

## Test Report

**Prepared for:** 701x

**Address:** 700 Main Avenue  
Fargo, North Dakota 58103

**Product:** xTAG

**FCC ID:** 2AZT3-701XT1

**Test Report No:** R2010414-20-E1A

**Approved by:**



**Nic S. Johnson, NCE**

Technical Manager

iNARTE Certified EMC Engineer #EMC-003337-NE

**DATE:** 24 August 2021

**Total Pages:** 40

*The Nebraska Center for Excellence in Electronics (NCEE) authorizes the above named company to reproduce this report provided it is reproduced in its entirety for use by the company's employees only. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. NCEE accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report applies only to the items tested.*



|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

## REVISION PAGE

| Rev. No. | Date           | Description                                                                               |
|----------|----------------|-------------------------------------------------------------------------------------------|
| 0        | 30 July 2021   | Original – NJohnson<br>Prepared by FLane                                                  |
| A        | 19 August 2021 | Added FCC ID<br>Added conducted power values<br>Updated description in output power plots |



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

## CONTENTS

|                                                                                       |    |
|---------------------------------------------------------------------------------------|----|
| Revision Page .....                                                                   | 2  |
| 1.0 Summary of test results.....                                                      | 4  |
| 2.0 EUT Description .....                                                             | 5  |
| 2.1 Equipment under test .....                                                        | 5  |
| 2.2 Description of test modes .....                                                   | 6  |
| 2.3 Description of support units.....                                                 | 6  |
| 3.0 Laboratory description.....                                                       | 7  |
| 3.1 Laboratory description.....                                                       | 7  |
| 3.2 Test personnel.....                                                               | 7  |
| 3.3 Test equipment.....                                                               | 8  |
| 3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS .....                      | 9  |
| 4.0 Detailed results.....                                                             | 10 |
| 4.1 Duty Cycle .....                                                                  | 11 |
| 4.2 Radiated emissions.....                                                           | 12 |
| 4.3 Peak Output Power .....                                                           | 19 |
| 4.4 Bandwidth.....                                                                    | 20 |
| 4.5 Bandedges .....                                                                   | 21 |
| 4.6 Carrier frequency separation, number of hopping channels, time of occupancy ..... | 22 |
| Appendix A: Sample Calculation .....                                                  | 23 |
| Appendix B – Measurement Uncertainty .....                                            | 25 |
| Appendix C – Graphs and Tables .....                                                  | 26 |
| REPORT END.....                                                                       | 40 |

|                                                                                  |                |                 |     |   |
|----------------------------------------------------------------------------------|----------------|-----------------|-----|---|
|  | Report Number: | R20210414-20-E1 | Rev | A |
|                                                                                  | Prepared for:  | 701x            |     |   |

## 1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

- (1) US Code of Federal Regulations, Title 47, Part 15
- (2) ISSED RSS-Gen, Issue 5
- (3) ISSED RSS-247, Issue 2

| SUMMARY                                            |                                                                                             |        |                                     |
|----------------------------------------------------|---------------------------------------------------------------------------------------------|--------|-------------------------------------|
| Standard Section                                   | Test Type and Limit                                                                         | Result | Remark                              |
| FCC 15.203                                         | Unique Antenna Requirement                                                                  | Pass   | PCB antenna                         |
| FCC 15.209<br>RSS-Gen, 7.1                         | Receiver Radiated Emissions                                                                 | Pass   | Meets the requirement of the limit. |
| FCC 15.247(a)(1)(i)<br>RSS-247, 5.1(c)             | Minimum Bandwidth,<br>Limit: Max. 250kHz                                                    | Pass   | Meets the requirement of the limit. |
| FCC 15.247(b)(1)<br>RSS-247, 5.1                   | Maximum Peak Output Power, Limit: Max. 30 dBm                                               | Pass   | Meets the requirement of the limit. |
| FCC 15.209<br>RSS-Gen, 8.9<br>RSS-247, 5.5         | Transmitter Radiated Emissions                                                              | Pass   | Meets the requirement of the limit. |
| FCC 15.247(a) (1) (i)<br>RSS-247, 5.1(c)           | Frequency hopping system, Channel Dwell Time<br>Limit: Max. 0.4 Seconds in 20 Second Period | Pass   | Meets the requirement of the limit. |
| FCC 15.209, 15.205<br>RSS-Gen, 8.9<br>RSS-247, 5.5 | Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency        | Pass   | Meets the requirement of the limit. |
| FCC 15.205(a)<br>FCC 15.247(d)                     | Restricted Band Edge Measurement, Limit: FCC 15.209 Limits in restricted bands              | Pass   | Meets the requirement of the limit. |
| FCC 15.207<br>RSS-Gen. 8.8                         | Conducted AC Emissions                                                                      | NA     | Battery Powered.                    |



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

## 2.0 EUT DESCRIPTION

### 2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless FHSS transmitter.

|                |                       |
|----------------|-----------------------|
| EUT            | Cattle Tracker        |
| EUT Received   | 7/7/2021              |
| EUT Tested     | 7/7/2021 - 7/8/2021   |
| Serial No.     | 001 (assigned by lab) |
| Operating Band | 902.0 – 928.0 MHz     |
| Device Type    | FHSS                  |
| Power Supply   | Internal Battery      |

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

## 2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

| Channel | Frequency |
|---------|-----------|
| Low     | 902.2     |
| Middle  | 915.0     |
| High    | 927.8     |

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

## 2.3 DESCRIPTION OF SUPPORT UNITS

None

|                                                                                  |                |                 |     |   |
|----------------------------------------------------------------------------------|----------------|-----------------|-----|---|
|  | Report Number: | R20210414-20-E1 | Rev | A |
|                                                                                  | Prepared for:  | 701x            |     |   |

### 3.0 LABORATORY DESCRIPTION

#### 3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)  
 4740 Discovery Drive  
 Lincoln, NE 68521

A2LA Certificate Number: 1953.01  
 FCC Accredited Test Site Designation No: US1060  
 Industry Canada Test Site Registration No: 4294A-1  
 CAB MRA Recognition Identification No: US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of  $35 \pm 4\%$   
 Temperature of  $22 \pm 3^\circ$  Celsius



#### 3.2 TEST PERSONNEL

| No. | PERSONNEL      | TITLE             | ROLE               |
|-----|----------------|-------------------|--------------------|
| 1   | Nic Johnson    | Technical Manager | Review of Results  |
| 2   | Fox Lane       | EMC Test Engineer | Testing and Report |
| 3   | Karthik Vepuri | EMC Test Engineer | Testing            |

**Notes:**

All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

### 3.3 TEST EQUIPMENT

| DESCRIPTION AND MANUFACTURER             | MODEL NO. | SERIAL NO. | LAST CALIBRATION DATE | CALIBRATION DUE DATE |
|------------------------------------------|-----------|------------|-----------------------|----------------------|
| Keysight MXE Signal Analyzer (26.5GHz)** | N9038A    | MY56400083 | May 5, 2020           | May 5, 2022          |
| SunAR RF Motion                          | JB1       | A082918-1  | August 17, 2020       | August 17, 2021      |
| EMCO Horn Antenna**                      | 3115      | 6415       | March 16, 2020        | March 16, 2022       |
| Rohde & Schwarz Preamplifier*            | TS-PR18   | 3545700803 | April 14, 2020        | April 14, 2022       |
| Trilithic High Pass Filter*              | 6HC330    | 23042      | April 14, 2020        | April 14, 2022       |
| MiniCircuits High Pass Filter*           | VHF-1320+ | 15542      | April 14, 2020        | April 14, 2022       |
| RF Cable (preamplifier to antenna)*      | MFR-57500 | 01-07-002  | April 14, 2020        | April 14, 2022       |
| TDK Emissions Lab Software               | V11.25    | 700307     | NA                    | NA                   |

\*Internal Characterization

\*\*2 Year Calibration Cycle

**Notes:**

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

### 3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Measurement type presented in this report (Please see the checked box below):

#### Conducted ☐

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.



Figure 1 - Bandwidth Measurements Test Setup

#### Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

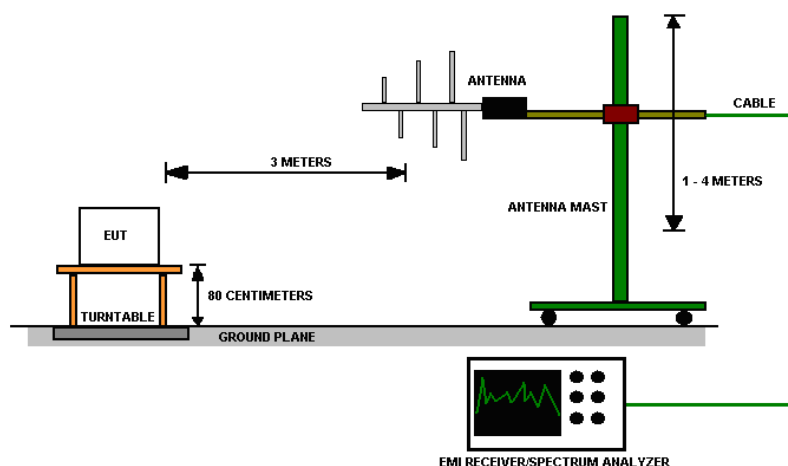


Figure 2 - Radiated Emissions Test Setup



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

#### 4.0 DETAILED RESULTS

| Radio Measurements |             |                          |                       |                              |                                   |        |                            |                          |
|--------------------|-------------|--------------------------|-----------------------|------------------------------|-----------------------------------|--------|----------------------------|--------------------------|
| CHANNEL            | Transmitter | Occupied Bandwidth (kHz) | 20 dB Bandwidth (kHz) | PEAK OUTPUT POWER EIRP (dBm) | PEAK OUTPUT POWER Conducted (dBm) | RESULT | No. of Hoping Channels     | Time of Occupancy (msec) |
|                    |             |                          |                       |                              |                                   |        | 129                        | 368                      |
| Low                | Continuous  | 94.78                    | 103.00                | 17.854                       | 15.654                            | PASS   | Frequency Separation (kHz) |                          |
| Mid                | Continuous  | 92.91                    | 102.40                | 13.301                       | 11.101                            | PASS   |                            |                          |
| High               | Continuous  | 94.30                    | 101.60                | 16.128                       | 13.928                            | PASS   | 201.075                    |                          |

\*Measurements were taken while EUT was transmitting continuously modulated with a duty cycle of >99%

Peak Output Power EIRP = SA Reading + Transducer + Cable + 107 – 95.23

\*Conducted measurements = EIRP – antenna gain

Antenna gain = 2.2 dBi



|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

#### 4.1 DUTY CYCLE

**Test Method:** NA

## 4.2 RADIATED EMISSIONS

**Test Method:** ANSI C63.10-2013, Section 6.5, 6.6

### Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

| FREQUENCIES<br>(MHz) | FIELD<br>STRENGTH<br>( $\mu\text{V/m}$ ) | MEASUREMENT<br>DISTANCE (m) |
|----------------------|------------------------------------------|-----------------------------|
| 0.009-0.490          | 2400/F(kHz)                              | 300                         |
| 0.490-1.705          | 24000/F(kHz)                             | 30                          |
| 1.705-30.0           | 30                                       | 3                           |
| 30-88                | 100                                      | 3                           |
| 88-216               | 150                                      | 3                           |
| 216-960              | 200                                      | 3                           |
| Above 960            | 500                                      | 3                           |

### NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) =  $20 * \log * \text{Emission level } (\mu\text{V/m})$ .
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

### Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1GHz and 1.5m for measurements from 1GHz to 10 GHz.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.
- h. The EUT was tested during the preview scan with all radios transmitting simultaneously. If any intermodulation products were measured within the laboratory's measurement sensitivity, they were recorded in the results.

|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

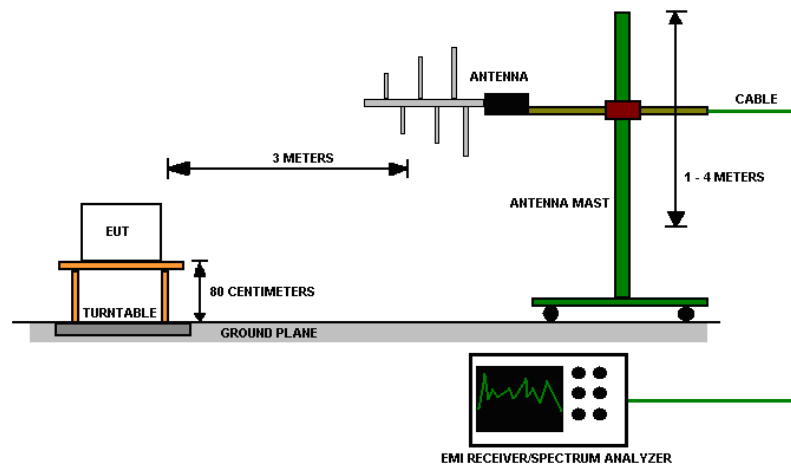
**NOTE:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

**Deviations from test standard:**

No deviation.

**Test setup:**

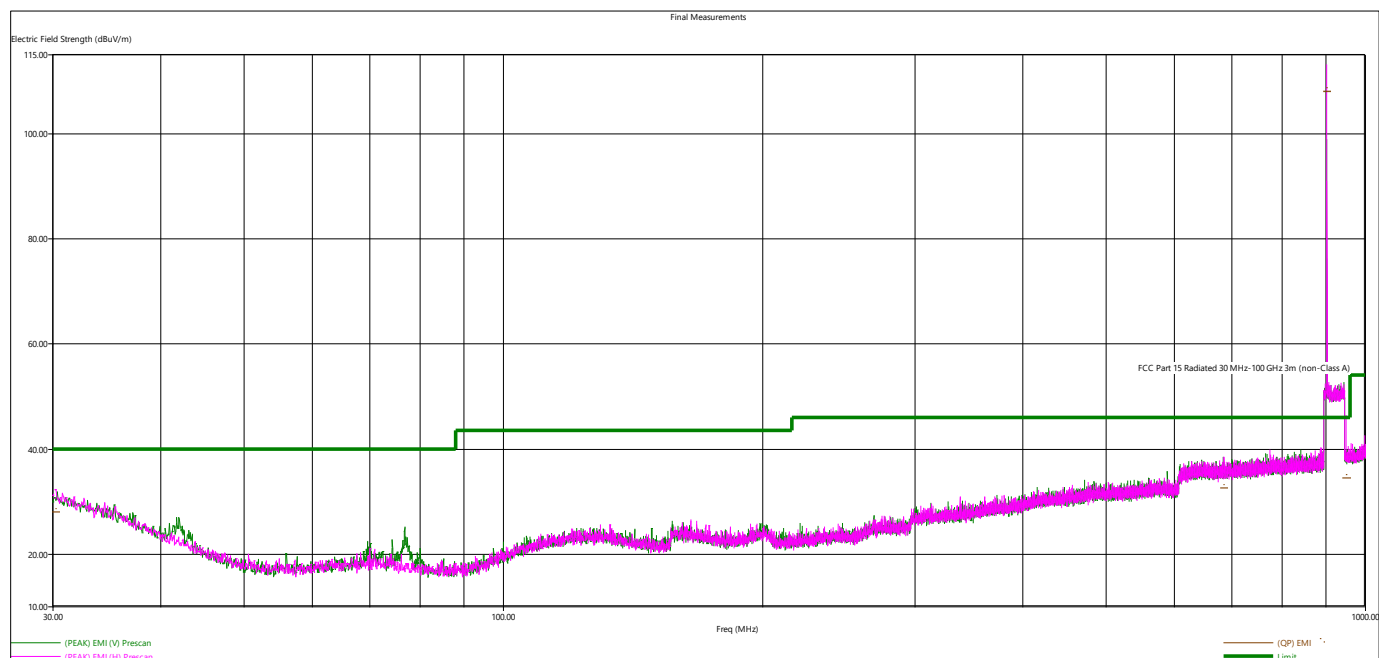


**Figure 3 - Radiated Emissions Test Setup**

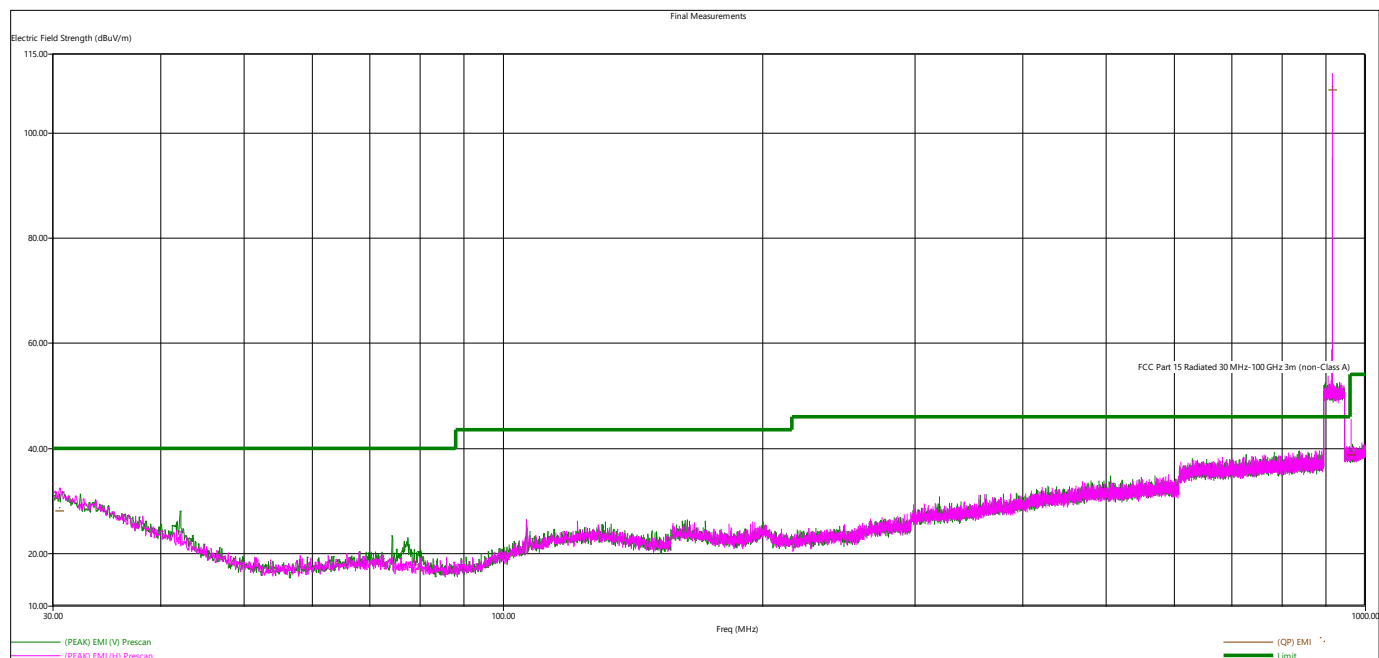
**EUT operating conditions**

The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

**Test results:**



**Figure 4 - Radiated Emissions Plot, Low Channel**



**Figure 5 - Radiated Emissions Plot, Mid Channel**

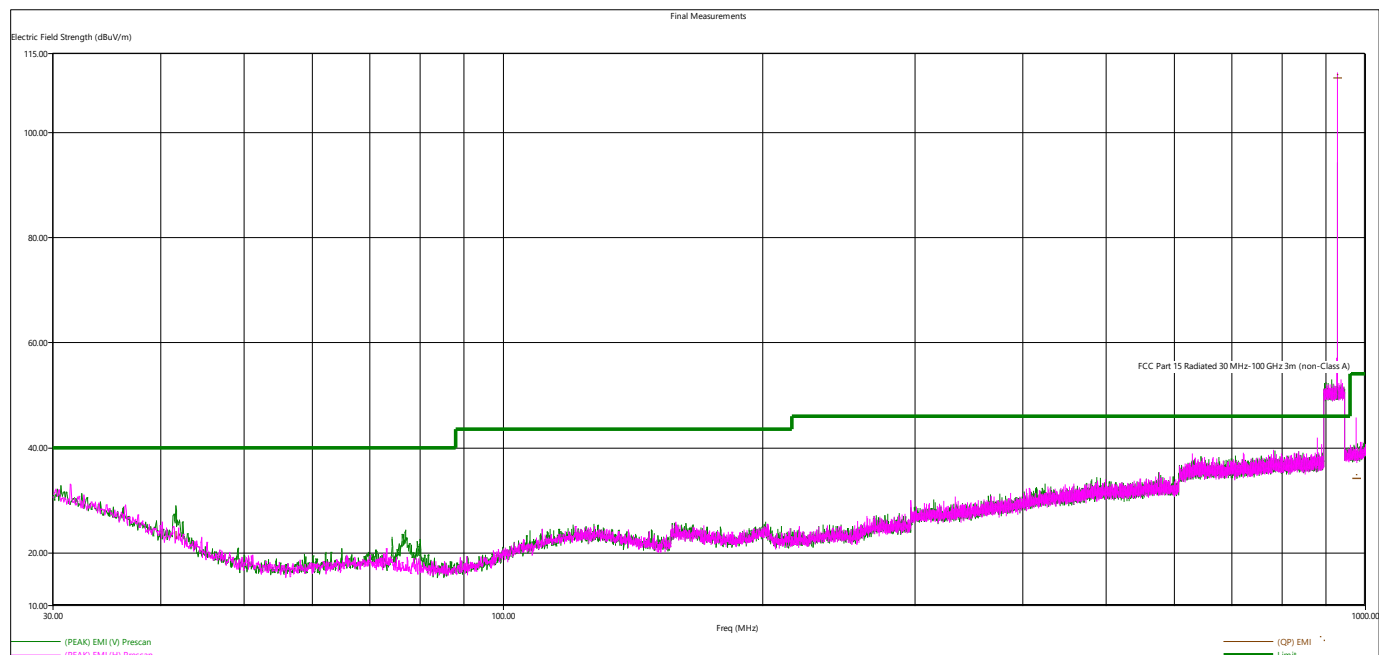


Figure 6 - Radiated Emissions Plot, High Channel

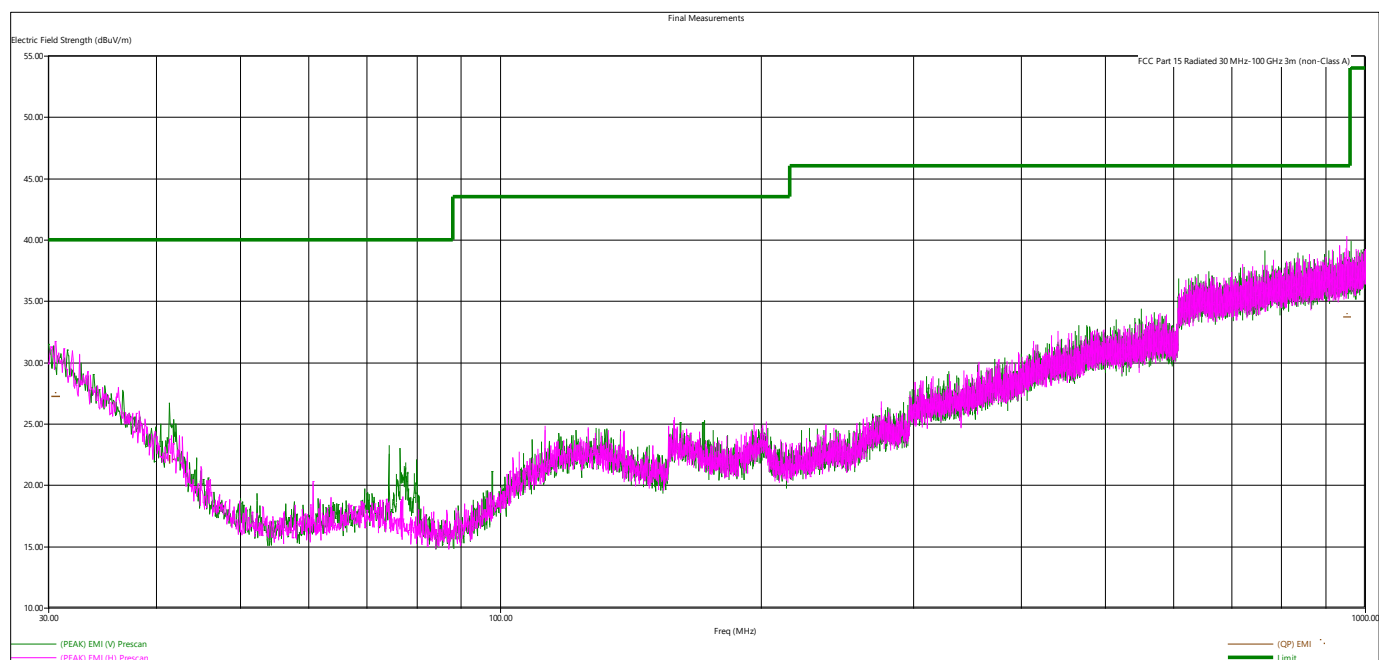


Figure 7 - Radiated Emissions Plot, Receive Mode

Figure 8 - Radiated Emissions Plot, Receive Channel

| Quasi-Peak Measurements |        |        |        |        |        |     |         |
|-------------------------|--------|--------|--------|--------|--------|-----|---------|
| Frequency               | Level  | Limit  | Margin | Height | Angle  | Pol | Channel |
| MHz                     | dBµV/m | dBµV/m | dB     | cm.    | deg.   |     |         |
| 30.241200               | 27.90  | 40.00  | 12.10  | 268.00 | 249.00 | H   | Low     |
| 685.924800              | 32.38  | 46.02  | 13.64  | 141.00 | 278.00 | H   | Low     |
| 902.165440              | 107.88 | NA     | NA     | 103.00 | 116.00 | H   | Low     |
| 950.047920              | 34.35  | 46.02  | 11.67  | 103.00 | 79.00  | H   | Low     |
| 30.529920               | 27.88  | 40.00  | 12.12  | 356.00 | 58.00  | H   | Mid     |
| 914.986720              | 108.05 | NA     | NA     | 100.00 | 58.00  | H   | Mid     |
| 962.962320              | 38.52  | 53.98  | 15.46  | 108.00 | 50.00  | H   | Mid     |
| 41.699760               | 23.26  | 40.00  | 16.74  | 110.00 | 342.00 | V   | High    |
| 927.812320              | 110.17 | NA     | NA     | 103.00 | 298.00 | H   | High    |
| 975.625920              | 34.09  | 53.98  | 19.89  | 398.00 | 85.00  | H   | High    |
| 30.454080               | 27.16  | 40.00  | 12.84  | 184.00 | 221.00 | H   | Receive |
| 951.826080              | 33.65  | 46.02  | 12.37  | 236.00 | 182.00 | H   | Receive |
| 41.357520               | 22.07  | 40.00  | 17.93  | 130.00 | 4.00   | V   | Receive |

\*Measurements taken with EUT in CW mode

Module Verification of Cellular Module (FCC ID: XMR201912BG77) investigated and found to be within 2dB of previous certification.

| Peak Measurements |        |        |        |        |       |     |         |
|-------------------|--------|--------|--------|--------|-------|-----|---------|
| Frequency         | Level  | Limit  | Margin | Height | Angle | Pol | Channel |
| MHz               | dBµV/m | dBµV/m | dB     | cm.    | deg.  |     |         |
| 1804.36           | 60.31  | 93.084 | 13.67  | 149    | 47    | H   | Low     |
| 2706.37           | 44.75  | 73.98  | 29.23  | 122    | 184   | H   | Low     |
| 4511.088          | 53.55  | 73.98  | 20.43  | 383    | 122   | V   | Low     |
| 1830.018          | 55.15  | 88.531 | 18.83  | 145    | 205   | H   | Mid     |
| 2744.93           | 47.28  | 73.98  | 26.7   | 295    | 313   | H   | Mid     |
| 4574.938          | 54.16  | 73.98  | 19.82  | 375    | 304   | V   | Mid     |
| 5489.948          | 48.81  | 88.531 | 25.17  | 158    | 164   | V   | Mid     |
| 6405.038          | 47.83  | 88.531 | 26.15  | 179    | 187   | V   | Mid     |
| 1855.556          | 58.67  | 91.358 | 15.31  | 138    | 209   | H   | High    |
| 2783.334          | 48.65  | 73.98  | 25.33  | 461    | 64    | H   | High    |
| 4639.064          | 51.6   | 73.98  | 22.38  | 479    | 308   | V   | High    |
| 5566.65           | 48.43  | 91.358 | 25.55  | 159    | 169   | V   | High    |
| 6494.398          | 47.52  | 91.358 | 26.46  | 115    | 175   | V   | High    |

\*Measurements taken with EUT in CW mode



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

| Average Measurements |              |              |        |        |       |     |         |
|----------------------|--------------|--------------|--------|--------|-------|-----|---------|
| Frequency            | Level        | Limit        | Margin | Height | Angle | Pol | Channel |
| MHz                  | dB $\mu$ V/m | dB $\mu$ V/m | dB     | cm.    | deg.  |     |         |
| 1804.36              | 59.76        | NA           | NA     | 149    | 47    | H   | Low     |
| 2706.37              | 39.79        | 53.98        | 14.19  | 122    | 184   | H   | Low     |
| 4511.088             | 50.72        | 53.98        | 3.26   | 383    | 122   | V   | Low     |
| 1830.018             | 54.26        | NA           | NA     | 145    | 205   | H   | Mid     |
| 2744.93              | 44.18        | 53.98        | 9.8    | 295    | 313   | H   | Mid     |
| 4574.938             | 52.12        | 53.98        | 1.86   | 375    | 304   | V   | Mid     |
| 5489.948             | 41.66        | NA           | NA     | 158    | 164   | V   | Mid     |
| 6405.038             | 41.23        | NA           | NA     | 179    | 187   | V   | Mid     |
| 1855.556             | 58.09        | NA           | NA     | 138    | 209   | H   | High    |
| 2783.334             | 46.01        | 53.98        | 7.97   | 461    | 64    | H   | High    |
| 4639.064             | 48.59        | 53.98        | 5.39   | 479    | 308   | V   | High    |
| 5566.65              | 40.24        | NA           | NA     | 159    | 169   | V   | High    |
| 6494.398             | 41.05        | NA           | NA     | 115    | 175   | V   | High    |

Measurements taken with average detector and EUT in CW mode

**REMARKS:**

1. Emission level (dB $\mu$ V/m) = Raw Value (dB $\mu$ V) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Limit Value – Emission Level.
5. The EUT was measured in all 3 orthogonal axes. See the test setup photo exhibit for details on the orientations.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

#### 4.3 PEAK OUTPUT POWER

**Test Method:** ANSI C63.10, Section(s) 7.8.5

**Limits of output power measurements:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels.

**Test procedures:**

Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel.

**Deviations from test standard:**

No deviation.

**Test setup:**

Details can be found in section 3.4 of this report.

**EUT operating conditions:**

Details can be found in section 2.1 of this report.

**Test results:**

**Pass**

Comments:

1. All the output power plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

#### 4.4 BANDWIDTH

**Test Method:** ANSI C63.10, Section(s) 6.9.2

**Limits of bandwidth measurements:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

**Test procedures:**

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 30 kHz VBW.

The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB. The 99% bandwidth is defined as the bandwidth that contains 99% of the power.

**Deviations from test standard:**

No deviation.

**Test setup:**

Details can be found in section 3.4 of this report.

**EUT operating conditions:**

Details can be found in section 2.1 of this report.

**Test results:**

### Pass

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.



|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

#### 4.5 BANDEDGES

**Test Method:** ANSI C63.10, Section(s) 6.10.6

**Limits of band edge measurements:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

For emissions outside of the allowed band of operation (902 – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

**Test procedures:**

The EUT was tested in the same method as described in section 4.4 - *Bandwidth*. The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band edge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the band edge was measured and recorded. For restricted band edge measurements, the unit was tested to the same method as section 4.2 of this report.

**Deviations from test standard:**

No deviation.

**Test setup:**

Details can be found in section 3.4 of this report.

**EUT operating conditions:**

Details can be found in section 2.1 of this report.

**Test results:**

**Pass**

Comments:

1. All the band edge plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

#### 4.6 CARRIER FREQUENCY SEPARATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

**Test Method:** ANSI C63.10, Section 7.8.2, 7.8.3, 7.8.4

**Limits for Time of Occupancy:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

(1)(i) Average time of occupancy on any frequency, not to exceed 0.4 seconds within a 10 second period.

**Limits for Time of Number of Hopping Channels:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

(1)(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

**Limits for Carrier Frequency Separation:**

*§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz*

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

**Test procedures:**

The method from KDB 558074 D01 v05

**Test setup:**

Details can be found in section 3.4 of this report.

**EUT operating conditions:**

Details can be found in section 2.1 of this report.

**Test results:**

**Pass**

Comments:

1. All the plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

## APPENDIX A: SAMPLE CALCULATION

### Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB $\mu$ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB $\mu$ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB $\mu$ V/m value can be mathematically converted to its corresponding level in  $\mu$ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by taking the  $20 \cdot \log(T_{\text{on}}/100)$  where  $T_{\text{on}}$  is the maximum transmission time in any 100ms window.



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

## EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

$$EIRP (Watts) = [Field Strength (V/m) \times antenna distance (m)]^2 / 30$$

$$Power (watts) = 10^{[Power (dBm)/10]} / 1000$$

$$Voltage (dB\mu V) = Power (dBm) + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field Strength (V/m) = 10^{[Field Strength (dB\mu V/m) / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$

Conversion from 3m field strength to EIRP (d=3):

$$EIRP = [FS(V/m) \times d^2]/30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(dBm) = FS(dB\mu V/m) - 10(\log 10^9) + 10\log[0.3] = FS(dB\mu V/m) - 95.23$$

*10log( 10^9) is the conversion from micro to milli*



Report Number: R20210414-20-E1

Rev

A

Prepared for: 701x

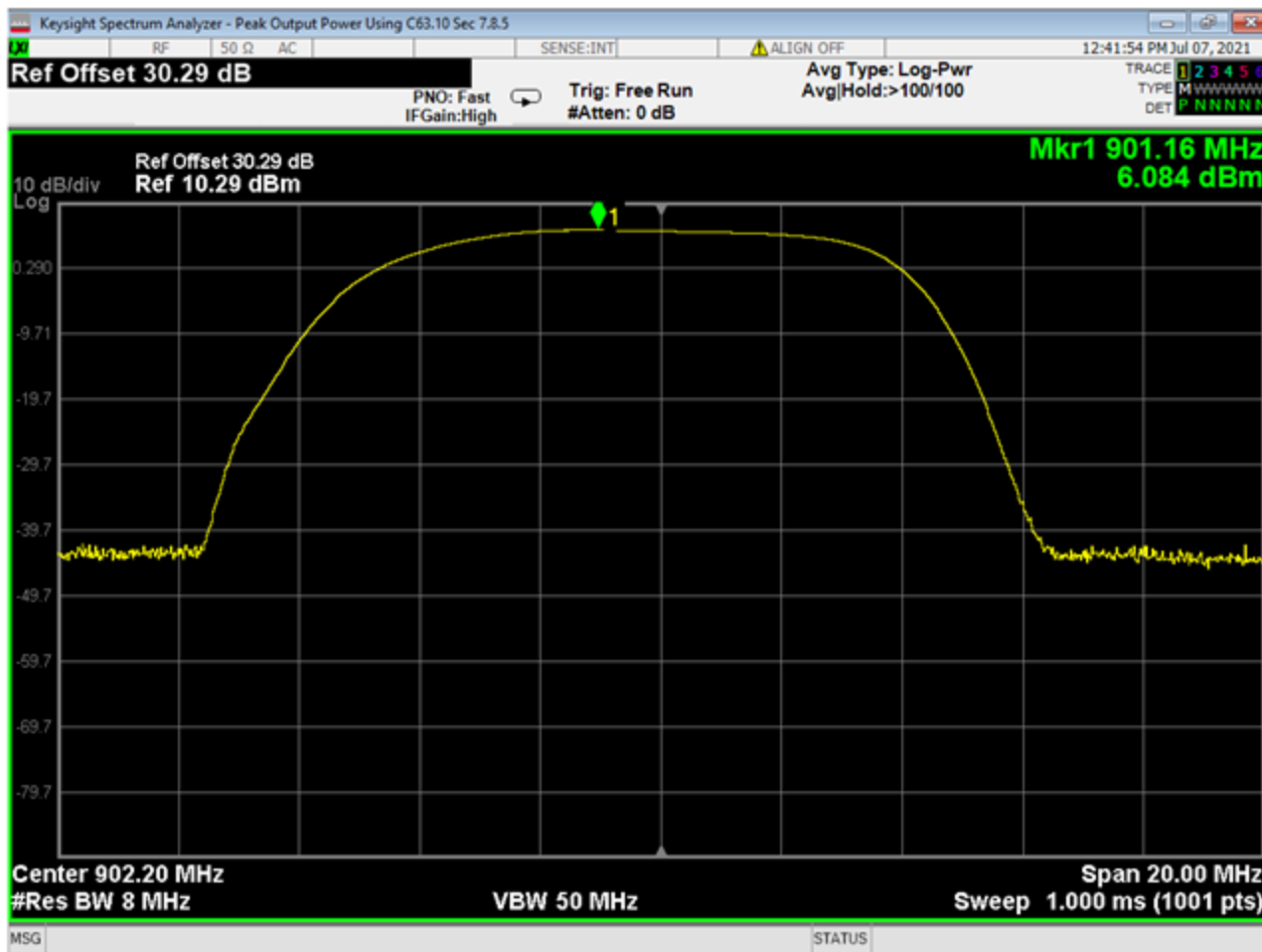
## APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

| Test                        | Frequency Range | Uncertainty Value (dB) |
|-----------------------------|-----------------|------------------------|
| Radiated Emissions, 3m      | 30MHz - 1GHz    | 3.82                   |
| Radiated Emissions, 3m      | 1GHz - 18GHz    | 4.44                   |
| Emissions limits, conducted | 30MHz – 18GHz   | ±3.30 dB               |

Expanded uncertainty values are calculated to a confidence level of 95%.

## APPENDIX C – GRAPHS AND TABLES

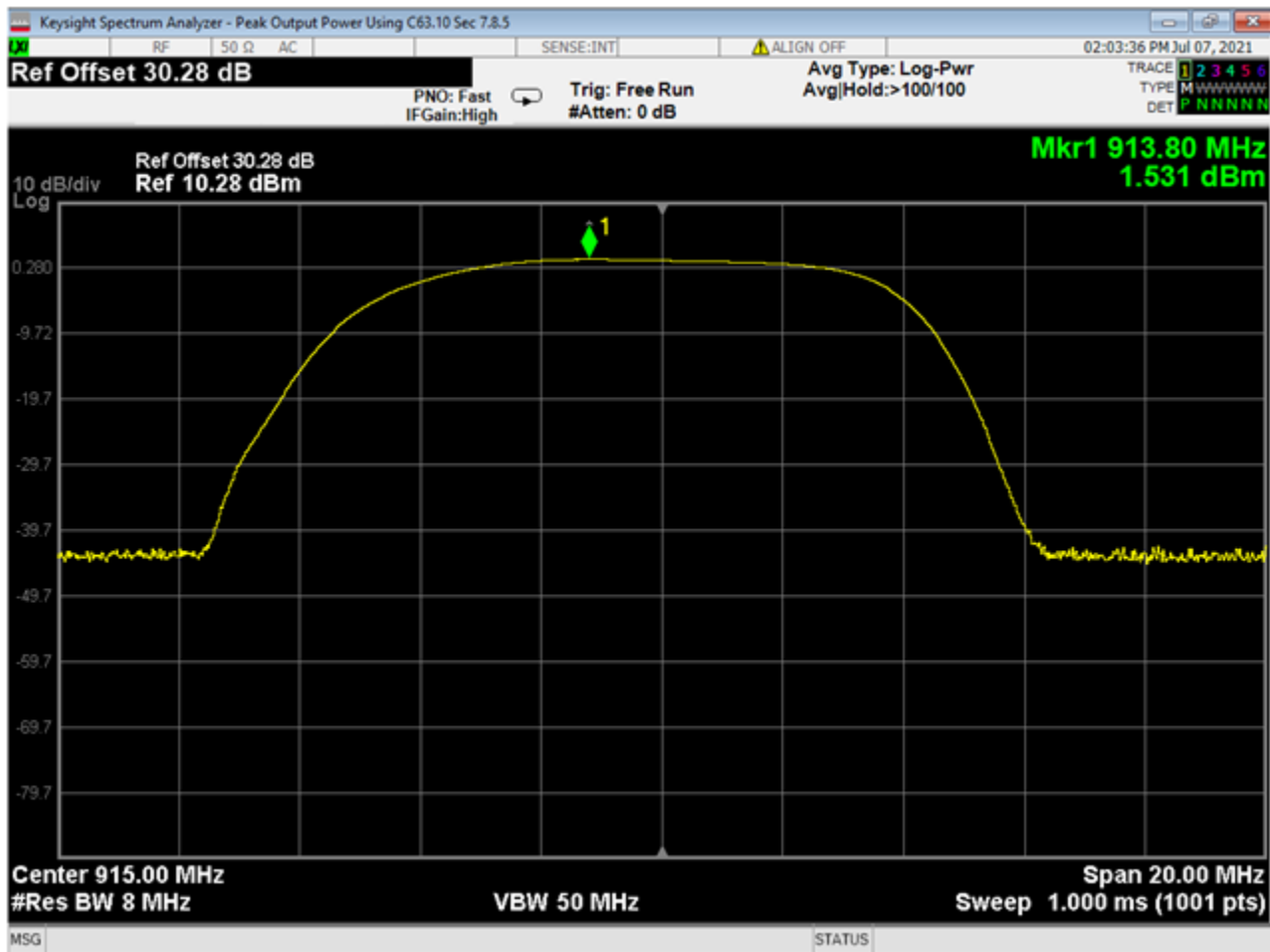


01 Peak Output Power, Low

Transducer and Cable Corrections included in Ref Offset

Plots show corrected Radiated Field Strength measurement taken at 3m test distance

$$\text{Peak Output Power EIRP} = \text{Field Strength} + 107 - 95.23$$

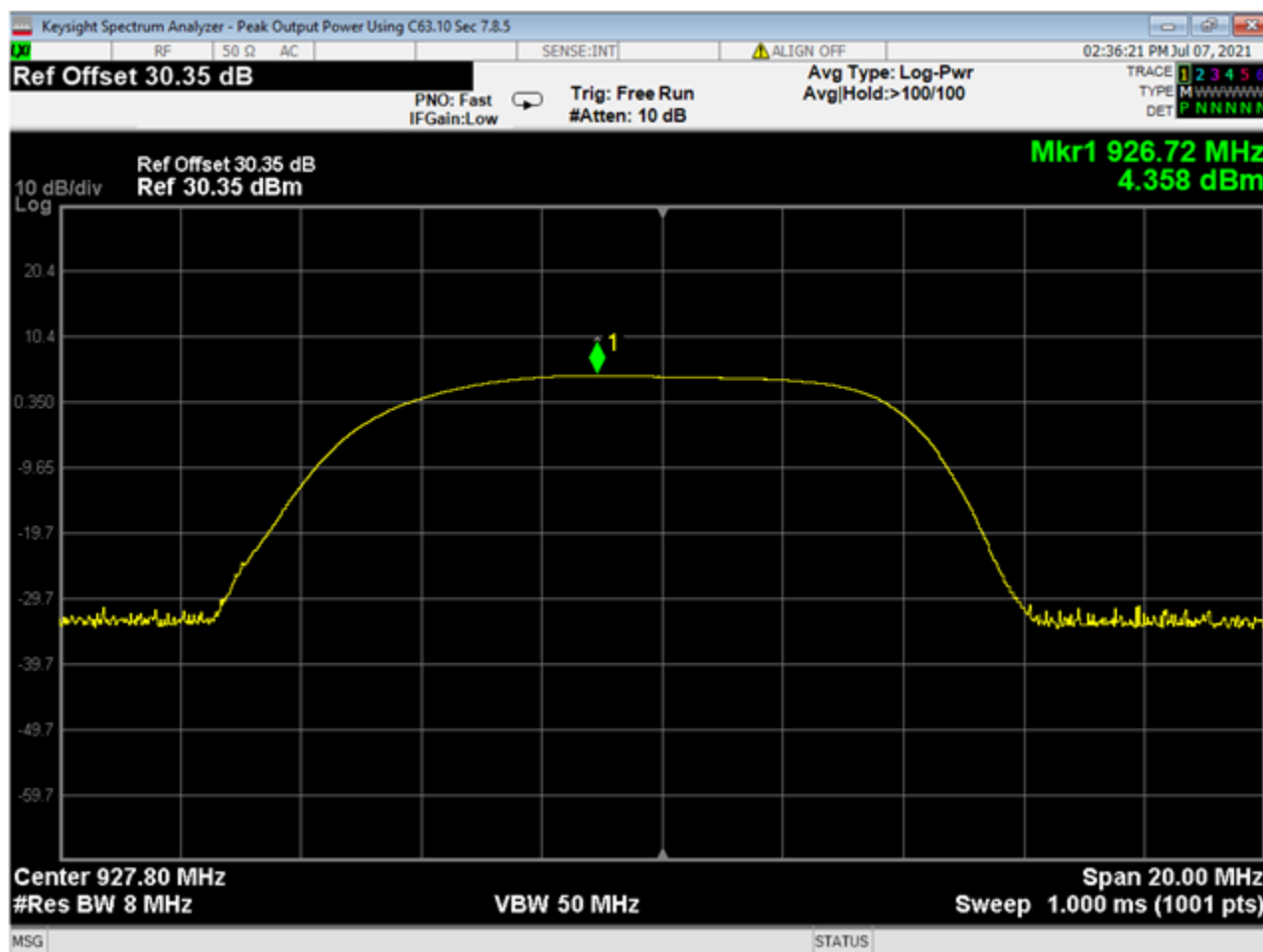


02 Peak Output Power, Mid

Transducer and Cable Corrections included in Ref Offset

Plots show corrected Radiated Field Strength measurement taken at 3m test distance

Peak Output Power EIRP = Field Strength + 107 – 95.23

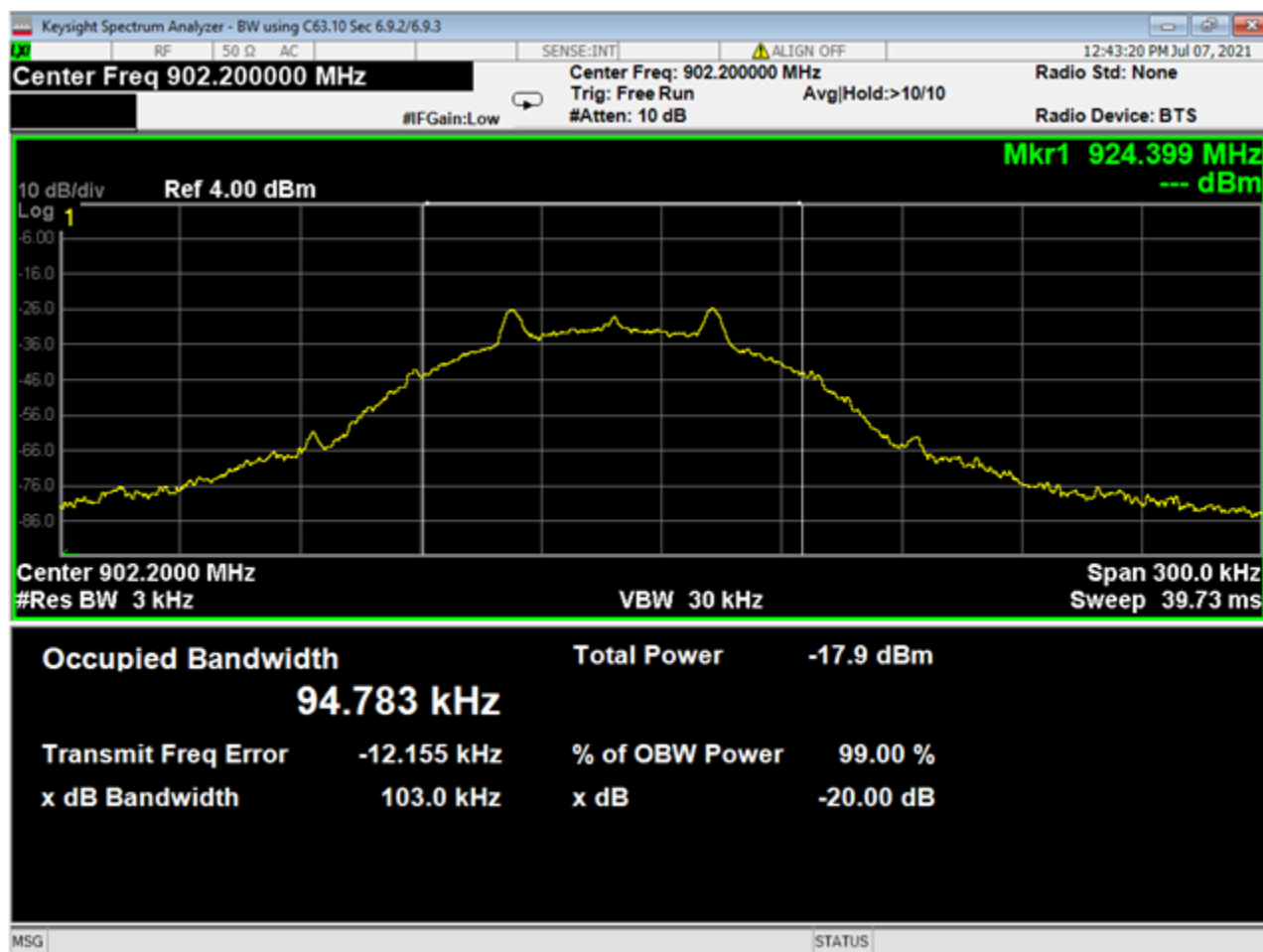


03 Peak Output Power, High

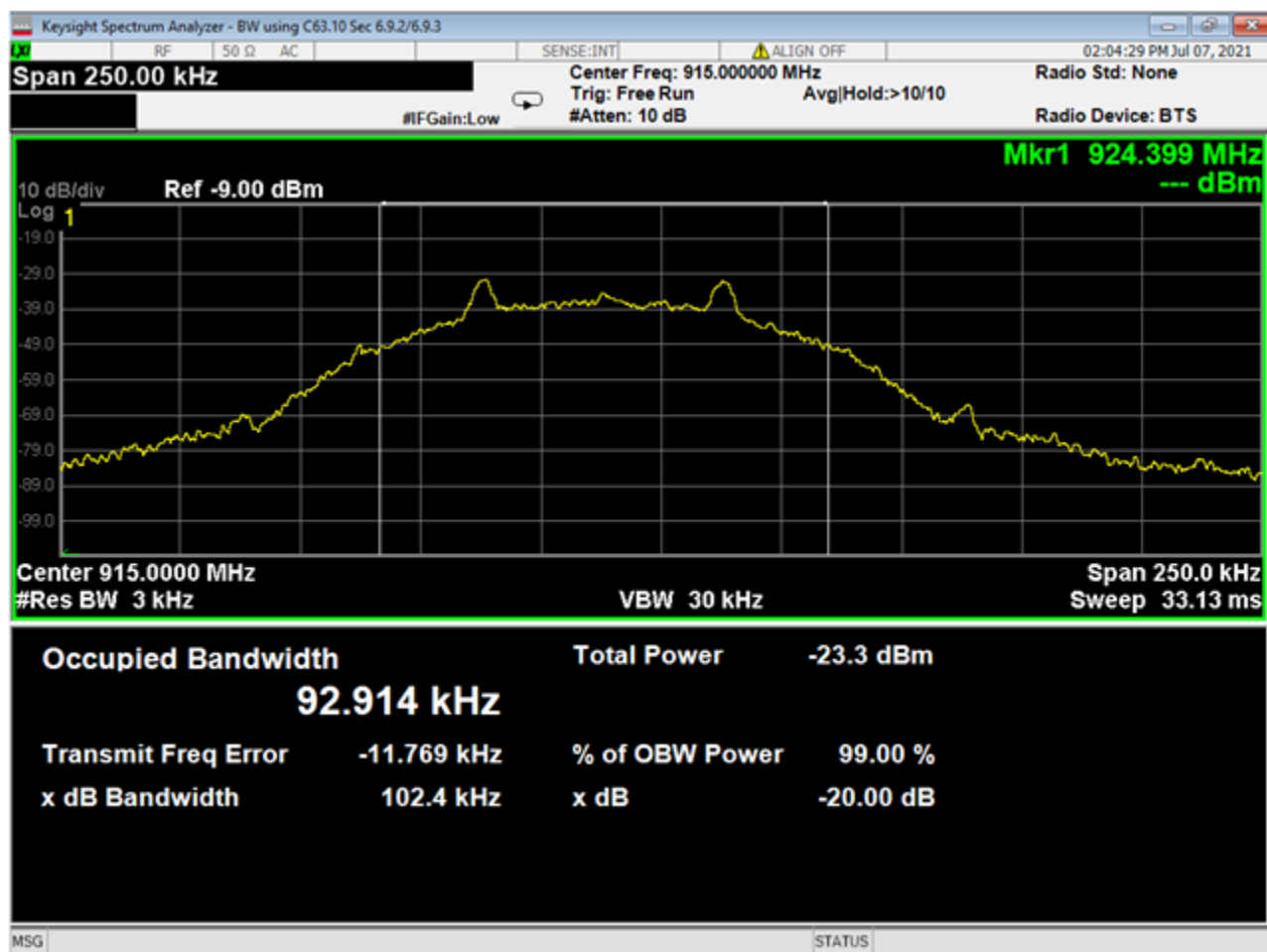
Transducer and Cable Corrections included in Ref Offset

Plots show corrected Radiated Field Strength measurement taken at 3m test distance

Peak Output Power EIRP = Field Strength + 107 – 95.23

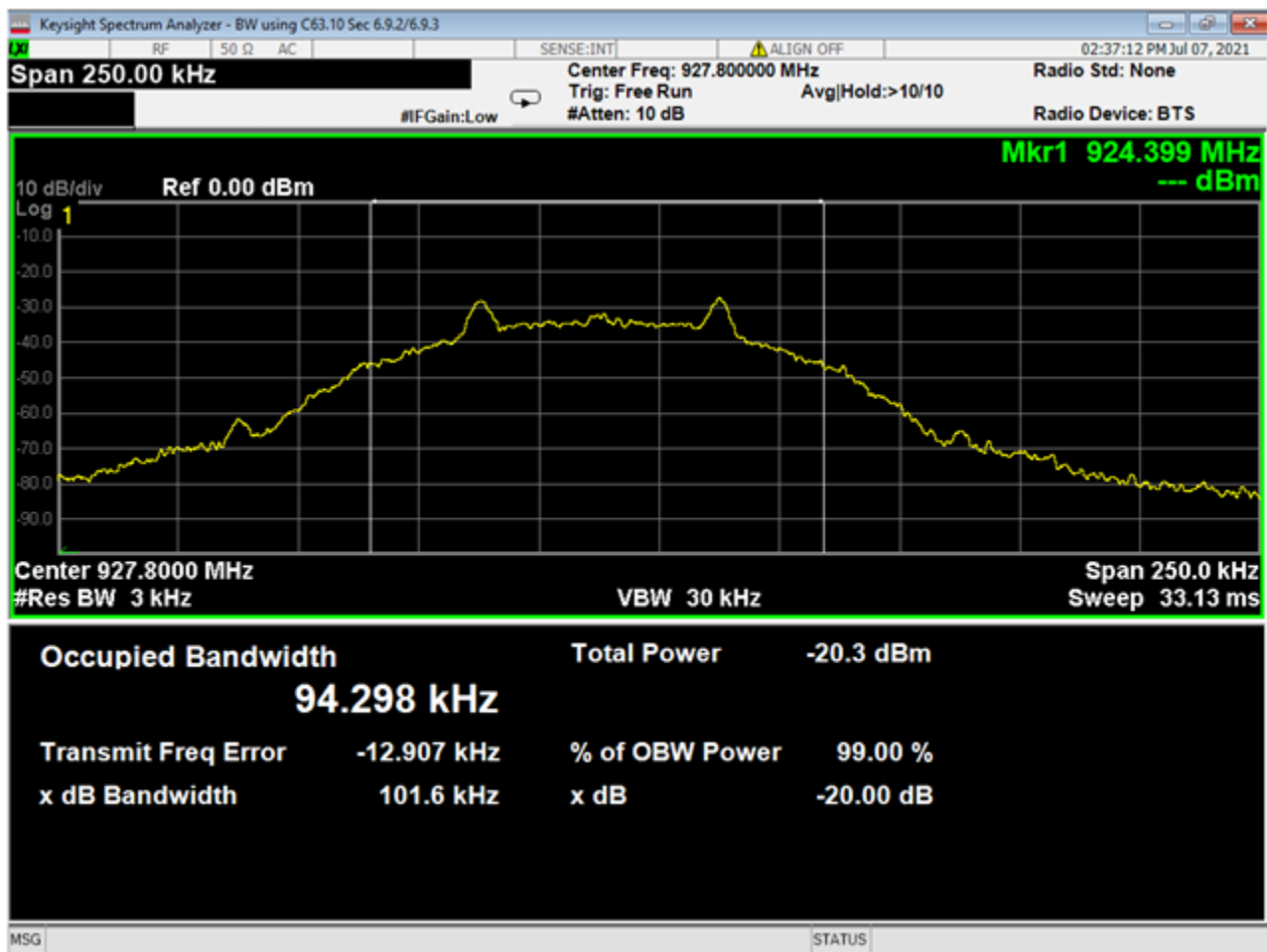


04 OBW-20dB, Low

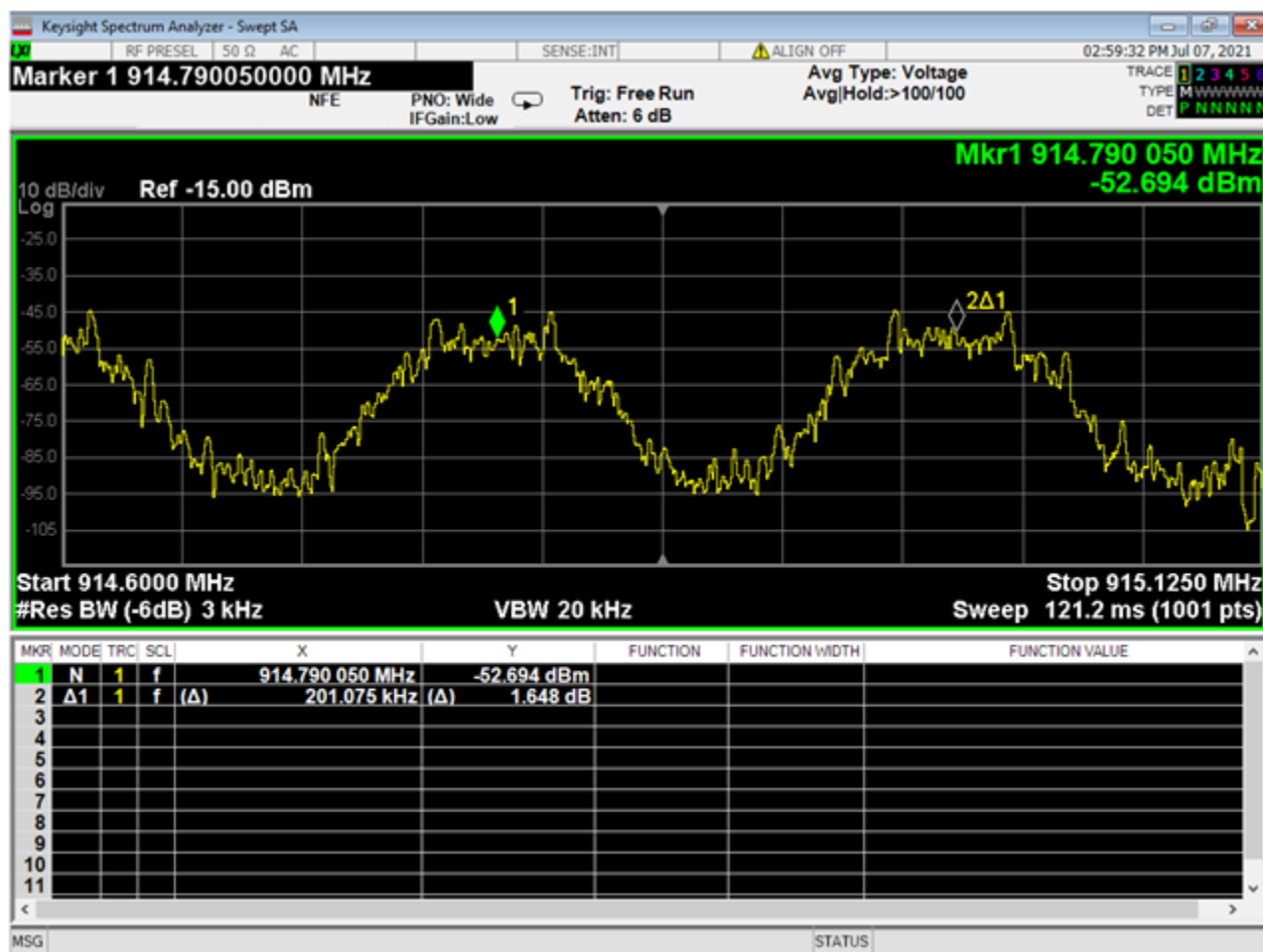


05 OBW-20dB, Mid

|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |



06 OBW-20dB, High



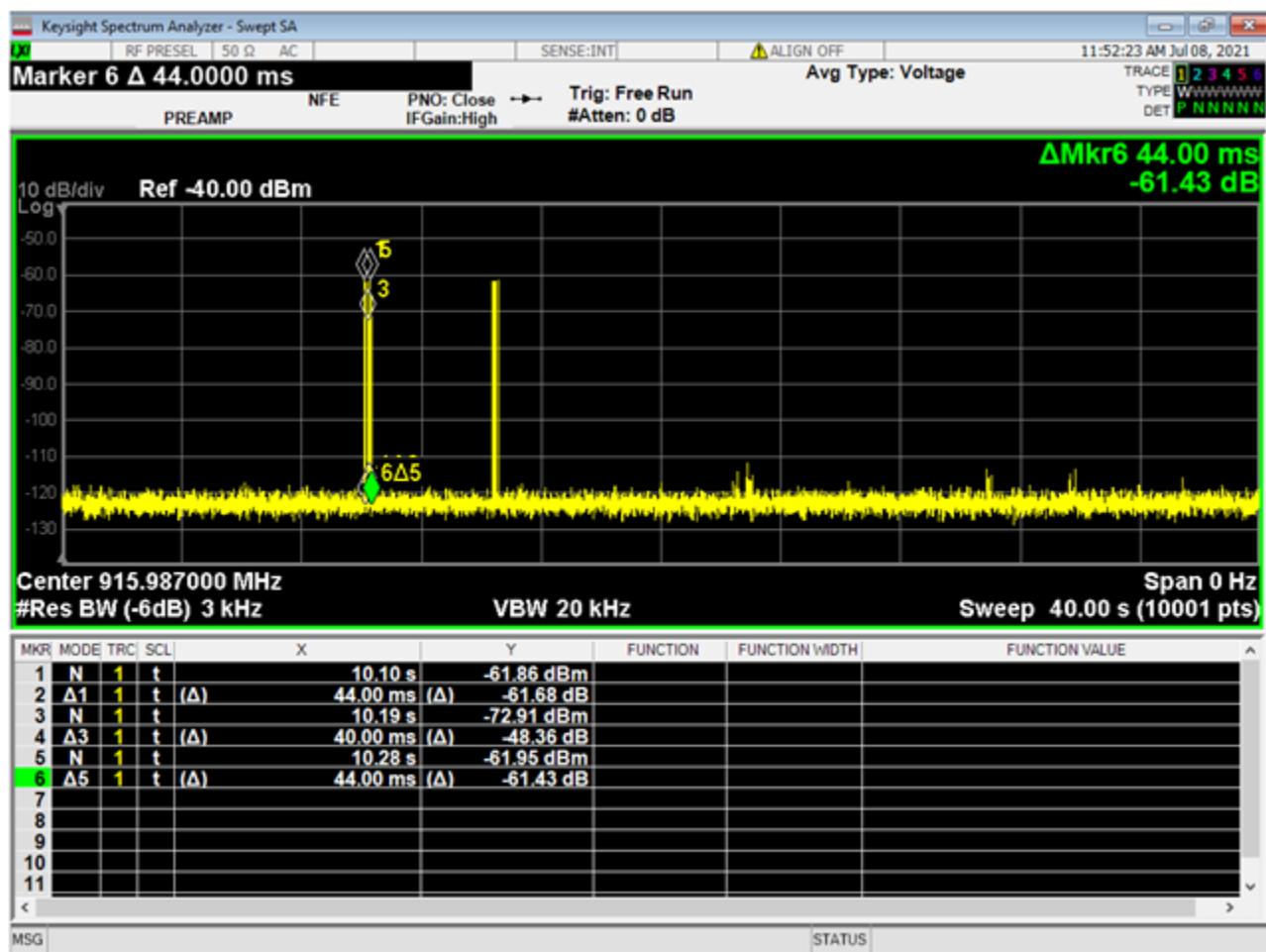
07 Channel Separation



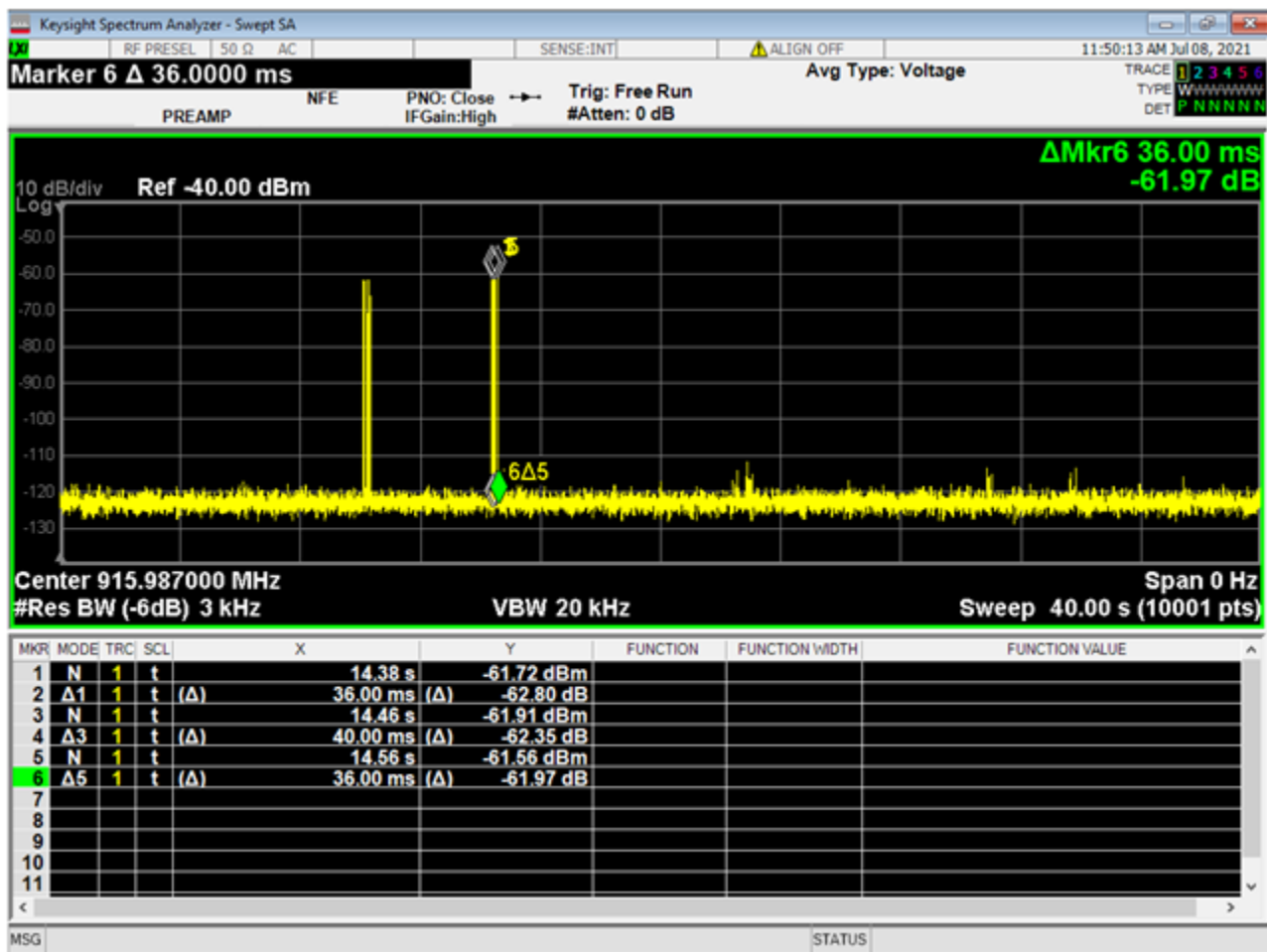




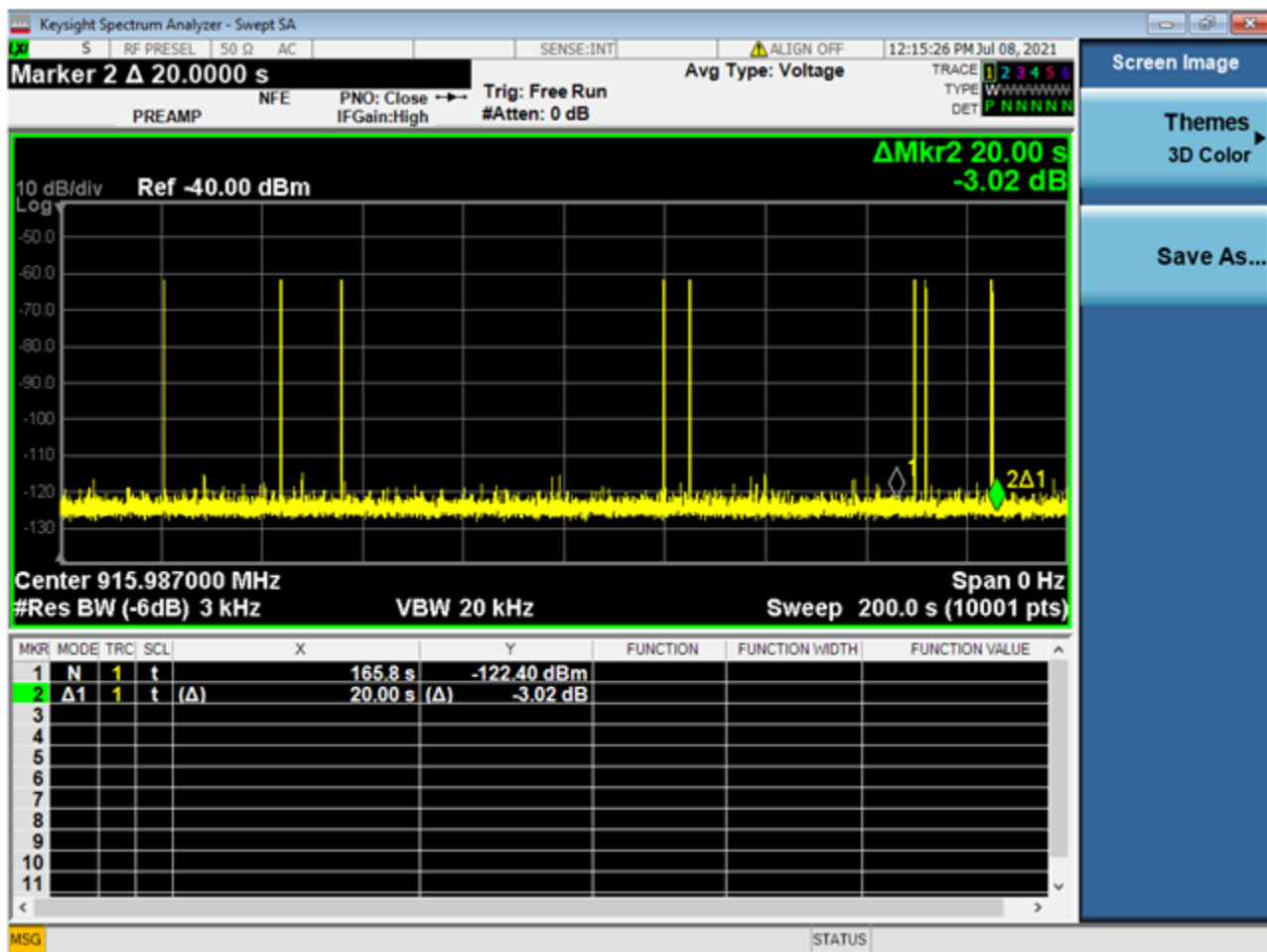




12 Time of Occupancy 40 Seconds (1)



13 Time of Occupancy 40 Seconds (2)



14 200s dwell time, 3 Signals within 20 Secs

Total dwell time was taken using worst case signal ON time.



|                |                 |     |   |
|----------------|-----------------|-----|---|
| Report Number: | R20210414-20-E1 | Rev | A |
| Prepared for:  | 701x            |     |   |

REPORT END