



FCC / IC Test Report

FOR:

Pearl Automation Inc.

Model Name: / Model Number:

Rear Vision Camera Frame / P110

Product Description:

RearVision consists of 2 main components. The "Car Adapter", which is an accessory that connects to the vehicle's OBD-II diagnostic port, and the "Camera Frame" which is an accessory that is mounted at the license plate of the vehicle. The "Car Adapter" will relay information from the "Camera Frame" and vehicle environmental and state information over Bluetooth/WiFi, and that information will be relayed to the phone over Bluetooth/WiFi and displayed to the driver via the phone app.

FCC ID: 2AG6M-P110

Per:

FCC CFR 47 Part 15.407

REPORT #: EMC-PEARL-004-16001-FCC-15-407-UNII3-P110

DATE: September 30, 2016




CETECOM Inc.

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CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.407 of Title 47 of the Code of Federal Regulations.

No deviations were ascertained during the course of testing performed.

Company	Description	Model #
Pearl Automation Inc.	RearVision Camera Frame	P110

Responsible for Testing Laboratory:

September 30, Franz Engert
2016 Compliance (Compliance Manager)

Date	Section	Name	Signature
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Responsible for the Report:

September 30, James Donnellan
2016 Compliance (Sr. EMC Engineer)

Date	Section	Name	Signature
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The test results of this test report relate exclusively to the test item specified in Section 3.

CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

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2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC 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
Manager Compliance Services:	Franz Engert
Project Manager:	Ruther Navarro

2.2 Identification of the Client

Applicant's Name:	Pearl Automation Inc.
Street Address:	100 Enterprise Way, Suite A101
City/Zip Code	Scotts Valley, CA 95066
Country	USA
Contact Person:	Hagan O'Connor / Erturk Kocalar
Phone No.	+1 408 655-3319 (Hagan) / +1 408 410-0144 (Erturk)
e-mail:	hagan@pearlauto.com / erturk@pearlauto.com.

2.3 Identification of the Manufacturer

Manufacturer's Name:	Dongguan Primax Electronic & Telecommunications Products Co. Ltd,
Manufacturers Address:	Liu Wu District, Shek Kit Town,
City/Zip Code	DongGuan City, Guang Dong,
Country	China.

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3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model #:	P110
HW Version :	DVT1B
SW Version :	001.668
FCC-ID :	2AG6M-P110
Product Description:	RearVision Camera Frame
Regulatory Band:	UNII-3 5725 MHz – 5825 MHz
Channels Used:	802.11, UNII-3, 149, 153, 157, 161, 165 (20MHz), 151, 159 (40MHz)
Type(s) of Modulation:	802.11 a/n with QPSK, BPSK, 16 QAM, 64 QAM + OFDM
Modes of Operation:	Communicates with and transmits video traffic to the RearVision Car Adapter module in peer to peer mode. Both devices are clients.
Antenna Type:	1 Custom internal PCB Trace Antenna. For RF conducted measurements, a temporary connection was made from measurement equipment to the 50Ohm UFL port of the EUT.
Max. Declared Antenna Gain:	6dBi
Max. Conducted Output Power per declaration	13dBm + 2dB tolerance for 802.11a mid and high channel
Power Supply:	Internal Li-ion Rechargeable Battery (Solar)
Rated Operating Voltage Range:	Vmin: 2.8 V DC - Vmax: 4.2V DC USB 4.4 VDC - 5.25 VDC
Operating Temperature Range:	Tlow: -20° - Tmax: 45° C
Other Radios included in the Device:	2.4GHz WLAN BTLE
Sample Revision:	<input checked="" type="checkbox"/> Prototype; <input type="checkbox"/> Production; <input type="checkbox"/> Pre-Production

3.2 EUT Sample details


EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	A2A6170576	DVT1B	001.668	Radiated Sample
2	A2A61008K4	DVT1B	001.668	Conducted Sample

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number	Notes.
1	12W USB Power Adapter	A143	Apple	-	Used to charge internal battery when needed
2	MacBook Air	A1465	Apple	C2QQ606&G4FY	Used to setup channel modes prior to test.
3	Lamp	-	-	-	To stimulate solar charging

3.1 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user.
2	EUT#2 + AE2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected. The measurement equipment was connected to the 50Ohm UFL port of the EUT.
3	EUT#1 + AE#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.
4	EUT#1 + AE#3	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The EUT was connected to the AC mains through a USB charger.

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4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT per the relevant requirements specified in FCC rules Part 15.407 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the FCC ID: 2AG6M-P110.

Testing procedures are based on

KDB 789033 v01r03 Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices
Part15, Subpart E and ANSI C63.10 2013

5 Measurement Results Summary

Test Specification	Test Case	Pass	Fail	NA	NP	Result
§15.407(e)	6 dB Bandwidth	■	□	□	□	Complies
§15.407(a)(3)	Transmitter Output Power and EIRP	■	□	□	□	Complies
§15.407(a)(3)	Power Spectral Density	■	□	□	□	Complies
§15.407(b)	Unwanted Emissions	■	□	□	□	Complies
§15.407(b)	Out of Band Emissions at the Band Edge	■	□	□	□	Complies
§15.207(a)	AC Conducted Emissions	□	□	■	□	See Note 2

Note:

1. NA= Not Applicable; NP= Not Performed.
2. AC power line conducted emissions is not required as the radios are not operational during charging.

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

	Uncertainty in dB radiated <30MHz	Uncertainty in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
standard deviation k=1	2.56	1.71	2.22	0.67
95% confidence interval in dB	5.01	3.34	4.35	1.31
95% confidence interval in dB in delta to Result (rounded up to next decimal point)	+/- 2.5 dB	+/- 2.0 dB	+/- 2.3dB	+/- 0.7dB

7 Environmental Conditions During Testing

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25°C
- Relative humidity: 40-60%

8 Dates of Testing

February - June, 2016

9 Measurement Procedures

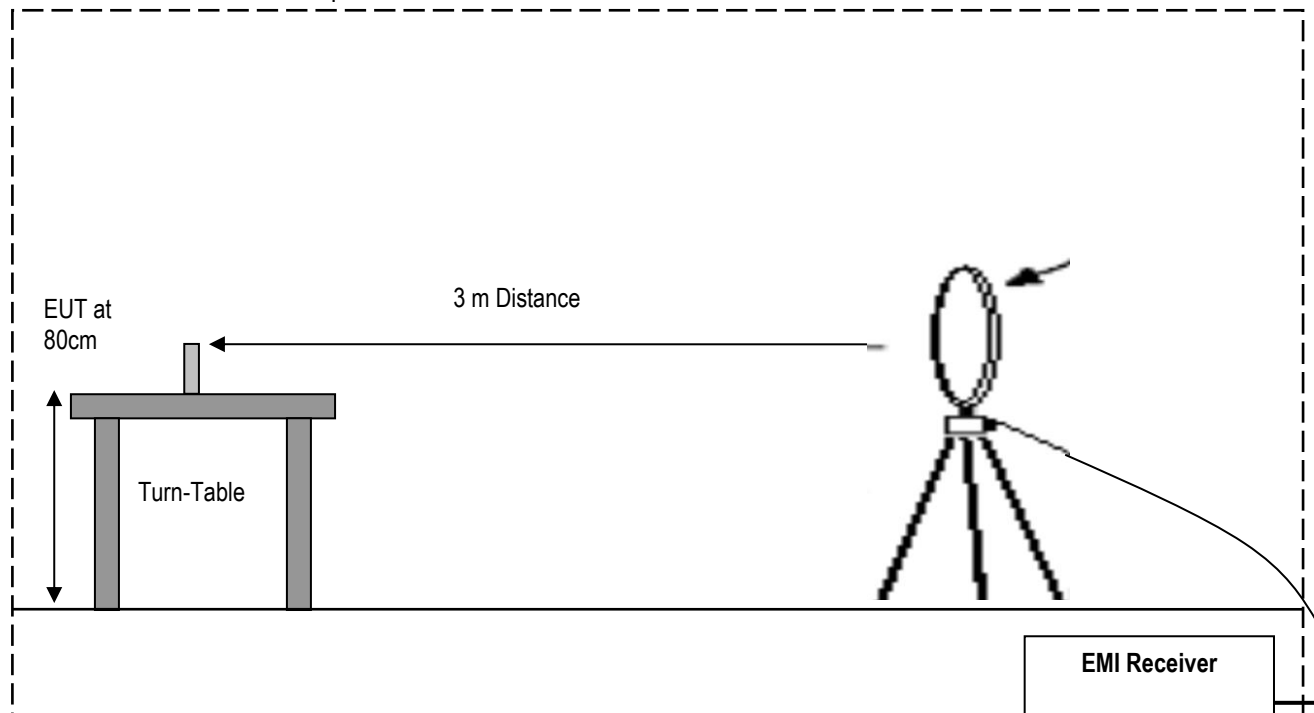
9.1 Radiated Measurement

The radiated measurement is performed according to:

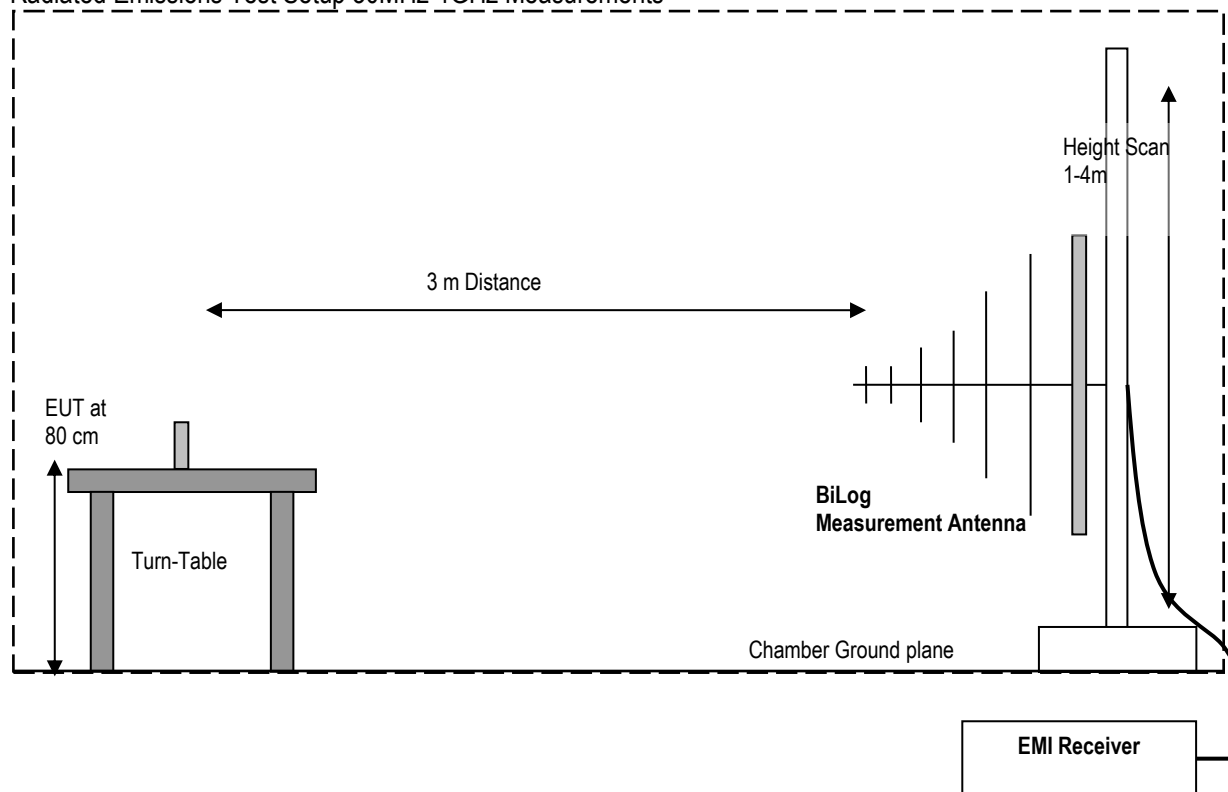
ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running sweeps at 1 and 4m antenna heights over the required frequency range with R&S Test-SW EMC32 for both antenna polarizations. During each frequency scan the turntable rotates by no more than 10deg.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then again maximized through a fine search in frequency domain, maximized in the 360deg range of the turntable, and maximized over antenna height between 1m and 4m and for positioning of the EUT.
- The above procedure is repeated for transmission low mid and high channel.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

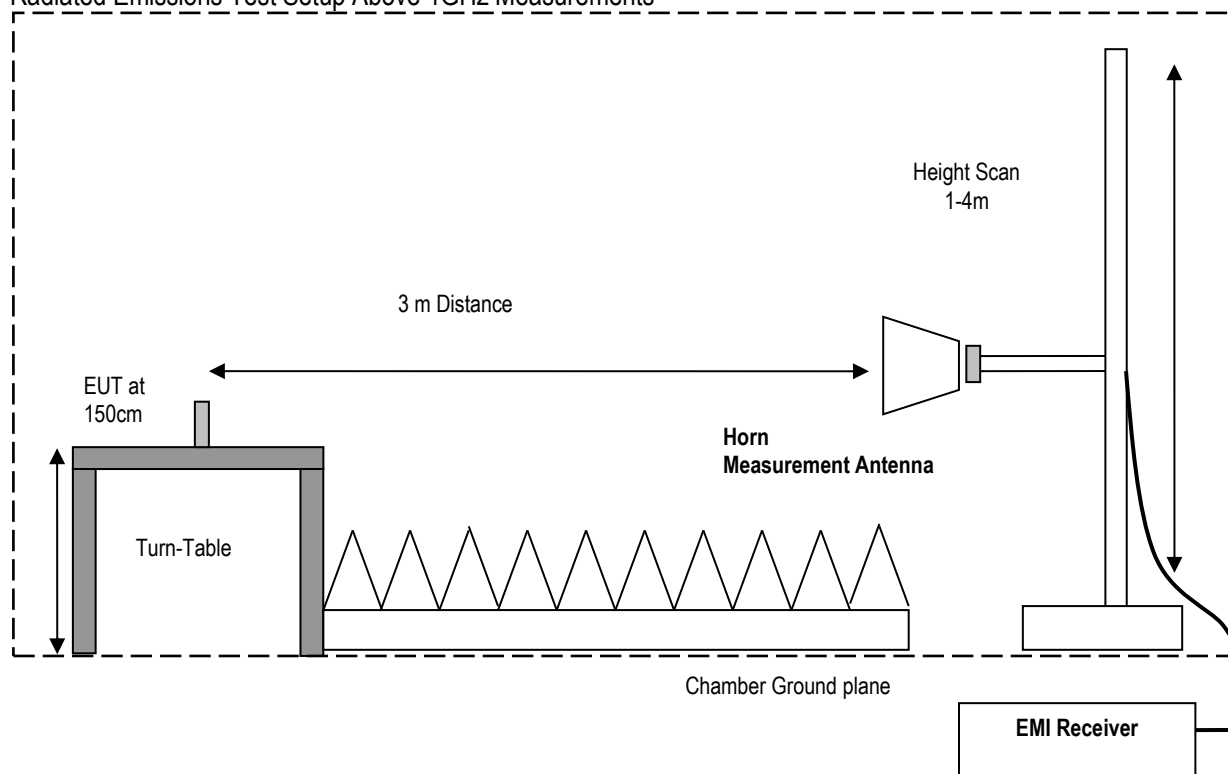
Radiated Emissions Test Setup below 30MHz Measurements




Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



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9.2 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

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

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

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} - \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

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

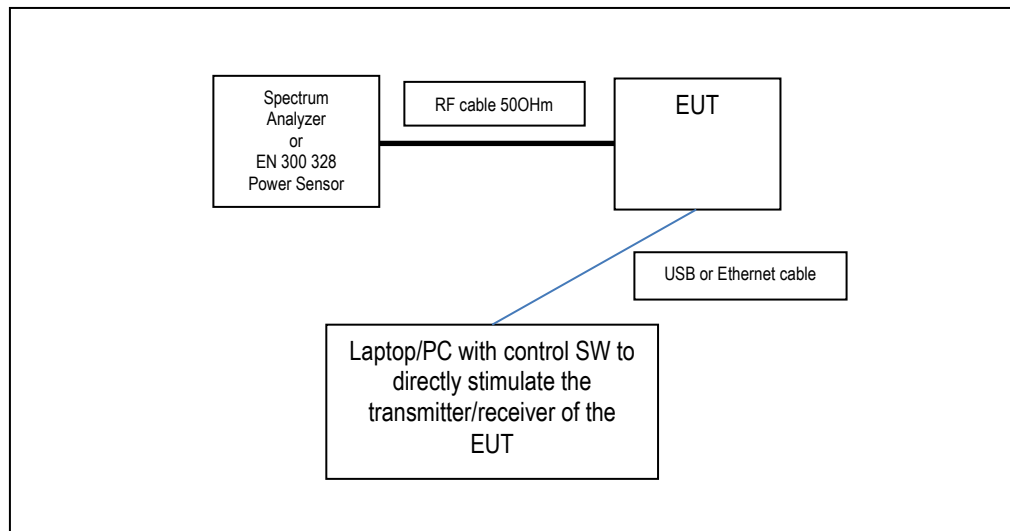
9.3 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to:


ANSI C63.4 (2014)

9.4 RF Conducted Measurement Procedure

9.4.1 Conducted Measurement Setup without companion device



See plots for spectrum analyzer settings.

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10 Duty Cycle

10.1 Measurement Method.

Measurements are according to FCC KDB 789033 D02 V01R03, Section B, measurement technique (b).

10.2 Limits

No limit

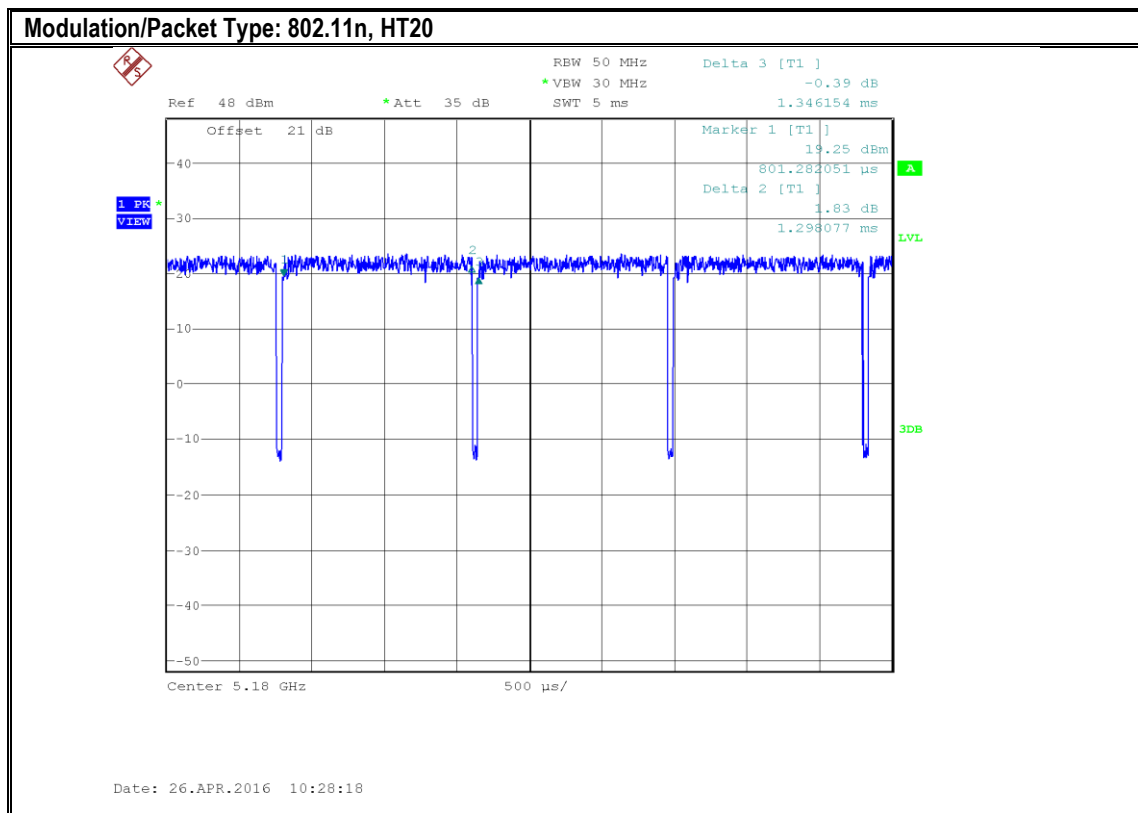
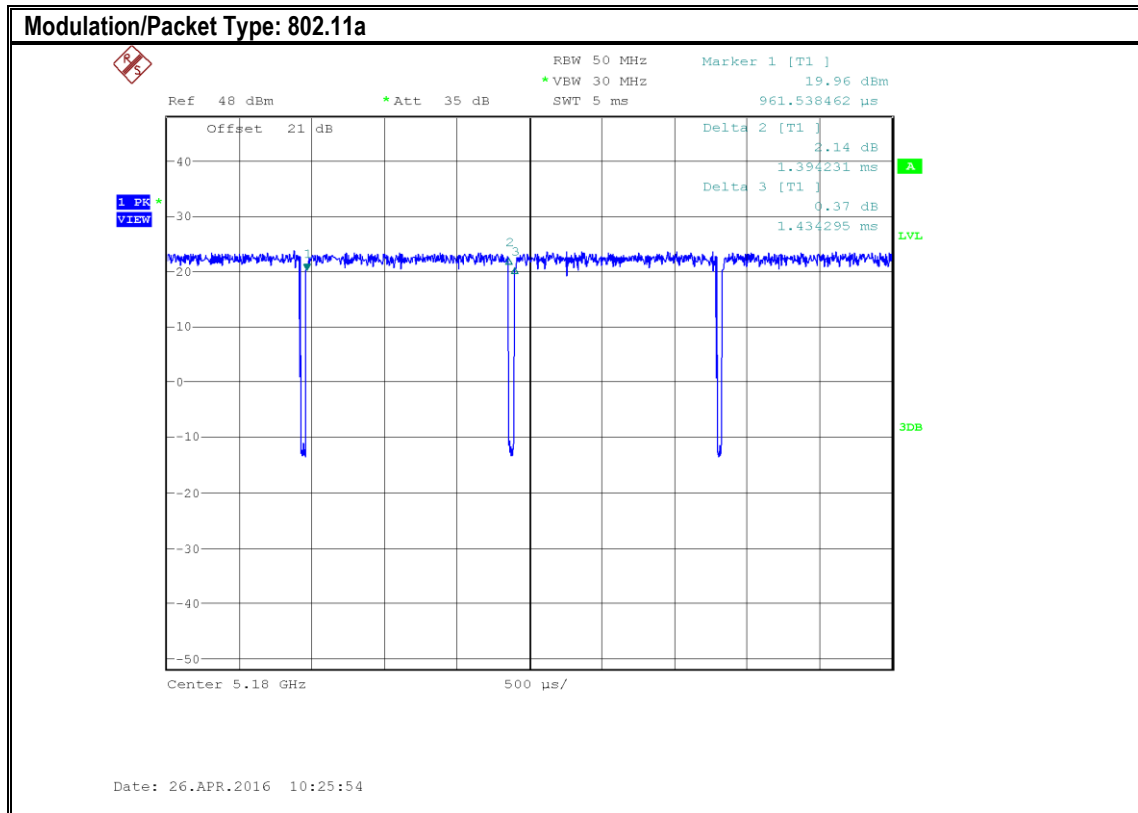
10.3 Test conditions and setup

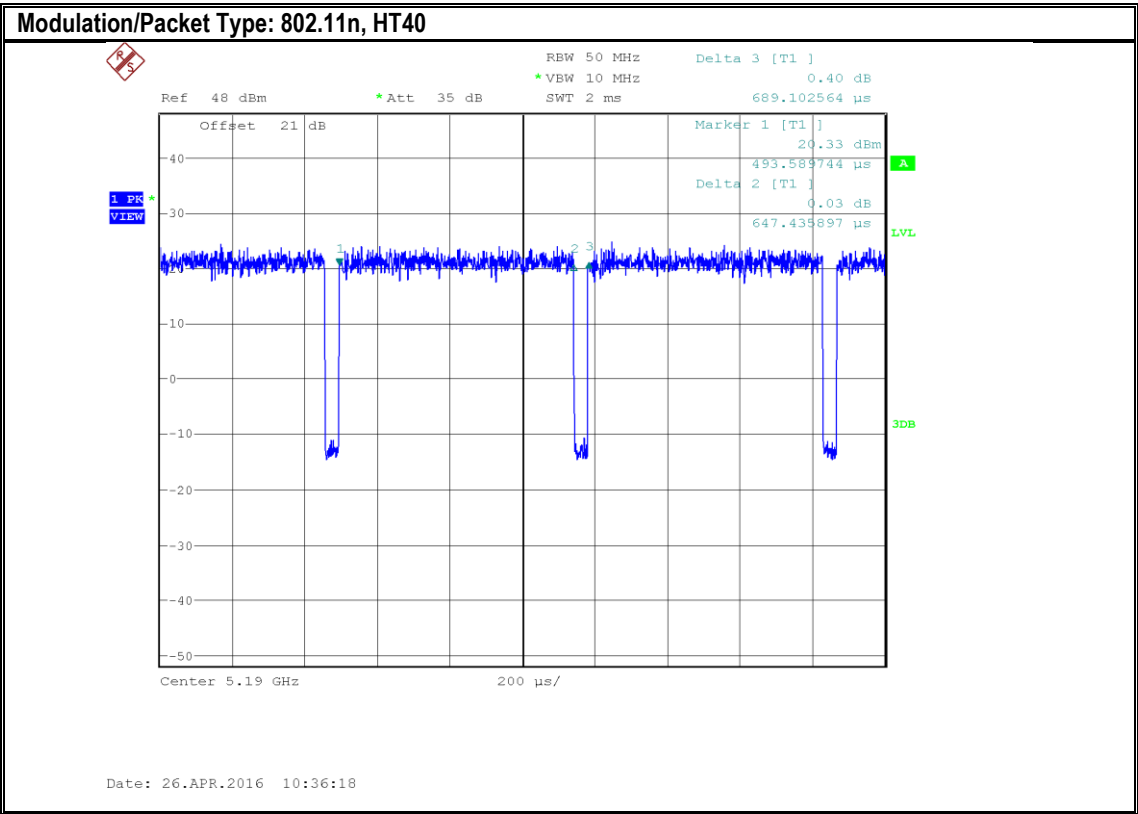
Ambient Temperature	EUT Set-Up #	Power Input
23° C	2	Battery

10.4 Measurement result

Operating Mode	Tx On	Tx On + Tx Off	Duty Cycle
802.11a	1.39 ms	1.43 ms	97%
802.11n, HT20	1.30	1.35	96%
802.11n, HT40	647.4 μ s	689.1 μ s	94%

10.5 Measurement Plots





11 Bandwidth

11.1 Measurement Method

Measurements are according to FCC KDB 789033 D02 V01R02, section C and D.

11.2 Limits

Emission Bandwidth: None

Occupied Bandwidth: None

6 dB Emission Bandwidth: ≥ 500 kHz

11.3 Test conditions and setup:

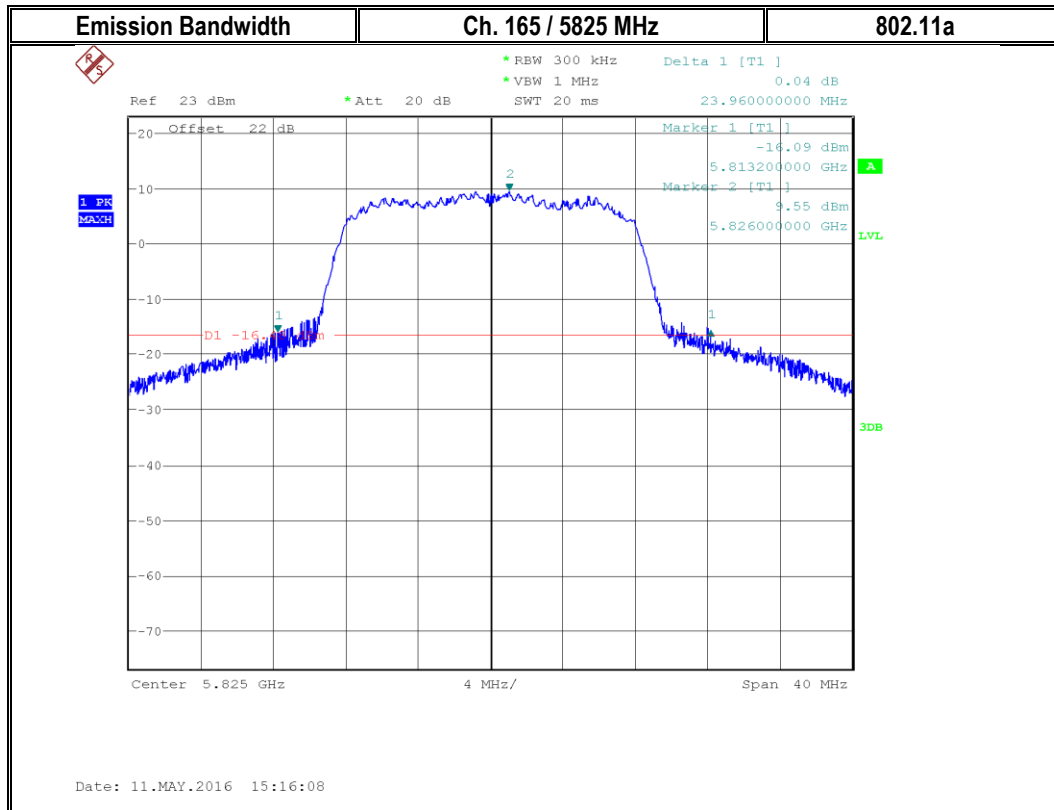
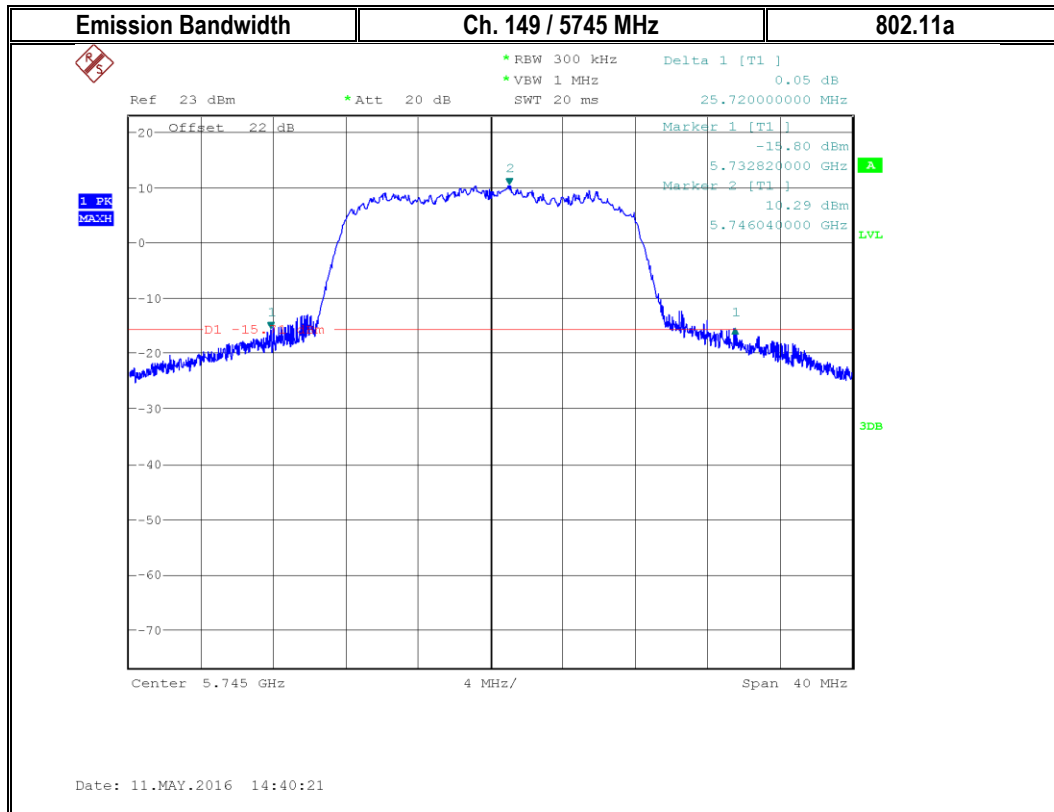
Ambient Temperature	EUT Set-Up #	Power Input
23.0° C	2	Battery

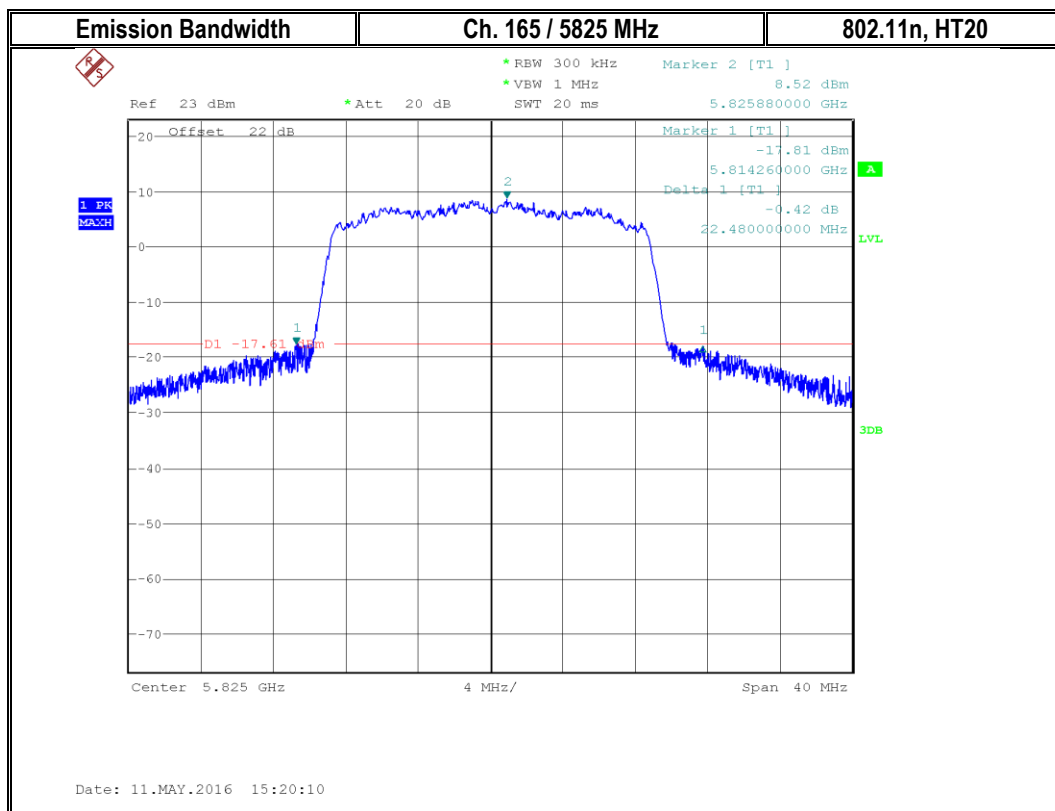
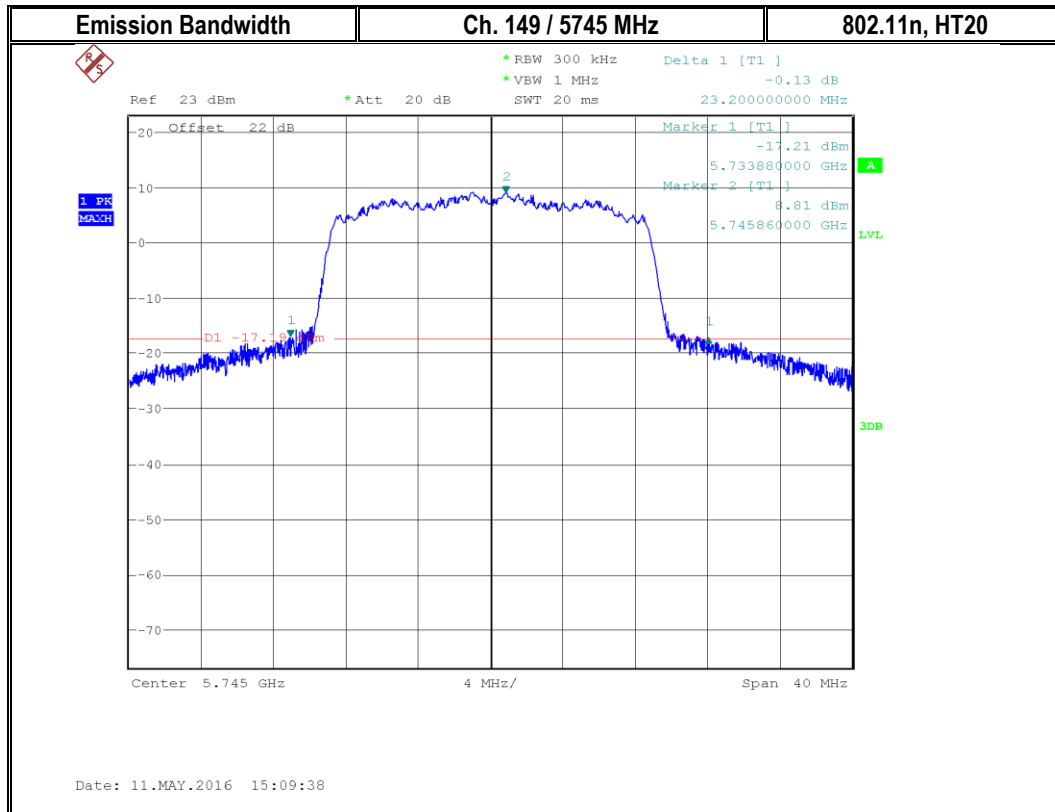
11.4 Measurement result:

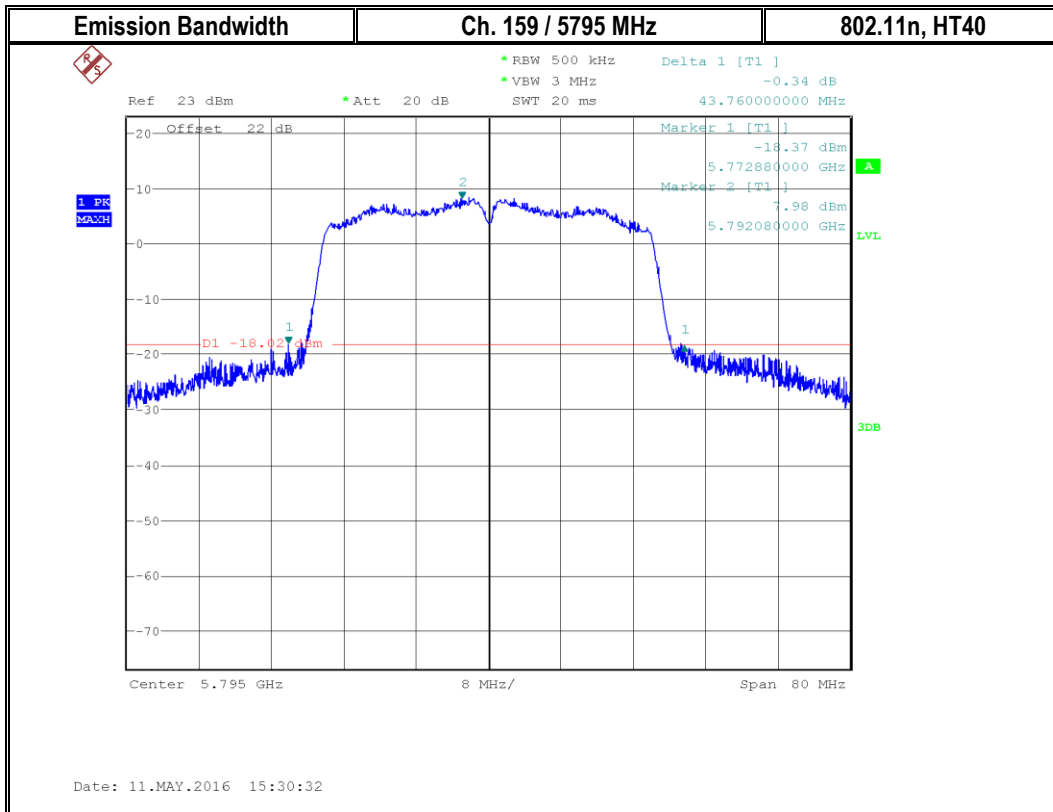
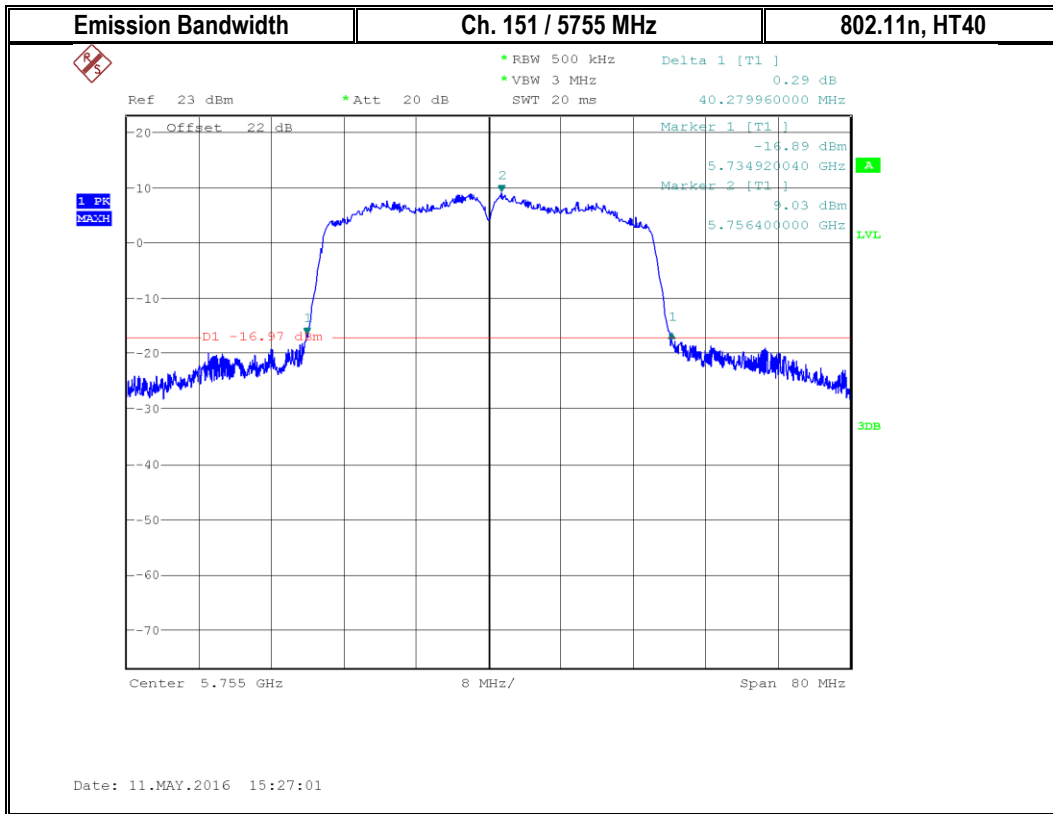
Operating Mode	Frequency (MHz)	Emission Bandwidth (MHz)	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)
802.11a	5745	25.72	16.5	15.46
	5825	23.96	16.46	15.00
802.11n, HT20	5745	23.2	17.5	15.00
	5825	22.48	17.52	15.49
802.11n, HT40	5755	40.28	36.24	35.00
	5795	43.76	36.24	35.16

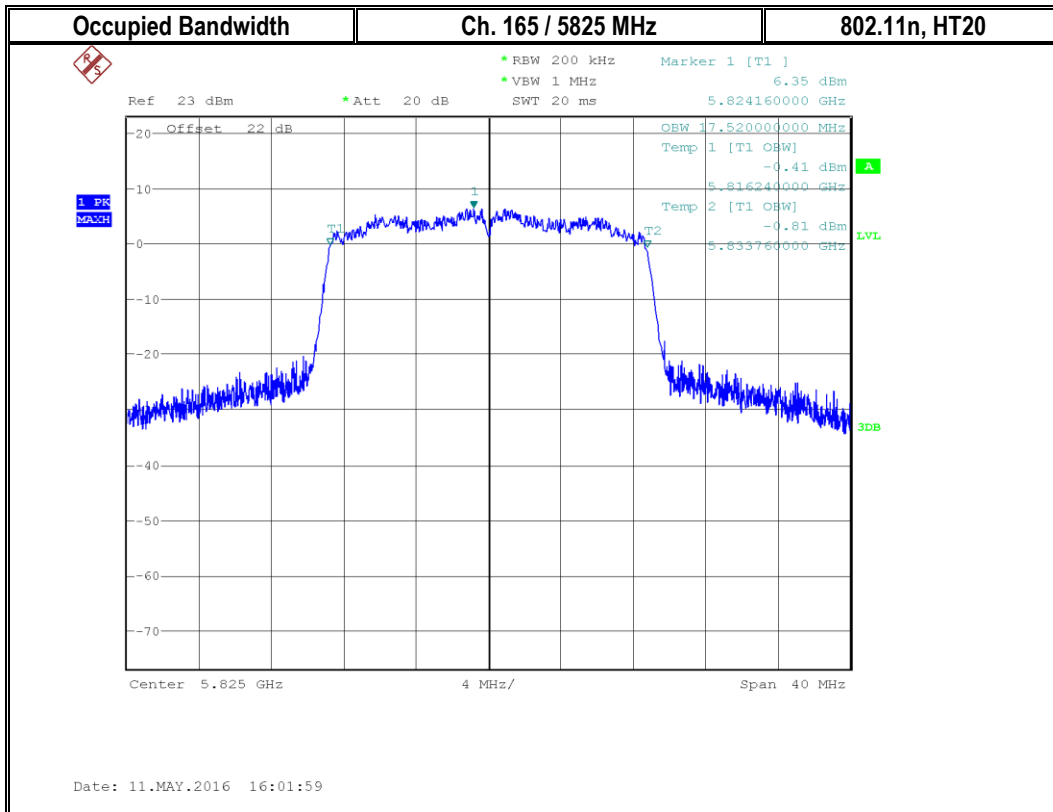
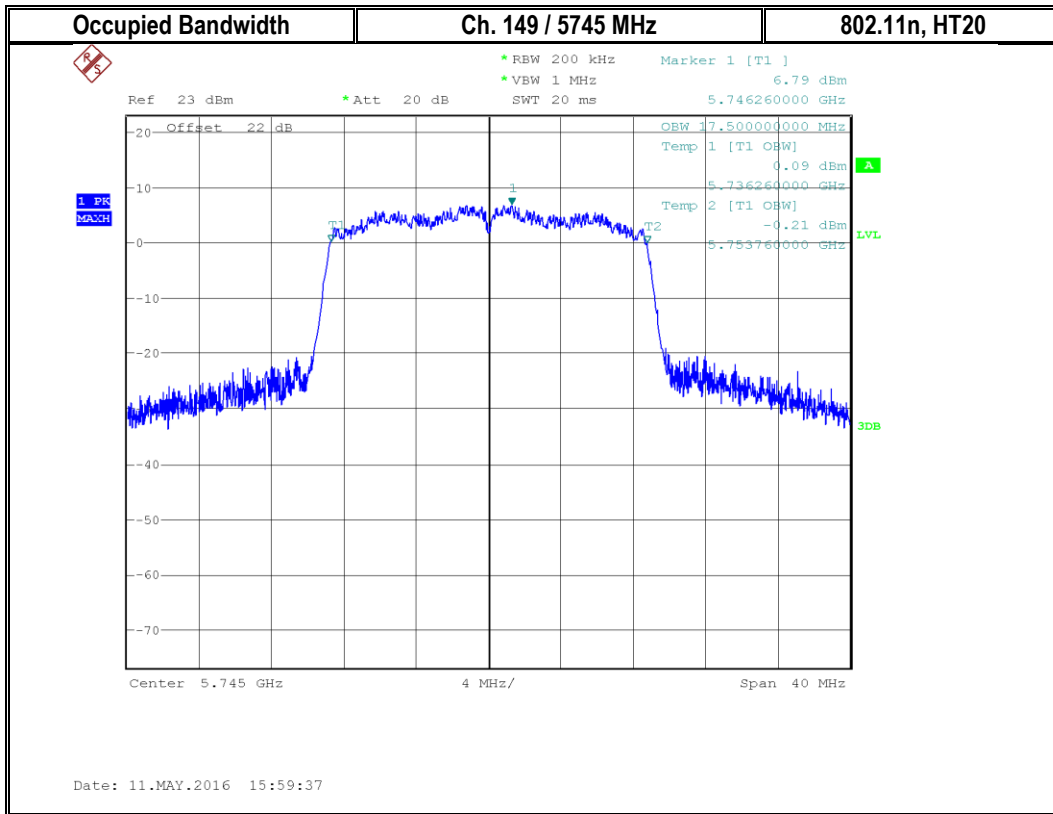
11.5 Measurement Plots

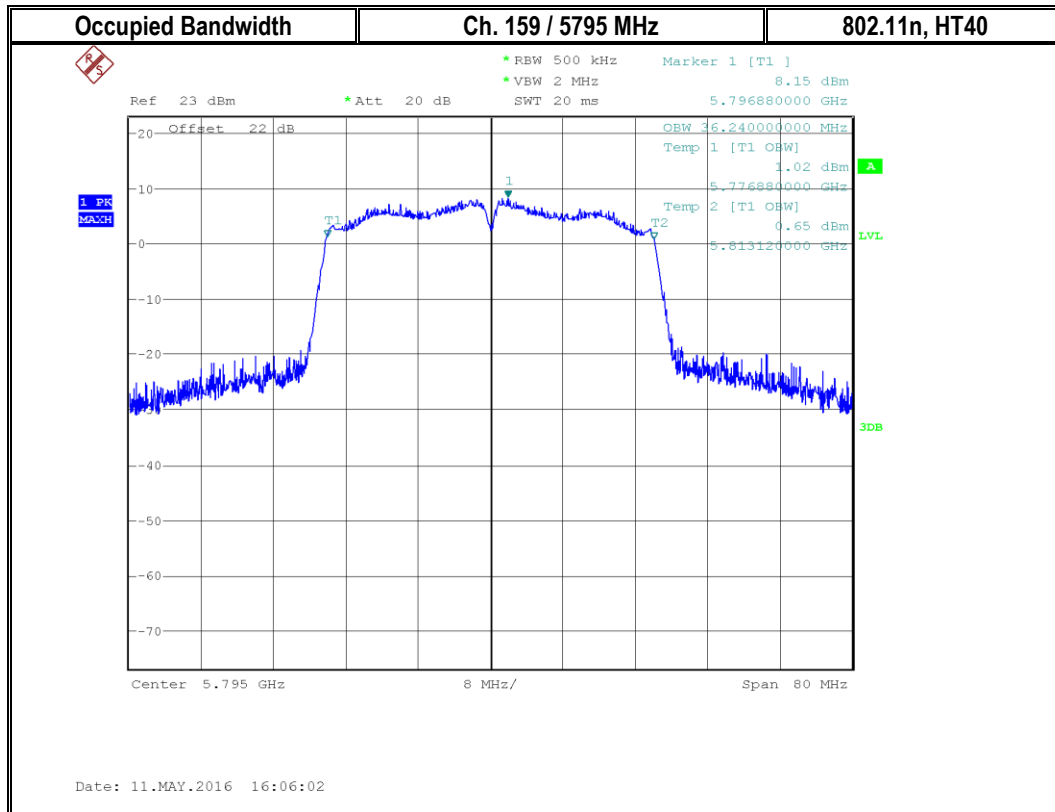
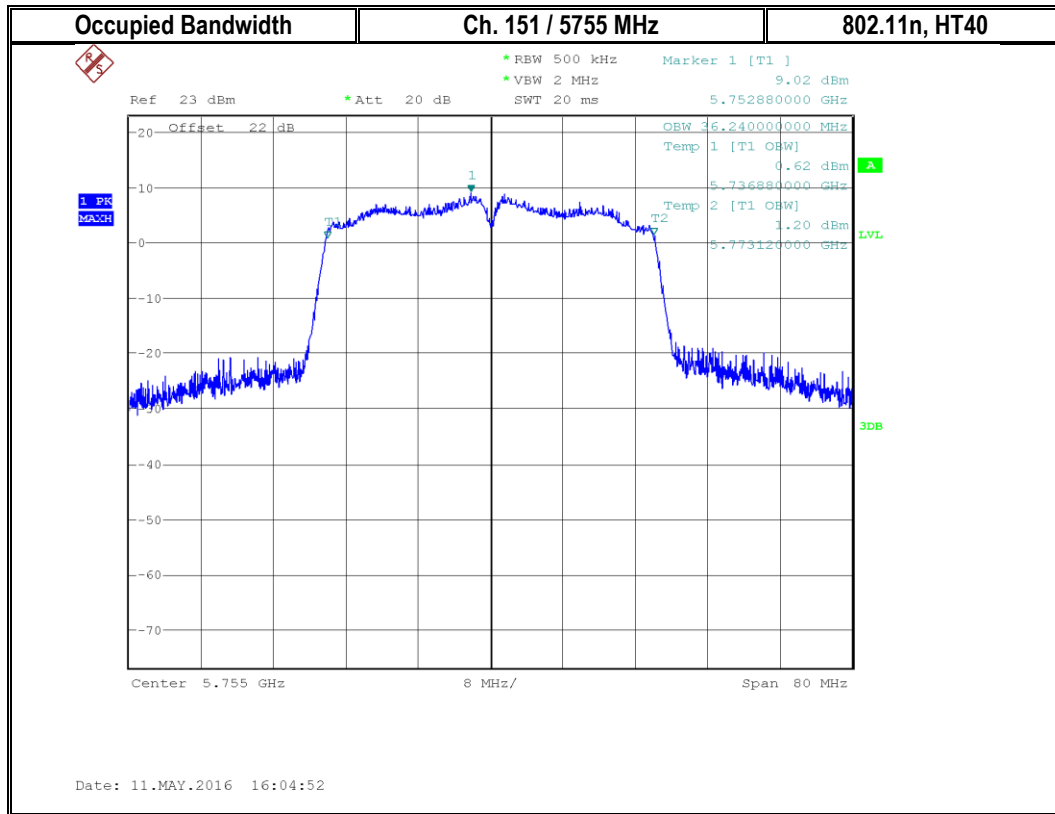
11.5.1 Emission Bandwidth



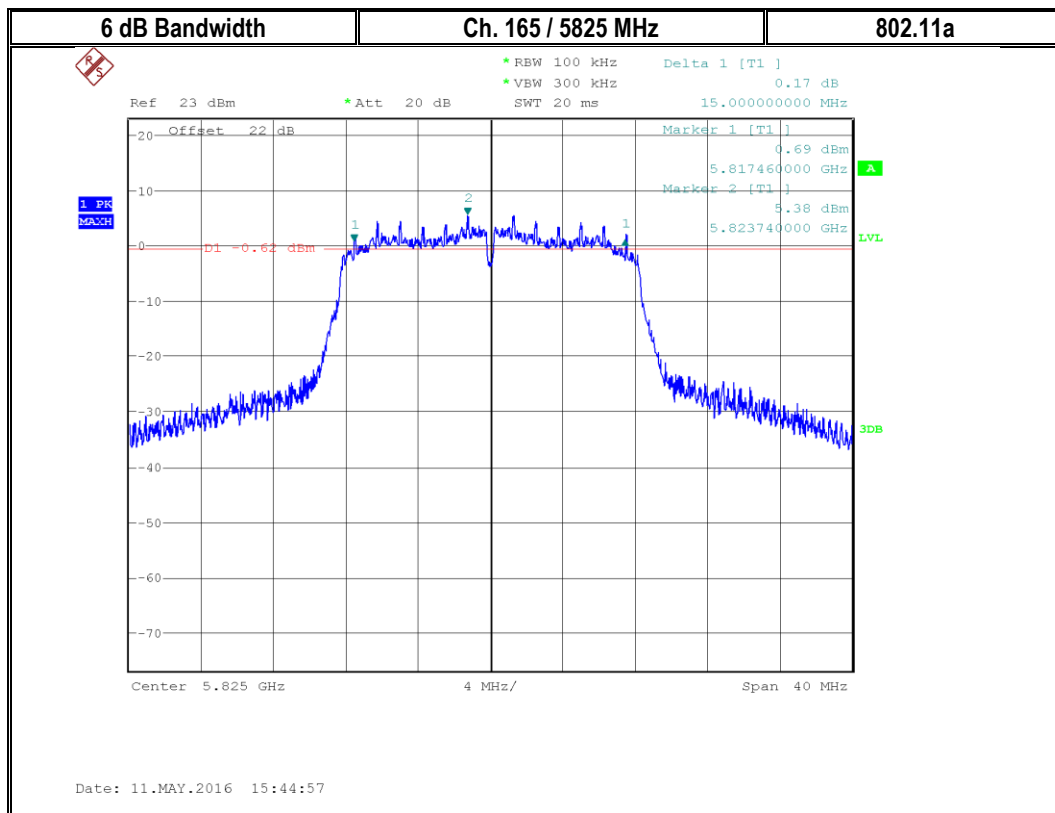
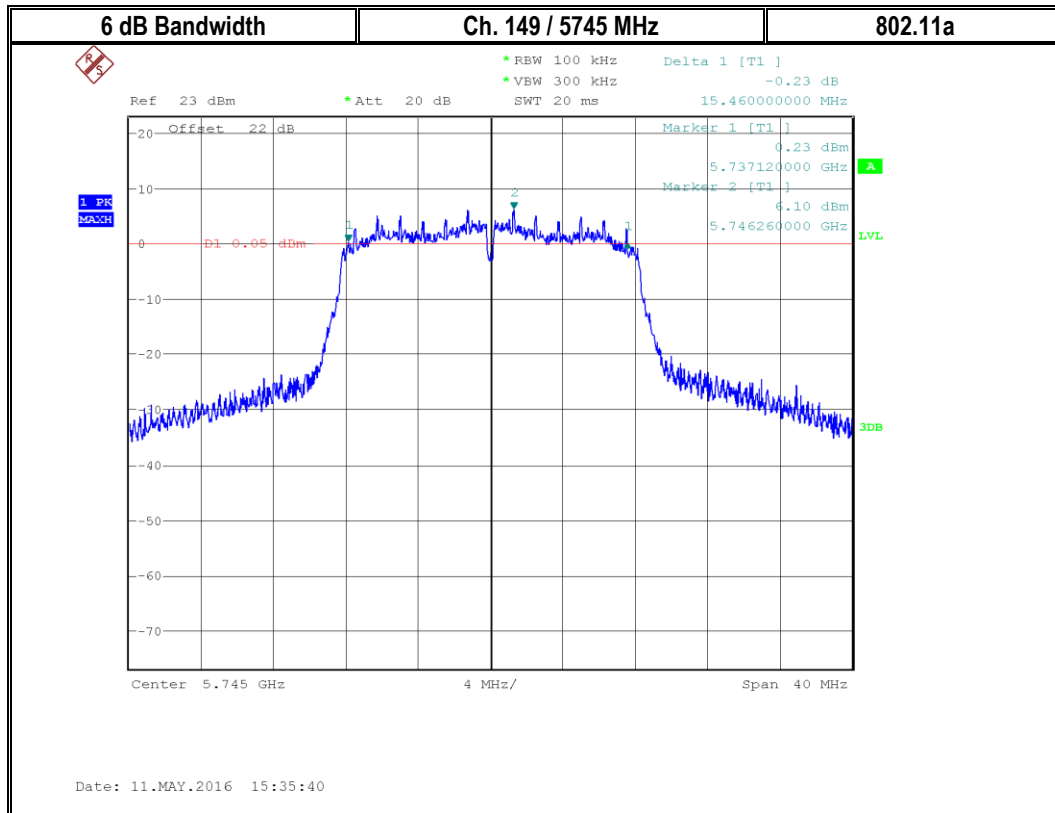


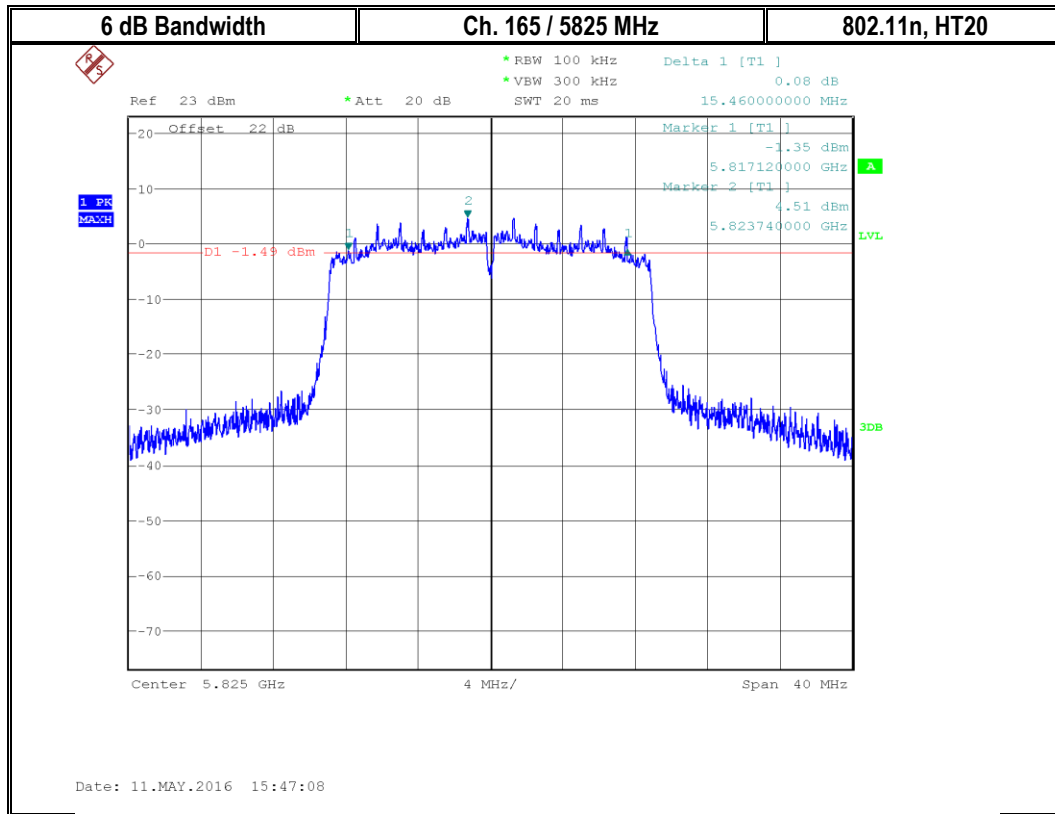
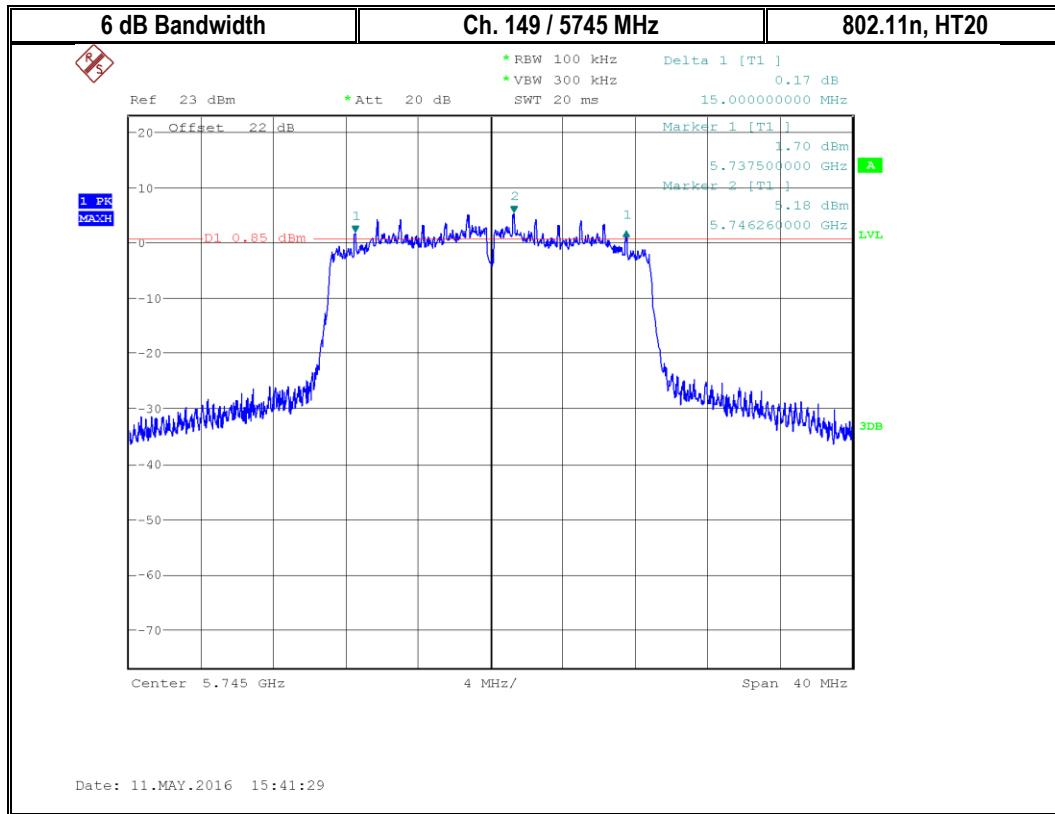


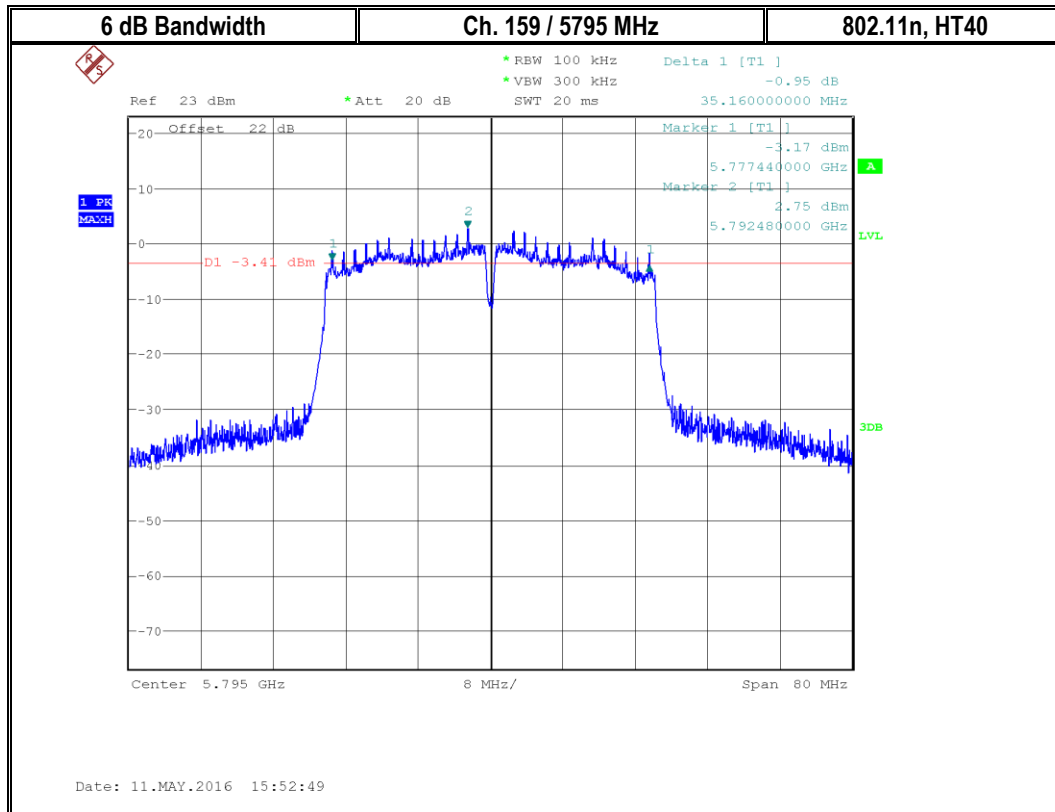
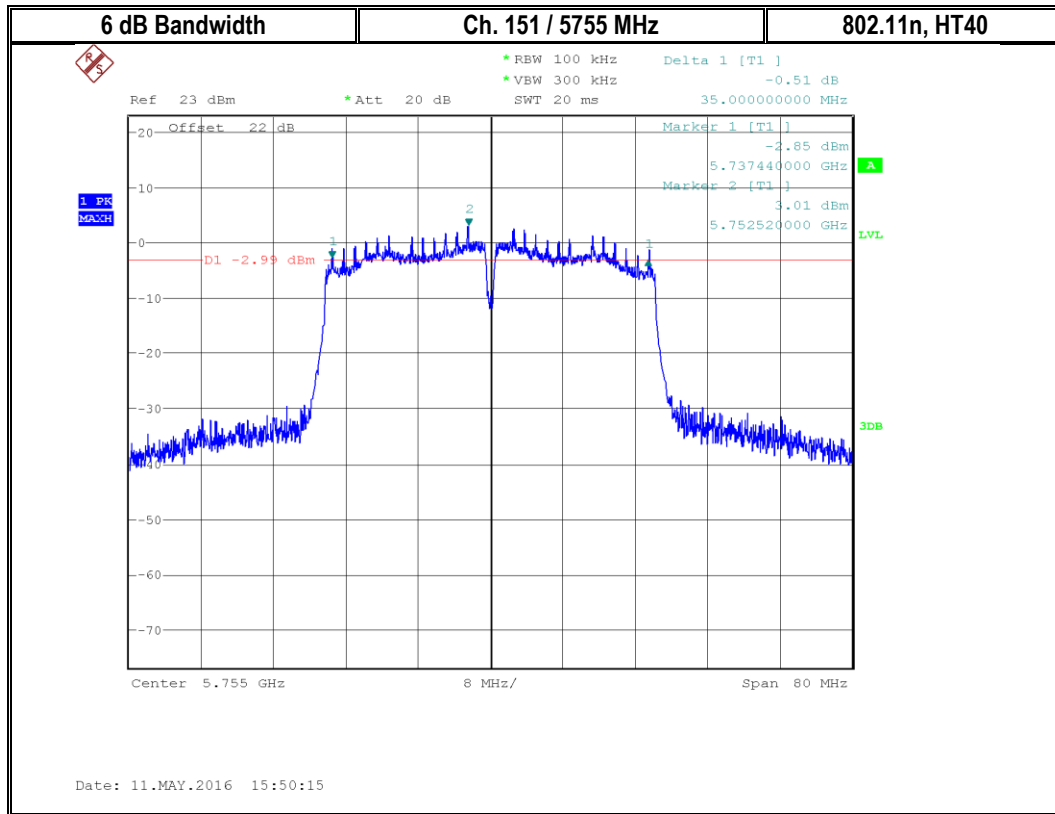





11.5.3 6 dB Emission Bandwidth







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12 Transmitter Output power and EIRP

12.1 Measurement Method.

Measurements are according to FCC KDB 789033 D02 V01R03, section II.E, Method SA-2.

12.2 Limits

When the antenna gain does not exceed 6 dBi:

Conducted Output Power: 1 W (30 dBm)

EIRP: 4 W (36 dBm)

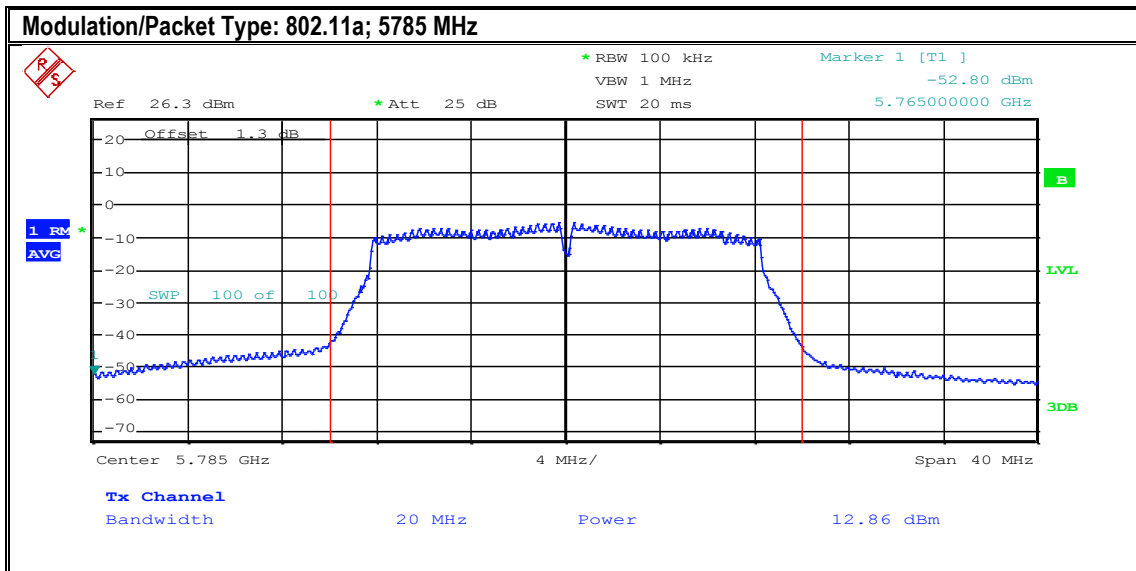
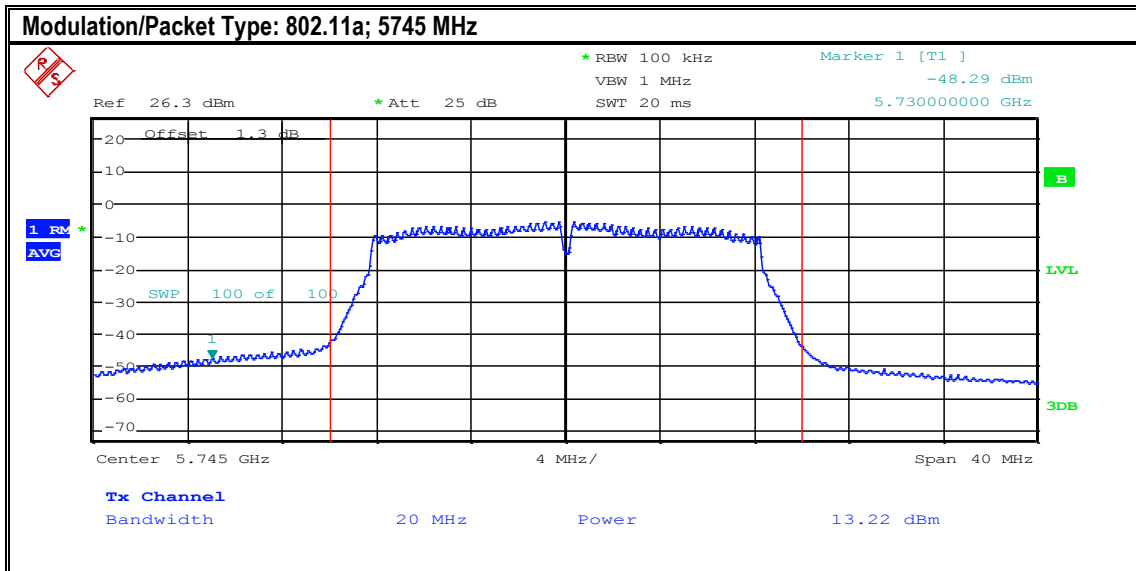
12.3 Test conditions and setup

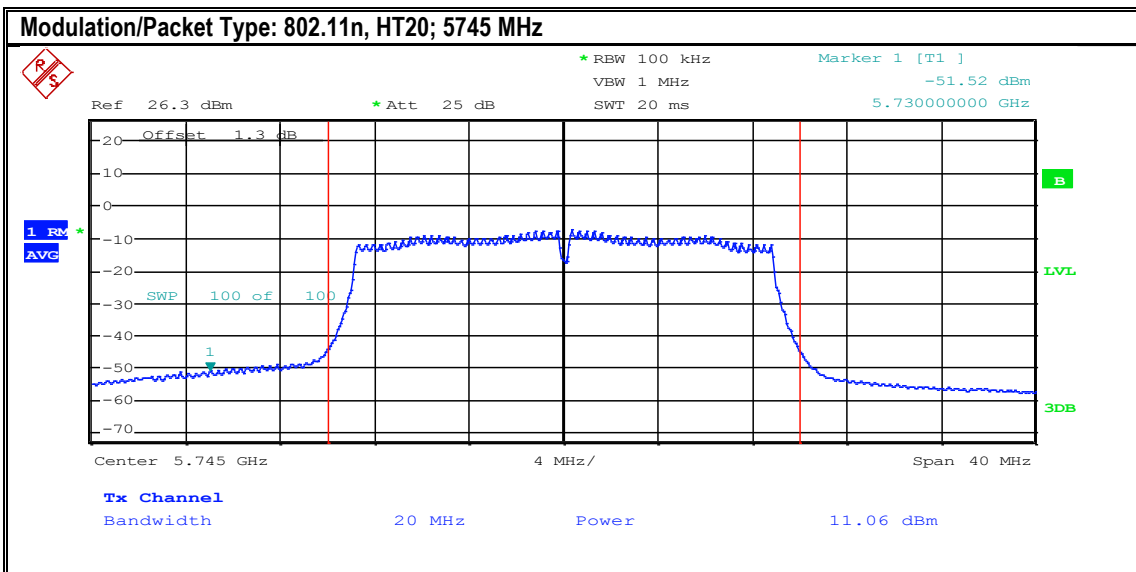
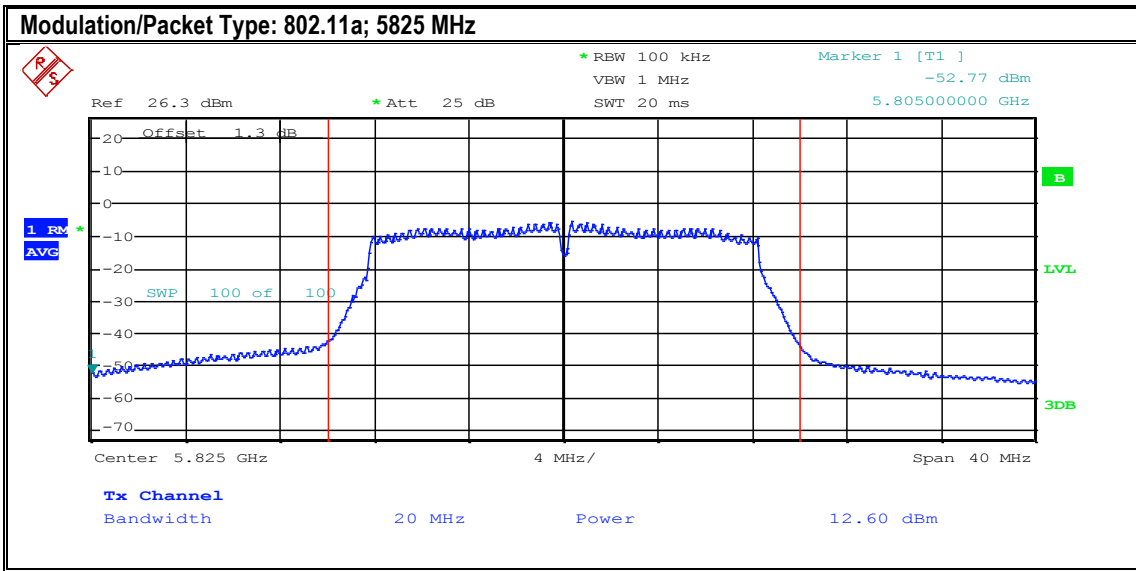
Ambient Temperature	EUT Set-Up #	Power Input
23.4	2	Battery

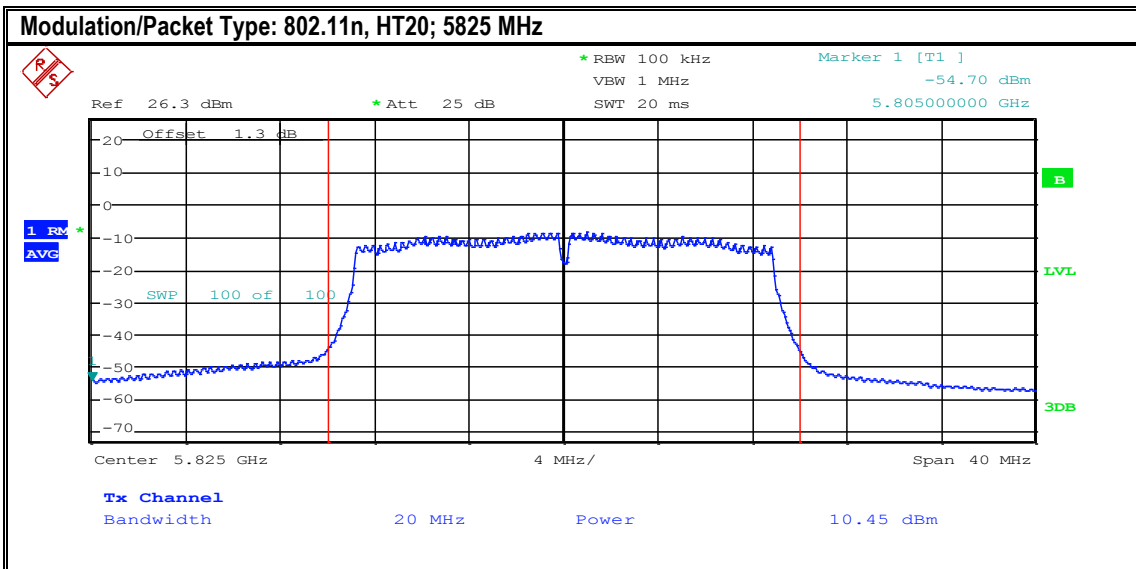
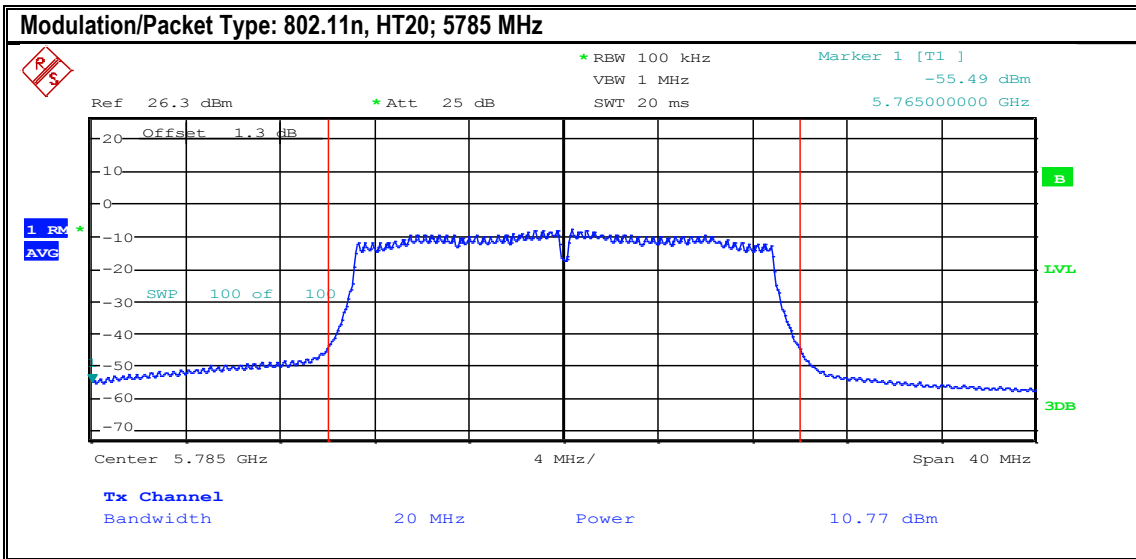
12.4 Measurement Result

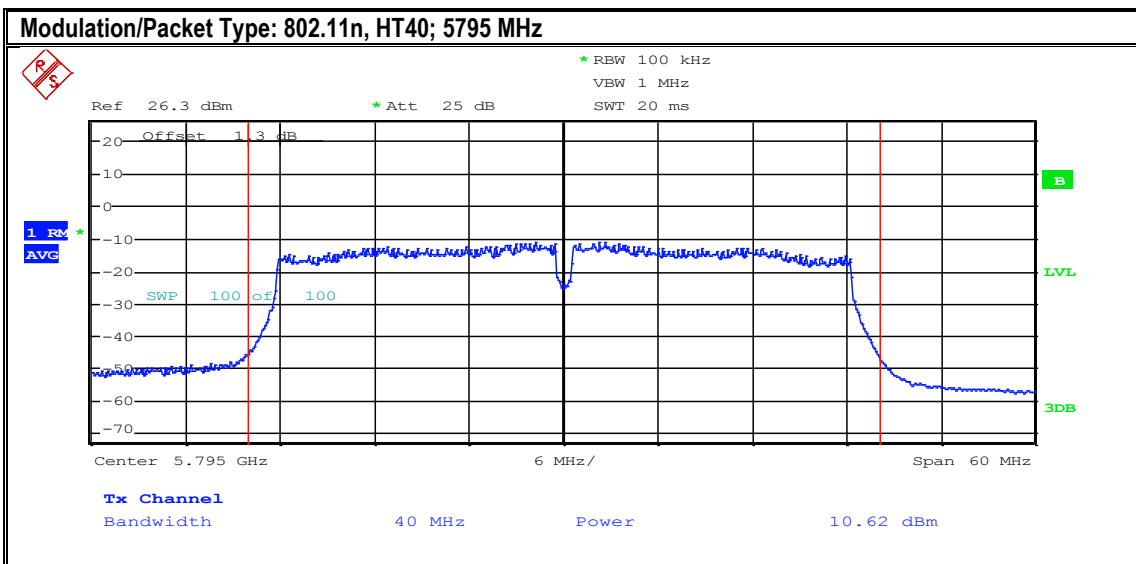
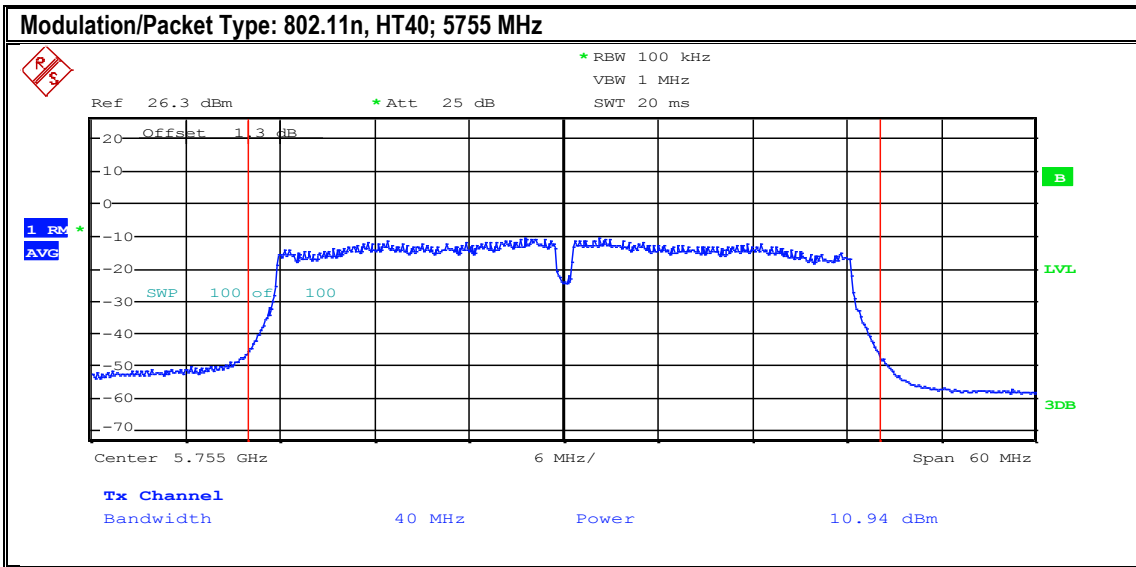
Operating Mode	Frequency (MHz)	Duty Cycle correction (dB)	Measured Conducted Averaged Output Power (dBm)	Duty Cycle Corrected Conducted Average Output Power (dBm)	Calculated EIRP (dBm)	Verdict
802.11a	5745	.13	13.22	13.35	19.35	PASS
	5785	.13	12.86	12.99	18.99	PASS
	5825	.13	12.60	12.73	18.73	PASS
802.11n, HT20	5745	.18	11.06	11.24	17.24	PASS
	5785	.18	10.77	10.95	16.95	PASS
	5825	.18	10.45	10.63	16.63	PASS
802.11n, HT40	5755	.27	10.94	11.21	17.21	PASS
	5795	.27	10.62	10.89	16.89	PASS


12.5 Measurement Plots









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13 Power Spectral Density

13.1 Measurement Method.

Measurements are according to FCC KDB 789033 D02 V01R02, section II.E, Method SA-2.

13.2 Limits

FCC §15.407 (a)(3): 30 dBm / 500 kHz

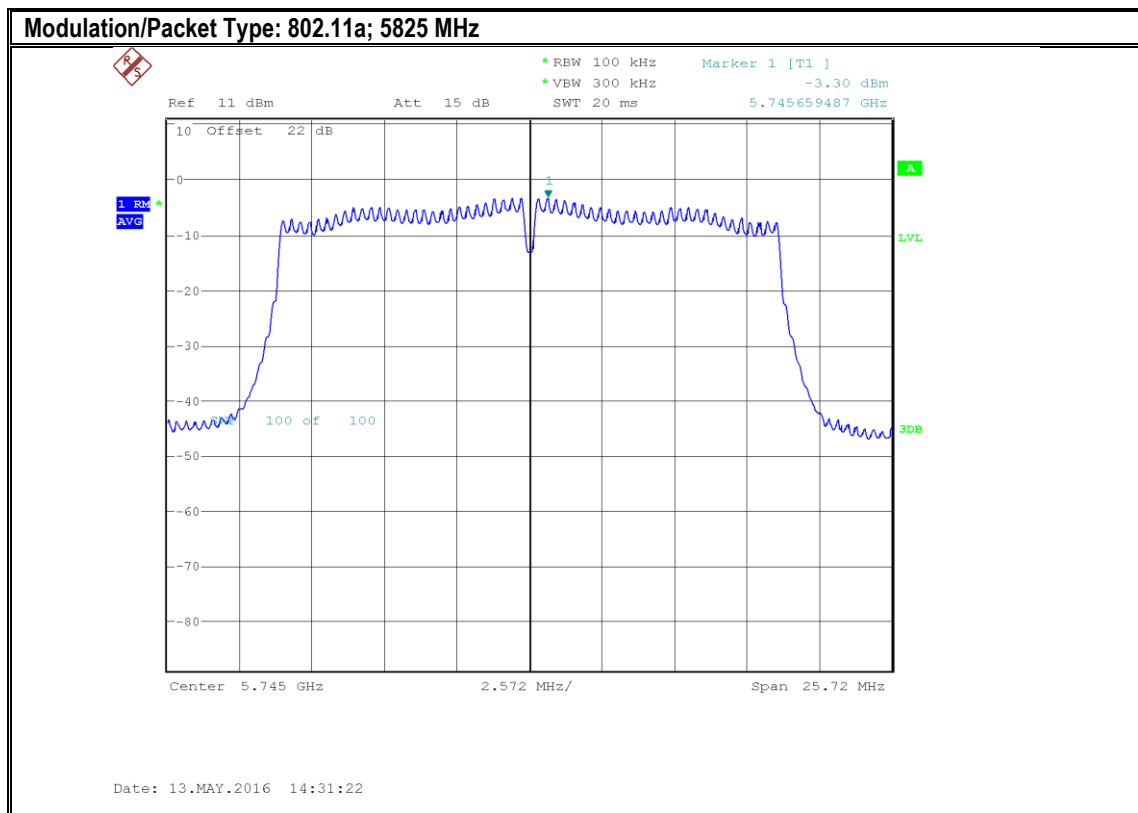
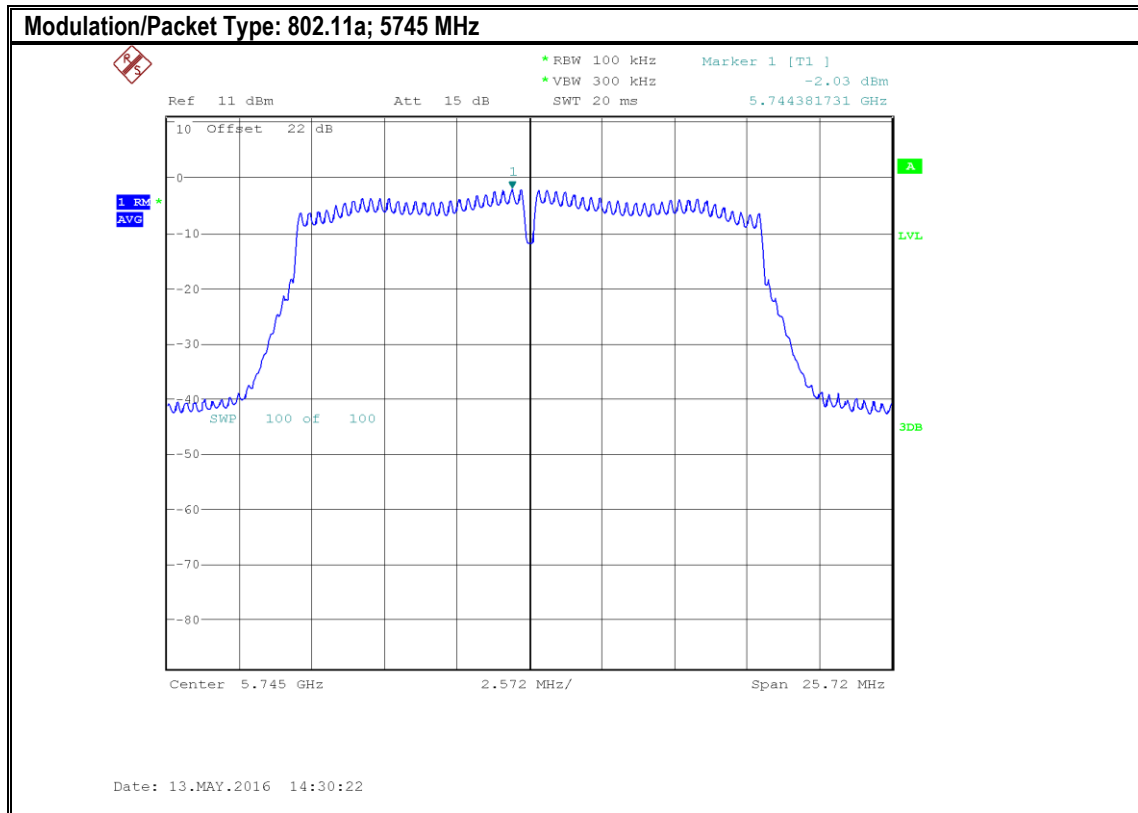
13.3 Test conditions and setup:

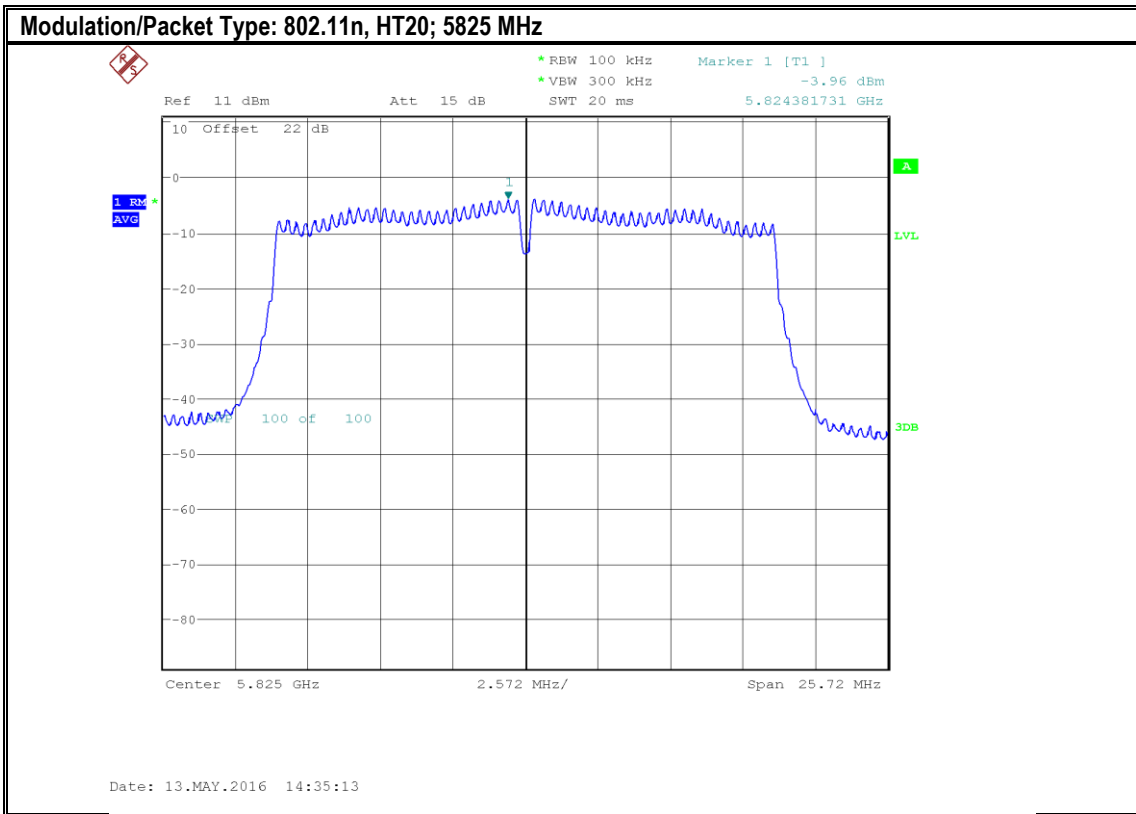
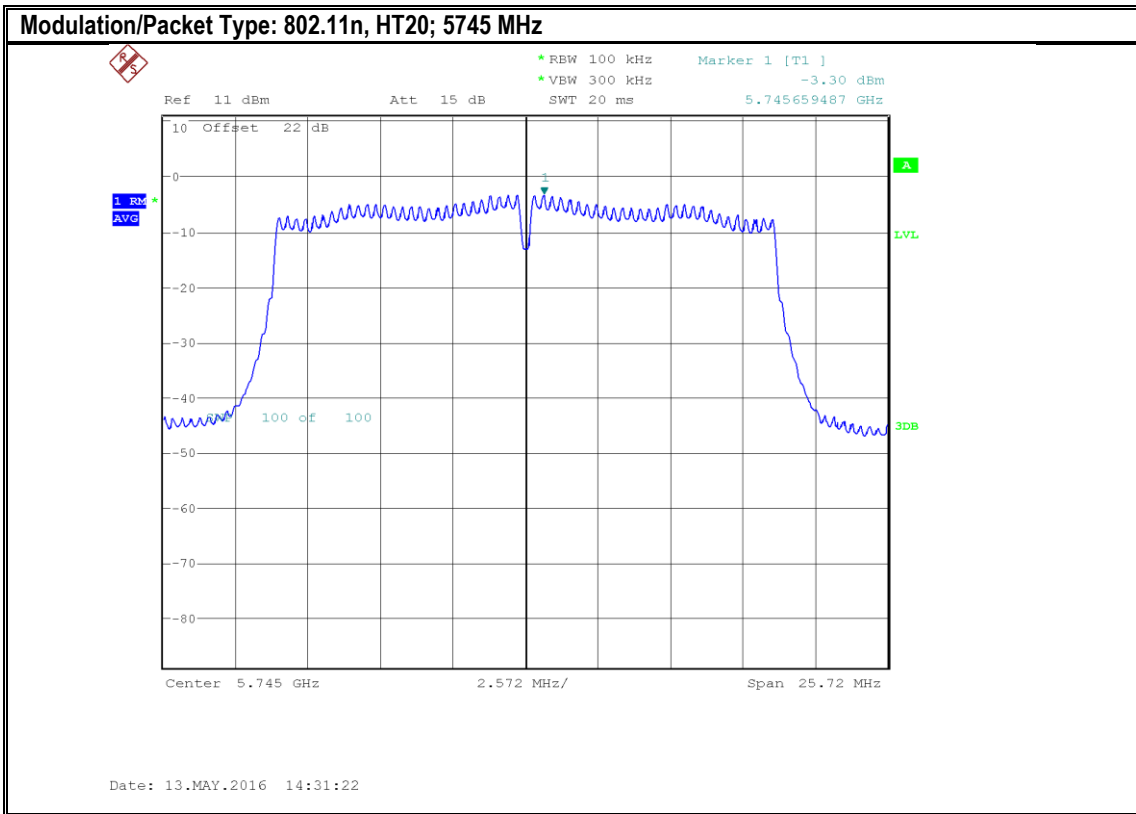
Ambient Temperature	EUT Set-Up #	Power Input	Antenna Gain (dBi)
24° C	2	Battery	6

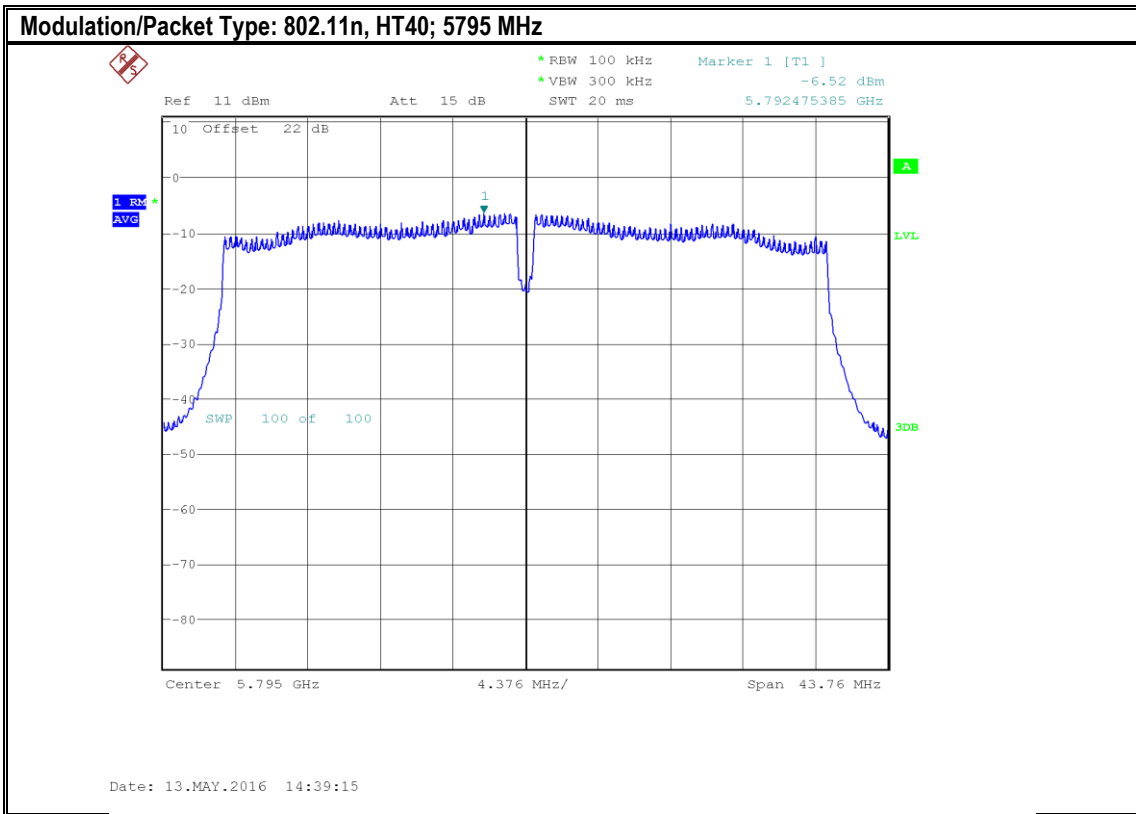
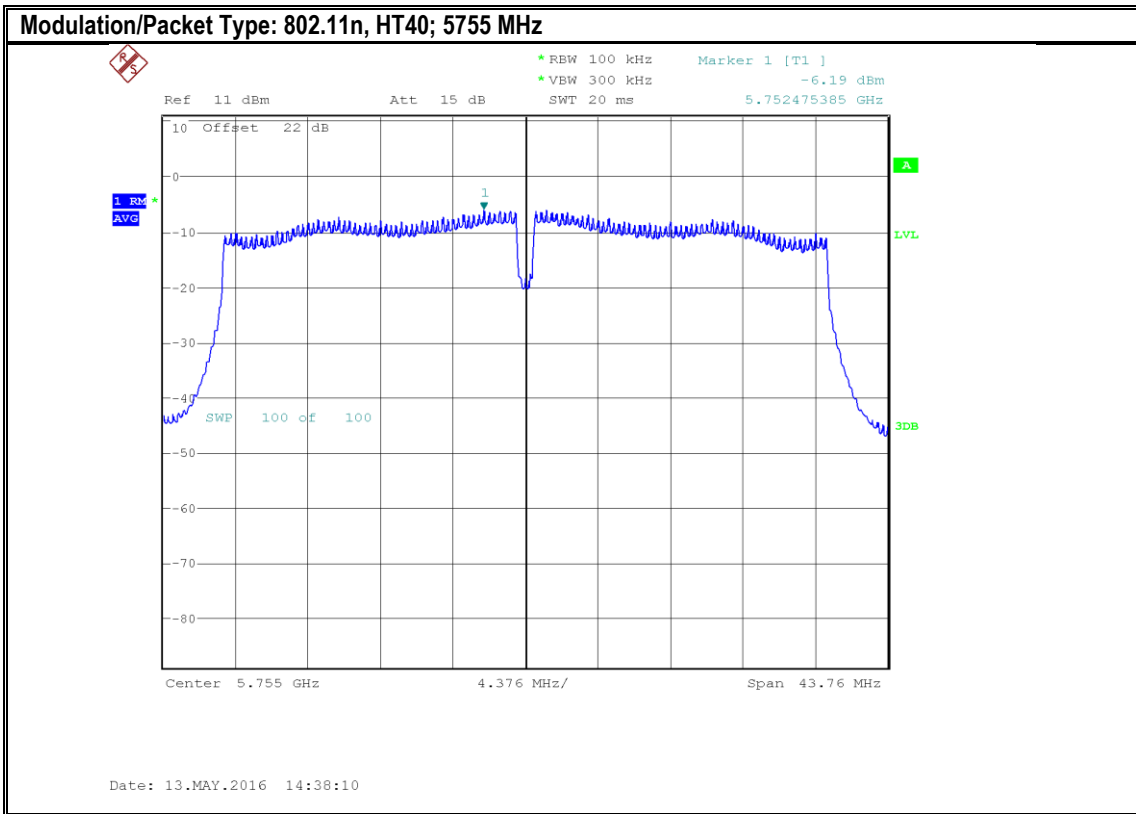
13.4 Measurement result


Operating Mode	Frequency (MHz)	Duty Cycle (%)	Measured Conducted Power Spectral Density (dBm)	Duty Cycle & RBW Corrected Conducted Power Spectral Density (dBm)
802.11a	5745	97	-2.03	5.09
	5825	97	-3.30	3.82
802.11n, HT20	5745	96	-3.30	3.87
	5825	96	-3.96	3.21
802.11n, HT40	5755	94	-6.19	1.07
	5795	94	-6.52	0.74

13.5 Measurement Plots







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14 Out of Band Emissions at the Band Edge

14.1 Measurement Method.

According to FCC KDB 789033 D02 V01R02

Receiver settings for band edge:

Set the center frequency and span to encompass frequency range to be measured

RBW = 1 MHz

Step Size < 200 kHz

Sweep Time: Auto

Detector = peak

Trace = max hold

Allow trace to fully stabilize

Use the peak marker function to determine the maximum amplitude level

Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge.

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT. Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

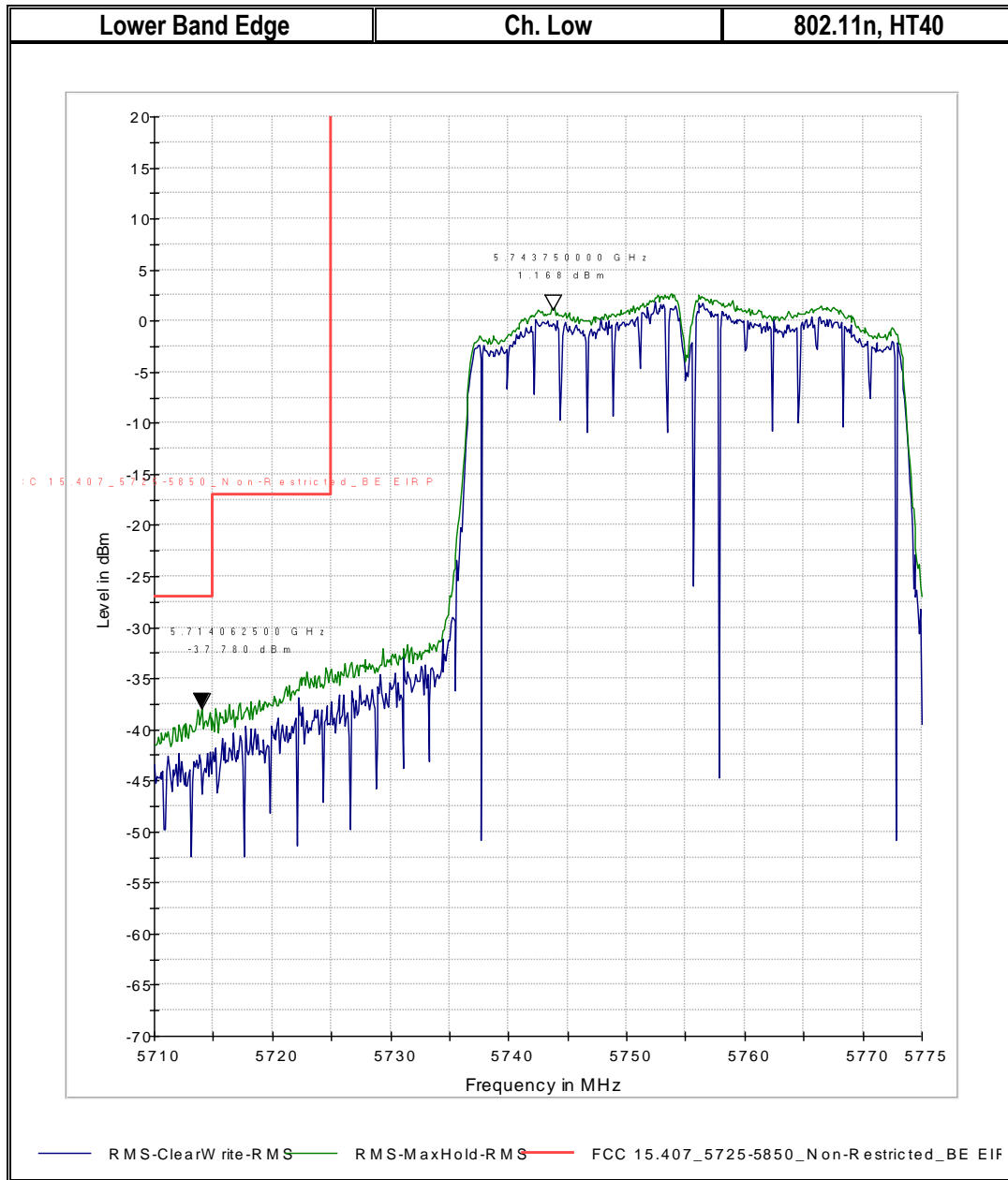
14.2 Limits

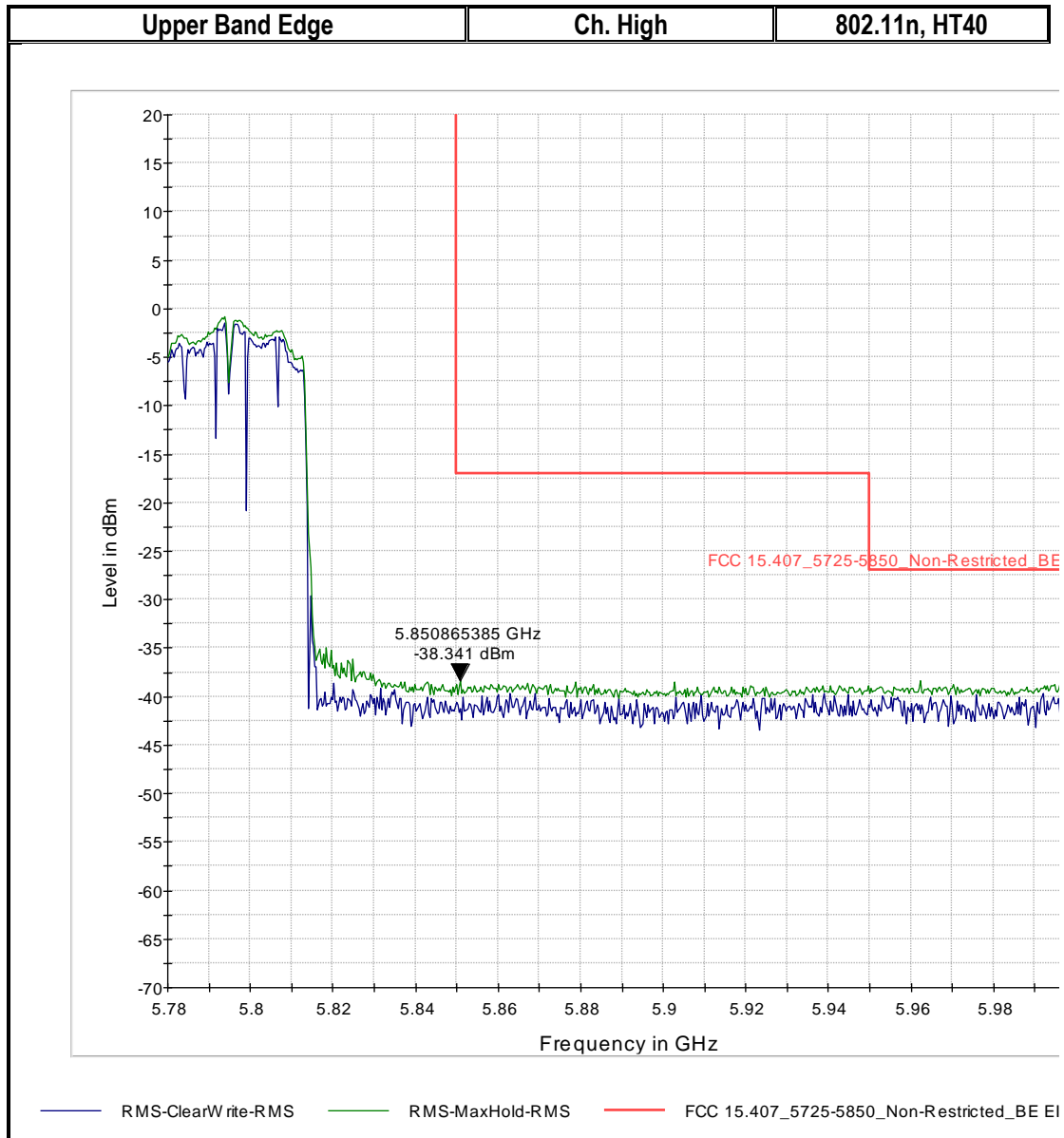
For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of -27 dBm/MHz.

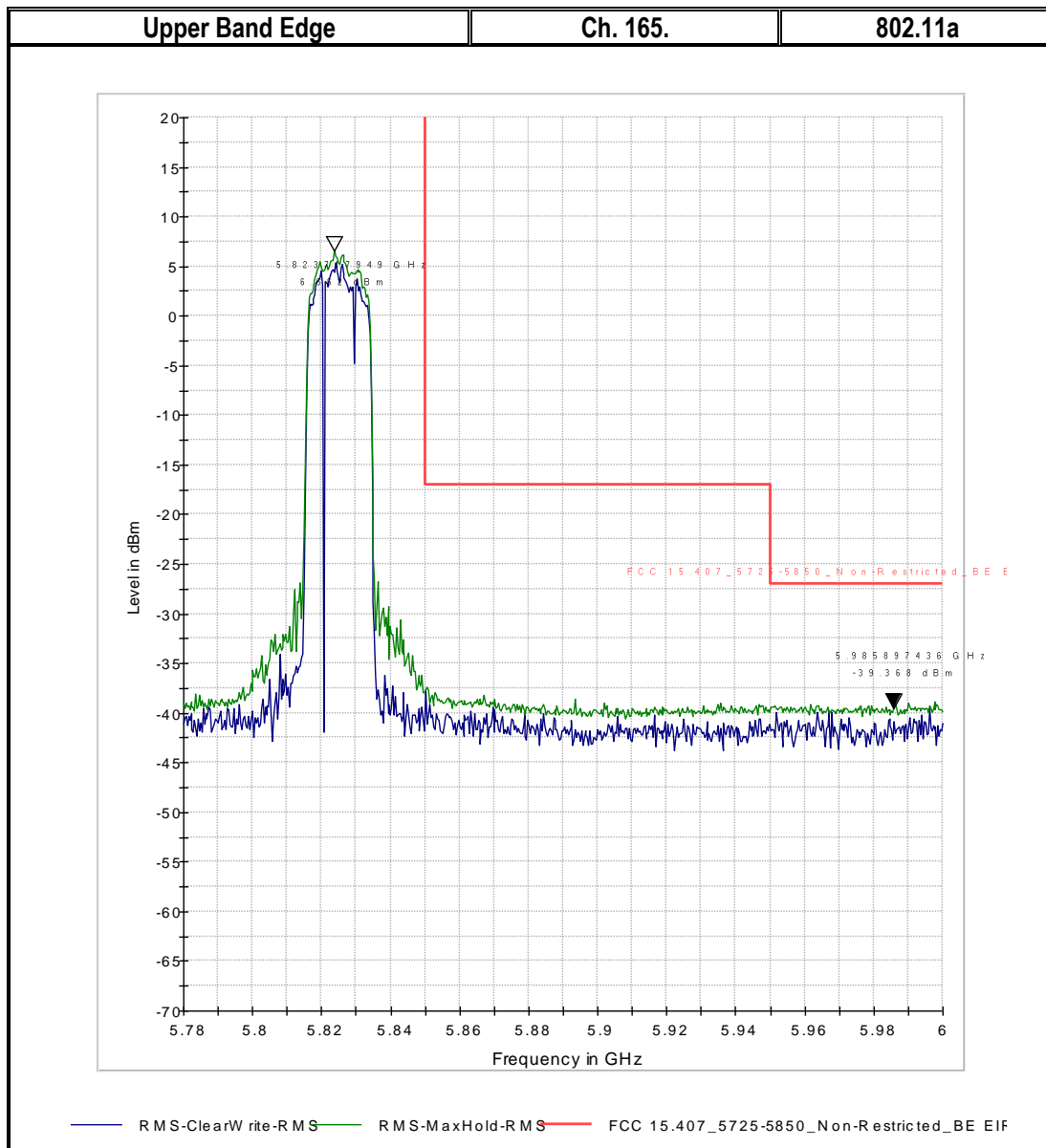
14.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input
22.5	1	Battery

14.4 Measurement Plots:







15 Unwanted Emissions

15.1 Measurement Method.

According to FCC KDB 789033 D02 V01R02

Analyzer Settings:

Frequency = 9 KHz – 30 MHz

RBW = 9 KHz

Detector: Peak

Frequency = 30 MHz – 1 GHz

Detector = Peak / Quasi-Peak

RBW=120 KHz (<1GHz)

Frequency > 1 GHz

Detector = Peak / Average

RBW= 1MHz

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT. Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

15.2 Limits: §15.407/15.205/15.209 (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.

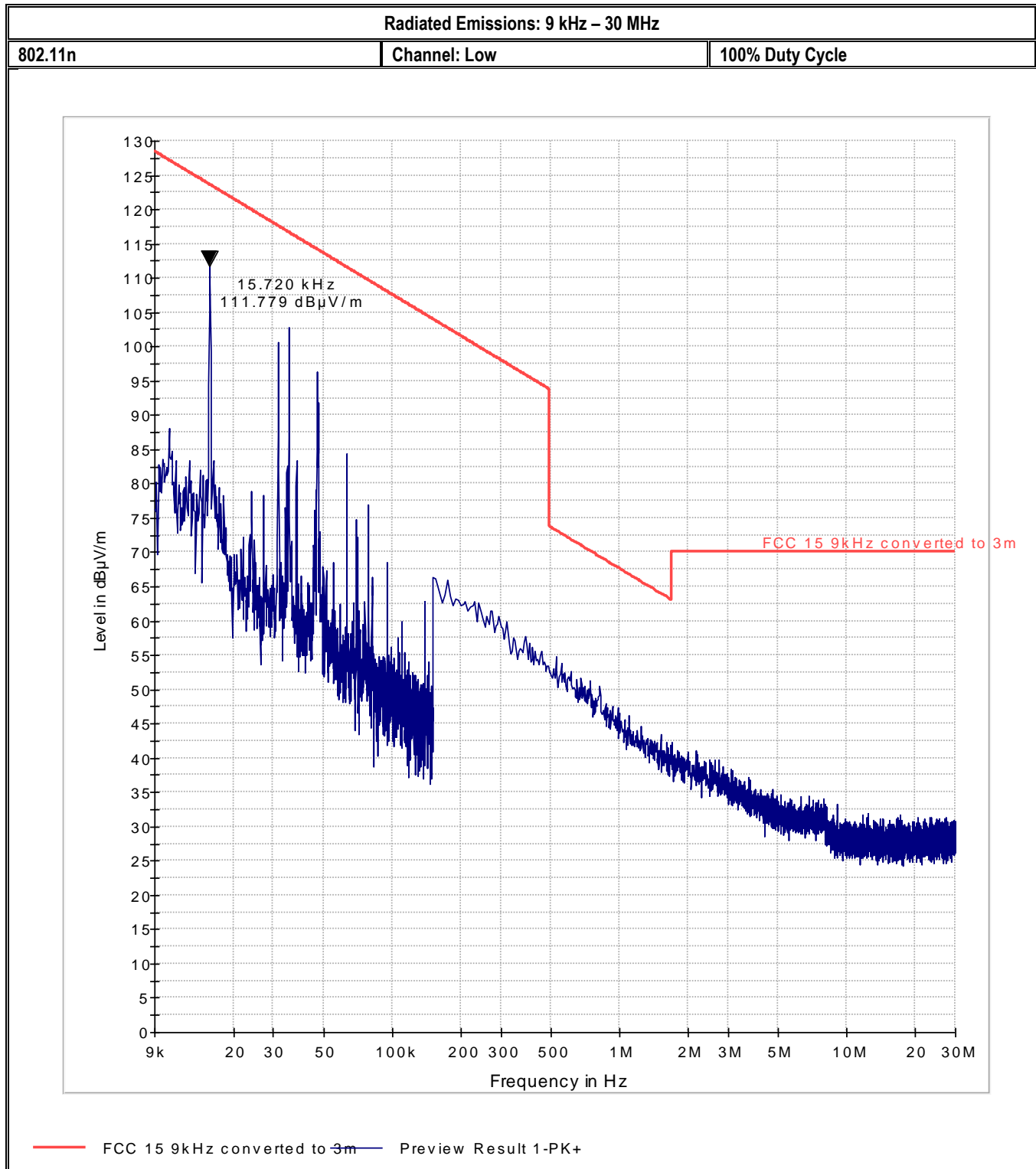
For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow:

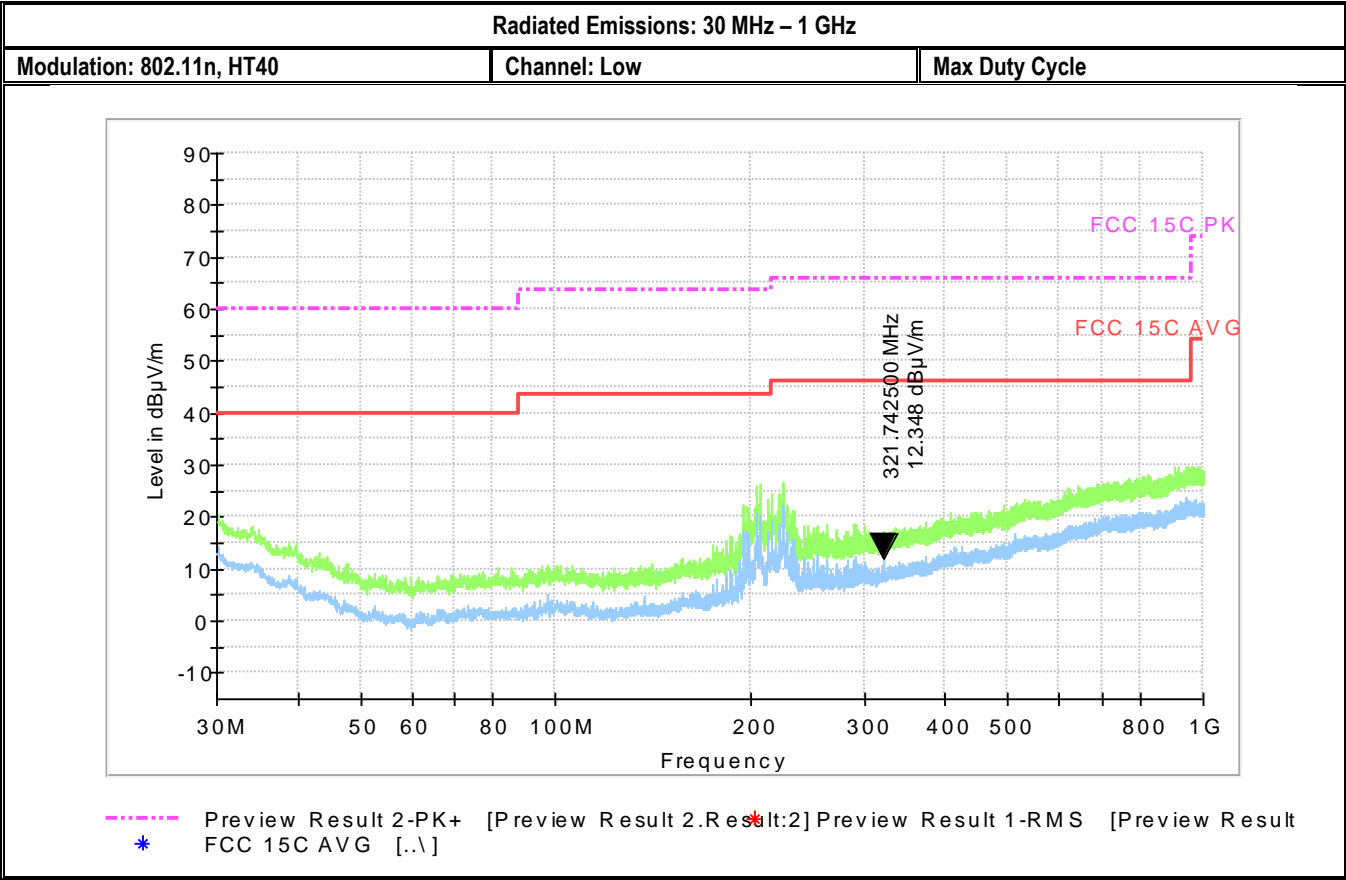
Conversion factor (CF) = $40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$

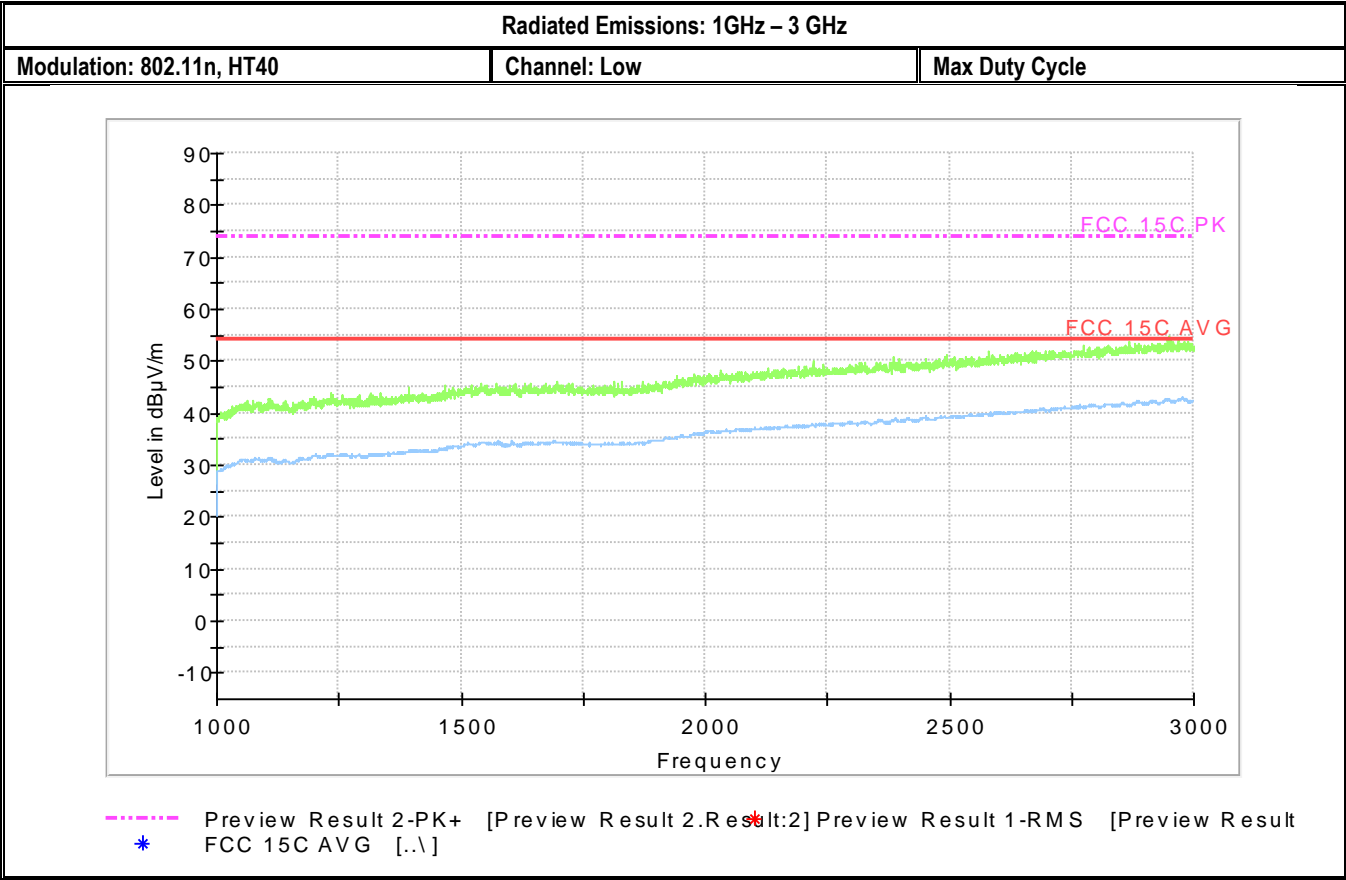
15.3 Test conditions and setup:

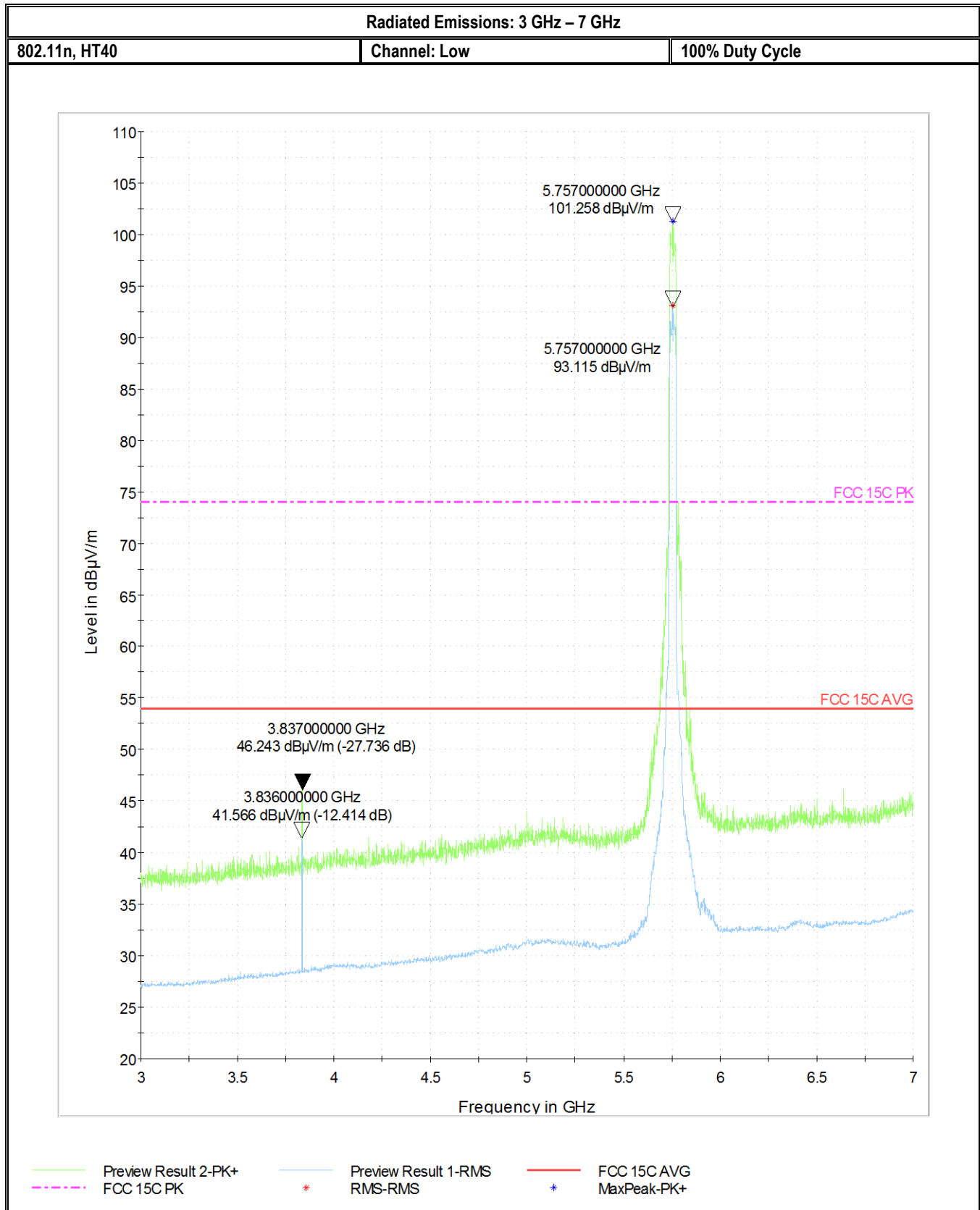
Ambient Temperature	EUT Set-Up #	Power Input
22° C	1, 3	Battery / Solar

15.4 Measurement Plots:







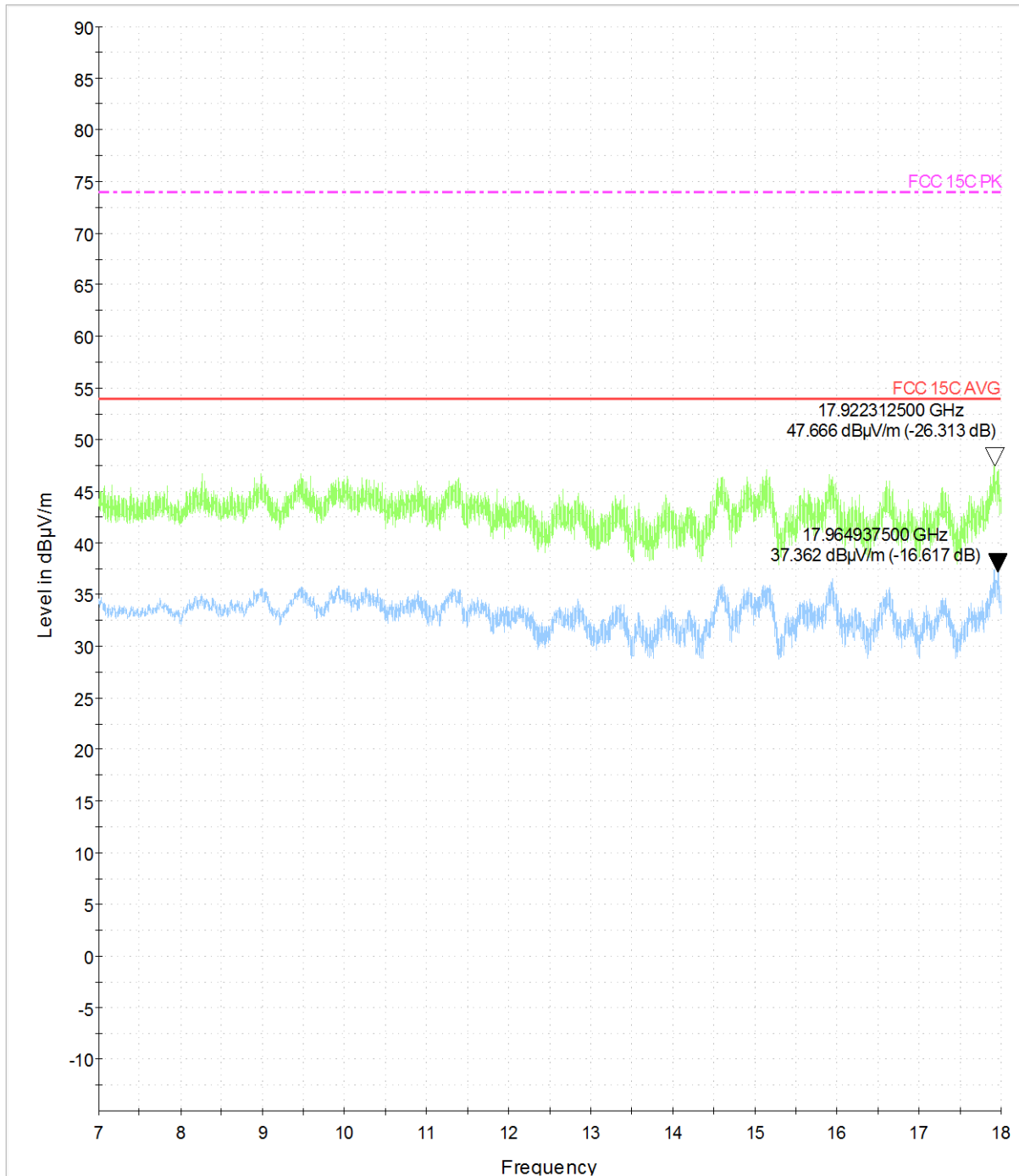


Radiated Emissions: 7 GHz – 18 GHz

802.11n, HT40

Channel: Low

100% Duty Cycle



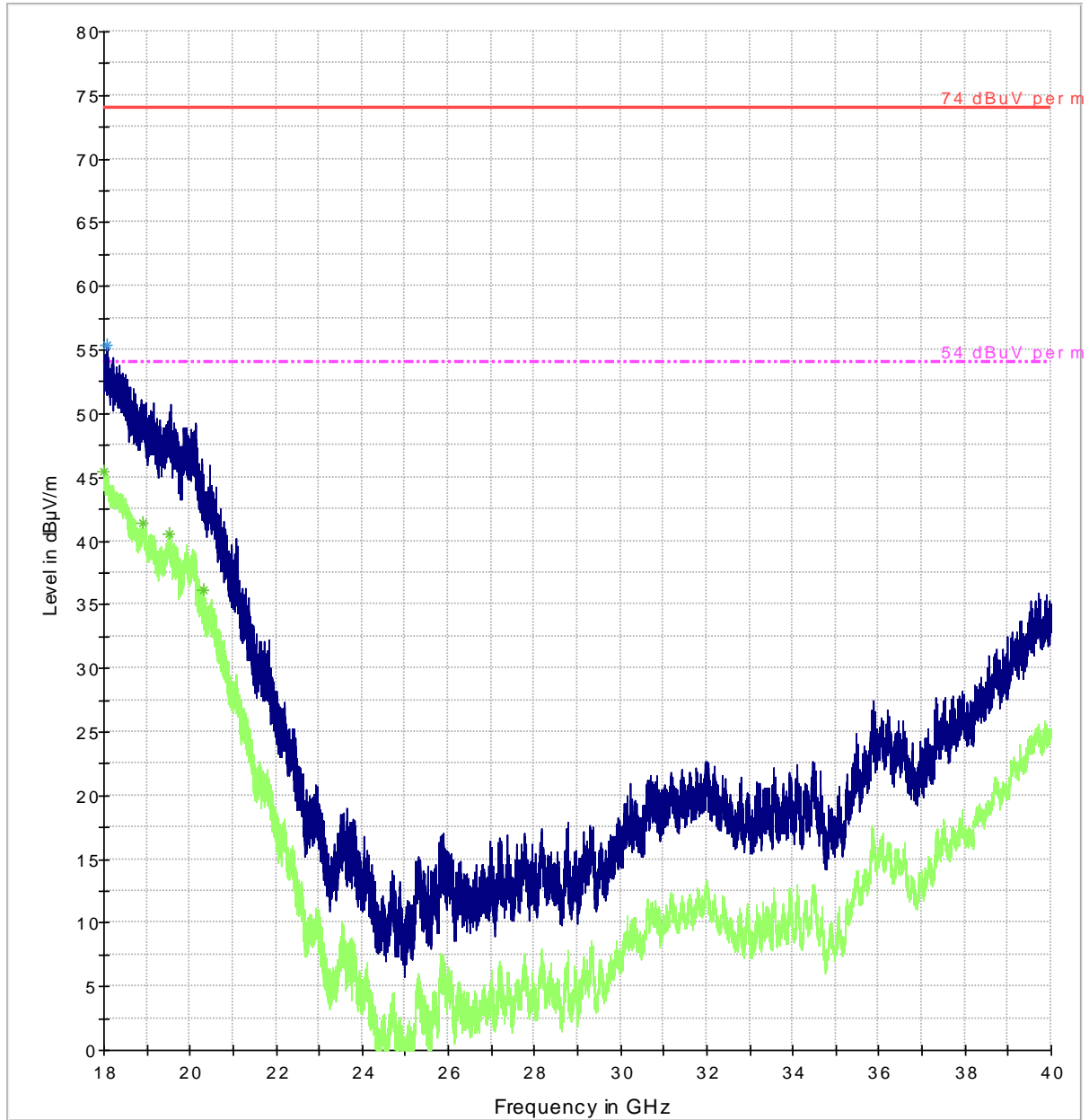
— Preview Result 2-PK+	— Preview Result 1-RMS	— FCC 15C AVG
- - - FCC 15C PK	* RMS-RMS	* MaxPeak-PK+

Radiated Emissions: 18 GHz – 40 GHz


802.11n, HT40

Channel: Low

100% Duty Cycle



— 74 dBuV per m	- - - 54 dBuV per m	— Preview Result 1-PK+
— Preview Result 2-RMS	* Data Reduction Result 1 [6]-PK	* Data Reduction Result 2 [6]-RMS

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16 EUT Setup Pictures

Please refer to EMC-PEARL-004-16001-P110-TestSetupPhotos.pdf

17 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Turn table	Turn table	EMCO	2075	N/A	N/A	N/A
MAPS Position Controller	Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
Antenna Mast	Antenna Mast	EMCO	2075	N/A	N/A	N/A
High Pass Filter	Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
High Pass Filter	Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6GHz High Pass Filter	Filter	HPM50106	Microtronics	001	Part of system calibration	
Pre-Amplifier	Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
Relay Switch Unit	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
Spectrum Analyzer	Analyzer	Rohde&Schwarz	FSU	200302	3 Years	Jun 2013
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	6/14/2014
Antenna Loop 6512	Loop Antenna	ETS Lindgren	6512	49838	3 years	3/13/2014
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	7/24/2015
Spectrum Analyzer FSU26	Spectrum Analyzer	R&S	FSU26	200065	3 years	7/4/2015
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	4/7/2015
ESU 40	Receiver	R&S	ESU 40	100251	2 years	6/29/2015
Thermometer Humidity TM320	Thermometer Humidity	Dickson	TM320	5283196	1 Year	10/27/2015

Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.

Calibration due dates, unless defined specifically, falls on the last day of the month.

Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

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18 Revision History

Date	Report Name	Report Changes	Report prepared by
September 30, 2016	EMC-PEARL-004-16001-FCC-15-407-UNII3-P110	Initial Version	James Donnellan