

October 5, 2021

Neology, Inc
13520 Evening Creek Drive N., Suite 460
San Diego, CA 92128

Dear Dave Missimer,

Enclosed is the EMC Wireless test report for compliance testing of the Neology, Inc, RFID Reader 7204 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), FCC Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins Electrical and Electronic Testing NA, Inc. If you have any questions regarding these results or if Eurofins Electrical and Electronic Testing NA, Inc. can be of further service to you, please feel free to contact me.

Sincerely yours,
Eurofins Electrical and Electronic Testing NA, Inc.



Michelle Tawmging
Documentation Department

Reference: (\Neology, Inc\WIR110053-FCC247 Rev. 2)

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Electromagnetic Compatibility Criteria Test Report

for the

**Neology, Inc
RFID Reader 7204**

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart C
15.247 for Intentional Radiators

Report: WIR110053-FCC247 Rev. 2

October 5, 2021

Prepared For:

**Neology, Inc
13520 Evening Creek Drive N., Suite 460
San Diego, CA 92128**

Prepared By:
Eurofins Electrical and Electronic Testing NA, Inc.
914 West Patapsco Ave.,
Baltimore MD 21230

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Donald Salguero, Project Engineer
Wireless Lab



Michelle Tawmging
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 the FCC Rules Part 15.247 under normal use and maintenance.



Michael Griffiths
Manager, Wireless Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	August 11, 2021	Initial Issue.
1	August 25, 2021	Implemented Customer-Requested Revisions.
2	October 5, 2021	RF Exposure Section Updated

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB μ A	Decibels above one microamp
dB μ V	Decibels above one microvolt
dB μ A/m	Decibels above one microamp per meter
dB μ V/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μ H	microhenry
μ	microfarad
μ s	microseconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

Executive Summary

A. Purpose of Test

An EMC Wireless evaluation was performed to determine compliance of the Neology, Inc RFID Reader 7204 , with the requirements of Part 15, §15.247. 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 RFID Reader 7204 . Neology, Inc should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the RFID Reader 7204 , 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 15, §15.247, in accordance with Neology, Inc, purchase order number 5990-00. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	20 dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	Number of RF Channels	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(1)	RF Channel Separation	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Conducted Emissions	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Table 1. Executive Summary of EMC Wireless Part 15.247 Compliance Testing

Equipment Configuration

A. Overview

Eurofins Electrical and Electronic Testing NA, Inc. was contracted by Neology, Inc to perform testing on the RFID Reader 7204 , under Neology, Inc’s purchase order number 5990-00.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Neology, Inc, RFID Reader 7204 .

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

Model(s) Tested:	RFID Reader 7204	
Model(s) Covered:	RFID Reader 7204	
EUT Specifications:	Primary Power: 18-30 VDC	
	FCC ID: 2AKNF7204	
	Type of Modulations:	DSB-ASK or PR-ASK
	Equipment Code:	FHSS
	Peak RF Output Power:	28.3dBm; 0.676W
	EUT Frequency Ranges:	FCC_A: 902.3 – 912.1 MHz (50 Channels) FCC_B: 910.1 – 919.9 MHz (50 Channels) FCC_C: 917.9 – 927.7 MHz (50 Channels) FCC_Dense: 902.75 – 927.25 MHz (50 Channels)
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Donald Salguero	
Report Date(s):	August 25, 2021	

Table 2. EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
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
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 558074 v05r02	Guidance For Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under Section 15.247

Table 3. References

C. Test Site

All testing was performed at Eurofins Electrical and Electronic Testing NA, Inc., 914 West Patapsco Ave., Baltimore MD 21230. 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 Eurofins Electrical and Electronic Testing NA, Inc.

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%

Table 4. Uncertainty Calculations Summary

E. Equipment Details

Name of EUT/Model:	RFID Reader 7204
Description of EUT and Intended Use:	The four port RFID reader is a multi-protocol, multi-regional Radio Frequency Identification (RFID) system that operates in the 902-928MHz UHF frequency band. All antenna ports operate sequentially with only one port transmitting at a given time from a single transmit source. The RF path is internally switched between selected ports. Product is typically used in vehicle applications to acquire transponder information from target vehicle from one or more antennas and is professionally installed. Product is both FCC Part90 and Part15 capable/certified.
Selected Operation Mode(s):	The product is a UHF Wireless radio which supports communications over eight different wireless protocols. Each protocol uses amplitude shift keying modulation but the data rates and encoding will vary by protocol. The device has two operational modes: STANDBY where RF transmission is disabled, and ACTIVE where RF transmissions are produced continuously. The product is designed for worldwide regulatory compliance. Under FCC it supports both unlicensed Part15.247 operation with frequency hopping, and licensed Part90.231 operation with fixed frequency. Normal product operation is with ACTIVE mode. Specific antenna and protocol usage must be configured. Neology will provide appropriate instruction and utilities to ease transition between selections.
Rationale for the selection of the Operation Mode(s):	The product supports configurable RF power levels of 1 to 35dBm. Actual testing will utilize the highest power appropriate for the specific test. Product will be tested across the FCC and ETSI frequency bands. These same bands have been adopted in some form worldwide for RFID usage, and this initial testing will set the basis for future international certifications.
Monitoring Method(s):	The product has an external LED to indicate RF transmissions. If this LED is off, no RF transmissions are occurring. If this LED is on solid, then RF transmissions are occurring but there is not a 2 way communication with another device. If this LED is on and flickering off and on, then RF transmissions are occurring with an external device. In addition, the product will be supplied with a GUI application which can display status of RF activity.
Emissions Class Declaration:	Class B
Configurations:	Configuration information will be provided in a separate document.
EUT Power Requirement	
Voltage:	110-240V AC/DC converter; 18-30V DC side
AC or DC:	AC
Voltage Frequency:	60 Hz
Number of Phases:	1
Current:	0.8 nominal
Physical Description	
EUT Arrangement:	Both
System with Multiple Chassis?:	False
Size (HxWxD) inches:	3.25 x 16.5 x 13
Weight (lbs.):	13.8
Highest Internal Frequency (MHz):	928
Other Info	
EUT Software (Internal to EUT):	Custom embedded application
Support Software (used by support PC to exercise EUT):	Neology Reader Startup Tool
Firmware:	1.0.80

Transmitter Parameters	
Description of your unit:	FHSS
Modulation Type:	DSB-ASK or PR-ASK
Number of Channels:	0
Frequency Range (MHz):	902 – 928 MHz
Antenna Type:	Linear patch and Circular
Antenna Gain (dB):	Linear polarized: 15dBi, 13dBi; Circular polarized: 9.5dBiC
PMN:	Toll RFID Reader
HVIN:	7204
FVIN:	1.0
HMN:	NA
Data Rates:	CW, 40kbps, 80kbps, 120kbps, 160kbps, 300kbps, 500kbps
Expected Power Level:	33dBm
Number of Antenna:	4
Number of Intentional Transmitters:	1
Number of Certified Intentional Transmitter Modules:	0

Table 5. Equipment Details

Ref. ID	Port Name on EUT	Cable Desc. or reason for none	QTY	Length as tested (m)	Max Length (m)	Shielded?	Termination Box ID & Port Name
-	18-30V	DC power cable	1	-	100	Yes	-
-	Antenna 4 symbol	RF coaxial cable	1	-	-	Yes	-
-	Ethernet symbol	Ethernet data cable	1	-	100	Yes	-
-	Antenna 3 symbol	RF coaxial cable	1	-	-	Yes	-
-	I/O symbol	product synchronization	1	-	-	Yes	-
-	Antenna 2 symbol	RF coaxial cable	1	-	-	Yes	-
-	AUX	unused (for diagnostic/test or additional I/O if needed)	0	-	-	Yes	-
-	Antenna 1 symbol	RF coaxial cable	1	-	-	Yes	-

Table 6. Ports and Cabling

Ref. ID	Name/Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
	AC/DC power converter	CUI, Inc.	PDRC-75-24-2	NA
	Laptop	Dell, Inc.	To be supplied	NA
	RF Antenna	Neology, Inc.		NA
	RFID Reader 7204	Neology, Inc.	7204	NA

Table 7. Support Equipment

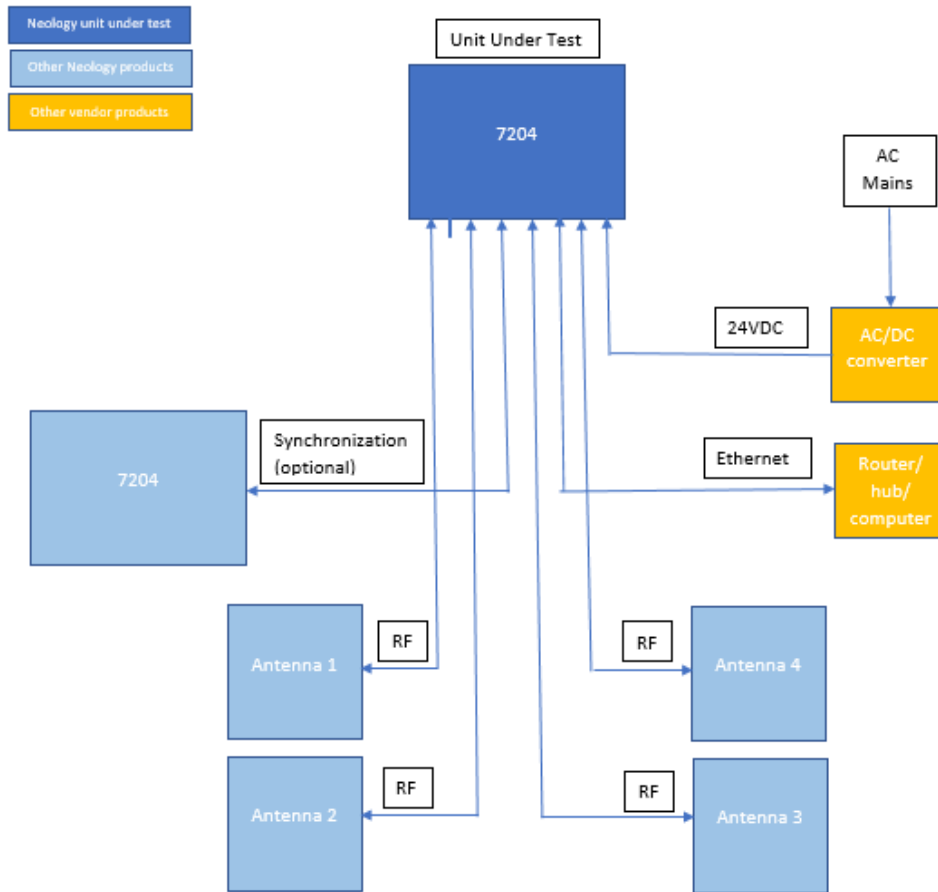


Figure 1. Block Diagram of Test Configuration

F. 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.

G. Disposition of EUT

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

Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators**§ 15.203 Antenna Requirement**

Test Requirement: § 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is **compliant** the criteria of §15.203. EUTs are professionally installed.

Test Engineer(s): Donald Salguero

Test Date(s): July 30, 2021

22-degree beam width, 15dBi, linear polarized
36-degree beam width, 13dBi, linear polarized
63-degree beam width, 9.5dBiC, circular polarized

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): § 15.207 (a): For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Σ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dB μ V)	
	Quasi-Peak	Average
* 0.15 - 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Table 8. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Note: *Decreases with the logarithm of the frequency.

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω /50 μ H Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.10-2013*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H LISN as the input transducer to an EMC/field intensity meter.

Test Results: The EUT as tested is **compliant** with this requirement. Measured emissions were below applicable limits.

Test Engineer(s): Donald Salguero

Test Date(s): August 6, 2021

Line Under Test:		Phase													
Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	External Attenuation (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Pass/Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	External Attenuation (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Pass/Fail AVG	Margin (dB) AVG	
0.1796	37.31	0	10	47.31	64.5	PASS	-17.19	28.86	0	10	38.86	54.5	PASS	-15.64	
0.267	34.41	0	10	44.41	61.21	PASS	-16.8	27.8	0	10	37.8	51.21	PASS	-13.41	
0.3155	32.81	0	10	42.81	59.82	PASS	-17.01	21.49	0	10	31.49	49.82	PASS	-18.33	
0.343	31.77	0	10	41.77	59.13	PASS	-17.36	24.59	0	10	34.59	49.13	PASS	-14.54	
0.8562	26.71	0	10	36.71	56	PASS	-19.29	17.12	0	10	27.12	46	PASS	-18.88	
1.115	26.15	0	10	36.15	56	PASS	-19.85	16.95	0	10	26.95	46	PASS	-19.05	

Table 9. 15.207 Conducted Emissions datasheet_phase

Line Under Test:		Neutral													
Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	External Attenuation (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Pass/Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	External Attenuation (dB)	Corrected Measurement (dBuV) AVG	Limit (dBuV) AVG	Pass/Fail AVG	Margin (dB) AVG	
0.1545	30.65	0	10	40.65	65.75	PASS	-25.1	18.56	0	10	28.56	55.75	PASS	-27.19	
0.1796	37.2	0	10	47.2	64.5	PASS	-17.3	32.42	0	10	42.42	54.5	PASS	-12.08	
0.2625	36.07	0	10	46.07	61.35	PASS	-15.28	34.17	0	10	44.17	51.35	PASS	-7.18	
0.313	34.44	0	10	44.44	59.89	PASS	-15.45	27.77	0	10	37.77	49.89	PASS	-12.12	
0.8588	27.79	0	10	37.79	56	PASS	-18.21	21.27	0	10	31.27	46	PASS	-14.73	
1.33	26.8	0	10	36.8	56	PASS	-19.2	21.01	0	10	31.01	46	PASS	-14.99	

Table 10. 15.207 Conducted Emissions datasheet_neutral

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) 20 dB Occupied Bandwidth

Test Requirements: § 15.247(a): (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure: The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1-5% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

Test Results The EUT as tested is **compliant** with § 15.247 (a)(2). No anomalies noted. While the EUT does have 4 RF ports, they are controlled by a RF switch, and they never transmit at the same time. It was found that ‘Port 2’ exhibits the worst case/higher emissions. Data shown belongs to worst case output on ‘Port 2’

Test Engineer(s): Donald Salguero

Test Date(s): August 2, 2021

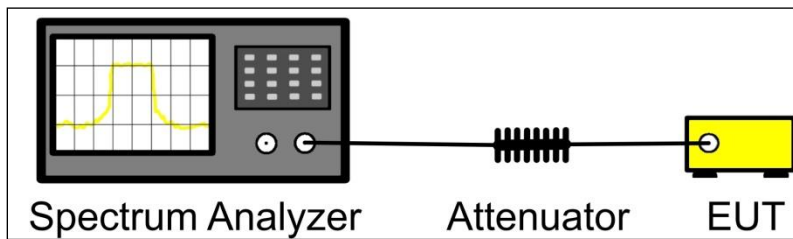


Figure 2. -20 dB Occupied Bandwidth Test Setup

Band	Center Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
FCC A	902.3	52.455	55.7155
	912.1	51.905	55.5946
FCC B	910.1	52.508	55.6231
	919.9	52.594	56.0425
FCC C	917.9	52.192	55.7893
	927.7	51.795	55.8599
FCC Dense	902.75	89.631	91.7438
	915	90.636	92.3686
	927.25	90.371	92.5975

Table 11. OBW - Table

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Average Time of Occupancy (Dwell Time)

Test Requirements: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.4 from ANSI C63.10 – 2013 was used to compute the unit's dwell time.

Remarks: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Test Engineer(s): Donald Salguero

Test Date(s): August 9, 2021

Band	Center Frequency (MHz)	Pulse Width (ms)	Pulses per Period	Dwell Time (ms)	Limit (S)	Margin
FCC A	902.3	368.7	1	368.7	0.4	-0.0313
FCC B	910.1	365	1	365	0.4	-0.035
FCC C	917.9	368.8	1	368.8	0.4	-0.0312
FCC Dense	902.75	367.5	1	367.5	0.4	-0.0325

Table 12. Dwell Time - Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) Number of RF Channels

Test Requirements: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.3 from ANSI C63.10 – 2013 was used to count the number of hopping channels.

Test Results The EUT as tested is **compliant** with § 15.247 (a)(1)(i). No anomalies detected.

Test Engineer(s): Donald Salguero

Test Date(s): August 2, 2021

Mode	No of Channels
FCC_A	50
FCC_B	50
FCC_C	50
FCC_Dense	50

Table 13. Number of Channels - Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(1) RF Channel Separation

- Requirement:** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
- Procedure:** The EUT had its hopping function enabled. Procedure 7.8.2 from ANSI C63.10 – 2013 was used to measure the channel separation.
- Test Results** The EUT as tested is **compliant** with § 15.247 (a)(1). No anomalies detected.
- Test Engineer(s):** Donald Salguero
- Test Date(s):** August 2, 2021

Mode	Channel Separation (kHz)
FCC_A	200
FCC_B	200
FCC_C	200
FCC_Dense	500

Table 14. Channel Separation - Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements:

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure:

The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band transmitting at max power. Procedure 7.8.5 from ANSI C63.10-2013 was used to measure the peak power output.

Test Results:

The EUT as tested is **compliant** with the Peak Power Output limits of §15.247(b). No anomalies noted.

While the EUT does have 4 RF ports, they are controlled by a RF switch, and they never transmit at the same time. It was found that ‘Port 2’ exhibits the worst case/higher emissions. Data shown belongs to worst case output on ‘Port 2’

Typical installation of the EUT makes use of a RF cable connecting the RF port on the EUT and the corresponding antenna used on the installation. The overall gain seen by the EUT was determined by the Antenna gain minus a representative loss on a short run cable. It was determined that a 1.8dB loss is the representative value.

Test Engineer(s): Donald Salguero

Test Date(s): August 2, 2021

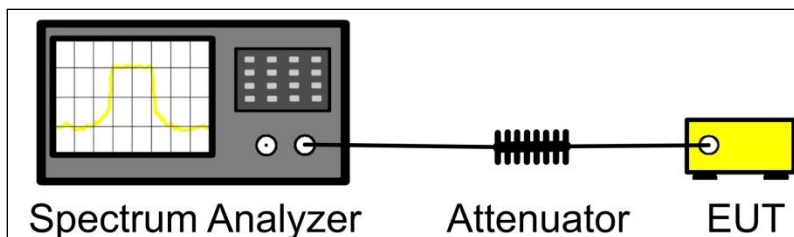


Figure 3. Power Output Test Setup

Band	Center Frequency (MHz)	Conducted Peak Power (dBm)	System Gain (dBi)	Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	Margin EIRP (dB)
FCC A	902.3	24.79	11.2	24.8	-0.01	35.99	36	-0.01
	912.1	24.79	11.2	24.8	-0.01	35.99	36	-0.01
FCC B	910.1	24.78	11.2	24.8	-0.02	35.98	36	-0.02
	919.9	24.7	11.2	24.8	-0.1	35.9	36	-0.1
FCC C	917.9	24.66	11.2	24.8	-0.14	35.86	36	-0.14
	927.7	24.52	11.2	24.8	-0.28	35.72	36	-0.28
FCC Dense	902.75	24.67	11.2	24.8	-0.13	35.87	36	-0.13
	915	24.52	11.2	24.8	-0.28	35.72	36	-0.28
	927.25	24.38	11.2	24.8	-0.42	35.58	36	-0.42

Table 15. Output Power - 13dBi Antenna

Band	Center Frequency (MHz)	Conducted Peak Power (dBm)	System Gain (dBi)	Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	Margin EIRP (dB)
FCC A	902.3	22.73	13.2	22.8	-0.07	35.93	36	-0.07
	912.1	22.74	13.2	22.8	-0.06	35.94	36	-0.06
FCC B	910.1	22.74	13.2	22.8	-0.06	35.94	36	-0.06
	919.9	22.6	13.2	22.8	-0.2	35.8	36	-0.2
FCC C	917.9	22.68	13.2	22.8	-0.12	35.88	36	-0.12
	927.7	22.49	13.2	22.8	-0.31	35.69	36	-0.31
FCC Dense	902.75	22.77	13.2	22.8	-0.03	35.97	36	-0.03
	915	22.63	13.2	22.8	-0.17	35.83	36	-0.17
	927.25	22.52	13.2	22.8	-0.28	35.72	36	-0.28

Table 16. Output Power - 15dBi Antenna

Band	Center Frequency (MHz)	Conducted Peak Power (dBm)	System Gain (dBi)	Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	Margin EIRP (dB)
FCC A	902.3	28.2	7.7	28.3	-0.1	35.9	36	-0.1
	912.1	28.2	7.7	28.3	-0.1	35.9	36	-0.1
FCC B	910.1	28.16	7.7	28.3	-0.14	35.86	36	-0.14
	919.9	28.11	7.7	28.3	-0.19	35.81	36	-0.19
FCC C	917.9	28.25	7.7	28.3	-0.05	35.95	36	-0.05
	927.7	28.08	7.7	28.3	-0.22	35.78	36	-0.22
FCC Dense	902.75	28.3	7.7	28.3	0	36	36	0
	915	28.18	7.7	28.3	-0.12	35.88	36	-0.12
	927.25	28.05	7.7	28.3	-0.25	35.75	36	-0.25

Table 17. Output Power - 9.5dBi Antenna

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: §15.247(d); §15.205: Emissions outside the frequency band.

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

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

MHz	MHz	MHz	GHz
0.090–0.110-----	16.42–16.423	399.9–410	4.5–5.15
¹ 0.495–0.505-----	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905-----	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128-----	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775-----	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775-----	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218-----	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825-----	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225-----	123–138	2200–2300	14.47–14.5
8.291–8.294-----	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366-----	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675-----	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475-----	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293-----	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025-----	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725-----	322–335.4	3600–4400	(²)
13.36–13.41			

Figure 4. Restricted Bands of Operation

¹ Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

² Above 38.6

Test Requirement(s): § 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 18.

Frequency (MHz)	§ 15.209(a), Radiated Emission Limits (dB μ V) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Table 18. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedure: The transmitter was set to the mid channel at the highest output power and placed on a 0.8 m high wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurement were repeated the measurement at the low and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

Radiated Band Edge Measurements

Test Procedures: The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.

Test Results: The EUT as tested is **compliant** with the Radiated Spurious Emission limits of §15.247(d). Measured emissions were below applicable limits.

While the EUT does have 4 RF ports, they are controlled by a RF switch, and they never transmit at the same time. It was found that 'Port 2' exhibits the worst case/higher emissions. Data shown belongs to worst case output on 'Port 2'

Test Engineer(s): Donald Salguero

Test Date(s): August 9, 2021

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

The EUT was connected to a spectrum analyzer through a cable and an attenuator. Measurements were taken with the EUT set to transmit continuously on its low, mid, and high channels for all its bandwidths at maximum power. Conducted spurious emissions were measured according to sections 11.11.2 and 11.11.3 of ANSI C63.10-2013. See following pages for detailed test results with RF Conducted Spurious Emissions.

Test Results: The EUT as tested is **compliant** with the Conducted Spurious Emission limits of §15.247(d). Measured emissions were below applicable limits.

While the EUT does have 4 RF ports, they are controlled by a RF switch, and they never transmit at the same time. It was found that ‘Port 2’ exhibits the worst case/higher emissions. Data shown belongs to worst case output on ‘Port 2’

Test Engineer(s): Donald Salguero

Test Date(s): August 2, 2021

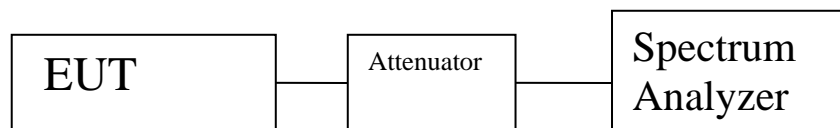


Figure 5. Block Diagram, Conducted Spurious Emissions Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

RF Exposure Requirements: §1.1307(b)(1) and §1.1307(b)(2): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission’s guidelines.

RF Radiation Exposure Limit: §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

FCC									
Frequency (MHz)	Con. Pwr. (dBm)	Con. Pwr. (mW)	System Gain (dBd)	Ant. Gain numeric	Pwr. Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
902.75	28.3	676.083	5.55	3.589	0.6018	0.6018	0	17.9125	Pass

Where ‘System Gain’ is the combination of Antenna Gain (dBd) and representative cable loss (dB)

Antenna Gain = 9.5dBi = 7.35 dBd

Cable Loss = 1.8dB

System Gain = 7.35dBd-1.8dB = 5.55dBd

Since calculated safe distance is less than 20cm, then the minimum safe distance for fixed equipment is 20cm.

Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

Asset	Equipment	Manufacturer	Model	Calibration Date	Calibration Due Date
1T4612	Spectrum Analyzer	Agilent Technologies	E4407B	03/04/2020	09/04/2021
1T8907	LISN	Com-Power	LI-150C	04/12/2021	10/12/2022
1T8910	LISN	Com-Power	LI-150C	04/12/2021	10/12/2022
1T7478	Transient Limiter	Com-Power	LIT-153A	Func. Verify	Func. Verify

ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL	CAL DATE
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	1/21/2021	1/21/2022
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	3/4/2020	9/4/2021
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	12/21/2020	6/21/2022
1T4757	ANTENNA; HORN	ETS-LINDGREN	3117	6/29/2020	12/29/2021
1T4300B	SEMI-ANECHOIC 3M CHAMBER SVSWR	EMC TEST SYSTEMS	NONE	8/16/2019	8/16/2021
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	8/16/2019	8/16/2021
1T4425	NOTCH FILTER TUNABLE	TRILITHIC	7325213057	FUNC VERIFY	FUNC VERIFY
1T8743	PREAMPLIFIER	A.H. SYSTEMS, INC.	PAM-0118P	FUNC VERIFY	FUNC VERIFY

Table 19. Test Equipment List

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

Certification & User's Manual Information

Certification & User's Manual Information

H. 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 stages; 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 user's 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 A 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 A 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 commercial 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. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

- (b) 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