Testing Tomorrow's Technology

Application

For

Title 47 USC Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, Paragraphs15.207and 15.209

And

Industry Canada, Radio Standards Specifications: RSS Gen Issue 4 and RSS-210 Issue 9

For the

Radio Systems

Model: RAC00-15373

FCC ID: KE3-3003079
IC: 2721A-3003079

UST Project: 18-0161
Issue Date: June 30, 2018

Total Pages in This Report: 22

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date: June 30, 2018

TESTING
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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Radio Systems Corporation

MODEL: RAC00-15373

FCC ID: KE3-3003079

IC: 2721A-3003079

DATE: June 30, 2018

This report concerns: Class II change [X]

Equipment type: 7.5 kHz or 10.5 kHz Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until:_____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

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Table of Contents

List of Figures

Figures **Title** **Page**

List of Tables

Table **Title** **Page**

List of Attachments

Agency Agreement
Application Forms
Letter of Confidentiality
Test Configuration Photographs
Theory of Operation
Permissive change Letter

1 General Information

1.1 Purpose of this Report

The Shields Plus, Model RAC00-15373 has been updated to include a second mode of operation. The only difference between the original version of the product and the updated version is the modulation scheme. No hardware changes are required for this new mode of operation. The firmware was changed to transmit a signal of different modulation. The 7.5 K and 10.5 K transmit frequencies stayed the same. Instead of the OOK modulation that transmits a digital code to the collar that would generally cause activation, this new version generates a signal that prevents the collar from activating. The masking signal is about 42% duty cycle and 105 Hz. The change is implemented with a firmware update. No changes were made to the transmitter circuitry.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 6, 2018 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Radio Systems Shields Plus, Model RAC00-15373.The RAC00-15373 transmitter is designed to transmit a signal through an internal wire-wound antenna as part of pet avoidance system. It produces a signal that communicates with your pet's Computer Collar® unit to keep your pet away from unwanted areas. The signal can be delivered from the transmitter either through a wireless sphere or through up to 150 feet of wire. The EUT is powered by an internal rechargeable battery pack or AC Adpater.

The signals transmitted from the transmitter are detected by the receiver and define which operating mode the receiver is to operate in. Multiple user selectable switches are used to set the operating modes, operating frequency, transmission rate, transmission code, and motion detection operation.

The EUT can operate at 10.5 kHz and 7.5 kHz. Since no limits are set below 9 kHz, the EUT was only tested at 10.5 kHz.

- Frequency: 7.5 kHz or 10.5 kHz
- Modulation: Wireless Mask
-

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009 and ANSI C63.4:2013, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009)* for FCC subpart A Digital equipment Verification requirements and per *ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for FCC subpart C Intentional Radiators.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is subject to the following FCC authorizations:

a) Certification under sections 15.207 and 15.209 as a transmitter.
b) Verification under 15.101 as a digital device.

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (Parts 15.107 and 15.109) for the EUT is included herein.

Table 1. EUT and Peripherals

EUT AND MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
Pet Containment System Radio Systems Corp (EUT)	RAC-0015373	Engineering Sample	FCC: KE3-3003079 IC: 2721A-3003079	(None)
PERIPHERAL AND MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID**	**CABLES P/D**
Power Adapter Radio Systems Corp. (Peripheral)	SPS-02C5-1C-US	SS07187000119	(None)	1.8 m U P
Sealed Rechargeable Battery Power Sonic (Peripheral)	PS-1212	(None)	(None)	0.8 m U P

U= Unshielded S= Shielded P= Power D= Data

2 Tests and Measurements

2.1 Test Equipment

The table below lists the test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2.Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER (USED ONLY FOR RADIATED EMISSIONS TESTING)	E4407B	Agilent	US41442935	6/22/2018
SPECTRUM ANALYZER (USED ONLY FOR CONDUCTED EMISSIONS TESTING)	DSA815	RIGOL	DSA8A1803 00138	10/11/2019 2 yr
PREAMP	8447D	HEWLETT-PACKARD	1937A02980	3/7/2019
LOOP ANTENNA	6502	ETS Lindgren	9810-3246	1/22/2020 2 yr
BICONICAL ANTENNA	3110B	EMCO	9306-1708	5/2/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	9/21/2018 2 yr
LISN x 2	9247-50-TS-50-N	Solar Electronics	955824 & 955826	3/9/2019

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates at 7.5 kHz or 10.5 kHz, 1 test frequency was used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirements, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

2.6 EUT Antenna Requirements (CFR 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. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna 1	Radio Systems	Integral Loop Antenna	Engineering Sample	N/A	Integral Loop Antenna

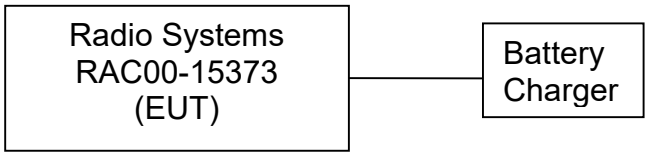

Figure 1. Block Diagram of Test Configuration

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious emissions cannot exceed the limits of 15.209. Radiated Harmonics and other Spurious Emissions are examined for this requirement; see paragraph 2.1.

2.8 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT is battery-powered and includes an AC powered battery charger; 100/240 V and 50/60 Hz. Power line conducted emissions testing was performed to ensure that with the EUT in operation (exercising all transmitter functions), the complete system continues to meet the applicable requirements for CFR 15.207. These measurements were completed while the EUT was connected to the battery charger and transmitting while charging. Results are displayed along with the 15.107 power line test data in the sections below.

2.9 Intentional Radiator, Radiated Emissions (CFR 15.209, (IC RSS 210))

Radiated Radio measurements: the EUT was placed into a continuous transmit mode of operation and a preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the product. To obtain the worst case results, the EUT was placed on a table top of a non-conductive table, 80 cm above the ground floor. The EUT was positioned 3 meters away from the receiving antenna during testing (1 meter at frequencies above 6 GHz and if the emissions were less than 6 dB from the noise floor). The EUT was tested in X, Y and Z axes or the position of normal operation to determine the worst case orientation. Radiated measurements below 30 MHz were tested with a RBW = 9 kHz; emissions below 1 GHz were tested with a RBW = 120 kHz and radiated measurements above 1 GHz were measured using a RBW =1 MHz. VBW was set to three times the RBW value.

The test data is detailed below for this section. For radiated emissions, any emission that was greater than 20 dB from the applicable limit was not recorded. If radiated emissions above 1 GHz were measured at a distance of 1 meter, the measured value at 1 meter was extrapolated to the results at 3 meters using an inverse distance extrapolation factor of -20 dB/decade. There were no test failures.

Table 5. Intentional Radiated Emissions 9kHz to 30 MHz

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems			
Project: 18-0159				**Model:** RAC00-15373			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
0.0105	**91.27**	**15.60**	**106.87**	**127.1**	**3 meters**	**20.2**	**PK**
All other detected emissions were 20 dB or more below the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculations: at 0.0105 MHz, 91.27 dBuV + (15.60)= 106.87 dBuV/m
Limit @ 3m= 127.1 dBuV/m
Margin= 20.2 dB

Test Date: June 16-18, 2018

Tested By
Signature:  Name: Afzal Fazal

NOTE: Measurements above 30 MHz are presented in Table 9.

2.10 99% Occupied Bandwidth (IC RSS 210, A8.1)

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in Table 7 and Figure 2.

Table 6. 20 dB Bandwidth and 99% Occupied Bandwidth

Frequency (kHz)	20 dB Bandwidth (kHz)	99% Occupied Bandwidth (kHz)
10.5	0.702	0.726

Test Date: June 16-18, 2018

Tested By
Signature: Afzal Fazal Name: Afzal Fazal

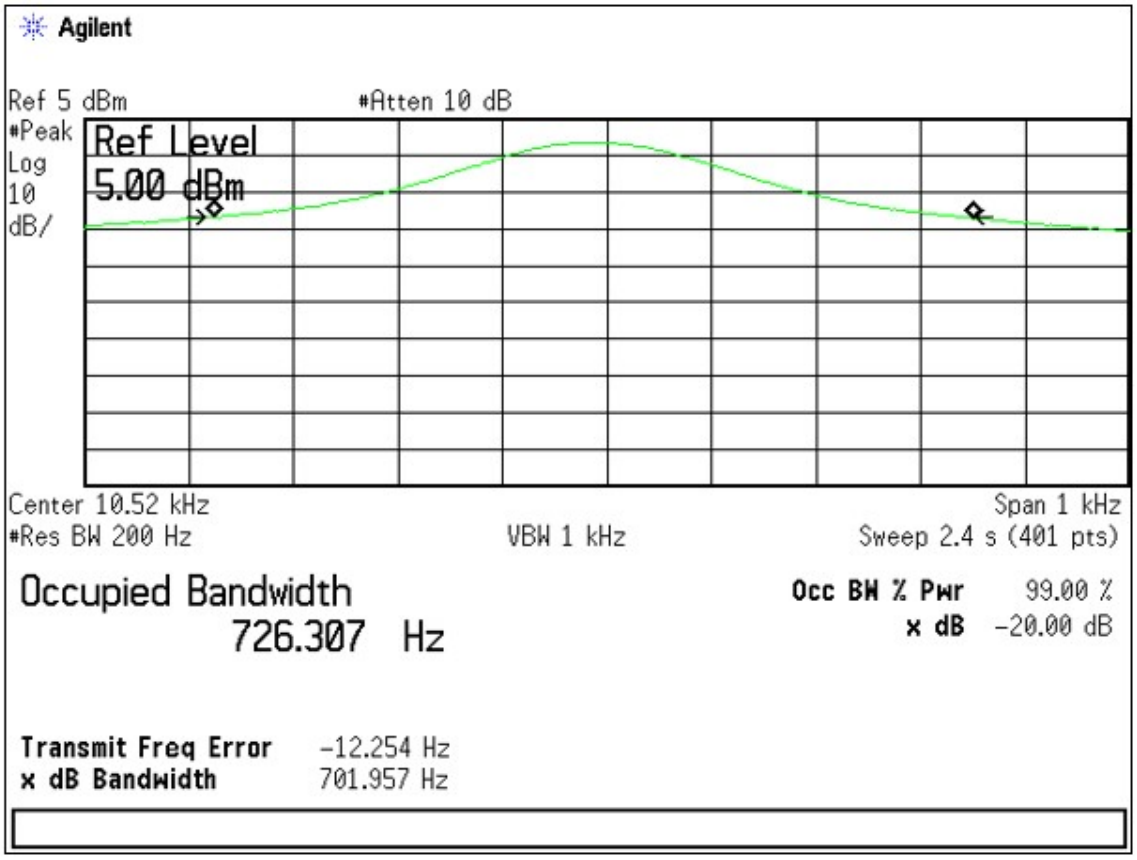

Figure 2. 20 dB & 99% Bandwidth

2.11 Unintentional/Intentional Radiator, Power line Emissions (CFR 15.107 and 15.207)

The power line conducted voltage emissions measurements have been carried out in accordance with CFR 15.107, per ANSI C63.4:2009 and ANSI C63.4:2013, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

The worst-case results for conducted emissions were determined to be produced when the EUT was operating under continuous transmission. The worst case measurement occurred on the Phase line at 1.553 MHz. The emission level was 7.1 dB from the applicable limit. All other emissions were at least 8.2 dB from the limit. Those results are given in the table following.

Table 7. Transmitter Power Line Conducted Emissions Test Data, (15.107 and 15.207)

150 kHz to 30 MHz with Class B Limits						
Test: Power Line Conducted Emissions				**Client:** Radio Systems		
Project: 18-0159				**Model:** RAC00-15373		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
120 VAC, 60 Hz Phase						
0.3168	40.70	0.20	40.90	49.8	8.9	**PK**
0.7142	37.65	0.14	37.79	46.0	8.2	**PK**
1.0670	35.73	0.14	35.87	46.0	10.1	**PK**
5.3750	28.79	0.25	29.04	50.0	21.0	**PK**
19.8170	34.13	0.63	34.76	50.0	15.2	**PK**
21.8330	33.82	0.68	34.50	50.0	15.5	**PK**
120VAC, 60 Hz Neutral						
0.3378	40.44	0.33	40.77	49.3	8.5	**PK**
0.5400	33.13	0.29	33.42	46.0	12.6	**PK**
1.5530	38.55	0.30	38.85	46.0	7.1	**PK**
8.8080	31.73	0.48	32.21	50.0	17.8	**PK**
19.9670	36.34	0.71	37.05	50.0	13.0	**PK**
20.5330	37.65	0.72	38.37	50.0	11.6	**PK**

SAMPLE CALCULATION at 0.3168 MHz:

Magnitude of Measured Frequency 40.70dBuV		
+ Cable Loss+ LISN Loss	0.20	dB
=Corrected Result	40.90	dBuV
Limit	49.80	dBuV
-Corrected Result	40.90	dBuV
Margin	9.9	dB

Test Date: June 26, 2018

Tested By
Signature: Afzal Fazal Name:Afzal Fazal

2.12 Unintentional/Intentional Radiator, Radiated Emissions (CFR 15.109 and 15.209)

Radiated emissions disturbance Measurements were performed with EUT in constant transmit mode and using an instrument having both peak and quasi-peak detectors over the frequency range of 9 kHz to 1 GHz. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

The worst-case radiated emission in the range of 9 kHz to 1 GHz was 6.0 dB below the limit at 154.10, 211.14, and 277.38 MHz. This signal is found in Table 9. All other radiated emissions were 5.6dB or more below the limit.

Table 8. Unintentional Radiated Emissions 9 kHz to 30 MHz

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems			
Project: 18-0161				**Model:** RAC00-16425			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
27.52	**42.63**	**9.66**	**52.59**	**58.8**	**3 meter**	**6.5**	**PK**
All other detected emissions were 20 dB or more from the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculations: at 27.52 MHz, 42.63 dBuV + (9.66) = 52.59 dBuV/m
Limit @ 3m= 58.8 dBuV/m
Margin= 6.5 dB

Test Date: June 16-18, 2018

Tested By
Signature:  Name:Afzal Fazal

NOTE: Measurements above 30 MHz are presented in Table 9.

Table 9. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109, 15.209), 30 MHz to 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Radio Systems			
Project: 18-0161				**Model:** RAC00-15373			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
38.50	44.49	-15.71	28.78	40.0	3m./VERT	11.2	**QP**
154.10	51.13	-13.60	37.53	43.5	3m./HORZ	6.0	**PK**
210.20	49.29	-14.02	35.27	43.5	3m./VERT	8.2	**QP**
211.14	52.10	-14.62	37.48	43.5	3m./HORZ	6.0	**PK**
266.22	52.42	-12.93	39.49	46.0	3m./VERT	6.5	**QP**
277.38	52.12	-12.14	39.98	46.0	3m./HORZ	6.0	**QP**
967.40	29.84	-0.50	29.34	54.0	3m./VERT	24.7	**PK**
998.00	29.59	0.61	30.20	54.0	3m./HORZ	23.8	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 38.50 MHz:

Magnitude of Measured Frequency	44.49	dBuV
+ Cable Loss+ LISN Loss	-15.71	dB
=Corrected Result	28.78	dBuV
Limit	40.00	dBuV
-Corrected Result	28.78	dBuV
Margin	11.20	dB

Test Date: June 18, 2018

Tested By
Signature:  Name :Afzal Fazal

2.13 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.13.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.78dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.

2.13.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.