EMC TEST REPORT

Title 47 CFR Part 15B, ISED ICES-003 Issue 7

Report Reference No	G0M-2201-1254-EF0115B-V01
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	A2LA - Registration number: 1983.01 (ISED) ISED wireless device testing laboratory: CN 3470A DAkkS - Registration number : D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant	Nokeval Oy
Address	Rounionkatu 107 37150 Nokia Finland
Test Specification Standard(s)	Title 47 CFR Part 15 Subpart B ISED ICES-Gen Issue 1 ; Amendment 1 (February 2021) ISED ICES-003 Issue 7 ANSI C63.4:2014+A1:2017
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	LoRaWAN temperature transmitter with external sensor
Model(s)	Flex2-Radio-LWNA
Additional Model(s)	Flex2-Module-CS, Flex2-Module-T, Flex2-Module-T-RH Flex2-Module-ES, Flex2-Module-nSens
Brand Name(s)	None
Hardware Version(s)	Flex2-Radio-LWNA : V1.0a Additional Models: V1.2
Software Version(s)	Flex2-Radio-LWNA: V1.1.06 Additional Models: V1.1
FCC-ID	2A3B4FLEX21
IC	28328-FLEX21
Test Result	**PASSED**

Possible test case verdicts:	
required by standard but not tested	N/T
not required by standard	N/R
required by standard but not appl. to test object	N/A
test object does meet the requirement	P(PASS)
test object does not meet the requirement	F(FAIL)

Testing:		
Date of receipt of test item	2022-02-24	
Report:		
Compiled by	Manuel Engel	
Tested by (+ signature) (Responsible for Test)	Manuel Engel	
Approved by (+ signature) (EMC Senior Test Technician)	Matthias Handrik	
Date of Issue	2022-05-04	
Total number of pages	80	

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:

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EUT	Equipment Under Test
FCC	Federal Communications Commission
ISED	Innovation, Science and Economic Development Canada
T_{NOM}	Nominal operating temperature
V_{NOM}	Nominal supply voltage

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2022-05-04	Initial Release	-

REPORT INDEX

1 Equipment (Test Item) Under Test

Description	LoRaWAN temperature transmitter with external sensor		
Intended Use	Flex2-Module-CS: Measurement module for an external Pt100 temperature sensor; Flex2-Module-T: Measurement module for ambient temperature Flex2-Module-T-RH: Measurement module for ambient temperature and humidity Flex2-Module-ES: Measurement module for an external Pt100 temperature sensor Flex2-Module-nSens: Measurement module for ambient temperature and humidity with a Novasina probel		
Model	Flex2-Radio-LWNA		
Additional Model(s)	Flex2-Module-CS, Flex2-Module-T, Flex2-Module-T-RH Flex2-Module-ES, Flex2-Module-nSens		
Brand Name(s)	None		
Sample Identification	EUT #	Sample-ID	Serial Number
	EUT 1 (Flex2-Radio-LWNA)	38624	P524947
	EUT 2 (Flex2-Module-CS)	38628	P528215
	EUT 3 (Flex2-Module-T)	38630	P528223
	EUT 4 (Flex2-Module-T-RH)	38631	P528230
	EUT 5 (Flex2-Module-ES)	38632	P528219
	EUT 6 (Flex2-Module-nSens)	38633	P528226
Hardware Version(s)	Flex2-Radio-LWNA : V1.0a Additional Models: V1.2		
Software Version(s)	Flex2-Radio-LWNA: V1.1.06 Additional Models: V1.1		
EUT Dimensions [mm]	Flex2-Radio-LWNA with mounted module Flex2-Module-CS: 60 x 32.5 x 204.7 Flex2-Module-T: 60 x 32.5 x 171 Flex2-Module-T-RH: 60 x 32.5 x 212.8 Flex2-Module-ES: 60 x 32.5 x 197.3 Flex2-Module-nSens: 60 x 32.5 x 292.8 (probe attached)		
FCC-ID	2A3B4FLEX21		
IC	28328-FLEX21		
Class	Class B		
Equipment type	Table top		
Highest internal frequency [MHz]	32 (clock); 928 (Radio frequency)		
Protective Earth	None		
Radio Module (Model Flex2-Radio-LWNA)	Type	LoRaWAN	
	Model	CMWX1ZZABZ-093	
	Manufacturer	Murata	
	FCC-ID	VPYCMABZ	
	IC	772C-CMABZ	
Supply Voltage	V_{NOM}	3.6 V DC (via internal lithium thionyl chloride battery of sensor unit)	
AC/DC-Adaptor	None		
Manufacturer	Nokeval Oy Rounionkatu 107 37150 Nokia Finland		
Factory	Nokeval Oy Rounionkatu 107 37150 Nokia Finland		

1.1 Equipment Ports

Model: Flex2-Radio-LWNA

Name	Type	Attributes		Comment
Interface plug	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - IN, IO No No	12 pin port interface plug

Model: Flex2-Module-CS

Name	Type	Attributes		Comment
Interface socket	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - OUT, IO No No	12 pin port interface socket
USB	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 5 IO Yes Yes	For configuration; not visible normal. Not tested
External sensor	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 30 IO No No	For external sensor M12 4 pin socket, connected with external sensor during test. 5m cable was used for measurement.

Model: Flex2-Module-T

Name	Type	Attributes		Comment
Interface socket	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - OUT, IO No No	12 pin port interface socket
USB	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 5 IO Yes Yes	For configuration; not visible normal. Not tested

Model: Flex2-Module-T-RH

Name	Type	Attributes		Comment
Interface socket	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - OUT, IO No No	12 pin port interface socket
USB	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 5 IO Yes Yes	For configuration; not visible normal. Not tested

Model: Flex2-Module-ES

Name	Type	Attributes		Comment
Interface socket	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - OUT, IO No No	12 pin port interface socket
USB	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 5 IO Yes Yes	For configuration; not visible normal. Not tested
External sensor	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 30 IO No No	For external sensor, spring loaded connector for bare wire ends, connected with external sensor during test. 5m cable was used for measurement.

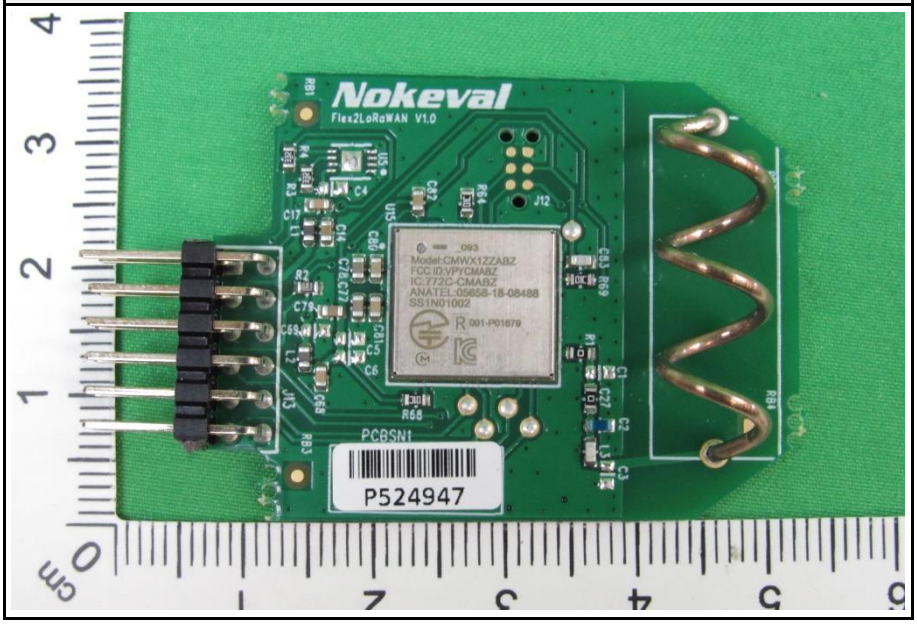
Flex2-Module-nSens

Name	Type	Attributes		Comment
Interface socket	BAT, IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 - OUT, IO No No	12 pin port interface socket
USB	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 5 IO Yes Yes	For configuration; not visible normal. Not tested
External sensor	IO	Count: Cable length [m]: Direction: Service only: Shielded:	1 2 IO No No	For external sensor, socket Binder 99-9108-00-03, connected direct with external humidity probe during test, without cable.

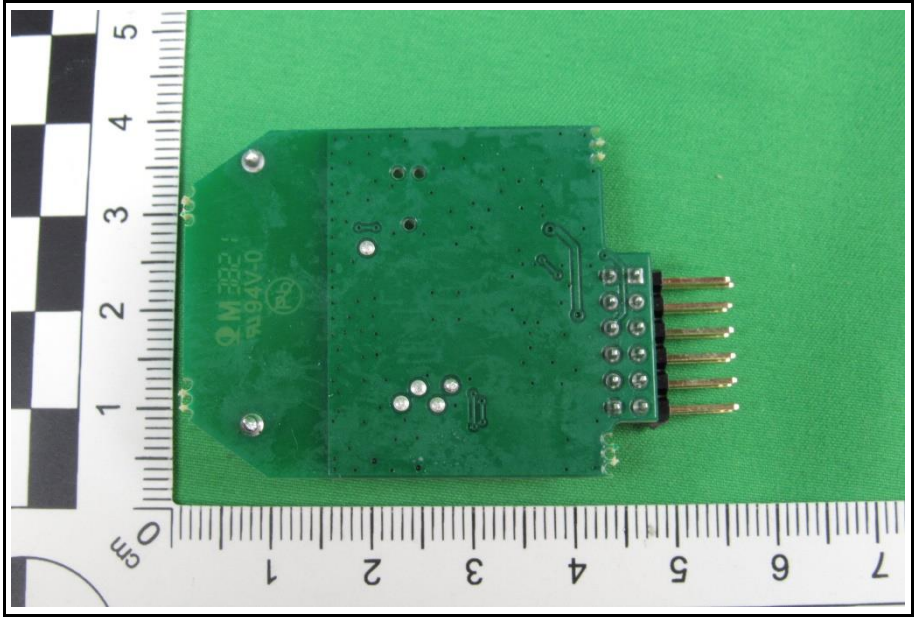
Description:	
AC	AC mains power input/output port
DC	DC power input/output port
BAT	DC power input port connected to external battery
IO	Input/Output port
TP	Telecommunication port
NE	Non-electrical port

1.2 Equipment Photos - Internal

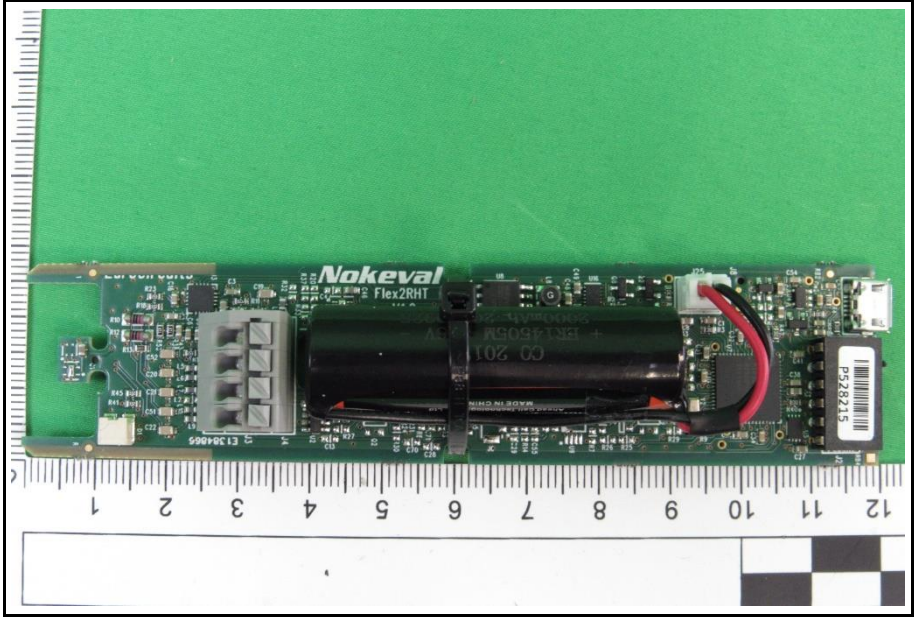
Model Flex2-Radio-LWNA PCB front view

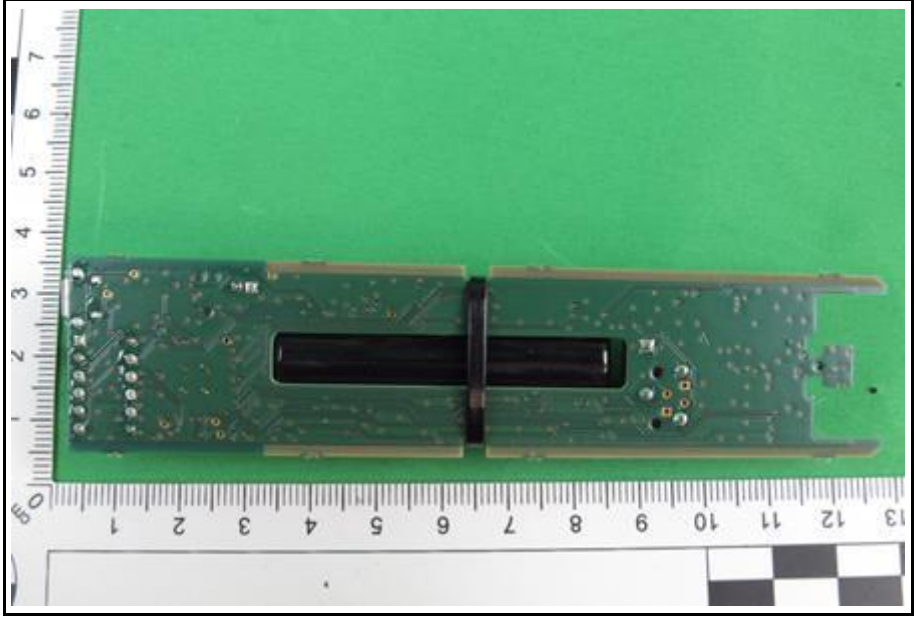


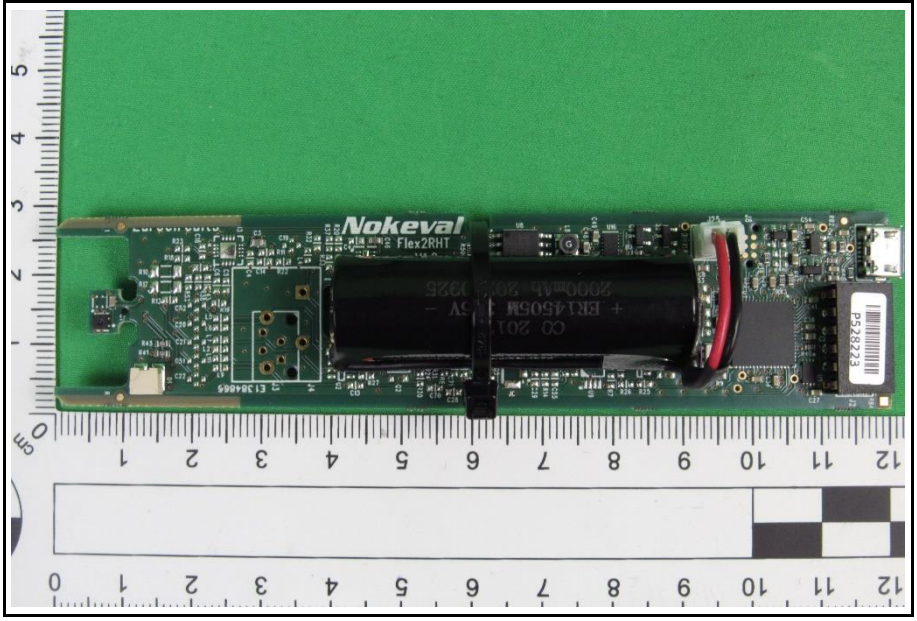
Model Flex2-Radio-LWNA PCB back view

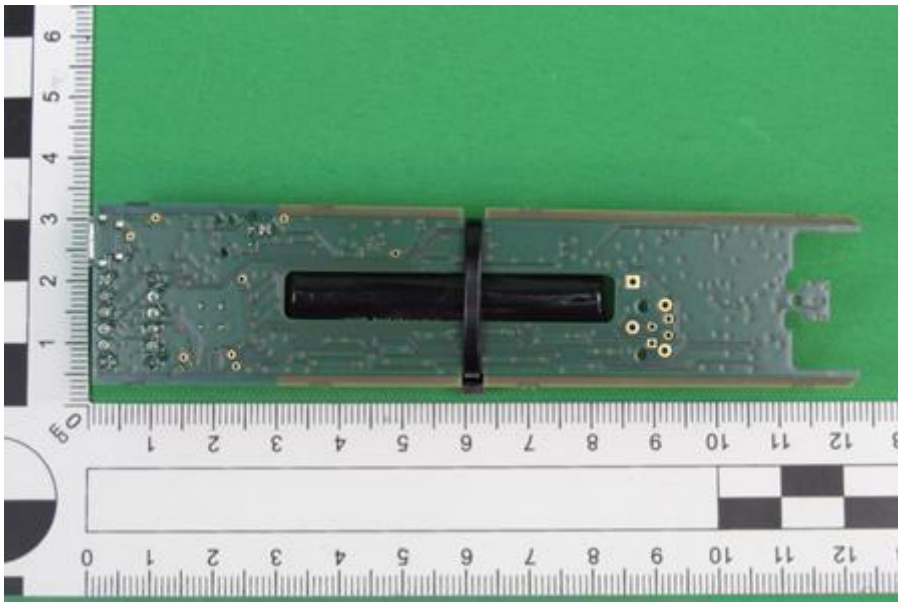


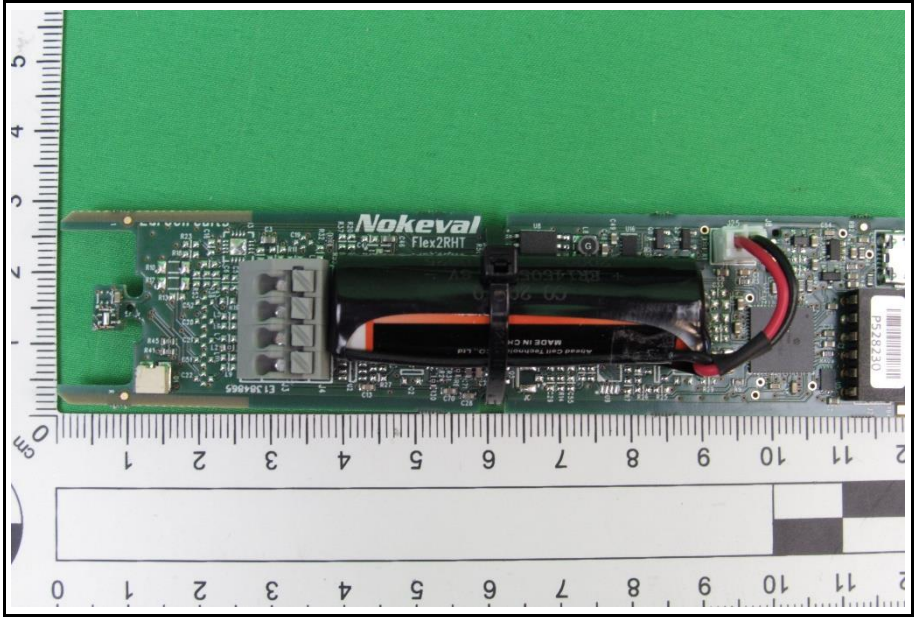
Model Flex2-Radio-LWNA PCB front view

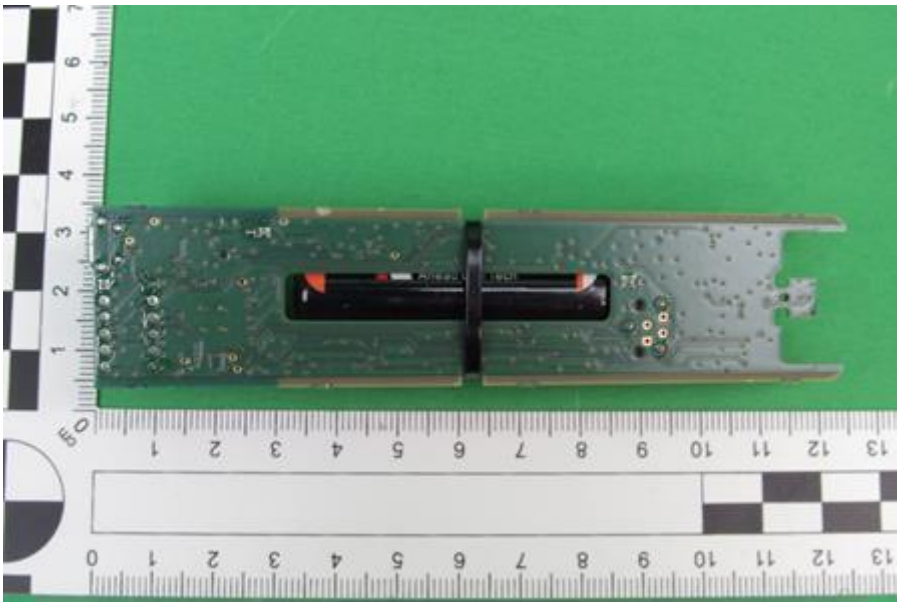

Model Flex2-Module-CS PCB front


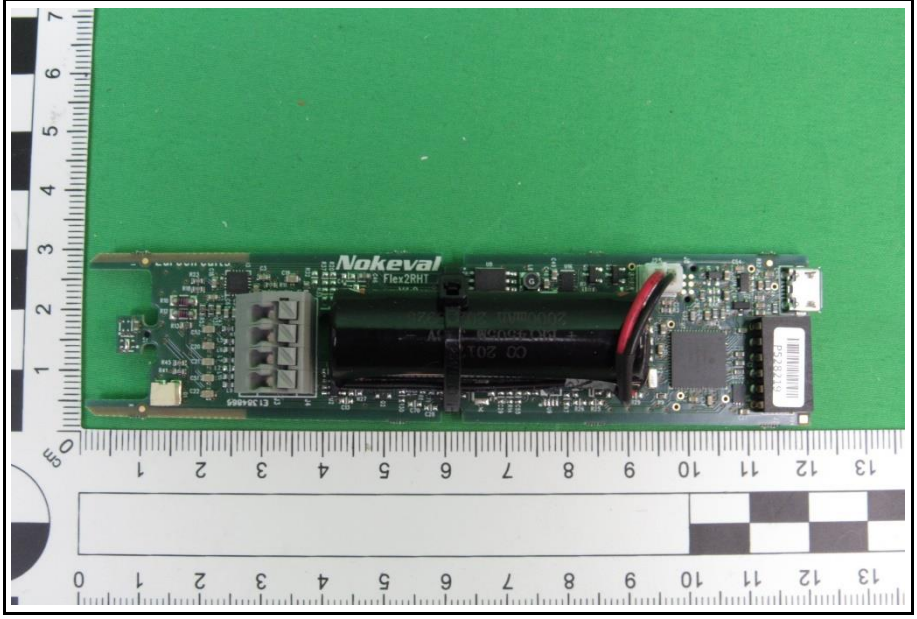
Model Flex2-Module-CS PCB bottom


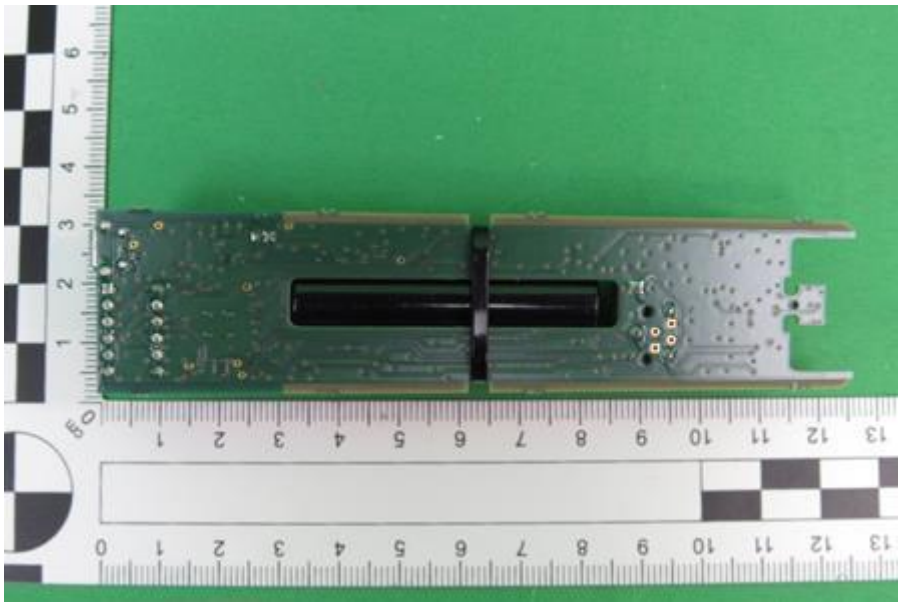
Model Flex2-Module-T PCB top


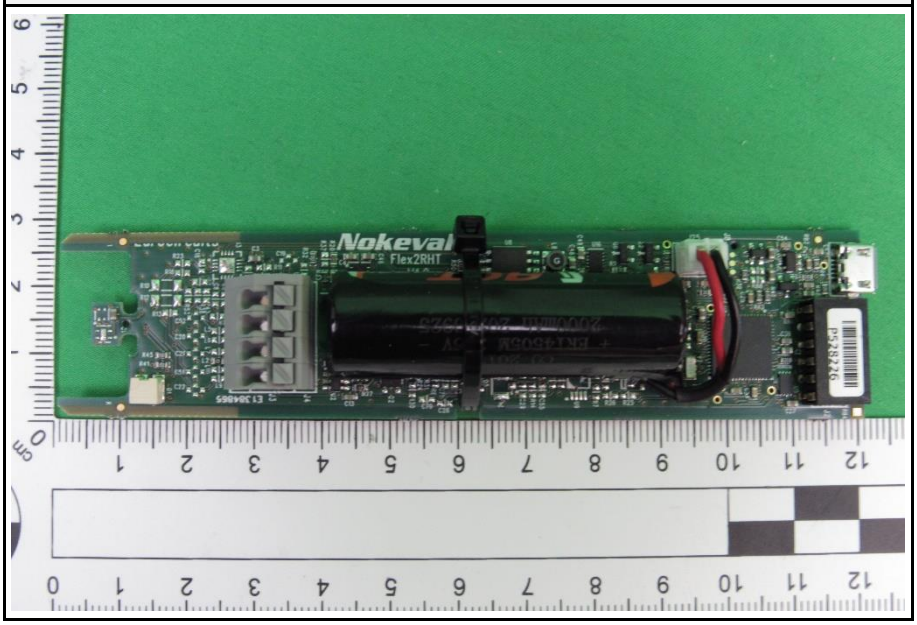
Model Flex2-Module-T PCB bottom view


Model Flex2-Module-T-RH PCB top view


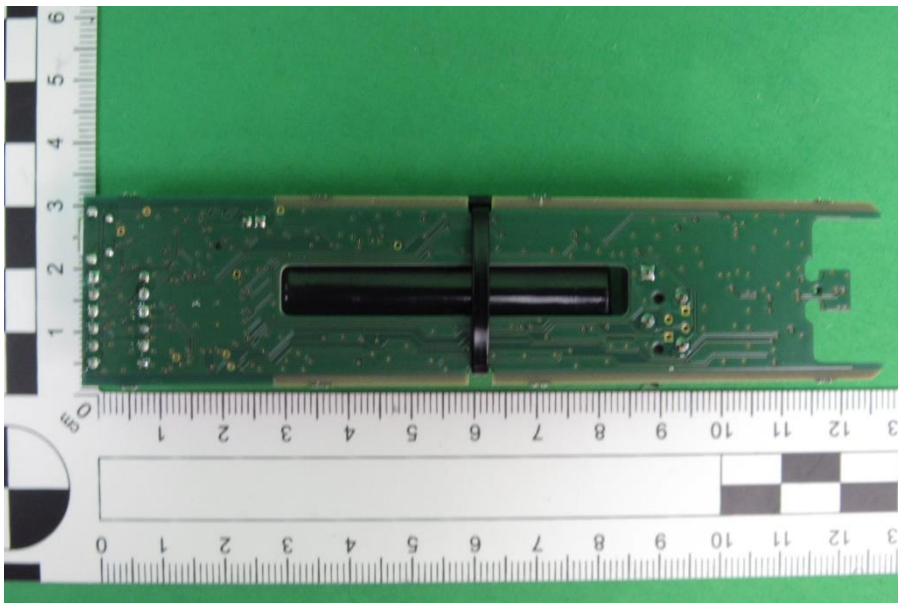
Model Flex2-Module-T-RH PCB bottom view


Model Flex2-Module-ES PCB top view


Model Flex2-Module-ES PCB bottom view


Model Flex2-Module-nSens PCB top view


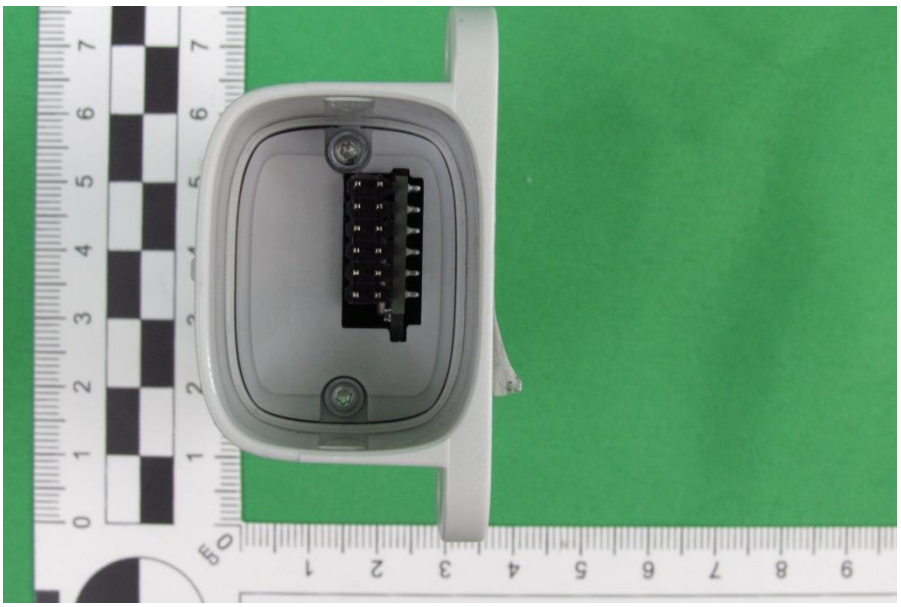
Model Flex2-Module-nSens PCB bottom view

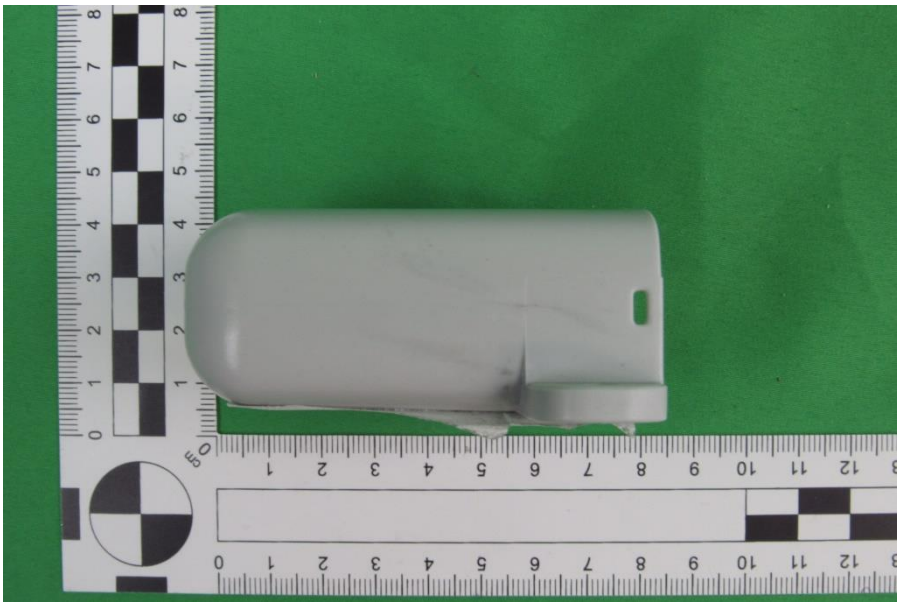


1.3 Equipment Photos - External

Model Flex2-Radio-LWNA front view

Model Flex2-Radio-LWNA back view

Model Flex2-Radio-LWNA right view


Model Flex2-Radio-LWNA bottom view


Model Flex2-Radio-LWNA top view


Model Flex2-Radio-LWNA left view

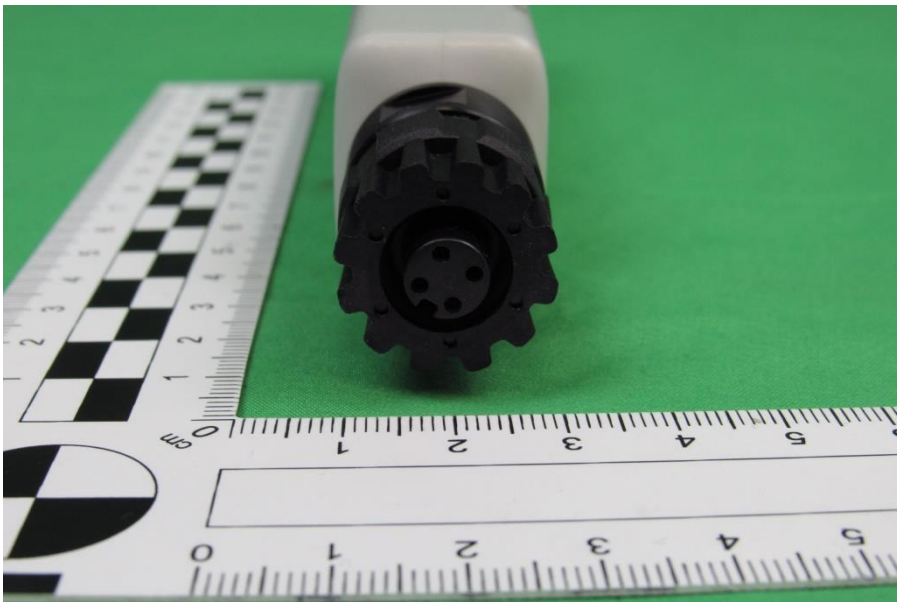

Model Flex2-Module-CS front view

Model Flex2-Module-CS back view

Model Flex2-Module-CS top view

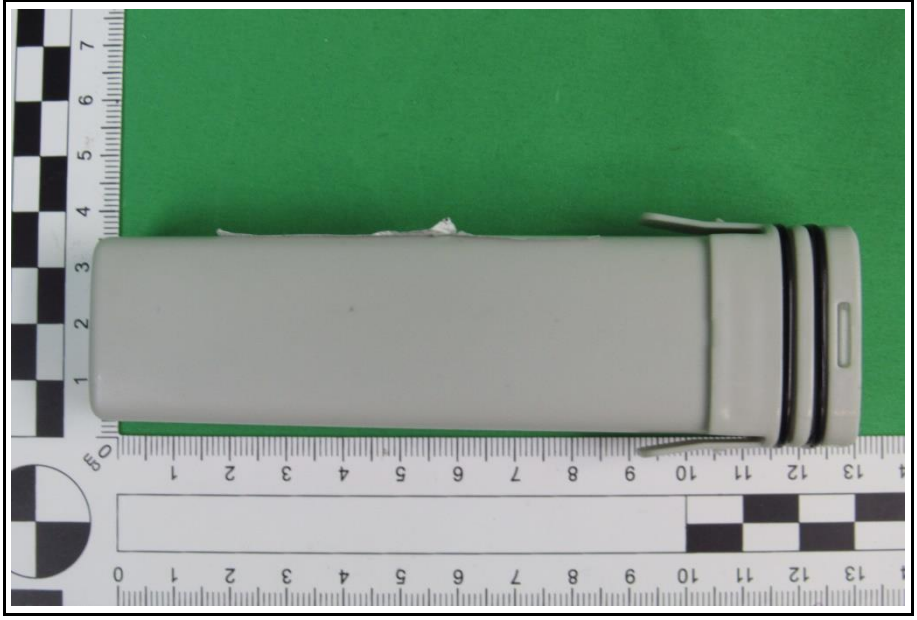
Model Flex2-Module-CS bottom view

Model Flex2-Module-CS left view


Model Flex2-Module-CS right view


Model Flex2-Module-T front view

Model Flex2-Module-T back view

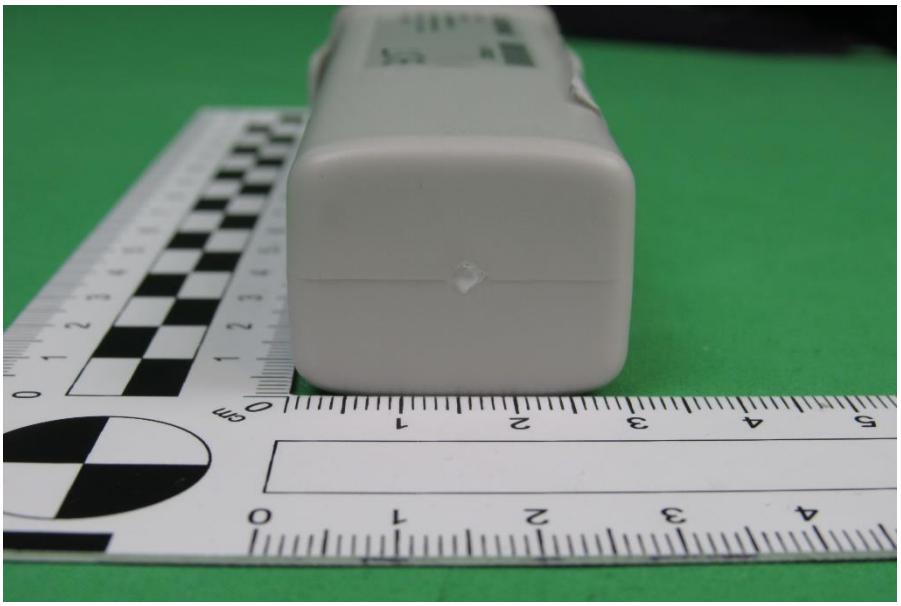


Model Flex2-Module-T top view


Model Flex2-Module-T bottom view


Model Flex2-Module-T left view

Model Flex2-Module-T right view



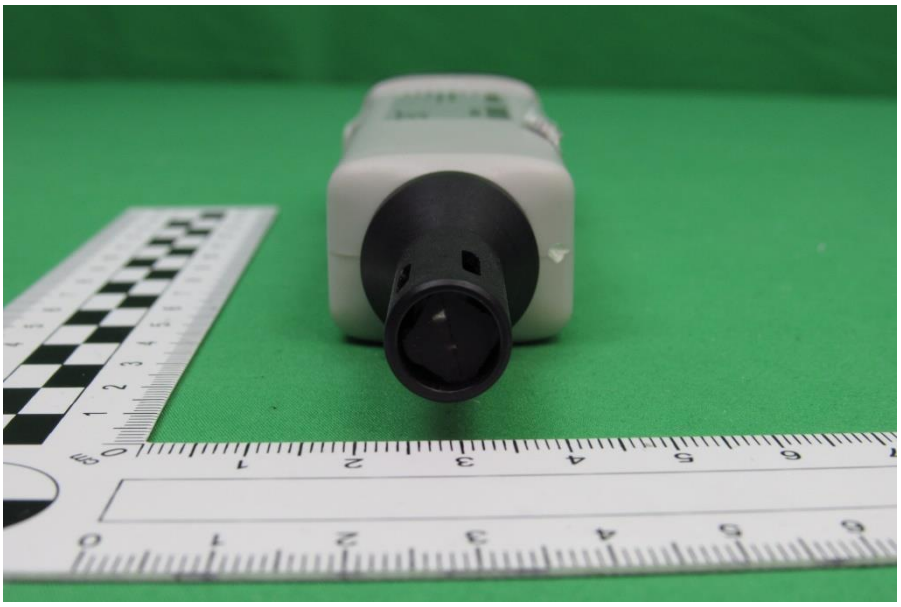
Model Flex2-Module-T-RH front view


Model Flex2-Module-T-RH back view


Model Flex2-Module-T-RH top view


Model Flex2-Module-T-RH bottom view


Model Flex2-Module-T-RH left view


Model Flex2-Module-T-RH right view


Model Flex2-Module-ES front view

Model Flex2-Module-ES back view

Model Flex2-Module-ES top view

Model Flex2-Module-ES bottom view

Model Flex2-Module-ES left view


Model Flex2-Module-ES right view


Model Flex2-Module-nSens front view

Model Flex2-Module-nSens back view

Model Flex2-Module-nSens top view


Model Flex2-Module-nSens bottom view


Model Flex2-Module-nSens left view


Model Flex2-Module-nSens right view


Auxiliary equipment

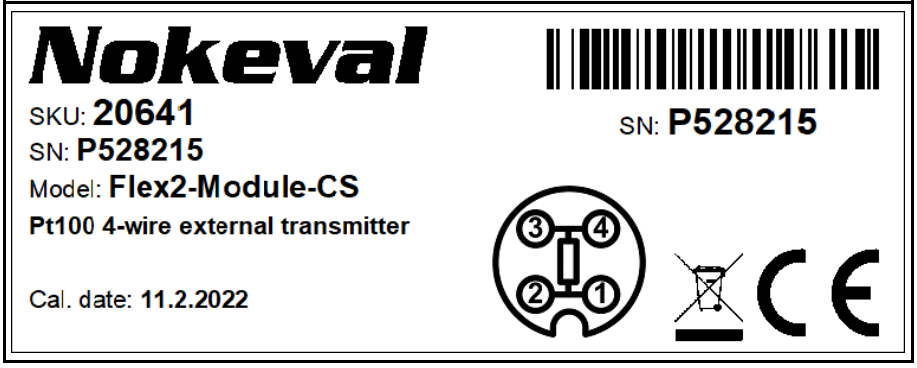
Previous labels shown at the picture above of the EUT are prototype labels.
Final Labels for these EUTs are shown on the next pages.

Draft final label model Flex2-Radio-LWNA

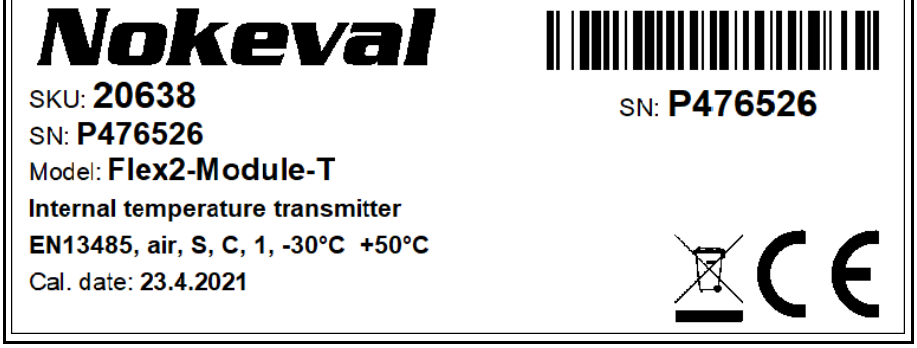
Nokeval

SN: **P12345**
Model: **Flex2-Radio-LWNA**
Radio: **902 - 928 MHz, max 20 dBm**
DevEUI: **C4AC590000CC6CA8**
FCC ID: 2A3B4FLEX21
IC: 28328-FLEX21
FVIN: V1.1.06
Manufacturer: **Nokeval Oy**

Draft final label model Flex2-Module-CS



Draft final label model Flex2-Module-T-RH



Draft final label model Flex2-Module-T-RH

Nokeval

SKU: **20639**
SN: **P428814**
Model: **Flex2-Module-T-RH**
Temperature & Humidity transmitter
Temperature channel: 1
Humidity channel: 2
Cal. date: **25.11.2020**

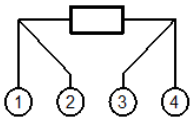
SN: **P428814**

Draft final label model Flex2-Module-ES

Nokeval

SKU: **20640**
SN: **P528219**
Model: **Flex-Module-ES**
Pt100 4-wire external transmitter

Cal. date: **11.2.2022**



SN: **P528219**

Draft final label model Flex2-Module-nSens

1.4 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	External sensor PT 100	TC Direct	IKES-50-6.0-5m/4-250C	M12 plug or bare ends version on site, customer equipment
AE	Humidity probe	Novasina	nSens-HT-ENS	for nSens model, customer equipment
AE, MON	Raspberry Pie with Antenna and ACDC Adapter	Raspberry	ER14505	Monitoring operation status, customer equipment
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
MON	Monitoring Equipment			
CBL	Connecting Cable			
Comment:				

1.5 Operational Modes

Mode #	Description
1	Device measuring environmental data, send data to auxiliary equipment Raspberry Pie via LoRaWAN. Software was modified for testing, measurement interval set on 2 s.
Comment: -	

1.6 EUT Configuration

Configuration #	Description
1	Model Flex2-Radio-LWNA plugged in model Flex2-Module-CS via 12 pin port interface plug. External PT 100 sensor mounted
2	Model Flex2-Radio-LWNA plugged in model Flex2-Module-T via 12 pin port interface plug.
3	Model Flex2-Radio-LWNA plugged in model Flex2-Module-T-RH via 12 pin port interface plug.
4	Model Flex2-Radio-LWNA plugged in model Flex2-Module-ES via 12 pin port interface plug. External PT 100 sensor mounted.
5	Model Flex2-Radio-LWNA plugged in model Flex2-Module-nSens via 12 pin port interface plug. External humidity probe direct mounted.
Comment: The auxiliary equipment Raspberry Pie is outside the test site during test but has access via antenna to the EUT in the test site.	

1.7 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 analyser in dBµV. Any external preamplifiers used are taken into account through internal analyser 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 analyser. 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 Analyser (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

Title 47 CFR Part 15B, ISED ICES-003 Issue 7				
Reference	**Requirement**	**Reference Method**	**Result**	**Remarks**
Emission				
FCC 15.109 ICES-003, 3.2.2	Radiated emissions	ANSI C63.4:2014 +A1:2017	PASS	-
FCC 15.107 ICES-003, 3.2.1	AC power line conducted emissions	ANSI C63.4:2014 +A1:2017	N/R	-
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

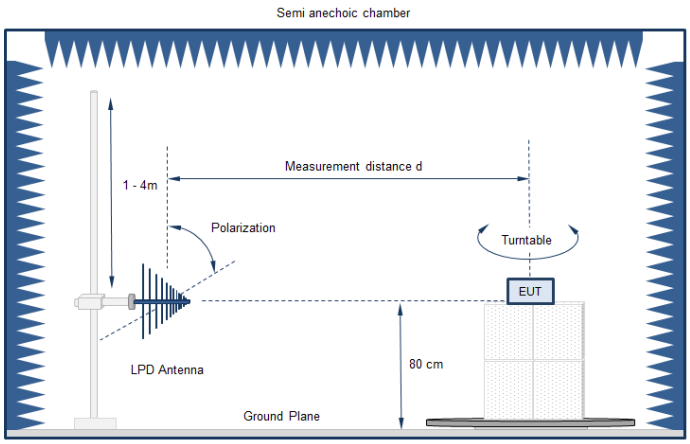
2.1 Test Conditions and Results - Radiated emissions acc. to ANSI C63.4

2.1.1 Information

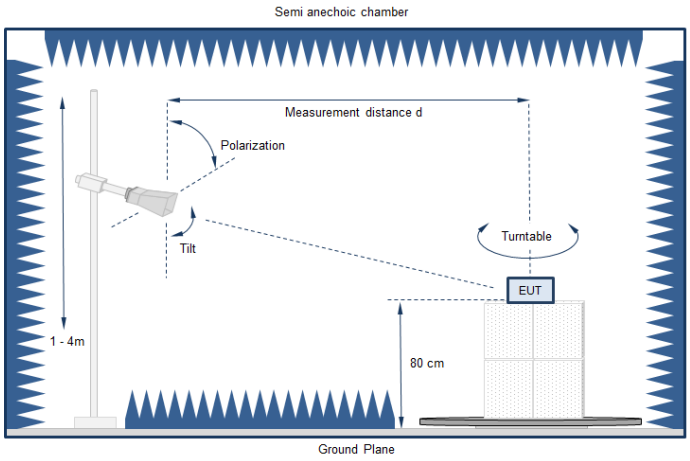
Test Information	
Reference	FCC 15.109, ICES-003, 3.2.2
Reference method	ANSI C63.4:2014+A1:2017 Section 8
Equipment class	Class B
Equipment type	Table top
Highest internal frequency [MHz]	928
Measurement range	30 MHz to 5000 MHz
Temperature [°C]	22 ± 2
Humidity [%]	40 ± 4
Operator	Manuel Engel
Date	2022-04-08

2.1.2 Setup

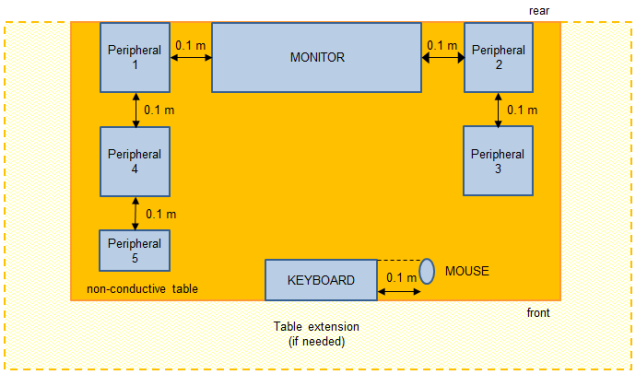
Measurement up to 1 GHz



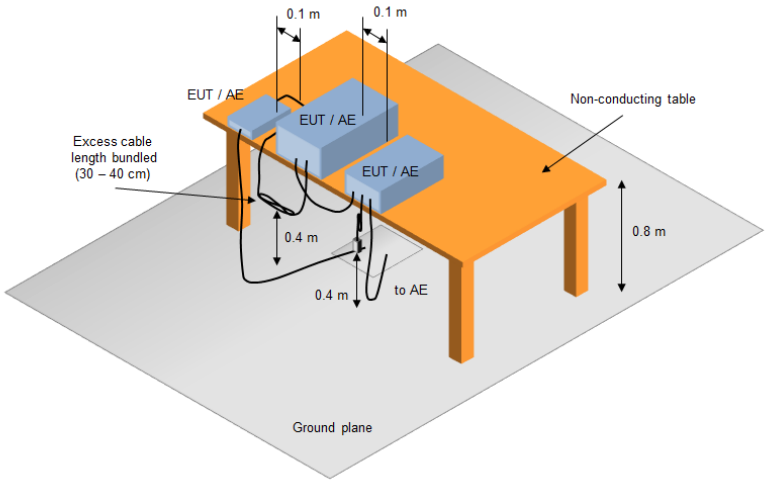
Measurement above 1 GHz



Equipment placement - Table top



Test Setup



2.1.3 Equipment

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

Test Equipment above 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber (SVSWR)	Frankonia	AC 1	EF01011	2019-06	2022-06
EMI Test Receiver	Keysight	N9038A-526/WXP	EF01070	2021-07	2022-07
Horn Antenna	Schwarzbeck	BBHA9120D	EF00018	2019-10	2022-10
Climatic Sensor	Embedded Data Systems, LLC.	2800100000254 17E	EF01054	2021-03	2022-04

Test Equipment up to 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber (NSA)	Frankonia	AC6	EF00910	2021-07	2024-07
EMI Test Receiver	R&S	ESU26	EF00887	2021-07	2022-07
TRILOG Broadband Antenna	Schwarzbeck	VULB 9162	EF00978	2019-10	2022-10
Climatic Sensor	Embedded Data Systems, LLC.	9A00100000254 77E	EF01124	2021-03	2022-04

2.1.4 Procedure

Exploratory measurement
1. The EUT was placed on a non-conductive table at a height of 0.8m. 2. The EUT and support equipment, if needed, were set up to simulate typical usage. 3. Cables, of type and length specified by the manufacturer, were connected to at least one port of each type and were terminated by a device or simulating load of actual usage. 4. The antenna was placed at a distance of 3 or 10 m. 5. The received signal was monitored at the measurement receiver. 6. This procedure has to be performed in both antenna polarizations, horizontal and vertical. 7. The arrangement of the equipment with the maximum emission level is shown on the setup picture at item 2.1.2

Final measurement
1. The EUT was placed on a 0.8 m non-conductive table at a 3 m distance from the receive antenna. The antenna output was connected to the measurement receiver. 2. A biconical antenna was used for the frequency range 30 – 200 MHz, a logarithmic periodical antenna was used for the frequency range from 200 – 1000 MHz. Above one 1 GHz a Double Ridged Broadband Horn antenna was used. The antenna was placed on an adjustable height antenna mast. 3. The EUT and cable arrangement were based on the exploratory measurement results. 4. Emissions were maximized at each frequency by rotating the EUT and adjusting the receive antenna height and polarization. The maximum values were recorded. 5. The test data of the worst-case conditions were recorded and shown on the next pages.

2.1.5 Limits

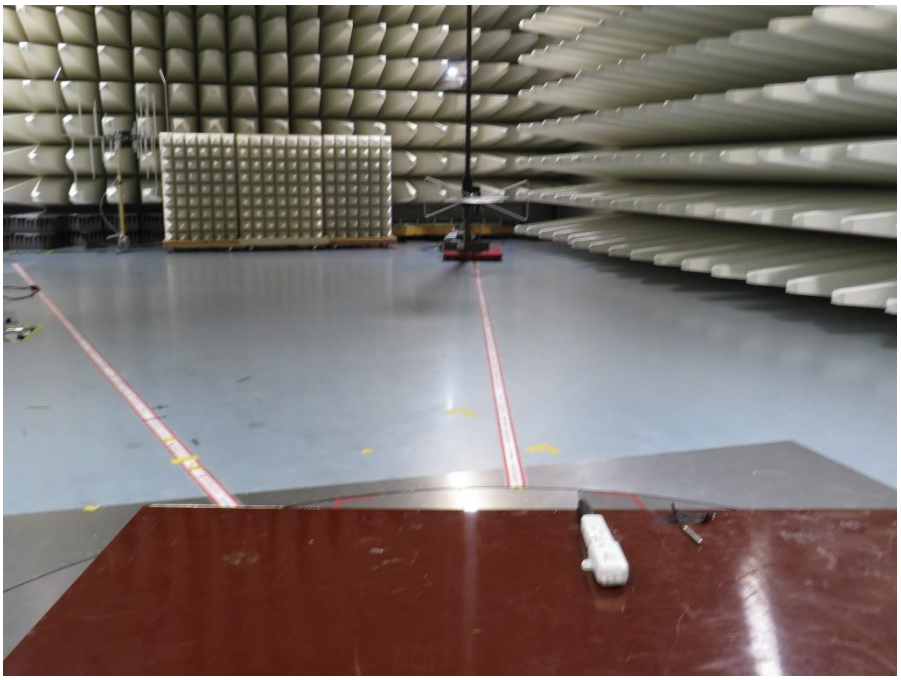
Class B @ 3 m		
Frequency [MHz]	Detector	Limit [dBµV/m]
30 - 88	Quasi-peak	40
88 - 216	Quasi-peak	43.5
216 - 960	Quasi-peak	46
960 - 1000	Quasi-peak	54
> 1000	Peak Average	74 54

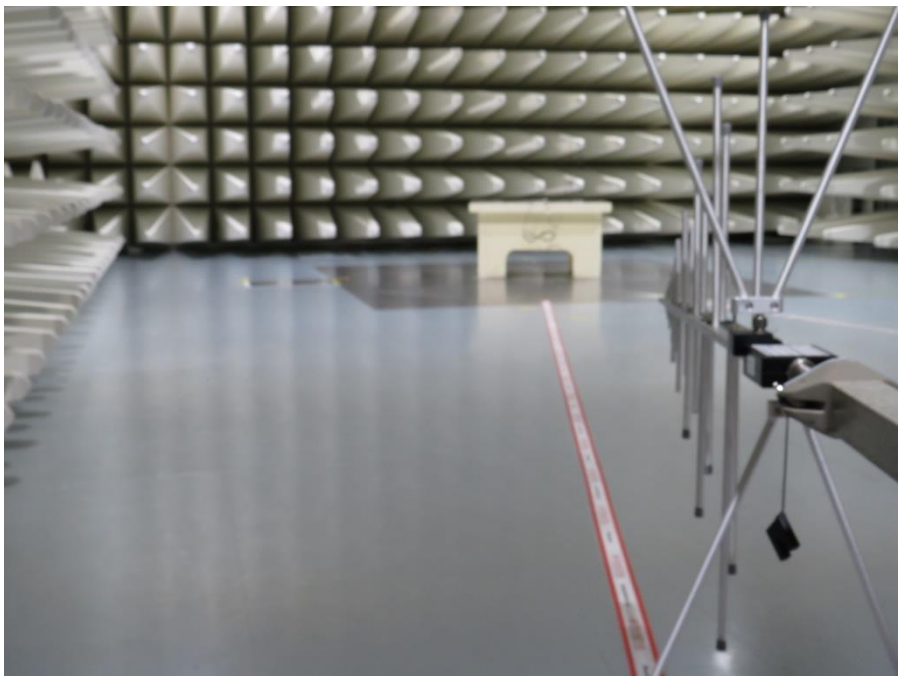
2.1.6 Results

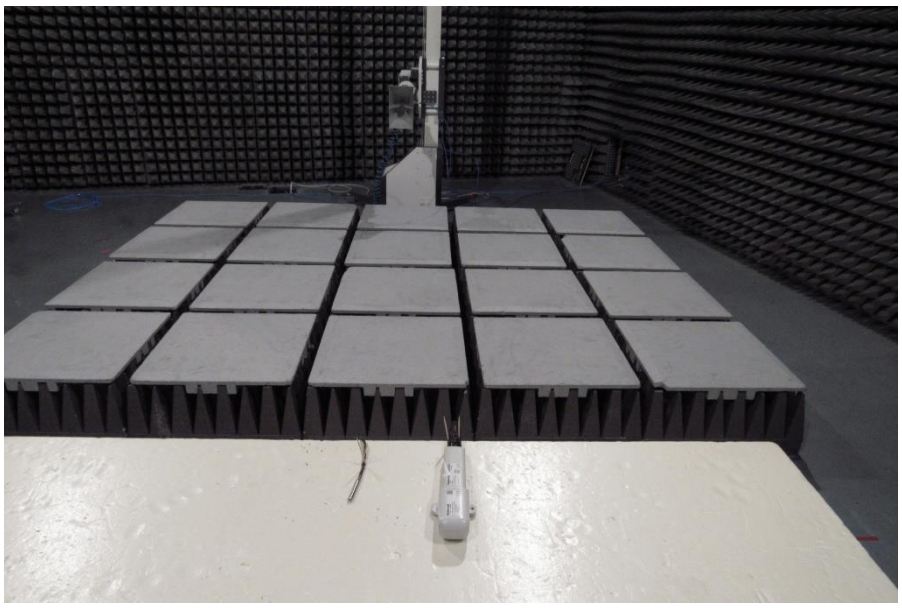
Test Results			
Operational mode	EUT Configuration	Verdict	Remark
1	1	PASS	-
1	2	PASS	-
1	3	PASS	-
1	4	PASS	-
1	5	PASS	-

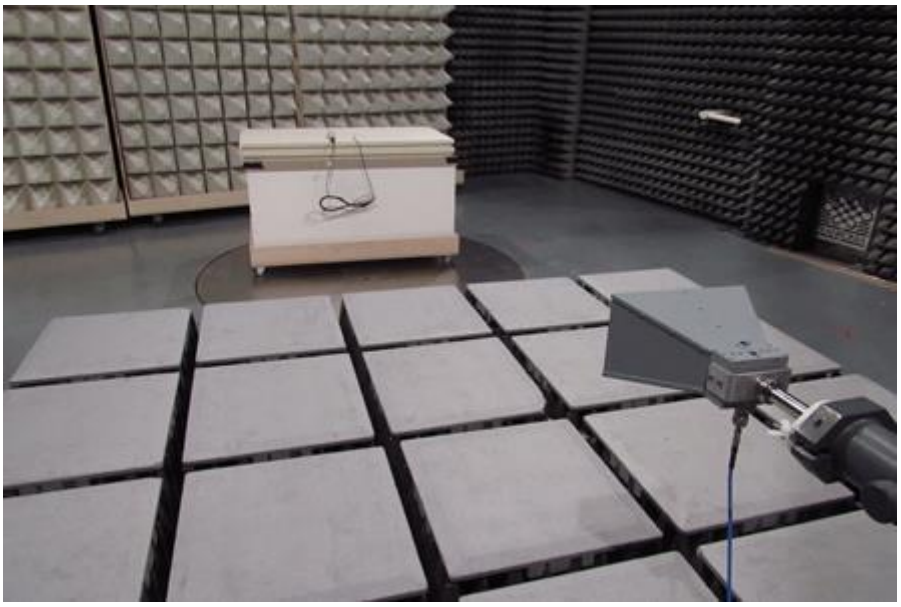
2.1.7 Setup Photos

Arrangement configuration 1


Test setup configuration 1 antenna VULB 9162 horizontal AC 6


Test setup configuration 1 antenna VULB 9162 vertical AC 6


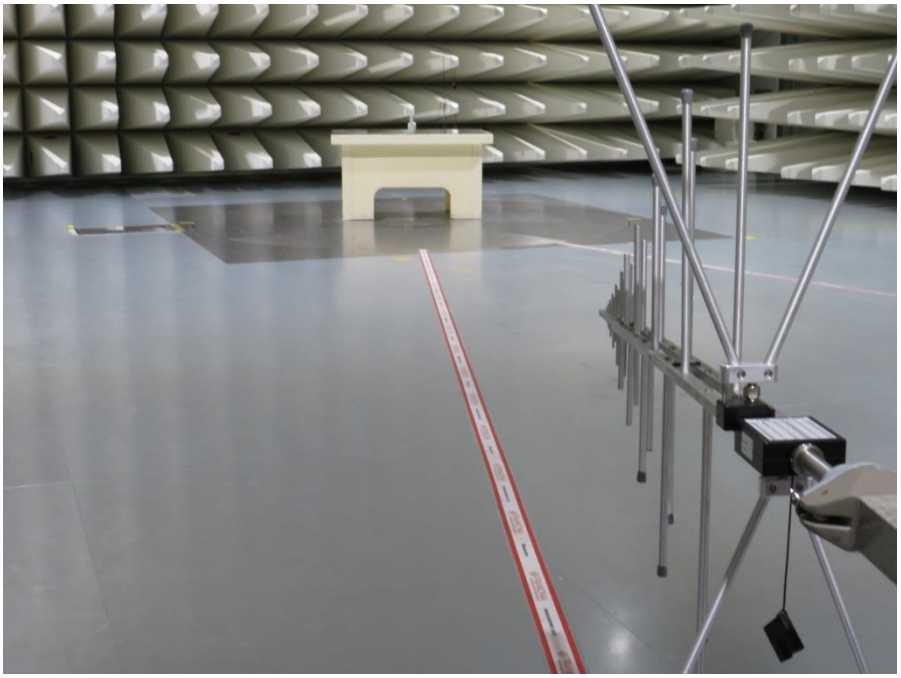
Test setup configuration 1 antenna BBHA9120D horizontal AC 1


Test setup configuration 1 antenna BBHA9120D vertical AC 1


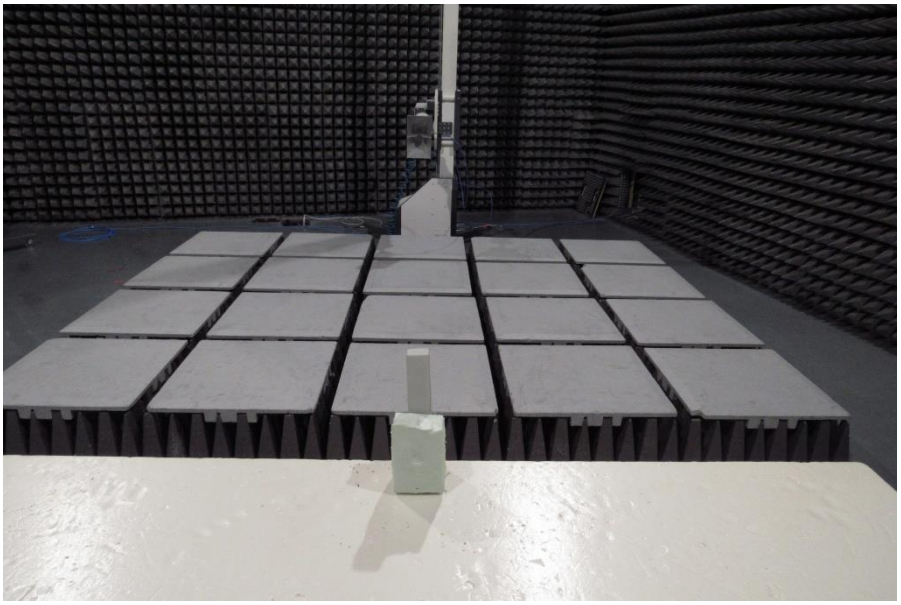
Arrangement configuration 2


Test setup configuration 2 antenna VULB 9162 horizontal AC 6

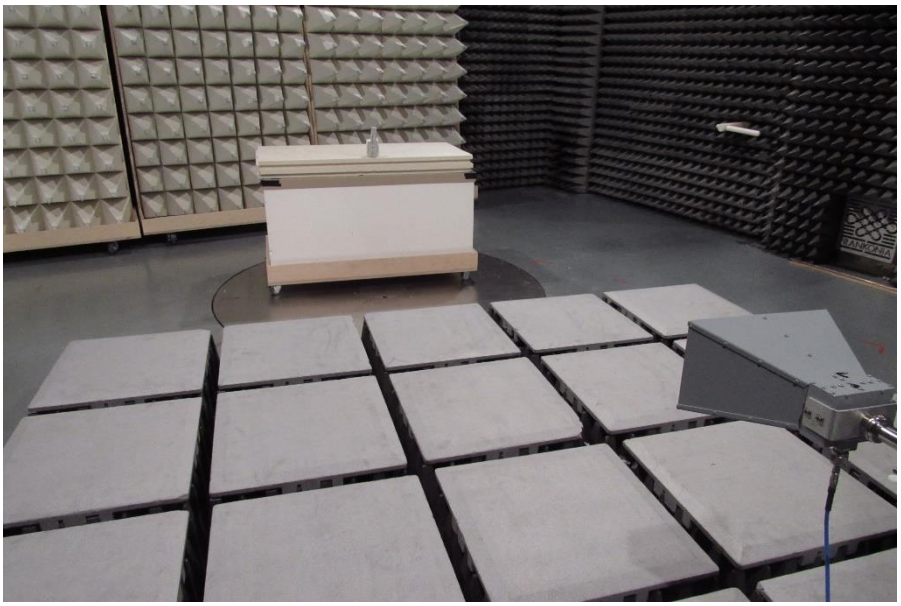
Test setup configuration 2 antenna VULB vertical AC 6



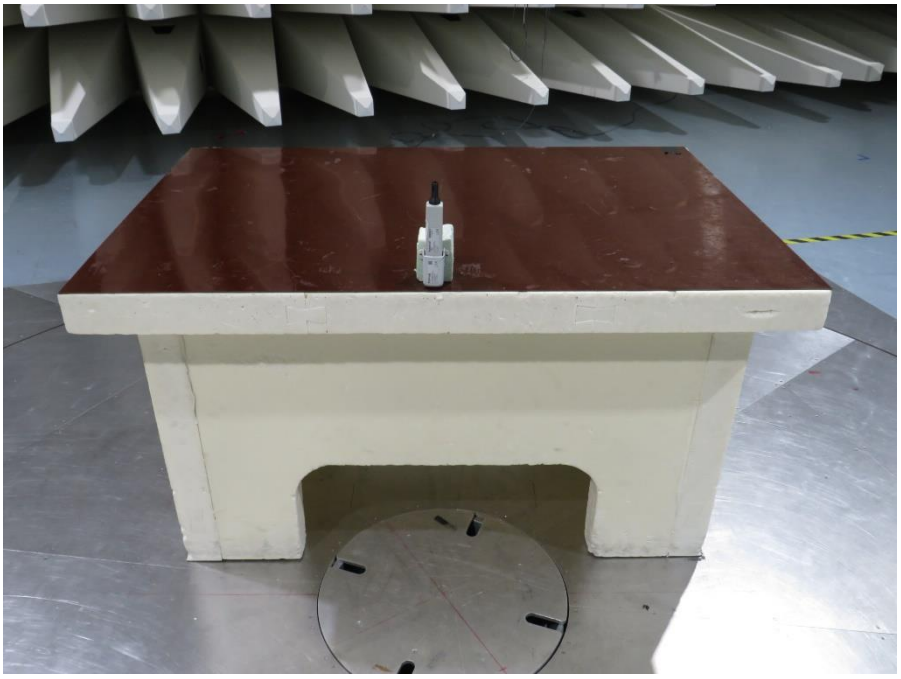
Test setup configuration 2 antenna BBHA9120D horizontal AC 1



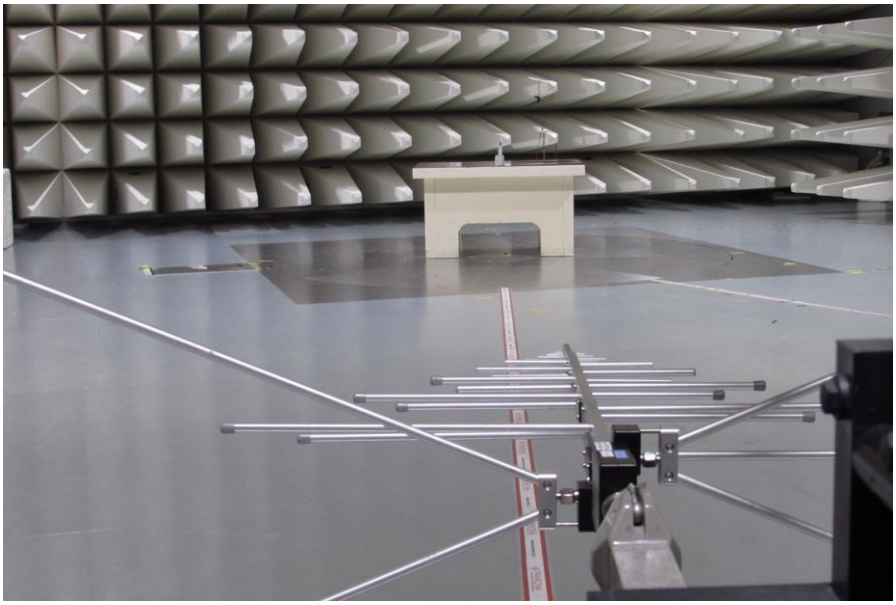
Test setup configuration 2 antenna BBHA9120D vertical AC 1



Arrangement configuration 3

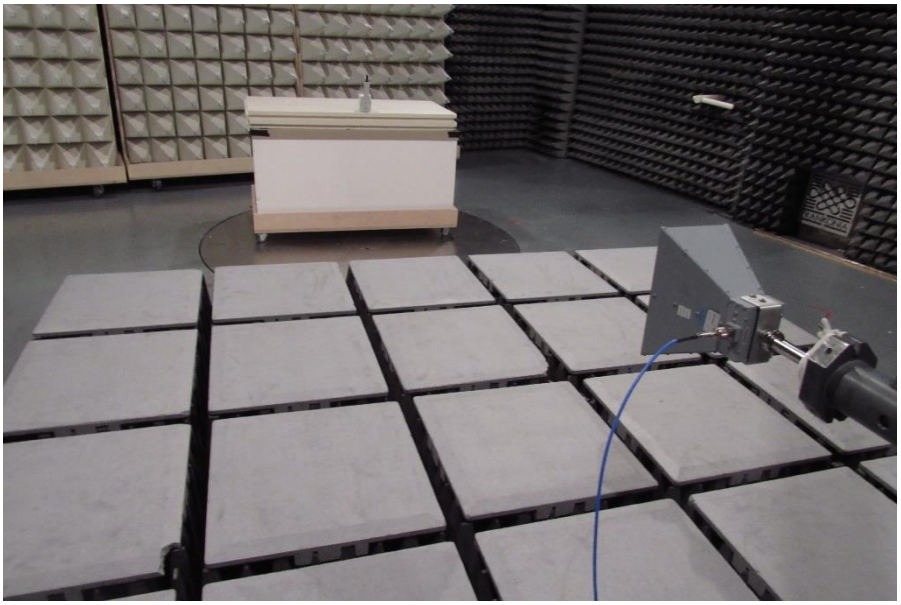


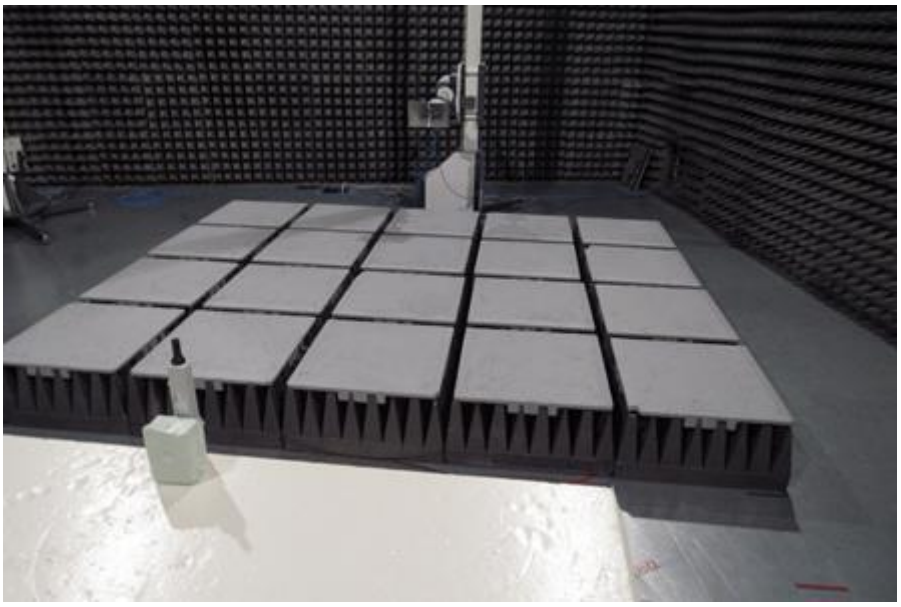
Test setup configuration 3 antenna VULB 9126 horizontal AC 6

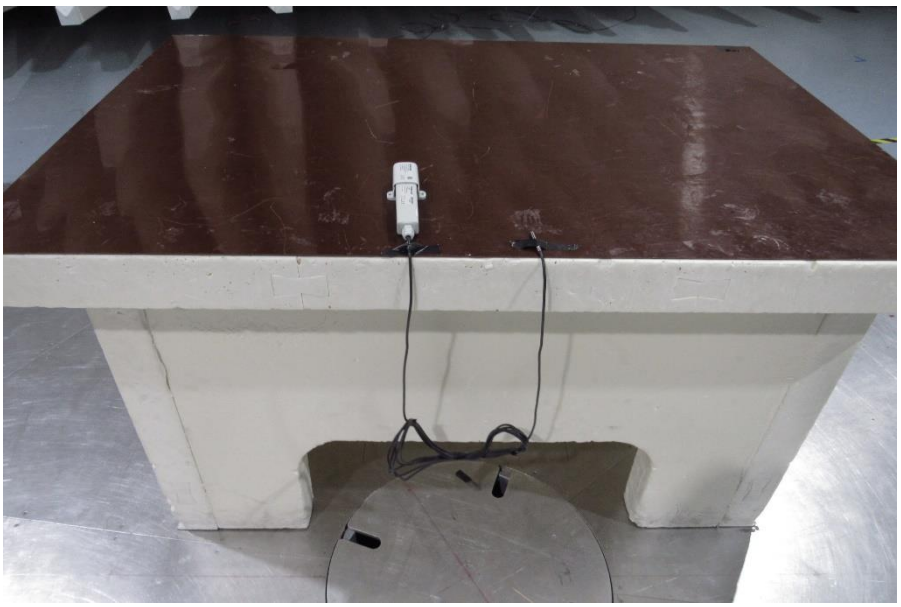


Test setup configuration 3 antenna VULB 9126 horizontal AC 6

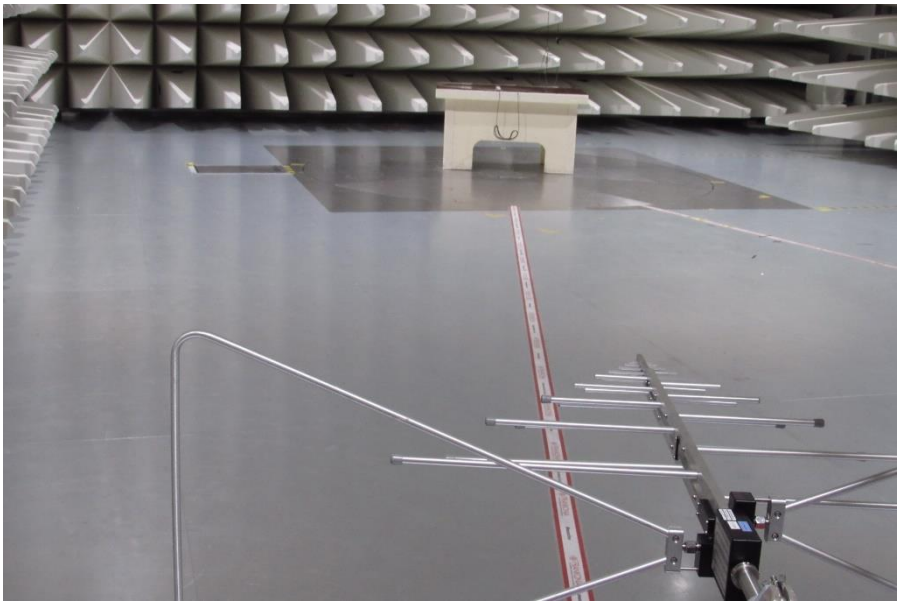
Test setup configuration 3 antenna VULB 9126 horizontal AC 1



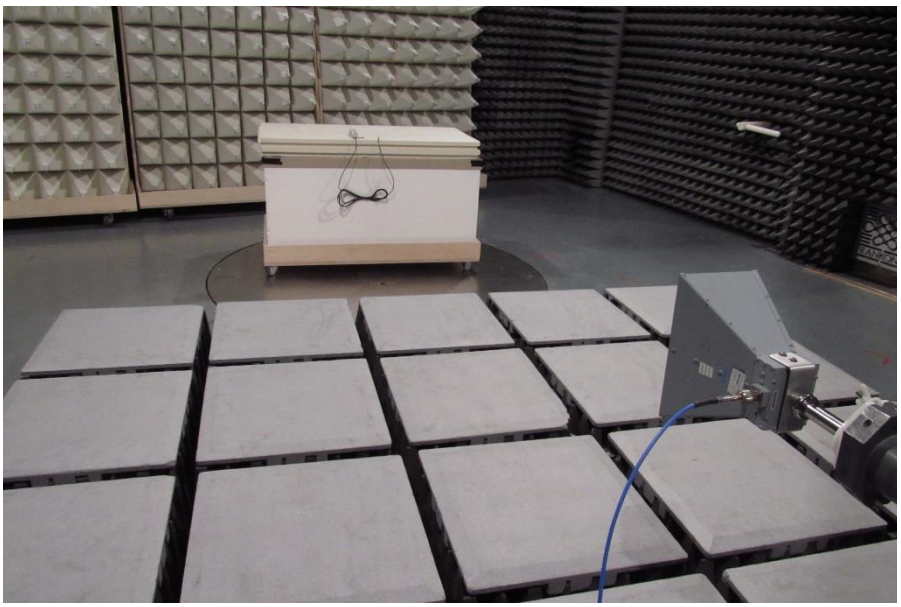
Test setup configuration 3 antenna BBHA9120D vertical AC 1


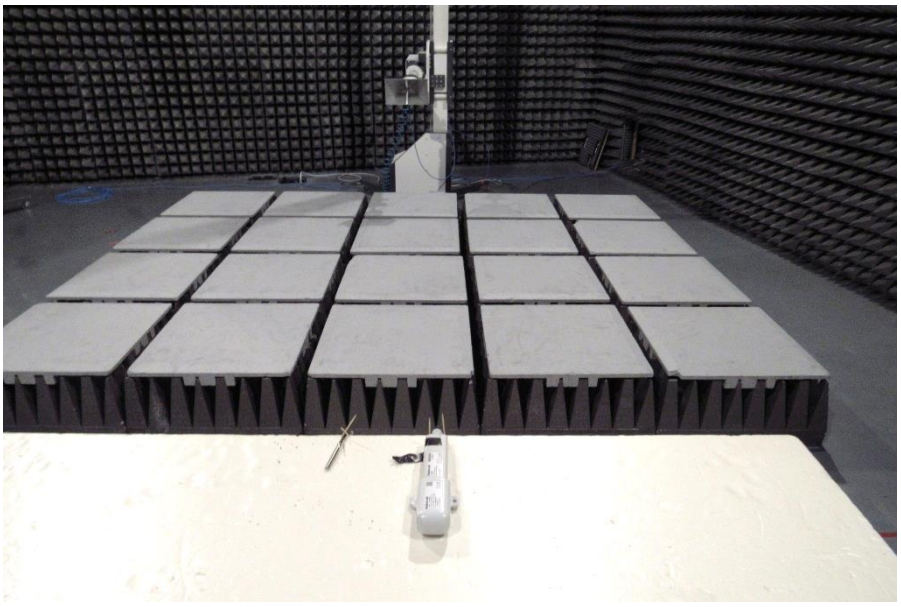
Arrangement configuration 4


Test setup configuration 4 antenna VULB 9126 horizontal AC 6

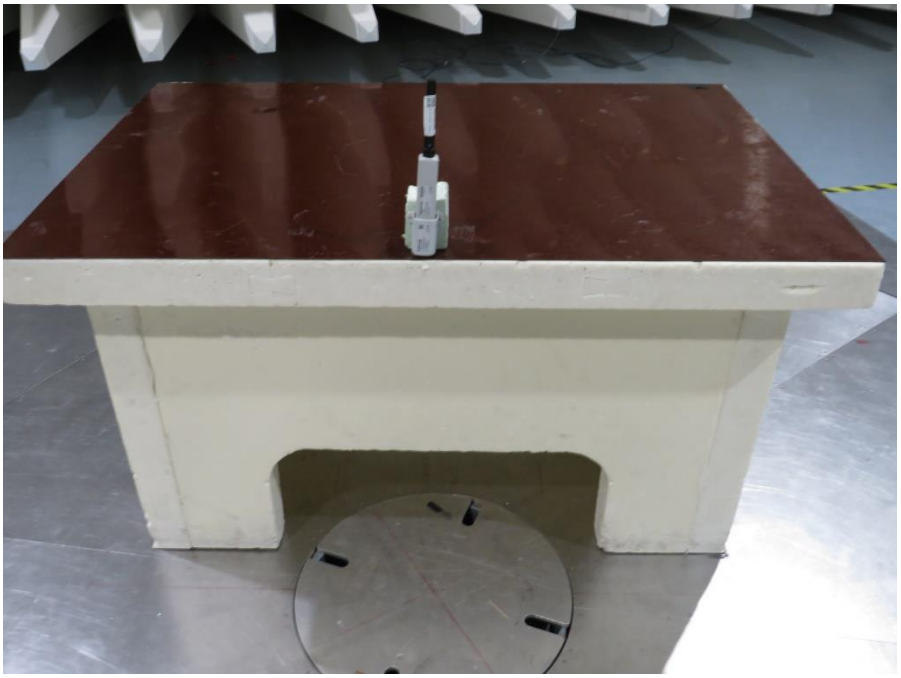


Test setup configuration 4 antenna VULB 9126 vertical AC 6

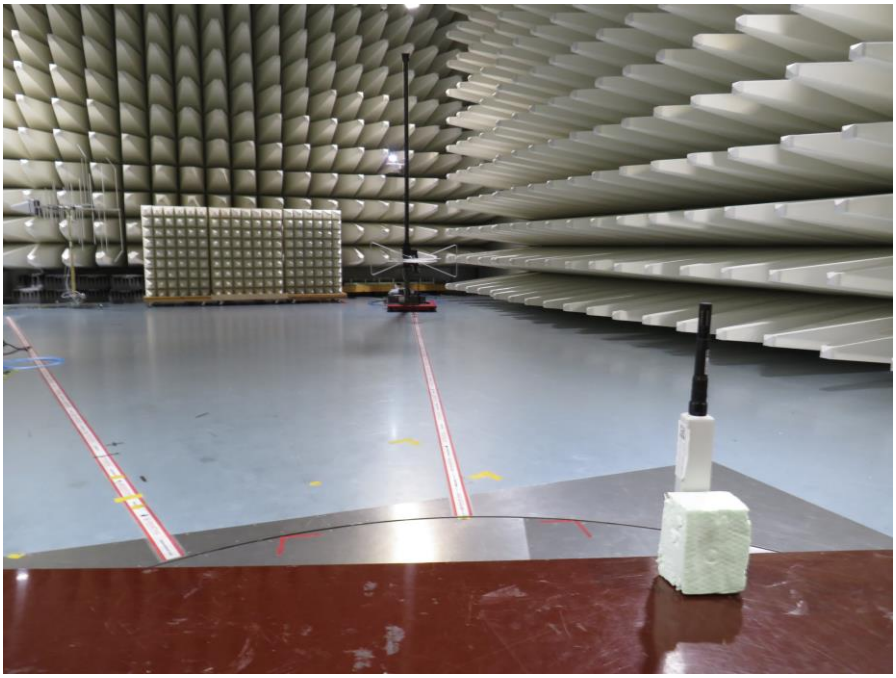
Test setup configuration 4 antenna BBHA9120D horizontal AC 1


Test setup configuration 4 antenna BBHA9120D vertical AC 1


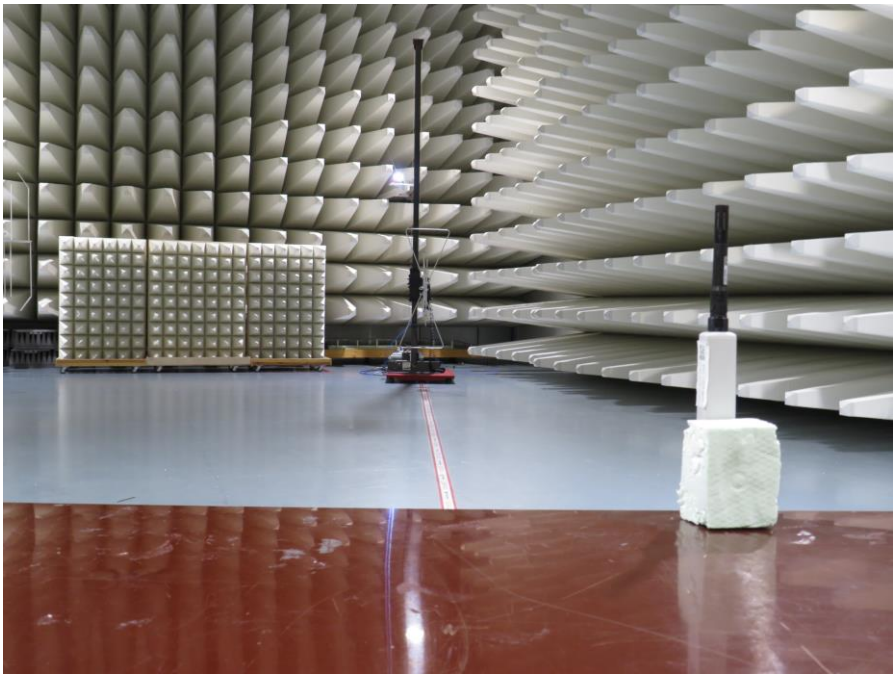
Arrangement configuration 5



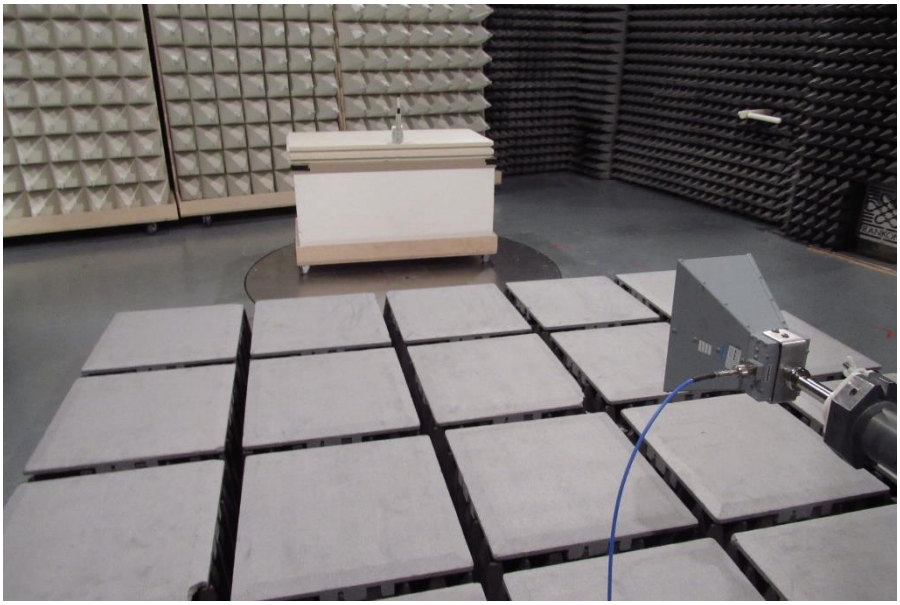
Test setup configuration 5 antenna VULB 9126 horizontal AC 6

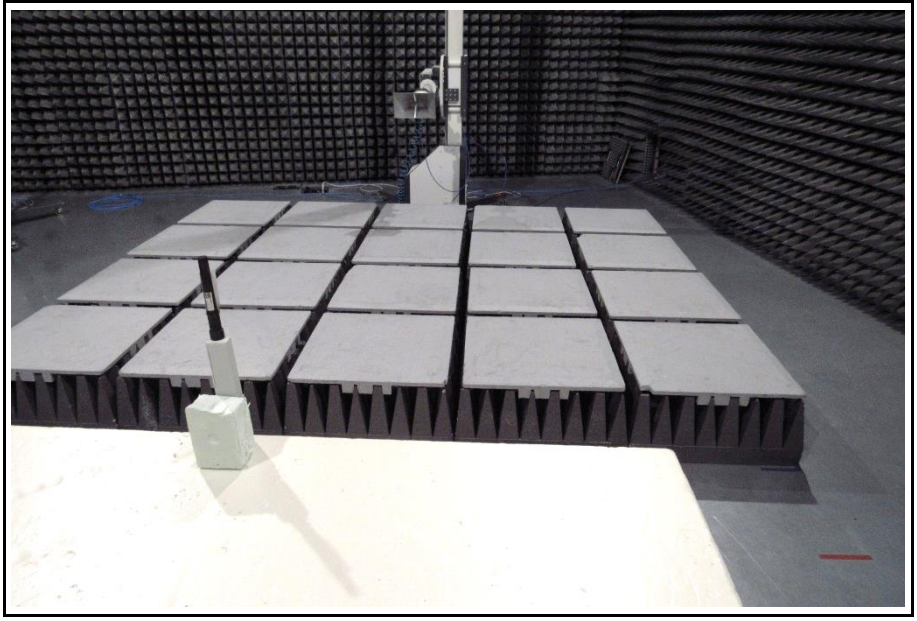


Test setup configuration 5 antenna VULB 9126 vertical AC 6



Test setup configuration 5 antenna VULB 9126 horizontal AC 1

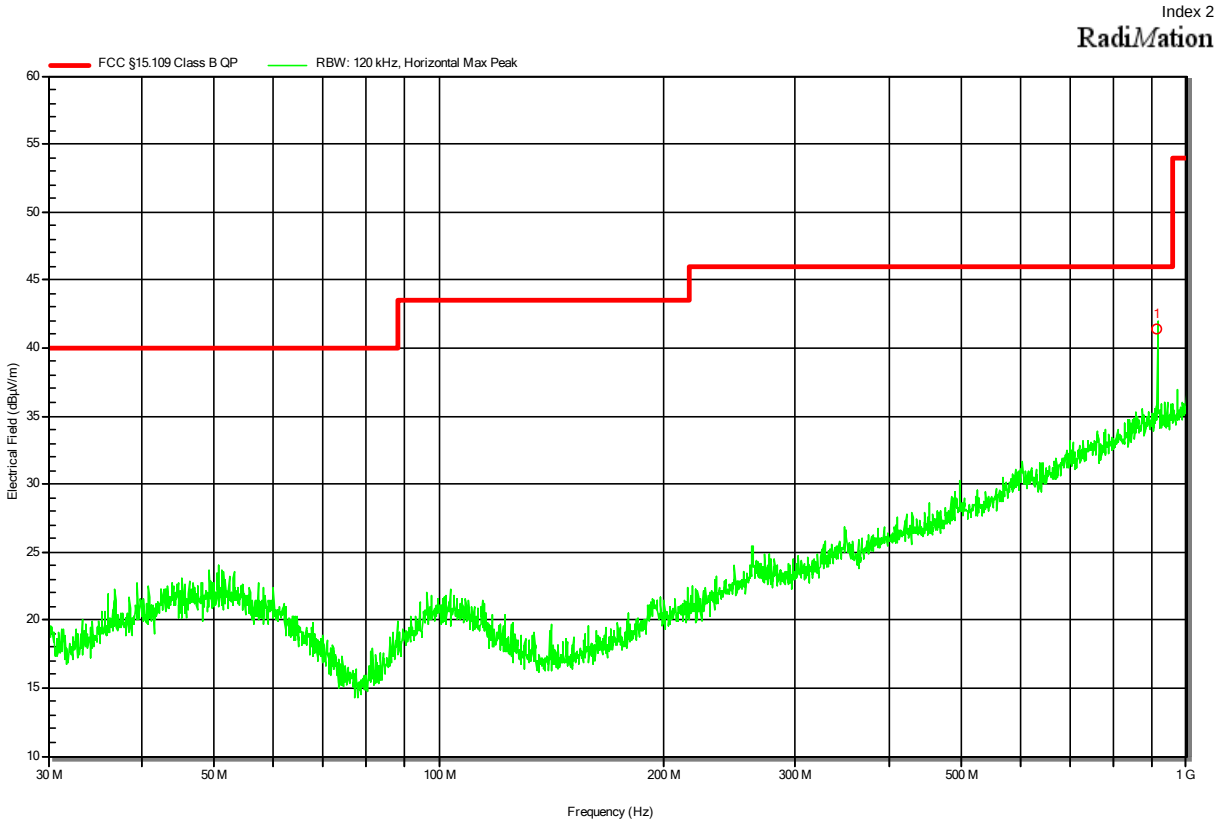


Test setup configuration 5 antenna VULB 9126 vertical AC 1


2.1.8 Records

Radiated emissions according to FCC 15B

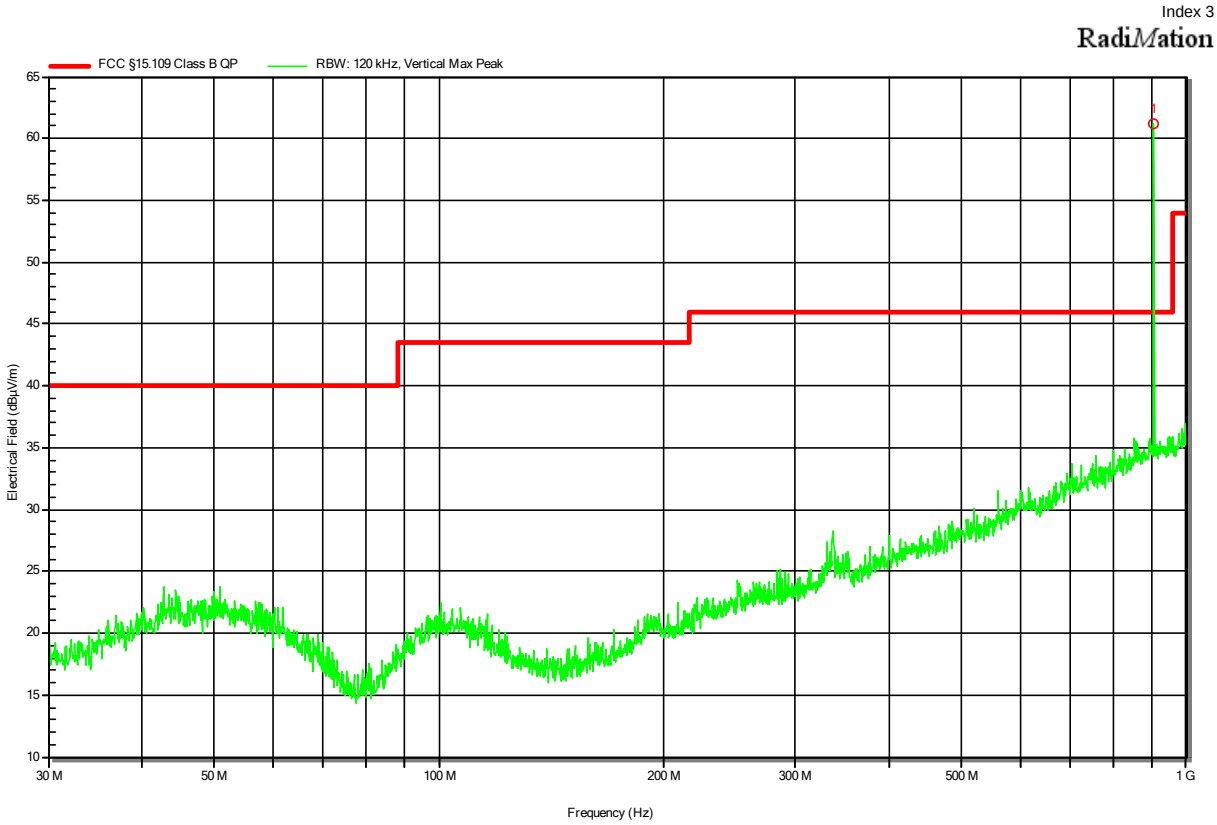
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-CS
Test Sample ID:	38628, 38624
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Horizontal
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 1
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	914.768 MHz	Carrier signal LoRaWAN	

Radiated emissions
according to FCC 15B

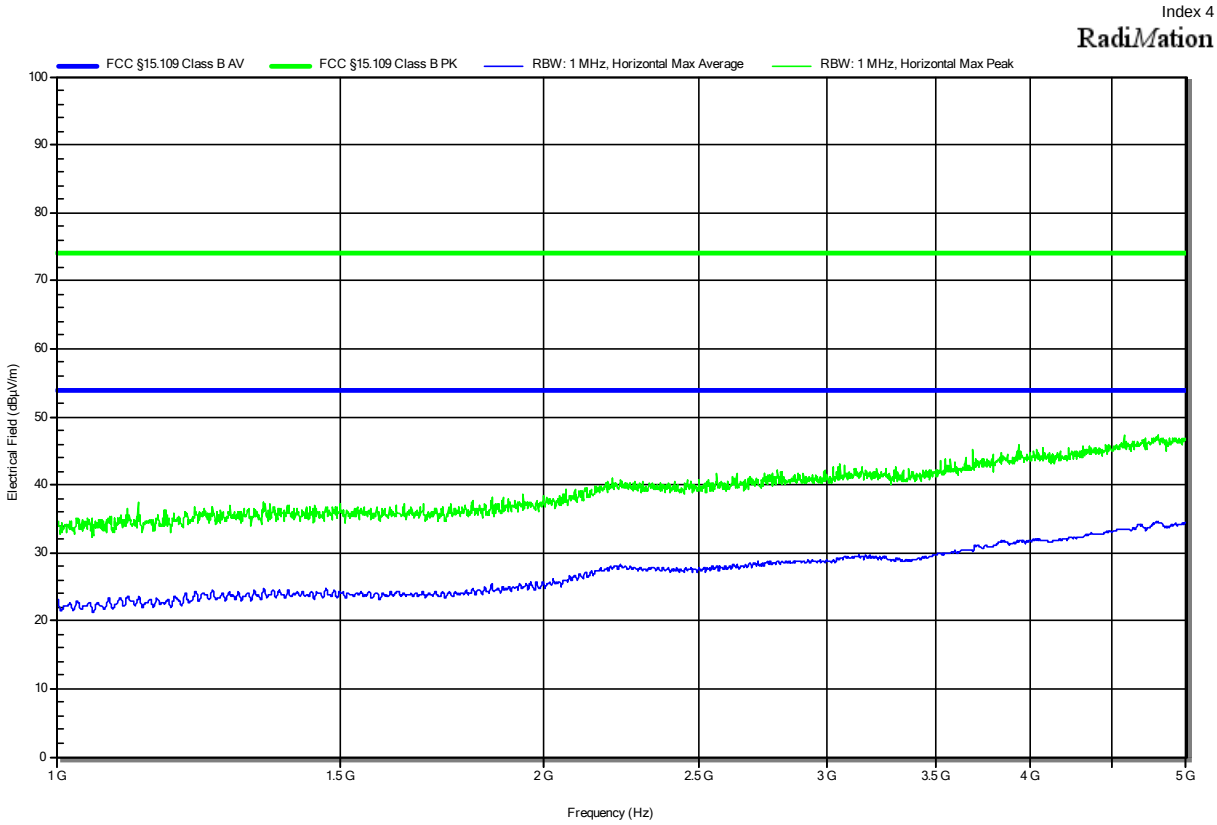
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-CS
Test Sample ID:	38628, 38624
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Vertical
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 1
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	905.94 MHz	Carrier signal LoRaWAN	

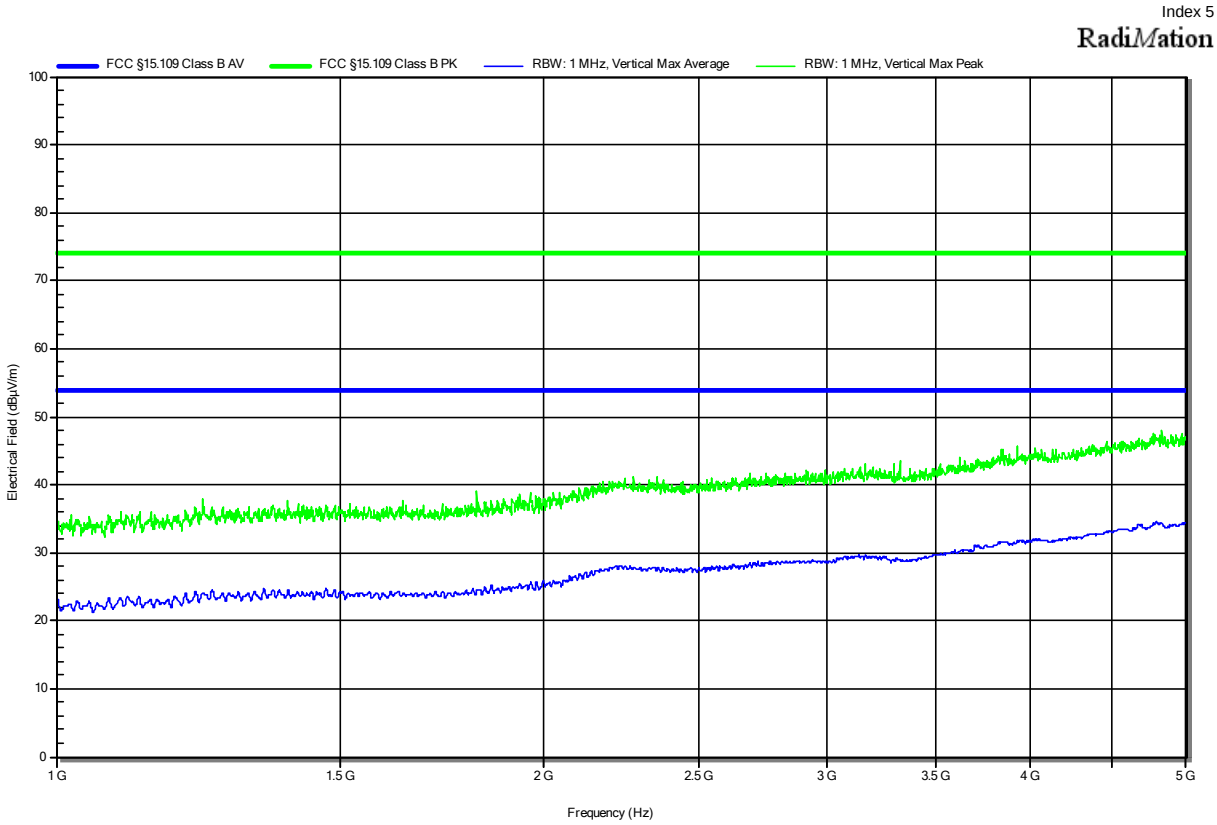
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-CS
Test Sample ID:	38628, 38624
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 1
Note 1:	Height 1 m, angle 0°



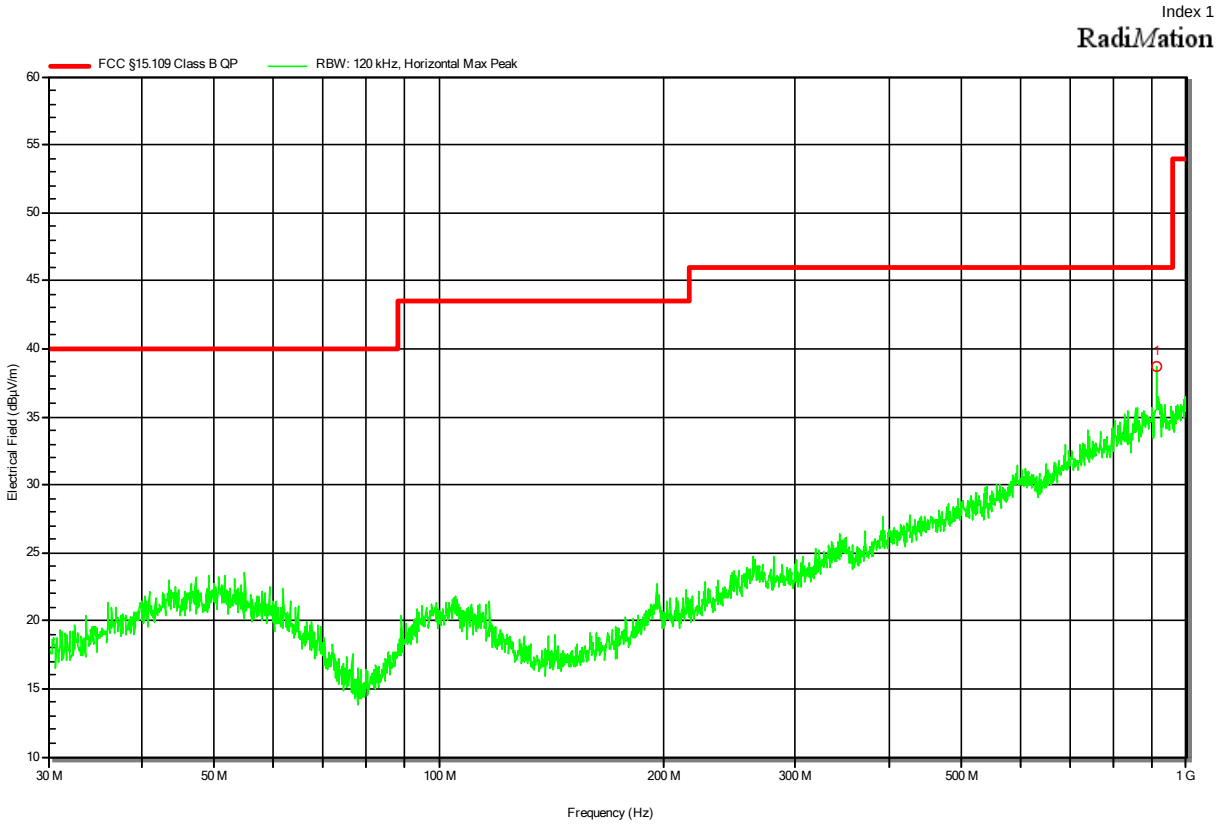
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-CS
Test Sample ID:	38628, 38624
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 1
Note 1:	Height 1 m, angle 0°



Radiated emissions
according to FCC 15B

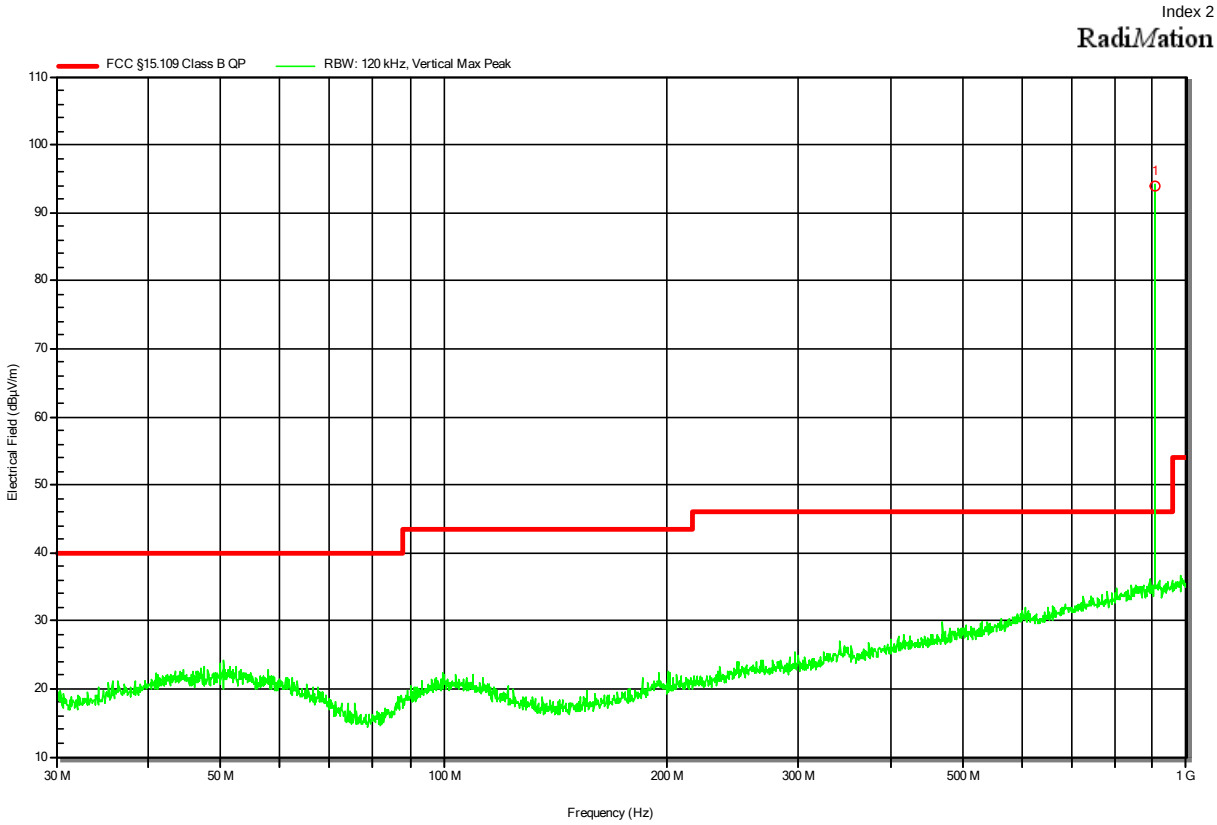
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-T
Test Sample ID:	38624, 38630
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Horizontal
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 2
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	911.777 MHz	Carrier signal LoRaWAN	

Radiated emissions
according to FCC 15B

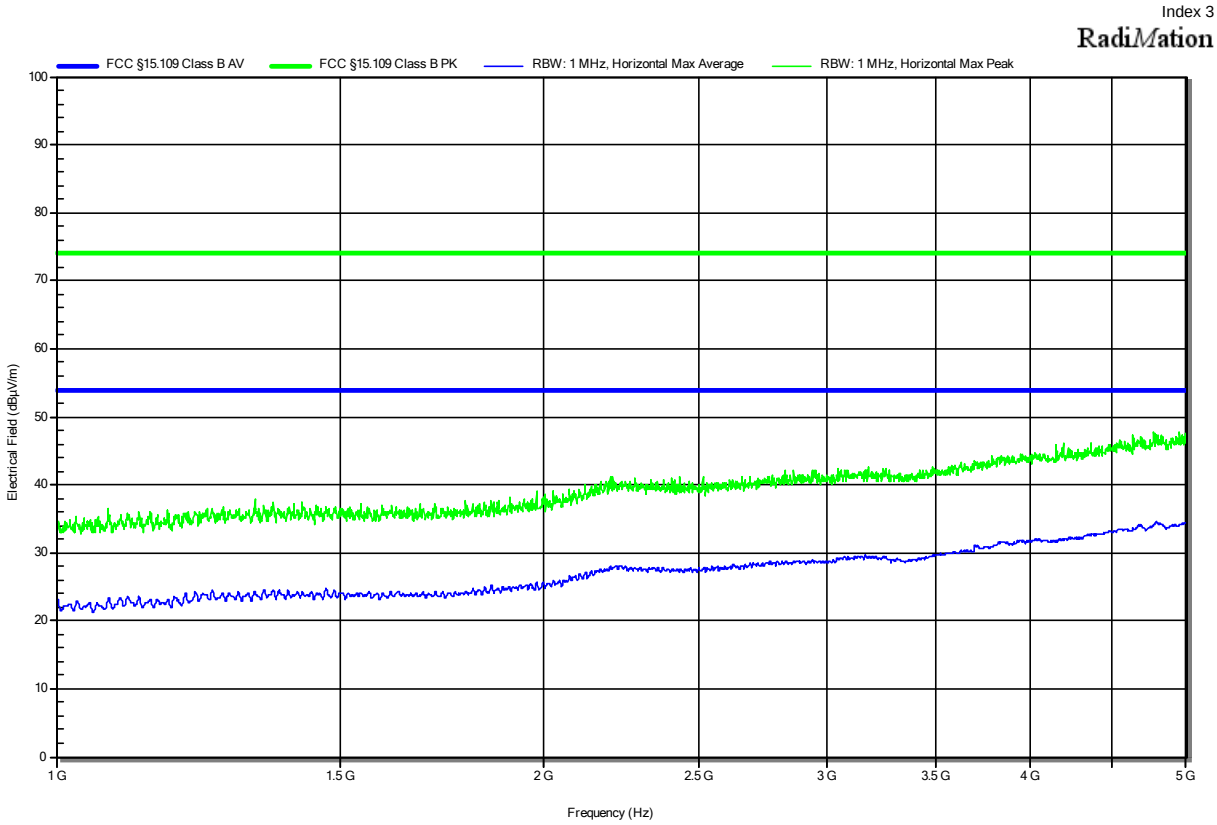
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-T
Test Sample ID:	38624, 38630
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Vertical
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 2
Note 1:	Height 1m, angle 0°



Peak Number	Frequency	Angle	Height
1	906.562 MHz	Carrier signal LoRaWAN	

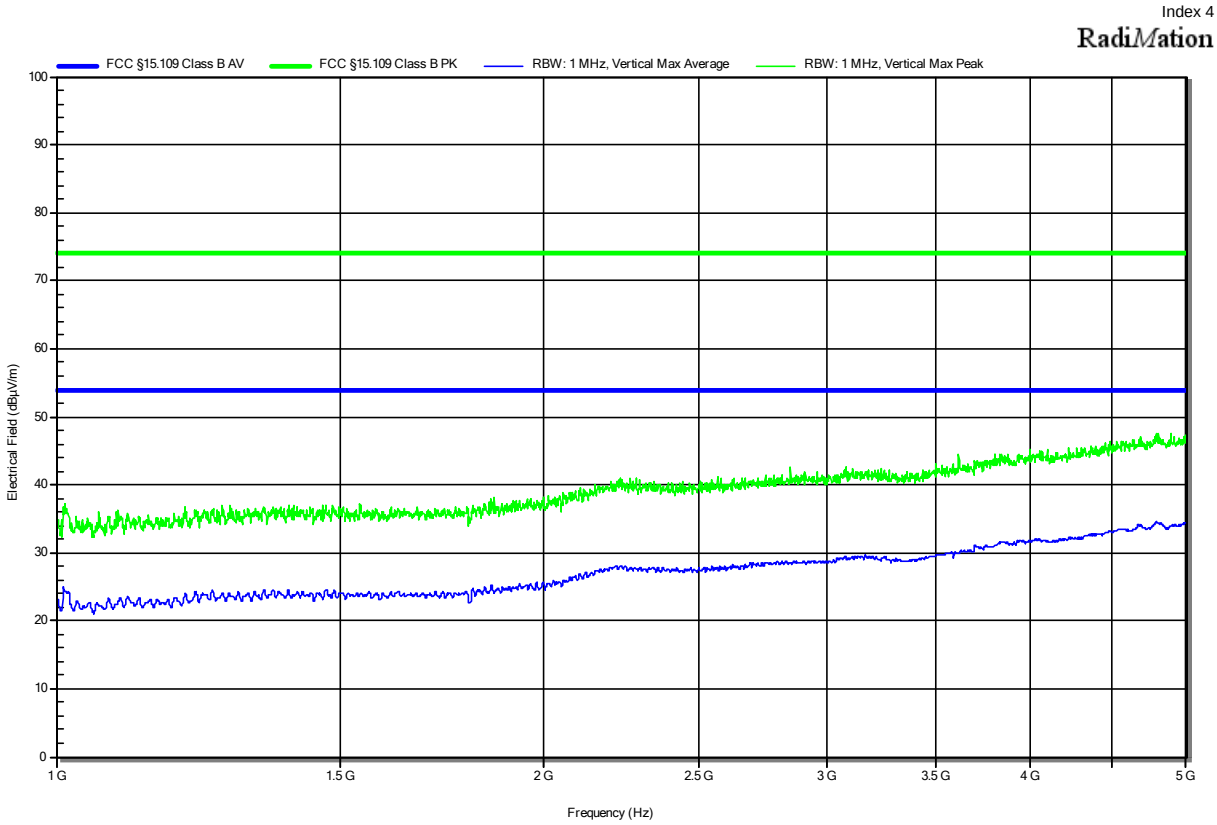
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-T
Test Sample ID:	38624, 38630
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 2
Note 1:	Height 1 m, angle 0°



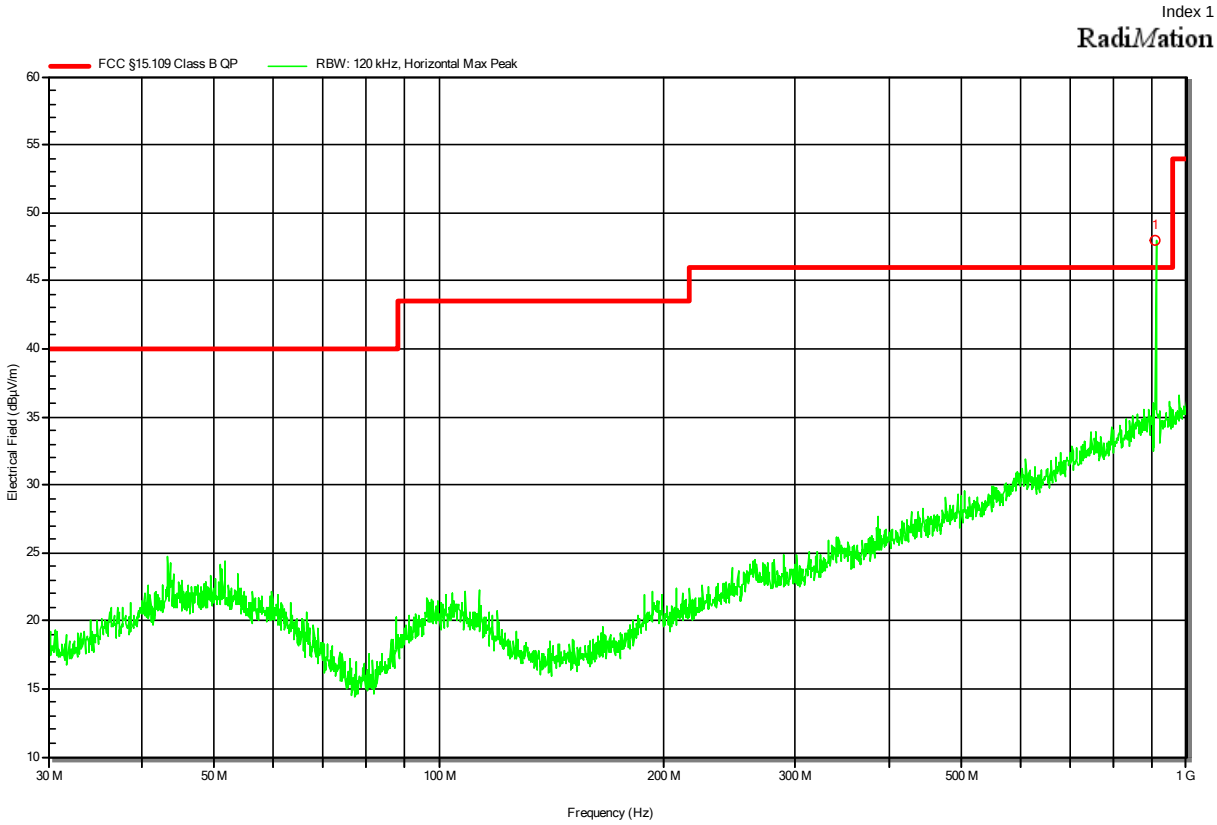
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-T
Test Sample ID:	38624, 38630
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 2
Note 1:	Height 1 m, angle 0°



Radiated emissions
according to FCC 15B

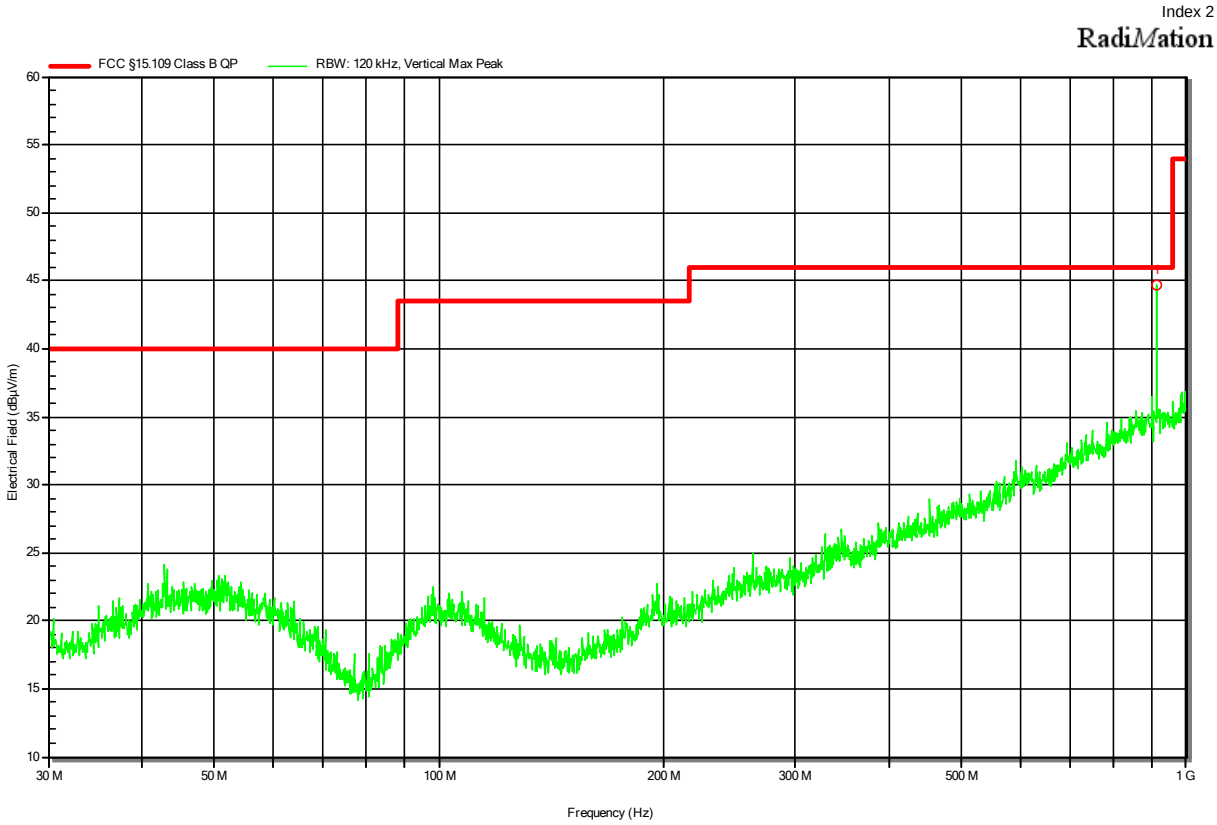
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter
Model:	Flex2-Radio-LWNA with Flex2-Module-T-RH
Test Sample ID:	38624, 38631
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Horizontal
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 3
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	909.882 MHz	Carrier signal LoRaWAN	

Radiated emissions
according to FCC 15B

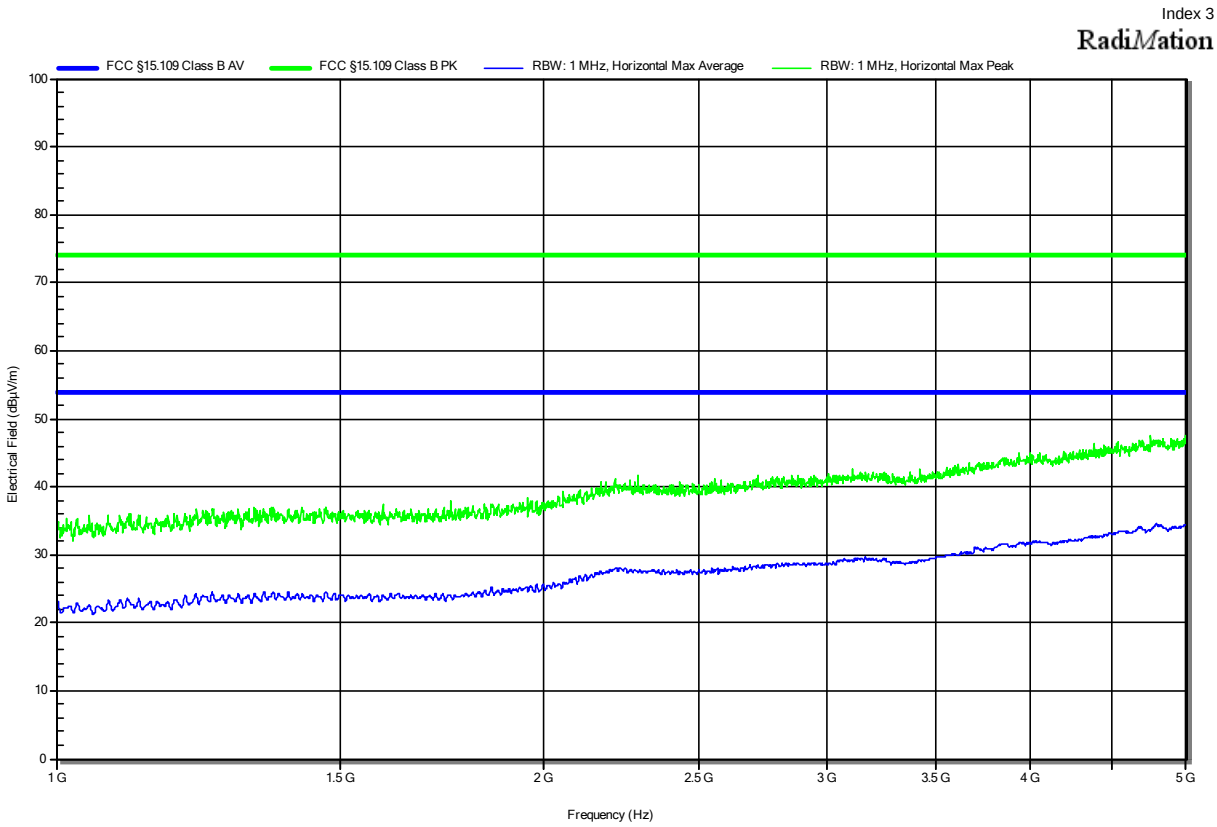
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter
Model:	Flex2-Radio-LWNA with Flex2-Module-T-RH
Test Sample ID:	38624, 38631
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Vertical
Measurement Distance:	10m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 3
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	912.926 MHz	Carrier signal LoRaWAN	

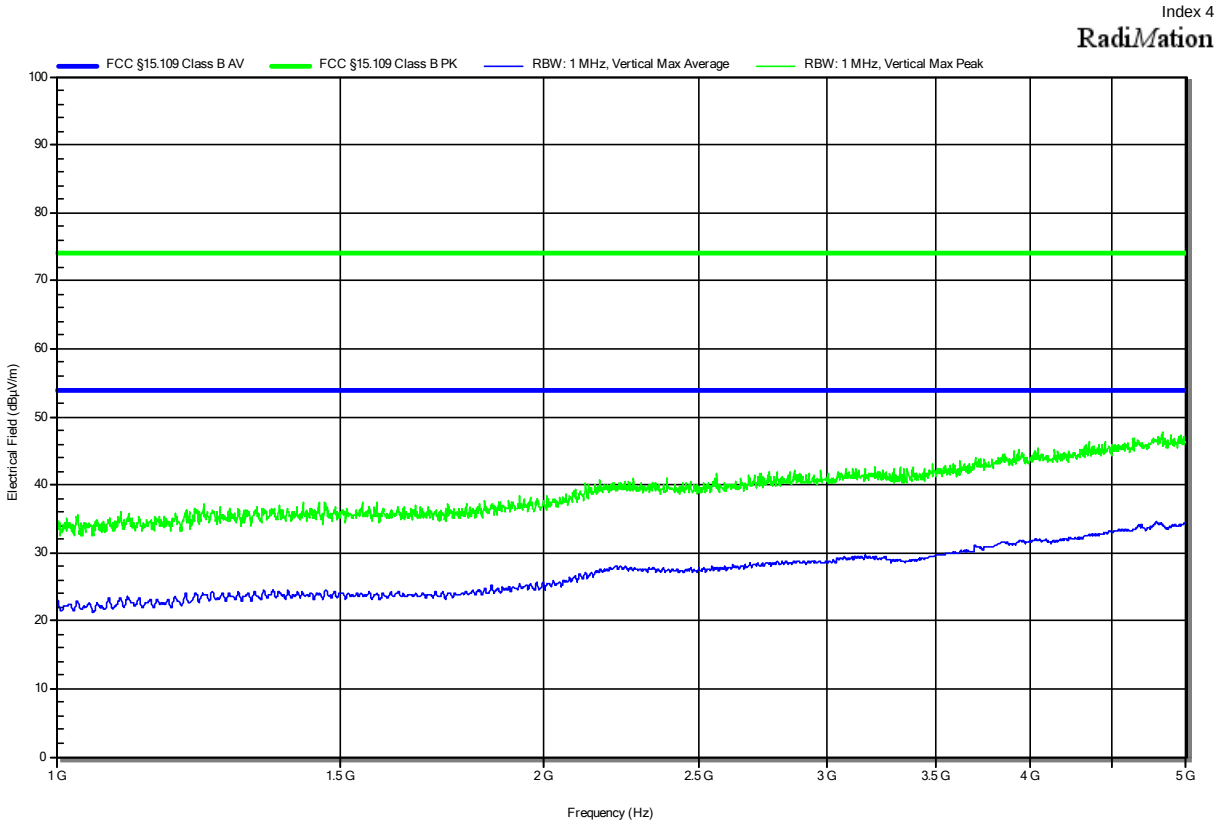
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter
Model:	Flex2-Radio-LWNA with Flex2-Module-T-RH
Test Sample ID:	38624, 38631
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 3
Note 1:	Height 1 m, angle 0°



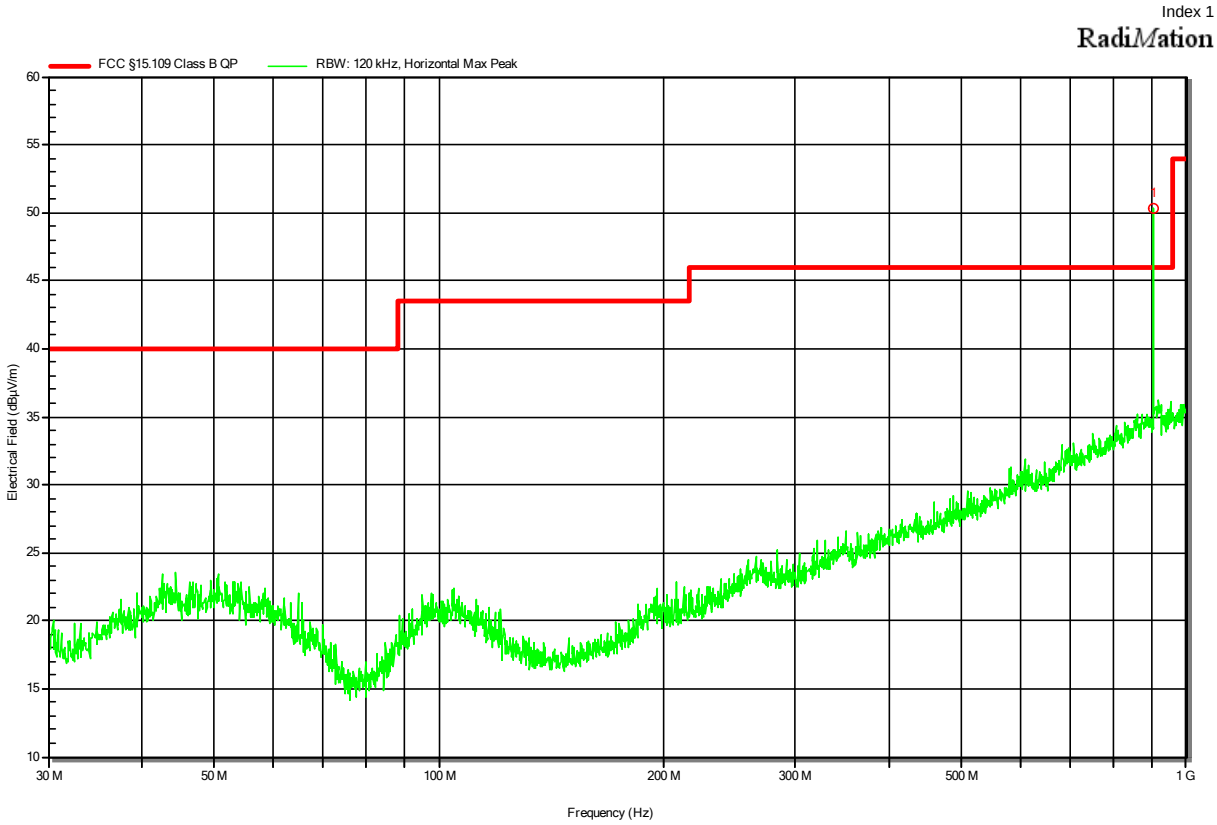
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter
Model:	Flex2-Radio-LWNA with Flex2-Module-T-RH
Test Sample ID:	38624, 38631
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 3
Note 1:	Height 1 m, angle 0°



Radiated emissions
according to FCC 15B

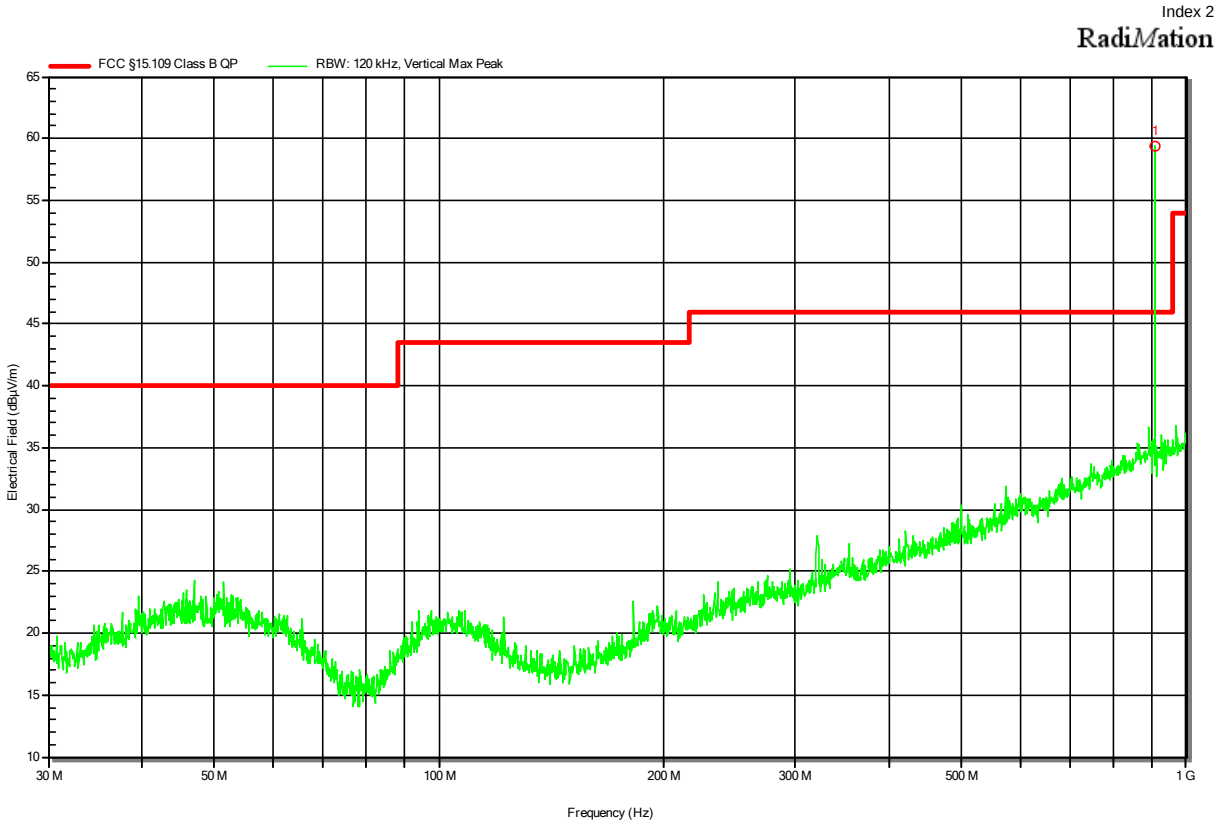
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-LWNA-ES
Test Sample ID:	38624, 38632
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Horizontal
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	configuration 4
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	904.113 MHz	Carrier signal LoRaWAN	

Radiated emissions
according to FCC 15B

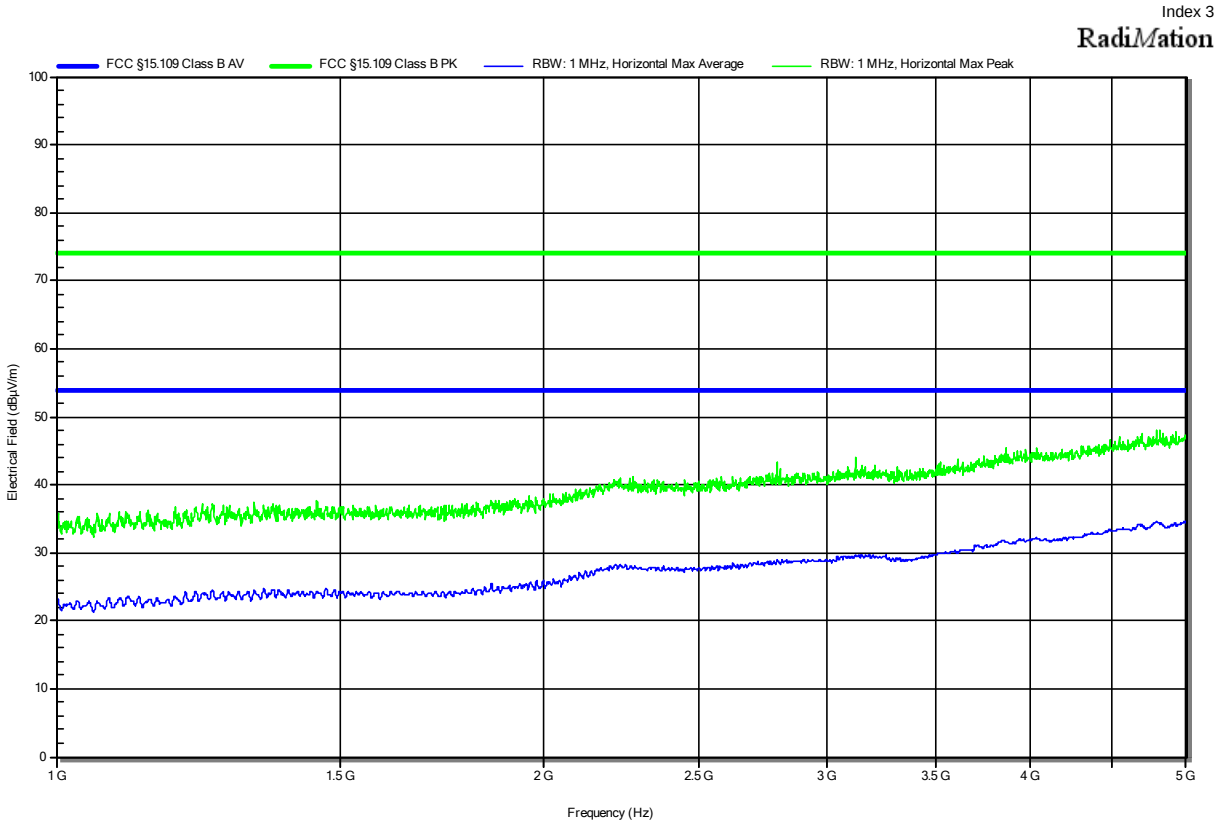
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-LWNA-ES
Test Sample ID:	38624, 38632
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Vertical
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 4
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	908.92 MHz	Carrier signal LoRaWAN	

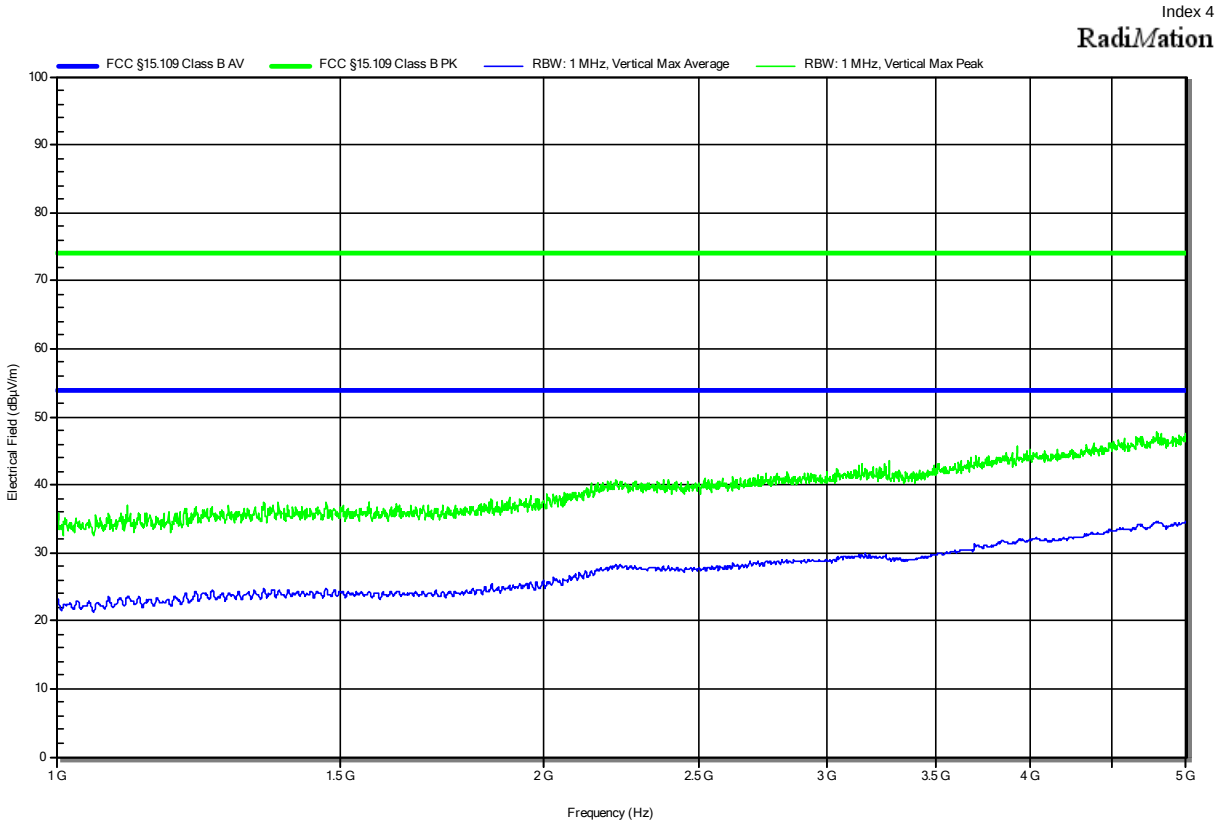
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-LWNA-ES
Test Sample ID:	38624, 38632
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 4
Note 1:	Height 1 m, angle 0°



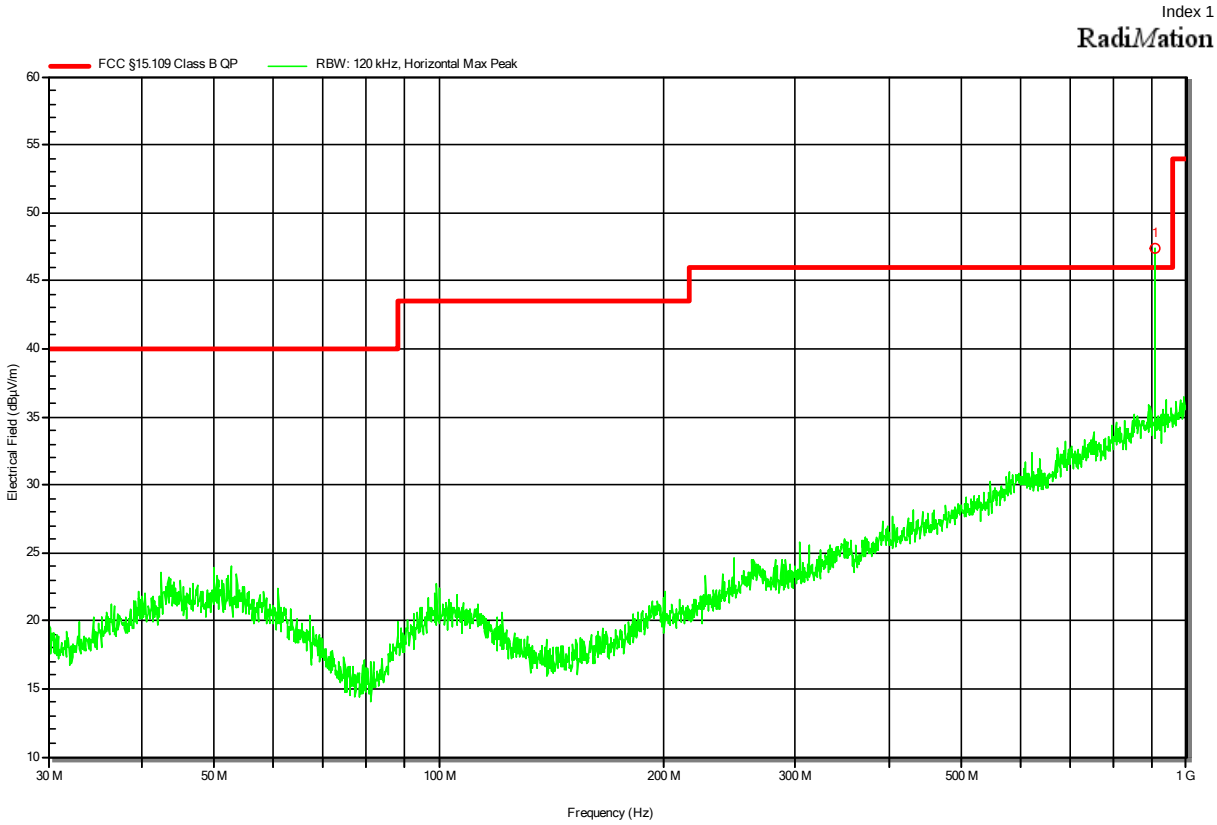
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-LWNA-ES
Test Sample ID:	38624, 38632
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 4
Note 1:	Height 1 m, angle 0°



Radiated emissions
according to FCC 15B

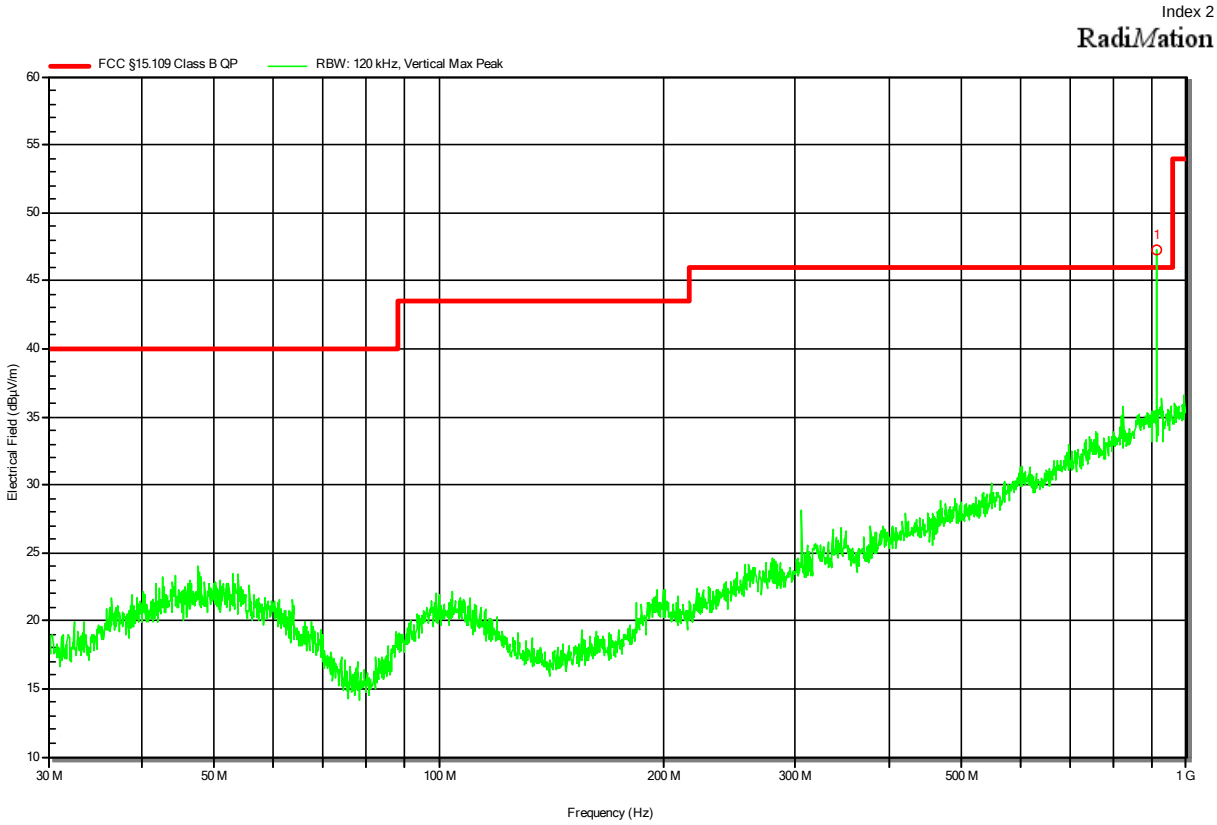
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-nSens
Test Sample ID:	38624, 38633
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Horizontal
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 5
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	906.771 MHz	Carrier signal LoRaWAN	

Radiated emissions
according to FCC 15B

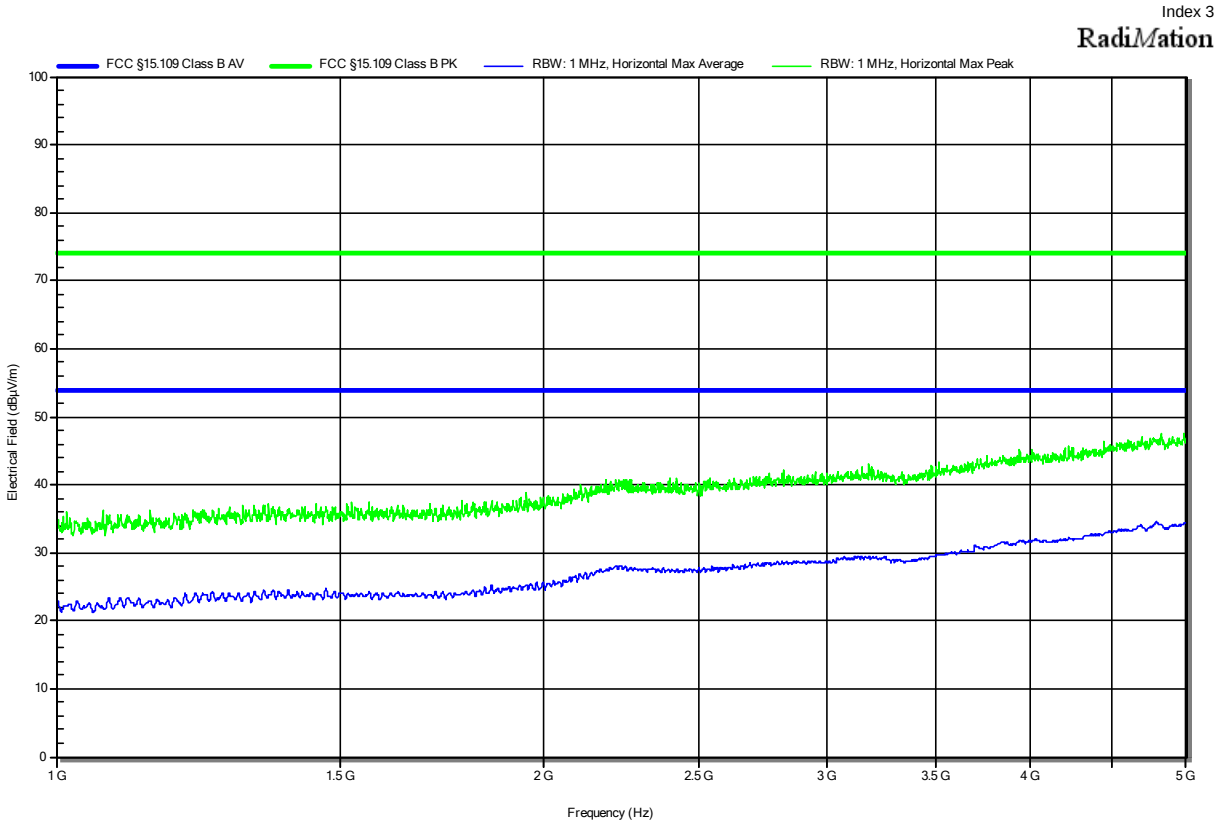
Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-nSens
Test Sample ID:	38624, 38633
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck VULB 9162, Vertical
Measurement Distance:	10 m, converted to 3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 5
Note 1:	Height 1 m, angle 0°



Peak Number	Frequency	Angle	Height
1	911.243 MHz	Carrier signal LoRaWAN	

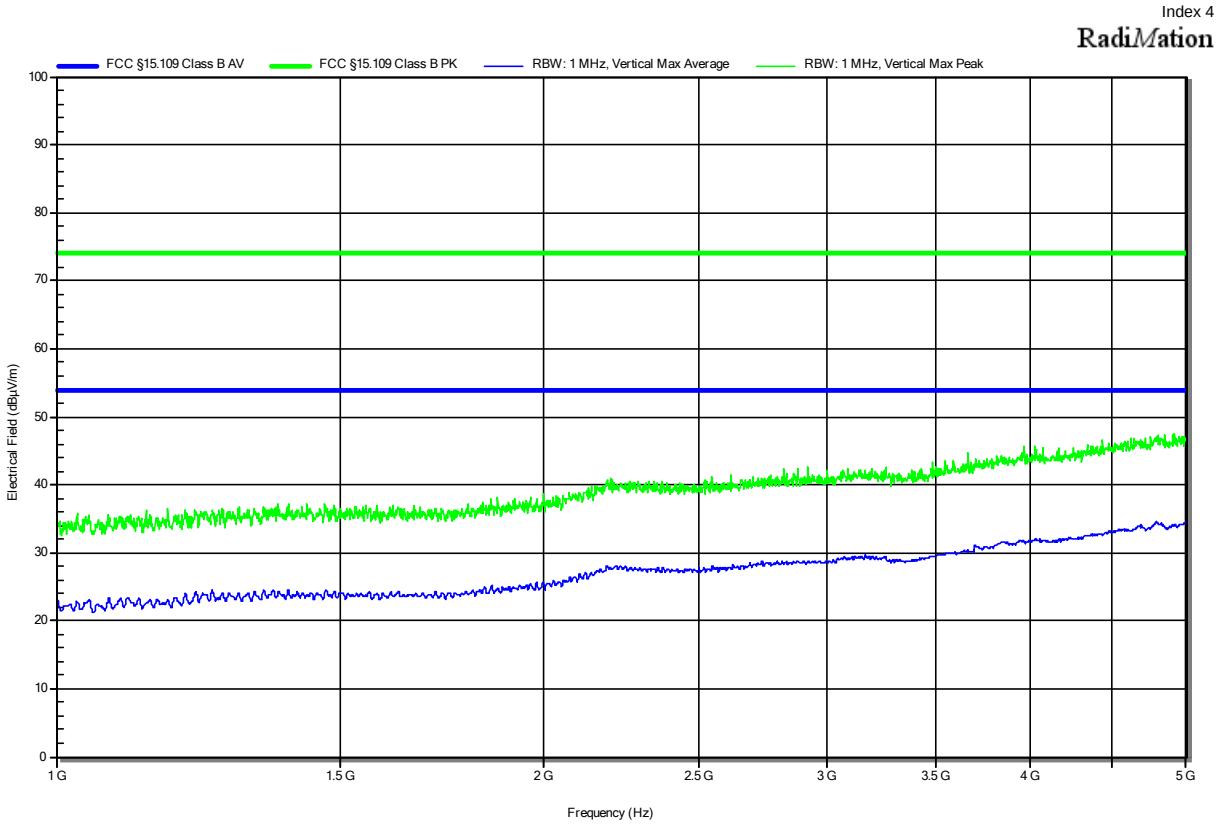
Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-nSens
Test Sample ID:	38624, 38633
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 5
Note 1:	Height 1 m, angle 0°



Radiated emissions
according to FCC 15B

Project Number:	G0M-2201-1254
Applicant:	Nokeval Oy
Model Description:	LoRaWAN temperature transmitter with external sensor
Model:	Flex2-Radio-LWNA with Flex2-Module-nSens
Test Sample ID:	38624, 38633
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Engel
Test Date:	2022-04-08
Operating Conditions:	ambient temperature: 22 °Celsius power input: via internal battery 3.6 V lithium thionyl chloride
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3 m
Operational Mode:	Mode 1
EUT Configuration:	Configuration 5
Note 1:	Height 1 m, angle 0°



3 Measurement Uncertainty

All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2.

Test Name	Measurement Uncertainty
Radiated Emission AC 1	>1GHz to 6GHz @3m, 5.95dB

Test Name	Measurement Uncertainty
Radiated Emission AC 6	30 MHz to 1 GHz @ 10 m, 6.25 dB