The Nebraska Center for Excellence in Electronics
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Amended

FCC/IC Test Report

Includes NCEE Labs report R20160414-20-01 and its amendment in full

Prepared for:	**Hunter Douglas**
Address:	**2550 Midway Boulevard** **Broomfield, CO 80020**
Product:	**Satellite Receiver Ed2** **Wireless Window Blind Controller Module**
FCC ID:	**UXUSTRX2**
IC:	**7316A-STRX2**
Test Report No:	**R20160414-20-01A**
Approved By:	 **Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**30 June 2016**
Total Pages:	**28**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
FCC Part 15.203	Unique Antenna Requirement	Pass	Permanently attached antenna
FCC Part 15.207 RSS-Gen Section 8.8	Conducted Emissions	Pass	Representative Power supply was used
RSS-Gen Section 6.6 RSS-Gen Section 6.12	Bandwidth and peak EIRP	NA	Informational only
FCC Part 15.209 RSS-Gen Section 7.0	Receiver Radiated Emissions,	Pass	Meets the requirement of the limit.
FCC Part 15.249 RSS-Gen Section 8.9 RSS-210 A2.9	Transmitter Radiated Emissions,	Pass	Meets the requirement of the limit.
FCC Part 15.249 RSS-Gen Section 8.9 RSS-210 A2.9	Band Edge Measurement	Pass	Meets the requirement of the limit.

1.2 Amendment History

1. Added this line as the second sentence in 4.2.2(g): “In both positions, the EUT was rotated a full 360° so that all three axis were tested”.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a wireless module used to control window blinds. It operates from 2407 to 2480 MHz and has transmit and receive capabilities. It is intended to be paired with a remote.

EUT Received Date: 17 May 2016
EUT Tested Dates: 27 May 2016 – 22 June 2016

MODEL	Satellite Ed2
Serial No.	"NCEE Compliance Code" (Assigned)(PN:1010512379 Rev2) "NCEE Standard Code (Assigned)" All serial numbers were assigned by the lab as the test samples were not serialized.
POWER SUPPLY	18 VDC Class 2 Power Supply Part No. 2989048000 Model: ADS0366-W180200 Input: 100-240VAC, 1.0A Output: 18V, 2.0A Note: the power supply was used as a representative sample and the EUT will not be sold with a specific power supply. It contains the required power regulation to meet the modular approval requirements.
ANTENNA TYPE	PCB antenna

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 Laboratory description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number :	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 50 ± 4%
Temperature of 22 ± 3° Celsius

2.3 Description of test modes

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low	2407
Middle	2440
High	2480

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

2.4 Applied standards

The EUT uses digital modulation and operates between 2400.0MHz and 2483.5MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

(1) FCC Part 15, Subpart C (15.207, 15.209, 15.249)
(2) ANSI C63.10:2013
(3) Industry Canada RSS-Gen Issue 4
(4) Industry Canada RSS-210 Issue 8

All test items have been performed and recorded as per the above.

2.5 Description of support units

None

2.6 Configuration of system under test

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES126	100037	08 Feb 2016	08 Feb 2017
EMCO Biconilog Antenna	3142B	1647	23 Jun 2015	23 Jun 2016
EMCO Horn Antenna	3115	6416	25 Jan 2016	25 Jan 2018
EMCO Horn Antenna	3116	2576	26 Jan 2016	26 Jan 2018
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	14 Dec 2015*	14 Dec 2016*
Trilithic High Pass Filter	6HC330	23042	14 Dec 2015*	14 Dec 2016*
Rohde & Schwarz LISN	ESH3-Z5	100023	27 Jan 2016	27 Jan 2017

*Internal Characterization

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

4.1.2 Antenna description

The antenna on the EUT is a PCB antenna. The antenna is not replaceable.

4.2 Radiated emissions

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was measured in both the horizontal and vertical orientation. In both positions, the EUT was rotated a full 360° so that all three axis were tested. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

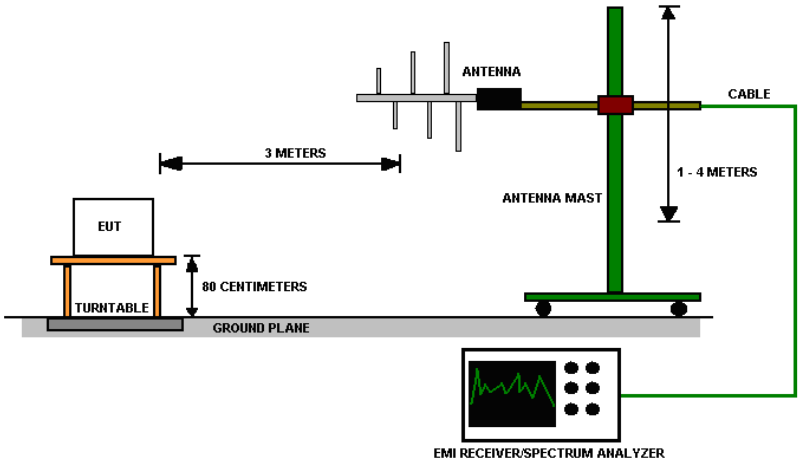

Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

The EUT was powered by 18 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.2.6 Test results

EUT MODULE	Satellite Receiver Ed2	MODE	Receive
INPUT POWER	18 VDC	FREQUENCY RANGE	30MHz – 26GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

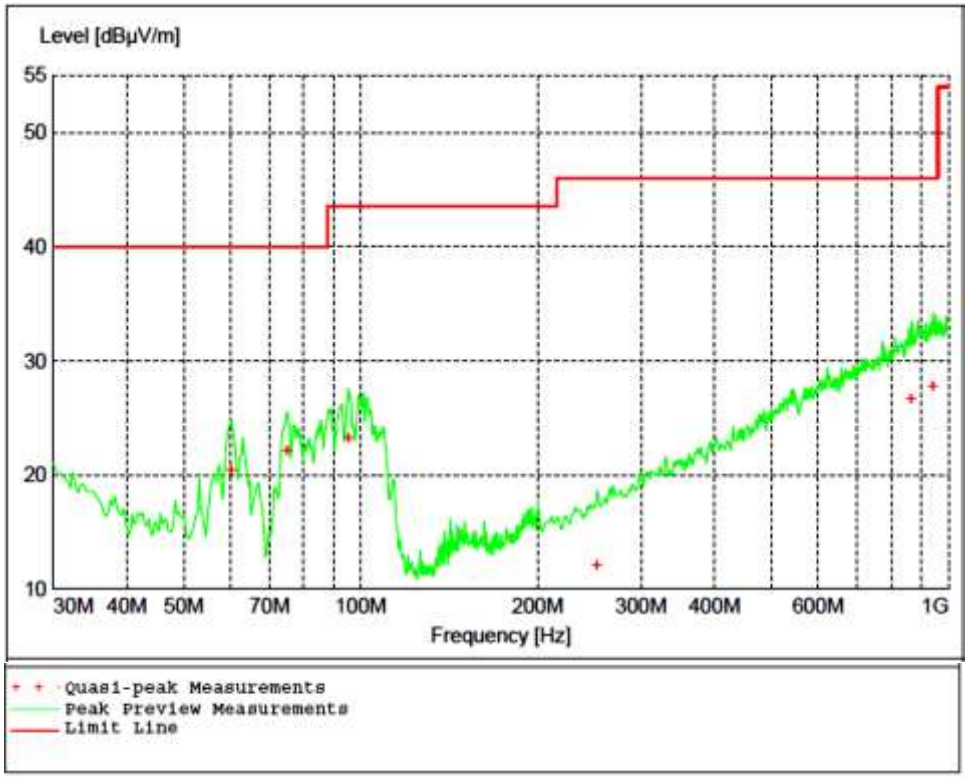

Figure 2 - Radiated Emissions Plot, Receive

Vertical orientation was found to be the worse-case

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. Since peak measurements were compliant with the average limit, average measurements were not required.
6. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 1 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
60.180000	20.44	40.00	19.60	190	5	VERT
74.940000	22.07	40.00	17.90	115	4	VERT
95.460000	23.22	43.50	20.30	109	0	VERT
252.480000	12.08	46.00	33.90	106	99	VERT
863.880000	26.61	46.00	19.40	400	231	VERT
941.220000	27.72	46.00	18.30	102	302	HORI

Table 2 - Radiated Emissions Peak Measurements vs. Average Limit, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2437.000000	36.92	54.00	17.10	100	235	VERT
4883.200000	42.00	54.00	12.00	397	187	HORI
7328.400000	44.11	54.00	9.90	104	0	HORI
9764.400000	46.11	54.00	7.90	99	198	VERT
12217.200000	42.04	54.00	12.00	184	231	VERT

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

EUT	Satellite Receiver Ed2	MODE	Transmit, Low Channel
INPUT POWER	18 VDC	FREQUENCY RANGE	30MHz – 26 GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

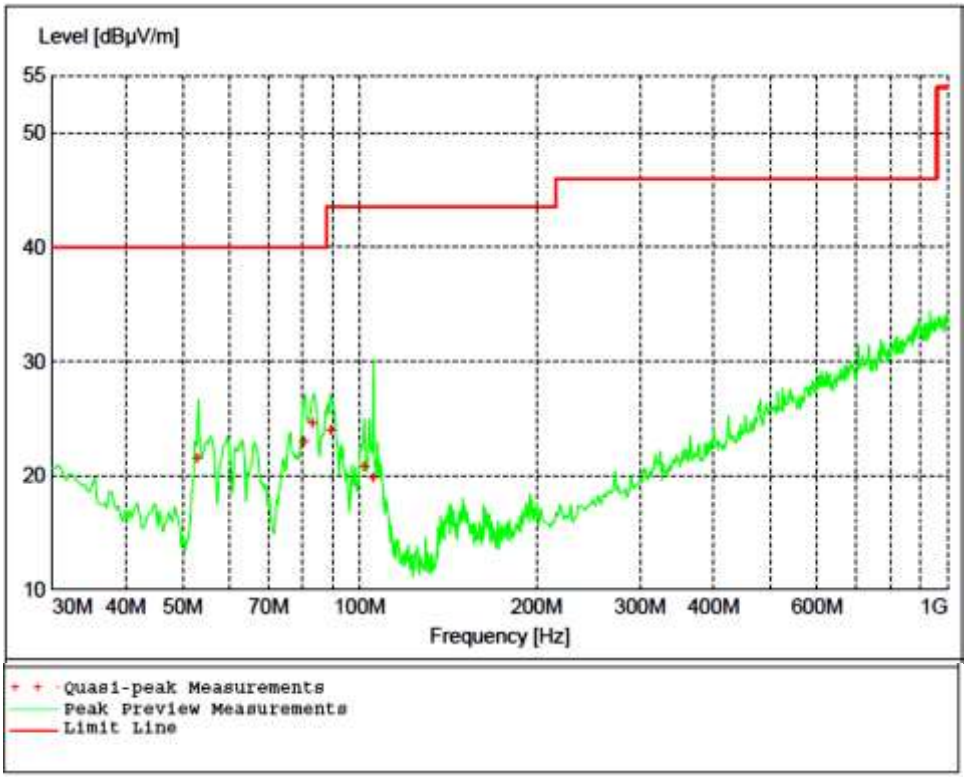

Figure 3 - Radiated Emissions Plot, Low Channel

Vertical orientation was found to be the worse-case

Table 3 - Radiated Emissions Quasi-peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
52.980000	21.53	40.00	18.50	100	0	VERT
80.460000	23.02	40.00	17.00	155	33	VERT
83.160000	24.62	40.00	15.40	100	0	VERT
89.340000	23.99	43.50	19.50	166	0	VERT
101.820000	20.80	43.50	22.70	100	0	VERT
105.360000	19.80	43.50	23.70	99	32	VERT

Table 4 - Radiated Emissions Average Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2407.000000	71.88	NA	NA	99	228	VERT
4814.000000	35.94	54.00	18.06	99	167	VERT
7208.000000	24.24	54.00	29.76	227	119	HORI
9630.600000	25.72	54.00	28.28	342	303	VERT
12027.600000	22.17	54.00	31.83	156	0	VERT
14427.200000	30.64	54.00	23.36	396	322	HORI
16862.600000	29.83	54.00	24.17	387	40	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6, 7 and 8. 20dB was used.

Table 5 - Radiated Emissions Peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2407.000000	91.88	NA	NA	99	228	VERT
4814.000000	55.94	74.00	18.06	99	167	VERT
7208.000000	44.24	74.00	29.76	227	119	HORI
9630.600000	45.72	74.00	28.28	342	303	VERT
12027.600000	42.17	74.00	31.83	156	0	VERT
14427.200000	50.64	74.00	23.36	396	322	HORI
16862.600000	49.83	74.00	24.17	387	40	VERT

EUT	Satellite Receiver Ed2	MODE	Transmit, Mid Channel
INPUT POWER	18 VDC	FREQUENCY RANGE	30MHz – 26 GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

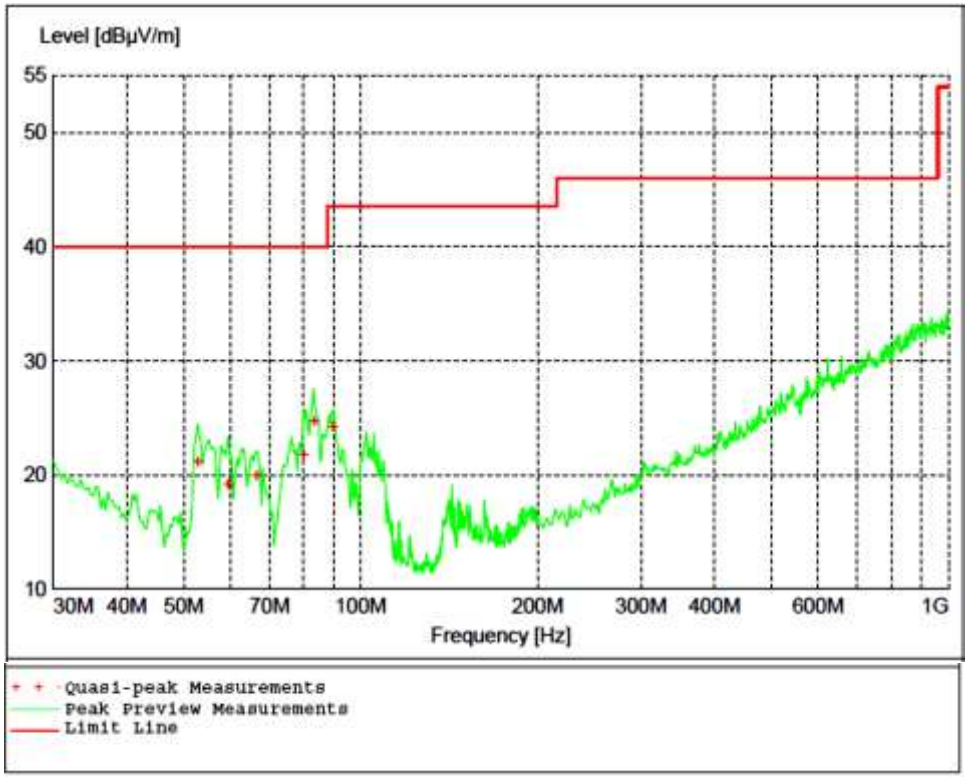

Figure 4 - Radiated Emissions Plot, Mid Channel
Vertical orientation was found to be the worse-case

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 6 - Radiated Emissions Quasi-peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
52.860000	21.09	40.00	18.90	100	0	VERT
59.520000	19.20	40.00	20.80	220	48	VERT
66.600000	19.91	40.00	20.10	112	38	VERT
79.980000	21.73	40.00	18.30	200	0	VERT
83.460000	24.70	40.00	15.30	149	0	VERT
89.760000	24.14	43.50	19.40	129	1	VERT

Table 7 - Radiated Emissions Average Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2440.000000	72.26	NA	NA	100	228	VERT
4880.000000	35.97	54.00	18.03	149	355	VERT
7320.400000	23.72	54.00	30.28	318	324	HORI
9767.400000	26.11	54.00	27.89	396	53	HORI
12220.000000	21.95	54.00	32.05	99	285	HORI
14663.600000	28.96	54.00	25.04	221	0	VERT
17081.800000	32.34	54.00	21.66	312	128	HORI

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6, 7 and 8. 20dB was used.

Table 8 - Radiated Emissions Peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2440.000000	92.26	NA	NA	100	228	VERT
4880.000000	55.97	74.00	18.03	149	355	VERT
7320.400000	43.72	74.00	30.28	318	324	HORI
9767.400000	46.11	74.00	27.89	396	53	HORI
12220.000000	41.95	74.00	32.05	99	285	HORI
14663.600000	48.96	74.00	25.04	221	0	VERT
17081.800000	52.34	74.00	21.66	312	128	HORI

EUT MODULE	Satellite Receiver Ed2	MODE	Transmit, High Channel
INPUT POWER	18 VDC	FREQUENCY RANGE	30MHz – 26 GHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

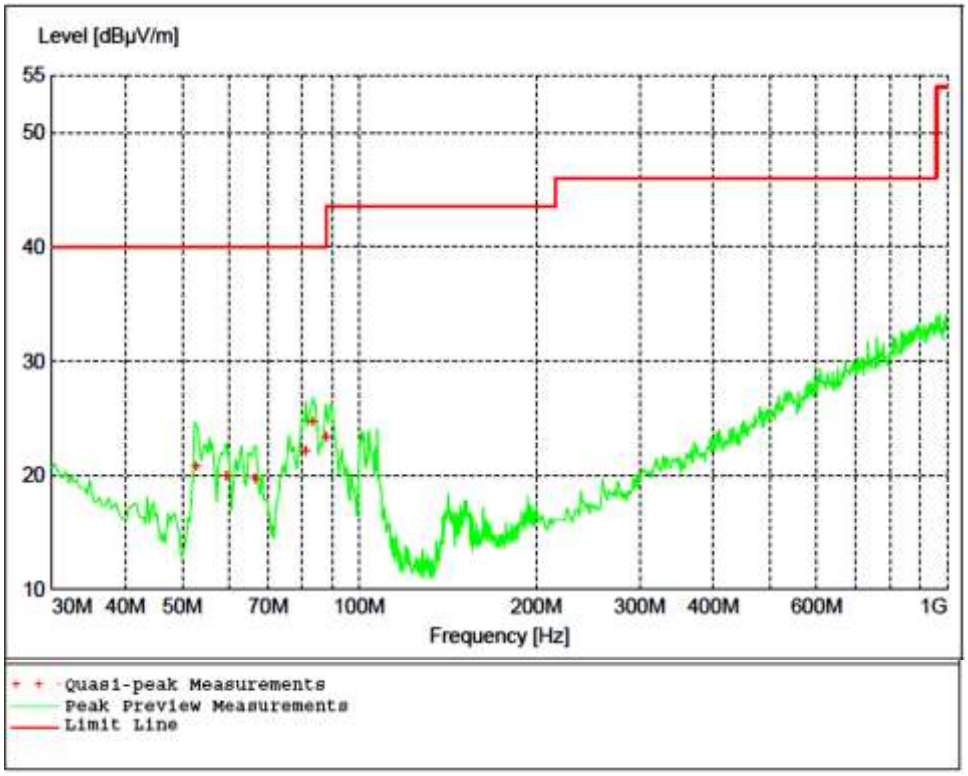

Figure 5 - Radiated Emissions Plot, High Channel
Vertical orientation was found to be the worse-case

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 9 - Radiated Emissions Quasi-peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
52.740000	20.74	40.00	19.30	100	0	VERT
59.460000	19.86	40.00	20.10	203	28	VERT
66.540000	19.70	40.00	20.30	100	13	VERT
81.000000	22.11	40.00	17.90	163	0	VERT
83.340000	24.67	40.00	15.30	100	10	VERT
87.900000	23.37	40.00	16.60	146	0	VERT

Table 10 - Radiated Emissions Average Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2480.000000	72.87	NA	NA	115	228	VERT
4960.000000	34.67	54.00	19.33	100	195	VERT
7417.400000	22.59	54.00	31.41	396	202	HORI
9926.200000	25.46	54.00	28.54	229	141	VERT
12421.000000	25.48	54.00	28.52	393	65	HORI
14882.800000	29.57	54.00	24.43	190	94	VERT
17370.600000	32.62	54.00	21.38	368	4	VERT

Note: Average Level = Peak Level – Duty Cycle Correction Factor
Duty Cycle Correction Factor is calculated in Figures 6, 7 and 8. 20dB was used.

Table 11 - Radiated Emissions Peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2480.000000	92.87	NA	NA	115	228	VERT
4960.000000	54.67	74.00	19.33	100	195	VERT
7417.400000	42.59	74.00	31.41	396	202	HORI
9926.200000	45.46	74.00	28.54	229	141	VERT
12421.000000	45.48	74.00	28.52	393	65	HORI
14882.800000	49.57	74.00	24.43	190	94	VERT
17370.600000	52.62	74.00	21.38	368	4	VERT

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

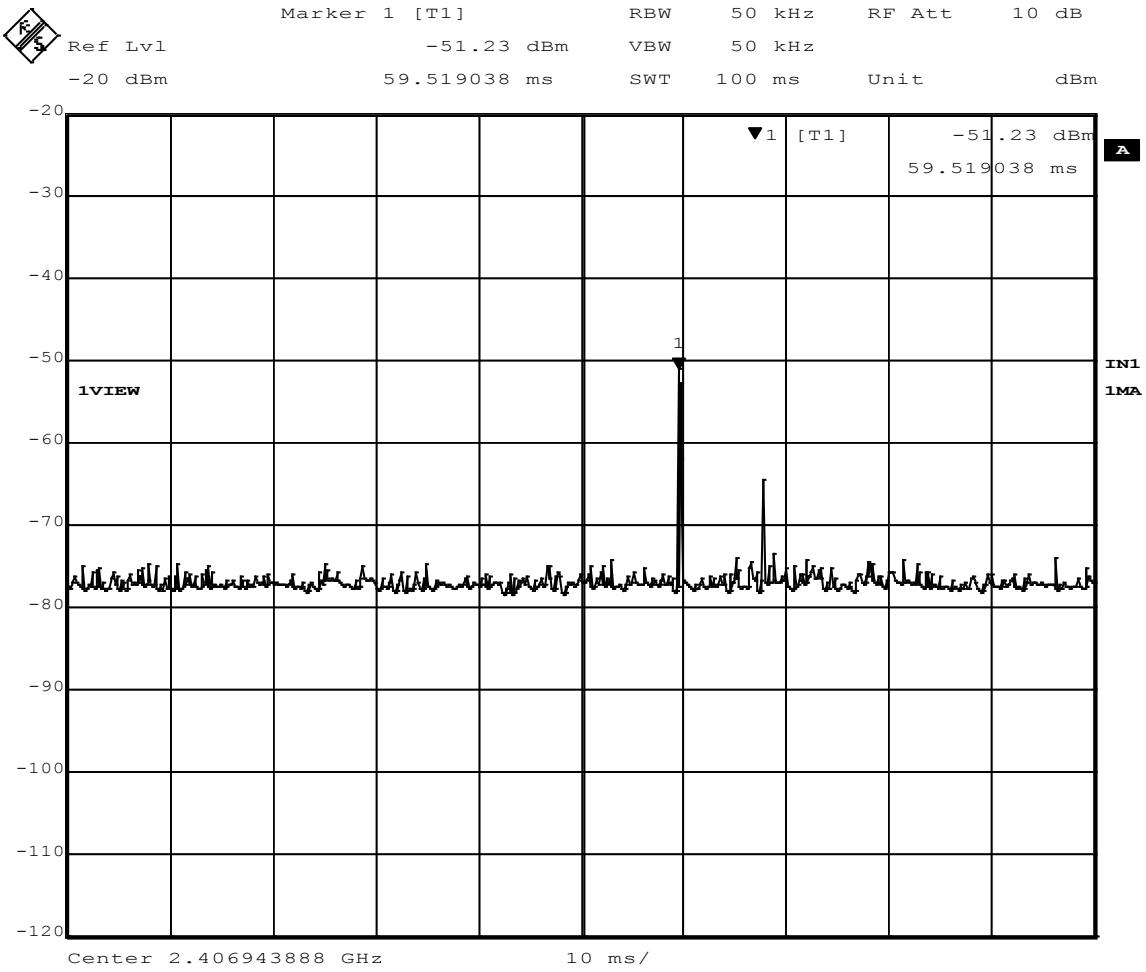

Figure 6 – Duty Cycle 1

A maximum 1 pulses can occur in any 100 ms window

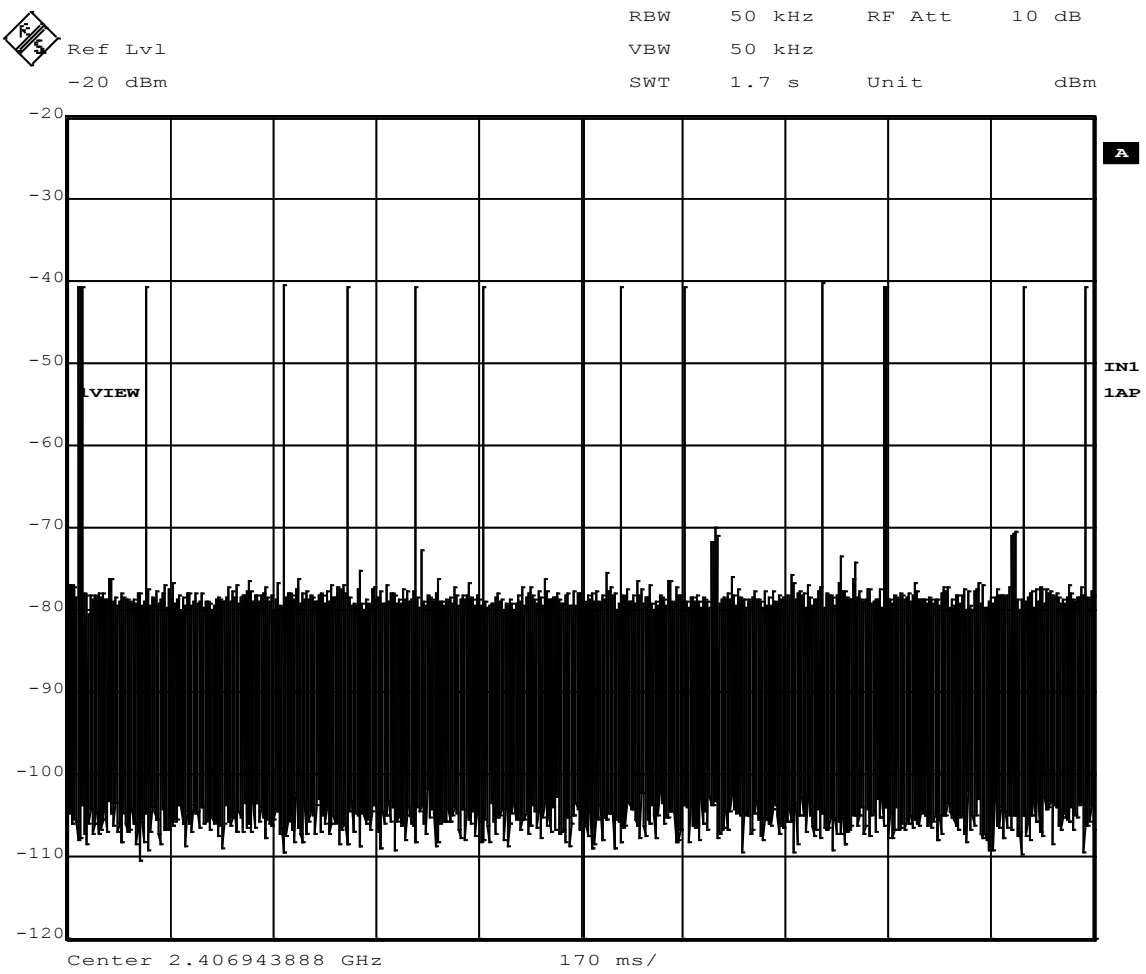

Figure 7 – Duty Cycle 2

A maximum 1 pulses can occur in any 100 ms window

Note: The transmissions at approximately -70 dBm are from the remote. The receiver would not transmit unless prompted by the eremote. These transmissions are ignored.

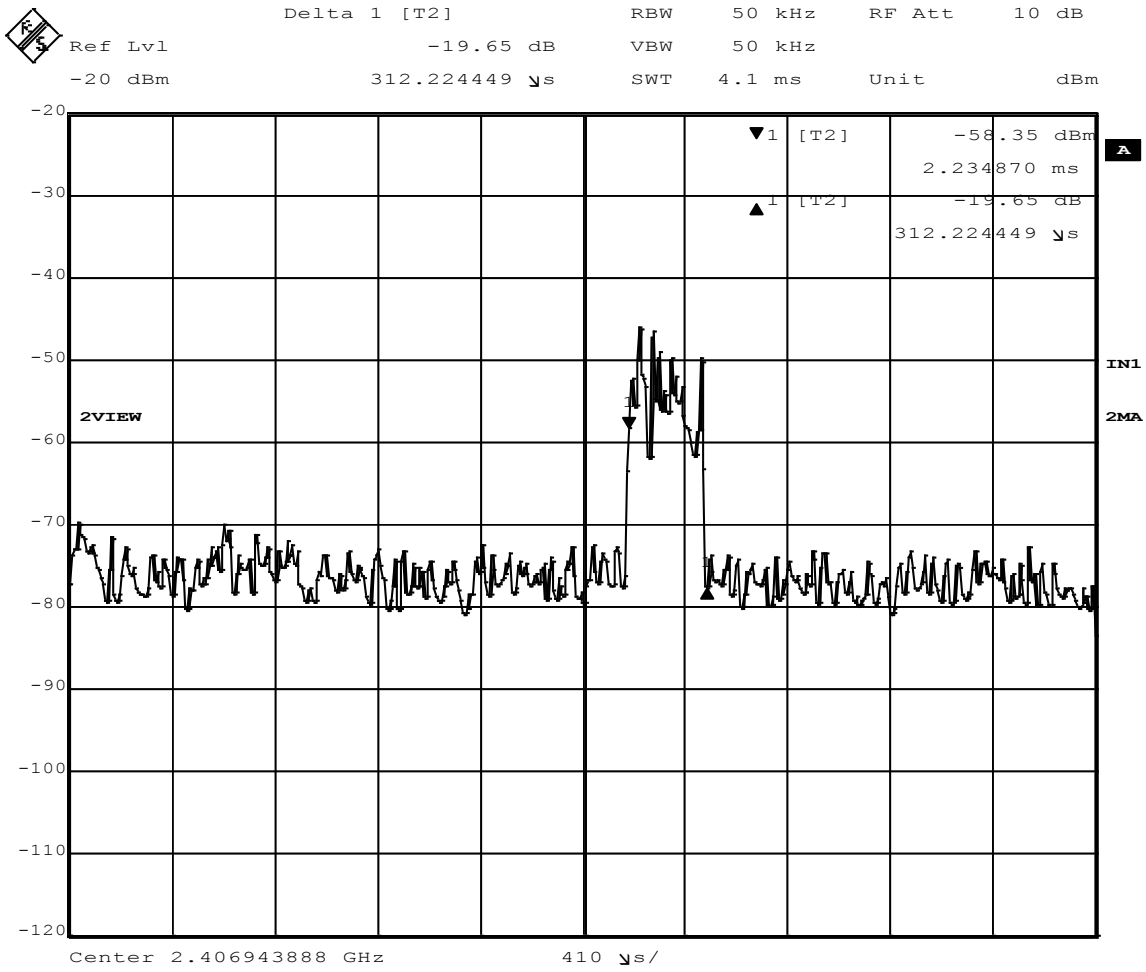

Figure 8 – Maximum Pulse Width

Duty cycle correction factor = 20*log((0.312)/100) = -50.11 dB

Note 1: 100ms is the longest allowed period per FCC Part 15.35

Note 2: 20dB is the maximum useable averaging factor, so that was used.

Note 3: that the initial pulse seen on the plot that is below -55 dBm is from the remote that was used to activate the EUT. It is not considered part of the duty cycle.

4.3 Bandwidth and Peak EIRP

4.3.1 Limits of bandwidth measurements

The 99% occupied bandwidth and peak EIRP are displayed for informational purposes only.

The peak EIRP was measured using a 10 MHz RBW, which was over-laid on the plot showing the bandwidth using a 1 MHz RBW.

4.3.2 Test procedures

All measurements were taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 1MHz RBW and 10 MHz VBW.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then captured with a 1 MHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

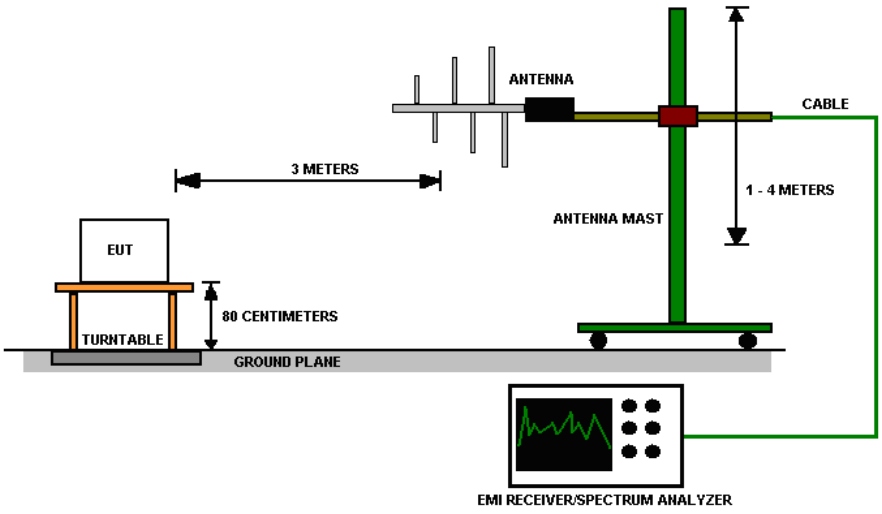

Figure 9 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 18 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.3.6 Test results

EUT MODULE	Satellite Receiver Ed2	MODE	Transmit
INPUT POWER	18 VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

99% Occupied Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW (MHz)
1	2407	3.22
2	2440	3.28
3	2480	3.28

REMARKS:
None

Peak EIRP

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK POWER OUTPUT (dBm)	RESULT
1	2407	-1.76	PASS
2	2440	-1.91	PASS
3	2480	-1.63	PASS

All measurements were taken from the 99% occupied bandwidth screen captures.

REMARKS:
None

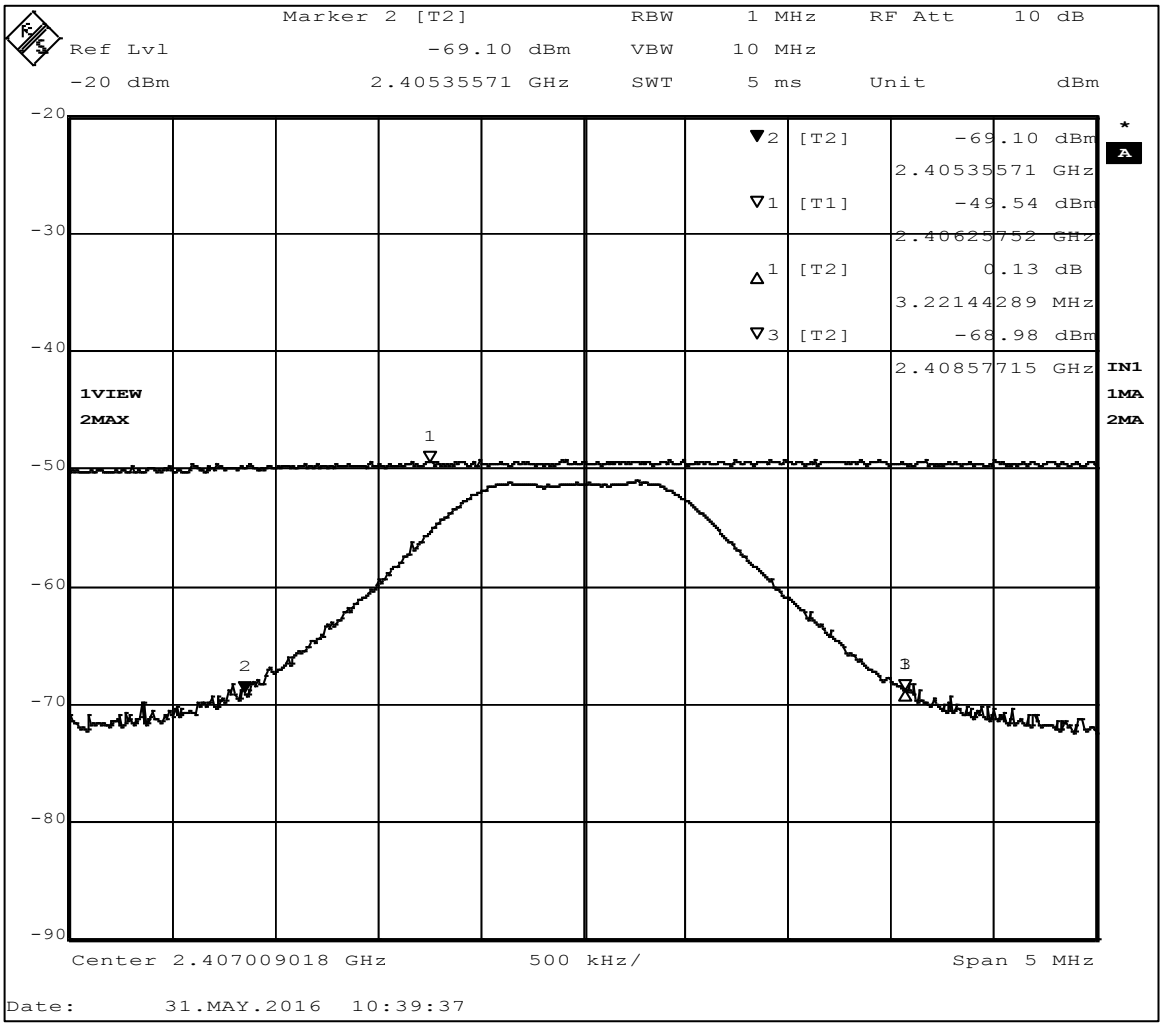

Figure 10 - 99% Occupied Bandwidth, Low Channel. 3.22 MHz

Maximum power = -49.54 dBm + 107 + CL + AF - 95.23 = -1.76 dBm

CL = cable loss = 7.70 dB
AF = antenna factor = 28.31 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 1 MHz RBW.

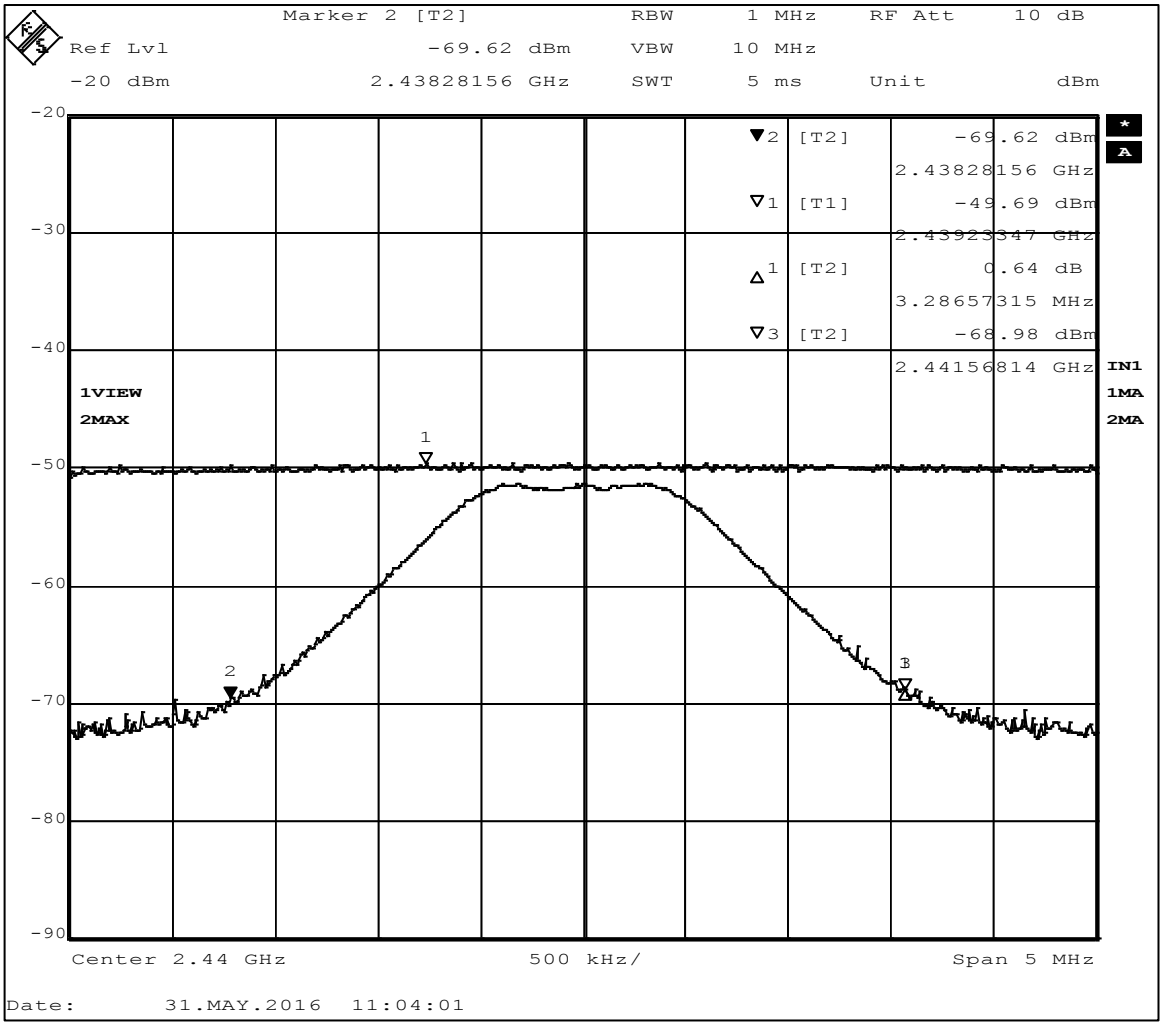

Figure 11 - 99% Occupied Bandwidth, Mid Channel, 3.28 MHz

Maximum power = -49.69 dBm + 107 + CL + AF - 95.23 = -1.91 dBm

CL = cable loss = 7.70 dB
AF = antenna factor = 28.31 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 1 MHz RBW.

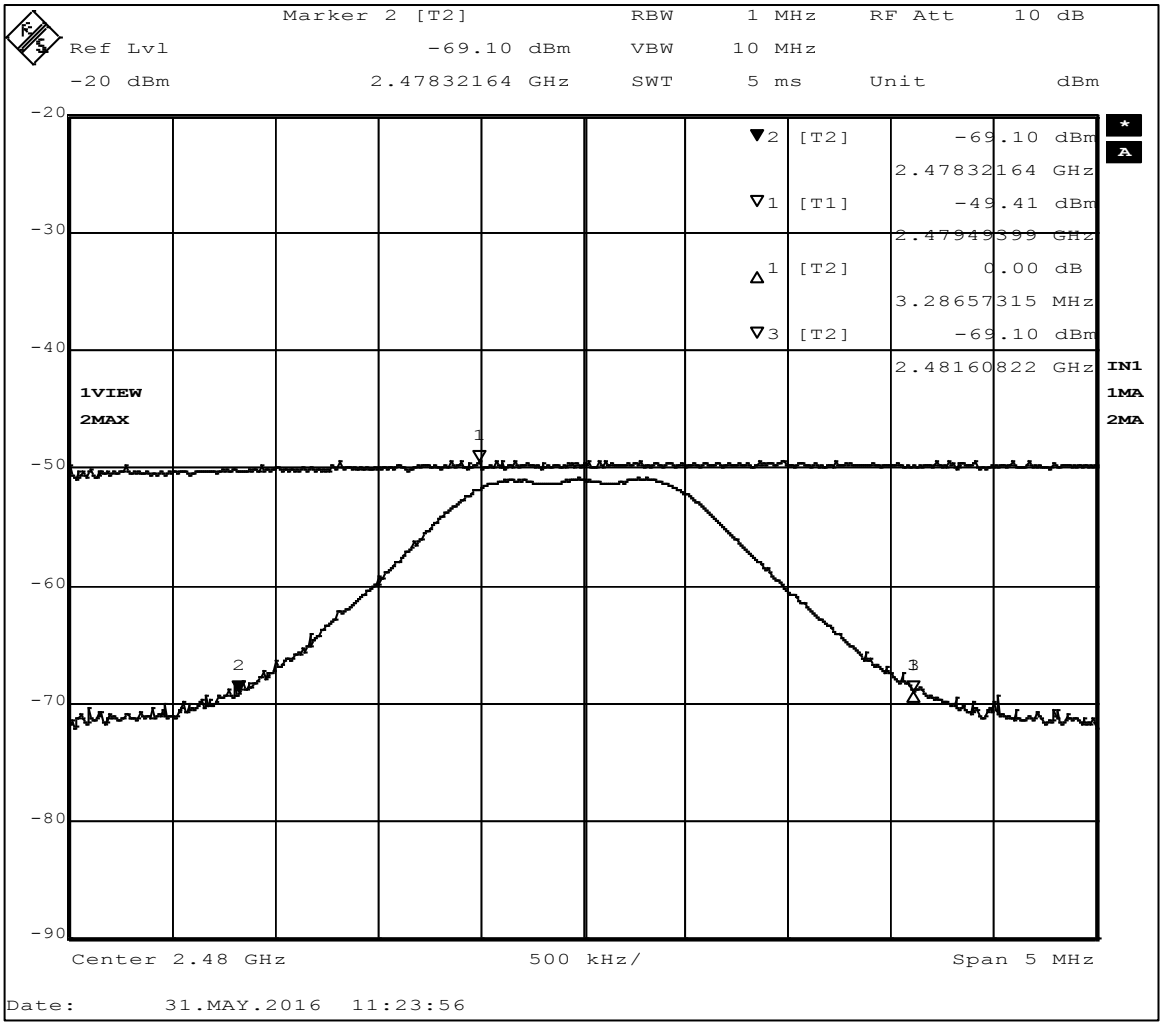

Figure 12 - 99% Occupied Bandwidth, High Channel, 3.28 MHz

Maximum power = -49.41dBm + 107 + CL + AF - 95.23 = -1.63 dBm

CL = cable loss = 7.70 dB
AF = antenna factor = 28.31 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance.

Note: the trace at the top where Marker 1 is located was made with a 10MHz resolution bandwidth and saved on the screen. The trace on the bottom was made with a 1 MHz RBW.

4.4 Bandedges

4.4.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (2400.0MHz – 2483.5MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.4.2 Test procedures

The EUT was tested in the same method as described in section *4.3 - Bandwidth*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 30kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

See Section 4.3

4.4.5 EUT operating conditions

The EUT was powered by 18 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.4.6 Test results

EUT MODULE	Satellite Receiver Ed2	MODE	Transmit
INPUT POWER	18 VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level dBm	Relative Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	2390.0	-107.29	-54.99	52.30	17.88	PASS
3	2483.5	-107.00	-54.25	52.75	18.87	PASS

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

From Section 4.2

Fundamental average field strength at 2407MHz for low channel = 71.88dBµV/m
Fundamental average field strength at 2480MHz for high channel = 72.87dBµV/m

Channel 1 minimum delta = 71.88 – 54.0 dBµV/m = 17.88 dBc
Channel 3 minimum delta = 72.87 – 54.0 dBµV/m = 18.87 dBc

Measurements do not include correction factors and are intended to be relative measurements only.

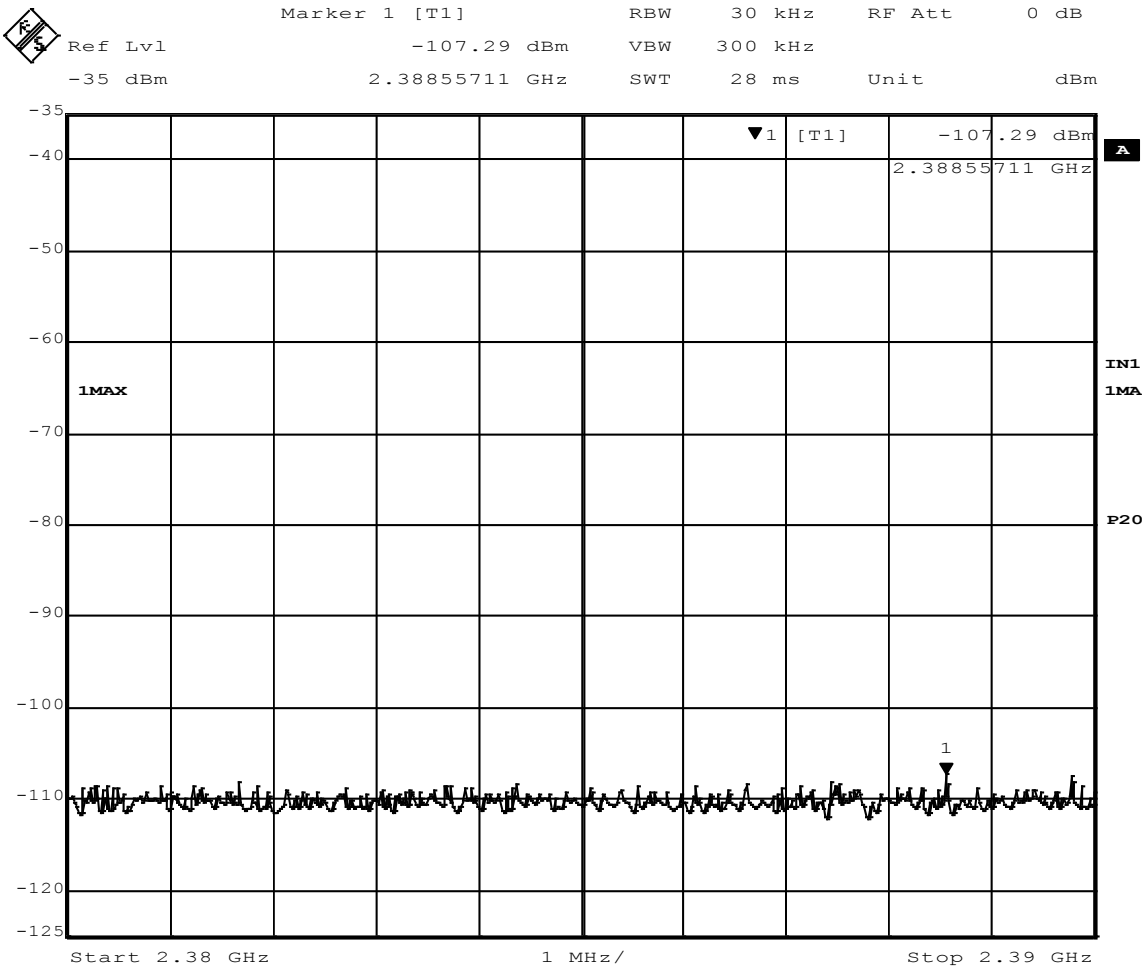

Figure 13 - Band-edge Measurement, Low Channel, Restricted Frequency

The plot shows an uncorrected measurement, used for relative measurements only.

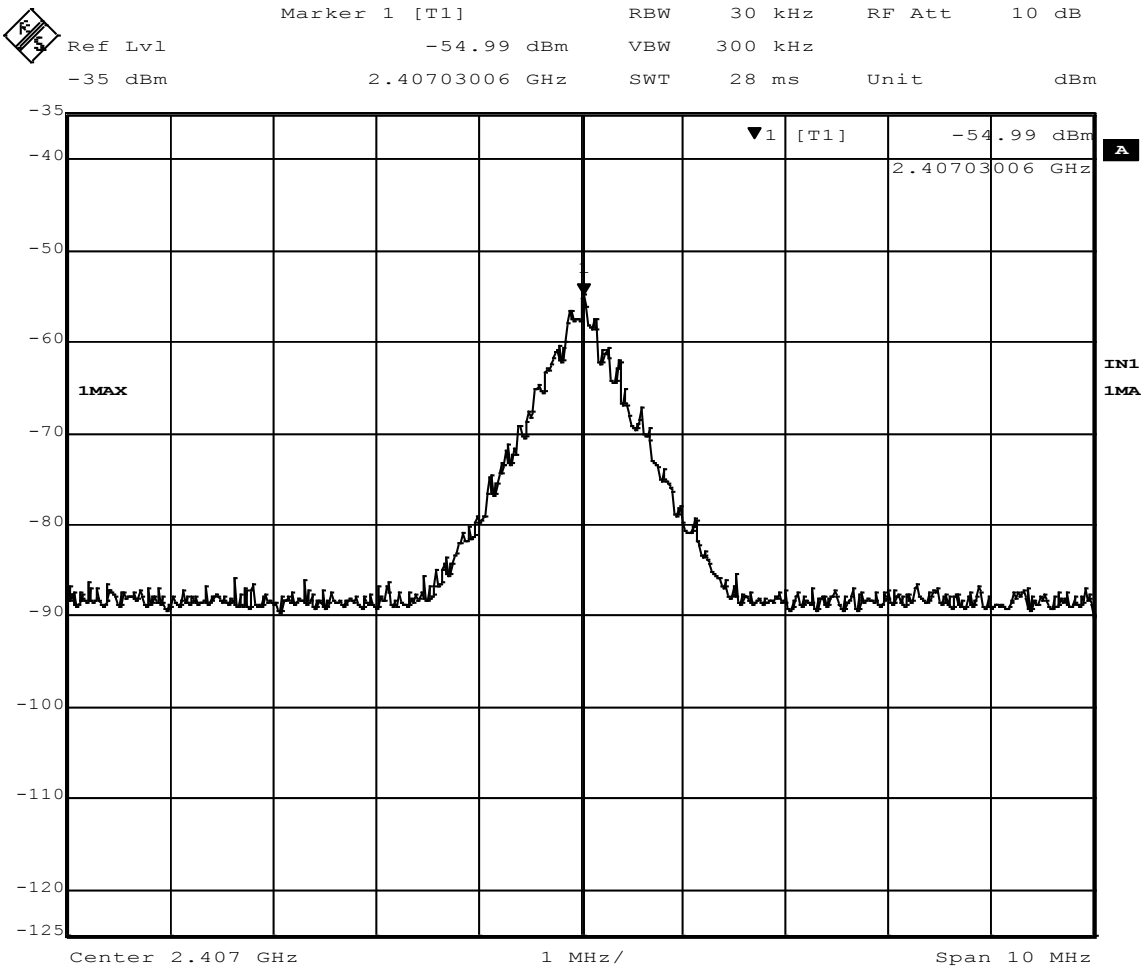

Figure 14 - Band-edge Measurement, Low Channel, Fundamental

The plot shows an uncorrected measurement, used for relative measurements only.

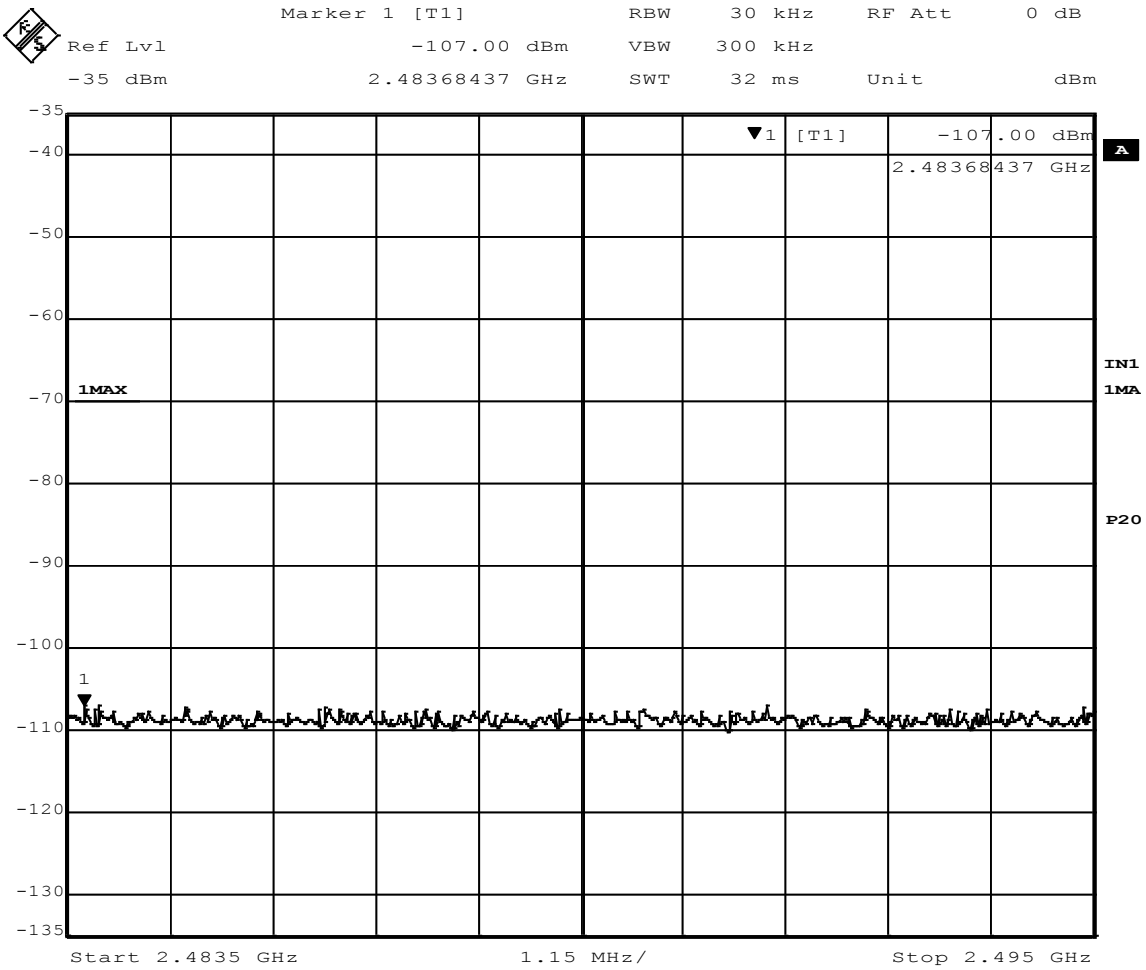

Figure 15 - Band-edge Measurement, High Channel, Restricted Frequency

The plot shows an uncorrected measurement, used for relative measurements only.

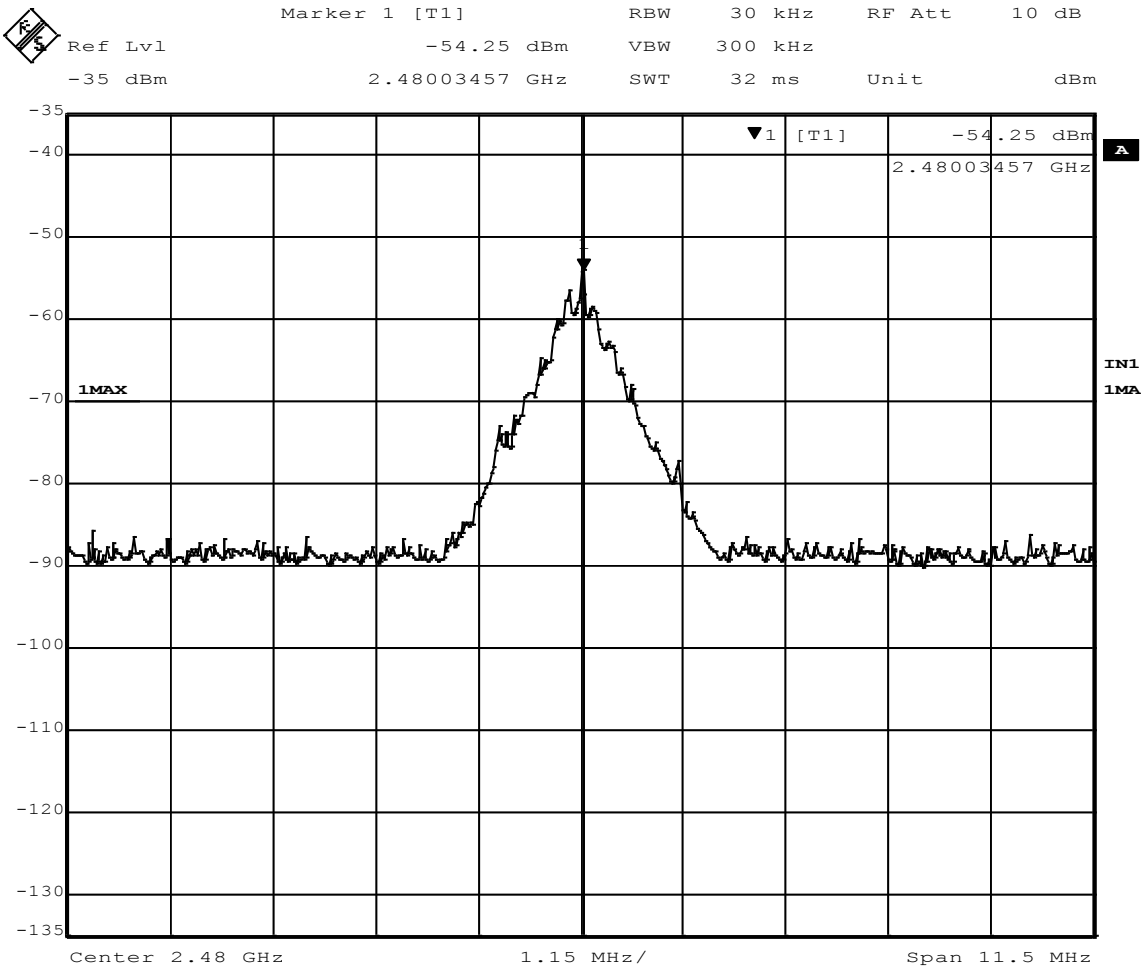

Figure 16 - Band-edge Measurement, High Channel, Fundamental

The plot shows an uncorrected measurement, used for relative measurements only.

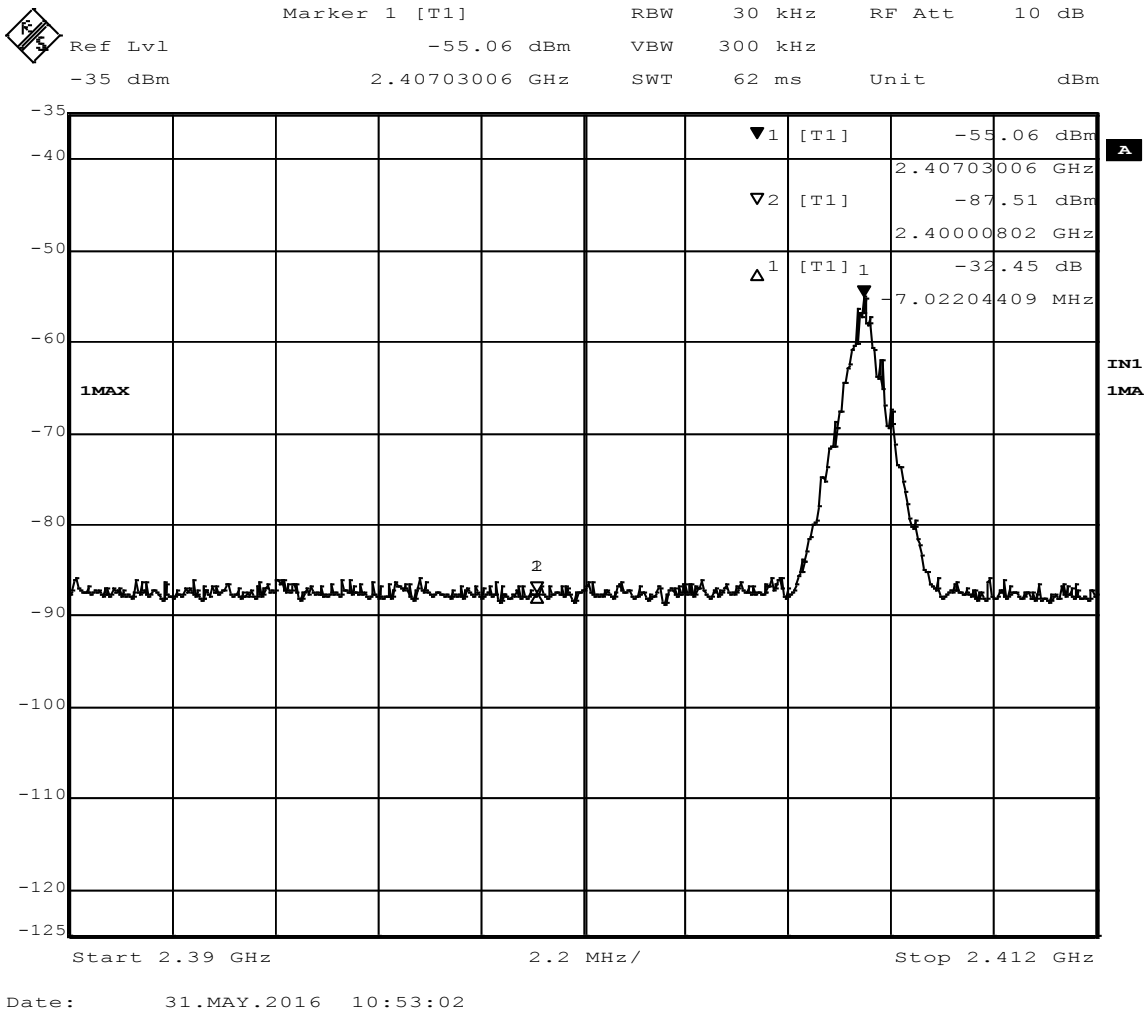

Figure 17 – Band-edge Measurement, High Channel, out-of-band

Delta = 32.45 dB Minimum = 20 dB

4.5 *Conducted AC Mains Emissions*

4.5.1 Limits for conducted emissions measurements

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: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.5.2 Test Procedures

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits could not be reported.
d. Results were compared to the 15.207 limits.

4.5.3 Deviation from the test standard

No deviation

4.3.4 Test setup

See photographs in Appendix A

4.3.5 EUT operating conditions

The EUT was powered by 18 VDC unless specified and set to transmit continuously on the Middle channel of its operating range.

4.3.6 Test Results

EUT MODULE	Satellite Receiver Ed2	MODE	Transmit (middle channel used)
INPUT POWER	18 VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	50 % ± 5% RH 23 ± 3ºC	TECHNICIAN	KVepuri

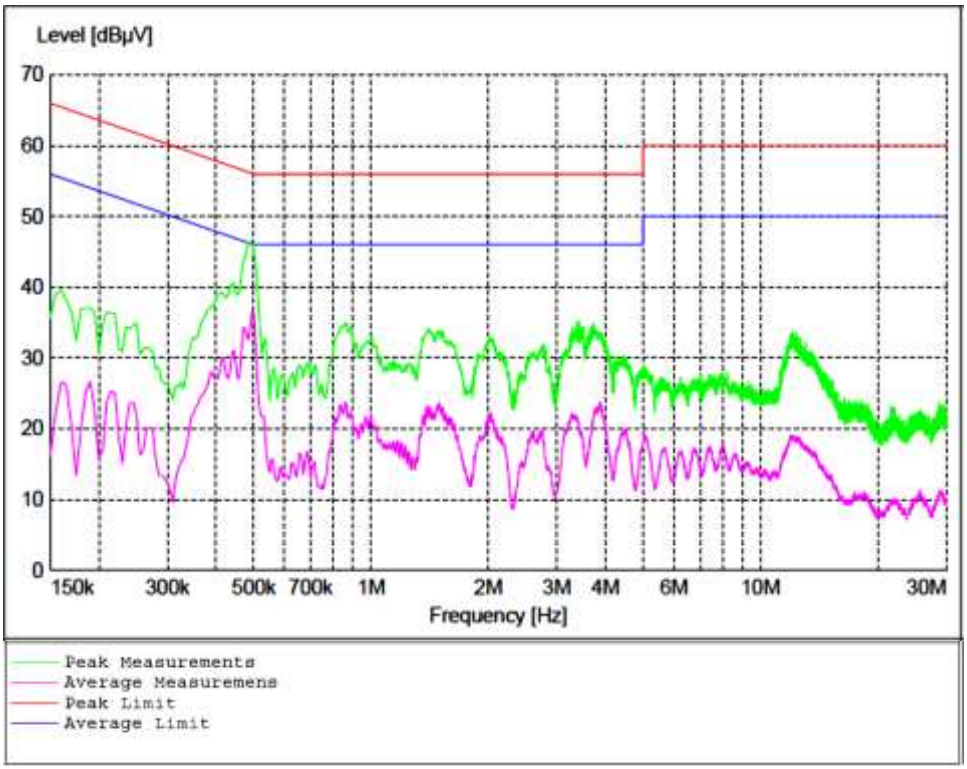

Figure 18 - Conducted Emissions Plot

All measurements were found to be at least 10dB below the applicable limit.

Appendix A: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBµV/m) = Field Strength (dBm) = 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = (FS x d^2)/30 = FS [(d^2)/30] = FS [0.3}

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = -95.23

10log(10^) is the conversion from micro to milli

Annex B – Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

Expanded uncertainty values are calculated to a confidence level of 95%.

Appendix B: Table of Figures

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