FCC / ISED Test Report

FOR:
Transparent Technologies

Model Name:
T2-SYS-GTWY

Product Description:
The Gateway is a device to bridge the gap of meters in the field and our server.

FCC ID: RXNGW1BH1025
IC ID: 6872A-0421GWBH

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)
RSS-247 Issue 2 (DTS) & RSS-Gen Issue 5

REPORT #: EMC_TRANS-001-21001_15.247_ISM_DTS_R2

DATE: 2021-05-25

A2LA Accredited

IC recognized #
3462B-2
CABID: US0187

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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 #
Transparent Technologies	The Gateway is a device to bridge the gap of meters in the field and our server.	T2-SYS-GTWY

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2021-05-25	Compliance	Kevin Wang (EMC Lab Manager)	kevin.wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2021.05.25 14:15:01 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
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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

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
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EMC Lab Manager:	Kevin Wang
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	Transparent Technologies
Street Address:	5665 Airport Blvd
City/Zip Code:	Boulder, CO 80301
Country:	USA

2.3 Identification of the Manufacturer

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

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	T2-SYS-GTWY
HW Version :	v1.1.2
SW Version :	v1.10
FCC-ID:	RXNGW1BH1025
IC-ID:	6872A-0421GWBH
HVIN:	T2-SYS-GTWY
PMN:	VN Gateway
Product Description:	The Gateway is a device to bridge the gap of meters in the field and our server.
Frequency Range / number of channels:	Module name: SemTech Module number: SX1232IMLTRT Nominal band: 903 MHz – 927 MHz; Center to center: 903 MHz (ch 0) – 927 MHz (ch 19), 24 channels
Type(s) of Modulation:	2GFSK
Modes of Operation:	ISM in both advertising and connected mode of operation
Antenna Information as declared:	Skywave LTE Flex Antena 15-8324-B 704~960 MHz /1710~2155MHz VSWR ⩽ 3.0 2.1 dBi Gain (nominal)
Max. Peak Output Power:	Conducted Power 14.91 dBm
Power Supply/ Rated Operating Voltage Range:	Low 3.0 VDC, Nominal 3.6 VDC, High 3.7 VDC
Operating Temperature Range:	Low -10ºC, Nominal 20ºC, High 50ºC
Other Radios included in the device:	❖ LTE • Module name: Telit • Module number: LE910-SVL • FCC/IC ID: RI7LE910SVL / 5131A-LE910SVL ❖ GPS • Module name: Telit • Module number: SE873

Sample Revision:	☐Prototype Unit; ■ Production Unit; ☐ Pre-Production

3.2 EUT Sample details

EUT #	IMEI Number	HW Version	SW Version	Notes/Comments
1	359636092326881	v1.1.2	v1.10	Radiated Emissions
2	359636092326865	v1.1.2	v1.10	Conducted RF

3.3 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1+ AE#1	Select push button and enter push button used to configure the ISM radio to low, mid and high channels provided by the client that will not be available to the end user. For radiated measurements, the external antenna was connected.
2	EUT#2 + AE#1	Select push button and enter push button used to configure the ISM radio to low, mid and high channel provided by the client that will not be available to the end user. For conducted measurements, the equipment was connected to RF connector of the EUT.

3.4 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels. The EUT was configured to the highest duty cycle 100% and maximum output power 20 dBm through commands.

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 assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

Testing procedures are based on 558074 D01 DTS Meas Guidance v05r02 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

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(1)	Emission Bandwidth	Nominal	2GFSK	■	☐	☐	Complies
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	2GFSK	■	☐	☐	Complies
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	2GFSK	■	☐	☐	Complies
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	2GFSK	■	☐	☐	Complies
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	2GFSK	■	☐	☐	Complies
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	2GFSK	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	2GFSK	☐	■	☐	N/A[2]

Note1: NA= Not Applicable; NP= Not Performed.
Note2: EUT is powered by Battery

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=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
RF conducted measurement	±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html.

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:

03/26/2021-03/30/2021

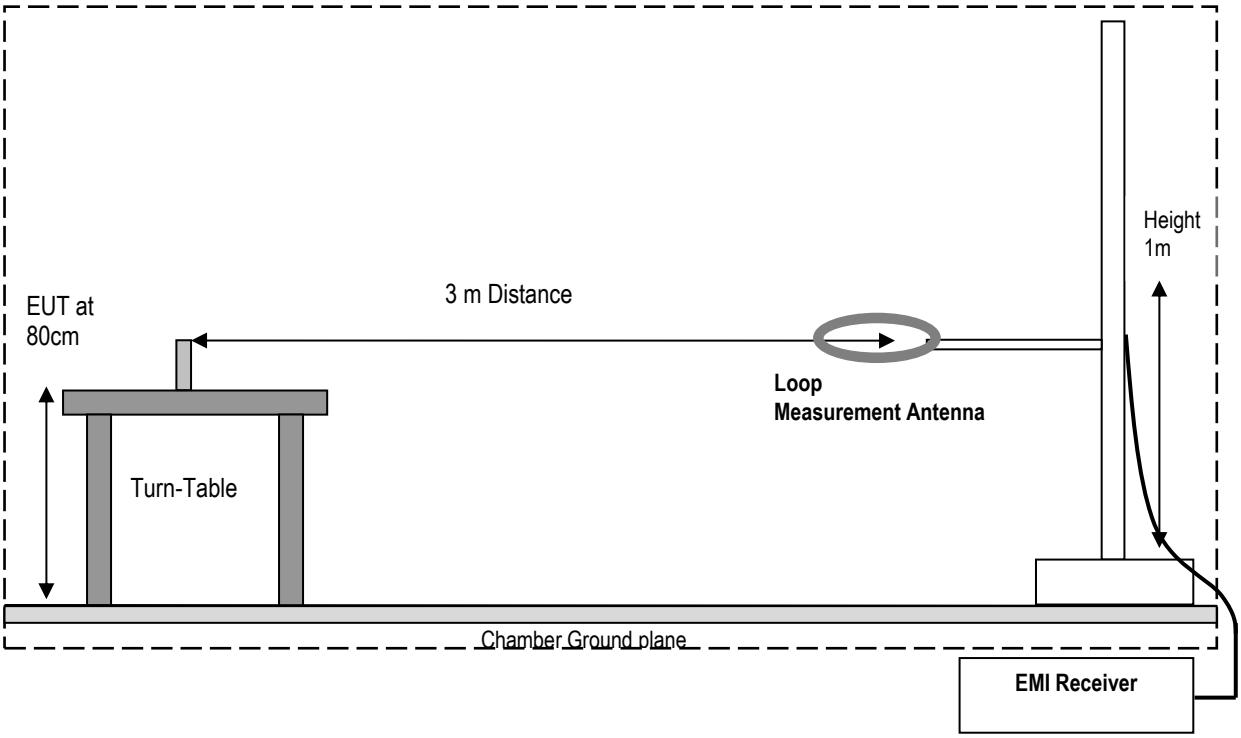
7 Measurement Procedures

7.1 Radiated Measurement

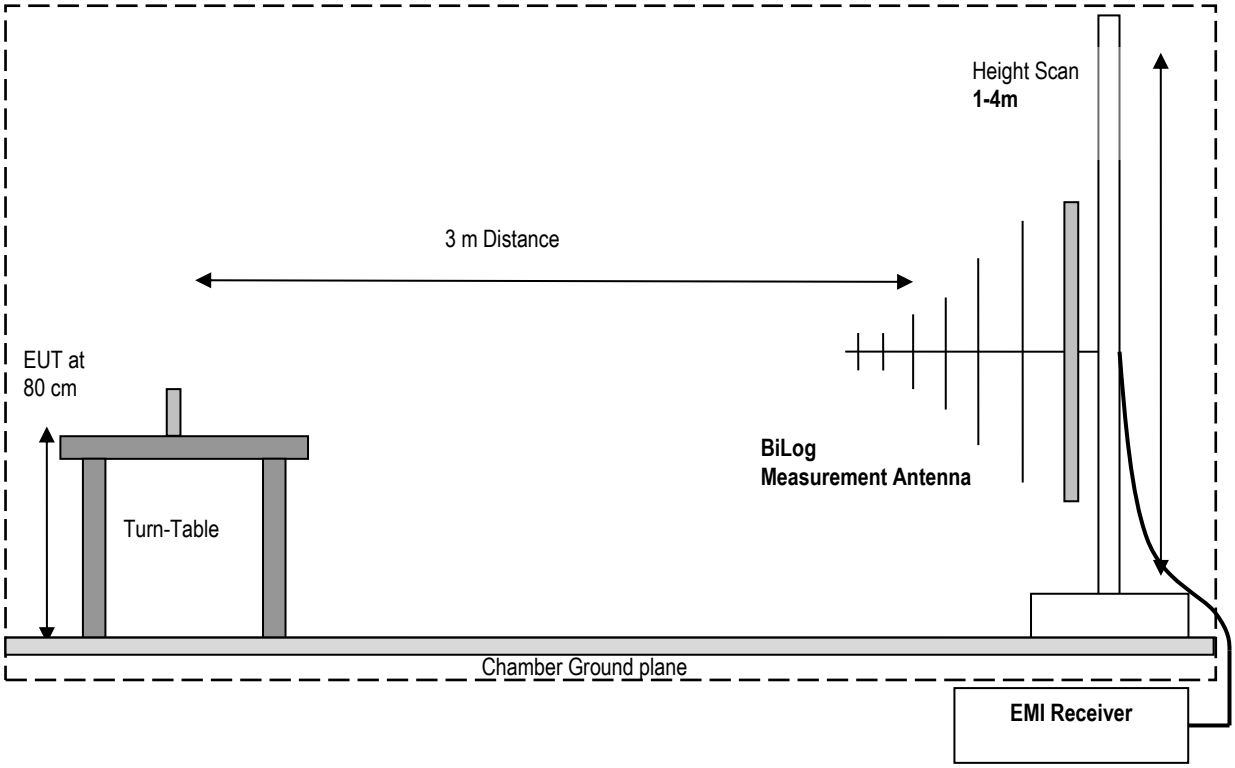
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

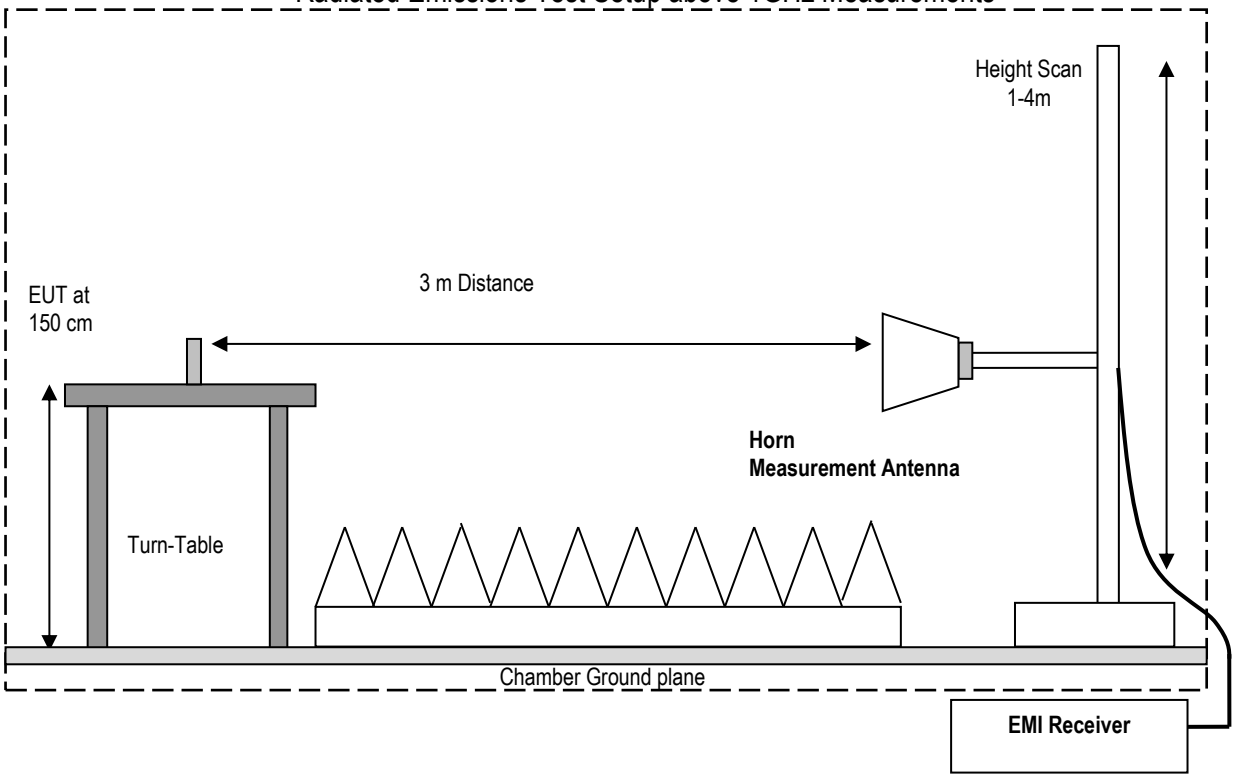
Radiated Emissions Test Setup below 30MHz Measurements



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:

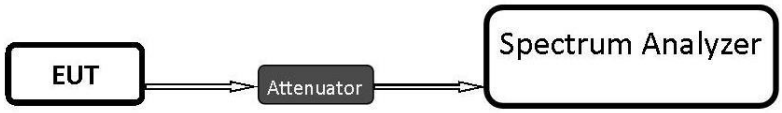
FS (dBµV/m) = Measured Value on SA (dBµV) + Cable Loss (dB)+ Antenna Factor (dB/m)

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 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 DTS Meas Guidance v05r02 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - 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.
- Calculate the conducted power by taking into account attenuation of the cable and the attenuator

8 Test Result Data

8.1 Maximum Peak Conducted Output Power

8.1.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05

Spectrum Analyzer settings:

- RBW ≥ DTS bandwidth
- VBW ≥ 3 x RBW
- Span ≥ 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	2	2GFSK	Battery 3.6 VDC	2.1 dBi

8.1.4 Measurement result:

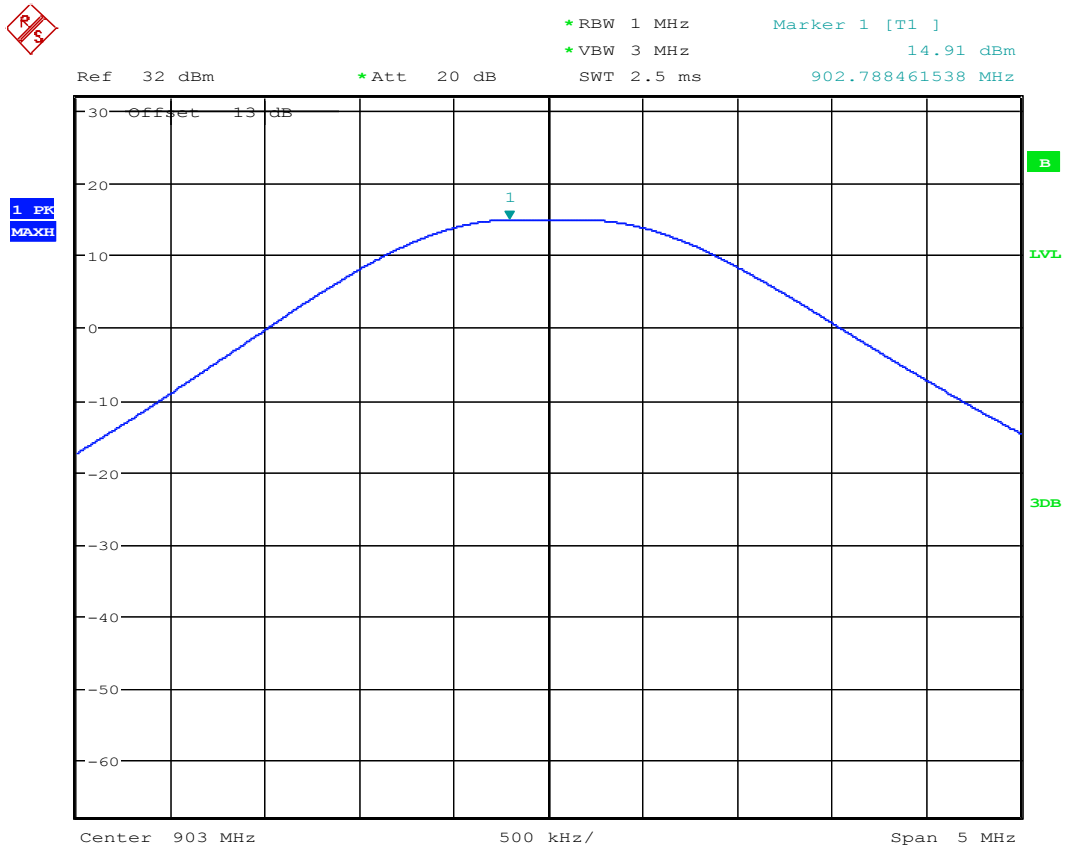
Attenuation of cable and attenuator (already taken into account): 13.0 dB

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	903	14.91	17.01	30 (Pk) / 36 (EIRP)	Pass
2	920	13.73	15.83	30 (Pk) / 36 (EIRP)	Pass
3	927	13.25	15.35	30 (Pk) / 36 (EIRP)	Pass

8.1.5 Measurement Plots:

Plot #1

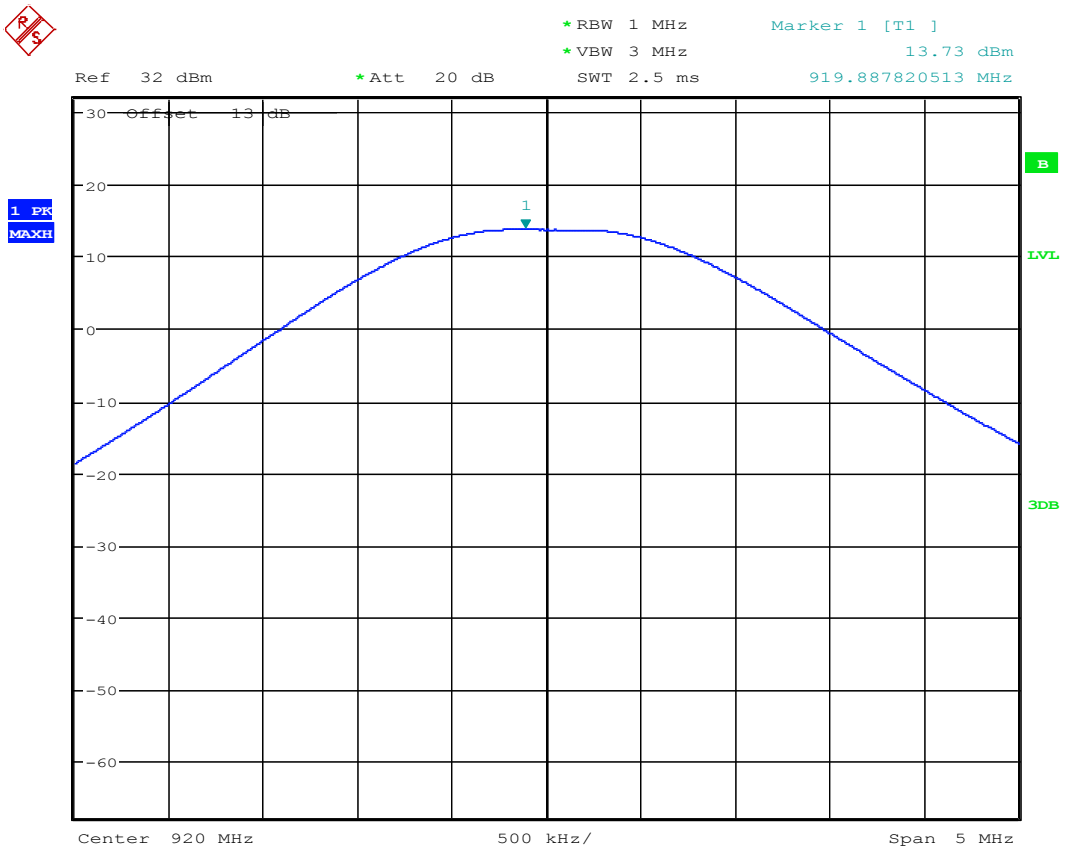
Low channel	Modulation/Packet Type: 2GFSK



Date: 13.MAY.2021 13:57:35

Plot #2

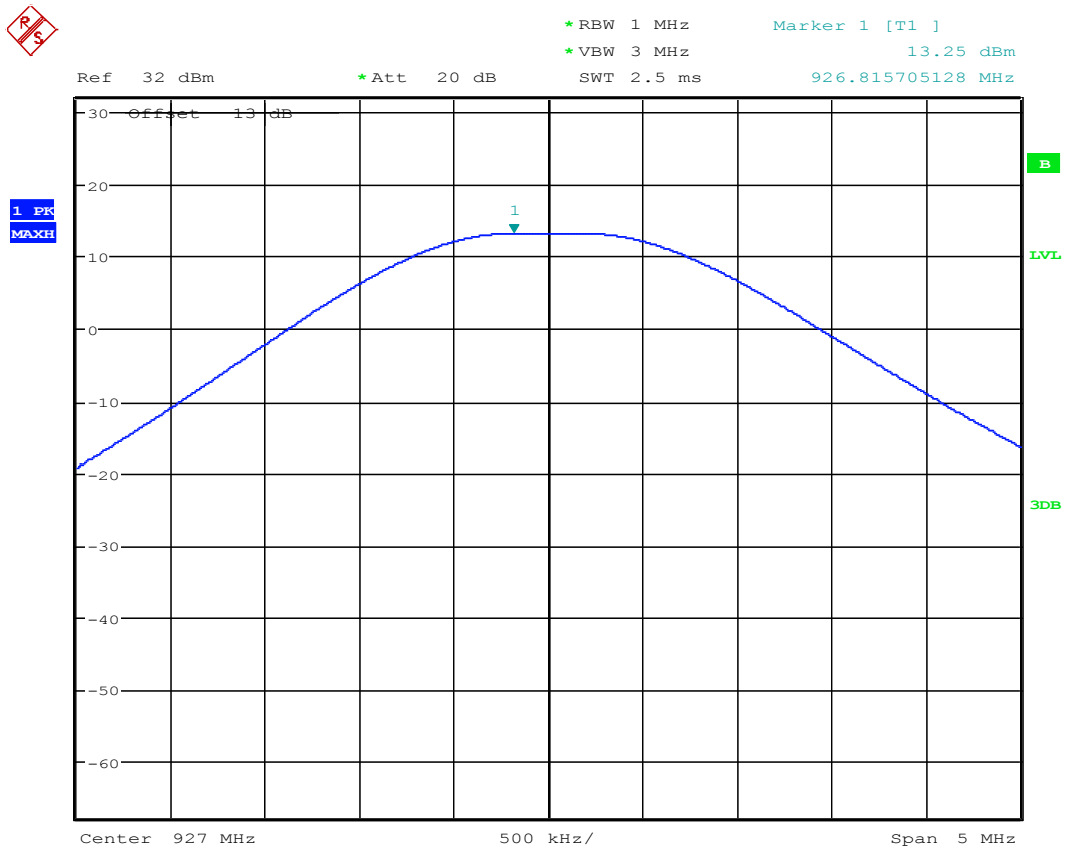
Mid channel	Modulation/Packet Type: 2GFSK



Date: 13.MAY.2021 13:59:11

Plot #3

High channel	Modulation/Packet Type: 2GFSK



Date: 13.MAY.2021 14:00:13

8.2 Power Spectral Density

8.2.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05

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 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x 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(2)

- 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
23° C	2	2GFSK	Battery 3.6 VDC	2.1 dBi

8.2.4 Measurement result:

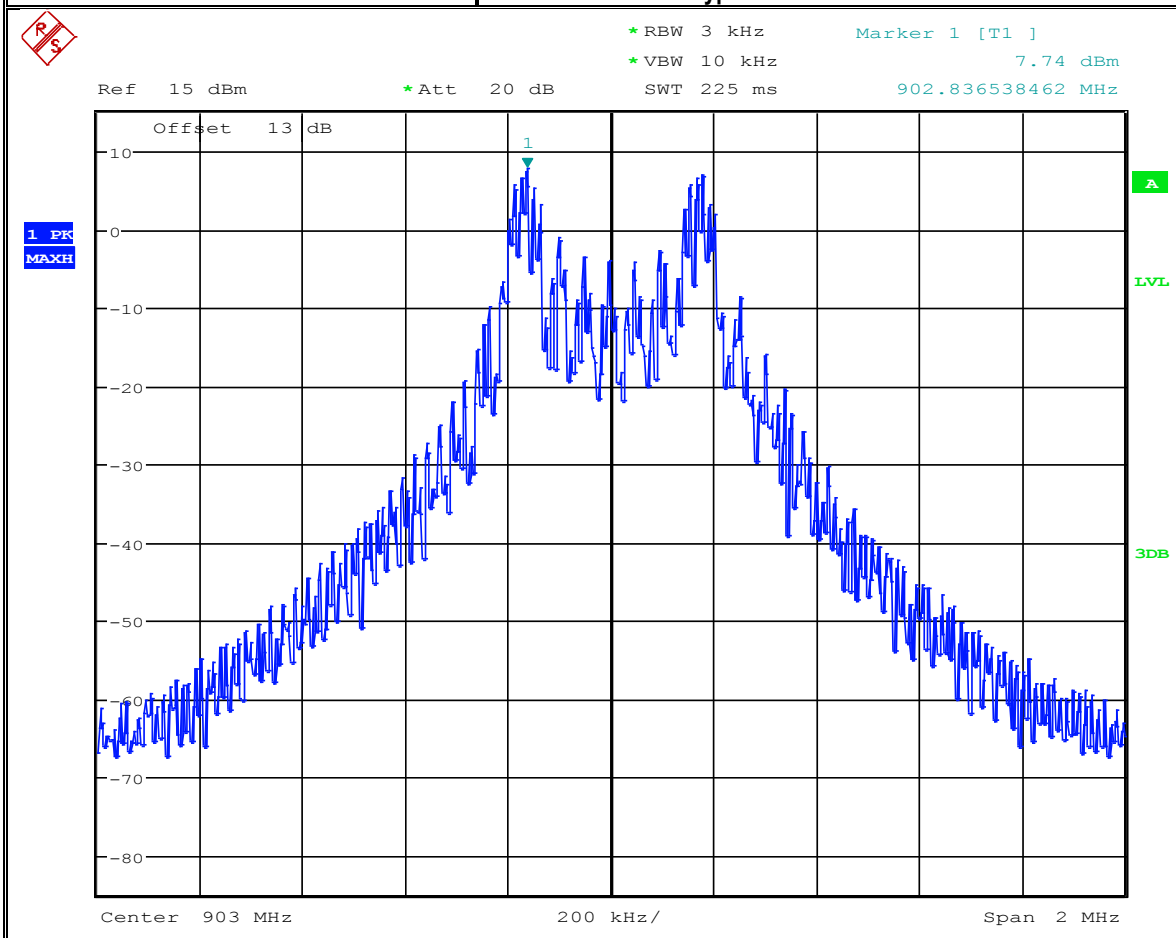
Attenuation of cable and attenuator (already taken into account): 13.0 dB

Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm/3 kHz)	Limit (dBm / 3 kHz)	Result
4	903	7.74	8	Pass
5	920	6.41	8	Pass
6	927	5.99	8	Pass

8.2.5 Measurement Plots:

Plot #4

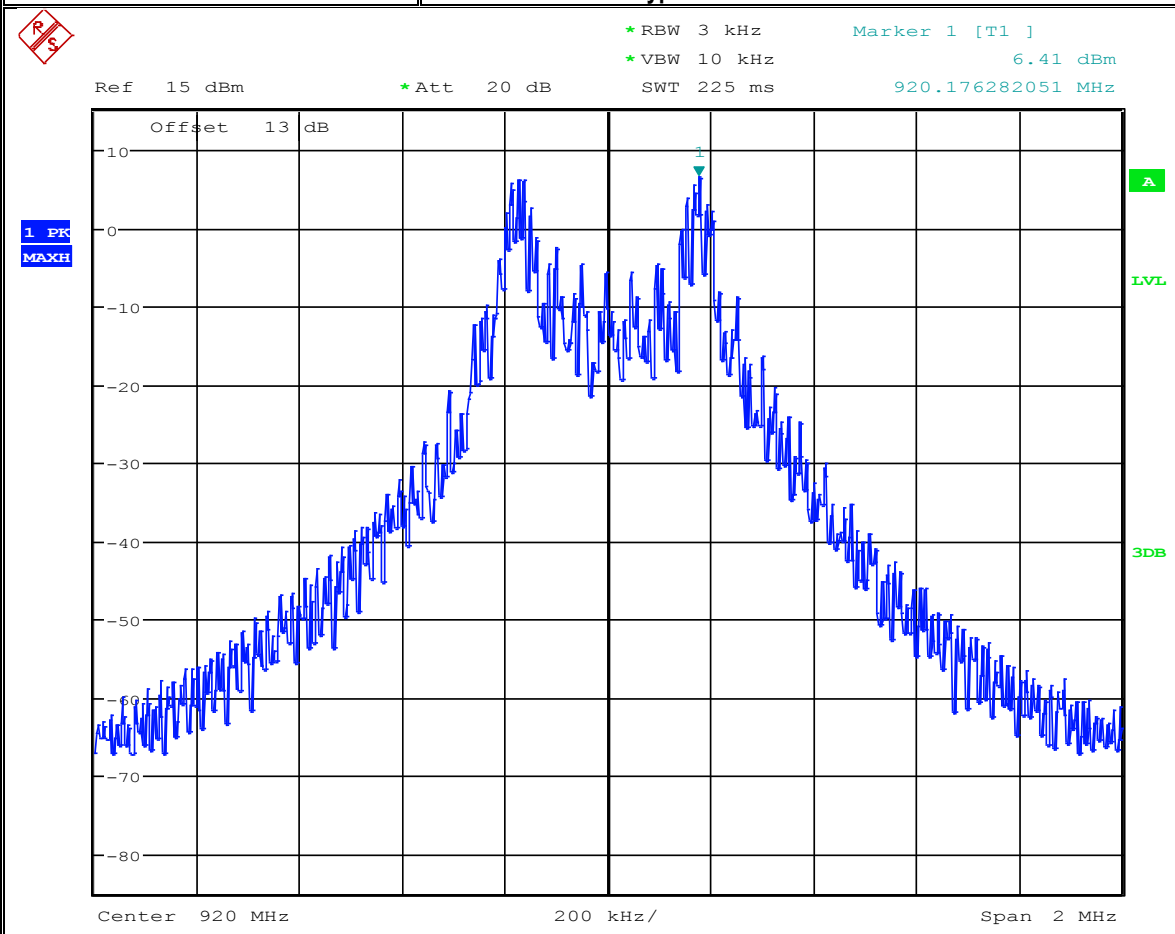
Low channel	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 14:40:16

Plot #5

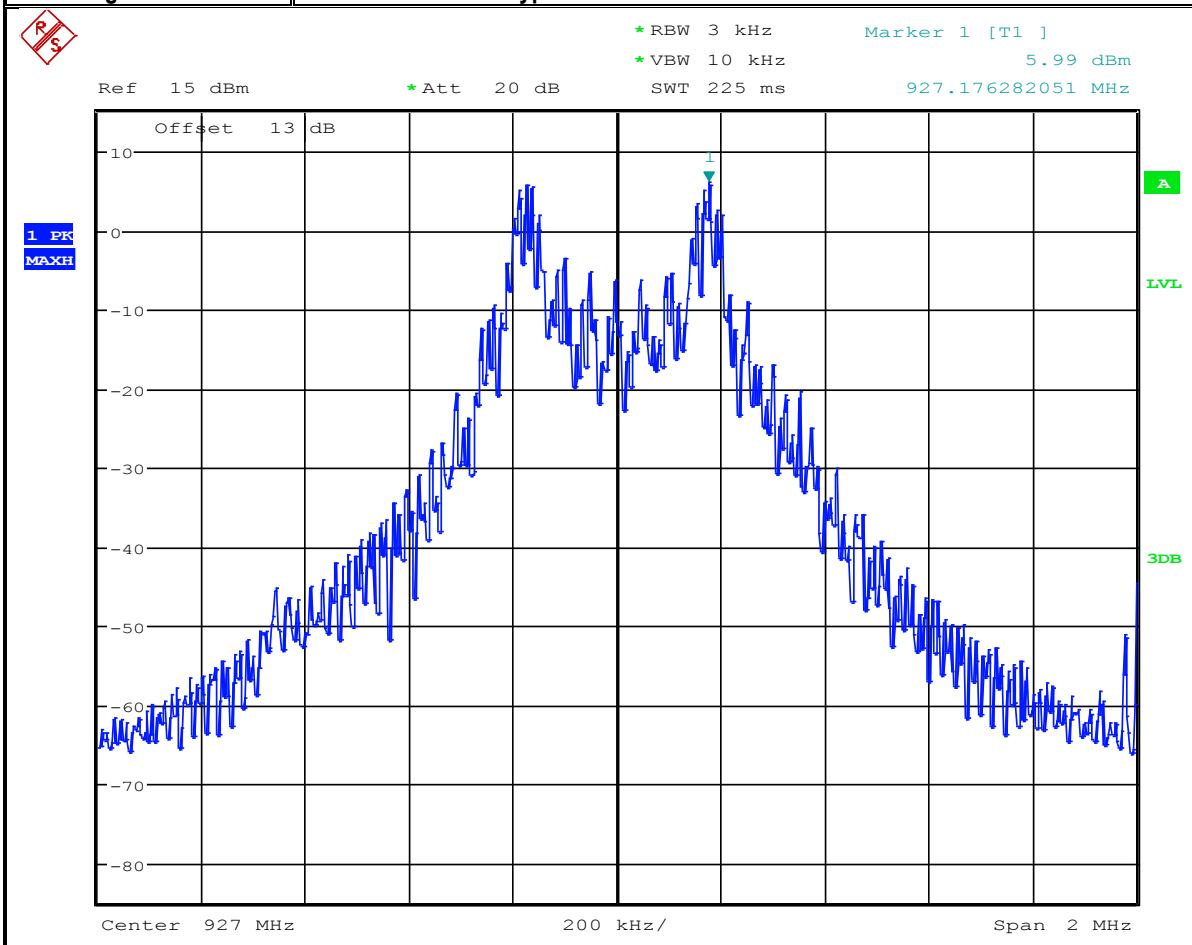
Mid channel	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 14:39:12

Plot #6

High channel	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 14:37:46

8.3 Duty cycle

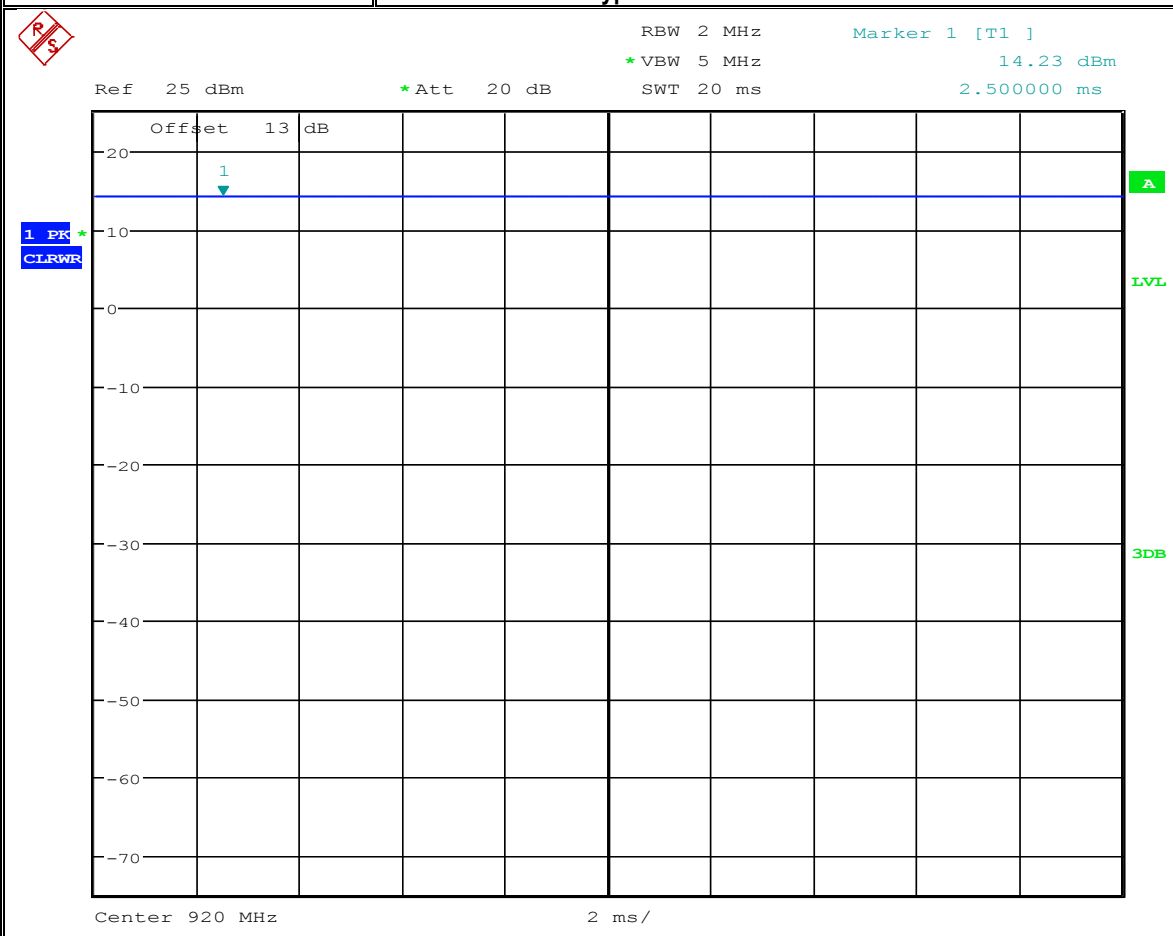
8.3.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05

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 measurement	
Mid channel / 920 MHz	Modulation/Packet Type: 2GFSK



Duty cycle =100%
Duty cycle correction factor =10*log (1/1) = 0 dB

8.4 Band Edge Compliance

8.4.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05

Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 100 kHz
- VBW ≥ 3 x 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)).

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- 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:

(b)

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	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	2	2GFSK	Battery 3.6 VDC	2.1 dBi

8.4.5 Measurement result:

Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
7	2GFSK	Lower, Non-restricted	-60.49	-20	Pass
8	2GFSK	Higher, Non-restricted	-50.68	-20	Pass

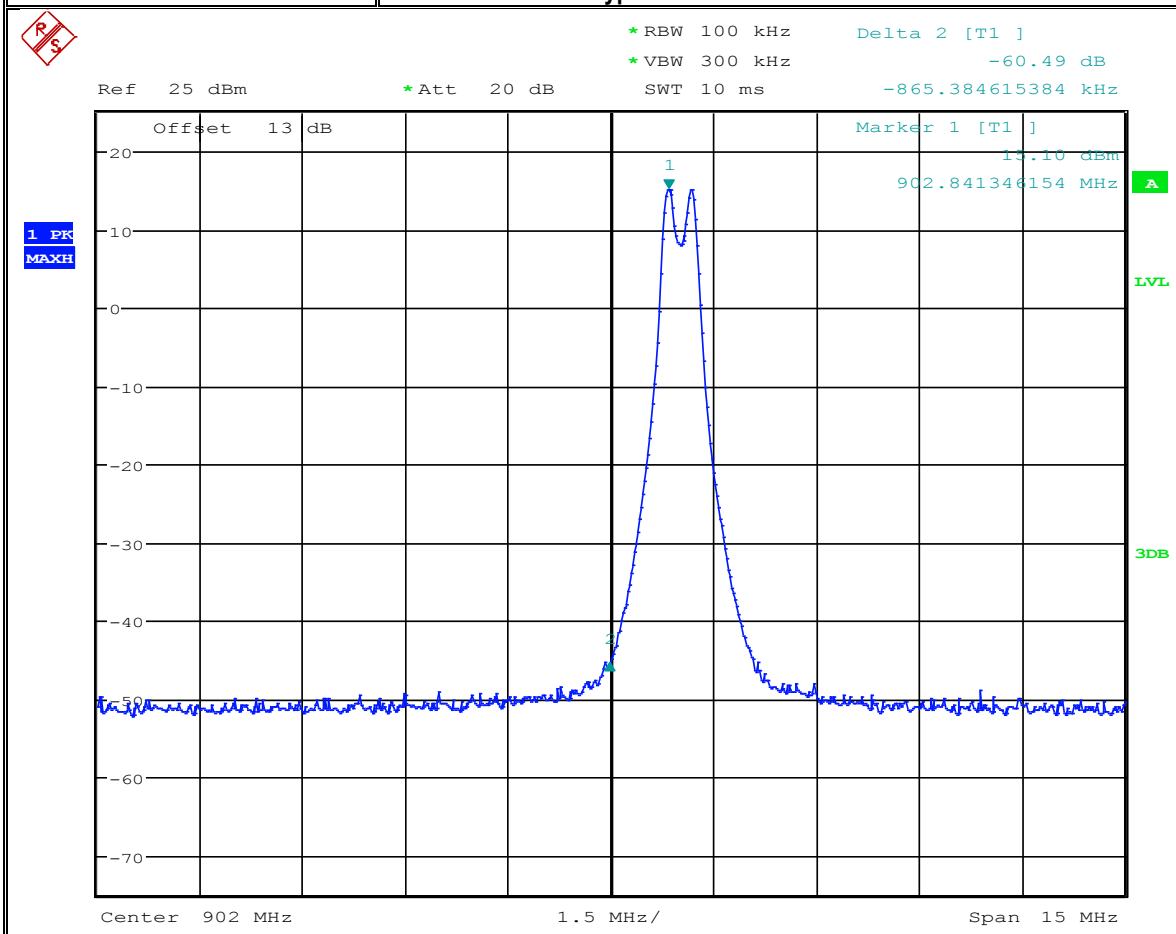
Plot #	EUT operating mode	Band Edge	Measured Peak Value (dBm)	Corrected by duty cycle	Corrected by Antenna Gain (dBm)	Limit (dBm)	Result
9	2GFSK	Upper Restricted peak	-44.63	NA	-42.53	-21.23 Peak	Pass
10	2GFSK	Upper Restricted Average	-55.97	-55.97	-53.87	-41.23 AVG	Pass

Note: According to ANSI C63.10 §11.12.2.6, if Antenna Gain is less than 2 dBi, then 2 dBi should be used to determine the EIRP.

8.4.6 Measurement Plots:

Plot #7

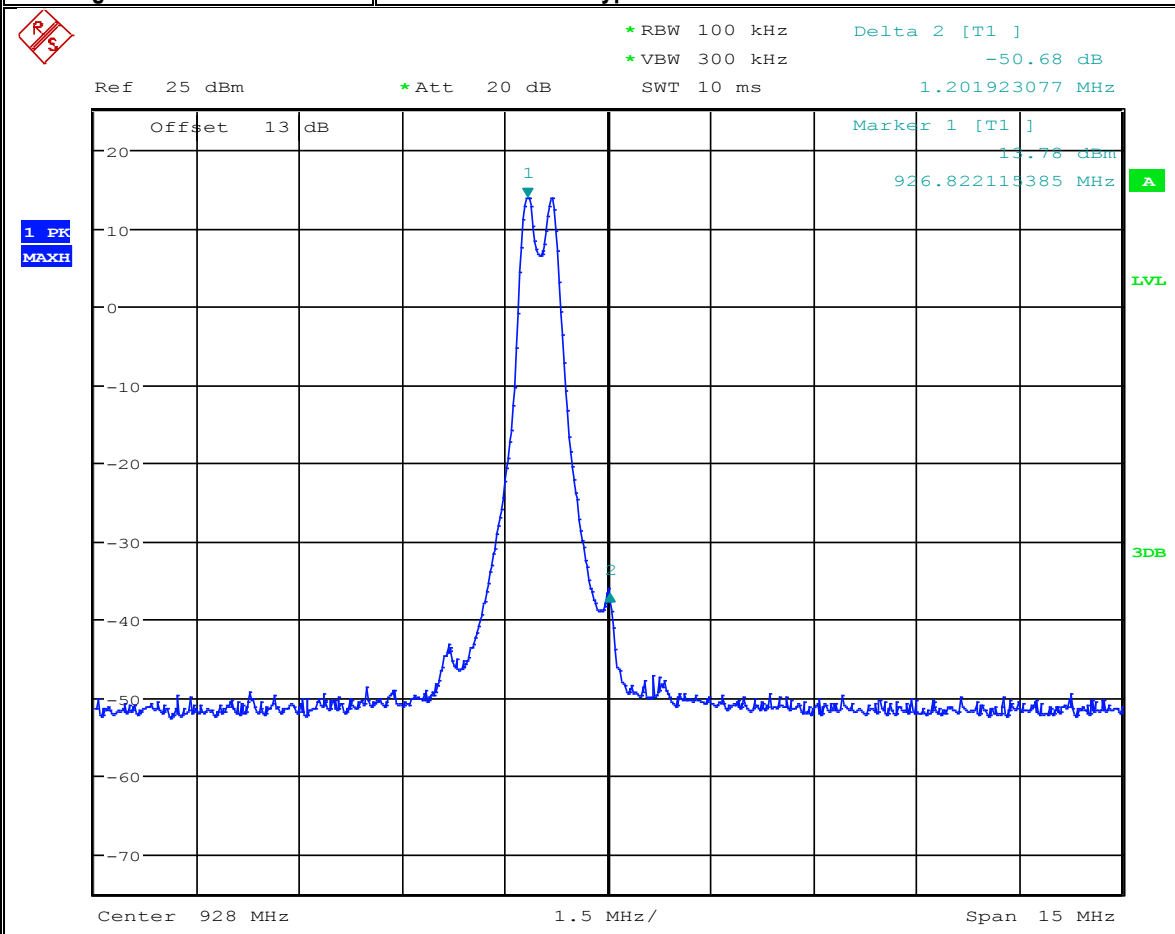
Low channel / 903 MHz	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 14:45:58

Plot #8

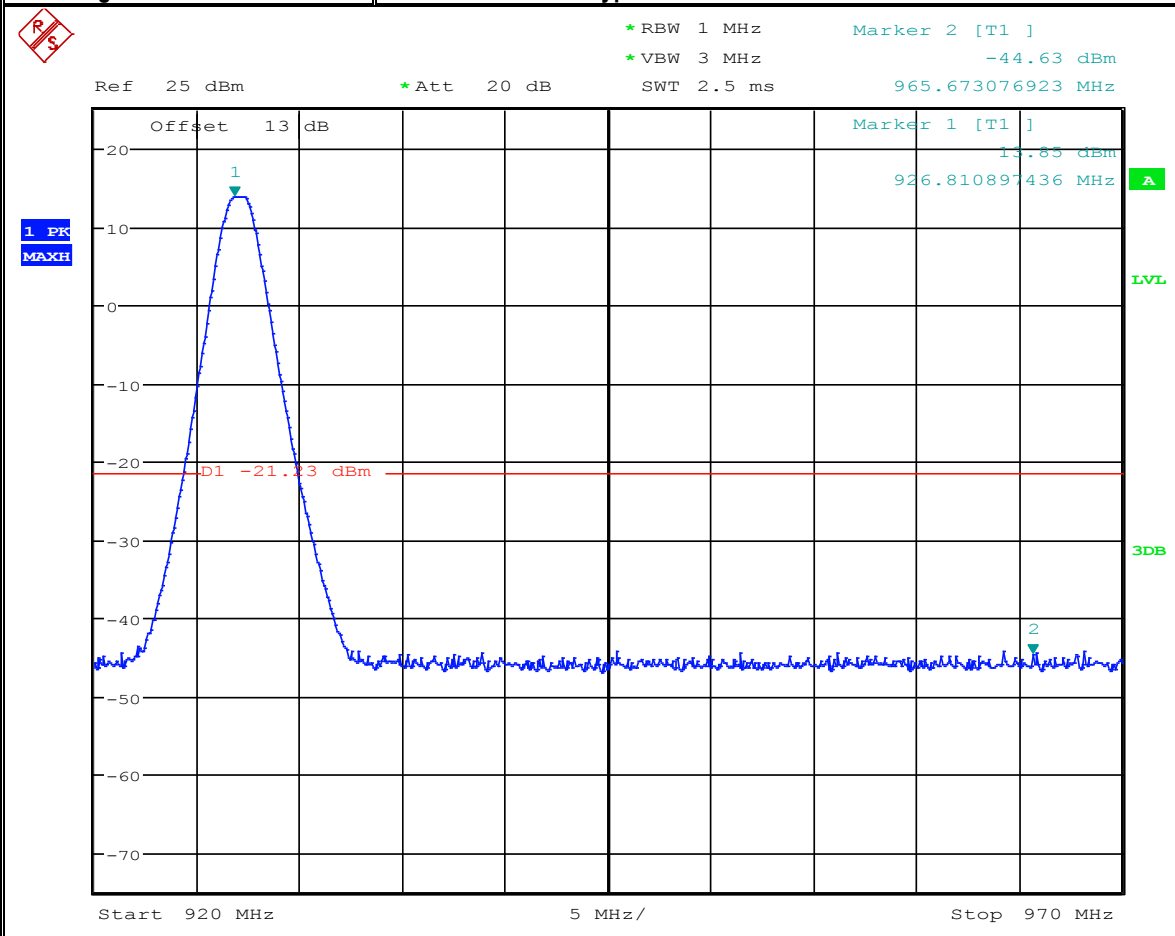
High channel / 927 MHz	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 14:49:53

Plot #9

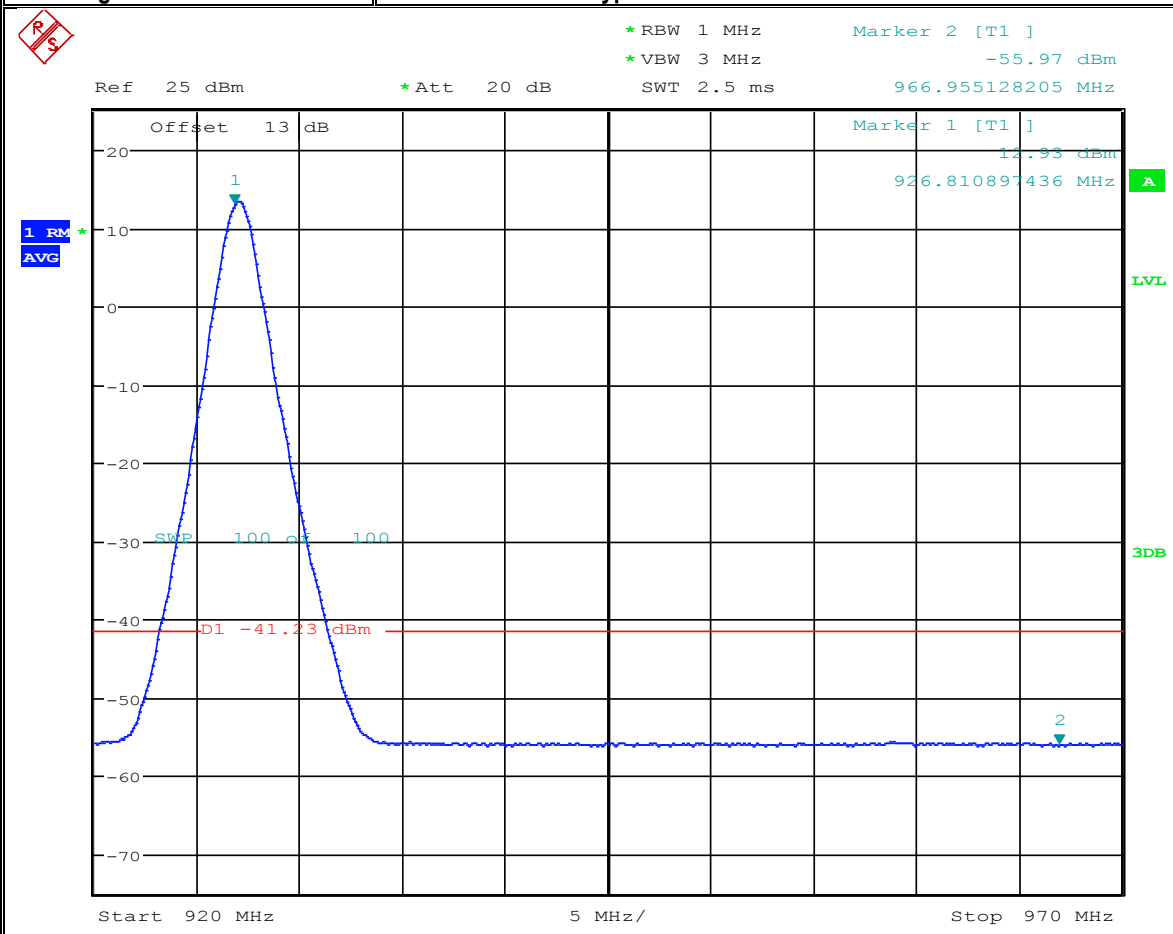
High channel 927 MHz	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 16:40:43

Plot #10

High channel 927 MHz	Modulation/Packet Type: 2GFSK



Date: 30.MAR.2021 16:41:48

8.5 Emission Bandwidth 6 dB and 99% Occupied Bandwidth

8.5.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v05

Spectrum Analyzer settings:

- Set RBW = 100 kHz
- Set the video bandwidth (VBW) ≥ 3 x 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.

8.5.2 Limits:

FCC §15.247(a)(1) and RSS-247 5.2(1)

- 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	2	2GFSK	Battery 3.6 VDC

8.5.4 Measurement result:

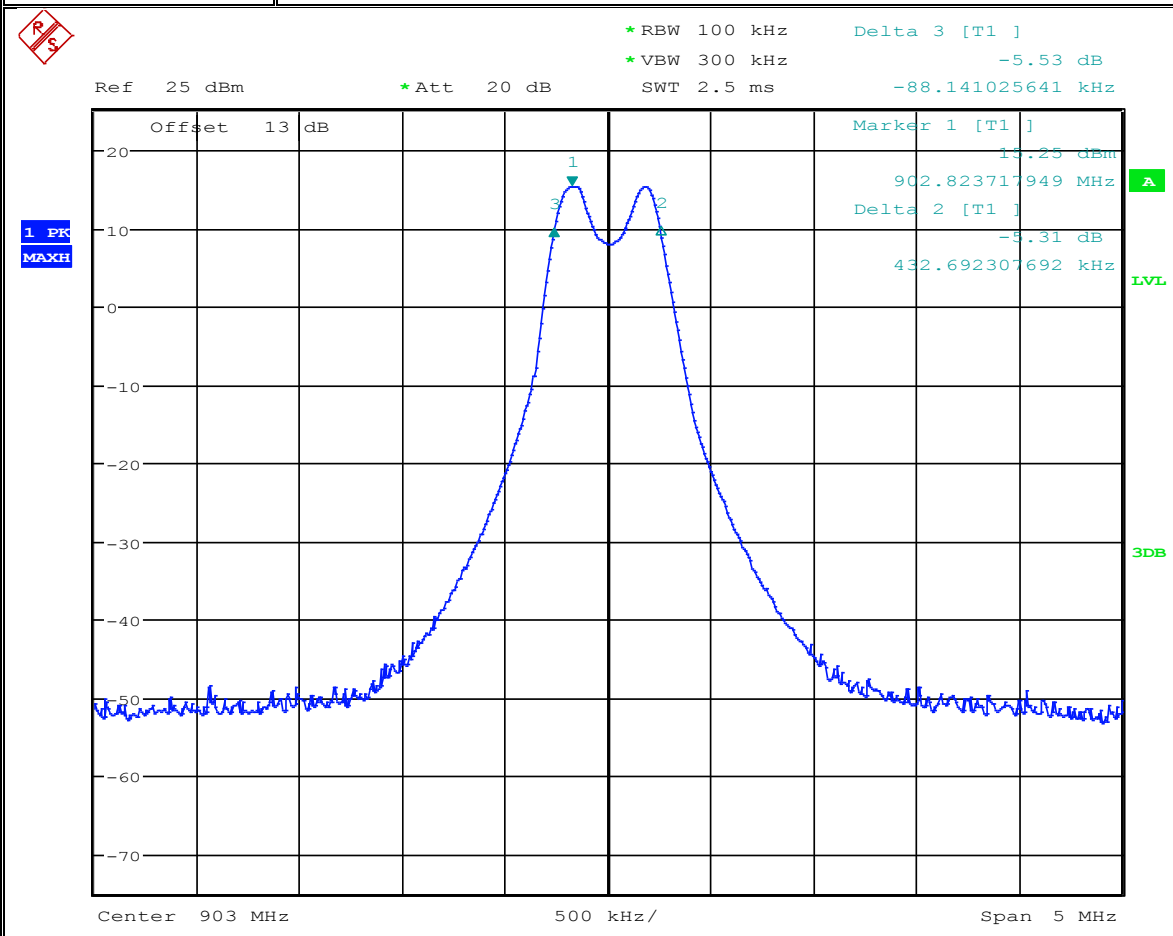
Plot #	Frequency (MHz)	6 dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
11	903	0.521	> 0.5	Pass
12	920	0.521	> 0.5	Pass
13	927	0.521	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
14	903	0.609	> 0.5	Pass
15	920	0.609	> 0.5	Pass
16	927	0.617	> 0.5	Pass

8.5.5 Measurement Plots:

Plot #11

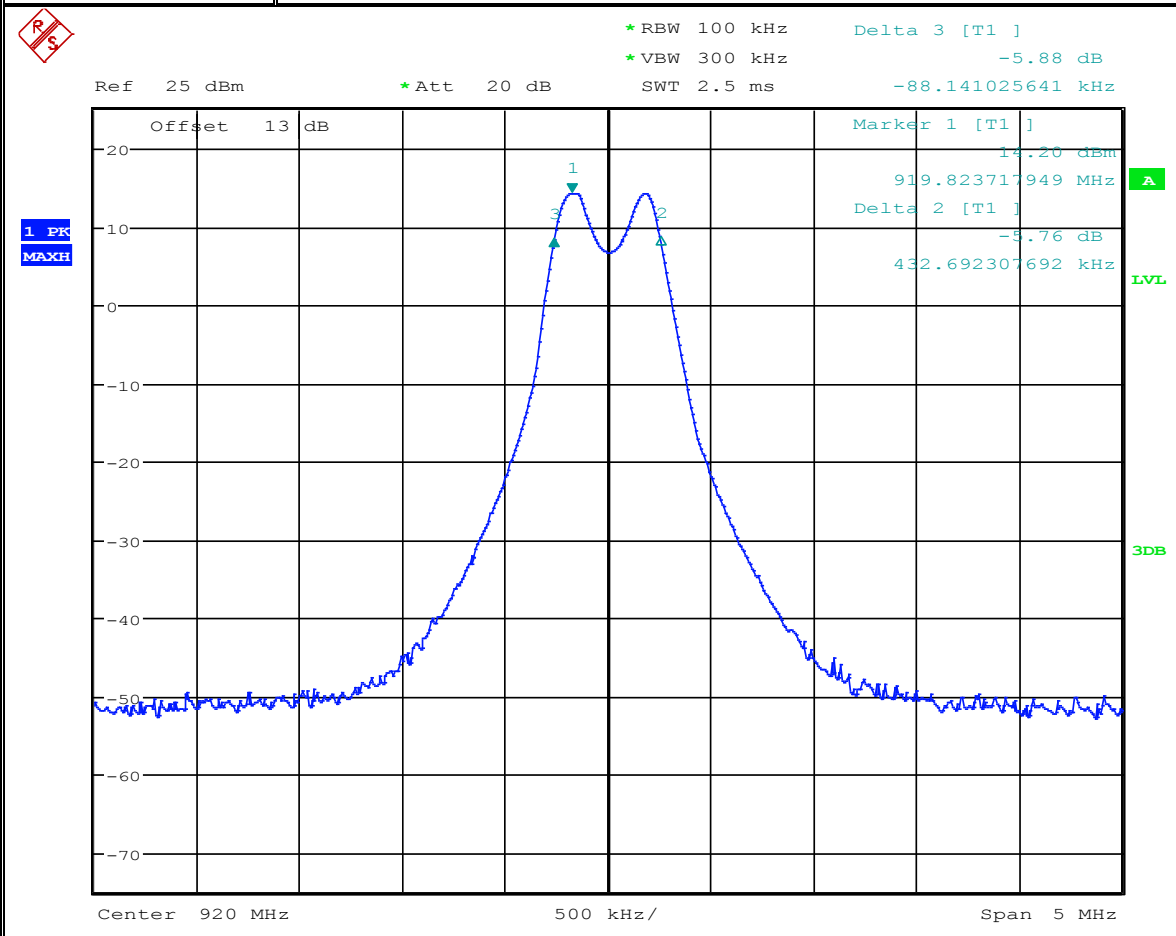
Low channel	Mode: 2GFSK



Date: 30.MAR.2021 15:02:55

Plot #12

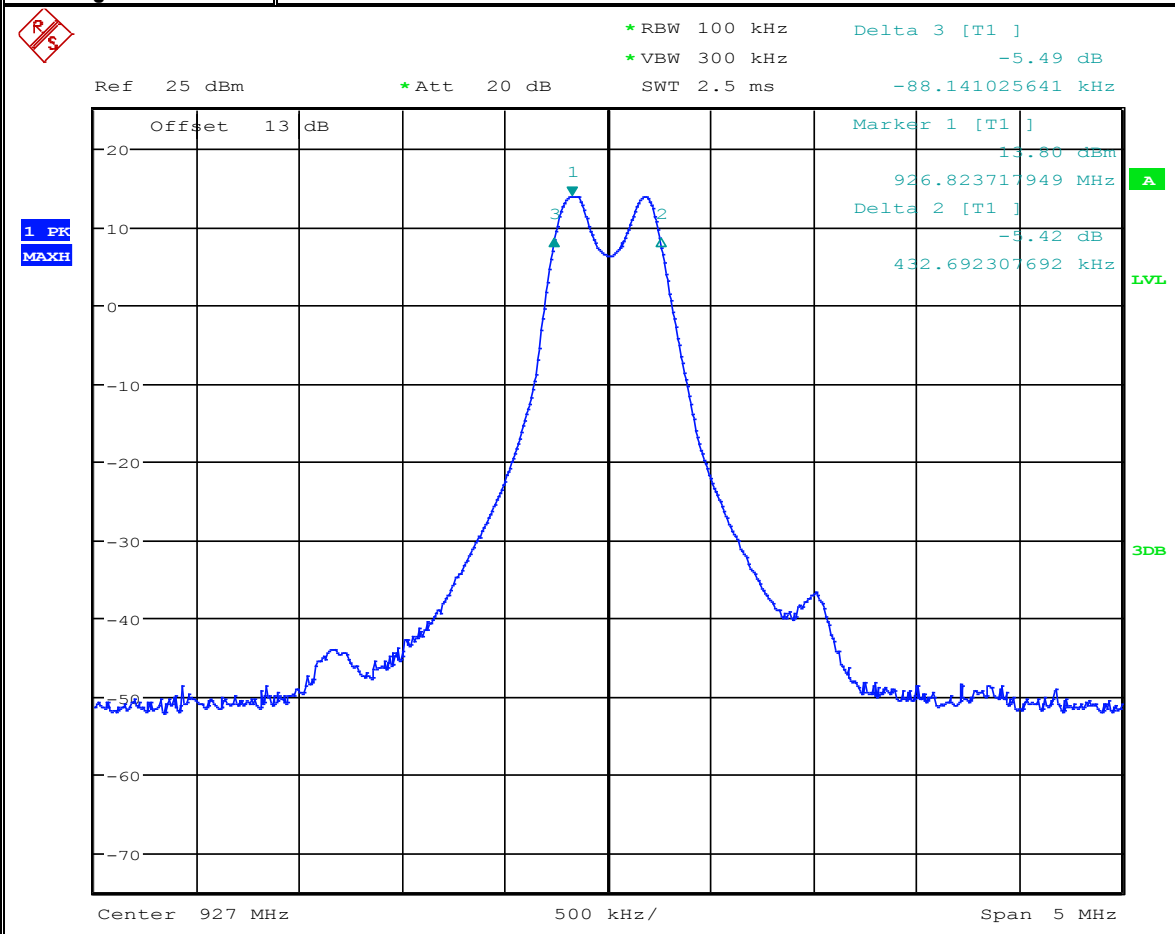
Mid channel	Mode: 2GFSK



Date: 30.MAR.2021 15:04:22

Plot #13

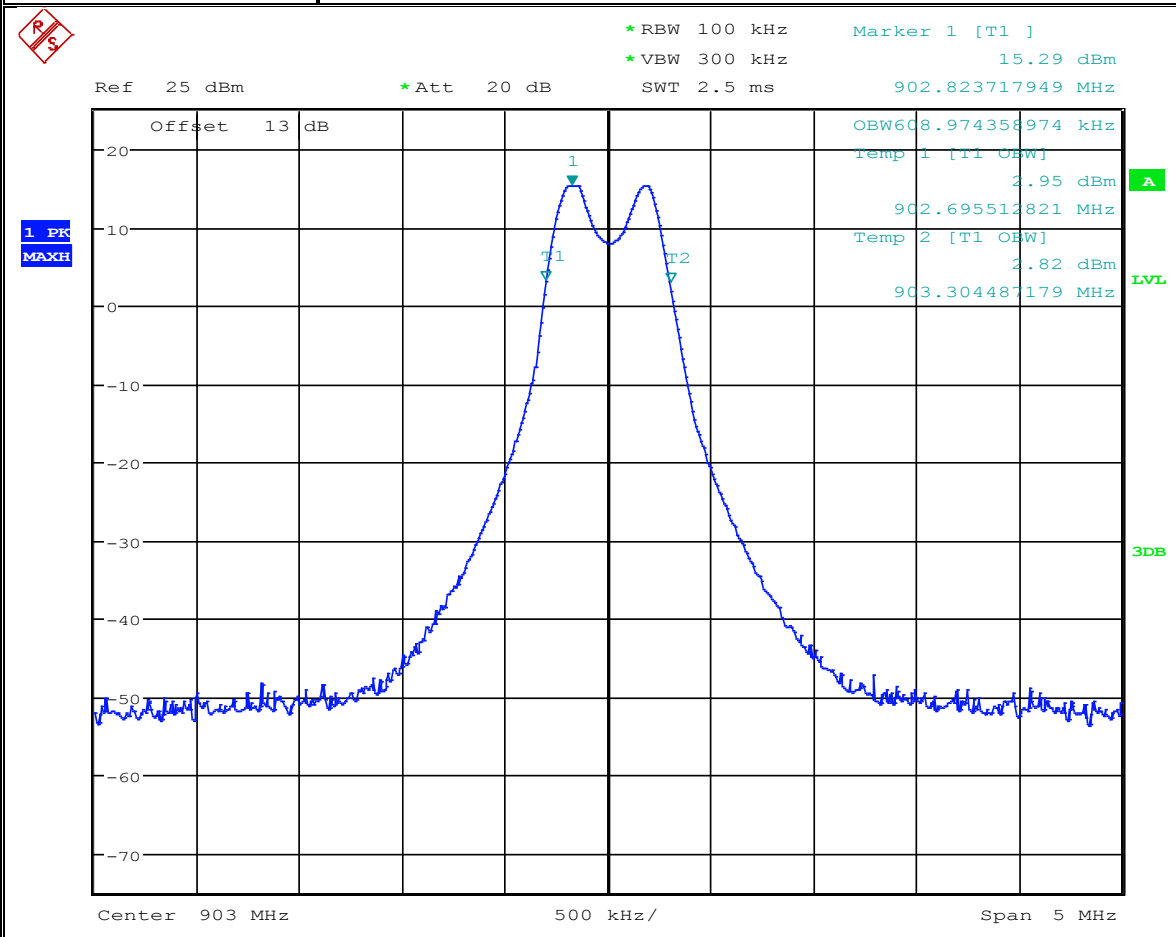
High channel	Mode: 2GFSK



Date: 30.MAR.2021 15:00:04

Plot #14

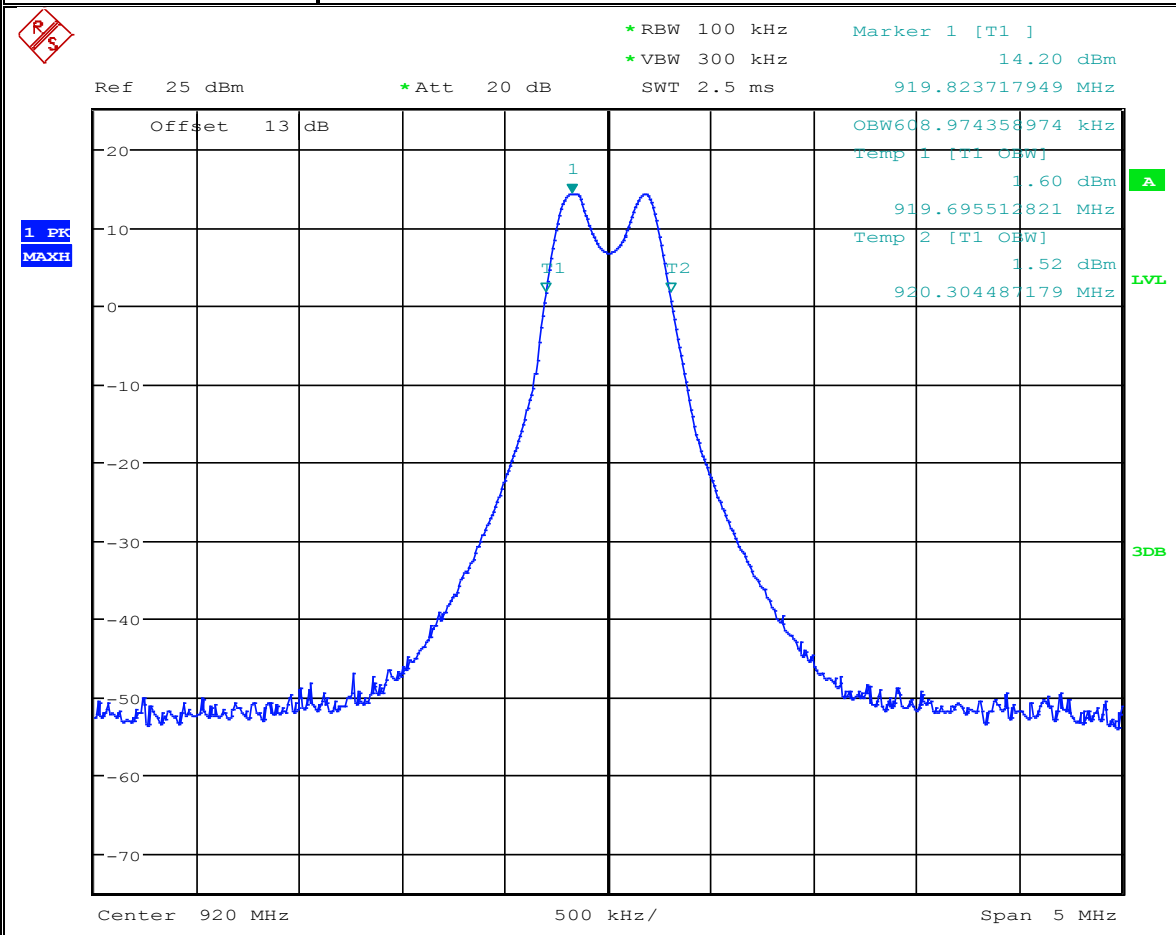
Low channel	Mode: 2GFSK



Date: 30.MAR.2021 15:02:18

Plot #15

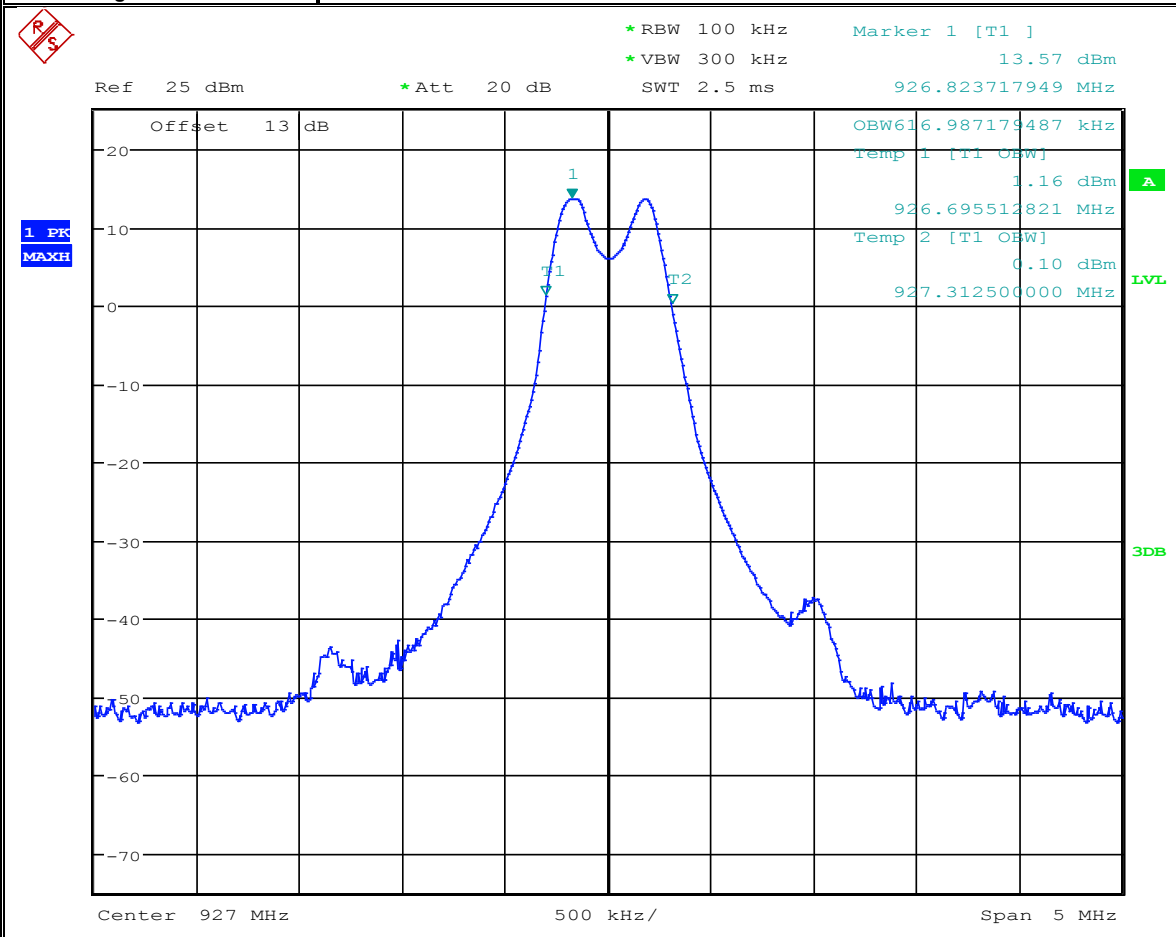
Mid channel	Mode: 2GFSK



Date: 30.MAR.2021 15:04:48

Plot #16

High channel	Mode: 2GFSK



Date: 30.MAR.2021 15:00:52

8.6 Radiated Transmitter Spurious Emissions and Restricted Bands

8.6.1 Measurement according to ANSI C63.10 (2013)

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 at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

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
[1]0.495-0.505	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:

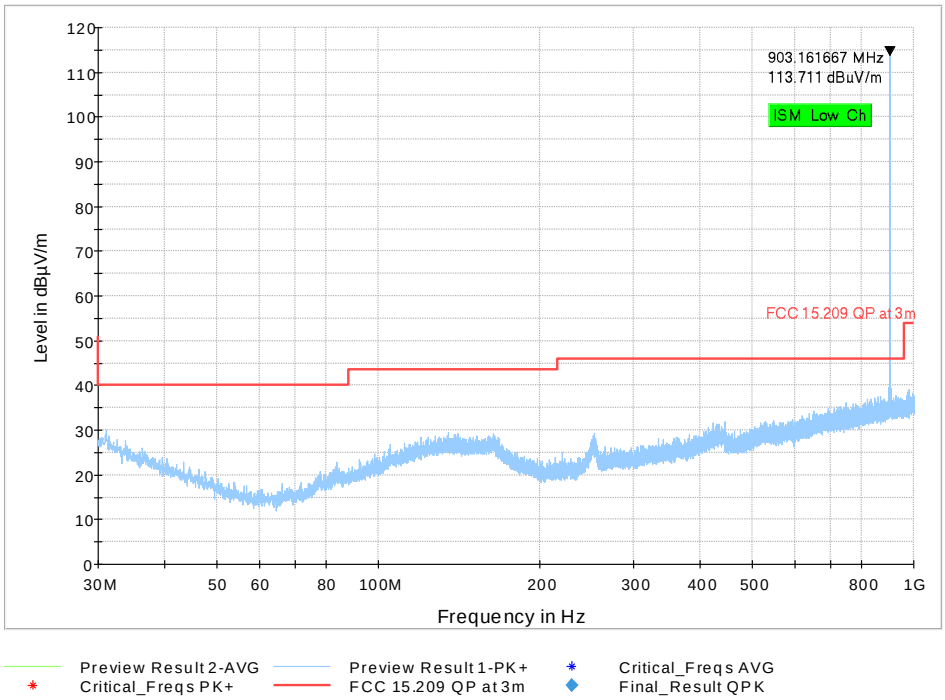
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	2GFSK	Battery 3.6 VDC

8.6.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
17-19	Low	30 MHz – 18 GHz	See section 8.6.2	Pass
20-23	Mid	9 kHz – 18 GHz	See section 8.6.2	Pass
24-26	High	30 MHz – 18 GHz	See section 8.6.2	Pass

8.6.5 Measurement Plots:

Plot #17 Radiated Emissions: 30 MHz – 1GHz	
Modulation: 2GFSK	**Channel: Low**

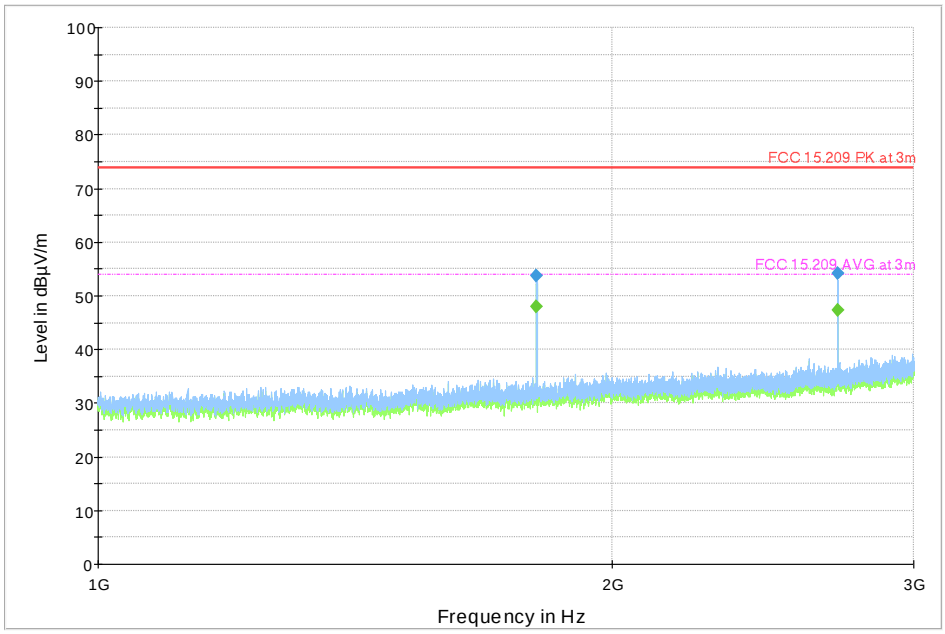


Plot #18 Radiated Emissions: 1-3 GHz

Modulation: 2GFSK | **Channel: Low**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1805.571	---	48.03	53.98	5.95	500.0	1000.000	158.0	V	162.0	4.3	
1805.571	53.80	---	73.98	20.18	500.0	1000.000	158.0	V	162.0	4.3	
2708.429	---	47.29	53.98	6.69	500.0	1000.000	196.0	V	291.0	7.1	
2708.429	54.31	---	73.98	19.67	500.0	1000.000	196.0	V	291.0	7.1	



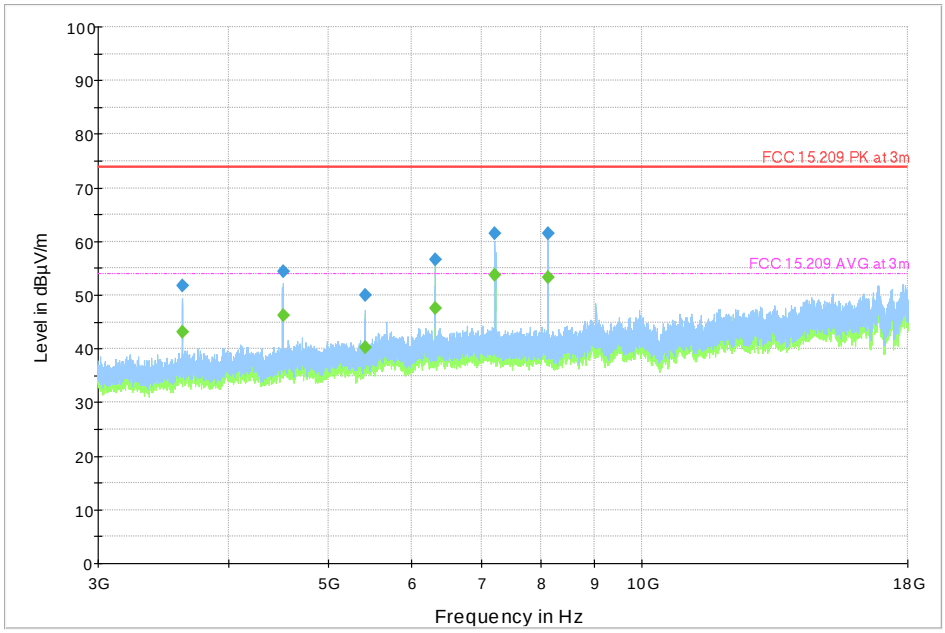
Preview Result 2-AVG
FCC 15.209 AVG at 3m
Preview Result 1-PK+
Final_Result PK+
FCC 15.209 PK at 3m
Final_Result CAV

Plot #19 Radiated Emissions: 3-18 GHz

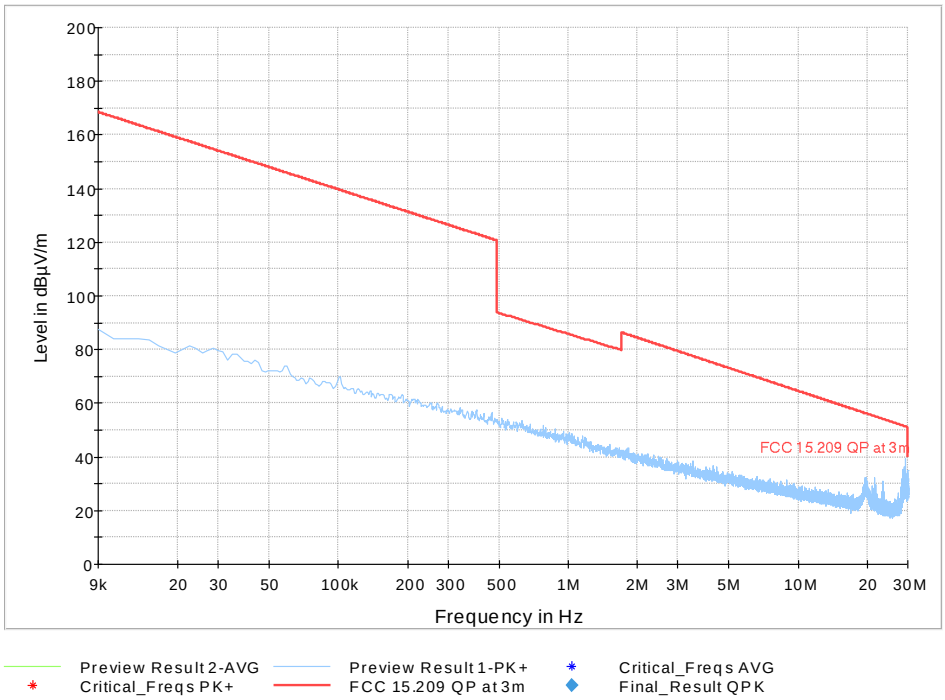
Modulation: 2GFSK | **Channel: Low**

Final_Result

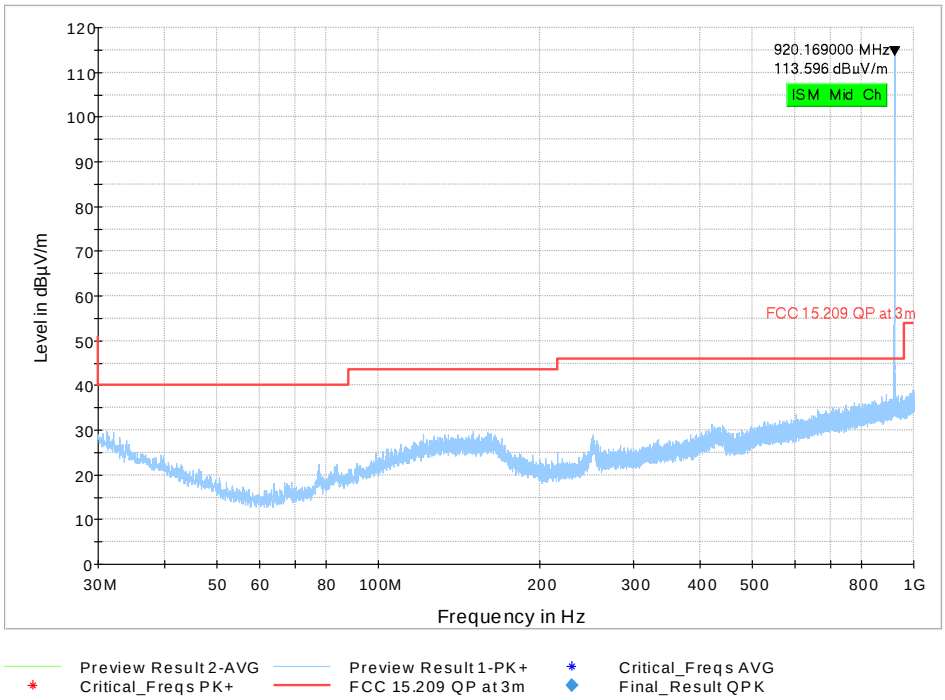
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3612.500	51.87	---	73.98	22.11	500.0	1000.000	100.0	V	259.0	-6.0	
3612.500	---	43.12	53.98	10.86	500.0	1000.000	100.0	V	259.0	-6.0	
4515.750	54.52	---	73.98	19.46	500.0	1000.000	100.0	H	140.0	-4.1	
4515.750	---	46.26	53.98	7.72	500.0	1000.000	100.0	H	140.0	-4.1	
5416.750	50.05	---	73.98	23.93	500.0	1000.000	181.0	V	12.0	-2.5	
5416.750	---	40.22	53.98	13.76	500.0	1000.000	181.0	V	12.0	-2.5	
6322.000	---	47.49	53.98	6.49	500.0	1000.000	100.0	V	142.0	-0.5	
6322.000	56.59	---	73.98	17.39	500.0	1000.000	100.0	V	142.0	-0.5	
7222.500	---	53.79	53.98	0.18	500.0	1000.000	100.0	V	162.0	-0.5	
7222.500	61.51	---	73.98	12.47	500.0	1000.000	100.0	V	162.0	-0.5	
8125.250	61.42	---	73.98	12.56	500.0	1000.000	100.0	V	152.0	0.0	
8125.250	---	53.24	53.98	0.74	500.0	1000.000	100.0	V	152.0	0.0	



Plot #20 Radiated Emissions: 9 KHz – 30 MHz	
Modulation: 2GFSK	**Channel: Mid**



Plot #21 Radiated Emissions: 30 MHz – 1GHz	
Modulation: 2GFSK	**Channel: Mid**

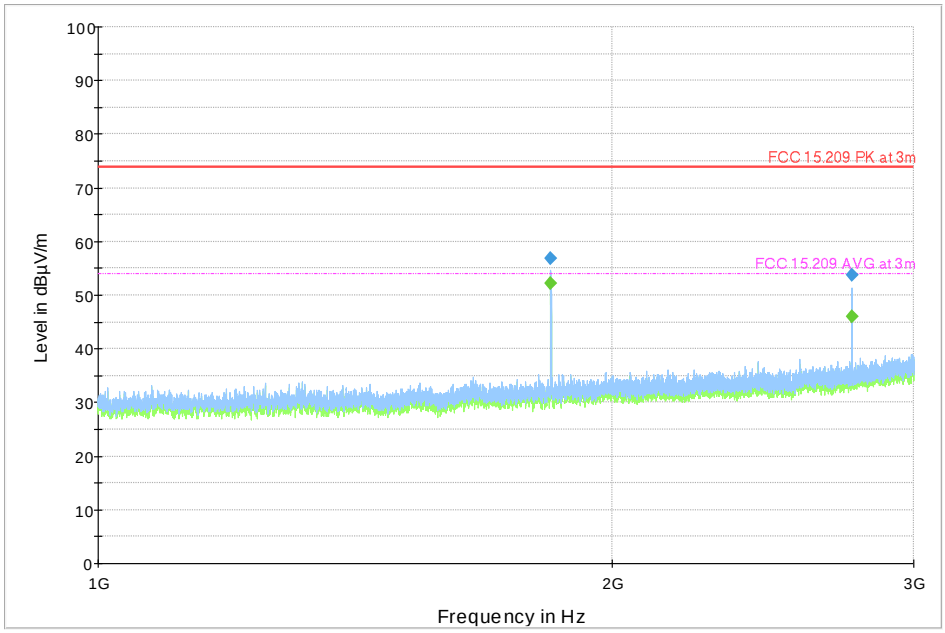


Plot #22 Radiated Emissions: 1-3 GHz

Modulation: 2GFSK | **Channel: Mid**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1840.286	56.85	---	73.98	17.13	500.0	1000.000	167.0	V	198.0	4.5	
1840.286	---	52.32	53.98	1.66	500.0	1000.000	167.0	V	198.0	4.5	
2760.571	53.81	---	73.98	20.17	500.0	1000.000	107.0	H	173.0	7.2	
2760.571	---	46.02	53.98	7.96	500.0	1000.000	107.0	H	173.0	7.2	



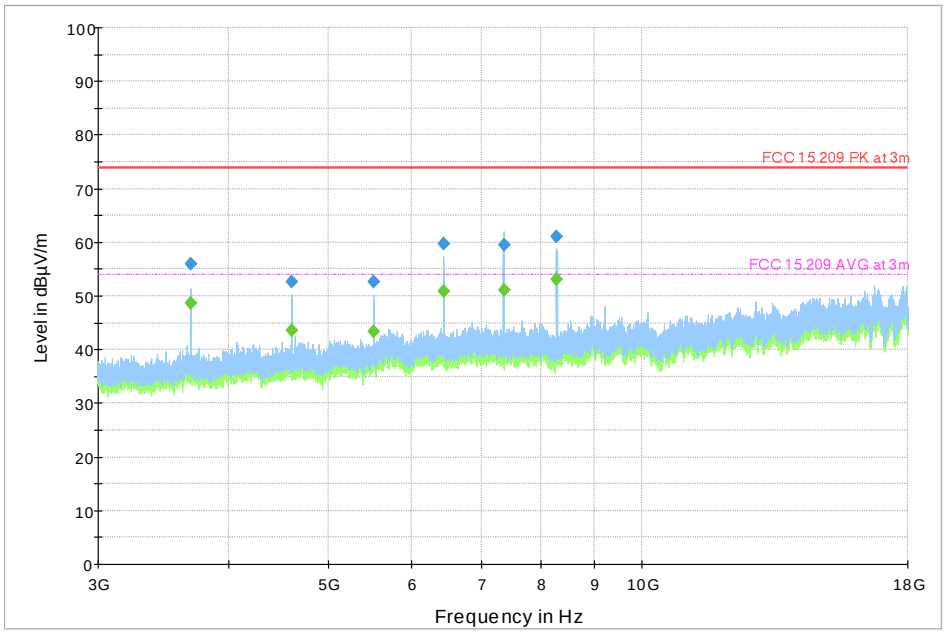
Preview Result 2-AVG
FCC 15.209 AVG at 3m
Preview Result 1-PK+
Final_Result PK+
FCC 15.209 PK at 3m
Final_Result CAV

Plot #23 Radiated Emissions: 3-18 GHz

Modulation: 2GFSK | **Channel: Mid**

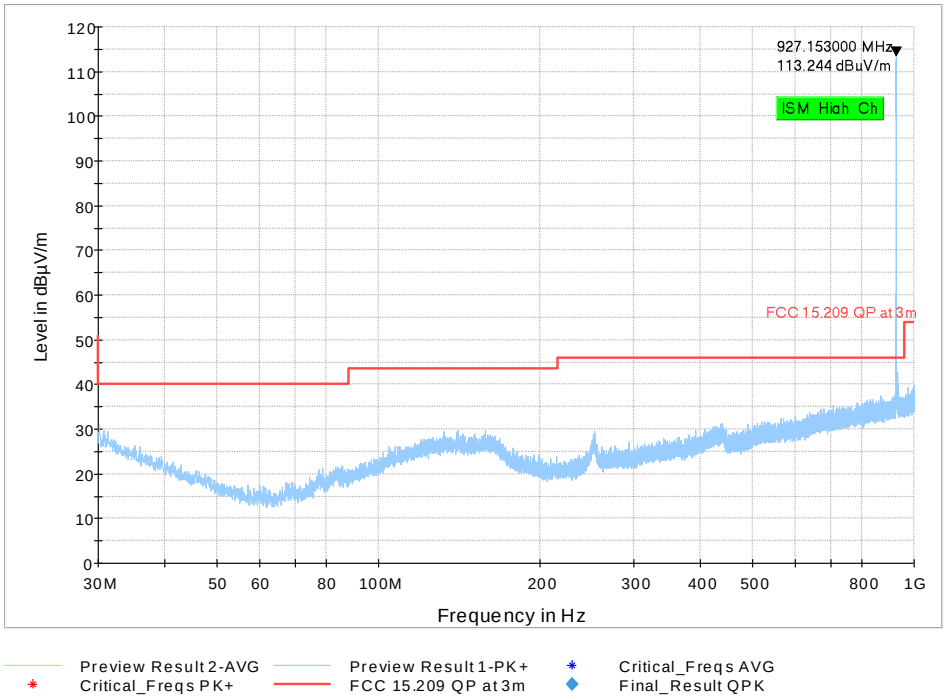
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3679.250	---	48.73	53.98	5.25	500.0	1000.000	158.0	H	38.0	-5.6	
3679.250	55.91	---	73.98	18.07	500.0	1000.000	158.0	H	38.0	-5.6	
4600.750	---	43.60	53.98	10.37	500.0	1000.000	100.0	H	323.0	-3.5	
4600.750	52.60	---	73.98	21.38	500.0	1000.000	100.0	H	323.0	-3.5	
5521.000	52.59	---	73.98	21.39	500.0	1000.000	178.0	V	3.0	-2.5	
5521.000	---	43.33	53.98	10.65	500.0	1000.000	178.0	V	3.0	-2.5	
6438.500	---	50.90	53.98	3.08	500.0	1000.000	134.0	V	348.0	-0.7	
6438.500	59.71	---	73.98	14.27	500.0	1000.000	134.0	V	348.0	-0.7	
7361.250	59.52	---	73.98	14.46	500.0	1000.000	188.0	V	23.0	-0.3	
7361.250	---	51.14	53.98	2.84	500.0	1000.000	188.0	V	23.0	-0.3	
8281.500	61.11	---	73.98	12.87	500.0	1000.000	107.0	V	72.0	-0.4	
8281.500	---	53.03	53.98	0.95	500.0	1000.000	107.0	V	72.0	-0.4	



Preview Result 2-AVG
FCC 15.209 AVG at 3m
Preview Result 1-PK+
Final_Result PK+
FCC 15.209 PK at 3m
Final_Result CAV

Plot #24 Radiated Emissions: 30 MHz – 1GHz	
Modulation: 2GFSK	**Channel: High**

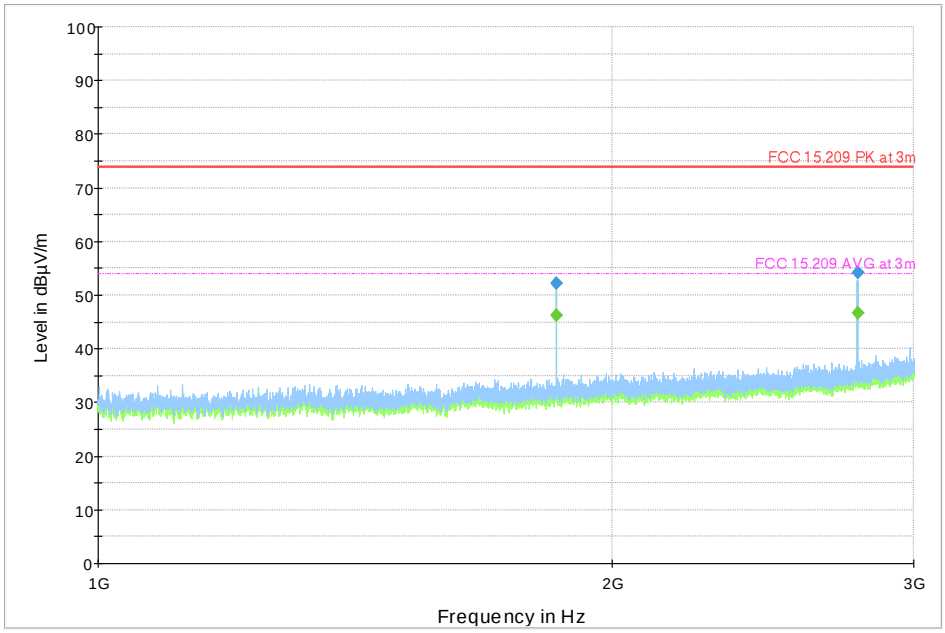


Plot #25 Radiated Emissions: 1-3 GHz

Modulation: 2GFSK	Channel: High

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1853.571	52.30	---	73.98	21.68	500.0	1000.000	168.0	V	76.0	4.5	
1853.571	---	46.25	53.98	7.73	500.0	1000.000	168.0	V	76.0	4.5	
2781.571	54.27	---	73.98	19.71	500.0	1000.000	310.0	H	170.0	7.3	
2781.571	---	46.58	53.98	7.40	500.0	1000.000	310.0	H	170.0	7.3	



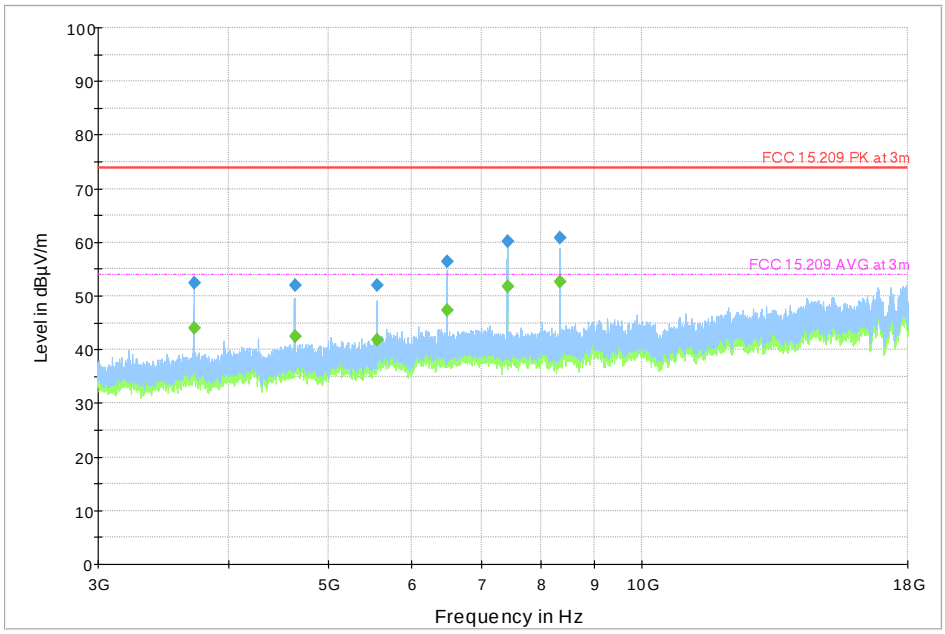
Preview Result 2-AVG
FCC 15.209 AVG at 3m
Preview Result 1-PK+
Final_Result PK+
FCC 15.209 PK at 3m
Final_Result CAV

Plot #26 Radiated Emissions: 3-18 GHz

Modulation: 2GFSK | **Channel: High**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
3708.500	---	44.07	53.98	9.91	500.0	1000.000	100.0	H	44.0	-5.5	
3708.500	52.35	---	73.98	21.63	500.0	1000.000	100.0	H	44.0	-5.5	
4635.750	---	42.53	53.98	11.45	500.0	1000.000	100.0	V	279.0	-3.2	
4635.750	51.89	---	73.98	22.09	500.0	1000.000	100.0	V	279.0	-3.2	
5562.750	52.03	---	73.98	21.95	500.0	1000.000	240.0	V	145.0	-2.2	
5562.750	---	41.92	53.98	12.06	500.0	1000.000	240.0	V	145.0	-2.2	
6490.000	56.31	---	73.98	17.67	500.0	1000.000	100.0	V	145.0	-1.0	
6490.000	---	47.37	53.98	6.61	500.0	1000.000	100.0	V	145.0	-1.0	
7417.250	60.12	---	73.98	13.86	500.0	1000.000	107.0	V	165.0	0.2	
7417.250	---	51.78	53.98	2.20	500.0	1000.000	107.0	V	165.0	0.2	
8341.250	60.94	---	73.98	13.04	500.0	1000.000	100.0	V	258.0	0.1	
8341.250	---	52.63	53.98	1.35	500.0	1000.000	100.0	V	258.0	0.1	



Preview Result 2-AVG
FCC 15.209 AVG at 3m
Preview Result 1-PK+
Final_Result PK+
FCC 15.209 PK at 3m
Final_Result CAV

9 Test setup photos

Setup photos are included in supporting file name: “EMC_TRANS-001-21001_15.247_Setup_Photos_R2.pdf”

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	A.H.Systems	3049	569	3 YEARS	09/24/2020
HORN ANTENNA	ETS.LINDGREN	3115	00035111	3 YEARS	04/17/2019
HORN ANTENNA	ETS LINDGREN	3117	00169547	3 YEARS	09/01/2020
SIGNAL ANALYZER	R&S	FSV 40	101022	3 YEARS	07/15/2019
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	10510-922	200236891	3 YEARS	04/13/2020
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	191871994	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 Revision History

Date	Report Name	Changes to report	Report prepared by
2021-04-13	EMC_TRANS_001_21001_15.247_ISM_DTS	Initial version	Yuchan Lu
2021-04-13	EMC_TRANS_001_21001_15.247_ISM_DTS_R1	Updated output power measurement and antenna gain	Yuchan Lu
2021-05-25	EMC_TRANS_001_21001_15.247_ISM_DTS_R2	Updated the antenna gain and antenna detals in the information tables. Added CABID and “The End”.	Yuchan Lu

<<The End>>