Test report for

47 CFR Part 15 Subpart B

ICES-Gen, ICES-003

Test report No. : P000334442 008 Ver 2.0

The RvA is signatory to ILAC - MRA

Product name	: TCU V5.5
Applicant	: The Goodyear Tire & Rubber Company
FCC ID	: 2BEXS-TPH55M
IC	: 32033-TPH55M

Laboratory information

Accreditation

Kiwa Nederland B.V. complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2017. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L248 and is granted by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

Kiwa Nederland B.V. is designated by the FCC as an Accredited Test Firm for compliance testing of equipment subject to Certification under Parts 15 & 18. The Designation number is: NL0001.

Kiwa Nederland B.V. is a Wireless Device Testing laboratory recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.
The Industry Canada company number for Kiwa Nederland B.V. is: 4173A. The CABID is NL0001.

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Documentation

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at Kiwa Nederland B.V.

Testing Location

Test Site	Kiwa Nederland B.V.
Test Site location	Wilmersdorf 50 7327 AC Apeldoorn The Netherlands Tel. +31 88998 3393
Test Site FCC	NL0001
CABID	NL0001

Revision History

Version	Date	Remarks	By
v0.50	25-10-2024	First draft	MHK
v1.00	11-12-2024	Initial release	MHK
V2.0	11-03-2025	Update assessor comments	MHK

Table of Contents

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.109 (a)	ICES-003 Table 2	Radiated spurious emissions < 1GHz	3.1	Pass
15.109 (a)	ICES-003 Table 4	Radiated spurious emissions > 1GHz	3.1	Pass

Decision rule: Pass/Fail decisions are based on measurement results without taking into account measurement uncertainty.

1 General Description

1.1 Applicant

Client name:	The Goodyear Tire & Rubber Company
Address:	200 Innovation Way, OH 44316 Akron, USA
Telephone:	00352691964033
E-mail:	chris_helsel@goodyear.com
Contact name:	Christopher P. Helsel

1.2 Manufacturer

Manufacturer name:	IOSiX, LLC
Address:	1161 Oak Valley Dr, MI 48108 Ann Arbor, USA
Telephone:	0014158002060
E-mail:	info@iosix.com
Contact name:	Robert Vogt

1.1 Tested Equipment Under Test (EUT)

Product name:	TCU V5.5
Brand name:	Goodyear
FCC ID:	2BEXS-TPH55M
IC:	32033-TPH55M
Product description:	IoT gateway for vehicle and tire remote monitoring
Variant model(s):	--
Batch and/or serial No.	--
Software version:	--
Hardware version:	--
Date of receipt	05-04-2024
Tests started:	06-05-2024
Testing ended:	30-10-2024

Auxiliary items

AUX1

Product name:	Notebook
Product type:	Lenovo ThinkPad
Remarks:	Connects to EUT USB port, property test lab

1.2 Product specifications of Equipment under test

Tx Frequency:	2412-2462MHz (Wi-Fi) 2402-2480 (Bluetooth), Band 2, 4, 5, 12, 13, 17, 25, 26, 66 (LTE, NB-IoT)
Rx frequency:	2412-2462MHz (Wi-Fi), 2402-2480 (Bluetooth) and 433.92MHz (Rx only) and GNSS 1559-1610 MHz (Rx only) , Band 2, 4, 5, 12, 13, 17, 25, 26, 66 (LTE, NB-IoT)
Occupied channel width:	Wi-Fi:20 MHz, 40 MHz BLE: 1 MHz, 2 MHz
Antenna type:	PCB inverted F (Wi-Fi/BLE) and Folded inverted F (433.92MHz)
Antenna gain:	2.87dBi (Wi-Fi/BLE) & -5 dB Folded inverted F (433.92MHz)
Type of modulation:	QPSK, 16QAM, GFSK, π/4-DQPSK,8-DPSK,BPSK, 64QAM
Emission designator	Wi-Fi: 20M0F1D, 40M0F1D BLE: 1M00F1D, 2M00F1D

Disclaimer: above info is declared by the applicant

The EUT is considered as a Class B device.

1.3 Environmental conditions

Test date	06-05-2024	08-05-2024	13-05-2024
Ambient temperature (°C)	20.1	21.1	22.8
Humidity (%)	45.7	43.7	53.4

1.4 Measurement standards

- ANSI C63.4:2014

1.5 Applicable standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart B
- ICES-003 Issue 7
- ICES-Gen Issue 2

1.6 Observation and remarks

EUT is used flat on a table.
EUT should be connected to 12 V automotive adapter, therefore no conducted measurements were performed.

1.7 Conclusions

The sample of the product showed **NO NON-COMPLIANCES** to the specifications stated in paragraph 1.8 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Kiwa Nederland B.V. accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.8 *"Applicable standards".*

All tests are performed by:

Name : ing. M.H. Khan

Review of test methods and report by:

Name : P. van Wanrooij, BASc

The above conclusions have been verified by the following signatory:

Date : 11-03-2025

Name : P. van Wanrooij

Function : Test Engineer

Signature :

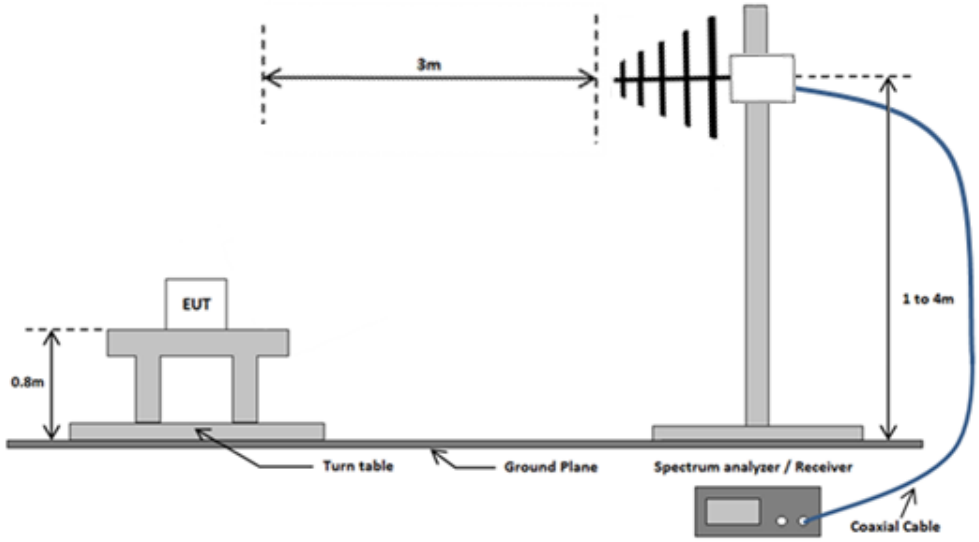
2 Test configuration of the Equipment Under Test

2.1 Test mode

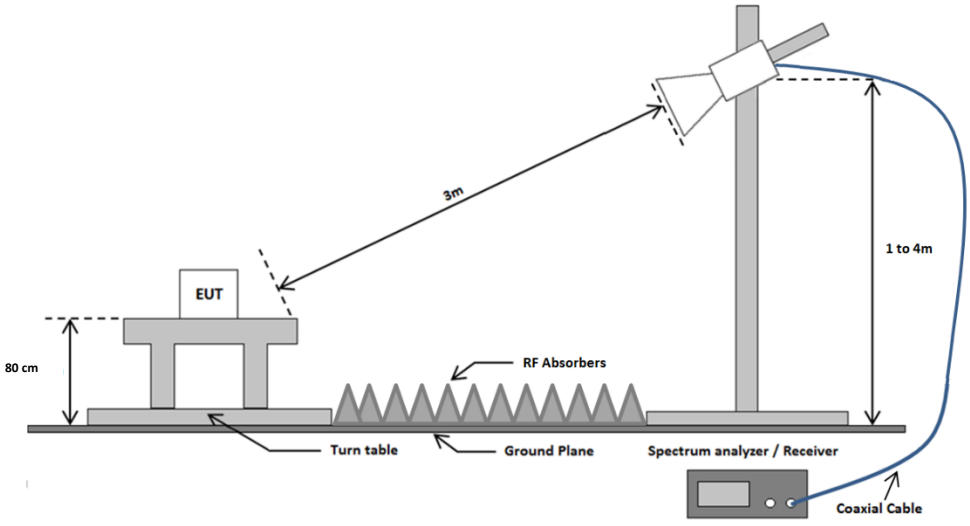
All radio's idle.

2.2 Test setups

2.2.1 Radiated emissions test setup 30 MHz - 1 GHz



2.2.2 Radiated emissions test setup above 1 GHz



2.3 Observation and remarks

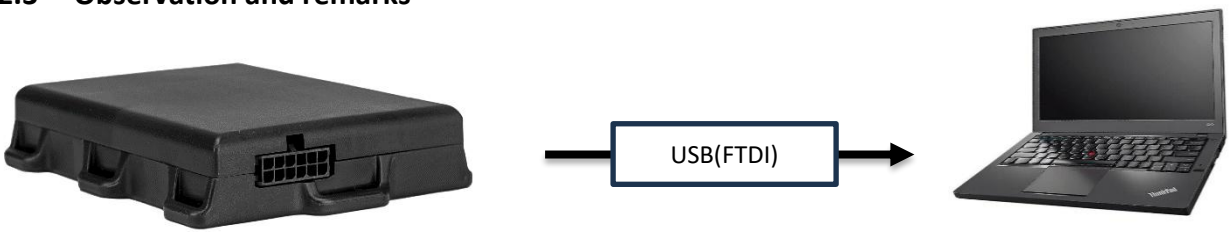


Figure 1. EUT and auxiliary setup

List of used cables					
Number	**Function**	**From**	**To**	**Length**	**Remarks**
1	12-24 Vdc power	EUT	Battery	< 3m	-
2	USB	EUT	Test laptop	<3m	-

2.4 Test methodology.

The test methodology used is based on the requirements of 47 CFR Part 15, sections 15.31, 15.107 and 15.109, ICES-003 and ICES-Gen. The test methods, which have been used, are based on ANSI C63.4-2014.

2.5 Equipment modifications.

No modifications have been made to the equipment.

2.6 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Cal. Done date	Cal. due date	Used at Par.
EMI Receiver	Rohde & Schwarz	ESR7	114605	11-2024	11-2025	3.1
Spectrum Analyzer	Rohde & Schwarz	FSV3044	114923	10-2023	10-2025	3.1
Active loop antenna	EMCO	6502	114515	01-2022	01-2025	3.1
Biconical antenna + 6dB attenuator	Schwarzbeck + HP	VHA9103 + 8491A	114436 + 114254	08-2024	08-2027	3.1
Logperiodic antenna	EMCO	3147	114385	02-2021	02-2026	3.1
Horn antenna	EMCO	3115	114607	01-2021	01-2025	3.1
Horn antenna	FLANN-MICROWAVE	20240-25	114518	NA*	NA*	3.1
Preamplifier	µComp	MCNA-40-001080	114771	05-2022	05-2024	3.1
Preamplifier 18-40 GHz	Schwarzbeck	BBV 9721	115434	01-2024	01-2025	3.1
Semi-Anechoic room	ETS Lindgren	SAR	114624	03-2023	03-2026	3.1
Test software	Raditeq	Radimation Version 2023.2.3	--	--	--	3.1

*Note: Standard gain horn antennas do not need calibration
Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2017 has been confirmed before testing.
NA= Not Applicable

2.7 Sample calculations

All formulas for data conversions and conversion factors are reported in chapter 4 of this test report.

3 Test results

3.1 Radiated spurious emissions

3.1.1 Limit

Except for Class A digital devices, the field strength of radiated emissions from an unintentional radiator shall not exceed the field strength levels specified in the following tables.
On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified.
Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function.
When average radiated emission measurements are specified in this part, there is also a limit on the peak level of the emissions. Unless otherwise specified, the limit on peak emissions is 20 dB above the average limit.
The product under test shall comply with both the average and the peak limits.

ICES-003 Issue 7 section 3.2.2
The quasi-peak limits for the electric component of the radiated field strength emitted from ITE or digital apparatus, within 30 MHz to 1 GHz, for a measurement distance of 3m are presented in table below.
At and above 1 GHz, except for outdoor units of home satellite receiving systems, the ITE or digital apparatus shall comply with the limits specified in table below up to the frequency F_M, which shall be determined. The product under test shall comply with both the average and the peak limits.

FCC 15.109(a)

Frequency (MHz)	Field strength (µV/meter)	Field strength (dBµV/m)	Measurement distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

ICES-003 tables 2, 4

Frequency (MHz)	Field strength (µV/meter)	Field strength (dBµV/m)	Measurement distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-230	200	46.0	3
230 -960	224	47.0	3
Above 960	500	54.0	3

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.5 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.2.1 and 2.2.2 of this report.

3.1.4 Test procedure

30 MHz to 26.5 GHz: According to ANSI C63.4-2014, section 8.3

30 MHz to 1 GHz: IRN 441 – Method 1
1 GHz to 18 GHz: IRN 441 – Method 2
18 to 26.5 GHz: IRN 441– Method 3

In case of handheld and/or body-worn equipment, the EUT's orientation (X, Y, Z) was varied in order to ensure that maximum emission amplitudes were attained. In all other cases the associated cabling and the EUT orientation was varied for maximum emissions.

The spectrum was examined from 30MHz to the highest measurement frequency according to the table below. Final radiated emission measurements were made at 3m distance.

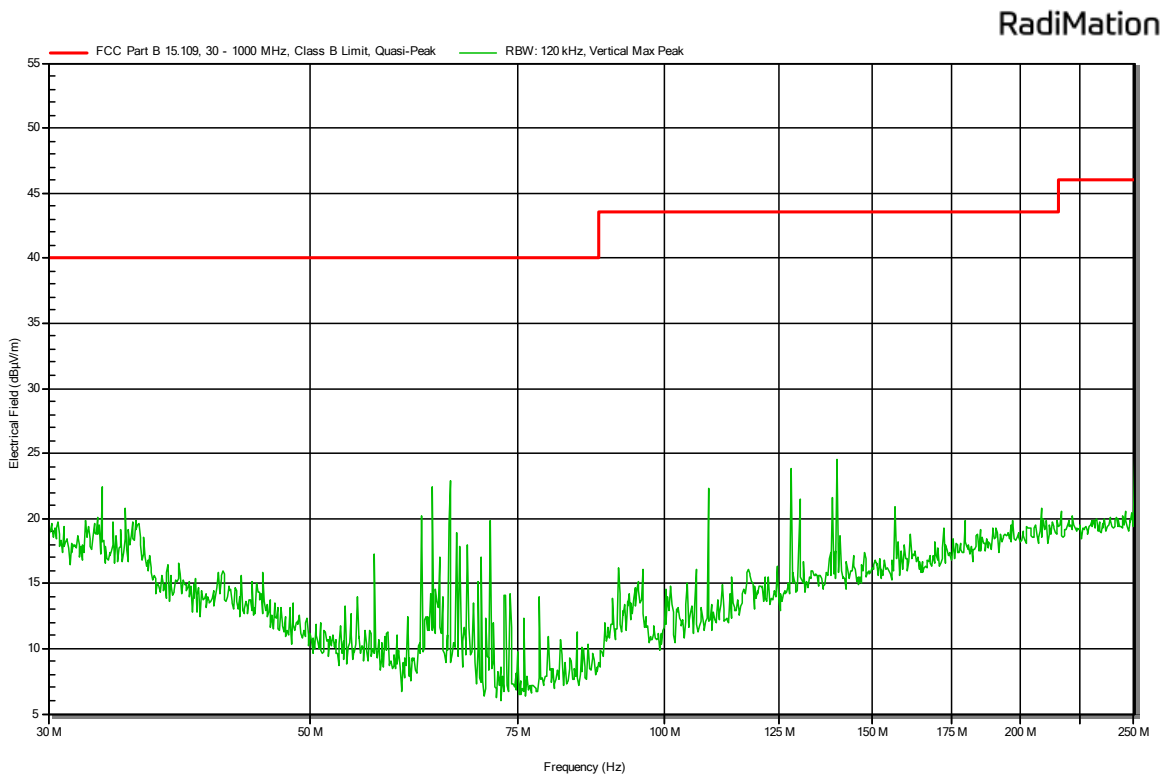
Highest internal frequency (F_X) [i]	Highest measurement frequency (F_M)
$F_X \leq 108$ MHz	1 GHz
108 MHz < $F_X \leq 500$ MHz	2 GHz
500 MHz < $F_X \leq 1$ GHz	5 GHz
$F_X > 1$ GHz	5 x F_X up to a maximum of 40 GHz
i. F_X is the highest fundamental frequency generated and/or used in the ITE or digital apparatus under test.	

The 6 highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

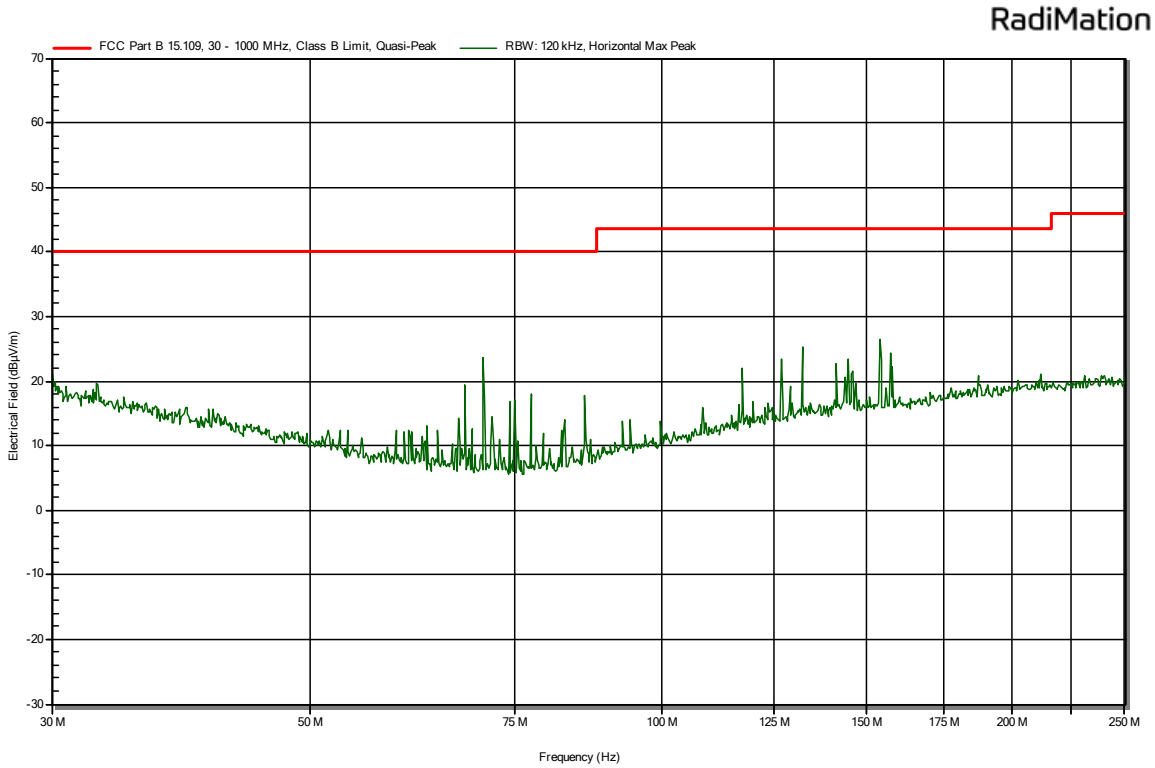
3.1.5 Measurement Uncertainty

Frequency range	Polarization	Uncertainty
30 – 200 MHz	Horizontal	±4.5 dB
	Vertical	±5.4 dB
200 -1000 MHz	Horizontal	±3.6 dB
	Vertical	±4.6 dB
1 – 18 GHz	Horizontal	±5.7 dB
	Vertical	±5.7 dB
18 – 26.5 GHz	Horizontal	±4.9 dB
	Vertical	±4.9 dB

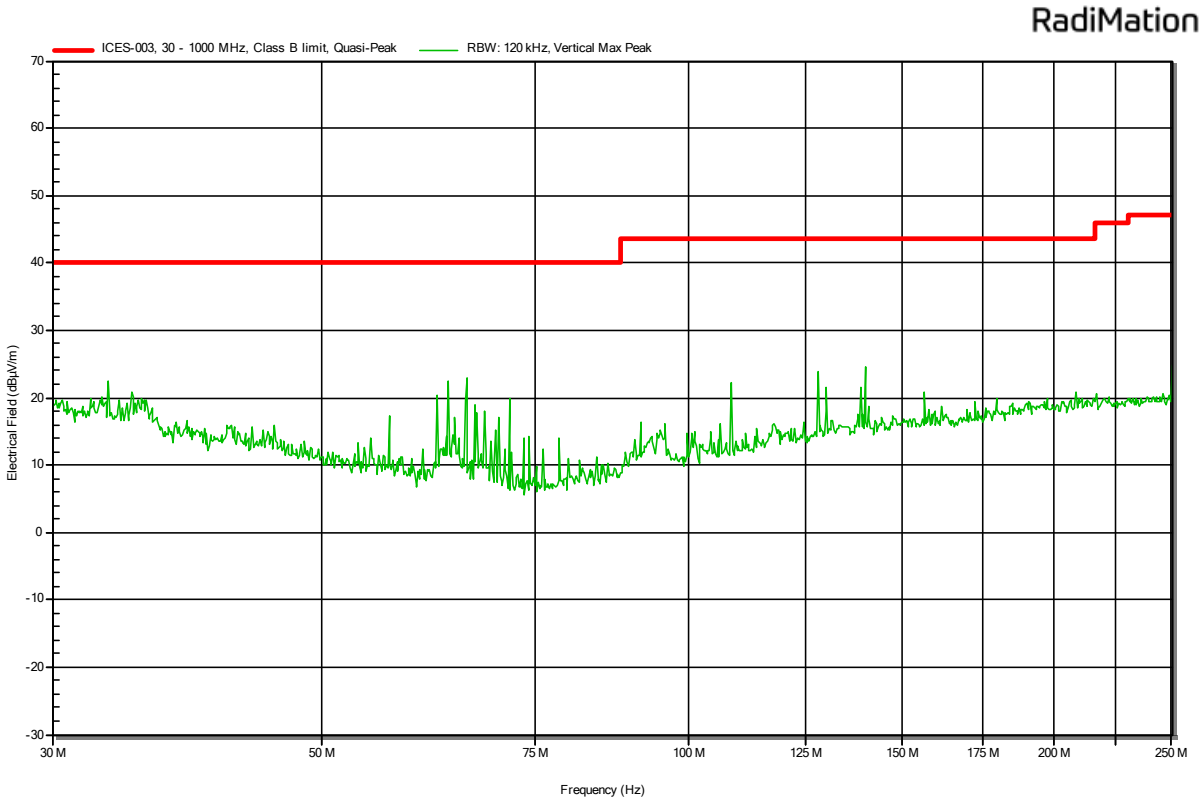
3.1.6 Plots of the Radiated Spurious Emissions Measurement



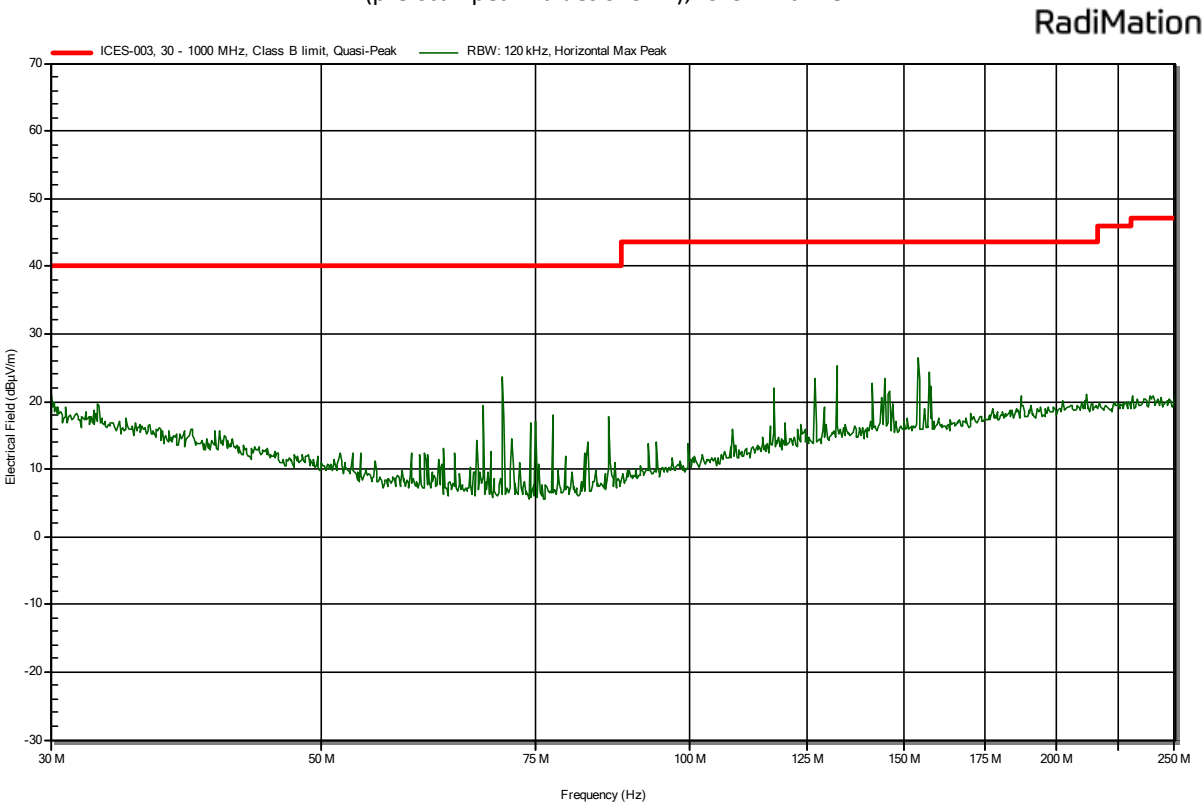
Plot 1a: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown), FCC limit line



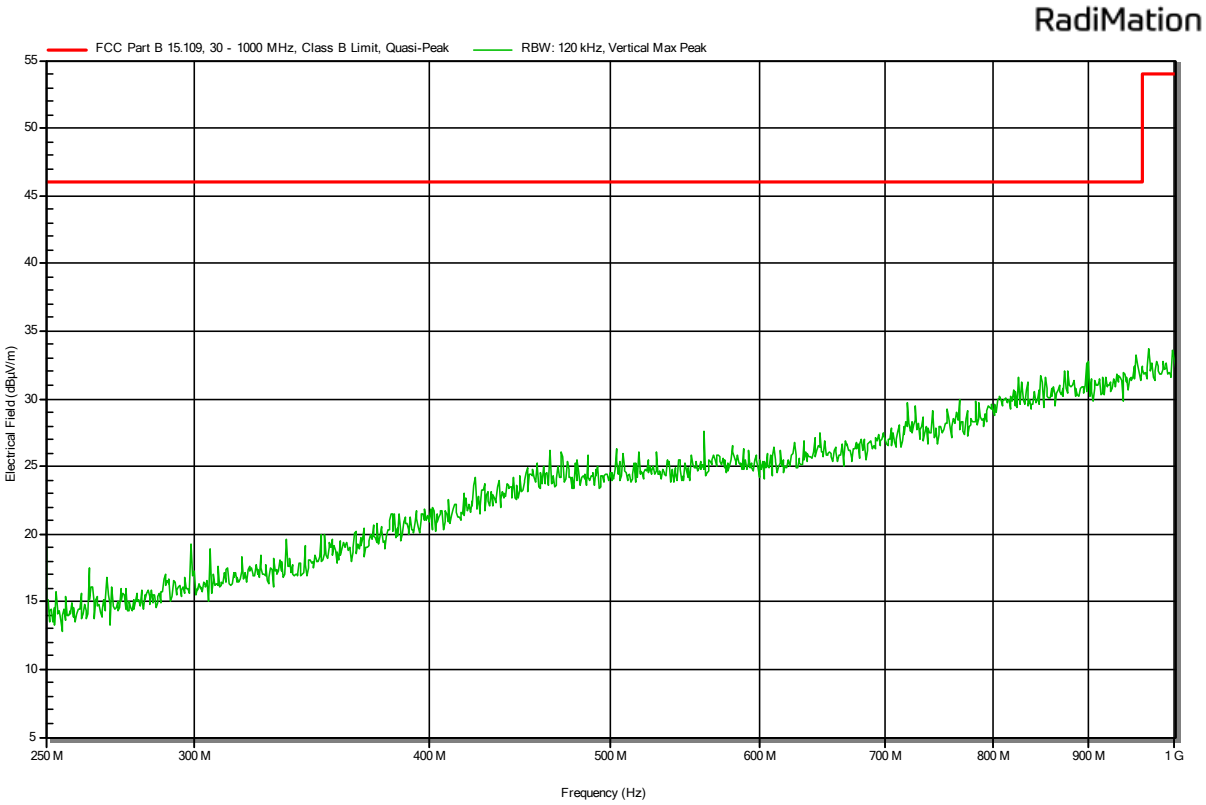
Plot 1b: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown), FCC limit line



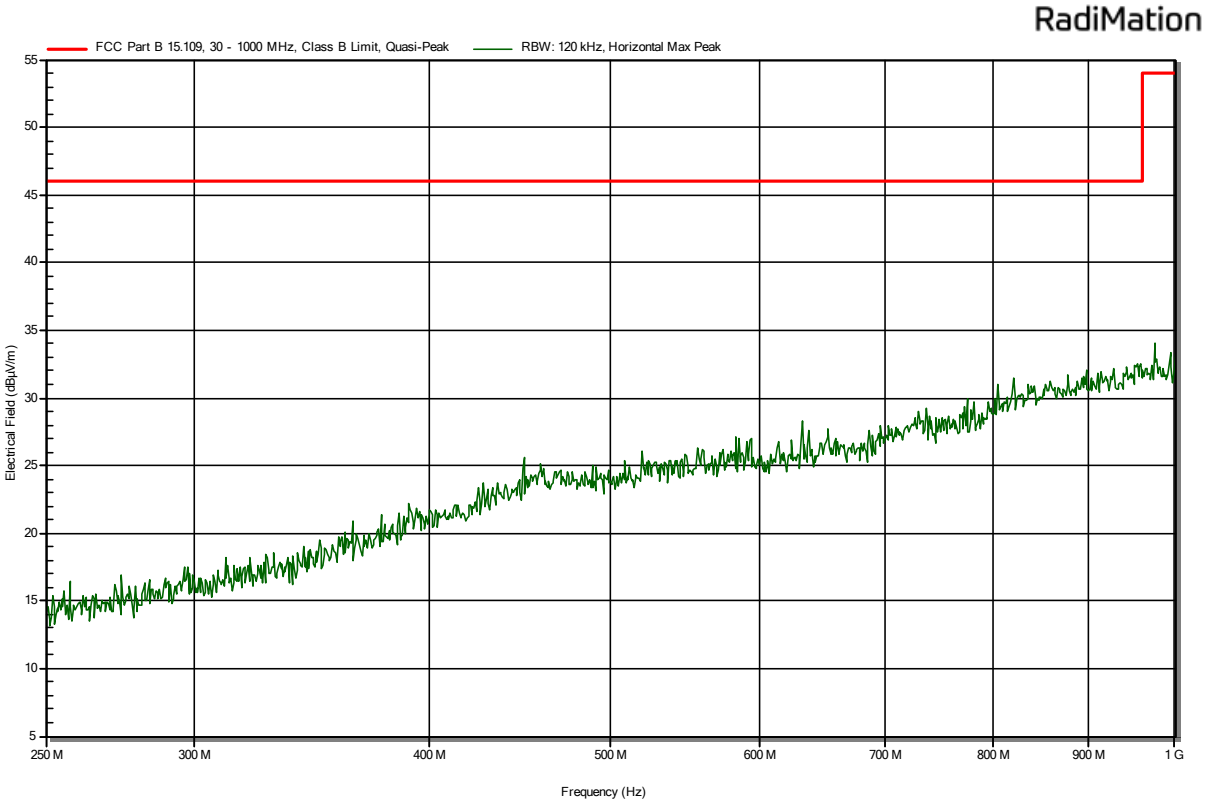
Plot 1c: radiated emissions of the EUT, Antenna vertical, in the range 30 – 250 MHz (pre-scan peak values shown), ICES limit line



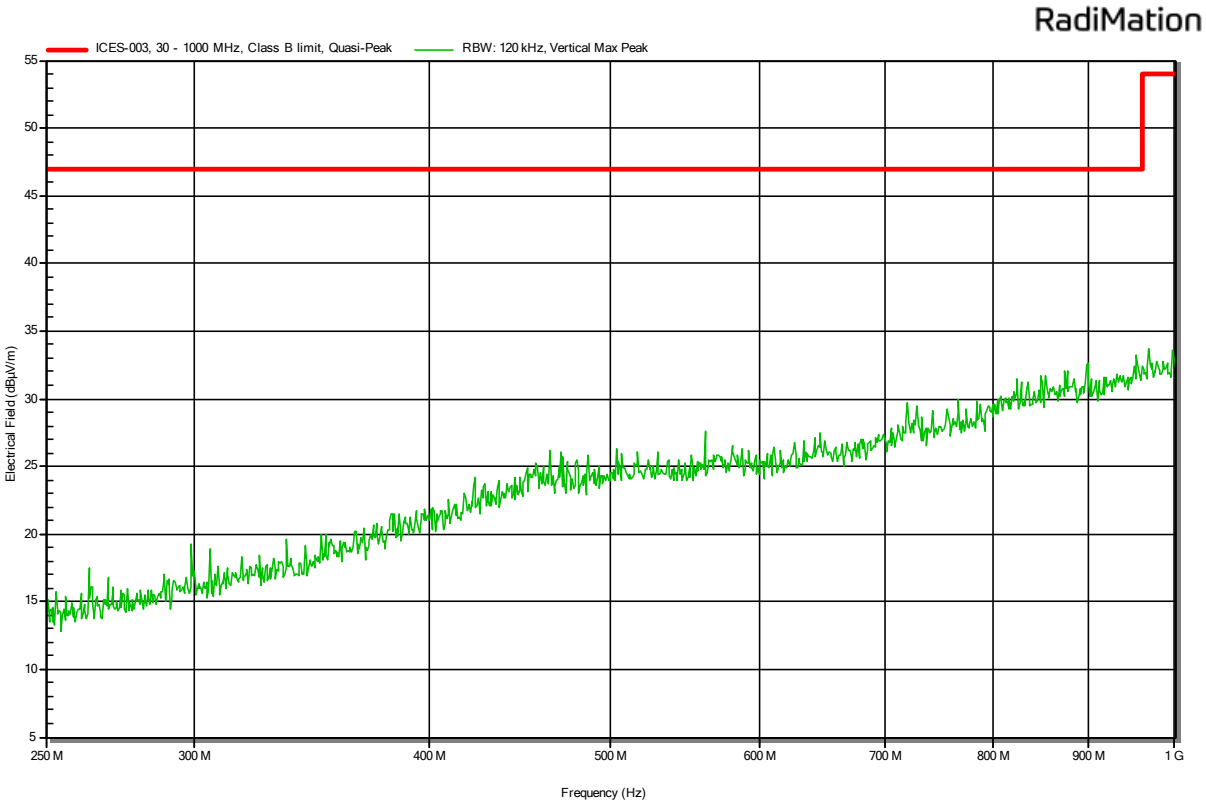
Plot 1d: radiated emissions of the EUT, Antenna horizontal, in the range 30 – 250 MHz (pre-scan peak values shown), ICES limit line



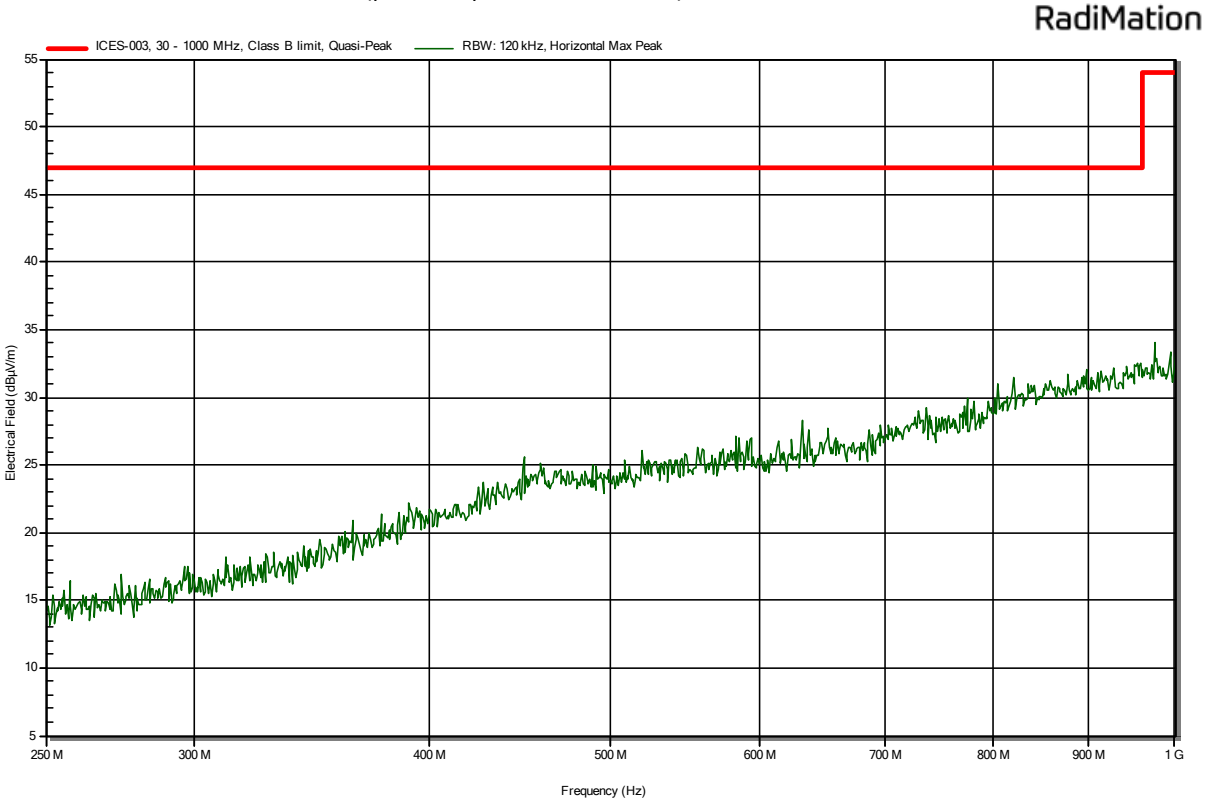
Plot 2a: radiated emissions of the EUT, Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown), FCC limit line



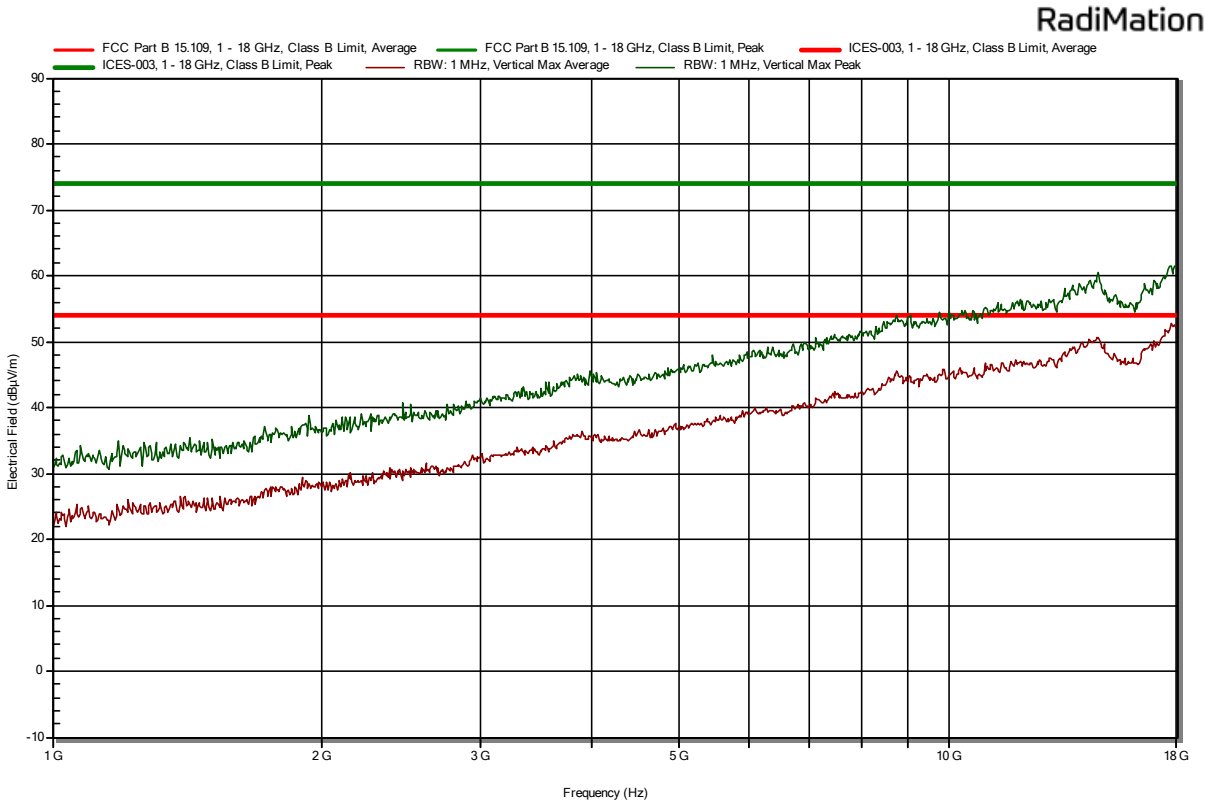
Plot 2b: radiated emissions of the EUT, Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown), FCC limit line



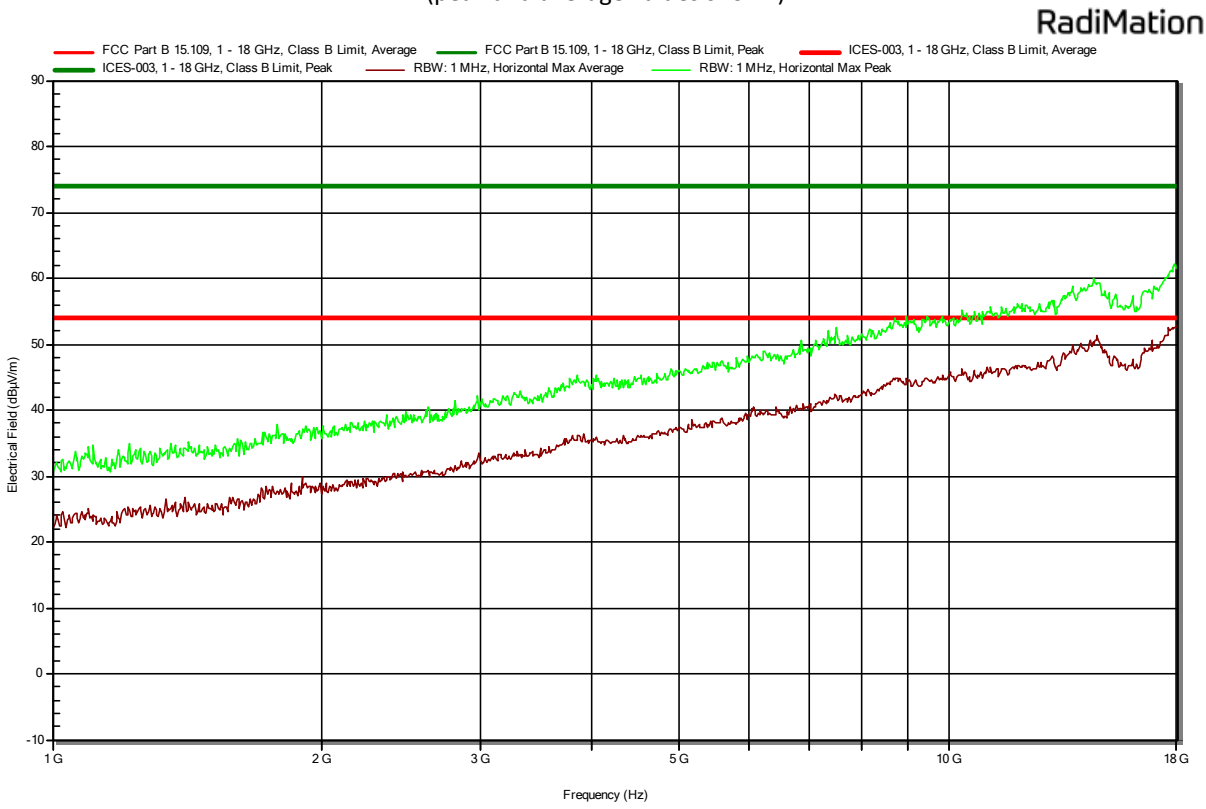
Plot 2c: radiated emissions of the EUT, Antenna vertical, in the range 250-1000 MHz (pre-scan peak values shown), ICES limit line



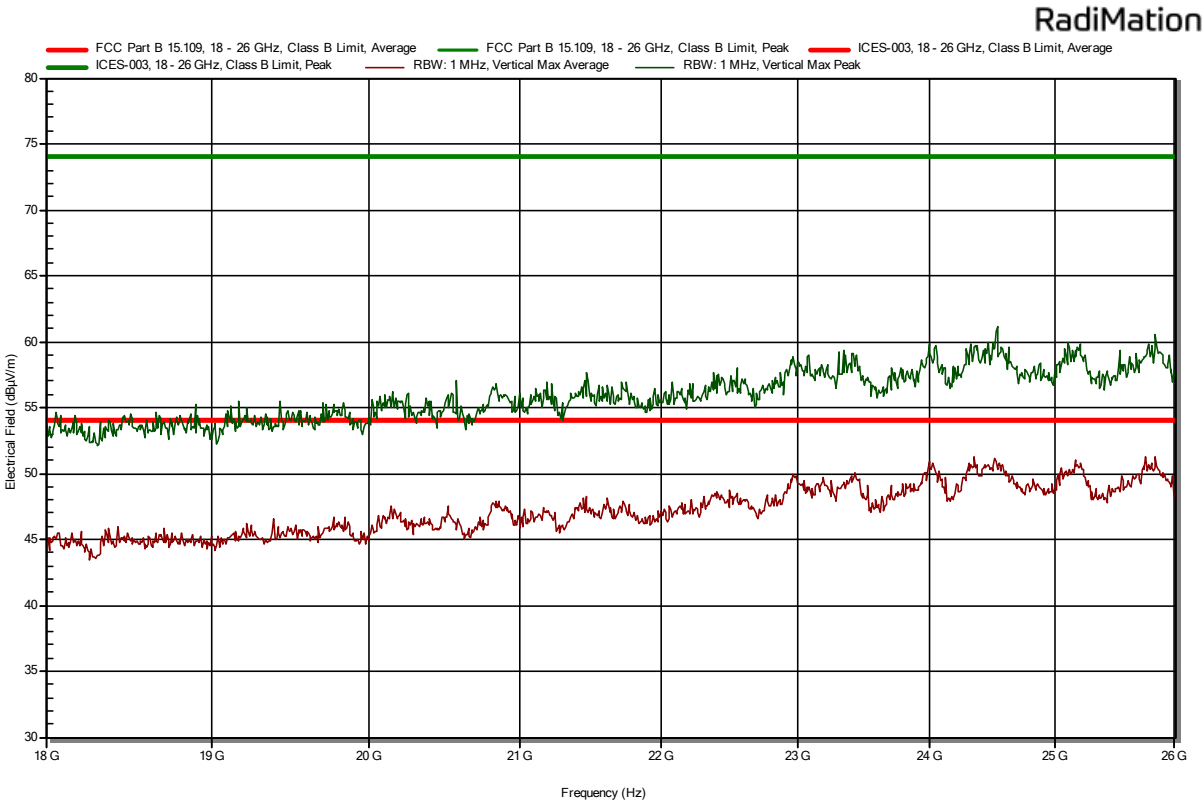
Plot 2d: radiated emissions of the EUT, Antenna horizontal, in the range 250-1000 MHz (pre-scan peak values shown),ICES limit line



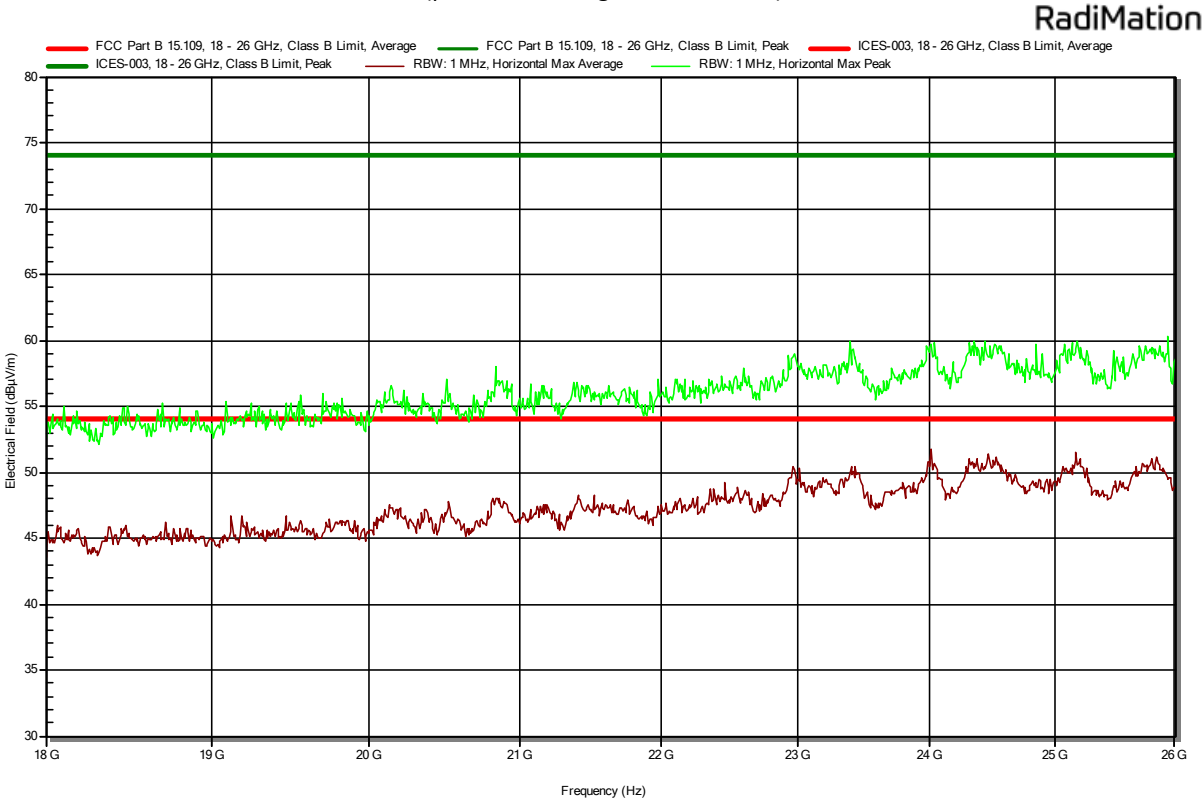
Plot 3a: radiated emissions of the EUT, Antenna vertical, in the range 1-18 GHz
(peak and average values shown)



Plot 3b: radiated emissions of the EUT, Antenna horizontal, in the range 1-18GHz
(peak and average values shown)



Plot 4a: radiated emissions of the EUT, Antenna vertical, in the range 18-26 GHz
(peak and average values shown)



Plot 4b: radiated emissions of the EUT, Antenna horizontal, in the range 18-26 GHz
(peak and average values shown)

4 Sample calculations

All formulas for data conversions and conversion factors are reported in this chapter.

Field Strength Measurement:

E (dBµV/m) = U(dBµV) + AF (dB/m) + Corr. (dB)

Where:
E = Electric field strength
U = Measuring receiver voltage
AF = Antenna factor
CL = Cable loss

Corr. = sum of single correction factors of used cable and amplifier (if applicable).
Linear interpolation will be used for frequencies in between the values in the table.
Tables shows an extract of the values.

Frequency (MHz)	AF (dB/m) ID: 114436 VHA 9103 + BBA 9106 SN: 9856	Cable loss (dB) Id: SAR cable	Corr. (dB)
30	18.6	0.68	19.28
100	10.4	1.15	11.55
150	14.8	1.41	16.21
200	16.0	1.63	17.63
250	16.9	1.93	18.83

Frequency (MHz)	Gain (dBi) ID: 114385 EMCO LPDA SN: 9856	Cable loss (dB) Id: SAR cable	Corr. (dB)
250	11.8	1.93	13.73
300	13	2.12	15.12
350	15.6	2.2	17.8
400	17.1	2.29	19.39
450	17.3	2.53	19.83
500	17.7	2.67	20.37
550	18.4	2.9	21.3
600	19.2	3.02	22.22
650	19.7	3.09	22.79
700	20.3	3.22	23.52
750	21.4	3.56	24.96
800	22	3.69	25.69
900	22.1	3.81	25.91
950	22.6	3.91	26.51
1000	22.5	4.3	26.8

Frequency (MHz)	AF (dB/m) TE 00531 Emco 3115 SN: 9412-4377	Gain (dB) TE 11132 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
1000	23,6	40,4	2,0	66
1500	25,1	40,5	2,4	68
2000	27,1	40,5	2,7	70,3
2500	28,6	40,7	3,2	72,5
3000	30,5	40,7	3,2	74,4
3500	31,2	40,7	3,4	75,3
4000	32,7	40,9	4,9	78,5
4500	32,4	40,9	4,4	77,7
5000	33,2	40,7	4,6	78,5
5500	34,0	40,5	4,5	79
6000	34,6	40,0	5,2	79,8
6500	34,3	39,4	5,9	79,6
7000	35,2	38,6	5,7	79,5
7500	36,4	39,2	5,9	81,5
8000	37,0	38,9	6,3	82,2
8500	37,5	38,4	6,4	82,3
9000	38,1	37,4	6,5	82
9500	37,8	37,0	7,1	81,9
10000	38,2	36,5	7,3	82
10500	38,1	36,7	7,6	82,4
11000	38,3	36,9	8,3	83,5
11500	38,5	37,6	8,1	84,2
12000	39,1	38,3	8,4	85,8
12500	38,7	38,5	8,3	85,5
13000	39,2	38,9	9,2	87,3
13500	40,5	40,2	8,3	89
14000	41,1	40,0	8,2	89,3
14500	41,4	40,1	8,2	89,7
15000	40,2	41,4	8,3	89,9
15500	37,9	41,4	8,6	87,9
16000	37,5	42,8	9,2	89,5
16500	38,6	42,3	8,8	89,7
17000	41,1	43,1	9,4	93,6
17500	42,7	43,2	9,4	95,3
18000	44,0	44,2	9,8	98

Frequency (MHz)	AF (dB/m) TE 00818 Flann 20240-25 SN: 163703	Gain (dB) TE 11131 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
18000	31,3	26,2	9,8	67,3
19000	31,5	26,1	9,6	67,2
20000	31,7	25,9	11	68,6
21000	31,9	24,3	10,7	66,9
22000	32,1	18,3	10,5	60,9
23000	32,2	18,9	10,8	61,9
24000	32,3	23,6	11,4	67,3
25000	32,4	24,5	11,6	68,5
26000	32,5	25,3	11,7	69,5

5 Photograph test setup

5.1 Photograph test setup Radiated Emissions

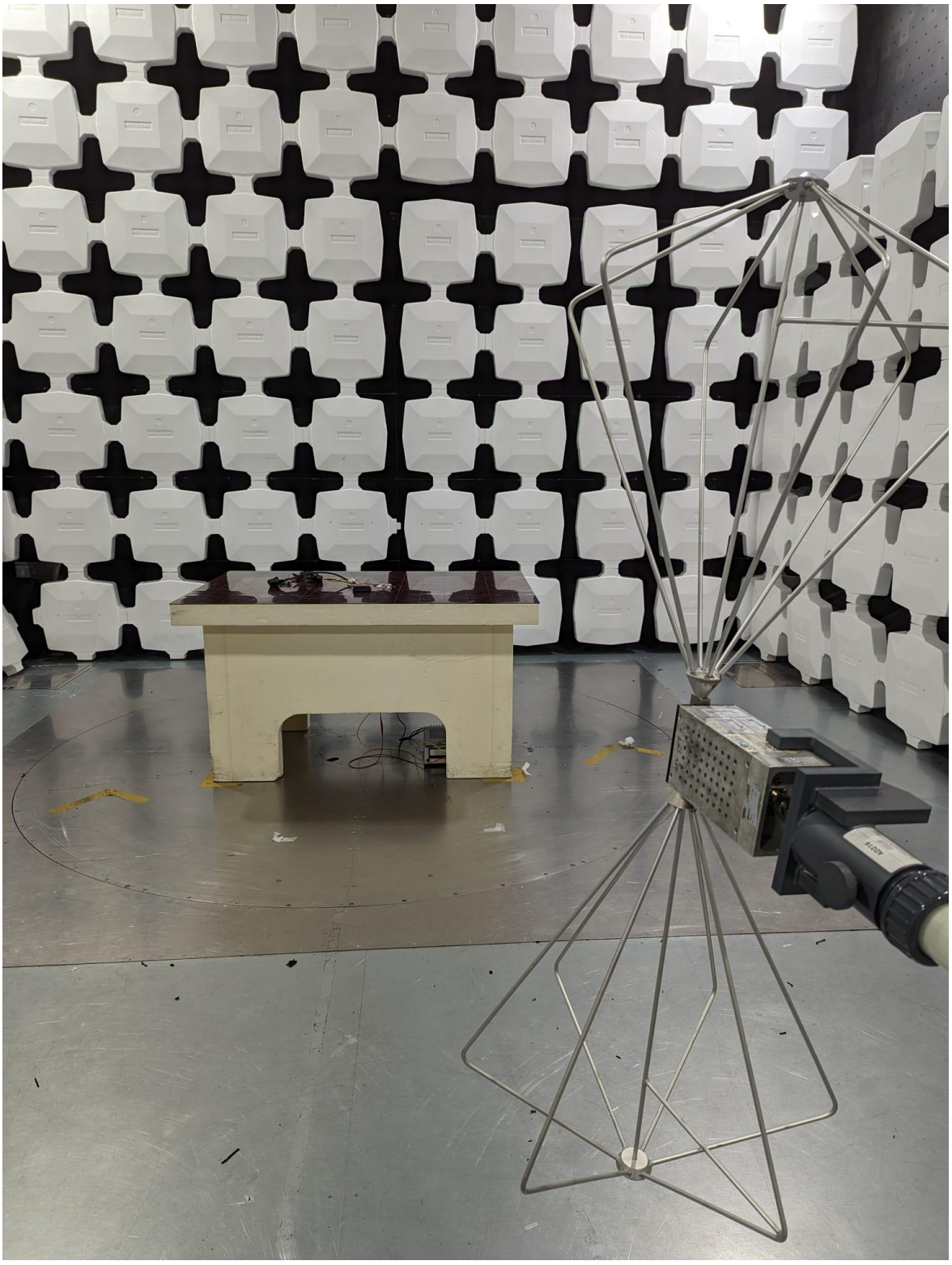


Photo 1 Photograph test setup radiated emissions 30-250 MHz, report section 3.1

Photo 2 Photograph test setup radiated emissions 250-1000 MHz, report section 3.1

No photo available

Photo 3 Photograph test setup radiated emissions 18-26 GHz, report section 3.1

<<END OF REPORT>>