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

# TEST AND MEASUREMENT REPORT

For

## Intel Corporation

2200 Mission College Blvd.,

Santa Clara, CA 95054, USA

**FCC ID: 2AB8ZND18**
**IC: 1000X-ND18**

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Wearable Glasses |

| | |
|---|---|
| **Prepared By:** | Todd Moy<br>Test Engineer |
| **Report Number:** | R1604212-247 DSS |
| **Report Date:** | 2016-06-07 |
| **Reviewed By:** | Simon Ma<br>RF Lead |

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# TABLE OF CONTENTS

# DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|---|---|---|---|
| 0 | R1604212-247 DSS | Original Report | 2016-06-07 |

# 1 General Description

## 1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Intel Corporation*, and their product model: *Radar Pace,* FCC ID: 2AB8ZND18; IC: 1000X-ND18 or the "EUT" as referred to in this report. The EUT are wearable glasses with Bluetooth, Bluetooth Low Energy, and ANT+ capabilities.

## 1.2 Mechanical Description of EUT

The EUT measures approximately 140 mm (L) x 150 mm (W) x 53 mm (H) and weight 50 g.

*The test data gathered are from typical production sample, serial number: FC5960FZ6030038-L assigned by Intel Corporation.*

## 1.3 Objective

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

The objective is to determine compliance with FCC Part 15.247 and ISED 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.

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

FCC Part 15, Subpart C, Equipment DTS with FCC ID: 2AB8ZND18
FCC Part 15, Subpart C, Equipment DXX with FCC ID: 2AB8ZND18

## 1.5 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.

## 1.6 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.

Based on CISPR16-4-2:2011, The Treatment of Uncertainty in EMC Measurements, the values ranging from $\pm$2.0 dB for Conducted Emissions tests and $\pm$4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

## 1.7 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:
1- An independent Commercial Test Laboratory accredited to ISO 17025: 2005 by A2LA, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminares and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea ( Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to ISO 17065: 2012 by A2LA to certify:
2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.
3. Radio Communication Equipment for Singapore.
4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.
5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).
6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s),Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997, and Article 8 of the VCCI regulations on December 25, 1997. The test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.10-2013, ANSI C63.4-2014, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b

# 2 System Test Configuration

## 2.1 Justification

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

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 Tera Term*;* the software was verified by *Todd Moy* 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:

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

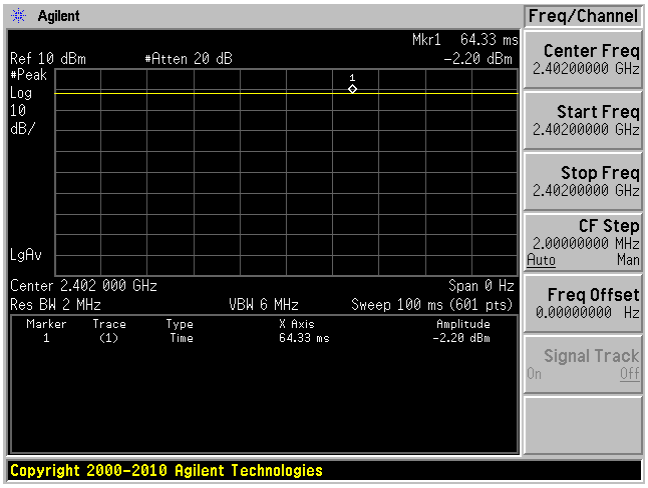
where
$\delta$ is the duty cycle correction factor (dB)
$\Delta$ is the duty cycle (dimensionless)

| Radio Mode | On Time (µs) | Period (µs) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) |
|---|---|---|---|---|
| GFSK | - | - | 100 | 0 |
| π/4-DQPSK | - | - | 100 | 0 |
| 8DPSK | - | - | 100 | 0 |

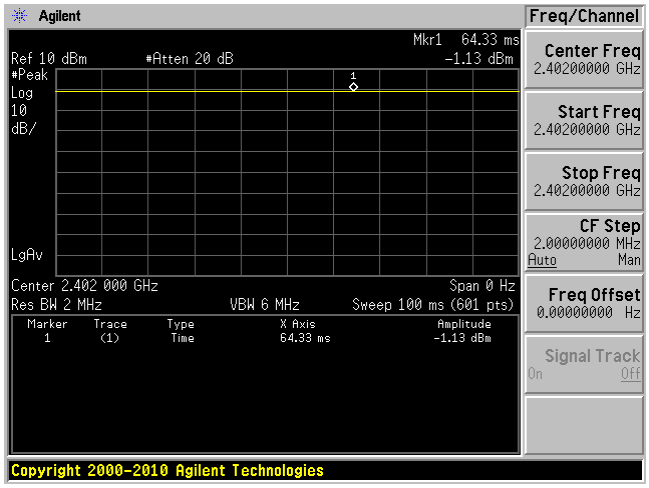
Duty Cycle = On Time (ms)/ Period (ms)

Please refer to the following plots.

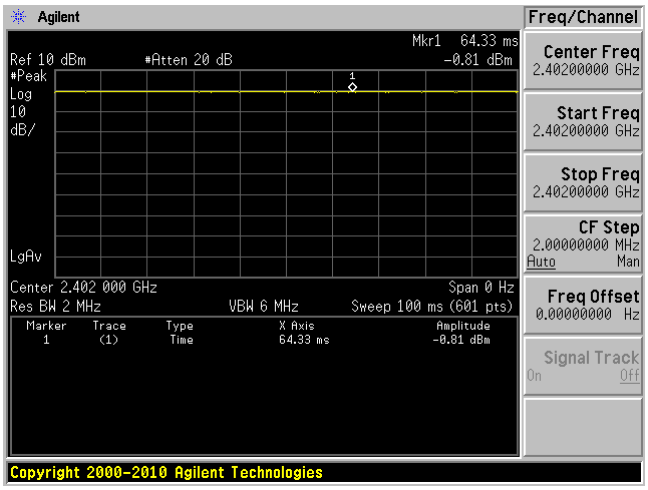
GFSK Mode




π/4-DQPSK Mode




8DPSK Mode



### 2.4 Equipment Modifications

SMA cables were connected to the output trace of the Bluetooth and ANT+ circuits.

## 2.5 Local Support Equipment

| Manufacturer | Description | Model |
|---|---|---|
| Dell | Laptop | Latitude D630 |

### 2.6 EUT Internal Configuration Details

| Manufacturer | Description | Model |
|---|---|---|
| Intel | Main Board | Radar Pace |

### 2.7 Support Equipment

| Manufacturer | Description | Model |
|---|---|---|
| Intel | USB to UART Driver | H81964-001 |

## 2.8 Interface Ports and Cabling

| Cable Description | Length (m) | To | From |
|---|---|---|---|
| USB Cable | < 1 m | Laptop | EUT |
| SMA Pigtails | < 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<br>ISED RSS-Gen §8.3 | Antenna Requirement | Compliant |
| FCC §15.207<br>ISED RSS-Gen §8.8 | AC Line Conducted Emissions | Compliant |
| FCC §2.1093, §15.247(i)<br>ISED RSS-102 | RF Exposure | Compliant |
| FCC §2.1051, §15.247 (d)<br>ISED RSS-247 §5.5 | Spurious Emissions at Antenna Port | Compliant |
| FCC §2.1053, §15.205, §15.209, §15.247(d)<br>ISED RSS-247 §5.5<br>RSS-Gen §8.9, §8.10 | Radiated Spurious Emissions | Compliant |
| FCC §15.247(a)(1)<br>ISED RSS-247 §5.1 (1) | 20 dB & 99% Emission Bandwidth | Compliant |
| FCC §15.247(b)(1)<br>ISED RSS-247 §5.1(2) | Maximum Peak Output Power | Compliant |
| FCC §15.247(d)<br>ISED RSS-247 §5.5 | 100 kHz Bandwidth of Frequency Band Edge | Compliant |
| FCC §15.247(a)(1)(iii)<br>ISED RSS-247 §5.1(4) | Number of Hopping Channels | Compliant |
| FCC §15.247(a)(1)<br>ISED RSS-247 §5.1 (2) | Hopping Channel Separation | Compliant |
| FCC §15.247(a)(1)(iii)<br>ISED RSS-247 §5.1 (4) | Dwell Time | Compliant |

# 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 ISED 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 permanently attached antennas.

| Radio | Maximum Antenna Gain (dBi) @ 2.4GHz |
|---|---|
| Bluetooth | -1.2 |
| ANT+ | -1.2 |

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

## 5.1 Applicable Standards

According to FCC KDB 447498 D01 General RF Exposure Guidance v05r02 Section 4.3.1, Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition, listed below, is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander (see 5) of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops & tablets etc.

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

   [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

   • f(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
   • 3.0 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 ≤ 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.

2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B:

   a) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·( f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

3) At frequencies below 100 MHz, the following may be considered for SAR test exclusion, and as illustrated in Appendix C:

   a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by [1 + log(100/f(MHz))] for test separation distances > 50 mm and < 200 mm
   b) The power threshold determined by the equation in a) for 50 mm and 100 MHz is multiplied by ½ for test separation distances ≤ 50 mm
   c) SAR measurement procedures are not established below 100 MHz. When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any test results to be acceptable.

According to ISED RSS-102 Issue 5 §2.5.1,

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance

| Frequency (MHz) | Exemption Limits (mW) | | | | |
|---|---|---|---|---|---|
| | At separation distance of ≤ 5 mm | At separation distance of 10 mm | At separation distance of 15 mm | At separation distance of 20 mm | At separation distance of 25 mm |
| ≤ 300 | 71 | 101 | 132 | 162 | 193 |
| 450 | 52 | 70 | 88 | 106 | 123 |
| 835 | 17 | 30 | 42 | 55 | 67 |
| 1900 | 7 | 10 | 18 | 34 | 60 |
| 2450 | 4 | 7 | 15 | 30 | 52 |
| 3500 | 2 | 6 | 16 | 32 | 55 |
| 5800 | 1 | 6 | 15 | 27 | 41 |

| Frequency (MHz) | Exemption Limits (mW) | | | | |
|---|---|---|---|---|---|
| | At separation distance of 30 mm | At separation distance of 35 mm | At separation distance of 40 mm | At separation distance of 45 mm | At separation distance of ≥ 50 mm |
| ≤ 300 | 223 | 254 | 284 | 315 | 345 |
| 450 | 141 | 159 | 177 | 195 | 213 |
| 835 | 80 | 92 | 105 | 117 | 130 |
| 1900 | 99 | 153 | 225 | 316 | 431 |
| 2450 | 83 | 123 | 173 | 235 | 309 |
| 3500 | 86 | 124 | 170 | 225 | 290 |
| 5800 | 56 | 71 | 85 | 97 | 106 |

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required. For medical implants devices, the exemption limit for routine evaluation is set at 1 mW.

The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

## 5.2 RF Exposure Evaluation Results

The highest measured peak conducted power as reported in Section 9.5 of this report was 9.89 dBm (9.75 mW) at 2402 MHz. Due to the duty cycle of Bluetooth transmission in this device's normal operation is 6.25%, the calculated maximum average output power is 9.89 dBm – 10*log(1/6.25%) = -2.15 dBm (0.61 mW). The maximum average output power is lower than both FCC and ISED SAR Exemption limit. Thus, SAR was exempted for this device.

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

## 6.1 Applicable Standards

As per FCC §15.207 and ISED 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 ISED 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:

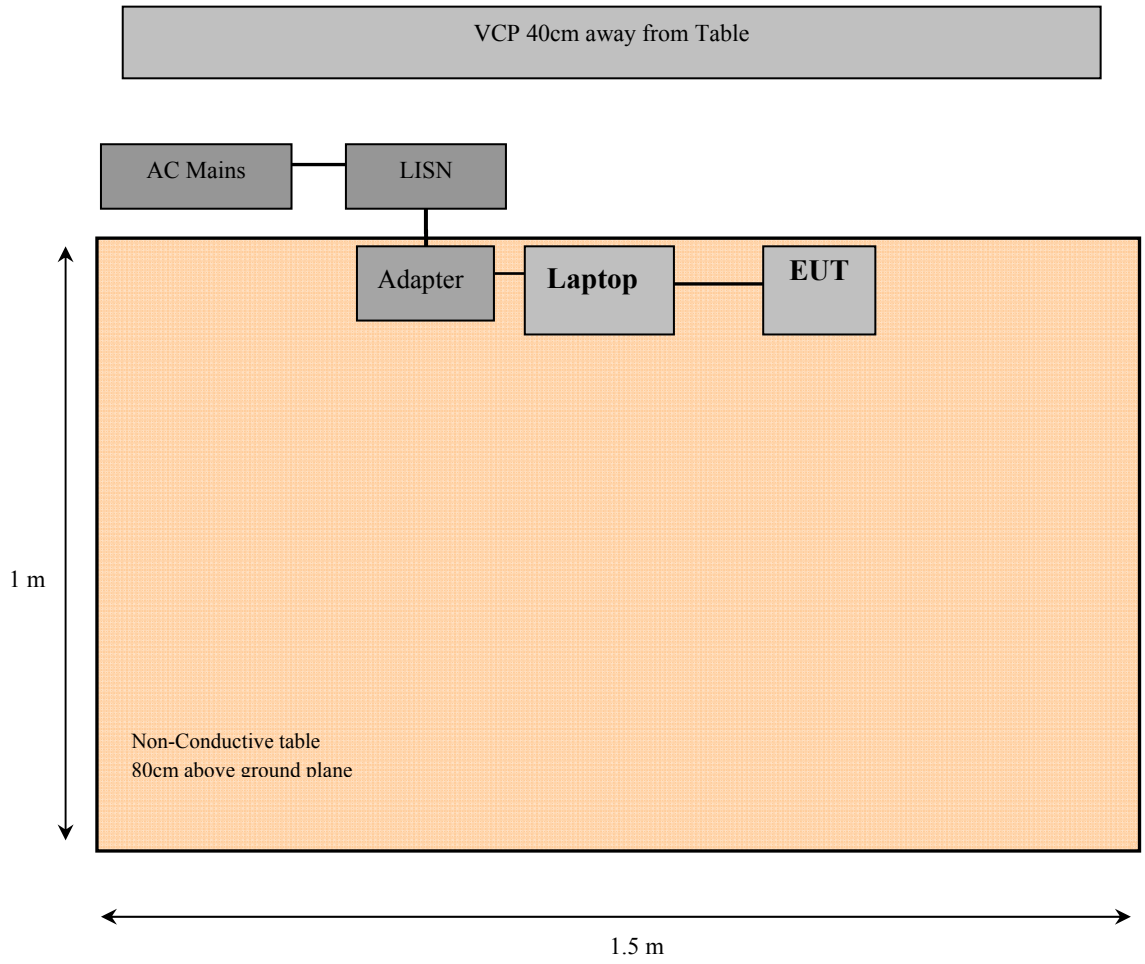
CA = Ai + CL + Atten

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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Rohde & Schwarz | Receiver, EMI Test | ESCI 1166.5950K03 | 100044 | 2015-07-23 | 1 year |
| Rohde & Schwarz | Impulse Limiter | ESH3-Z2 | 101963 | 2015-07-15 | 1year |
| Keysight Technologies | RF Limiter | 11867A | MY42242931 | 2015-12-15 | 1year |
| Solar Electronics Company | High Pass Filter | Type 7930-100 | 7930150204 | 2016-03-09 | 1 Year |
| Wireless Solutions | Conducted Emission Cable | LMR 400 | 691 | 2015-07-02 | 1year |
| FCC | LISN | FCC-LISN-50-25-2-10-CISPR16 | 160129 | 2016-04-11 | 1year |

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

## 6.7 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 15º C |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 101.31 kPa |

*The testing was performed by Leonard Gray on 2016-05-06 in 5 chamber 3.*

## 6.8 Summary of Test Results

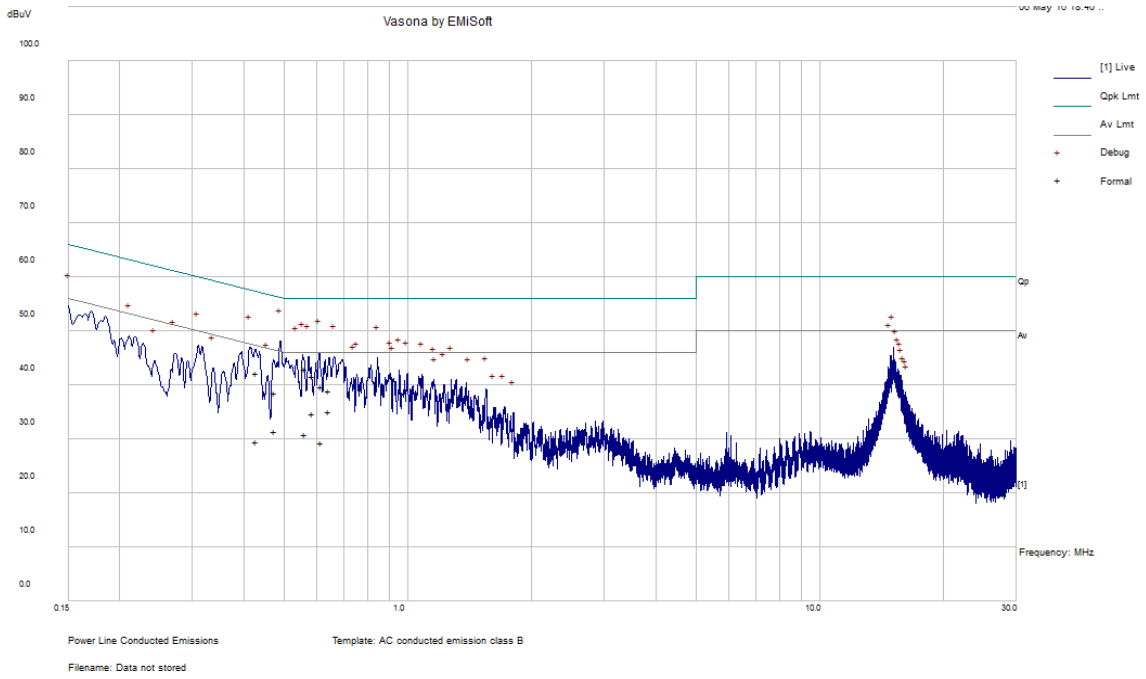
According to the recorded data in following table, the EUT complied with the FCC 15C and ISED RSS-Gen standard's conducted emissions limits, with the margin reading of:

| **Connection: AC/DC adapter connected to 120 V/60 Hz, AC** | | | |
|---|---|---|---|
| **Margin (dB)** | **Frequency (MHz)** | **Conductor Mode (Line/Neutral)** | **Range (MHz)** |
| 10.83 | 0.644217 | Line | 0.15-30 |

## 6.9 Conducted Emissions Test Plots and Data

Worst Mode of Operation: Hopping Mode

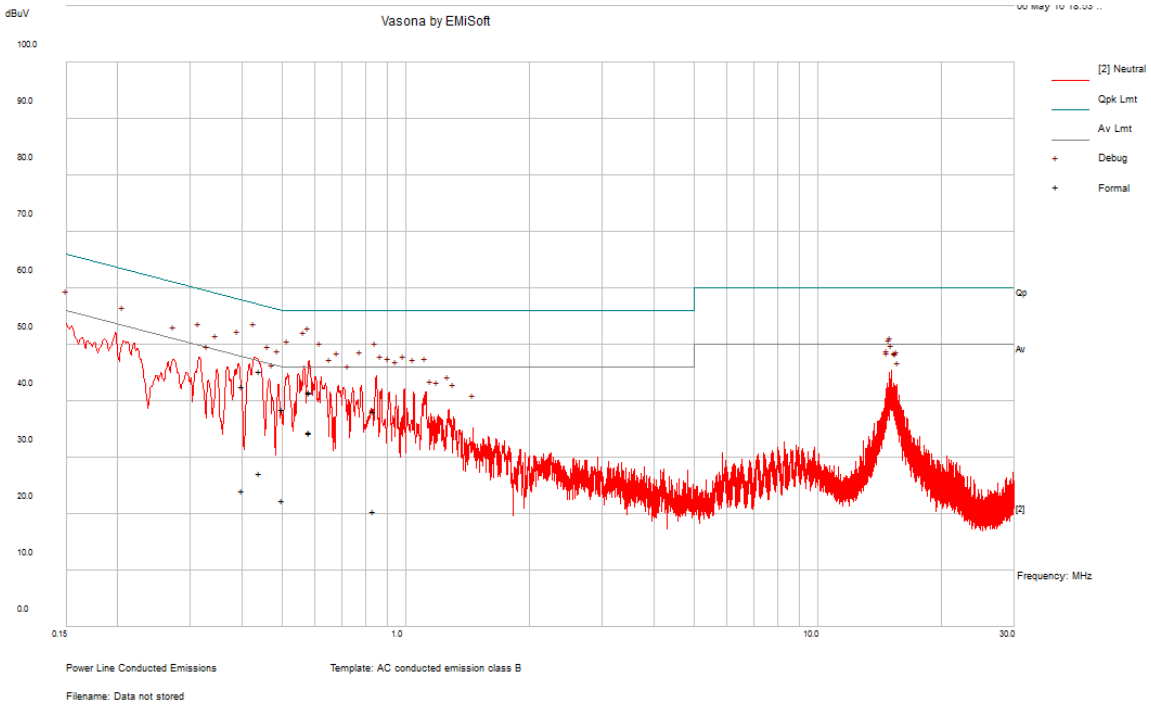
**120 V, 60 Hz – Line**




| Frequency (MHz) | Corrected Amplitude (dBuV) | Conductor (Line/Neutral) | Limit (dBuV) | Margin (dB) | Detector (QP/Ave.) |
|---|---|---|---|---|---|
| 0.474849 | 38.6 | Line | 56.43 | -17.83 | QP |
| 0.618252 | 39.76 | Line | 56 | -16.24 | QP |
| 0.563595 | 43.05 | Line | 56 | -12.95 | QP |
| 0.428871 | 42.29 | Line | 57.27 | -14.98 | QP |
| 0.586125 | 41.57 | Line | 56 | -14.43 | QP |
| 0.644217 | 39.02 | Line | 56 | -16.98 | QP |

| Frequency (MHz) | Corrected Amplitude (dBuV) | Conductor (Line/Neutral) | Limit (dBuV) | Margin (dB) | Detector (QP/Ave.) |
|---|---|---|---|---|---|
| 0.474849 | 31.56 | Line | 46.43 | -14.87 | Ave. |
| 0.618252 | 29.27 | Line | 46 | -16.73 | Ave. |
| 0.563595 | 30.87 | Line | 46 | -15.13 | Ave. |
| 0.428871 | 29.48 | Line | 47.27 | -17.79 | Ave. |
| 0.586125 | 34.73 | Line | 46 | -11.27 | Ave. |
| 0.644217 | 35.17 | Line | 46 | -10.83 | Ave. |

## 120 V, 60 Hz – Neutral




| Frequency (MHz) | Corrected Amplitude (dBuV) | Conductor (Line/Neutral) | Limit (dBuV) | Margin (dB) | Detector (QP/Ave.) |
|---|---|---|---|---|---|
| 0.583134 | 41.49 | Neutral | 56 | -14.51 | QP |
| 0.443076 | 45.29 | Neutral | 57 | -11.71 | QP |
| 0.58329 | 41.76 | Neutral | 56 | -14.24 | QP |
| 0.501243 | 38.56 | Neutral | 56 | -17.44 | QP |
| 0.400593 | 42.61 | Neutral | 57.84 | -15.23 | QP |
| 0.835395 | 38.28 | Neutral | 56 | -17.72 | QP |

| Frequency (MHz) | Corrected Amplitude (dBuV) | Conductor (Line/Neutral) | Limit (dBuV) | Margin (dB) | Detector (QP/Ave.) |
|---|---|---|---|---|---|
| 0.583134 | 34.33 | Neutral | 46 | -11.67 | Ave. |
| 0.443076 | 27.28 | Neutral | 47 | -19.72 | Ave. |
| 0.58329 | 34.52 | Neutral | 46 | -11.48 | Ave. |
| 0.501243 | 22.39 | Neutral | 46 | -23.61 | Ave. |
| 0.400593 | 24.16 | Neutral | 47.84 | -23.68 | Ave. |
| 0.835395 | 20.53 | Neutral | 46 | -25.47 | 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<br>0.495 – 0.505<br>2.1735 – 2.1905<br>4.125 – 4.128<br>4.17725 – 4.17775<br>4.20725 – 4.20775<br>6.215 – 6.218<br>6.26775 – 6.26825<br>6.31175 – 6.31225<br>8.291 – 8.294<br>8.362 – 8.366<br>8.37625 – 8.38675<br>8.41425 – 8.41475<br>12.29 – 12.293<br>12.51975 – 12.52025<br>12.57675 – 12.57725<br>13.36 – 13.41 | 16.42 – 16.423<br>16.69475 – 16.69525<br>25.5 – 25.67<br>37.5 – 38.25<br>73 – 74.6<br>74.8 – 75.2<br>108 – 121.94<br>123 – 138<br>149.9 – 150.05<br>156.52475 – 156.52525<br>156.7 – 156.9<br>162.0125 –167.17<br>167.72 – 173.2<br>240 – 285<br>322 – 335.4<br>399.9 – 410<br>608 – 614 | 960 – 1240<br>1300 – 1427<br>1435 – 1626.5<br>1645.5 – 1646.5<br>1660 – 1710<br>1718.8 – 1722.2<br>2200 – 2300<br>2310 – 2390<br>2483.5 – 2500<br>2690 – 2900<br>3260 – 3267<br>3.332 – 3.339<br>3 3458 – 3 358<br>3.600 – 4.400 | 4. 5 – 5. 15<br>5. 35 – 5. 46<br>7.25 – 7.75<br>8.025 – 8.5<br>9.0 – 9.2<br>9.3 – 9.5<br>10.6 – 12.7<br>13.25 – 13.4<br>14.47 – 14.5<br>15.35 – 16.2<br>17.7 – 21.4<br>22.01 – 23.12<br>23.6 – 24.0<br>31.2 – 31.8<br>36.43 – 36.5<br>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 ISED 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 ISED 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 ISED 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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Rohde & Schwarz | Receiver, EMI Test | ESCI 1166.5950K03 | 100044 | 2015-07-23 | 1 year |
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| Sunol Science Corp | System Controller | SC99V | 011003-1 | N/R | N/R |
| Sunol Sciences | Antenna, Biconi-Log | JB3 | A020106-2 | 2015-07-11 | 2 years |
| Sunol Sciences | Antenna, Horn | DRH-118 | A052704 | 2015-03-09 | 2 years |
| Agilent | Amplifier, Pre | 8447D | 2944A10187 | 2016-03-23 | 1 year |
| Wireless Solutions | Conducted Emission Cable | LMR 400 | 691 | 2015-07-02 | 1 year |
| - | SMA cable | - | 606 | Each time[1] | N/A |
| IW | High Frequency Co AX Cable | DC 1531 | KPS-1501A3960KPS | 2015-08-10 | 1 year |
| Agilent | Pre-Amplifier | 8449B | 3008A01978 | 2015-09-02 | 1 year |
| Wisewave | Amplifier, Low Noise | ALN-22093530-01 | 12263-01 | 2016-05-16 | 1 year |
| Wisewave | Antenna, Horn | ARH-4223-02 | 10555-02 | 2013-09-20 | 3 years |

Note[1]: cable and attenuator included in the test set-up will be 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 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 20-22 ºC |
| **Relative Humidity:** | 42-50 % |
| **ATM Pressure:** | 102.7 kPa |

*The testing was performed by Todd Moy from 2016-04-25 to 2016-05-11 in 5m chamber 3.*

## 7.7 Summary of Test Results

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

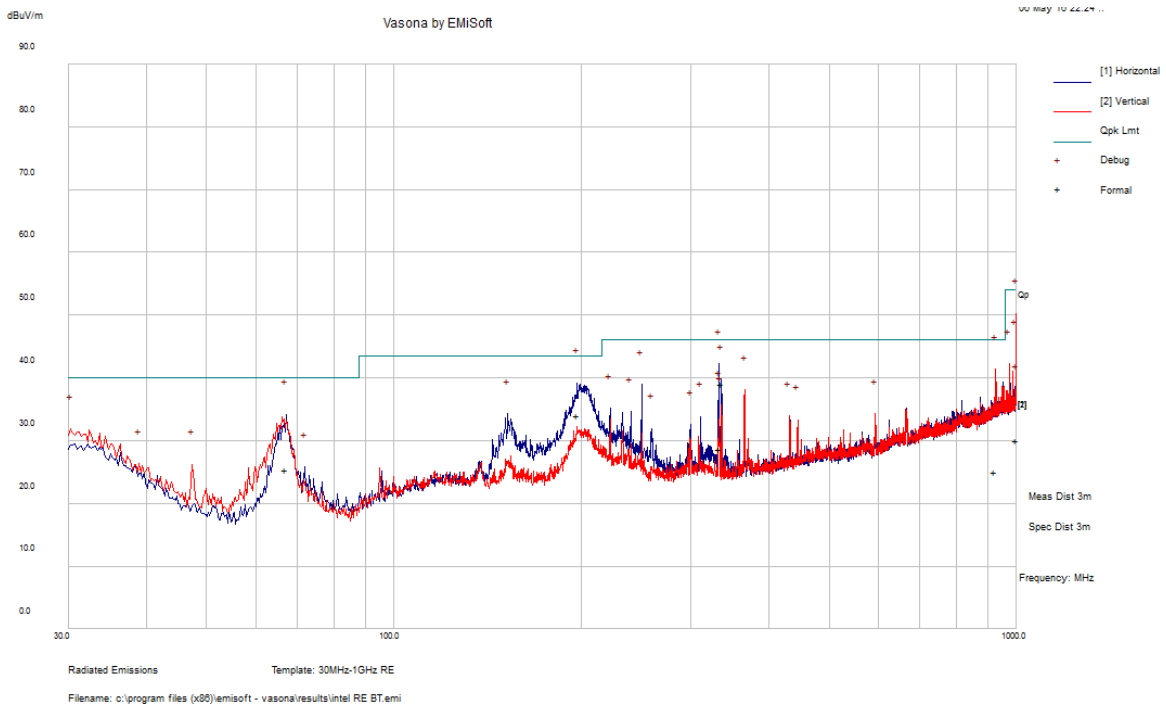
| **Mode: Transmitting** | | | |
|---|---|---|---|
| **Margin (dB)** | **Frequency (MHz)** | **Polarization (Horizontal/Vertical)** | **Mode, Channel** |
| 0.01 | 2483.5 | Vertical | 8PSK, High Channel |

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

## 7.8 Radiated Emissions Test Results

Worst Mode of Operation: Hopping Mode

### 1) 30 MHz- 1 GHz, 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 |
|---|---|---|---|---|---|---|---|
| 998.365 | 29.98 | 101 | V | 100 | 54 | -24.02 | QP |
| 332.6195 | 28.67 | 118 | H | 27 | 46 | -17.33 | QP |
| 197.0145 | 33.98 | 123 | H | 101 | 43.5 | -9.52 | QP |
| 924.6518 | 25.06 | 284 | V | 22 | 46 | -20.94 | QP |
| 67.0635 | 25.33 | 239 | H | 13 | 40 | -14.67 | QP |
| 336.016 | 39.11 | 101 | H | 33 | 46 | -6.89 | QP |

**2) 1-25 GHz, Measured at 3 meters**

GFSK Mode

| Frequency (MHz) | Receiver | | Rx Antenna | | Cable Loss (dB) | Pre-Amp Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBµV) | Detector (PK/QP/AV) | Polar (H/V) | Factor (dB/m) | | | | | |
| Frequency: 2402 MHz Power Setting: 12 | | | | | | | | | |
| 2402 | 71.26 | PK | H | 29.05 | 5.21 | 0.00 | 105.52 | N/A | N/A |
| 2402 | 71.2 | AV | H | 29.05 | 5.21 | 0.00 | 105.46 | N/A | N/A |
| 2402 | 69.06 | PK | V | 29.05 | 5.21 | 0.00 | 103.32 | N/A | N/A |
| 2402 | 68.92 | AV | V | 29.05 | 5.21 | 0.00 | 103.18 | N/A | N/A |
| 2390 | 28.41 | PK | V | 28.98 | 5.20 | 0.00 | 62.59 | 74.00 | 11.41 |
| 2390 | 16.6 | AV | V | 28.98 | 5.20 | 0.00 | 50.78 | 54.00 | 3.22 |
| 4804 | 52.38 | PK | V | 32.48 | 7.88 | 36.64 | 56.10 | 74.00 | 17.90 |
| 4804 | 47.19 | AV | V | 32.48 | 7.88 | 36.64 | 50.91 | 54.00 | 3.09 |
| 7206 | 48.18 | PK | V | 36.72 | 10.45 | 36.42 | 58.93 | 74.00 | 15.07 |
| 7206 | 40.31 | AV | V | 36.72 | 10.45 | 36.42 | 51.06 | 54.00 | 2.94 |
| 9608 | 50.17 | PK | V | 37.78 | 11.37 | 36.66 | 62.66 | 85.52 | 22.86 |
| 9608 | 42.15 | AV | V | 37.78 | 11.37 | 36.66 | 54.64 | 85.46 | 30.82 |
| Frequency: 2441 MHz Power Setting: 11 | | | | | | | | | |
| 2441 | 67.21 | PK | H | 29.19 | 5.22 | 0.00 | 101.62 | N/A | N/A |
| 2441 | 67.02 | AV | H | 29.19 | 5.22 | 0.00 | 101.43 | N/A | N/A |
| 2441 | 64.78 | PK | V | 29.19 | 5.22 | 0.00 | 99.19 | N/A | N/A |
| 2441 | 64.58 | AV | V | 29.19 | 5.22 | 0.00 | 98.99 | N/A | N/A |
| 4882 | 53.02 | PK | V | 32.61 | 7.93 | 36.63 | 56.93 | 74.00 | 17.07 |
| 4882 | 48.44 | AV | V | 32.61 | 7.93 | 36.63 | 52.35 | 54.00 | 1.65 |
| 7323 | 48 | PK | V | 37.15 | 10.68 | 36.43 | 59.40 | 74.00 | 14.60 |
| 7323 | 40.32 | AV | V | 37.15 | 10.68 | 36.43 | 51.72 | 54.00 | 2.28 |
| 9764 | 50.11 | PK | V | 37.89 | 11.46 | 36.69 | 62.77 | 81.62 | 18.85 |
| 9764 | 41.35 | AV | V | 37.89 | 11.46 | 36.69 | 54.01 | 81.43 | 27.42 |
| Frequency: 2480 MHz Power Setting: 11 | | | | | | | | | |
| 2480 | 69.55 | PK | H | 29.34 | 5.22 | 0.00 | 104.11 | N/A | N/A |
| 2480 | 69.45 | AV | H | 29.34 | 5.22 | 0.00 | 104.01 | N/A | N/A |
| 2480 | 67.3 | PK | V | 29.34 | 5.22 | 0.00 | 101.86 | N/A | N/A |
| 2480 | 67.01 | AV | V | 29.34 | 5.22 | 0.00 | 101.57 | N/A | N/A |
| 2483.5 | 28.22 | PK | V | 29.35 | 5.83 | 0.00 | 63.40 | 74.00 | 10.60 |
| 2483.5 | 16.7 | AV | V | 29.35 | 5.83 | 0.00 | 51.88 | 54.00 | 2.12 |
| 4960 | 53.48 | PK | V | 32.85 | 7.97 | 36.59 | 57.71 | 74.00 | 16.29 |
| 4960 | 49.63 | AV | V | 32.85 | 7.97 | 36.59 | 53.86 | 54.00 | 0.14 |
| 7440 | 47.36 | PK | V | 37.04 | 10.82 | 36.45 | 58.77 | 74.00 | 15.23 |
| 7440 | 38.19 | AV | V | 37.04 | 10.82 | 36.45 | 49.60 | 54.00 | 4.40 |
| 9920 | 48.86 | PK | V | 38.00 | 11.54 | 36.70 | 61.70 | 74.00 | 12.30 |
| 9920 | 38.69 | AV | V | 38.00 | 11.54 | 36.70 | 51.53 | 54.00 | 2.47 |

π/4-DQPSK Mode

| Frequency (MHz) | Receiver | | Rx Antenna | | Cable Loss (dB) | Pre-Amp Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBµV) | Detector (PK/QP/AV) | Polar (H/V) | Factor (dB/m) | | | | | |
| Frequency: 2402 MHz Power Setting: 12 | | | | | | | | | |
| 2402 | 70.91 | PK | H | 29.05 | 5.21 | 0.00 | 105.17 | N/A | N/A |
| 2402 | 67.84 | AV | H | 29.05 | 5.21 | 0.00 | 102.10 | N/A | N/A |
| 2402 | 68.73 | PK | V | 29.05 | 5.21 | 0.00 | 102.99 | N/A | N/A |
| 2402 | 65.63 | AV | V | 29.05 | 5.21 | 0.00 | 99.89 | N/A | N/A |
| 2390 | 27.84 | PK | H | 28.98 | 5.20 | 0.00 | 62.02 | 74.00 | 11.98 |
| 2390 | 16.45 | AV | H | 28.98 | 5.20 | 0.00 | 50.63 | 54.00 | 3.37 |
| 4804 | 51.56 | PK | V | 32.48 | 7.88 | 36.64 | 55.28 | 74.00 | 18.72 |
| 4804 | 43.7 | AV | V | 32.48 | 7.88 | 36.64 | 47.42 | 54.00 | 6.58 |
| 7206 | 48.41 | PK | V | 36.72 | 10.45 | 36.42 | 59.16 | 74.00 | 14.84 |
| 7206 | 39.52 | AV | V | 36.72 | 10.45 | 36.42 | 50.27 | 54.00 | 3.73 |
| 9608 | 49.05 | PK | V | 37.78 | 11.37 | 36.66 | 61.54 | 74.00 | 12.46 |
| 9608 | 38.51 | AV | V | 37.78 | 11.37 | 36.66 | 51.00 | 54.00 | 3.00 |
| Frequency: 2441 MHz Power Setting: 12 | | | | | | | | | |
| 2441 | 67.74 | PK | H | 29.19 | 5.22 | 0.00 | 102.15 | N/A | N/A |
| 2441 | 65.33 | AV | H | 29.19 | 5.22 | 0.00 | 99.74 | N/A | N/A |
| 2441 | 65.29 | PK | V | 29.19 | 5.22 | 0.00 | 99.70 | N/A | N/A |
| 2441 | 62.87 | AV | V | 29.19 | 5.22 | 0.00 | 97.28 | N/A | N/A |
| 4882 | 53.5 | PK | V | 32.61 | 7.93 | 36.63 | 57.41 | 74.00 | 16.59 |
| 4882 | 45.31 | AV | V | 32.61 | 7.93 | 36.63 | 49.22 | 54.00 | 4.78 |
| 7323 | 47.77 | PK | V | 37.15 | 10.68 | 36.43 | 59.17 | 74.00 | 14.83 |
| 7323 | 38.48 | AV | V | 37.15 | 10.68 | 36.43 | 49.88 | 54.00 | 4.12 |
| 9764 | 49.27 | PK | V | 37.89 | 11.46 | 36.69 | 61.93 | 74.00 | 12.07 |
| 9764 | 39.75 | AV | V | 37.89 | 11.46 | 36.69 | 52.41 | 54.00 | 1.59 |
| Frequency: 2480 MHz Power Setting: 12 | | | | | | | | | |
| 2480 | 70.48 | PK | H | 29.34 | 5.22 | 0.00 | 105.04 | N/A | N/A |
| 2480 | 67.37 | AV | H | 29.34 | 5.22 | 0.00 | 101.93 | N/A | N/A |
| 2480 | 68.06 | PK | V | 29.34 | 5.22 | 0.00 | 102.62 | N/A | N/A |
| 2480 | 64.97 | AV | V | 29.34 | 5.22 | 0.00 | 99.53 | N/A | N/A |
| 2483.5 | 29.44 | PK | H | 29.35 | 5.83 | 0.00 | 64.62 | 74.00 | 9.38 |
| 2483.5 | 18.72 | AV | H | 29.35 | 5.83 | 0.00 | 53.90 | 54.00 | 0.10 |
| 4960 | 54.23 | PK | V | 32.85 | 7.97 | 36.59 | 58.46 | 74.00 | 15.54 |
| 4960 | 46.91 | AV | V | 32.85 | 7.97 | 36.59 | 51.14 | 54.00 | 2.86 |
| 7440 | 48.32 | PK | V | 37.04 | 10.82 | 36.45 | 59.73 | 74.00 | 14.27 |
| 7440 | 37.67 | AV | V | 37.04 | 10.82 | 36.45 | 49.08 | 54.00 | 4.92 |
| 9920 | 47.11 | PK | V | 38.00 | 11.54 | 36.70 | 59.95 | 74.00 | 14.05 |
| 9920 | 36.29 | AV | V | 38.00 | 11.54 | 36.70 | 49.13 | 54.00 | 4.87 |

8DPSK Mode

| Frequency (MHz) | Receiver | | Rx Antenna | | Cable Loss (dB) | Pre-Amp Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBµV) | Detector (PK/QP/AV) | Polar (H/V) | Factor (dB/m) | | | | | |
| Frequency: 2402 MHz Power Setting: 12 | | | | | | | | | |
| 2402 | 71.51 | PK | H | 29.05 | 5.21 | 0.00 | 105.77 | N/A | N/A |
| 2402 | 67.83 | AV | H | 29.05 | 5.21 | 0.00 | 102.09 | N/A | N/A |
| 2402 | 69.28 | PK | V | 29.05 | 5.21 | 0.00 | 103.54 | N/A | N/A |
| 2402 | 65.64 | AV | V | 29.05 | 5.21 | 0.00 | 99.90 | N/A | N/A |
| 2390 | 27.78 | PK | H | 28.98 | 5.20 | 0.00 | 61.96 | 74.00 | 12.04 |
| 2390 | 16.49 | AV | H | 28.98 | 5.20 | 0.00 | 50.67 | 54.00 | 3.33 |
| 4804 | 51.87 | PK | V | 32.48 | 7.88 | 36.64 | 55.59 | 74.00 | 18.41 |
| 4804 | 43.23 | AV | V | 32.48 | 7.88 | 36.64 | 46.95 | 54.00 | 7.05 |
| 7206 | 49.47 | PK | V | 36.72 | 10.45 | 36.42 | 60.22 | 74.00 | 13.78 |
| 7206 | 40.06 | AV | V | 36.72 | 10.45 | 36.42 | 50.81 | 54.00 | 3.19 |
| 9608 | 49.56 | PK | V | 37.78 | 11.37 | 36.66 | 62.05 | 74.00 | 11.95 |
| 9608 | 38.93 | AV | V | 37.78 | 11.37 | 36.66 | 51.42 | 54.00 | 2.58 |
| Frequency: 2441 MHz Power Setting: 12 | | | | | | | | | |
| 2441 | 68.12 | PK | H | 29.19 | 5.22 | 0.00 | 102.53 | N/A | N/A |
| 2441 | 65.33 | AV | H | 29.19 | 5.22 | 0.00 | 99.74 | N/A | N/A |
| 2441 | 65.88 | PK | V | 29.19 | 5.22 | 0.00 | 100.29 | N/A | N/A |
| 2441 | 62.78 | AV | V | 29.19 | 5.22 | 0.00 | 97.19 | N/A | N/A |
| 4882 | 53.87 | PK | V | 32.61 | 7.93 | 36.63 | 57.78 | 74.00 | 16.22 |
| 4882 | 46.53 | AV | V | 32.61 | 7.93 | 36.63 | 50.44 | 54.00 | 3.56 |
| 7323 | 47.97 | PK | V | 37.15 | 10.68 | 36.43 | 59.37 | 74.00 | 14.63 |
| 7323 | 38.25 | AV | V | 37.15 | 10.68 | 36.43 | 49.65 | 54.00 | 4.35 |
| 9764 | 49.86 | PK | V | 37.89 | 11.46 | 36.69 | 62.52 | 74.00 | 11.48 |
| 9764 | 40.11 | AV | V | 37.89 | 11.46 | 36.69 | 52.77 | 54.00 | 1.23 |
| Frequency: 2480 MHz Power Setting: 12 | | | | | | | | | |
| 2480 | 71.07 | PK | H | 29.34 | 5.22 | 0.00 | 105.63 | N/A | N/A |
| 2480 | 67.32 | AV | H | 29.34 | 5.22 | 0.00 | 101.88 | N/A | N/A |
| 2480 | 68.72 | PK | V | 29.34 | 5.22 | 0.00 | 103.28 | N/A | N/A |
| 2480 | 64.99 | AV | V | 29.34 | 5.22 | 0.00 | 99.55 | N/A | N/A |
| 2483.5 | 30.21 | PK | V | 29.35 | 5.83 | 0.00 | 65.39 | 74.00 | 8.61 |
| 2483.5 | 18.81 | AV | V | 29.35 | 5.83 | 0.00 | 53.99 | 54.00 | 0.01 |
| 4960 | 55.23 | PK | V | 32.85 | 7.97 | 36.59 | 59.46 | 74.00 | 14.54 |
| 4960 | 47.41 | AV | V | 32.85 | 7.97 | 36.59 | 51.64 | 54.00 | 2.36 |
| 7440 | 47.84 | PK | V | 37.04 | 10.82 | 36.45 | 59.25 | 74.00 | 14.75 |
| 7440 | 37.75 | AV | V | 37.04 | 10.82 | 36.45 | 49.16 | 54.00 | 4.84 |
| 9920 | 48.1 | PK | V | 38.00 | 11.54 | 36.70 | 60.94 | 74.00 | 13.06 |
| 9920 | 36.64 | AV | V | 38.00 | 11.54 | 36.70 | 49.48 | 54.00 | 4.52 |

# 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 ISED 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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| - | 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 Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

*The testing was performed by Todd Moy on 2016-04-26 in RF site.*

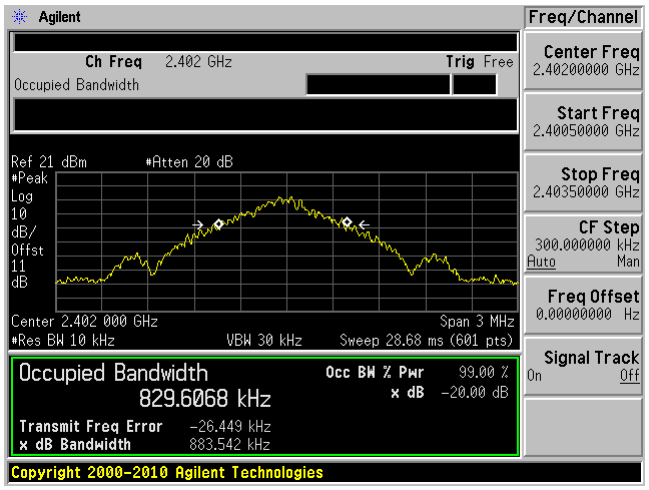
## 8.5 Test Results

| Channel | Frequency (MHz) | 99% OBW (kHz) | 20 dB OBW (kHz) |
|---|---|---|---|
| GFSK | | | |
| Low | 2402 | 829.6068 | 883.542 |
| Middle | 2441 | 855.5276 | 922.542 |
| High | 2480 | 857.2354 | 917.301 |
| π/4-DQPSK | | | |
| Low | 2402 | 1269.7 | 1392 |
| Middle | 2441 | 1227.1 | 1359 |
| High | 2480 | 1236.2 | 1379 |
| 8DPSK | | | |
| Low | 2402 | 1254.2 | 1388 |
| Middle | 2441 | 1272.5 | 1386 |
| High | 2480 | 1252.9 | 1385 |

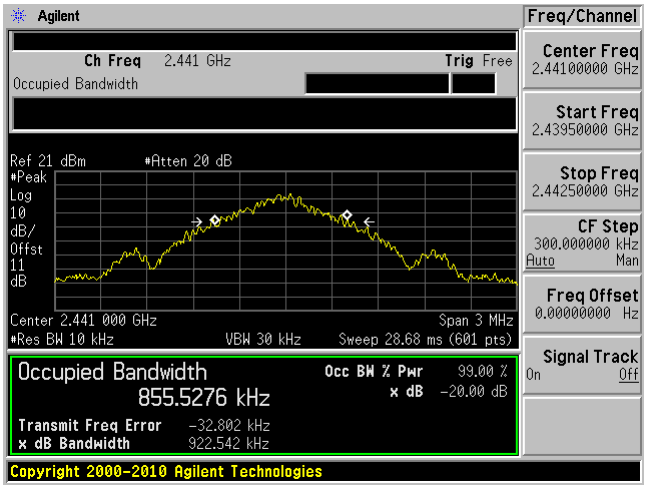
Please refer to the following plots for detailed test results.

## GFSK

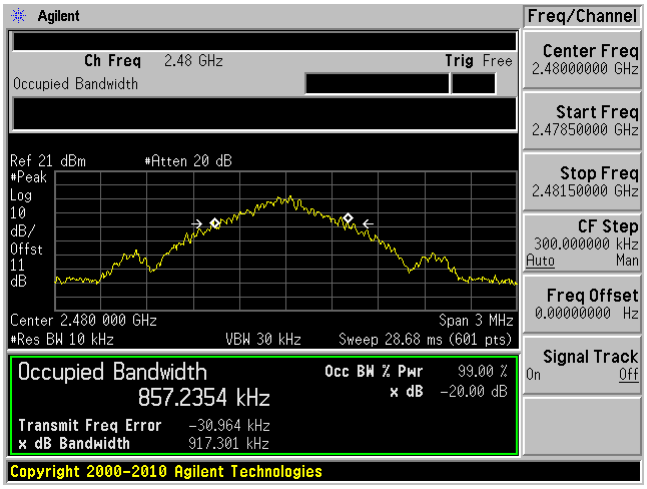
Low Channel 2402 MHz




Middle Channel 2441 MHz

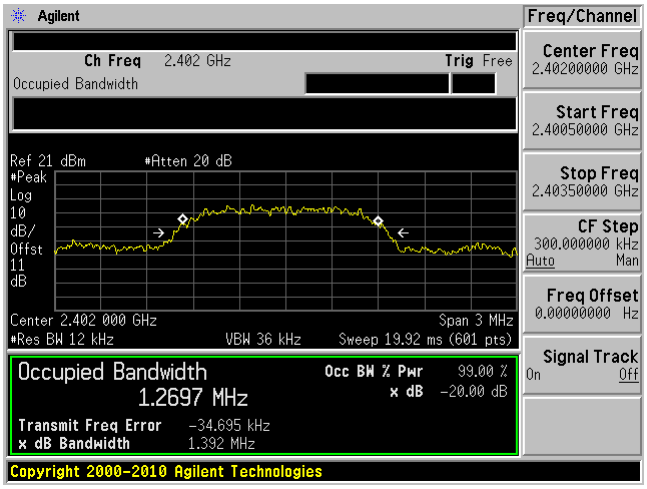



High Channel 2480 MHz

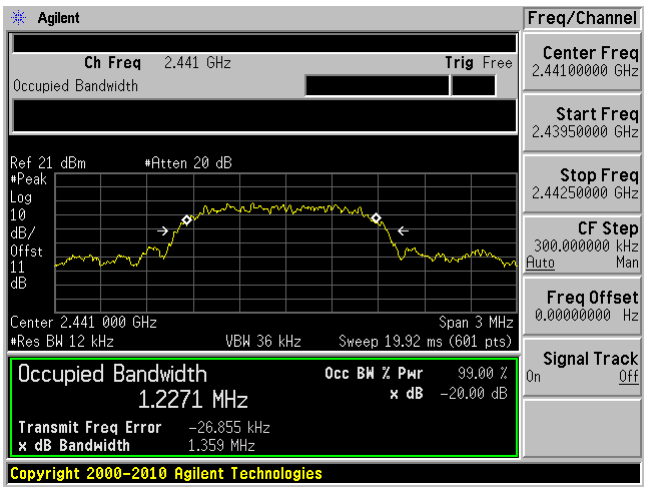


## π/4-DQPSK

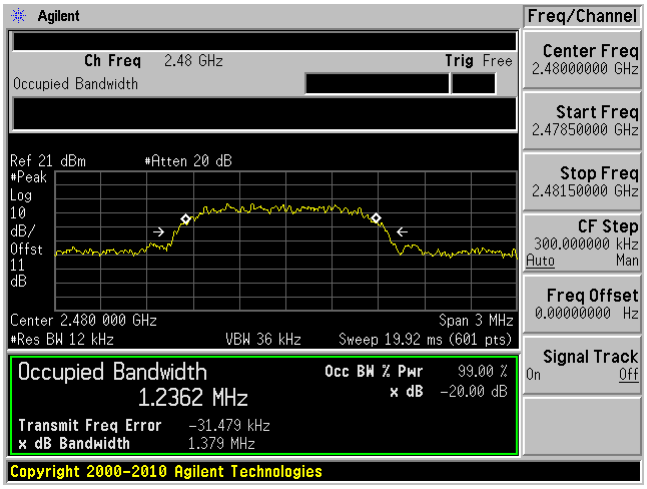
Low Channel 2402 MHz




Middle Channel 2441 MHz

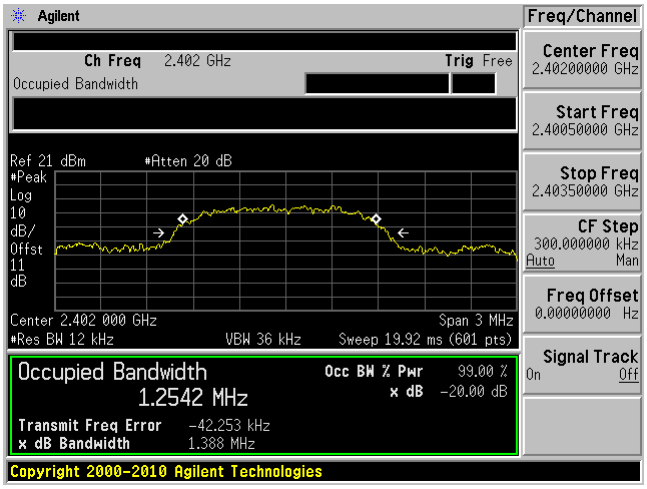



High Channel 2480 MHz

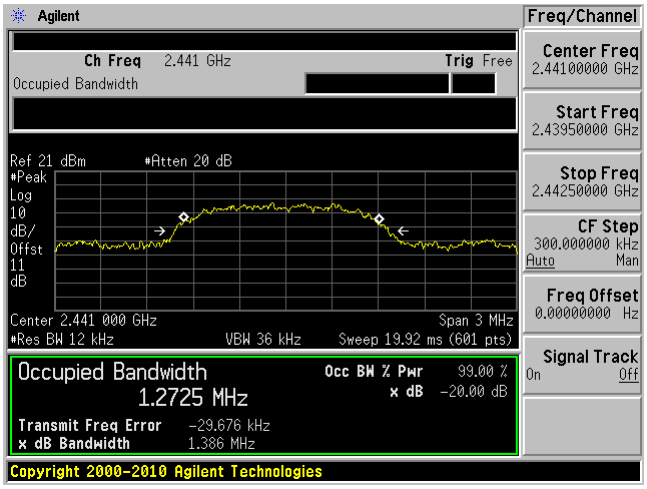


**8DPSK**

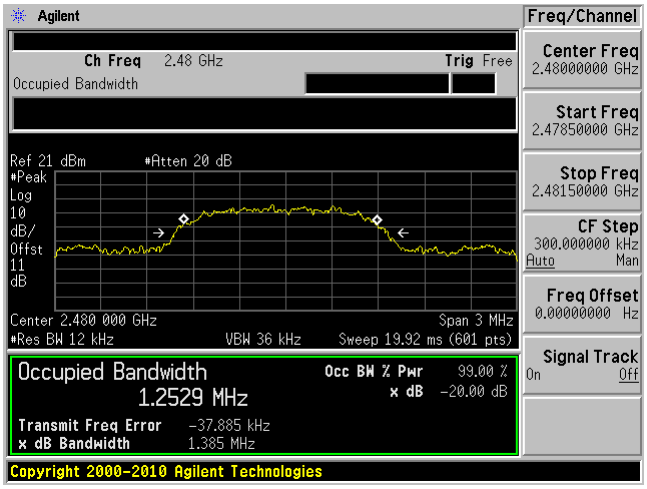
Low Channel 2402 MHz




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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| Rohde & Schwarz | Signal Analyzer | FSQ26 | 200749 | 2016-03-24 | 1year |
| - | 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.*

## 9.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

*The testing was performed by Jose Martinez on 2016-05-27 in RF site.*

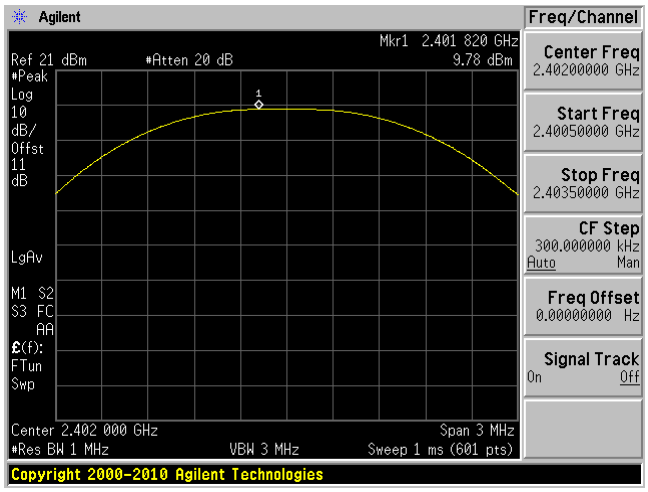
## 9.5 Test Results

| Channel | Frequency (MHz) | Conducted Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | | | |
| Low | 2402 | 9.78 | 30 |
| Middle | 2441 | 7.31 | 30 |
| High | 2480 | 7.92 | 30 |
| π/4-DQPSK | | | |
| Low | 2402 | 9.73 | 30 |
| Middle | 2441 | 8.37 | 30 |
| High | 2480 | 9.01 | 30 |
| 8DPSK | | | |
| Low | 2402 | 9.89 | 30 |
| Middle | 2441 | 8.80 | 30 |
| High | 2480 | 9.34 | 30 |

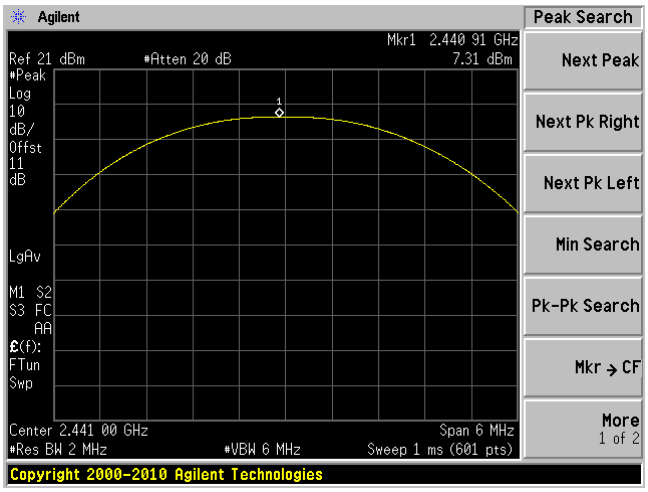
Please refer to the following plots for detailed test results.

## GFSK

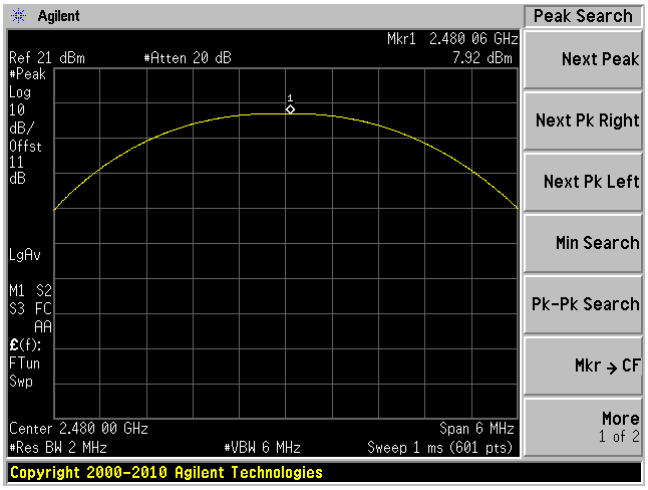
Low Channel 2402 MHz




Middle Channel 2441 MHz

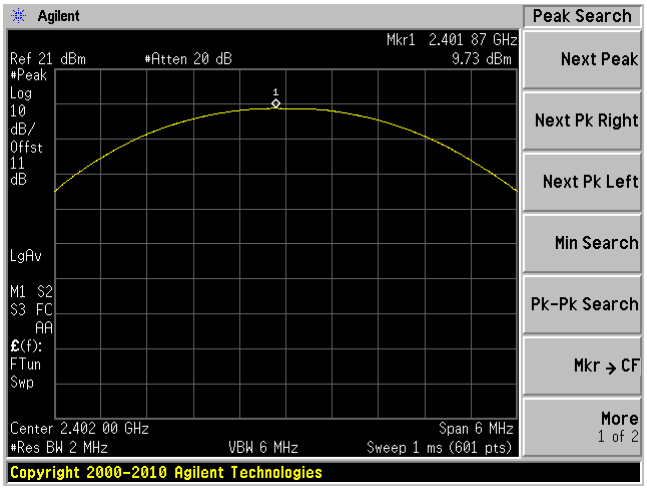



High Channel 2480 MHz

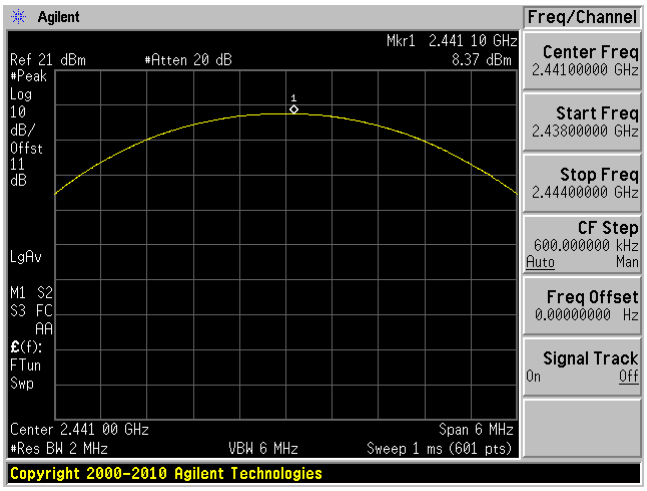


**π/4-DQPSK**

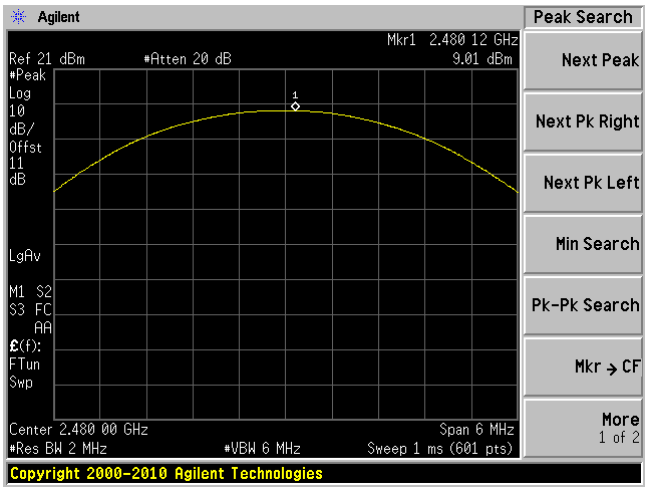
Low Channel 2402 MHz




Middle Channel 2441 MHz

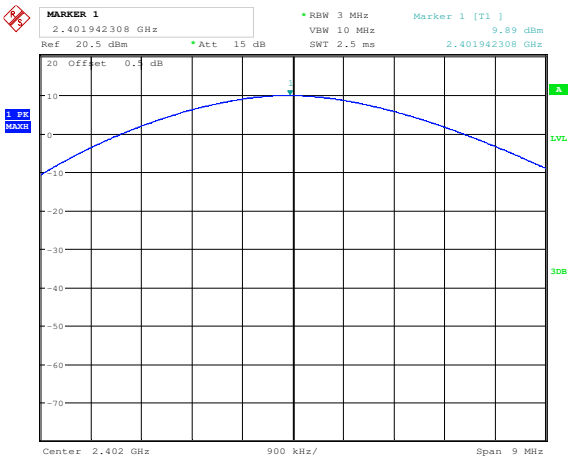



High Channel 2480 MHz



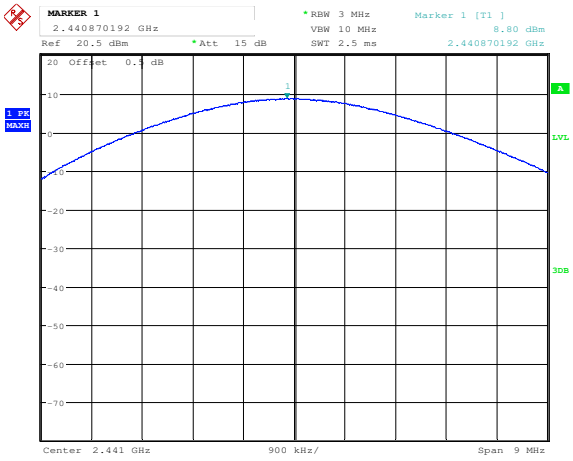
## 8DPSK

Low Channel 2402 MHz



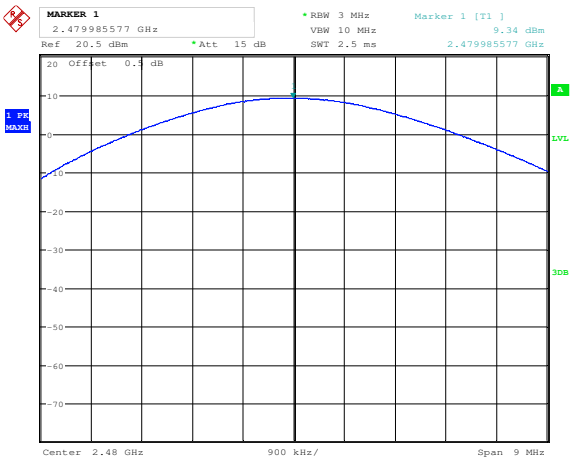

Date: 30.MAY.2016 21:35:12

Middle Channel 2441 MHz




Date: 30.MAY.2016 21:39:27

High Channel 2480 MHz




Date: 30.MAY.2016 21:40:37

# 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 ISED 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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| - | 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.*

## 10.4 Test Environmental Conditions

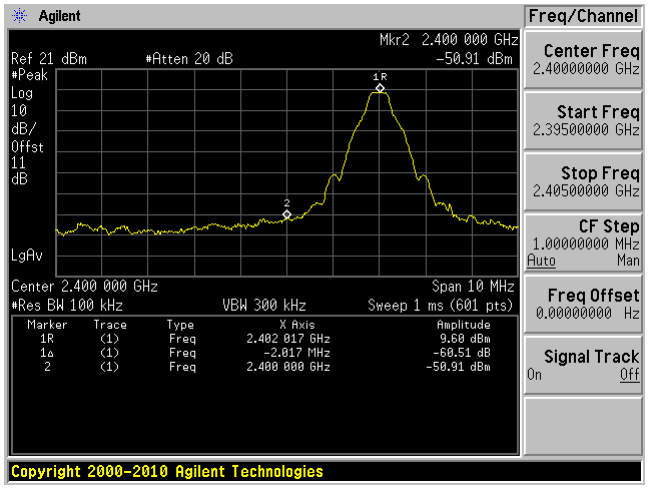
| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

*The testing was performed by Jose Martinez on 2016-05-27 in RF site.*

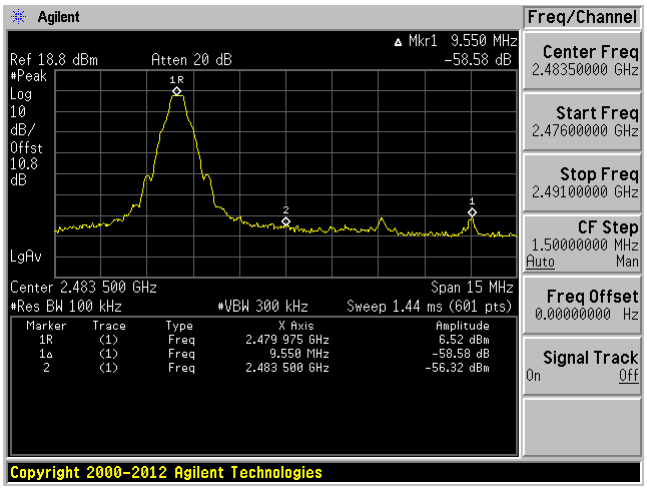
## 10.5 Test Results

**GFSK**

Low Channel 2402 MHz

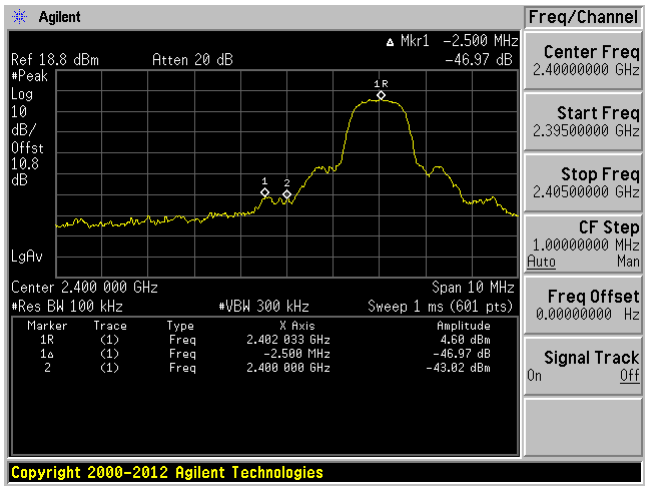



High Channel 2480 MHz

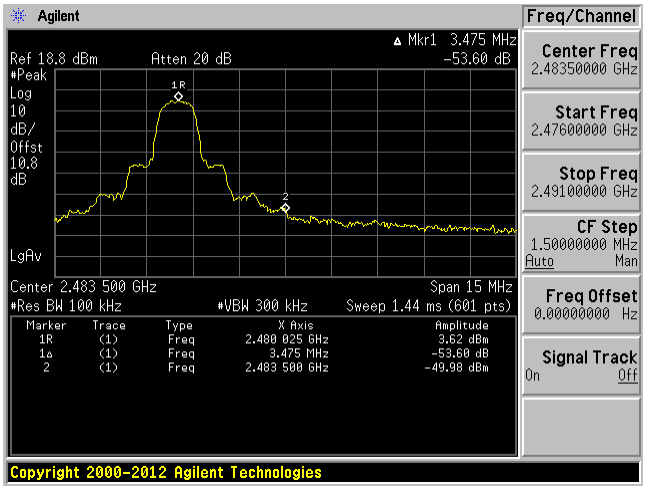


## π/4-DQPSK

Low Channel 2402 MHz

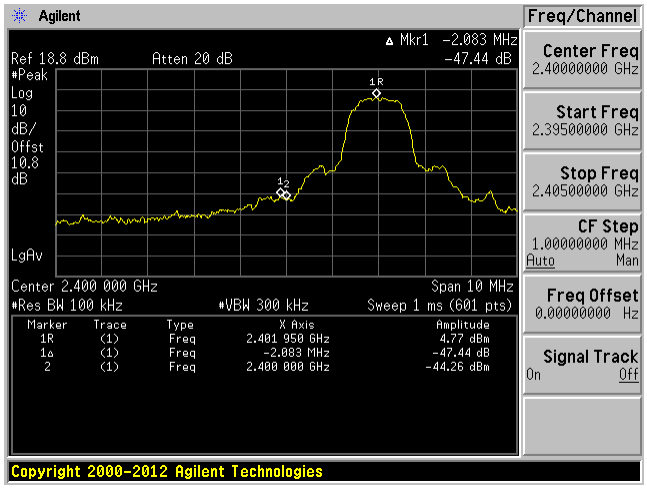



High Channel 2480 MHz

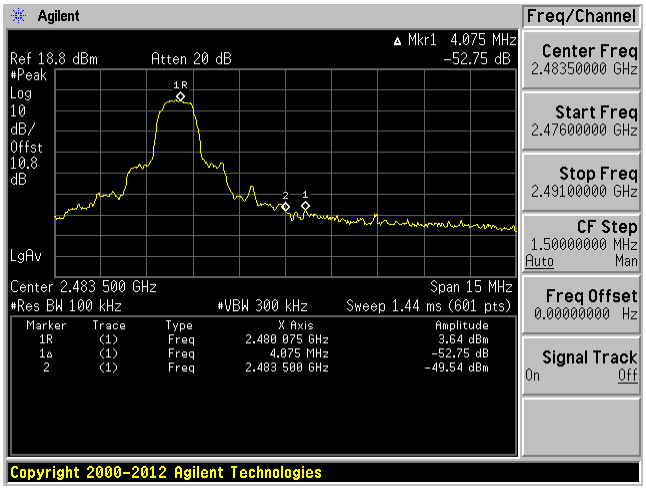



## 8DPSK

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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| - | 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.*

## 11.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

*The testing was performed by Todd Moy on 2016-04-27 in RF site.*

## 11.5 Test Results

Please refer to the following tables and plots.

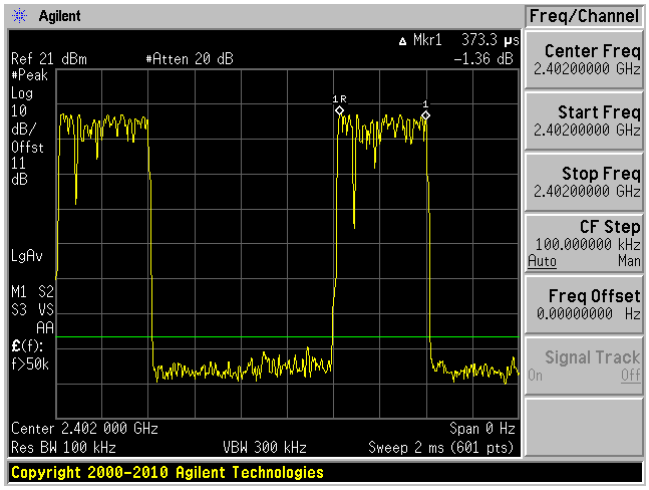
| Channel | Pulse Width (ms) | Number of Hops in the Period Specified in the Requirements | Average Time of Occupancy (s) | Limit (sec) | Results |
|---|---|---|---|---|---|
| GFSK, DM1 | | | | | |
| Low | 0.3733 | 320 | 0.119456 | 0.4 | Compliant |
| Middle | 0.3733 | 320 | 0.119456 | 0.4 | Compliant |
| High | 0.3733 | 320 | 0.119456 | 0.4 | Compliant |
| GFSK, DM3 | | | | | |
| Low | 1.617 | 170 | 0.27489 | 0.4 | Compliant |
| Middle | 1.633 | 140 | 0.22862 | 0.4 | Compliant |
| High | 1.617 | 140 | 0.22638 | 0.4 | Compliant |
| GFSK, DM5 | | | | | |
| Low | 2.85 | 80 | 0.228 | 0.4 | Compliant |
| Middle | 2.85 | 100 | 0.285 | 0.4 | Compliant |
| High | 2.825 | 100 | 0.2825 | 0.4 | Compliant |
| GFSK, DH1 | | | | | |
| Low | 0.3833 | 330 | 0.126489 | 0.4 | Compliant |
| Middle | 0.3833 | 330 | 0.126489 | 0.4 | Compliant |
| High | 0.3867 | 320 | 0.123744 | 0.4 | Compliant |
| GFSK, DH3 | | | | | |
| Low | 1.617 | 150 | 0.24255 | 0.4 | Compliant |
| Middle | 1.617 | 150 | 0.24255 | 0.4 | Compliant |
| High | 1.617 | 160 | 0.25872 | 0.4 | Compliant |
| GFSK, DH5 | | | | | |
| Low | 2.85 | 80 | 0.228 | 0.4 | Compliant |
| Middle | 2.875 | 120 | 0.345 | 0.4 | Compliant |
| High | 2.775 | 110 | 0.30525 | 0.4 | Compliant |

| Channel | Pulse Width (ms) | Number of Hops in the Period Specified in the Requirements | Average Time of Occupancy (s) | Limit (sec) | Results |
|---|---|---|---|---|---|
| π/4-DQPSK, DH1 | | | | | |
| Low | 0.39 | 310 | 0.1209 | 0.4 | Compliant |
| Middle | 0.39 | 290 | 0.1131 | 0.4 | Compliant |
| High | 0.3933 | 310 | 0.121923 | 0.4 | Compliant |
| π/4-DQPSK, DH3 | | | | | |
| Low | 1.633 | 140 | 0.22862 | 0.4 | Compliant |
| Middle | 1.633 | 140 | 0.22862 | 0.4 | Compliant |
| High | 1.65 | 190 | 0.3135 | 0.4 | Compliant |
| π/4-DQPSK, DH5 | | | | | |
| Low | 2.725 | 120 | 0.327 | 0.4 | Compliant |
| Middle | 2.725 | 100 | 0.2725 | 0.4 | Compliant |
| High | 2.7 | 140 | 0.378 | 0.4 | Compliant |
| 8DPSK, DH1 | | | | | |
| Low | 0.3867 | 320 | 0.123744 | 0.4 | Compliant |
| Middle | 0.3933 | 310 | 0.121923 | 0.4 | Compliant |
| High | 0.3833 | 310 | 0.118823 | 0.4 | Compliant |
| 8DPSK, DH3 | | | | | |
| Low | 1.65 | 150 | 0.2475 | 0.4 | Compliant |
| Middle | 1.617 | 140 | 0.22638 | 0.4 | Compliant |
| High | 1.65 | 160 | 0.264 | 0.4 | Compliant |
| 8DPSK, DH5 | | | | | |
| Low | 2.9 | 80 | 0.232 | 0.4 | Compliant |
| Middle | 2.875 | 130 | 0.37375 | 0.4 | Compliant |
| High | 2.875 | 100 | 0.2875 | 0.4 | Compliant |

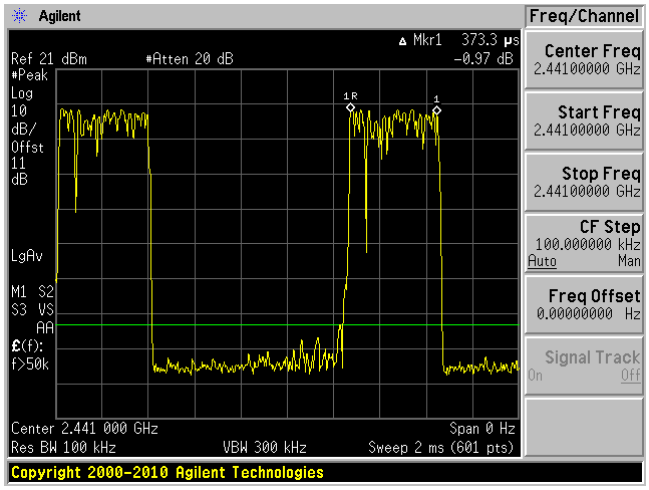
Note: The worst case hopping rates were used for testing.

## GFSK, DM1 Pulse Width

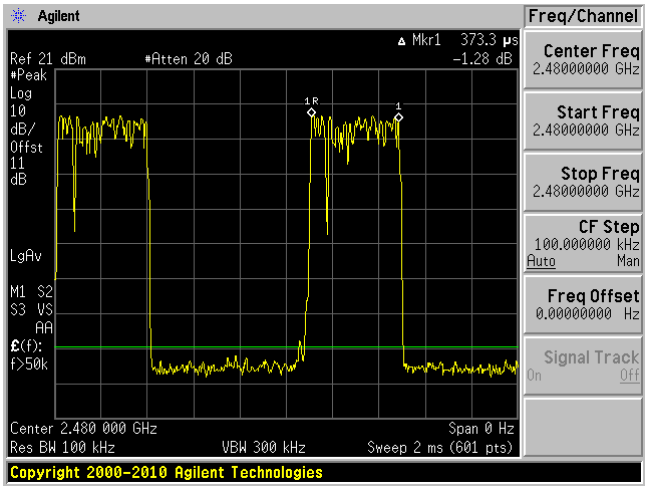
Low Channel 2402 MHz




Middle Channel 2441 MHz

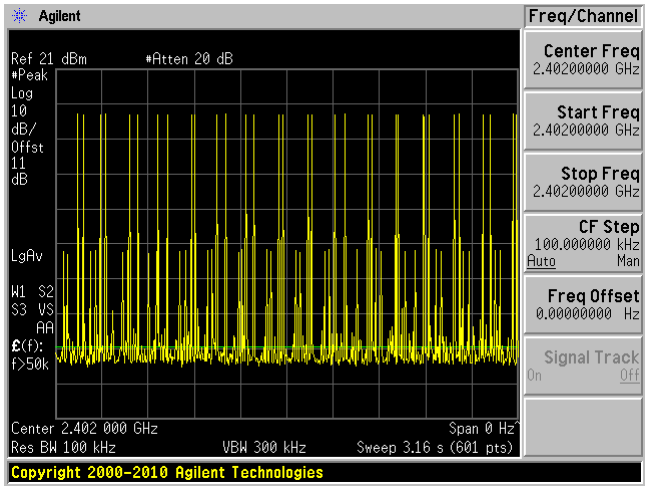



High Channel 2480 MHz

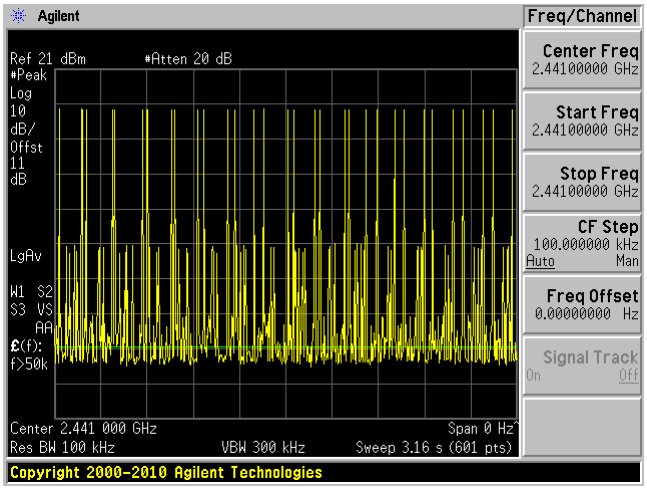


**GFSK, DM1 Number of Pulses within a Specified Time**

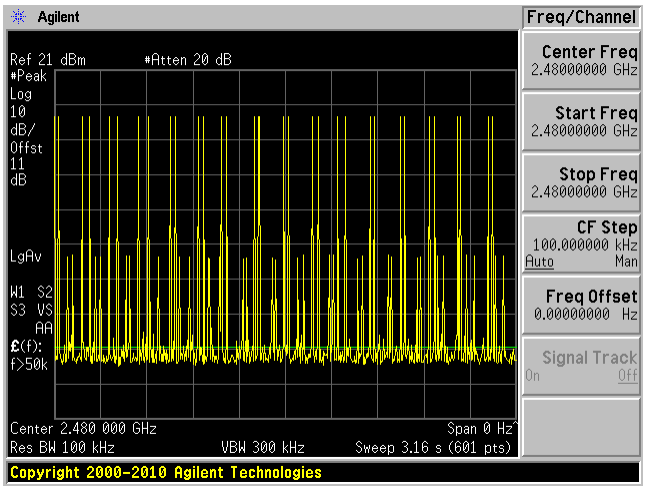
Low Channel 2402 MHz




Middle Channel 2441 MHz

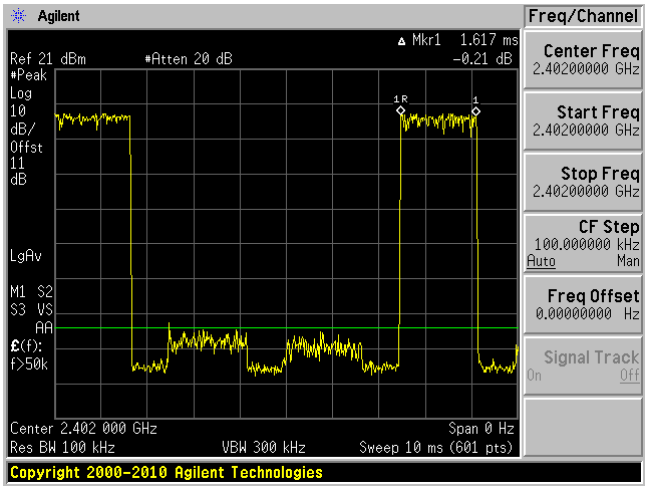



High Channel 2480 MHz

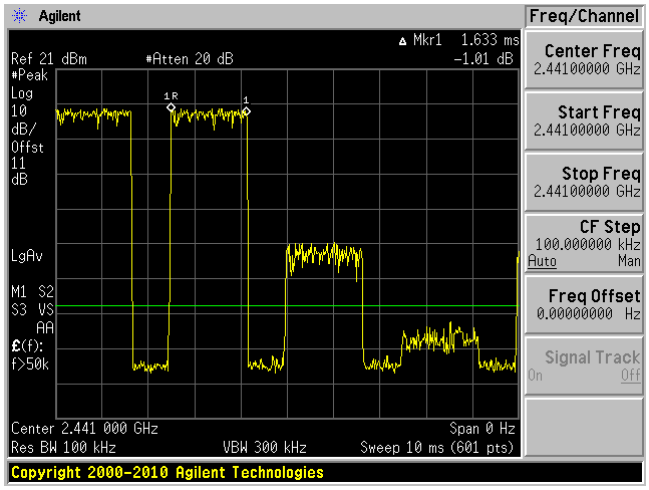


## GFSK, DM3 Pulse Width

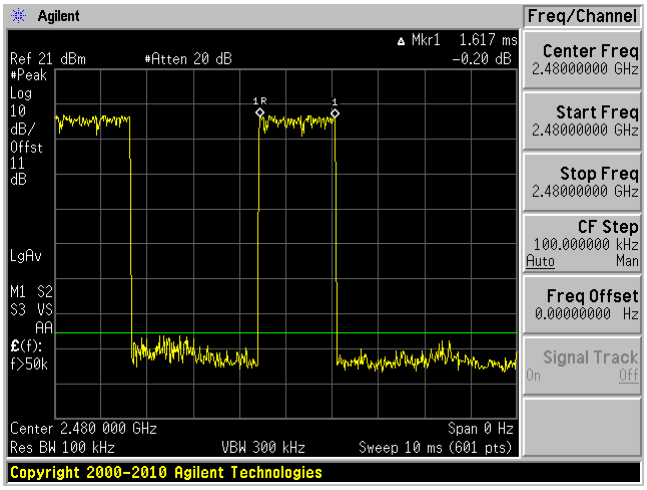
Low Channel 2402 MHz




Middle Channel 2441 MHz

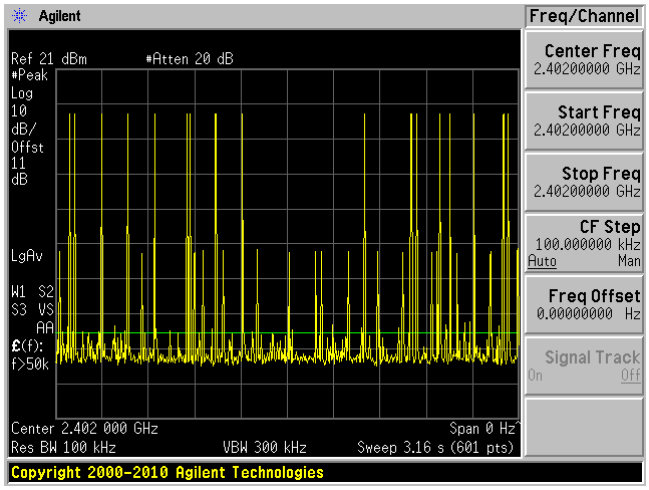



High Channel 2480 MHz

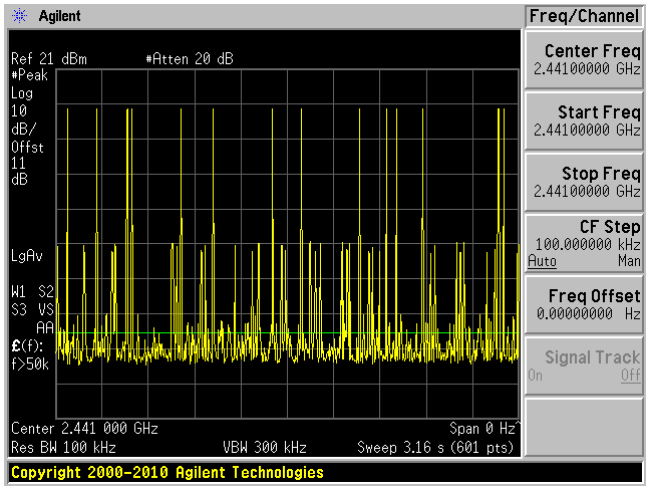


## GFSK, DM3 Number of Pulses within a Specified Time

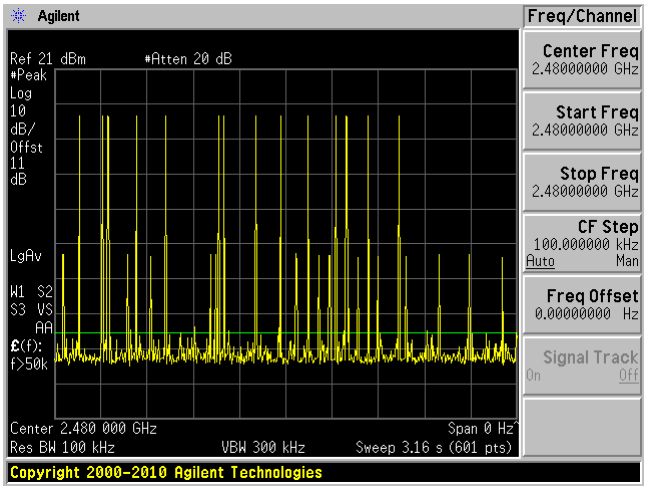
Low Channel 2402 MHz




Middle Channel 2441 MHz

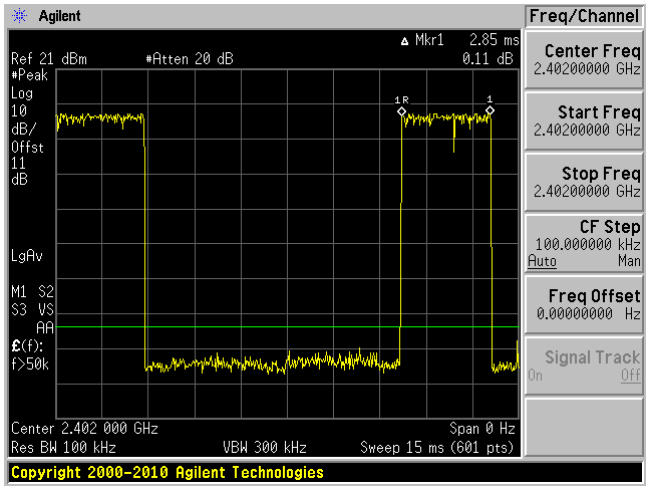



High Channel 2480 MHz

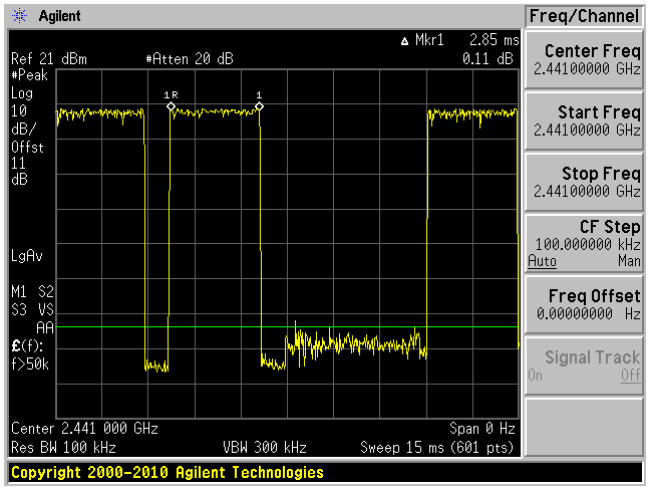


## GFSK, DM5 Pulse Width

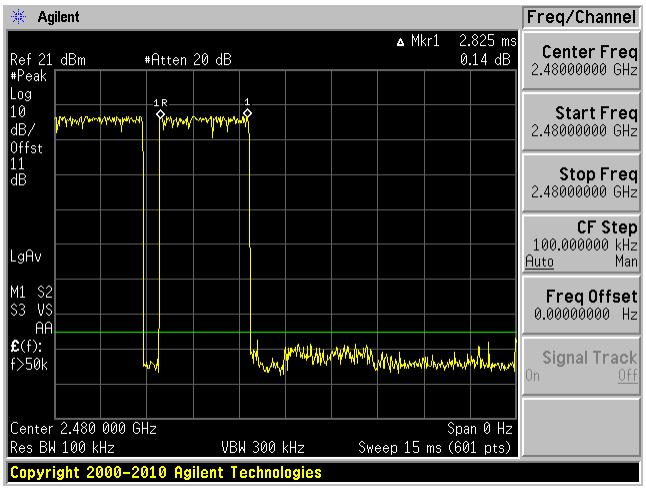
Low Channel 2402 MHz




Middle Channel 2441 MHz

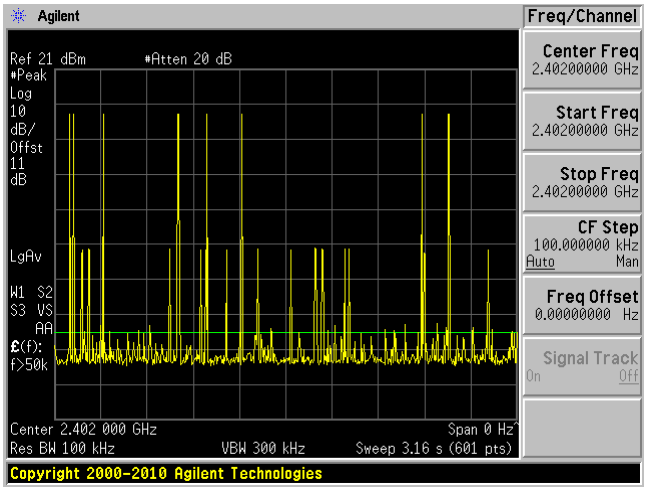



High Channel 2480 MHz

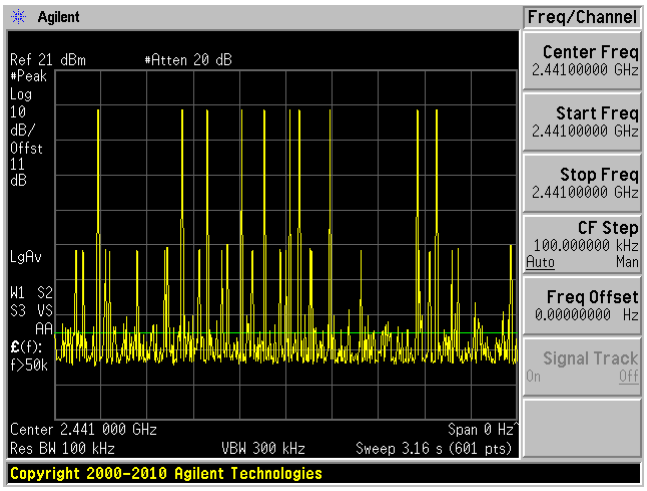


**GFSK, DM5 Number of Pulses within a Specified Time**

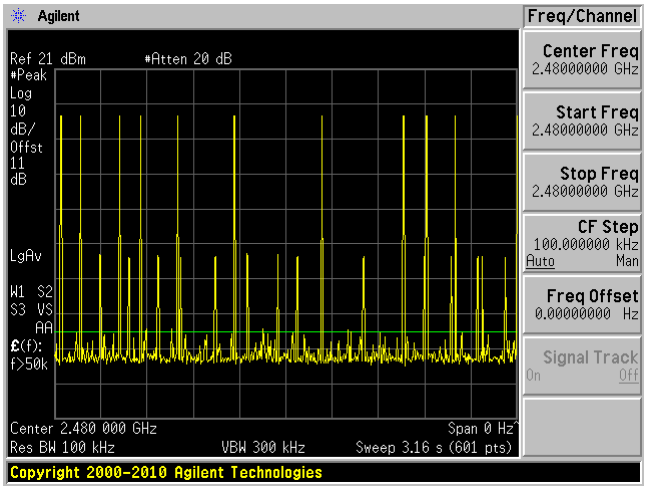
Low Channel 2402 MHz




Middle Channel 2441 MHz

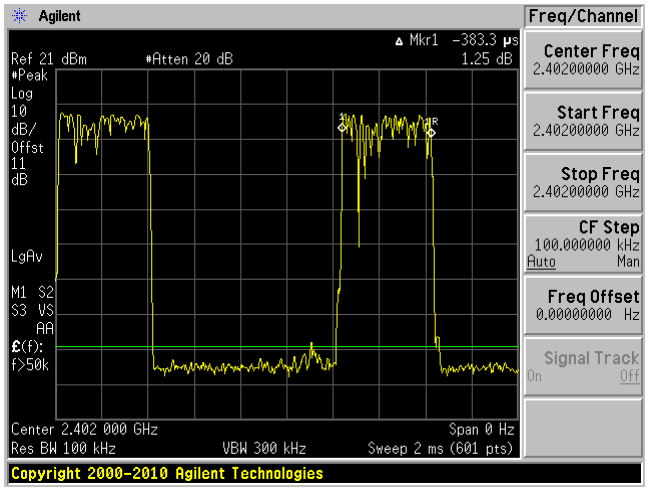



High Channel 2480 MHz

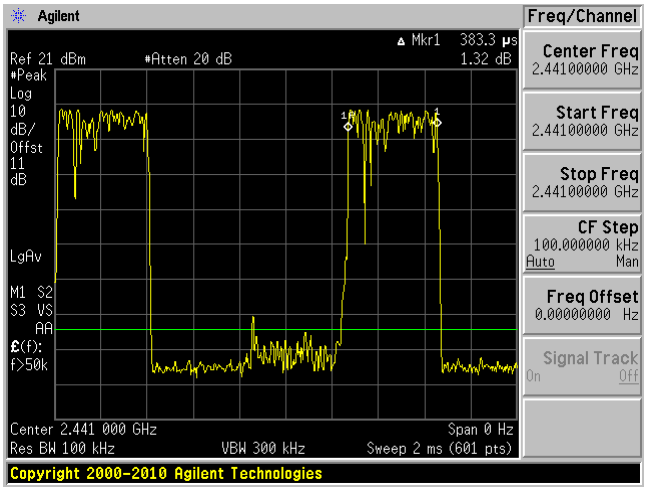


## GFSK, DH1 Pulse Width

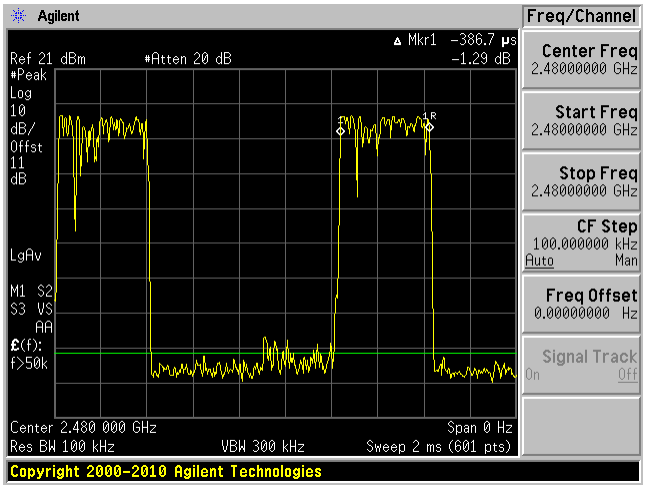
Low Channel 2402 MHz




Middle Channel 2441 MHz

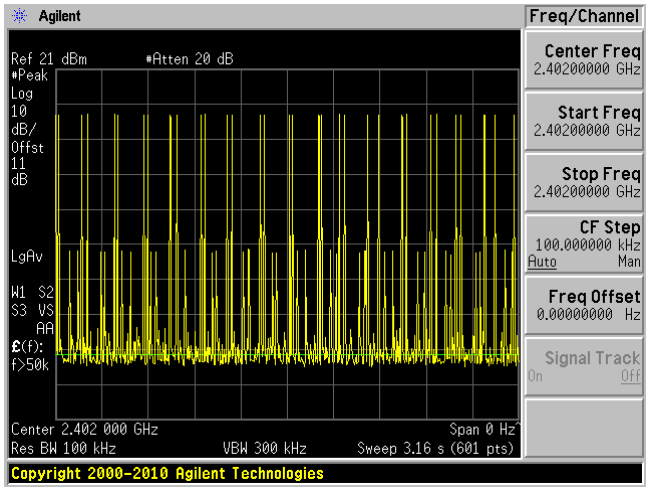



High Channel 2480 MHz

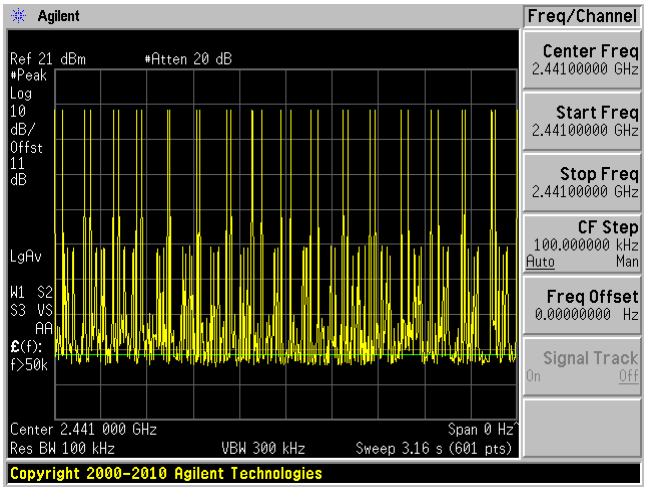


## GFSK, DH1 Number of Pulses within a Specified Time

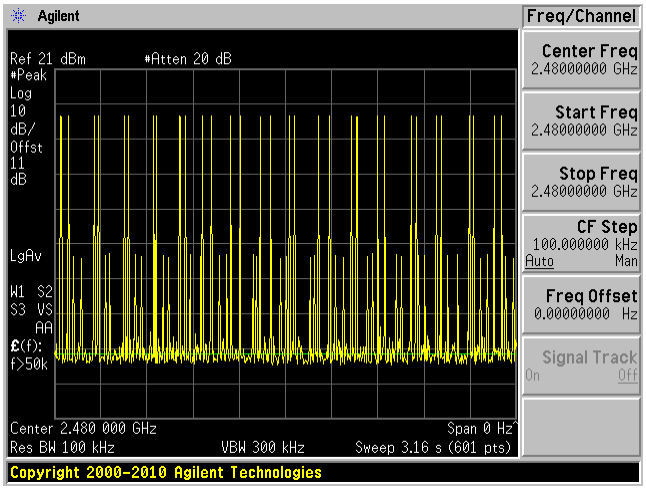
Low Channel 2402 MHz




Middle Channel 2441 MHz

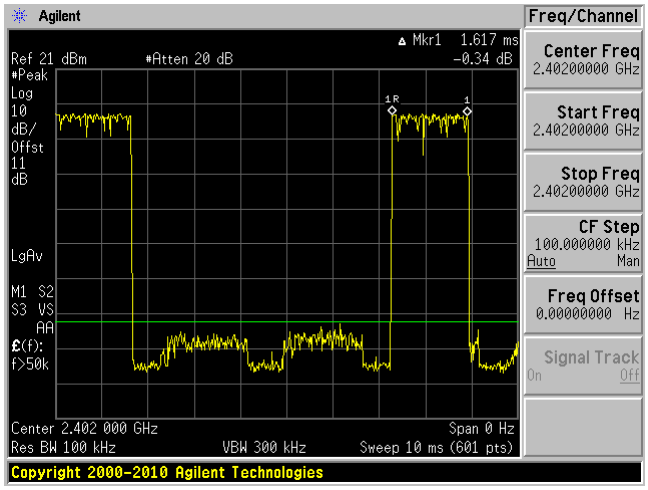



High Channel 2480 MHz

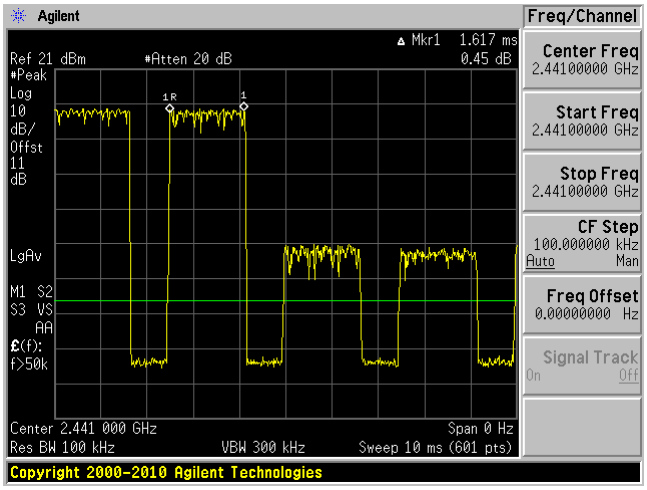


## GFSK, DH3 Pulse Width

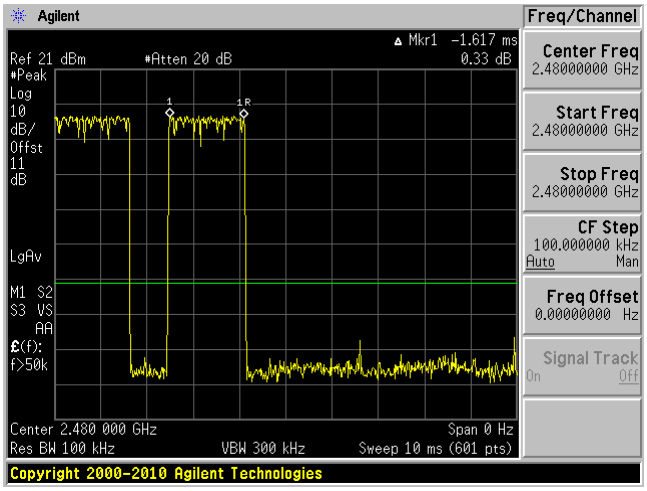
Low Channel 2402 MHz




Middle Channel 2441 MHz

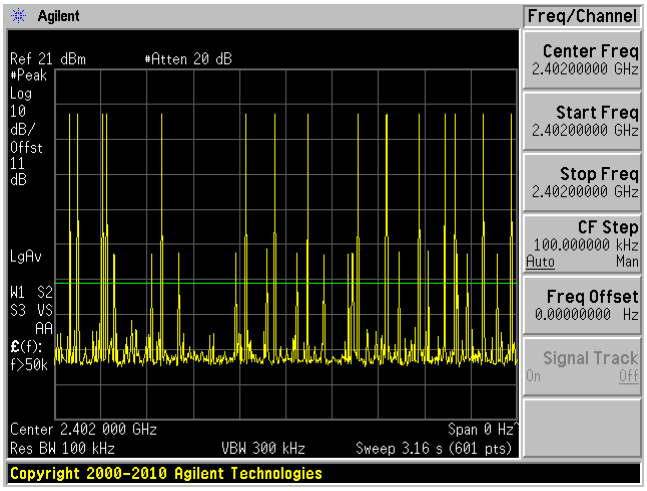



High Channel 2480 MHz

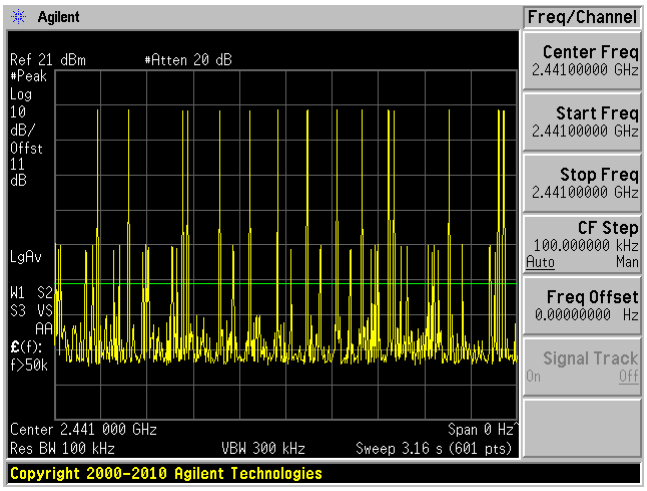


## GFSK, DH3 Number of Pulses within a Specified Time

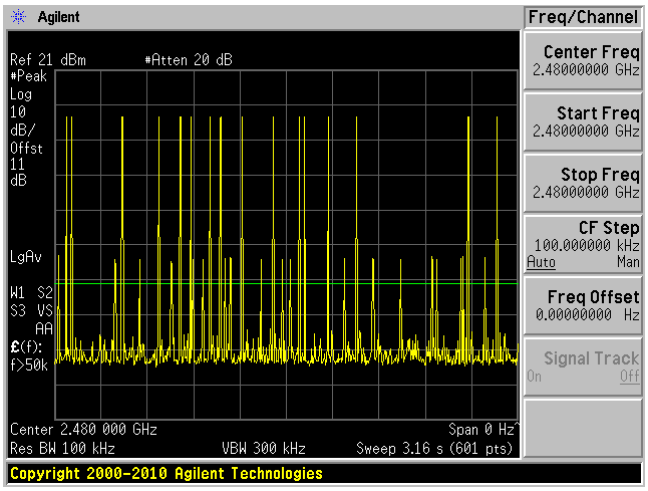
Low Channel 2402 MHz




Middle Channel 2441 MHz

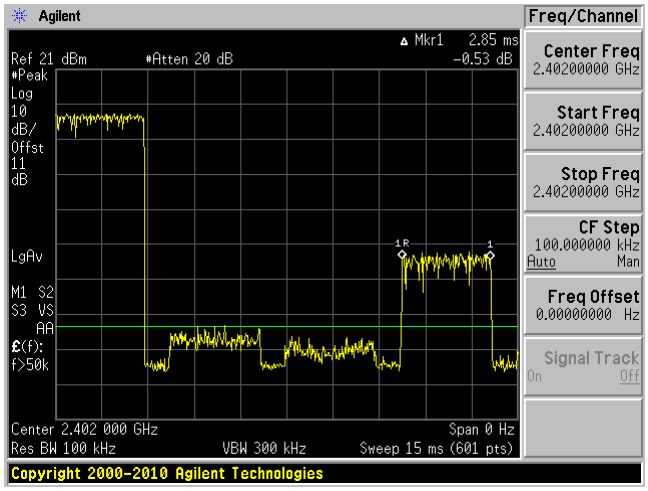



High Channel 2480 MHz

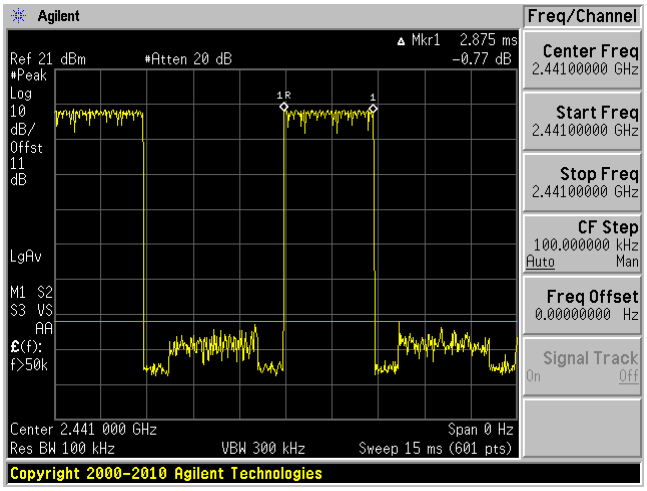


## GFSK, DH5 Pulse Width

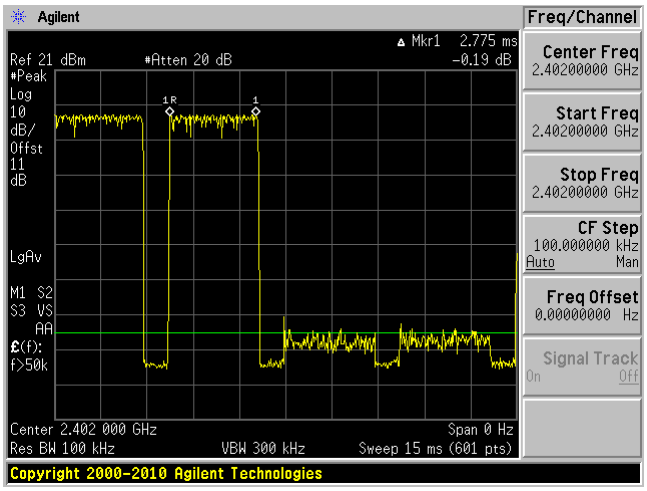
Low Channel 2402 MHz




Middle Channel 2441 MHz

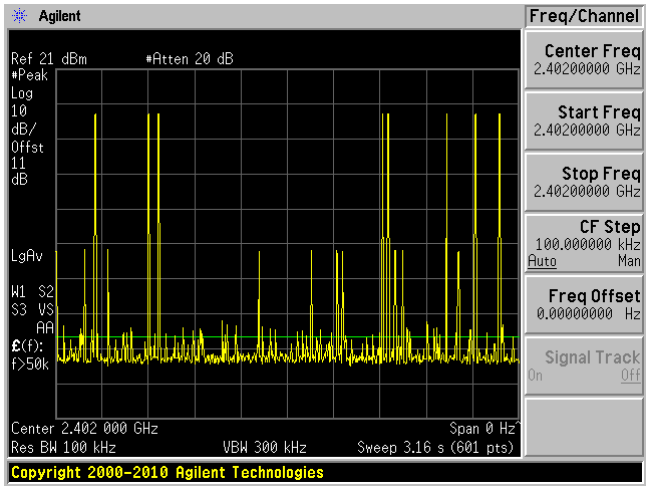



High Channel 2480 MHz

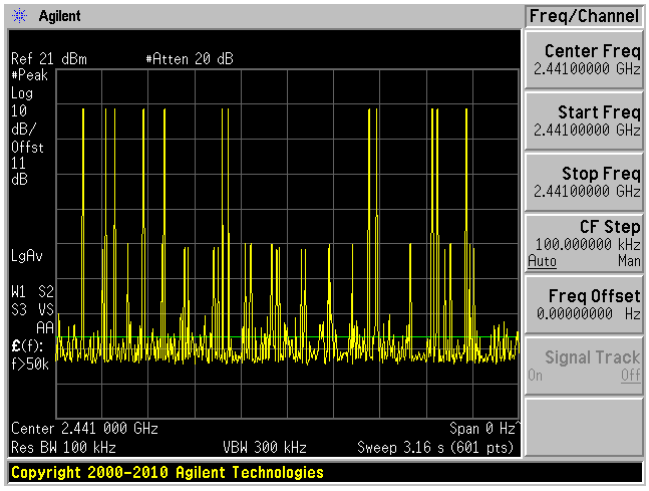


## GFSK, DH5 Number of Pulses within a Specified Time

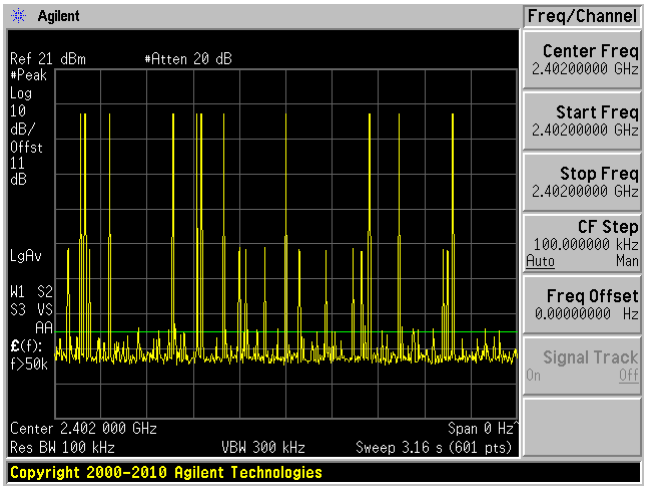
Low Channel 2402 MHz




Middle Channel 2441 MHz

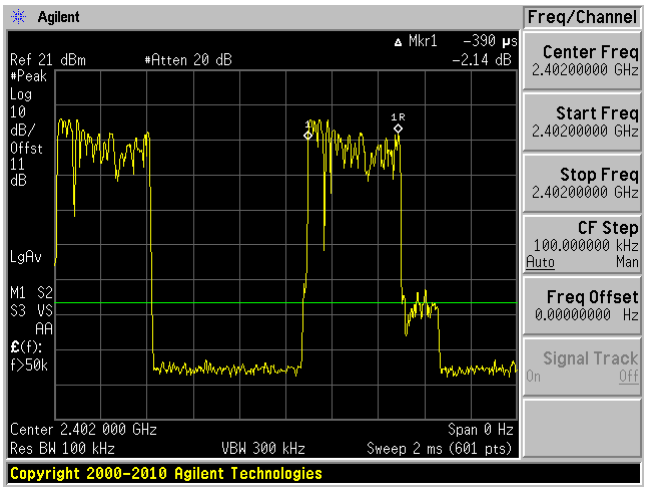



High Channel 2480 MHz

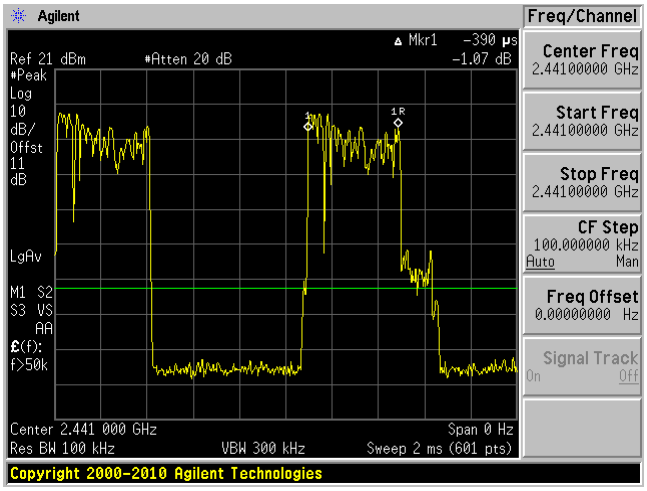


## π/4-DQPSK, DH1 Pulse Width

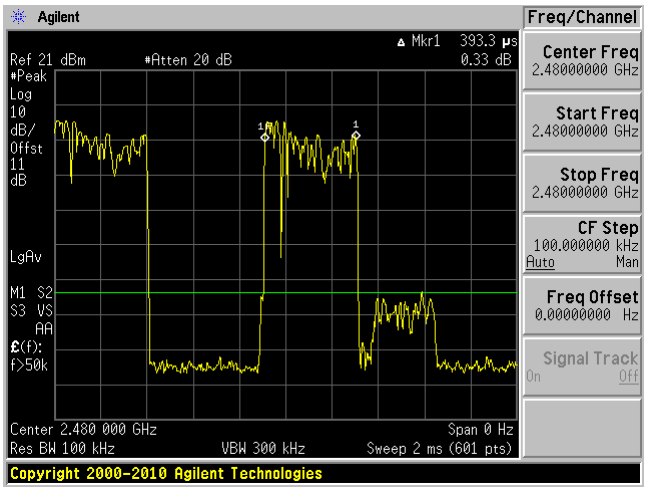
Low Channel 2402 MHz




Middle Channel 2441 MHz

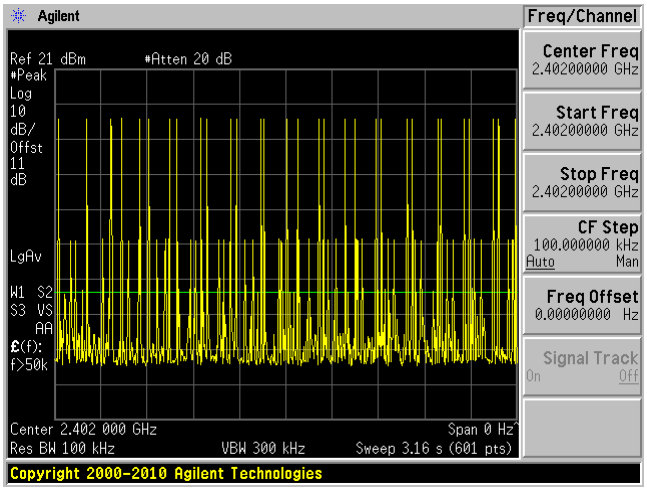



High Channel 2480 MHz

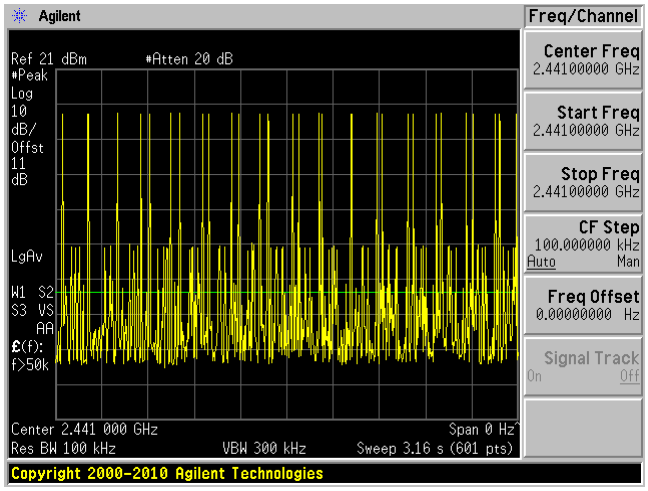


## π/4-DQPSK, DH1 Number of Pulses within a Specified Time

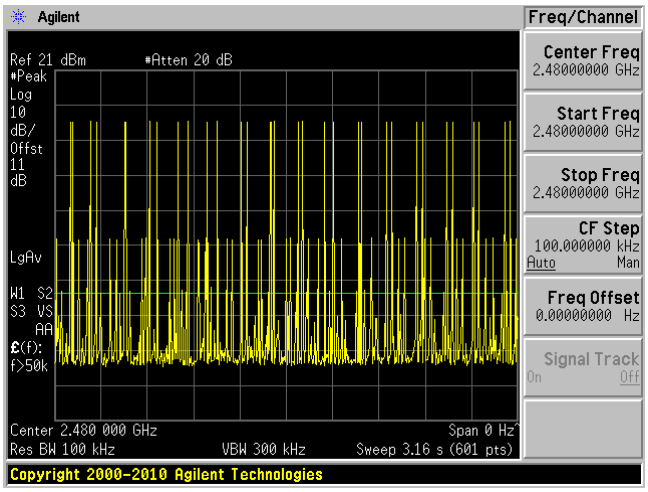
Low Channel 2402 MHz




Middle Channel 2441 MHz

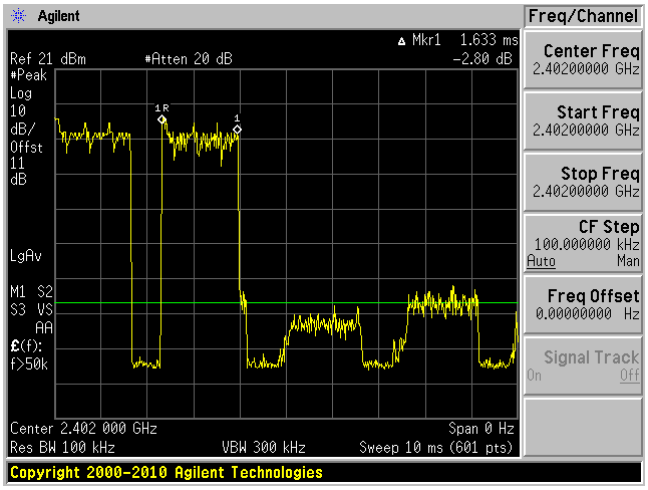



High Channel 2480 MHz

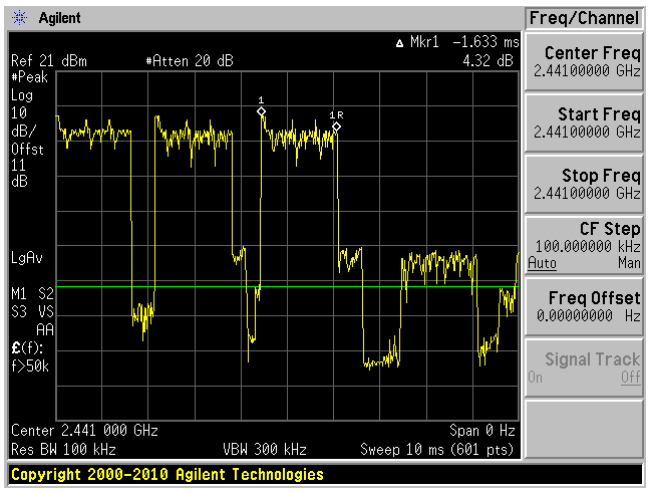


## π/4-DQPSK, DH3 Pulse Width

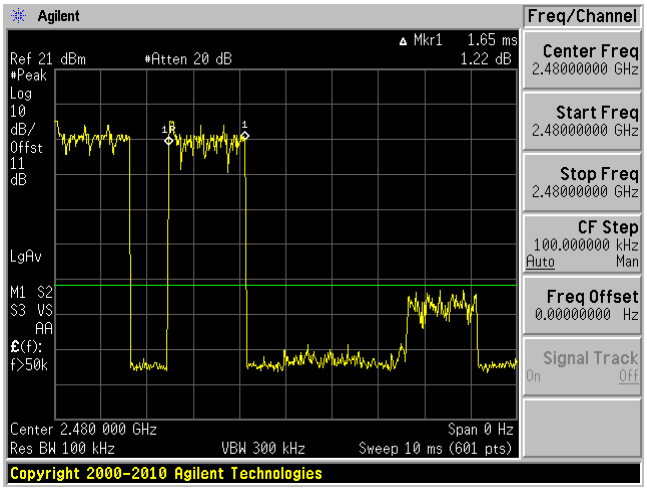
Low Channel 2402 MHz




Middle Channel 2441 MHz

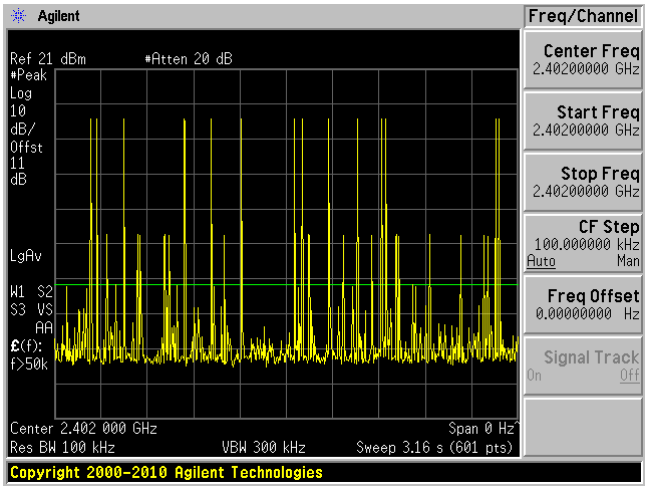



High Channel 2480 MHz

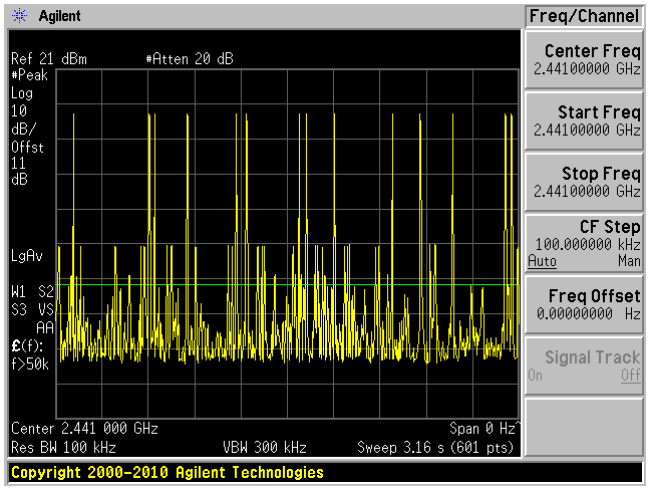


**π/4-DQPSK, DH3 Number of Pulses within a Specified Time**

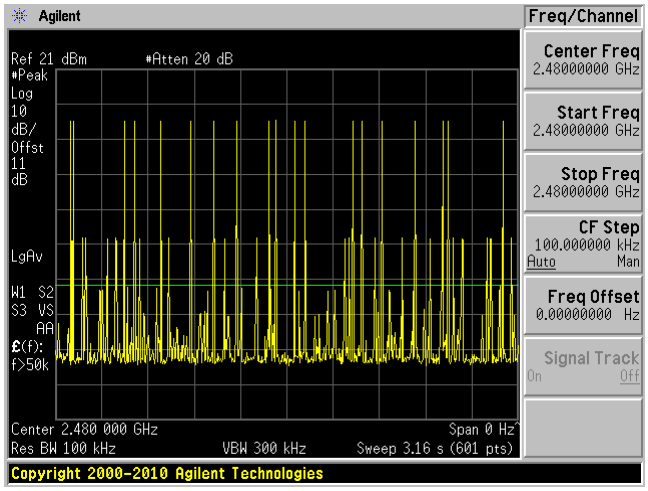
Low Channel 2402 MHz




Middle Channel 2441 MHz

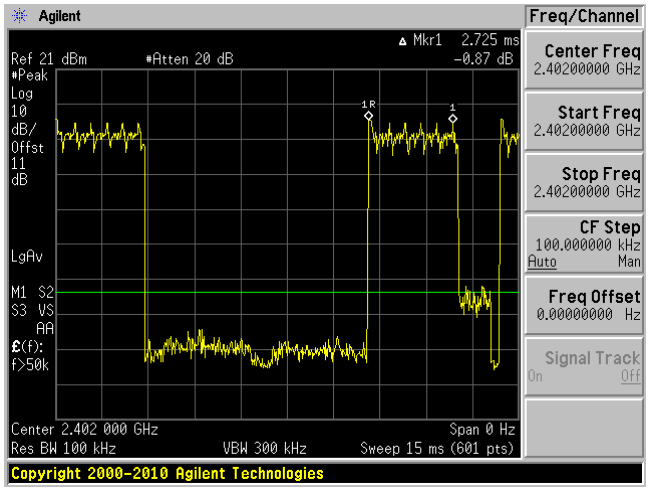



High Channel 2480 MHz

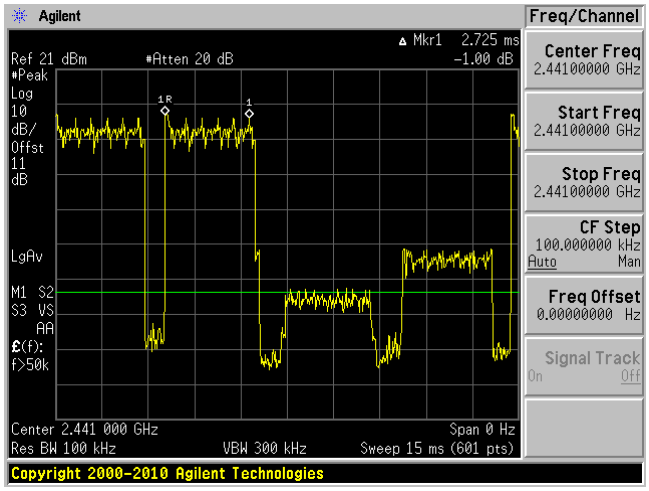


## π/4-DQPSK, DH5 Pulse Width

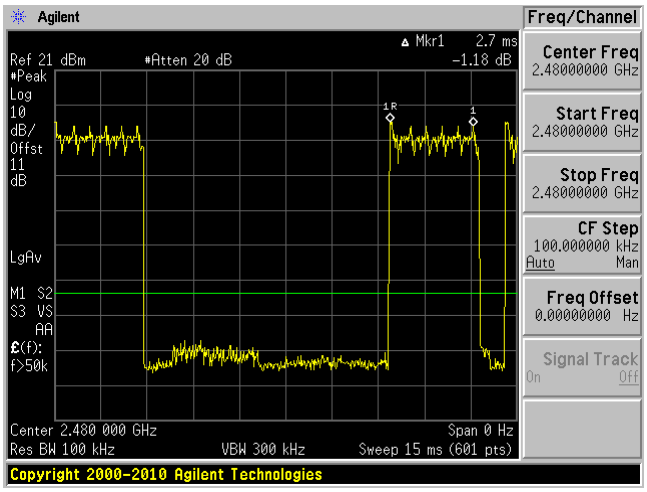
Low Channel 2402 MHz




Middle Channel 2441 MHz

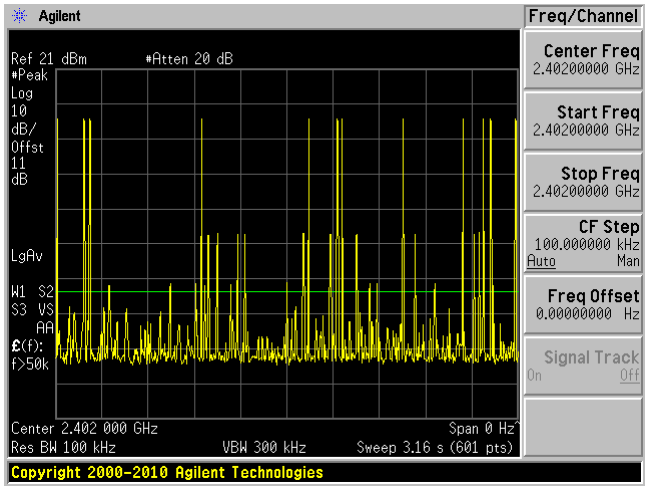



High Channel 2480 MHz

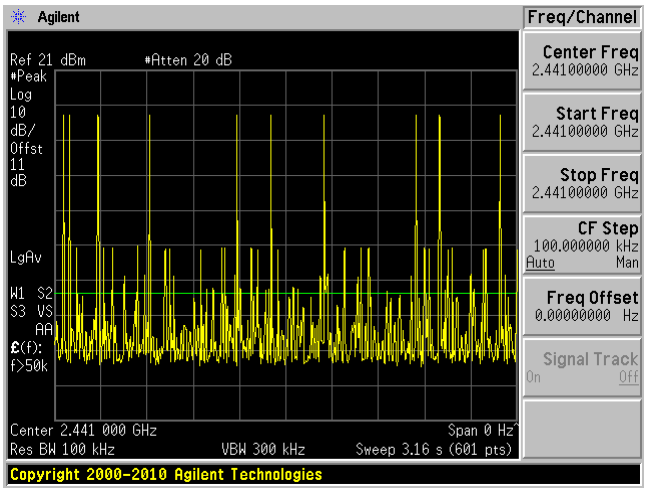


**π/4-DQPSK, DH5 Number of Pulses within a Specified Time**

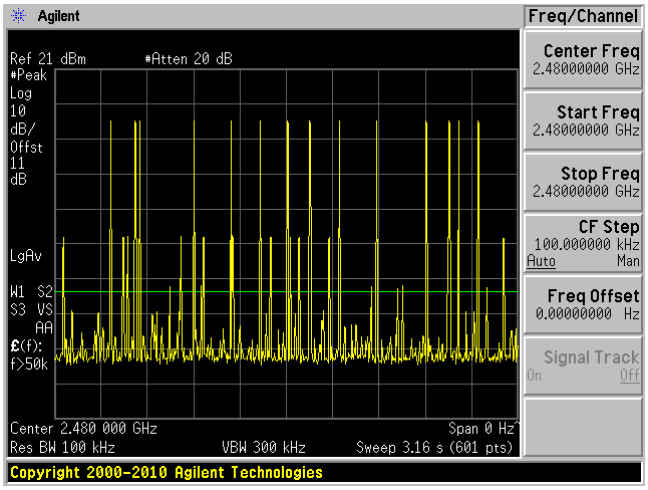
Low Channel 2402 MHz




Middle Channel 2441 MHz

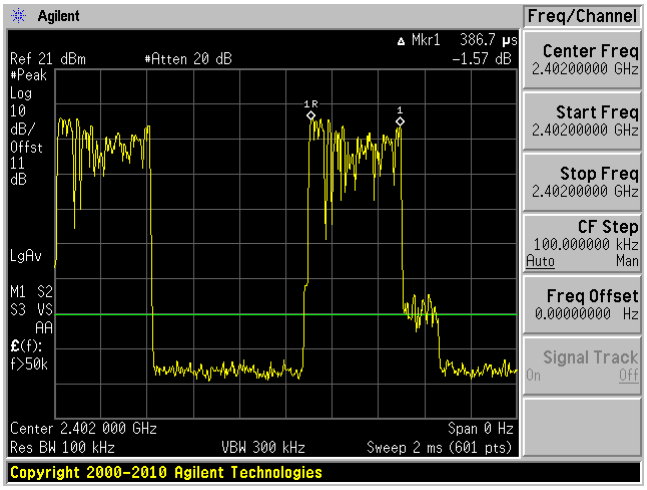



High Channel 2480 MHz

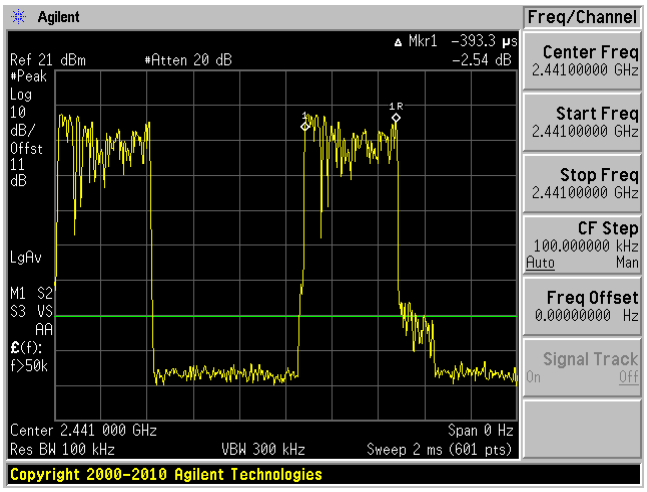


## 8DPSK, DH1 Pulse Width

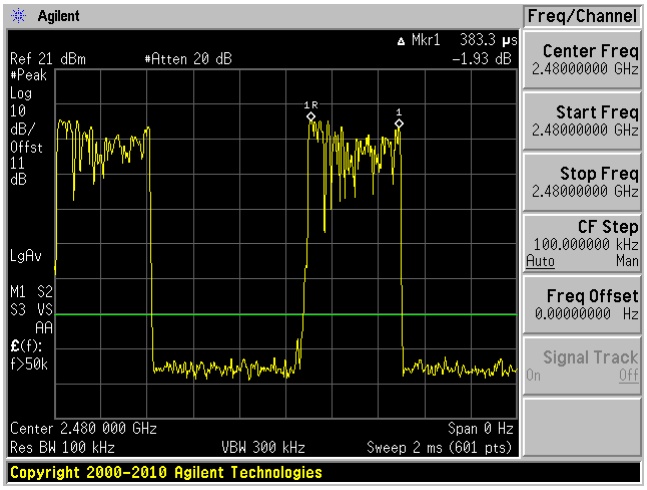
Low Channel 2402 MHz




Middle Channel 2441 MHz

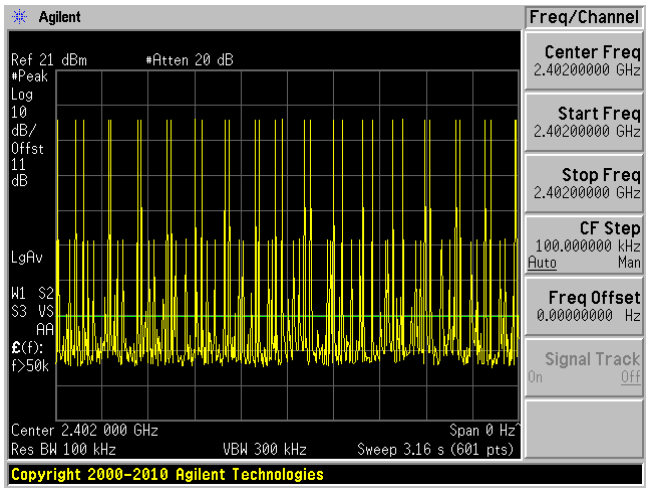



High Channel 2480 MHz

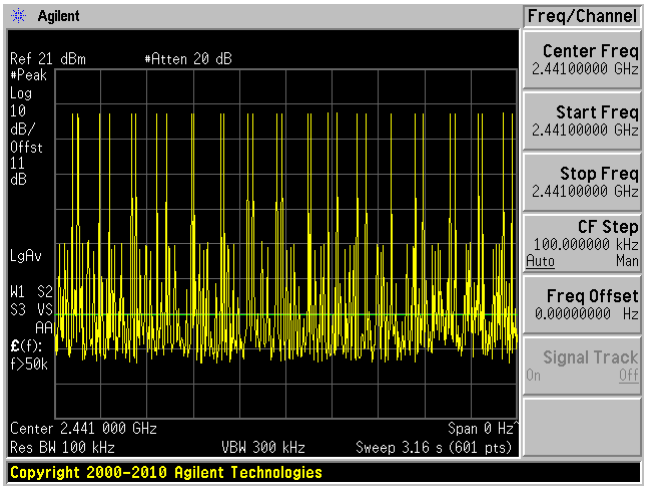


## 8DPSK, DH1 Number of Pulses within a Specified Time

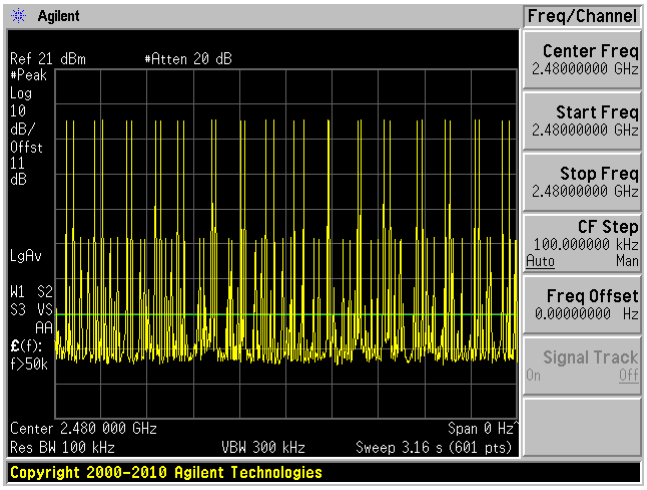
Low Channel 2402 MHz




Middle Channel 2441 MHz

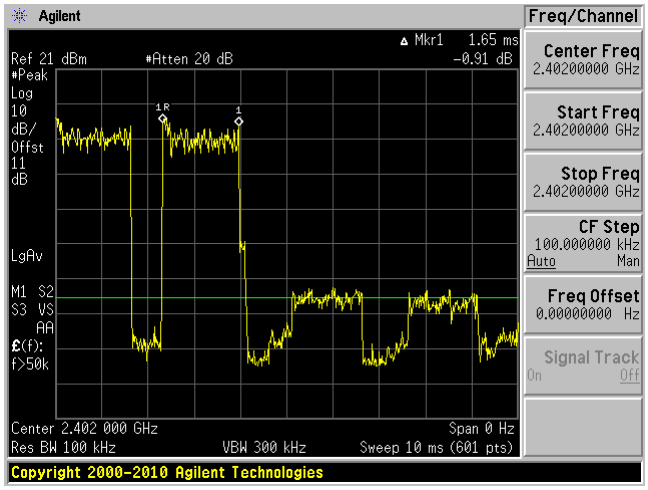



High Channel 2480 MHz

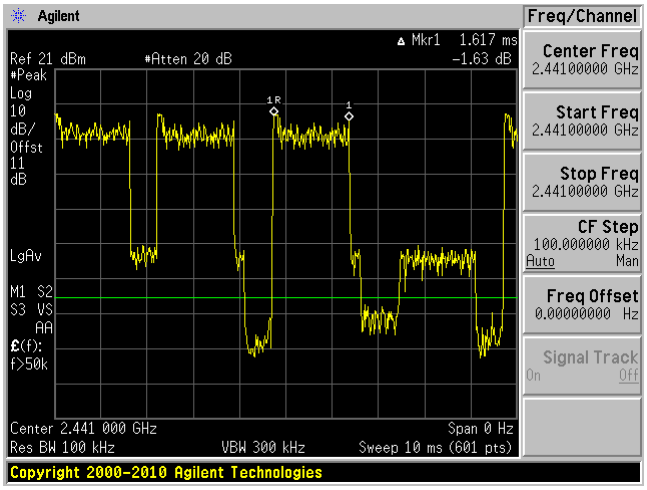


## 8DPSK, DH3 Pulse Width

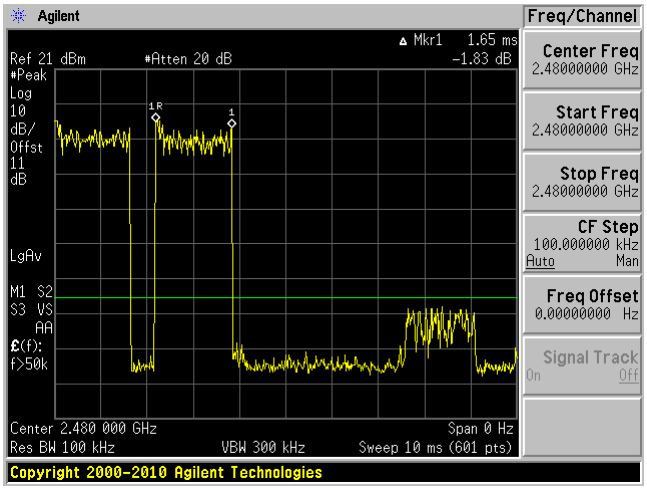
Low Channel 2402 MHz




Middle Channel 2441 MHz

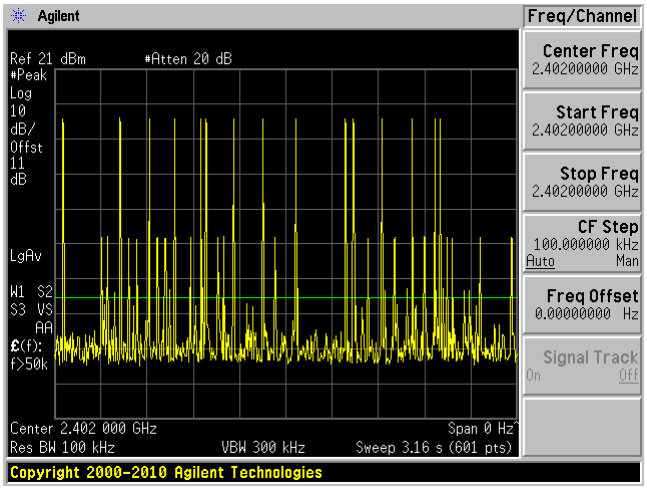



High Channel 2480 MHz

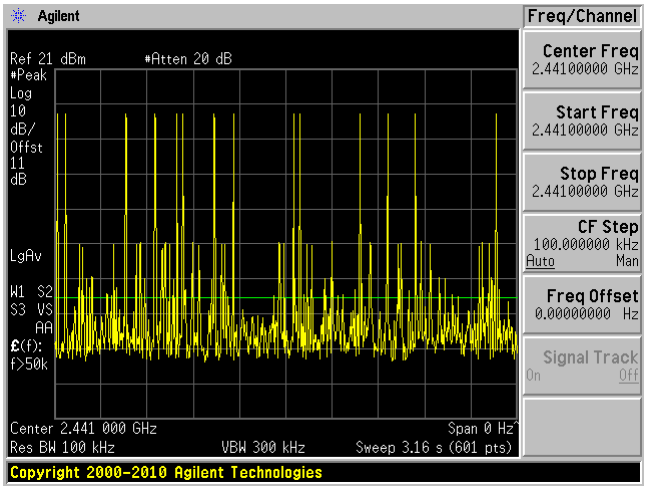


## 8DPSK, DH3 Number of Pulses within a Specified Time

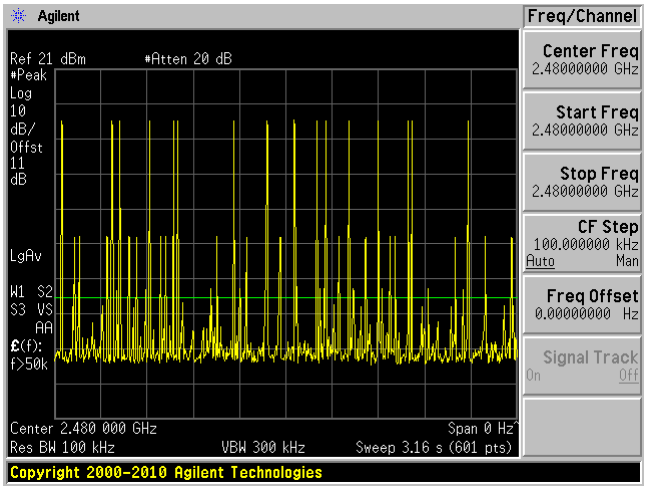
Low Channel 2402 MHz




Middle Channel 2441 MHz

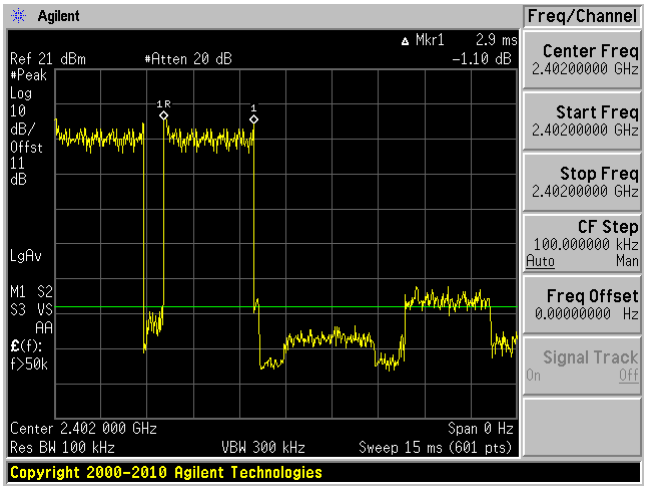



High Channel 2480 MHz

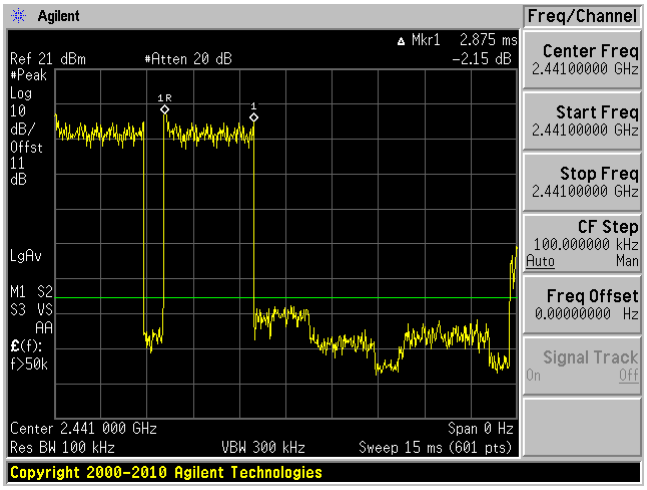


## 8DPSK, DH5 Pulse Width

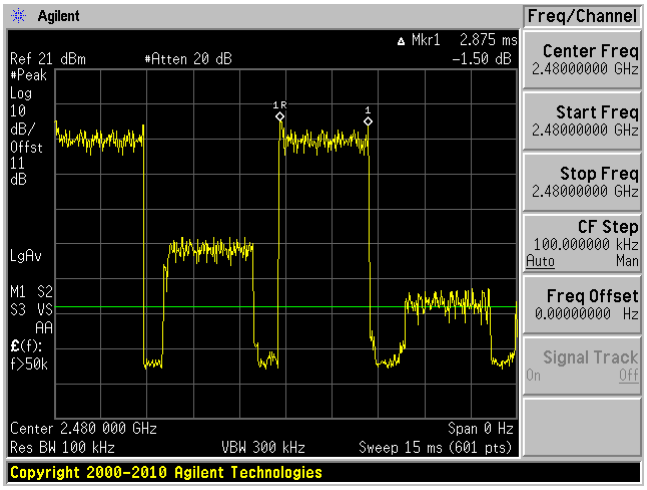
Low Channel 2402 MHz




Middle Channel 2441 MHz

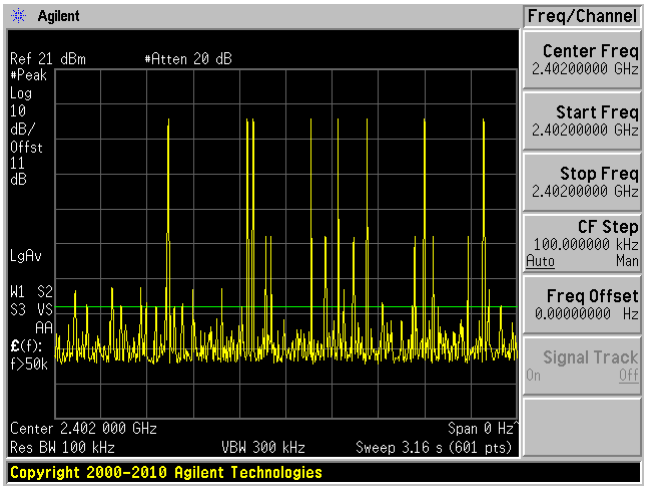



High Channel 2480 MHz

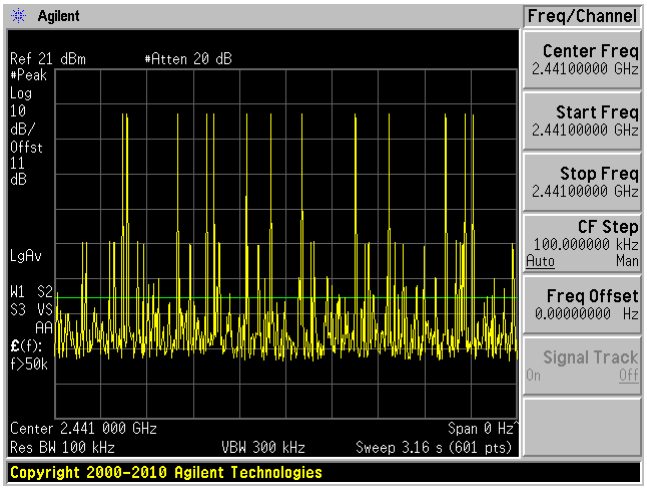


**8DPSK, DH5 Number of Pulses within a Specified Time**

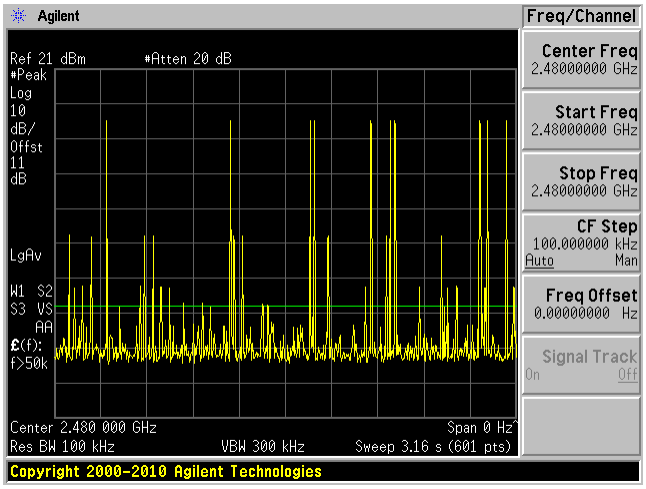
Low Channel 2402 MHz




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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 1 year |
| - | 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.*

## 12.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

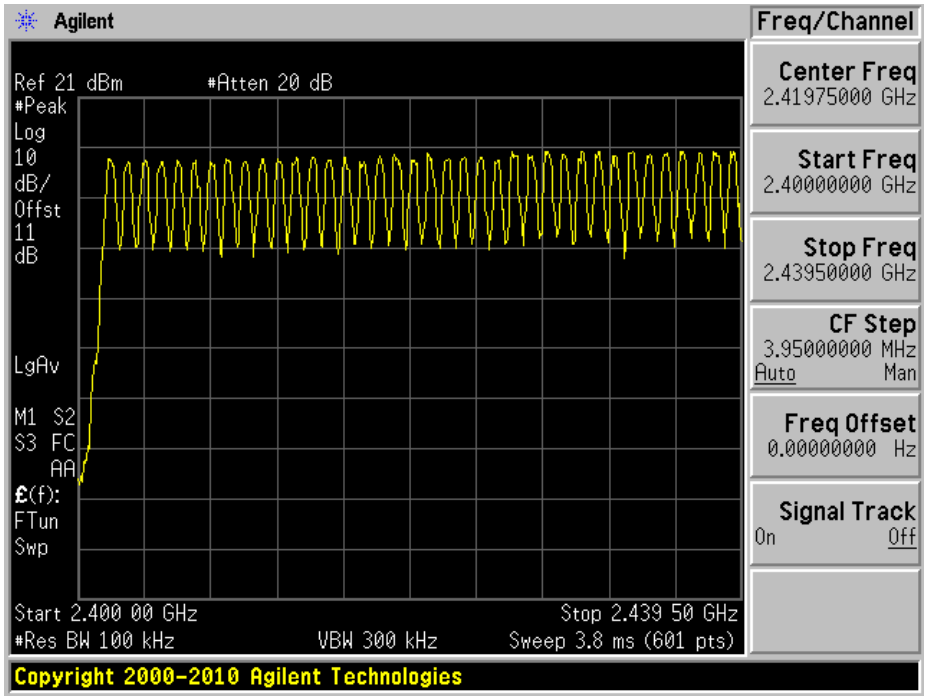
*The testing was performed by Todd Moy on 2016-04-27 in RF site.*

## 12.5 Test Results

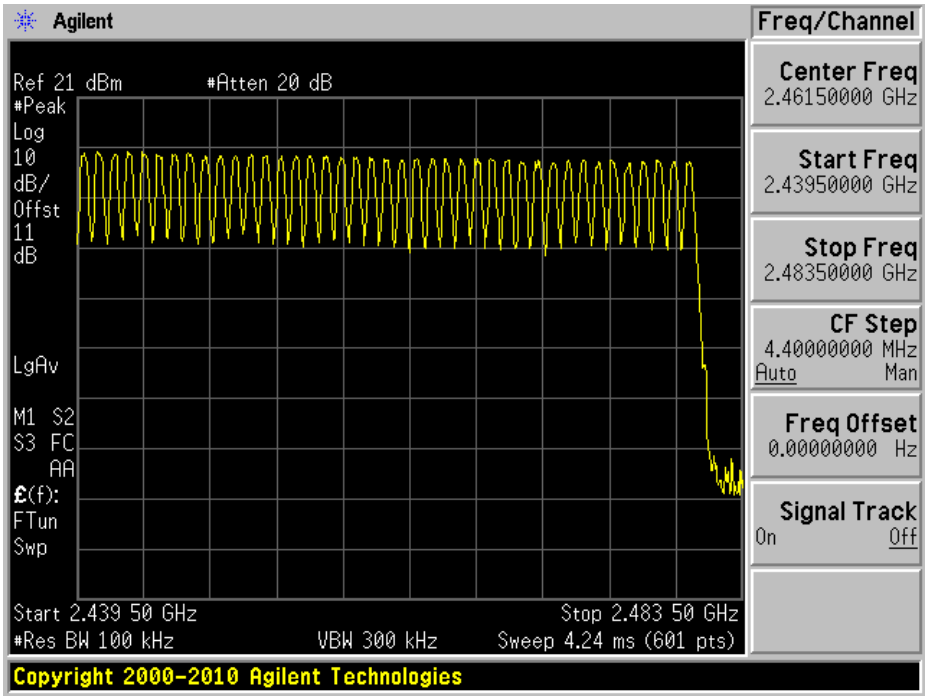
| Modulation | Number of Hopping Channels |
|---|---|
| GFSK | 79 |
| π/4-DQPSK | 79 |
| 8DPSK | 79 |

**GFSK**

2400 to 2439.5 MHz

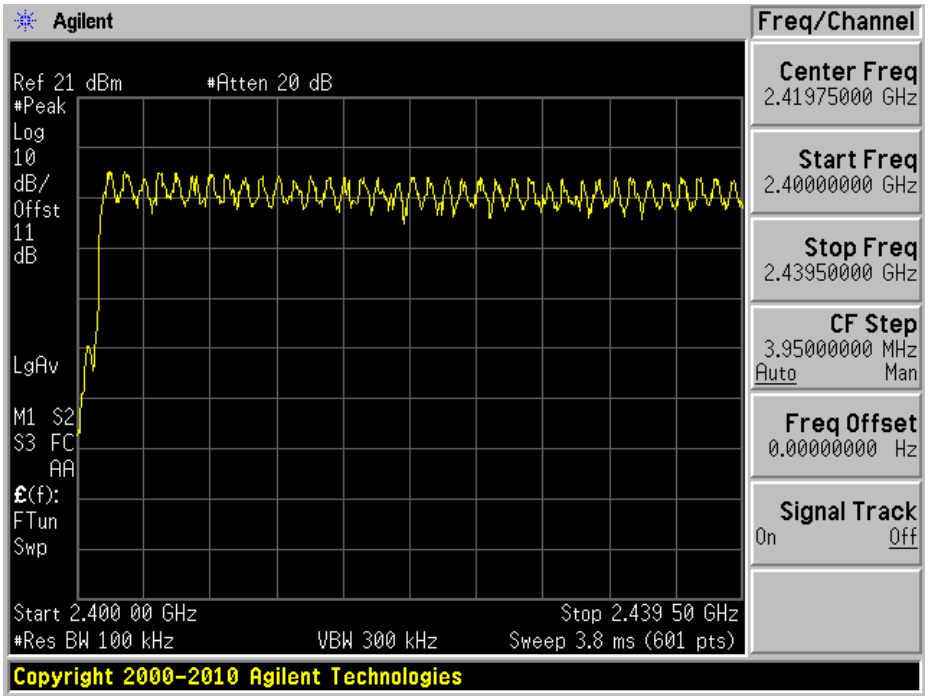



2439.5 to 2483.5 MHz

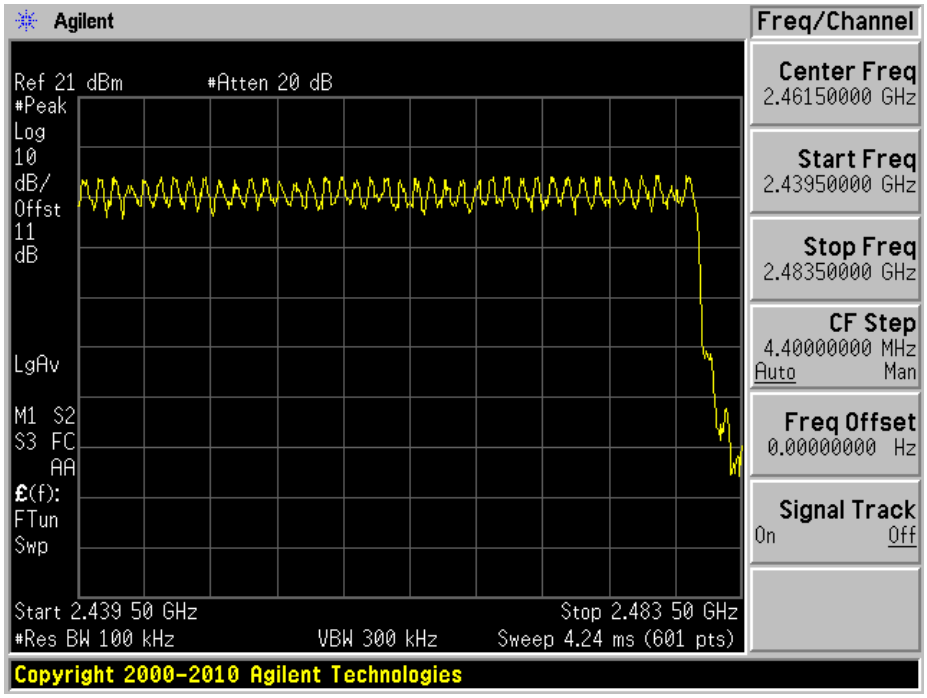


**π/4-DQPSK**

2400 to 2439.5 MHz

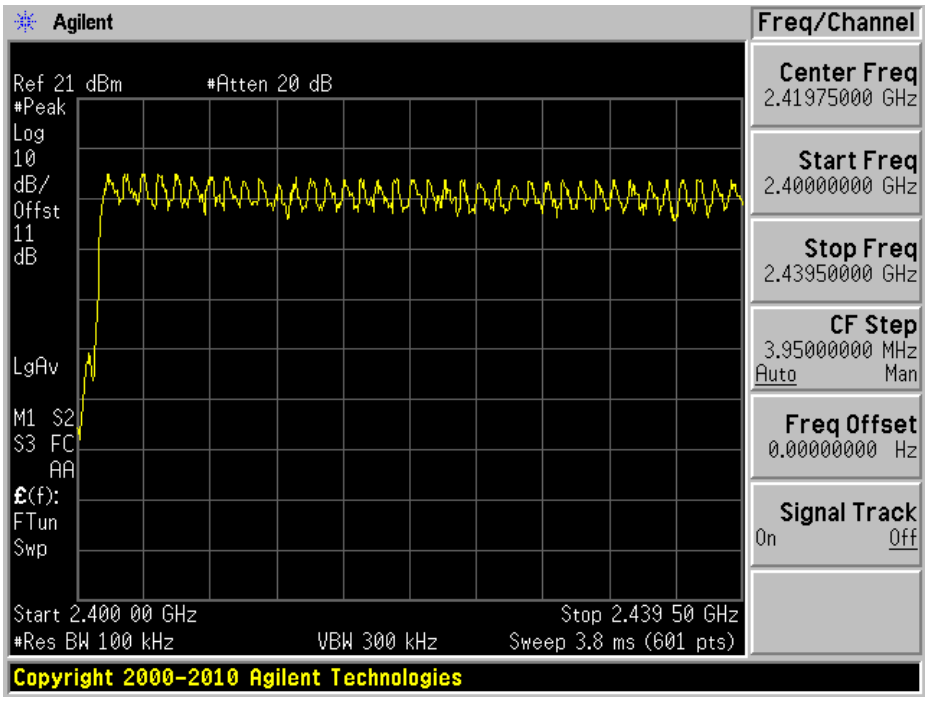



2439.5 to 2483.5 MHz

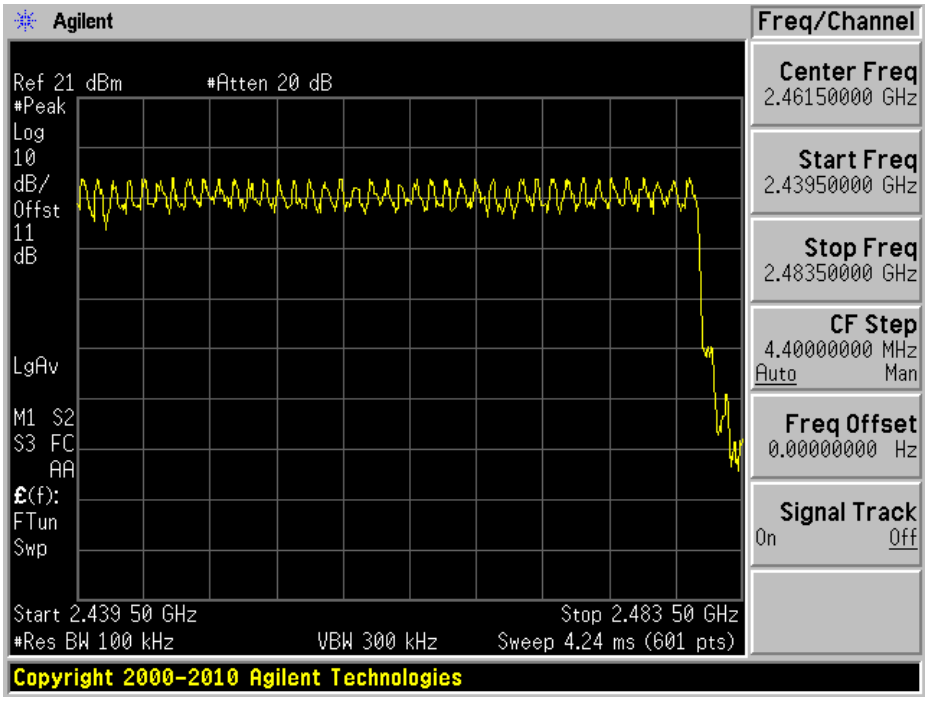


**8DPSK**

2400 to 2439.5 MHz




2439.5 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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 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.*

## 13.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

*The testing was performed by Todd Moy on 2016-04-27 in RF site.*

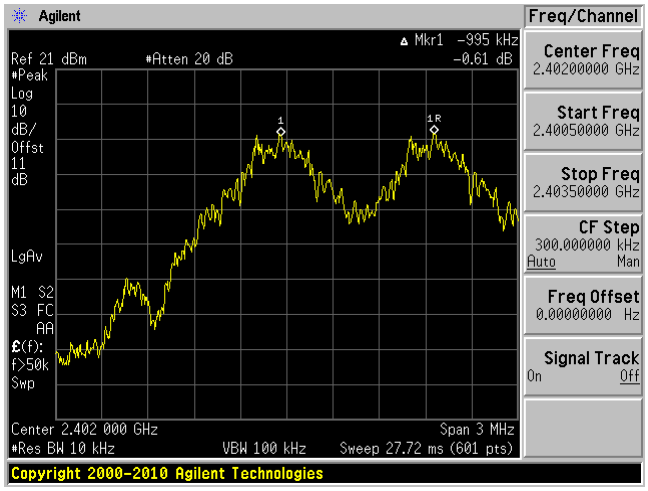
## 13.5 Test Results

| Channel | Frequency (MHz) | Channel Separation (kHz) | Limit > 2/3 20 dB Bandwidth (kHz) |
|---|---|---|---|
| GFSK | | | |
| Low | 2402 | 995 | 589.03 |
| Middle | 2441 | 1000 | 615.03 |
| High | 2480 | 1005 | 611.53 |
| π/4-DQPSK | | | |
| Low | 2402 | 1000 | 928.00 |
| Middle | 2441 | 1190 | 906.00 |
| High | 2480 | 1000 | 919.33 |
| 8DPSK | | | |
| Low | 2402 | 1000 | 925.33 |
| Middle | 2441 | 1005 | 924.00 |
| High | 2480 | 995 | 923.33 |

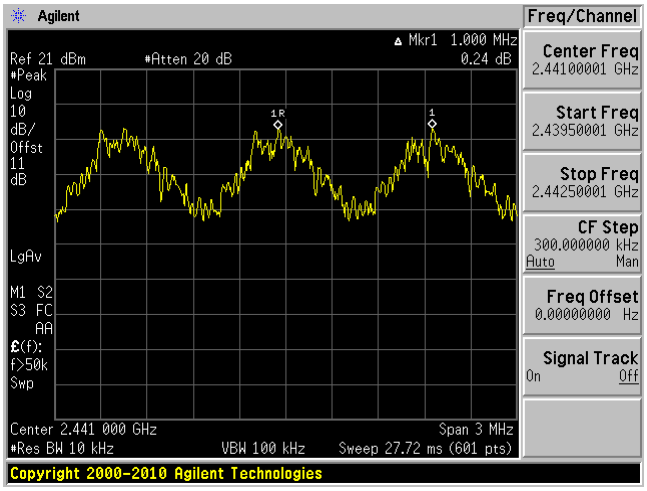
Please refer to following plots.

## GFSK

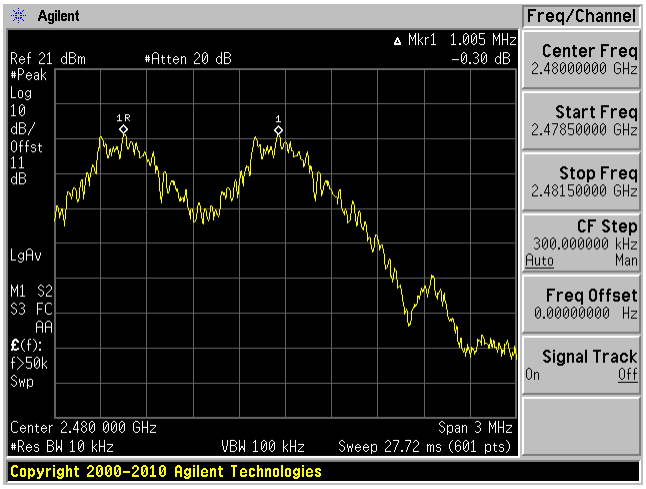
Low Channel 2402 MHz




Middle Channel 2441 MHz

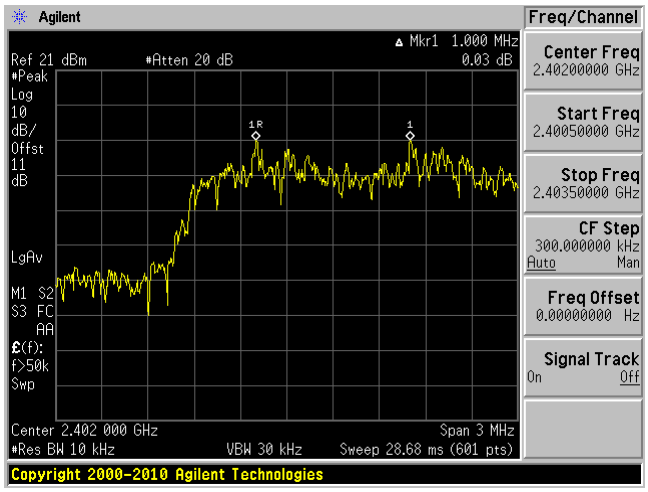



High Channel 2480 MHz

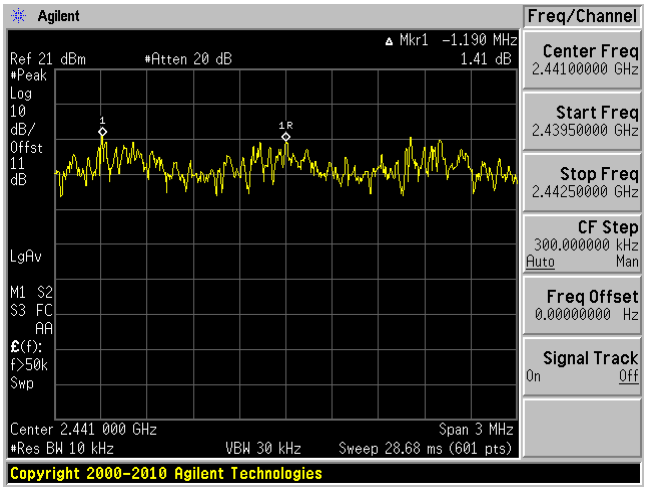


**π/4-DQPSK**

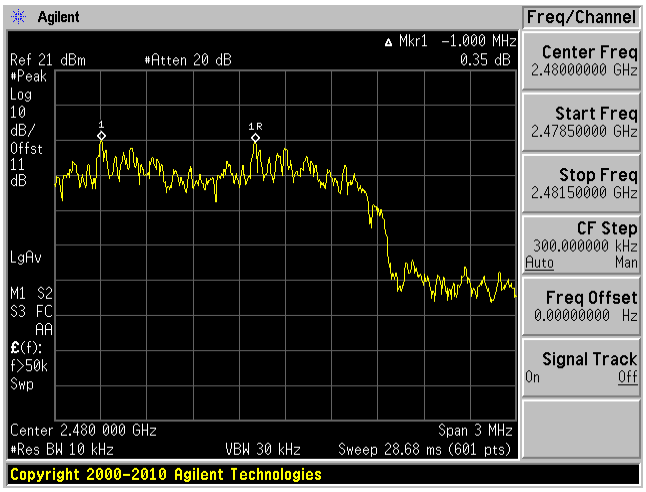
Low Channel 2402 MHz




Middle Channel 2441 MHz

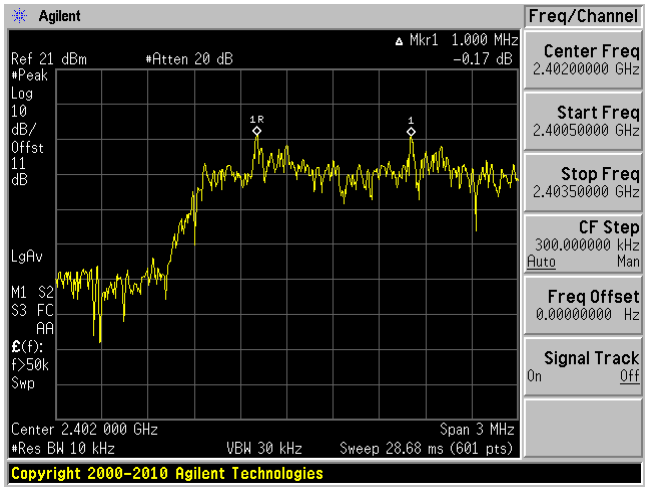



High Channel 2480 MHz

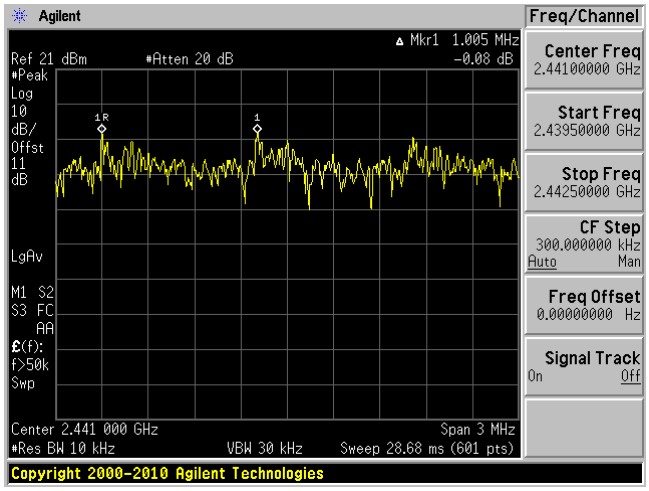


**8DPSK**

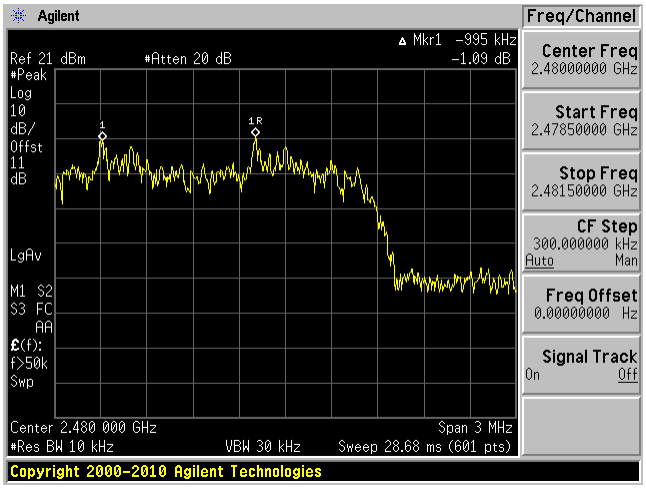
Low Channel 2402 MHz




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 ISED 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

| Manufacturer | Description | Model No. | Serial No. | Calibration Date | Calibration Interval |
|---|---|---|---|---|---|
| Agilent | Analyzer, Spectrum | E4440A | MY44303352 | 2015-06-22 | 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.*

## 14.4 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22 ºC |
| **Relative Humidity:** | 42 % |
| **ATM Pressure:** | 102.7 KPa |

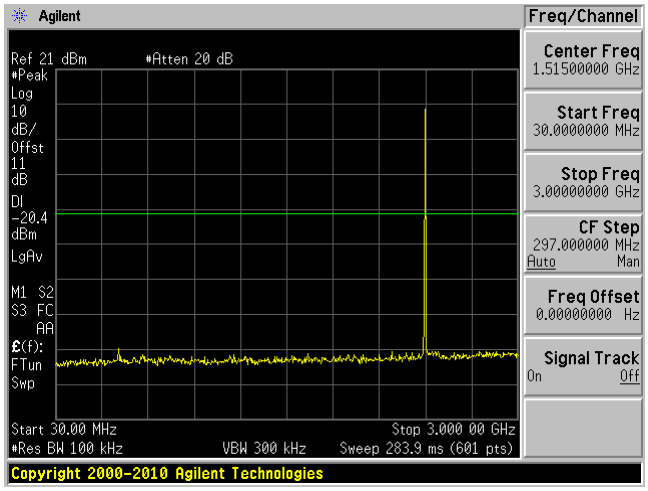
*The testing was performed by Jose Martinez on 2016-05-27 in RF site.*

## 14.5 Test Results

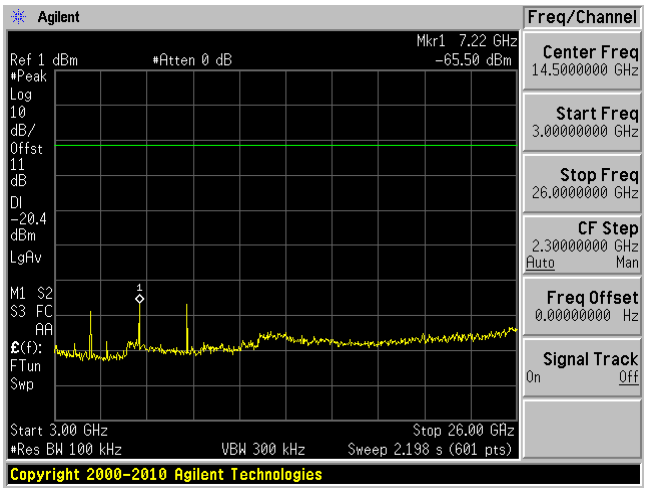
Please refer to following plots.

**GFSK**

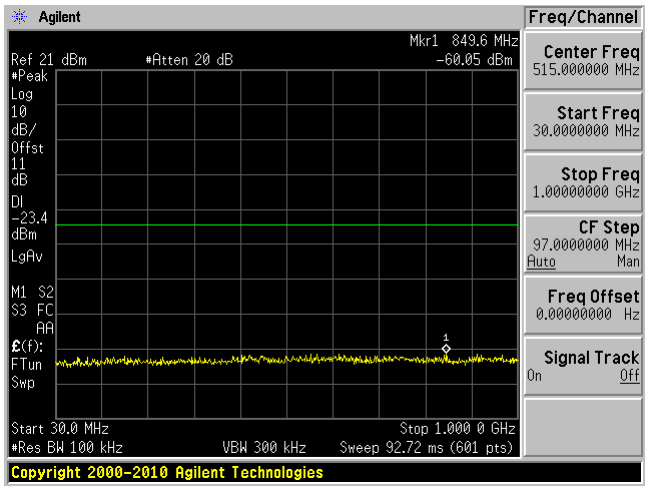
Low Channel 30 MHz – 3 GHz



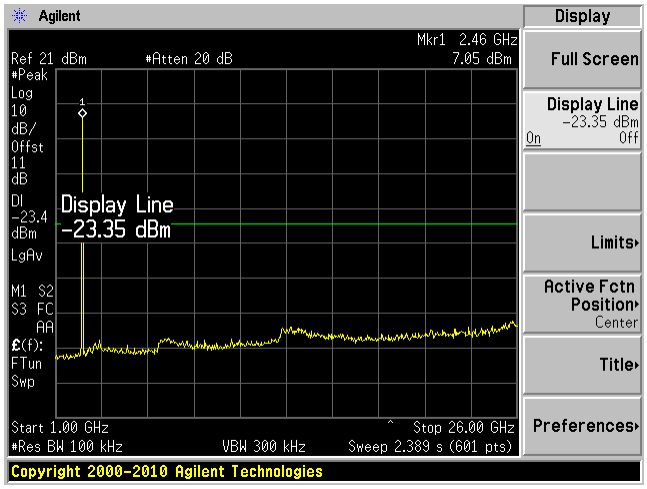

Low Channel 3GHz – 25 GHz



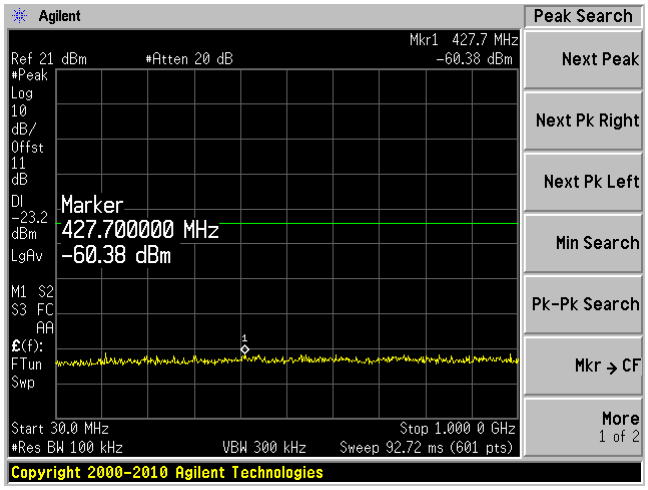
Middle Channel 30 MHz – 1 GHz



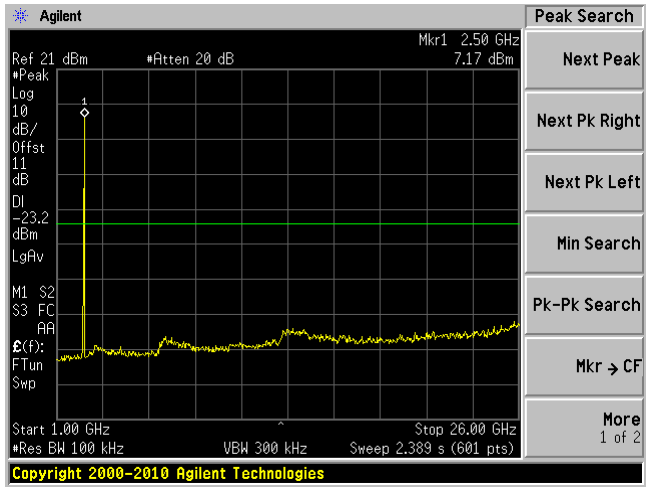

Middle Channel 1 GHz – 25 GHz




High Channel 30 MHz – 1 GHz

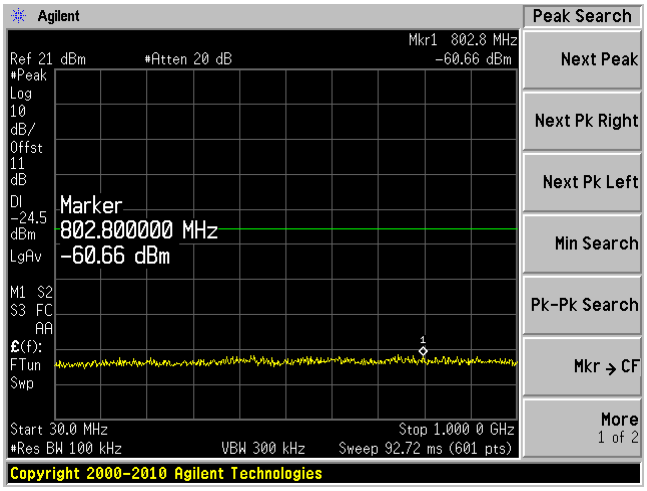



High Channel 1 GHz – 25 GHz

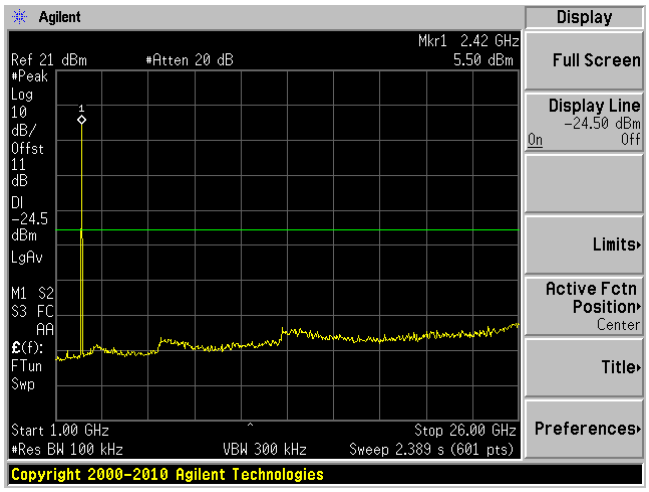


## π/4-DQPSK

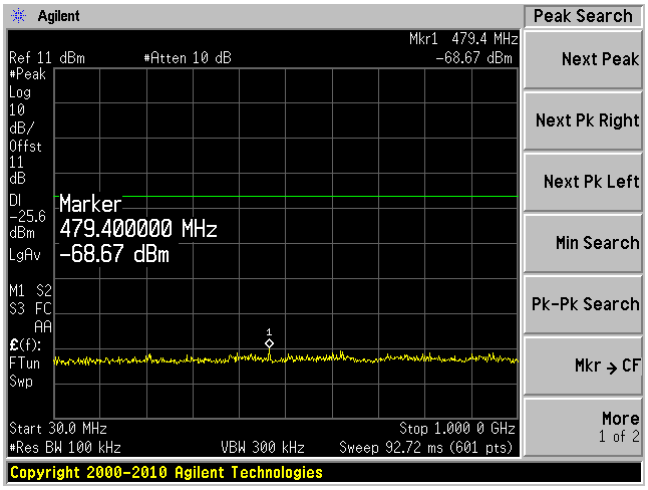
Low Channel 30 MHz – 1 GHz



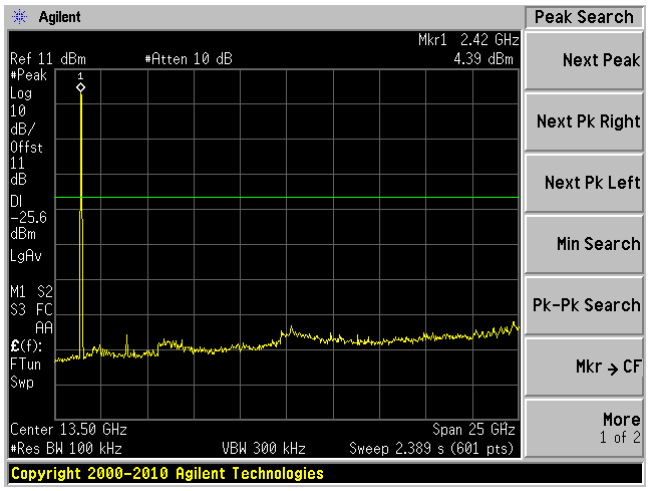

Low Channel 1 GHz – 25 GHz



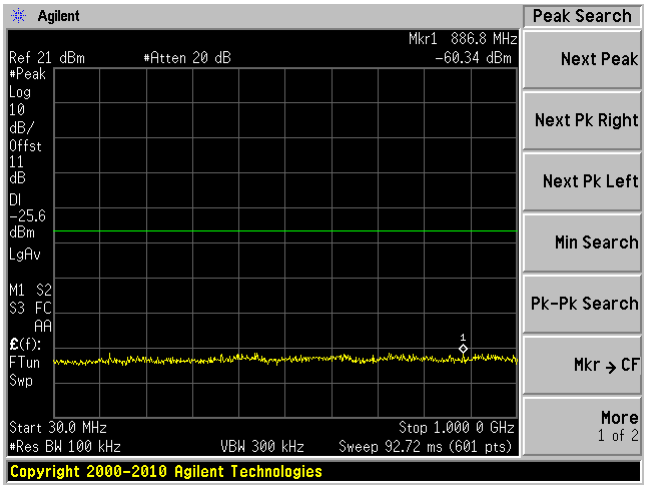

Middle Channel 30 MHz – 1 GHz



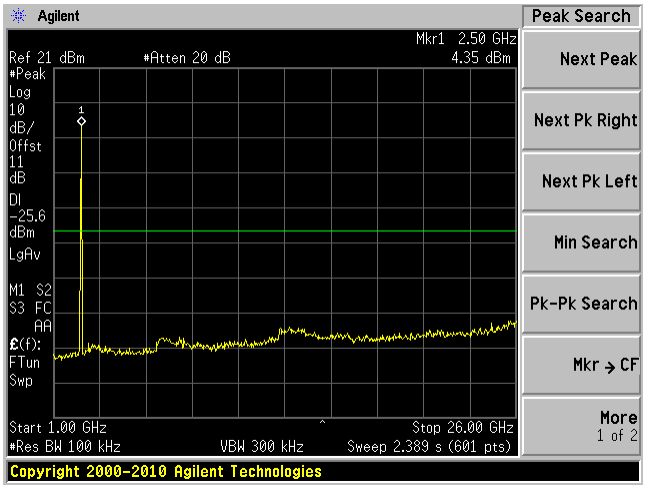

Middle Channel 1 GHz – 25 GHz



High Channel 30 MHz – 1 GHz

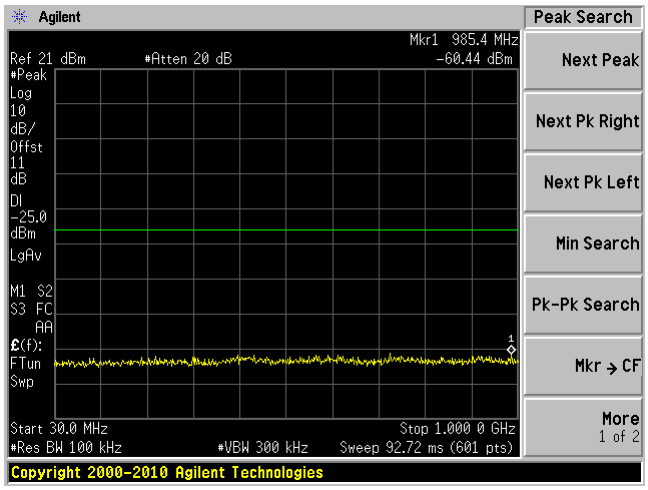



High Channel 1 GHz – 25 GHz

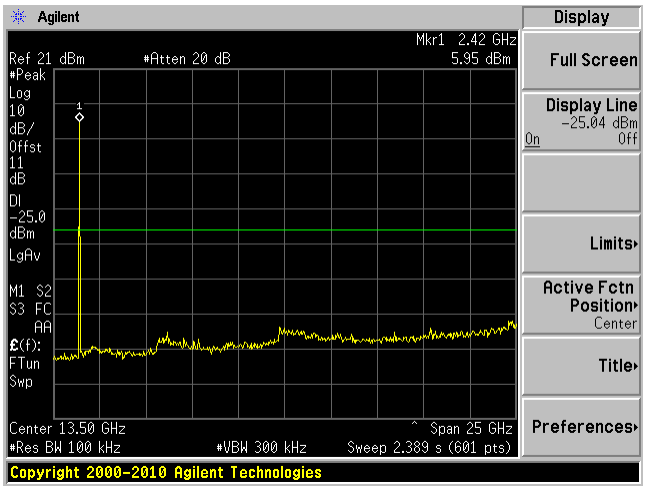


## 8DPSK

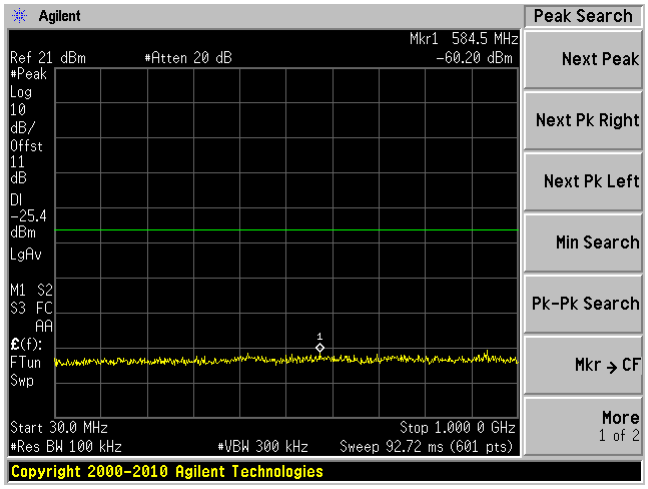
Low Channel 30 MHz –1 GHz



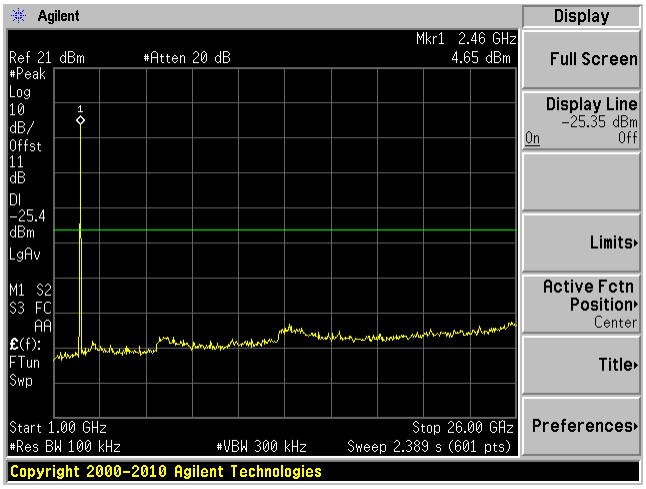

Low Channel 1 GHz – 25 GHz



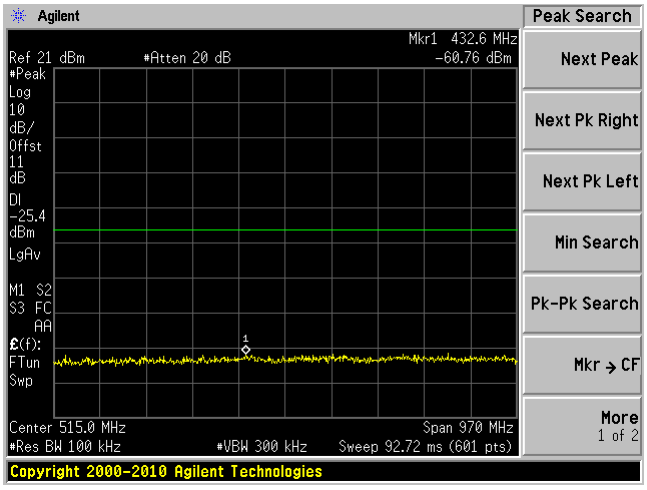

Middle Channel 30 MHz – 1 GHz




Middle Channel 1 GHz – 25 GHz



High Channel 30 MHz – 1 GHz




High Channel 1 GHz – 25 GHz