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Wireless test report – 357553-1TRFWL

Applicant:

Pluritag Inc.

Product name:

TOF RTLS SYSTEM

Model:

TOF RTLS READER V1

FCC ID:

2AP77PLURITAG

IC Registration number:

24070-PLURITAG

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.250

  Operation of wideband systems within the band 5925–7250 MHz.

- RSS-210, Issue 9, August 2016, Annex K

  Wideband devices operating within the band 5925–7250 MHz

Date of issue: December 10, 2018

Test engineer(s):	Avul Nzenza, EMC/Wireless Specialist	Signature:	
Reviewed by:	Andrey Adelberg, Senior Wireless/EMC Specialist	Signature:	Andrey Adelberg

Test location(s)

Company name	Nemko Canada Inc.
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City	Pointe-Claire
Province	Quebec
Postal code	H9R 5L8
Country	Canada
Telephone	+1 514 694 2684
Facsimile	+1 514 694 3528
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2041; IC: 2040G-5 (3 m SAC)

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Pluritag Inc.
Address	462 rue des Forges
City	Trois-Rivières
Province/State	Quebec
Postal/Zip code	G9A 2H5
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15 Subpart C, §15.250	Operation of wideband systems within the band 5925–7250 MHz.
RSS-210, Issue 9, August 2016, Annex K	Wideband devices operating within the band 5925–7250 MHz.

1.3 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	December 10, 2018	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, intentional radiators test results

Table 2.1-1: FCC 15.250 results

Part	Test description	Verdict
§15.203	Antenna Requirement	Pass
§15.207	AC power-line conducted emissions limits	Pass
§15.250(a)	Band of operation	Pass
§15.250(b)	Occupied bandwidth	Pass
§15.250(d)(1) and (4)	Spurious Emissions	Pass
§15.250(d) (2)	Radiated Emissions in GPS Bands	Pass
§15.250(d) (3)	Peak Emissions	Pass

2.2 ISED RSS-210, Issue 9, test results

Table 2.2-1: RSS-210 results

Part	Test description	Verdict
RSS 210 (Annex K.1)	Antenna Requirement	Pass
RSS-Gen, Issue 5 (8.8)	AC power-line conducted emissions limits	Pass
RSS 210 (Annex K.2.1)	Occupied bandwidth	Pass
RSS 210 (Annex K.2.2)	Limits of Radiated Emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	July 9, 2018
Nemko sample ID number	Item #1 and 2

3.2 EUT information

Product name	TOF RTLS SYSTEM
Model	TOF RTLS READER V1
Serial number	DW8F86-R0001

3.3 Technical information

Applicant IC company number	24070
IC UPN number	PLURITAG
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-210, Issue 9, August 2016, Annex K
Frequency band	5925 to 7250 MHz
Frequency (MHz)	6500
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), EIRP	N/A
Field strength, Units @ distance	58.40 dBµV/m
Measured BW (MHz) (99%)	708.3
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	BPM-BPSK (802.15.4-2011 UWB PHY)
Emission classification (F1D, G1D, D1D)	708M3F1D
Transmitter spurious, Units @ distance	51.03 dBµV/m @ 6346.3 MHz, 3 m
Power requirements	100-240 Vac, 50/60 Hz Power Supply
Antenna information	Printed PCB antenna (6.5 GHz)

3.4 Product description and theory of operation

PLURITAG'S TOF technology is a RTLS system based on Decawave's DWM1001 module. This module uses a Decawave's DW1000 UWB transceiver IC compliant with IEEE-802.15.4-2011. The purpose of the technology is to do indoor localization using readers and tags deployed at a customer's site. The readers are installed at fixed positions and tags are used on items that needs to be localized inside plants or buildings. This system is designed to be used an environment ranging from 0 to 50 degrees Celsius.

Per IEEE-802.15.4-2011, the UWB PHY waveform is based upon an impulse radio signaling scheme using band-limited data pulses. The DWM1001 module operates on the channel 5 of the IEEE-802.15.4-2011 specification, with a center frequency of 6489.6 MHz and a bandwidth of 499.2 MHz. The combined BPM-BPSK is used to modulate the symbols, with each symbol being composed of an active burst of UWB pulses.

A more precise theory of operation is described in the Decawave's DWM1001 module and DW1000 transceiver IC specification sheets included with this application.

3.5 EUT exercise details

The readers are installed at fixed positions and tags are used on items that need to be localized inside plants or buildings. The system is set to transmit at a center frequency of 6.5 MHz.

3.6 EUT setup diagram

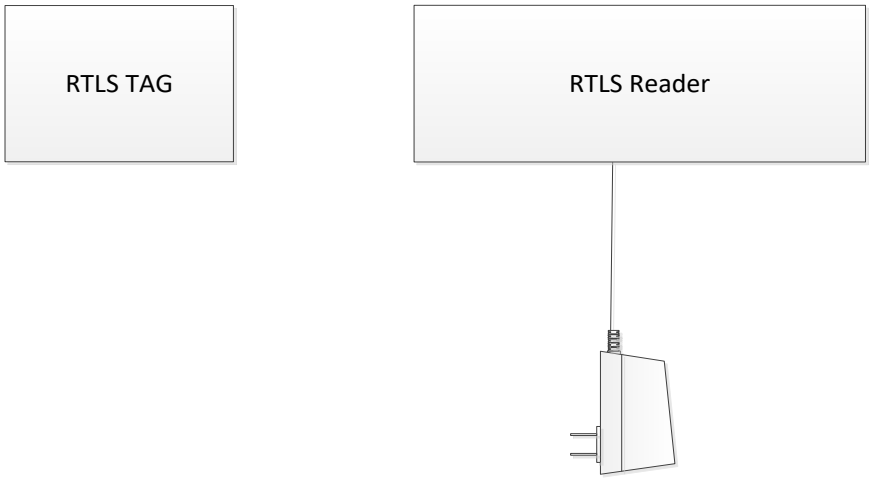


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
RTLS Reader	PLURITAG	TOF RTLS READER V1	DW8F86-R0001

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 6.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002532	2 year	June 5/19
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
3 Phase AC Power Source	apc AC Power	45 kVA	FA002677	—	VOU
Power Meter	HIOKI	PW3337	FA002727	1 year	July 25/18
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Sept. 18/18
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Dec. 15/18
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Dec. 6/18
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	April 27/19
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	Sept. 21/18
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	June 6/19
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	Sept. 21/18
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	April 27/19

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

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

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: Conducted emissions limit

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

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test date

Start date	July 9, 2018

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

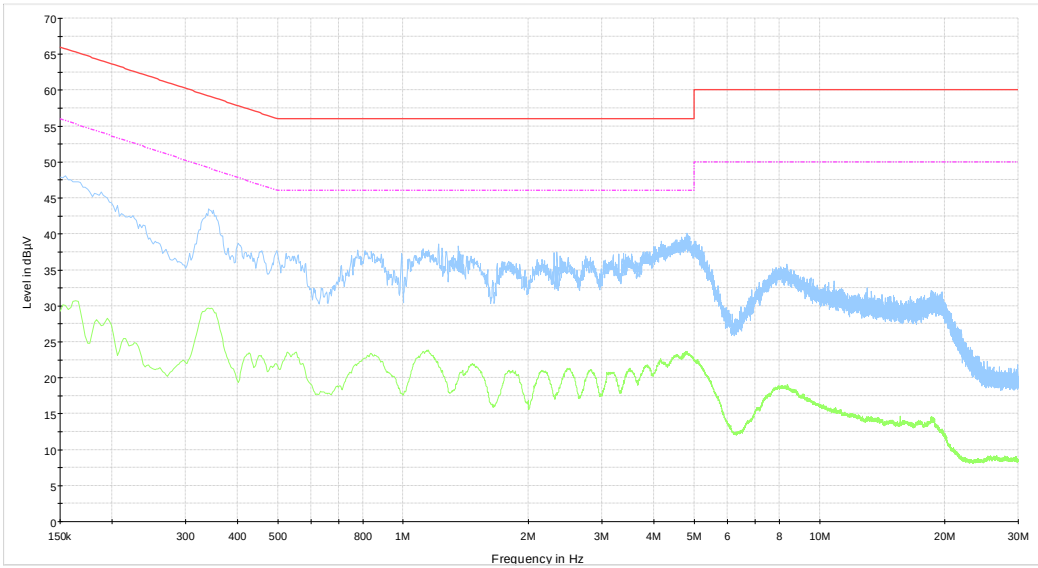
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

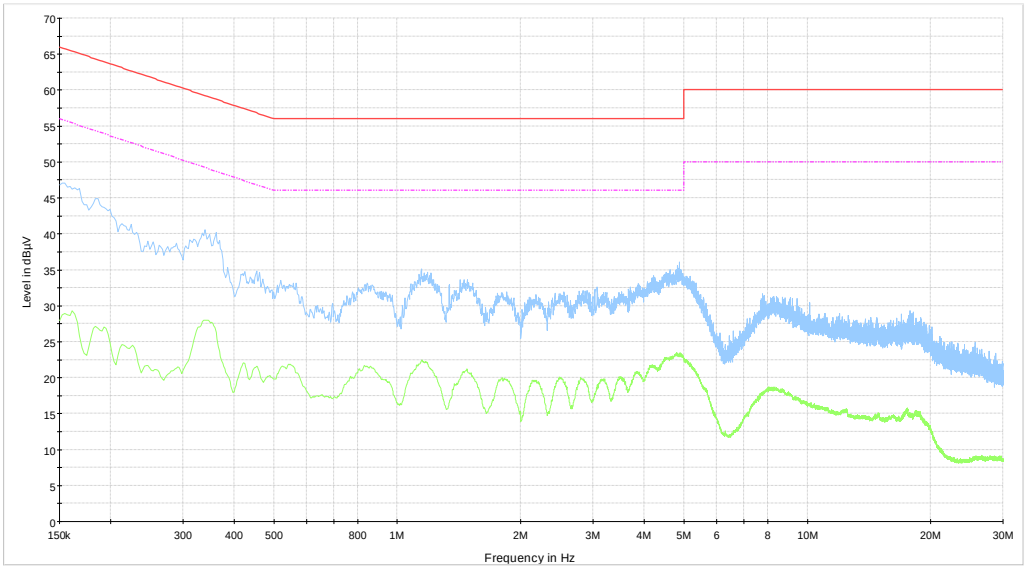
Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data



Plot 8.1-1: Conducted emissions on phase line



Plot 8.1-2: Conducted emissions on neutral line

8.2 FCC 15.250 (a) and RSS-210 (Annex K.2.1) Band of operation

8.2.1 Definitions and limits

FCC:
The −10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925–7250 MHz band under all conditions of operation including the effects from stepped frequency y, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

ISED:
(a) The 10 dB bandwidth of the device shall be within the band 5925-7250 MHz under all conditions of operation, including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed, as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

8.2.1 Test date

Start date	July 19, 2018

8.2.2 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Frequency span	1 GHz
Detector mode	Peak
Trace mode	Max Hold

8.2.3 Test data

Table 8.2-1: Band of operation results

Temperature, deg	Supply voltage, V_{AC}	Frequency, MHz	fL of −10 dB BW, MHz	Lower limit, MHz	Margin, MHz	fH of −10 dB BW, MHz	Upper limit, MHz	Margin, MHz
0	120	6500.0	6263.2	5925.0	338.2	6718.3	7250.0	531.7
10	120	6500.0	6332.1	5925.0	407.1	6747.2	7250.0	502.8
20	102*	6500.0	6270.0	5925.0	345.0	6721.1	7250.0	528.9
20	120	6500.0	6360.0	5925.0	435.0	6705.5	7250.0	544.5
25	138*	6500.0	6255.0	5925.0	330.0	6771.0	7250.0	479.0
30	120	6500.0	6392.9	5925.0	467.9	6757.6	7250.0	492.4
40	120	6500.0	6385.7	5925.0	460.7	6717.1	7250.0	532.9
50	120	6500.0	6535.3	5925.0	610.3	6715.6	7250.0	534.4

Notes: * - Supply voltage was changed ±15%

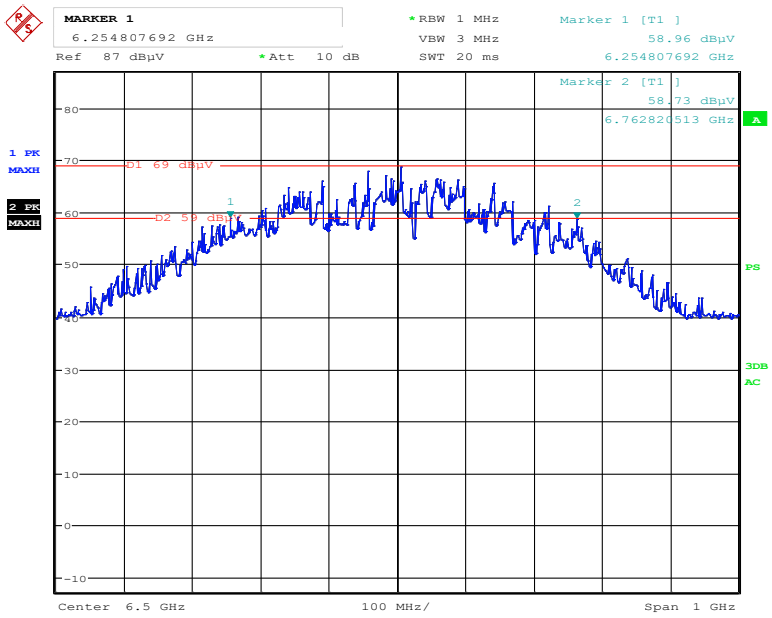


Figure 8.2-1: Band of operation –Sample

8.3 FCC 15.250 (b) and RSS-210 (Annex K.2.1) Occupied bandwidth

8.3.1 Definitions and limits

FCC:
The −10 dB bandwidth of the fundamental emission shall be at least 50 MHz For transmitters that employ frequency hopping, stepped frequency or similar modulation types, measurement of the −10 dB minimum bandwidth specified in this paragraph shall be made with the frequency hop or step function disabled and with the transmitter operating continuously at a fundamental frequency following the provisions of § 15.31(m).

ISED:

The 10 dB bandwidth of the device shall be within the band 5925-7250 MHz under all conditions of operation, including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed, as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.
The 10 dB bandwidth of the device shall be at least 50 MHz For transmitters that employ frequency hopping, stepped frequency or similar modulation types, measurement of the 10 dB bandwidth specified in this paragraph shall be made with the frequency hop or step function disabled, and with the transmitter operating continuously at a frequency chosen in accordance with the provisions of RSS-Gen for determining measurement frequencies.

8.3.1 Test date

Start date	July 19, 2018

8.3.2 Test data

Table 8.3-1: Occupied bandwidth measurement results

Frequency fM, MHz	fL of –10 dB BW, MHz	fH of –10 dB BW, MHz	10 dB BW, MHz	Minimum limit, MHz	Margin, MHz
6520.8	6283.6	6708.3	424.7	50.0	374.7

Notes: 10 dB BW (B_{-10}) = fH − fL

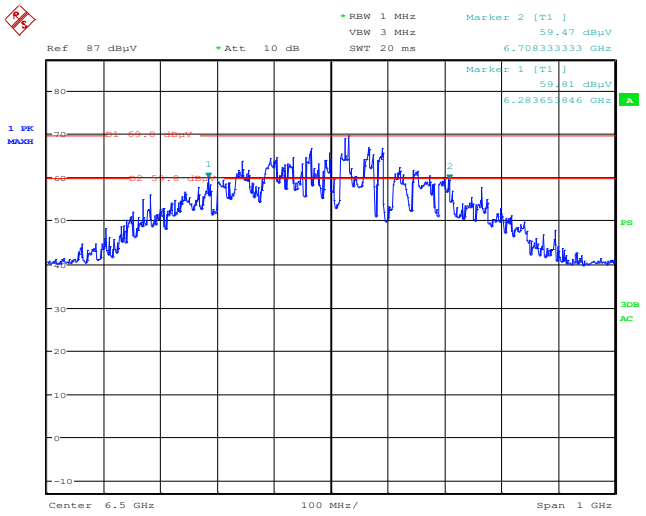


Figure 8.3-1: –10 dB bandwidth

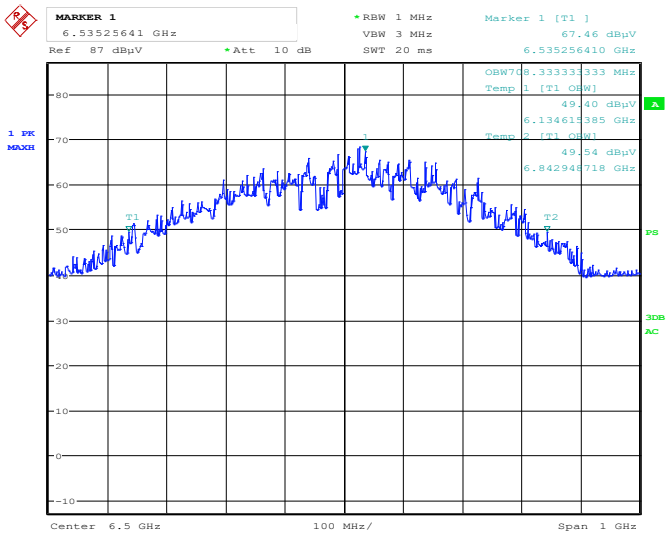


Figure 8.3-2: 99% OBW

8.4 FCC 15.250 (d)(1) and (4) and RSS-210 (Annex K.2.2) Spurious emissions

8.4.1 Definitions and limits

FCC:
(d) Emissions from a transmitter operating under this section shall not exceed the following equivalent isotropically radiated power (EIRP) density levels:
(1) The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following RMS average limits based on measurements using a 1 MHz resolution bandwidth.
(2) Radiated emissions at or below 960 MHz shall not exceed the emission levels in §15.209.
ISED:
(a) The e.i.r.p. of radiated emissions above 960 MHz shall not exceed the limits in Table K1, and shall be measured using root-mean-square (RMS)average detector and a 1 MHz resolution bandwidth:
(d).Radiated emissions at or below 960 MHz shall not exceed the emission levels in RSS-Gen.

Table 8.4-1: Spurious emissions limits above 960 MHz

Frequency, MHz	EIRP (RMS), dBm/MHz	3 m Field strength equivalent, dBµV/m
960–1610	−75.3	19.93
1610–1990	−63.3	31.93
1990–3100	−61.3	33.93
3100–5925	−51.3	43.93
5925–7250	−41.3	53.93
7250–10600	−51.3	43.93
Above 10600	−61.3	33.93

Note: dBµV/m to dBm factor of 95.23 dB was used.
Sample Calculation: 19.93 dBµV/m - 95.23 dB = −75.3 dBm

Table 8.4-2: FCC 15.209 and RSS-Gen spurious emissions below 960 MHz

Frequency, MHz	Quasi-peak Field Strength (µV/m)	Measurement distance, m	EIRP, dBmW
0.009–0.490	2400 / F	300	$10 \times \text{Log} (17.28 / F^2)$
0.490–1.705	24000 / F	30	$10 \times \text{Log} (17.28 / F^2)$
1.705–30	30	30	−45.7
30–88	100	3	−55.2
88–216	150	3	−51.7
216–960	200	3	−49.2

Notes: F is in kHz
The emission limits for the bands 9–90 kHz and 110–490 kHz are based on measurements employing an average emissions detector.

8.4.1 Test date

Start date	July 12, 2018

8.4.2 Observations, settings and special notes

Spectrum analyser settings for radiated measurements 10–150 kHz

Resolution bandwidth:	200kHz
Video bandwidth:	2 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for radiated measurements 150 kHz to 30 MHz

Resolution bandwidth:	9 kHz
Video bandwidth:	100 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for radiated measurements 30 kHz to 960 MHz

Resolution bandwidth:	120 kHz
Video bandwidth:	1 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements above 960 MGHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	RMS
Trace mode:	Max Hold

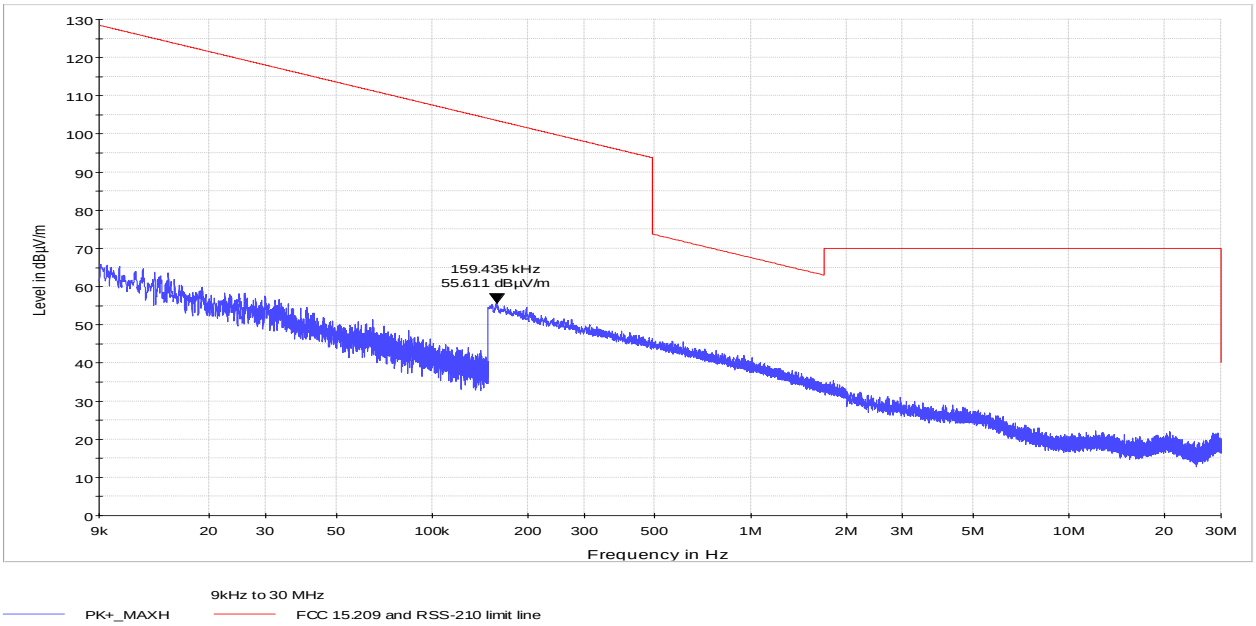


Figure 8.4-1: Radiated spurious emissions within 9 kHz to 30 MHz

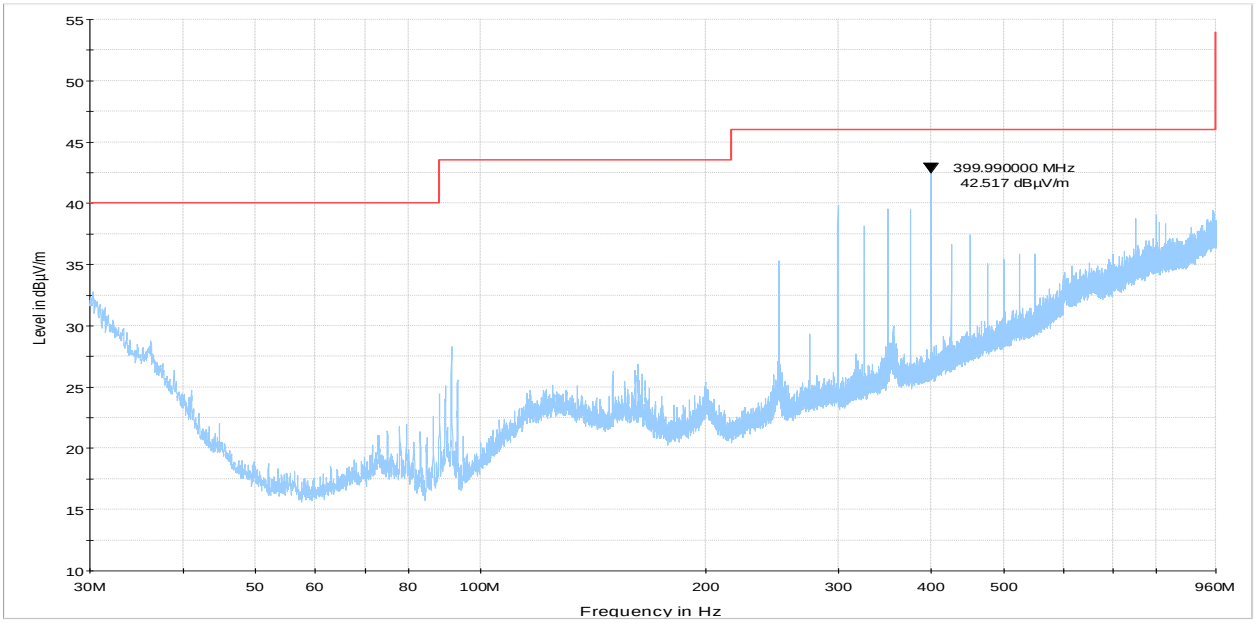


Figure 8.4-2: Radiated spurious emissions within 30–960 MHz

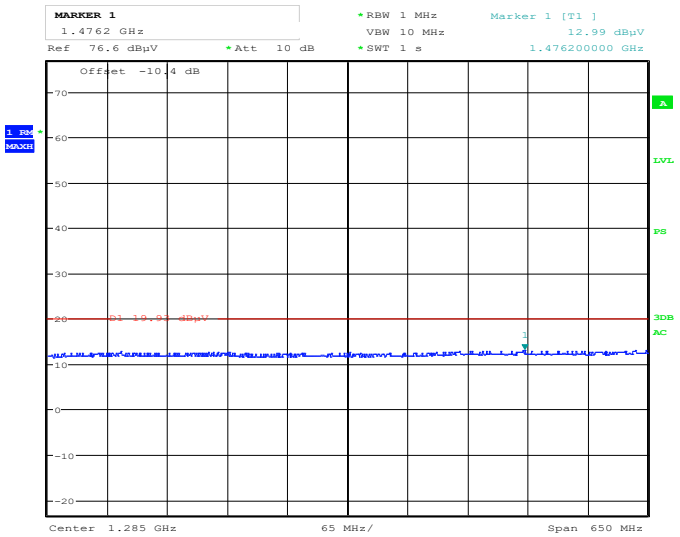


Figure 8.4-3: Radiated spurious emissions within 960–1610 MHz

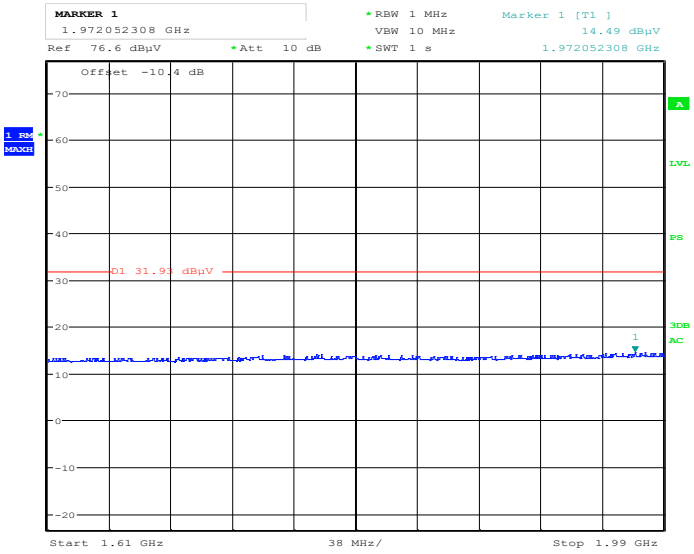


Figure 8.4-4: Radiated spurious emissions within 1610–1990 MHz

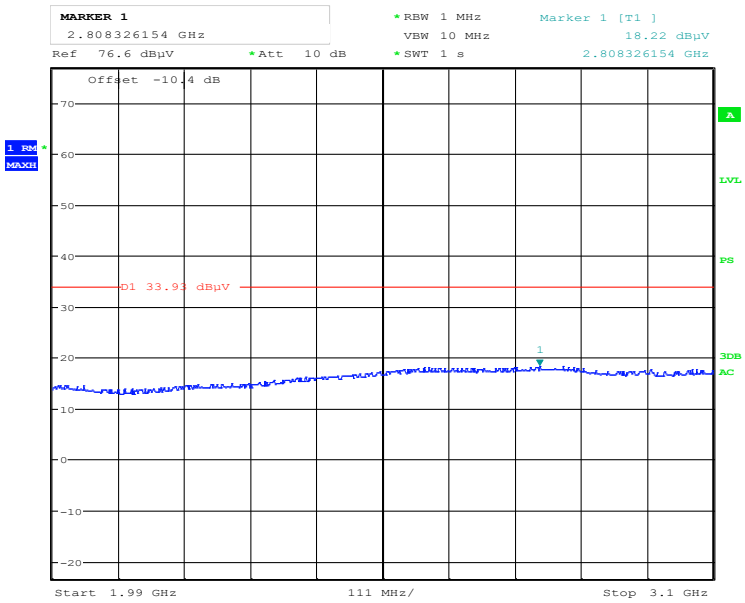


Figure 8.4-5: Radiated spurious emissions within 1990–3100 MHz

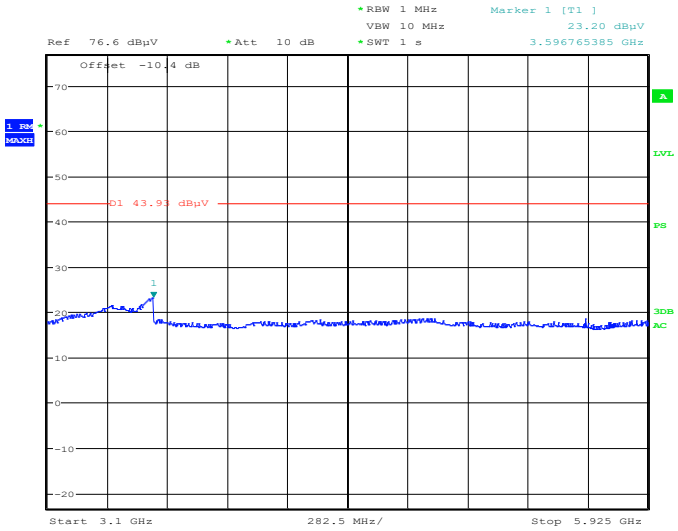


Figure 8.4-6: Radiated spurious emissions within 3100–5925 MHz

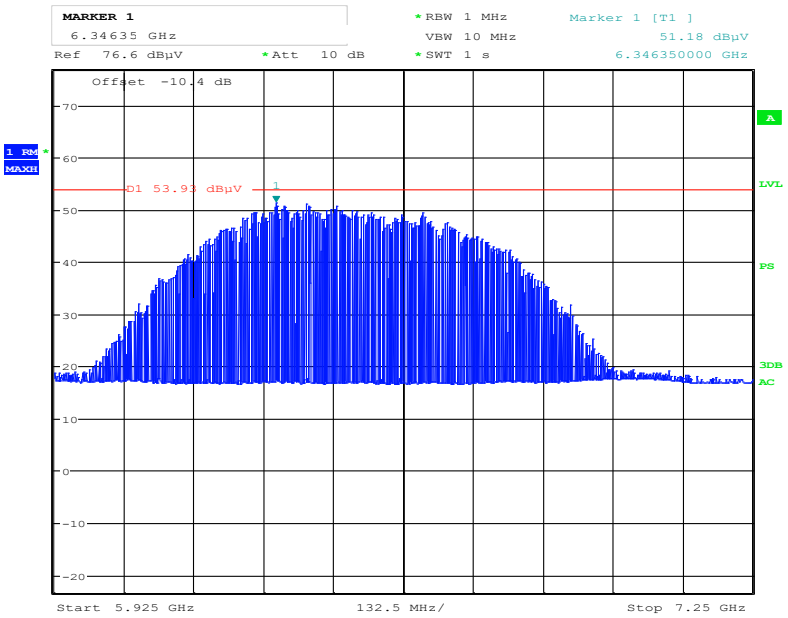


Figure 8.4-7: Radiated spurious emissions within 5925–7250 MHz

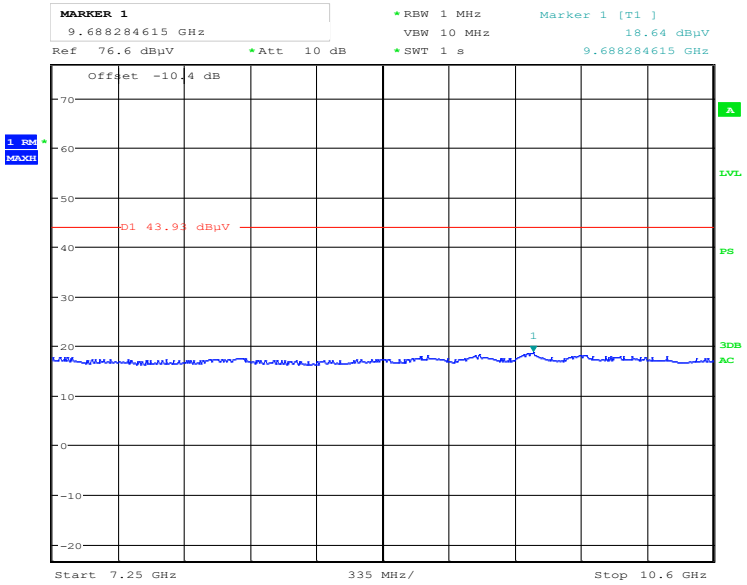


Figure 8.4-8: Radiated spurious emissions within 7250–10600 MHz

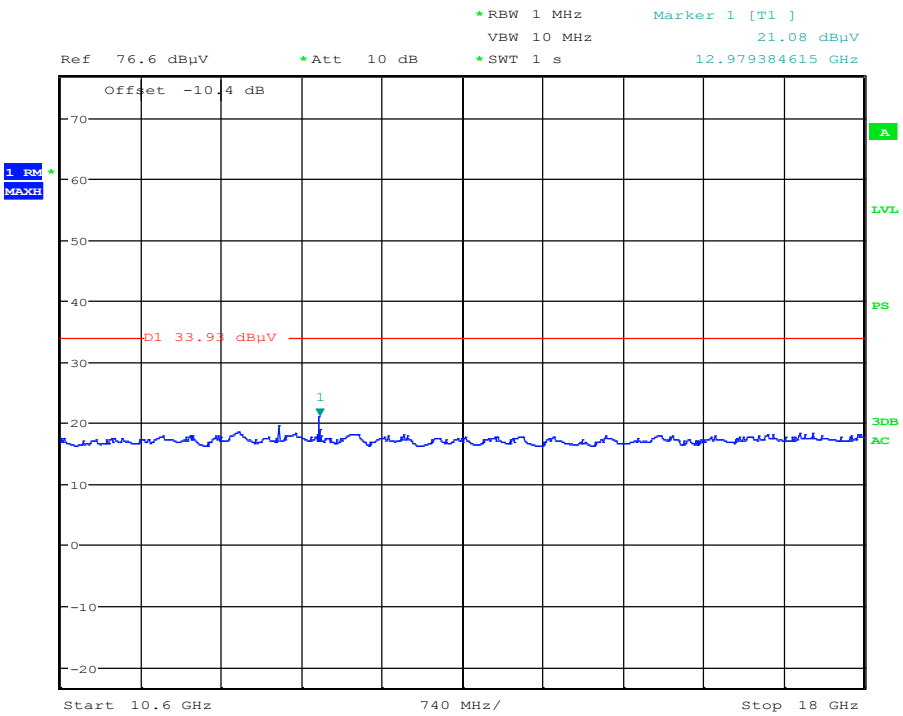


Figure 8.4-9: Radiated spurious emissions within 10600–18000 MHz

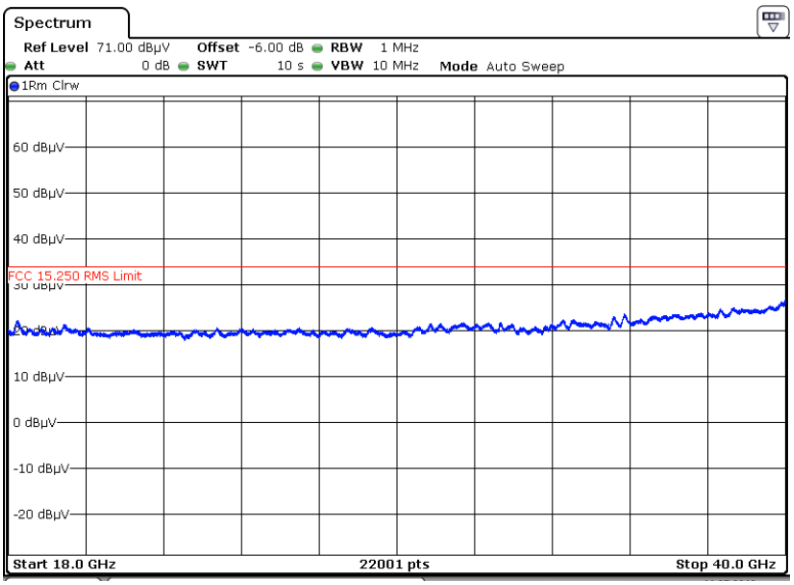


Figure 8.4-10: Radiated spurious emissions within 18000–40000 MHz

8.5 FCC 15.250 (d) (2) and RSS-210 (Annex K.2.2. (b)) Spurious emissions in GPS Bands

8.5.1 Definitions and limits

FCC:
(2) In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz.
ISED:
(b).In addition to the radiated emission limits specified in Table K1, the transmitters' e.i.r.p. shall not exceed the RMS average limits specified in Table K2 when measured using a resolution bandwidth of no less than 1 kHz.

Table 8.5-1: Spurious emissions limits in GPS Bands

Frequency, MHz	EIRP (RMS) in dBm/kHz	3 m Field strength equivalent, dBµV/m
1164–1240	−85.3	9.93
1559–1610	−85.3	9.93

Note: dBµV/m to dBm factor of 95.23 dB was used.
Sample Calculation: 19.93 dBµV/m - 95.23 dB = −75.3 dBm

8.5.1 Test date

Start date	July 17, 2018

8.5.2 Observations, settings and special notes

Resolution bandwidth:	1 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	1.5 times the OBW
Detector mode:	RMS

8.5.1 Test data

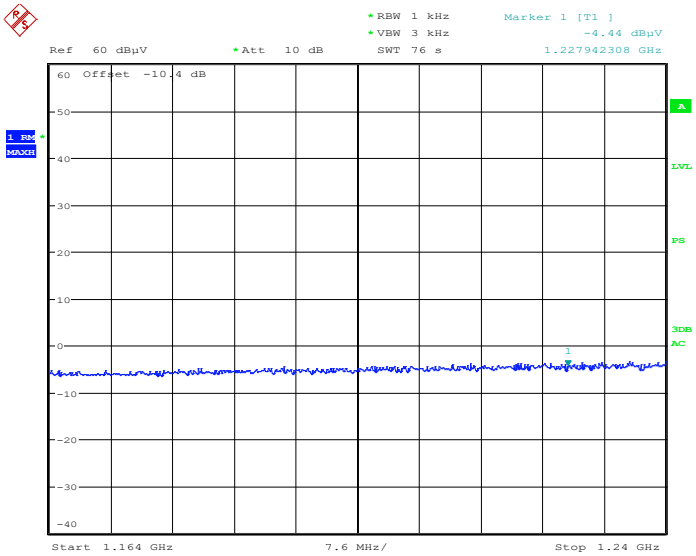


Figure 8.5-1: Spurious Radiated Emissions in GPS Band (1164–1240 MHz)

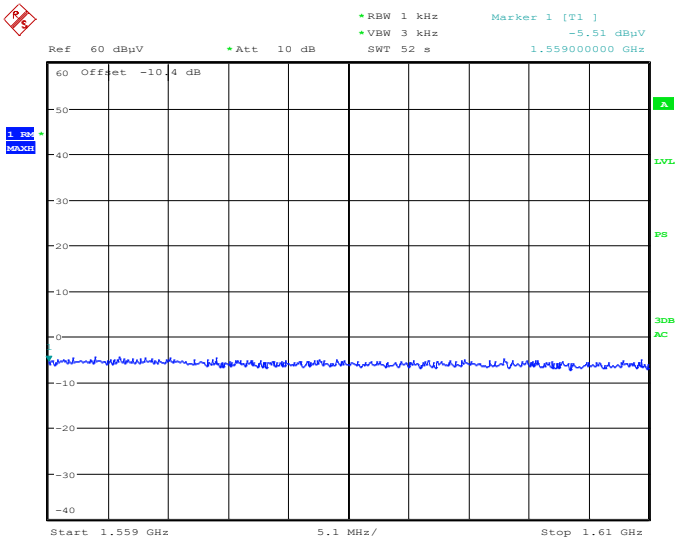


Figure 8.5-2: Spurious Radiated Emissions in GPS Band (1559–1610 MHz)

8.6 FCC 15.250 (d) (3) and RSS-210 (Annex K.2.2 (c) Peak Emissions in a 50 MHz Bandwidth

8.6.1 Definitions and limits

FCC:
(3) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs and this 50 MHz bandwidth must be contained within the 5925–7250 MHz band. The peak EIRP limit is 20 log (RBW/50) dBm where RBW is the resolution bandwidth in megahertz that is employed by the measurement instrument. RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than RBW. If RBW is greater than 3 MHz, the application for certification filed with the Commission shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

ISED:
(C) In a 50 MHz bandwidth contained within the band 5925-7250 MHz and centred on the frequency at which the highest radiated emission level occurs, the peak e.i.r.p. level of the emissions in this 50 MHz bandwidth shall not exceed 20 log (RBW/50) dBm, where "RBW" is the resolution bandwidth in MHz that is employed by the measurement instrument. The RBW shall not be lower than 1 MHz or greater than 50 MHz The video bandwidth of the measurement instrument shall not be less than the RBW. If the RBW is greater than 3 MHz, the application for certification shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed during testing.

8.6.2 Test date

Start date	July 17, 2018

8.6.3 Observations, settings and special notes

Resolution bandwidth:	1 MHz
Video bandwidth:	≥3 × RBW
Frequency span:	1 GHz
Detector mode:	Peak

Peak EIRP Limit calculation for 1 MHz RBW:
20 × Log (1 / 50) dBm = −33.98 dBm
3 m Field Strength limit calculation for 1 MHz RBW:
−33.98 dBm + 95.23 dB = 61.25 dBµV/m

8.6.4 Test data

Table 8.6-1: Peak Emissions

Frequency, MHz	Field Strength, (dBµV/m)/MHz	Field Strength Limit, (dBµV/m)/MHz	Margin, dB
6500	58.40	61.25	2.85

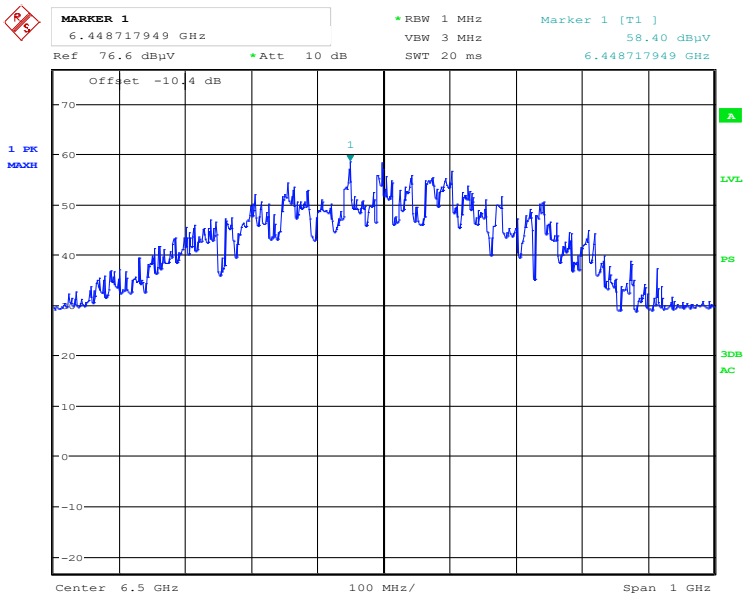
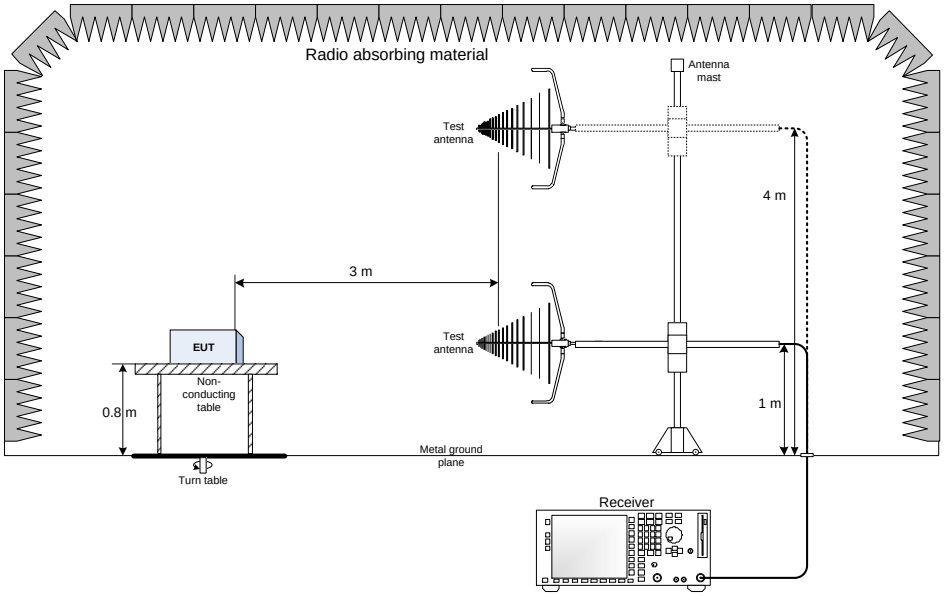


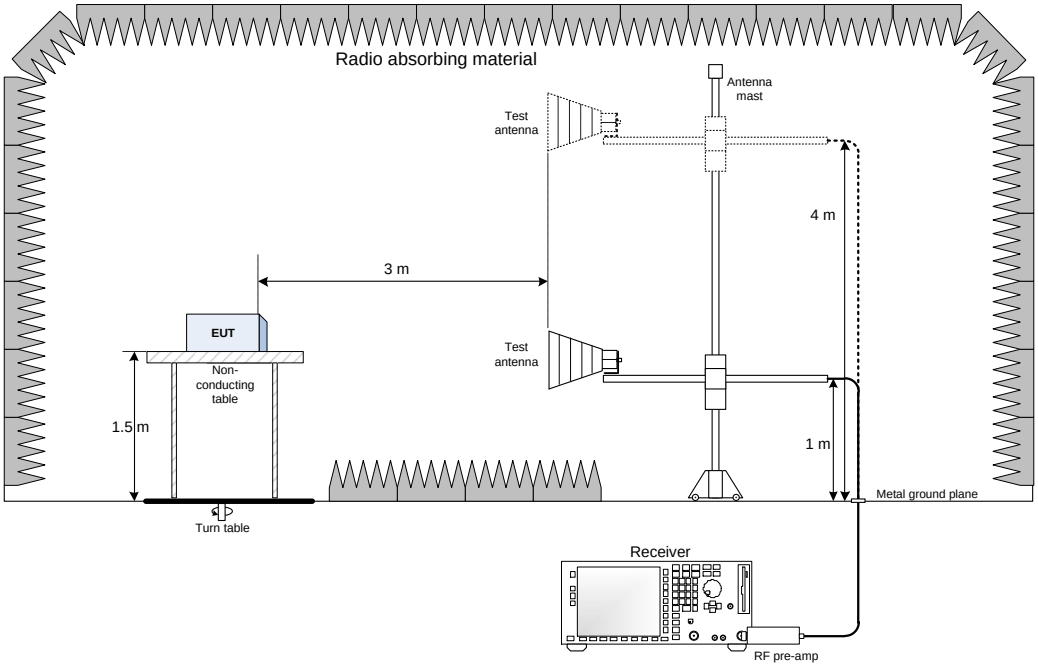
Figure 8.6-1: Peak Emissions in a 50 MHz

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up