MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372
3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372
13301 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

September 6, 2018

Full Spectrum
687 N. Pastoria Avenue
Sunnyvale, CA 94085

Dear Menashe Shahar,

Enclosed is the EMC Wireless Test report for compliance testing of the Full Spectrum, Venus as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 80 for Stations in the Maritime Services.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
MET LABORATORIES, INC.

Joel Huna
Documentation Department

Reference: (\Full Spectrum\EMCS98836-FCC80 Rev. 3)

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
33439 WESTERN AVENUE • UNION CITY, CALIFORNIA 94587 • PHONE (510) 489-6300 • FAX (510) 489-6372
3162 BELICK STREET • SANTA CLARA, CA 95054 • PHONE (408) 748-3585 • FAX (510) 489-6372
13301 MCCALLEN PASS • AUSTIN, TEXAS 78753 • PHONE (512) 287-2500 • FAX (512) 287-2513

Electromagnetic Compatibility Criteria
Test report

for the

Full Spectrum
Model Venus

Verified under
FCC Certification Rules
Title 47 of the CFR, Part 22 Subpart C
for Public Mobile Service
and
Title 47 of the CFR, Part 80
for Stations in the Maritime Services

MET Report: EMCS98836-FCC80 Rev. 3

September 6, 2018

Prepared For:

Full Spectrum
687 N. Pastoria Avenue
Sunnyvale, CA 94085

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test report

for the

Full Spectrum
Model Venus

Verified under
FCC Certification Rules
Title 47 of the CFR, Part 80
for Stations in the Maritime Services

James Borrott, Project Engineer
Electromagnetic Compatibility Lab

Joel Huna
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 80of the FCC Rules under normal use and maintenance.

John Mason, Director
Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	July 27, 2018	Initial Issue.
1	August 29, 2018	Engineer corrections.
2	September 4, 2018	TCB Corrections.
3	September 6, 2018	Updates to the RF Exposure section.

Table of Contents

List of Tables

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**microh**enry
µ	**microf**arad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Full Spectrum Venus, with the requirements of Part 80. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Venus. Full Spectrum should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Venus, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 80, in accordance with Full Spectrum, quote number 9FUL1804R1.

Reference	Description	Compliance
§2.1049; §80.205	Occupied Bandwidth	Compliant
§80.207	Classes of Emissions	Compliant
§2.1055; §80.209	Frequency Tolerance	Compliant
§2.1051; §80.211	Spurious Emissions at Antenna Terminal	Compliant
§2.1053; §80.211	Field Strength of Spurious Radiated Emissions	Compliant
§2.1047; §80.213	Modulation	Compliant
§2.1046; §80.215	Transmitter Power	Compliant
§2.1091; §80.227	RF Exposure	Compliant

Table 1. Executive Summary of EMC ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Full Spectrum to perform testing on the Venus under quote number 9FUL1804R1.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Full Spectrum, Venus.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	Venus	
Model(s) Covered:	Venus	
EUT Specifications:	Primary Power: 24 - 48 VDC; 50 Hz	
	FCC ID: X27-FS-V200	
	Type of Modulations:	OFDMA with 128 FFT The subcarriers are 64QAM modulated
	Equipment Code:	TNB
	Max Peak and Output Power:	32.57 dBm @ 219.5MHz
	EUT Frequency Ranges:	217MHz – 220MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	James Borrott	
Date(s):	September 6, 2018	

B. References

CFR 47, Part 80, Subpart E	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 80: Stations in Maritime Service
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26: 2015	Compliance Testing of Transmitters Used in Licensed Radio Services
ISO/IEC 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories
EIA/TIA-603-D-2010	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards
KDB 971168 v02r02	MEASUREMENT GUIDANCE FOR CERTIFICATION OF LICENSED DIGITAL TRANSMITTERS

Table 2. References

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick Street, Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

E. Description of Test Sample

The Full Spectrum Venus platform, Equipment Under Test (EUT), is a Point to Multipoint broadband wireless radio platform designed to operate in the frequency range 217 to 218 MHz & 219 to 220 Mhz. The Venus platform can run both base station and remote station application layer software. It is running 500 KHz and 1 MHz wide channel configuration and Time Division Duplex (TDD) mode of operation for communication in both direction over the same frequency.

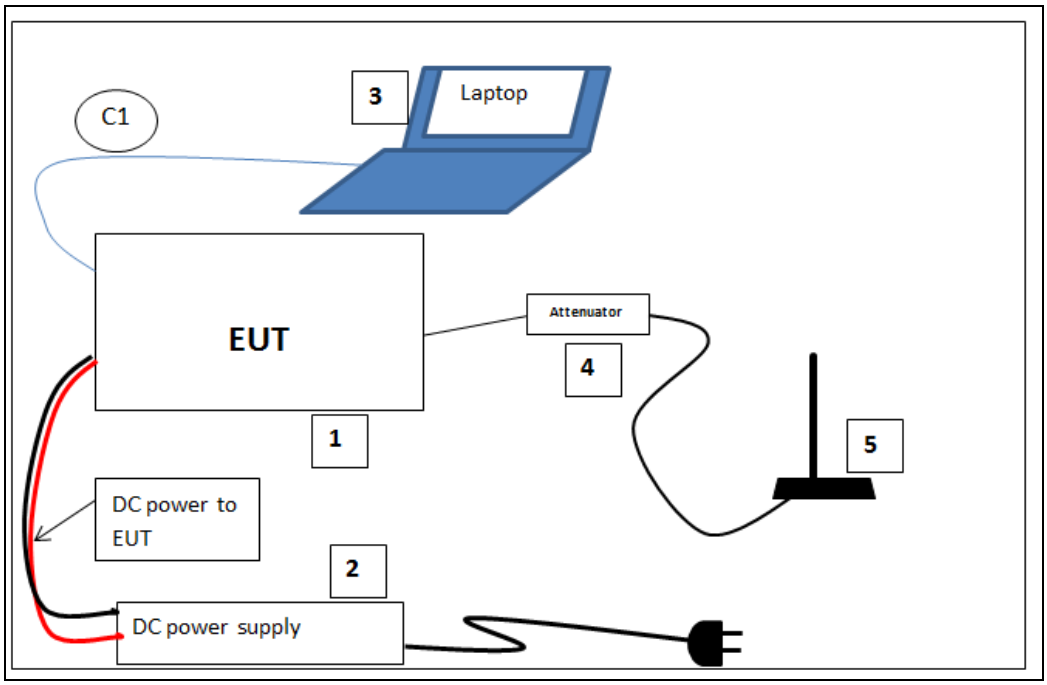


Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

All cards, racks, etc., incorporated as part of the EUT are included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
1	NA	Venus radio platform	VN-0500	VN-0500	0050018140050	1.0

Table 3. Equipment Configuration

G. Support Equipment

Full Spectrum supplied support equipment necessary for the operation and testing of the Venus. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number
2	AC/DC Power supply	MW	RS-150-24
3	Laptop	NA	NA
C1	Cable connecting laptop to EUT	NA	NA
4	Attenuator	JFW	50BR-018
5	Whip antenna	Laird Technologies	B2003S

Table 4. Support Equipment

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	Console	RJ45	1	NA	NA	No	NA
2	DC Input	2 conductors	1	NA	NA	No	NA
3	RF	LMR400	1	NA	NA	Yes	NA

Table 5. Ports and Cabling Information

I. Mode of Operation

The EUT will employ a special test mode that will force it to transmit in every TDD downlink sub-frame. The transmission will employ 64QAM. The following parameters will be modified during the tests:

1. 1 MHz wide channel @ center frequencies 217.500 and 219.500 MHz
2. 500 kHz wide channel @ center frequencies 217.250, 217.750, 219.250 and 219.750 MHz
3. Transmission Power level: Up to 4 watts

J. Method of Monitoring EUT Operation

1. A spectrum analyzer will be used to monitor the transmission from the EUT.
2. Proper operation of the EUT will also be monitored from a console connected to the EUT during the tests.

K. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Full Spectrum upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 80.205 Occupied Bandwidth

Test Requirement(s): According to FCC §80.205 and WT Docket No. 98.169, the bandwidth can go up to 1MHz

§80.205 Bandwidths:

(a) An emission designator shows the necessary bandwidth for each class of emission of a station except that in ship earth stations it shows the occupied or necessary bandwidth, whichever is greater. The following table gives the class of emission and corresponding emission designator and authorized bandwidth:

Class of Emission	Emission Designator	Authorized Bandwidth (kHz)
A1A	160HA1A	0.4
A1B[1]	160HA1B	0.4
A1D[12]	16K0A1D	20.0
A2A	2K66A2A	2.8
A2B[1]	2K66A2B	2.8
A2D[12]	16K0A2D	20.0
A3E	6K00A3E	8.0
A3N[2]	2K66A3N	2.8
A3X[3]	3K20A3X	25.0
F1B[4]	280HF1B	0.3
F1B[5]	300HF1B	0.5
F1B[6]	16KOF1B	20.0
F1C	2K80F1C	3.0
F1D[12]	16K0F1D	20.0
F2B[6]	16KOF2B	20.0
F2C[7]	16KOF2C	20.0
F2D[12]	16K0F2D	20.0
F3C	2K80F3C	3.0
F3C[7]	16KOF3C	20.0
F3E[8]	16KOF3E	20.0
F3N[9]	20MOF3N	20,000.0
G1D[12]	16K0G1D	20.0
G2D[12]	16K0G2D	20.0
G3D[10]	16KOG3D	20.0
G3E[8]	16KOG3E	20.0
G3N[3, 13]	16KOG3N	20.0
H2A	1K40H2A	2.8
H2B[1]	1K40H2B	2.8
H3E[11]	2K80H3E	3.0
H3N	2K66H3N	2.8
J2A	160HJ2A	0.4
J2B[4]	280HJ2B	0.3
J2B[5]	300HJ2B	0.5
J2B	2K80J2B	3.0
J2C	2K80J2C	3.0
J2D[14]	2K80J2D	3.0
J3C	2K80J3C	3.0
J3E[11]	2K80J3E	3.0
J3N	160HJ3N	0.4
NON	NON	0.4
PON	([12])	([12])
R3E[11]	2K80R3E	3.0

[1] On 500 kHz and 2182 kHz A1B, A2B, H2B and J2B emissions indicate transmission of the auto alarm signals.
[2] Applicable only to transmissions in the 405–525 kHz band for direction finding.
[3] Applicable only to EPIRB's.
[4] Radioprinter transmissions for communications with private coast stations.
[5] NB-DP radiotelegraph and data transmissions for communications with public coast stations.
[6] Applicable only to radioprinter and data in the 156–162 MHz band and radioprinter in the 216–220 MHz band.
[7] Applicable only to facsimile in the 156–162 MHz and 216–220 MHz bands.
[8] Applicable only when maximum frequency deviation is 5 kHz. See also paragraph (b) of this section.
[9] Applicable only to marine hand-held radar.
[10] Applicable only to on-board frequencies for maneuvering or navigation.
[11] Transmitters approved prior to December 31, 1969, for emission H3E, J3E and R3E and an authorized bandwidth of 3.5 kHz may continue to be operated. These transmitters will not be authorized in new installations.
[12] Applicable to radiolocation and associated telecommand ship stations operating on 154.585 MHz, 159.480 MHz, 160.725 MHz. 160.785 MHz, 454.000 MHz, and 459.000 MHz; emergency position indicating radiobeacons operating in the 406.000–406.1000 MHz frequency bank; and data transmissions in the 156–162 MHz band.
[13] Class C EPIRB stations may not be used after February 1, 1999.
[14] The information is contained in multiple very low level subcarriers.

(b) For land stations the maximum authorized frequency deviation for F3E or G3E emission is as follows:
  (1) 5 kHz in the 72.0–73.0 MHz, 75.4–76.0 MHz and 156–162 MHz bands;
  (2) 15 kHz for stations which were authorized for operation before December 1, 1961, in the 73.0–74.6 MHz band.

Test Procedures: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% - 5% of the total emission bandwidth, VBW > RBW. The 99% Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer(s): Jun Qi

Test Date(s): 04/26/2018

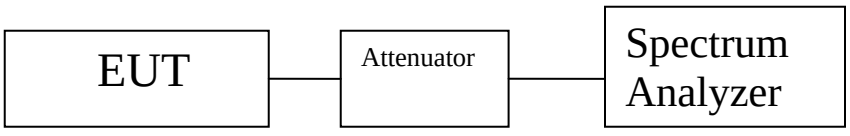
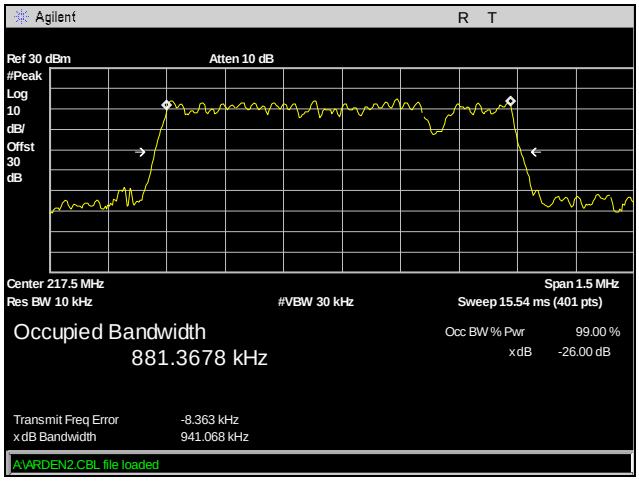
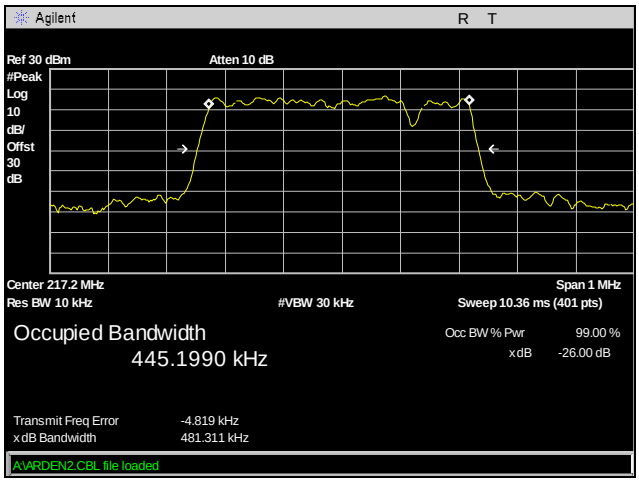


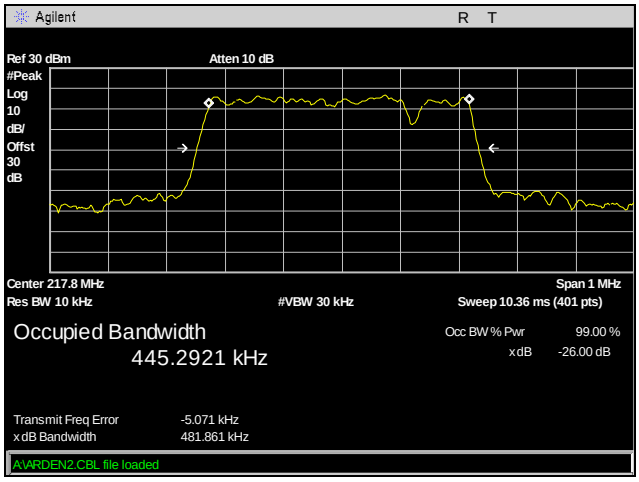
Figure 2. Test Setup



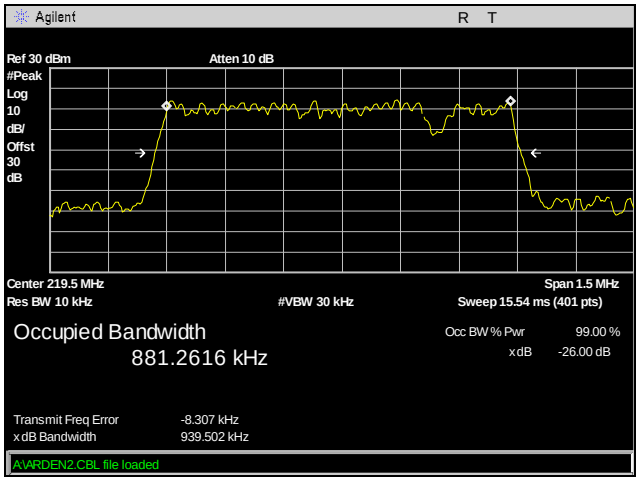
Plot 1. Occupied Bandwidth, Channel 217.5 MHz, 64QAM, BW 1MHz



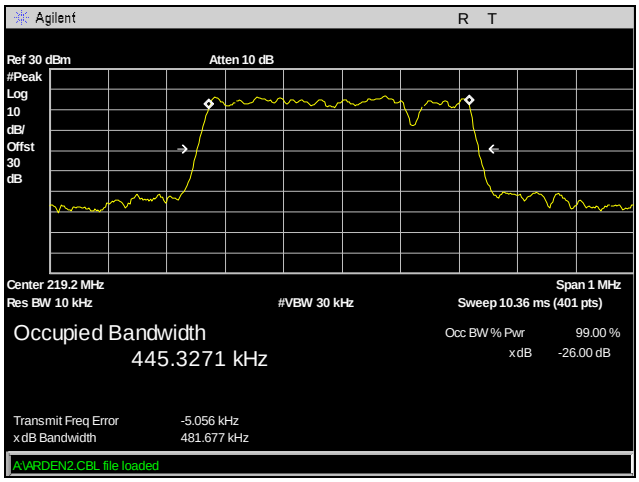
Plot 2. Occupied Bandwidth, Channel 217.25 MHz, 64QAM, BW 500 kHz



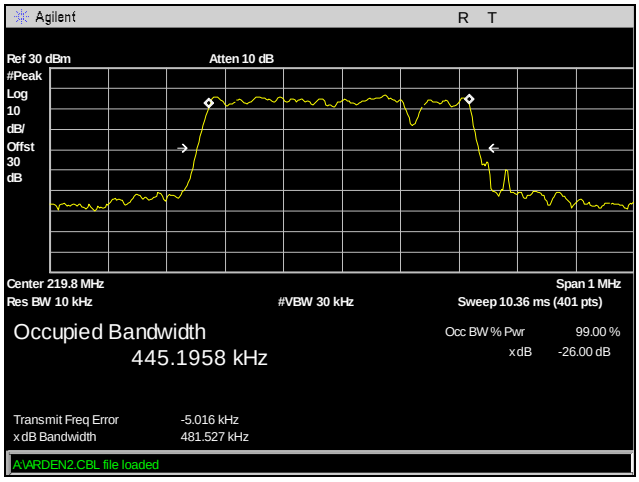
Plot 3. Occupied Bandwidth, Channel 217.75 MHz, 64QAM, BW 500 kHz



Plot 4. Occupied Bandwidth, Channel 219.5 MHz, 64QAM, BW 1 MHz



Plot 5. Occupied Bandwidth, Channel 219.25 MHz, 64QAM, BW 500 kHz



Plot 6. Occupied Bandwidth, Channel 219.75 MHz, 64QAM, BW 500 kHz

§80.207 Classes of Emissions

Test Requirements: **§80.207 Classes of Emissions**

(a) Authorization to use radiotelephone and radiotelegraph emissions by ship and coast stations includes the use of digital selective calling and selective calling techniques in accordance with § 80.225.
(b) In radiotelegraphy communications employing a modulated carrier the carrier must be keyed and modulated by an audio frequency.
(c) Authorization to use single sideband emission is limited to emitting a carrier;
  (1) For full carrier transmitters at a power level between 3 and 6 dB below peak envelope power;
  (2) For suppressed carrier transmitters at a power level at least 40 dB below peak envelope power; and
  (3) For reduced or variable level carrier:
    (i) In the 1600–4000 kHz band:
      (A) For coast station transmitters 18±2 dB below peak envelope power;
      (B) For ship station transmitters installed before January 2, 1982, 16±2 dB below peak envelope power; and
      (C) For ship station transmitters installed after January 1, 1982, 18±2 dB below peak envelope power.
    (ii) In the 4000–27500 kHz band:
      (A) For coast station transmitters 18±2 dB below peak envelope power;
      (B) For ship station transmitters installed before January 2, 1978, 16±2 dB below peak envelope power; and
      (C) For ship station transmitters installed after January 1, 1978, 18±2 dB below peak envelope power.
(d) The authorized classes of emission are as follows: See FCC Part §80.207.

Test Results: Based on manufacturer's declaration this requirement is considered to be met.

Test Engineer(s): Jun Qi

Test Date(s): 05/07/2018

§80.209 Frequency Tolerance

Test Requirement(s): **§2.1055 and §80.209**

Test Procedures: As required by 47 CFR 2.1055, *Frequency Stability measurements* were made at the RF output terminals of the EUT.

The EUT was placed in an Environmental Chamber with all support equipment are outside of the chamber on a table. The EUT was set to transmitter an un-modulated carrier. The reference frequency at 20°C was observed and put on 'view' under Trace 1 of the Spectrum Analyzer. As temperature or voltage was varied, the drift in frequency was observed in Trace 2. The frequency error was measured using delta markers between Trace 1 and 2. The frequency drift was investigated for every 10°C increment until the unit was stabilized then recorded the reading in tabular format with the temperature range of -20 to 50°C.

Voltage supplied to the EUT was 24VDC and 48VDC reference temperature was at 20°C. The voltage was varied by ± 15 % of nominal.

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer(s): Jun Qi

Test Date(s): 04/30/2018

(217.25MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	217.249750	1.151
	24.00		217.249875	0.575
	20.40		217.249875	0.575
	27.60	40	217.250000	0.000
	24.00		217.249750	1.151
217.250000	20.40		217.250000	0.000
	27.60	30	217.249875	0.575
	24.00		217.250000	0.000
	20.40		217.250000	0.000
	27.60	20	217.249875	0.575
	24.00		217.250000	0.000
	20.40		217.250000	0.000
	27.60	10	217.249875	0.575
	24.00		217.249875	0.575
	20.40		217.249750	1.151
	27.60	0	217.249875	0.575
	24.00		217.249875	0.575
	20.40		217.249875	0.575
	27.60	-10	217.250125	0.575
	24.00		217.250000	0.000
	20.40		217.249875	0.575
	27.60	-20	217.250000	0.000
	24.00		217.250000	0.000
	20.40		217.249875	0.575

Table 6. Frequency Tolerance, 24V, 217.25 MHz, Test Results

(217.75MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	217.749750	1.148
	24.00		217.749750	1.148
	20.40		217.749750	1.148
	27.60	40	217.749750	1.148
	24.00		217.749750	1.148
217.750000	20.40		217.749750	1.148
	27.60	30	217.749750	1.148
	24.00		217.749750	1.148
	20.40		217.749750	1.148
	27.60	20	217.749750	1.148
	24.00		217.750000	0.000
	20.40		217.750000	0.000
	27.60	10	217.749750	1.148
	24.00		217.749750	1.148
	20.40		217.750000	0.000
	27.60	0	217.749750	1.148
	24.00		217.749750	1.148
	20.40		217.749750	1.148
	27.60	-10	217.749875	0.574
	24.00		217.749875	0.574
	20.40		217.750000	0.000
	27.60	-20	217.750000	0.000
	24.00		217.750000	0.000
	20.40		217.750000	0.000

Table 7. Frequency Tolerance, 24V, 217.75 MHz, Test Results

(219.25MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	219.249500	2.281
	24.00		219.249750	1.140
	20.40		219.249750	1.140
	27.60	40	219.249750	1.140
	24.00		219.249750	1.140
219.250000	20.40		219.250000	0.000
	27.60	30	219.249750	1.140
	24.00		219.250000	0.000
	20.40		219.249750	1.140
	27.60	20	219.250000	0.000
	24.00		219.250000	0.000
	20.40		219.250000	0.000
	27.60	10	219.249750	1.140
	24.00		219.249750	1.140
	20.40		219.249750	1.140
	27.60	0	219.250000	0.000
	24.00		219.249750	1.140
	20.40		219.249750	1.140
	27.60	-10	219.249875	0.570
	24.00		219.250000	0.000
	20.40		219.249750	1.140
	27.60	-20	219.249875	0.570
	24.00		219.250125	0.570
	20.40		219.250000	0.000

Table 8. Frequency Tolerance, 24V, 219.25 MHz, Test Results

(219.75MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	219.749750	1.138
	24.00		219.749750	1.138
	20.40		219.749750	1.138
	27.60	40	219.749750	1.138
	24.00		219.749750	1.138
219.750000	20.40		219.750000	0.000
	27.60	30	219.749750	1.138
	24.00		219.749750	1.138
	20.40		219.749750	1.138
	27.60	20	219.750000	0.000
	24.00		219.750000	0.000
	20.40		219.749750	1.138
	27.60	10	219.750000	0.000
	24.00		219.750000	0.000
	20.40		219.749500	2.275
	27.60	0	219.749750	1.138
	24.00		219.749750	1.138
	20.40		219.750000	0.000
	27.60	-10	219.750175	0.796
	24.00		219.750050	0.228
	20.40		219.749925	0.341
	27.60	-20	219.750000	0.000
	24.00		219.750000	0.000
	20.40		219.749875	0.569

Table 9. Frequency Tolerance, 24V, 219.75 MHz, Test Results

(217.5MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	217.499500	2.299
	24.00		217.499750	1.149
	20.40		217.499750	1.149
	27.60	40	217.499750	1.149
	24.00		217.500000	0.000
217.500000	20.40		217.499750	1.149
	27.60	30	217.499750	1.149
	24.00		217.499750	1.149
	20.40		217.499750	1.149
	27.60	20	217.499750	1.149
	24.00		217.500000	0.000
	20.40		217.499750	1.149
	27.60	10	217.500000	0.000
	24.00		217.499750	1.149
	20.40		217.499750	1.149
	27.60	0	217.499750	1.149
	24.00		217.499750	1.149
	20.40		217.499750	1.149
	27.60	-10	217.499875	0.575
	24.00		217.500000	0.000
	20.40		217.500000	0.000
	27.60	-20	217.499875	0.575
	24.00		217.500250	1.149
	20.40		217.500000	0.000

Table 10. Frequency Tolerance, 24V, 217.50 MHz, Test Results

(219.5MHzl)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	27.60	50	219.499750	1.139
	24.00		219.499750	1.139
	20.40		219.499750	1.139
	27.60	40	219.499750	1.139
	24.00		219.499750	1.139
219.500000	20.40		219.499750	1.139
	27.60	30	219.500000	0.000
	24.00		219.499750	1.139
	20.40		219.499750	1.139
	27.60	20	219.499750	1.139
	24.00		219.500000	0.000
	20.40		219.500000	0.000
	27.60	10	219.499750	1.139
	24.00		219.499750	1.139
	20.40		219.499750	1.139
	27.60	0	219.499750	1.139
	24.00		219.499750	1.139
	20.40		219.500000	0.000
	27.60	-10	219.500125	0.569
	24.00		219.499750	1.139
	20.40		219.499750	1.139
	27.60	-20	219.500000	0.000
	24.00		219.499875	0.569
	20.40		219.500000	0.000

Table 11. Frequency Tolerance, 24V, 219.50 MHz, Test Results

(217.25MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	217.249750	1.151
	48.00		217.249875	0.575
	40.80		217.249875	0.575
	55.20	40	217.250000	0.000
	48.00		217.249750	1.151
217.250000	40.80		217.250000	0.000
	55.20	30	217.249875	0.575
	48.00		217.249875	0.575
	40.80		217.250000	0.000
	55.20	20	217.249875	0.575
	48.00		217.250000	0.000
	40.80		217.250000	0.000
	55.20	10	217.249875	0.575
	48.00		217.249875	0.575
	40.80		217.249750	1.151
	55.20	0	217.249875	0.575
	48.00		217.249875	0.575
	40.80		217.249875	0.575
	55.20	-10	217.250125	0.575
	48.00		217.250000	0.000
	40.80		217.249875	0.575
	55.20	-20	217.249750	1.151
	48.00		217.250000	0.000
	40.80		217.249875	0.575

Table 12. Frequency Tolerance, 48V, 217.25 MHz, Test Results

(217.75MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	217.749750	1.148
	48.00		217.749750	1.148
	40.80		217.749750	1.148
	55.20	40	217.749750	1.148
	48.00		217.750000	0.000
217.750000	40.80		217.749750	1.148
	55.20	30	217.749750	1.148
	48.00		217.750000	0.000
	40.80		217.750000	0.000
	55.20	20	217.750000	0.000
	48.00		217.750000	0.000
	40.80		217.750000	0.000
	55.20	10	217.749750	1.148
	48.00		217.749750	1.148
	40.80		217.749750	1.148
	55.20	0	217.749500	2.296
	48.00		217.749750	1.148
	40.80		217.749750	1.148
	55.20	-10	217.749875	0.574
	48.00		217.750000	0.000
	40.80		217.749875	0.574
	55.20	-20	217.750000	0.000
	48.00		217.750000	0.000
	40.80		217.749750	1.148

Table 13. Frequency Tolerance, 48V, 217.75 MHz, Test Results

(219.25MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	219.249500	2.281
	48.00		219.249750	1.140
	40.80		219.249500	2.281
	55.20	40	219.249750	1.140
	48.00		219.249750	1.140
219.250000	40.80		219.249750	1.140
	55.20	30	219.249750	1.140
	48.00		219.249750	1.140
	40.80		219.249500	2.281
	55.20	20	219.250000	0.000
	48.00		219.250000	0.000
	40.80		219.249750	1.140
	55.20	10	219.250000	0.000
	48.00		219.249750	1.140
	40.80		219.249750	1.140
	55.20	0	219.249750	1.140
	48.00		219.249750	1.140
	40.80		219.249750	1.140
	55.20	-10	219.250125	0.570
	48.00		219.250000	0.000
	40.80		219.250250	1.140
	55.20	-20	219.249750	1.140
	48.00		219.249875	0.570
	40.80		219.250000	0.000

Table 14. Frequency Tolerance, 48V, 219.25 MHz, Test Results

(219.75MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	219.749750	1.138
	48.00		219.749750	1.138
	40.80		219.749750	1.138
	55.20	40	219.749750	1.138
	48.00		219.749750	1.138
219.750000	40.80		219.749750	1.138
	55.20	30	219.749750	1.138
	48.00		219.749750	1.138
	40.80		219.749750	1.138
	55.20	20	219.750000	0.000
	48.00		219.750000	0.000
	40.80		219.749750	1.138
	55.20	10	219.749500	2.275
	48.00		219.749750	1.138
	40.80		219.749750	1.138
	55.20	0	219.749750	1.138
	48.00		219.749750	1.138
	40.80		219.749750	1.138
	55.20	-10	219.750050	0.228
	48.00		219.749925	0.341
	40.80		219.749800	0.910
	55.20	-20	219.749875	0.569
	48.00		219.750000	0.000
	40.80		219.750000	0.000

Table 15. Frequency Tolerance, 48V, 219.75 MHz, Test Results

(217.5MHz)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	217.499750	1.149
	48.00		217.499750	1.149
	40.80		217.499750	1.149
	55.20	40	217.499750	1.149
	48.00		217.499750	1.149
217.500000	40.80		217.499750	1.149
	55.20	30	217.499750	1.149
	48.00		217.499750	1.149
	40.80		217.499750	1.149
	55.20	20	217.499750	1.149
	48.00		217.500000	0.000
	40.80		217.499750	1.149
	55.20	10	217.500000	0.000
	48.00		217.499750	1.149
	40.80		217.499750	1.149
	55.20	0	217.500000	0.000
	48.00		217.499750	1.149
	40.80		217.500000	0.000
	55.20	-10	217.500000	0.000
	48.00		217.499750	1.149
	40.80		217.499875	0.575
	55.20	-20	217.500000	0.000
	48.00		217.499750	1.149
	40.80		217.500000	0.000

Table 16. Frequency Tolerance, 48V, 217.50 MHz, Test Results

(219.5MHzl)				
	Voltage (DC)	Temperature (C)	Frequency (MHz)	PPM
Reference Frequency	55.20	50	219.499750	1.139
	48.00		219.499750	1.139
	40.80		219.499750	1.139
	55.20	40	219.499750	1.139
	48.00		219.499750	1.139
219.500000	40.80		219.499500	2.278
	55.20	30	219.499750	1.139
	48.00		219.499750	1.139
	40.80		219.499750	1.139
	55.20	20	219.499750	1.139
	48.00		219.500000	0.000
	40.80		219.500000	0.000
	55.20	10	219.499500	2.278
	48.00		219.499750	1.139
	40.80		219.499750	1.139
	55.20	0	219.499750	1.139
	48.00		219.499750	1.139
	40.80		219.499750	1.139
	55.20	-10	219.499875	0.569
	48.00		219.499875	0.569
	40.80		219.499875	0.569
	55.20	-20	219.499875	0.569
	48.00		219.499875	0.569
	40.80		219.500125	0.569

Table 17. Frequency Tolerance, 48V, 219.50 MHz, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§80.211(f); §2.1051 Spurious Emissions at Antenna Terminals

Test Requirement(s):

§2.1051 Measurements required: Spurious emissions at antenna terminals: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§80.211(f): The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:

(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10log10 (mean power in watts) dB.

Test Procedures:

The EUT was tested according to the unwanted emissions procedures of ANSI C63.26 5.7.3.The spectrum analyzer was used and configured in the following manner:

(a) Frequency Range = 30MHz – 10th Harmonic
(b) RBW = 1% of the OBW, or greater
(c) VBW 1-3 x the RBW
(d) Detector = Peak
(e) Sweet Time = Auto

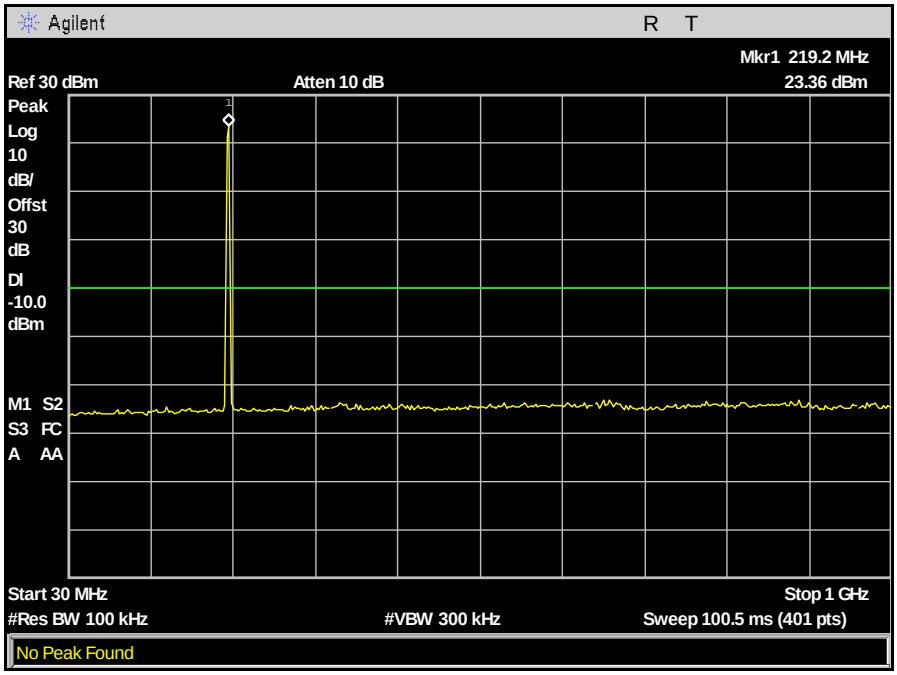
Test Results:

The EUT was compliant with the requirements of this section.

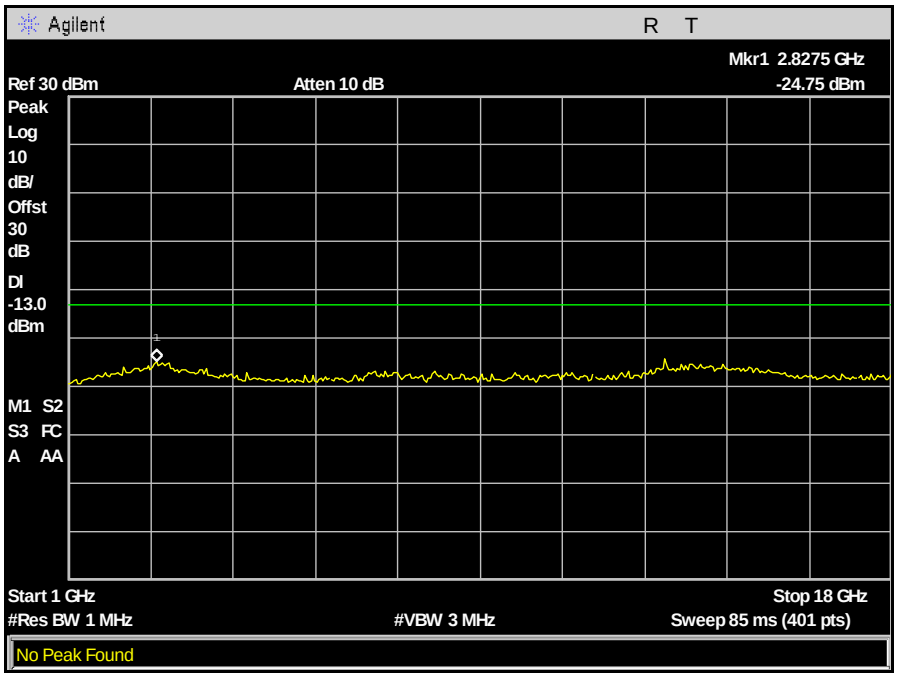
All configurations were evaluated. The worse-case data is reported.

Test Engineer(s): Jun Qi

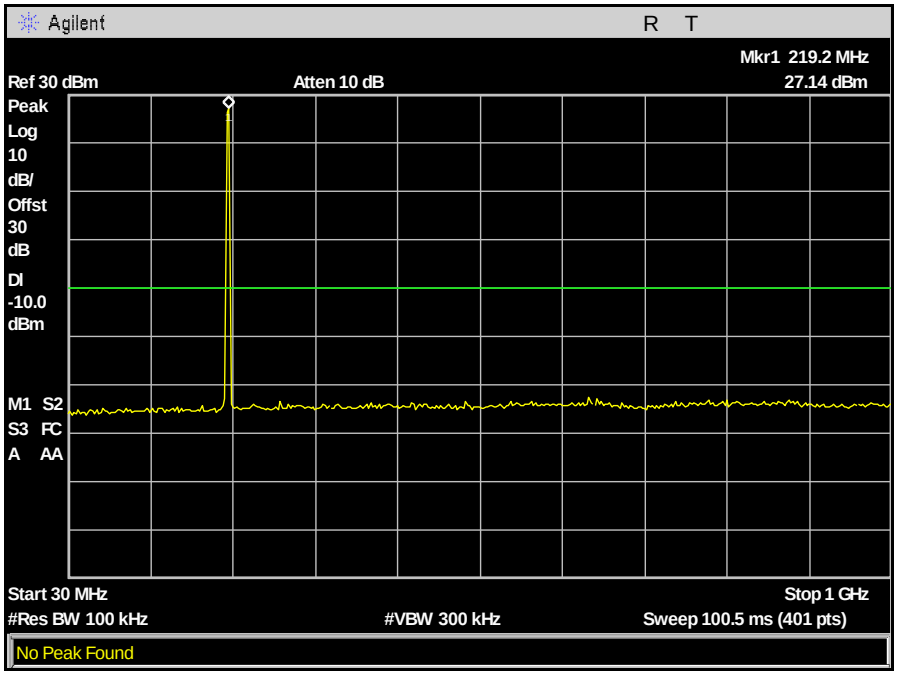
Test Date(s): 04/26/18



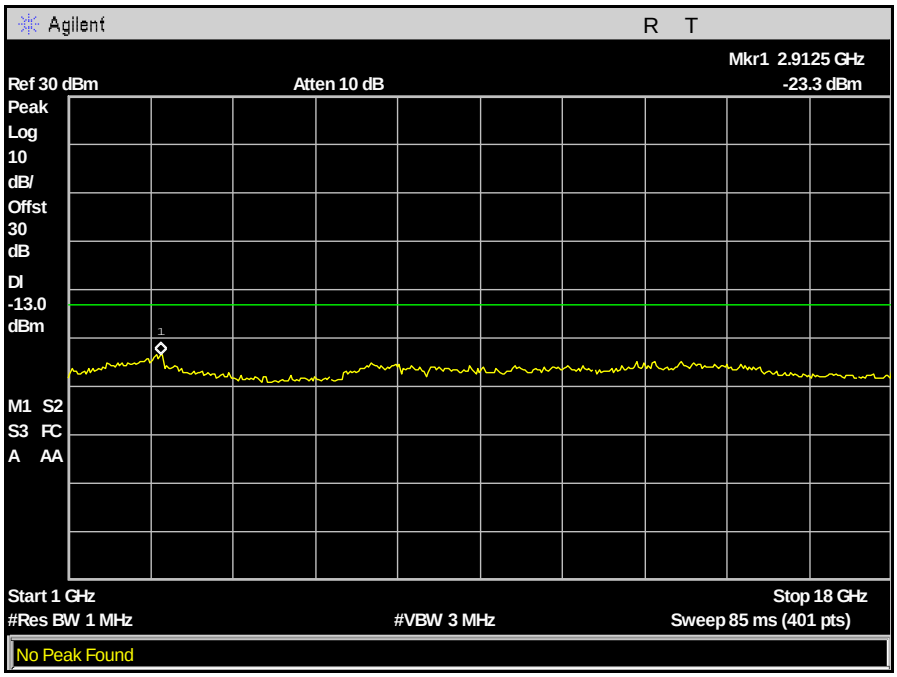
Plot 7. Unwanted Emissions, Channel 217.5 MHz, 64QAM, BW 1 MHz, 30 MHz – 1 GHz



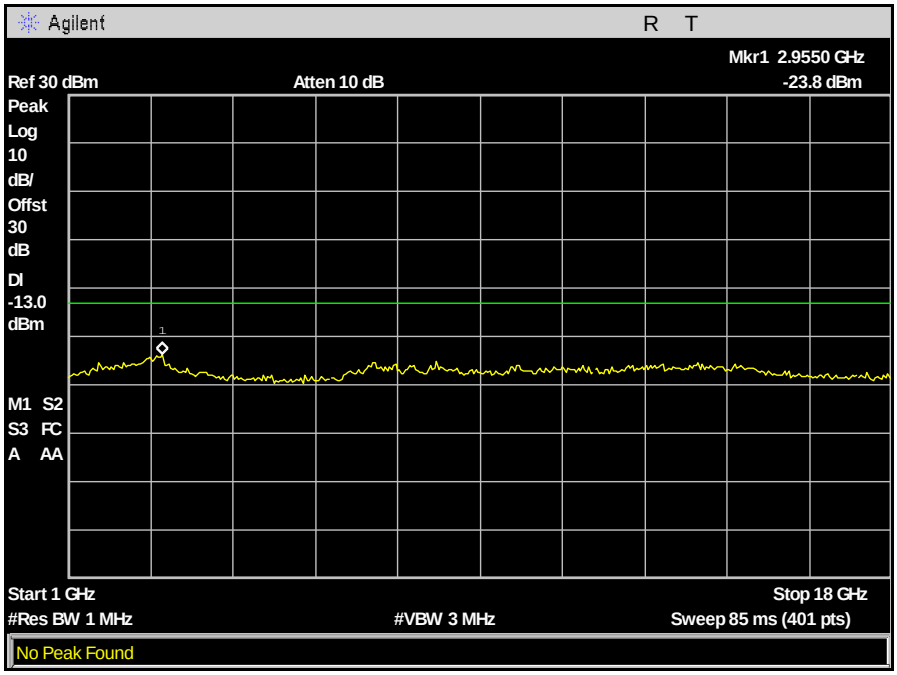
Plot 8. Unwanted Emissions, Channel 217.5 MHz, 64QAM, BW 1 MHz, 1 GHz – 18 GHz



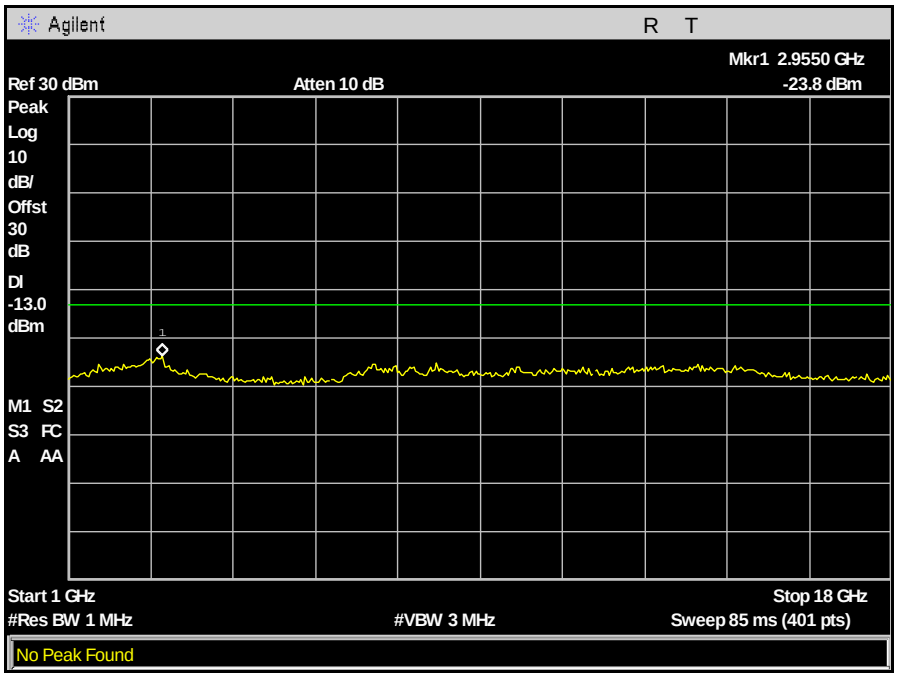
Plot 9. Unwanted Emissions, Channel 217.25 MHz, 64QAM, BW 500 kHz, 30 MHz – 1 GHz



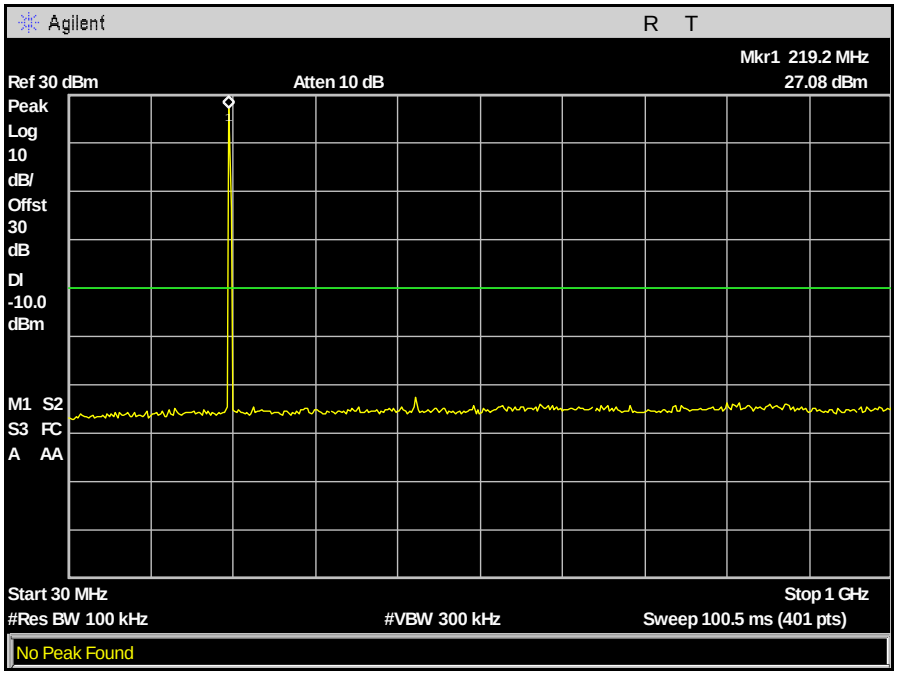
Plot 10. Unwanted Emissions, Channel 217.25 MHz, 64QAM, BW 500 kHz, 1 GHz – 18 GHz



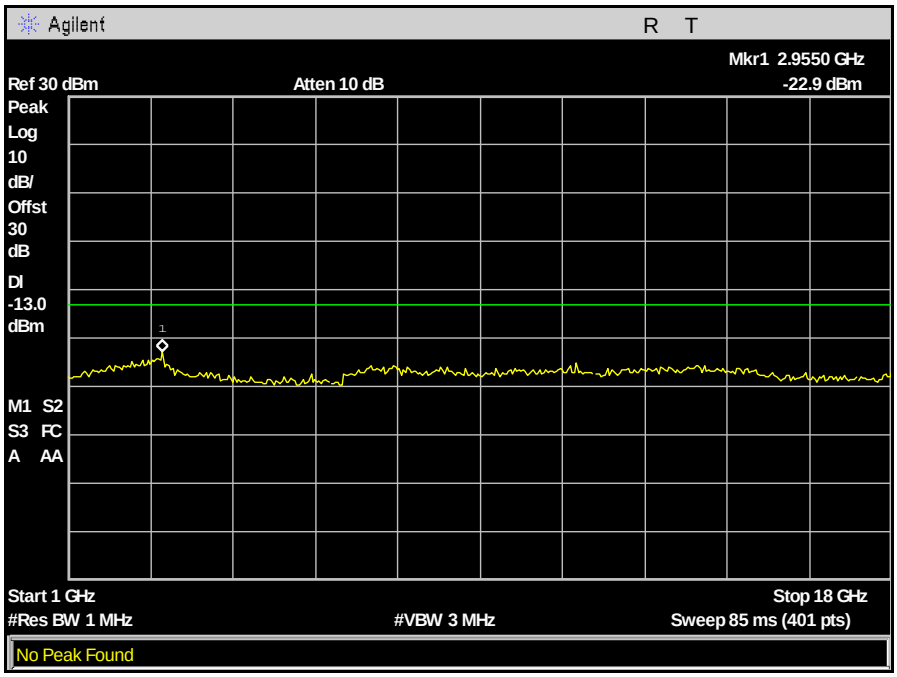
Plot 11. Unwanted Emissions, Channel 217.75 MHz, 64QAM, BW 500 kHz, 30 MHz – 1 GHz



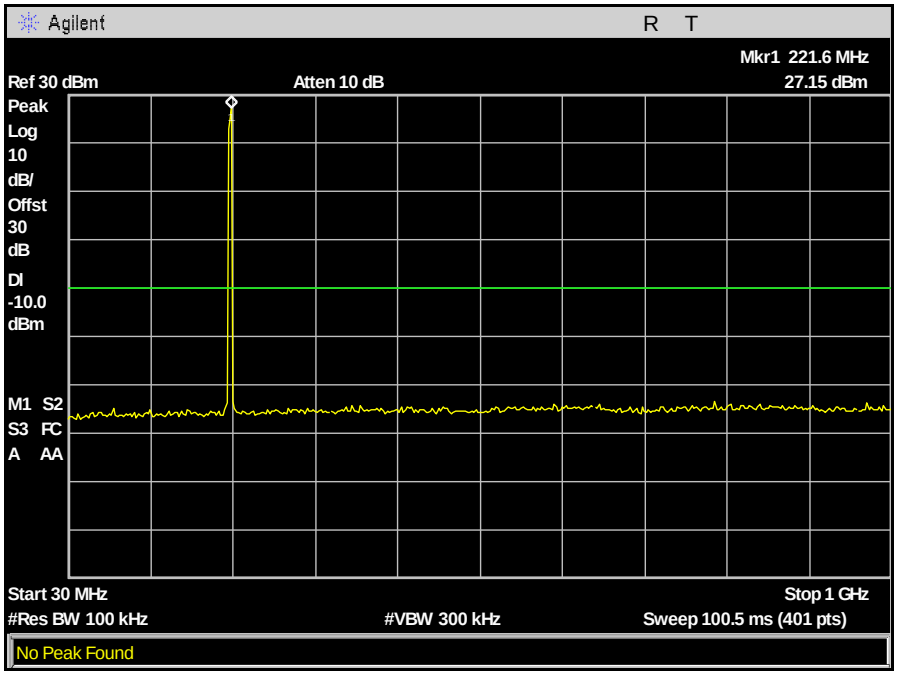
Plot 12. Unwanted Emissions, Channel 217.75 MHz, 64QAM, BW 500 kHz, 1 GHz – 18 GHz



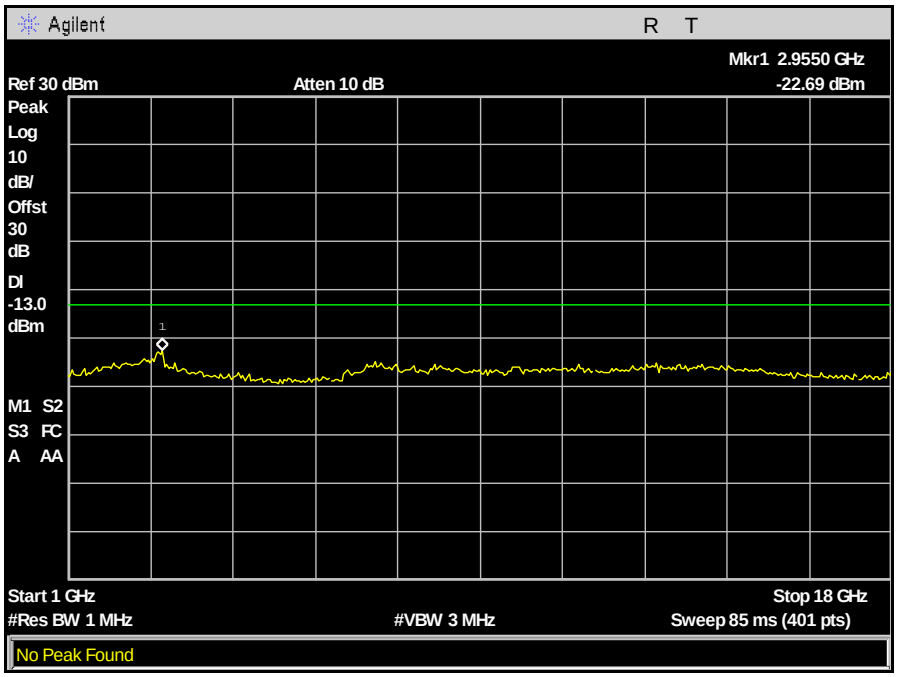
Plot 13. Unwanted Emissions, Channel 219.25 MHz, 64QAM, BW 500 kHz, 30 MHz – 1 GHz



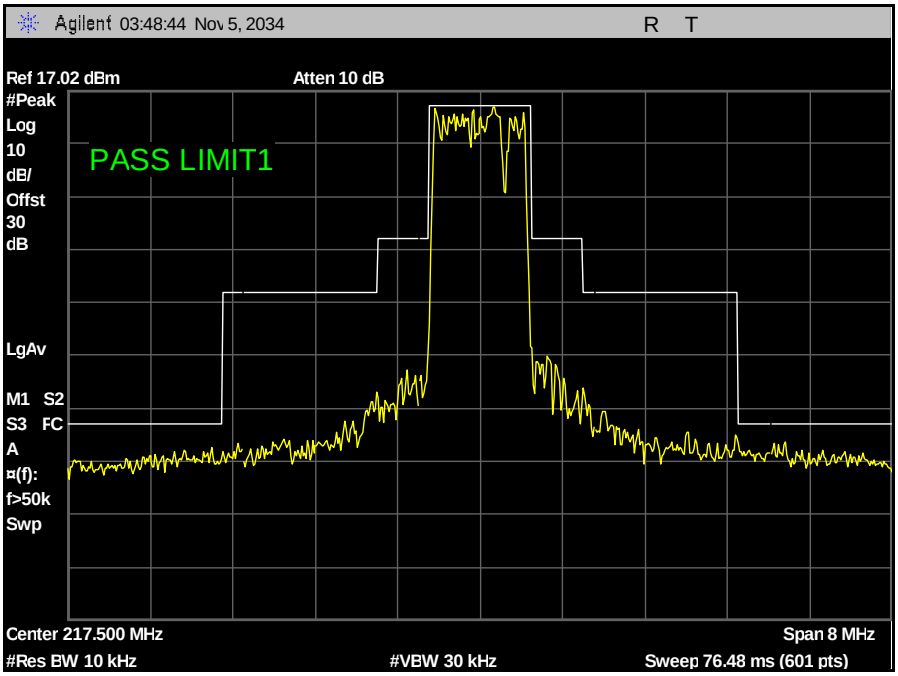
Plot 14. Unwanted Emissions, Channel 219.25 MHz, 64QAM, BW 500 kHz, 1 GHz – 18 GHz



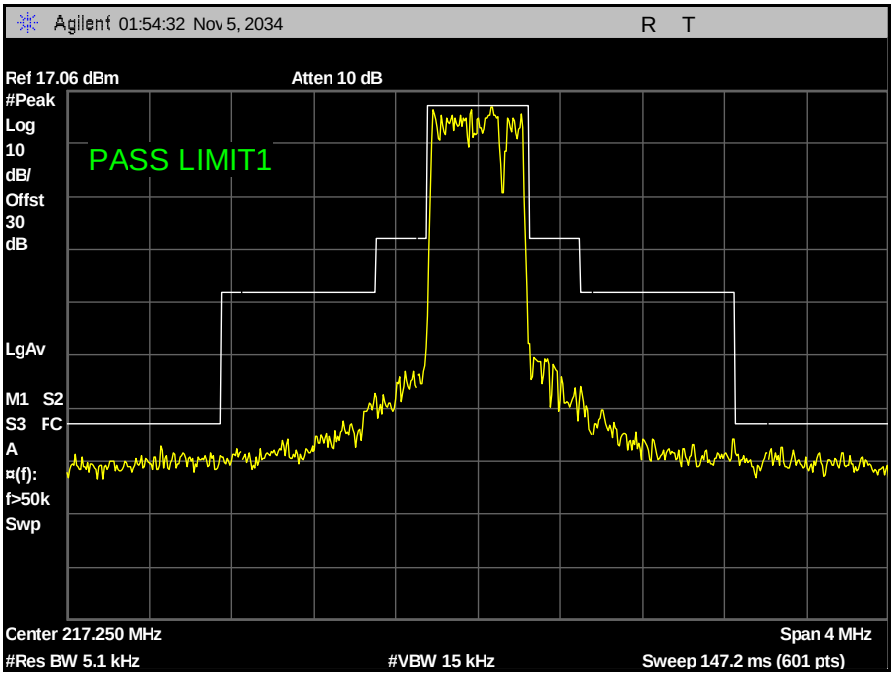
Plot 15. Unwanted Emissions, Channel 219.75 MHz, 64QAM, BW 500 kHz, 30 MHz – 1 GHz



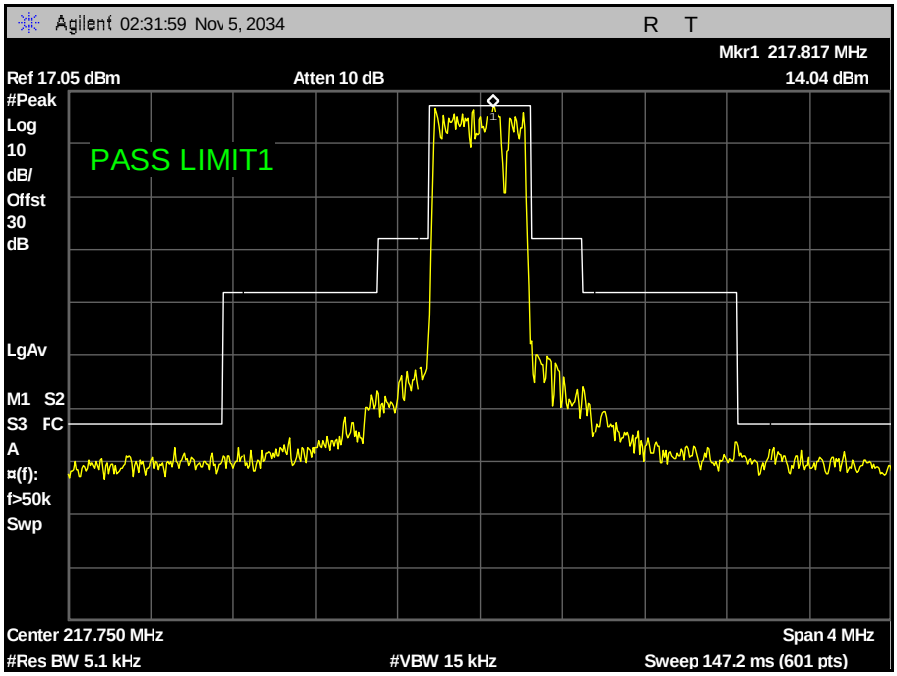
Plot 16. Unwanted Emissions, Channel 219.75 MHz, 64QAM, BW 500 kHz, 1 GHz – 18 GHz



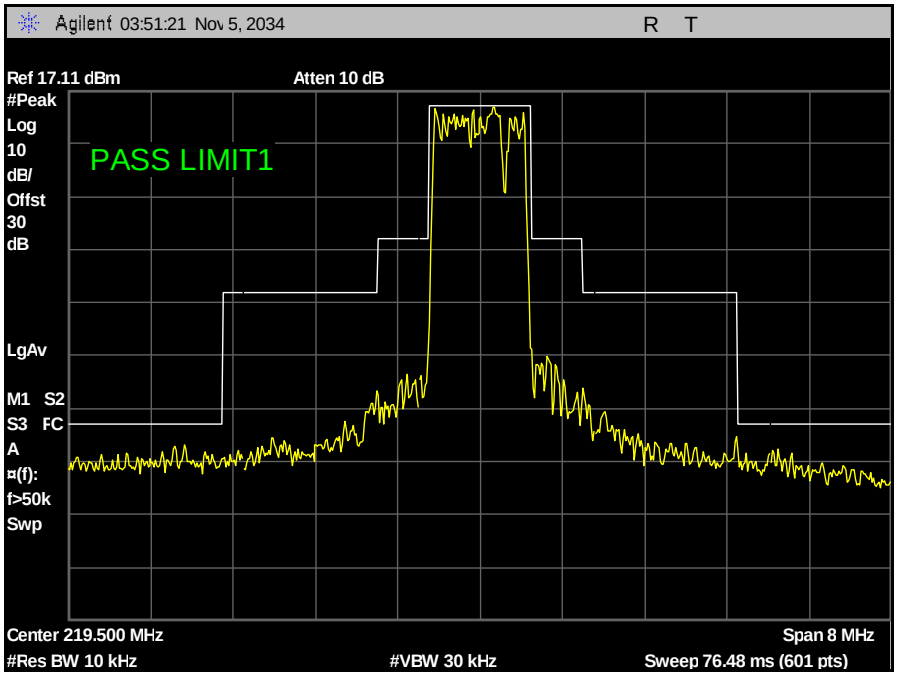
Plot 17. Emission Mask, Channel 217.5 MHz, 64QAM, BW 1 MHz



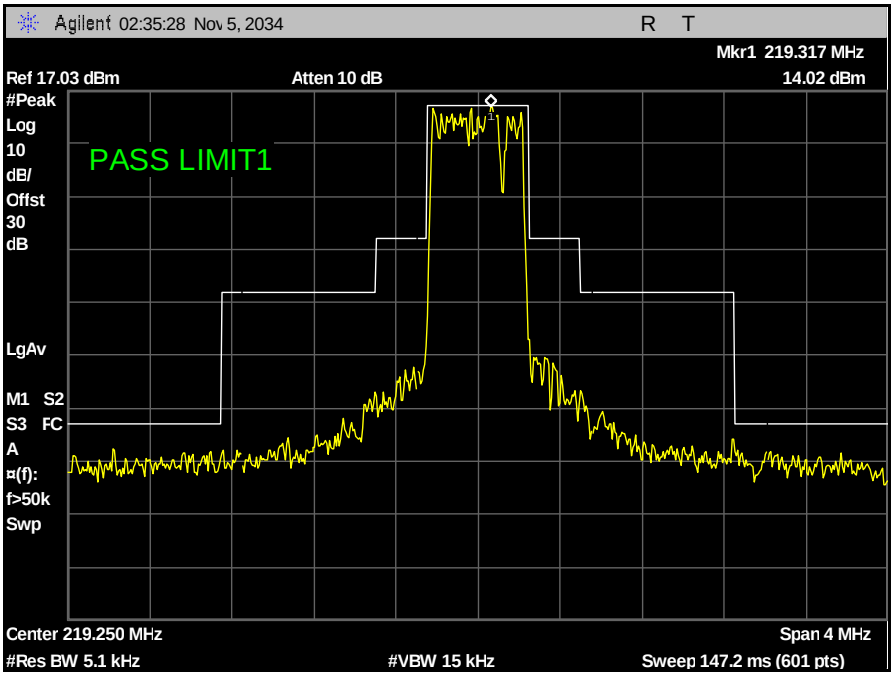
Plot 18. Emission Mask, Channel 217.25 MHz, 64QAM, BW 500 kHz



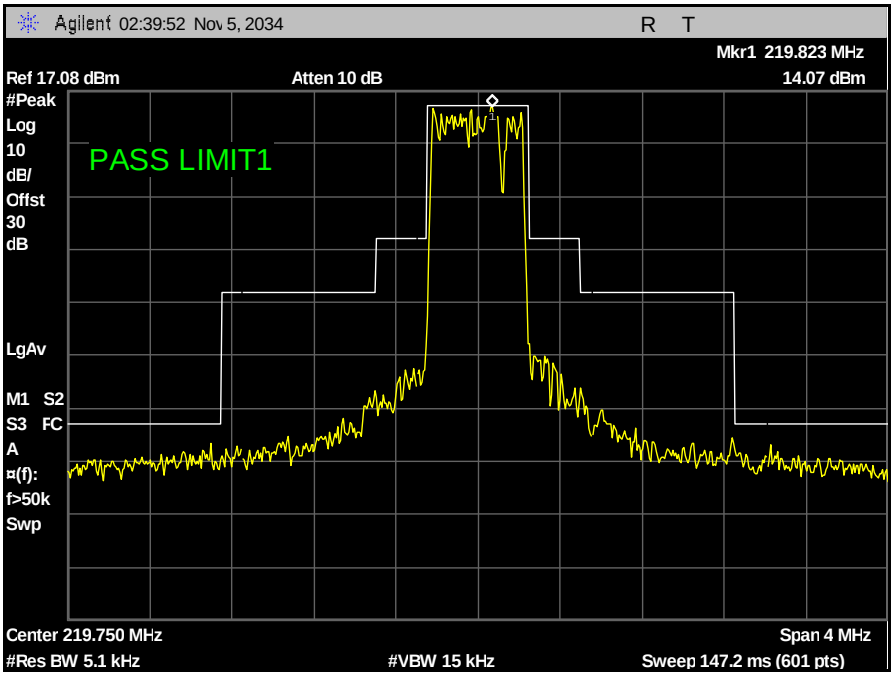
Plot 19. Emission Mask, Channel 217.75 MHz, 64QAM, BW 500 kHz



Plot 20. Emission Mask, Channel 219.5 MHz, 64QAM, BW 1 MHz



Plot 21. Emission Mask, Channel 219.25 MHz, 64QAM, BW 500 kHz



Plot 22. Emission Mask, Channel 219.75 MHz, 64QAM, BW 500 kHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§80.211(f); §2.1053 Radiated Spurious Emissions

Test Requirement(s): **§ 2.1053 Measurements required: Field strength of spurious radiation.**

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

Test Procedures: The EUT was tested according to field strength method of ANSI C63.26 5.5.4.The spectrum analyzer was used and configured in the following manner:

(a) Frequency Range = Lowest Generated – 10^{th} Harmonic
(b) RBW = 100kHz for 30Mhz-1GHz & 1MHz for above 1GHz
(c) VBW 1-3 x the RBW
(d) Detector = Average

Radiated emission measurements were performed inside a 3 meter chamber that satisfies the site requirements of ANSI C63.4-2014. The EUT was place on an rf transparent 80 cm table for measurements below 1GHz and an rf transparent 1.5 meter table for measurements above 1GHz. The EUT's RF ports were terminated to 50ohm load. The EUT was tested using all modulations and at the low, mid, and high channels. The EUT was rotated about 360^0 and the receiving antenna scanned from 1-4m in order to capture the maximum emission. The plots are corrected for cable loss, antenna correction factor, and distance correction. The field strength was mathematically corrected to an E.I.R.P.

Emissions below 30MHz and above 18GHz were more than 20dB below the limit. The worse-case configurations are reported.

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer: James Borrott

Test Date(s): 05/03/18

Channel: 217.75		Scan				Substitution Ant. Method					
Freq (MHz)	Table Azimuth	Height	Polar (H/V)	Measured	dBuV	S.G. Reading (dBm)	Ant gain	Cable loss	Final	Limit	Margin
435.78	180	200	V	-43.49	54.11	-31.57	1.8	1.92	-31.69	-13	-18.69
435.78	70	200	H	-51.51	46.09	-40.33	1.8	1.92	-40.45	-13	-27.45
654.03	200	200	V	-45.25	52.35	-26.49	2	2.34	-26.83	-13	-13.83
654.03	230	200	H	-49.02	48.58	-30.29	2	2.34	-30.63	-13	-17.63
870.67	180	100	V	-50.56	47.04	-32.42	2.4	2.75	-32.77	-13	-19.77
870.67	200	100	H	-45.63	51.97	-27.46	2.4	2.75	-27.81	-13	-14.81
1088.75	0	200	V	-50.28	47.32						
1088.75	70	200	H	-49.78	47.82						

Table 18. Field Strength of Radiated Emissions, 217.75 MHz

Channel: 217.5		Scan				Substitution Ant. Method					
Freq (MHz)	Table Azimuth	Height	Polar (H/V)	Measured	dBuV	S.G. Reading (dBm)	Ant gain	Cable loss	Final	Limit	Margin
434.99	180	200	V	-43.21	54.39	-31.67	1.8	1.92	-31.79	-13	-18.79
434.99	70	200	H	-51.48	46.12	-40.01	1.8	1.92	-40.13	-13	-27.13
652.42	200	200	V	-43.52	54.08	-24.57	2	2.34	-24.91	-13	-11.91
652.42	230	200	H	-50.16	47.44	-31.37	2	2.34	-31.71	-13	-18.71
869.99	180	100	V	-50.34	47.26	-32.3	2.4	2.75	-32.65	-13	-19.65
869.99	200	100	H	-48.15	49.45	-30.04	2.4	2.75	-30.39	-13	-17.39
1087.5	0	200	V	-49.89	47.71						
1087.5	70	200	H	-48.51	49.09						

Table 19. Field Strength of Radiated Emissions, 217.5 MHz

Channel: 219.25		Scan				Substitution Ant. Method					
Freq (MHz)	Table Azimuth	Height	Polar (H/V)	Measured	dBuV	S.G. Reading (dBm)	Ant gain	Cable loss	Final	Limit	Margin
438.498	90	200	V	-43.41	54.19	-32.01	1.8	1.92	-32.13	-13	-19.13
438.498	70	200	H	-50.76	46.84	-39.31	1.8	1.92	-39.43	-13	-26.43
657.73	270	100	V	-43.48	54.12	-24.83	2.1	2.34	-25.07	-13	-12.07
657.73	230	200	H	-49.37	48.23	-30.75	2.1	2.34	-30.99	-13	-17.99
877.13	230	100	V	-49.3	48.3	-31.02	2.3	2.75	-31.47	-13	-18.47
877.13	230	100	H	-44.75	52.85	-26.42	2.3	2.75	-26.87	-13	-13.87
1096.25	0	200	V	-47.93	49.67						
1096.25	200	200	H	-47.13	50.47						

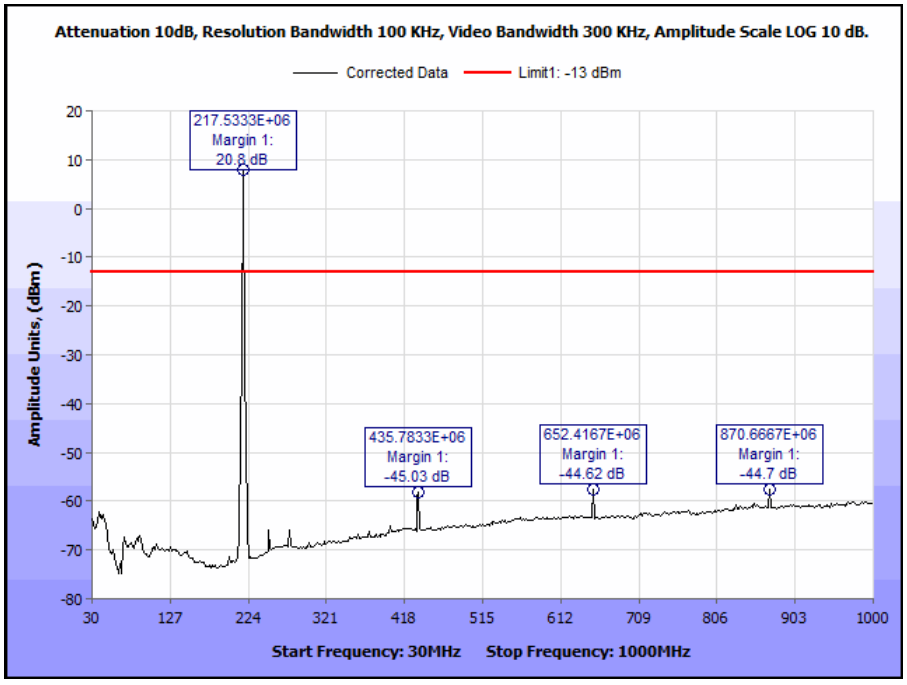
Table 20. Field Strength of Radiated Emissions, 219.25 MHz

Channel: 219.5		Scan				Substitution Ant. Method					
Freq (MHz)	Table Azimuth	Height	Polar (H/V)	Measured	dBuV	S.G. Reading (dBm)	Ant gain	Cable loss	Final	Limit	Margin
439	200	200	V	-43.46	54.14	-32.03	1.8	1.92	-32.15	-13	-19.15
439	70	200	H	-51.7	45.9	-40.21	1.8	1.92	-40.33	-13	-27.33
658.49	270	100	V	-42.88	54.72	-24.43	2.1	2.34	-24.67	-13	-11.67
658.49	230	200	H	-48.81	48.79	-30.21	2.1	2.34	-30.45	-13	-17.45
877.997	230	100	V	-47.85	49.75	-29.7	2.3	2.75	-30.15	-13	-17.15
877.997	230	100	H	-43.93	53.67	-25.72	2.3	2.75	-26.17	-13	-13.17
1097.5	0	200	V	-49.6	48						
1097.5	0	200	H	-48.55	49.05						

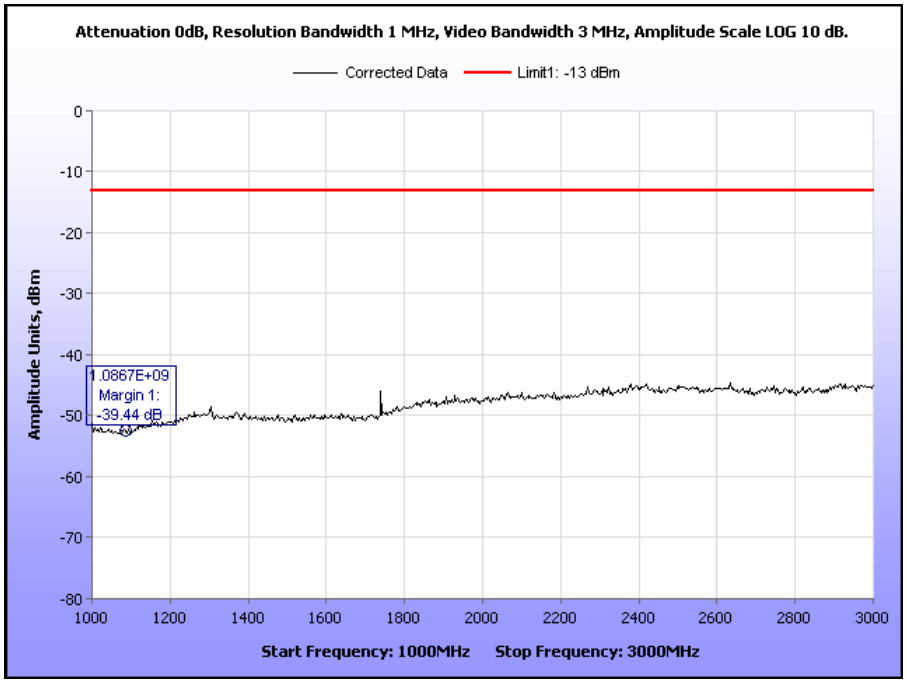
Table 21. Field Strength of Radiated Emissions, 219.5 MHz

Channel: 219.75		Scan				Substitution Ant. Method					
Freq (MHz)	Table Azimuth	Height	Polar (H/V)	Measured	dBuV	S.G. Reading (dBm)	Ant gain	Cable loss	Final	Limit	Margin
439.497	90	200	V	-43.09	54.51	-31.71	1.8	1.92	-31.83	-13	-18.83
439.497	70	200	H	-51.92	45.68	-40.65	1.8	1.92	-40.77	-13	-27.77
659.24	270	100	V	-43.33	54.27	-24.66	2.1	2.34	-24.9	-13	-11.9
659.24	230	200	H	-48.76	48.84	-30.22	2.1	2.34	-30.46	-13	-17.46
879.005	180	200	V	-47.73	49.87	-29.5	2.3	2.75	-29.95	-13	-16.95
879.005	230	100	H	-44.65	52.95	-26.54	2.3	2.75	-26.99	-13	-13.99
1098.75	0	200	V	-48.57	49.03						
1098.75	0	200	H	-47.96	49.64						

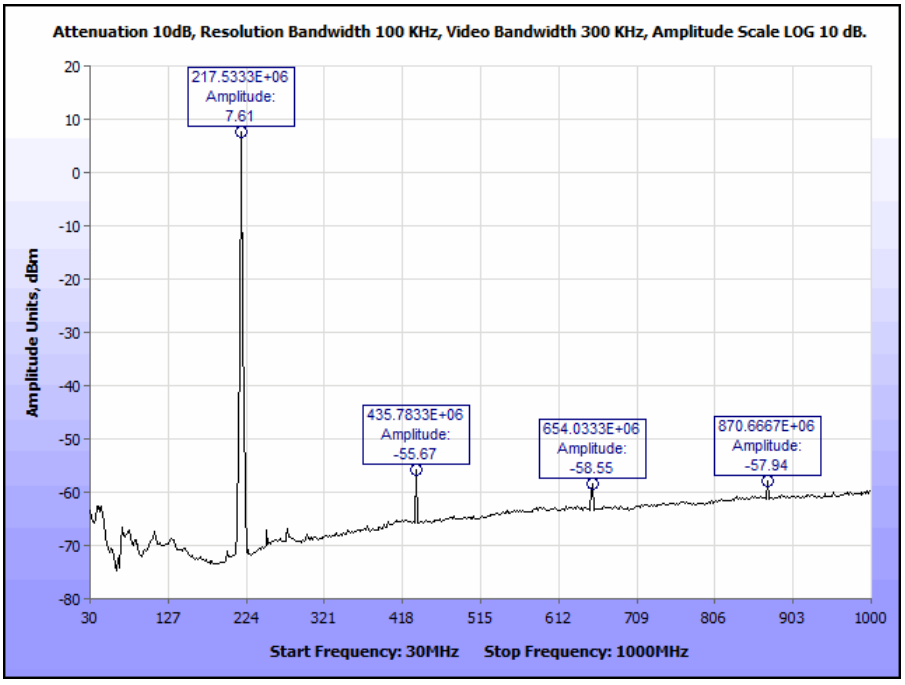
Table 22. Field Strength of Radiated Emissions, 219.75 MHz



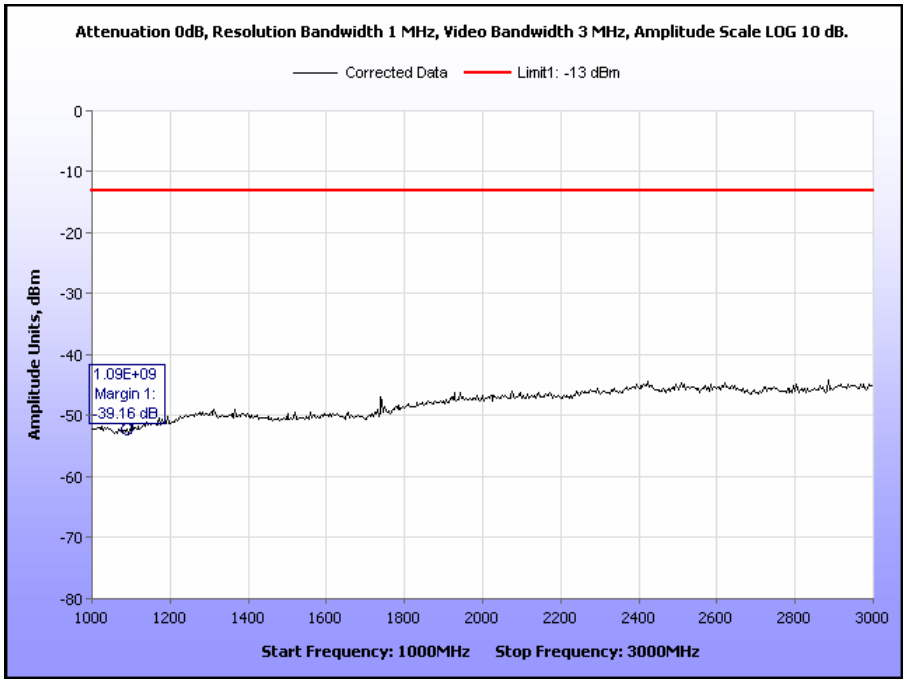
Plot 23. Field Strength of Radiated Emissions, 217.5 MHz, 30 MHz – 1 GHz



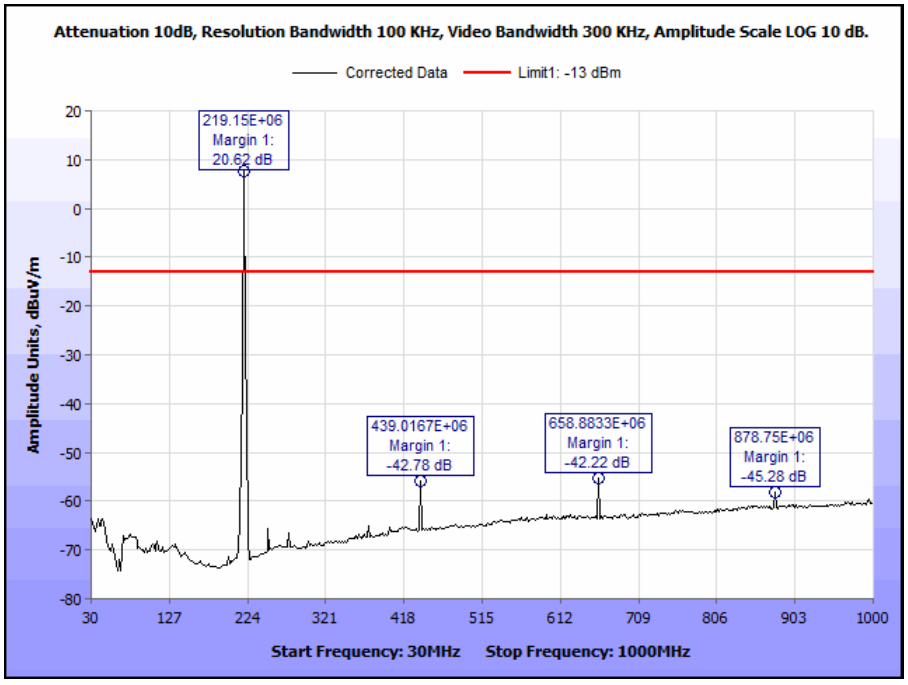
Plot 24. Field Strength of Radiated Emissions, 217.5 MHz, 1 GHz – 3 GHz



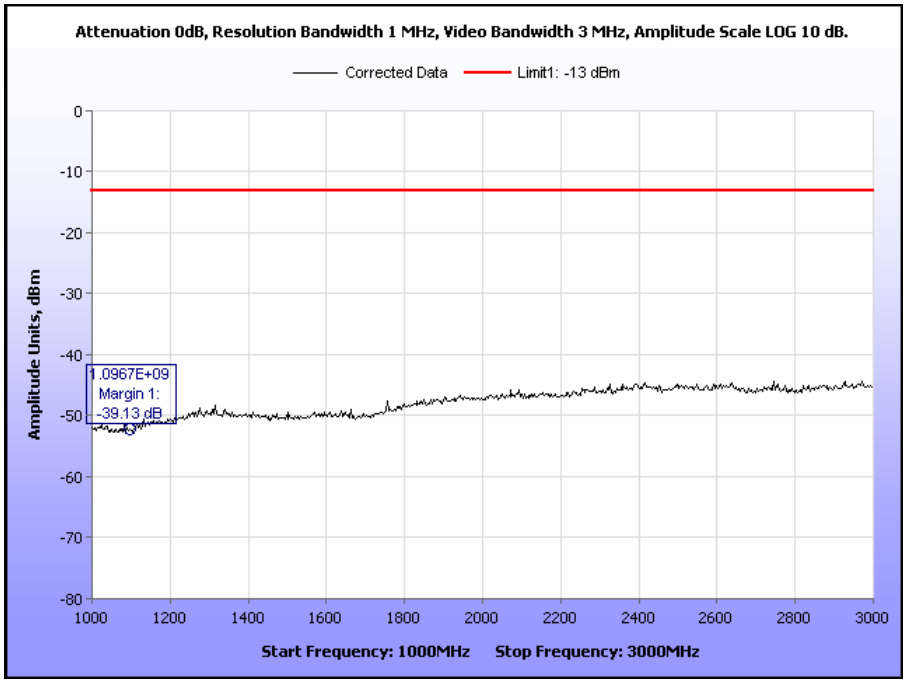
Plot 25. Field Strength of Radiated Emissions, 217.75 MHz, 30 MHz – 1 GHz



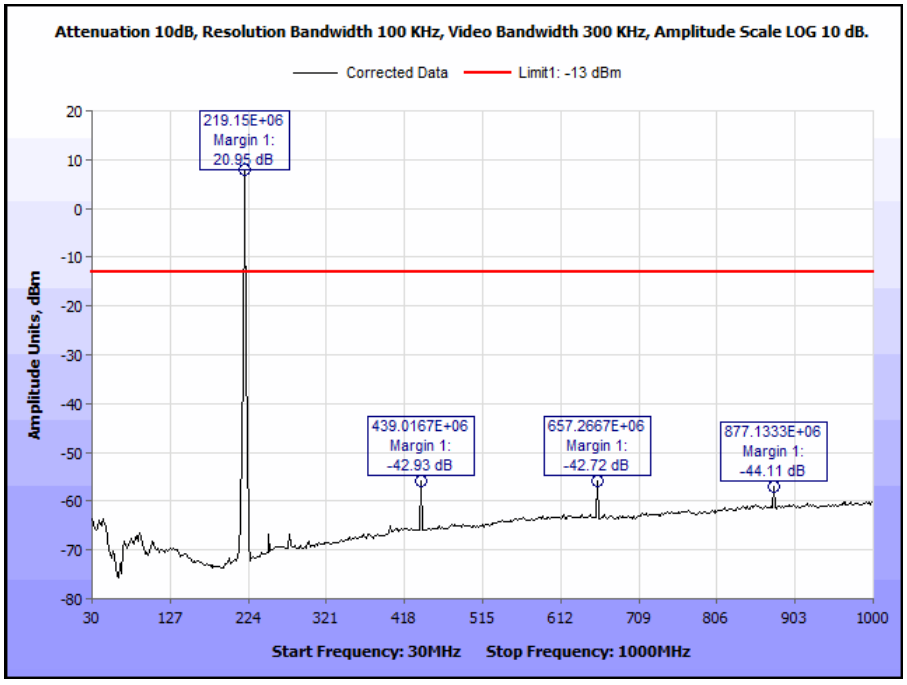
Plot 26. Field Strength of Radiated Emissions, 217.75 MHz, 1 GHz – 3 GHz



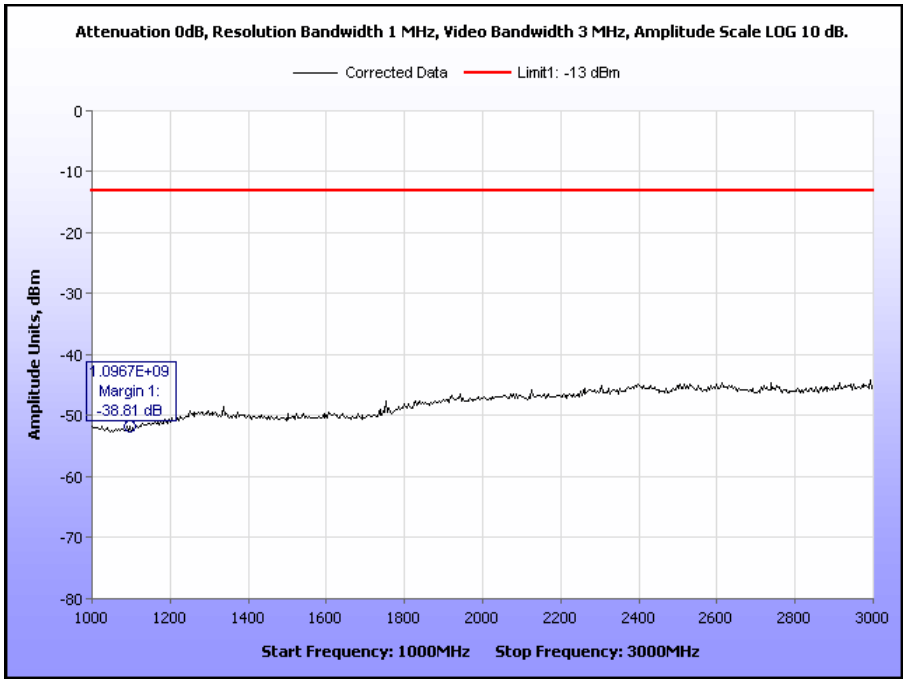
Plot 27. Field Strength of Radiated Emissions, 219.5 MHz, 30 MHz – 1 GHz



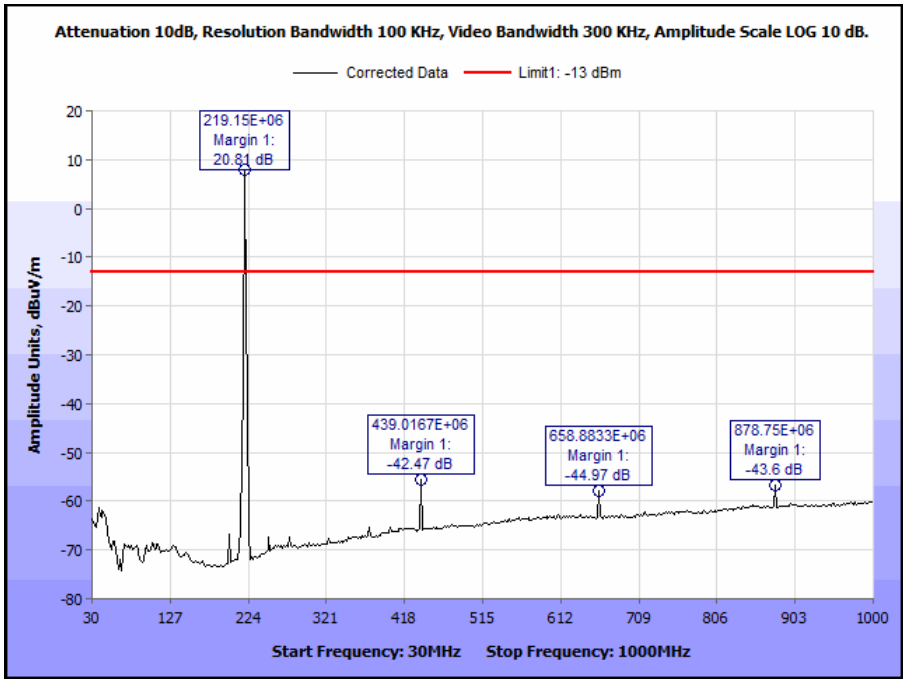
Plot 28. Field Strength of Radiated Emissions, 219.5 MHz, 1 GHz – 3 GHz



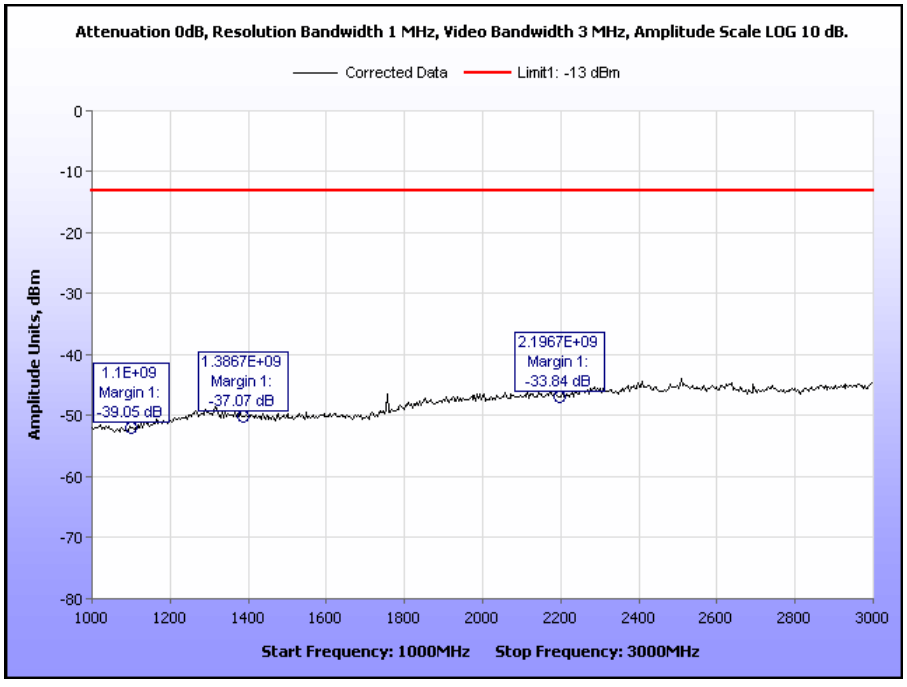
Plot 29. Field Strength of Radiated Emissions, 219.25 MHz, 30 MHz – 1 GHz



Plot 30. Field Strength of Radiated Emissions, 219.25 MHz, 1 GHz – 3 GHz



Plot 31. Field Strength of Radiated Emissions, 219.75 MHz, 30 MHz – 1 GHz



Plot 32. Field Strength of Radiated Emissions, 219.75 MHz, 1 GHz – 3 GHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§80.213; §2.1047 Modulation

Test Requirement(s): **§ 2.1047 Measurements required: Modulation characteristics.**

(a) *Voice modulated communication equipment*. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

(b) *Equipment which employs modulation limiting.* A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

(c) *Single sideband and independent sideband radiotelephone transmitters which employ a device or circuit to limit peak envelope power*. A curve showing the peak envelope power output versus the modulation input voltage shall be supplied. The modulating signals shall be the same in frequency as specified in paragraph (c) of § 2.1049 for the occupied bandwidth tests.

(d) *Other types of equipment.* A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test Results: Based on manufacturer's declaration this requirement is considered to be met.

Test Engineer: Jun Qi

Test Date(s): 05/07/18

Electromagnetic Compatibility Criteria for Intentional Radiators

§80.215 Transmitter Power

Test Requirement(s): **§ 80.215 Transmitter Power**

(h) Coast stations in an AMTS may radiate as follows, subject to the condition that no harmful interference will be caused to television reception except that TV services authorized subsequent to the filing of the AMTS station application will not be protected.

(5) The transmitter power, as measured at the input terminals to the station antenna, must be 50 watts or less.

(i) A ship station must have a transmitter output not exceeding 25 watts and an ERP not exceeding 18 watts. The maximum transmitter output power is permitted to be increased to 50 watts under the following conditions:

(1) Increases exceeding 25 watts are made only by radio command from the controlling coast stations; and

(2) The application for an equipment authorization demonstrates that the transmitter output power is 25 watts or less when external radio commands are not present.

Test Procedures: The transmitter was connected to a calibrated spectrum analyzer.

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer: Jun Qi

Test Date(s): 04/26/18

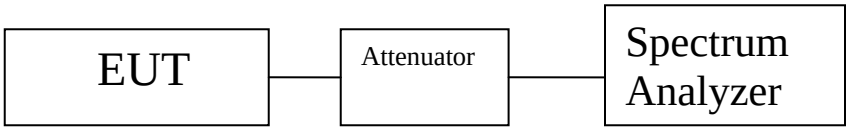
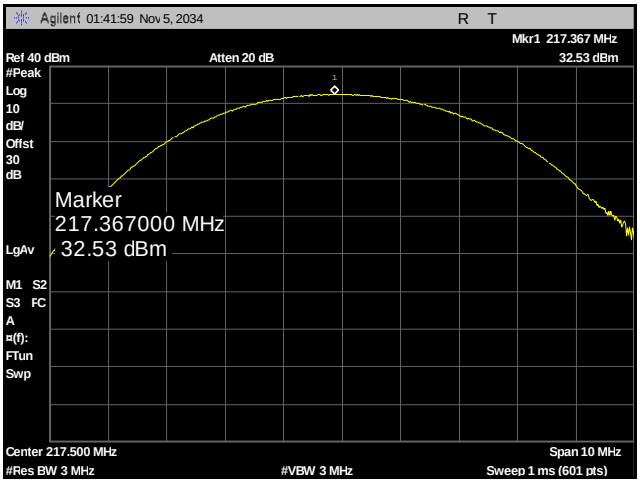


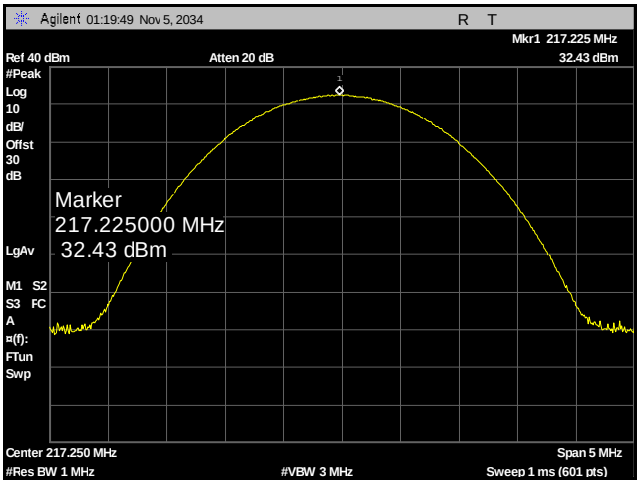
Figure 3. Peak Power Output Test Setup

Frequency	Measured Conducted Power	Antenna Gain	EIRP	ERP	ERP Limit
(MHz)	(dBm)	(dBi)	(dBm)	(dBm)	(dBm)
217.25	32.43	3	35.43	33.28	44
217.75	32.44	3	35.44	33.29	44
219.25	32.44	3	35.44	33.29	44
219.75	32.48	3	35.48	33.33	44
217.5	32.53	3	35.53	33.38	44
219.5	32.57	3	35.57	33.42	44

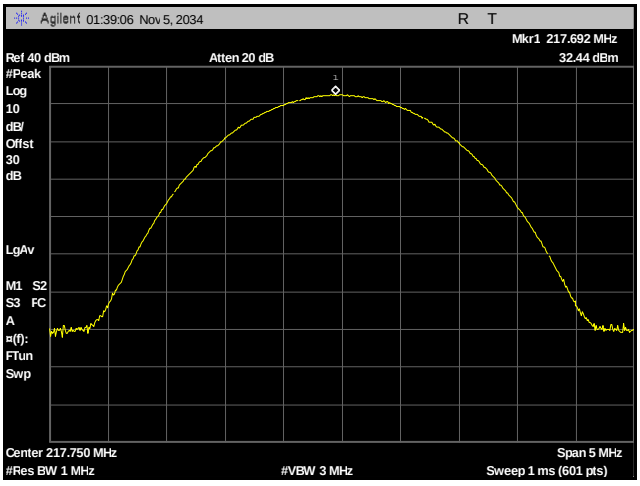
Table 23. Peak Output Power, Test Results



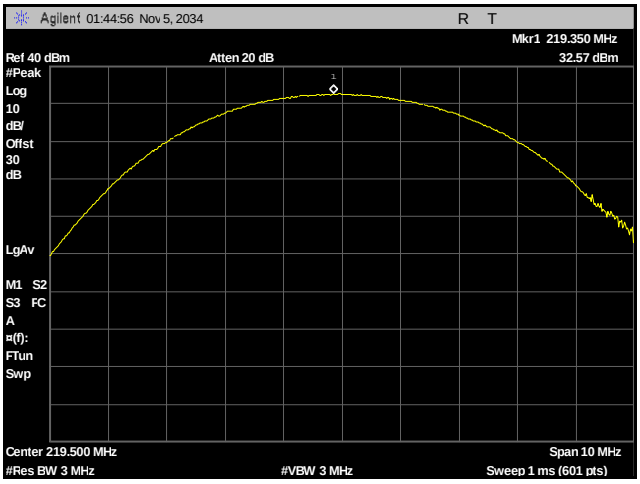
Plot 33. Transmitter Power, 217.5 MHz, 64QAM, BW 1 MHz



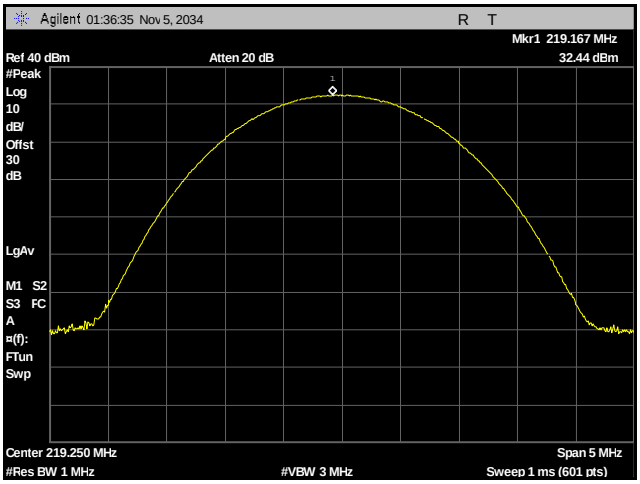
Plot 34. Transmitter Power, 217.25 MHz, 64QAM, BW 500 kHz



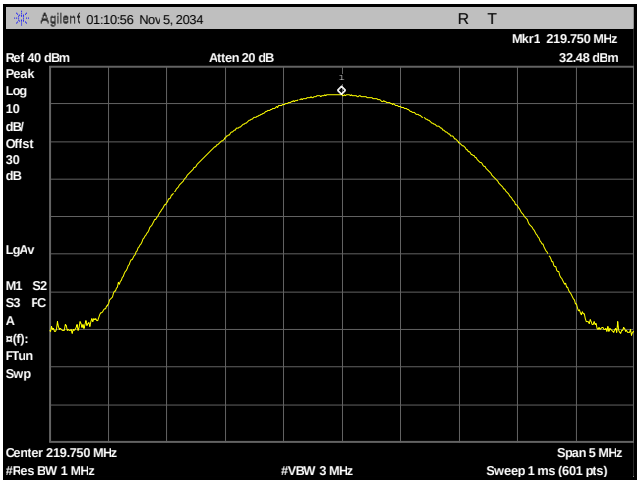
Plot 35. Transmitter Power, 217.75 MHz, 64QAM, BW 500 kHz



Plot 36. Transmitter Power, 219.5 MHz, 64QAM, BW 1 MHz



Plot 37. Transmitter Power, 219.25 MHz, 64QAM, BW 500 kHz



Plot 38. Transmitter Power, 219.75 MHz, 64QAM, BW 500 kHz

Electromagnetic Compatibility Criteria for Intentional Radiators

§80.227; §2.1091 RF Exposure

Test Requirement(s): **§ 80.227 RF Exposure**

Test Procedures: Equation from page 18 of OET 65, Edition 97-01

$S = PG / 4\pi R^2$ or $R = \sqrt{PG / 4\pi S}$

where, S = Power Density (mW/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (dBi numeric)

Test Results: The EUT was compliant with the requirements of this section.

Test Engineer: Jun Qi

Test Date(s): 04/30/18

Frequency (MHz)	Con. Pwr. (dBm)	Con. Pwr (mW)	Ant. Gain (dBi)	Ant. Gain numeric	Pwr. Denisty (mW/cm^2)	Limit (mW/cm^2)	Margin	Distance (cm)
219.5	32.57	1807.174	3	1.995	0.1795	0.2	0.0205	39.98

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

Asset	Equipment	Manufacturer	Model	Calibration Date	Asset
1S3892	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	11/11/2017	11/11/2018
1S3826	DRG HORN ANTENNA	ETS-LINDGREN	3117	09/30/2016	09/30/2018
1S2583	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4447A	11/10/2017	11/10/2018
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	11/28/2016	11/28/2018
1S2603	DOUBLE RIDGED WAVEGUIDE HORN	ETS-LINDGREN	3117	08/09/2016	08/09/2018
1S2229	TEMPERATURE CHAMBER	TENNY ENGINEERING	T63C	5/11/2018	5/11/2020
1S2121	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	SEE NOTE	
1S3905	VECTOR SIGNAL GENERATOR	KEYSIGHT TECHNOLOGIES	N5172B	04/25/2017	04/25/2019
1S3830	Biconilog Antenna	SUNOL SCIENCE	JB	4/27/2017	10/27/2018

Table 24. Test Equipment

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

> Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
>
> – Reorient or relocate the receiving antenna.
>
> – Increase the separation between the equipment and receiver.
>
> – Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
>
> – Consult the dealer or an experienced radio/TV technician for help.

End of Report

