FCC / ISED Test Report

FOR:

HUF

Model Name:

HUFGM2699

Product Description:

General Motors Keyfob

FCC ID: YGOG20TB1
IC ID: 4008C–G20TB1

Applied Rules and Standards:
47 CFR Part: 15.231
RSS-210 & RSS-Gen Issue 5

REPORT #: EMC_HUFUS-004-17001_15.231

DATE: 2018-05-10

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 15.231 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-210 & RSS-Gen Issue 5.

No deviations were ascertained.

Company	Description	Model #
HUF	General Motors Keyfob	HUFGM2699

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2018-05-10	Compliance	James Donnellan (Lab Manager)	

Responsible for the Report:

Date	Section	Name	Signature
2018-05-10	Compliance	Kris Lazarov (Senior EMC Engineer)	Digitally signed by Kris Lazarov Date: 2018.05.25 15:23:27 -07'00'

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
Fax:	+1 (408) 586 6299
Compliance Manager:	James Donnellan
Responsible Project Leader:	Kris Lazarov

2.2 Identification of the Client

Applicant's Name:	Huf Hülsbeck & Fürst GmbH & Co. KG
Street Address:	Steeger Str. 17
City/Zip Code	Velbert 42551
Country	Germany

2.3 Identification of the Manufacturer

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

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	HUFGM2699
HW Version :	3.2
SW Version :	MRD 130
FCC-ID :	YGOG20TB1
IC-ID:	4008C–G20TB1
FWIN:	MRD 130
HVIN:	HUFGM2699
PMN:	GM MY20 B1 KEYFOB
Product Description:	General Motors Keyfob
Frequency Range / number of channels:	433.2 MHz to 434.64 MHz / 3 channels
Type(s) of Modulation:	ASK / FSK
Modes of Operation:	Short term pulsed transmission
Antenna Information as declared:	Internal PCB
Max. Peak Output Power:	Radiated power: 90 dBuV/m
Power Supply/ Rated Operating Voltage Range:	Vmin: 2.4 VDC/ Vnom: 3 VDC / Vmax: 3.3VDC
Operating Temperature Range	-20 ºC to 70 ºC
Other Radios included in the device:	125 kHz receiver only
Sample Revision	☐Prototype Unit; ☐Production Unit; ■Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	Engineering Sample	3.2	MRD 130	Test Code
2	Engineering Sample	3.2	MRD 130	Production code

3.3 Test Sample Configuration

Set-up #	EUT / AE used for set-up	Comments
1	EUT #1	
2	EUT #2	Powered with dummy battery

3.4 Mode of Operation

EUT Set-up #	Combination of AE used for test set up	Comments
1	ASK	Continuous ASK transmission at 433.2 MHz or 434.64 MHz
2	FSK	Continuous FSK transmission at 433.2 MHz or 434.64 MHz
3	Trigger	Short transmission triggered manually or with 125 kHz signal
4	CW	Unmodulated carrier at middle channel

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low and high channels, and highest possible duty cycle. 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. It was determined during a pretesting that the worst emissions occur with the EUT at vertical orientation.

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 15.231 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-210 & RSS-Gen Issue 5 of ISED Canada.

This test report is to support a request for new equipment authorization under the FCC ID: YGOG20TB1, and IC ID: 4008C–G20TB1

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.231(c) RSS-210 A1.1.3	Emission Bandwidth	Nominal	ASK FSK	■	☐	☐	Complies
§15.231(b) RSS-210 A1.1	Field strength	Nominal	ASK FSK	■	☐	☐	Complies
§15.231(b); §15.205 RSS-210 A1.1	TX Spurious emissions-Radiated	Nominal	ASK FSK	■	☐	☐	Complies
§15.231(a,2) RSS Gen 210 A1.1.1	5 s Periodic Operation	Nominal	Auto/Manual Trigger	■	☐	☐	Complies
§2.1055; RSS-133 6.3	Frequency Stability	Extreme	CW	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	NA	☐	■	☐	See Note 2

Note1: NA= Not Applicable; NP= Not Performed.
Note2: This device does not connect to AC network; hence the test 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=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. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

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:

04/09/2018 - 04/12/2018

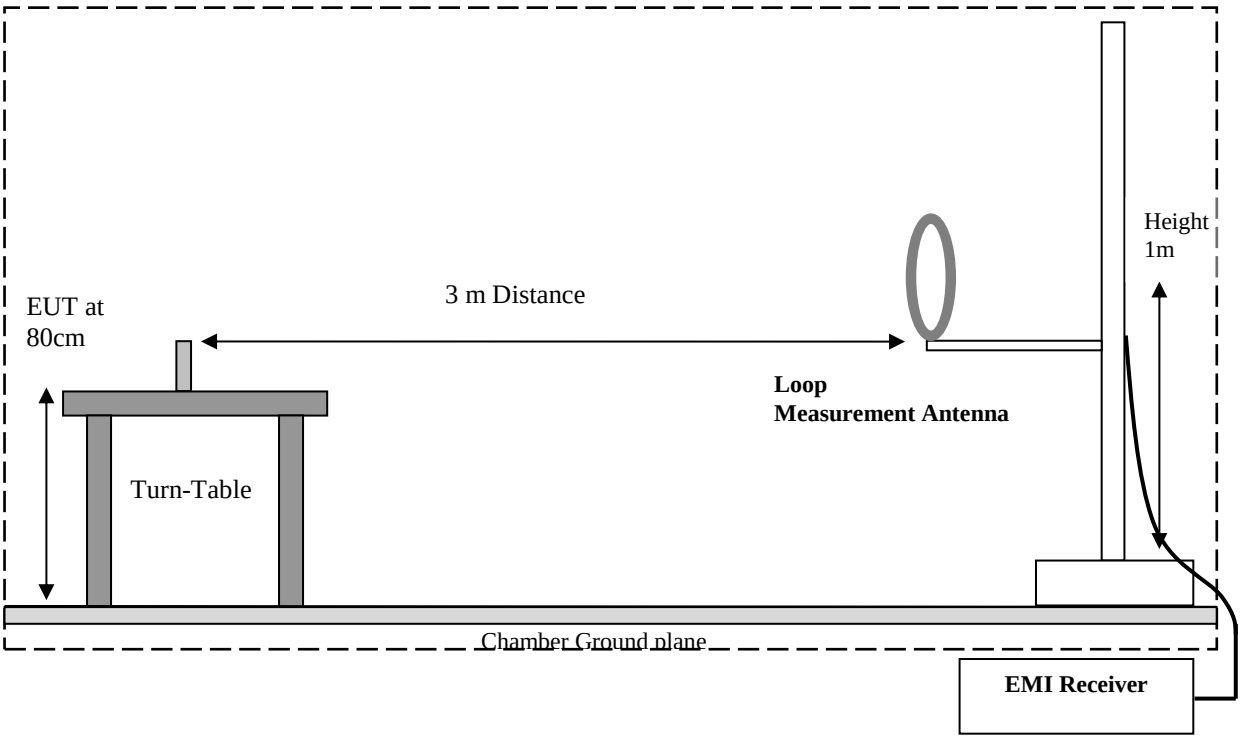
7 Measurement Procedures

7.1 Radiated Measurement

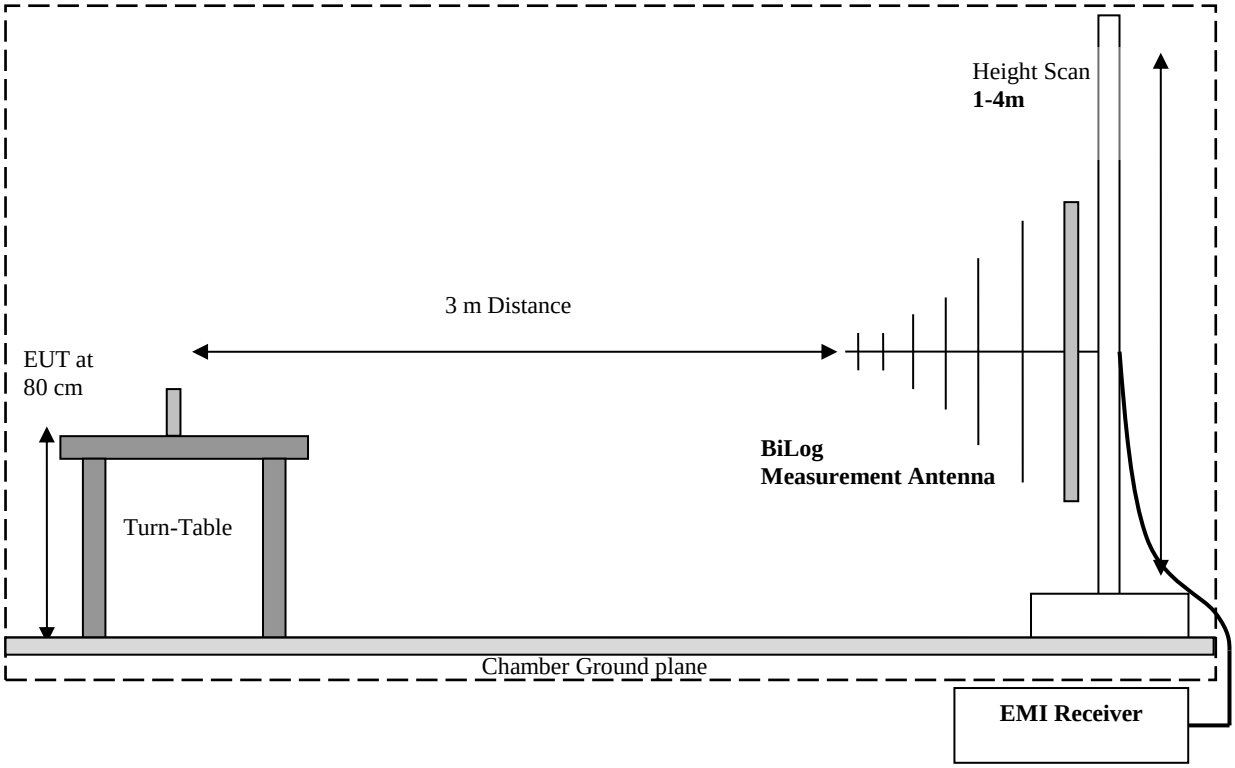
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

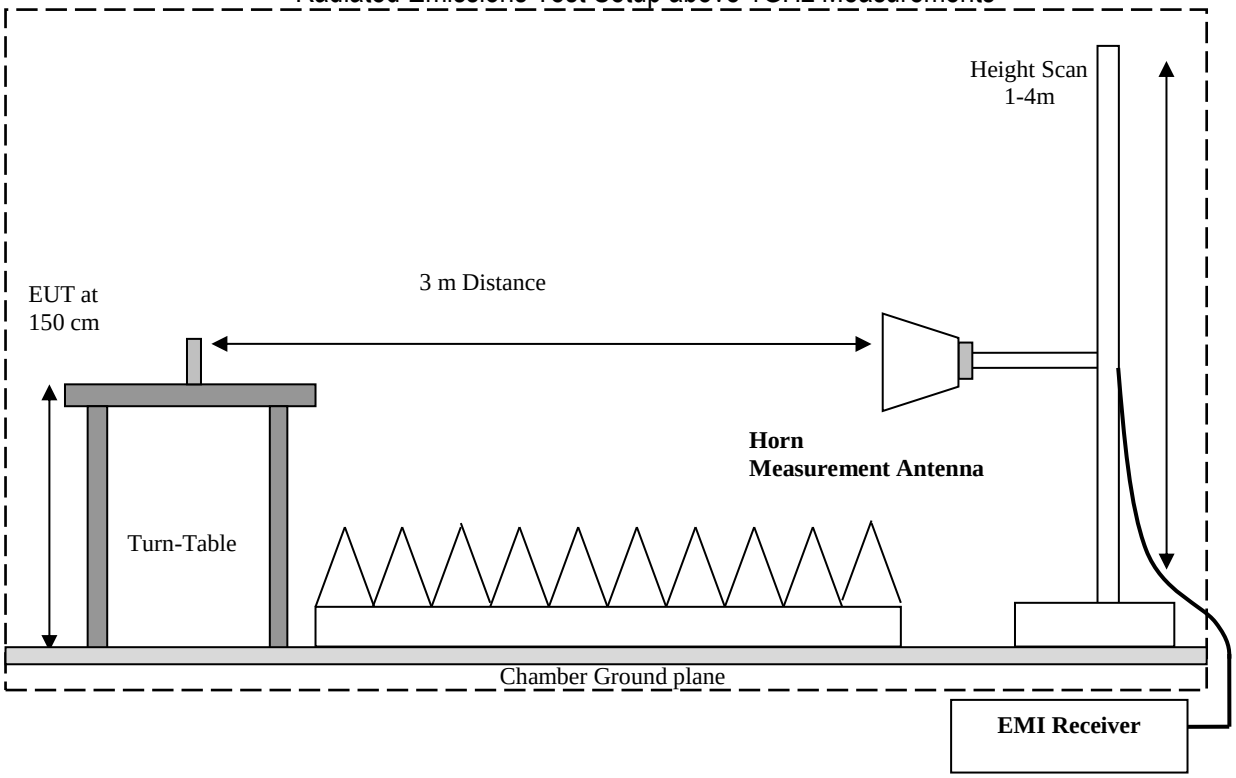
Radiated Emissions Test Setup below 30MHz Measurements



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

8 Test Result Data

8.1 Field strength

8.1.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer settings:

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

8.1.2 Limits:

Maximum Peak Output Power:

- §15.231(b) and RSS 210 A1.1: In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)
260-470	3,750 to 12,500 Linear interpolations

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	433.2 MHz / 434.64 MHz	3 V Battery

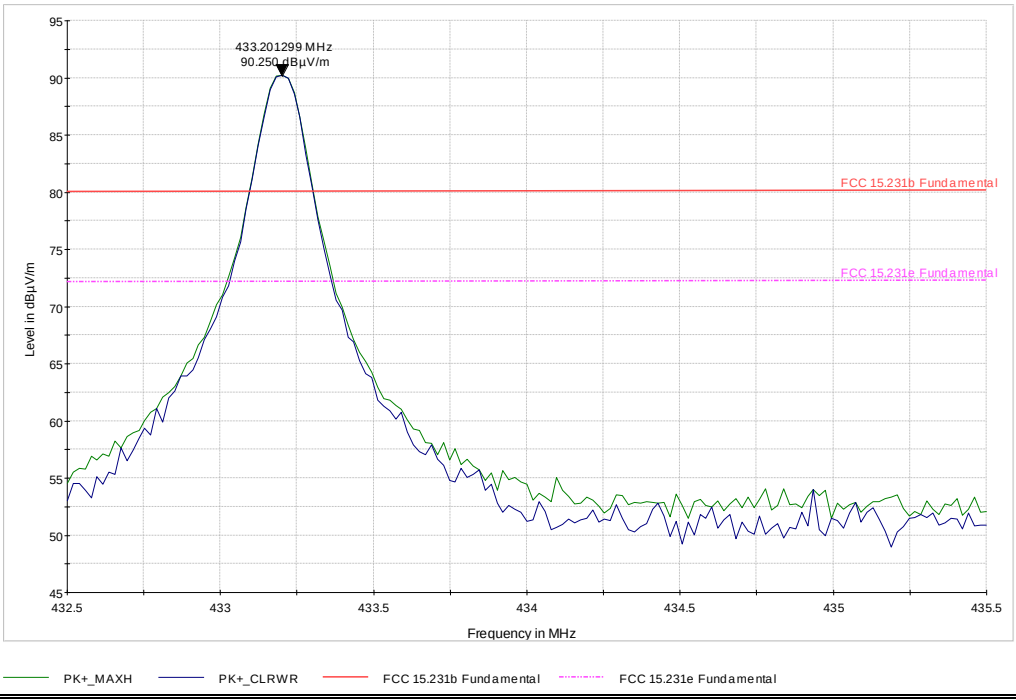
8.1.4 Measurement result:

Plot #	Fundamental frequency (MHz)	Modulation	Fundamental Field Strength (dBµV/m)	Corrected For Duty Cycle* (dBµV/m)	Limit (dBµV/m)	Result
1	433.2	ASK	90.25	77.85	80.00	Pass
2	433.2	FSK	90.44	78.04	80.00	Pass
3	434.64	ASK	90.24	77.84	80.00	Pass
4	434.64	FSK	90.37	77.97	80.00	Pass

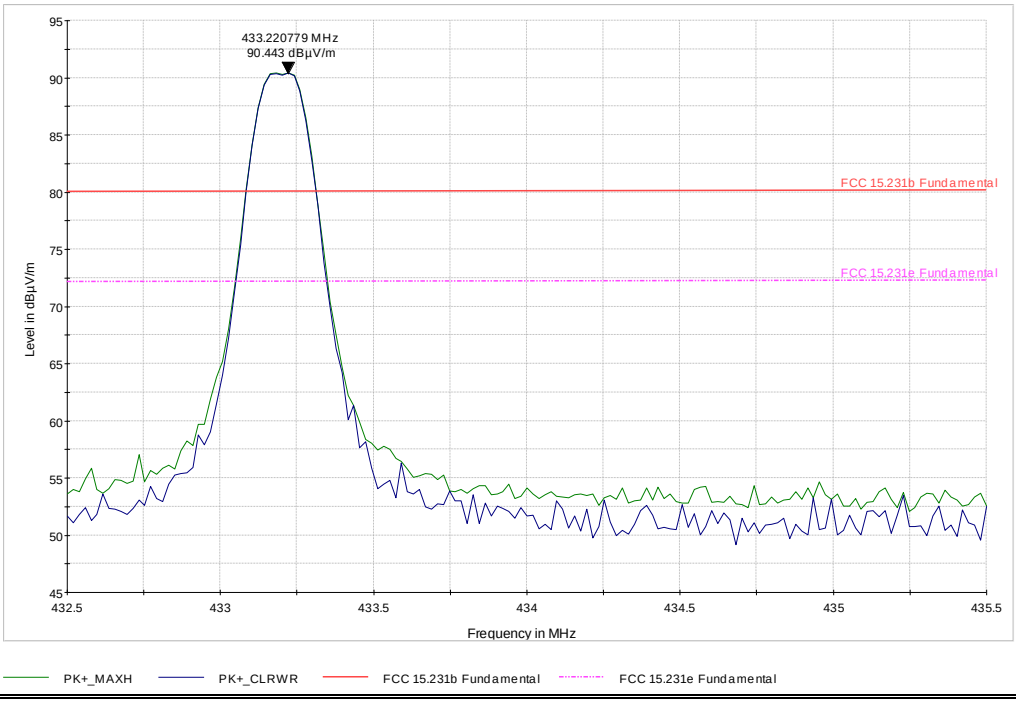
* The field strength results were corrected for the maximum for the device 24% duty cycle, by applying an offset of -12.4 dB calculated using the following formula: 20 * log (Duty Cycle) = 20 * log 0.24 = (-12.4 dB)

8.1.5 Measurement Plots:

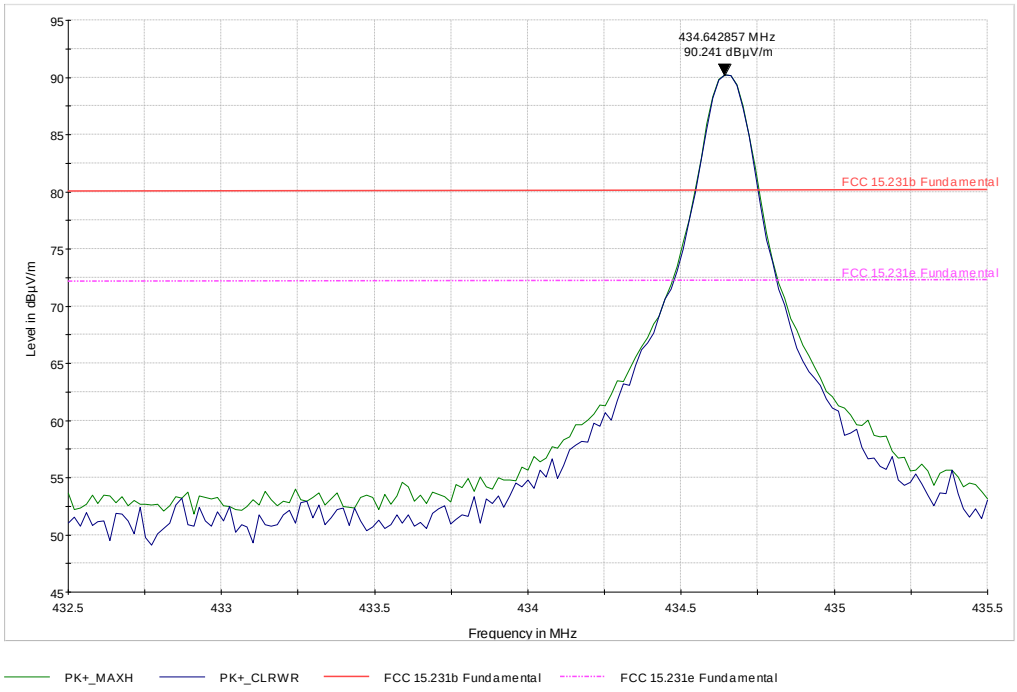
Plot # 1



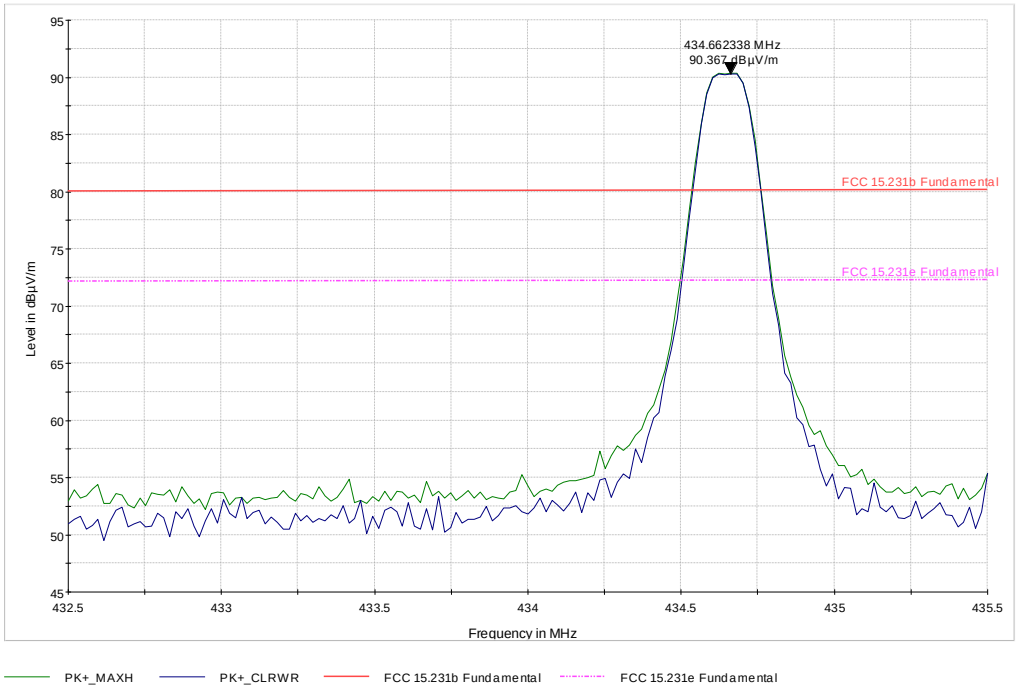
Plot # 2



Plot # 3


434.642857 MHz
90.241 dBµV/m
FCC 15.231b Fundamental
FCC 15.231e Fundamental
Level in dBµV/m
Frequency in MHz
PK+_MAXH
PK+_CLRWR
FCC 15.231b Fundamental
FCC 15.231e Fundamental

Plot # 4


434.662338 MHz
90.367 dBµV/m
FCC 15.231b Fundamental
FCC 15.231e Fundamental
Level in dBµV/m
Frequency in MHz
PK+_MAXH
PK+_CLRWR
FCC 15.231b Fundamental
FCC 15.231e Fundamental

8.2 Emission Bandwidth

8.2.1 Measurement according to ANSI C63.10 (2013)

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.

8.2.2 Limits:

- FCC §15.231(c): The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.
- RSS-210 A1.1.3: The 99% bandwidth shall be no wider than 0.25% of the center frequency for devices operating between 70 MHz and 900 MHz.

8.2.3 Test conditions and setup:

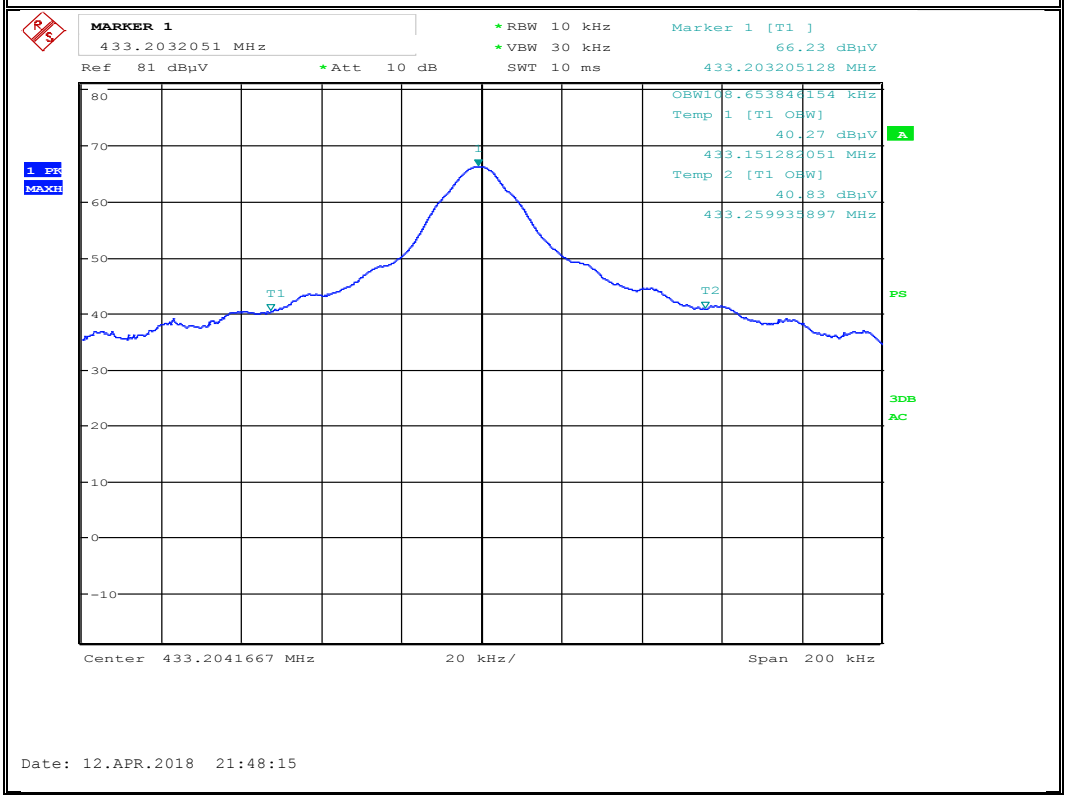
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	433.2 MHz / 434.64 MHz	3 V Battery

8.2.4 Measurement result:

Plot #	Frequency (MHz)	Modulation	99% Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	433.2	ASK	0.108	1.082	Pass
2	433.2	FSK	0.095	1.082	Pass
3	434.64	ASK	0.108	1.082	Pass
4	434.64	FSK	0.094	1.082	Pass

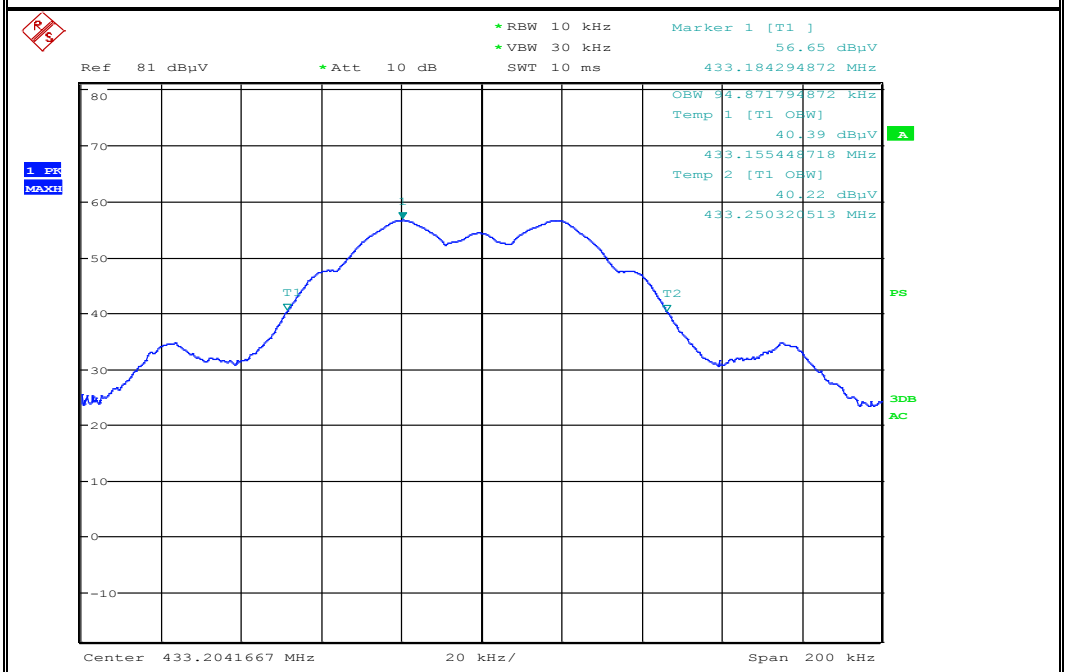
8.2.5 Measurement Plots:

Plot #1



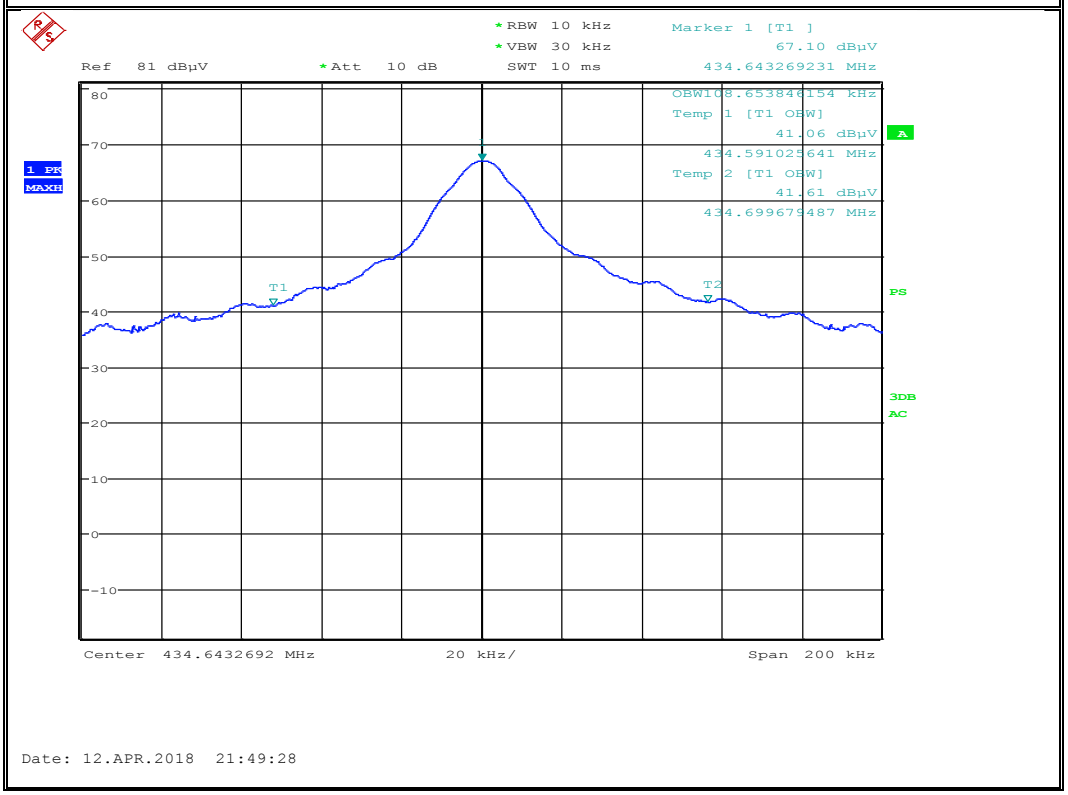
Date: 12.APR.2018 21:48:15

Plot #2



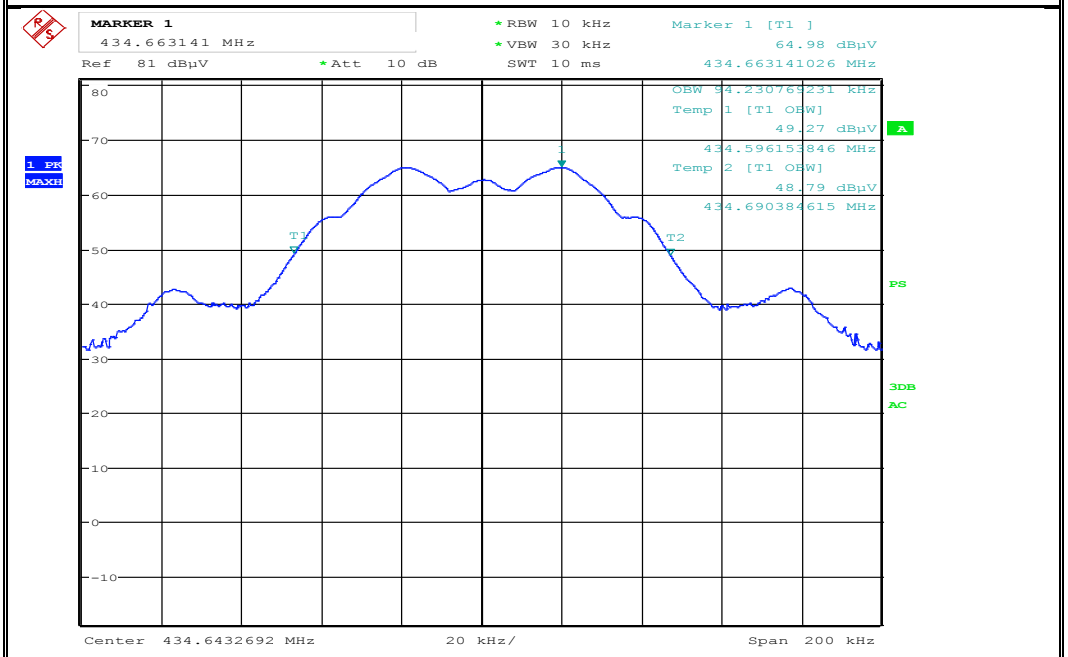
Date: 12.APR.2018 21:45:34

Plot #3



Date: 12.APR.2018 21:49:28

Plot #4



Date: 12.APR.2018 21:50:26

8.3 Radiated Transmitter Spurious Emissions and Restricted Bands

8.3.1 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

8.3.2 Limits:

- §15.231(b) and RSS 210 A1.1: In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	2,250	225
70-130	1,250	125
130-174	[1]1,250 to 3,750	[1]125 to 375
174-260	3,750	375
260-470	[1]3,750 to 12,500	[1]375 to 1,250
Above 470	12,500	1,250

- 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 (see §15.205(b)).

8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	433.2 MHz / 434.64 MHz	3 VDC

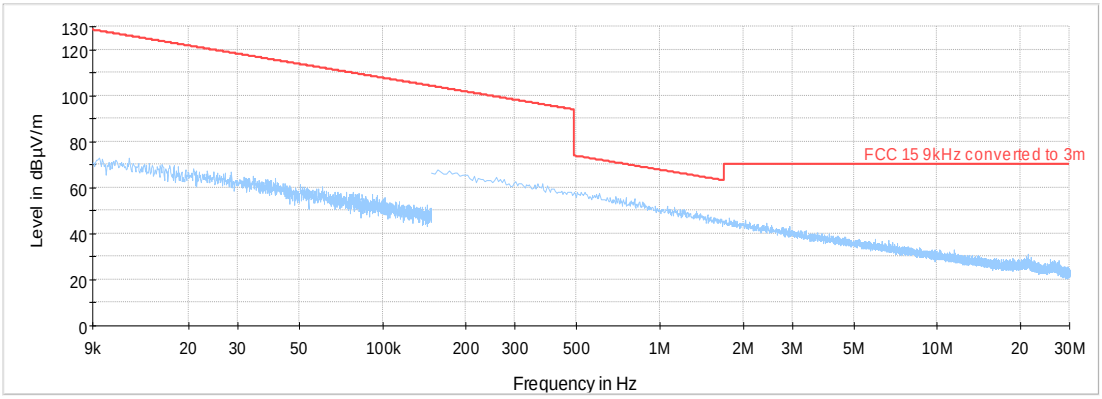
8.3.4 Measurement result:

Plot #	Channel #	Modulation	Scan Frequency	Limit	Result
1-4	433.2	ASK	9 kHz – 5 GHz	See section 8.3.2	Pass
5-8	433.2	FSK	9 kHz – 5 GHz	See section 8.3.2	Pass
9-12	434.64	ASK	9 kHz – 5 GHz	See section 8.3.2	Pass
13-16	434.64	FSK	9 kHz – 5 GHz	See section 8.3.2	Pass

Note: The field strength results were corrected for the maximum for the device 24% duty cycle, by applying an offset of -12.4 dB calculated using the following formula: 20 * log (Duty Cycle) = 20 * log 0.24 = (-12.4 dB)

8.3.5 Measurement Plots:

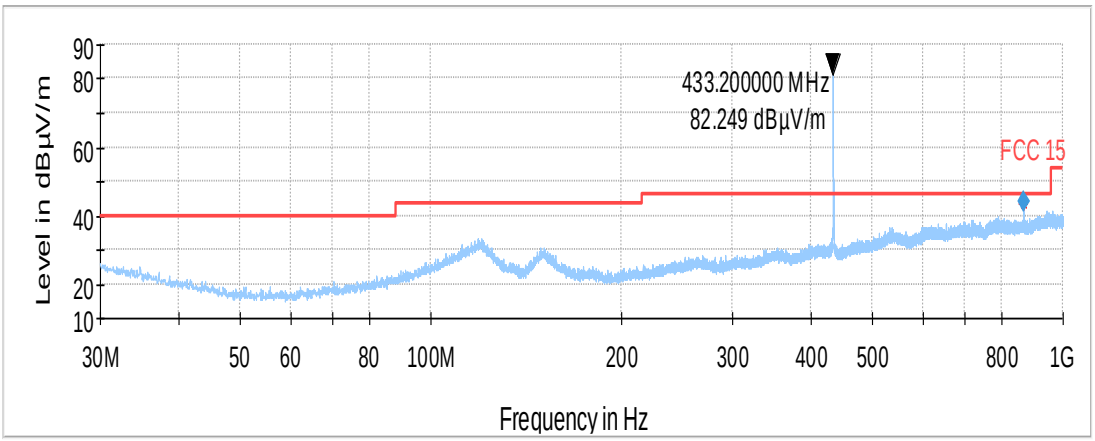
Plot # 1 Radiated Emissions: 9 KHz – 30 MHz		
Modulation: ASK	**Fundamental @ 433.2 MHz**	**100% Duty Cycle**



Preview Result 2-AVG
Critical_Freqs PK+
Final_Result AVG
Preview Result 1-PK+
FCC 15 9kHz converted to 3m
Critical_Freqs AVG
Final_Result PK+

Plot # 2 Radiated Emissions: 30 MHz – 1GHz		
Modulation: ASK	**Fundamental @ 433.2 MHz**	**100% Duty Cycle**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
866.40000	44.11	46.02	1.91	200.0	120.000	186.0	H	251.0	25.2

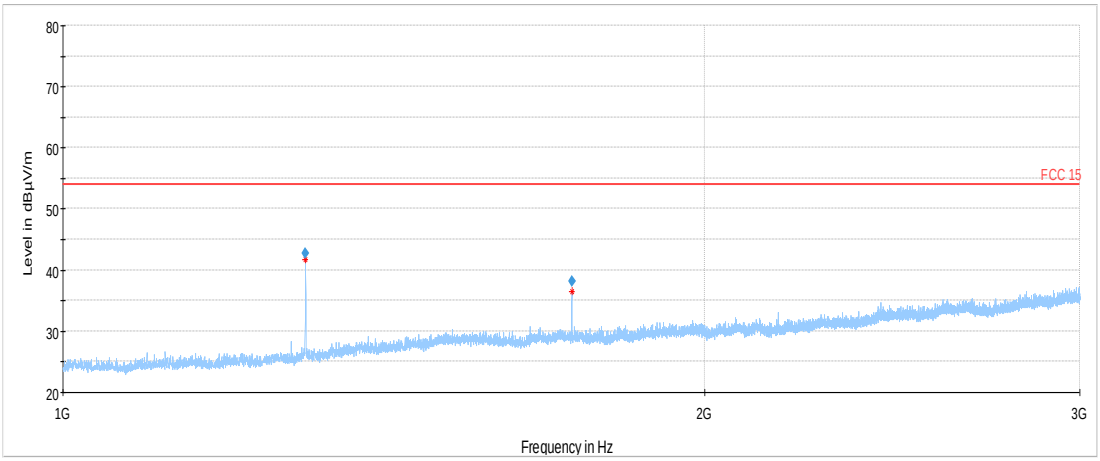


Preview Result 2-AVG
Critical_Freqs PK+
Preview Result 1-PK+
FCC 15
Critical_Freqs AVG
Final_Result QPK

Plot # 3 Radiated Emissions: 1GHz - 3 GHz

Modulation: ASK	Fundamental @ 433.2 MHz	100% Duty Cycle

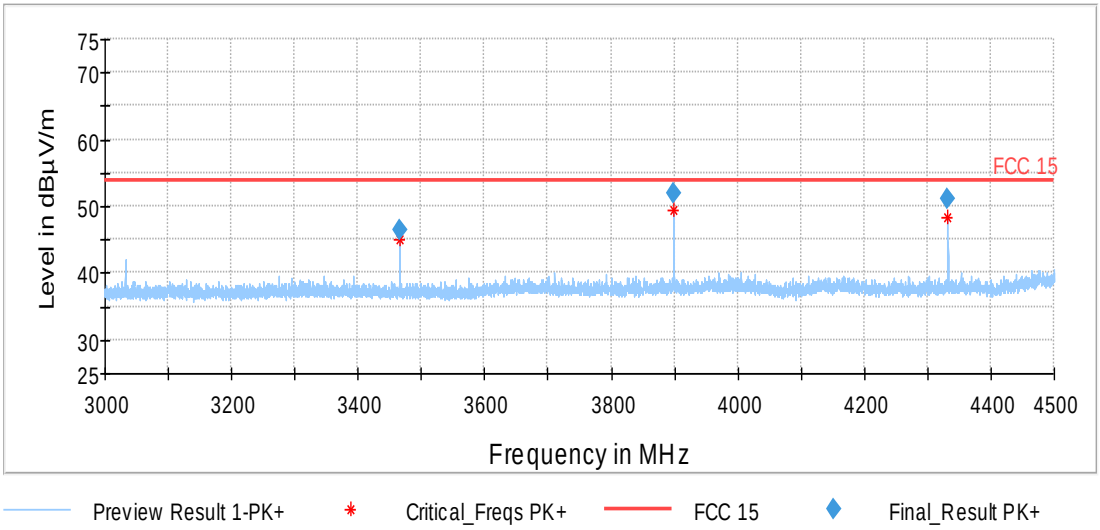
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1299.6	30.37	53.98	23.61	200	1000	190	V	273	-1
1732.8	25.72	53.98	28.26	200	1000	166	V	128	1.8



Plot # 4 Radiated Emissions: 3 GHz - 5 GHz

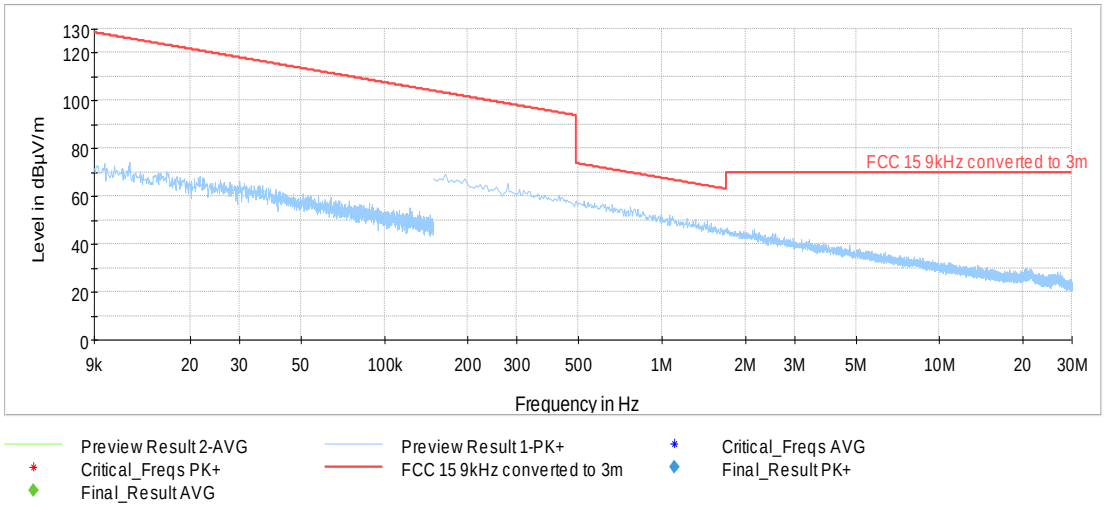
Modulation: ASK	Fundamental @ 433.2 MHz	100% Duty Cycle

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3465.6	33.96	53.98	20.02	200	1000	169	V	292	-7.8
3898.8	39.6	53.98	14.38	200	1000	300	H	45	-6.1
4332	38.62	53.98	15.36	200	1000	286	H	86	-5.2



Plot # 5 Radiated Emissions: 9 KHz – 30 MHz

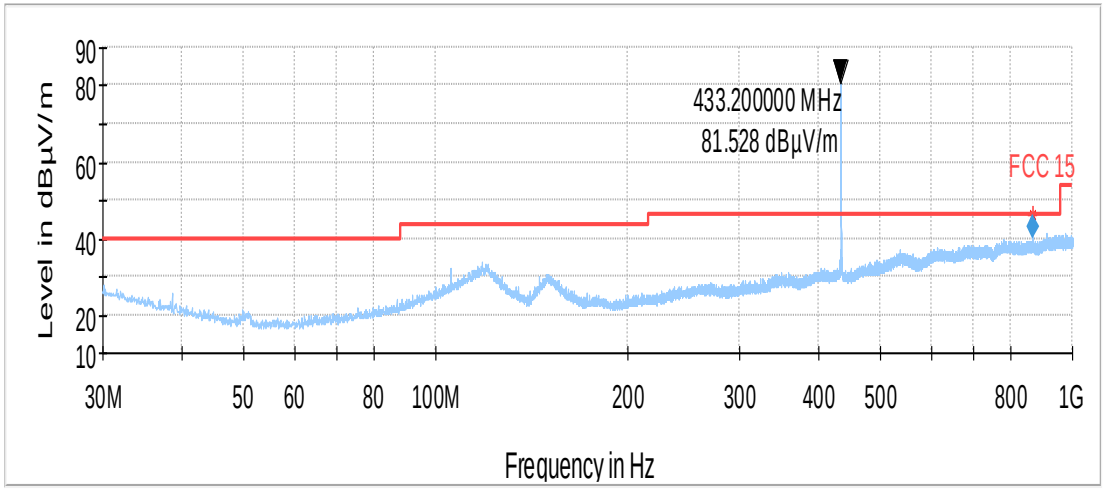
Modulation: FSK	Fundamental @ 433.2 MHz	100% Duty Cycle



Plot # 6 Radiated Emissions: 30 MHz – 1GHz

Modulation: FSK	Fundamental @ 433.2 MHz	100% Duty Cycle

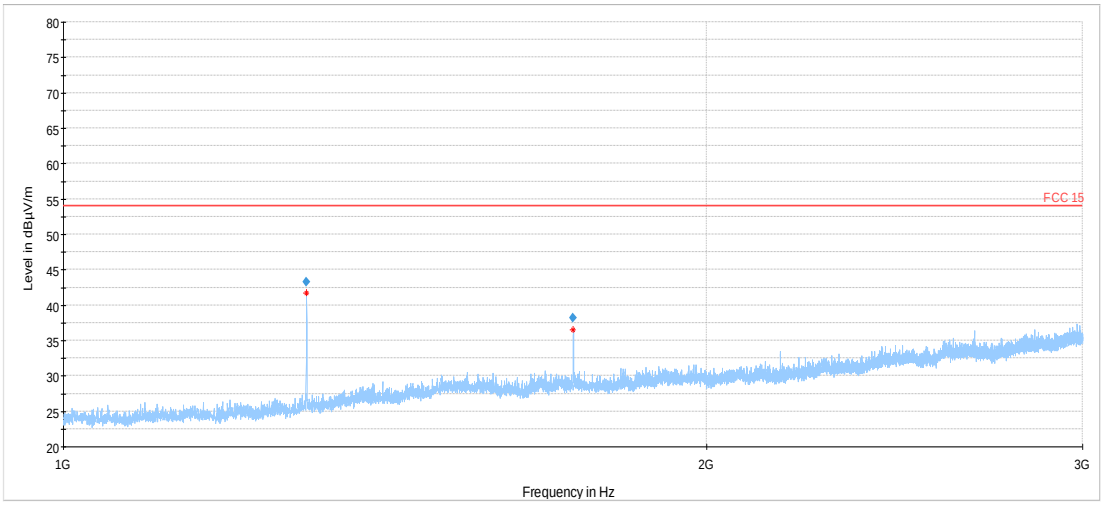
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
866.460000	43.17	46.02	2.85	200.0	120.000	152.0	H	94.0	25.2



Plot # 7 Radiated Emissions: 1GHz - 3 GHz

Modulation: FSK	Fundamental @ 433.2 MHz	100% Duty Cycle

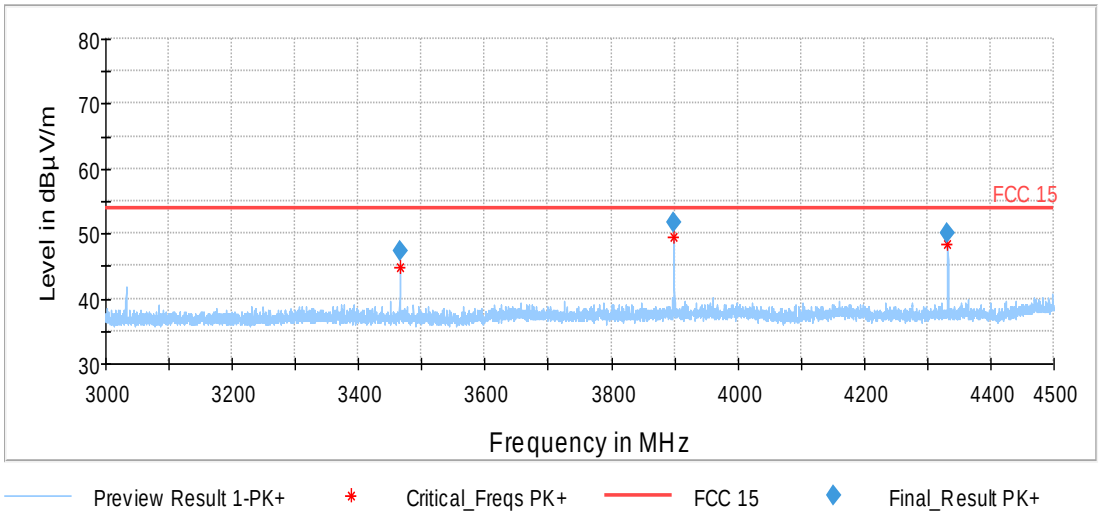
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1299.6	30.88	53.98	23.1	200	1000	180	V	274	-1
1732.7	25.8	53.98	28.18	200	1000	226	V	115	1.8



Plot # 8 Radiated Emissions: 3 GHz - 5 GHz

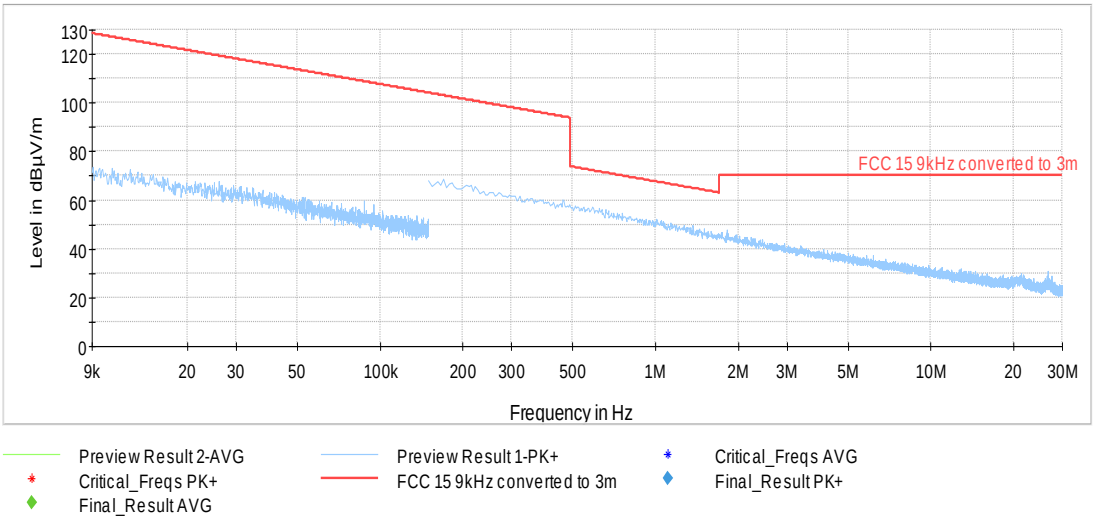
Modulation: FSK	Fundamental @ 433.2 MHz	100% Duty Cycle

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3465.4	34.81	53.98	19.17	200	1000	174	V	286	-7.8
3899	39.34	53.98	14.64	200	1000	274	H	50	-6.1
4332.3	37.6	53.98	16.38	200	1000	300	H	88	-5.2



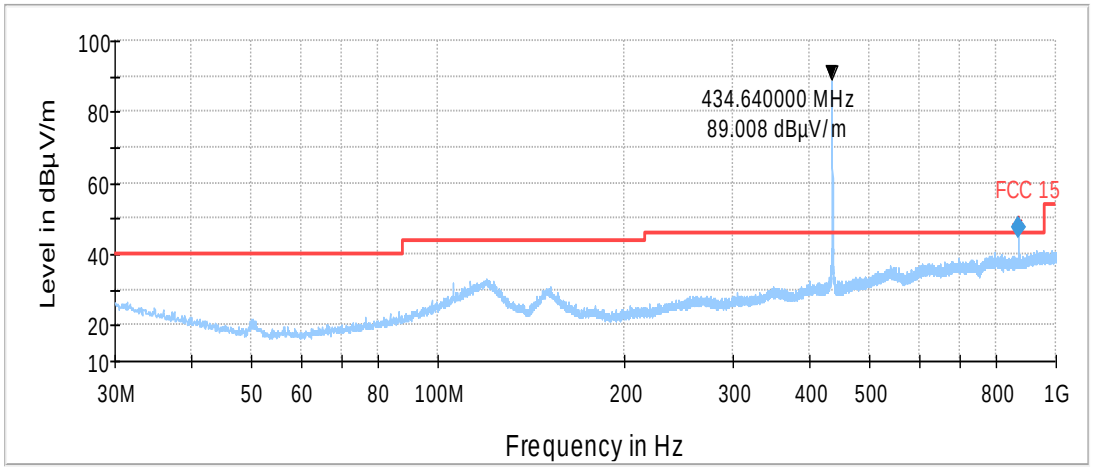
Plot # 9 Radiated Emissions: 9 KHz – 30 MHz

Modulation: ASK	Fundamental @ 434.64 MHz	100% Duty Cycle



Plot # 10 Radiated Emissions: 30 MHz – 1GHz		
Modulation: ASK	Fundamental @ 434.64 MHz	100% Duty Cycle

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
869.28000	47.57	46.02	-1.55	200.0	120.000	185.0	H	94.0	25.2

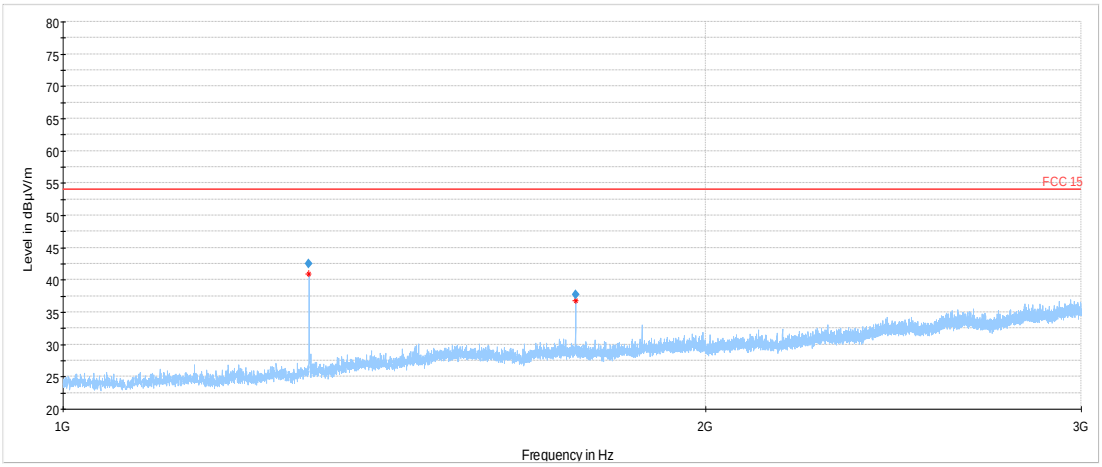


Note: The emissions at 869.28 MHz pass the FCC 15.231 limit of 62 dBµV/m applicable outside of the restricted bands.

Plot # 11 Radiated Emissions: 1GHz - 3 GHz

Modulation: ASK	Fundamental @ 434.64 MHz	100% Duty Cycle

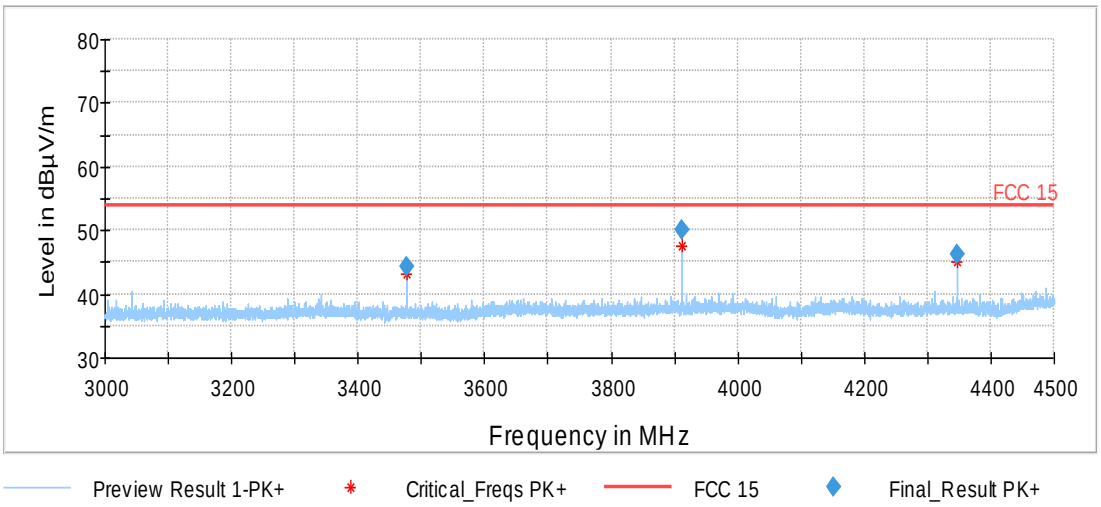
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1303.9	30.13	53.98	23.85	200	1000	183	V	267	-0.9
1738.6	25.31	53.98	28.67	200	1000	162	V	154	1.8



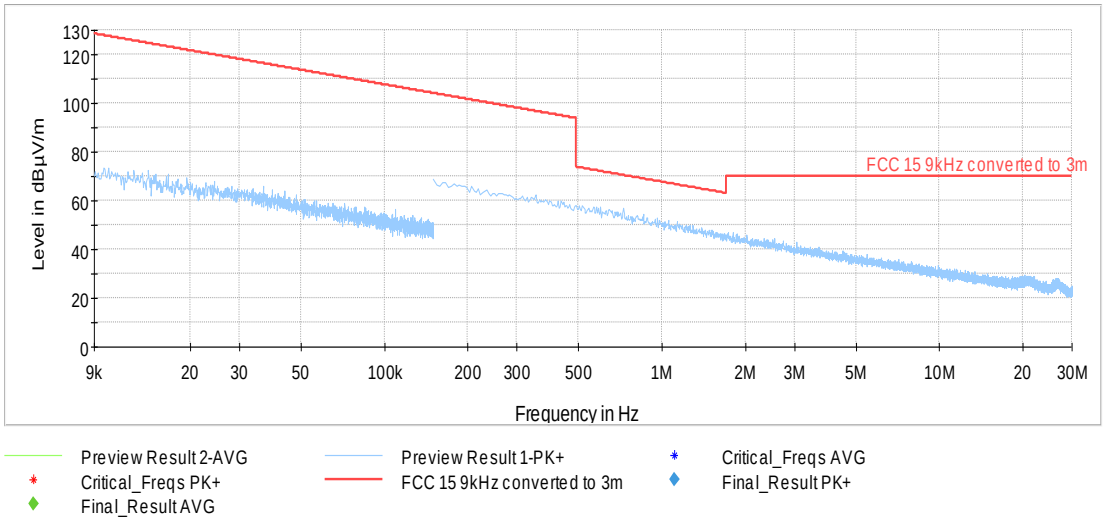
Plot # 12 Radiated Emissions: 3 GHz - 5 GHz

Modulation: ASK	Fundamental @ 434.64 MHz	100% Duty Cycle

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3477.1	31.93	53.98	22.05	200	1000	152	H	90	-7.8
3911.8	37.71	53.98	16.27	200	1000	270	H	67	-6.1
4346.6	33.72	53.98	20.26	200	1000	286	H	81	-5.2

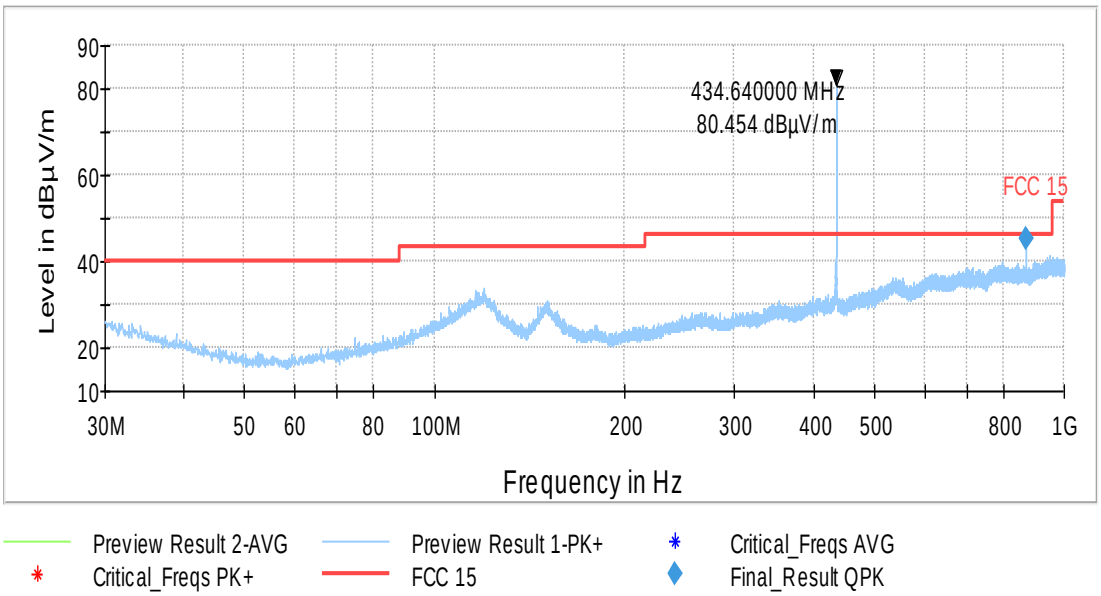


Plot # 13 Radiated Emissions: 9 KHz – 30 MHz		
Modulation: FSK	**Fundamental @ 434.64 MHz**	**100% Duty Cycle**



Plot # 14 Radiated Emissions: 30 MHz – 1GHz		
Modulation: FSK	**Fundamental @ 434.64 MHz**	**100% Duty Cycle**

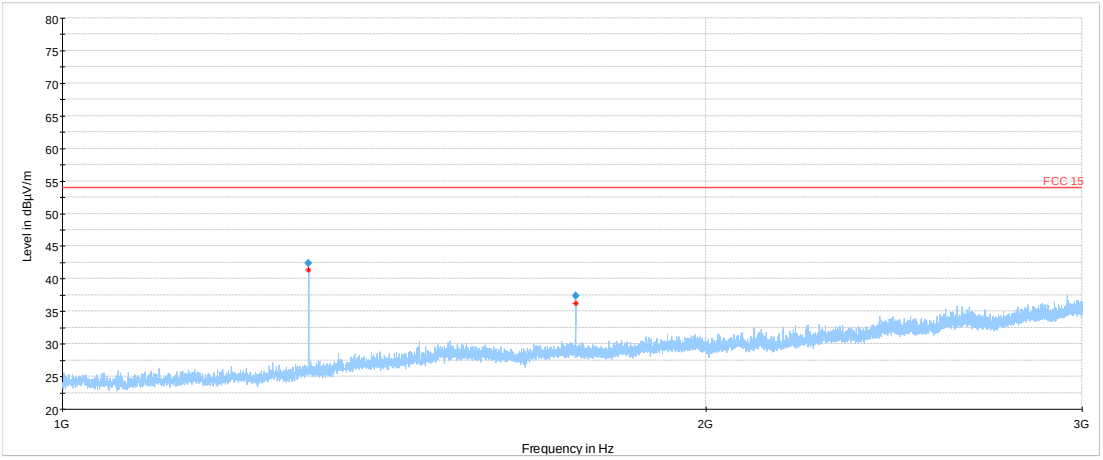
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
869.340000	45.06	46.02	0.96	200.0	120.000	151.0	H	94.0	25.2



Plot # 15 Radiated Emissions: 1GHz - 3 GHz

Modulation: FSK	Fundamental @ 434.64 MHz	100% Duty Cycle

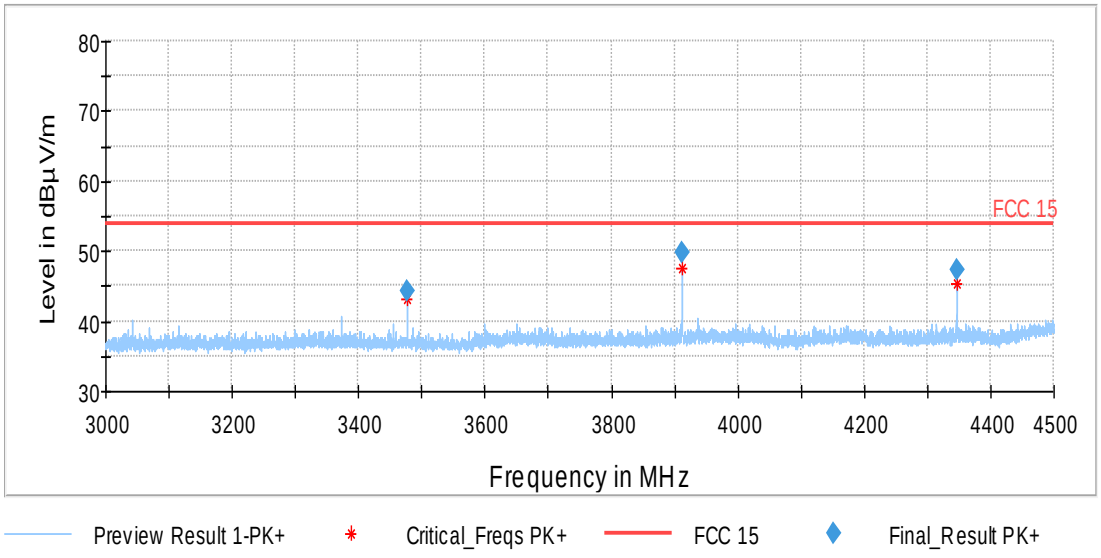
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1303.9	29.97	53.98	24.01	200	1000	186	V	271	-0.9
1738.7	24.96	53.98	29.02	200	1000	205	V	114	1.8



Plot # 16 Radiated Emissions: 3 GHz - 5 GHz

Modulation: FSK	Fundamental @ 434.64 MHz	100% Duty Cycle

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3477	31.93	53.98	22.05	200	1000	223	H	91	-7.8
3911.6	37.29	53.98	16.69	200	1000	300	H	44	-6.1
4346.8	34.92	53.98	19.06	200	1000	263	H	93	-5.2



8.4 5 s Periodic Operation

8.4.1 Measurement according to FCC 15.231

Spectrum Analyzer settings:

- Center Frequency = Channel Frequency
- Span = Zero Span
- Set RBW = 3 kHz
- Set the video bandwidth (VBW) ≥ 3 x RBW
- Detector = Peak
- Trace mode = Max hold
- Trigger = Video
- Sweep Time = Sufficient to capture complete transmission
- Use marker delta to measure the duration of transmission

8.4.2 Limits:

- FCC §15.231 (a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:
    - (1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.
    - (2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.
- RSS-210 A1.1: Devices shall comply with the following for momentary operation:
    - A manually operated transmitter shall be equipped with a push-to-operate switch and be under manual control at all times during transmission. When released, the transmitter shall cease transmission within no more than 5 seconds of being released.
    - A transmitter that has been activated automatically shall cease transmission within 5 seconds of activation.

8.4.3 Test conditions and setup:

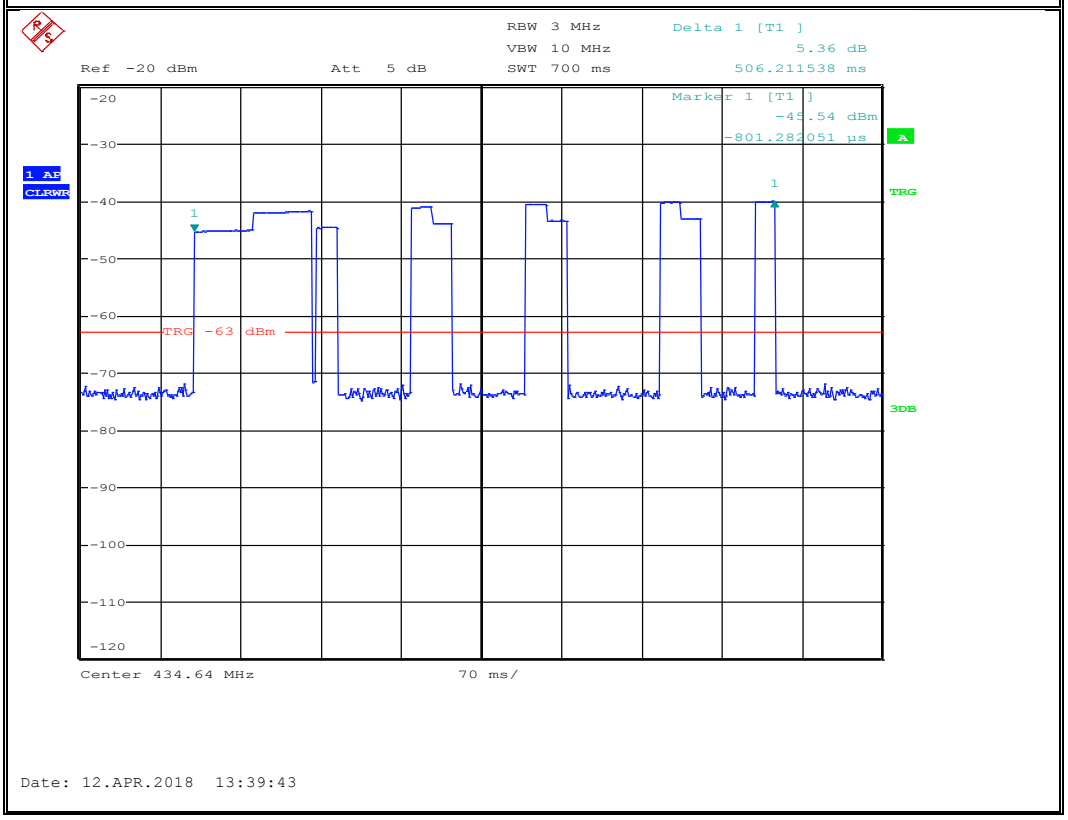
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	433.2 MHz Triggered	3 V Battery

8.4.4 Measurement result:

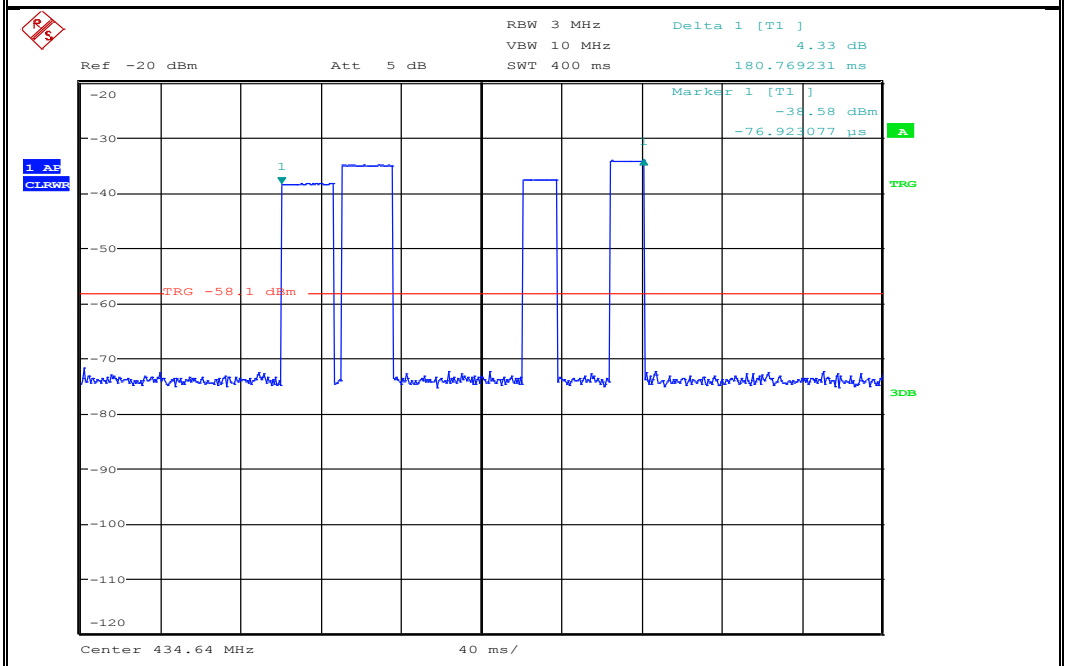
Plot #	Frequency (MHz)	Trigger	Total transmission time (s)	Limit (s)	Result
1	433.2	Manual	0.5	<5	Pass
2	433.2	Remote	0.2	<5	Pass

8.4.5 Measurement Plots:

Plot #1


RBW 3 MHz
VBW 10 MHz
SWT 700 ms
Delta 1 [T1]
5.36 dB
506.211538 ms
Ref -20 dBm
Att 5 dB
Marker 1 [T1]
-45.54 dBm
-801.282051 µs
1 AP
CLRWR
A
TRG
3DB
TRG -63 dBm
Center 434.64 MHz
70 ms/
Date: 12.APR.2018 13:39:43

Plot #2


RBW 3 MHz
VBW 10 MHz
SWT 400 ms
Delta 1 [T1]
4.33 dB
180.769231 ms
Ref -20 dBm
Att 5 dB
Marker 1 [T1]
-38.58 dBm
-76.923077 µs
1 AP
CLRWR
A
TRG
3DB
TRG -58.1 dBm
Center 434.64 MHz
40 ms/
Date: 12.APR.2018 13:42:31

8.5 Frequency Stability

8.5.1 Measurement according to: FCC: CFR 47 Part 2.1055

The center frequency of transmission on middle channel was measured at the low and high supply voltage specified for the equipment in the range of 0 ºC to 50 ºC' at 10 ºC intervals. The frequency stability was calculated using the following equation:

$$ppm\ error = \left(\frac{MCF_{MHz}}{ACF_{MHz}} - 1 \right) * 10^6$$

where

MCF_{MHz} is the Measured Carrier Frequency in MHz
ACF_{MHz} is the Assigned Carrier Frequency in MHz

Spectrum Analyzer settings:

- RBW =30 kHz
- VBW ≥ 300Hz
- Set span = 10MHz
- Sweep time = auto couple
- Detector = Pk
- Trace mode = Clear Write
- Marker Stepsize = SWP POINTS
- Sweep Points = 10000 points
- Measure the frequency at the low and high edge (F low and F high)
- Calculate the center frequency MCF = F low + (F high – F low)/2

8.5.2 Test conditions and setup:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power Input (VDC)
23° C	2	CW	Dummy Battery

8.5.3 Measurement result:

Temperature (°C)	Supply Power (V)	MCF (MHz)	ACF (MHz)	Frequency Stability (ppm)
-20	2.4	433.9289	433.92	2.1
-20	3.3	433.9281	433.92	1.9
-10	2.4	433.9282	433.92	1.9
-10	3.3	433.9289	433.92	2.1
0	2.4	433.9284	433.92	1.9
0	3.3	433.9281	433.92	1.9
10	2.4	433.927	433.92	1.6
10	3.3	433.9279	433.92	1.8
20	2.4	433.925	433.92	1.2
20	3.3	433.9246	433.92	1.1
30	2.4	433.9222	433.92	0.5
30	3.3	433.9223	433.92	0.5
40	2.4	433.9211	433.92	0.3
40	3.3	433.9208	433.92	0.2
50	2.4	433.9184	433.92	-0.4
50	3.3	433.9189	433.92	-0.3
60	2.4	433.9169	433.92	-0.7
60	3.3	433.9172	433.92	-0.6
70	2.4	433.9162	433.92	-0.9
70	3.3	433.9164	433.92	-0.8

9 Test setup photos

Setup photos are included in supporting file name: “EMC_HUFUS-004-17001_15.231_Setup_Photos.pdf”

10 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	6/27/2017
Magnetic Loop Antenna	Loop Antenna	ETS Lindgren	6512	164698	3 years	7/8/2017
Antenna Horn 3115	Horn Antenna	ETS Lindgren	3115	35114	3 years	31/6/2017
Antenna Horn 3117-PA	Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	8/8/2017
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	6/8/2017
FSV40	Spectrum Analyzer	R&S	FSV40	101022	2 years	5/7/2017
FSU26	Spectrum Analyzer	R&S	FSU26	200302	2 years	7/5/2017
Thermometer Humidity TM320	Thermometer Humidity	Dickson	TM320	1625369	1 Year	6/1/2017

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	Report prepared by
2018-05-10	EMC_HUFUS-004-17001_15.231	Initial Version	Kris Lazarov