



## FCC / ISED Test Report

**For:**

Telular Corporation

**Model#:**

ST90M

**Marketing Name:**

ST90 CAT-M

**Product Description:**

Tank level monitoring

**FCC ID:** MTFST90M

**IC:** 2175D-ST90M

**Applied Rules and Standards:**

47 CFR Part 15.247 (DTS)

RSS-247 Issue 3 (DTSs) & RSS-Gen Issue 5

**REPORT #:** EMC\_TELUL\_222\_24001\_FCC\_15\_247\_ISM

**DATE:** 2024-05-28



A2LA Accredited

IC recognized #  
3462B-1

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**1 Assessment**

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Telular Corporation	Tank level monitoring	ST90M

**Responsible for the Report:**

2024-05-28	Compliance	Cheng Song (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section3. CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

## 2 Administrative Data

### 2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

<b>Company Name:</b>	CETECOM Inc.
<b>Department:</b>	Compliance
<b>Street Address:</b>	411 Dixon Landing Road
<b>City/Zip Code</b>	Milpitas, CA 95035
<b>Country</b>	USA
<b>Telephone:</b>	+1 (408) 586 6200
<b>Fax:</b>	+1 (408) 586 6299
<b>EMC Engineer</b>	Cheng Song
<b>Responsible Project Leader:</b>	Sangeetha Sivaraman

### 2.2 Identification of the Client

<b>Client's Name:</b>	Telular Corporation
<b>Street Address:</b>	3225 Cumberland Blvd.
<b>City/Zip Code</b>	Suite 300, Atlanta, GA 30339
<b>Country</b>	USA

### 2.3 Identification of the Manufacturer

<b>Manufacturer's Name:</b>	Same as Client
<b>Manufacturers Address:</b>	
<b>City/Zip Code</b>	
<b>Country</b>	

### 3 Equipment Under Test (EUT)

#### 3.1 EUT Specifications

<b>Model No:</b>	ST90M																						
<b>Brand:</b>	Tank Monitoring																						
<b>HW Version :</b>	A																						
<b>SW Version :</b>	2.50																						
<b>FCC-ID :</b>	MTFST90M																						
<b>IC:</b>	2175D-ST90M																						
<b>HVIN:</b>	ST90M																						
<b>PMN:</b>	ST90 CAT-M																						
<b>Product Description:</b>	Tank level monitoring																						
<b>Radio Information as declared:</b>	<p><b>ISM:</b></p> <ul style="list-style-type: none"> <li>Module: Texas Instruments CC1200 Chipset</li> <li>Frequency of Operation: 902-928 MHz</li> </ul> <p><b>Cellular:</b></p> <ul style="list-style-type: none"> <li>Module: Telit ME910G1-W1</li> <li>LTE Bands: 2, 4, 12, 13</li> <li>FCC ID: RI7ME910G1W1; IC: 5131A-ME910G1W1 (CAT-M1)</li> </ul>																						
<b>Antenna Information as declared:</b>	<p><b>LTE ISM US FPC Dual Feed Embedded Antenna:</b></p> <table border="1"> <thead> <tr> <th>Feed</th> <th>ISM</th> <th colspan="2">LTE</th> </tr> </thead> <tbody> <tr> <td>Frequency (MHz)</td> <td>902 - 928 MHz</td> <td>700 - 900 MHz</td> <td>1710 – 2155 MHz</td> </tr> <tr> <td>Average Efficiency</td> <td>50%</td> <td>52%</td> <td>59%</td> </tr> <tr> <td>Peak Gain</td> <td>0.5dBi</td> <td>0.9dBi</td> <td>3dBi</td> </tr> <tr> <td>VSWR Match</td> <td>2.0:1 max</td> <td>4.5:1 max</td> <td>3.5:1 max</td> </tr> </tbody> </table>			Feed	ISM	LTE		Frequency (MHz)	902 - 928 MHz	700 - 900 MHz	1710 – 2155 MHz	Average Efficiency	50%	52%	59%	Peak Gain	0.5dBi	0.9dBi	3dBi	VSWR Match	2.0:1 max	4.5:1 max	3.5:1 max
Feed	ISM	LTE																					
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Peak Gain	0.5dBi	0.9dBi	3dBi																				
VSWR Match	2.0:1 max	4.5:1 max	3.5:1 max																				
<b>Max. Peak Output Power:</b>	10.38 dBm																						
<b>Power Supply/ Rated Operating Voltage Range:</b>	Vmin: 5 VDC/ Vnom: 6 VDC / Vmax: 6.3 VDC																						
<b>Operating Temperature Range</b>	-30 °C to 70 °C																						
<b>Sample Revision</b>	<input type="checkbox"/> Production Unit; <input checked="" type="checkbox"/> Pre-Production																						
<b>EUT Dimensions</b>	100 x 107 x 150mm																						
<b>Note:</b> Details about the Equipment Under Test (EUT) are provided by the client or applicant.																							

### 3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	942106500	A	2.50	-

### 3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	-	-	-	-

### 3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	Conducted Measurement
2	EUT#1	Radiated Measurement

### 3.5 Mode of Operation

Mode of Operation	Description of Operating modes	Additional Information
1	ISM	<p>ISM was tested on Low, Mid and High Channels at the maximum power.</p> <p>❖ The client provides a USB cable to communicate with the device and send commands for configuring the ISM radio into a specific test mode. This test mode configuration, designed for worst-case scenarios, is not intended for end-user application and is outlined as follows:</p> <ul style="list-style-type: none"> <li>ISM: continuous modulated transmission at the maximum output power settings, highest duty cycle, and Low, Mid and High Channels.</li> </ul>

### **3.6 Justification for Worst Case Mode of Operation**

During the testing process the ISM radio was tested with transmitter sets to low, mid and high channels at the maximum power, as it is described in section 3.5 of this document; representing the worst case mode of operation.

For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

#### 4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to evaluate the compliance of the EUT against the relevant requirements specified in section 1.

The testing was conducted in accordance with RSS-247 Issue 2 (DTSS) and is still compliant with the updated RSS-247 Issue 3 (DTSS). The modifications introduced in the latest version do not affect the aspects of testing that were performed.

#### 5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1) RSS-247 5.2(a)	Emission Bandwidth	Nominal	Op. 1	■	□	□	Complies
§15.247(e) RSS-247 5.2(b)	Power Spectral Density	Nominal	Op. 1	■	□	□	Complies
§15.247(b)(1) RSS-247 5.4(d)	Maximum Conducted Output Power and EIRP	Nominal	Op. 1	■	□	□	Complies
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	Op. 1	■	□	□	Complies
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	Op. 1	■	□	□	Complies
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	Op. 1	■	□	□	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	-	□	■	□	Note 1 Note 2

**Note 1:** NA= Not Applicable; NP= Not Performed.

**Note 2:** The EUT does not utilize power from the AC public mains, hence the testing is not applicable.



## 6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=2.

Measurement System	EMC 1	EMC 2
Conducted Emissions (mains port)	1.12 dB	0.46 dB
Radiated Emissions		
(<30 MHz)	3.66 dB	3.88 dB
(30 MHz – 1 GHz)	3.17 dB	3.34 dB
(1 GHz – 3 GHz)	5.01 dB	4.45 dB
(> 3 GHz)	4.0 dB	4.79 dB

### 6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

### 6.2 Dates of Testing:

03/24/2022 - 04/02/2022

### 6.3 Decision Rule:

Cetecom advanced follows ILAC G8:2019 chapter 4.2.1 (Simple Acceptance Rule).

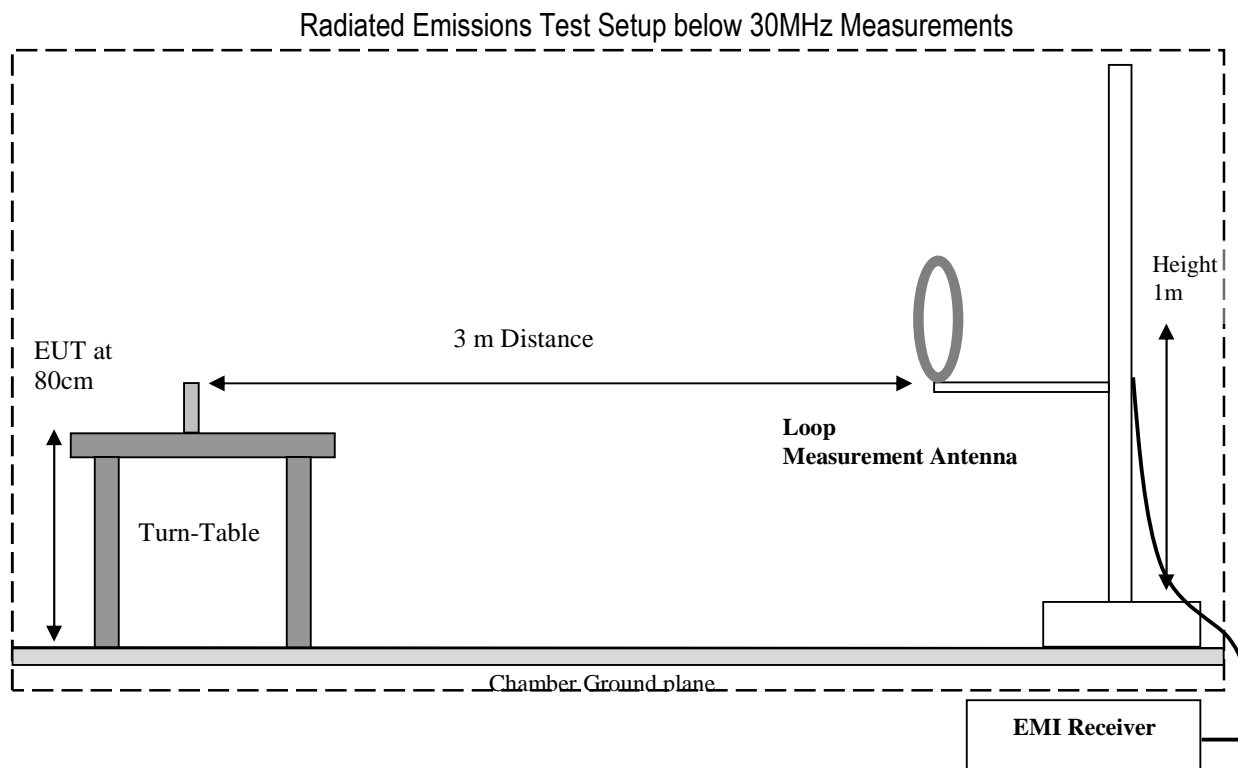
Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3. The measurement uncertainty is mentioned in this test report, See chapter 9, but is not taken into account – neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong.

## 7 Measurement Procedures

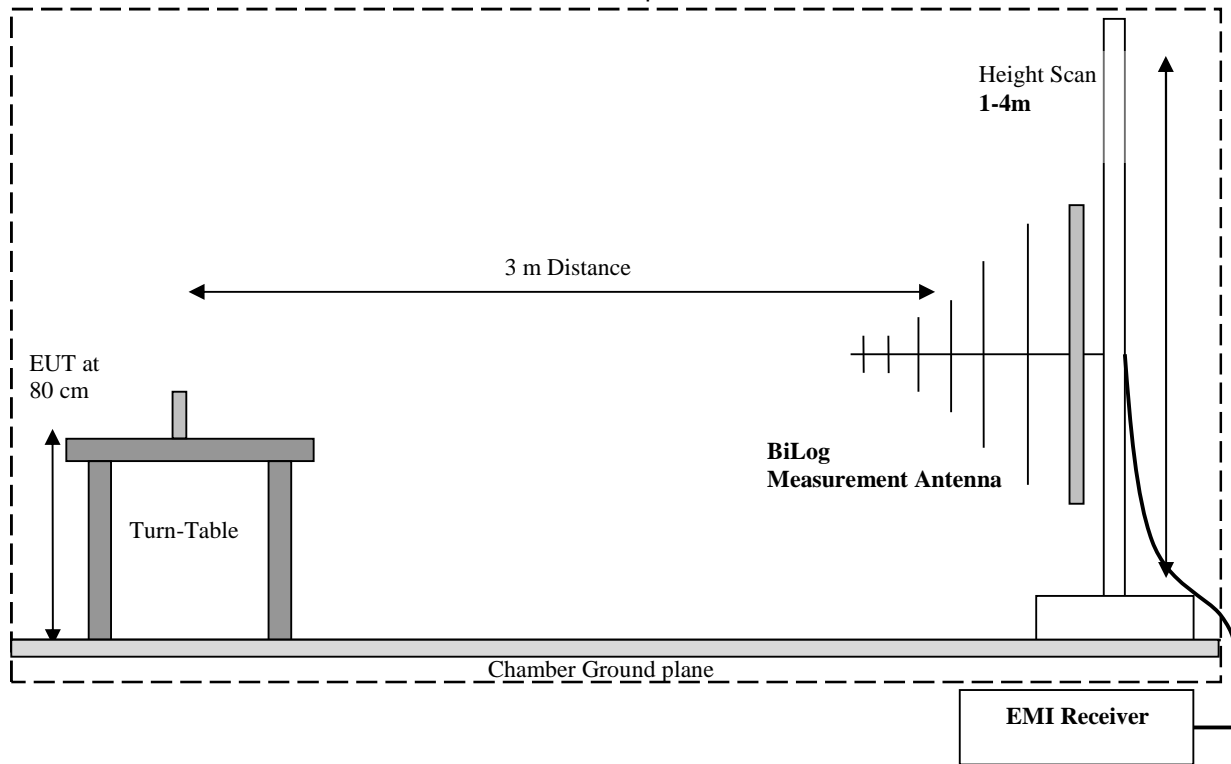
### 7.1 Radiated Measurement

The radiated measurement is performed according to ANSI C63.10 (2013)

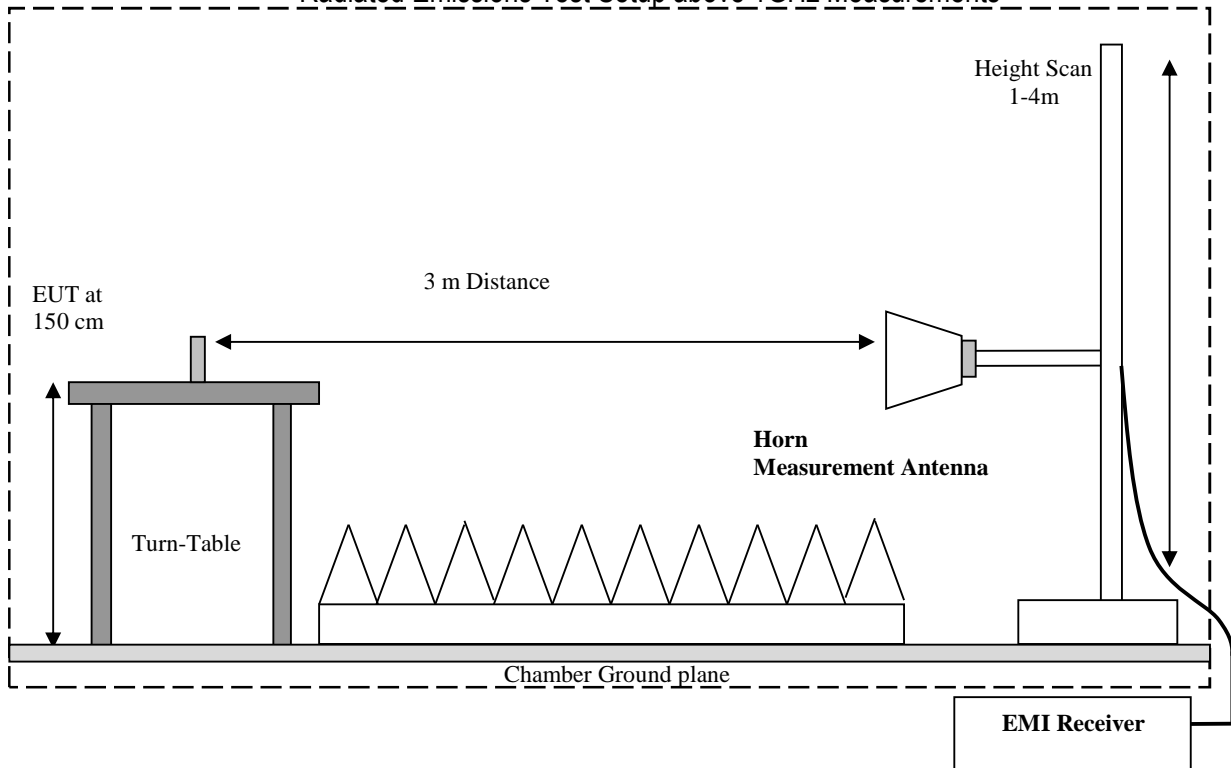
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.



### Radiated Emissions Test Setup 30MHz-1GHz Measurements



### Radiated Emissions Test Setup above 1GHz Measurements



### 7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBμV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

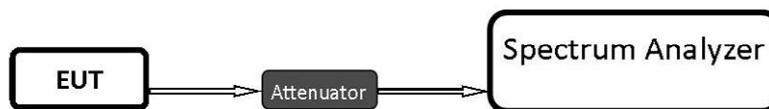
Frequency (MHz)	Measured SA (dBμV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBμV/m)
1000	80.5	3.5	14	98.0

### 7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

### 7.3 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – “GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES” - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

## 8 Test Result Data

### 8.1 Maximum Peak Conducted Output Power

#### 8.1.1 Measurement according to ANSI C63.10 Clause 11

##### Spectrum Analyzer settings:

- RBW  $\geq$  DTS bandwidth
- VBW  $\geq$  3 x RBW
- Span  $\geq$  3 x RBW
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max hold
- Use peak marker function to determine the peak amplitude level

#### 8.1.2 Limits:

##### Maximum Peak Output Power:

- FCC §15.247 (b)(1): 1 W
- IC RSS-247: 1 W

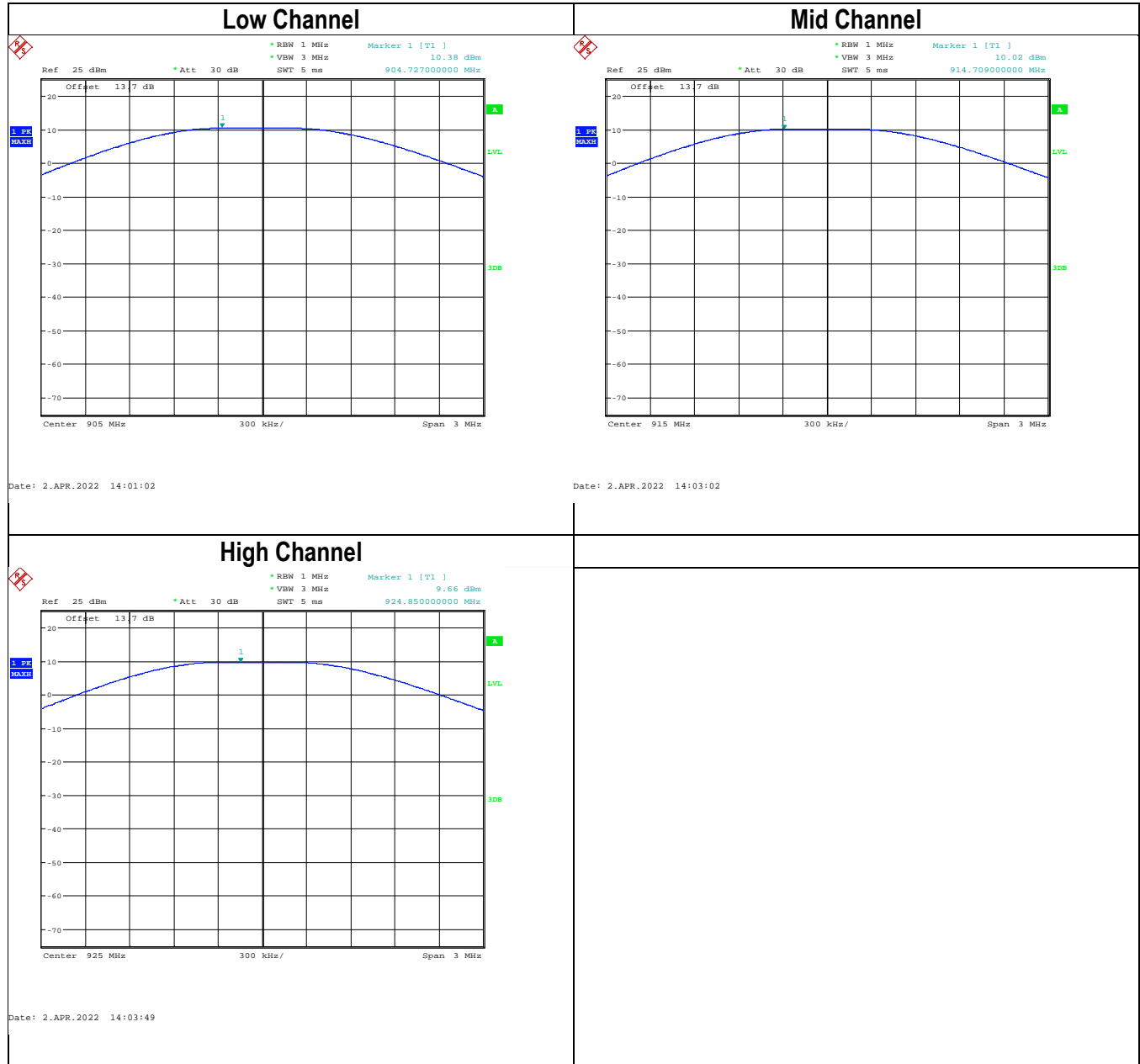
#### 8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	1	Op. 1	Battery	0.5 dBi

#### 8.1.4 Measurement result:

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	905	10.38	10.88	30 (Pk) / 36 (EIRP)	Pass
2	915	10.02	10.52	30 (Pk) / 36 (EIRP)	Pass
3	925	9.66	10.16	30 (Pk) / 36 (EIRP)	Pass

### 8.1.5 Measurement Plots:



## 8.2 Power Spectral Density

### 8.2.1 Measurement according to ANSI C63.10 Clause 11

#### Spectrum Analyzer settings for Peak PSD method:

- Set analyzer center frequency to DTS channel center frequency
- Set the span to 1.5 x DTS bandwidth
- Set RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- Set the VBW  $\geq 3 \times \text{RBW}$
- Detector = Peak
- Sweep time = Auto couple
- Trace mode = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level within the RBW
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat

### 8.2.2 Limits:

#### FCC§15.247(e) & RSS-247 5.2(b)

- For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

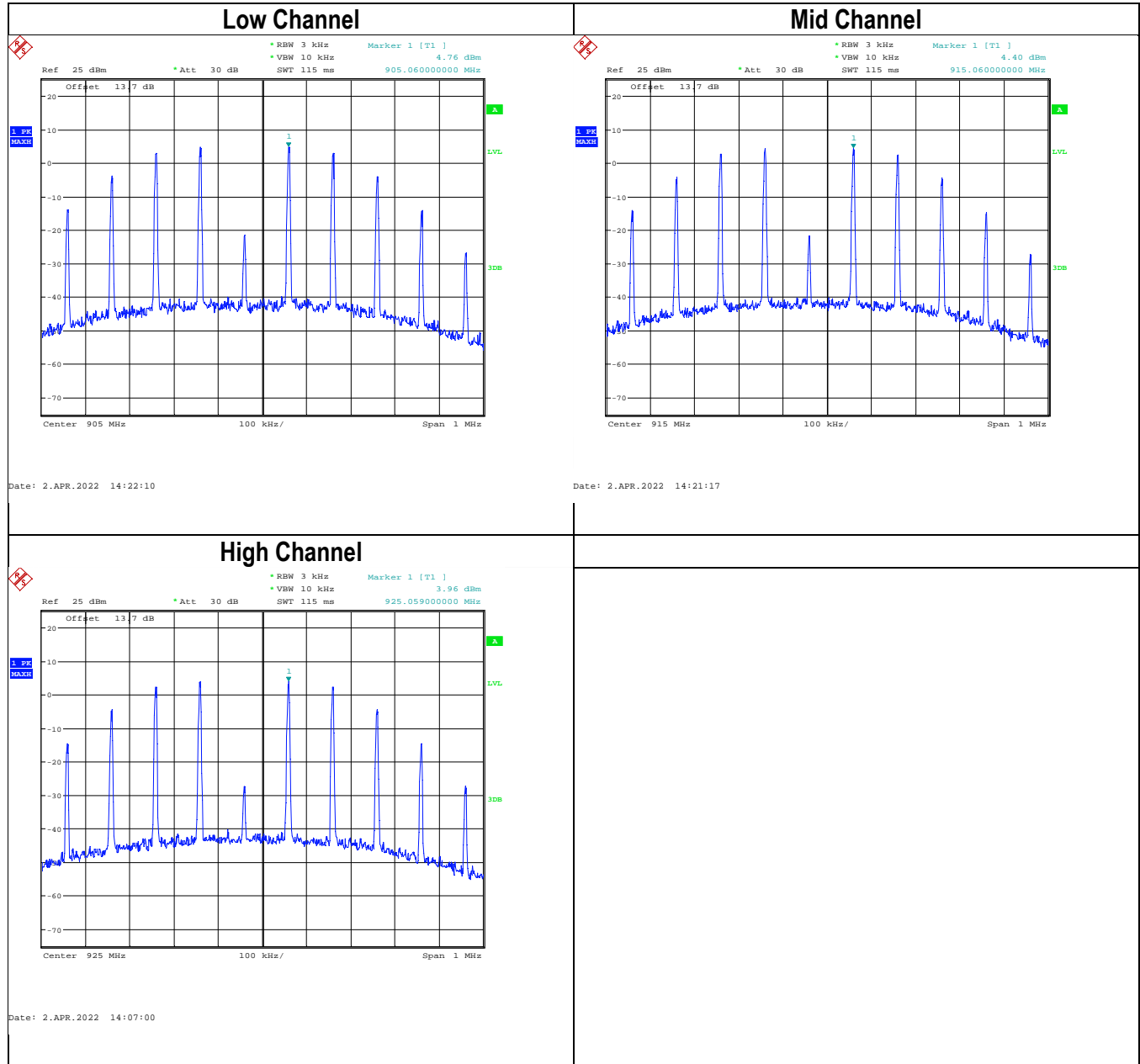
### 8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	1	Op. 1	Battery	0.5 dBi

### 8.2.4 Measurement result:

Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm/3 kHz)	Limit ( dBm / 3 kHz )	Result
1	905	4.76	8	Pass
2	915	4.40	8	Pass
3	925	3.96	8	Pass

### 8.2.5 Measurement Plots:





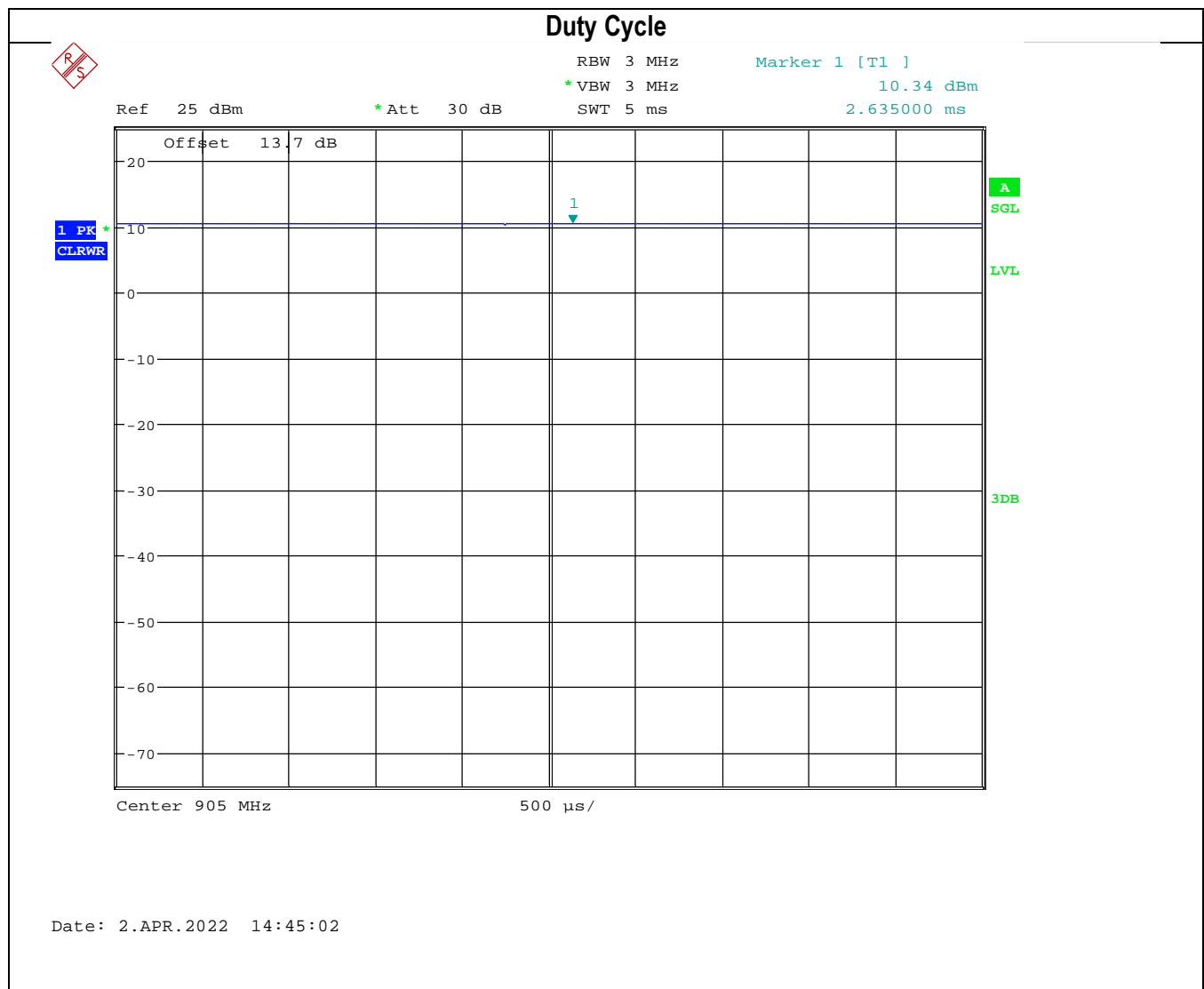
### 8.3 Duty cycle

#### 8.3.1 Measurement according to ANSI C63.10 Clause 11

##### Spectrum Analyzer settings:

- Set the center frequency and of the instrument to the center frequency of the transmission
- Zero span
- Set RBW >=OBW if possible; otherwise, set RBW to the largest available value
- Detector = Peak or average

#### 8.3.2 Measurement result



Duty cycle = 100%

Duty cycle correction factor =  $10 \cdot \log(1/1) = 0$  dB

## 8.4 Band Edge Compliance

### 8.4.1 Measurement according to ANSI C63.10 Clause 11

#### Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 100 kHz
- VBW  $\geq 3 \times$  RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level
- Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge

### 8.4.2 Limits non restricted band:

#### FCC§15.247 (d)

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

#### RSS-247 5/5

- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB.

#### Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz

### 8.4.3 Limits restricted band §15.247/15.209/15.205 and RSS-Gen 8.9/8.10

- \*PEAK LIMIT= 74 dBµV/m @3m =-21.23 dBm
- \*AVG. LIMIT= 54 dBµV/m @3m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 8.10
- Measurements with a peak detector were used to show compliance to average limits, thus showing compliance to both peak and average limits.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

### 8.4.4 Test conditions and setup:

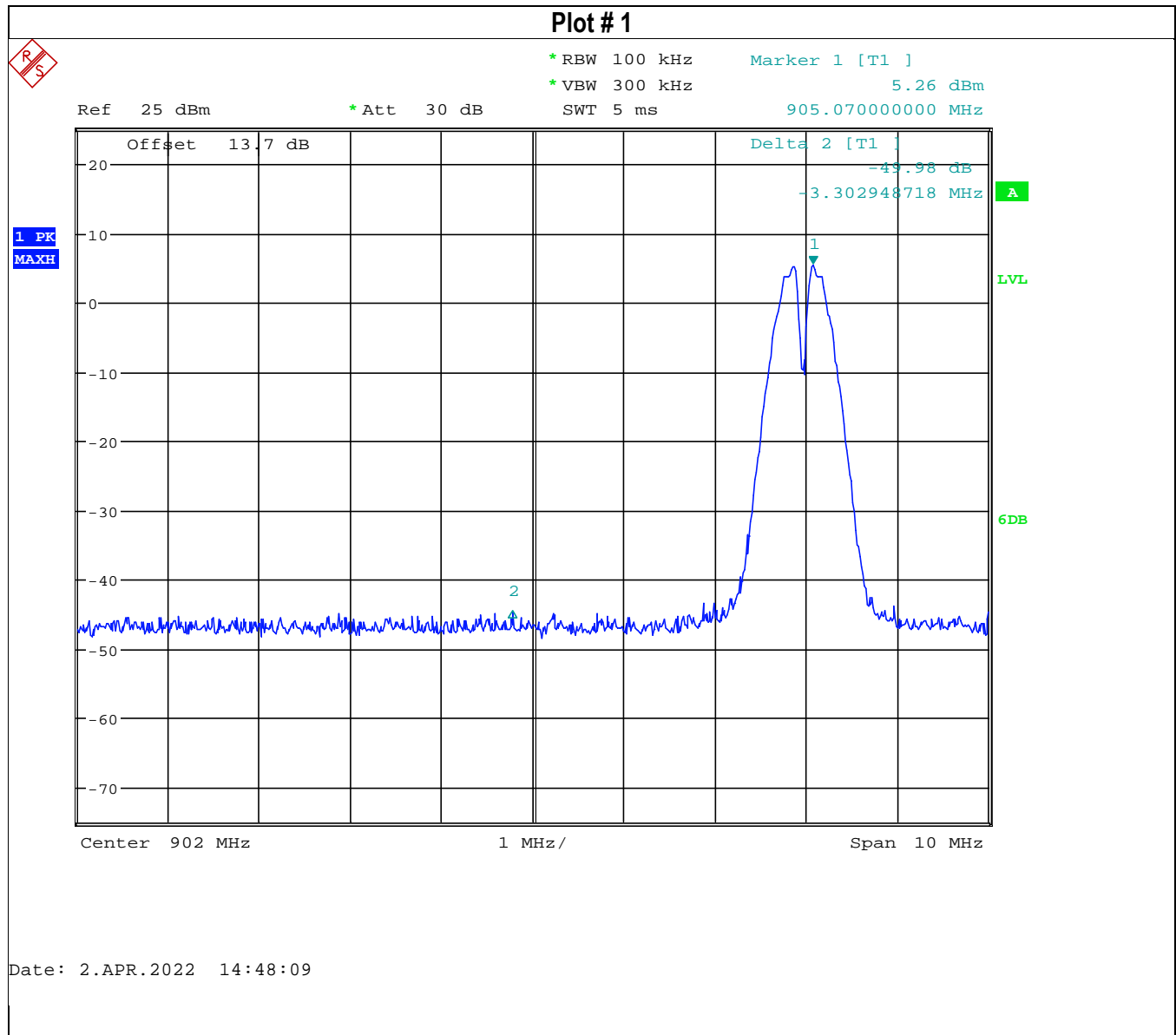
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	1 & 2	Op. 1	Battery	0.5 dBi

### 8.4.5 Measurement result:

Plot #	EUT operating mode	EUT Set-Up #	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	Op. 1	1	Lower Non-restricted	49.98	20	Pass

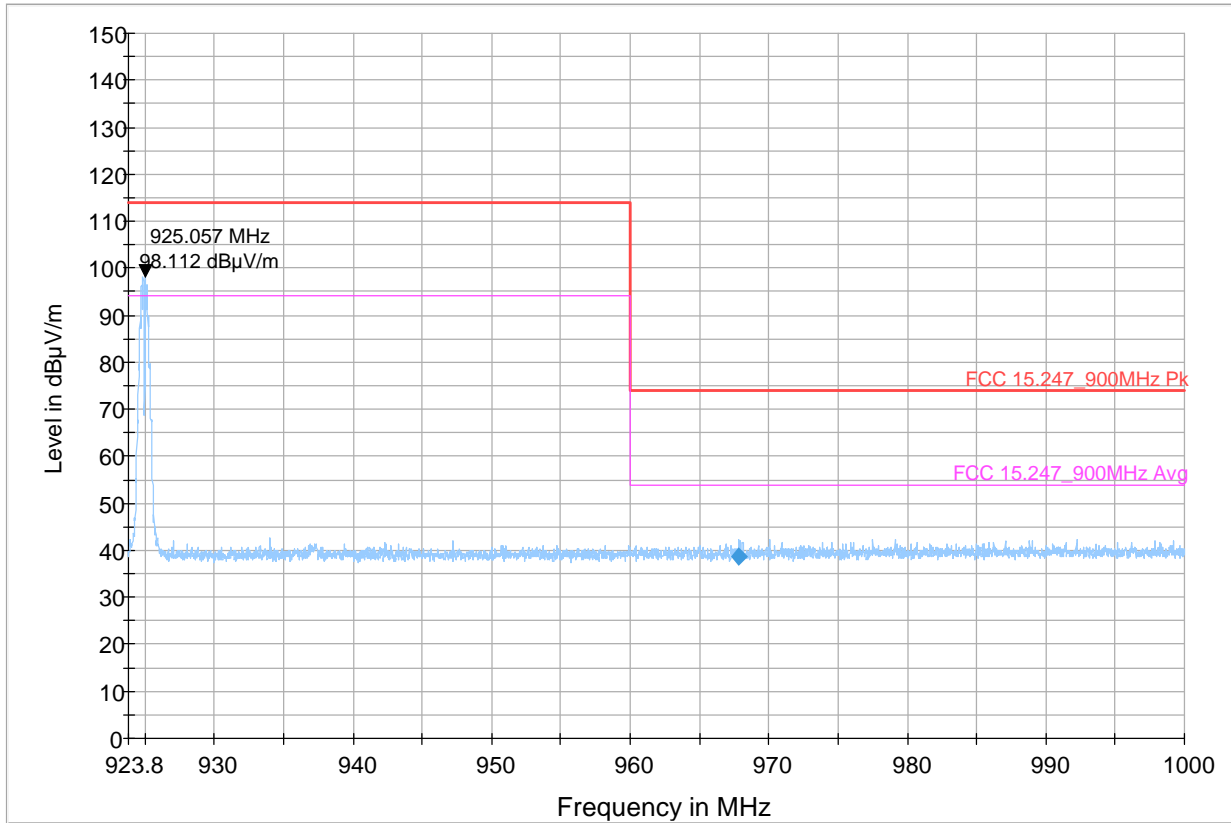
Plot #	EUT operating mode	EUT Set-Up #	Band Edge	Limit	Result
2	Op. 1	2	Upper Restricted	See section 8.4.3	Pass

### 8.4.6 Measurement Plots:



**Plot # 2**

Frequency	QuasiPeak	MaxPeak	Limit (dBµV/m)	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)	Sig Pat	Pream p	Trd Corr.	Raw Rec
967.848	38.582	---	74.00	35.42	500.0	120.000	107.0	H	104.0	-2.5	-	0.0	29.6	41.1



- AVG\_MAXH
- FCC 15.247\_900MHz Avg
- PK+\_MAXH
- ◆ Final\_Result QPK
- FCC 15.247\_900MHz Pk
- ◆ Final\_Result PK+

## 8.5 Emission Bandwidth 6dB and 99% Occupied Bandwidth

### 8.5.1 Measurement according to ANSI C63.10 Clause 11

#### Spectrum Analyzer settings:

##### 6dB (DTS) 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.

##### 99% Occupied Bandwidth:

- Set frequency = nominal EUT channel center frequency
- Set Span = 1.5 x to 5.0 x OBW
- Set RBW = 1% to 5% of OBW
- Set the video bandwidth (VBW)  $\approx 3 \times$  RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth
- If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

### 8.5.2 Limits:

#### FCC §15.247(a)(2) and RSS-247 5.2(a)

- Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

**8.5.3 Test conditions and setup:**

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	Op. 1	Battery

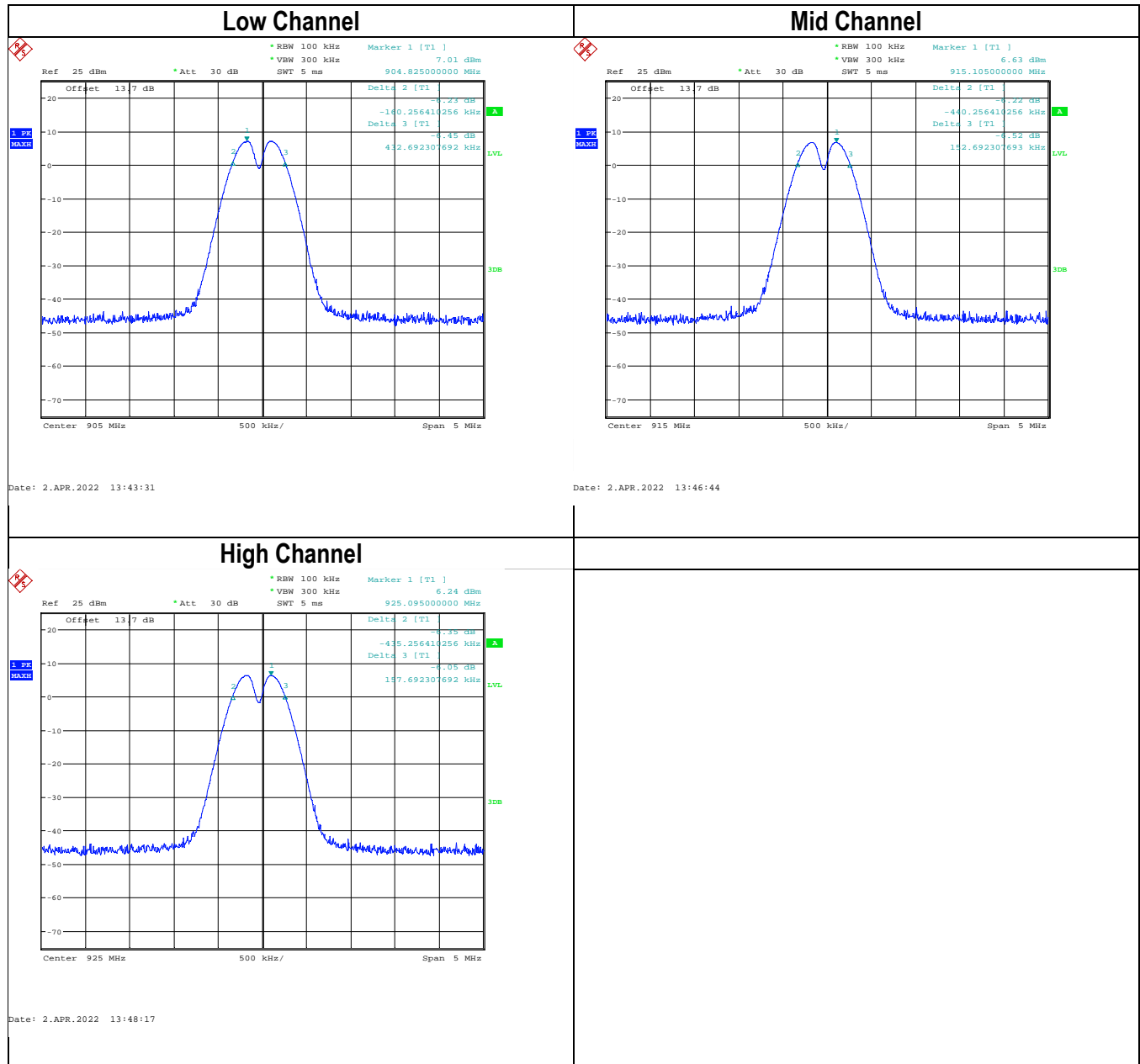
**8.5.4 Measurement result:**

Plot #	Frequency (MHz)	6dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	905	0.593	> 0.5	Pass
2	915	0.593	> 0.5	Pass
3	925	0.593	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)
4	905	0.642
5	915	0.642
6	925	0.642

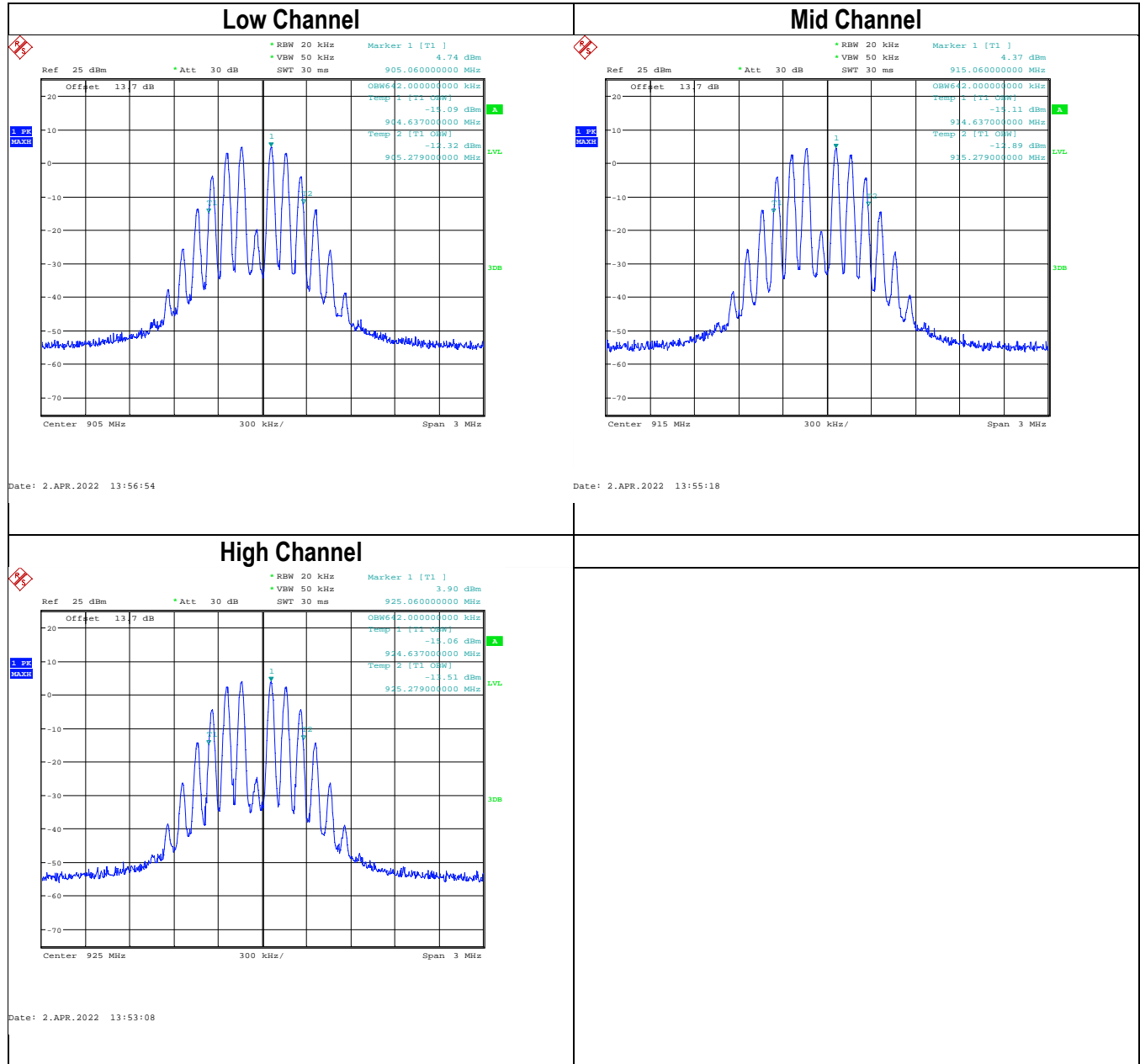
### 8.5.5 Measurement Plots:

#### 6dB Bandwidth





### 99% Occupied Bandwidth



## 8.6 Radiated Transmitter Spurious Emissions and Restricted Bands

### 8.6.1 Measurement according to ANSI C63.10 (2020)

#### Spectrum Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Peak
  
- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)
  
- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz
  
- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

### 8.6.2 Limits:

#### FCC §15.247

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

FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength @ 3m (dBµV/m)
0.009–0.490	2400/F(kHz) / -----	300	-
0.490–1.705	24000/F(kHz) / -----	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBµV/m
88–216	150	3	43.5 dBµV/m
216–960	200	3	46 dBµV/m
Above 960	500	3	54 dBµV/m

FCC §15.205 & RSS-Gen 8.10

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
  - \*PEAK LIMIT= 74 dBµV/m
  - \*AVG. LIMIT= 54 dBµV/m

**8.6.3 Test conditions and setup:**

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	Op. 1	Battery

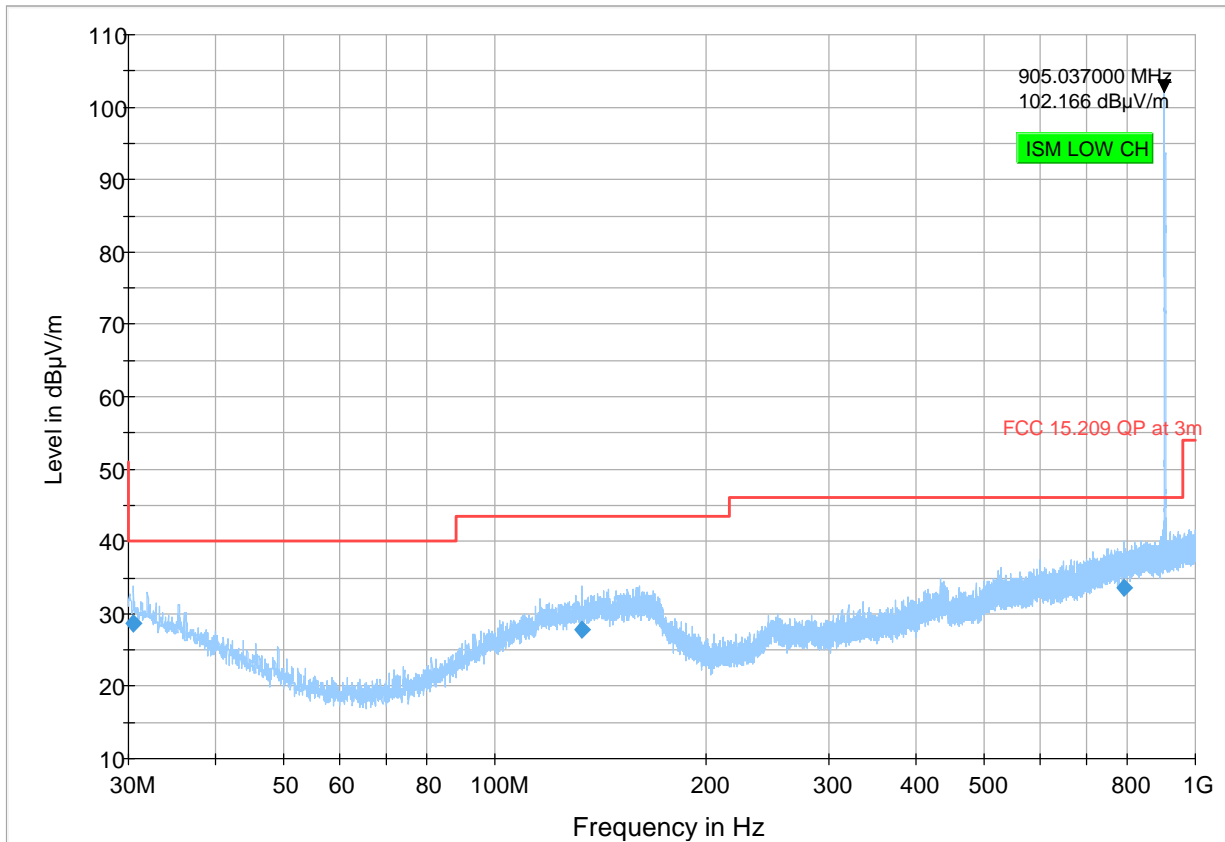
**8.6.4 Measurement result:**

Plot #	Channel #	Scan Frequency	Limit	Worst Case Spurious Emissions (dBµV/m)	Result
1-3	Low	30 MHz – 18 GHz	See section 8.6.2	53.36	Pass
4-7	Mid	9 kHz – 18 GHz	See section 8.6.2	53.29	Pass
8-10	High	30 MHz – 18 GHz	See section 8.6.2	54.99	Pass

### 8.6.5 Measurement Plots:

Plot # 1

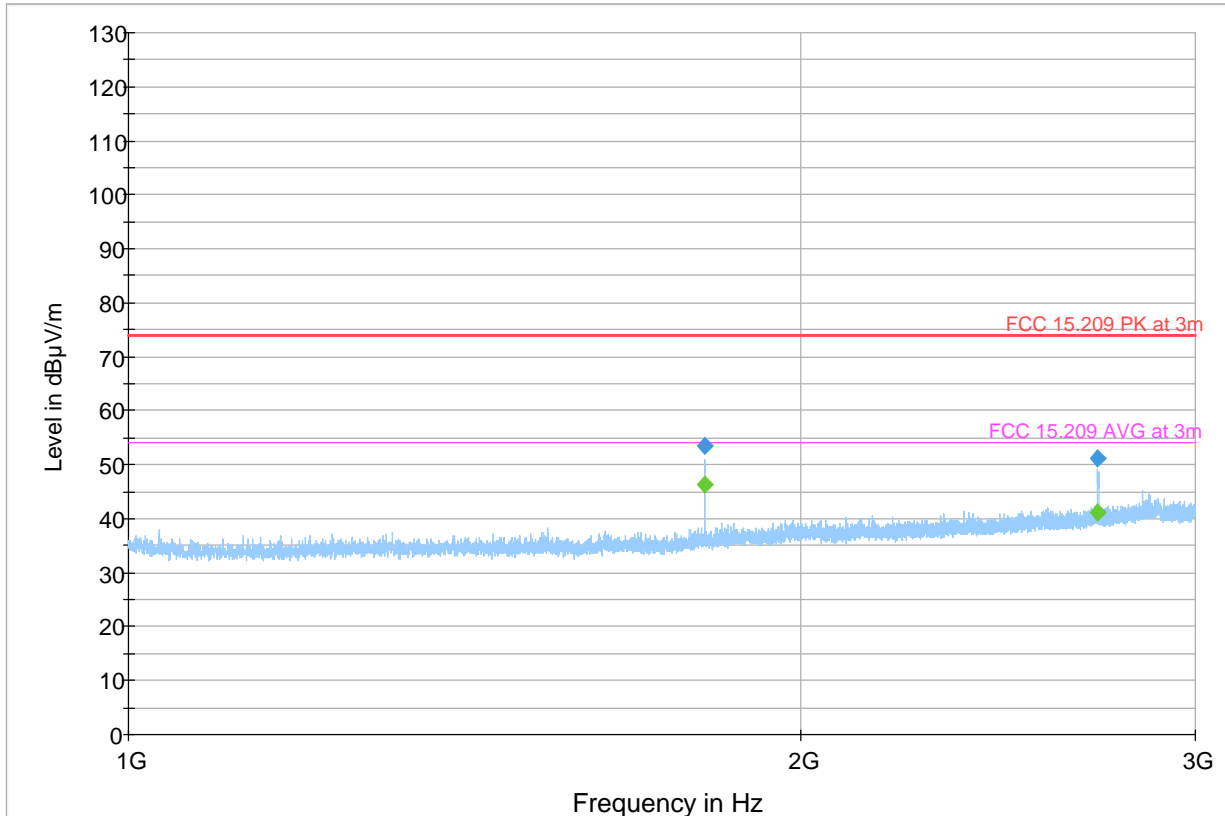
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.49	28.67	40.00	11.33	500.0	120.0	100.0	H	13.0	24.5
133.24	27.81	43.50	15.69	500.0	120.0	135.0	V	135.0	24.8
792.36	33.71	46.02	12.31	500.0	120.0	247.0	V	299.0	30.6



Preview Result 2-AVG    Preview Result 1-PK+    FCC 15.209 QP at 3m    Final\_Result C

**Plot # 2**

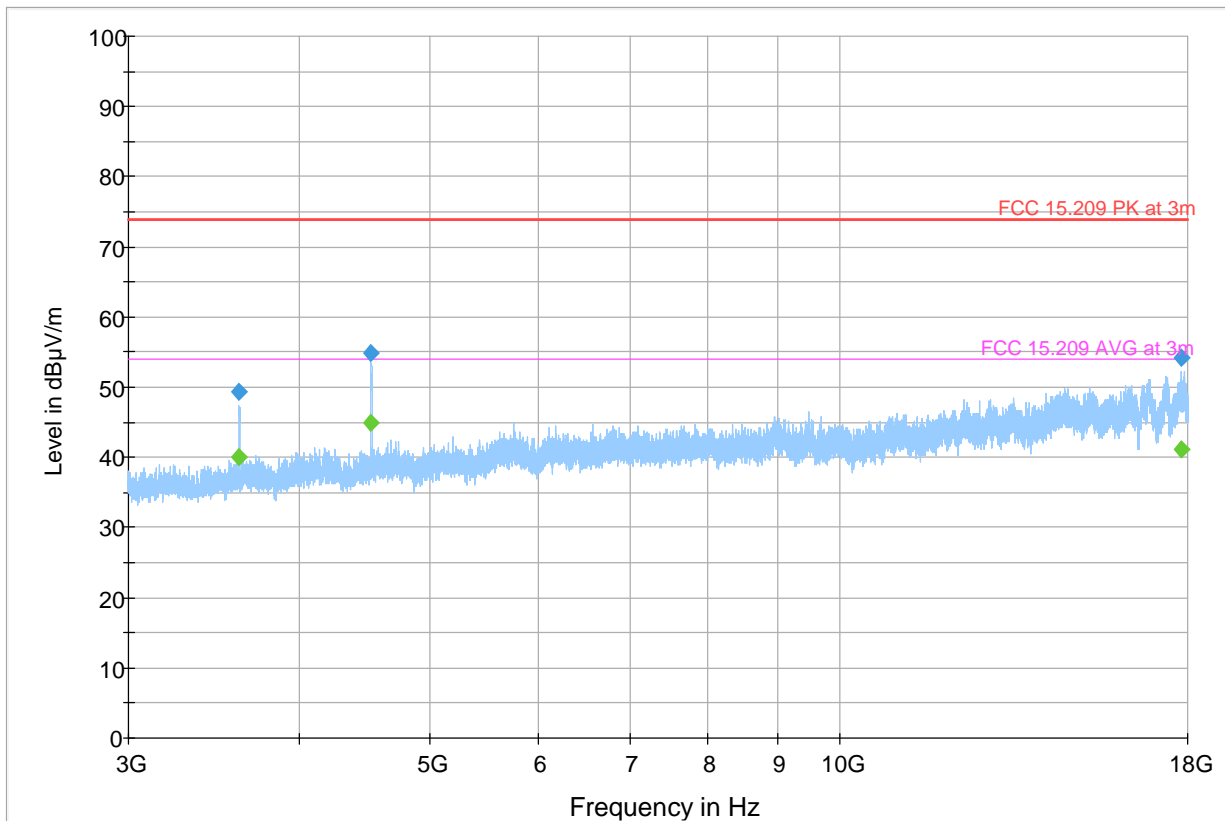
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1809.43	53.36	---	73.98	20.62	500.0	1000.0	125.0	V	280.0	4.2
1809.43	---	46.44	53.98	7.54	500.0	1000.0	125.0	V	280.0	4.2
2714.14	51.10	---	73.98	22.88	500.0	1000.0	151.0	H	262.0	7.2
2714.14	---	41.18	53.98	12.80	500.0	1000.0	151.0	H	262.0	7.2



— Preview Result 2-AVG    
 — Preview Result 1-PK+    
 — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m    
 ◆ Final\_Result PK+    
 ◆ Final\_Result CAV

**Plot # 3**

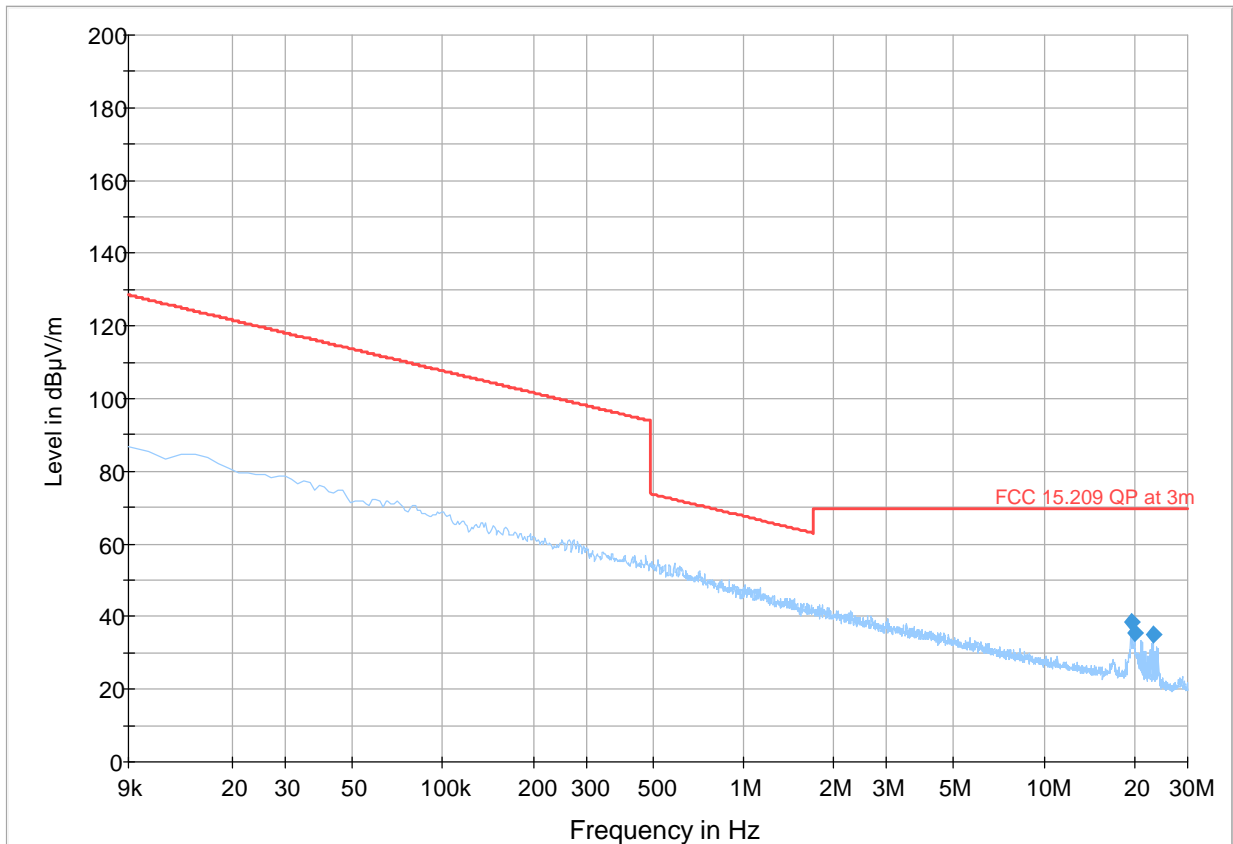
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3619.50	49.26	---	73.98	24.72	500.0	1000.0	100.0	V	201.0	-6.0
3619.50	---	39.94	53.98	14.04	500.0	1000.0	100.0	V	201.0	-6.0
4525.25	54.96	---	73.98	19.02	500.0	1000.0	161.0	V	256.0	-3.9
4525.25	---	44.99	53.98	8.99	500.0	1000.0	161.0	V	256.0	-3.9
17792.25	---	41.25	53.98	12.73	500.0	1000.0	167.0	V	85.0	17.6
17792.25	54.14	---	73.98	19.84	500.0	1000.0	167.0	V	85.0	17.6



— Preview Result 2-AVG    
 — Preview Result 1-PK+    
 — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m    
 ◆ Final\_Result PK+    
 ◆ Final\_Result CAV

**Plot # 4**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	MaxPeak (dBµV/m)	Average (dBµV/m)
19.44	38.45	69.50	31.05	500.0	9.0	100.0	V	158.0	16.5	---	---
19.97	35.50	69.50	34.00	500.0	9.0	100.0	V	302.0	16.5	---	---
23.13	35.16	69.50	34.34	500.0	9.0	100.0	V	213.0	16.2	---	---

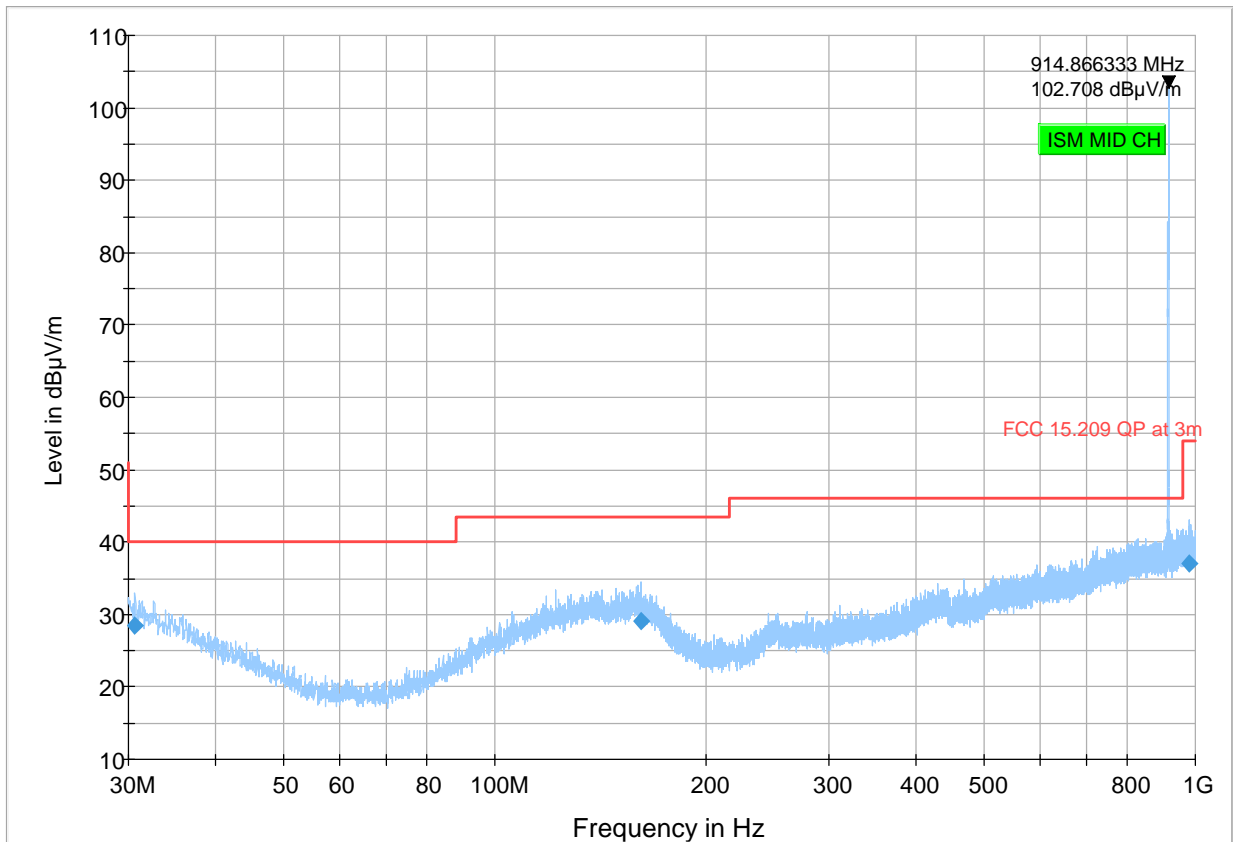


— AVG\_MAXH   
 — PK+\_MAXH   
 — FCC 15.209 QP at 3m   
 ◆ Final\_Result QPK



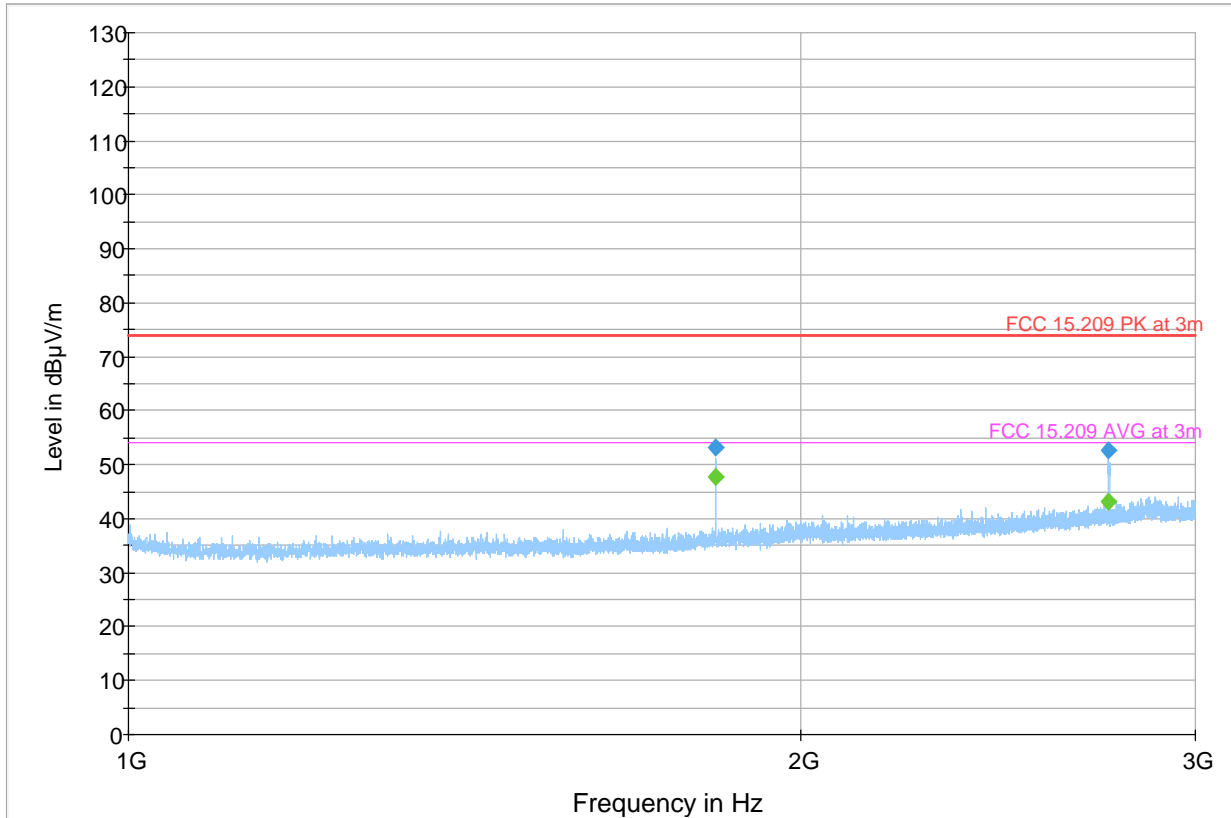
**Plot # 5**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.68	28.51	40.00	11.49	500.0	120.0	116.0	H	128.0	24.4
161.31	29.07	43.50	14.43	500.0	120.0	194.0	V	209.0	26.4
980.73	36.99	53.98	16.99	500.0	120.0	100.0	V	4.0	32.7



**Plot # 6**

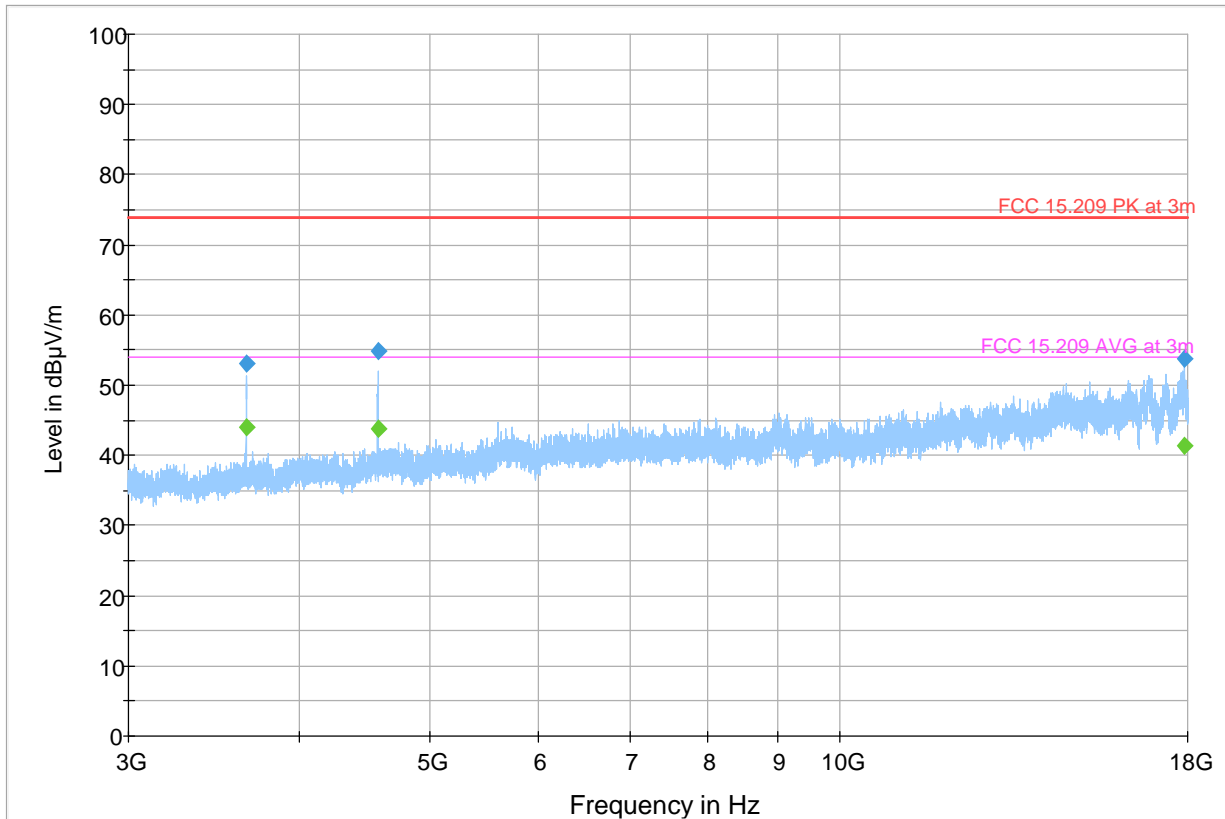
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1830.29	53.29	---	73.98	20.69	500.0	1000.0	107.0	V	293.0	4.4
1830.29	---	47.83	53.98	6.15	500.0	1000.0	107.0	V	293.0	4.4
2744.14	52.62	---	73.98	21.36	500.0	1000.0	100.0	H	279.0	7.3
2744.14	---	43.10	53.98	10.88	500.0	1000.0	100.0	H	279.0	7.3



— Preview Result 2-AVG     — Preview Result 1-PK+     — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m     ◆ Final\_Result PK+     ◆ Final\_Result CAV

Plot # 7

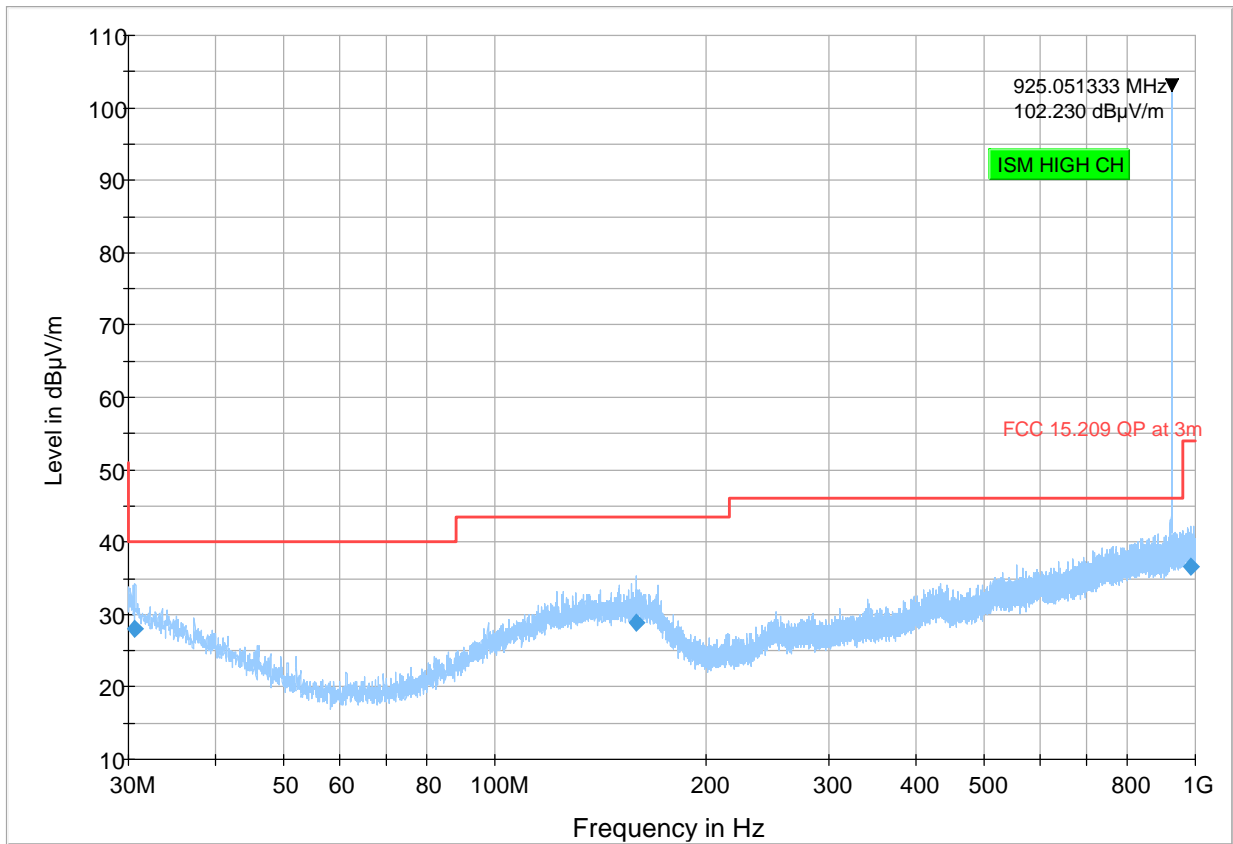
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3660.50	53.04	---	73.98	20.94	500.0	1000.0	100.0	V	310.0	-5.8
3660.50	---	44.02	53.98	9.96	500.0	1000.0	100.0	V	310.0	-5.8
4574.75	---	43.87	53.98	10.10	500.0	1000.0	179.0	V	266.0	-3.5
4574.75	54.95	---	73.98	19.03	500.0	1000.0	179.0	V	266.0	-3.5
17882.50	53.73	---	73.98	20.25	500.0	1000.0	116.0	H	53.0	18.2
17882.50	---	41.28	53.98	12.69	500.0	1000.0	116.0	H	53.0	18.2



— Preview Result 2-AVG    
 — Preview Result 1-PK+    
 — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m    
 ◆ Final\_Result PK+    
 ◆ Final\_Result CAV

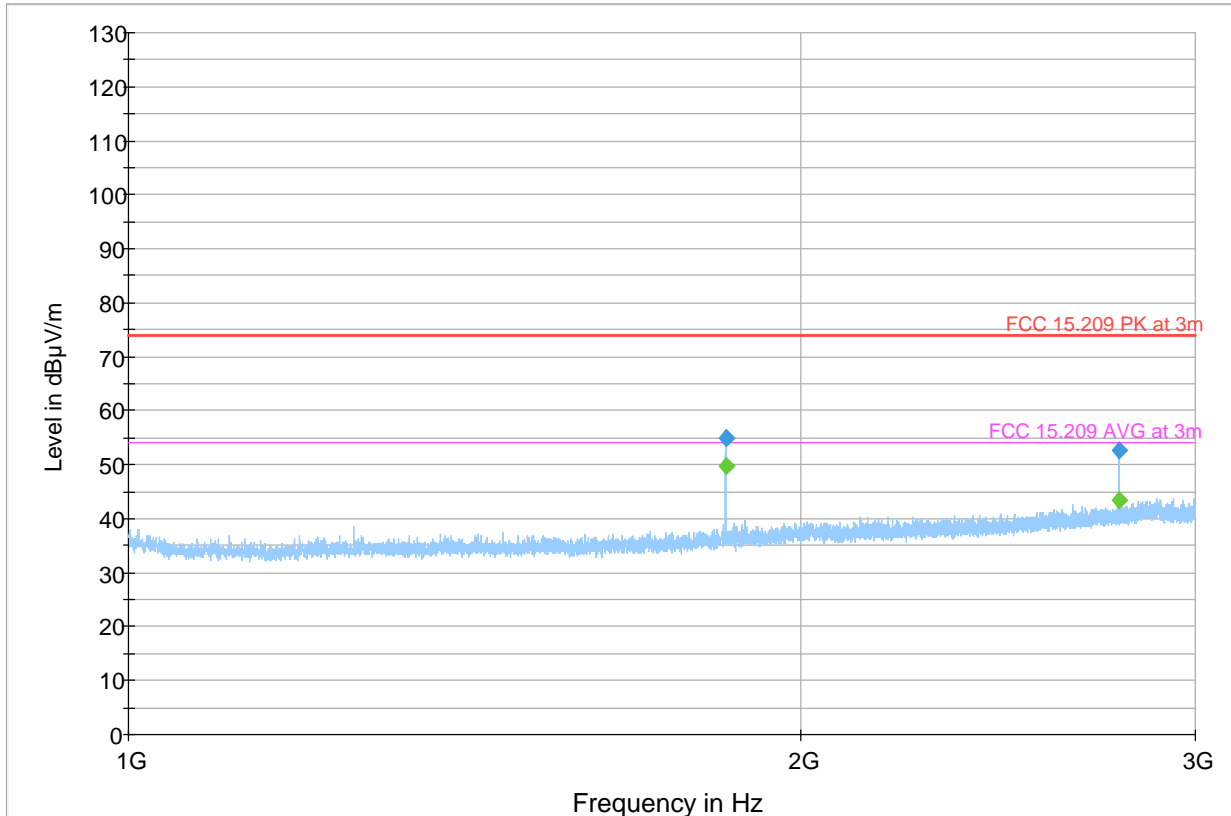
**Plot # 8**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.68	28.11	40.00	11.89	500.0	120.0	107.0	V	-18.0	24.0
159.53	28.98	43.50	14.52	500.0	120.0	186.0	V	235.0	26.3
984.51	36.66	53.98	17.32	500.0	120.0	180.0	V	341.0	32.6



**Plot # 9**

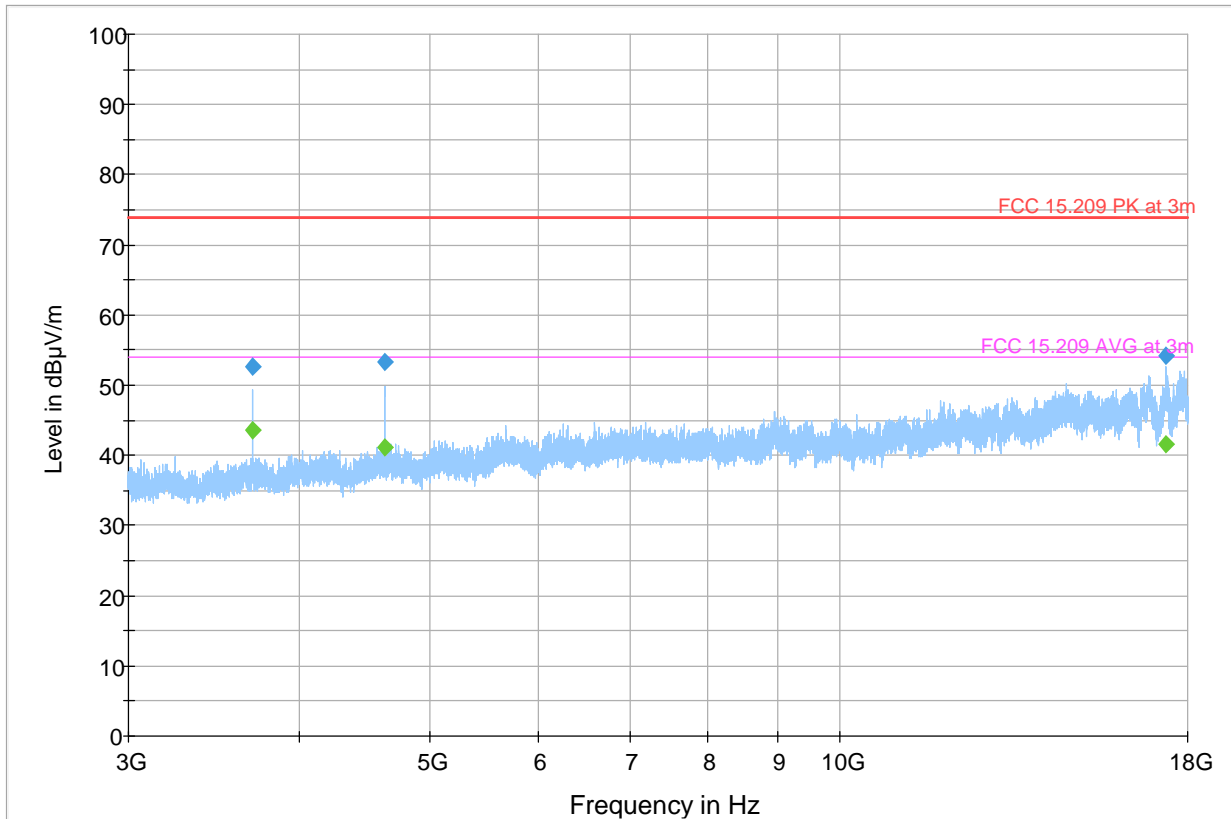
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1850.29	54.99	---	73.98	18.99	500.0	1000.0	125.0	V	273.0	4.5
1850.29	---	49.64	53.98	4.34	500.0	1000.0	125.0	V	273.0	4.5
2775.57	52.54	---	73.98	21.44	500.0	1000.0	107.0	H	273.0	7.4
2775.57	---	43.29	53.98	10.69	500.0	1000.0	107.0	H	273.0	7.4



— Preview Result 2-AVG     — Preview Result 1-PK+     — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m     ◆ Final\_Result PK+     ◆ Final\_Result CAV

**Plot # 10**

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3700.50	52.56	---	73.98	21.42	500.0	1000.0	100.0	H	232.0	-5.4
3700.50	---	43.68	53.98	10.30	500.0	1000.0	100.0	H	232.0	-5.4
4623.50	---	41.04	53.98	12.94	500.0	1000.0	126.0	H	192.0	-3.3
4623.50	53.31	---	73.98	20.67	500.0	1000.0	126.0	H	192.0	-3.3
17365.00	54.16	---	73.98	19.82	500.0	1000.0	275.0	H	-45.0	15.9
17365.00	---	41.49	53.98	12.49	500.0	1000.0	275.0	H	-45.0	15.9



— Preview Result 2-AVG     — Preview Result 1-PK+     — FCC 15.209 PK at 3m  
— FCC 15.209 AVG at 3m     ◆ Final\_Result PK+     ◆ Final\_Result CAV

**9 Test setup photos**

Setup photos are included in supporting file name: “EMC\_TELUL\_222\_24001\_FCC\_Setup\_Photos”

**10 Test Equipment And Ancillaries Used For Testing**

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
ACTIVE LOOP ANTENNA	ETS LINDGREN	6507	00161344	3 YEARS	10/30/2020
BILOG ANTENNA	ETS.LINDGREN	3142E	00166067	3 YEARS	03/12/2020
HORN ANTENNA	EMCO	3115	00035114	3 YEARS	08/10/2020
HORN ANTENNA	ETS.LINDGREN	3117	00215984	3 YEARS	01/31/2021
TEST RECEIVER	R&S	ESU40	100251	3 YEARS	09/13/2021
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	10510-922	200236891	3 YEARS	04/13/2020
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	181230565	3 YEARS	01/10/2019

**Note:** Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.



## 11 History

Date	Report Name	Changes to report	Prepared by
2024-05-28	EMC_TELUL_222_24001_FCC_15_247_ISM	Initial Version	Cheng Song

<<< The End >>>