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TIMCO ENGINEERING, Inc.

An IIA Company

FCC CFR 47 Part 80, Part 90 & ISED RSS-238 Radar Test Report

APPLICANT	KELVIN HUGHES LIMITED
ADDRESS	VOLTAGE, MOLLISON AVENUE ENFIELD UNITED KINGDOM EN3 7XQ
FCC ID	CICDTX-A603-SF
IC	1493A-DTXA603SF
MODEL NUMBER	DTX-A1-APNA
PRODUCT DESCRIPTION	S-BAND RADAR
DATE SAMPLE RECEIVED	04/03/2019
FINAL TEST DATE	04/30/2019
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
319UT19TestReport_	Rev1	Initial Issue	07/28/2021
	Rev2	Updated address	11/12/2021

TABLE OF CONTENTS

GENERAL REMARKS

Summary

The device under test does:

☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.

☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669
Designation #: US1070

Signature:

Name & Title: **Terri Allen, Technical Assistant**
Date of Signature
(YYYY-MM-DD): 2021-07-28

Sr. EMC Engineer
EMC-003838-NE

Signature:

Name & Title: **Tim Royer, EMC Engineer**
Date of Signature
(YYYY-MM-DD): 2021-07-28

GENERAL INFORMATION

Definitions: FCC Part 80.5, 90.7, RSS-238 s.1

The EUT is a Ship-borne Radar Station operating in the Maritime Radiodetermination Service performing radiodetermination and/or radionavigation.

Radar. A radiodetermination system based upon the comparison of reference signals with radio signals reflected, or re-transmitted, from the position to be determined.

Maritime radiodetermination service. A maritime radiocommunication service for determining the position, velocity, and/or other characteristics of an object, or the obtaining of information relating to these parameters, by the propagation properties of radio waves.

Radiolocation. Radiodetermination used for purposes other than those of radionavigation.

Radionavigation. Radiodetermination used for the purposes of navigation, including obstruction warning.

Radiodetermination service. A radiocommuncation service which uses radiodetermination. Radiodetermination is the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation of radio waves. A station in this service is called a radiodetermination station.

Radionavigation service. A radiodetermination service for the purpose of radionavigation. Radionavigation is the use of radiodetermination for the purpose of navigation, including obstruction warning.

ISED Scope of Testing: RSS-238 s.1

1. Scope

This Radio Standards Specification (RSS) sets out minimum requirements for the certification of shipborne radar operating in the maritime radionavigation service in the bands 2900-3100 MHz and 9225-9500 MHz and having a rated peak transmit power of less than or equal to 60 kW.

GENERAL INFORMATION

Testing Information

EUT Description	S-BAND RADAR		
FCC ID	CICIDTX-A603-SF		
IC	1493A-DTXA603SF		
Model Number	DTX-A1-APNA		
Operating Band(s)	2930 – 3070 MHz		
Test Frequencies	2930, 3010, 3070 MHz		
FCC Emission Designator	62M2P0N		
Measurement Method	99% Occupied Bandwidth		
IC Emission Designator	200MP0N		
Measurement Method	-40dB Occupied Bandwidth		
Modulation	Pulse/FM Chirp		
EUT Power Source	☒110–120 VAC	☐ DC Power (12 V)	☐ Battery Operated
Test Item	☐ Prototype	☒ Pre-Production	☐ Production
Type of Equipment	☒ Fixed	☐ Mobile	☐ Portable
Antenna Connector	SMA		
Modification to the EUT	The EUT was not modified.		
Test Exercise	The EUT was operated using control software provided by the manufacturer in accordance with the user manual.		
Applicable Standards	FCC CFR 47 Part 2, Part 80, Part 90, & ISED RSS-238 (i1), RSS-GEN (i5), using ANSI C63.26-2015, TIA-603-E 2015. Referencing: ITU-R M.1177-4, NTIA "Manual Of Regulations"		
Test Conditions	Laboratory temperature: 26ºC, Relative humidity: 50%		
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070		

GENERAL INFORMATION

Operating Frequencies

Band 1: 2.9 – 3.1 GHz

Rule Part No.: FCC Part 80.45, 80.375, 90.103, RSS-238 s.1, RSS-238 s.3.2 p2

(d) *Radiodetermination frequency bands above 2400 MHz.* (1) The radiodetermination frequency bands assignable to ship and shore stations including ship and shore radar and transponder stations are as follows: 2450-2500 MHz; 2900-3100 MHz; 5460-5650 MHz; and 9300-9500 MHz.

(2) Assignment of these bands to ship and coast stations are subject to the following conditions:

(ii) The use of the 2900-3100 MHz, 5470-5650 MHz and 9300-9500 MHz bands for radiolocation must not cause harmful interference to the radionavigation and Government radiolocation services. Additionally, the use of the 2900-3000 MHz band for radiolocation must not cause harmful interference to the Government meteorological aids service.

(iii) In the 2920-3100 MHz and 9320-9500 MHz bands the use of fixed-frequency transponders for radionavigation is not permitted;

§90.103 Radiolocation Service.

(b) *Frequencies available.* The following table indicates frequencies available for assignment to stations in the Radiolocation Service, together with the class of station(s) to which they are normally assigned, and the specific assignment limitations, which are explained in paragraph (c) of this section:

RADIOLOCATION SERVICE FREQUENCY TABLE

Frequency or band	Class of station(s)	Limitation
	Megahertz	
2900 to 3100	.....do	10, 11

(10) Speed measuring devices will not be authorized in this band.

(11) This frequency band is shared with and is on a secondary basis to the Maritime Radionavigation Stations (part 80) and to the Government Radiolocation Service.

ISED Operating Frequencies: RSS-238 s.1

1. Scope

This Radio Standards Specification (RSS) sets out minimum requirements for the certification of shipborne radar operating in the maritime radionavigation service in the bands 2900-3100 MHz and 9225-9500 MHz and having a rated peak transmit power of less than or equal to 60 kW.

3.2 Test Report

All tests shall be conducted on a frequency that is near the middle of the frequency range within which the equipment is designed to operate.

SUMMARY OF TESTING

FCC Rule Parts	ISED Rule Parts	Testing Performed	Result
2.1033(c)(4), 80.207(d), 80.205(a)	N/A	Modulation Characteristics	**PASS**
N/A	RSS-238 s.3.2(a)	Pulse Characteristics	**PASS**
2.1046(a), 80.215(a)(3), 80.215(i)(1), (2), 90.205(r)	RSS-238 s.4.2	RF Power Output	**PASS**
2.1049(i), 80.213(g), 80.209(b), 90.207(k), (n), 90.209(b)(5)	RSS-238 s.3.2(c)	Occupied Bandwidth	**PASS**
80.211(f)(1), (2), 90.210(n), (b)(1), (2)	RSS-238 s.4.3	Emission Masks	**PASS**
2.1051(a), 2.1057(a)(1), 80.211(f)(3), 90.210(n), (b)(3)	RSS-238 s.4.3	Spurious Emissions at Antenna Terminals	**PASS**
2.1053(a), 2.1057(a)(1), 80.211(f)(3), 90.210(n), (b)(3)	RSS-238 s.4.3	Field Strength of Spurious Emissions	**PASS**
2.1055(a)(2), 80.209(b), 90.213(a)	RSS-238 s.4.1	Frequency Stability	**PASS**

MODULATION CHARACTERISTICS

Rule Part No.: Part 2.1033(c)(4), 80.207(d), 80.205(a)

§80.207 Classes of emission.

(d) The authorized classes of emission are as follows:

Types of stations	Classes of emission
Ship Stations[1]	
Radiodetermination:	
2.4-9.5 GHz	PON.
Land Stations[1]	
Radiodetermination:	
2.4-9.6 GHz	PON.

[1]Excludes distress, EPIRBs, survival craft, and automatic link establishment.

§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)
PON	([12])	([12])

[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.

Note: Per footnote 12, 80.205(a) does not state requirements for an emission designator or an Authorized bandwidth for radar operating above 2.4 GHz. However, the class of emission shall be P0N.

FCC Bandwidth

Worst-case 99% Occupied Bandwidth: **62.180 MHz**
Emission Designation: **62M2P0N**

Note: Please see "99% Occupied Bandwidth" section for details.

ISED Bandwidth

Worst-case 40 dB-down Occupied Bandwidth: **200.321 MHz**
Emission Designation: **200MP0N**

Note: Please see "40dB Occupied Bandwidth" section for details.

PULSE CHARACTERISTICS

Rule Part No.: RSS-238 s.3.2(a)

3.2 Test Report

In addition to the required information and measurements specified in RSS-Gen, the test report submitted with the application shall contain the following information:

- (a) the pulse width, pulse rise time and pulse repetition rate;

Pulse Characteristics Table

The EUT employs 13 operational modes, each consisting of a fixed array of pulses from among 3 pulse types, in test modes 1 – 3.

Subpulse Name	Pulse On-Time	Pulse Rise Time (nS)	Pulse Fall Time (nS)
Single Chirp	750 nS	20 nS	15 nS
Pulse 1	100 nS		
Pulse 2	30 µS		
Pulse 3	5 µS		

Pulse Train Characteristics Table

Test Mode	User Selected Range (nm)	Pulse Train	Total Pulse On-Time	Pulse Repetition Factor (kHz)	Pulse Repetition Time (µS)
1	Single Chirp	Single Chirp	750 nS	2.941	340
2	12 nm	Pulse 1	100 nS	2.058	486
3	24 nm	Pulse 1, 2, 3	35.1 µS	1.623	616
4	48 nm	Pulse 1, 2, 3	35.1 µS	1.037	964

PULSE CHARACTERISTICS

RF POWER OUTPUT

Rule Part No.: FCC Part 2.1046(a), 80.215(a)(3), 90.205(r), RSS-238 s.4.2

Requirements:

§80.215 Transmitter power.

(a) Transmitter power shown on the radio station authorization is the maximum power the licensee is authorized to use. Power is expressed in the following terms:

(3) For PON and F3N emission: Mean power;

§90.205 Power and antenna height limits.

(r) *All other frequency bands.* Requested transmitter power will be considered and authorized on a case by case basis.

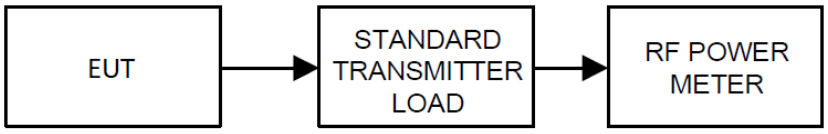
Note: the frequency bands referred to in 90.205 do not include 9.3 – 9.5 GHz. These frequencies are covered by clause (r).

4.2 Transmitter Output Power and Antenna Gain

The transmitter output power shall not exceed 60 kW and the antenna gain shall not exceed 35 dBi.

Test Procedure: ANSI C63.26

Test Setup Block Diagram:



RF POWER OUTPUT

Test Data: Mode 1, Mean Power Output

Mode	Peak Frequency (MHz)	Mean Output Power (dBm)	Loss (dB)	Antenna Gain (dBi)	Coax Loss (dB)	Total Mean Power Output (dBm)	Mean Power Output (W)
1	2930.000	-20.46	-52.960	0.0	0.0	32.500	1.78
	3010.000	-20.01	-53.040	0.0	0.0	33.030	2.01
	3070.000	-20.21	-53.030	0.0	0.0	32.820	1.91

Test Data: Mode 2, Mean Power Output

Mode	Peak Frequency (MHz)	Meas. Output (dBm)	Meas. Loss (dB)	Antenna Gain (dBi)	Coax Loss (dB)	Mean Power Output (dBm)	Mean Power Output (W)
2	2930.000	-30.81	-52.960	0.0	0.0	22.15	0.16
	3010.000	-30.21	-53.040	0.0	0.0	22.83	0.19
	3070.000	-30.53	-53.030	0.0	0.0	22.50	0.18

RF POWER OUTPUT

Test Data: Mode 3, Mean Power Output

Mode	Peak Frequency (MHz)	Meas. Output (dBm)	Meas. Loss (dB)	Antenna Gain (dBi)	Coax Loss (dB)	Mean Power Output (dBm)	Mean Power Output (W)
3	2930.000	-12.69	-52.960	0.0	0.0	40.27	10.64
	3010.000	-12.35	-53.040	0.0	0.0	40.69	11.72
	3070.000	-12.47	-53.030	0.0	0.0	40.56	11.38

Test Data: Mode 4, Mean Power Output

Mode	Peak Frequency (MHz)	Meas. Output (dBm)	Meas. Loss (dB)	Antenna Gain (dBi)	Coax Loss (dB)	Mean Power Output (dBm)	Mean Power Output (W)
4	2930.000	-14.71	-52.960	0.0	0.0	38.25	6.68
	3010.000	-14.31	-53.040	0.0	0.0	38.73	7.46
	3070.000	-14.46	-53.030	0.0	0.0	38.57	7.19

Maximum Mean Power: **Mode 3, 11.72 W**

POWER AT THE FINAL AMPLIFIER

Rule Part No.: FCC Part 2.1033(c)(8)

Requirement:

(c) Applications for equipment other than that operating under parts 15, 11 and 18 of this chapter shall be accompanied by a technical report containing the following information:

(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

Test Data: Power at the Final Amplifier

INPUT POWER: (110 VAC) (11.5 A) = **1265 Watts**

OCCUPIED BANDWIDTH & EMISSION MASK

99% Occupied Bandwidth Rule Parts

Rule Part No.: Part 2.1049(i), 80.213(g), 80.209(b), 90.207(k), (n), 90.209(b)(5)

§2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(i) Transmitters designed for other types of modulation—when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

§80.213 Modulation requirements.

(g) Radar stations operating in the bands above 2.4 GHz may use any type of modulation consistent with the bandwidth requirements in §80.209(b).

§80.209 Transmitter frequency tolerances.

(b) When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where "T" is the pulse duration in microseconds. In the band 14.00-14.05 GHz the center frequency must not vary more than 10 MHz from 14.025 GHz.

§90.207 Types of emissions.

(k) For radiolocation operations as may be authorized in accordance with subpart F, unless otherwise provided for any type of emission may be authorized upon a satisfactory showing of need.

(n) *Other emissions.* Requests for emissions other than those listed in paragraphs (c) through (e) of this section will be considered on a case-by-case basis to ensure that the requested emission will not cause more interference than other currently permitted emissions.

§90.209 Bandwidth limitations.

(b) The maximum authorized single channel bandwidth of emission corresponding to the type of emission specified in §90.207 is as follows:

STANDARD CHANNEL SPACING/BANDWIDTH

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
Above 2500[2]		

[2]Bandwidths for radiolocation stations in the 420-450 MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by-case basis.

Test Procedure: ANSI C63.26, 5.4.4

Note: The receiver's automatic 99% Occupied Bandwidth function was used. The function is identical in operation to the measurement method of ANSI C63.26, 5.4.4, Step e).

OCCUPIED BANDWIDTH

40dB Occupied Bandwidth Rule Parts

Rule Part No.: RSS-238 s.3.2(c)

3.2 Test Report

In addition to the required information and measurements specified in RSS-Gen, the test report submitted with the application shall contain the following information:

- (c) the 40 dB bandwidth.

Test Procedure: ANSI C63.26, 5.4.3

Note: The receiver's automatic ndB Down Occupied Bandwidth function was used. The function is identical in operation to the measurement method of ANSI C63.26, 5.4.3.

Test Data: Occupied Bandwidth Measurement Table

Mode	99% Occupied Bandwidth (MHz)	40 dB Occupied Bandwidth (MHz)
1	13.381	54.327
2	62.180	200.321
3	7.692	61.859
4	7.692	61.539

Max 99% Occupied Bandwidth of EUT = **62.180 MHz**

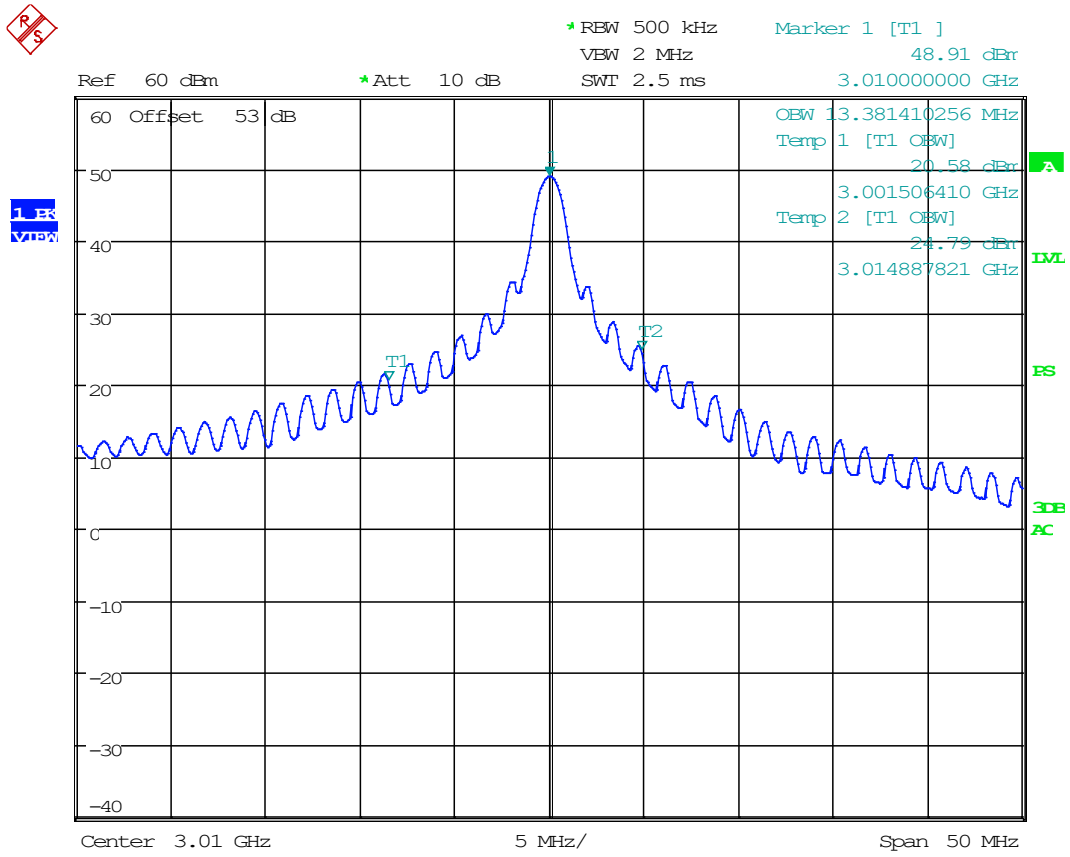
FCC Emission Designator = **62M2P0N**

Max 40dB Occupied Bandwidth of EUT = **200.321 MHz**

ISED Emission Designator = **200MP0N**

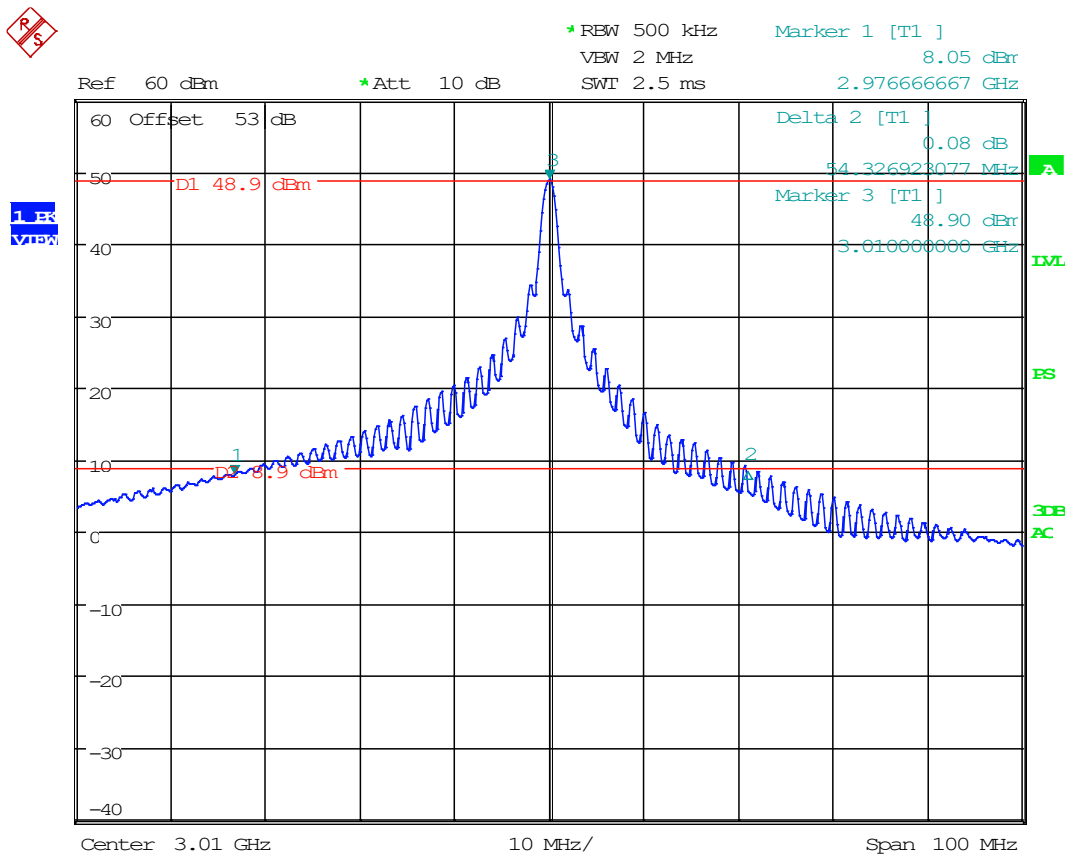
OCCUPIED BANDWIDTH

Test Data: Mode 1 99% OBW Plot



OCCUPIED BANDWIDTH

Test Data: Mode 1 40dB OBW Plot



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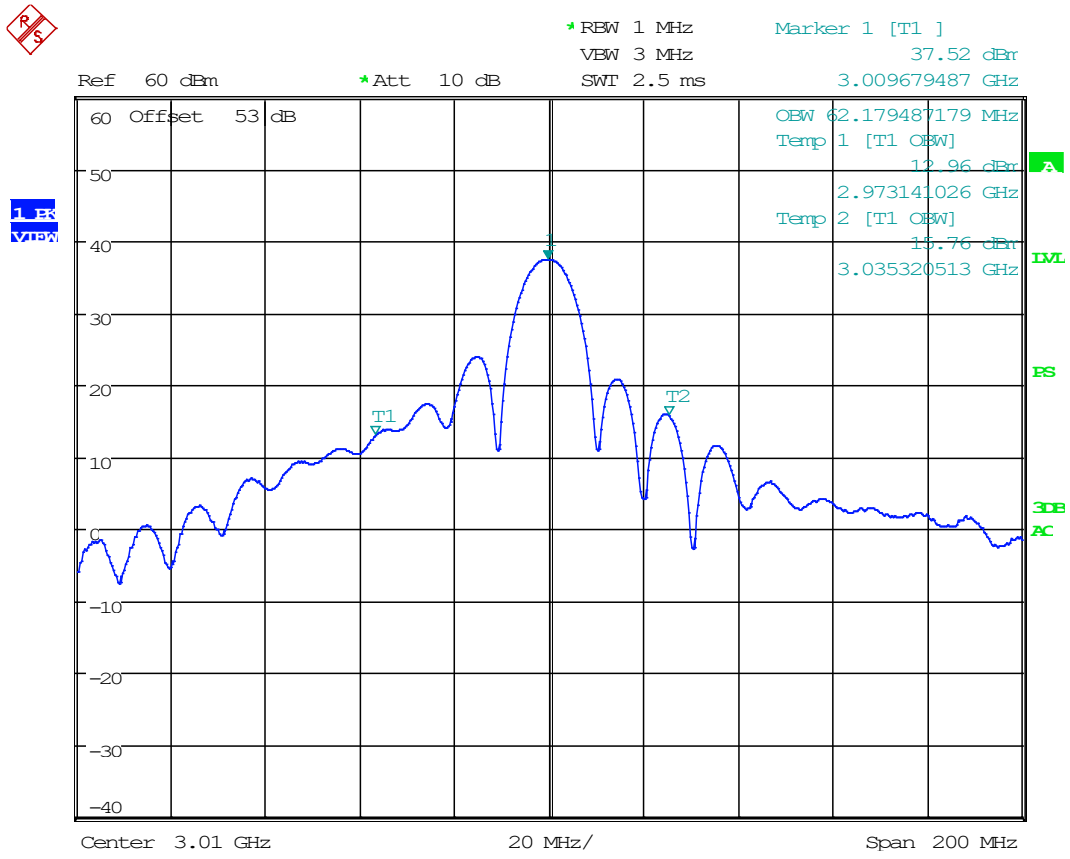
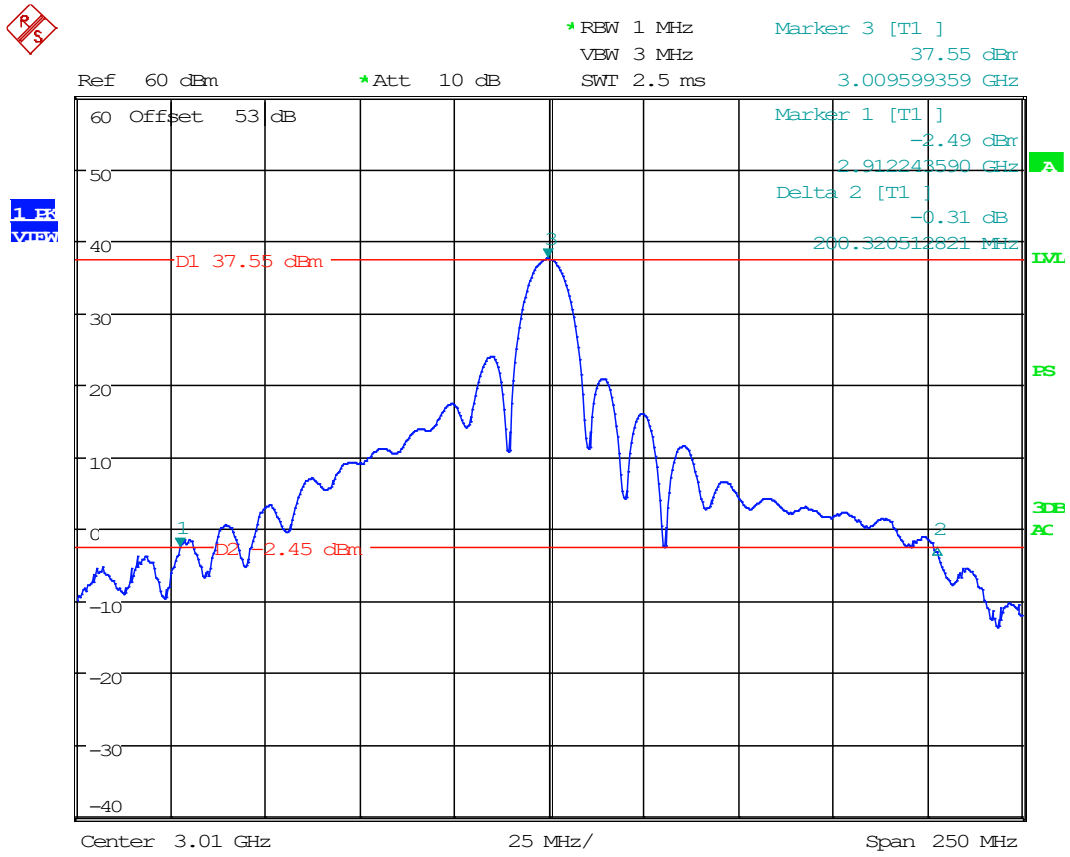
OCCUPIED BANDWIDTH

Test Data: Mode 2 99% OBW Plot



OCCUPIED BANDWIDTH

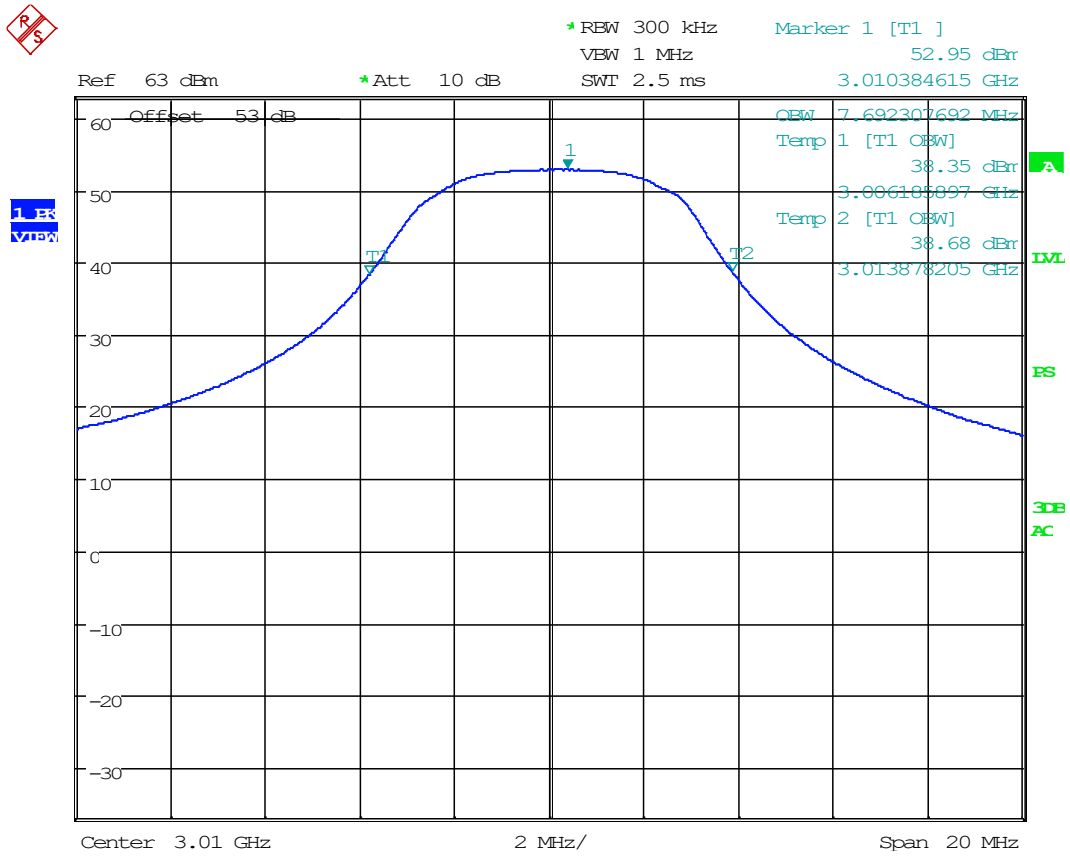
Test Data: Mode 2 40dB OBW Plot



Date: 29.APR.2019 18:35:50

OCCUPIED BANDWIDTH

Test Data: Mode 3 99% OBW Plot



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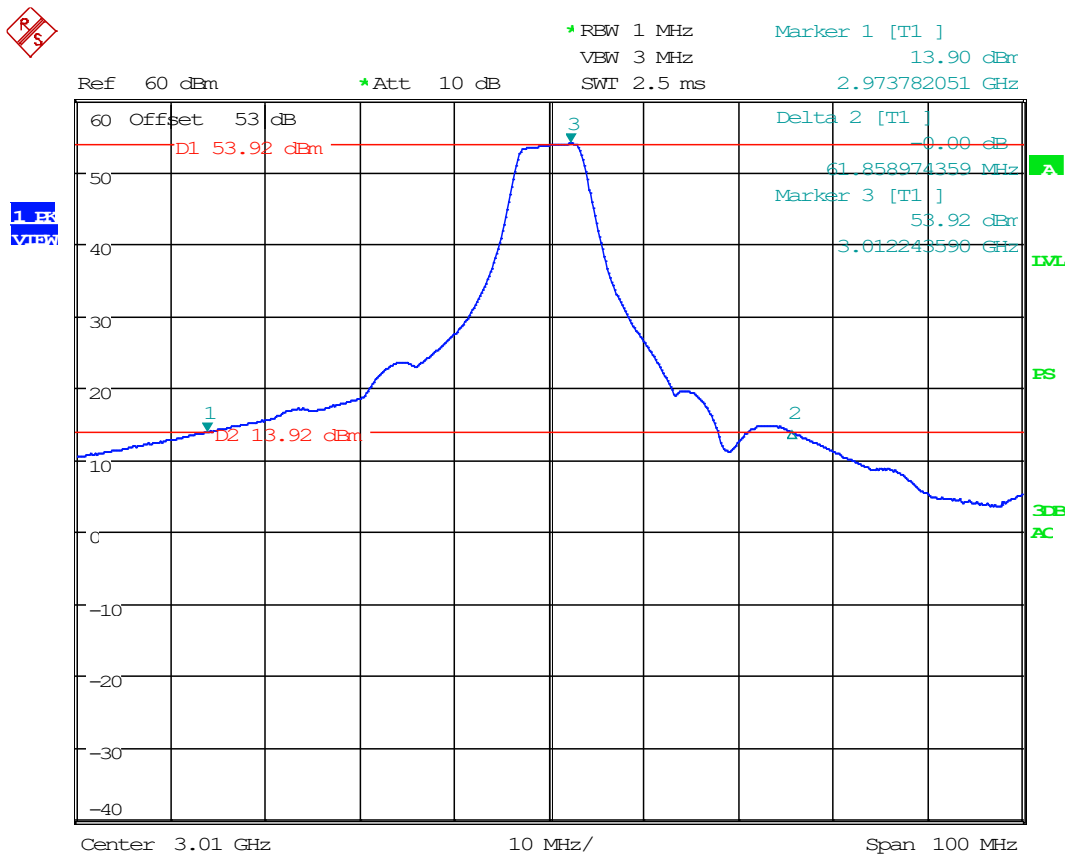
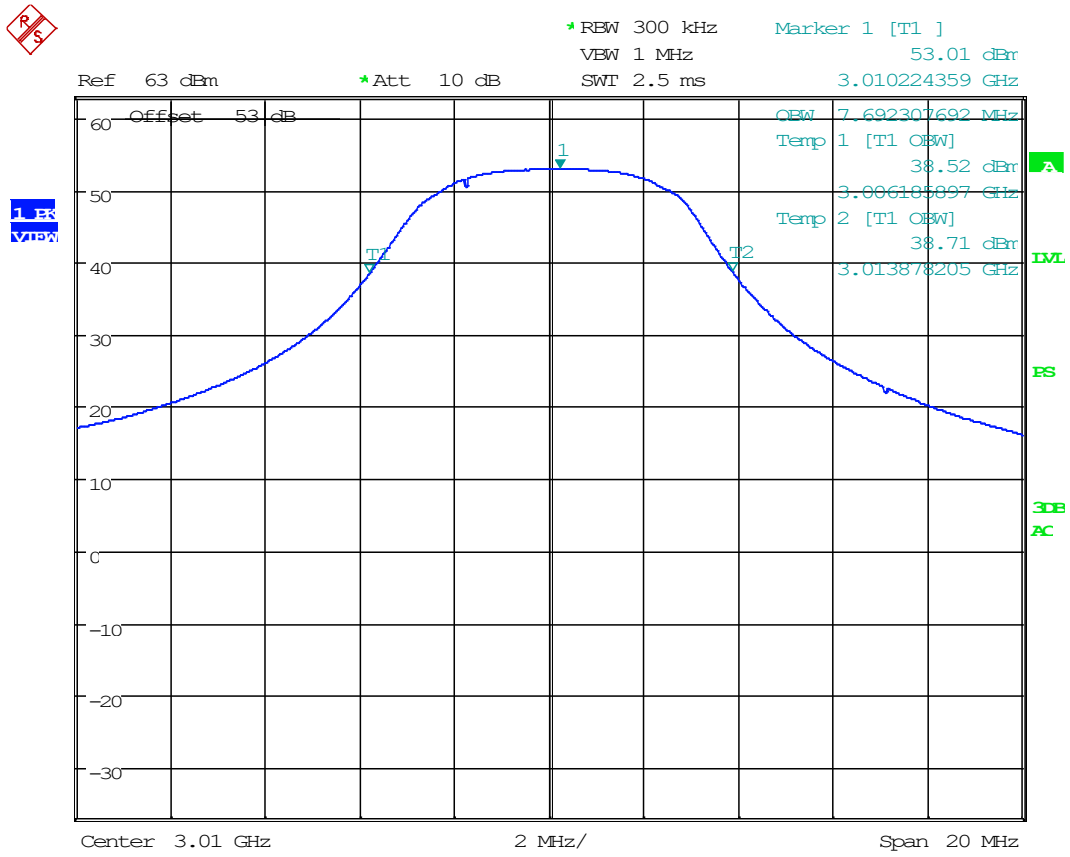
OCCUPIED BANDWIDTH

Test Data: Mode 3 40dB OBW Plot



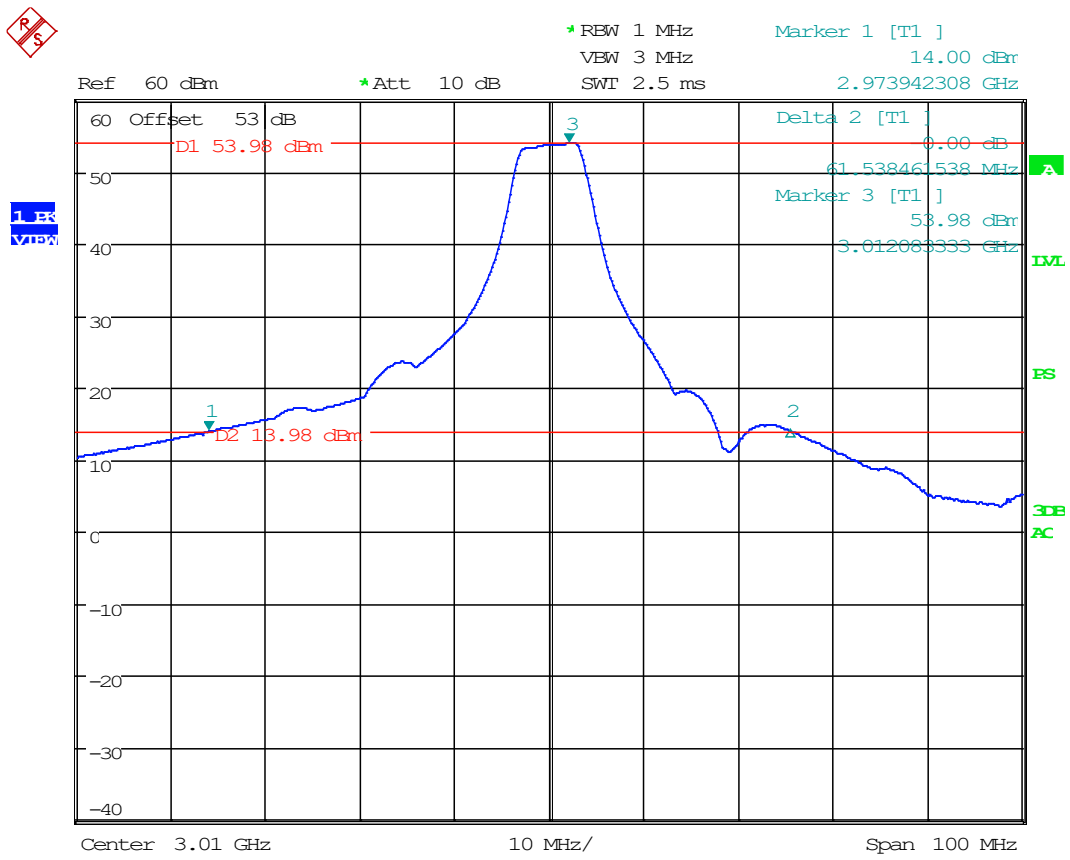
OCCUPIED BANDWIDTH

Test Data: Mode 4 99% OBW Plot



OCCUPIED BANDWIDTH

Test Data: Mode 4 40dB OBW Plot



EMISSION MASK

Rule Part No.: 80.211(f)(1), (2), 90.210(n), (b)(1), (2), RSS-238 s.4.3

Requirements:

§80.211 Emission limitations.

(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

§90.210 Emission masks.

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

(b) *Emission Mask B.* For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

4.3 Transmitter Unwanted Emissions

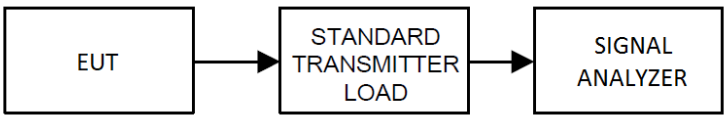
The unwanted emission and the transmitter power shall be measured using a peak detector.

The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40 dB bandwidth and beyond.

The unwanted emissions power shall not need to be attenuated more than 60 dB below the transmitter peak power.

Test Procedure: ANSI C63.26, 5.4.4; ITU-R M.1177-4

Test Setup Block Diagram:



EMISSION MASK

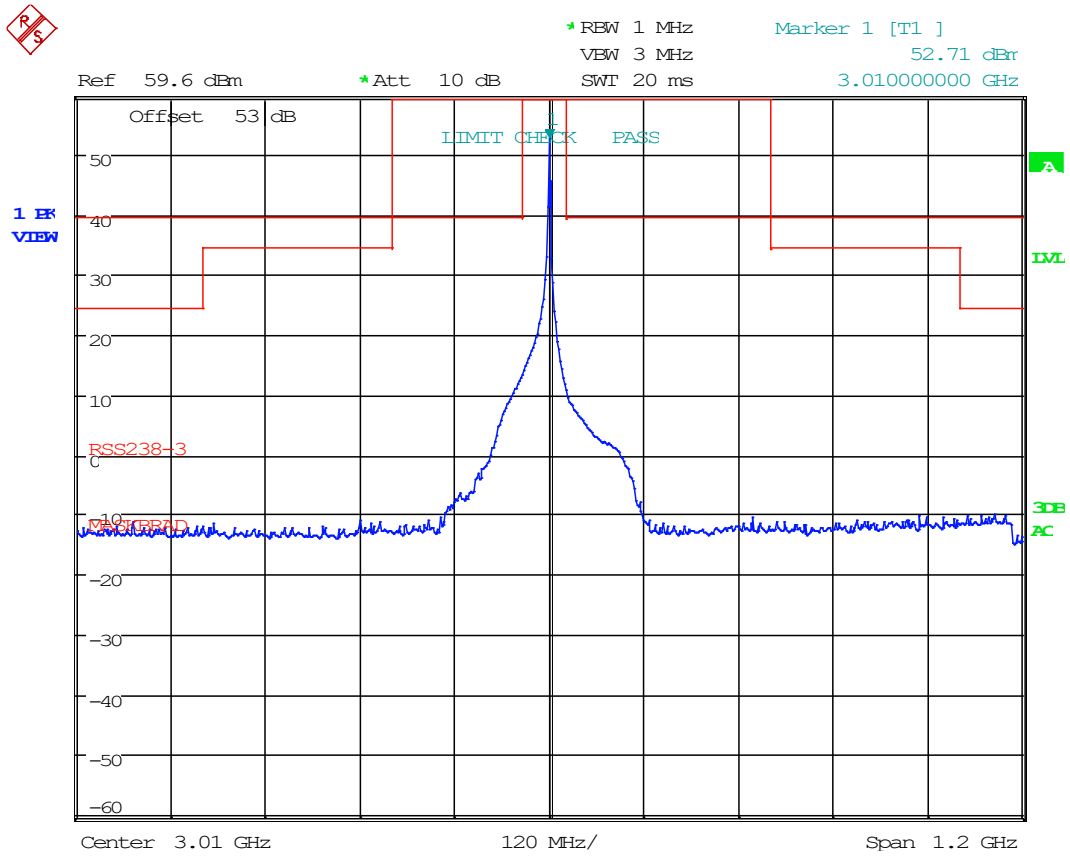
Test Data: Emission Mask Calculations

	Mode 1			Mode 2			Mode 3			Mode 4		
	Peak Power Output (dBm):		59.554	Peak Power Output (dBm):		59.656	Peak Power Output (dBm):		53.91	Peak Power Output (dBm):		53.079
FCC Emission Mask	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm
	0.03	72.55	-13.00	0.03	72.66	-13.00	0.03	66.91	-13.00	0.03	66.08	-13.00
	1970.00	72.55	-13.00	1970.00	72.66	-13.00	1970.00	66.91	-13.00	1970.00	66.08	-13.00
	1970.00	35	24.55	1970.00	35	24.66	1970.00	35	18.91	1970.00	35	18.08
	2570.00	35	24.55	2570.00	35	24.66	2570.00	35	18.91	2570.00	35	18.08
	2570.00	25	34.55	2570.00	25	34.66	2570.00	25	28.91	2570.00	25	28.08
	2810.00	25	34.55	2810.00	25	34.66	2810.00	25	28.91	2810.00	25	28.08
	2810.00	0	59.55	2810.00	0	59.66	2810.00	0	53.91	2810.00	0	53.08
	2930.00	0	59.55	2930.00	0	59.66	2930.00	0	53.91	2930.00	0	53.08
	3170.00	0	59.55	3170.00	0	59.66	3170.00	0	53.91	3170.00	0	53.08
	3290.00	0	59.55	3290.00	0	59.66	3290.00	0	53.91	3290.00	0	53.08
	3290.00	25	34.55	3290.00	25	34.66	3290.00	25	28.91	3290.00	25	28.08
	3530.00	25	34.55	3530.00	25	34.66	3530.00	25	28.91	3530.00	25	28.08
	3530.00	35	24.55	3530.00	35	24.66	3530.00	35	18.91	3530.00	35	18.08
	4130.00	35	24.55	4130.00	35	24.66	4130.00	35	18.91	4130.00	35	18.08
	4130.00	72.55	-13.00	4130.00	72.66	-13.00	4130.00	66.91	-13.00	4130.00	66.08	-13.00
	40000.00	72.55	-13.00	40000.00	72.66	-13.00	40000.00	66.91	-13.00	40000.00	66.08	-13.00
ISED Emission Mask	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm	Frequency (MHz)	dBc	dBm
	29.77	60	-0.45	29.12	60	-0.34	29.74	60	-6.09	29.74	60	-6.92
	29.77	40	19.55	29.12	40	19.66	29.74	40	13.91	29.74	40	13.08
	297.66	40	19.55	291.22	40	19.66	297.38	40	13.91	297.39	40	13.08
	297.66	20	39.55	291.22	20	39.66	297.38	20	33.91	297.39	20	33.08
	2976.64	20	39.55	2912.24	20	39.66	2973.78	20	33.91	2973.94	20	33.08
	2976.64	0	59.55	2912.24	0	59.66	2973.78	0	53.91	2973.94	0	53.08
	3031.33	0	59.55	3112.56	0	59.66	3035.64	0	53.91	3035.48	0	53.08
	3031.33	20	39.55	3112.56	20	39.66	3035.64	20	33.91	3035.48	20	33.08
	30313.30	20	39.55	31125.60	20	39.66	30356.40	20	33.91	30354.80	20	33.08
	30313.30	40	19.55	31125.60	40	19.66	30356.40	40	13.91	30354.80	40	13.08
	40000.00	40	19.55	40000.00	40	19.66	40000.00	40	13.91	40000.00	40	13.08

EMISSION MASK

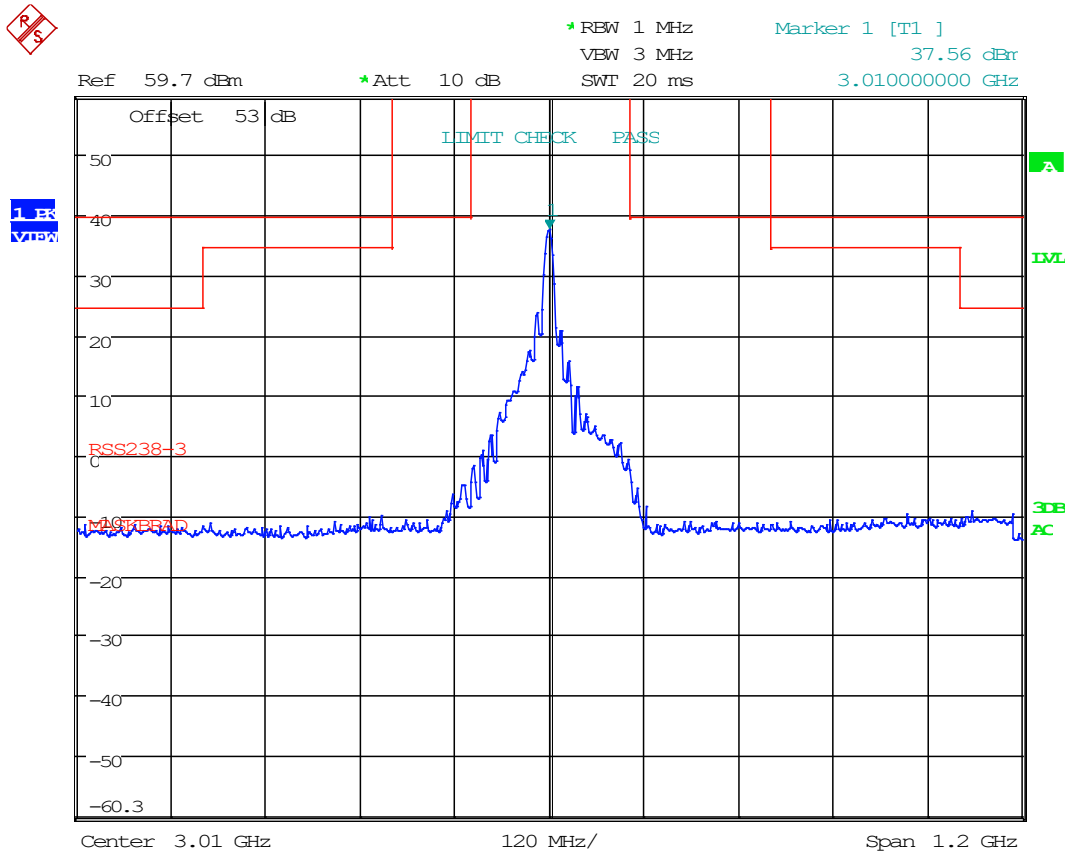
Note: The FCC Emission Mask and the ISED Emission Mask are shown simultaneously in the plots below, to demonstrate compliance.

Test Data: Mode 1 FCC & ISED Emission Mask Plot



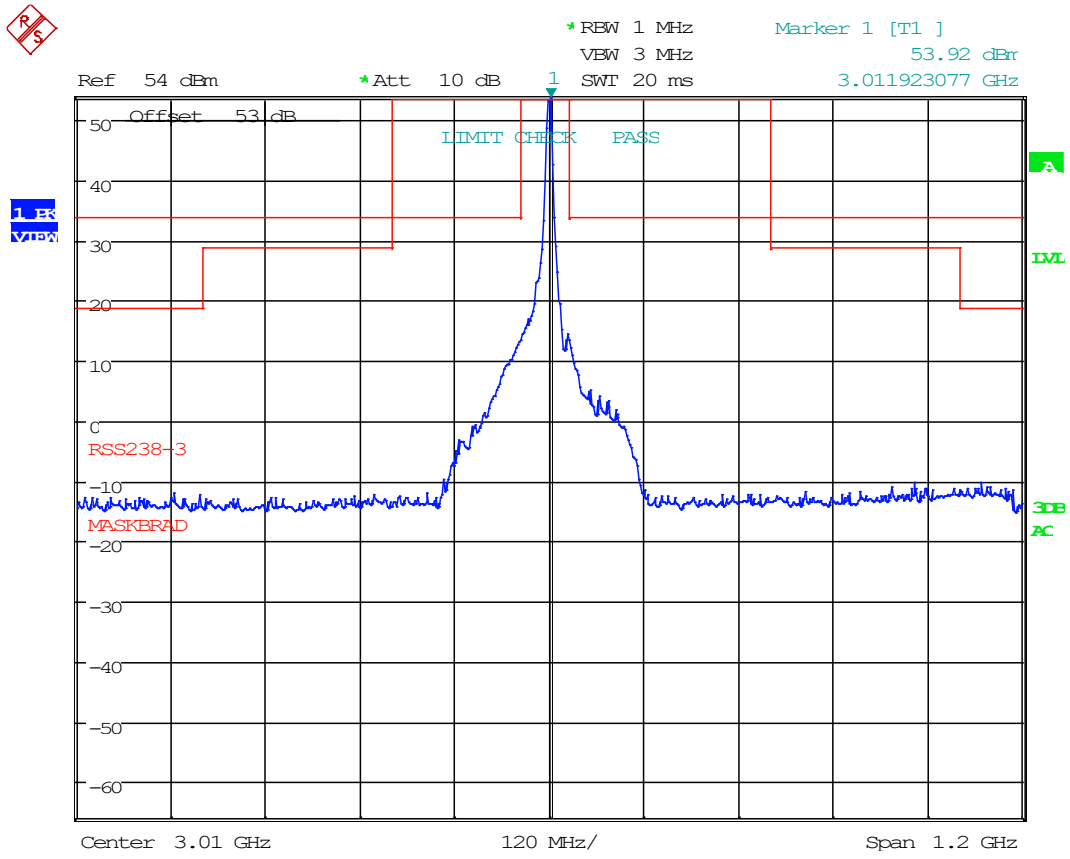
EMISSION MASK

Test Data: Mode 2 FCC & ISED Emission Mask Plot



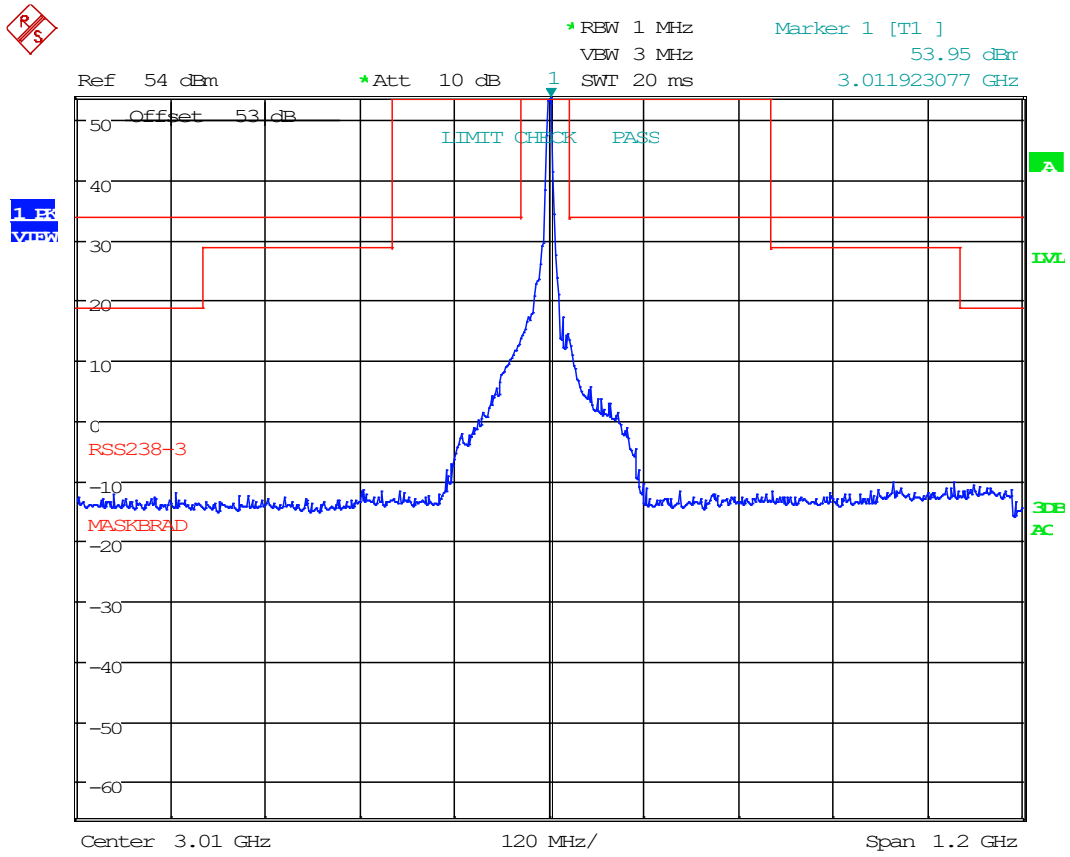
EMISSION MASK

Test Data: Mode 3 FCC & ISED Emission Mask Plot



EMISSION MASK

Test Data: Mode 4 FCC & ISED Emission Mask Plot



SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED)

Rule Part No.: Part 2.1051(a), 2.1057(a)(1), 80.211(f)(3), 90.210(n), (b)(3), RSS-238 s.4.3

§2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in §§2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

§80.211 Emission limitations.

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

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

§90.210 Emission masks.

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

(b) *Emission Mask B.* For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

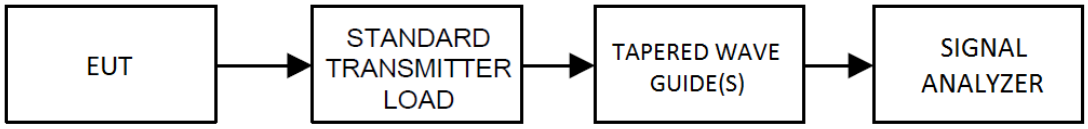
4.3 Transmitter Unwanted Emissions

The unwanted emission and the transmitter power shall be measured using a peak detector.

The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40 dB bandwidth and beyond.

The unwanted emissions power shall not need to be attenuated more than 60 dB below the transmitter peak power.

Test Setup Block Diagram:



Note: The spectrum was pre-scanned from 30 kHz to 40 GHz, and frequencies of interest (particularly harmonic emissions) have been provided below in tabular format, using the bandwidth compensation formulae, found in ITU-R M.1177, Annex 1 (cited below) with the limit.

Note: The graphical data plotted below is a representative of the final results in relation to the limit, after all compensations were made.

Unwanted spurious emission max worst-case emission, based on, per mode, the average of the worst-case emissions, per harmonic: **Test Mode 3**

UNWANTED SPURIOUS EMISSIONS

Test Procedure: TIA 603-E, 2.2.13; ITU-R M.1177-4, Annex 1

2 Reference bandwidth

For radar systems, the reference bandwidth, B_{ref}, used to define unwanted emission limits (Recommendations ITU-R SM.329 and ITU-R SM.1541, and RR Appendix 3) should be calculated for each particular radar system. For the four general types of radar pulse modulation utilized for radionavigation, radiolocation, acquisition, tracking and other radiodetermination functions, the reference bandwidth values are determined using the following formulas:

– for FM or chirped radar, the square root of the quantity obtained by dividing the chirp bandwidth (MHz) by the pulse length (μs) (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10 μs, then the reference bandwidth is $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73\ \text{MHz}$);

In all cases, where the bandwidths above are greater than 1 MHz, then a reference bandwidth, B_{ref}, of 1 MHz should be used.

3 Measurement bandwidth and detector parameters

The measurement bandwidth, B_m, is defined as the impulse bandwidth of the receiver and is greater than the IF bandwidth, B_{if}, (sometimes referred to as resolution bandwidth for spectrum analyzers). The measurement bandwidth, B_m, may be derived from the following equation:

$$B_m = B_{if} \times MBR$$

The MBR needs to be determined for the measurement receiver being used. MBR is approximately 3/2 for a –3 dB IF bandwidth Gaussian filter as typically used in many commercial spectrum analyzer receivers (in some instruments the IF bandwidth is defined at the –6 dB point).

An appropriate receiver IF bandwidth should be selected to give one of the following recommended measurement bandwidths.

Measurement bandwidth B_m[1]	≤	$(B_c/T)^{1/2}$ for swept-frequency (FM, or chirp) radars, where B_c is the range of frequency sweep during each pulse and T is the pulse length (e.g. if radar sweeps (chirps) across the frequency range of 1 250-1 280 MHz (= 30 MHz of spectrum) during each pulse, and if the pulse length is 10 μs, then the measurement bandwidth should be $\leq ((30\ \text{MHz})/(10\ \mu\text{s}))^{1/2} = \sqrt{3}\ \text{MHz} \approx 1.73\ \text{MHz}$. In accordance with footnote [1] a measurement bandwidth close to but less than or equal to 1 MHz should be used in this example.
Video bandwidth	≥	measurement system bandwidth.
Detector		positive peak.

[1] In all cases, if the above derived measurement bandwidth is greater than 1 MHz, then the corrections described in § 3.2 should be used.

UNWANTED SPURIOUS EMISSIONS

Test Procedures, Con't.

3.2 Measurements within the spurious domain

3.2.1 Correction of the measurement within the spurious domain

Where the measurement bandwidth, B_m, differs from the reference bandwidth, B_{ref}, a correction factor needs to be applied to the measurements conducted within the spurious domain to express the results in the reference bandwidth. Then the following correction factor should be applied:

$$\text{Spurious level, } B_{ref} = \text{Spurious level (measured in } B_m) + 10 \times \log(B_{ref}/B_m)$$

NOTE 1 – This correction factor should be used except where it is known that the spurious is not noise-like, where a factor between 10 and 20 $\log(B_{ref}/B_m)$ may apply and may be derived by measurements in more than one bandwidth. In all cases the most precise result will be obtained using a measurement bandwidth (B_m) equal to the reference bandwidth. For radars operating above 1 GHz the reference bandwidth (B_{ref}) is 1 MHz.

Bandwidth Compensation Calculation Table:

Mode	Occupied Bandwidth		99% Bref (MHz)		40dB Bref (MHz)		MBR (MHz)	Bm (MHz)	Spurious Noise Correction (dBm)	Spurious Emissions Correction (dBm)
	99% (MHz)	40 dB (MHz)	(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bif x MBR = Bm (MHz)	If Bm > 1, 10 x Log(Bref/Bm)	If Bm > 1, 20 x Log(Bref/Bm)
1	13.381	54.327	4.22	1.00	52.12	1.00	1.50	4.50	-6.53	-13.06
2	62.180	200.321	25.87	1.00	334.37	1.00	1.50	4.50	-6.53	-13.06
3	7.692	61.859	25.87	1.00	296.94	1.00	1.50	4.50	-6.53	-13.06
4	7.692	61.539	25.87	1.00	237.35	1.00	1.50	4.50	-6.53	-13.06

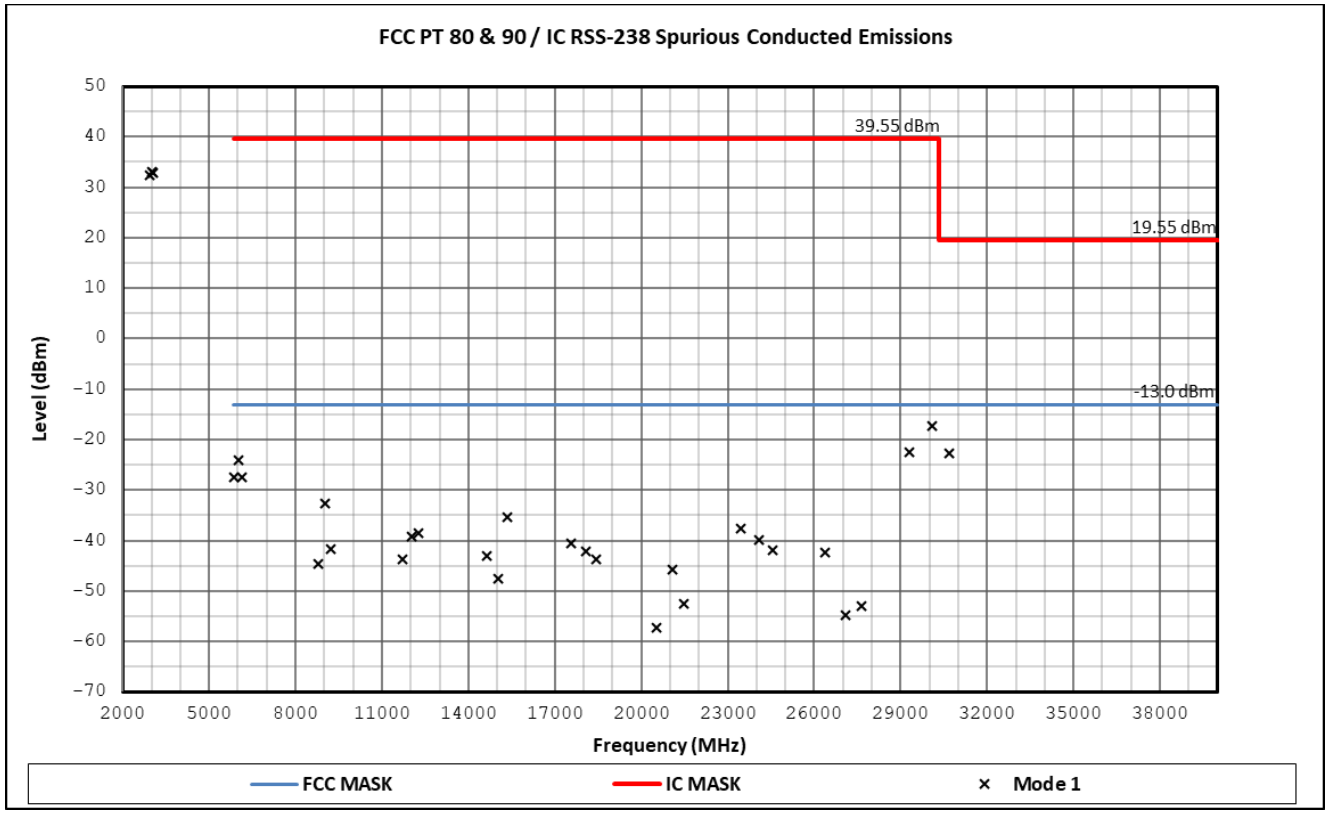
Limit Calculation Part 80.211(f)(3)

43 + 10 x Log(Power, in Watts)

Mode	Maximum Mean Power Output (W)	Relative Limit (dBc)	Absolute Limit (dBm)
1	2.01	46.03	-13.00
2	0.19	35.79	-13.00
3	11.72	53.69	-13.00
4	7.46	51.73	-13.00

UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 1, Spurious Conducted Emissions Plot



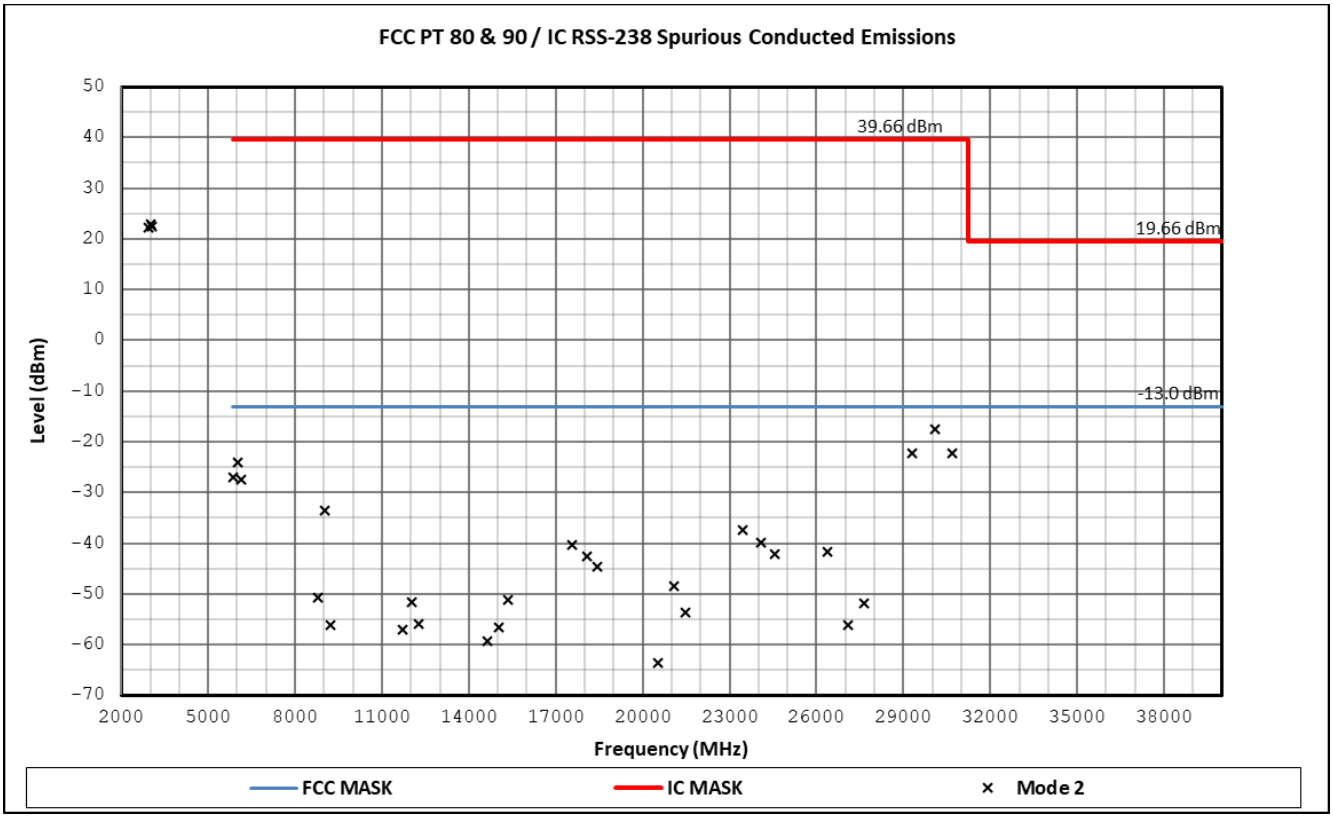
UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 1, Spurious Emission Measurement Table

Harmonic	Harmonic Frequency (MHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
2nd	5860.0	-66.76	-79.824	52.310	-27.514	-13.00	14.51
	6020.0	-66.20	-79.264	55.220	-24.044	-13.00	11.04
	6140.0	-66.68	-79.744	52.330	-27.414	-13.00	14.41
3rd	8790.0	-67.69	-80.754	36.220	-44.534	-13.00	31.53
	9030.0	-73.68	-86.744	54.110	-32.634	-13.00	19.63
	9210.0	-50.31	-63.374	21.710	-41.664	-13.00	28.66
4th	11720.0	-53.46	-66.524	22.800	-43.724	-13.00	30.72
	12040.0	-49.91	-62.974	23.870	-39.104	-13.00	26.10
	12280.0	-48.73	-61.794	23.200	-38.594	-13.00	25.59
5th	14650.0	-52.69	-65.754	22.700	-43.054	-13.00	30.05
	15050.0	-66.32	-79.384	31.870	-47.514	-13.00	34.51
	15350.0	-53.43	-66.494	31.030	-35.464	-13.00	22.46
6th	17580.0	-73.83	-86.894	46.420	-40.474	-13.00	27.47
	18060.0	-74.23	-87.294	45.160	-42.134	-13.00	29.13
	18420.0	-91.01	-104.074	60.290	-43.784	-13.00	30.78
7th	20510.0	-84.72	-97.784	40.620	-57.164	-13.00	44.16
	21070.0	-88.59	-101.654	55.920	-45.734	-13.00	32.73
	21490.0	-89.36	-102.424	50.000	-52.424	-13.00	39.42
8th	23440.0	-89.66	-102.724	65.150	-37.574	-13.00	24.57
	24080.0	-89.88	-102.944	63.070	-39.874	-13.00	26.87
	24560.0	-89.47	-102.534	60.590	-41.944	-13.00	28.94
9th	26370.0	-88.77	-101.834	59.450	-42.384	-13.00	29.38
	27090.0	-86.69	-99.754	44.890	-54.864	-13.00	41.86
	27630.0	-87.25	-100.314	47.290	-53.024	-13.00	40.02
10th	29300.0	-87.61	-100.674	78.200	-22.474	-13.00	9.47
	30100.0	-87.05	-100.114	82.780	-17.334	-13.00	4.33
	30700.0	-87.71	-100.774	78.070	-22.704	-13.00	9.70

UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 2, Spurious Conducted Emissions Plot



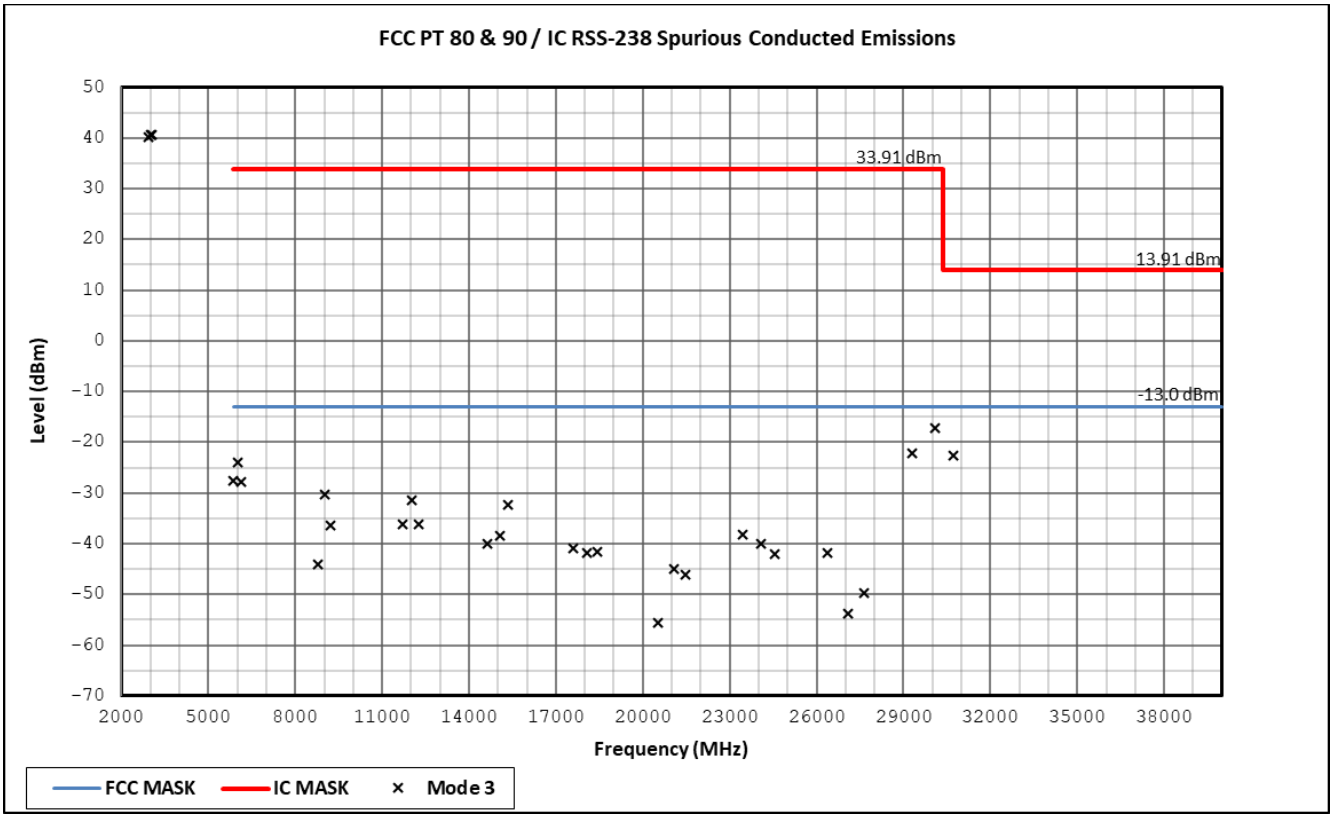
UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 2, Spurious Emission Measurement Table

Harmonic	Harmonic Frequency (MHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
2nd	5860.0	-66.32	-79.384	52.310	-27.074	-13.00	14.07
	6020.0	-66.24	-79.304	55.220	-24.084	-13.00	11.08
	6140.0	-66.66	-79.724	52.330	-27.394	-13.00	14.39
3rd	8790.0	-73.98	-87.044	36.220	-50.824	-13.00	37.82
	9030.0	-74.69	-87.754	54.110	-33.644	-13.00	20.64
	9210.0	-64.83	-77.894	21.710	-56.184	-13.00	43.18
4th	11720.0	-66.81	-79.874	22.800	-57.074	-13.00	44.07
	12040.0	-62.49	-75.554	23.870	-51.684	-13.00	38.68
	12280.0	-66.07	-79.134	23.200	-55.934	-13.00	42.93
5th	14650.0	-68.83	-81.894	22.700	-59.194	-13.00	46.19
	15050.0	-75.42	-88.484	31.870	-56.614	-13.00	43.61
	15350.0	-69.24	-82.304	31.030	-51.274	-13.00	38.27
6th	17580.0	-73.71	-86.774	46.420	-40.354	-13.00	27.35
	18060.0	-74.58	-87.644	45.160	-42.484	-13.00	29.48
	18420.0	-91.87	-104.934	60.290	-44.644	-13.00	31.64
7th	20510.0	-91.24	-104.304	40.620	-63.684	-13.00	50.68
	21070.0	-91.38	-104.444	55.920	-48.524	-13.00	35.52
	21490.0	-90.59	-103.654	50.000	-53.654	-13.00	40.65
8th	23440.0	-89.39	-102.454	65.150	-37.304	-13.00	24.30
	24080.0	-89.81	-102.874	63.070	-39.804	-13.00	26.80
	24560.0	-89.73	-102.794	60.590	-42.204	-13.00	29.20
9th	26370.0	-88.13	-101.194	59.450	-41.744	-13.00	28.74
	27090.0	-87.87	-100.934	44.890	-56.044	-13.00	43.04
	27630.0	-86.05	-99.114	47.290	-51.824	-13.00	38.82
10th	29300.0	-87.37	-100.434	78.200	-22.234	-13.00	9.23
	30100.0	-87.28	-100.344	82.780	-17.564	-13.00	4.56
	30700.0	-87.34	-100.404	78.070	-22.334	-13.00	9.33

UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 3, Spurious Conducted Emissions Plot



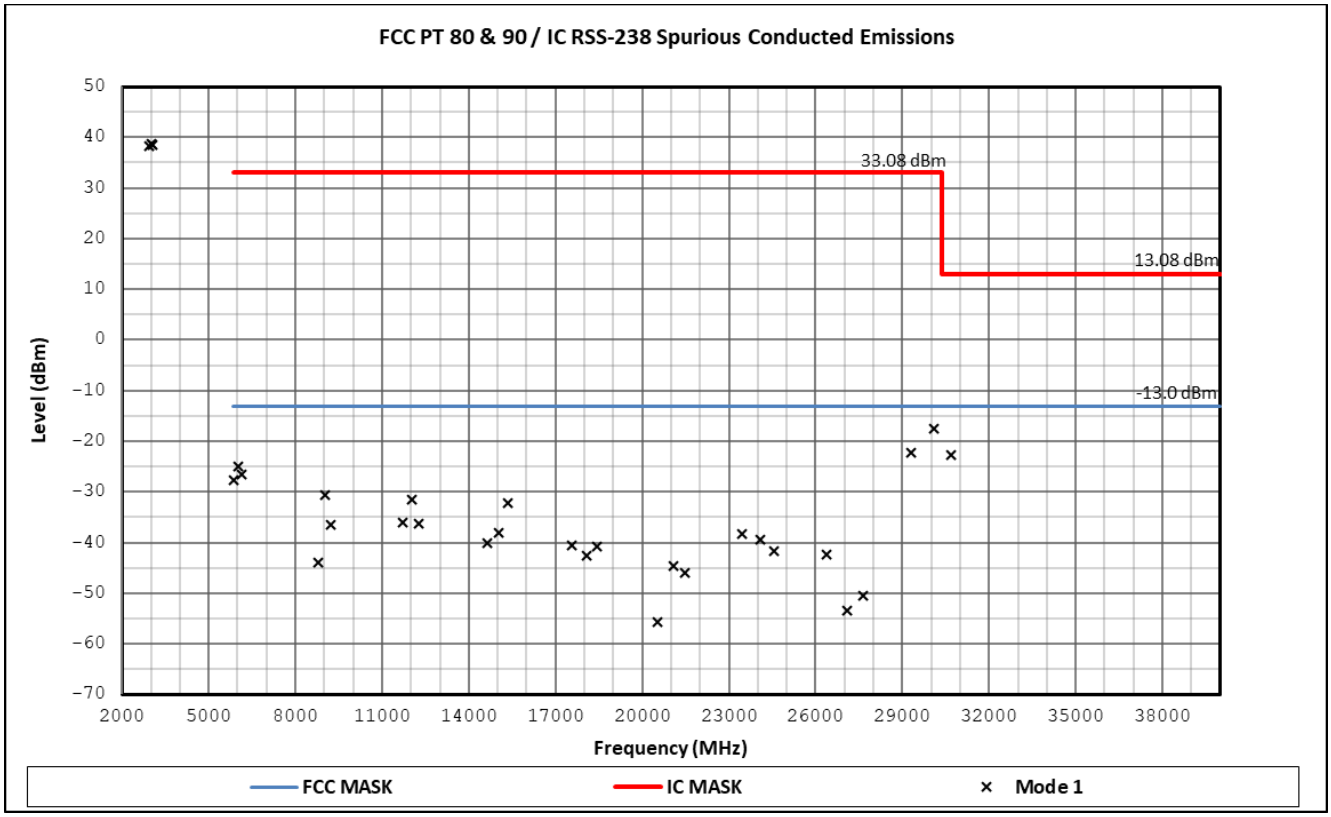
UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 3, Spurious Emission Measurement Table

Harmonic	Harmonic Frequency (MHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
2nd	5860.0	-66.90	-79.964	52.310	-27.654	-13.00	14.65
	6020.0	-66.13	-79.194	55.220	-23.974	-13.00	10.97
	6140.0	-67.09	-80.154	52.330	-27.824	-13.00	14.82
3rd	8790.0	-67.19	-80.254	36.220	-44.034	-13.00	31.03
	9030.0	-71.44	-84.504	54.110	-30.394	-13.00	17.39
	9210.0	-45.06	-58.124	21.710	-36.414	-13.00	23.41
4th	11720.0	-45.82	-58.884	22.800	-36.084	-13.00	23.08
	12040.0	-42.26	-55.324	23.870	-31.454	-13.00	18.45
	12280.0	-46.41	-59.474	23.200	-36.274	-13.00	23.27
5th	14650.0	-49.66	-62.724	22.700	-40.024	-13.00	27.02
	15050.0	-57.25	-70.314	31.870	-38.444	-13.00	25.44
	15350.0	-50.27	-63.334	31.030	-32.304	-13.00	19.30
6th	17580.0	-74.17	-87.234	46.420	-40.814	-13.00	27.81
	18060.0	-73.90	-86.964	45.160	-41.804	-13.00	28.80
	18420.0	-88.81	-101.874	60.290	-41.584	-13.00	28.58
7th	20510.0	-83.22	-96.284	40.620	-55.664	-13.00	42.66
	21070.0	-87.79	-100.854	55.920	-44.934	-13.00	31.93
	21490.0	-83.00	-96.064	50.000	-46.064	-13.00	33.06
8th	23440.0	-90.33	-103.394	65.150	-38.244	-13.00	25.24
	24080.0	-89.90	-102.964	63.070	-39.894	-13.00	26.89
	24560.0	-89.60	-102.664	60.590	-42.074	-13.00	29.07
9th	26370.0	-88.27	-101.334	59.450	-41.884	-13.00	28.88
	27090.0	-85.52	-98.584	44.890	-53.694	-13.00	40.69
	27630.0	-83.83	-96.894	47.290	-49.604	-13.00	36.60
10th	29300.0	-87.36	-100.424	78.200	-22.224	-13.00	9.22
	30100.0	-86.87	-99.934	82.780	-17.154	-13.00	4.15
	30700.0	-87.73	-100.794	78.070	-22.724	-13.00	9.72

UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 4, Spurious Conducted Emissions Plot



UNWANTED SPURIOUS EMISSIONS

Test Data: Mode 4, Spurious Emission Measurement Table

Harmonic	Harmonic Frequency (MHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
2nd	5860.0	-66.76	-79.824	52.310	-27.514	-13.00	14.51
	6020.0	-66.20	-79.264	55.220	-24.044	-13.00	11.04
	6140.0	-66.68	-79.744	52.330	-27.414	-13.00	14.41
3rd	8790.0	-67.69	-80.754	36.220	-44.534	-13.00	31.53
	9030.0	-73.68	-86.744	54.110	-32.634	-13.00	19.63
	9210.0	-50.31	-63.374	21.710	-41.664	-13.00	28.66
4th	11720.0	-53.46	-66.524	22.800	-43.724	-13.00	30.72
	12040.0	-49.91	-62.974	23.870	-39.104	-13.00	26.10
	12280.0	-48.73	-61.794	23.200	-38.594	-13.00	25.59
5th	14650.0	-52.69	-65.754	22.700	-43.054	-13.00	30.05
	15050.0	-66.32	-79.384	31.870	-47.514	-13.00	34.51
	15350.0	-53.43	-66.494	31.030	-35.464	-13.00	22.46
6th	17580.0	-73.83	-86.894	46.420	-40.474	-13.00	27.47
	18060.0	-74.23	-87.294	45.160	-42.134	-13.00	29.13
	18420.0	-91.01	-104.074	60.290	-43.784	-13.00	30.78
7th	20510.0	-84.72	-97.784	40.620	-57.164	-13.00	44.16
	21070.0	-88.59	-101.654	55.920	-45.734	-13.00	32.73
	21490.0	-89.36	-102.424	50.000	-52.424	-13.00	39.42
8th	23440.0	-89.66	-102.724	65.150	-37.574	-13.00	24.57
	24080.0	-89.88	-102.944	63.070	-39.874	-13.00	26.87
	24560.0	-89.47	-102.534	60.590	-41.944	-13.00	28.94
9th	26370.0	-88.77	-101.834	59.450	-42.384	-13.00	29.38
	27090.0	-86.69	-99.754	44.890	-54.864	-13.00	41.86
	27630.0	-87.25	-100.314	47.290	-53.024	-13.00	40.02
10th	29300.0	-87.61	-100.674	78.200	-22.474	-13.00	9.47
	30100.0	-87.05	-100.114	82.780	-17.334	-13.00	4.33
	30700.0	-87.71	-100.774	78.070	-22.704	-13.00	9.70

FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Part No.: Part 2.1053(a), 2.1057(a)(1), 80.211(f)(3), 90.210(n), (b)(3), RSS-238 s.4.3

Requirements:

§2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in §§2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

§80.211 Emission limitations.

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

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

§90.210 Emission masks.

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

(b) *Emission Mask B.* For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

4.3 Transmitter Unwanted Emissions

The unwanted emission and the transmitter power shall be measured using a peak detector.

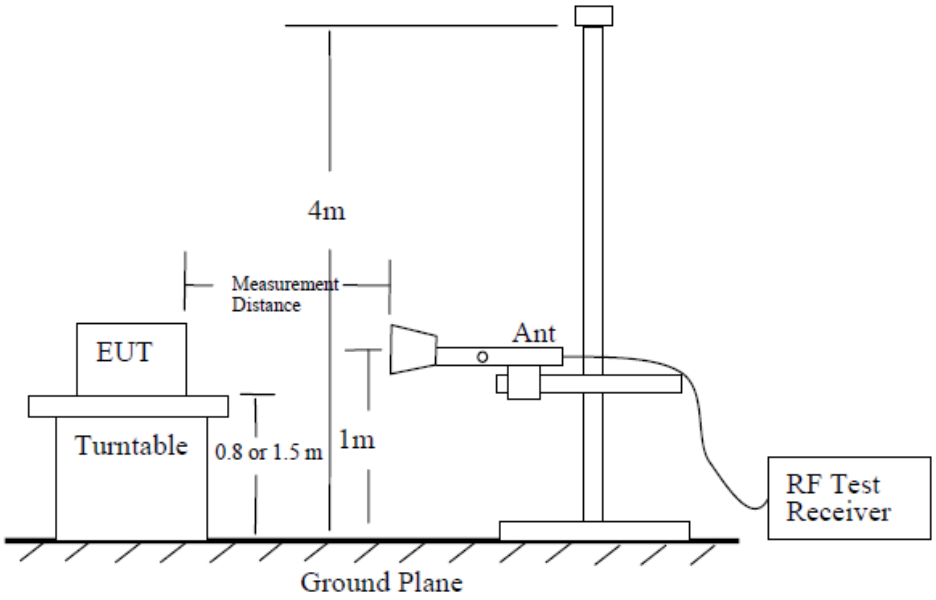
The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40 dB bandwidth and beyond.

The unwanted emissions power shall not need to be attenuated more than 60 dB below the transmitter peak power.

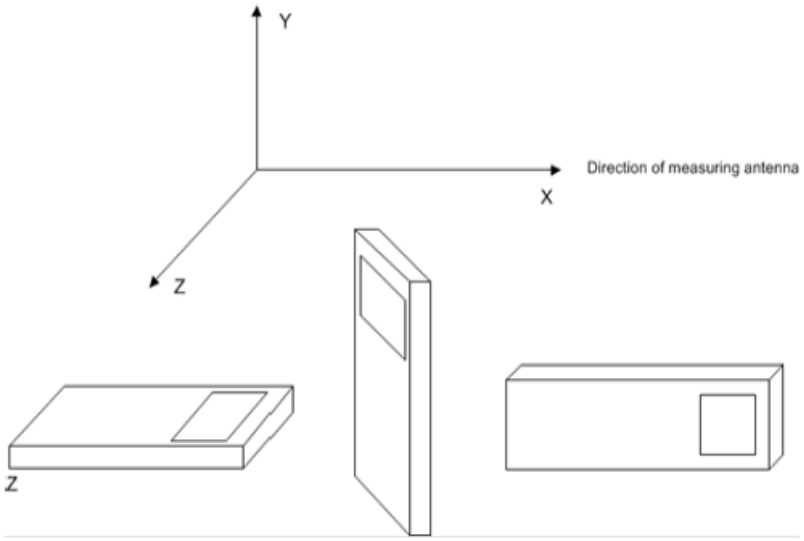
Test Procedure: ANSI C63.26, 5.5.4; ITU-R M.1177-4, ANNEX 1

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Site Setup:



EUT Orientation(s):



FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Procedure: TIA 603-E, 2.2.13; ITU-R M.1177-4, Annex 1

2 Reference bandwidth

For radar systems, the reference bandwidth, B_{ref}, used to define unwanted emission limits (Recommendations ITU-R SM.329 and ITU-R SM.1541, and RR Appendix 3) should be calculated for each particular radar system. For the four general types of radar pulse modulation utilized for radionavigation, radiolocation, acquisition, tracking and other radiodetermination functions, the reference bandwidth values are determined using the following formulas:

– for FM or chirped radar, the square root of the quantity obtained by dividing the chirp bandwidth (MHz) by the pulse length (μs) (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10 μs, then the reference bandwidth is $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73\ \text{MHz}$);

In all cases, where the bandwidths above are greater than 1 MHz, then a reference bandwidth, B_{ref}, of 1 MHz should be used.

3 Measurement bandwidth and detector parameters

The measurement bandwidth, B_m, is defined as the impulse bandwidth of the receiver and is greater than the IF bandwidth, B_{if}, (sometimes referred to as resolution bandwidth for spectrum analyzers). The measurement bandwidth, B_m, may be derived from the following equation:

$$B_m = B_{if} \times MBR$$

The MBR needs to be determined for the measurement receiver being used. MBR is approximately 3/2 for a –3 dB IF bandwidth Gaussian filter as typically used in many commercial spectrum analyzer receivers (in some instruments the IF bandwidth is defined at the –6 dB point).

An appropriate receiver IF bandwidth should be selected to give one of the following recommended measurement bandwidths.

Measurement bandwidth B_m[1]	≤	$(B_c/T)^{1/2}$ for swept-frequency (FM, or chirp) radars, where B_c is the range of frequency sweep during each pulse and T is the pulse length (e.g. if radar sweeps (chirps) across the frequency range of 1 250-1 280 MHz (= 30 MHz of spectrum) during each pulse, and if the pulse length is 10 μs, then the measurement bandwidth should be $\leq ((30\ \text{MHz})/(10\ \mu\text{s}))^{1/2} = \sqrt{3}\ \text{MHz} \approx 1.73\ \text{MHz}$. In accordance with footnote [1] a measurement bandwidth close to but less than or equal to 1 MHz should be used in this example.
Video bandwidth	≥	measurement system bandwidth.
Detector		positive peak.

[1] In all cases, if the above derived measurement bandwidth is greater than 1 MHz, then the corrections described in § 3.2 should be used.

FIELD STRENGTH OF SPURIOUS EMISSIONS

3.2 Measurements within the spurious domain

3.2.1 Correction of the measurement within the spurious domain

Where the measurement bandwidth, B_m, differs from the reference bandwidth, B_{ref}, a correction factor needs to be applied to the measurements conducted within the spurious domain to express the results in the reference bandwidth. Then the following correction factor should be applied:

$$\text{Spurious level, } B_{ref} = \text{Spurious level (measured in } B_m) + 10 \times \log(B_{ref}/B_m)$$

NOTE 1 – This correction factor should be used except where it is known that the spurious is not noise-like, where a factor between 10 and 20 $\log(B_{ref}/B_m)$ may apply and may be derived by measurements in more than one bandwidth. In all cases the most precise result will be obtained using a measurement bandwidth (B_m) equal to the reference bandwidth. For radars operating above 1 GHz the reference bandwidth (B_{ref}) is 1 MHz.

Bandwidth Compensation Calculation Table

Mode	Occupied Bandwidth		99% Bref (MHz)		40dB Bref (MHz)		MBR (MHz)	Bm (MHz)	Spurious Noise Correction (dBm)	Spurious Emissions Correction (dBm)
	99% (MHz)	40 dB (MHz)	(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bif x MBR = Bm (MHz)	If Bm > 1, 10 x Log(Bref/Bm)	If Bm > 1, 20 x Log(Bref/Bm)
3	7.692	61.859	19.61	1.00	316.86	1.00	1.50	4.50	-6.53	-13.06

Limit Calculation Part 80.211(f)(3)

43 + 10 x Log(Power, in Watts)

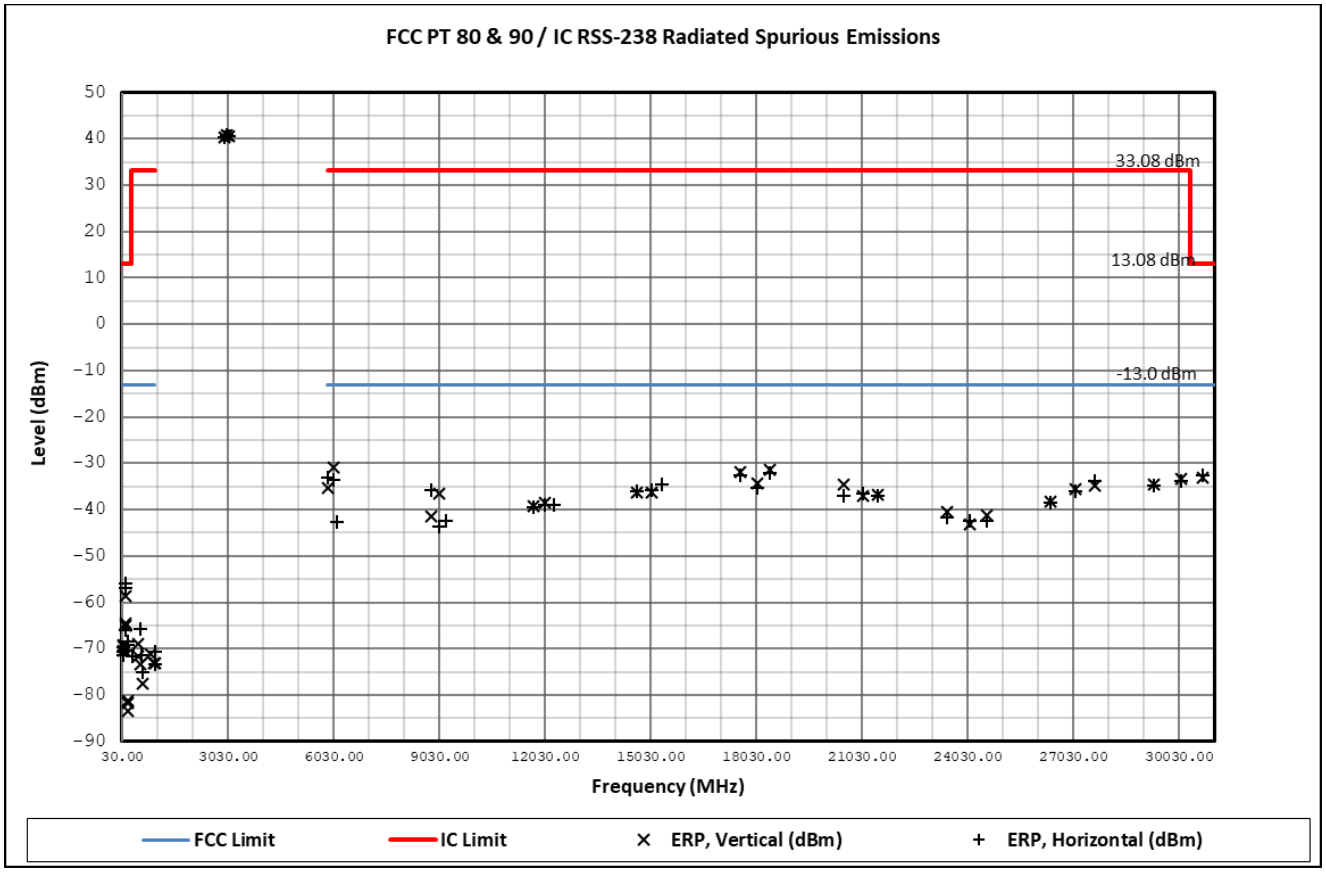
Mode	Maximum Mean Power Output (W)	Relative Limit (dBc)	Absolute Limit (dBm)
3	11.72	53.69	-13.00

Note: The data shows the results of the radiated field strength emissions test. The spectrum was scanned from the lowest frequency generated internally to the tenth harmonic of the fundamental frequency or 40 GHz, whichever is less. This test was conducted in accordance with the referenced standards. Measurements were made at the test site of TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669. The measurements below represent the worst case of all the frequencies tested.

Worst-case Mode of Operation to be Investigated = **Test Mode 3**

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Radiated Spurious Emissions Plot



Note: All recorded data was plotted. Six (6) or more of the highest emissions of the worst-case operational mode of the EUT are represented below in tabular format. Emissions 20 dB below the limit are not required to be reported.

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Radiated Spurious Emissions Table

Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	ERP (dBm)	Bandwidth Correction (dBm)	Limit (dBm)	Margin (dBm)
2930	17580.00	21.42	V	14.80	42.38	3.00	78.60	-18.78	-31.84	-13.00	18.84
2930	17580.00	20.58	H	14.80	42.38	3.00	77.76	-19.62	-32.68	-13.00	19.68
2930	5860.00	34.09	H	8.39	34.97	3.00	77.45	-19.93	-32.99	-13.00	19.99
2930	20510.00	15.27	V	16.29	44.38	3.00	75.94	-21.43	-34.49	-13.00	21.49
2930	29300.00	10.45	V	19.00	46.46	3.00	75.91	-21.47	-34.53	-13.00	21.53
2930	29300.00	10.23	H	19.00	46.46	3.00	75.69	-21.69	-34.75	-13.00	21.75

Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	ERP (dBm)	Bandwidth Correction (dBm)	Limit (dBm)	Margin (dBm)
3010	6020.00	35.72	V	8.65	35.15	3.00	79.52	-17.86	-30.92	-13.00	17.92
3010	30100.00	10.84	V	19.87	46.32	3.00	77.03	-20.35	-33.41	-13.00	20.41
3010	6020.00	33.14	H	8.65	35.15	3.00	76.94	-20.44	-33.50	-13.00	20.50
3010	30100.00	10.45	H	19.87	46.32	3.00	76.64	-20.74	-33.80	-13.00	20.80
3010	18060.00	15.86	V	15.45	44.73	3.00	76.04	-21.34	-34.40	-13.00	21.40
3010	18060.00	14.99	H	15.45	44.73	3.00	75.17	-22.21	-35.27	-13.00	22.27

Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	ERP (dBm)	Bandwidth Correction (dBm)	Limit (dBm)	Margin (dBm)
3070	18420.00	19.01	V	15.38	44.74	3.00	79.13	-18.25	-31.31	-13.00	18.31
3070	18420.00	18.08	H	15.38	44.74	3.00	78.20	-19.18	-32.24	-13.00	19.24
3070	30700.00	10.75	H	20.14	46.84	3.00	77.73	-19.64	-32.70	-13.00	19.70
3070	30700.00	10.36	V	20.14	46.84	3.00	77.34	-20.03	-33.09	-13.00	20.09
3070	27630.00	10.68	H	19.28	46.68	3.00	76.64	-20.74	-33.80	-13.00	20.80
3070	15350.00	20.71	H	14.13	41.07	3.00	75.91	-21.47	-34.53	-13.00	21.53

FREQUENCY STABILITY

Rule Part No.: Part 2.1055(a)(2), 80.209(b), 90.213(a)

§80.209 Transmitter frequency tolerances.

(b) When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where "T" is the pulse duration in microseconds. In the band 14.00-14.05 GHz the center frequency must not vary more than 10 MHz from 14.025 GHz.

§90.213 Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

MINIMUM FREQUENCY STABILITY

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Above 2450[10]			

[10]Except for DSRCS equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850-5925 MHz band is specified in subpart M of this part.

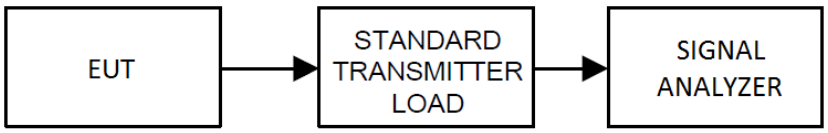
IC Rule Part No.: RSS-238 s.4.1

4.1 Frequency Stability

The carrier frequency shall not depart from the reference frequency in excess of 800 ppm for equipment which operates in the band 2900-3100 MHz nor in excess of 1250 ppm for equipment which operates in the band 9225-9500 MHz.

Test Procedure: TIA 603-E, 2.2.2

Test Setup Block Diagram:

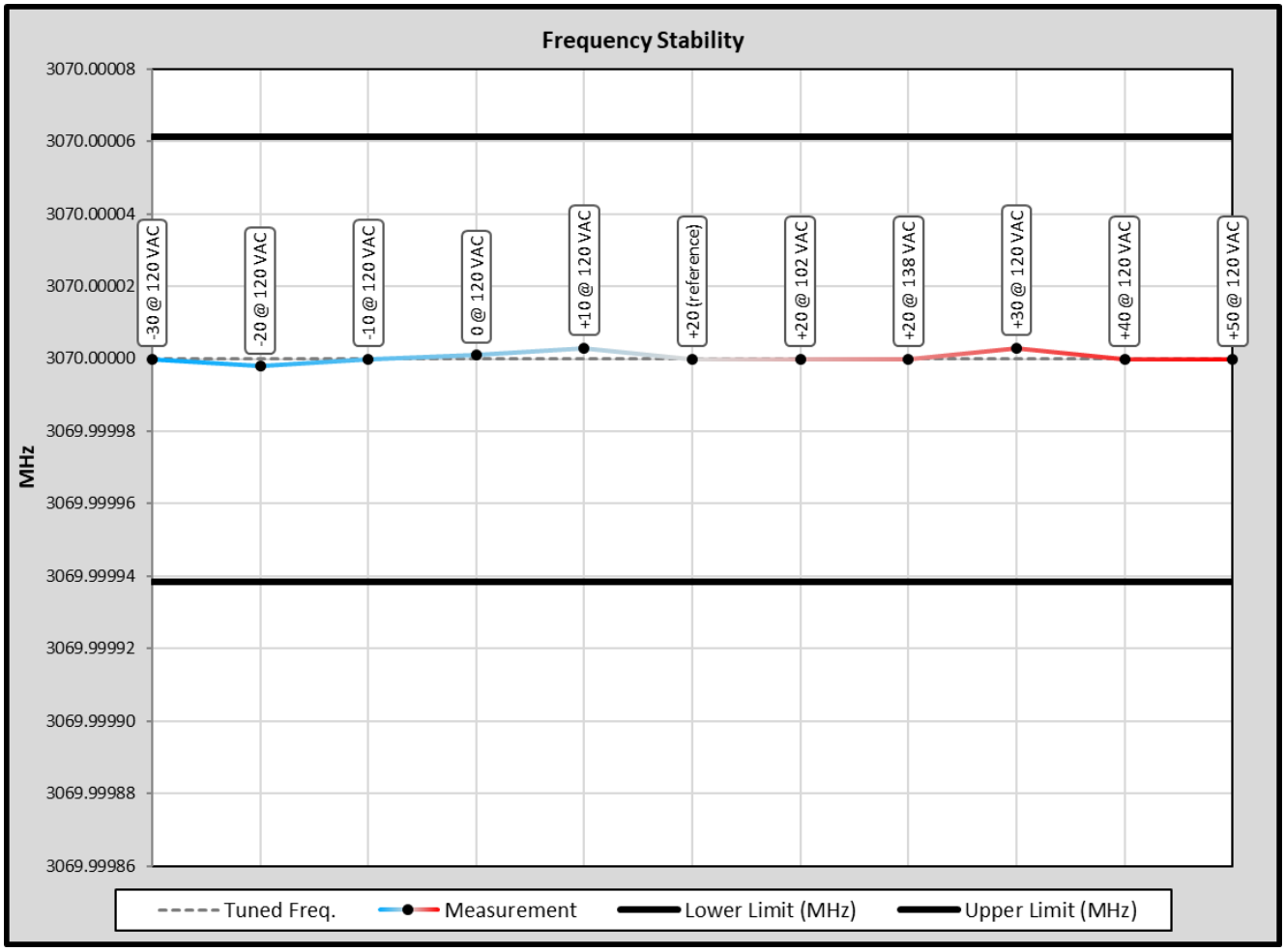


Test Data: Frequency Stability Calculation

T Max Pulse (µS)	80.209(b) Limit (MHz) = 1.5 / T	Part 80 Max Authorized BW (MHz) = Max 99% OBW	Part 80 Freq. Stability (MHz) = ABW - (2*Limit)	Lowest Tx Frequency (MHz)	80.209(b) Limit (ppm) = FS / Tx	RSS-238 4.1 Limit (ppm)
30	0.05	62.18	62.08	2930	0.021	800.000

FREQUENCY STABILITY

Test Data: Frequency Error Measurement Plot



FREQUENCY STABILITY

Test Data: Frequency Error Measurement Table

	Limit (ppm)	0.02	
	Limit (Hz)	61.400	
	Lower Limit (MHz)	3069.999939	
	Upper Limit (MHz)	3070.000061	
	Rated Supply Voltage	120.0	(•) AC ( ) DC
Temperature / Voltage Variation			
Temperature (°C)	**Supplied Voltage (V)**	**Frequency (MHz)**	**Deviation (kHz)**
-30	120.0	3070.000000	0.000
-20	120.0	3069.999998	0.002
-10	120.0	3070.000000	0.000
0	120.0	3070.000001	-0.001
+10	120.0	3070.000003	-0.003
+20 (reference)	120.0	3070.000000	0.000
+20	102.0	3070.000000	0.000
+20	138.0	3070.000000	0.000
+30	120.0	3070.000003	-0.003
+40	120.0	3070.000000	0.000
+50	120.0	3070.000000	0.000

STATEMENT OF MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: "Uncertainty in EMC Measurements" and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	Notes
RF Frequency Accuracy	±49.5 Hz	(1)
RF Conducted Power	±0.93dB	(1)
Conducted spurious emission of transmitter to 40GHz	±1.86dB	
Occupied Bandwidth	±2.65%	
Radiated RF Power	±1.4dB	
Rad Emissions of transmitter up to 26.5GHz	±2.14dB	
Rad Emissions of transmitter to 40GHz	±2.36dB	
Temperature	±1.0°C	(1)
Humidity	±5.0%	

Note: (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Antenna: Biconical 1096	Eaton	94455-1	1096	08/01/17	08/01/19
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/26/17	07/26/19
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	09/01/16	09/01/19
RF Lambda Pre-Amplifier	RF-LAMBDA	RLNA00M45GA	NA	02/27/19	02/27/21
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 KMKM-0670-01 KFKF-0197-00	02/27/19	02/27/21
CHAMBER	Panashield	3M	N/A	12/31/17	12/31/19
Antenna: Double-Ridged Horn/ETS Horn 1	ETS-Lindgren	3117	00035923	01/30/17	01/30/20
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
Type K J Thermometer	Martel	303	080504494	11/02/17	11/02/19
EMI Test Receiver R & S ESU 40	Rohde & Schwarz	ESU 40	100320	08/28/18	08/28/20
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	N/A	N/A
Terminator N 20W DC-18G	Narda	8205	#14	N/A	N/A
High Pass Filter 18GHz	Micro-Tronics	HPS18771	-002	05/13/18	05/13/20
Antenna: Double-Ridged Horn 18-40 GHz	EMCO	3116	9011-2145	12/08/17	12/08/19
Coaxial Cable - KMKM-0180-00 Aqua	Micro-Coax	N/A	KMKM-0180-00	04/03/19	04/03/21
Coaxial Cable - KMKM-0180-01 Aqua	Micro-Coax	N/A	KMKM-0180-01	04/03/19	04/03/21
Coaxial Cable - SMSM-0019-00 Black	N/A	N/A	SMSM-0019-00	04/03/19	04/03/21
Adapter Waveguide WR-28 to Waveguide WR-90	ATM	28/90-8-6-6	S539708-01	N/A	N/A
Adapter Waveguide WR-28 to Coax K	ATM	28-25KZA-6	S539908-01	N/A	N/A
Adapter Waveguide WR-42 to Waveguide WR-90	ATM	42/90-8-6-6	S539408-01	N/A	N/A
Adapter Waveguide WR-42 to Coax K	ATM	42-25KA-6	S539508-01	N/A	N/A
Adapter Waveguide WR-62 to Waveguide WR-90	ATM	62/90-6-6-6	S539608-01	N/A	N/A
Adapter Waveguide WR-62 to Coax SMA	ATM	62-251A-6	S539808-01	N/A	N/A
Adapter WR-90 to SMA	Pasternack	PE9804	N/A	N/A	N/A
Load WR-90 90W	Pasternack	PE6824	N/A	N/A	N/A
Antenna: Double-Ridged Horn 18-40 GHz	EMCO	3116	9011-2145	12/08/17	12/08/19
Terminator N 20W DC-18G	Narda	8205	#14	N/A	N/A
Attenuator N 30dB 100W DC-6G	Pasternack	PE7214-30	#109	05/24/17	05/23/19
Attenuator N 20dB 20W DC-12G	Narda	768-20-SP	344	07/10/17	07/10/19
Attenuator N 30dB 100W DC-6G	Pasternack	PE7214-30	#109	05/24/17	05/24/19
HP Directional Coupler	HP	X752D	1829A24209	N/A	N/A

***EMI RECEIVER SOFTWARE VERSION**

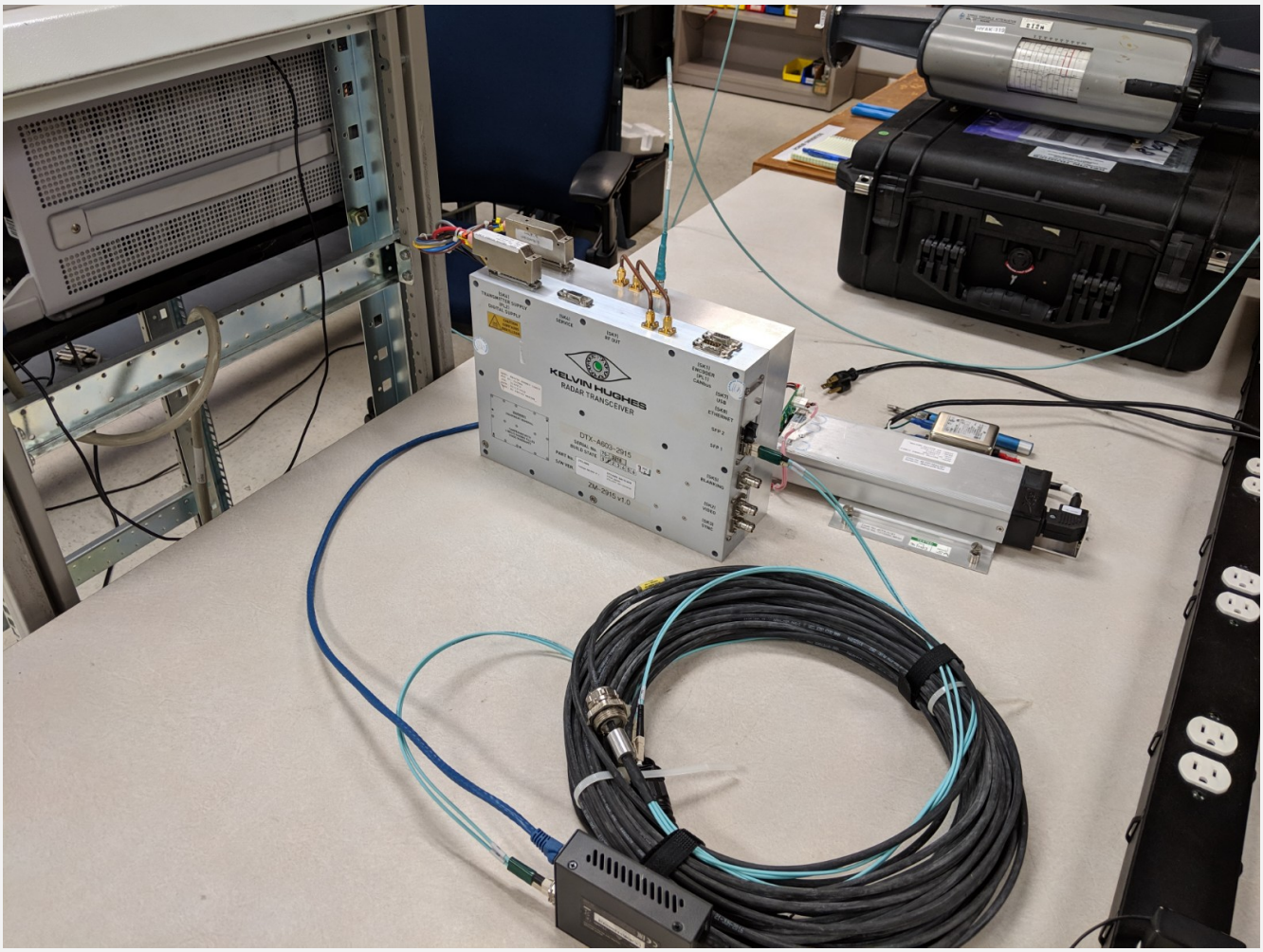
The receiver firmware used was version 4.43 Service Pack 3

END OF REPORT

Document Name	Description of Change	Revision Date	Approved By
PT 80 Rpt	Initial Issue		SS Sanders
	Added Document History to Template		G Greene
	Added Uc Table	170508	Cory Leverett
S-Band Radar Part 80, 90, & ISED RSS-238 Report	Overhauled Report	05/02/2019	Franklin Rose

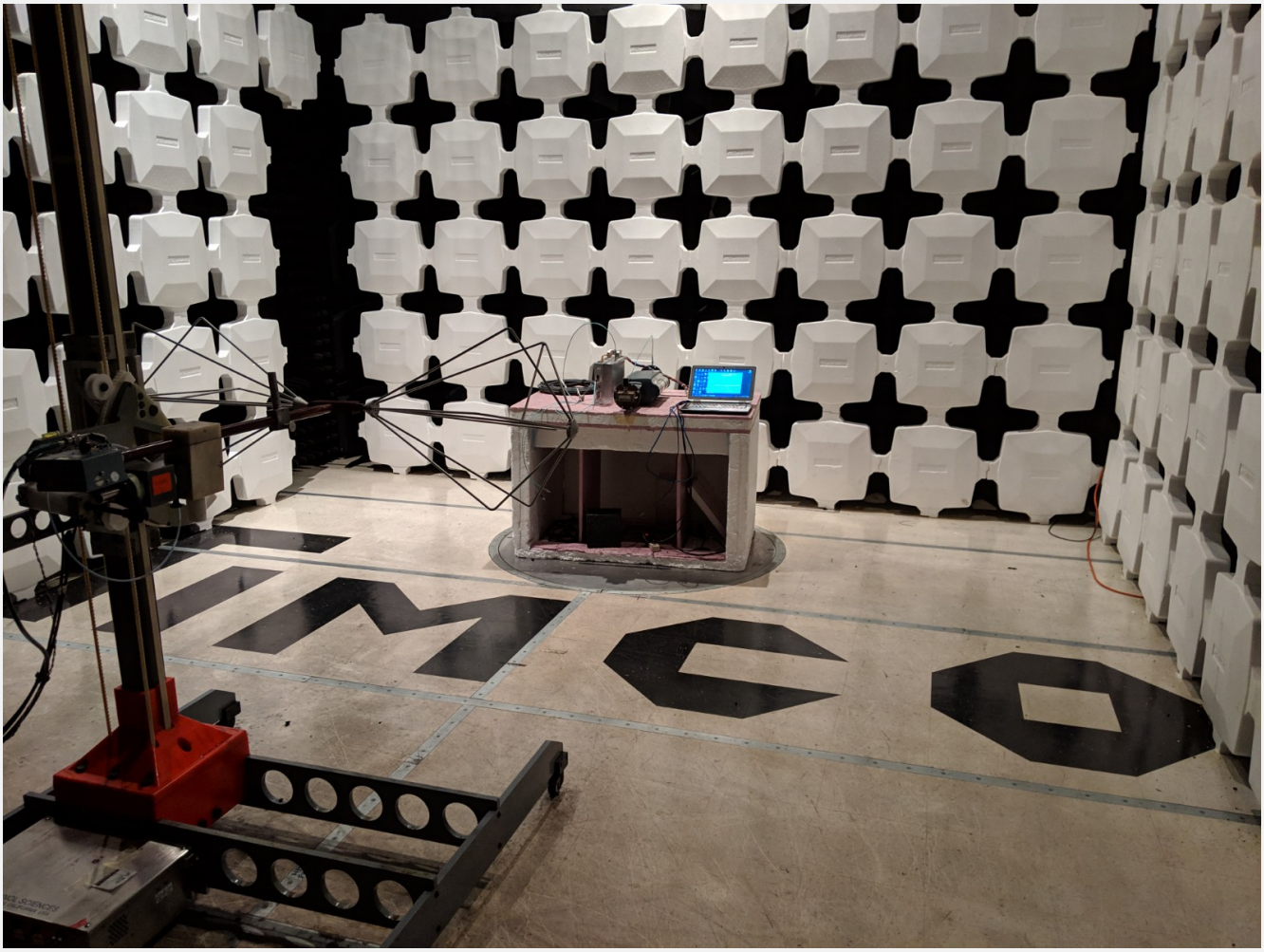
TEST SETUP PHOTOGRAPHS

Applicant: **KELVIN HUGHES LIMITED**
FCC ID: CICIDTX-A603-SF
IC: 1493A-DTXA603SF

Conducted Measurements: Table Setup


TEST SETUP PHOTOGRAPHS

Field Strength of Spurious Emissions 30 MHz to 200 MHz (Biconical Antenna)

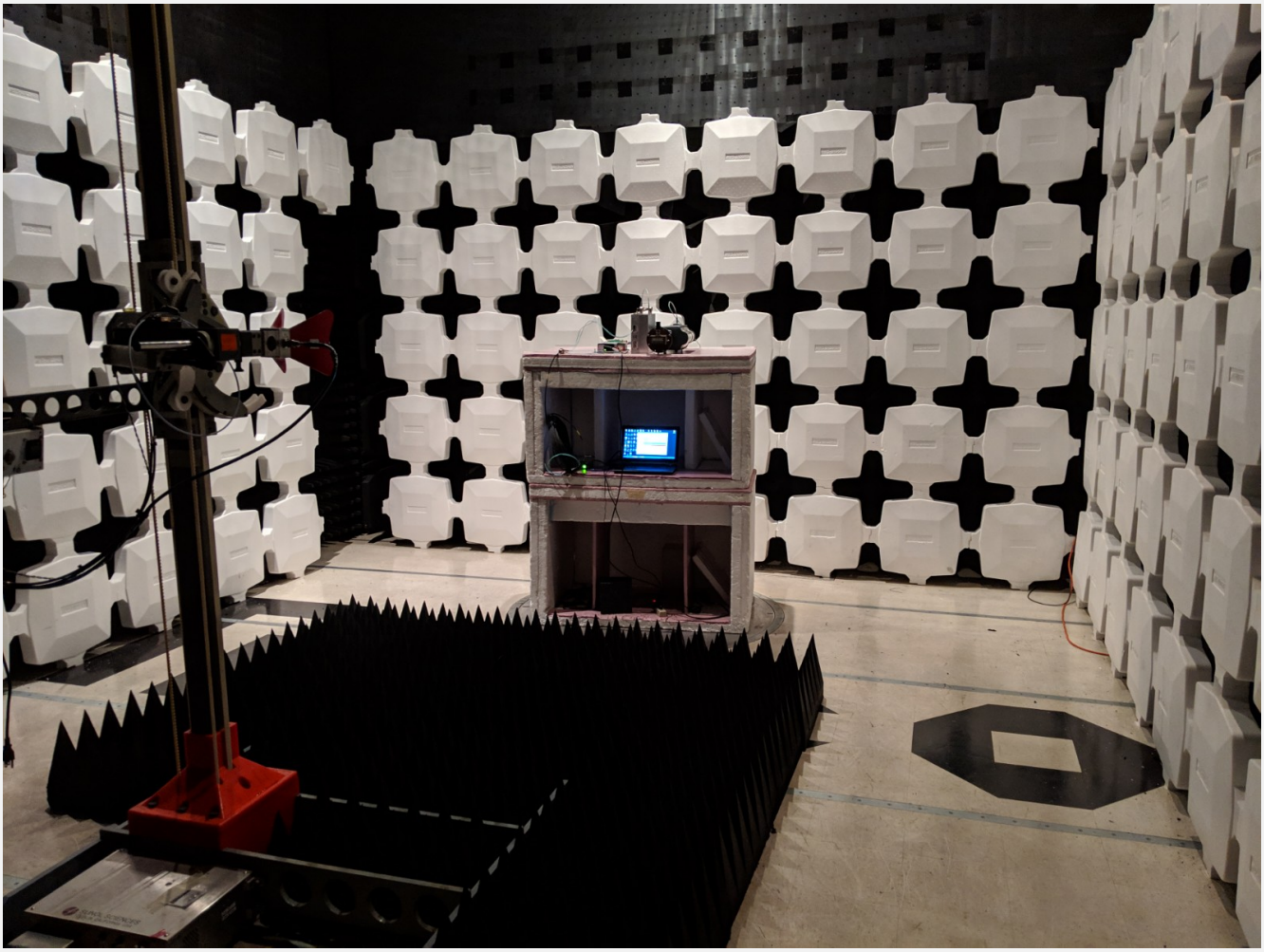


TEST SETUP PHOTOGRAPHS

Field Strength of Spurious Emissions 200 MHz to 1 GHz (Log Periodic Antenna)

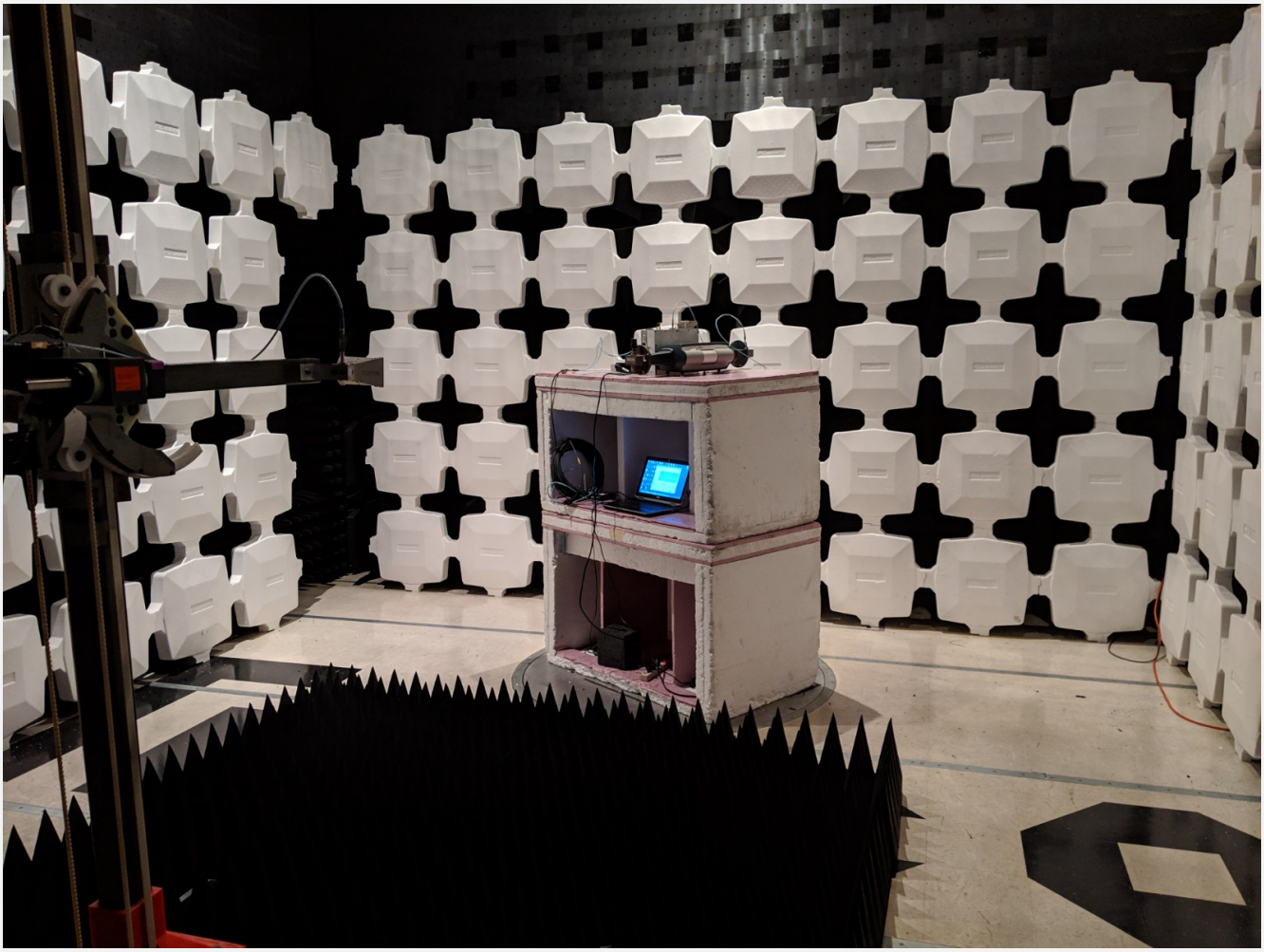
TEST SETUP PHOTOGRAPHS

Field Strength of Spurious Emissions 1 – 18 GHz (Dual Ridge Waveguide Antenna)



TEST SETUP PHOTOGRAPHS

Field Strength of Spurious Emissions > 18 GHz (Double Ridge Horn Antenna)



TEST SETUP PHOTOGRAPHS

Frequency Stability