

WIRELESS TEST REPORT – 381042-2TRWL

Applicant:

Satcube AB

Product:

Portable satellite terminal

Model:

Satcube Ku

FCC ID:

2AUV4SATCUBEKU

Specifications:

FCC 47 CFR Part 25

FCC 47 CFR Part 15 Subpart C, §15.247

Date of issue: September 27, 2020

Andrey Adelberg, Senior EMC/Wireless Specialist

Tested by



Signature

David Duchesne, Senior EMC/Wireless Specialist

Reviewed by



Signature

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada.
The tests included in this report are within the scope of this accreditation

Lab locations

Company name	Nemko Canada Inc.			
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Test site registration	Organization	Recognition numbers and location		
	FCC/ISED	CA2040 (Ottawa/Almonte); CA2041 (Montreal); CA0101 (Cambridge)		
Website	www.nemko.com			

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 contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 25	Satellite communications
FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz

1.2 Exclusions

Only spurious emissions test of two transmitters operating simultaneously was tested.

1.3 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 1.2 above. 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 Test report revision history

Table 1.4-1: Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	September 27, 2020	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

Colocation of two transmitter modules was assessed when Wi-Fi was set to transmit at the middle channel at 2436 MHz and Satellite band at 14.25 GHz

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	30 % – 60 %
Air pressure	86 kPa (860 mbar) – 106 kPa (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.

3.2 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 $\pm 5\%$, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 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 4.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13

Section 5 Summary of test results

5.1 Testing location

Test location (s)	Ottawa
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5.2 Testing period

Test start date	September 25, 2020
Test end date	September 25, 2020

5.3 Sample information

Receipt date	September 23, 2020
Nemko sample ID number	Item # 1

5.4 Test results

Table 5.4-1: Result summary

Part	Test description	Verdict
§15.247(d)	Spurious emissions	Pass
25.202(f)	Emission limits	Pass

5.5 Technical information

All used IC test site(s) Reg. number	2040A-4
Frequency range, GHz	Sat: Transmit: 13.75 to 14.5, Receive: 10.95 to 12.75, Wi-Fi: 2400–2483.5 MHz
Test frequencies, GHz	Sat: 14.25, Wi-Fi: 2.436
Types of modulation	Sat: QPSK ¼, 8PSK ¼ and 16APSK ¼, Wi-Fi: OFDM
Channel bandwidth	Sat: 10, 7.5, 5 and 2.5, Wi-Fi: 20 MHz
RF power Max (W)	Sat:20 (43 dBm)
Measured BW (MHz) (99 %)	Sat:9
Calculated BW (kHz), as per TRC-43	N/A
Power requirements	24 V _{DC} (Via AC/DC adapter 100 – 240 V _{AC} , 47 – 63 Hz, 150 W)
Antenna information	Tx antenna gain = 31.2 dBi @ 13.75 GHz, 32 dBi @ 14.25 GHz, and 31.9 dBi @ 14.5 GHz

Section 6 Information provided by the applicant

6.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

6.2 Applicant

Company name	Satcube AB
Address	Box 7111 SE-40232 Gothenburg, Sweden

6.3 Manufacturer

Company name	Satcube AB
Address	Anders Carlssons gata 7, SE-41755 Gothenburg, Sweden

6.4 EUT information

Serial number	000021
Description/theory of operation	The EUT is a portable satellite terminal that provides broadband connectivity.
HW version	1.0.0
SW version	0.4.24

6.5 EUT setup details

6.5.1 EUT test configuration

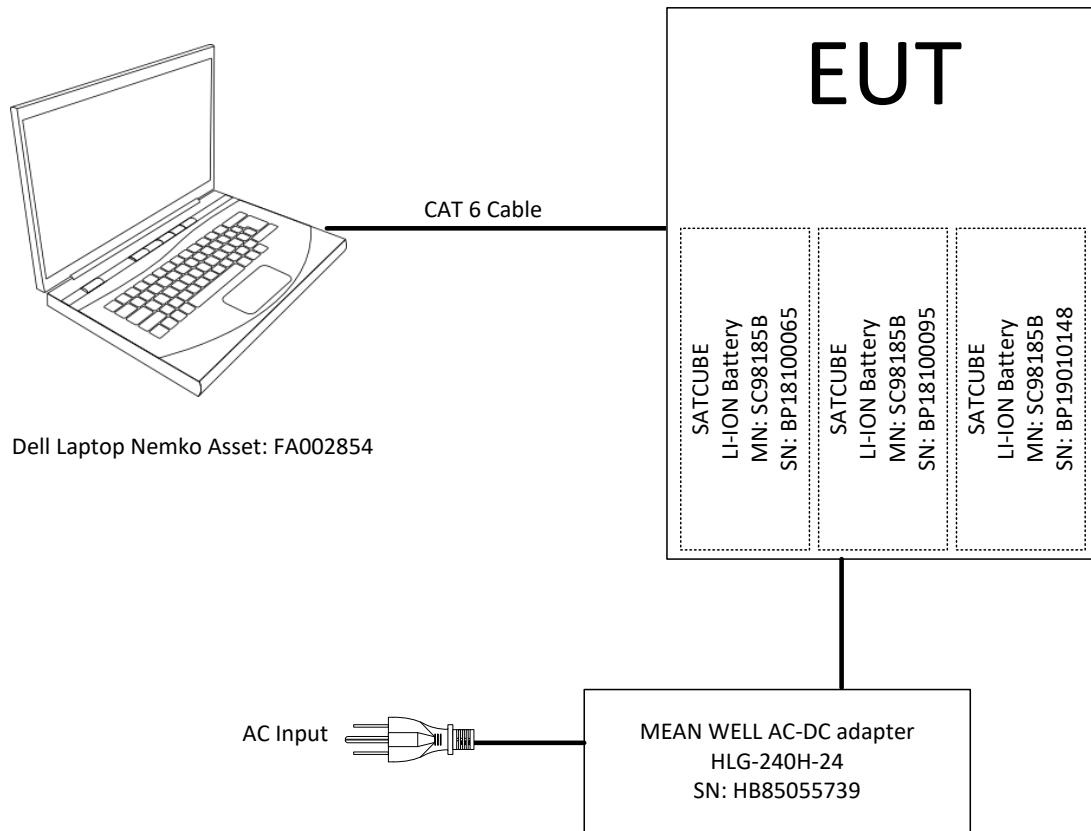


Figure 6.5-1: block diagram

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	January 24, 2021
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 8, 2020
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	January 14, 2021
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	October 31, 2020
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	November 7, 2020
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
50 Ω coax cable	C.C.A.	None	FA002556	1 year	April 9, 2021
50 Ω coax cable	Huber + Suhner	None	FA003099	1 year	April 9, 2021
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	October 31, 2020

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

Section 8 Testing data

8.1 Spurious emission limits

8.1.1 Definitions and limits

§25.202

(f) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section.

- (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
- (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
- (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts (−13 dBm fixed);

FCC §15.247:

- (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Table 8.1-1: FCC §15.209 – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	μV/m	dBμV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

Definitions and limits, continued

Table 8.1-2: FCC restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.1.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	September 25, 2020

8.1.3 Observations, settings and special notes

- **Test Method:** KDB 971168 D01 Power Meas License Digital Systems v03r01
- **Test procedure used:** ANSI C63.26-2015-Section 5.7
- Spurious radiation (enclosure) was scanned from 30 MHz to 40 GHz.

Spectrum analyser settings:

Resolution bandwidth:	100kHz for below 1GHz or 1MHz for above 1GHz
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Sweep time:	Auto couple
Trace mode:	Max-hold

8.1.4 Test data

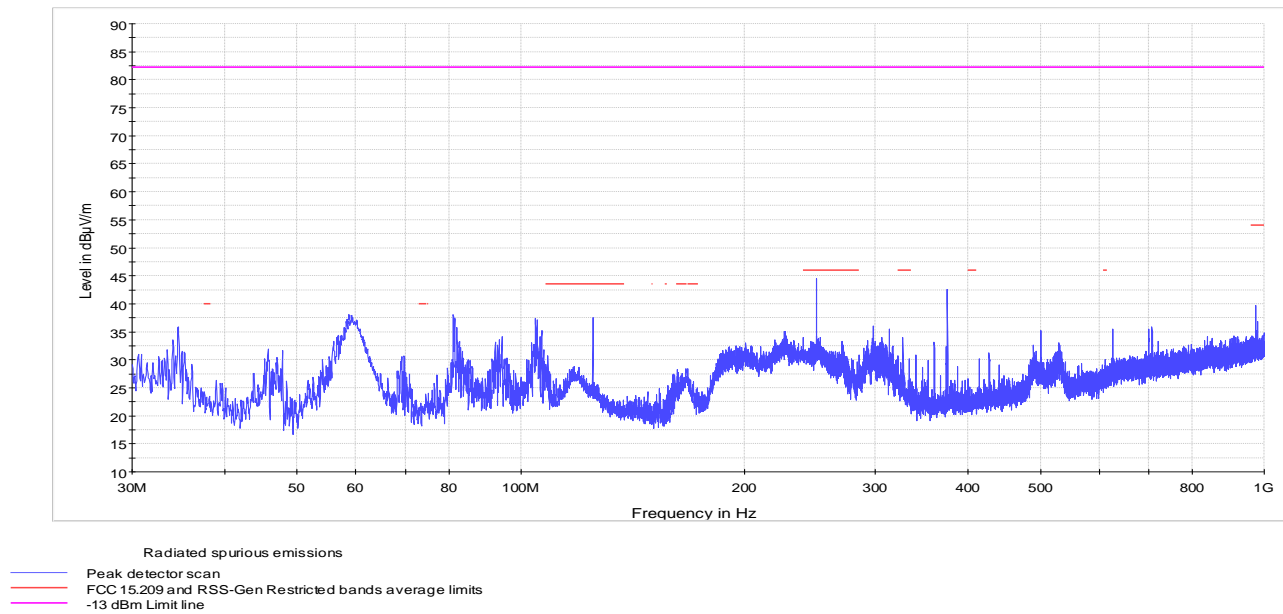


Figure 8.1-1: Radiated spurious emissions co-location test below 1 GHz

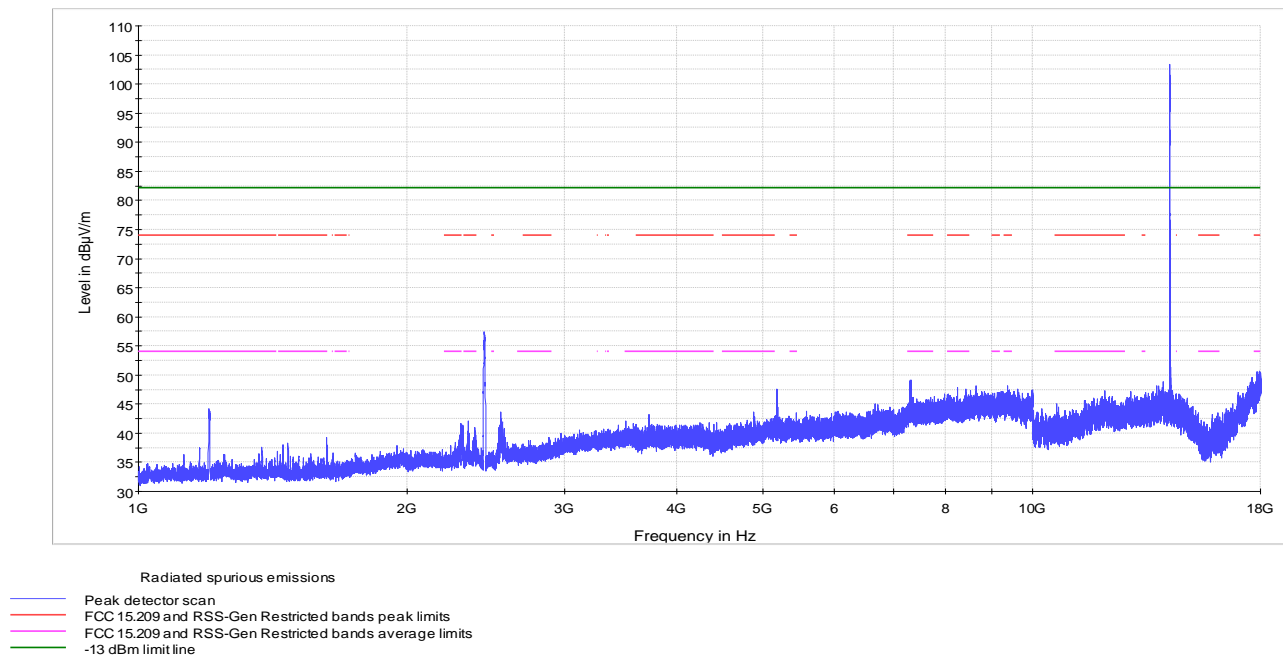


Figure 8.1-2: Radiated spurious emissions co-location test within 1–18 GHz

Note: Emission at 2436 MHz is the fundamental of Wi-Fi module and 14.25 GHz is fundamental of Satellite transmitter.

8.1.4 Test data, continued

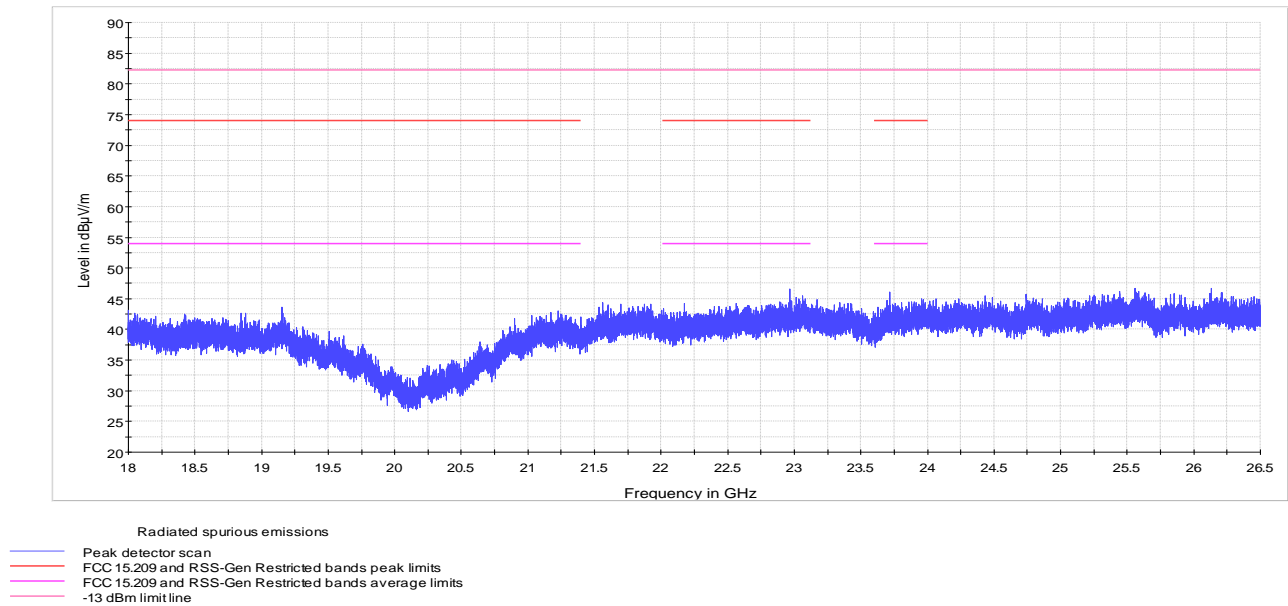


Figure 8.1-3: Radiated spurious emissions co-location test within 18–26.5 GHz

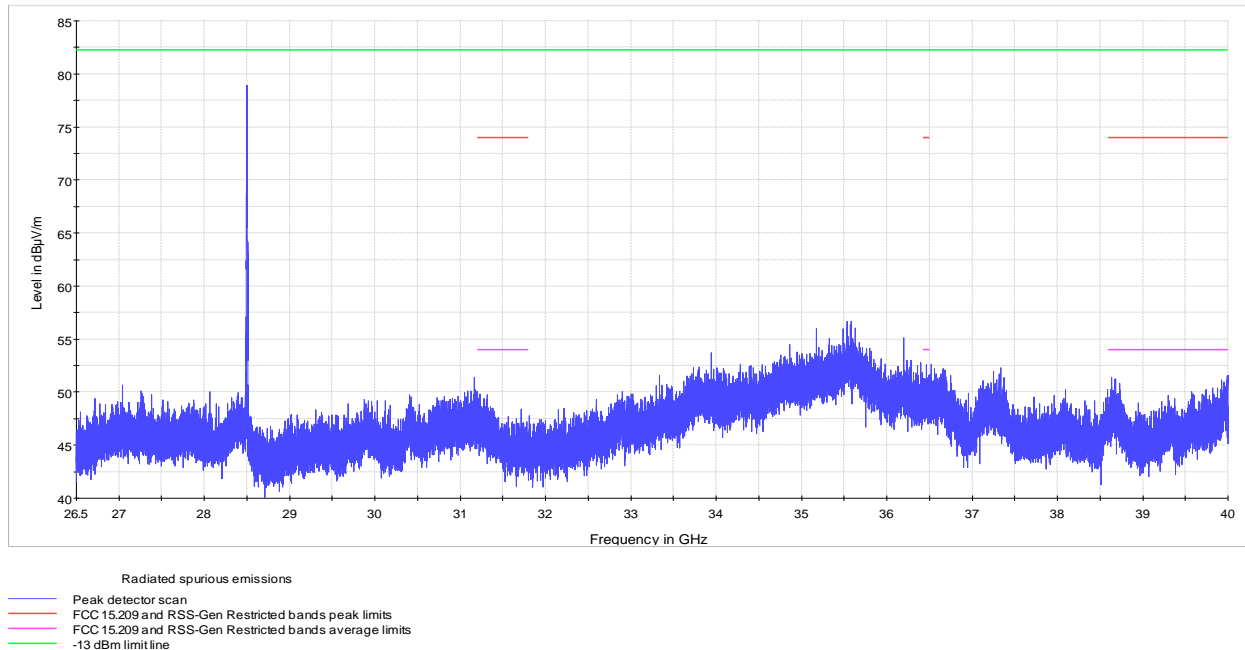


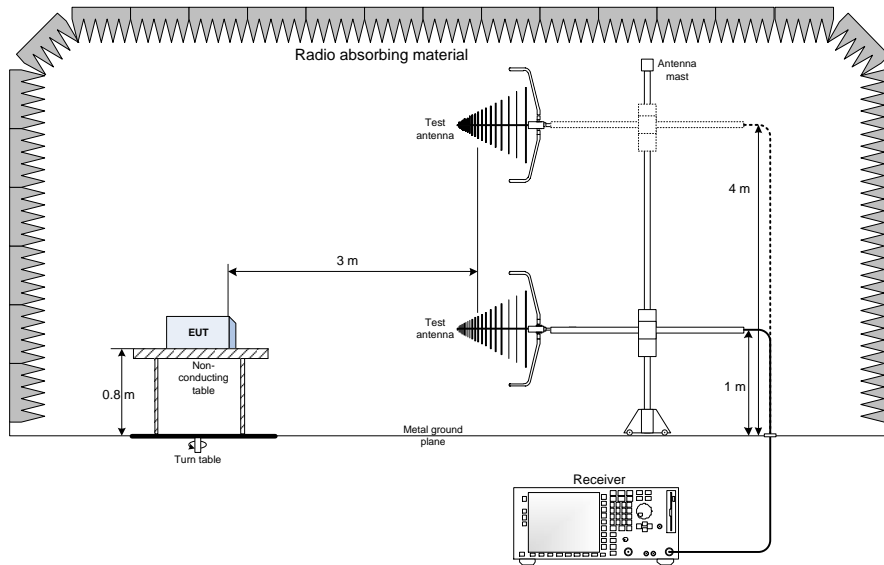
Figure 8.1-4: Radiated spurious emissions co-location test within 26.5–40 GHz

Note: emission at 28.5 GHz is the second harmonic of Satellite transmission.

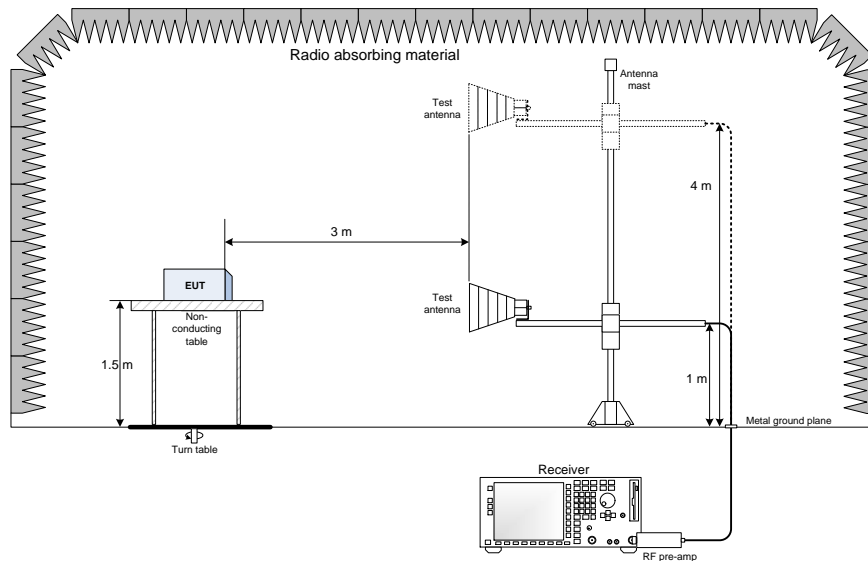
All other spurious radiation emissions were greater than 10 dB below the limit.

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



Note: RF absorbers were placed on the floor to comply with the FCC Part 15 setup requirements.

End of report