ONE WORLD ○ OUR APPROVAL

Test report

310061-1R1TRFWL

Date of issue: March 4, 2019

Applicant:

FLIR Radars Inc.

Product:

Perimeter Surveillance Radar

Model:

921-0011-06-R06

Model variants:

Ranger R1, Ranger R2, Ranger R3, Ranger R3D

FCC ID:

2AEYU-R3

Specifications:

- FCC 47 CFR Part 90 Subpart F

  Radiolocation service

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2040; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	March 4, 2019
Signature of reviewer	

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	FLIR Radars Inc.
Address	3440 Francis-Hughes, Suite 120
City	Laval
Province/State	Quebec
Postal/Zip code	H7L 5A9
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 90 Subpart F	Radiolocation service

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. 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.

1.4 Exclusions

None

1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued
R1TRF	Updated sections

Section 2. Summary of test results

2.1 FCC Part 90 test results

Part	Test description	Verdict
§2.1046	Output power	Pass
§2.1049	Occupied bandwidth	Pass
§2.1051	Spurious emissions at the antenna terminal	Pass
§2.1053	Field strength of spurious radiation	Pass
§2.1055	Frequency stability	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	June 9, 2016
Nemko sample ID number	133-002841

3.2 EUT information

Product name	Perimeter Surveillance Radar
Model	921-0011-06-R06
Model variants	Ranger R1, Ranger R2, Ranger R3 (fast scan mode) Ranger R3D (Doppler mode)
Serial number	16050626

3.3 Technical information

Frequency band	33.4–36.0 GHz
Frequency Min	34.75 GHz
Frequency Max	35.25 GHz
RF power Max	28.95 dBm
Field strength, Units @ distance	N/A
Measured BW (99 %)	498.39 MHz (Fast scan mode), 99.68 MHz (Doppler mode)
Type of modulation	Swept frequency and Doppler
Emission classification (F1D, G1D, D1D)	N0N
Power requirements	18–32 V_{DC}, 2 A from 120 V_{AC} 60 Hz power supply
Antenna information	32.5 dBi bi-static antenna The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

EUT is a perimeter RADAR system, which rotates through 360° to indicate any objects within its scan range.

3.5 EUT exercise details

EUT was set to transmit in two modes of operation: Fast scan mode and Doppler mode. For some tests scanning was stopped.

3.6 EUT setup diagram

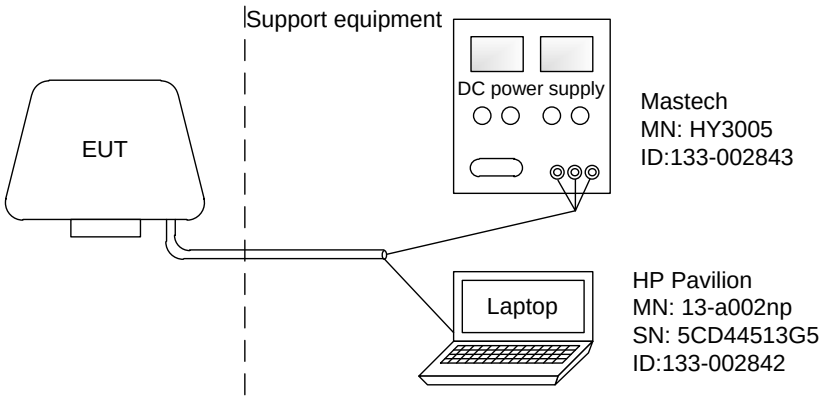


Figure 3.6-1: *Setup diagram*

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

All model variants are exactly the same assembly (electronic and mechanic). The difference is only a software key that controls the software on the PC. The software keys changes how the R1, R2 and will display the range information on the computer. R1 will show a shorter range on the computer than the R2. The R2 will show a shorter range on the computer than the R3. The transmit power and bandwidth are always the same. If a customer wants a range upgrade, they buy a software activation key that will allow the display to show that range.

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

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

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	FA002047	1 year	Dec. 01/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 28/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 26/17
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Apr.15/17
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 year	May. 16/19
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322	—	VOU
60–90 GHz Harmonic mixer	OML	WR12 M12HWD	FA001524	3 year	May. 16/19
60–90 GHz Standard gain horn	Millitech	U SGH-12	FA001524	—	VOU
90–140 GHz Harmonic mixer	OML	WR08 M08HWD	FA001525	3 year	May. 16/19
90–140 GHz Standard gain horn	Millitech	U SGH-08	FA001525	—	VOU
140–220 GHz Harmonic mixer	OML	WR05 M05HWD	FA001526	3 year	May. 16/19
140–220 GHz Standard gain horn	Millitech	U SGH-05	FA001526	—	VOU
Temperature chamber	Espec	EPX-4H	FA002735	1 year	Jan 26/17
Laser probe interface	AR	FI7000	FA002593	—	NCR
Laser powered field probe	AR	FL7040	FA002592	1 year	Oct 5, 2017

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

Section 8. Testing data

8.1 FCC 2.1046 Output power

8.1.1 Definitions and limits

For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

8.1.2 Test summary

Test date	June 9, 2016	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.1.3 Observations, settings and special notes

The test was performed using peak detector of the spectrum analyzer with RBW of 1 MHz and VBW of 3 MHz.
The test was performed with the sweeping turned on and off.

8.1.4 Test data

Table 8.1-1: *Output power with scanning turned off measurement result*

Frequency, GHz	Output power, dBm
34.75	25.30
35.00	25.60
35.25	28.42

Table 8.1-2: *Output power with scanning turned on measurement result*

Frequency, GHz	Output power, dBm
34.75–35.25	28.95

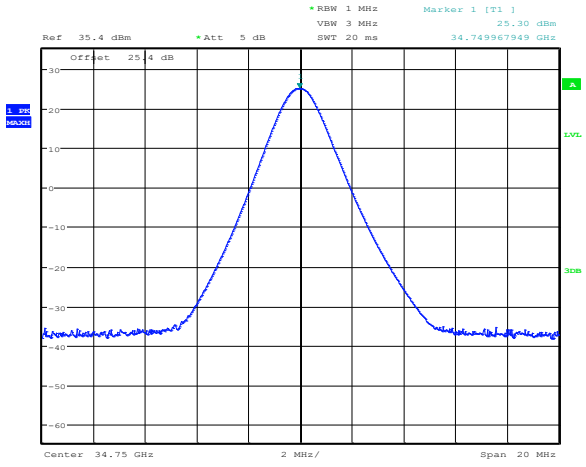


Figure 8.1-1: *Output power with scanning turned off at the lowest frequency*

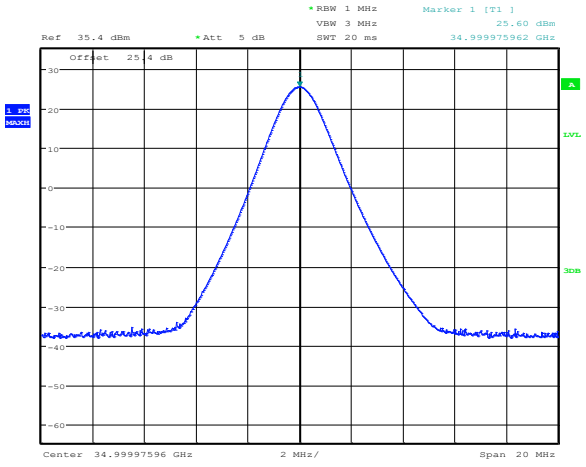


Figure 8.1-2: *Output power with scanning turned off at the middle frequency*

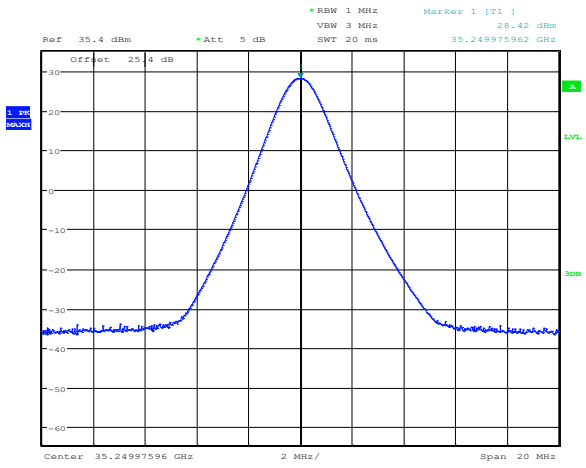


Figure 8.1-3: *Output power with scanning turned off at the highest frequency*

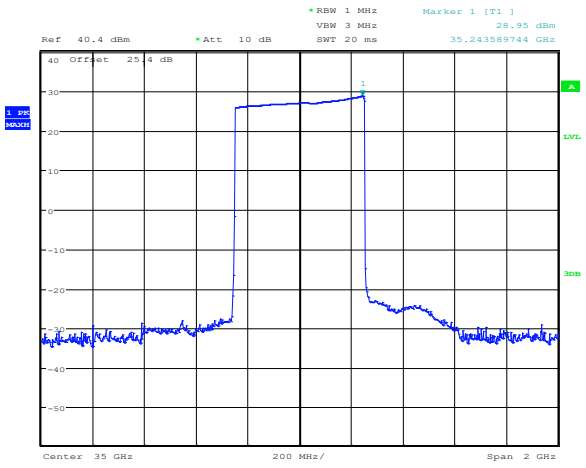


Figure 8.1-4: *Output power with scanning turned on*

8.2 FCC 2.1049 Occupied bandwidth

8.2.1 Definitions and limits

Emission bandwidth must be within assigned band. No channel spacing and authorized bandwidth defined for frequency band above 2.5 GHz. As per §90.103(b) Radiolocation service frequency table, there is a Radiolocation land or mobile class station at 33.4–36.0 GHz band.

8.2.2 Test summary

Test date	June 9, 2016	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings for measurements with scanning turned off:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for measurements with scanning turned on:

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

8.2.4 Test data

Table 8.2-1: *Occupied bandwidth measurement results*

Frequency, GHz	99% occupied bandwidth, MHz
35.00	240.38
34.75–35.25 (R3 – fast scan mode)	498.39
34.75–35.25 (R3D – Doppler mode)	99.68

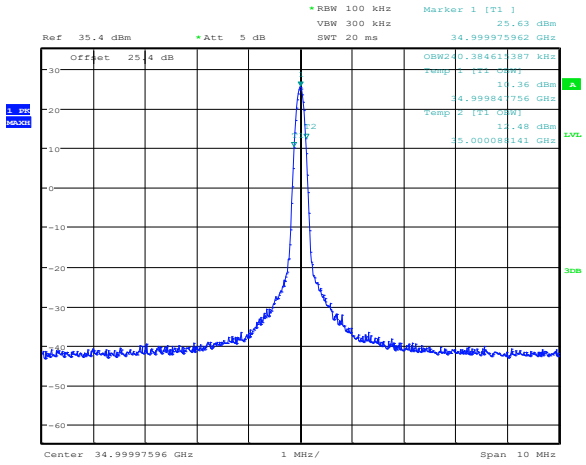


Figure 8.2-1: *Occupied bandwidth with scanning turned off*

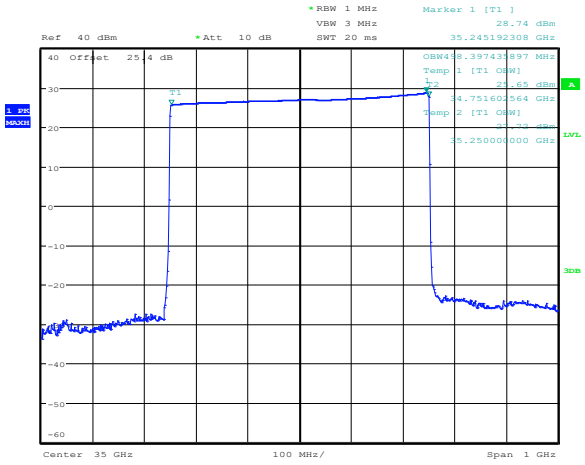


Figure 8.2-2: *Occupied bandwidth with scanning turned on (R3)*

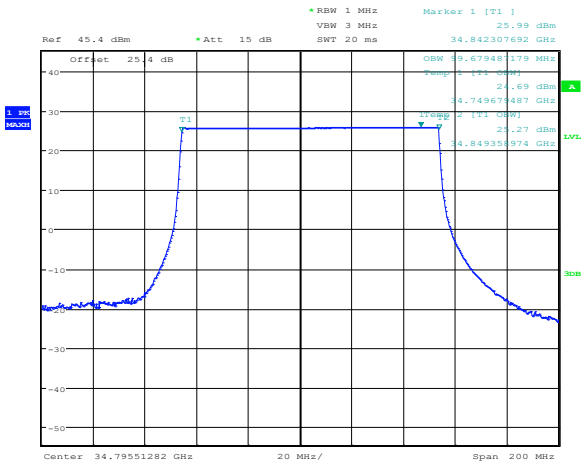


Figure 8.2-3: *Occupied bandwidth with scanning turned on (R3D)*

8.3 FCC 2.1051 Spurious emissions at antenna terminal

8.3.1 Definitions and limits

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions, which are attenuated more than 20 dB below the permissible value, need not be specified.

Table 8.3-1: *Spurious emissions limit*

Frequency range, MHz	Attenuation below carrier, dBc	Absolute spurious emission, dBm
30–220,000	43 + 10 Log_{10} (P)	–13

8.3.2 Test summary

Test date	June 9, 2016	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.3.3 Observations, settings and special notes

EUT was scanned within 30 MHz to 220 GHz frequency range in two operational modes: R3 – fast scan mode and R3D – Doppler mode.
Spectrum analyser settings for measurements below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for measurements above 1 GHz:

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

8.3.4 Test data

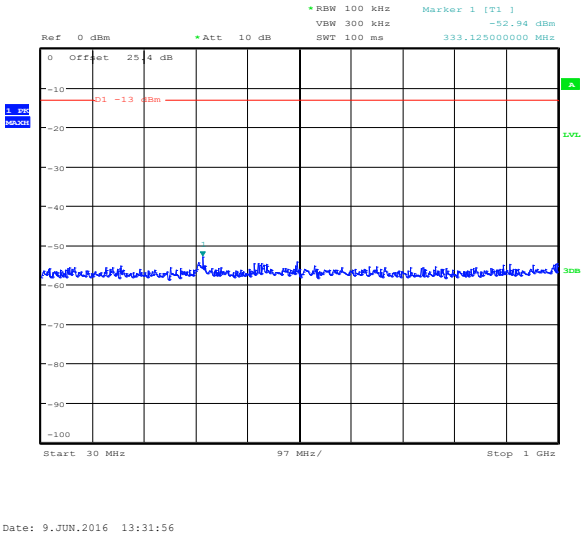


Figure 8.3-1: *Spurious emissions within 30–1000 MHz, R3*

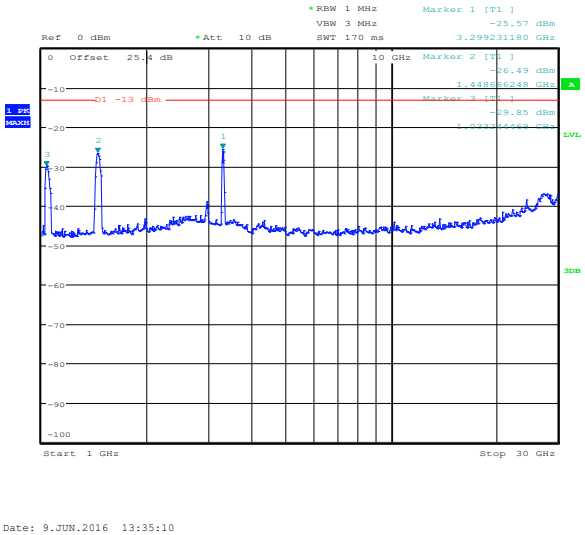


Figure 8.3-2: *Spurious emissions within 1–30 GHz, R3*

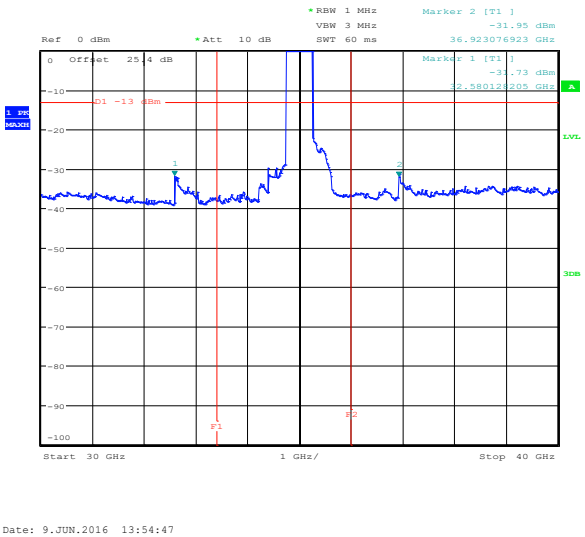


Figure 8.3-3: *Spurious emissions within 30–40 GHz, R3*

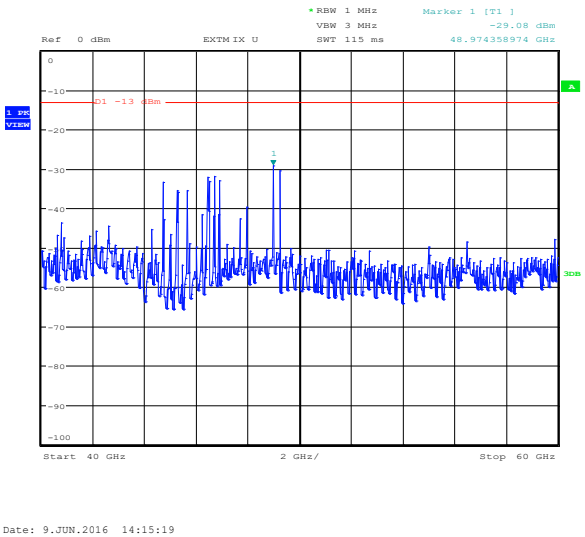


Figure 8.3-4: *Spurious emissions within 40–60 GHz, R3*

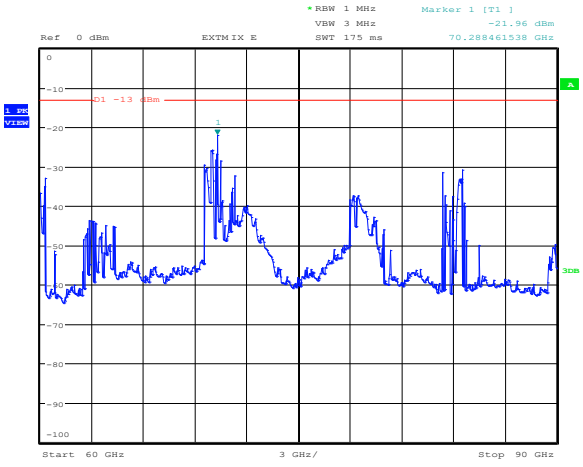


Figure 8.3-5: *Spurious emissions within 60–90 GHz, R3*

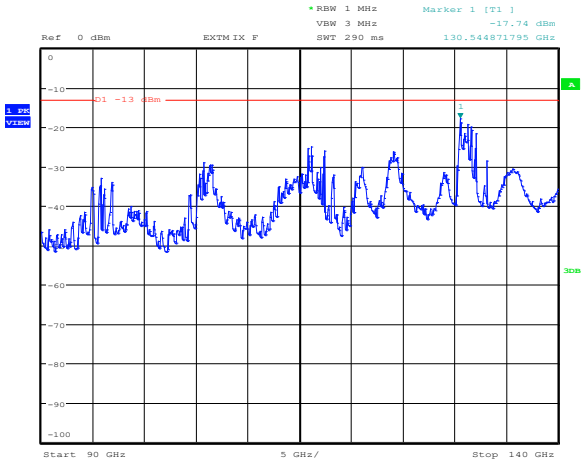


Figure 8.3-6: *Spurious emissions within 90–140 GHz, R3*

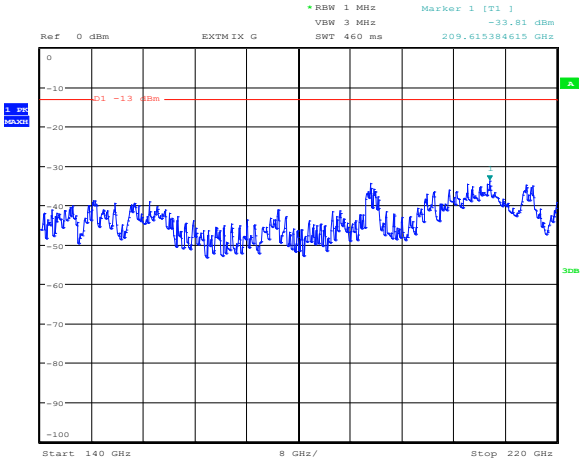


Figure 8.3-7: *Spurious emissions within 140–220 GHz, R3*

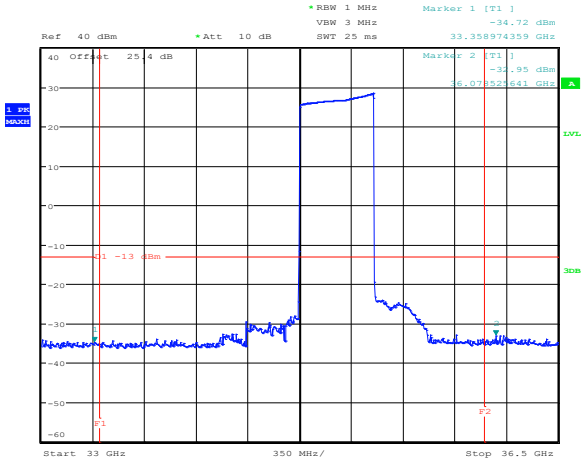


Figure 8.3-8: *Spurious emissions at the band-edges, R3*

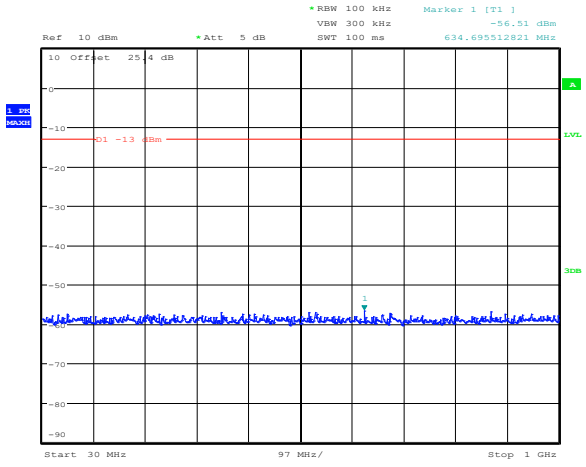


Figure 8.3-9: *Spurious emissions within 30–1000 MHz, R3D*

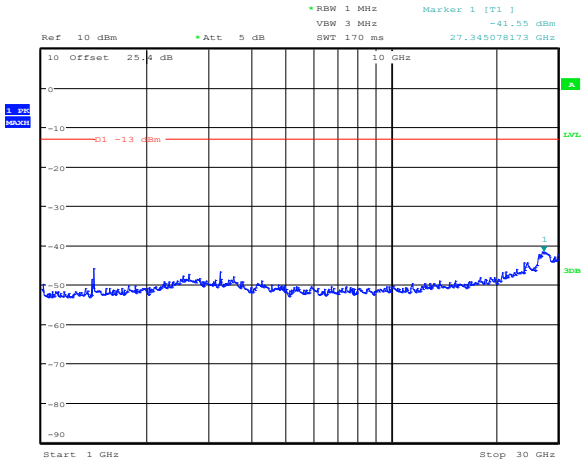


Figure 8.3-10: *Spurious emissions within 1–30 GHz, R3D*

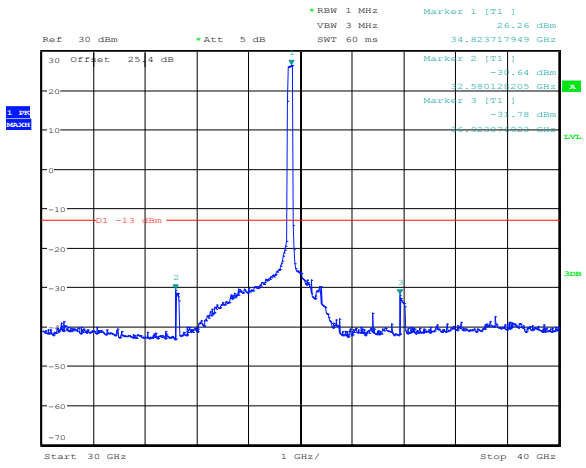


Figure 8.3-11: *Spurious emissions within 30–40 GHz, R3D*

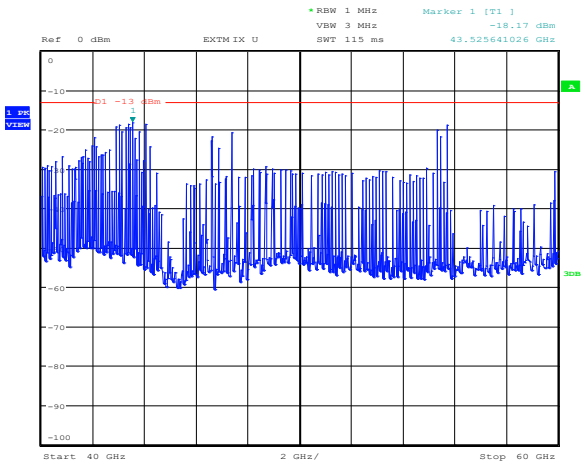


Figure 8.3-12: *Spurious emissions within 40–60 GHz, R3D*

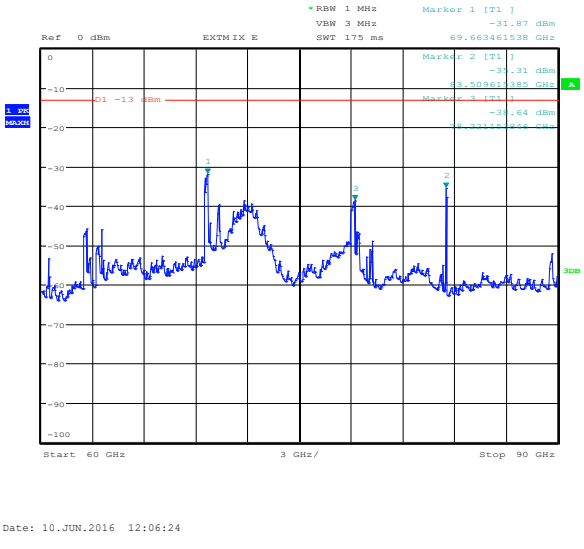


Figure 8.3-13: *Spurious emissions within 60–90 GHz, R3D*

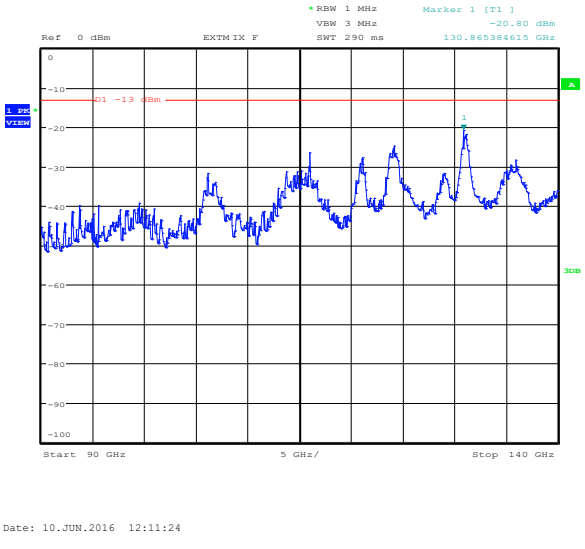


Figure 8.3-14: *Spurious emissions within 90–140 GHz, R3D*

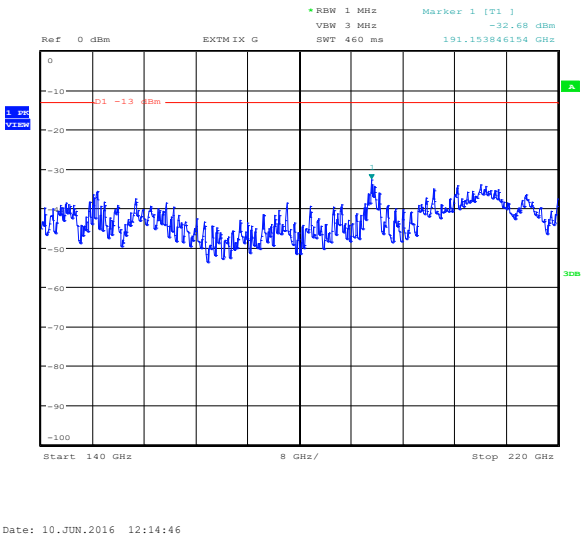


Figure 8.3-15: *Spurious emissions within 140–220 GHz, R3D*

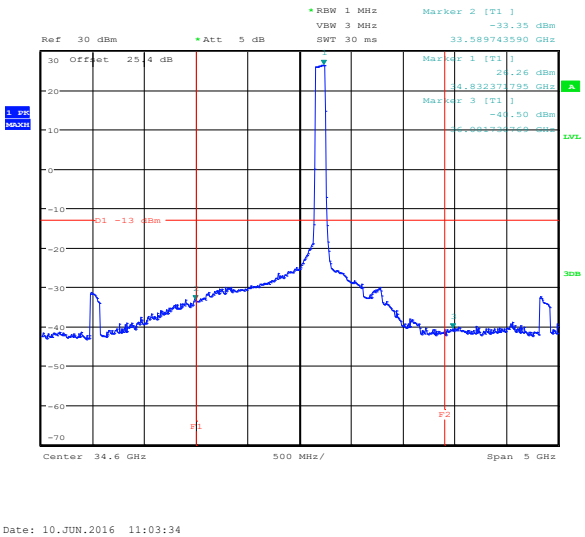


Figure 8.3-16: *Spurious emissions at the band-edges, R3D*

8.4 FCC 2.1053 Field strength of spurious radiation

8.4.1 Definitions and limits

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required; with the measuring instrument antenna located in the far field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections, which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half wave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

Table 8.4-1: *Spurious emissions limit*

Frequency range, MHz	Attenuation below carrier, dBc	Spurious emissions, dBm	Field strength of spurious radiation* at 3 m, dBµV/m
30–220,000	43 + 10 Log_{10} (P)	–13	82.23

Note: theoretical conversion is for the preliminary results only.

8.4.2 Test summary

Test date	June 9, 2016	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 220 GHz. The measurements above 40 GHz were performed at 30 cm. Fast scan mode (as worst case scenario was set). Spectrum analyser settings for measurements below 1 GHz:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for measurements above 1 GHz:

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

8.4.4 Test data

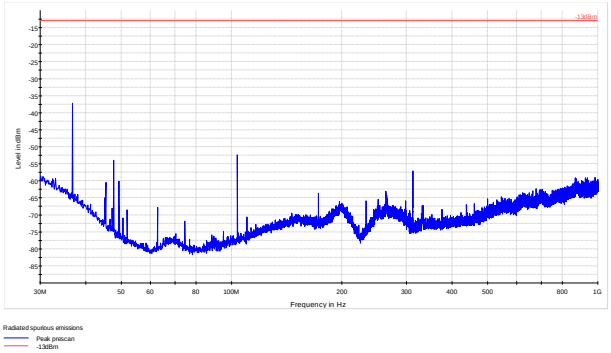


Figure 8.4-1: *Spurious emissions within 30–1000 MHz*

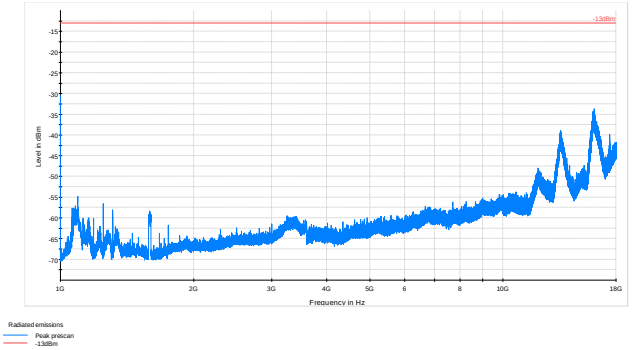


Figure 8.4-2: *Spurious emissions within 1–18 GHz*

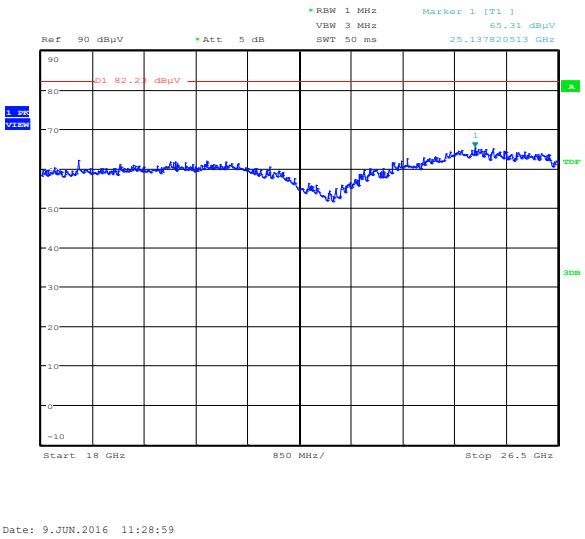


Figure 8.4-3: *Spurious emissions within 18–26.5 GHz*

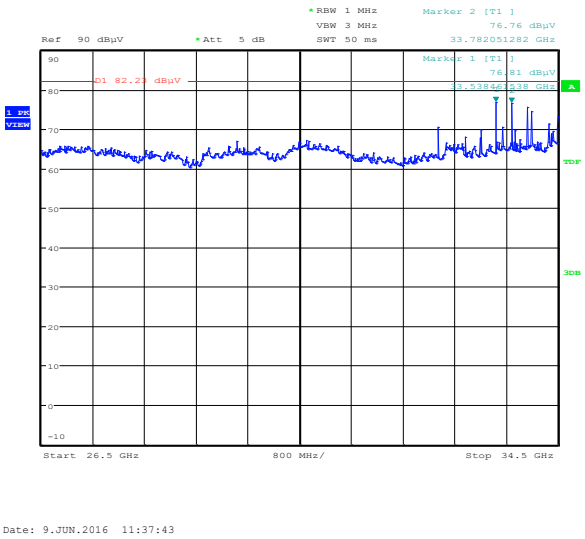


Figure 8.4-4: *Spurious emissions within 26.5–34.5 GHz*

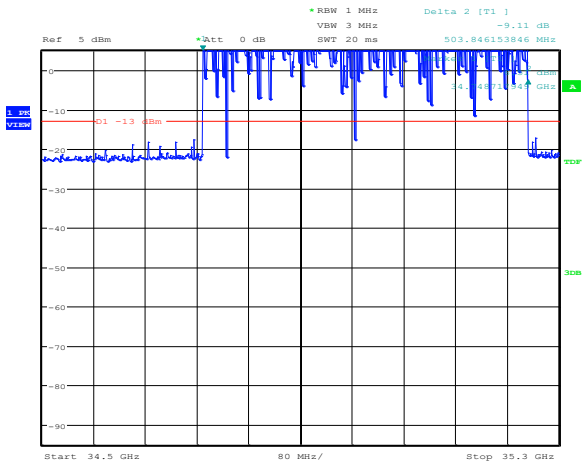


Figure 8.4-5: *Spurious emissions within 34.5–35.3 GHz*

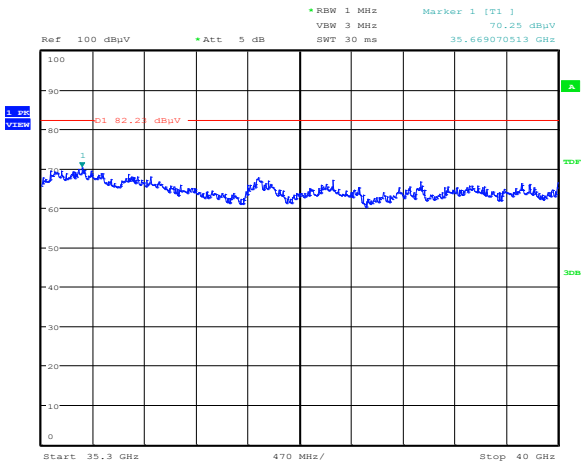


Figure 8.4-6: *Spurious emissions within 35.3–40 GHz*

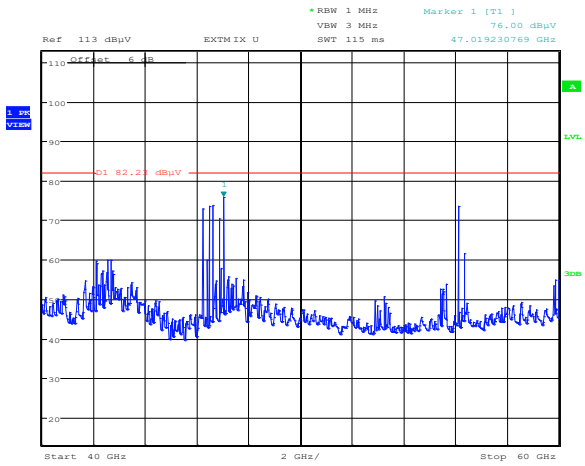


Figure 8.4-7: *Spurious emissions within 40–60 GHz*

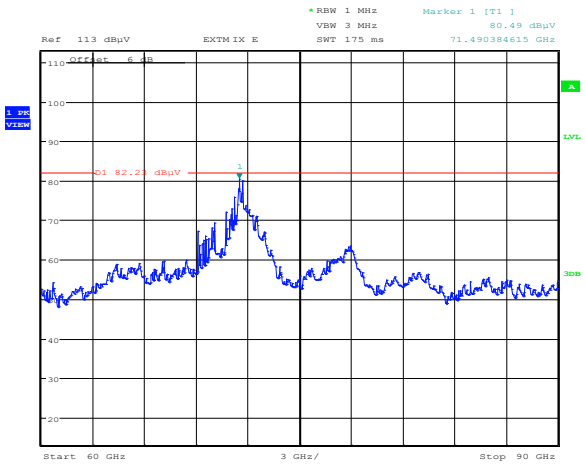


Figure 8.4-8: *Spurious emissions within 60–90 GHz*

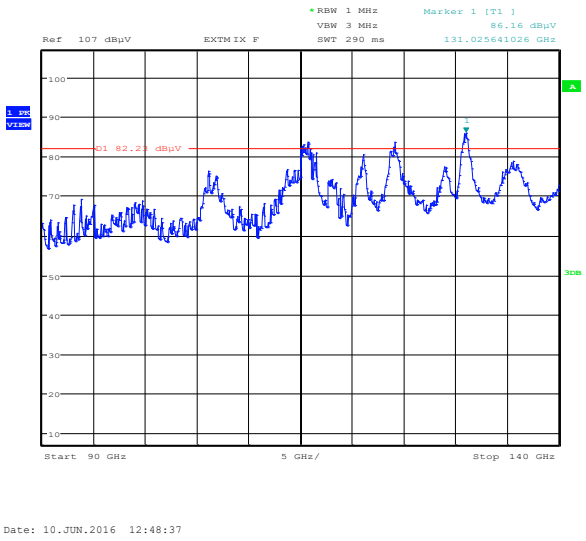


Figure 8.4-9: *Spurious emissions within 90–140 GHz*

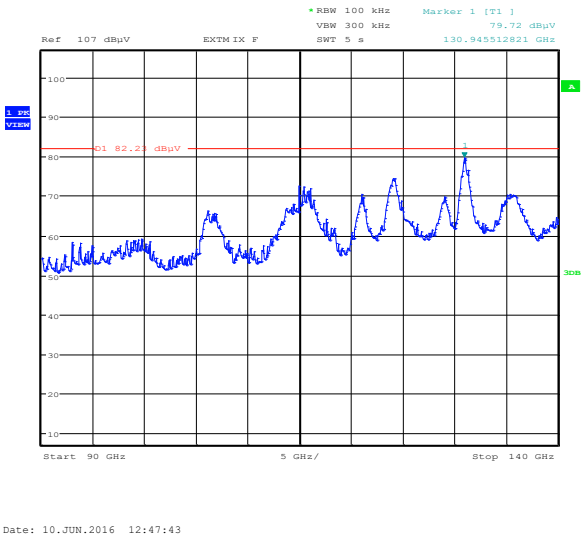


Figure 8.4-10: *Spurious emissions within 90–140 GHz (reduced RBW to increase receiver sensitivity)*

Note: Since the potential harmonics would have a narrow band characteristics, reduction of the RBW shouldn't change much their level, unlike the surrounding noise floor (wideband type of noise) which will be dropped substantially. The above plots show that there are no spurious emissions below the noise floor peaks that exceeded the limit line with 1 MHz RBW.

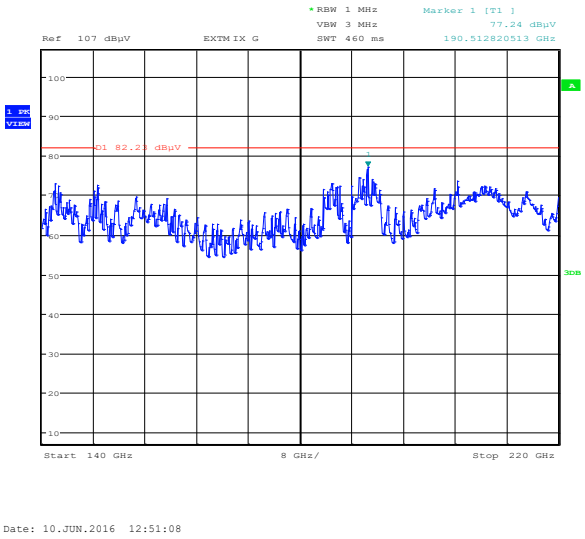


Figure 8.4-11: *Spurious emissions within 140–220 GHz*

8.5 FCC 2.1055 Frequency stability

8.5.1 Definitions and limits

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From −30 °C to +50 °C for all equipment except that specified in paragraphs (a)(2) and (3) of this section
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° C through the range.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

8.5.2 Test summary

Test date	June 9, 2016	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.5.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	50 Hz
Video bandwidth	200 Hz
Frequency span	5 kHz
Detector mode	Peak

8.5.4 Test data

Table 8.5-1: *Frequency drift measurement results*

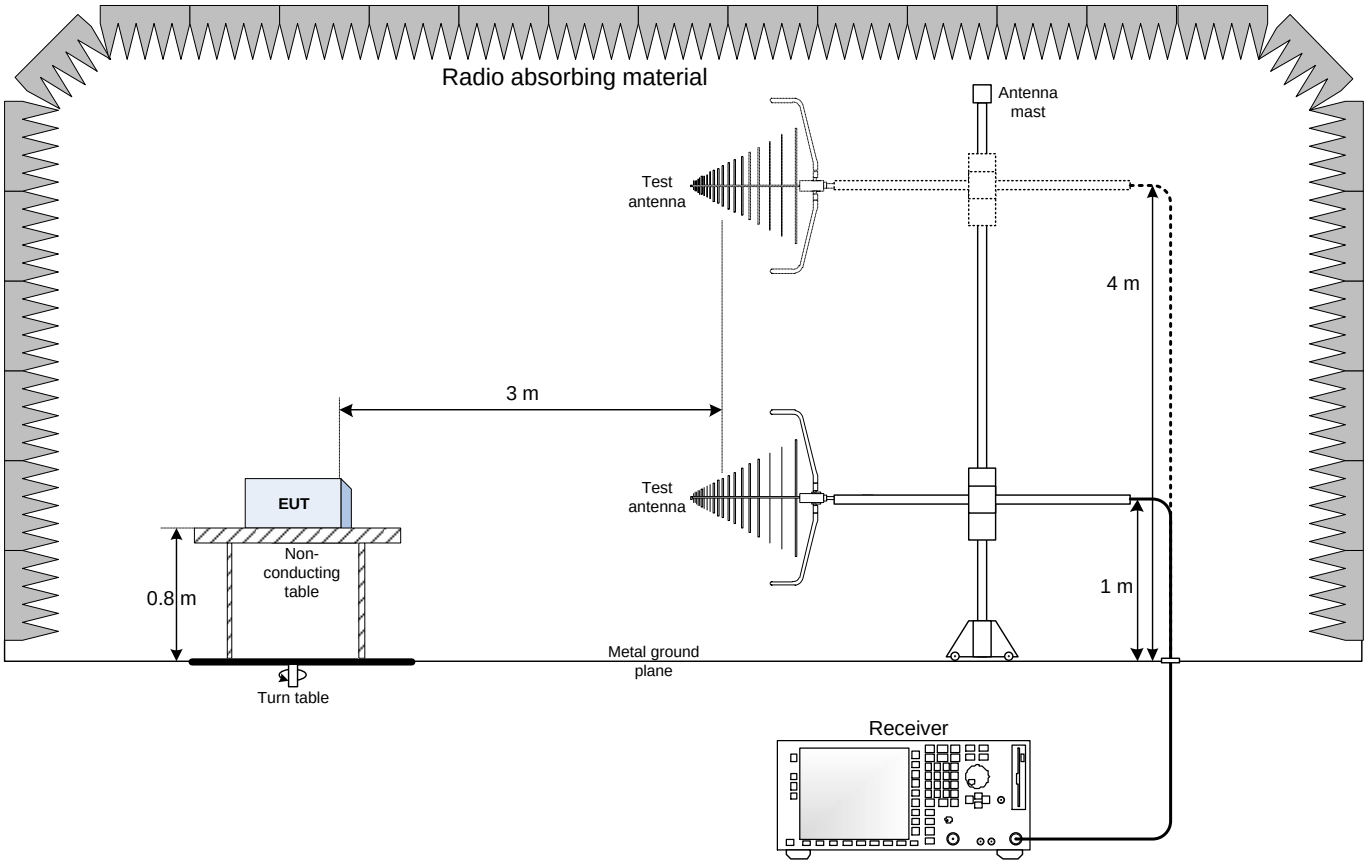
Test conditions	Frequency, GHz	Offset, ppm
+50 °C, Nominal	34.999981322	-0.09202861
+40 °C, Nominal	34.999985970	0.04077145
+30 °C, Nominal	34.999986843	0.06571431
+20 °C, +15 %	34.999985192	0.01854287
+20 °C, Nominal	34.999984543	Reference
+20 °C, -15 %	34.999985753	0.03457144
+10 °C, Nominal	34.999980929	-0.10325719
0 °C, Nominal	34.999988462	0.11197148
−10 °C, Nominal	34.999998558	0.40042875
−20 °C, Nominal	35.000006066	0.61494313
−30 °C, Nominal	35.000010833	0.75114319

Note: Offset was calculated as per the following formula:

$$\frac{F_{Measured} - F_{reference}}{F_{reference}} \times 1 \cdot 10^{6}$$

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