FCC PART 15, SUBPART C
ISED RSS-247, ISSUE 1, MAY 2015

TEST AND MEASUREMENT REPORT

For

GoPro, Inc.

3000 Clearview Way,

San Mateo, CA 94402, USA

FCC ID: CNFASST1
IC: 10193A-ASST1

Report Type:	**Product Type:**
Original Report	Video Camera

Prepared By:	Xiao Lin Test Engineer
Report Number:	R1605201-247 DSS
Report Date:	2016-08-03
Reviewed By:	Bo Li RF Supervisor

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1605201-247 DSS	Original Report	2016-08-03

1 General Description

1.1 General Statements

Bay area Compliance Laboratory Corp. [BACL] hereby makes the following Statements:

- The Unit(s) described in this Test Report were received at BACL's facilities on 6 June 2016 and was in working condition upon arrival. Testing was performed on the Unit(s) described in this Test Report during the period 15 through 30 June 2016.
- The Test Results reported herein apply only to the Unit(s) actually tested, and to substantially identical Units.
- This Test Report must not be used to claim product endorsement by A2LA, or any agency of the U.S. Government, or by any other foreign government.
- This Test Report is the property of BACL, and shall not be reproduced, except in full, without prior written approval of BACL.

1.2 Agent for the Responsible Party

Company Name:	Go Global Compliance
Contact:	Mr. Peter S. Merguerian
Telephone:	+1-408-416-3772
E-mail:	peter@goglobalcompliance.com

1.3 Responsible Party

Company Name:	GoPro, Inc.
Contact:	Mr. Steven Kim
Street Address:	3000 Clearview Way,
City/State/Zip:	San Mateo, CA 94402
Country:	USA
Telephone:	+1-650 436-5020
E-mail:	skim@gopro.com
Web:	www.gopro.com

1.4 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *GoPro, Inc.*, and their product model: *HERO5 BLACK (ASST1), FCC ID:* CNFASST1; IC: 10193A-ASST1 or the "EUT" as referred to in this report. It is a Portable camera with Wi-Fi, Bluetooth and BLE functions. It operates in the 2.4 GHz and 5 GHz bands.

1.5 Mechanical Description of EUT

Dimensions: approximately 6cm (L) x 2.4cm (W) x 4.3cm (H)
Weight: 118 grams.
Serial Number: C31613 DVT13166 and C31613 DVT13161 assigned by GoPro, Inc.
EUT Photos: See Exhibit C of this Test Report.

1.6 Objective

This report is prepared on behalf of *GoPro, Inc,* in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's rules and IC RSS-247 Issue 1, MAY 2015.

The objective is to determine compliance with FCC Part 15.247 and IC RSS-247 rules for Output Power, Antenna Requirements, 20 dB Bandwidth, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions, Number of Hopping Channels, Dwell Time, and Hopping Channel Separation.

1.7 Related Submittal(s)/Grant(s)

FCC Part 15, Subpart C, Equipment DTS with FCC ID: CNFASST1
FCC Part 15, Subpart E, Equipment NII with FCC ID: CNFASST1

1.8 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.9 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the 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.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±1.48 dB
Unwanted Emissions, conducted	±1.57 dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ºC
Humidity	±5 %
DC and low frequency voltages	±1 %
Time	±2 %
Duty Cycle	±3 %

1.10 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.11 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3279.02)*****,** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.03)*** to certify

- For the USA (Federal Communications Commission):
    1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
    2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
    3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
    1- All Scope 1-Licence-Exempt Radio Frequency Devices;
    2- All Scope 2-Licensed Personal Mobile Radio Services;
    3- All Scope 3-Licensed General Mobile & Fixed Radio Services;
    4- All Scope 4-Licensed Maritime & Aviation Radio Services;
    5- All Scope 5-Licensed Fixed Microwave Radio Services
    6- All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
    1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
    2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2

- For the Hong Kong Special Administrative Region:
  1 All Radio Equipment, per KHCA 10XX-series Specifications;
  2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  1 MIC Telecommunication Business Law (Terminal Equipment):
  - All Scope A1 - Terminal Equipment for the Purpose of Calls;
  - All Scope A2 - Other Terminal Equipment
  2 Radio Law (Radio Equipment):
  - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
  - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
  - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)
- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D- ***A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:***

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Industry Canada - IC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;

  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - Radio & Teleterminal Equipment (R&TTE) Directive 1995/5/EC
    US -EU EMC & Telecom MRA CAB
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA)
  APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Development Authority - IDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing in accordance to ANSI C63.10-2013.

The worst-case data rates are determined by measuring the peak power across all data rates.

2.2 EUT Exercise Software

The test utility used was QCA Radio Control Toolkit version 3.0.174.0t provided by *GoPro, Inc,* the software was verified by *Xiao Lin* to comply with the standard requirements being tested against.

2.3 Duty Cycle Correction Factor

According to ANSI C63.10-2013 section 7.5:

Unless otherwise specified, 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 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval. The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in following equation:

$\delta(dB) = 20\log(\Delta)$

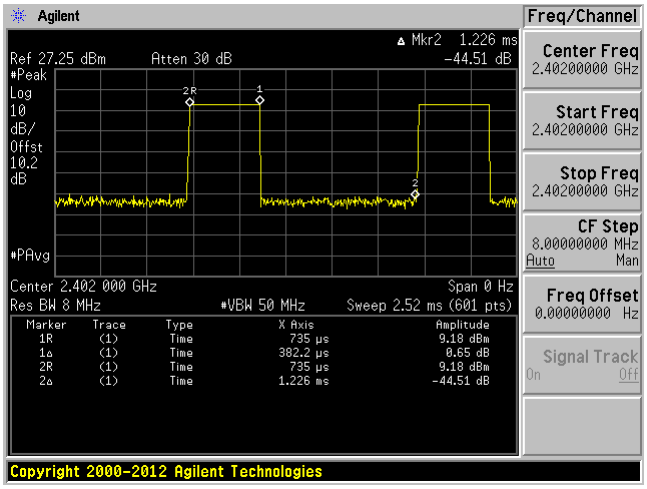
Where,
δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

Radio Mode	On Time (µs)	Period (µs)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
GFSK	382.2	1226	31.17	-10.125
π/4-DQPSK	382.2	1226	31.17	-10.125
8DPSK	386.4	1231	31.39	-10.064

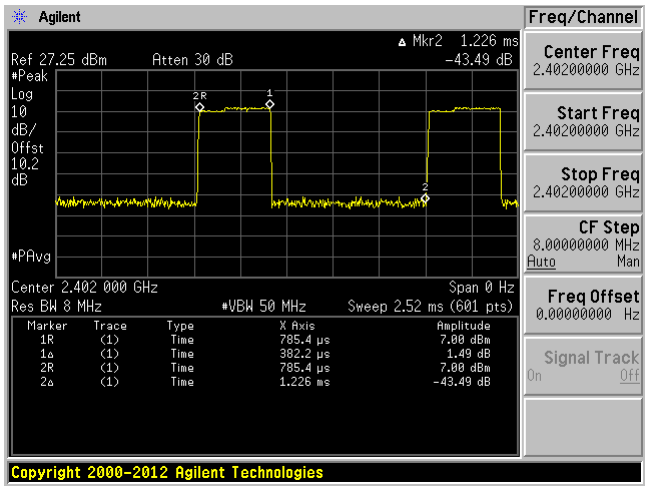
Duty Cycle = On Time (ms)/ Period (ms)

Please refer to the following plots.

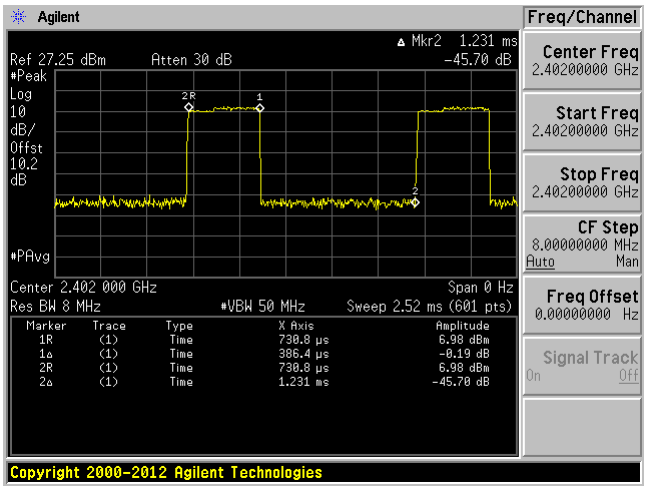
GFSK Mode



π/4-DQPSK Mode



8DPSK Mode



2.4 Equipment Modifications

A SMA pigtail cable connected to the EUT.

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude D630

2.6 EUT Internal Configuration Details

Manufacturer	Description	Serial Number
GoPro	FPC, Microphone + Button	656-10756-000
GoPro	PCB, Main	656-10705-000
GoPro	RFPC, I/O	656-10826-000
GoPro	RFPC, Sensor	656-10703-000
GoPro	PCB	656-12190-000
GoPro	FPC, Speaker + LED	656-12297-000

2.7 Support Equipment

Manufacturer	Description	Model
GoPro	Debug Board	898A

2.8 Interface Ports and Cabling

Cable Description	Length (m)	To	From
USB-C Cable	< 1 m	Laptop	EUT
SMA pigtail	< 1 m	EUT	PSA

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & ISED Rules	Description of Test	Results
FCC §15.203 ISED RSS-Gen §8.3	Antenna Requirement	Compliant
FCC §15.207 ISED RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1093, §15.247(i) ISED RSS-102	RF Exposure	Compliant[1]
FCC §2.1051, §15.247 (d) ISED RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247(d) ISED RSS-247 §5.5 RSS-Gen §8.9, §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(1) ISED RSS-247 §5.1 (1)	20 dB & 99% Emission Bandwidth	Compliant
FCC §15.247(b)(1) ISED RSS-247 §5.1(2)	Maximum Peak Output Power	Compliant
FCC §15.247(d) IC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(a)(1)(iii) ISED RSS-247 §5.1(4)	Number of Hopping Channels	Compliant
FCC §15.247(a)(1) ISED RSS-247 §5.1 (2)	Hopping Channel Separation	Compliant
FCC §15.247(a)(1)(iii) ISED RSS-247 §5.1 (4)	Dwell Time	Compliant

[1] RF exposure analysis is covered in a separate report. Please refer to R1605201-SAR.

4 FCC §15.203 & ISED RSS-Gen §8.3 - Antenna Requirements

4.1 Applicable Standards

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.

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to IC RSS-Gen §8.3: Transmitter Antenna

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

4.2 Antenna Description

The antennas used by the EUT are permanent attached to the internal PCB.

Radio	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
Wi-Fi/Bluetooth	2400-2483.5	-0.9
Wi-Fi	5150-5850	3.0

5 FCC §2.1093, §15.247(i) & ISED RSS-102 - RF Exposure

5.1 Applicable Standards

FCC §2.1093, §15.247(i) & ISED RSS-102

5.2 Test Results

Please refer to the SAR Report: R1605201- SAR.

6 FCC §15.207 & ISED RSS-Gen §8.8 - AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and IC RSS-Gen §8.8 Conducted limits:

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.
Note 2: A linear average detector is required

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2013 measurement procedure. The specification used was FCC §15.207 and IC RSS-Gen §8.8 limits.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

6.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-1 and the power cords of support equipment were connected to LISN-2.

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

All data were recorded in the peak detection mode, quasi-peak, and average detection mode. Quasi-Peak readings are distinguished with a “QP.” Average readings are distinguished with an “Ave”.

6.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Cable Loss (CL), the Attenuator Factor (Atten) to indicated Amplitude (Ai) reading. The basic equation is as follows:

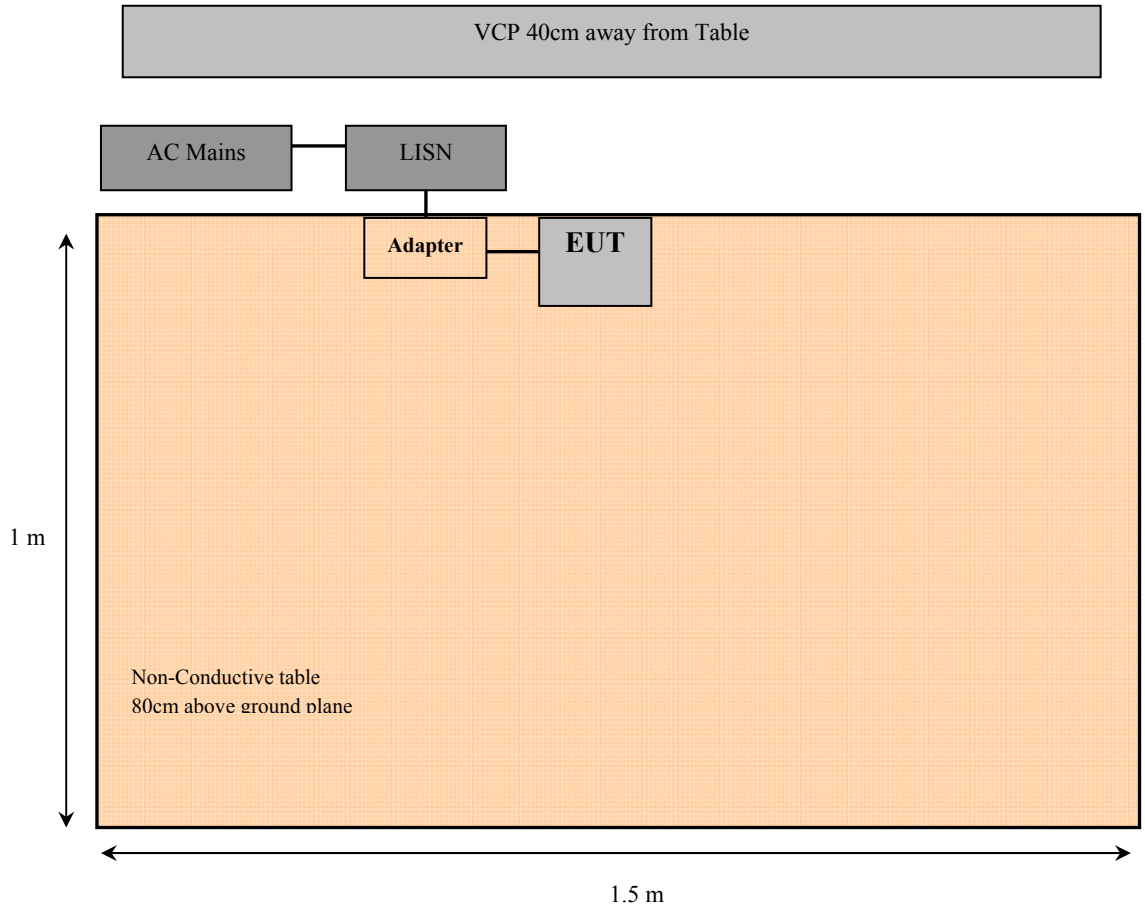
CA = Ai + CL + Atten

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 dB) + Attenuator (10 dB)

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

Margin = Corrected Amplitude – Limit

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
124	Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2015-07-23	1 year
679	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101963	2015-07-15	1 year
714	Keysight Technologies	RF Limiter	11867A	MY42242932	2015-12-15	1 year
726	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2016-03-09	1 year
689	Suirong	30 ft conductive emission cable	LMR 400	PS 29	N/R	N/R
732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2016-04-11	1 year
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

6.7 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-28
Test Site:	Ground Plane Test Site
Temperature:	22° C
Relative Humidity:	43 %
Barometric Pressure:	101.8 kPa
Test Personnel:	Jose Martinez

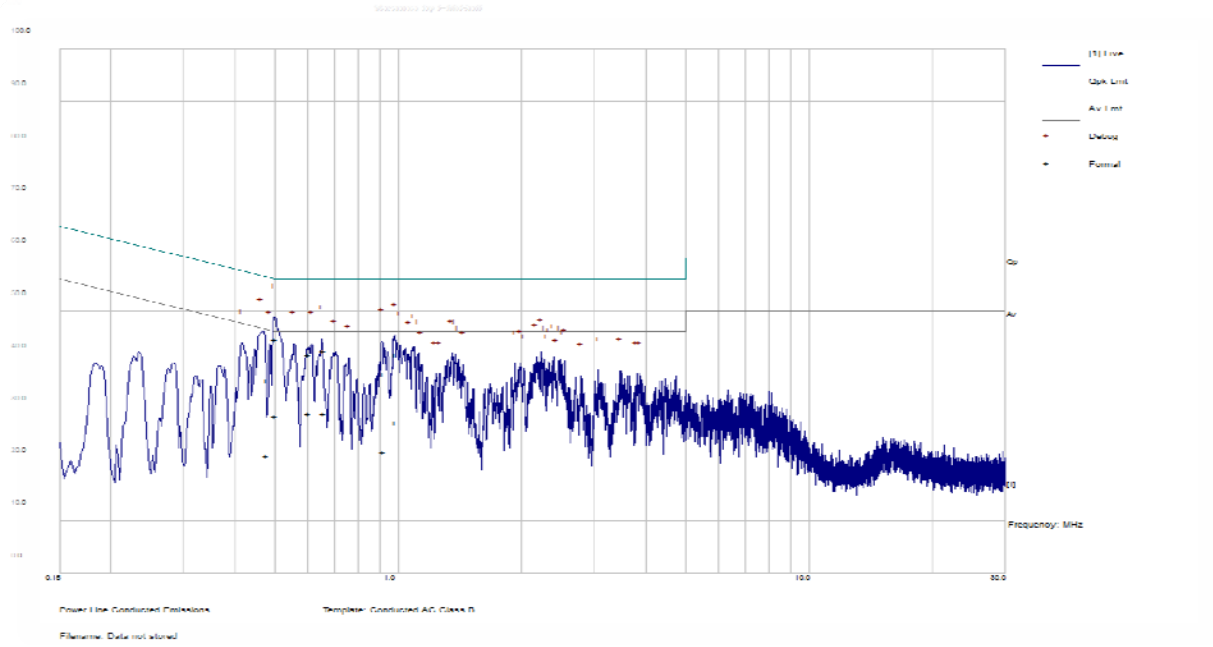
6.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC 15C and IC RSS-Gen standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Hot/Neutral)**	**Range (MHz)**
-11.38	0.501351	Line	0.15-30

6.9 Conducted Emissions Test Plots and Data

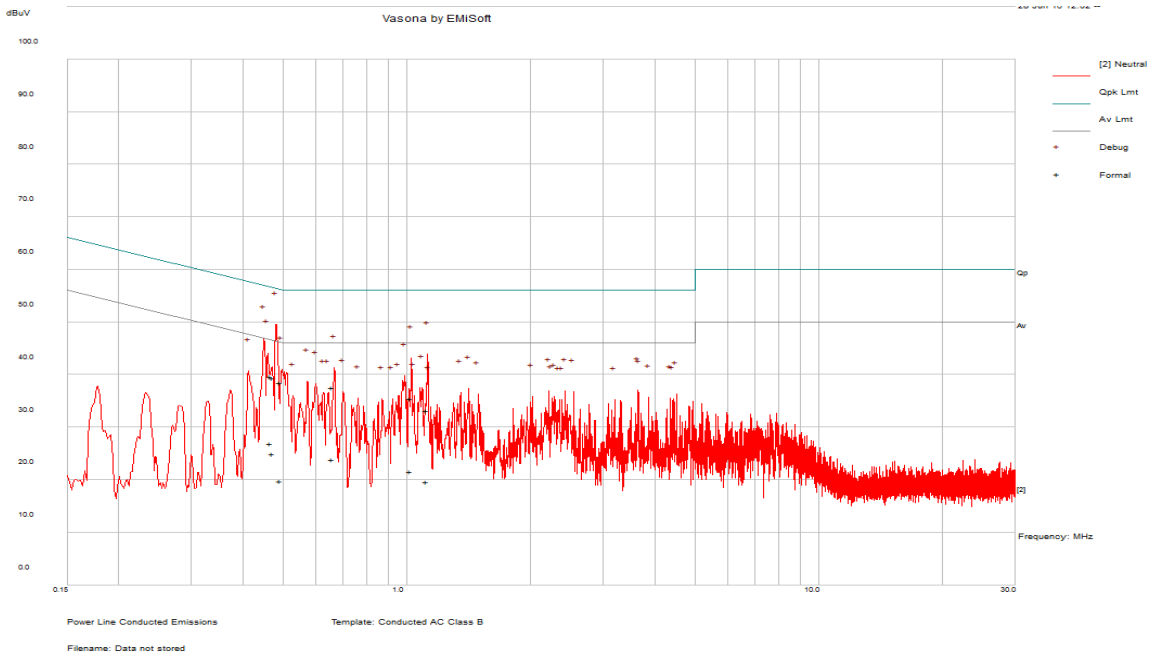
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.501351	44.62	Line	56	-11.38	QP
0.659002	42.35	Line	56	-13.65	QP
0.607303	41.73	Line	57.64	-15.91	QP
0.984893	41.48	Line	56	-14.52	QP
0.917796	37.9	Line	56	-18.1	QP
0.4794	36.73	Line	56.35	-19.62	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.607303	30.47	Line	46	-15.53	Ave.
0.659002	30.35	Line	46	-15.65	Ave.
0.501351	30	Line	46	-16	Ave.
0.984893	28.62	Line	46	-17.38	Ave.
0.917796	23.09	Line	46	-22.91	Ave.
0.4794	22.29	Line	46.35	-24.06	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.467104	39.62	Neutral	56.57	-16.95	QP
0.471427	39.44	Neutral	56.49	-17.05	QP
0.492481	38.48	Neutral	56.13	-17.65	QP
0.657474	37.51	Neutral	56	-18.49	QP
1.02006	35.49	Neutral	56	-20.51	QP
1.116771	33.17	Neutral	56	-22.83	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.467104	26.87	Neutral	46.57	-19.7	Ave.
0.471427	24.97	Neutral	46.49	-21.52	Ave.
0.657474	23.85	Neutral	46	-22.15	Ave.
1.02006	21.66	Neutral	46	-24.34	Ave.
0.492481	19.85	Neutral	46.13	-26.28	Ave.
1.116771	19.67	Neutral	46	-26.33	Ave.

7 FCC §15.209, §15.247(d) & ISED RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions

7.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per IC RSS-Gen 8.9,

> Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µv/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per IC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C and IC RSS-247 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

7.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was connected to the AC floor outlet.

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

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz / Sweep = Auto

7.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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

Margin = Corrected Amplitude - Limit

7.5 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
124	Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2015-07-23	1 year
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
323	Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
321	Sunol Science Corp	Antenna, Biconi-Log	JB3	A020106-2	2015-07-11	2 years
473	EMCO	Antenna, Horn	3115	9511-4627	2016-01-18	2 years
125	Agilent	Pre-Amplifier	8447D	2944A10187	2016-03-23	1 year
689	Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/R
-	-	SMA cable	-	C0002	Each time[1]	N/A
-	IW Microwave	High Frequency Cable	DC-1438	SPS-2303-3840-SPS	2016-01-18	1 year
658	Agilent	Pre-Amplifier	8449B	3008A01978	2016-05-23	1year
411	Wisewave	Pre-Amplifier	ALN-22093530-01	12263-01	2016-05-16	1 year
91	Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2013-09-20	3 year
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

[1] cable and attenuator included in the test set-up were checked each time before testing.
***Statement of Traceability: BACL** attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

7.6 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-23
Test Site:	5M Chamber 3
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.7 kPa
Test Personnel:	Jin Yang

7.7 Summary of Test Results

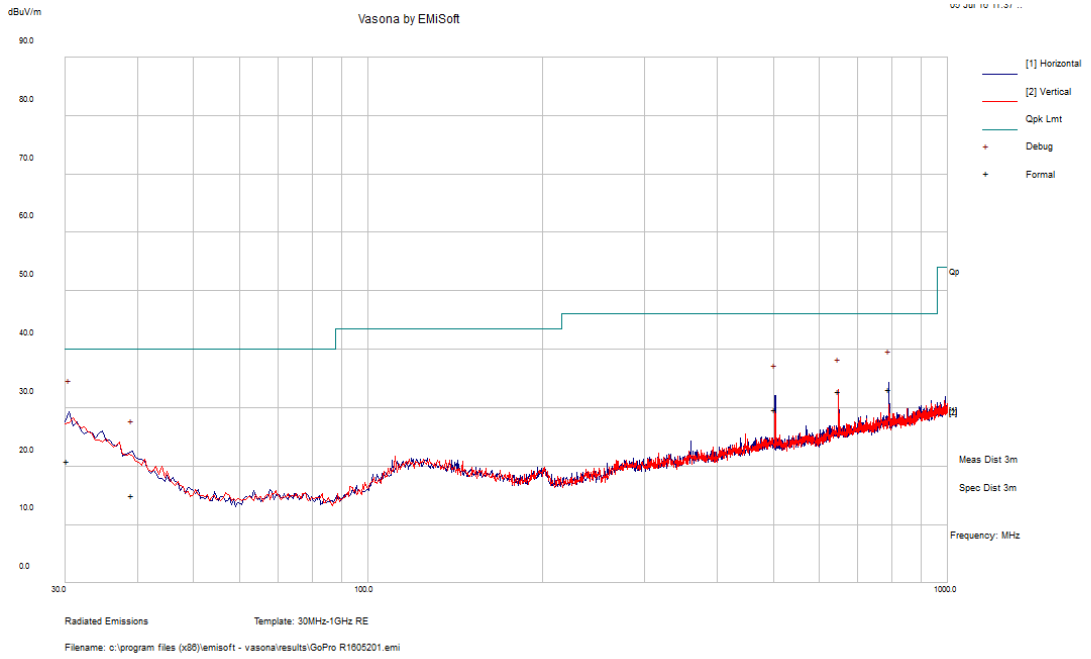
According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C and IC RSS-247 standard's radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-4.22	2483.5	Horizontal	GFSK, High Channel

Please refer to the following table and plots for specific test result details.

7.8 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
792.019	33.13	100	H	120	46	-12.87	QP
647.99125	32.91	125	V	304	46	-13.09	QP
503.996	29.75	157	H	0	46	-16.25	QP
30.296	20.97	275	H	20	40	-19.03	QP
39.158	14.93	266	H	7	40	-25.07	QP

2) 1–25 GHz Measured at 3 meters

GFSK mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz (power setting: 9)											
2402	73.59	82	305	H	29.05	5.22	0.00	107.86	-	-	PK
2402	73.26	82	305	H	29.05	5.22	0.00	107.53	-	-	AV
2402	66.51	80	285	V	29.05	5.22	0.00	100.78	-	-	PK
2402	65.47	80	285	V	29.05	5.22	0.00	99.74	-	-	AV
2390	26.74	156	307	H	28.98	5.22	0.00	60.94	74.00	-13.06	PK
2390	14.71	156	307	H	28.98	5.22	0.00	48.91	54.00	-5.09	AV
2390	25.89	158	315	V	28.98	5.22	0.00	60.09	74.00	-13.91	PK
2390	14.84	158	315	V	28.98	5.22	0.00	49.04	54.00	-4.96	AV
4804	49.53	105	289	H	32.48	7.88	36.64	53.25	74.00	-20.75	PK
4804	41.67	105	289	H	32.48	7.88	36.64	45.39	54.00	-8.61	AV
7206	44.93	233	235	H	36.72	10.45	36.42	55.68	74.00	-18.32	PK
7206	34.66	233	235	H	36.72	10.45	36.42	45.41	54.00	-8.59	AV
9608	45.38	236	238	H	37.78	11.37	36.66	57.87	74.00	-16.13	PK
9608	34.71	236	238	H	37.78	11.37	36.66	47.20	54.00	-6.80	AV
Middle Channel 2441 MHz (power setting: 9)											
2441	73.15	81	299	H	29.19	5.22	0.00	107.56	-	-	PK
2441	72.85	81	299	H	29.19	5.22	0.00	107.26	-	-	AV
2441	66.26	239	221	V	29.19	5.22	0.00	100.67	-	-	PK
2441	63.12	239	221	V	29.19	5.22	0.00	97.53	-	-	AV
4882	49.31	233	269	H	32.61	7.93	36.63	53.22	74.00	-20.78	PK
4882	40.47	233	269	H	32.61	7.93	36.63	44.38	54.00	-9.62	AV
7323	44.72	236	240	H	37.15	10.68	36.43	56.12	74.00	-17.88	PK
7323	33.81	236	240	H	37.15	10.68	36.43	45.21	54.00	-8.79	AV
9764	45.85	235	268	H	37.89	11.46	36.69	58.51	74.00	-15.49	PK
9764	34.98	235	268	H	37.89	11.46	36.69	47.64	54.00	-6.36	AV
High Channel 2480 MHz (power setting: 9)											
2480	70.33	78	295	H	29.34	5.22	0.00	104.89	-	-	PK
2480	69.97	78	295	H	29.34	5.22	0.00	104.53	-	-	AV
2480	68.06	80	270	V	29.34	5.22	0.00	102.62	-	-	PK
2480	67.15	80	270	V	29.34	5.22	0.00	101.71	-	-	AV
2483.5	27.36	78	295	H	29.35	5.35	0.00	62.06	74.00	-11.94	PK
2483.5	15.08	78	295	H	29.35	5.35	0.00	49.78	54.00	-4.22	AV
4960	46.97	233	272	H	32.85	7.97	36.59	51.20	74.00	-22.80	PK
4960	39.12	233	272	H	32.85	7.97	36.59	43.35	54.00	-10.65	AV
7440	46.04	238	244	H	37.04	10.82	36.45	57.45	74.00	-16.55	PK
7440	34.93	238	244	H	37.04	10.82	36.45	46.34	54.00	-7.66	AV
9920	45.94	238	242	H	38.00	11.54	36.70	58.78	74.00	-15.22	PK
9920	34.78	238	242	H	38.00	11.54	36.70	47.62	54.00	-6.38	AV

π/4-DQPSK mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz (power setting: 9)											
2402	72.31	82	305	H	29.05	5.22	0.00	106.58	-	-	PK
2402	69.35	82	305	H	29.05	5.22	0.00	103.62	-	-	AV
2402	65.41	80	285	V	29.05	5.22	0.00	99.68	-	-	PK
2402	61.82	80	285	V	29.05	5.22	0.00	96.09	-	-	AV
2390	25.91	156	307	H	28.98	5.22	0.00	60.11	74.00	-13.89	PK
2390	14.72	156	307	H	28.98	5.22	0.00	48.92	54.00	-5.08	AV
2390	26.45	158	315	V	28.98	5.22	0.00	60.65	74.00	-13.35	PK
2390	14.83	158	315	V	28.98	5.22	0.00	49.03	54.00	-4.97	AV
4804	46.89	105	289	H	32.48	7.88	36.64	50.61	74.00	-23.39	PK
4804	37.82	105	289	H	32.48	7.88	36.64	41.54	54.00	-12.46	AV
7206	45.72	233	235	H	36.72	10.45	36.42	56.47	74.00	-17.53	PK
7206	34.71	233	235	H	36.72	10.45	36.42	45.46	54.00	-8.54	AV
9608	45.13	236	238	H	37.78	11.37	36.66	57.62	74.00	-16.38	PK
9608	34.63	236	238	H	37.78	11.37	36.66	47.12	54.00	-6.88	AV
Middle Channel 2441 MHz (power setting: 9)											
2441	71.78	81	299	H	29.19	5.22	0.00	106.19	-	-	PK
2441	68.82	81	299	H	29.19	5.22	0.00	103.23	-	-	AV
2441	65.25	239	221	V	29.19	5.22	0.00	99.66	-	-	PK
2441	62.32	239	221	V	29.19	5.22	0.00	96.73	-	-	AV
4882	47.15	233	269	H	32.61	7.93	36.63	50.80	74.00	-23.20	PK
4882	37.11	233	269	H	32.61	7.93	36.63	41.73	54.00	-12.27	AV
7323	44.68	236	240	H	37.15	10.68	36.43	56.08	74.00	-17.92	PK
7323	33.79	236	240	H	37.15	10.68	36.43	45.19	54.00	-8.81	AV
9764	45.61	235	268	H	37.89	11.46	36.69	58.27	74.00	-15.73	PK
9764	34.97	235	268	H	37.89	11.46	36.69	47.63	54.00	-6.37	AV
High Channel 2441 MHz (power setting: 9)											
2480	68.99	78	295	H	29.34	5.22	0.00	103.55	-	-	PK
2480	66.04	78	295	H	29.34	5.22	0.00	100.60	-	-	AV
2480	66.92	80	270	V	29.34	5.22	0.00	101.48	-	-	PK
2480	63.29	80	270	V	29.34	5.22	0.00	97.85	-	-	AV
2483.5	26.65	78	295	H	29.35	5.35	0.00	61.35	74.00	-12.65	PK
2483.5	15.05	78	295	H	29.35	5.35	0.00	49.75	54.00	-4.25	AV
4960	46.94	233	272	H	32.85	7.97	36.59	51.17	74.00	-22.83	PK
4960	36.11	233	272	H	32.85	7.97	36.59	40.34	54.00	-13.66	AV
7440	45.79	238	244	H	37.04	10.82	36.45	57.20	74.00	-16.80	PK
7440	34.87	238	244	H	37.04	10.82	36.45	46.28	54.00	-7.72	AV
9920	45.91	238	242	H	38.00	11.54	36.70	58.75	74.00	-15.25	PK
9920	34.71	238	242	H	38.00	11.54	36.70	47.55	54.00	-6.45	AV

8DPSK mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz (power setting: 9)											
2402	72.59	82	305	H	29.05	5.22	0.00	106.86	-	-	PK
2402	69.39	82	305	H	29.05	5.22	0.00	103.66	-	-	AV
2402	65.58	80	285	V	29.05	5.22	0.00	99.85	-	-	PK
2402	61.95	80	285	V	29.05	5.22	0.00	96.22	-	-	AV
2390	25.93	156	307	H	28.98	5.22	0.00	60.13	74.00	-13.87	PK
2390	14.83	156	307	H	28.98	5.22	0.00	49.03	54.00	-4.97	AV
4804	46.77	105	289	H	32.48	7.88	36.64	50.49	74.00	-23.51	PK
4804	37.82	105	289	H	32.48	7.88	36.64	41.54	54.00	-12.46	AV
7206	45.76	233	235	H	36.72	10.45	36.42	56.51	74.00	-17.49	PK
7206	34.68	233	235	H	36.72	10.45	36.42	45.43	54.00	-8.57	AV
9608	45.69	236	238	H	37.78	11.37	36.66	58.18	74.00	-15.82	PK
9608	34.57	236	238	H	37.78	11.37	36.66	47.06	54.00	-6.94	AV
Middle Channel 2441 MHz (power setting: 9)											
2441	72.08	81	299	H	29.19	5.22	0.00	106.49	-	-	PK
2441	68.83	81	299	H	29.19	5.22	0.00	103.24	-	-	AV
2441	65.59	239	221	V	29.19	5.22	0.00	100.00	-	-	PK
2441	62.31	239	221	V	29.19	5.22	0.00	96.72	-	-	AV
4882	47.05	233	269	H	32.61	7.93	36.63	50.96	74.00	-23.04	PK
4882	37.01	233	269	H	32.61	7.93	36.63	40.92	54.00	-13.08	AV
7323	45.11	236	240	H	37.15	10.68	36.43	56.51	74.00	-17.49	PK
7323	33.79	236	240	H	37.15	10.68	36.43	45.19	54.00	-8.81	AV
9764	45.72	235	268	H	37.89	11.46	36.69	58.38	74.00	-15.62	PK
9764	34.92	235	268	H	37.89	11.46	36.69	47.58	54.00	-6.42	AV
High Channel 2441 MHz (power setting: 9)											
2480	69.42	78	295	H	29.34	5.22	0.00	103.98	-	-	PK
2480	65.99	78	295	H	29.34	5.22	0.00	100.55	-	-	AV
2480	67.17	80	270	V	29.34	5.22	0.00	101.73	-	-	PK
2480	63.28	80	270	V	29.34	5.22	0.00	97.84	-	-	AV
2483.5	26.28	78	295	H	29.35	5.35	0.00	60.98	74.00	-13.02	PK
2483.5	15.01	78	295	H	29.35	5.35	0.00	49.71	54.00	-4.29	AV
4960	46.25	233	272	H	32.85	7.97	36.59	50.48	74.00	-23.52	PK
4960	36.11	233	272	H	32.85	7.97	36.59	40.34	54.00	-13.66	AV
7440	45.49	238	244	H	37.04	10.82	36.45	56.90	74.00	-17.10	PK
7440	34.84	238	244	H	37.04	10.82	36.45	46.25	54.00	-7.75	AV
9920	45.58	238	242	H	38.00	11.54	36.70	58.42	74.00	-15.58	PK
9920	34.66	238	242	H	38.00	11.54	36.70	47.50	54.00	-6.50	AV

Note: duty cycle factor was taking into account.

8 FCC §15.247(a) (1) & ISED RSS-247 §5.1, RSS-Gen §6.6 - Emission Bandwidth

8.1 Applicable Standards

According to FCC §15.247(a) (1) and IC RSS-247 §5.1: the maximum 20 dB bandwidth of the hopping channel shall be presented.

8.2 Measurement Procedure

Span = approximately 2 to 5 times the 99% occupied bandwidth, centered on a hopping channel

RBW = 1% to 5 % of the 99% occupied bandwidth

VBW = 3RBW

Sweep = auto

Detector function = peak

Trace = max hold

8.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10 dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-15
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jose Martinez

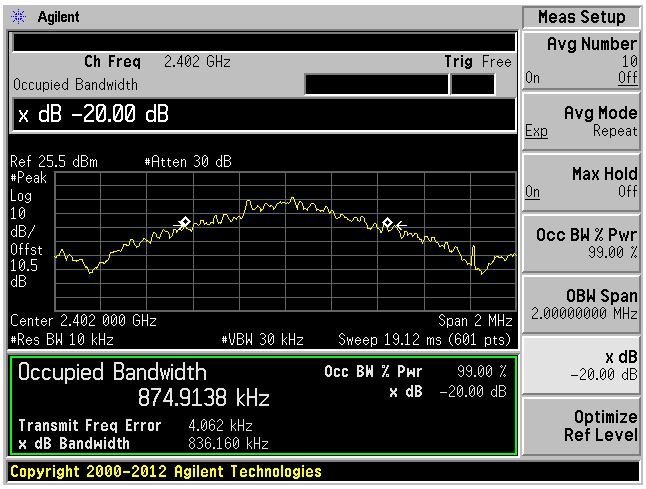
8.5 Test Results

Channel	Frequency (MHz)	99% OBW (kHz)	20 dB OBW (kHz)
GFSK			
Low	2402	874.91	836.16
Middle	2441	876.63	836.32
High	2480	873.92	836.19
π/4-DQPSK			
Low	2402	1158.2	1214
Middle	2441	1164.5	1215
High	2480	1159.2	1215
8DPSK			
Low	2402	1151.8	1248
Middle	2441	1146.7	1192
High	2480	1145.7	1192

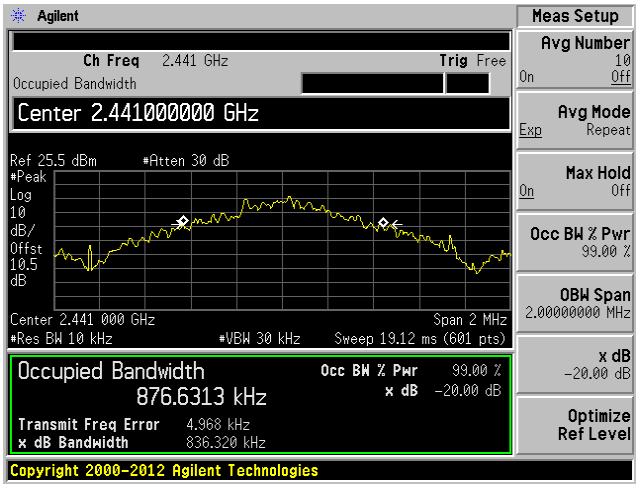
Please refer to the following plots for detailed test results.

GFSK

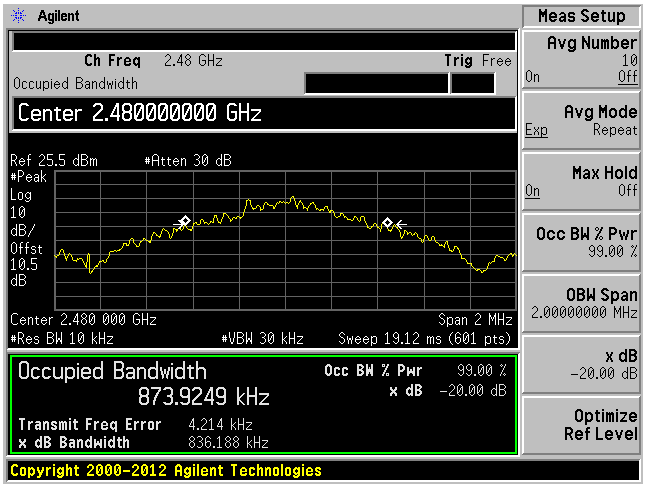
Low Channel 2402 MHz



Middle Channel 2441 MHz

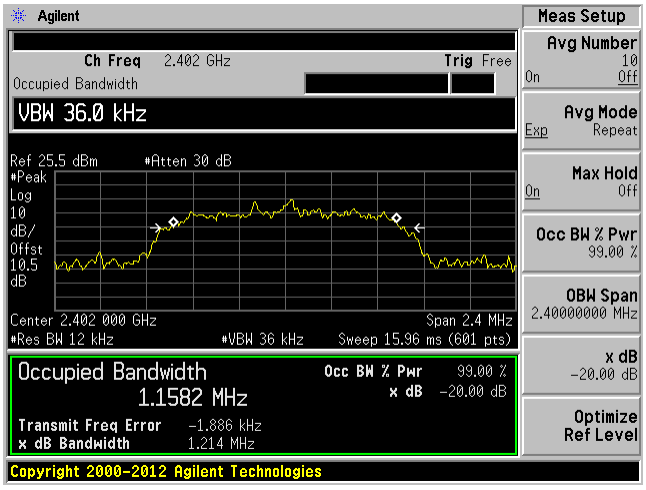


High Channel 2480 MHz

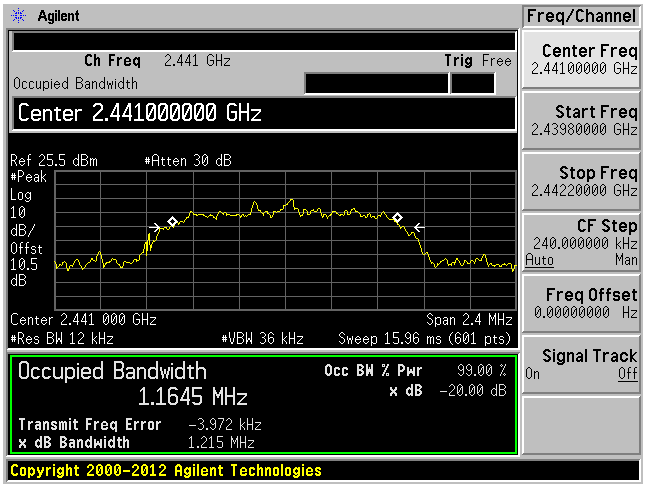


π/4-DQPSK

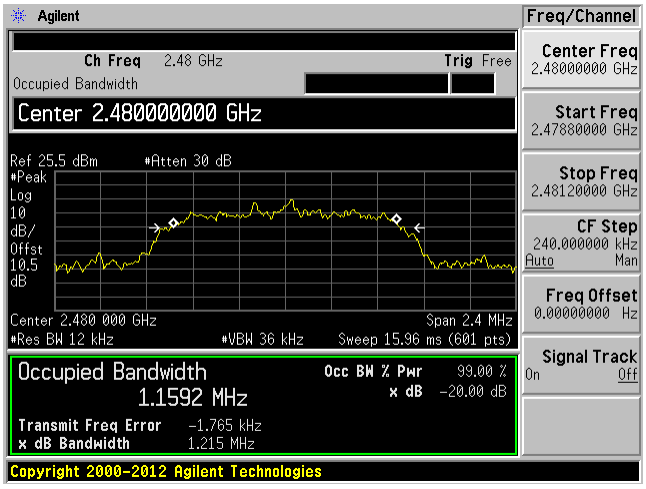
Low Channel 2402 MHz



Middle Channel 2441 MHz

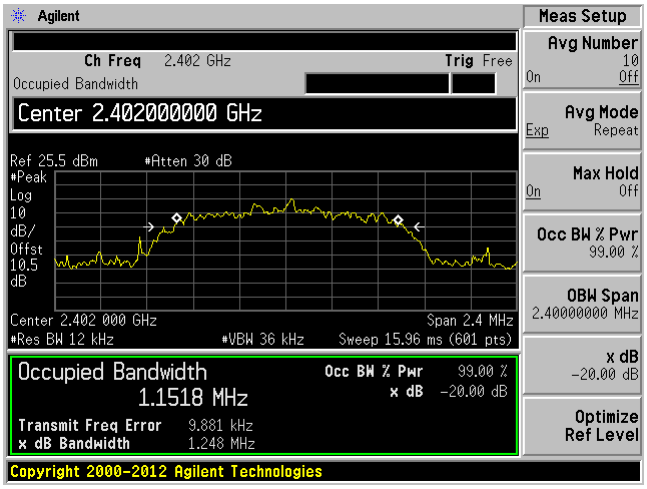


High Channel 2480 MHz

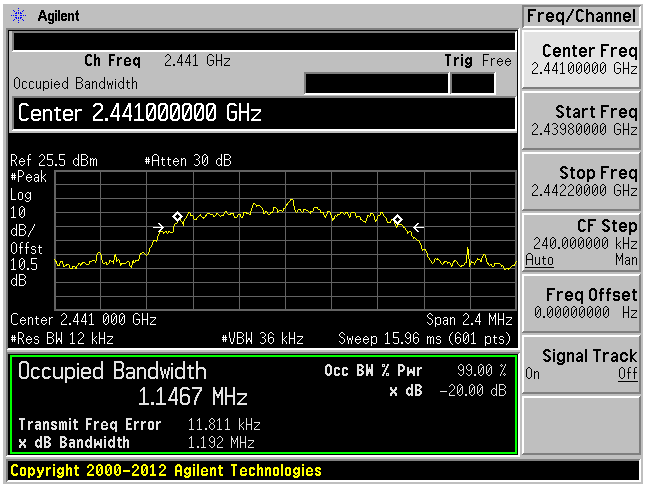


8DPSK

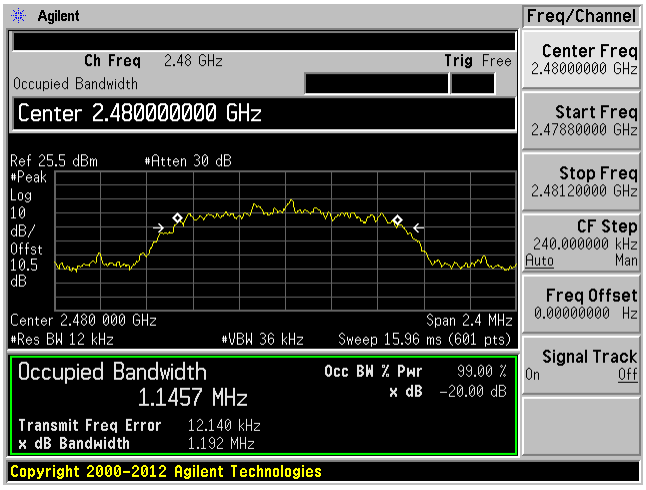
Low Channel 2402 MHz



Middle Channel 2441 MHz



High Channel 2480 MHz



9 FCC §15.247(b) (1) & ISED RSS-247 §5.4 -Output Power

9.1 Applicable Standards

According to FCC §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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

According to RSS-247 §5.4: For frequency hopping systems operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels.

9.2 Measurement Procedure

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

9.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

9.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-22
Test Site:	RF Site
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.9 kPa
Test Personnel:	Jose Martinez

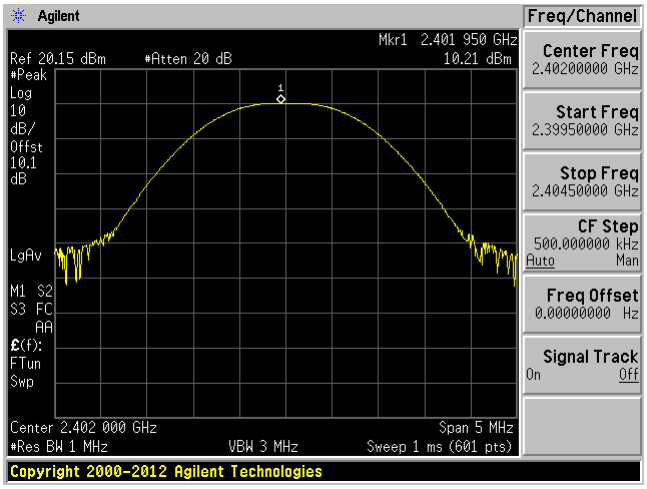
9.5 Test Results

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)
GFSK			
Low	2402	10.21	30
Middle	2441	10.32	30
High	2480	10.13	30
π/4-DQPSK			
Low	2402	9.12	30
Middle	2441	9.24	30
High	2480	9.02	30
8DPSK			
Low	2402	9.53	30
Middle	2441	9.63	30
High	2480	9.43	30

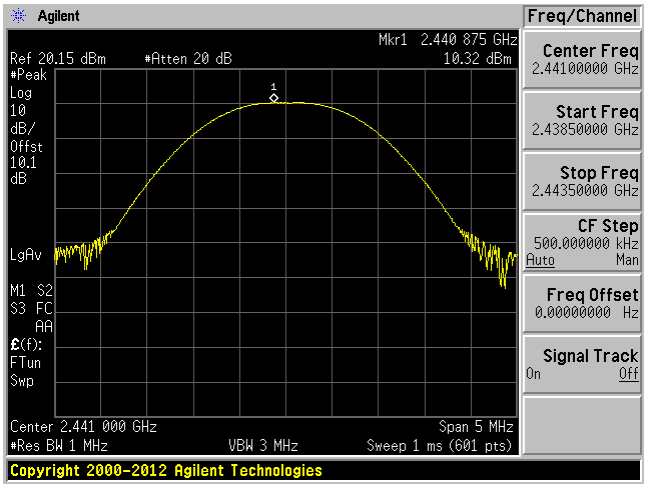
Please refer to the following plots for detailed test results.

GFSK

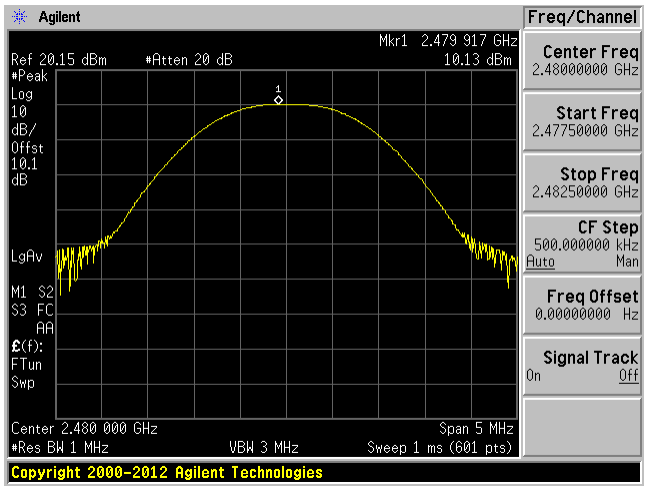
Low Channel 2402 MHz



Middle Channel 2441 MHz

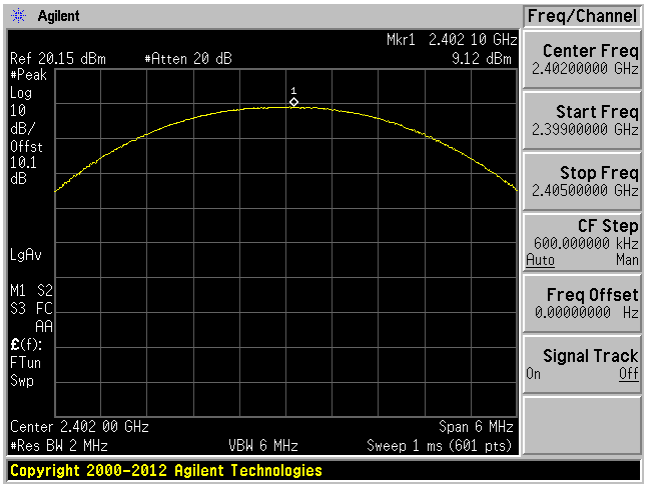


High Channel 2480 MHz

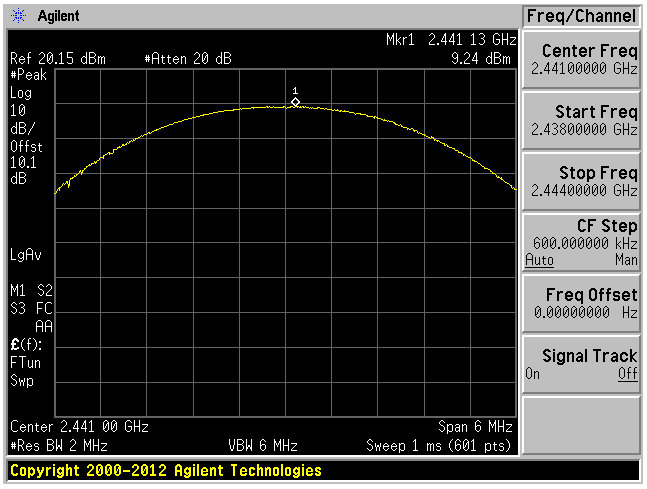


π/4-DQPSK

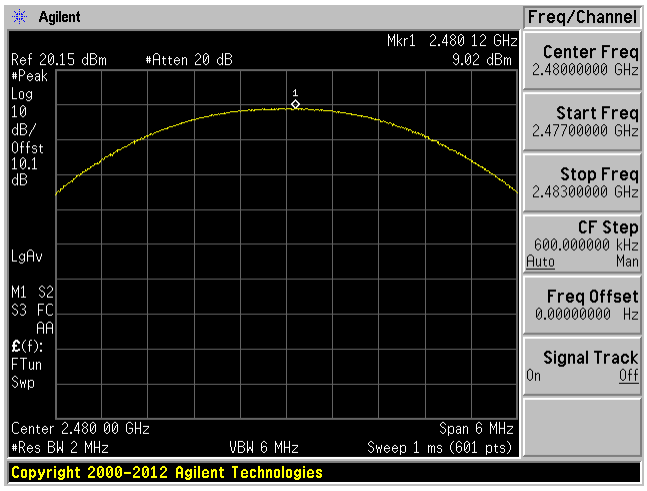
Low Channel 2402 MHz



Middle Channel 2441 MHz

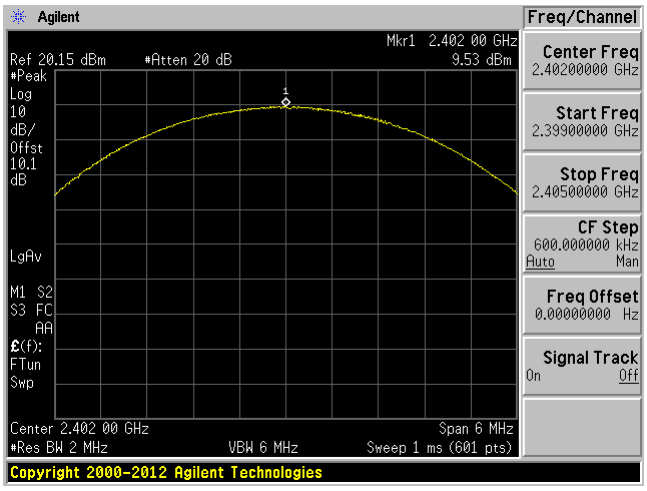


High Channel 2480 MHz

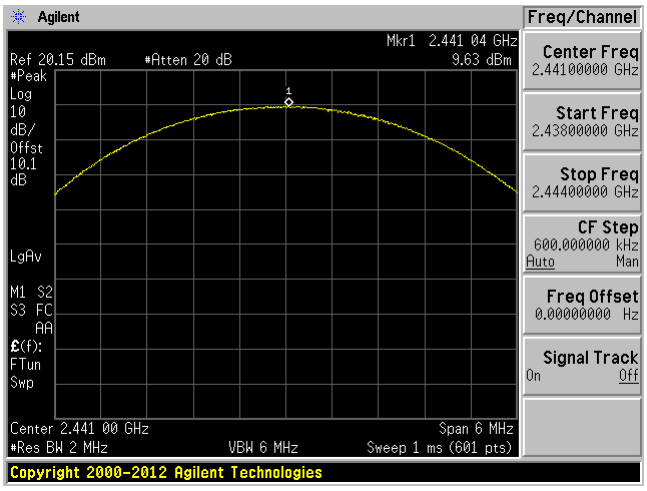


8DPSK

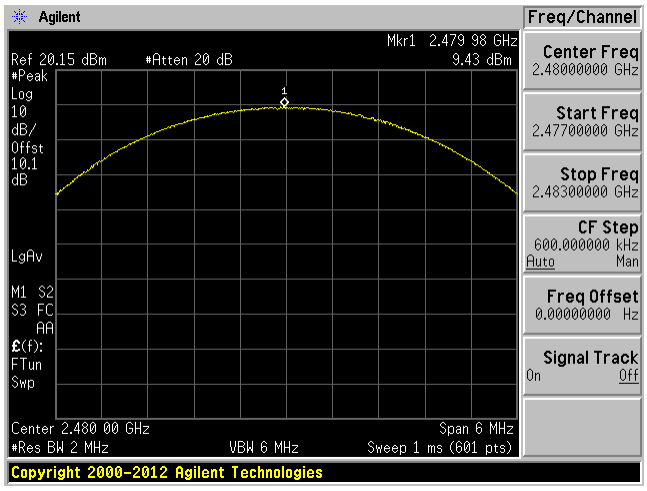
Low Channel 2402 MHz



Middle Channel 2441 MHz



High Channel 2480 MHz



10 FCC §15.247(d) & ISED RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges

10.1 Applicable Standards

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

According to IC RSS-247 §5.5.In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.2 Measurement Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz
VBW = 300 kHz
Sweep = coupled
Detector function = peak
Trace = max hold

10.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10 dB attenuator	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

10.4 Test Location, Date, Personnel and Environmental Conditions

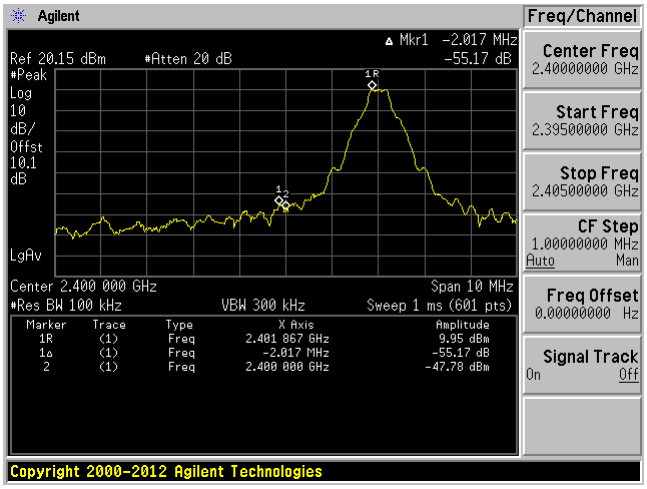
Test Date:	2016-06-15
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jose Martinez

10.5 Test Results

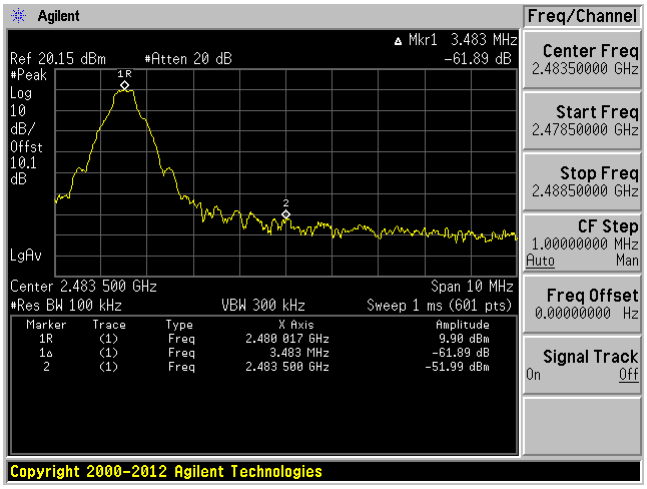
Please refer to the following plots,

GFSK

Low Channel 2402 MHz

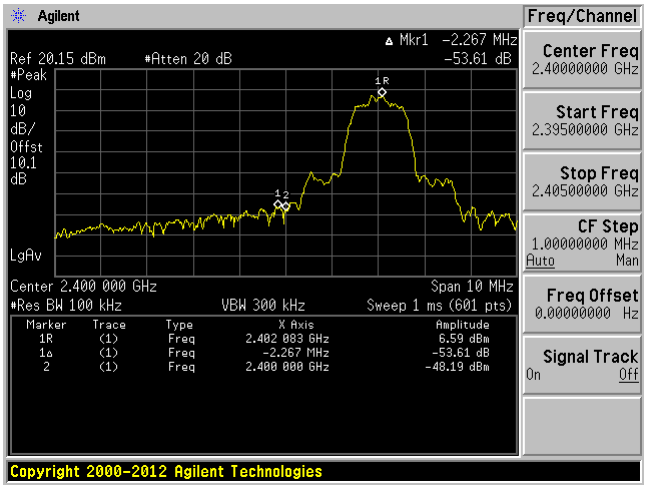


High Channel 2480 MHz

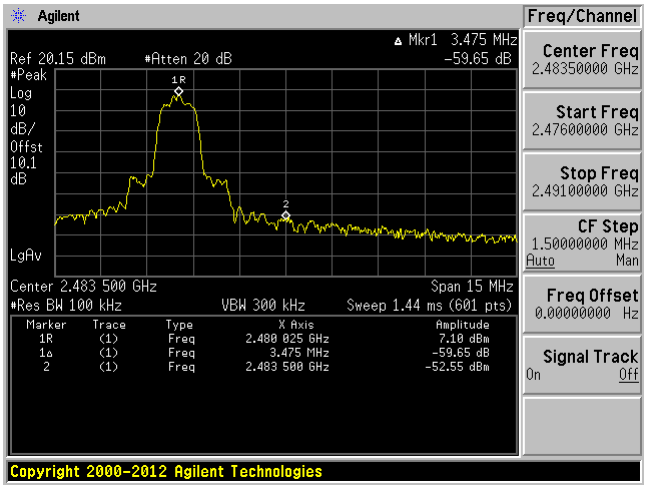


π/4-DQPSK

Low Channel 2402 MHz

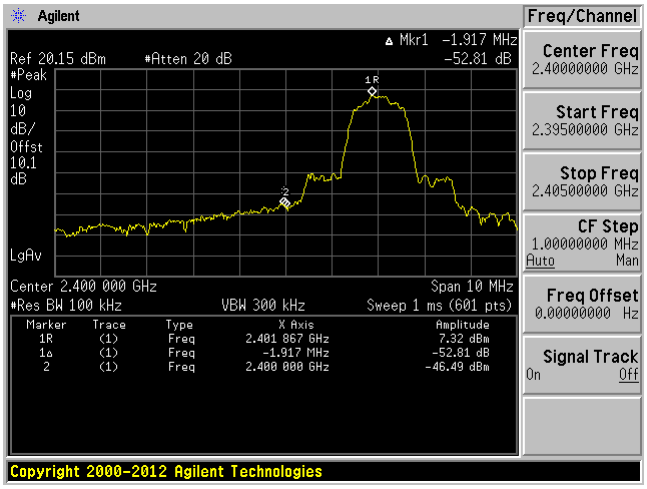


High Channel 2480 MHz

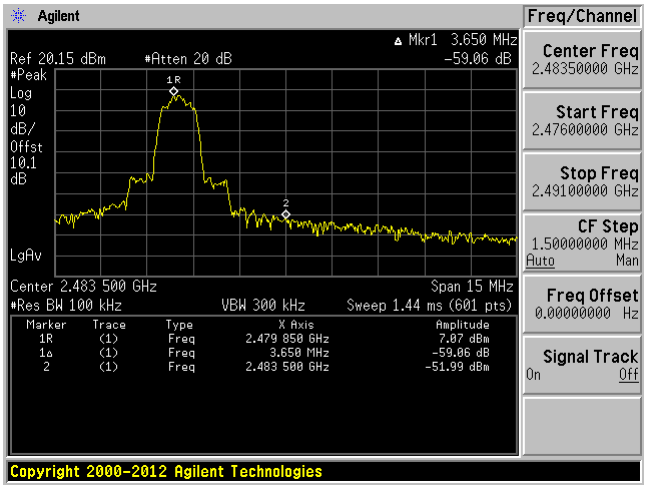


8DPSK

Low Channel 2402 MHz



High Channel 2480 MHz



11 FCC §15.247(a) (1) (iii) & ISED RSS-247 §5.1 (4) - Dwell Time

11.1 Applicable Standards

According to FCC §15.247(a) (1) (iii) and RSS-247 §5.1(4), 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.

11.2 Measurement Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel
RBW ≤ channel spacing and where possible RBW should be set >> 1/*T*, where *T* is the expected dwell time per channel
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) x (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

11.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10 dB attenuator	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

11.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-30
Test Site:	RF Site
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.5 kPa
Test Personnel:	Xiao Lin

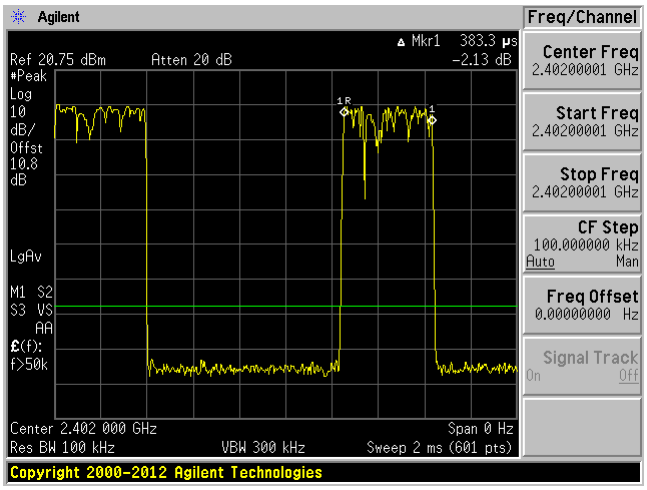
11.5 Test Results

Channel	Pulse Width (ms)	Number of Hops in the Period Specified in the Requirements	Average Time of Occupancy (s)	Limit (s)	Results
GFSK, DH1					
Low	0.3833	310	0.1188	0.4	compliant
Middle	0.39	320	0.1248	0.4	compliant
High	0.38	310	0.1178	0.4	compliant
GFSK, DH3					
Low	1.633	160	0.26128	0.4	compliant
Middle	1.633	140	0.22862	0.4	compliant
High	1.633	140	0.22862	0.4	compliant
GFSK, DH5					
Low	2.85	70	0.1995	0.4	compliant
Middle	2.875	110	0.3163	0.4	compliant
High	2.9	100	0.2900	0.4	compliant
π/4-DQPSK, DH1					
Low	0.3833	320	0.1227	0.4	compliant
Middle	0.3833	320	0.1227	0.4	compliant
High	0.3833	320	0.1227	0.4	compliant
π/4-DQPSK, DH3					
Low	1.583	160	0.2533	0.4	compliant
Middle	1.583	170	0.2691	0.4	compliant
High	1.633	130	0.2123	0.4	compliant
π/4-DQPSK, DH5					
Low	2.833	90	0.2550	0.4	compliant
Middle	2.867	110	0.3154	0.4	compliant
High	2.9	90	0.2610	0.4	compliant
8DPSK, DH1					
Low	0.3917	320	0.1253	0.4	compliant
Middle	0.3917	310	0.1214	0.4	compliant
High	0.3917	320	0.1253	0.4	compliant
8DPSK, DH3					
Low	1.617	180	0.2911	0.4	compliant
Middle	1.617	170	0.2749	0.4	compliant
High	1.6	160	0.2560	0.4	compliant
8DPSK, DH5					
Low	2.9	120	0.348	0.4	compliant
Middle	2.9	130	0.377	0.4	compliant
High	2.9	110	0.319	0.4	compliant

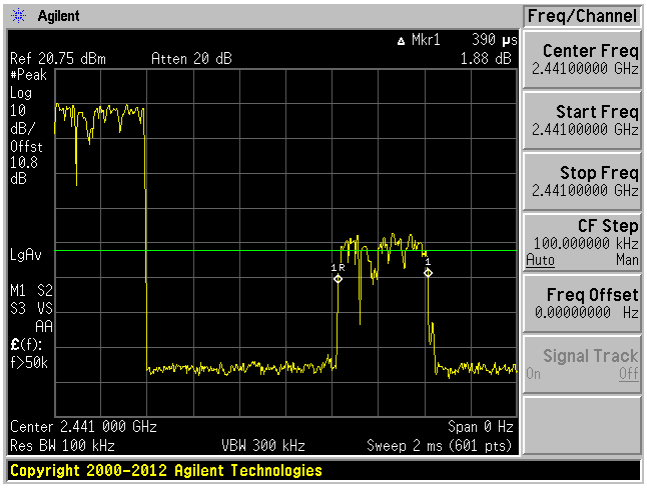
Please refer to the following plots for detailed test results.

GFSK, DH1 Pulse Width

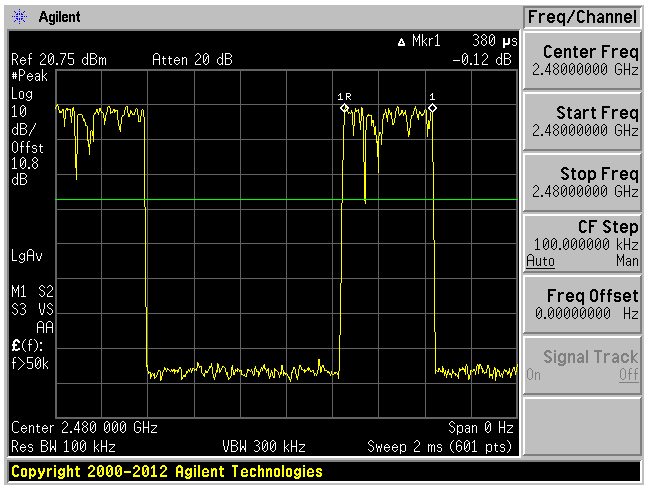
Low Channel 2402 MHz



Middle Channel 2441 MHz

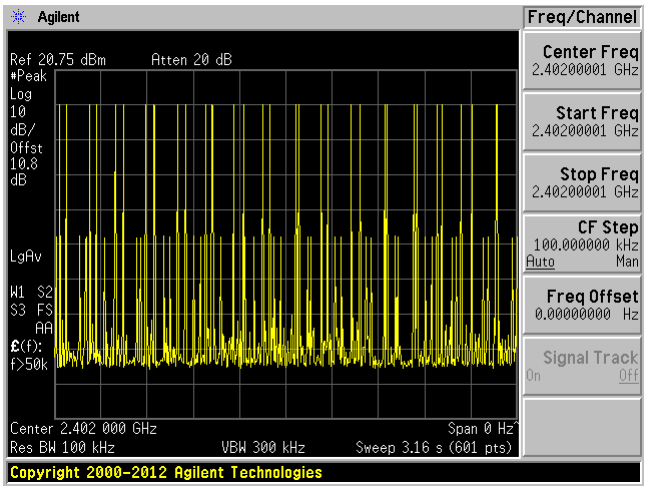


High Channel 2480 MHz

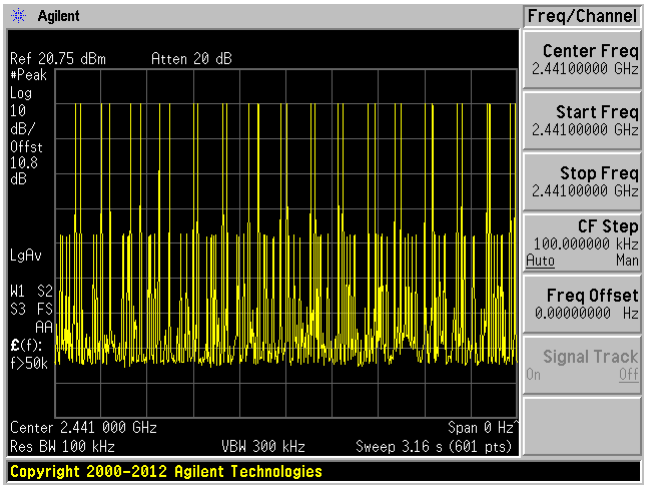


GFSK, DH1 Number of Pulses within a Specified Time

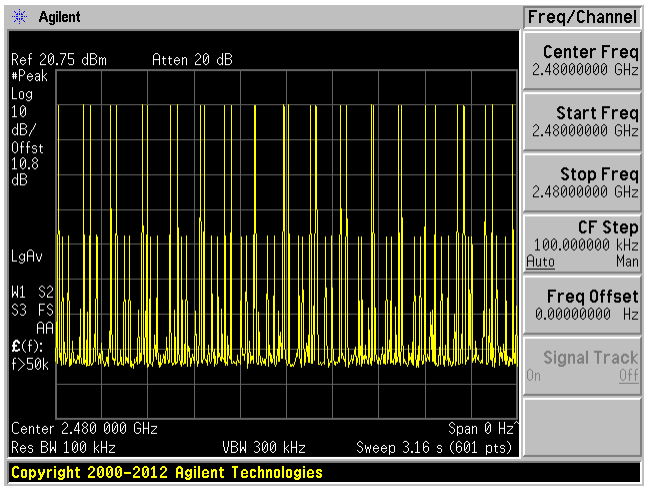
Low Channel 2402 MHz



Middle Channel 2441 MHz

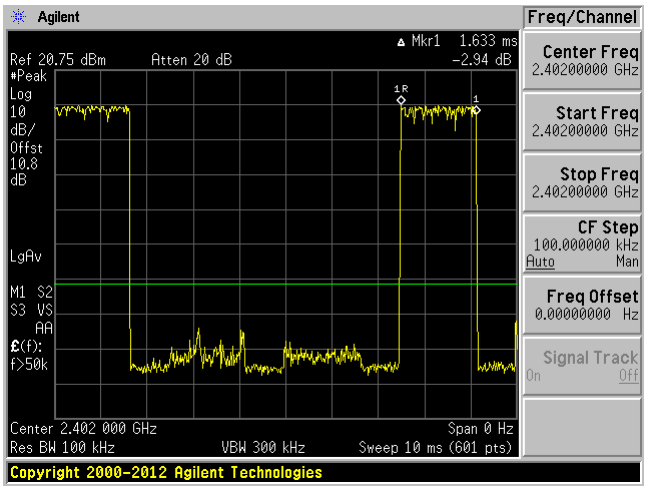


High Channel 2480 MHz

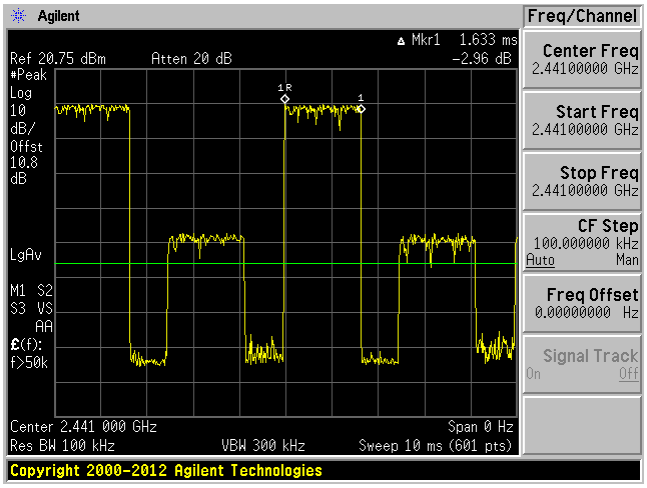


GFSK, DH3 Pulse Width

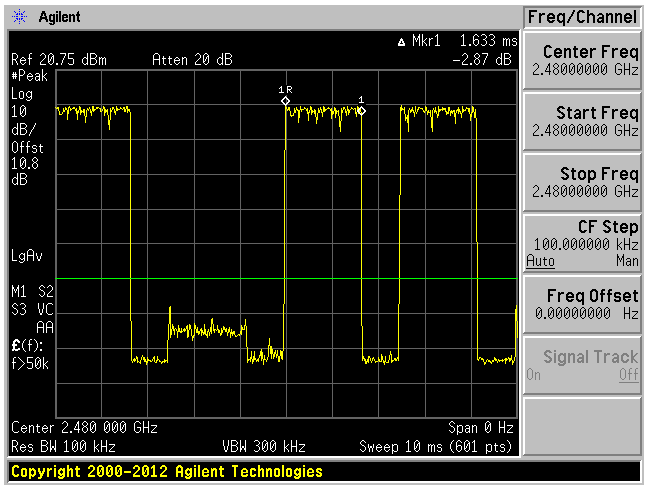
Low Channel 2402 MHz



Middle Channel 2441 MHz

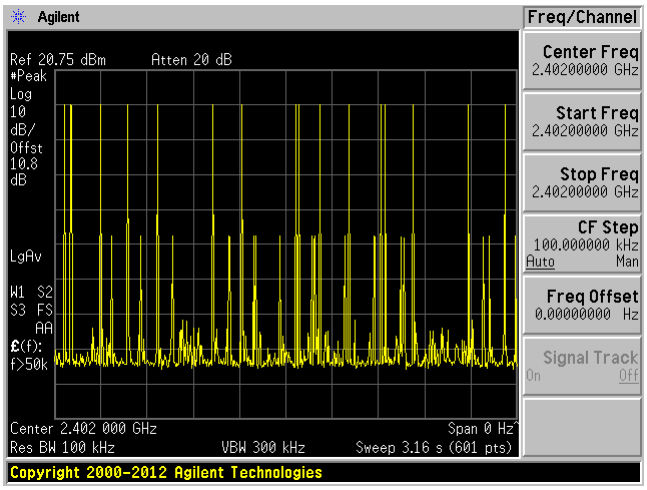


High Channel 2480 MHz

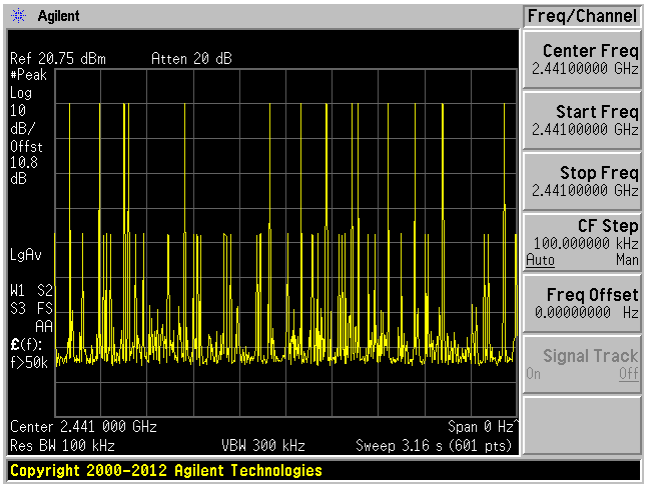


GFSK, DH3 Number of Pulses within a Specified Time

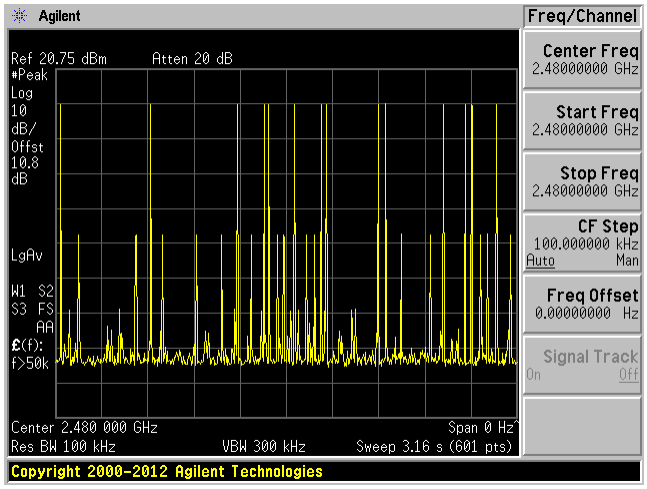
Low Channel 2402 MHz



Middle Channel 2441 MHz

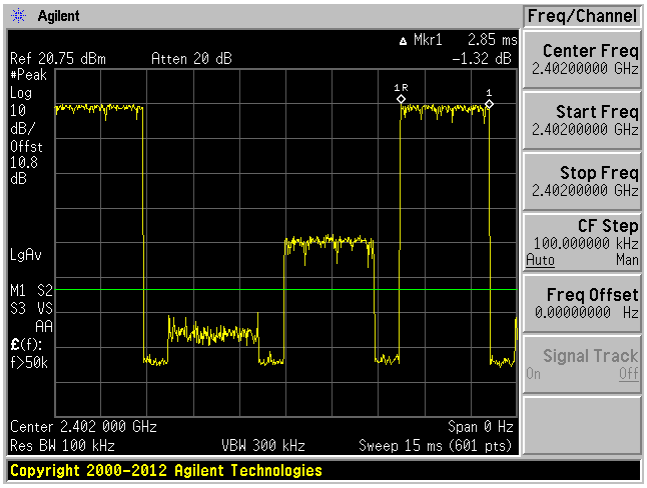


High Channel 2480 MHz

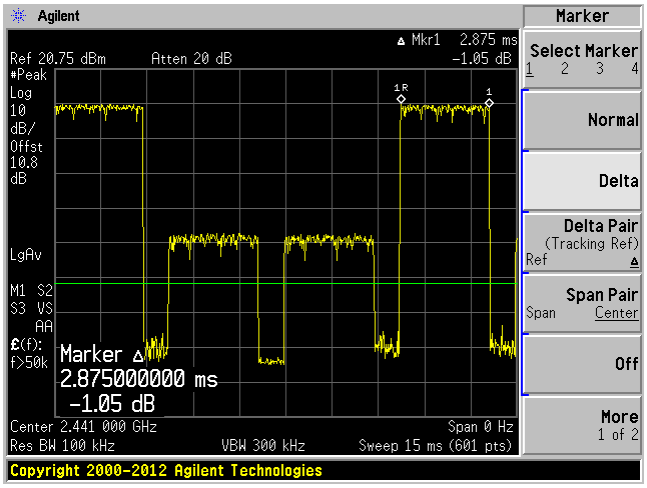


GFSK, DH5 Pulse Width

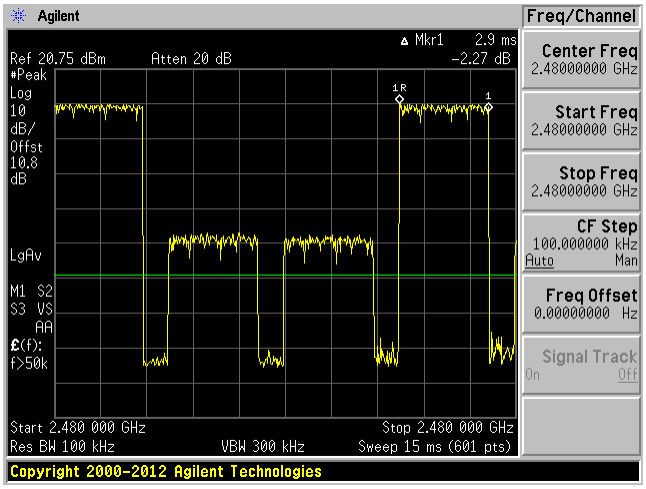
Low Channel 2402 MHz



Middle Channel 2441 MHz

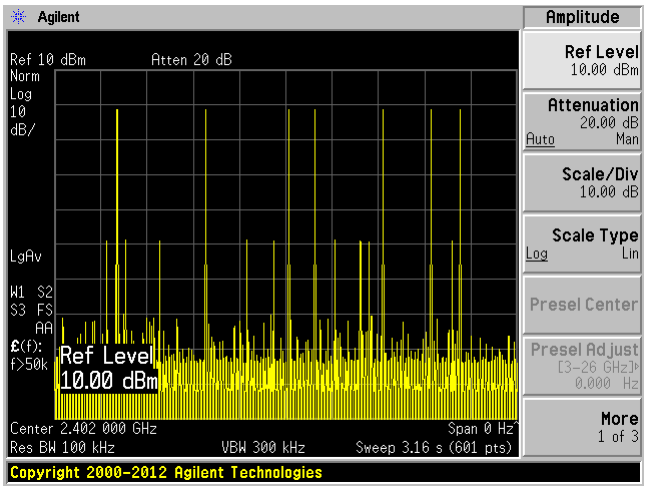


High Channel 2480 MHz

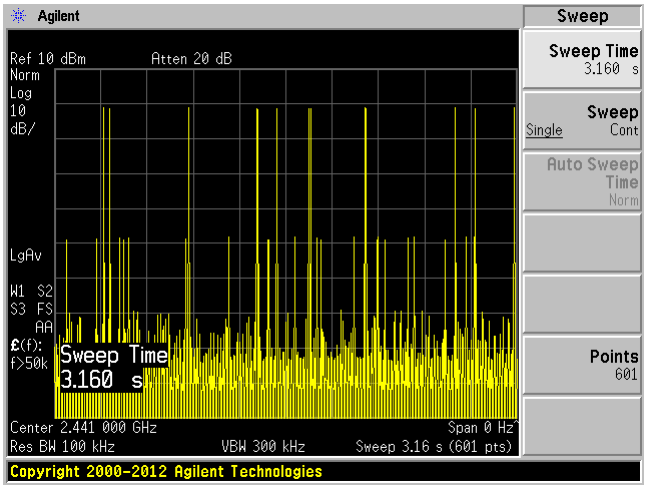


GFSK, DH5 Number of Pulses within a Specified Time

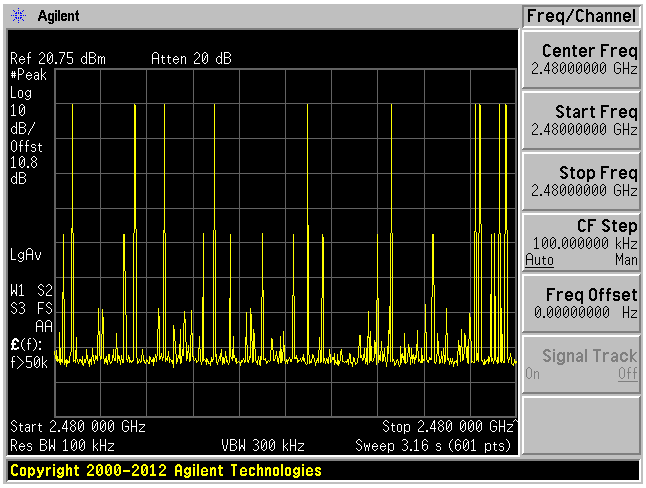
Low Channel 2402 MHz



Middle Channel 2441 MHz

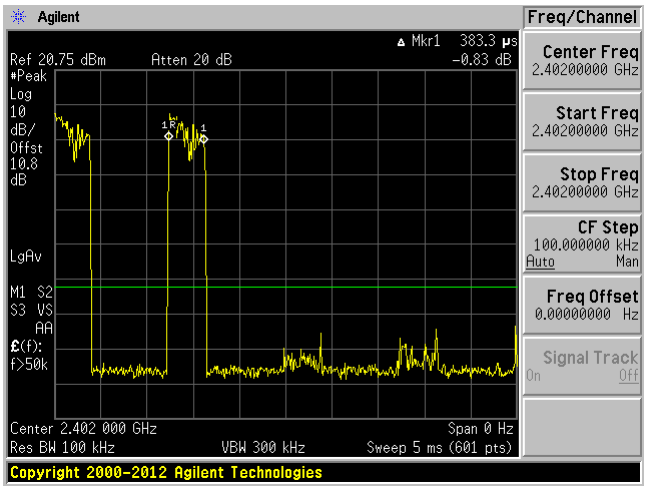


High Channel 2480 MHz

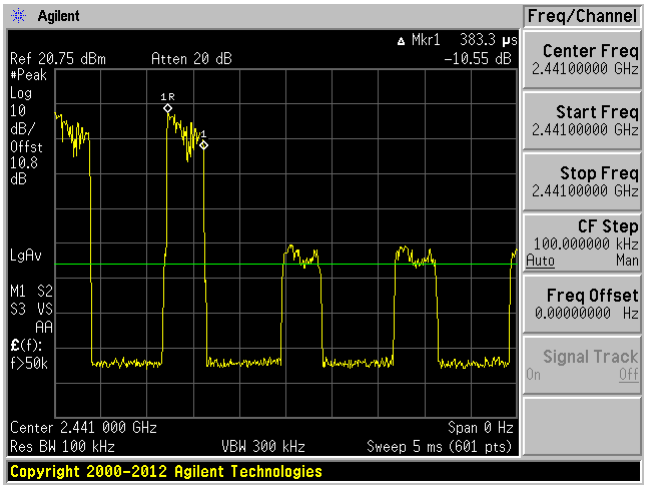


π/4-DQPSK, DH1 Pulse Width

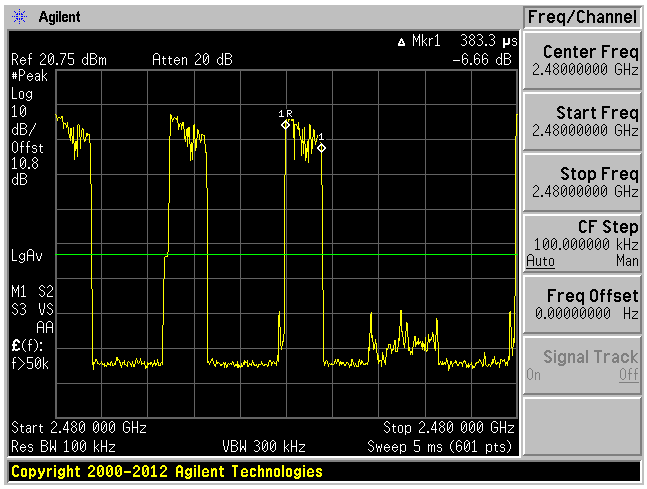
Low Channel 2402 MHz



Middle Channel 2441 MHz

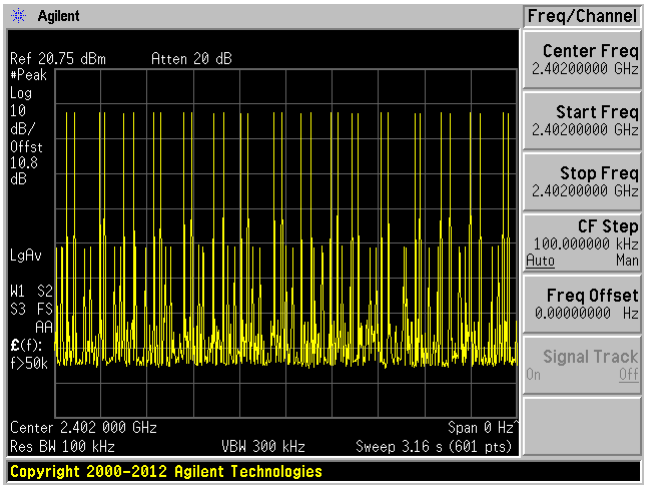


High Channel 2480 MHz

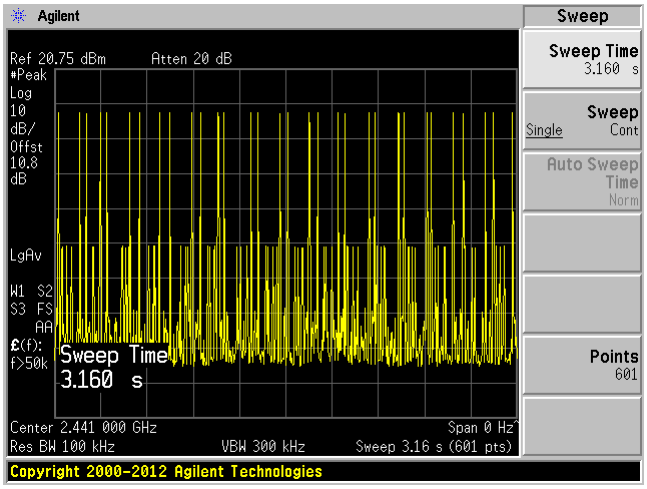


π/4-DQPSK, DH1 Number of Pulses within a Specified Time

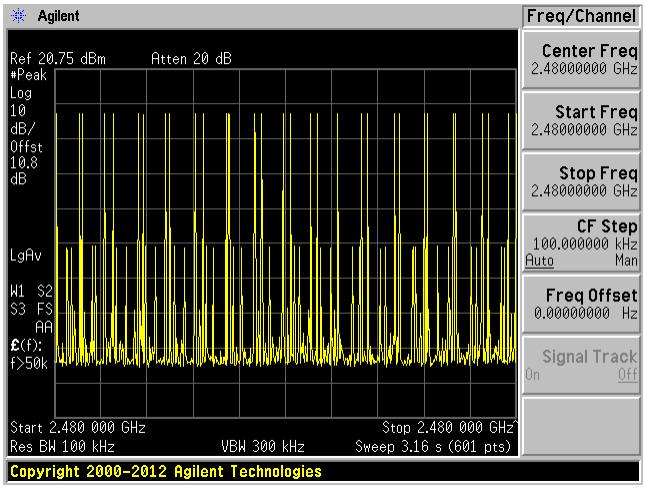
Low Channel 2402 MHz



Middle Channel 2441 MHz

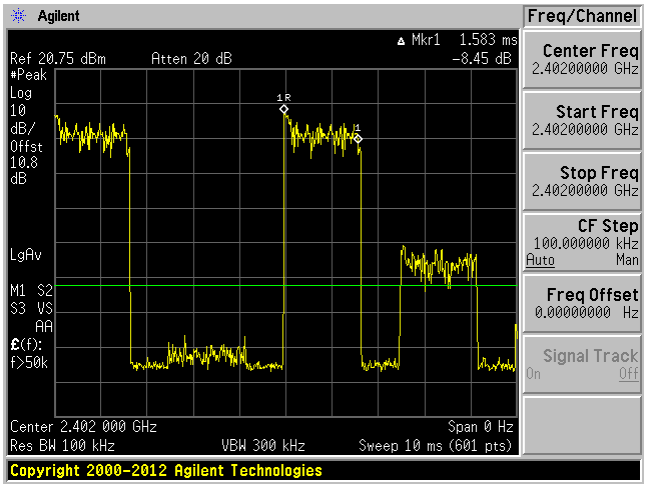


High Channel 2480 MHz

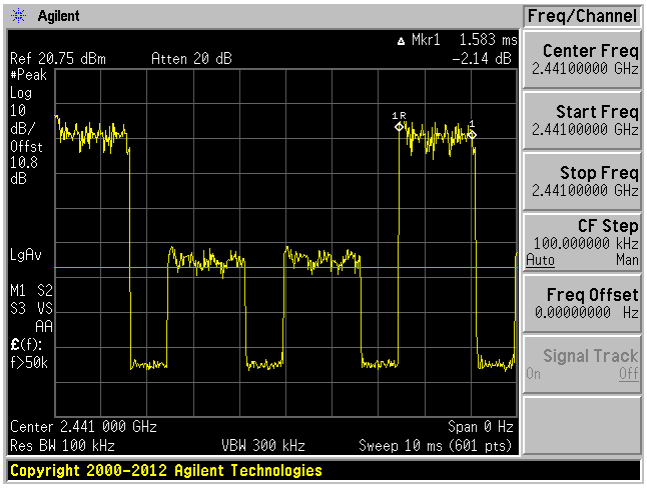


π/4-DQPSK, DH3 Pulse Width

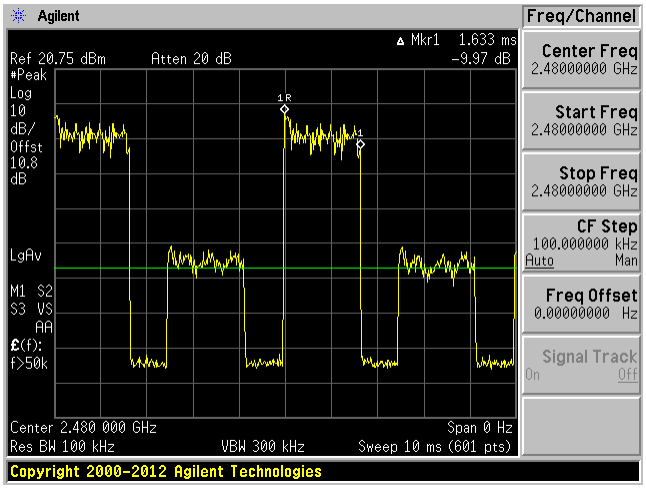
Low Channel 2402 MHz



Middle Channel 2441 MHz

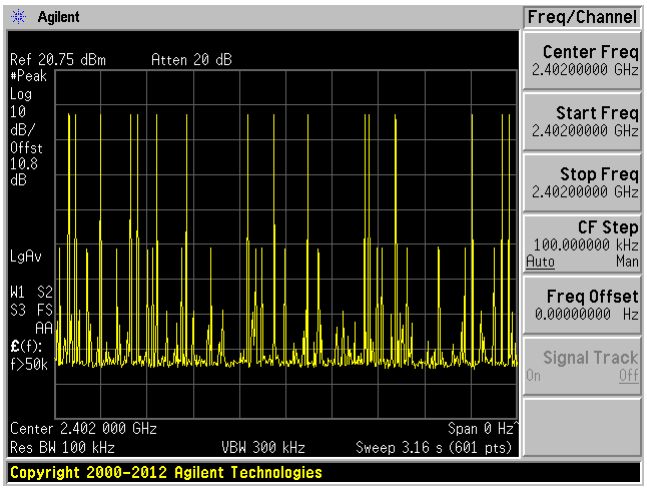


High Channel 2480 MHz

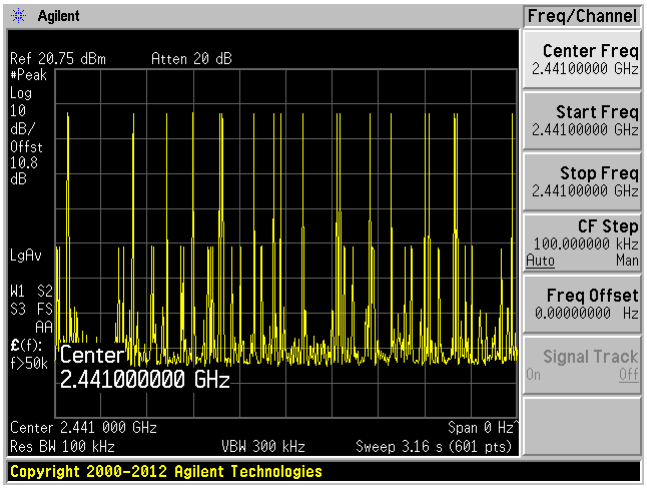


π/4-DQPSK, DH3 Number of Pulses within a Specified Time

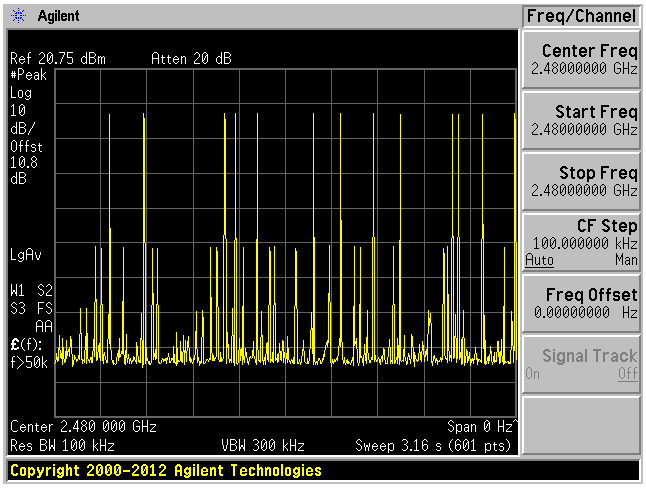
Low Channel 2402 MHz



Middle Channel 2441 MHz

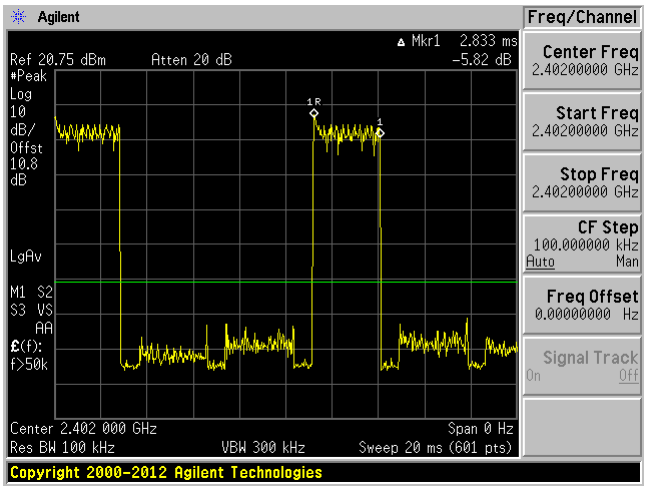


High Channel 2480 MHz

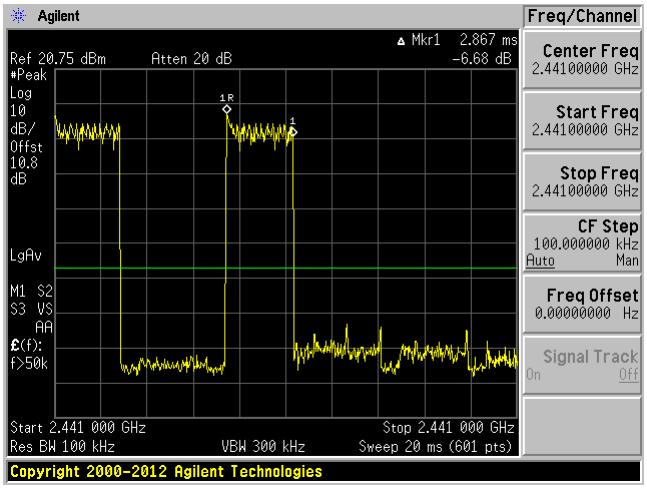


π/4-DQPSK, DH5 Pulse Width

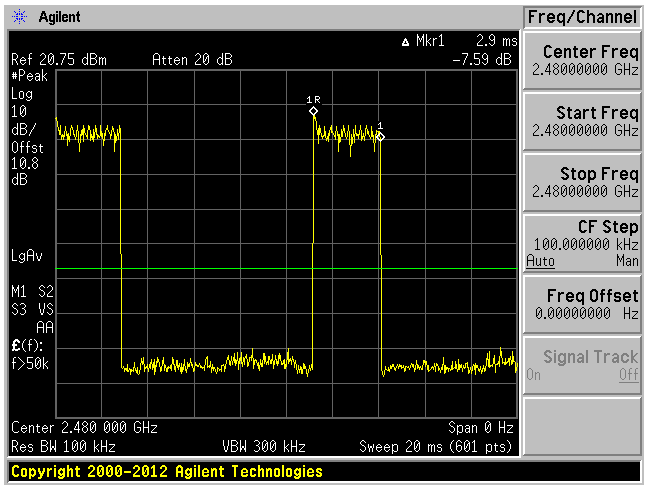
Low Channel 2402 MHz



Middle Channel 2441 MHz

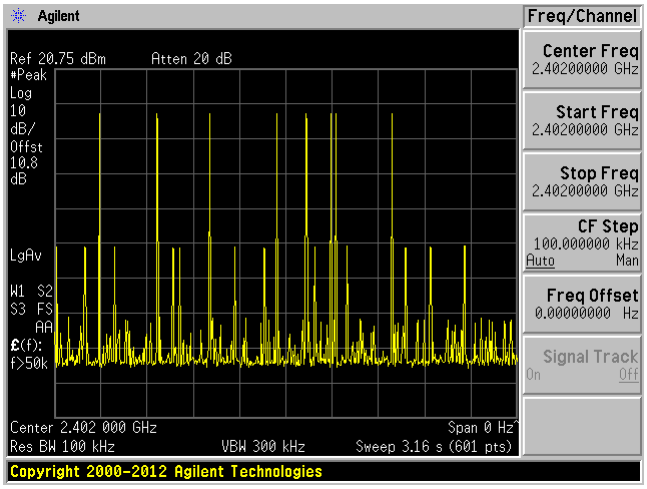


High Channel 2480 MHz

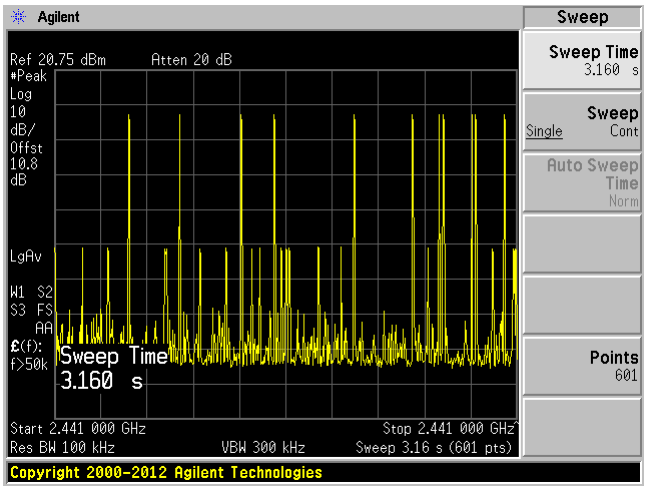


π/4-DQPSK, DH5 Number of Pulses within a Specified Time

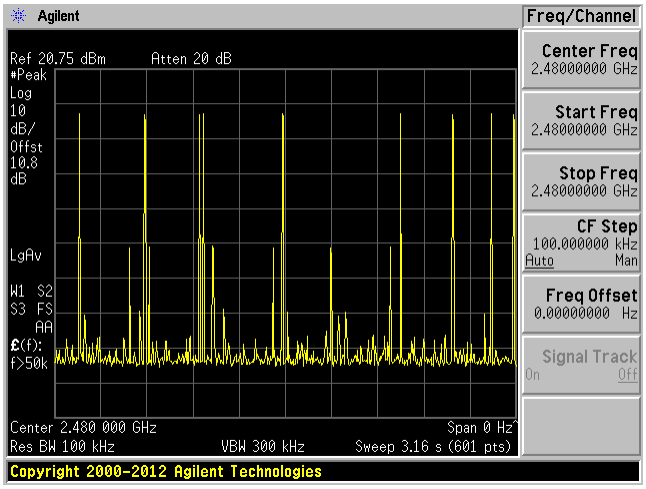
Low Channel 2402 MHz



Middle Channel 2441 MHz

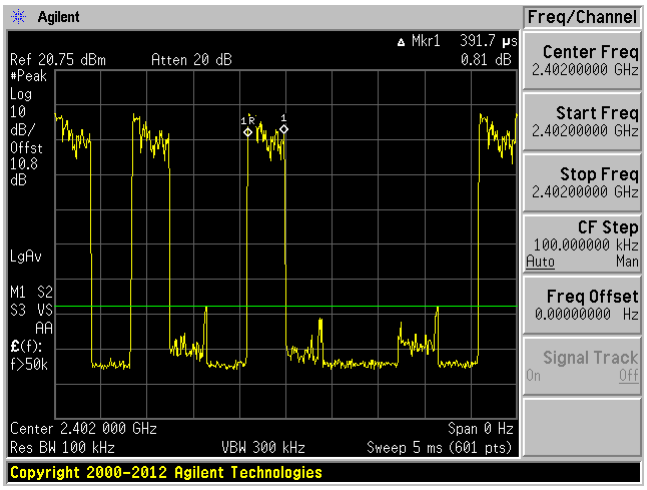


High Channel 2480 MHz

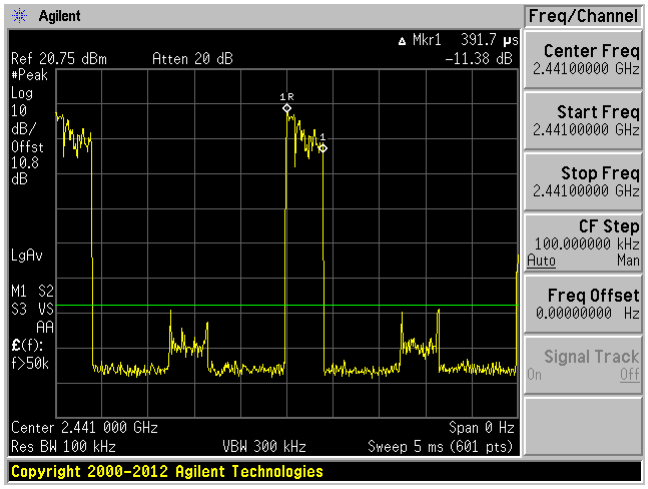


8DPSK, DH1 Pulse Width

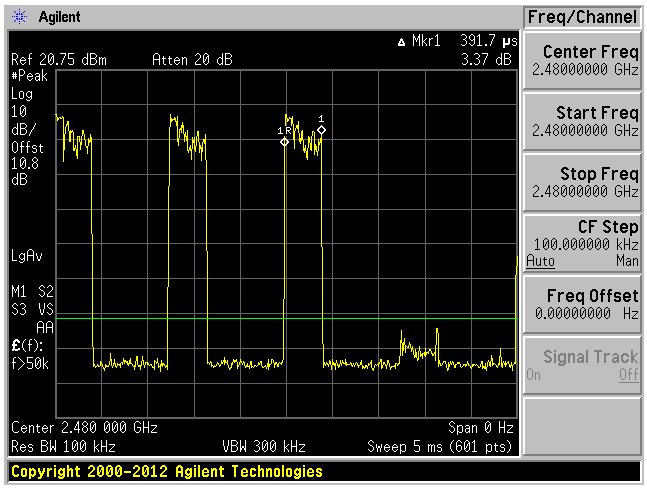
Low Channel 2402 MHz



Middle Channel 2441 MHz

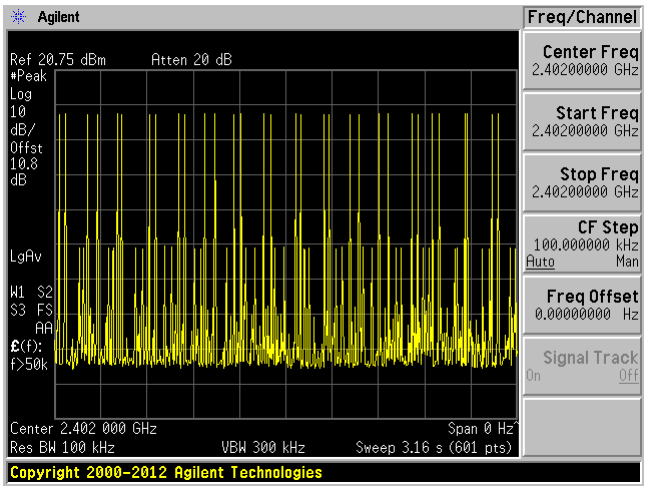


High Channel 2480 MHz

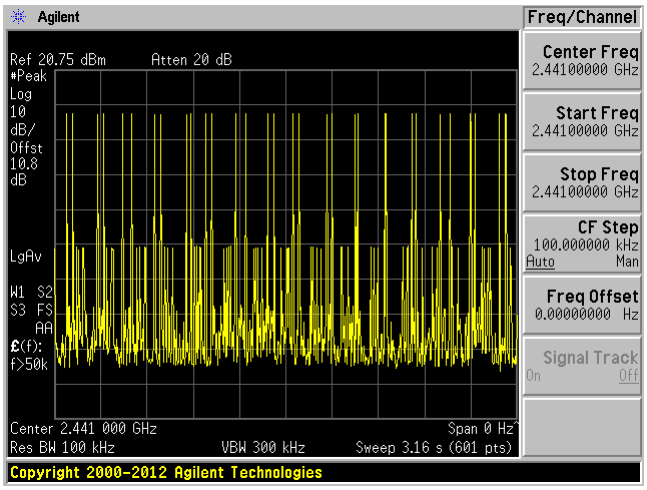


8DPSK, DH1 Number of Pulses within a Specified Time

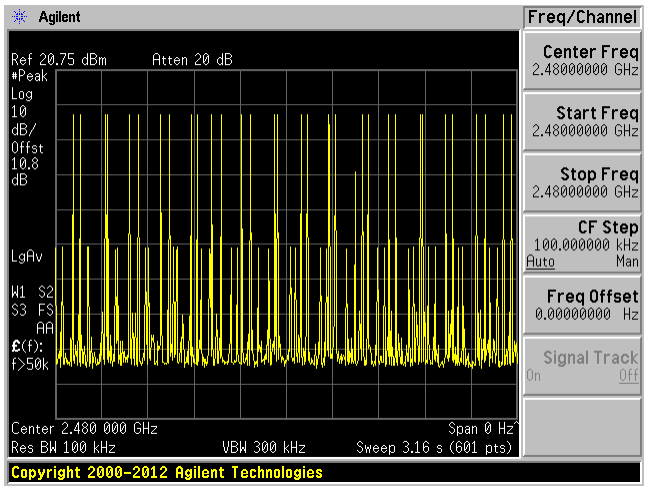
Low Channel 2402 MHz



Middle Channel 2441 MHz

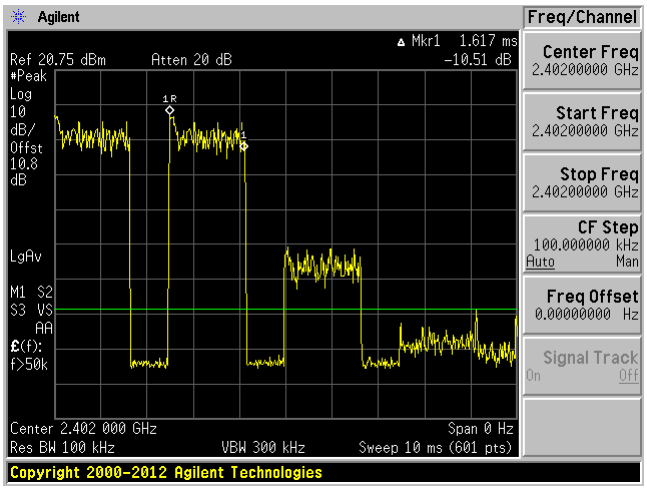


High Channel 2480 MHz

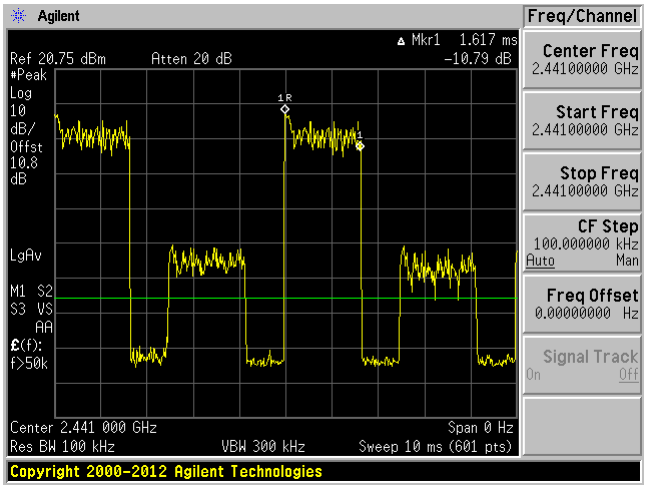


8DPSK, DH3 Pulse Width

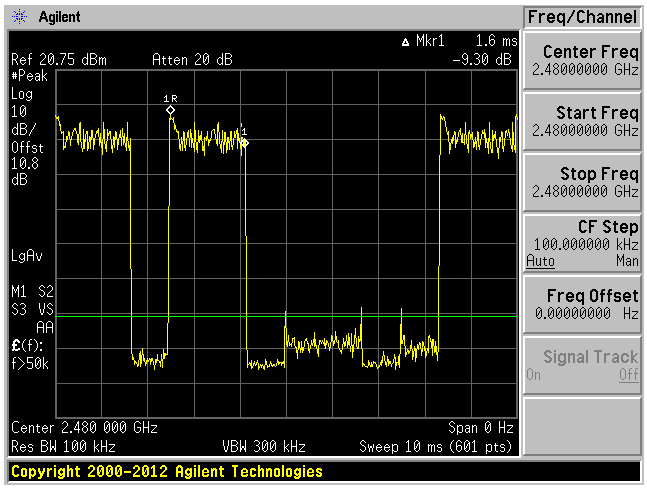
Low Channel 2402 MHz



Middle Channel 2441 MHz

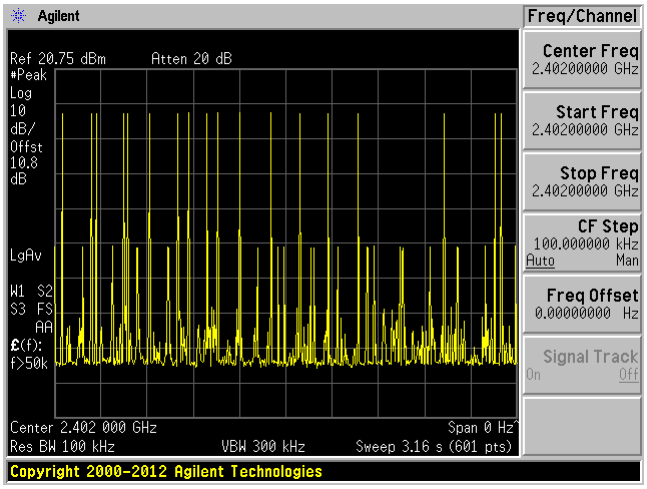


High Channel 2480 MHz

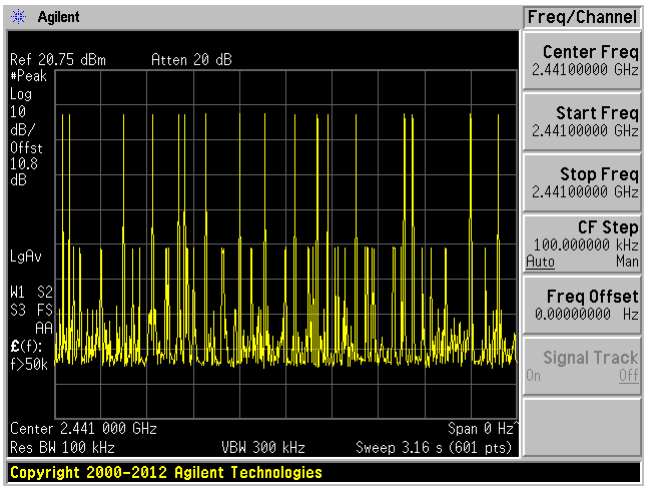


8DPSK, DH3 Number of Pulses within a Specified Time

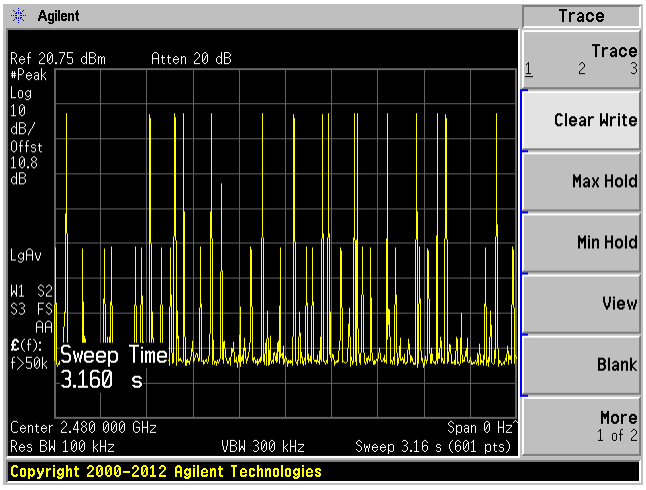
Low Channel 2402 MHz



Middle Channel 2441 MHz

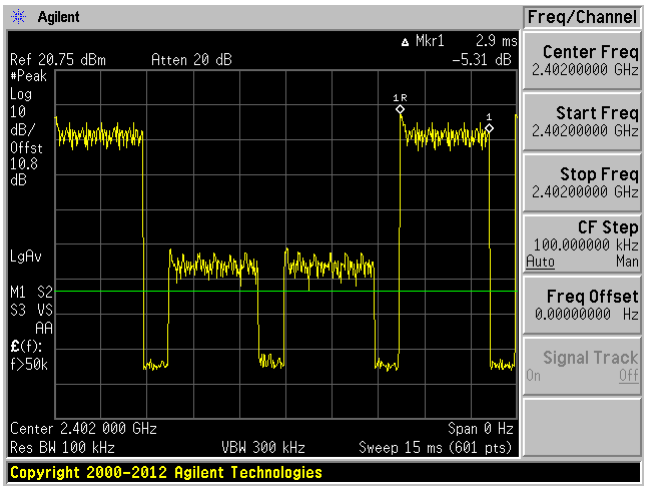


High Channel 2480 MHz

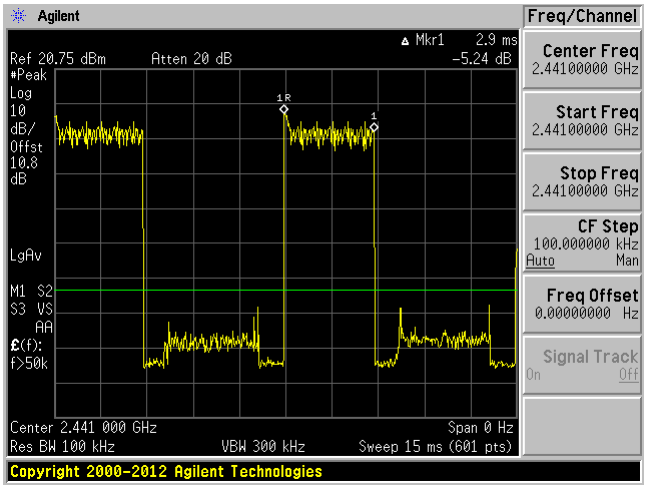


8DPSK, DH5 Pulse Width

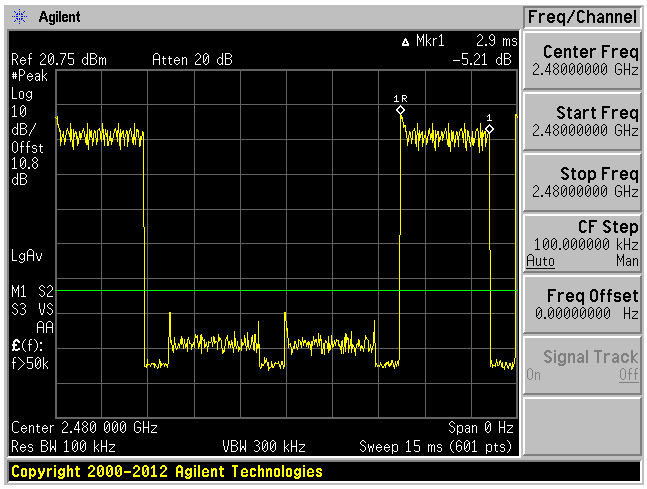
Low Channel 2402 MHz



Middle Channel 2441 MHz

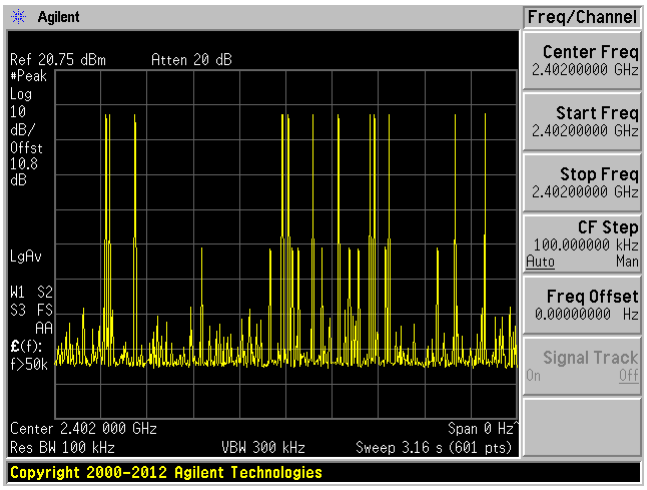


High Channel 2480 MHz

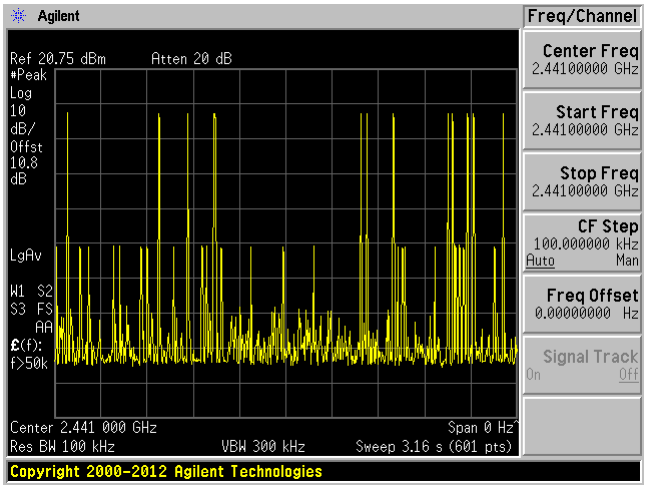


8DPSK, DH5 Number of Pulses within a Specified Time

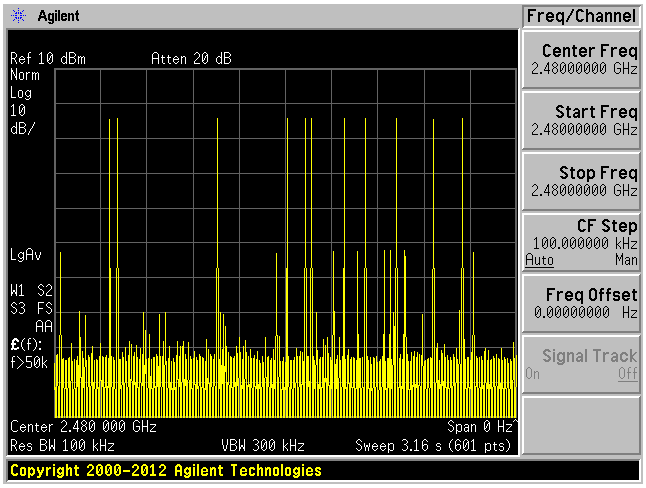
Low Channel 2402 MHz



Middle Channel 2441 MHz



High Channel 2480 MHz



12 FCC §15.247(a) (1)(iii) & ISED RSS-247 §5.1 (4) - Number of Hopping Channels

12.1 Applicable Standards

According to FCC §15.247(a) (1) (iii) and RSS-247 §5.1(4): 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.

12.2 Test Procedure

Span = the frequency band of operation

RBW < 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

12.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10dB attenuator	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

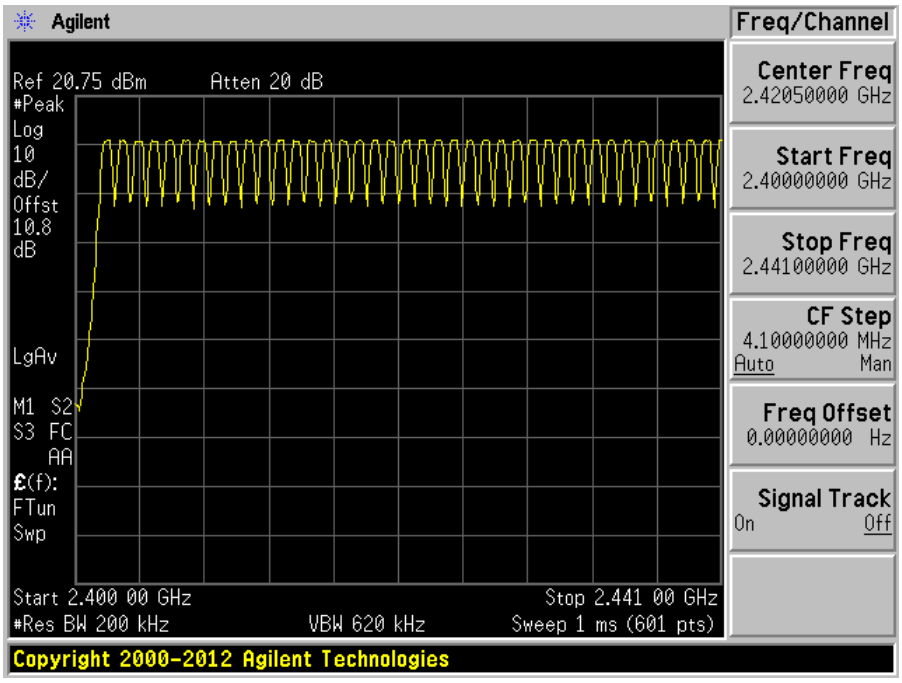
12.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-30
Test Site:	RF Site
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.5 kPa
Test Personnel:	Xiao Lin

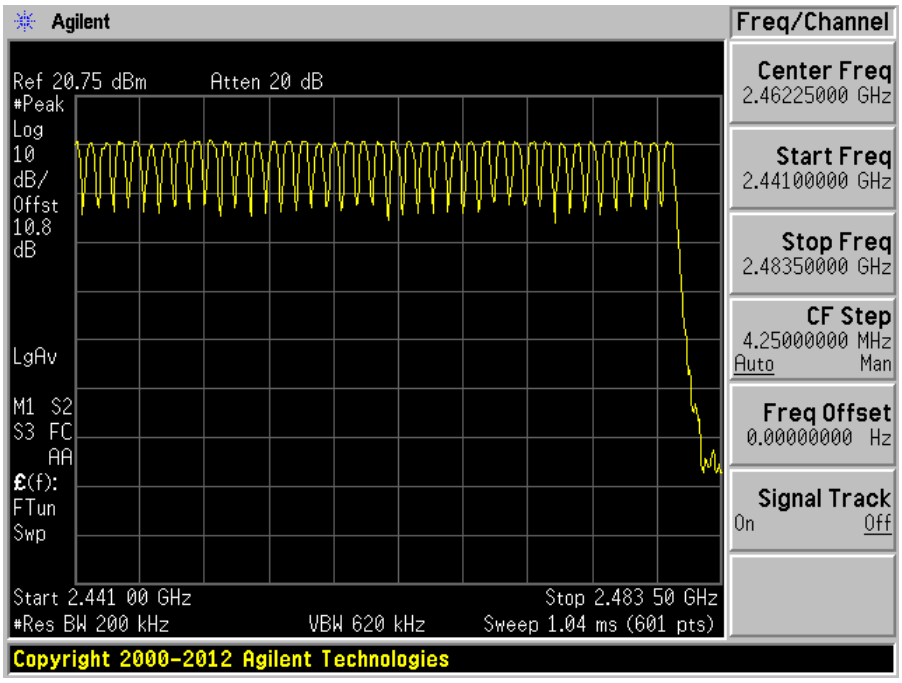
12.5 Test Results

Total 79 channels; please refer to the plots hereinafter.

40 Channels between 2400 to 2441 MHz



39 Channels between 2441 to 2483.5 MHz



13 FCC §15.247(a) (1) & ISED RSS-247 §5.1 (2) - Hopping Channel Separation

13.1 Applicable Standards

According to FCC §15.247(a) (1) and RSS-247 §5.1(2): 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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

13.2 Test Procedure

Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≈ 30% of the channel spacing, adjust as necessary to best identify the center of each individual channel

Video (or Average) Bandwidth (VBW) ≥RBW
Sweep = auto
Detector function = peak
Trace = max hold

13.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10dB attenuator	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

13.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-06-30
Test Site:	RF Site
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.5 kPa
Test Personnel:	Xiao Lin

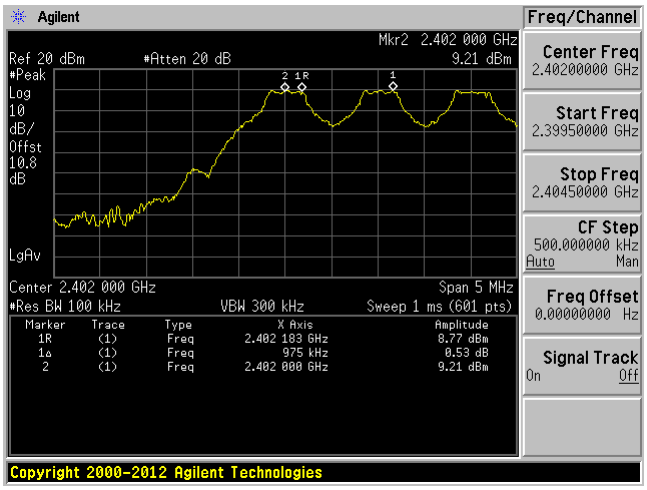
13.5 Test Results

Channel	Frequency (MHz)	Channel Separation (kHz)	Limit > 2/3 20 dB OBW (kHz)
GFSK			
Low	2402	975	557.44
Middle	2441	883	557.55
High	2480	1183	557.46
π/4-DQPSK			
Low	2402	1025	809.33
Middle	2441	1025	810.00
High	2480	1008	810.00
8DPSK			
Low	2402	1000	832
Middle	2441	983	794.67
High	2480	867	794.67

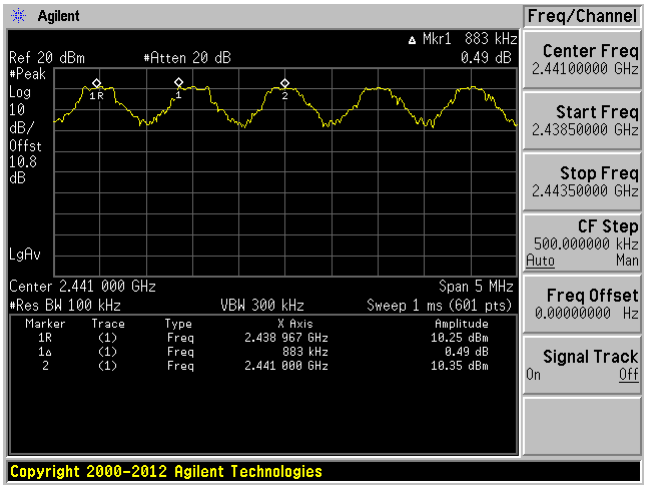
Please refer to following plots.

GFSK

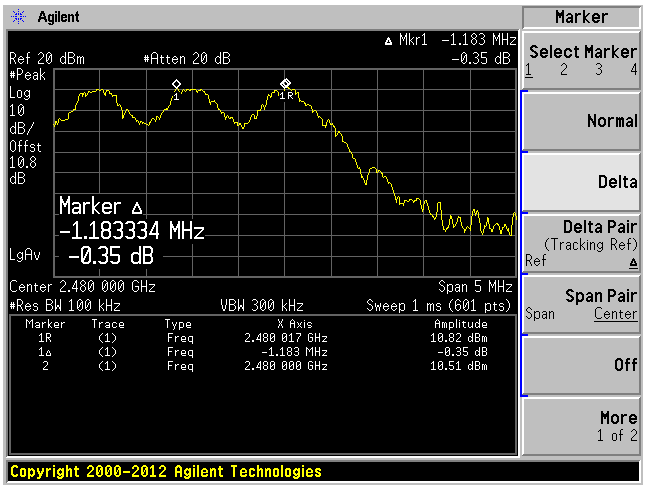
Low Channel 2402 MHz



Middle Channel 2441 MHz

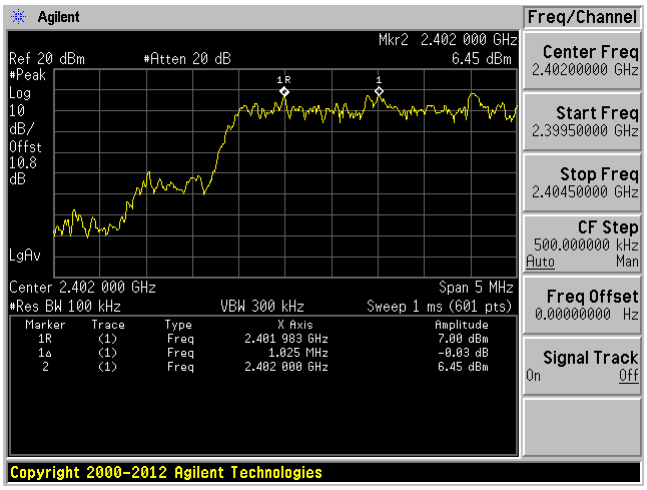


High Channel 2480 MHz

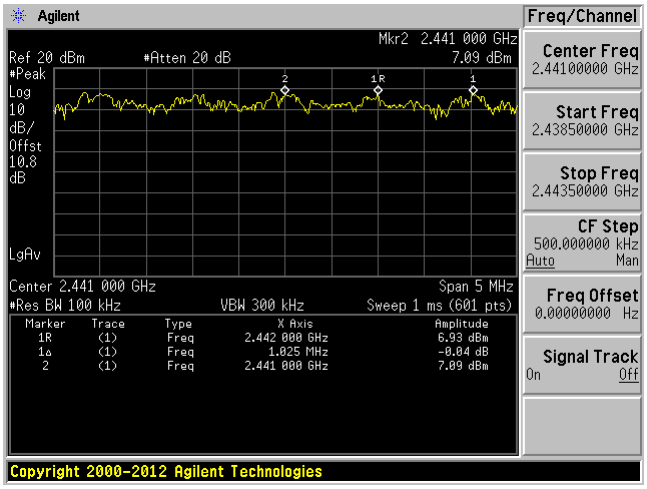


π/4-DQPSK

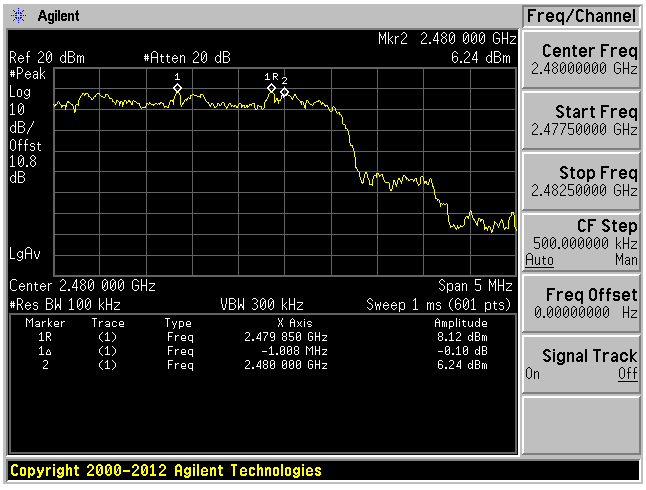
Low Channel 2402 MHz



Middle Channel 2441 MHz

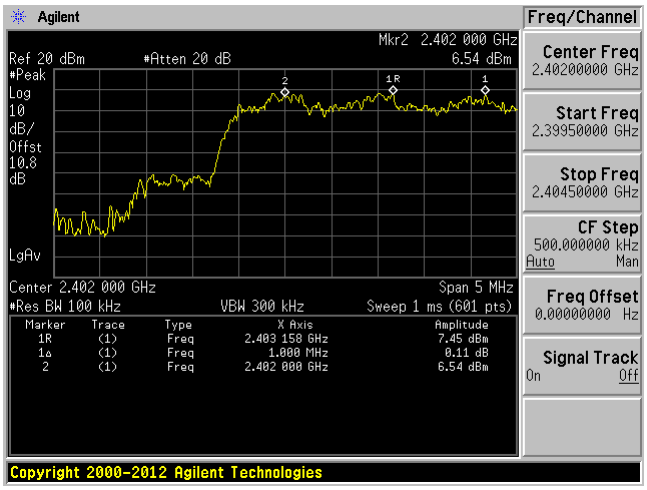


High Channel 2480 MHz

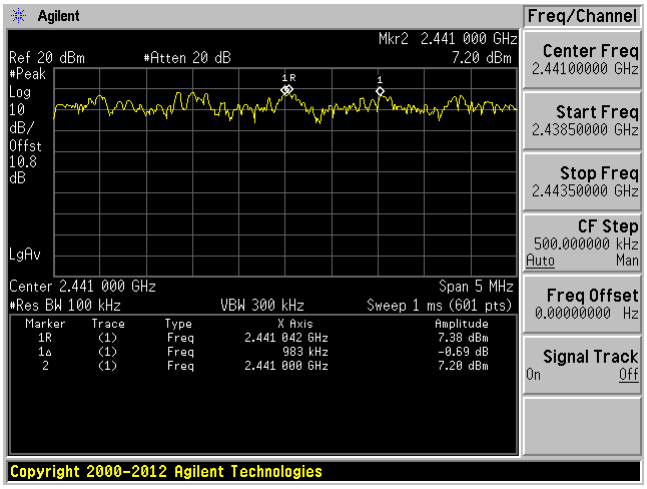


8DPSK

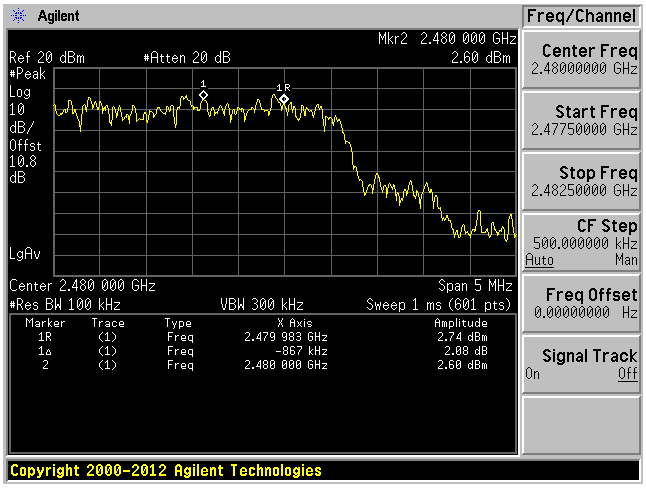
Low Channel 2402 MHz



Middle Channel 2441 MHz



High Channel 2480 MHz



14 FCC §15.247(d) & ISED RSS-247 §5.5 - Spurious Emissions at Antenna Terminals

14.1 Applicable Standards

For FCC §15.247(d) in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

As per IC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

14.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

14.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Cal. Date	Cal. Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A
-	-	10dB attenuator	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

14.4 Test Location, Date, Personnel and Environmental Conditions

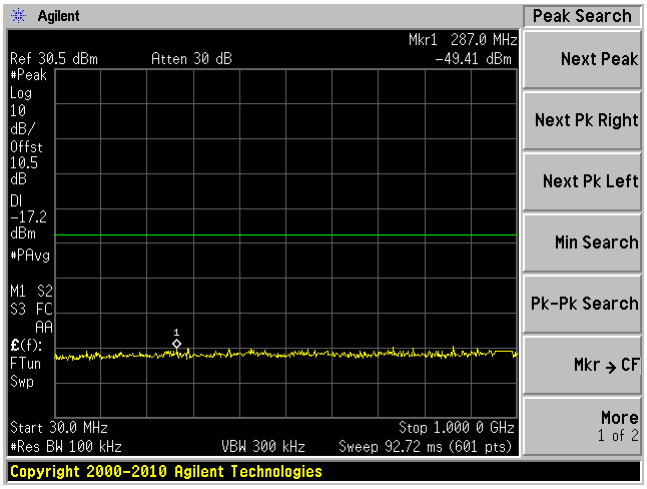
Test Date:	2016-06-30
Test Site:	RF Site
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.5 kPa
Test Personnel:	Xiao Lin

14.5 Test Results

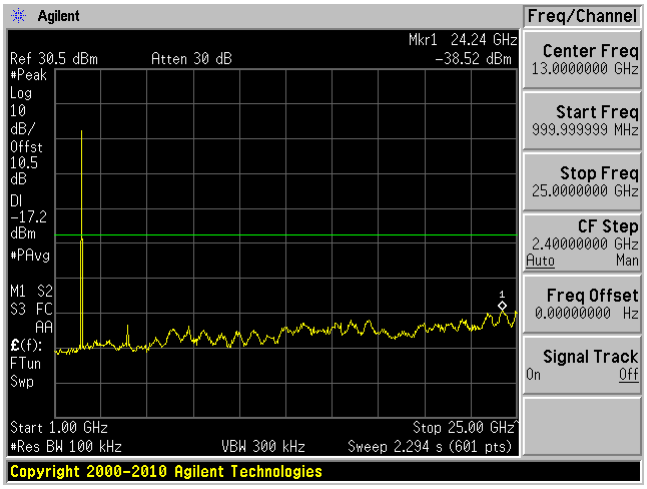
Please refer to following plots.

GFSK

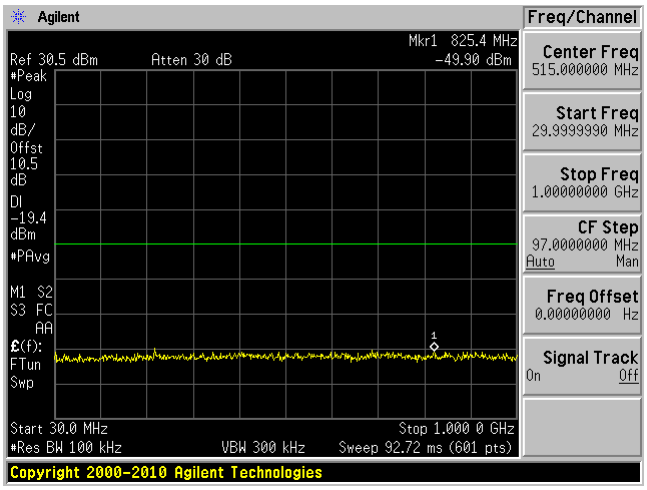
Low Channel 30 MHz – 1 GHz



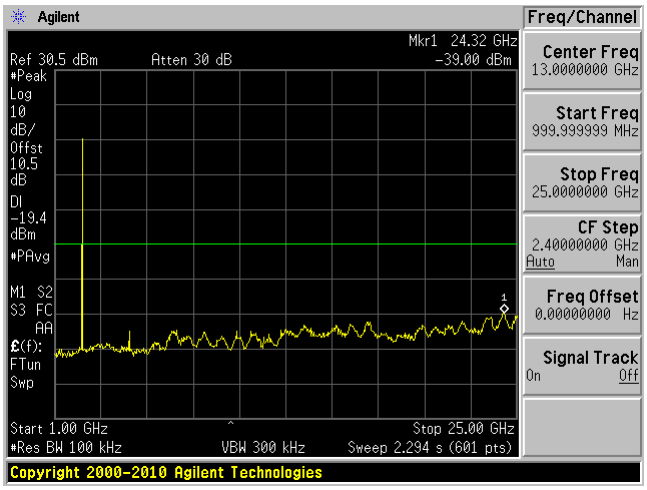
Low Channels 1GHz – 25 GHz



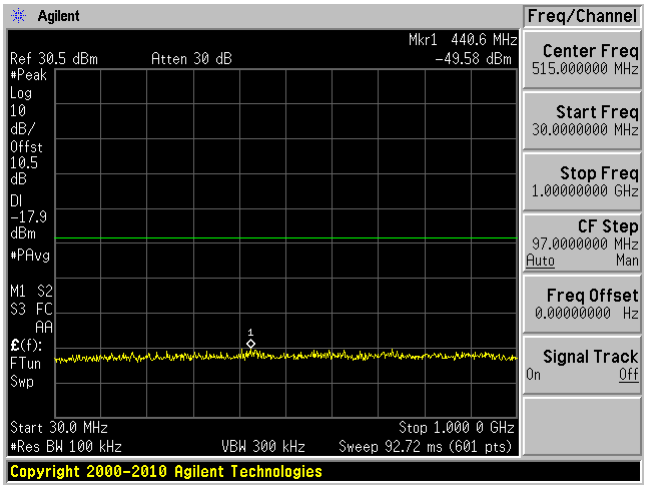
Middle Channel 30 MHz – 1 GHz



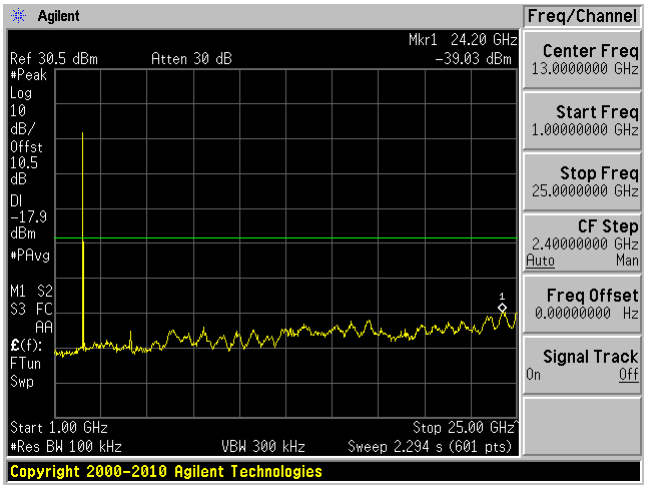
Middle Channels 1 GHz – 25 GHz



High Channel 30 MHz – 1 GHz

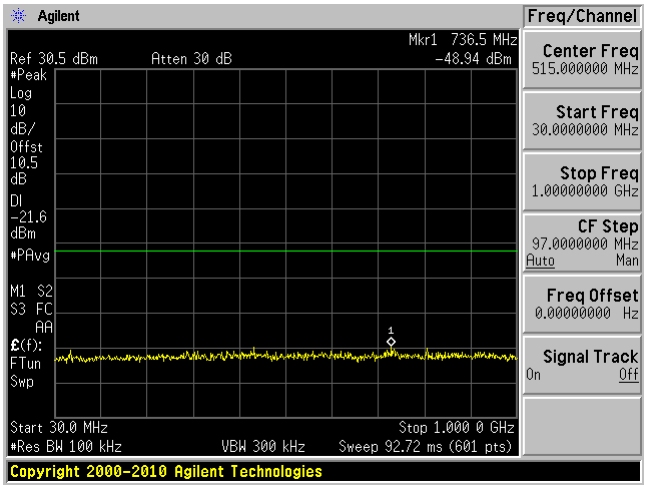


High Channels 1 GHz – 25 GHz

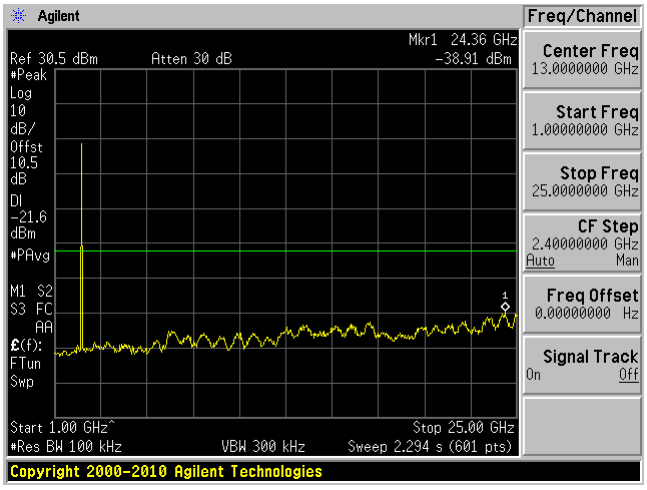


π/4-DQPSK

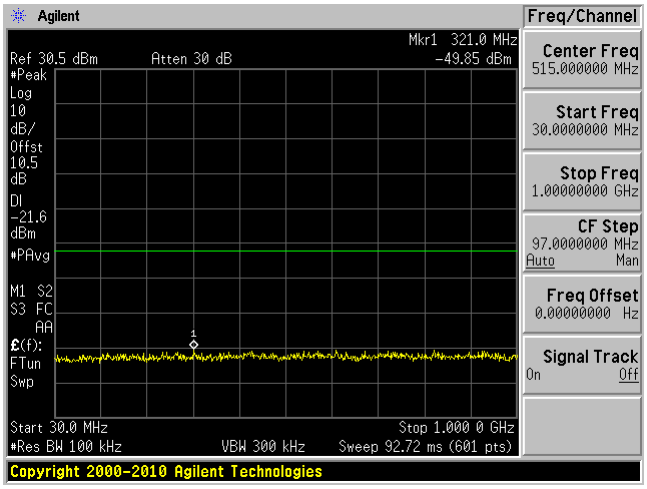
Low Channel 30 MHz – 1 GHz



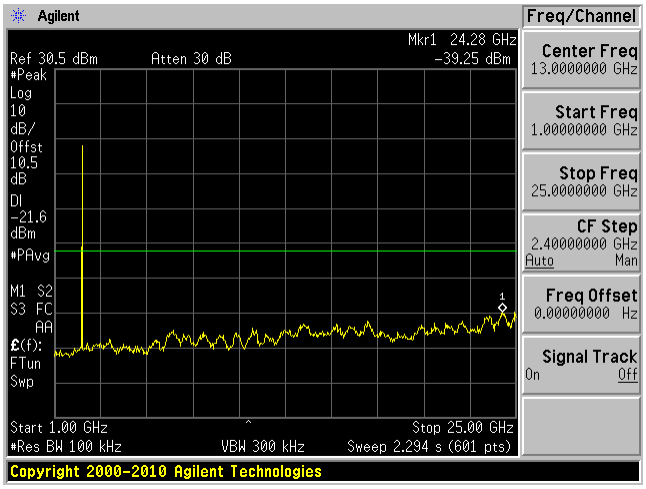
Low Channels 1 GHz – 25 GHz



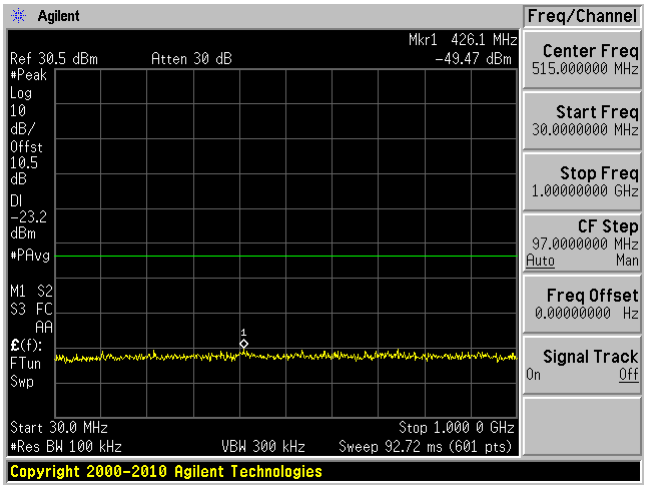
Middle Channel 30 MHz – 1 GHz



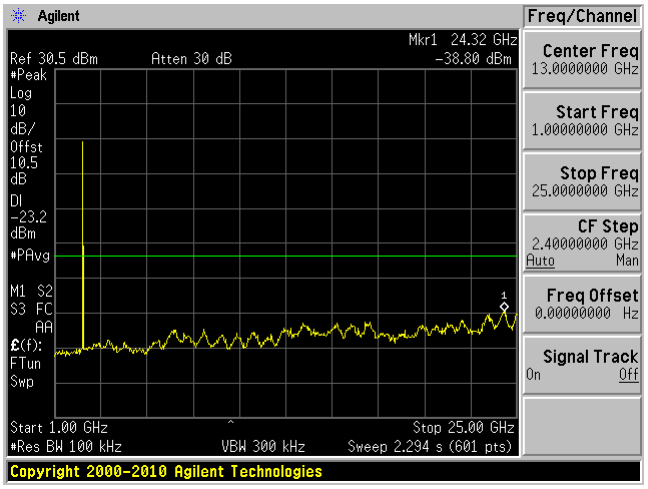
Middle Channels 1 GHz – 25 GHz



High Channel 30 MHz – 1 GHz

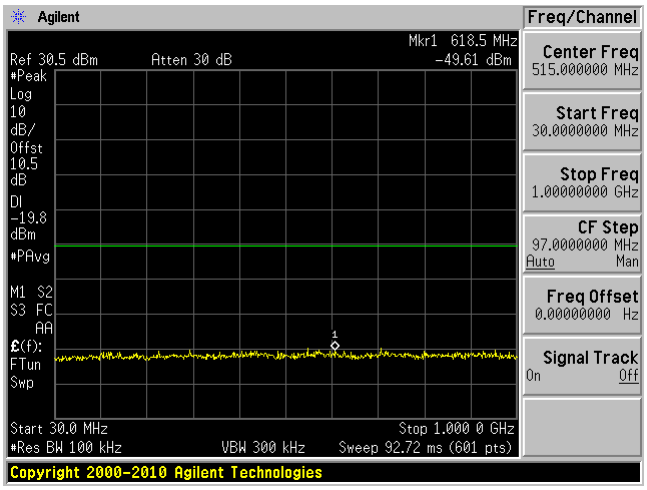


High Channels 1 GHz – 25 GHz

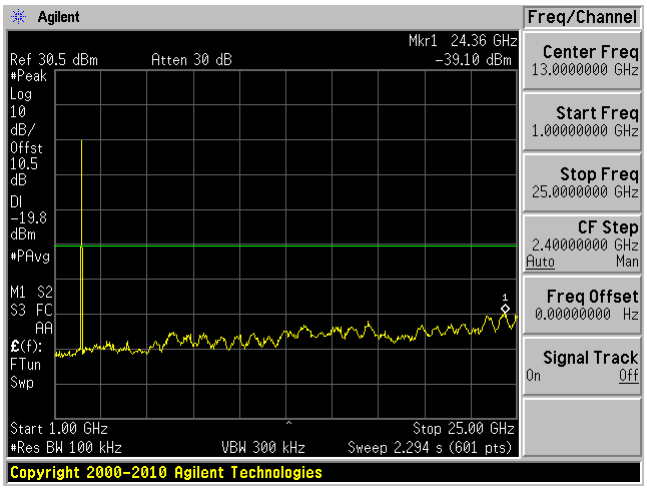


8DPSK

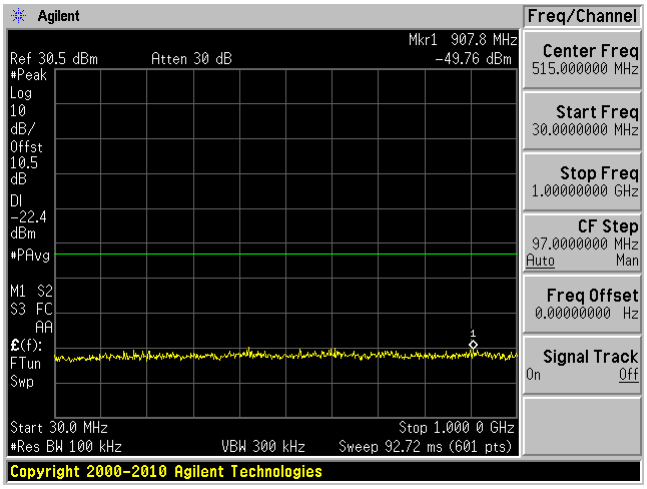
Low Channel 30 MHz –1 GHz



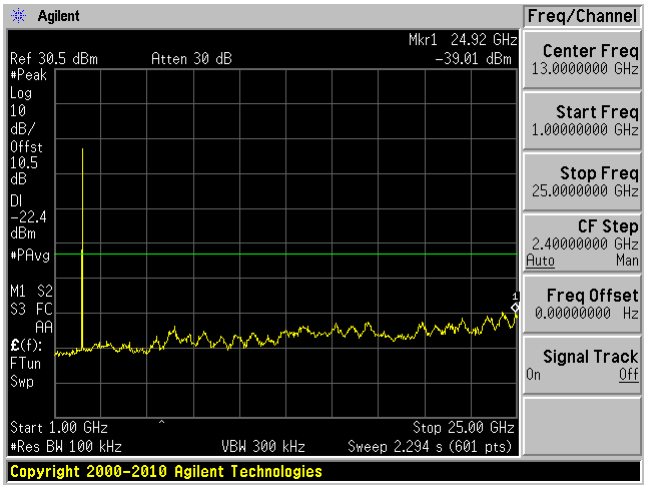
Low Channels 1 GHz – 25 GHz



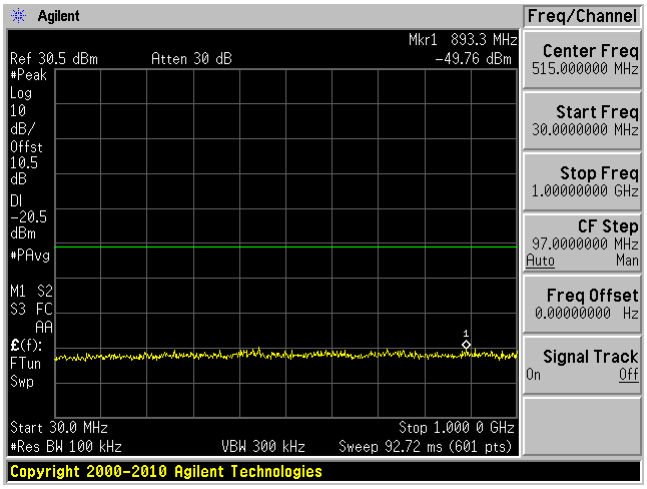
Middle Channel 30 MHz – 1 GHz



Middle Channels 1 GHz – 25 GHz



High Channel 30 MHz – 1 GHz



High Channels 1 GHz – 25 GHz