



**FCC 47 CFR PART 15 SUBPART C  
ISED RSS 247 ISSUE 2  
CERTIFICATION TEST REPORT**

*For*

**SMART VACUUM CLEANER**

**MODEL NUMBER: VS12210AUS**

**ADDITIONAL MODEL NUMBER: VS12240AUS, VS12250AUS**

**PROJECT NUMBER: 4789392958**

**REPORT NUMBER: 4789392958-2**

**FCC ID: 2ASWB-S12VP**

**IC: 24918-S12VP**

**ISSUE DATE: Apr. 03, 2020**

*Prepared for*

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Revision History

| Rev. | Issue Date | Revisions     | Revised By |
|------|------------|---------------|------------|
| V0   | 04/03/2020 | Initial Issue |            |



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## 1. ATTESTATION OF TEST RESULTS

### Applicant Information

Company Name: Ecovacs Robotics Co Ltd  
Address: No. 108 Shihu Road West, Wuzhong Zone, Suzhou, 215128  
P.R.China

### Manufacturer Information

Company Name: Ecovacs Robotics Co Ltd  
Address: No. 108 Shihu Road West, Wuzhong Zone, Suzhou, 215128  
P.R.China

### Factory Information

Company Name: Ecovacs Robotics Co Ltd  
Address: No. 108 Shihu Road West, Wuzhong Zone, Suzhou, 215128  
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### EUT Description

Product Name SMART VACUUM CLEANER  
Model Name VS12210AUS  
Additional No. VS12240AUS, VS12250AUS  
Sample Number 2936358  
Date of Receipt Sample Mar. 09, 2020  
Date Tested Mar. 13, 2020~ Apr.01, 2020

| APPLICABLE STANDARDS     |              |
|--------------------------|--------------|
| STANDARD                 | TEST RESULTS |
| CFR 47 Part 15 Subpart C | PASS         |
| ISED RSS-247 Issue 2     | PASS         |
| ISED RSS-GEN Issue 5     | PASS         |



| Summary of Test Results                                                                                                                                                                                                                      |                                           |                                                                                                               |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------|
| Clause                                                                                                                                                                                                                                       | Test Items                                | FCC /ISED Rules                                                                                               | Test Results |
| 1                                                                                                                                                                                                                                            | 20dB Bandwidth And 99% Bandwidth          | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (a)                                                                  | Complied     |
| 2                                                                                                                                                                                                                                            | Peak Conducted Output Power               | FCC 15.247 (b) (1)<br>RSS-247 Clause 5.1 (b)                                                                  | Complied     |
| 3                                                                                                                                                                                                                                            | Carrier Hopping Channel Separation        | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (b)                                                                  | Complied     |
| 4                                                                                                                                                                                                                                            | Number of Hopping Frequency               | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d)                                                                  | Complied     |
| 5                                                                                                                                                                                                                                            | Time of Occupancy (Dwell Time)            | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d)                                                                  | Complied     |
| 6                                                                                                                                                                                                                                            | Conducted Bandedge                        | FCC 15.247 (d)<br>RSS-247 Clause 5.5                                                                          | Complied     |
| 7                                                                                                                                                                                                                                            | Radiated Bandedge and Spurious            | FCC 15.247 (d)<br>FCC 15.209<br>FCC 15.205<br>RSS-247 Clause 5.5<br>RSS-GEN Clause 8.9<br>RSS-GEN Clause 8.10 | Complied     |
| 8                                                                                                                                                                                                                                            | Conducted Emission Test for AC Power Port | FCC 15.207<br>RSS-GEN Clause 8.8                                                                              | Complied     |
| 9                                                                                                                                                                                                                                            | Antenna Requirement                       | FCC 15.203<br>RSS-GEN Clause 6.8                                                                              | Complied     |
| Remark:<br>1) The measurement result for the sample received is <Pass> according to < ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15C, ISED RSS-GEN Issue5, ISED RSS-247 Issue2> > when <Accuracy Method> decision rule is applied. |                                           |                                                                                                               |              |

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## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15 ISSED RSS-GEN ISSUE 5 and ISSED RSS-247 ISSUE 2.

## 3. FACILITIES AND ACCREDITATION

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Location             | UL-CCIC Company Limited, EMC&RF Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Address                   | No. 2, Chengwan Road, Suzhou Industrial Park, Suzhou 215122 ,China                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Accreditation Certificate | <b>CNAS (Certificate No.: L2065)</b><br>The Laboratory has been assessed and proved to be in compliance with CNAS, The Certificate Registration Number is L2065.<br><b>A2LA (Certificate No.: 4829.01)</b><br>UL-CCIC COMPANY LIMITED has been assessed and proved to be in compliance with A2LA.<br><b>FCC (FCC Designation No.: CN1247)</b><br>UL-CCIC COMPANY LIMITED has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules.<br><b>IC (IC Designation No.: 25056)</b><br>UL-CCIC COMPANY LIMITED has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules. |

Note 1: All tests measurement facilities use to collect the measurement data are located at No. 2, Chengwan Road, Suzhou Industrial Park, Suzhou 215122, People's Republic of China

Note 2: For below 30MHz, lab had performed measurements at test anechoic chamber and comparing to measurements obtained on an open field site. These measurements below 30MHz had been correlated to measurements performed on an OFS.

Note 3: The test anechoic chamber in UL-CCIC COMPANY LIMITED had been calibrated and compared to the open field sites and the test anechoic chamber is shown to be equivalent to or worst case from the open field site.



## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Test Item                                                                                                                                     | Uncertainty           |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Conduction emission                                                                                                                           | 3.00dB                |
| Radiation Emission test(include Fundamental emission)<br>(9KHz-30MHz)                                                                         | 3.32dB                |
| Radiation Emission test(include Fundamental emission)<br>(30MHz-1GHz)                                                                         | 3.27dB                |
| Radiation Emission test<br>(1GHz to 26GHz)( include Fundamental emission)                                                                     | 3.80dB (1GHz-18Gz)    |
|                                                                                                                                               | 4.11dB (18GHz-26.5Gz) |
| Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. |                       |





## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

|                                    |                                                                                                                                                                    |                     |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Product Name:                      | SMART VACUUM CLEANER                                                                                                                                               |                     |
| Model No.:                         | VS12210AUS                                                                                                                                                         |                     |
| Product Description<br>(Bluetooth) | Operation Frequency                                                                                                                                                | 2402 MHz ~ 2480 MHz |
|                                    | Modulation Type                                                                                                                                                    | Data Rate           |
|                                    | GFSK                                                                                                                                                               | 1Mbps               |
|                                    | π/4-DQPSK                                                                                                                                                          | 2Mbps               |
|                                    | 8DPSK                                                                                                                                                              | 3Mbps               |
| Test software of EUT:              | EspRFtestTool_2.0 (manufacturer declare)                                                                                                                           |                     |
| Antenna Type:                      | Meandered printed inverted-F antenna                                                                                                                               |                     |
| Antenna Gain:                      | 3.0 dBi                                                                                                                                                            |                     |
|                                    | Remark: This data is provided by customer and our lab isn't responsible for this data                                                                              |                     |
| Battery                            | NAME: Rechargeable Li-ion Battery<br>MODEL:A12NA-02<br>OUTPUT: 21.6V 2500mAh 54Wh                                                                                  |                     |
| Adapter                            | MODEL:YLS0241A-T260070<br>INPUT:100-240V~50/60Hz 0.8A Max<br>OUTPUT:26V  700 mA |                     |

Model No.:

| Number: | Name:      | Number: | Name:      | Number: | Name:      |
|---------|------------|---------|------------|---------|------------|
| 1       | VS12210AUS | 2       | VS12240AUS | 3       | VS12250AUS |

Remark: Only the main model **VS12210AUS** was tested and only the data of this model is shown in this test report. Since Their electrical circuit design, layout, components used and internal wiring are identical, only the model name, product color, marketing channel and sale century.



## 5.2. MAXIMUM OUTPUT POWER

| Bluetooth Mode | Frequency(MHz) | Channel Number | Max Output Power (dBm) |
|----------------|----------------|----------------|------------------------|
| GFSK           | 2402-2480      | 0-78[79]       | -1.19                  |
| 8DPSK          | 2402-2480      | 0-78[79]       | -4.20                  |

## 5.3. PACKET TYPE CONFIGURATION

| Test Mode | Packet Type | Setting(Packet Length) |
|-----------|-------------|------------------------|
| GFSK      | DH1         | 27                     |
|           | DH3         | 183                    |
|           | DH5         | 339                    |
| π/4-DQPSK | 2-DH1       | 54                     |
|           | 2-DH3       | 367                    |
|           | 2-DH5       | 679                    |
| 8DPSK     | 3-DH1       | 83                     |
|           | 3-DH3       | 552                    |
|           | 3-DH5       | 1021                   |



#### 5.4. CHANNEL LIST

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 00      | 2402            | 20      | 2422            | 40      | 2442            | 60      | 2462            |
| 01      | 2403            | 21      | 2423            | 41      | 2443            | 61      | 2463            |
| 02      | 2404            | 22      | 2424            | 42      | 2444            | 62      | 2464            |
| 03      | 2405            | 23      | 2425            | 43      | 2445            | 63      | 2465            |
| 04      | 2406            | 24      | 2426            | 44      | 2446            | 64      | 2466            |
| 05      | 2407            | 25      | 2427            | 45      | 2447            | 65      | 2467            |
| 06      | 2408            | 26      | 2428            | 46      | 2448            | 66      | 2468            |
| 07      | 2409            | 27      | 2429            | 47      | 2449            | 67      | 2469            |
| 08      | 2410            | 28      | 2430            | 48      | 2450            | 68      | 2470            |
| 09      | 2411            | 29      | 2431            | 49      | 2451            | 69      | 2471            |
| 10      | 2412            | 30      | 2432            | 50      | 2452            | 70      | 2472            |
| 11      | 2413            | 31      | 2433            | 51      | 2453            | 71      | 2473            |
| 12      | 2414            | 32      | 2434            | 52      | 2454            | 72      | 2474            |
| 13      | 2415            | 33      | 2435            | 53      | 2455            | 73      | 2475            |
| 14      | 2416            | 34      | 2436            | 54      | 2456            | 74      | 2476            |
| 15      | 2417            | 35      | 2437            | 55      | 2457            | 75      | 2477            |
| 16      | 2418            | 36      | 2438            | 56      | 2458            | 76      | 2478            |
| 17      | 2419            | 37      | 2439            | 57      | 2459            | 77      | 2479            |
| 18      | 2420            | 38      | 2440            | 58      | 2460            | 78      | 2480            |
| 19      | 2421            | 39      | 2441            | 59      | 2461            |         |                 |

#### 5.5. TEST CHANNEL CONFIGURATION

| Test Mode | Test Channel Number | Test Channel      |
|-----------|---------------------|-------------------|
| GFSK      | CH 00, CH 39, CH 78 | Low, Middle, High |
| 8DPSK     | CH 00, CH 39, CH 78 | Low, Middle, High |

#### 5.6. THE WORSE CASE POWER SETTING PARAMETER

| The Worst Case Power Setting Parameter under 2400 ~ 2483.5MHz Band |                         |              |       |       |
|--------------------------------------------------------------------|-------------------------|--------------|-------|-------|
| Test Software                                                      |                         | FCCTool      |       |       |
| Modulation Type                                                    | Transmit Antenna Number | Test Channel |       |       |
|                                                                    |                         | CH 00        | CH 39 | CH 78 |
| GFSK                                                               | 1                       | 2            | 2     | 2     |
| 8DPSK                                                              | 1                       | 2            | 2     | 2     |



## 5.7. DESCRIPTION OF AVAILABLE ANTENNAS

| Ant. | Frequency (MHz) | Antenna Type                         | Antenna Gain (dBi) |
|------|-----------------|--------------------------------------|--------------------|
| 1    | 2402-2480       | Meandered printed inverted-F antenna | 3.0                |

| Test Mode | Transmit and Receive Mode | Description                                            |
|-----------|---------------------------|--------------------------------------------------------|
| GFSK      | 1TX, 1RX                  | Chain 1 can be used as transmitting/receiving antenna. |
| 8DPSK     | 1TX, 1RX                  | Chain 1 can be used as transmitting/receiving antenna. |



## 5.8. WORST-CASE CONFIGURATIONS

| Bluetooth Mode | Modulation Technology | Modulation Type | Data Rate (Mbps) |
|----------------|-----------------------|-----------------|------------------|
| BR             | FHSS                  | GFSK            | 1Mbit/s          |
| EDR            | FHSS                  | 8DPSK           | 3Mbit/s          |

Note: Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.

## 5.9. TEST ENVIRONMENT

| Environment Parameter | Selected Values During Tests |           |
|-----------------------|------------------------------|-----------|
| Relative Humidity     | 55 ~ 65%                     |           |
| Atmospheric Pressure: | 101kPa                       |           |
| Temperature           | TN                           | 23 ~ 28°C |
| Voltage               | VL                           | N/A       |
|                       | VN                           | DC 21.6V  |
|                       | VH                           | N/A       |

Note: VL= Lower Extreme Test Voltage  
VN= Nominal Voltage.  
VH= Upper Extreme Test Voltage  
TN= Normal Temperature

## 5.10. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

| Item | Equipment             | Brand Name | Model Name | Description                    |
|------|-----------------------|------------|------------|--------------------------------|
| 1    | Laptop                | ThinkPad   | E550c      | N/A                            |
| 2    | Fixed Frequency Board | N/A        | N/A        | Supply by Customer             |
| 3    | USB Cable             | N/A        | N/A        | Supply by UL Lab(100cm length) |

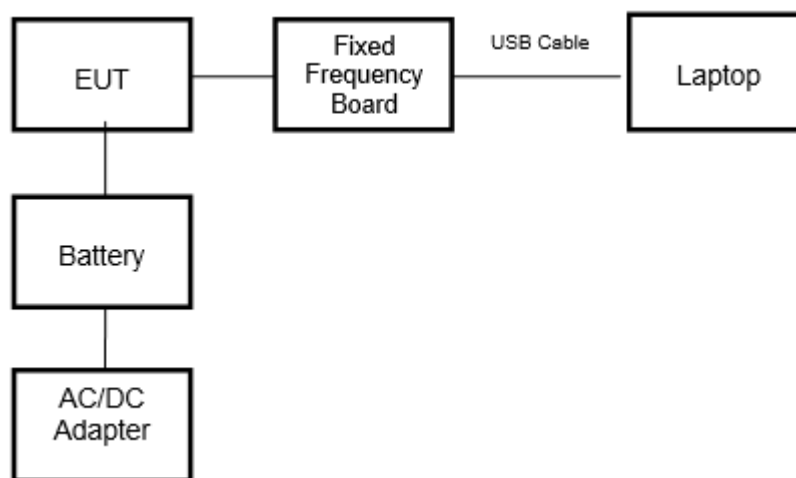
### ACCESSORY

| Item | Accessory | Brand Name                  | Model Name       | Description                                                                                                                              |
|------|-----------|-----------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Battery   | Rechargeable Li-ion Battery | A12NA-02         | OUTPUT: 21.6V 2500mAh 54Wh                                                                                                               |
| 2    | Adapter   | N1A                         | YLS0241A-T260070 | INPUT:100-240V~50/60Hz 0.8A Max<br>OUTPUT:26V  700 mA |

### TEST SETUP

The EUT can work in an engineer mode with a software through a PC.

### SETUP DIAGRAM FOR TESTS





### 5.11. MEASURING INSTRUMENT AND SOFTWARE USED

| Conducted Emissions (Instrument)    |                                         |                                  |                                     |             |                 |            |            |
|-------------------------------------|-----------------------------------------|----------------------------------|-------------------------------------|-------------|-----------------|------------|------------|
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No.  | Upper Last Cal. | Last Cal.  | Next Cal.  |
| <input checked="" type="checkbox"/> | EMI Test Receiver                       | R&S                              | ESR3                                | 126700      | 2018-12-13      | 2019-12-12 | 2020-12-11 |
| <input checked="" type="checkbox"/> | Two-Line V-Network                      | R&S                              | ENV216                              | 126701      | 2018-12-13      | 2019-12-12 | 2020-12-11 |
| <input checked="" type="checkbox"/> | Artificial Mains Networks               | R&S                              | ENY81                               | 126711      | 2018-12-13      | 2019-12-12 | 2020-12-11 |
| Software                            |                                         |                                  |                                     |             |                 |            |            |
| Used                                | Description                             |                                  | Manufacturer                        | Name        | Version         |            |            |
| <input checked="" type="checkbox"/> | Test Software for Conducted disturbance |                                  | R&S                                 | EMC32       | Ver. 9.25       |            |            |
| Radiated Emissions (Instrument)     |                                         |                                  |                                     |             |                 |            |            |
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No.  | Upper Last Cal. | Last Cal.  | Next Cal.  |
| <input checked="" type="checkbox"/> | Spectrum Analyzer                       | Keysight                         | N9010B                              | MY57110128  | 2018-05-30      | 2019-05-29 | 2020-05-28 |
| <input checked="" type="checkbox"/> | EMI test receiver                       | R&S                              | ESR26                               | 1267603     | 2018-12-13      | 2019-12-12 | 2020-12-11 |
| <input checked="" type="checkbox"/> | Receiver Antenna (9kHz-30MHz)           | Schwarzbeck                      | FMZB 1513                           | 513-265     | 2018-06-17      | 2019-06-16 | 2020-06-15 |
| <input checked="" type="checkbox"/> | Receiver Antenna (30MHz-1GHz)           | SunAR RF Motion                  | JB1                                 | 126704      | N/A             | 2019-01-28 | 2022-01-27 |
| <input checked="" type="checkbox"/> | Receiver Antenna (1GHz-18GHz)           | R&S                              | HF907                               | 126705      | 2019-01-26      | 2020-01-25 | 2021-01-24 |
| <input checked="" type="checkbox"/> | Receiver Antenna (18GHz-26.5GHz)        | Schwarzbeck                      | BBHA9170                            | 126706      | 2019-02-06      | 2020-02-05 | 2021-02-04 |
| <input checked="" type="checkbox"/> | Pre-amplification (To 18GHz)            | Compliance Direction System Inc. | PAP-1G18-50                         | 14140-13467 | 2019-02-06      | 2020-02-05 | 2021-02-04 |
| <input checked="" type="checkbox"/> | Pre-amplification (To 26.5GHz)          | R&S                              | SCU-26D                             | 134668      | 2019-03-18      | 2020-03-17 | 2021-03-16 |
| <input checked="" type="checkbox"/> | Band Reject Filter                      | Wainwright                       | WRCJV8-2350-2400-2483.5-2533.5-40SS | 1           | 2019-02-06      | 2020-01-23 | 2021-01-22 |
| <input checked="" type="checkbox"/> | Highpass Filter                         | Wainwright                       | WHKX10-2700-3000-18000-40SS         | 2           | 2019-05-29      | 2020-01-23 | 2021-01-22 |
| Software                            |                                         |                                  |                                     |             |                 |            |            |
| Used                                | Description                             |                                  | Manufacturer                        | Name        | Version         |            |            |
| <input checked="" type="checkbox"/> | Test Software for Radiated disturbance  |                                  | Tonscend                            | JS32        | V1.0            |            |            |
| Other instruments                   |                                         |                                  |                                     |             |                 |            |            |
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No.  | Upper Last Cal. | Last Cal.  | Next Cal.  |
| <input checked="" type="checkbox"/> | Spectrum Analyzer                       | Keysight                         | N9010B                              | MY57110128  | 2018-05-30      | 2019-05-29 | 2020-05-28 |



## 6. ANTENNA PORT TEST RESULTS

### 6.1. ON TIME AND DUTY CYCLE

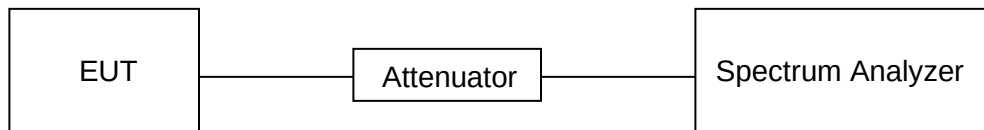
#### LIMITS

None; for reporting purposes only

#### PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method

#### TEST SETUP

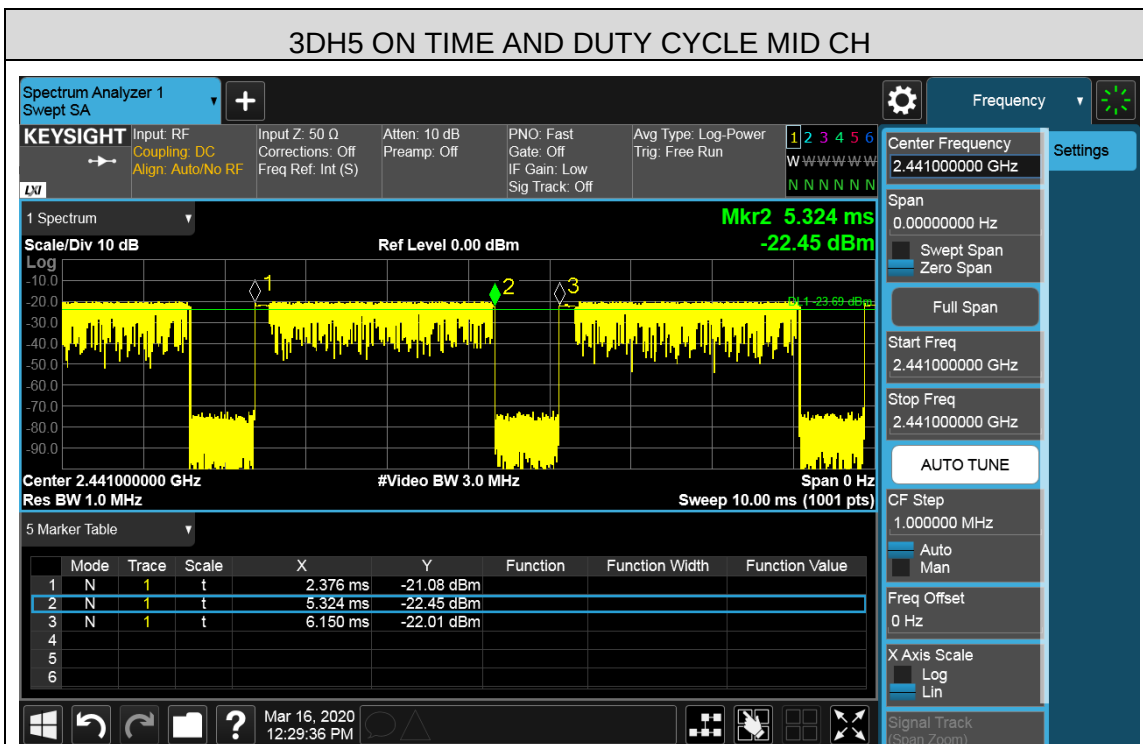
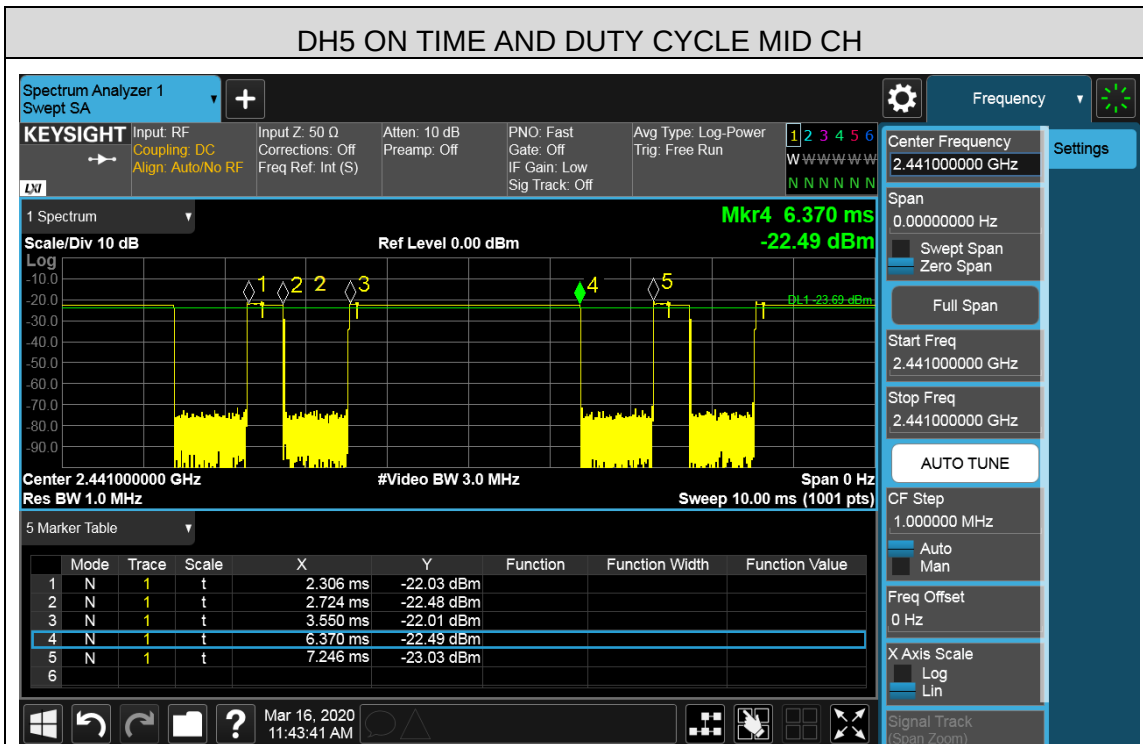


#### RESULTS

| Mode  | On Time (msec) | Period (msec) | Duty Cycle x (Linear) | Duty Cycle (%) | Duty Cycle Correction Factor (db) | 1/T Minimum VBW (KHz) | Final VBW(kHz) |
|-------|----------------|---------------|-----------------------|----------------|-----------------------------------|-----------------------|----------------|
| GFSK  | 3.238          | 4.940         | 0.655                 | 65.5           | 1.84                              | 0.31                  | 1              |
| 8DPSK | 2.948          | 3.744         | 0.787                 | 78.7           | 1.04                              | 0.34                  | 1              |

Note: Duty Cycle Correction Factor= $10\log(1/x)$ .  
Where: x is Duty Cycle (Linear)  
Where: T is On Time (transmit duration)







## 6.2. 20 dB BANDWIDTH

### LIMITS

| FCC Part15 (15.247) Subpart C<br>RSS-247 ISSUE 2 |                |        |                       |
|--------------------------------------------------|----------------|--------|-----------------------|
| Section                                          | Test Item      | Limit  | Frequency Range (MHz) |
| RSS-247 Clause 5.1 (a)                           | 20dB Bandwidth | 500KHz | 2400-2483.5           |
| RSS-Gen Clause 6.6                               | 99% Bandwidth  | N/A    | 2400-2483.5           |

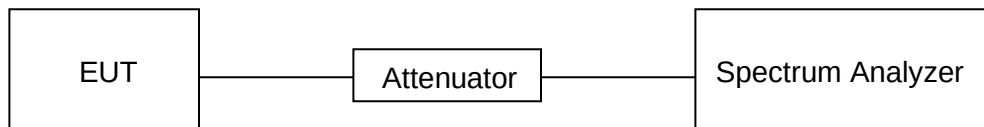
### TEST PROCEDURE

Connect the UUT to the spectrum Analyzer and use the following settings:

|                  |                                                                                                       |
|------------------|-------------------------------------------------------------------------------------------------------|
| Center Frequency | The centre frequency of the channel under test                                                        |
| Detector         | Peak                                                                                                  |
| RBW              | For 20dB Bandwidth:1% of the 20 dB bandwidth<br>For 99% Bandwidth: 1% to 5% of the occupied bandwidth |
| VBW              | For 20dB Bandwidth: $\geq$ RBW<br>For 99% Bandwidth: approximately $3 \times$ RBW                     |
| Span             | approximately 2 to 5 times the 20 dB bandwidth                                                        |
| Trace            | Max hold                                                                                              |
| Sweep            | Auto couple                                                                                           |

Allow the trace to stabilize and measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

### TEST SETUP



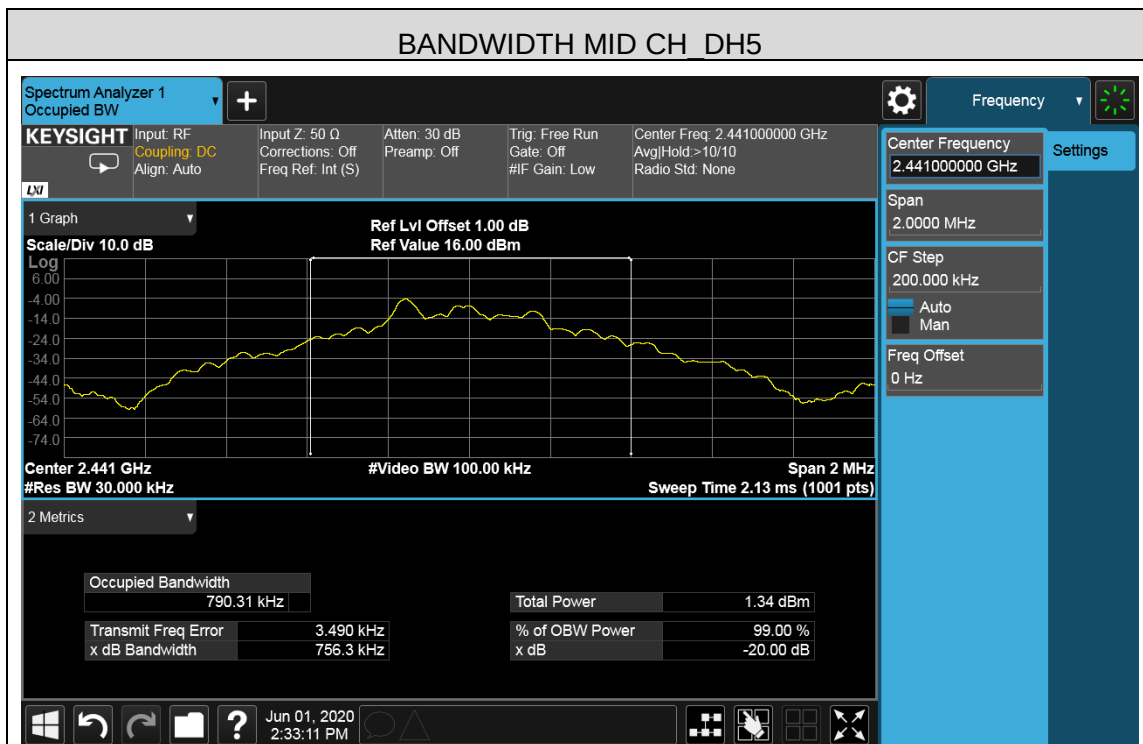
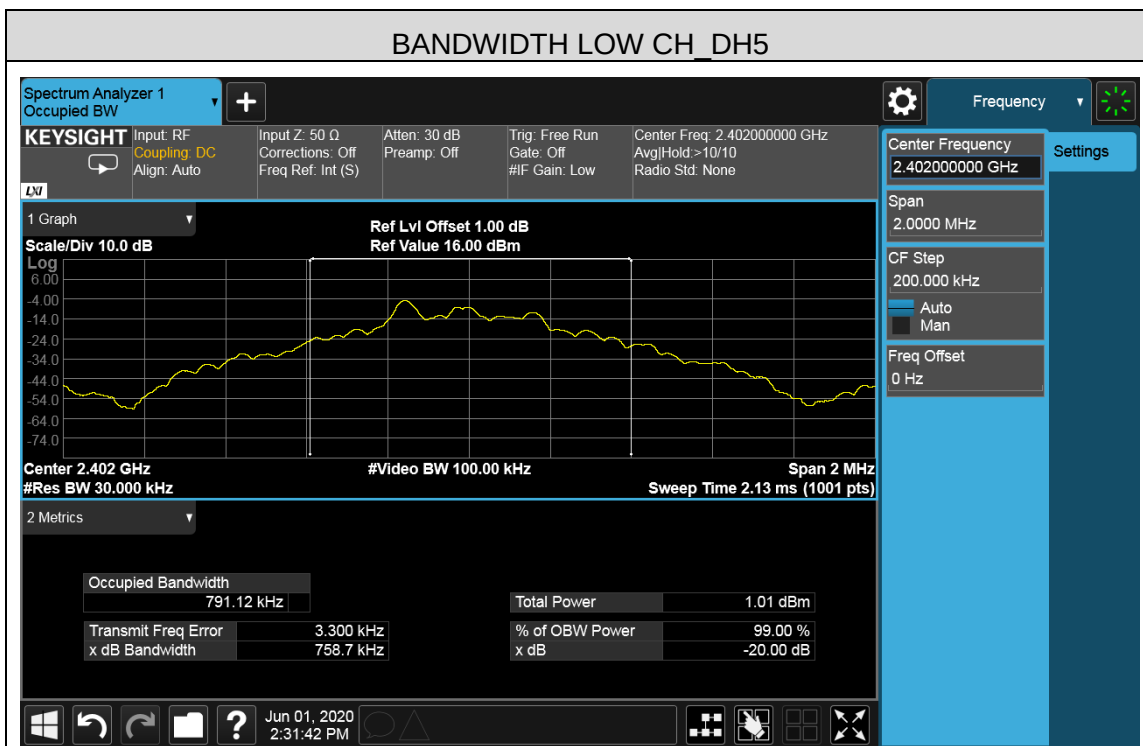


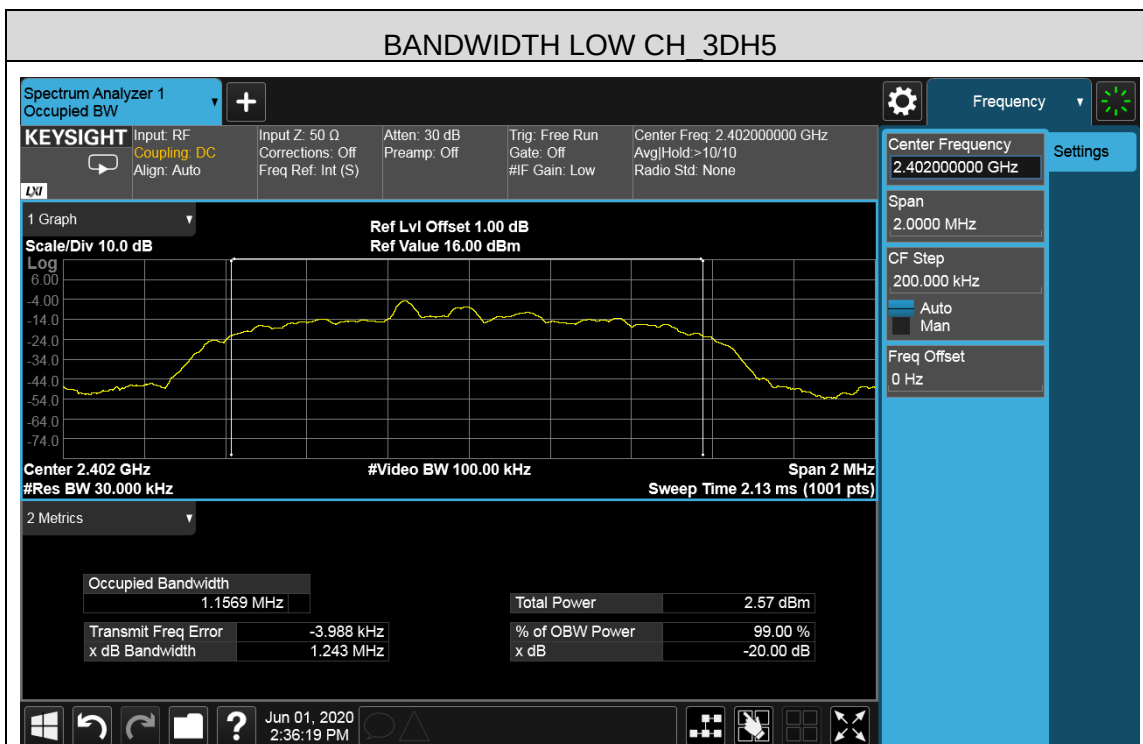
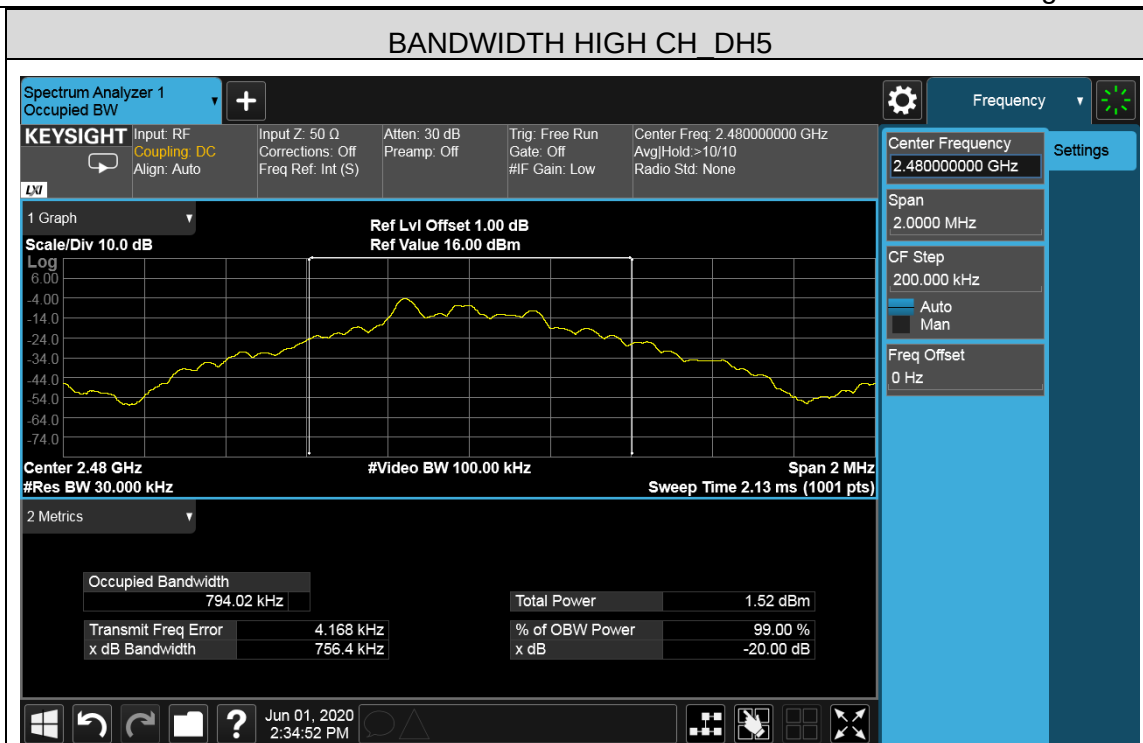
**RESULTS TABLE**

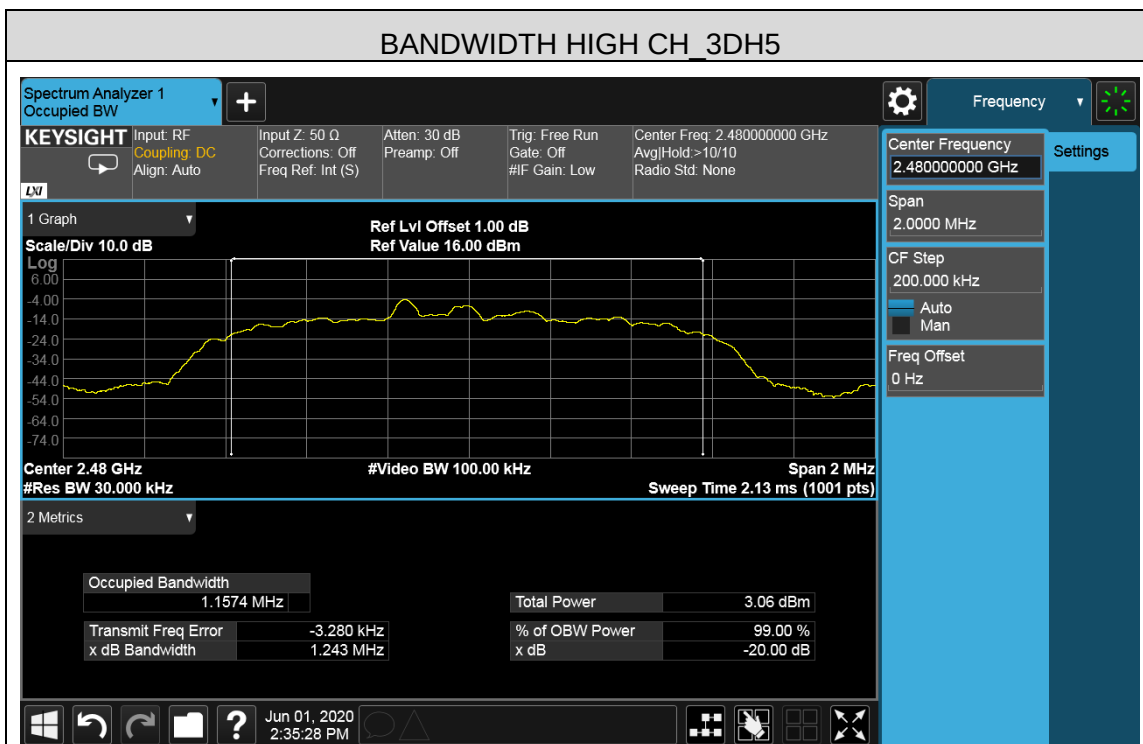
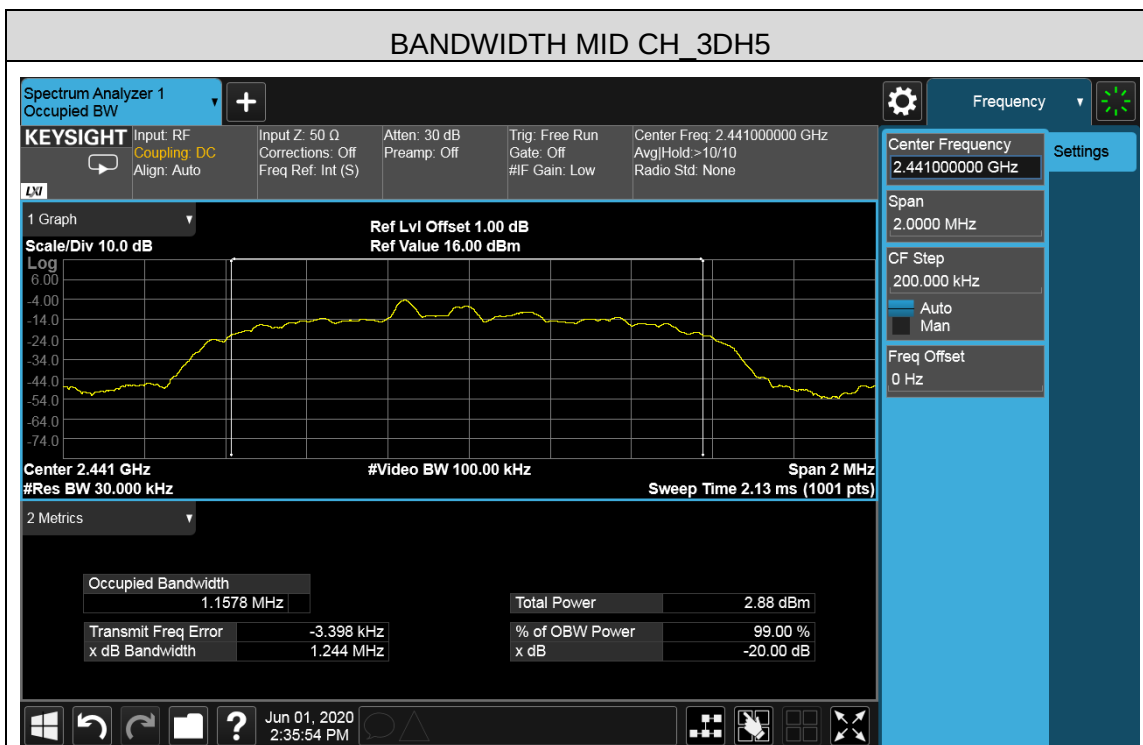
| Test Mode | Test Channel | 20dB bandwidth (MHz) | 99% Occupied Bandwidth (MHz) | Result |
|-----------|--------------|----------------------|------------------------------|--------|
| GFSK      | LCH          | 0.759                | 0.791                        | Pass   |
|           | MCH          | 0.756                | 0.790                        | Pass   |
|           | HCH          | 0.756                | 0.794                        | Pass   |
| 8DPSK     | LCH          | 1.243                | 1.157                        | Pass   |
|           | MCH          | 1.244                | 1.158                        | Pass   |
|           | HCH          | 1.243                | 1.157                        | Pass   |



## Test Graphs









### 6.3. PEAK CONDUCTED OUTPUT POWER

#### LIMITS

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 |                             |                                                                                                                                                                                                                                                                               |                       |
|----------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Section                                            | Test Item                   | Limit                                                                                                                                                                                                                                                                         | Frequency Range (MHz) |
| FCC 15.247 (b) (1),<br>RSS-247<br>Clause 5.4 (b)   | Peak Conducted Output Power | Hopping channel carrier frequencies separated by a minimum of 25KHz or the 20dB bandwidth of the hopping channel: 1 watt or 30dBm;<br>Hopping channel carrier frequencies that are separated by 25KHz or two-thirds of the 20 dB bandwidth of hopping channel: 125mW or 21dBm | 2400-2483.5           |

#### TEST PROCEDURE

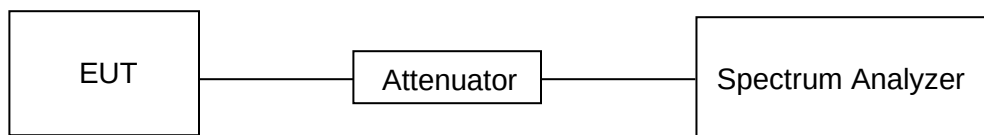
Disable the hopping function, connect the UUT to the spectrum Analyzer and use the following settings:

|                  |                                                       |
|------------------|-------------------------------------------------------|
| Center Frequency | The center frequency of the channel under test        |
| Detector         | Peak                                                  |
| RBW              | $\geq 20$ dB bandwidth of the emission being measured |
| VBW              | $\geq$ RBW                                            |
| Span             | Approximately five times the 20 dB bandwidth          |
| Trace            | Max hold                                              |
| Sweep time       | Auto couple                                           |

Allow trace to fully stabilize and use peak marker function to determine the peak amplitude level.

#### TEST SETUP

for peak power measurement:

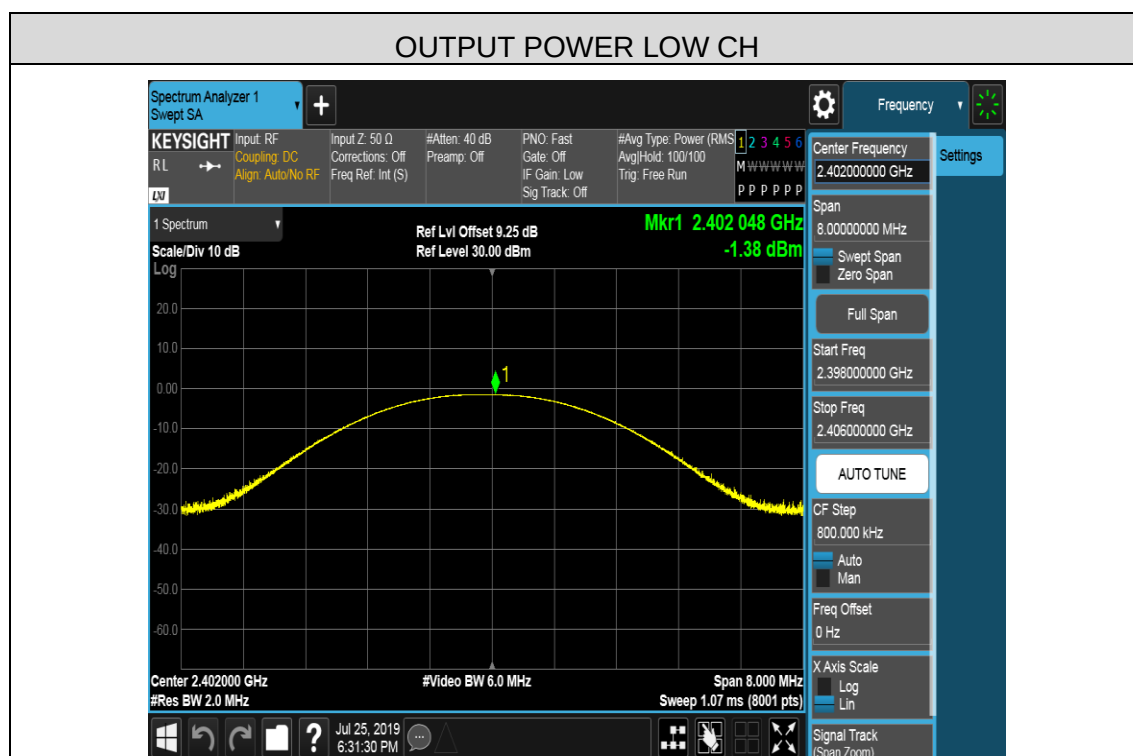




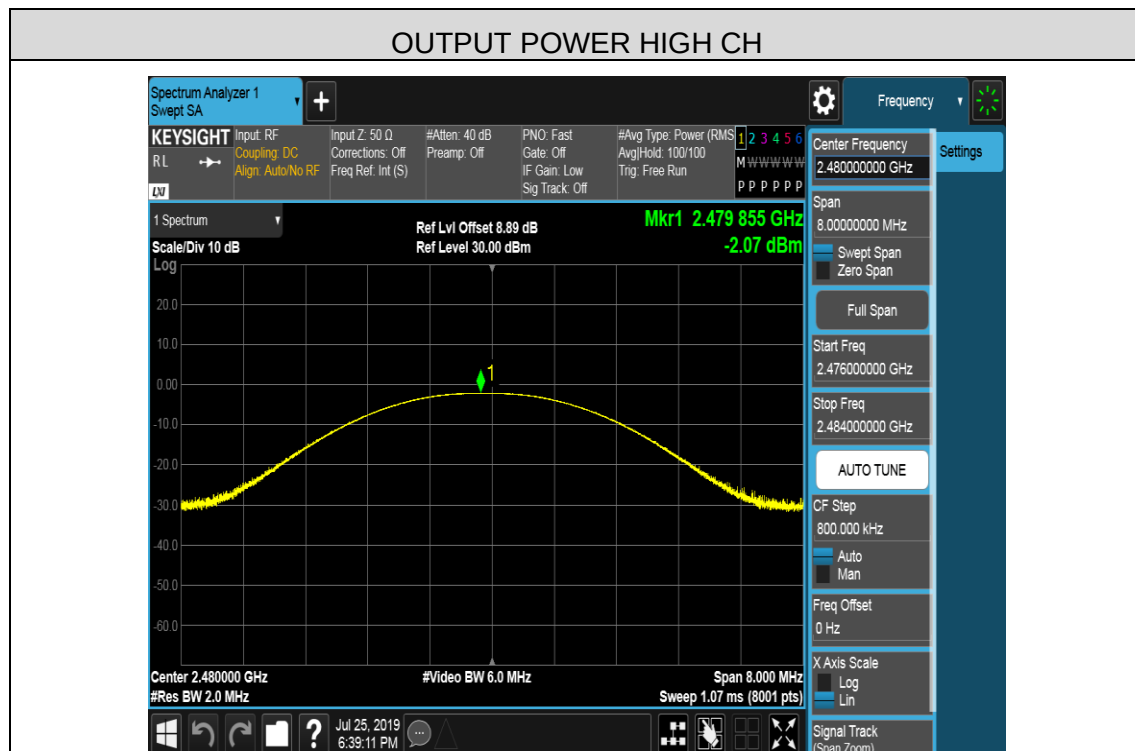
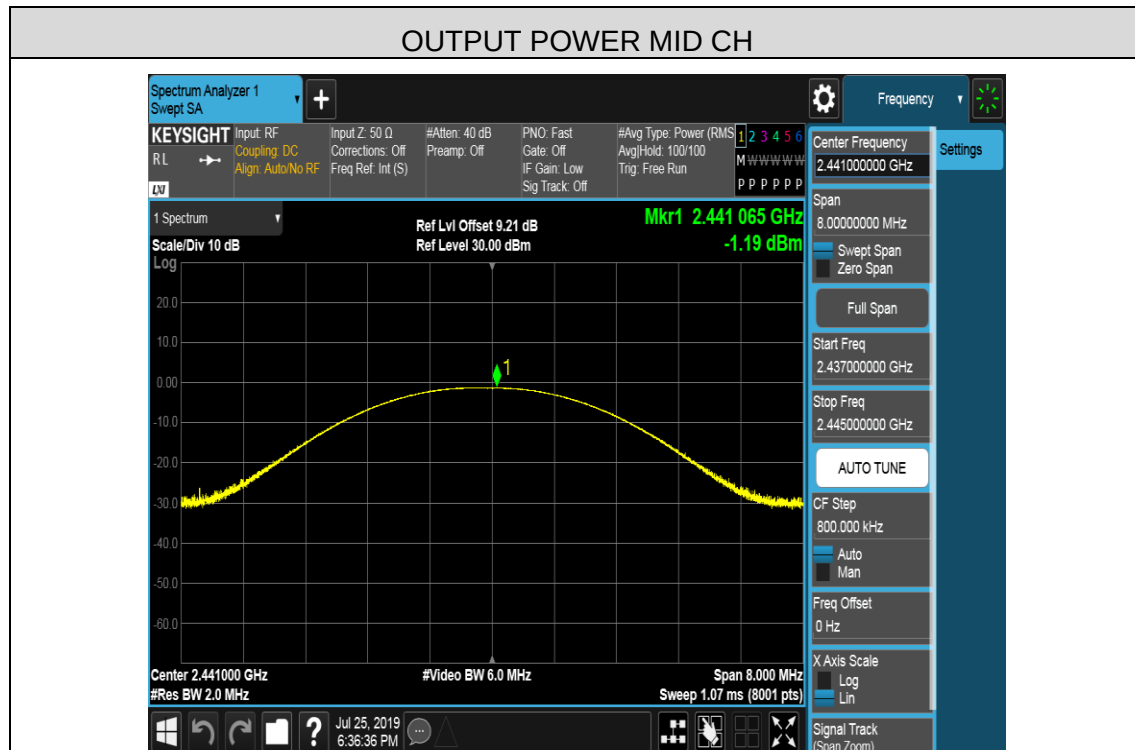
## RESULTS

### 6.3.1. GFSK MODE

| Channel | Frequency | Maximum PK Conducted Output Power | Result |
|---------|-----------|-----------------------------------|--------|
|         | (MHz)     | (dBm)                             |        |
| Low     | 2402      | -1.38                             | Pass   |
| Middle  | 2441      | -1.19                             | Pass   |
| High    | 2480      | -2.07                             | Pass   |

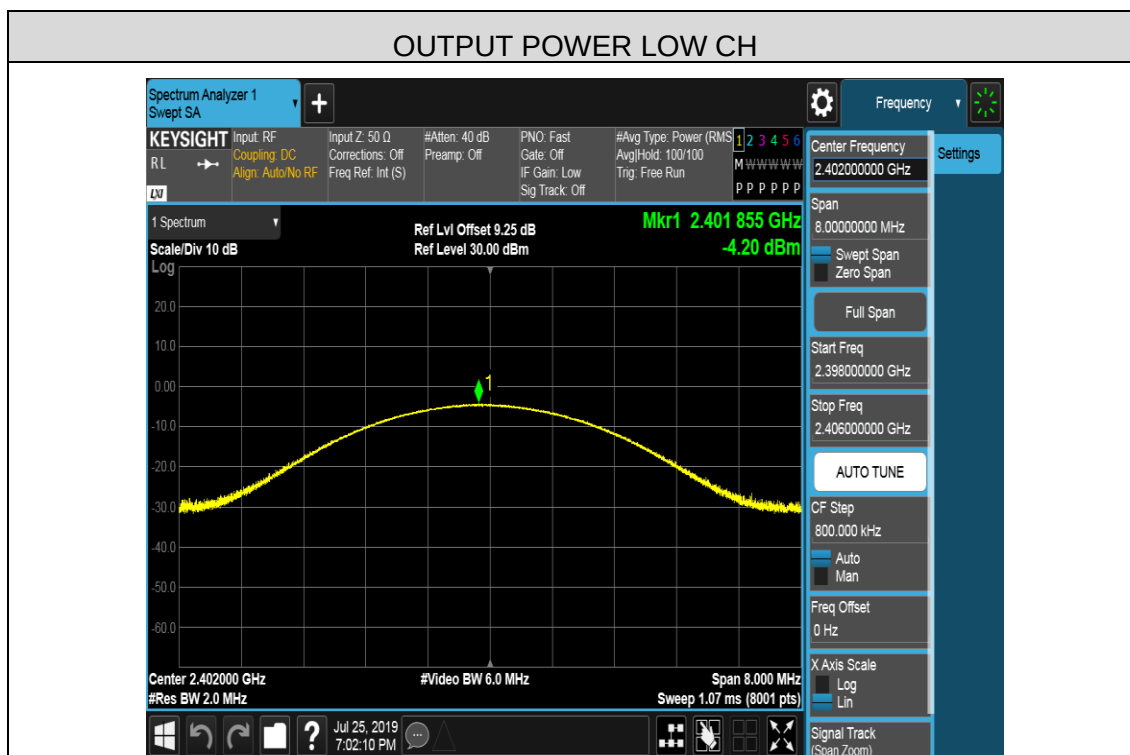


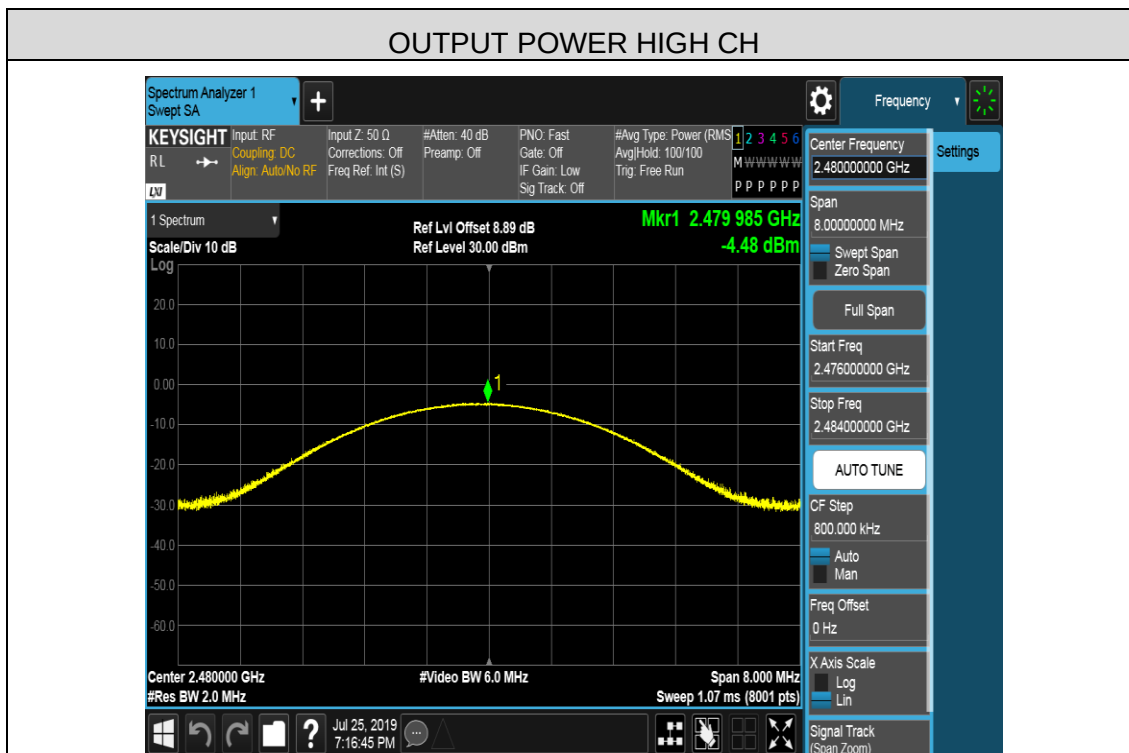
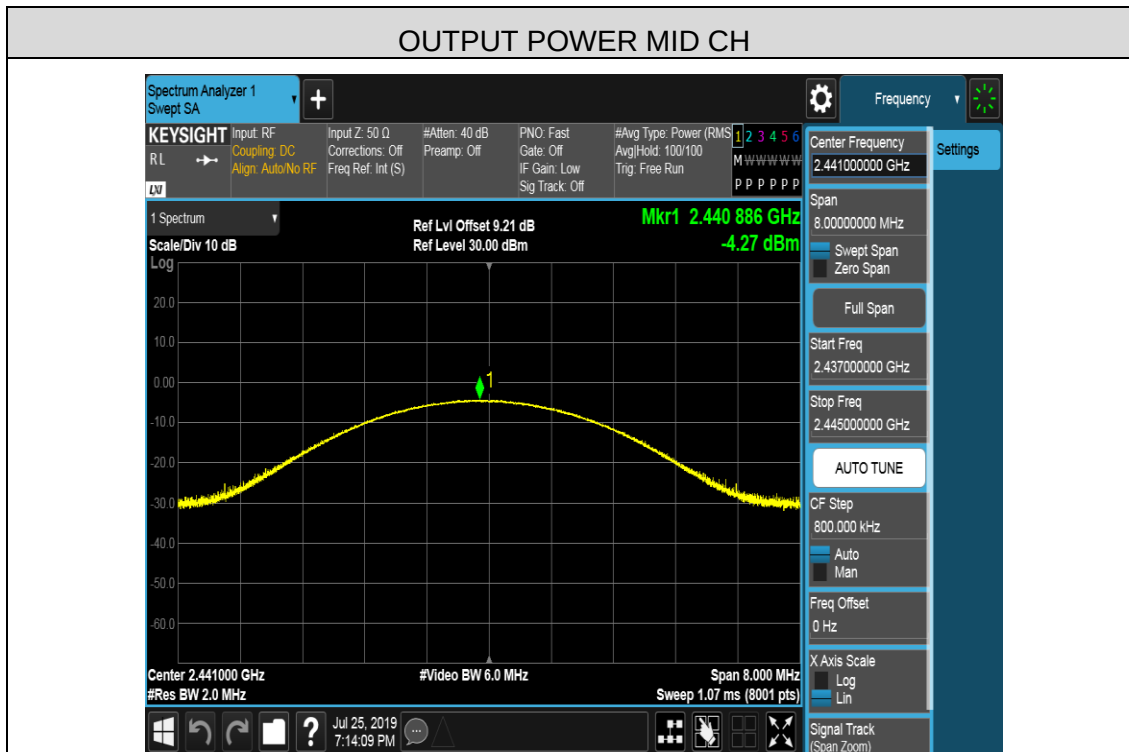




### 6.3.2. 8DPSK MODE

| Channel | Frequency | Maximum PK Conducted Output Power | Result |
|---------|-----------|-----------------------------------|--------|
|         | (MHz)     | (dBm)                             |        |
| Low     | 2402      | -4.20                             | Pass   |
| Middle  | 2441      | -4.27                             | Pass   |
| High    | 2480      | -4.48                             | Pass   |







## 6.4. CARRIER HOPPING CHANNEL SEPARATION

### LIMITS

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2     |                                    |                                                                                                                                                                                                                                                                                                                                                                                                   |                       |
|--------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Section                                                | Test Item                          | Limit                                                                                                                                                                                                                                                                                                                                                                                             | Frequency Range (MHz) |
| FCC 15.247<br>(a) (1),<br>RSS-247<br>Clause 5.1<br>(b) | Carrier Hopping Channel Separation | Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25KHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25KHz or two-thirds of the 20 dB bandwidth of the hopping channel. | 2400-2483.5           |

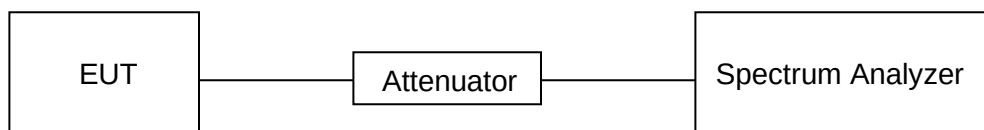
### TEST PROCEDURE

Connect the UUT to the spectrum Analyzer and use the following settings:

|                  |                                                                                                                                                |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Center Frequency | The center frequency of the channel under test                                                                                                 |
| Span             | wide enough to capture the peaks of two adjacent channels                                                                                      |
| Detector         | Peak                                                                                                                                           |
| RBW              | Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel |
| VBW              | $\geq$ RBW                                                                                                                                     |
| Trace            | Max hold                                                                                                                                       |
| Sweep time       | Auto couple                                                                                                                                    |

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

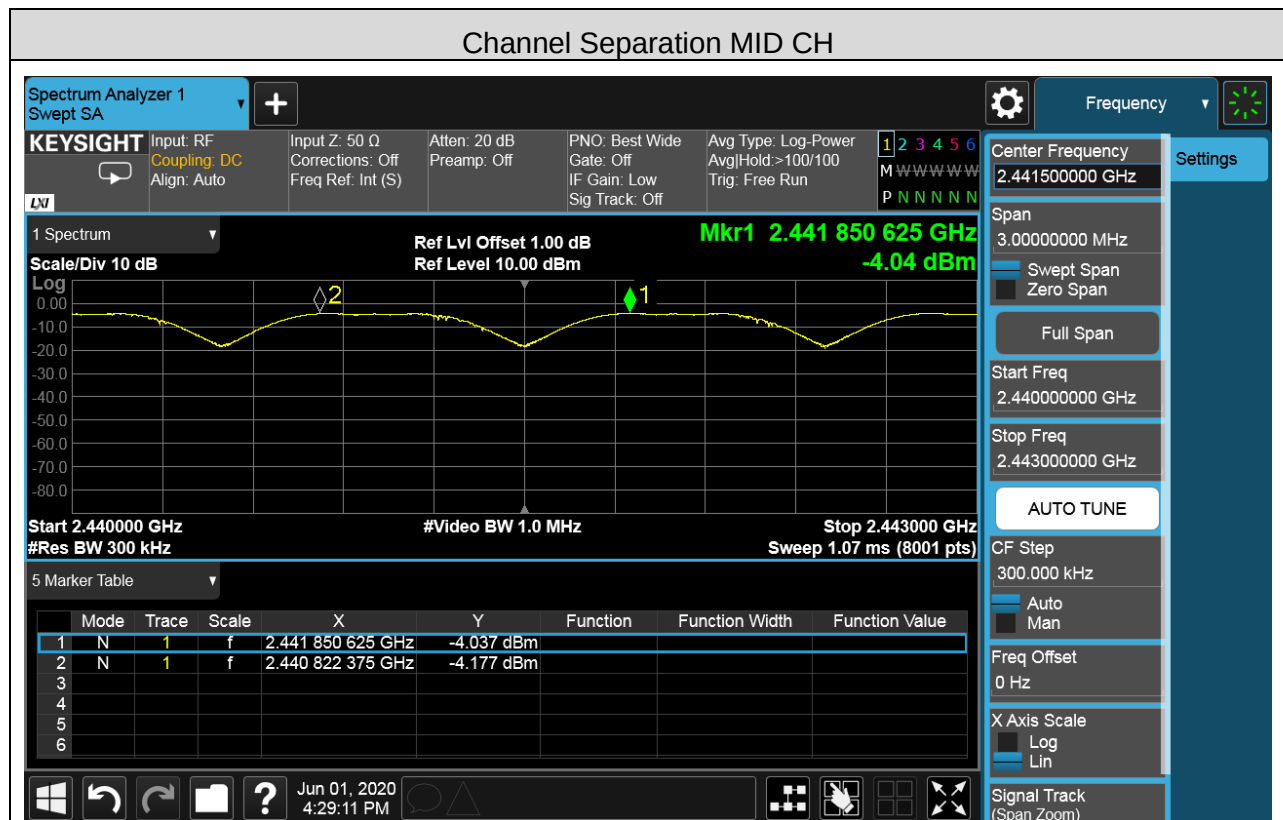
### TEST SETUP



## RESULTS

### 6.4.1. GFSK MODE

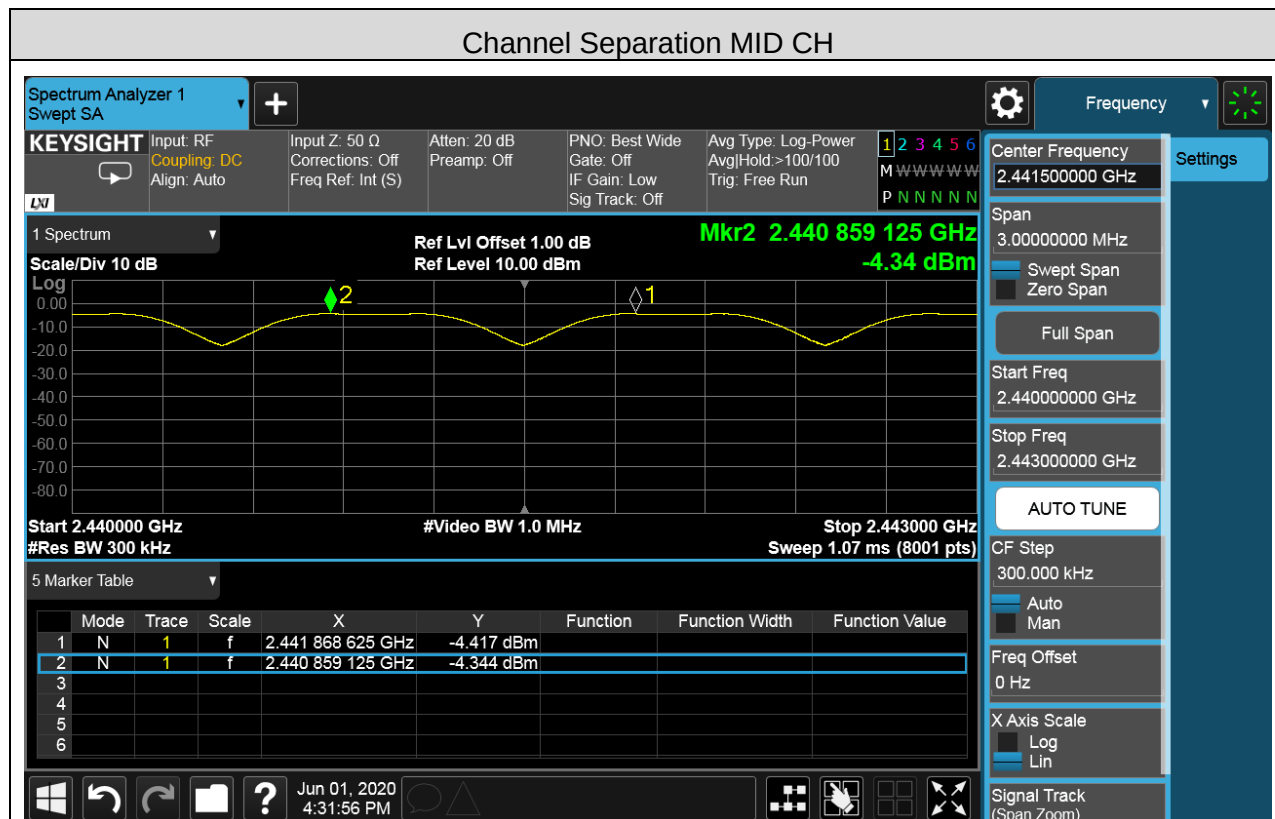
| Channel | Carrier Hopping Channel Separation (MHz) | Result |
|---------|------------------------------------------|--------|
| Middle  | 1.028                                    | PASS   |



Note: For 20 dB Bandwidth of The Hopping Channel, please refer to clause 6.2.

### 6.4.2. 8DPSK MODE

| Channel | Carrier Hopping Channel Separation (MHz) | Result |
|---------|------------------------------------------|--------|
| Middle  | 1.010                                    | PASS   |



Note: For 20 dB Bandwidth of The Hopping Channel, please refer to clause 6.2.

## 6.5. NUMBER OF HOPPING FREQUENCY

### LIMITS

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 |                             |                              |
|----------------------------------------------------|-----------------------------|------------------------------|
| Section                                            | Test Item                   | Limit                        |
| 15.247 (a) (1) III                                 | Number of Hopping Frequency | at least 15 hopping channels |
| RSS-247 Clause 5.1 (d)                             | Number of Hopping Frequency | at least 15 hopping channels |

### TEST PROCEDURE

Connect the EUT to the spectrum Analyzer and use the following settings:

|            |                                                                                                                                                                                                                                     |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Detector   | Peak                                                                                                                                                                                                                                |
| RBW        | To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller                                                                                       |
| VBW        | $\geq$ RBW                                                                                                                                                                                                                          |
| Span       | The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen |
| Trace      | Max hold                                                                                                                                                                                                                            |
| Sweep time | Auto couple                                                                                                                                                                                                                         |

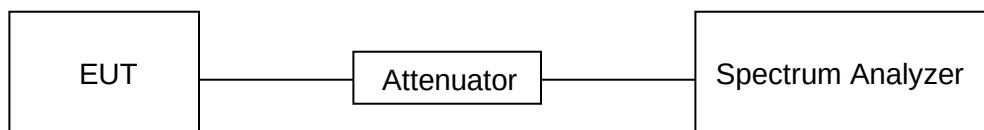
Set EUT to transmit maximum output power and switch on frequency hopping function. then set enough count time (larger than 5000 times) to get all the hopping frequency channel displayed on the screen of spectrum analyzer.

Count the quantity of peaks to get the number of hopping channels.

Normal Mode: 79 Channels observed.

AFH Mode: 20 Channels declared.

### TEST SETUP

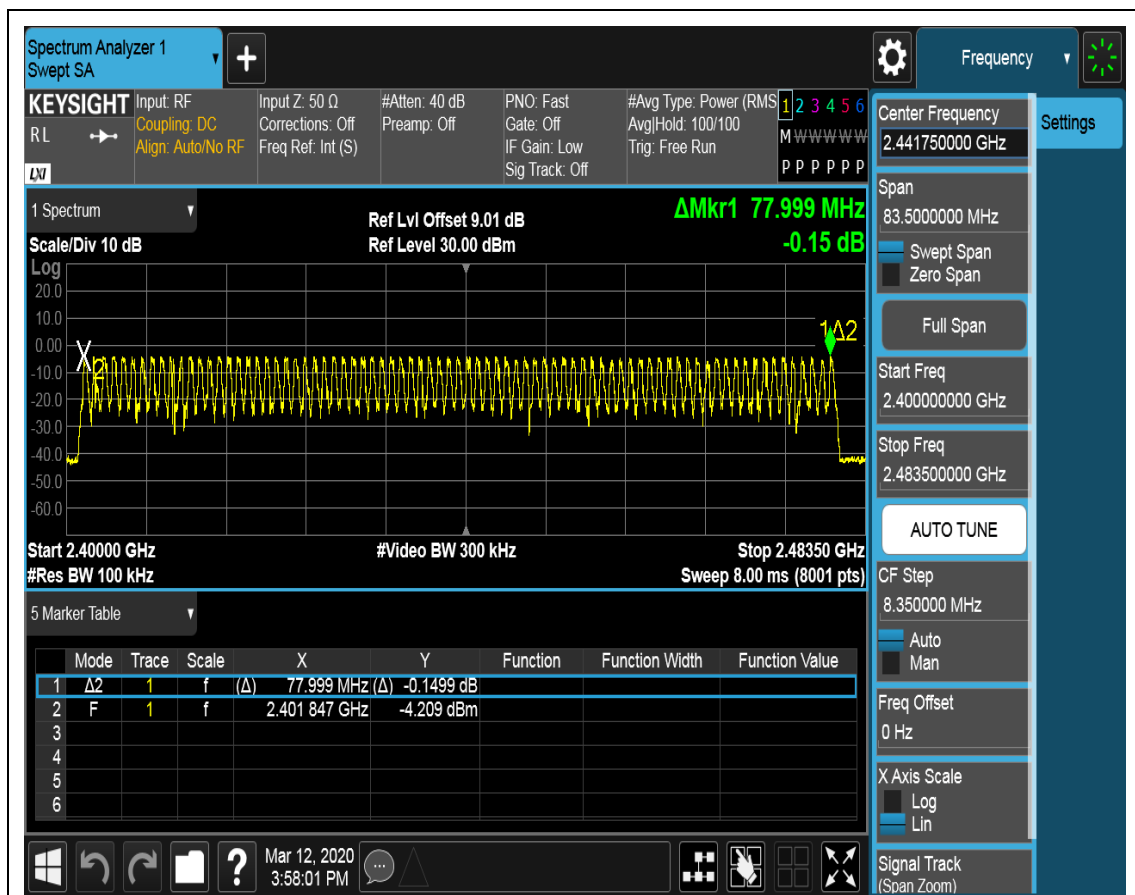




## RESULTS

### 6.5.1. GFSK MODE

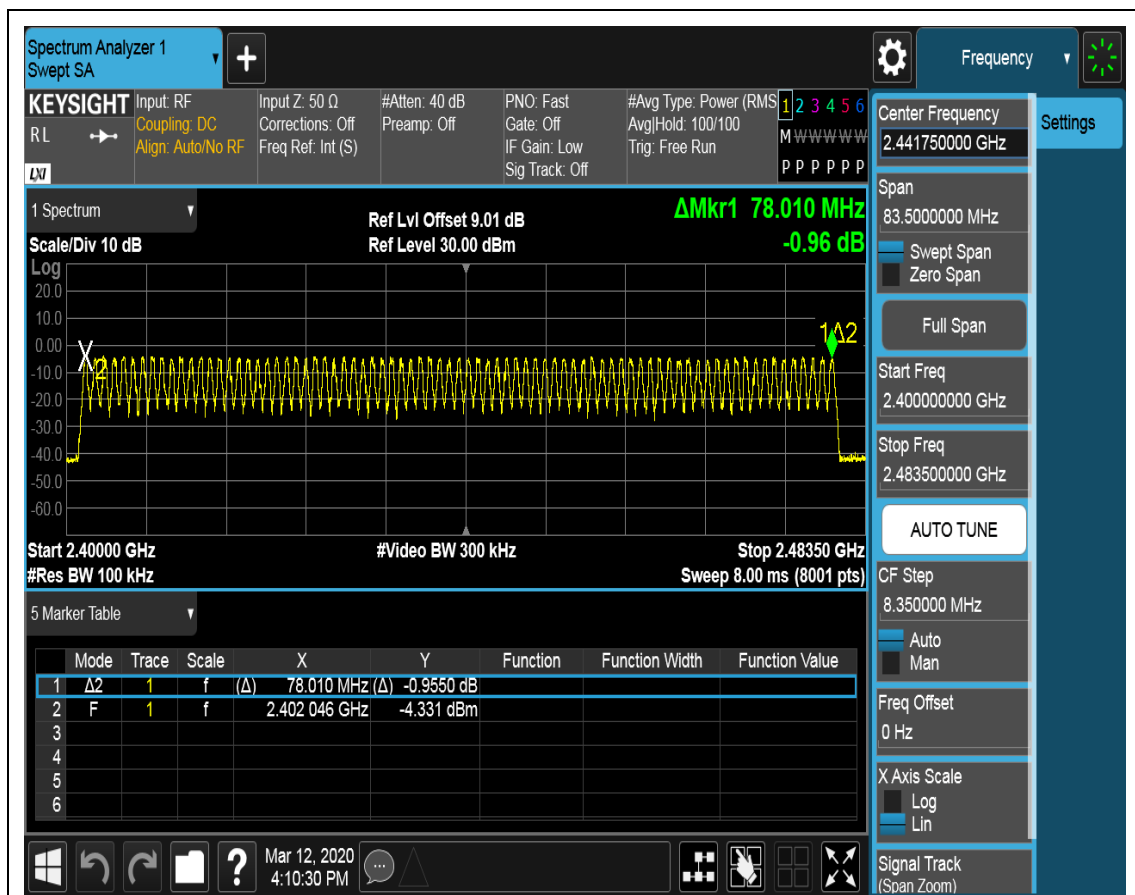
| Hopping numbers | Limit | Results |
|-----------------|-------|---------|
| 79              | >15   | Pass    |





### 6.5.2. 8DPSK MODE

| Hopping numbers | Limit | Results |
|-----------------|-------|---------|
| 79              | >15   | Pass    |



## 6.6. TIME OF OCCUPANCY (DWELL TIME)

### LIMITS

| FCC Part15 (15.247) , Subpart C |                                |                                                                                                                                                                           |
|---------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Section                         | Test Item                      | Limit                                                                                                                                                                     |
| 15.247 (a) (1) III              | Time of Occupancy (Dwell Time) | 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. |

### TEST PROCEDURE

Connect the UUT to the spectrum Analyzer and use the following settings:

|                  |                                                                   |
|------------------|-------------------------------------------------------------------|
| Center Frequency | The centre frequency of the channel under test                    |
| Detector         | Peak                                                              |
| RBW              | 1 MHz                                                             |
| VBW              | ≥RBW                                                              |
| Span             | zero span                                                         |
| Trace            | Max hold                                                          |
| Sweep time       | As necessary to capture the entire dwell time per hopping channel |

- The transmitter output (antenna port) was connected to the spectrum analyzer
- Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
- Use a video trigger with the trigger level set to enable triggering only on full pulses.
- Sweep Time is more than once pulse time.
- Set the center frequency on any frequency would be measure and set the frequency span to zero span.
- Measure the maximum time duration of one single pulse.
- Set the EUT for DH5, DH3 and DH1 packet transmitting.
- Measure the maximum time duration of one single pulse.  
A Period Time = (channel number)\*0.4

For Normal Mode (79 Channel):

DH1 Time Slot: Reading \* (1600/2)\*31.6/(channel number)

DH3 Time Slot: Reading \* (1600/4)\*31.6/(channel number)

DH5 Time Slot: Reading \* (1600/6)\*31.6/(channel number)

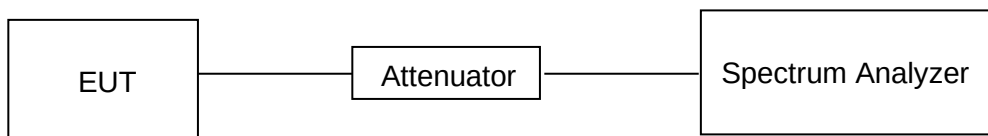
For AFH Mode (20 Channel):

DH1 Time Slot: Reading \* (800/2)\*8/(channel number)

DH3 Time Slot: Reading \* (800/4)\*8/(channel number)

DH5 Time Slot: Reading \* (800/6)\*8/(channel number)

### TEST SETUP

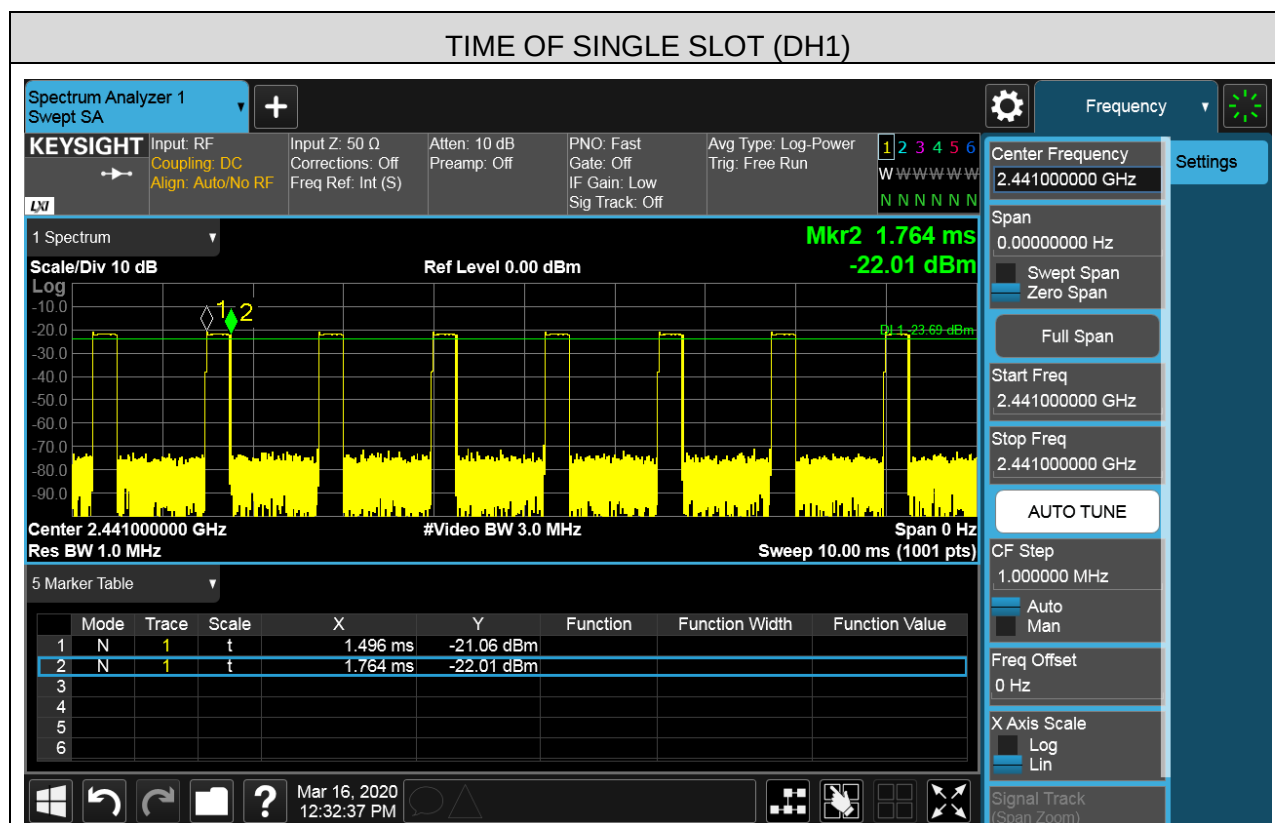


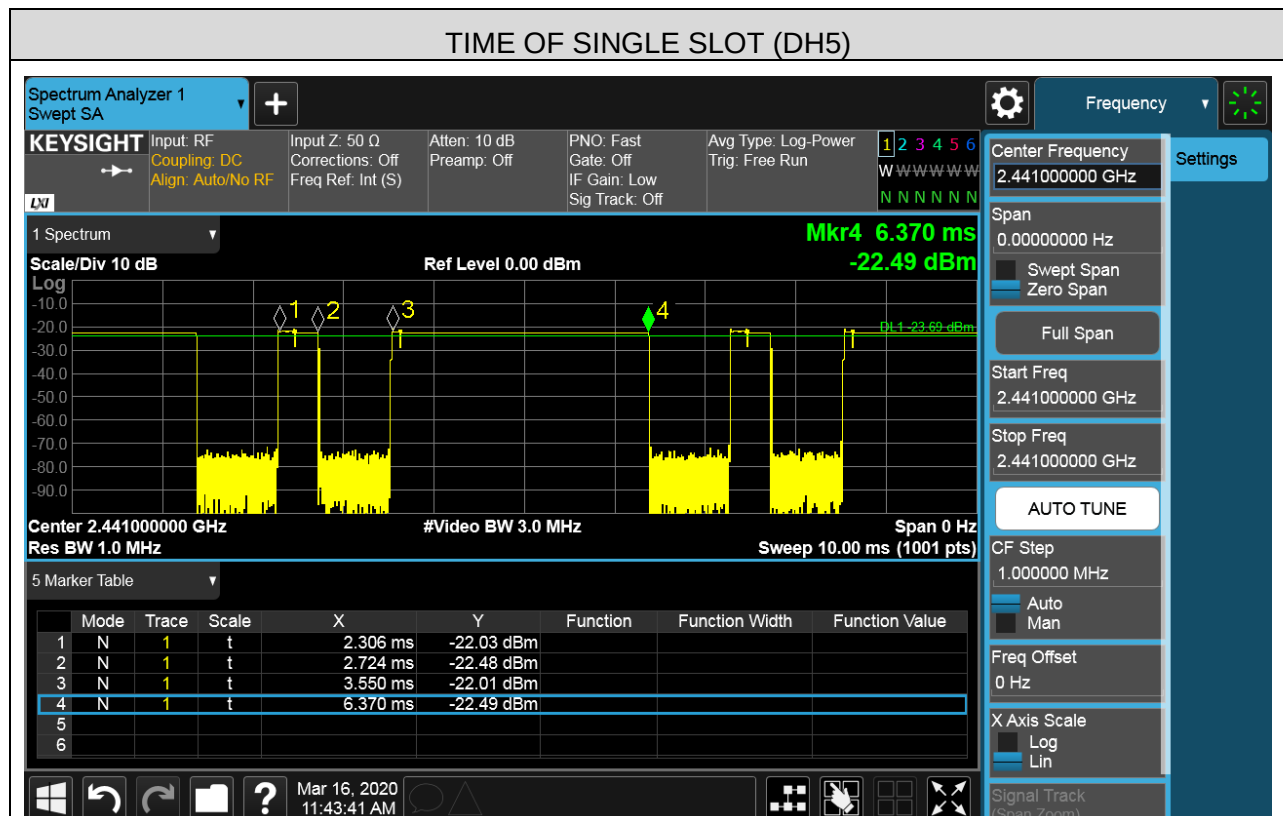
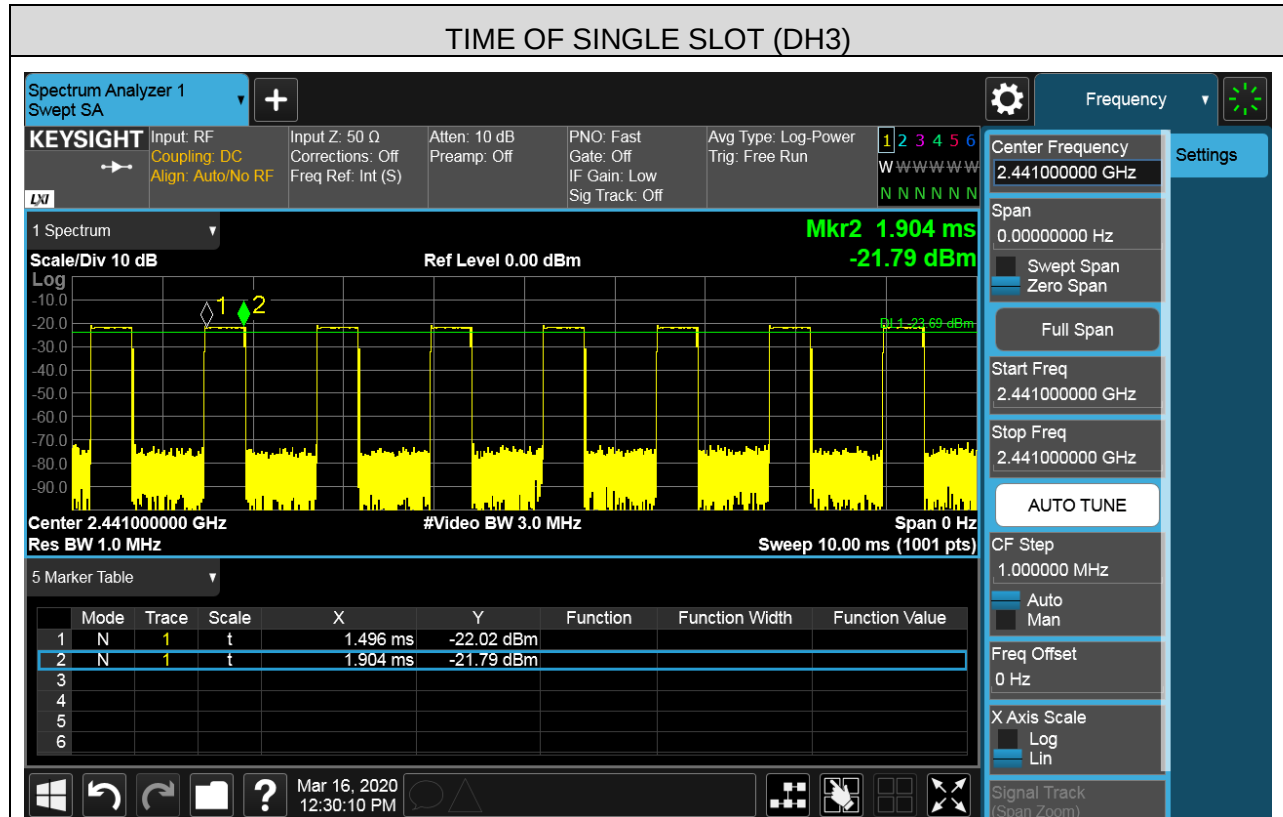
## RESULTS

### 6.6.1. GFSK MODE

| Normal Mode |         |                            |                   |         |
|-------------|---------|----------------------------|-------------------|---------|
| Packet      | Channel | Burst Width<br>[ms/hop/ch] | Dwell Time<br>[s] | Results |
| DH1         | MCH     | 0.268                      | 0.086             | PASS    |
| DH3         | MCH     | 0.408                      | 0.065             | PASS    |
| DH5         | MCH     | 3.238                      | 0.345             | PASS    |
| AFH Mode    |         |                            |                   |         |
| DH1         | MCH     | 0.268                      | 0.043             | PASS    |
| DH3         | MCH     | 0.408                      | 0.033             | PASS    |
| DH5         | MCH     | 3.238                      | 0.173             | PASS    |

### Test Graph

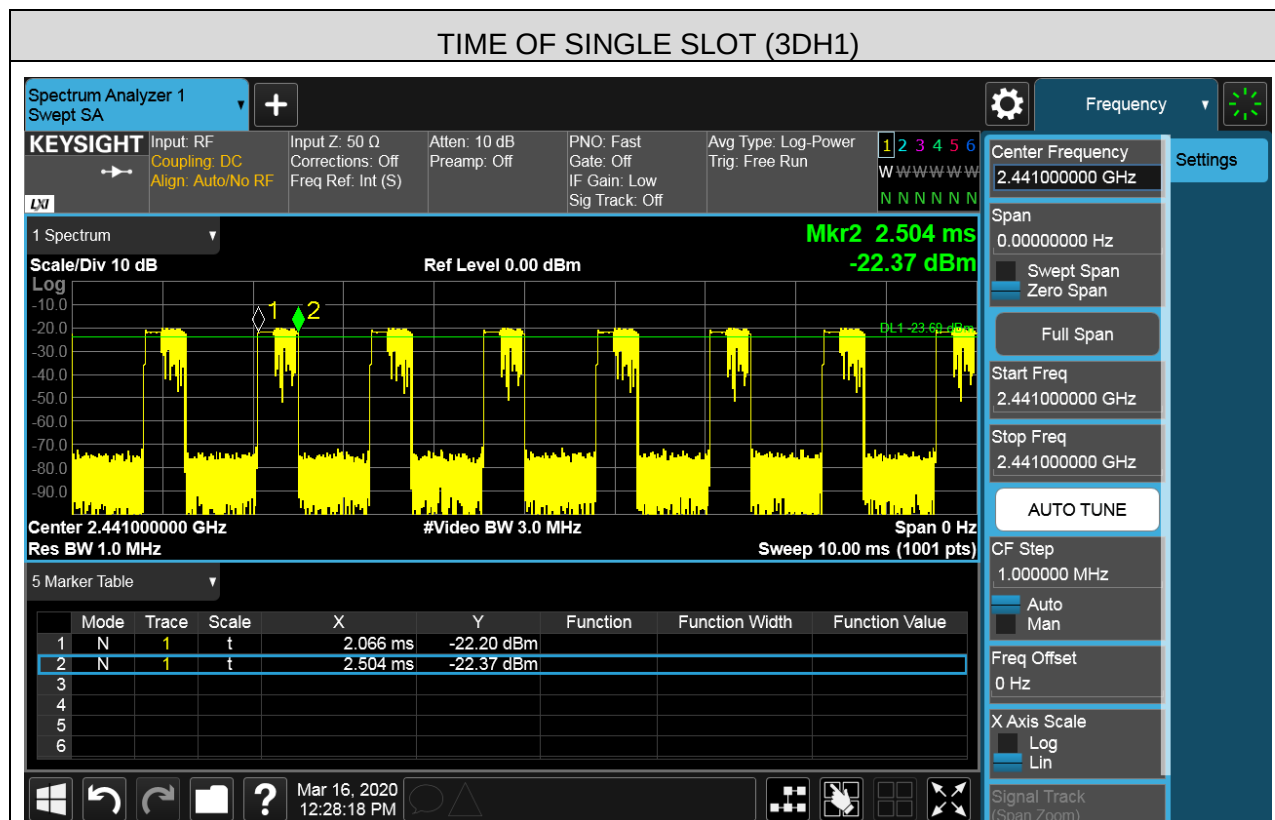


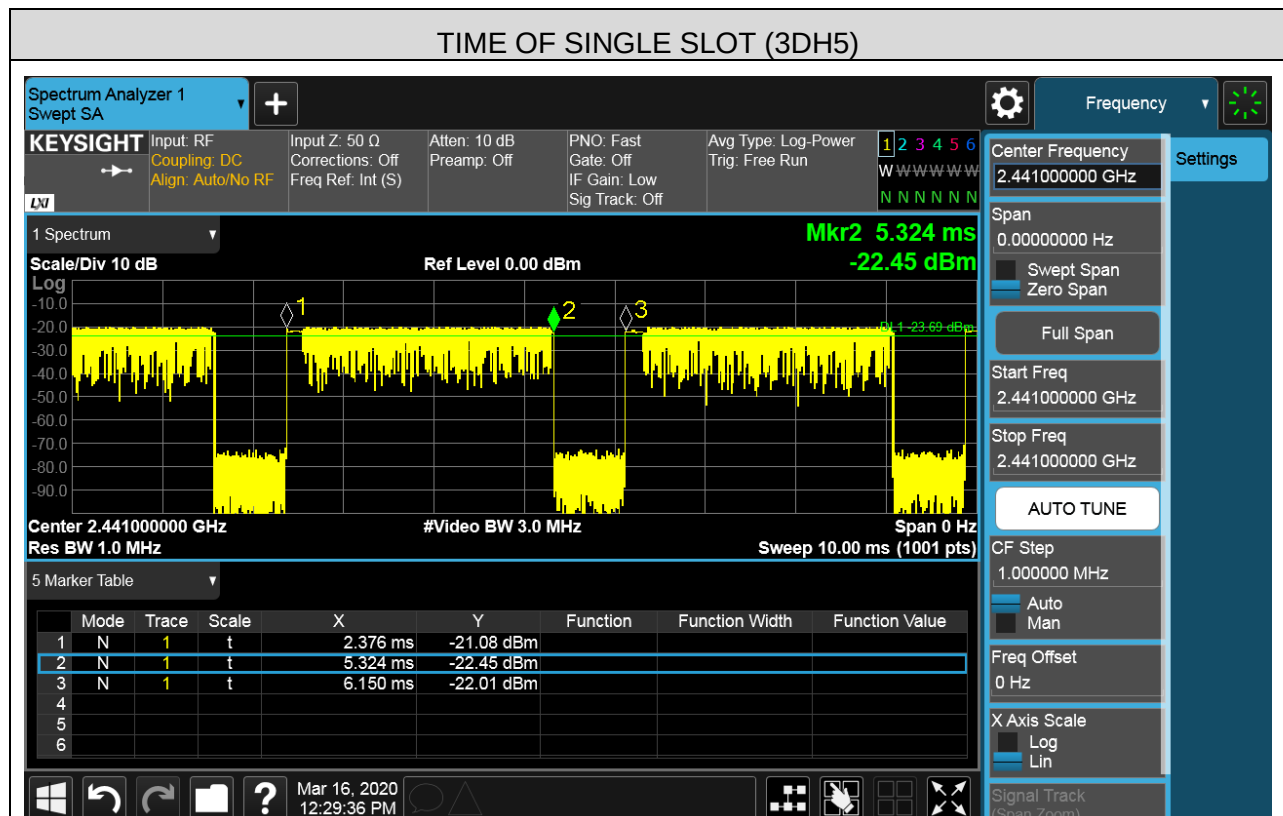
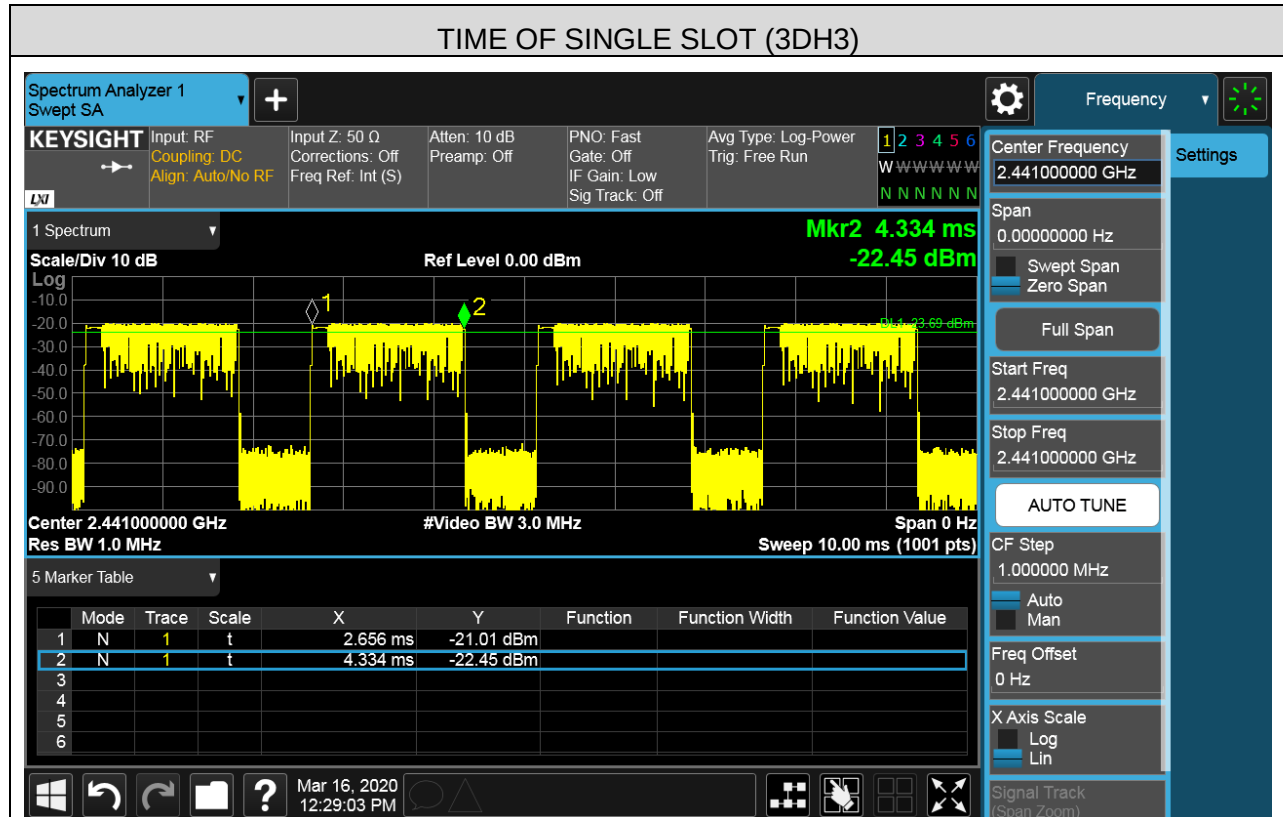


## 6.6.2. 8DPSK MODE

| Normal Mode |         |                            |                   |         |
|-------------|---------|----------------------------|-------------------|---------|
| Packet      | Channel | Burst Width<br>[ms/hop/ch] | Dwell Time<br>[s] | Results |
| 3DH1        | MCH     | 0.438                      | 0.140             | PASS    |
| 3DH3        | MCH     | 1.678                      | 0.268             | PASS    |
| 3DH5        | MCH     | 2.948                      | 0.314             | PASS    |
| AFH Mode    |         |                            |                   |         |
| 3DH1        | MCH     | 0.438                      | 0.07              | PASS    |
| 3DH3        | MCH     | 1.678                      | 0.134             | PASS    |
| 3DH5        | MCH     | 2.948                      | 0.157             | PASS    |

### Test Graph







## 6.7. CONDUCTED SPURIOUS EMISSION

### LIMITS

| FCC Part15 (15.247) , Subpart C<br>RSS-247 ISSUE 2 |                             |                                                                                                                         |
|----------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Section                                            | Test Item                   | Limit                                                                                                                   |
| FCC §15.247 (d)                                    | Conducted Spurious Emission | at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power |
| RSS-247 5.5                                        | Conducted Spurious Emission | at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power |

### TEST PROCEDURE

For Band-edge use the following settings:

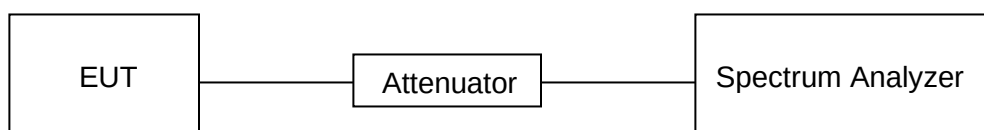
|            |                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------|
| Detector   | Peak                                                                                                    |
| RBW        | 1 MHz                                                                                                   |
| VBW        | 3 × RBW                                                                                                 |
| Span       | Wide enough to capture the peak level of the emission operating on the channel closest to the band edge |
| Trace      | Max hold                                                                                                |
| Sweep time | Couple                                                                                                  |

For Spurious Emission use the following settings:

|            |                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------|
| Detector   | Peak                                                                                                    |
| RBW        | 100 kHz                                                                                                 |
| VBW        | 300 kHz                                                                                                 |
| Span       | Wide enough to capture the peak level of the emission operating on the channel closest to the band edge |
| Trace      | Max hold                                                                                                |
| Sweep time | Couple                                                                                                  |

Use the peak marker function to determine the maximum amplitude level.

### TEST SETUP





### 6.7.1. GFSK MODE

#### Part I: CONDUCTED BANDEDGE

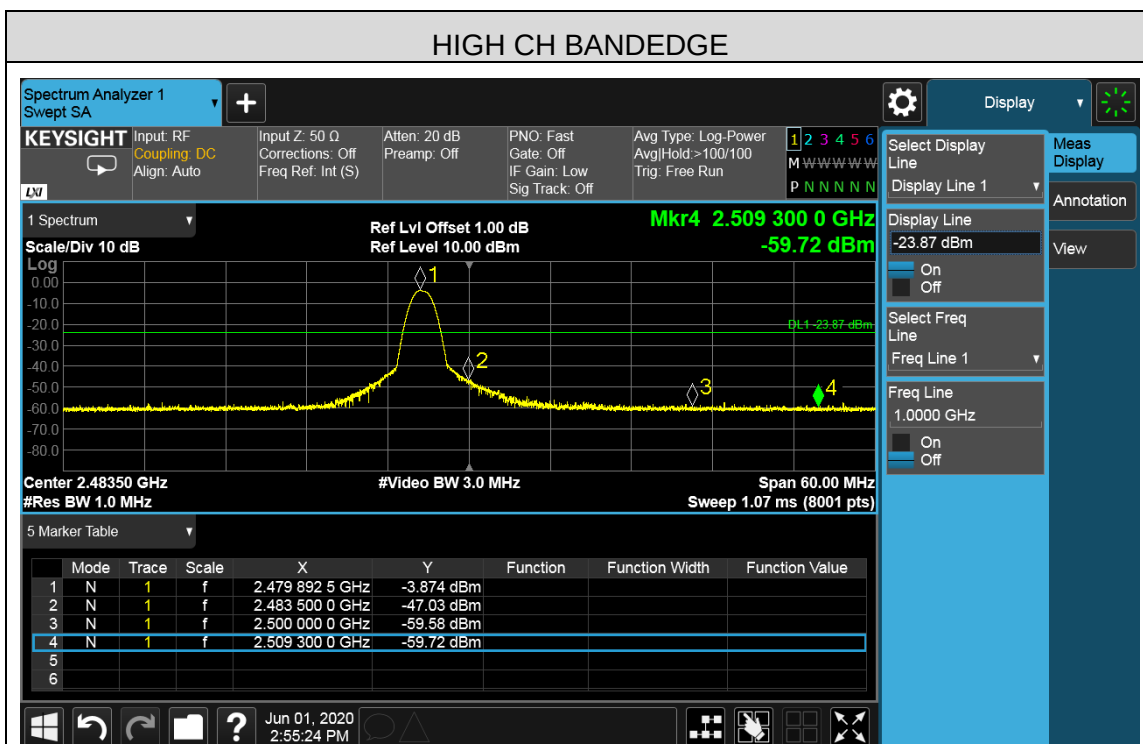
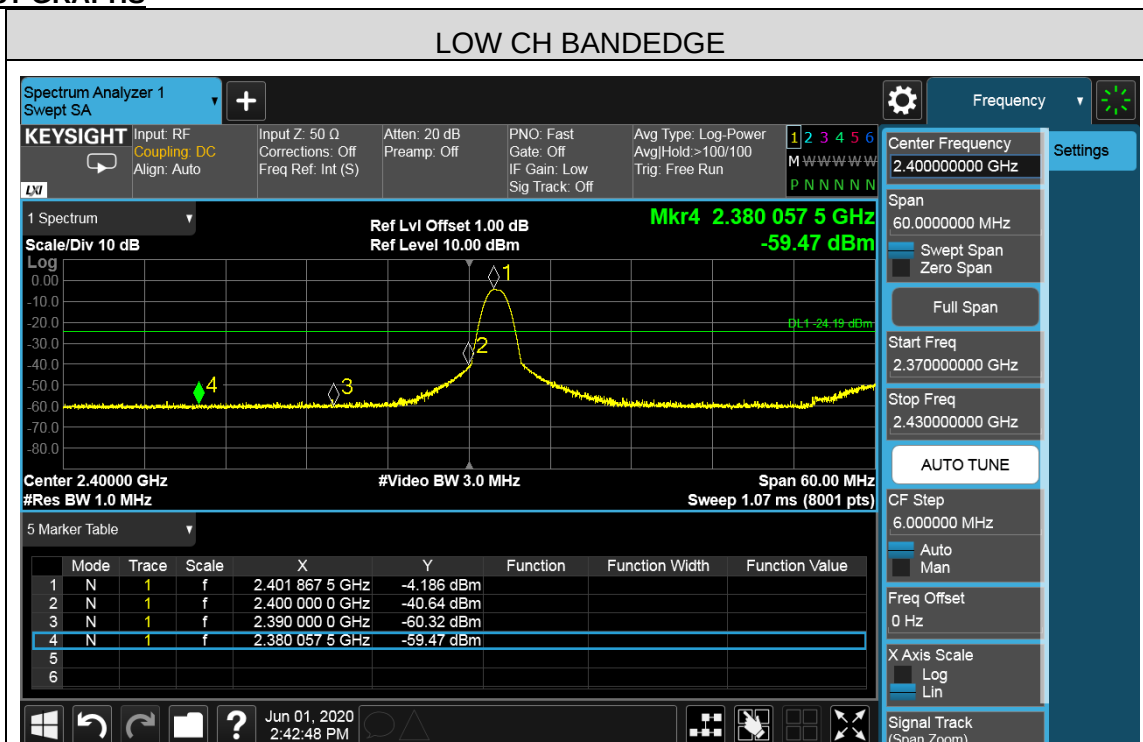
#### RESULTS TABLE

| Test Mode | Test Channel | Carrier Power[dBm] | Max. Spurious Level [dBm] | Limit [dBm] | Verdict |
|-----------|--------------|--------------------|---------------------------|-------------|---------|
| GFSK      | LCH          | -4.186             | -40.64                    | -24.19      | PASS    |
|           | HCH          | -3.874             | -47.03                    | -23.87      | PASS    |





## TEST GRAPHS



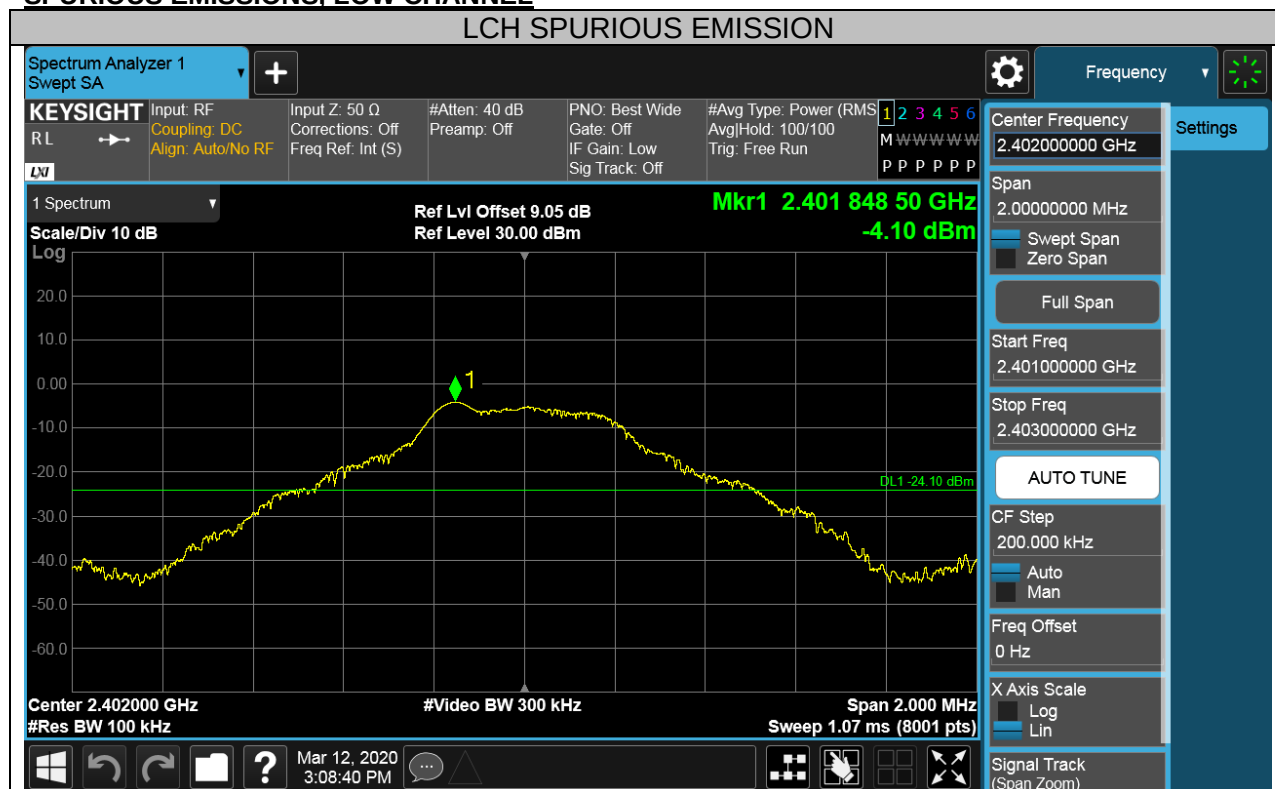


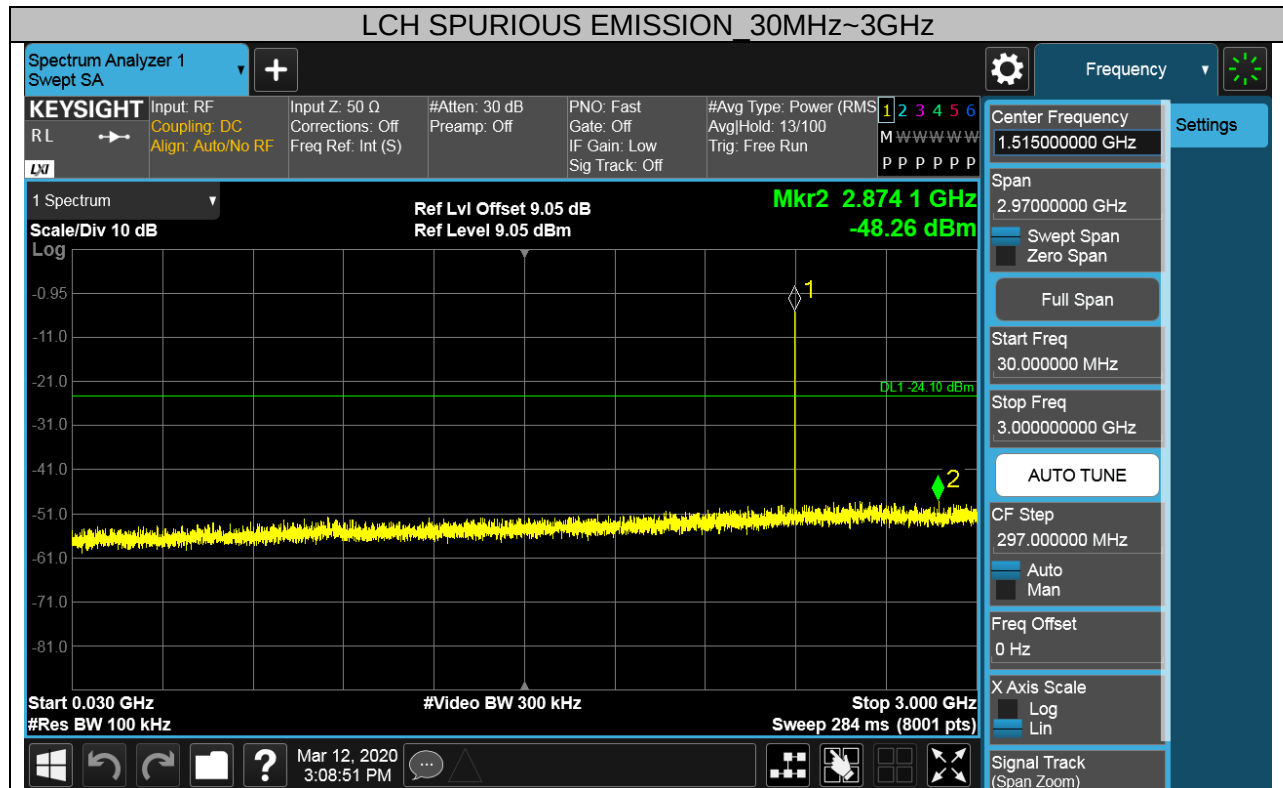
## Part II: CONDUCTED SPURIOUS EMISSIONS

### RESULTS TABLE

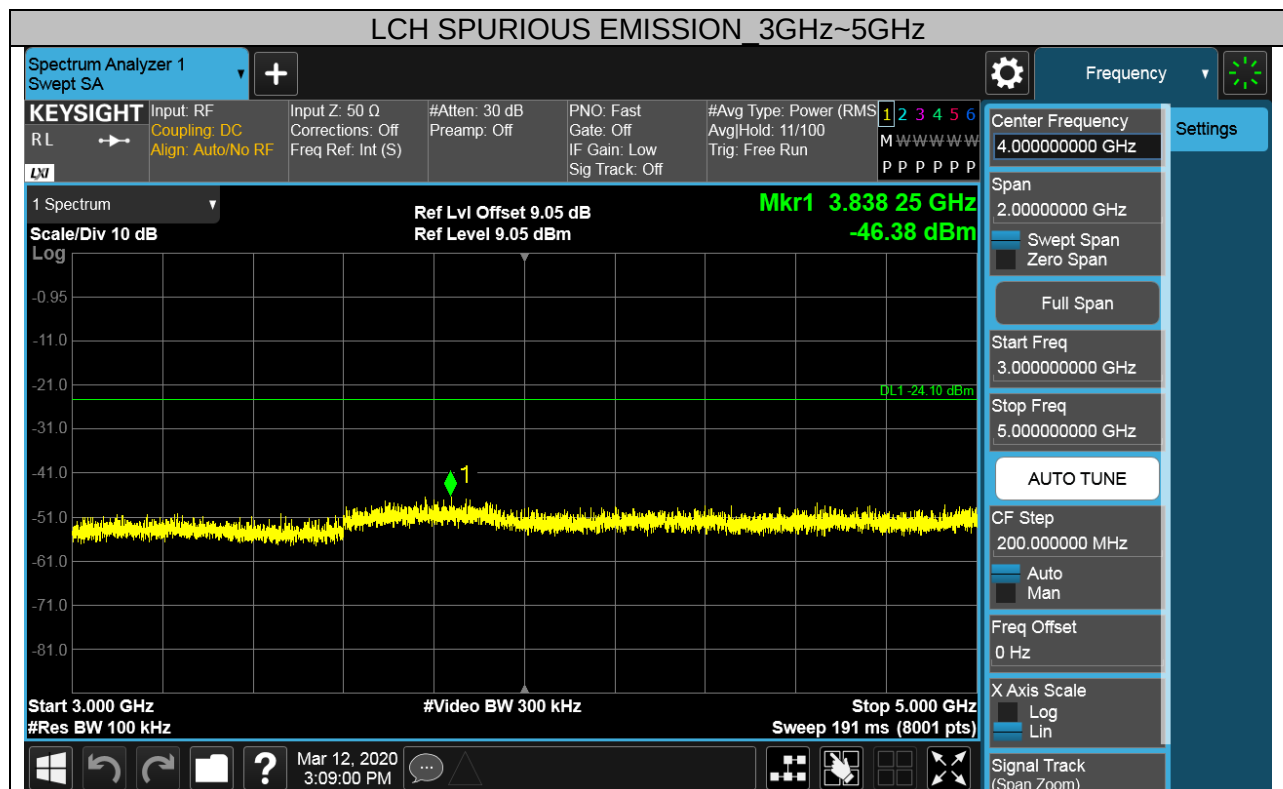
| Test Mode | Channel | Pref(dBm) | Puw(dBm) | Verdict |
|-----------|---------|-----------|----------|---------|
| GFSK      | LCH     | -4.10     | <Limit   | PASS    |
|           | MCH     | -4.33     | <Limit   | PASS    |
|           | HCH     | -4.65     | <Limit   | PASS    |

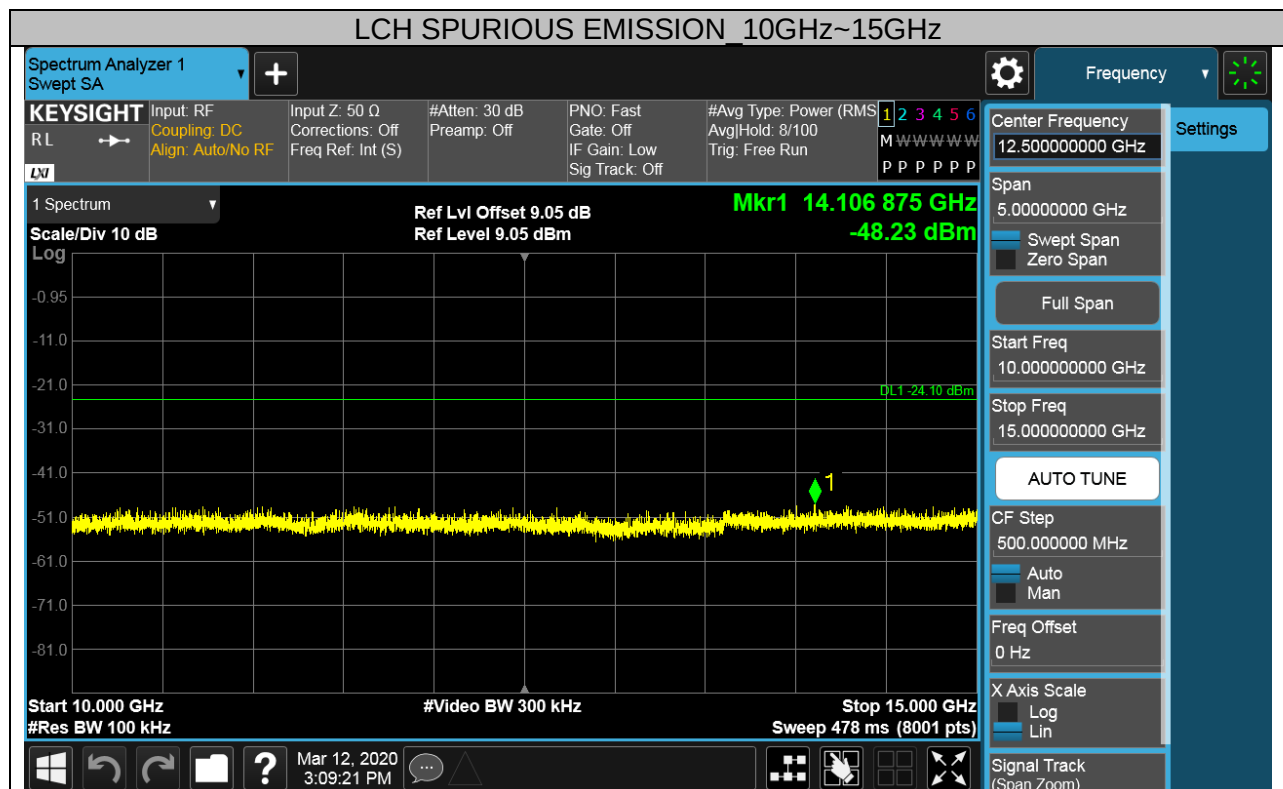
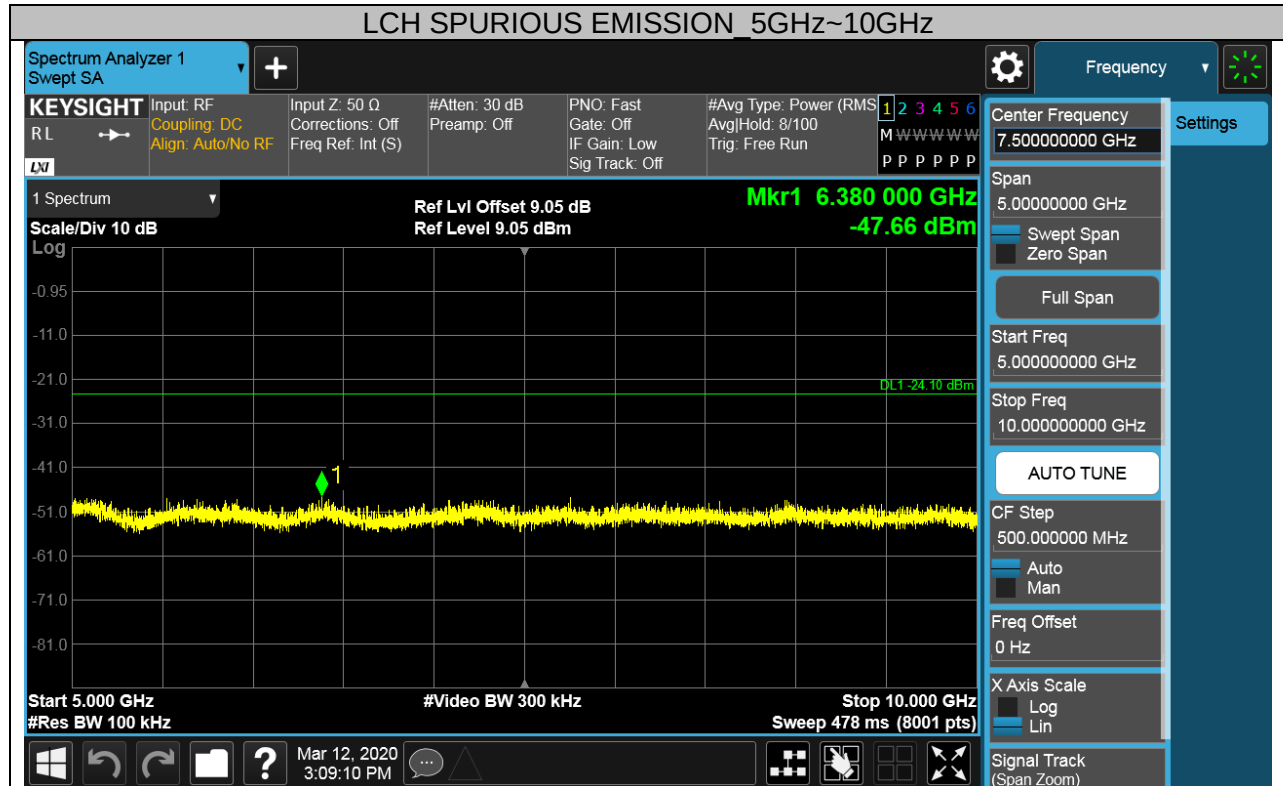
### SPURIOUS EMISSIONS, LOW CHANNEL

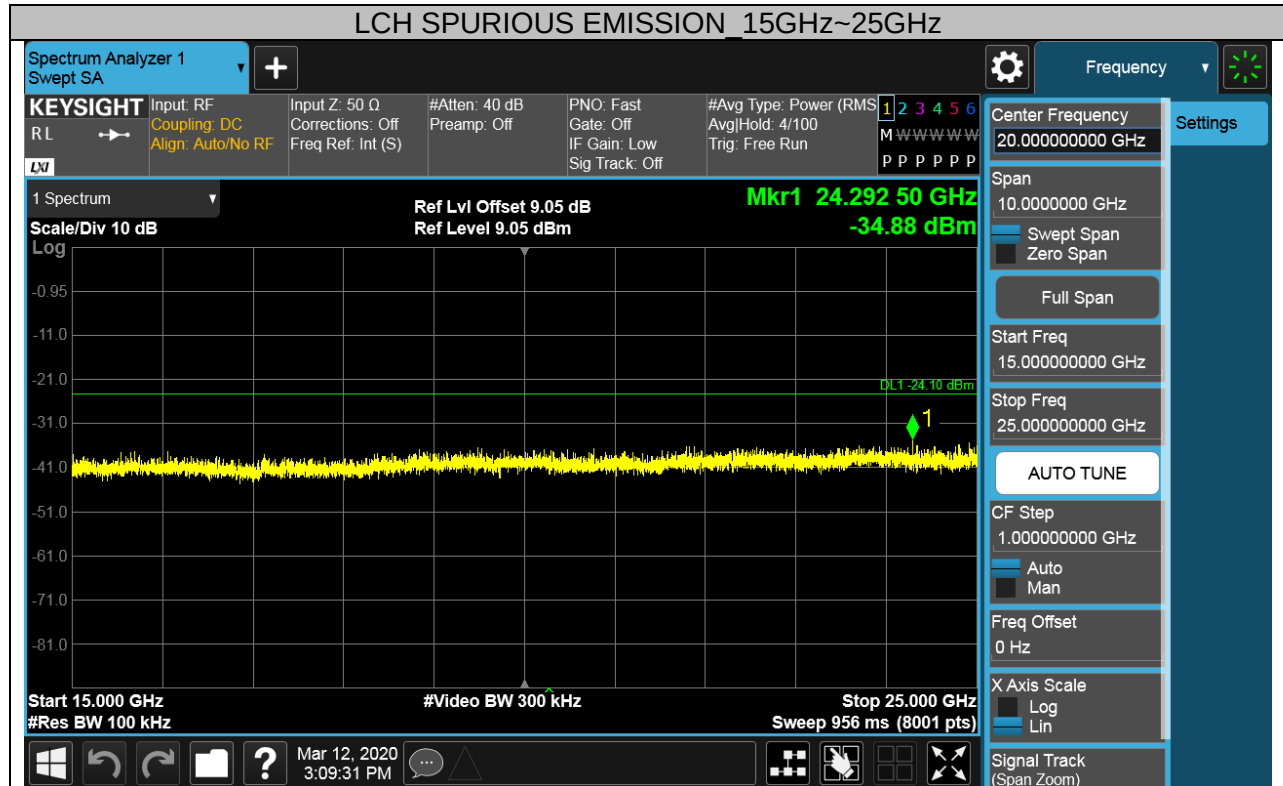




Note: The point 1 which exceeds the limit is 2.4G main carrier.

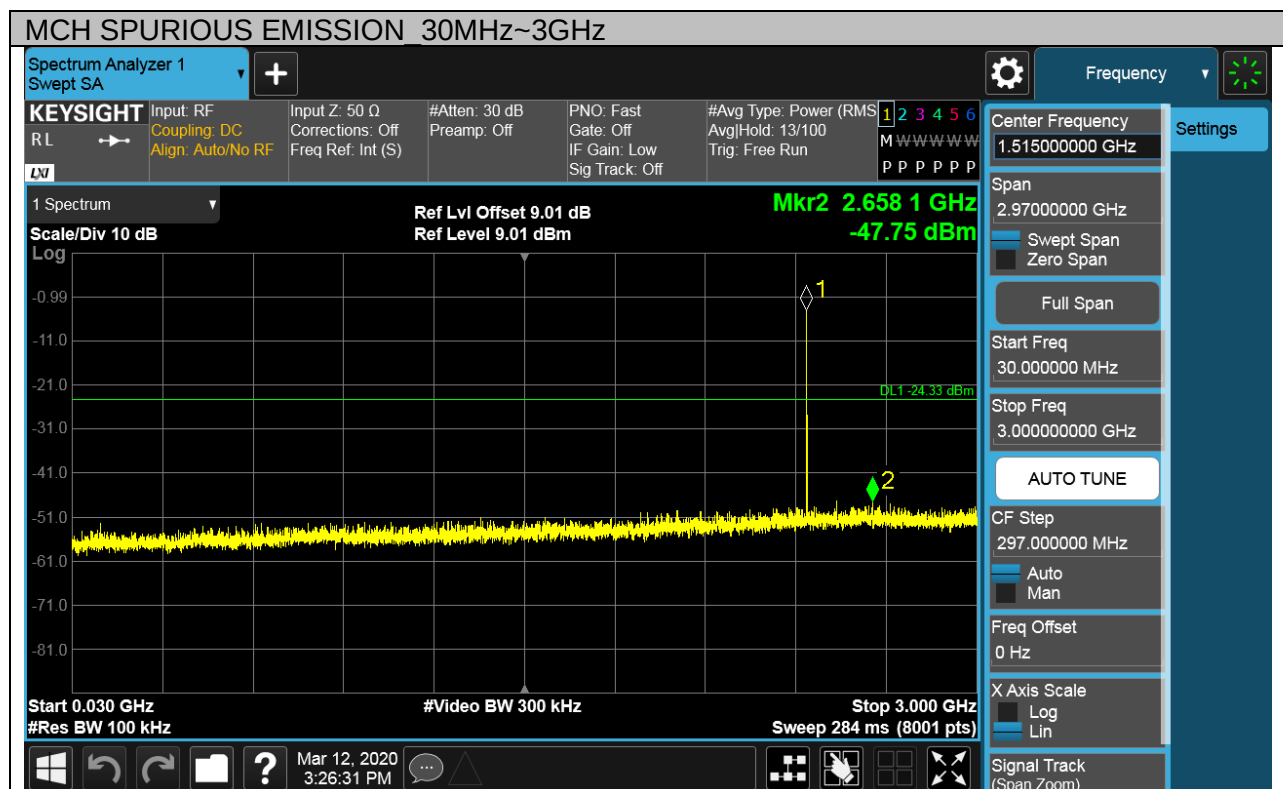
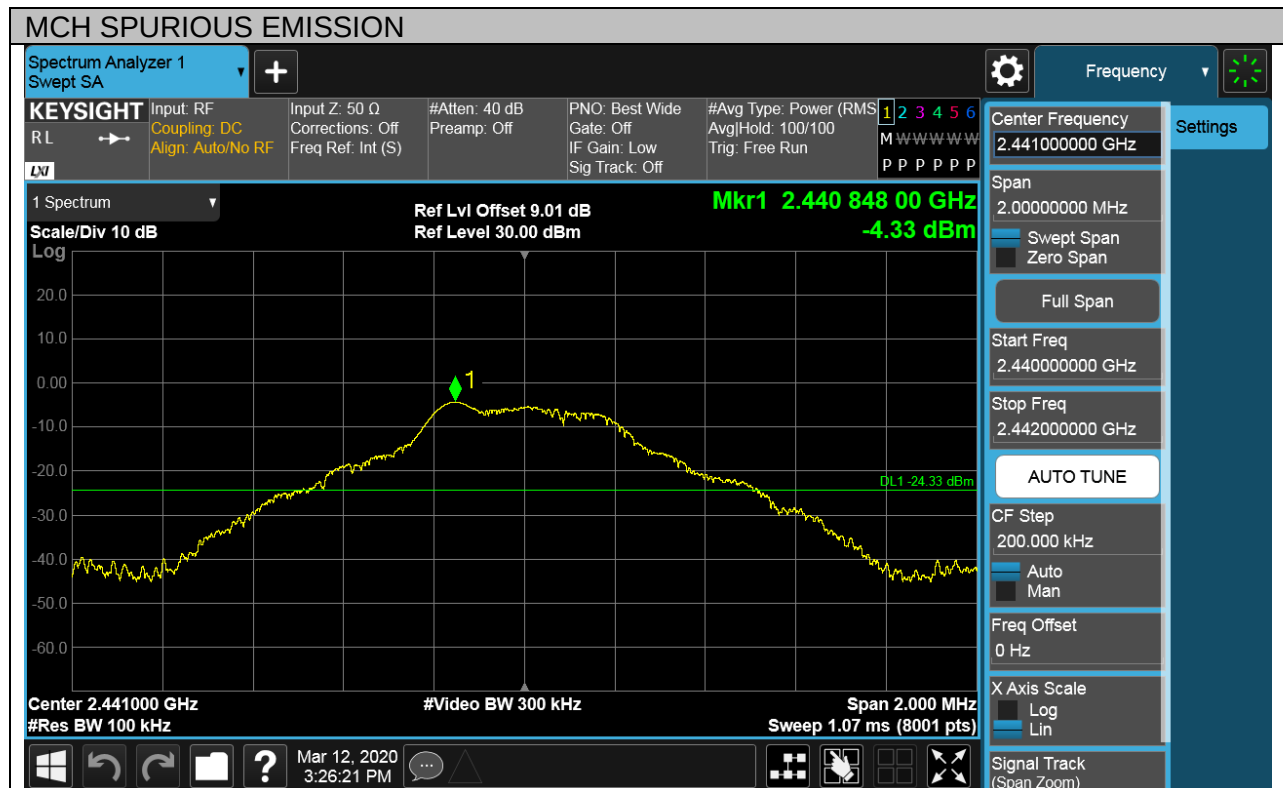




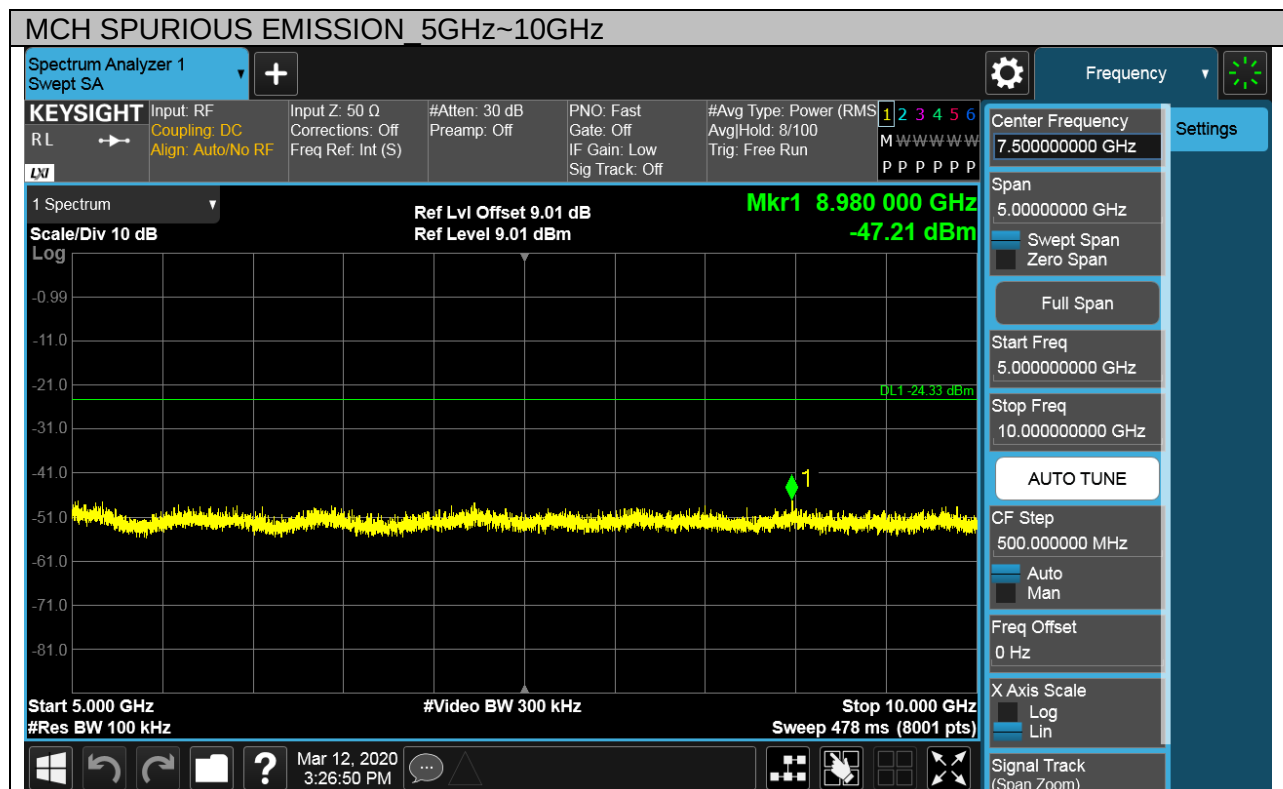
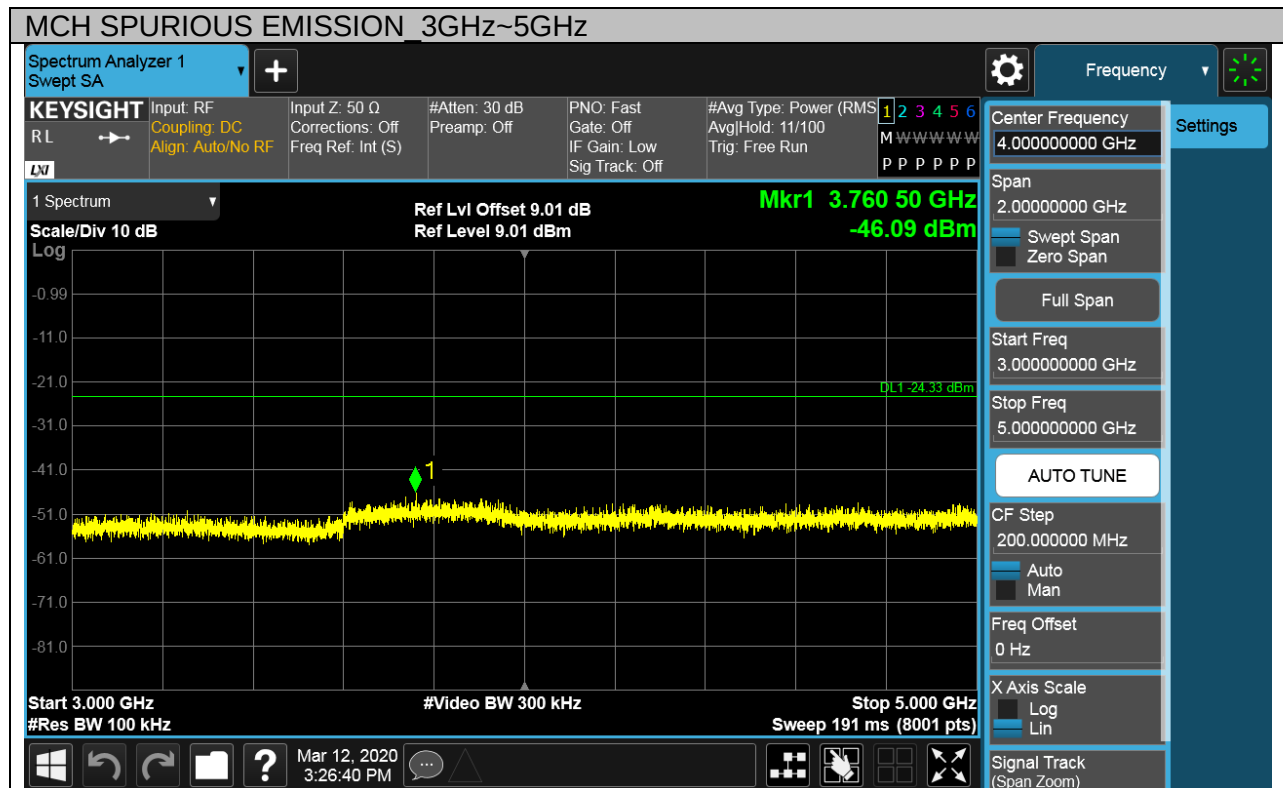


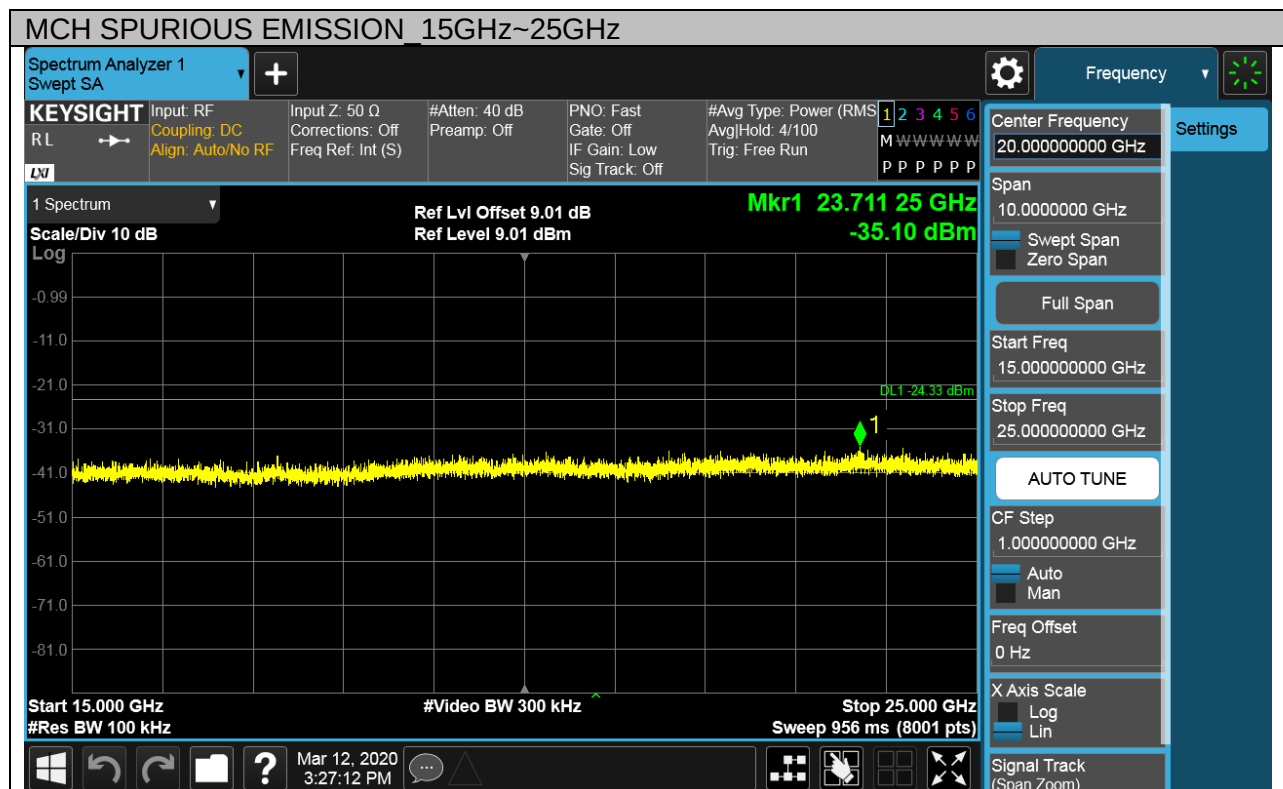
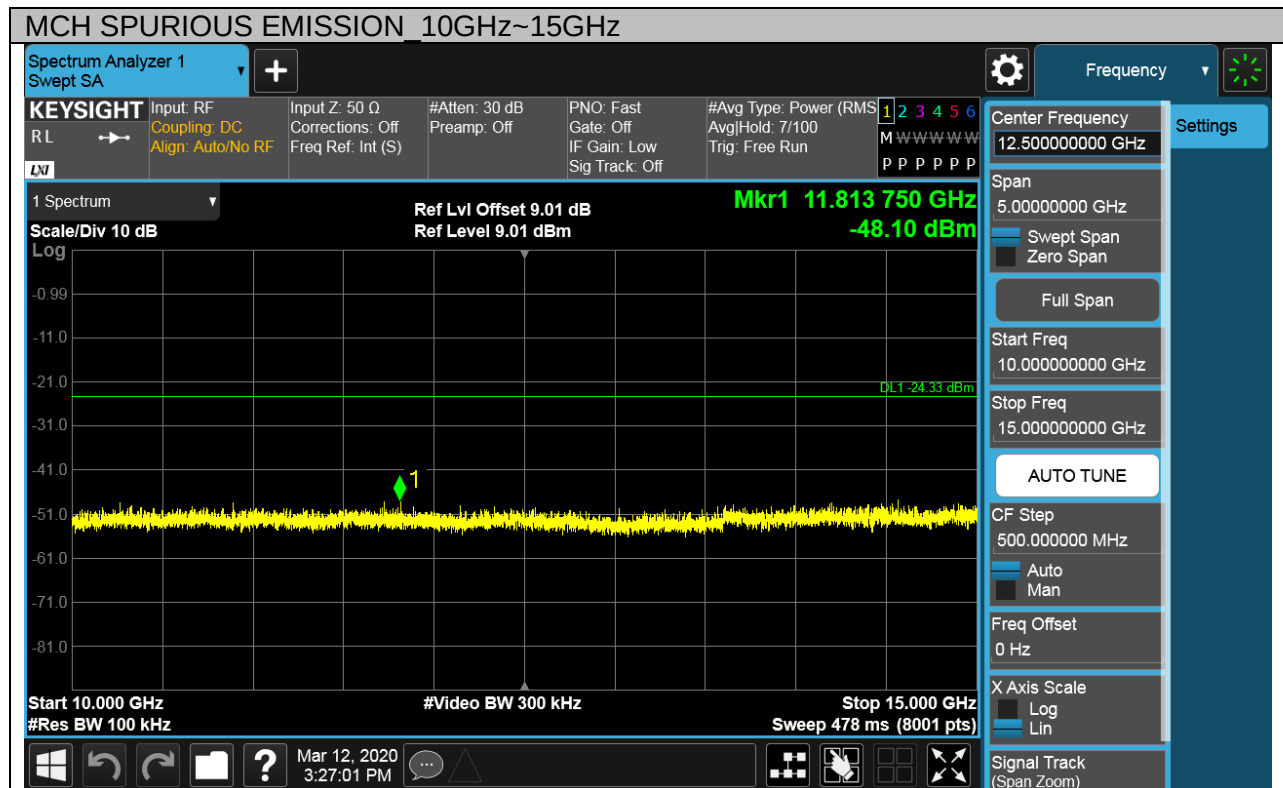


### SPURIOUS EMISSIONS, MID CHANNEL



Note: The point 1 which exceeds the limit is 2.4G main carrier.

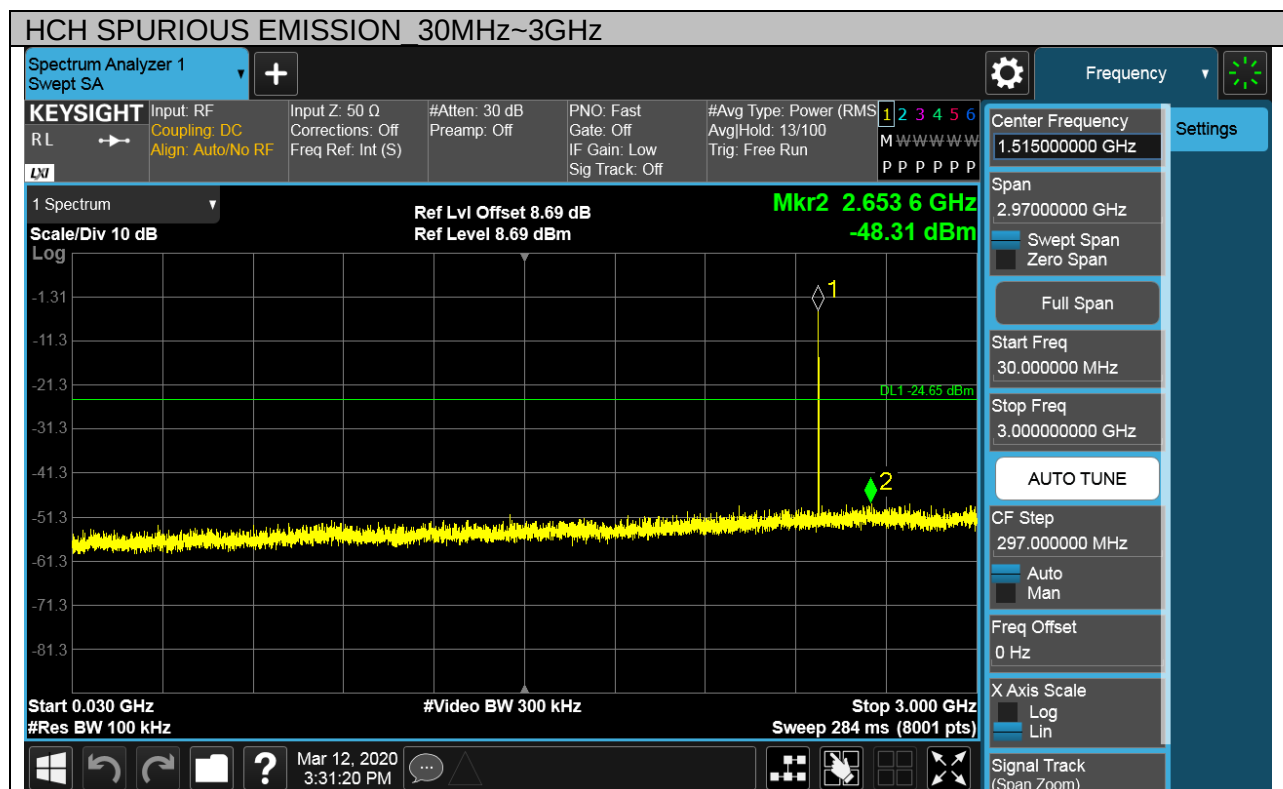
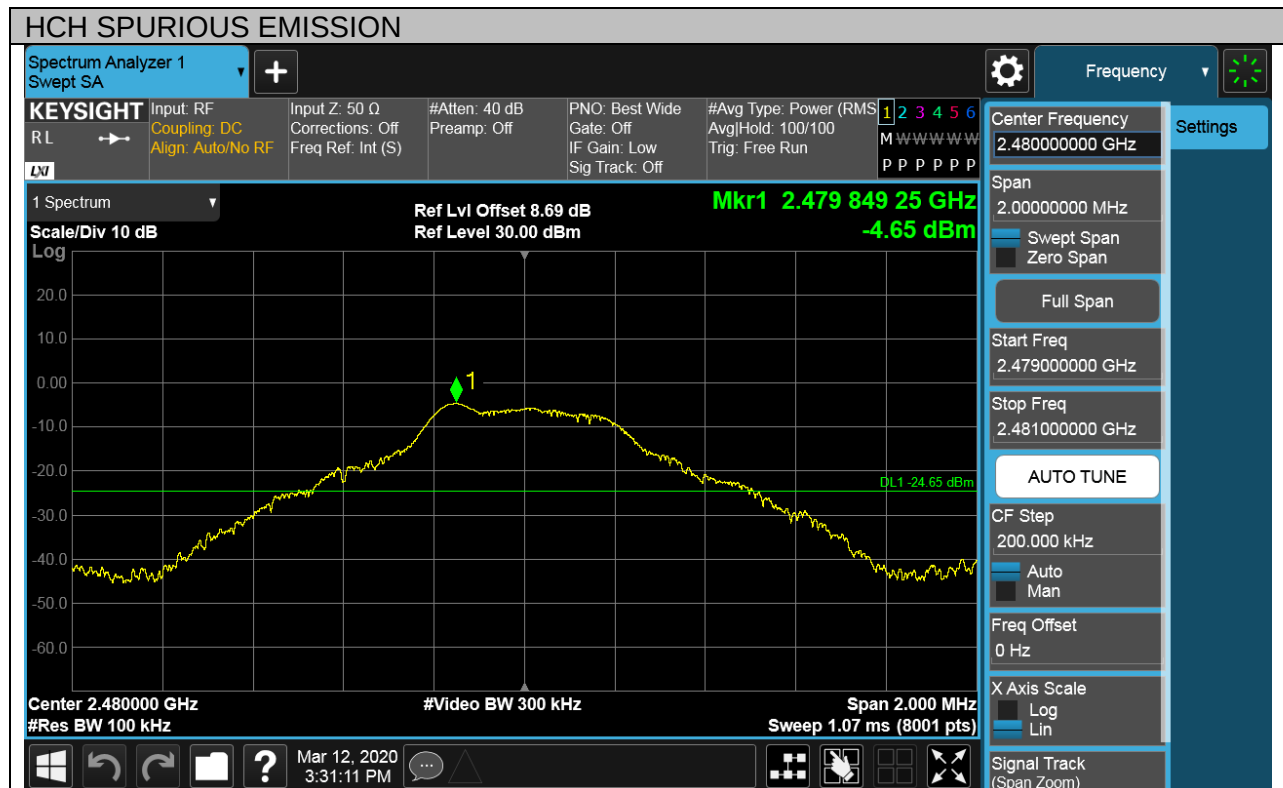




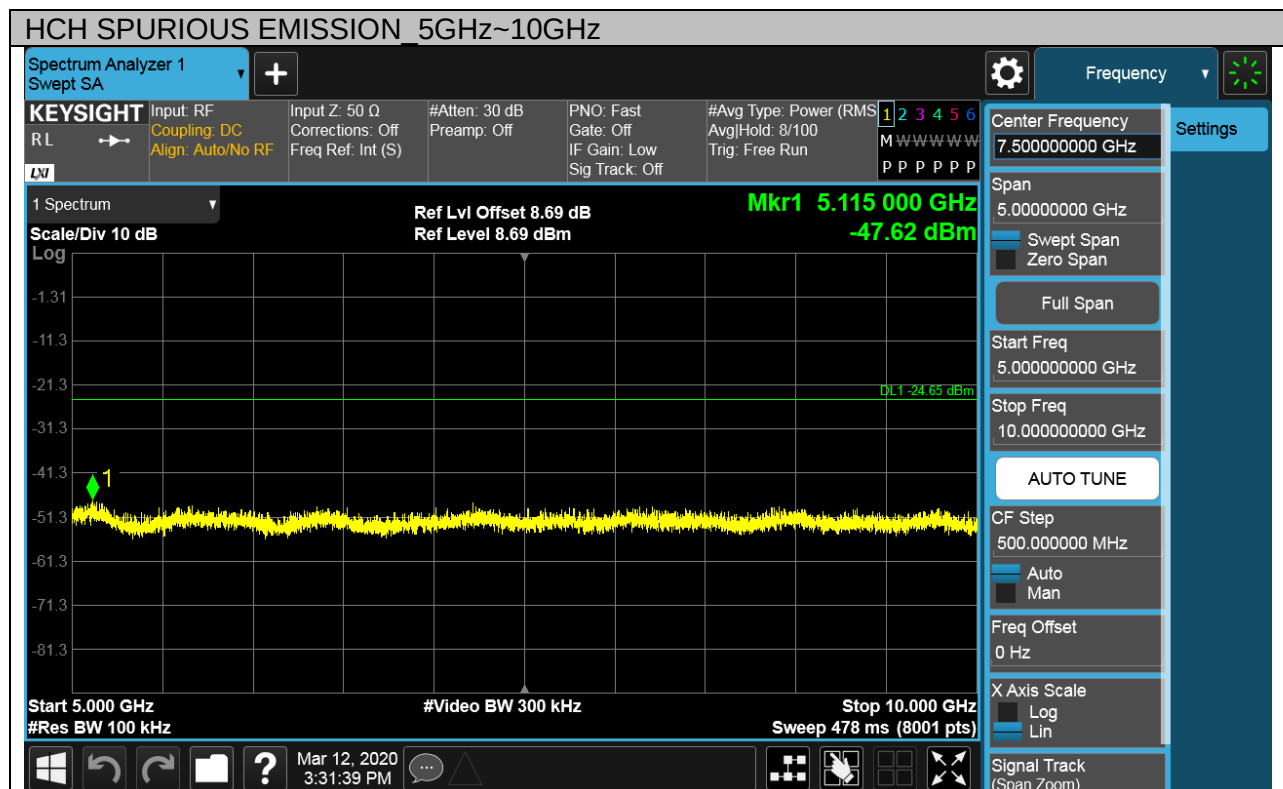
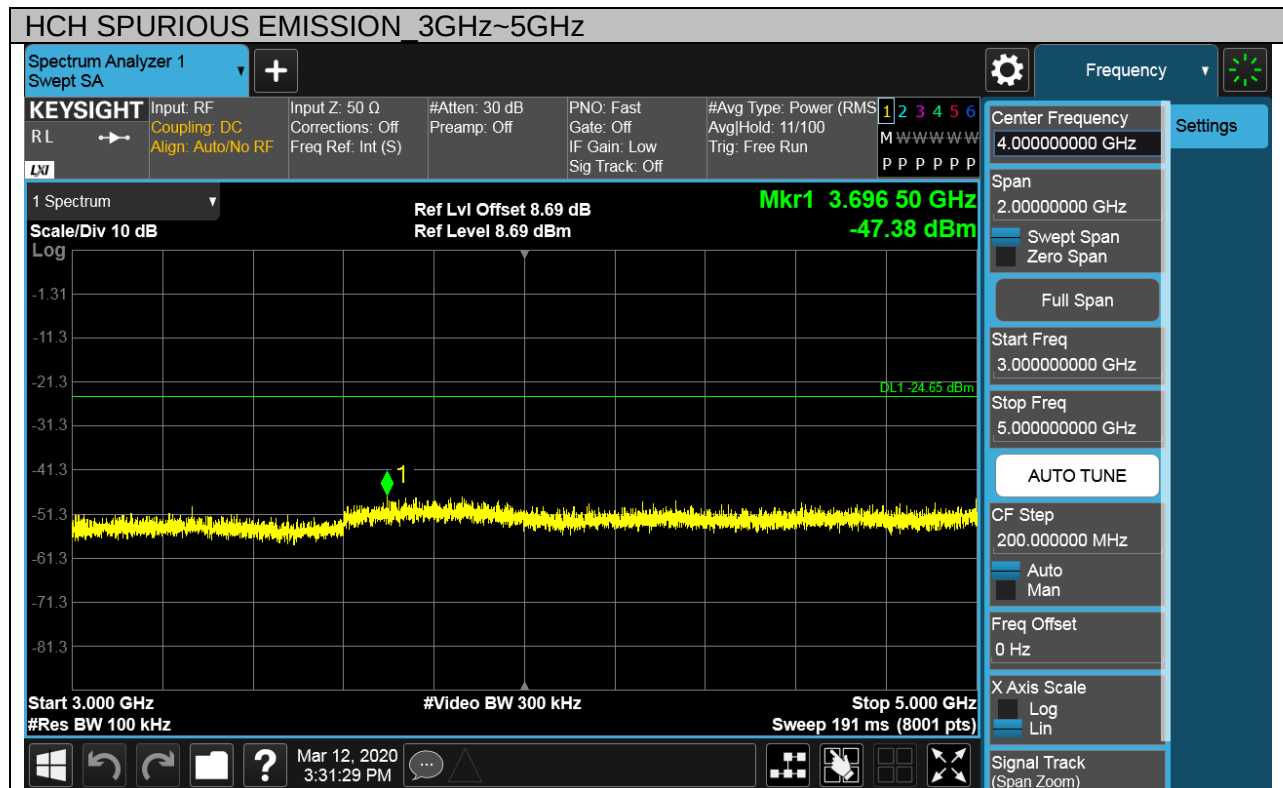


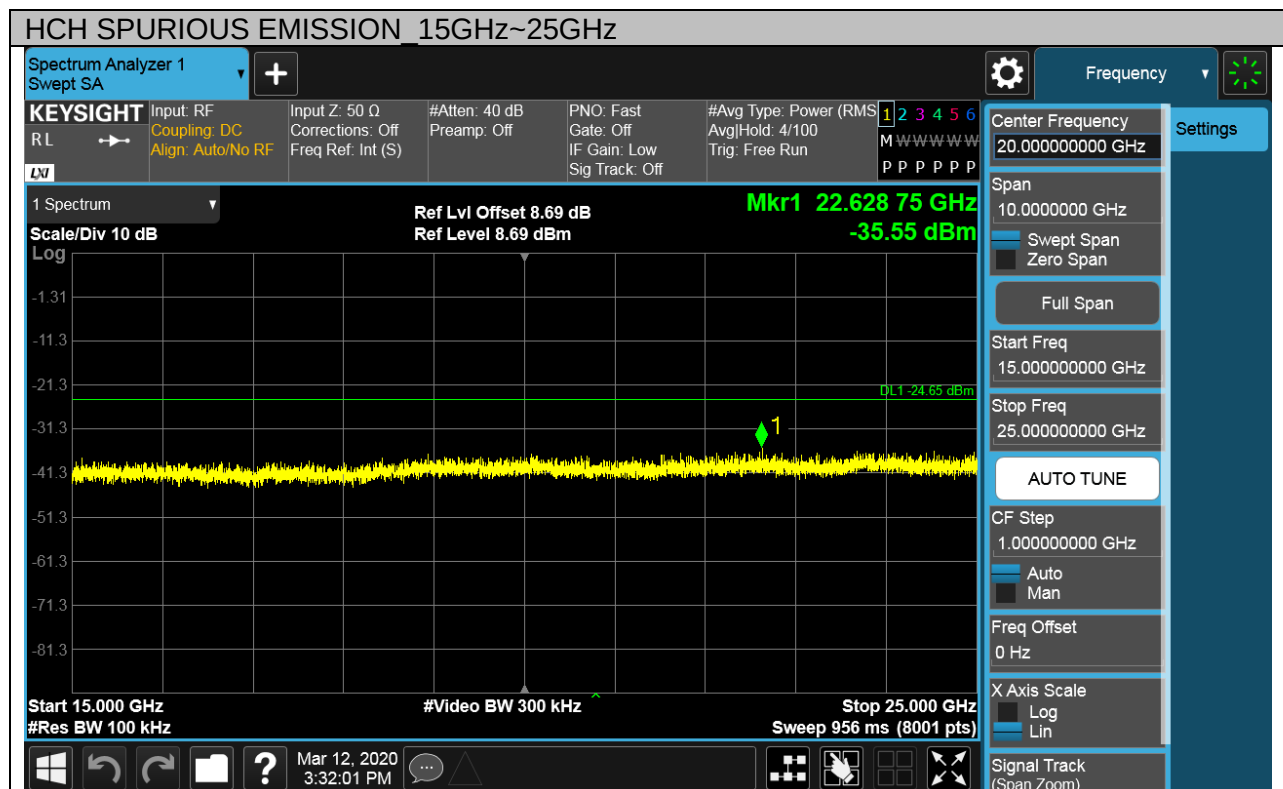
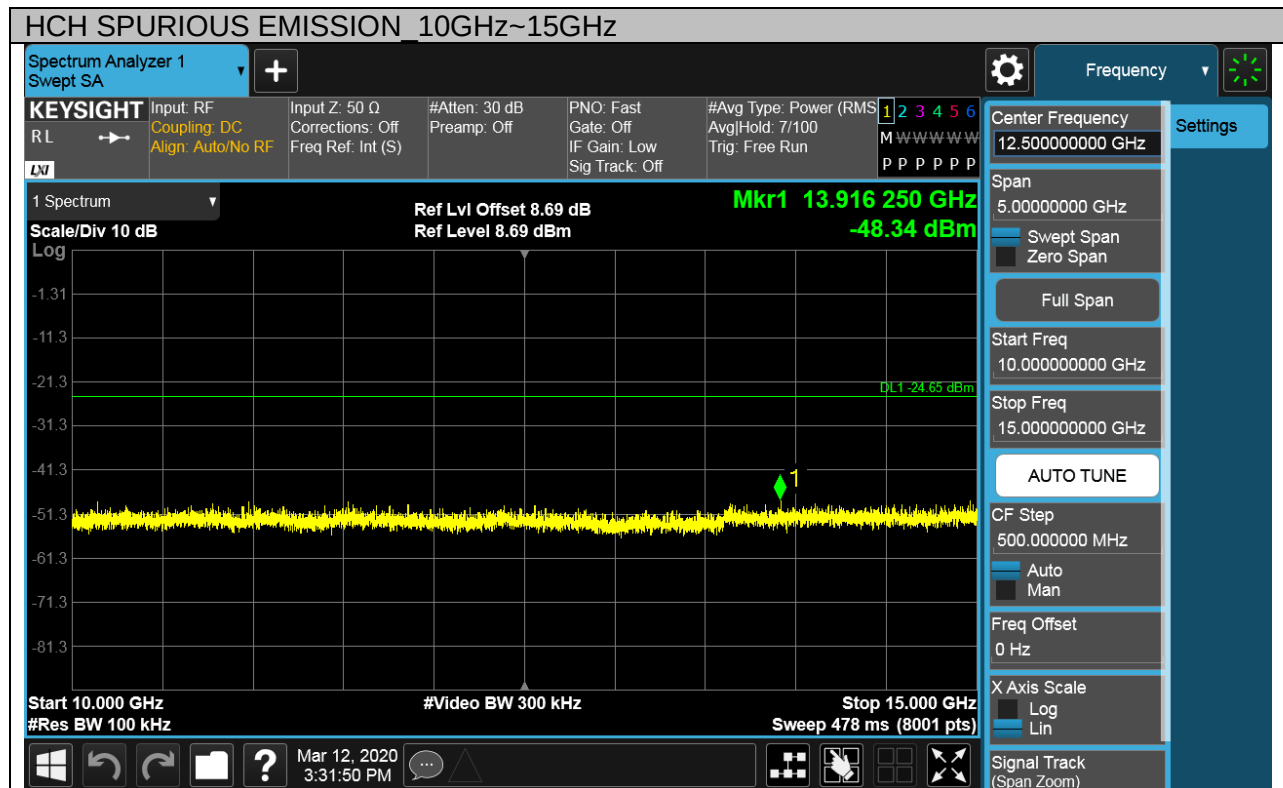


### SPURIOUS EMISSIONS, HIGH CHANNEL



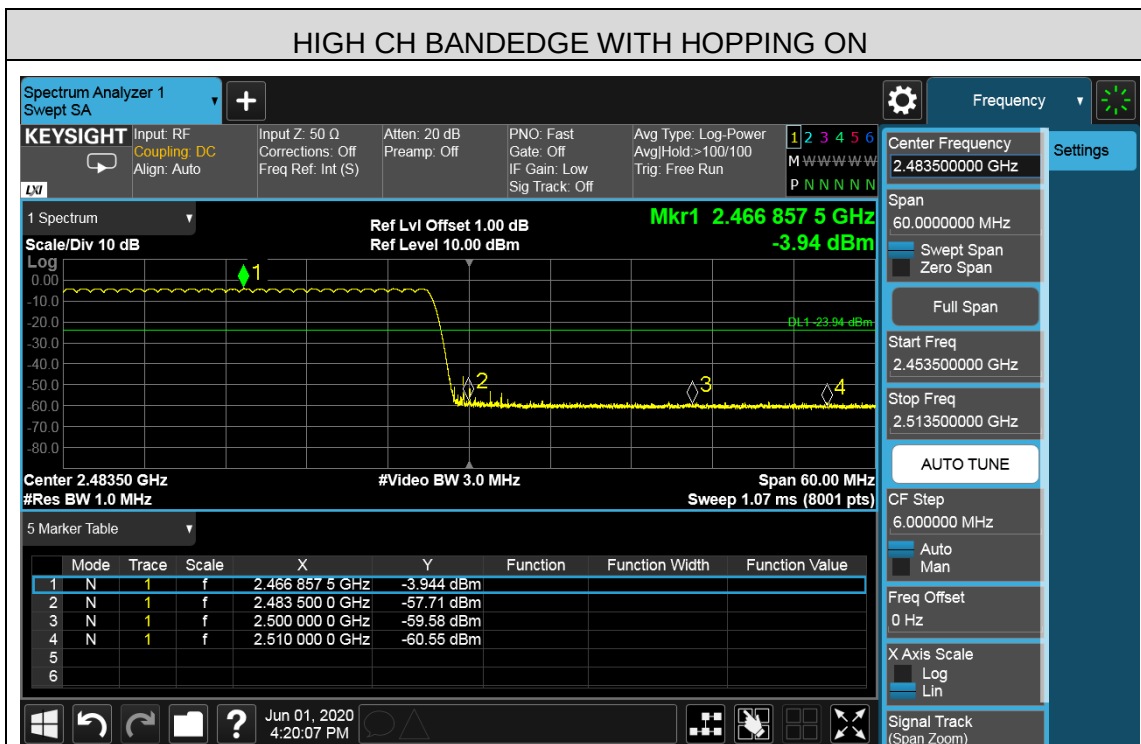
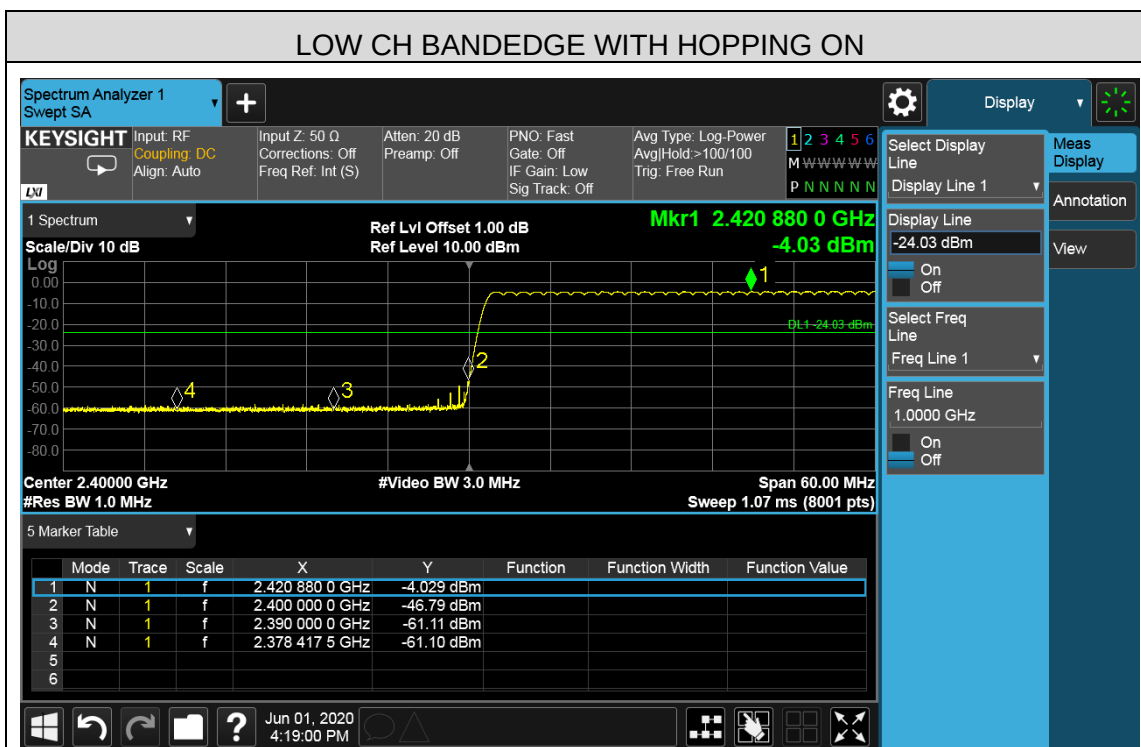
Note: The point 1 which exceeds the limit is 2.4G main carrier.







## SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON





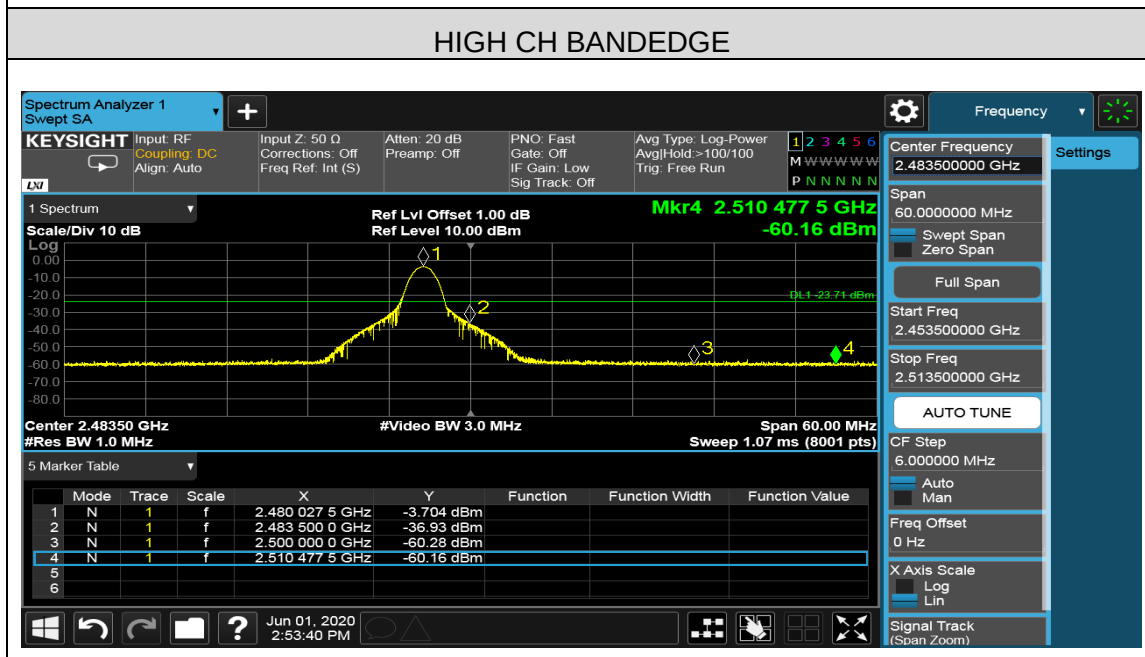
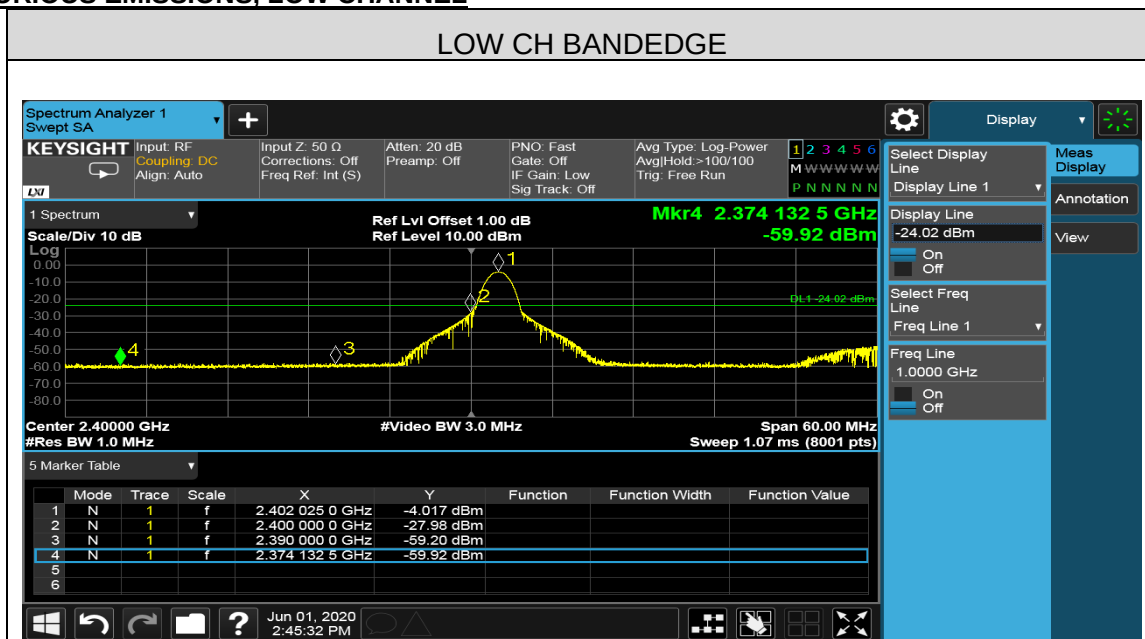
## 6.7.2. 8DPSK MODE

### Part I: CONDUCTED BANDEDGE

#### RESULTS TABLE

| Test Mode | Test Channel | Carrier Power[dBm] | Max. Spurious Level [dBm] | Limit [dBm] | Verdict |
|-----------|--------------|--------------------|---------------------------|-------------|---------|
| 8DPSK     | LCH          | -4.017             | -27.98                    | -24.02      | PASS    |
|           | HCH          | -3.704             | -36.93                    | -23.71      | PASS    |

#### SPURIOUS EMISSIONS, LOW CHANNEL

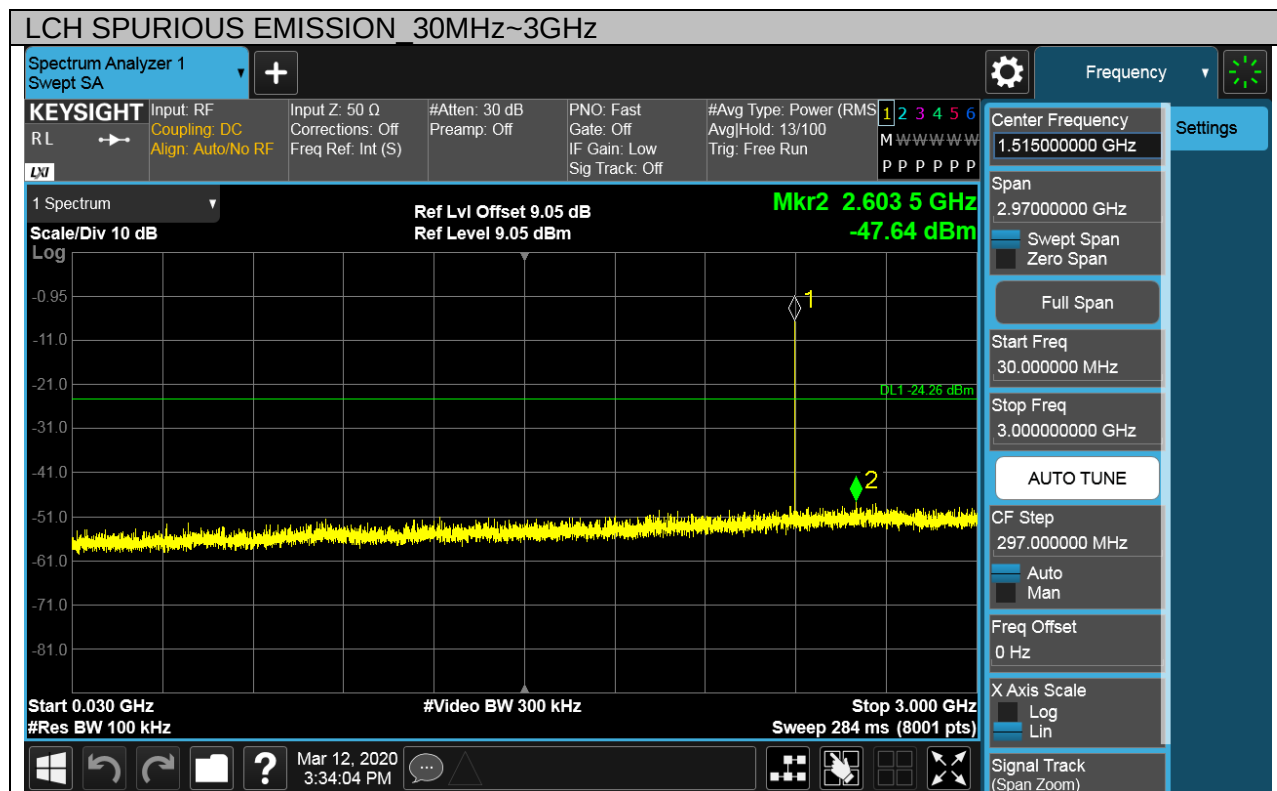
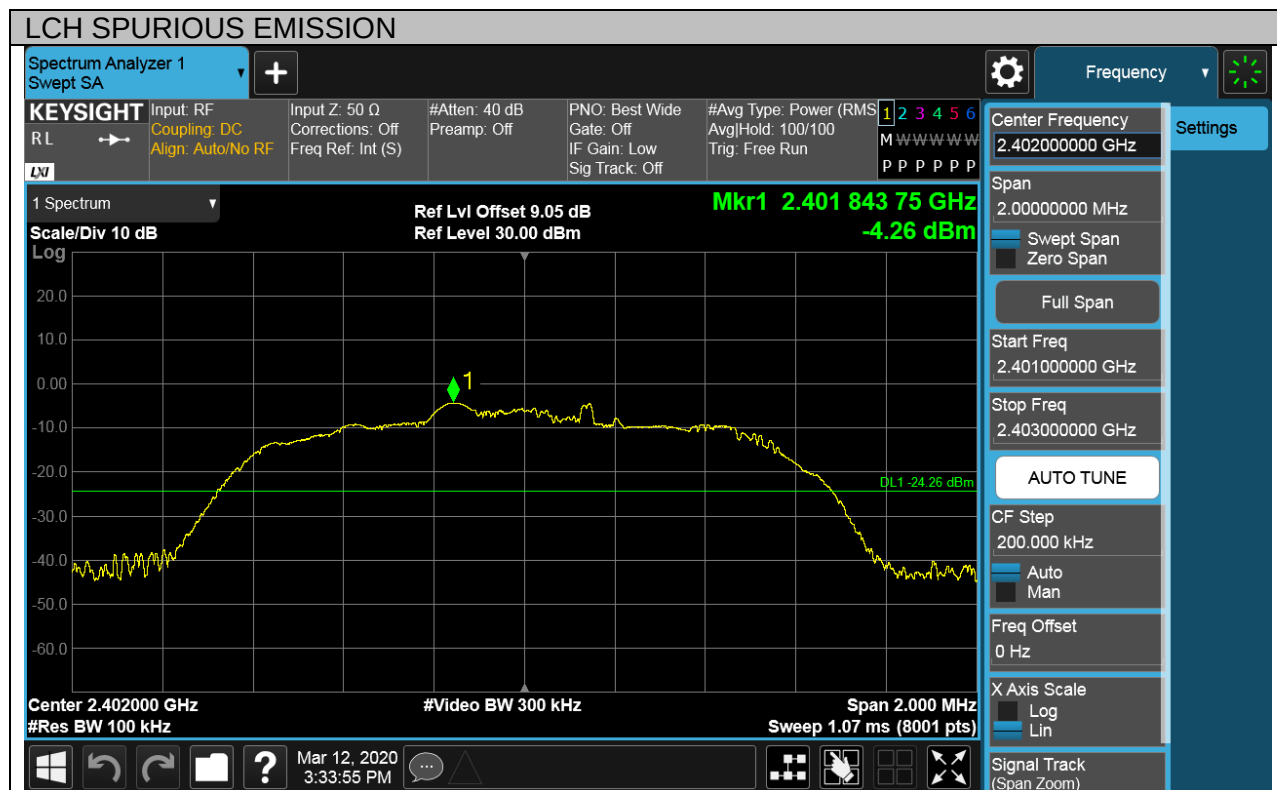




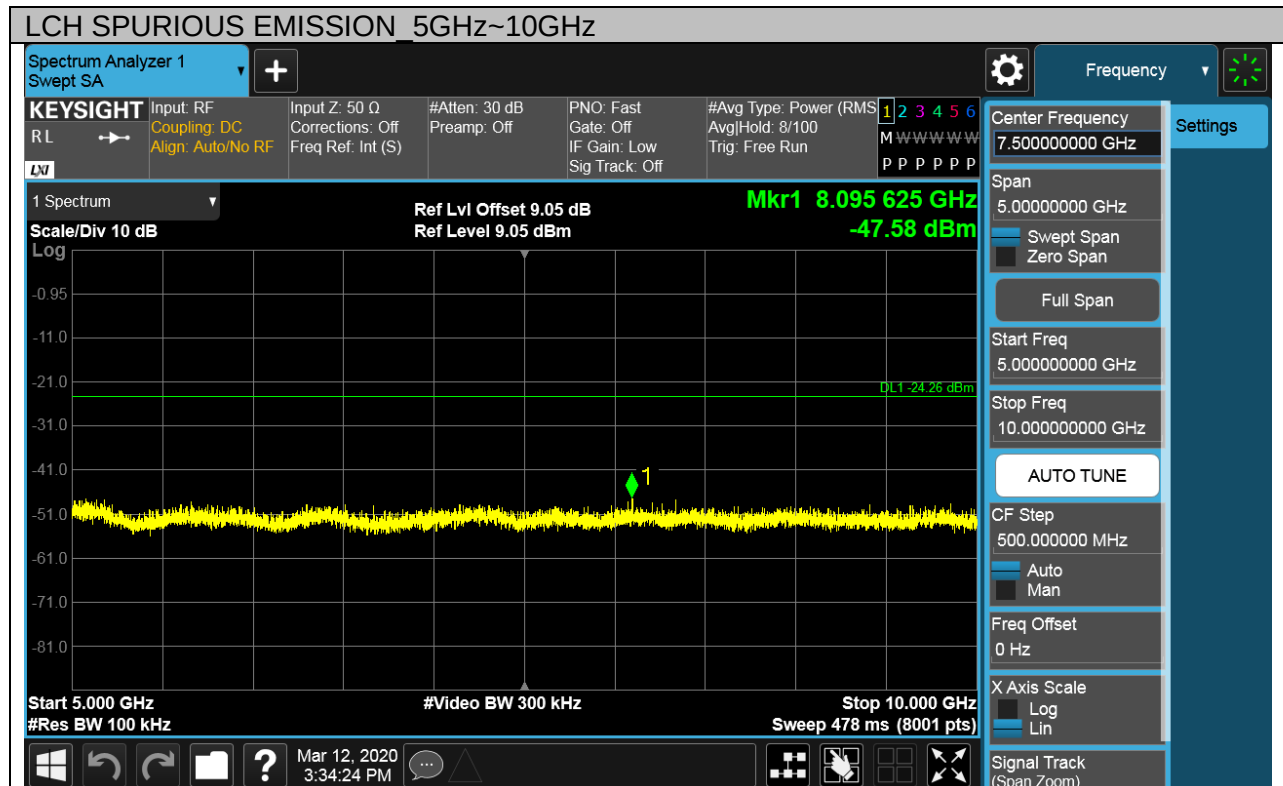
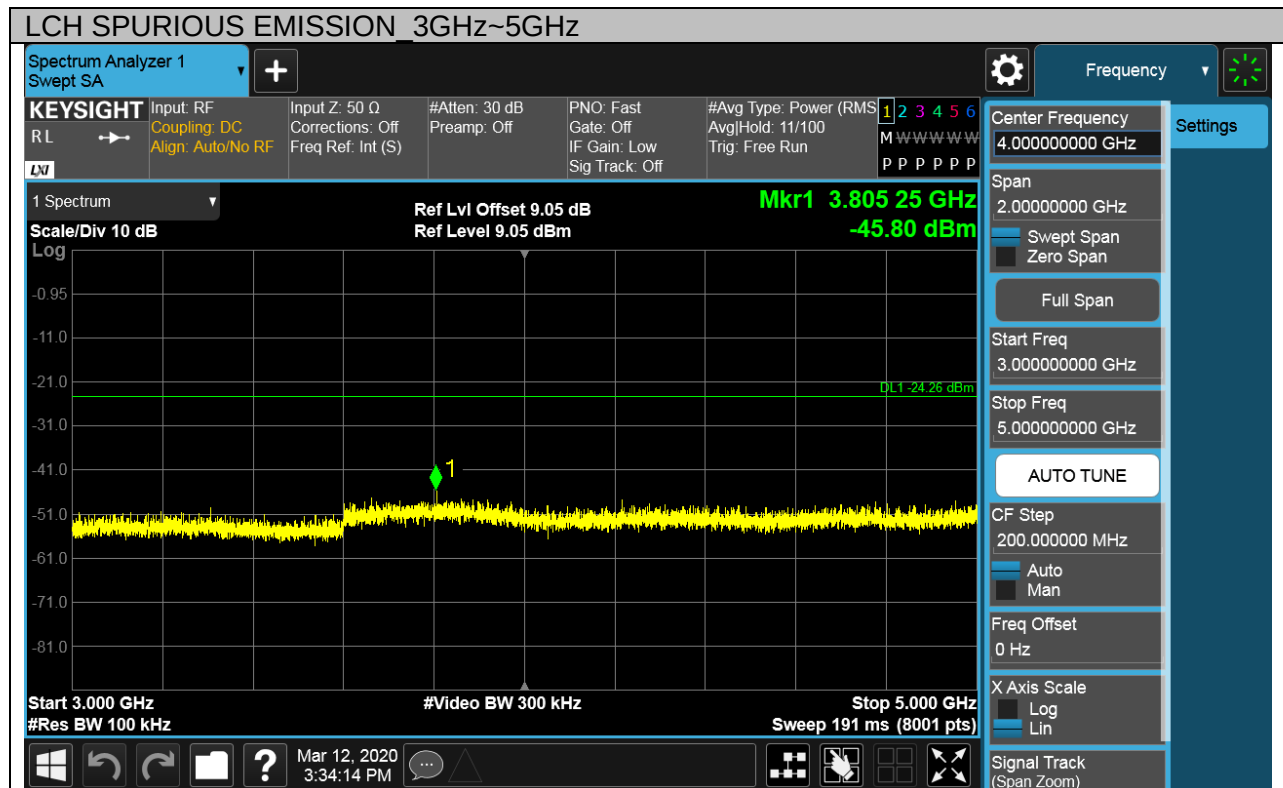
**Part II: CONDUCTED SPURIOUS EMISSIONS**

**RESULTS TABLE**

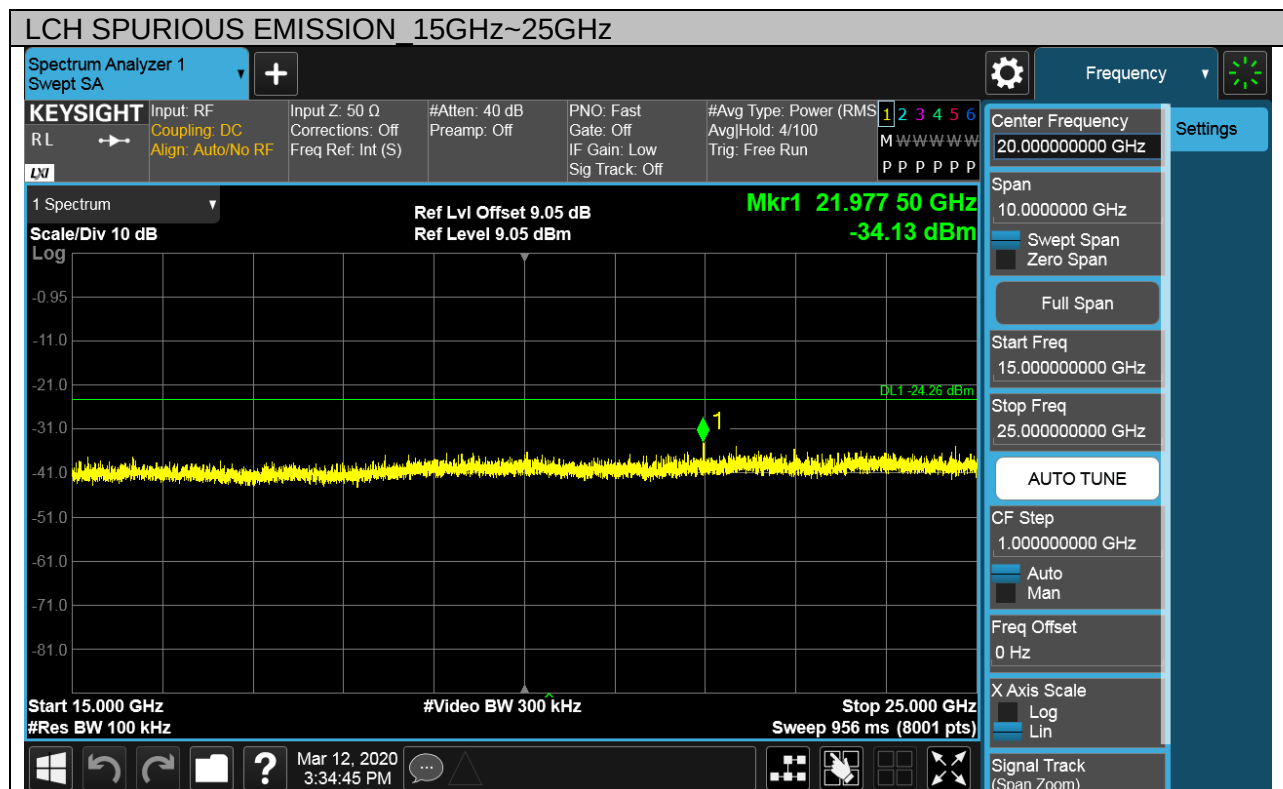
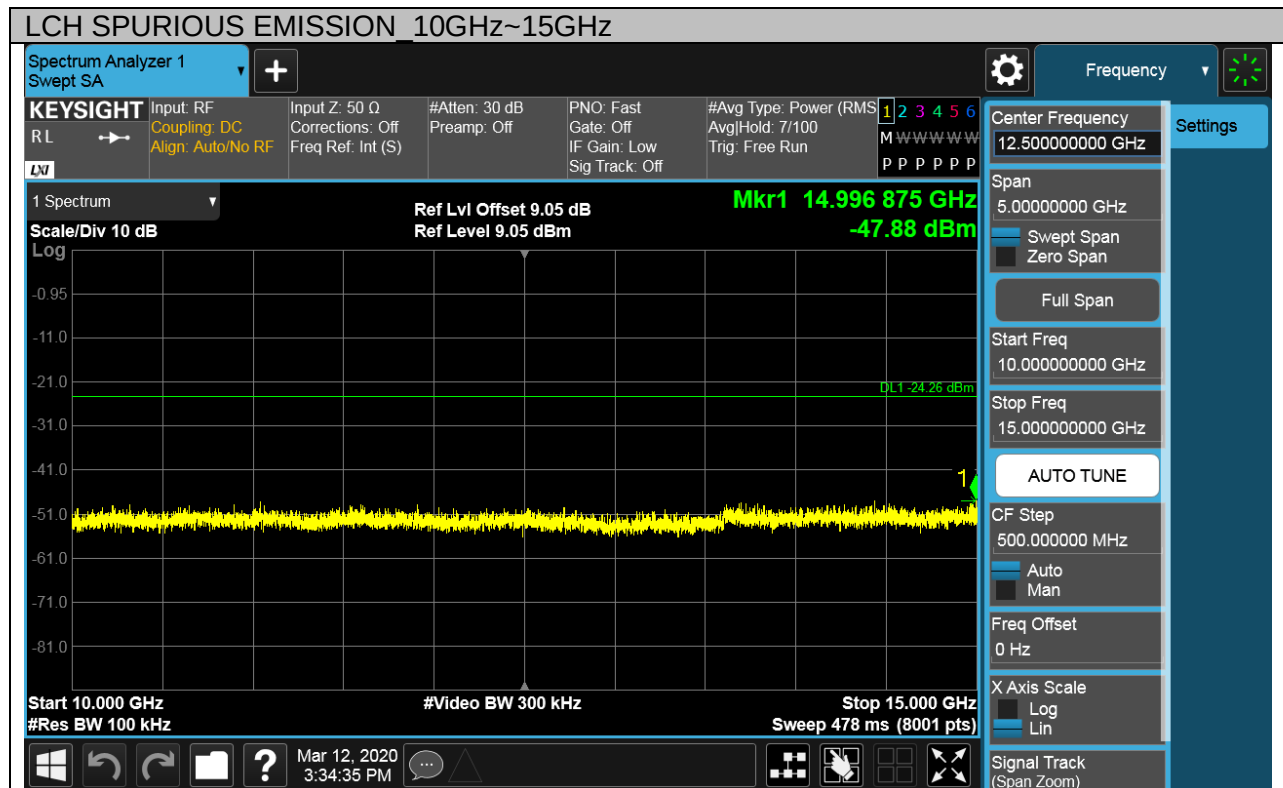
| Test Mode | Channel | Pref(dBm) | Puw(dBm) | Verdict |
|-----------|---------|-----------|----------|---------|
| 8DPSK     | LCH     | -4.26     | <Limit   | PASS    |
|           | MCH     | -4.47     | <Limit   | PASS    |
|           | HCH     | -4.81     | <Limit   | PASS    |



Note: The point 1 which exceeds the limit is 2.4G main carrier.

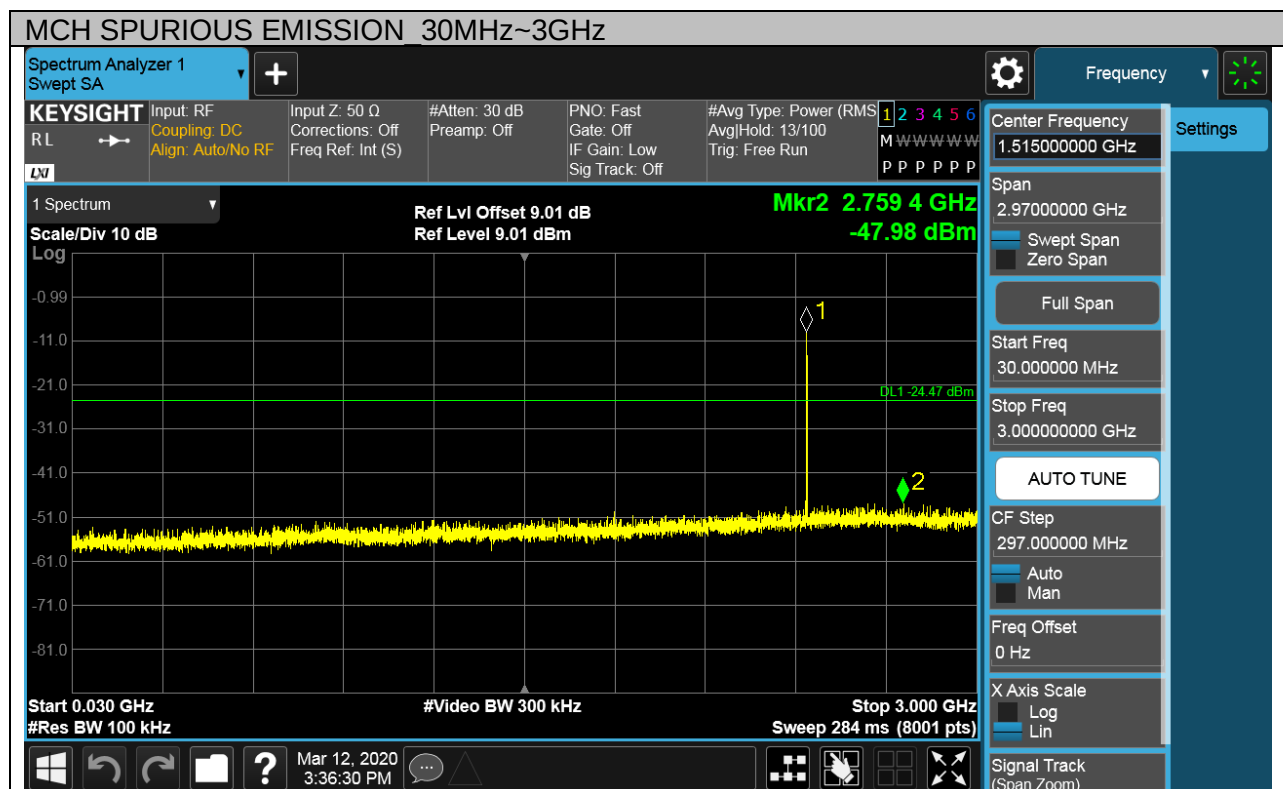
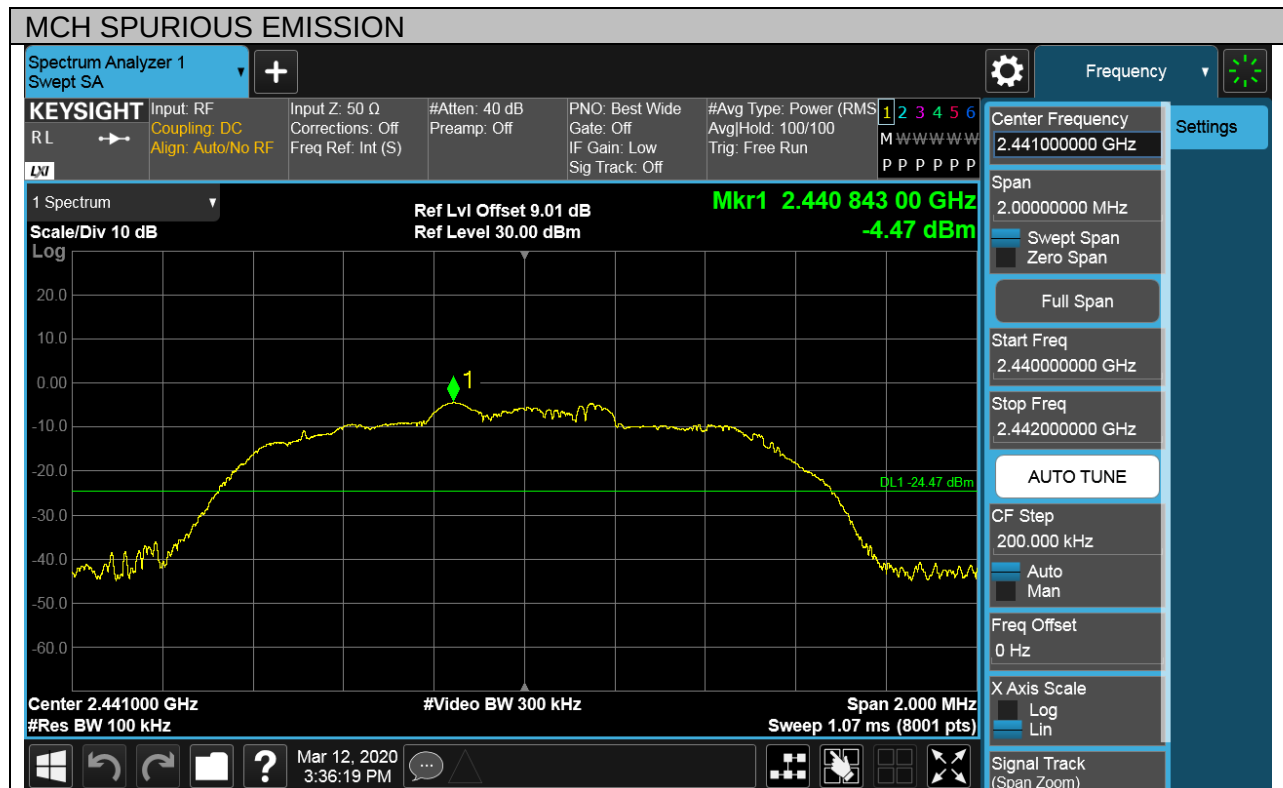








### SPURIOUS EMISSIONS, MID CHANNEL



Note: The point 1 which exceeds the limit is 2.4G main carrier.

