Itron, Inc.

REVISED EMC TEST REPORT TO 105444-6

AMR Transceiver Device For Communicating With Utility Meters
Models: IMRD-INT and IMRD-EXT

Tested to The Following Standards:

FCC Part 101 Subpart C

Report No.: 105444-6A

Date of issue: November 9, 2021

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Test Certificate # 803.01

Testing the Future
CKC LABORATORIES, INC.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

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Liberty Lake WA 99019

Representative: Jay Holcomb
Customer Reference Number: 238223

REPORT PREPARED BY:

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CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 105444

DATE OF EQUIPMENT RECEIPT: June 21, 2021
DATE(S) OF TESTING: June 21, 2021 to July 19, 2021

Revision History

Original: Testing of the AMR Transceiver Device For Communicating With Utility Meters
Modeld: IMRD-INT and IMRD-EXT to FCC Part 101 Subpart C.
Revision A: To remove incorrect test method references, removed limit references for Section 101.111(a)(5) Emissions Limitations, Conducted and Radiated, and added measurement uncertainty table to the end of the report.

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.
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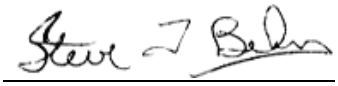


Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
22116 23rd Drive S.E.,
Canyon Park, Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.19
EMITest Immunity	5.03.10

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

SUMMARY OF RESULTS

Standard / Specification: FCC Part 2 / 101

Test Procedure	Description	Modifications	Results
2.1055 / 101.107(a)	Frequency Tolerance	NA	Pass
2.1049 / 101.109(c)	Bandwidth	NA	Pass
2.1051 / 101.111(a)(5)	Emissions Limitations- Conducted	NA	Pass
2.1053 / 101.111	Emissions Limitations- Radiated	NA	Pass
2.1046 / 101.113	Transmitter Power Limitations	NA	Pass
2.1047	Modulation Characteristics	NA	NA1

NA = Not Applicable

NA1 = Not applicable because the EUT does not employ any modulation types outlined in the rules.

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

During testing numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
AMR transceiver device for communicating with utility meters	Itron, Inc.	IMRD-EXT	105444-ext

Support Equipment:

Device	Manufacturer	Model #	S/N
Toughpad	Panasonic	FZ-G1	NA
DC Power Supply	Rigol	DP711	NA

Configuration 2

Equipment Tested:

Device	Manufacturer	Model #	S/N
AMR transceiver device for communicating with utility meters	Itron, Inc.	IMRD-INT	105444-int cond

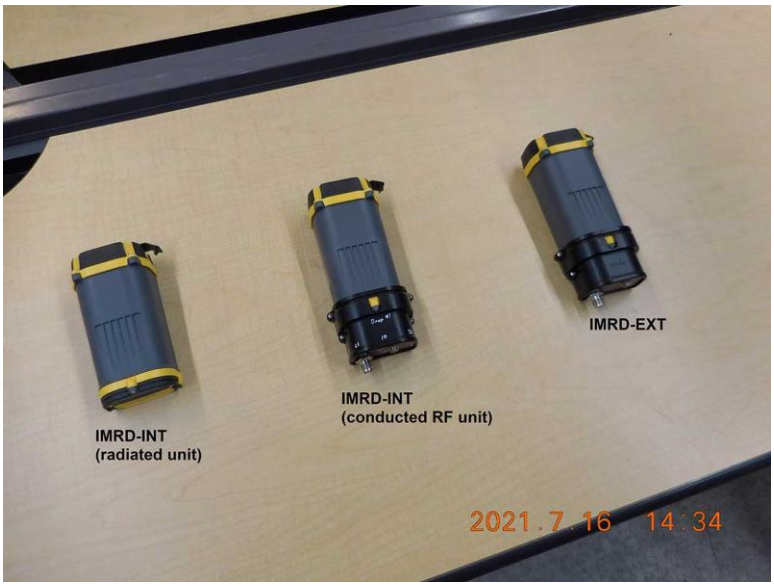
Support Equipment:

Device	Manufacturer	Model #	S/N
Toughpad	Panasonic	FZ-G1	NA
DC Power Supply	Rigol	DP711	NA

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Modulation Type(s):	OOK
Antenna Type(s) and Gain:	Internal PIFA 2.0 dBi External Omni Vehicle 5 dBi External Omni Attached 3dBi
Antenna Connection Type:	Integral and External variant
Nominal Input Voltage:	120VAC 60Hz to AC Adapter on Internal Unit 13.8V DC on External Unit
Firmware / Software used for Test:	DSP Version 7.00.00.26 / FPGA Version 3.08 / MC3 Test v 4.0.3.5
Temperature Range	-20°C to 50°C (for frequency stability it will be tested down to -30C)

EUT Photo(s)

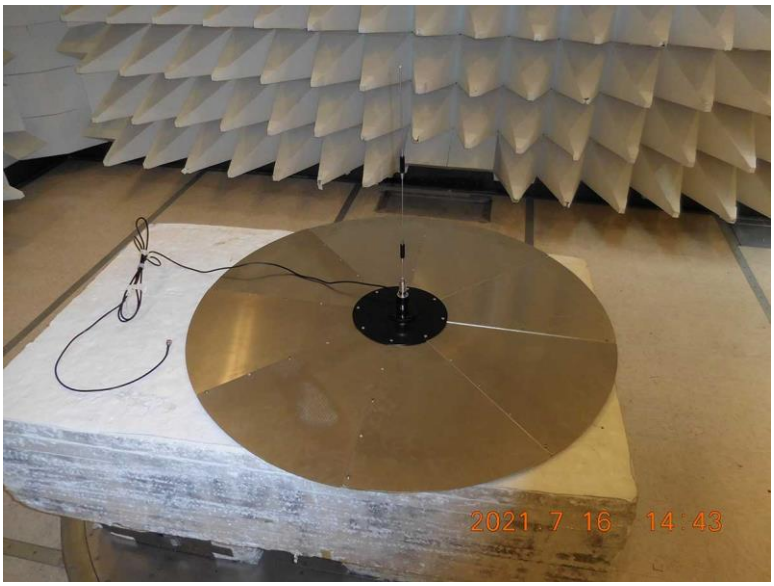


Support Equipment Photo(s)

AC-USB Adapter

Attached Antenna with adapter

DC Power Supply

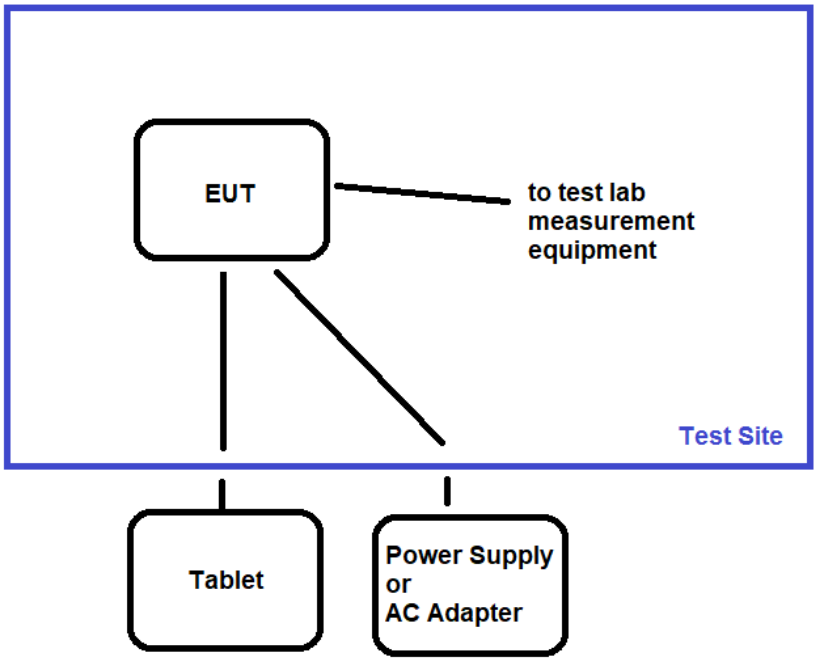


External Antenna + Ground Plane

Tablet

Block Diagram of Test Setup(s)

Test Setup Block Diagram



Configuration 1 and 2

FCC Part(s) 101 Subpart C

2.1055 / 101.107(a) Frequency Tolerance

Test Setup/Conditions			
Test Location:	Bothell Lab Bench 2	Test Engineer:	M. Atkinson
Test Method:	FCC CFR 47 Part 101.107, , ANSI C63.26 (2015)	Test Date(s):	7/19/2021
Configuration:	1 and 2		
Test Setup:	The EUTs are in a temperature chamber, configuration 1 and 2 are in the chamber at the same time. However, only one EUT is tested at a time, the appropriate connections are swapped on the outside of the test chamber depending on which unit is tested. EUT is transmitting with modulation (data reported is for 64Hz modulation). For the Internal Antenna version, a unit with a temporary antenna port has been provided by the manufacturer. At time of test low channel command used was 952.00625 MHz and high channel command used was 959.85MHz.		

Environmental Conditions			
Temperature (ºC)	22-25	Relative Humidity (%):	39-45

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
P07670	Attenuator	Pasternack	PE7389-20	8/20/2020	8/20/2022
P06454	Cable	Andrews	Heliax	1/20/2020	1/20/2022
P06996	Multimeter	Fluke	87-5	6/16/2020	6/16/2022
P07527	Variac	Simpson	NA	1/27/2021	1/27/2023
02272	Power Source, AC	California Instruments	1251WP	1/18/2021	1/18/2023
P07355	Power Supply	YescomUSA	DCP305D	3/3/2020	3/3/2022
02673	Spectrum Analyzer	Agilent	E4446A	2/3/2021	2/3/2023
02757	Temperature Chamber	Bemco	F100/350-8	12/16/2020	12/16/2022
03029	Thermometer, Digital Infrared	Fluke	566	3/11/2021	3/11/2023

Test Data Summary (External Low Channel)					
Temperature (ºC)	**Voltage**	**Frequency (MHz)**	**Frequency Tolerance (%)**	**Limit (%)**	**Results**
-30	$V_{Nominal}$	952.00621	0.00001	0.0005	Pass
-20	$V_{Nominal}$	952.00638	0.00001	0.0005	
-10	$V_{Nominal}$	952.00624	0.00000	0.0005	
0	$V_{Nominal}$	952.00635	0.00001	0.0005	
10	$V_{Nominal}$	952.00628	0.00000	0.0005	
20	$V_{Nominal}$	952.00627	0.00000	0.0005	
30	$V_{Nominal}$	952.00629	0.00000	0.0005	
40	$V_{Nominal}$	952.00627	0.00000	0.0005	
50	$V_{Nominal}$	952.00626	0.00000	0.0005	
20	$V_{Minimum}$	952.00622	0.00001	0.0005	
20	$V_{Maximum}$	952.00620	0.00001	0.0005	
Nominal Frequency:		952.00627			

Test Data Summary (External High Channel)					
Temperature (ºC)	**Voltage**	**Frequency (MHz)**	**Frequency Tolerance (%)**	**Limit (%)**	**Results**
-30	$V_{Nominal}$	959.84995	0.00001	0.0005	Pass
-20	$V_{Nominal}$	959.85008	0.00001	0.0005	
-10	$V_{Nominal}$	959.85000	0.00000	0.0005	
0	$V_{Nominal}$	959.85003	0.00000	0.0005	
10	$V_{Nominal}$	959.85002	0.00000	0.0005	
20	$V_{Nominal}$	959.85000	0.00000	0.0005	
30	$V_{Nominal}$	959.85002	0.00000	0.0005	
40	$V_{Nominal}$	959.85001	0.00000	0.0005	
50	$V_{Nominal}$	959.85002	0.00000	0.0005	
20	$V_{Minimum}$	959.85001	0.00000	0.0005	
20	$V_{Maximum}$	959.85001	0.00000	0.0005	
Nominal Frequency:		959.850001			

Test Data Summary (Internal Low Channel)					
Temperature (ºC)	**Voltage**	**Frequency (MHz)**	**Frequency Tolerance (%)**	**Limit (%)**	**Results**
-30	$V_{Nominal}$	952.00659	0.00004	0.0005	Pass
-20	$V_{Nominal}$	952.00617	0.00000	0.0005	
-10	$V_{Nominal}$	952.00626	0.00001	0.0005	
0	$V_{Nominal}$	952.00613	0.00001	0.0005	
10	$V_{Nominal}$	952.00612	0.00001	0.0005	
20	$V_{Nominal}$	952.00618	0.00000	0.0005	
30	$V_{Nominal}$	952.00622	0.00000	0.0005	
40	$V_{Nominal}$	952.00628	0.00001	0.0005	
50	$V_{Nominal}$	952.00637	0.00002	0.0005	
20	$V_{Minimum}$	952.00683	0.00007	0.0005	
20	$V_{Maximum}$	952.00683	0.00007	0.0005	
Nominal Frequency:		952.006181			

Test Data Summary (Internal High Channel)					
Temperature (ºC)	**Voltage**	**Frequency (MHz)**	**Frequency Tolerance (%)**	**Limit (%)**	**Results**
-30	$V_{Nominal}$	959.85012	0.00002	0.0005	Pass
-20	$V_{Nominal}$	959.84985	0.00001	0.0005	
-10	$V_{Nominal}$	959.84988	0.00001	0.0005	
0	$V_{Nominal}$	959.84981	0.00002	0.0005	
10	$V_{Nominal}$	959.84981	0.00002	0.0005	
20	$V_{Nominal}$	959.84996	0.00000	0.0005	
30	$V_{Nominal}$	959.84993	0.00000	0.0005	
40	$V_{Nominal}$	959.84997	0.00000	0.0005	
50	$V_{Nominal}$	959.85011	0.00002	0.0005	
20	$V_{Minimum}$	959.84997	0.00000	0.0005	
20	$V_{Maximum}$	959.84995	0.00000	0.0005	
Nominal Frequency:		959.849962			

Parameter Definitions (External Antenna Version):

Measurements performed at input voltage Vnominal ± 15%.

Parameter	Value
$V_{Nominal}$:	13.8VDC
$V_{Minimum}$:	11.7VDC
$V_{Maximum}$:	15.9VDC

Parameter Definitions (Internal Antenna Version):

Measurements performed at input voltage Vnominal ± 15%.

Parameter	Value
$V_{Nominal}$:	120 VAC
$V_{Minimum}$:	102.00 VAC
$V_{Maximum}$:	138.00 VAC

Test Setup Photo(s)

2.1049 / 101.109(c) Bandwidth (20dB)

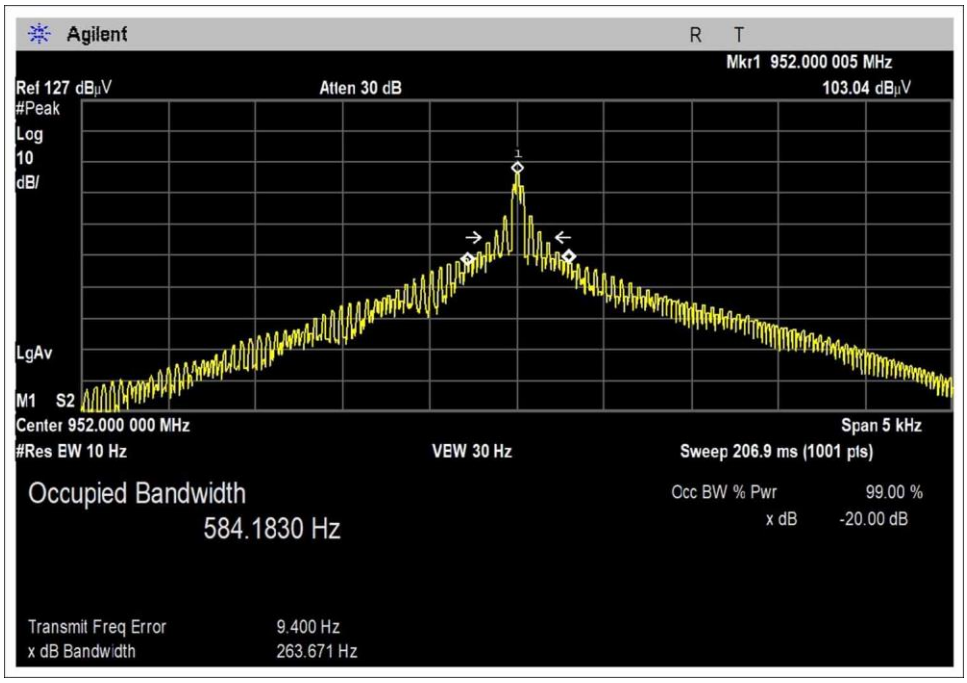
Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Harrison/M. Atkinson
Test Method:	FCC CFR 47 Part 101.109, , ANSI C63.26 (2015)	Test Date(s):	6/21/2021 to 7/1/2021
Configuration:	1		
Test Setup:	EUT directly connected to spectrum analyzer through appropriate cables and attenuators. EUT is transmitting with modulation. For the Internal Antenna version, a unit with a temporary antenna port has been provided by the manufacturer.		

Environmental Conditions			
Temperature (ºC)	23-25	Relative Humidity (%):	35-45

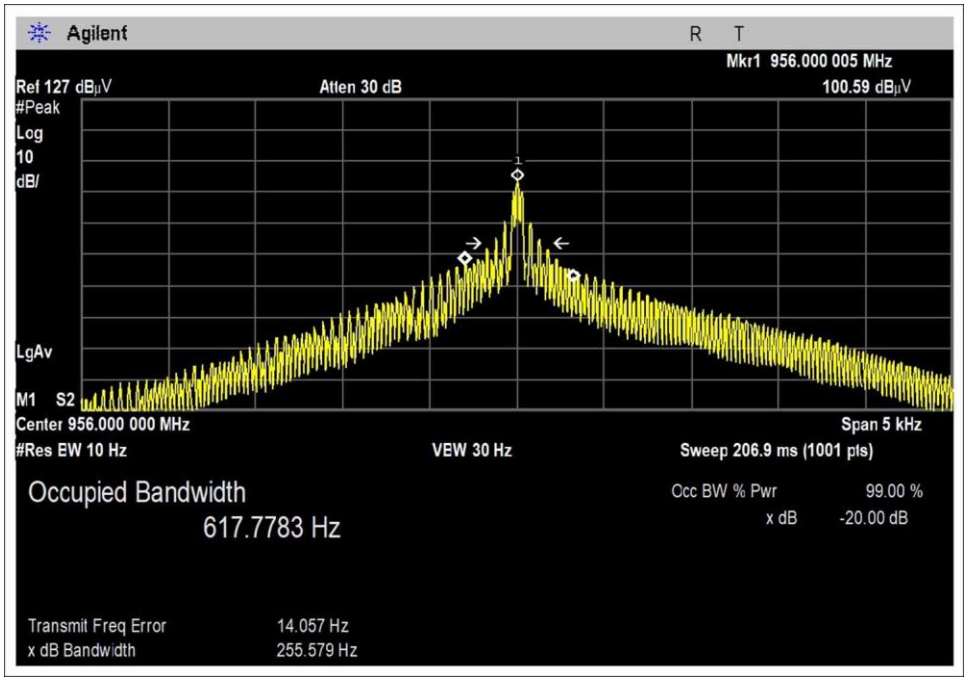
Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02871	Spectrum Analyzer	Agilent	E4440A	3/12/2020	3/12/2022
P07670	Attenuator	Pasternack	PE7389-20	8/20/2020	8/20/2022
P06454	Cable	Andrews	Heliax	1/20/2020	1/20/2022

Test Data Summary				
Frequency (MHz)	**Modulation**	**Measured (kHz)**	**Limit (kHz)**	**Results**
952	24.74Hz	0.264	<12.5	Pass
956	24.74Hz	0.256	<12.5	Pass
959.85	24.74Hz	0.255	<12.5	Pass
952	32.5Hz	0.335	<12.5	Pass
956	32.5Hz	0.345	<12.5	Pass
959.85	32.5Hz	0.331	<12.5	Pass
952	57.78Hz	0.480	<12.5	Pass
956	57.78Hz	0.588	<12.5	Pass
959.85	57.78Hz	0.599	<12.5	Pass
952	64.00Hz	0.672	<12.5	Pass
956	64.00Hz	0.659	<12.5	Pass
959.85	64.00Hz	0.667	<12.5	Pass

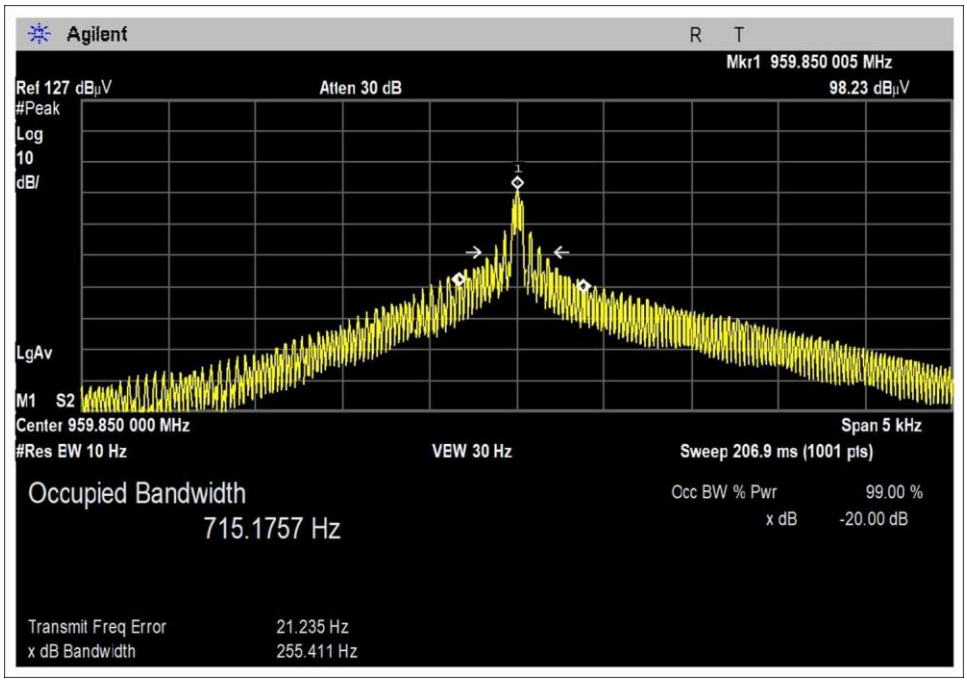
Plot(s)



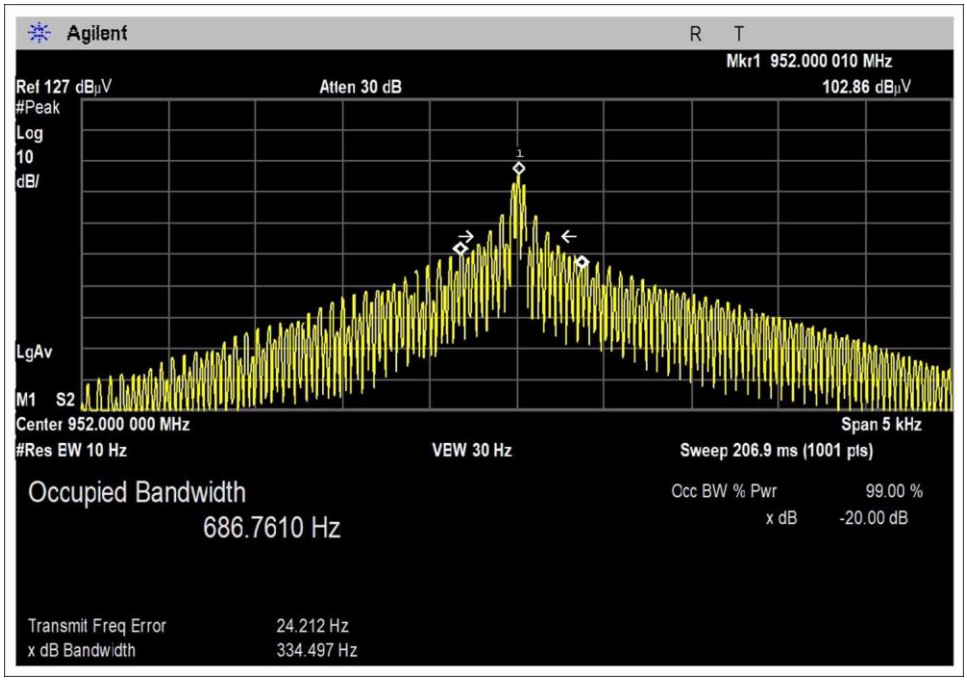
24.74Hz Low Channel



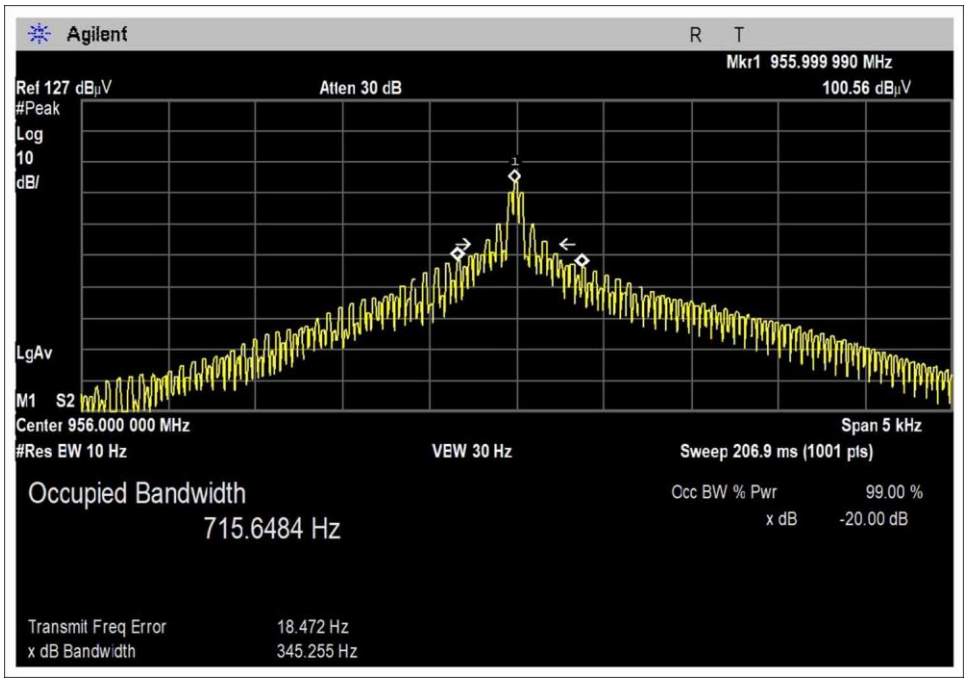
24.74Hz Middle Channel



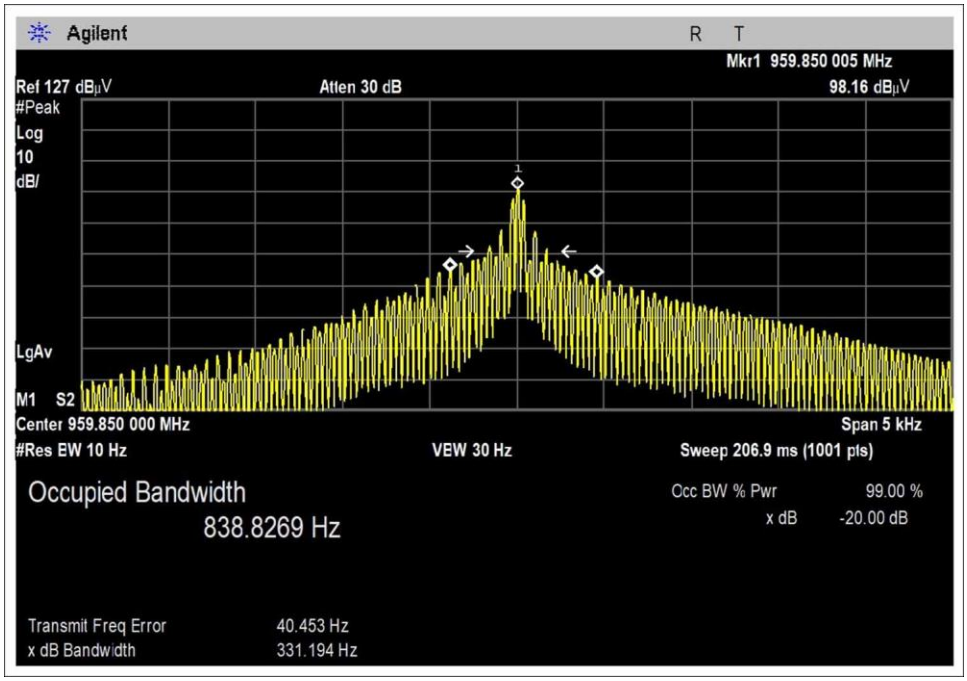
24.74Hz High Channel



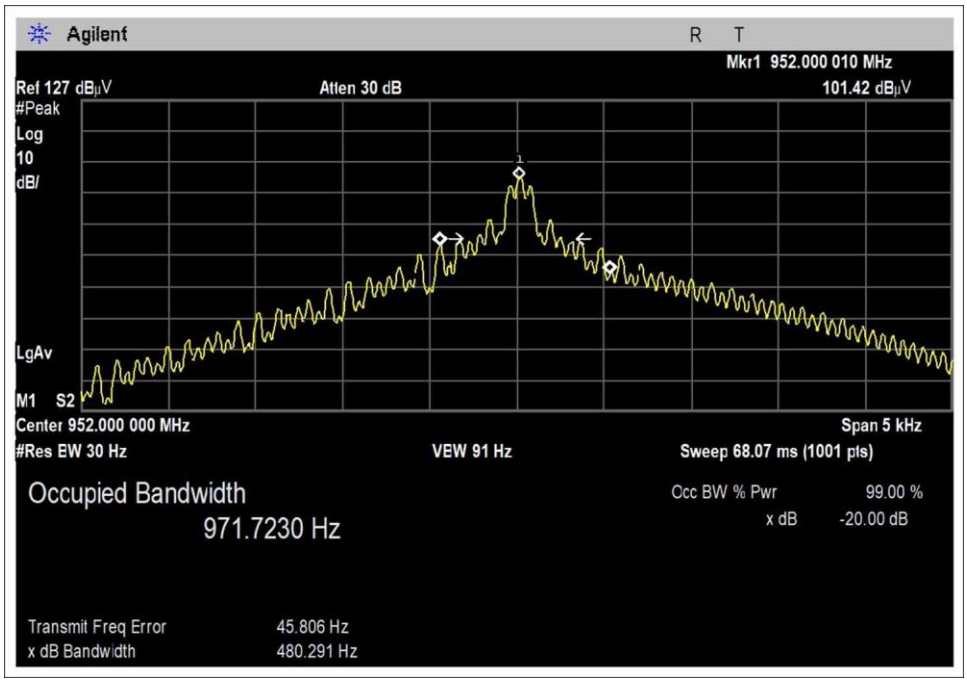
32.5Hz Low Channel



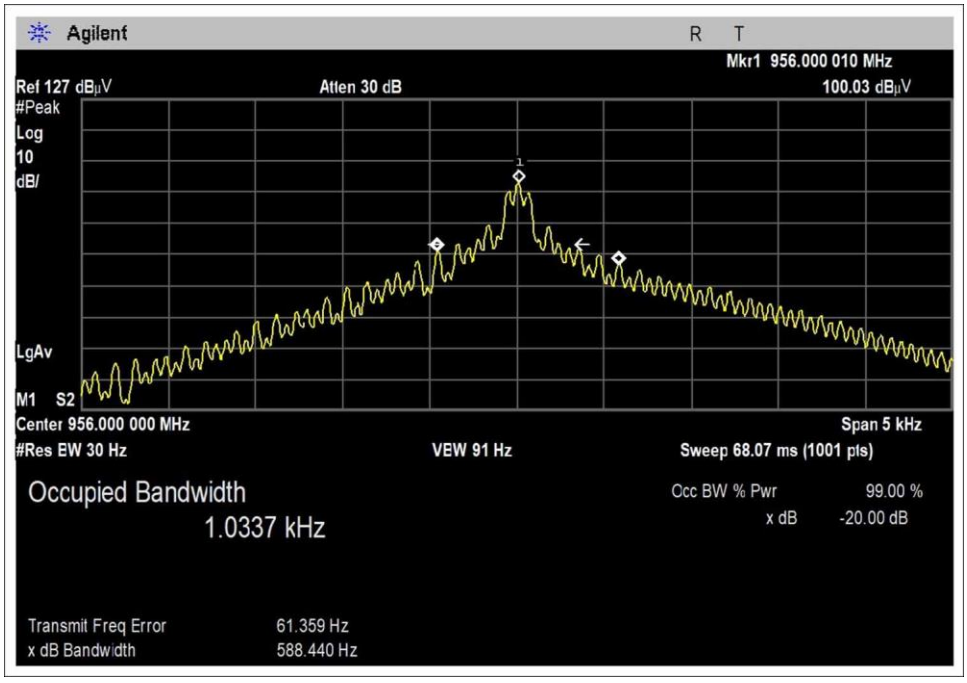
32.5Hz Middle Channel



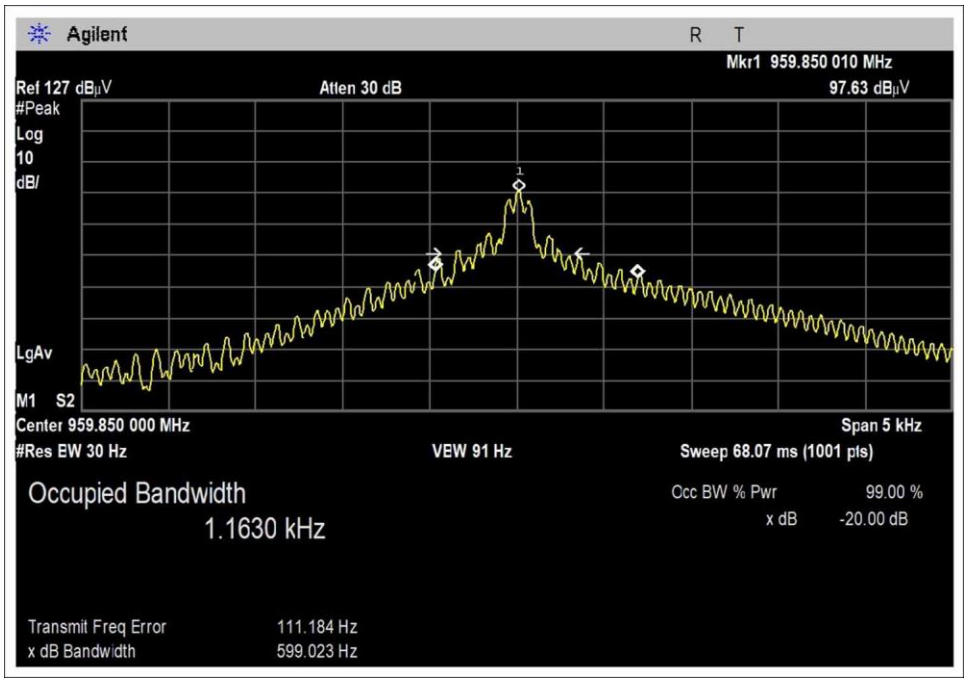
32.5Hz High Channel



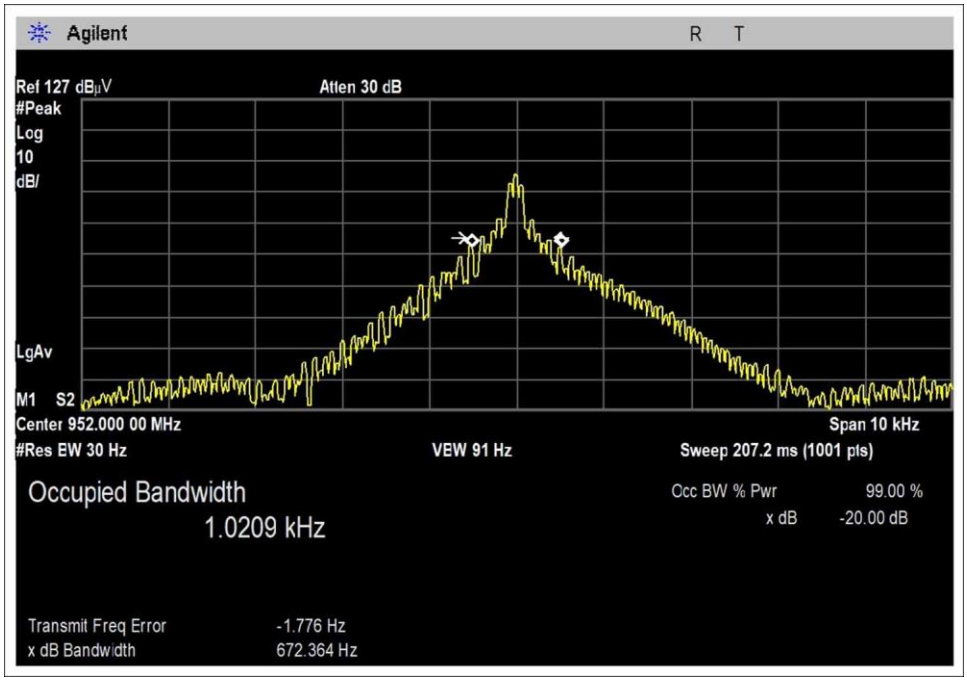
57.78Hz Low Channel



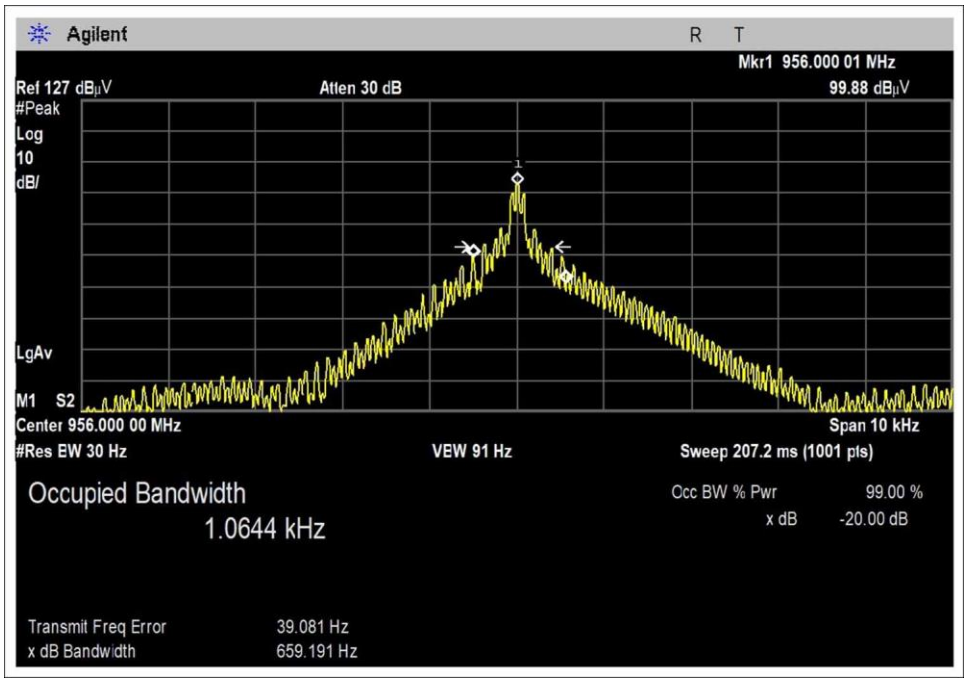
57.78Hz Middle Channel



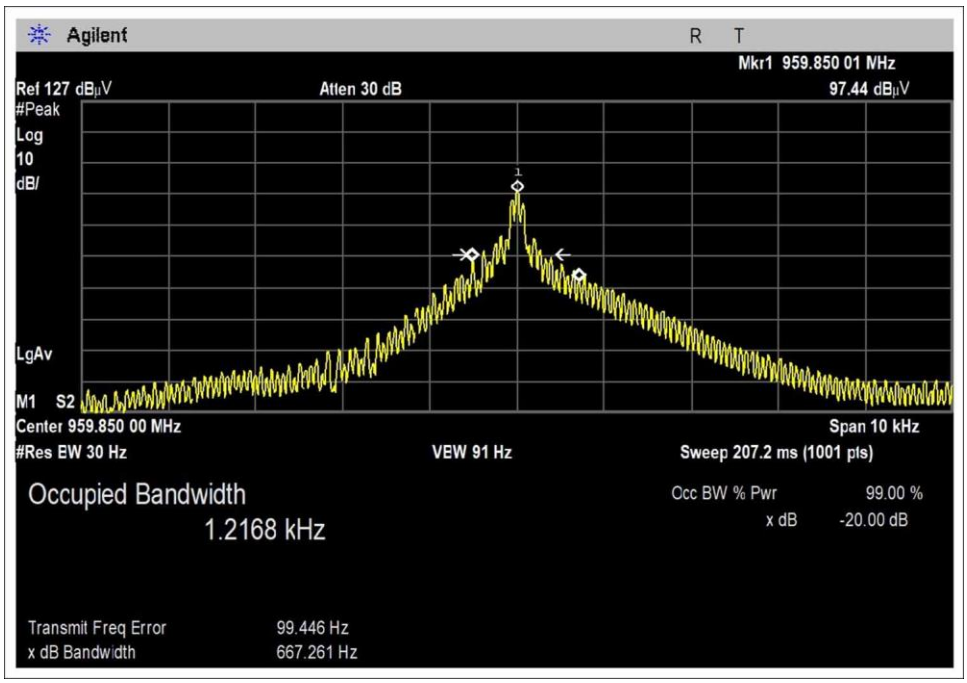
57.78Hz High Channel



64Hz Low Channel



64Hz Middle Channel



64Hz High Channel

Test Setup Photo(s)

2.1051 / 101.111(a)(5) Emissions Limitations - Conducted

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Atkinson
Test Method:	FCC CFR 47 Part 101.111, ANSI C63.26 (2015)	Test Date(s):	7/15/2021
Configuration:	1 and 2		
Test Setup:	EUT directly connected to spectrum analyzer through appropriate cables and attenuators. EUT is transmitting with modulation. For the Internal Antenna version, a unit with a temporary antenna port has been provided by the manufacturer. The manufacturer declares there is 0.74dB of loss in the temporary port cabling, the data below will account for the 0.74dB correction.		

Environmental Conditions			
Temperature (ºC)	23	Relative Humidity (%):	45

Test Equipment Radiated					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02673	Spectrum Analyzer	Agilent	E4446A	2/3/2021	2/3/2023
P06454	Cable	Andrews	Heliax	1/20/2020	1/20/2022
P07638	Attenuator	API Weinschel	47-20-34	6/19/2020	6/19/2022

Test Data Summary					
Configuration 1 (External Antenna Version)					
Low Channel – 952MHz					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Results**	**Notes**
2856	66.3	87	-20.7	Pass	32.5
2856	65.7	87	-21.3	Pass	64
2856	65.6	87	-21.4	Pass	57.78
2855.999	63	87	-24	Pass	24.74
6663.99	58.7	87	-28.3	Pass	32.5
6664.01	58.6	87	-28.4	Pass	64
6664	57.4	87	-29.6	Pass	57.78
437.7	56.7	87	-30.3	Pass	32.5
928	56.6	87	-30.4	Pass	24.74
4760	55.5	87	-31.5	Pass	32.5
4759.99	55.2	87	-31.8	Pass	57.78
6663.999	55.2	87	-31.8	Pass	24.74
4760.01	54.8	87	-32.2	Pass	64
4760.001	54.2	87	-32.8	Pass	24.74
1904	53.1	87	-33.9	Pass	64
1903.98	52.4	87	-34.6	Pass	32.5
1903.99	52.1	87	-34.9	Pass	57.78
1903.999	51	87	-36	Pass	24.74

Test Data Summary					
Configuration 1 (External Antenna Version)					
High Channel – 959.85MHz					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Results**	**Notes**
2879.55	61.4	87	-25.6	Pass	24.74
4799.25	53.9	87	-33.1	Pass	24.74
6718.95	55.1	87	-31.9	Pass	24.74
935.999	57.5	87	-29.5	Pass	24.74
2879.55	65	87	-22	Pass	32.5
4799.25	53.2	87	-33.8	Pass	32.5
6718.95	54.5	87	-32.5	Pass	32.5
2879.55	64.7	87	-22.3	Pass	57.78
4799.25	53.2	87	-33.8	Pass	57.78
6718.96	53.1	87	-33.9	Pass	57.78
2879.55	65.1	87	-21.9	Pass	64
4799.249	54.2	87	-32.8	Pass	64
6718.953	54	87	-33	Pass	64
2879.55	61.4	87	-25.6	Pass	24.74
4799.25	53.9	87	-33.1	Pass	24.74
6718.95	55.1	87	-31.9	Pass	24.74

Test Data Summary					
Configuration 2 (Internal Antenna Version)					
Low Channel – 952MHz					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Results**	**Notes**
476	85.1	87	-1.9	Pass	64
476	84.9	87	-2.1	Pass	32.5
476	84.9	87	-2.1	Pass	24.74
476	84.7	87	-2.3	Pass	57.78
7008	66	87	-21	Pass	24.74
2856	64.9	87	-22.1	Pass	32.5
2856	64.5	87	-22.5	Pass	57.78
2856.001	63.9	87	-23.1	Pass	24.74
2856	63.8	87	-23.2	Pass	24.74
968	59.6	87	-27.4	Pass	64
968	59.3	87	-27.7	Pass	57.78
1904.007	58.8	87	-28.2	Pass	32.5
976	58.7	87	-28.3	Pass	32.5
1904	57.7	87	-29.3	Pass	57.78
456	57.5	87	-29.5	Pass	24.74
1904	57.3	87	-29.7	Pass	24.74

Test Data Summary					
Configuration 2 (Internal Antenna Version)					
Low Channel – 959.85MHz					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV)**	**Limit (dBµV)**	**Margin (dB)**	**Results**	**Notes**
479.925	83.5	87	-3.5	Pass	64
479.925	83.3	87	-3.7	Pass	32.5
479.926	83.2	87	-3.8	Pass	57.78
479.927	82.9	87	-4.1	Pass	24.74
2879.55	65.5	87	-21.5	Pass	32.5
2879.55	65.5	87	-21.5	Pass	24.74
2879.55	64.4	87	-22.6	Pass	57.78
2879.55	64.3	87	-22.7	Pass	64
1919.66	60.5	87	-26.5	Pass	32.5
1919.7	60.5	87	-26.5	Pass	24.74
936	58.6	87	-28.4	Pass	24.74
983.6	58.2	87	-28.8	Pass	24.74
1919.7	57.8	87	-29.2	Pass	64
1919.71	57.6	87	-29.4	Pass	57.78
95.86	52.3	87	-34.7	Pass	24.74

Note: Limit applied: Part 101.111 (a) (5)

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 log10 (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 log10 (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 log10 (fd/5.3) decibels; and

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 log10(P) or 70 decibels, whichever is the lesser attenuation.

Conversion to Limit (dBµV) = Limit (dBm) +107

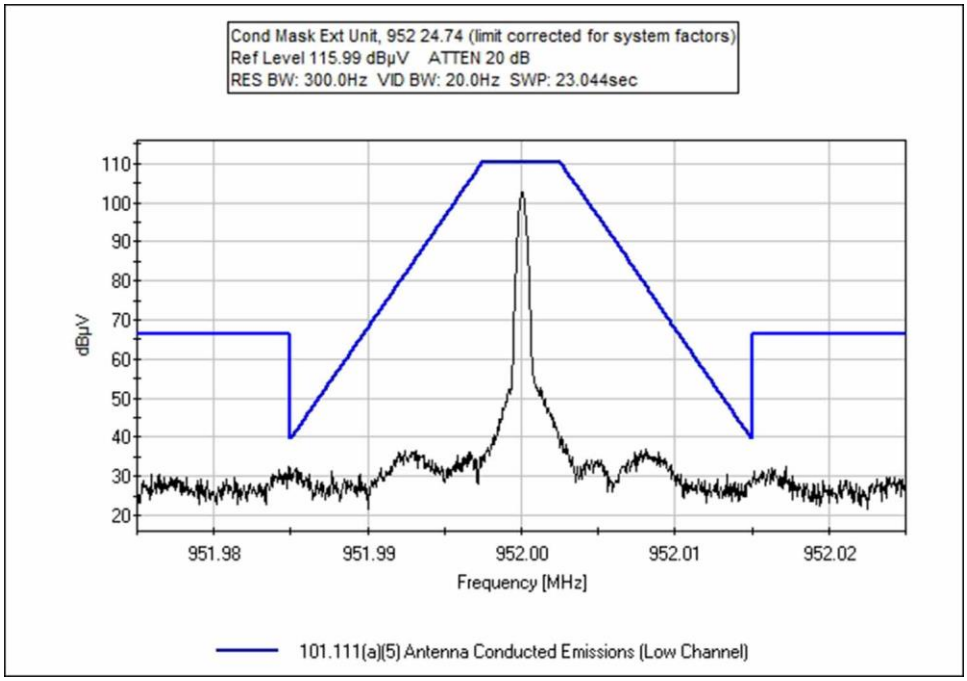
For 101.111 (a) (5) (iv) outside the emissions mask (removed greater than 15kHz) the limit will be -20dBm = 87dBµV. This will be true for all fundamental values measured on this device when calculating the lesser attenuation of 70dB or 50 + 10log10(P) db [where P = power in watts]. The 70dB attenuation would only apply for devices above 50dBm.

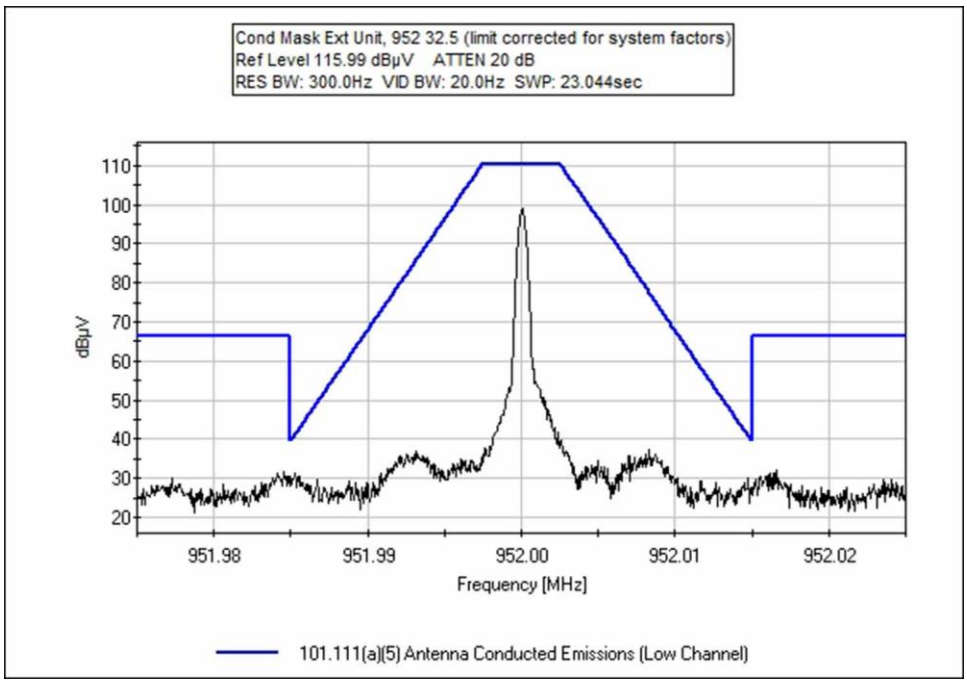
For example, where P=30dBm=1 watt, the attenuation would be 50dB, so the overall limit would be 30-50dBm=-20dBm.

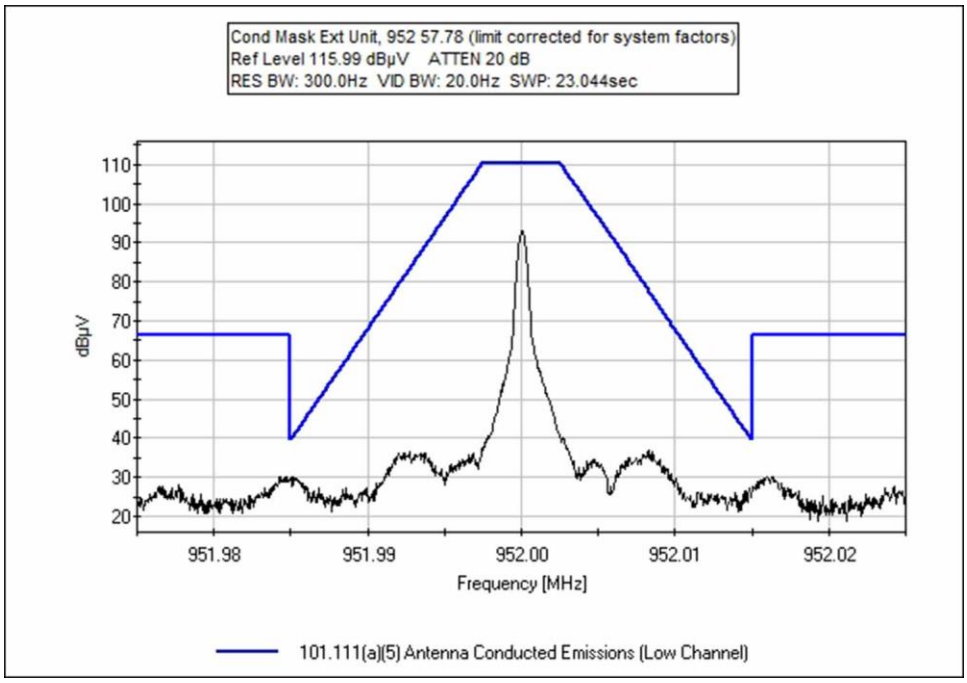
For example, where P=10dBm=0.01watt, the attenuation would be 30dB, so the overall limit would be 10-30dBm = -20dBm.

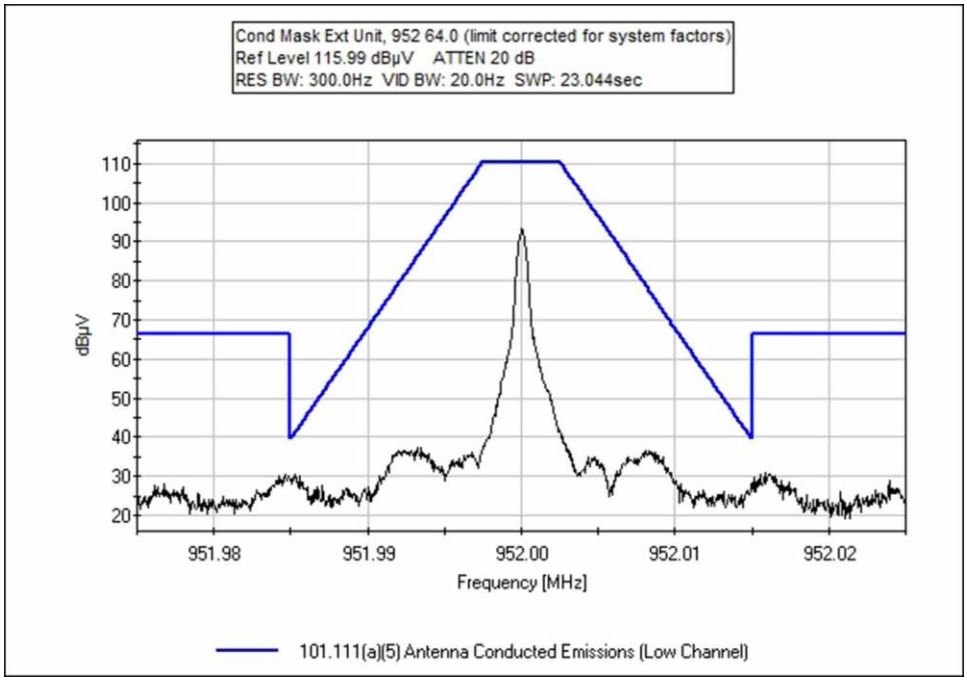
Plots

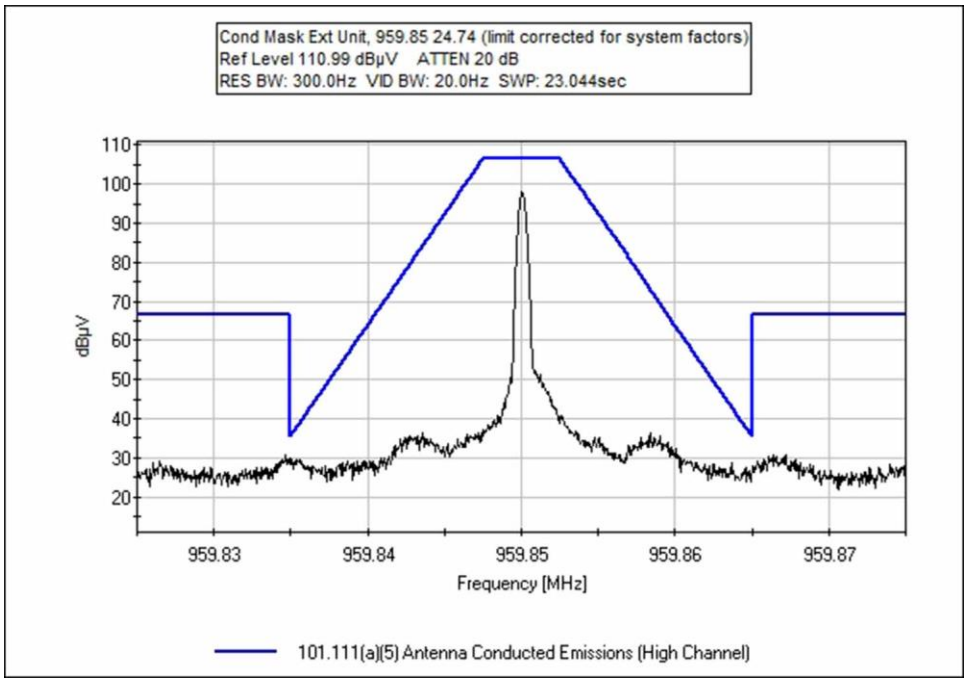
Configuration 1

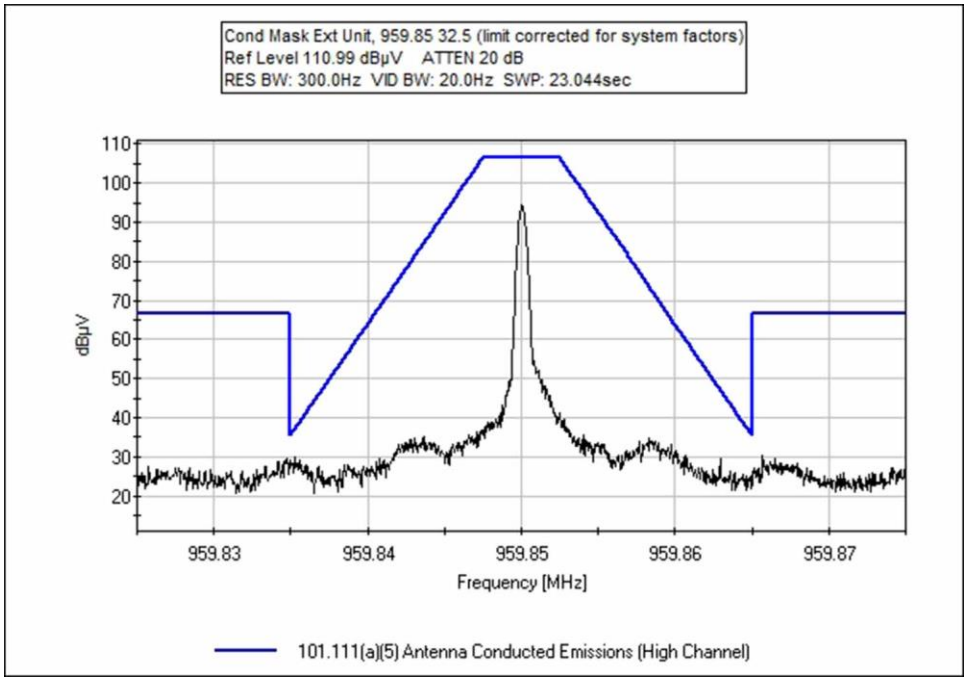


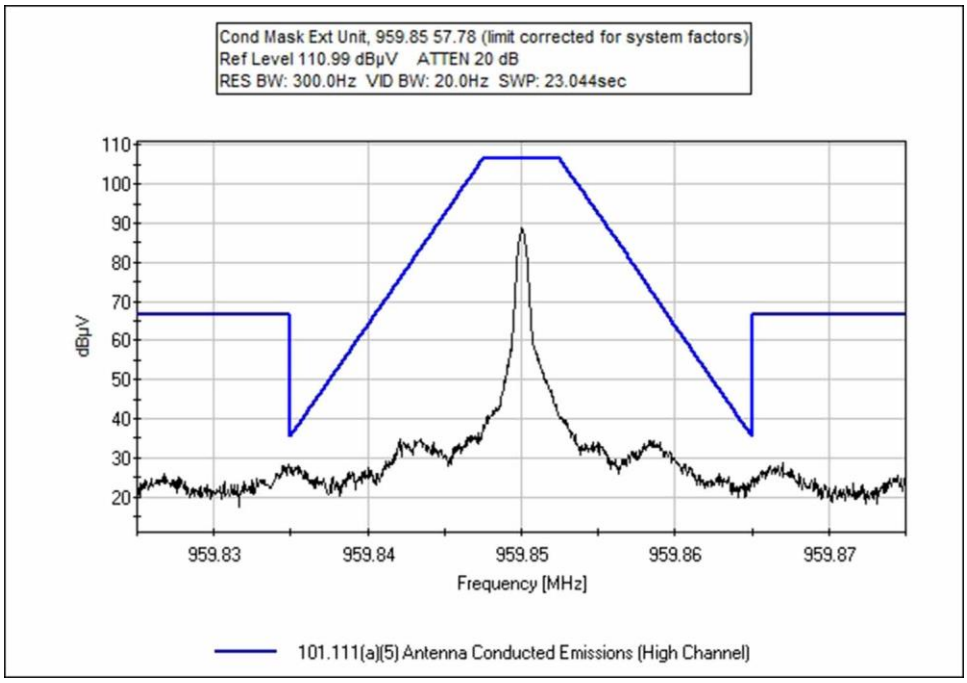


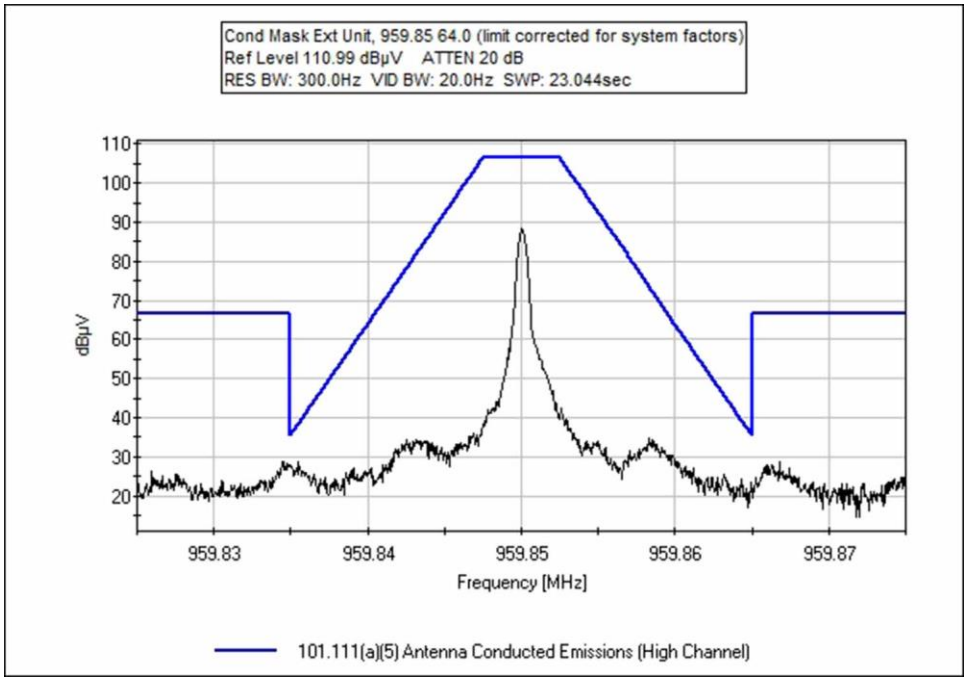

Cond Mask Ext Unit, 952 57.78 (limit corrected for system factors)
Ref Level 115.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
951.98
951.99
952.00
952.01
952.02
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (Low Channel)


Cond Mask Ext Unit, 952 64.0 (limit corrected for system factors)
Ref Level 115.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
951.98
951.99
952.00
952.01
952.02
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (Low Channel)

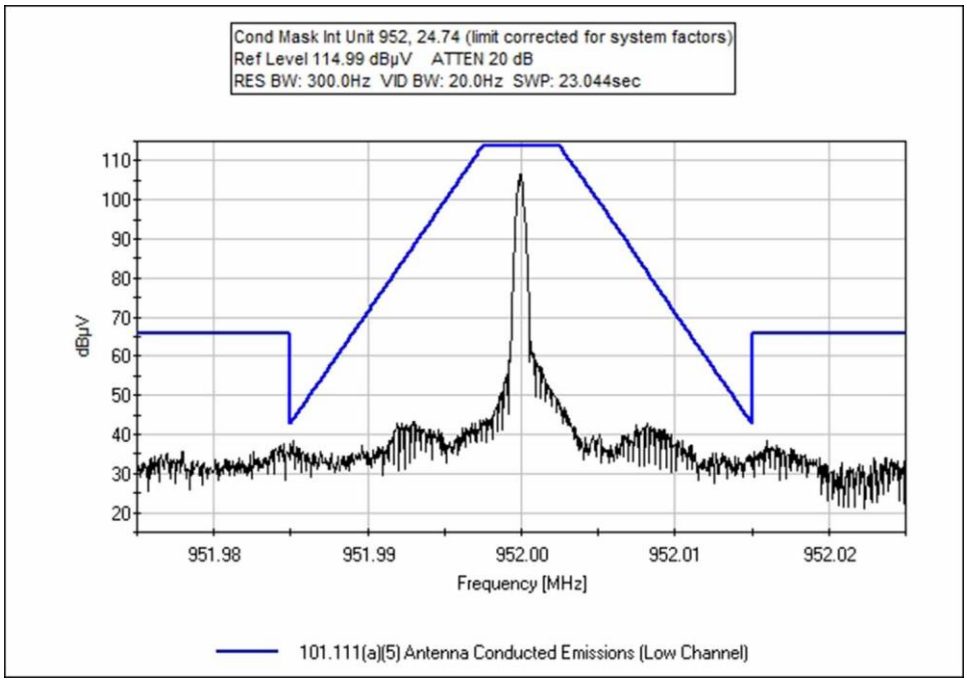

Cond Mask Ext Unit, 959.85 24.74 (limit corrected for system factors)
Ref Level 110.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
110
100
90
80
70
60
50
40
30
20
dBµV
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)

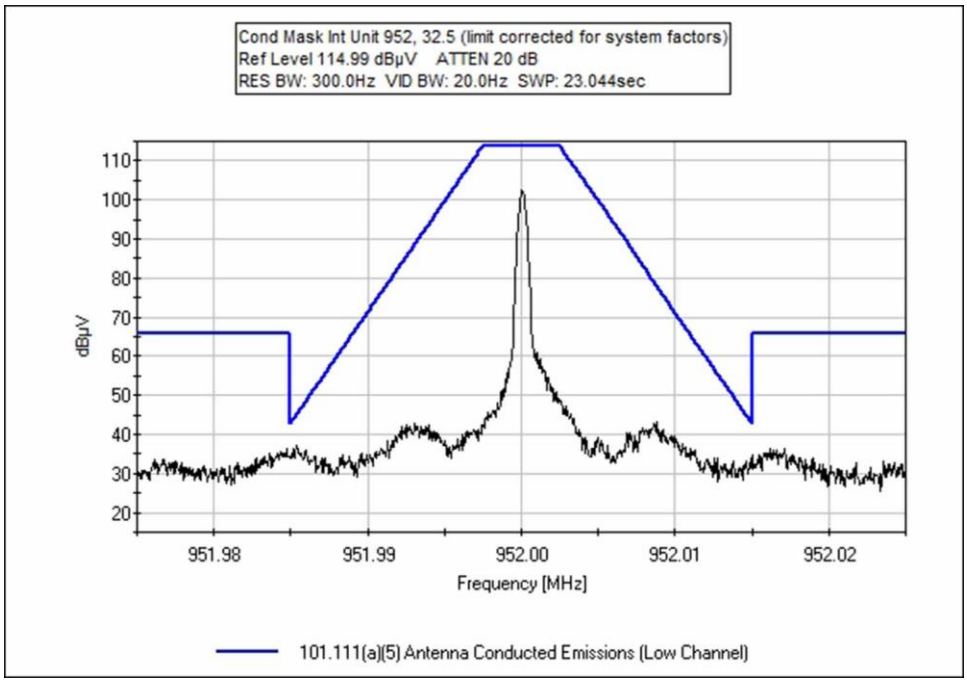

Cond Mask Ext Unit, 959.85 32.5 (limit corrected for system factors)
Ref Level 110.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
110
100
90
80
70
60
50
40
30
20
dBµV
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)

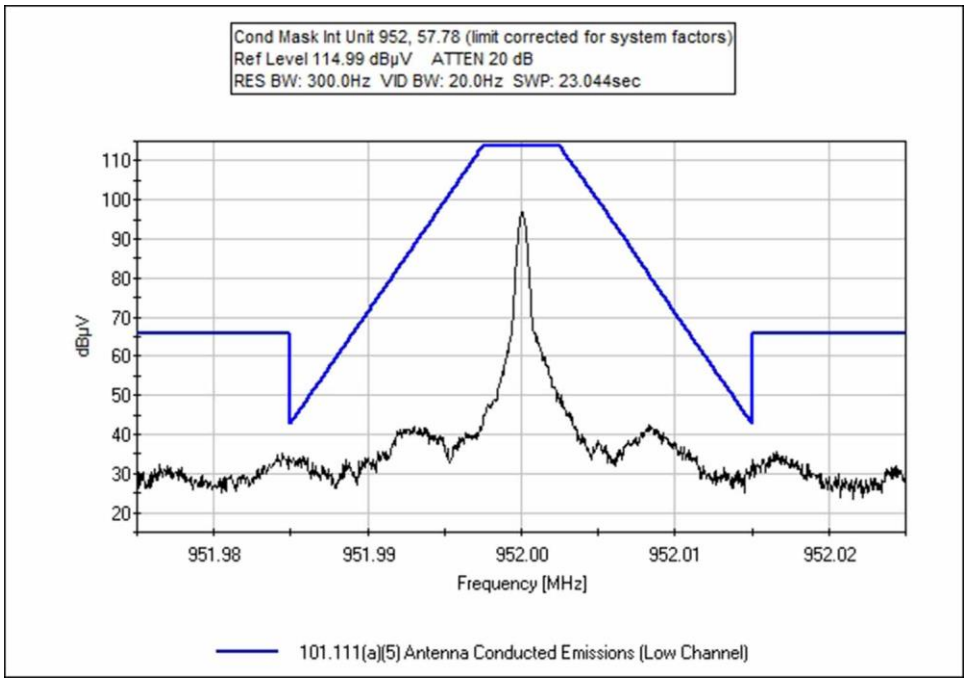

Cond Mask Ext Unit, 959.85 57.78 (limit corrected for system factors)
Ref Level 110.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
110
100
90
80
70
60
50
40
30
20
dBµV
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)

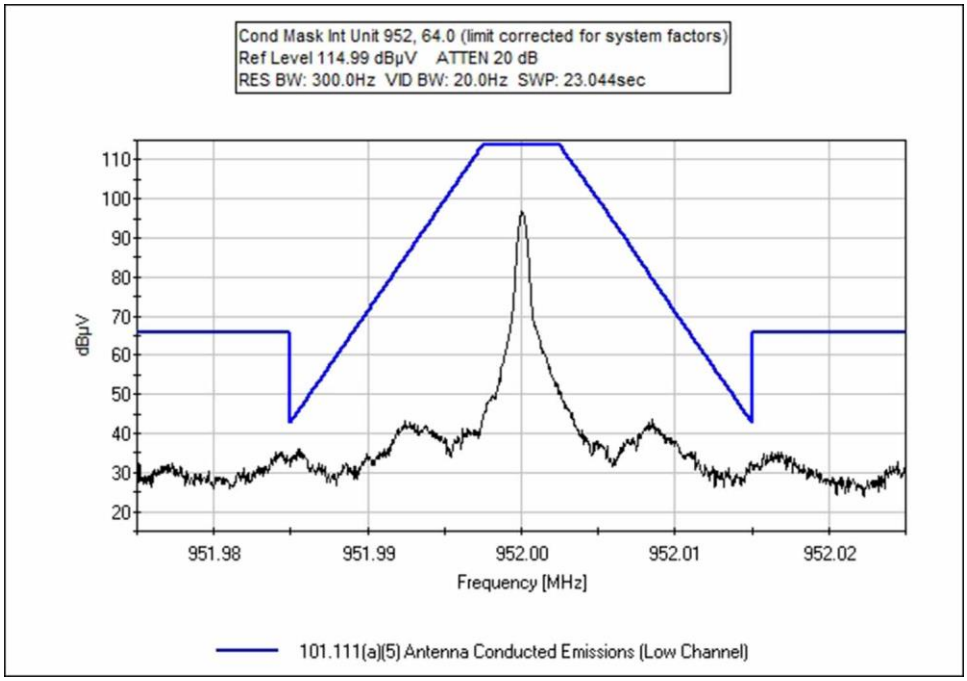

Cond Mask Ext Unit, 959.85 64.0 (limit corrected for system factors)
Ref Level 110.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
110
100
90
80
70
60
50
40
30
20
dBµV
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)

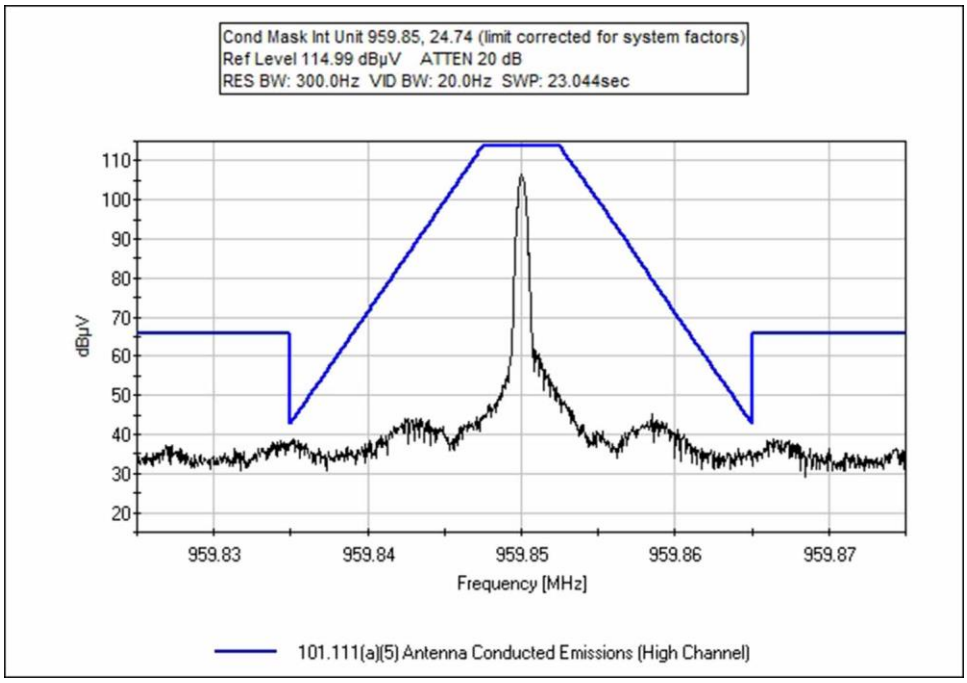
Configuration 2

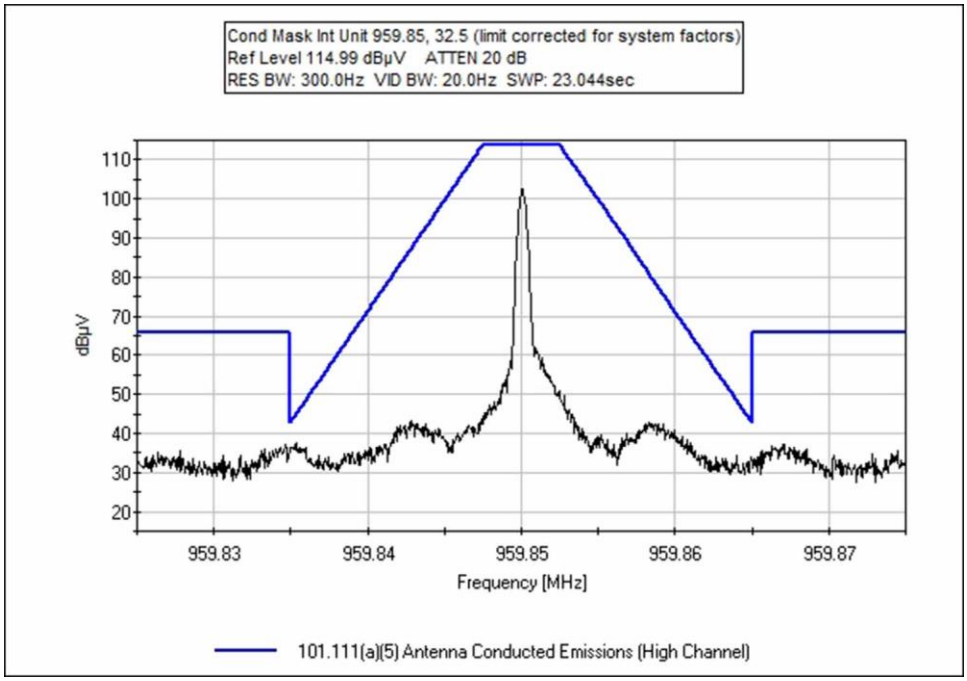


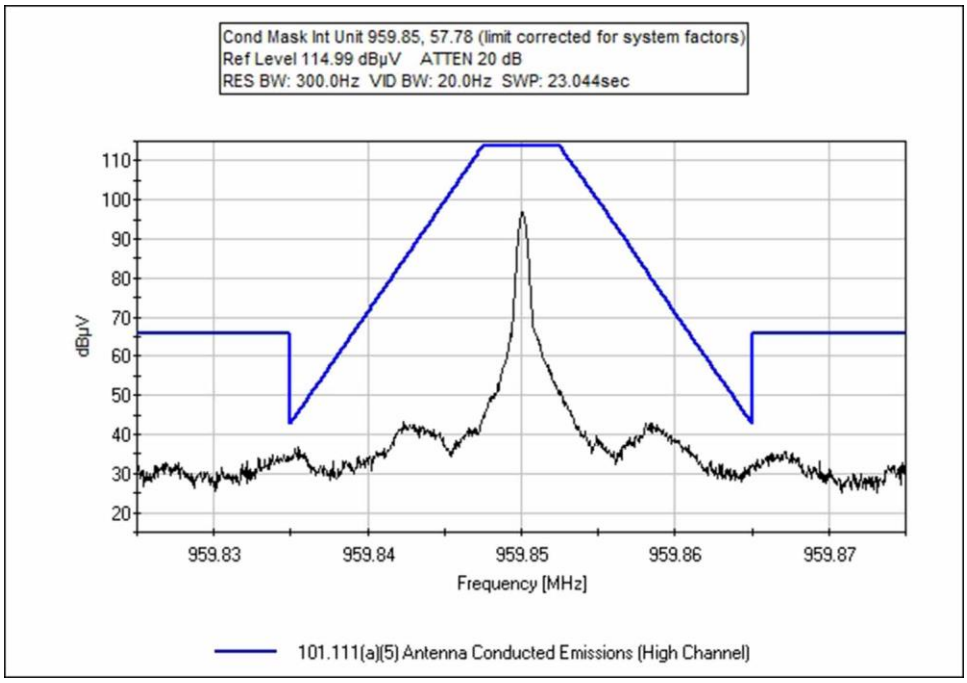


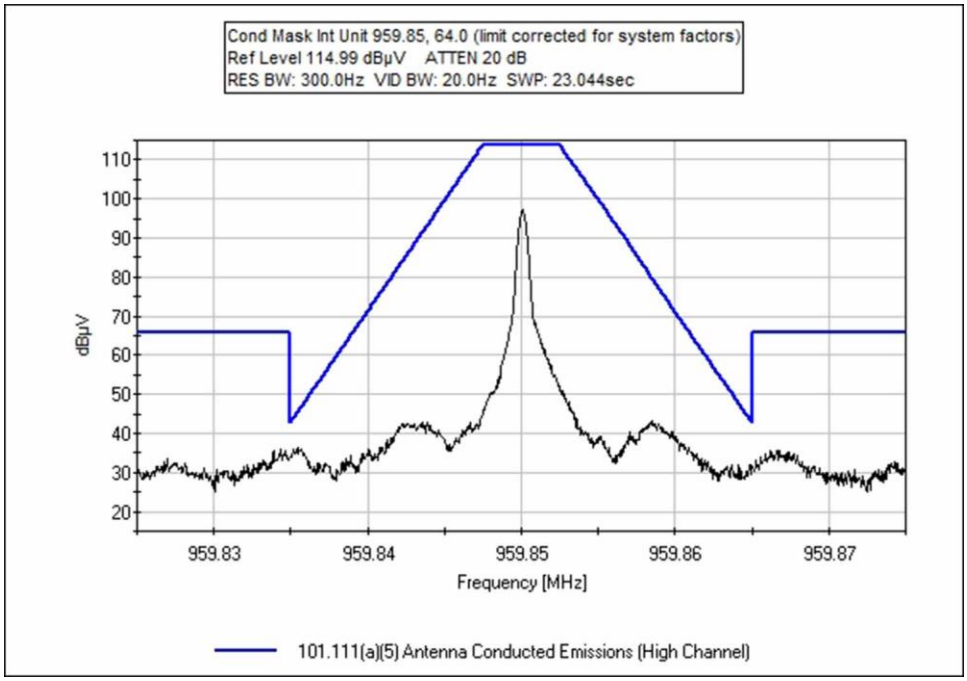

Cond Mask Int Unit 952, 57.78 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
951.98
951.99
952.00
952.01
952.02
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (Low Channel)


Cond Mask Int Unit 952, 64.0 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
951.98
951.99
952.00
952.01
952.02
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (Low Channel)


Cond Mask Int Unit 959.85, 24.74 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)


Cond Mask Int Unit 959.85, 32.5 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)


Cond Mask Int Unit 959.85, 57.78 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)


Cond Mask Int Unit 959.85, 64.0 (limit corrected for system factors)
Ref Level 114.99 dBµV ATTEN 20 dB
RES BW: 300.0Hz VID BW: 20.0Hz SWP: 23.044sec
dBµV
110
100
90
80
70
60
50
40
30
20
959.83
959.84
959.85
959.86
959.87
Frequency [MHz]
101.111(a)(5) Antenna Conducted Emissions (High Channel)

Test Setup Photo(s)

Configuration 1

Configuration 2

2.1053 / 101.111(a)(5) Emissions Limitations - Radiated

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Atkinson
Test Method:	FCC CFR 47 Part 101.111, ANSI C63.26 (2015)	Test Date(s):	6/25/2021 to 7/9/2021
Configuration:	1 and 2		
Test Setup:	EUT is on foam table. EUT has antenna port has termination installed. EUT is transmitting with modulation. For the Internal Antenna version, a unit with a temporary antenna port has been provided by the manufacturer. XYZ EUT axes investigated, horizontal and vertical measurement antenna polarities investigated above 30MHz, below 30MHz 3 x orthogonal measurement antenna polarities investigated, worst case reported.		

Environmental Conditions			
Temperature (ºC)	22-25	Relative Humidity (%):	40-50

Test Equipment Radiated					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02673	Spectrum Analyzer	Agilent	E4446A	2/3/2021	2/3/2023
P06540	Cable	Andrews	Heliax	8/23/2019	8/23/2021
P05305	Cable	Andrews	ETSI-50T	9/6/2019	9/6/2021
P05360	Cable	Belden	RG214	2/3/2020	2/3/2022
03628	Biconilog Antenna	ETS	3142E	6/3/2021	6/3/2023
P06515	Cable	Andrews	Heliax	7/1/2020	7/1/2022
00052	Loop Antenna	EMCO	6502	5/4/2020	5/4/2022
03540	Preamp	HP	83017A	5/14/2021	5/14/2023
P07505	Cable	TMS	CLU40-KMKM-02.00F	1/26/2021	1/26/2023
02374ANSI	Horn Antenna	Electrometrics	RGA-60	5/25/2021	5/25/2023

Test Data Summary (Below 1GHz)					
Configuration 1, External Antenna Version					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV/m at 3m)**	**Limit (dBµV/m at 3m)**	**Margin (dB)**	**Results**	**Notes**
981.6	59.4	75.2	-15.8	Pass	959.85
989.3	59	75.2	-16.2	Pass	952
66.9	57.3	75.2	-17.9	Pass	
702.2	57	75.2	-18.2	Pass	959.85
73.6	56.5	75.2	-18.7	Pass	952
526.6	54.4	75.2	-20.8	Pass	959.85
74.6	54	75.2	-21.2	Pass	952
71.7	53.3	75.2	-21.9	Pass	
59.1	50.7	75.2	-24.5	Pass	959.85
60.1	50.4	75.2	-24.8	Pass	
20.193	49.4	75.2	-25.8	Pass	
282.2	49.1	75.2	-26.1	Pass	952
285.1	49	75.2	-26.2	Pass	959.85
208.5	48.9	75.2	-26.3	Pass	959.85
208.5	48	75.2	-27.2	Pass	952
29.4	47.9	75.2	-27.3	Pass	
19.173	47.5	75.2	-27.7	Pass	
24.002	46.7	75.2	-28.5	Pass	
115.4	46.5	75.2	-28.7	Pass	952
228.8	46.3	75.2	-28.9	Pass	959.85
28.5	46	75.2	-29.2	Pass	
104.7	45.8	75.2	-29.4	Pass	959.85

Test Data Summary (Above 1GHz)					
Configuration 1, External Antenna Version					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV/m at 3m)**	**Limit (dBµV/m at 3m)**	**Margin (dB)**	**Results**	**Notes**
9598.43	65	75.2	-10.2	Pass	959.85, 64
9520.1	63.5	75.2	-11.7	Pass	952, 24.74, Y
9598.53	63.1	75.2	-12.1	Pass	959.85, 57.78
9524.93	63.1	75.2	-12.1	Pass	952.5, 57.78
9519.98	63	75.2	-12.2	Pass	952, 32.5
7616.05	62.8	75.2	-12.4	Pass	952, 32.5
9520.01	62.7	75.2	-12.5	Pass	952, 64
9598.53	62.7	75.2	-12.5	Pass	959.85, 24.74
7616.07	62.6	75.2	-12.6	Pass	952, 64
7616.06	62.6	75.2	-12.6	Pass	952, 57.78
9525.03	62.5	75.2	-12.7	Pass	952.5 ,32.5
9520.01	62.3	75.2	-12.9	Pass	952, 57.78
7619.99	61.8	75.2	-13.4	Pass	952.5 ,32.5
7620.05	61.6	75.2	-13.6	Pass	952.5, 64
4974	61.4	75.2	-13.8	Pass	
9519.98	61.4	75.2	-13.8	Pass	952, 27.74, Z
7616.08	61	75.2	-14.2	Pass	952, 24.74, Y
7678.81	60.6	75.2	-14.6	Pass	959.85, 57.78
7678.83	60.4	75.2	-14.8	Pass	959.85, 32.5
7678.85	60.4	75.2	-14.8	Pass	959.85, 24.74
7616.06	60.3	75.2	-14.9	Pass	952, 24.74, X
7616.02	60.1	75.2	-15.1	Pass	952, 27.74, Z
9520.06	59.6	75.2	-15.6	Pass	952, 24.74, X
7620.08	59.1	75.2	-16.1	Pass	952.5, 57.78
9598.48	58.1	75.2	-17.1	Pass	959.85, 32.5
9524.96	57.8	75.2	-17.4	Pass	952.5, 64
7678.86	57.6	75.2	-17.6	Pass	959.85, 64
5002	57.4	75.2	-17.8	Pass	
7616	57.1	75.2	-18.1	Pass	952, 24.74, X
7615.96	56.5	75.2	-18.7	Pass	952, 24.74, Y
6664.2	55.9	75.2	-19.3	Pass	952, 24.74, Y
6667.55	55.6	75.2	-19.6	Pass	952.5, 64
6718.98	55.5	75.2	-19.7	Pass	959.85, 57.78
8638.7	55.5	75.2	-19.7	Pass	959.85, 24.74
6667.54	55.3	75.2	-19.9	Pass	952.5, 57.78
8638.66	55.1	75.2	-20.1	Pass	959.85, 57.78
6664.01	55.1	75.2	-20.1	Pass	952, 57.78
8638.71	55	75.2	-20.2	Pass	959.85, 64
9598.55	55	75.2	-20.2	Pass	959.85, 24.74
6718.92	54.9	75.2	-20.3	Pass	959.85, 64
6664.02	54.9	75.2	-20.3	Pass	952, 32.5
6667.52	54.8	75.2	-20.4	Pass	952.5 ,32.5
6719.03	54.5	75.2	-20.7	Pass	959.85, 24.74

Frequency (MHz)	Measured (dBµV/m at 3m)	Limit (dBµV/m at 3m)	Margin (dB)	Results	Notes
6664.11	54.4	75.2	-20.8	Pass	952, 64
9519.94	54.3	75.2	-20.9	Pass	952, 27.74, Z
5760.08	54.2	75.2	-21	Pass	959.85, 24.74
6664.02	54	75.2	-21.2	Pass	952, 27.74, Z
5760.2	53.8	75.2	-21.4	Pass	959.85, 57.78
6719	53.8	75.2	-21.4	Pass	959.85, 32.5
5760.17	53.8	75.2	-21.4	Pass	959.85, 32.5
5760.02	53.7	75.2	-21.5	Pass	959.85, 24.74
8572.58	53.6	75.2	-21.6	Pass	952.5, 57.78
6664.04	53.5	75.2	-21.7	Pass	952, 24.74, X
1996	53.2	75.2	-22	Pass	
5760.14	53.1	75.2	-22.1	Pass	959.85, 64
2856.08	52.2	75.2	-23	Pass	952, 32.5
2855.98	51.9	75.2	-23.3	Pass	952, 64
5714.98	51.6	75.2	-23.6	Pass	952.5 ,32.5
2857.54	51.4	75.2	-23.8	Pass	952.5, 64
2879.6	51.4	75.2	-23.8	Pass	959.85, 32.5
5712.08	51.3	75.2	-23.9	Pass	952, 32.5
5714.98	51.2	75.2	-24	Pass	952.5, 64
5711.94	51.1	75.2	-24.1	Pass	952, 57.78
1812	51.1	75.2	-24.1	Pass	
2857.48	51	75.2	-24.2	Pass	952.5 ,32.5
2856.03	50.7	75.2	-24.5	Pass	952, 57.78
3809.98	50.3	75.2	-24.9	Pass	952.5 ,32.5
2856.14	50.2	75.2	-25	Pass	952, 24.74, X
2856.02	49.9	75.2	-25.3	Pass	952, 24.74, Y
1110	49.7	75.2	-25.5	Pass	
2879.57	49.4	75.2	-25.8	Pass	959.85, 64
2879.52	49.1	75.2	-26.1	Pass	959.85, 57.78
2136	49.1	75.2	-26.1	Pass	
2857.54	49	75.2	-26.2	Pass	952.5, 57.78
1919.72	48.6	75.2	-26.6	Pass	959.85, 24.74
1904.46	48.5	75.2	-26.7	Pass	952, 24.74, X
2879.6	48.5	75.2	-26.7	Pass	959.85, 24.74
1919.72	48.1	75.2	-27.1	Pass	959.85, 32.5
2856.02	48.1	75.2	-27.1	Pass	952, 27.74, Z
1904.1	47.9	75.2	-27.3	Pass	952, 24.74, Y
1904.02	47.6	75.2	-27.6	Pass	952, 27.74, Z
1903.87	47.5	75.2	-27.7	Pass	952, 64
2856.06	47	75.2	-28.2	Pass	952, 24.74, X
1904.98	46.9	75.2	-28.3	Pass	952.5 ,32.5
1919.75	46.9	75.2	-28.3	Pass	959.85, 24.74
1919.66	46.8	75.2	-28.4	Pass	959.85, 64
1046	46.7	75.2	-28.5	Pass	
2879.57	46.6	75.2	-28.6	Pass	959.85, 24.74
1905.04	46.4	75.2	-28.8	Pass	952.5, 64

Frequency (MHz)	Measured (dBµV/m at 3m)	Limit (dBµV/m at 3m)	Margin (dB)	Results	Notes
1904.08	46.3	75.2	-28.9	Pass	952, 57.78

Test Data Summary (Below 1GHz)					
Configuration 2, Internal l Antenna Version					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV/m at 3m)**	**Limit (dBµV/m at 3m)**	**Margin (dB)**	**Results**	**Notes**
561.6	73.9	75.2	-13.1	Pass	952
457.8	71.5	75.2	-15.5	Pass	952
349.1	69.1	75.2	-16.1	Pass	952
152.2	62	75.2	-17.9	Pass	959.85
874.9	59.1	75.2	-21.2	Pass	
79.5	54	75.2	-22	Pass	
81.4	53.2	75.2	-23.6	Pass	
83.4	51.6	75.2	-25	Pass	
4.658	48.8	75.2	-26.4	Pass	
28.71	46.7	75.2	-28.5	Pass	
82.4	46.5	75.2	-30.3	Pass	952
201.7	44.9	75.2	-31.3	Pass	
155.1	43.9	75.2	-31.7	Pass	
193	43.5	75.2	-33.7	Pass	
58.1	43	75.2	-34.9	Pass	952
128	41.5	75.2	-40.5	Pass	
20.133	40.3	75.2	-44	Pass	

Test Data Summary (Above 1GHz)					
Configuration 2, Internal Antenna Version					
*See note for Limit Calculation					
Frequency (MHz)	**Measured (dBµV/m at 3m)**	**Limit (dBµV/m at 3m)**	**Margin (dB)**	**Results**	**Notes**
9520.09	63	75.2	-12.2	Pass	952, 24.74, Y
9519.967	62.7	75.2	-12.5	Pass	952, 32.5
9598.517	62.7	75.2	-12.5	Pass	959.85, 24.74
9519.9	62.4	75.2	-12.8	Pass	952, 57.78
9598.5	62.3	75.2	-12.9	Pass	959.85, 32.5
9525.083	62.2	75.2	-13	Pass	952.5, 24.74
4987	61.9	75.2	-13.3	Pass	
9598.533	61.8	75.2	-13.4	Pass	959.85, 57.78
9598.583	61.7	75.2	-13.5	Pass	959.85, 64
9519.98	61.7	75.2	-13.5	Pass	952, 27.74 Z
9519.817	61.6	75.2	-13.6	Pass	952, 64
7615.983	61.5	75.2	-13.7	Pass	952, 57.78
7616.017	61.4	75.2	-13.8	Pass	952, 32.5
7616.017	60.9	75.2	-14.3	Pass	952, 64
4980	60.7	75.2	-14.5	Pass	
9520.09	60.2	75.2	-15	Pass	952, 24.74, X
7616.11	60.1	75.2	-15.1	Pass	952, 24.74, X
7678.767	60	75.2	-15.2	Pass	959.85, 57.78
7619.933	59.7	75.2	-15.5	Pass	952.5, 24.74
7678.783	59.2	75.2	-16	Pass	959.85, 24.74
7678.8	58.6	75.2	-16.6	Pass	959.85, 32.5
9520.01	58	75.2	-17.2	Pass	952, 24.74, X
7678.883	57.8	75.2	-17.4	Pass	959.85, 64
5760.2	57	75.2	-18.2	Pass	959.85, 24.74
7616.09	56.7	75.2	-18.5	Pass	952, 24.74, Y
6718.95	56.6	75.2	-18.6	Pass	959.85, 32.5
5760	56.1	75.2	-19.1	Pass	959.85, 32.5
7615.93	56	75.2	-19.2	Pass	952, 24.74, X
5760.083	55.8	75.2	-19.4	Pass	959.85, 57.78
9520.09	55.7	75.2	-19.5	Pass	952, 24.74, Z
8638.65	55.2	75.2	-20	Pass	959.85, 32.5
8638.633	55.2	75.2	-20	Pass	959.85, 24.74
5760.133	54.7	75.2	-20.5	Pass	959.85, 64
6718.933	54.7	75.2	-20.5	Pass	959.85, 24.74
8638.733	54.6	75.2	-20.6	Pass	959.85, 64
6719.067	54.6	75.2	-20.6	Pass	959.85, 57.78
8572.433	54.6	75.2	-20.6	Pass	952.5, 24.74
6664.017	54.3	75.2	-20.9	Pass	952, 32.5
8568.017	54.1	75.2	-21.1	Pass	952, 32.5
2014.4	54	75.2	-21.2	Pass	
6663.95	53.7	75.2	-21.5	Pass	952, 57.78
6663.98	53.2	75.2	-22	Pass	952, 24.74, X
6667.433	52.6	75.2	-22.6	Pass	952.5, 24.74

Frequency (MHz)	Measured (dBµV/m at 3m)	Limit (dBµV/m at 3m)	Margin (dB)	Results	Notes
6664.09	51.1	75.2	-24.1	Pass	952, 24.74, Y
1904.017	51	75.2	-24.2	Pass	952, 32.5
1000	50.6	75.2	-24.6	Pass	
1919.783	50.2	75.2	-25	Pass	959.85, 24.74
1919.817	50	75.2	-25.2	Pass	959.85, 64
1904	50	75.2	-25.2	Pass	952, 57.78
1904.033	49.5	75.2	-25.7	Pass	952, 64
1919.7	49.2	75.2	-26	Pass	959.85, 32.5
1147	49.1	75.2	-26.1	Pass	
1919.667	48.8	75.2	-26.4	Pass	959.85, 57.78
1904.01	48	75.2	-27.2	Pass	952, 24.74, X

**Note: Limit applied: Part 101.111 (a) (5)
Conducted limit is converted to a radiated field strength limit using the following equation :
EIRP (dBµV/m) = P (dBm) – 20*LOG(d) – G + 104.77
where G = 0, d= 3 meters
The limit and measurements were recorded and corrected for dBµV/m at 3m using correction factors based on known measurement system losses.
See Conducted Limit Calculation Below:
(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 log10 (fd/2.5) decibels;
(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 log10 (fd/3.9) decibels;
(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 log10 (fd/5.3) decibels; and
(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 log10(P) or 70 decibels, whichever is the lesser attenuation.
For 101.111 (a) (5) (iv) outside the emissions mask (removed greater than 15kHz) the limit will be -20dBm = 87dBµV. This will be true for all fundamental values measured on this device when calculating the lesser attenuation of 70dB or 50 + 10log10(P) db [where P = power in watts]. The 70dB attenuation would only apply for devices above 50dBm.
For example, where P=30dBm=1 watt, the attenuation would be 50dB, so the overall limit would be 30-50dBm=-20dBm.
For example, where P=10dBm=0.01watt, the attenuation would be 30dB, so the overall limit would be 10-30dBm = -20dBm.

Test Setup Photo(s)

Configuration 1

X Axis

Y Axis

Z Axis

Below 1GHz

Above 1GHz

Configuration 2

X Axis

Y Axis

Z Axis

Below 1GHz

Above 1GHz

2.1046 / 101.113 Transmitter Power Limitations

Test Setup/Conditions			
Test Location:	Bothell Lab Bench	Test Engineer:	M. Atkinson/M. Harrison
Test Method:	FCC CFR 47 Part 101.113, ANSI C63.26 (2015)	Test Date(s):	7/1/2021
Configuration:	1 and 2		
Test Setup:	EUT directly connected to spectrum analyzer through appropriate cables and attenuators to verify signal. EUT is transmitting with modulation. For the Internal Antenna version, a unit with a temporary antenna port has been provided by the manufacturer. The manufacturer declares there is 0.74dB of loss in the temporary port cabling, the data below will account for the 0.74dB correction. Final measurements collected with a peak power meter, peak data reported as it is worst case when compared to the average power limit.		

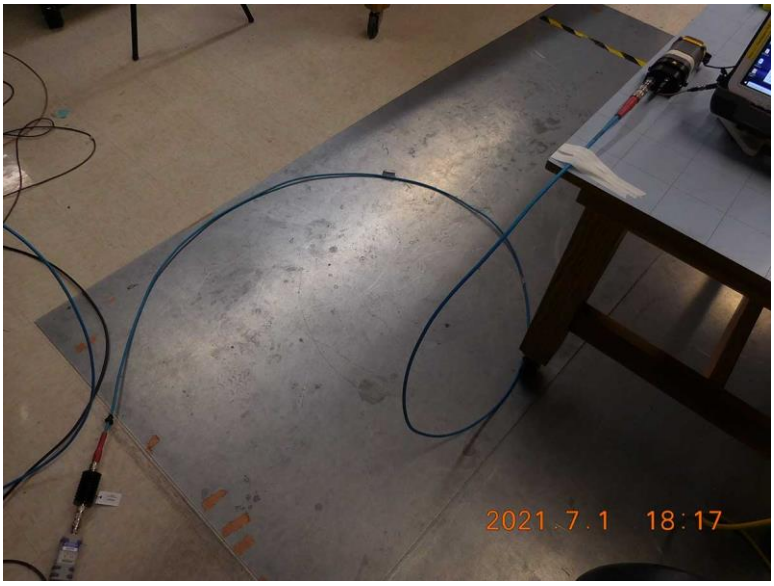
Environmental Conditions			
Temperature (ºC)	25	Relative Humidity (%):	44

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	Agilent	E4440A	11/18/2019	11/18/2021
03477	Power Sensor	Rohde & Schwarz	NRP-Z81	11/7/2019	11/7/2021
P06454	Cable	Andrews	Heliax	1/20/2020	1/20/2022
P07670	Attenuator	Pasternack	PE7389-20	8/20/2020	8/20/2022

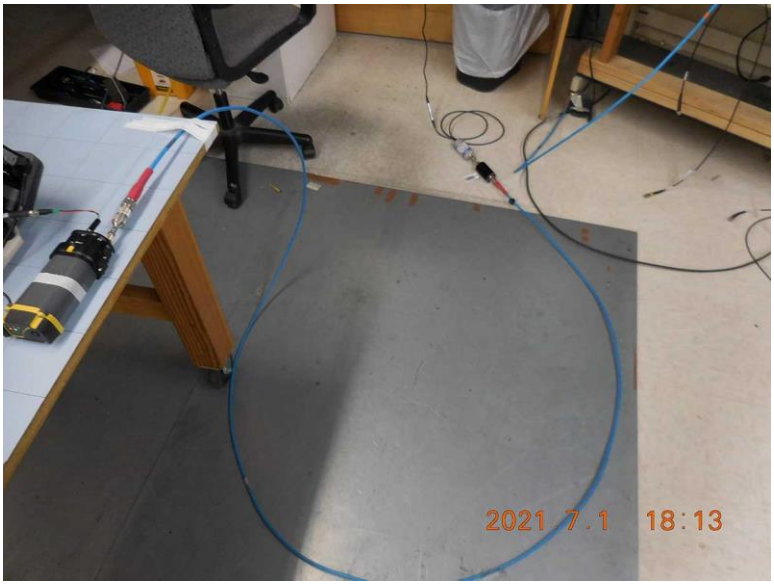
Test Data Summary (Configuration 1, External Antenna)							
Frequency (MHz)	Modulation	Measured Power (dBm)	Max Antenna Gain (dBi)	Calculated EIRP (dBm)	Calculated EIRP (Watts)	EIRP Limit Watts	Results
952	24.74Hz	23.7	5.0	28.7	0.74	25	Pass
956	24.74Hz	21.3	5.0	26.3	0.43		
959.85	24.74Hz	19.0	5.0	24	0.25		
952	32.5Hz	23.6	5.0	28.6	0.72	25	Pass
956	32.5Hz	21.2	5.0	26.2	0.42		
959.85	32.5Hz	18.8	5.0	23.8	0.24		
952	57.78Hz	23.5	5.0	28.5	0.71	25	Pass
956	57.78Hz	21.1	5.0	26.1	0.41		
959.85	57.78Hz	18.8	5.0	23.8	0.24		
952	64.00Hz	23.5	5.0	28.5	0.71	25	Pass
956	64.00Hz	21.1	5.0	26.1	0.41		
959.85	64.00Hz	18.8	5.0	23.8	0.24		

Test Data Summary (Configuration 2, Internal Antenna)							
Frequency (MHz)	Modulation	Measured Power (dBm)	Max Antenna Gain (dBi)	Calculated EIRP (dBm)	Calculated EIRP (Watts)	EIRP Limit Watts	Results
952	24.74Hz	27.9	2.0	29.9	0.98	25	Pass
956	24.74Hz	27.9	2.0	29.9	0.98		
959.85	24.74Hz	27.8	2.0	29.8	0.95		
952	32.5Hz	27.9	2.0	29.9	0.98	25	Pass
956	32.5Hz	27.9	2.0	29.9	0.98		
959.85	32.5Hz	27.8	2.0	29.8	0.95		
952	57.78Hz	27.9	2.0	29.9	0.98	25	Pass
956	57.78Hz	27.9	2.0	29.9	0.98		
959.85	57.78Hz	27.8	2.0	29.8	0.95		
952	64.00Hz	27.9	2.0	29.9	0.98	25	Pass
956	64.00Hz	27.9	2.0	29.9	0.98		
959.85	64.00Hz	27.8	2.0	29.8	0.95		

Test Setup Photo(s)



Configuration 1



Configuration 2

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.