Application

For

Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

Industry Canada RSS-Gen, Issue 5 and RSS-247, Issue 2

For the

Cort Business Services dba Tapdn (FCC)
Cort Business Services Inc (ISED)

Model: TAPDN-PIR-0002

FCC ID: 2AT6B-0002
IC: 26085-PIR0002

UST Project: 19-0478
Issue Date: May 22, 2020

Total Pages in This Report: 80

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date May 22, 2020

TESTING
NVLAP LAB CODE 200162-0

Testing Tomorrow's Technology

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Cort Business Services dba Tapdn (FCC)
Cort Business Services Inc (ISED)

MODEL: TAPDN-PIR-0002

FCC ID: 2AT6B –PIR-0002

IC: 26085-PIR0002

DATE: May 22, 2020

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 902-928 MHz ISM Radio

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date

agrees to notify the Commission by N/A
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

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External Photographs
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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 247 and Industry Canada RSS-247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on October 30, 2019 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Model TAPDN-PIR-0002. It is a passive infrared sensor that is used to detect motion within a short range of the device. This motion detection is then sent via LoRaWAN to a local gateway, which is then transmitted to the cloud. Multiple sensors are typically used in an environment and the data is aggregated together in the cloud to provide information via an application about how spaces are utilized within the environment. The devices also advertise a BLE beacon, allowing for a proximity connection to perform diagnostics and OTA updates.

Antenna: Chip antenna – see Table 5
Modulation: FHSS (902.3 – 914.9 MHz)
Modulation: DTS (903.0 – 914.2 MHz)

Maximum measured Output Power: 11.83 dBm (FHSS)
12.91 dBm (DTS)

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for FCC subpart A Digital equipment Verification requirements. Also, *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* was used as a test procedure guide.

A list of the EUT and Peripherals is found in Table 1 following. Block diagrams of the tested system are shown in Figures 1 and 2. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The Equipment under Test (EUT) is subject to the following FCC/IC authorizations:

a) Certification under section 15.247/IC RSS-247 as a transmitter.
b) SDoC under 15.101/ICES-003 as a digital device and receiver.

The SDoC Report is under separate cover.

1.7 Test Results

In our opinion, and as indicated by the test results documented following, when tested in the configuration as described in this report, the EUT meets the applicable requirements of FCC and IC, including: FCC Parts 2.902, 15.101, 15.207, 15.209, 15.247, RSS GEN, and RSS-247.

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC and IC ID	CABLES P/D
Cort Business Services (EUT)	TAPDN-PIR-0002	Engineering Sample	FCC: 2AT6B-0002 IC ID:26085-PIR0002	N/A
Antenna See antenna details	--	--	--	--

U= Unshielded S= Shielded
P= Power D= Data

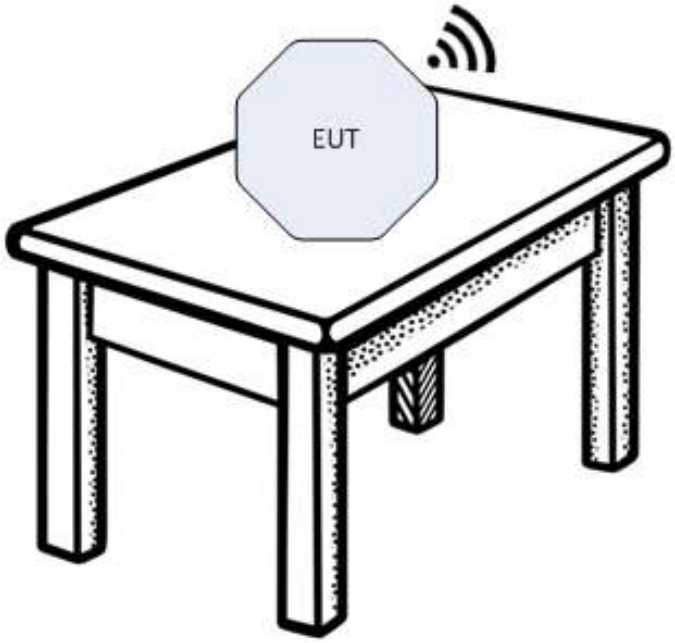


Figure 1. Block Diagram of Test Configuration

Table 2. Details of I/O Cables Attached to EUT

<table>
<tr><th>DESCRIPTION OF CABLE</th><th colspan="3">DETAILS OF CABLE</th><th>CABLE LENGTH</th></tr>
<tr><td rowspan="7">N/A</td><td colspan="3">Manufacturer and Part Number</td><td rowspan="7">N/A</td></tr>
<tr><td colspan="3">N/A</td></tr>
<tr><td>Shield Type</td><td>Shield Termination</td><td>Type of Backshell</td></tr>
<tr><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">Various</td></tr>
<tr><td>Shield Type</td><td>Shield Termination</td><td>Type of Backshell</td></tr>
<tr><td>CND</td><td>CND</td><td>PU</td></tr>
</table>

Shield Type
N/A = None
F = Foil
B = Braided
2B = Double Braided
CND = Could Not Determine

Shield Termination
N/A = None
360 = 360 Degrees
P = Pigtail/Drain Wire
CND = Could Not Determine
MU = Metal Unshielded

Type of Backshell
N/A = Not Applicable
PS = Plastic Shielded
PU = Plastic Unshielded
MS = Metal Shielded

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 3. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020 2 yr. Cal
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	1/29/2022 2 yr. Cal
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	5/7/2020
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	7/8/2020 Extended
EMC LOOP ANTENNA	6502	ETS Lindgren	9810-3246	4/6/2022 2 yr. Cal
BICONICAL ANTENNA	3110B	EMCO	9306-1708	6/27/2021 2 yr. Cal
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr. Cal
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr. Cal
HIGH PASS FILTER	VHF-1320 15542	Mini-Circuits Inc.	30843	5/11/2021

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (Part 15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 4. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over a range of 12.6 MHz, 3 test frequencies were used for each mode. For FHSS, the frequencies used were 902.3, 908.6, and 914.9 MHz. For DTS/DSSS and Hybrid, the frequencies used were 903, 907.8, and 914.2 MHz.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

2.6 EUT Antenna Requirements (CFR 15.203)

This equipment is not available to the general public and will only be installed by a professional installer working for an approved utility. The equipment therefore meets the intent of the above requirement. Only the antennas listed in Table 4 will be used with this module.

Table 5. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna 1	Johanson Technology	Chip	0915AT43A0026	-1.0	SMD

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement. See paragraph 2.10 of the test report.

2.8 Transmitter Duty Cycle (CFR 15.35 (c))

When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT is powered by two AA Lithium batteries; therefore, this test is not applicable.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98% duty cycle) and tested per ANSI C63.10-2013. The EUT was tested in 3 orthogonal positions because the device is considered portable.

Radiated measurements were conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 125 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 125 kHz to 30 MHz, a RBW of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 100/120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The EUT was investigated per CFR 15.209, General requirements for unwanted spurious emissions. The conducted spurious method as described below was used to investigate all other emissions emanating from the antenna port.

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% duty cycle) and tested per ANSI C63.10-2013 for conducted out of band emissions emanating from the antenna port over the frequency range of 30 MHz or lowest operating clock frequency to ten times the highest operating clock frequency. A conducted scan was performed on the EUT to identify and record the spurious signals that were related to the transmitter.

Table 6. FHSS Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PEAK							
902.30	90.61	-1.79	88.82	-	3.0m./VERT	-	**PK**
4511.50	54.06	6.64	60.70	74.0*	3.0m./VERT	13.3	**PK**
5413.80	54.49	13.87	68.36	74.0*	3.0m./VERT	5.6	**PK**
6316.10	55.83	5.21	61.04~	74.0	1.0m./VERT	13.0	**PK**
7218.40	51.83	8.62	60.45~	74.0	1.0m./VERT	13.5	**PK**
Mid Channel – PEAK							
908.60	89.38	-2.02	87.36	-	3.0m./VERT	-	**PK**
4543.00	54.03	7.25	61.28	74.0*	3.0m./VERT	12.7	**PK**
5451.60	55.28	10.71	65.99	74.0*	3.0m./VERT	8.0	**PK**
6360.20	56.01	5.07	61.08~	74.0	1.0m./VERT	12.9	**PK**
7268.80	51.64	9.21	60.85~	74.0*	1.0m./VERT	13.1	**PK**
High Channel – PEAK							
914.90	88.77	-2.19	86.58	-	3.0m./VERT	-	**PK**
4574.50	52.84	7.21	60.05	74.0*	3.0m./VERT	14.0	**PK**
5489.40	54.72	10.73	65.45	74.0	3.0m./VERT	8.6	**PK**
6404.30	55.03	5.08	60.11~	74.0	1.0m./VERT	13.9	**PK**
7319.20	51.72	9.63	61.35~	74.0*	1.0m./VERT	12.7	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 902.30 MHz:

Magnitude of Measured Frequency	90.61	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.79	dB/m
Corrected Result	88.82	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 7. FHSS Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
902.30	90.43	-1.79	88.64	-	3.0m./VERT	-	**AVG**
4511.50	39.76	6.64	46.40	54.0*	3.0m./VERT	7.6	**AVG**
5413.80	35.65	13.87	49.52	54.0*	3.0m./VERT	4.5	**AVG**
6316.10	39.90	5.21	45.11~	54.0	1.0m./VERT	8.9	**AVG**
7218.40	43.27	8.62	51.89~	54.0	1.0m./VERT	2.1	**AVG**
Mid Channel – AVERAGE							
908.60	88.90	-2.02	86.88	-	3.0m./VERT	-	**AVG**
4543.00	38.93	7.25	46.18	54.0*	3.0m./VERT	7.8	**AVG**
5451.60	37.66	10.71	48.37	54.0*	3.0m./VERT	5.6	**AVG**
6360.20	38.55	5.07	43.62~	54.0	1.0m./VERT	10.4	**AVG**
7268.80	39.56	9.21	48.77~	54.0*	1.0m./VERT	5.2	**AVG**
High Channel – AVERAGE							
914.90	85.01	-2.19	82.82	-	3.0m./VERT	-	**AVG**
4574.50	38.97	7.21	46.18	54.0*	3.0m./VERT	7.8	**AVG**
5489.40	38.96	10.73	49.69	54.0	3.0m./VERT	4.3	**AVG**
6404.30	38.98	5.08	44.06~	54.0	1.0m./VERT	9.9	**AVG**
7319.20	39.67	9.63	49.30~	54.0*	1.0m./VERT	4.7	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 902.30 MHz:

Magnitude of Measured Frequency	90.43	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.79	dB/m
Corrected Result	88.64	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 8. DTS Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PEAK							
903.00	91.18	-1.74	89.44	-	3.0m./VERT	-	**PK**
4515.00	55.62	7.25	62.87	74.0*	3.0m./VERT	11.1	**PK**
5418.00	55.37	13.87	69.24	74.0*	3.0m./VERT	4.8	**PK**
6321.00	56.96	5.21	62.17~	74.0	1.0m./VERT	11.8	**PK**
7224.00	53.02	8.62	61.64~	74.0	1.0m./VERT	12.4	**PK**
Mid Channel – PEAK							
907.80	92.32	-2.02	90.30	-	3.0m./VERT	-	**PK**
4539.00	53.50	7.25	60.75	74.0*	3.0m./VERT	13.2	**PK**
5446.80	54.40	10.72	65.12	74.0*	3.0m./VERT	8.9	**PK**
6354.60	56.01	5.07	61.08~	74.0	1.0m./VERT	12.9	**PK**
7262.40	51.94	9.21	61.15~	74.0*	1.0m./VERT	12.8	**PK**
High Channel – PEAK							
914.20	91.31	-2.19	89.12	-	3.0m./VERT	-	**PK**
4571.00	52.42	7.21	59.63	74.0*	3.0m./VERT	14.4	**PK**
5485.20	55.63	10.71	66.34	74.0	3.0m./VERT	7.7	**PK**
6399.40	56.67	5.06	61.73~	74.0	1.0m./VERT	12.3	**PK**
7313.60	52.95	9.63	62.58~	74.0*	1.0m./VERT	11.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.00 MHz:

Magnitude of Measured Frequency	91.18	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.74	dB/m
Corrected Result	89.44	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 9. DTS Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
903.00	90.82	-1.74	89.08	-	3.0m./VERT	-	**AVG**
4515.00	41.70	7.25	48.95	54.0*	3.0m./VERT	5.0	**AVG**
5418.00	37.07	13.87	50.94	54.0*	3.0m./VERT	3.1	**AVG**
6321.00	41.10	5.21	46.31~	54.0	1.0m./VERT	7.7	**AVG**
7224.00	40.60	8.62	49.22~	54.0	1.0m./VERT	4.8	**AVG**
Mid Channel – AVERAGE							
907.80	92.32	-2.02	86.88	-	3.0m./VERT	-	**AVG**
4539.00	39.03	7.25	46.28	54.0*	3.0m./VERT	7.7	**AVG**
5446.80	41.19	10.72	51.91	54.0*	3.0m./VERT	2.1	**AVG**
6354.60	39.82	5.07	44.89~	54.0	1.0m./VERT	9.1	**AVG**
7262.40	40.78	9.21	49.99~	54.0*	1.0m./VERT	4.0	**AVG**
High Channel – AVERAGE							
914.20	91.04	-2.19	88.85	-	3.0m./VERT	-	**AVG**
4571.00	37.88	7.21	45.09	54.0*	3.0m./VERT	8.9	**AVG**
5485.20	42.11	10.71	52.82	54.0	3.0m./VERT	1.2	**AVG**
6399.40	40.26	5.06	45.32~	54.0	1.0m./VERT	8.7	**AVG**
7313.60	41.13	9.63	50.76~	54.0*	1.0m./VERT	3.2	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.00 MHz:

Magnitude of Measured Frequency	90.82	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.74	dB/m
Corrected Result	89.08	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 10. Hybrid Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PEAK							
903.00	92.56	-1.74	90.82	-	3.0m./VERT	-	**PK**
4515.00	54.97	7.25	62.22	74.0*	3.0m./VERT	11.8	**PK**
5418.00	56.86	13.87	70.73	74.0*	3.0m./VERT	3.3	**PK**
6321.00	56.06	5.21	61.27~	74.0	1.0m./VERT	12.7	**PK**
Mid Channel – PEAK							
907.80	90.72	-2.02	88.70	-	3.0m./VERT	-	**PK**
4539.00	55.24	7.25	62.49	74.0*	3.0m./VERT	11.5	**PK**
5446.80	57.60	10.72	68.32	74.0*	3.0m./VERT	5.7	**PK**
6354.60	57.56	5.07	62.63~	74.0	1.0m./VERT	11.4	**PK**
7262.40	55.12	9.21	64.33~	74.0*	1.0m./VERT	9.7	**PK**
High Channel – PEAK							
914.20	89.47	-2.19	87.28	-	3.0m./VERT	-	**PK**
4571.00	54.34	7.21	61.55	74.0*	3.0m./VERT	12.5	**PK**
5485.20	58.26	10.71	68.97	74.0	3.0m./VERT	5.0	**PK**
6399.40	60.03	5.06	65.09~	74.0	1.0m./VERT	8.9	**PK**
7313.60	57.47	9.63	67.10~	74.0*	1.0m./VERT	6.9	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.00 MHz:

Magnitude of Measured Frequency	92.56	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.74	dB/m
Corrected Result	90.82	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 11. Hybrid Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – AVERAGE							
903.00	92.39	-1.74	90.65	-	3.0m./VERT	-	**AVG**
4515.00	40.50	7.25	47.75	54.0*	3.0m./VERT	6.2	**AVG**
5418.00	38.08	13.87	51.95	54.0*	3.0m./VERT	2.1	**AVG**
6321.00	41.29	5.21	46.50~	54.0	1.0m./VERT	7.5	**AVG**
Mid Channel – AVERAGE							
907.80	89.88	-2.02	87.86	-	3.0m./VERT	-	**AVG**
4539.00	40.42	7.25	47.67	54.0*	3.0m./VERT	6.3	**AVG**
5446.80	38.38	10.72	49.10	54.0*	3.0m./VERT	4.9	**AVG**
6354.60	42.97	5.07	48.04~	54.0	1.0m./VERT	6.0	**AVG**
7262.40	37.09	9.21	46.30~	54.0*	1.0m./VERT	7.7	**AVG**
High Channel – AVERAGE							
914.20	89.08	-2.19	86.89	-	3.0m./VERT	-	**AVG**
4571.00	39.91	7.21	47.12	54.0*	3.0m./VERT	6.9	**AVG**
5485.20	39.98	10.71	50.69	54.0	3.0m./VERT	3.3	**AVG**
6399.40	47.06	5.06	52.12	54.0	1.0m./VERT	1.9	**AVG**
7313.60	41.45	9.63	51.08	54.0*	1.0m./VERT	2.9	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 903.00 MHz:

Magnitude of Measured Frequency	92.39	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-1.74	dB/m
Corrected Result	90.65	dBuV/m

Test Date: December 27, 2019
Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Conducted Spurious Emissions:

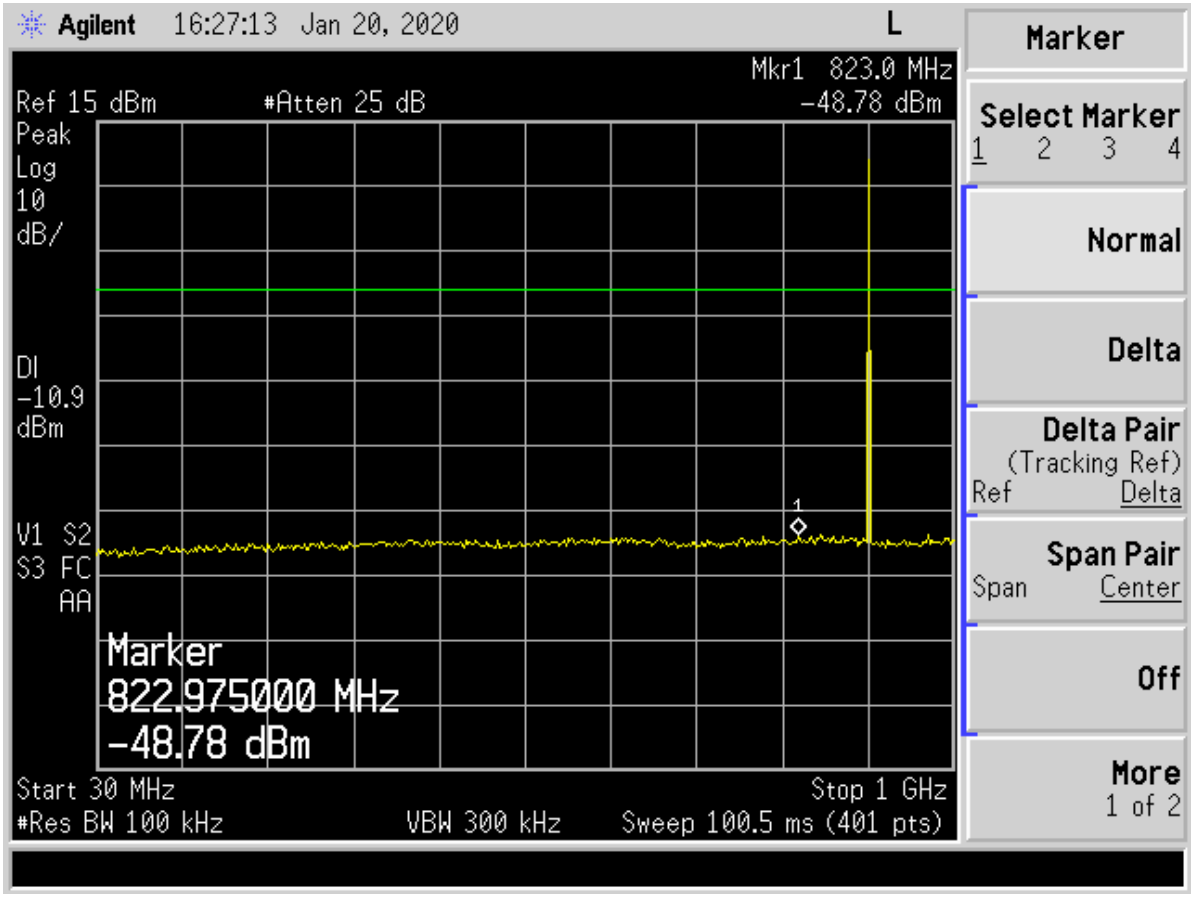


Figure 2. FHSS Antenna Conducted Emissions Low Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

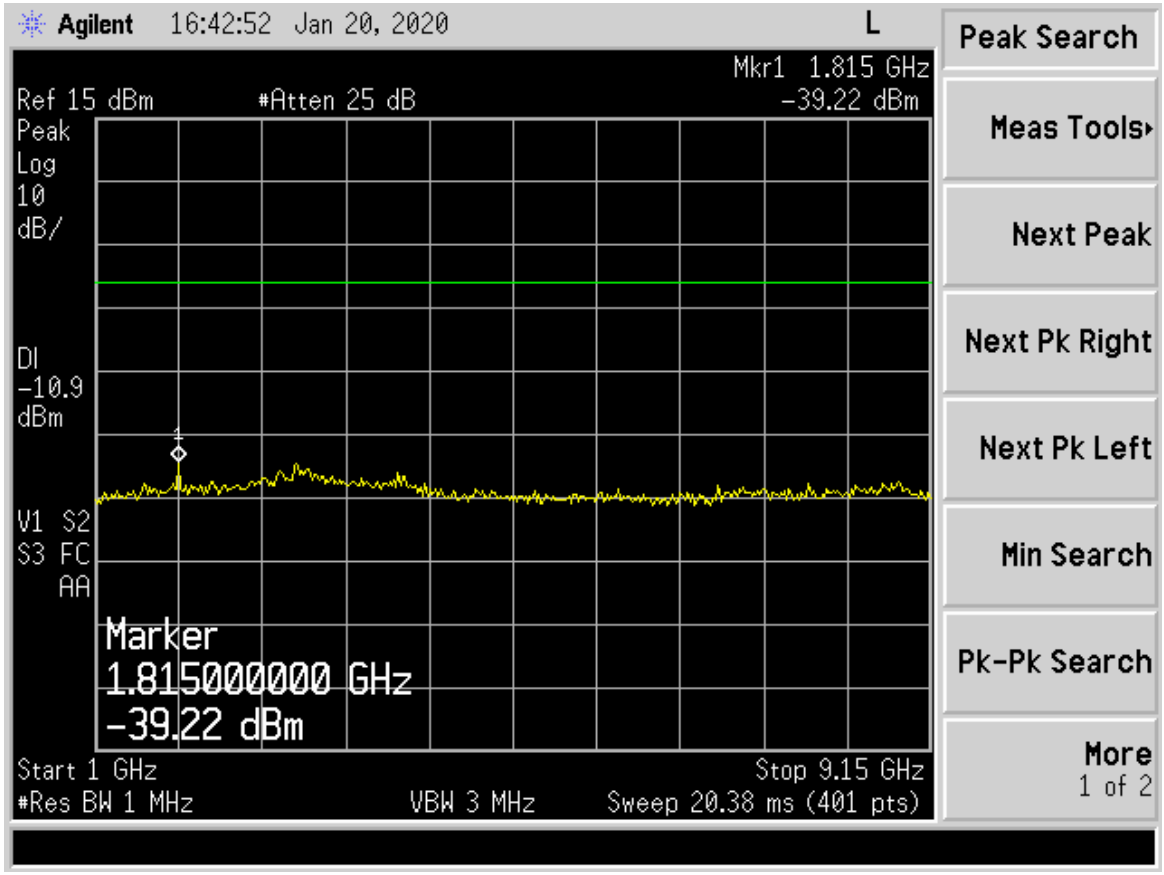


Figure 3. FHSS Antenna Conducted Emissions Low Channel, 1 to 9.3 GHz

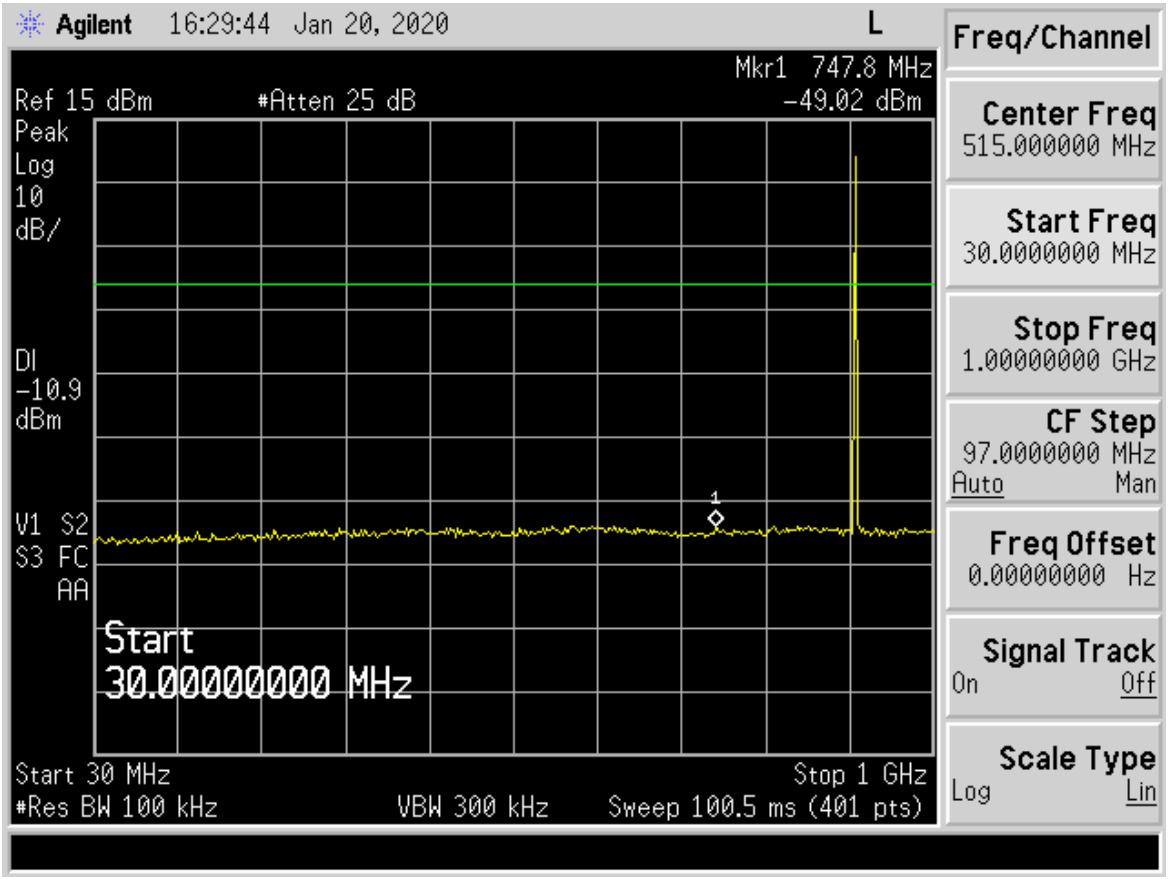


Figure 4. FHSS Antenna Conducted Emissions Mid Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

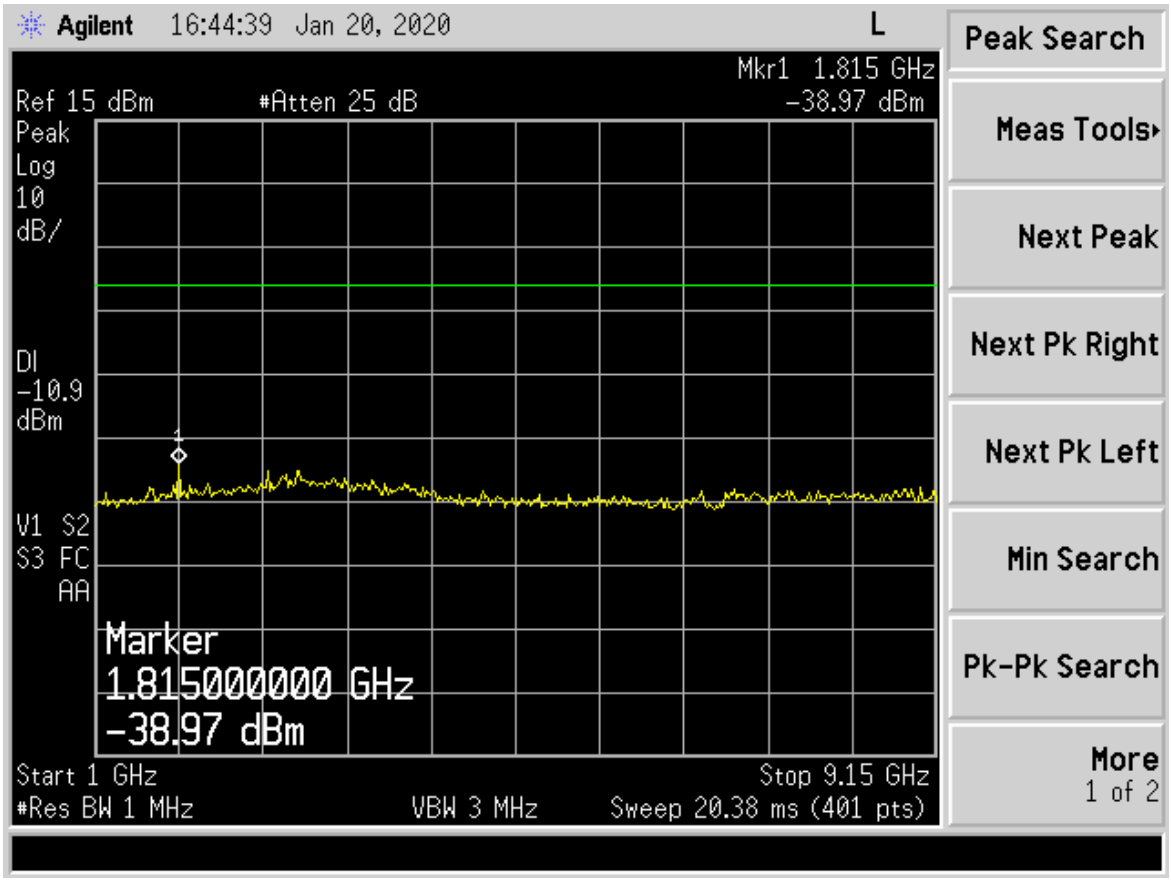


Figure 5. FHSS Antenna Conducted Emissions Mid Channel, 1 to 9.3 GHz

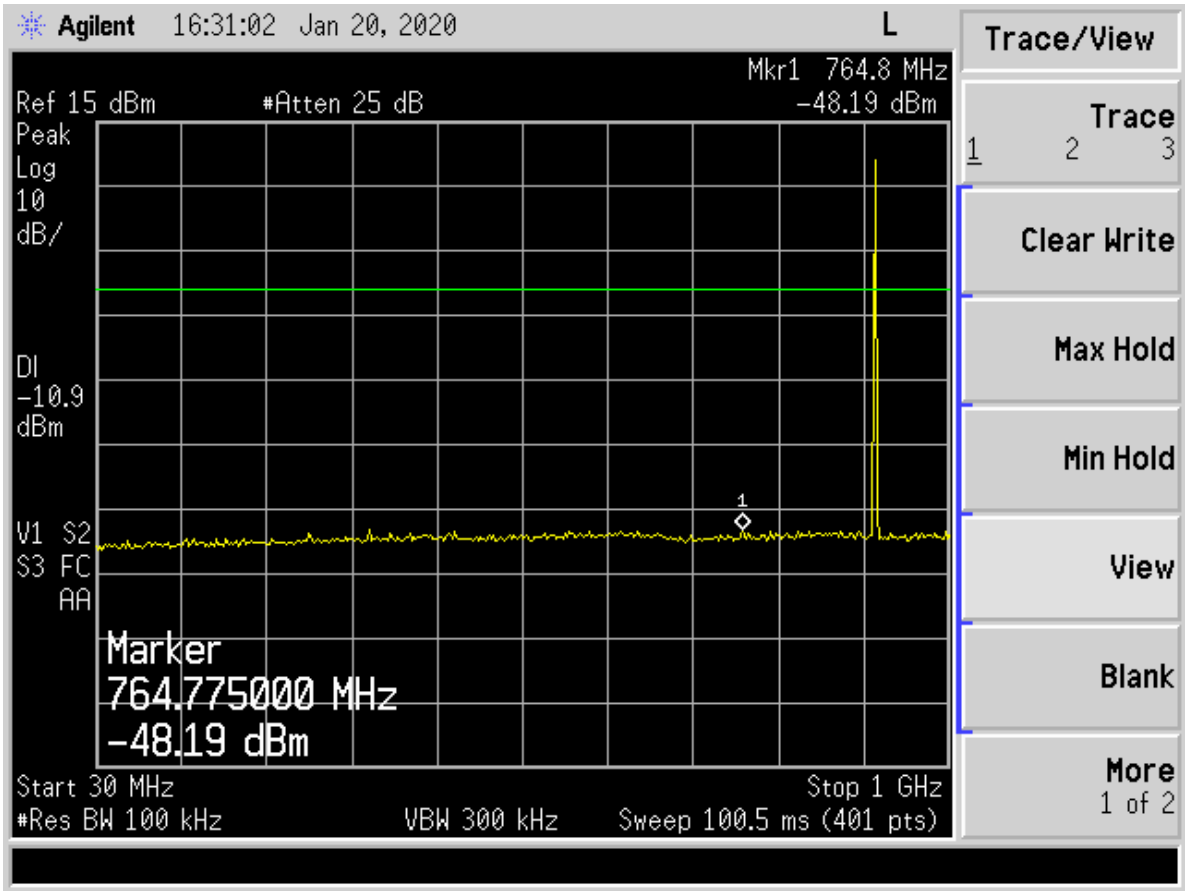


Figure 6. FHSS Antenna Conducted Emissions High Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

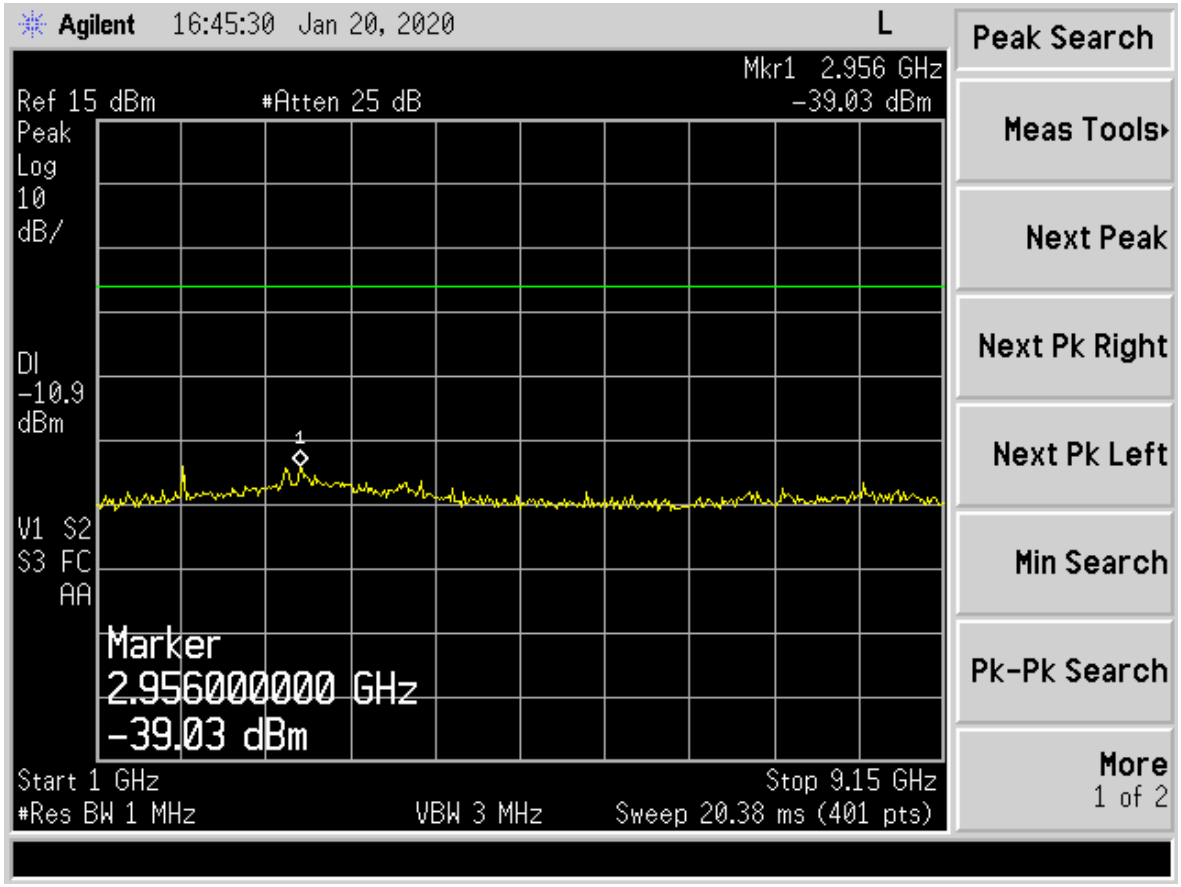


Figure 7. FHSS Antenna Conducted Emissions High Channel, 1 to 9.3 GHz

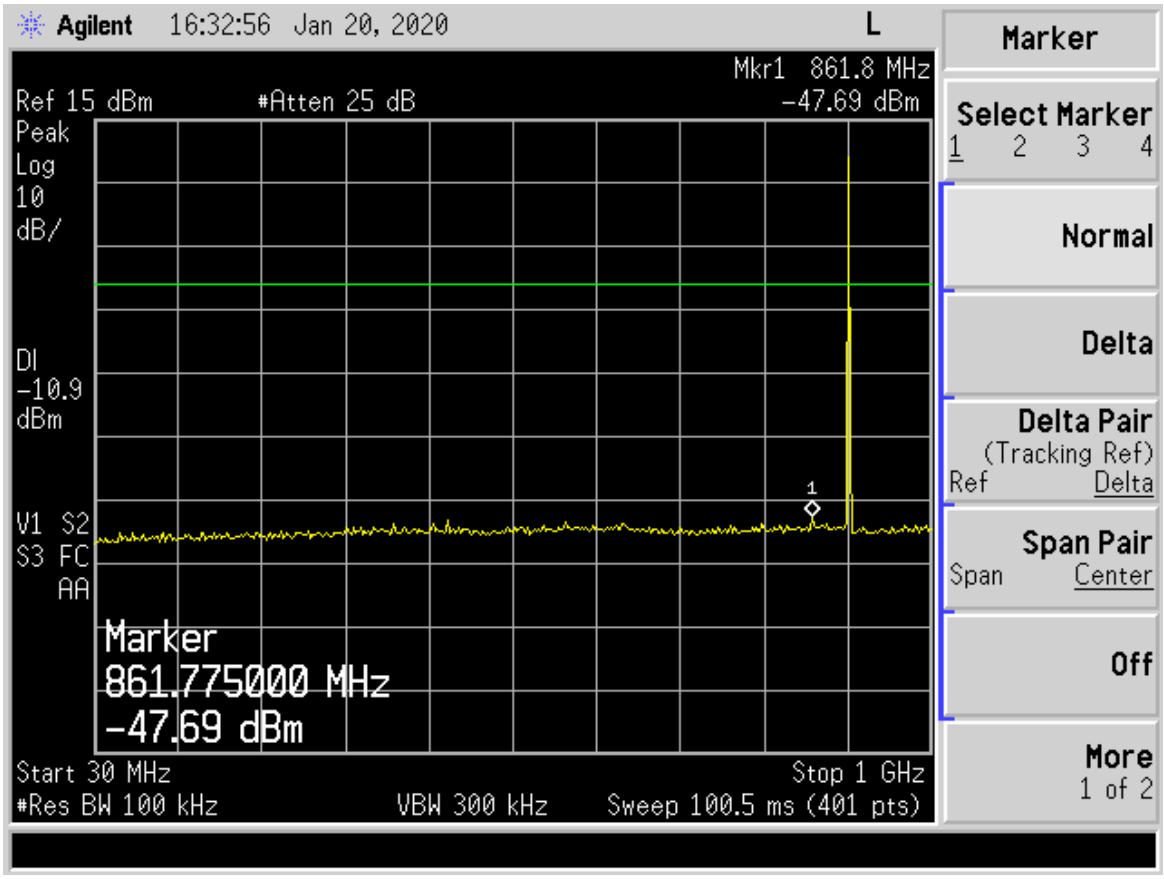


Figure 8. DTS Antenna Conducted Emissions Low Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

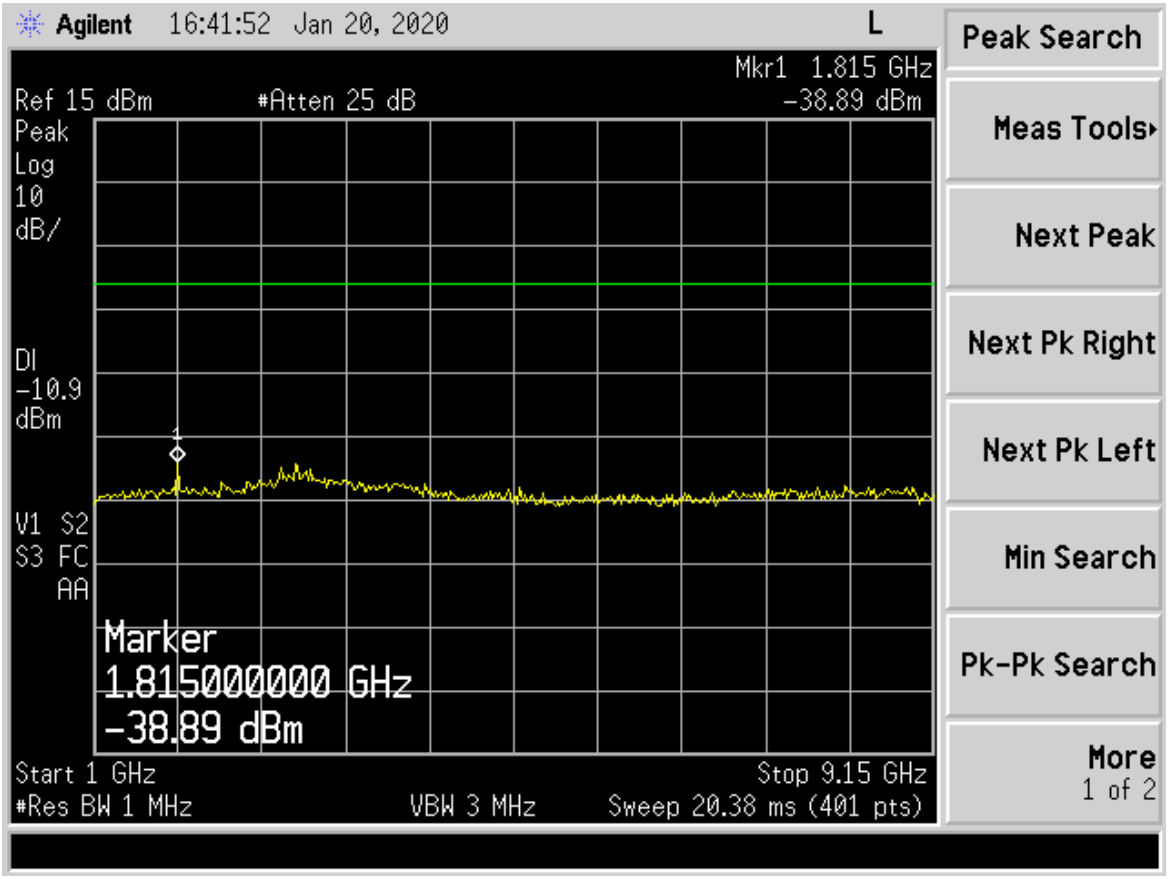


Figure 9. DTS Antenna Conducted Emissions Low Channel, 1 to 9.3 GHz

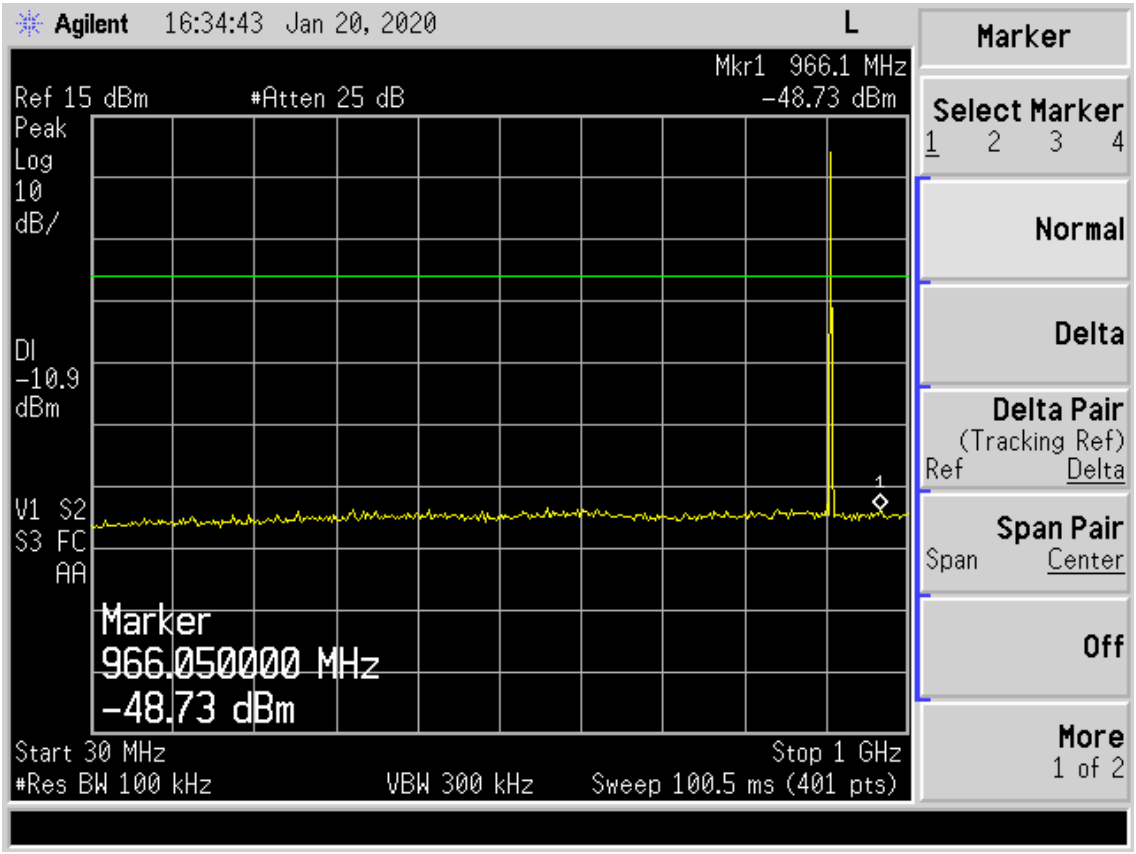


Figure 10. DTS Antenna Conducted Emissions Mid Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

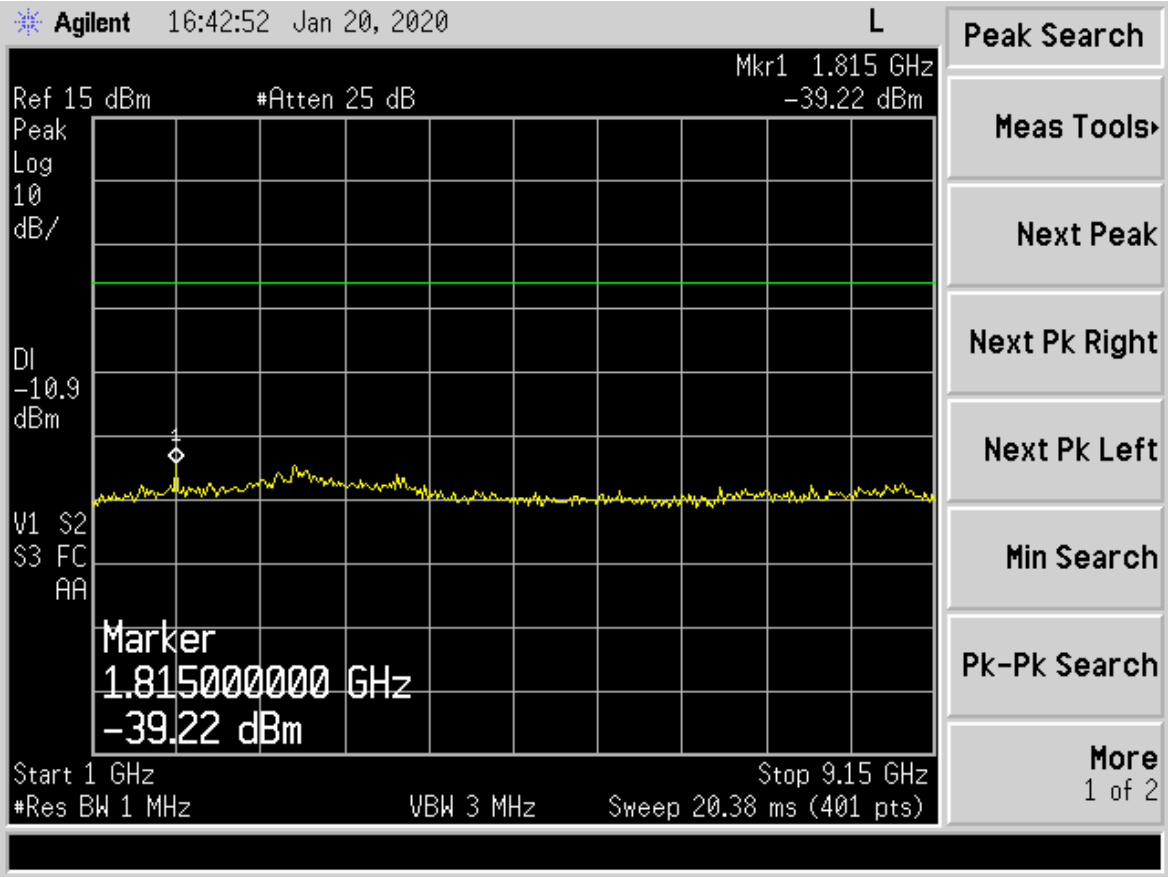


Figure 11. DTS Antenna Conducted Emissions Mid Channel, 1 to 9.3 GHz

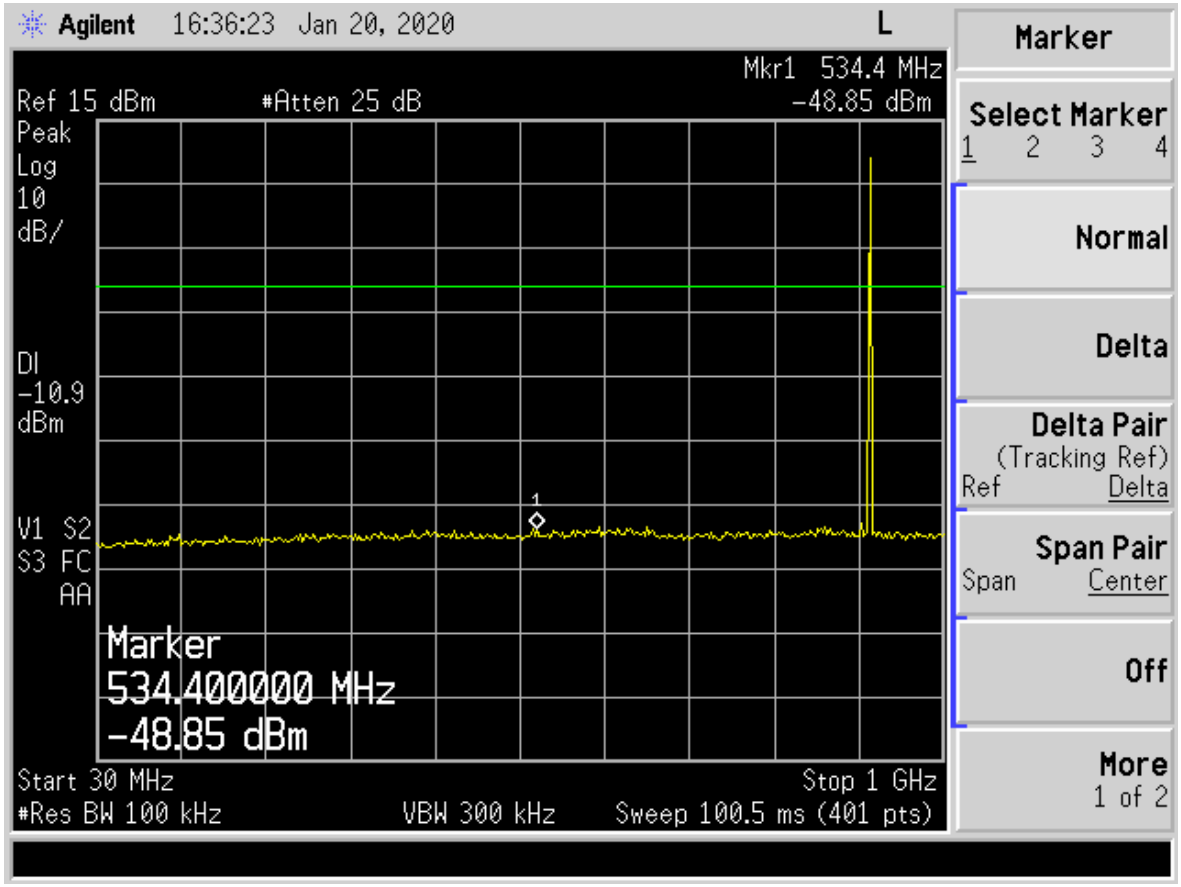


Figure 12. DTS Antenna Conducted Emissions High Channel, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

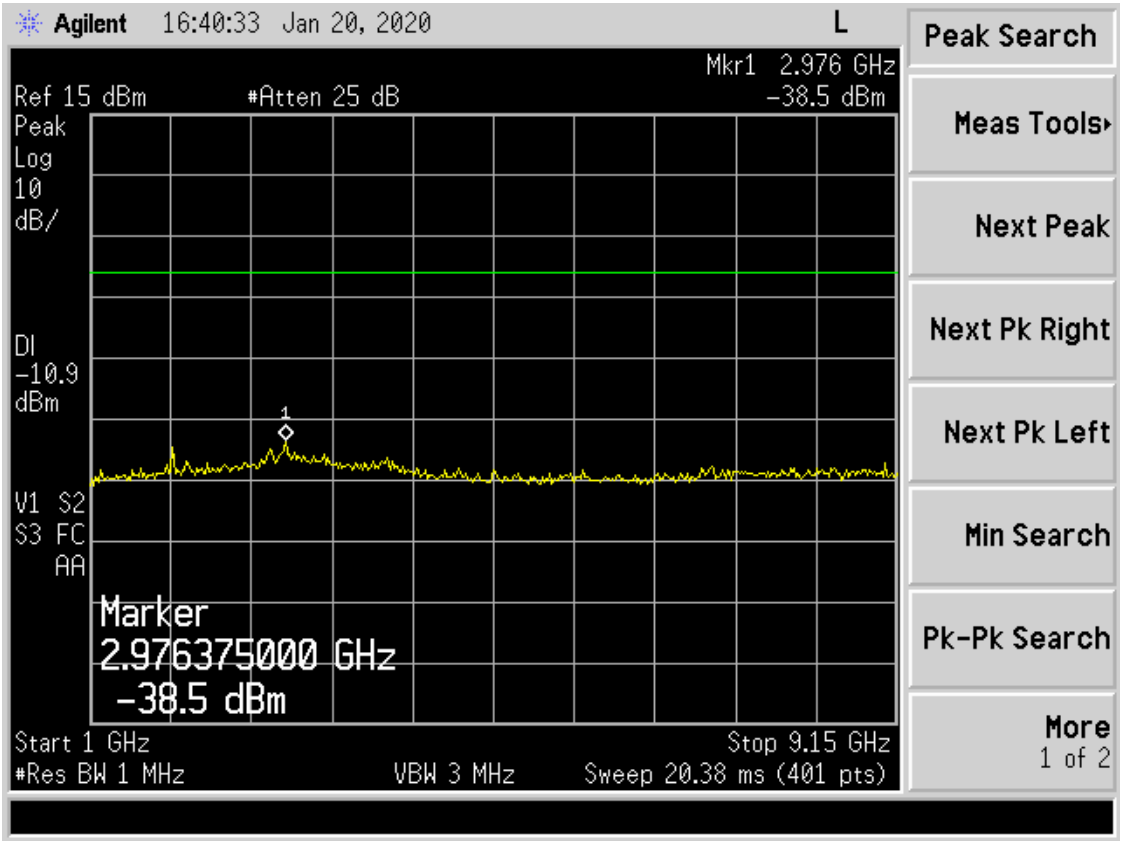


Figure 13. DTS Antenna Conducted Emissions High Channel, 1 to 9.3 GHz

2.11 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made, following the guidelines in ANSI 63.10-2013, with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band).

To capture the band edge, set the Spectrum Analyzer frequency span large enough (usually around 2 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Radiated measurements are performed with RBW = 100 kHz. The VBW is set ≥ RBW. See figure and calculations below for more detail.

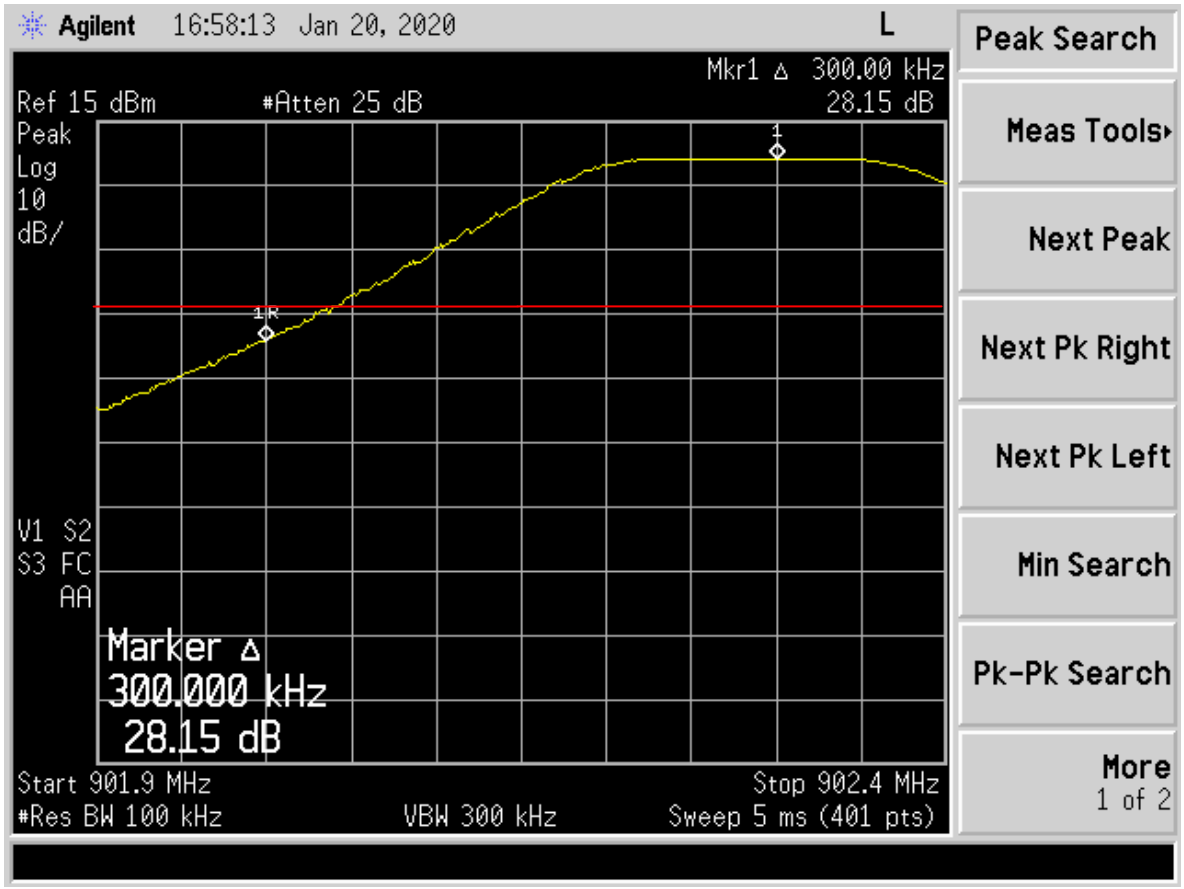


Figure 14. FHSS Band Edge Compliance, Low Channel Delta, Peak

Measured Delta (from Figure 15)	28.15	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	8.15	dB

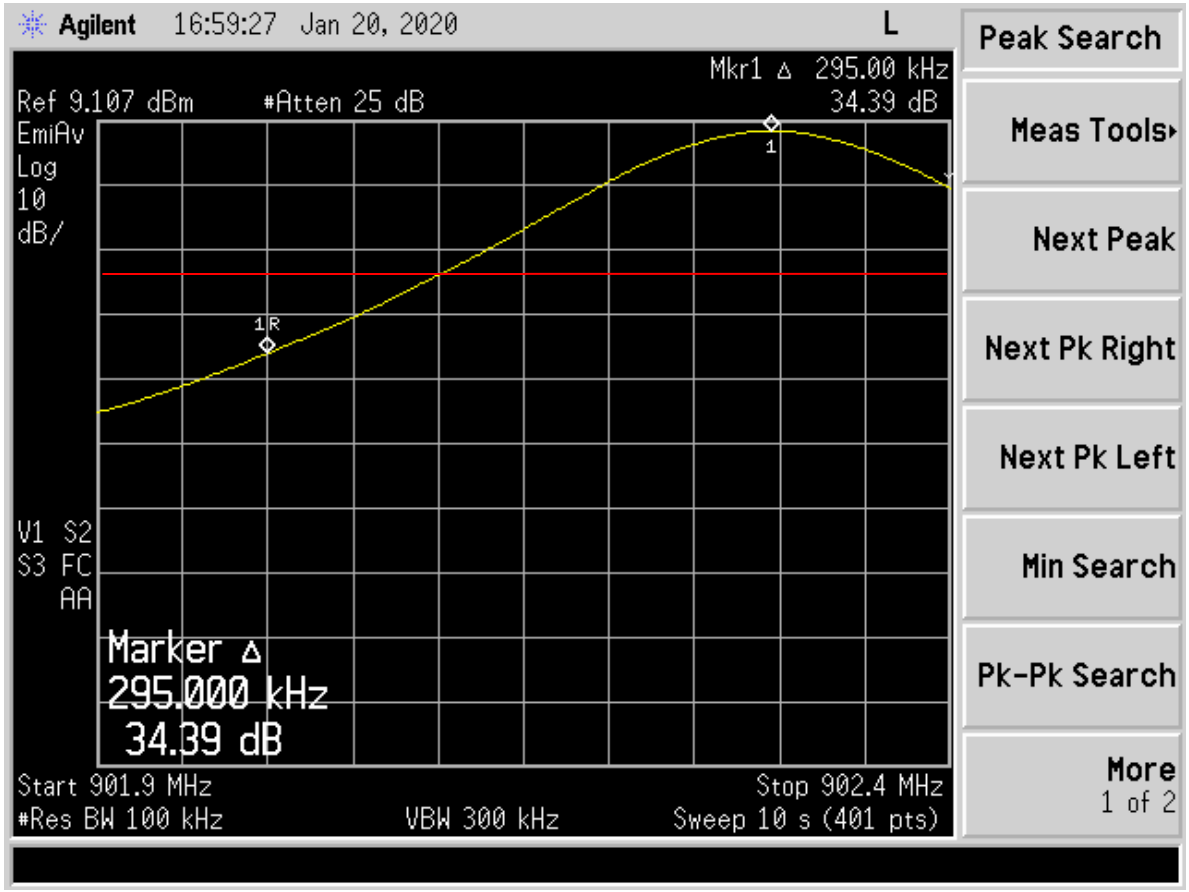


Figure 15. FHSS Band Edge Compliance, Low Channel Delta, Average

Measured Delta (from Figure 16)	34.39	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	14.39	dB

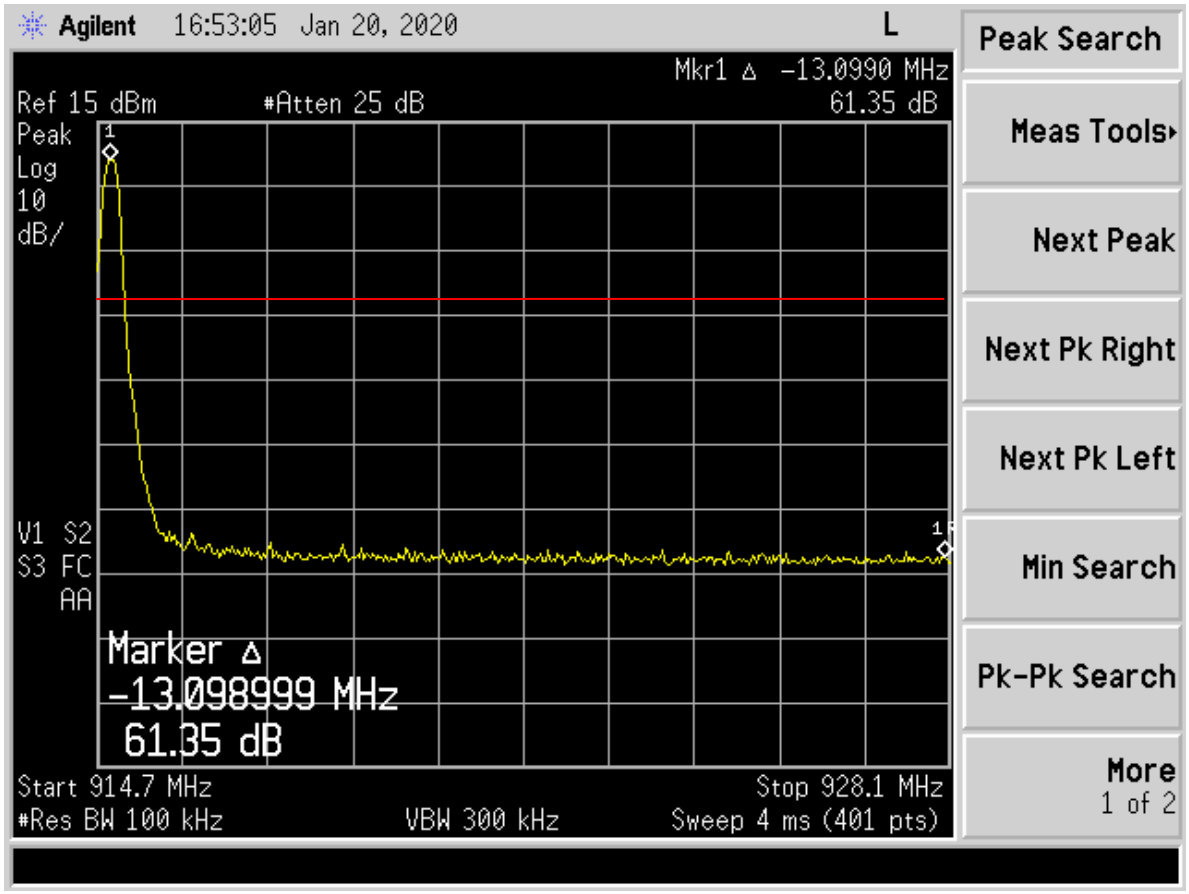


Figure 16. FHSS Band Edge Compliance, High Channel Delta, Peak

Measured Delta (from Figure 17)	61.35	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.35	dB

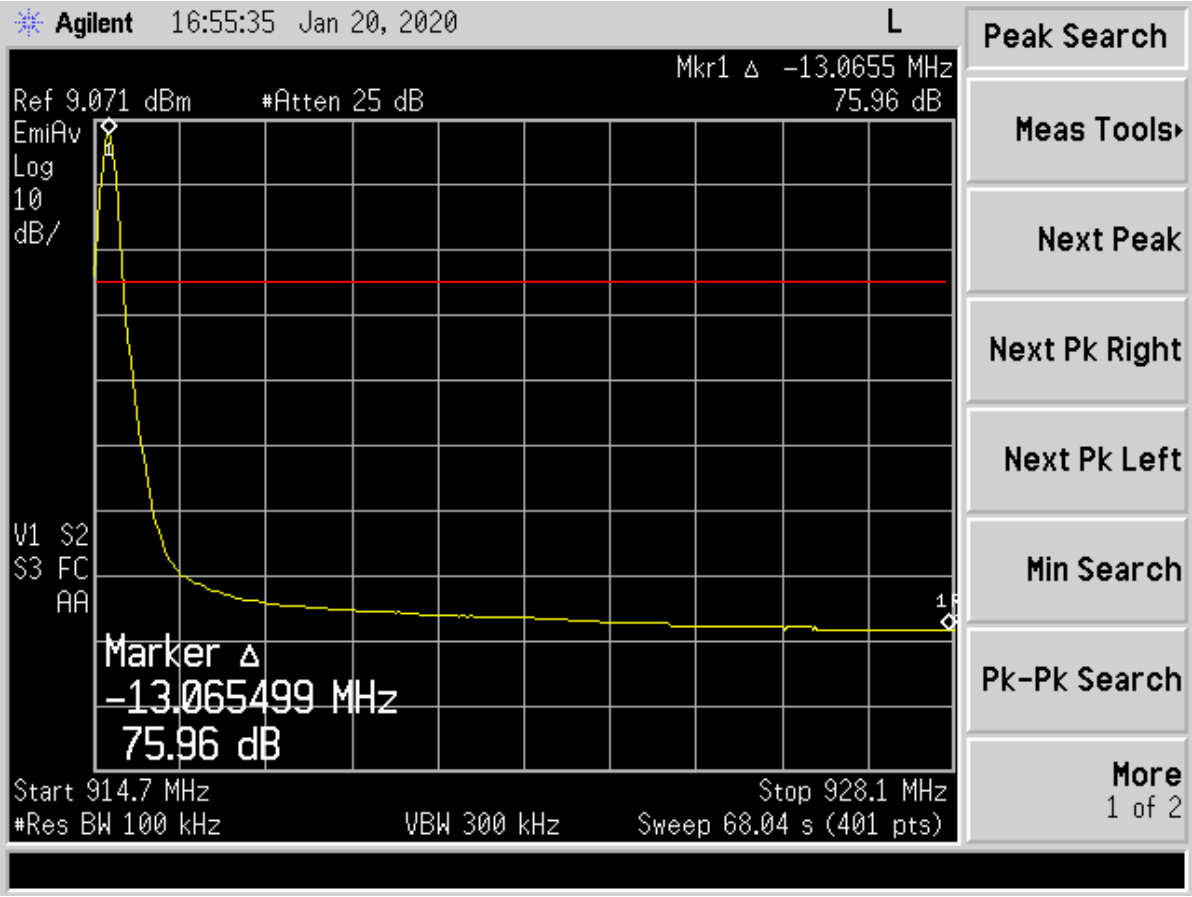


Figure 17. FHSS Band Edge Compliance, High Channel Delta, Average

Measured Delta (from Figure 18)	75.96	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	55.96	dB

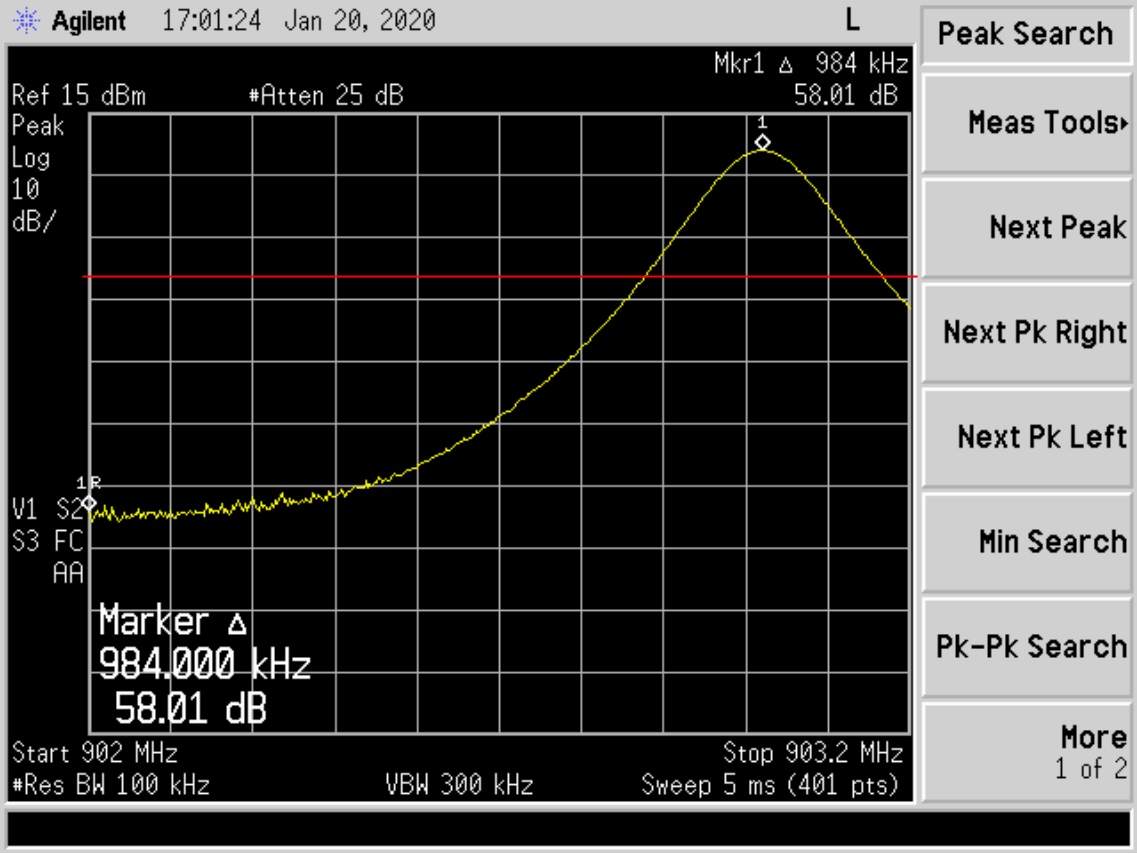


Figure 18. DTS Band Edge Compliance, Low Channel Delta, Peak

Measured Delta (from Figure 19)	58.01	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	38.01	dB

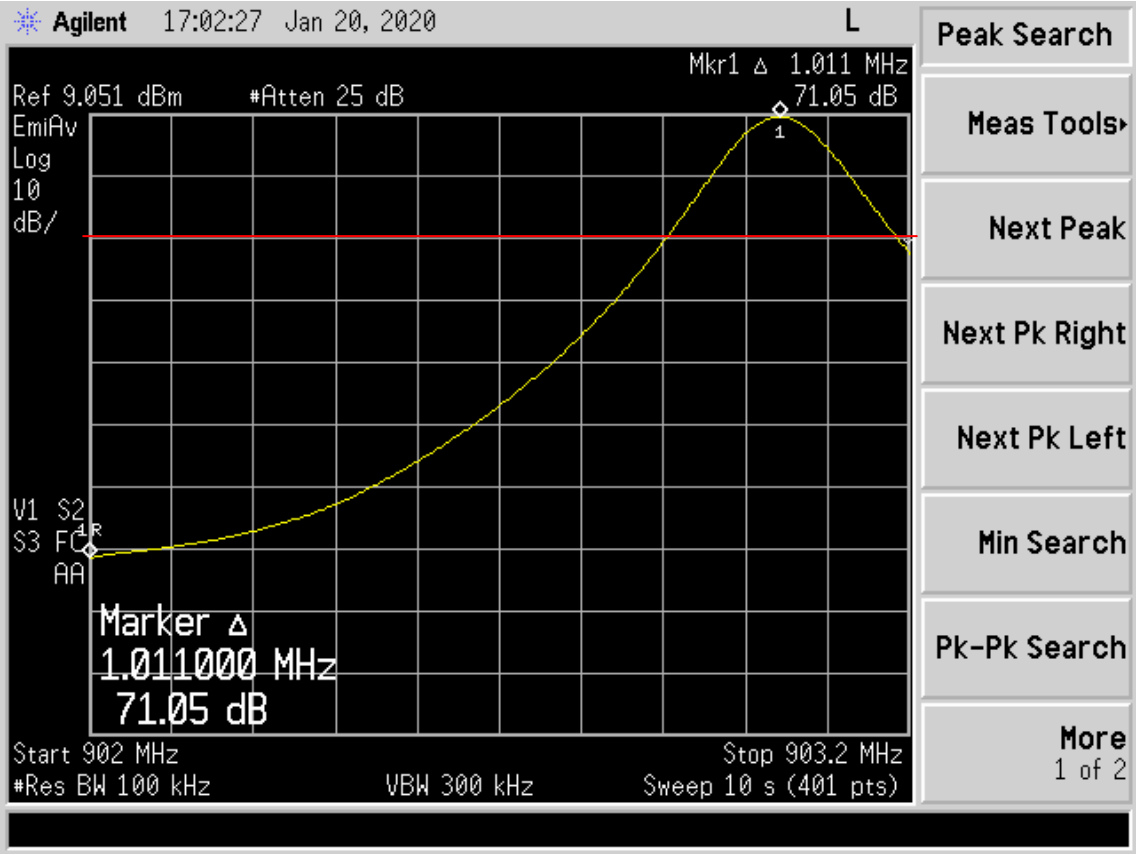


Figure 19. DTS Band Edge Compliance, Low Channel Delta, Average

Measured Delta (from Figure 20)	71.05	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	51.05	dB

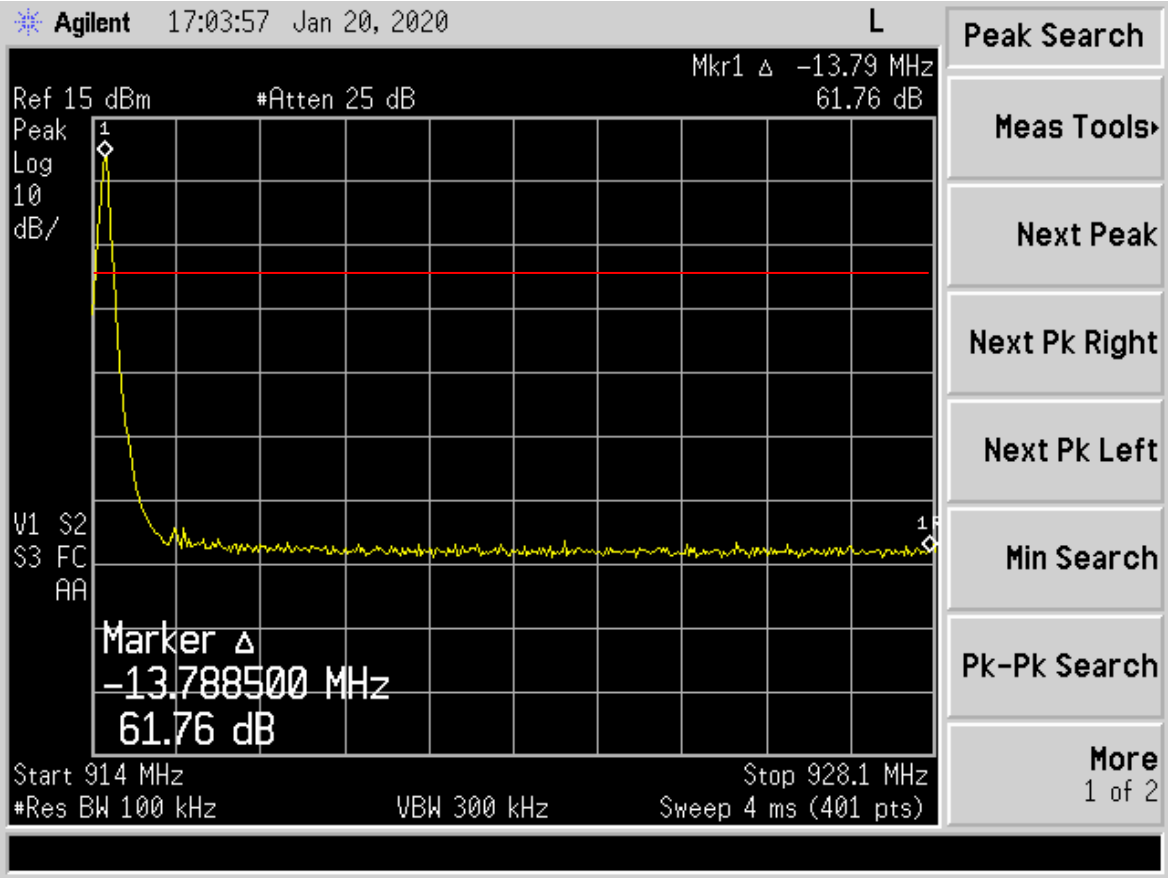


Figure 20. DTS Band Edge Compliance, High Channel Delta, Peak

Measured Delta (from Figure 21)	61.76	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.76	dB

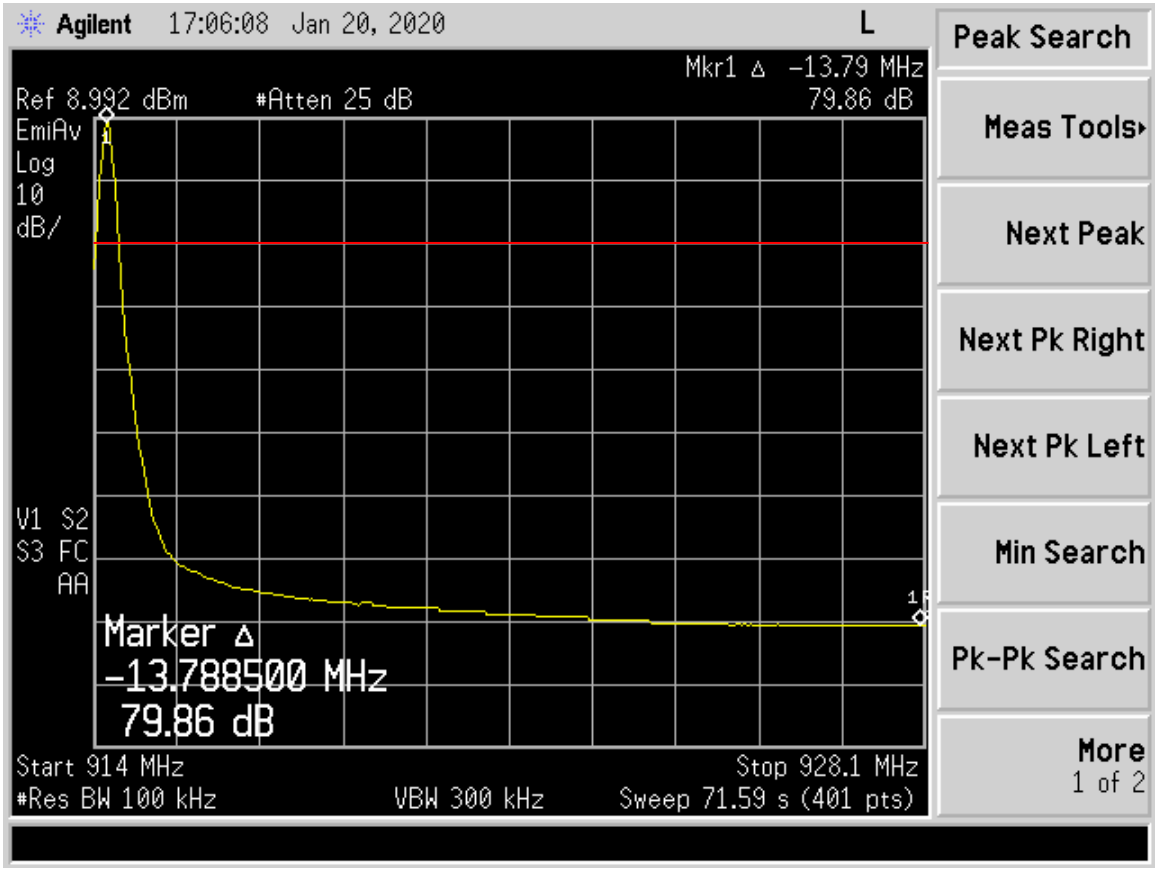


Figure 21. DTS Band Edge Compliance, High Channel Delta, Average

Measured Delta (from Figure 22)	79.86	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	59.86	dB

2.12 Bandwidth measurements (CFR 15.247 (a) (1), CFR 15.247 (a) (2))

For frequency hopping systems operating in the 902-928 MHz band the maximum allowed 20 dB bandwidth is 500 kHz. For digital modulation systems operating in the 902-928 MHz band the minimum allowed 6 dB bandwidth is 500 kHz.

These measurements were performed while the EUT was in a constant transmit mode. The results of this test are given in Table and Figures following.

Table 12. Twenty (20) dB Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Limit (kHz)	99% Occupied Bandwidth (kHz)
902.3	139.4	500	127.7
908.6	136.7	500	127.7
914.9	139.1	500	127.5

Test Date: May 21, 2020

Tested By
Signature: Afzal Fazal Name: Afzal Fazal

Table 13. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (kHz)	Minimum Limit (kHz)	99% Occupied Bandwidth (kHz)
903.0	790.0	500	623.1
907.8	760.0	500	610.8
914.2	765.0	500	630.2

Test Date: May 21, 2020

Tested By
Signature: Afzal Fazal Name: Afzal Fazal

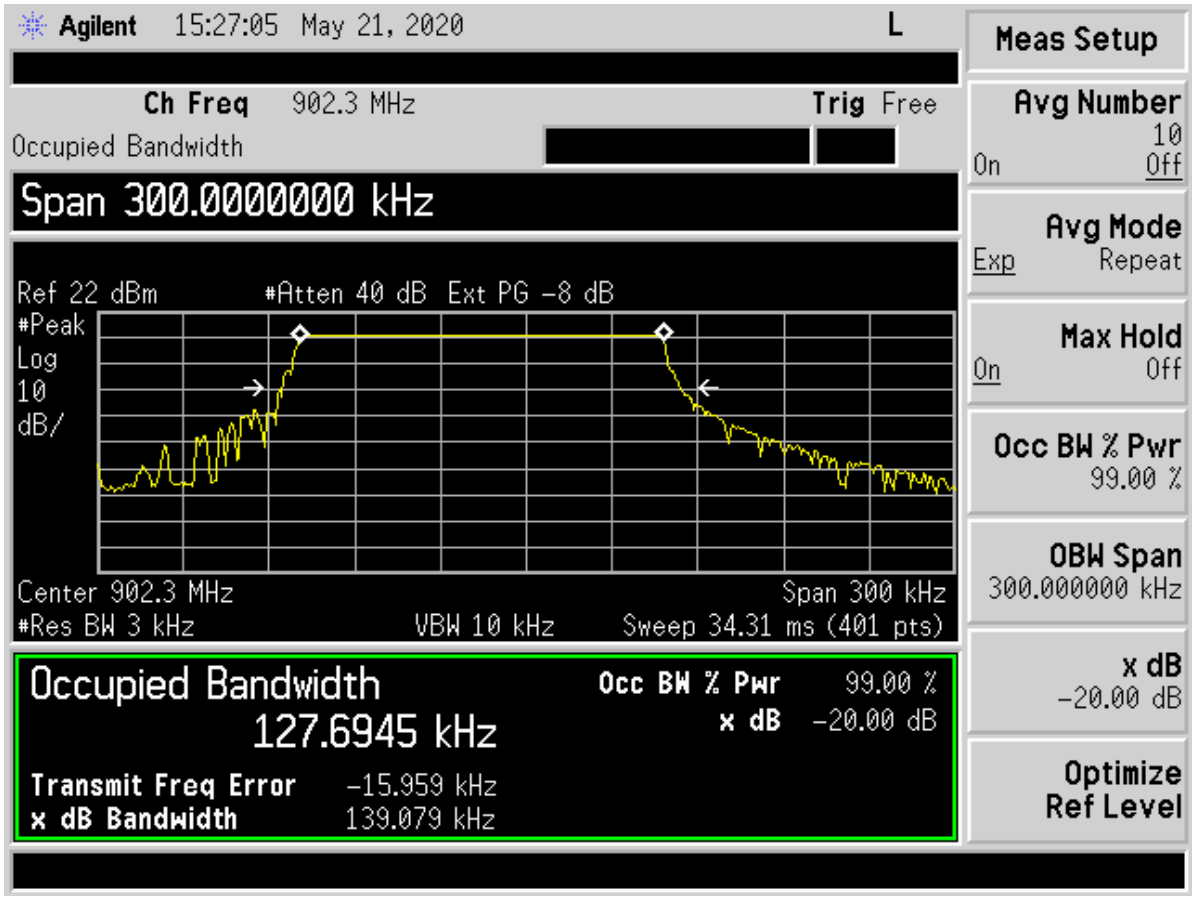


Figure 22. FHSS 20 dB Bandwidth – Low Channel

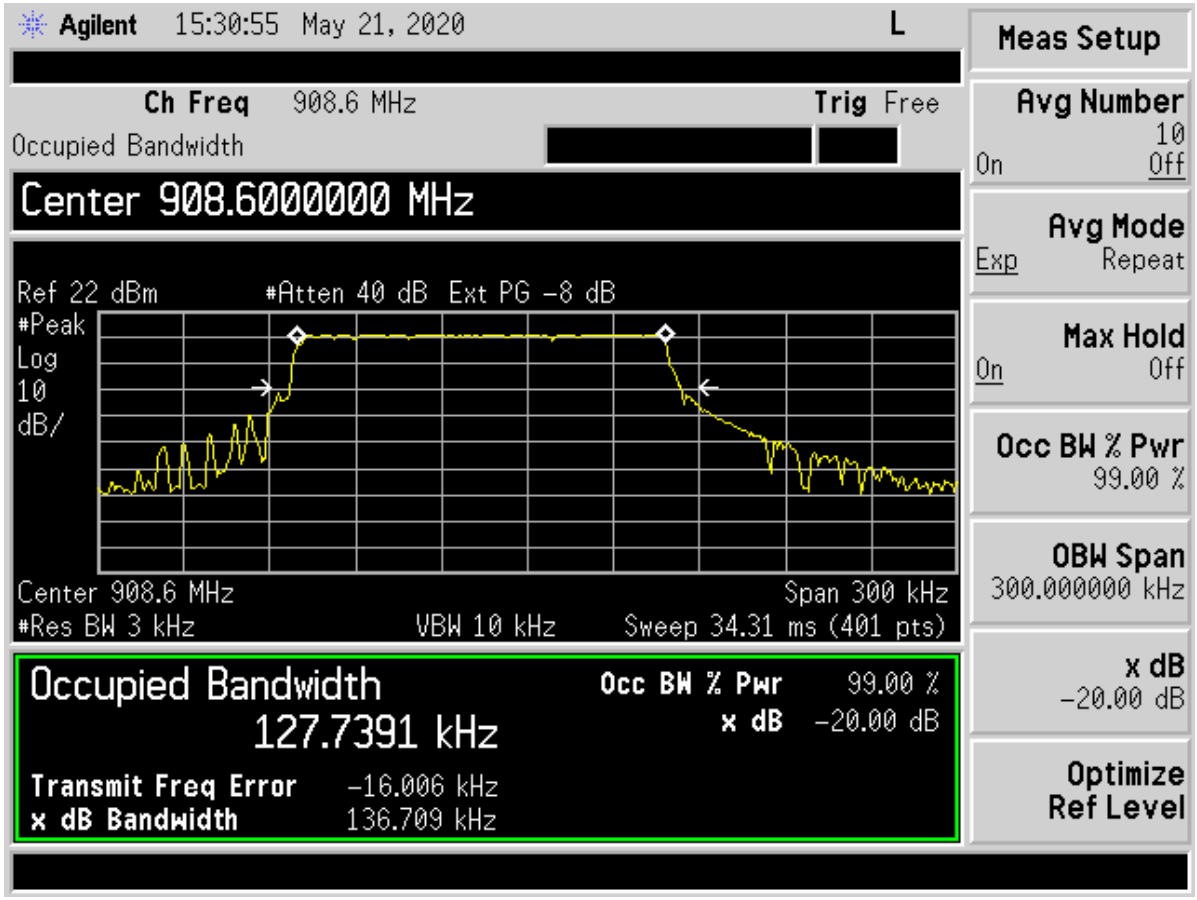


Figure 23. FHSS 20 dB Bandwidth – Mid Channel

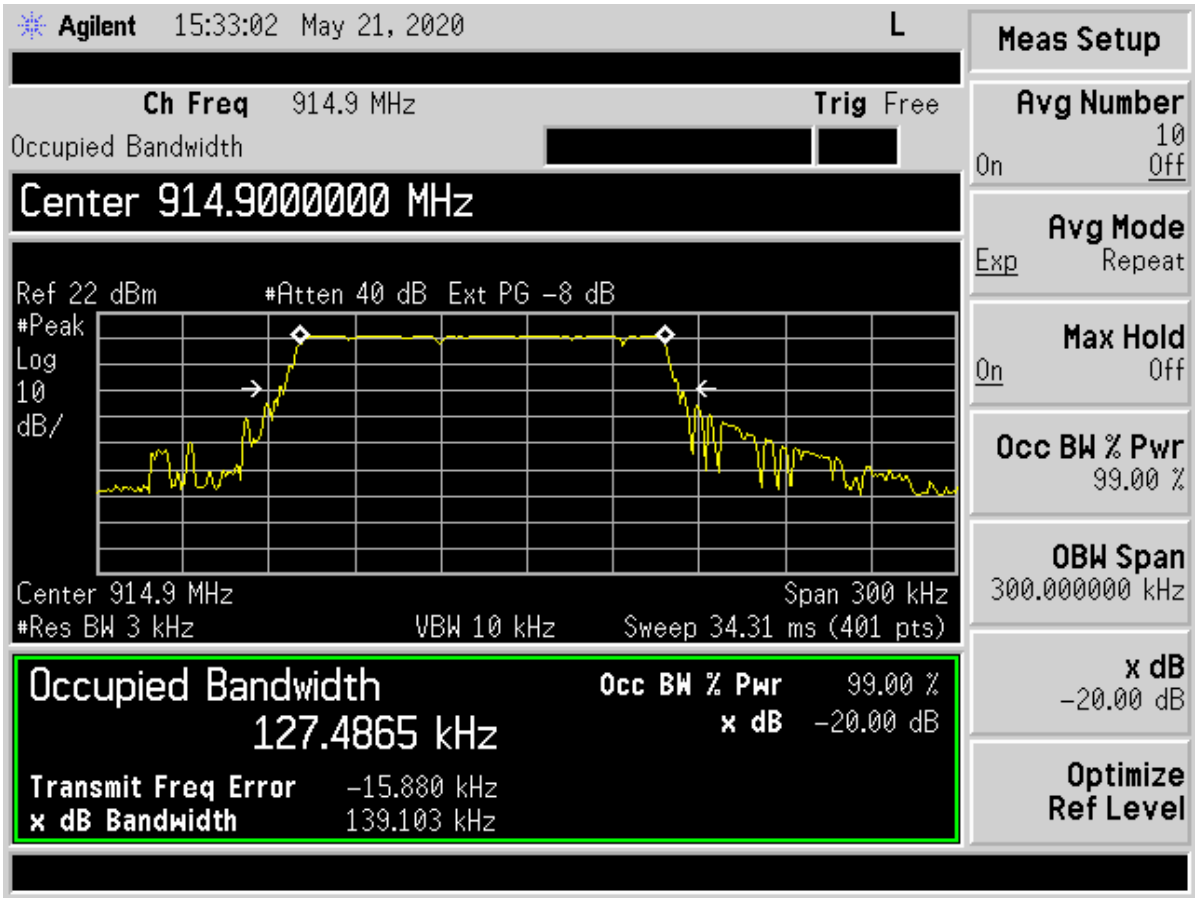


Figure 24. FHSS 20 dB Bandwidth – High Channel

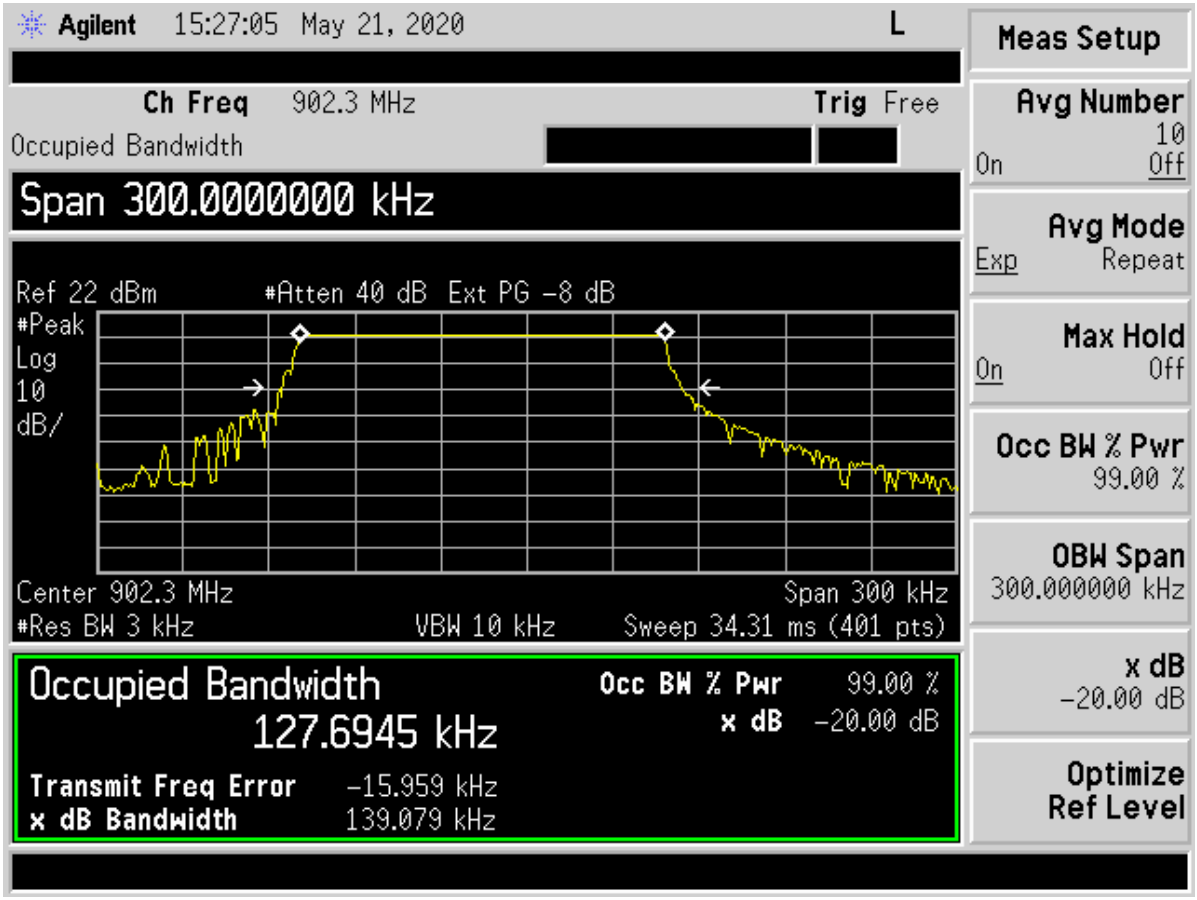


Figure 25. FHSS 99% Occupied Bandwidth – Low Channel

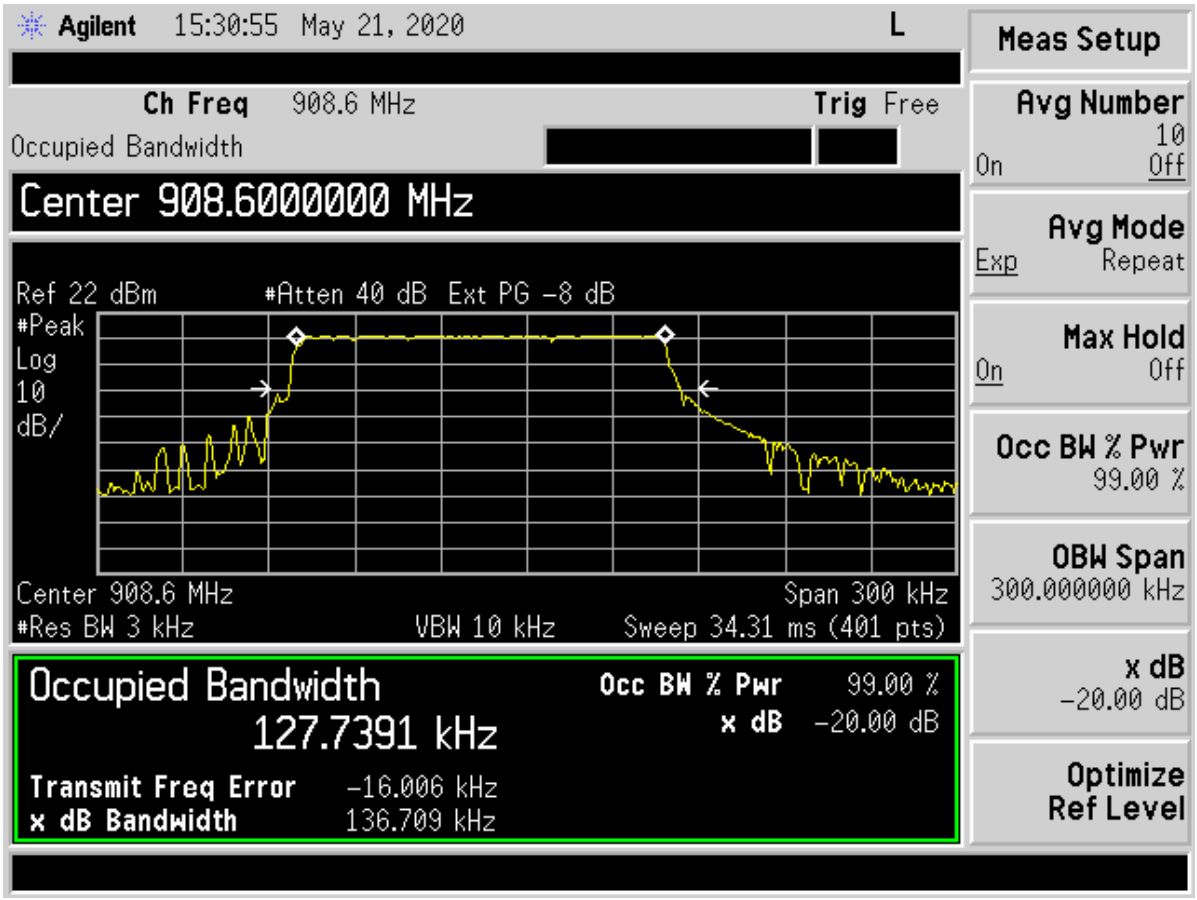


Figure 26. FHSS 99% Occupied Bandwidth – Mid Channel

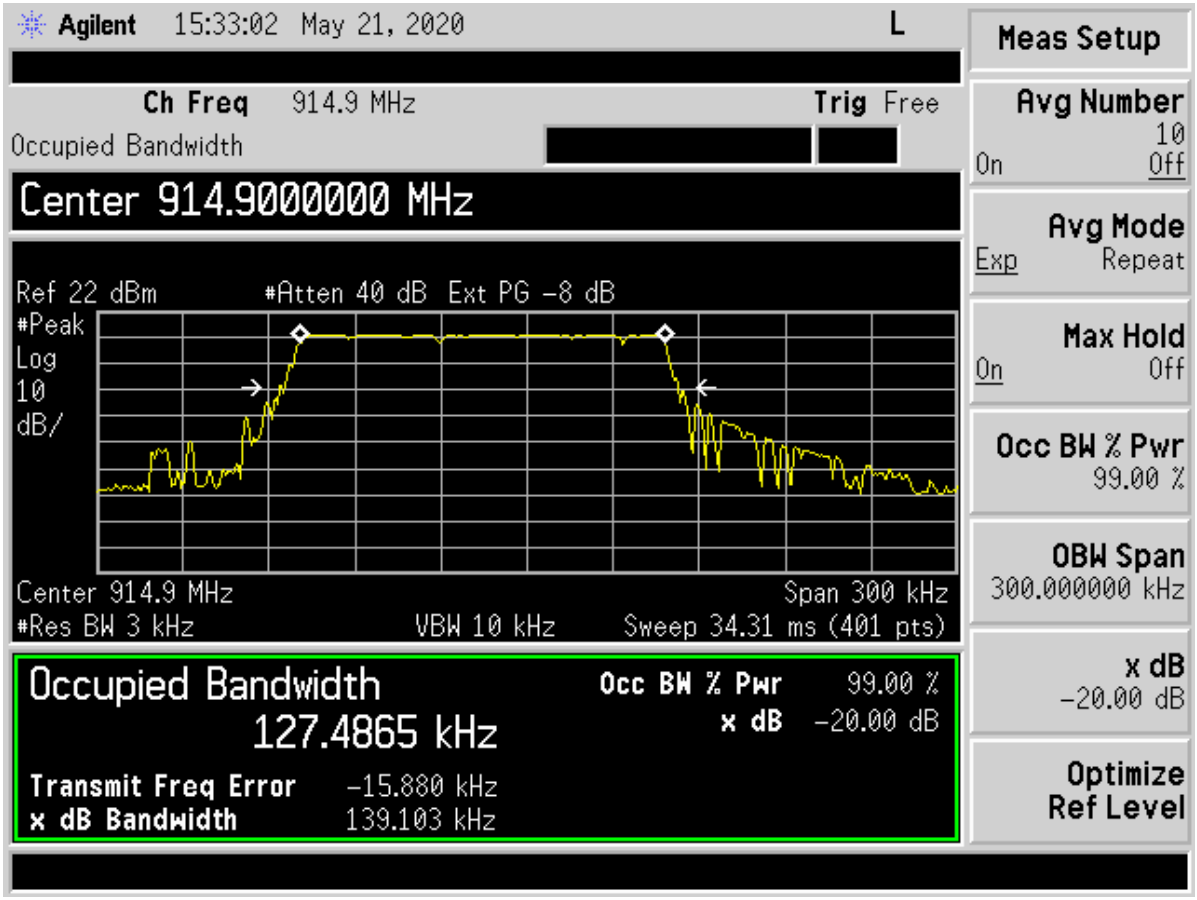


Figure 27. FHSS 99% Occupied Bandwidth – High Channel

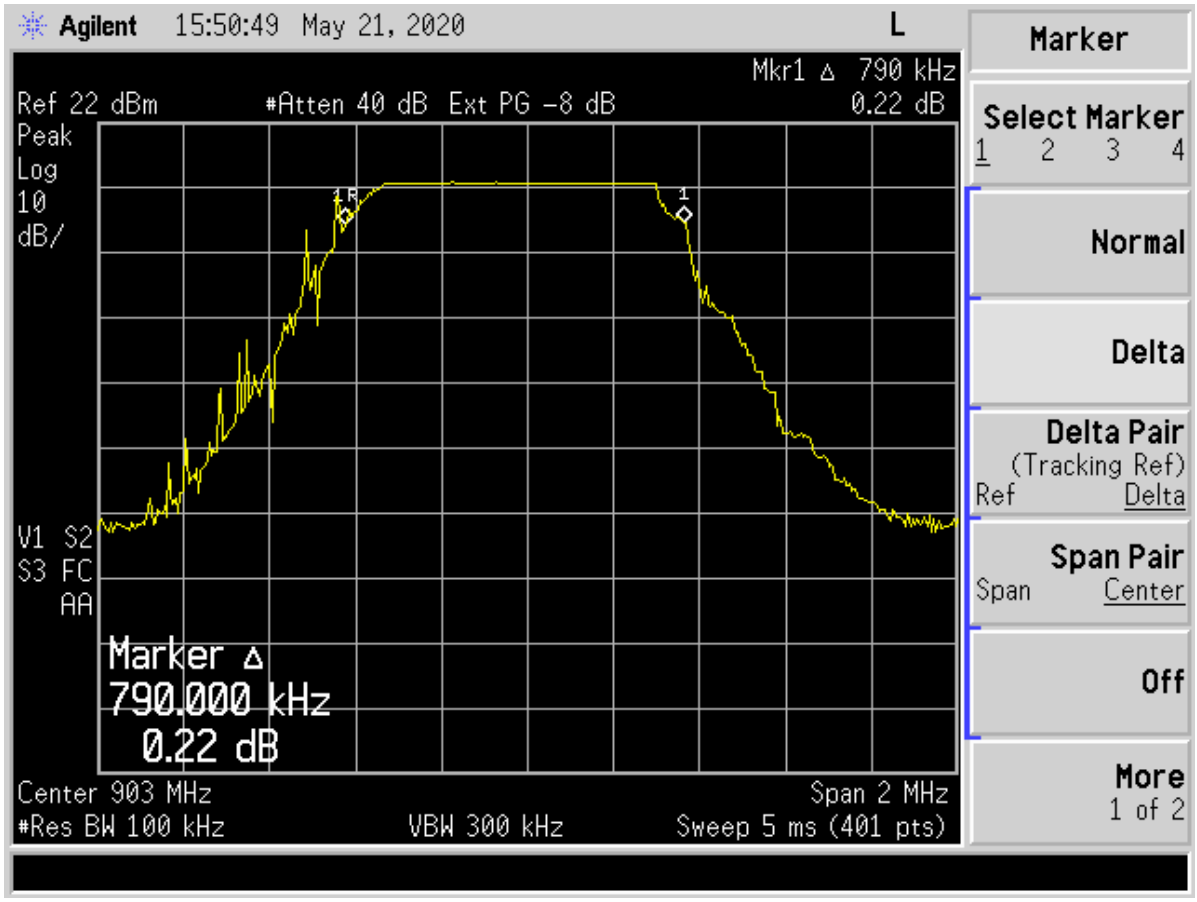


Figure 28. DTS 6 dB Bandwidth – Low Channel

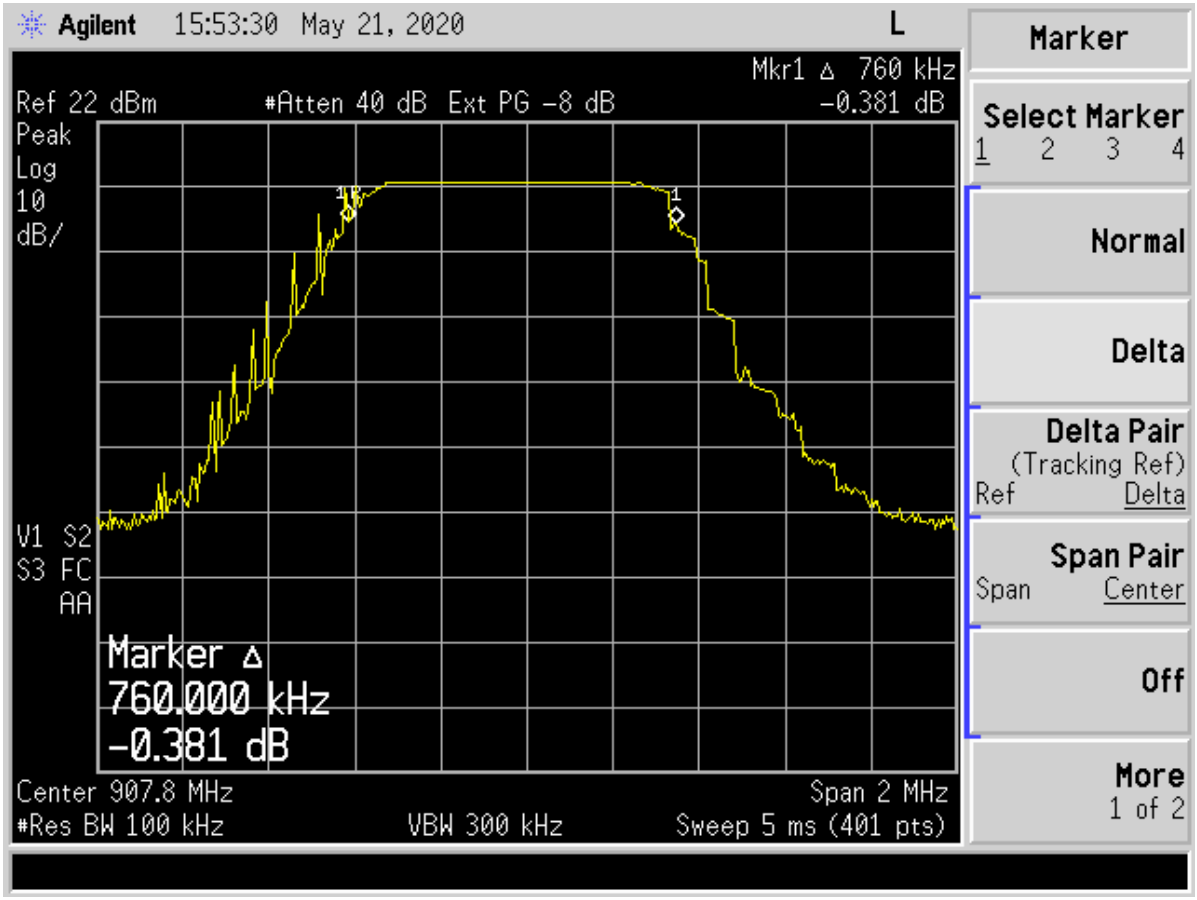


Figure 29. DTS 6 dB Bandwidth – Mid Channel

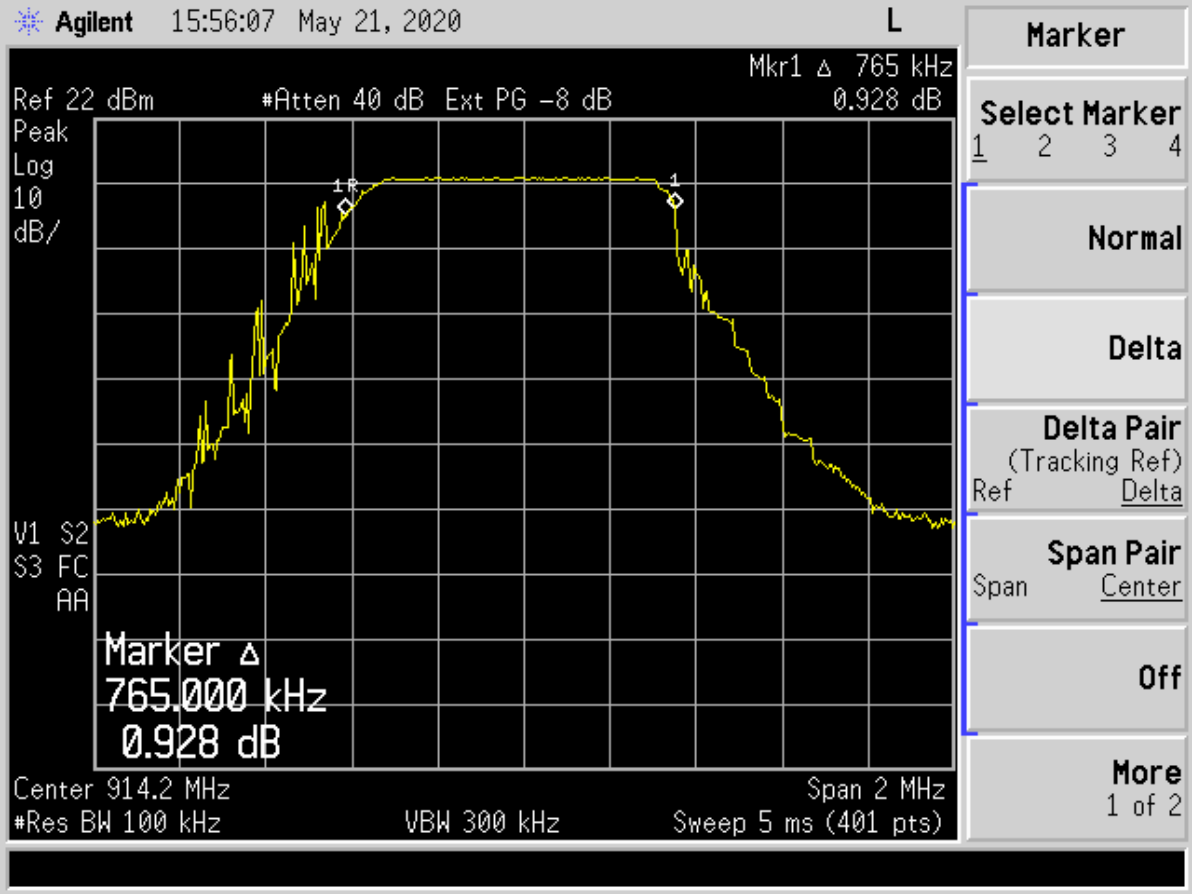


Figure 30. DTS 6 dB Bandwidth – High Channel

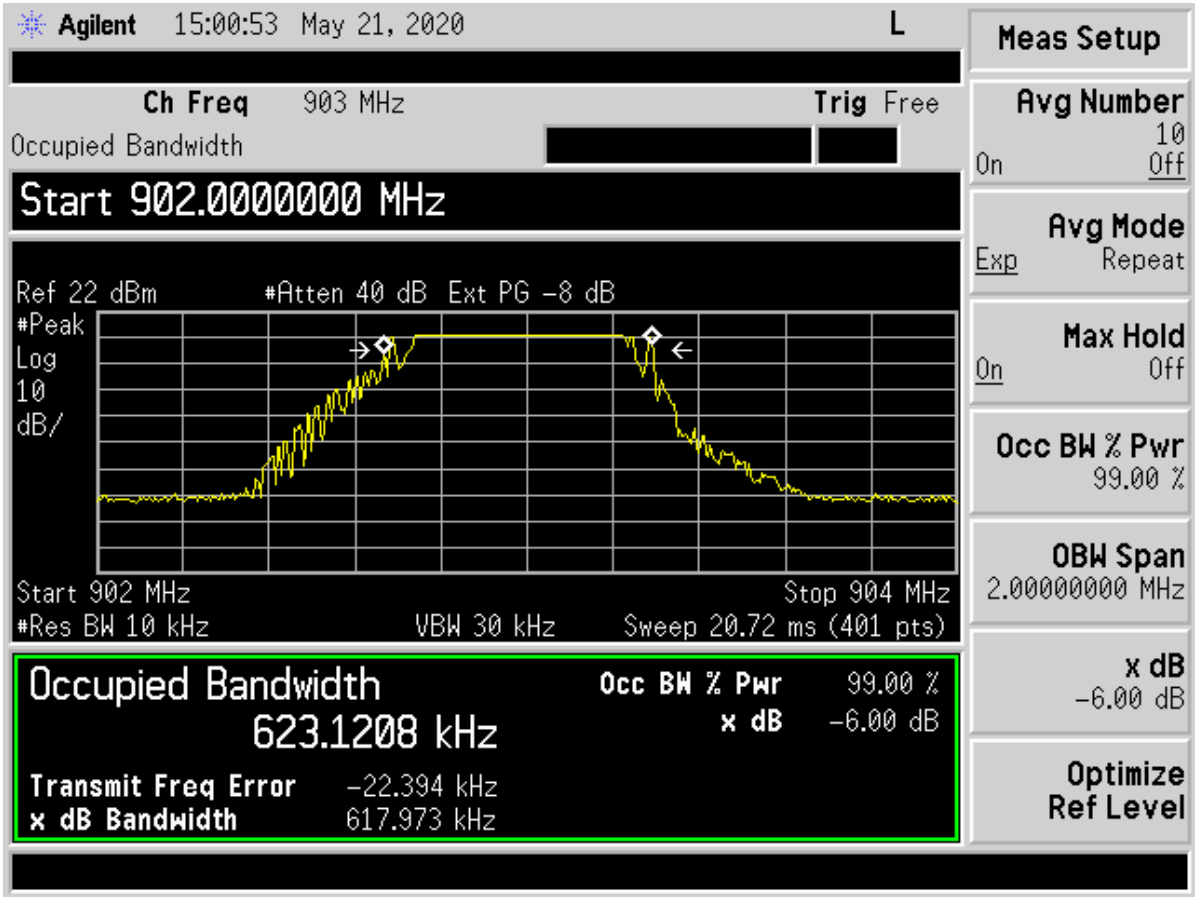


Figure 31. DTS 99% Occupied Bandwidth – Low Channel

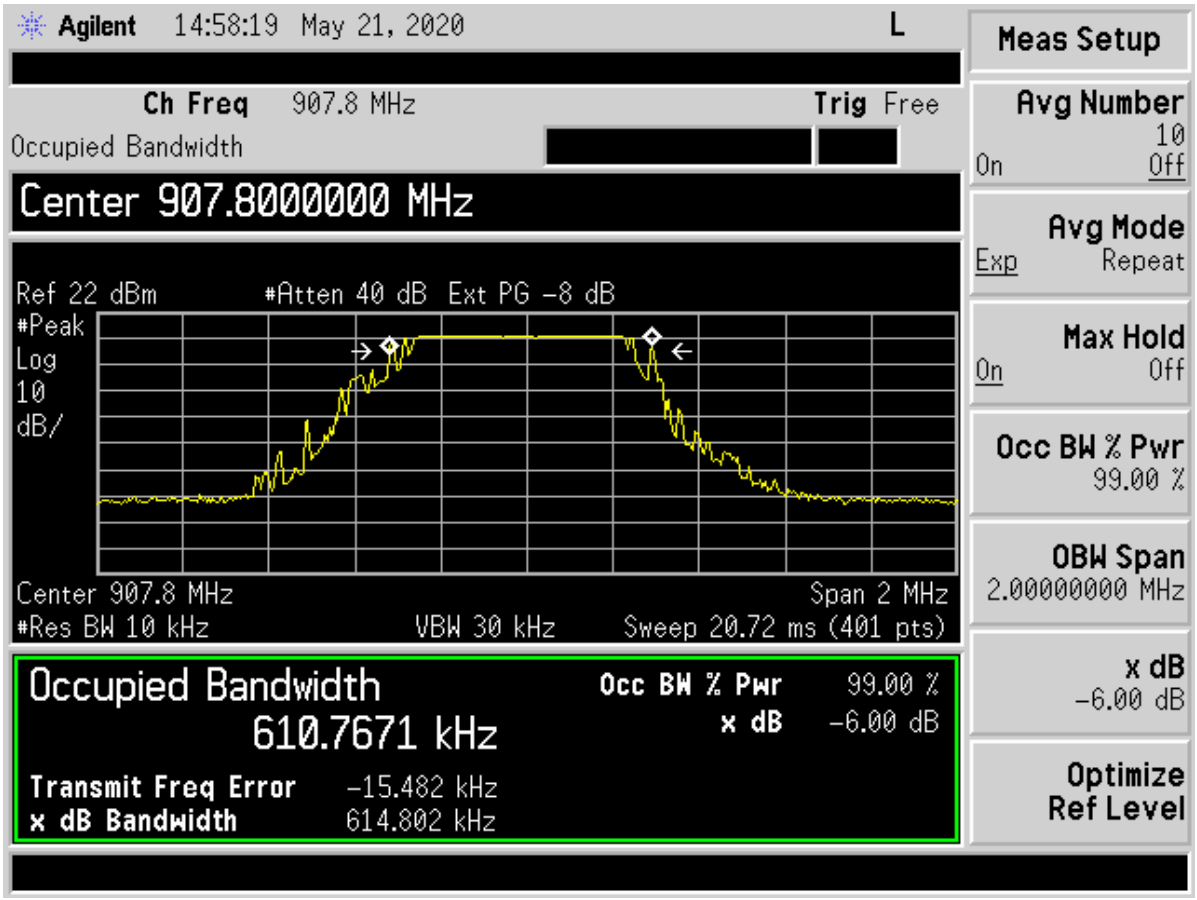


Figure 32. DTS 99% Occupied Bandwidth – Mid Channel

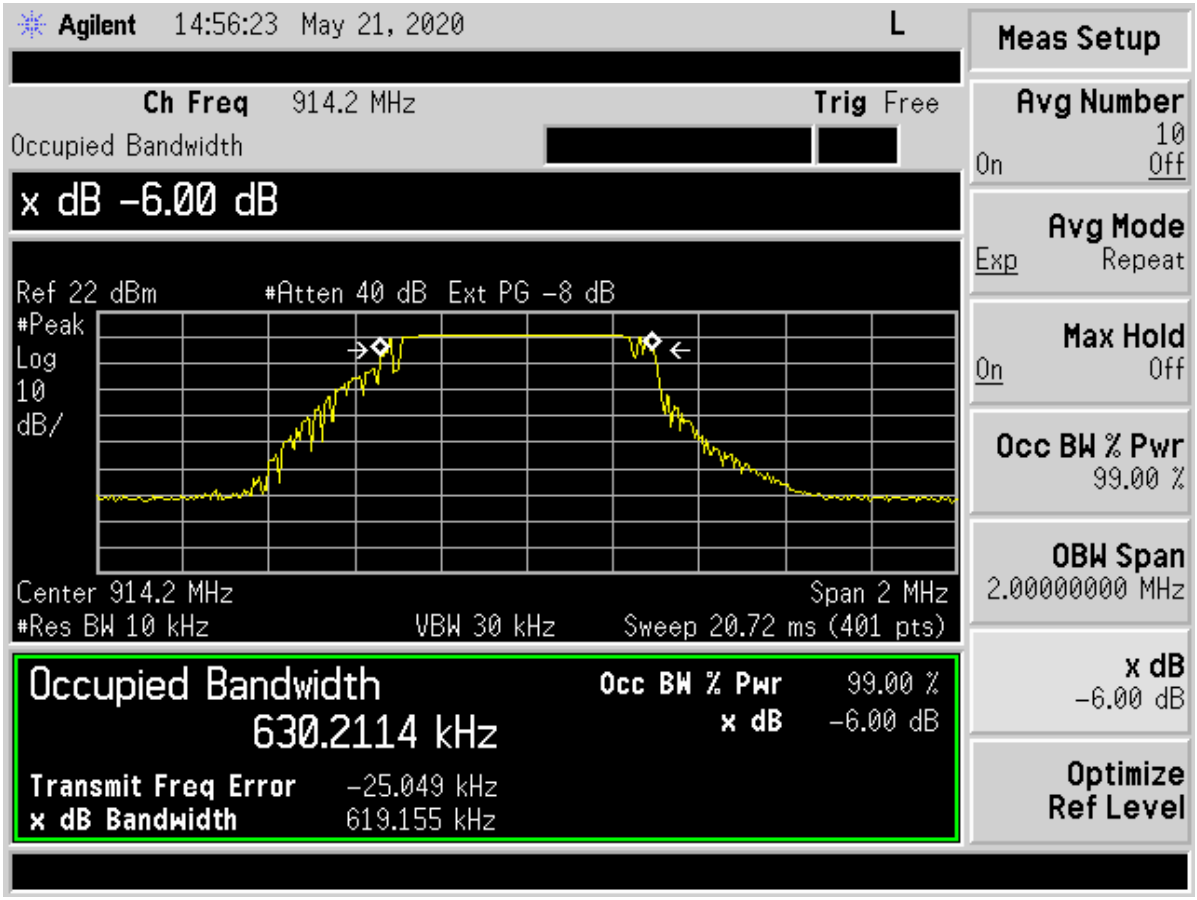


Figure 33. DTS 99% Occupied Bandwidth – High Channel

2.13 Maximum Peak Conducted Output Power (CFR 15.247 (b) (2), CFR 15.247 (b) (3))

For frequency hopping systems in the 902-928 MHz band with at least 50 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed 1 watt. Systems with less than 50 hopping channels, but at least 25 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed .25 watts. Since the EUT has 50 hopping channels, the maximum peak conducted output power shall not exceed 1 watt.

For systems using digital modulation in the 902-928 MHz, the maximum peak conducted output power of the intentional radiator shall not exceed 1 watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Peak power within the band 902 MHz to 915 MHz was measured per ANSI C63.10-2013 as an Antenna Conducted test with a spectrum analyzer. For these measurements the EUT antenna port was connected to a spectrum analyzer having a 50Ω input impedance. The setup losses were corrected by using a -8.00 dB offset in the analyzer measurements. Peak antenna conducted output power is tabulated in the table below.

Table 14. Peak Antenna Conducted Output Power per Part 15.247 (b) (2)

Frequency (MHz)	Test Data (dBm)	Converted Data (mW)	FCC Limit (mW Maximum)
902.3	11.74	14.93	1000
908.6	11.61	14.49	1000
914.9	11.56	14.32	1000

Test Date: January 17, 2020

Tested By
Signature:  Name: Afzal Fazal

Table 15. Peak Antenna Conducted Output Power per Part 15.247 (b) (3)

Frequency (MHz)	Raw Test Data (dBm)	Converted Data (mW)	FCC Limit (mW Maximum)
903.0	12.91	19.54	1000
907.8	12.82	19.15	1000
914.2	12.76	18.88	1000

Test Date: May 26, 2020

Tested By
Signature:  Name: Afzal Fazal

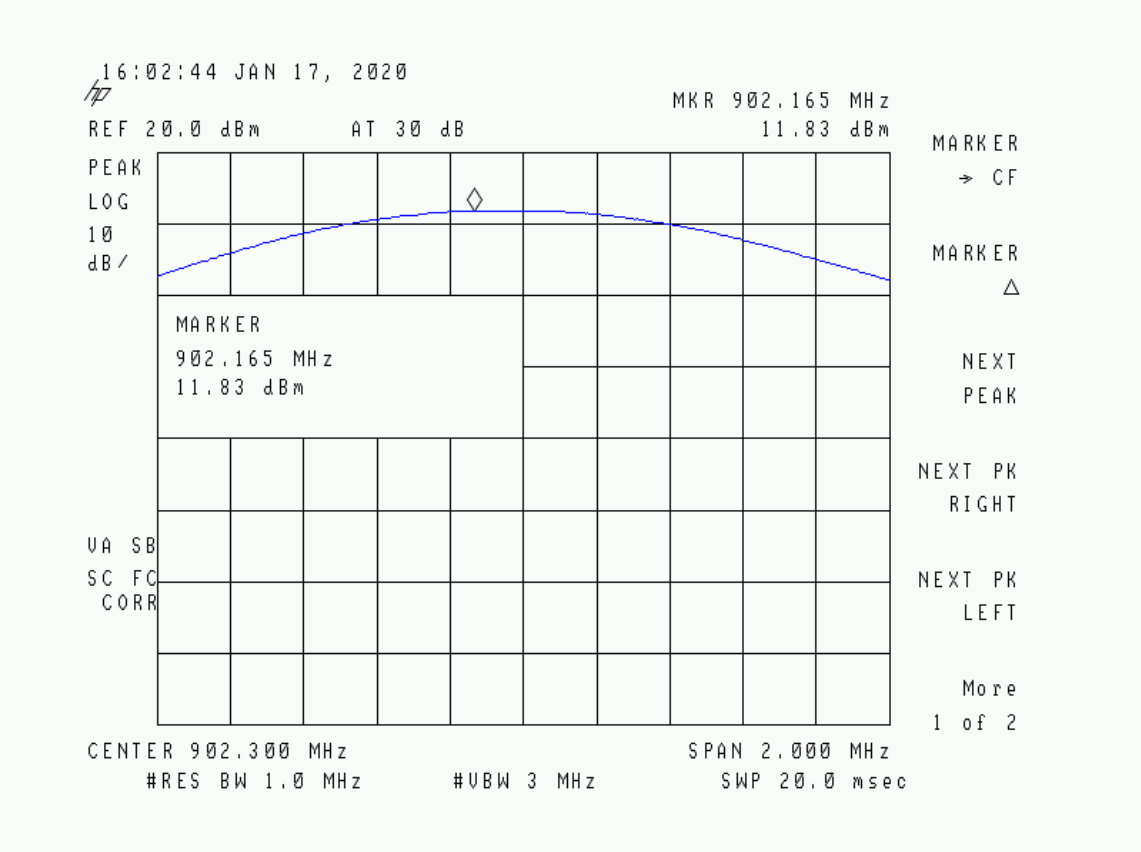


Figure 34. FHSS Peak Antenna Conducted Output Power, Low Channel

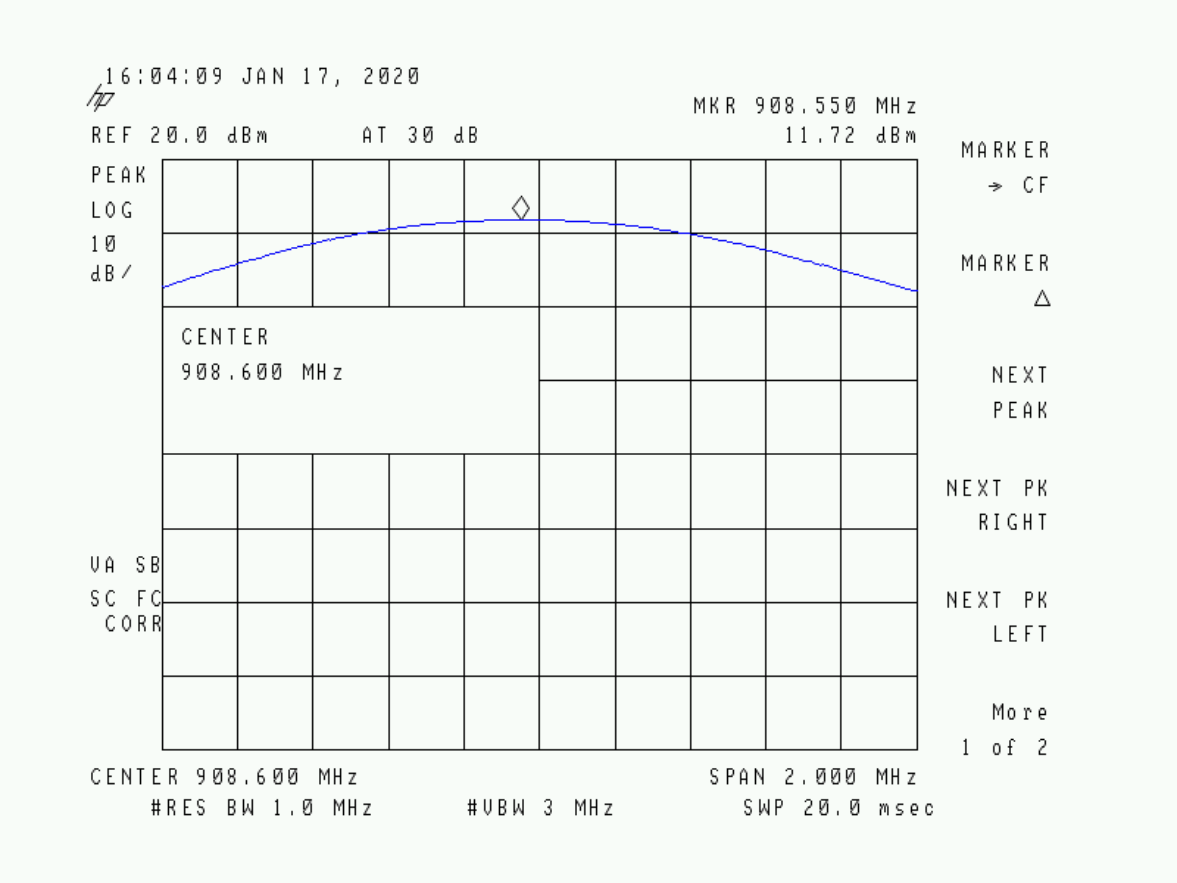


Figure 35. FHSS Peak Antenna Conducted Output Power, Mid Channel

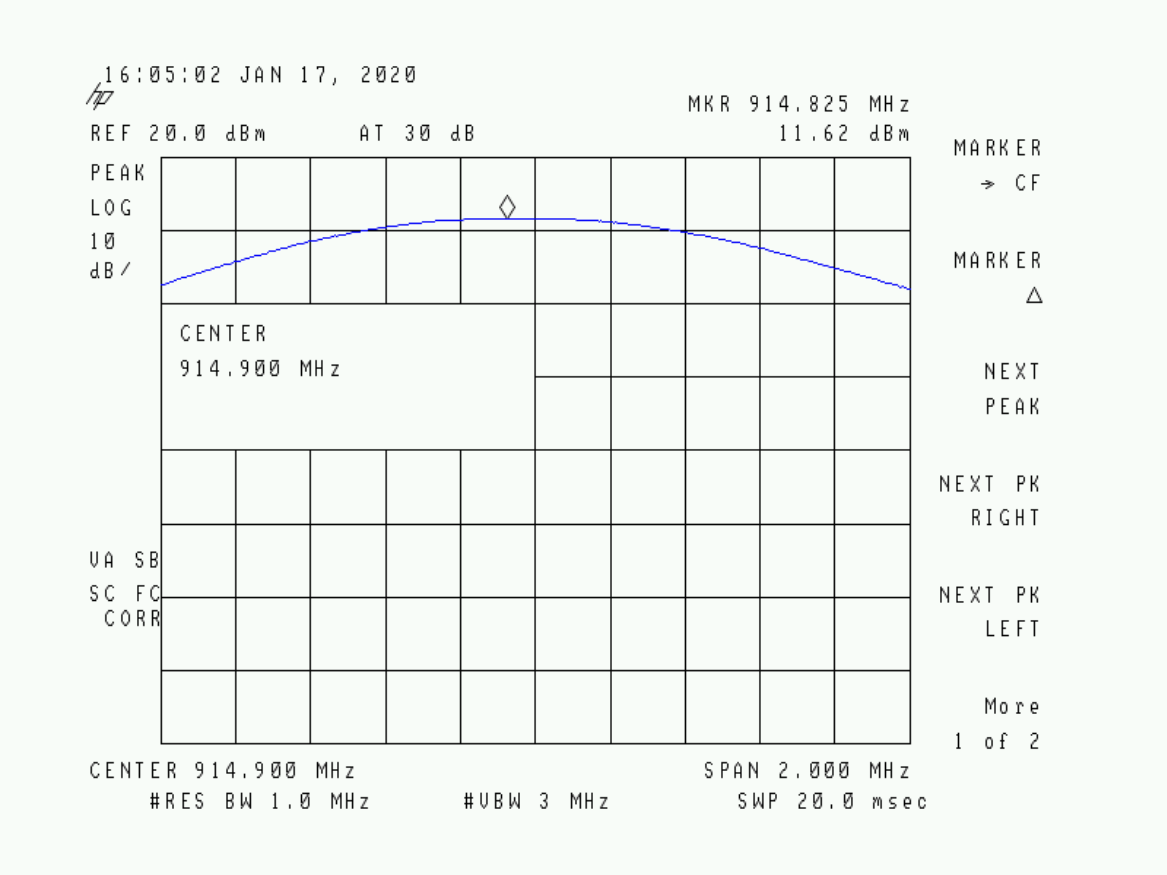


Figure 36. FHSS Peak Antenna Conducted Output Power, High Channel

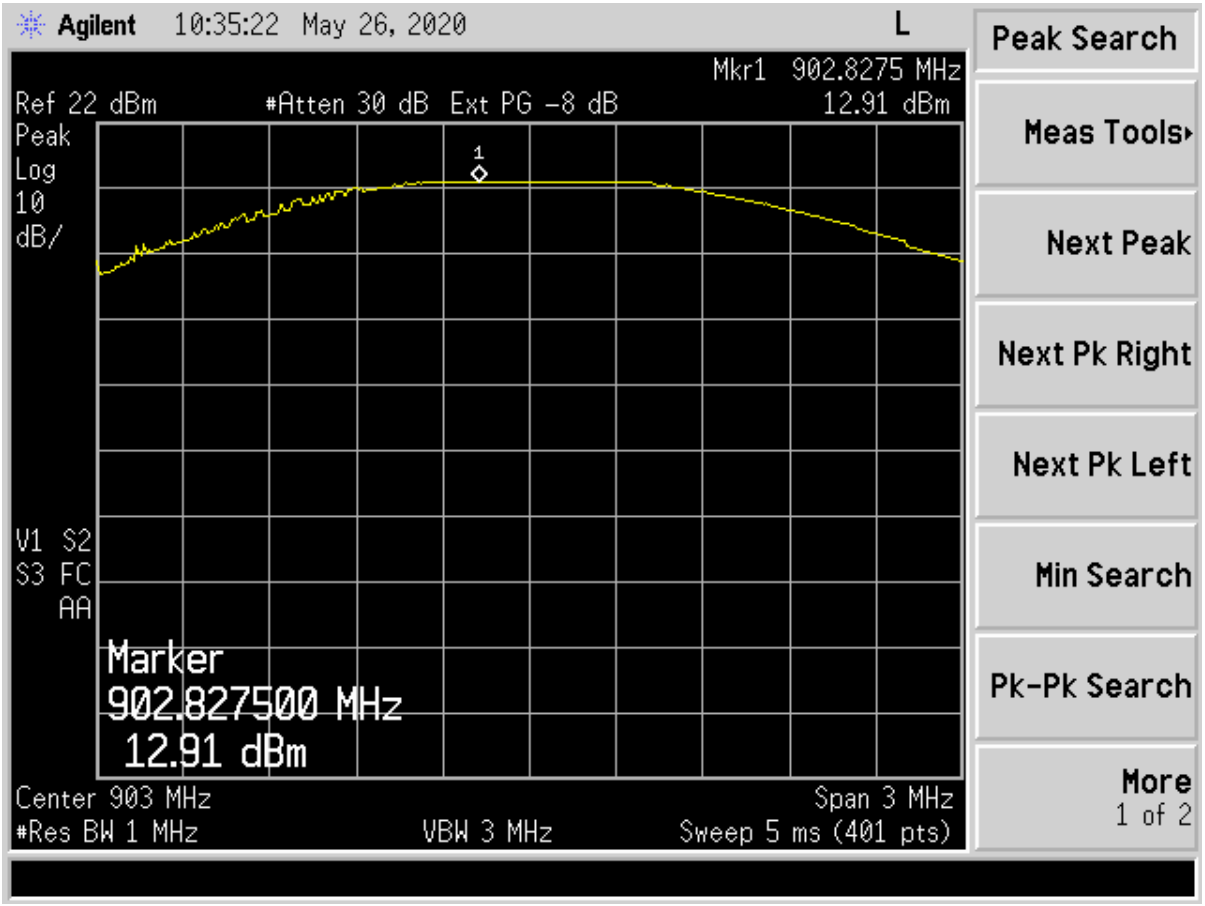


Figure 37. DTS Peak Antenna Conducted Output Power, Low Channel

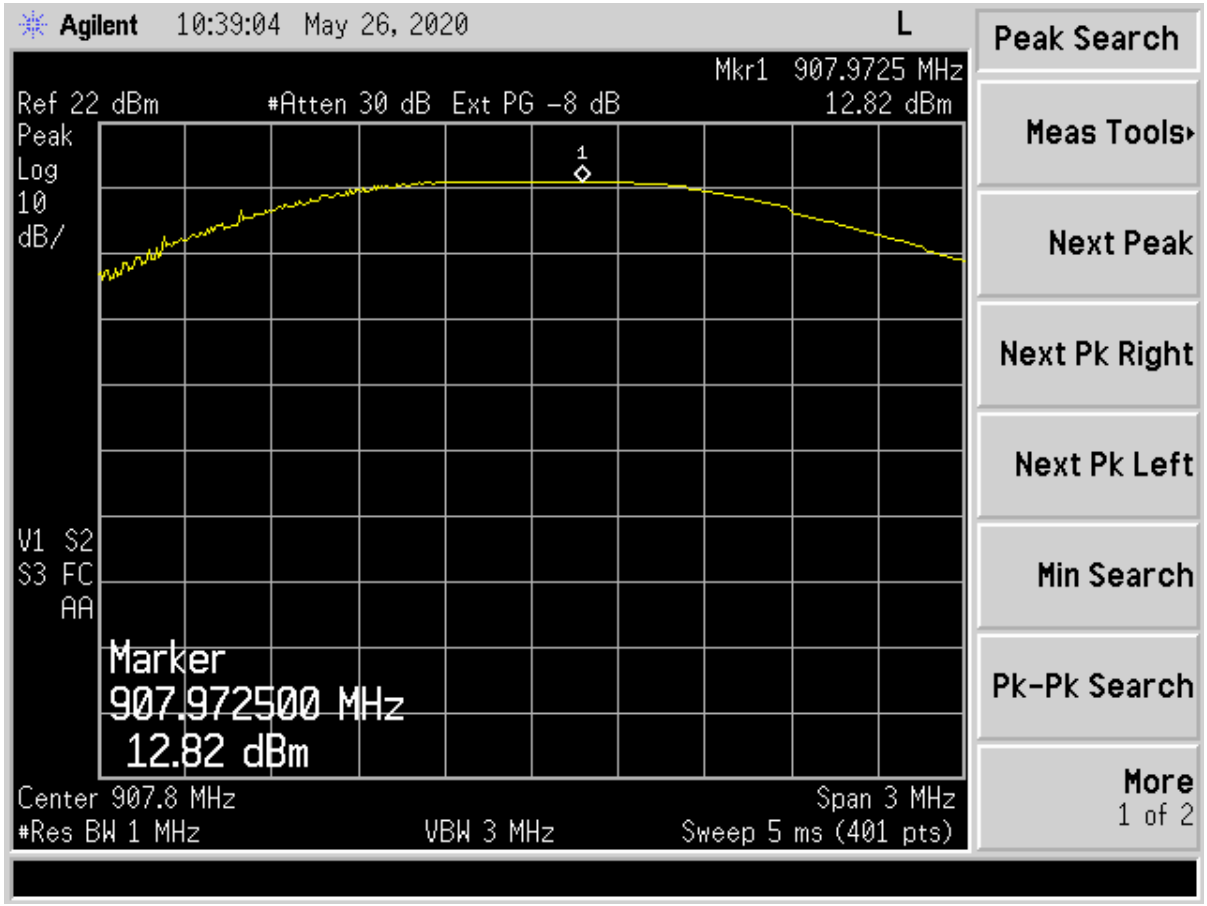


Figure 38. DTS Peak Antenna Conducted Output Power, Mid Channel

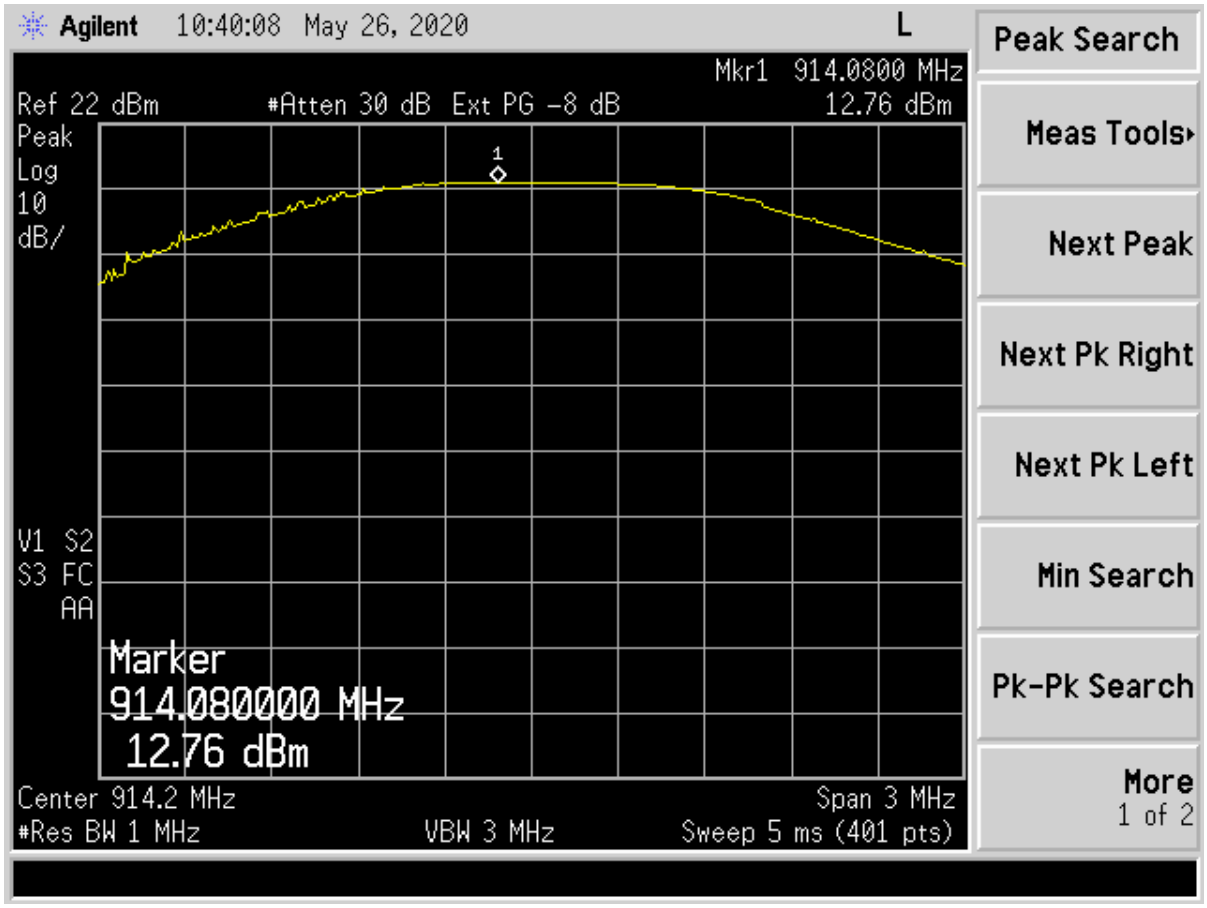


Figure 39. DTS Peak Antenna Conducted Output Power, High Channel

2.14 Number of Hopping Frequencies (CFR 15.247 (a)(1))

Frequency hopping systems in the 902-928 MHz band shall have at least 50 hopping frequencies if the 20 dB bandwidth is less than 250 kHz. If the 20 dB bandwidth is 250 kHz or greater, then the system shall have at least 25 hopping frequencies. Since the EUT has a 20 dB bandwidth less than 250 kHz, then at least 50 hopping frequencies shall be used.

The test procedures outlined in ANSI C63.10-2013 were used to conduct measurements.

The figures below show all available channels. There are a total of 50 channels.

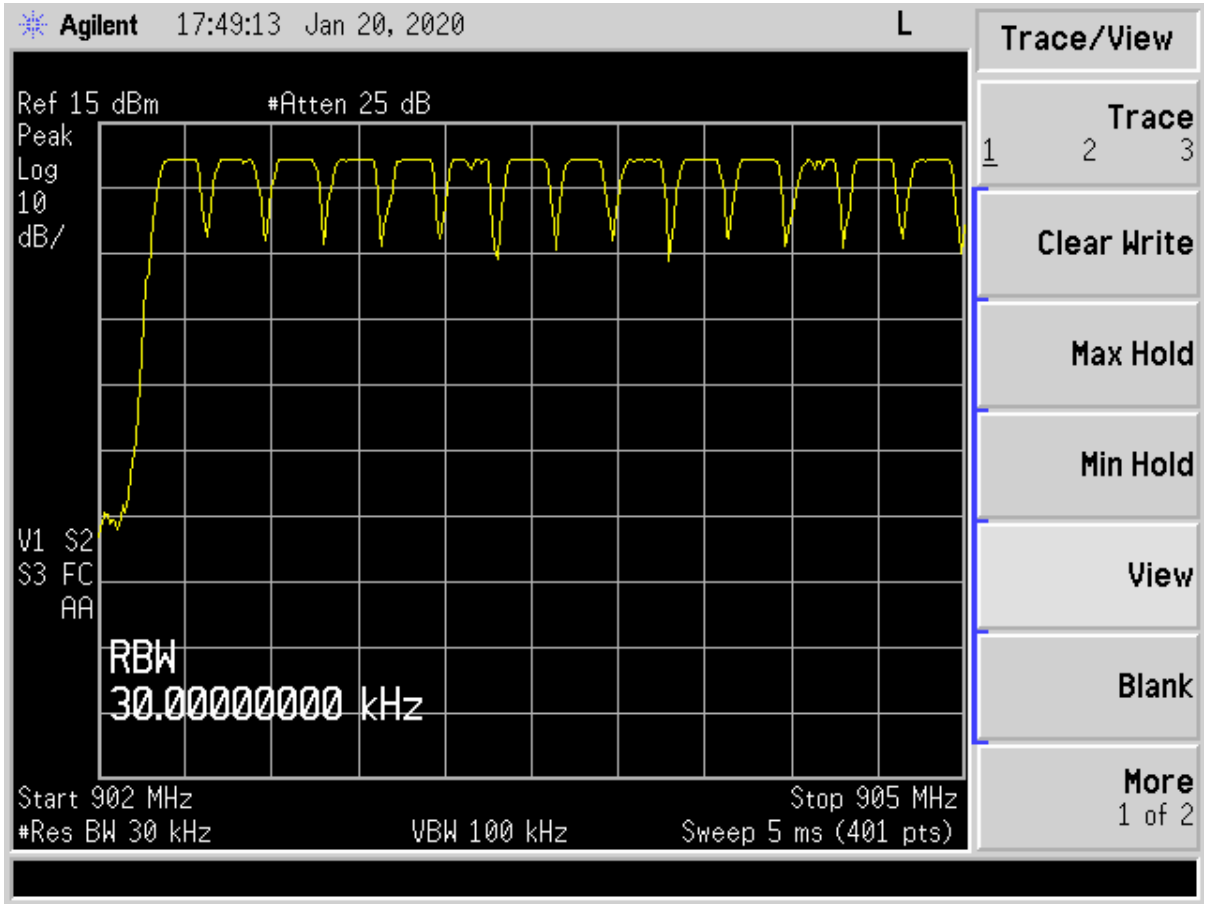


Figure 40. Hopping Channels 1 through 14

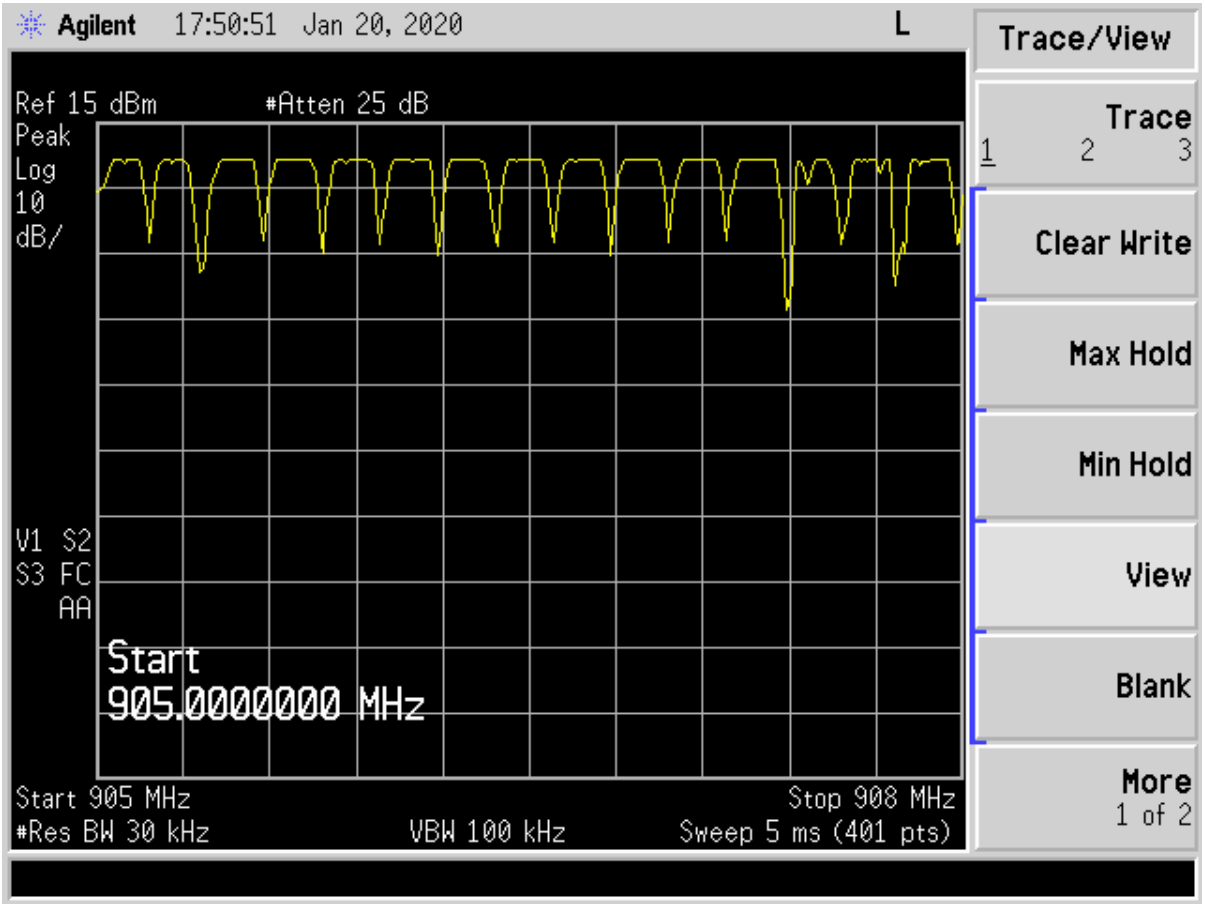


Figure 41. Hopping Channels 15 through 29

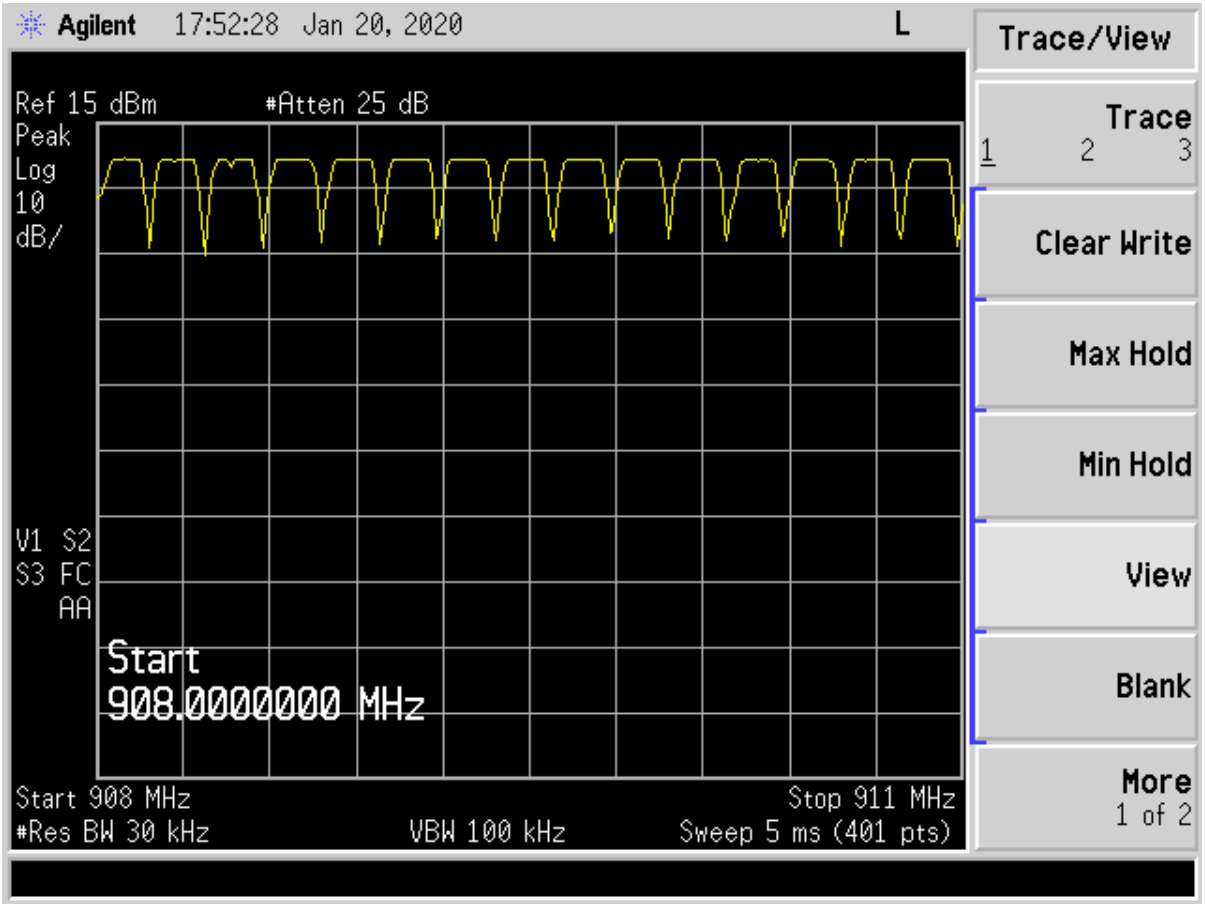


Figure 42. Hopping Channels 30 through 44

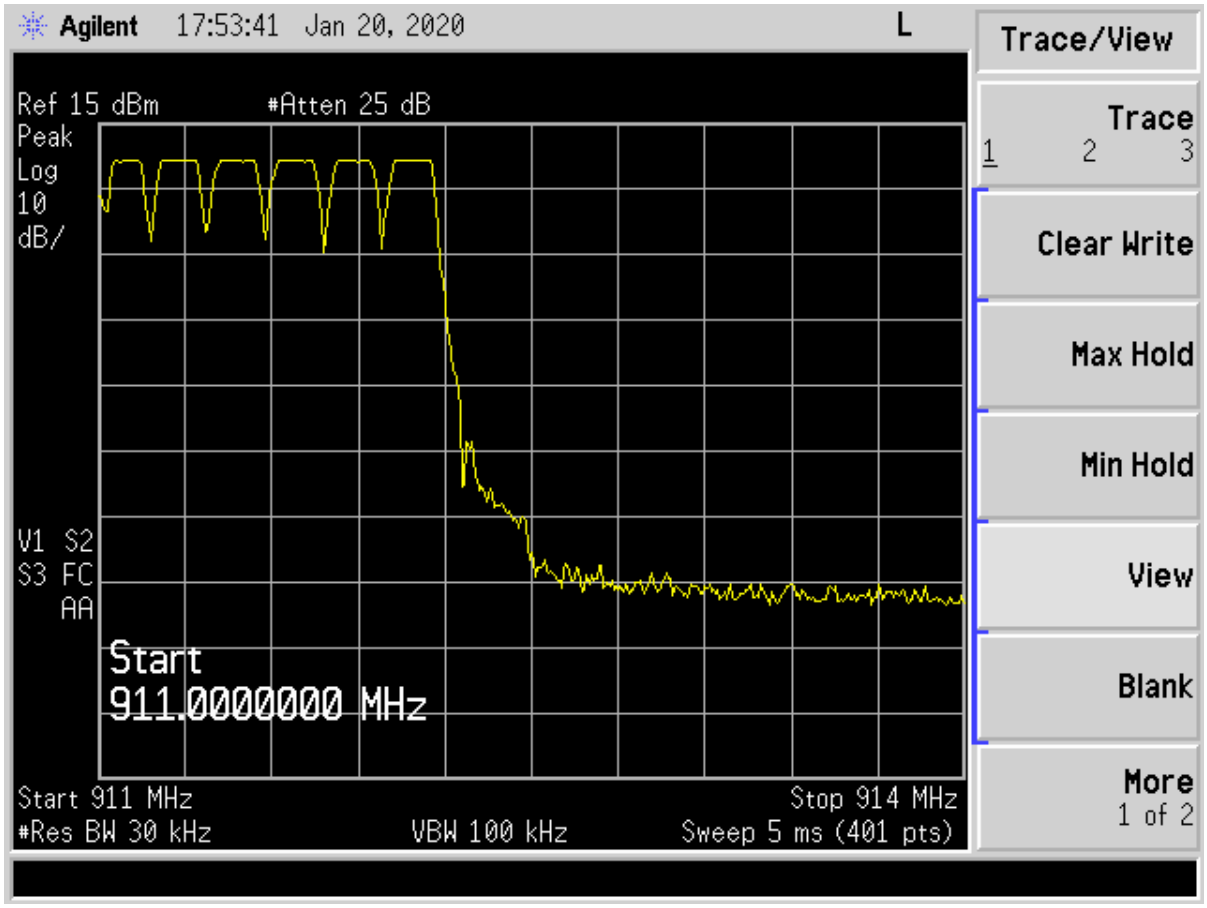


Figure 43. Hopping Channels 44 through 50

2.15 Frequency Separation (CRF 15.247(a)(1))

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. In this case, the 20 dB bandwidth of the Frequency hopping system is greater than 25 kHz, so the minimum requirement used was the 20 dB bandwidth, 72.5 kHz. Therefore the frequency separation must be greater than 72.5 kHz.

The EUT does meet the frequency separation requirement.

The test procedure outlined in ANSI C63.10-2013 was used to conduct measurements. The EUT hopping function was enabled during the testing.

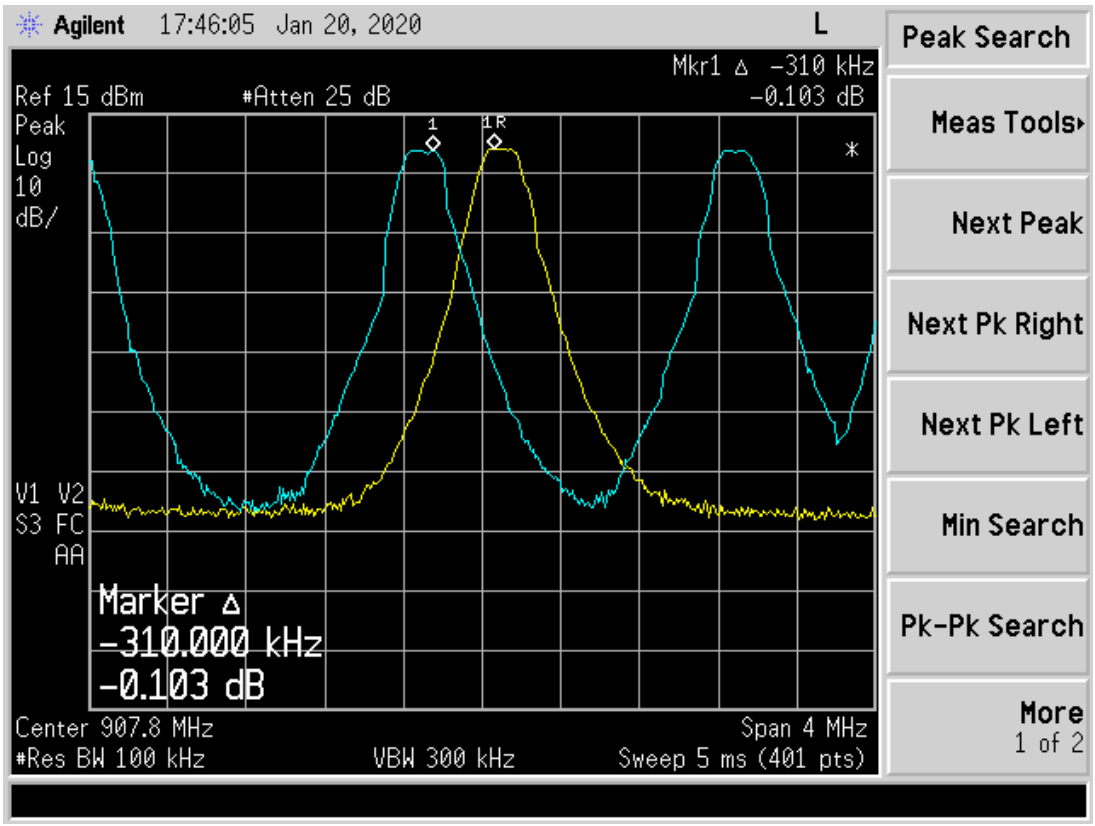


Figure 44. Channel Separation

Measured Delta (Figure 45 above)	310.0 kHz
-Limit (20 dB Bandwidth)	72.5 kHz
Margin	237.5 kHz

2.16 Average Time of Occupancy (CFR 15.247(f))

The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The EUT meets this requirement, as presented in the figure below.

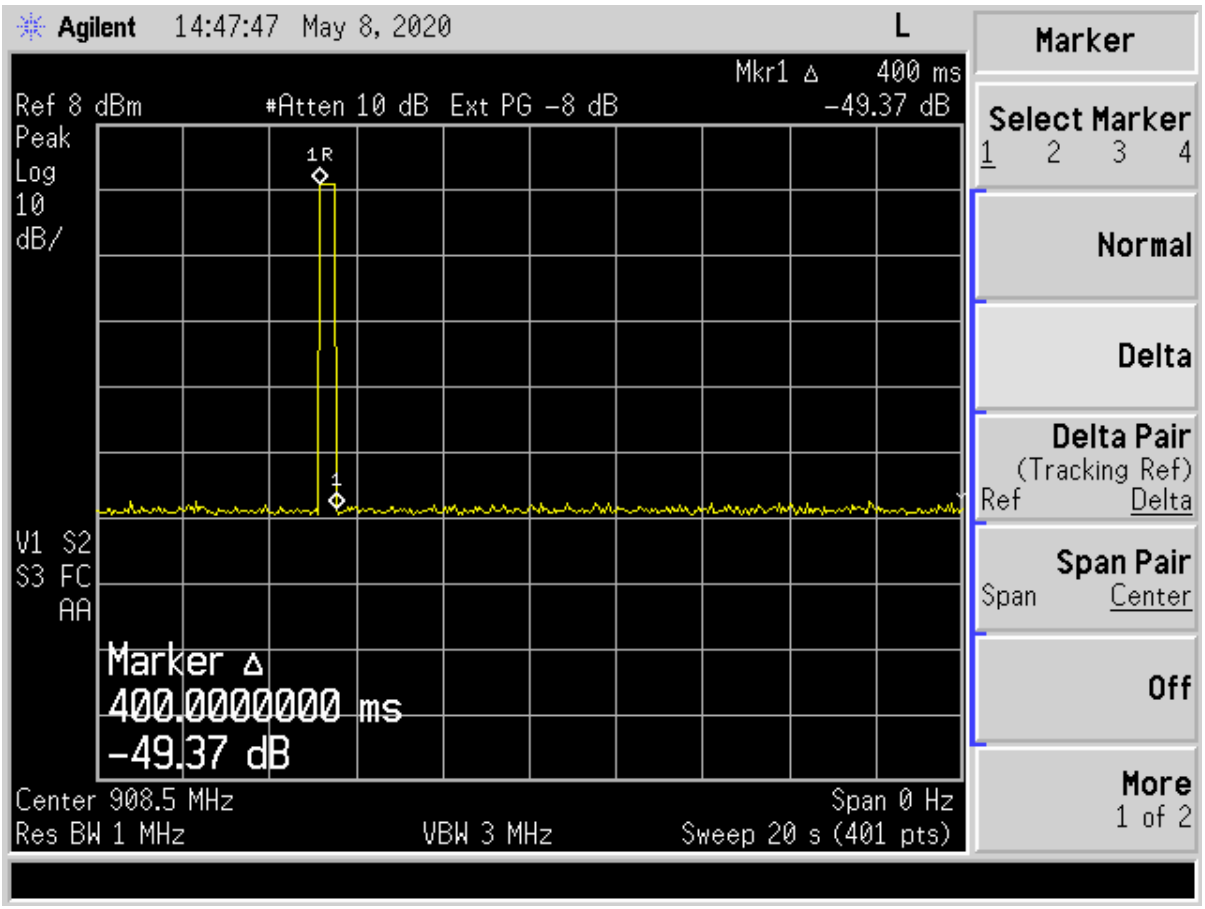


Figure 45. Time of Occupancy

2.17 Power Spectral Density (CFR 15.247(e), RSS-247, 5.2(b))

The transmitter was placed into a continuous mode of operation at all applicable frequencies. The measurements were performed per the procedures of ANSI C63.10-2013. The RBW was set to 3 kHz and the Video Bandwidth was set to ≥ RBW. The trace capture time was set to (Span/3 kHz).

In accordance with 15.247 (e), the power spectral density shall be no greater than +8 dBm per any 3 kHz band.

Results are shown in the table below and figures below. All are less than +8 dBm per 3 kHz band. SEE figures above.

Note: dBm/Hz correct to dBm/kHz using the following formula, 10 log RBWref/RBWmeasured.

Table 16. Power Spectral Density for Low, Mid and High Bands

Frequency (MHz)	Measured Results (dBm/Hz)	FCC Limit (dBm/3 kHz)	Verdict
903.0	7.151	+8.0	PASS
907.8	4.885	+8.0	PASS
914.2	6.203	+8.0	PASS

Test Date: May 21, 2020

Tested By
Signature: Afzal Fazal Name: Afzal Fazal

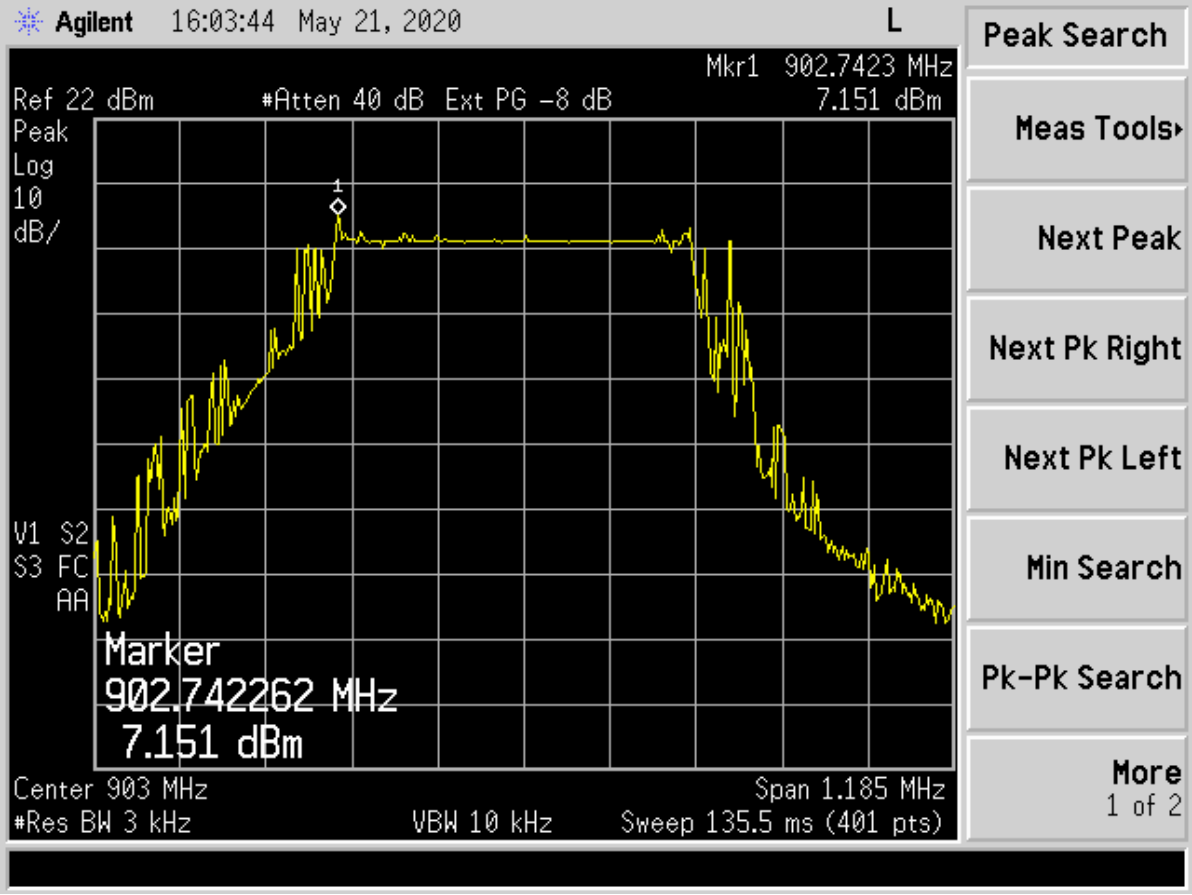


Figure 46. Power Spectral Density, Low Channel

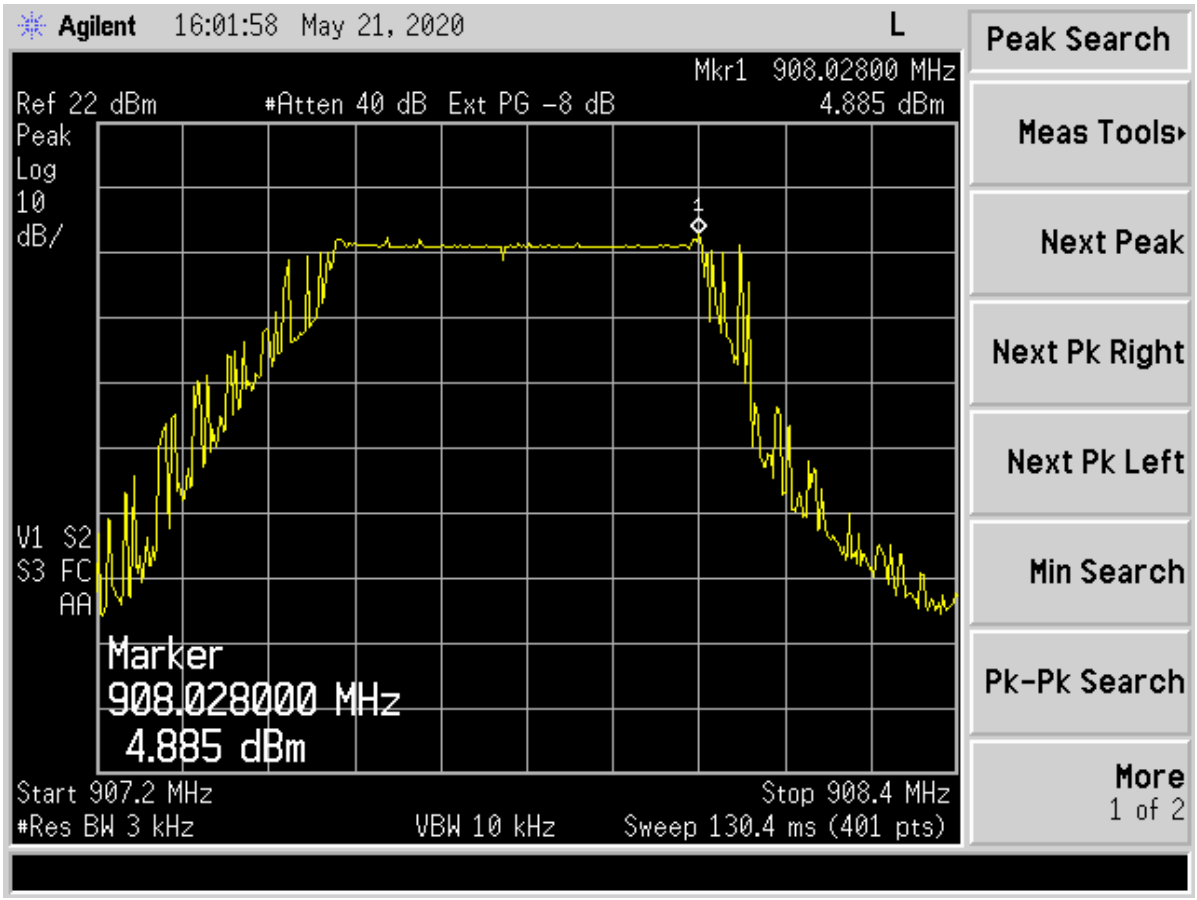


Figure 47. Power Spectral Density, Mid Channel

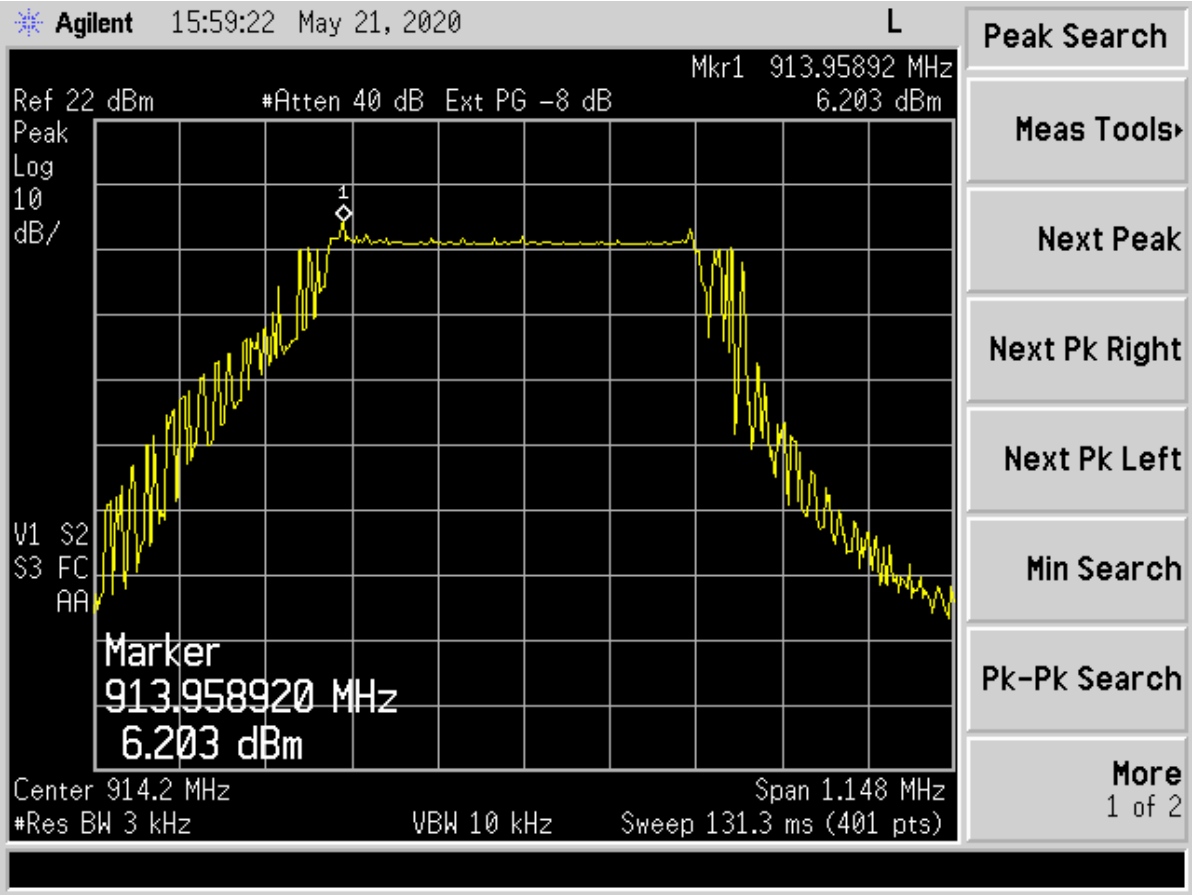


Figure 48. Power Spectral Density, High Channel

2.18 Intentional Radiator, Powerline Emissions (CFR 15.207)

The EUT was battery powered; therefore this test was not applicable.

2.19 Intentional Radiator, Radiated Emissions (CFR 15.209)

Radiated emissions disturbance measurements were performed with the EUT set to the DTS mode since that mode had the highest fundamental emission output.

An instrument having both peak and quasi-peak detectors was used to perform the test over the frequency range of 30 MHz to five times the highest clock frequency. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

The worst-case radiated emission in the range of 30 MHz to 9.3 GHz was 8.3 dB below the limit at 45.78 MHz, as shown in the Table below. All other radiated emissions were 14.2 dB or more below the limit.

Table 17. Part 15.209 Limits

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (meters)	Measurement Distance Correction Factor
0.009-0.490	20*log (2400/F(kHz))	300	+80
0.490-1.705	20* log (24000/F(kHz))	30	+40
1.705-30.0	29.5	30	+40
30-88	40	3	+0
88-216	43.5	3	+0
216-960	46.0	3	+0
Above 960	54.0	3	+0

Measurements are PK or QP unless the following: frequencies in the band 9-90 kHz, 110-490 kHz and above 1000 MHz are performed using PK or AVG detection.

Table 18. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209) 9 kHz to 30 MHz

9 kHz to 30 MHz							
Test: Radiated Emissions				**Client:** Cort Business Services dba Tapdn.			
Project: 19-0478				**Model:** TAPDN- PIR -0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
No emissions seen at 9 kHz to 30 MHz above the noise floor levels. The evaluation was performed with the spectrum analyzer in Peak detection mode. The limits applied during testing were Part 15.209 limits as presented in the table above.							

Tested from 30 kHz to 30 MHz

SAMPLE CALCULATION: N/A

Test Date: December 27, 2019

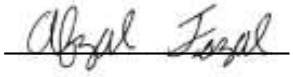
Tested By
Signature:  Name: Afzal Fazal

Table 19. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209) 30 MHz to 1000 MHz

30 MHz to 1000 MHz							
Test: Radiated Emissions							
Project: 19-0478				**Model:** TAPDN-PIR-0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
45.70	48.16	-16.43	31.73	40.0	3m./VERT	8.3	**PK**
106.10	36.18	-15.38	20.80	43.5	3m./VERT	22.7	**PK**
189.40	37.01	-11.46	25.55	43.5	3m./HORZ	18.0	**PK**
206.60	36.79	-14.19	22.60	43.5	3m./HORZ	20.9	**PK**
306.20	35.69	-9.73	25.96	46.0	3m./VERT	20.0	**PK**
948.80	34.05	-2.25	31.80	46.0	3m./VERT	14.2	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 45.70 MHz:

Magnitude of Measured Frequency	48.16	dBuV
+ Cable Loss+Antenna Factor-Amp Gain	-16.43	dB
=Corrected Result	31.73	dBuV
Limit	40.00	dBuV
-Corrected Result	31.73	dBuV
Margin	8.27	dB

(Note: rounded to the nearest tenth)

Test Date: December 23-26, 2019

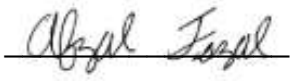
Tested By
Signature:  Name: Afzal Fazal

Table 20. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209) 1 GHz to 10 GHz

1 GHz to 10 GHz							
Test: Radiated Emissions							
Project: 19-0478				**Model:** TAPDN- PIR -0002			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
No emissions, aside from the fundamental and harmonics, were seen from 1 GHz to 10 GHz above the noise floor levels. This test was performed with the spectrum analyzer in Peak detection mode. The limits applied during testing were Part 15.209 limits as presented in the table above.							

SAMPLE CALCULATION: N/A

Test Date: December 23-26, 2019

Tested By
Signature: Afzal Fazal Name: Afzal Fazal

2.20 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

3 Conclusions

Based on the test measurements performed in this test report. The EUT is deemed to have met all the applicable requirements.