

TEST REPORT

Test Report No.: 1-0001/15-01-22



Deutsche
Akkreditierungsstelle
D-PL-12076-01-00

Testing Laboratory

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Accredited Test Laboratory:

The testing laboratory (FCC part 15 D) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS). The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-00

Applicant

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 Phone: +49 5130 600-1465

Manufacturer

Sennheiser electronic GmbH & Co. KG
 Am Labor 1
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 GERMANY

Test Standard/s

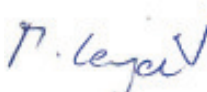
FCC Part 15, subpart D	Isochronous UPCS Device 1920 – 1930 MHz
Industry Canada RSS-213, Issue 2	2 GHz Licence-exempt Personal Communication Service Devices (LE-PCS)

Test Item

Kind of test item:	DECT Portable Part
Model name:	TC-W Satellite
FCC ID:	DMOTCWS
IC:	2099A-TCWS
S/N serial number:	1455000720
HW hardware status:	563807-05 Slave
SW software status:	System: 04.04.01; DECT: 03.01.03.61042
Frequency [MHz]:	1920 -1930
Type of Modulation:	Digital (Gaussian Frequency Shift Keying)
Number of channels:	5 RF Channels, 5x12 = 60 TDMA Duplex Channels
Antenna:	2 ceramic antennas
Power Supply:	Lithium-Ion battery, 3.7 V
Temperature Range:	-20°C to 50°C



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1 Table of contents

1	Table of contents	2
2	General information	4
2.1	Notes and disclaimer	4
2.2	Application details	4
3	Test standard/s:.....	4
4	Test Environment	5
5	Test Item.....	5
6	RSP100 Test report Cover Sheet/Performance Test Data.....	6
7	Summary of Measurement Results	7
8	Test Set-up.....	8
8.1	Frequency Measurements	8
8.2	Timing Measurements	8
8.3	Conducted Emission Test	8
8.4	Radiated Emission Test.....	9
8.5	Power Line Conducted Emissions Test.....	9
8.6	Monitoring Tests.....	10
8.7	Radiated Output Power Test	10
9	Detailed Test Results	11
9.1	Power Line Conducted Emissions	11
9.2	Coordination with fixed microwave.....	14
9.3	Digital Modulation Techniques	14
9.4	Labeling Requirements.....	14
9.5	Antenna Requirements	15
9.6	Channel Frequencies	15
9.7	Automatic Discontinuation of Transmission.....	16
9.8	Peak Power Output	17
9.9	Emission Bandwidth B	21
9.10	Power Spectral Density.....	24
9.11	In-Band Unwanted Emissions, Conducted	27
9.12	Out-of-Band Emissions, Conducted	30
9.13	Carrier Frequency Stability.....	34
9.14	Frame Repetition Stability	35
9.15	Frame Period and Jitter.....	35
9.16	Monitoring Threshold, Least Interfered Channel	37
9.17	Threshold Monitoring Bandwidth	39
9.18	Reaction Time and Monitoring Interval	40
9.19	Time and Spectrum Window Access Procedure	42
9.20	Acknowledgments and Transmission duration.....	43
9.21	Dual Access Criteria Check	45
9.22	Alternative monitoring interval.....	46
9.23	Spurious Emissions (Radiated).....	46
9.24	Receiver Spurious Emissions	49
10	Test equipment and ancillaries used for tests.....	52
11	Observations	53
	Annex A: Photographs of the Test Set-up	54
	Annex B: External Photographs of the EUT	55
	Annex C: Internal Photographs of the EUT	56
	Annex D: Document History	58



Annex E: Further Information.....59

Annex F: Accreditation Certificate60

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2015-10-22
Date of receipt of test item:	2015-10-28
Start of test:	2015-10-29
End of test:	2016-01-14
Person(s) present during the test:	/

3 Test standard/s:

Test Standard	Version	Test Standard Description
FCC Part 15, subpart D	2014-01	Isochronous UPCS Device 1920 – 1930 MHz
Industry Canada RSS-213, Issue 2	2005-12	2 GHz Licence-exempt Personal Communication Service Devices (LE-PCS)

4 Test Environment

Temperature: + 22 °C during room temperature tests
+ 50 °C during high temperature test
- 20 °C during low temperature test

Relative humidity content: 38 %

Air pressure: not relevant for this kind of testing

Power supply: Lithium-ion battery, 3.7 V

5 Test Item

Kind of test item	:	UPCS Portable station
Type identification	:	TC-W Satellite (Portable Part)
S/N serial number	:	1455000720
HW hardware status	:	563807-05 Slave
SW software status	:	System: 04.04.01; DECT: 03.01.03.61042
Power Supply	:	Lithium-Ion battery, 3.7 V
Temperature Range	:	-20°C to 50°C

6 RSP100 Test report Cover Sheet/Performance Test Data

Test Report Number	:	1-0001/15-01-22
Equipment Model Number	:	TC-W Satellite (Portable Part)
Certification Number	:	2099A-TCWS
Manufacturer	:	Sennheiser electronic GmbH & Co. KG
Tested to Radio Standards Specification (RSS) No.	:	RSS-213 Issue 2
Open Area Test Site Industry Canada Number	:	IC 3462C-1
Frequency Range (or fixed frequency)	:	1921.536 – 1928.448 MHz
RF Power [W] (max)	:	Conducted: 20.4 dBm, 109.6 mW Rad. EIRP: 22.9 dBm, 195.0 mW
Occupied Bandwidth (99% BW)	:	1.26MHz
Type of Modulation	:	Digital (Gaussian Frequency Shift Keying)
Emission Designator (TRC-43)	:	1M26F1D
Antenna information	:	2 ceramic antennas, no ext. connector
Transmitter Spurious (worst case)	:	-40.6 dBm
Receiver Spurious (worst case)	:	-70.0 dBm

ATTESTATION:

DECLARATION OF COMPLIANCE: I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above-mentioned Industry Canada standard(s); and that the equipment identified in this application has been subjected to all the applicable test conditions specified in the Industry Canada standards and all of the requirements of the standard have been met.

Signature:



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Date: 2016-01-14

Test engineer: Joachim Wolf

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Germany

7 Summary of Measurement Results

☒	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained

CFR 47 Part 15 UPCS

Name of test	FCC CFR 47 Paragraph	IC RSS-213 Paragraph	Verdict
Coordination with fixed microwave	15.307(b)	N/A	Complies
Digital Modulation Techniques	15.319(b)	6.1	Complies
Labeling requirements	15.19(a)(3)	RSS-GEN 5.2	Complies
Antenna requirements	15.317, 15.203	4.1(e)	Complies
Power Line Conducted Emission	15.107(a), 15.207(a)	6.3 RSS_GEN 7.2.2	Complies
Emission Bandwidth	15.323(a)	6.4	Complies
In-band Emission	15.323(d)	6.7.2	Complies
Out-of-band Emissions	15.323(d)	6.7.1	Complies
Peak Transmit Power	15.319(c)(e), 15.31(e)	6.5	Complies
Power Spectral Density	15.319(d)	4.3.2.1	Complies
Automatic discontinuation of transmission	15.319(f)	4.3.4(a)	Complies
Carrier frequency stability	15.323(f)	6.2	Complies
Frame repetition stability	15.323(e)	4.3.4(c)	Complies
Frame period and jitter	15.323(e)	4.3.4(c)	Complies
Monitoring threshold, Least interfered channel	15.323(c)(2);(5); (9)	4.3.4(b)	Complies
Monitoring of intended transmit window and maximum reaction time	15.323(c)(1)	4.3.4	Complies
Threshold monitoring bandwidth	15.323(c)(7)	4.3.4	Complies
Reaction time and monitoring interval	15.323(c)(1);(5); (7)	4.3.4	Complies
Access criteria test interval	15.323(c)(4);(6)	4.3.4	N/A ¹
Access criteria functional test	15.323(c)(4);(6)	4.3.4	N/A ¹
Acknowledgments	15.323(c)(4)	4.3.4	Complies
Transmission duration	15.323(c)(3)	4.3.4	Complies
Dual access criteria	15.323(c)(10)	4.3.4	N/A ⁵
Alternative monitoring interval	15.323(c)(10);(11)	4.3.4	N/A ²
Spurious Emissions (Antenna Conducted)	15.323(d)	6.7.1	Complies ³
Spurious Emissions (Radiated)	15.319(g), 15.109(a), 15.209(a)	4.3.3 RSS-GEN 7.2.3	Complies ⁴
Receiver Spurious Emissions	N/A	6.8	Complies

¹ Only applicable for EUT that can initiate a communication link

² The client declares that the tested equipment does not implement this provision

³ The tested equipment has integrated antennas only

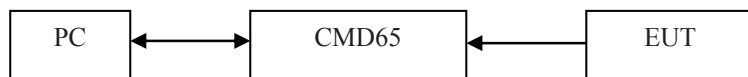
⁴ Only requirement FCC 15.109 for unintentional radiators was tested radiated

⁵ Only applicable for EUT that supports duplex channels

8 Test Set-up

8.1 Frequency Measurements

Test Set-up 1:



This setup is used for measuring Carrier Frequency Stability at nominal and extreme temperatures.

For long term Frequency Stability, the EUT was in loopback-mode and was controlled with the CMD65, the modulation pattern was set to 01010101....

8.2 Timing Measurements

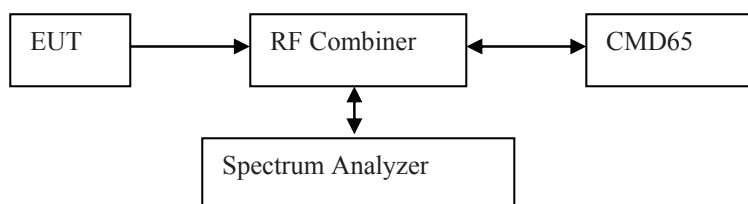
Test Set-up 2:



This setup is used for measuring Frame Repetition Stability, Frame Period and Jitter.

8.3 Conducted Emission Test

Test Set-up 3:



This setup is used for all conducted emission tests.

The EUT was in loopback-mode and was controlled with the CMD65, the modulation pattern was set to Pseudo-Random bit sequence to simulate normal speech.

8.4 Radiated Emission Test

Test Set-up 4:

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 20 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform with specifications ANSI C63.2-1987 clause 15 and ANSI C63.4-2003 clause 4.1.5. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63-4-2003 clause 4.2.

Antennas are conform with ANSI C63.2-1996 item 15.

9 kHz - 150 MHz: Quasi Peak measurement, 200 Hz Bandwidth, passive loop antenna.

150 kHz - 30 MHz: Quasi Peak measurement, 9 kHz Bandwidth, passive loop antenna.

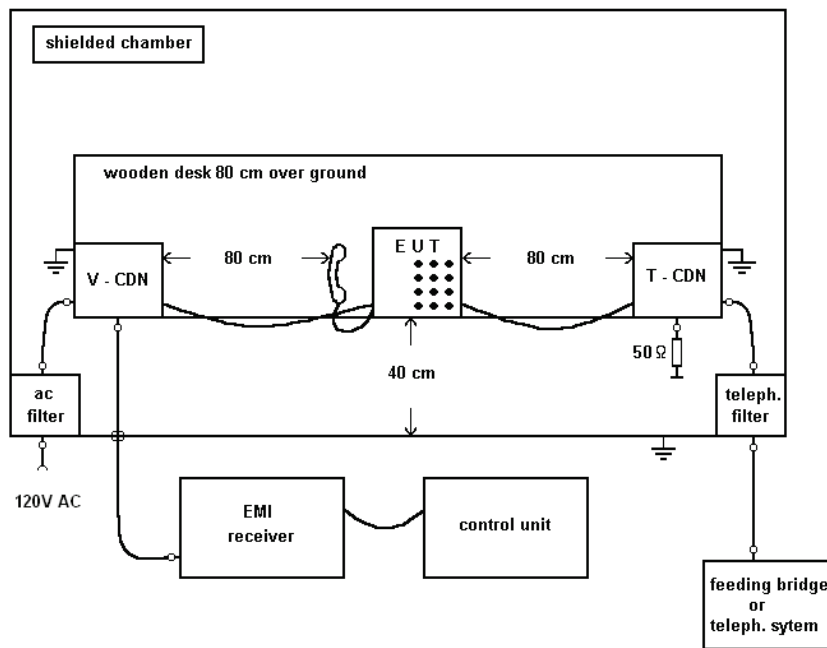
30 MHz - 200 MHz: Quasi Peak measurement, 120 KHz Bandwidth, bilog antenna

200MHz - 1GHz: Quasi Peak measurement, 120 KHz Bandwidth, bilog antenna

1GHz: Average, RBW 1MHz, VBW 10 MHz, waveguide horn

8.5 Power Line Conducted Emissions Test

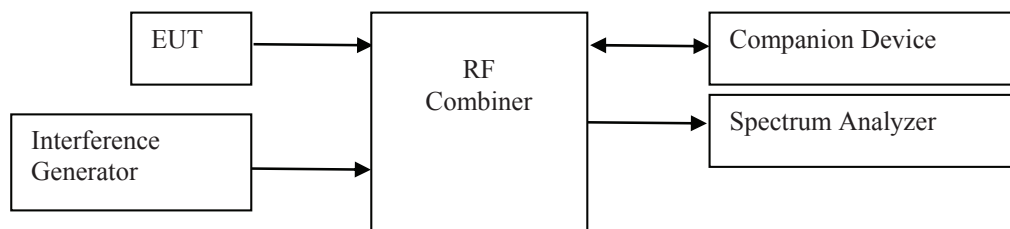
Test Set-up 5:



principle set up: conducted emission at ac power line

8.6 Monitoring Tests

Test Set-up 6:

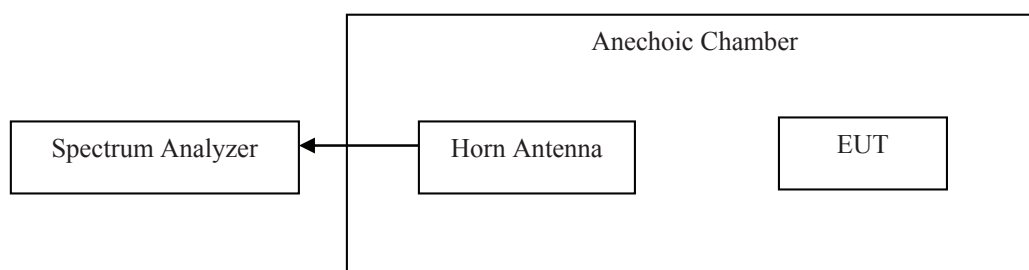


This test setup is used for all Monitoring and Time and Spectrum Access Procedure tests. The path loss from the signal generator to the EUT is measured with a power meter before the testing is started.

A clock signal is used to synchronize the Interference Generator to the start of the DECT frame, this signal always comes from the base station. If the EUT is a DECT Portable Part (i.e. a handset) the clock signal will come from the Companion Device.

8.7 Radiated Output Power Test

Test Set-up 7:



This setup is used for measuring the radiated output power in a fully anechoic chamber with a measurement distance of 1m.

9 Detailed Test Results

9.1 Power Line Conducted Emissions

Measurement Procedure:

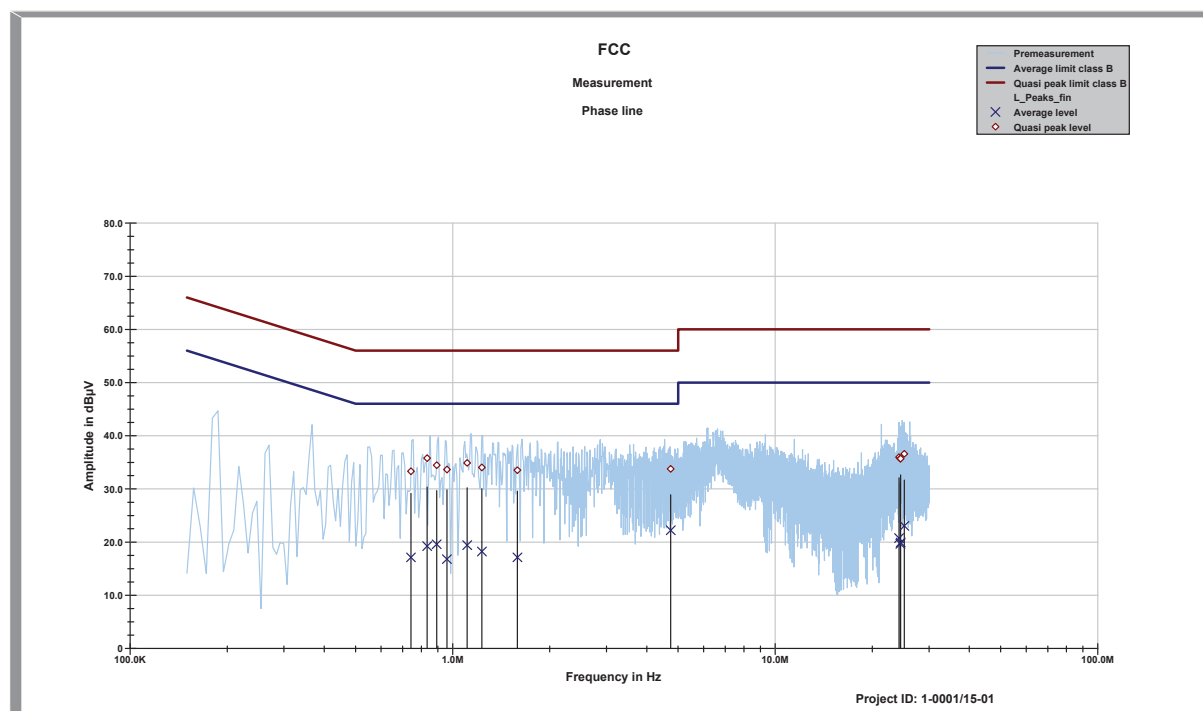
ANSI C63.4-2003 using 50 μ H/50 ohms LISN.

Test Result: N/A

Measurement Data:

Requirement: FCC 15.207 (a)

Idle mode, phase line



FCC

Phase line tbl

Project ID: 1-0001/15-01

12:43:57 PM, Monday, November 23, 2015

Frequency	Quasi peak level	Margin quasi peak	Average level	Margin average
MHz	dBµV	dBµV	dBµV	dBµV
0.74235	33.31	22.69	17.11	28.89
0.83326	35.79	20.21	19.23	26.77
0.89207	34.45	21.55	19.58	26.42
0.95942	33.63	22.37	16.77	29.23
1.10927	34.89	21.11	19.40	26.60
1.2319	34.03	21.97	18.23	27.77
1.587	33.51	22.49	17.11	28.89
4.7396	33.74	22.26	22.20	23.80
24.186	35.95	24.05	20.73	29.27
24.414	35.67	24.33	19.65	30.35
24.466	35.67	24.33	19.92	30.08
25.13	36.60	23.40	23.03	26.97

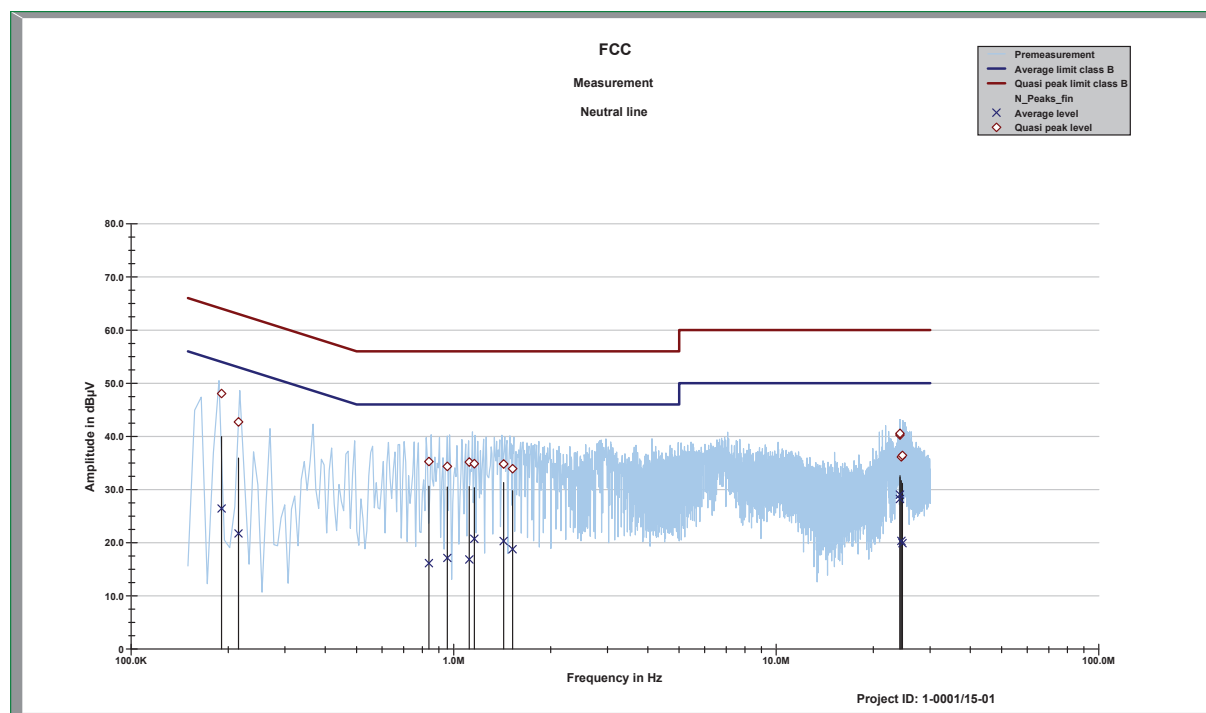
Project ID - 1-0001/15-01

EUT - MooX System (TC-W)

Serial Number - divers

Operating mode - charging

Idle mode, neutral line



FCC

Neutral line tbl

Project ID: 1-0001/15-01

12:43:57 PM, Monday, November 23, 2015

Frequency	Quasi peak level	Margin quasi peak	Average level	Margin average
MHz	dBµV	dBµV	dBµV	dBµV
0.19074	48.06	15.95	26.43	28.41
0.21529	42.71	20.29	21.72	32.41
0.83814	35.25	20.75	16.14	29.86
0.95548	34.34	21.66	17.11	28.89
1.11756	35.15	20.85	16.84	29.16
1.15908	34.86	21.14	20.71	25.29
1.4287	34.80	21.20	20.30	25.70
1.5222	33.90	22.10	18.77	27.23
24.181	40.24	19.76	29.01	20.99
24.183	40.54	19.46	28.22	21.78
24.42	36.12	23.88	20.33	29.67
24.612	36.41	23.59	19.90	30.10

Project ID - 1-0001/15-01

EUT - MooX System (TC-W)

Serial Number - divers

Operating mode - charging

9.2 Coordination with fixed microwave

The affidavit from UTAM, Inc. is included in the documentation supplied by the applicant:

☒ Yes

☐ No

Requirement: FCC 15.307 (b):

Each application for certification of equipment operating under the provisions of this Subpart must be accompanied by an affidavit from UTAM, Inc. certifying that the applicant is a participating member of UTAM, Inc. In the event a grantee fails to fulfill the obligations attendant to participation in UTAM, Inc., the commission may invoke administrative sanctions as necessary to preclude continued marketing and installation of devices covered by the grant of certification, including but not limited to revoking certification.

9.3 Digital Modulation Techniques

The tested equipment is based on DECT technology, the only difference is that the channel allocation is modified to operate in the 1920-1930 MHz band.

The EUT use Multi Carrier / Time Division Multiple Access / Time division duplex and Digital GFSK modulation.

For further details see the operational description provided by the applicant.

Requirement: FCC 15.319(b)

All transmissions must use only digital modulation techniques.

9.4 Labeling Requirements

See separate documents showing the label design and the placement of the label on the EUT.

Requirement: FCC 15.19

The FCC identifier shall be displayed on the label, and the device(s) shall bear the following statement in a conspicuous location on the device or in the user manual if the device is too small:

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The label itself shall be of a permanent type, not a paper label, and shall last the lifetime of the equipment.

9.5 Antenna Requirements

Does the EUT have detachable antenna(s)?

☐ Yes

☒ No

If detachable, is the antenna connector(s) non-standard?

☐ Yes

☐ No

The tested equipment has only integral antennas. The conducted tests were performed on a sample with a temporary antenna connector.

Requirements: FCC 15.203, 14.204. 15.317

9.6 Channel Frequencies

UPCS CHANNEL	FREQUENCY (MHz)
Upper Band Edge	1930.000
0 (Highest)	1928.448
1	1926.720
2	1924.992
3	1923.264
4 (Lowest)	1921.536
Lower Band Edge	1920.000

Requirement: FCC 15.303(d), (g)

Within 1920-1930 MHz band for isochronous devices.

9.7 Automatic Discontinuation of Transmission

Does the EUT transmit control and Signaling Information?	☐ Yes	☒ No
Type of EUT:	☒ Initiating device	☐ Responding device

The following tests simulate the reaction of the EUT in case of either absence of information to transmit or operational failure after a connection with the companion device is established.

Number	Test	EUT Reaction	Verdict
1	Power removed from EUT	C	Pass
2	EUT switched Off	C	Pass
3	Hook-On by companion device	N/A	N/A
4	Hook-On by EUT	N/A	N/A
5	Power removed from companion device	A	Pass
6	Companion device switched Off	A	Pass

- A – Connection breakdown, Cease of all transmissions
 B – Connection breakdown, EUT transmits control and signaling information
 C – Connection breakdown, companion device transmits control and signaling information
 N/A – Not applicable (the EUT does not have an on/off switch and can not perform Hook-On)

Requirement: FCC 15.319(f)

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. This provision is not intended to preclude transmission of control and signaling information or use of repetitive code used by certain digital modulation technologies to complete frame or burst intervals.

9.8 Peak Power Output

Measurement Procedure:

ANSI C63.17, clause 6.1.2.

Test Results: Pass

Measurement Data:

Maximum Conducted Output Power

Channel No.	Frequency (MHz)	Maximum Conducted Output Power (dBm)	Maximum Radiated Output Power (dBm)	Maximum Antenna Gain (dBi)
4	1921.536	20.4	22.9	2.5
2	1924.992	20.4	22.9	2.5
0	1928.448	20.4	22.9	2.5

For this test it was also checked that the input voltage variation of 85 and 115% of nominal value did not have any effect on the measured output power, neither radiated nor conducted.

Limit:

Conducted: $100 \mu\text{W} \times \text{SQRT}(B)$ where B is the measured Emission Bandwidth in Hz

FCC 15.319(c)(e): 20.8 dBm (119 mW)

RSS-213, Issue 2: 20.5 dBm (112 mW)

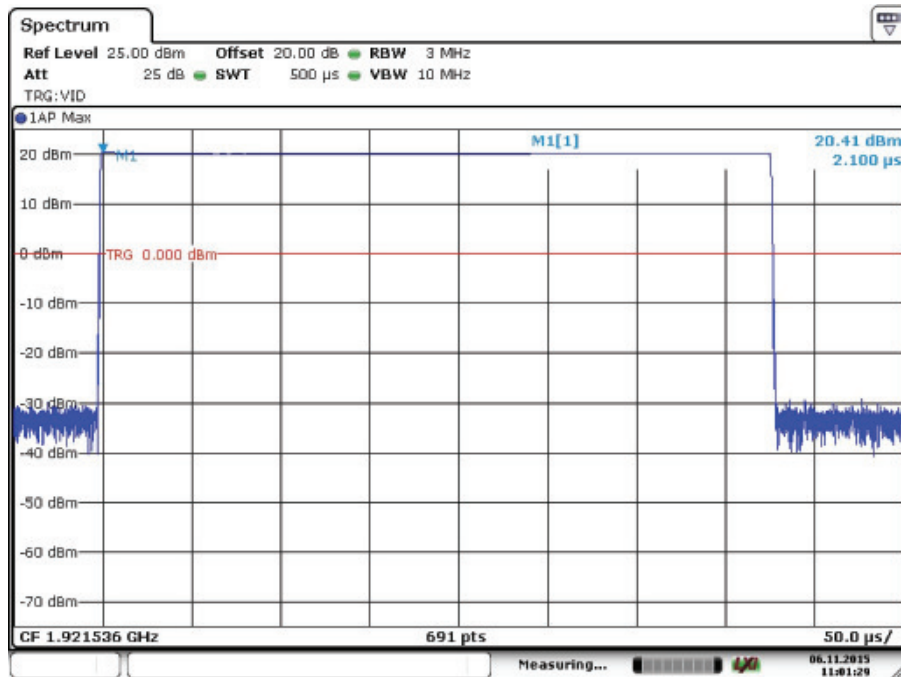
The antenna gain is below 3 dBi.

Requirements: FCC 15.319(f). RSS-213, Issue 2

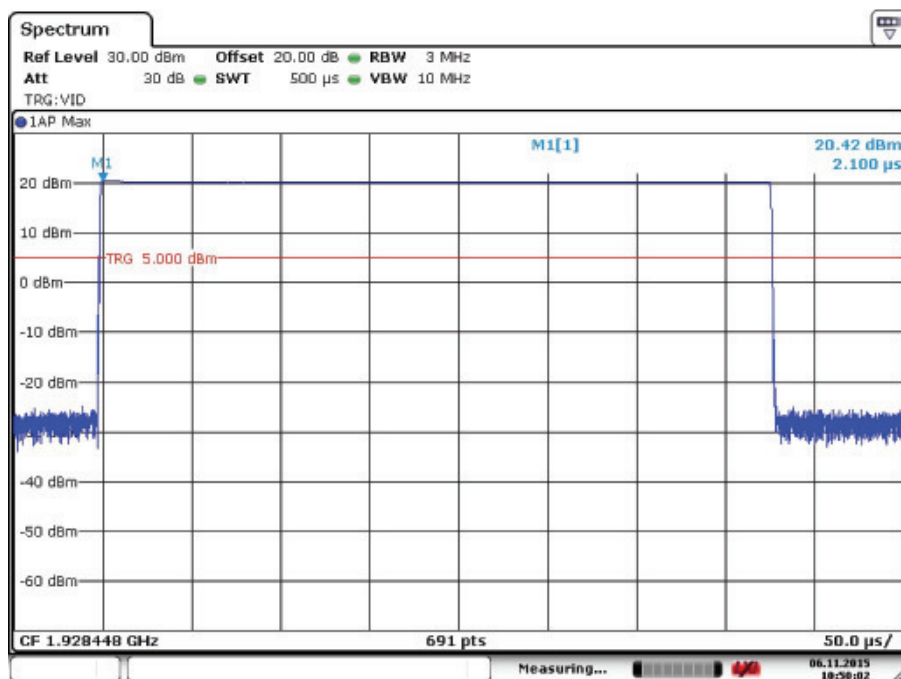
Peak transmit power shall not exceed 100 microwatts multiplied by the square root of the emission bandwidth in Hertz.

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

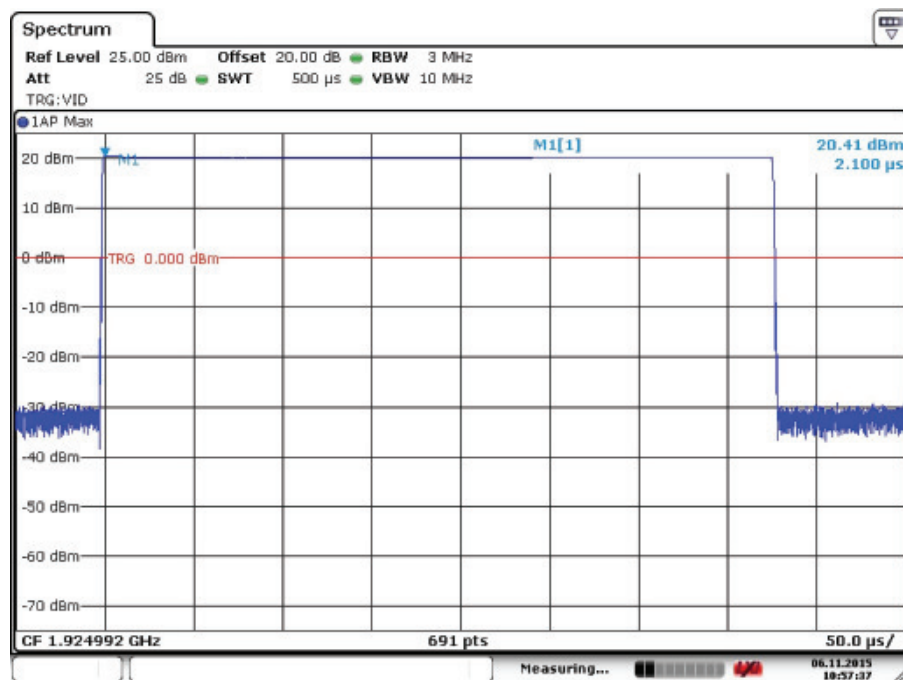
Conducted Peak Output Power



Lower Channel



Upper Channel



Middle Channel

Radiated Peak Output Power

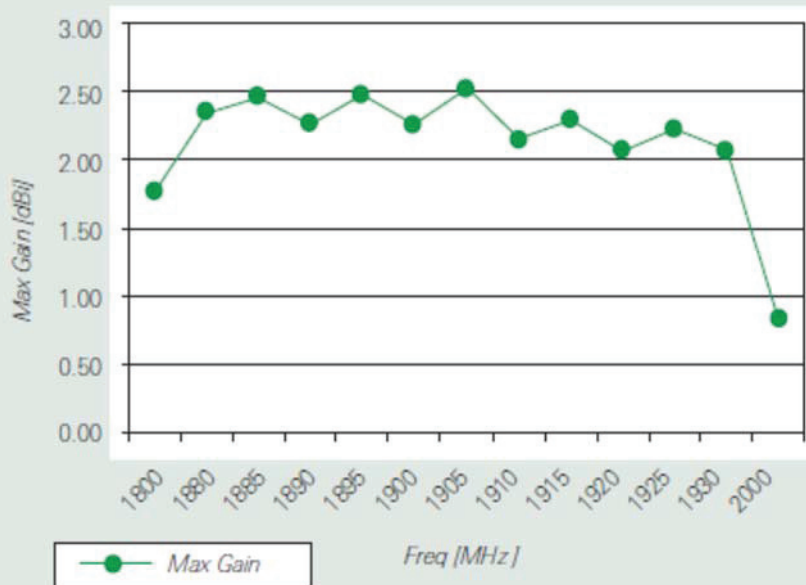
Measured maximum antenna gain: 2.5 dBi

DECT 1.88-1.93 GHz

Typical performance (testboard size 80 x 37 mm, PWB ground clearance area 10.80 x 6.25 mm)

Frequency Range [MHz]	Linear Max Gain [dBi]	Efficiency [%] / [dB]	Return Loss min. [dB]	Impedance [Ω]	Operating Temperature [°C]
1880 – 1930	2.5 (peak) 2 (band edges)	80 / -1 (peak) 70 / -1.55 (band edges)	-12	50	-40 to +85

DECT 1880-1930 MHz



9.9 Emission Bandwidth B

Measurement Procedure:

ANSI C63.17, clause 6.1.3.

Test Results: Pass

Measurement Data:

Channel No.	Frequency (MHz)	26 dB Bandwidth B (kHz)
4	1921.536	1408
0	1928.448	1411

Channel No.	Frequency (MHz)	20 dB Bandwidth B (kHz)
2	1924.992	1261

Channel No.	Frequency (MHz)	6 dB Bandwidth B (kHz)
4	1921.536	N/A
0	1928.448	N/A
Channel No.	Frequency (MHz)	12 dB Bandwidth B (kHz)
4	1921.536	N/A
0	1928.448	N/A

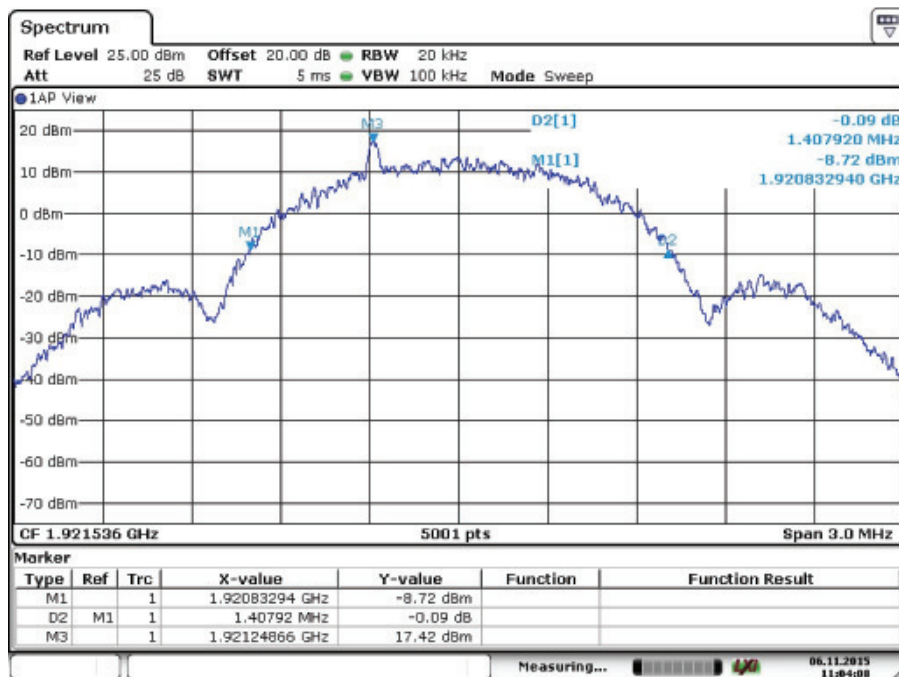
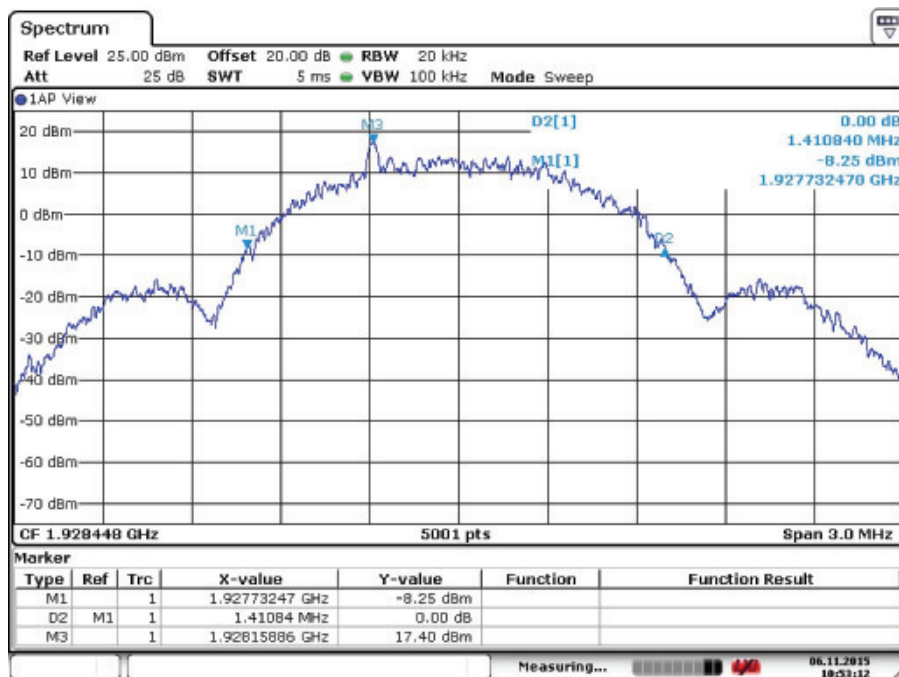
Requirement: FCC 15.323(a)

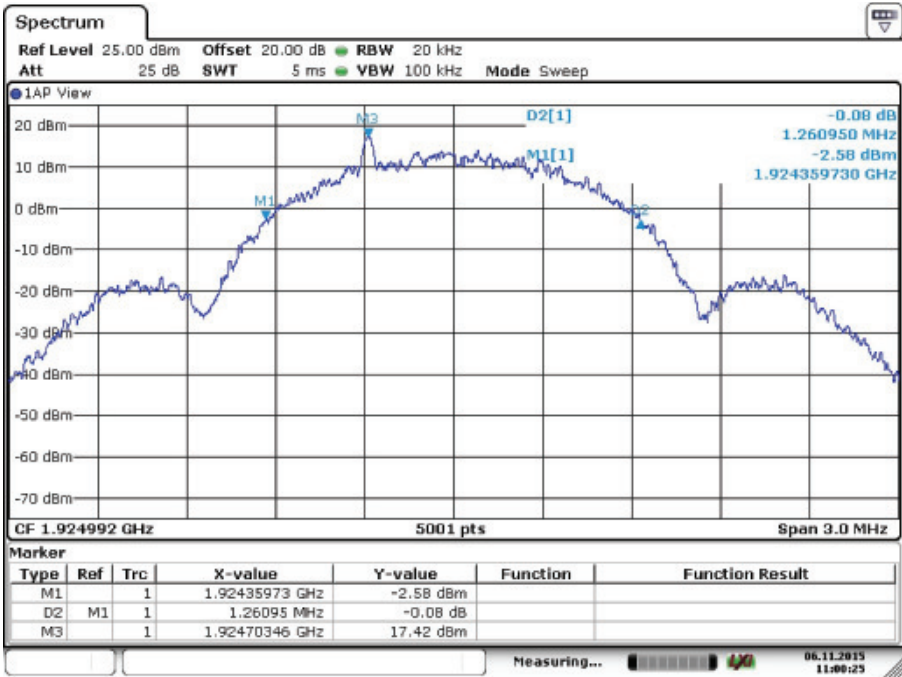
The 26 dB Bandwidth B shall be larger than 50 kHz and less than 2.5 MHz.

Requirement: RSS-213 Issue 2, clause 6.4

The 20 dB Bandwidth B shall be larger than 50 kHz and less than 2.5 MHz.

No requirement for 6 dB and 12 dB Bandwidth. These values are only used for testing Monitoring Bandwidth if the Simple Compliance test fails (ANSI C63.17, clause 7.4).

**Emission Bandwidth B, Lower Channel****Emission Bandwidth B, Upper Channel**



20 dB Bandwidth B, Middle Channel

9.10 Power Spectral Density

Measurement Procedure:

ANSI C63.17, clause 6.1.5.

Test Results: Pass

Measurement Data:

Channel No.	Frequency (MHz)	Power Spectral Density (mW/3kHz)
4	1921.26006	1.47
0	1928.18726	1.37

Averaged over 100 sweeps.

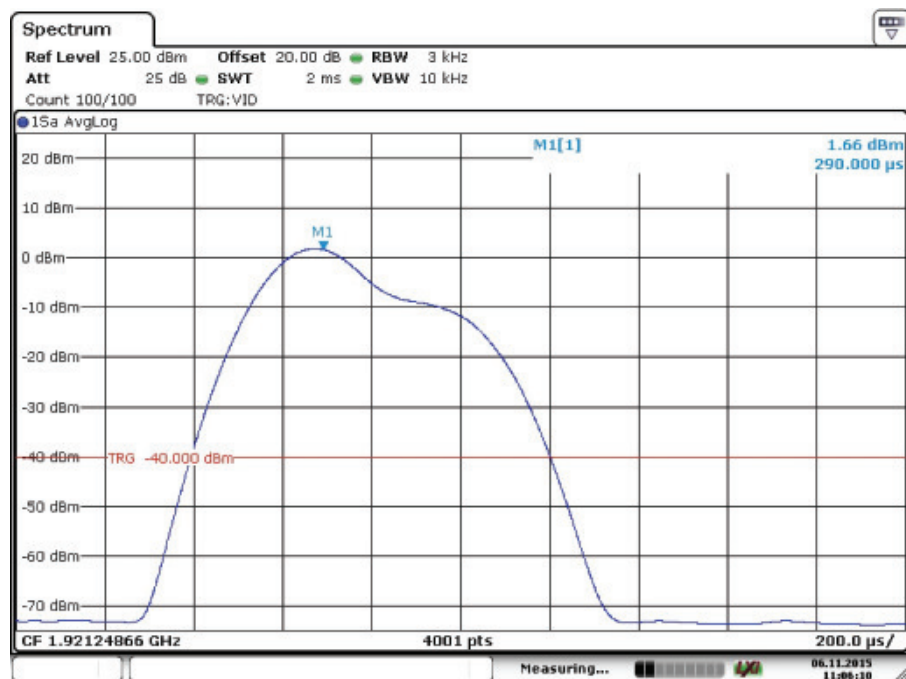
Requirement: FCC 15.319(d)

The Power Spectral Density shall be less than 3 mW (4.77 dBm) when averaged over at least 100 sweeps.

Power Spectral Density

Lower Channel:

Frequency of the maximum level was recorded under chapter 5.9.



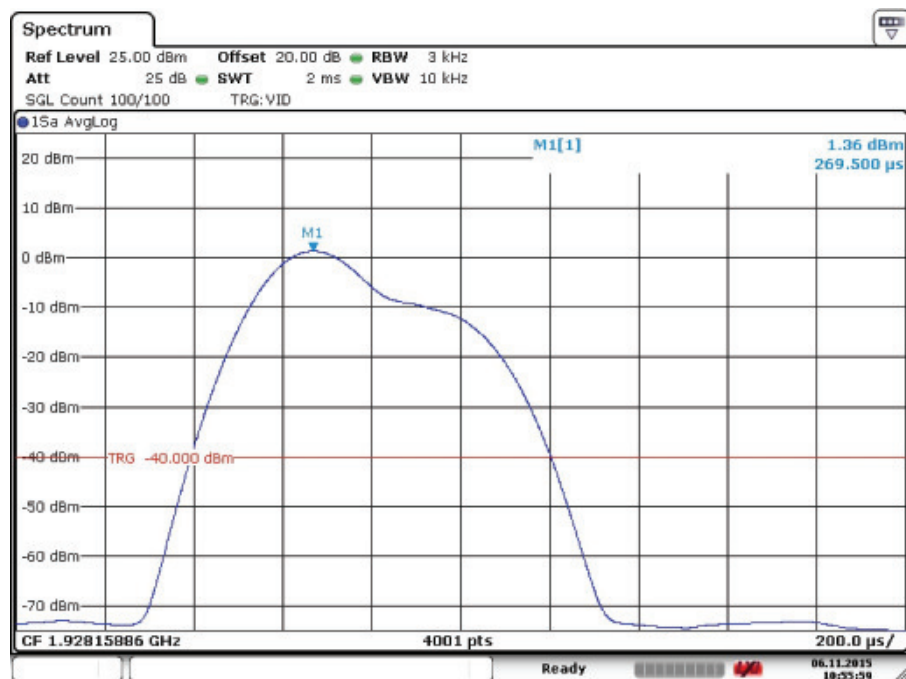
Averaged, 100 Sweeps

Pulse power [dBm]	1.66
Pulse power [mW]	1.47

Power Spectral Density

Upper Channel:

Frequency of the maximum level was recorded under chapter 5.9.



Averaged, 100 Sweeps

Pulse power [dBm]	1.36
Pulse power [mW]	1.37

9.11 In-Band Unwanted Emissions, Conducted

Measurement Procedure:

ANSI C63.17, clause 6.1.6.1.

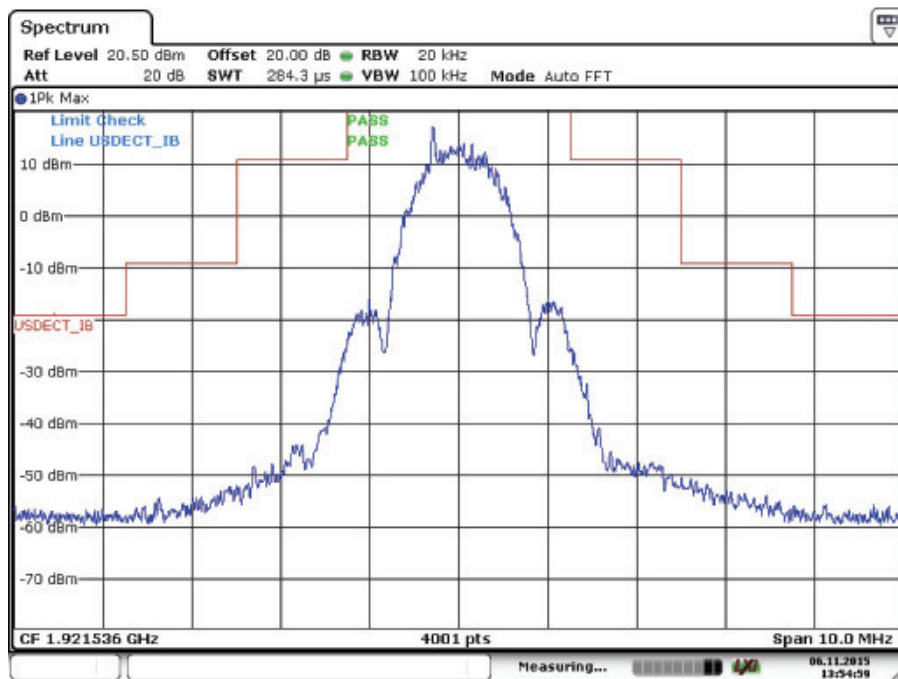
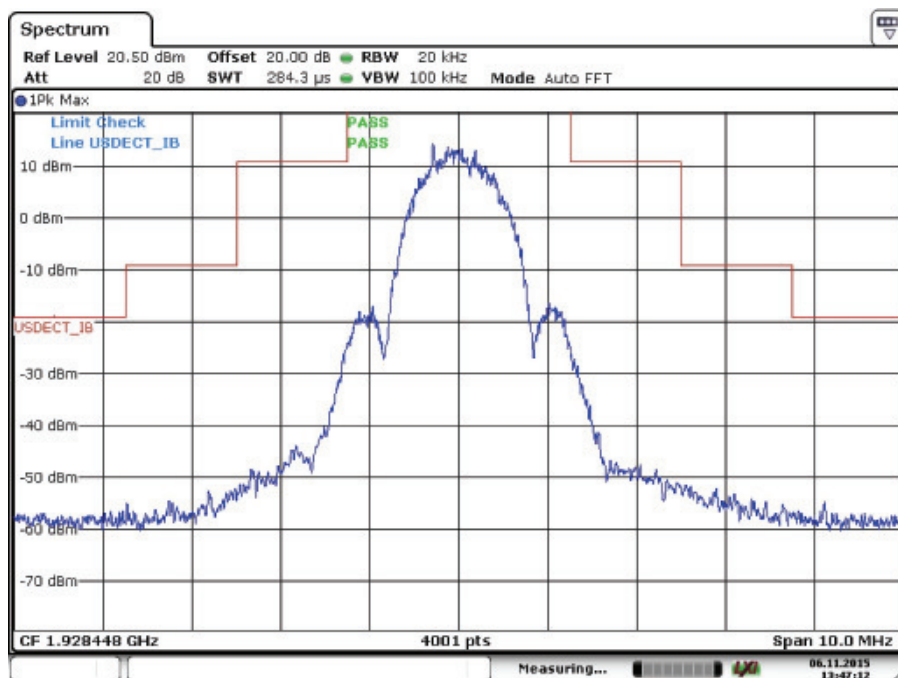
Test Results: Pass

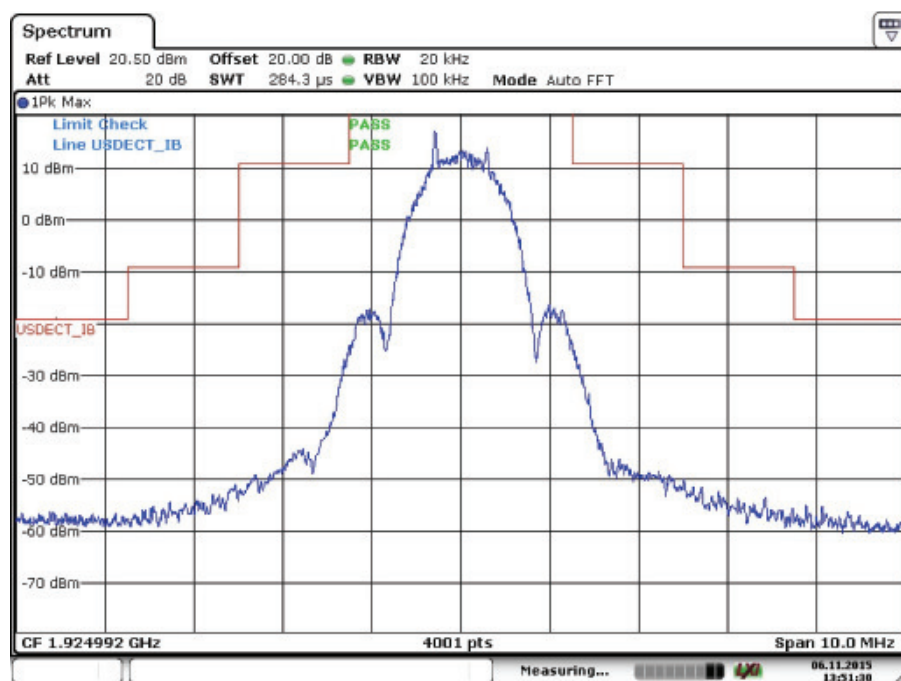
Measurement Data:

See plots.

Requirement: FCC 15.323(d)

B < f2 ≤ 2B:	less than or equal to 30 dB below max. permitted peak power level
2B < f2 ≤ 3B:	less than or equal to 50 dB below max. permitted peak power level
3B < f2 ≤ UPCS Band Edge:	less than or equal to 60 dB below max. permitted peak power level

In-Band Unwanted Emissions, Conducted**Lower Channel****Upper Channel**



Middle Channel

The BS spurious in-band transmission level is below the indicated limit.

9.12 Out-of-Band Emissions, Conducted

Measurement Procedure:

ANSI C63.17, clause 6.1.6.2.

Test Results: Pass

Measurement Data:

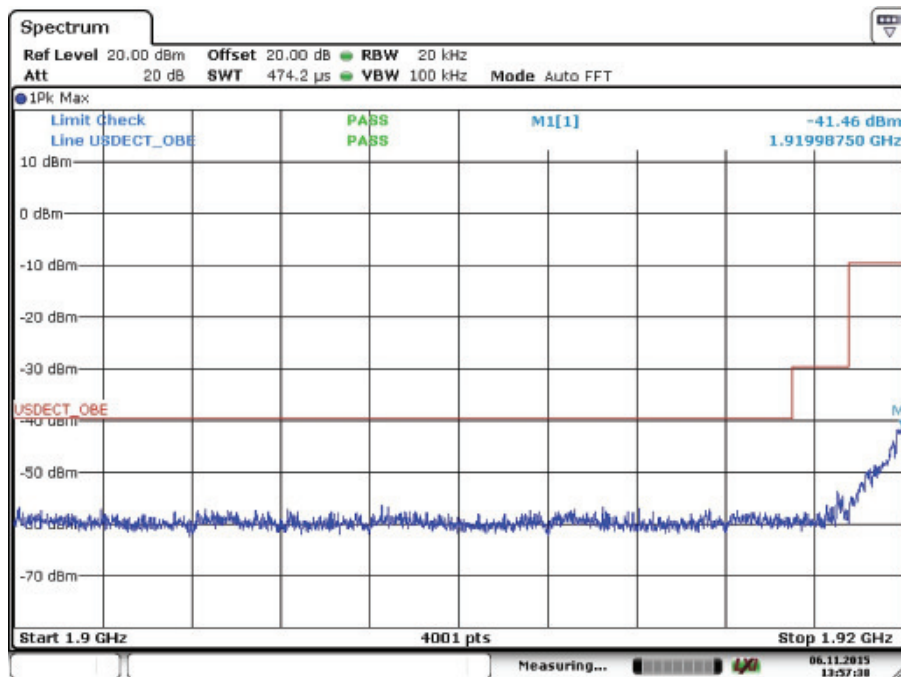
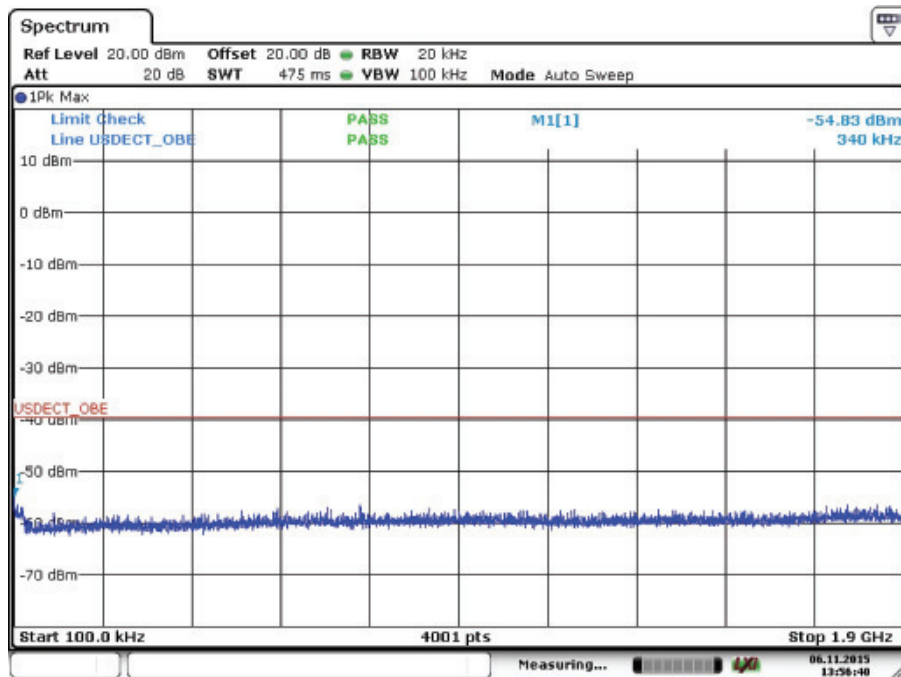
See plots.

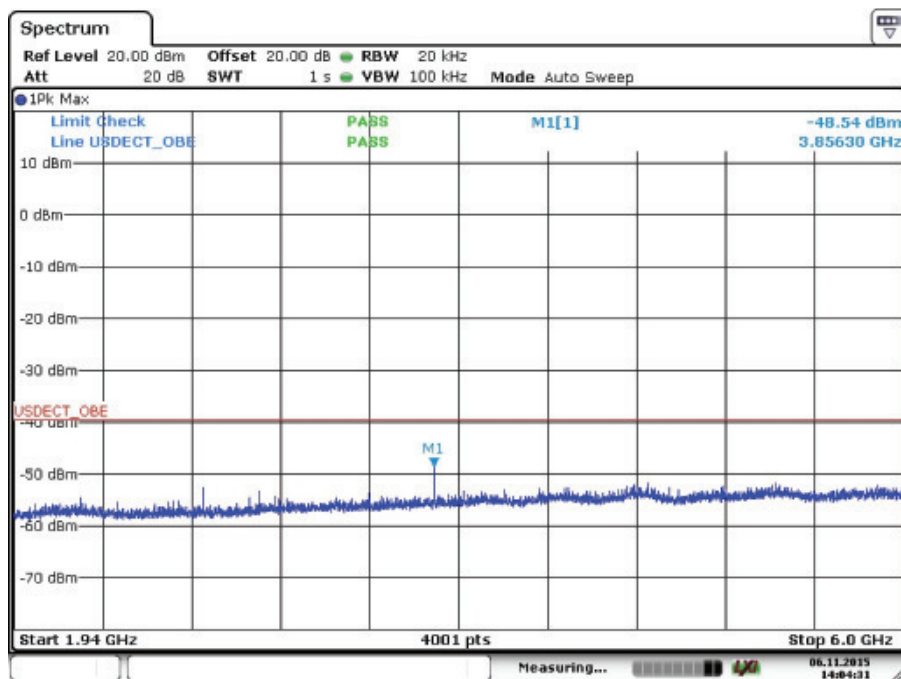
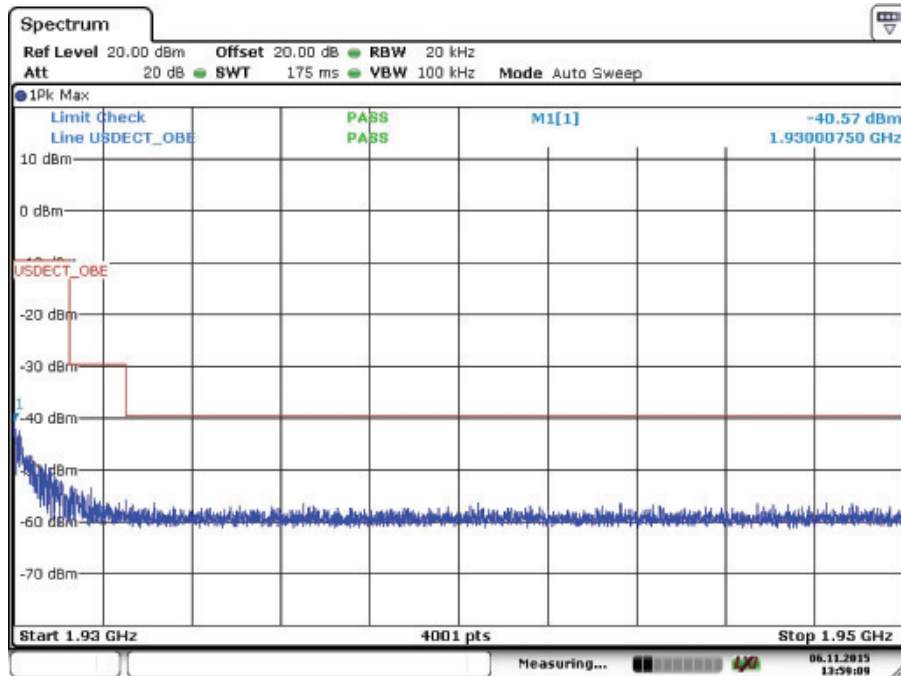
Requirement: FCC 15.323(d)

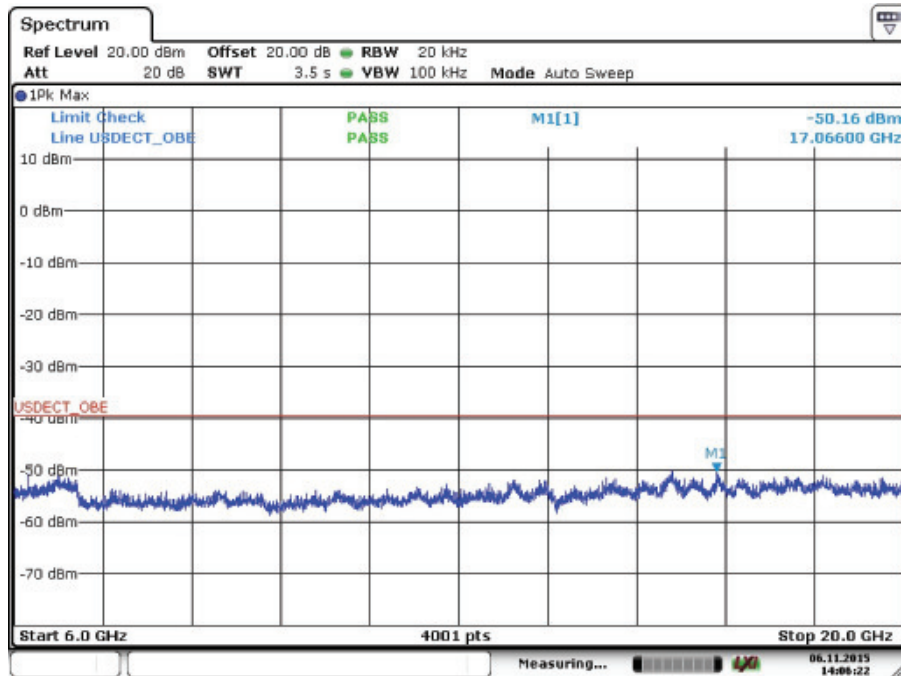
$f \leq 1.25$ MHz outside UPCS band:	≤ -9.5 dBm
$1.25 \text{ MHz} \leq f \leq 2.5$ MHz outside UPCS band:	≤ -29.5 dBm
$f \geq 2.5$ MHz outside UPCS band:	≤ -39.5 dBm

Out-of-Band Unwanted Emissions, Conducted

Upper and Lower Channel:



Out-of-Band Unwanted Emissions, Conducted

Out-of-Band Unwanted Emissions, Conducted

The BS spurious out-of-band transmission level is below the indicated limit.

9.13 Carrier Frequency Stability

Measurement Procedure:

ANSI C63.17, clause 6.2.1.

Test Results: Pass

Measurement Data:

The Frequency Stability is measured with the CMD65. The CMD65 was logged by a computer programmed to get the new readings as fast as possible (about 3 readings per second) over the noted time period or number of readings. The peak-to-peak difference was recorded and the mean value and deviation in ppm was calculated.

The Carrier Frequency Stability over power Supply Voltage and over Temperature is measured also with the CMD65.

Carrier Frequency Stability over Time at Nominal Temperature

Average Mean Carrier Frequency (MHz)	Max. Diff. (kHz)	Min. Diff. (kHz)	Max Dev. (ppm)	Limit (ppm)
1924.99219	0.5	-8.6	4.6	±10

Deviation ppm = ((Max.Diff. – Mean.Diff.) / Mean Carrier Freq.) x 10⁶

Deviation (ppm) is calculated from 3000 readings with the CMD65.

Carrier Frequency Stability over Power Supply at Nominal Temperature

Voltage	Measured Carrier Frequency (MHz)	Difference (kHz)	Deviation (ppm)	Limit (ppm)
115 V AC	1924.992	N/A	N/A	±10
98 V AC	1924.992	N/A	N/A	
132 V AC	1924.992	N/A	N/A	

Deviation ppm = ((Mean – Measured frequency) / Mean) x 10⁶

Carrier Frequency Stability over Temperature

Temperature	Measured Carrier Frequency (MHz)	Difference (kHz)	Deviation (ppm)	Limit (ppm)
T = +20°C	1924.989	Ref.	Ref.	±10
T = -20°C	1924.994	+5.0	+2.5	
T = +50°C	1924.994	+5.0	+2.5	

Deviation ppm = ((Mean – Measured frequency) / Mean) x 10⁶

9.14 Frame Repetition Stability

Measurement Procedure:

ANSI C63.17, clause 6.2.2.

Test Results: Pass

Measurement Data:

The Frame Repetition Stability is measured with the CMD65. The Frame Repetition Stability is 3 times the standard deviation.

Carrier Frequency (MHz)	Mean (Hz)	Standard Deviation (ppm)	Frame Repetition Stability (ppm)
1924.992	99.999999993	0.24	0.72

Limit:

Frame Repetition Stability	±10 ppm (TDMA)
----------------------------	----------------

Ref. FCC 15.323(e). ANSI C63.17, clause 6.2.2.

9.15 Frame Period and Jitter

Measurement Procedure:

ANSI C63.17, clause 6.2.3.

Test Results: Pass

Measurement Data:

The Frame Repetition Stability is measured with the CMD65

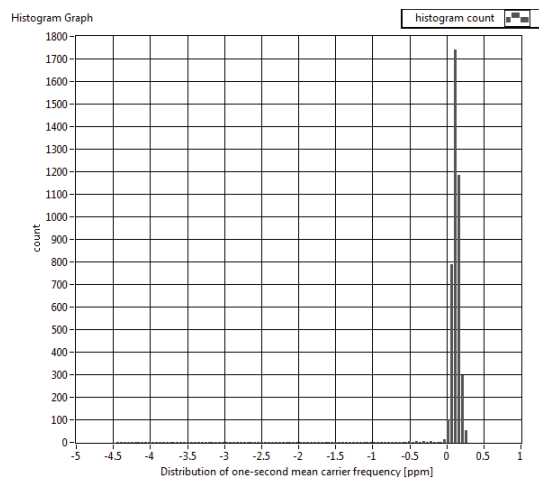
Carrier Frequency (MHz)	Frame Period (ms)	Max Jitter (µs)	3xStandard Deviation of Jitter (µs)
1924.992	10.000	0.77	0.20

Max Jitter = $(1/(\text{Frame Period} + \text{Pk-Pk})/2) - (1/\text{Frame Period})$, when Pk-Pk and Frame Period are in Hz.
 $3 \times \text{St.Dev. Jitter} = 3 \times (1/(\text{Frame Period} + \text{St.Dev})) - (1/\text{St.Dev}) \times 10^6$

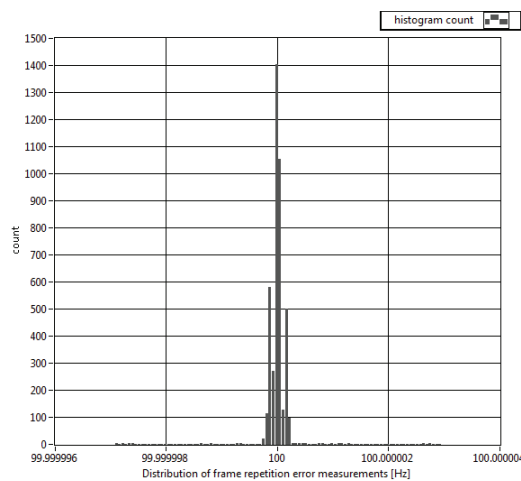
Limit:

Frame Period	20 or 10 ms
Max Jitter	25 µs
3 times St.Dev. of Jitter	12.5 µs

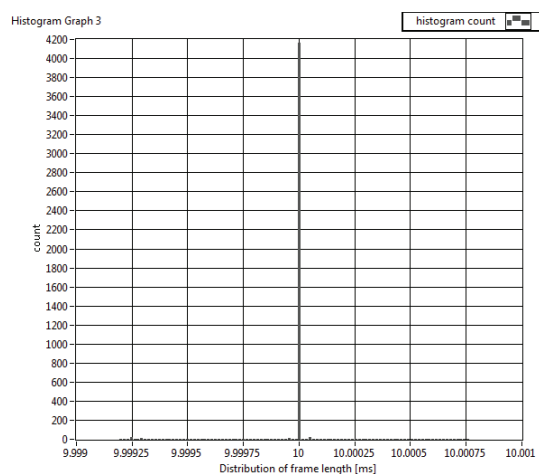
Ref. FCC 15.323(e). ANSI C63.17, clause 6.2.3.



Histogram of Carrier Frequency Stability



Histogram of Frame Repetition Stability



Histogram of Frame Period and Jitter

9.16 Monitoring Threshold, Least Interfered Channel

Monitoring Threshold limits:

Lower Threshold:

$$T_L = 15 \log B - 184 + 30 - P_{EUT} \text{ (dBm)}$$

Upper Threshold:

$$T_U = 15 \log B - 184 + 50 - P_{EUT} \text{ (dBm)}$$

B is measured Emission Bandwidth in Hz

P_{EUT} is measured Transmitter Power in dBm

Calculated values:

Lower Threshold	-82.2 dBm
Upper Threshold	-62.2 dBm

The Lower Threshold is applicable for systems which have defined less than 40 duplex system access channels. The Upper Threshold is applicable for systems with more than 40 duplex systems access channels and that implements the Least Interfered Channel Procedure (LIC).

Measurement Procedure:

The Upper Threshold is found by the procedure defined in ANSI C63.17 clause 7.3.1

Least Interfered Channel Procedure NOT used:	
Lower Threshold	N/A
Least Interfered Channel Procedure used:	
Upper Threshold	N/A

Least Interfered Channel (LIC) Procedure Test, FCC 15.323(b), (c)(2) and (c)(5)

ANSI C63.17 clause 7.3.2 ref.	Observation	Verdict
b) $f_1 T_L + 13 \text{ dB}$, $f_2 T_L + 6 \text{ dB}$	Transmission always on f_2	Pass
c) $f_1 T_L + 6 \text{ dB}$, $f_2 T_L + 13 \text{ dB}$	Transmission always on f_1	Pass
d) $f_1 T_L + 7 \text{ dB}$, $f_2 T_L$	Transmission always on f_2	Pass
e) $f_1 T_L$, f_2 at $T_L + 7 \text{ dB}$	Transmission always on f_1	Pass

Selected Channel Confirmation, FCC 15.323(c)(1) and (5)

ANSI C63.17 clause 7.3.3 ref.	Observation	Verdict
b) Shall not transmit on f_1	EUT transmits on f_2	N/A
d) Shall not transmit on f_2	EUT transmits on f_1	N/A

Limits:

Lower Threshold + 6 dB margin	-76.2 dBm
Upper Threshold + 6 dB margin	-56.2 dBm

Comment: The test is only applicable for devices which can manually activate a connection.

9.17 Threshold Monitoring Bandwidth

This test is only required if a dedicated monitoring receiver is used. If the test is not carried out the manufacturer shall declare and provide evidence that the monitoring is made through the radio receiver used for communication.

Measurement Procedure:

Simple Compliance Test, ANSI C63.17, clause 7.4.1

More Detailed Test, ANSI C63.17, clause 7.4.2

The test is passed if **either** the Simple Compliance Test or the More Detailed Test is passed.

During this test the spectrum analyzer is observed visually to see if the EUT transmits or not.

Test Results:

Test performed	Observation	Verdict
Simple Compliance Test, at $\pm 30\%$ of B	No transmissions	N/A
More Detailed Test, at -6 dB points	N/A	N/A
More Detailed Test, at -12 dB points	N/A	N/A

The More Detailed Test must be pass at both the -6dB and -12 dB points if the Simple Compliance Test fails.

Comment: The tested EUT uses the same receiver for monitoring and communication, this test is therefore not required.

Limits: FCC 15.323(c)(7):

The monitoring system bandwidth must be equal to or greater than the emission bandwidth of the intended transmission.

9.18 Reaction Time and Monitoring Interval

Measurement Procedure:

ANSI C63.17, clause 7.5

Test Results:

By administrative commands and out-of-operating region interference, the EUT is restricted to operate on carrier frequencies f_1 and f_2 .

Time-synchronized pulsed interference was then applied on f_1 at pulsed levels TL + UM to check that the EUT does not transmit. The level was raised 6 dB for part d) with 35 μ s pulses. Additionally a CW signal was applied on f_2 with a level of TL.

The pulses are synchronized with the EUT timeslots and applied cantered within all timeslots.

Pulse Width, ref. to ANSI C63.17 clause 7.5	Observation	Verdict
c) > largest of 50 μ s and $50 \cdot \text{SQRT}(1.25/B)$	Transmission on f_2	Pass
d) > largest of 35 μ s and $35 \cdot \text{SQRT}(1.25/B)$ and with interference level raised 6 dB	Transmission on f_2	Pass

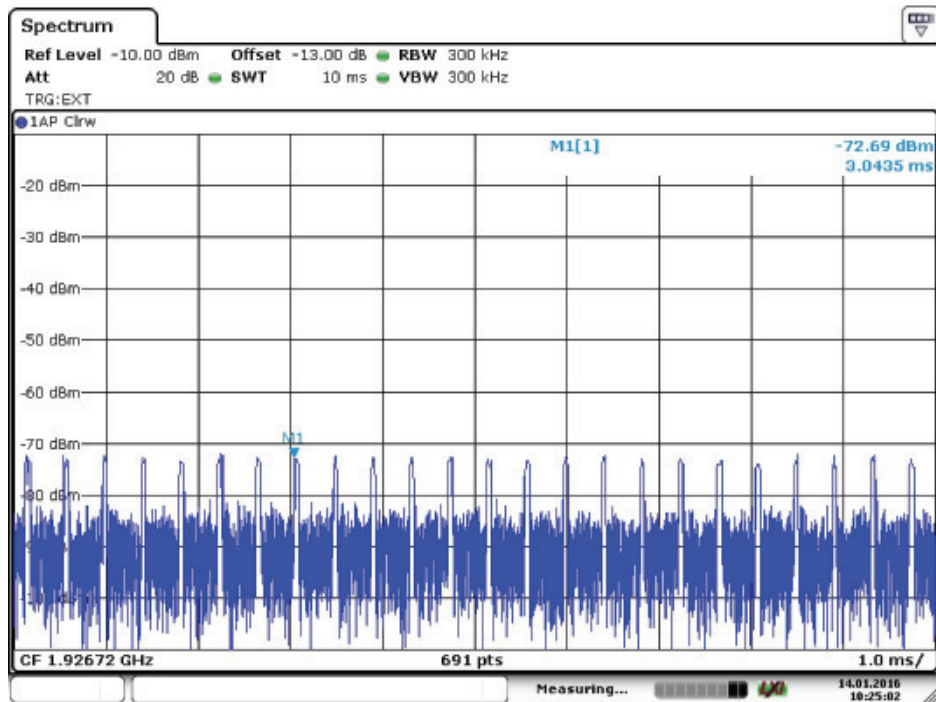
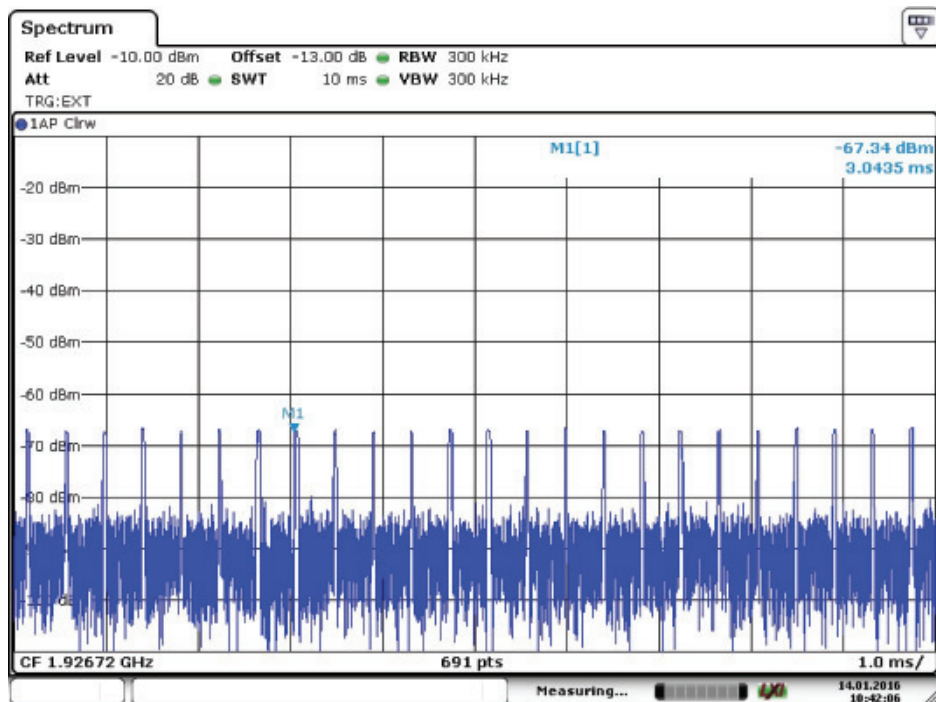
Comment: Since B is larger than 1.25 MHz, the test was performed with pulse lengths of 50 μ s and 35 μ s.

Limits: FCC 15.323(c)(1), (5) and (7)

The maximum reaction time must be less than $50 \cdot \text{SQRT}(1.25/\text{emission bandwidth in MHz})$ microseconds for signals at the applicable threshold level but shall not be required to be less than 50 microseconds.

If a signal is detected that is 6 dB or more above the applicable threshold level, the maximum reaction time shall be $35 \cdot \text{SQRT}(1.25/\text{emission bandwidth in MHz})$ microseconds but shall not be required to be less than 35 microseconds.

Comment: This test is only applicable for EUTs that can be an initiating device.

**50 μ s Pulses****35 μ s Pulses**

9.19 Time and Spectrum Window Access Procedure

This requirement is only for EUTs which transmit unacknowledged control and signaling information

Measurement Procedure:

Timing for EUTs using control and signaling channel type transmissions: ANSI C63.17, clause 8.1

Test results:

Access Criteria, ref. to ANSI C63.17 clause 8.1.1	Observation	Verdict
b) Check that the EUT transmits on the interference free time slot	N/A	N/A
b) The EUT must terminate or pause in its repetitive transmission of the control and signaling channel on the open channel to repeat the access criteria not less frequently than every 30 s	N/A	N/A

If FCC 15.323(c)(6) option Random Waiting Interval is NOT implemented

Access Criteria, ref. to ANSI C63.17 clause 8.1.2	Observation	Verdict
b) Check that the EUT changes to interference free time slot when interference is introduced on the time slot in use	N/A	N/A

If FCC 15.323(c)(6) option Random Waiting Interval is implemented

Access Criteria, ref. to ANSI C63.17 clause 8.1.3	Observation	Verdict
b-d) Check that the EUT uses random waiting interval before continuing transmission on an interfered time slot	N/A	N/A

Comment: The tested EUT does not transmit unacknowledged control and signaling information.

Limits:

FCC 15.323(c)(4):

Once access to specific combined time and spectrum windows is obtained an acknowledgement from a system participant must be received by the initiating transmitter within one second or transmission must cease. Periodic acknowledgments must be received at least every 30 seconds or transmission must cease. Channels used exclusively for control and signaling information may transmit continuously for 30 seconds without receiving an acknowledgement, at which the time access criteria must be repeated.

FCC 15.323(c)(6):

If the selected combined time and spectrum windows are unavailable, the device may either monitor and select different windows or seek to use the same windows after waiting an amount of time, randomly chosen from a uniform random distribution between 10 and 150 milliseconds, commencing when the channel becomes available.

9.20 Acknowledgments and Transmission duration

Measurement Procedure:

Acknowledgments: ANSI C63.17, clause 8.2.1

Transmission Duration: ANSI C63.17, clause 8.2.2

During the test **Initial transmission without acknowledgments** the signal from the EUT to the companion device is blocked by circulators in addition to the tunable attenuator.

The test **Transmission time after loss of acknowledgments** is performed by cutting-off the signal from the companion device by a RF switch the time until the EUT stops transmitting.

The **Transmission Duration** test is performed by monitoring the slot in use and measuring the time until the EUT changes to a different slot.

Test Results:

Acknowledgments

Test ref. to ANSI C63.17 clause 8.2.1	Observation	Verdict
a) Initial transmission without acknowledgments	0.38 ms	Pass
c) Transmission time after loss of acknowledgments	2.7 s	Pass

Transmission Duration

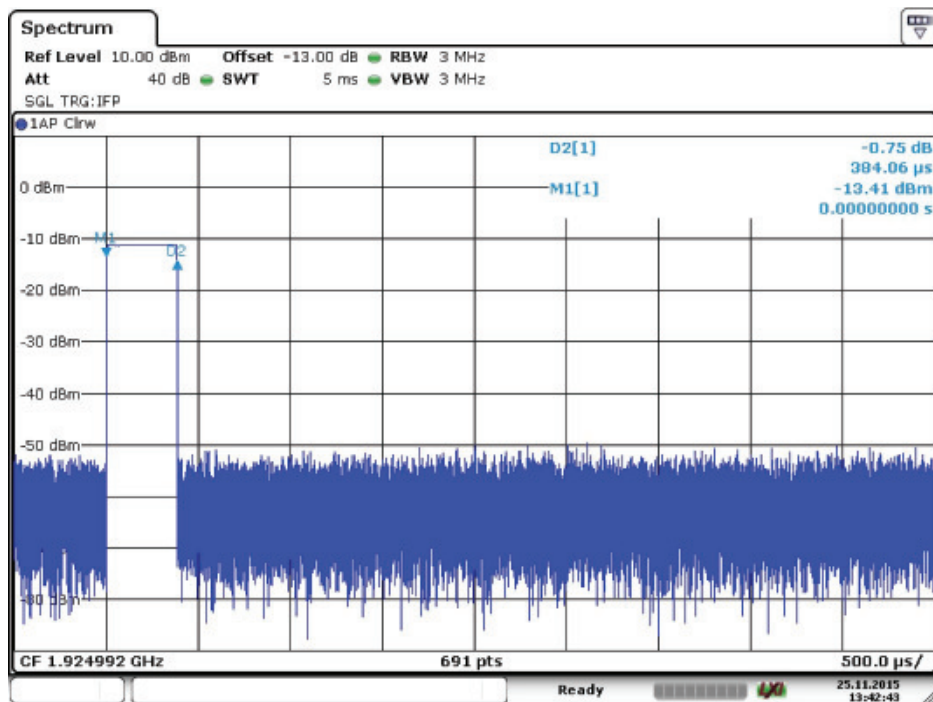
Test ref. to ANSI C63.17 clause 8.2.2	Observation	Verdict
b) Transmission duration on same time and frequency window	7.5 h	Pass

Comment: /

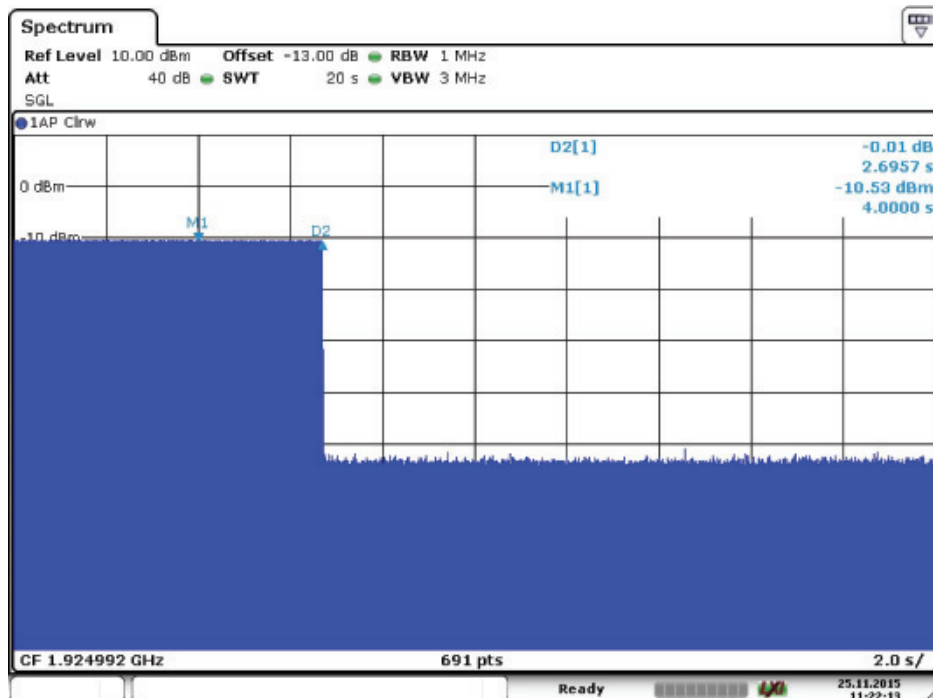
Limits: FCC 15.323(c)(3) and (4)

Occupation of the same combined time and spectrum windows by a device or group of cooperating devices continuously over a period of time longer than 8 hours is not permitted without repeating the access criteria. Once access to specific combined time and spectrum windows is obtained an acknowledgment from a system participant must be received by the initiating transmitter within one second or transmission must cease.

Periodic acknowledgments must be received at least every 30 seconds or transmission must cease. Channels used exclusively for control and signaling information may transmit continuously for 30 seconds without receiving an acknowledgement, at which the time access criteria must be repeated.



8.2.1a) Initial Transmission Time without Acknowledgments



8.2.1c) Transmission Time after Loss of Acknowledgments

9.21 Dual Access Criteria Check

Measurement Procedure:

EUTs that do not implement the Upper Threshold: ANSI C62.17, clause 8.3.1

EUTs that implement the Upper Threshold: ANSI C62.17, clause 8.3.2

This test is required for equipment that uses the access criteria in FCC 15.323(c)(10).

Test Results:

EUTs that do NOT implement the Upper Threshold:

Test ref. to ANSI C63.17 clause 8.3.1	Observation	Verdict
b) EUT is restricted to a single carrier f_1 for TDMA systems. The test is pass if the EUT can set up a communication link.	N/A	N/A
c) d) No transmission on interference-free receive time/spectrum window. All transmit slots blocked	N/A	N/A
e) f) No transmission on interference-free transmit time/spectrum window. All transmit slots blocked	N/A	N/A

EUTs that implement the Upper Threshold:

Test ref. to ANSI C63.17 clause 8.3.2	Observation	Verdict
b) EUT is restricted to a single carrier f_1 for TDMA systems. The test is pass if the EUT can set up a communication link.	N/A	N/A
c) d) Transmission on interference-free receive time/spectrum window.	N/A	N/A
e) f) Transmission on interference-free transmit time/spectrum window.	N/A	N/A
g) Transmission not possible on any time/spectrum window.	N/A	N/A

Comment: This test is only applicable for EUTs that can be an initiating device for duplex connections.

Limits: FCC 15.323(c)(10)

An initiating device may attempt to establish a duplex connection by monitoring both, its intended transmit and receive time and spectrum windows. If both the intended transmit and receive time and spectrum windows meet the access criteria, then the initiating device can initiate a transmission in the intended transmit time and spectrum window. If the power detected by the responding device can be decoded as a duplex connection signal from the initiating device, then the responding device may immediately begin transmitting on the receive time and spectrum window monitored by the initiating device.

9.22 Alternative monitoring interval

Test procedure described in ANSI C63.17, clause 8.4.

This test is required if the EUT implements the provision of FCC 15.323(c)(11).

Test Result:

Not tested. The tested EUT does not implement this provision. See manufacturer's declaration.

9.23 Spurious Emissions (Radiated)

Measurement Procedure:

FCC 15.209, FCC 15.109

Test Result:

Tests for intentional radiators according to FCC 15.209 are not required when Out-of-Band Emission was tested conducted with a pass result.

Measurement Data:

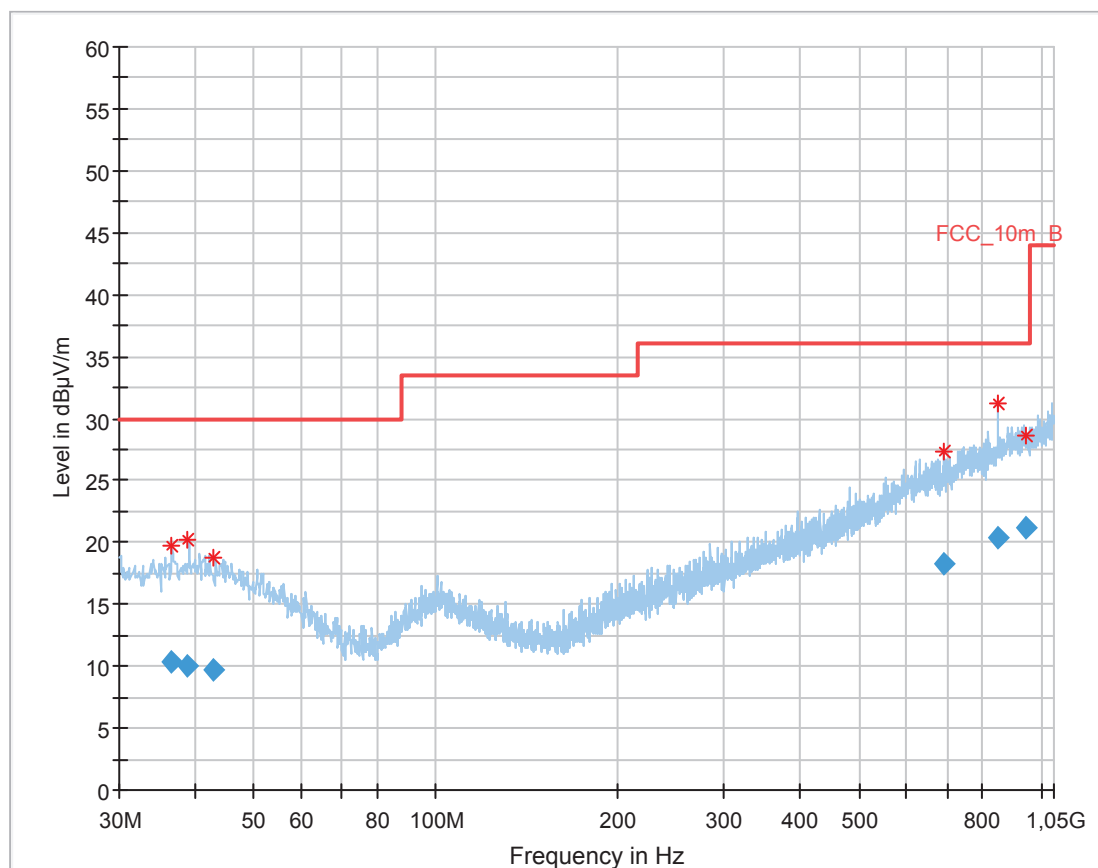
See plots.

Requirement: FCC 15.109(b)

30 – 88 MHz:	90 $\mu\text{V/m}$
88 – 216 MHz:	150 $\mu\text{V/m}$
216 – 960 MHz:	210 $\mu\text{V/m}$
960 – 1000 MHz:	300 $\mu\text{V/m}$

Common Information

EUT:	TC-W Satellite
Serial number:	1455000728
Test description:	FCC part 15 class B @ 10m
Operating condition:	idle
Operator name:	Hennemann
Comment:	battery powered (3,7 V)

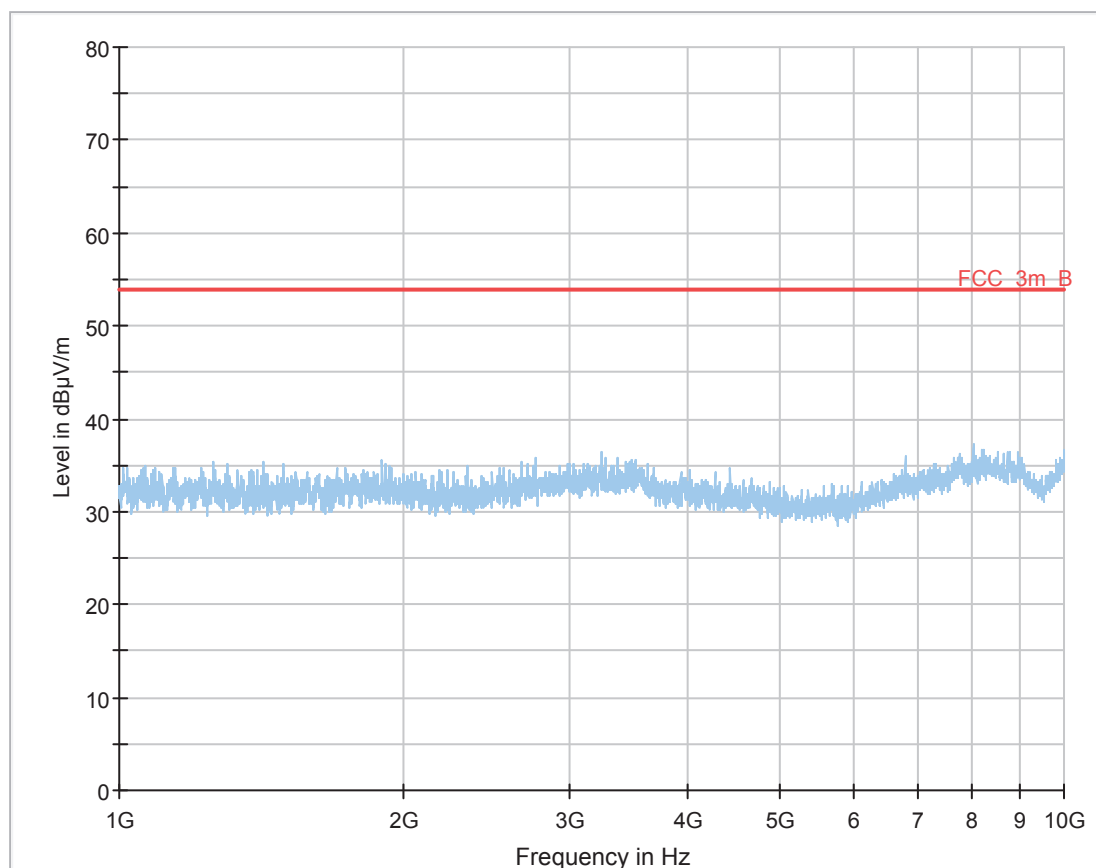


Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.576300	10.35	30.00	19.65	1000.0	120.000	200.0	V	97	13.9
39.003150	10.10	30.00	19.90	1000.0	120.000	174.0	H	97	14.0
42.892200	9.77	30.00	20.23	1000.0	120.000	103.0	V	320	13.9
691.207050	18.34	36.00	17.66	1000.0	120.000	273.0	H	9	21.5
847.567500	20.33	36.00	15.67	1000.0	120.000	273.0	V	1	23.4
947.424000	21.12	36.00	14.88	1000.0	120.000	103.0	H	275	24.3

Common Information

EUT:	TC-W Satellite
Serial number:	1455000728
Test description:	FCC part 15 class B
Operating condition:	idle
Operator name:	Hennemann
Comment:	battery powered (3,7 V)



The radiated spurious emission of the unintentional radiator is below the indicated limit.

9.24 Receiver Spurious Emissions

Measurement Procedure:

Industry Canada RSS-213 paragraph 6.8 and RSS-GEN paragraphs 4.8 and 6.

Test results:

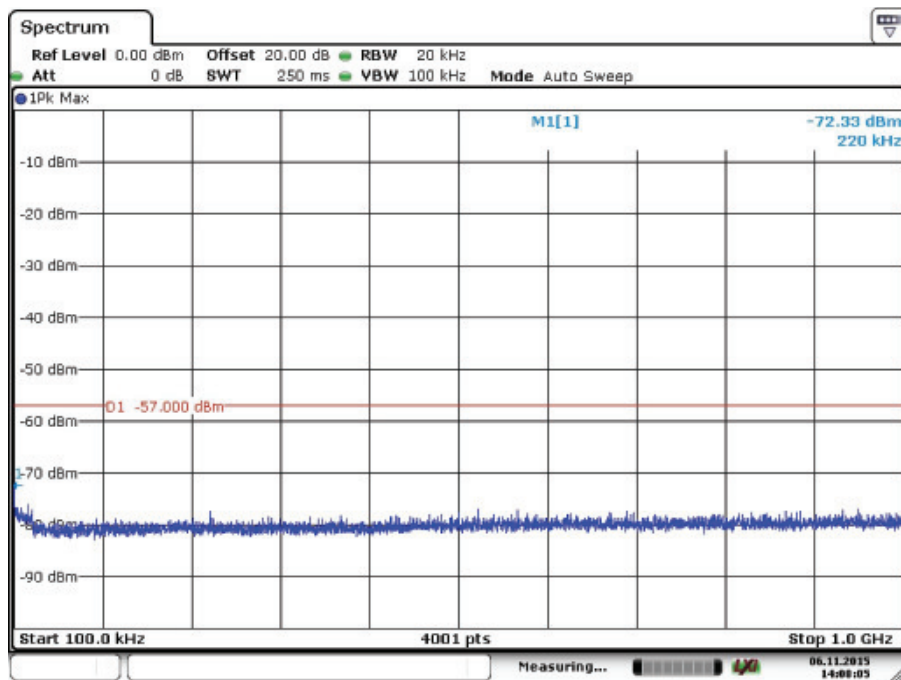
Frequency MHz	Carrier No.	Measured Value Conducted dBm	Conducted Limit dBm	Margin dB
30 - 1000	all	-72.3	-57	15.3
> 1000	all	-70.0	-53	17.0

Requirements: RSS-GEN Issue 2, clause 6

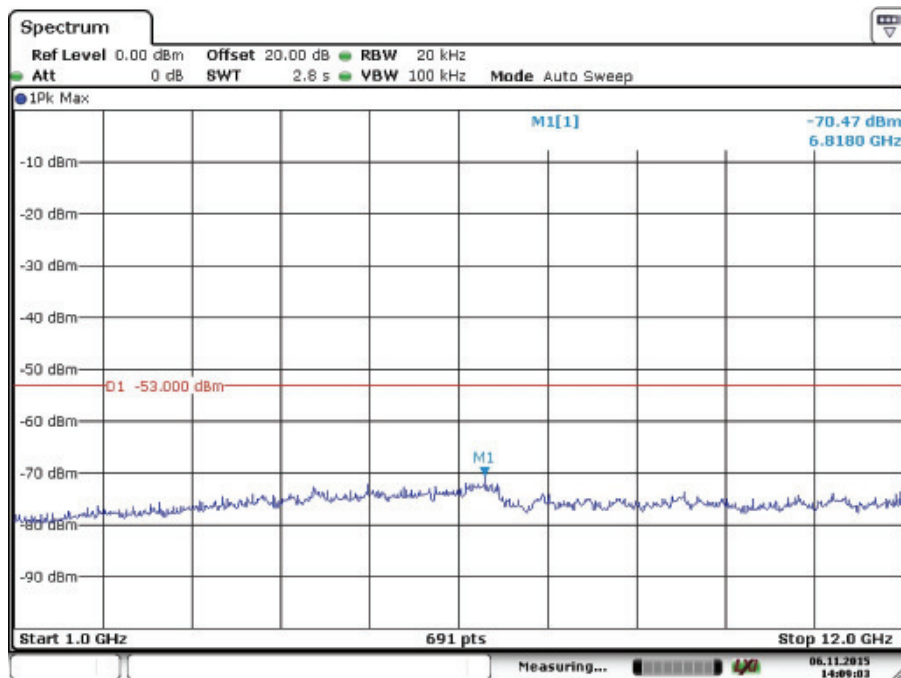
The measurement can be performed either radiated or conducted.

When measured conducted: No spurious signals appearing at the antenna terminals shall exceed 2 nW per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nW above 1 GHz.

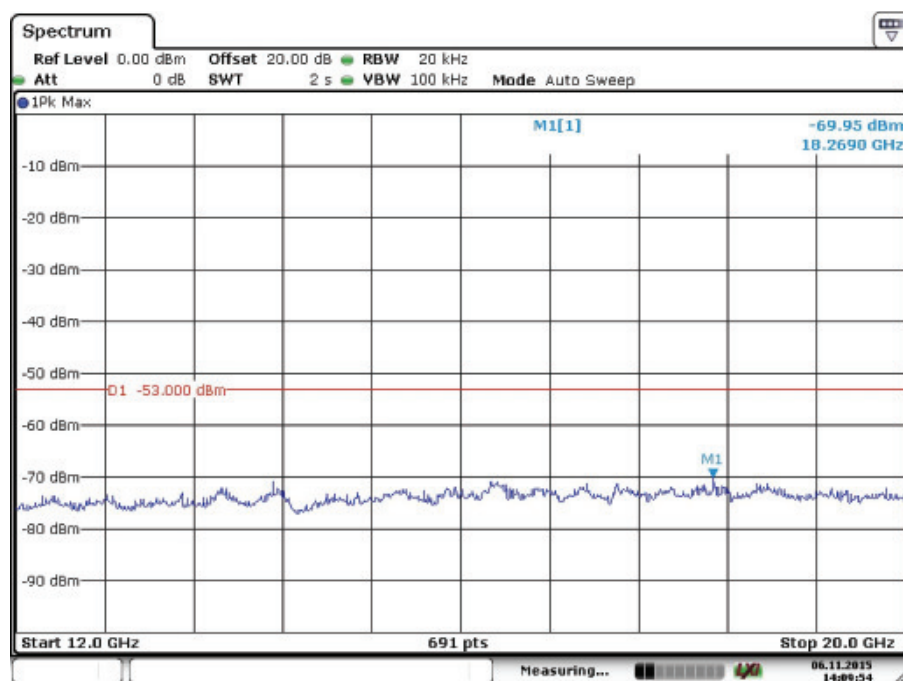
When measured radiated: See table 1 in RSS-GEN Issue2, clause 6.



Receiver Spurious Emissions, Conducted, 100 kHz – 1 GHz



Receiver Spurious Emissions, Conducted, 1 GHz – 12 GHz



Receiver Spurious Emissions, Conducted, 12 GHz – 20 GHz

10 Test equipment and ancillaries used for tests

To simplify the identification of the test equipment and/or ancillaries which were used, the reporting of the relevant test cases only refer to the test item number as specified in the table below.

No.	Instrument/Ancillary	Manufacturer	Type	Serial-No.	Internal identification
<u>Radiated Emission</u>					
F-1	Control Computer	F+W		FW0502032	300003303
F-2	Trilog antenna	Schwarzbeck	VULB 9163	9163-295	- / -
F-3a	Amplifier	Veritech Microwave Inc.	0518C-138	- / -	- / -
F-4b	Switch	HP	3488A	- / -	300000368
F-5	EMI Test receiver	R&S	ESCI	100083	300003312
F-6	Turntable Controller	EMCO	1061 3M	1218	300000661
F-7	Tower Controller	EMCO	1051 Controller	1262	300000625
F-8	Tower	EMCO	1051 Tower	1262	300000625
F-9	EMI Test receiver	R&S	ESU	- / -	300003555
<u>Power Line Conducted Emission</u>					
G-1	EMI Receiver	Hewlett Packard	8542 E	3617A00170	300000568
G-2	V-ISN	Rohde & Schwarz	ESH 3-Z5	892475/017	300002209
G-2a	V-ISN	Rohde & Schwarz	ESH 2-Z5	892602/024	300000587
G-3	2-Wire ISN	Schaffner	ISN T200	19075	300003422
G-4	4-Wire ISN	Schaffner	ISN T400	22325	300003423
G-5	Shielded wire ISN	Schaffner	ISN ST08	22583	300003433
G-6	Unshielded 8 wire ISN	Teseq	ISN T800	26113	300003833
G-7	Unshielded 8 wire ISN	Teseq	ISN T8-Cat. 6	26374	300003851
G-8	RF Current probe	FCC	F-33-4	46	300003257
G-9	V-ISN	Schaffner	ISN PLC-150	21579	300003318
G-10	V-ISN	Schaffner	ISN PLC-25-30	21584	300003319
G 10a	PLC Filter	TESEQ	Filter PLC	23436	300003598
G 10b	Coupling unit 75 Ohm	Fiedler	AC	- / -	300003272.04
<u>Conducted</u>					
L-1	Spectrum Analyzer	R&S	FSV30	100763	300003950
L-2	Signal Generator	R&S	SMBV100A	257858	300004529
L-3	Oscilloscope	R&S	RTO1044	30084	300004615
L-4	Signaling Unit	R&S	CMD 65	847527/005	300003611
L-5	Combiner	R&S	1025.3400.02	- / -	- / -
L-6	Combiner	Suhner	4901.19A	- / -	- / -
L-7	Combiner	Weinschel	1515	KW438	- / -
L-8	Detector	Hewlett Packard	HP 8473C	03690	- / -
L-9	Attenuator	Narda	4779-50	9101	- / -
L-10	Attenuator	Narda	4779-30	9305	- / -
L-11	Attenuator	Narda	4779-20	9310	- / -
L-12	Control PC	F+W	- / -	FW0712052	300003735

11 Observations

No observations exceeding those reported with the single test cases have been made.