TEST REPORT

Report Number: 103177090MPK-002
Project Number: G103177090
November 06, 2017

Testing performed on the
Pillbox
Model: v2.5

FCC ID: 2ANUG-PBXV2-5-USA
IC: 23220-PB25US

To

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 2

For

TowerView Health, Inc.

Test Performed by:	Test Authorized by:
Intertek	TowerView Health, Inc.
1365 Adams Court	STE 2500, 2001 Market Street
Menlo Park, CA 94025	Philadelphia, PA 19103
USA	USA

Prepared by: _____ **Date:** November 06, 2017
Aaron Chang

Reviewed by: _____ **Date:** November 06, 2017
Krishna K Vemuri

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Report No. 103177090MPK-002

Equipment Under Test:	Pillbox
Trade Name:	TowerView Health, Inc.
Model Number:	v2.5
Applicant:	TowerView Health, Inc.
Contact:	Ankur Aggarwal
Address:	TowerView Health, Inc. STE 2500, 2001 Market Street Philadelphia, PA 19103
Country	USA
Tel. Number:	(650) 776-9322
Email:	Ankur@towerviewhealth.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
Date of Test:	October 3-27 and November 1, 2017

We attest to the accuracy of this report:

Aaron Chang
Project Engineer

Krishna K Vemuri
Engineering Team Lead

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1.0 Introduction

This report is designed to show compliance of the 2.4 GHz transceiver with the requirements of FCC Part 15 Subpart C (15.247) and RSS-247. This test report covers only the FHSS radio.

1.1 Summary of Tests

TEST	REFERENCE FCC Part 15 Subpart C (15.247)	REFERENCE RSS-247	RESULTS
RF Output Power	15.247(b)	5.4.2	Complies
20-dB Bandwidth	15.247(a)(1)	5.1.1	Complies
Channel Separation	15.247(a)(1)	5.1.2	Complies
Number of Hopping Channels	15.247(a)(1)	5.14	Complies
Average Channel Occupancy Time	15.247(a)(1)	5.14	Complies
Out-of-Band Antenna Conducted Emission	15.247(d)	5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-GEN	Complies
RF Exposure	15.247(i)	RSS-102	Complies
AC Conducted Emission	15.207	RSS-GEN	Complies*
Antenna Requirement	15.203	RSS-GEN	Complies. The EUT utilizes internal antenna.

*See report 103177090MPK-001 for 15.207 data.

2.0 General Description

2.1 Product Description

TowerView Health, Inc. supplied the following description of the EUT:

The TowerView pillbox stores a patient's medications for a week in a 4x7 grid of wells (4 doses per day, 7 days per week). Under each well is a capacitance sensing pad that allows the host microcontroller and system of IC's to detect if and when the patient removes his or her medications. If the patient does not take his or her medications within a certain window of his or her prescribed time, the pillbox triggers alarms in the forms of lights and sound on the pillbox itself, as well as text, phone, and email reminders, as configurable via TowerView's server. The pillbox also periodically sends sensing and telemetry data to the server via wireless networks using WIFI, Bluetooth, and/or cellular technologies.

For more information, see user's manual provided by the manufacturer.

Information about the Bluetooth FHSS radio is presented below:

For more information, refer to the following product specification, declared by the manufacturer.

Information about the 2.4 GHz radio is presented below:

Applicant	TowerView Health, Inc.
Model No.	v2.5
FCC Identifier	2ANUG-PBXV2-5-USA
IC Identifier	23220-PB25US
Type of Transmission	Frequency Hopping Spread Spectrum
Rated RF Output	12.43 dBm
Antenna(s) & Gain	Internal Antenna, Gain: 1.00 dBi
Frequency Range	2402 – 2480 MHz
Number of Channel(s)	79, (Channels 0-78)
Modulation Type	GFSK, π/4-DQPSK, 8DPSK
Data Rate	Up to 3Mbps
Applicant Name & Address	TowerView Health, Inc. STE 2500, 2001 Market Street Philadelphia, PA 19103 USA

EUT receive date:	October 02, 2017
EUT receive condition:	The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.
Test start date:	October 3, 2017
Test completion date:	November 1, 2017

The test results in this report pertain only to the item tested.

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Antenna conducted measurements were performed according to the procedure from ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems

Radiated emissions measurements were performed according to the procedures in ANSI C63.10: 2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the **"Data Sheet"** of this Application.

All other measurements were made in accordance with the procedures in part 2 of CFR 47.

Following is the channel test plan:

Channels in 2.4 GHz band			
Test Channel		Frequency, MHz	Tested
Low	0	2402	√
Middle	39	2441	√
High	78	2480	√

2.4 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

3.0 System Test Configuration

3.1 Support Equipment

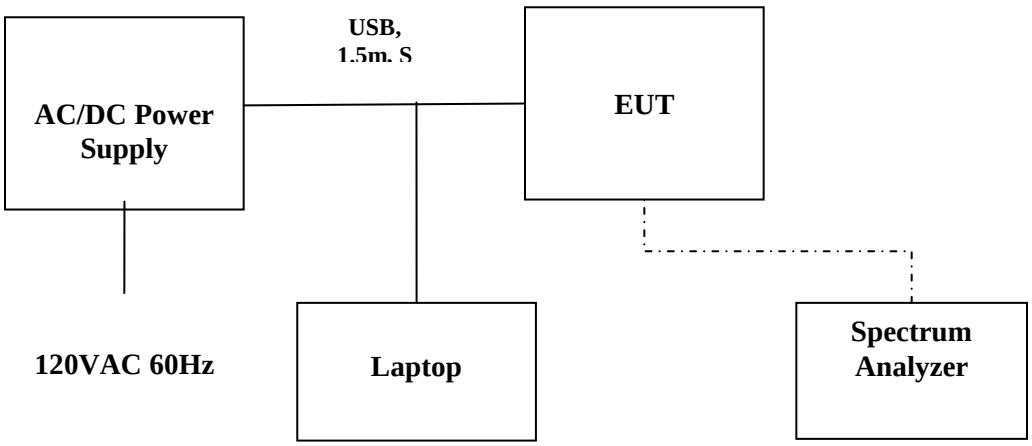
Description	Manufacturer	Model Number
Laptop	HP	EliteBook 840
AC/DC Power Adapter	No Markings	No Markings

3.2 Block Diagram of Test Setup

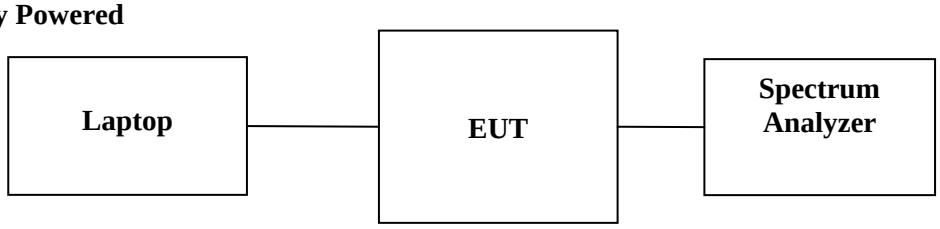
Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Pillbox	TowerView Health, Inc.	v2.5	17380001

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.

AC Powered



Battery Powered



S = Shielded **U** = Unshielded	**F** = With Ferrite **m** = Length in Meters

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT is attached to peripherals and they are connected and operational (as typical as possible). The EUT is wired to transmit full power. During testing, all cables are manipulated to produce worst-case emissions.

3.4 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously at maximum RF power on the low channel, middle channel, high channel and with hopping channels enabled.

3.5 Modifications Required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.6 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Transmitter Emissions Measurement Results

4.1 20dB Bandwidth, and 99% Occupied Bandwidth
FCC Rule 15.247(a)(1)

4.1.1 Procedure

The Procedure described in the ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the 20dB bandwidth.

- Span = Approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20 dB bandwidth
- VBW = 3 x RBW
- Sweep = Auto
- Detector function = Peak
- Trace = Max hold

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

For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer.

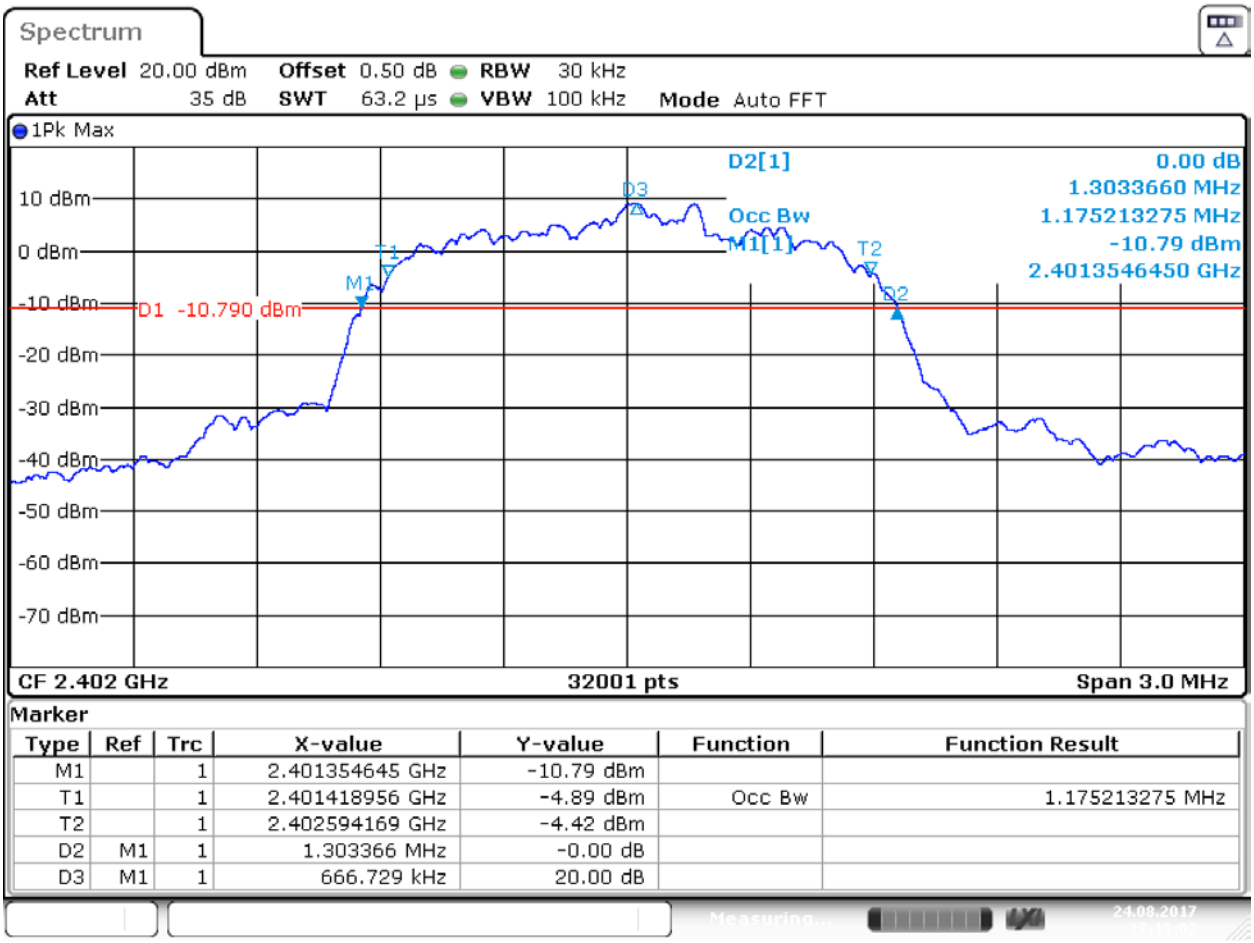
The antenna port of the EUT was connected to the input of a spectrum analyzer (SA). For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A Peak output reading was taken, a Display line was drawn for 20dB lower than Peak level. The 20dB bandwidth was determined from where the channel output spectrum intersected the display line.

Tested By:	Aaron Chang
Test Date:	October 19, 2017

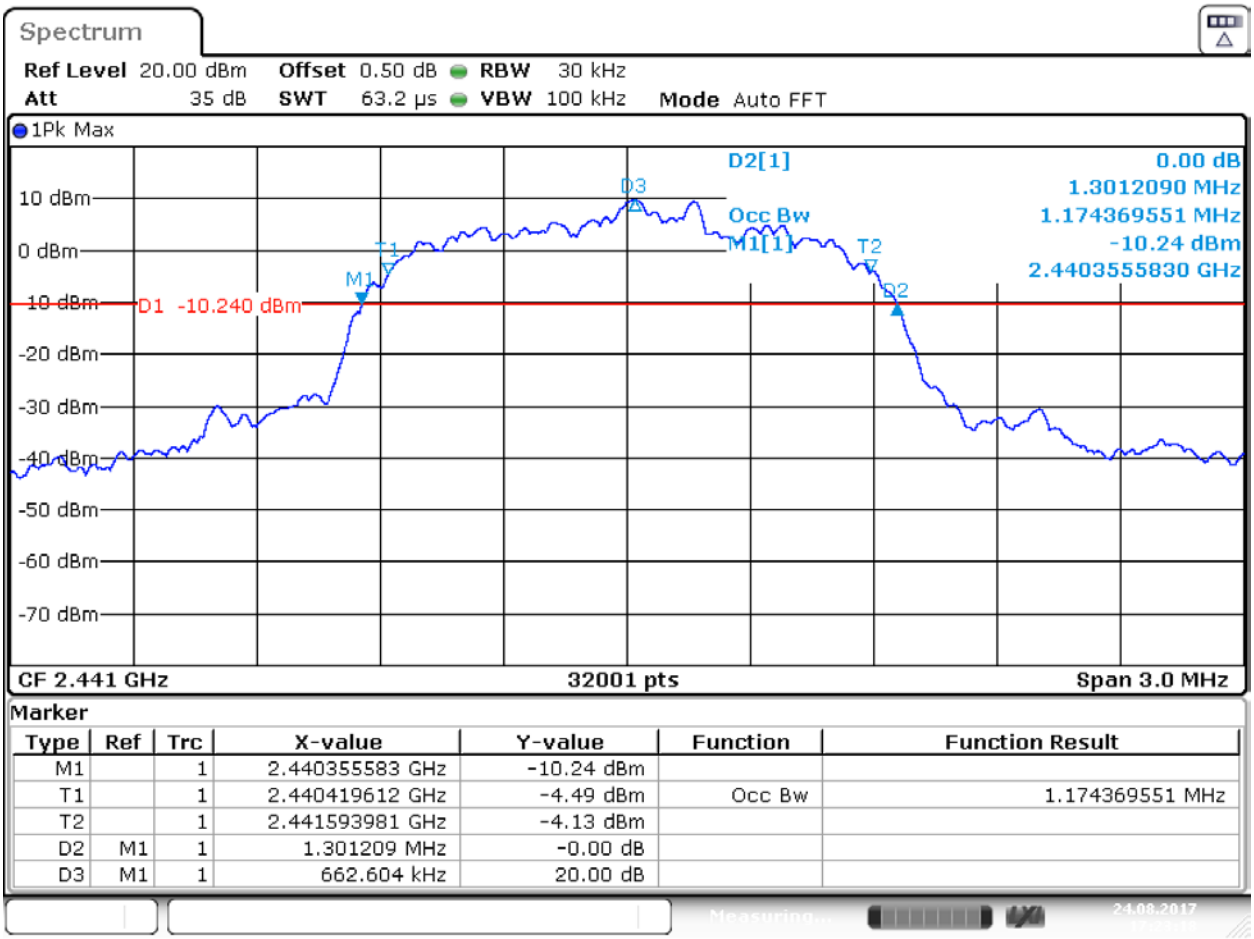
4.1.2 Test Result

Modulation Type	Channel	Frequency MHz	20 dB FCC Bandwidth, MHz	99% Bandwidth, MHz	Plot #
GFSK	0	2402	1.303	1.175	1.1
	39	2441	1.301	1.174	1.2
	78	2480	1.303	1.180	1.3
π/4-DQPSK	0	2402	1.303	1.175	1.4
	39	2441	1.301	1.174	1.5
	78	2480	1.303	1.180	1.6
8DPSK	0	2402	1.303	1.175	1.7
	39	2441	1.301	1.174	1.8
	78	2480	1.303	1.180	1.9

Plot 1. 1 – 20dB Bandwidth Low Channel GFSK



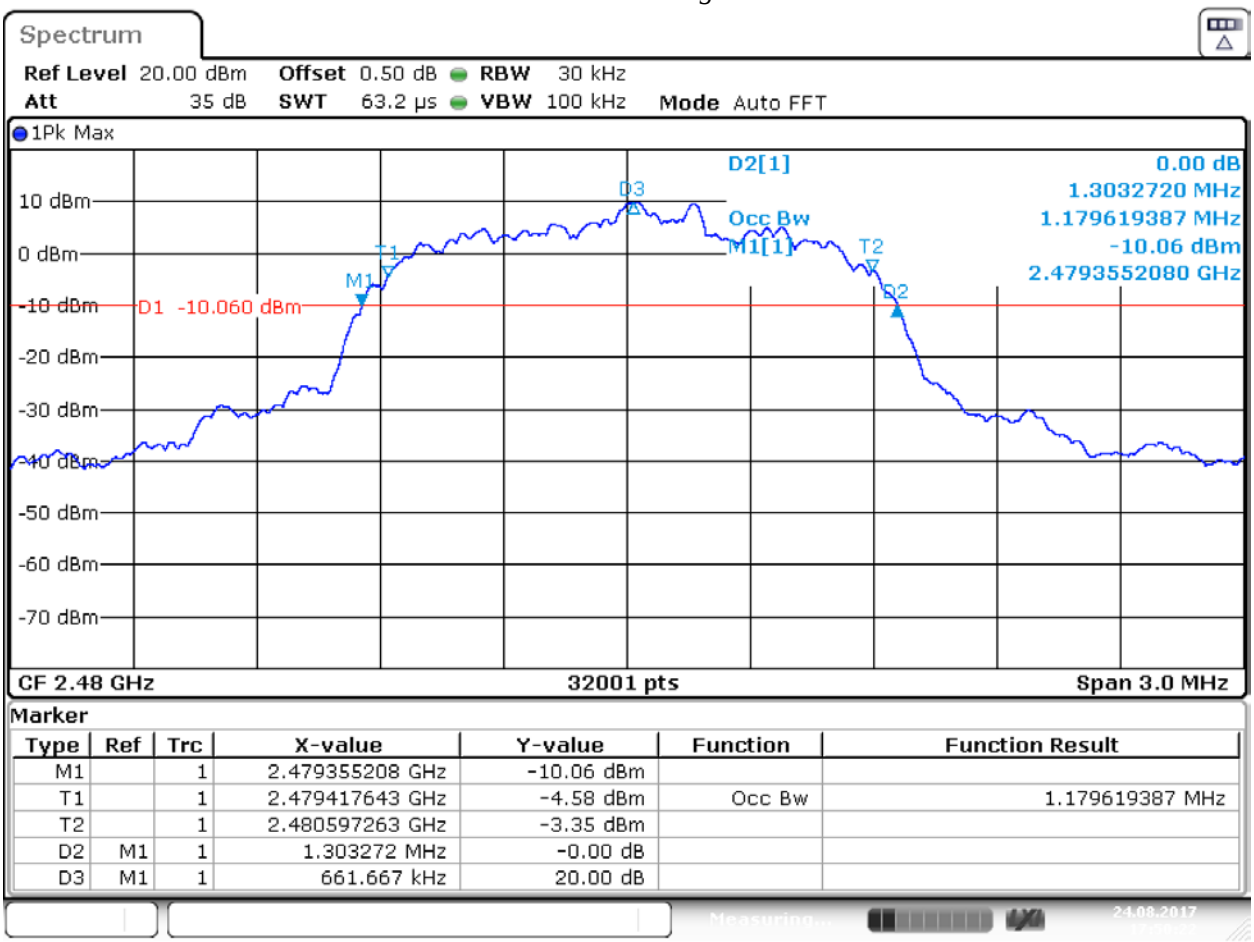
Plot 1. 2 – 20dB Bandwidth Middle Channel GFSK



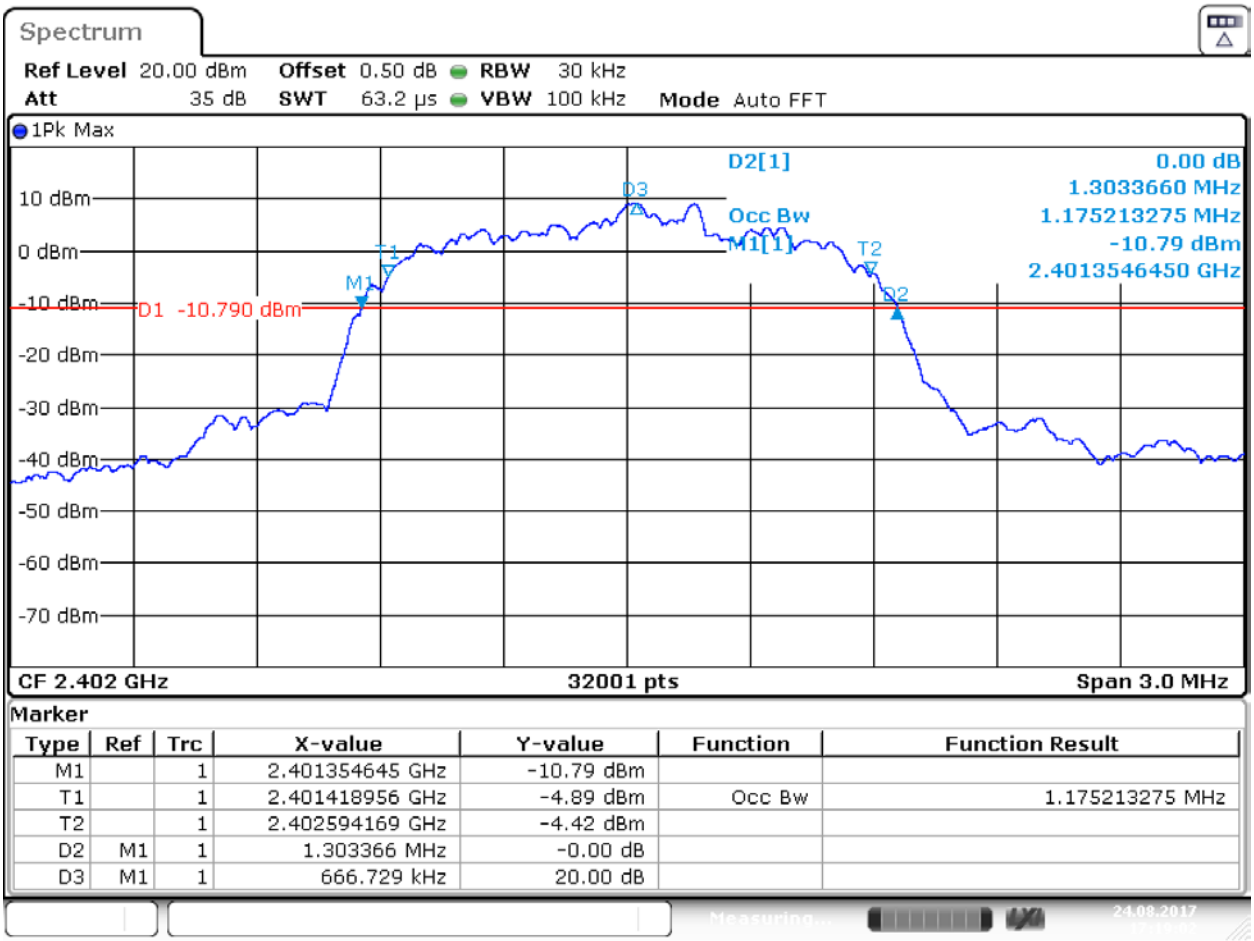
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.440355583 GHz	-10.24 dBm		
T1		1	2.440419612 GHz	-4.49 dBm	Occ Bw	1.174369551 MHz
T2		1	2.441593981 GHz	-4.13 dBm		
D2	M1	1	1.301209 MHz	-0.00 dB		
D3	M1	1	662.604 kHz	20.00 dB		

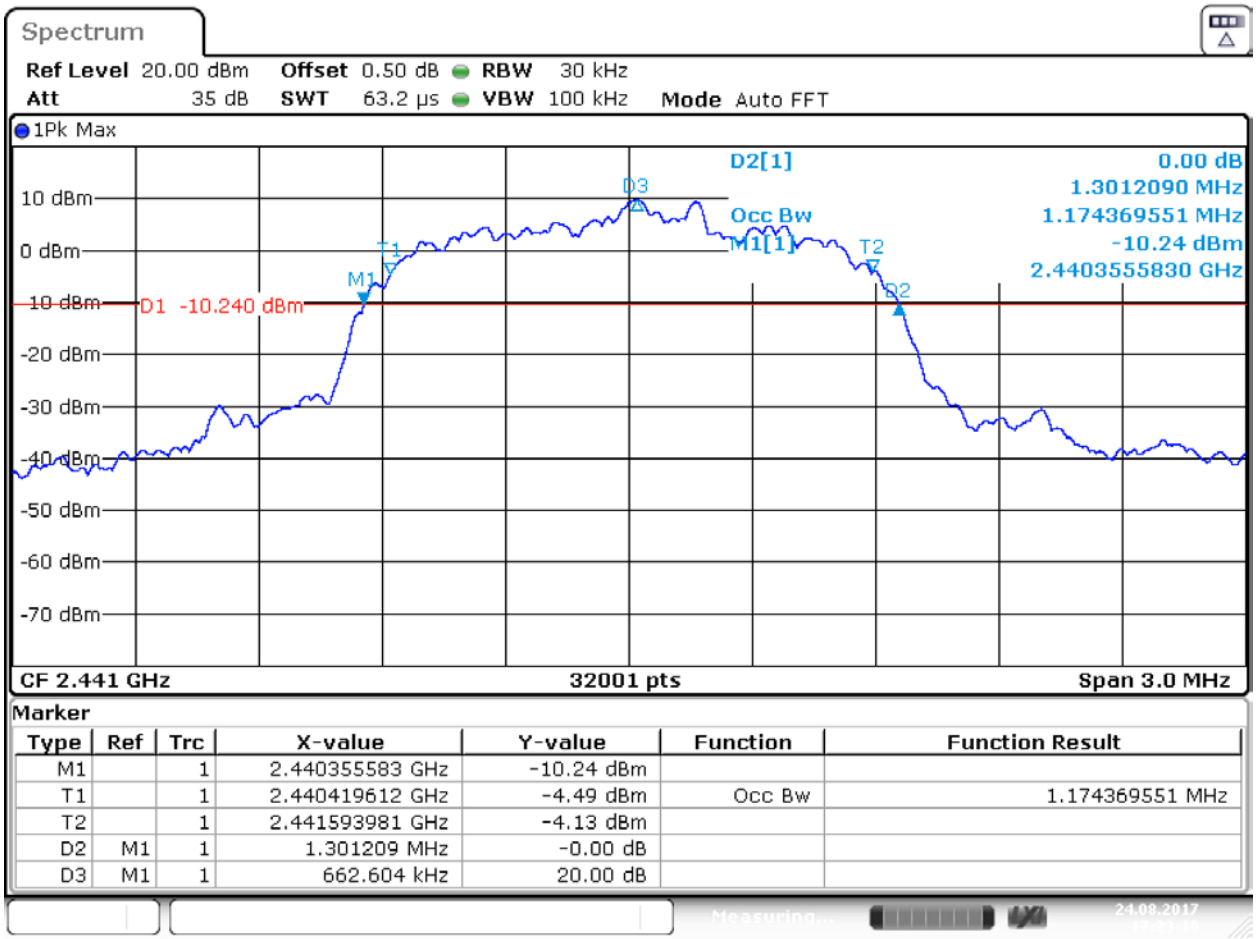
Plot 1. 3 – 20dB Bandwidth High Channel GFSK



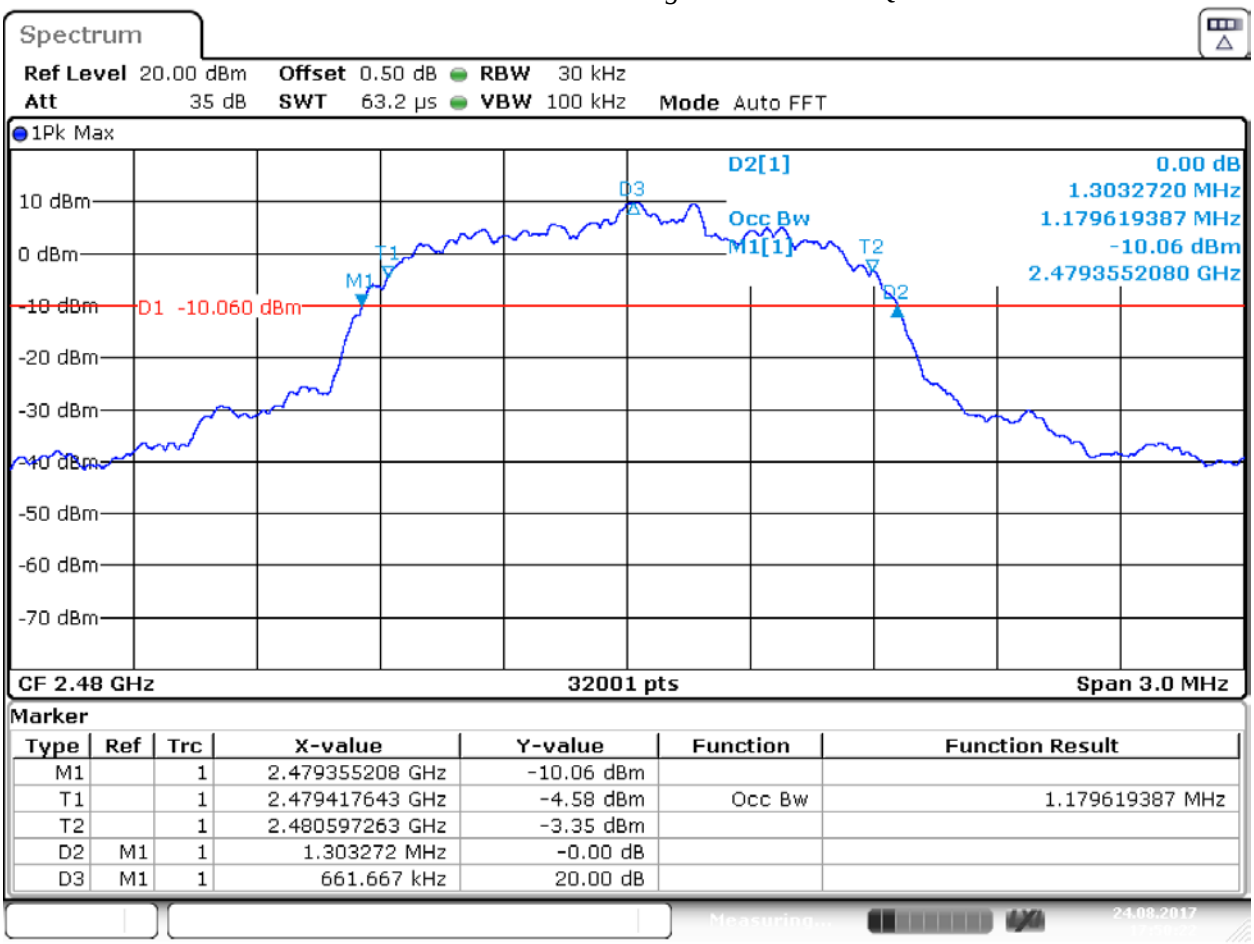
Plot 1. 4 – 20dB Bandwidth Low Channel π/4-DQPSK



Plot 1. 5 – 20dB Bandwidth Middle Channel π/4-DQPSK



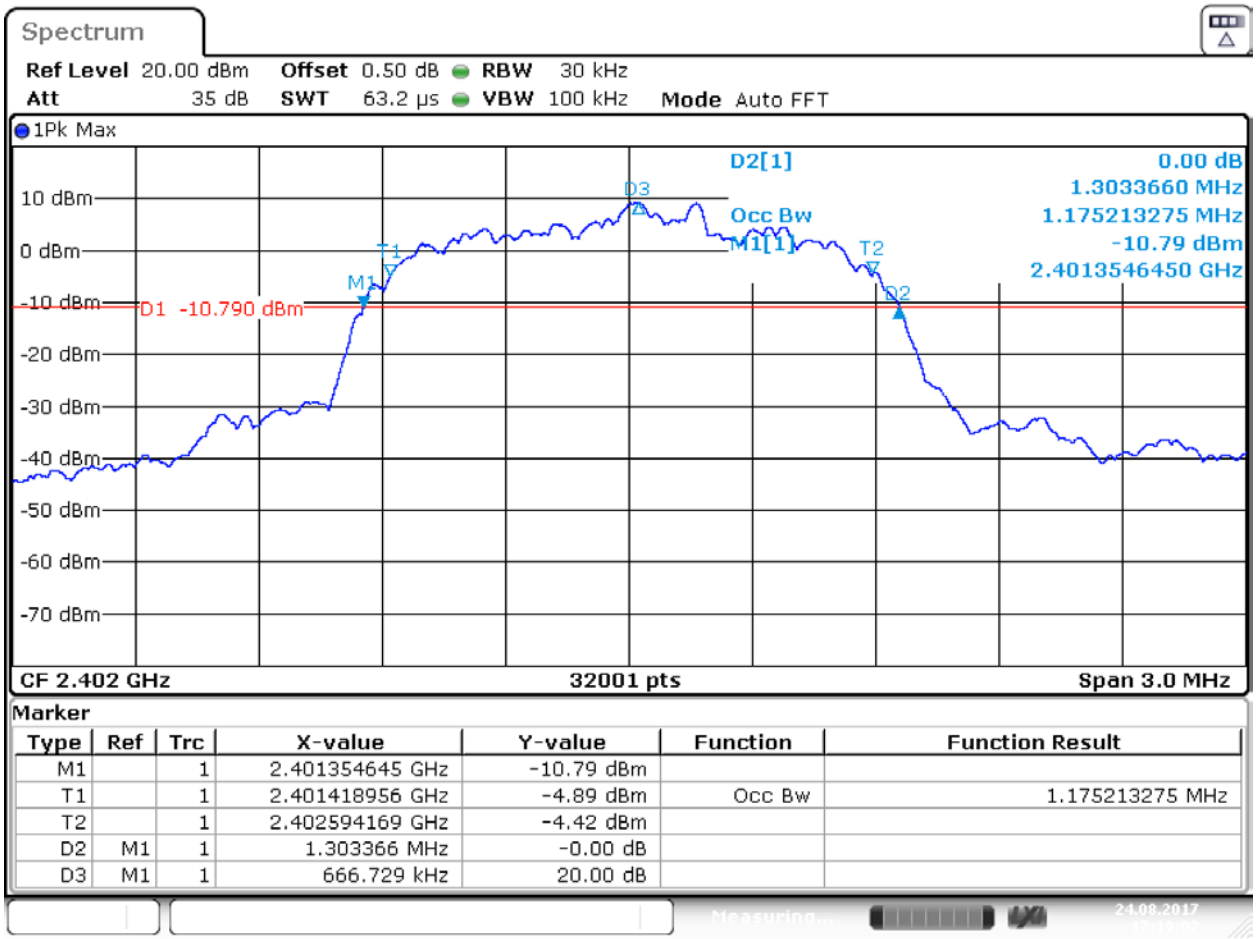
Plot 1. 6 – 20dB Bandwidth High Channel π/4-DQPSK



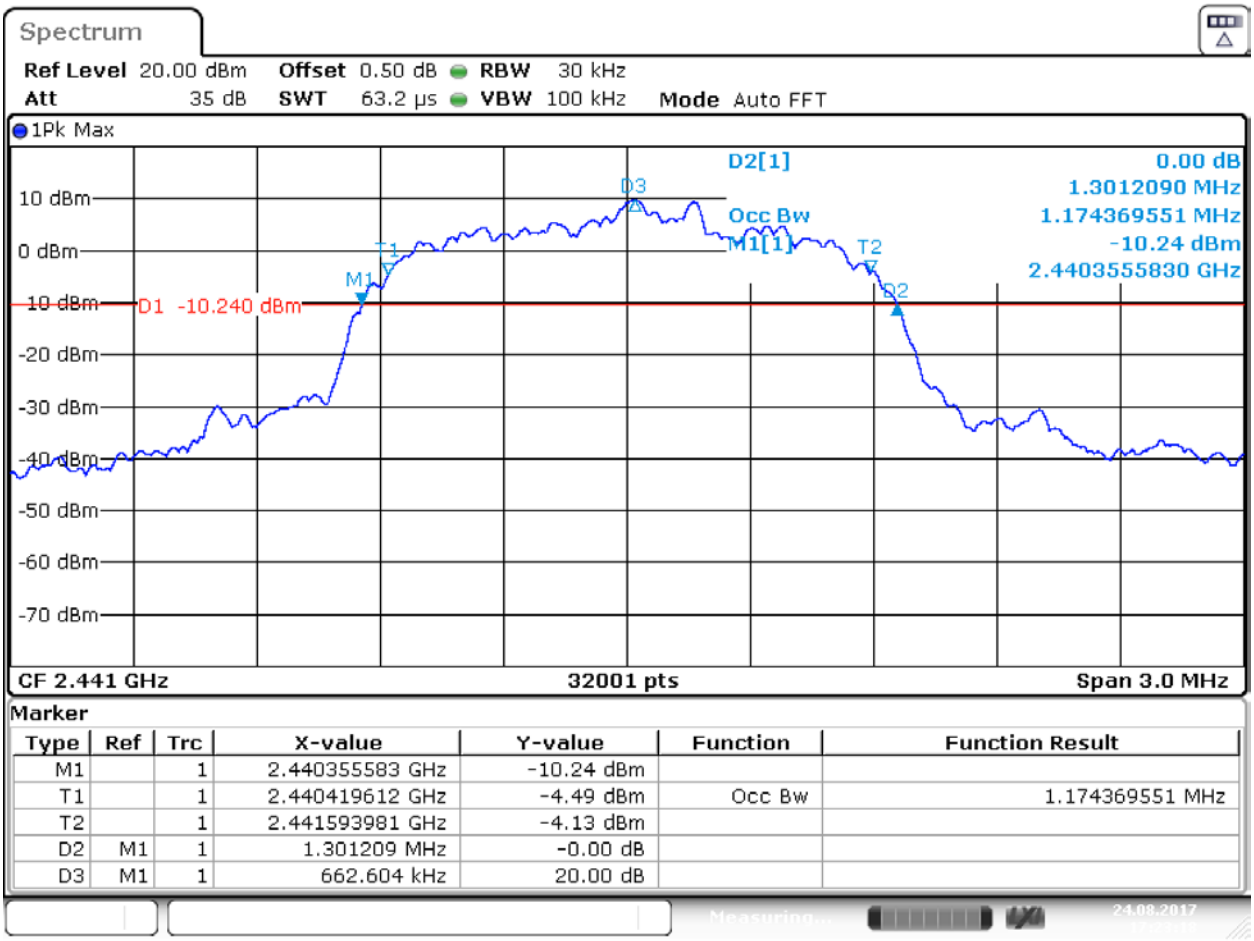
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.479355208 GHz	-10.06 dBm		
T1		1	2.479417643 GHz	-4.58 dBm	Occ Bw	1.179619387 MHz
T2		1	2.480597263 GHz	-3.35 dBm		
D2	M1	1	1.303272 MHz	-0.00 dB		
D3	M1	1	661.667 kHz	20.00 dB		

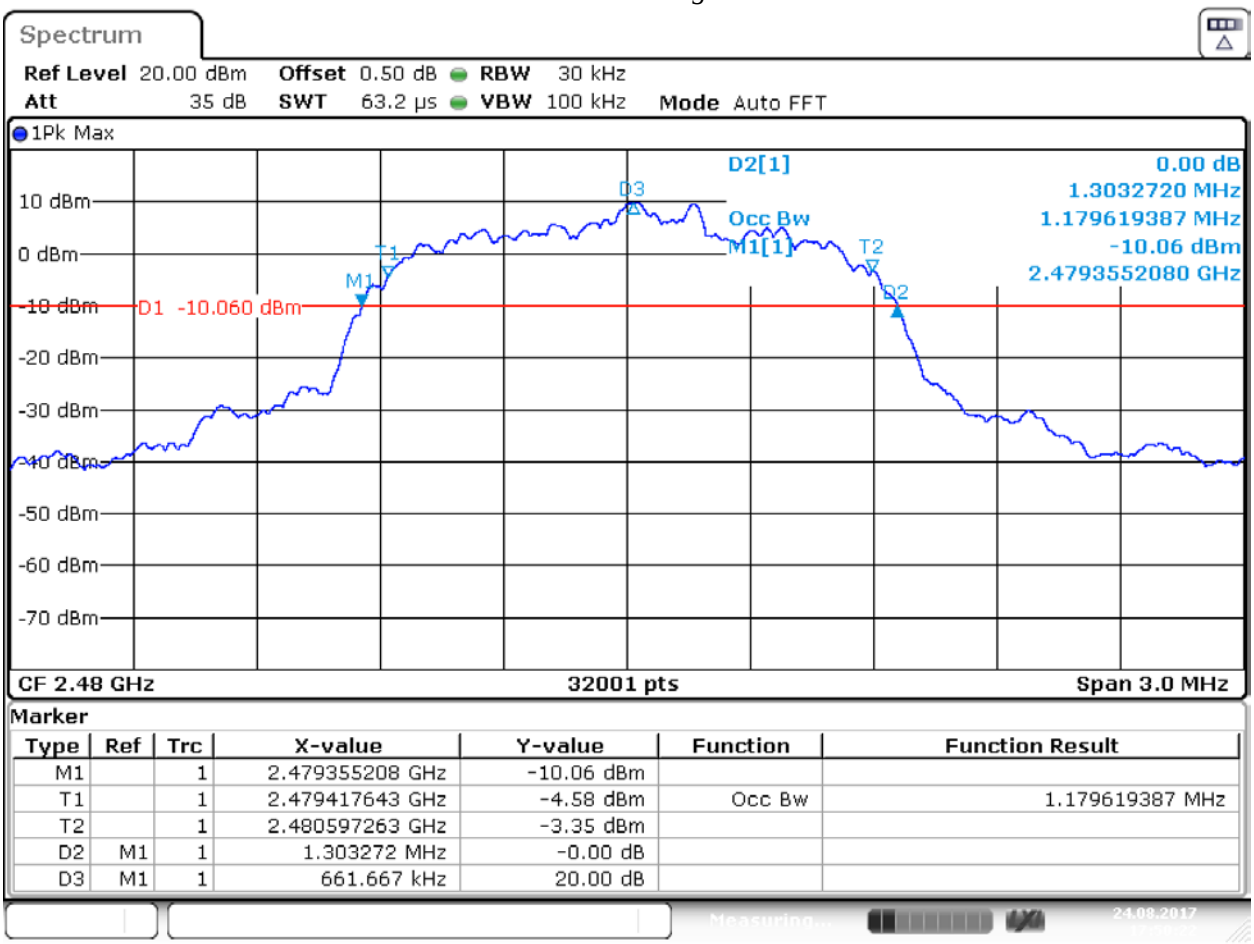
Plot 1. 7 – 20dB Bandwidth Low Channel 8DPSK



Plot 1. 8 – 20dB Bandwidth Middle Channel 8DPSK



Plot 1. 9 – 20dB Bandwidth High Channel 8DPSK



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.479355208 GHz	-10.06 dBm		
T1		1	2.479417643 GHz	-4.58 dBm	Occ Bw	1.179619387 MHz
T2		1	2.480597263 GHz	-3.35 dBm		
D2	M1	1	1.303272 MHz	-0.00 dB		
D3	M1	1	661.667 kHz	20.00 dB		

4.2 Conducted Output Power at Antenna Terminals
FCC Rule 15.247(b)(1)

4.2.1 Requirement

For systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, the maximum peak output power is 1 watt (30 dBm), for all other systems 0.125 W (21 dBm).

4.2.2 Procedure

The Procedure described in the ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the RF Output Power.

- Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
- RBW > the 20 dB bandwidth of the emission being measured
- VBW = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot.

The antenna port of the EUT was connected to the input of a spectrum analyzer. Power was read directly from the spectrum analyzer and cable loss correction was added to the reading to obtain the power at the antenna terminals.

Tested By:	Aaron Chang
Test Date:	October 19, 2017

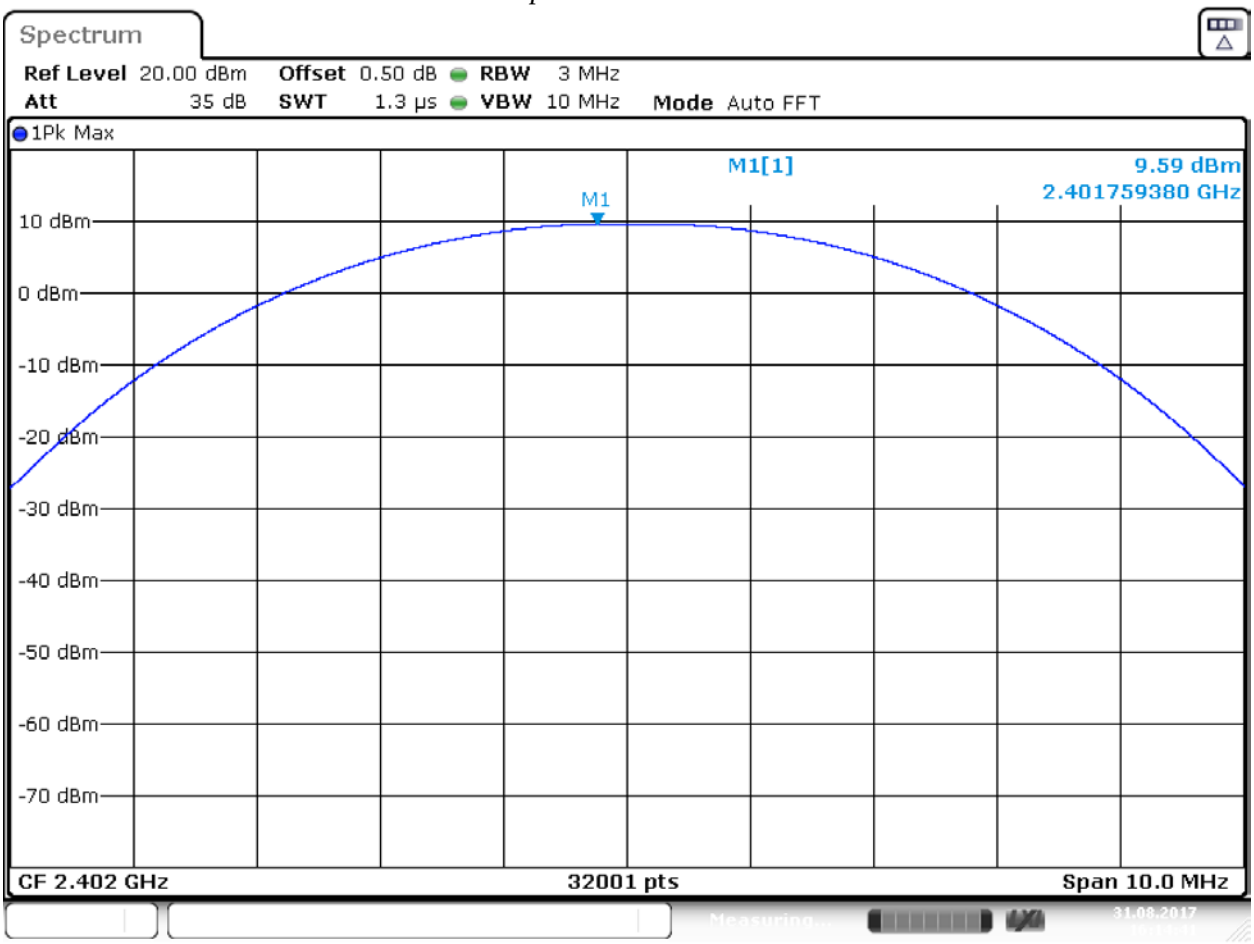
4.3.3 Test Result

Refer to the following plots for the test result:

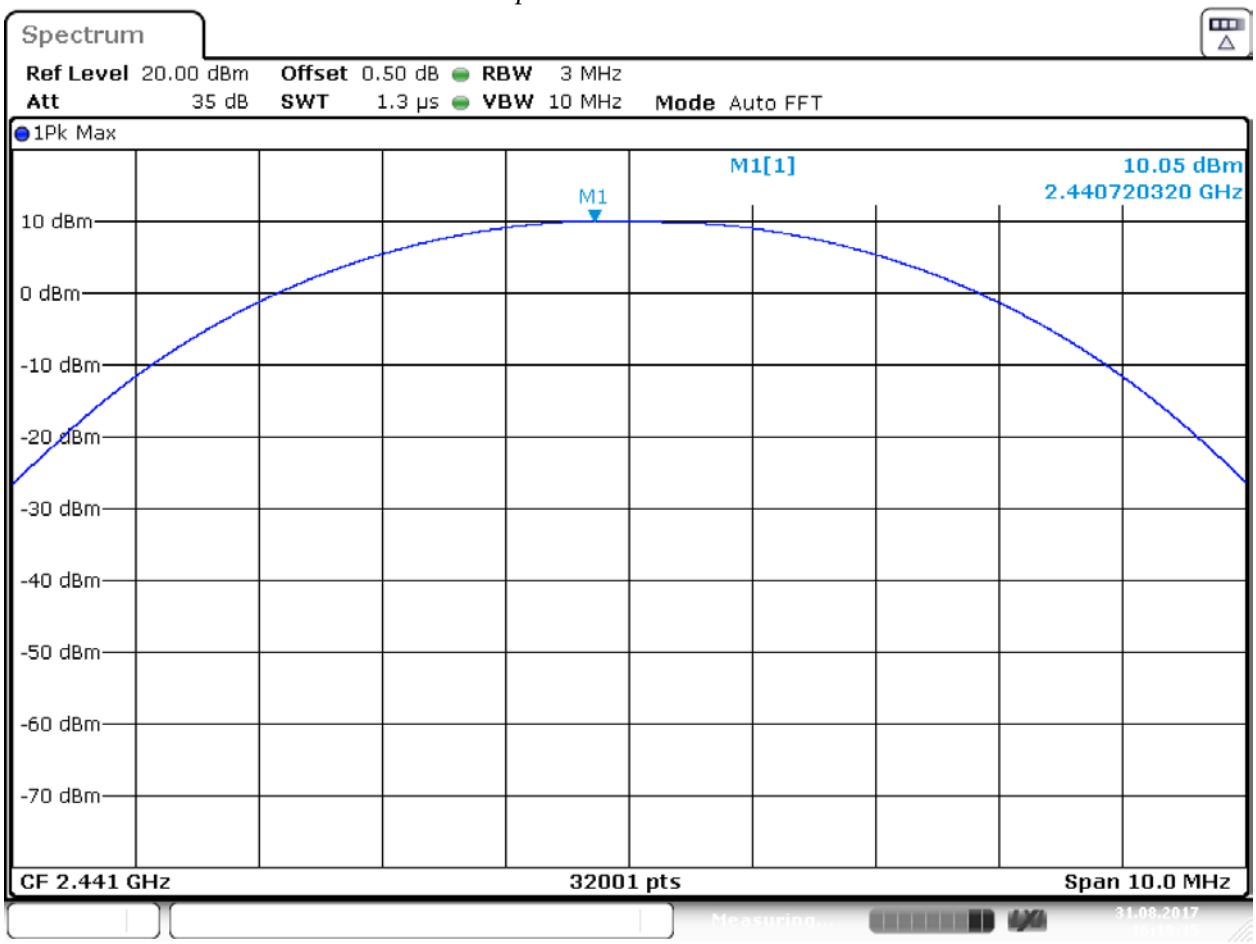
Modulation Type	Channel	Frequency MHz	Conducted Peak Power dBm	Conducted Peak Power mW	Plot #
GFSK	0	2402	9.59	9.10	2.1
	39	2441	10.05	10.12	2.2
	78	2480	10.11	10.26	2.3
π/4-DQPSK	0	2402	11.86	15.35	2.4
	39	2441	12.03	15.96	2.5
	78	2480	11.95	15.67	2.6
8DPSK	0	2402	11.90	15.49	2.7
	39	2441	12.43	17.50	2.7
	78	2480	12.18	16.52	2.9

Results	**Complies**

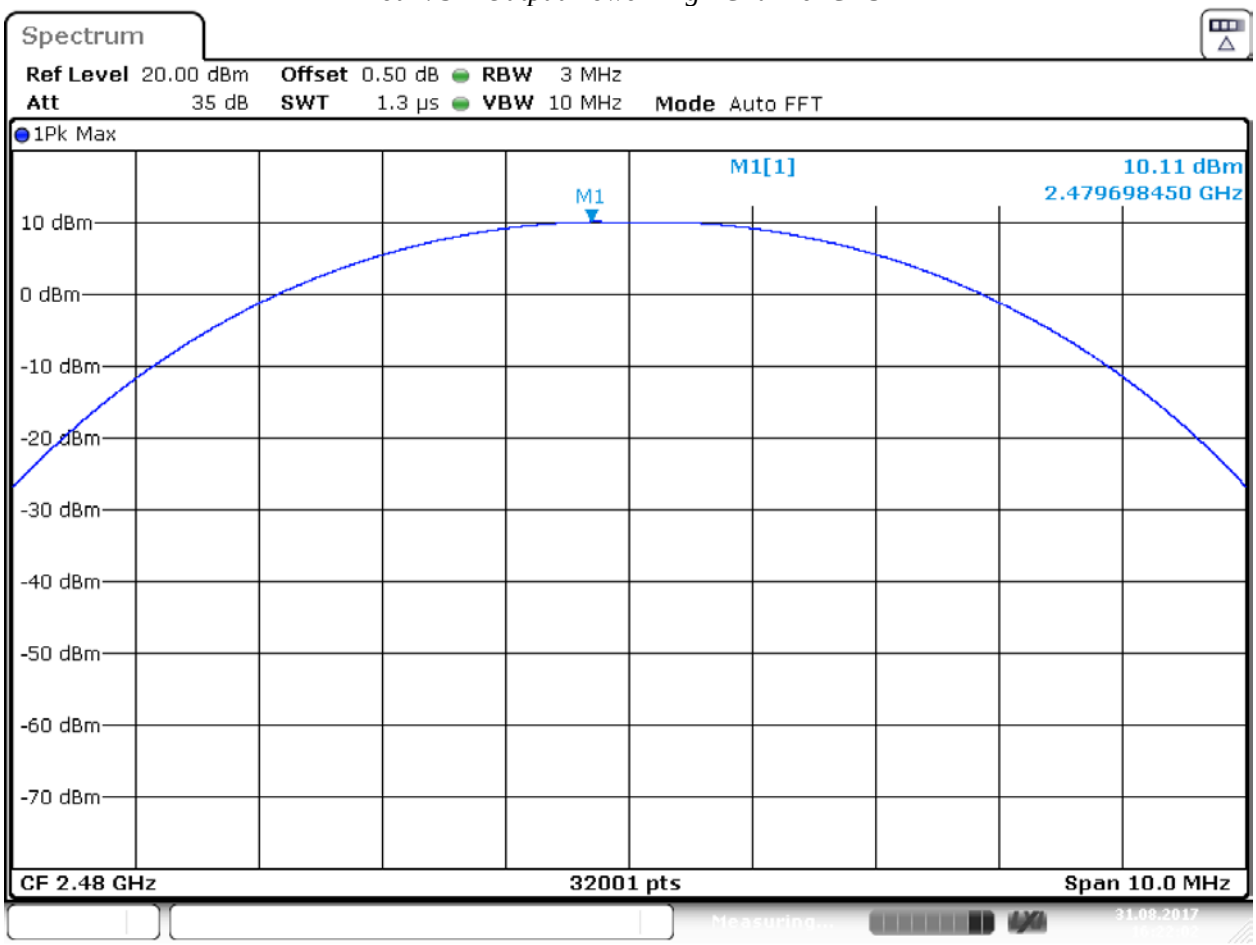
Plot 2. 2 – Output Power Low Channel GFSK



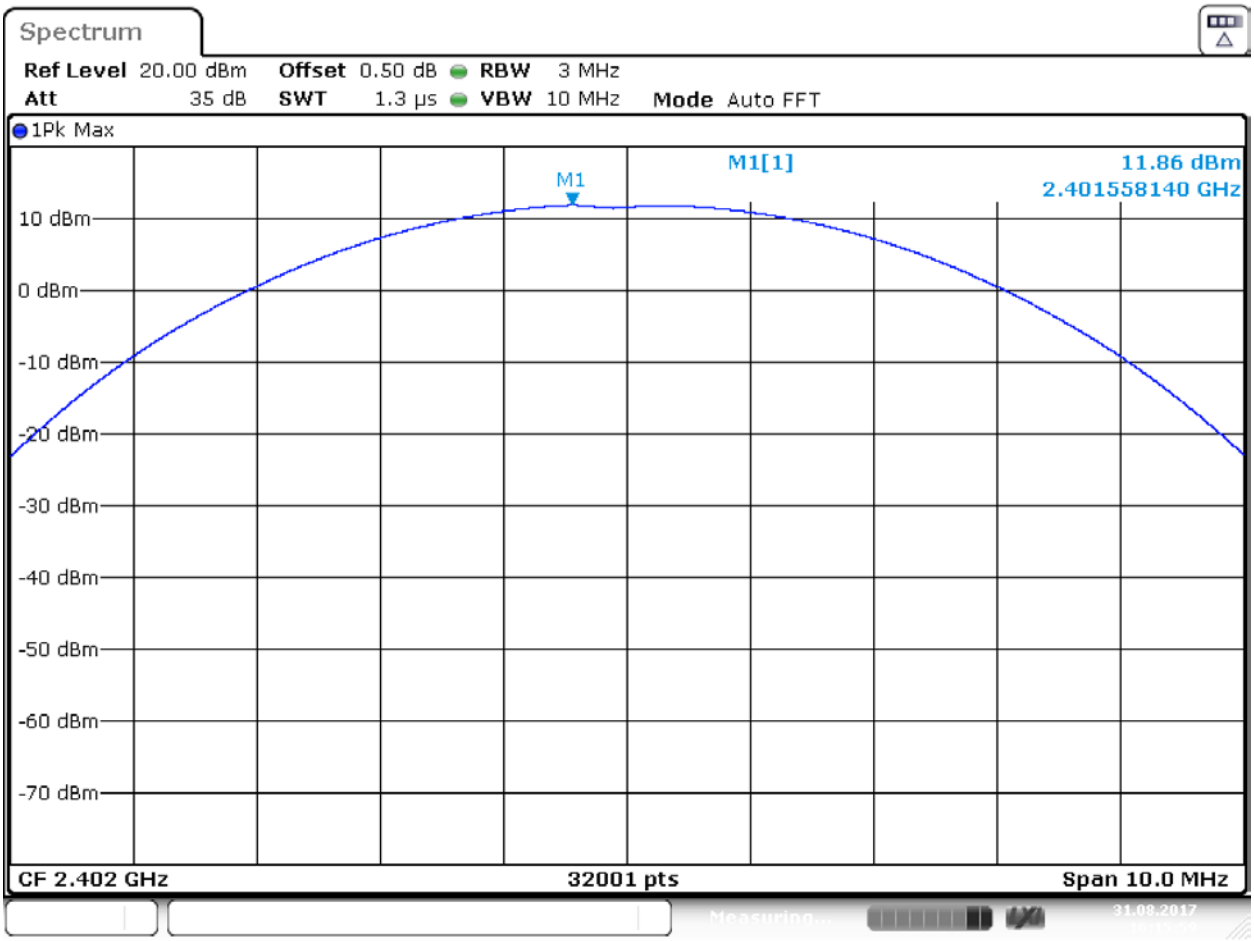
Plot 2. 2 – Output Power Middle Channel GFSK



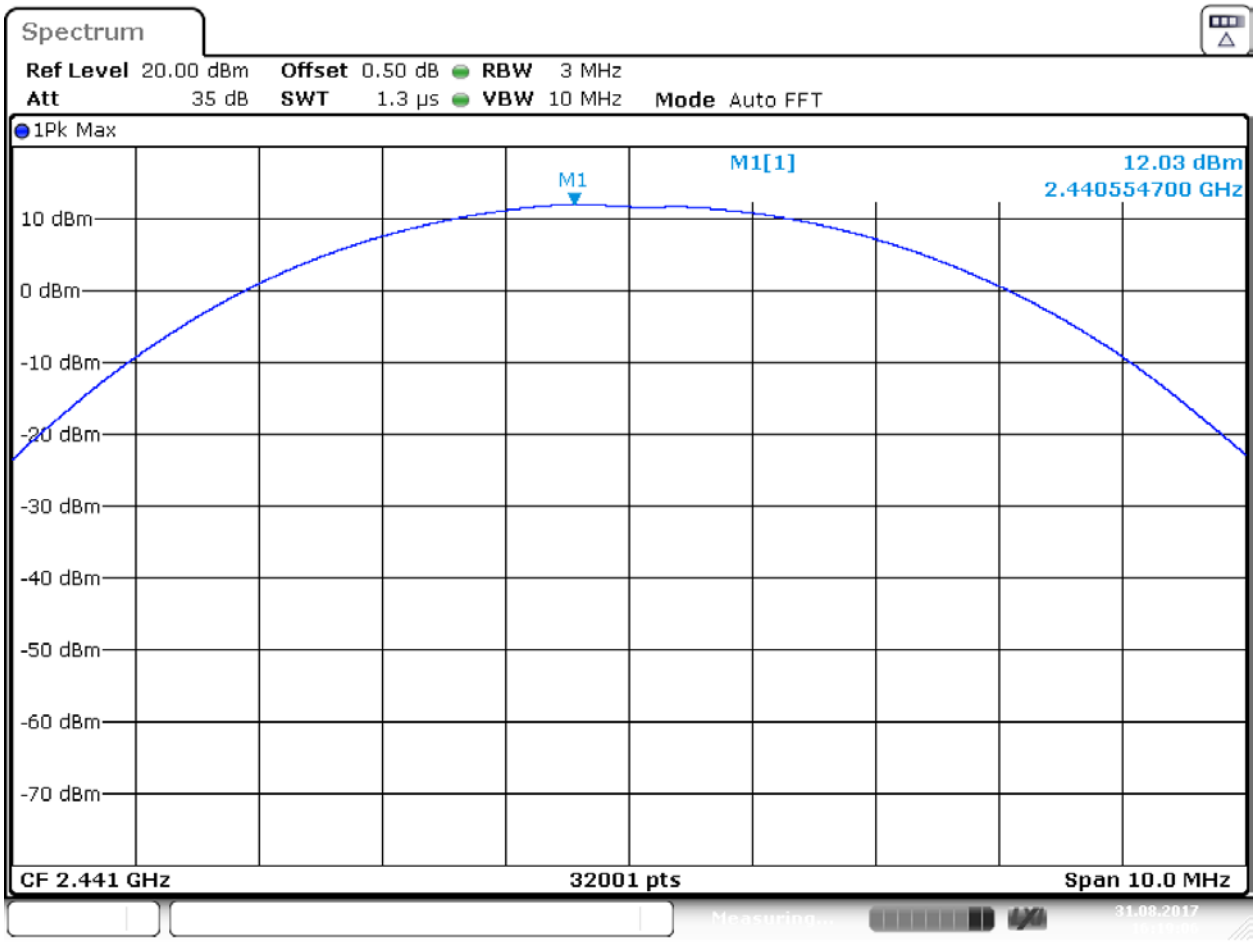
Plot 2. 3 – Output Power High Channel GFSK



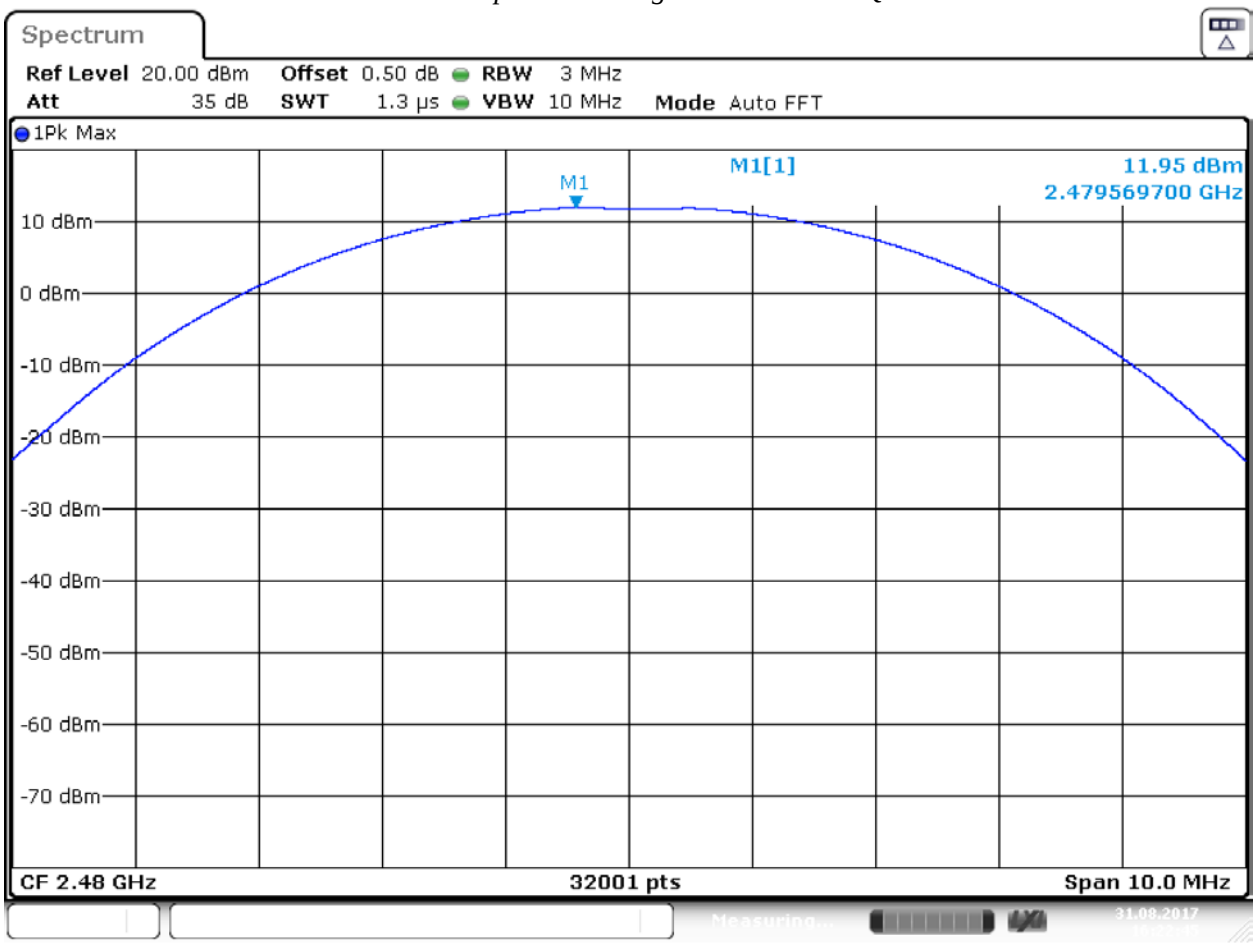
Plot 2. 4 – Output Power Low Channel π/4-DQPSK



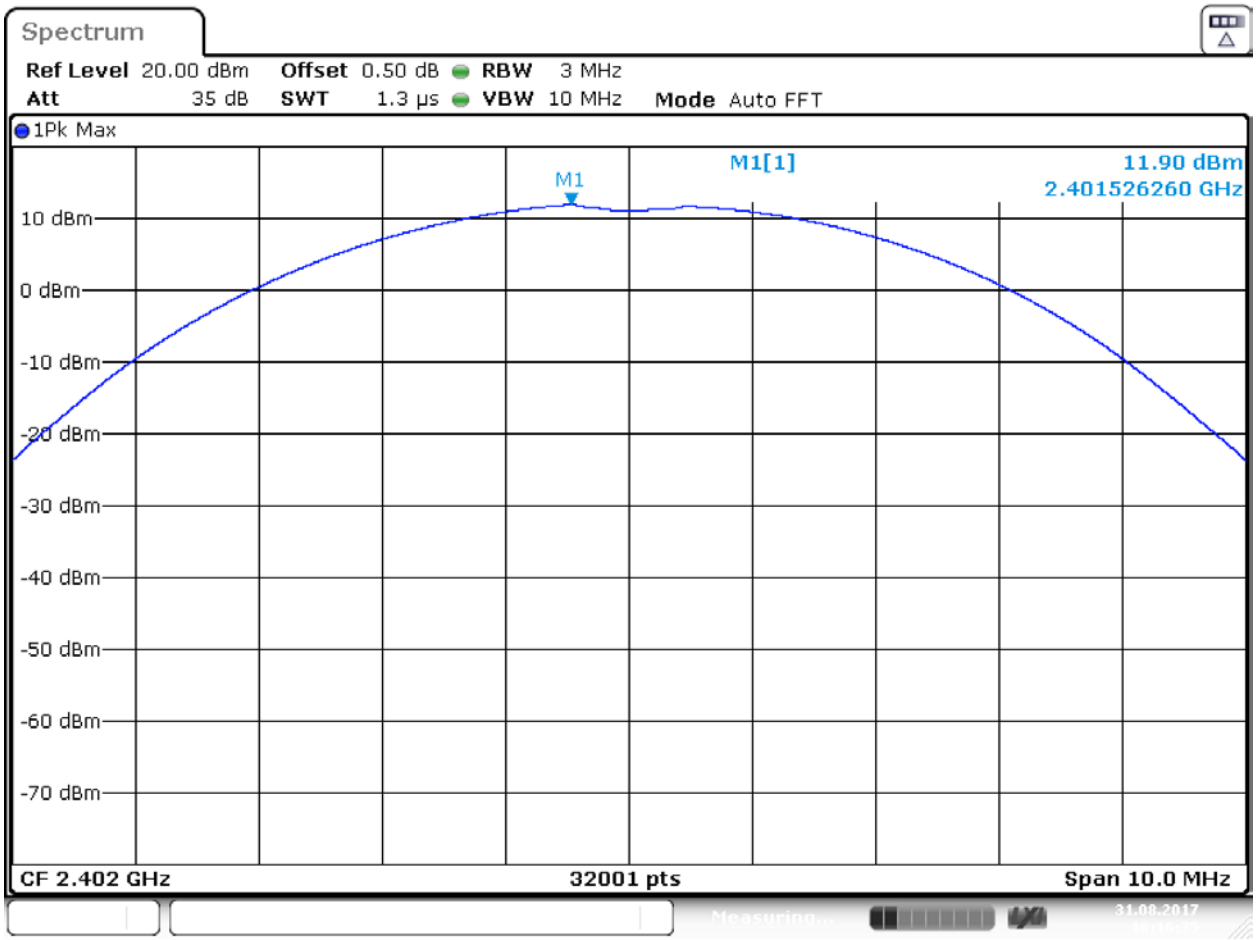
Plot 2. 5 – Output Power Middle Channel π/4-DQPSK



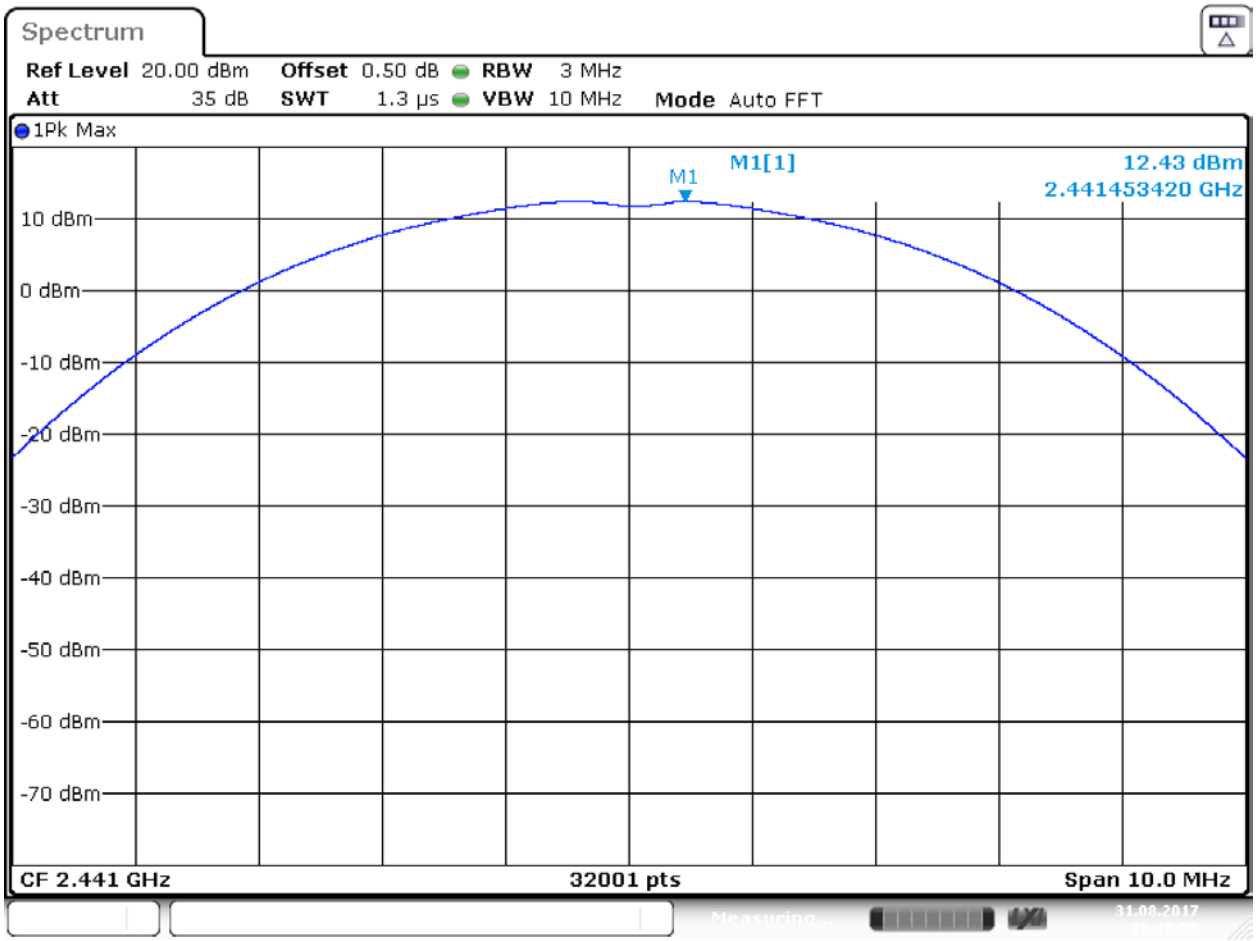
Plot 2. 6 – Output Power High Channel π/4-DQPSK



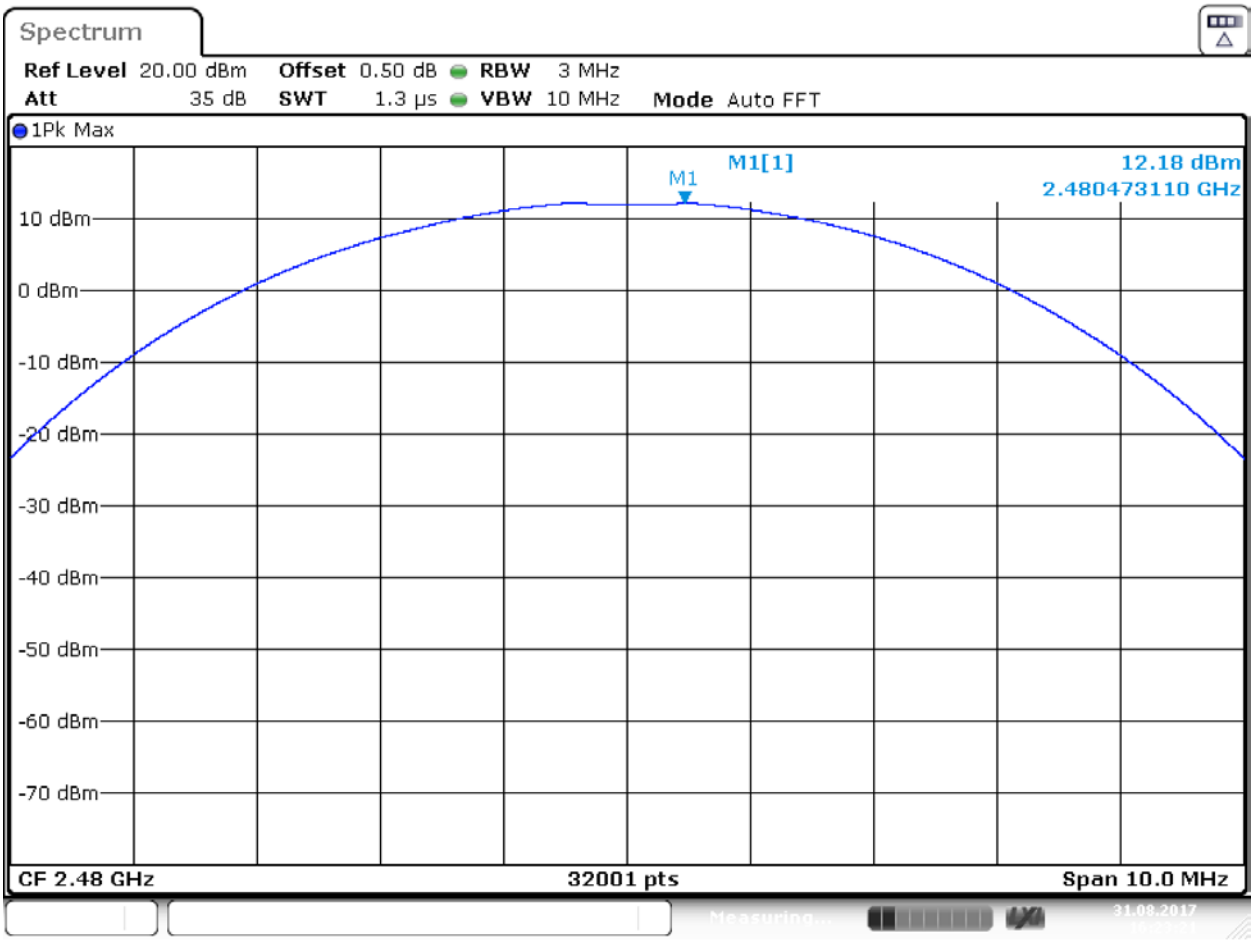
Plot 2. 7 – Output Power Low Channel 8DPSK



Plot 2. 8 – Output Power Middle Channel 8DPSK



Plot 2. 9 – Output Power High Channel 8DPSK



4.3 Carrier Frequency Separation
FCC 15.247 (a)(1)

4.3.1 Requirement

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.

4.3.2 Procedure

The Procedure described in the ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Carrier Frequency Separation.

- The EUT must have its hopping function enabled
- Span = wide enough to capture the peaks of two adjacent channels
- Resolution (or IF) Bandwidth (RBW) = 1% of the span
- Video (or Average) Bandwidth (VBW) = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Tested By:	Aaron Chang
Test Date:	October 19, 2017

4.3.3 Test Result

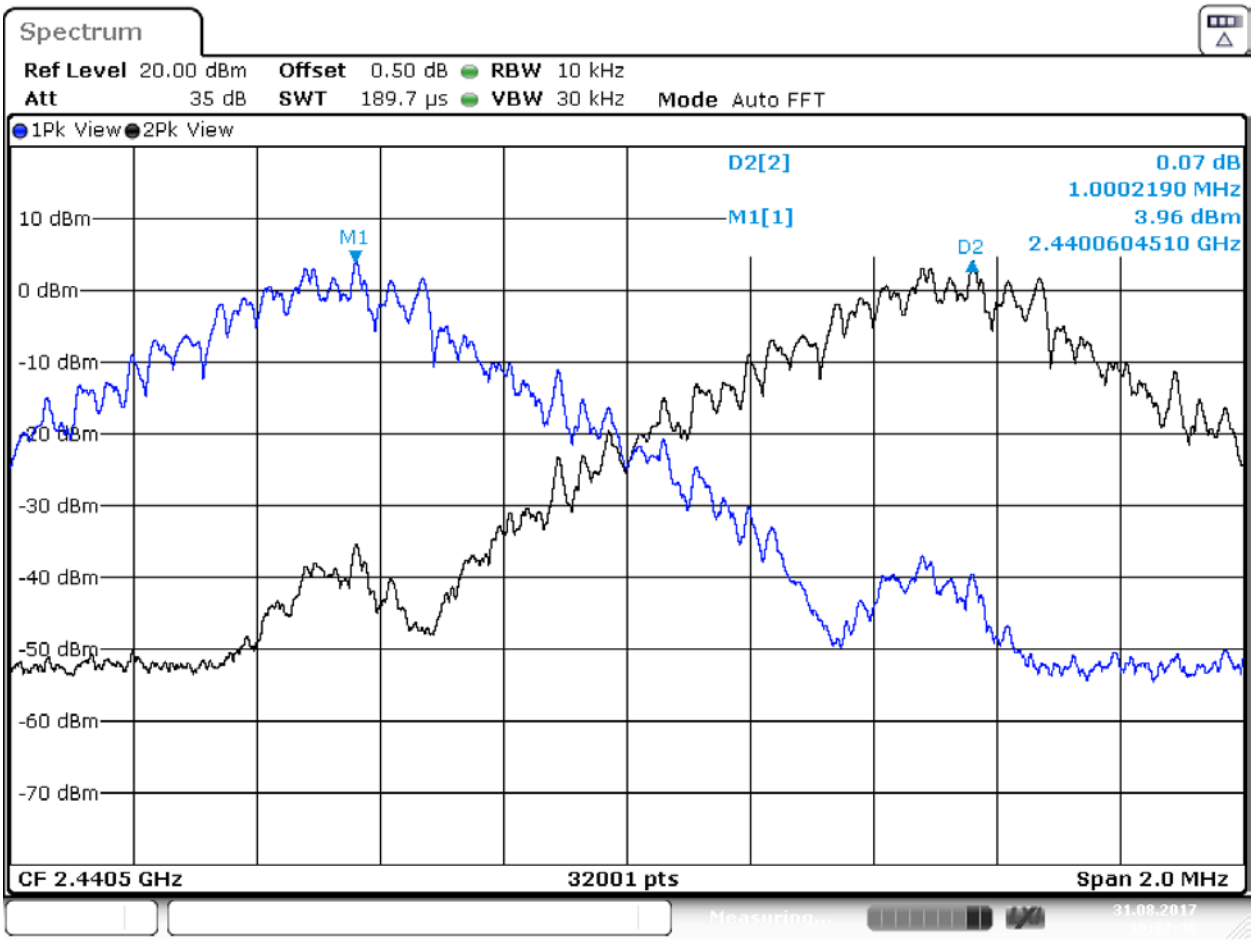
The worst case 20dB Bandwidth is 1.370 MHz, therefor this bandwidth was used to calculate the minimum limit for Carrier Frequency Separation below.

(2/3) * 1.370 MHz = 0.914 MHz (minimum requirement)

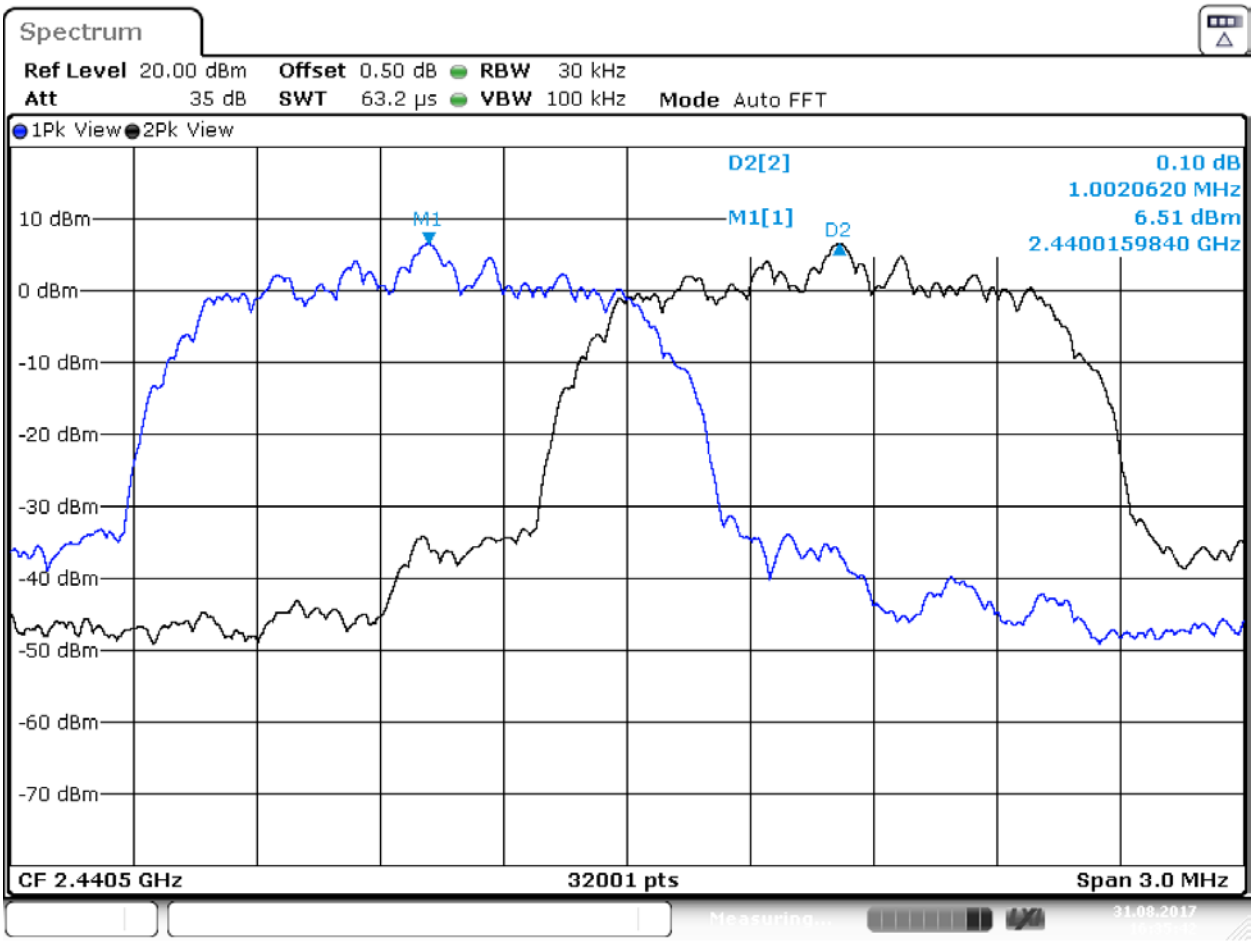
The Carrier Frequency Separation is **1.00 MHz**, therefore meets the minimum requirement. Please refer to spectrum analyzer plot 3.1 to 3.3 below for the test result.

Results	**Complies**

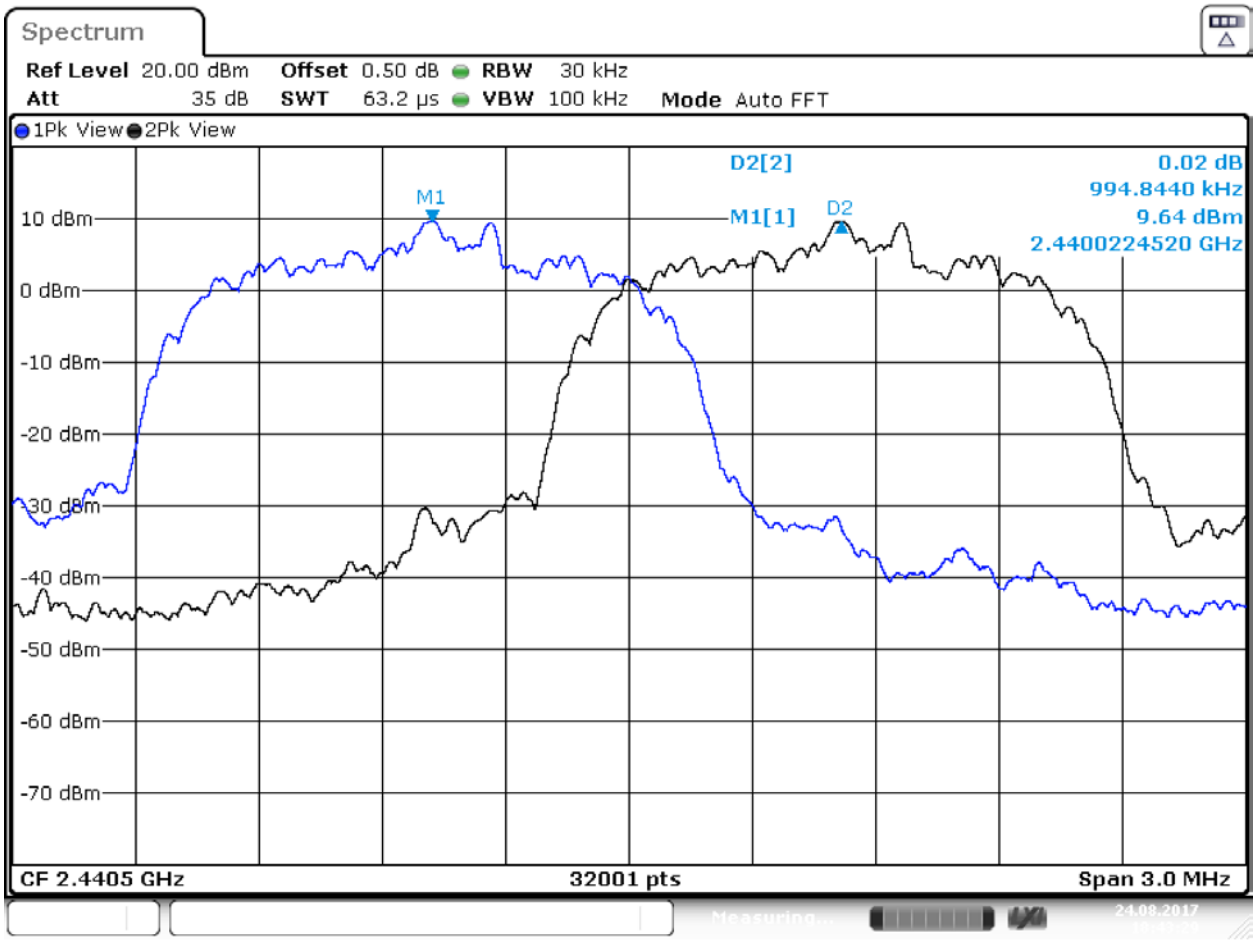
Plot 3.1– Channel Separation GFSK



Plot 3.2– Channel Separation π/4-DQPSK



Plot 3.3– Channel Separation DPQSK



4.4 Number of Channels
FCC 15.247 (a)(1)(iii)

4.4.1 Requirement

Systems operating in the 2400-2483.5 MHz band shall use at least 15 hopping channels.

4.4.2 Procedure

The Procedure described in the ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Number of Channels.

- The EUT must have its hopping function enabled.
- Span = the frequency band of operation
- RBW = 1% of the span
- VBW = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

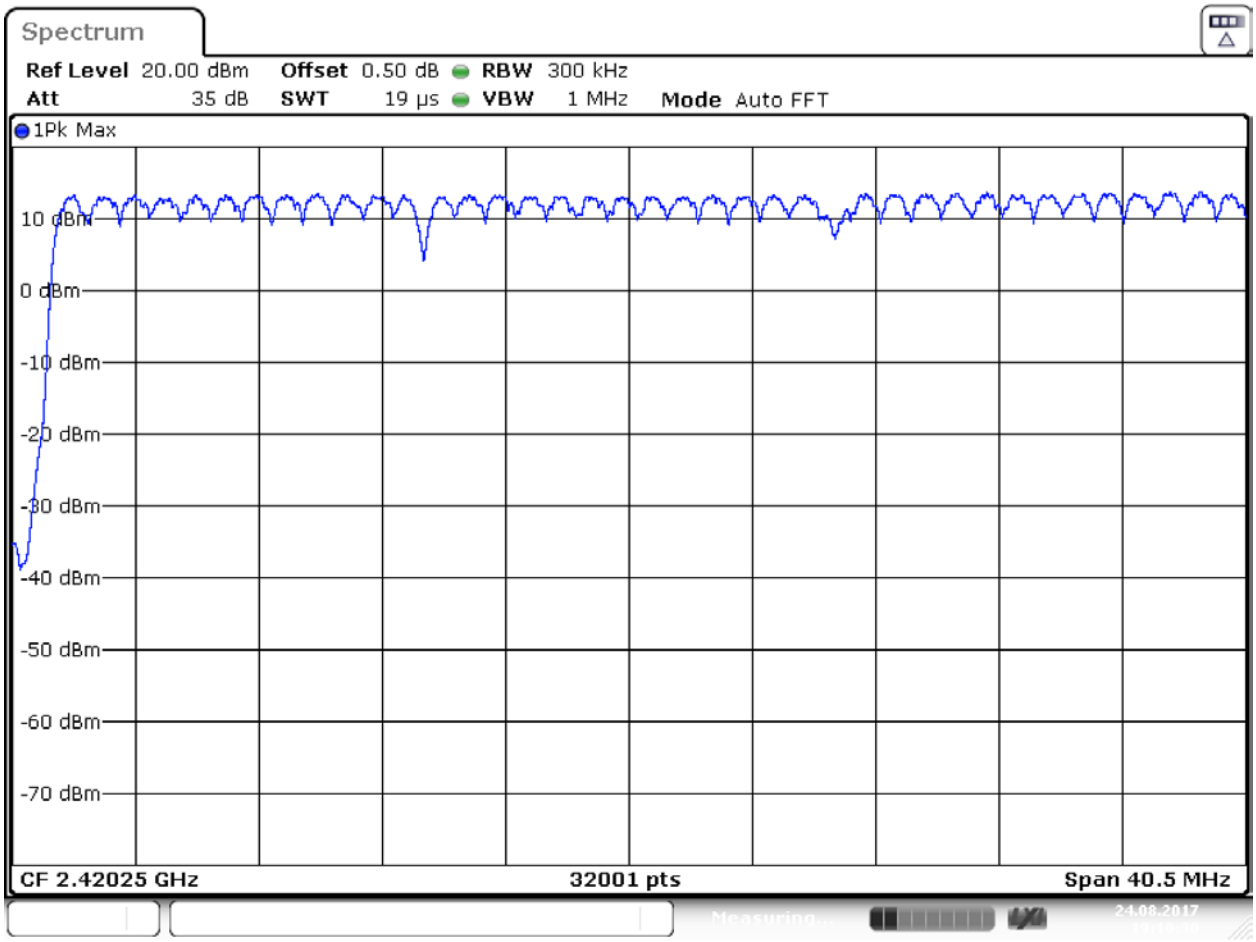
With the analyzer set to MAX HOLD, readings were taken once channels were filled in. The traces were broken down into 2 spans from 2400 to 2483.5MHz. The channel peaks were recorded and compared to the minimum number of channels required in the regulation.

Tested By:	Aaron Chang
Test Date:	October 12, 2017

4.4.3 Test Result

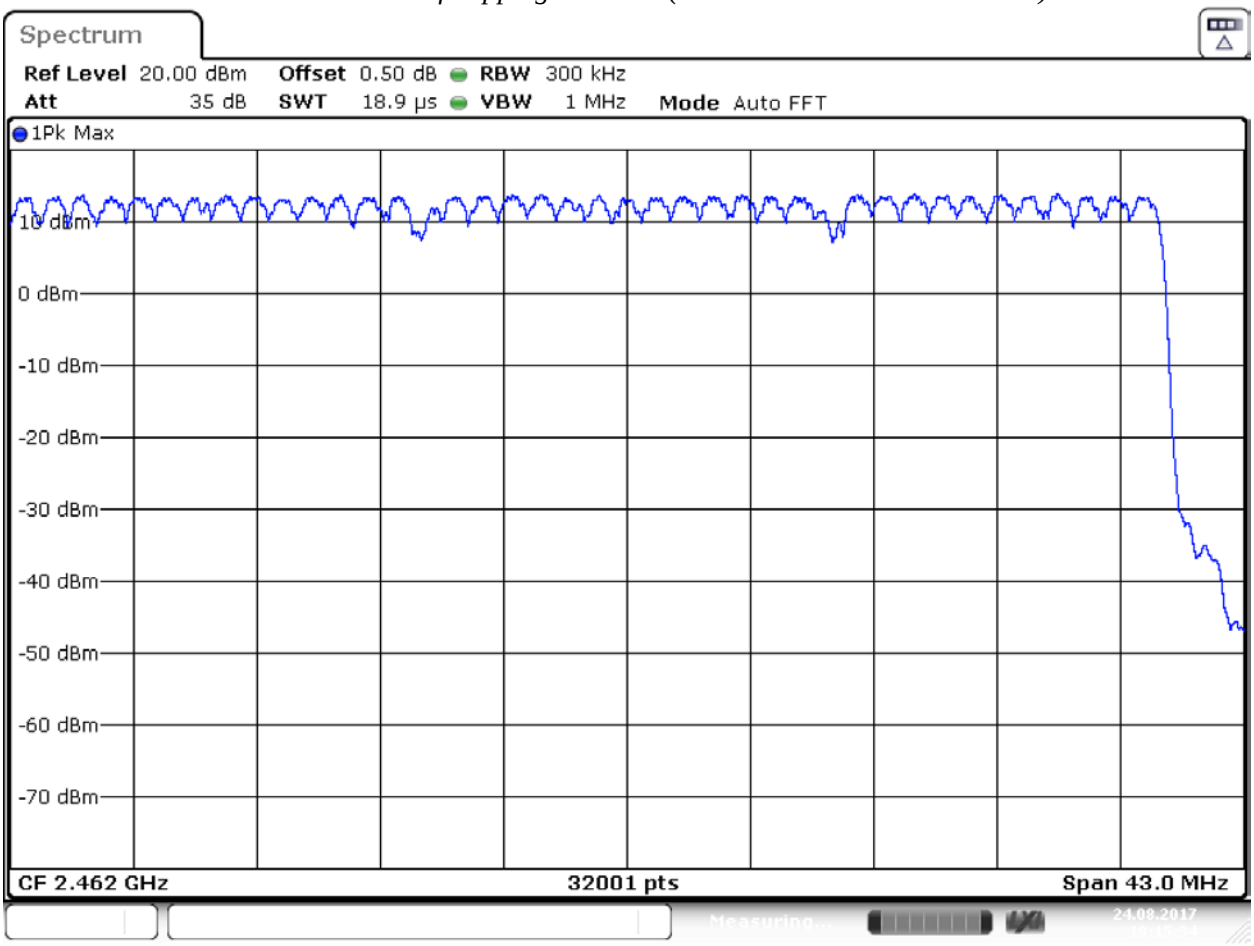
Results	79 Channels -Complies

Plot 4.1 - Number of hopping channels (2400 to 2442.5 MHz)



Date: 24.AUG.2017 19:10:30

Plot 4.2 - Number of hopping channels (GFSK - 2442.5 to 2483.5 MHz)



4.5 Average Channel Occupancy Time
FCC 15.247(a)(1)

4.5.1 Requirement

For systems operating in the 2400-2483.5 MHz band, the average time of occupancy on any channel shall not be greater than 0.4 second within a period of 0.4 second multiplied by the number of hopping channels employed.

4.5.2 Procedure

The Procedure described in the ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Average Channel Occupancy Time.

- The EUT must have its hopping function enabled.
- Span = zero span, centered on a hopping channel
- RBW = 1 MHz
- VBW = 3 x RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. An oscilloscope may be used instead of a spectrum analyzer.

The spectrum analyzer center frequency was set to one of the known hopping channels, the SPAN was set to ZERO SPANS, and the TRIGGER was set to VIDEO. The time duration of the transmission so captured was measured with the MARKER DELTA function.

Since the radio is employed 78 hopping channels, the Occupancy Time was calculated for the period of 0.4 * 79 = 31.6 sec.

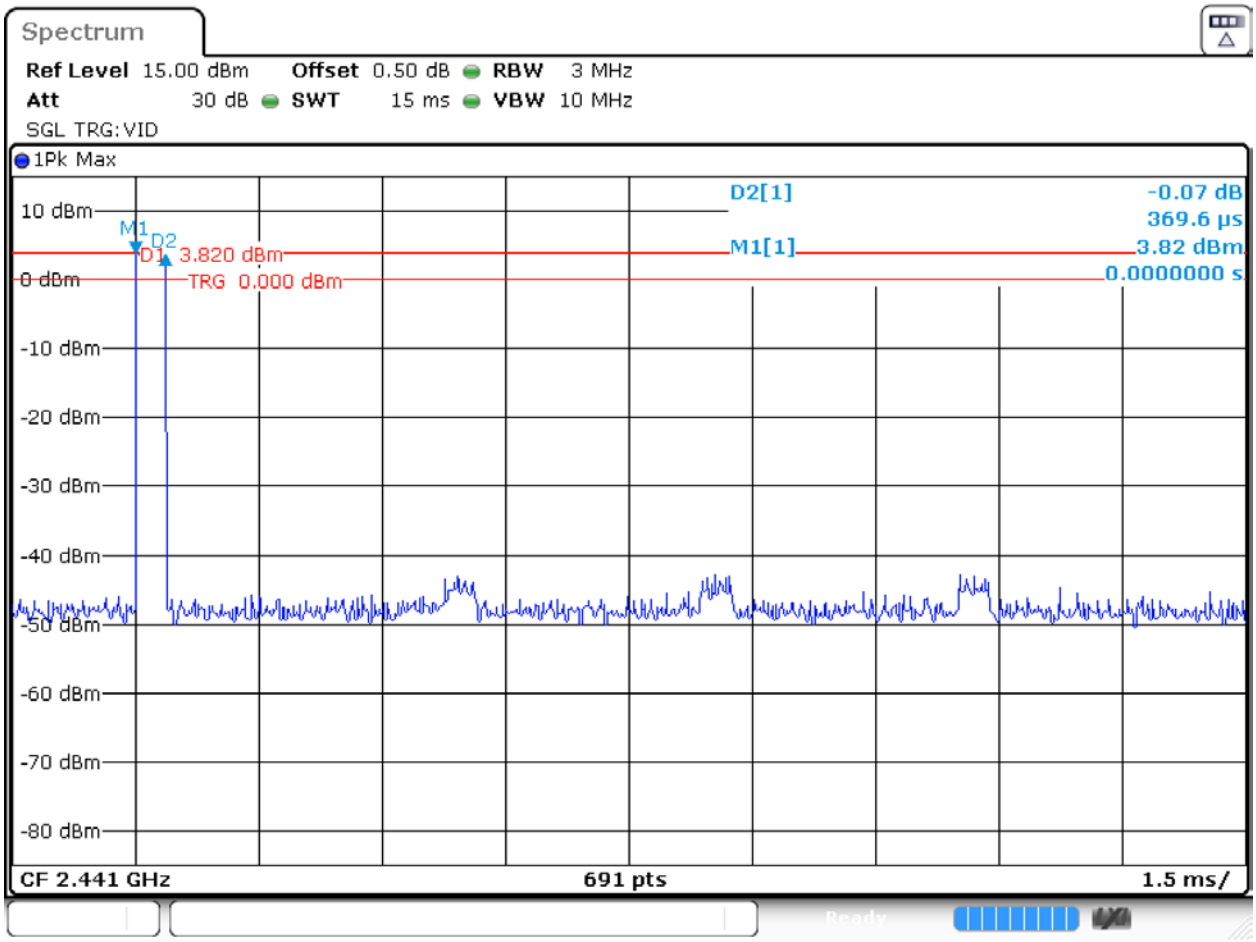
Tested By:	Aaron Chang
Test Date:	October 19, 2017

4.5.3 Test Results

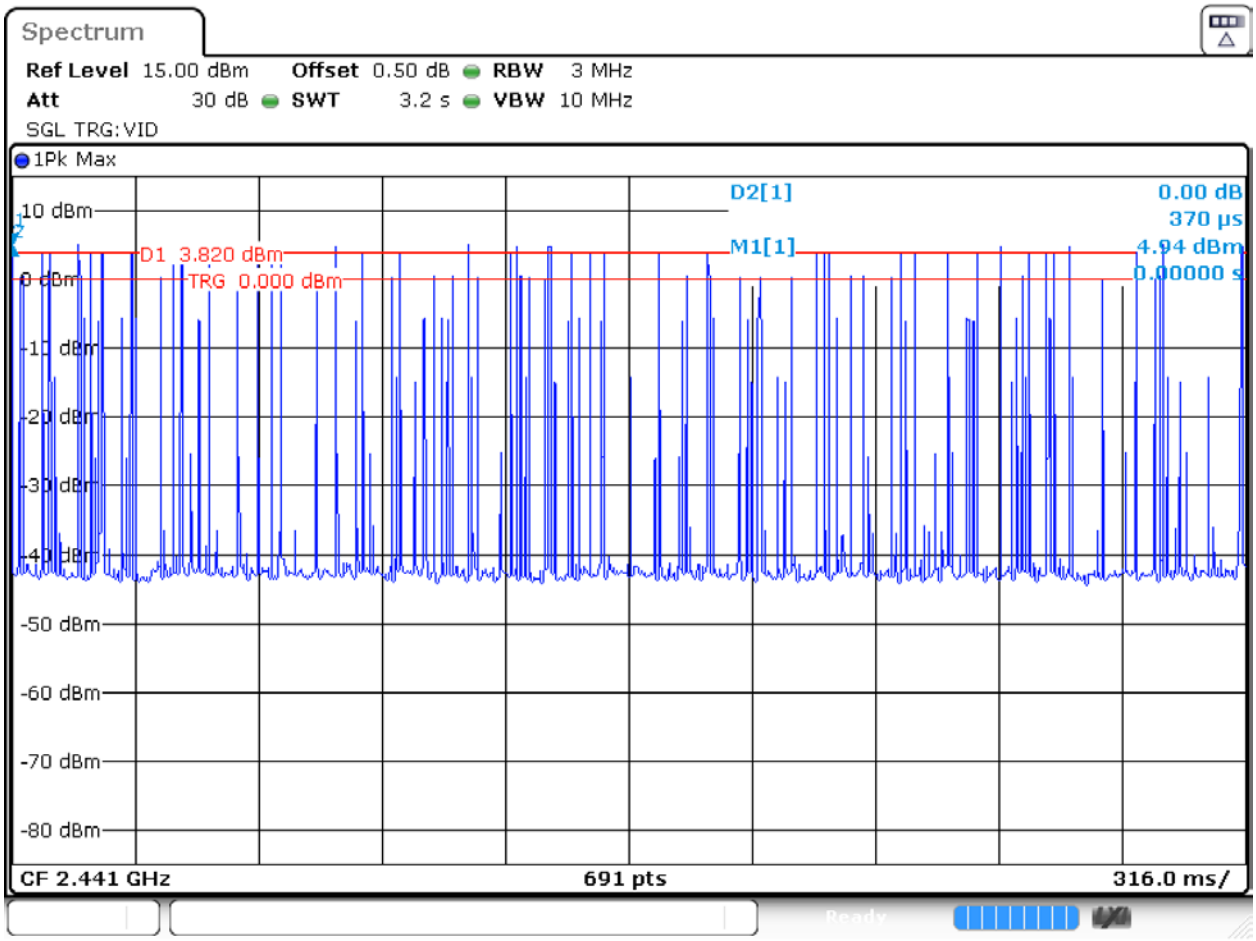
Results	Complies

GFSK, DH1

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
33*10	0.370	122.1	400



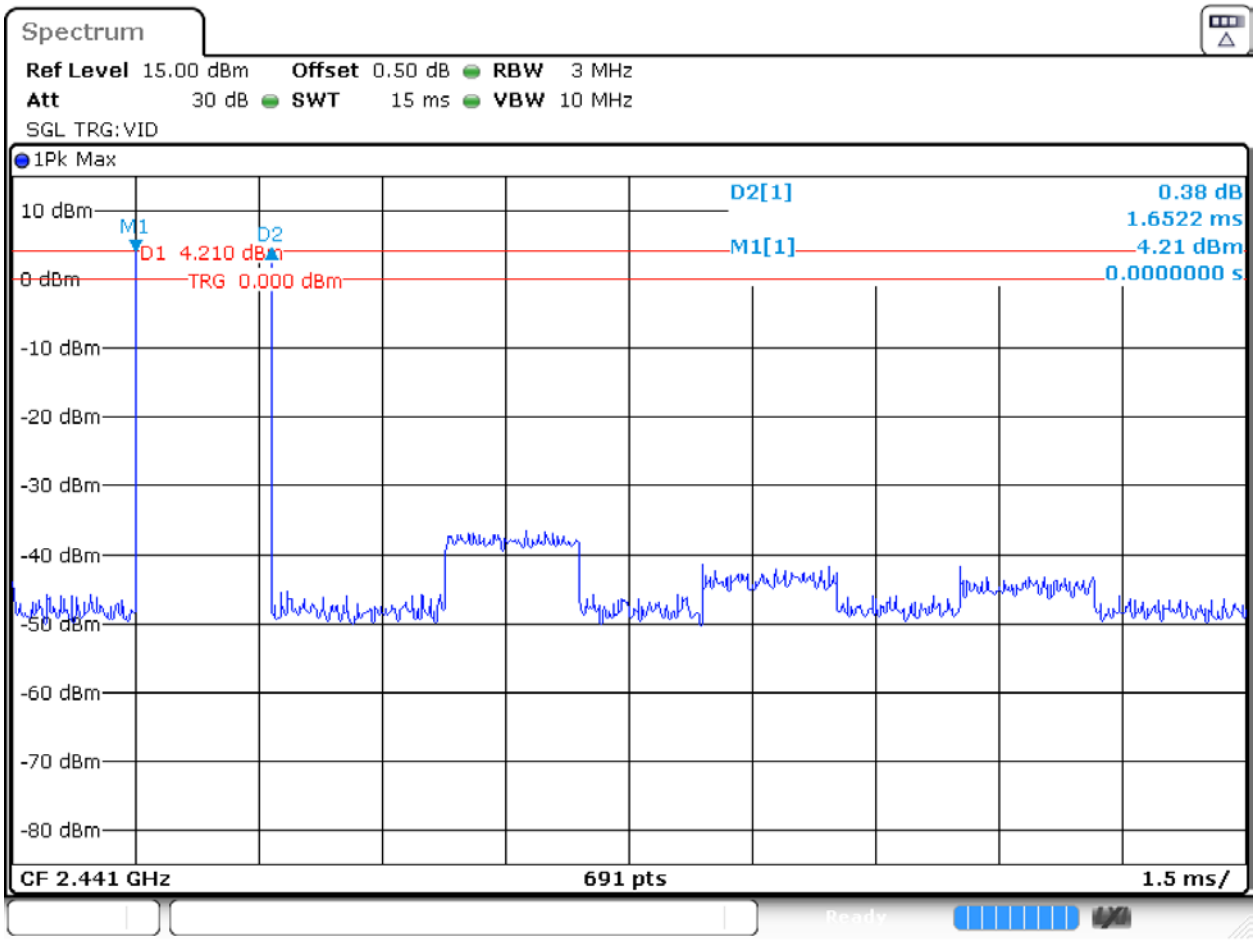
Date: 26.OCT.2017 17:36:56



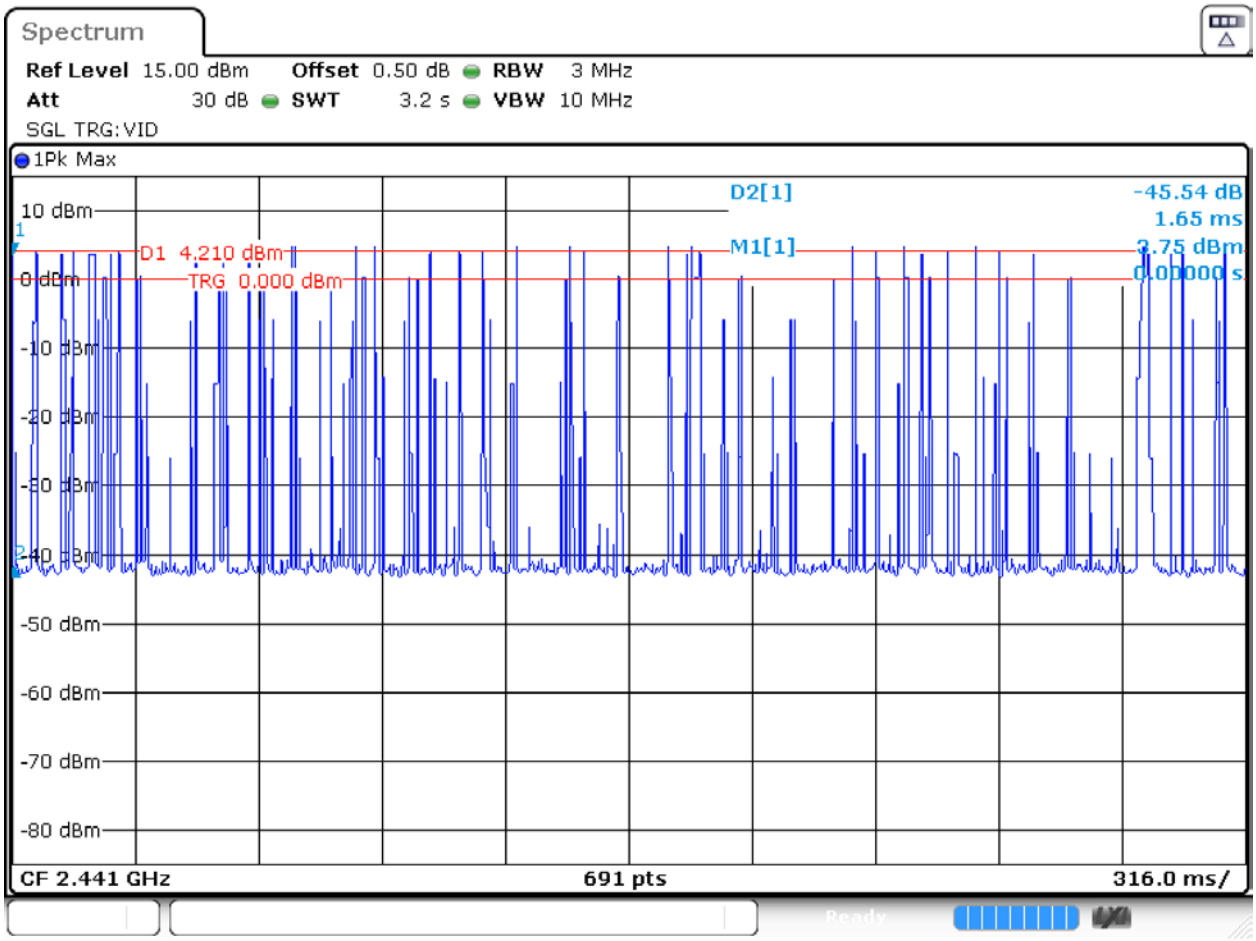
Date: 26.OCT.2017 17:37:17

GFSK, DH3

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
13*10	1.652	214.76	400



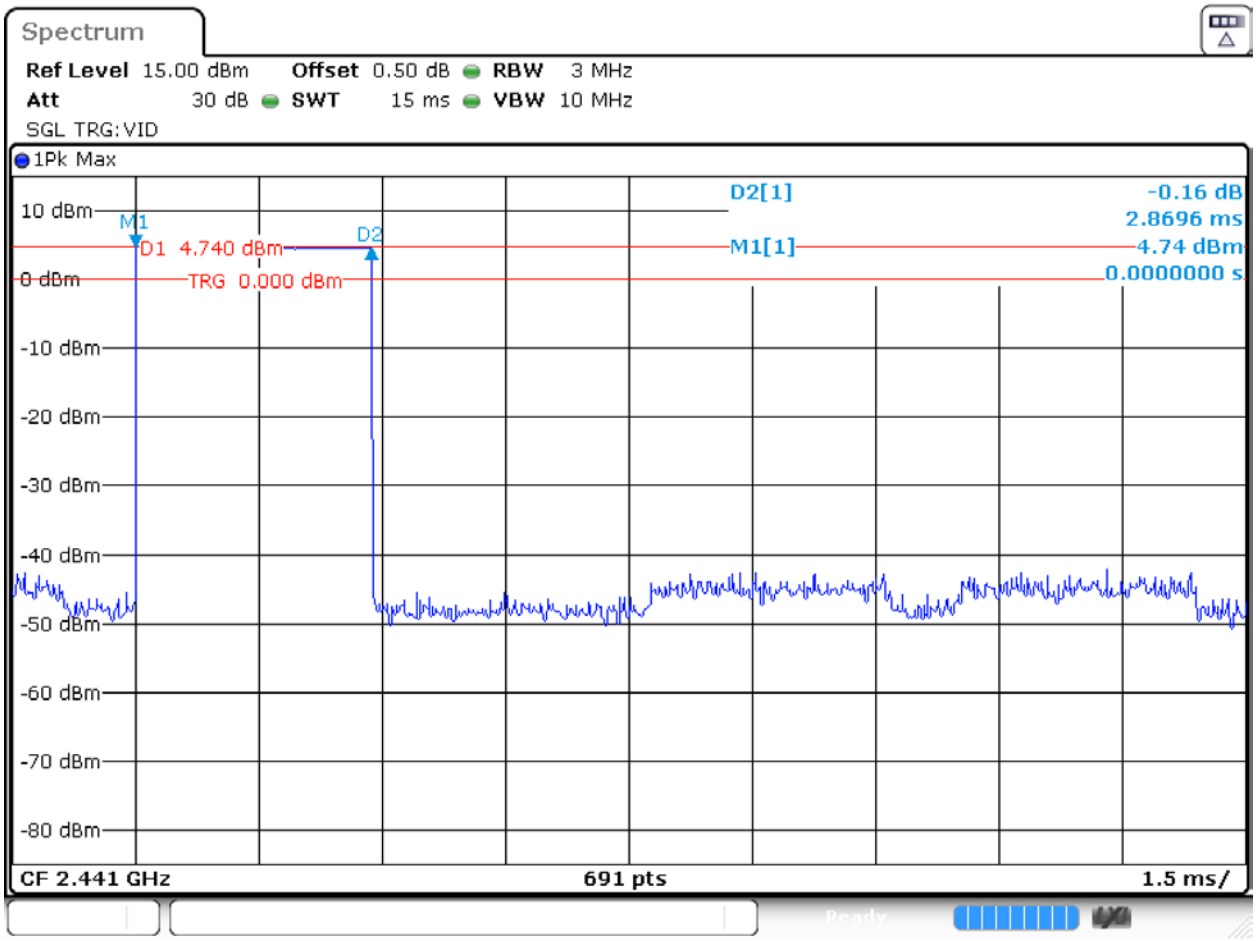
Date: 26.OCT.2017 17:38:30



Date: 26.OCT.2017 17:38:48

GFSK, DH5

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
7*10	2.87	200.9	400



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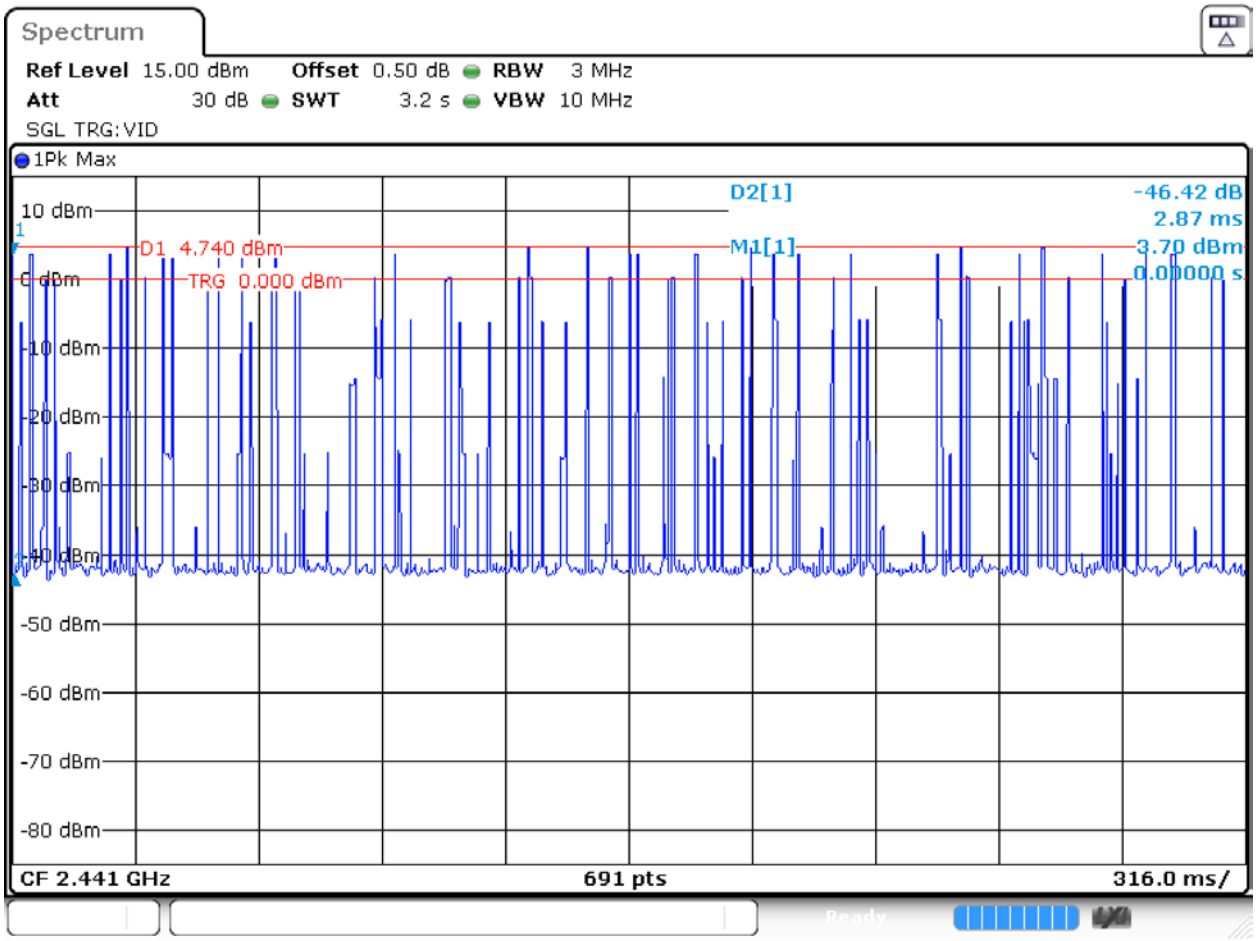
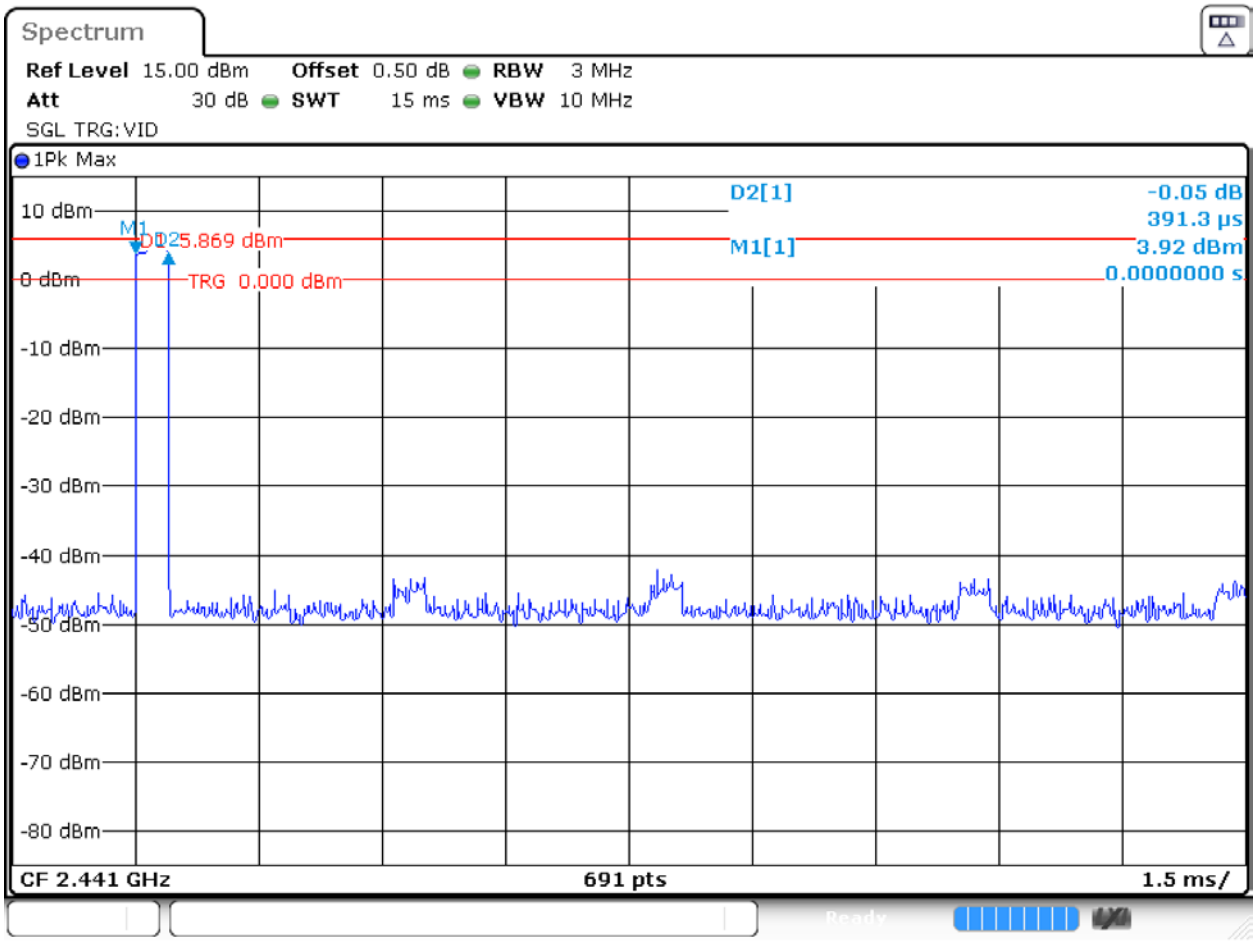


Date: 26.OCT.2017 17:40:00

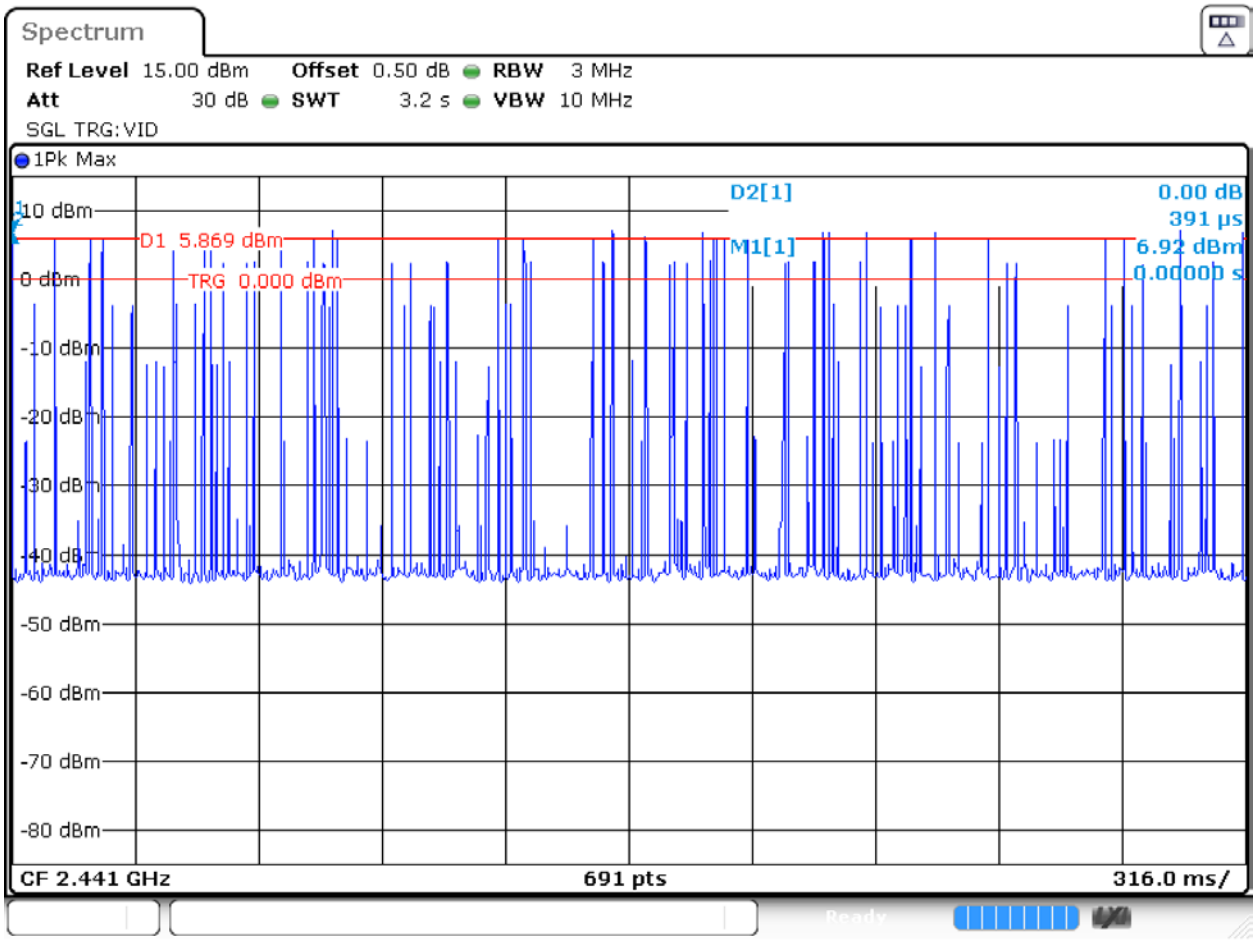
4.5.3 Test Results (Continued)

π/4-DQPSK, DH1

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
22*10	0.391	86.02	400



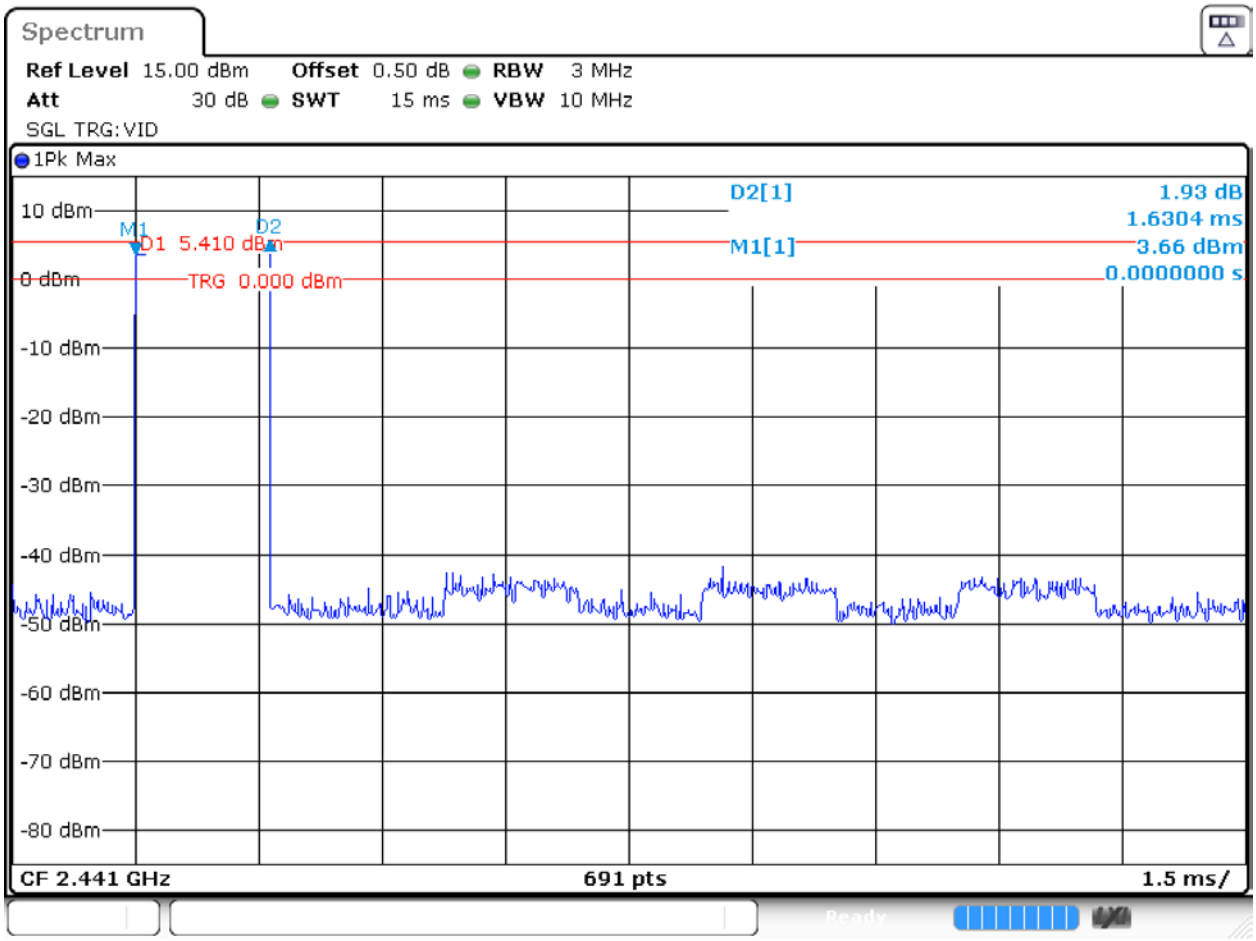
Date: 26.OCT.2017 17:46:26



Date: 26.OCT.2017 17:46:42

π/4-DQPSK, DH3

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
24*10	1.63	391.2	400



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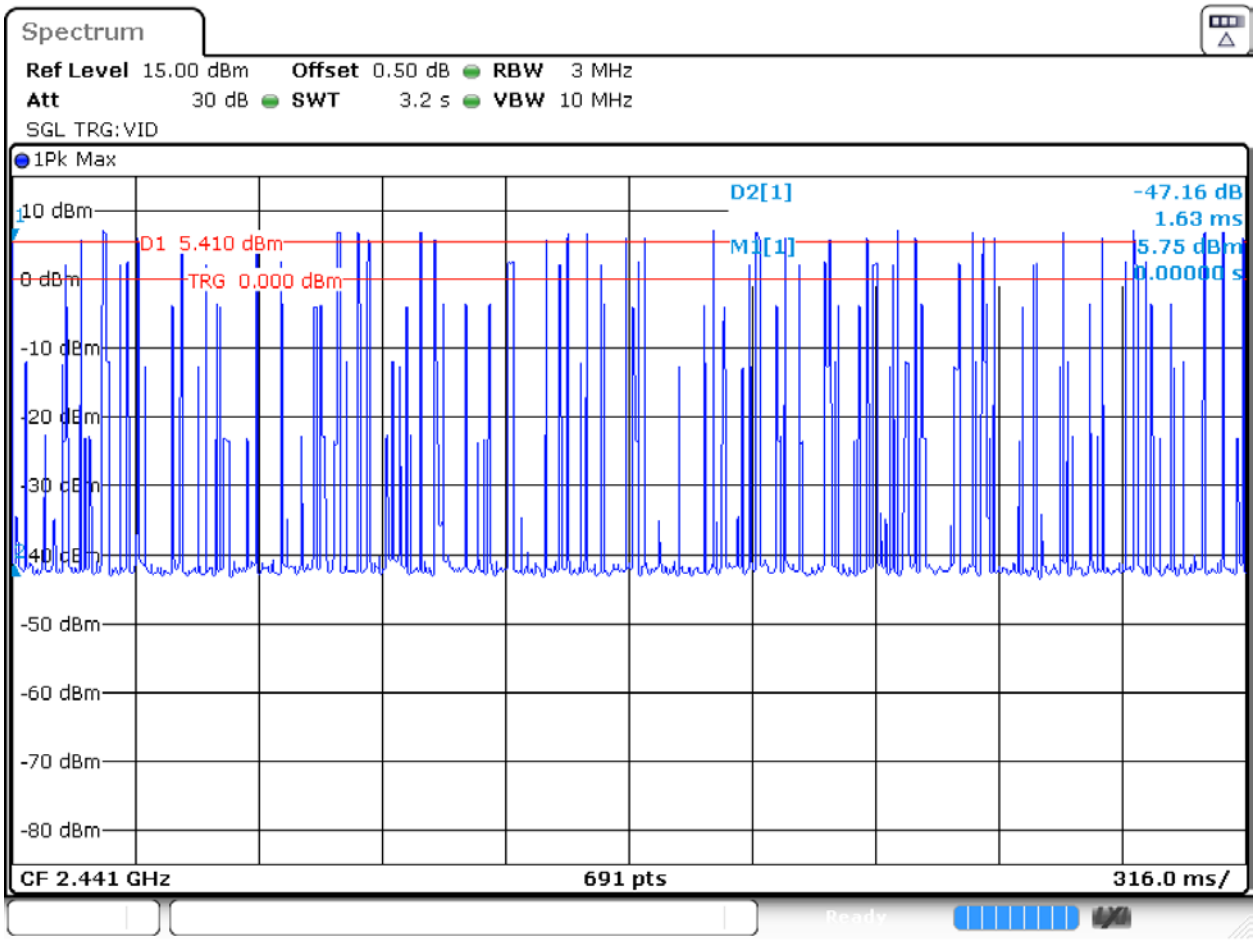
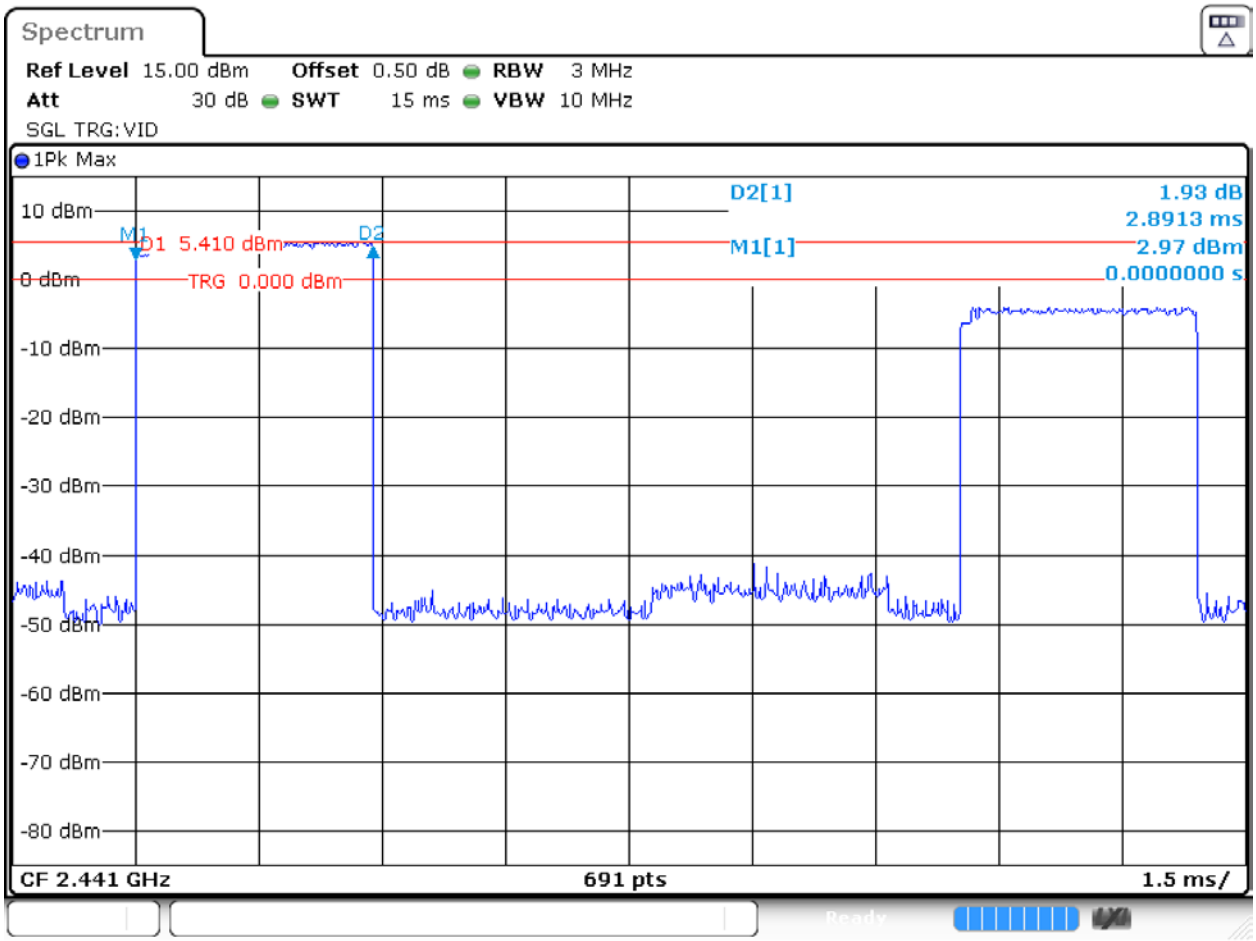


Date: 26.OCT.2017 17:47:37

π/4-DQPSK, DH5

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
13*10	2.89	375.7	400



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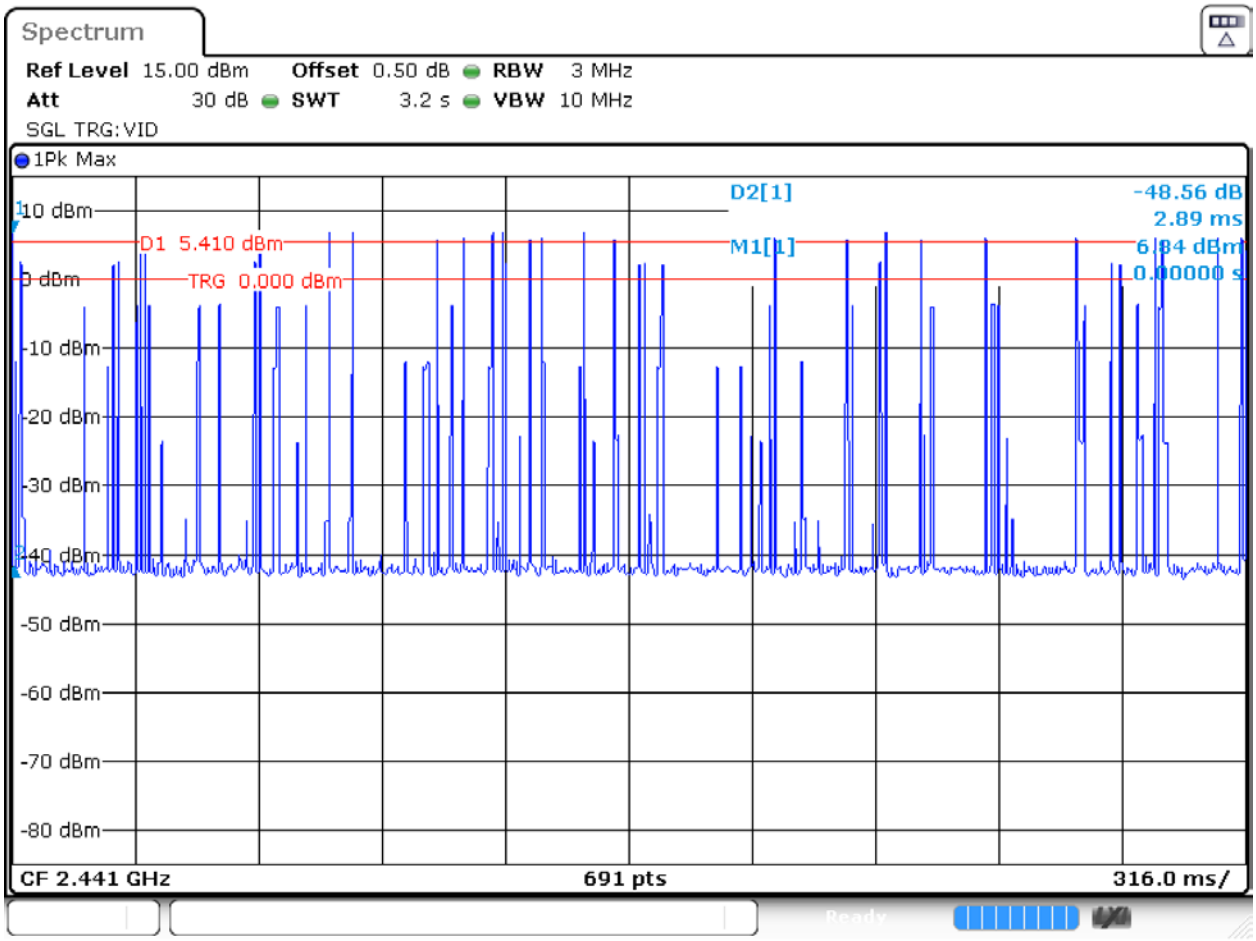
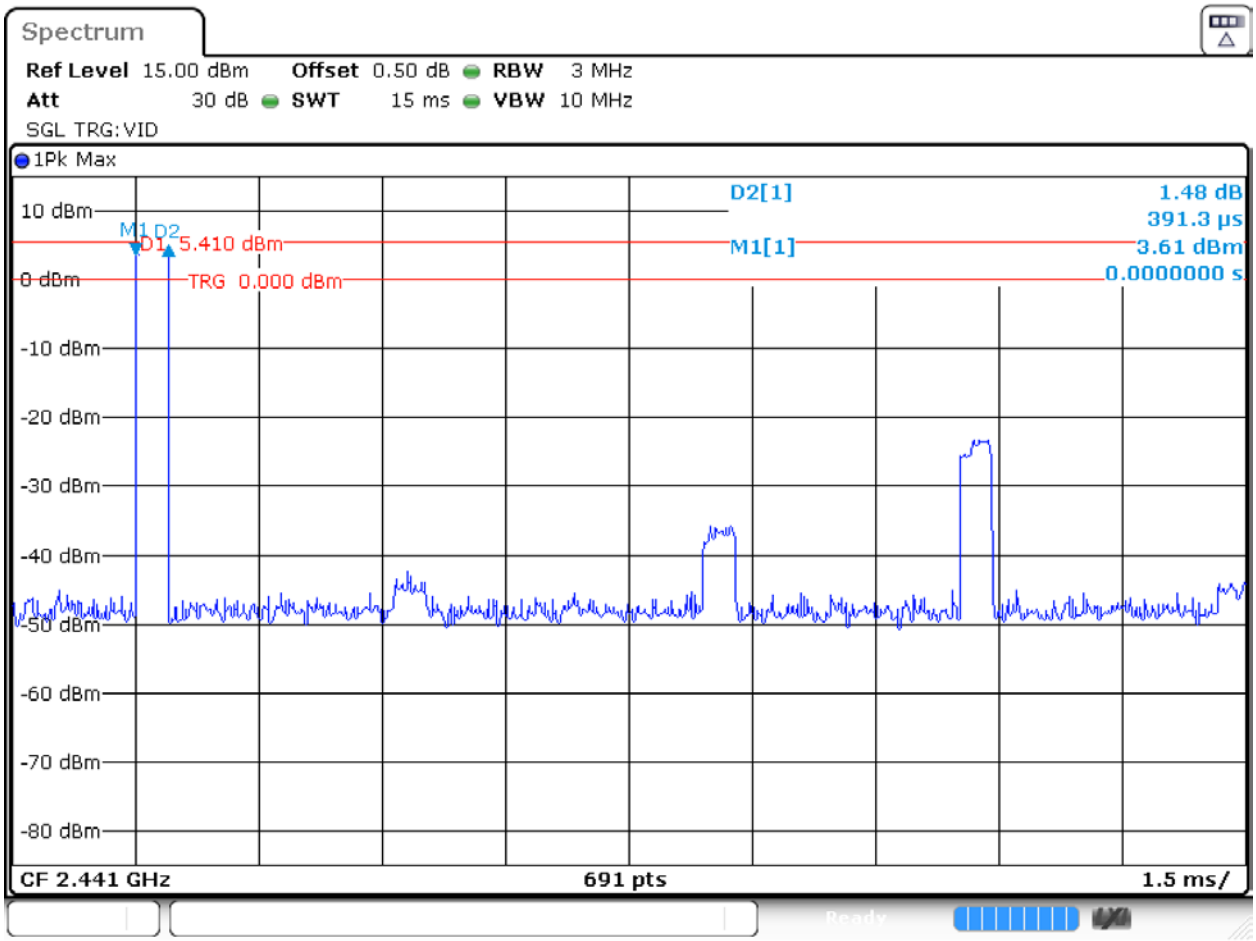


Date: 26.OCT.2017 17:48:23

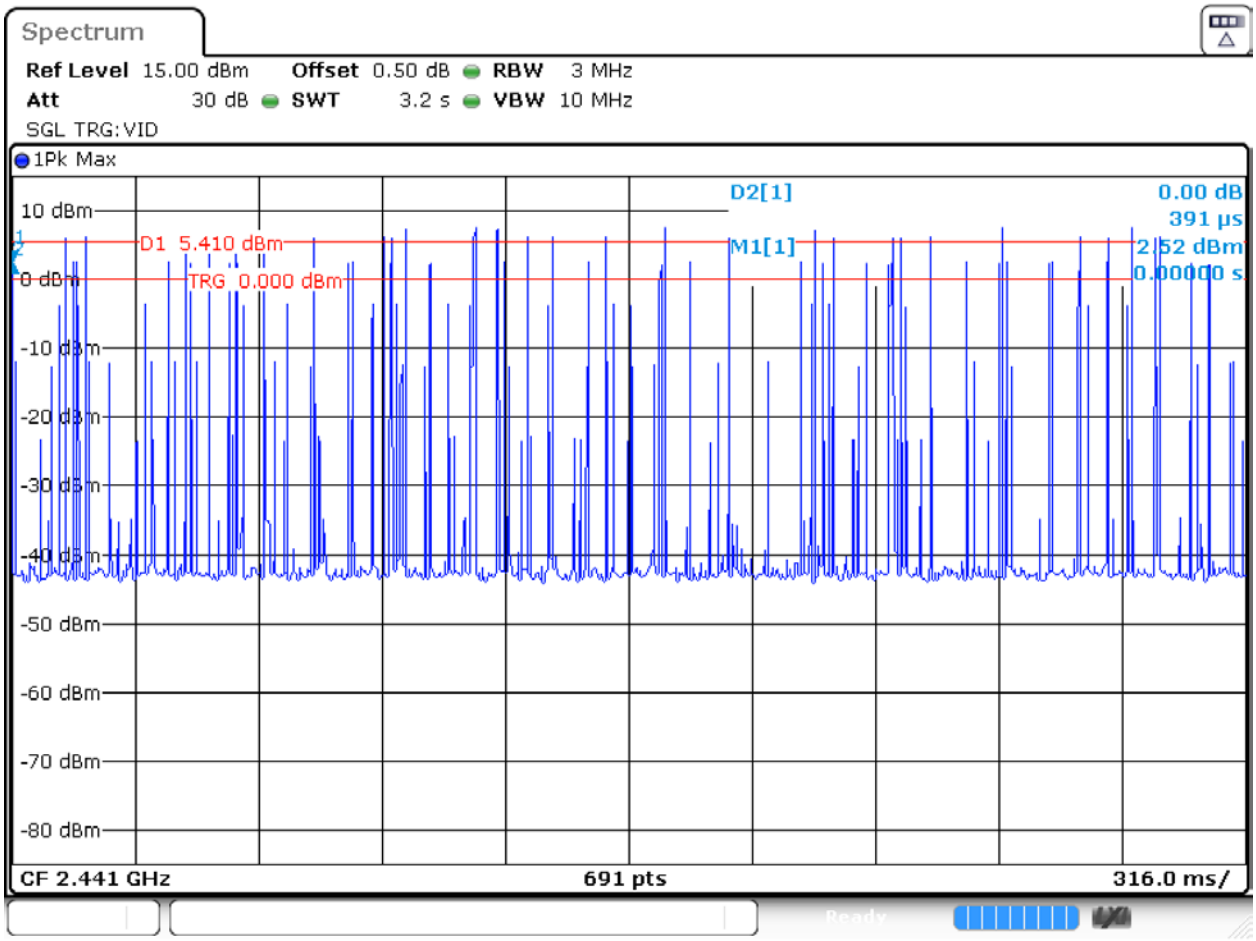
4.5.3 Test Results (Continued)

8DPSK, DH1

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
24*10	0.391	93.84	400



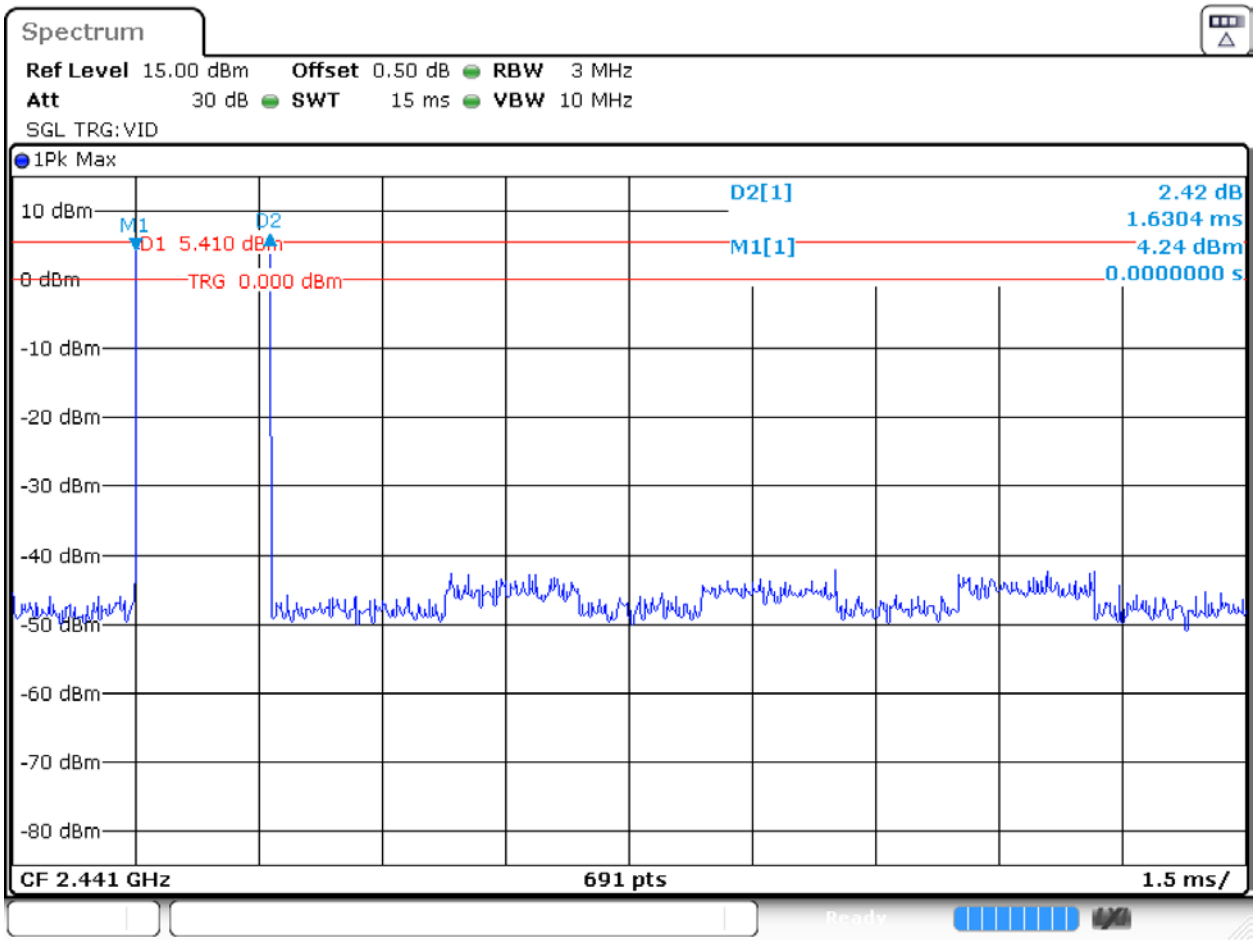
Date: 26.OCT.2017 17:49:06



Date: 26.OCT.2017 17:49:25

8DPSK, DH3

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
11*10	1.63	179.3	400



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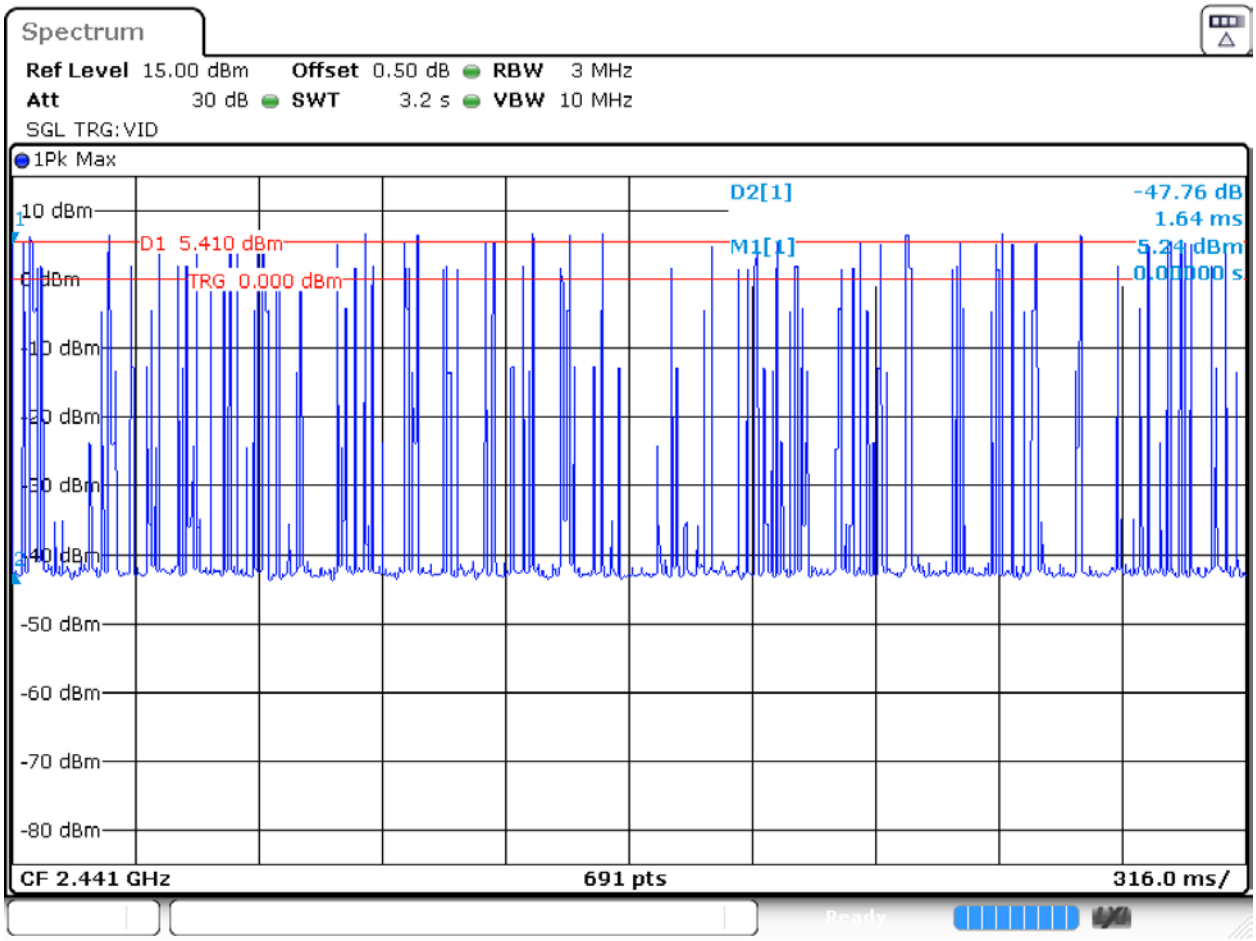
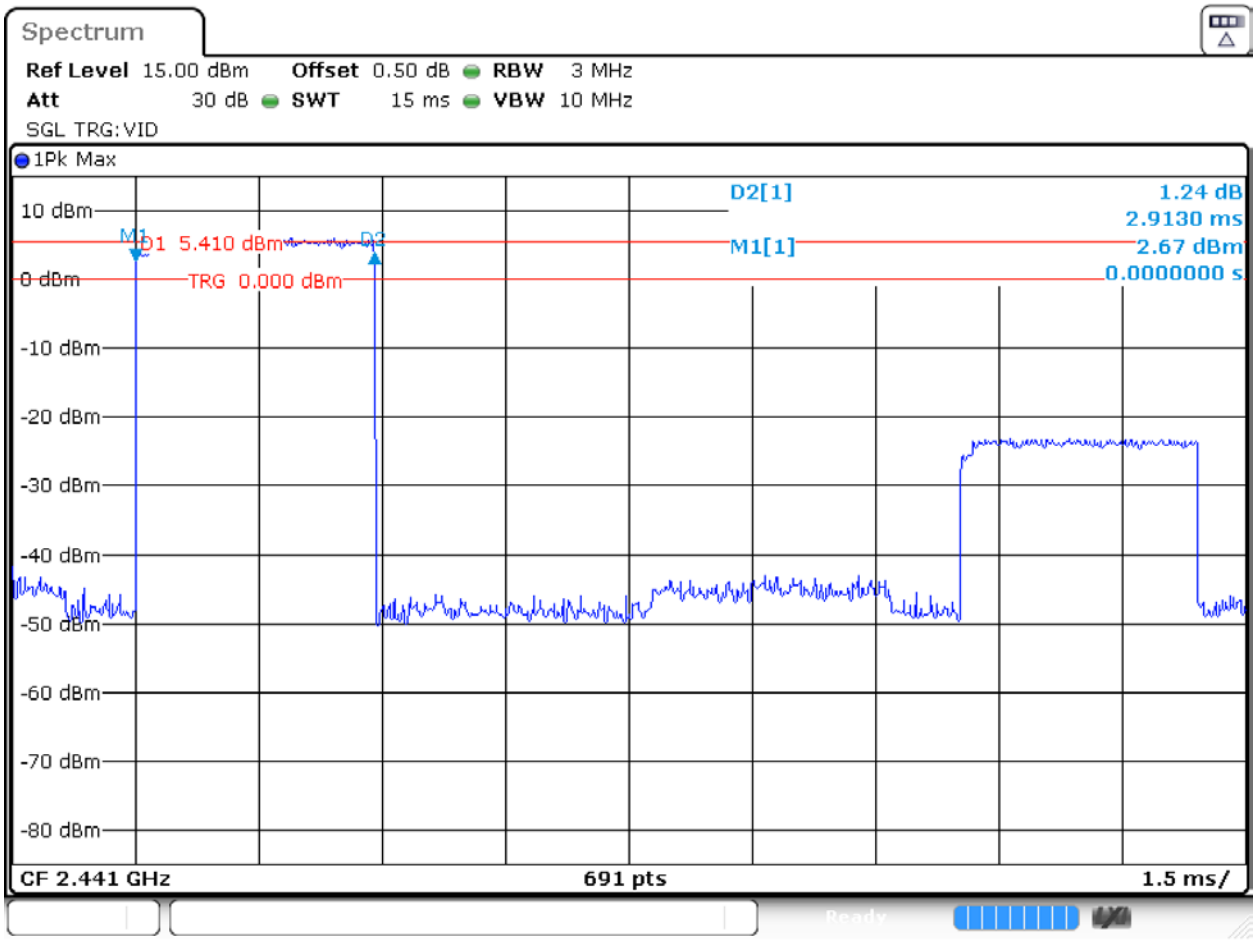


Date: 26.OCT.2017 19:10:52

8DPSK, DH5

No. of Burst in 3.16s (31.6s Period)	Burst On Time (ms)	Dwell Time (ms)	Dwell Time limit (ms)
8*10	2.913	233.04	400



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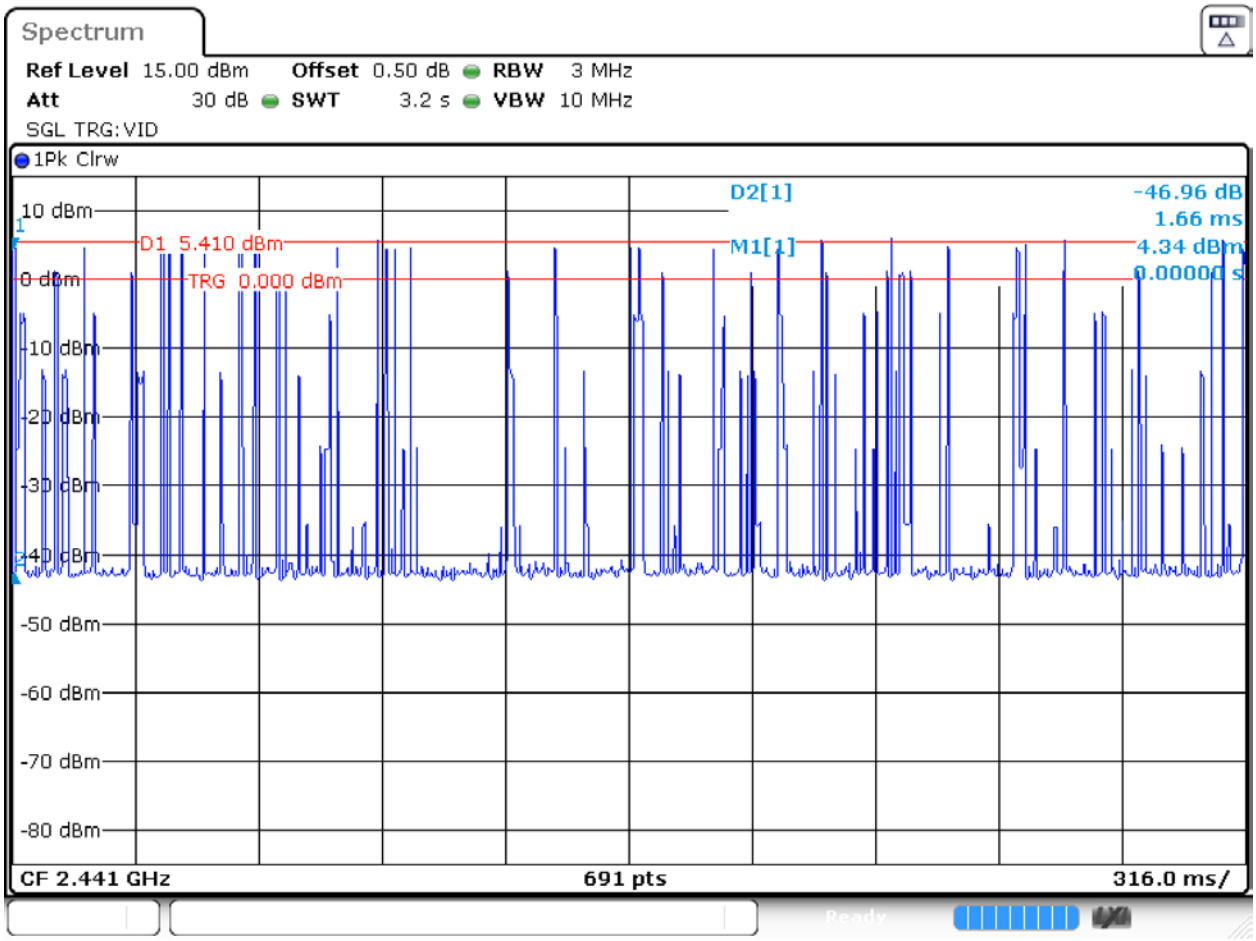

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