FCC / IC Test Report

FOR:

Philips Respironics Inc.

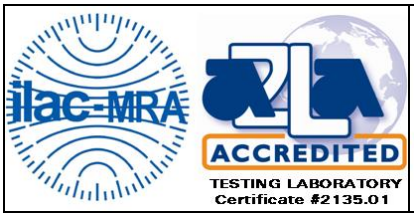
Philips Dream Station

Continuous Airway Pressure Device with Bluetooth Radio (BDR/EDR)
(limited single modular approval of the Bluetooth modular transmitter)

FCC ID: THO1116426
IC ID: 3234B-1116426, Model: 1116426

47 CFR Part 15.247
RSS-210 Issue 8 & RSS-Gen Issue 4

TEST REPORT #: EMC_PHIL4-00-14001_15.247_BT_EDR
DATE: 2015-06-17



FCC accredited

IC recognized #3462B-1

***CETECOM* Inc.**
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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant IC standard RSS-210 issue 8, Annex 8.
No deviations were ascertained.

Company	Description	Marketing Name / Model No:
Philips Respironics Inc.	Continuous Airway Pressure Device with Bluetooth Radio (BDR/EDR)	700x110 (US) 700x120 (Canada)

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2015-06-17	Compliance	Franz Engert (Compliance Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com Date: 2015.06.17 18:36:36 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2015-06-17	Compliance	Kris Lasarov (EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov DN: cn=Kris Lazarov, o=CETECOM, ou, email=kris.lazarov@cetecom.com, c=US Date: 2015.06.17 18:41:24 -07'00'

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Compliance Manager:	Franz Engert
Responsible Project Leader:	Yu-Chien Ho

2.2 Identification of the Client

Client Firm/Name:	Philips Respironics Inc.
Street Address:	1740 Golden Mile Highway
City/Zip Code	Monroeville, PA 15146
Country	USA
Contact Person:	Jonathan Kurtz
Phone No.	724-387-7578
e-mail:	Jonathan.Kurtz@Philips.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Respironics Inc. (Philips Respironics)
Manufacturers Address:	1001 Murry Ridge Lane
City/Zip Code	Murrysville, PA 15668
Country	USA

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name / Model No:	700x110 (US) 700x120 (Canada)
HW Version :	00
FCC-ID :	THO1116426
IC-ID / Model no.:	3234B-1116426 / M/N: 1116426
Product Description:	Continuous Airway Pressure Device with Bluetooth BDR/EDR and LE Radio **Note: subject to this test / test report is the BDR/EDR (FHS) function of Bluetooth radio located on the motherboard of the host device (the Philips Dream Station), for limited single modular approval acc. FCC part 15.212).**
Frequency Range / number of channels:	Nominal band: 2400 – 2483.5; Center to center: 2402 (Ch.0) – 2480 (Ch.78), 79 channels
Type(s) of Modulation:	FHSS with GFSK, π /4 DQPSK, 8DPSK
Modes of Operation:	Bluetooth BDR and EDR
Antenna Information as declared:	Internal, PIFA PCB, peak gain= 1.5 dBi (typ.)
Max. Output Power:	5.13 dBm (measured with 2-DH5 and 3-DH5, peak, conducted)
Power Supply/ Rated Operating Voltage Range:	host (Dream Station): AC/DC Adapter; Input:100-240V~50-60 Hz, 2.0-1.0 A; Output: 12 V, 6.67 A; the Bluetooth chip is supplied by 3.3V acc. to documentation;
operating temperature range	5- 35°C (acc. host manual)
Prototype / Production unit	Production
Other Radios included in the device:	none (the Bluetooth LE function is part of the functional scope of the Bluetooth radio)

3.2 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	JPP251765ADA8	00	B0.0.0.2061	Radiated Sample
2	JPP25184192FB	00	B0.0.0.2061	Conducted Sample

3.3 Identification of Accessory equipment

AE #	Type	Manufacturer	Model	Serial Number
1	Humidifier	Philips Respironics Inc.	DSXH	HPP10019330E7
2	AC/DC Adapter	Delta Electronics Inc.	MDS-080AAS12 A	70HW512001W

3.4 Environmental conditions during Test:

The following environmental conditions were maintained during the course of testing:
Ambient Temperature: 20-25^{o}C
Relative humidity: 40-60%

3.5 Dates of Testing:

2015/03/09 – 2015/03/23

3.6 Testing Notes:

The EUT was set to the required test mode (hopping, non-hopping, channel, modulation option) by special test SW (EZRasp Communicator) which will not be available to end-users in production samples.

3.7 Test mode of operation with multiple modulations:

Mode	Data rate (Mbps)	Modulation scheme(*)
Bluetooth BDR/EDR	1.0 2.0 3.0	**DH5** **2-DH5** **3-DH5**

(*) DH5 stands for 5-slot data package. The number before the package gives the modulation, i.e. no number of 1- for GFSK, 2- for π /4-DQPSK and 3- for 8DPSK

4 Subject of Investigation

The objective of the evaluation documented in this report was to establish compliance of the EUT as described in section 3 with the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-210 Issue 8, Annex 8 of Industry Canada.

This test report is to support a request for new equipment authorization (limited single modular acc. to Part 15.212) under the **FCC ID THO1116426 and the IC certification number 3234B-1116426 / model no. 1116426.**

All testing was performed on the product referred to in Section 3 as EUT.

Testing procedures are based on FCC Public Notice "DA 00-705: March 30, 2000" and ANSI C63.10:2013 for FHSS systems.

Pre-evaluation has shown the highest output power when transmitting with operation mode 2-DH5 (π/4DQPSK with 5 slot package) which is therefore the mode for unwanted emission measurements.

The tests were performed with the EUT transmitter sets to low, mid and high channels where required. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

5 Summary of Measurement Results

Test Specification	Test Case	Mode	Pass	Fail	NA	NP	Result
§15.247(a)(1) RSS-210 A8.1(b)	Carrier Frequency Separation	π/4DQPSK	■	☐	☐	☐	Complies
§15.247(a)(1) RSS-210 A8.1(d)	Number of Hopping Channels	π/4DQPSK	■	☐	☐	☐	Complies
§15.247(a)(1)(iii) RSS-210 A8.3(1)	Time of occupancy	π/4DQPSK	■	☐	☐	☐	Complies
§15.247(a)(1) RSS-210 A8.1(a)	-20 dB band width	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(b)(1) RSS-210 A8.4(2)	Maximum Peak Conducted Output Power	GFSK π/4DQPSK 8DPSK	■	☐	☐	☐	Complies
§15.247(d) RSS-210 A8.5	Band edge compliance-	π/4DQPSK	■	☐	☐	☐	Complies
§15.247(d) §15.209 (a) RSS-210 A8.5 RSS-Gen 6.13	TX Spurious emissions-Radiated	π/4DQPSK	■	☐	☐	☐	Complies
§15.207(a) RSS-Gen 8.8	AC Conducted Emissions <30MHz	π/4DQPSK	■	☐	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.

6 Measurements

6.1 Radiated Measurement Procedure

Ref: ANSI C63.10 (2013)

Section 5.4: Measurements around the EUT

Measurements shall be made at a test site that incorporates a turntable allowing EUT rotation of 0° through 360°, except where the EUT is so large that a suitable turntable is not readily available. A remotely controlled turntable shall be installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. Continuous azimuth searches shall be made. The maximum field strength at the frequency being measured shall be reported in the test report.32 See ANSI C63.4 for details of the test site, turntable, and antenna positioner. Where a continuous azimuth search cannot be made, as is the case for example where the EUT is so large that a suitable turntable is not readily available, frequency scans of the EUT field strength with both polarizations of the measuring antenna shall be made, starting with a minimum of 16 azimuth angles around the EUT, nominally spaced by 22.5°, in characterizing the EUT radio-noise profile. If directional EUT radiation patterns are suspected, especially above 1 GHz then additional and smaller azimuth angles shall be examined.

Section 5.3.2: Test distance for frequencies below 30 MHz

Radiated emissions limits are usually defined at a specific distance from the EUT. Where possible, measurements shall be made at the distance specified in the limits. This might not be possible in all cases, however, due to the physical limitations of the test facility, physical access problems at the required distance (especially for measurements that must be made in situ or on-site), or levels of ambient noise or other radiated signals present at the time and location where measurements are made. See 6.4.3 for more information about antenna selection, location, and test distance. If measurements cannot practically be made at the EUT limit distance, then they may be made at a different distance (usually closer) and extrapolated to the limit distance using one of the procedures described in 6.4.4, 6.4.5, or 7.7, depending on the EUT source and size.31 The test report shall specify the extrapolation method used to determine compliance of the EUT.

Section 5.3.3: Test distance for frequencies at or above 30 MHz

Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment (see 4.3.4). Measurements shall not be performed at a distance greater than 30 m for frequencies above 30 MHz, unless it can be further demonstrated that measurements at a distance of 30 m or less are impractical. Measurements from 18 GHz to 40 GHz are typically made at distances significantly less than 3 m from the EUT. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade of distance (inverse of linear distance for field-strength measurements or inverse of linear distance-squared for power-density measurements).

ANSI C63.10 (2013)

Section 6.6.4.2: Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Section 6.6.4.3: Final radiated emissions measurements

The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

NOTES

1— Where limits are specified by agencies for both average and peak (or quasi-peak) detection, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

2—Use of waveguide and flexible waveguide may be necessary at frequencies above 10 GHz to achieve usable signal-to noise ratios at required measurement distances. If so, it may be necessary to restrict the height search of the antenna, and special care should be taken to ensure that maximum emissions are correctly measured.

3—All presently known devices causing emissions above 10 GHz are physically small compared with the beam-widths of typical horn antennas used for EMC measurements. For such EUTs and frequencies, it may be preferable to vary the height and polarization of the EUT instead of the receiving antenna to maximize the measured emissions.

6.1.1 Sample Calculations for Radiated Measurements

6.1.1.1 Field Strength Measurements:

Measurements from the Spectrum Analyzer/ Receiver are used to calculate the Field Strength, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

FS (dBµV/m) = Measured Value on SA (dBµV)+ Cable Loss (dB)+ Antenna Factor (dB/m)
Eg:

Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the above equation.

6.1.2 Measurement Uncertainty

	Uncertainty in dB radiated <30MHz	**Uncertainty in in dB radiated 30MHz - 1GHz**	**Uncertainty in dB radiated > 1GHz**	**Uncertainty in dB Conducted measurement**
standard deviation k=1	2.48	1.93	2.16	0.63
95% confidence interval in dB	4.86	3.79	4.23	1.24
95% confidence interval in dB in delta to Result	+-2.5 dB	+-2.0 dB	+- 2.3dB	+-0.7dB

6.2 Conducted Emissions Procedure AC mains

Ref: ANSI C63.10 (2013)

Section 6.2: Standard test method for ac power-line conducted emissions from unlicensed wireless devices

Section 6.2.1: General considerations
AC power-line conducted emission measurements shall be made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz, to determine the line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network. These measurements may also be required between 9 kHz and 150 kHz.

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an "off-the-shelf" unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host (see also 5.10.3).

Section 6.2.2: Measurement requirements
The LISN housing, measuring instrument case, reference ground plane, vertical conducting plane, if used, shall be bonded together.

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe, where permitted, or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

ANSI C63.10 (2013)

Section 6.2.4: Exploratory ac power-line conducted emission measurements
Exploratory tests shall be run with the modulating signal(s) specified in 5.12 applied to the EUT. Antenna(s) can be integral or detachable. If detachable, the antenna(s) shall be attached during the test. On any one convenient frequency specified in 5.5 and 5.6, exploratory measurements shall be used to identify the frequency of the emission that has the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable positions, and with a typical system equipment configuration and arrangement. For each mode of operation and for each ac power current-carrying conductor, cable manipulation shall be performed within the range of likely configurations. For this measurement or series of measurements, the frequency spectrum of interest shall be monitored looking for the emission that has the highest amplitude relative to the limit. Once that emission is found for each current-carrying conductor of each power cord associated with the EUT (but not the cords associated with non-EUT equipment in the overall system), the one configuration and arrangement and mode of operation that produces the emission closest to the limit over all of the measured conductors shall be recorded.

Section 6.2.5: Final ac power-line conducted emission measurements
Based on the exploratory tests of the EUT performed in 6.2.4, the one EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit is selected for the final measurement, while applying the appropriate modulating signal to the EUT. If the EUT is relocated from an exploratory test site to a final test site, the highest emissions shall be remaximized at the final test location before final ac power-line conducted emission measurements are performed. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) is then performed for the full frequency range for which the EUT is being tested for compliance without further variation of the EUT arrangement, cable positions, or EUT mode of operation. If the EUT is composed of equipment units that have their own separate ac power connections (e.g., floor-standing equipment with independent power cords for each shelf that are able to connect directly to the ac power network), then each current-carrying conductor of one unit is measured while the other units are connected to a second (or more) LISN(s). All units shall be measured separately. If a power strip is provided by the manufacturer, to supply all of the units making up the EUT, only the conductors in the power cord of the power strip shall be measured.

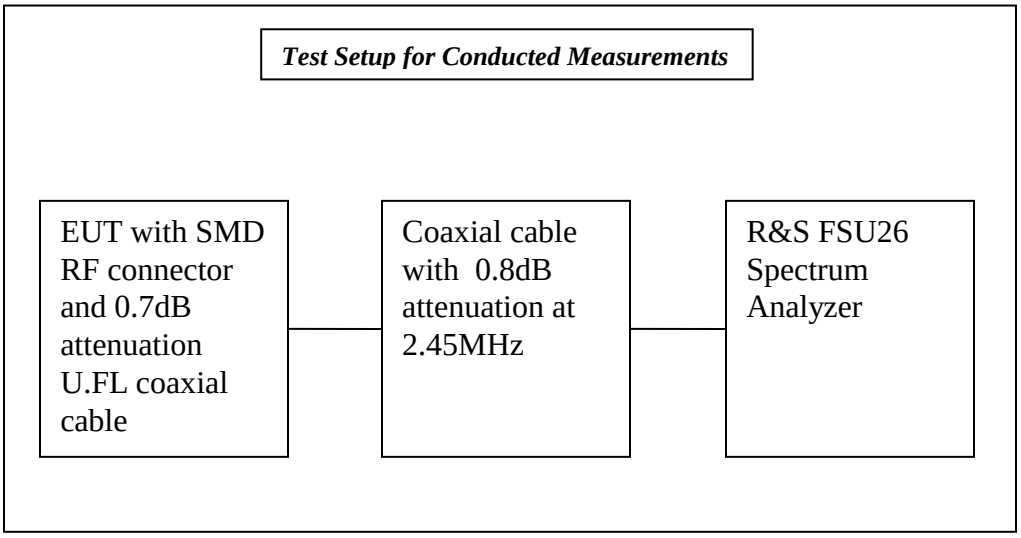
If the EUT operates above 30 MHz and uses a detachable antenna, then these measurements shall be made with a representative antenna connected to the antenna output terminals. These tests shall be made with the antenna connected and, if adjustable, fully extended.

Record the six highest EUT emissions relative to the limit of each of the current-carrying conductors of the power cords of the equipment that comprises the EUT over the frequency range specified by the procuring or regulatory agency.

6.3 RF Conducted Measurement at 50Ohm connector

6.3.1 Measurement procedure

Reference: FCC Public Notice DA 00-705:2000 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems). FCC 15.247.



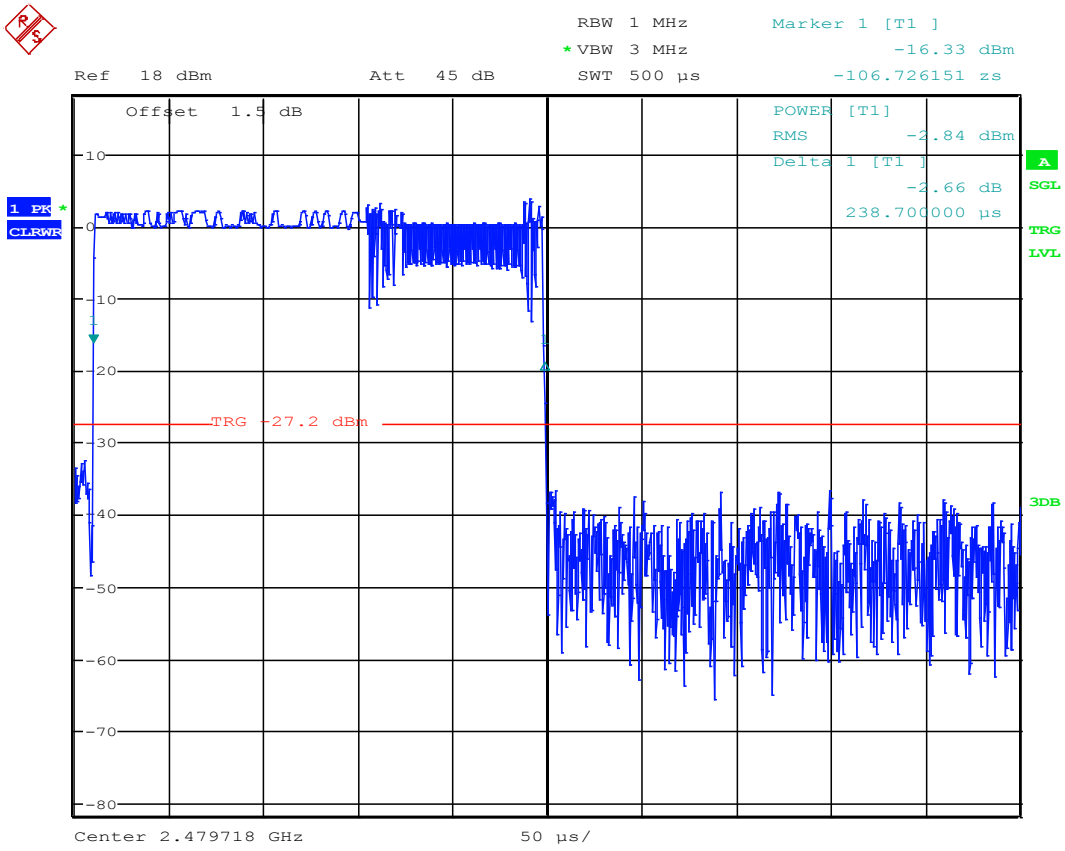
1. Connect the equipment as shown in the above diagram.
2. Adjust the settings of the SA according to the latest KDB.
3. Offset the SA for the attenuation as stated above. Use network analyzer to determine unknown attenuation.
4. Do not offset for antenna gains and duty cycles at SA. Account for these factors in result summary.
5. Antenna gains shall be considered for Average and Peak measurements. Duty cycles shall be considered for Average measurements only.
6. Measurements are to be performed for low, middle and high channels, with all modulation schemes GFSK, π/4DQPSK and 8-DPSK and with hopping on/off as per the requirements in the latest KDB.
7. Make sure to measure the duty cycle for every mode of operation where corrections are needed as it is likely to change.
8. On timing measurements make sure to use 30000 sweep points for optimum resolution and make sweep time as short as possible.
9. Measure all emissions with the mode that delivered the highest output power (worst case).

6.3.2 Measurement Uncertainty:

	Uncertainty in dB Conducted measurement
standard deviation k=1	0.63
95% confidence interval in dB	1.24
95% confidence interval in dB in delta to Result	+-0.7dB

6.3.3 Duty Cycle evaluation

6.3.4 π/4DQPSK / 2-DH5 Tx ON



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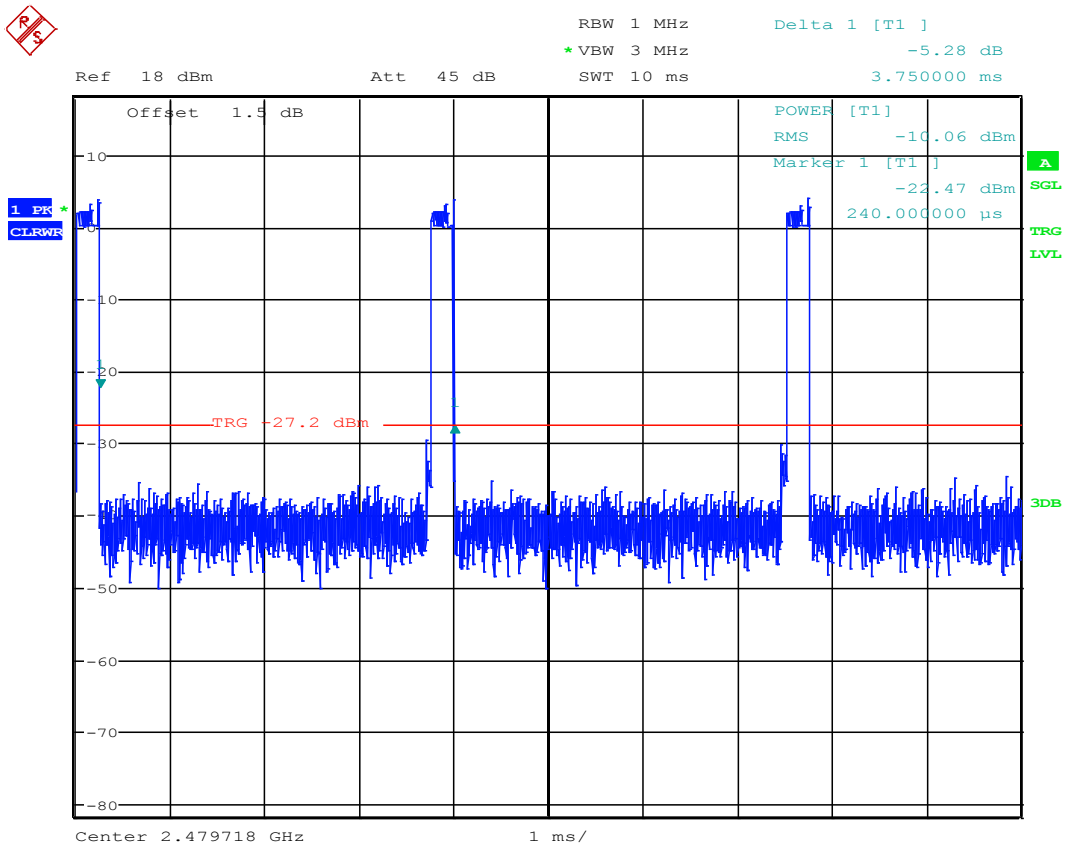
6.3.1 π/4DQPSK / 2-DH5 (Tx ON + TX OFF)



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6.3.2 Duty Cycle Correction Factor

10lg(TXon+TXoff)/TXon = 10log3750.7/239 = **12dB**

7 Maximum Peak Conducted Output Power

7.1 Limits:

Maximum Peak Output Power:
FCC §15.247 (b)(1): 1W
IC RSS-210 issue 8, annex 8.4(2): 1W
EIRP:
IC RSS-210 issue 8, annex 8.4(2): 4W

7.2 Test Conditions:

Tnom: 22°C; Vnom: 120 VAC

7.3 Test Procedure:

Refer to DA 00-705:2000
Use the marker-peak function to set the marker to the peak of the emission.

Hopping Function: Disabled.

Spectrum Analyzer settings:

Centre Frequency	The center frequency of the channel under test.
Span	Approximately 5 times the 20 dB bandwidth.
RBW	> 20 dB bandwidth of the emission being measured.
VBW	≥ RBW
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

Antenna Gain (dBi):
2.4 – 2.48GHz: 1.5 dBi

7.4 Measurement Verdict:

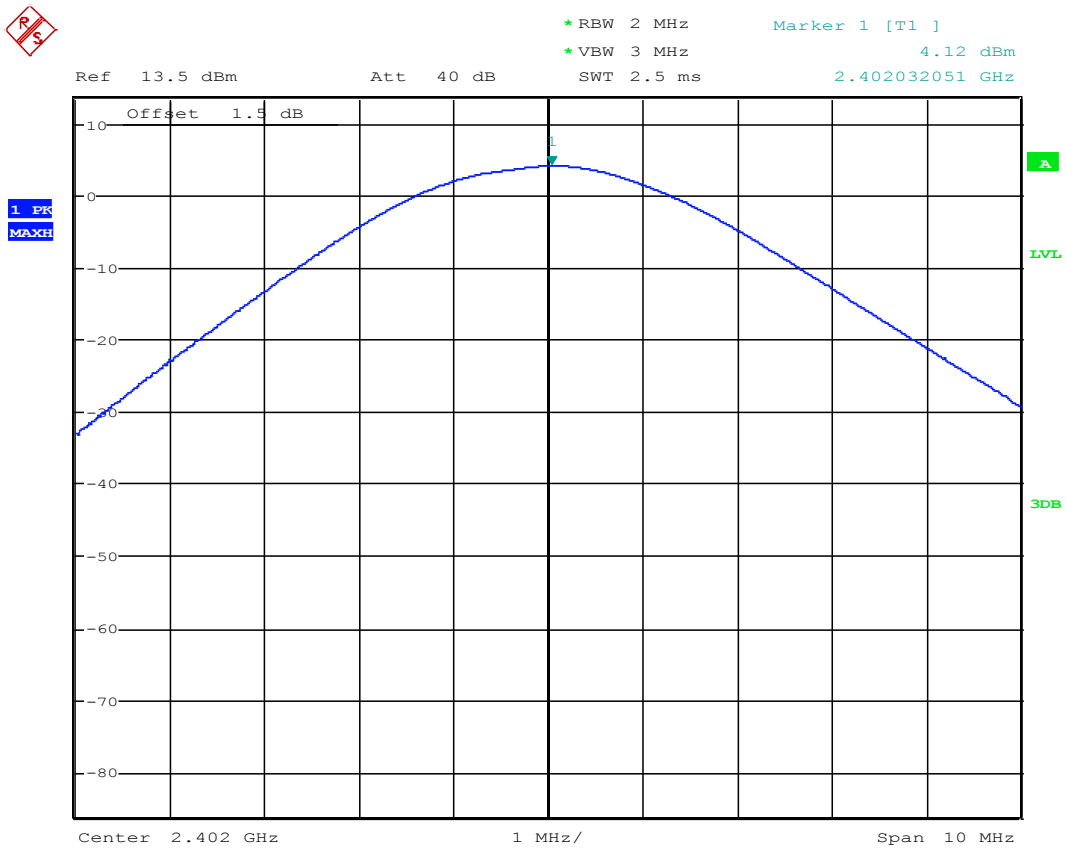
Pass

7.5 Test Result:

Maximum Peak Conducted Output Power (dBm)			
Modulation /Packet Type	**Channel 0 (2402MHz)**	**Channel 39 (2440MHz)**	**Channel 78 (2480MHz)**
QPSK / DH5	4.12 dBm	4.54 dBm	4.88 dBm
π/4DQPSK / 2-DH5	4.3 dBm	4.72 dBm	**5.13 dBm**
8-DPSK / 3-DH5	4.07 dBm	5.13 dBm	4.92 dBm

Measurement Plots:

7.5.1 Ch.0, 2402 MHz, DH5



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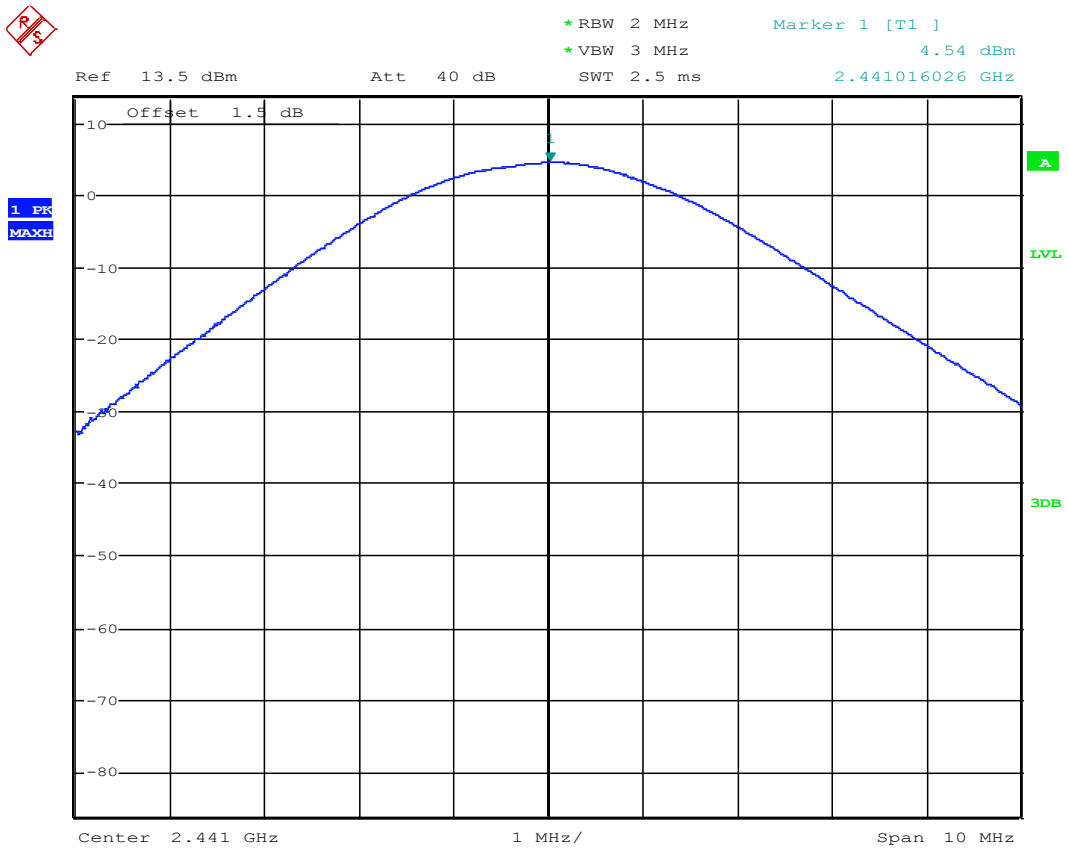
7.5.2 Ch.39, 2441 MHz, DH5



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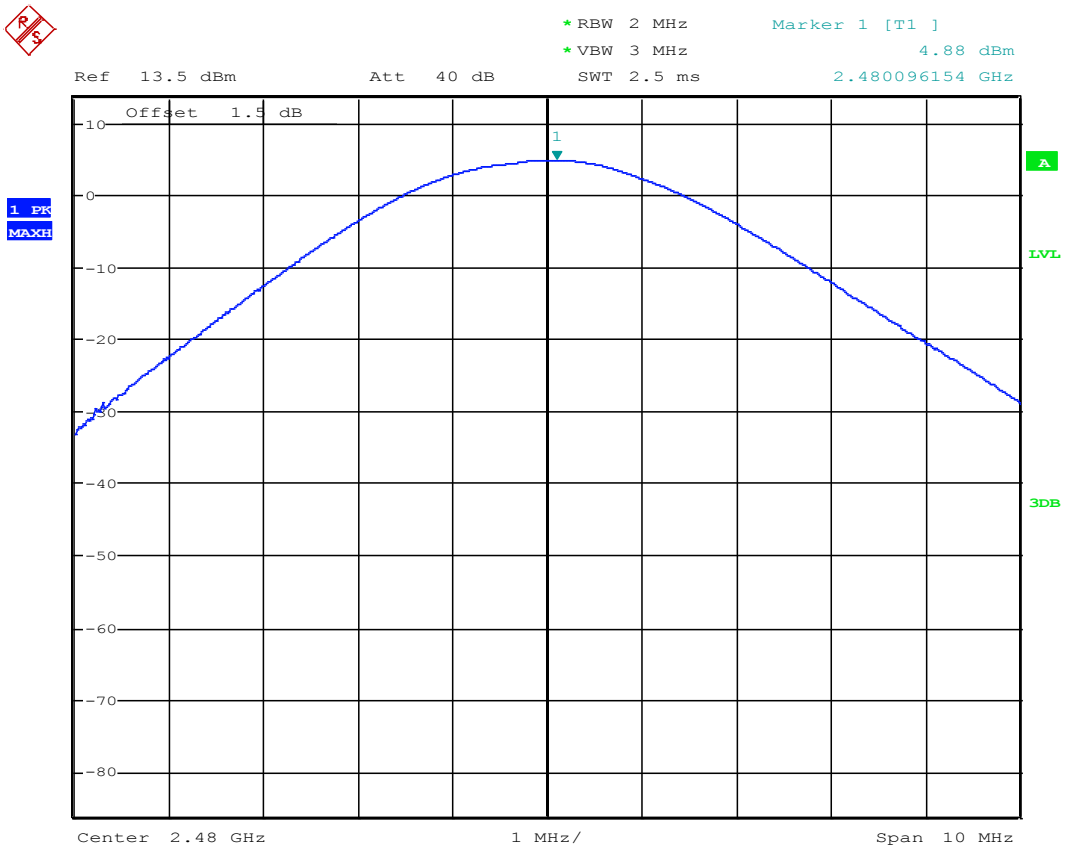
7.5.3 Ch.78, 2480 MHz, DH5



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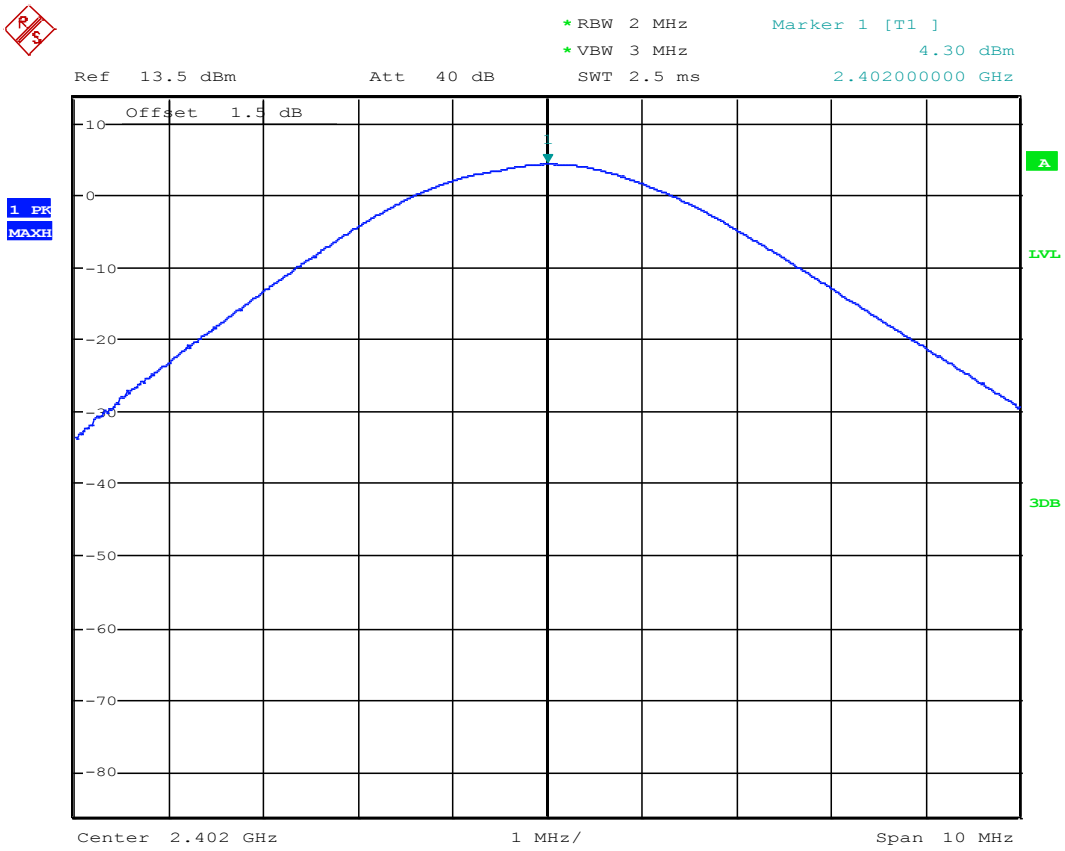
7.5.4 Ch.0, 2402 MHz, 2-DH5



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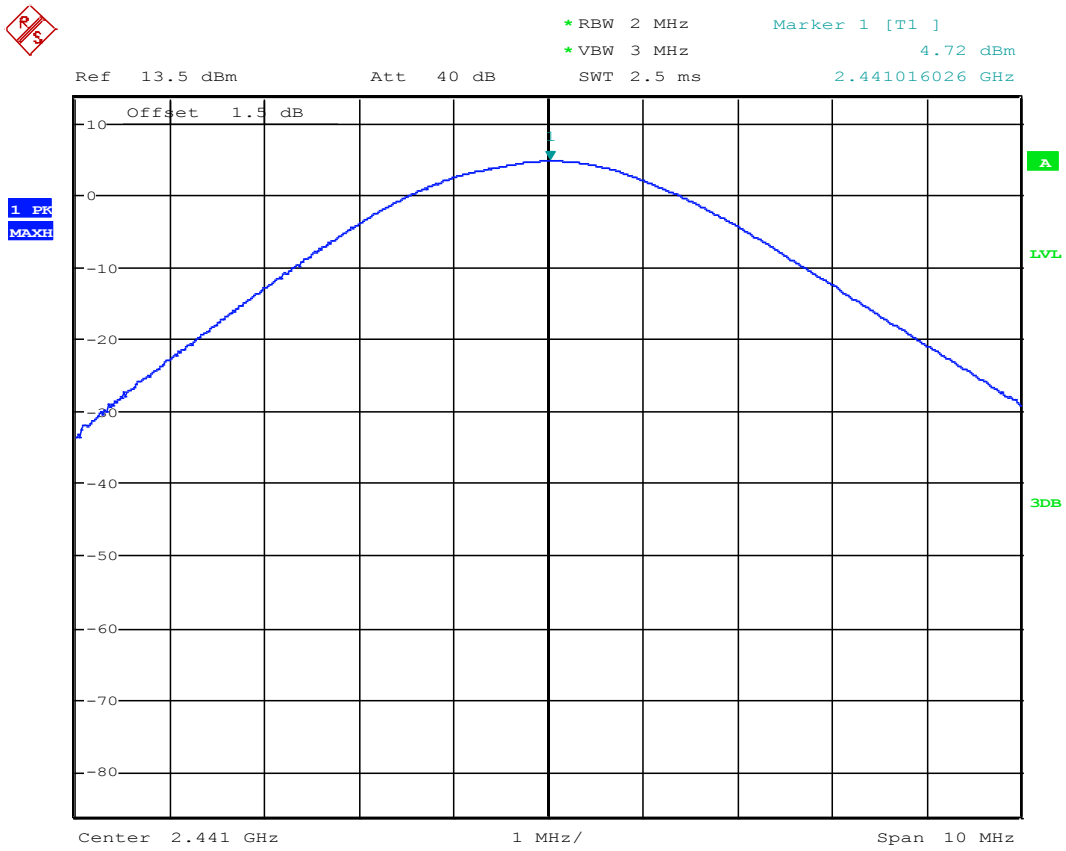
7.5.5 Ch.39, 2441 MHz, 2-DH5



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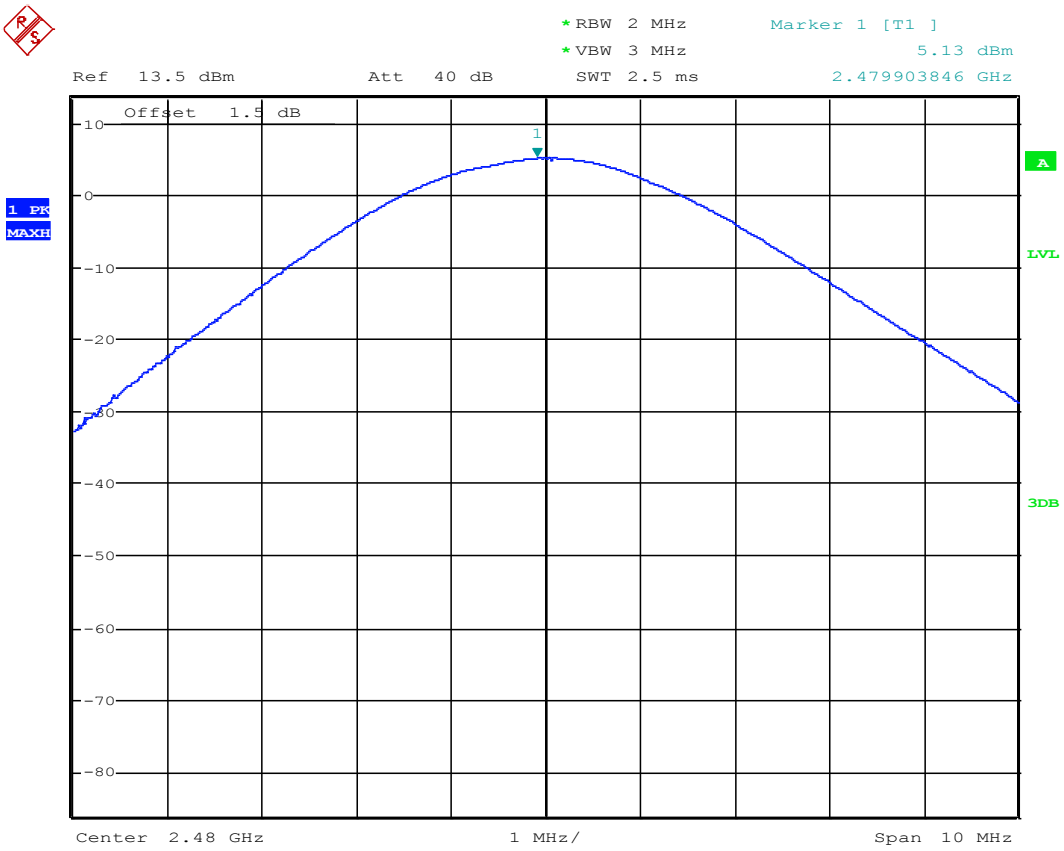
7.5.6 Ch.78, 2480 MHz, 2-DH5



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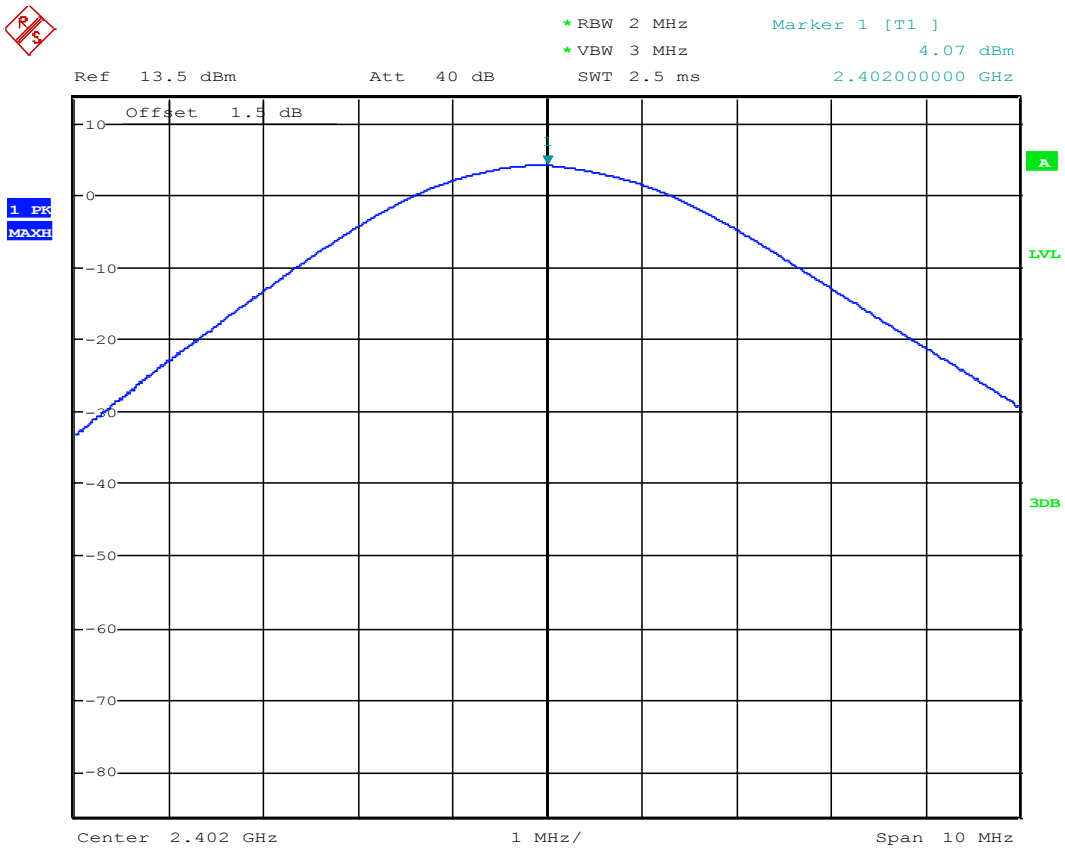
7.5.7 Ch.0, 2402 MHz, 3-DH5



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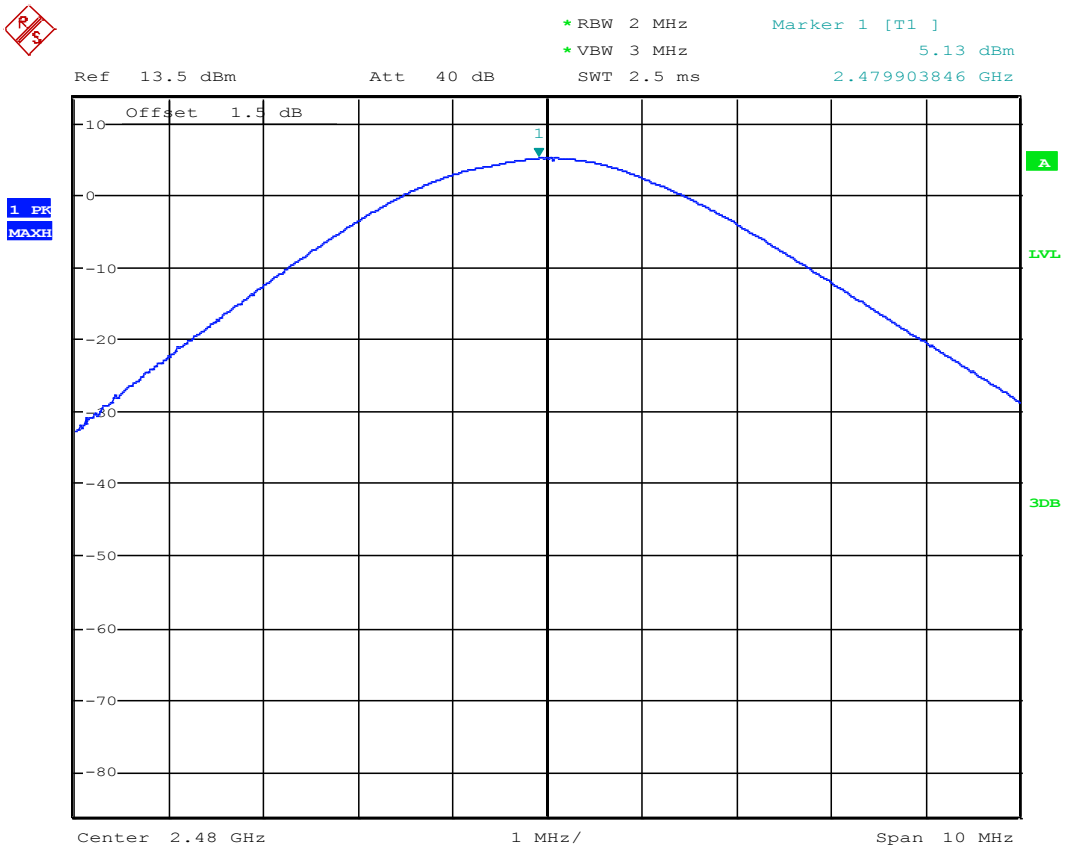
7.5.8 Ch.39, 2441 MHz, 3-DH5



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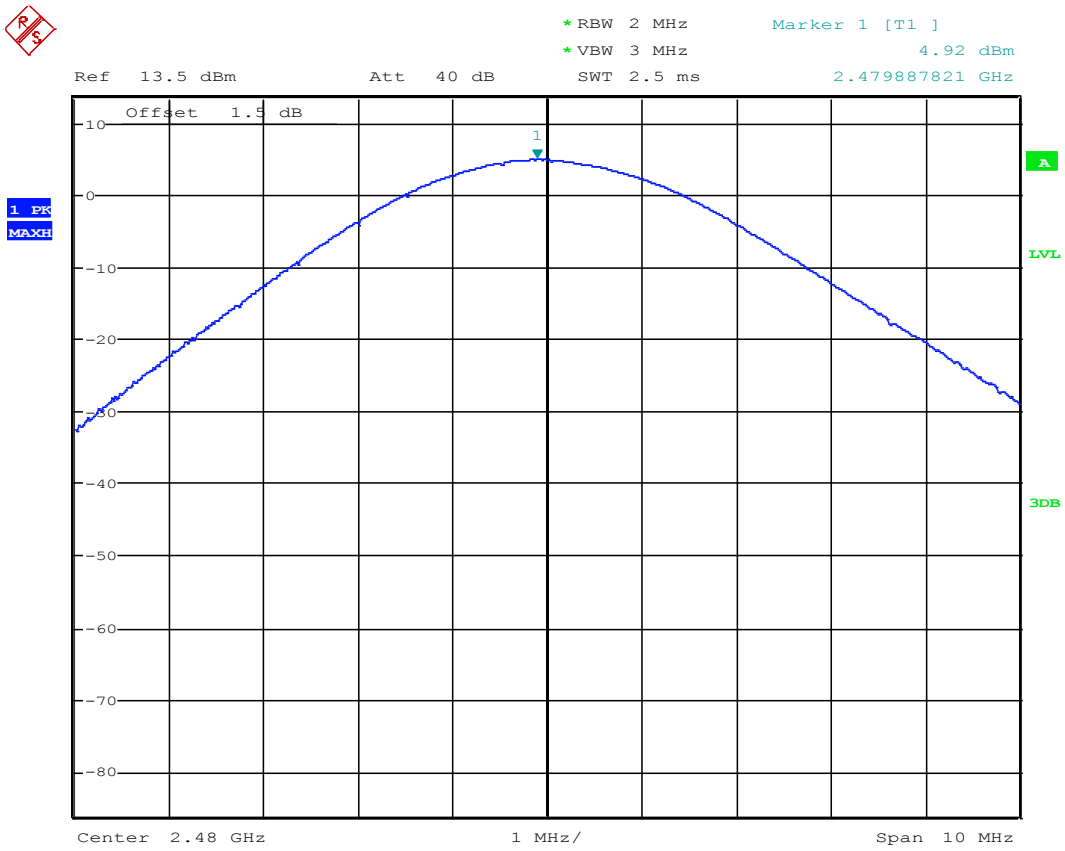
7.5.9 Ch.78, 2480 MHz, 3-DH5



Date: 10.MAR.2015 14:18:45

8 Band Edge Compliance at Restricted and Non-restricted Band Edges

8.1 Limits restricted band edge:

§15.247/15.205 & RSS-210 A8.5/RSS-Gen 8.10

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]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	([2])
13.36 - 13.41			

*PEAK LIMIT= 74dBµV/m (relates to -21.23 dBm for 3m distance)
*AVG. LIMIT= 54dBµV/m (relates to -41.23 dBm for 3m distance)

8.2 Limits non restricted band edge

FCC15.247 (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)).

RSS-210 A8.5

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.

8.3 Test Conditions

Tnom: 20°C; Vnom: 120 VAC

8.4 Test Procedure

According DA 00-705:2000 and 15.247 hopping is disabled for non restricted

The worst case modulation in terms of conducted output power has been chosen for these measurements DQPSK.

Spectrum Analyzer settings non restricted band edge:

Centre Frequency	Band Edge
Span	Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
RBW	100kHz
VBW	≥ RBW
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

Spectrum Analyzer settings for restricted band:

Peak Measurement	
Start Frequency	Band Edge
Span	From Start Frequency to 2.5GHz
RBW	1 MHz
VBW	3MHz
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

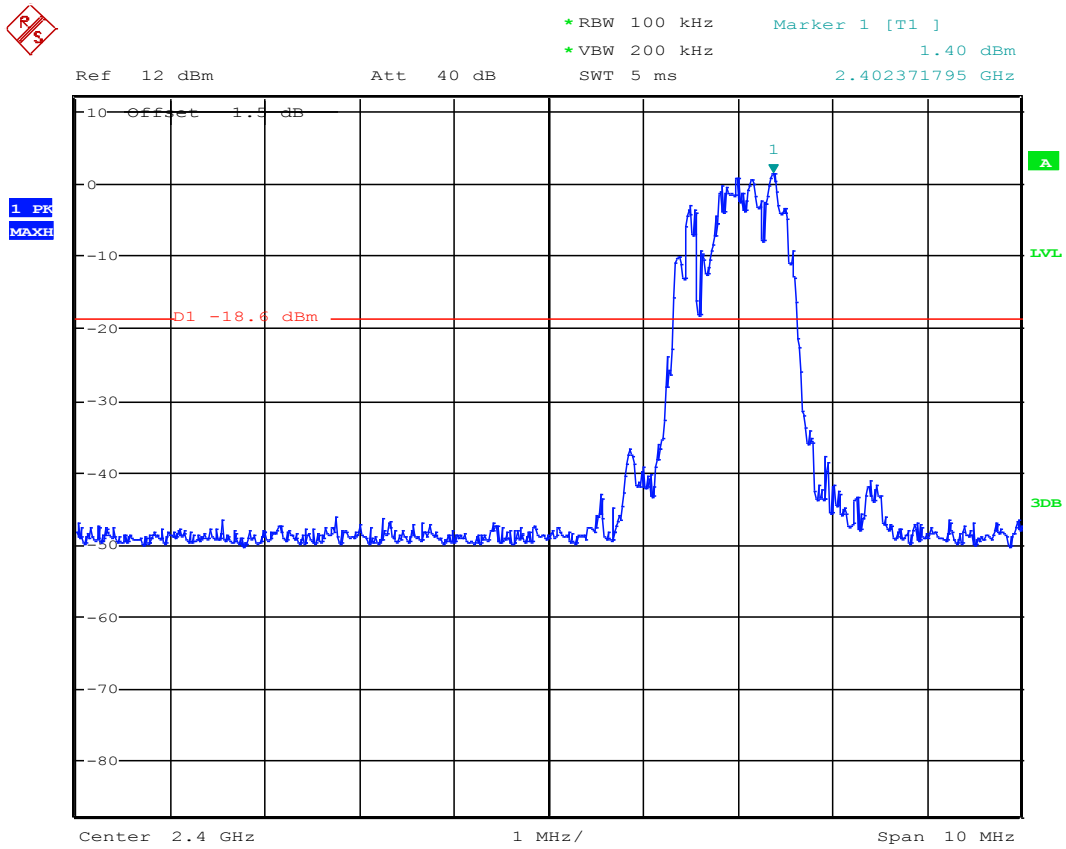
Average Measurement	
Centre Frequency	The center frequency of the channel under test
Span	From Start Frequency to 2.5GHz
RBW	1 MHz
VBW	3MHz
Sweep time	Auto
Detector	Average
Trace Mode	Average over at least 100bursts

8.5 Measurement Verdict:

Pass.

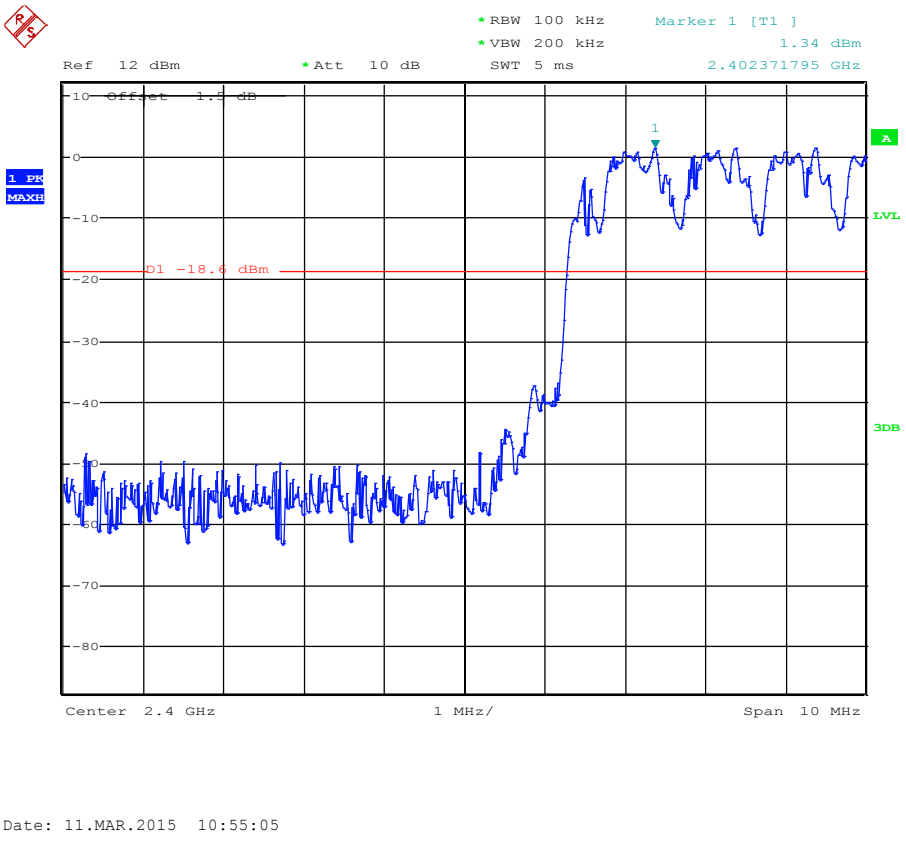
8.6 Measurement Plots:

8.6.1 Lower, non-restricted Band Edge, Hopping Disabled



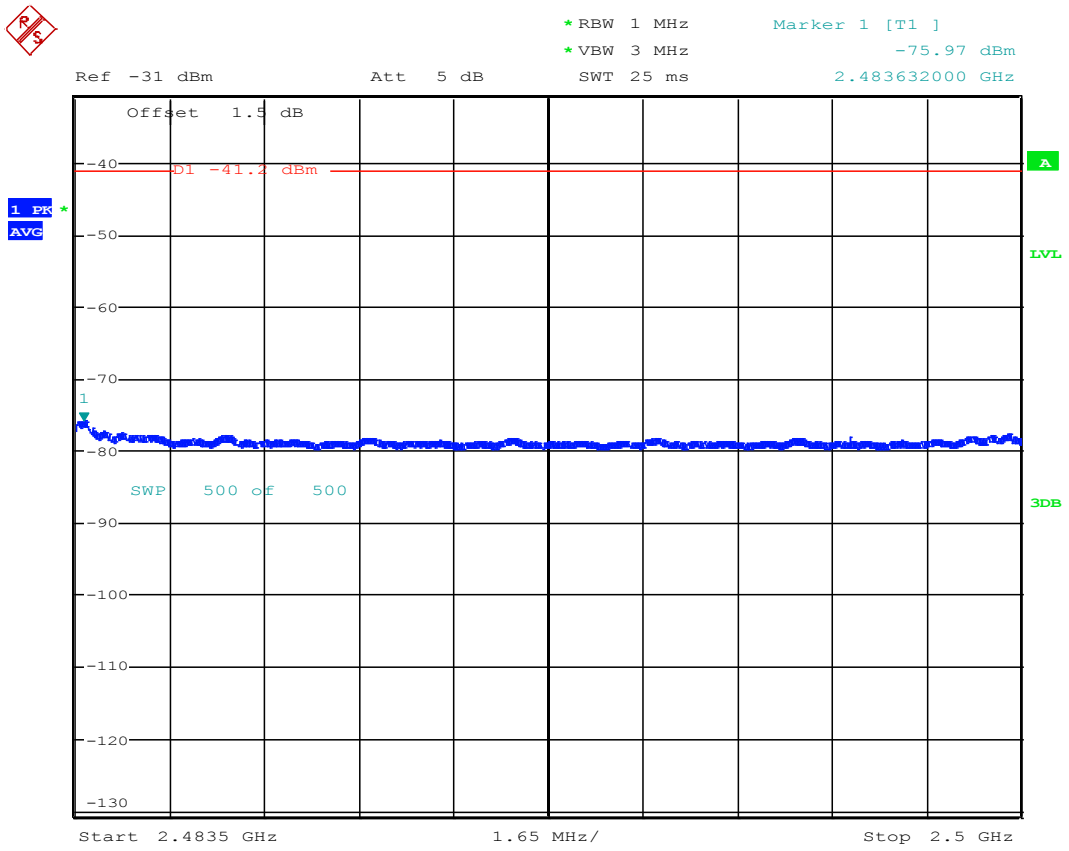
Delta TX signal max to Band Edge > 45dB, Pass

8.6.2 Lower, non-restricted Band Edge, Hopping Enabled



Delta TX signal max to Band Edge > 45dB, Pass

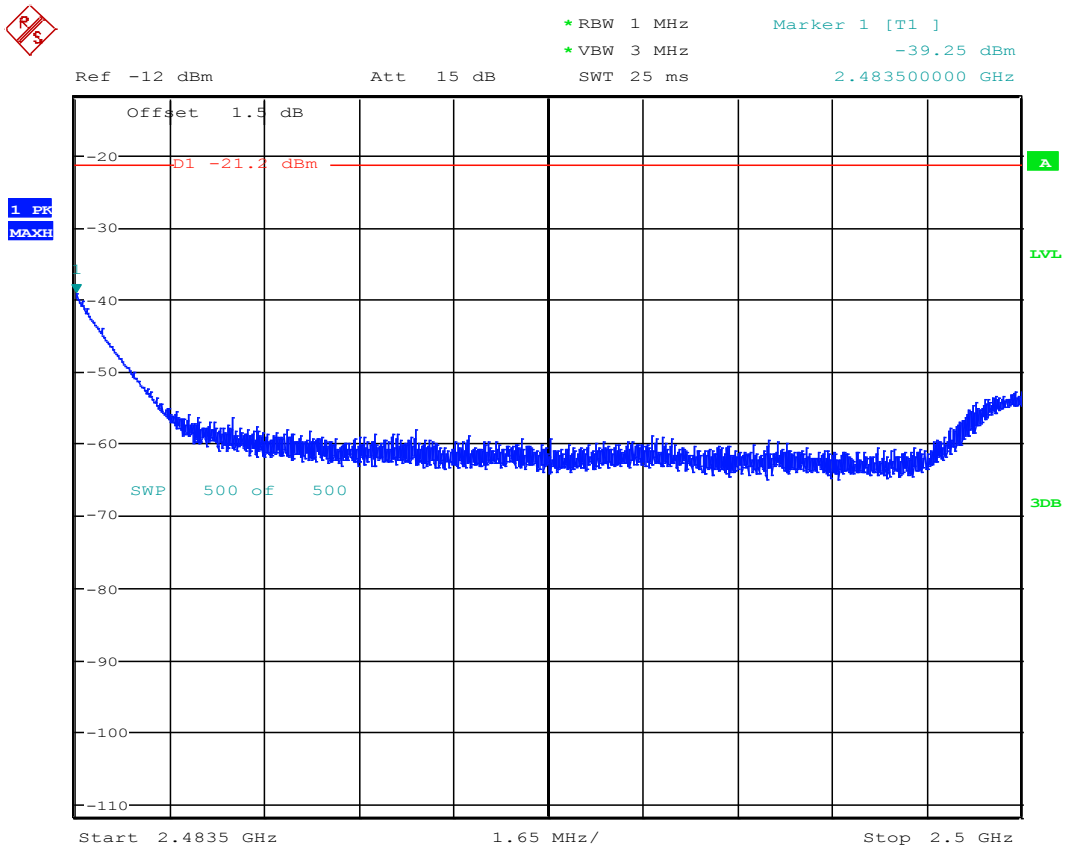
8.6.3 Upper, restricted Band Edge, fixed channel 79, average, 6%duty cycle



Date: 16.JUN.2015 11:52:19

Margin to the limit 35dB > antenna gain: +1.5dBi + Duty Cycle Offset: +12dB, PASS

8.6.4 Upper, restricted Band Edge, fixed channel 79, peak, 6%duty cycle



Date: 16.JUN.2015 11:54:53

Margin to the limit 19dB > antenna gain: +1.5dBi, PASS

9 20dB Bandwidth

9.1 Limits:

There are no immediate bandwidth limits set from FCC or IC for 2.4 GHz hopping systems but the minus-20dB bandwidth is indirectly used to establish performance criteria for the channel separation.

§15.247 (a) (1), RSS-210 A8.1 (d)
FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

9.2 Test Conditions:

Tnom: 21°C; Vnom: 120 VAC
Hopping Function: Disabled.

9.3 Test Procedure

Measurement according to DA 00-705:2000
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Spectrum Analyzer settings:

Centre Frequency	The center frequency of the channel under test
Span	Approximately 2 to 3 times the 20 dB bandwidth, centered on the hopping channel.
RBW	≥ 1% of the -20 dB bandwidth
VBW	≥ RBW
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

9.4 Measurement Verdict:

n/a

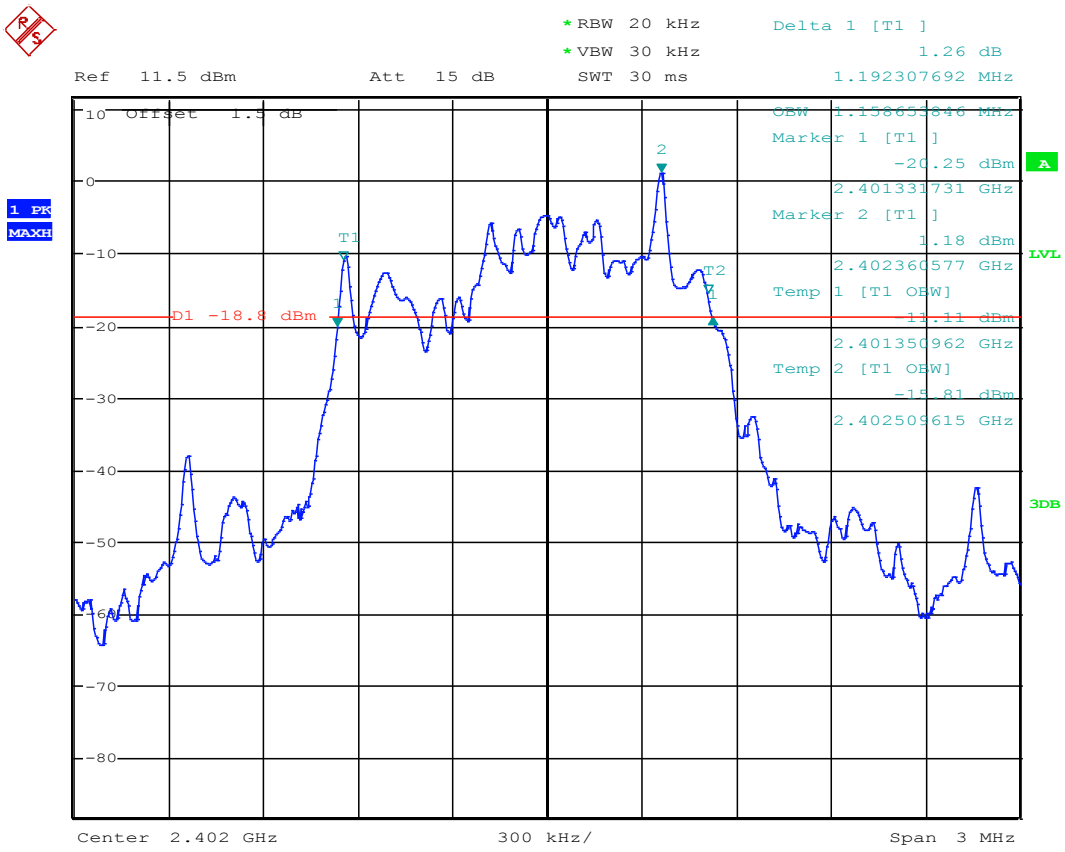
9.5 Test Results:

20dB Bandwidth in MHz (and 2/3 value used as channel separation limit)						
Modulation /Packet Type	**Channel 0 (2402MHz)**		**Channel 39 (2441MHz)**		**Channel 78 (2480MHz)**	
	-20dB BW	**2/3 of -20dB BW**	**-20dB BW**	**2/3 of -20dB BW**	**-20dB BW**	**2/3 of -20dB BW**
QPSK / DH5	1.197	0.80	1.19	0.67	1.19	0.67
π/4DQPSK / 2-DH5	1.26	0.84	1.26	0.84	1.27	0.85
8-DPSK / 3-DH5	1.15	0.77	1.16	0.73	1.17	0.78

Since 2/3 of the -20dB BW is > than 25kHz the limits for channel separation are set by the 2/3 BW values in above table

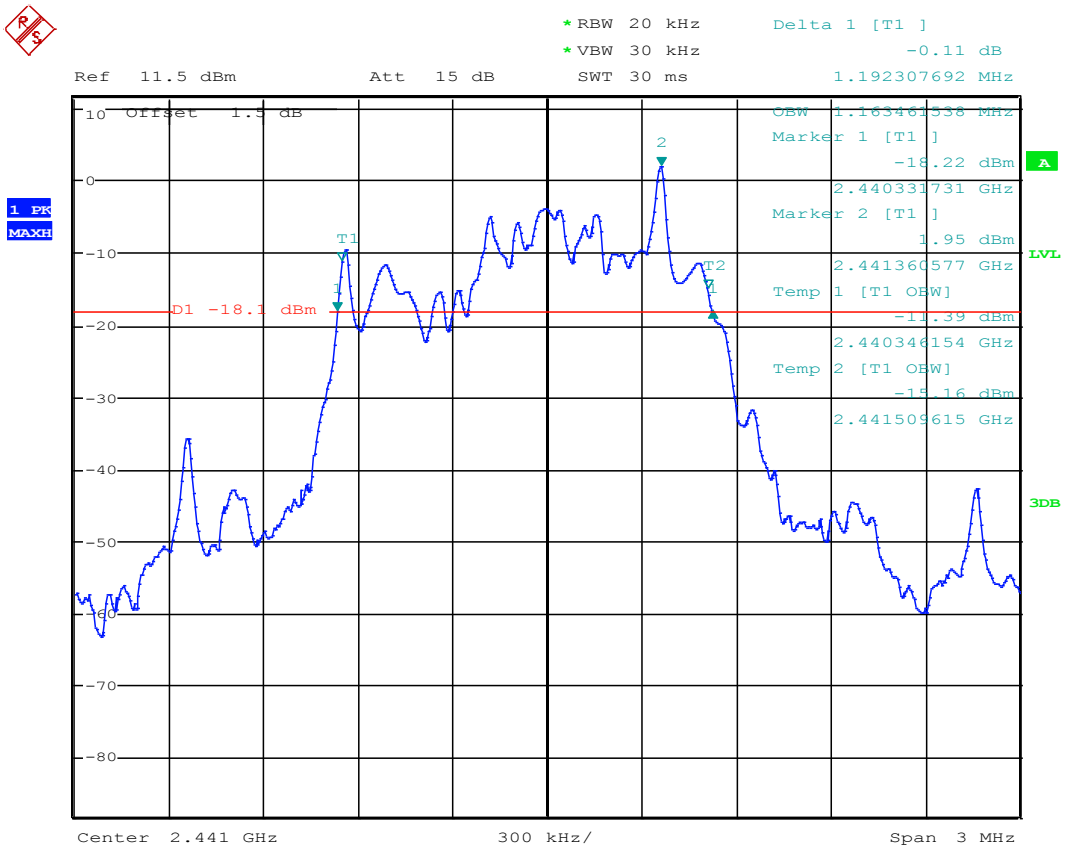
9.6 Measurement Plots:

9.6.1 Ch.0, 2402 MHz, DH5

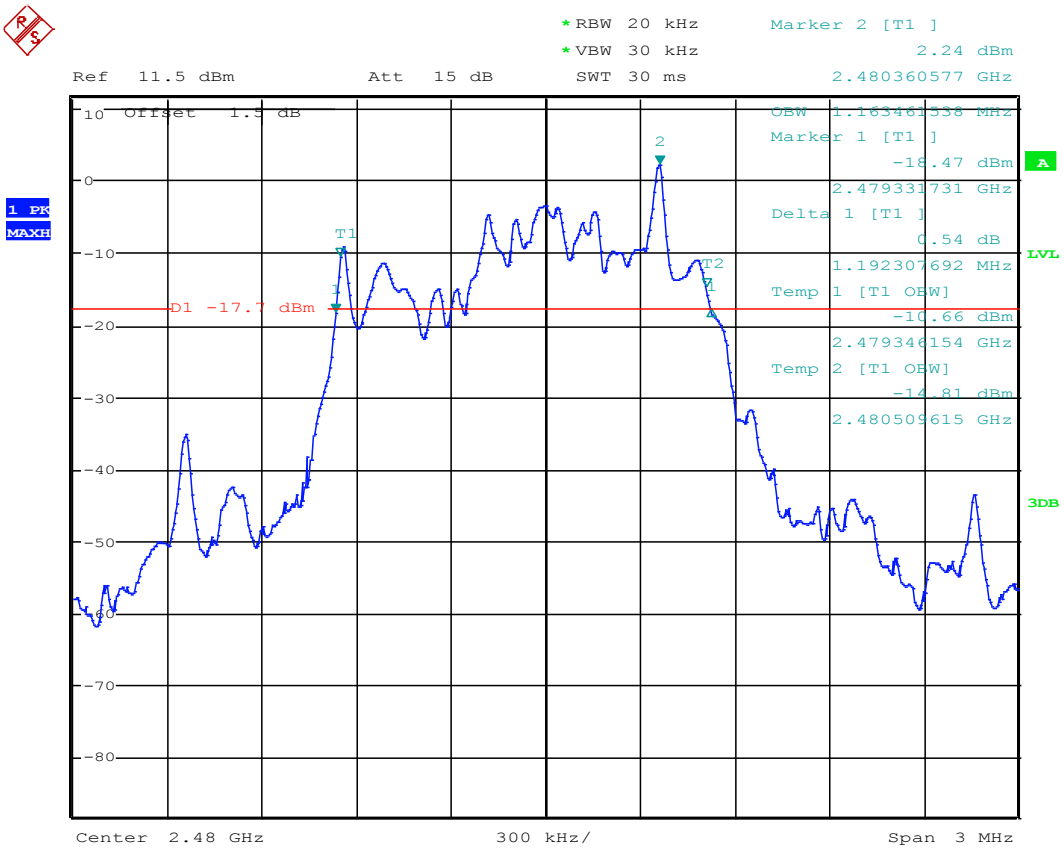


Date: 12.JUN.2015 11:17:06

9.6.2 Ch.39, 2441 MHz, DH5

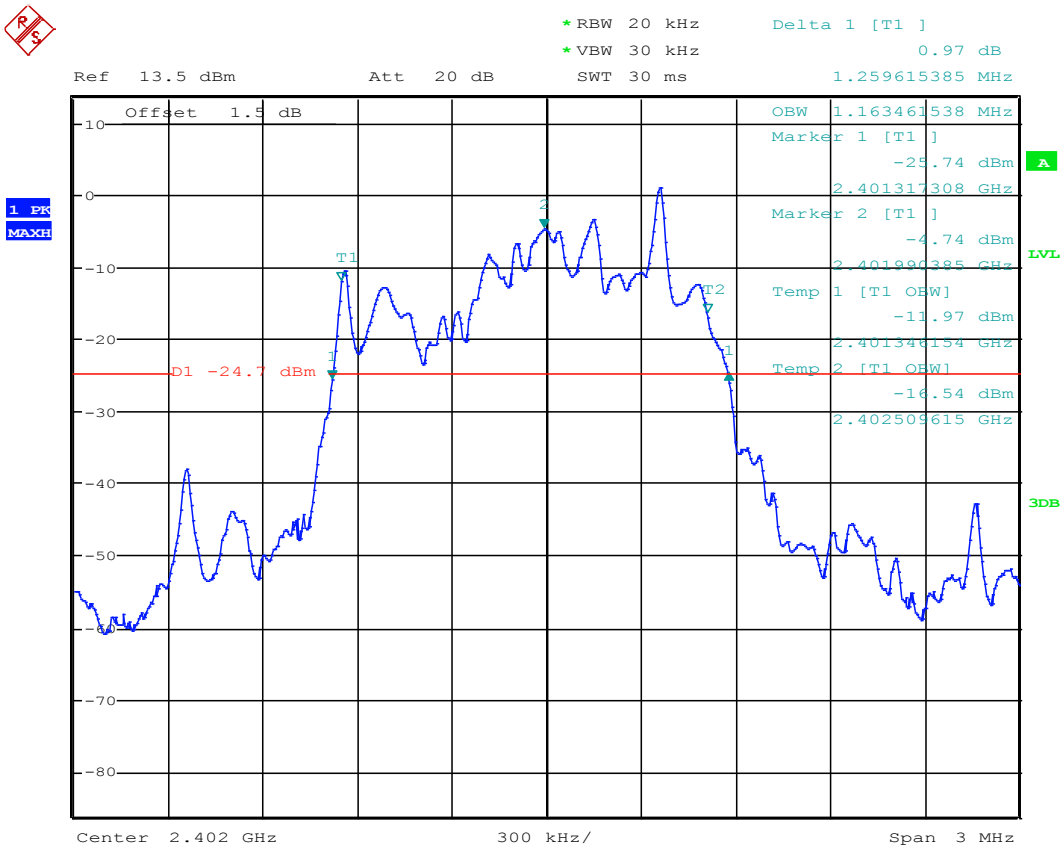


9.6.3 Ch.78, 2480 MHz, DH5



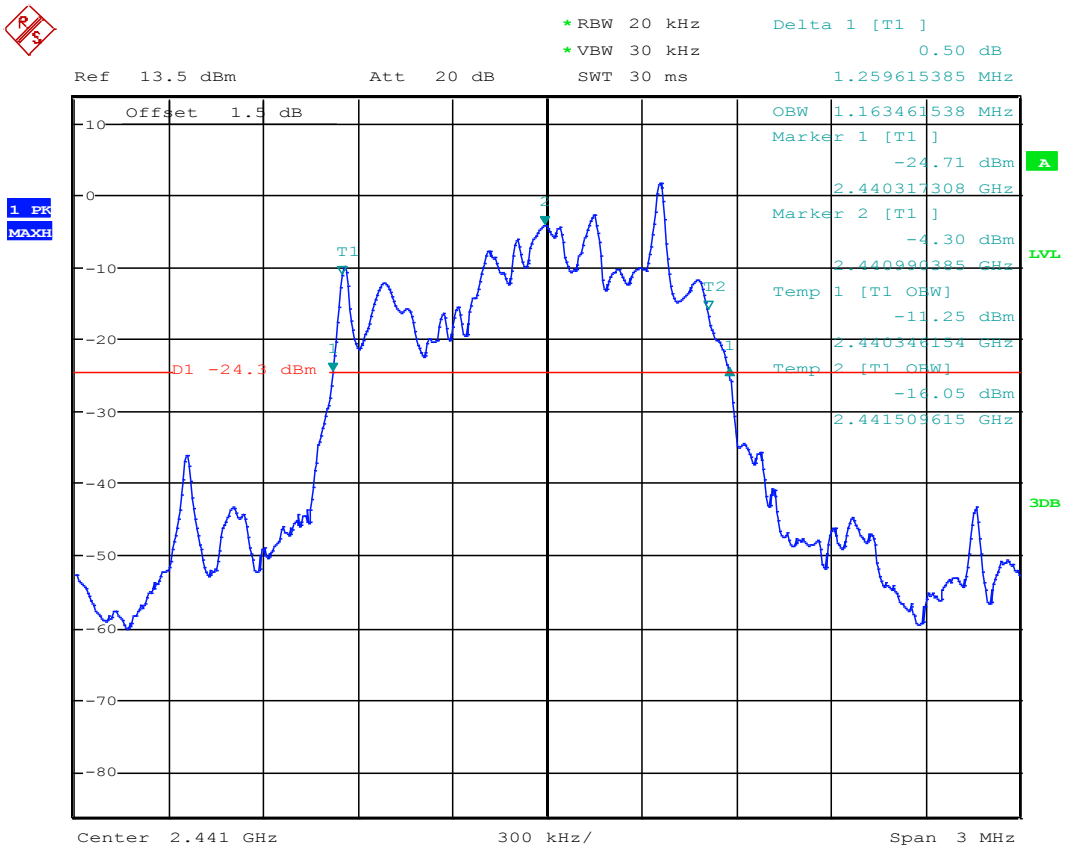
Date: 12.JUN.2015 11:13:22

9.6.4 Ch.0, 2402 MHz, 2-DH5

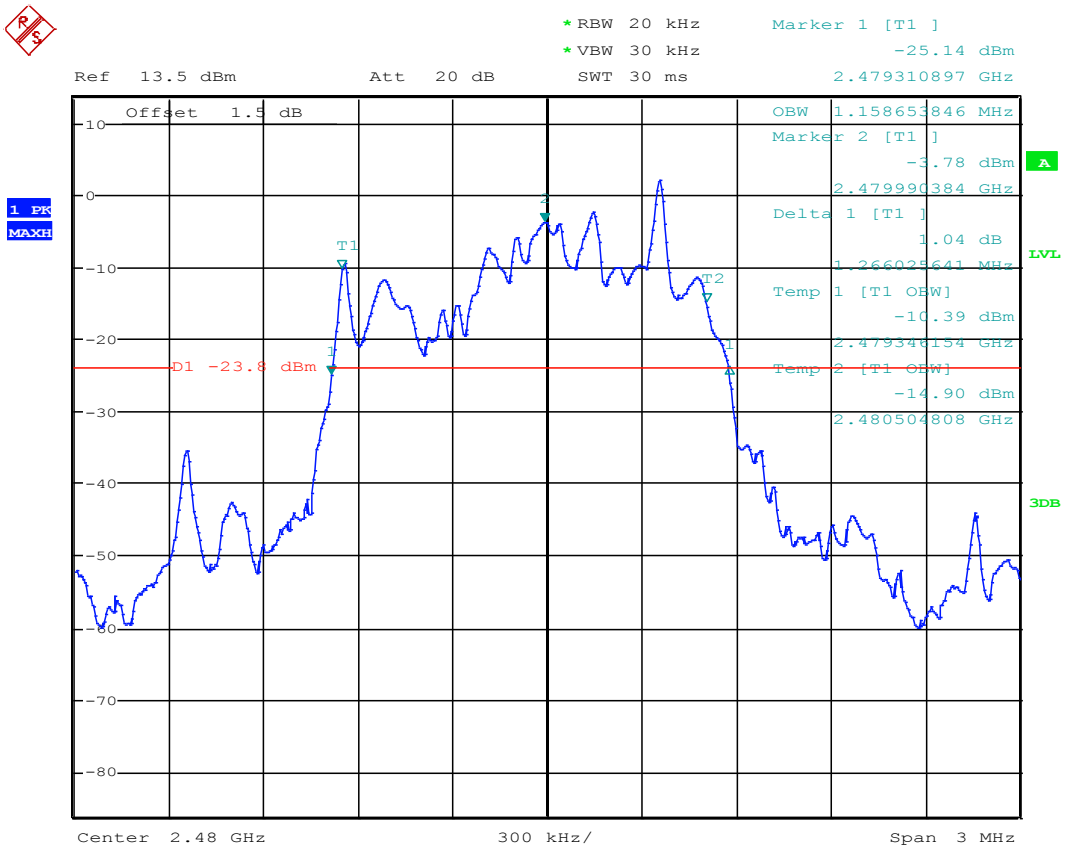


Date: 10.MAR.2015 14:49:51

9.6.5 Ch.39, 2441 MHz, 2-DH5

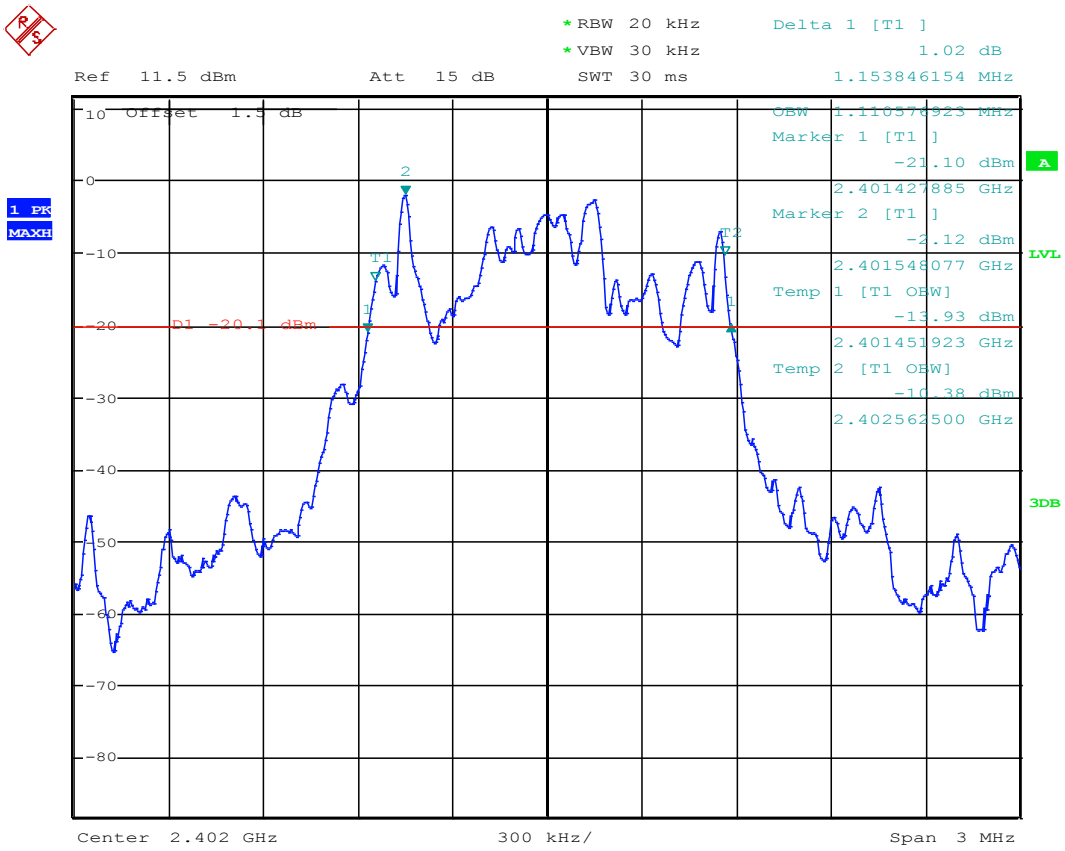


9.6.6 Ch.78, 2480 MHz, 2-DH5



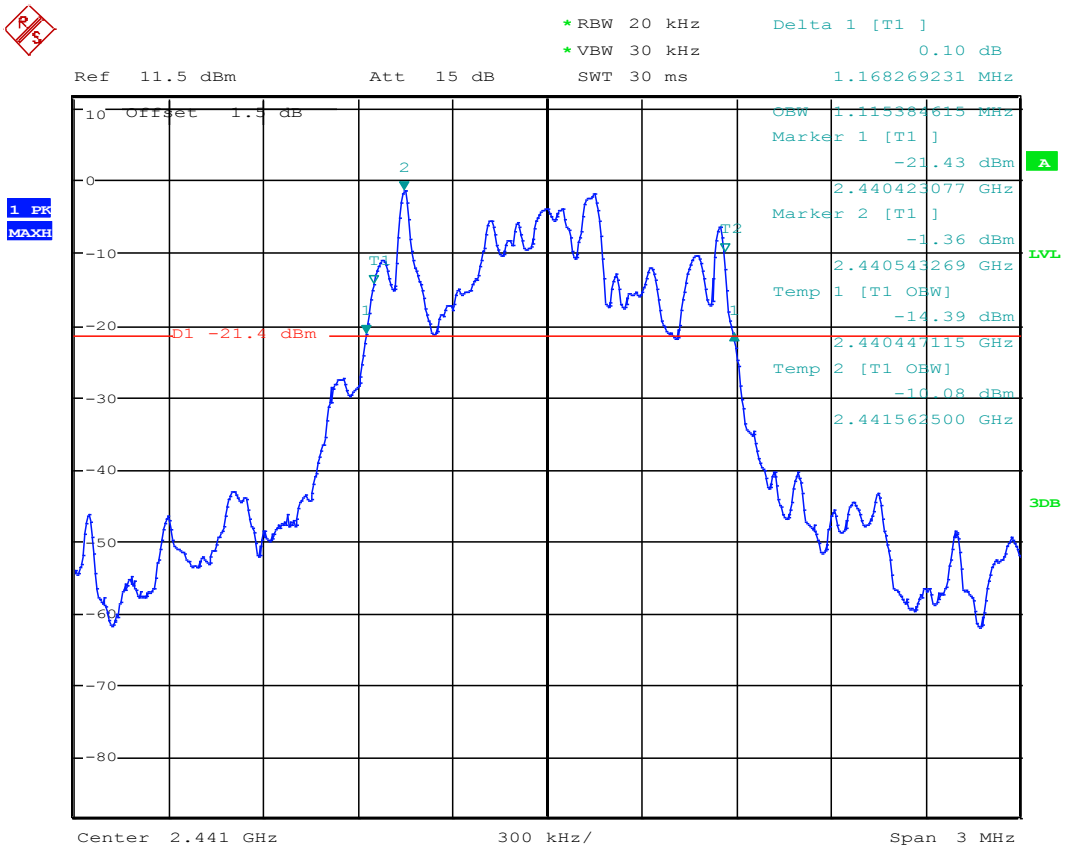
Date: 10.MAR.2015 14:45:37

9.6.7 Ch.0, 2402 MHz, 3-DH5



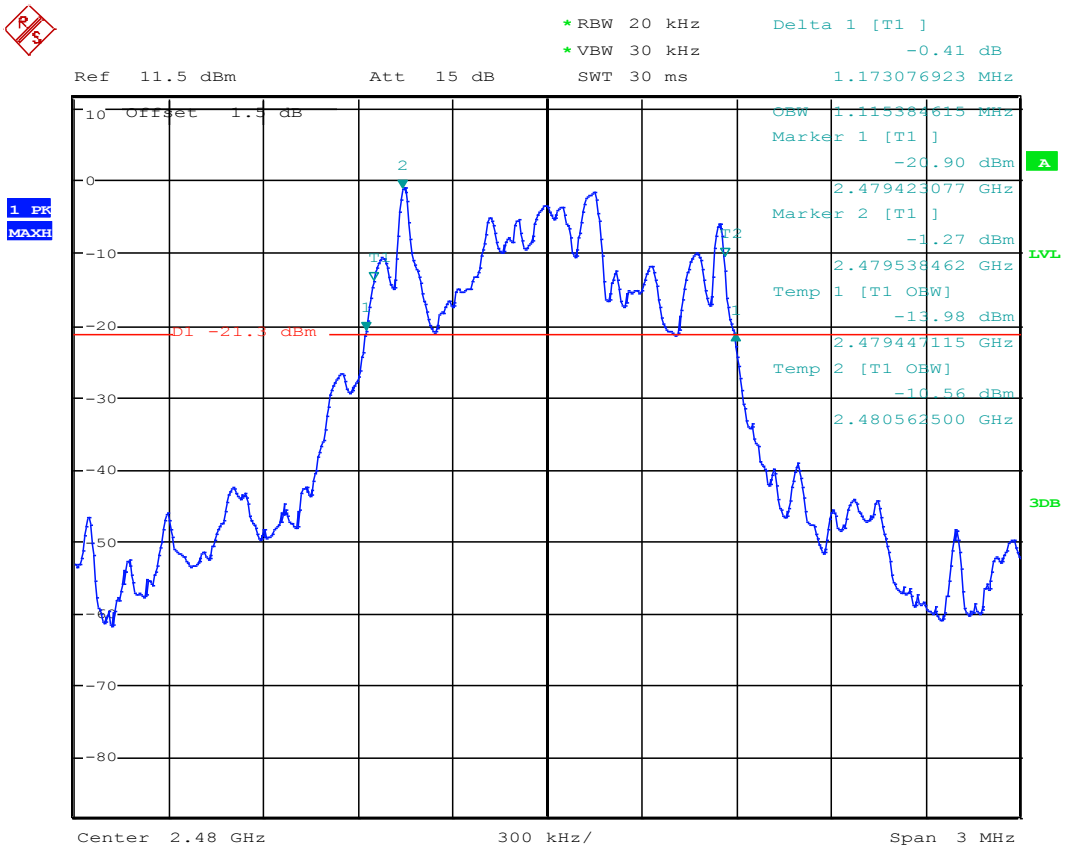
Date: 12.JUN.2015 11:22:43

9.6.8 Ch.39, 2441 MHz, 3-DH5



Date: 12.JUN.2015 11:24:27

9.6.9 Ch.78, 2480 MHz, 3-DH5



Date: 12.JUN.2015 11:26:29

10 Carrier Frequency Separation

10.1 Limits:

§ 15.247 (a) (1) & RSS-210 (A8.1) (b)
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

See 2/3 bandwidth results from bandwidth test above which set the limits.

10.2 Test Conditions:

Tnom: 22°C; Vnom: 120VAC

10.3 Test Procedure:

Measurement according to DA 00-705:2000
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Hopping function: enabled

Spectrum Analyzer settings:

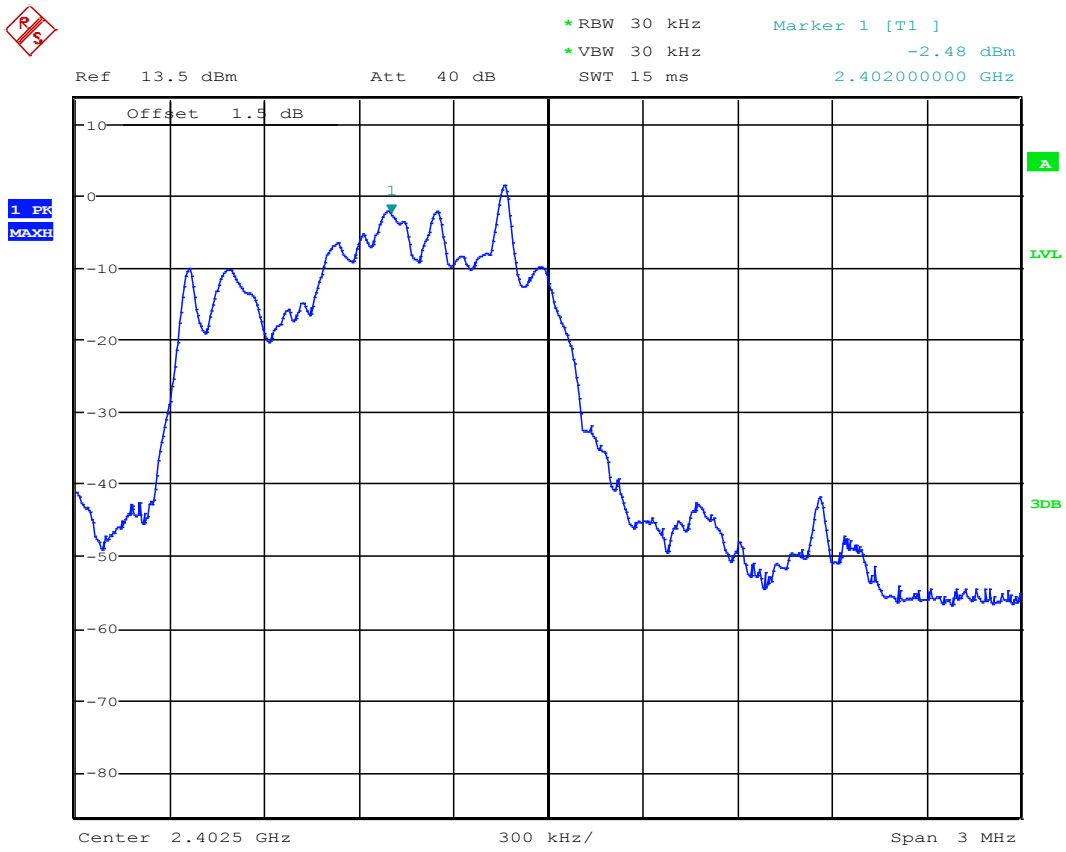
Centre Frequency	Wide enough to capture the peaks of the two adjacent channels.
Span	Approximately 2 to 3 times the 20 dB bandwidth, centered on the hopping channel.
RBW	≥ 1% of the span.
VBW	≥ RBW
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

10.4 Test Verdict:

Pass (channel separation is > the 2/3 BW values established above)

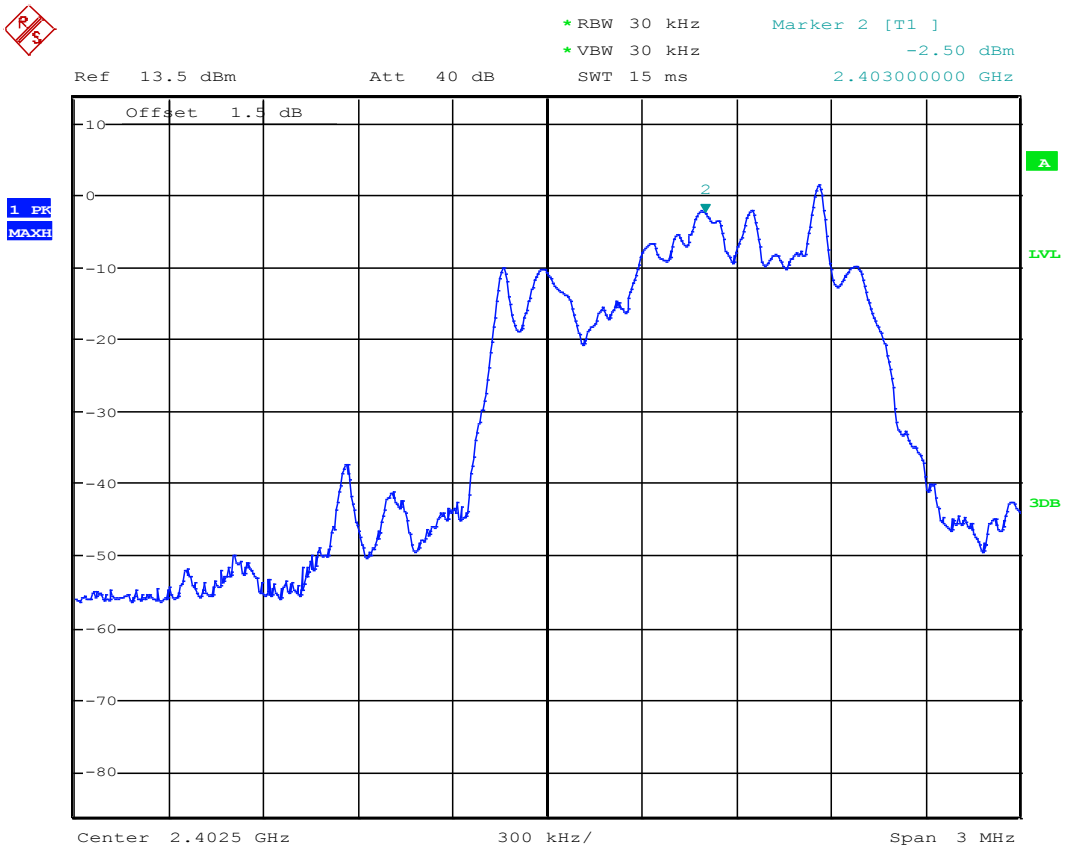
10.5 Measurement plots:

10.5.1 Ch.0, 2402 MHz, 2-DH5



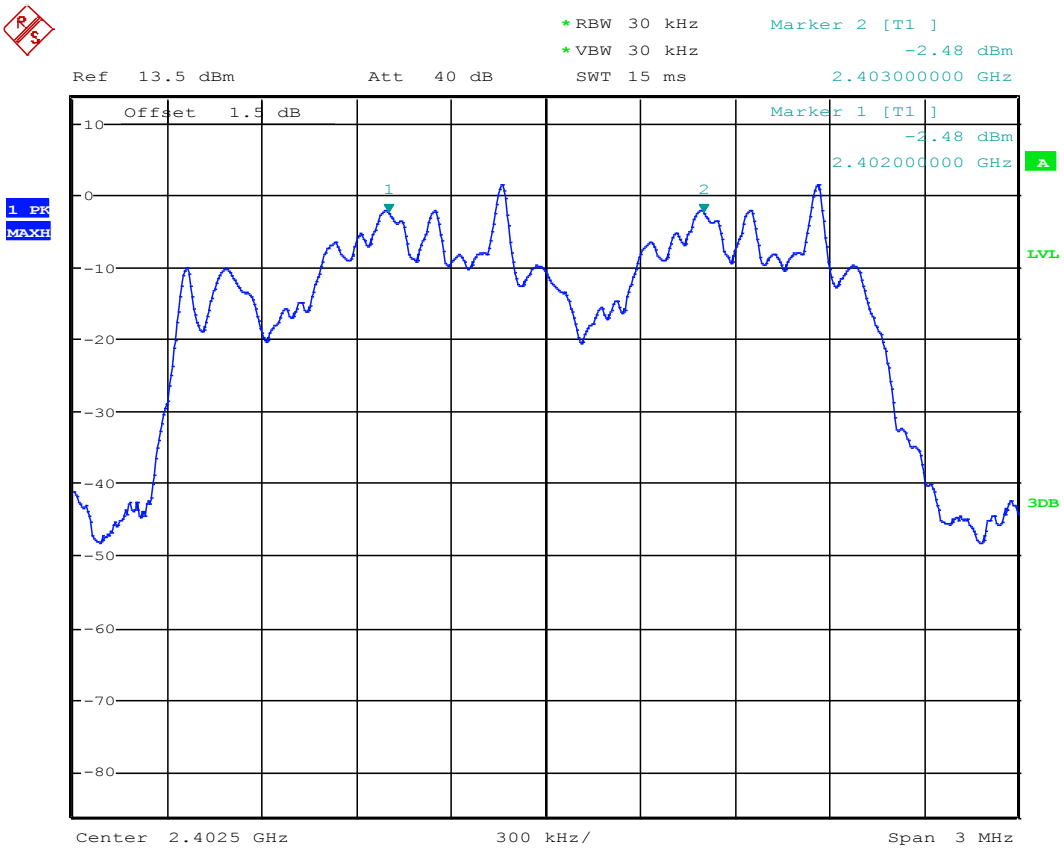
Date: 11.MAR.2015 10:08:14

10.5.2 Ch.1, 2403 MHz, 2-DH5



Date: 11.MAR.2015 10:12:30

10.5.3 Ch.0 and Ch. 1



Date: 11.MAR.2015 10:11:14

11 Number of hopping channels

11.1 Limits:

§ 15.247 (a) (1) (ii) (iii) & RSS-210 A8.1 (d) (e)
At least 15 non-overlapping channels

11.2 Test Conditions:

Tnom: 22°C; Vnom: 120 VAC

11.3 Test Procedure:

Measurement according to DA 00-705
Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Hopping function: enabled

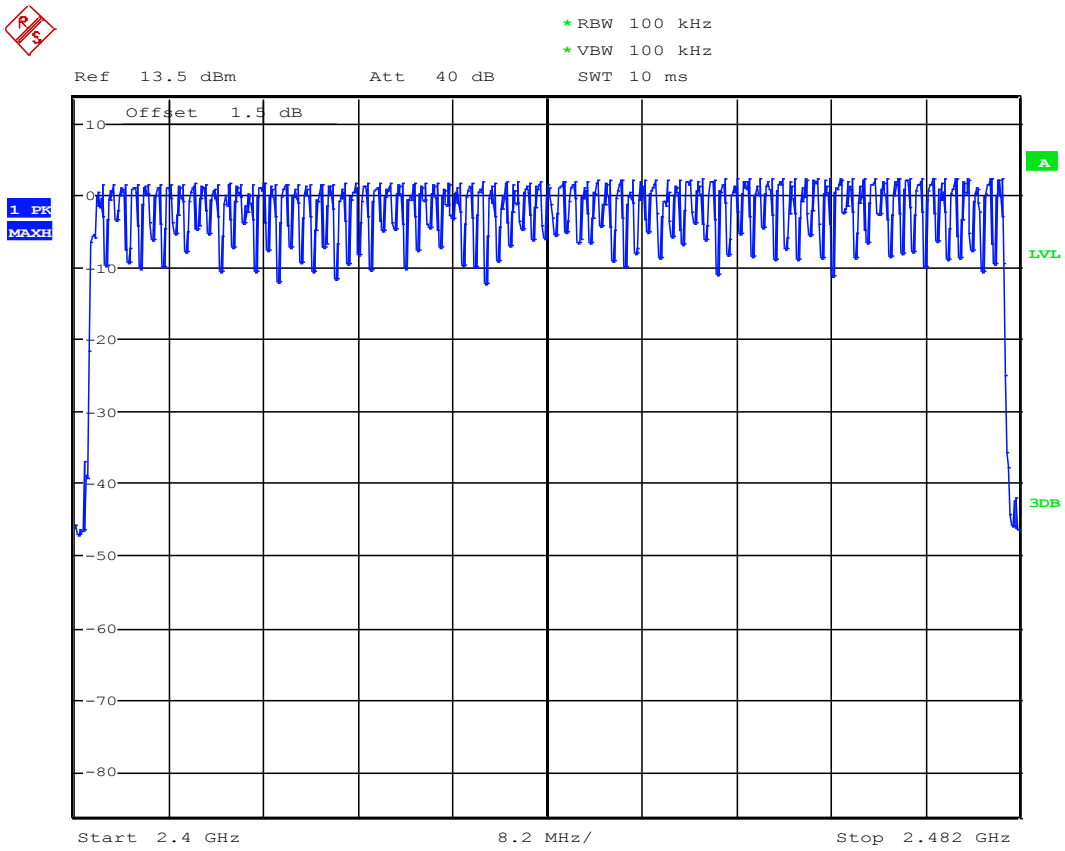
Spectrum Analyzer settings:

Span	The entire frequency band of operation.
RBW	≥ 1% of the span.
VBW	≥ RBW
Sweep time	Auto
Detector	Peak
Trace Mode	Max hold

11.4 Test Verdict:

Pass

11.5 Measurement Plots:



Date: 11.MAR.2015 10:38:09

12 Time of occupancy / Dwell time

12.1 Limits:

§ 15.247 (a) (1) (iii) & RSS-210 A8.1 (d) (e)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

12.2 Time occupancy calculation

Period = 0.4s x No. of hopping channels
= 0.4 x 79 = **31.6s**

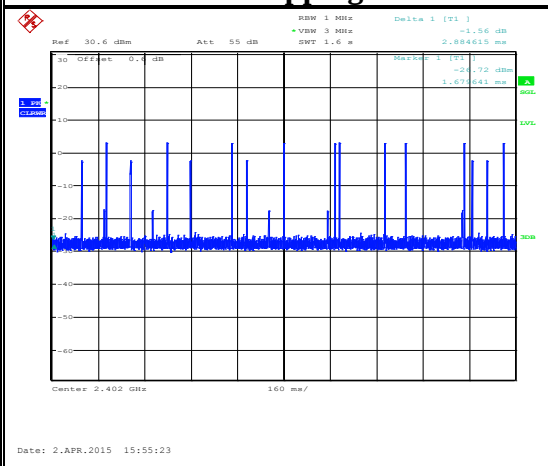
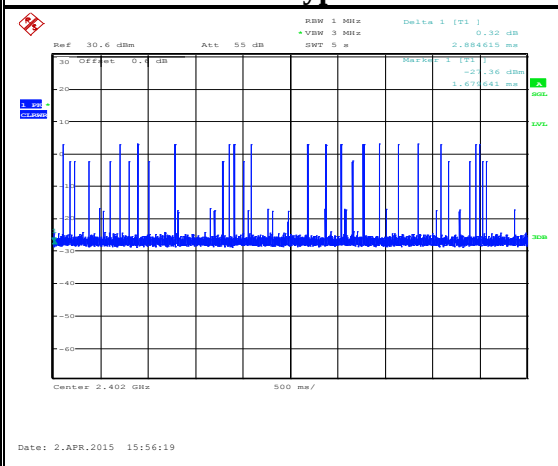
12.3 Test Verdict:

Pass

12.4 Test Plots:

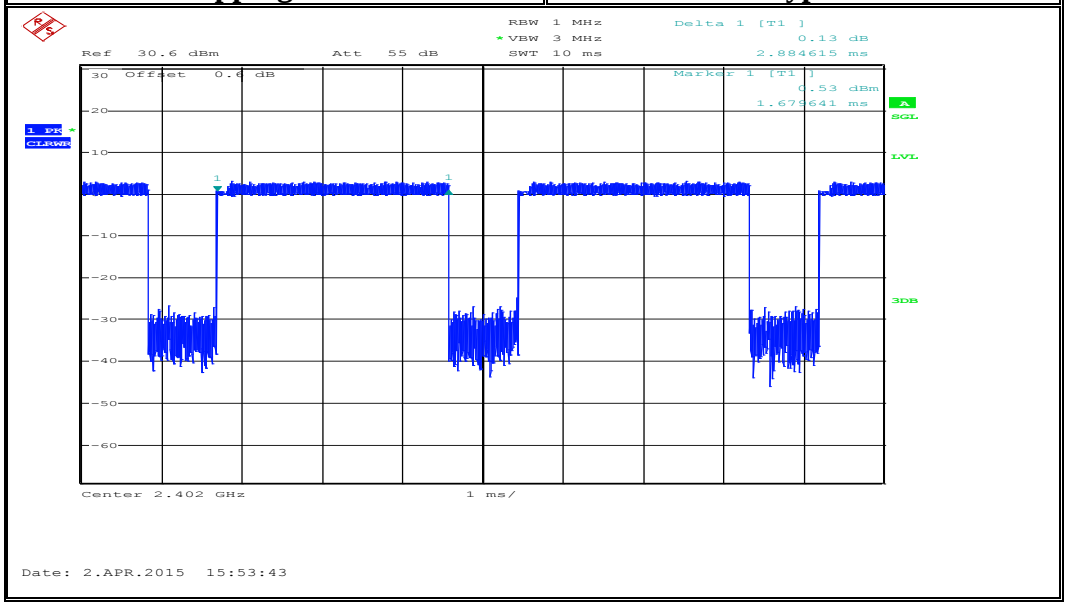
Burst Width (ms)	Total Bursts in 5s	Total Burst in 30s = total burst in 5s * 6	Total Burst in 1.6s	Total bursts in 31.6s = total bursts in 30s + total burst in 1.6s
2.88	17	102	10	112
Average time occupancy on any channel in 31.6s = Burst Width * Total # of bursts in 31.6s = 2.88 * 112 = **322.56 ms** < 400 ms				

Time of Occupancy

Mode: Hopping Enable	Packet Type: 2-DH1
	
Total # burst in 1.6s = 10	Total # burst in 5s = 17

Average Time Occupancy on 1 channel

Mode: Hopping on 1 channel	Packet Type: 2-DH1



13 Transmitter Spurious Emissions

13.1 Limits:

§15.247/15.205/15.209 & RSS-210 A8.5 / RSS-Gen 8.9/ 8.10 (restricted bands)
(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]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	([2])
13.36 - 13.41			

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)).

*PEAK LIMIT= 74dBµV/m
*AVG. LIMIT= 54dBµV/m

Table 1:

Frequency of emission (MHz)	Field strength @ 3m (µV/m)	Field strength @ 3m (dBµV/m)
30–88	100	40dBµV/m
88–216	150	43.5 dBµV/m
216–960	200	46 dBµV/m
Above 960	500	54 dBµV/m

Table 2:

Frequency of emission (MHz)	Field strength (µV/m) / (dBuV/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 / (29.5)	30

Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements described in 5.4.
The highest (or worst-case) data rate shall be recorded for each measurement.

When testing at other than specified distance in the standard, the approach calculation by using 40 dB/decade extrapolation factor equation (4) as follow:

Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

Therefore, 80 dB shall be added to the specified limit @ 30 m to convert to actual test limit @ 3m or shall be subtracted from the actual readings if the specified limit @ 30 m remains the same.

13.2 Test Conditions

Tnom: 23°C; Vnom: 120 VAC

13.3 Test Procedure

Measurement according to ANSI C63.10:2013
Refer to section 6, 6.1 in this test report

Analyzer Settings:
From 9 KHz – 30 MHz
RBW = 9 KHz
Detector: Peak

From 30 MHz – 1 GHz
Detector = Peak / Quasi-Peak
RBW=120 KHz (<1GHz)

Above 1 GHz
Detector = Peak / Average
RBW= 1MHz

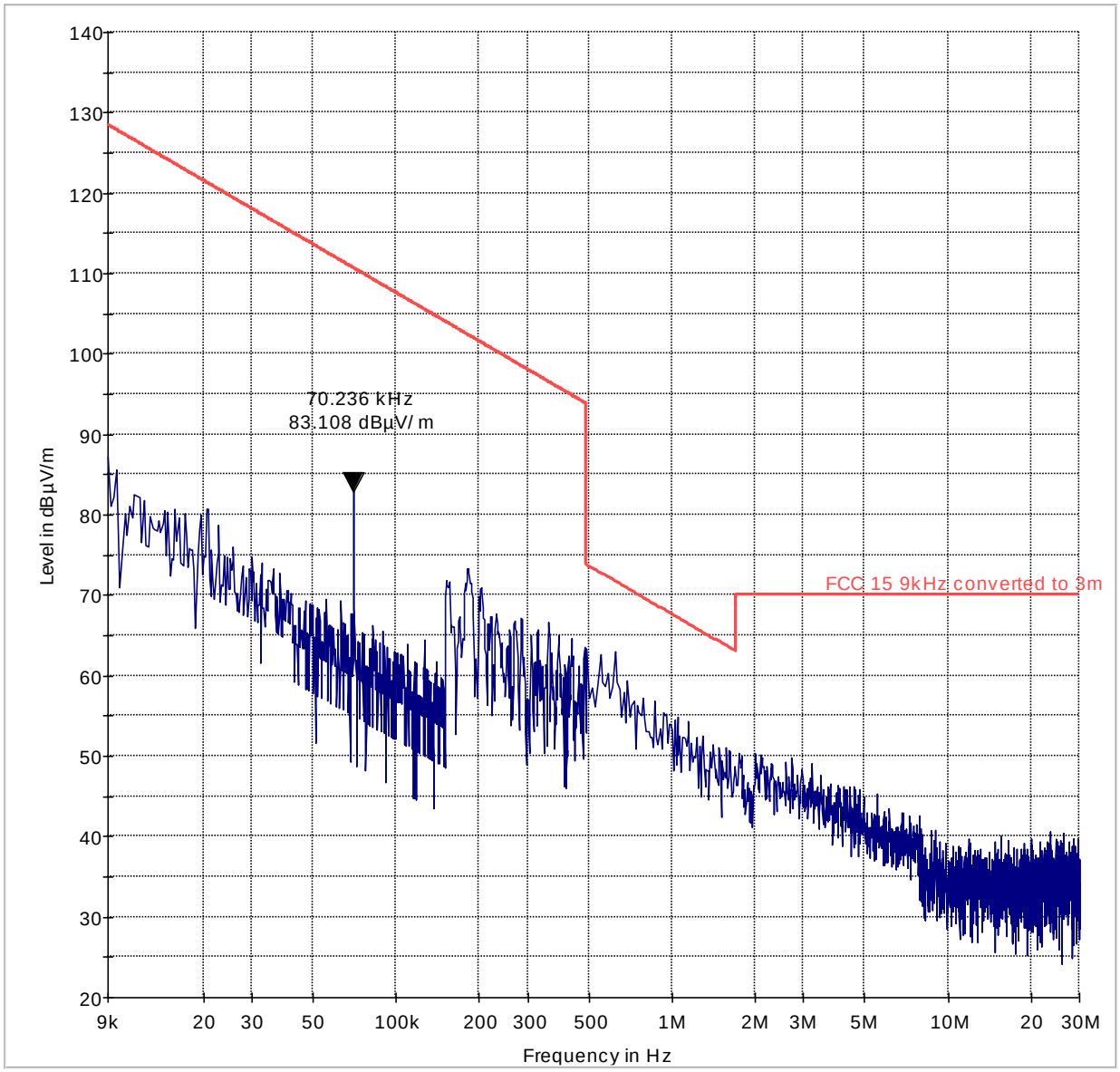
Test mode: *Modulation:* π /4 DQPSK since determined to be the mode with the highest conducted output power.
Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.
Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

13.4 Test Verdict:

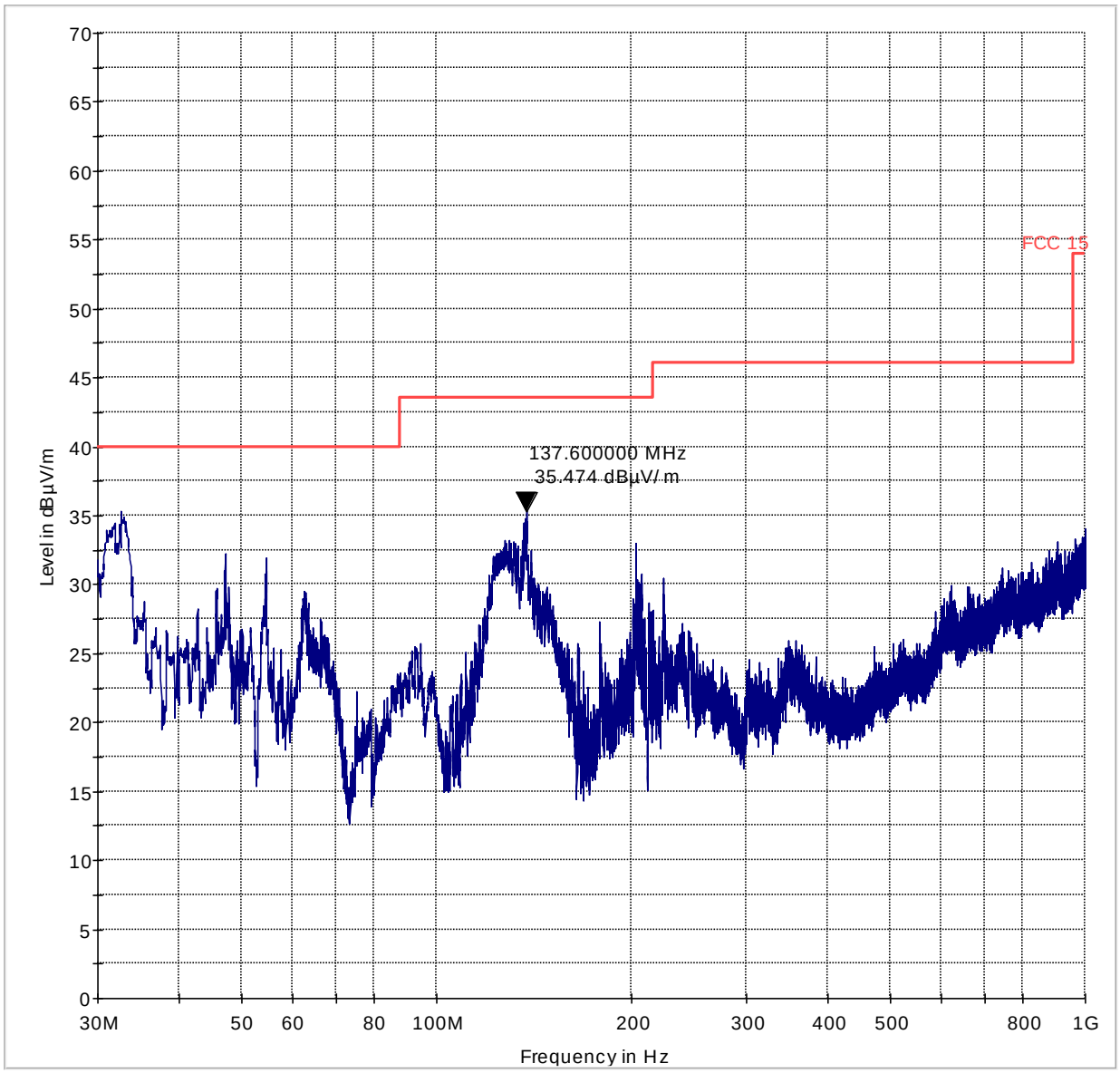
Pass.

13.5 Measurement plots:

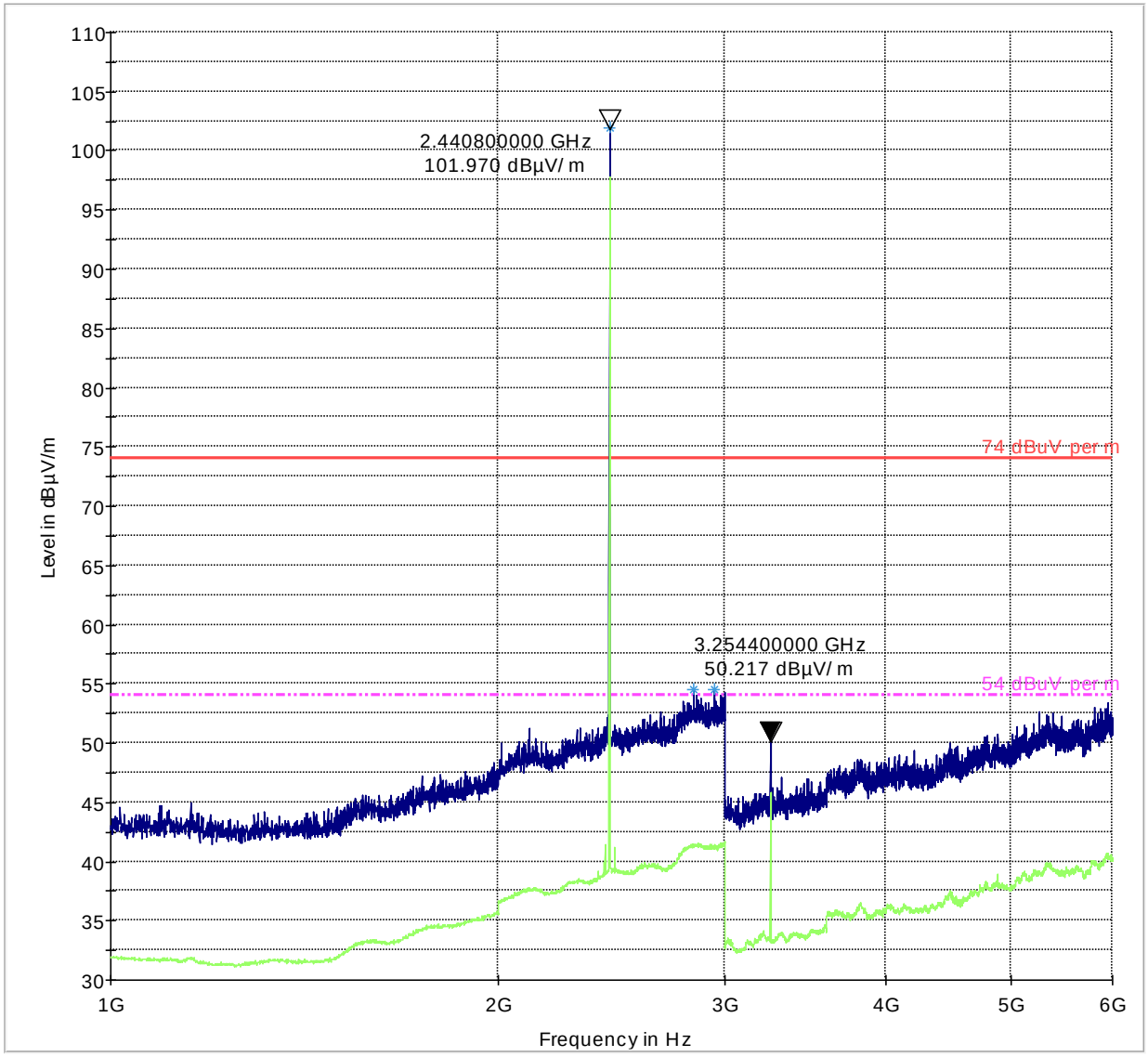
13.5.1 9 KHz – 30 MHz: Ch.39, 2440 MHz, 2-DH5



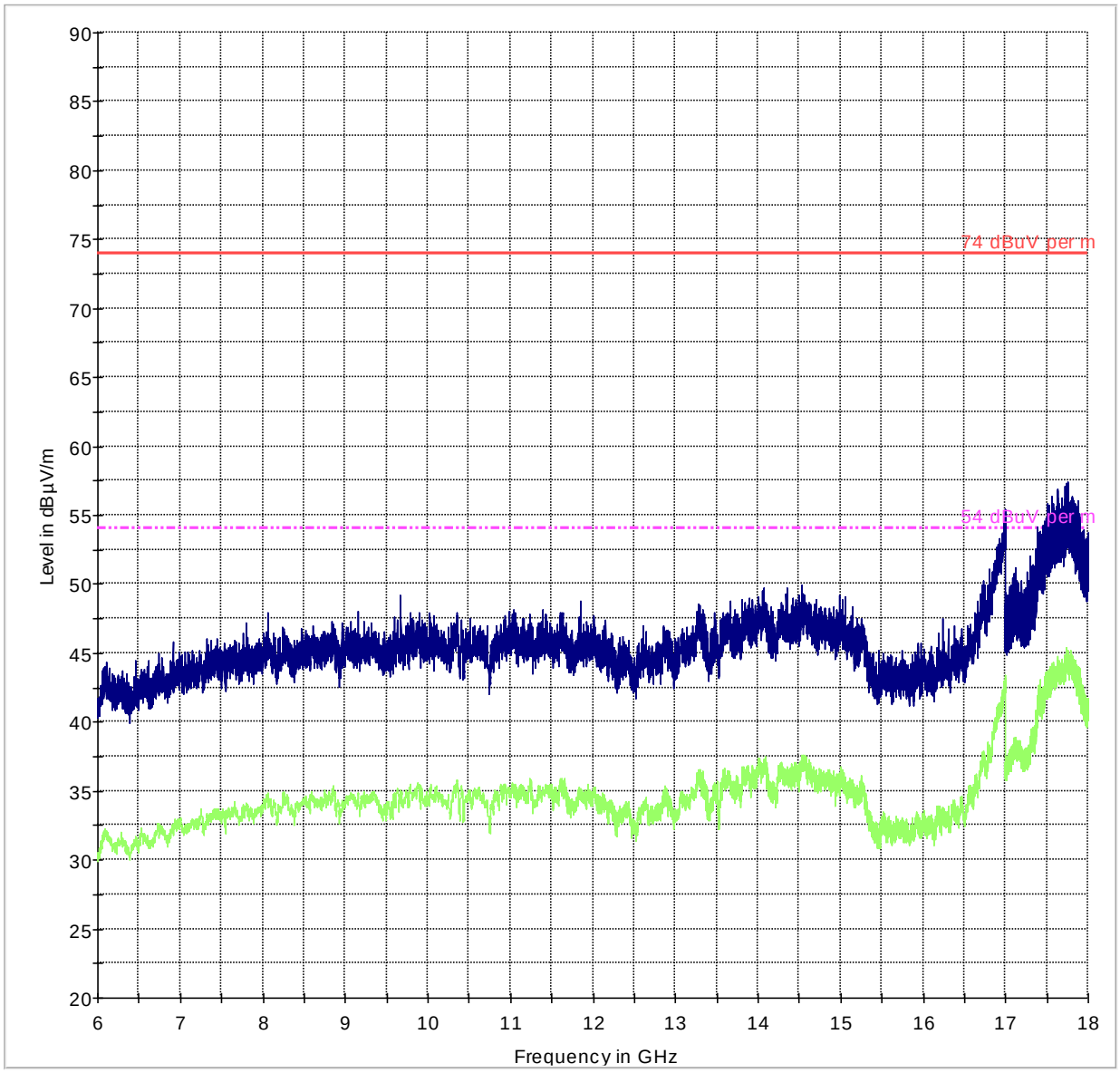
13.5.2 30 MHz – 1 GHz: Ch. 39, 2440 MHz, 2-DH5



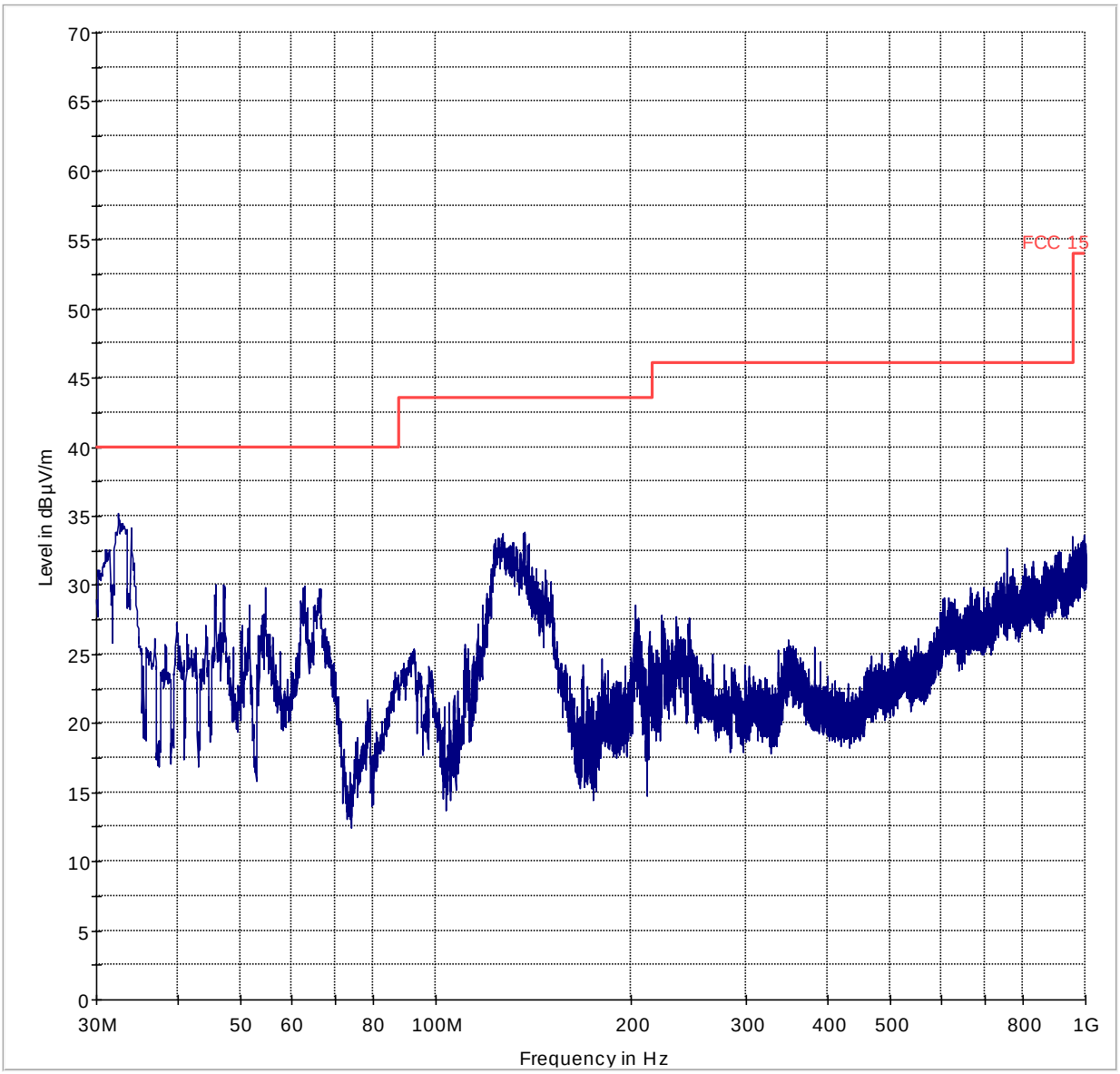
13.5.3 1 GHz – 6 GHz: Ch. 39, 2440 MHz, 2-DH5



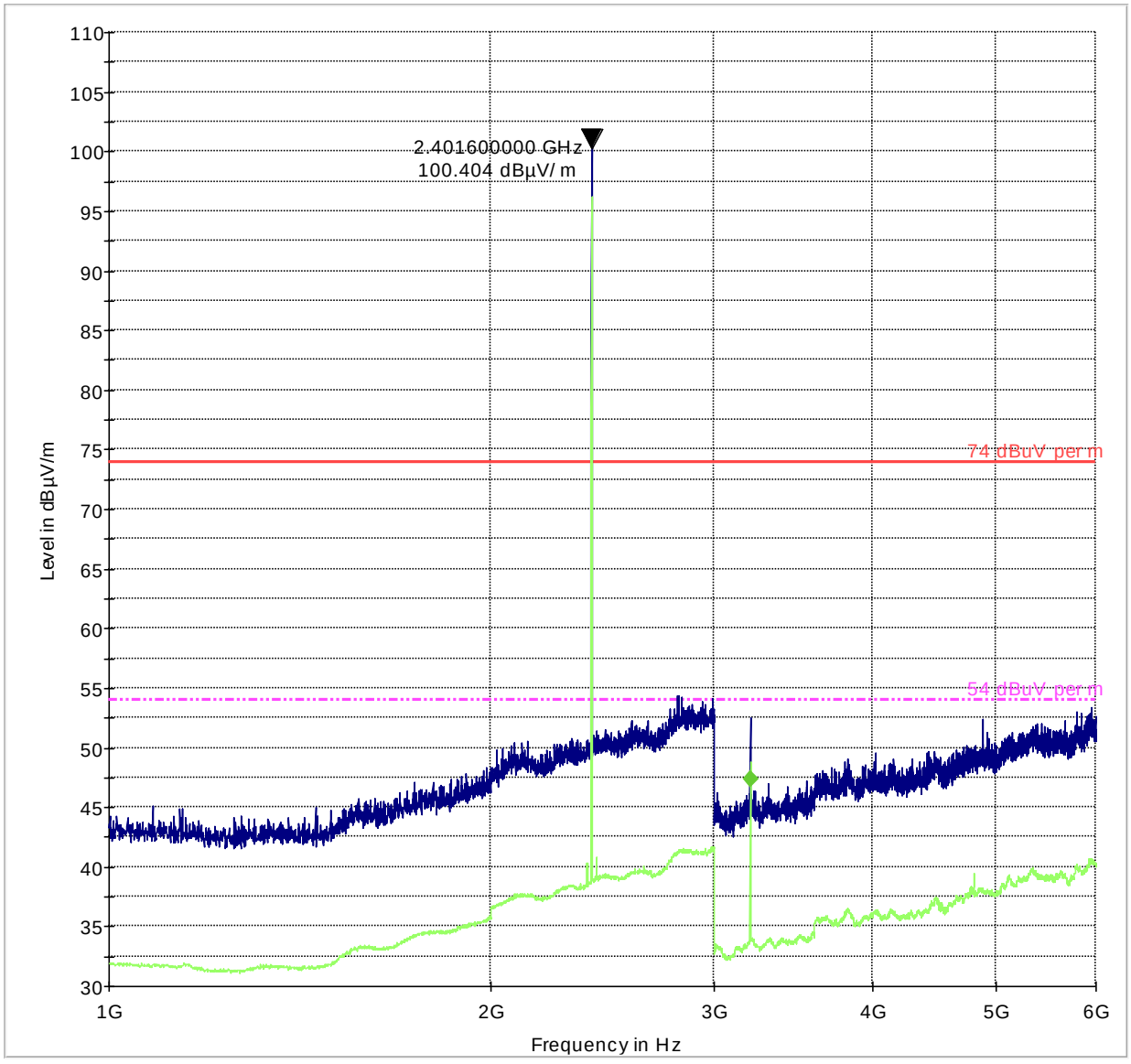
13.5.4 6 GHz – 18 GHz: Ch. 39, 2440 MHz, 2-DH5



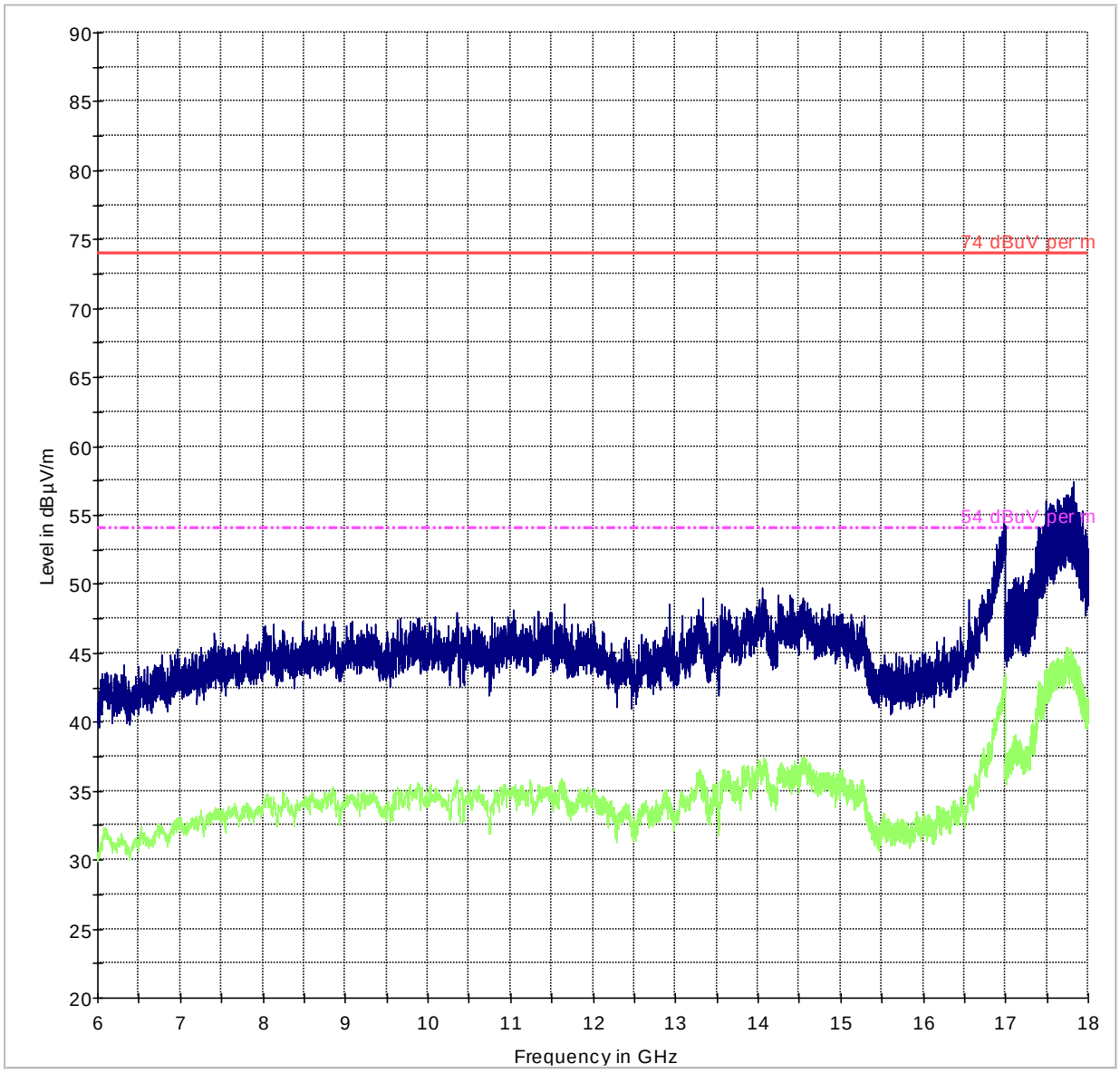
13.5.5 30 MHz – 1 GHz: Ch. 0, 2402 MHz, 2-DH5



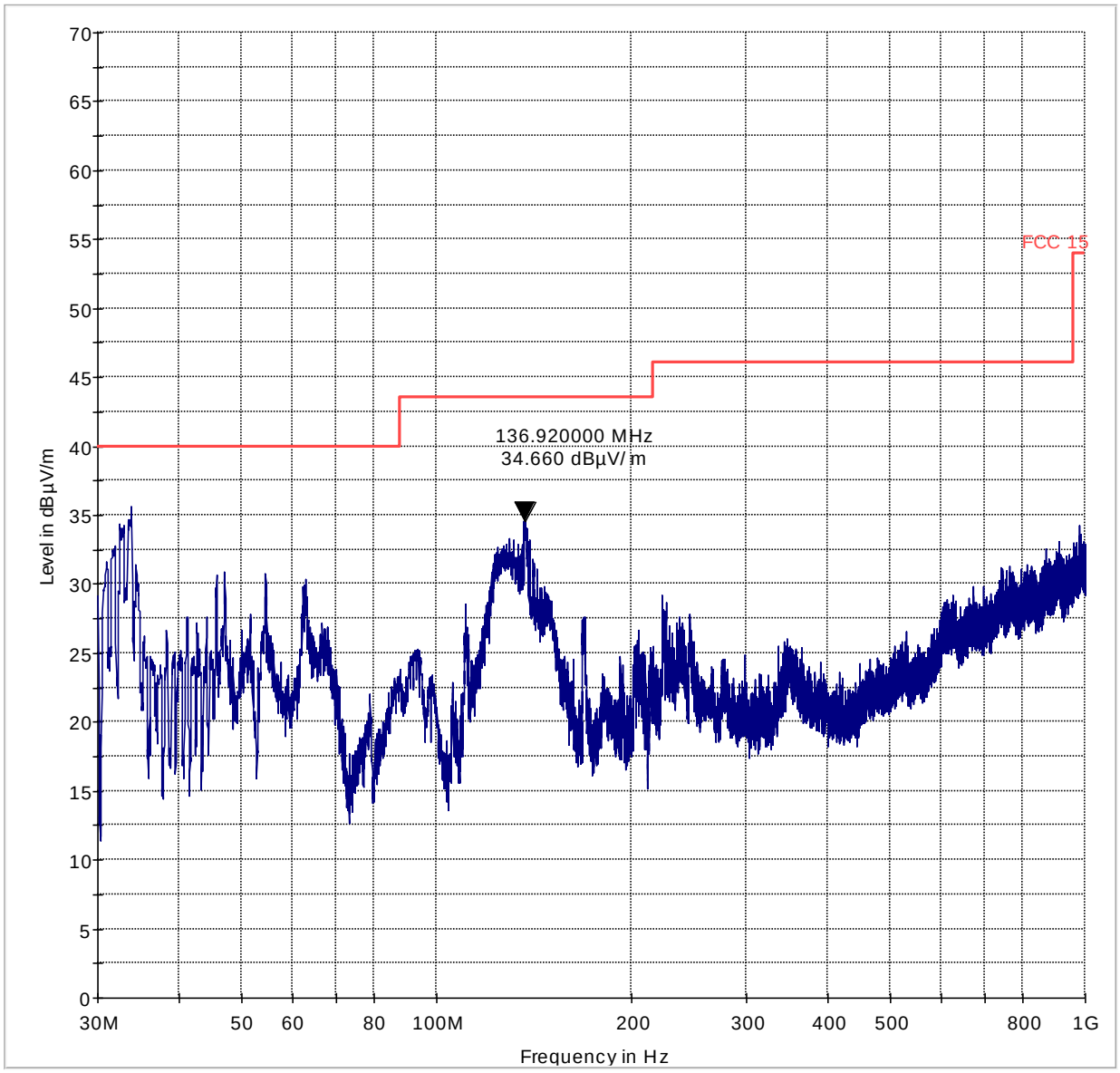
13.5.6 1 GHz – 6 GHz: Ch. 0, 2402 MHz, 2-DH5



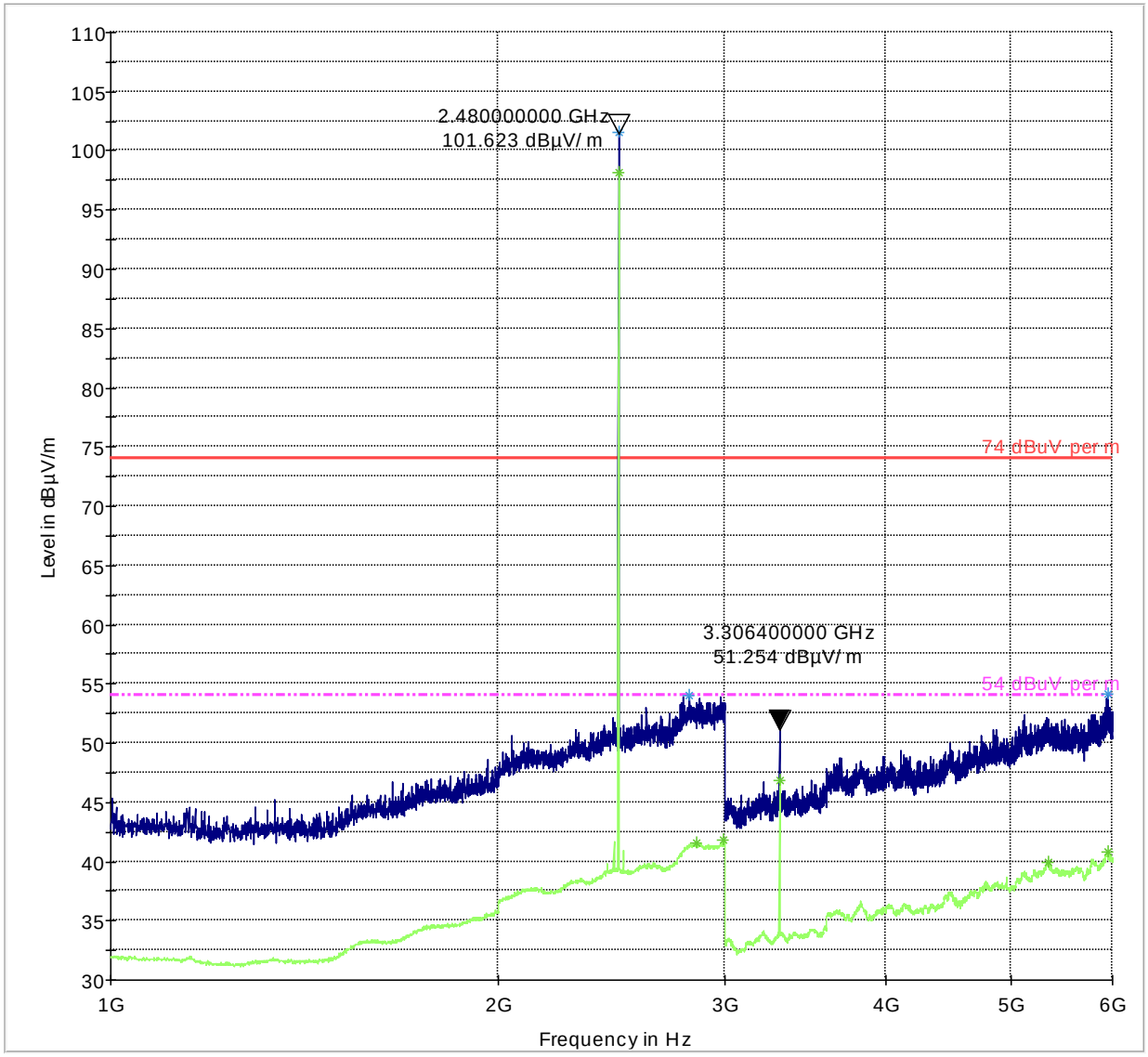
13.5.7 6 GHz – 18 GHz: Ch. 0, 2402 MHz, 2-DH5



13.5.8 30 MHz – 1 GHz: Ch. 78, 2480 MHz, 2-DH5

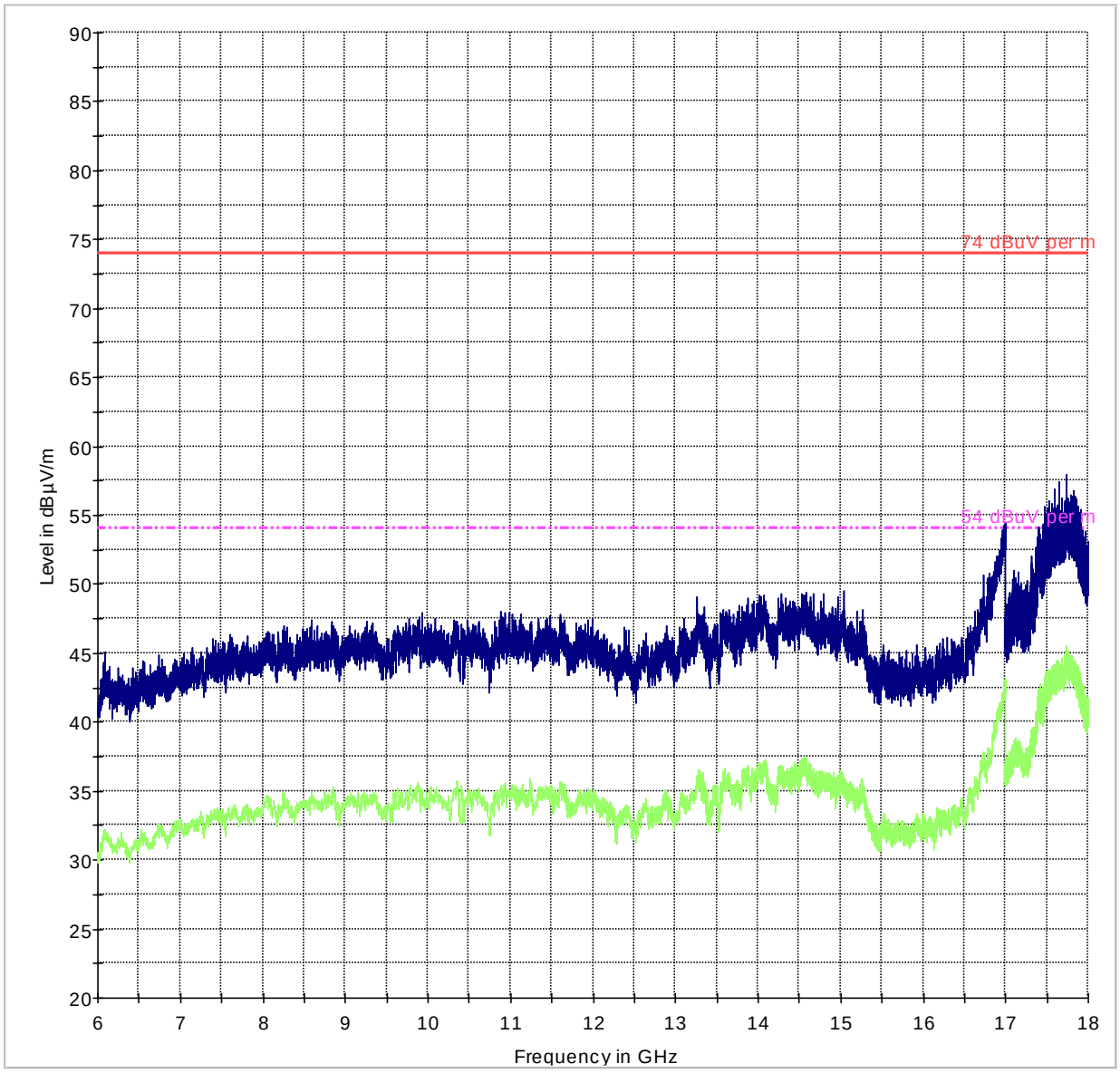


13.5.9 1 GHz – 6 GHz: Ch. 78, 2480 MHz, 2-DH5



74 dBuV per m
Preview Result 1-PK+
Data Reduction Result 1 [3]-PK+
54 dBuV per m
Preview Result 2-AVG
Data Reduction Result 2 [3]-AVG

13.5.10 6 GHz – 18 GHz: Ch. 78, 2480 MHz, 2-DH5



14 AC Power Line Conducted Emissions

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

14.1.1 Limits:

§15.207 & RSS-Gen 8.8

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 1:

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

*Decreases with the logarithm of the frequency.

14.1.2 Test Conditions:

Modulation: 8-DPSK modulation - Transmit and Receive modes of operation
Tnom: 20°C; Vnom: 120VAC

14.1.3 Test Procedure

Measurement according to ANSI C63.10:2013 section 6.2 and 4.1 (also refer to section 6, 6.3 in this test report)

Analyzer Settings:
RBW = 9 KHz (CISPR Bandwidth)
Detector: Qusi-Peak / Average

14.1.4 Results

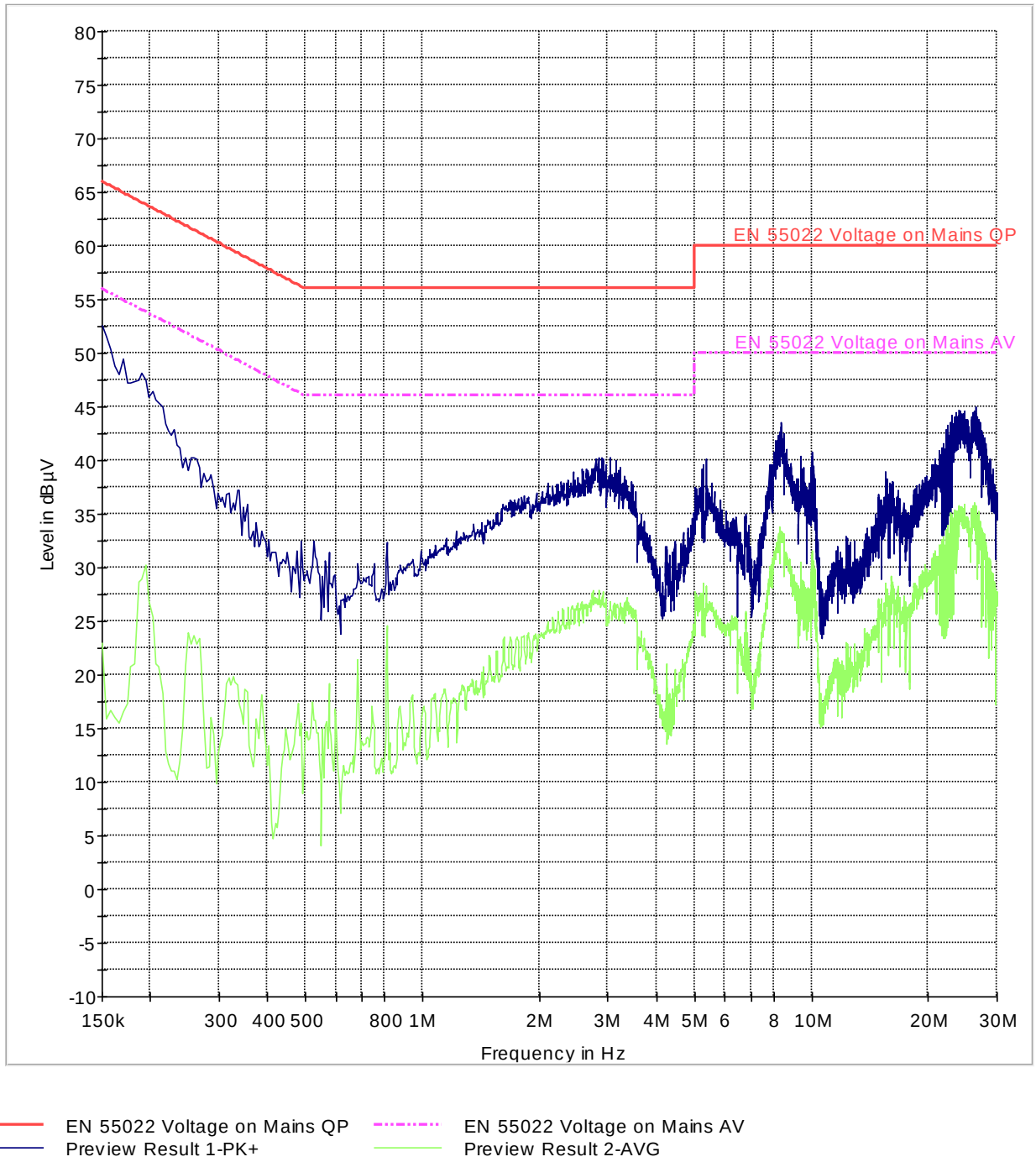
Plots shown here represent the combined worse case emissions for power lines (phases and neutral line).
Pass.

14.1.5 Test Data

Conducted Emissions: 150 KHz – 30 MHz
Note: All peak levels are below average limit. Final measurements are not required.

14.1.6 Measurement Plots:

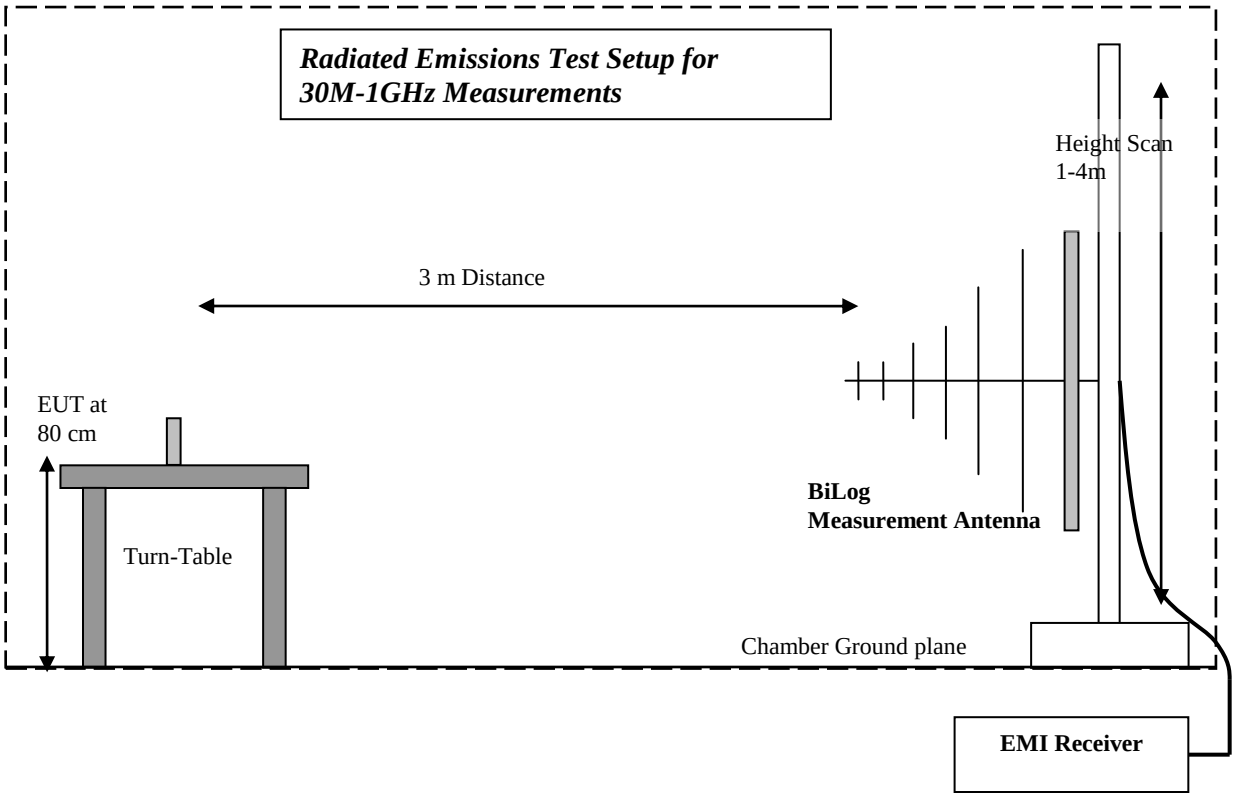
Conducted Emissions: 150 KHz – 30 MHz

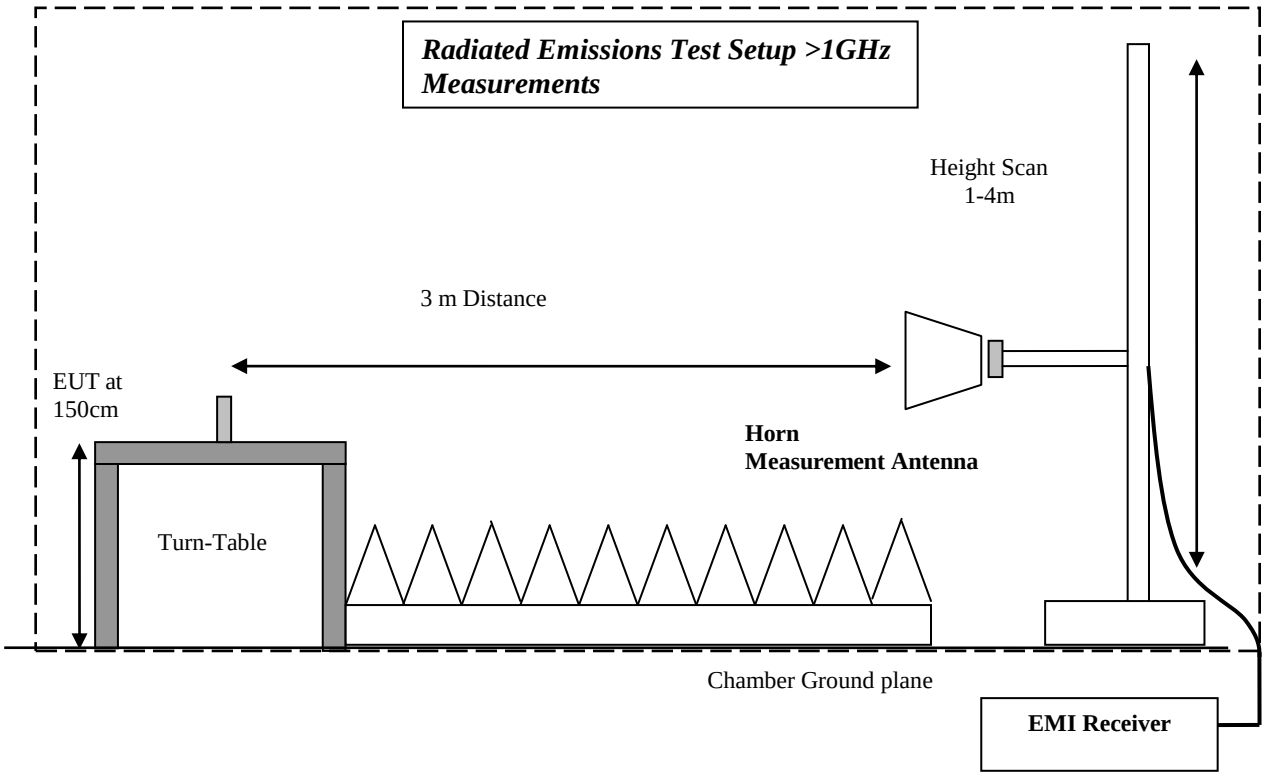


15 Test Equipment and Ancillaries used for tests

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
3m Semi- Anechoic Chamber:						
X	Turn table	EMCO	2075	N/A	N/A	N/A
X	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
X	Antenna Mast	EMCO	2075	N/A	N/A	N/A
X	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
X	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	Sep 2013	2 Year
X	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
X	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
X	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
X	Binconilog Antenna	EMCO	3141	0005-1186	Apr 2012	4 Years
X	Horn Antenna	EMCO	3115	35114	Mar 2012	4 Years
Other Equipment						
	Spectrum Analyzer	Rohde&Schwarz	FSU 8	200256	Jun 2013	2 Years
X	Spectrum Analyzer	Rohde&Schwarz	FSU 26.5	100189	Jun 2013	2 Years
	Spectrum Analyzer	Rohde&Schwarz	FSU 26.5	200065	Jun 2013	2 Years
	Vector Signal Generator (Interferer)	Rohde&Schwarz	SMU200A	101935	Feb 2015	2 Years
	Signal Generator (Blocker)	Rohde&Schwarz	SMP04	100151	Jun 2013	2 Years
X	Fast Power Detector 5Ms/s	ETS Lindgren	7002-006	00160034	Sep 2014	2 Years
X	Temperature Sensor	Dickson	SM320	0929600	Apr 2014	2 Years
X	Temperature Chamber	Test Equity	115	150384	N/A	N/A
	Vector Signal generator (Interferer)	Keysight	EE4438C	MY45094596	Jun 2013	2 Years
	WLAN AP (companion device)	Rhode&Schwarz	CMW500	125754	Jun 2013	2 Years
	WLAN AP (companion device)	Cisco	Aironet 1260	FTX1553E037	N/A	N/A
X	DC Power Supply	HP	E3610A	KR83023316	N/A	N/A

16 Test Setup Diagram:




Radiated Emissions Test Setup >1GHz Measurements
Height Scan
1-4m
3 m Distance
EUT at
150cm
Horn
Measurement Antenna
Turn-Table
Chamber Ground plane
EMI Receiver

17 Revision History

Date	Report Name	Changes to report	Report prepared by
2015-06-12	EMC_PHIL4-007_14001_15.247_BT_EDR	1st Version	Yu-Chien Ho