



FCC / IC Test Report

FOR:
CalAmp

Model Name:
LMU3640LAB / LMU3640LVB

Product Description:
Vehicle tracking and telemetry device

FCC ID: APV-3640LAB / APV-3640LVB
IC ID: 5843A-3640LAB / 5843A-3640LVB

Applied Rules and Standards:
47 CFR Part 15.247 (DSS)
RSS-247 Issue 2 (FHSs) & RSS-Gen Issue 4

REPORT #: EMC_CALAM-063-17001_15.247_BT_DSS

DATE: 10/05/2017



A2LA Accredited

IC recognized #
3462B-1

CETECOM Inc.

411 Dixon Landing Road ♦ Milpitas, CA 95035 ♦ U.S.A.

Phone: + 1 (408) 586 6200 ♦ Fax: + 1 (408) 586 6299 ♦ E-mail: info@cetecom.com ♦ <http://www.cetecom.com>

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

TABLE OF CONTENTS

1	ASSESSMENT.....	3
2	ADMINISTRATIVE DATA	4
2.1	IDENTIFICATION OF THE TESTING LABORATORY ISSUING THE EMC TEST REPORT	4
2.2	IDENTIFICATION OF THE CLIENT	4
2.3	IDENTIFICATION OF THE MANUFACTURER.....	4
3	EQUIPMENT UNDER TEST (EUT).....	5
3.1	EUT SPECIFICATIONS	5
3.2	EUT SAMPLE DETAILS	6
3.3	ACCESSORY EQUIPMENT (AE) DETAILS.....	6
3.4	TEST SAMPLE CONFIGURATION	6
3.5	JUSTIFICATION FOR WORST CASE MODE OF OPERATION.....	6
4	SUBJECT OF INVESTIGATION	7
5	MEASUREMENT RESULTS SUMMARY	7
6	MEASUREMENTS.....	8
6.1	MEASUREMENT UNCERTAINTY	8
6.2	ENVIRONMENTAL CONDITIONS DURING TESTING:.....	8
6.3	DATES OF TESTING:	8
7	MEASUREMENT PROCEDURES.....	9
7.1	RADIATED MEASUREMENT.....	9
7.2	RF CONDUCTED MEASUREMENT PROCEDURE	12
8	TEST RESULT DATA	13
8.1	MAXIMUM PEAK CONDUCTED OUTPUT POWER.....	13
8.2	BAND EDGE COMPLIANCE	24
8.3	20DB BANDWIDTH	31
8.4	CARRIER FREQUENCY SEPARATION	35
8.5	NUMBER OF HOPPING CHANNELS	37
8.6	TIME OF OCCUPANCY (DWEIL TIME)	39
8.7	TRANSMITTER SPURIOUS EMISSIONS AND RESTRICTED BANDS	42
9	TEST SETUP PHOTOS	55
10	TEST EQUIPMENT AND ANCILLARIES USED FOR TESTING	55
11	REVISION HISTORY	55

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 ISED Canada standard RSS-247.

Both devices LMU3640LAB / LMU3640LVB are using the same Bluetooth Basic/EDR and Bluetooth LE Chipset.

No deviations were ascertained.

Company	Description	Model #
CalAmp	Vehicle tracking and telemetry device	LMU3640LAB / LMU3640LVB

Responsible for Testing Laboratory:

Peter Nevermann

10/05/2017 Compliance (Director Radio Communications and EMC)

Date	Section	Name	Signature
------	---------	------	-----------

Responsible for the Report:

Issa Ghanma

10/05/2017 Compliance (EMC Engineer)

Date	Section	Name	Signature
------	---------	------	-----------

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.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Director Radio Com. and EMC:	Peter Nevermann
Responsible Project Leader:	Issa Ghanma

2.2 Identification of the Client

Applicant's Name:	CalAmp
Street Address:	2177 Salk Ave, Suite 200
City/Zip Code	Carlsbad, CA 90228
Country	USA
Contact Person:	Imad Rizk
Phone No.	760 814 9697
e-mail:	lrizk@calamp.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Applicant
Manufacturers Address:	-----
City/Zip Code	-----
Country	-----

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	LMU3640LAB / LMU3640LVB
HW Version :	REV A
SW Version :	6.1
FCC-ID :	APV-3640LAB / APV-3640LVB
IC-ID:	5843A-3640LAB / 5843A-3640LVB
FWIN:	N/A
HVIN:	LMU3640LAB / LMU3640LVB
PMN:	LMU-3640
Product Description:	Vehicle tracking and telemetry device
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 78), 79 Channels
Type(s) of Modulation:	Bluetooth Basic/EDR: GFSK, $\pi/4$ DQPSK, 8DPSK
Modes of Operation:	Hopping
Antenna Information as declared:	max gain 1.39 dBi
Max. declared output Powers:	Conducted Power 11.51dBm
Power Supply/ Rated Operating Voltage Range:	8 VDC – 32 VDC
Operating Temperature Range	-10 ^o to 60 ^o C
Other Radios included in the device:	Bluetooth 4.2 Low Energy (BT LE) Cellular: LE910-NA1 / LE910-SVL
Sample Revision	☐ Prototype Unit; ☒ Production Unit; ☐ Pre-Production
EUT Dimensions	144X54X30mm

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	00022	REV A	6.1	Radiated Emissions
2	00011	REV A	6.1	Conducted RF

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	NA	NA	NA	NA

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#2	The radio of the EUT was configured to a fixed channel transmission with dynamic 50%-80% duty cycle using Putty tool to configure the EUT. The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT#1	The radio of the EUT was configured to a fixed channel transmission with dynamic 50%-80% duty cycle using Putty tool to configure the EUT. The internal antenna was connected.

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels, and 50%-80% dynamic duty cycle.

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.

For conducted measurements, the highest power and the widest occupied bandwidth mode of operation (8DPSK), was used to evaluate the worst case performance of the EUT, including the band edge compliance and TX radiated spurious emissions testing. Maximum peak conducted output power and spectrum bandwidth, were measured in all supported modulation modes for the EUT.

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 Issue 2 of ISSED Canada.

This test report is to support a request for new equipment authorization under the:

- FCC ID: APV-3640LAB / APV-3640LVB
- IC ID: 5843A-3640LAB / 5843A-3640LVB

Testing procedures are based on ANSI C63.10:2013 including section 7.8 for FHSS systems.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(b)(1) RSS-247 5.4(b)	Maximum Peak Conducted Output Power	Nominal	GFSK DH5 DQPSK DH5 8DPSK DH5	■	□	□	Complies
§15.247(d) RSS-247 5.5 RSS-Gen 8.10	Band Edge Compliance	Nominal	8DPSK	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(b)	Spectrum Bandwidth	Nominal	GFSK DH5 DQPSK DH5 8DPSK DH5	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(b)	Carrier Frequency Separation	Nominal	GFSK	■	□	□	Complies
§15.247(a)(1) RSS-247 5.1(d)	Number of Hopping Channels	Nominal	GFSK	■	□	□	Complies
§15.247(a)(1)(iii) RSS-247 5.1(d)	Time of occupancy	Nominal	8DPSK	■	□	□	Complies
§15.247(d) §15.209 (a) RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	8DPSK	■	□	□	Complies
§15.207(a) RSS-Gen 8.8	AC Conducted Emissions	-	-	□	■	□	Note 2 Complies

Note1: NA= Not Applicable; NP= Not Performed.

Note2: Device does not connect to AC main power.

6 Measurements

6.1 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.

Radiated measurement

9 kHz to 30MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

RF conducted measurement	±0.5 dB
--------------------------	---------

6.2 Environmental Conditions During Testing:

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

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

6.3 Dates of Testing:

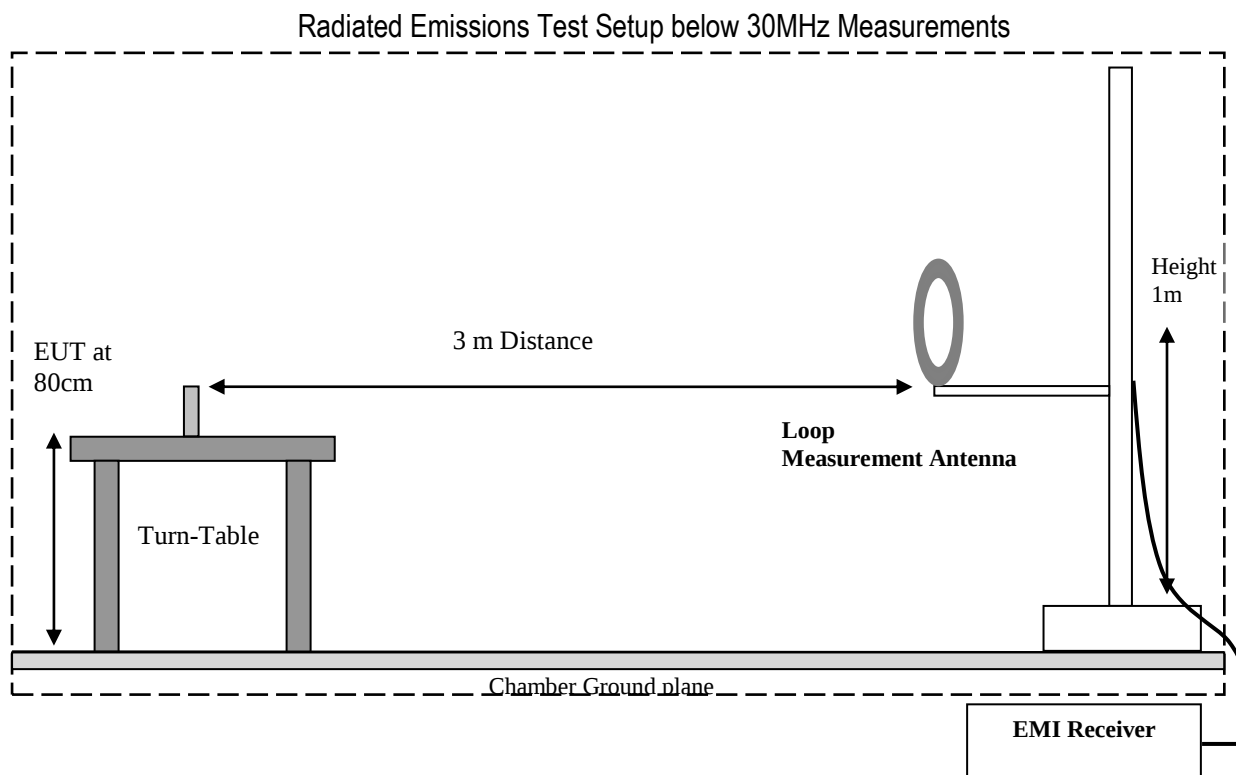
8/23/2017 – 9/22/2017

7 Measurement Procedures

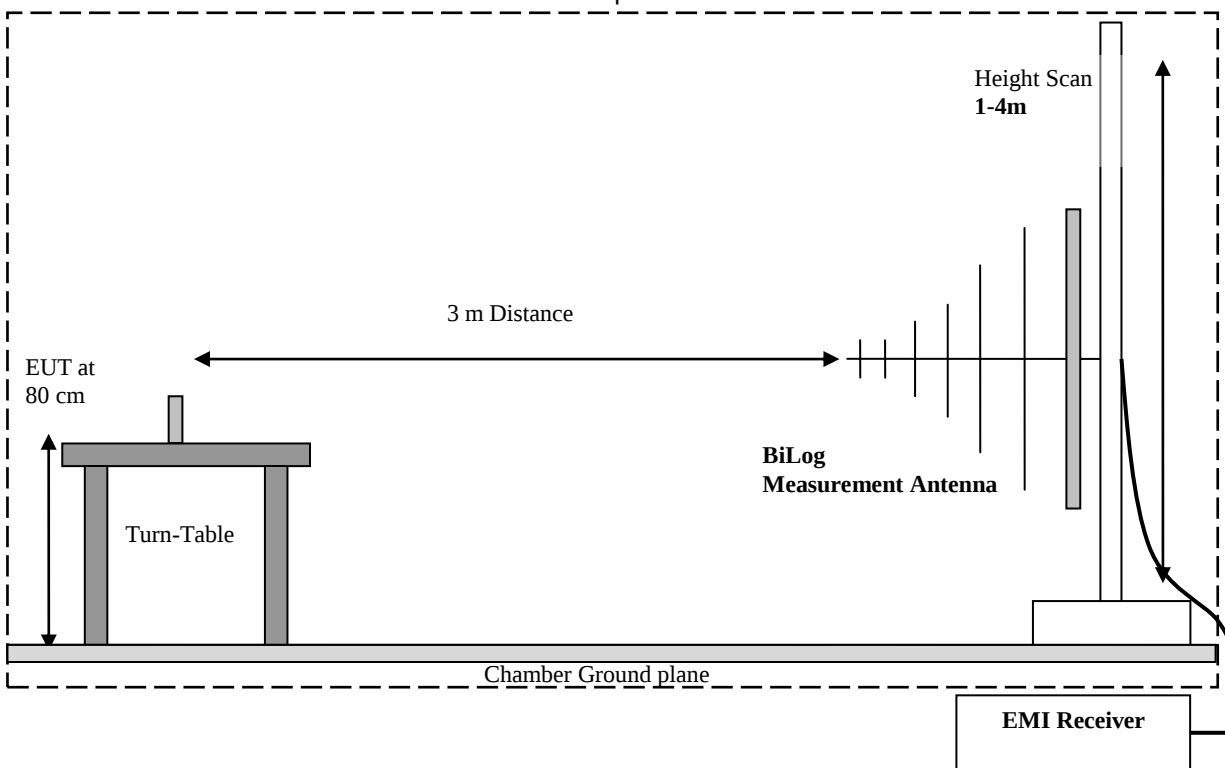
7.1 Radiated Measurement

The radiated measurement is performed according to: ANSI C63.10 (2013)

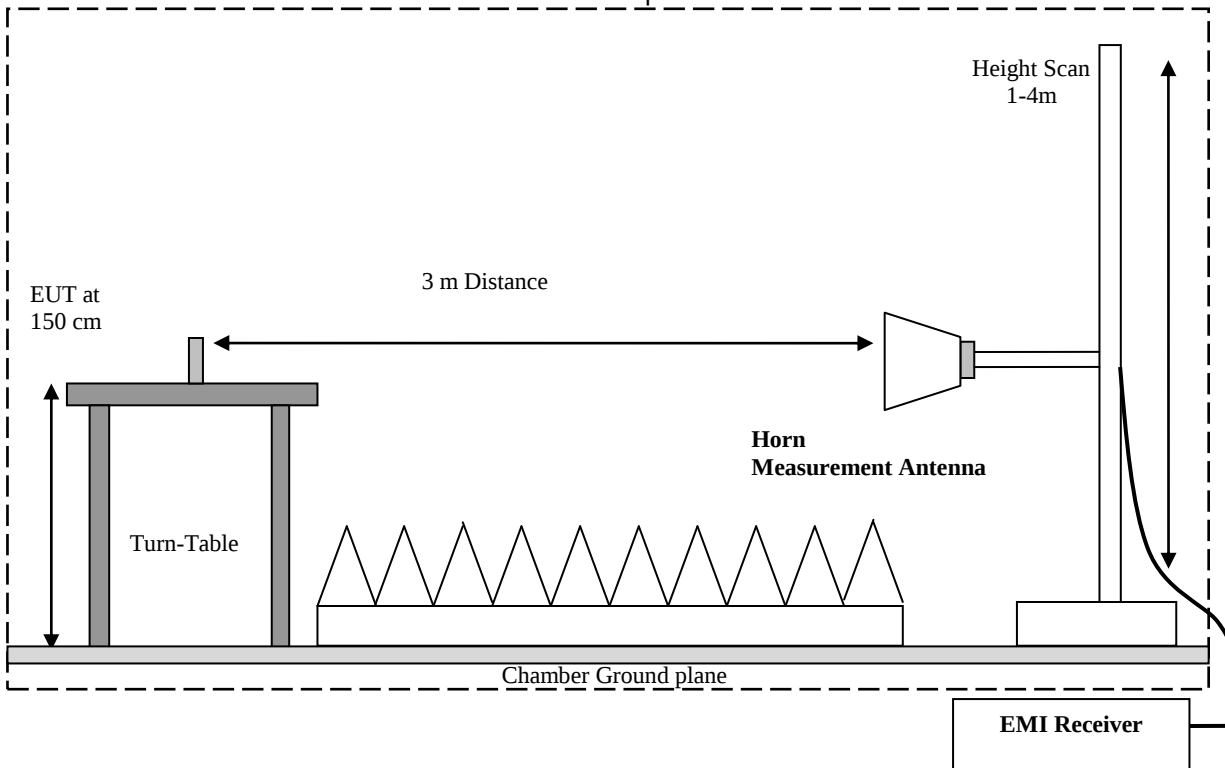
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- 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 put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- 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 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 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:

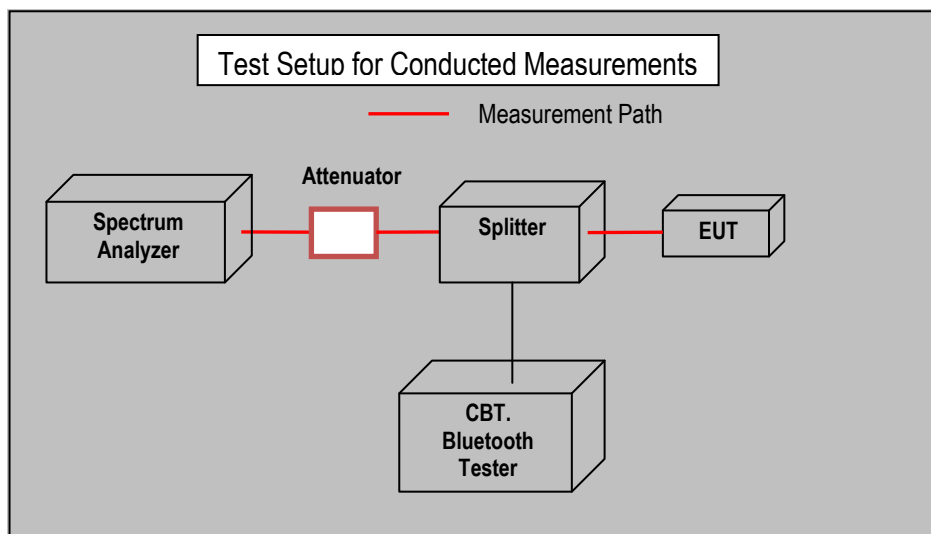
$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} - \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

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

7.2 RF Conducted Measurement Procedure

Reference: ANSI C63.10 (2013) Section 6.9, 6.10, and 7.8



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

8 Test Result Data

8.1 Maximum Peak Conducted Output Power

8.1.1 Measurement according to ANSI C63.10 Section 7.8

Spectrum Analyzer settings:

- Span = approximately 5 times the 20 dB bandwidth
- RBW > the 20 dB bandwidth of the emission being measured
- VBW $\geq$ RBW
- Sweep = Auto Couple
- Detector function = Peak
- Trace = Max hold
- Use the marker-peak function to set the marker to the peak of the emission.

8.1.2 Limits:

Maximum Peak Output Power:

FCC 15.247: (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

IC RSS-247 5.4:

- (b) For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels.

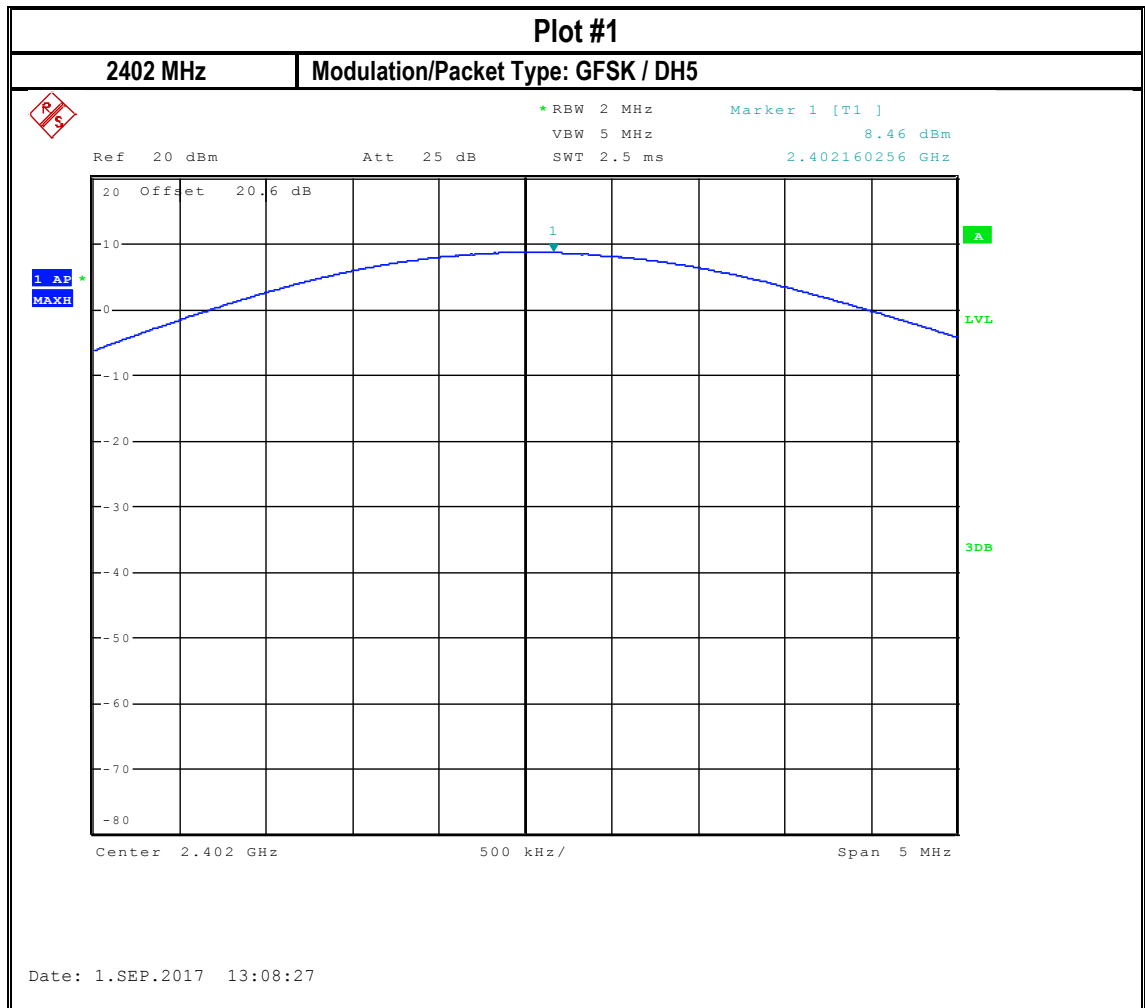
8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23° C	2	GFSK, DQPSK, 8DPSK – DH5	12 VDC	1.39 dBi

8.1.4 Measurement result:

Plot #	Frequency (MHz)	EUT operating mode	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	2402	GFSK DH5	8.46	9.85	30(Pk) / 36(EIRP)	Pass
2	2402	DQPSK DH5	9.27	10.66	30(Pk) / 36(EIRP)	Pass
3	2402	8DPSK DH5	9.55	10.94	30(Pk) / 36(EIRP)	Pass
4	2441	GFSK DH5	9.03	10.42	30(Pk) / 36(EIRP)	Pass
5	2441	DQPSK DH5	10.17	11.56	30(Pk) / 36(EIRP)	Pass
6	2441	8DPSK DH5	10.56	11.95	30(Pk) / 36(EIRP)	Pass
7	2480	GFSK DH5	9.58	10.97	30(Pk) / 36(EIRP)	Pass
8	2480	DQPSK DH5	11.00	12.39	30(Pk) / 36(EIRP)	Pass
9	2480	8DPSK DH5	11.51	12.90	30(Pk) / 36(EIRP)	Pass

8.1.5 Measurement Plots:



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

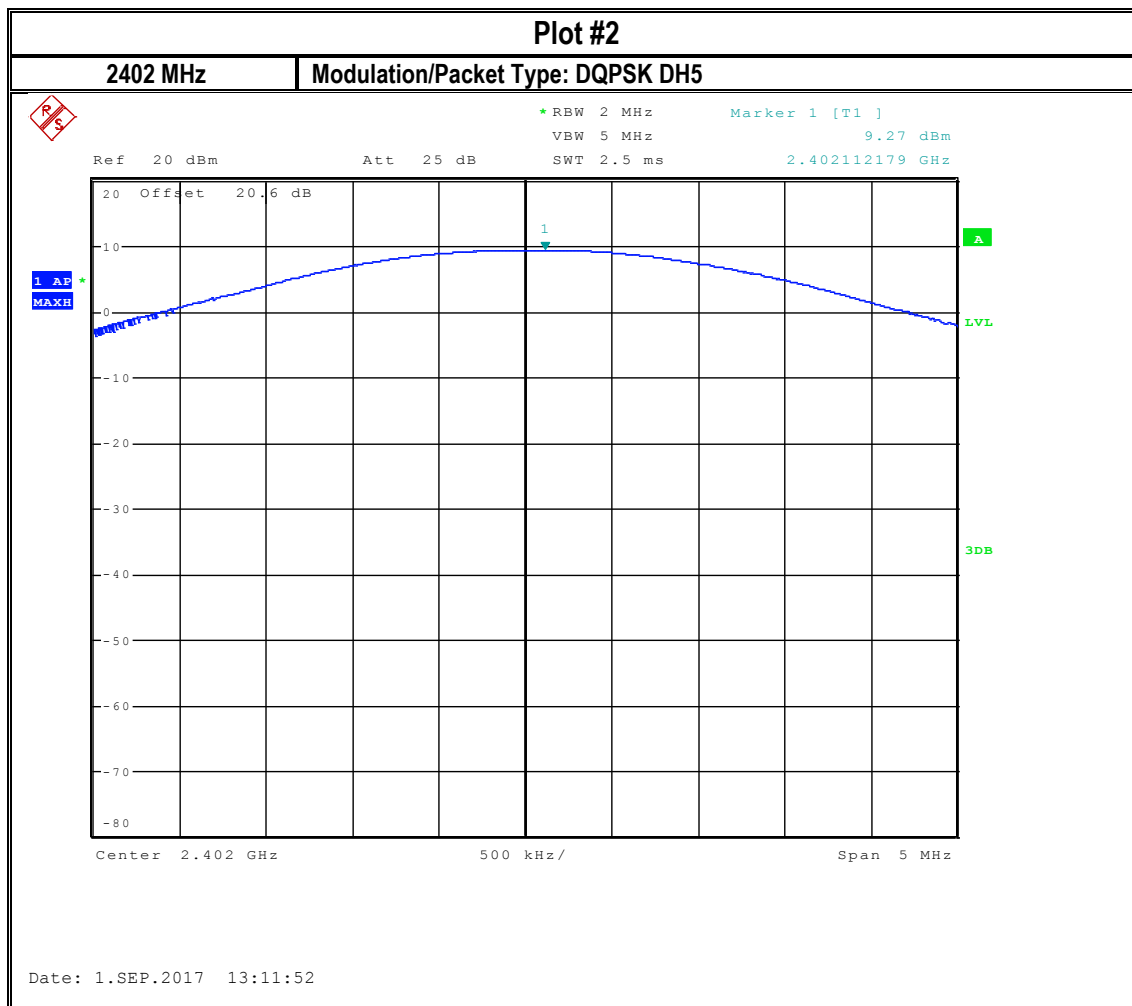
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 16 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

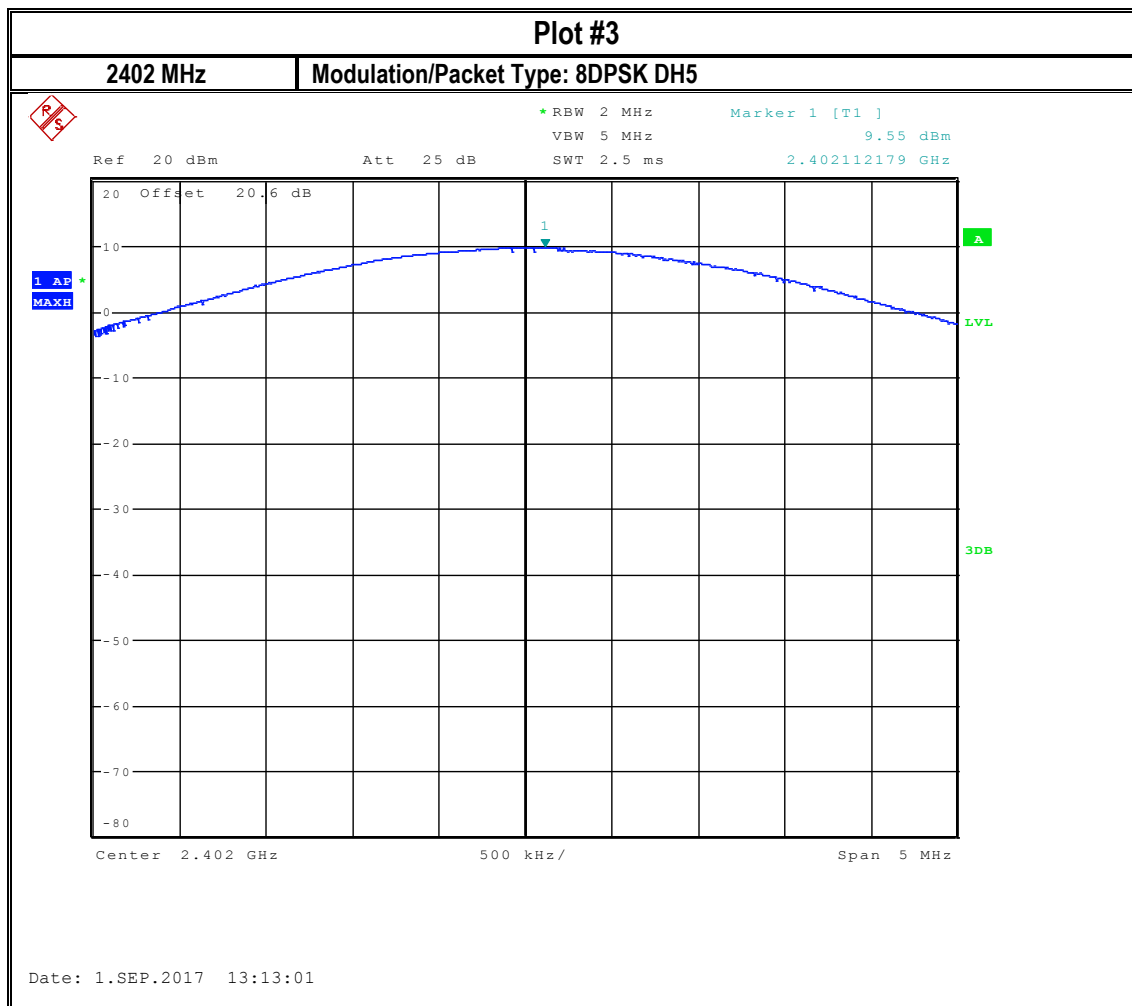
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 17 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

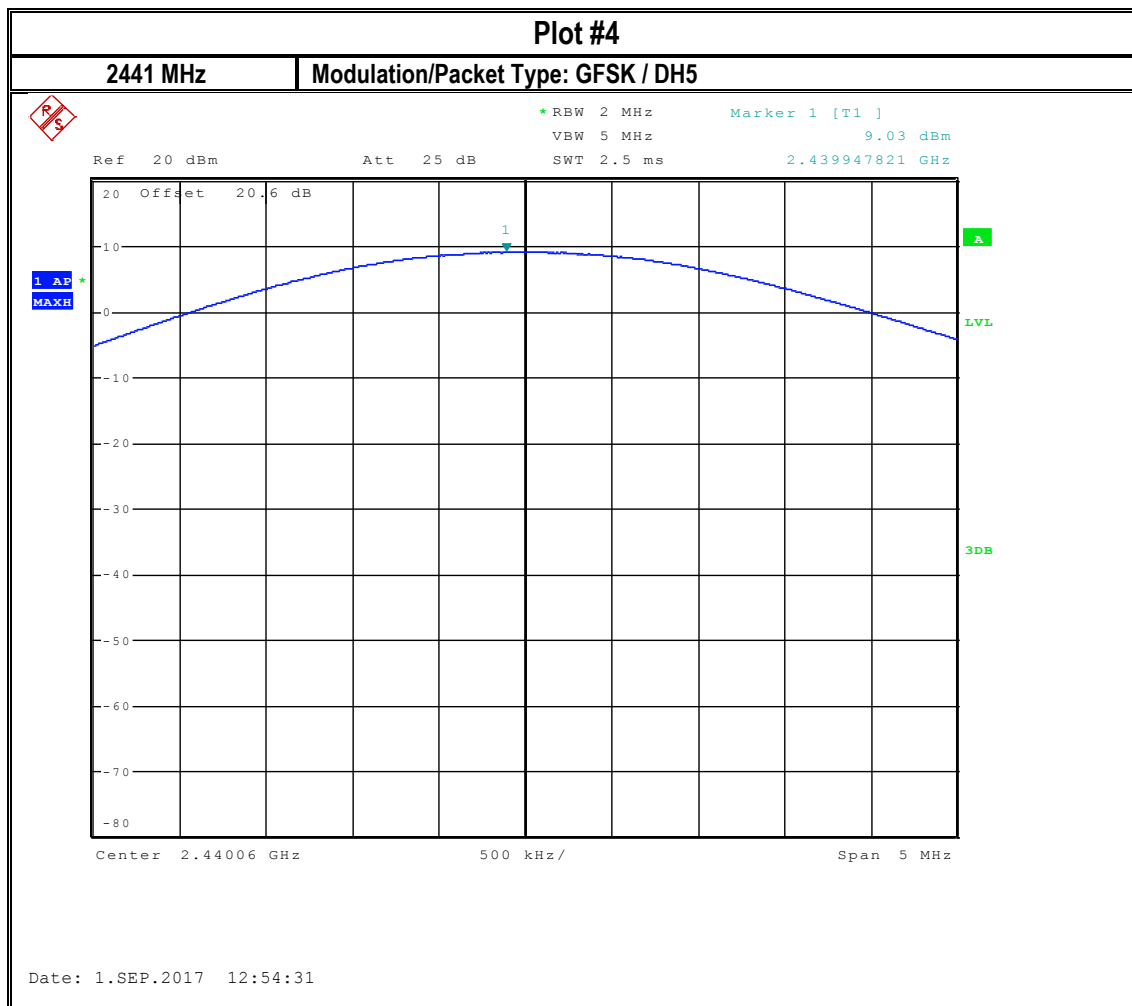
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 18 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

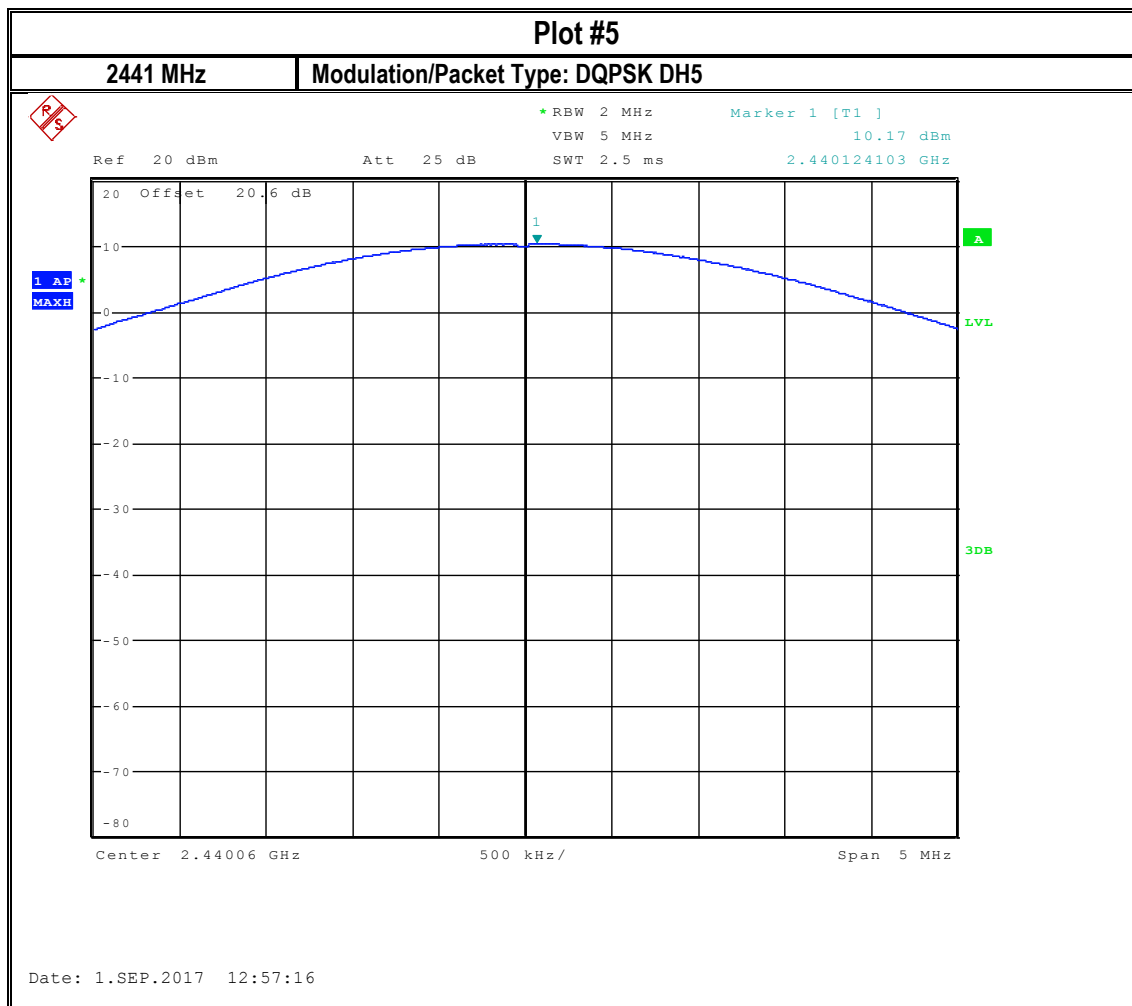
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 19 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Date: 1.SEP.2017 12:57:16

Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

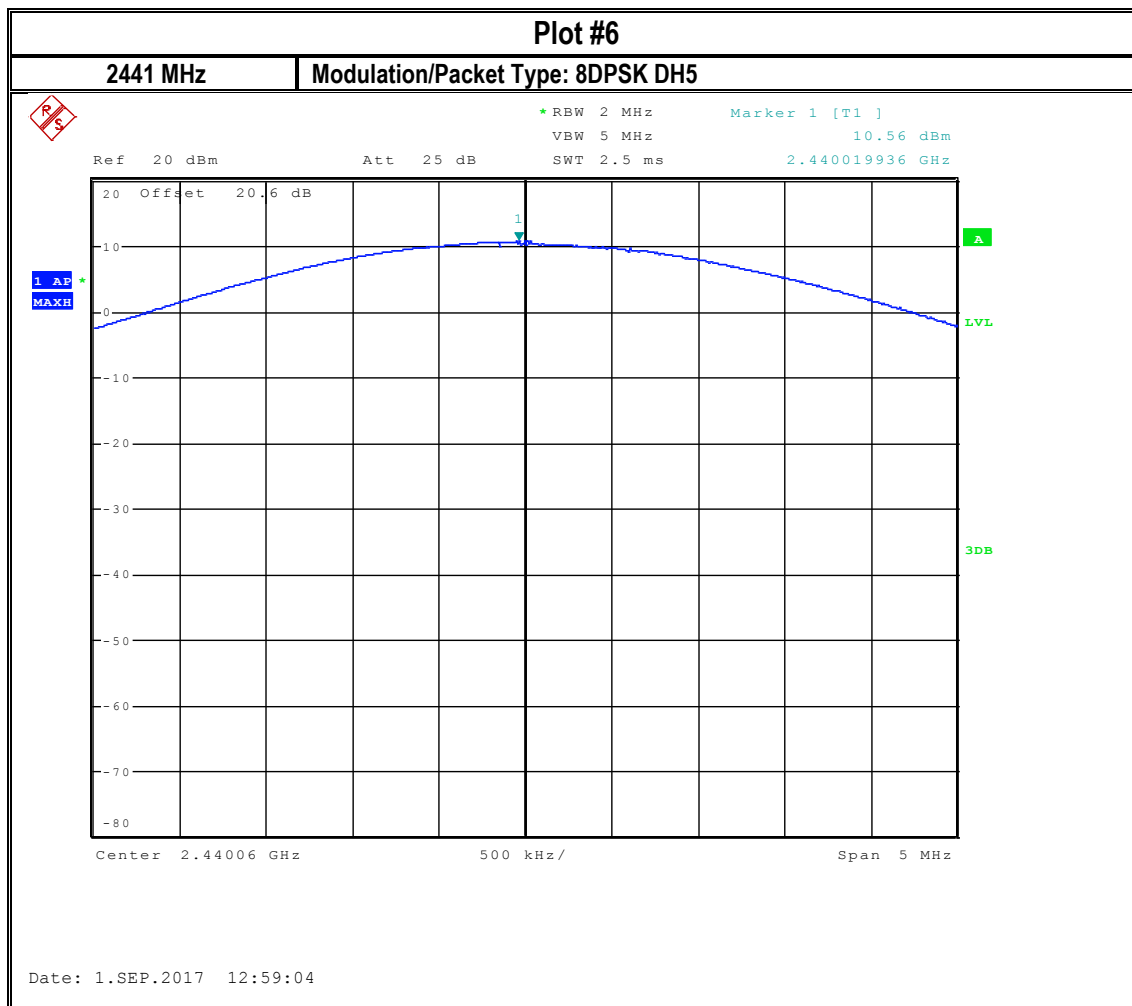
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 20 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

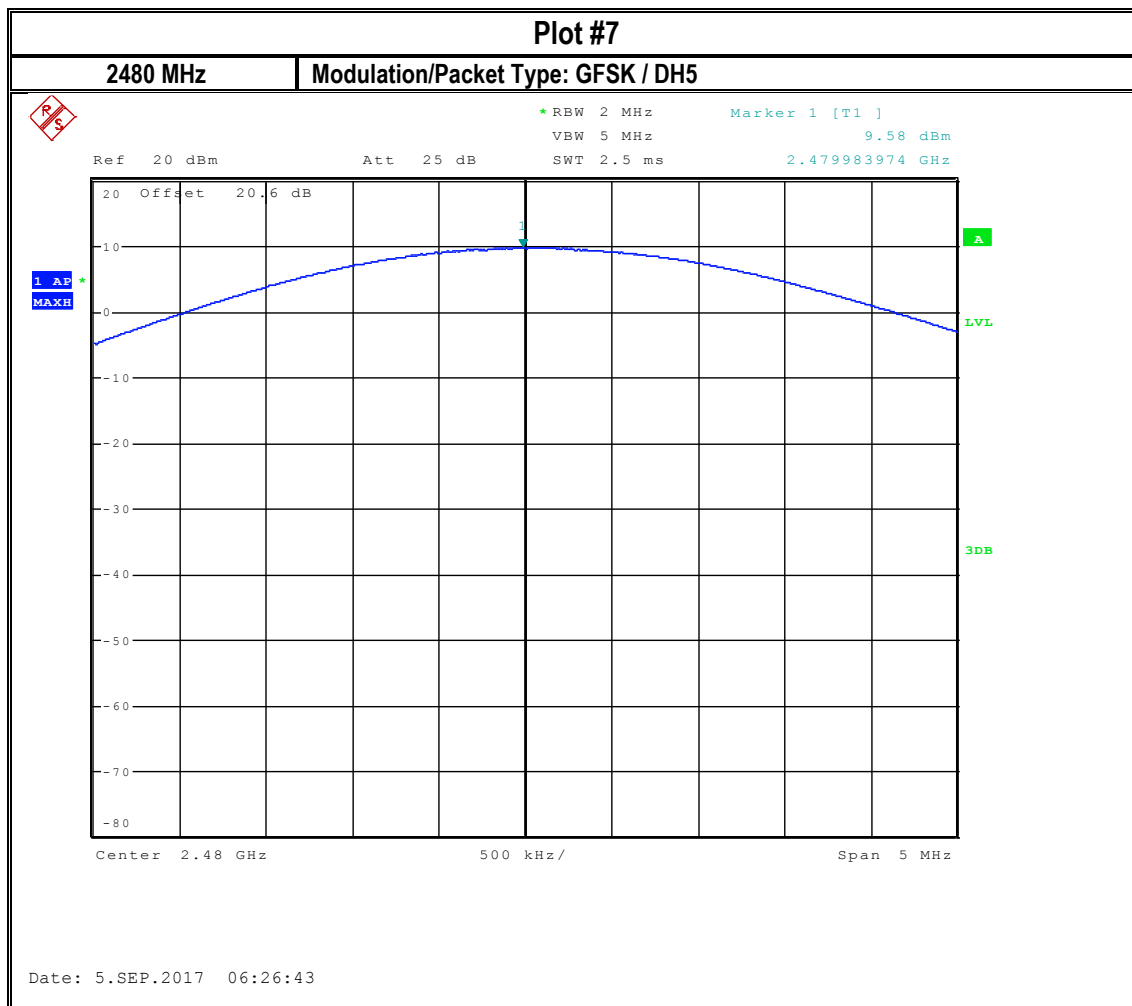
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 21 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

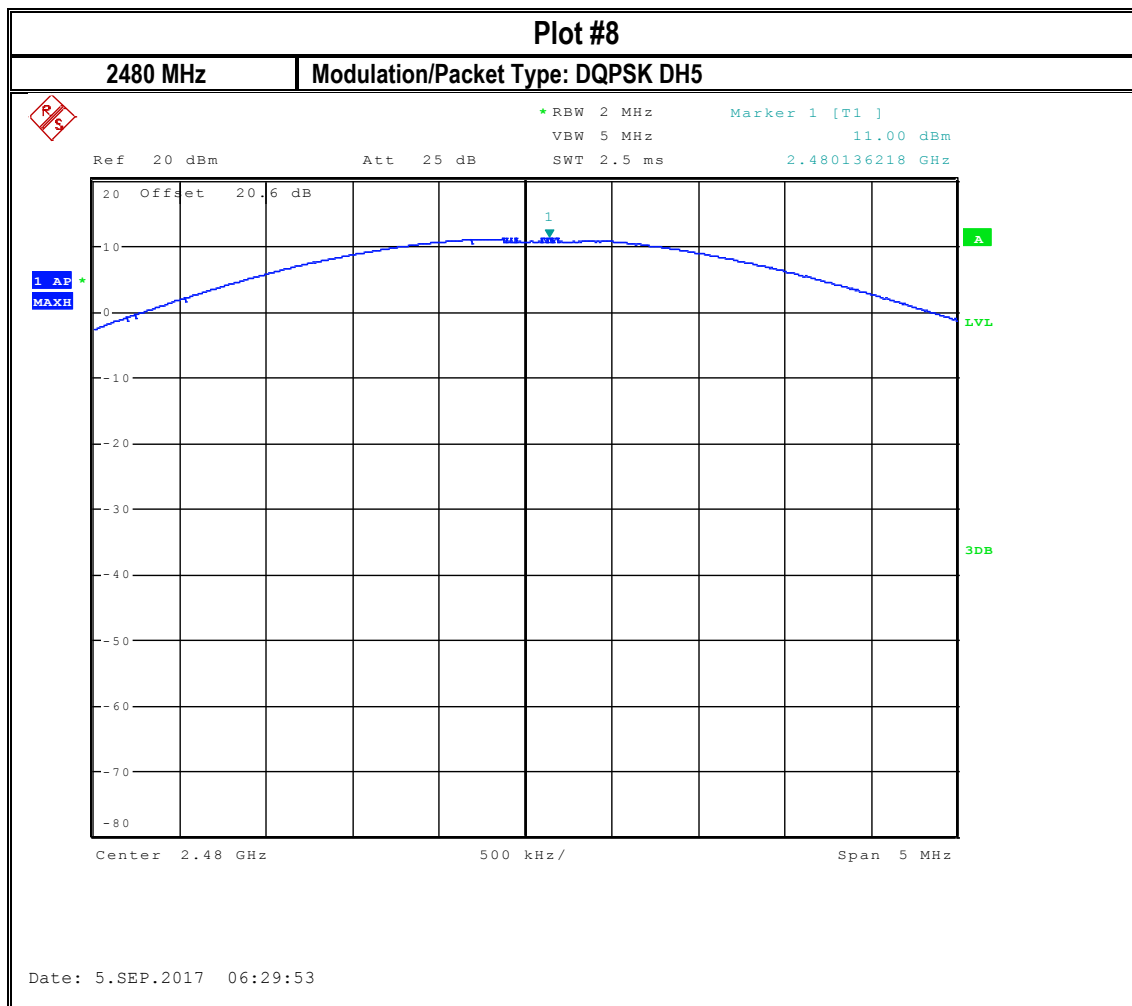
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 22 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

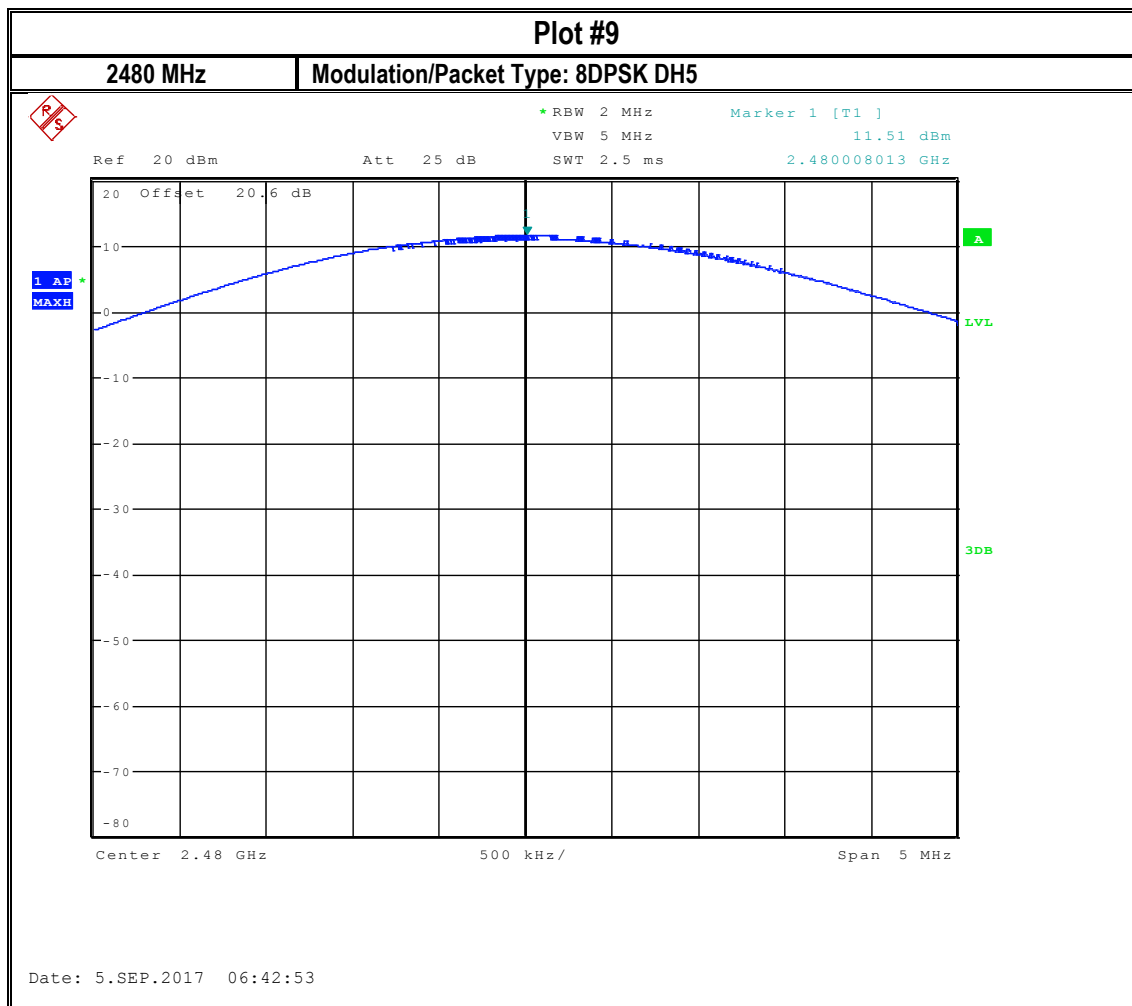
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 23 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



8.2 Band Edge Compliance

8.2.1 Measurement according to ANSI C63.10 Section 6.10

Spectrum Analyzer settings for non-restricted 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 $\geq$ 1% of the span
- VBW $\geq$ RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- 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.
- Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
- Now, using the same instrument settings, enable the hopping function of the EUT.
- Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz

8.2.2 Limits: Restricted Band FCC 15.209 and RSS-Gen 8.10

- PEAK LIMIT= 74 dB μ V/m @3 m =-21.23 dBm
- AVG. LIMIT= 54 dB μ V/m @3 m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205

Restricted bands of operation:

- Except as shown in CFR 47 Part 15.205 paragraph (d), 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
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

8.2.3 Limits: Non-restricted Band §15.247 and RSS-247 5.5

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-247 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

8.2.4 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna gain
22° C	2	8DPSK DH5 - fixed channel 8DPSK DH5 - hopping	12 VDC	1.39 dBi

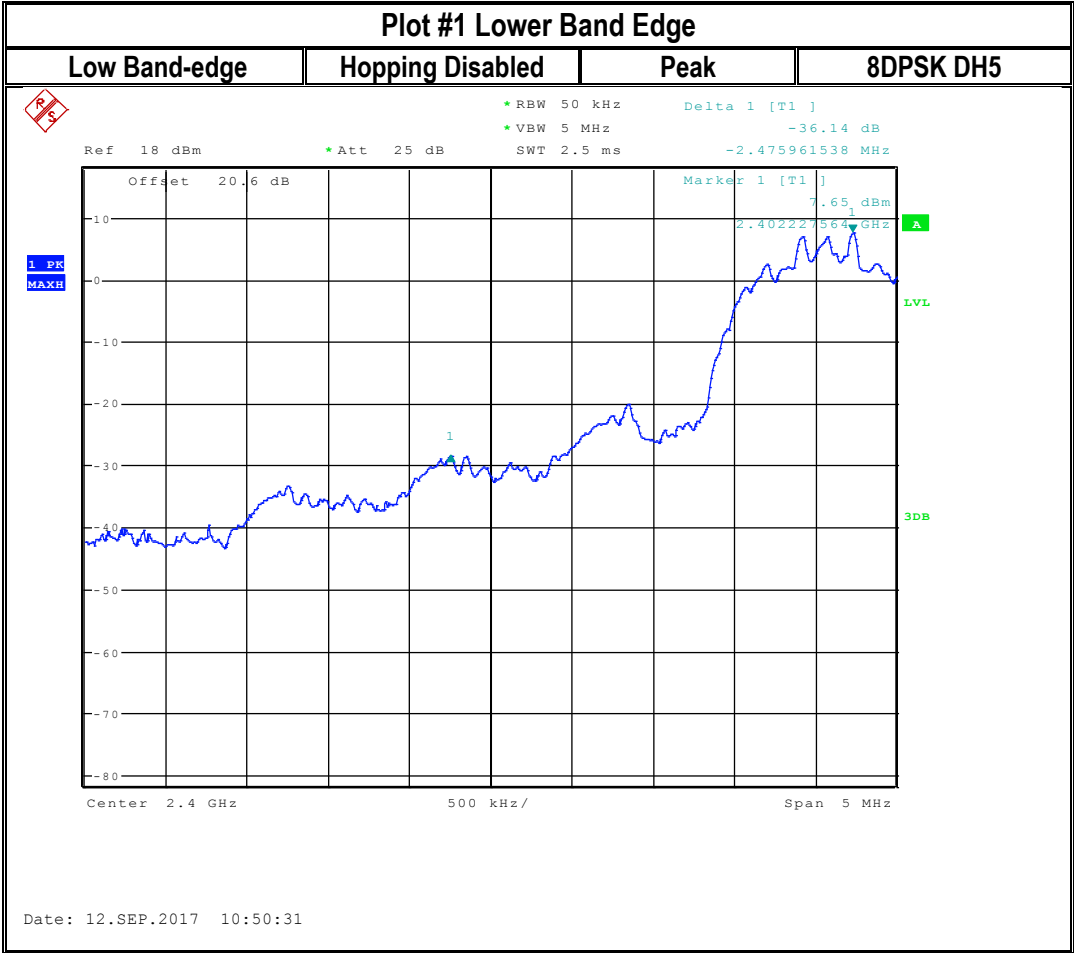
8.2.5 Measurement result:

Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	8DPSK DH5 fixed channel	Lower, non-restricted	36.14	> 20	Pass
2	8DPSK DH5 hopping	Lower, non-restricted	33.57	> 20	Pass

Plot #	EUT operating mode	Band Edge	Measured value	Corrected by duty cycle	Corrected by Antenna gain	Limit (dBm)	Result
3	8DPSK DH5 fixed channel	Upper restricted peak	-43.31	NA due to peak detector	-41.92	-21.23 Peak -41.23 AVG	Pass
4	8DPSK DH5 hopping	Upper restricted peak	-43.55	NA due to peak detector	-42.16	-21.23 Peak -41.23 AVG	Pass

Note: The peak measurement passes both peak and average limits.

8.2.6 Measurement Plots:



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

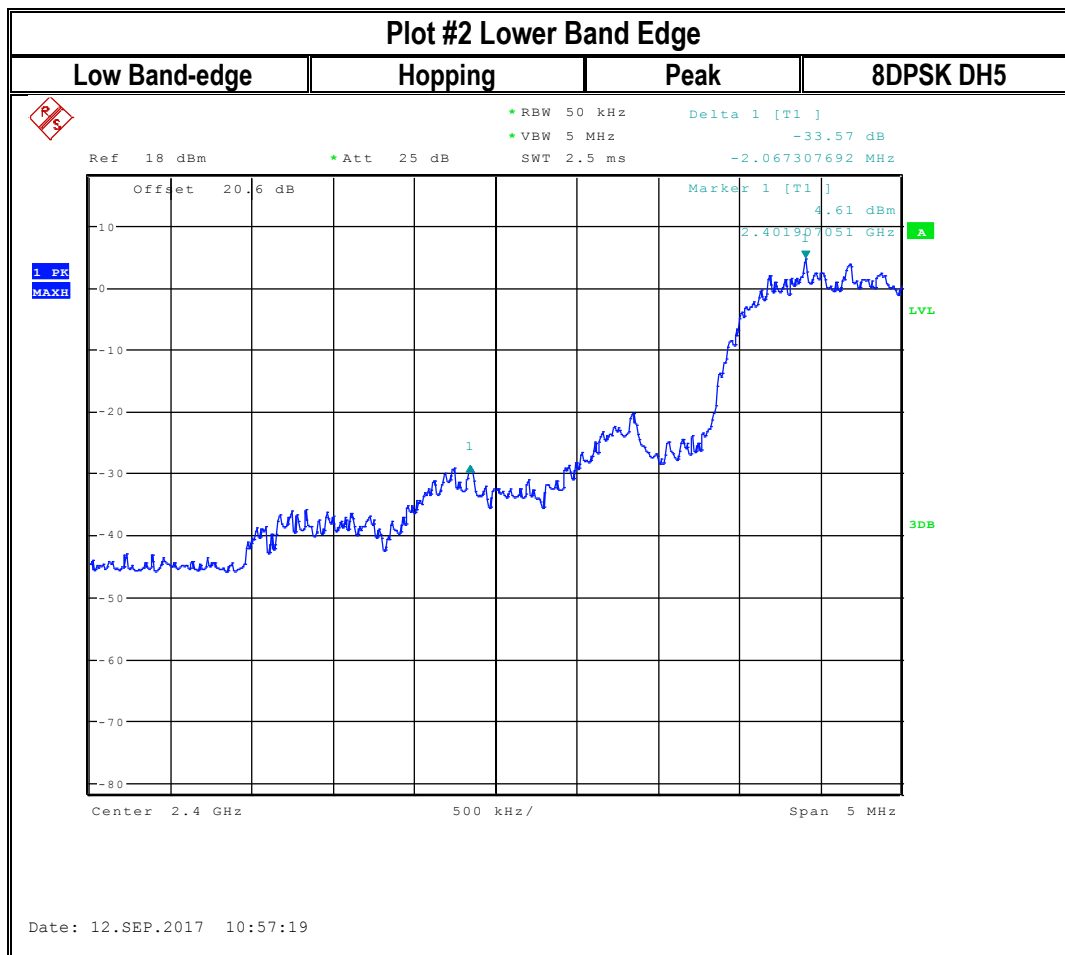
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 28 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

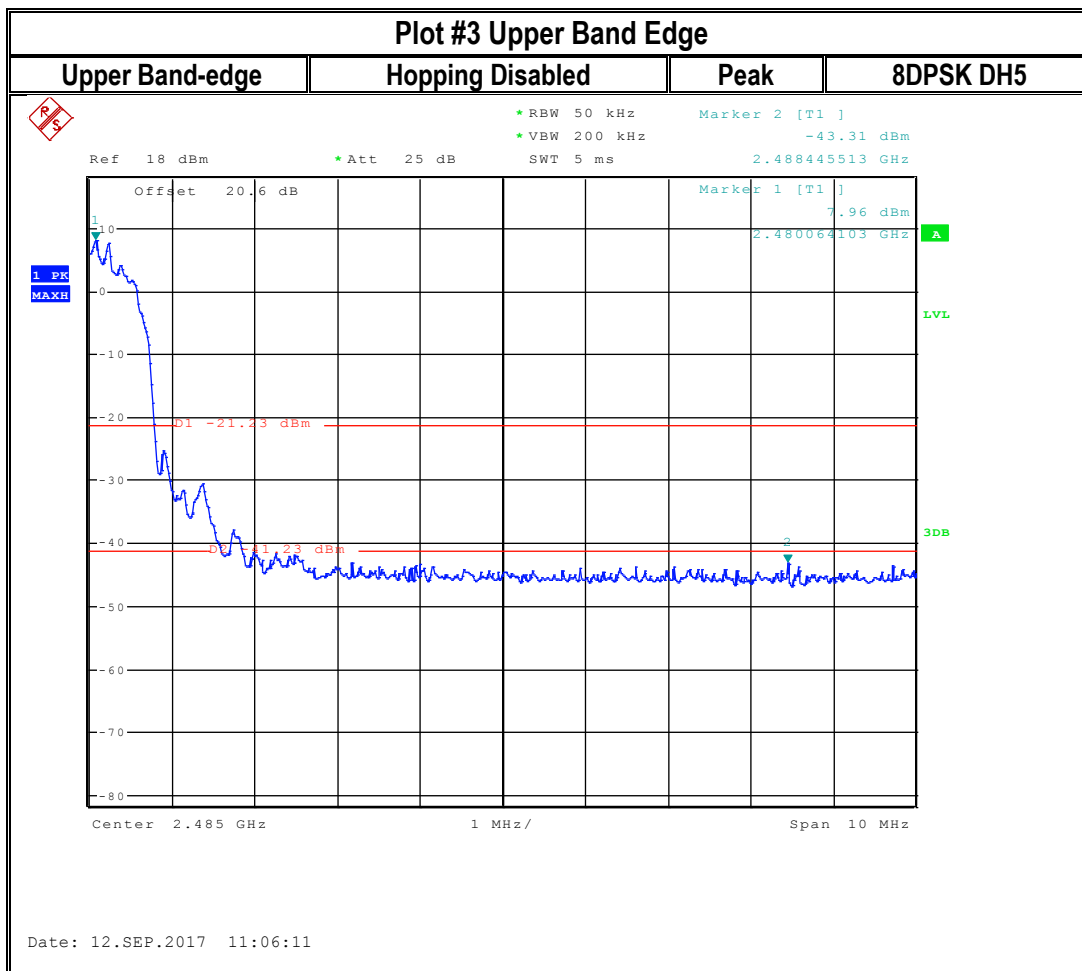
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 29 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

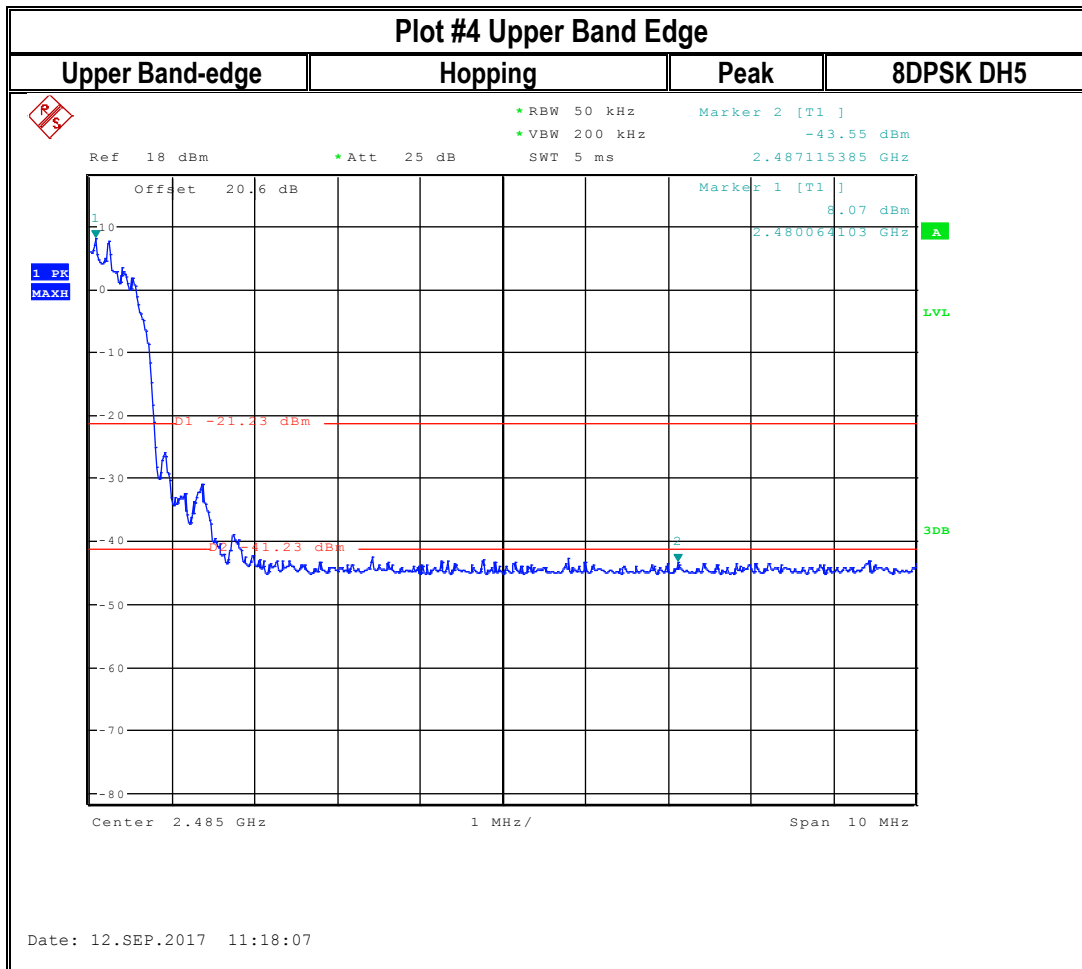
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 30 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



8.3 20dB Bandwidth

8.3.1 Measurement according to ANSI C63.10 Section 6.9

Spectrum Analyzer settings:

- Span: approximately 2 to 3 times the 20 dB bandwidth, centered on the hopping channel
- RBW $\geq$ 1% of the 20 dB bandwidth
- Sweep Time = Auto couple
- Detector = Peak
- Trace = Max hold

8.3.2 Limits: FCC 15.247 (a) (1), RSS-247 5.1(b)

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.

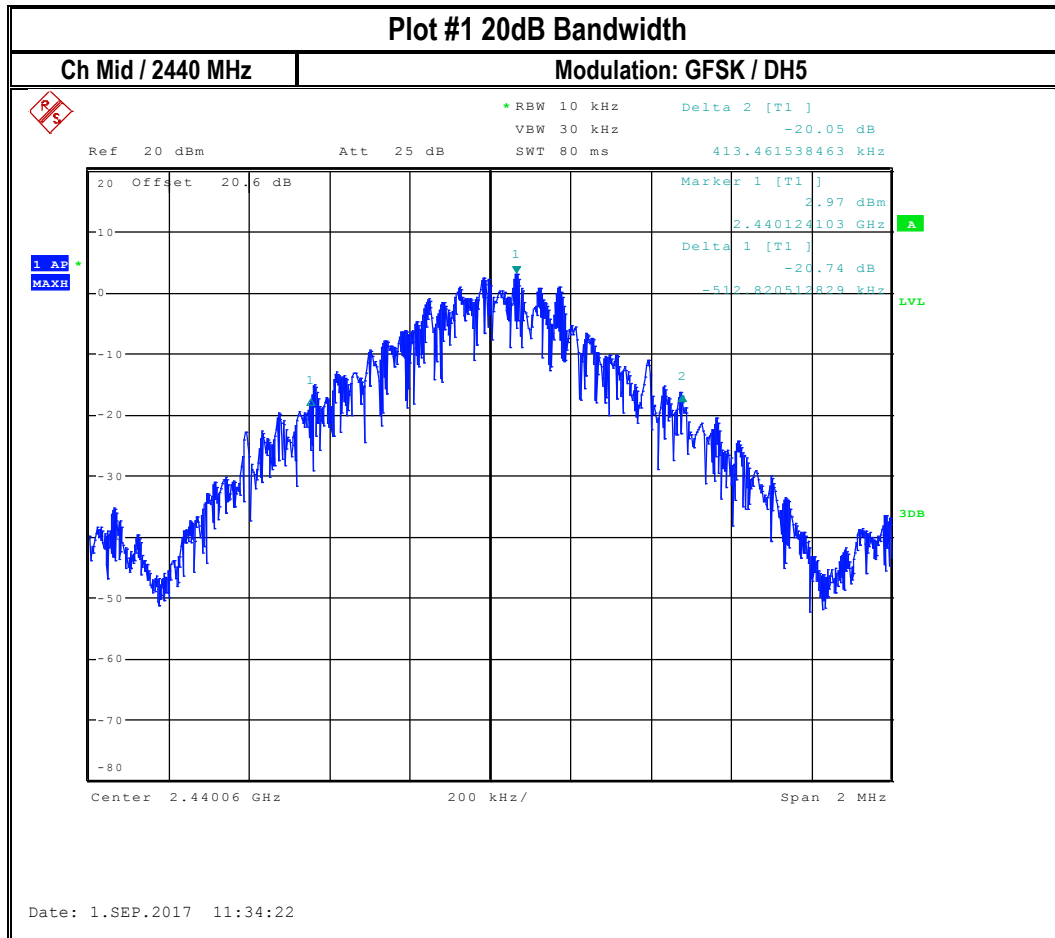
8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	GFSK, DQPSK, 8DPSK – DH5	12 VDC

8.3.4 Measurement result:

Plot #	EUT operating mode	20 dB Bandwidth (MHz)
1	GFSK DH5 fixed channel	0.93
2	DQPSK DH5 fixed channel	1.32
3	8DPSK DH5 fixed channel	1.32

8.3.5 Measurement Plots:



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

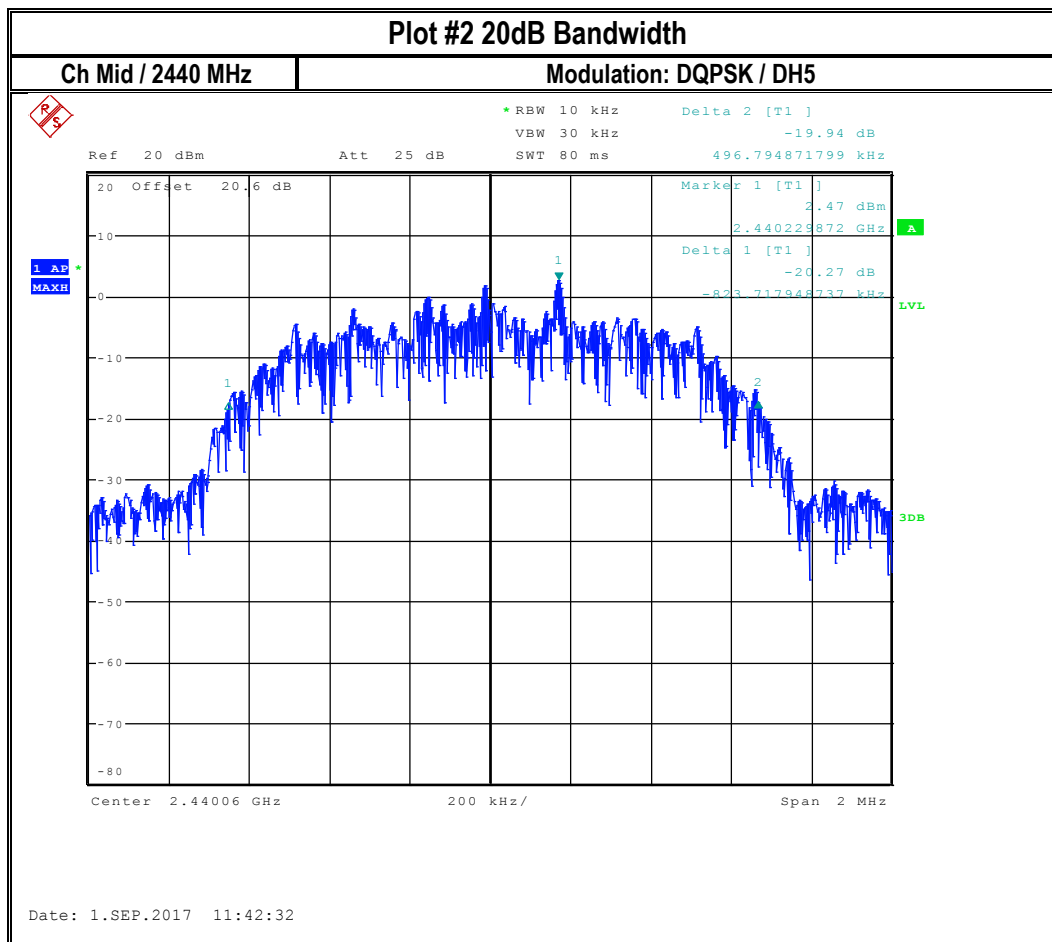
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 33 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



Test Report #: EMC_CALAM-063-17001_15.247_BT_DSS

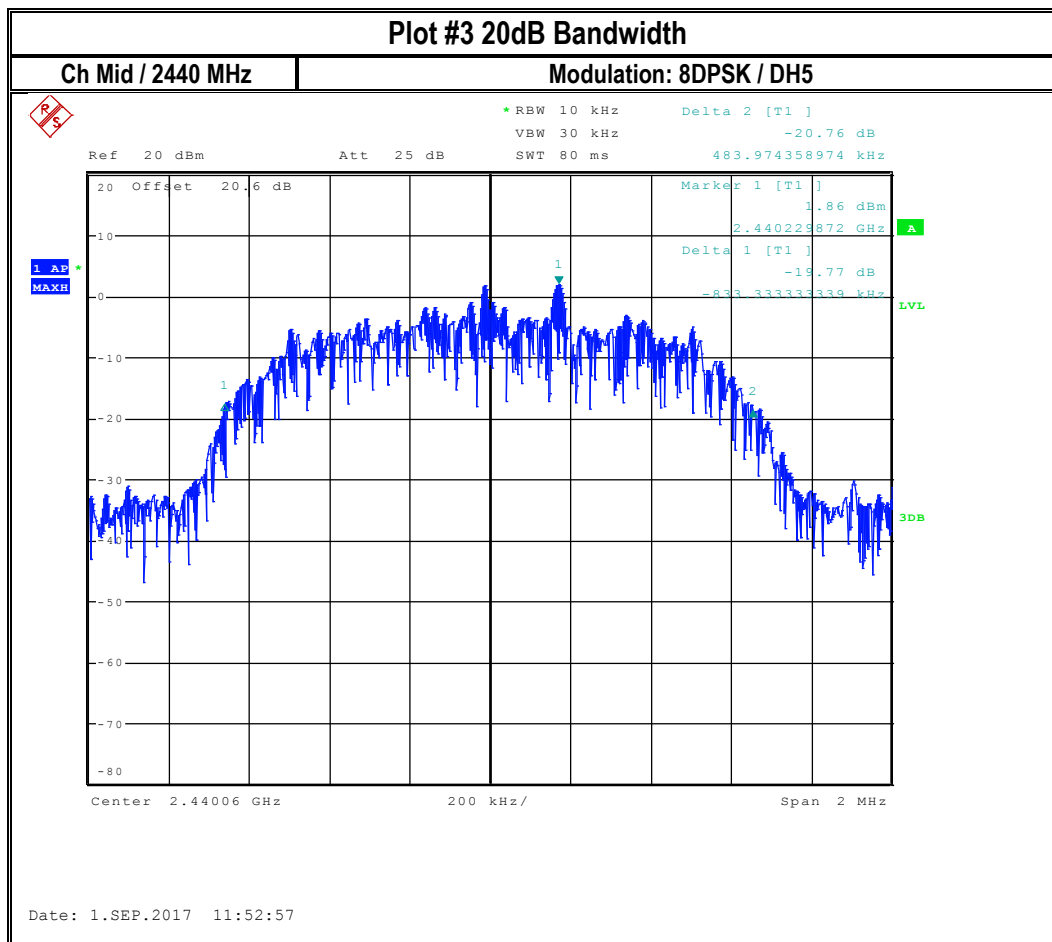
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 34 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



8.4 Carrier Frequency Separation

8.4.1 Measurement according to ANSI C63.10 Section 7.8

Spectrum Analyzer settings:

- Span = Wide enough to capture the peaks of the two adjacent channels
- RBW $\geq$ 1% of the span
- VBW $\geq$ RBW or 3 x
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max hold
- Use marker-delta function to determine the separation between the peaks of the two adjacent channels.

8.4.2 Limits: FCC 15.247 (a) (1) & RSS-247 5.1 (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.

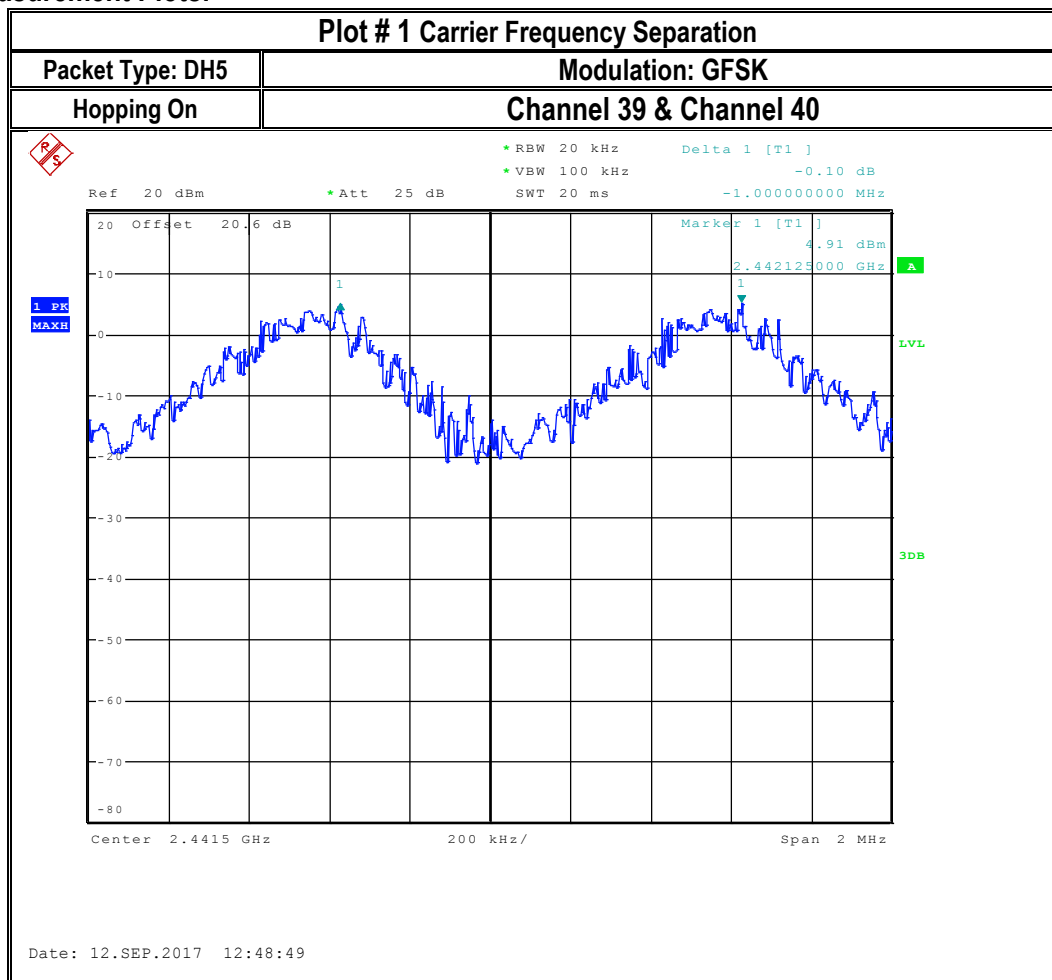
8.4.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	GFSK DH5 Hopping	12 VDC

8.4.4 Measurement result:

Plot #	Carrier Frequency Separation (MHz)	Limit (MHz)	Result
1	1.00	$> 2/3 * \text{OBW} = 0.63$	Pass

8.4.5 Measurement Plots:



8.5 Number of hopping channels

8.5.1 Measurement according to ANSI C63.10 Section 7.8

Spectrum Analyzer settings:

- Span = the entire frequency band of operation
- RBW $\geq$ 50 KHz
- VBW $\geq$ RBW or 3X
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max hold

8.5.2 Limits: FCC 15.247 (a) (1) (ii)(iii) & RSS-247 5.1 (d)

At least 15 non-overlapping channels

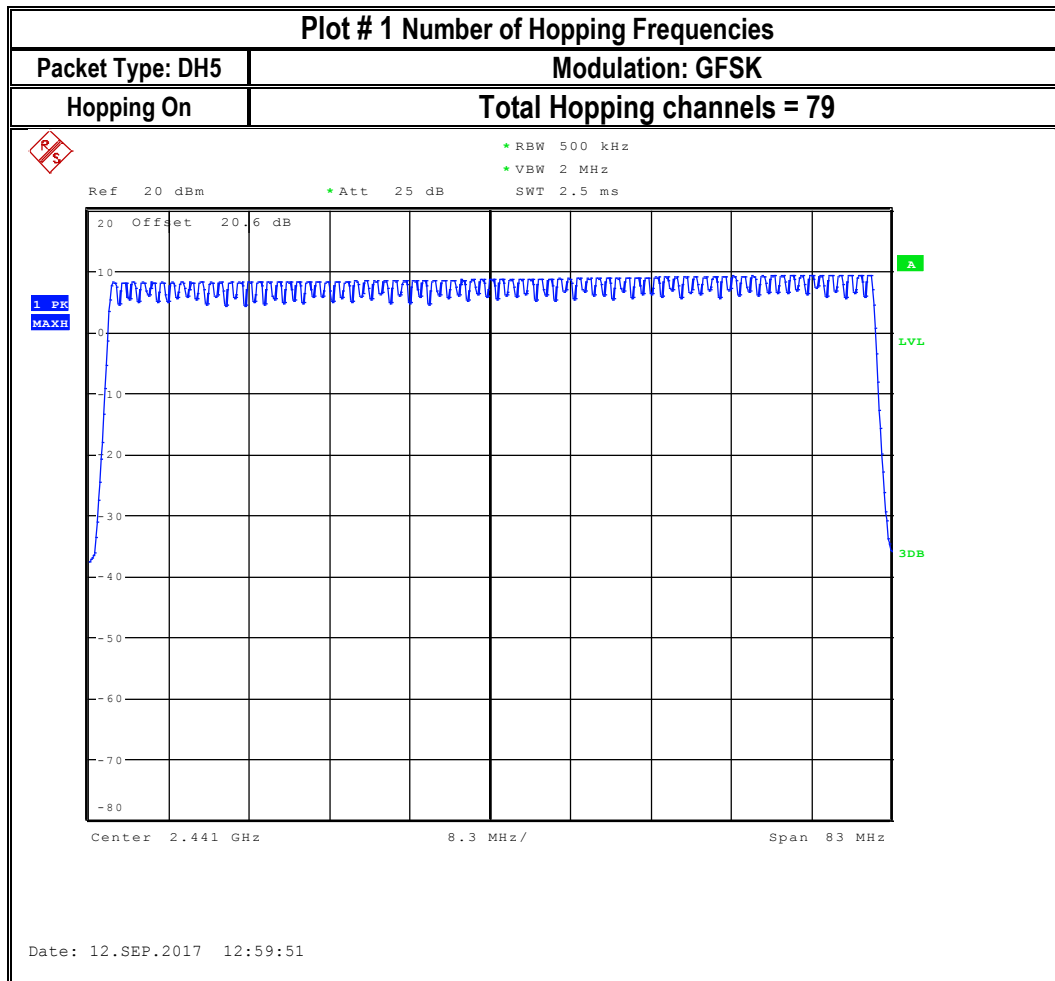
8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	GFSK DH5 hopping	12 VDC

8.5.4 Measurement result:

Plot #	Number of Hopping Frequencies	Limit	Result
1	79	15 non-overlapping channels	Pass

8.5.5 Measurement Plots:



8.6 Time of Occupancy (Dwell Time)

8.6.1 Measurement according to ANSI C63.10 Section 7.8

Spectrum Analyzer settings:

Duration of Pulse Measurement

- RBW = 1 MHz
- VBW = 3 MHz
- Span = 0
- Sweep Time = 10 ms
- Sweep Mode = Single
- Detector = Peak
- Trigger = Video

Observation Period

- RBW = 1 MHz
- VBW = 3 MHz
- Span = 0
- Sweep Time = 31.6 s
- Sweep Mode = Single
- Detector = Peak
- Trigger = Free Run

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

8.6.2 Limits: FCC 15.247 (a) (1) (iii) & RSS-247 5.1 (d)

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.

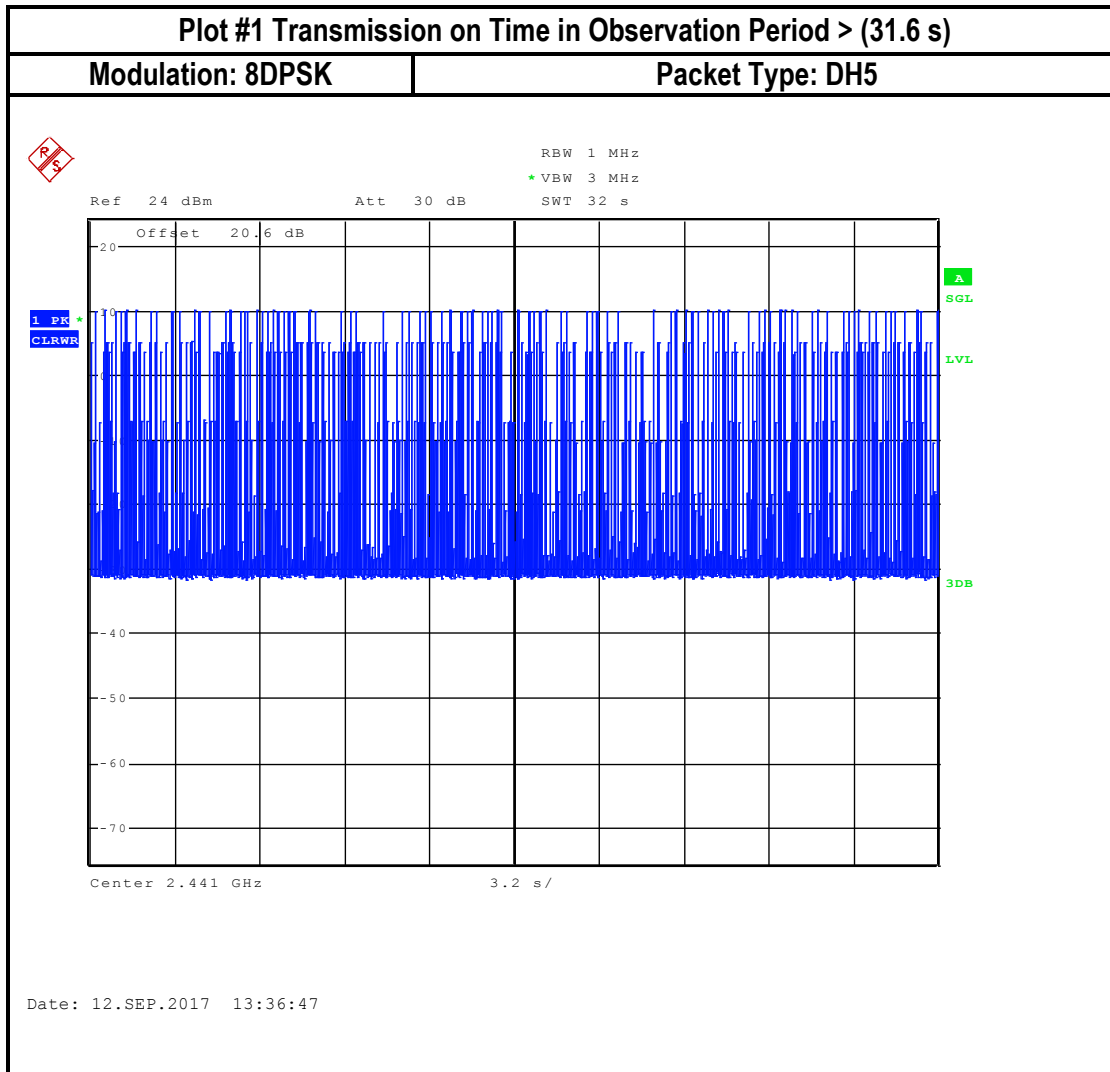
8.6.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	8DPSK DH5 hopping	12 VDC

8.6.4 Measurement result:

Plot #	Modulation	Timing	Number of hops 31.6s	Pulse Width (ms)	Total Dwell Time in 31.6s (ms)	Limit (ms)	Result
1	8DPSK	DH5	113	2.9	327	< 400 in 31.6s	Pass

8.6.5 Measurement Plots:



Test Report #:

EMC_CALAM-063-17001_15.247_BT_DSS

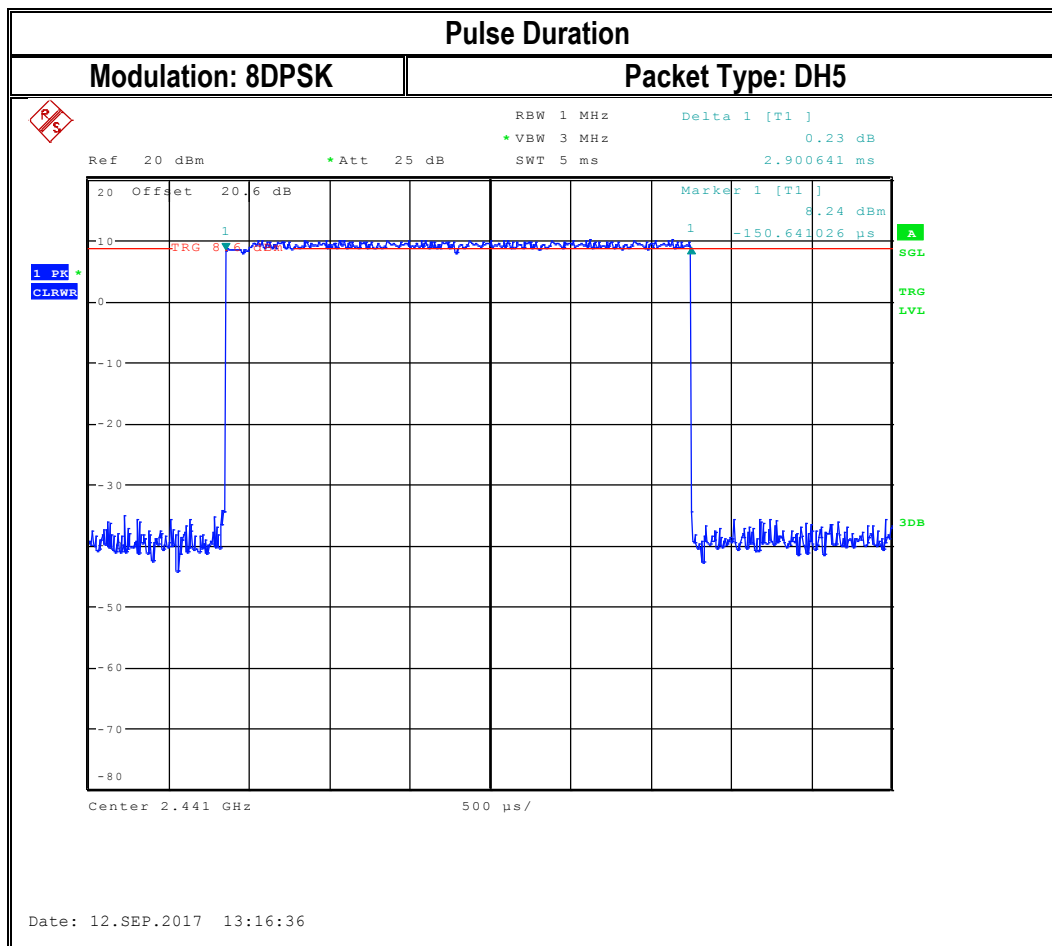
FCC ID: APV-3640LAB/
APV-3640LVB



Date of Report 10/05/2017

Page 41 of 55

IC ID: 5843A-3640LAB/
5843A-3640LVB



8.7 Transmitter Spurious Emissions and Restricted Bands

8.7.1 Measurement according to ANSI C63.10

Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector = Peak
- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW = 120 KHz (<1 GHz)
- 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.

8.7.2 Limits: FCC 15.247(d)/15.209(a) /RSS-Gen 6.13

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- 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= 74dB μ V/m
- AVG. LIMIT= 54dB μ V/m
- Except as shown in CFR 47 Part 15.205 paragraph (d), only spurious emissions are permitted in any of the frequency bands listed below

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

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 as follow:

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

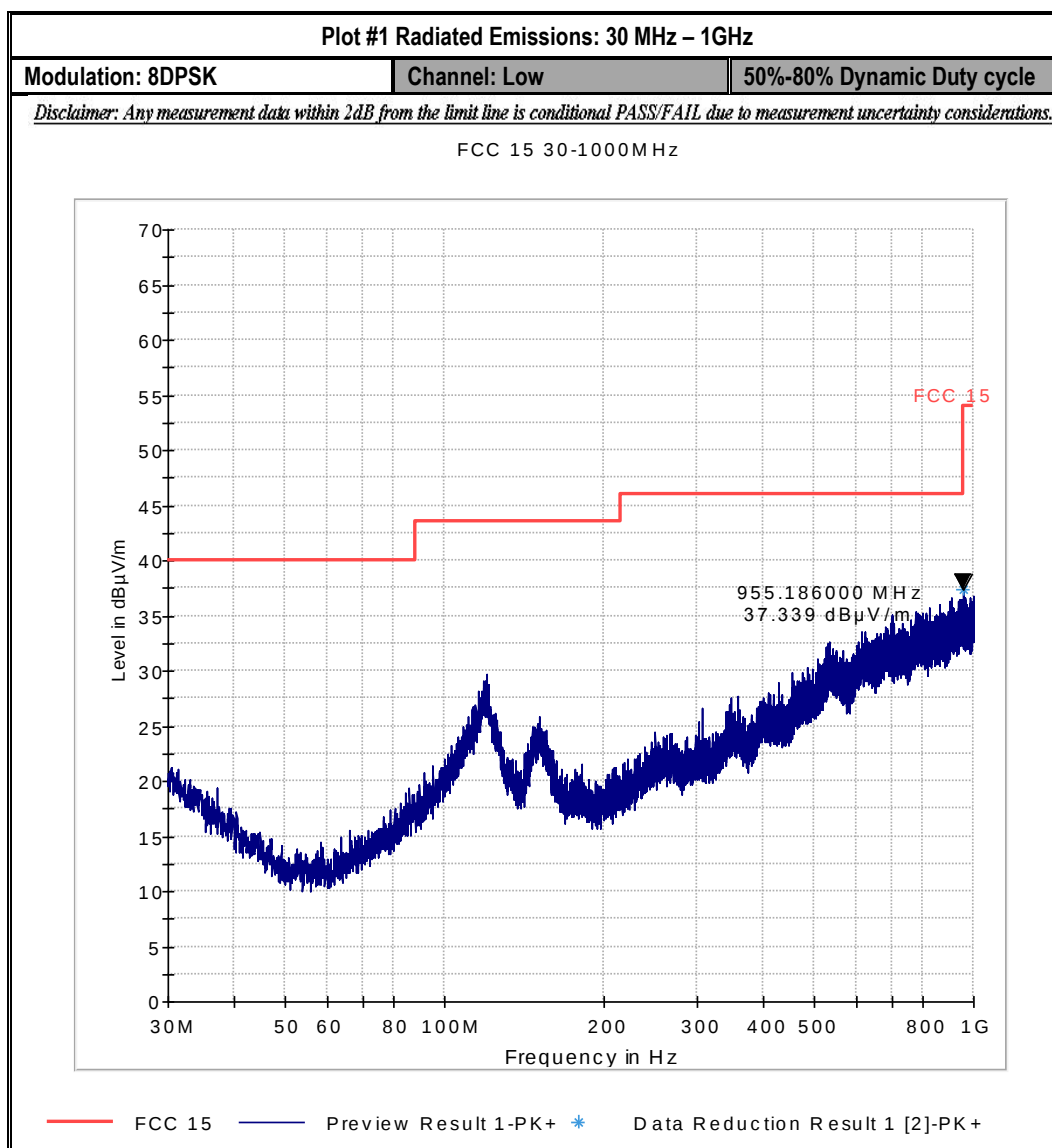
8.7.3 Test conditions and setup:

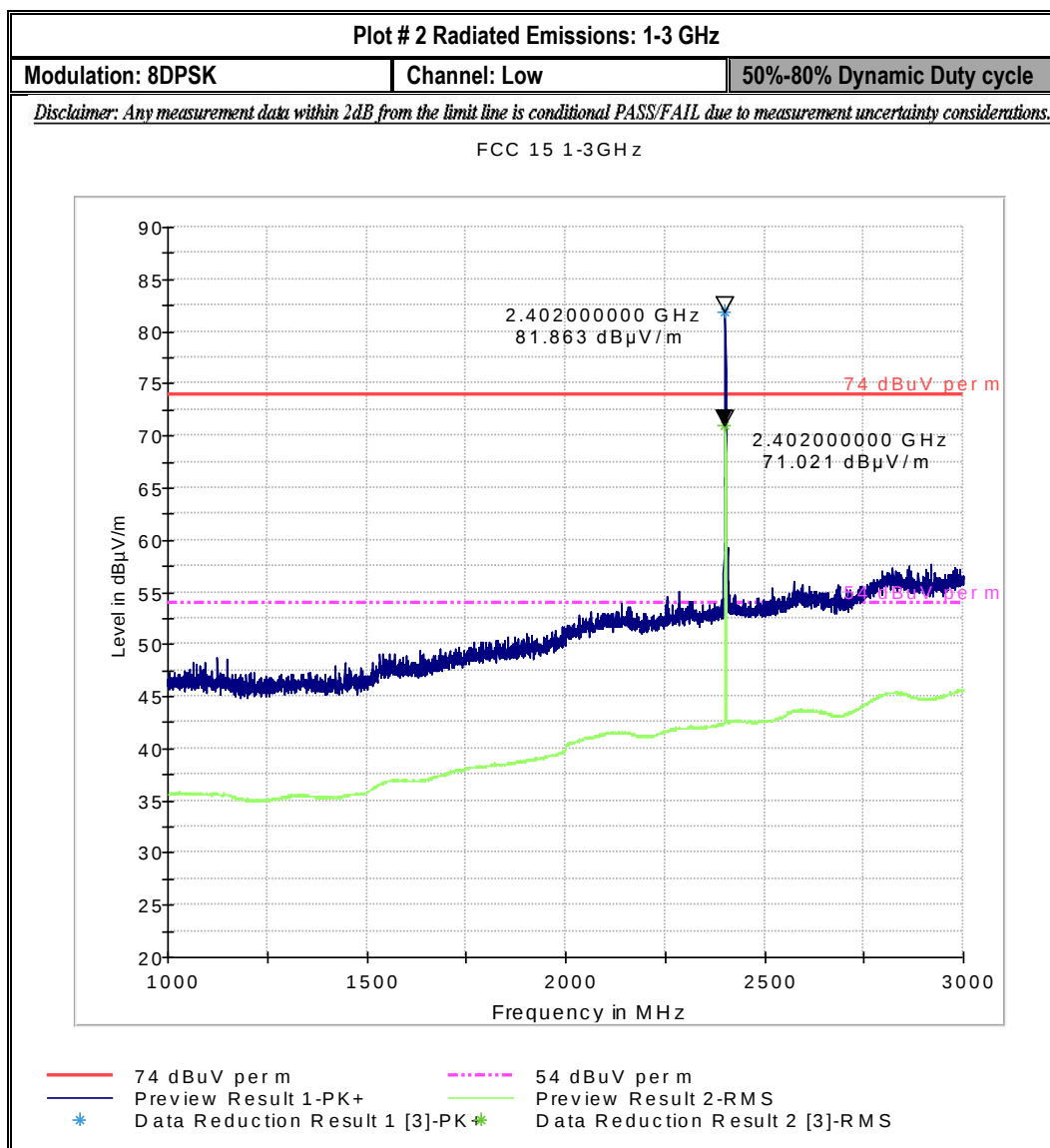
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	8DPSK DH5 fixed channel	12 VDC

8.7.4 Measurement result:

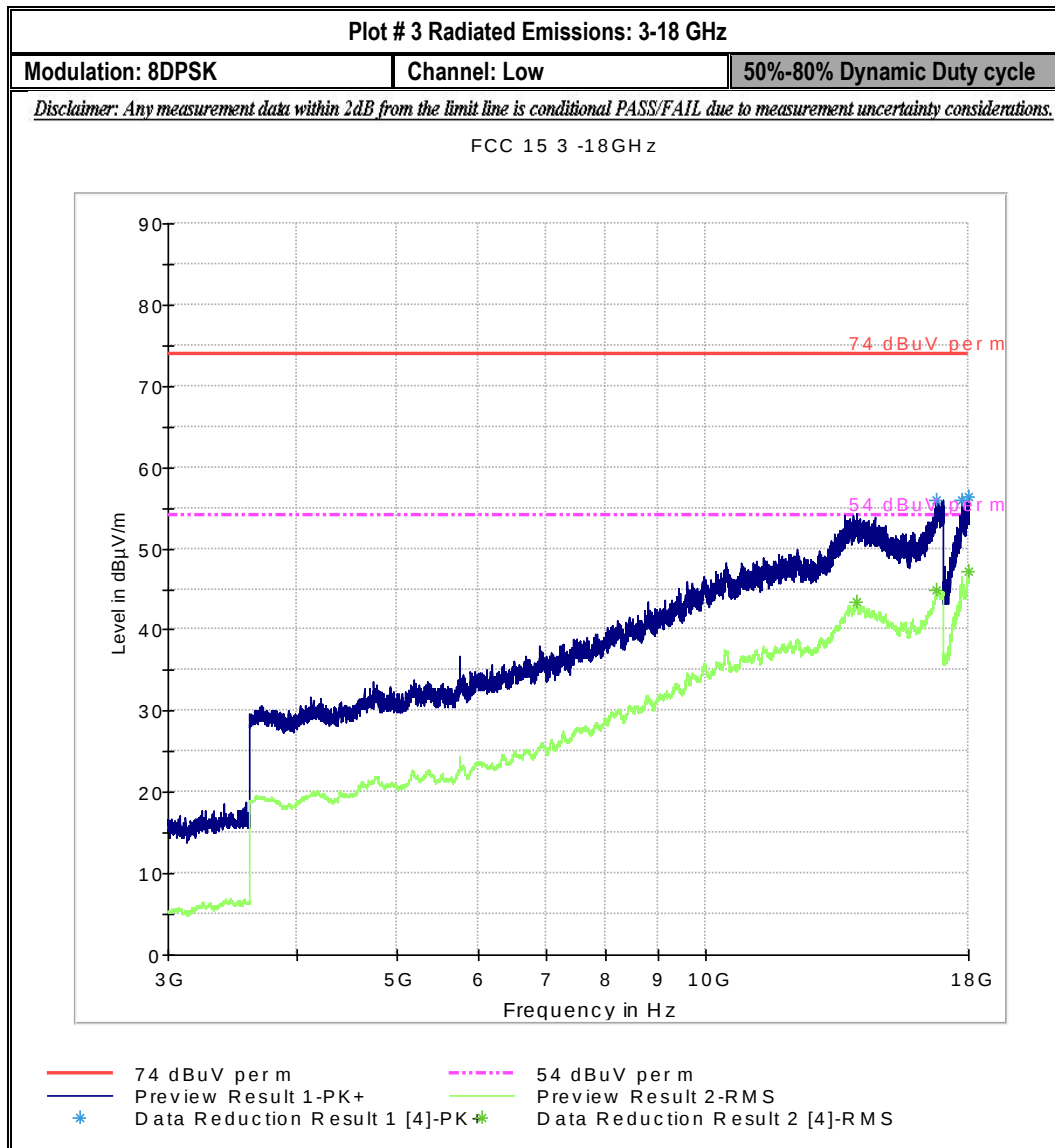
Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.7.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.7.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.7.2	Pass

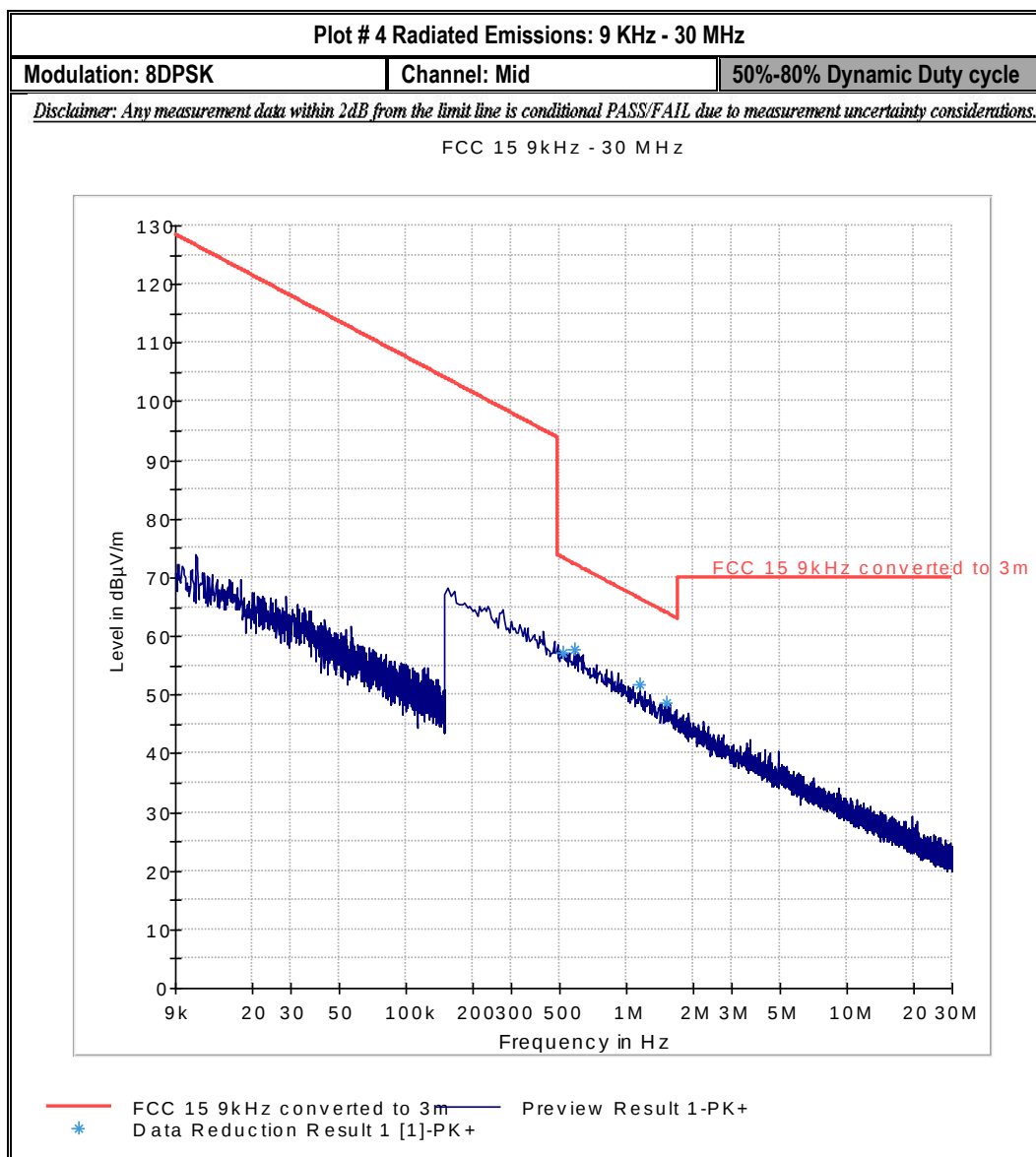
8.7.5 Measurement Plots:

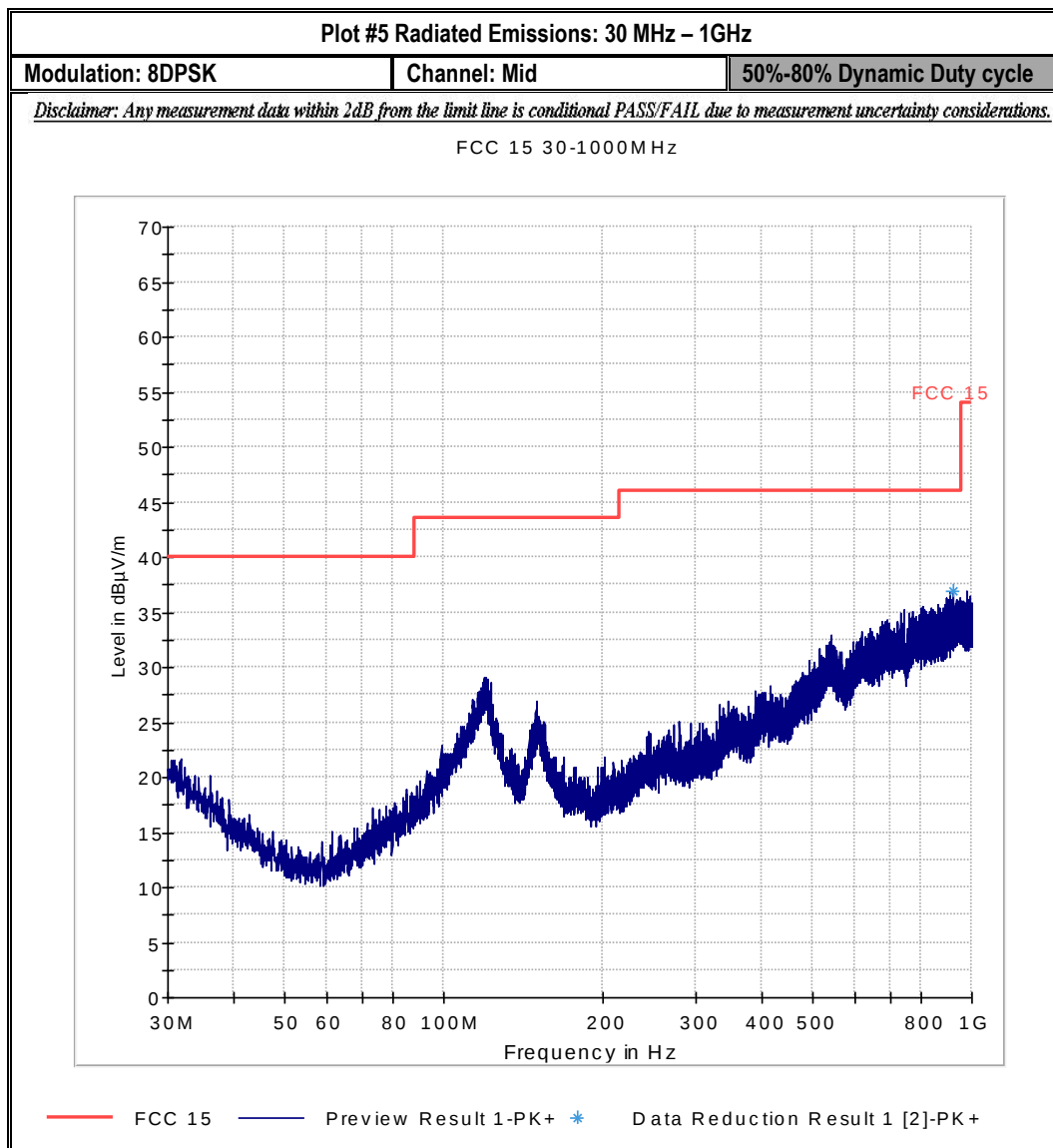


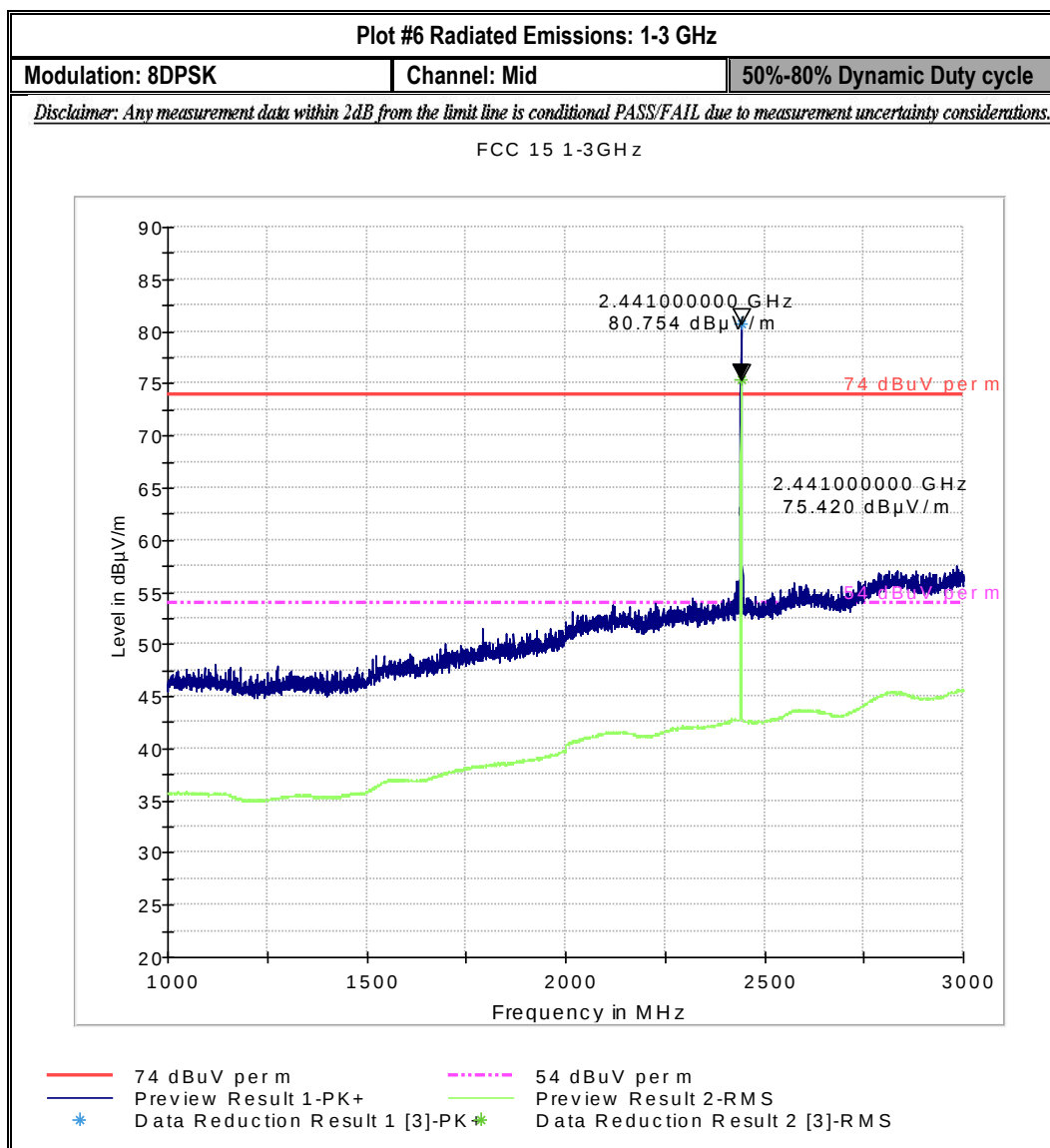


Note: The peak signal above is the transmit channel.

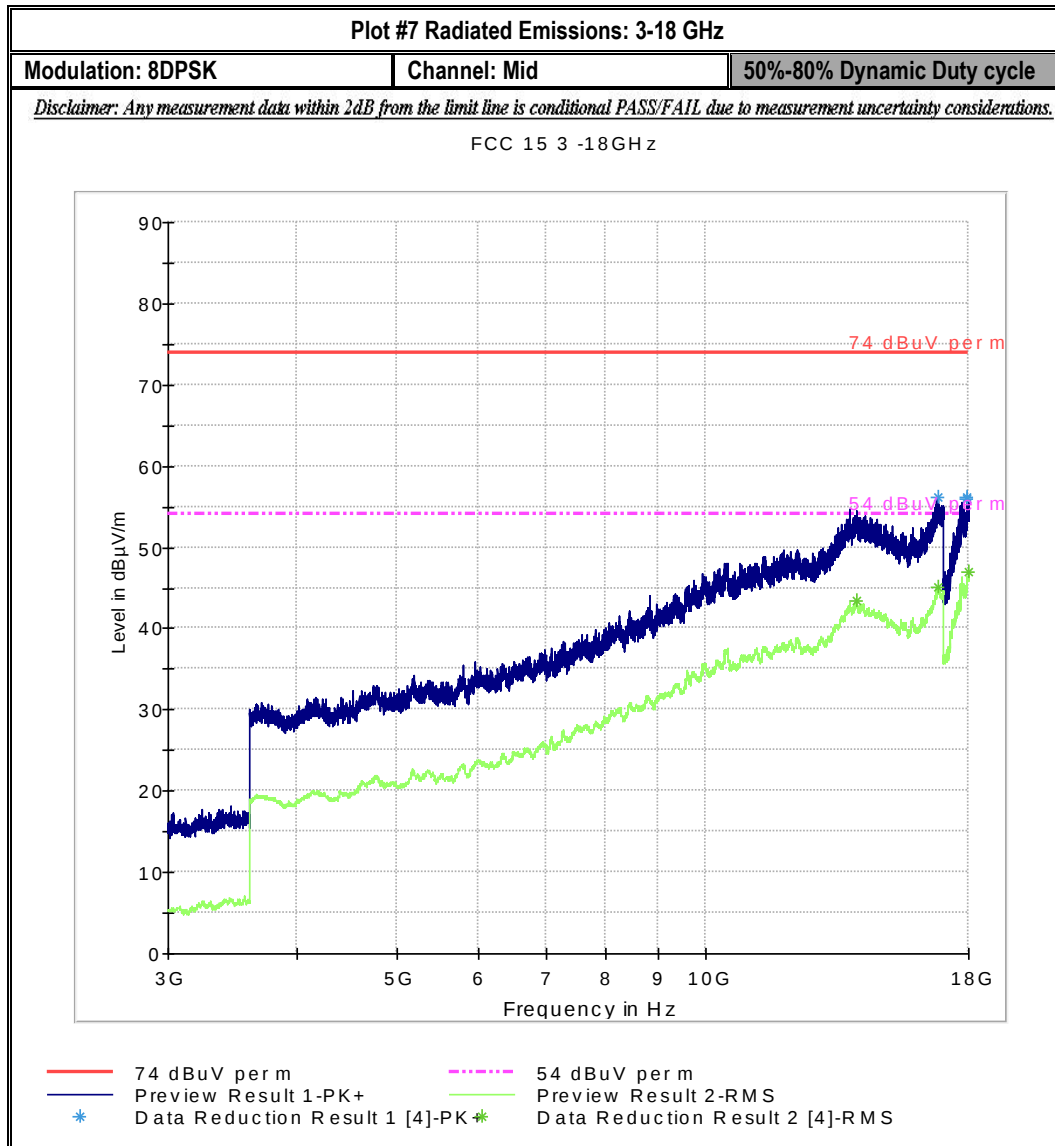


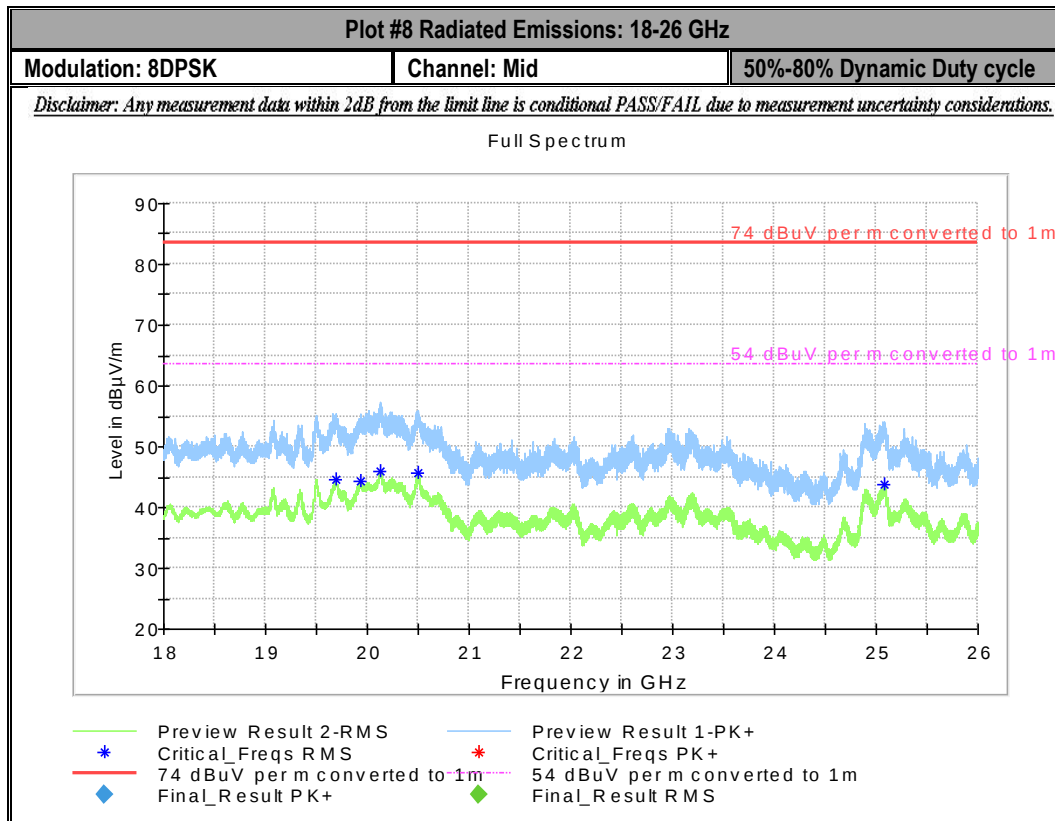


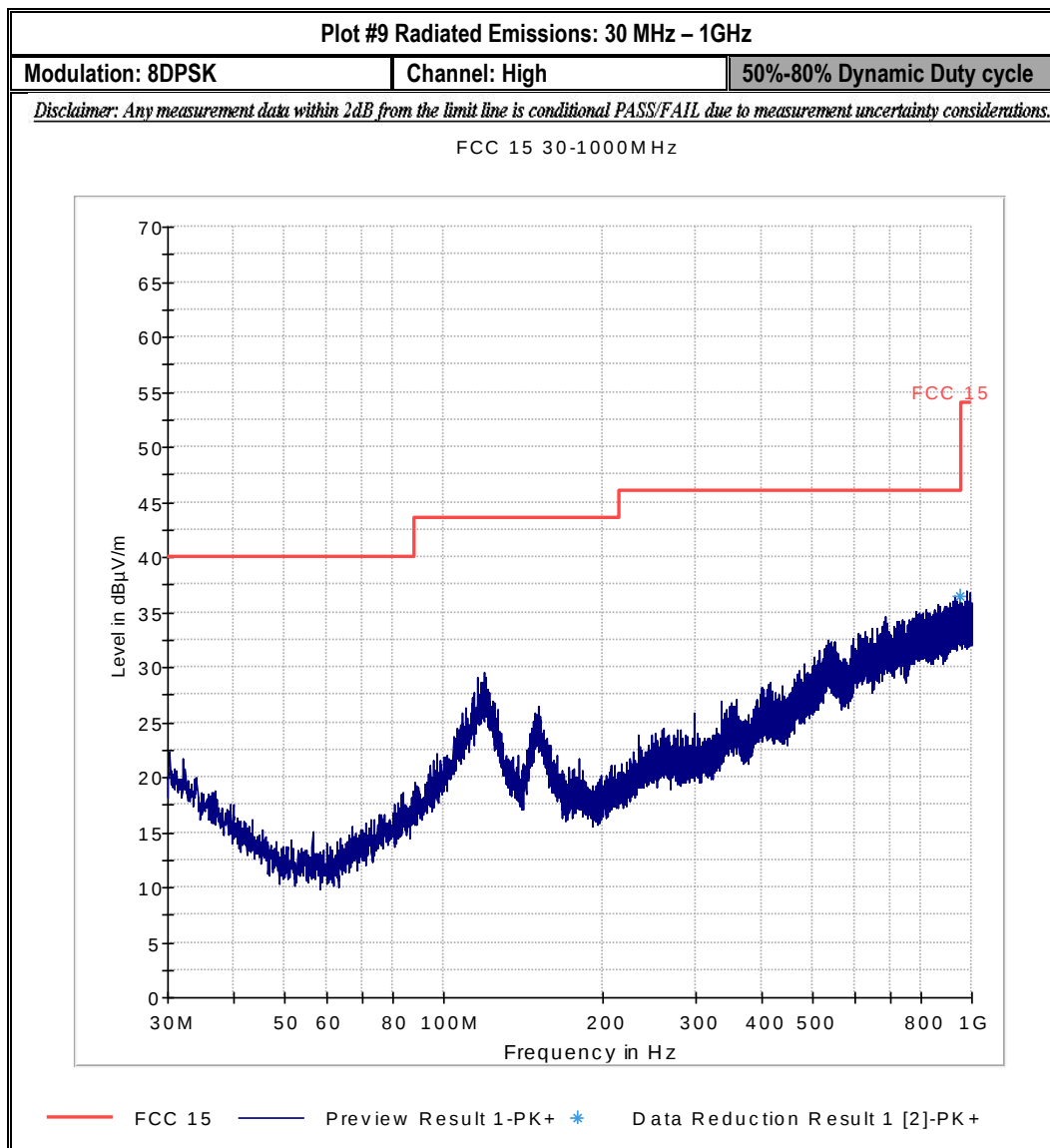


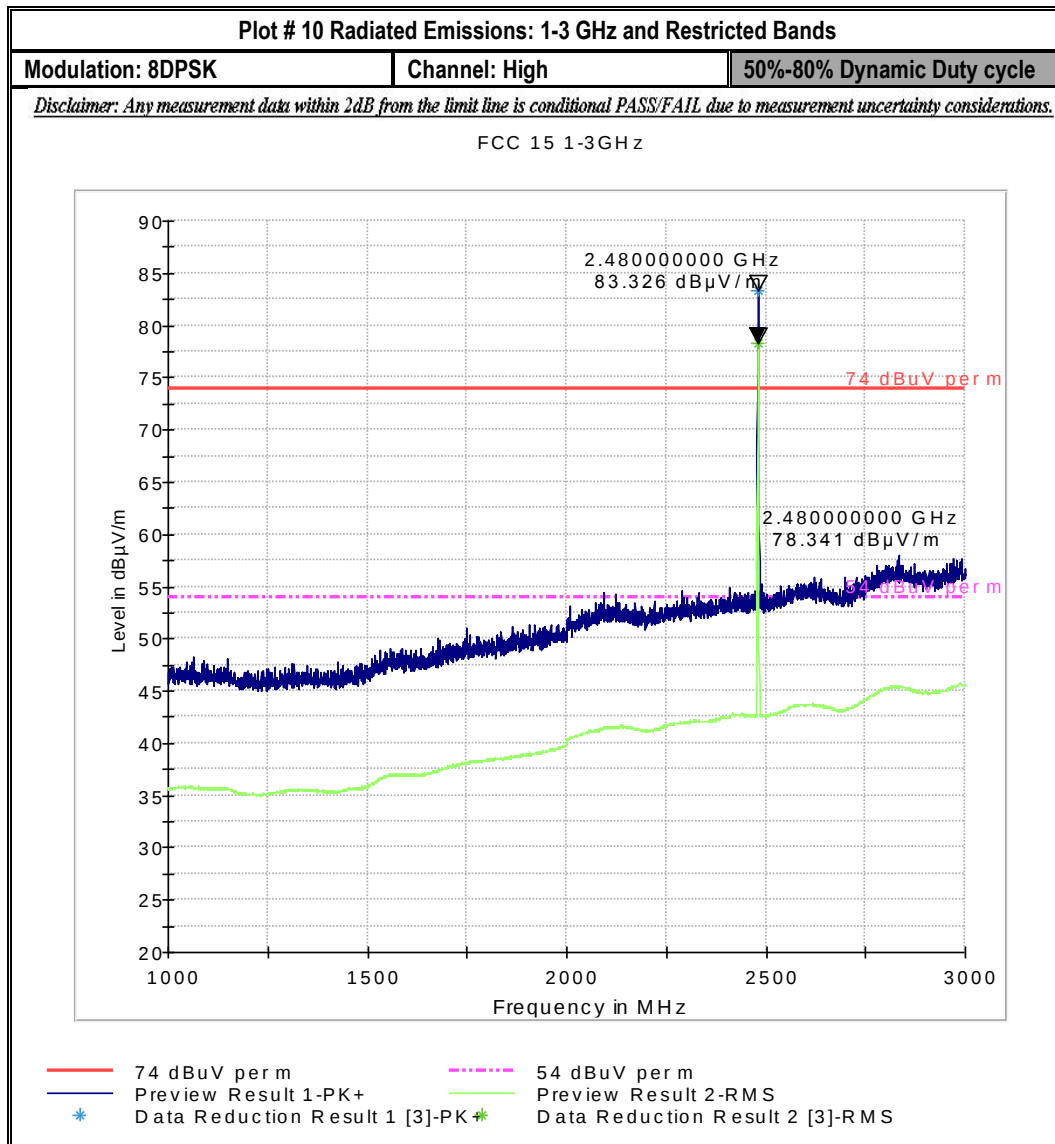


Note: The peak signal above is the transmit channel.

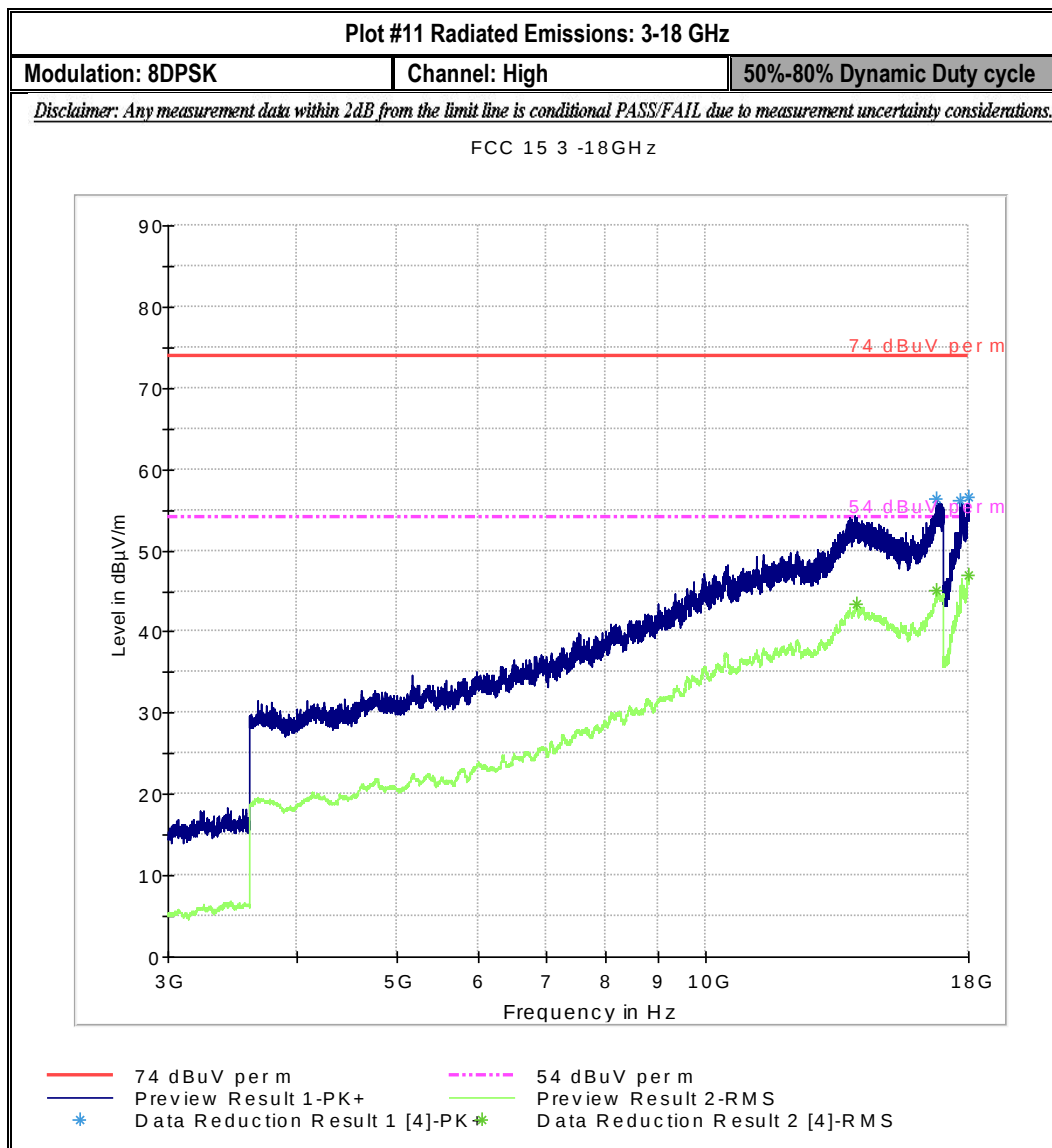








Note: The peak signal above is the transmit channel.



9 Test setup photos

Setup photos are included in supporting file name: "EMC_CALAM-063-17001_FCC_IC_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	6/22/2017
Active Loop 6507	Loop Antenna	ETS Lindgren	6507	00161344	3 years	2/13/2015
Antenna Horn 3115	Horn Antenna	EMCO	3115	35111	3 years	7/24/2015
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	1 Years	6/5/2017
ESU . EMI Test Receiver	Test Receiver	R&S	ESU	1302.6005K40 -100251-KB	2 years	7/10/2017
CBT. Bluetooth Tester	Bluetooth Tester	R&S	CBT	100212	2 Years	7/9/2017
FSU	Spectrum Analyzer	R&S	FSU	200302	2 Years	7/5/2017
Thermometer Humidity TM320	Thermometer Humidity	Dickson	AY1072	0528	1 Year	11/2/2016

Note: 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.

11 Revision History

Date	Report Name	Changes to report	Report prepared by
10/05/2017	EMC_CALAM-063-17001_15.247_BT_DSS	Initial Version	Issa Ghanma