H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Microchip Technology Inc.

Low Power Long Range LoRa Technology Transceiver Module Model RN2903

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.247 for

Digitally Transmitting Sequence / Hybrid

Prepared for:

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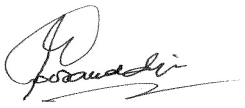

Hoosamuddin Bandukwala

Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 15 of the FCC Rules under normal use and maintenance.

Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	May 28, 2015	Initial Issue

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15.247. All tests were conducted using measurement procedure from ANSI C63.10-2009, FCC Public Notice 558074 DTS Guide April 09, 2013 as appropriate.

Test Name	Test Method/Standard	Result	Comments
Unintentional Radiated Emissions	15.109	Pass	
A/C Powerline Conducted Emissions	15.207	N/A	Battery Operated device
Occupied Bandwidth	15.247(a)(2)	Pass	
Peak Output Power	15.247(b)	Pass	
Conducted Spurious Emissions	15.247(d)	Pass	
Radiated Spurious Emissions & Restricted Band	15.247(d), 15.209(a), 15.205	Pass	
Emissions At Band Edges	15.247(d), 15.209(a), 15.205	Pass	
Power Spectral Density	15.247(e)	Pass	
Time of Occupancy (Dwell Time)	15.247(a)	Pass	
Carrier Frequency Separation	15.247(a)	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Link Labs to perform testing on the Low power transceiver LoRa Technology module RN2903 under the purchase order number 60002972

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Microchip Technology, Low power transceiver LoRa Technology module RN2903.

The tests were based on FCC Part 15 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Microchip Technology should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	Low-Power Long Range LoRa Technology Transceiver Module
Model(s) Tested:	RN2903
FCC ID:	T9JRN2903
Supply Voltage Input:	Primary Power : 3.3 Vdc
Frequency Range:	902.3 - 927.5MHz
No. of Channels:	8 (DTS) 25 or 64 (FHSS)
Necessary Bandwidth	N/A
Type(s) of Modulation:	FSK
Range of Operation Power:	0.0809W
Emission Designator:	N/A
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment :	Fixed
Antenna Requirement (§15.203) :	Type of Antenna: External Sleeve Dipole Gain of Antenna: +6dBi
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at Artesyn Embedded & H.B. Compliance Solutions
Test Date(s):	04/20/15 till 05/13/15

2. Test Facility

Radiated Emission testing was performed at Artesyn Embedded Technologies. This facility is located at 2900 S. Diablo Way, Suite 190, Tempe, AZ 85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Test facility at Artesyn Embedded Technologies is an A2LA accredited test site. The A2LA certificate number is 2716.01. The scope of accreditation covers the FCC Method - 47 CFR Part 15, ICES-003, CISPR 22, AS/NZS 3548 and VCCI

Conducted testing was performed at H.B. Compliance Solutions. This facility is located at 5005 S. Ash Avenue, Suite # A-10, Tempe AZ 85282.

Radiated Emissions measurements were performed in a semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Emerson Network Power.

3. Description of Test Sample

The Microchip, RN2903 is a low power long range LoRa Technology transceiver module which provides an easy to use low-power solution for long range wireless data transmission902-928MHz LoRa Technology modules with an external antenna connector.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Low Power Long Range Transceiver Module	RN2903	N/A
# 2	L-com 6dBi Sleeve Dipole Antenna	HGV-906U	N/A

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
# 3	Laptop Computer	IBM	Thinkpad T 41	99-K3967

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
# 4	Power	USB	1	2	N	Laptop

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

The EUT will be configured to transmit at maximum power level. The modules were programmed with special test software that allowed to cycle through test modes. Test mode was provided to select the lower, middle and upper band of the. This software allowed the selection of the channel on the transmitter from three frequencies modulated and the other three in CW mode. These settings were created for testing purpose only.

Description of Test Modes

To investigate the maximum EMC emission characteristics generated from the EUT, the test system was pre-tested for the following EUT operation mode or test configuration mode which can produce the highest EMI emission level. Each of these EUT configuration mode(s) mentioned below was evaluated respectively. Only the highest test mode for each test has been reported.

Spreading Factor (S.F)	Payload
7	158
8	85
9	40
10	14

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Microchip Technology upon completion of testing & certification

Criteria for Un-Intentional Radiators

1. Radiated Emissions

Test Requirement(s):	§15.109	**Test Engineer(s):**	Frank Farrone
Test Results:	Pass	**Test Date(s):**	05/05/2015

Test Procedures:

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 NSA requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, antenna height, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

> *Note: The specified distance is the horizontal separation between the closest periphery of the EUT and the center of the axis of the elements of the receiving antenna. However, if the receiving antenna is a log-periodic array, the specified distance shall be the distance between the closest periphery of the EUT and the front-to-back center of the array of elements.*

Tests were made with the antenna positioned in both the horizontal and vertical polarization planes. The measurement was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
30 MHz to 1 GHz	120 kHz	120 kHz	N/A
1 GHz to 11 GHz	1MHz	N/A	1MHz
Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver.			

Table 4. Radiated Emissions – Measurement Bandwidth

Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using Rohde and Schwarz ES-K1 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + (CF –AG)

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

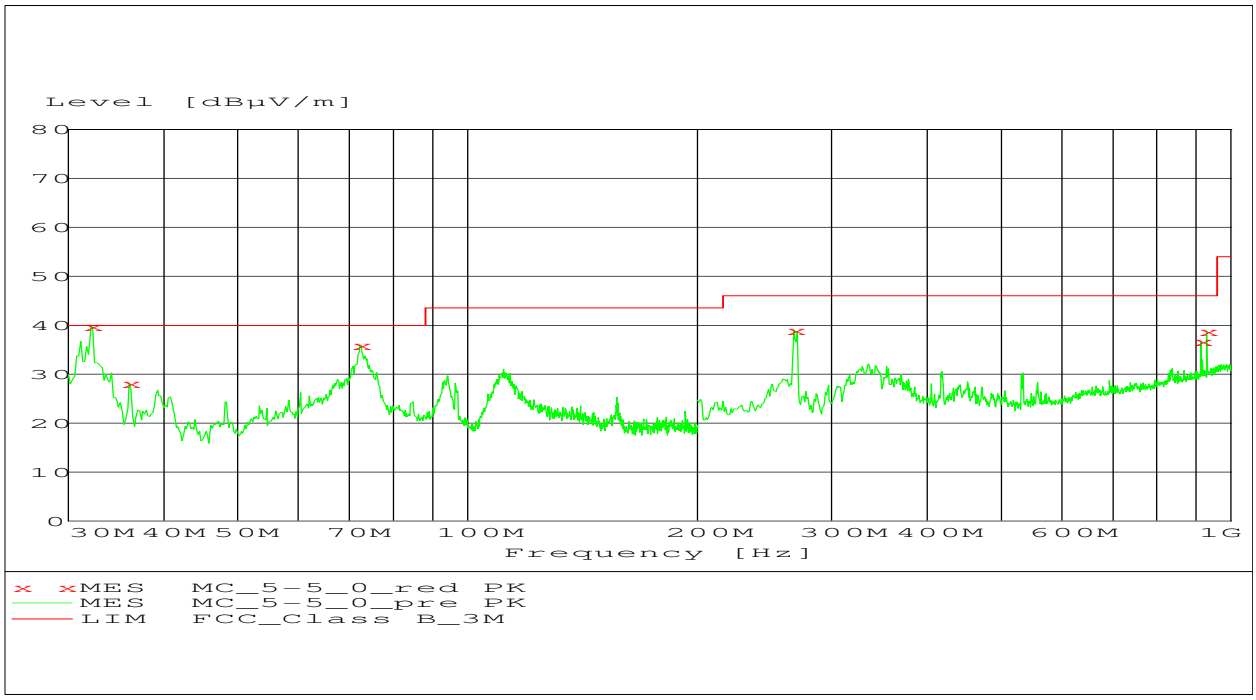
For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

FS = 52.5 + 7.4 + (-27.9) = 32 dBuV/m

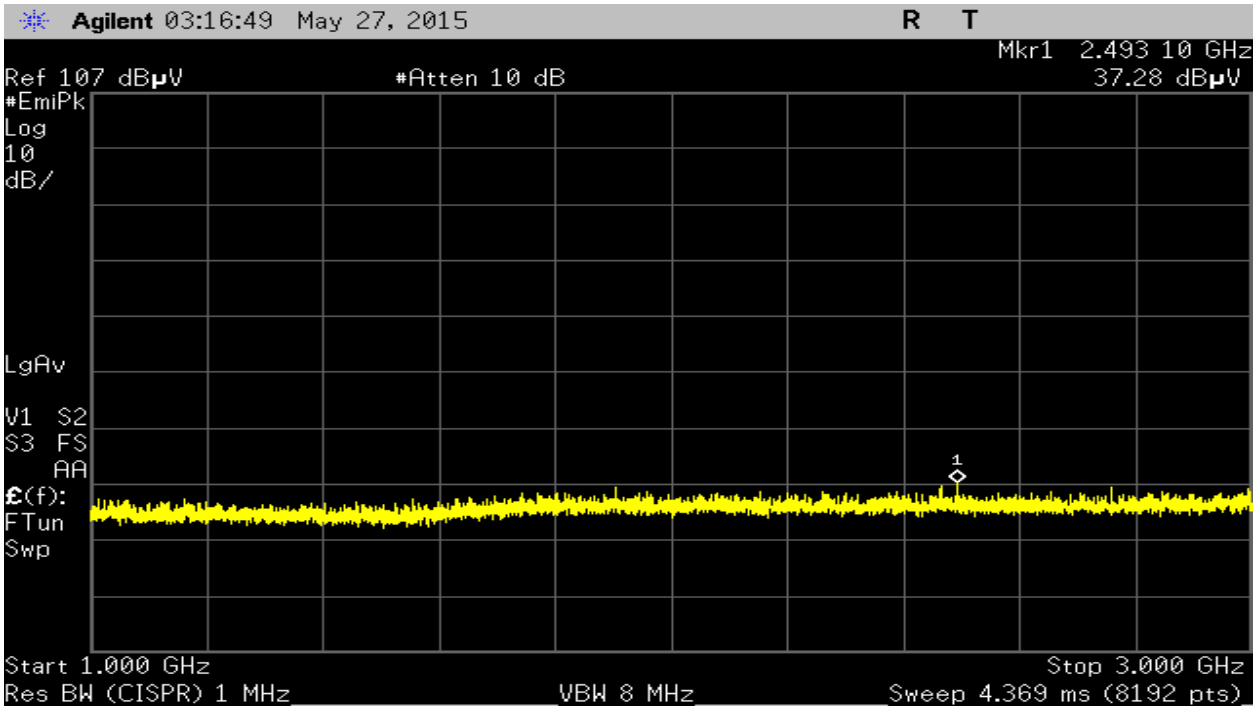
FS = 32 dBuV/m

If desired, this can be converted into its corresponding level in uV/m:

FS = 10^((32 dBuV/m)/20) = 39.8 uV/m



Plot 1 – Radiated Emissions – 30MHz to 1GHz



Plot 2 – Radiated Emissions – 1GHz to 3GHz (For Industry Canada RSS-GEN)

Frequency (MHz)	Measured Level (dBuV/m)	Height(cm)	Azimuth (deg)	Polarization
32.07	39.78	200	315	Vertical
36.04	28.08	400	45	Vertical
72.28	35.92	100	45	Vertical
267.55	38.95	100	135	Vertical
912.88	36.68	100	180	Vertical
929.77	38.75	100	180	Vertical

Table 5. Final Measurement Results for Radiated Emissions

2. Conducted Emissions

Test Requirement(s):	§15.207	Test Engineer(s):	None
Test Results:	N/A	Test Date(s):	None

Test Procedures: The EUT was placed on a non-metallic table, 80cm above the ground plane inside a shielded enclosure. The EUT was powered through a 50Ω/50µH LISN. The conducted emissions tests were performed using the mode of operation and configuration noted within this report. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are 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 the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are the same as those cords normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network). All 50 Ohm measuring ports of the LISN are terminated by 50 Ohms, either by the 50 Ohm EMI receiver or a 50 Ohm resistive load.

Refer to the Emissions Tests Calculations section in the Radiated Emissions section for sample calculations. For the purposes of the conducted emissions test, the Antenna Factor (AF) is replaced by the LISN correction factor.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.150 - 30	9.0	9.0	9.0
Measurements were made using the bandwidths and detectors specified. No video filter was used.			

Table 1.Conducted Emissions – Measurement Bandwidth

Frequency Range (MHz)	15.107(b), Class A Limits (dBuV)		15.107(a), Class B Limits (dBuV)	
	Quasi-Peak	Average	Quasi Peak	Average
0.15 – 0.5	79	66	66 - 56	56 - 46
0.5 – 5.0	73	60	56	46
5.0 – 30	73	60	60	50
Note 1 – The lower limit shall apply at the transition frequencies.				

Table 2. Conducted Emissions Limits – FCC Limits from Section 15.107(a)(b)

1. Occupied Bandwidth

Test Requirement(s):	15.247(a)(2), ANSI C63.10	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	05/14/15

Test Procedure: As required by 47 CFR 15.247(a): System using digital modulation techniques may operate in the 902-928MHz, 2400 – 2483.5MHz, and 5725 – 5850MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to 100kHz and VBW>RBW. Measurements were carried out at the low, mid and high channels of the TX band at the output terminals of the EUT.

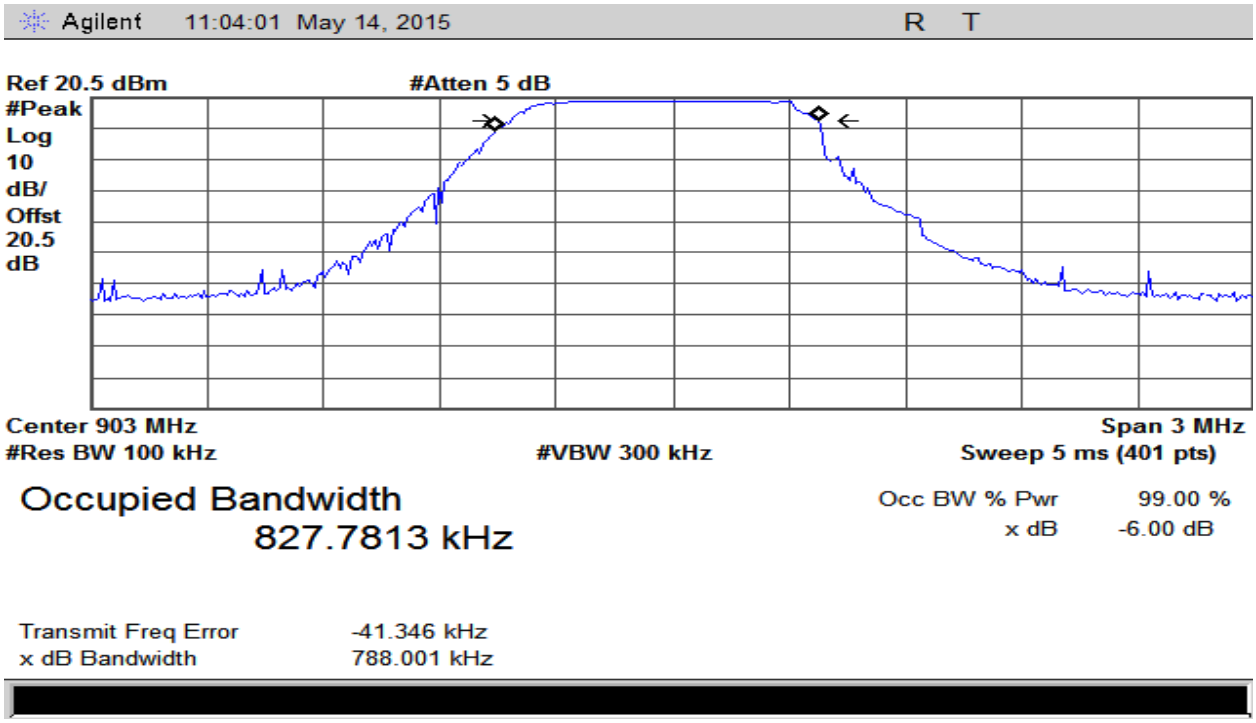
Frequency (MHz)	Recorded Measurement	Specification Limit
903.0	788.00 kHz	≥ 500 KHz
914.3	755.55 kHz	≥ 500 KHz
927.5	777.35 kHz	≥ 500 KHz

Table 3. Occupied Bandwidth Summary, Test Results

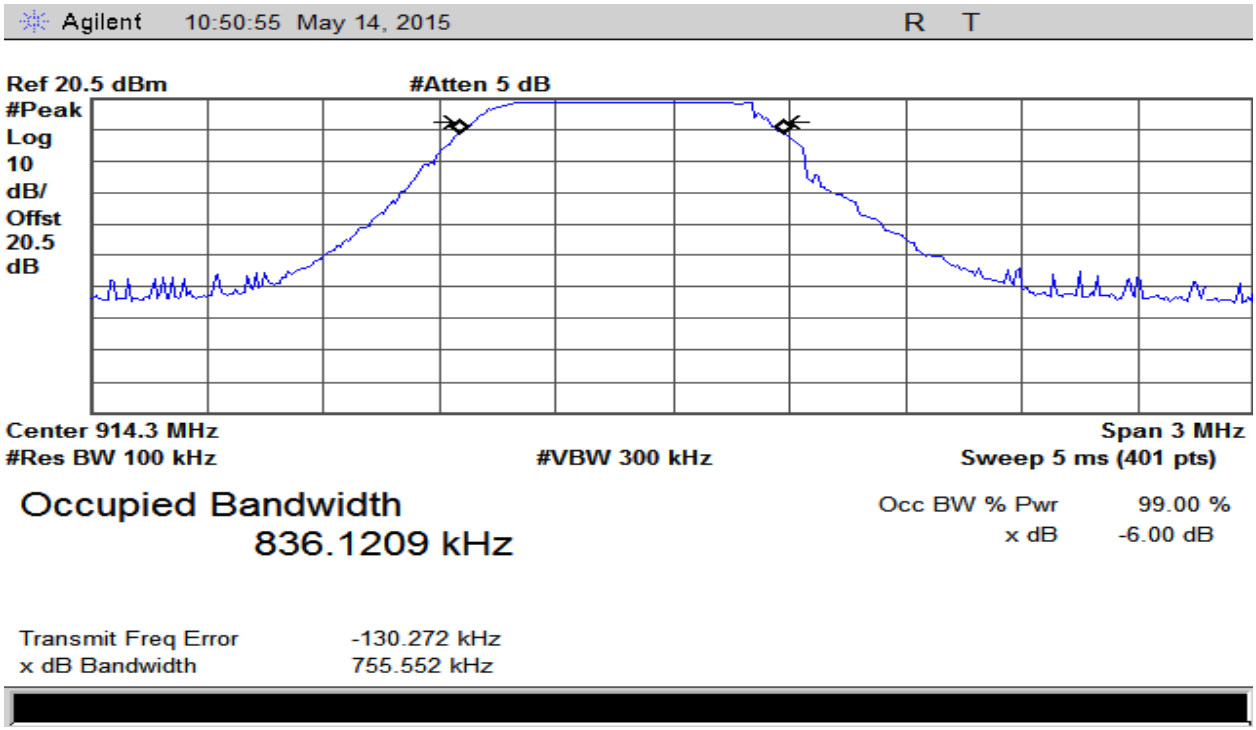
Frequency (MHz)	Recorded Measurement	Comment
902.6	827.78 kHz	DTS Mode
916	836.12 kHz	DTS Mode
927.4	837.61 kHz	DTS Mode
902.2	147.88 kHz	Hybrid Mode
916.0	147.56 kHz	Hybrid Mode
927.8	147.55 kHz	Hybrid Mode

Table 5. 99% Bandwidth, Test Results

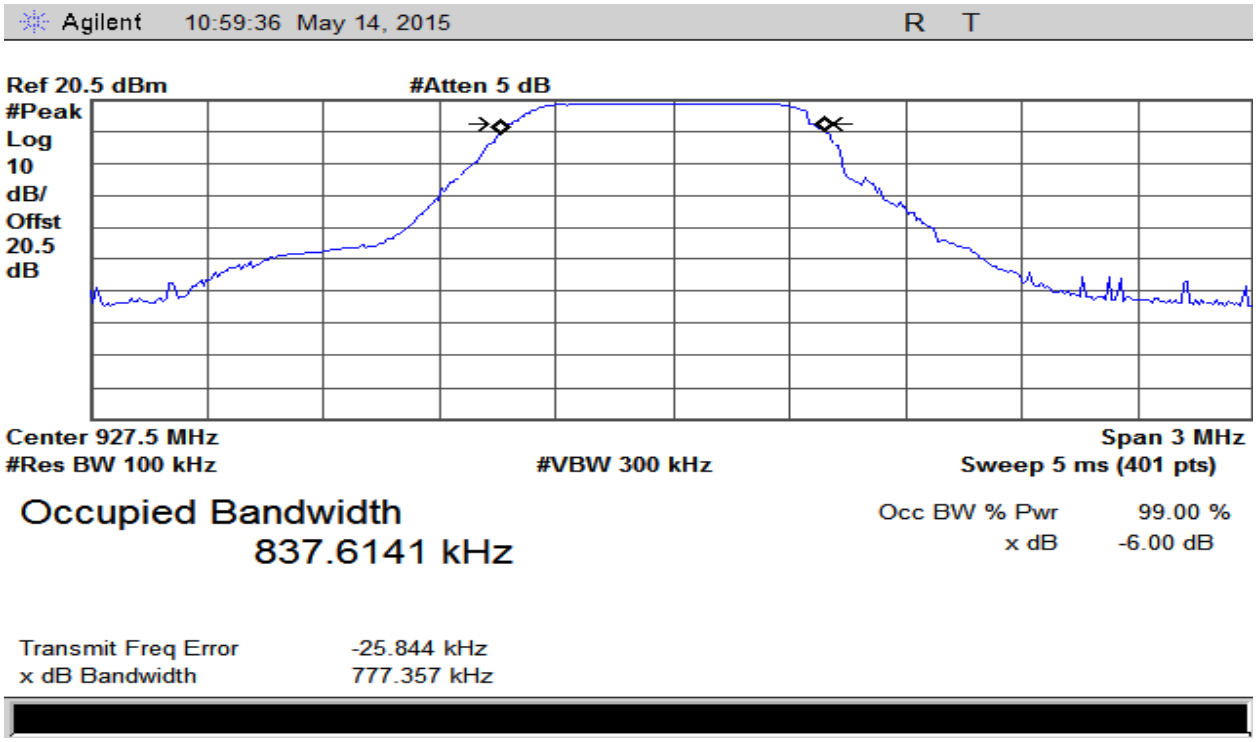
The following pages show measurements of Occupied Bandwidth plots:



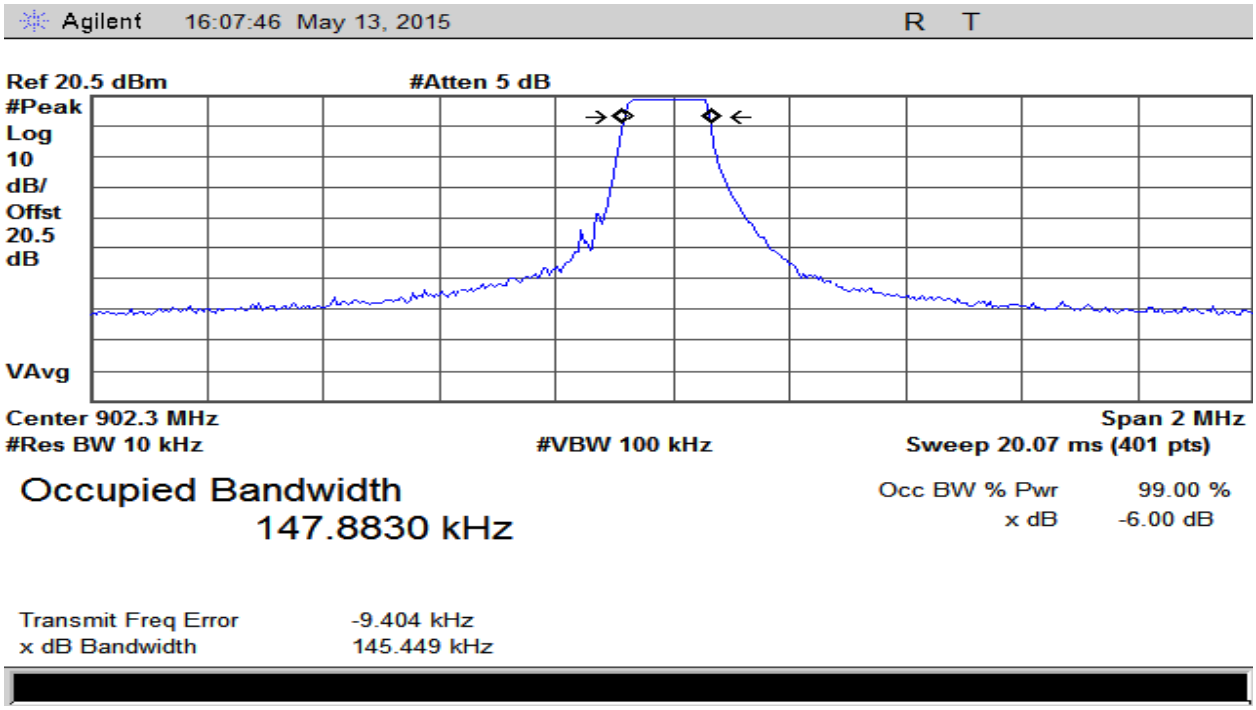
Plot 4 – Lowest Channel – 6dB BW – DTS Mode (SF 10)



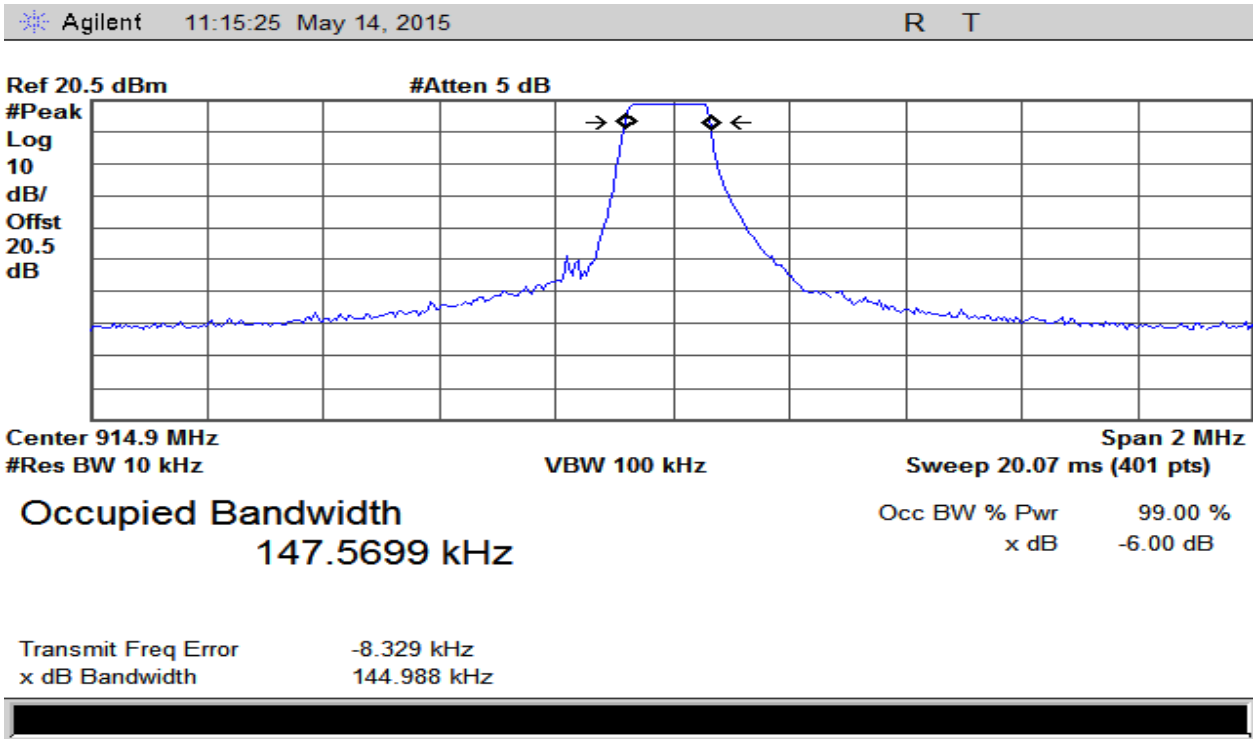
Plot 5 – Middle Channel – 6dB BW – DTS Mode (SF 10)



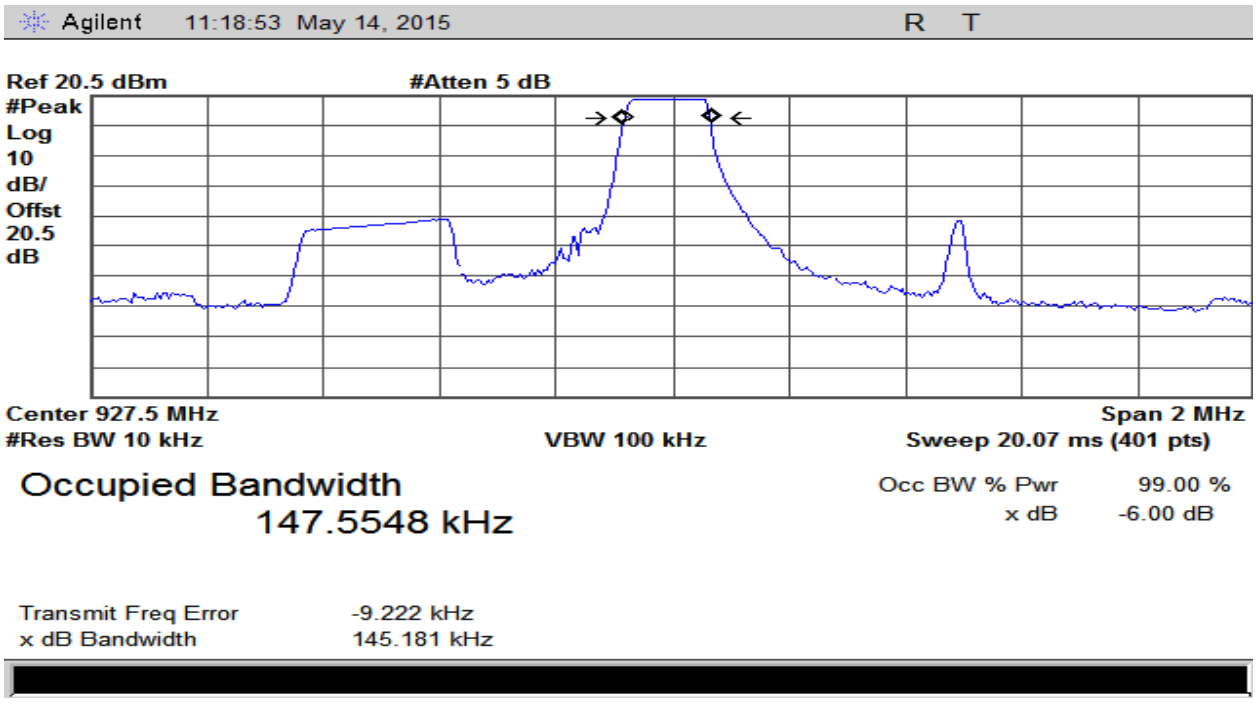
Plot 6 – Highest Channel – 6dB BW – DTS Mode (SF 10)



Plot 10 – Lowest Channel – 6dB BW – Hybrid Mode



Plot 11 – Middle Channel – 6dB BW – Hybrid Mode



Plot 12 – Highest Channel – 6dB BW – Hybrid Mode

2. RF Power Output

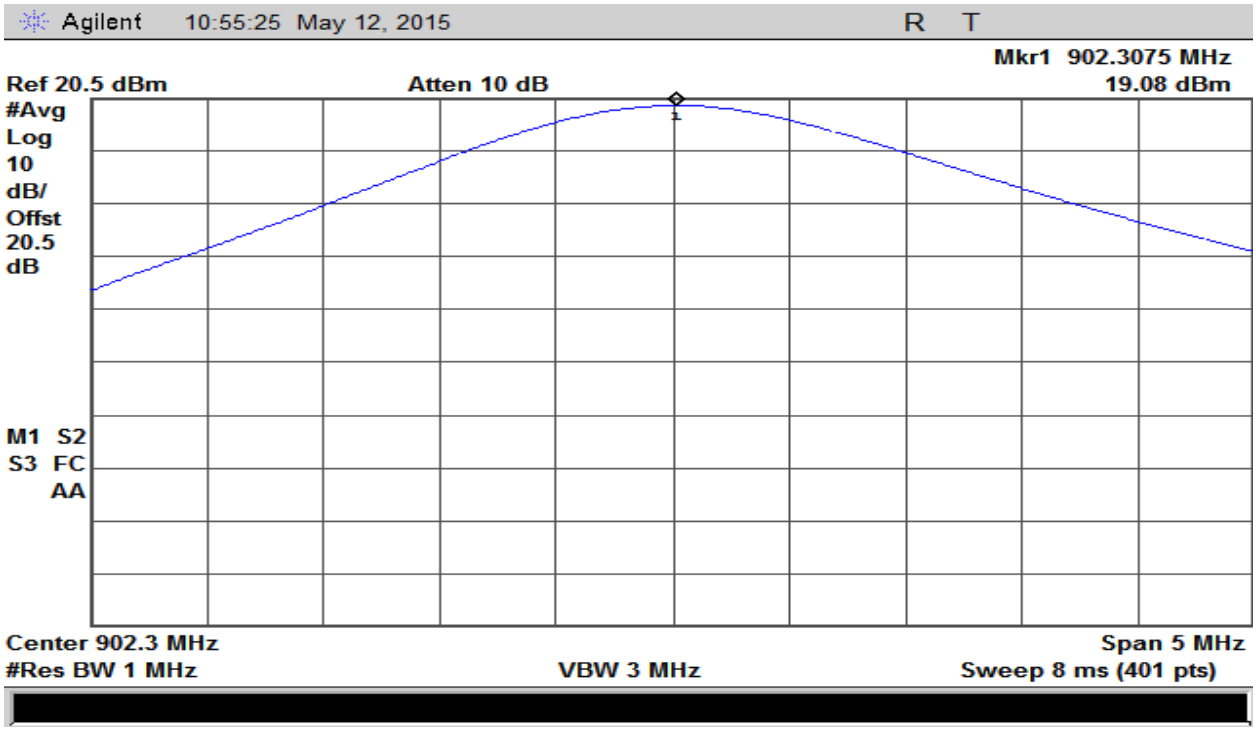
Test Requirement(s):	§15.247(b)(3)	Test Engineer(s):	Keith T.
Test Results:	Pass	Test Date(s):	05/12/15

Test Procedures: As required by 47 CFR 15.247(b)(3), RF Power output measurements were made at the RF output terminals of the EUT. DTS Procedure 9.2.2.2 was used for Average measurements

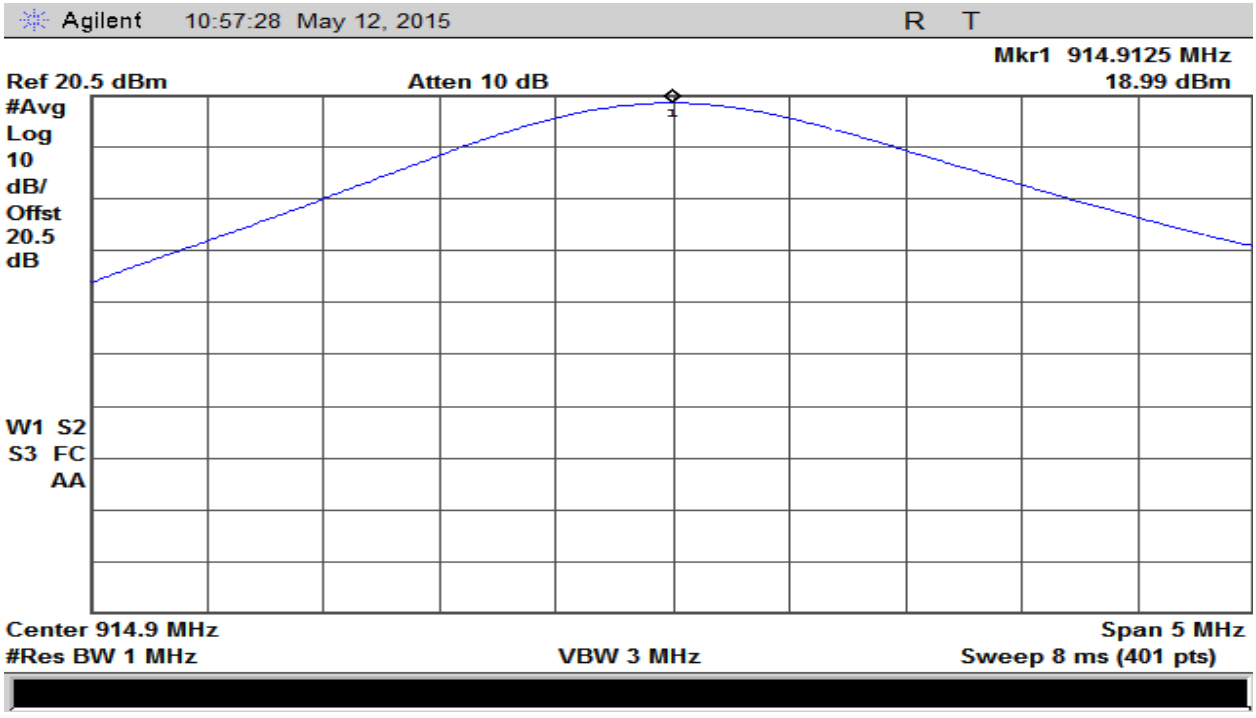
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer capable of making power measurements. Measurements were made at the low, mid, and high channels of the entire frequency band.

Frequency (MHz)	Conducted Power (dBm)	Conducted Power (W)	Specification Limit
902.3	19.08	0.08	1W
914.9	18.99	0.07	1W
927.5	18.84	0.07	1W

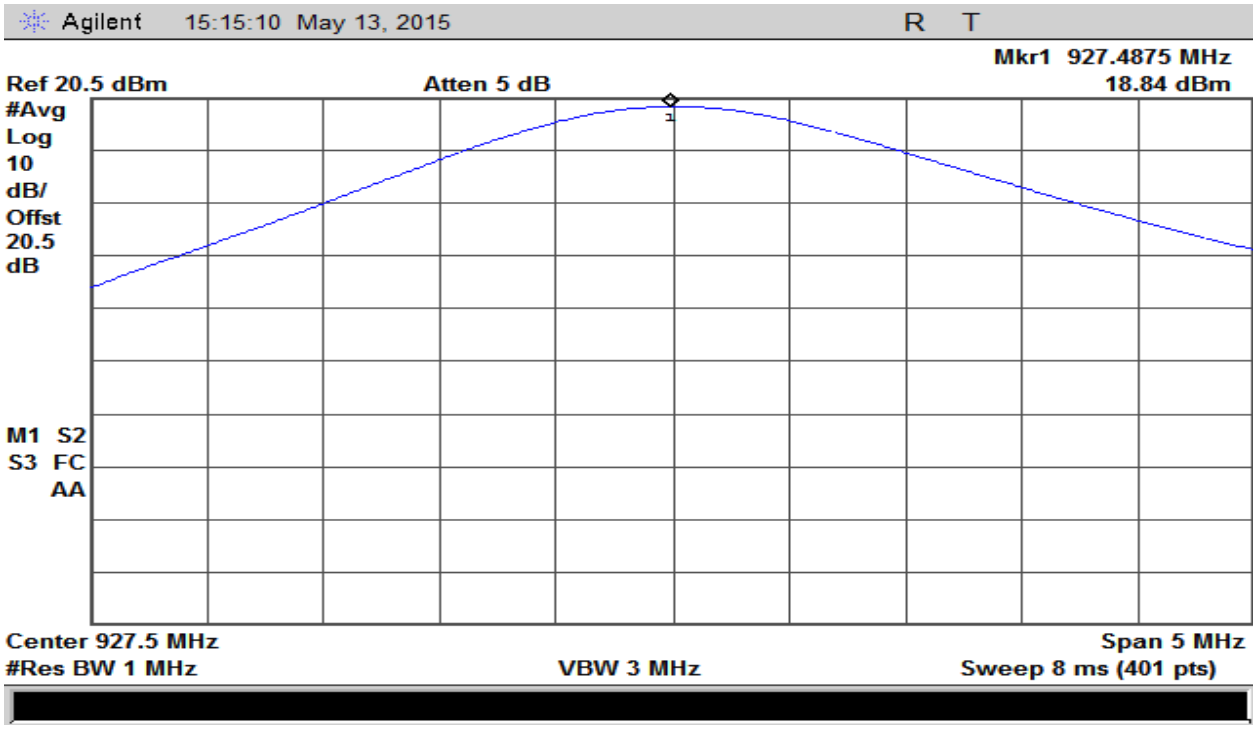
Table 4. RF Power Output, Test Results



Plot 13 – Output Power – Low



Plot 14– Output Power – Mid



Plot 15 – Output Power – High

3. Conducted Spurious Emissions

Test Requirement(s):	§15.247(c)	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	04/20/15

Test Procedures:

As required by 47 CFR 15.247(c): In any 100kHz bandwidth the frequency band in which the spread spectrum or digitally modulation intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either and RF conducted or a radiated measurement. Conducted spurious emissions at antenna terminal measurements were made at the RF output antenna terminal of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer with RBW set to 100KHz and VBW ≥ RBW. The Spectrum Analyzer was set to sweep from 30MHz up to 10th harmonic of the fundamental or 40GHz whichever is the lesser. Measurements were made at the low, mid and high frequency of the transmit band.

Test Data:

Frequency (MHz)	Measured Level (dBm)	Limit (dBm)
1000.00	-46.50	-10.9
7217.00	-60.67	-10.9

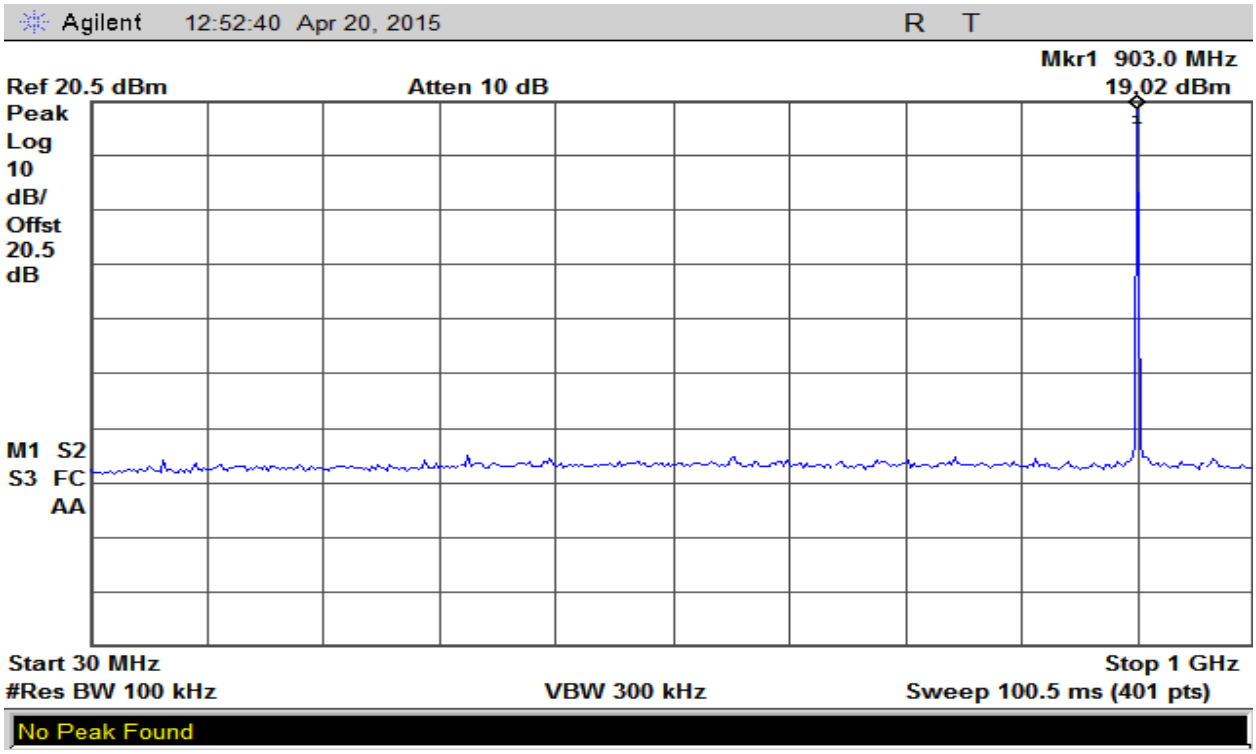
Table 10. Lowest Channel – Conducted Spurious Emissions, Test Results

Frequency (MHz)	Measured Level (dBm)	Limit (dBm)
1014.00	-47.33	-10.9
6483.00	-50.83	-10.9

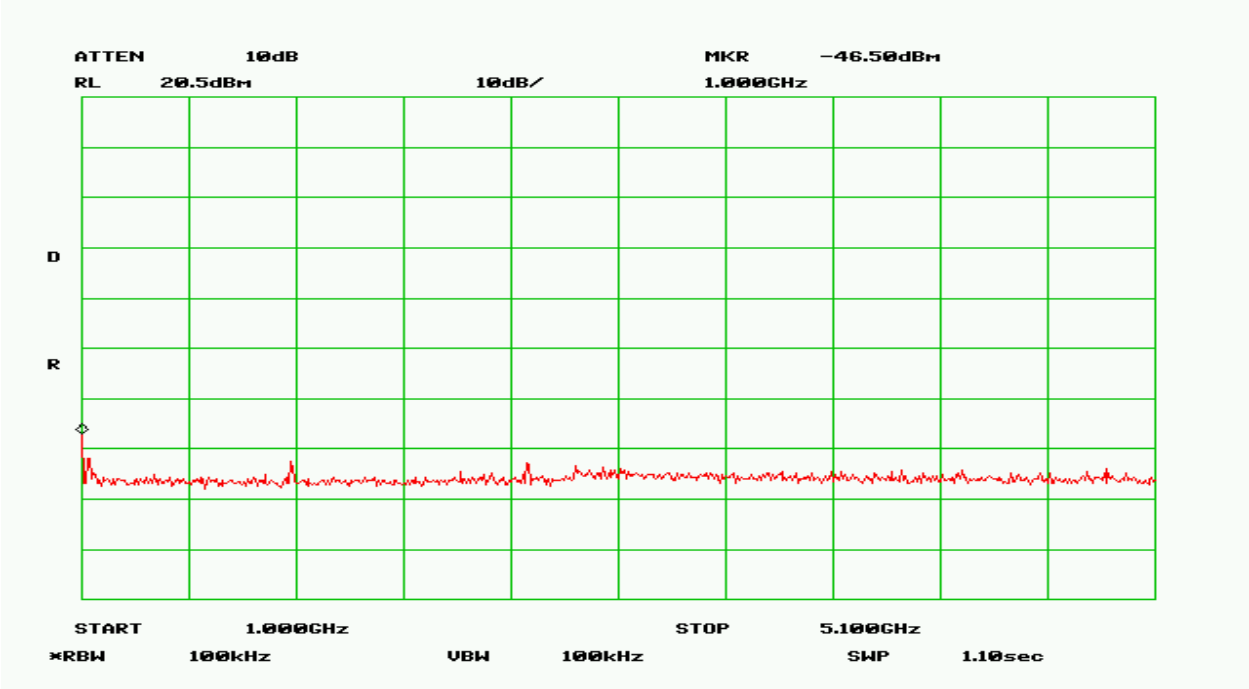
Table 11. Middle Channel – Conducted Spurious Emissions, Test Results

Frequency (MHz)	Measured Level (dBm)	Limit (dBm)
1000.00	-31.83	-10.9
6925.00	-50.67	-10.9

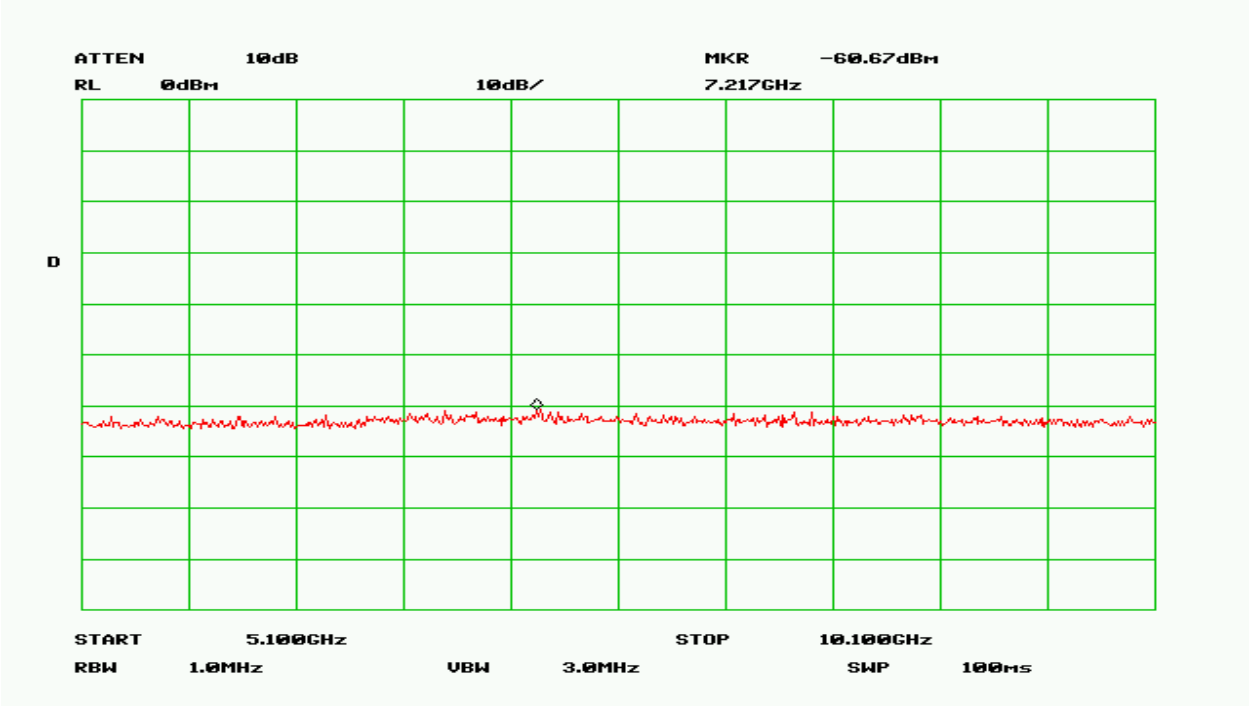
Table 12. Highest Channel – Conducted Spurious Emissions, Test Results



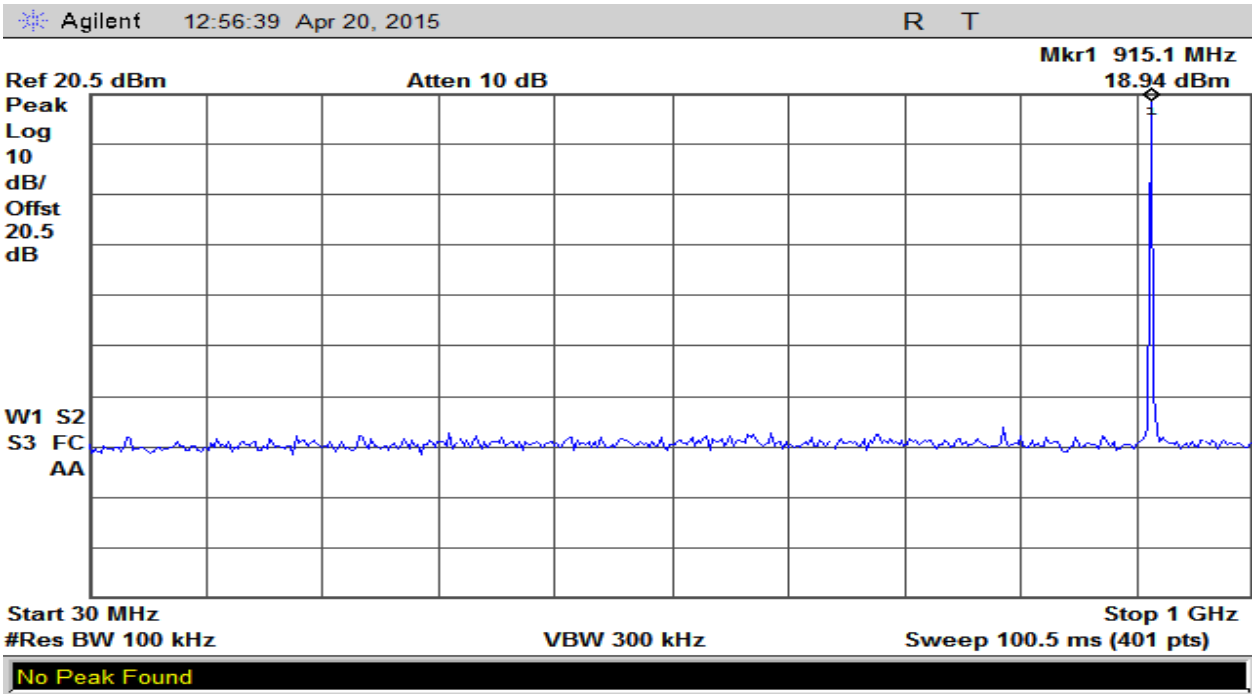
Plot 16 – Low Band – 30MHz to 1GHz



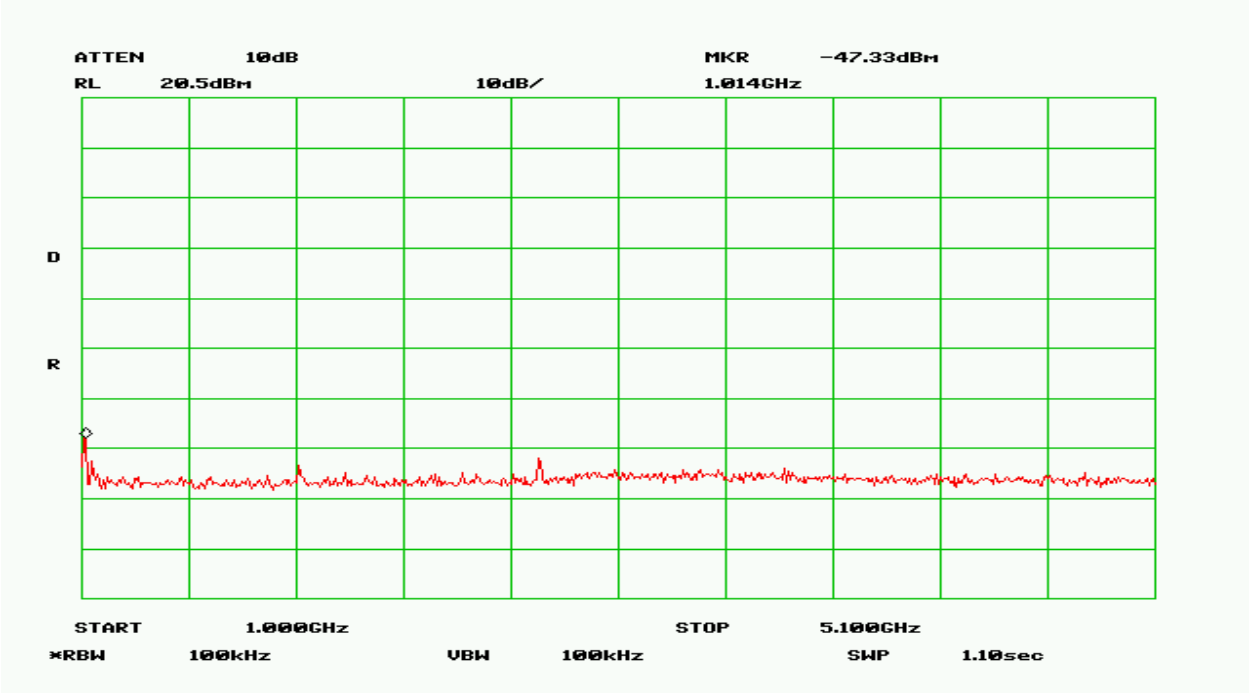
Plot 17 – Low Band – 1GHz to 5GHz



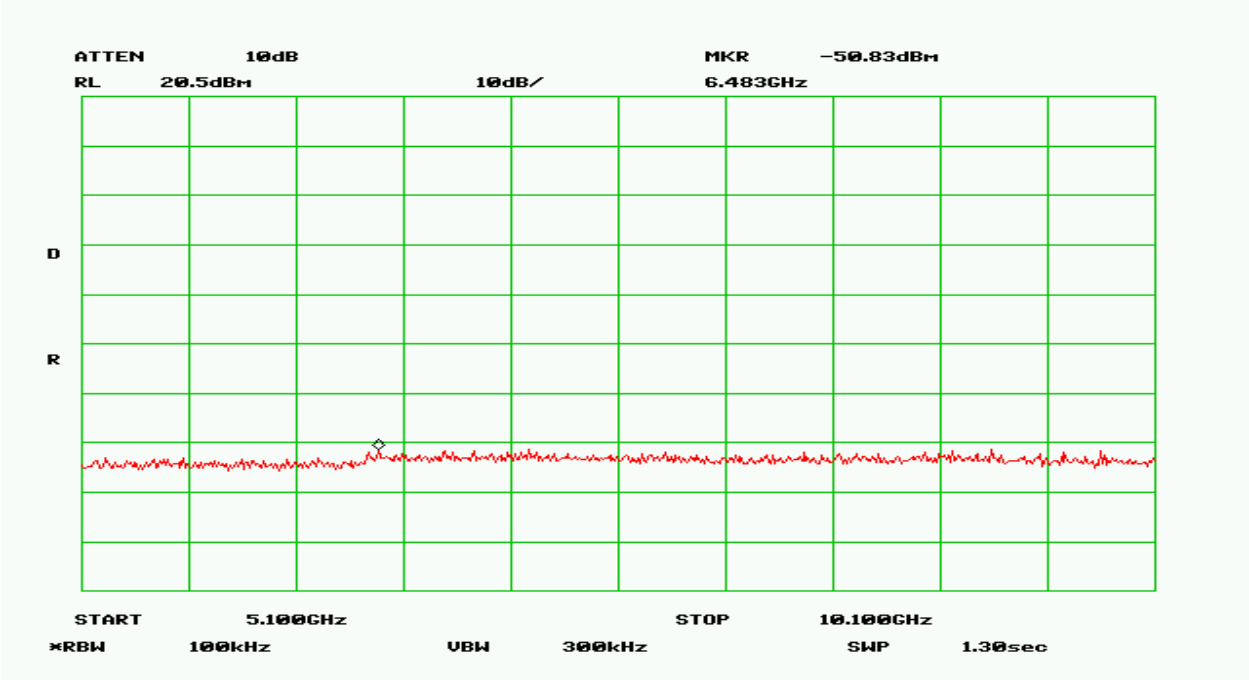
Plot 12 – Low Band – 5GHz to 10GHz



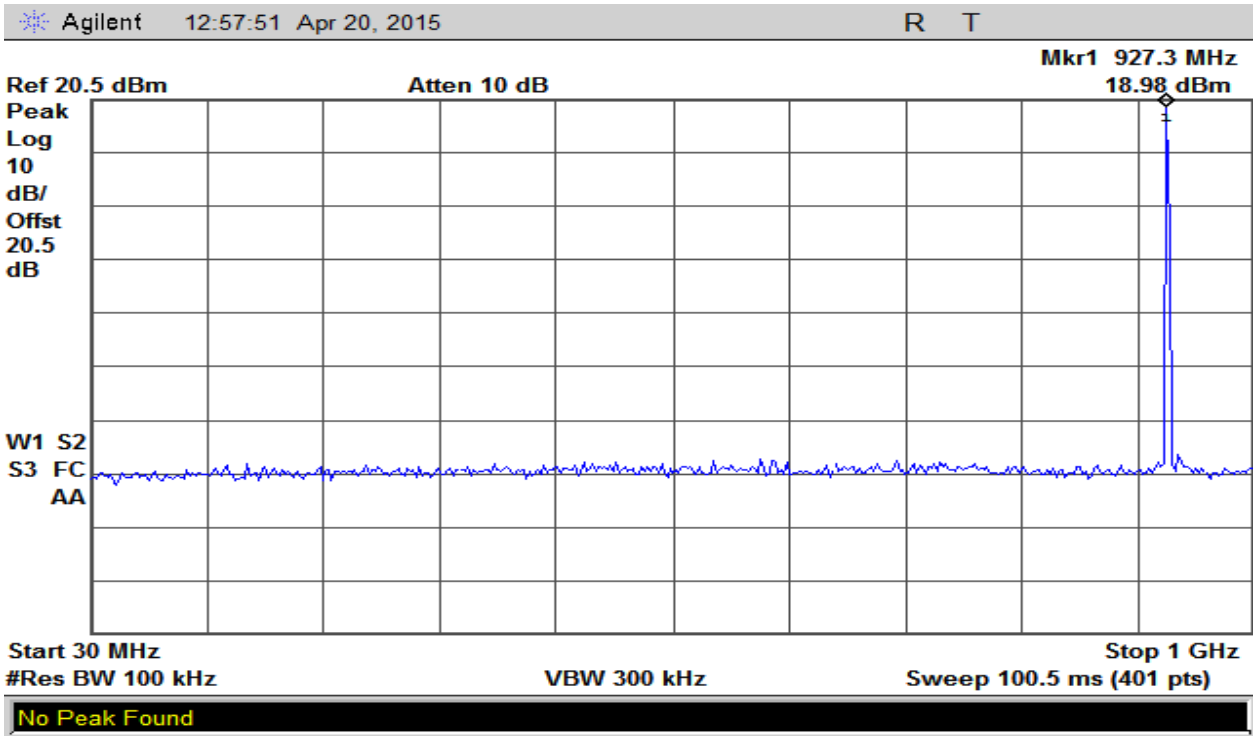
Plot 18 – Mid Band - 30MHz to 1GHz



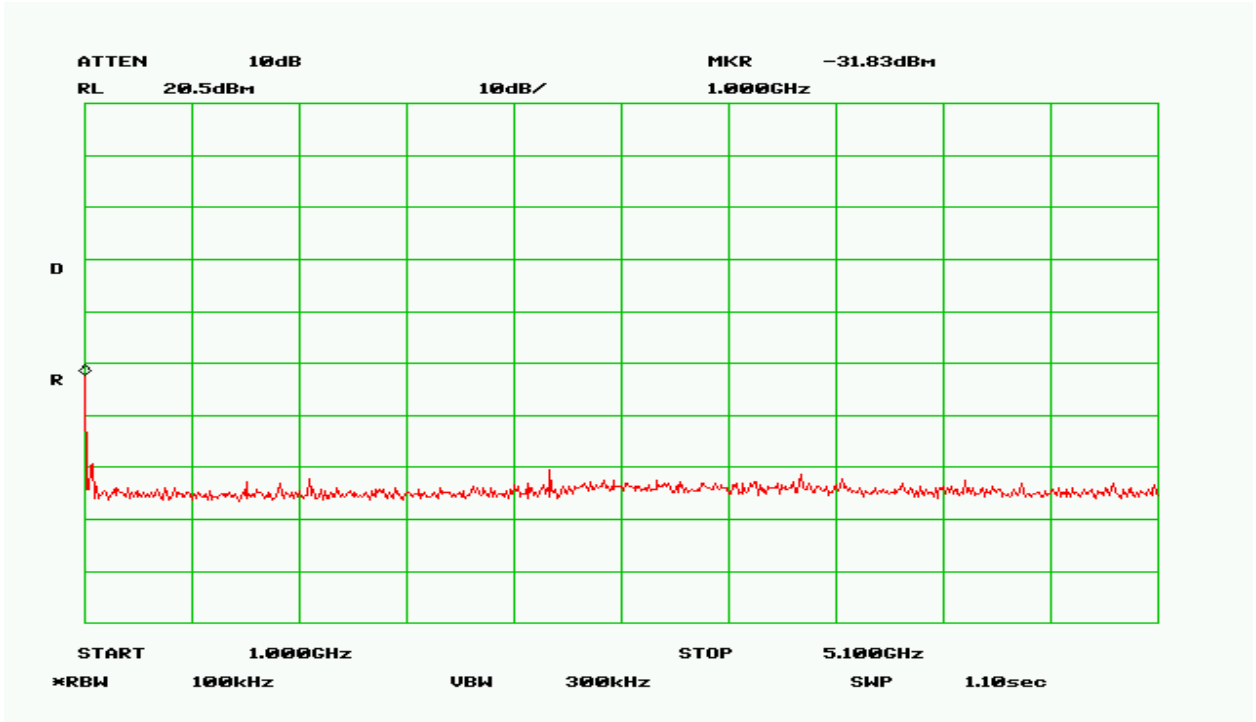
Plot 19 – Mid Band – 1GHz to 5GHz



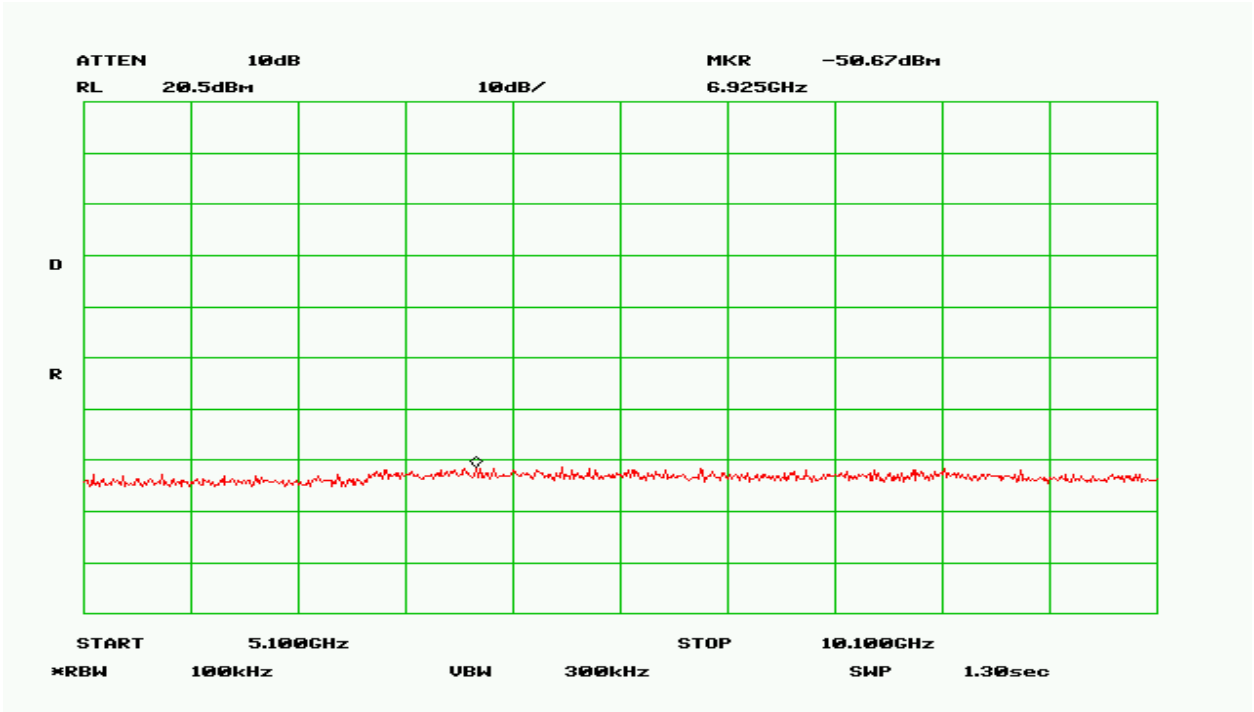
Plot 15 – Mid Band – 5GHz to 10GHz



Plot 20 – High Band – 30MHz to 1GHz



Plot 21 – High Band – 1GHz to 10GHz



Plot 15 – High Band - 5GHz to 10GHz

4. Radiated Spurious Emissions and Restricted Band

Test Requirement(s):	§15.247(d), 15.209(a), 15.205	**Test Engineer(s):**	Jerry Mejak
Test Results:	Pass	**Test Date(s):**	05/01/15

Test Procedures: As required by 47 CFR 15.247, Radiated spurious measurements were made in accordance with the procedures of the ANSI C63.10-2009.

The EUT was placed on a non-reflective table inside a 3 meter semi-anechoic room. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10th harmonic was investigated.

Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
Peak	1MHz	1MHz	As necessary
Average	1MHz	10Hz	0 Hz

Table 6. Analyzer Settings

Frequency (MHz)	Peak Amplitude (dbuV/m)	Peak Limit (dBuV/m)	Average Amplitude (dBuV/m))	Average Limit (dBuV/m)
1804.6	38.5	115.5	-	95.5
2706.9	40.33	115.5	-	95.5

Table 7 - Spurious Radiated Emission Data – Low Band –Chip Antenna

Frequency (MHz)	Peak Amplitude (dbuV/m)	Peak Limit (dBuV/m)	Average Amplitude (dBuV/m)	Average Limit (dBuV/m)
1832	36.6	115.5	-	95.5
2744.7	N.F.	115.5	-	95.5

Table 8– Spurious Radiated Emission Data – Mid Band - Chip Antenna

Frequency (MHz)	Peak Amplitude (dbuV/m)	Peak Limit (dBuV/m)	Average Amplitude (dBuV/m)	Average Limit (dBuV/m)
1855	34.17	115.5	-	95.5
2782.5	N.F.	115.5	-	95.5

Table 9– Spurious Radiated Emission Data – High Band - Chip Antenna

NOTE 1: There were no detectable emissions above the 6th harmonic.

Emission marked as "N.F" is system noise floor and no detectable emission were found from the EUT.

6. Emissions At Band Edges

Test Requirement(s):	§15.247(d)	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	04/20/15

Test Procedures: As required by 47 CFR 15.247, Band edge radiated emissions measurements were made at the RF antenna output terminals of the EUT using the marker-delta method.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

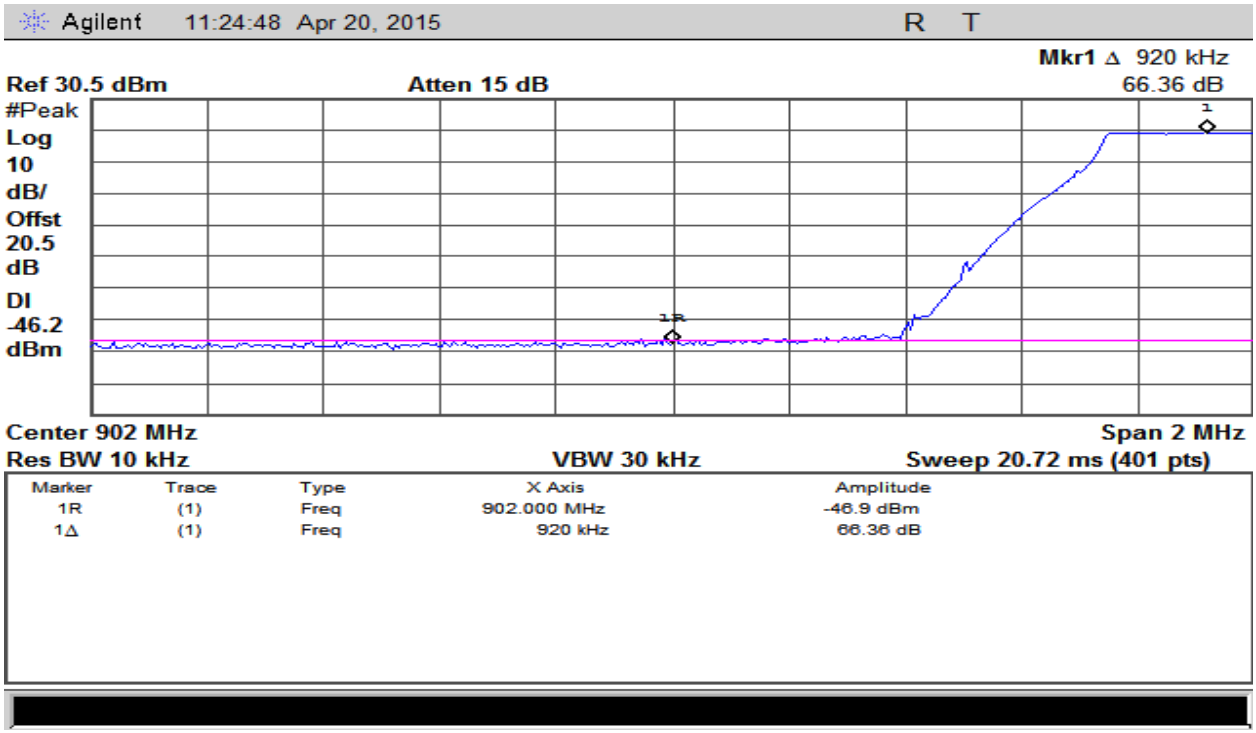
The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The EUT was set up at maximum power, first on the lowest operating channel, then on the highest operating channel of the transmit band.

Frequency (MHz)	Measured Level	Detector	Limit
902	-66.36dB	Peak	-20dBc
928	-33.29dB	Peak	-20dBc

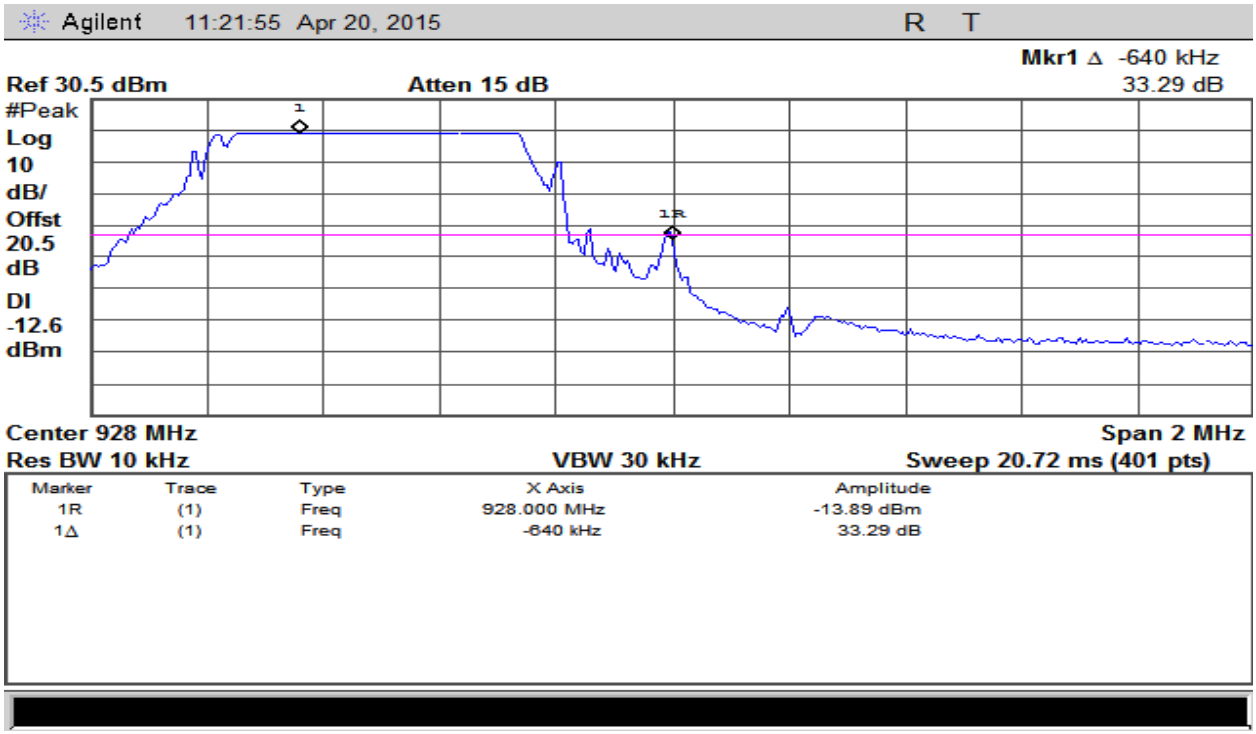
Table – Band Edge Emissions Summary – DTS Mode

Frequency (MHz)	Measured Level	Detector	Limit
902	-59.7dB	Peak	-20dBc
928	-42.8dB	Peak	-20dBc

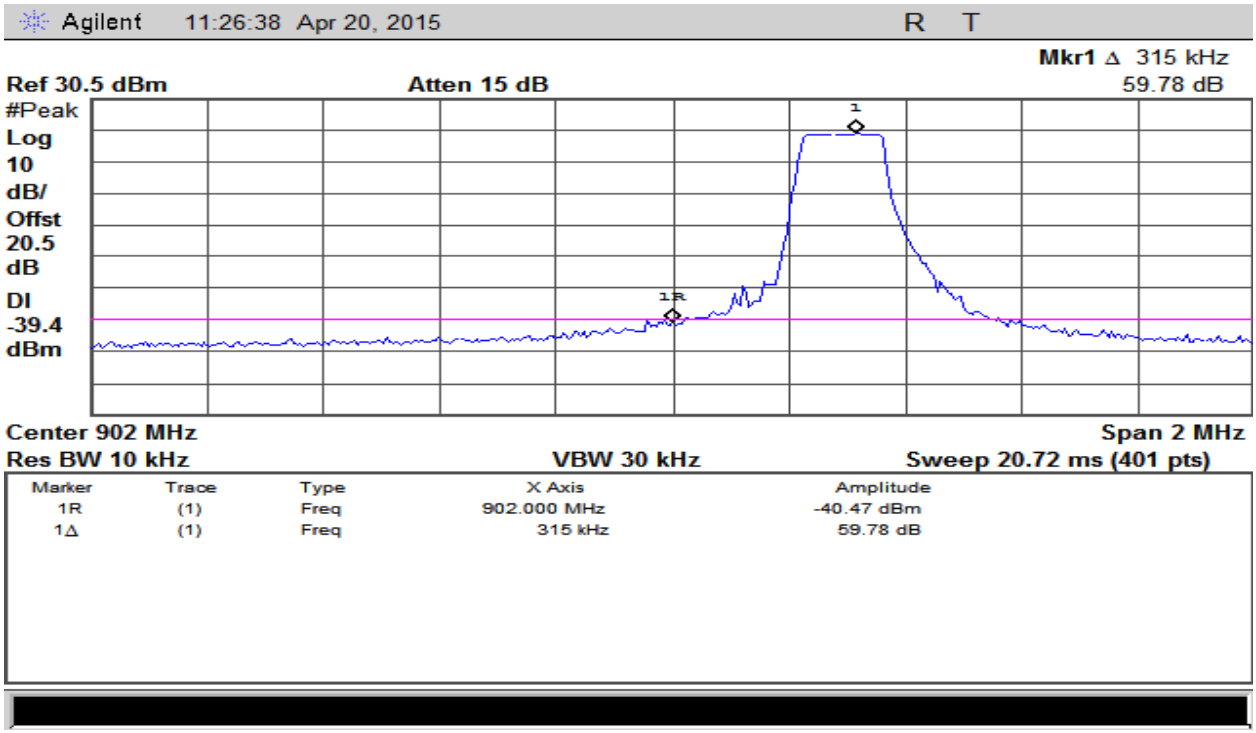
Table – Band Edge Emissions Summary – Hybrid Mode



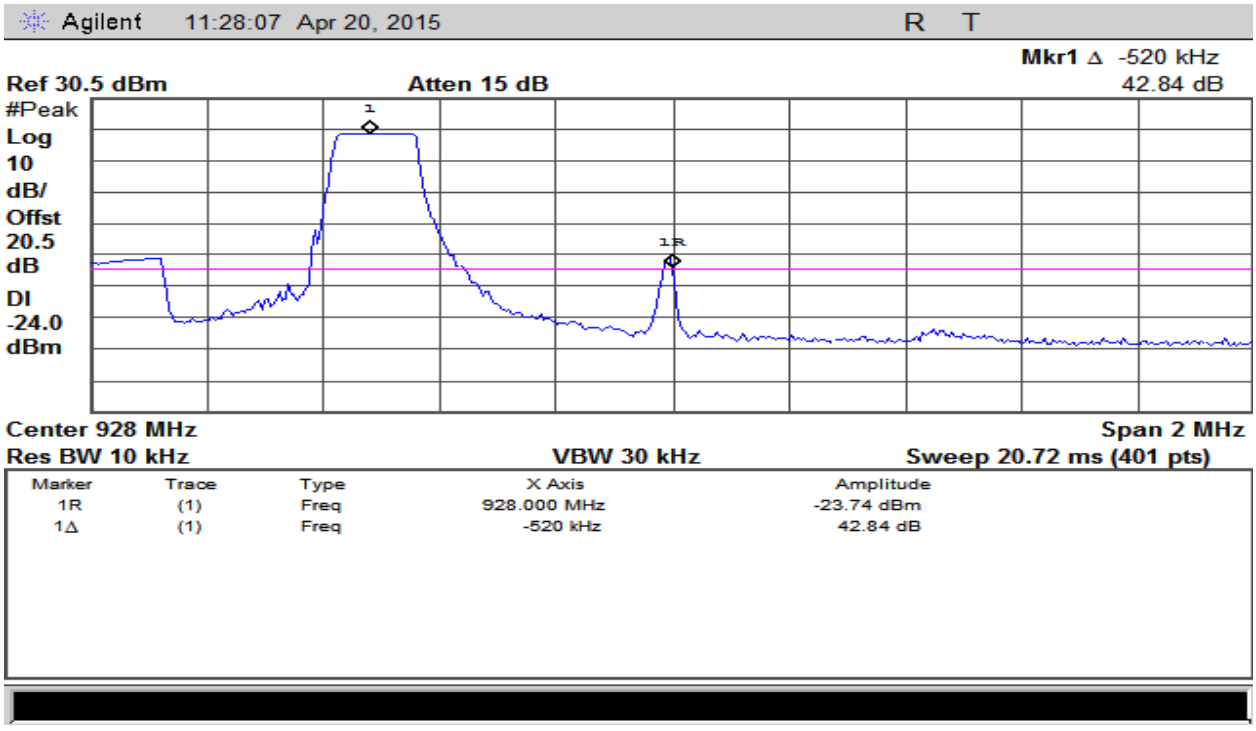
Plot 22 - Band Edge – Low Channel – DTS Mode



Plot 23 – Band Edge - High Channel – DTS Mode



Plot 24 - Band Edge – Low Channel – Hybrid Mode



Plot 25 – Band Edge - High Channel – Hybrid Mode

7. Power Spectral Density

Test Requirement(s):	§15.247(d)	Test Engineer(s):	Keith T.
Test Results:	Pass	Test Date(s):	05/13/15

Test Procedures: As required by 47 CFR 15.247(d), For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3kHz band during any time interval of continuous transmission. Power spectral density measurements were made at the RF antenna output terminals of the EUT using the DTS methods section 10.2 was used for DTS mode and section 10.3 was used for Hybrid mode.

The EUT output was connected directly to the spectrum analyzer through an attenuator. The measurements were made at the RF antenna output terminals of the EUT.

Detector Setting	Resolution Bandwidth	Sweep Time	Span
Peak	3KHz	500 seconds	2 MHz

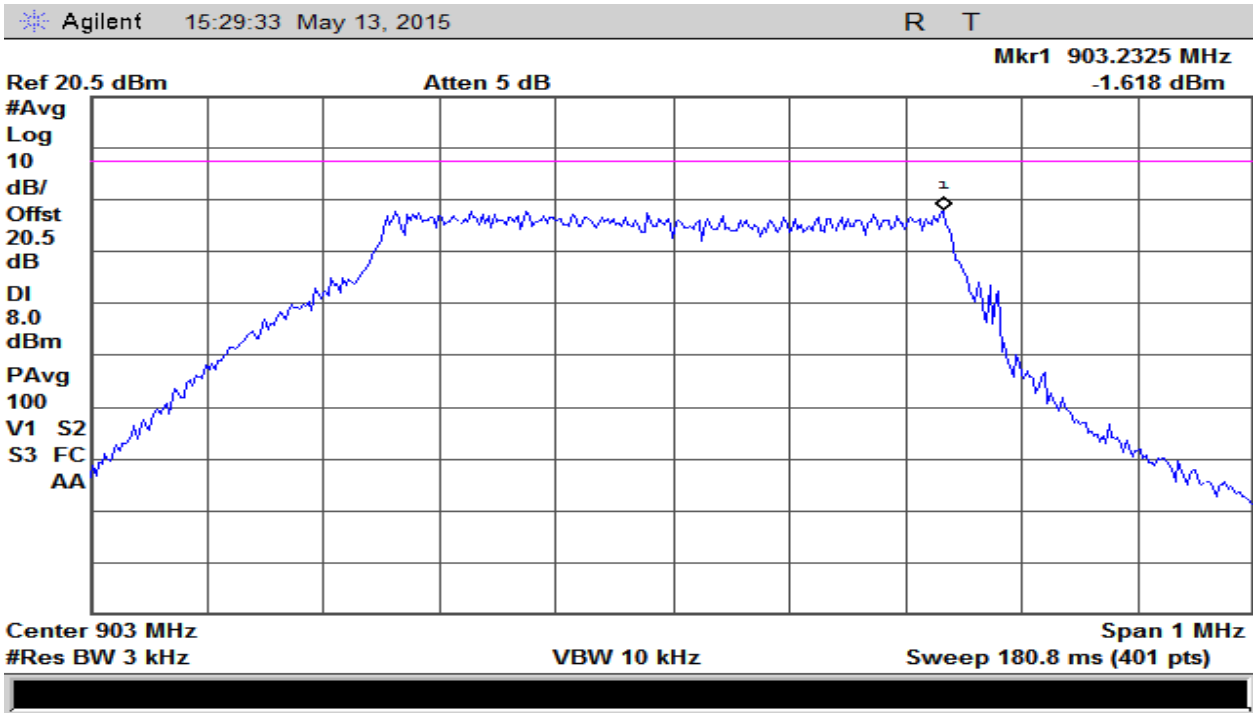
Table 5 – Analyzer settings

Frequency (MHz)	Measured Level	Limit
903	-1.61 dBm	8 dBm
914.2	-1.97 dBm	8 dBm
927.4	-1.72 dBm	8 dBm

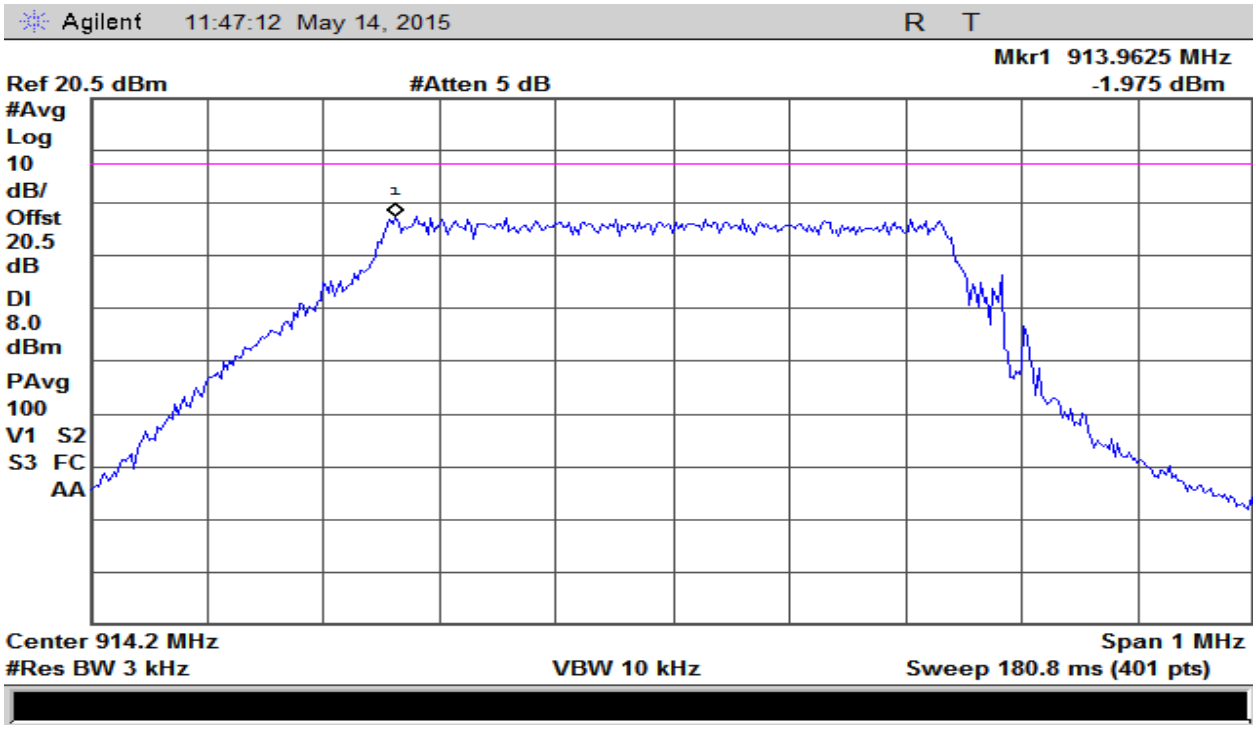
Table 6 - PSD Summary Test Result-DTS Mode

Frequency (MHz)	Measured Level	Limit
902.3	6.56 dBm	8 dBm
914.9	5.57 dBm	8 dBm
927.5	5.42 dBm	8 dBm

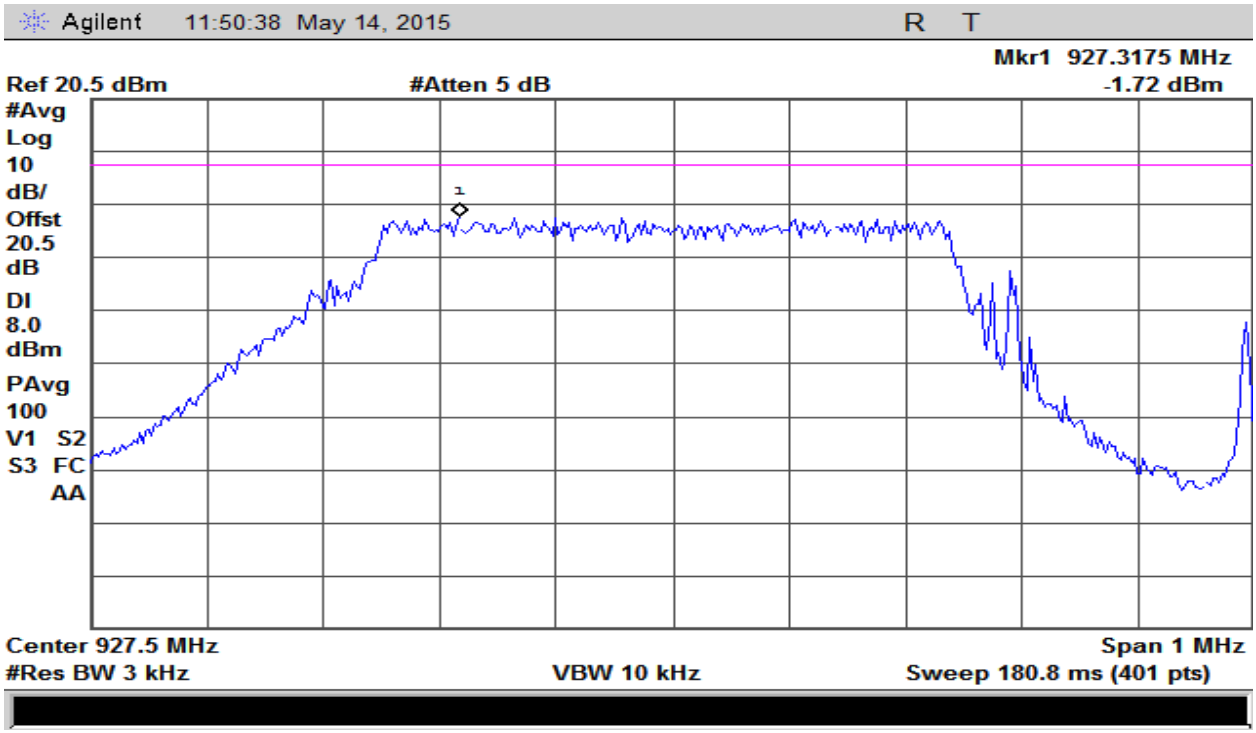
Table 6 - PSD Summary Test Result- Hybrid Mode



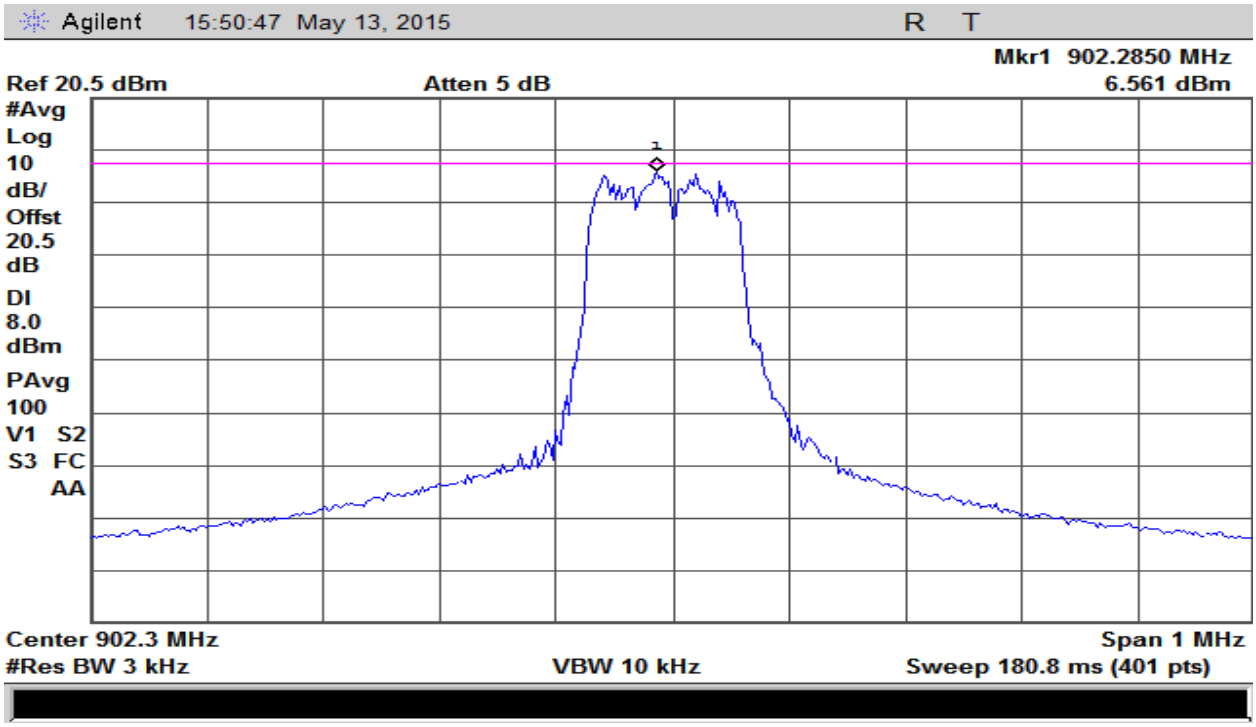
Plot 26 – Power Spectral Density – Lowest Channel - DTS Mode



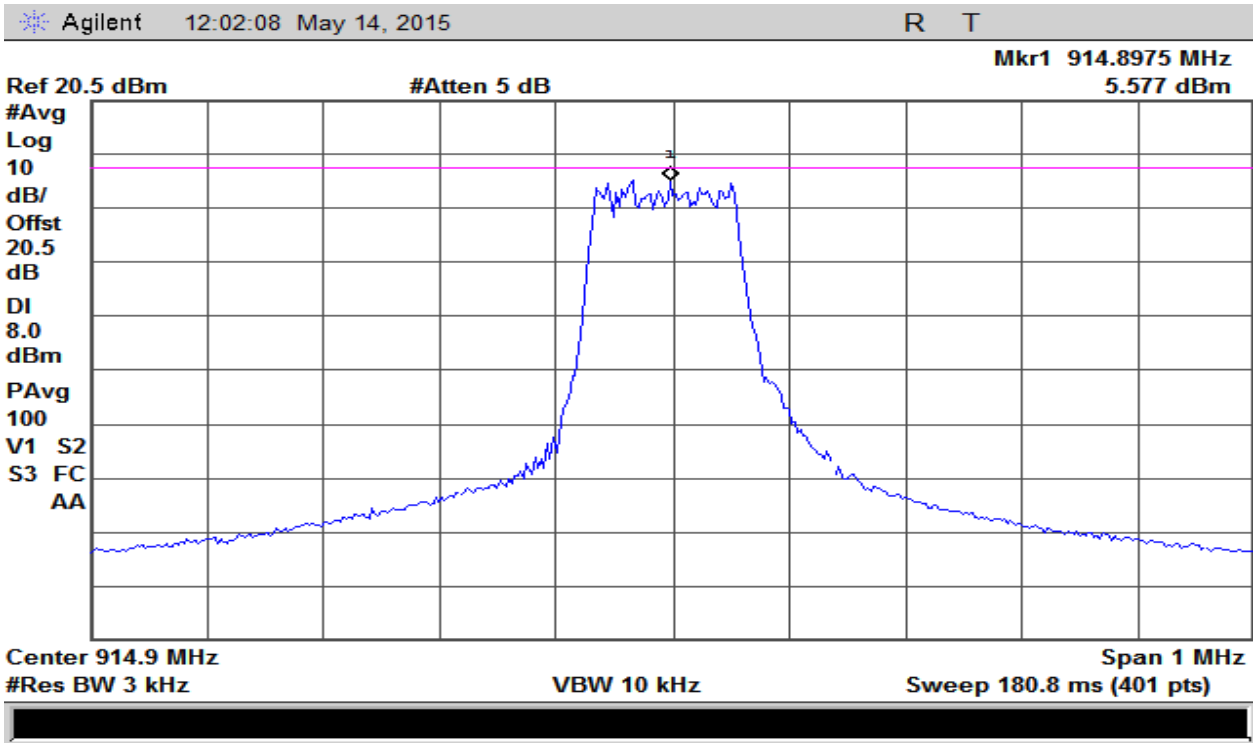
Plot 27 – Power Spectral Density – Middle Channel - DTS Mode



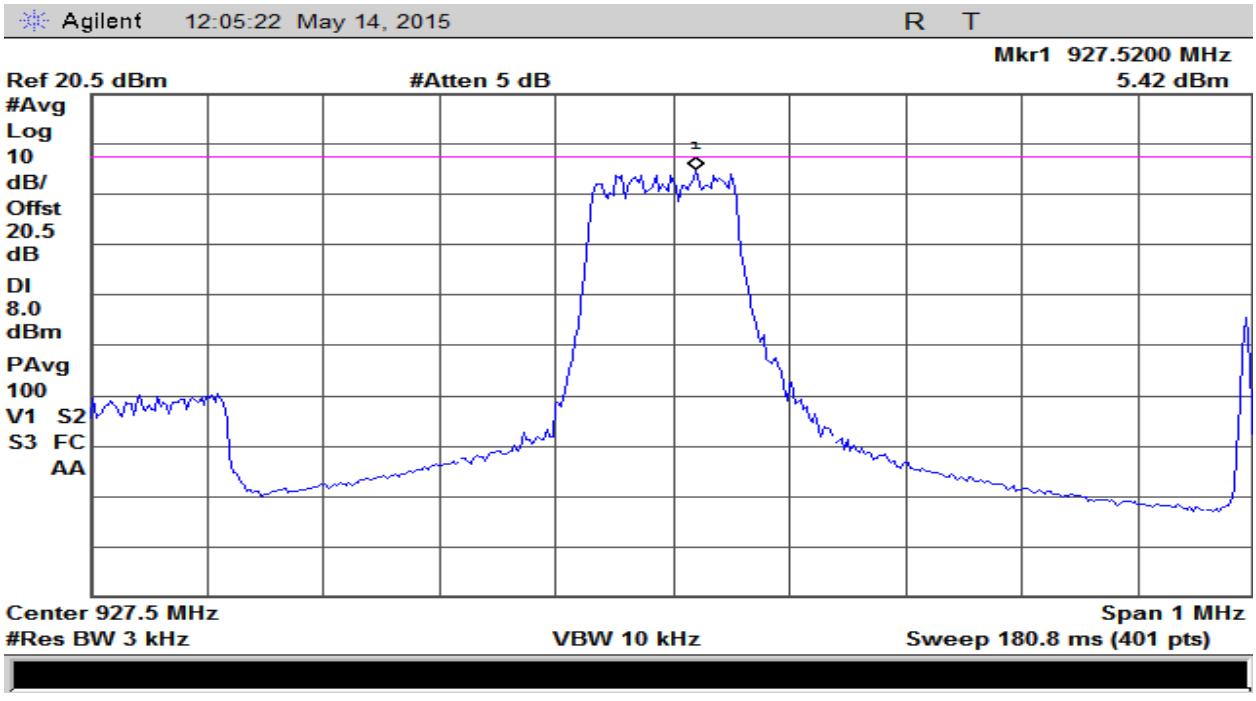
Plot 28 – Power Spectral Density – Highest Channel – DTS Mode



Plot 29 – Power Spectral Density – Lowest Channel – Hybrid Mode (SF10)



Plot 30 – Power Spectral Density – Middle Channel – Hybrid Mode (SF 10)



Plot 31 – Power Spectral Density – Highest Channel – Hybrid Mode (SF 10)

8. Time of Occupancy (Dwell Time)

Test Requirement(s):	§15.247(f)	**Test Engineer(s):**	Hoosam B.
Test Results:	Pass	**Test Date(s):**	02/19/15

Test Procedures: As required by 47 CFR 15.247(f), for hybrid systems, the average time of occupancy on any frequency shall not exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. Measurements were made with device hopping function enabled and direct sequence or digital modulation operation turned off.

The EUT output was connected directly to the spectrum analyzer through an attenuator. The measurements were made at the RF antenna output terminals of the EUT.

Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
Peak	1MHz	1MHz	0

Table 21 – Analyzer settings

Calculation: Device has two hopping set mode. 1 Hoping set is with 25 hops with 1MHz channel separation other one is 64 hops at 200KHz separation.

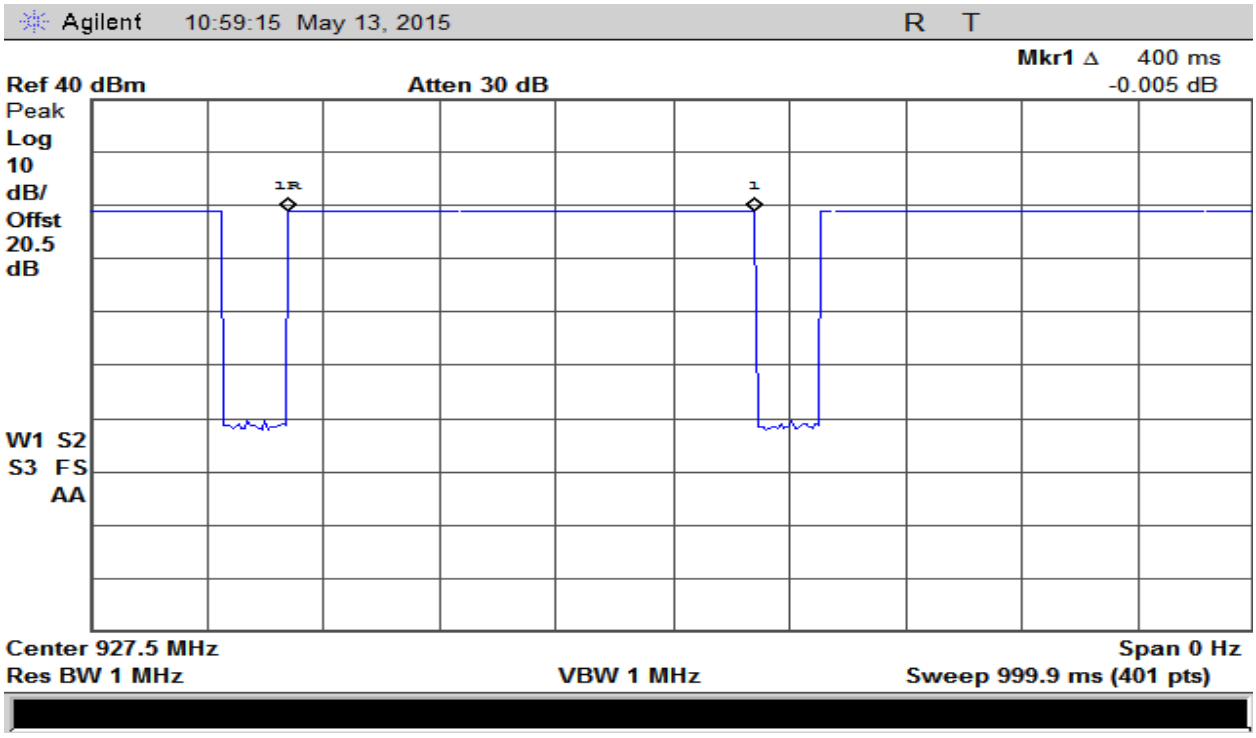
Mode 1: At channel 927.5MHz, Burst period is 400msec. There are total of 25 channels.

Time Period = 0.4 * 25 channels = 10 seconds.

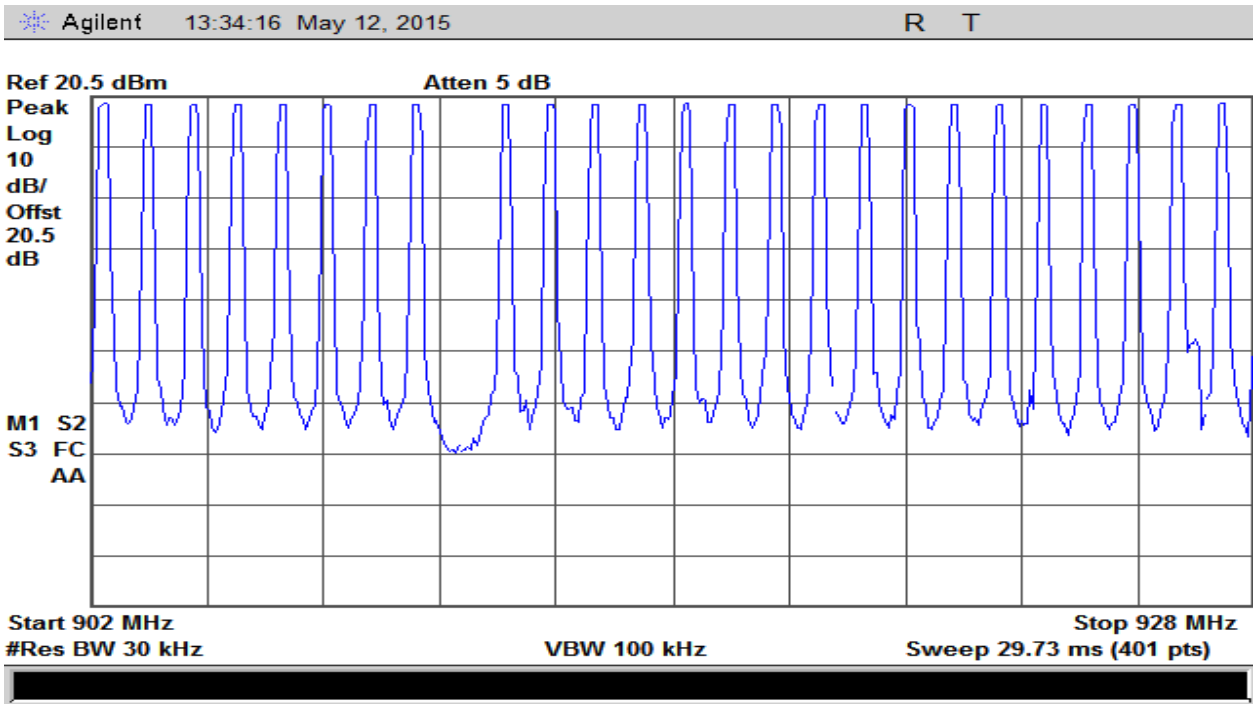
Mode 2: At channel 927.5MHz, Burst period is 400msec. There are total of 25 channels.

Time Period = 0.4 * 64 channels = 25.6 seconds.

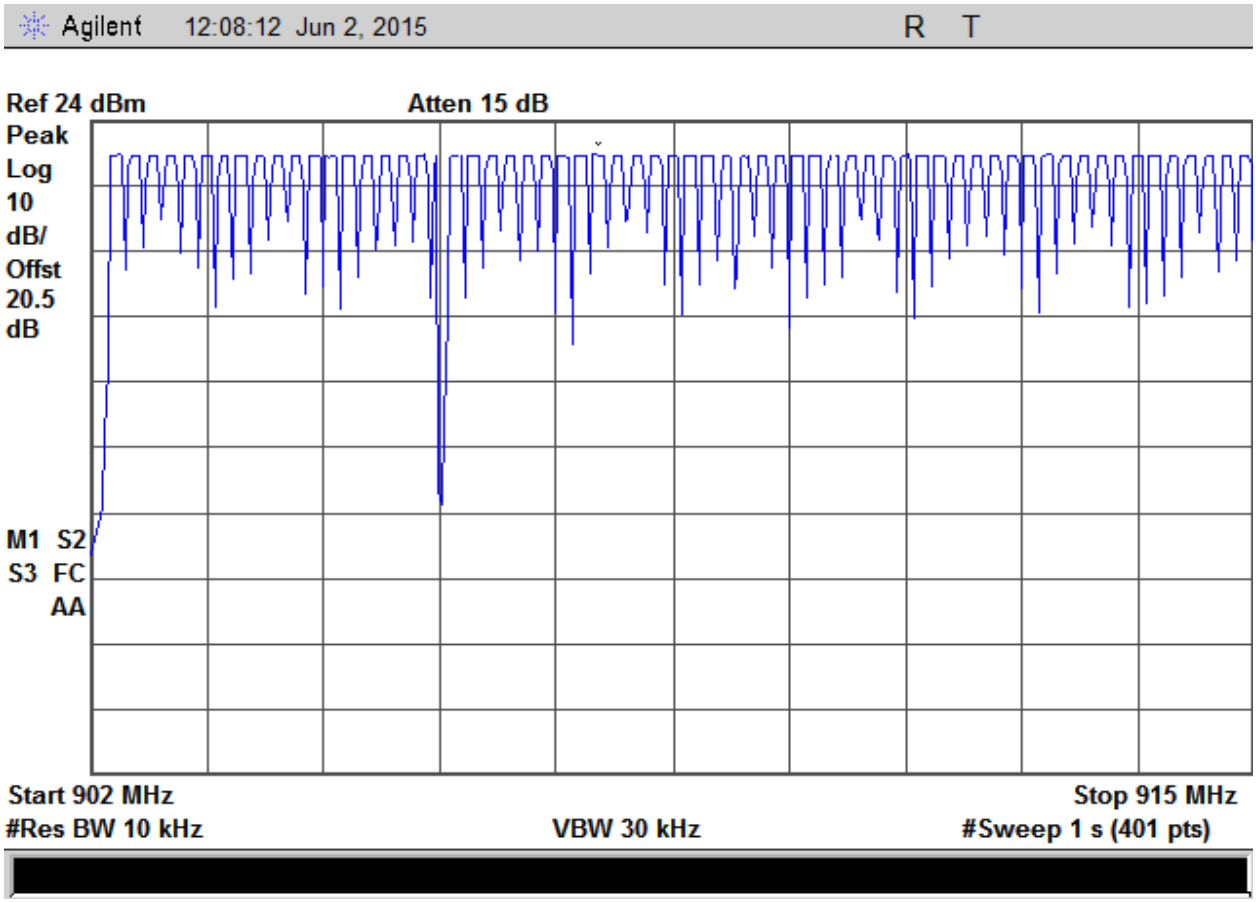
Device operates within the time period requirements



Plot 32 – Dwell Time – Hybrid Mode (SF 8)



Plot 33 – Time Period – Hybrid Mode (25 Hops)



Plot 34 – Time Period – Hybrid Mode (64 Hops)

9. Carrier Frequency Separation

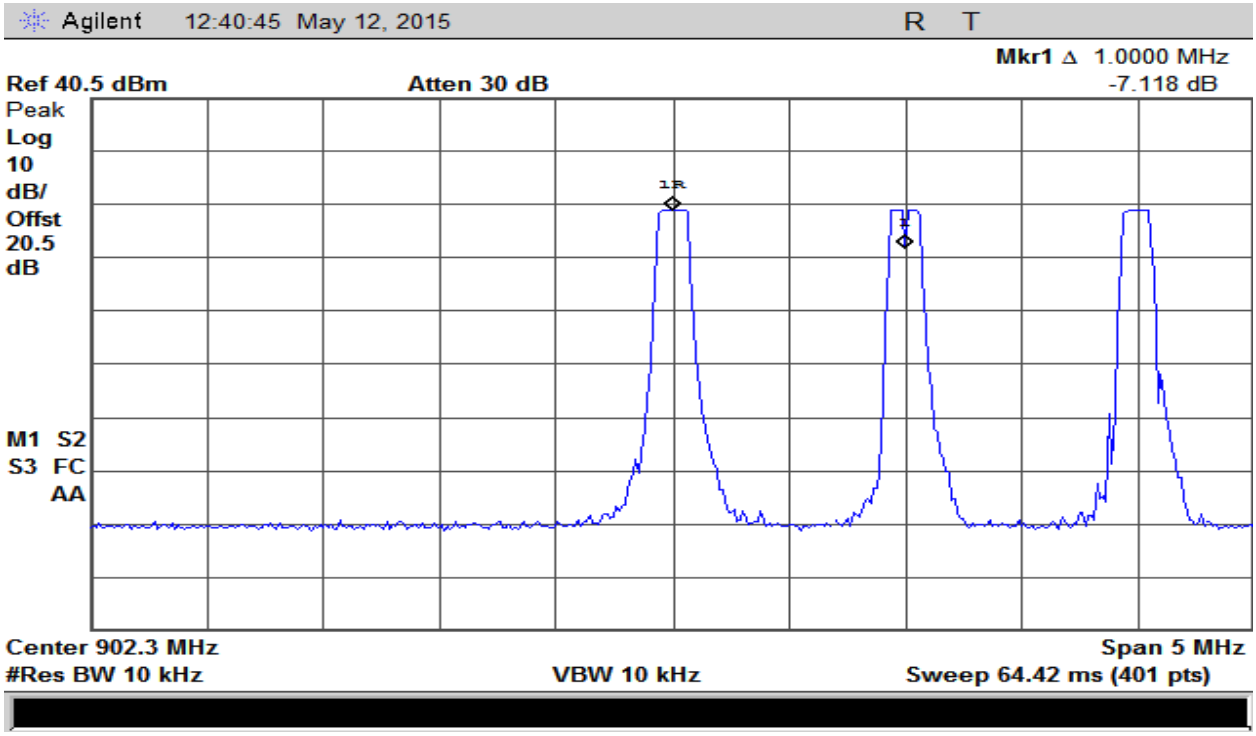
Test Requirement(s):	§15.247(a)(1)	**Test Engineer(s):**	Keith T.
Test Results:	Pass	**Test Date(s):**	05/12/15

Test Procedures: As required by 47 CFR 15.247(a), for frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Measurements were made with device hopping function enabled.

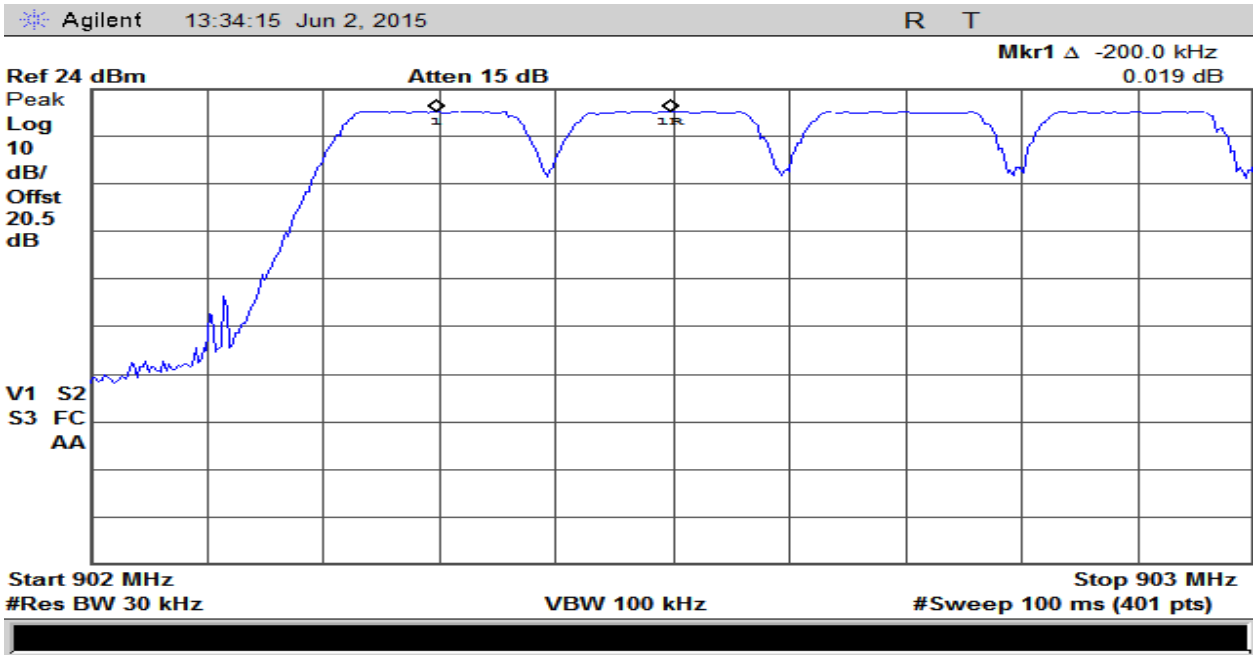
The EUT output was connected directly to the spectrum analyzer through an attenuator. The measurements were made at the RF antenna output terminals of the EUT. Peak detector was used and trace was set to max hold.

Frequency Measured (MHz)	Frequency Separation (kHz)	Detector	Limit (20dB BW)
902.3	1000 kHz	Peak	168.5 kHz
902.0	200 kHz	Peak	168.5 kHz

Table 22 – Carrier Frequency Separation - Summary



Plot 35 – Carrier Frequency Separation (Using Delta Marker Method) – For 25 channels.



Plot 36 – Carrier Frequency Separation (Using Delta Marker Method) – For 64 channels.

I. Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Spectrum Analyzer	Agilent	E4402B	US41192757	Jan/270/15	Jan/27/16
Temperature Meter	Control Company	6066N53	140536623	Aug/08/14	Aug/08/16
Spectrum Analyzer	Hewlett Packard	8563E	3821A09316	Sep/19/14	Sep/19/15
High Pass Filter	Mini-Circuits	VHF-3100+	1023	Verified	
EMI Receiver	R&S	ESCS-30	828985/007	Sep/03/14	Sep/03/15
High Pass Filter	Mini-Circuits	VHF-1320+	1034	Verified	
Signal Generator	R&S	SMY02	1062.5502.12	NCR	None
Attenuator 10dB	Huber+Suhner	6810.17.A	747300	Verified	
Horn Antenna	Com Power	AHA-118	711150	Feb/10/15	Feb/10/16
Bilog Antena	Chase	CBL6140	1040	Nov/09/14	Nov/09/15

Table 12 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

END OF TEST REPORT