
Mode	Frequency [MHz]	Bandwidth [MHz]
Transmit	902.3	0.127
Transmit	908.7	0.129
Transmit	914.9	0.128

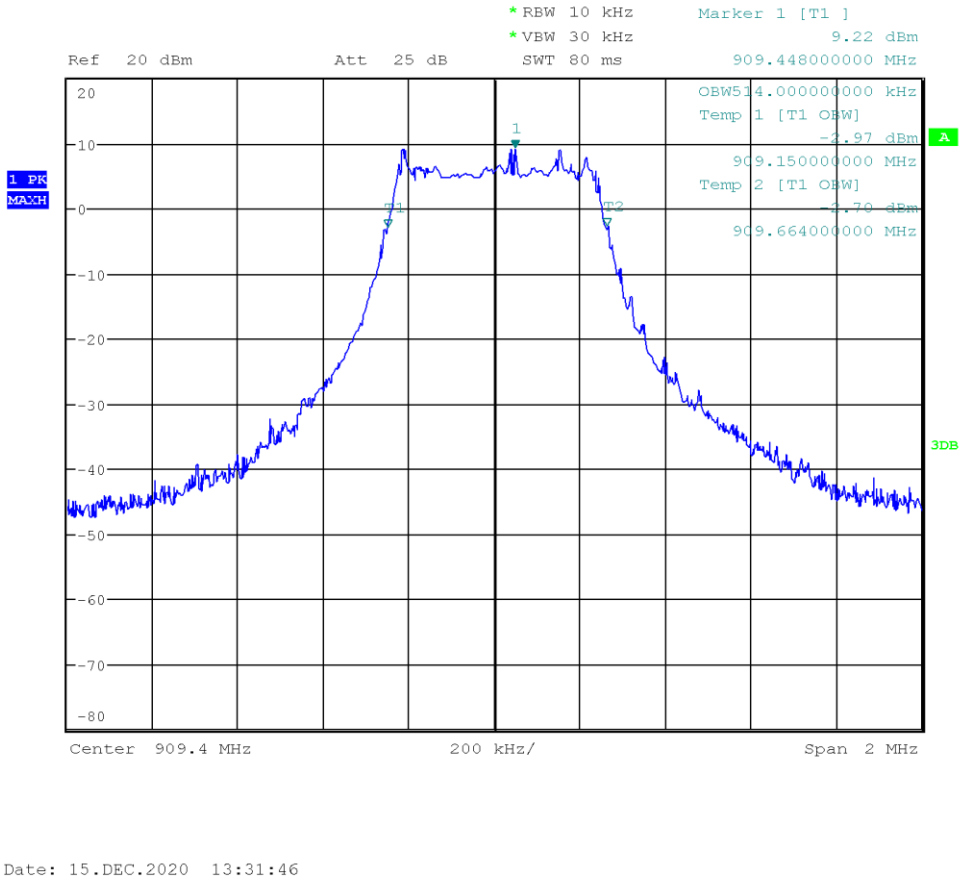
Occupied Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 500 kHz, SF7, Channel: 903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.524



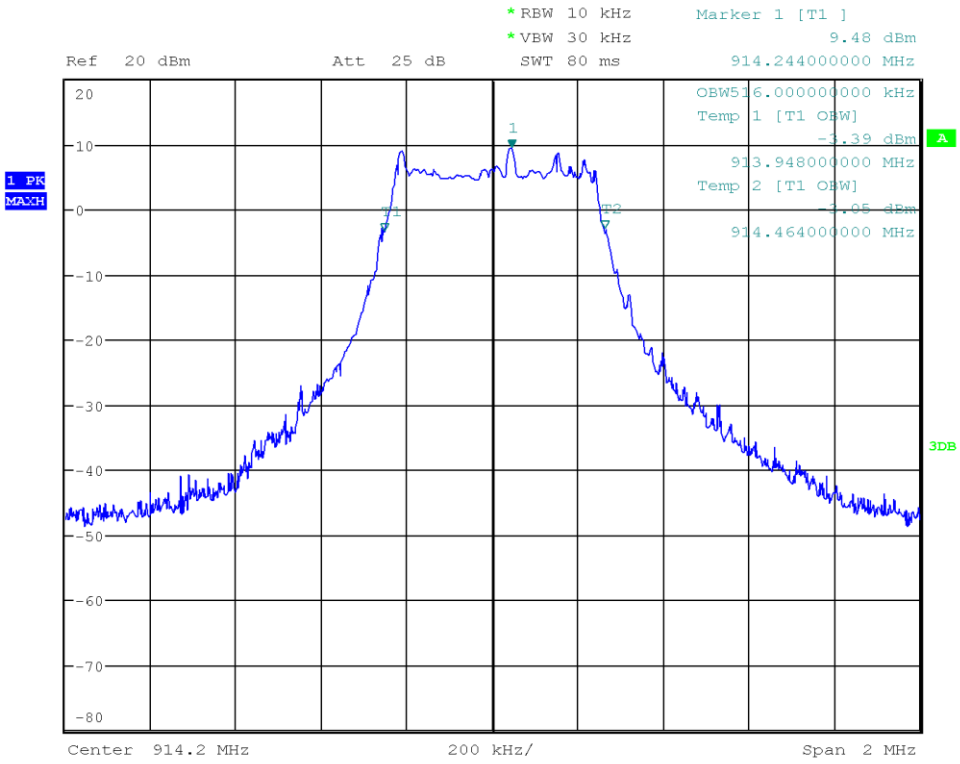
Occupied Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 500 kHz, SF7, Channel: 909.4 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.514



Occupied Bandwidth

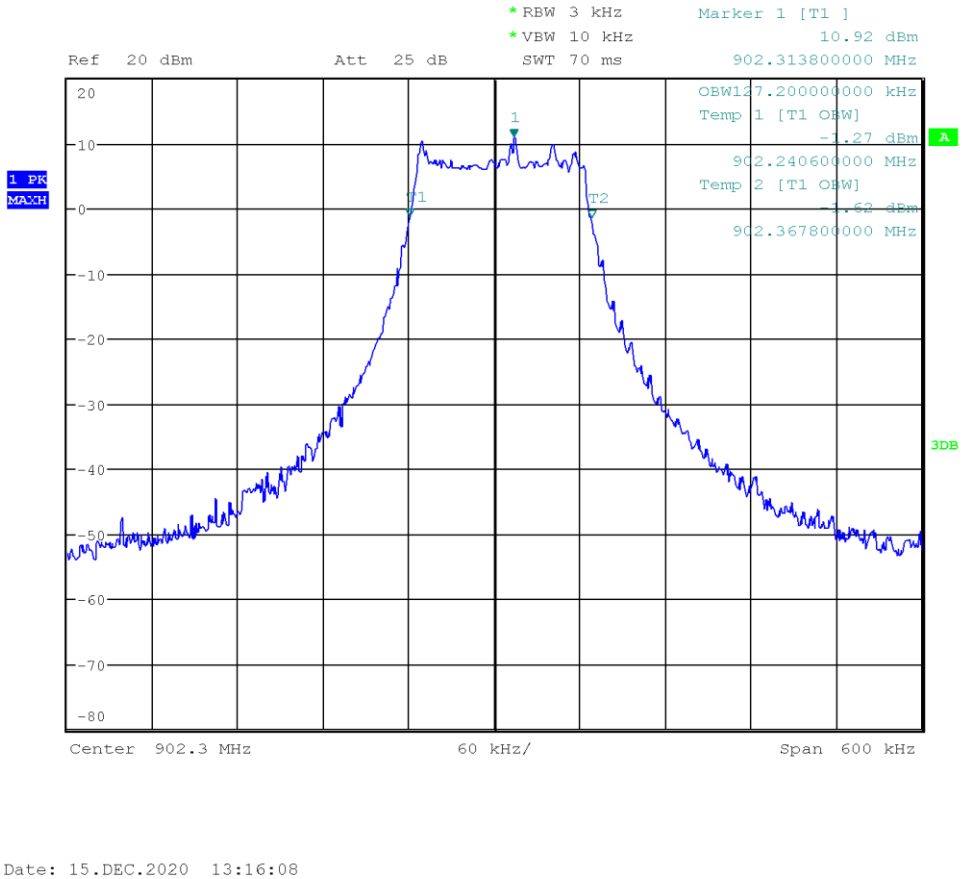
Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 500 kHz, SF7, Channel: 914.2 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.516



Date: 15.DEC.2020 13:33:29

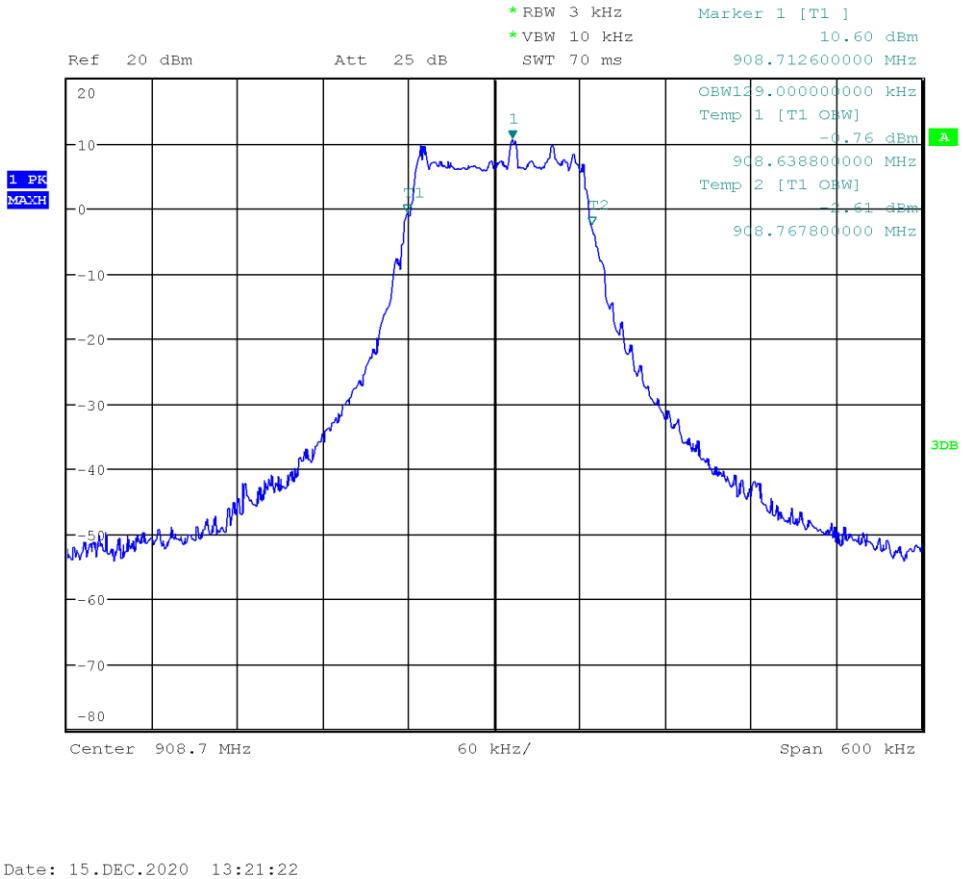
Occupied Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 125 kHz, SF7, Channel: 902.3 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.127



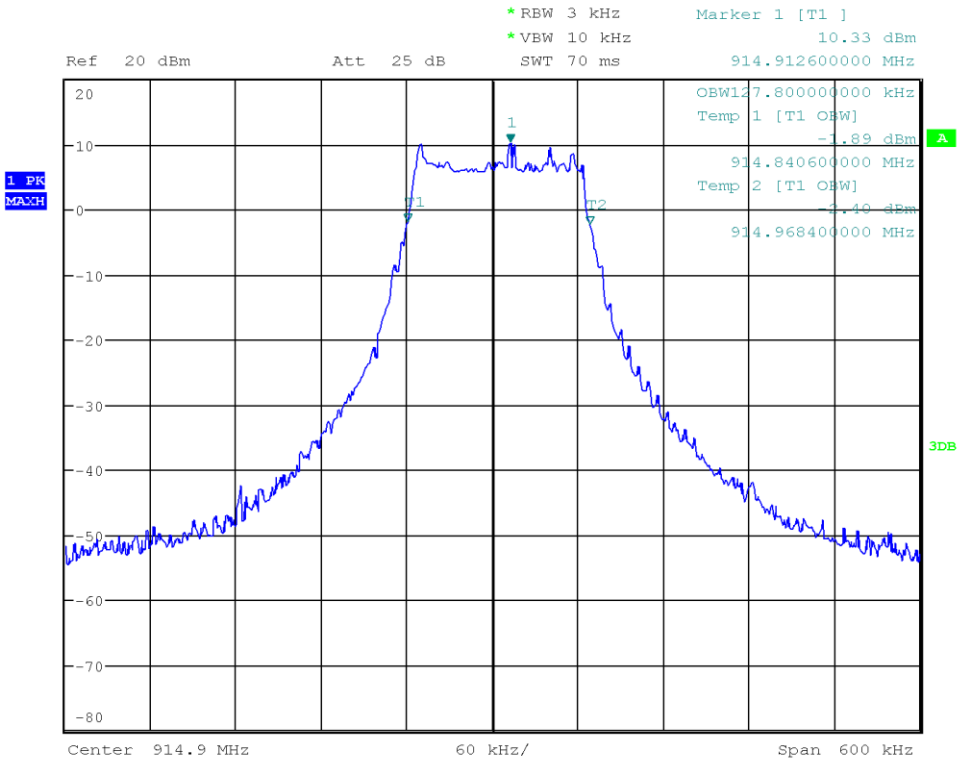
Occupied Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 125 kHz, SF 7, Channel: 908.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.129



Occupied Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.3
Operational Mode:	LoRa 125 kHz, SF 7, Channel: 914.9 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Occupied Bandwidth [MHz]:	0.128



Date: 15.DEC.2020 13:23:08

3.2 Test Conditions and Results - Maximum average conducted output power

3.2.1 Information

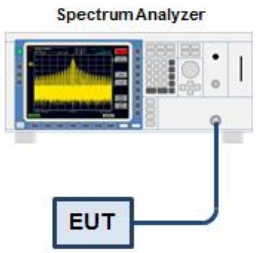
Test Information	
Reference	FCC § 15.247(b)(3); ISED RSS-247, Issue 2 (section 5.4)
Measurement Method	ANSI C63.10 11.9.2.2.3
Measurement Uncertainty:	± 0.66 dB
Operator	Wilfried Treffke
Date	2020-12-14

3.2.2 Limits

Limits
1 W (30 dBm)
The conducted output power limit specified above is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in the table, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2.3 Setup

Test Setup



3.2.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 26	EF01003	2020-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.2.5 Procedure

Test Procedure
1. A spectrum analyzer is connected to antenna port of the EUT 2. RWB is > 20 dB bandwidth 3. EUT transmitter is activated in test mode under normal conditions 4. The maximum power level is determined

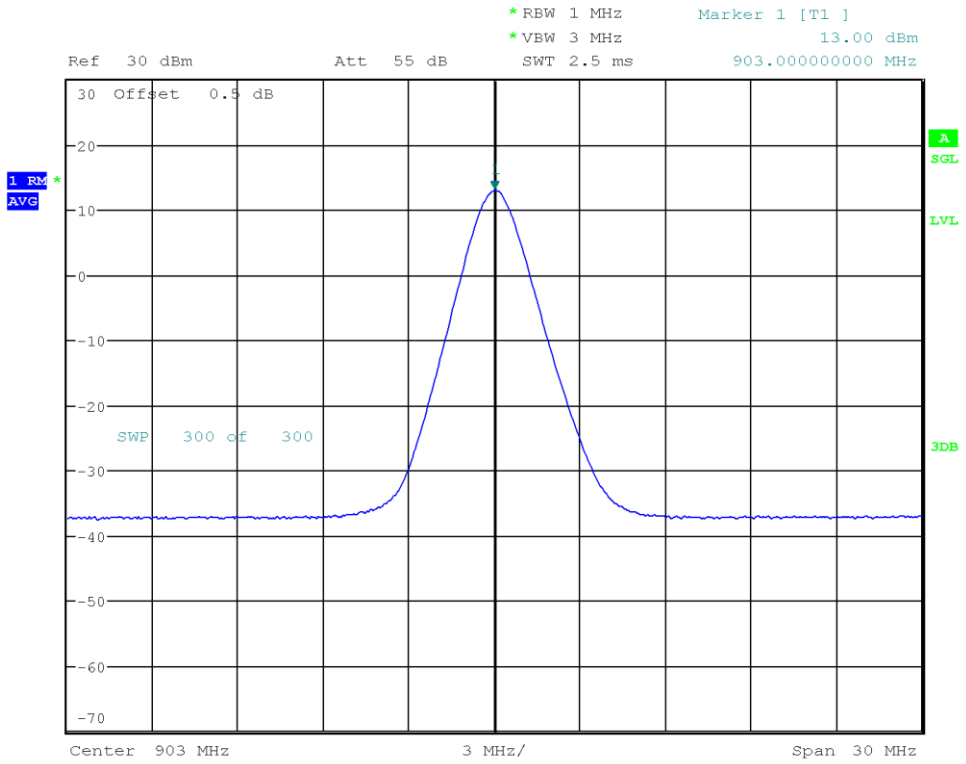
3.2.6 Results

Test Results – Mode2				
Channel [MHz]	Power [dBm]	Power [W]	Limit [W]	Verdict
903.0	13.000	0.0200	1.0	PASS
909.4	13.089	0.0204	1.0	PASS
914.2	**13.675**	**0.0233**	1.0	PASS

Test Results – Mode4				
Channel [MHz]	Power [dBm]	Power [W]	Limit [W]	Verdict
902.3	**14.544**	**0.0285**	1.0	PASS
908.7	13.785	0.0239	1.0	PASS
914.9	14.348	0.0272	1.0	PASS

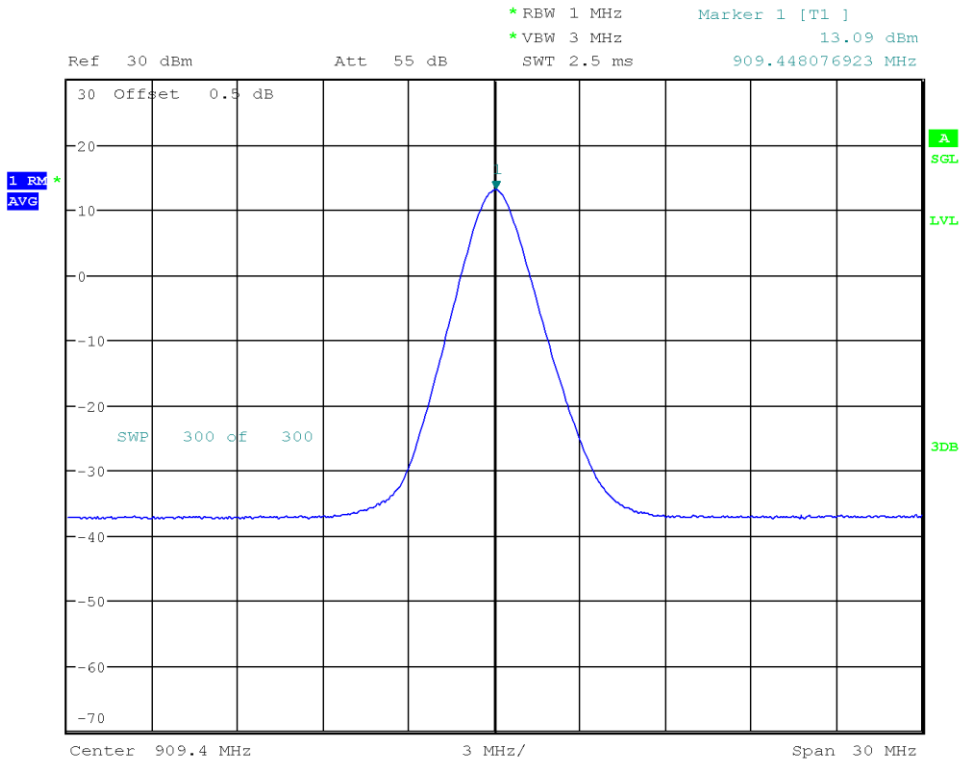
Maximum Conducted Average Output Power

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, Channel: 903 MHz, 500kHz, SF12
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Average Power [dBm]:	13.000
Average Power [W]:	0.0200



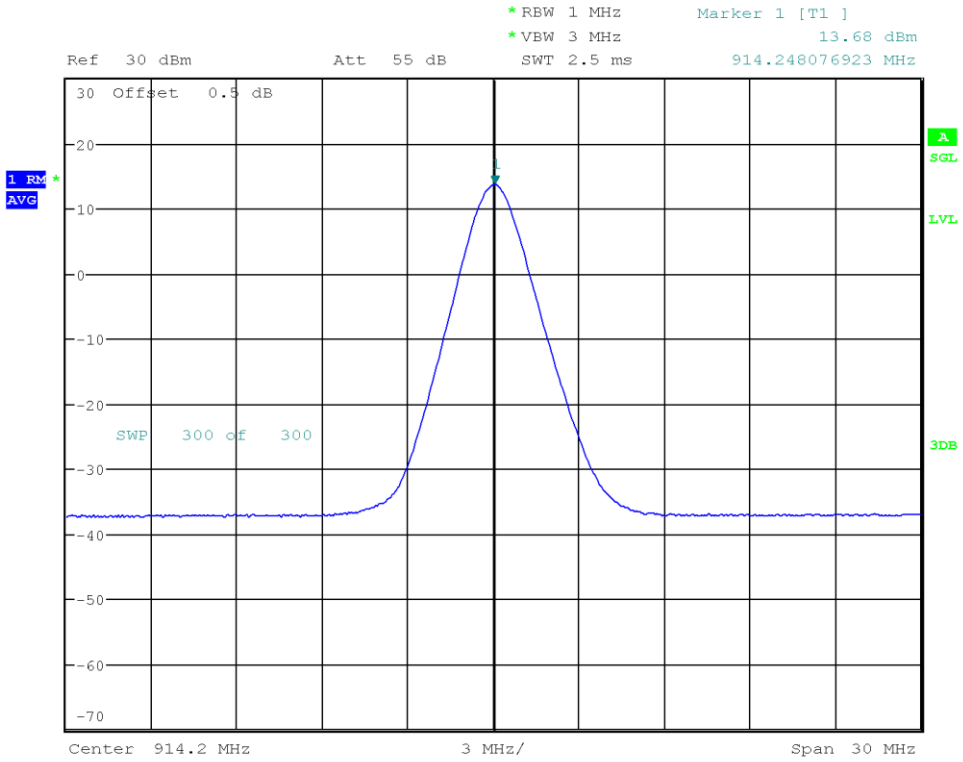
Maximum Conducted Average Output Power

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, Channel: 909.4 MHz, 500kHz, SF12
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Average Power [dBm]:	13.089
Average Power [W]:	0.0204



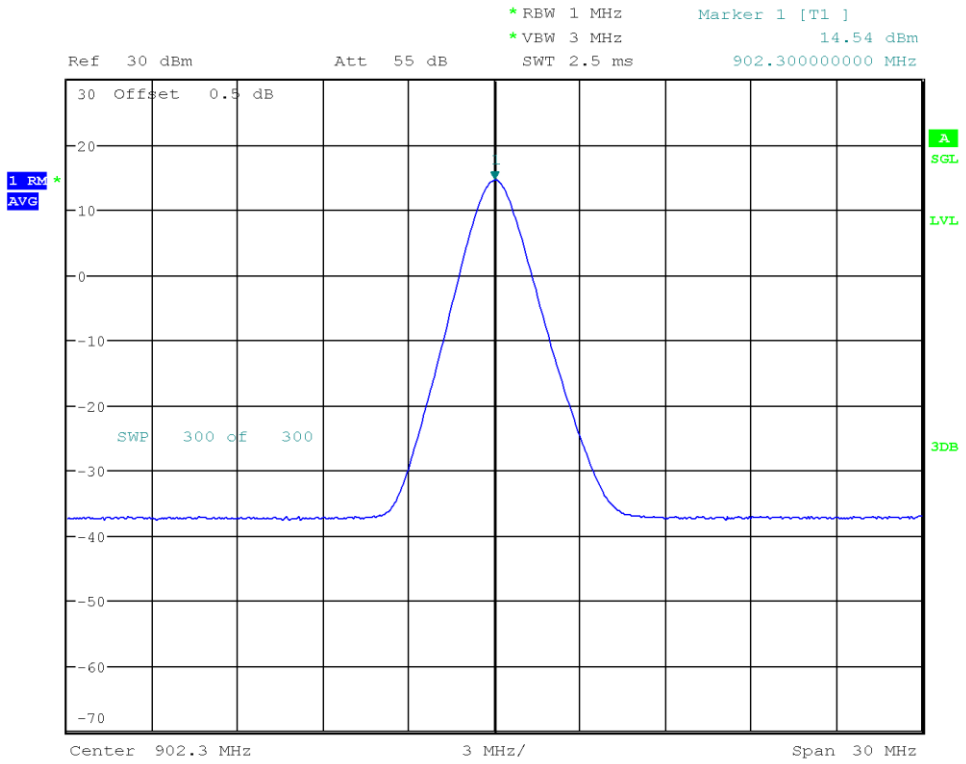
Maximum Conducted Average Output Power

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, Channel: 914.2 MHz, 500kHz, SF12
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Average Power [dBm]:	13.675
Average Power [W]:	0.0233



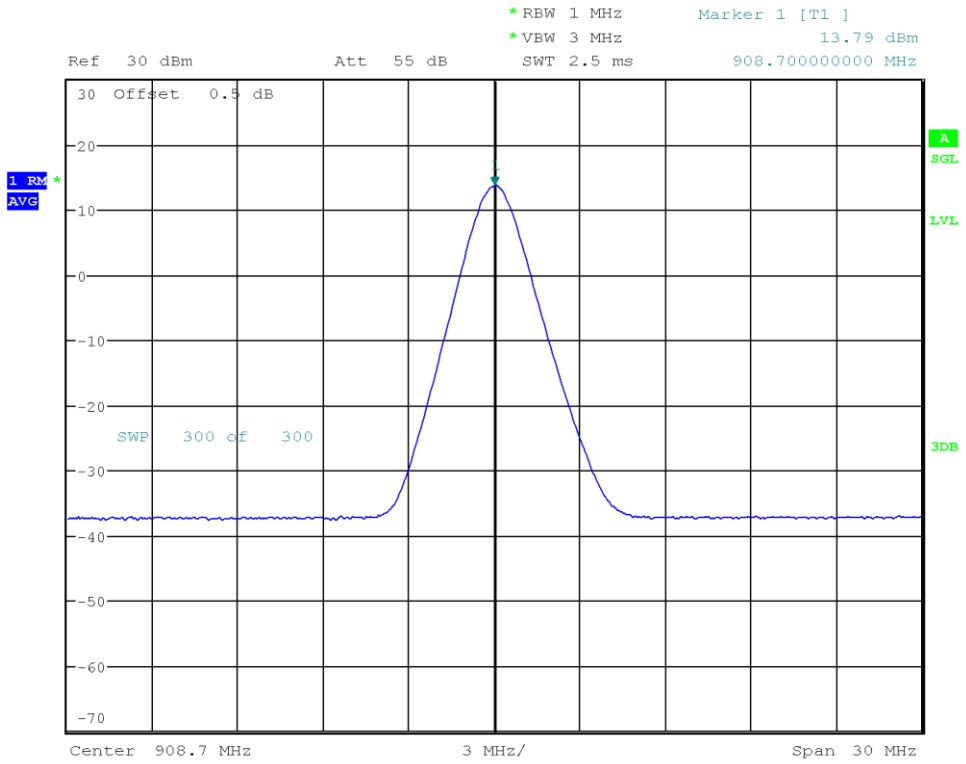
Maximum Conducted Average Output Power

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 902.3 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Average Power [dBm]:	14.544
Average Power [W]:	0.0285



Maximum Conducted Average Output Power

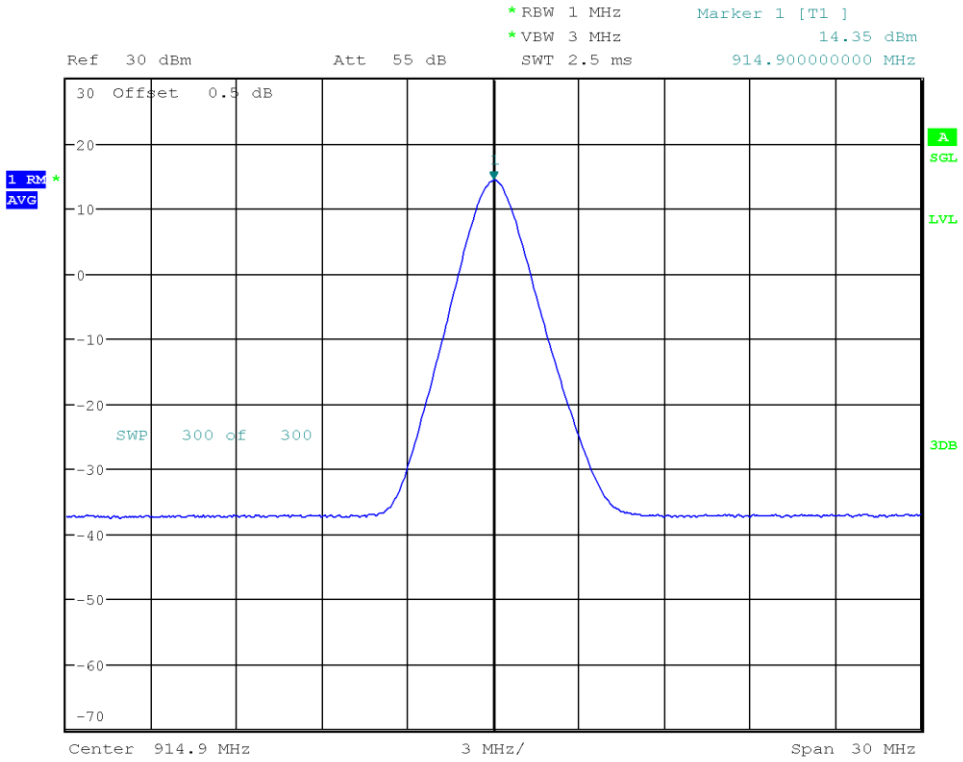
Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 908.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Average Power [dBm]:	13.785
Average Power [W]:	0.0239



Date: 16.DEC.2020 12:10:43

Maximum Conducted Average Output Power

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.9.2.2.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 914.9 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Average Power [dBm]:	14.348
Average Power [W]:	0.0272



3.3 Test Conditions and Results - Power spectral density

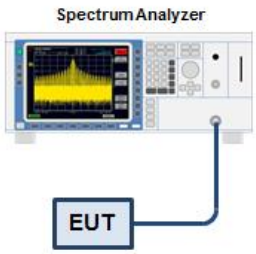
3.3.1 Information

Test Information	
Reference	FCC § 15.247(e); ISED RSS-247, Issue 2 (section 5.2)
Measurement Method	ANSI C63.10 11.10.3, 14.3.2
Measurement Uncertainty:	± 1.73 dB
Operator	Wilfried Treffke
Date	2020-12-14

3.3.2 Limits

Limits
8 dBm / 3 kHz

3.3.3 Setup

Test Setup


3.3.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 3	EF00241	2019-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.3.5 Procedure

Test Procedure
1. EUT set to test mode 2. The analyzer is set to DTS channel center frequency with a span of 1.5 times the DTS bandwidth 3. The RBW is set to 100 kHz with VBW ≥ RBW and the detector is set to RMS with trace averaging over a minimum of 100 traces. 4. After the trace has stabilized a marker is set to the envelope maximum 5. If the power spectral density is above the limit the RBW is reduced (not lower than 3 kHz) and the measurement is repeated 6. If the EUT has more than one transmit chain the procedure is repeated for each transmit chain

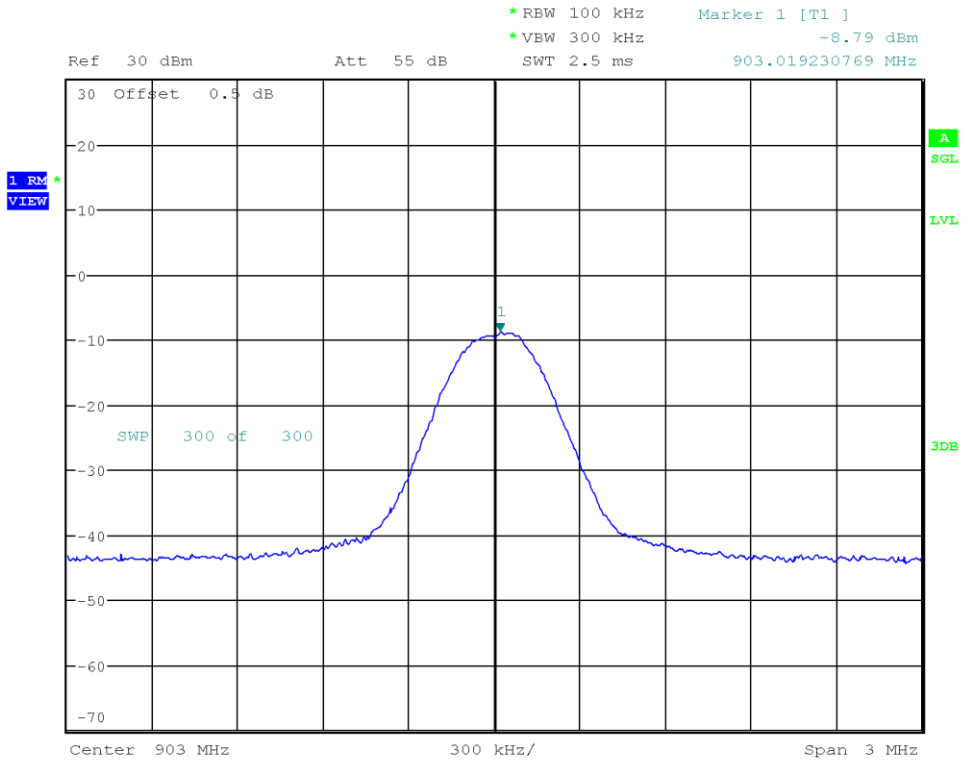
3.3.6 Results

Test Results – Mode 2			
Channel [MHz]	PSD [dBm/RBW]	Limit [dBm/3kHz]	Verdict
903.0	-8.787	8.0	PASS
909.4	-8.676	8.0	PASS
914.2	-7.724	8.0	PASS
RBW = 100 kHz			

Test Results – Mode 4			
Channel [MHz]	PSD [dBm/RBW]	Limit [dBm/3kHz]	Verdict
902.3	0.581	8.0	PASS
908.7	0.630	8.0	PASS
914.9	-0.238	8.0	PASS
RBW = 30 kHz			

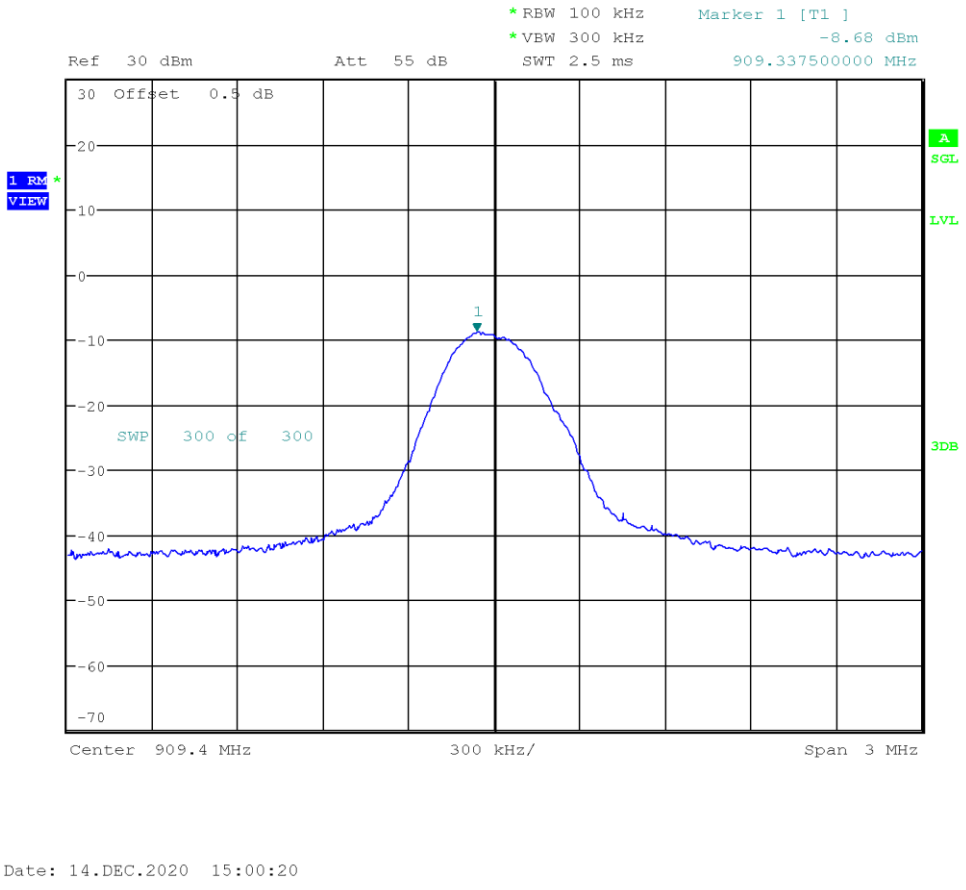
Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa (500kHz), Channel: 903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	903.019
Spectral Density [dBm/RBW]:	-8.787
Resolution Bandwidth [kHz]:	100 kHz



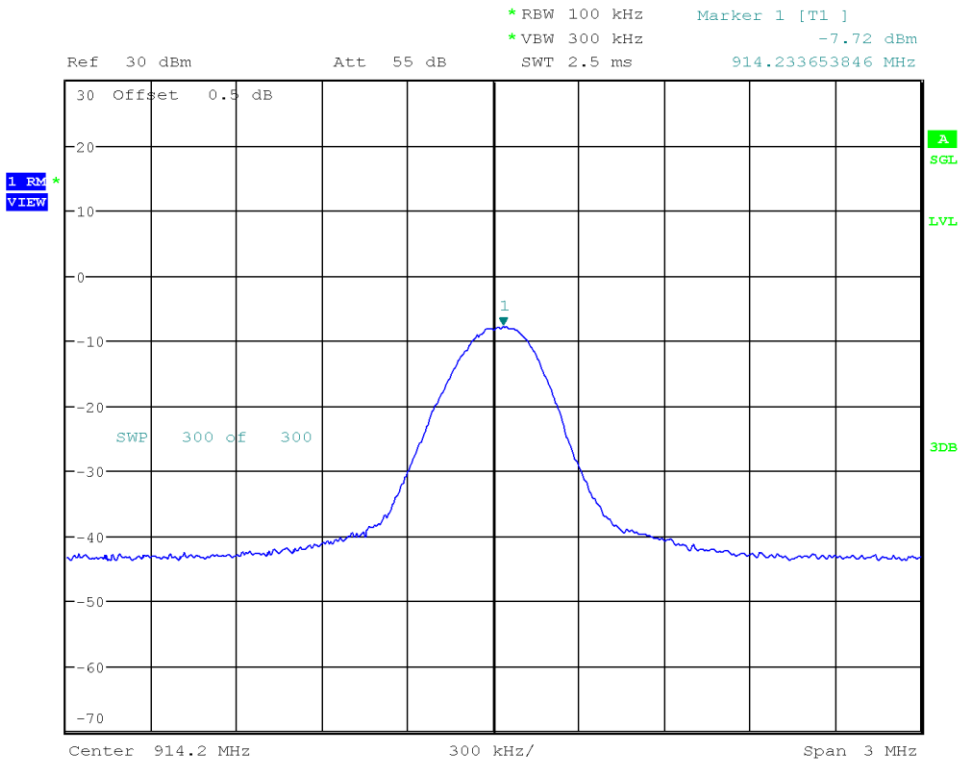
Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa (500kHz), Channel: 909.4 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	909.337
Spectral Density [dBm/RBW]:	-8.676
Resolution Bandwidth [kHz]:	100 kHz



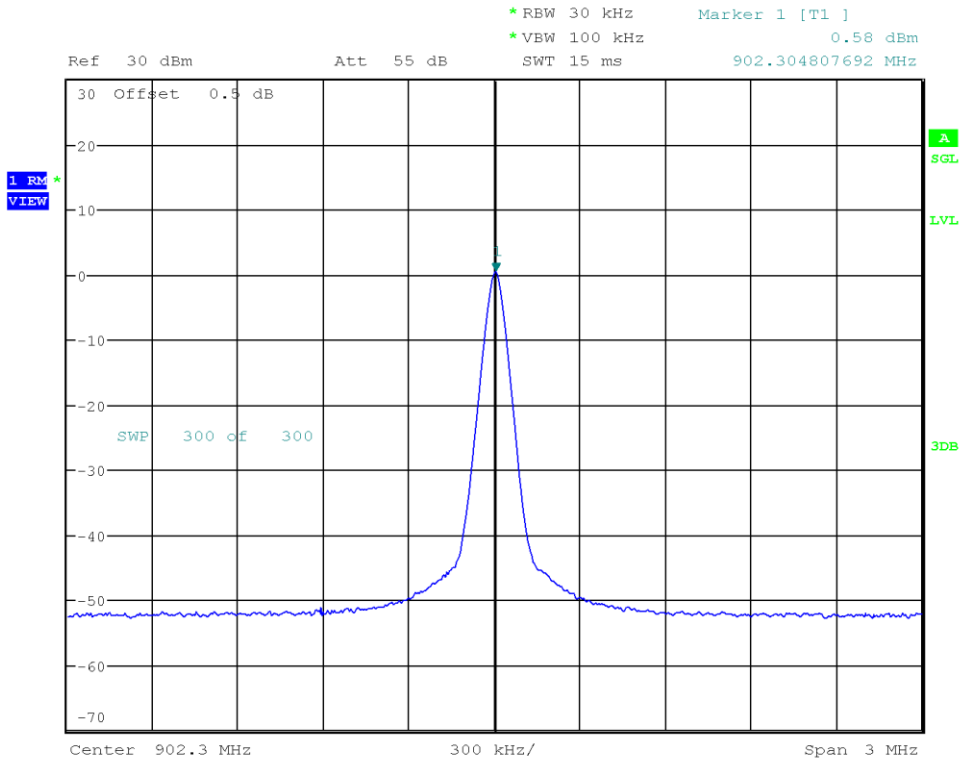
Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa (500kHz), Channel: 914.2 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	914.234
Spectral Density [dBm/RBW]:	-7.724
Resolution Bandwidth [kHz]:	100 kHz



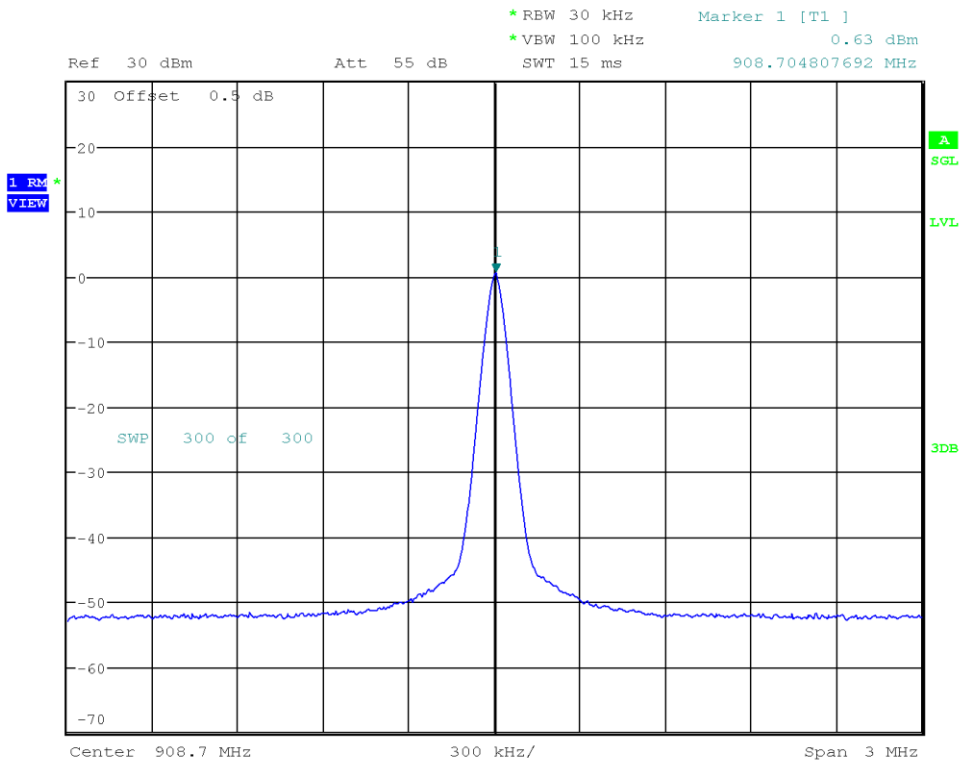
Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 902.3 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	902.305
Spectral Density [dBm/RBW]:	0.581
Resolution Bandwidth [kHz]:	30 kHz



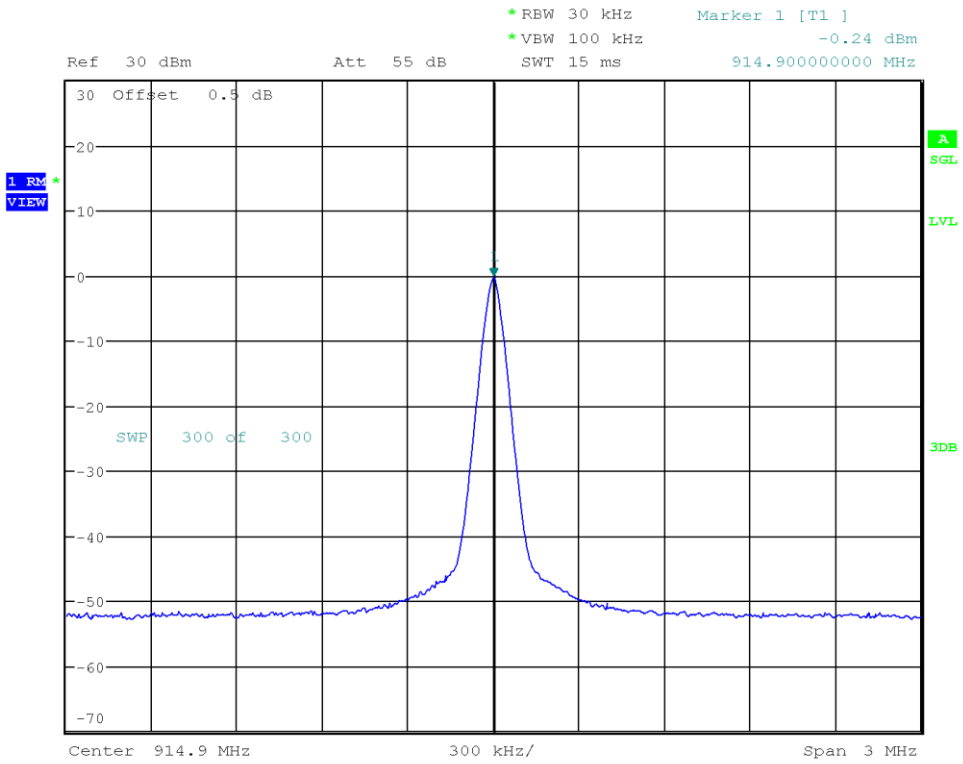
Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 908.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	908.705
Spectral Density [dBm/RBW]:	0.630
Resolution Bandwidth [kHz]:	30 kHz



Average Power Spectral Density

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.10.3
Operational Mode:	LoRa, 125kHz, SF12, Channel: 914.9 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-16
Note:	Based on max. cond. average output power
Peak Frequency [MHz]:	914.900
Spectral Density [dBm/RBW]:	-0.238
Resolution Bandwidth [kHz]:	30 kHz



3.4 Test Conditions and Results - 20 dB bandwidth

3.4.1 Information

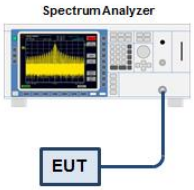
Test Information	
Reference	FCC 15.247(a)(1) / ISED RSS-247 5.1
Measurement Method	ANSI C63.10 6.9.2
Measurement Uncertainty	± 1.26 %
Test Sample ID	32168
Operator	Wilfried Treffke
Date	2020-12-15

3.4.2 Limits

Limits	
Number of hopping channels ≥ 50 (N/A for Hybrid systems) Time of occupancy ≤ 0.4 s within 20 s	20 dB BW < 250 kHz
Number of hopping channels ≥ 25 (N/A for Hybrid systems) Time of occupancy ≤ 0.4 s within 10 s	250 kHz ≤ 20 dB BW < 500 kHz

3.4.3 Setup

Test Setup



3.4.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 26	EF01003	2020-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.4.5 Procedure

Test Procedure

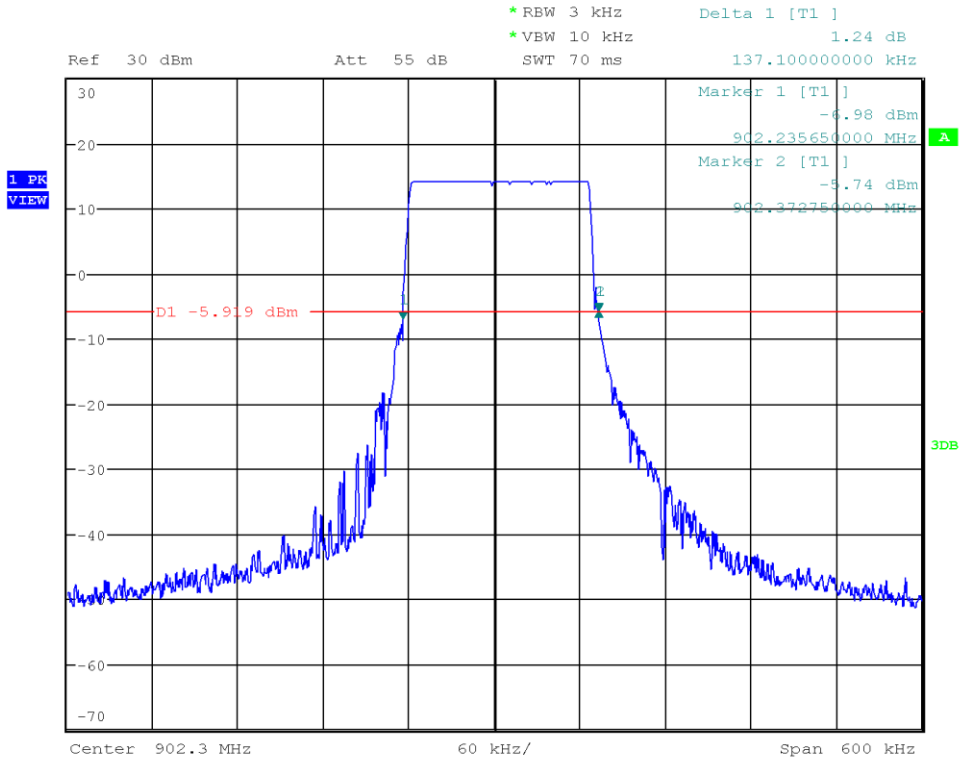
1. EUT set to test mode (Communication tester is used if needed)
2. Span set to at least twice the emission spectrum
3. Detector set to peak and max hold
4. Envelope peak value of emission spectrum is selected
5. Marker on envelope of spectrum is set to level of -20 dB to the left of the peak
6. Marker on envelope of spectrum is set to level of -20 dB to the right of the peak
7. 20dB Bandwidth is determined by marker frequency separation

3.4.6 Results

Test Results		
Mode	Frequency [MHz]	Bandwidth [kHz]
Mode 3	902.3	137
Mode 3	908.7	138
Mode 3	914.9	137

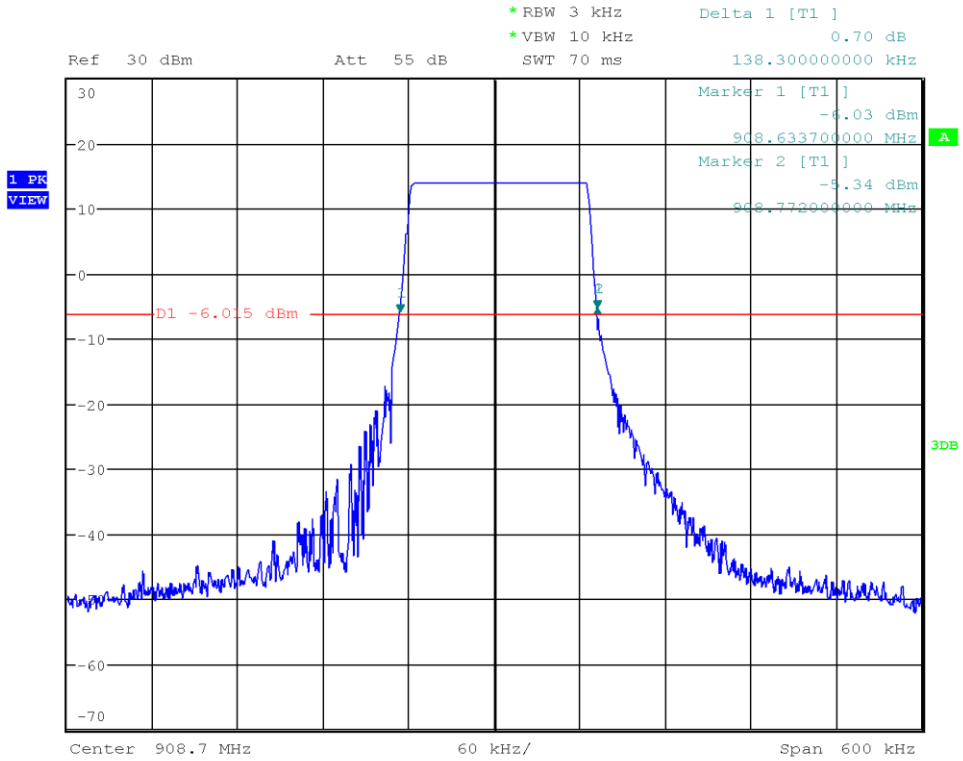
20 dB Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.2
Operational Mode:	LoRa 125kHz, single, Channel: 902.3 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Lower Frequency [MHz]:	902.236
Upper Frequency [MHz]:	902.373
20 dB Bandwidth [kHz]:	137



20 dB Bandwidth

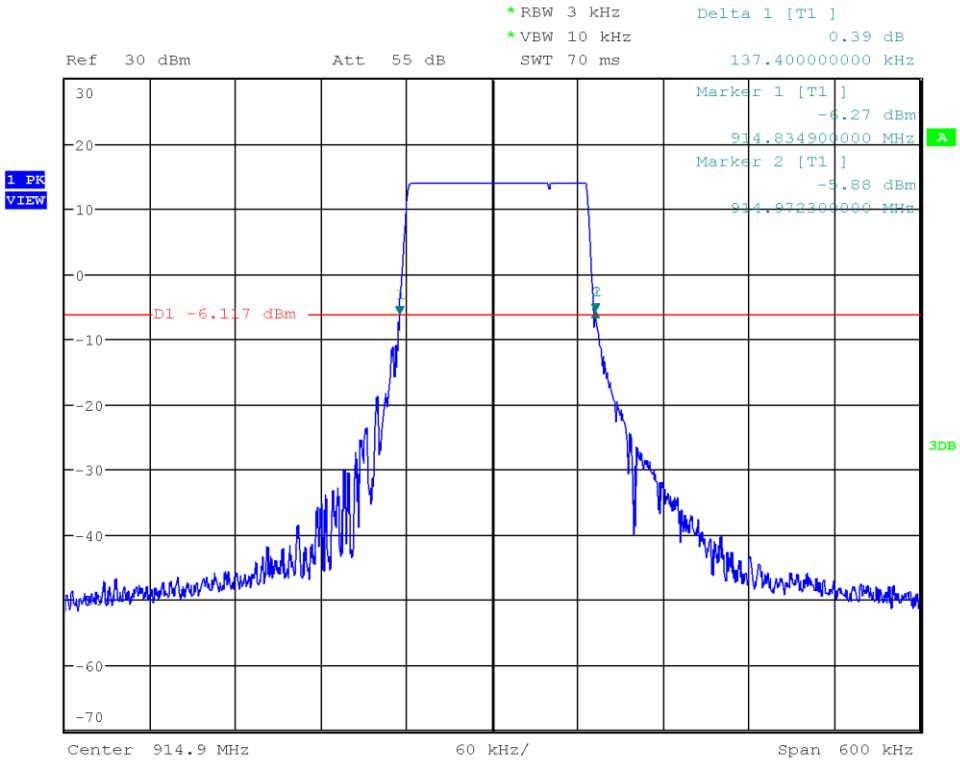
Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.2
Operational Mode:	LoRa 125kHz, single, Channel: 908.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Lower Frequency [MHz]:	908.634
Upper Frequency [MHz]:	908.772
20 dB Bandwidth [kHz]:	138



Date: 15.DEC.2020 13:01:06

20 dB Bandwidth

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.9.2
Operational Mode:	LoRa 125kHz, single, Channel: 914.9 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Lower Frequency [MHz]:	914.835
Upper Frequency [MHz]:	914.972
20 dB Bandwidth [kHz]:	137



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3.5 Test Conditions and Results - Frequency hopping channel separation

3.5.1 Information

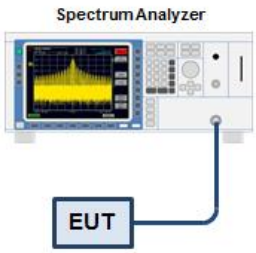
Test Information	
Reference	FCC § 15.247(a)(1); ISED RSS-247, Issue 2 (section 5.1)
Measurement Method	ANSI C63.10 7.8.4
Measurement Uncertainty	± 3.14 %
Operator	Wilfried Treffke
Date	2020-12-15

3.5.2 Limits

Limit
≥ 25 kHz or 20 dB bandwidth, whichever is greater

3.5.3 Setup

Test Setup



3.5.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 26	EF01003	2020-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.5.5 Procedure

Test Procedure

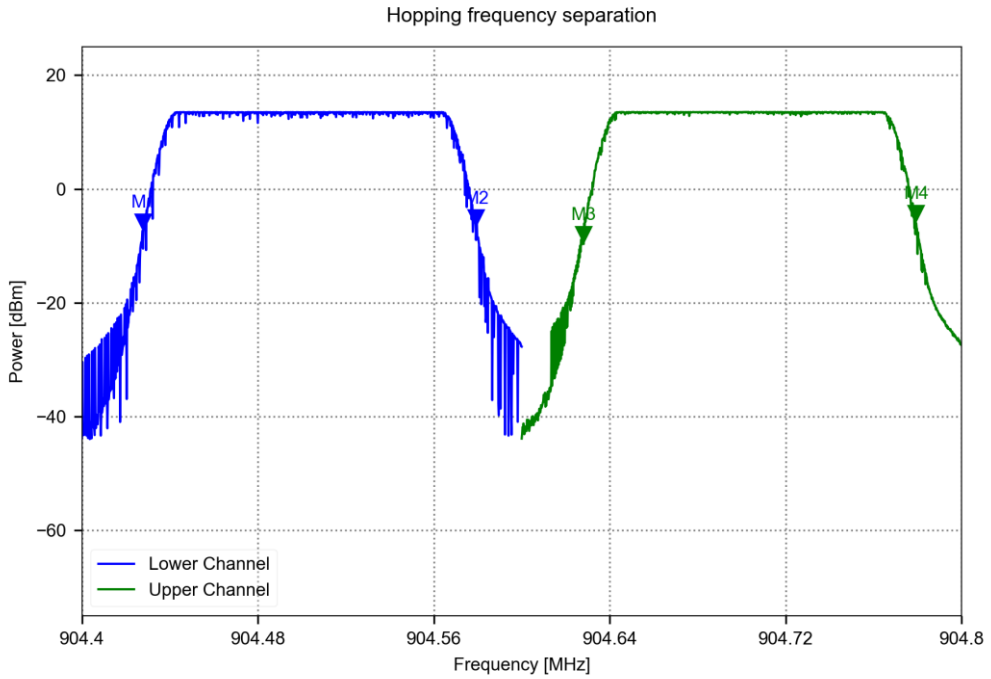
1. EUT set to test mode (Communication tester is used if needed)
2. Span set to measurement frequency range
3. Detector set to peak and max hold
4. Resolution bandwidth is set small enough to resolve hopping channel emission spectra
5. The two adjacent channel peaks are marked
6. Channel separation is determined from frequency separation of markers

3.5.6 Results

Test Results – Mode 5		
Channel separation [kHz]	Limit [kHz]	Verdict
200	≥138	PASS

Hopping frequency separation

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247(a)(1)
Reference Method:	ANSI C63.10:2013 7.8.2
Operational Mode:	LoRa, LoRa 125kHz, Channels: 904.5 + 904.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Lower Frequency (M1) [MHz]:	904.428
Upper Frequency (M2) [MHz]:	904.579
Lower Frequency (M3) [MHz]:	904.628
Upper Frequency (M4) [MHz]:	904.779
Lower center Frequency [MHz]:	904.504
Upper center Frequency [MHz]:	904.704
Hopping Frequency Separation [MHz]:	0.200



3.6 Test Conditions and Results - Time of occupancy (Dwell time)

3.6.1 Information

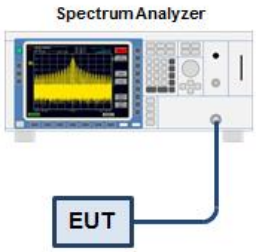
Test Information	
Reference	FCC § 15.247(a)(1)(i); ISED RSS-247, Issue 2 (section 5.1)
Measurement Method	ANSI C63.10 7.8.2
Measurement Uncertainty	± 78.53 %
Operator	Wilfried Treffke
Date	2020-12-15

3.6.2 Limits

Limits	
Condition	Limit
20 dB BW < 250 kHz Number of hopping channels ≥ 50 (N/A for Hybrid systems)	Time of occupancy ≤ 0.4 s within 20 s
250 kHz ≤ 20 dB BW < 500 kHz Number of hopping channels ≥ 25 (N/A for Hybrid systems)	Time of occupancy ≤ 0.4 s within 10 s

3.6.3 Setup

Test Setup



3.6.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 26	EF01003	2020-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.6.5 Procedure

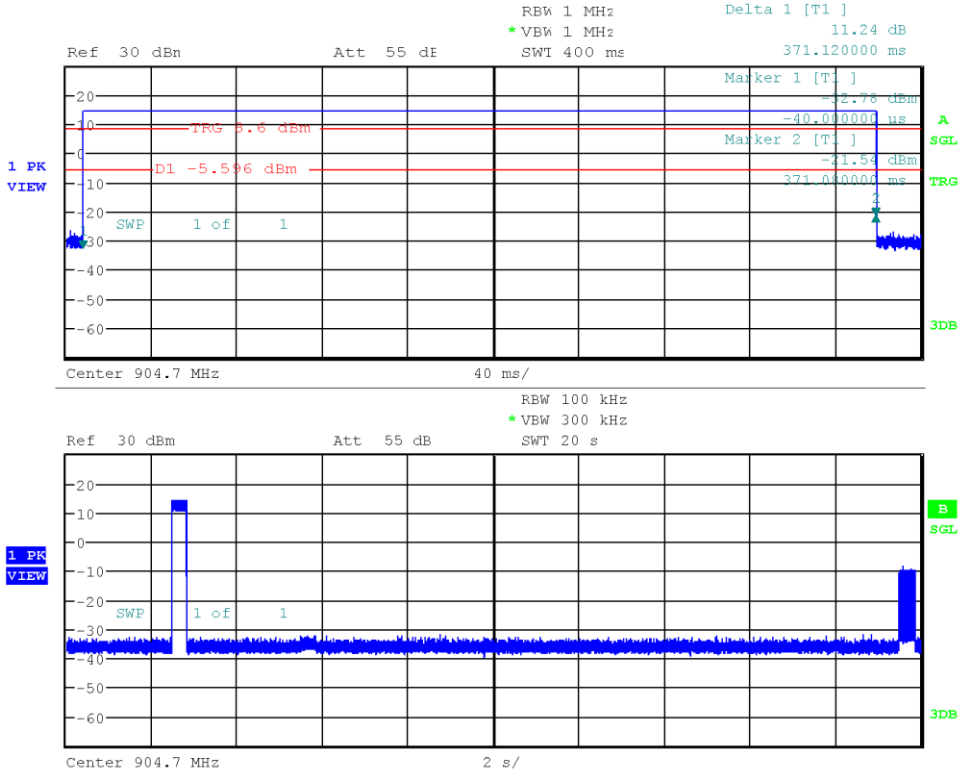
Test Procedure
1. EUT set to test hopping mode (Communication tester is used if needed) 2. Analyzer span is set to zero span 3. Detector set to peak and max hold 4. RBW is set to 100 kHz and VBW to 300 kHz 5. The sweep time is set to capture one single dwell time 6. Trigger is set to video trigger 7. A marker is set to the start and end positions of the burst 8. The dwell time is determined from the marker difference 9. Another sweep is initiated without trigger and sweep time set to the observation time 10. The number of hops is counted 11. The total time of occupancy is calculated from the dwell time per hop multiplied by the number of hops

3.6.6 Results

Test Results – Mode 5					
Observation Period [s]	Number of Hops	Dwell time per Hop [s]	Time of occupancy [s]	Limit [s]	Verdict
20	1	0.37112	0.371	0.4	Pass

Time of occupancy

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Method:	ANSI C63.10:2013 7.8.4
Operational Mode:	LoRa 125kHz, SF12, Hopping mode
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Dwell Time per Hop [ms]:	371.120
Number of Hops:	1
Time of occupancy [s]:	0.371



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3.7 Test Conditions and Results - Band-edge compliance

3.7.1 Information

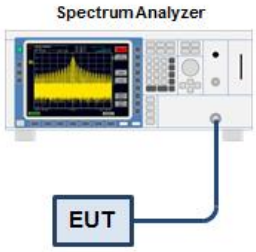
Test Information	
Reference	FCC § 15.247(d); ISED RSS-247, Issue 2 (section 5.5)
Measurement Method	ANSI C63.10 11.13 / 6.10
Measurement Uncertainty:	± 1.80 dB
Operator	Wilfried Treffke
Date	2020-12-14

3.7.2 Limits

Limits	
Power Measurement	Out-of-band attenuation [dB]
Peak	20
RMS	30

3.7.3 Setup

Test Setup



3.7.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSU 3	EF00241	2019-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.7.5 Procedure

Test Procedure

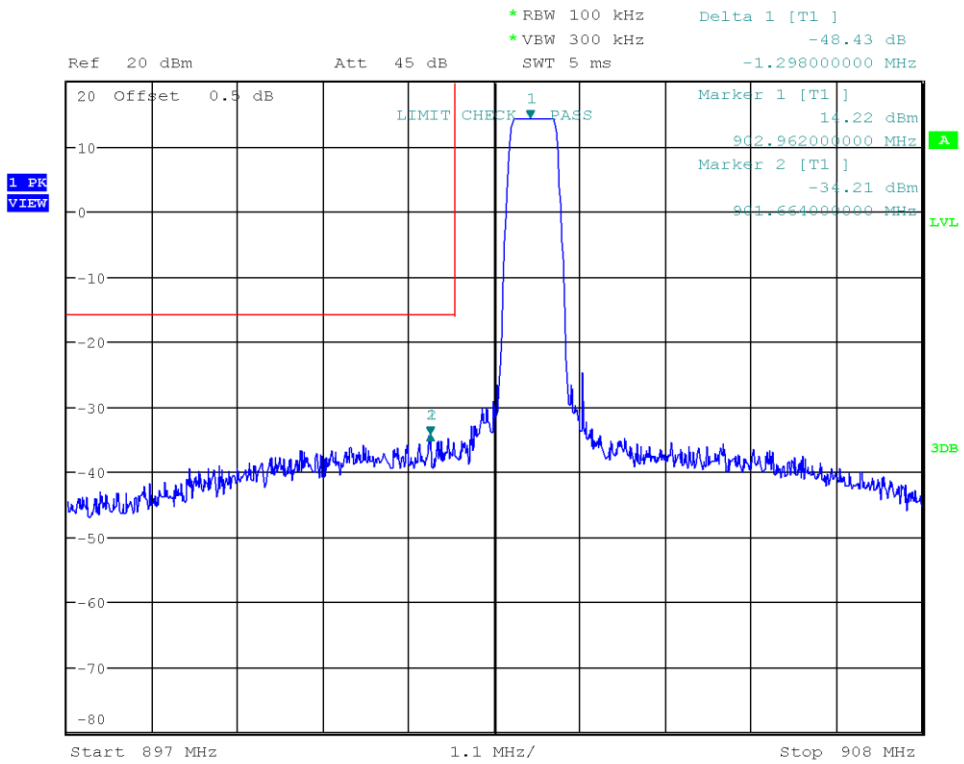
1. EUT set to test mode (Communication tester is used if needed)
2. Span set around lower band edge and detector is set to peak and max hold
3. Resolution bandwidth is set to 100 kHz
4. Markers are set to peak emission levels within frequency band and outside frequency band
5. Band edge attenuation is determined from level difference

3.7.6 Results

Test Results				
Mode	Channel [MHz]	Out-of-band Attenuation [dB]	Limit [dB]	Verdict
Mode 2	903.0	-48.43	-30	PASS
Mode 2	914.2	-56.04	-30	PASS
Mode 5	902.3	-50.67	-30	PASS
Mode 5	914.2	-55.04	-30	PASS

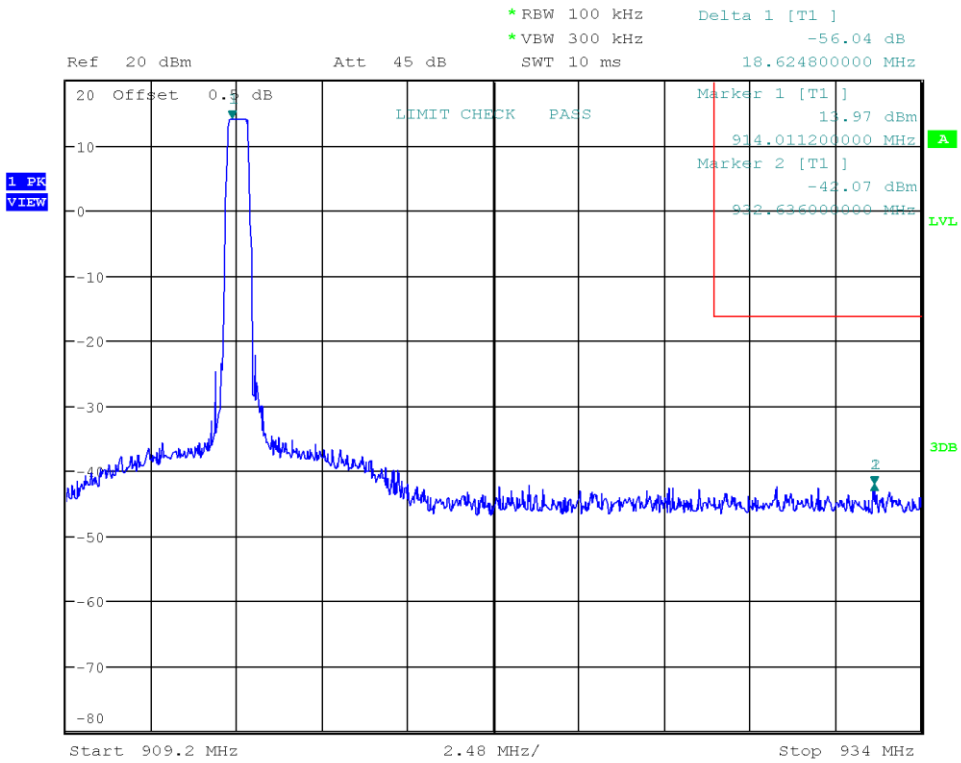
Emissions in non-restricted frequency bands at the Band-edge

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.10
Operational Mode:	Single frequency, Channel: 903.0 MHz, LoRa 500kHz
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on. cond. average output power (limit =-30dBc)
Band-edge	Lower
In-band Frequency [MHz]:	902.962
Max. in-band Level [dBm/100 kHz]:	14.219
Out-of-band Frequency [MHz]:	901.664
Max. out-of-band Level [dBm/100 kHz]:	-34.208
Attenuation [dB]:	-48.43



Emissions in non-restricted frequency bands at the Band-edge

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.10
Operational Mode:	Single frequency, Channel: 914.2 MHz, LoRa 500kHz
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average power (limit =-30dBc)
Band-edge	Upper
In-band Frequency [MHz]:	914.011
Max. in-band Level [dBm/100 kHz]:	13.97
Out-of-band Frequency [MHz]:	932.636
Max. out-of-band Level [dBm/100 kHz]:	-42.074
Attenuation [dB]:	-56.04



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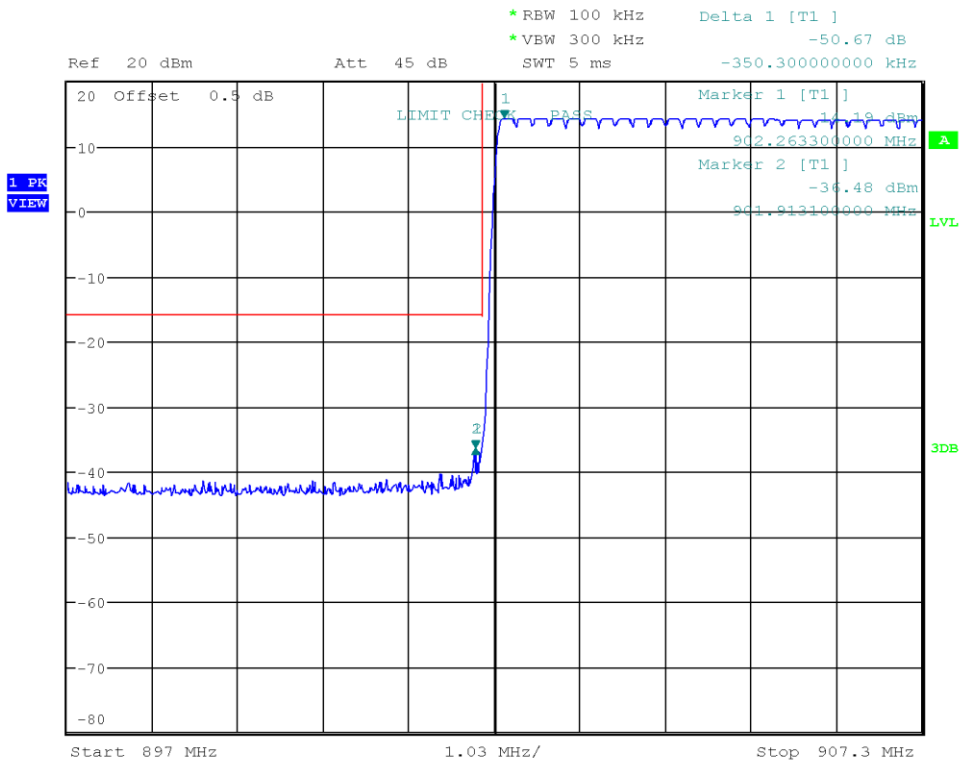
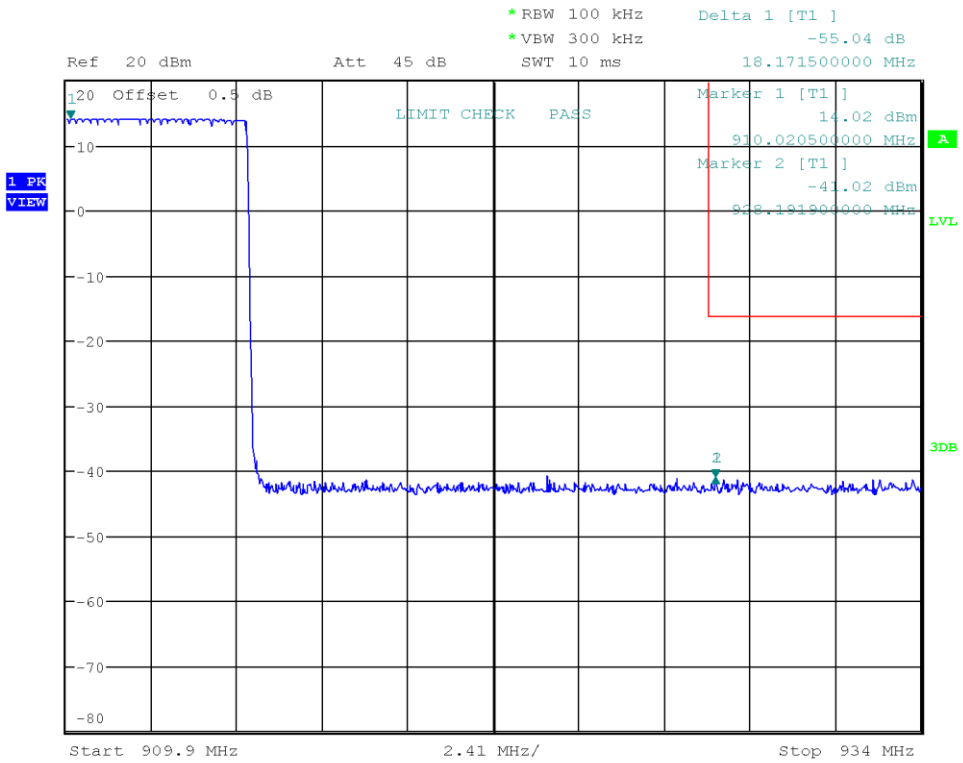
Emissions in non-restricted frequency bands at the Band-edge

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.10
Operational Mode:	hopping mode, Channel: 902.3 MHz
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Note:	Based on max. cond. Average power (limit =-30dBc)
Band-edge	Lower
In-band Frequency [MHz]:	902.263
Max. in-band Level [dBm/100 kHz]:	14.185
Out-of-band Frequency [MHz]:	901.913
Max. out-of-band Level [dBm/100 kHz]:	-36.482
Attenuation [dB]:	-50.67



Emissions in non-restricted frequency bands at the Band-edge

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 6.10
Operational Mode:	hopping mode, Channel: 914.9 MHz
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Note:	Based on max. cond. average power (limit =-30dBc)
Band-edge	Upper
In-band Frequency [MHz]:	910.02
Max. in-band Level [dBm/100 kHz]:	14.021
Out-of-band Frequency [MHz]:	928.192
Max. out-of-band Level [dBm/100 kHz]:	-41.016
Attenuation [dB]:	-55.04



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3.8 Test Conditions and Results - Conducted spurious emissions

3.8.1 Information

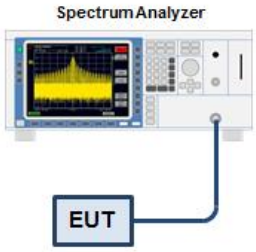
Test Information	
Reference	FCC § 15.247(d); ISED RSS-247, Issue 2 (section 5.5)
Measurement Method	ANSI C63.10 11.11
Measurement Uncertainty:	± 4.25 dB
Operator	Wilfried Treffke
Date	2020-12-15

3.8.2 Limits

Limits	
Power Measurement	Out-of-band attenuation [dB]
Peak	20
RMS	30

3.8.3 Setup

Test Setup



3.8.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSW 43	EF00896	2020-07	2021-07
Cable	Gigalane	SMS111B	EF00779 CAABC	2018-10	2020-12

3.8.5 Procedure

Test Procedure

1. EUT set to test mode (Communication tester is used if needed)
2. Span set around lower band edge and detector is set to peak and max hold
3. Resolution bandwidth is set to 100 kHz
4. Markers are set to peak emission levels outside frequency band

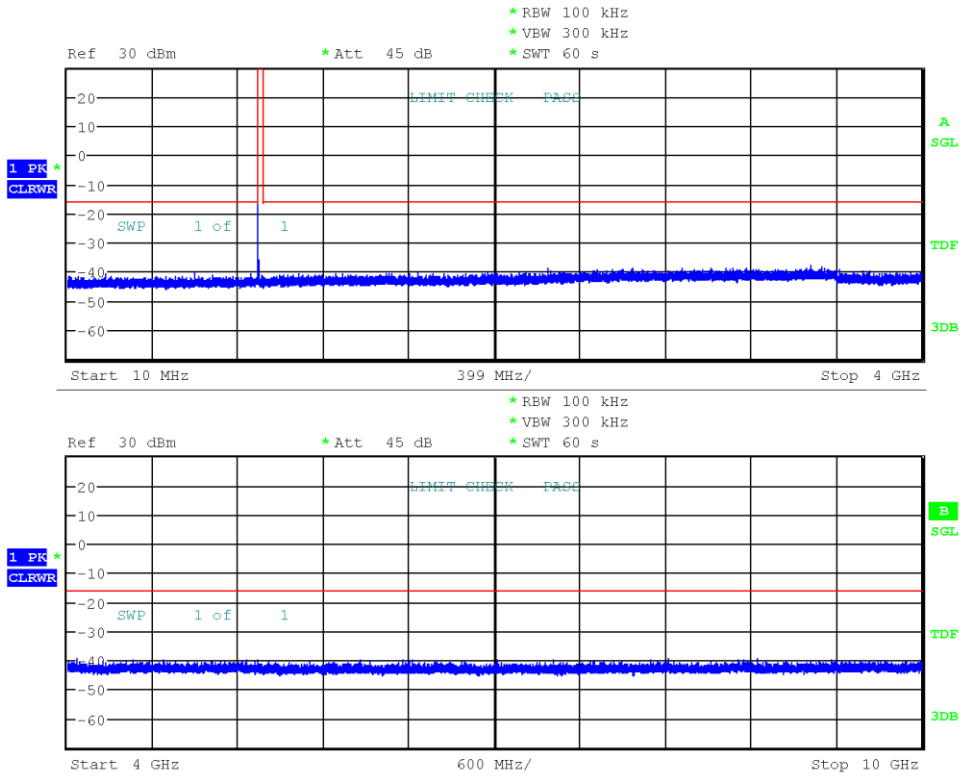
3.8.6 Results

Test Results		
Mode	Channel [MHz]	Verdict
Mode 2	903.0	PASS
Mode 2	909.4	PASS
Mode 2	914.2	PASS

Test Results		
Mode	Channel [MHz]	Verdict
Mode 4	902.3	PASS
Mode 4	908.7	PASS
Mode 4	914.9	PASS

Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 500kHz, Channel: 903 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power (limit =-30dBc)
Max. in-band Frequency [MHz]:	902.9
Max. in-band Level [dBm/100 kHz]:	14.0
Out-of-band Limit [dBm/100 kHz]:	-16.0



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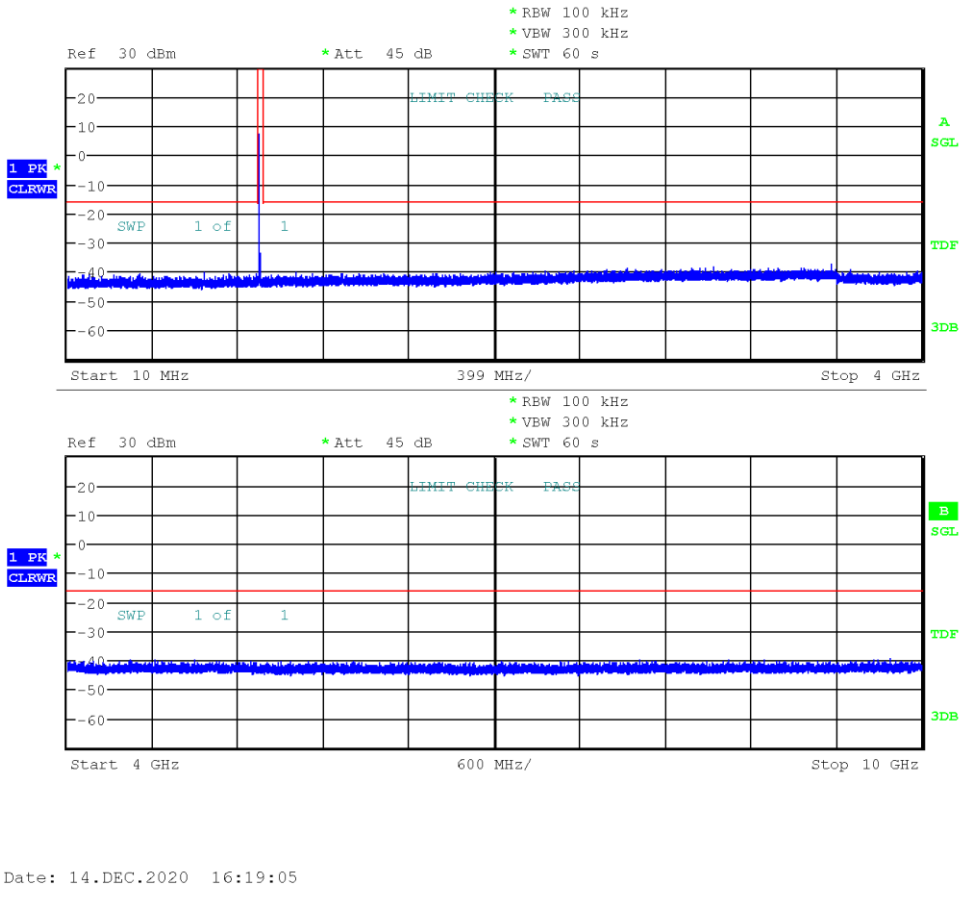
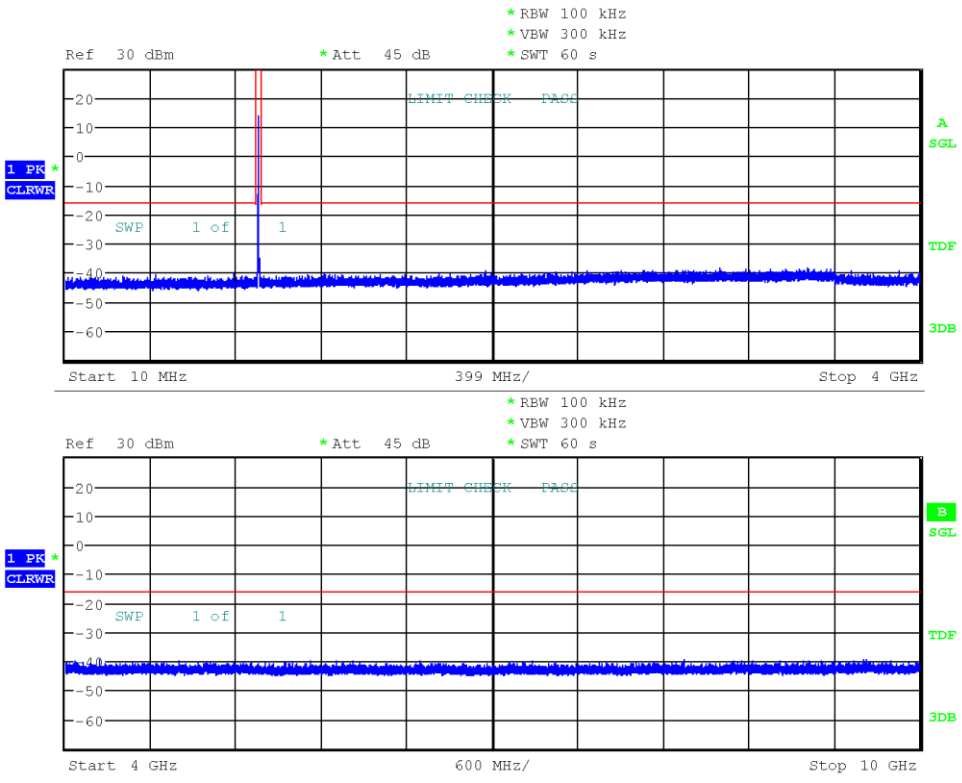
Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 500kHz, Channel: 909.4 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power (limit =-30dBc)
Max. in-band Frequency [MHz]:	909.3
Max. in-band Level [dBm/100 kHz]:	14.0
Out-of-band Limit [dBm/100 kHz]:	-16.0



Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 500kHz, Channel: 914.2 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-14
Note:	Based on max. cond. average output power (limit =-30dBc)
Max. in-band Frequency [MHz]:	914.2
Max. in-band Level [dBm/100 kHz]:	13.9
Out-of-band Limit [dBm/100 kHz]:	-16.1



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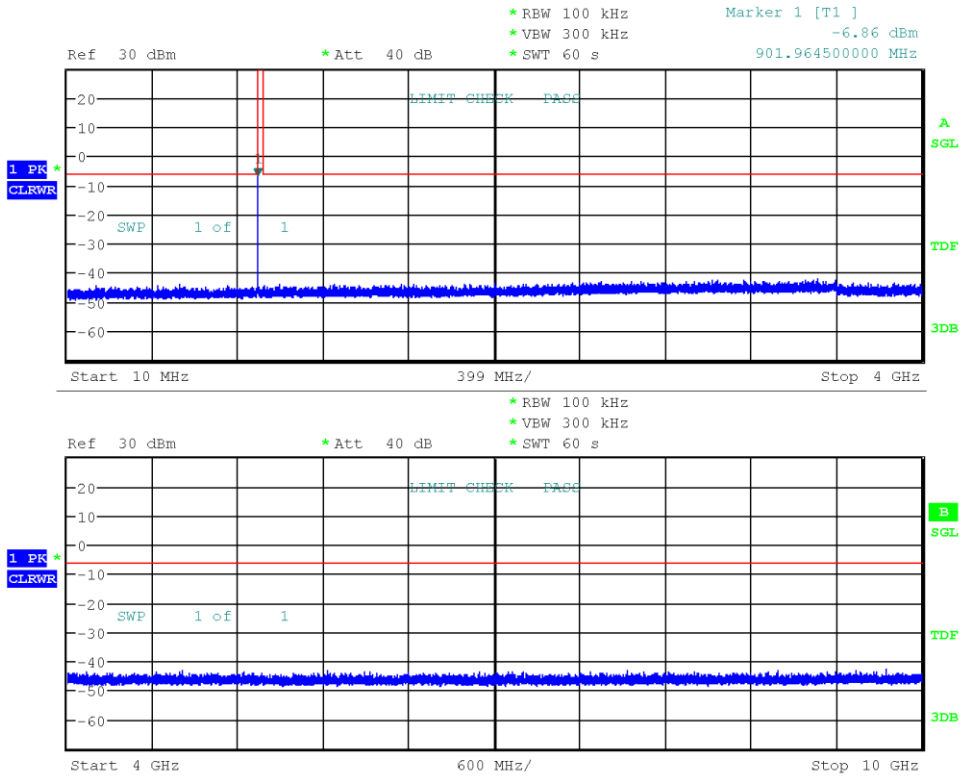
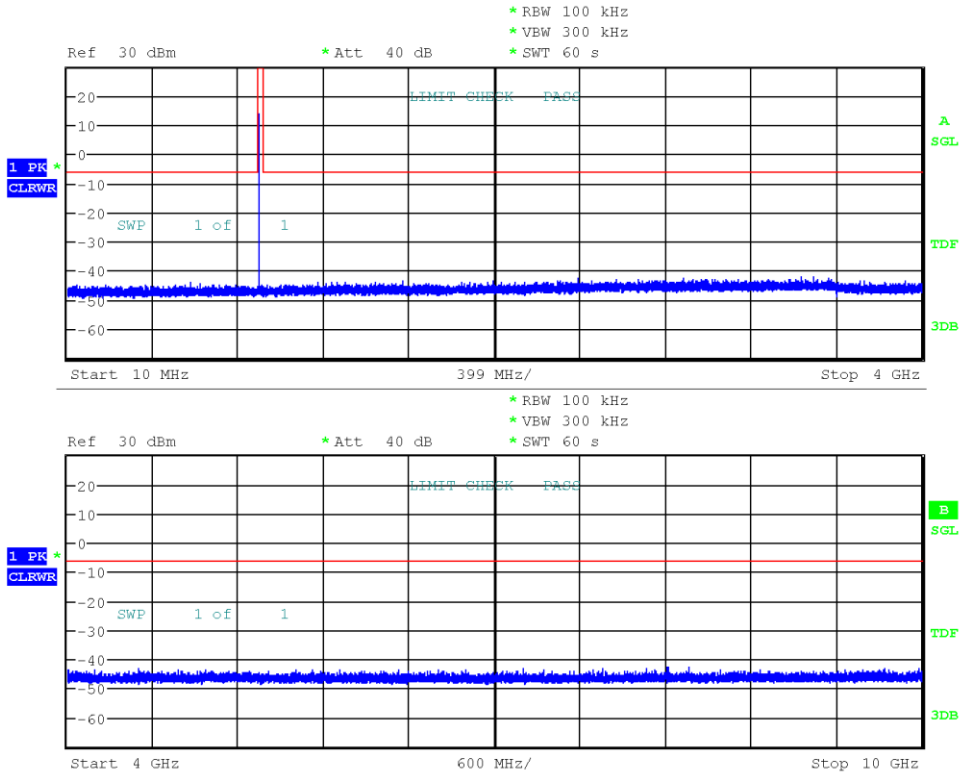
Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 125kHz, Channel: 902.3 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Max. in-band Frequency [MHz]:	902.3
Max. in-band Level [dBm/100 kHz]:	14.0
Out-of-band Limit [dBm/100 kHz]:	-6.0



Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 125kHz, Channel: 908.7 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Max. in-band Frequency [MHz]:	908.7
Max. in-band Level [dBm/100 kHz]:	13.9
Out-of-band Limit [dBm/100 kHz]:	-6.1



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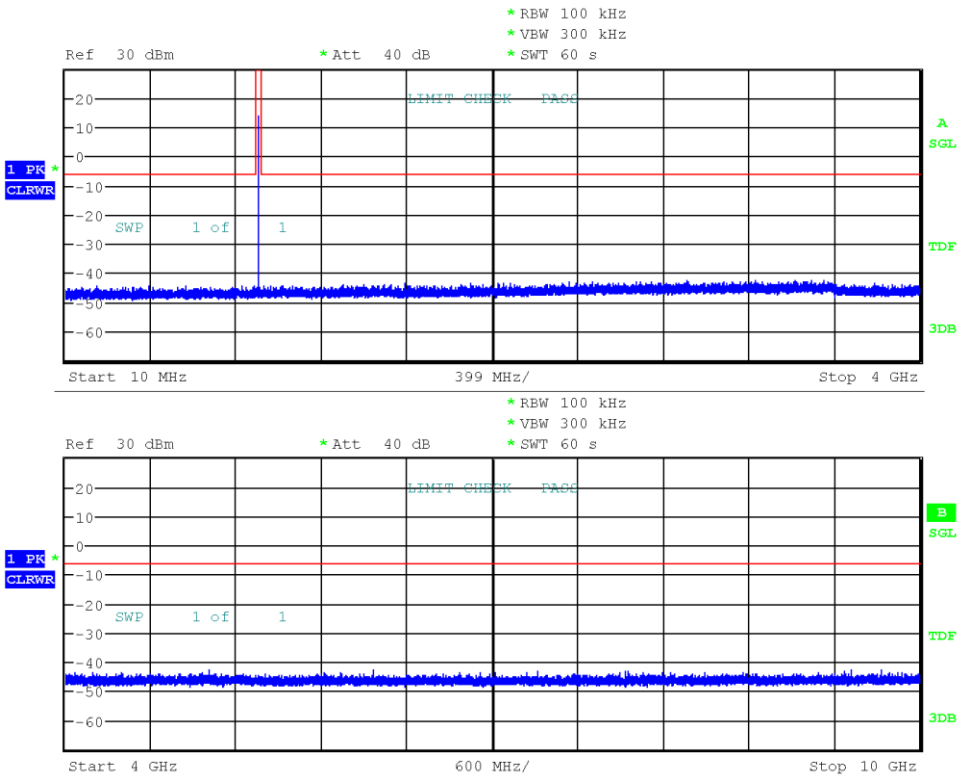
Conducted Spurious Emissions

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32168
Reference Standards:	FCC 15.247, RSS-247
Reference Method:	ANSI C63.10:2013, Section 11.11
Operational Mode:	LoRa 125kHz, Channel: 914.9 MHz
Operating Conditions:	Tnom/Vnom
Operator:	Wilfried Treffke
Test Site:	Eurofins Product Service GmbH
Test Date:	2020-12-15
Max. in-band Frequency [MHz]:	914.9
Max. in-band Level [dBm/100 kHz]:	13.8
Out-of-band Limit [dBm/100 kHz]:	-6.2



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3.9 Test Conditions and Results - Transmitter radiated emissions

3.9.1 Information

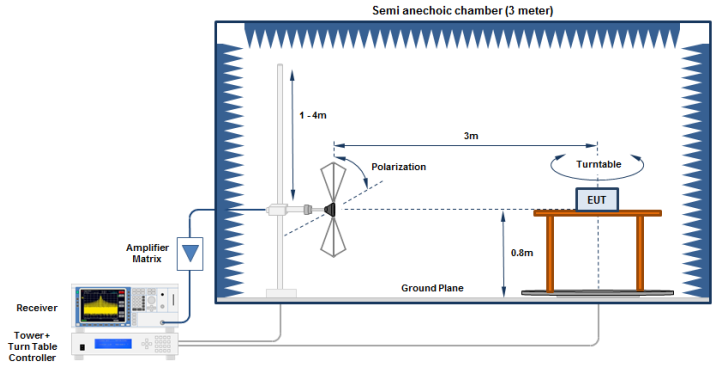
Test Information	
Reference	FCC § 15.247(d); FCC § 15.209; ISED RSS-Gen, Issue 5 (section 6.13)
Measurement Method	ANSI C63.10 6.4, 6.5, 6.6, 11.12
Measurement Uncertainty:	± 5.95 dB
Operator	Abdullah Al Jamal
Date	2020-12-02
Measurement note	Measurement plots not listed in this test report (related to the frequency range to be measured) contain noise floor only. No significant emissions detected in these measurement ranges. An evaluation was performed manually with the spectrum analyser.

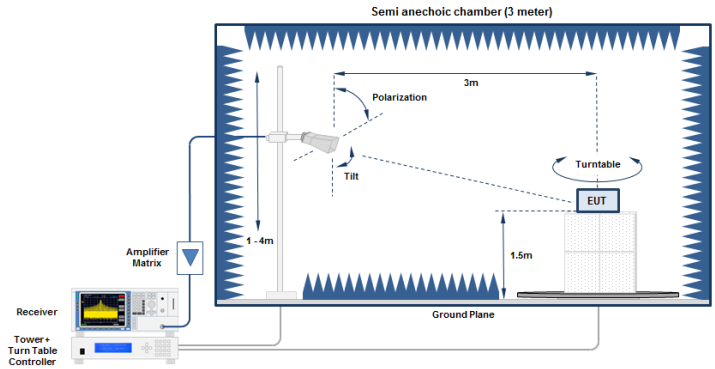
3.9.2 Limits

Limits			
Frequency [MHz]	Detector	Field strength [µV/m]	Measurement distance [m]
30 - 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
>1000	Average	500	3

3.9.3 Setup

Test Setup 30 MHz - 1000 MHz



Test Setup > 1 GHz


3.9.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8

Test Equipment 30 MHz - 1000 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
Measurement Receiver	R&S	ESU 26	EF00887	2020-07	2021-07
Antenna	R&S	HK 116	EF00030	2019-04	2022-04
Antenna	R&S	HL 223	EF00187	2019-05	2022-05

Test Equipment > 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
Measurement Receiver	R&S	ESU 26	EF00887	2020-07	2021-07
Antenna	Schwarzbeck	BBHA 9120D	EF01153	2020-11	2021-11

3.9.5 Procedure

Test Procedure 30 MHz - 1000 MHz
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector

Test Procedure > 1 GHz
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector

3.9.6 Results

Test Results – Mode 2						
Channel [MHz]	Emission [MHz]	Level [dBµV/m]	Det.	Pol.	Limit [dBµV/m]	Margin [dB]
903.0	960.077	46.70	pk	hor	54.00	-07.26
914.2	No significant spurious emissions					
Comment	The Mode 2 was selected as the worst case. An evaluation was performed manually with the spectrum analyser.					

3.10 Test Conditions and Results - Receiver radiated emissions

3.10.1 Information

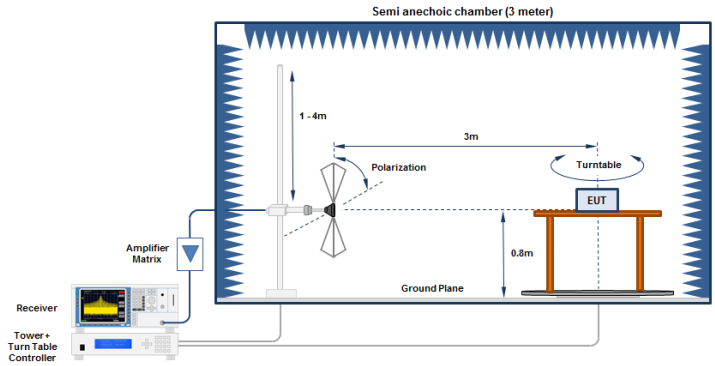
Test Information	
Reference	ISED RSS-247, Issue 2 (section 3.1)
Measurement Method	ANSI C63.10 6.5, 6.6, 11.12
Measurement Uncertainty:	± 5.95 dB
Operator	Wilfried Treffke
Date	2020-12-16

3.10.2 Limits

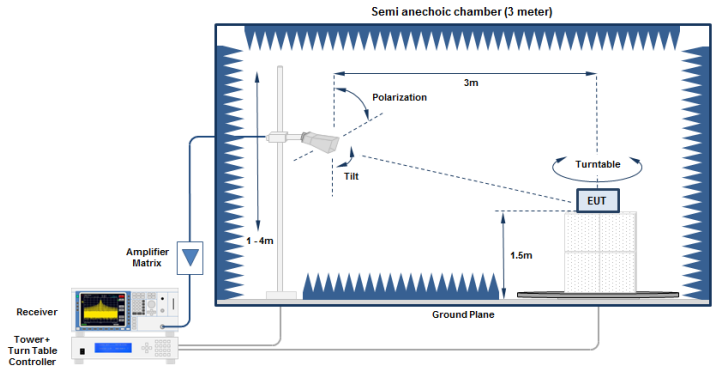
Limits			
Frequency [MHz]	Detector	Field strength [µV/m]	Measurement distance [m]
30 - 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
>1000	Average	500	3

3.10.3 Setup

Test Setup 30 - 1000 MHz



Test Setup > 1 GHz



3.10.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8

Test Equipment 30 MHz - 1000 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
Measurement Receiver	R&S	ESU 26	EF00887	2020-07	2021-07
Antenna	R&S	HK 116	EF00030	2019-04	2022-04
Antenna	R&S	HL 223	EF00187	2019-05	2022-05

Test Equipment > 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
Measurement Receiver	R&S	ESU 26	EF00887	2020-07	2021-07
Antenna	Schwarzbeck	BBHA 9120D	EF01153	2020-11	2021-11

3.10.5 Procedure

Test Procedure 30 - 1000 MHz
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground
2. EUT set to test mode
3. The receiver is set to peak detection with max hold
4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m
5. All significant emissions are measured again using the corresponding final detector

Test Procedure > 1 GHz
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground
2. EUT set to test mode
3. The receiver is set to peak detection with max hold
4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m
5. All significant emissions are measured again using the corresponding final detector

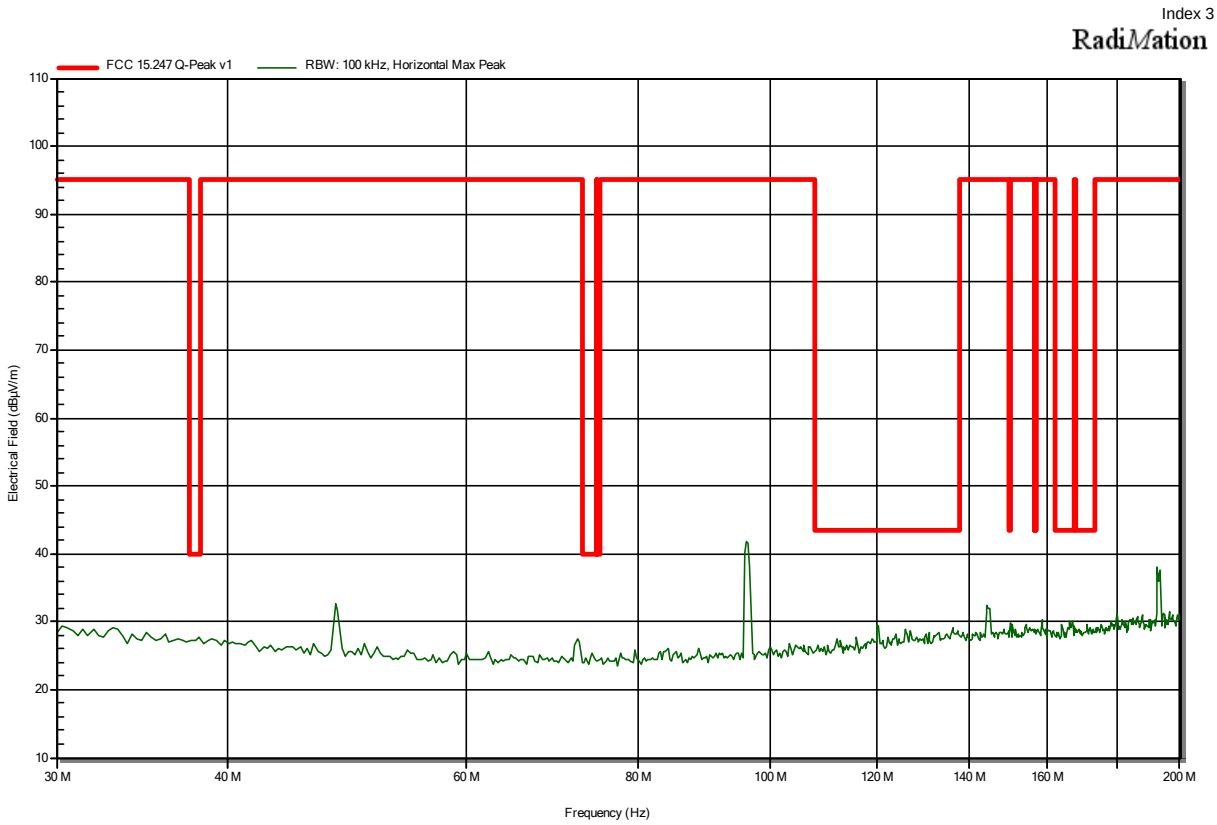
3.10.6 Results

Test Results						
Channel [MHz]	Emission [MHz]	Level [dBµV/m]	Det.	Pol.	Limit [dBµV/m]	Margin [dB]
925.100	358.974	16.85	ver	ver	46.00	-29.15
925.100	897.436	19.52	ver	hor	46.00	-26.48
925.100	2654	34.32	ver	ver	53.98	-19.66
925.100	4513	33.56	ver	hor	53.98	-20.42

ANNEX A Transmitter spurious emissions

Radiated Spurious Emissions according to FCC 47 CFR 15.247

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Abdullah Al Jamal
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 21.6 °, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement distance:	3 m
Mode:	Tx; SF12 – 903.0 MHz
Test Date:	2020-12-02
Note:	EUT horizontal



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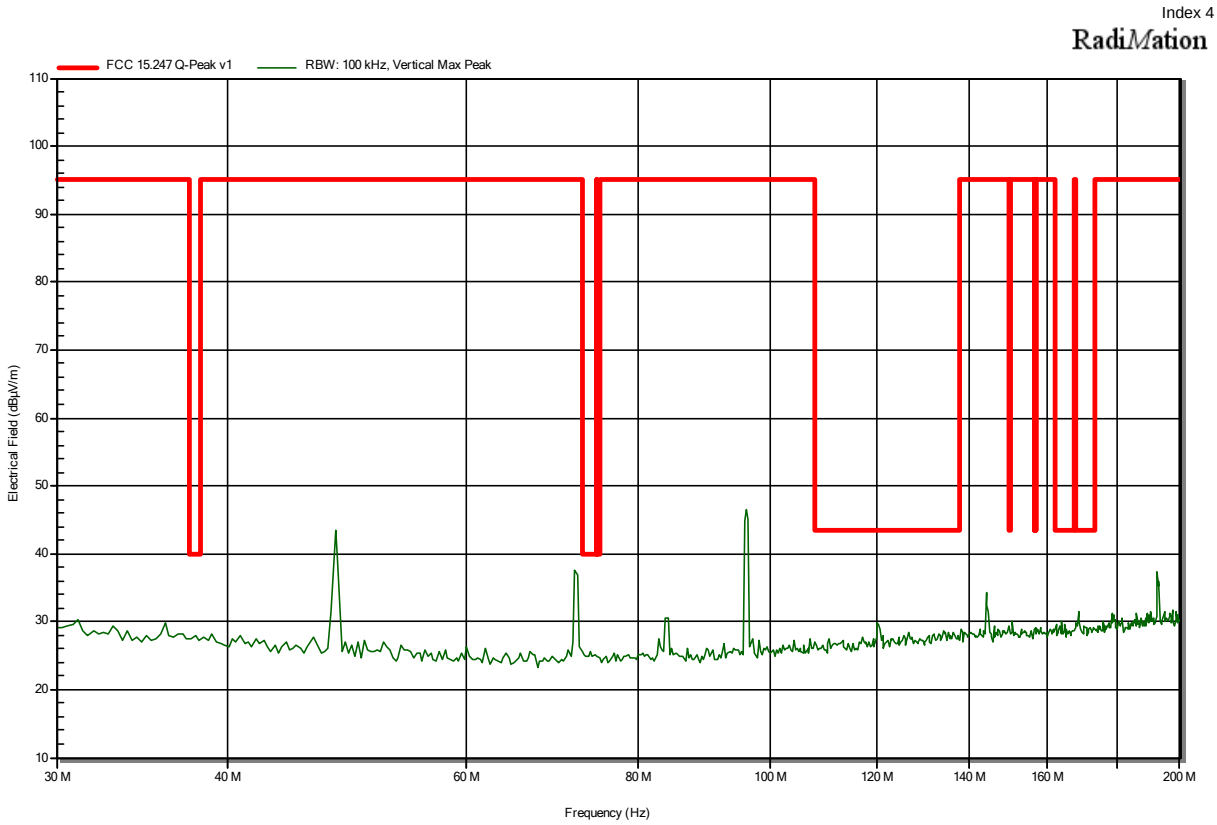
Operator:	Abdullah Al Jamal
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 21.6 °, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HK 116, Vertical
Measurement distance:	3 m
Mode:	Tx; SF12 – 903.0 MHz
Test Date:	2020-12-02
Note:	EUT horizontal



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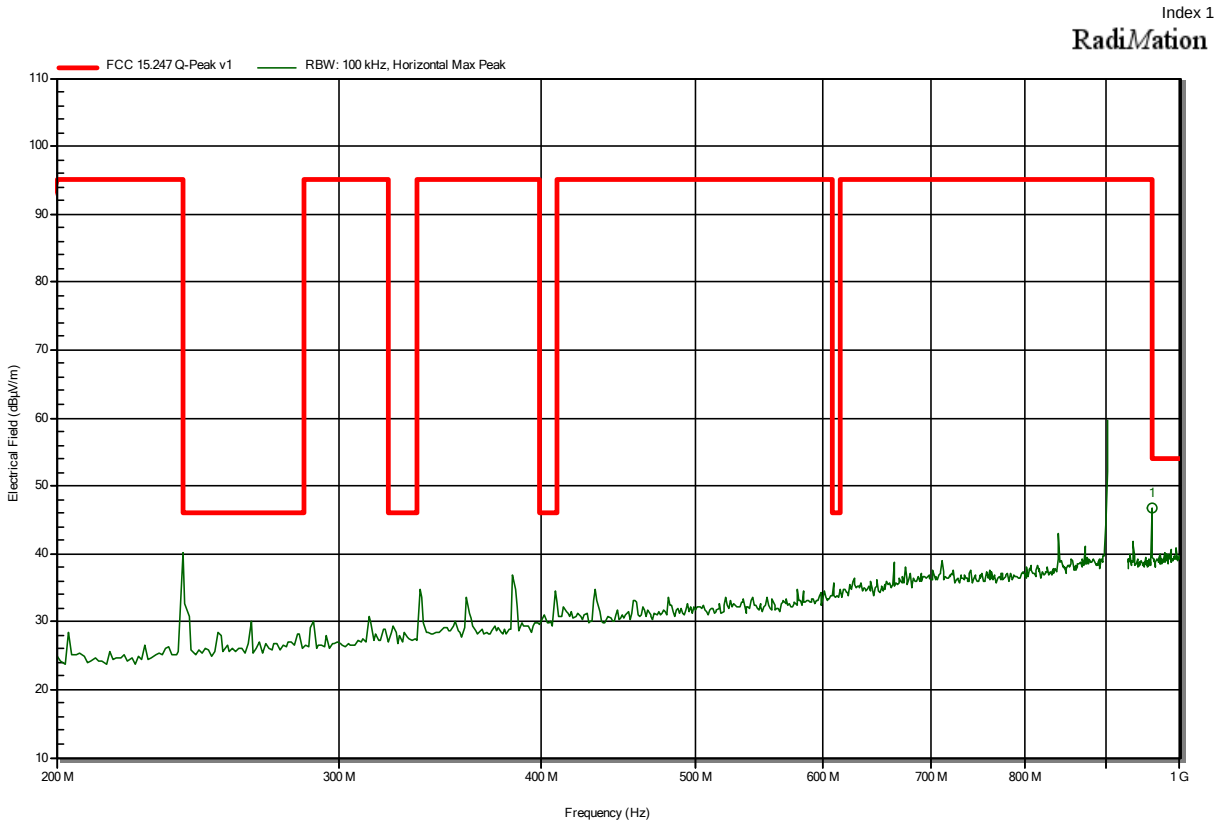
Operator:	Abdullah Al Jamal
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 21.6 °, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HL 223, Horizontal
Measurement distance:	3 m
Mode:	Tx; SF12 – 903.0 MHz
Test Date:	2020-12-02
Note:	EUT horizontal



Frequency	Peak	Peak Limit	Peak Difference	Peak Status
960.0769230769 MHz	46.7 dBµV/m	54 dBµV/m	-7.26 dB	Pass

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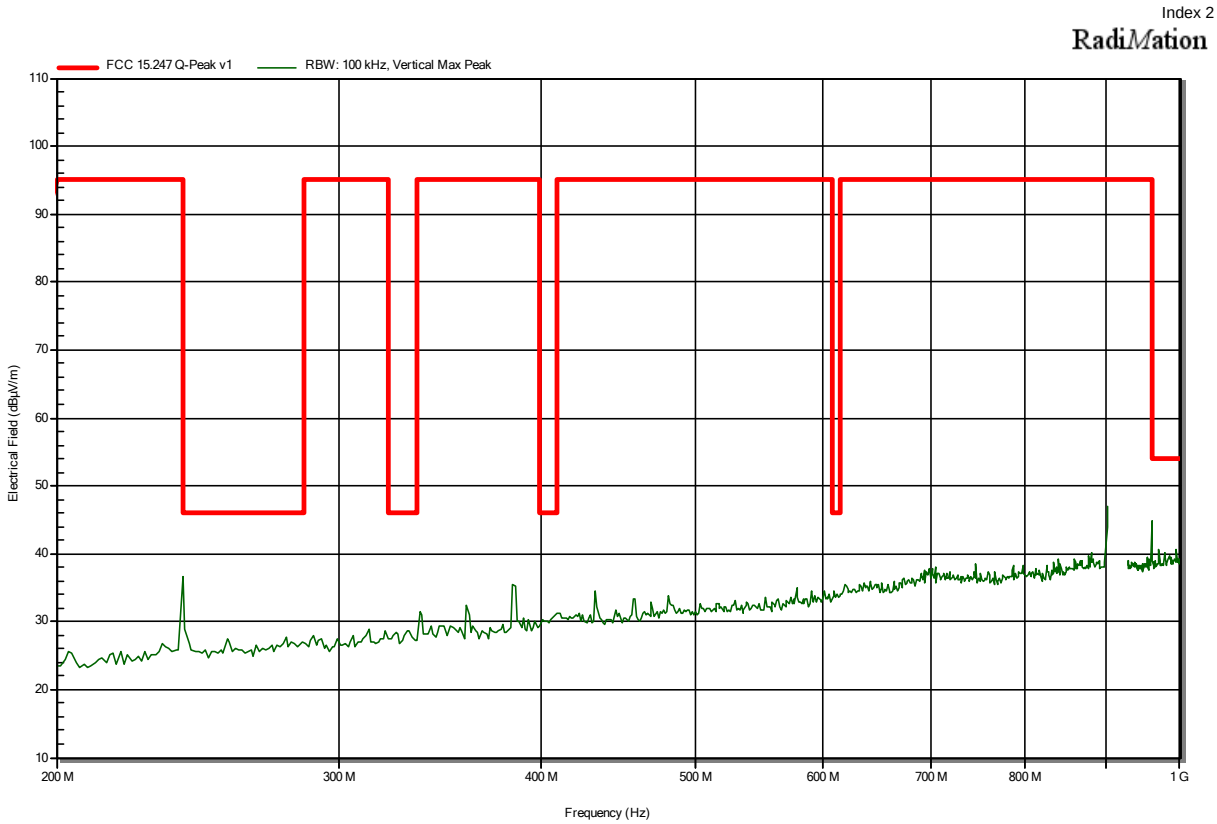
Note:	EUT horizontal



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Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement distance:	3 m
Mode:	Tx; SF12 – 903.0 MHz
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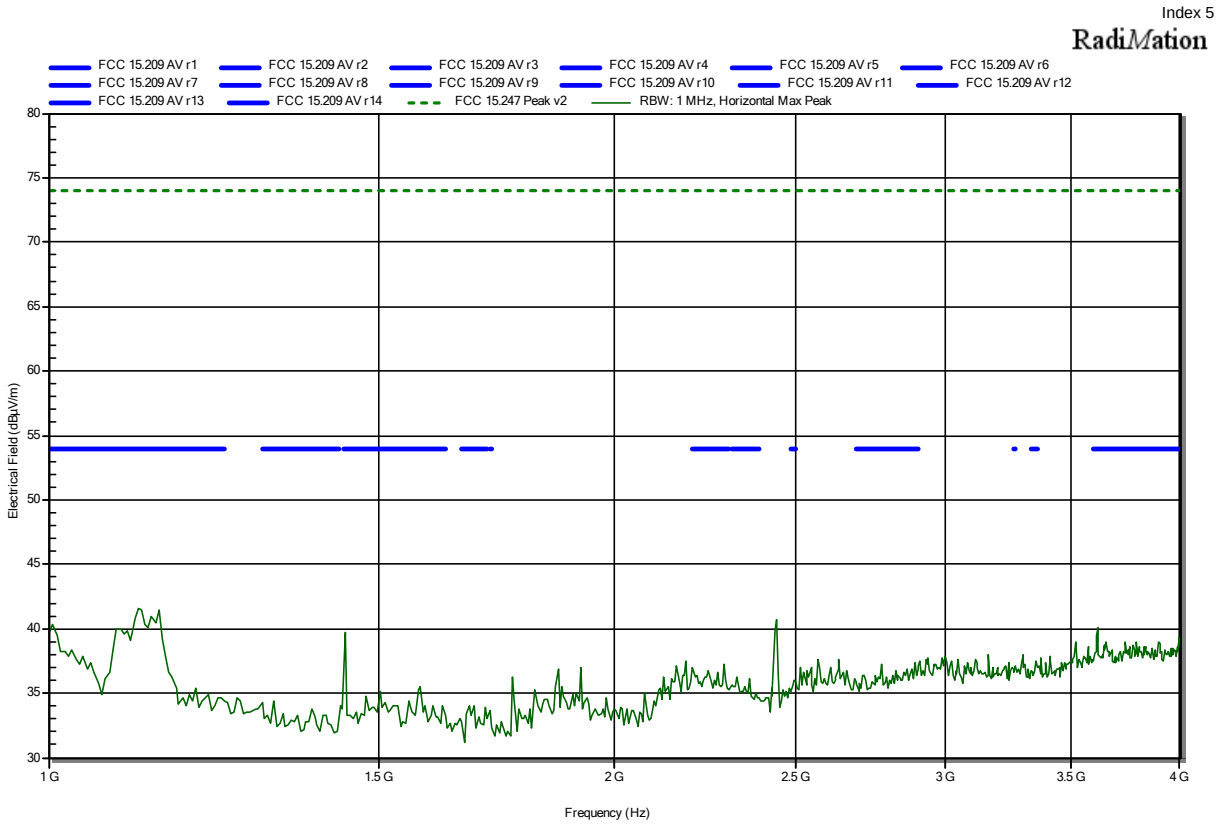

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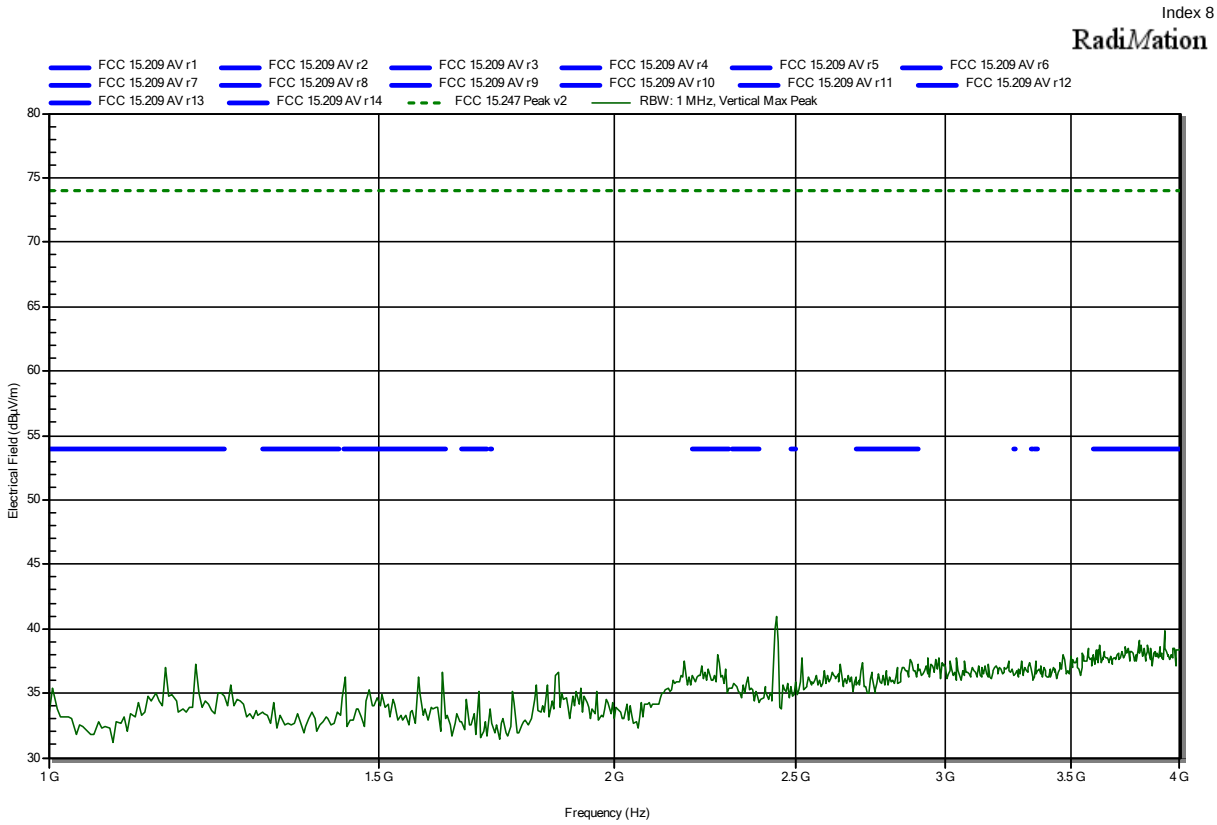

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Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement distance:	3 m
Mode:	Tx; SF12 – 903.0 MHz
Test Date:	2020-12-02
Note:	EUT horizontal

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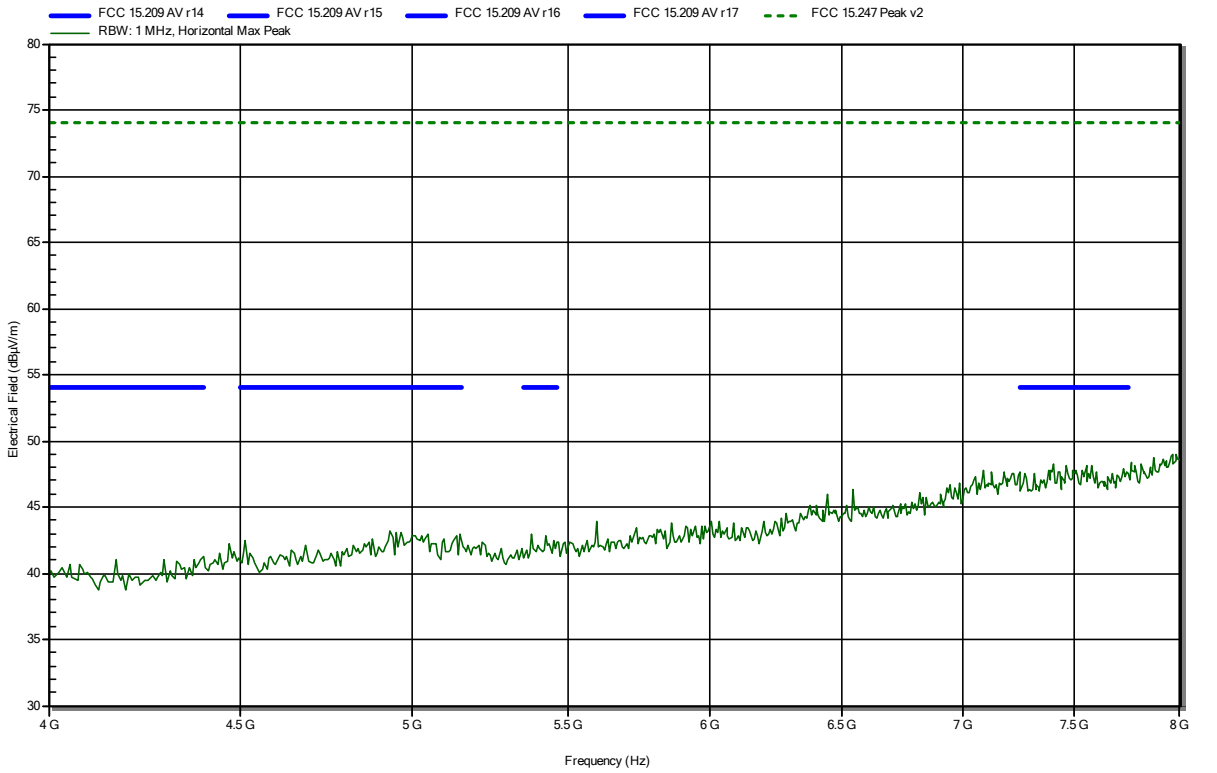
RadiMation



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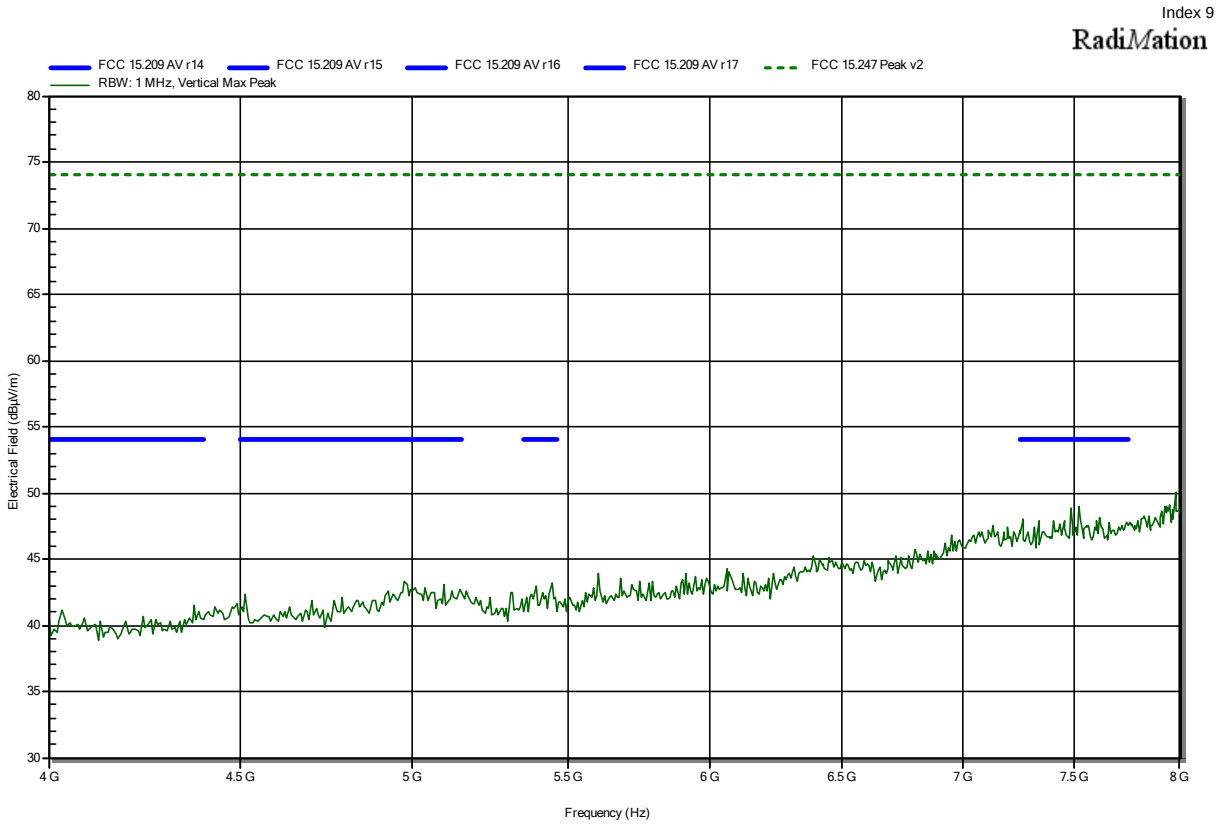

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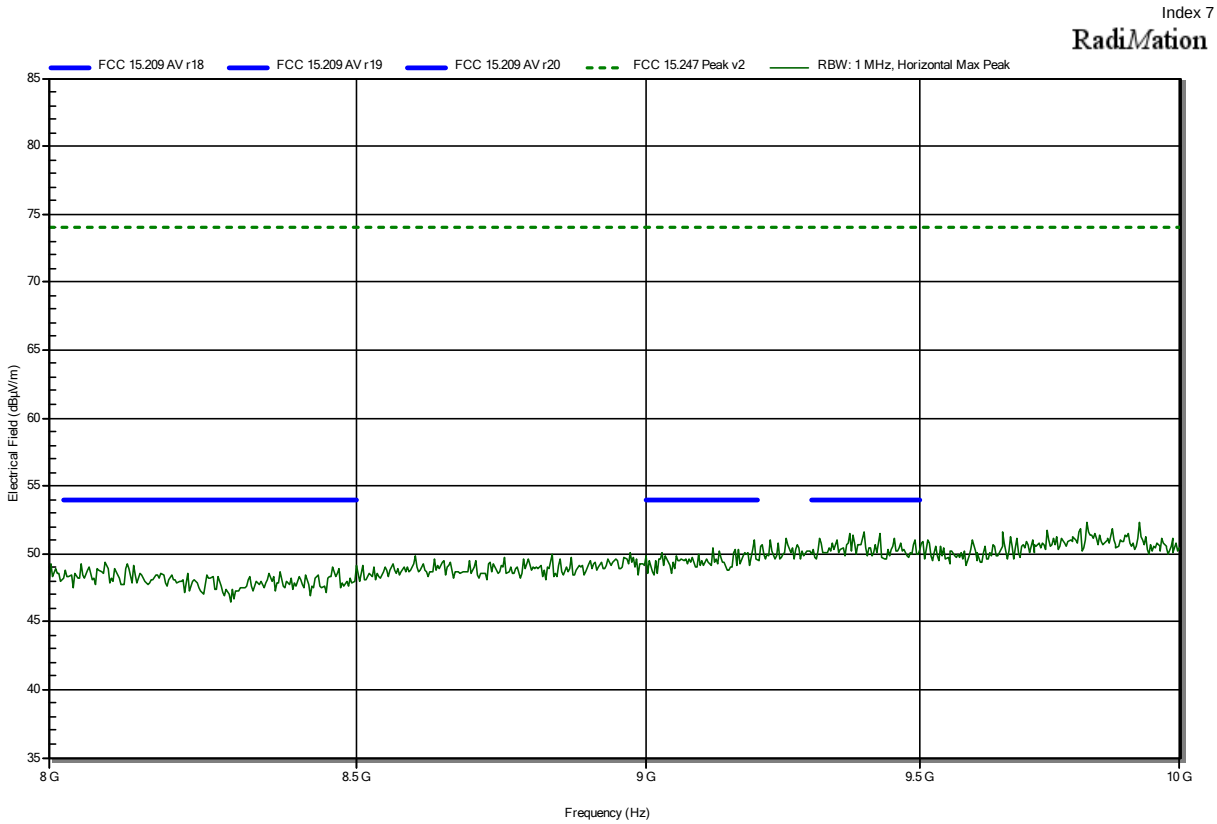

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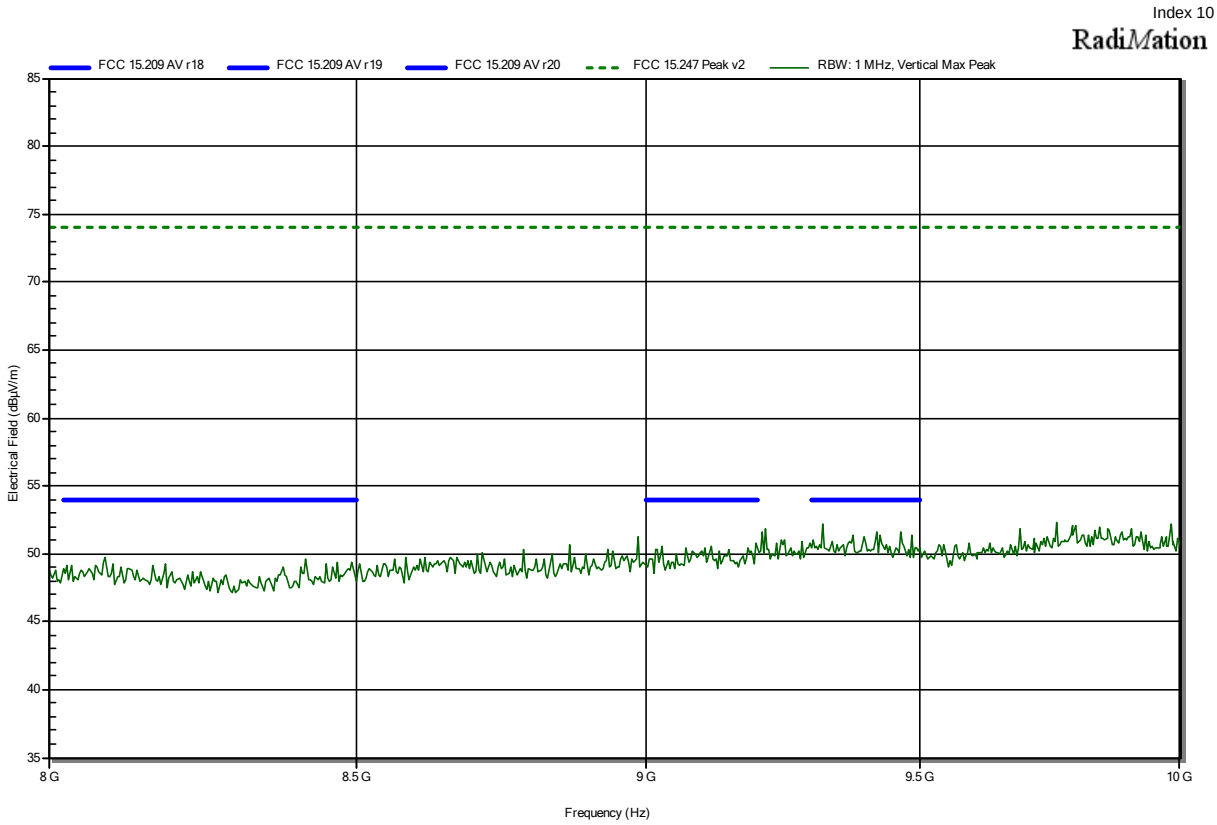

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Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement distance:	3 m
Mode:	Tx; SF12 – 914.2 MHz
Test Date:	2020-12-02
Note:	EUT horizontal

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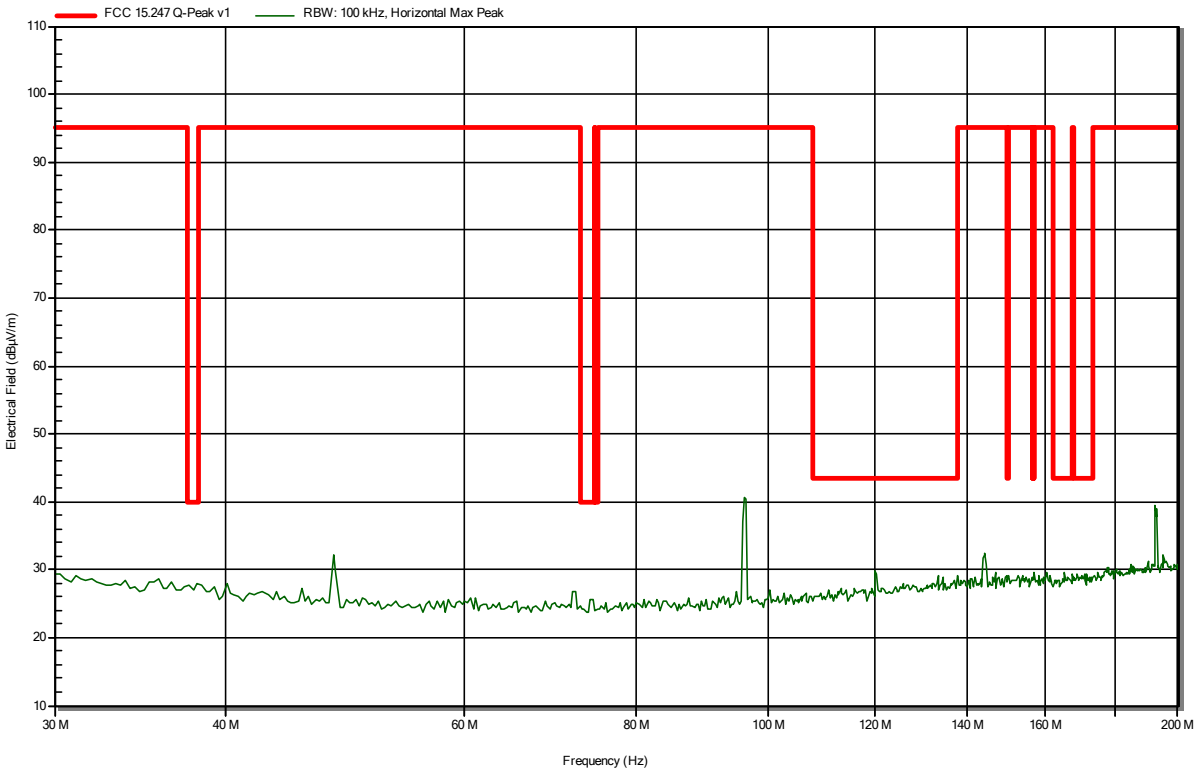
RadiMation



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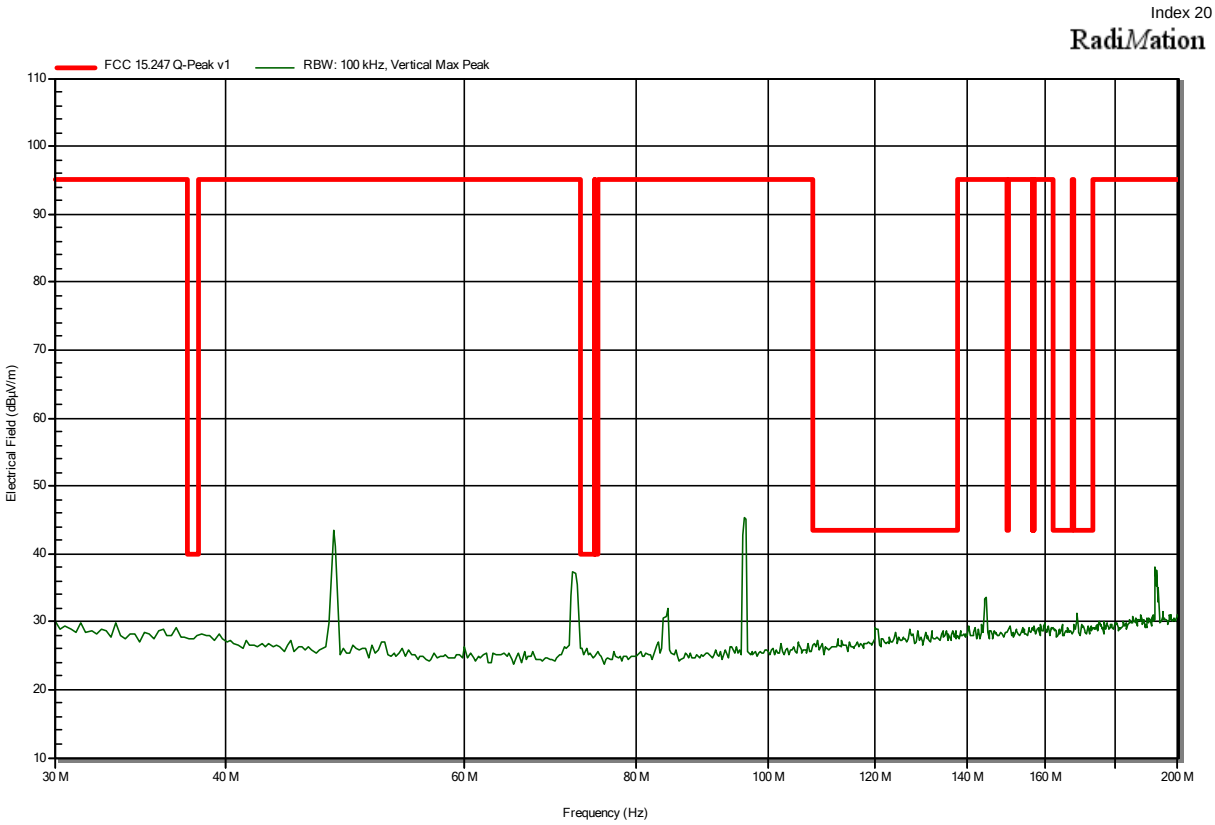

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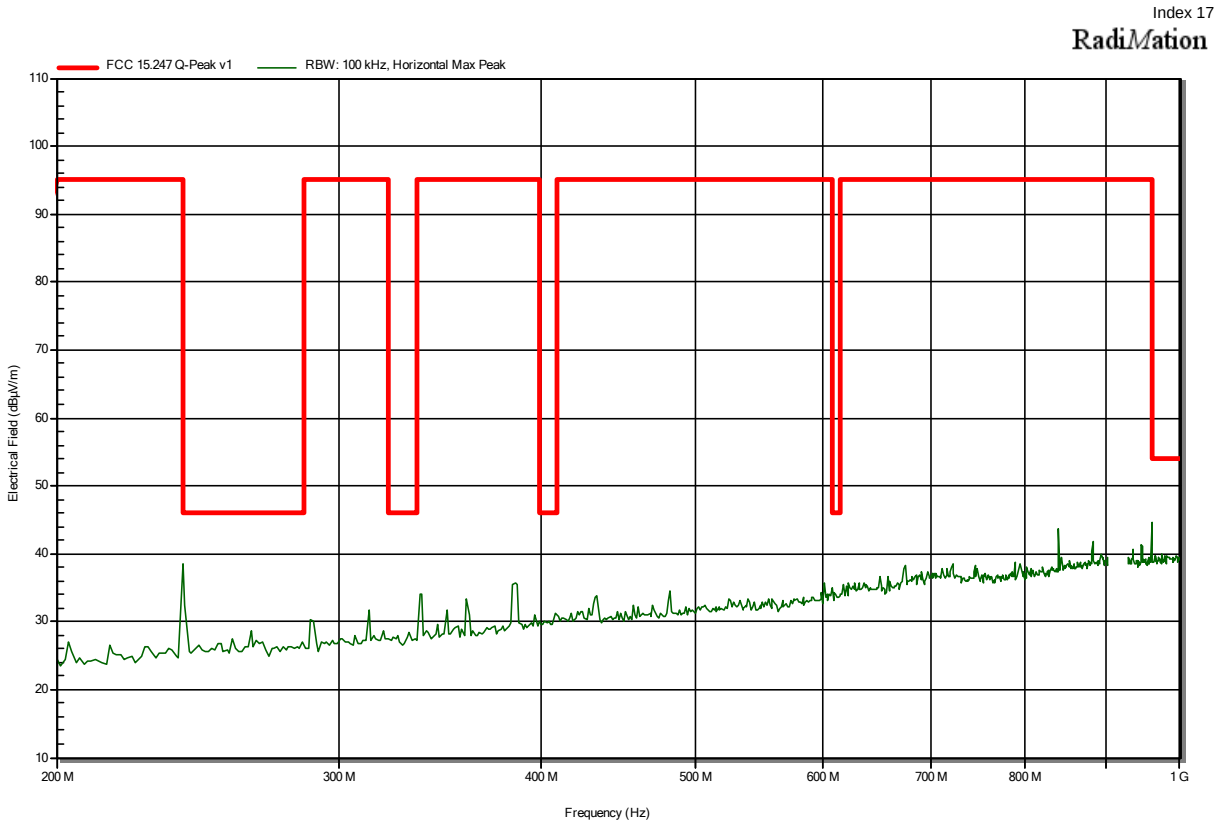

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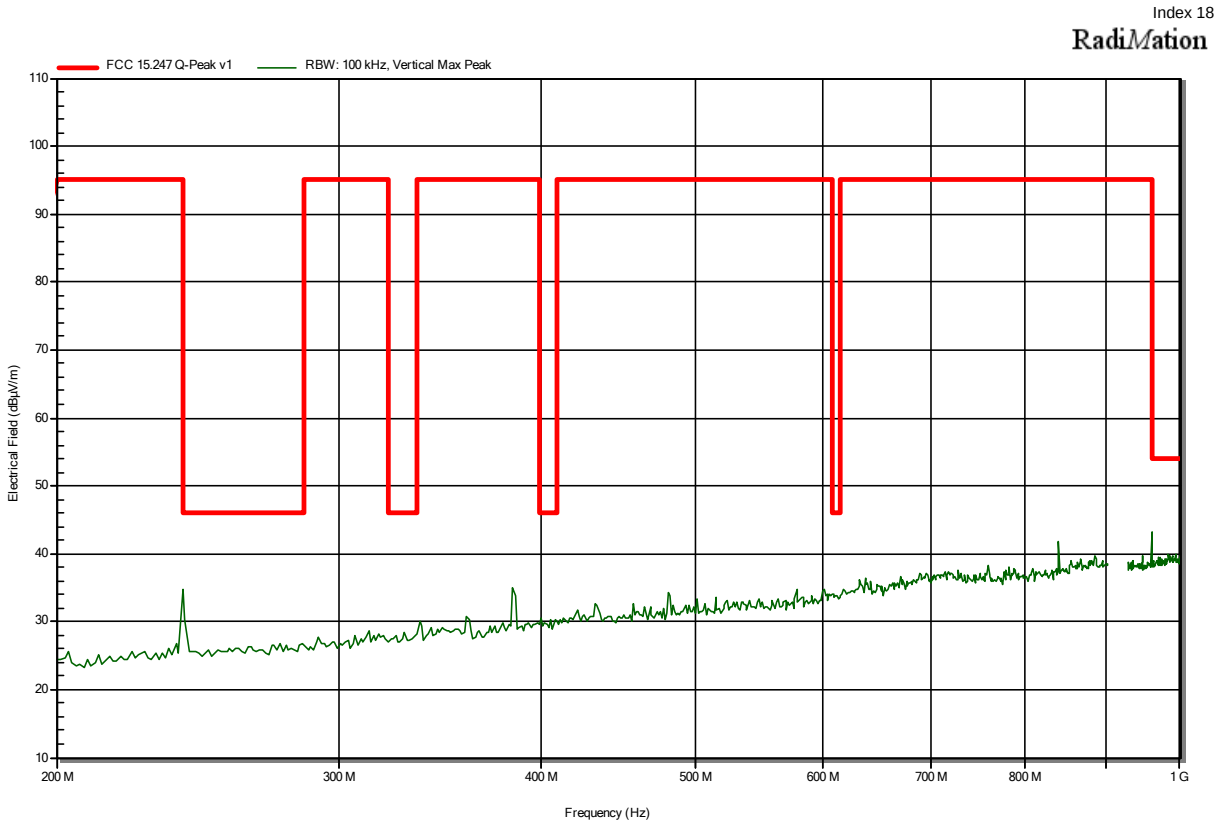

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Measurement distance:	3 m
Mode:	Tx; SF12 – 914.2 MHz
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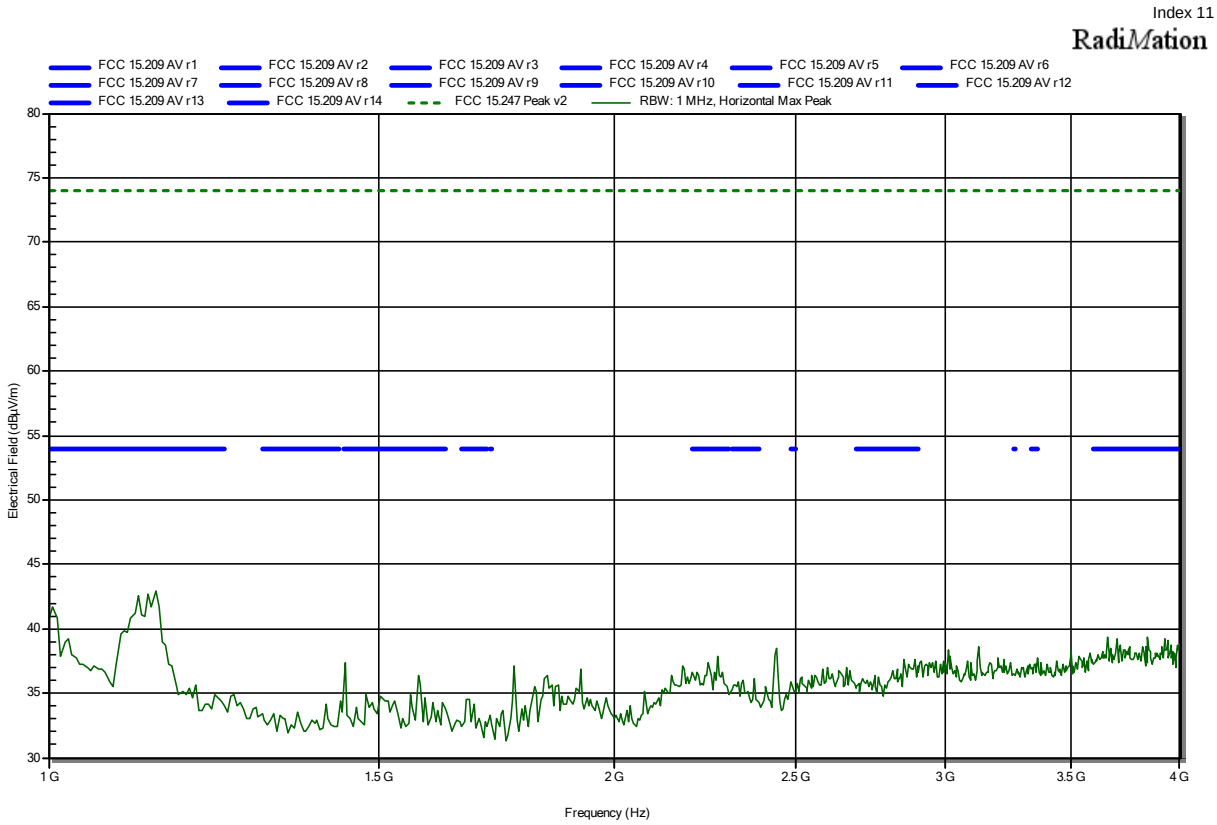
Note:	EUT horizontal



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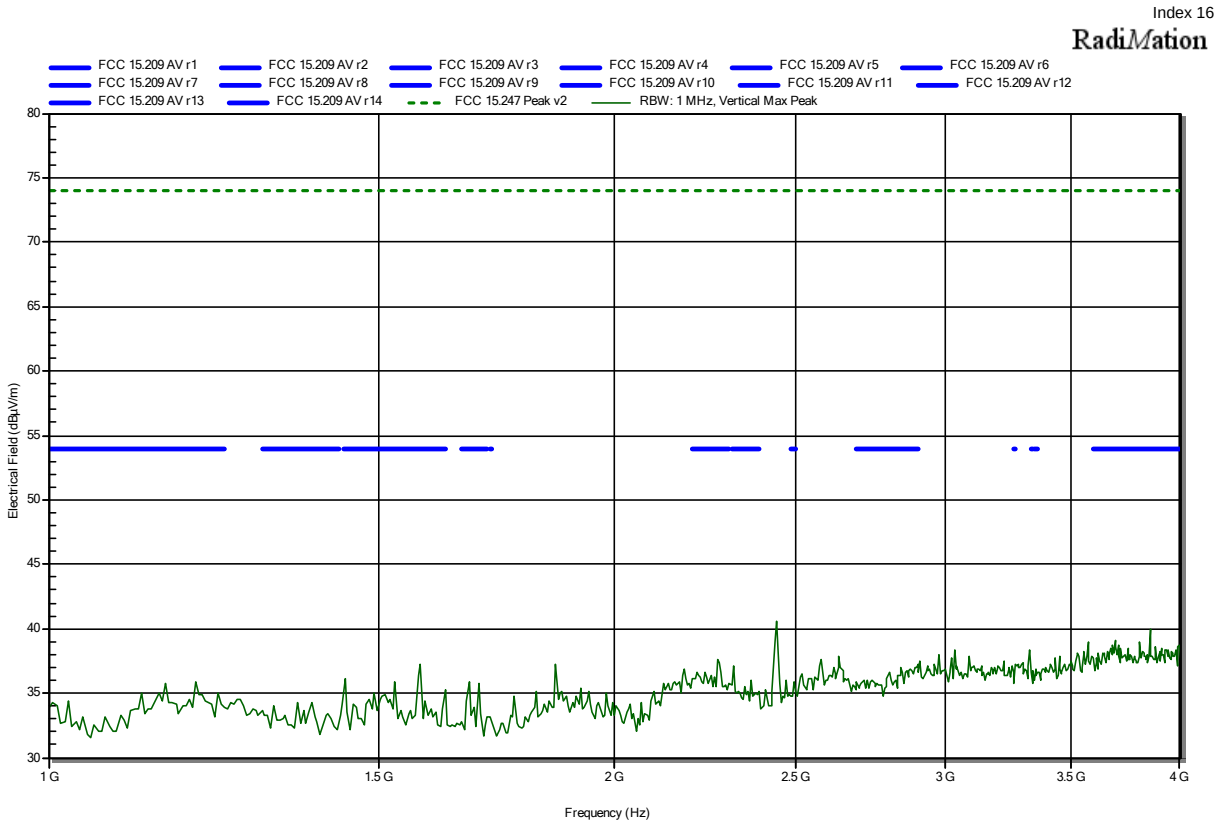

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Note:	EUT horizontal

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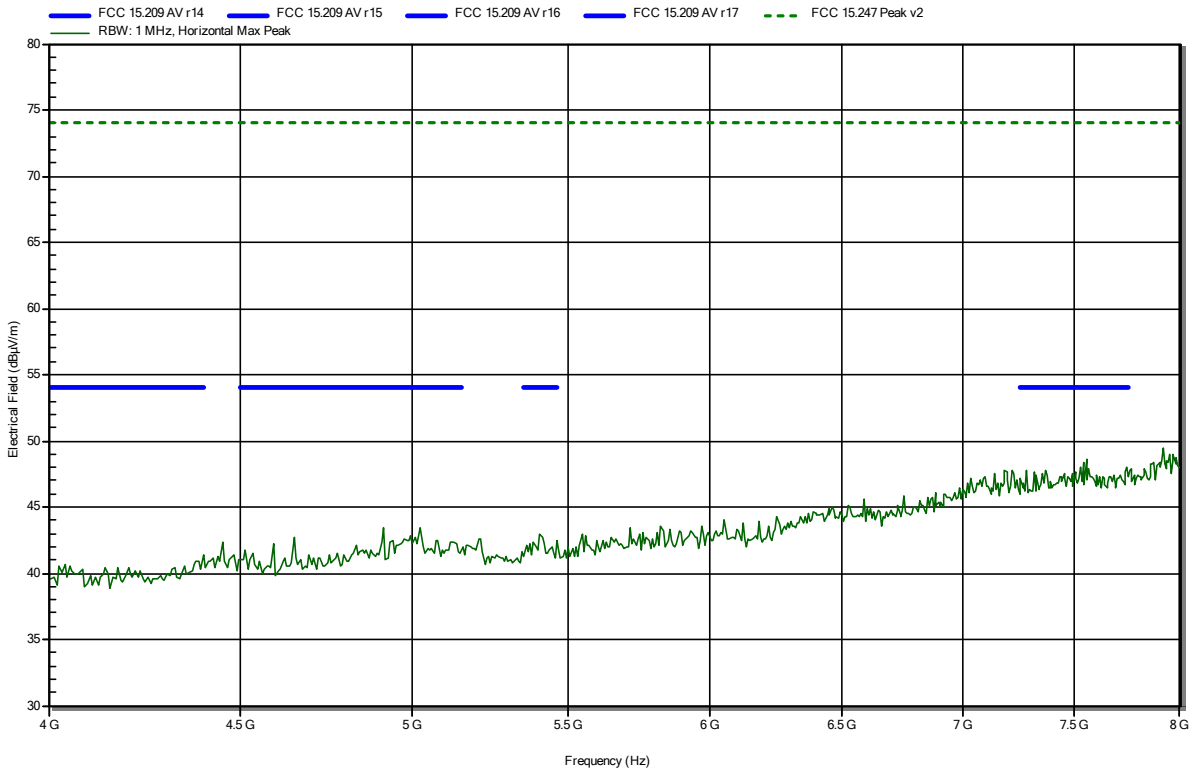
RadiMation



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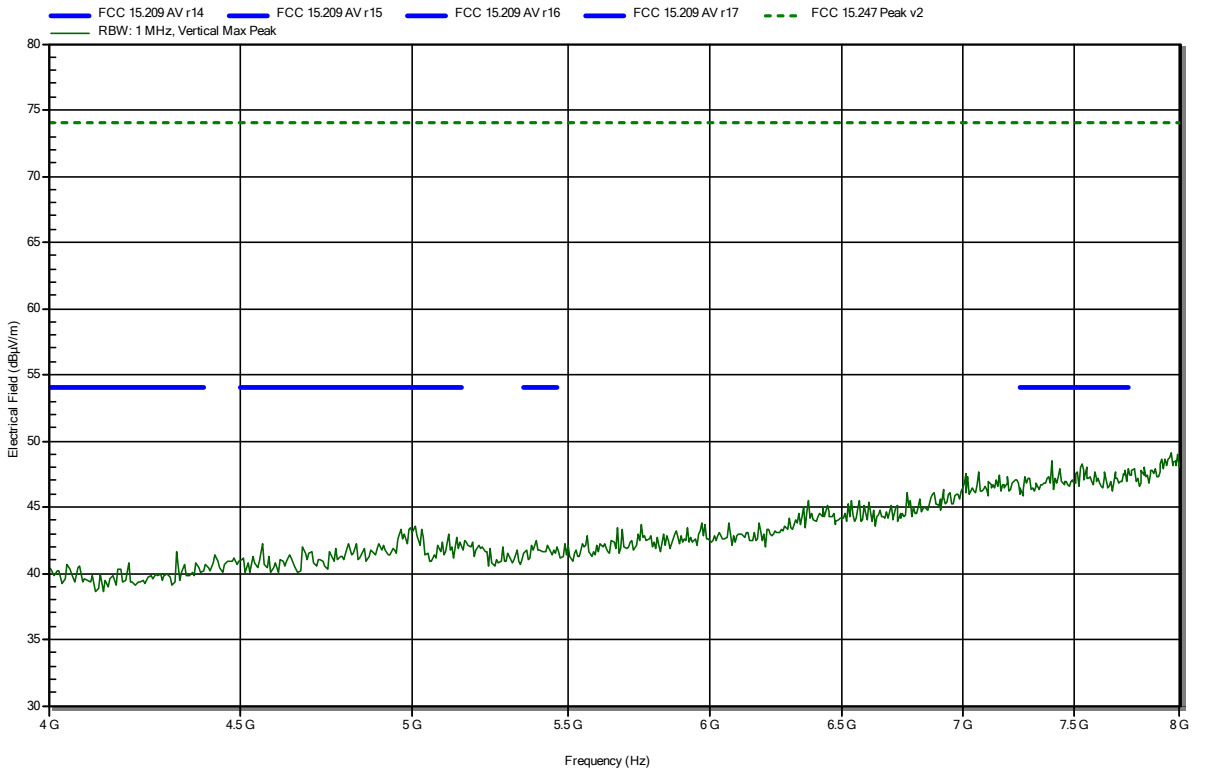
RadiMation



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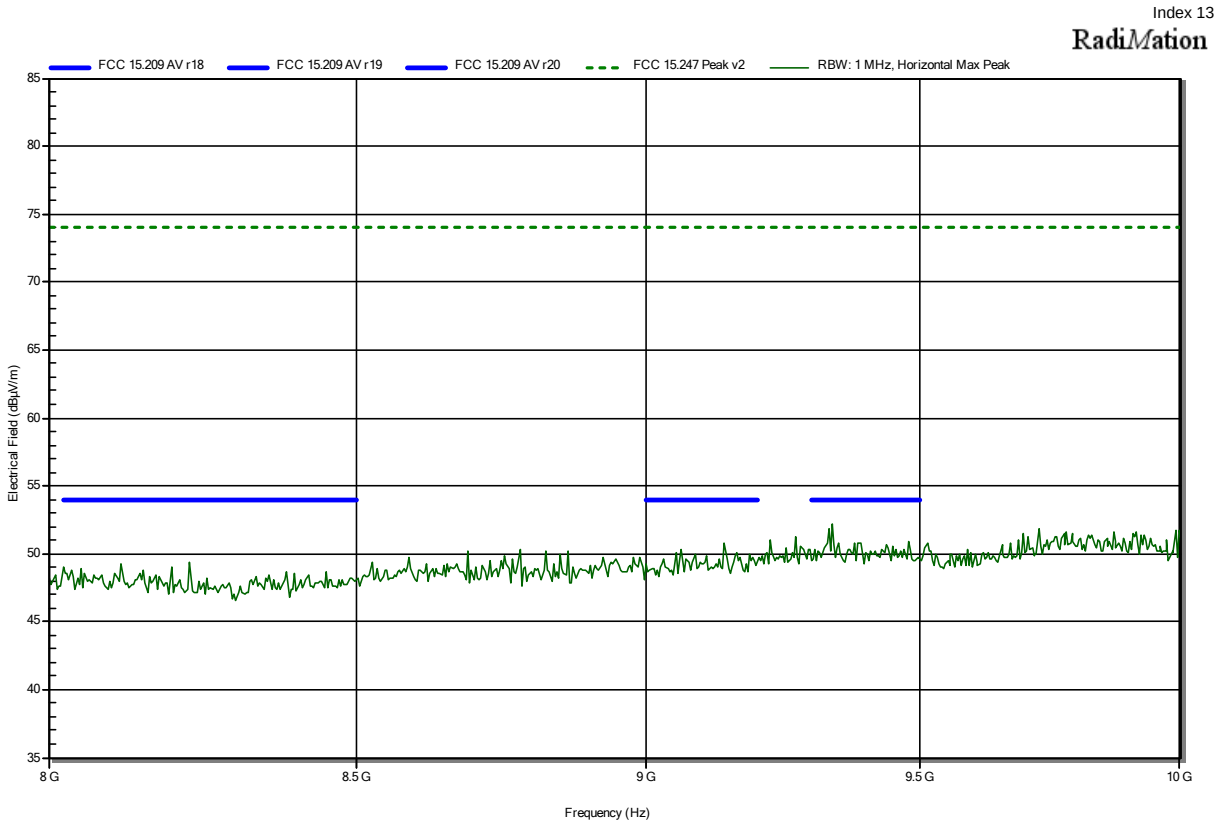

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Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement distance:	3 m
Mode:	Tx; SF12 – 914.2 MHz
Test Date:	2020-12-02
Note:	EUT horizontal

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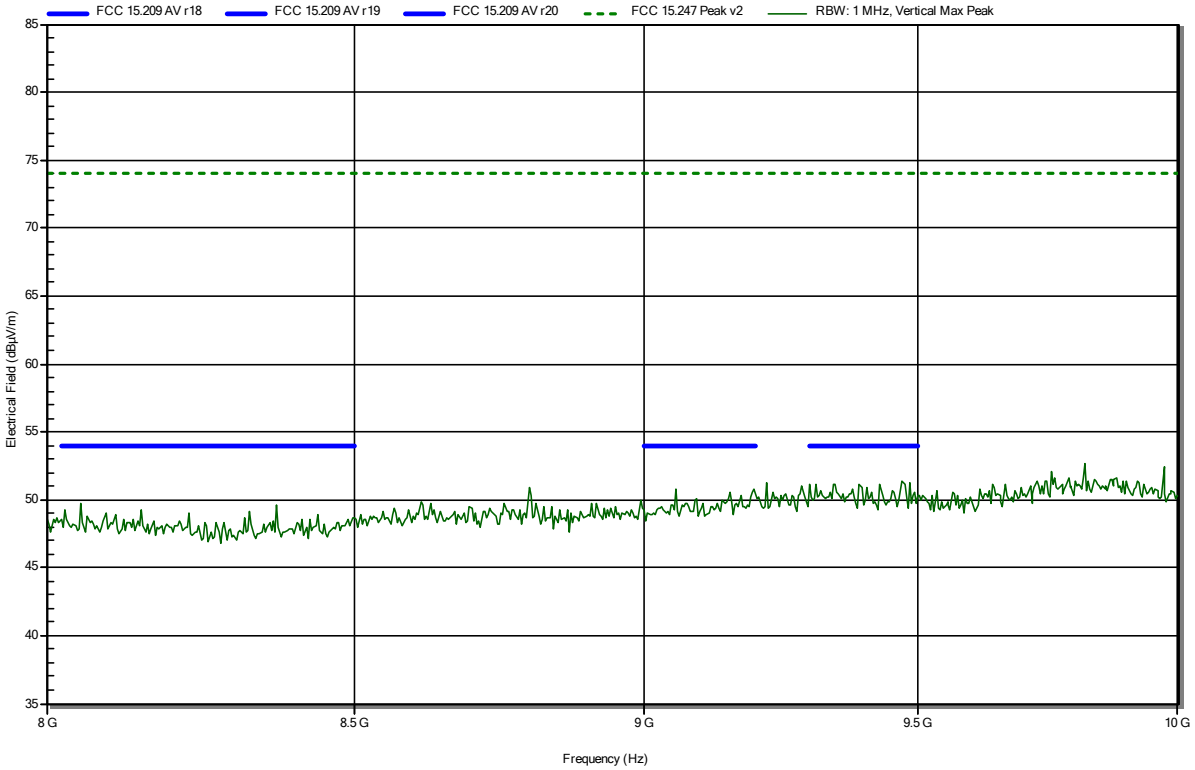
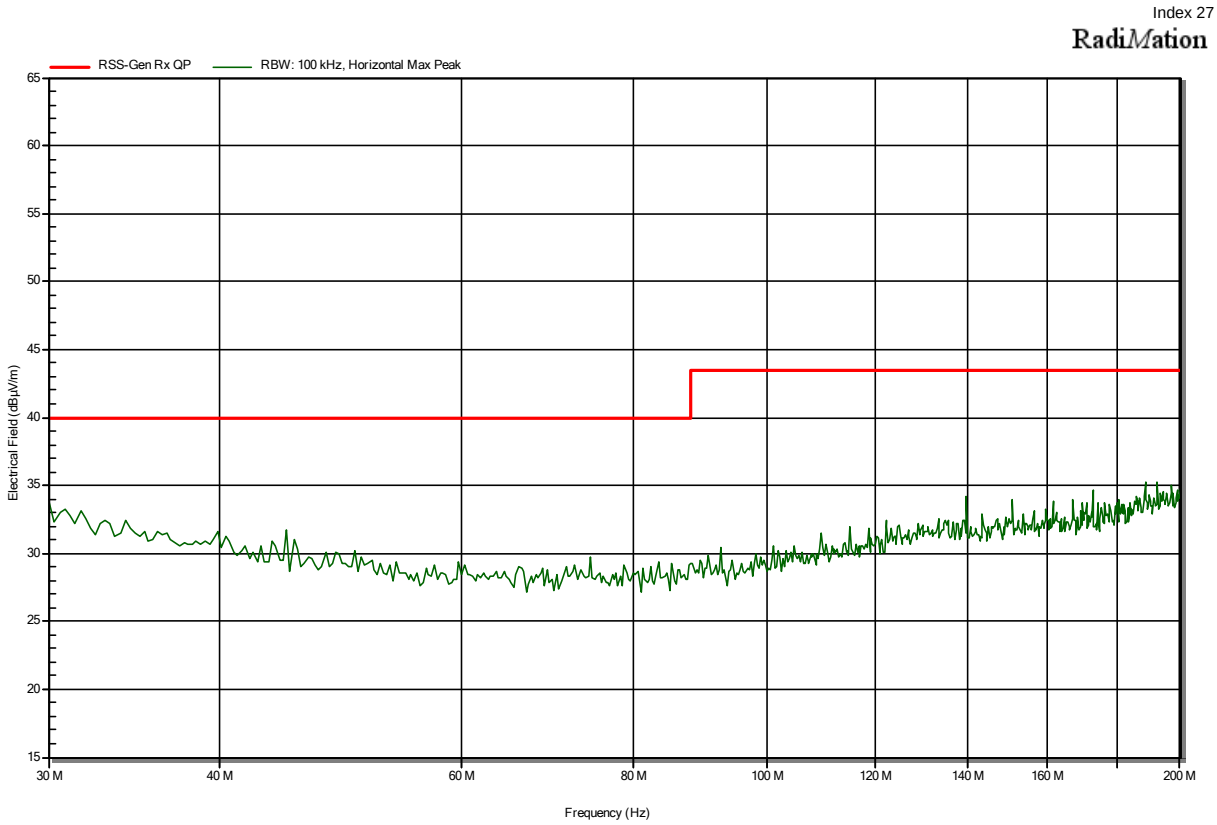
RadiMation



ANNEX B Receiver spurious emissions

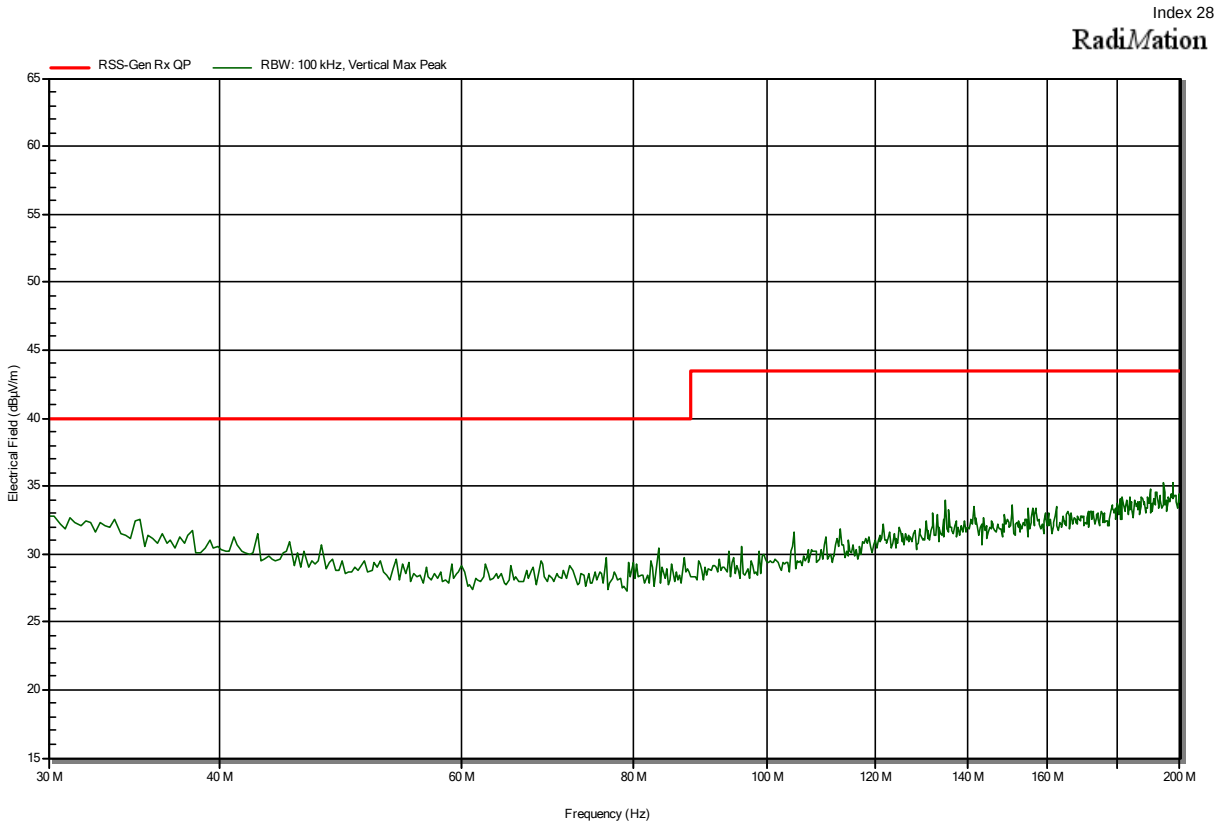
Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement distance:	3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



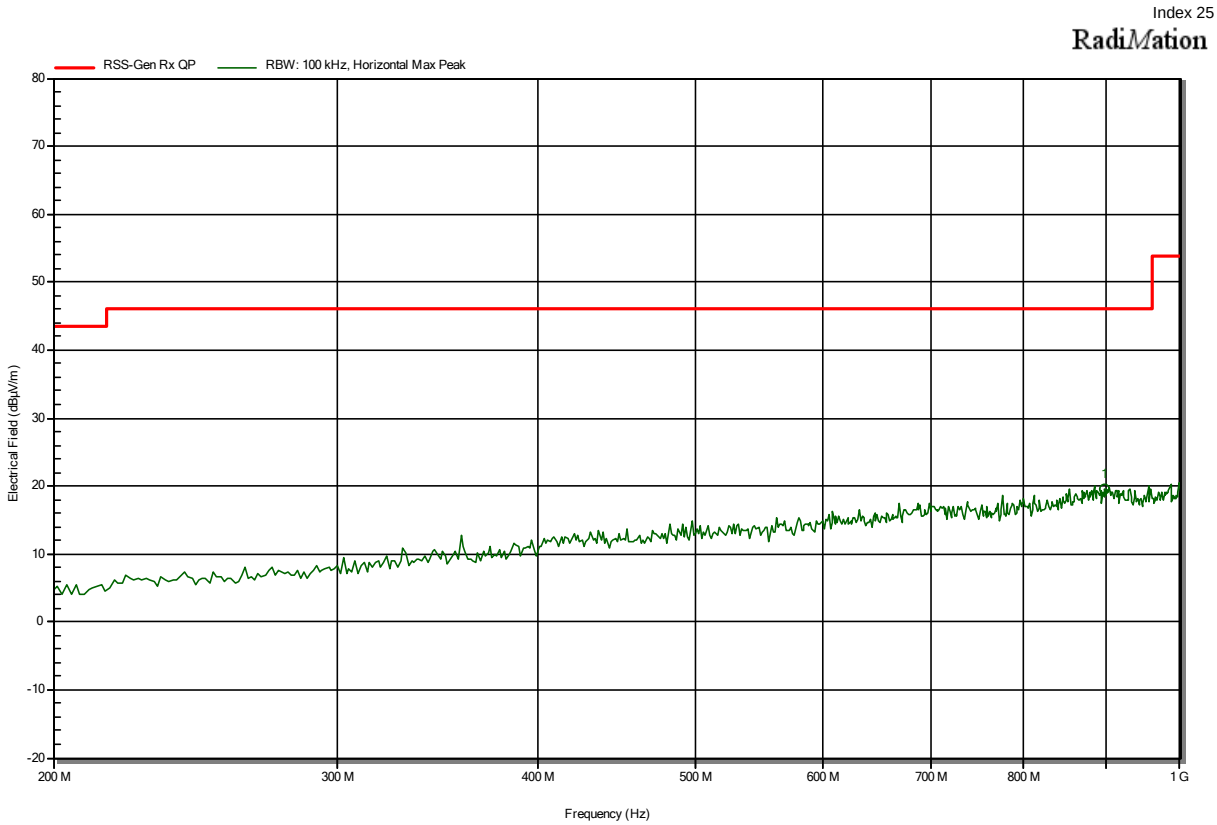
Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HK 116, Vertical
Measurement distance:	3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HL 223, Horizontal
Measurement distance:	3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Frequency	Peak	Peak Limit	Peak Difference	Peak Status
897.436 MHz	19.52 dBµV/m	46 dBµV/m	-26.48 dB	Pass

Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

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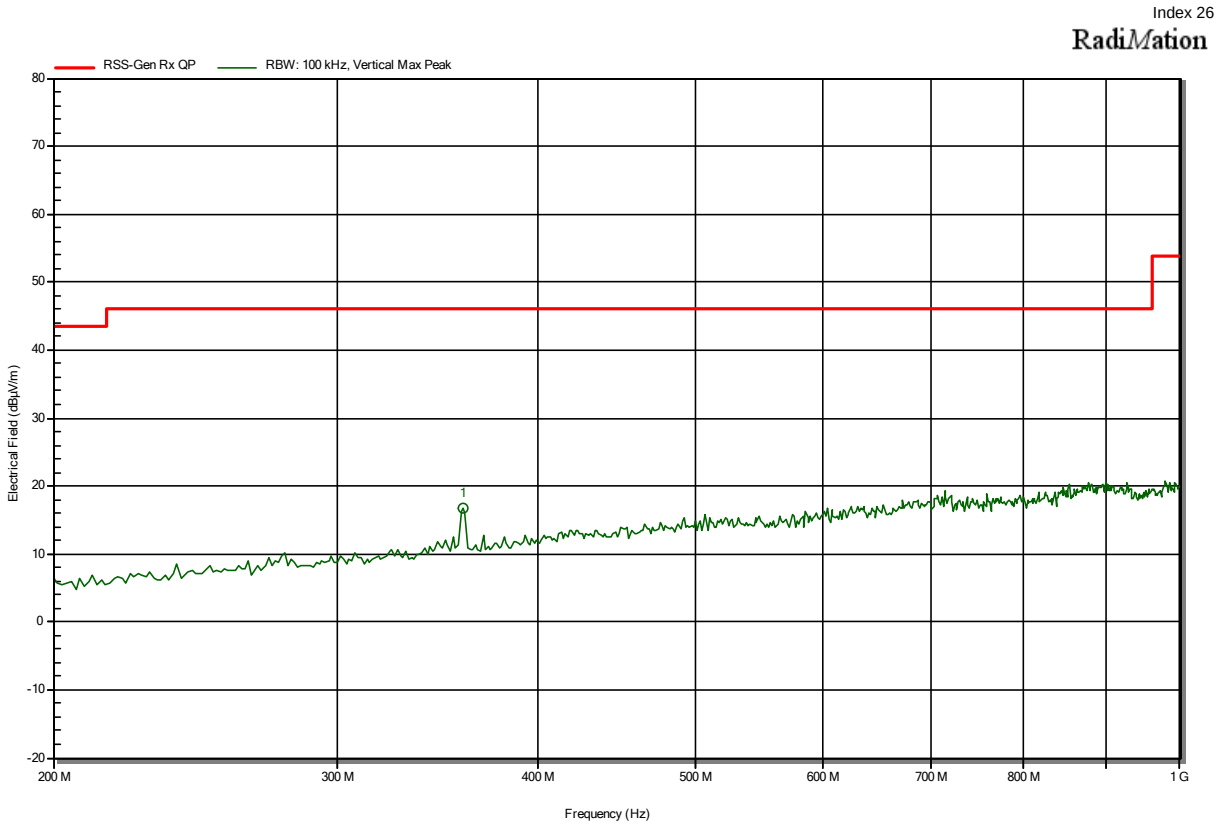
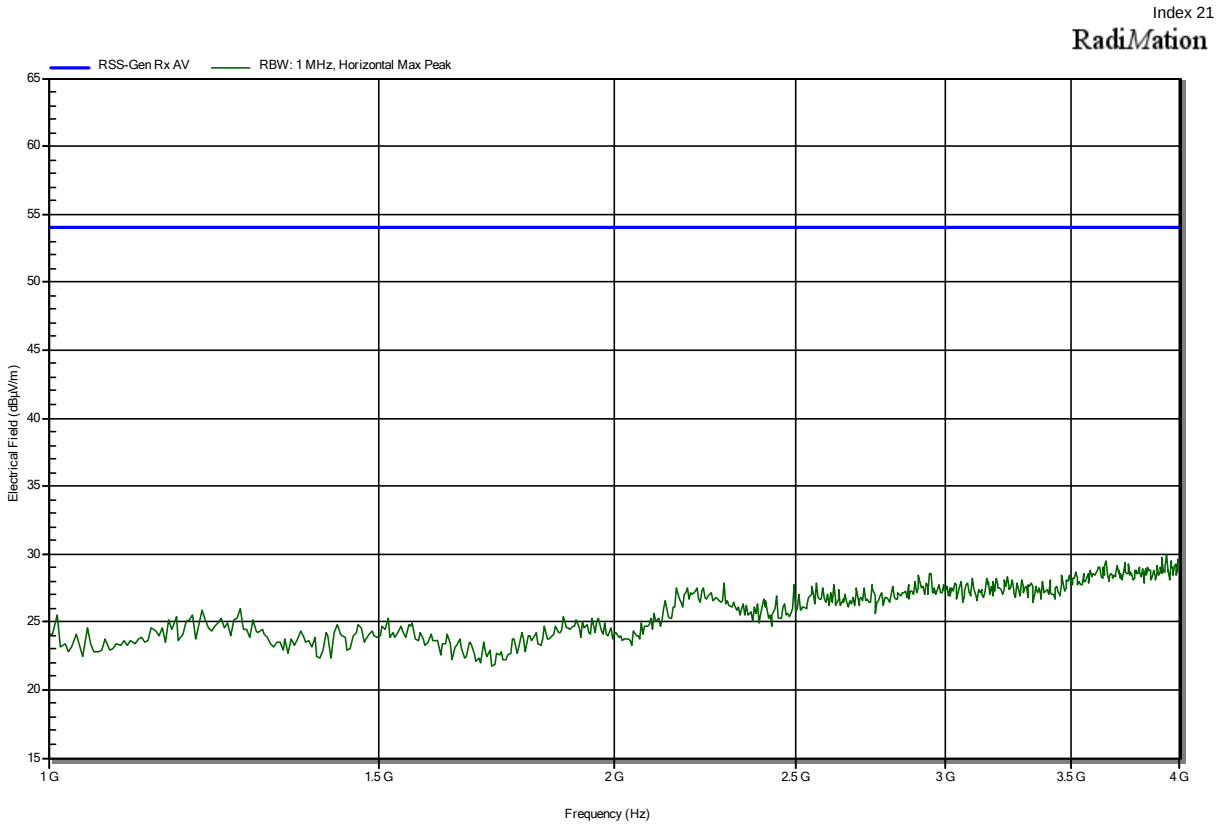
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Rohde & Schwarz HL 223, Vertical
Measurement distance:	3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Frequency	Peak	Peak Limit	Peak Difference	Peak Status
358.974 MHz	16.85 dBµV/m	46 dBµV/m	-29.15 dB	Pass

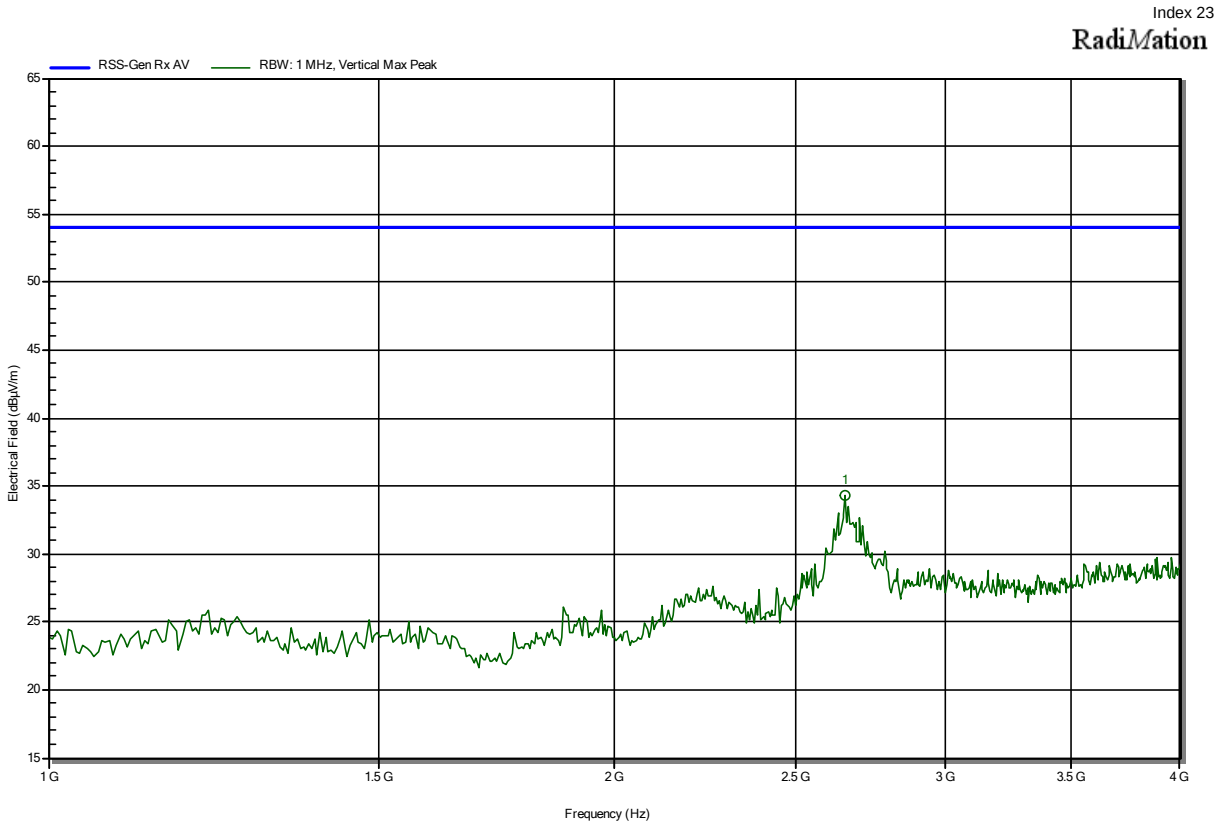
Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement distance:	1 m, converted to 3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement distance:	1 m, converted to 3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Frequency	Peak	Peak Limit	Peak Difference	Peak Status
2.654 GHz	34.32 dBµV/m	53.98 dBµV/m	-19.66 dB	Pass

Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
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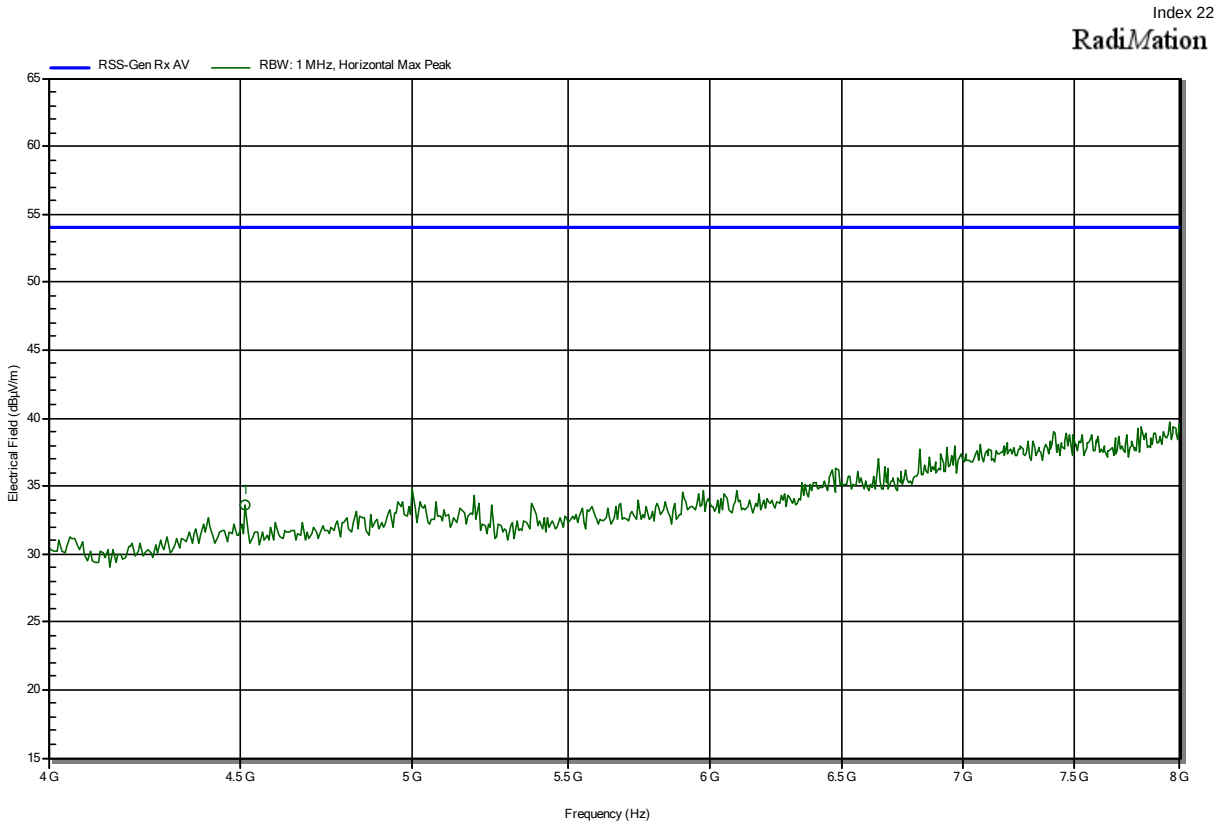
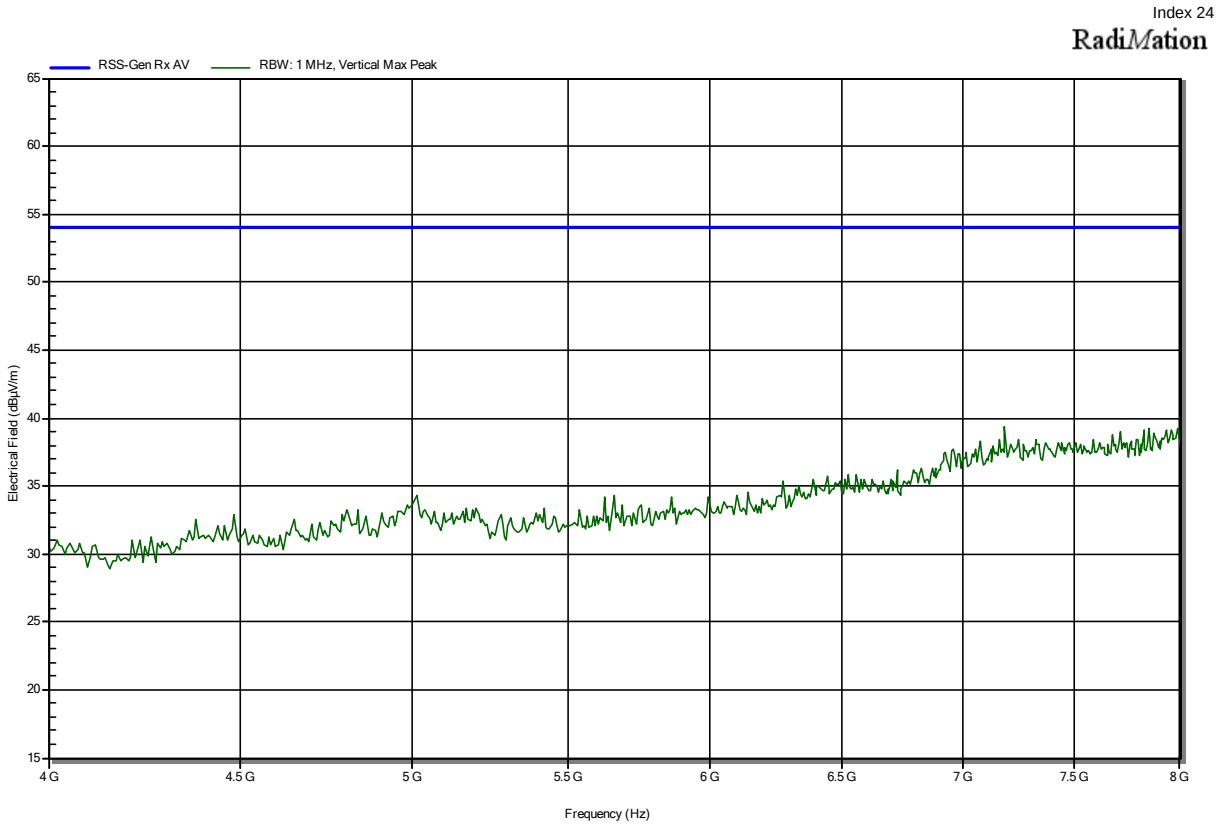
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement distance:	1 m, converted to 3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



Frequency	Peak	Peak Limit	Peak Difference	Peak Status
4.513 GHz	33.56 dBµV/m	53.98 dBµV/m	-20.42 dB	Pass

Radiated Spurious Emissions according to ISED RSS-Gen Issue 5, Amendment 1 (March 2019)

Project Number:	G0M-2008-9229
Applicant:	Hempel A/S
Model Description:	Temperature and humidity logger with BLE and LoRa communication
Model:	915 MHz
Test Sample ID:	32167
Test Site:	Eurofins Product Service GmbH
Operator:	Wilfried Treffke
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 22 °Celsius, Vnom: 3.6 VDC (removable lithium battery)
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement distance:	1 m, converted to 3 m
Mode:	Rx; LoRa, 925.100 MHz
Test Date:	2020-12-16
Note:	EUT horizontal



= = = END OF TEST REPORT = = =