

# TEST REPORT

**Product Name:** Wifi Module  
**Trade Mark:** N/A  
**Model No.:** MWH516B.01  
**HVIN:** MWH516B.01  
**Report Number:** 211230011RFC-3  
**Test Standards:** FCC 47 CFR Part 15 Subpart C  
RSS-247 Issue 2  
RSS-Gen Issue 5  
**FCC ID:** BBP-WLPIN01  
**IC:** 144D-WLPIN01  
**Test Result:** PASS  
**Date of Issue:** March 31, 2022

Prepared for:

**Ricoh Company Ltd**  
**2-7-1 Izumi, Ebina, Kanagawa 243-0460, Japan**

Prepared by:

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UTTR-RF-RSS247-V1.1

## Version

| Version No. | Date           | Description |
|-------------|----------------|-------------|
| V1.0        | March 31, 2022 | Original    |



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UTTR-RF-RSS247-V1.1

## CONTENTS

|                                                        |            |
|--------------------------------------------------------|------------|
| <b>1. GENERAL INFORMATION</b>                          | <b>4</b>   |
| 1.1 CLIENT INFORMATION                                 | 4          |
| 1.2 EUT INFORMATION                                    | 4          |
| 1.2.1 GENERAL DESCRIPTION OF EUT                       | 4          |
| 1.2.2 DESCRIPTION OF ACCESSORIES                       | 4          |
| 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD  | 5          |
| 1.4 OTHER INFORMATION                                  | 6          |
| 1.5 DESCRIPTION OF SUPPORT UNITS                       | 6          |
| 1.6 TEST LOCATION                                      | 6          |
| 1.7 TEST FACILITY                                      | 6          |
| 1.8 DEVIATION FROM STANDARDS                           | 7          |
| 1.9 ABNORMALITIES FROM STANDARD CONDITIONS             | 7          |
| 1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER       | 7          |
| 1.11 MEASUREMENT UNCERTAINTY                           | 7          |
| <b>2. TEST SUMMARY</b>                                 | <b>8</b>   |
| <b>3. EQUIPMENT LIST</b>                               | <b>9</b>   |
| <b>4. TEST CONFIGURATION</b>                           | <b>10</b>  |
| 4.1 ENVIRONMENTAL CONDITIONS FOR TESTING               | 10         |
| 4.1.1 NORMAL OR EXTREME TEST CONDITIONS                | 10         |
| 4.1.2 RECORD OF NORMAL ENVIRONMENT AND TEST SAMPLE     | 10         |
| 4.2 TEST CHANNELS                                      | 10         |
| 4.3 EUT TEST STATUS                                    | 10         |
| 4.4 PRE-SCAN                                           | 11         |
| 4.5 TEST SETUP                                         | 12         |
| 4.5.1 FOR RADIATED EMISSIONS TEST SETUP                | 12         |
| 4.5.2 FOR CONDUCTED EMISSIONS TEST SETUP               | 13         |
| 4.5.3 FOR CONDUCTED RF TEST SETUP                      | 14         |
| 4.6 SYSTEM TEST CONFIGURATION                          | 14         |
| 4.7 DUTY CYCLE                                         | 15         |
| <b>5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION</b>   | <b>18</b>  |
| 5.1 REFERENCE DOCUMENTS FOR TESTING                    | 18         |
| 5.2 ANTENNA REQUIREMENT                                | 18         |
| 5.3 CONDUCTED OUTPUT POWER                             | 19         |
| 5.4 6dB BANDWIDTH & OCCUPIED BANDWIDTH                 | 33         |
| 5.5 POWER SPECTRAL DENSITY                             | 59         |
| 5.6 CONDUCTED OUT OF BAND EMISSION                     | 73         |
| 5.7 RADIATED SPURIOUS EMISSIONS                        | 105        |
| 5.8 BAND EDGE MEASUREMENTS (RADIATED)                  | 114        |
| 5.9 CONDUCTED EMISSION                                 | 130        |
| <b>APPENDIX 1 PHOTOS OF TEST SETUP</b>                 | <b>133</b> |
| <b>APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS</b> | <b>133</b> |

## 1. GENERAL INFORMATION

### 1.1 CLIENT INFORMATION

|                                 |                                              |
|---------------------------------|----------------------------------------------|
| <b>Applicant:</b>               | Ricoh Company Ltd                            |
| <b>Address of Applicant:</b>    | 2-7-1 Izumi, Ebina, Kanagawa 243-0460, Japan |
| <b>Manufacturer:</b>            | Ricoh Company Ltd                            |
| <b>Address of Manufacturer:</b> | 2-7-1 Izumi, Ebina, Kanagawa 243-0460, Japan |

### 1.2 EUT INFORMATION

#### 1.2.1 General Description of EUT

|                                                             |                                     |                        |                   |
|-------------------------------------------------------------|-------------------------------------|------------------------|-------------------|
| <b>Product Name:</b>                                        | Wifi Module                         |                        |                   |
| <b>Model No.:</b>                                           | MWH516B.01                          |                        |                   |
| <b>HVIN:</b>                                                | MWH516B.01                          |                        |                   |
| <b>Trade Mark:</b>                                          | N/A                                 |                        |                   |
| <b>DUT Stage:</b>                                           | Identical Prototype                 |                        |                   |
| <b>EUT Supports Function:</b><br>(Provided by the customer) | 2.4 GHz ISM Band:                   | IEEE 802.11b/g/n       |                   |
|                                                             |                                     | Bluetooth 5.1          |                   |
|                                                             | 5 GHz U-NII Bands:                  | 5 150 MHz to 5 250 MHz | IEEE 802.11a/n/ac |
|                                                             |                                     | 5 250 MHz to 5 350 MHz | IEEE 802.11a/n/ac |
|                                                             |                                     | 5 470 MHz to 5 725 MHz | IEEE 802.11a/n/ac |
|                                                             |                                     | 5 725 MHz to 5 850 MHz | IEEE 802.11a/n/ac |
| <b>Sample Received Date:</b>                                | December 31, 2021                   |                        |                   |
| <b>Sample Tested Date:</b>                                  | February 17, 2022 to March 12, 2022 |                        |                   |

**Remark:** The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.

#### 1.2.2 Description of Accessories

None

### 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

|                                                    |                                                                                                                                                                                                           |                                                              |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Frequency Band:</b>                             | 2400 MHz to 2483.5 MHz                                                                                                                                                                                    |                                                              |
| <b>Frequency Range:</b>                            | 2412 MHz to 2462 MHz                                                                                                                                                                                      |                                                              |
| <b>Support Standards:</b>                          | IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40                                                                                                                                          |                                                              |
| <b>Type of Modulation:</b>                         | IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK)<br>IEEE 802.11g: OFDM (64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT20: OFDM (64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT40: OFDM (64-QAM, 16-QAM, QPSK, BPSK) |                                                              |
| <b>Data Rate:</b>                                  | IEEE 802.11b: Up to 11 Mbps<br>IEEE 802.11g: Up to 54 Mbps<br>IEEE 802.11n-HT20: Up to MCS15<br>IEEE 802.11n-HT40: Up to MCS15                                                                            |                                                              |
| <b>Number of Channels:</b>                         | IEEE 802.11b: 11<br>IEEE 802.11g: 11<br>IEEE 802.11n-HT20: 11<br>IEEE 802.11n-HT40: 7                                                                                                                     |                                                              |
| <b>Channel Separation:</b>                         | 5 MHz                                                                                                                                                                                                     |                                                              |
| <b>Antenna Type:</b>                               | Chain 0                                                                                                                                                                                                   | PCB Antenna                                                  |
|                                                    | Chain 1                                                                                                                                                                                                   | PCB Antenna                                                  |
| <b>Antenna Gain:</b><br>(Provided by the customer) | Chain 0                                                                                                                                                                                                   | 0.3 dBi                                                      |
|                                                    | Chain 1                                                                                                                                                                                                   | 0.2 dBi                                                      |
| <b>Directional gain:</b>                           | 3.26 dBi                                                                                                                                                                                                  |                                                              |
| <b>Maximum e.i.r.p</b>                             | SISO_ Chain 0                                                                                                                                                                                             | IEEE 802.11b: 16.63 dBm<br>IEEE 802.11g: 12.75 dBm           |
|                                                    | SISO_ Chain 1                                                                                                                                                                                             | IEEE 802.11b: 16.72 dBm<br>IEEE 802.11g: 13.02 dBm           |
|                                                    | MIMO_ Chain 0+1                                                                                                                                                                                           | IEEE 802.11n-HT20: 18.86 dBm<br>IEEE 802.11n-HT40: 18.92 dBm |
| <b>Maximum conducted output power:</b>             | SISO_ Chain 0                                                                                                                                                                                             | IEEE 802.11b: 16.33 dBm<br>IEEE 802.11g: 12.45 dBm           |
|                                                    | SISO_ Chain 1                                                                                                                                                                                             | IEEE 802.11b: 16.52 dBm<br>IEEE 802.11g: 12.82 dBm           |
|                                                    | MIMO_ Chain 0+1                                                                                                                                                                                           | IEEE 802.11n-HT20: 15.60 dBm<br>IEEE 802.11n-HT40: 15.66 dBm |
| <b>Normal Test Voltage:</b>                        | 5Vdc                                                                                                                                                                                                      |                                                              |

## 1.4 OTHER INFORMATION

| Operation Frequency Each of Channel                                                       |                                               |
|-------------------------------------------------------------------------------------------|-----------------------------------------------|
| IEEE 802.11b,<br>IEEE 802.11g,<br>IEEE 802.11n-HT20                                       | $f = 2407 + 5k \text{ MHz}, k = 1, \dots, 11$ |
| Note:<br><b>f</b> is the operating frequency (MHz);<br><b>k</b> is the operating channel. |                                               |

## 1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

### 1) Support Equipment

| Description      | Manufacturer | Model No.   | Serial Number   | Supplied by |
|------------------|--------------|-------------|-----------------|-------------|
| Notebook         | LENOVO       | E450        | PF-0EQBE3 15/11 | UnionTrust  |
| Notebook Adapter | LENOVO       | ADLX65NLC3A | 5A10J75114      | UnionTrust  |
| Mouse            | DELL         | MS111       | CN-011D3V-738   | UnionTrust  |
|                  |              |             |                 |             |

### 2) Support Cable

| Cable No. | Description         | Connector | Length     | Supplied by |
|-----------|---------------------|-----------|------------|-------------|
| 1         | Antenna Cable       | SMA       | 0.15 Meter | UnionTrust  |
| 2         | USB extension cable | USB       | 1 Meter    | UnionTrust  |
|           |                     |           |            |             |

## 1.6 TEST LOCATION

### Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China

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## 1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

### CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

### A2LA-Lab Certificate No.: 4312.01

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

### Shenzhen UnionTrust Quality and Technology Co., Ltd.

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### **ISED Wireless Device Testing Laboratories**

CAB identifier: CN0032

### **FCC Accredited Lab.**

Designation Number: CN1194

Test Firm Registration Number: 259480

## **1.8 DEVIATION FROM STANDARDS**

None.

## **1.9 ABNORMALITIES FROM STANDARD CONDITIONS**

None.

## **1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER**

None.

## **1.11 MEASUREMENT UNCERTAINTY**

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| No. | Item                            | Measurement Uncertainty           |
|-----|---------------------------------|-----------------------------------|
| 1   | Conducted emission 9kHz-150kHz  | ±3.2 dB                           |
| 2   | Conducted emission 150kHz-30MHz | ±2.7 dB                           |
| 3   | Radiated emission 9kHz-30MHz    | ± 4.7 dB                          |
| 4   | Radiated emission 30MHz-1GHz    | ± 4.9 dB                          |
| 5   | Radiated emission 1GHz-18GHz    | ± 4.8 dB                          |
| 6   | Radiated emission 18GHz-26GHz   | ± 5.1 dB                          |
| 7   | Radiated emission 26GHz-40GHz   | ± 5.1 dB                          |
| 8   | Conducted spurious emissions    | ± 2.7 dB                          |
| 9   | RF Power, Conducted             | ± 0.68 dB                         |
| 10  | Occupied Bandwidth              | ± 1.86 %                          |
| 11  | Radio Frequency                 | 2.4 GHz: ± 6.5 x 10 <sup>-8</sup> |
| 12  | Transmission Time               | ± 0.19 %                          |

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## 2. TEST SUMMARY

| FCC 47 CFR Part 15 Subpart C Test Cases                                                                                                                                                                                                                                                   |                                                                                              |                                                 |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------|--------|
| Test Item                                                                                                                                                                                                                                                                                 | Test Requirement                                                                             | Test Method                                     | Result |
| Antenna Requirement                                                                                                                                                                                                                                                                       | FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)<br>RSS-Gen Issue 5, Section 6.8       | N/A                                             | PASS   |
| AC Power Line Conducted Emission                                                                                                                                                                                                                                                          | FCC 47 CFR Part 15 Subpart C Section 15.207<br>RSS-Gen Issue 5, Section 8.8                  | ANSI C63.10-2013<br>Clause 6.2                  | PASS   |
| Conducted Output Power                                                                                                                                                                                                                                                                    | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)<br>RSS-247 Issue 2, Section 5.4(d)        | ANSI C63.10-2013<br>Clause 1.9.2.2.2            | PASS   |
| 6dB Bandwidth                                                                                                                                                                                                                                                                             | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)<br>RSS-247 Issue 2, Section 5.2(a)        | ANSI C63.10-2013<br>Clause 11.8.1               | PASS   |
| Occupied Bandwidth                                                                                                                                                                                                                                                                        | RSS-Gen Issue 5, Section 6.7                                                                 | RSS-Gen Issue 5,<br>Section 6.7                 | PASS   |
| Power Spectral Density                                                                                                                                                                                                                                                                    | FCC 47 CFR Part 15 Subpart C Section 15.247 (e)<br>RSS-247 Issue 2, Section 5.2(b)           | ANSI C63.10-2013<br>Clause 11.10.3              | PASS   |
| Conducted Out of Band Emission                                                                                                                                                                                                                                                            | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 2, Section 5.5               | ANSI C63.10-2013<br>Clause 11.11                | PASS   |
| Radiated Spurious Emissions                                                                                                                                                                                                                                                               | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-Gen Issue 5, Section 6.13/8.9/8.10 | ANSI C63.10-2013<br>Clause 11.11 & Clause 11.12 | PASS   |
| Band Edge Measurements (Radiated)                                                                                                                                                                                                                                                         | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-247 Issue 2, Section 5.5           | ANSI C63.10-2013<br>Clause 11.13                | PASS   |
| <b>Disclaimer and Explanations:</b><br>The declared of product specification and data (e.g. antenna gain, RF specification, etc) for EUT presented in the report are provided by the customer, and the customer takes all the responsibilities for the accuracy of product specification. |                                                                                              |                                                 |        |



### 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List |                                                      |               |            |                            |                         |                             |
|---------------------------------------|------------------------------------------------------|---------------|------------|----------------------------|-------------------------|-----------------------------|
| Used                                  | Equipment                                            | Manufacturer  | Model No.  | Serial Number              | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/>   | 3M SAC                                               | ETS-LINDGREN  | 3M         | Euroshiedpn-CT001270-1317  | Jan. 22, 2021           | Jan. 21, 2024               |
| <input checked="" type="checkbox"/>   | Receiver                                             | R&S           | ESIB26     | 100114                     | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>   | EXA Spectrum Analyzer                                | KEYSIGHT      | N9010A     | MY51440197                 | Apr. 22, 2021           | Apr. 21, 2022               |
| <input checked="" type="checkbox"/>   | Loop Antenna                                         | ETS-LINDGREN  | 6502       | 00202525                   | Nov. 11, 2021           | Nov. 10, 2023               |
| <input checked="" type="checkbox"/>   | Broadband Antenna                                    | ETS-LINDGREN  | 3142E      | 00201566                   | Nov. 11, 2021           | Nov. 10, 2023               |
| <input checked="" type="checkbox"/>   | 6dB Attenuator                                       | Talent        | RA6A5-N-18 | 18103002                   | Nov. 11, 2021           | Nov. 10, 2023               |
| <input checked="" type="checkbox"/>   | Preamplifier                                         | HP            | 8447F      | 2805A02960                 | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>   | Band Rejection Filter (2400MHz~2500MHz)              | Micro-Tronics | BRM50702   | G248                       | Nov. 06, 2021           | Nov. 05, 2022               |
| <input checked="" type="checkbox"/>   | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN  | 3117-PA    | 00201541                   | Apr. 30, 2021           | Apr. 29, 2023               |
| <input checked="" type="checkbox"/>   | Pre-amplifier                                        | ETS-Lindgren  | 00118385   | 00201874                   | Nov. 06, 2021           | Nov. 05, 2022               |
| <input checked="" type="checkbox"/>   | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN  | 3116C-PA   | 00202652                   | Nov. 14, 2020           | Nov. 13, 2023               |
| <input checked="" type="checkbox"/>   | Pre-amplifier                                        | ETS-Lindgren  | 00118384   | 00202652                   | Nov. 17, 2020           | Nov. 16, 2022               |
| <input checked="" type="checkbox"/>   | Multi device Controller                              | ETS-LINDGREN  | 7006-001   | 00160105                   | N/A                     | N/A                         |
| <input checked="" type="checkbox"/>   | Test Software                                        | Audix         | e3         | Software Version: 9.160323 |                         |                             |

| Conducted Emission Test Equipment List |               |              |           |                               |                         |                             |
|----------------------------------------|---------------|--------------|-----------|-------------------------------|-------------------------|-----------------------------|
| Used                                   | Equipment     | Manufacturer | Model No. | Serial Number                 | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/>    | Receiver      | R&S          | ESR7      | 1316.3003K07-101181-K3        | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>    | Pulse Limiter | R&S          | ESH3-Z2   | 0357.8810.54                  | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>    | LISN          | R&S          | ESH2-Z5   | 860014/024                    | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>    | LISN          | ETS-Lindgren | 3816/2SH  | 00201088                      | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/>    | Test Software | Audix        | e3        | Software Version: 9.20151119i |                         |                             |

| Conducted RF test Equipment List    |                                         |              |           |               |                         |                             |
|-------------------------------------|-----------------------------------------|--------------|-----------|---------------|-------------------------|-----------------------------|
| Used                                | Equipment                               | Manufacturer | Model No. | Serial Number | Cal. date (mm dd, yyyy) | Cal. Due date (mm dd, yyyy) |
| <input checked="" type="checkbox"/> | EXA Spectrum Analyzer                   | KEYSIGHT     | N9010A    | MY51440197    | Apr. 22, 2021           | Apr. 21, 2022               |
| <input checked="" type="checkbox"/> | USB Wideband Power Sensor               | KEYSIGHT     | U2021XA   | MY55430035    | Nov. 05, 2021           | Nov. 04, 2022               |
| <input type="checkbox"/>            | USB Wideband Power Sensor               | KEYSIGHT     | U2021XA   | MY55430023    | Nov. 05, 2021           | Nov. 04, 2022               |
| <input checked="" type="checkbox"/> | MXG X-Series RF Vector Signal Generator | KEYSIGHT     | N5182B    | MY51350267    | Nov. 05, 2021           | Nov. 04, 2022               |

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## 4. TEST CONFIGURATION

### 4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

#### 4.1.1 Normal or Extreme Test Conditions

| Environment Parameter                                           | Selected Values During Tests |         |                       |
|-----------------------------------------------------------------|------------------------------|---------|-----------------------|
| Test Condition                                                  | Ambient                      |         |                       |
|                                                                 | Temperature (°C)             | Voltage | Relative Humidity (%) |
| NV/NT                                                           | +15 to +35                   | 5Vdc    | 20 to 75              |
| <b>Remark:</b><br>1) NV: Normal Voltage; NT: Normal Temperature |                              |         |                       |

#### 4.1.2 Record of Normal Environment and Test Sample

| Test Item                          | Temperature (°C) | Relative Humidity (%) | Pressure (kPa) | Sample No.       | Tested by   |
|------------------------------------|------------------|-----------------------|----------------|------------------|-------------|
| AC Power Line Conducted Emission   | 25.3             | 45                    | 101.10         | 211230013-A01/11 | David Zhang |
| Conducted Peak Output Power        | 25.1             | 50                    | 100.01         | 211230013-A02/11 | Hank Wu     |
| 6dB Bandwidth & Occupied Bandwidth |                  |                       |                |                  |             |
| Power Spectral Density             |                  |                       |                |                  |             |
| Conducted Out of Band Emission     | 24.2             | 49                    | 100.02         | 211230013-A01/11 | Asia Yan    |
| Radiated Spurious Emissions        |                  |                       |                |                  |             |
| Band Edge Measurements (Radiated)  |                  |                       |                |                  |             |

## 4.2 TEST CHANNELS

| Mode              | Tx/Rx Frequency      | Test RF Channel Lists |           |            |
|-------------------|----------------------|-----------------------|-----------|------------|
|                   |                      | Lowest(L)             | Middle(M) | Highest(H) |
| IEEE 802.11b      | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11g      | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT20 | 2412 MHz to 2462 MHz | Channel 1             | Channel 7 | Channel 11 |
|                   |                      | 2412 MHz              | 2437 MHz  | 2462 MHz   |
| IEEE 802.11n-HT40 | 2422 MHz to 2452 MHz | Channel 3             | Channel 7 | Channel 9  |
|                   |                      | 2422 MHz              | 2437 MHz  | 2452 MHz   |

## 4.3 EUT TEST STATUS

| Mode                                                                   | Tx/Rx Function | Description                                                                            |
|------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------|
| IEEE 802.11b<br>IEEE 802.11g<br>IEEE 802.11n-HT20<br>IEEE 802.11n-HT40 | 1Tx            | 1. Keep the EUT in continuously transmitting or receiving with modulation test single. |
| IEEE 802.11n-HT20<br>IEEE 802.11n-HT40                                 | 2Tx            | 2. Keep the EUT in continuously transmitting or receiving with modulation test single. |

| Wi-Fi Power Setting (Provided by the customer) |           |         |           |         |            |         |
|------------------------------------------------|-----------|---------|-----------|---------|------------|---------|
| Mode                                           | Channel 1 |         | Channel 6 |         | Channel 11 |         |
|                                                | Chain 0   | Chain 1 | Chain 0   | Chain 1 | Chain 0    | Chain 1 |
| IEEE 802.11b                                   | 1E        | 1E      | 1E        | 1E      | 1E         | 1E      |
| IEEE 802.11g                                   | 16        | 16      | 16        | 16      | 16         | 16      |
| IEEE 802.11n-HT20                              | 18        | 18      | 18        | 18      | 18         | 18      |
| IEEE 802.11n-HT40                              | 18        | 18      | 18        | 18      | 18         | 18      |

| Test Software (Provided by the customer) |
|------------------------------------------|
| Test software name: QATool_Dbg;          |

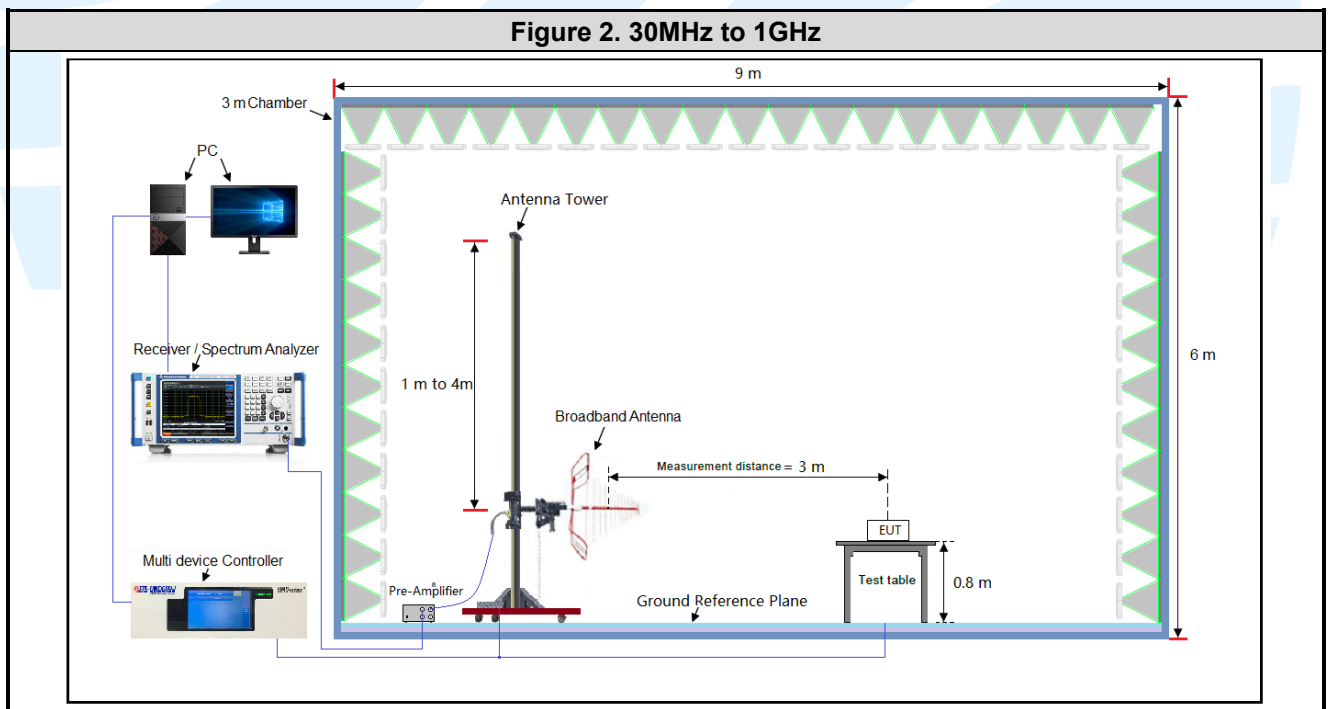
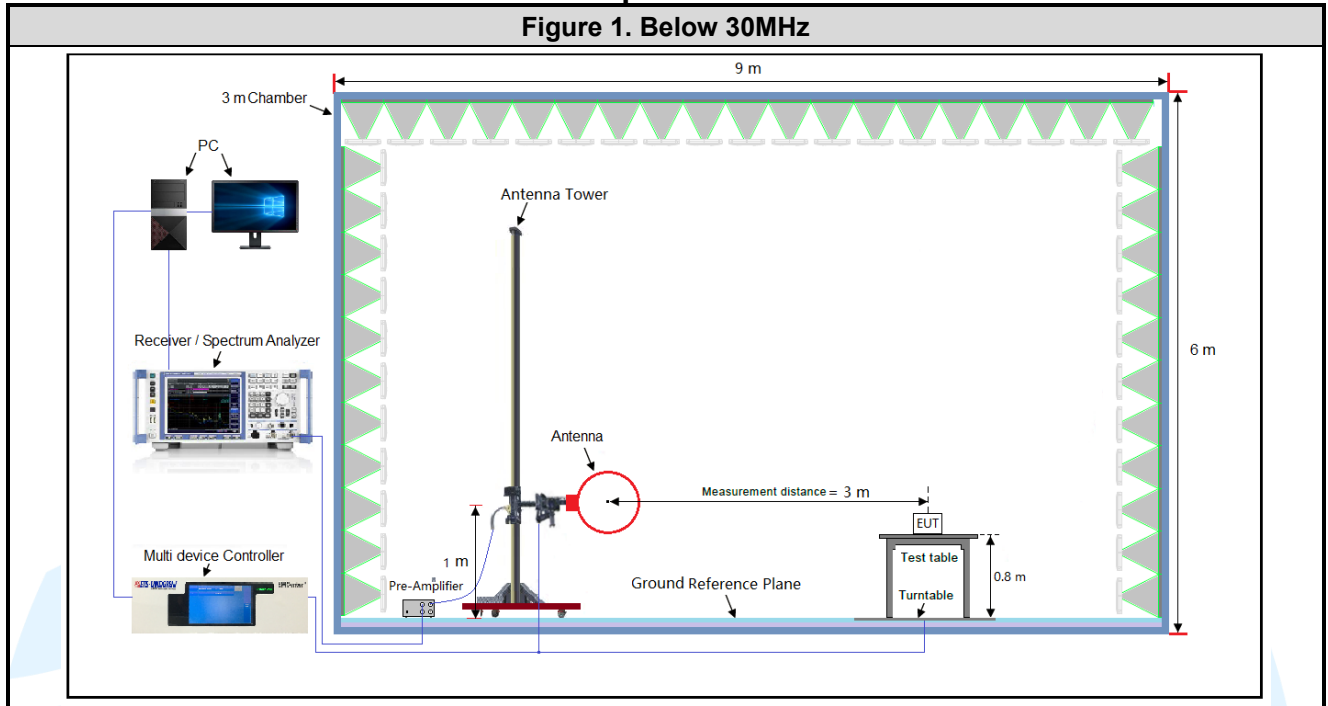
## 4.4 PRE-SCAN

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate. Following data rate was (were) selected for the final test as listed below

| Mode              | Worst-case data rates |
|-------------------|-----------------------|
| IEEE 802.11b      | 1 Mbps                |
| IEEE 802.11g      | 6 Mbps                |
| IEEE 802.11n-HT20 | MCS8                  |
| IEEE 802.11n-HT40 | MCS8                  |

## 4.5 TEST SETUP

### 4.5.1 For Radiated Emissions test setup

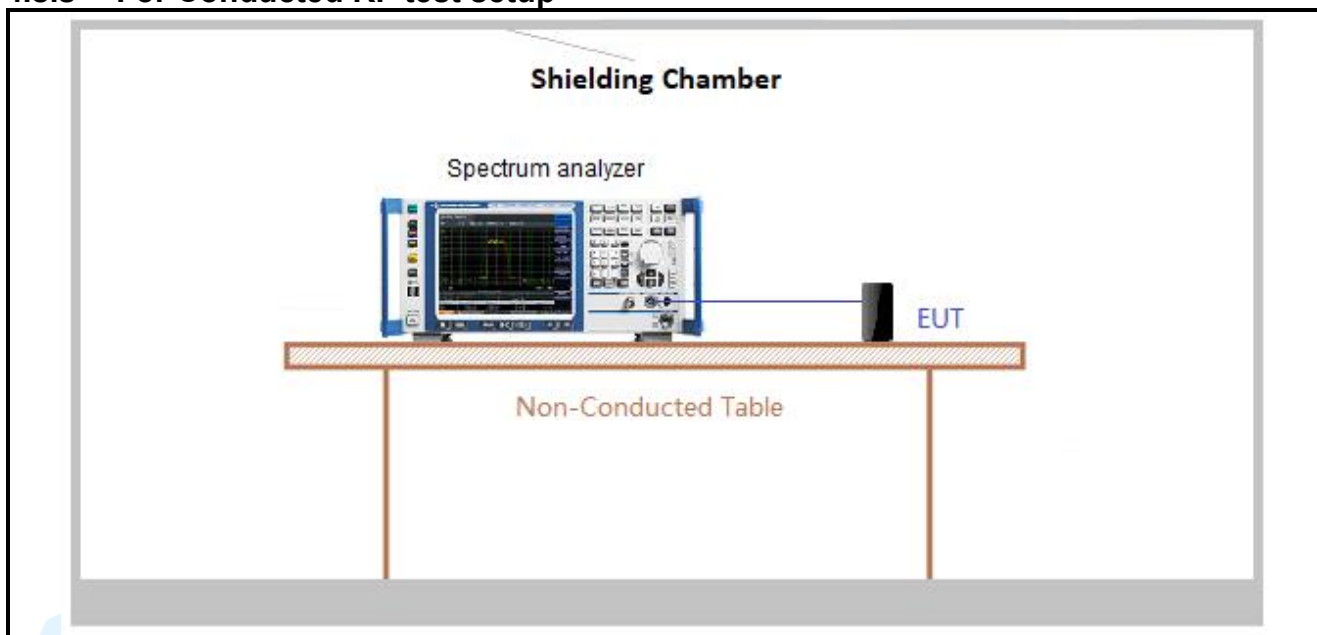


### Figure 3. Above 1GHz

The diagram illustrates the experimental setup for measurements above 1 GHz within a 3 m Chamber. The chamber has a width of 9 m and a height of 6 m. The walls are lined with gray pyramidal absorbers. A central Antenna Tower, adjustable from 1 m to 4 m, holds a Horn Antenna. A Pre-Amplifier is connected to the antenna. The measurement distance is 3 m. The Under Test Equipment (EUT) is placed on a Test table (1.5 m high) which sits on a Turntable. A Ground Reference Plane is also shown. The setup is connected to a Receiver / Spectrum Analyzer, which is linked to a PC and a Multi device Controller (containing a Keysight 89600B and a 3P Drive).

The diagram illustrates the layout of a Shielding Room used for EMI testing. On the left, a workstation on a table includes a PC, a Receiver, and a Pulse Limiter. A Ground Reference Plane is indicated below the table. Two LISN (Line Impedance Stabilization Network) units, LISN 1 and LISN 2, are connected to the AC Mains. LISN 1 is connected to the Pulse Limiter and the Receiver. LISN 2 is connected to the AC Mains. The test setup consists of a Test table with two EUT/AE (Equipment Under Test/Accessory Equipment) units and a PSU (Power Supply Unit). The EUT/AE units are spaced 10 cm apart, and the PSU is 10 cm from the second EUT/AE. The Test table is elevated 40 cm from the floor, with Insulation  $\leq 0.15$  m. The distance from the AC Mains to the Test table is 80 cm. The distance from the Pulse Limiter to the Test table is 80 cm. The distance from the PSU to the Test table is 80 cm.

#### 4.5.3 For Conducted RF test setup



### 4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

## 4.7 DUTY CYCLE

**Test Procedure:** ANSI C63.10-2013 Clause 11.6.

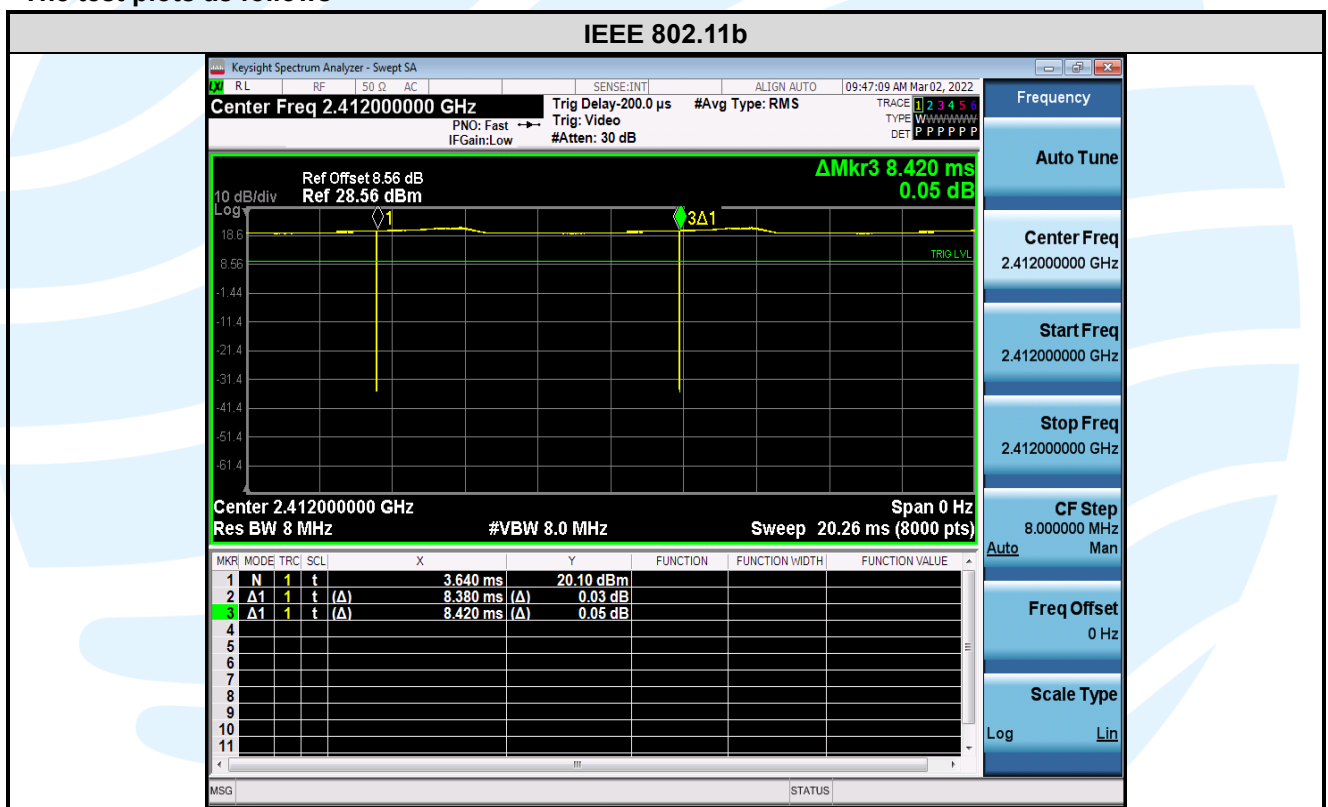
### Test Results

| Mode              | Data rates (Mbps) | On Time (msec) | Period (msec) | Duty Cycle (linear) | Duty Cycle (%) | Duty Cycle Factor (dB) | 1/ T Minimum VBW (kHz) | Average Factor (dB) |
|-------------------|-------------------|----------------|---------------|---------------------|----------------|------------------------|------------------------|---------------------|
| IEEE 802.11b      | 1                 | 8.38           | 8.42          | 1.00                | 99.52          | 0.00                   | 0.01                   | -0.04               |
| IEEE 802.11g      | 6                 | 1.390          | 1.440         | 0.97                | 96.53          | 0.15                   | 0.72                   | -0.31               |
| IEEE 802.11n-HT20 | MCS8              | 1.300          | 1.350         | 0.96                | 96.30          | 0.16                   | 0.77                   | -0.33               |
| IEEE 802.11n-HT40 | MCS8              | 0.640          | 0.690         | 0.93                | 92.75          | 0.33                   | 1.56                   | -0.65               |

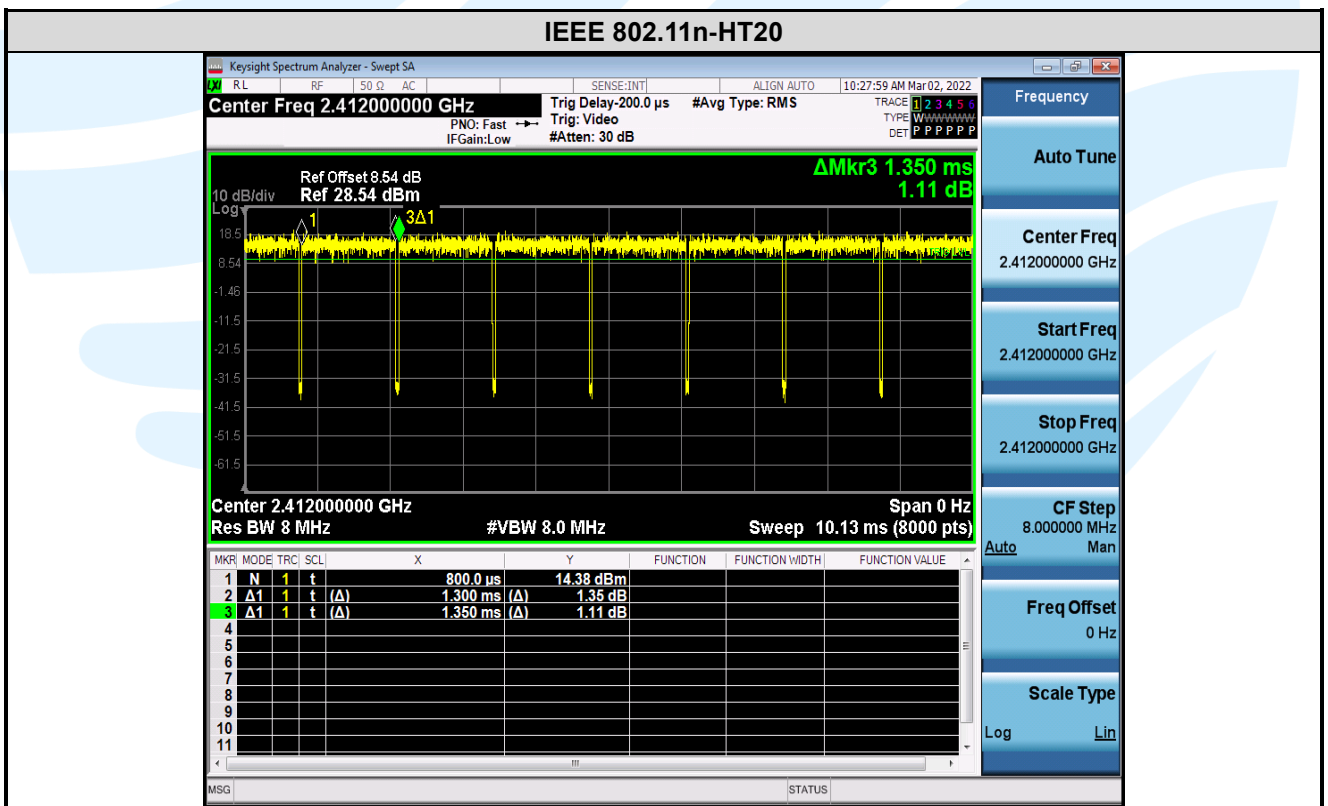
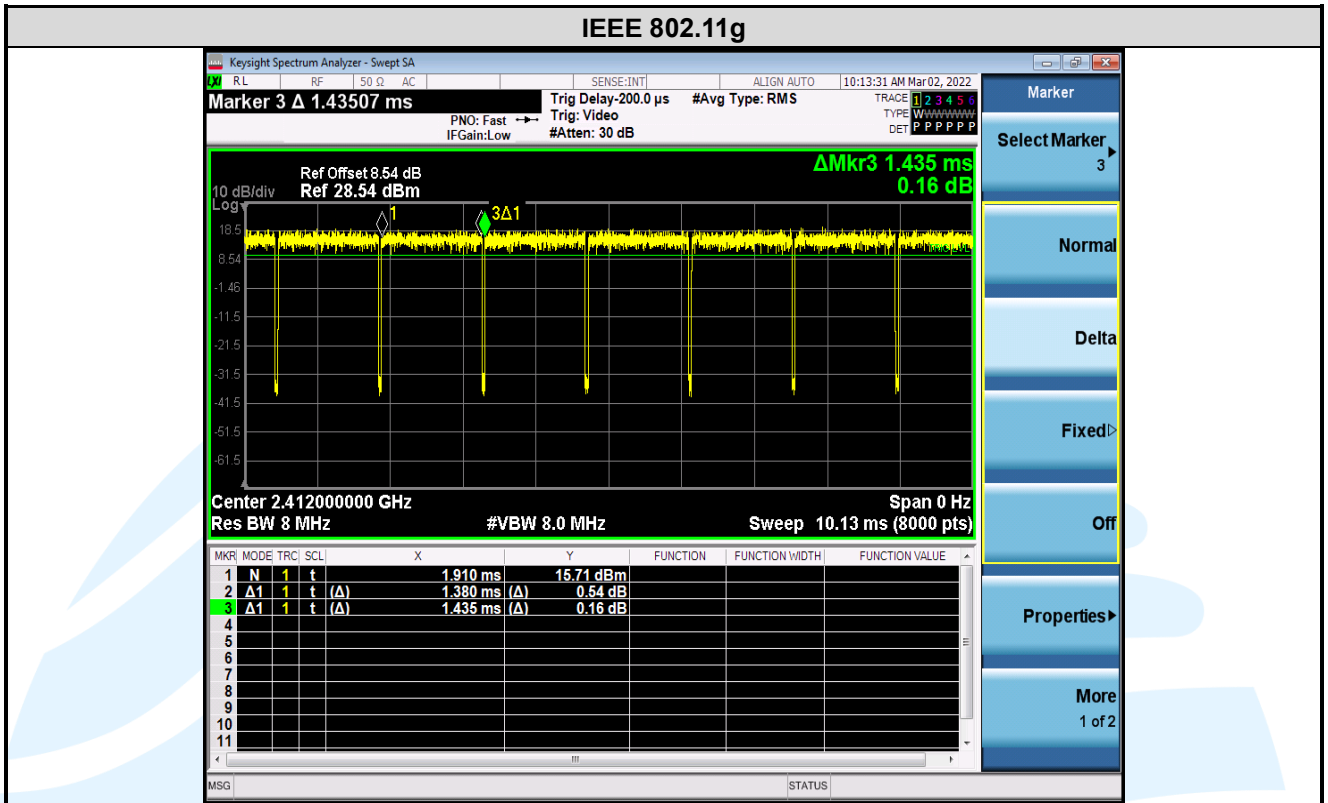
### Remark:

- 1) Duty cycle= On Time/ Period;
- 2) Duty Cycle factor =  $10 * \log(1/ \text{Duty cycle})$ ;
- 3) Average factor =  $20 \log_{10} \text{Duty Cycle}$ .

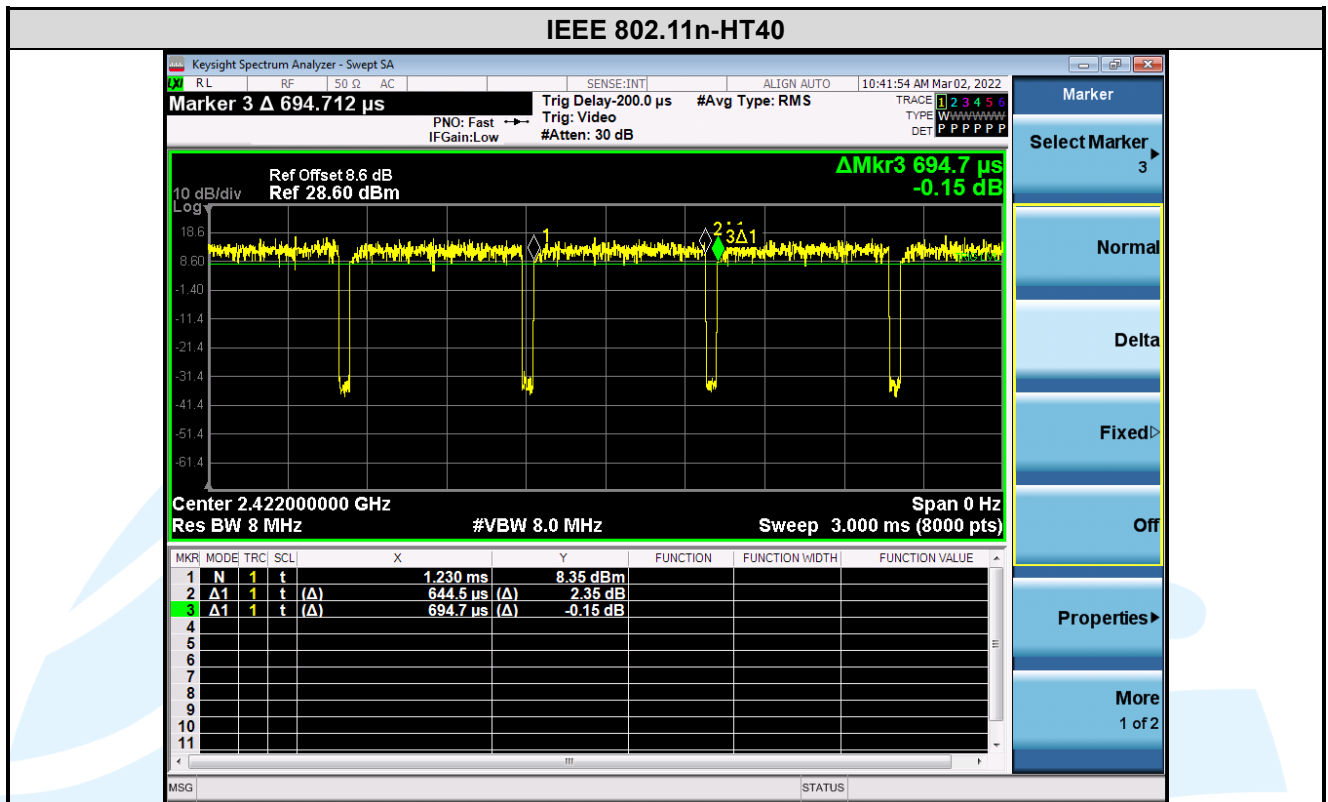
The test plots as follows











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## 5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

### 5.1 REFERENCE DOCUMENTS FOR TESTING

| No. | Identity                                   | Document Title                                                                                                                                                                            |
|-----|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | FCC 47 CFR Part 2                          | Frequency allocations and radio treaty matters; general rules and regulations                                                                                                             |
| 2   | FCC 47 CFR Part 15                         | Radio Frequency Devices                                                                                                                                                                   |
| 3   | RSS-247 Issue 2                            | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices                                                              |
| 4   | RSS-Gen Issue 5                            | General Requirements for Compliance of Radio Apparatus                                                                                                                                    |
| 5   | ANSI C63.10-2013                           | American National Standard for Testing Unlicensed Wireless Devices                                                                                                                        |
| 6   | KDB 558074 D01 15.247 Meas Guidance v05r02 | Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules |

### 5.2 ANTENNA REQUIREMENT

| Standard Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>15.203 requirement:</b><br/>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, 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.</p> <p><b>15.247(b) (4) requirement:</b><br/>The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.</p> <p><b>RSS-Gen Issue 5, Section 6.8 requirement:</b><br/>According to RSS-Gen Issue 5, Section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.</p> <p><b>EUT Antenna:</b><br/>Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is 3.26 dBi.</p> |

### 5.3 CONDUCTED OUTPUT POWER

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Requirement:</b> | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(3)<br>RSS-247 Issue 2, Section 5.4(d)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Test Method:</b>      | ANSI C63.10-2013 Clause 11.9.2.2.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Limit:</b>            | For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Test Procedure:</b>   | <p>Method AVGSA-1 uses trace averaging with the EUT transmitting at full power throughout each sweep. The procedure for this method is as follows:</p> <ul style="list-style-type: none"><li>a) Set span to at least 1.5 times the OBW.</li><li>b) Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz</li><li>c) Set VBW <math>\geq [3 \times \text{RBW}]</math>.</li><li>d) Number of points in sweep <math>\geq [2 \times \text{span} / \text{RBW}]</math>. (This gives bin-to-bin spacing <math>\leq \text{RBW} / 2</math>, so that narrowband signals are not lost between frequency bins.)</li><li>e) Sweep time = auto.</li><li>f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.</li><li>g) If transmit duty cycle <math>&lt; 98\%</math>, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at the maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle <math>\geq 98\%</math>, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run."</li><li>h) Trace average at least 100 traces in power averaging (rms) mode.</li><li>i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.</li></ul> |
| <b>Test Setup:</b>       | Refer to section 4.5.3 for details.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Instruments Used:</b> | Refer to section 3 for details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Test Results:</b>     | Pass                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Test Mode         | Antenna | Channel | Average power Result [dBm] | EIRP [dBm] | Limit[dBm] | Verdict |
|-------------------|---------|---------|----------------------------|------------|------------|---------|
| IEEE 802.11b      | Chain 0 | 2412    | 16.09                      | 16.39      | ≤30        | PASS    |
|                   | Chain 1 | 2412    | 16.27                      | 16.47      | ≤30        | PASS    |
|                   | Chain 0 | 2437    | 16.30                      | 16.60      | ≤30        | PASS    |
|                   | Chain 1 | 2437    | 16.52                      | 16.72      | ≤30        | PASS    |
|                   | Chain 0 | 2462    | 16.33                      | 16.63      | ≤30        | PASS    |
|                   | Chain 1 | 2462    | 16.32                      | 16.52      | ≤30        | PASS    |
| IEEE 802.11g      | Chain 0 | 2412    | 12.45                      | 12.75      | ≤30        | PASS    |
|                   | Chain 1 | 2412    | 12.82                      | 13.02      | ≤30        | PASS    |
|                   | Chain 0 | 2437    | 12.29                      | 12.59      | ≤30        | PASS    |
|                   | Chain 1 | 2437    | 12.58                      | 12.78      | ≤30        | PASS    |
|                   | Chain 0 | 2462    | 12.40                      | 12.70      | ≤30        | PASS    |
|                   | Chain 1 | 2462    | 12.80                      | 13.00      | ≤30        | PASS    |
| IEEE 802.11n-HT20 | Chain 0 | 2412    | 12.46                      | 12.76      | ≤30        | PASS    |
|                   | Chain 1 | 2412    | 12.64                      | 12.84      | ≤30        | PASS    |
|                   | Total   | 2412    | 15.56                      | 18.82      | ≤30        | PASS    |
|                   | Chain 0 | 2437    | 12.31                      | 12.61      | ≤30        | PASS    |
|                   | Chain 1 | 2437    | 12.39                      | 12.59      | ≤30        | PASS    |
|                   | Total   | 2437    | 15.36                      | 18.62      | ≤30        | PASS    |
|                   | Chain 0 | 2462    | 12.55                      | 12.85      | ≤30        | PASS    |
|                   | Chain 1 | 2462    | 12.62                      | 12.82      | ≤30        | PASS    |
|                   | Total   | 2462    | 15.60                      | 18.86      | ≤30        | PASS    |
| IEEE 802.11n-HT40 | Chain 0 | 2422    | 12.46                      | 12.76      | ≤30        | PASS    |
|                   | Chain 1 | 2422    | 12.83                      | 13.03      | ≤30        | PASS    |
|                   | Total   | 2422    | 15.66                      | 18.92      | ≤30        | PASS    |
|                   | Chain 0 | 2437    | 12.60                      | 12.90      | ≤30        | PASS    |
|                   | Chain 1 | 2437    | 12.63                      | 12.83      | ≤30        | PASS    |
|                   | Total   | 2437    | 15.63                      | 18.89      | ≤30        | PASS    |
|                   | Chain 0 | 2452    | 12.47                      | 12.77      | ≤30        | PASS    |
|                   | Chain 1 | 2452    | 12.56                      | 12.76      | ≤30        | PASS    |
|                   | Total   | 2452    | 15.53                      | 18.79      | ≤30        | PASS    |

Note: The maximum ERP/EIRP is calculated from max output power and antenna gain, the antenna gain provided by the customer, and the customer takes all the responsibilities for the accuracy of antenna gain.

Remark:

1. Directional gain and the maximum conducted output power limit see table below:

| Frequency Band         | Chain 0 Antenna Gain (dBi) | Chain 1 Antenna Gain (dBi) | Correlated chains directional gain (dBi) | Output Power Limit (dBm) |
|------------------------|----------------------------|----------------------------|------------------------------------------|--------------------------|
| 2400 MHz to 2483.5 MHz | 0.30                       | 0.20                       | 3.26                                     | 30.00                    |

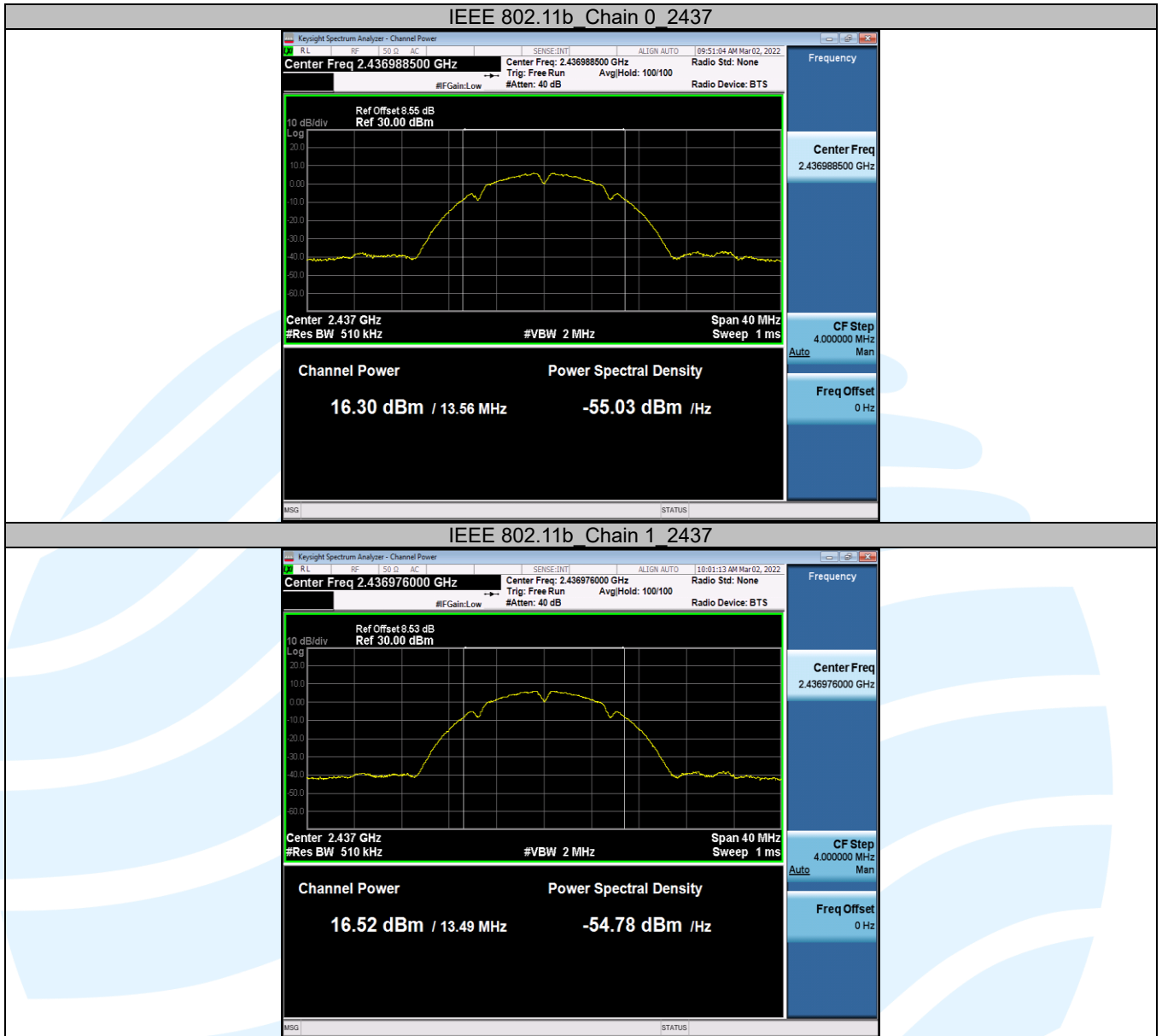
Unequal antenna gains, with equal transmit powers. Directional gain is to be computed as follows:

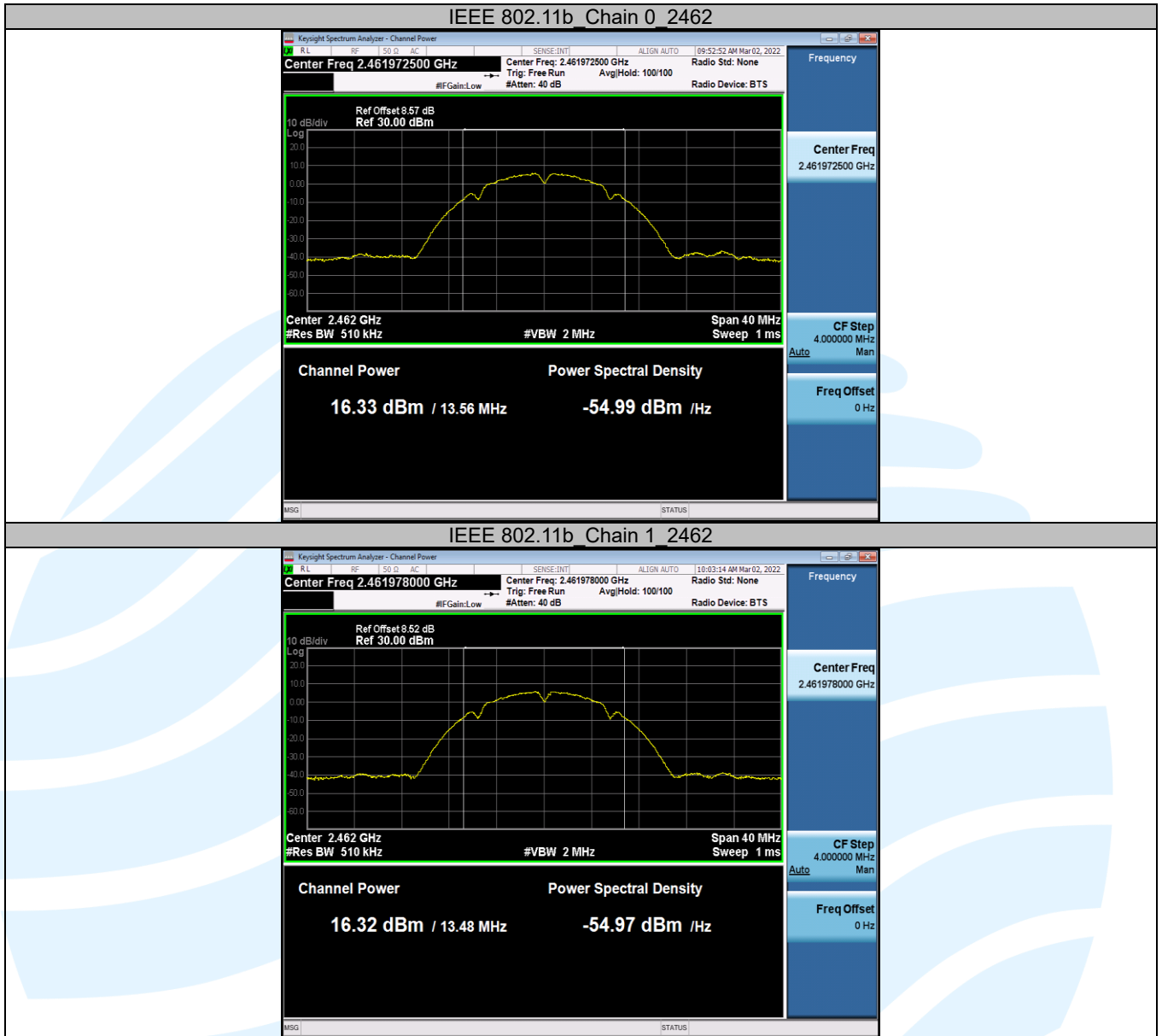
If transmit signals are correlated, then

Directional gain =  $10 \log[(10^{G_1/20} + 10^{G_2/20} + \dots + 10^{G_N/20})^2 / N \text{ANT}]$  dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

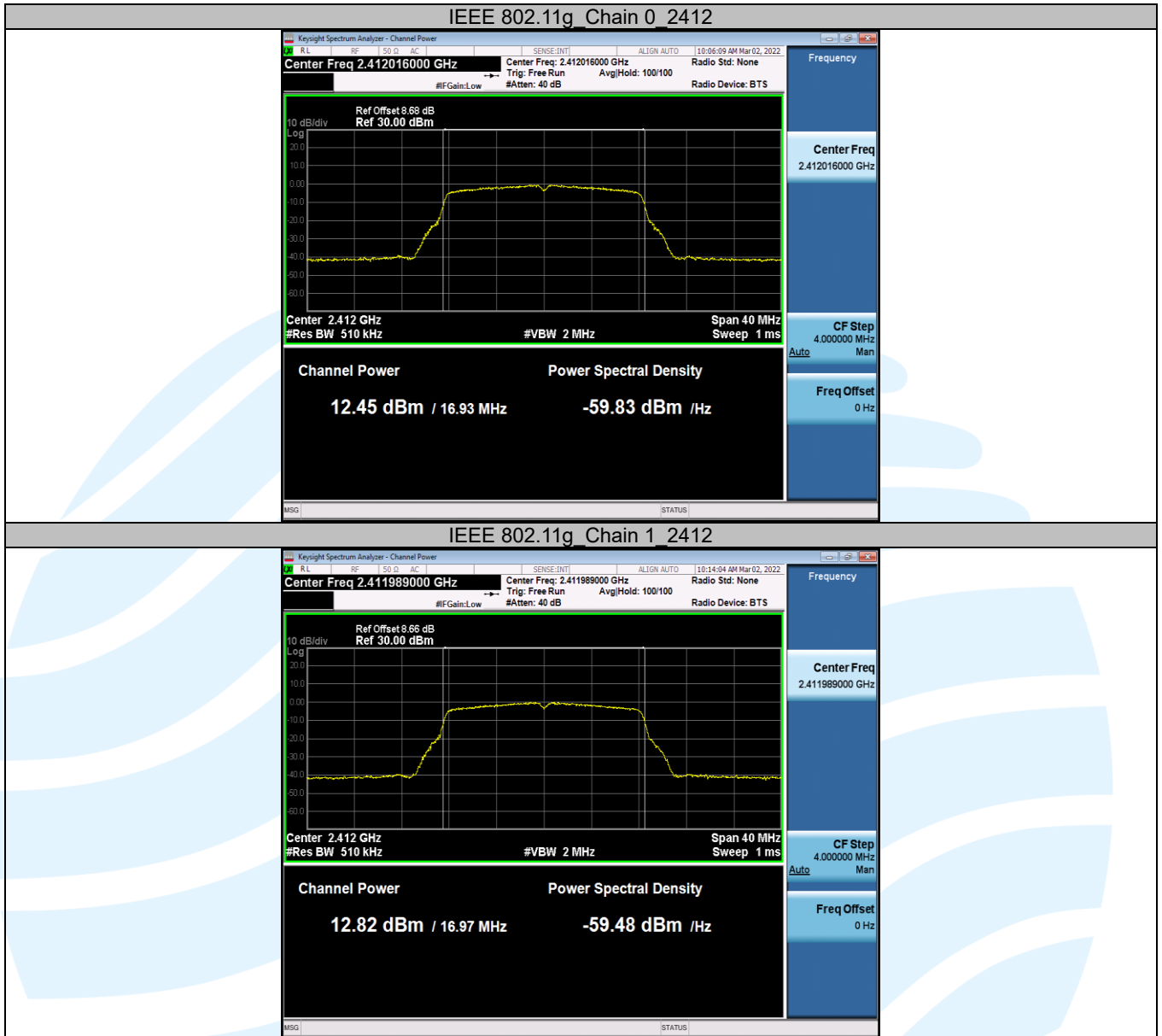
The test plots as follows:



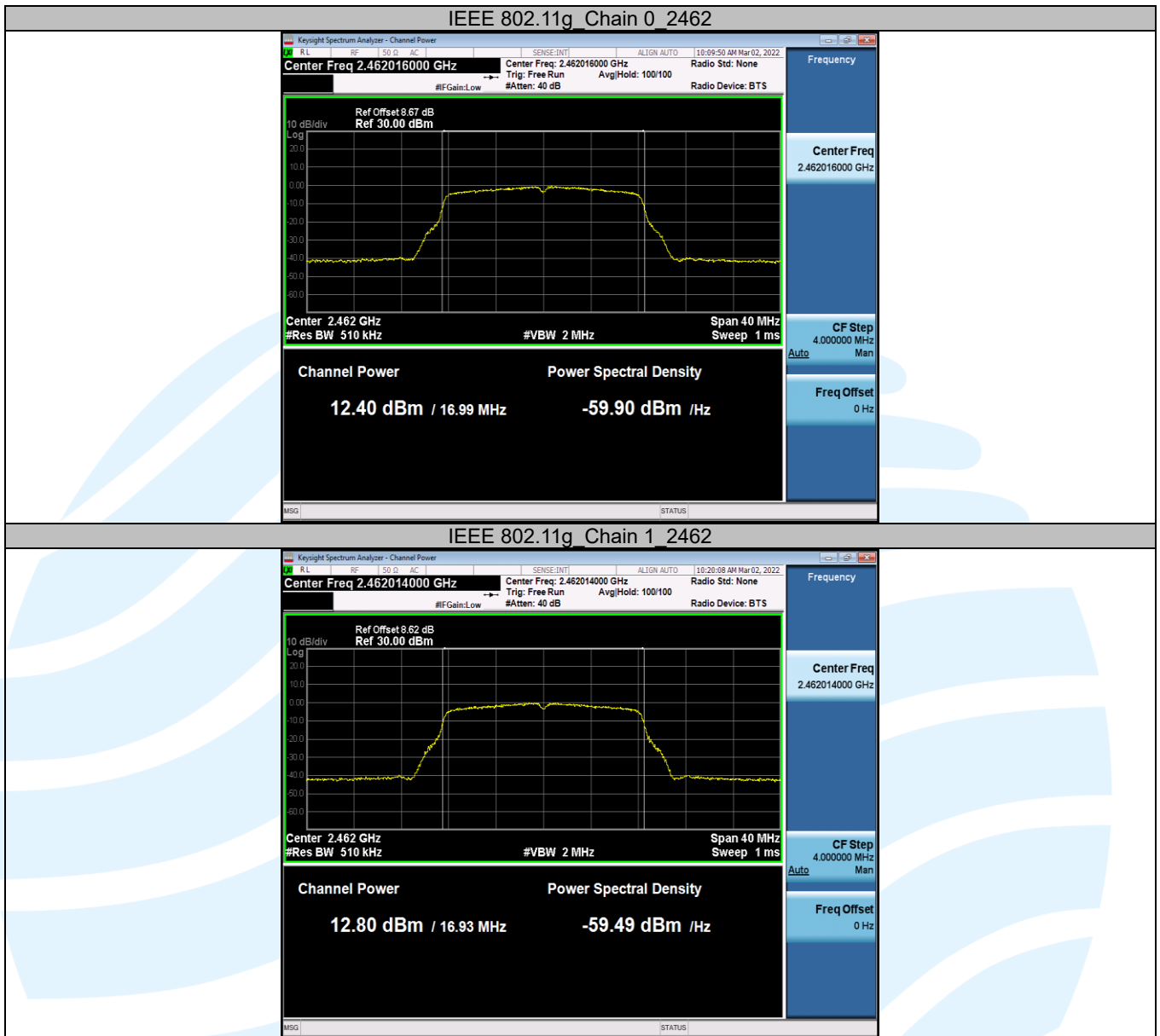


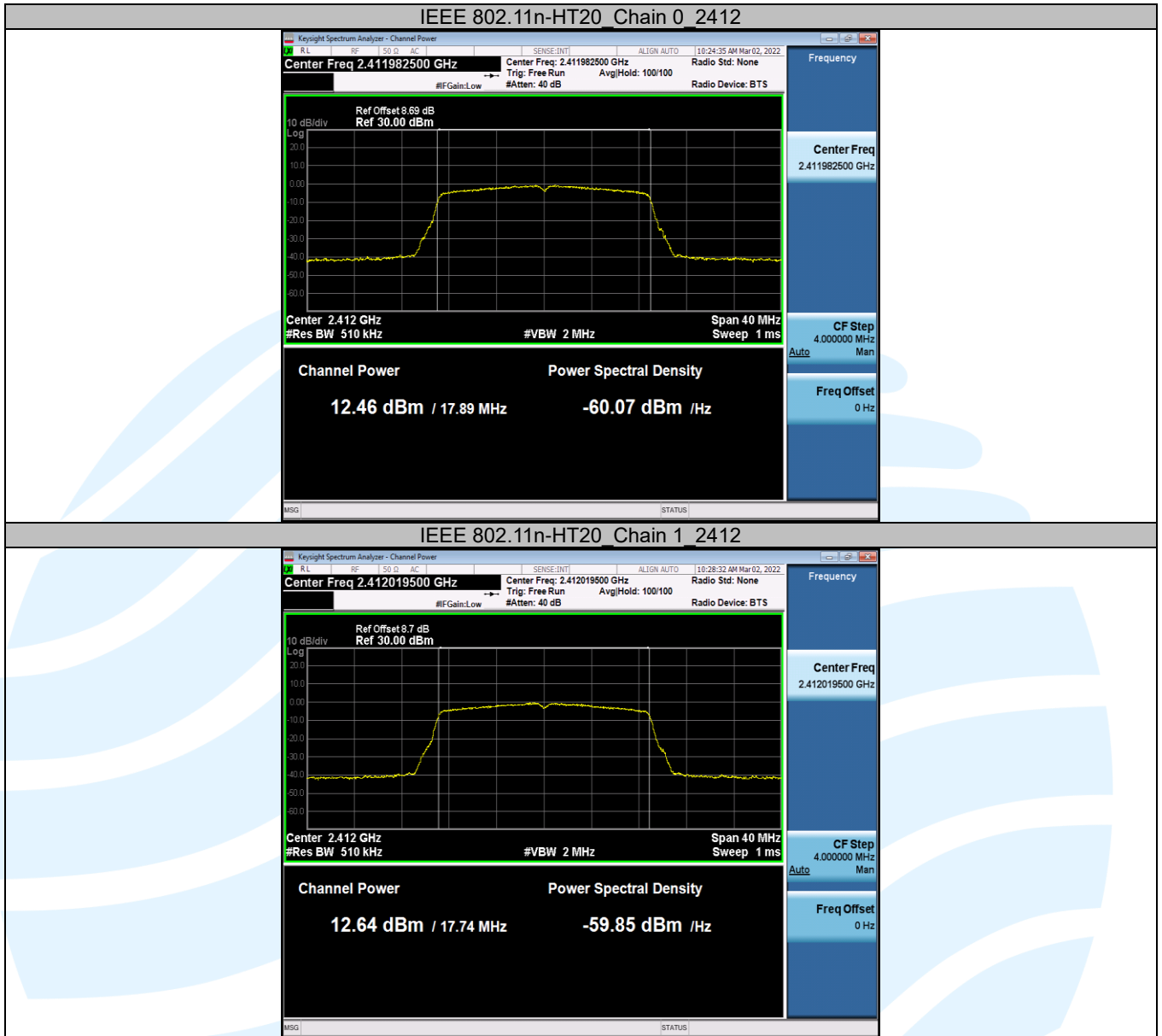


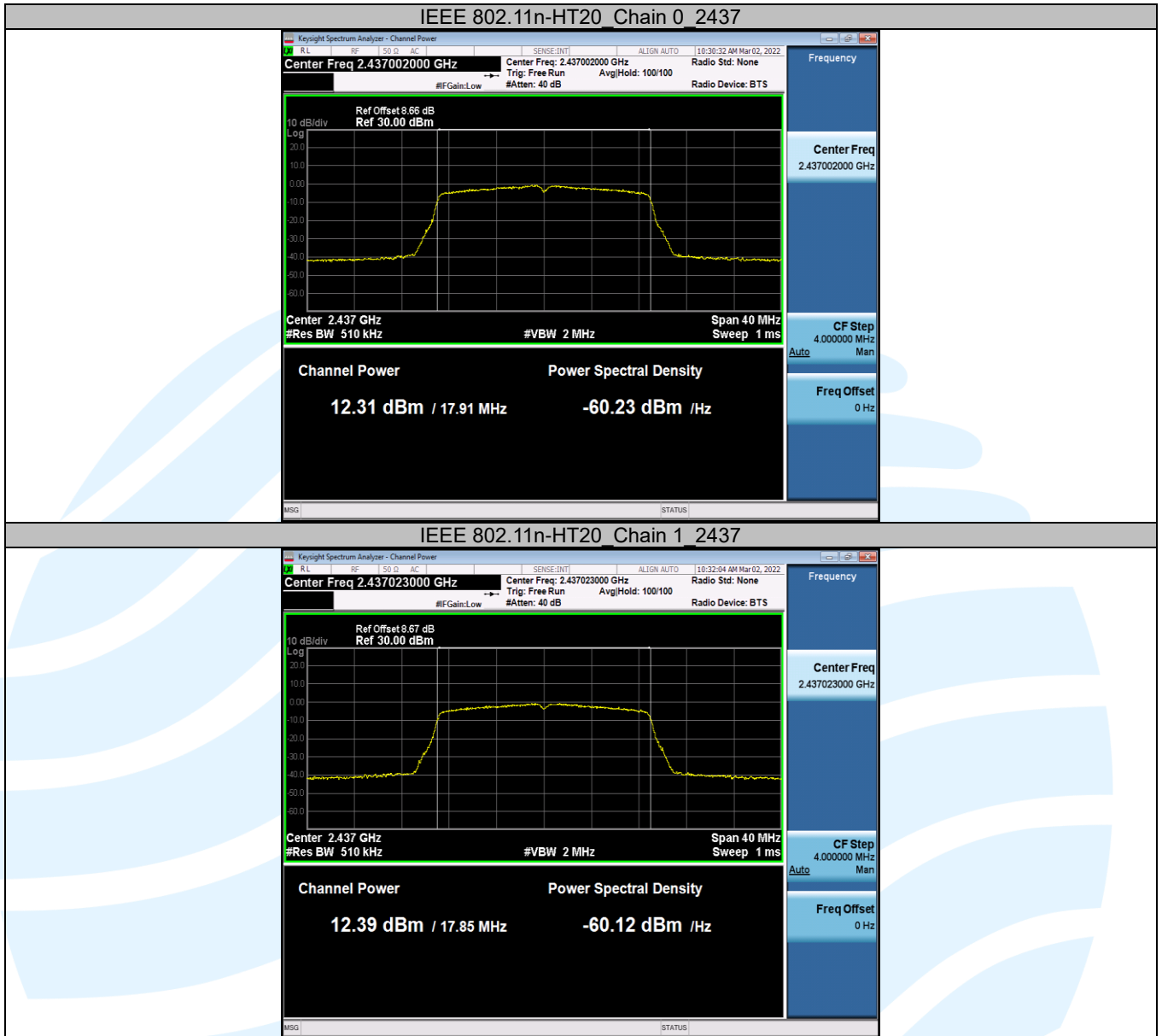


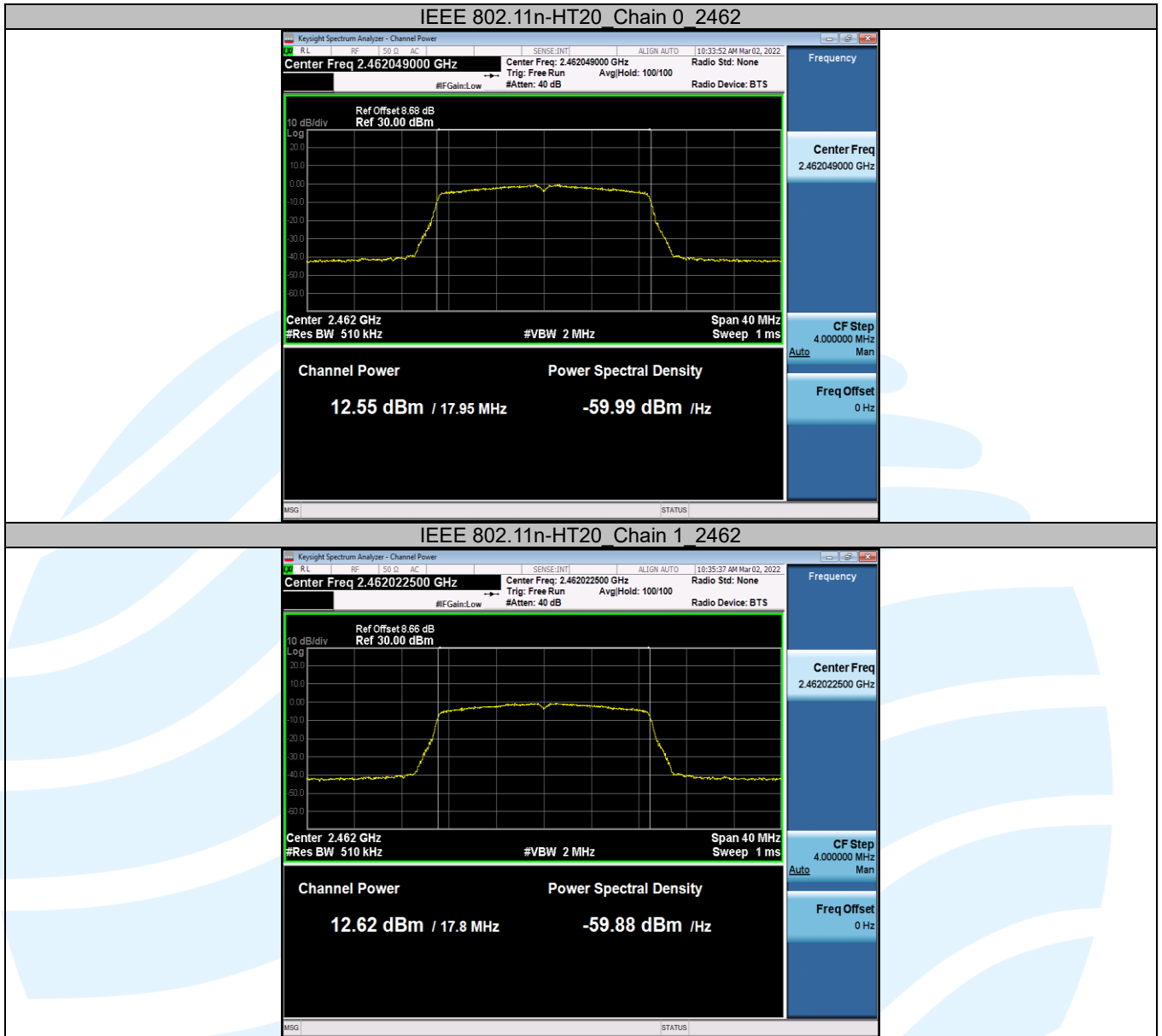


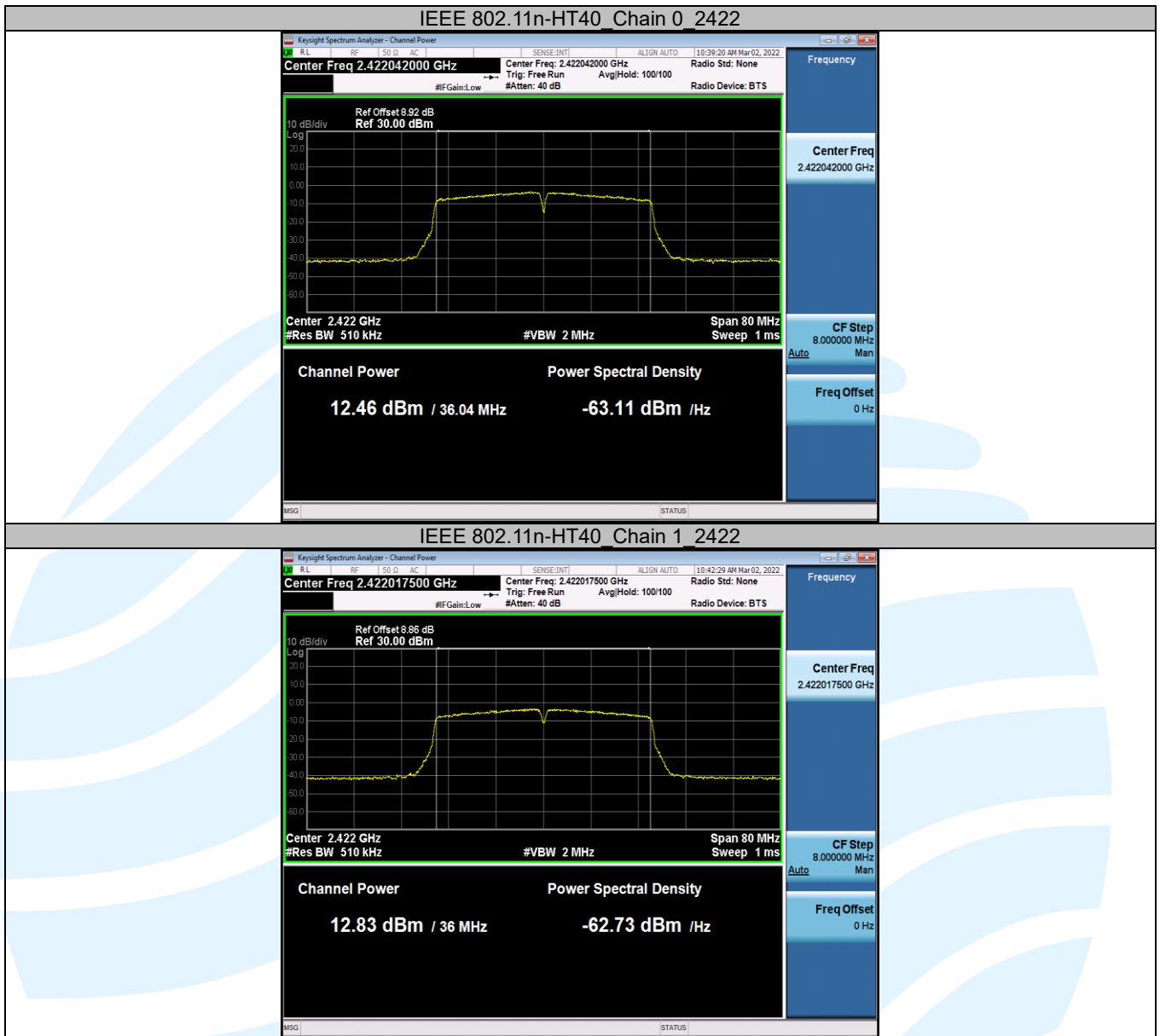




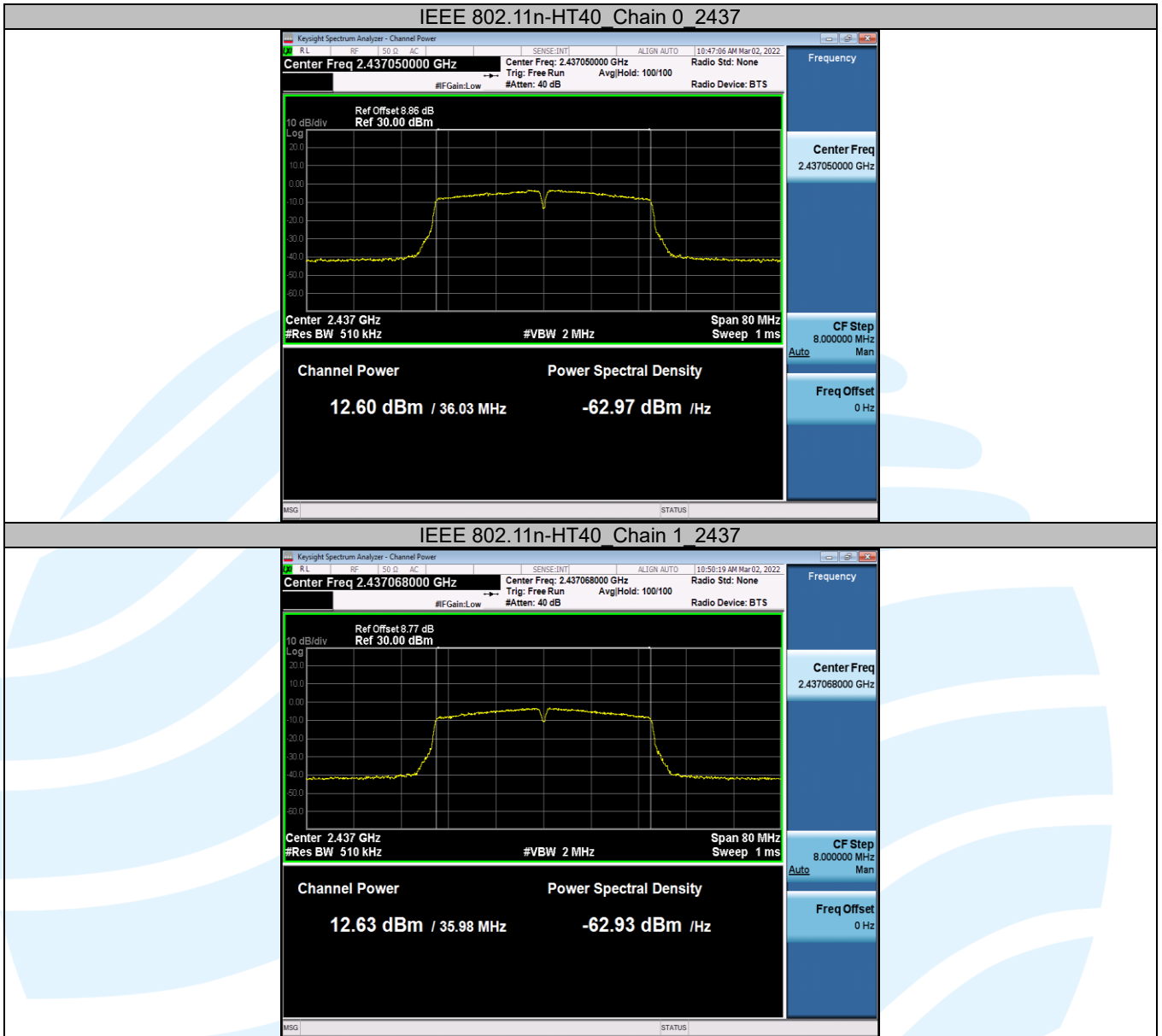


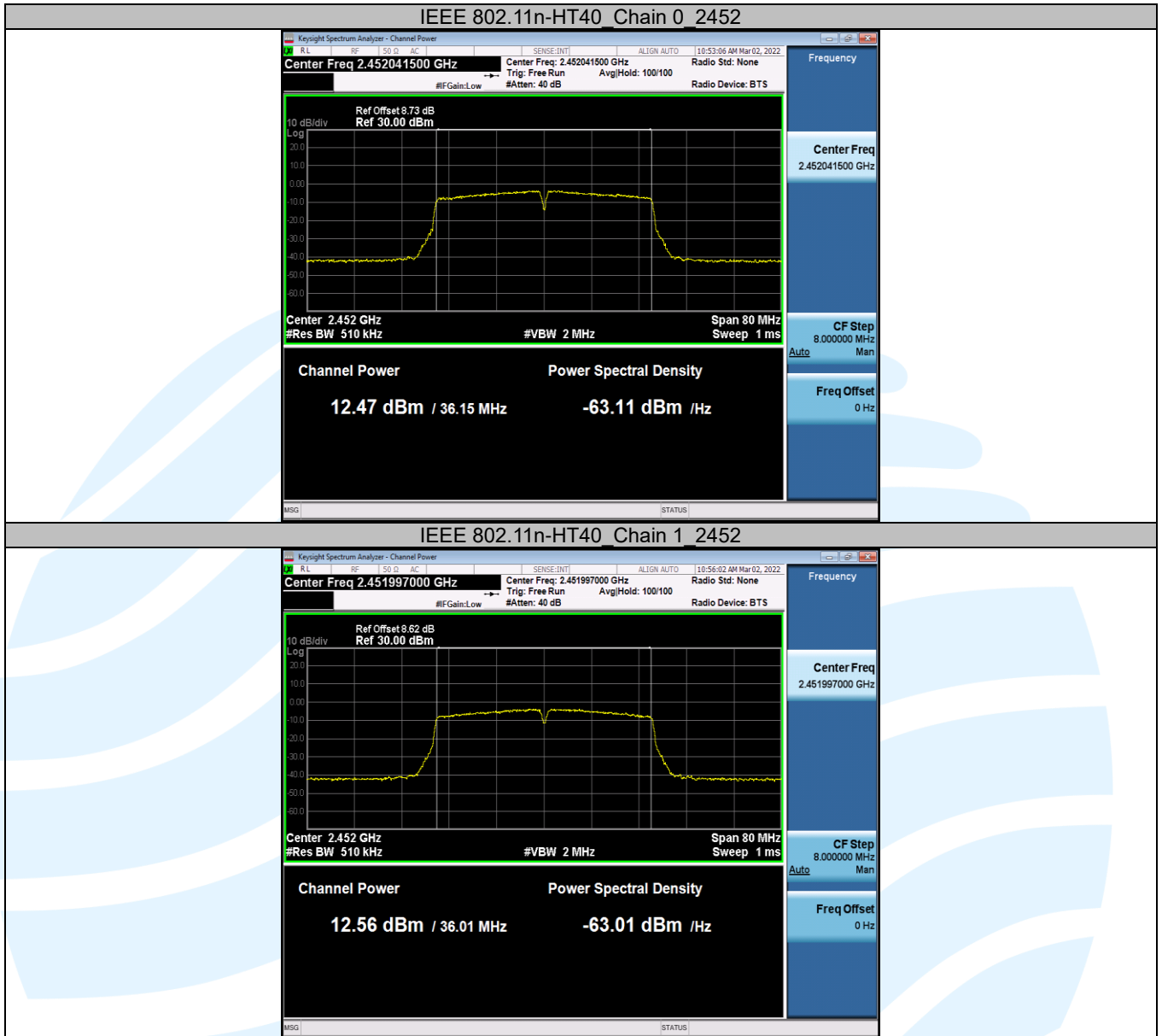












## 5.46DB BANDWIDTH & OCCUPIED BANDWIDTH

|                          |                                                                                                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Requirement:</b> | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(2)<br>RSS-247 Issue 2, Section 5.2(a)<br>RSS-Gen Issue 5, Section 6.7                                                 |
| <b>Test Method:</b>      | ANSI C63.10-2013 Clause 11.8.1<br>RSS-Gen Issue 5, Section 6.7                                                                                                        |
| <b>Limit:</b>            | For direct sequence systems, the minimum 6dB bandwidth shall be at least 500kHz                                                                                       |
| <b>Test Procedure:</b>   | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings: |

### 6dB Bandwidth

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- 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 6 dB relative to the maximum level measured in the fundamental emission.

### Occupied Bandwidth

- Set RBW = 1% to 5% of the occupied bandwidth
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

|                          |                                     |
|--------------------------|-------------------------------------|
| <b>Test Setup:</b>       | Refer to section 4.5.3 for details. |
| <b>Instruments Used:</b> | Refer to section 3 for details      |
| <b>Test Results:</b>     | Pass                                |

| Test Mode         | Antenna | Channel | DTS BW [MHz] | DTS BW Limit [MHz] | OCB [MHz] | Verdict |
|-------------------|---------|---------|--------------|--------------------|-----------|---------|
| IEEE 802.11b      | Chain 0 | 2412    | 8.040        | ≥0.5               | 13.567    | PASS    |
|                   | Chain 1 | 2412    | 8.560        | ≥0.5               | 13.478    | PASS    |
|                   | Chain 0 | 2437    | 8.520        | ≥0.5               | 13.563    | PASS    |
|                   | Chain 1 | 2437    | 8.520        | ≥0.5               | 13.490    | PASS    |
|                   | Chain 0 | 2462    | 8.040        | ≥0.5               | 13.559    | PASS    |
|                   | Chain 1 | 2462    | 8.600        | ≥0.5               | 13.480    | PASS    |
| IEEE 802.11g      | Chain 0 | 2412    | 15.080       | ≥0.5               | 16.926    | PASS    |
|                   | Chain 1 | 2412    | 15.040       | ≥0.5               | 16.968    | PASS    |
|                   | Chain 0 | 2437    | 16.280       | ≥0.5               | 17.001    | PASS    |
|                   | Chain 1 | 2437    | 15.040       | ≥0.5               | 17.007    | PASS    |
|                   | Chain 0 | 2462    | 15.320       | ≥0.5               | 16.990    | PASS    |
|                   | Chain 1 | 2462    | 15.240       | ≥0.5               | 16.934    | PASS    |
| IEEE 802.11n-HT20 | Chain 0 | 2412    | 15.120       | ≥0.5               | 17.891    | PASS    |
|                   | Chain 1 | 2412    | 14.400       | ≥0.5               | 17.741    | PASS    |
|                   | Chain 0 | 2437    | 15.640       | ≥0.5               | 17.914    | PASS    |
|                   | Chain 1 | 2437    | 15.040       | ≥0.5               | 17.850    | PASS    |
|                   | Chain 0 | 2462    | 15.040       | ≥0.5               | 17.954    | PASS    |
|                   | Chain 1 | 2462    | 14.440       | ≥0.5               | 17.799    | PASS    |
| IEEE 802.11n-HT40 | Chain 0 | 2422    | 33.760       | ≥0.5               | 36.038    | PASS    |
|                   | Chain 1 | 2422    | 35.120       | ≥0.5               | 35.997    | PASS    |
|                   | Chain 0 | 2437    | 32.640       | ≥0.5               | 36.030    | PASS    |
|                   | Chain 1 | 2437    | 35.040       | ≥0.5               | 35.984    | PASS    |
|                   | Chain 0 | 2452    | 35.040       | ≥0.5               | 36.145    | PASS    |
|                   | Chain 1 | 2452    | 35.120       | ≥0.5               | 36.012    | PASS    |

**The test plots as follows:**  
**DTS Bandwidth**



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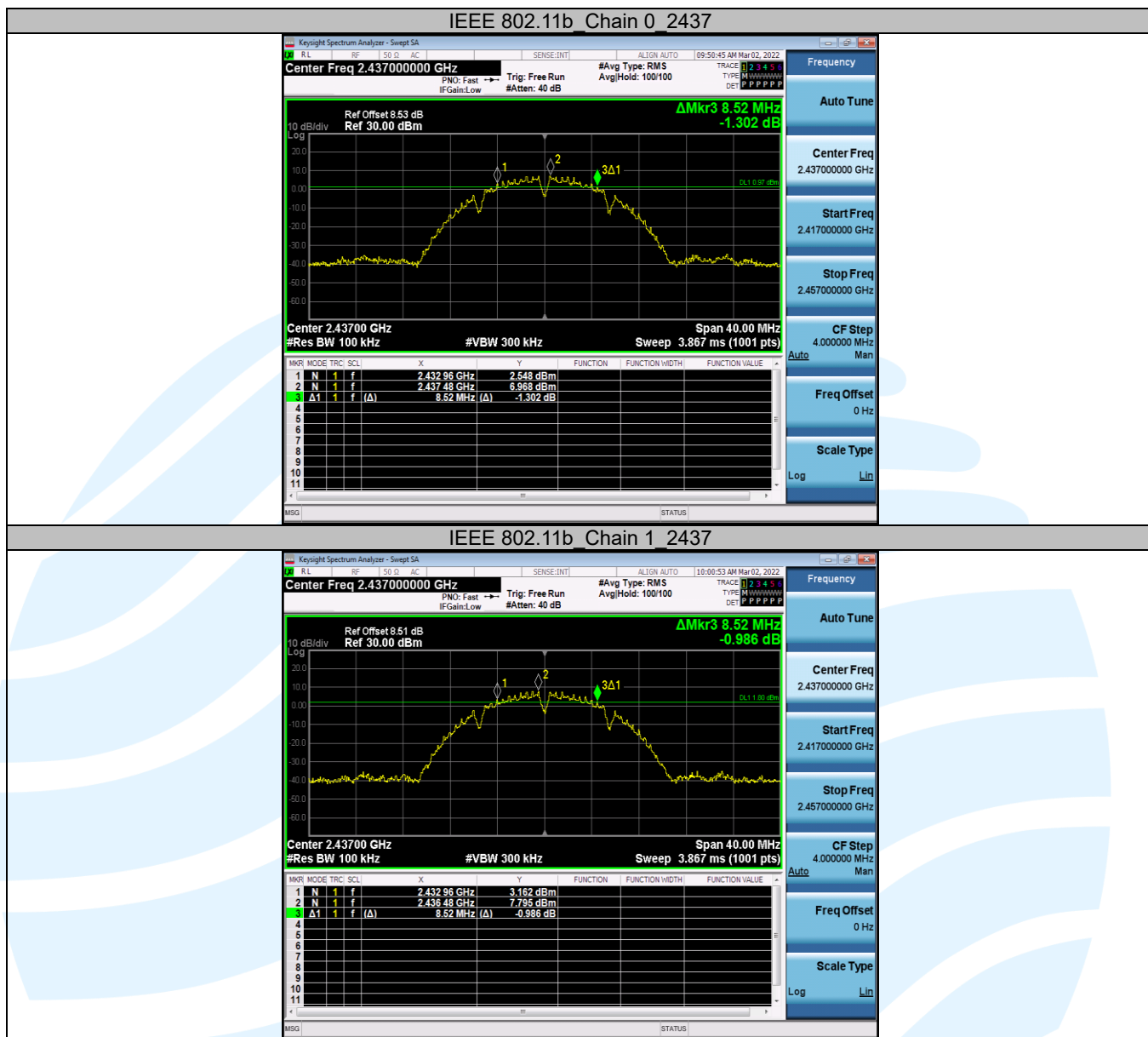
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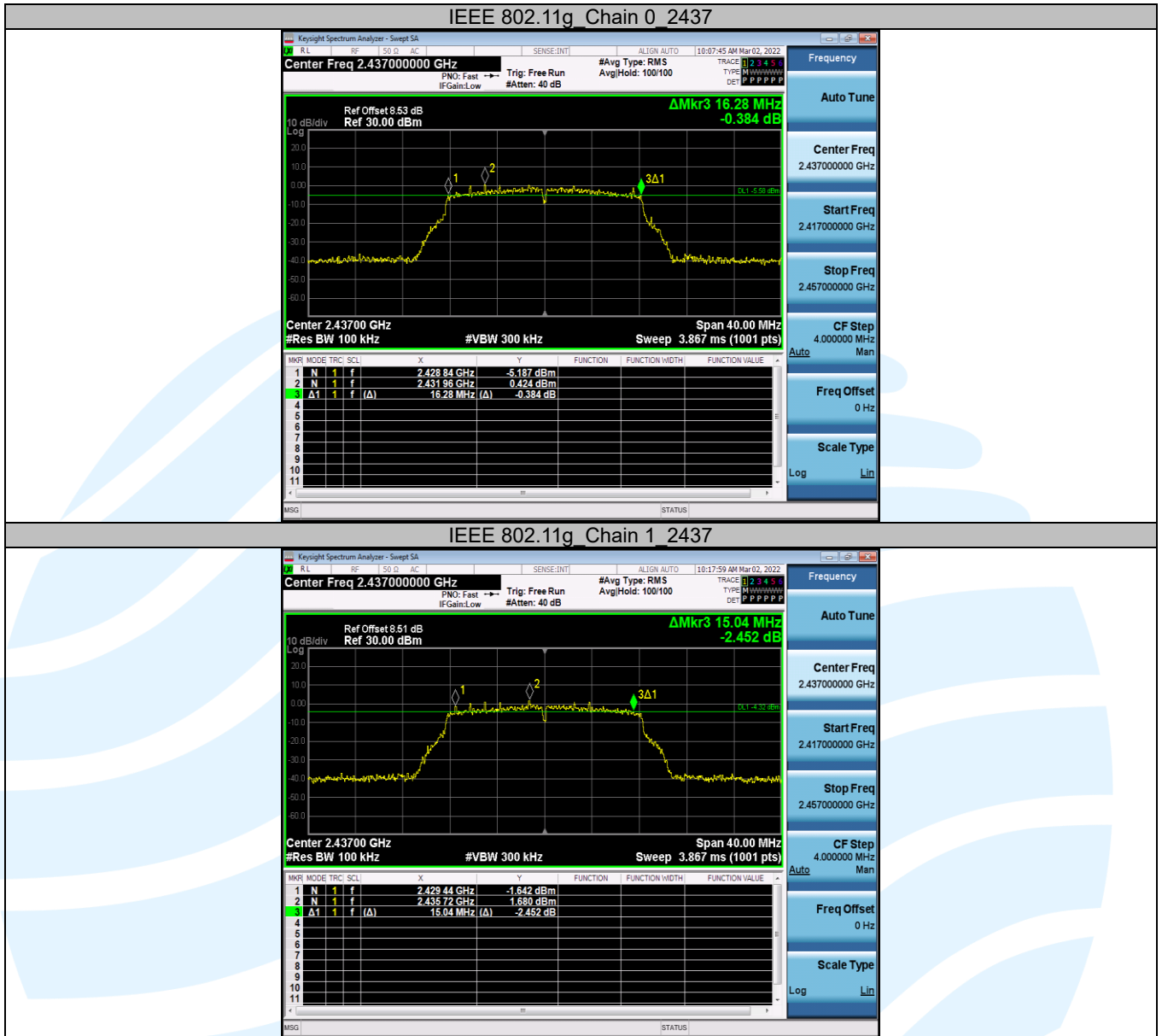
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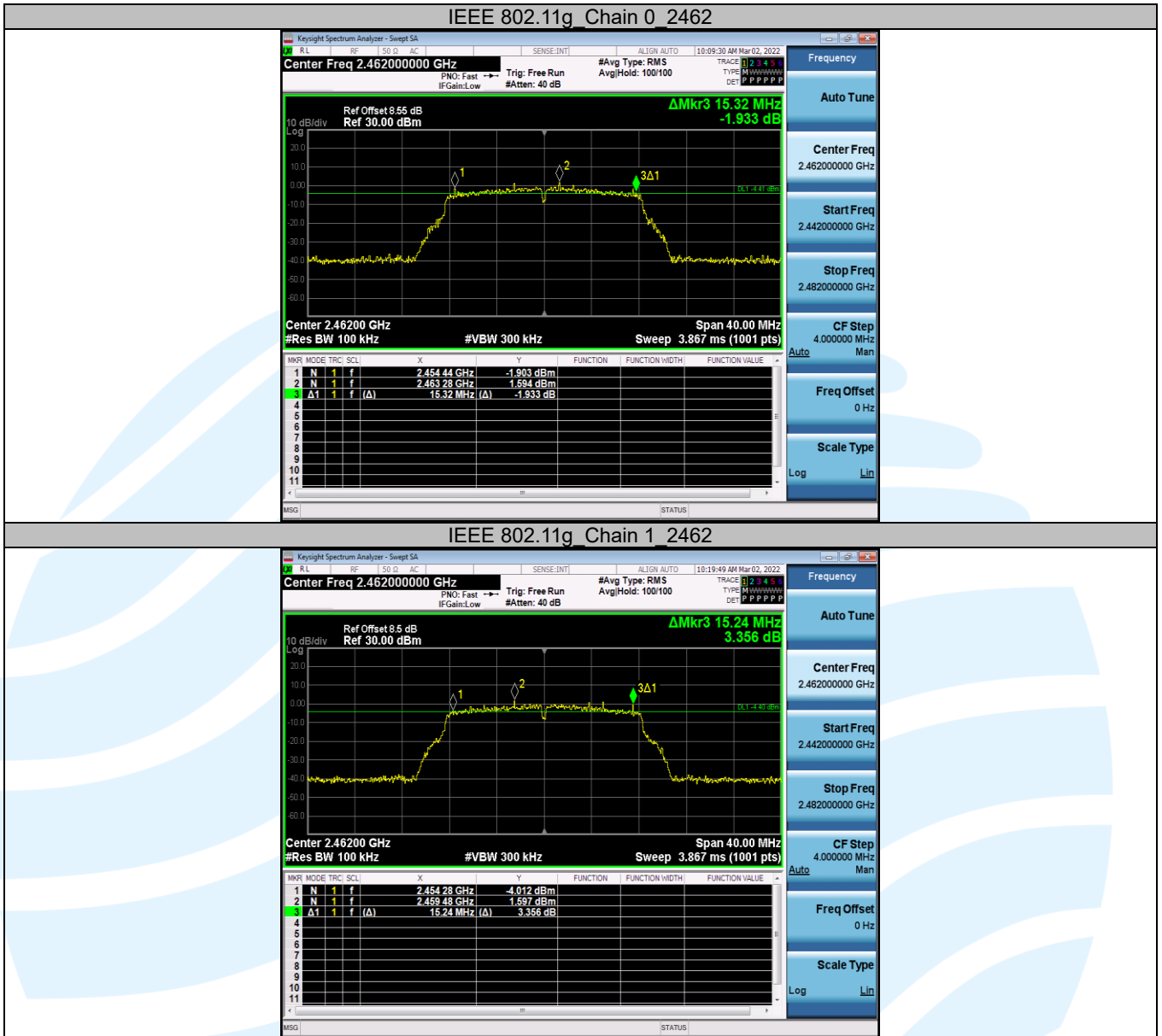
Tel: +86-755-28230888

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E-mail: info@uttlab.com

<http://www.uttlab.com>

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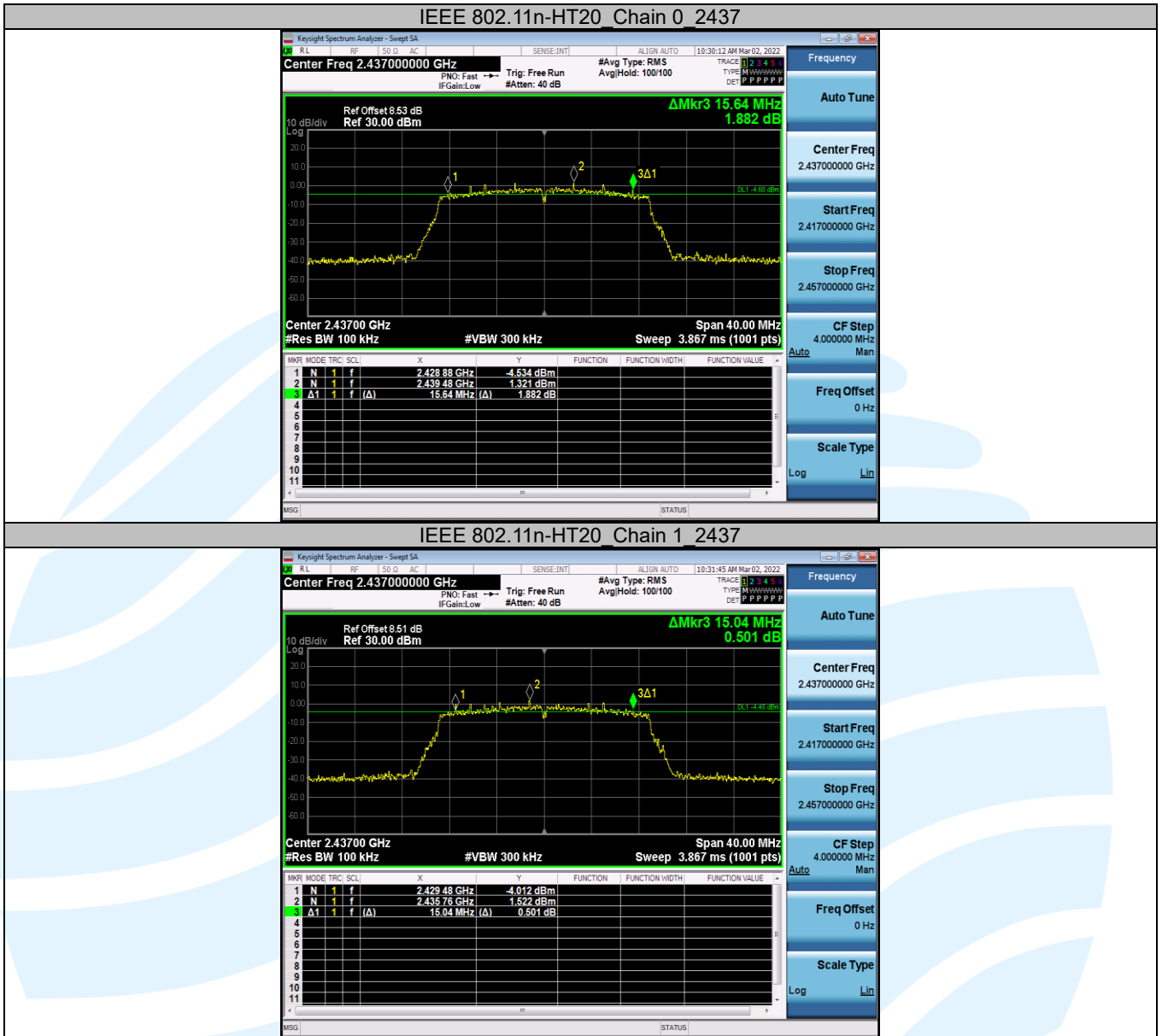
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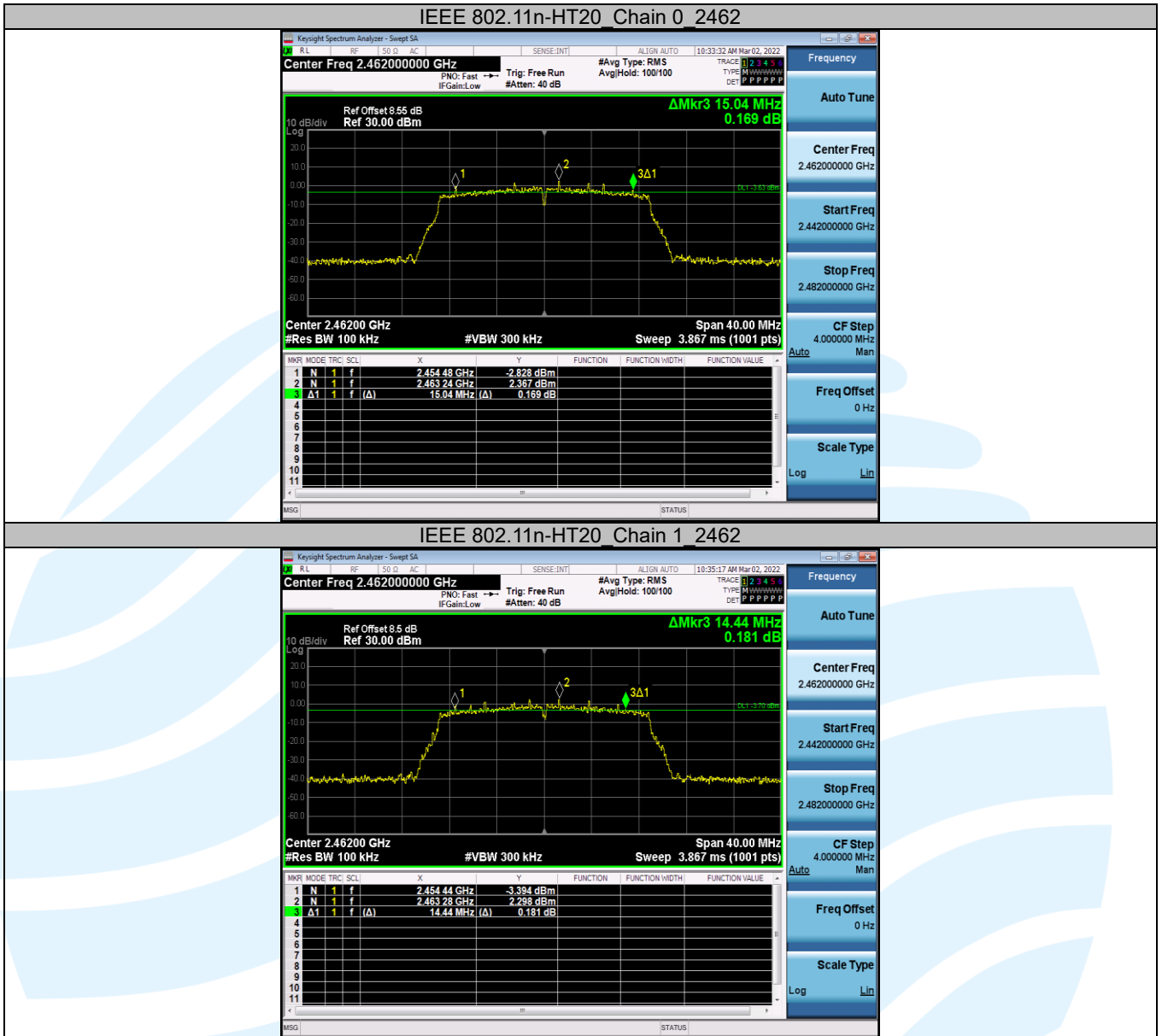
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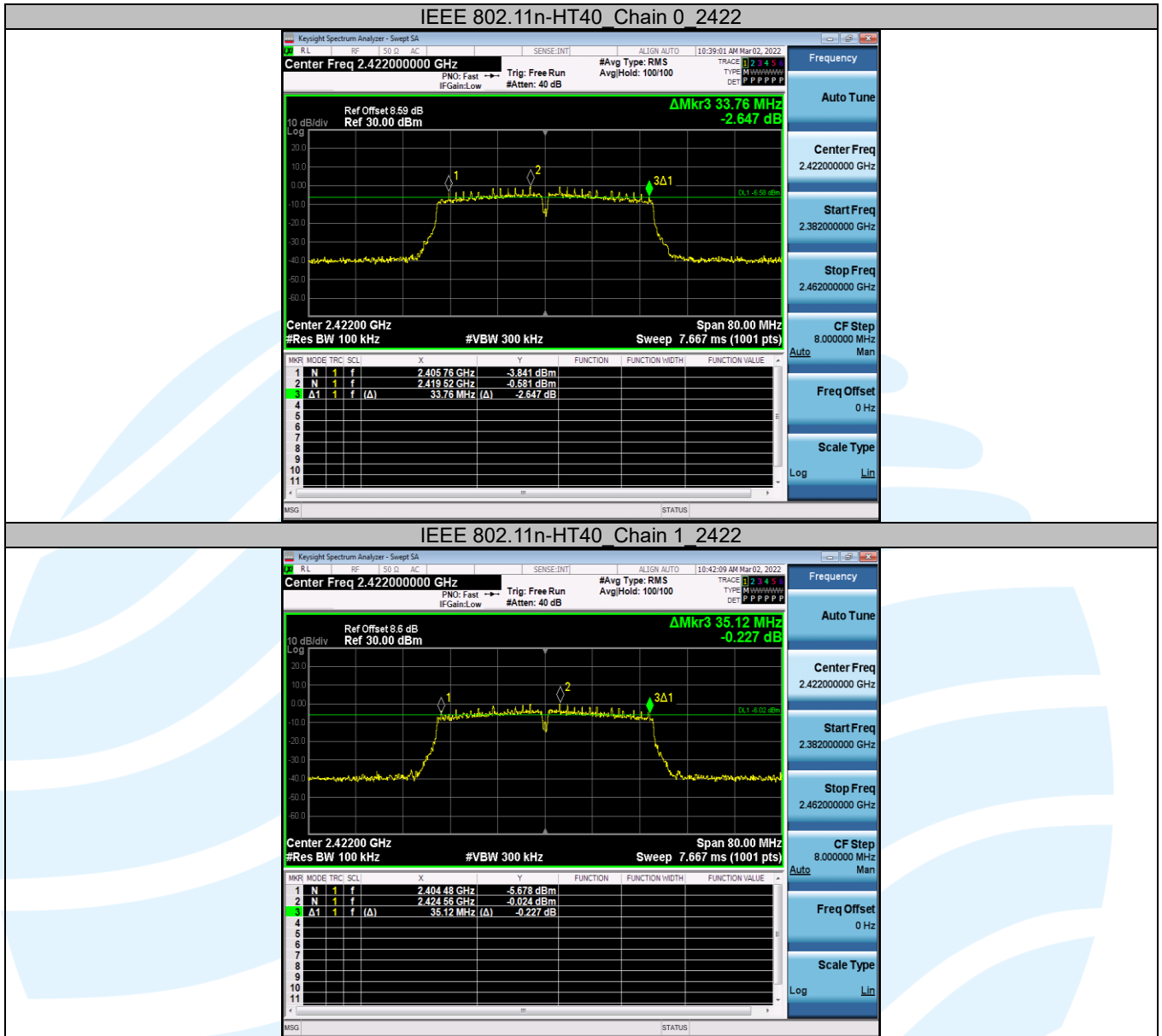
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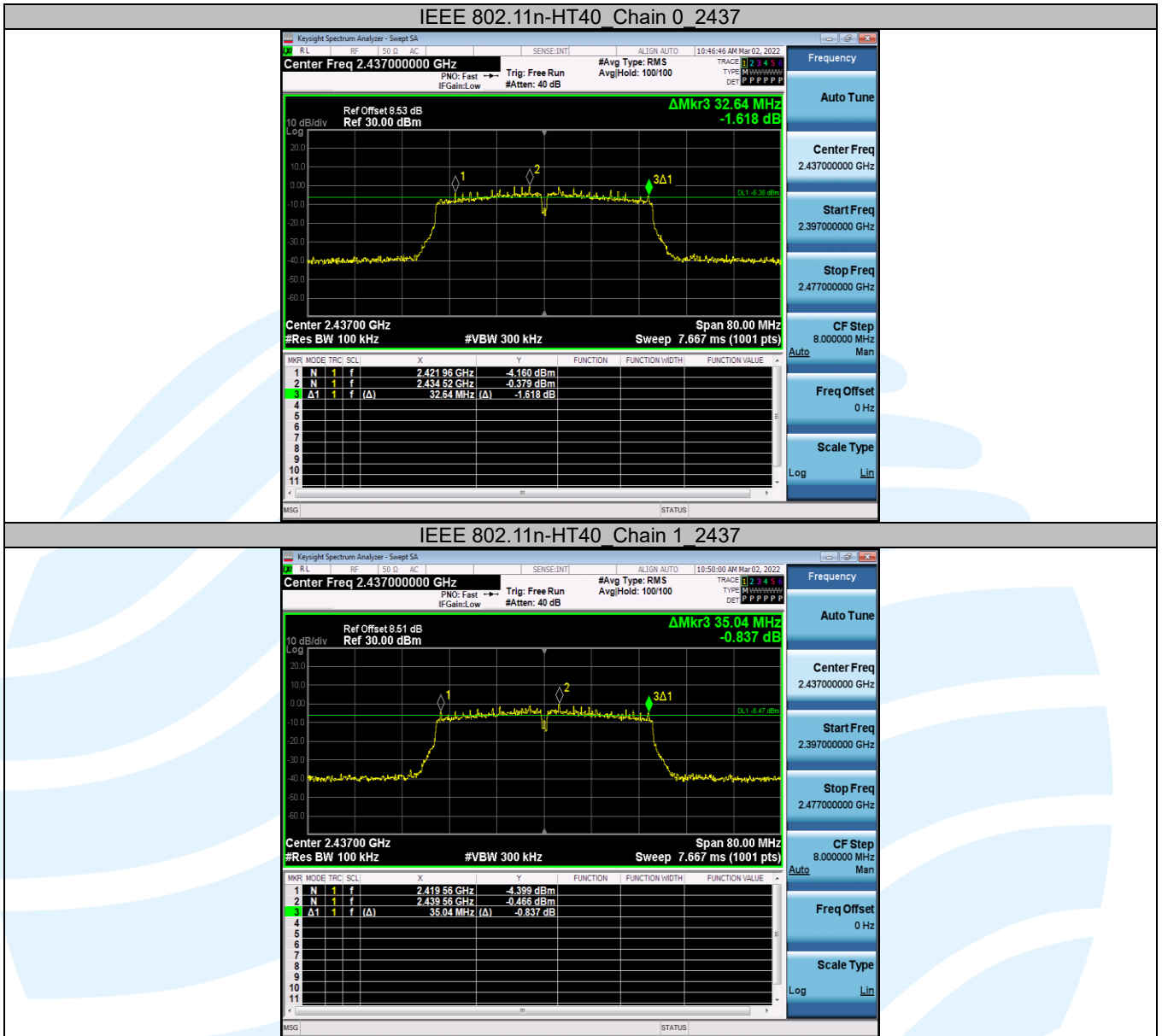
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