EMC TEST REPORT

FCC 47 CFR Part 15B, ISED ICES-003 Issue 6

Report Reference No	G0M-2006-9089-EF0115B-V01
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	In-Circuit GmbH
Address	Boltenhagener Str. 124 01109 Dresden GERMANY
Test Specification Standard(s)	47 CFR Part 15 Subpart B ISED ICES-003 Issue 6 ANSI C63.4:2014+A1:2017
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model(s)	radino40 DW1000
Additional Model(s)	None
Brand Name(s)	None
Hardware Version(s)	A
Software Version(s)	A
FCC-ID	2AWXURADINO40DW1000
IC	n/a
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	2020-06-18	
Report:		
Compiled by	Matthias Handrik	
Tested by (+ signature) (Responsible for Test)	Matthias Handrik	.....
Approved by (+ signature) (Head of Lab)	Christian Weber	.....
Date of Issue	2020-07-28	
Total number of pages	65	
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	2020-07-28	Initial Release	

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1 Equipment (Test Item) Under Test

Description	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)	
Model	radino40 DW1000	
Additional Model(s)	None	
Brand Name(s)	None	
Serial Number(s)	unspecified	
Hardware Version(s)	A	
Software Version(s)	A	
FCC-ID	2AWXURADINO40DW1000	
IC	n/a	
Class	Class B	
Equipment type	Table top	
Highest internal frequency [MHz]	63897.6	
Supply Voltage	V_{NOM}	3.3V DC
AC/DC-Adaptor	None	
Manufacturer	In-Circuit GmbH Boltenhagener Str. 124 01109 Dresden GERMANY	

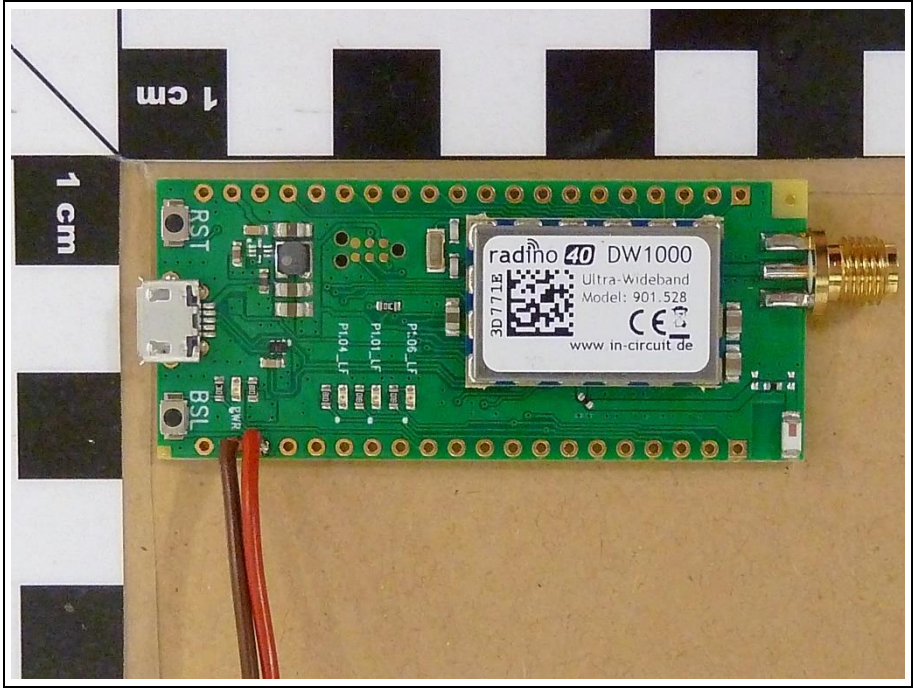
1.1 Equipment Ports

Name	Type	Attributes	Comment
DC Power	DC	Count: 1 Direction: In Service only: No	

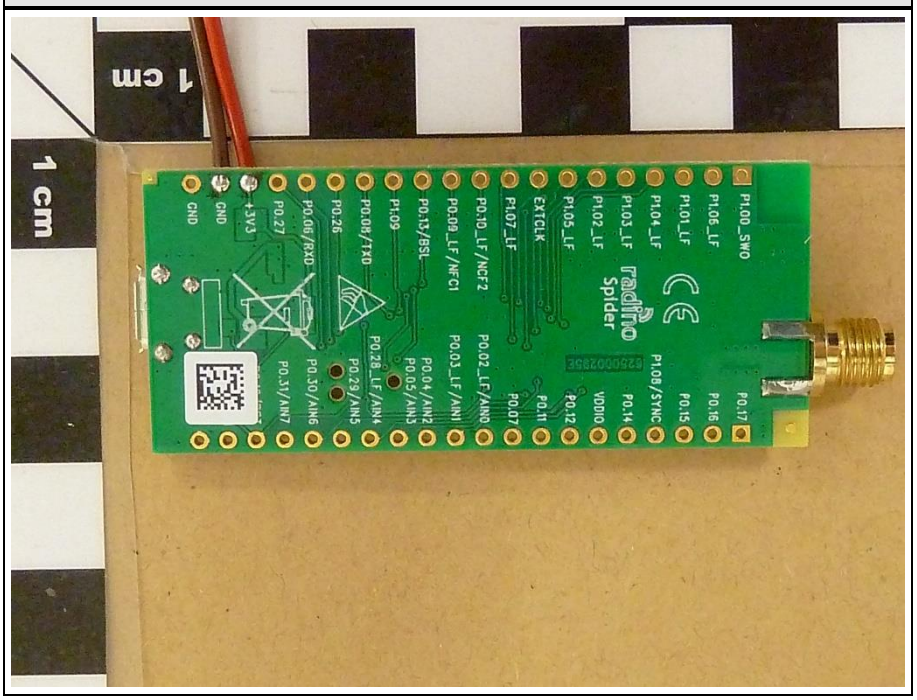
Description:	
AC	AC mains power input/output port
DC	DC power input/output port
BAT	DC power input port connected to external battery
IO	Input/Output port
TP	Telecommunication port
NE	Non-electrical port

1.2 Equipment Photos - External

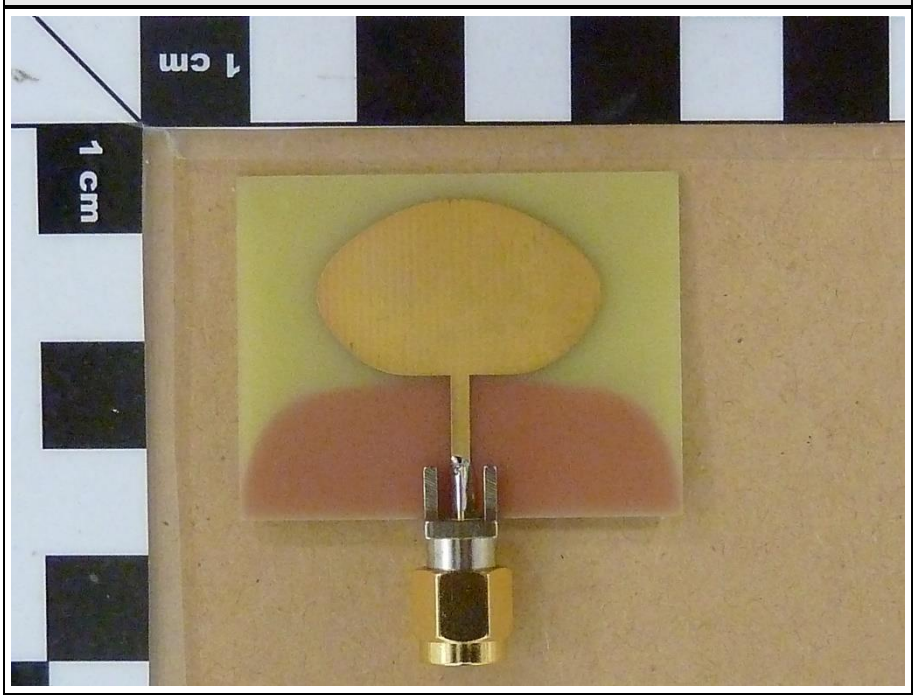
EUT + Evaluation board TOP



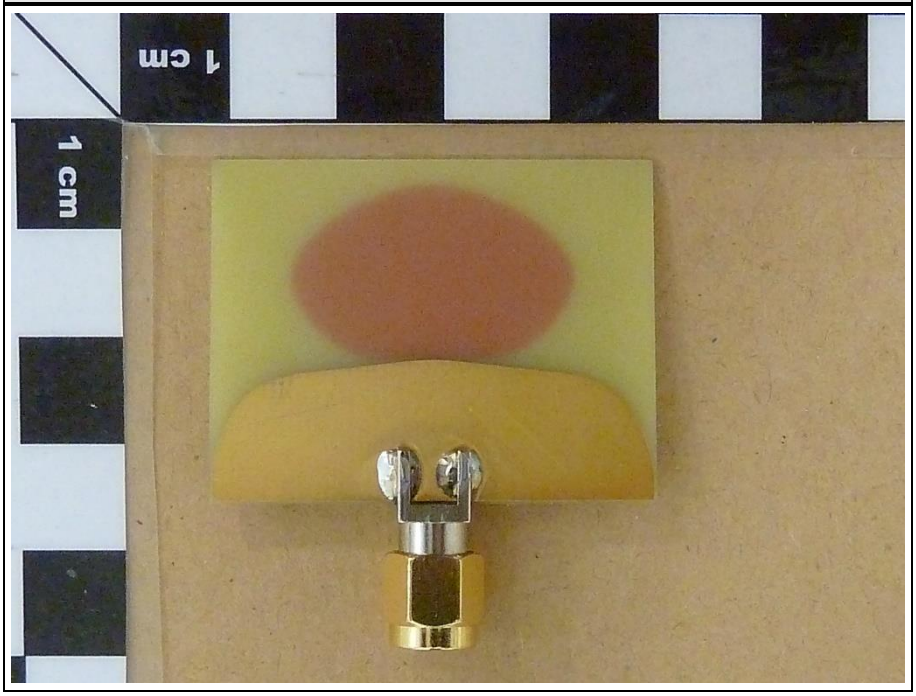
EUT + Evaluation board BOTTOM



EUT UWB Antenna TOP



EUT UWB Antenna BOTTOM



EUT Label + BTLE Antenna

1.3 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	Carrier board	In-Circuit GmbH	901.327E radino Spider RP-SMA	Customer support equipment
AE	Battery	TADRIAN Batteries	TLP-93111/A/IT3	-
AE	AC/DC adaptor	sonero	MW3K10GS/X-PS020	-
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
MON	Monitoring Equipment			
CBL	Connecting Cable			
Comment:				

1.4 Operational Modes

Mode #	Description
1	Bluetooth Low Energy transmission with 50 beacons / second
2	UWB transmission on Ch.: 2, with 1000 packets / second
3	UWB transmission on Ch.: 5, with 1000 packets / second
Comment:	

1.5 EUT Configuration

Configuration #	Description
1	EUT powered via external Battery.
2	EUT powered via 120V AC (AC/DC adaptor).
Comment:	

1.6 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

FCC 47 CFR Part 15B, ISED ICES-003 Issue 6				
Reference	**Requirement**	**Reference Method**	**Result**	**Remarks**
Emission				
FCC 15.109 ICES-003, 6.2	Radiated emissions	ANSI C63.4:2014 +A1:2017	PASS	-
FCC 15.107 ICES-003, 6.1	AC power line conducted emissions	ANSI C63.4:2014 +A1:2017	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

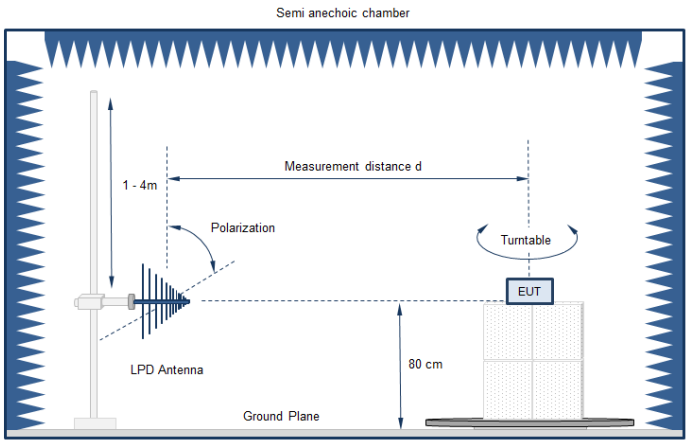
2.1 Test Conditions and Results - Radiated emissions acc. to ANSI C63.4

2.1.1 Information

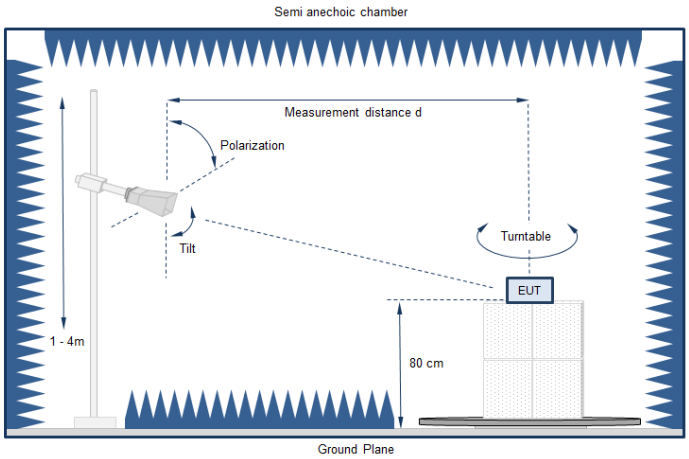
Test Information	
Reference	FCC 15.109, ICES-003, 6.2
Reference method	ANSI C63.4:2014+A1:2017 Section 8
Equipment class	Class B
Equipment type	Table top
Highest internal frequency [MHz]	63897.6
Measurement range	30 MHz to 40000 MHz
Temperature [°C]	20 - 21
Humidity [%]	45 - 57
Operator	Jens Marquardt; Matthias Handrik
Date	2020-07-07 – 2020-07-20

2.1.2 Setup

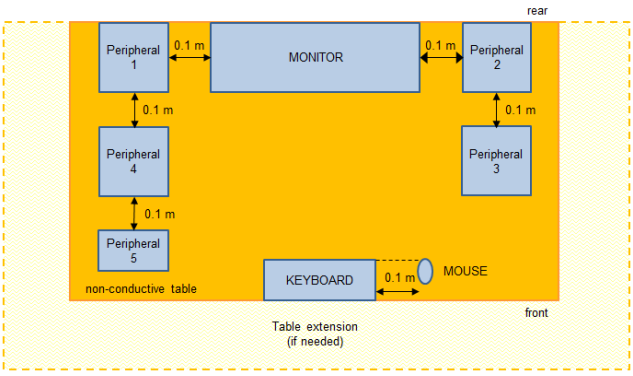
Measurement up to 1 GHz



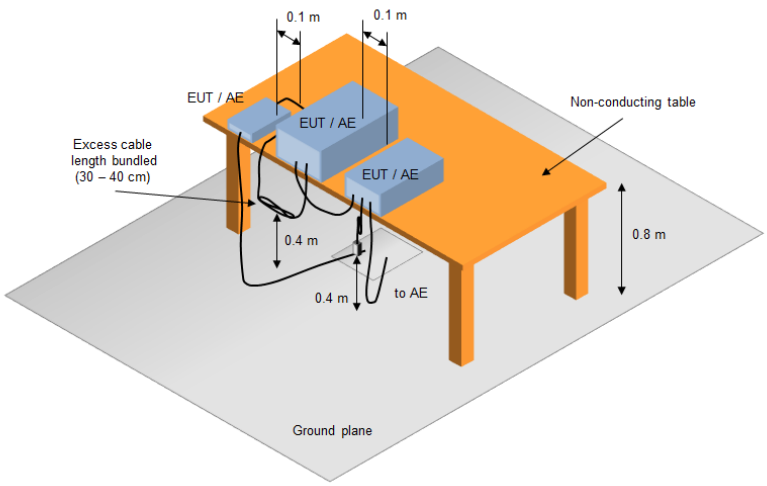
Measurement above 1 GHz



Equipment placement - Table top



Test Setup



2.1.3 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	Radimation	2016.1.10

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber	Frankonia	AC1	EF00062	2018-07	2021-07
EMI Test Receiver	Keysight	N9038A-526/WXP	EF01070	2020-06	2021-06
Biconical Antenna	R&S	HK 116	EF00030	2019-04	2022-04
LPD Antenna	R&S	HL 223	EF00187	2019-05	2022-05
40GHz High Gain Antenna	Amplifier Research	AT4560	EF00302	2019-05	2021-05
40GHz Standard Gain Horn with Amplifier	Flann Microwave Ltd	22240-25 Amp. CBL26402075	EF00301	2019-12	2022-12
Spectrum analyzer	Rohde & Schwarz Vertriebs GmbH	FSW43	EF00896	2019-07	2020-07
Horn Antenna	Schwarzbeck	BBHA9120D	EF00018	2019-10	2022-10
Climatic Sensor	Embedded Data Systems, LLC.	280010000025417E	EF01054	2020-03	2021-03
Climatic Sensor	Embedded Data Systems, LLC.	660010000028DF7E	EF01337	2020-03	2021-03
Climatic Sensor	Embedded Data Systems, LLC.	9A0010000025477E	EF01124	2020-03	2021-03
Climatic Sensor	Embedded Data Systems, LLC.	0200100000253 77E	EF01336	2020-03	2021-03

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 1.3

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.

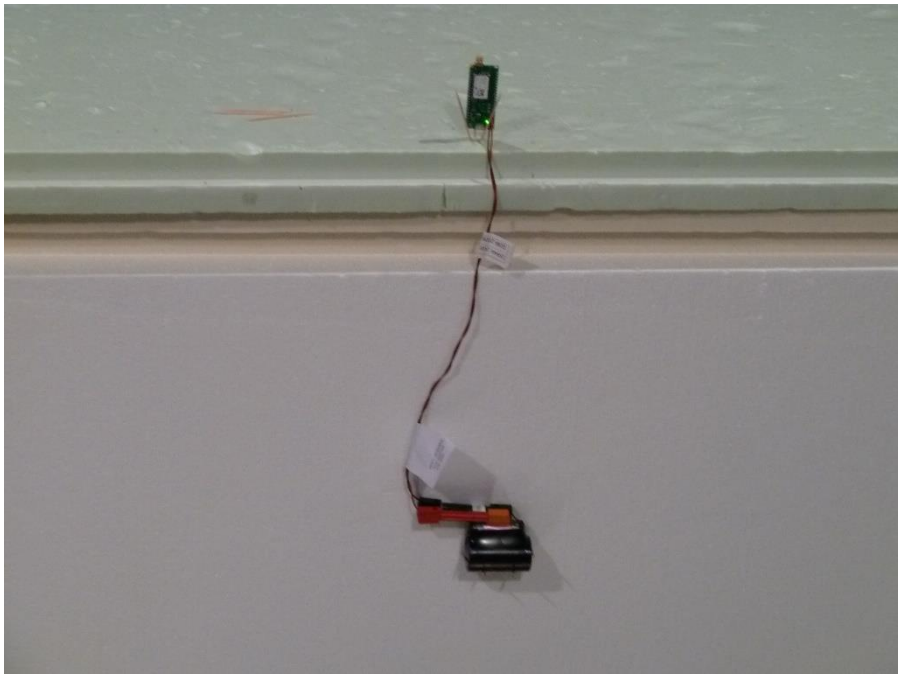
2.1.5 Limits

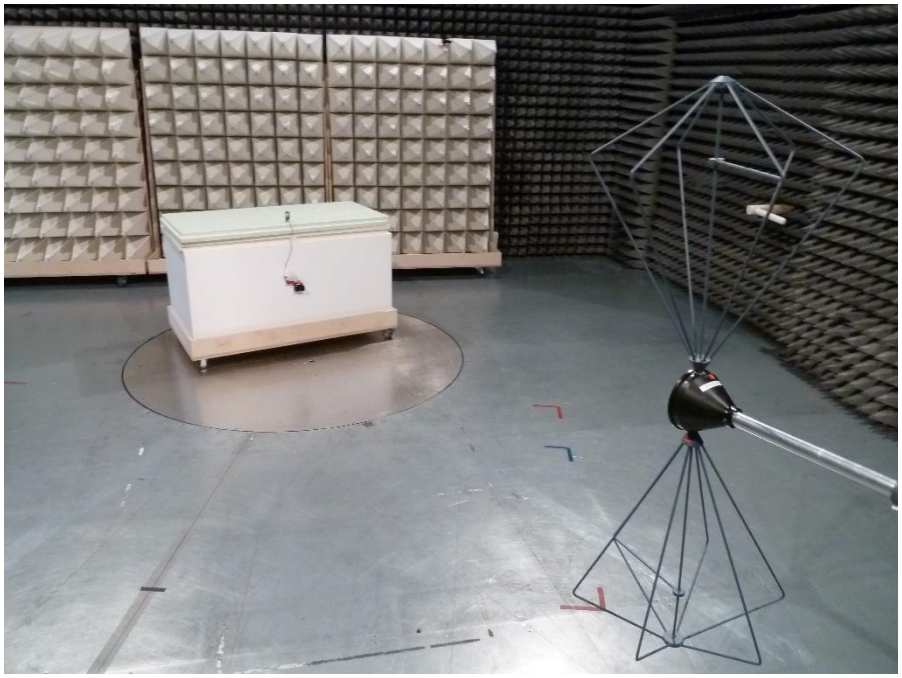
Class B @ 3 m		
Frequency [MHz]	Detector	Limit [dBµV/m]
30 - 88	Quasi-peak	40
88 - 216	Quasi-peak	43.5
216 - 960	Quasi-peak	46
960 - 1000	Quasi-peak	54
> 1000	Peak Average	74 54

2.1.6 Results

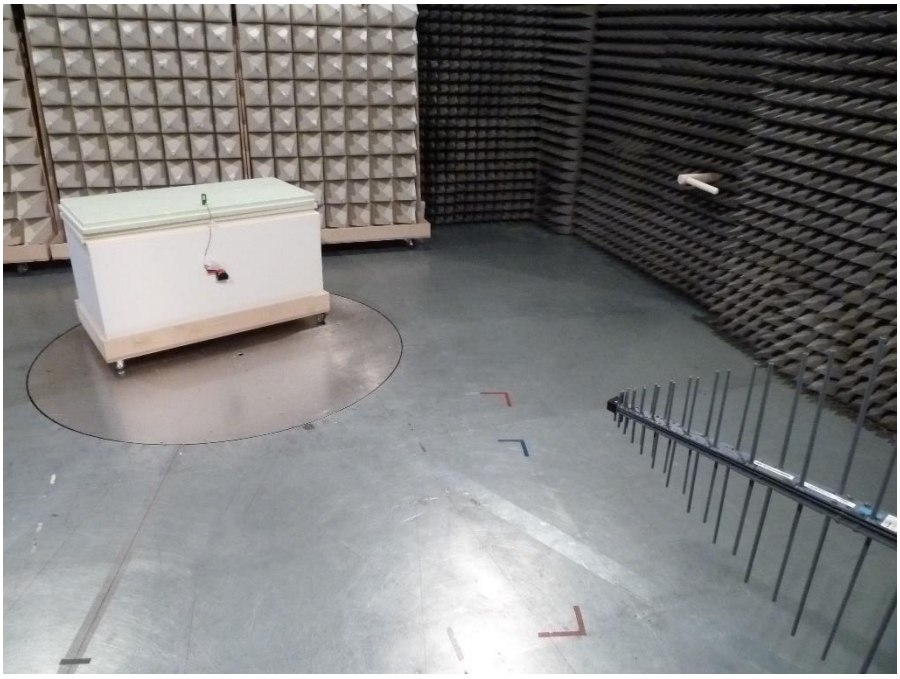
Test Results			
Operational mode	EUT Configuration	Verdict	Remark
1	1	PASS	-
2	1	PASS	-
3	1	PASS	-

2.1.7 Setup Photos

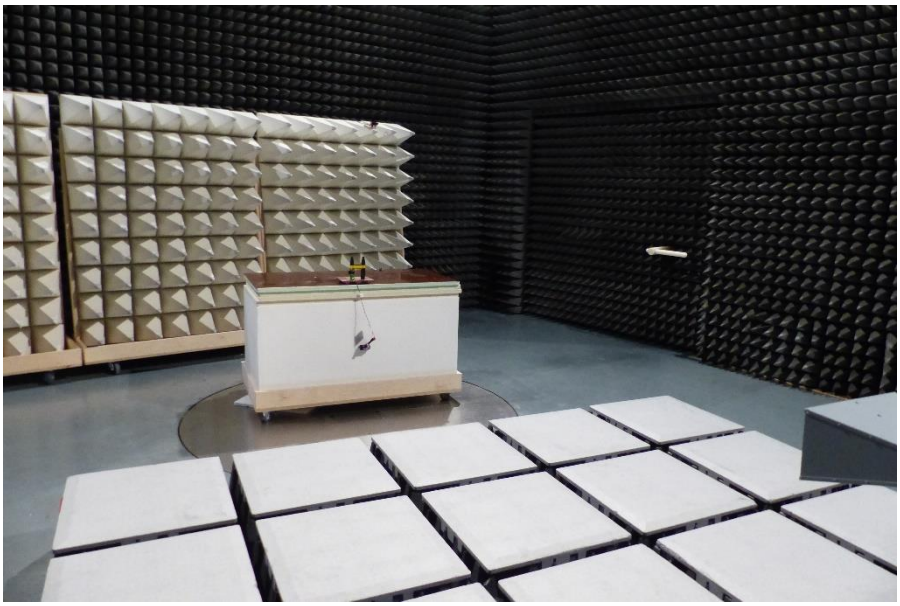
Test setup BLE


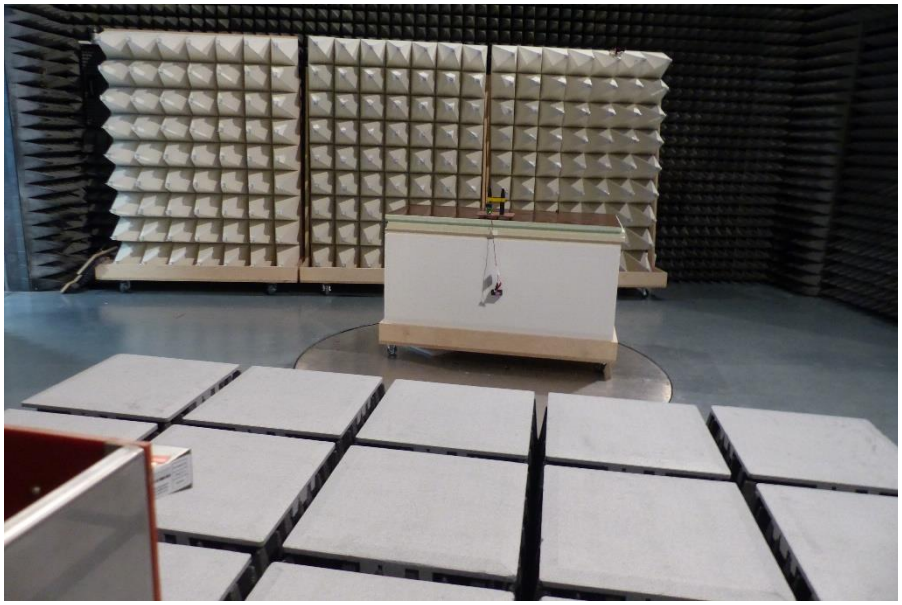
Test setup BLE 30-200MHz


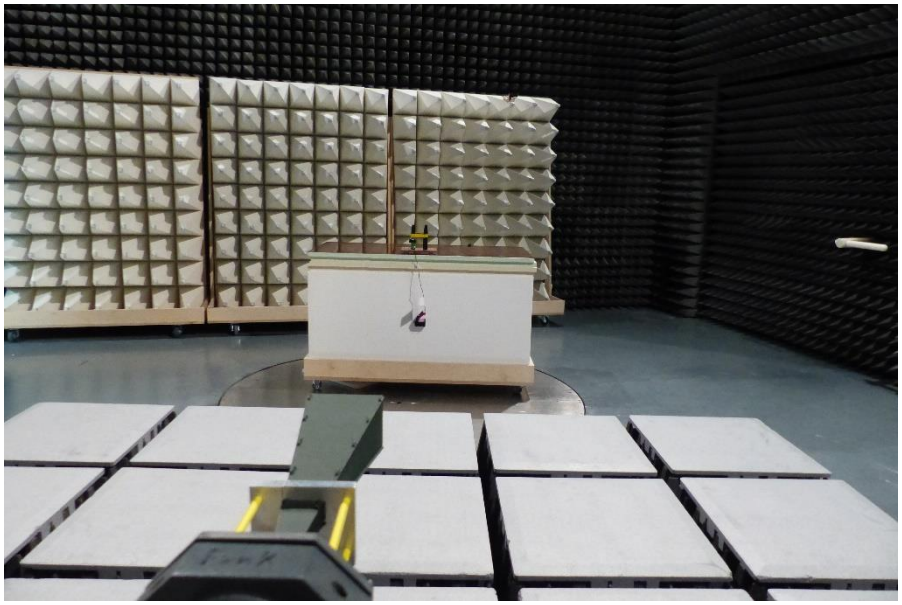
Test setup BLE 200-1000MHz

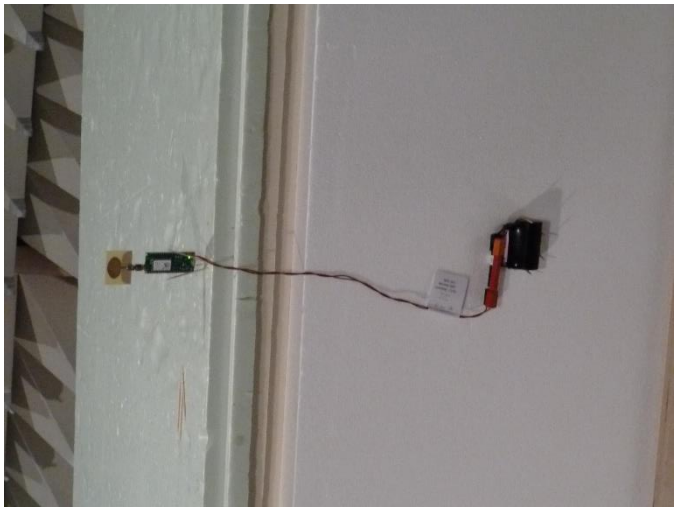


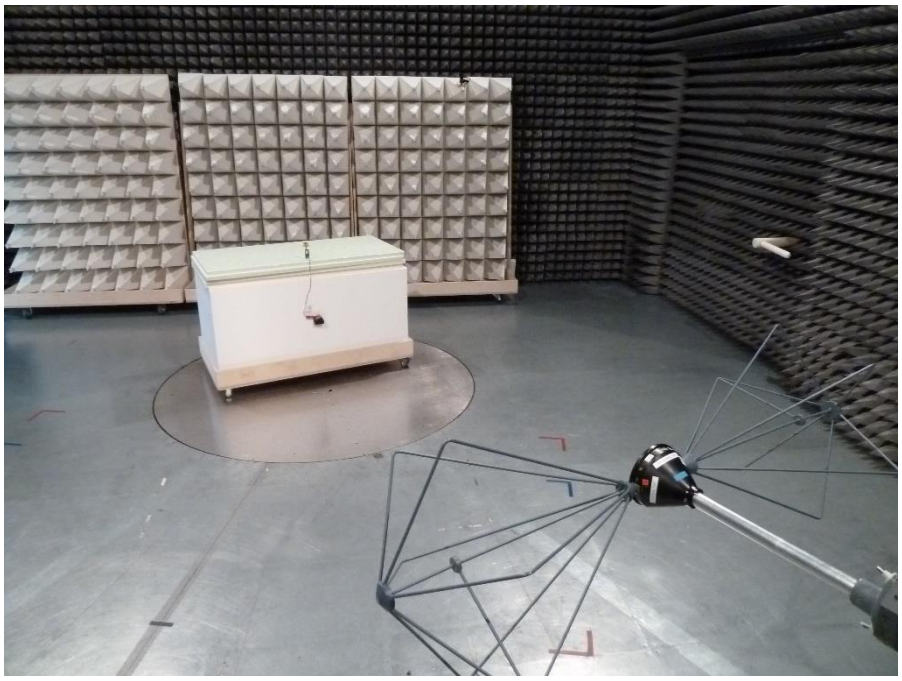
Test setup BLE 1-17GHz



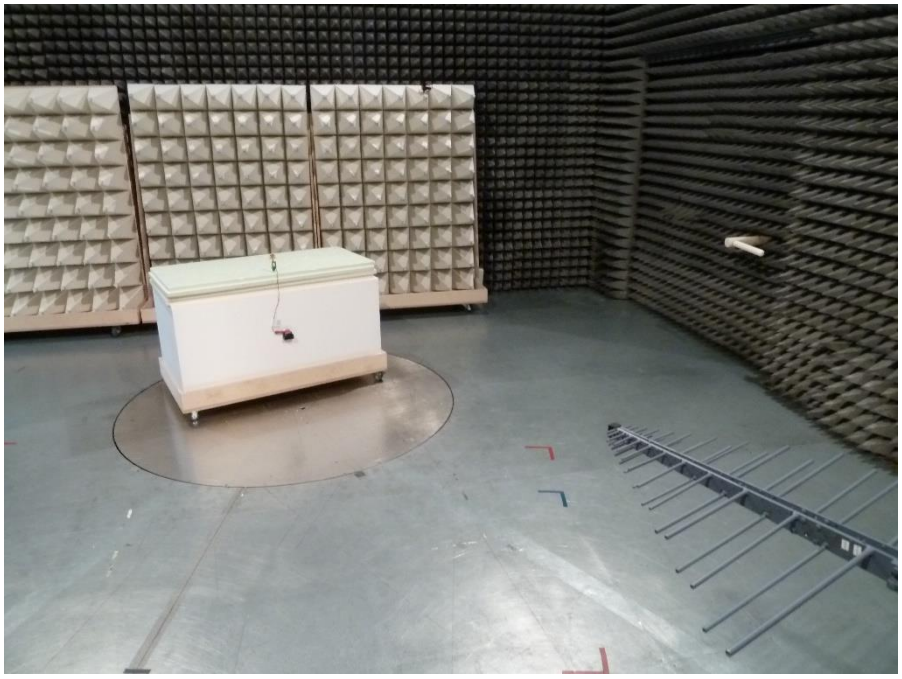
Test setup BLE 17-26.5GHz


Test setup BLE 26.5-40GHz


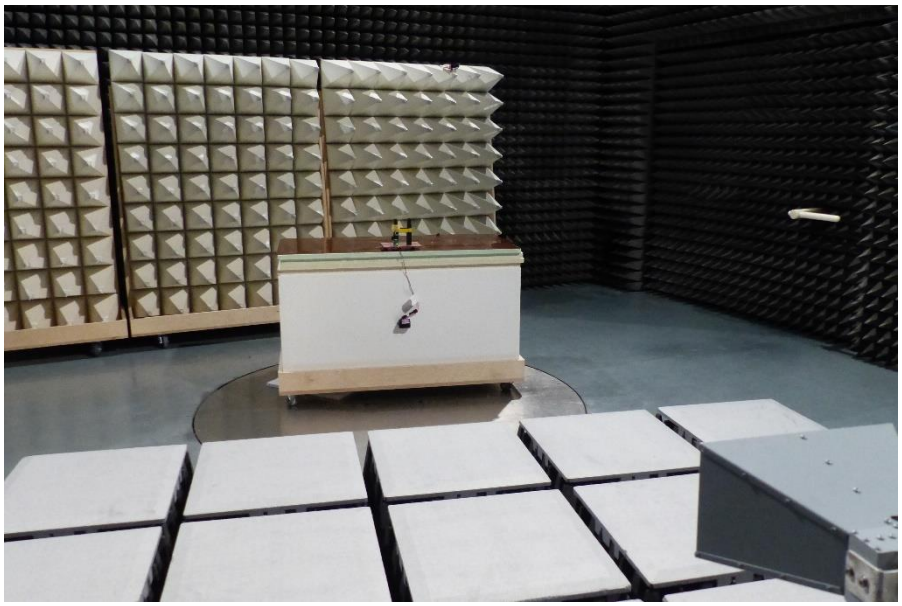
Test setup UWB


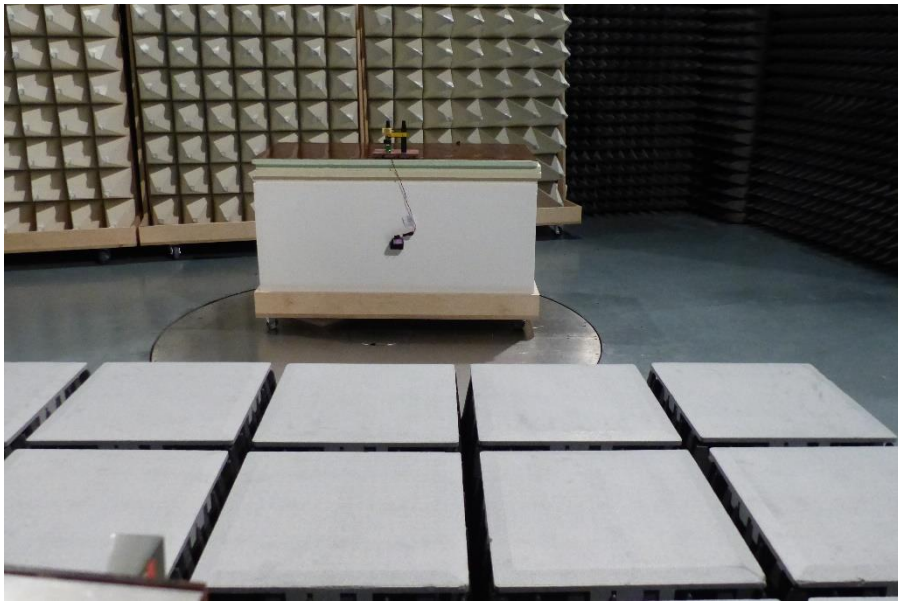
Test setup UWB 30-200MHz


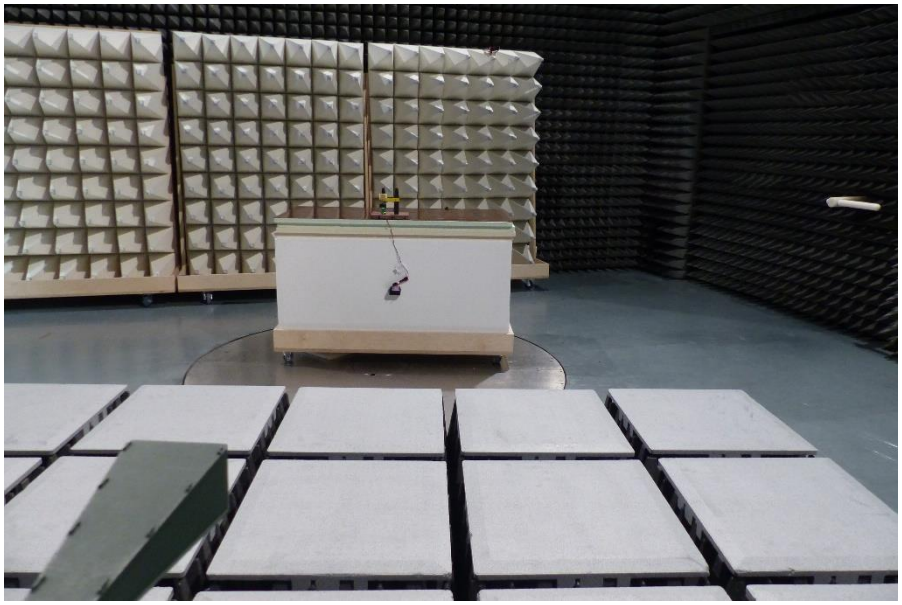
Test setup UWB 200-1000MHz



Test setup UWB 1-17GHz



Test setup UWB 17-26.5GHz


Test setup UWB 26.5-40GHz


2.1.8 Records

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Vertical
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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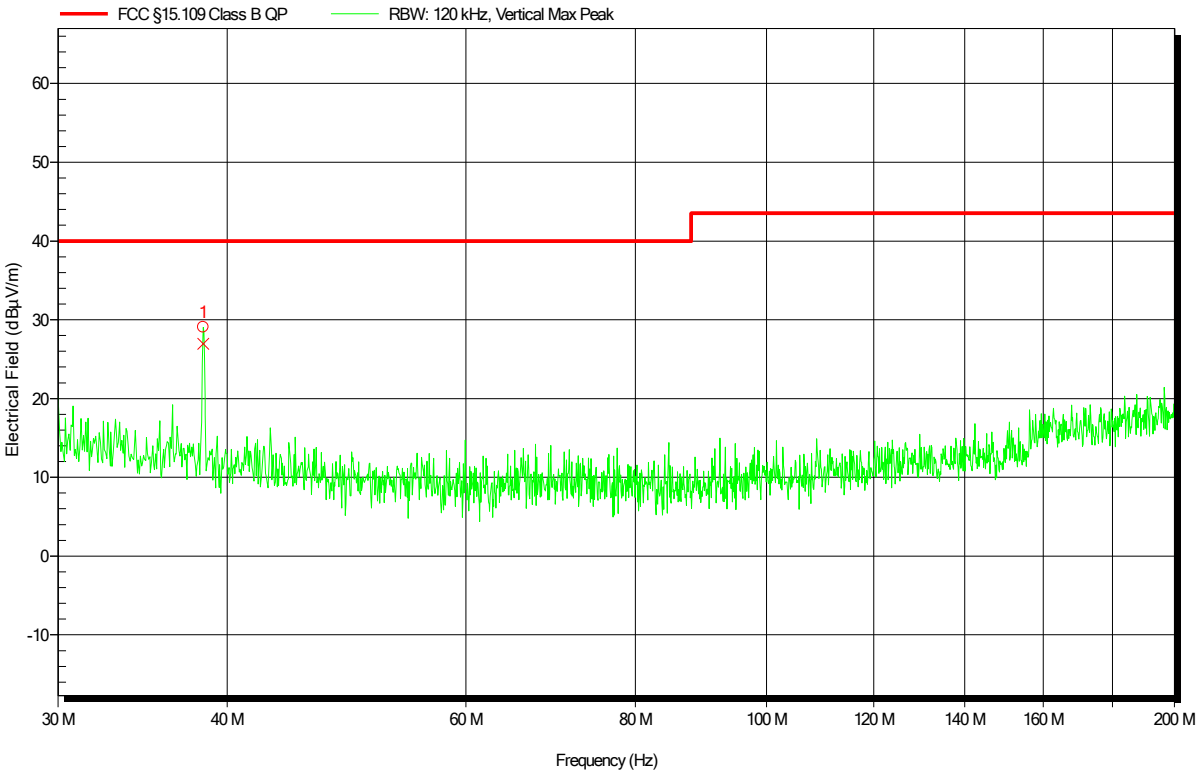

Peak Number	Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height
1	38.395 MHz	26.94 dBµV/m	40 dBµV/m	-13.06 dB	Pass	0 Degree	1 m

Radiated emissions according to FCC part 15B

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Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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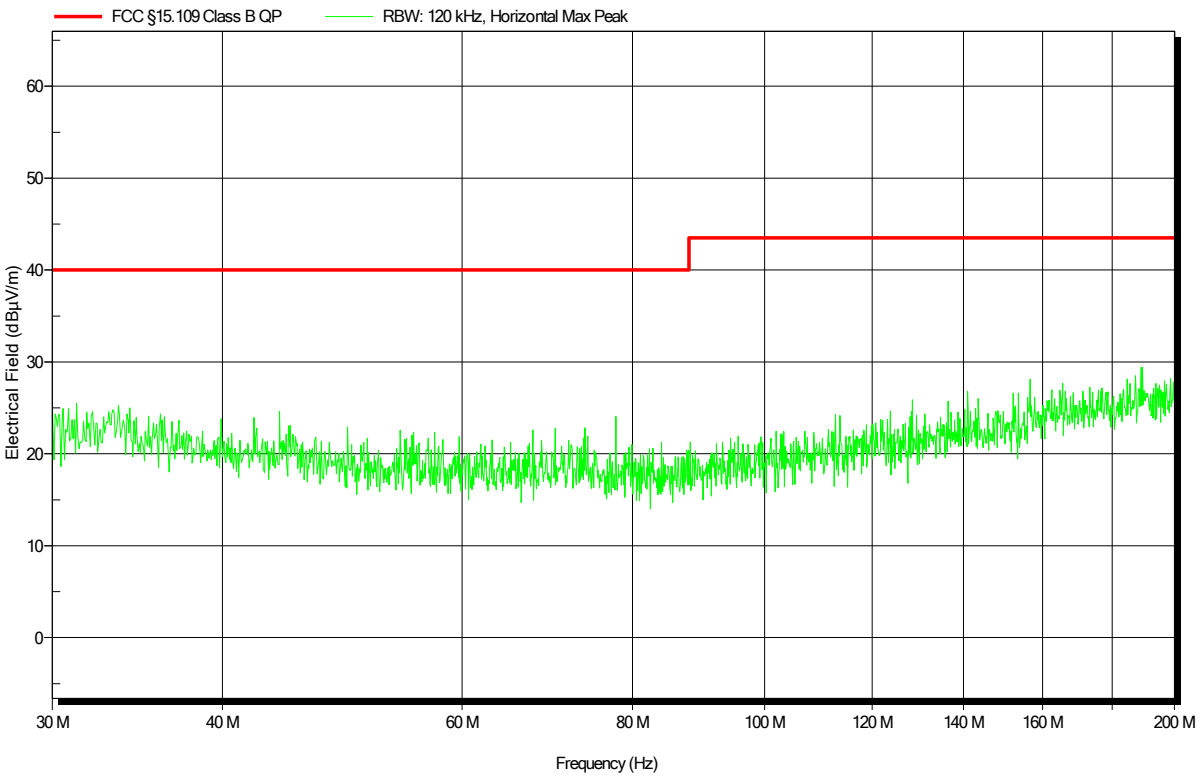

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
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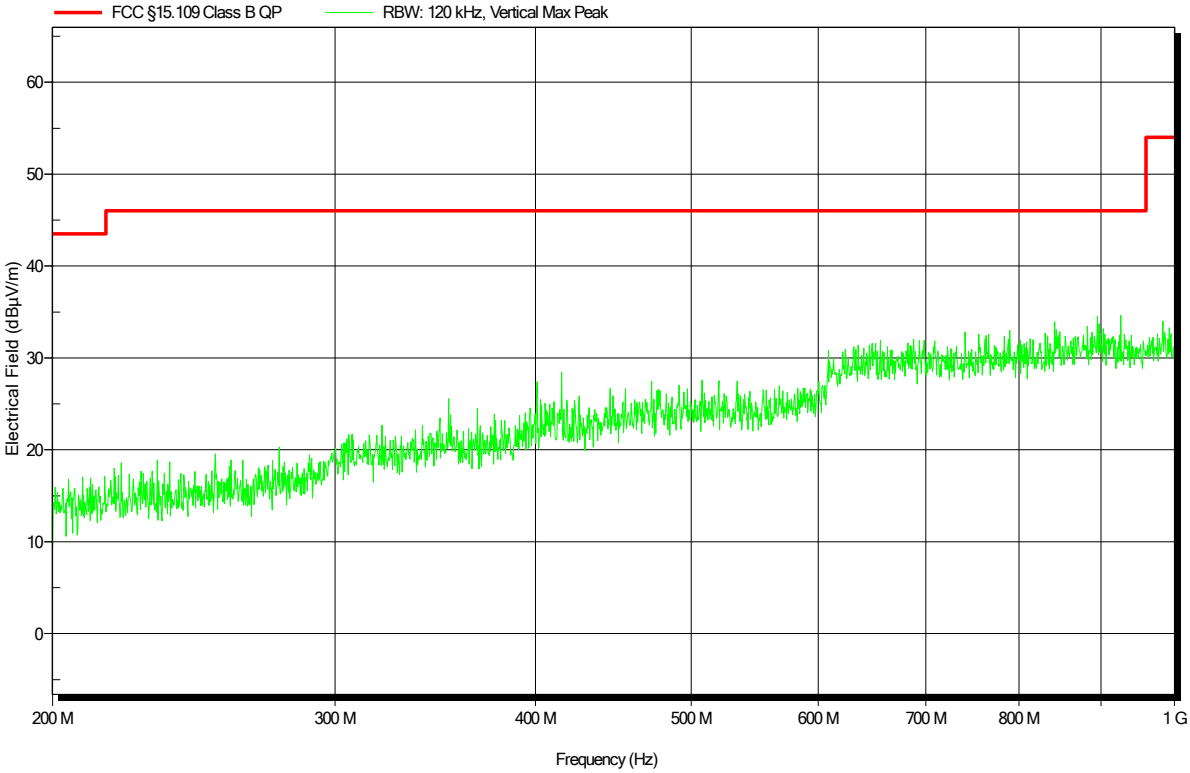
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Vertical
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

Index 3



Radiated emissions according to FCC part 15B

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Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
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Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Horizontal
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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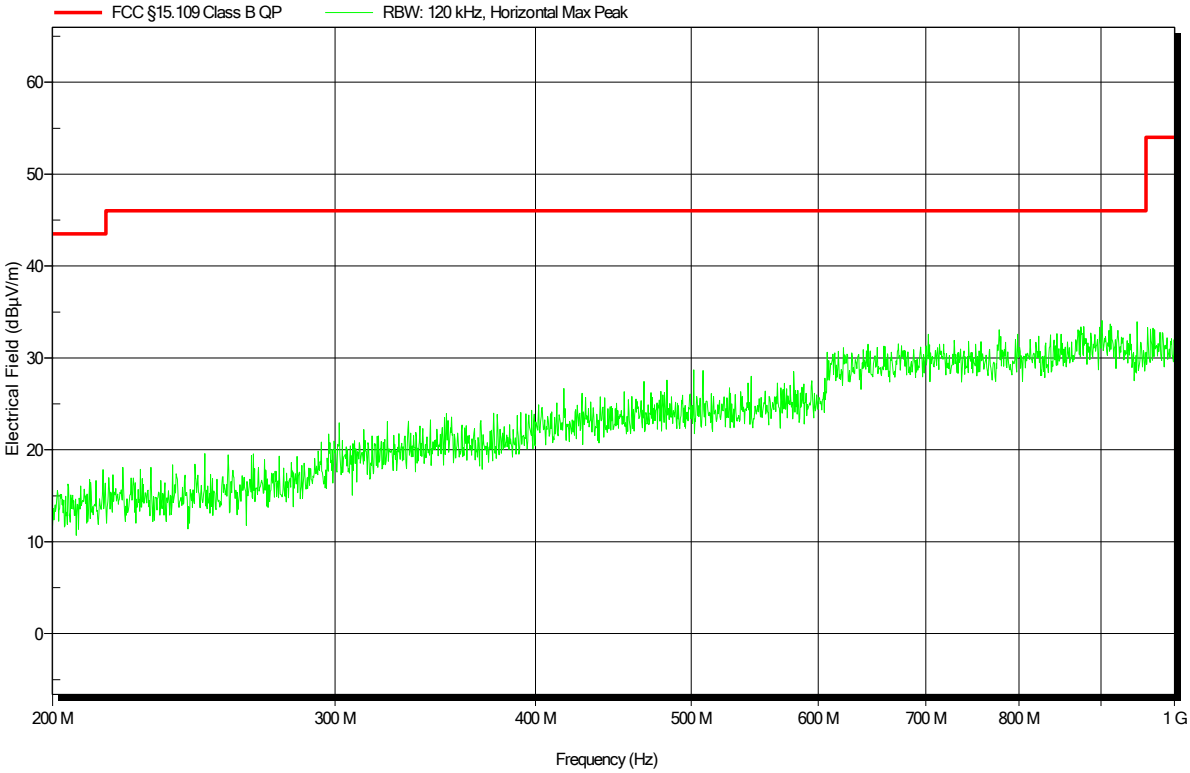

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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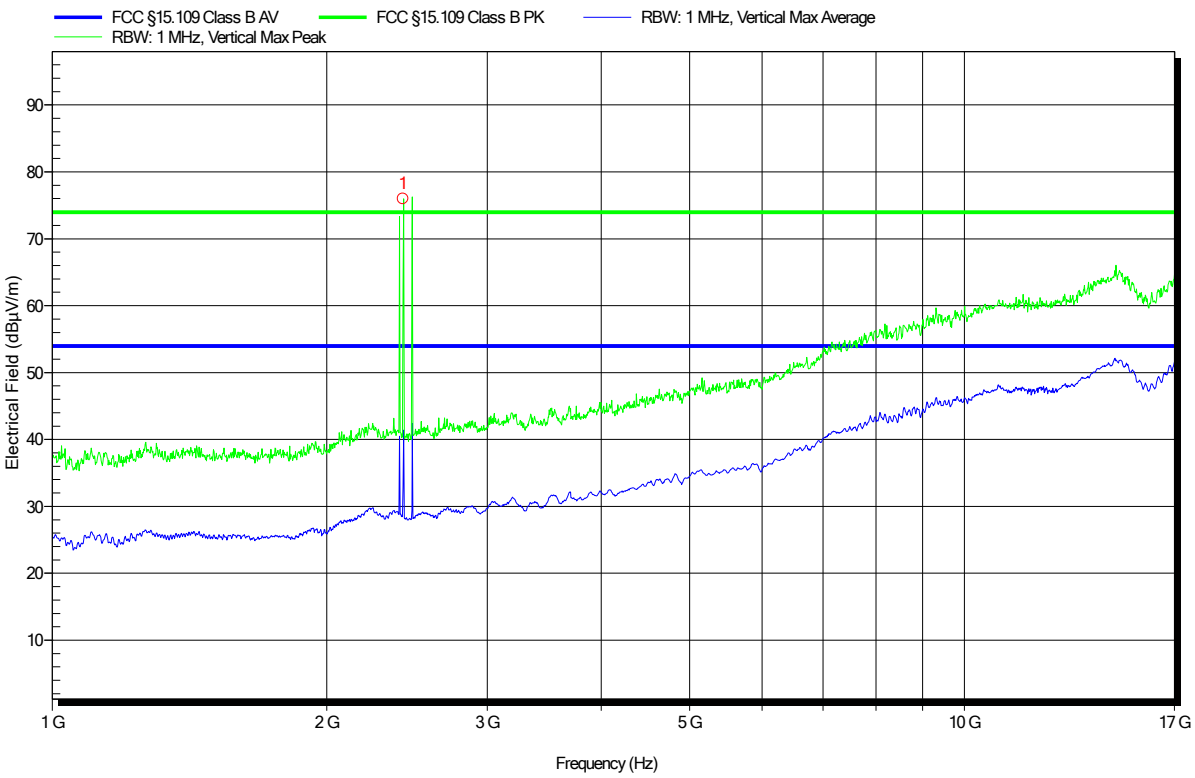

Peak Number	Frequency	Peak	Angle	Height
1	2.426 GHz	BLE carrier		

Radiated emissions according to FCC part 15B

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Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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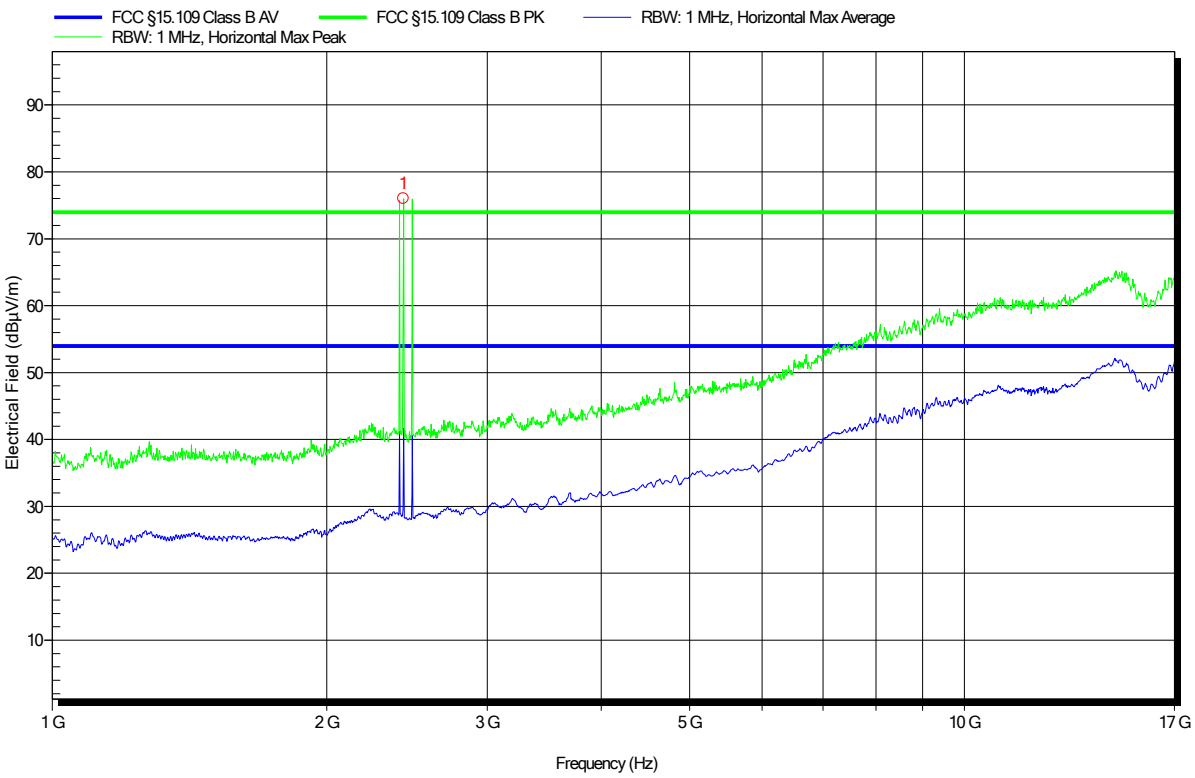

Peak Number	Frequency	Peak	Angle	Height
1	2.426 GHz	BLE carrier		

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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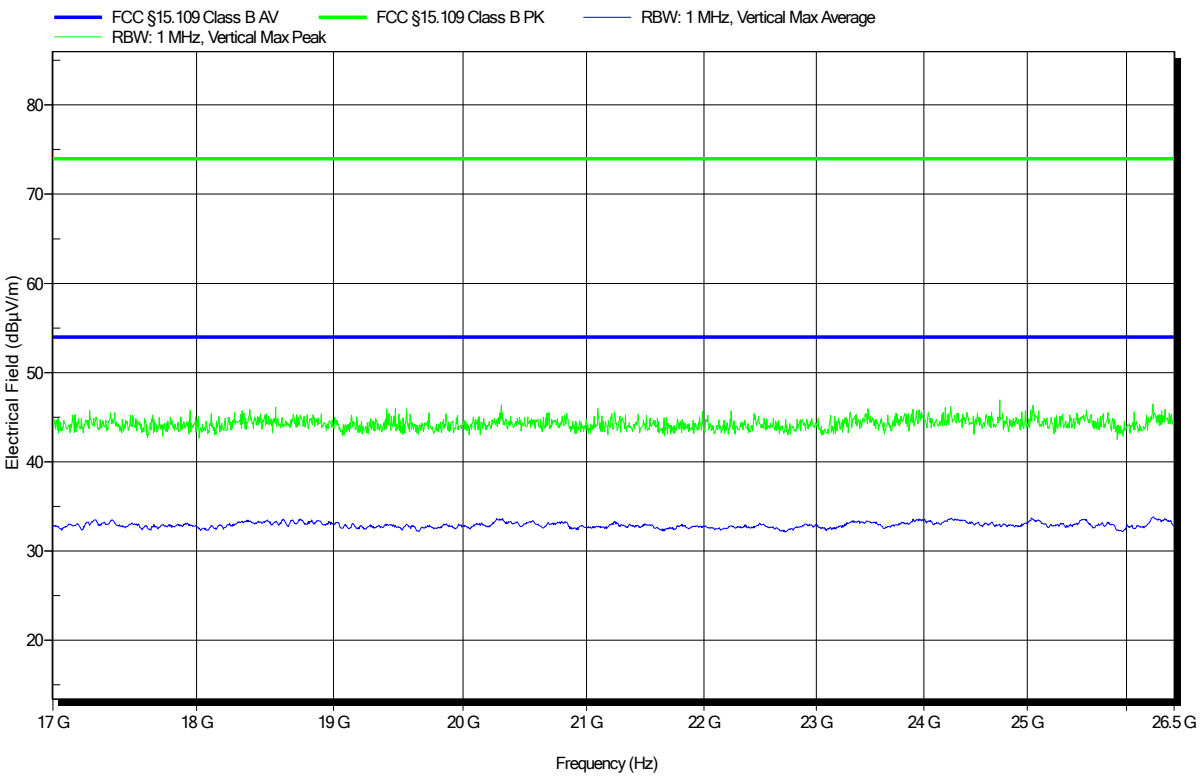

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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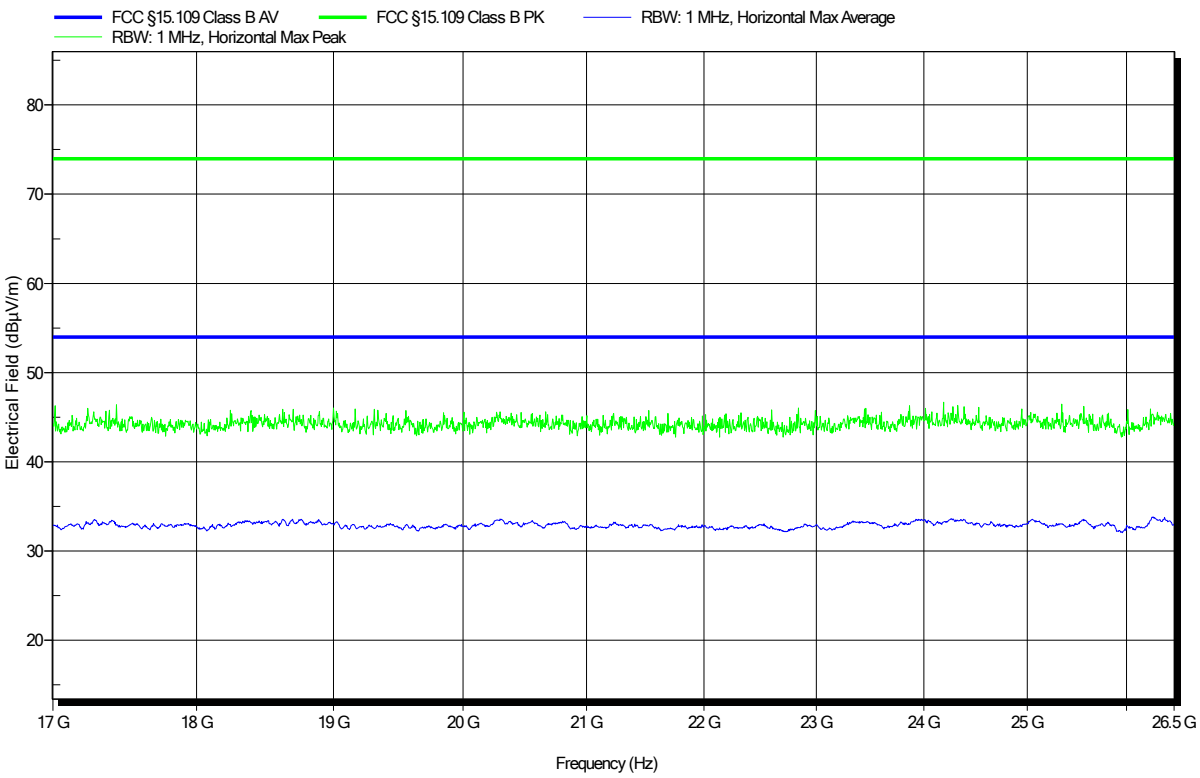

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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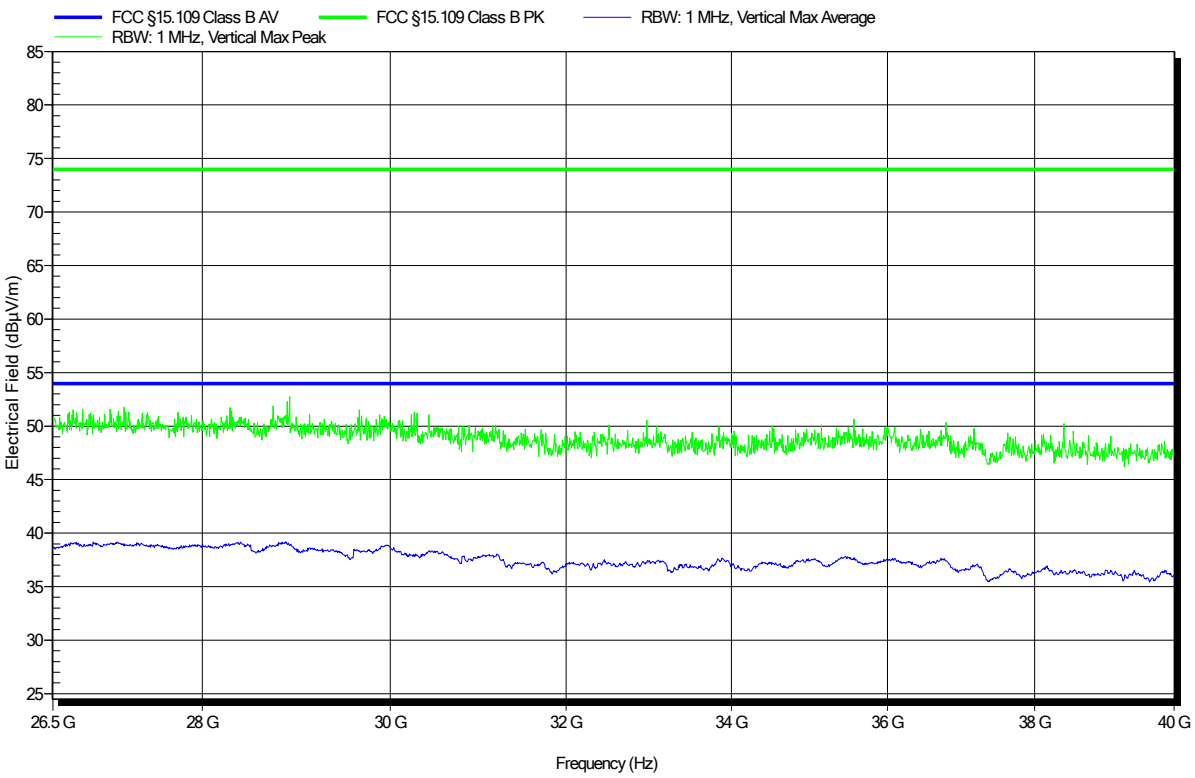

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	1 - BLE TX
Note 1:	

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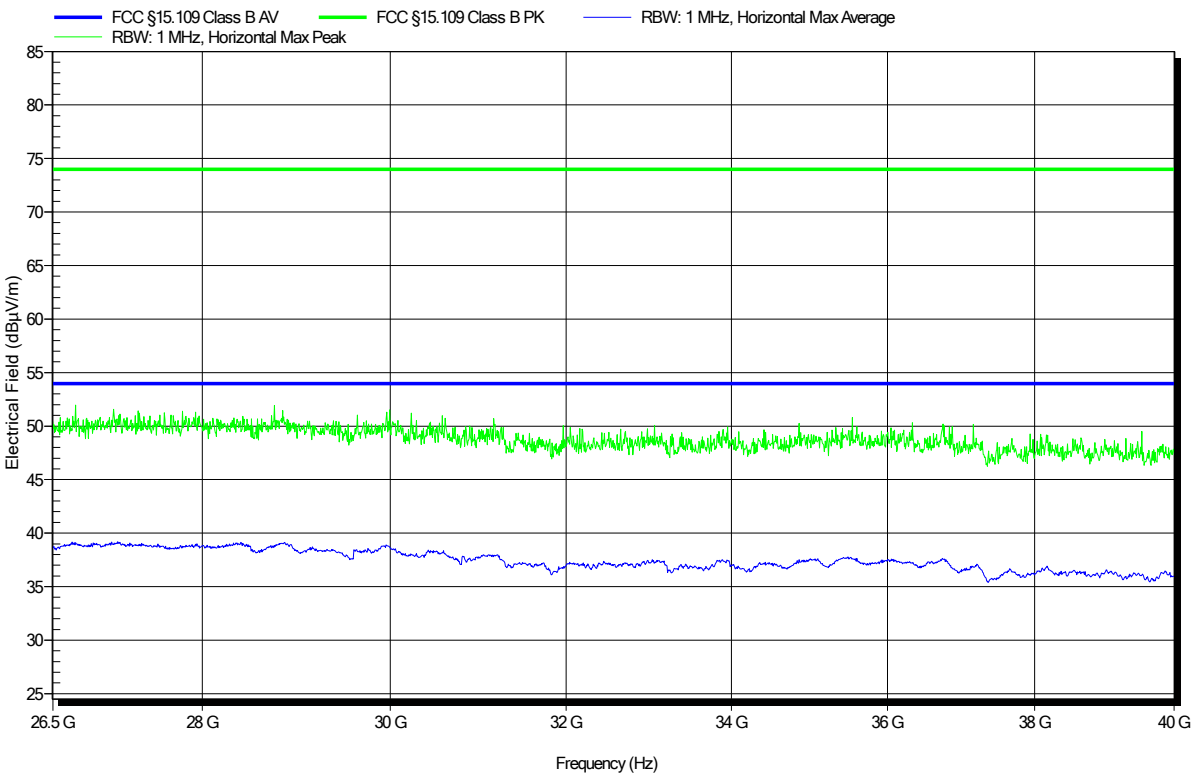

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Vertical
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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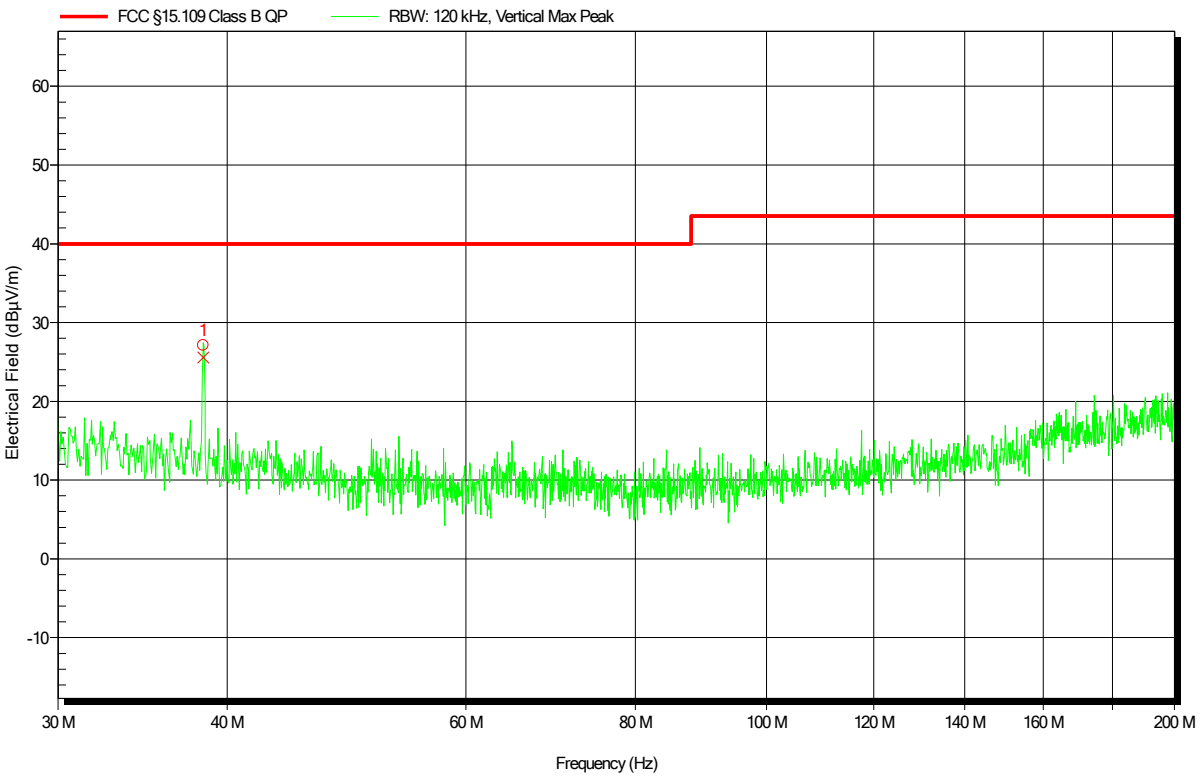

Peak Number	Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height
1	38.401 MHz	25.56 dBµV/m	40 dBµV/m	-14.44 dB	Pass	0 Degree	1 m

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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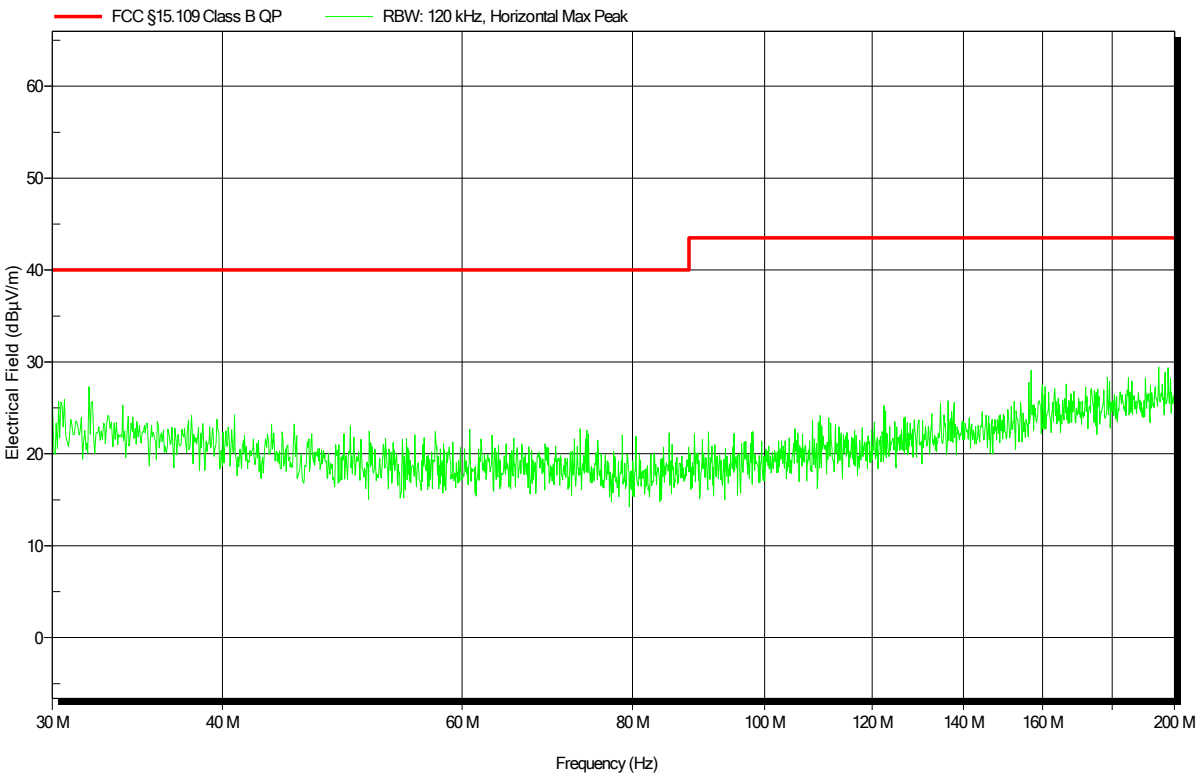

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Vertical
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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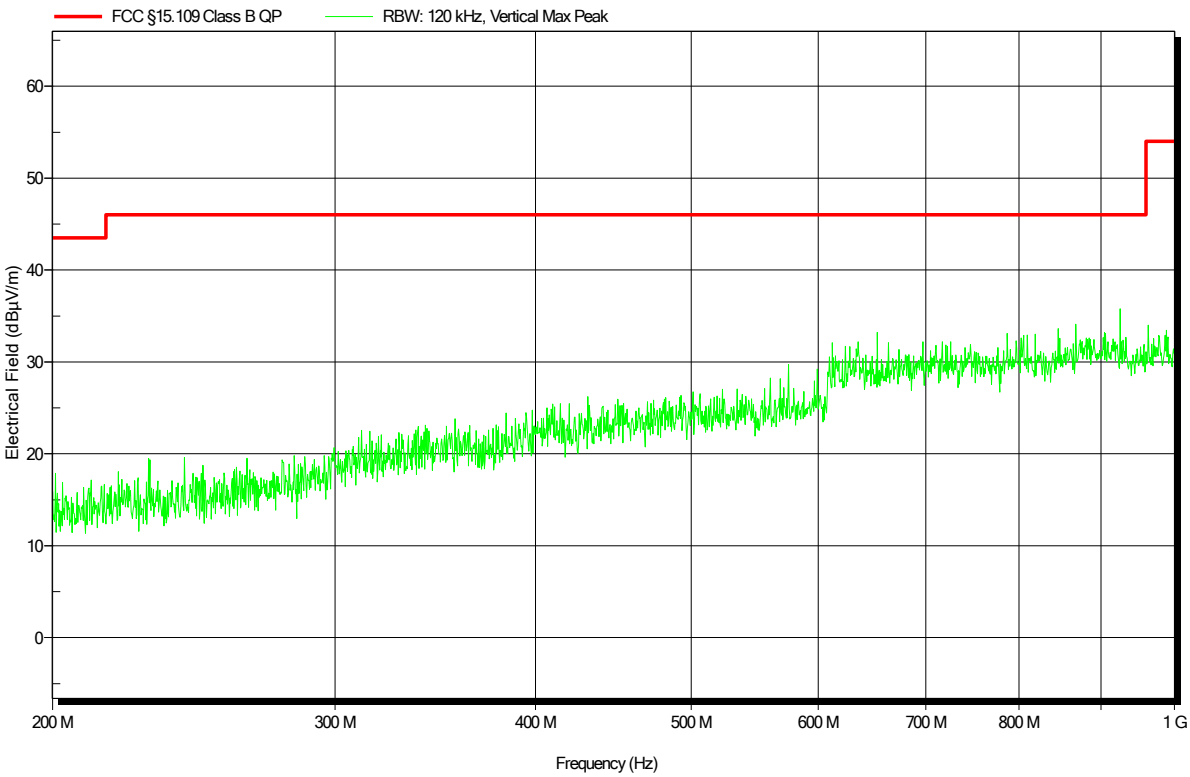

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Horizontal
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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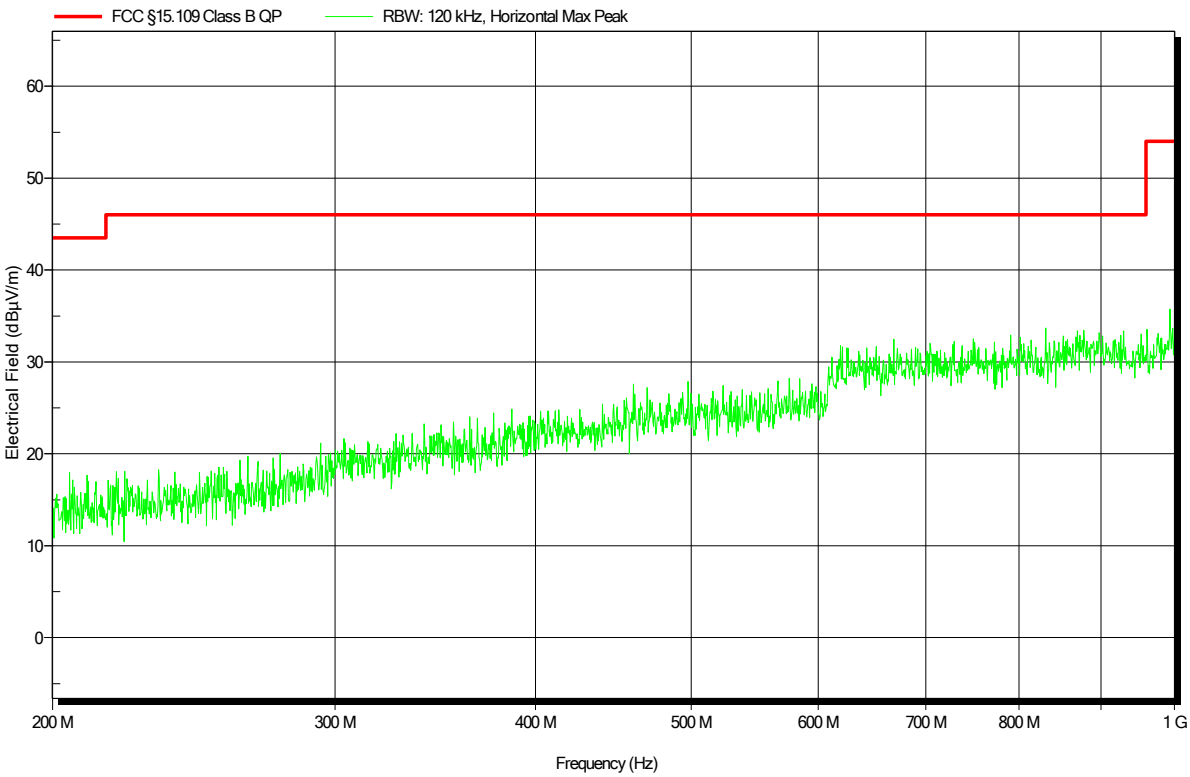

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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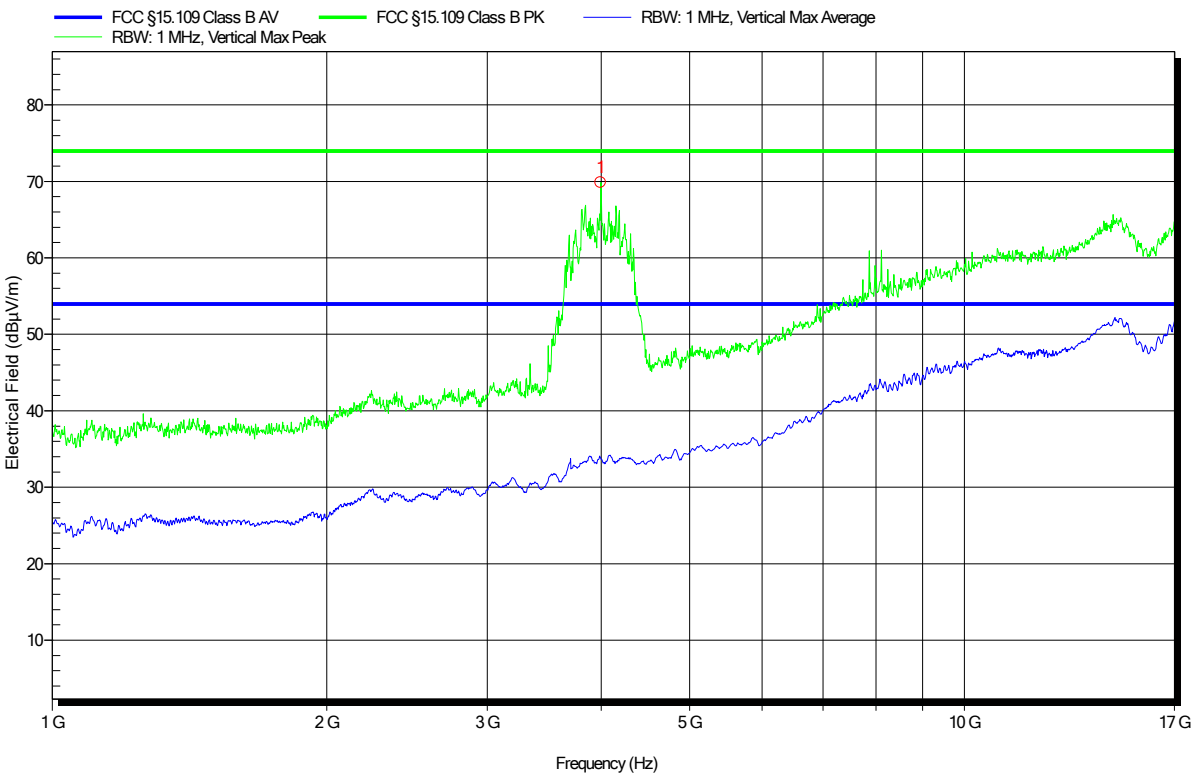

Peak Number	Frequency	Peak	Angle	Height
1	3.993 GHz	UWB Ch.: 2 carrier		

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3m
Mode:	2 - UWB Ch. 2 TX
Note 1:	

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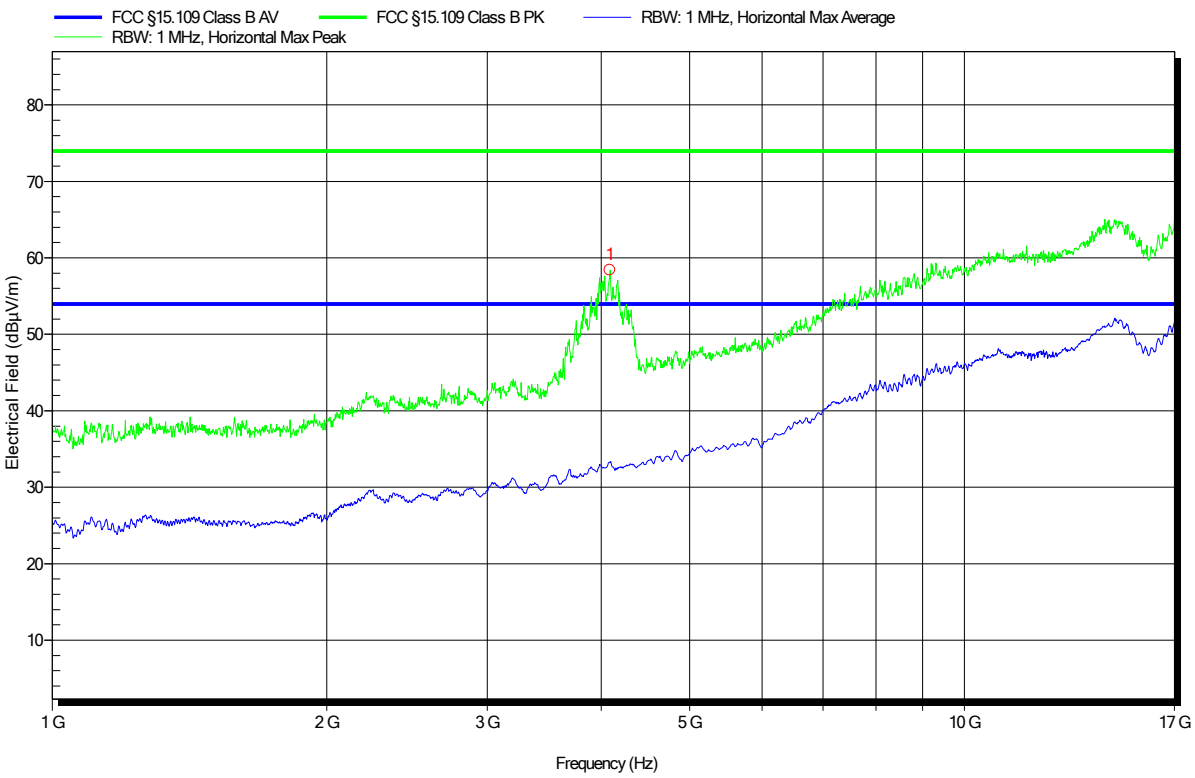

Peak Number	Frequency	Peak	Angle	Height
1	4.088 GHz	UWB Ch.: 2 carrier		

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	2 - UWB CH.: 2 TX
Note 1:	

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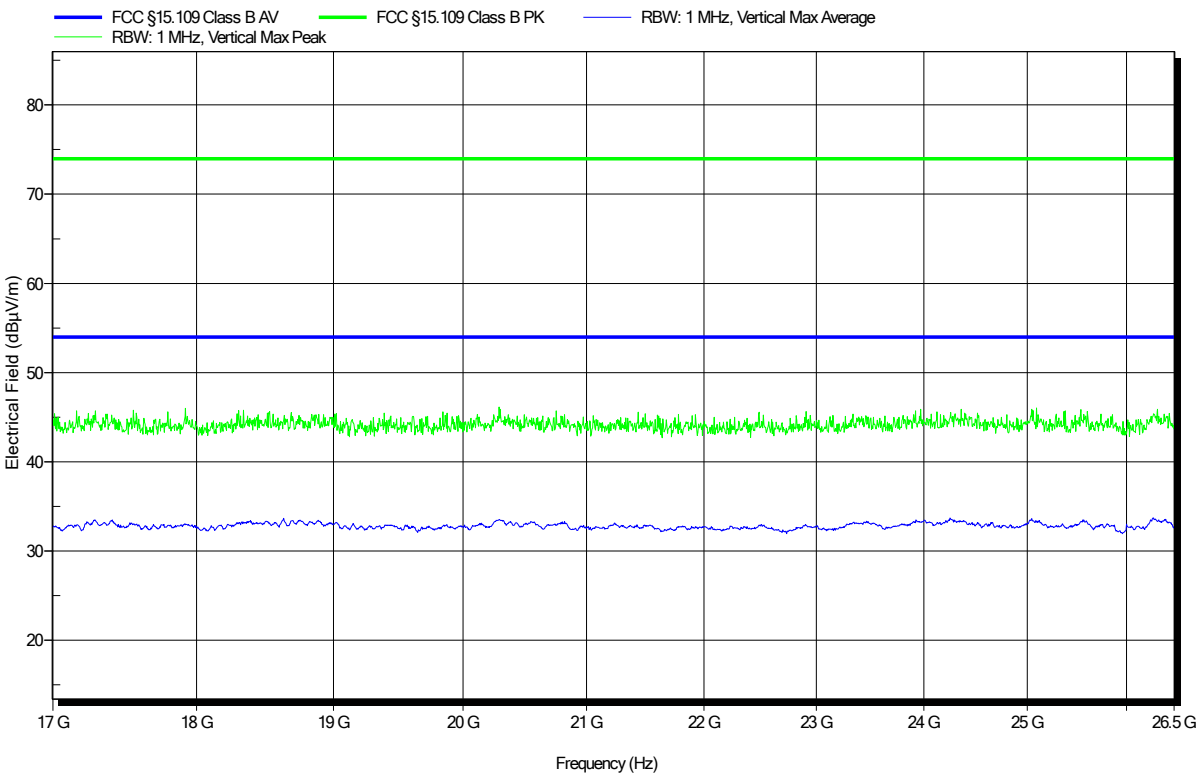

Radiated emissions
according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	2 - UWB CH.: 2 TX
Note 1:	

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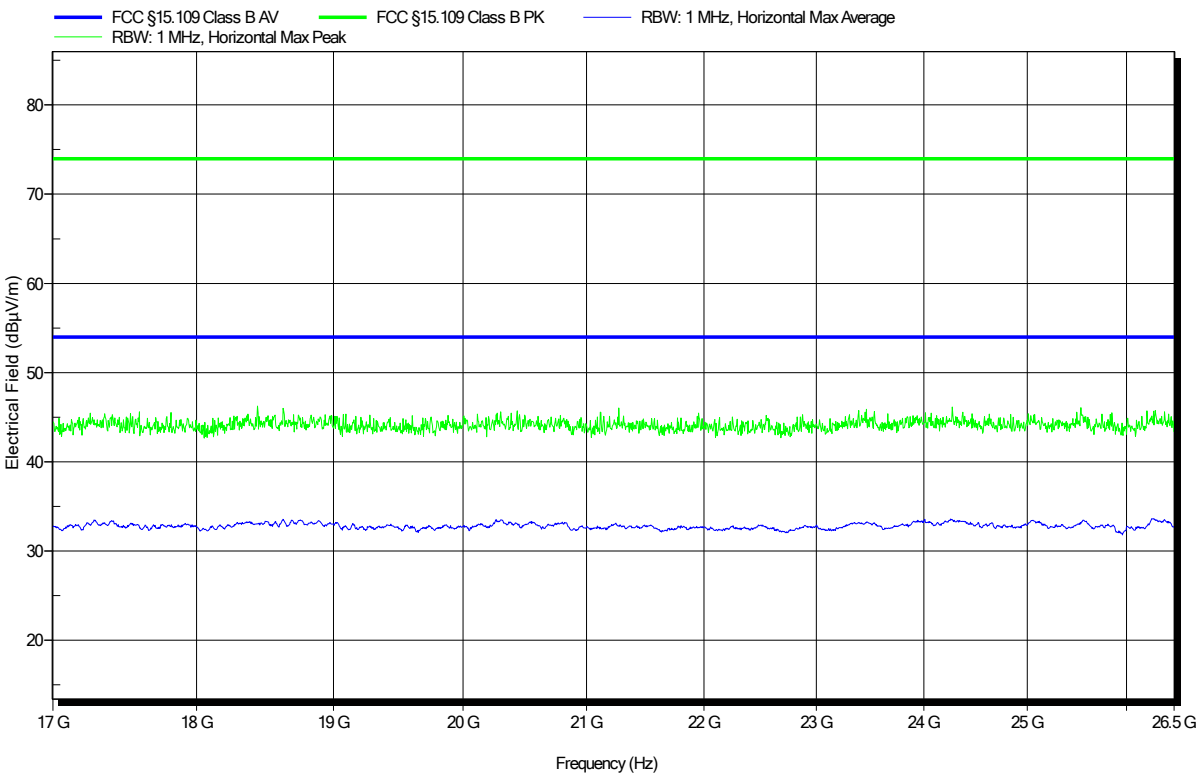

Radiated emissions
according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	2 - UWB CH.: 2 TX
Note 1:	

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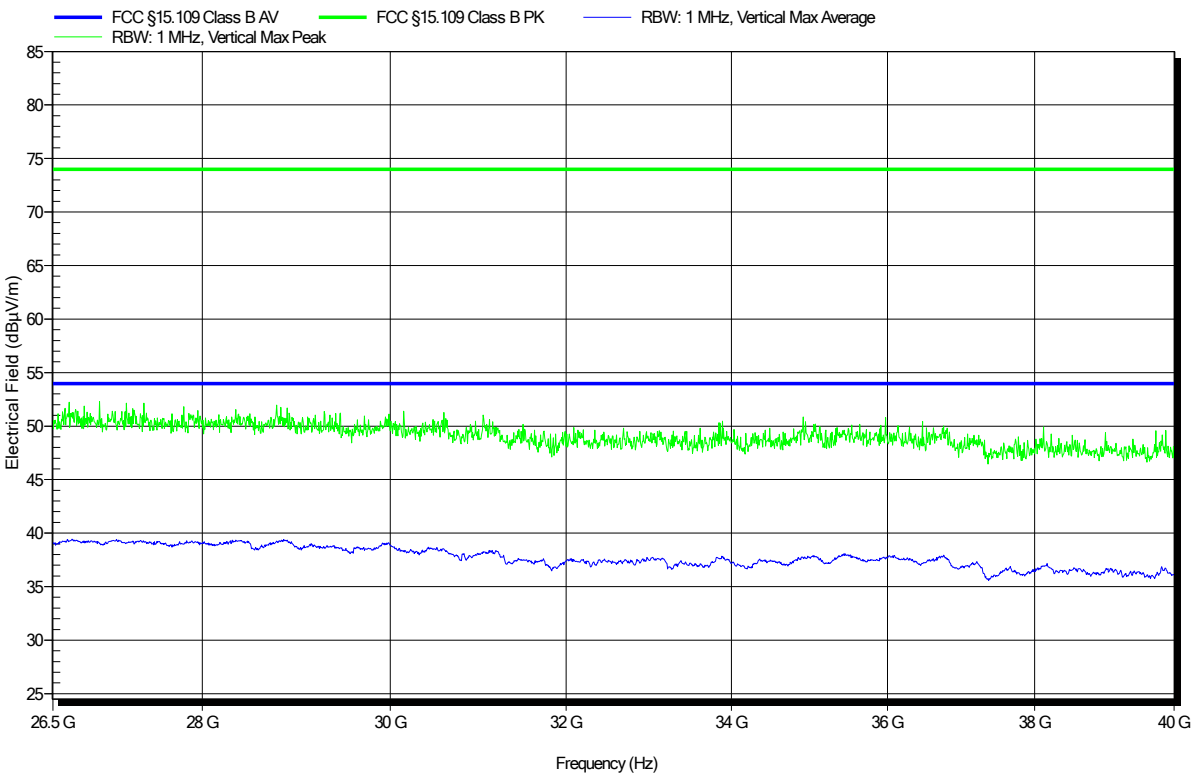

Radiated emissions
according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	2 - UWB CH.: 2 TX
Note 1:	

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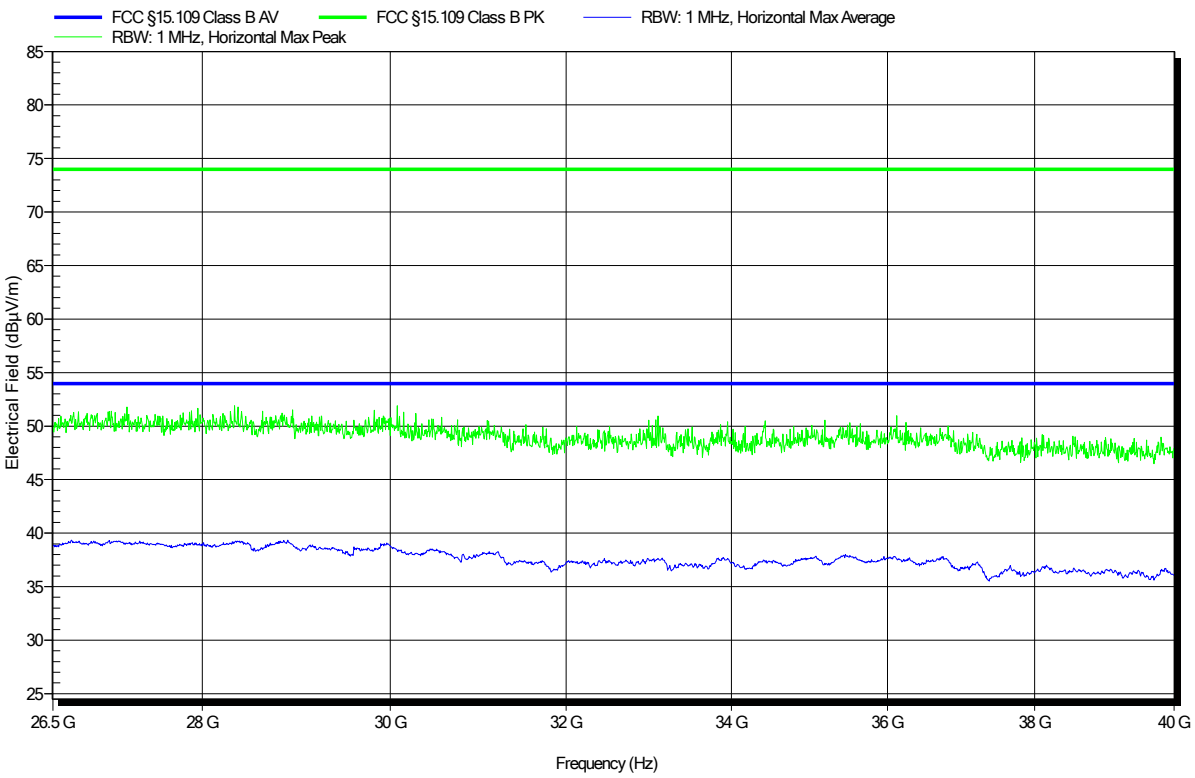

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Vertical
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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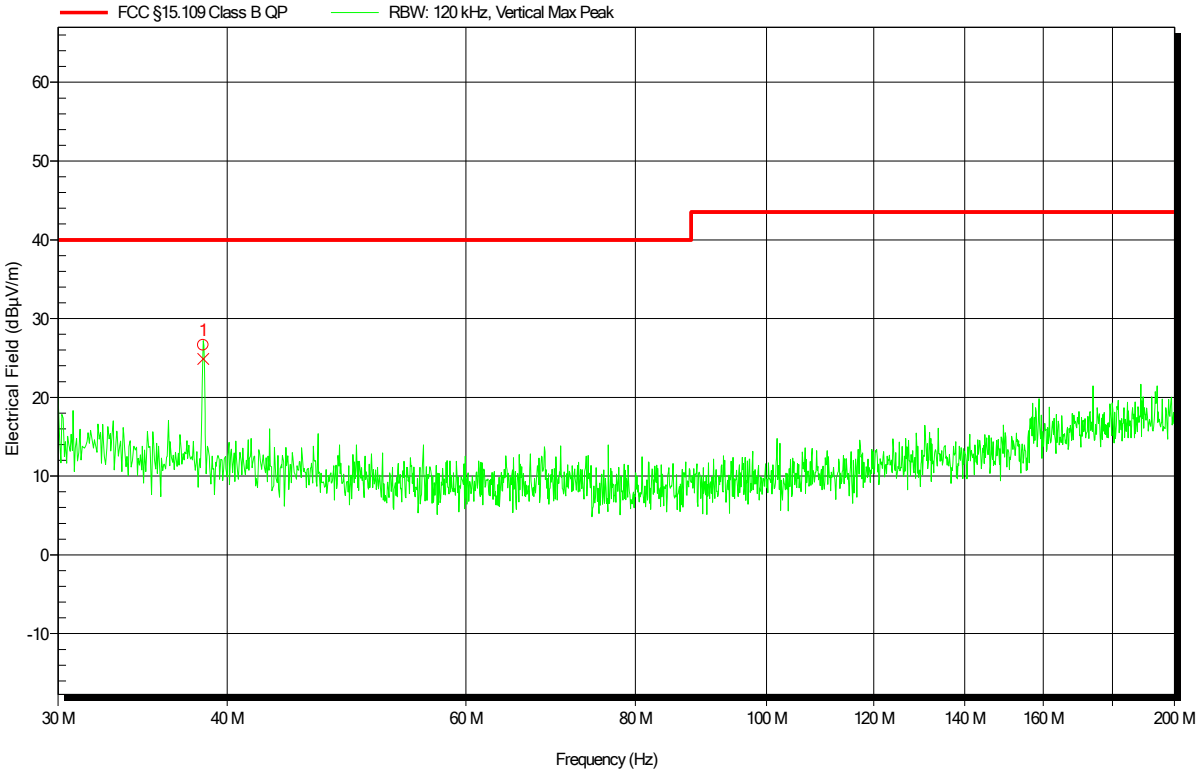

Peak Number	Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height
1	38.401 MHz	24.86 dBµV/m	40 dBµV/m	-15.14 dB	Pass	0 Degree	1 m

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HK 116, Horizontal
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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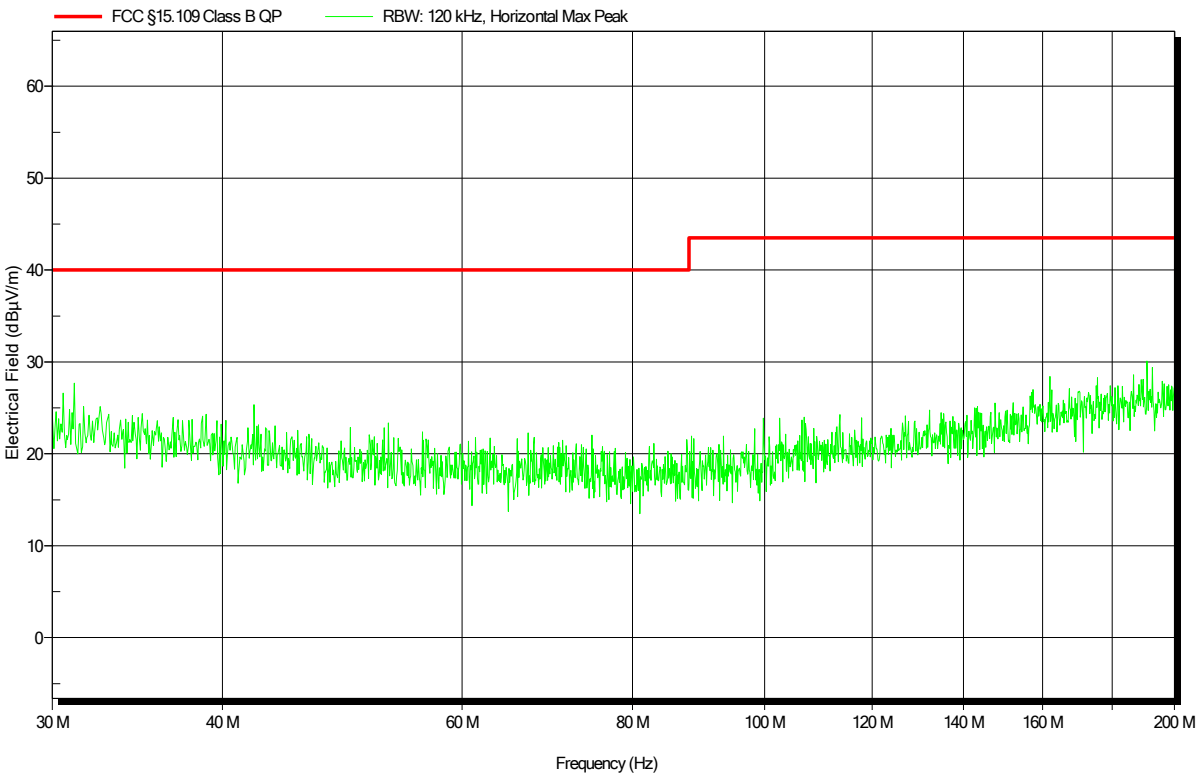

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Vertical
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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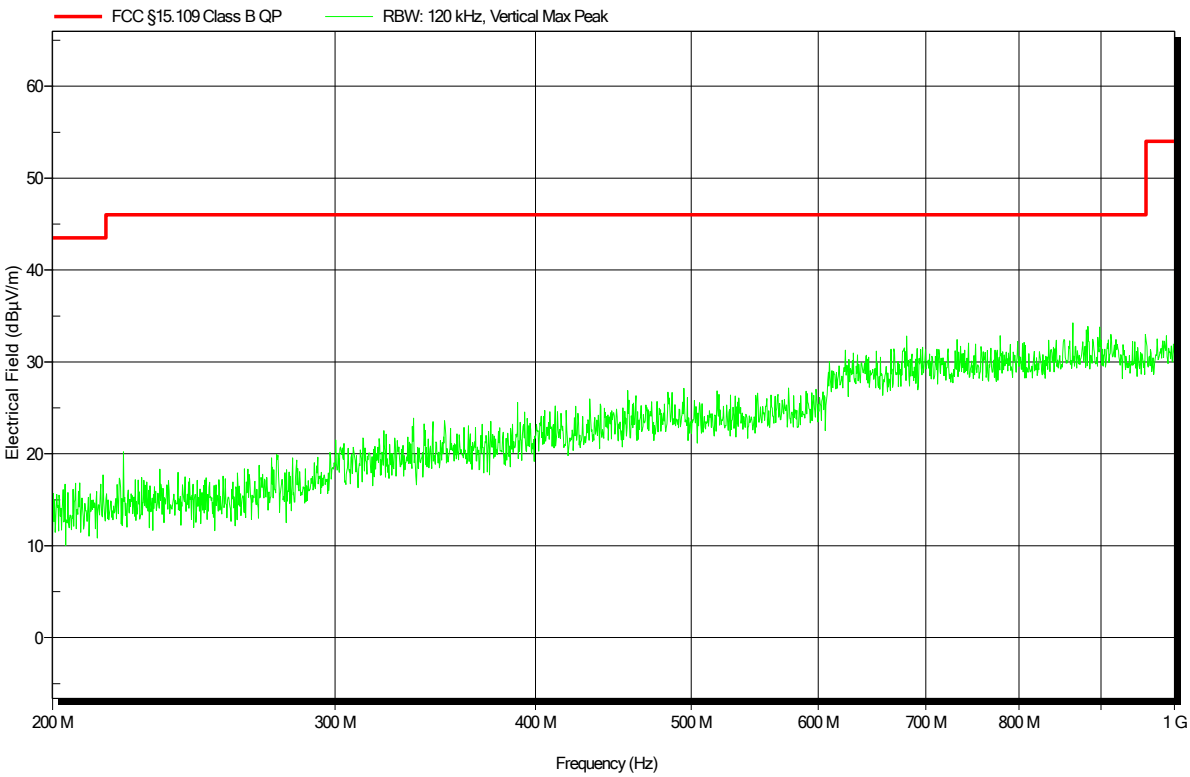

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-07
Operating Conditions:	ambient temperature: 20°C power input: 3.3V DC (battery)
Antenna:	Rohde & Schwarz HL 223, Horizontal
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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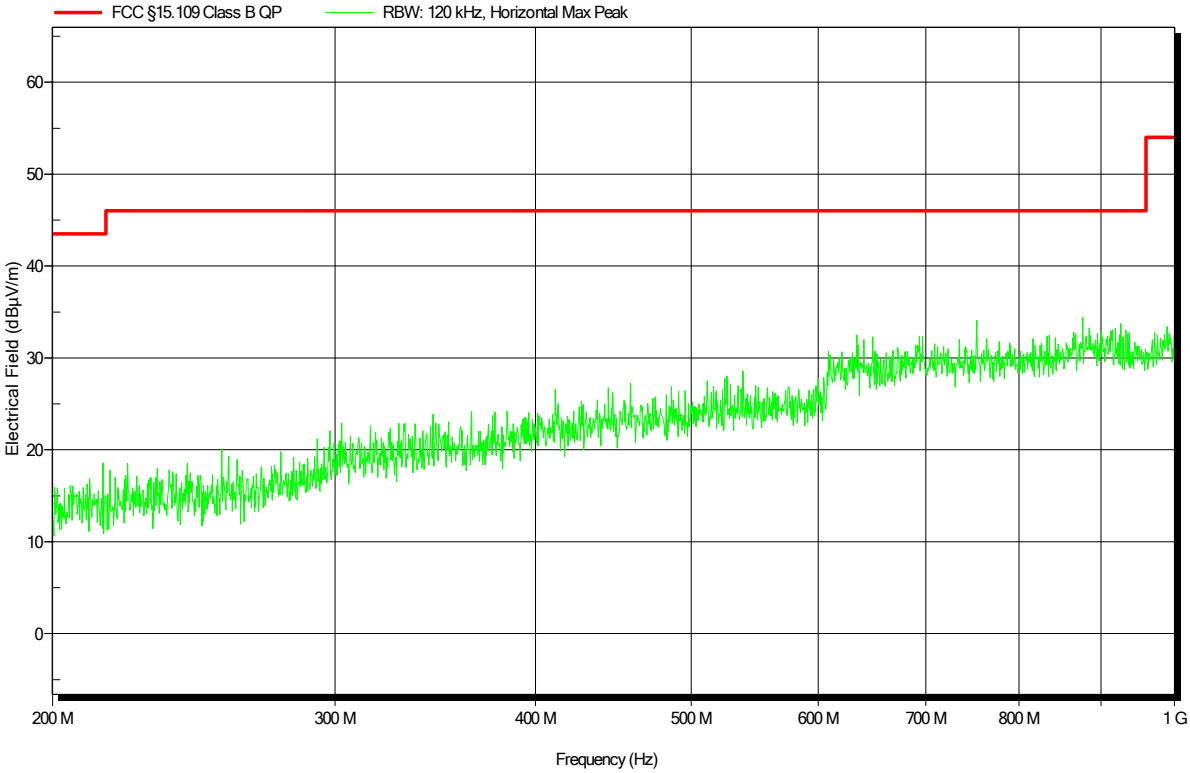

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Vertical
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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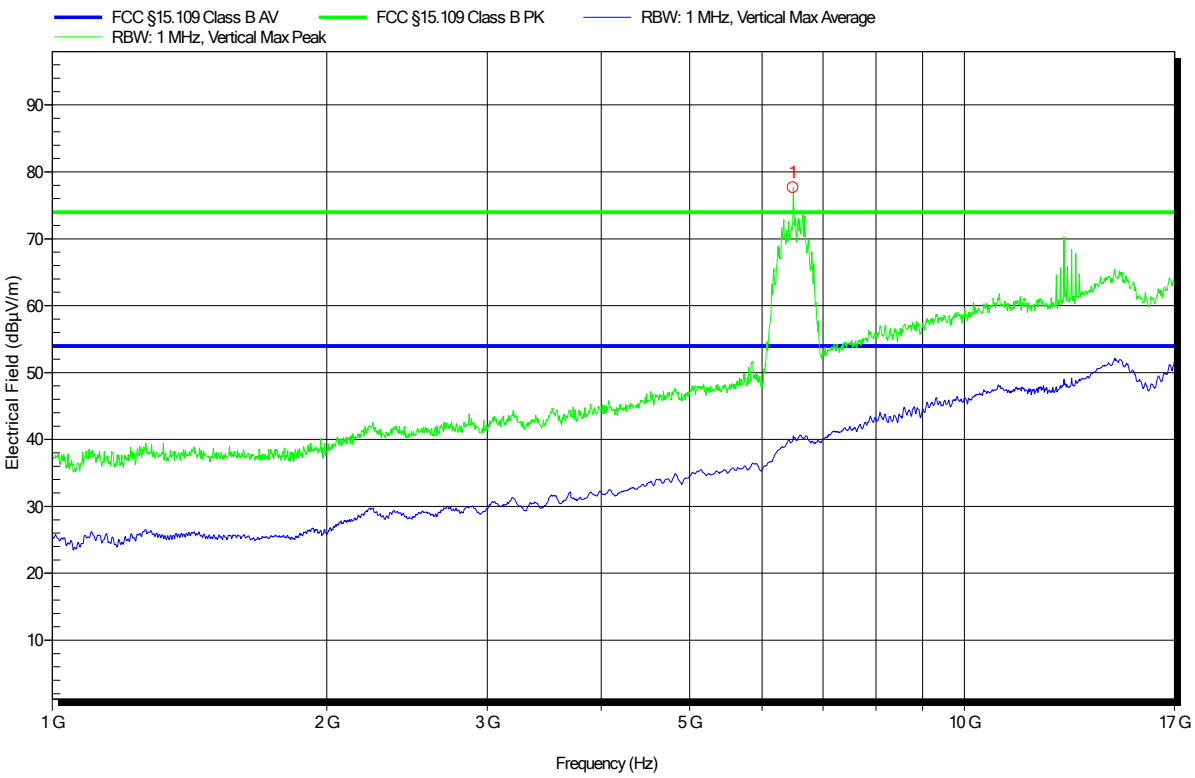

Peak Number	Frequency	Peak	Angle	Height
1	6.49 GHz	UWB Ch.: 5 carrier		

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Schwarzbeck BBHA 9120D, Horizontal
Measurement Distance:	3m
Mode:	3 - UWB Ch. 5 TX
Note 1:	

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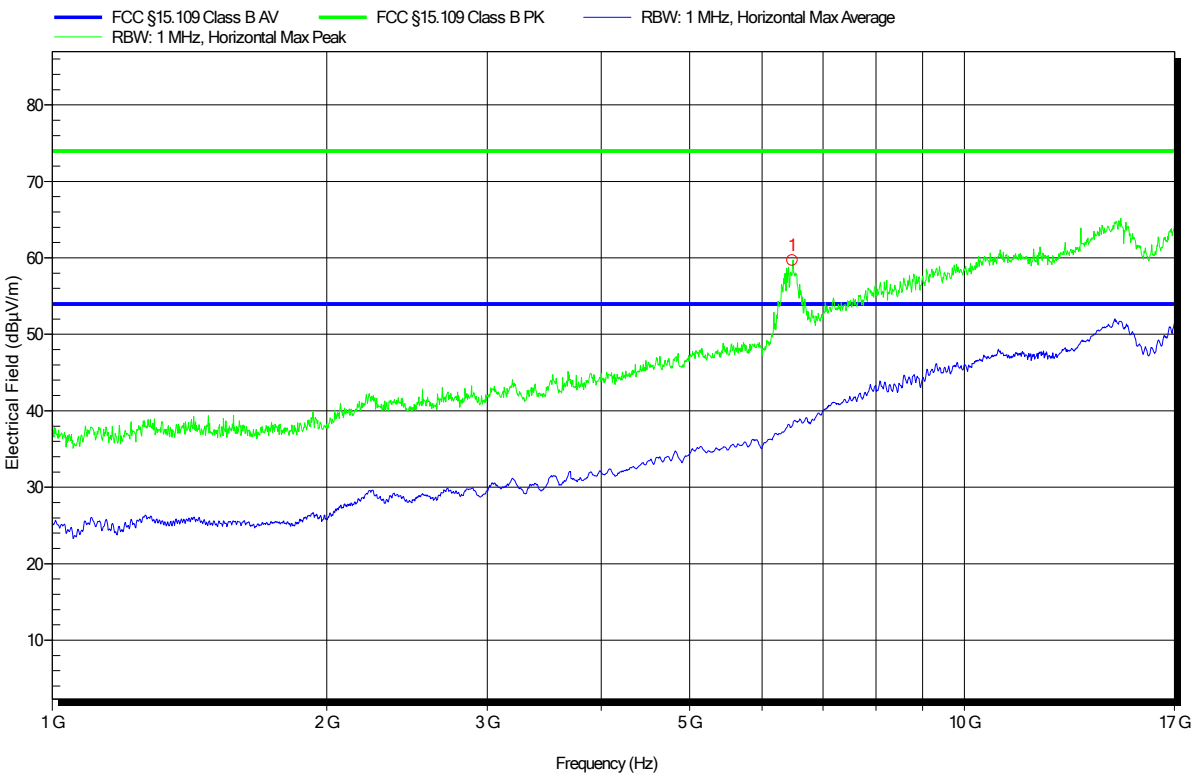

Peak Number	Frequency	Peak	Angle	Height
1	6.477 GHz	UWB Ch.: 5 carrier		

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	3 - UWB CH.: 5 TX
Note 1:	

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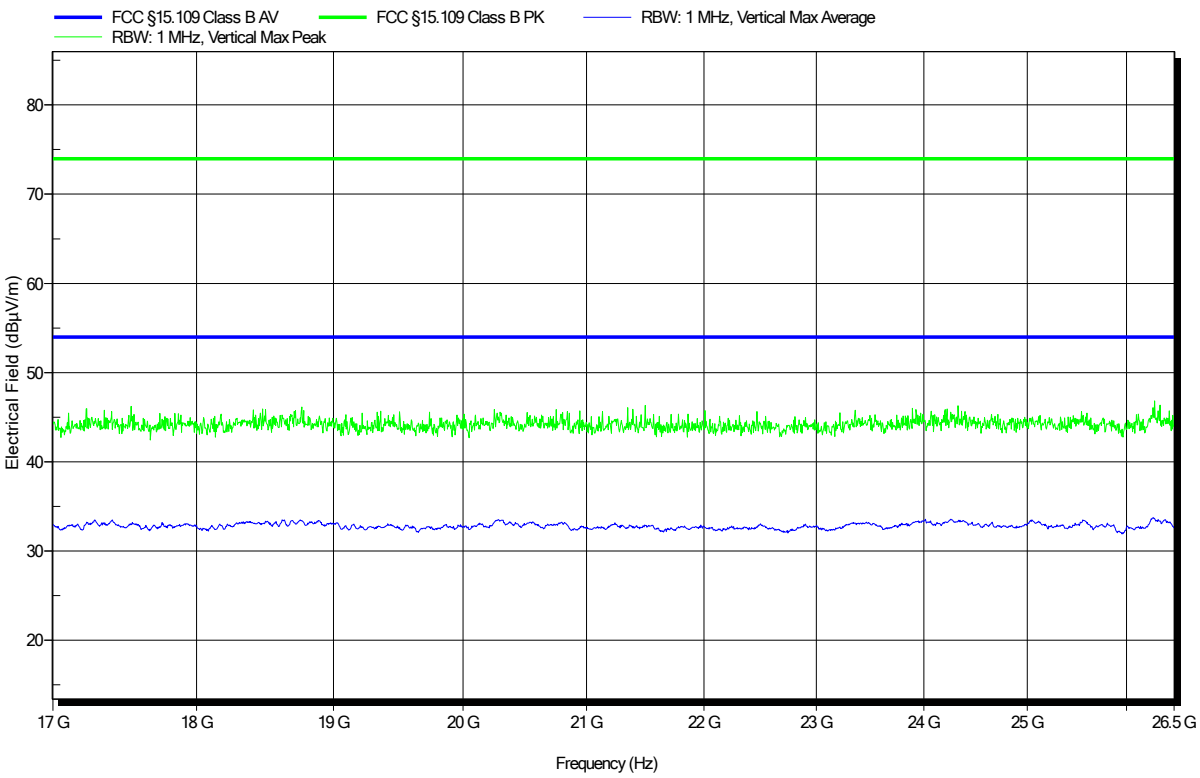

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	3 - UWB CH.: 5 TX
Note 1:	

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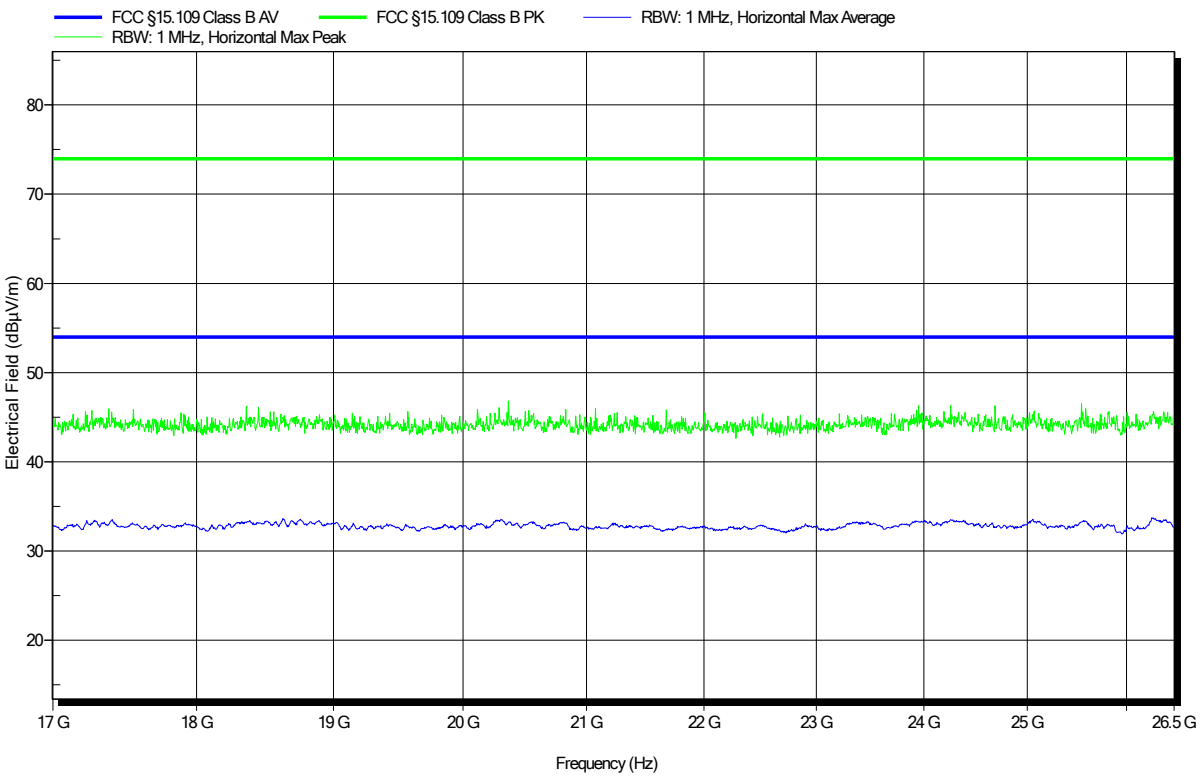

Radiated emissions according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Vertical
Measurement Distance:	3m
Mode:	3 - UWB CH.: 5 TX
Note 1:	

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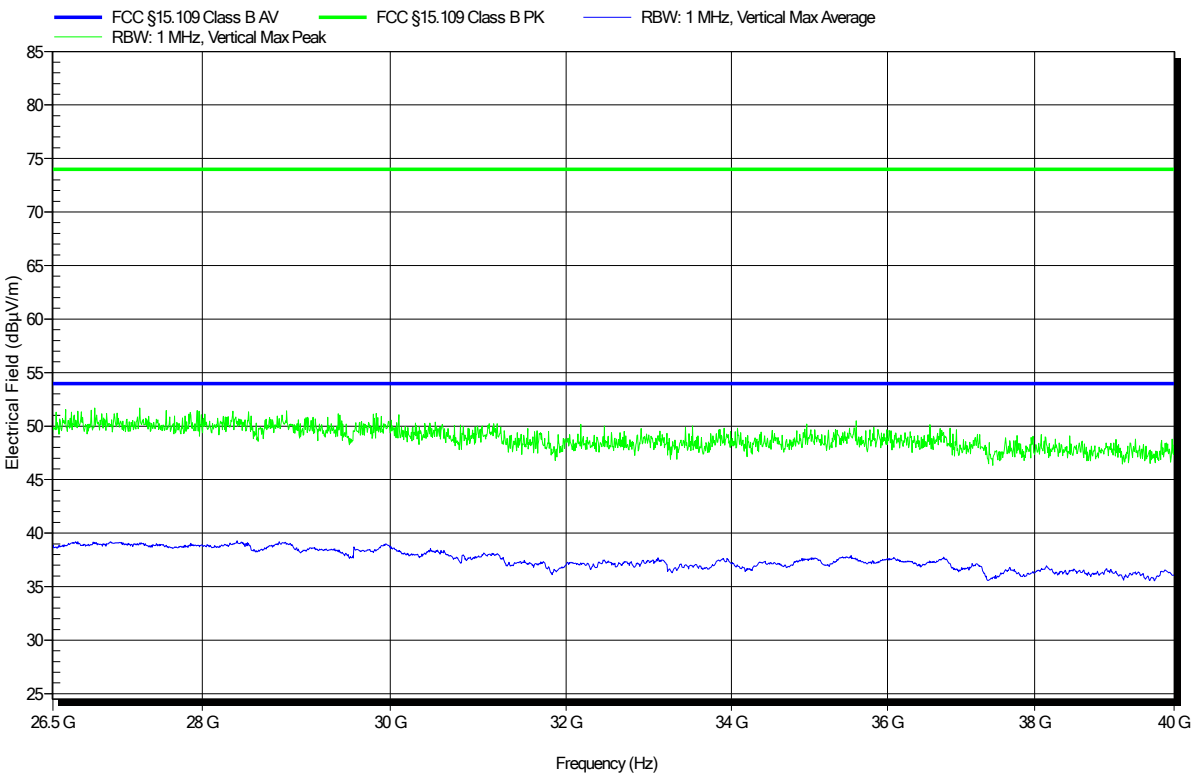

Radiated emissions
according to FCC part 15B

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Handrik
Test Date:	2020-07-21
Operating Conditions:	ambient temperature: 21°C power input: 3.3V DC (battery)
Antenna:	Configurable Antenna, Horizontal
Measurement Distance:	3m
Mode:	3 - UWB CH.: 5 TX
Note 1:	

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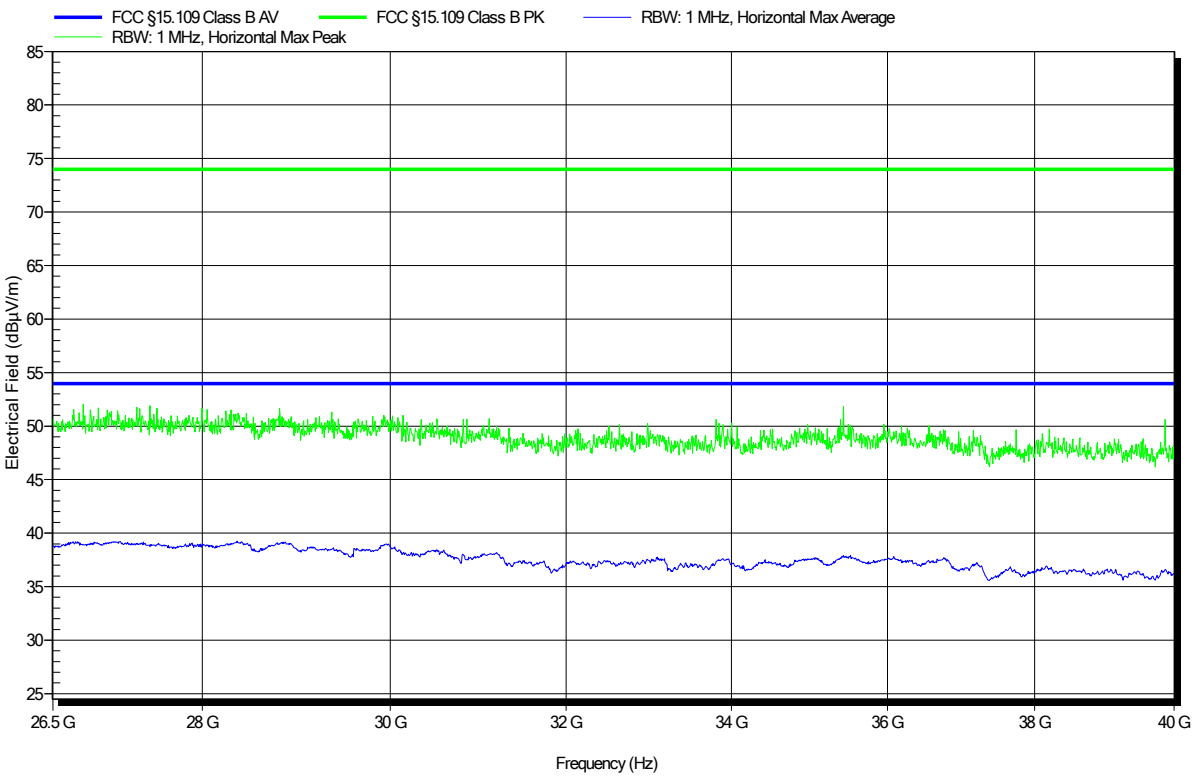


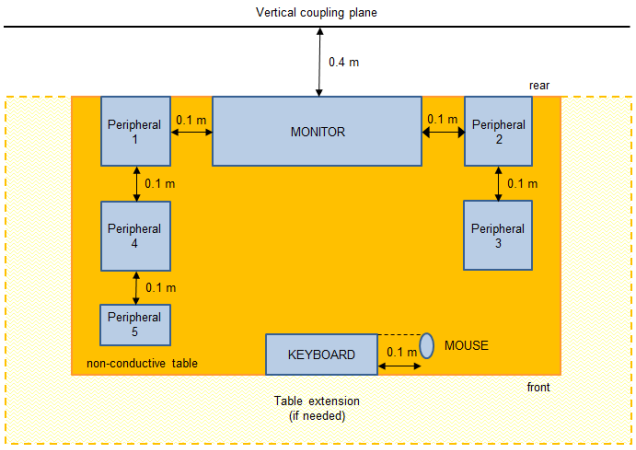
2.2 Test Conditions and Results - Conducted emissions acc. to ANSI C63.4

2.2.1 Information

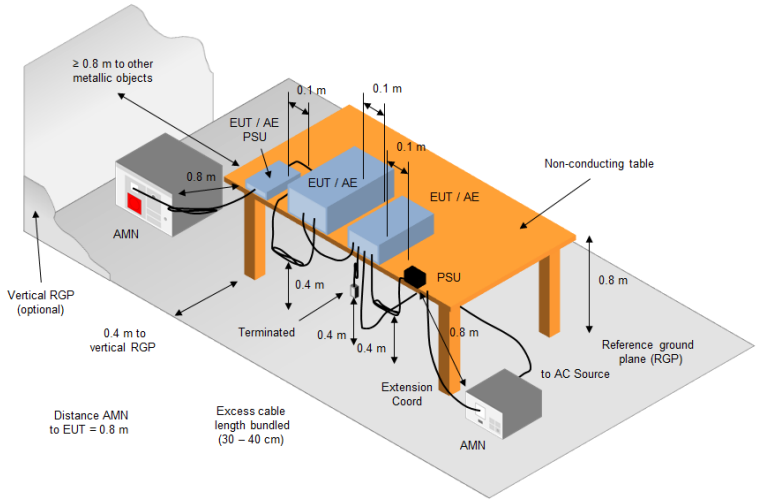
Test Information	
Reference	FCC 15.107, ICES-003, 6.1
Reference method	ANSI C63.4:2014+A1:2017 Section 12
Measurement range	150 kHz to 30 MHz
Equipment class	Class B
Equipment type	Table top
Temperature [°C]	22
Humidity [%]	58
Operator	Jens Marquardt
Date	2020-07-10

2.2.2 Setup

Equipment placement



Test Setup



2.2.3 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	Radimation	2016.1.10

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
AMN	Schwarzbeck	NSLK 8127	EF01592	2019-10	2020-10
Pulse Limiter	R&S	ESH3-Z2	EF01063	2019-07	2020-07
EMI Test Receiver	R&S	ESR 7	EF00943	2019-10	2020-10
Climatic Sensor	Embedded Data Systems, LLC.	2800100000254 17E	EF01054	2020-03	2021-03

2.2.4 Procedure

Exploratory measurement

1. The EUT was placed on a non conductive table 0.8 m above the reference ground plane and 0.4 m away from the vertical conducting plane (ANSI C63.4: 2014 item 7.3.1)
2. The power cord that is normally supplied or recommended by the manufacturer was connected to the LISN.
3. The distance between the outer edge of the EUT and the LISN shall be set to 0.8 m. A longer power cord shall be bundled to this length (bundling shall not exceed 40 cm in length).
4. The LISN measurement port was connected to a measurement receiver
5. I/O cables were bundled not longer than 0.4 m
6. Measurement was performed in the frequency range 0.15 – 30MHz on each current-carrying conductor
7. To maximize the emissions the cable positions were manipulated
8. The worst configuration of EUT and cables is shown on a test setup picture at item 1.3

Final measurement

1. The EUT was placed on a non conductive table 0.8 m above the reference ground plane and 0.4 m away from the vertical conducting plane (ANSI C63.4: 2014 item 7.3.1)
2. The power cord that is normally supplied or recommended by the manufacturer was connected to the LISN.
3. The distance between the outer edge of the EUT and the LISN shall be set to 0.8 m. A longer power cord shall be bundled to this length (bundling shall not exceed 40 cm in length).
4. The LISN measurement port was connected to a measurement receiver
5. The EUT and cable arrangement were based on the exploratory measurement results
6. The test data of the worst-case conditions were recorded and shown on the next pages

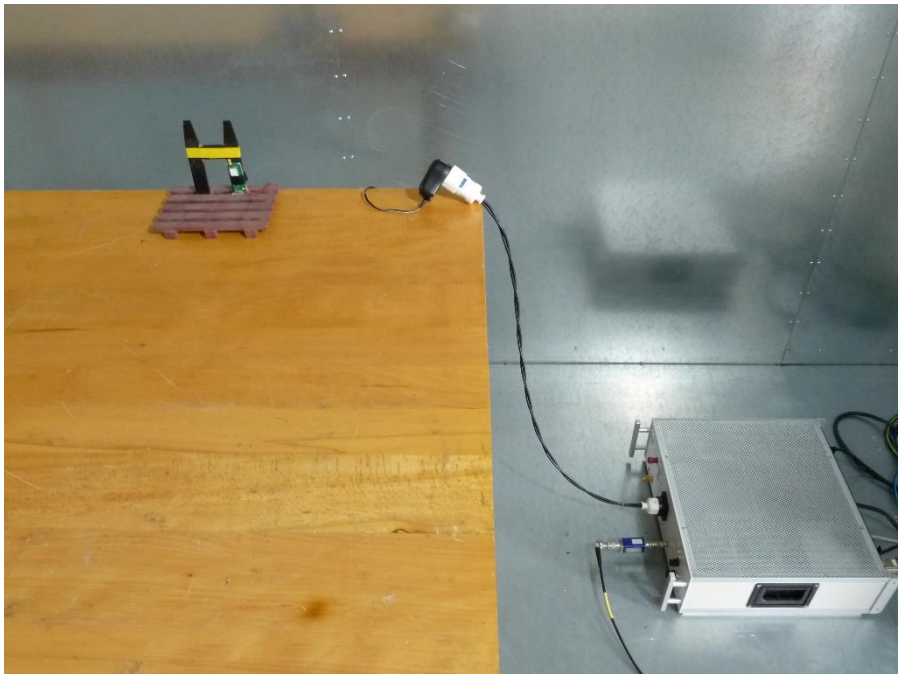
2.2.5 Limits

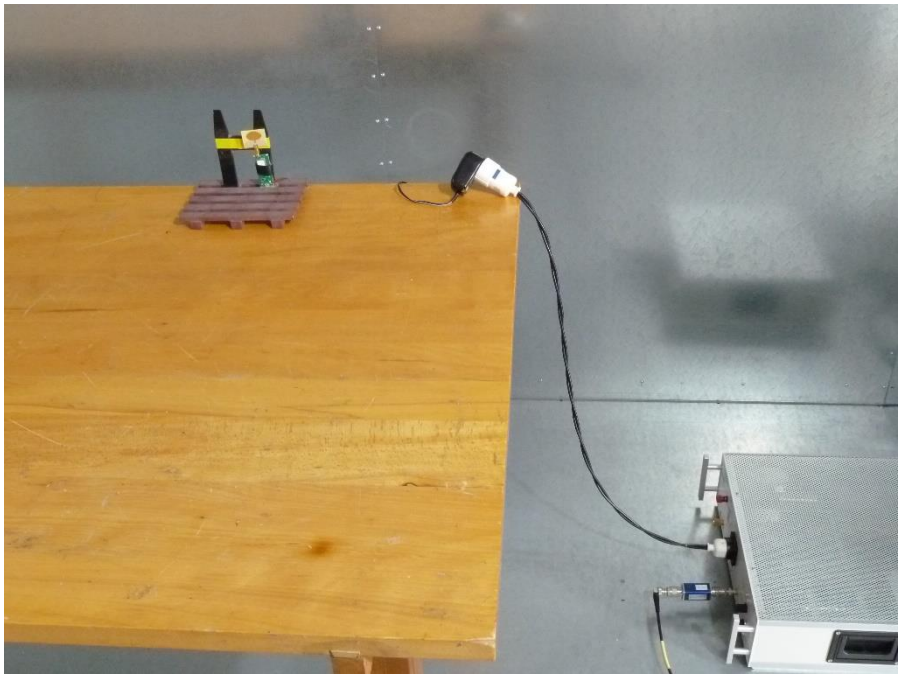
Class B		
Frequency [MHz]	Quasi-peak Limit [dBµV]	Average Limit [dBµV]
0.15 - 0.5	66 - 56 *	56 - 46 *
0.5 - 5	56	46
5 - 30	60	50
* Decreases with the logarithm of the frequency		

2.2.6 Results

AC power line conducted emissions					
Port	Coupling	Operational mode	EUT Configuration	Verdict	Remark
DC Power	AMN	1	2	PASS	-
DC Power	AMN	2	2	PASS	-
DC Power	AMN	3	2	PASS	-

2.2.7 Setup Photos

Test Setup BLE


Test Setup UWB


2.2.8 Records

Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC L
Mode:	1 - BLE TX
Applied to Port:	AC Mains
Note 1:	

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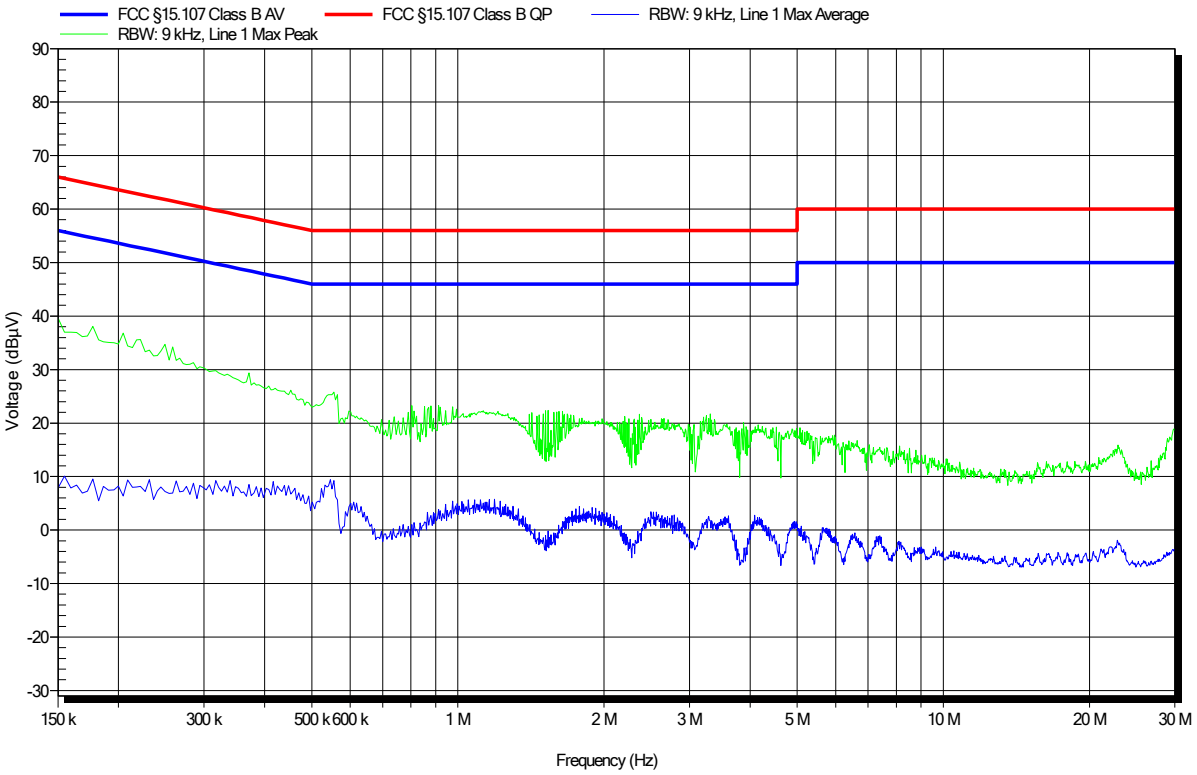

Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29944
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC N
Mode:	1 - BLE TX
Applied to Port:	AC Mains
Note 1:	

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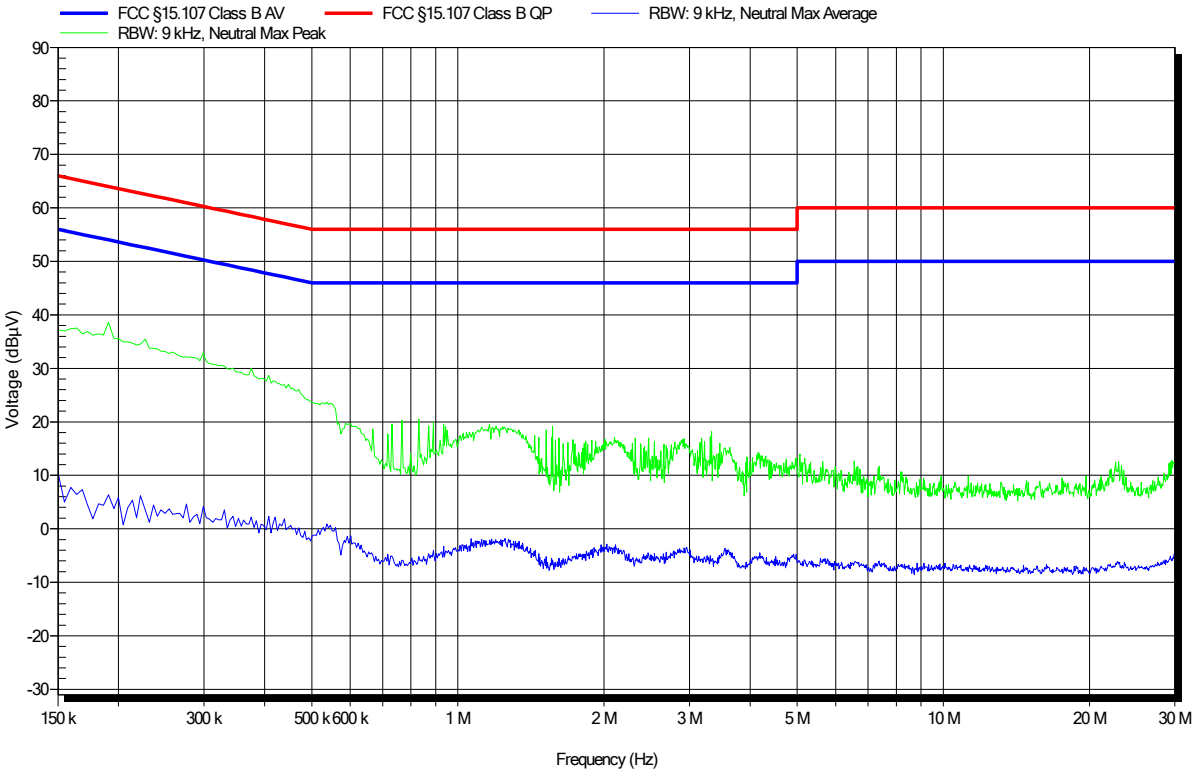

Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC L
Mode:	2 - UWB Ch. 2 TX
Applied to Port:	AC Mains
Note 1:	

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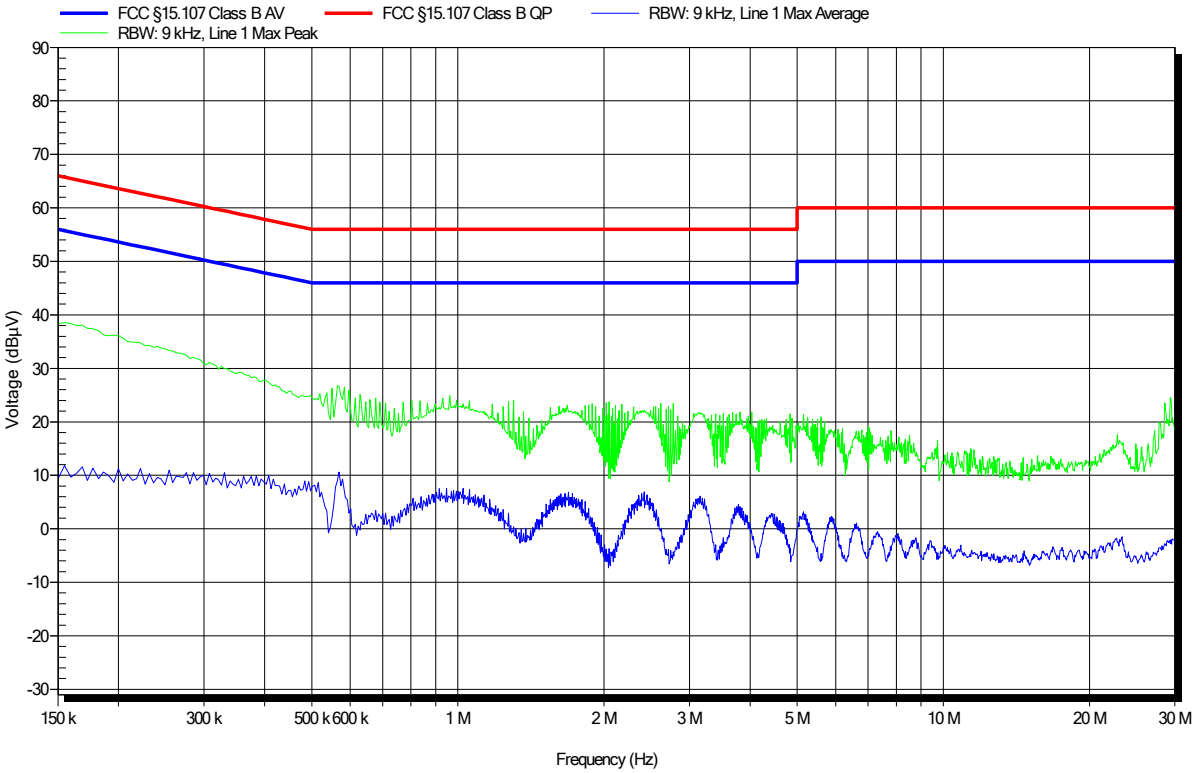

Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29799
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC N
Mode:	2 - UWB Ch. 2 TX
Applied to Port:	AC Mains
Note 1:	

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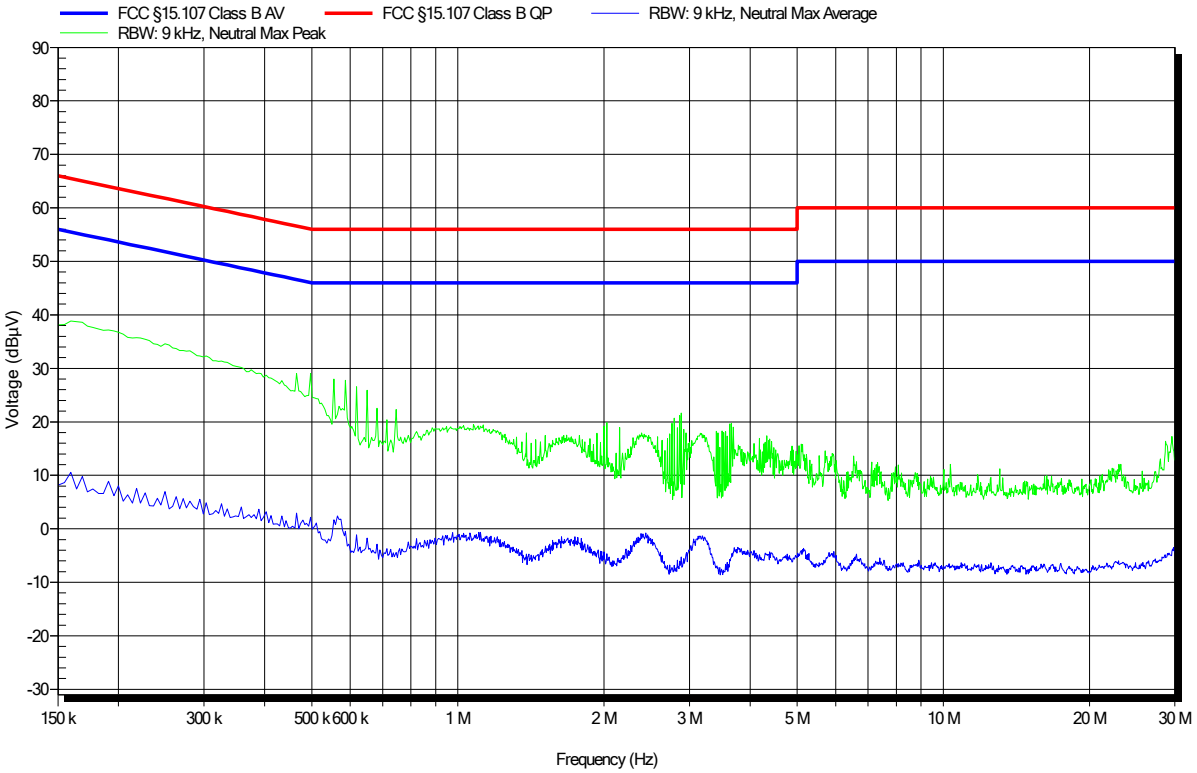

Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC L
Mode:	3 - UWB Ch. 5 TX
Applied to Port:	AC Mains
Note 1:	

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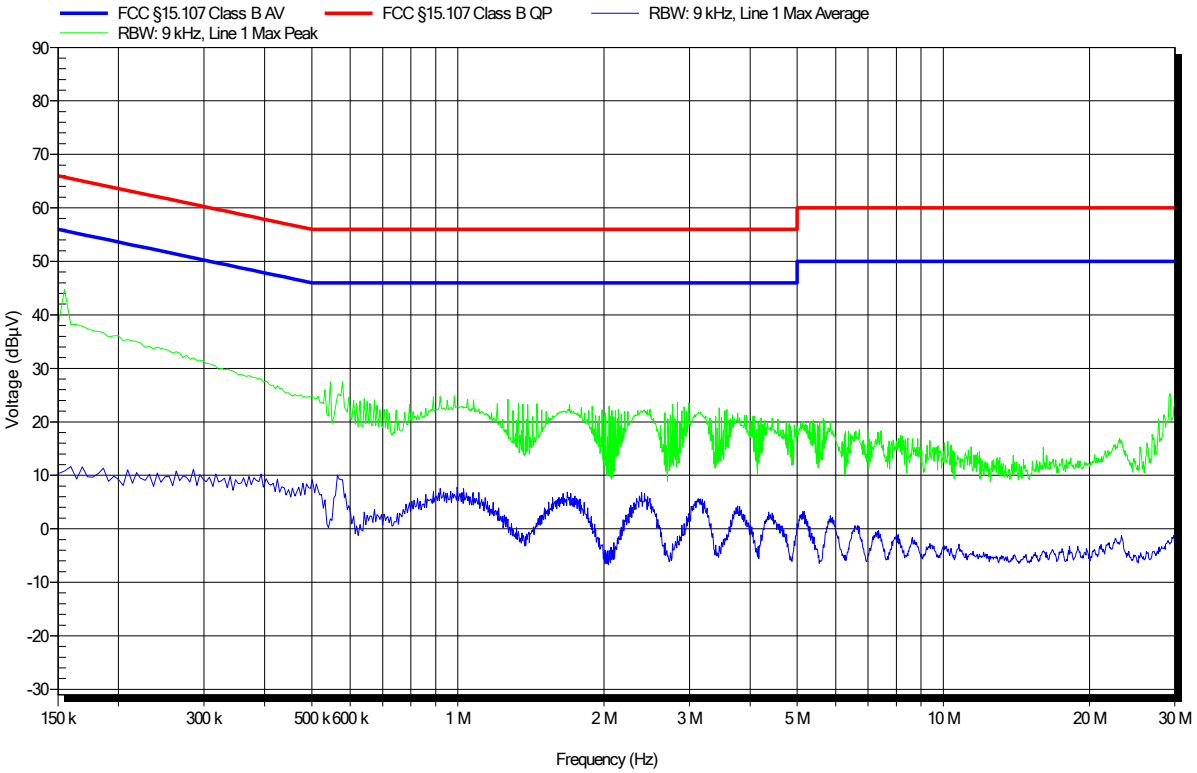
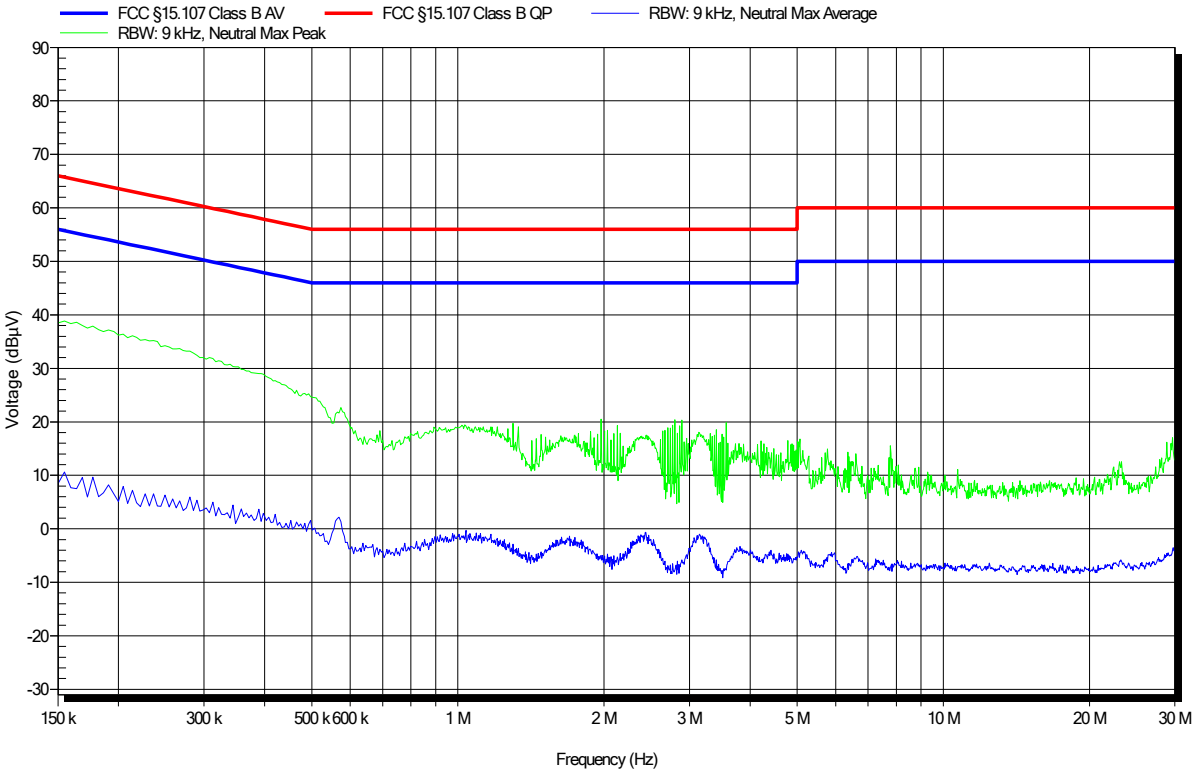


Conducted emissions at the mains power port according to FCC 47 e-CFR §15.107

Project Number:	G0M-2006-9089
Applicant:	In-Circuit GmbH
Model Description:	radio module with integrated microcontroller (nRF52840), BLE and UWB interface (DW1000)
Model:	radino40 DW1000
Test Sample ID:	ID 29803
Test Site:	Eurofins Product Service Germany
Operator:	Mr. Marquardt
Test Date:	2020-07-10
Operating Conditions:	ambient temperature: 22°C power input: 120 VDC (AC/DC adapter)
LISN:	Schwarzbeck NSLK 8127 RC N
Mode:	3 - UWB Ch. 5 TX
Applied to Port:	AC Mains
Note 1:	

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