

# FCC PART 15.247 TEST REPORT

For

## 3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION

3M Center, Building 251-01-E-19, St. Paul, MN 55144-1000 U.S.A

**FCC ID: 2AFHL-WTW90542**

<b>Report Type:</b> Original Report	<b>Product Type:</b> WorkTunes Wireless Hearing Protector
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<b>Report Number:</b> RSZ150701010-00	
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**Note:** This test report is prepared for the customer shown above and for the equipment described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp.

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## GENERAL INFORMATION

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### Product Description for Equipment under Test (EUT)

The 3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION's product, model number: *WorkTunes Wireless Hearing Protector* (FCC ID: 2AFHL-WTW90542) or the "EUT" in this report was a *WorkTunes Wireless Hearing Protector*, which was measured approximately: 16.0 cm (L) \* 9.0 cm (W) \* 25.0 cm (H), rated with input voltage: DC 3.7V rechargeable Li-ion battery or 2×1.5V AA dry batteries.

*\*All measurement and test data in this report was gathered from production sample serial number: 1505605 (Assigned by Shenzhen BACL). The EUT supplied by the applicant was received on 2015-07-01.*

### Objective

This test report is prepared on behalf of 3M CONSTRUCTION & HOME IMPROVEMENT MARKETS DIVISION in accordance with Part 2-Subpart J, Part 15-Subparts A, B and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Related Submittal(s)/Grant(s)

No related submittal(s).

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement uncertainty with radiated emission is 5.91 dB for 30MHz-1GHz, and 4.92 dB for above 1GHz, 1.95dB for conducted measurement.

## **Test Facility**

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F, the 3<sup>rd</sup> Phase of WanLi Industrial Building, ShiHua Road, FuTian Free Trade Zone Shenzhen, Guangdong, China.

Test site at Bay Area Compliance Laboratories Corp. (Shenzhen) has been fully described in reports submitted to the Federal Communication Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on December 06, 2010. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2009.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 382179. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in an engineering mode.

### EUT Exercise Software

InstallBlueSuite.

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

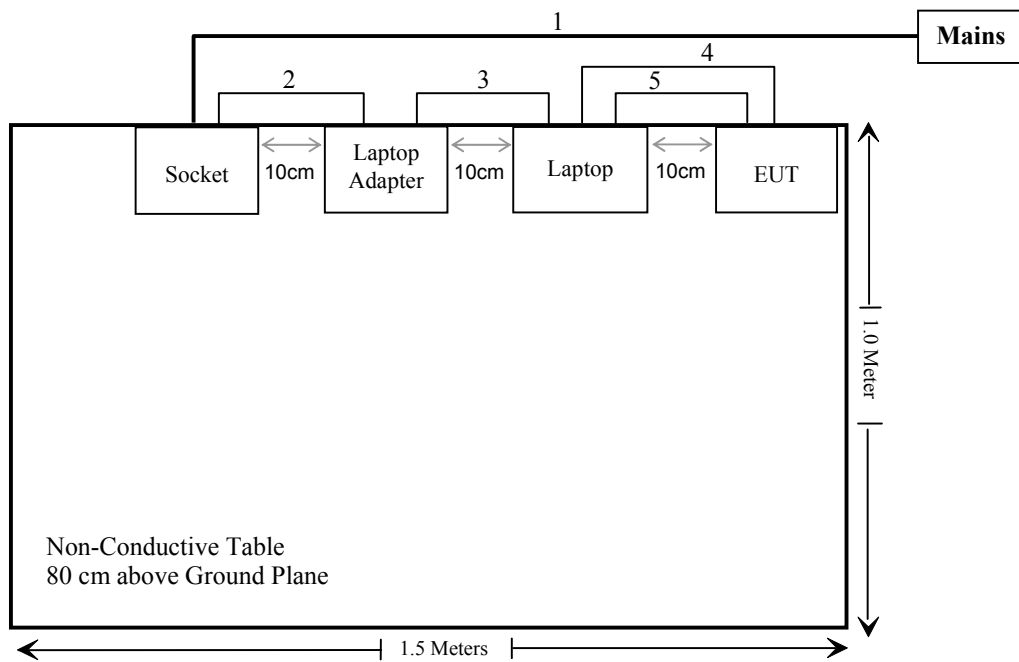
### Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
ACER	Laptop	Aspire E1-470G	33603827166
Longway	Adapter	TYP60-1207000Z	Lw516654
N/A	Socket	N/A	140217

### External I/O Cable

Cable Description		Length (m)	From Port	To
1	Un-Shielding Detachable AC Cable	1.2	Mains	Socket
2	Un-Shielding Detachable AC Cable	1.0	Socket	Adapter
3	Un-Shielding Un-Detachable DC Cable	0.5	Adapter	Laptop
4	Un-Shielding Detachable Audio Cable	1.0	Laptop	EUT
5	Shielding Detachable USB Cable	0.3	Laptop	EUT

## Block Diagram of Test Setup



**SUMMARY OF TEST RESULTS**

FCC Rules	Description of Test	Result
§15.247 (i), §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance



## FCC §15.247 (i) & §2.1093 – RF EXPOSURE

### Applicable Standard

According to §15.247(i) and §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB447498 D01 General RF Exposure Guidance v05r02:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

- $f(\text{GHz})$  is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is  $\leq 50$  mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

### Measurement Result

For worst case as below:

Frequency (MHz)	P (dBm)	P (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
2480	5.91	3.90	5.0	1.23	3.0	Yes

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**FCC §15.203 – ANTENNA REQUIREMENT**

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**Applicable Standard**

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

**Antenna Connector Construction**

The EUT has one PCB print antenna arrangement for bluetooth, which was permanently attached and the antenna gain is 0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

**Result:** Compliance.

## FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

### Applicable Standard

FCC §15.207(a)

### Measurement Uncertainty

Input quantities to be considered for conducted disturbance measurements maybe receiver reading, attenuation of the connection between LISN and receiver, LISN voltage division factor, LISN VDF frequency interpolation and receiver related input quantities, etc.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of conducted disturbance test at Bay Area Compliance Laboratories Corp. (Shenzhen) is shown as below. And the uncertainty will not be taken into consideration for the test data recorded in the report.

Port	Expanded Measurement uncertainty
AC Mains	3.26 dB (k=2, 95% level of confidence)
CAT 3	3.70 dB (k=2, 95% level of confidence)
CAT 5	3.86 dB (k=2, 95% level of confidence)
CAT 6	4.64 dB (k=2, 95% level of confidence)

### EUT Setup



- Note: 1. Support units were connected to second LISN.  
 2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.4-2009. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

The PC was connected to a 120 VAC/60 Hz power source.

## EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

## Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2015-06-03	2016-06-03
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2014-12-01	2015-12-01
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2015-05-14	2016-05-14
Rohde & Schwarz	CE Test software	EMC 32	V8.53	NCR	NCR

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207, the worst margin reading as below:

**18.0 dB at 0.189500 MHz** in the **Neutral** conducted mode

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BACL,  $U_{(L_m)}$  is less than  $U_{\text{cispr}}$ , if  $L_m$  is less than  $L_{\text{lim}}$ , it implies that the EUT complies with the limit.

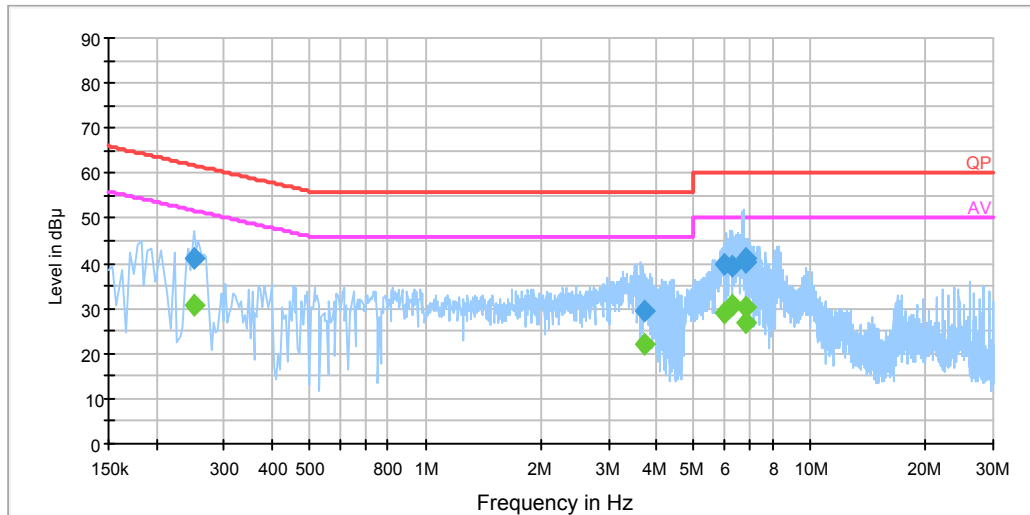
## Test Data

### Environmental Conditions

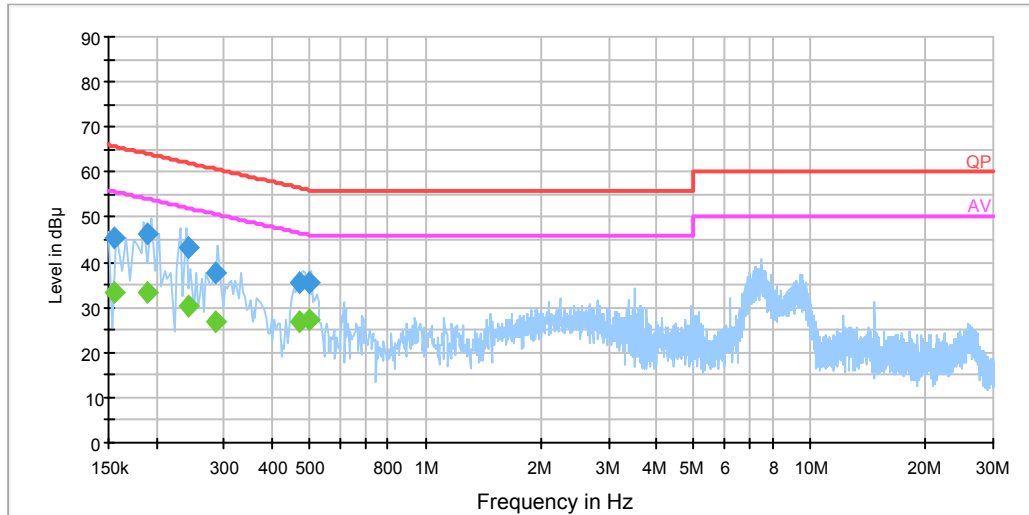
Temperature:	27 °C
Relative Humidity:	50 %
ATM Pressure:	100.5 kPa

*The testing was performed by Sewen Guo on 2015-07-13.*

*EUT operation mode: Charging & Transmitting*

**AC 120V/60 Hz, Line****EMI Auto Test L**

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.249500	41.3	20.0	61.8	20.5	QP
0.249500	30.9	20.0	51.8	20.9	Ave.
3.699310	29.6	20.0	56.0	26.4	QP
3.699310	22.0	20.0	46.0	24.0	Ave.
6.018890	40.0	20.0	60.0	20.0	QP
6.018890	28.9	20.0	50.0	21.1	Ave.
6.244790	39.2	20.0	60.0	20.8	QP
6.244790	30.9	20.0	50.0	19.1	Ave.
6.801230	40.2	20.0	60.0	19.8	QP
6.801230	26.8	20.0	50.0	23.2	Ave.
6.847010	41.2	20.0	60.0	18.8	QP
6.847010	30.2	20.0	50.0	19.8	Ave.

**AC 120V/60 Hz, Neutral****EMI Auto Test N**

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.154500	45.3	20.0	65.8	20.5	QP
0.154500	33.4	20.0	55.8	22.4	Ave.
0.189500	46.1	20.0	64.1	18.0	QP
0.189500	33.5	20.0	54.1	20.6	Ave.
0.241500	43.1	20.0	62.0	18.9	QP
0.241500	30.3	20.0	52.0	21.7	Ave.
0.285500	37.7	19.9	60.7	23.0	QP
0.285500	27.0	19.9	50.7	23.7	Ave.
0.470830	35.3	19.9	56.5	21.2	QP
0.470830	26.8	19.9	46.5	19.7	Ave.
0.498410	35.6	19.9	56.0	20.4	QP
0.498410	27.1	19.9	46.0	18.9	Ave.

**Note:**

- 1) Correction Factor = LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude

## **FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS**

### **Applicable Standard**

FCC §15.205; §15.209; §15.247(d)

### **Measurement Uncertainty**

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

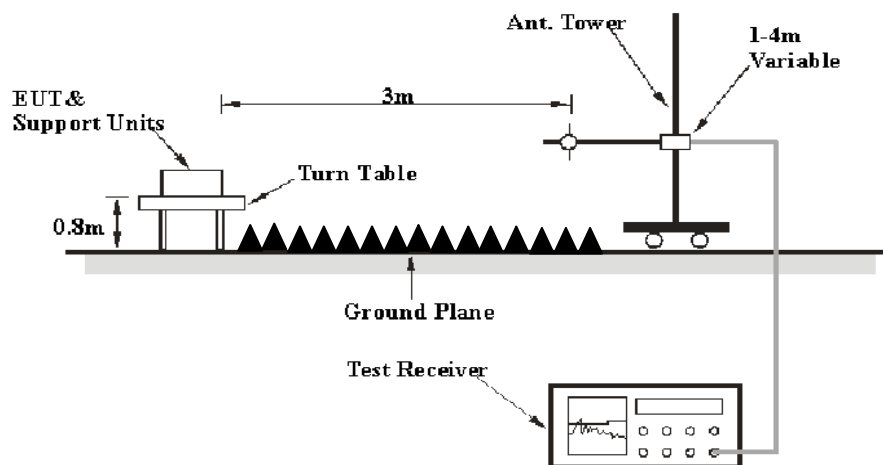
Based on CISPR 16-4-2:2011, the expanded combined standard uncertainty of radiation emissions at Bay Area Compliance Laboratories Corp. (Shenzhen) is 5.91 dB for 30MHz-1GHz, and 4.92 dB for above 1GHz. And this uncertainty will not be taken into consideration for the test data recorded in the report.

### **EUT Setup**

**Below 1 GHz:**





**Above 1GHz:**

The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.4-2009. The specification used was the FCC 15.209 and FCC 15.247 limits.

The PC was connected to a 120 VAC/60 Hz power source.

**EMI Test Receiver & Spectrum Analyzer Setup**

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Ave.

**Test Procedure**

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
HP	Amplifier	HP8447E	1937A01046	2015-05-06	2016-05-06
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2014-11-03	2015-11-03
Sunol Sciences	Bi-log Antenna	JB1	A040904-2	2014-12-07	2017-12-06
Mini	Amplifier	ZVA-183-S+	5969001149	2015-04-23	2016-04-23
A.H. System	Horn Antenna	SAS-200/571	135	2015-02-10	2016-02-10
Rohde & Schwarz	Signal Analyzer	FSIQ26	8386001028	2014-12-11	2015-12-11
the electro-Mechanics Co.	Horn Antenna	3116	9510-2270	2013-10-14	2016-10-13
TDK	Chamber	Chamber A	2#	2012-10-15	2015-10-15
TDK	Chamber	Chamber B	1#	2014-07-22	2015-07-22
DUCOMMUN	Pre-amplifier	ALN-22093530-01	991373-01	2014-08-03	2015-08-03
R&S	Auto test Software	EMC32	V9.10	NCR	NCR

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

**6.99 dB at 9764.00 MHz in the Vertical polarization for Middle Channel**

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(L_m)} \leq L_{lim} + U_{cispr}$$

In BACL,  $U_{(L_m)}$  is less than  $+ U_{cispr}$ , if  $L_m$  is less than  $L_{lim}$ , it implies that the EUT complies with the limit.

**Test Data****Environmental Conditions**

<b>Temperature:</b>	28 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	100.5 kPa

The testing was performed by Sewen Guo on 2015-07-09.

EUT operation mode: Transmitting

**30 MHz -25 GHz:** (Scan with GFSK,  $\pi/4$ -DQPSK, 8-DPSK mode, the worst case as below)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2402 MHz)									
177.22	40.13	QP	360	1.7	V	-14.9	25.23	43.5	18.27
2402.00	87.11	PK	342	2.2	H	4.27	91.38	/	/
2402.00	84.34	Ave.	342	2.2	H	4.27	88.61	/	/
2402.00	88.56	PK	6	1.9	V	4.17	92.73	/	/
2402.00	84.61	Ave.	6	1.9	V	4.17	88.78	/	/
2386.29	38.64	PK	241	2.1	H	4.27	42.91	74	31.09
2386.29	24.02	Ave.	241	2.1	H	4.27	28.29	54	25.71
2487.30	41.44	PK	82	1.7	H	7.99	49.43	74	24.57
2487.30	20.52	Ave.	82	1.7	H	7.99	28.51	54	25.49
3154.65	38.57	PK	102	1.3	V	14.69	53.26	74	20.74
3154.65	23.90	Ave.	102	1.3	V	14.69	38.59	54	15.41
4804.00	35.26	PK	276	1.4	V	18.51	53.77	74	20.23
4804.00	22.56	Ave.	276	1.4	V	18.51	41.07	54	12.93
7206.00	36.42	PK	313	1.1	H	22.28	58.70	74	15.30
7206.00	21.40	Ave.	313	1.1	H	22.28	43.68	54	10.32
9608.00	35.79	PK	75	2.1	V	25.22	61.01	74	12.99
9608.00	20.19	Ave.	75	2.1	V	25.22	45.41	54	8.59

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Middle Channel (2441 MHz)									
177.22	43.28	QP	342	1.7	V	-14.9	28.38	43.5	15.12
2441.00	89.28	PK	11	1.9	H	4.27	93.55	/	/
2441.00	85.48	Ave.	11	1.9	H	4.27	89.75	/	/
2441.00	88.36	PK	311	1.9	V	4.17	92.53	/	/
2441.00	84.18	Ave.	311	1.9	V	4.17	88.35	/	/
2332.56	38.00	PK	208	1.6	H	3.93	41.93	74	32.07
2332.56	24.42	Ave.	208	1.6	H	3.93	28.35	54	25.65
2484.97	41.63	PK	161	1.6	H	7.99	49.62	74	24.38
2484.97	20.52	Ave.	161	1.6	H	7.99	28.51	54	25.49
3154.65	37.88	PK	186	1.4	V	14.69	52.57	74	21.43
3154.65	23.19	Ave.	186	1.4	V	14.69	37.88	54	16.12
4882.00	35.26	PK	52	1.1	V	19.41	54.67	74	19.33
4882.00	21.88	Ave.	52	1.1	V	19.41	41.29	54	12.71
7323.00	36.38	PK	143	1.4	V	22.60	58.98	74	15.02
7323.00	21.11	Ave.	143	1.4	V	22.60	43.71	54	10.29
9764.00	34.86	PK	32	1.7	V	26.29	61.15	74	12.85
9764.00	20.72	Ave.	32	1.7	V	26.29	47.01	54	6.99
High Channel (2480 MHz)									
177.22	45.34	QP	219	1.3	V	-14.9	30.44	43.5	13.06
2480.00	88.37	PK	337	1.2	H	7.99	96.36	/	/
2480.00	84.72	Ave.	337	1.2	H	7.99	92.71	/	/
2480.00	89.38	PK	137	1.9	V	7.59	96.97	/	/
2480.00	84.98	Ave.	137	1.9	V	7.59	92.57	/	/
2388.60	38.85	PK	30	2.0	H	4.27	43.12	74	30.88
2388.60	24.43	Ave.	30	2.0	H	4.27	28.70	54	25.30
2488.07	42.47	PK	131	2.1	H	7.99	50.46	74	23.54
2488.07	20.52	Ave.	131	2.1	H	7.99	28.51	54	25.49
3154.65	38.82	PK	129	1.4	V	14.69	53.51	74	20.49
3154.65	23.74	Ave.	129	1.4	V	14.69	38.43	54	15.57
4960.00	35.96	PK	332	1.4	V	19.41	55.37	74	18.63
4960.00	22.18	Ave.	332	1.4	V	19.41	41.59	54	12.41
7440.00	35.65	PK	88	2.0	V	21.54	57.19	74	16.81
7440.00	20.45	Ave.	88	2.0	V	21.54	41.99	54	12.01
9920.00	34.54	PK	203	1.5	H	26.09	60.63	74	13.37
9920.00	19.97	Ave.	203	1.5	H	26.09	46.06	54	7.94

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

**FCC §15.247(a) (1)-CHANNEL SEPARATION TEST****Applicable Standard**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

**Test Procedure**

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2015-06-13	2016-06-13

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

**Test Data****Environmental Conditions**

Temperature:	28 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

*The testing was performed by Sewen Guo on 2015-07-09.*

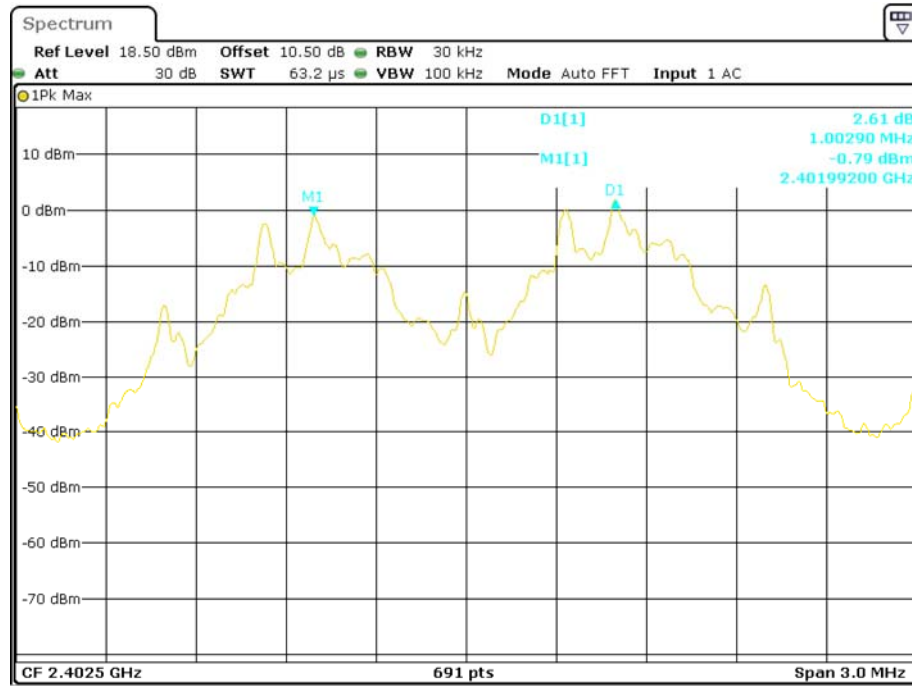
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following tables and plots*

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	$\geq$ Limit (MHz)	Result
<b>BDR (GFSK)</b>	Low	2402	1.0029	0.695	Pass
	Adjacent	2403			
	Middle	2441	1.0029	0.695	Pass
	Adjacent	2442			
	High	2480	1.0029	0.695	Pass
	Adjacent	2479			
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	1.0029	0.770	Pass
	Adjacent	2403			
	Middle	2441	1.0029	0.770	Pass
	Adjacent	2442			
	High	2480	1.0029	0.770	Pass
	Adjacent	2479			
<b>EDR (8DPSK)</b>	Low	2402	1.0029	0.793	Pass
	Adjacent	2403			
	Middle	2441	1.0029	0.796	Pass
	Adjacent	2442			
	High	2480	1.0029	0.796	Pass
	Adjacent	2479			

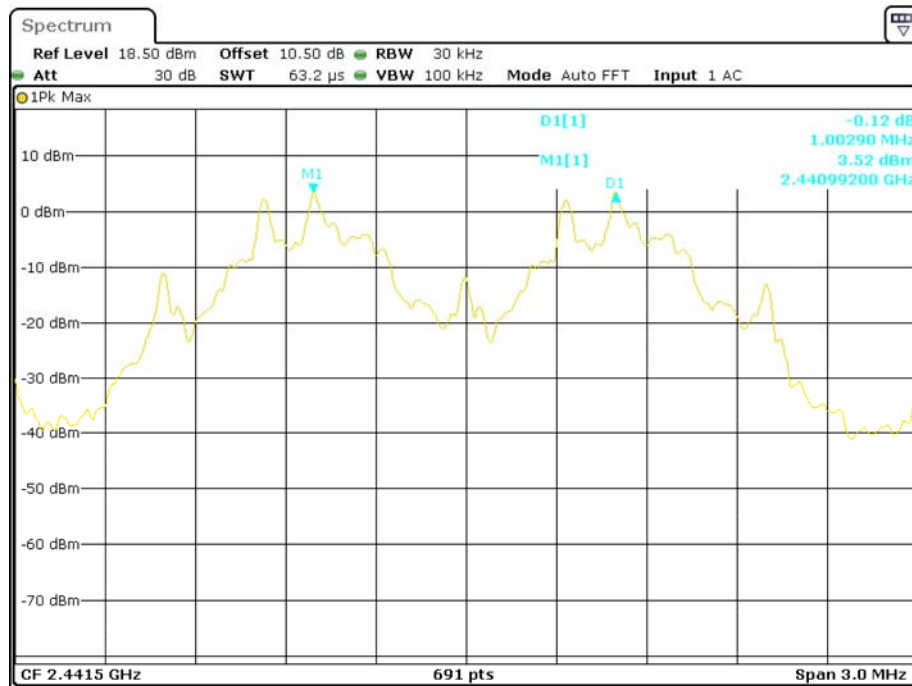
Note: Limit = 20 dB bandwidth \*2/3

### BDR (GFSK): Low Channel

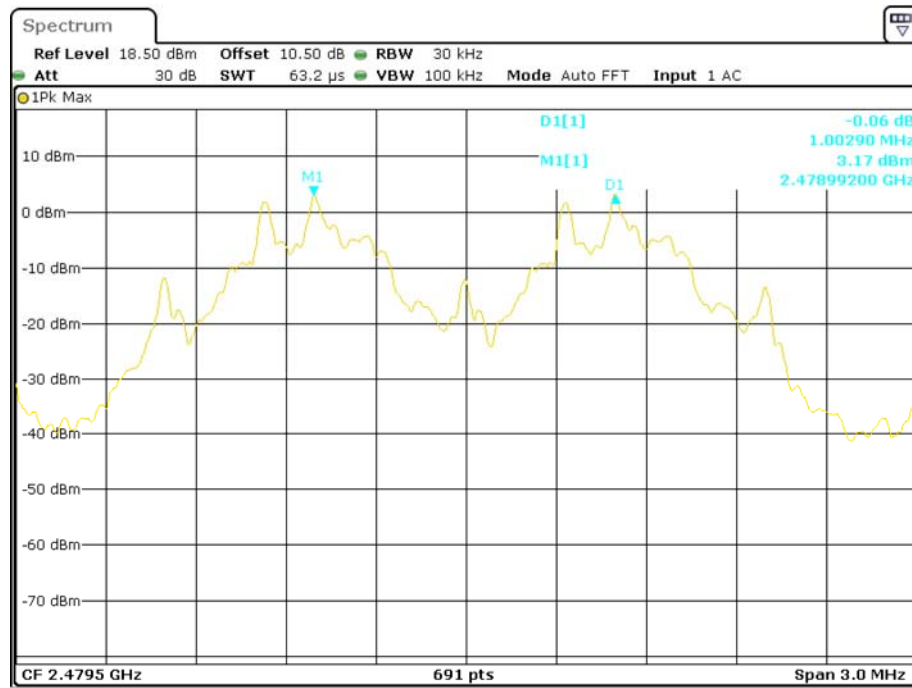


Date: 9.JUL.2015 20:56:10

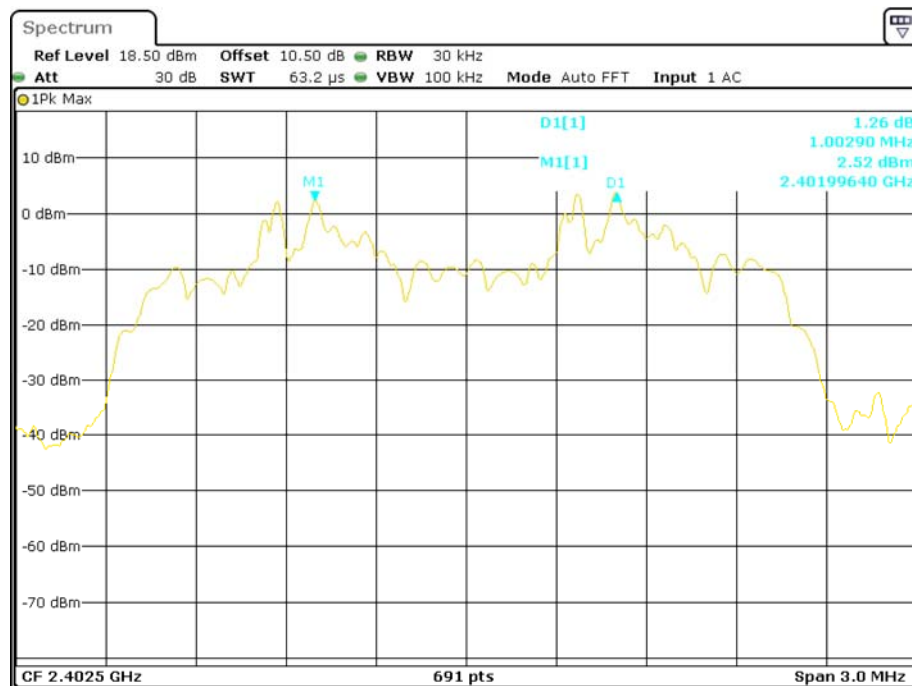
### BDR (GFSK): Middle Channel



Date: 9.JUL.2015 20:57:15

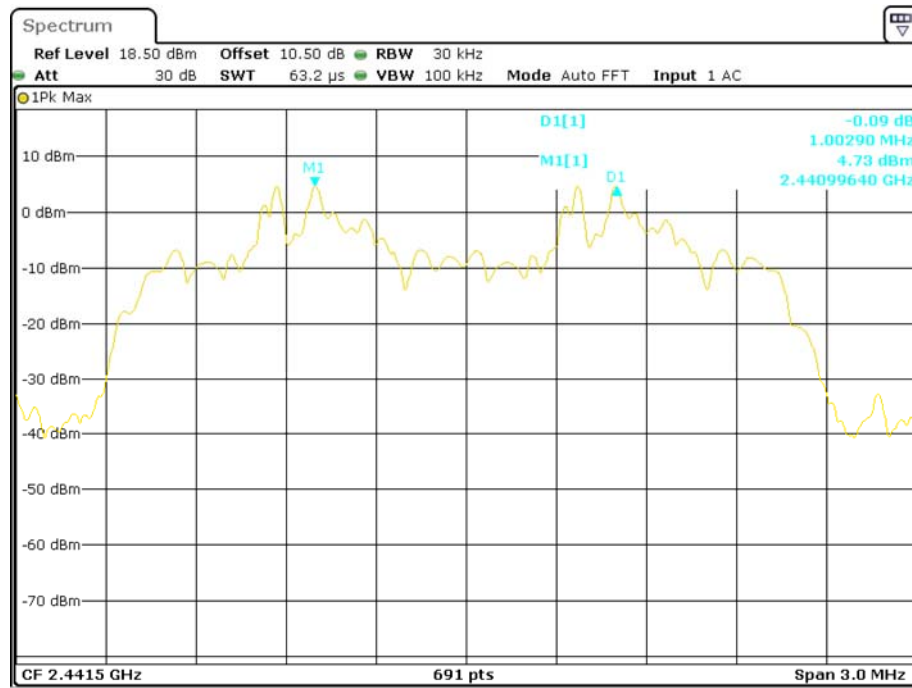
**BDR (GFSK): High Channel**

Date: 9.JUL.2015 20:58:02

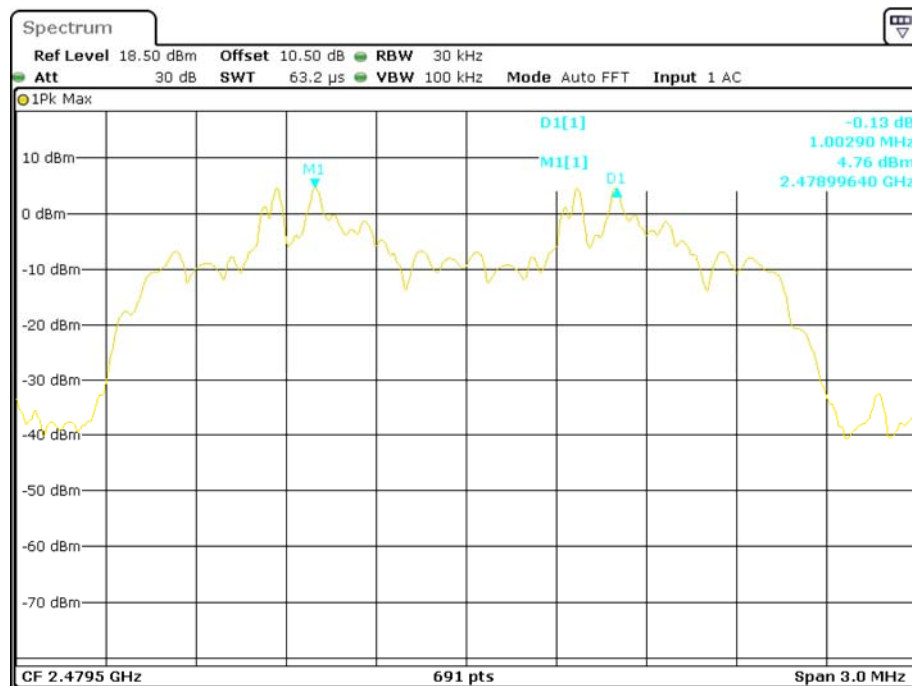
**EDR ( $\pi/4$ -DQPSK): Low Channel**

Date: 9.JUL.2015 20:59:20



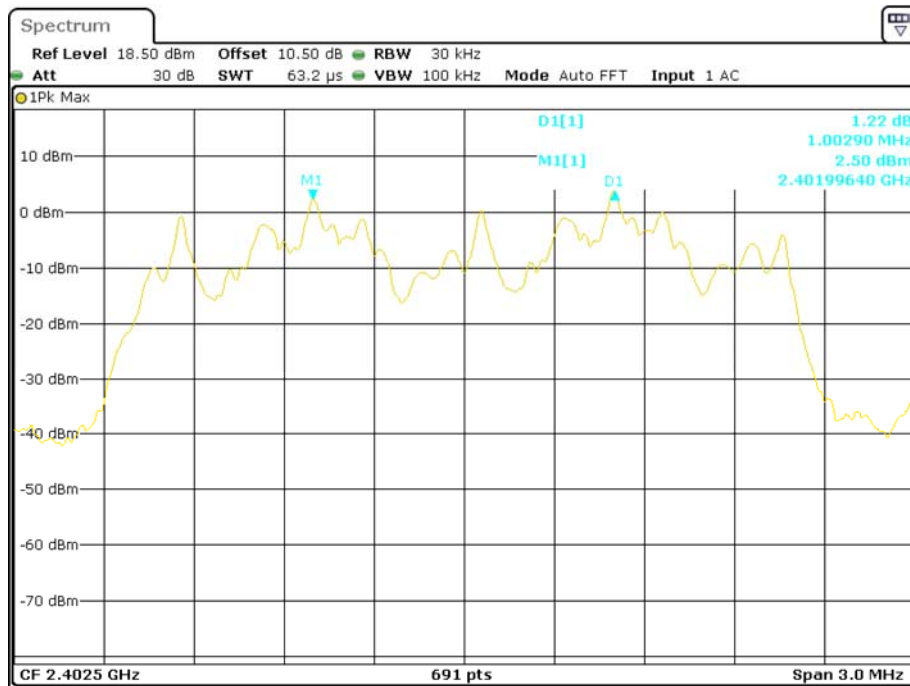
EDR ( $\pi/4$ -DQPSK): Middle Channel

Date: 9.JUL.2015 21:00:11

EDR ( $\pi/4$ -DQPSK): High Channel

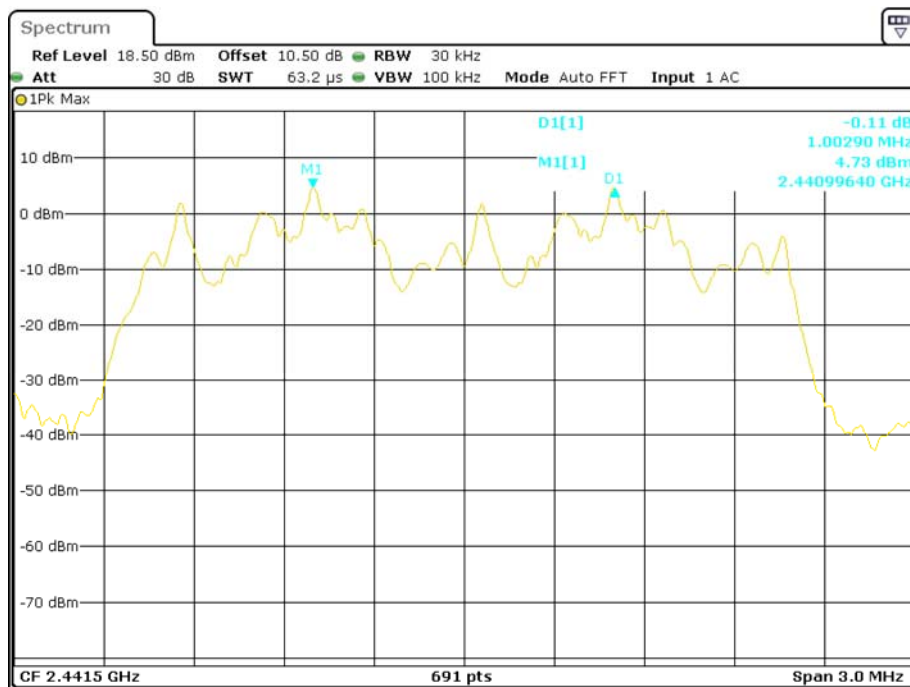
Date: 9.JUL.2015 21:00:55

### EDR (8DPSK): Low Channel

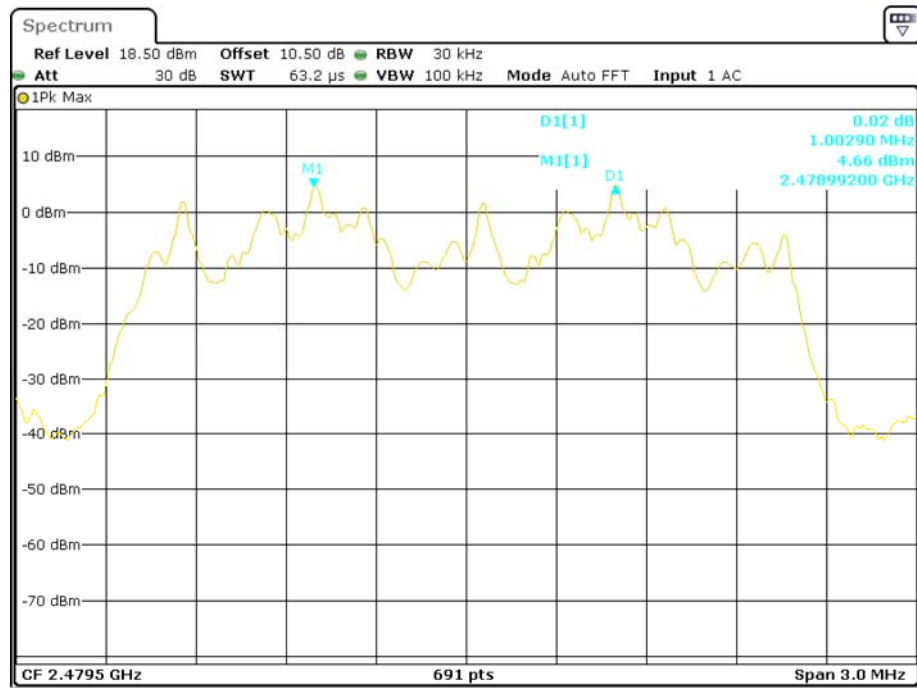


Date: 9.JUL.2015 21:02:11

### EDR (8DPSK): Middle Channel



Date: 9.JUL.2015 21:02:52

**EDR (8DPSK): High Channel**

Date: 9.JUL.2015 21:03:38

## FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH

### Applicable Standard

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

### Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2015-06-13	2016-06-13

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

### Test Data

#### Environmental Conditions

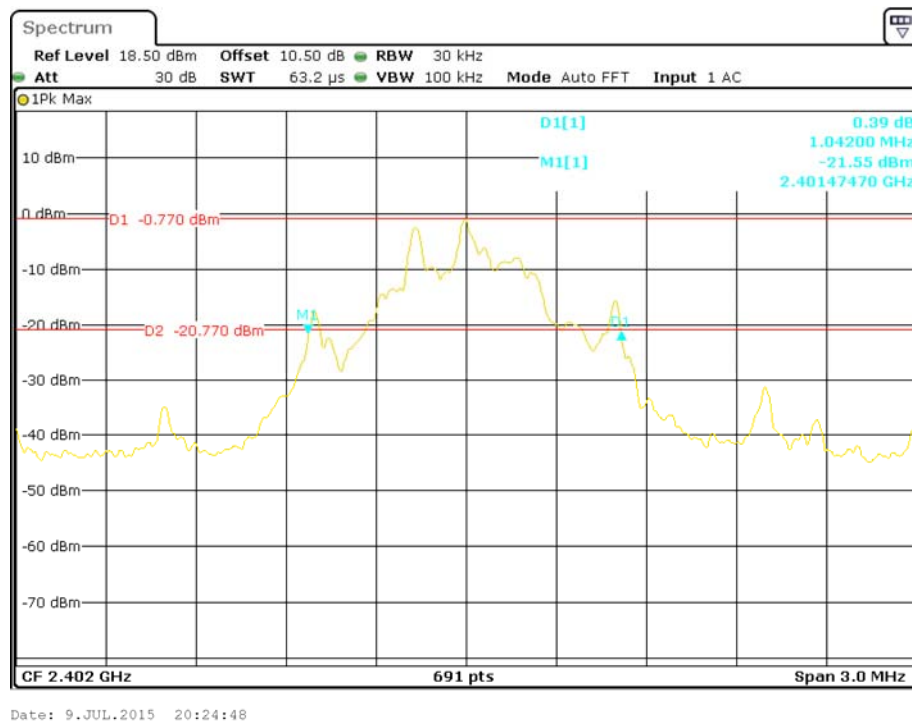
Temperature:	28 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

*The testing was performed by Sewen Guo on 2015-07-09.*

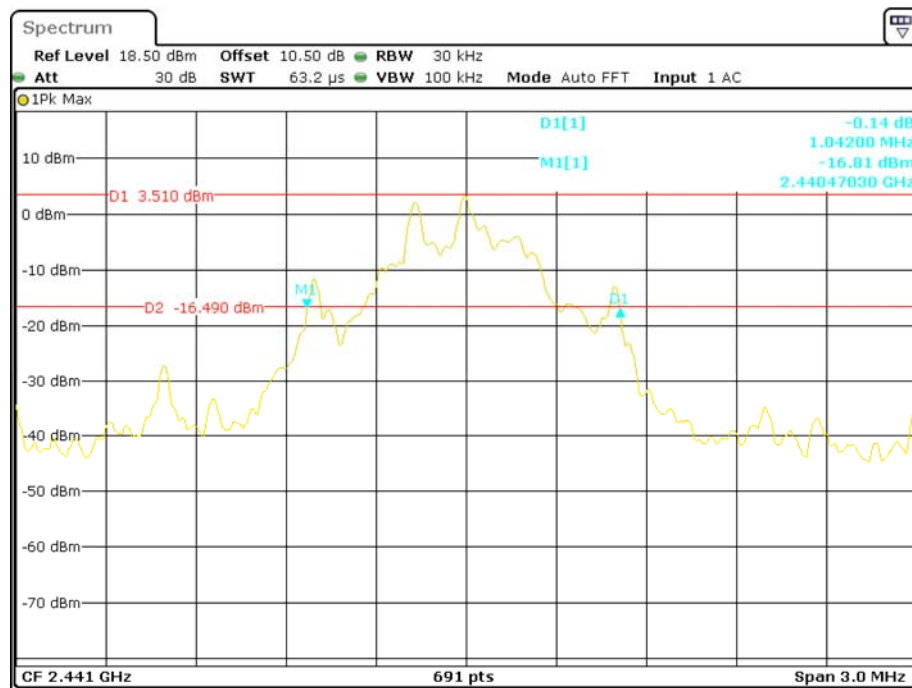
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following tables and plots.*

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
<b>BDR (GFSK)</b>	Low	2402	1.042
	Middle	2441	1.042
	High	2480	1.042
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	1.155
	Middle	2441	1.155
	High	2480	1.155
<b>EDR (8DPSK)</b>	Low	2402	1.190
	Middle	2441	1.194
	High	2480	1.194

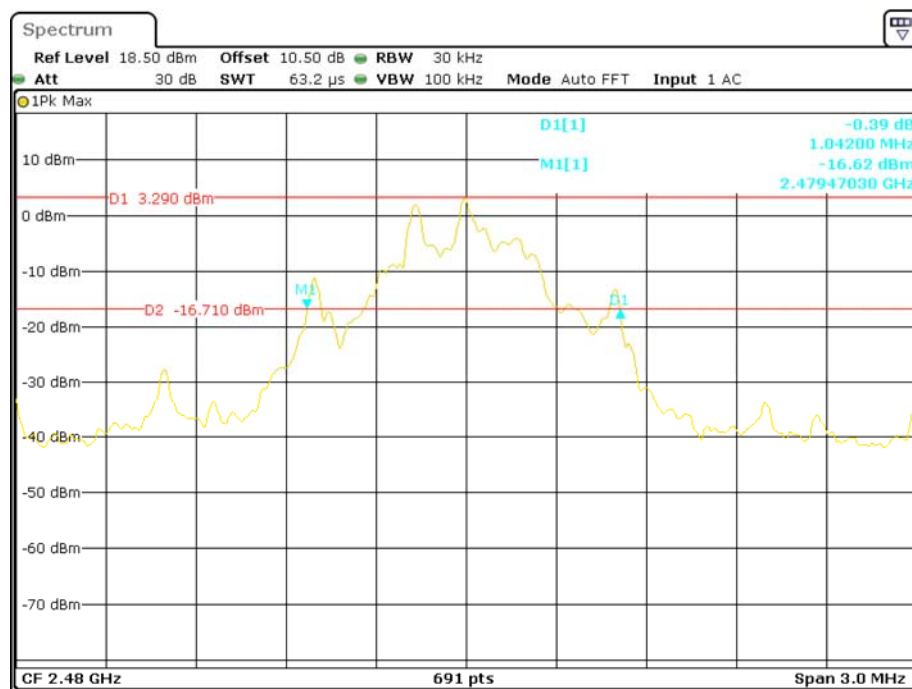
**BDR (GFSK): Low Channel**

### BDR (GFSK): Middle Channel



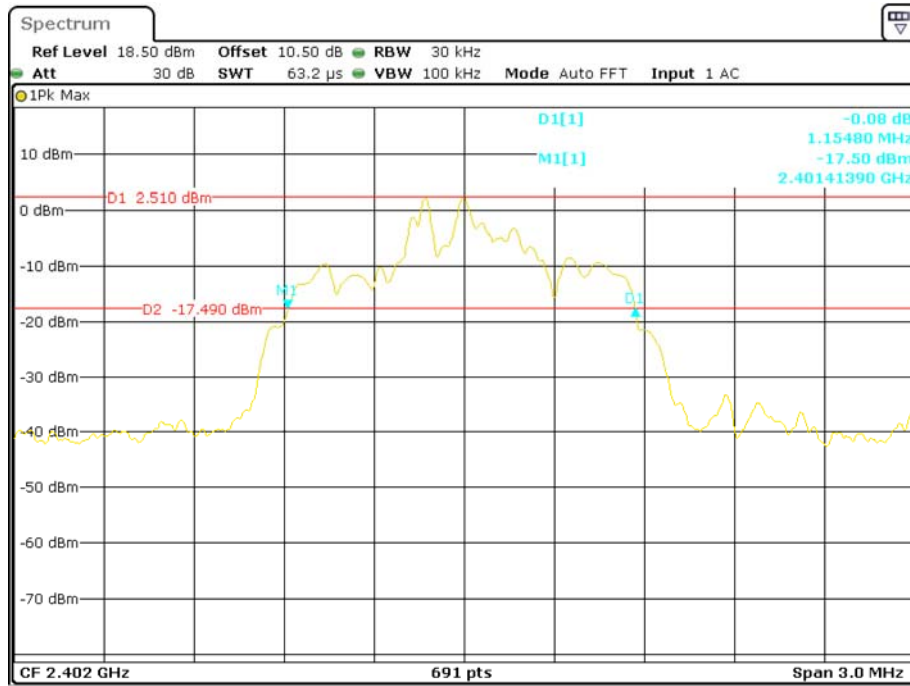
Date: 9.JUL.2015 20:23:39

### BDR (GFSK): High Channel



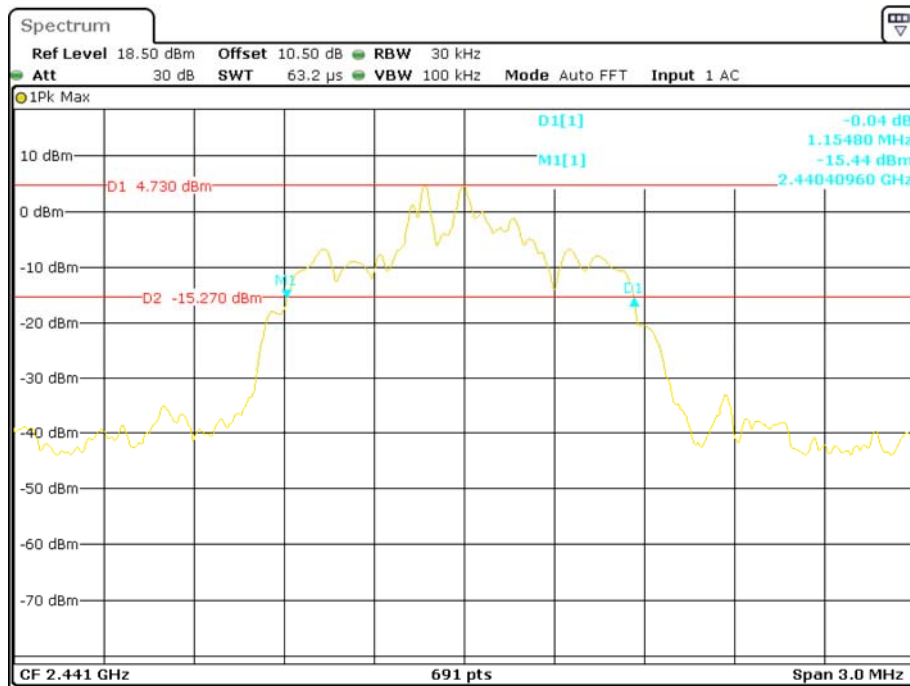
Date: 9.JUL.2015 20:20:54

### EDR ( $\pi/4$ -DQPSK): Low Channel

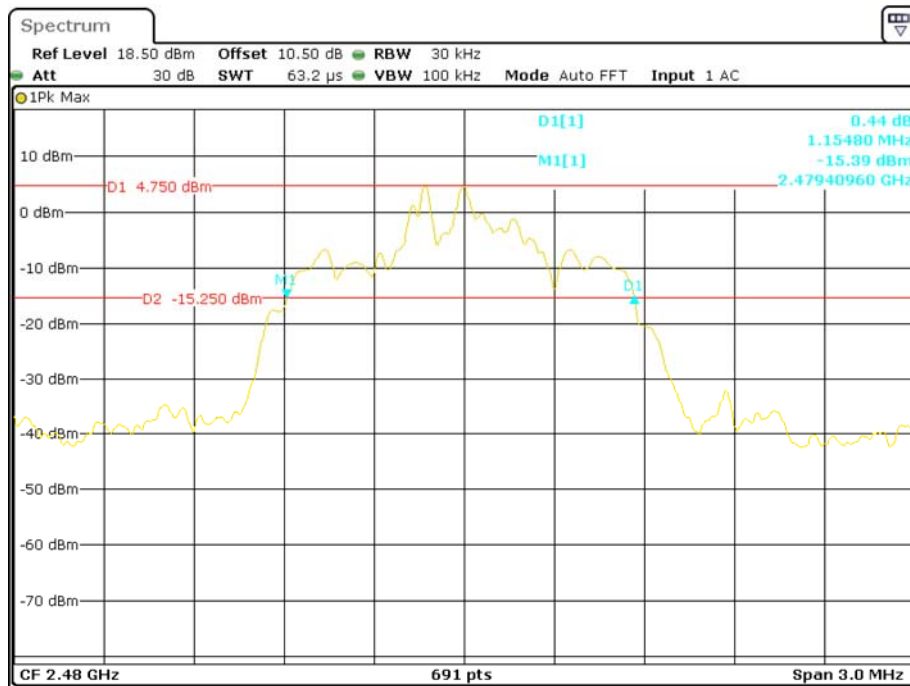


Date: 9.JUL.2015 20:26:29

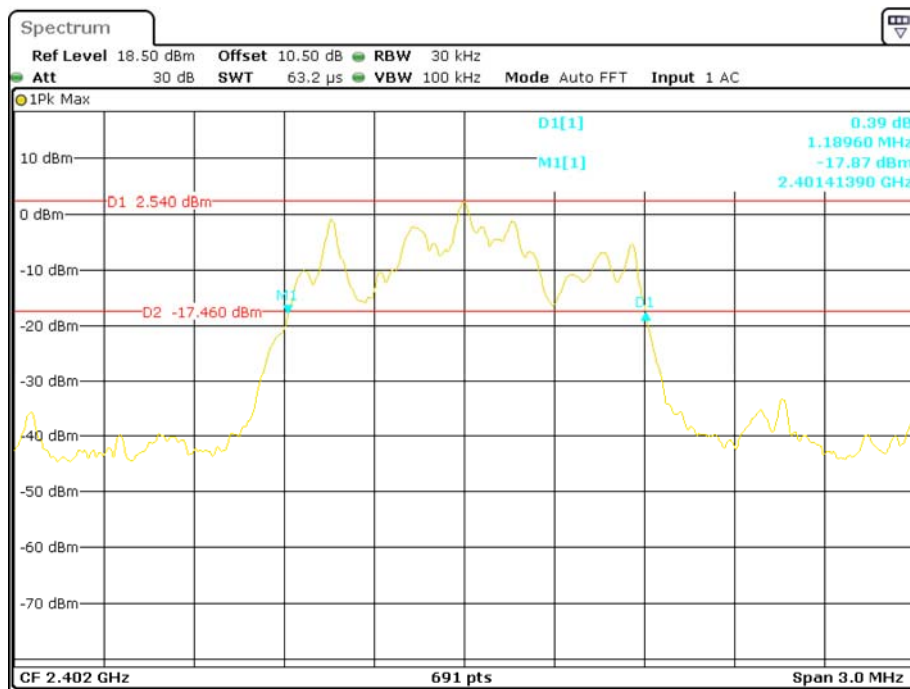
### EDR ( $\pi/4$ -DQPSK): Middle Channel



Date: 9.JUL.2015 20:27:52

**EDR ( $\pi/4$ -DQPSK): High Channel**

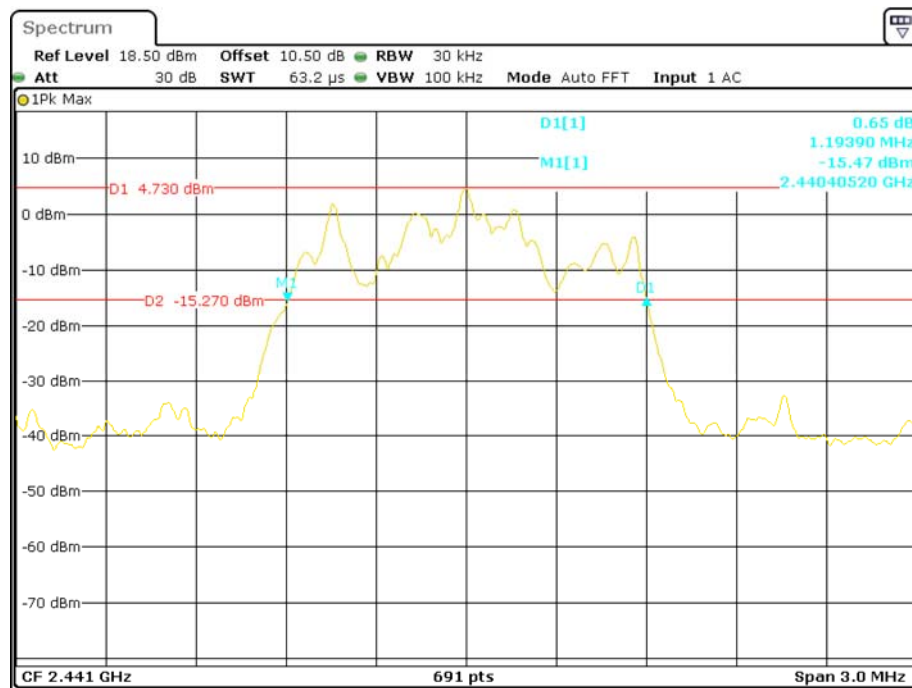
Date: 9.JUL.2015 20:29:59

**EDR (8DPSK): Low Channel**

Date: 9.JUL.2015 20:31:48

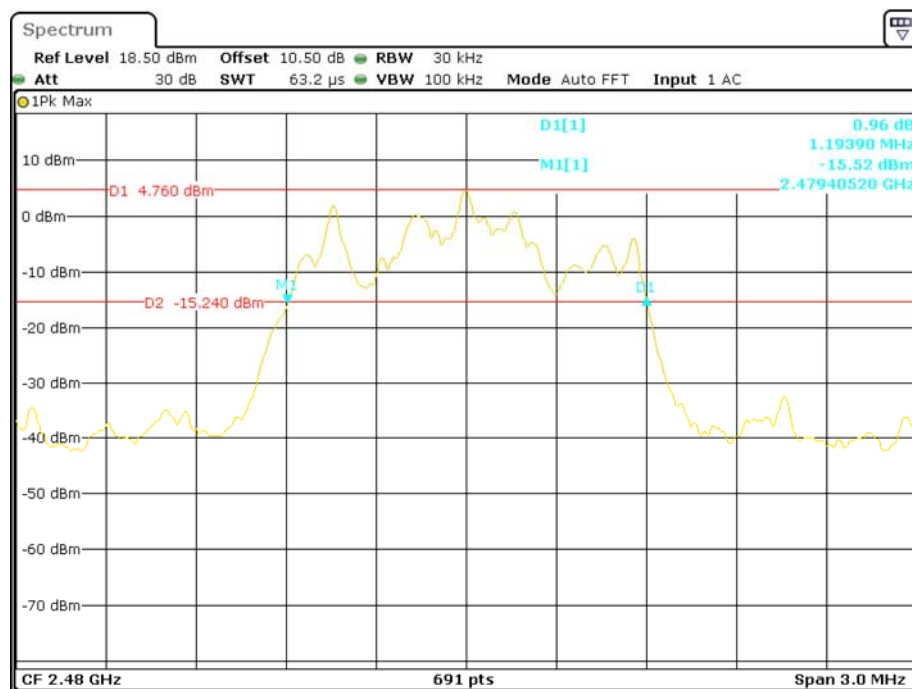


### EDR (8DPSK): Middle Channel



Date: 9.JUL.2015 20:33:28

### EDR (8DPSK): High Channel



Date: 9.JUL.2015 20:34:52

**FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST****Applicable Standard**

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

**Test Procedure**

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2015-06-13	2016-06-13

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

**Test Data****Environmental Conditions**

Temperature:	28 °C
Relative Humidity:	49 %
ATM Pressure:	101.0 kPa

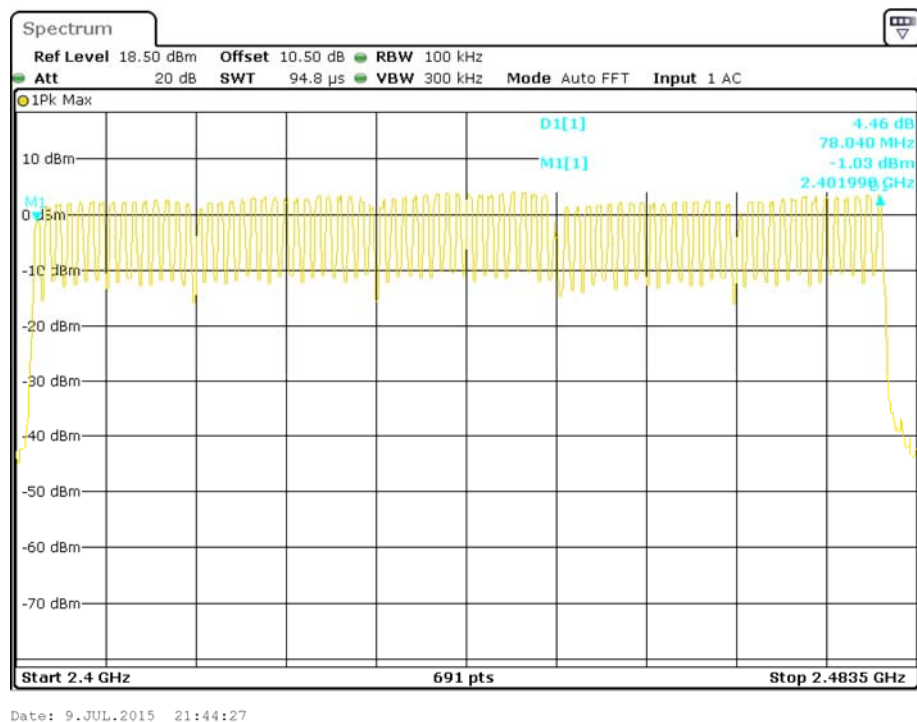
*The testing was performed by Sewen Guo on 2015-07-09.*

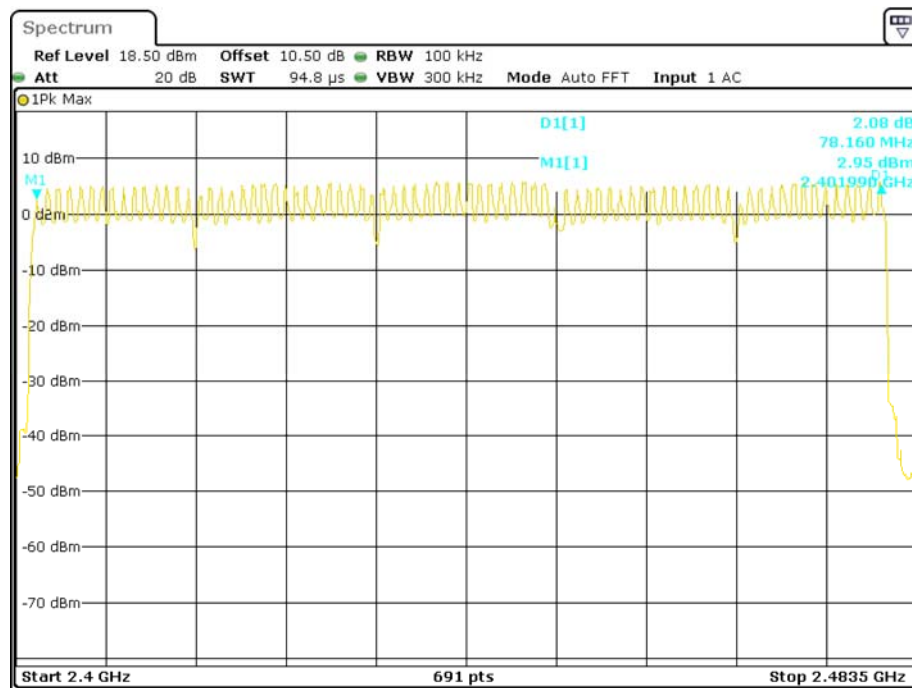
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following tables and plots.*

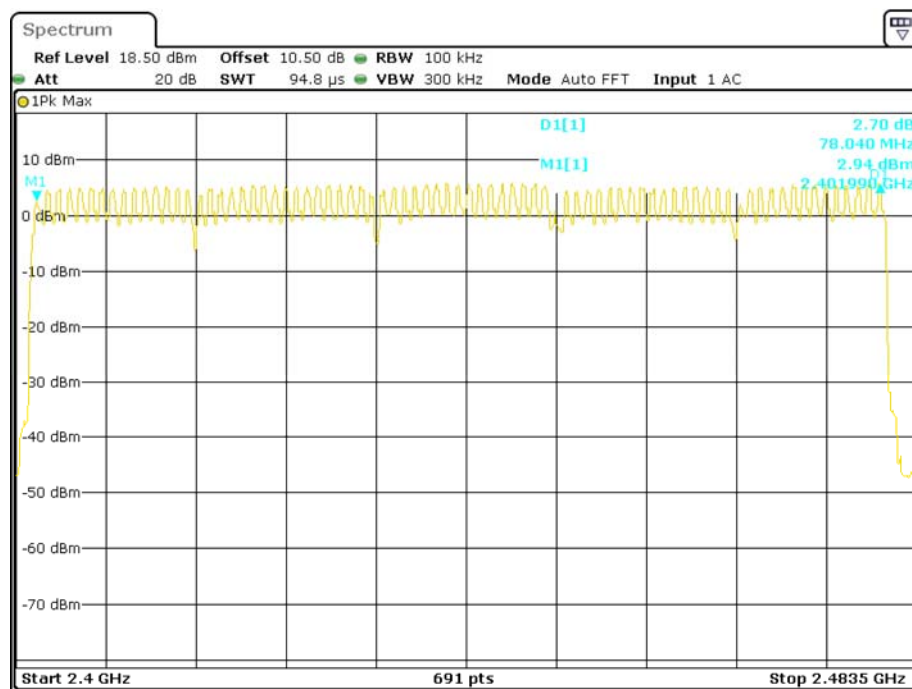
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	$\geq 15$
EDR ( $\pi/4$ -DQPSK)	2400-2483.5	79	$\geq 15$
EDR (8DPSK)	2400-2483.5	79	$\geq 15$

### BDR (GFSK): Number of Hopping Channels



**EDR ( $\pi/4$ -DQPSK): Number of Hopping Channels**

Date: 9.JUL.2015 21:48:16

**EDR (8DPSK): Number of Hopping Channels**

Date: 9.JUL.2015 21:57:40

**FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWEELL TIME)****Applicable Standard**

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

**Test Procedure**

The EUT was worked in channel hopping; Spectrum SPAN was set as 0. Sweep was set as 0.4 X channel no. (s), the quantity of pulse was get from single sweep. In addition, the time of single pulses was tested.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2015-06-13	2016-06-13

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

**Test Data****Environmental Conditions**

Temperature:	28 °C
Relative Humidity:	51 %
ATM Pressure:	101.0 kPa

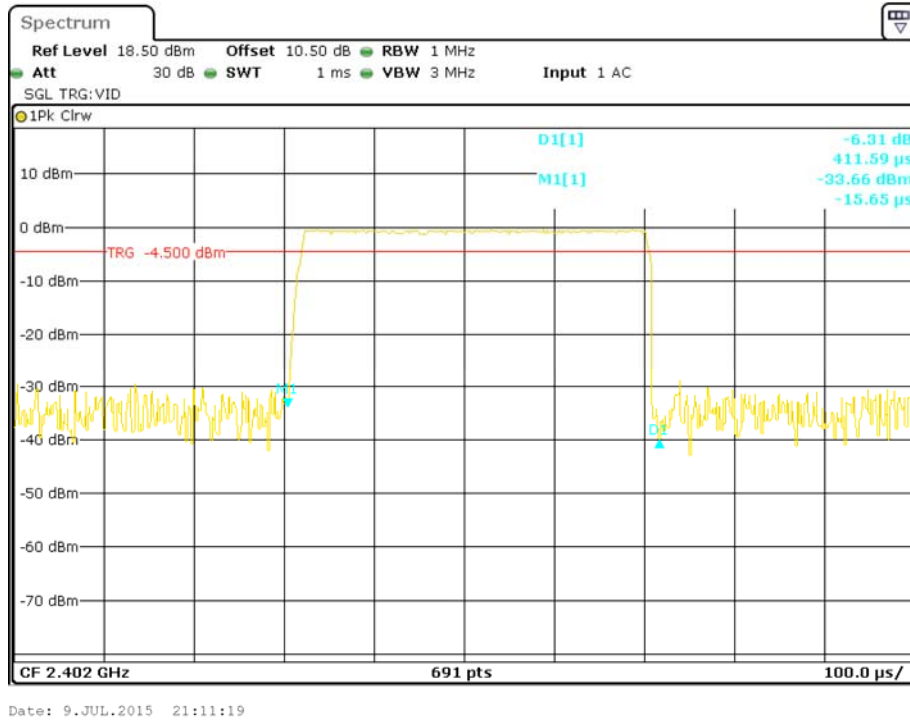
*The testing was performed by Sewen Guo on 2015-07-09.*

*EUT operation mode: Transmitting*

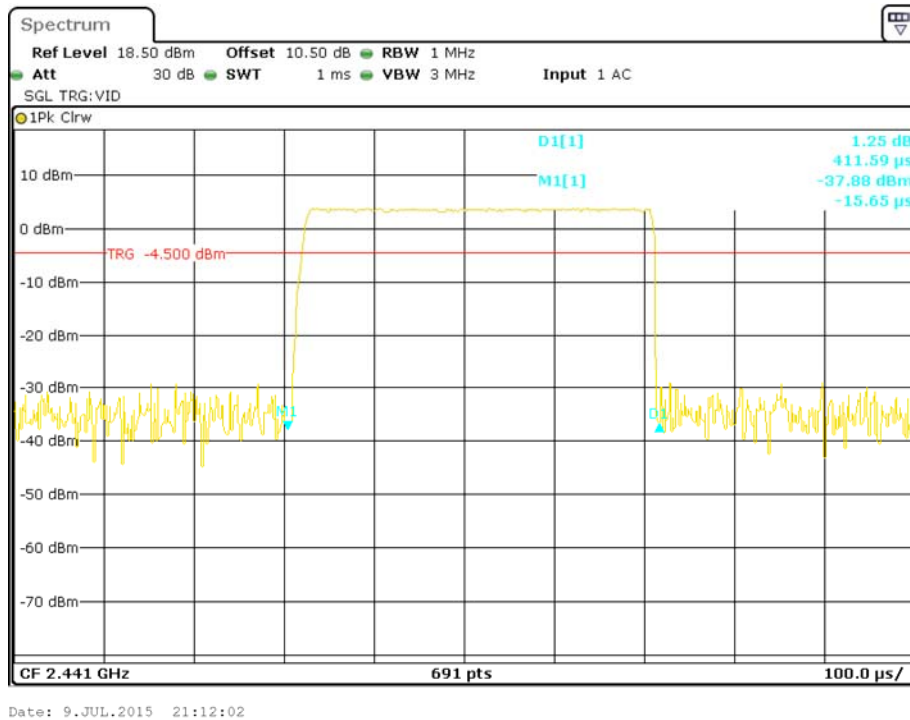
*Test Result: Compliance. Please refer to following tables and plots.*

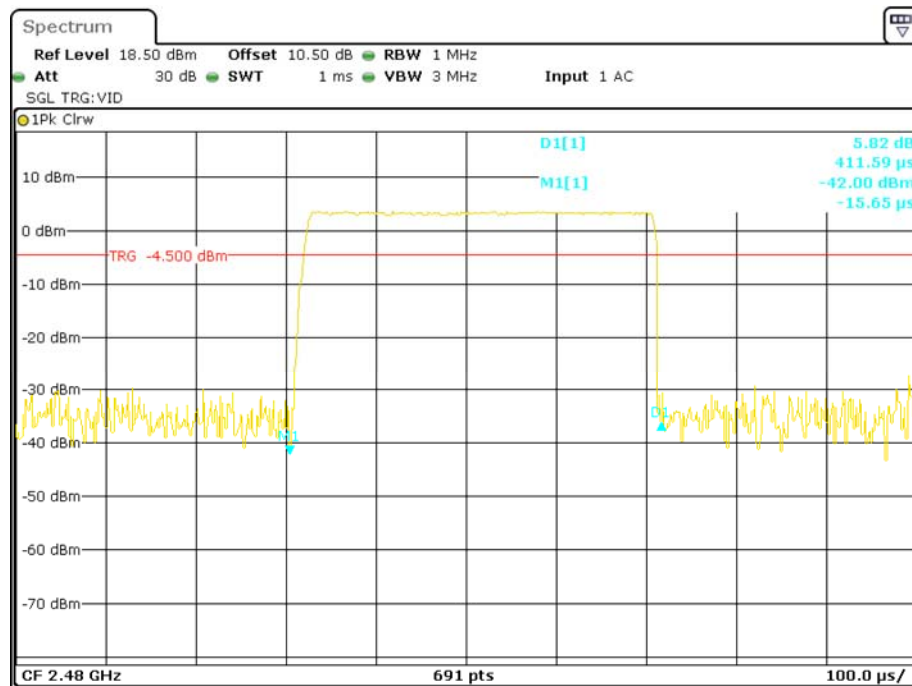
Mode		Channel	Pulse Width (ms)	Dwell Time (S)	Limit (S)	Result
BDR (GFSK)	DH 1	Low	0.412	0.132	0.4	Pass
		Middle	0.412	0.132	0.4	Pass
		High	0.412	0.132	0.4	Pass
		Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	DH 3	Low	1.681	0.269	0.4	Pass
		Middle	1.681	0.269	0.4	Pass
		High	1.681	0.269	0.4	Pass
		Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	DH 5	Low	2.949	0.315	0.4	Pass
		Middle	2.949	0.315	0.4	Pass
		High	2.949	0.315	0.4	Pass
		Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR ( $\pi/4$ -DQPSK)	2DH 1	Low	0.442	0.141	0.4	Pass
		Middle	0.446	0.143	0.4	Pass
		High	0.446	0.143	0.4	Pass
		Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	2DH 3	Low	1.716	0.275	0.4	Pass
		Middle	1.720	0.275	0.4	Pass
		High	1.716	0.275	0.4	Pass
		Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	2DH 5	Low	2.984	0.318	0.4	Pass
		Middle	2.984	0.318	0.4	Pass
		High	2.984	0.318	0.4	Pass
		Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				
EDR (8DPSK)	3DH 1	Low	0.441	0.141	0.4	Pass
		Middle	0.442	0.141	0.4	Pass
		High	0.442	0.141	0.4	Pass
		Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S				
	3DH 3	Low	1.699	0.272	0.4	Pass
		Middle	1.699	0.272	0.4	Pass
		High	1.699	0.272	0.4	Pass
		Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S				
	3DH 5	Low	2.967	0.316	0.4	Pass
		Middle	2.967	0.316	0.4	Pass
		High	2.967	0.316	0.4	Pass
		Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S				

# **BDR (GFSK):** **Pulse time, Low Channel, DH1**

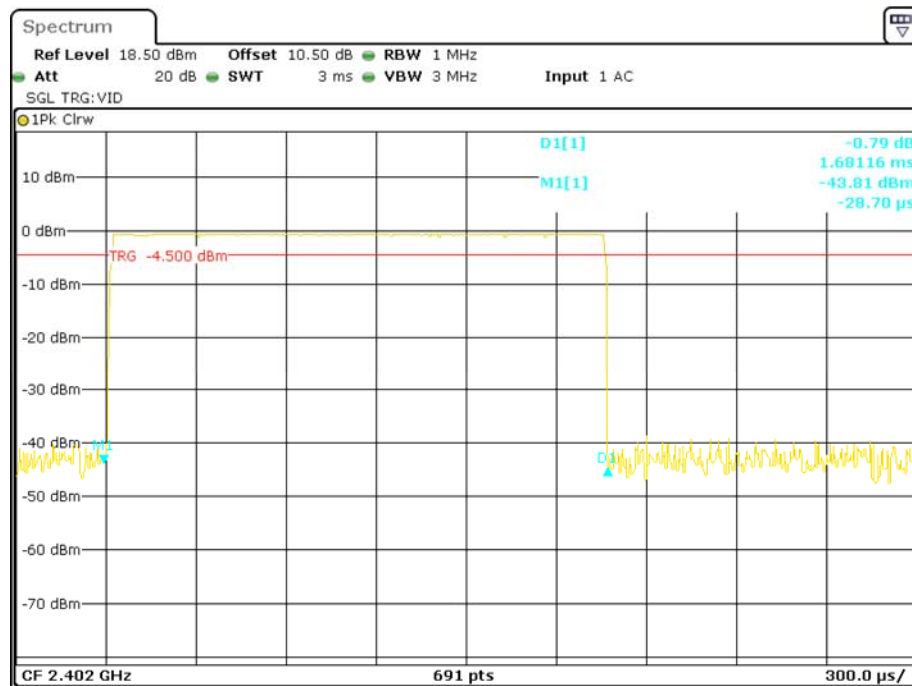


# **Pulse time, Middle Channel, DH1**



**Pulse time, High Channel, DH1**

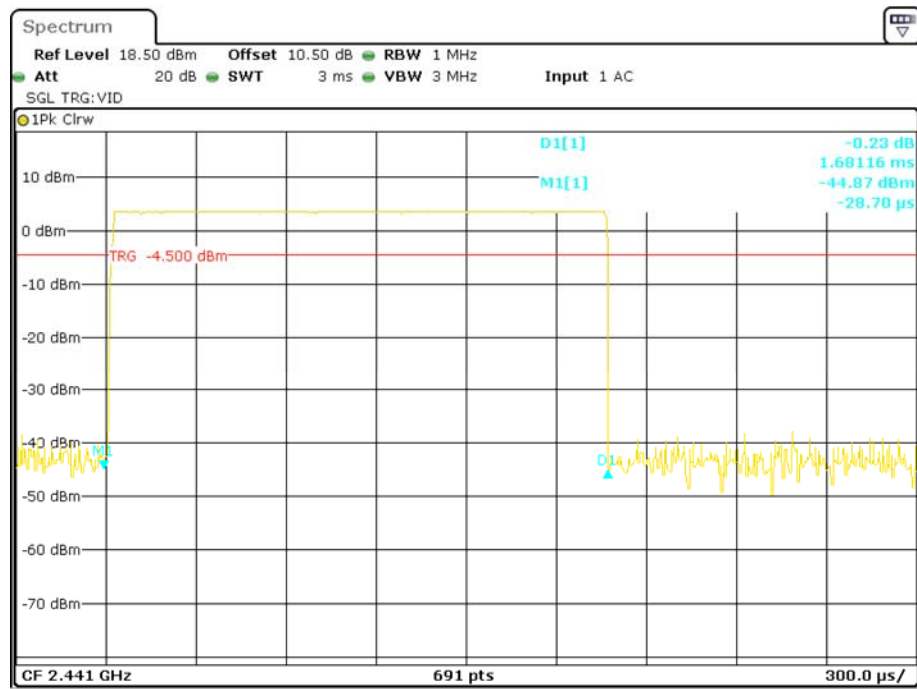
Date: 9.JUL.2015 21:12:35

**Pulse time, Low Channel, DH3**

Date: 9.JUL.2015 21:14:35

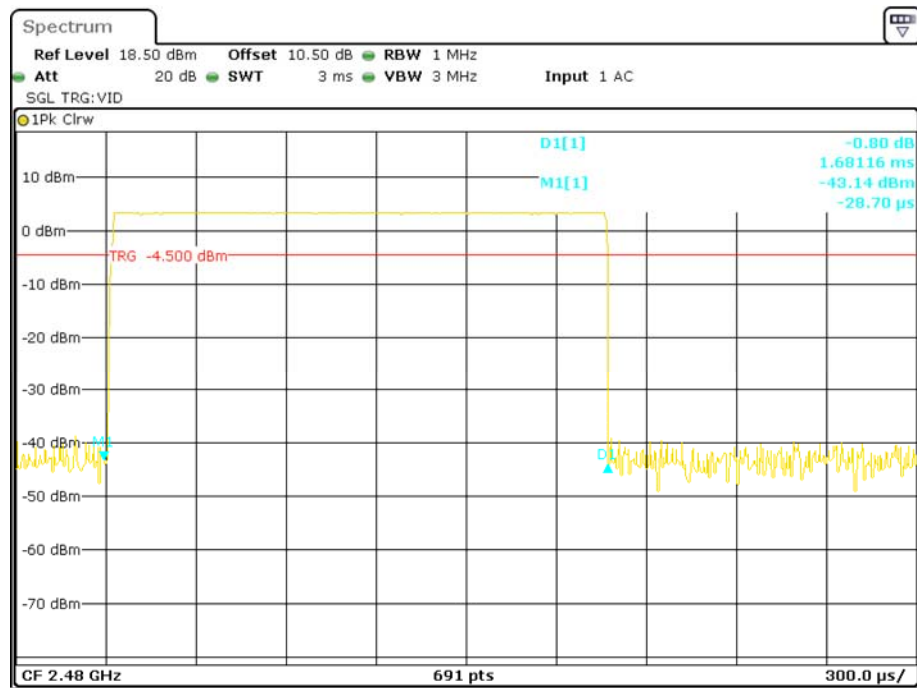


## Pulse time, Middle Channel, DH3



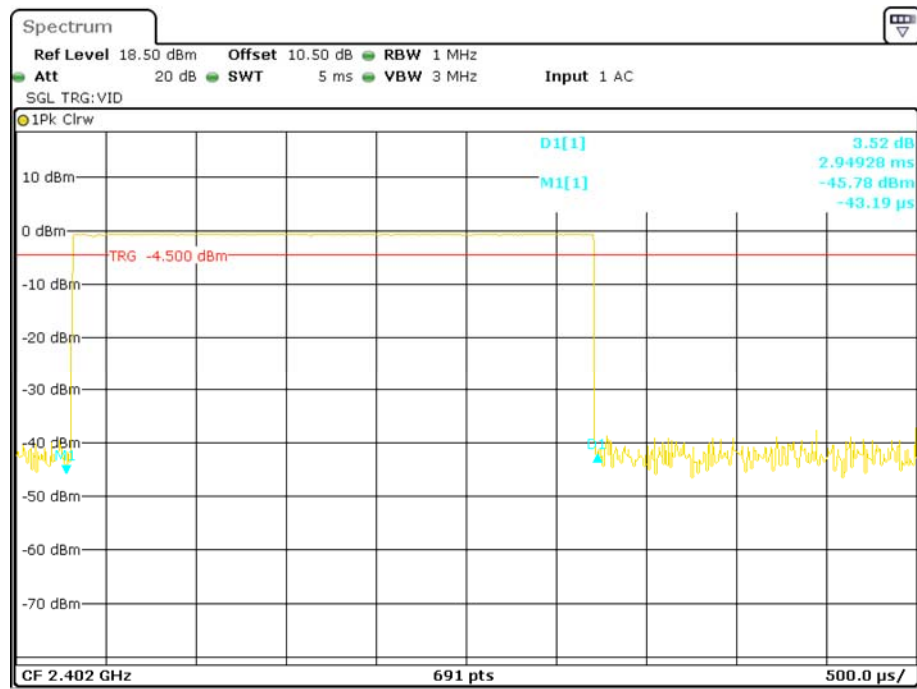
Date: 9.JUL.2015 21:15:16

## Pulse time, High Channel, DH3



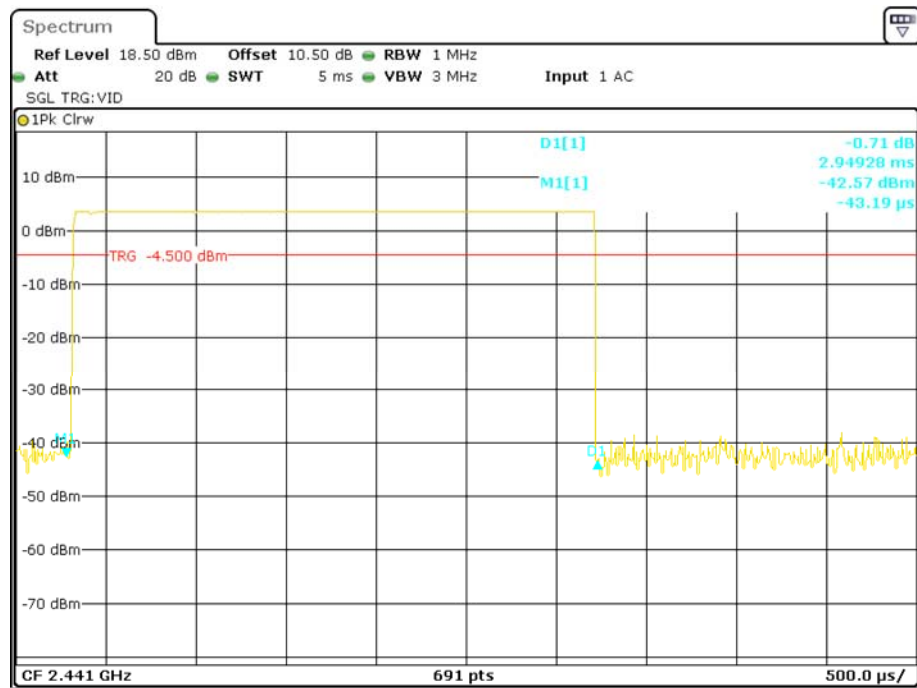
Date: 9.JUL.2015 21:15:39

## Pulse time, Low Channel, DH5

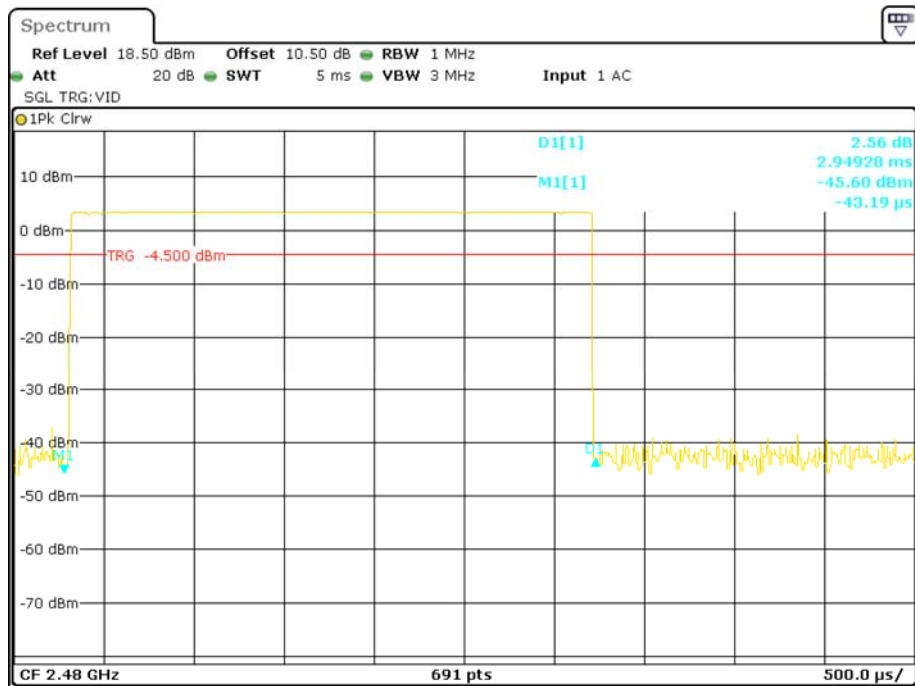


Date: 9.JUL.2015 21:16:55

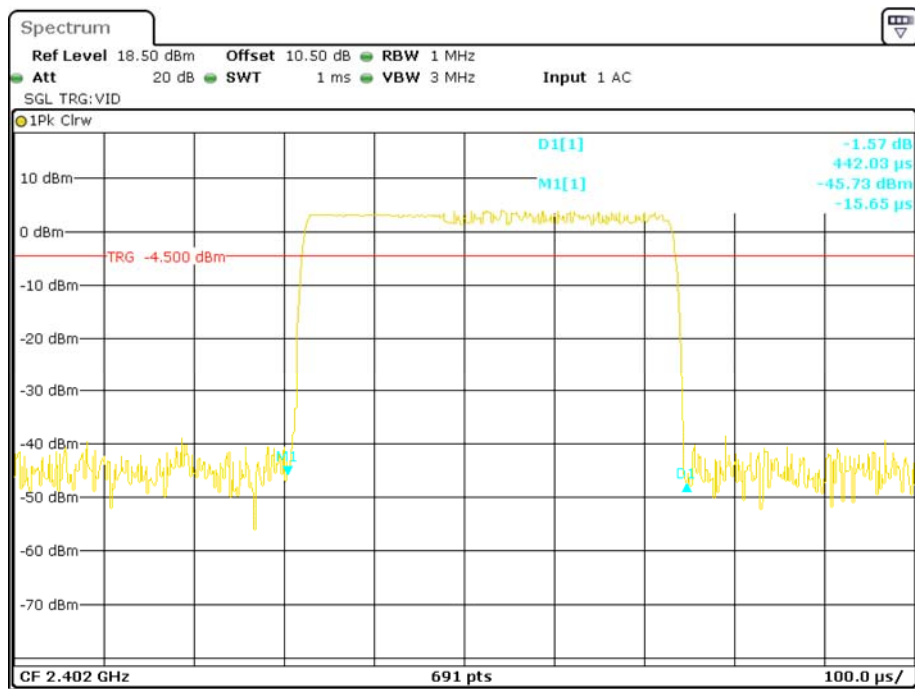
## Pulse time, Middle Channel, DH5



Date: 9.JUL.2015 21:17:37

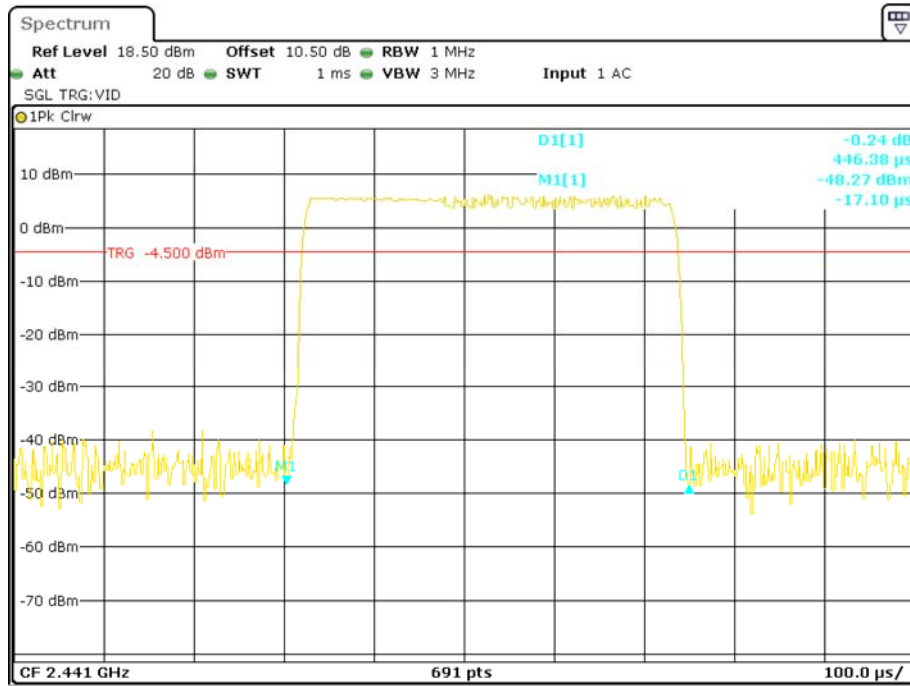
**Pulse time, High Channel, DH5**

Date: 9.JUL.2015 21:18:05

**EDR ( $\pi/4$ -DQPSK):  
Pulse time, Low Channel, 2DH1**

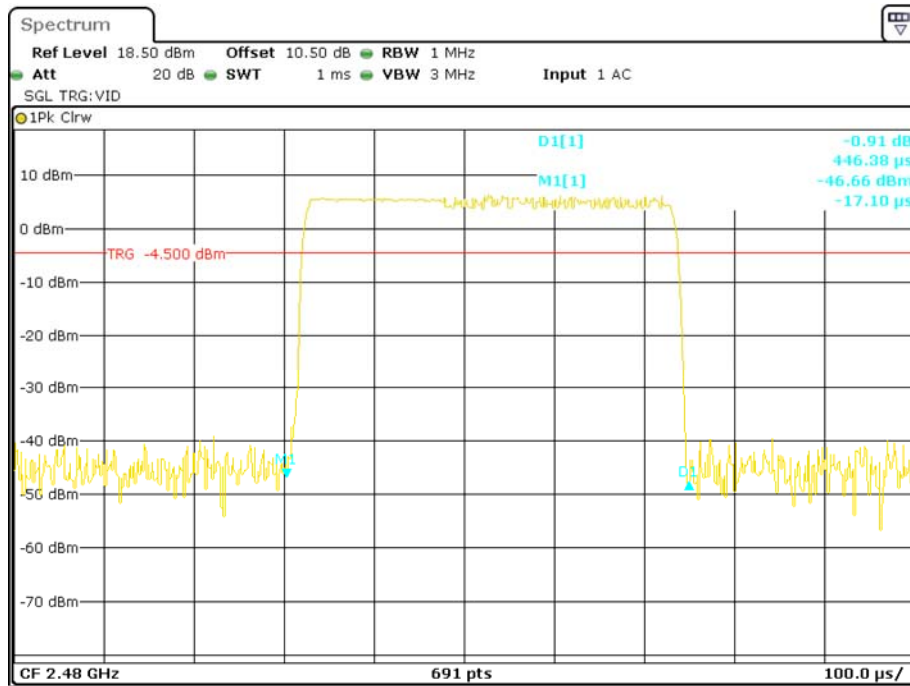
Date: 9.JUL.2015 21:19:40

### Pulse time, Middle Channel, 2DH1



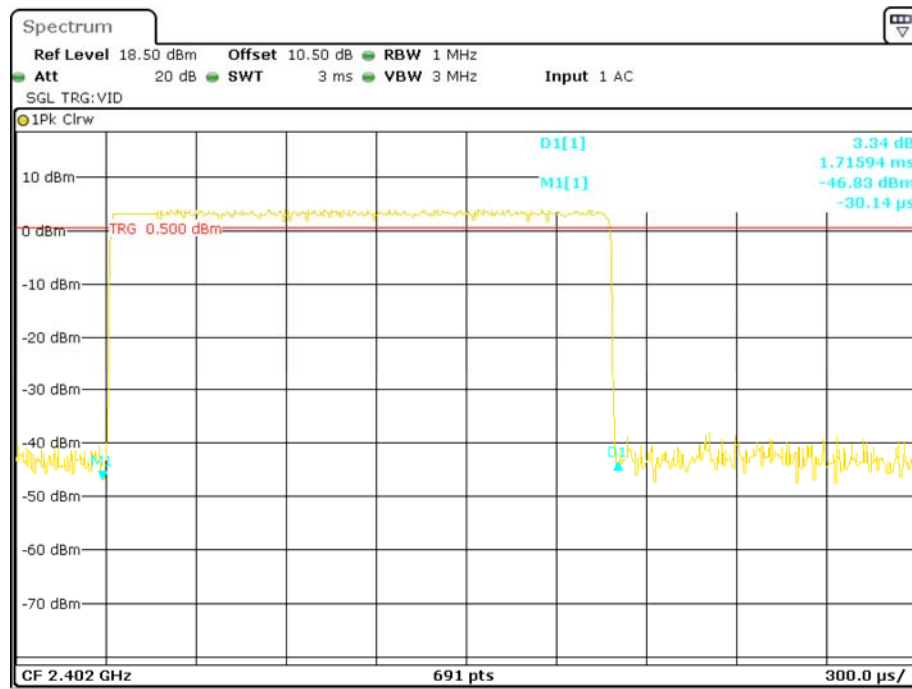
Date: 9.JUL.2015 21:20:55

### Pulse time, High Channel, 2DH1



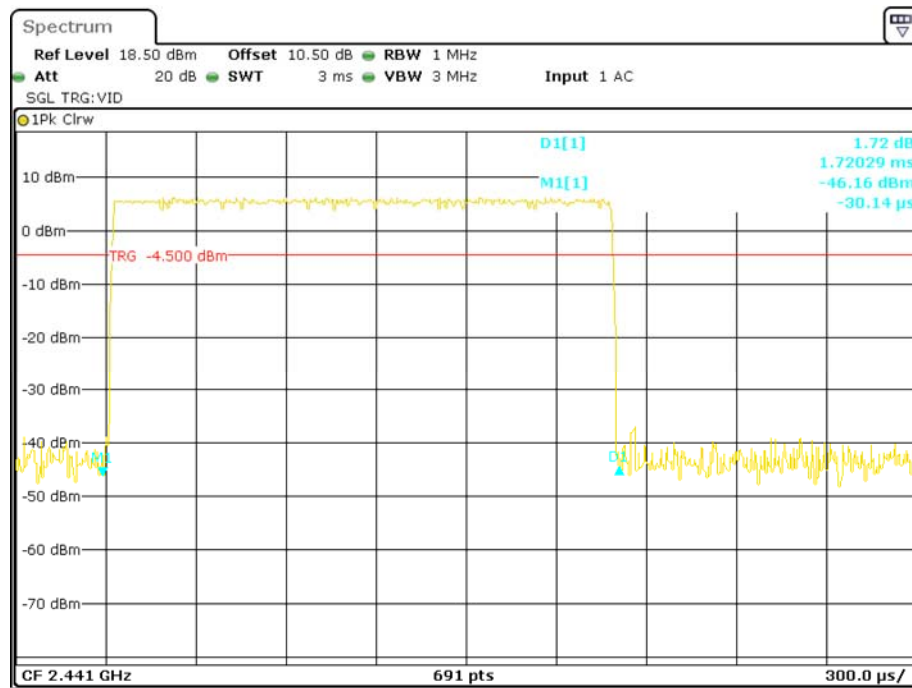
Date: 9.JUL.2015 21:21:51

## Pulse time, Low Channel, 2DH3



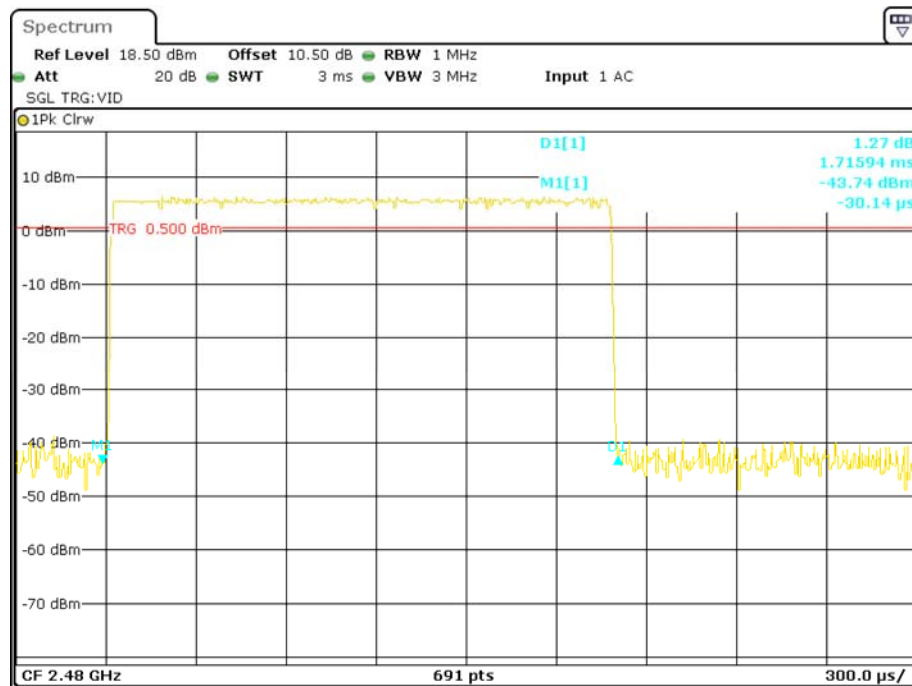
Date: 9.JUL.2015 21:26:04

## Pulse time, Middle Channel, 2DH3



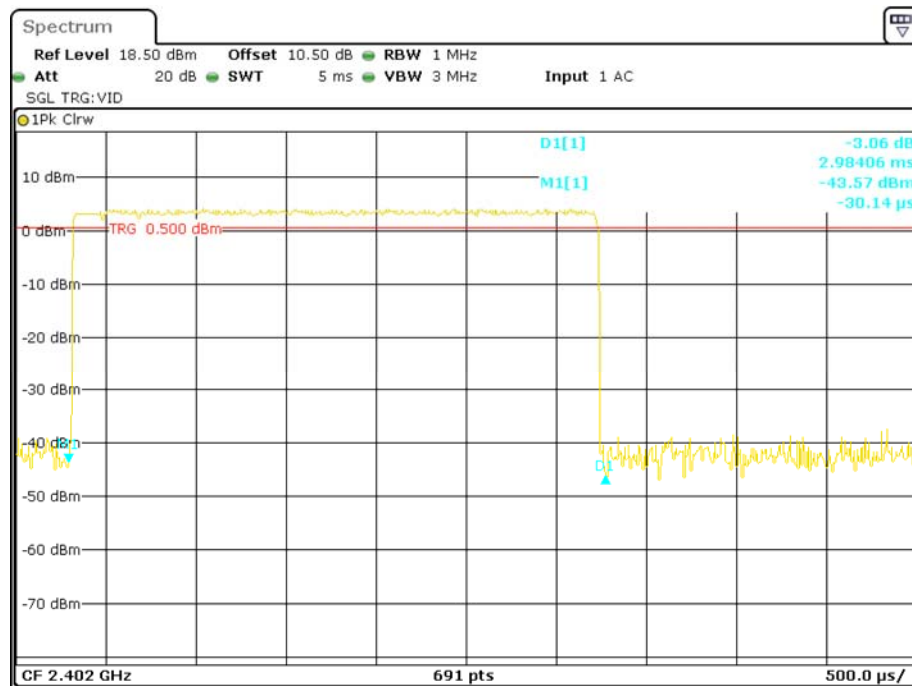
Date: 9.JUL.2015 21:24:47

## Pulse time, High Channel, 2DH3



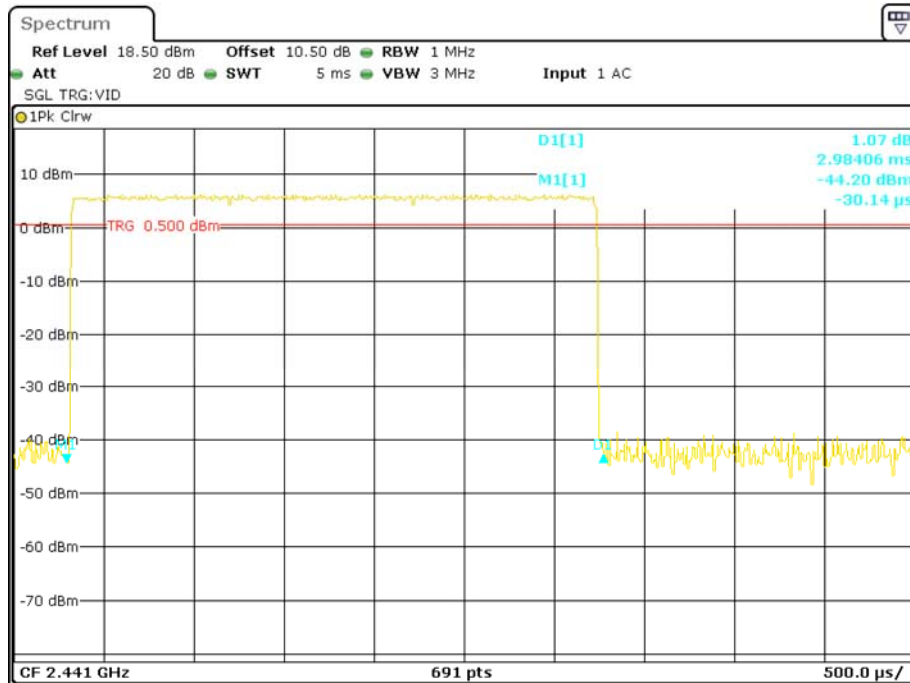
Date: 9.JUL.2015 21:25:31

## Pulse time, Low Channel, 2DH5



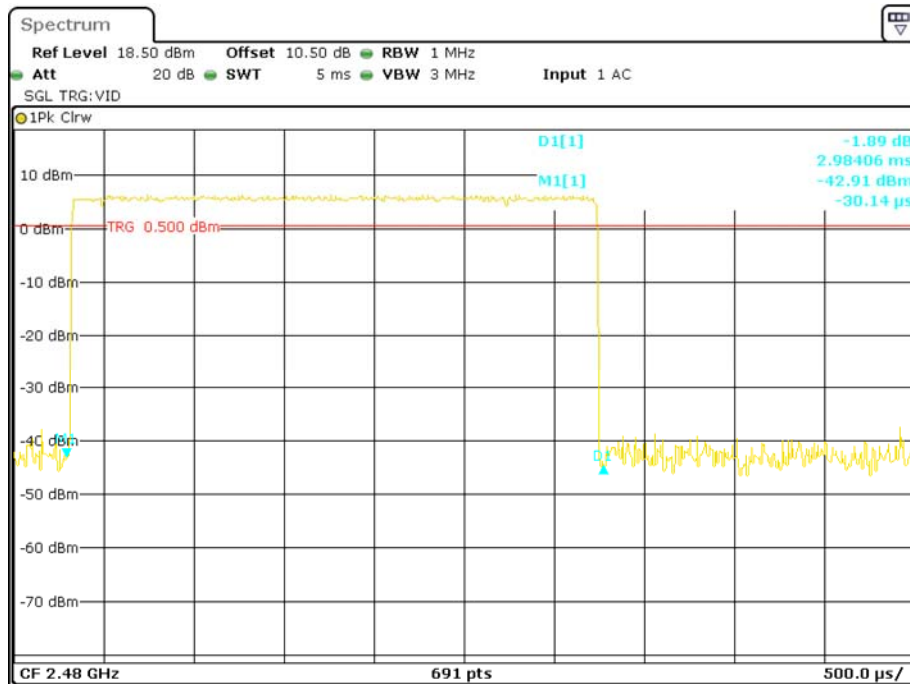
Date: 9.JUL.2015 21:26:58

### Pulse time, Middle Channel, 2DH5



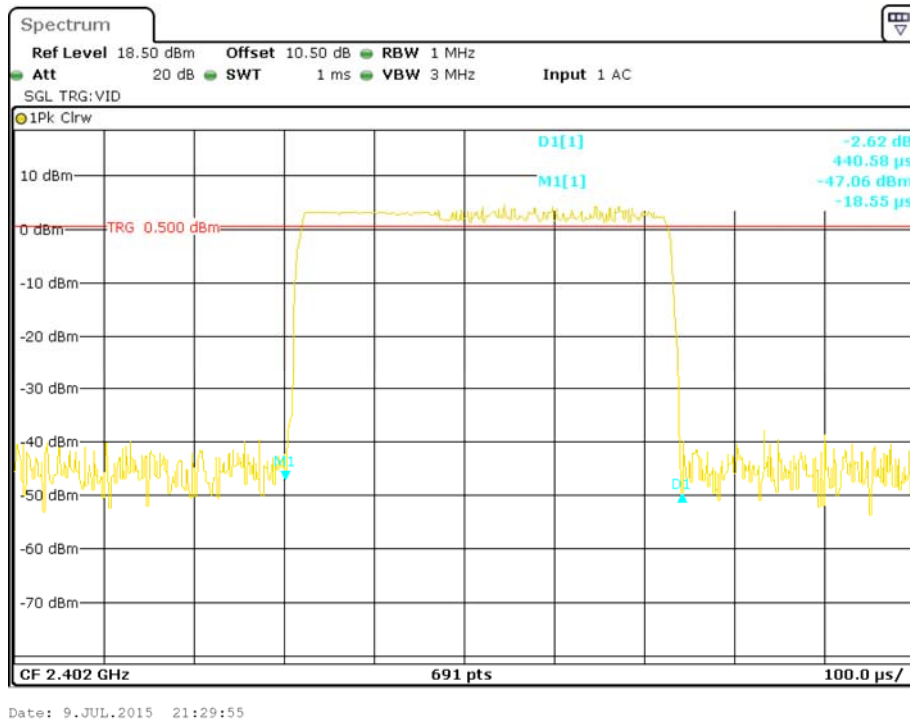
Date: 9.JUL.2015 21:27:55

### Pulse time, High Channel, 2DH5

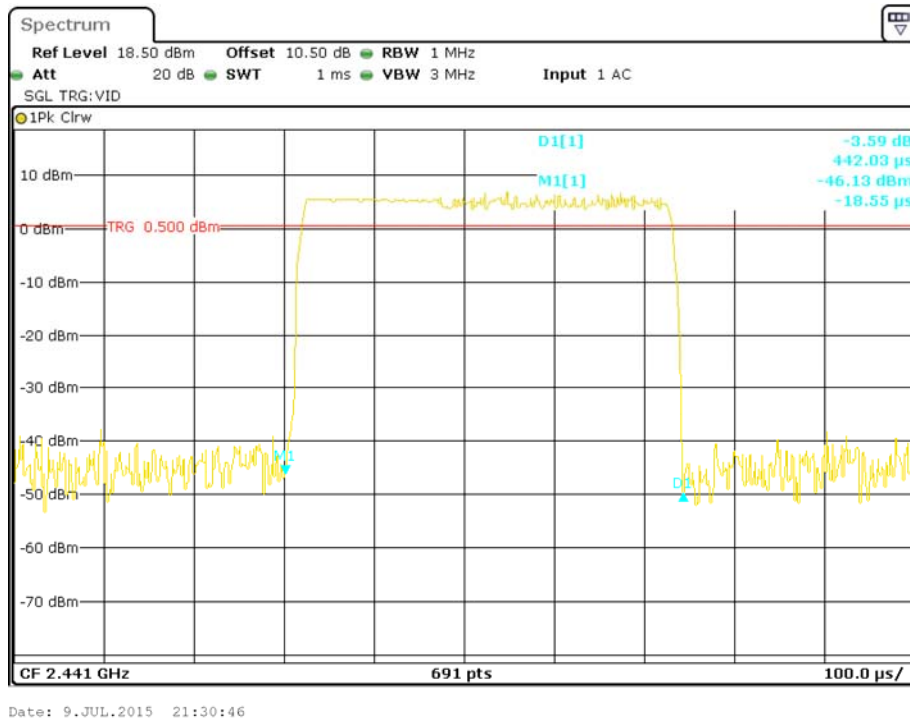


Date: 9.JUL.2015 21:28:21

### EDR (8DPSK): Pulse time, Low Channel, 3DH1

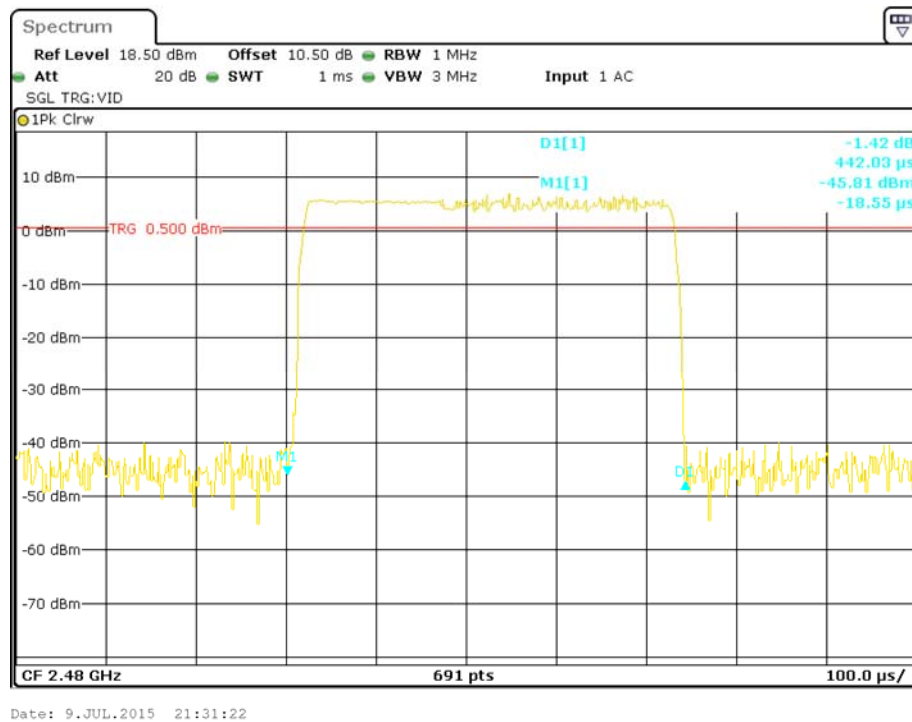


### Pulse time, Middle Channel, 3DH1

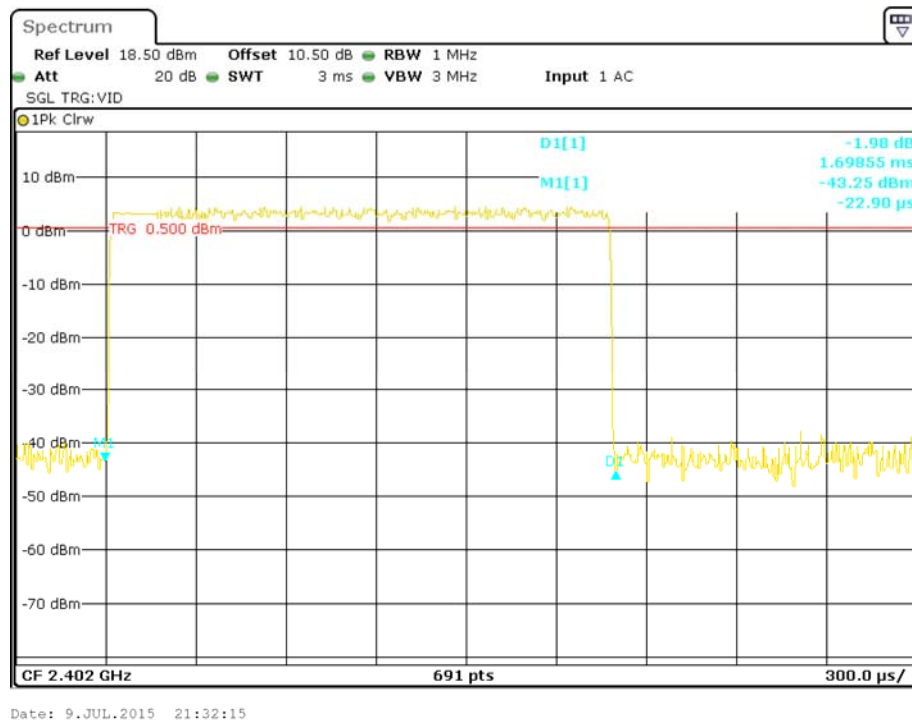




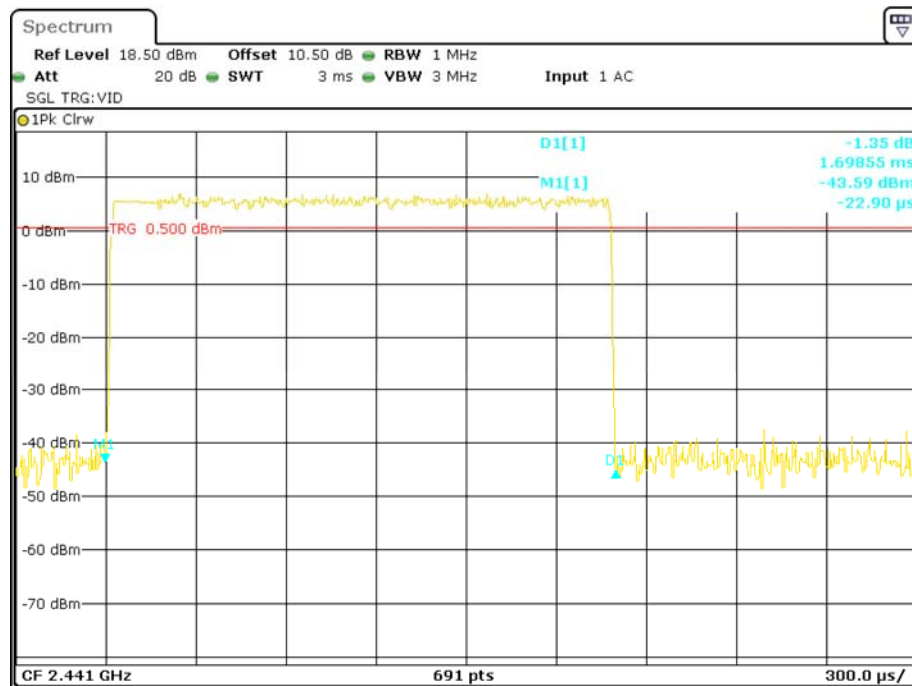
### Pulse time, High Channel, 3DH1



### Pulse time, Low Channel, 3DH3

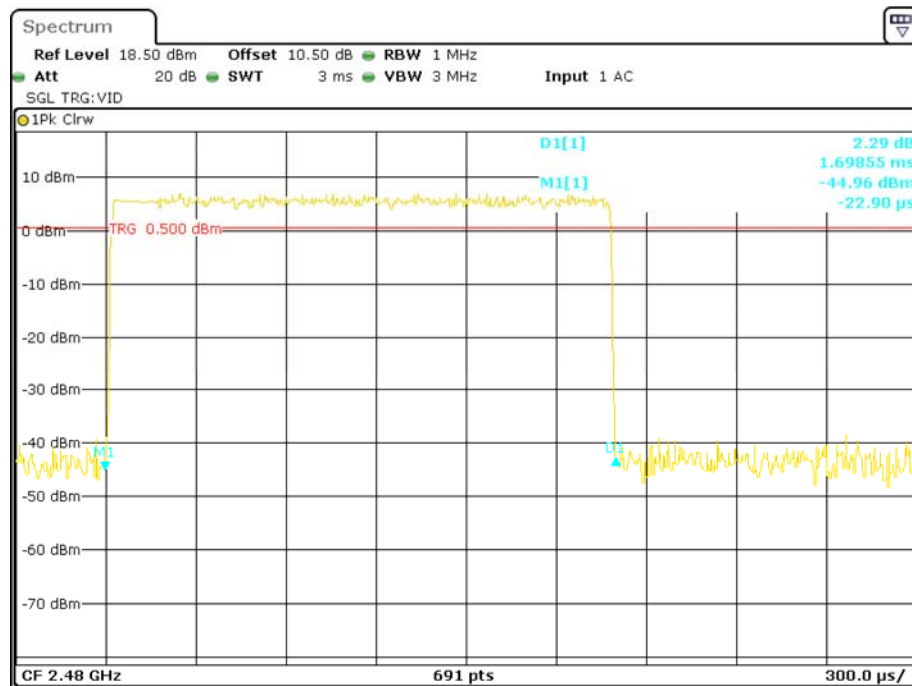


## Pulse time, Middle Channel, 3DH3



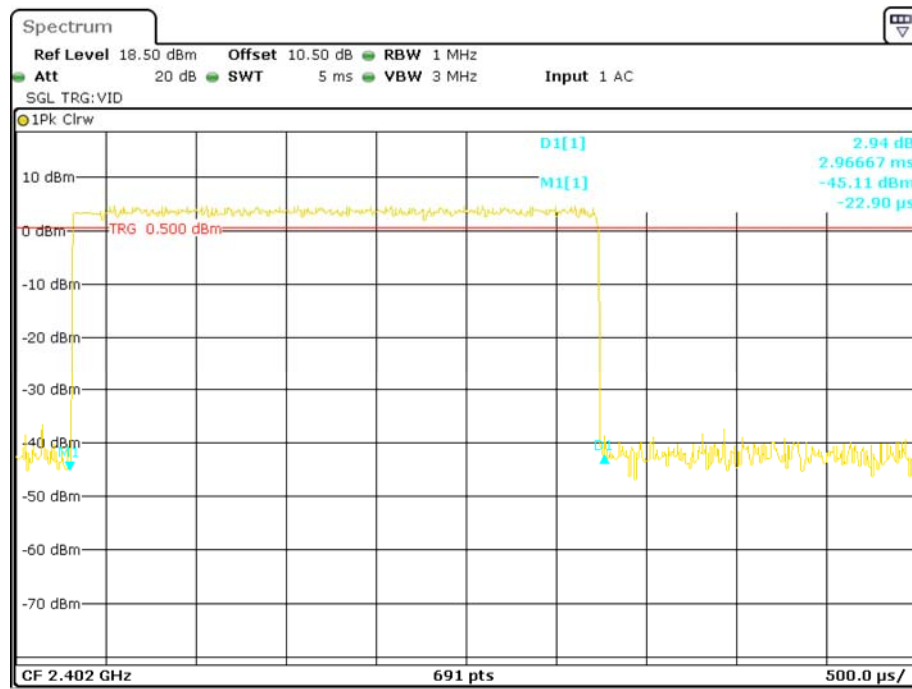
Date: 9.JUL.2015 21:32:46

## Pulse time, High Channel, 3DH3



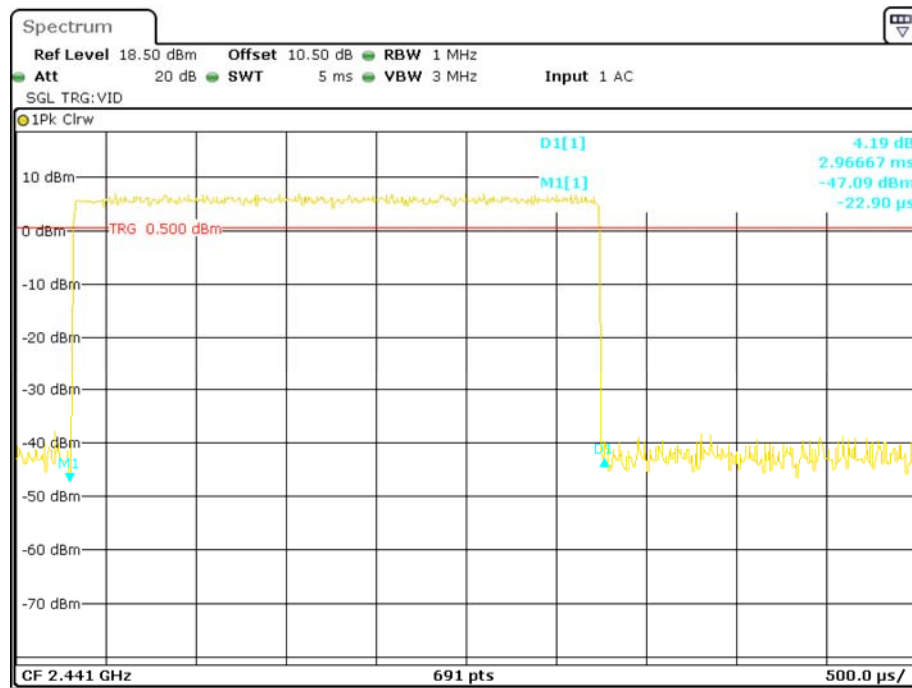
Date: 9.JUL.2015 21:33:17

## Pulse time, Low Channel, 3DH5

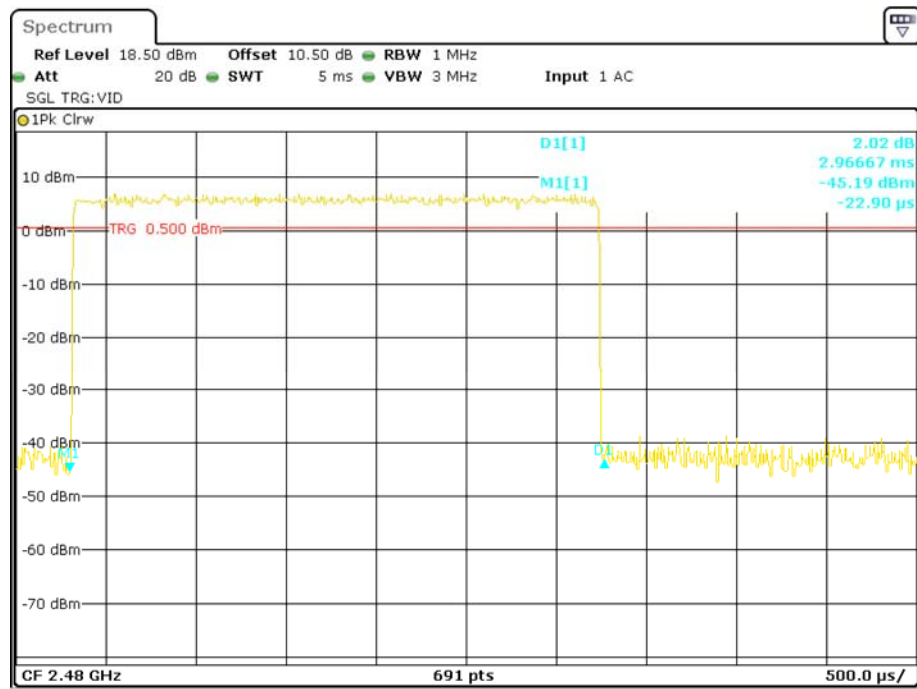


Date: 9.JUL.2015 21:34:05

## Pulse time, Middle Channel, 3DH5



Date: 9.JUL.2015 21:34:49

**Pulse time, High Channel, 3DH5**

Date: 9.JUL.2015 21:35:10

**FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT****Applicable Standard**

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

**Test Procedure**

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
HP	Power Meter	N1912A	MY5000448	2014-11-03	2015-11-03
HP	Power Sensor	N1921A	MY54210016	2014-11-03	2015-11-03

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

**Test Data****Environmental Conditions**

Temperature:	27 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

*The testing was performed by Sewen Guo on 2015-07-11.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following tables and plots.*

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mw)
			(dBm)	(mW)	
<b>BDR (GFSK)</b>	Low	2402	0.05	1.01	1000
	Middle	2441	4.01	2.52	1000
	High	2480	3.72	2.36	1000
<b>EDR (<math>\pi/4</math>-DQPSK)</b>	Low	2402	4.53	2.84	1000
	Middle	2441	5.49	3.54	1000
	High	2480	5.91	3.90	1000
<b>EDR (8DPSK)</b>	Low	2402	4.29	2.69	1000
	Middle	2441	5.35	3.43	1000
	High	2480	5.29	3.38	1000

Note: The data above was tested in conducted mode.

## FCC §15.247(d) - BAND EDGES TESTING

### Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

### Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2015-06-13	2016-06-13

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

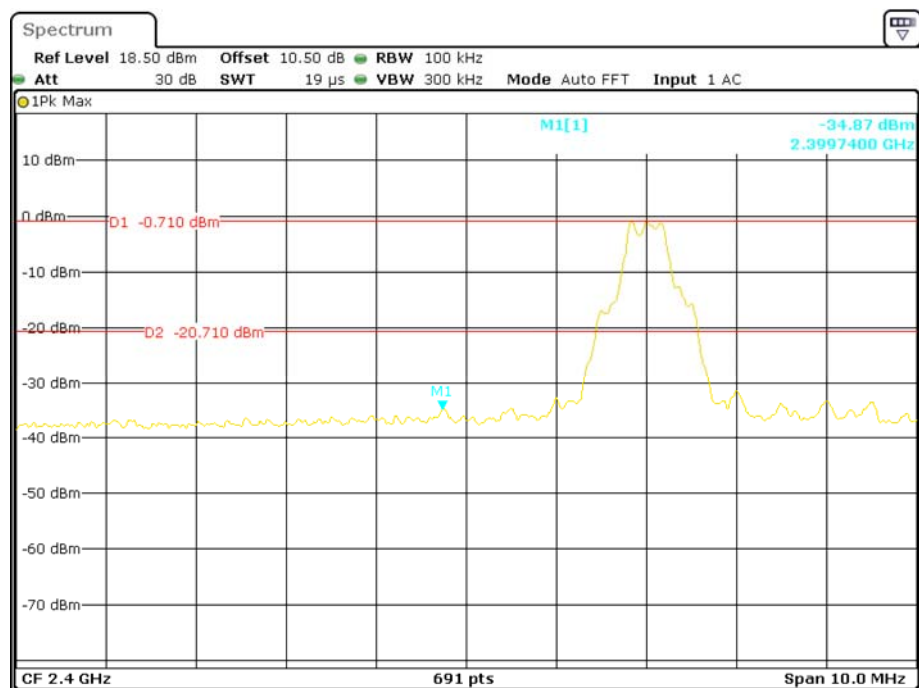
**Test Data****Environmental Conditions**

Temperature:	28 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Sewen Guo on 2015-07-09.

EUT operation mode: Transmitting

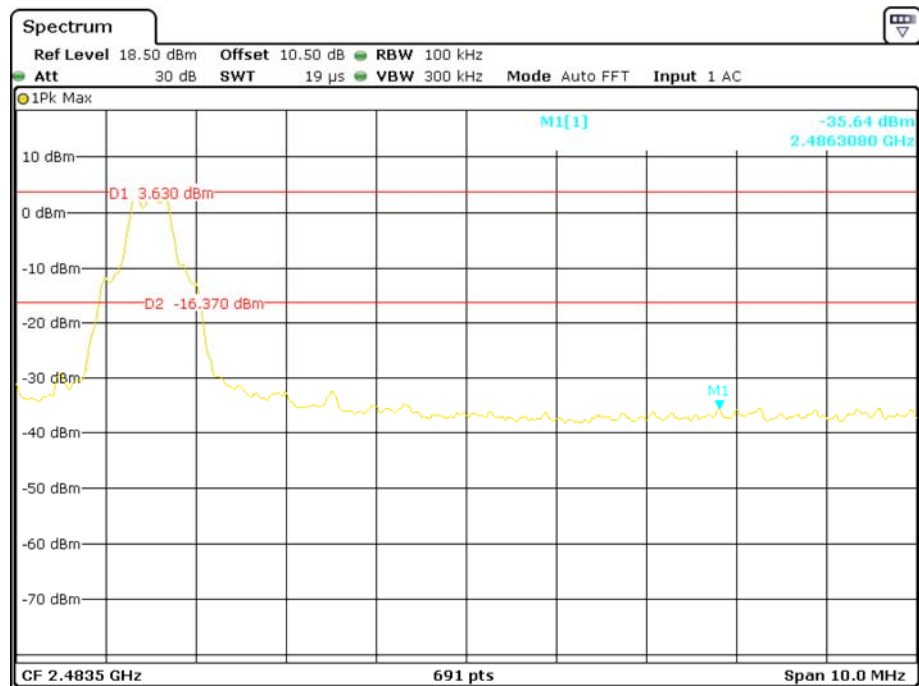
Test Result: Compliance. Please refer to following plots.

**BDR (GFSK): Band Edge-Left Side**

Date: 9.JUL.2015 20:50:26

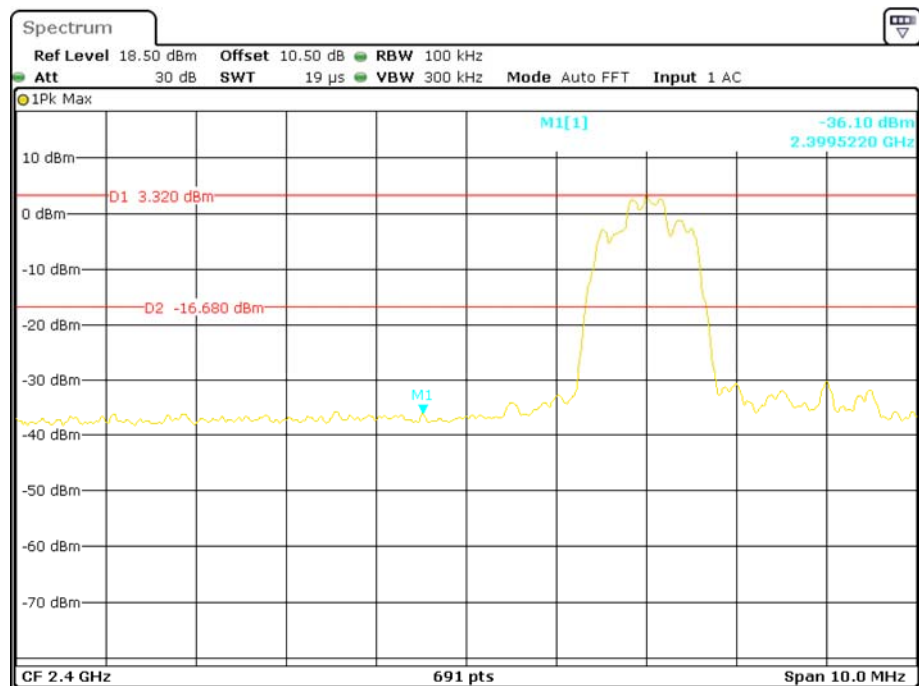


### BDR (GFSK): Band Edge-Right Side

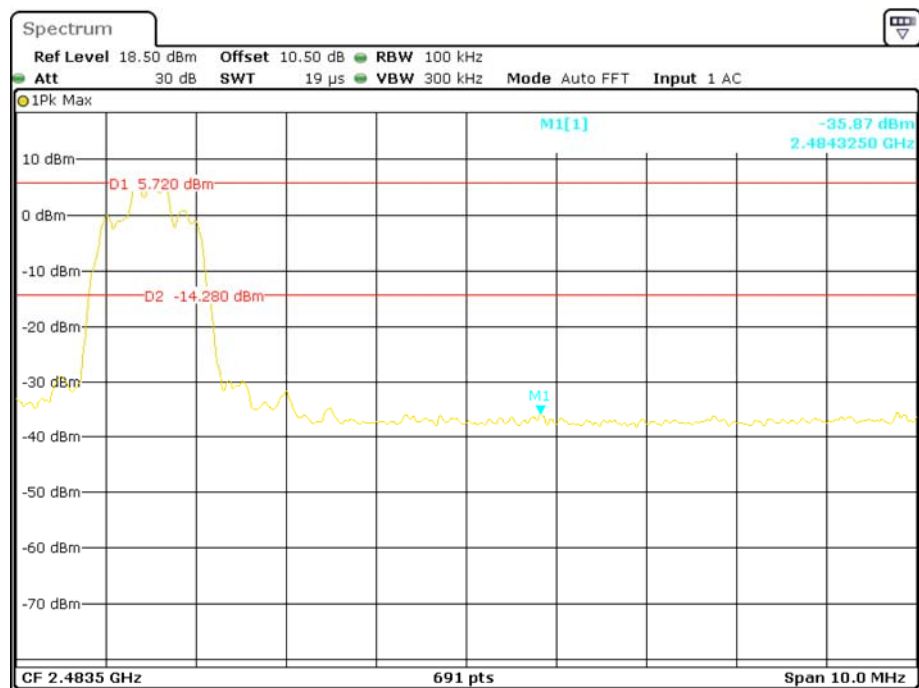


Date: 9.JUL.2015 20:48:51

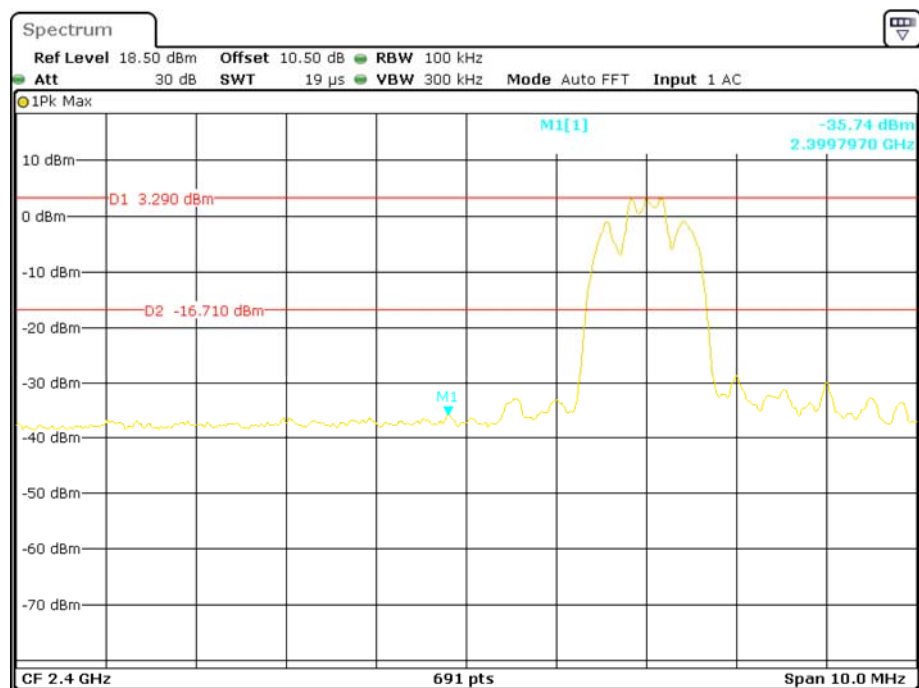
### EDR ( $\pi/4$ -DQPSK): Band Edge-Left Side



Date: 9.JUL.2015 20:45:20

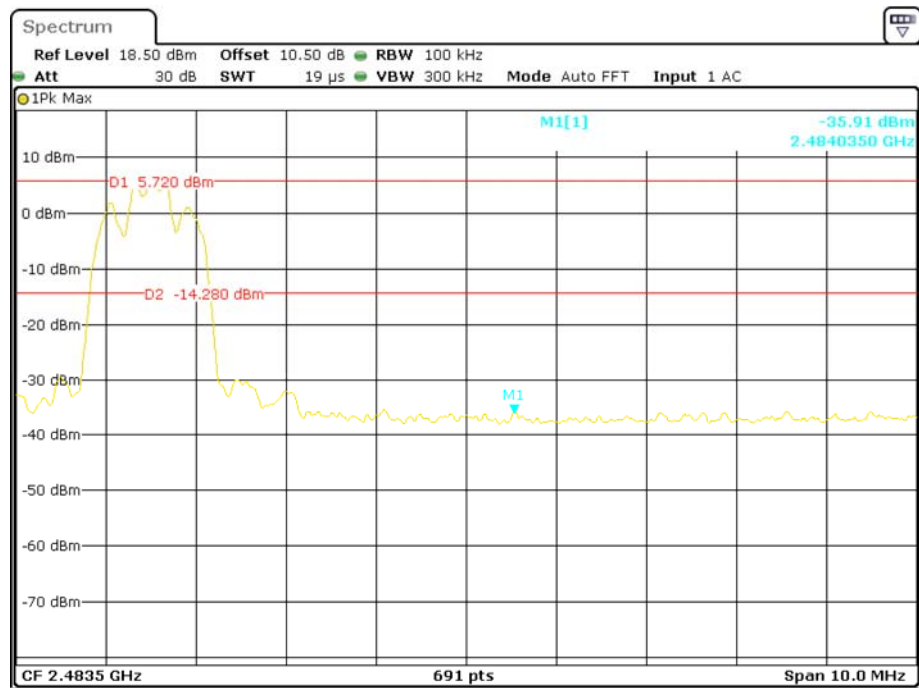
**EDR ( $\pi/4$ -DQPSK): Band Edge-Right Side**

Date: 9.JUL.2015 20:47:02

**EDR (8DPSK): Band Edge-Left Side**

Date: 9.JUL.2015 20:43:11

### BDR (8DPSK): Band Edge-Right Side



Date: 9.JUL.2015 20:41:09

\*\*\*\*\* END OF REPORT \*\*\*\*\*