849 NW STATE ROAD 45
NEWBERRY, FL 32669 USA

PHONE: 352.472.5500
EMAIL: INFO@TIMCOENGR.COM
WEB: HTTP://WWW.TIMCOENGR.COM

TIMCO ENGINEERING, Inc.

An IIA Company

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

APPLICANT	NAVICO INC.
ADDRESS	4500 S. 129TH EAST AVENUE SUITE 200 TULSA OK 74134-5885 USA
FCC ID	RAYHALO20PLUS
IC	978B-HALO20PLUS
MODEL NUMBER	Halo20+
PRODUCT DESCRIPTION	RADAR
DATE SAMPLE RECEIVED	07/17/2019
FINAL TEST DATE	07/23/2019
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
1833AUT19TestReport_	Rev1	Initial Issue	07/23/2019
1833AUT19TestReport_	Rev2	Clerical Updates. Updated Pulse Data	10/17/2019

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

Tested by:

Name and Title	Franklin Rose, Project Manager / EMC Specialist
Date	07/23/2019

Reviewed and Approved by:

Name and Title	Tim Royer, Project Manager / EMC Testing Engineer
Date	07/23/2019

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	RADAR		
FCC ID	RAYHALO20PLUS		
IC	978B-HALO20PLUS		
Model Number	Halo20+		
Operating Band(s)	Band 1: 9.3 – 9.5 GHz		
FCC Emission Designator	100MPON		
Measurement Method	99% Occupied Bandwidth		
IC Emission Designator	180MPON		
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	Type N		
Modification to the EUT	The EUT was tested without the rotational antenna, using an N-type connector for conducted power output measurement.		
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, IC: US0111, 2056A		

GENERAL INFORMATION

Operating Frequencies

Band 1: Band 1: 9.3 – 9.5 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	
9300 to 9500	.....do	10, 15, 18

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

(15) The non-Government Radiolocation Service in this band is secondary to the Maritime Radionavigation Stations (part 80), the Aeronautical Radionavigation Service (part 87) and the Government Radiolocation Service.

(18) Radiolocation installations will be coordinated with the Government Meteorological Aids Service, and insofar as practicable, will be adjusted to meet the needs of that service.

GENERAL INFORMATION

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.

Operating Modes

The EUT operates in the following modes. For the sake of brevity, the modes are also referred to using an alternate name. Based on the technical operation of the radar system, the modes have been divided according to their pulse widths into the modes, below:

Mode Name	Alternate Name	Test Mode
< 400 ft.	< 0.0625 nm	
1/8 Nautical Mile	0.125 nm	1
1/4 Nautical Mile	0.25 nm	
1/2 Nautical Mile	0.5 nm	2
3/4 Nautical Mile	0.75 nm	
1 Nautical Mile	1 nm	
1.5 Nautical Mile	1.5 nm	3
2 Nautical Mile	2 nm	
3 Nautical Mile	3 nm	4
4 Nautical Mile	4 nm	
6 Nautical Mile	6 nm	5
8 Nautical Mile	8 nm	
12 Nautical Mile	12 nm	
16 Nautical Mile	16 nm	6
24 Nautical Mile	24 nm	
36 Nautical Mile	≥ 36 nm	7

SUMMARY OF TESTING

FCC Rule Part No.	ISED Rule Part No.	Test 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

FCC Rule Parts: 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 of EUT = **100 MHz**
Emission Designation: **100MP0N**

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

ISED Bandwidth

Worst-case 40 dB-down Occupied Bandwidth: **179.81 MHz**
Emission Designation: **180MP0N**

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

PULSE CHARACTERISTICS

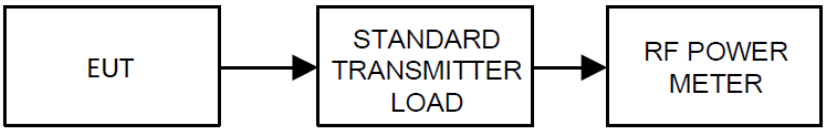
Rule Part No.: RSS-238 s.3.2(a)

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;

Test Setup Block Diagram:



Test Data: Pulse Measurement Table

The EUT employs 16 operational modes, each consisting of a fixed array of pulses from among 7 pulse types, P1 – P7.

Pulse Name	Width (µs)	Approximate Rise Time (µs)	Peak Power (dBm)
P1	1.590	0.2	42.56
P2	7.019	1.0	42.40
P3	14.075	1.0	42.30
P4	27.849	2.0	42.20
P5	36.280	5.0	42.93
P6	55.540	5.0	42.05
P7	55.540	5.0	42.05

PULSE TRAIN 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;

Test Data: Pulse Train Measurement Table

Operating Mode	Pulse Train	Total Pulse Width (µs)	Rep Rate (µs)	Duty Cycle (%)
1/8 nm	P1	1.590	1109.0	0.143%
1/4 nm	P1-P2	8.609	1025.0	0.840%
1.5 nm	P1-P3	22.684	1032.0	2.198%
3 nm	P1-P4	50.533	1060.0	4.767%
6 nm	P1-P5	86.813	1045.0	8.307%
16 nm	P1-P4, P6	106.073	1110.0	9.556%
36 nm	P1-P4, P7	106.073	1230.0	8.624%

Worst-case Pulse Width = **106.073 µs**

Worst-case Duty Cycle = **9.556 %**

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

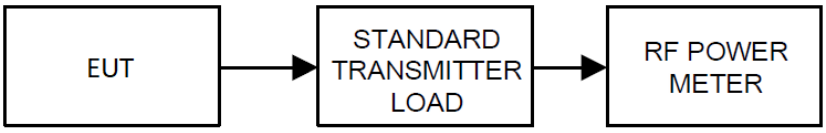
The mean power was calculated based on formula:

Pa = Pm * DC

Where:

Pa	Mean linear power in Watts (W)
Pm	Peak linear power in Watts (W)
DC	Duty Cycle (numeric)

Test Setup Block Diagram:



RF POWER OUTPUT

Test Data: Power Measurement Table

Mode	Peak Frequency (MHz)	Pulse Length (µs)	Pulse Repetition Period (µs)	Duty Cycle (%)	Mean Output Power (dBm)	Loss (dB)	Total Mean Power Output (dBm)	Mean Power Output (W)	Peak Power Output (dBm)	Peak Power Output (W)
0.125 nm	9299.29	1.59	1109	0.143%	-36.04	50.160	14.12	0.03	42.56	18.03
0.25 nm	9405.00	8.609	1025	0.840%	-28.36	50.160	21.80	0.15	42.56	18.03
1.5 nm	9453.55	22.684	1032	2.198%	-24.18	50.160	25.98	0.40	42.56	18.03
3 nm	9434.32	50.533	1060	4.767%	-20.82	50.160	29.34	0.86	42.56	18.03
6 nm	9434.40	86.813	1045	8.307%	-18.04	50.160	32.12	1.63	42.93	19.63
16 nm	9433.98	106.073	1110	9.556%	-17.80	50.160	32.36	1.72	42.56	18.03
36 nm	9433.98	106.073	1230	8.624%	-18.24	50.160	31.92	1.55	42.56	18.03

Maximum Peak Power: **19.63 W**

Maximum Mean Power: **1.72 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: (12 VDC) (2.5 A) = **30 Watts**

INPUT POWER: (24 VDC) (1.5 A) = **30 Watts**

OCCUPIED BANDWIDTH & EMISSION MASK

99% Occupied Bandwidth Rule Parts

FCC Rule Parts: 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).

OBW & EMISSION MASK

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.

OBW & EMISSION MASK

Emission Mask Rule Parts

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

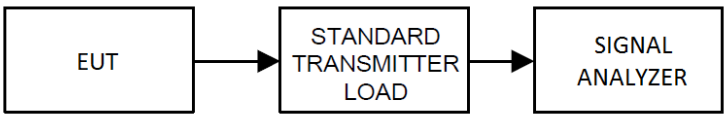
The unwanted emission and the transmitter power shall be measured using a peak detector.

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:



OBW & EMISSION MASK

Test Data: Occupied Bandwidth Measurement Table

Mode	Center Freq (MHz)	99% OBW (MHz)	40 dB OBW (MHz)
0.125 nm	9299.290	71.79	179.81
0.25 nm	9.405	37.17	83.01
1.5 nm	9453.550	65.38	112.01
3 nm	9434.320	62.98	109.61
6 nm	9434.400	92.78	125.00
16 nm	9433.980	97.11	128.36
≥ 36 nm	9433.980	100.00	120.77

Max 99% Occupied Bandwidth of EUT = **100 MHz**

FCC Emission Designator = **100MP0N**

Max 40dB Occupied Bandwidth of EUT = **179.81 MHz**

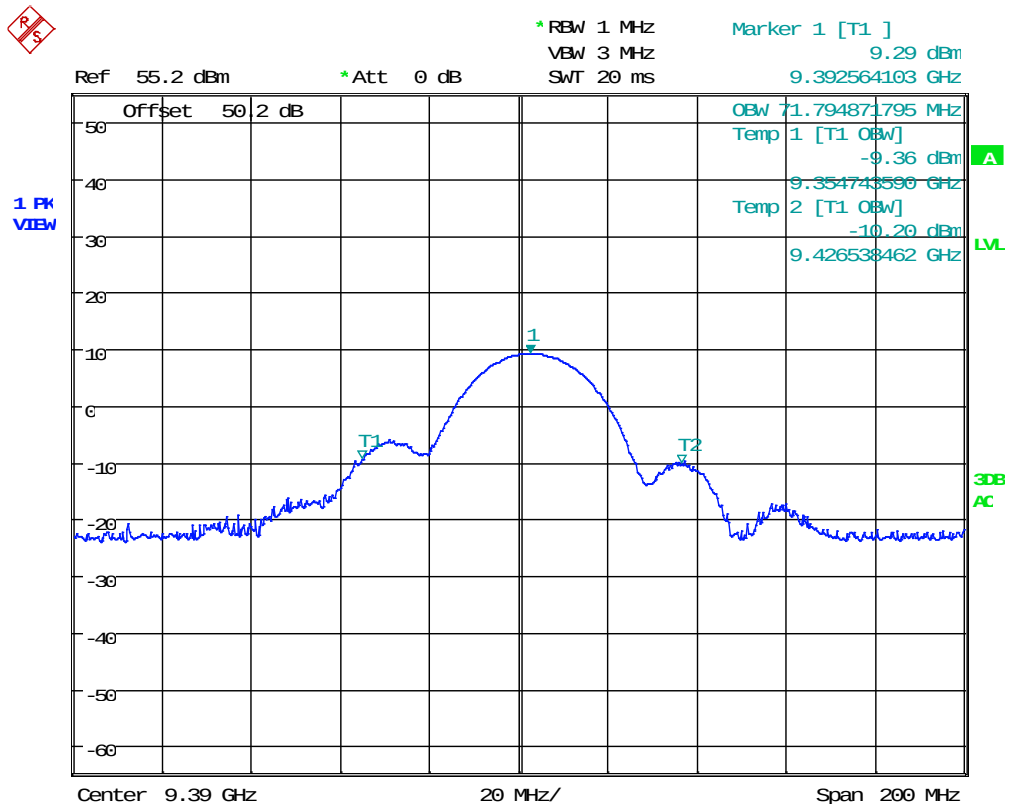
ISED Emission Designator = **180MP0N**

OBW & EMISSION MASK

Note: OBW and Emission Mask plots are compatible, and the data has been combined in the plots below.
Note: The FCC Emission Mask and the ISED Emission Mask are shown simultaneously in the plots below, to demonstrate compliance.

99% OBW & EMISSION MASK

Test Data: 1/8 Nautical Mile Mode 99% OBW Plot

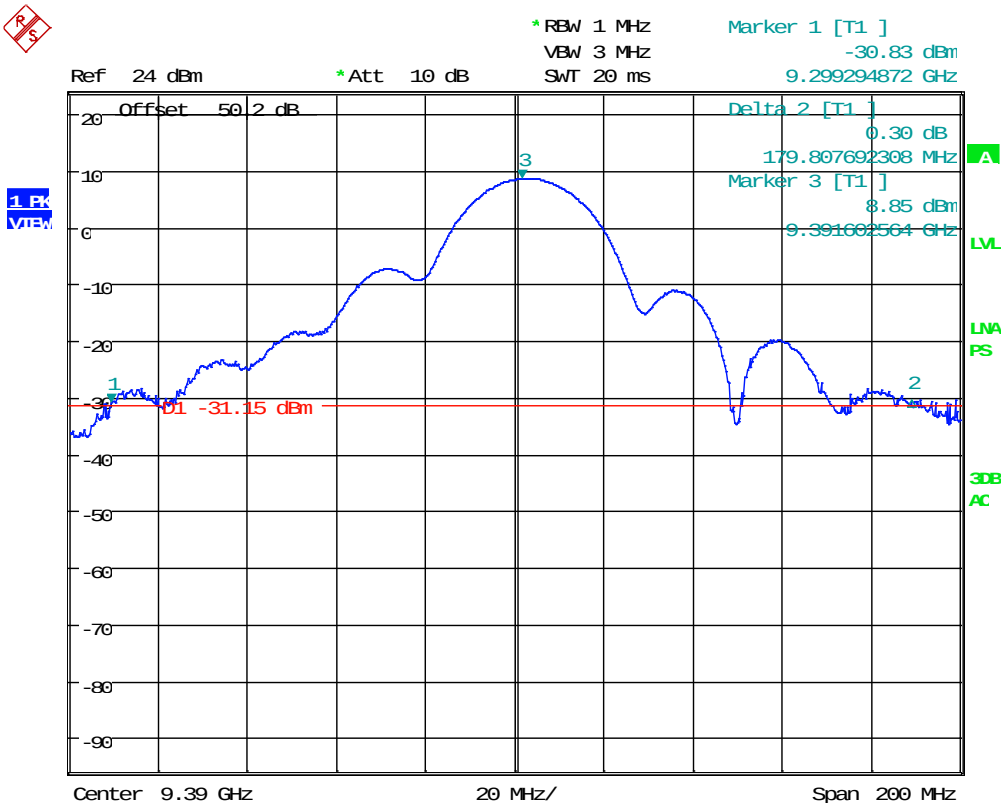


Date: 18.JUL.2019 17:59:47

1/8 Nautical Mile Mode 99% OBW = **71.79 MHz**

40 dB OBW & EMISSION MASK

Test Data: 1/8 Nautical Mile Mode 40 dB OBW Plot

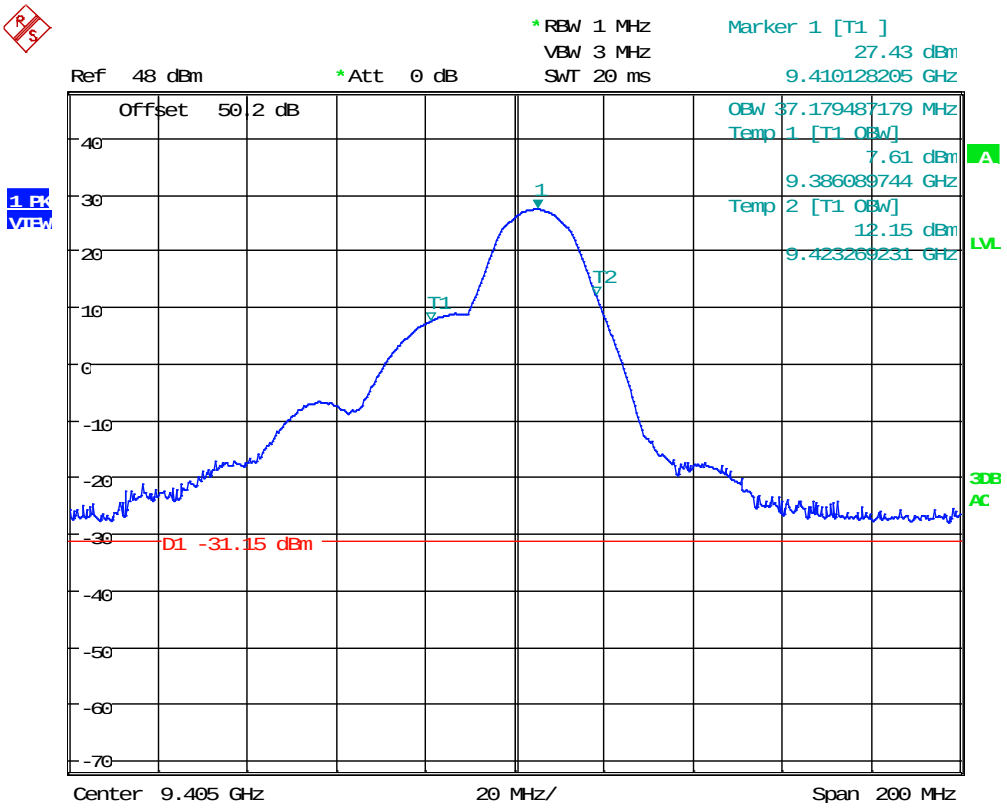


Date: 18.JUL.2019 18:04:29

1/8 Nautical Mile Mode 40 dB OBW = **179.8 MHz**

99% OBW & EMISSION MASK

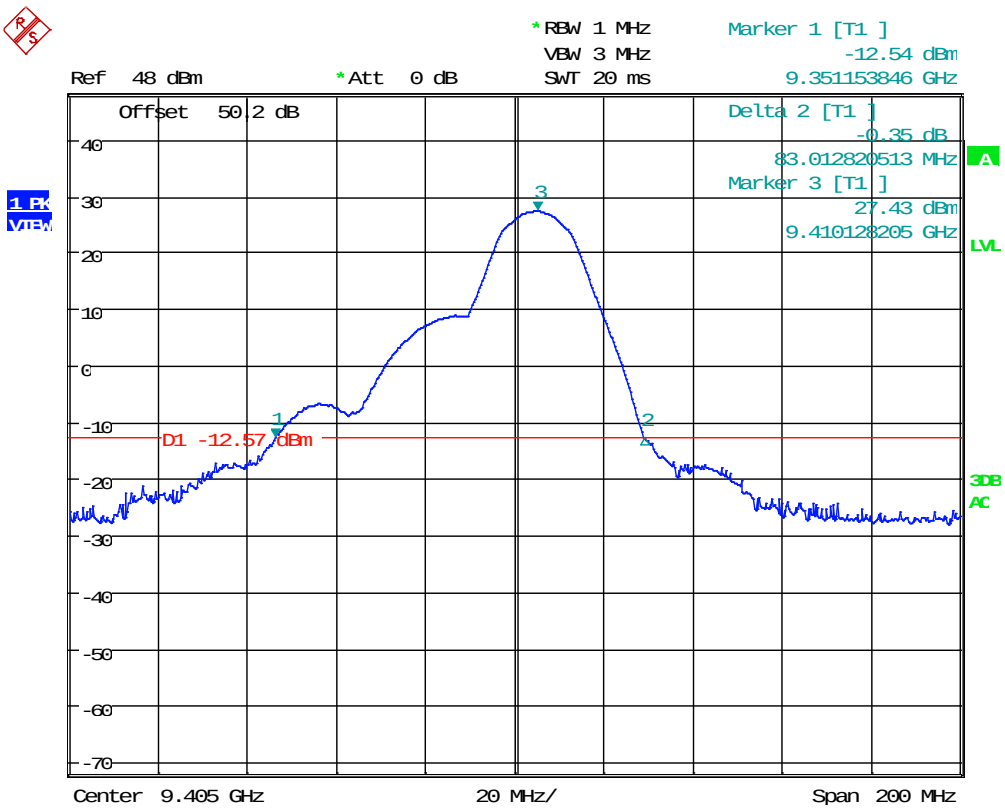
Test Data: 1/4 Nautical Mile Mode 99% OBW Plot



1/4 Nautical Mile Mode 99% OBW = **37.17 MHz**

40 dB OBW & EMISSION MASK

Test Data: 1/4 Nautical Mile Mode 40 dB OBW Plot

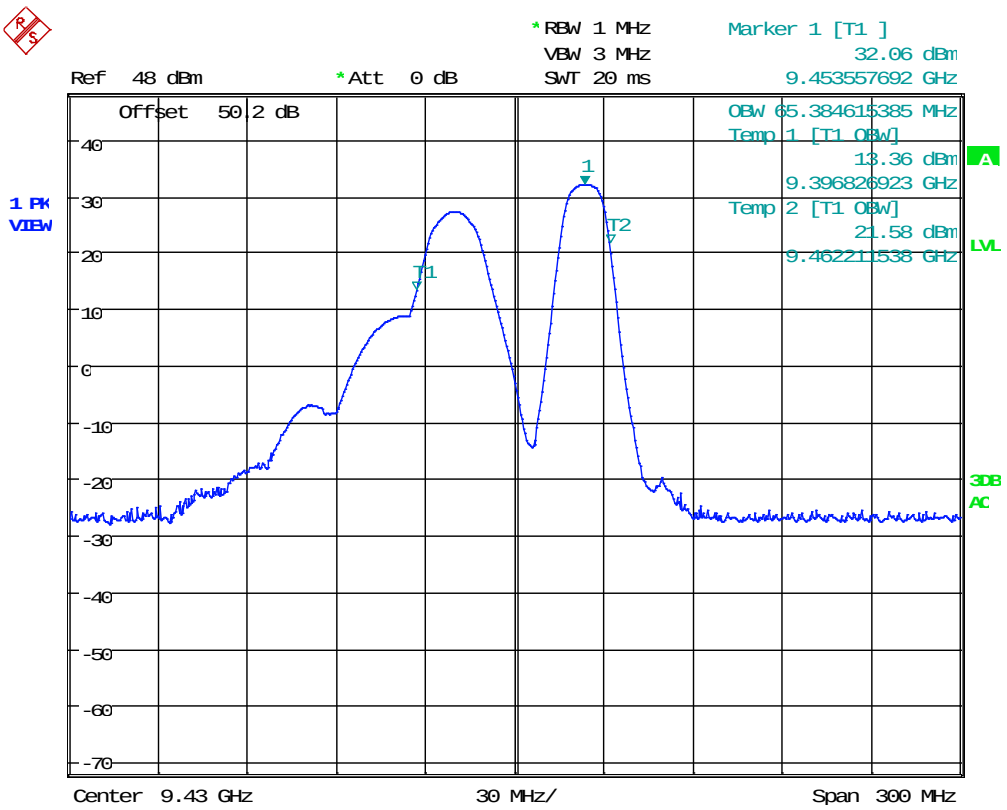


Date: 18.JUL.2019 18:08:46

1/4 Nautical Mile Mode 40 dB OBW = **83.01 MHz**

99% OBW & EMISSION MASK

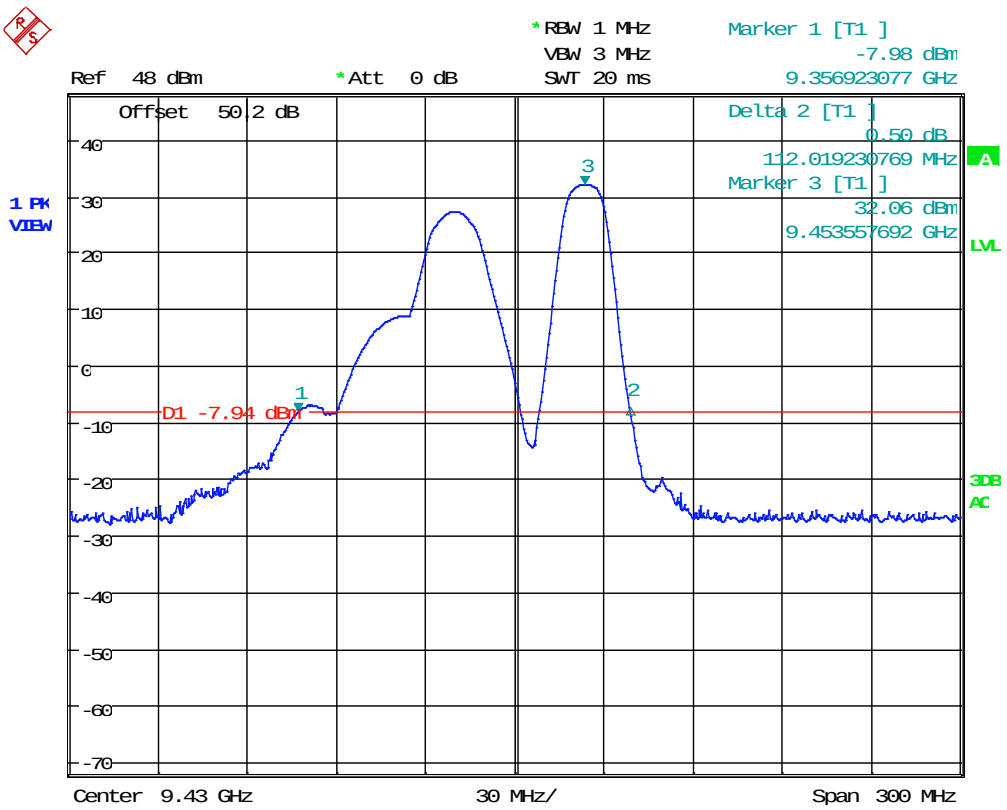
Test Data: 1.5 Nautical Mile Mode 99% OBW Plot



1.5 Nautical Mile Mode 99% OBW = **65.38 MHz**

40 dB OBW & EMISSION MASK

Test Data: 1.5 Nautical Mile Mode 40 dB OBW Plot

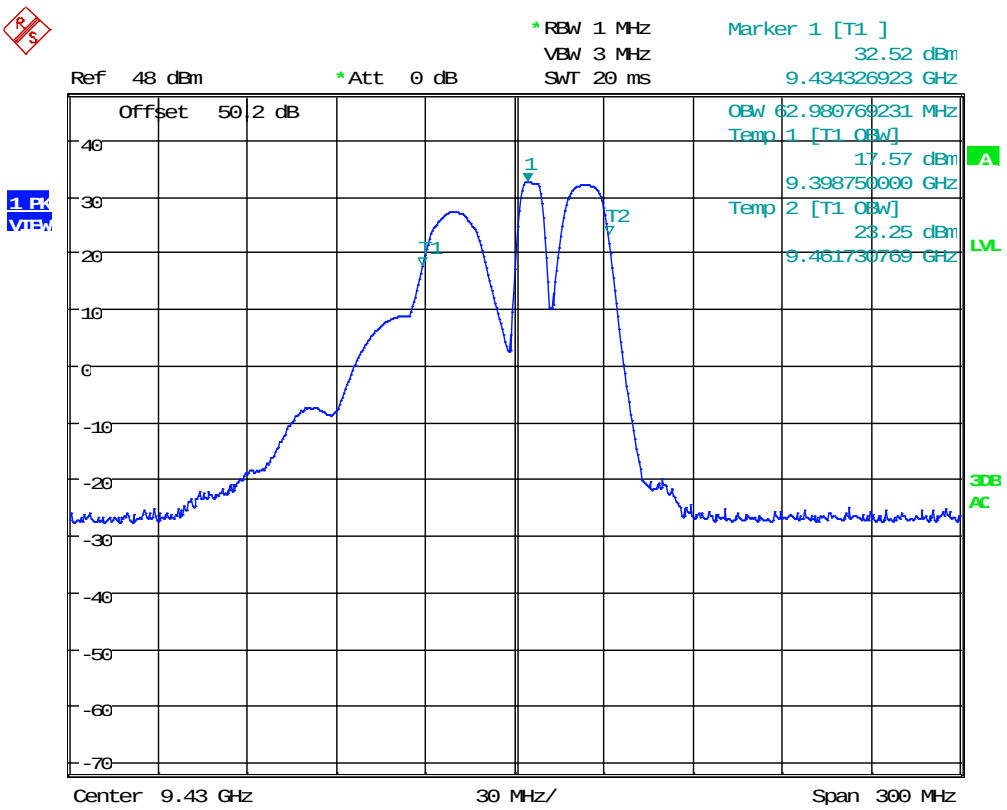


Date: 18.JUL.2019 18:14:12

1.5 Nautical Mile Mode 40 dB OBW = **112.02 MHz**

99% OBW & EMISSION MASK

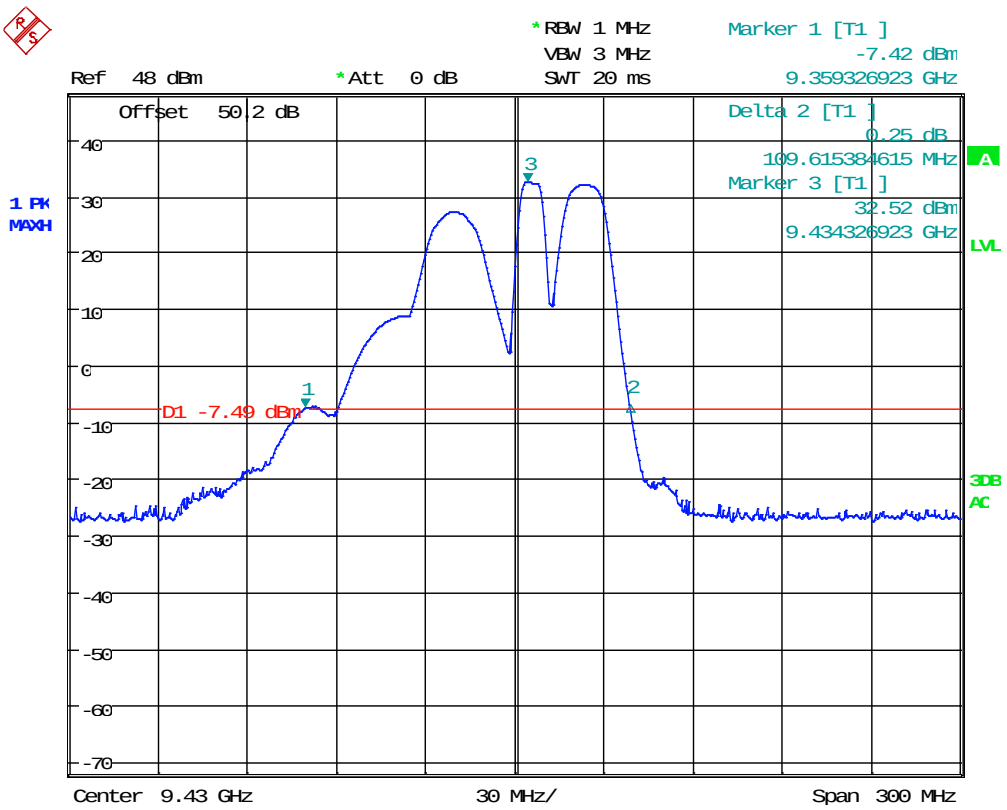
Test Data: 3 Nautical Mile Mode 99% OBW Plot



3 Nautical Mile Mode 99% OBW = **62.98 MHz**

40 dB OBW & EMISSION MASK

Test Data: 3 Nautical Mile Mode 40 dB OBW Plot

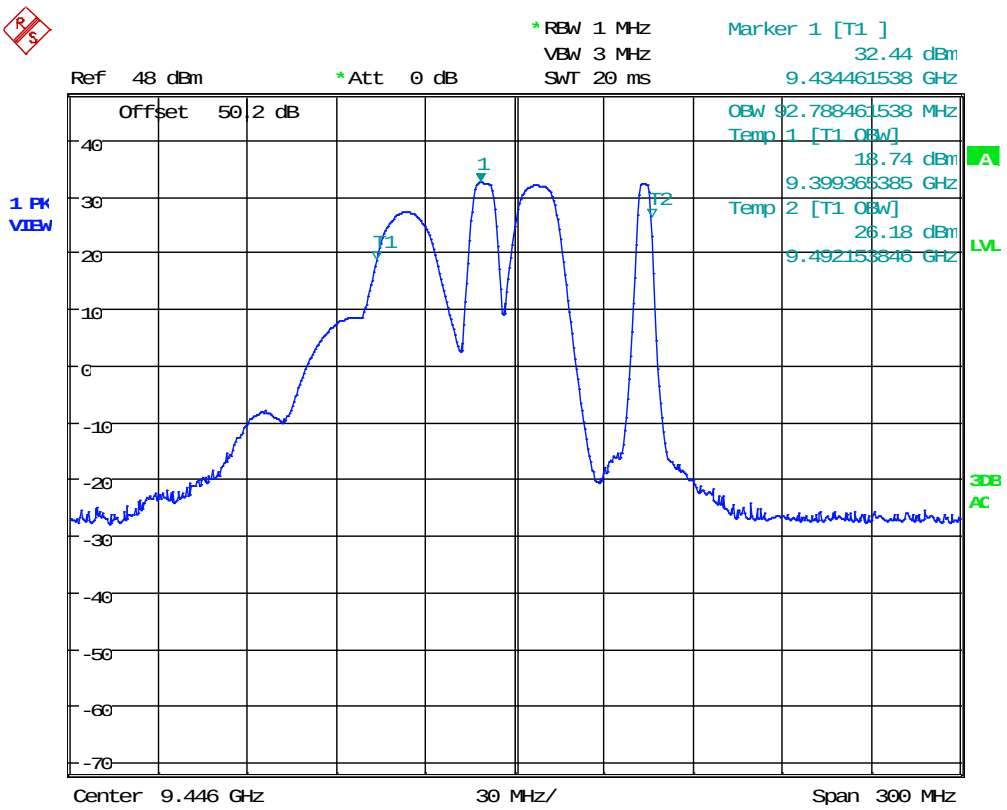


Date: 18.JUL.2019 18:15:54

3 Nautical Mile Mode 40 dB OBW = **109.62 MHz**

99% OBW & EMISSION MASK

Test Data: 6 Nautical Mile Mode 99% OBW Plot

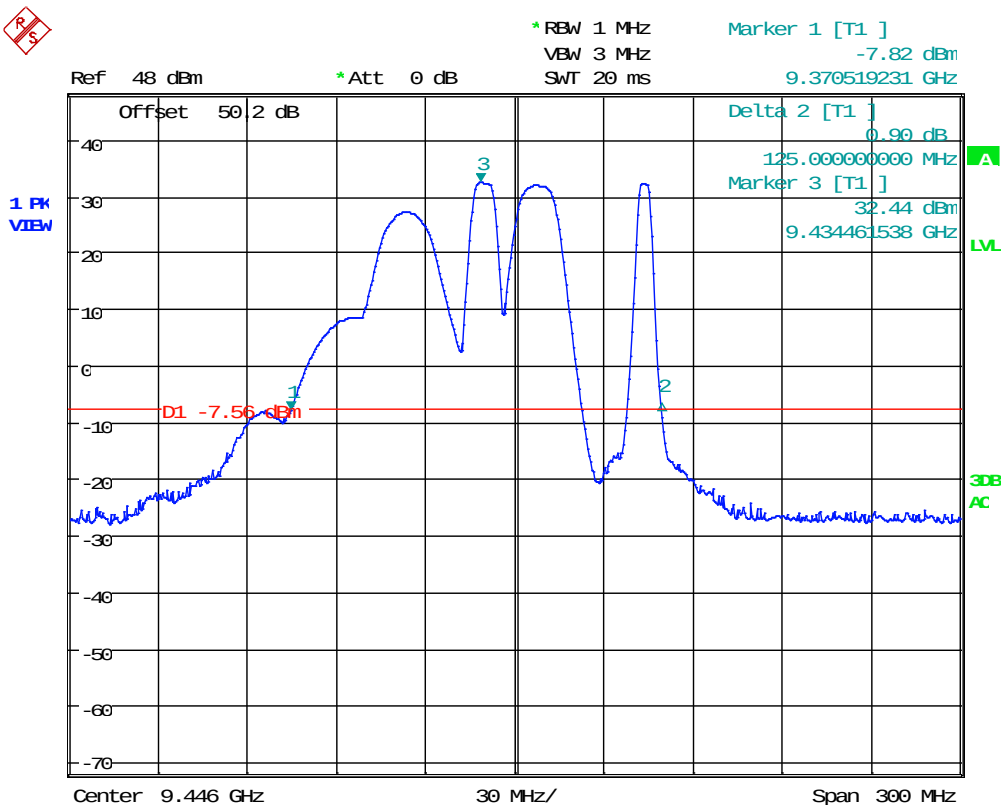


Date: 18.JUL.2019 18:20:59

6 Nautical Mile Mode 99% OBW = **92.78 MHz**

40 dB OBW & EMISSION MASK

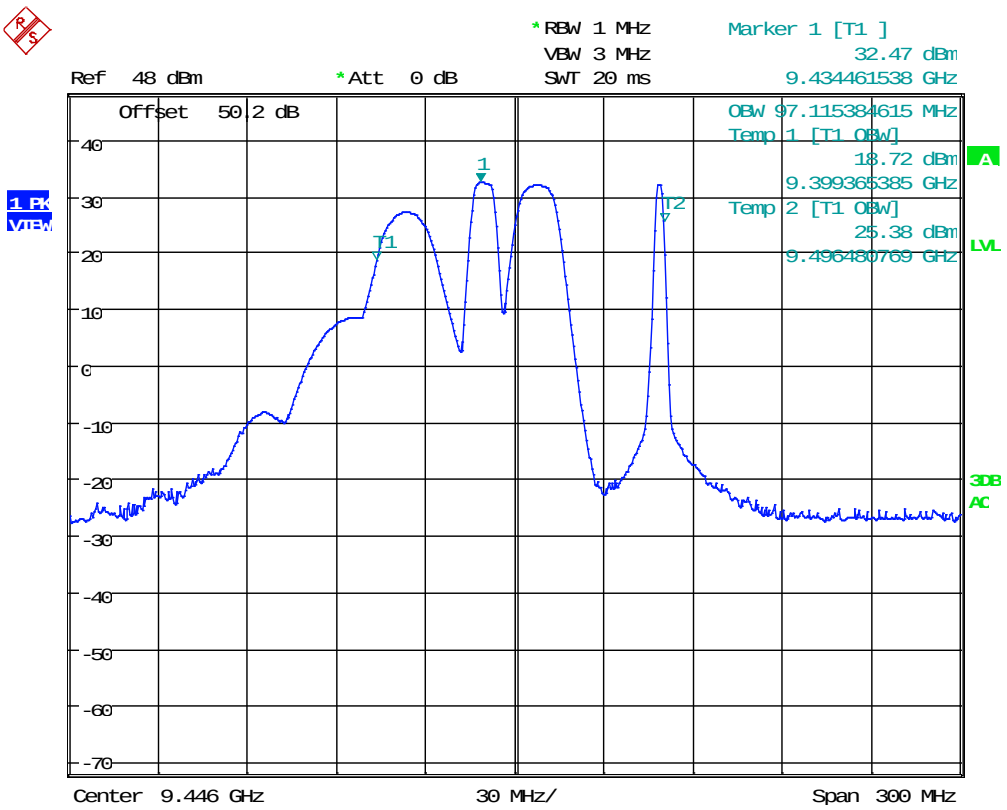
Test Data: 6 Nautical Mile Mode 40 dB OBW Plot



6 Nautical Mile Mode 40 dB OBW = **125 MHz**

99% OBW & EMISSION MASK

Test Data: 16 Nautical Mile Mode 99% OBW Plot

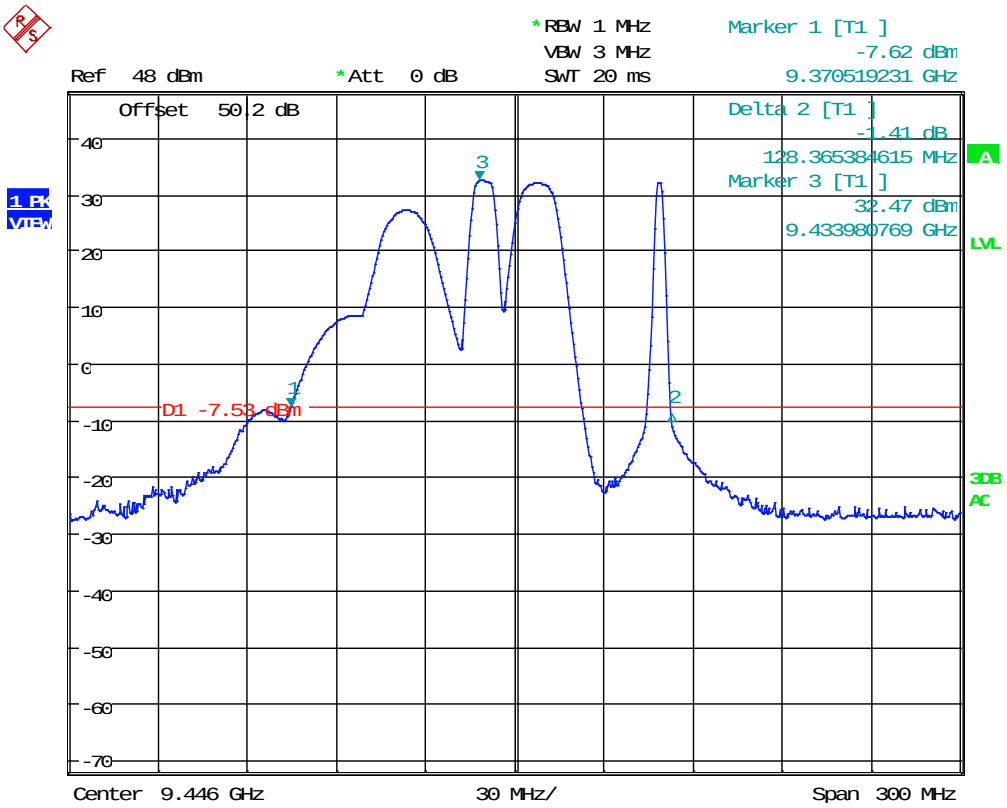


Date: 18.JUL.2019 18:27:12

16 Nautical Mile Mode 99% OBW = **97.11 MHz**

40 dB OBW & EMISSION MASK

Test Data: 16 Nautical Mile Mode 40 dB OBW Plot

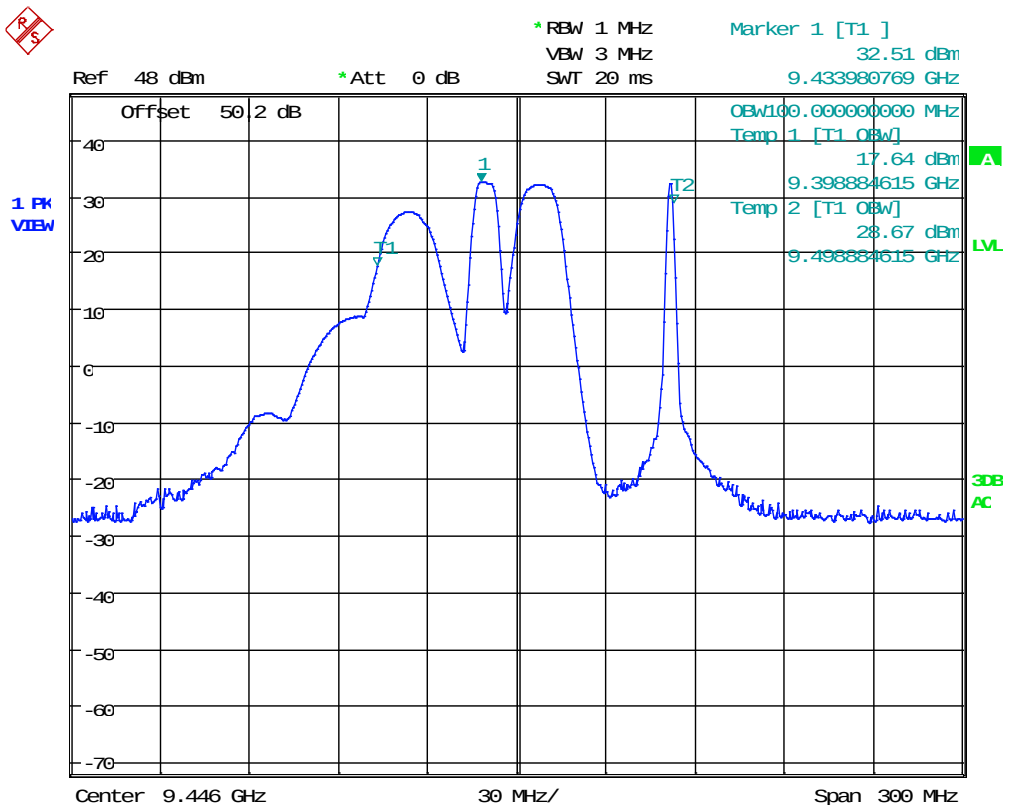


Date: 18.JUL.2019 18:25:49

16 Nautical Mile Mode 40 dB OBW = **128.36 MHz**

99% OBW & EMISSION MASK

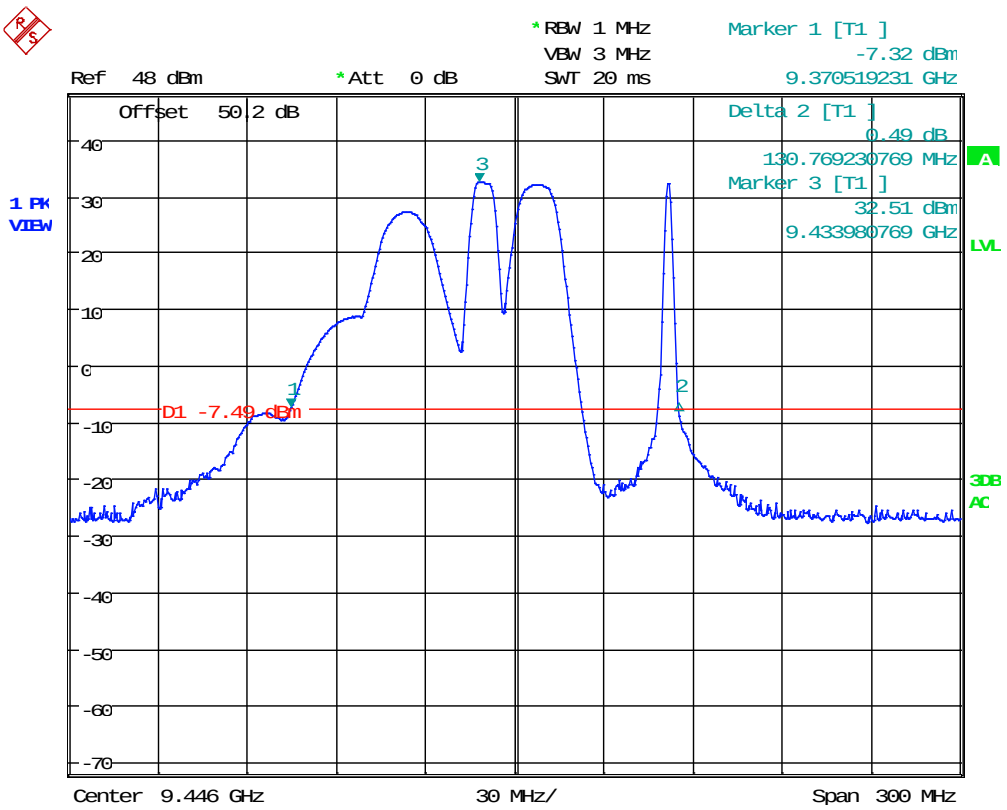
Test Data: ≥ 36 Nautical Mile Mode 99% OBW Plot



≥ 36 Nautical Mile Mode 99% OBW = **100 MHz**

40 dB OBW & EMISSION MASK

Test Data: ≥ 36 Nautical Mile Mode 40 dB OBW Plot

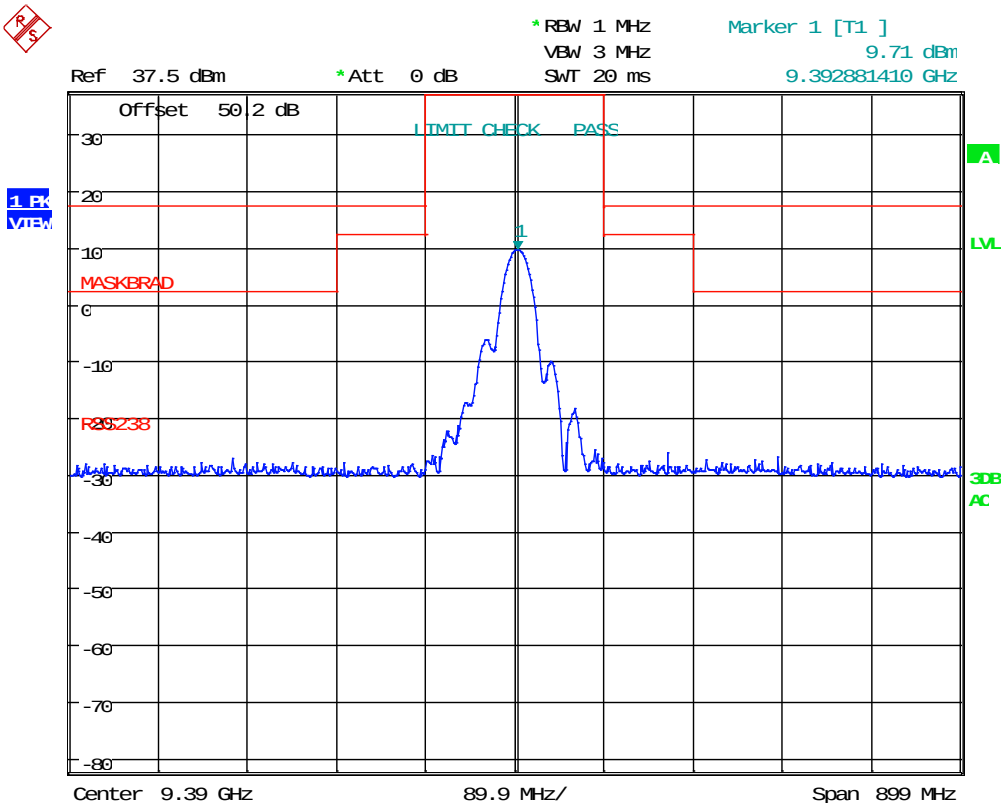


Date: 18.JUL.2019 18:30:25

≥ 36 Nautical Mile Mode 40 dB OBW = **120.77 MHz**

EMISSION MASK

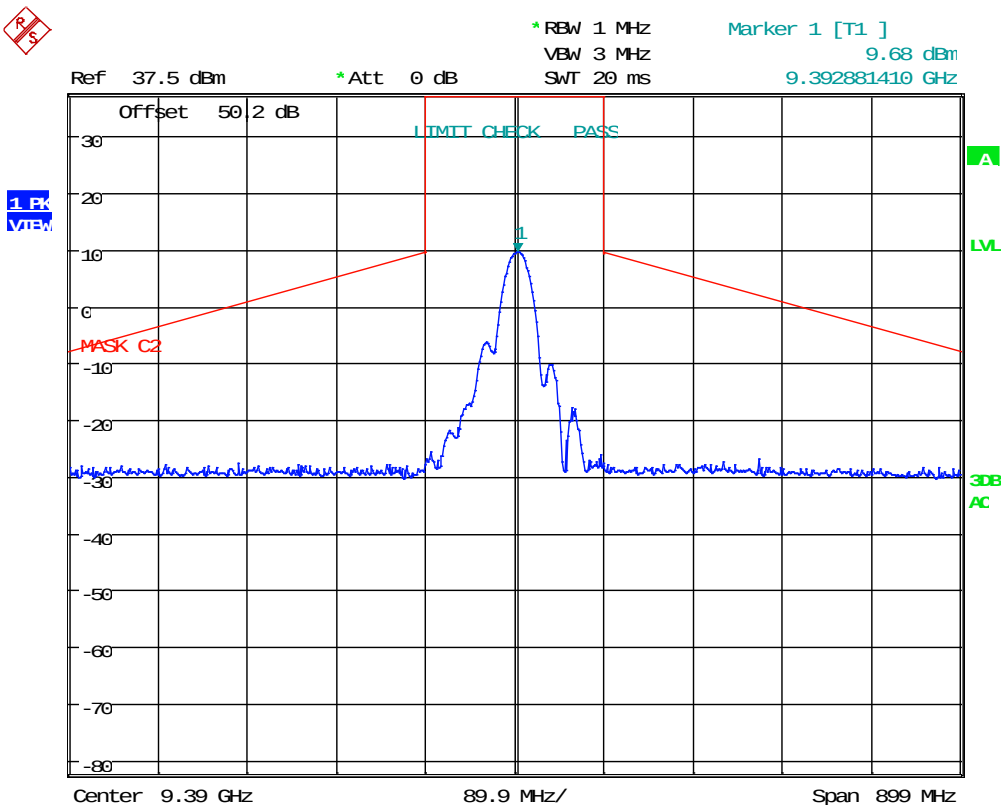
Test Data: 1/8 Nautical Mile Mode Emission Mask 80, 90 & RSS-238 Plot



Date: 19.JUL.2019 15:58:30

EMISSION MASK

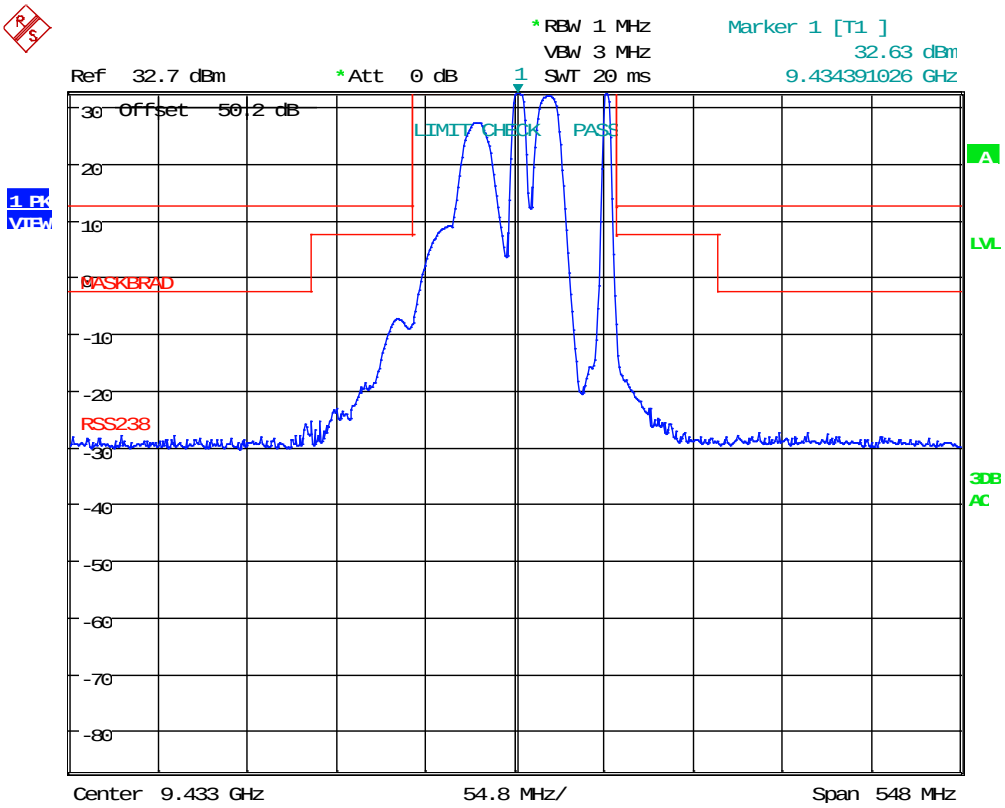
Test Data: 1/8 Nautical Mile Mode Emission Mask C Plot



Date: 19.JUL.2019 16:10:31

EMISSION MASK

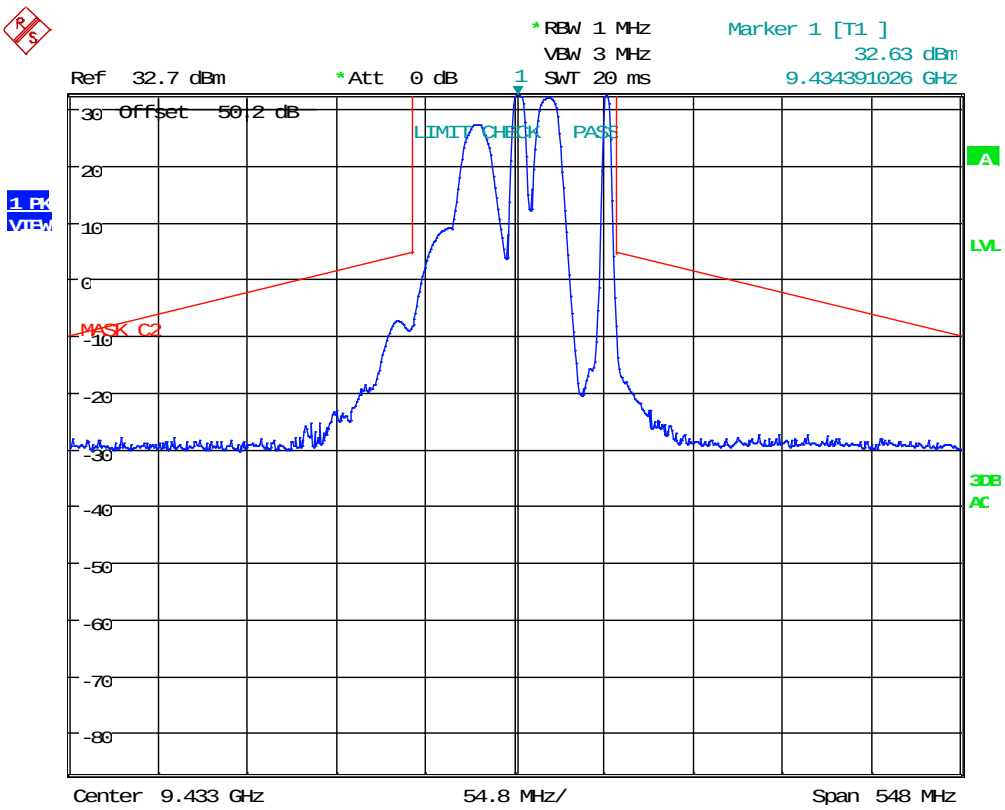
Test Data: 6 Nautical Mile Mode Emission Mask 80, 90 & RSS-238 Plot



Date: 19.JUL.2019 16:54:04

EMISSION MASK

Test Data: 6 Nautical Mile Mode Emission Mask C Plot



Date: 19.JUL.2019 16:50:50

SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED)

FCC Rule Parts: 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.

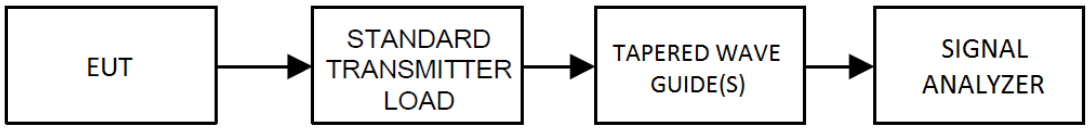
4.3 Transmitter Unwanted Emissions

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: **Test Modes 1, 5**

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	T (µs) Pulse Length (µs)	Bc (MHz) 40 dB BW (MHz)	40dB Bref (MHz) (Bc/T)^0.5 = Bref (MHz)	40dB Bref (MHz) If Bref > 1, Bref = 1 (MHz)	MBR (MHz) If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bm (MHz) Bif x MBR = Bm (MHz)	Spurious Noise Correction (dBm) If Bm > 1, 10 x Log(Bref/Bm)	Spurious Emissions Correction (dBm) If Bm > 1, 20 x Log(Bref/Bm)
1	1.59	165.06	322.20	1.00	1.50	4.50	-6.53	-13.06
5	86.813	124.52	37.87	1.00	1.50	4.50	-6.53	-13.06

Limit Calculation Part 80.211(f)(3)

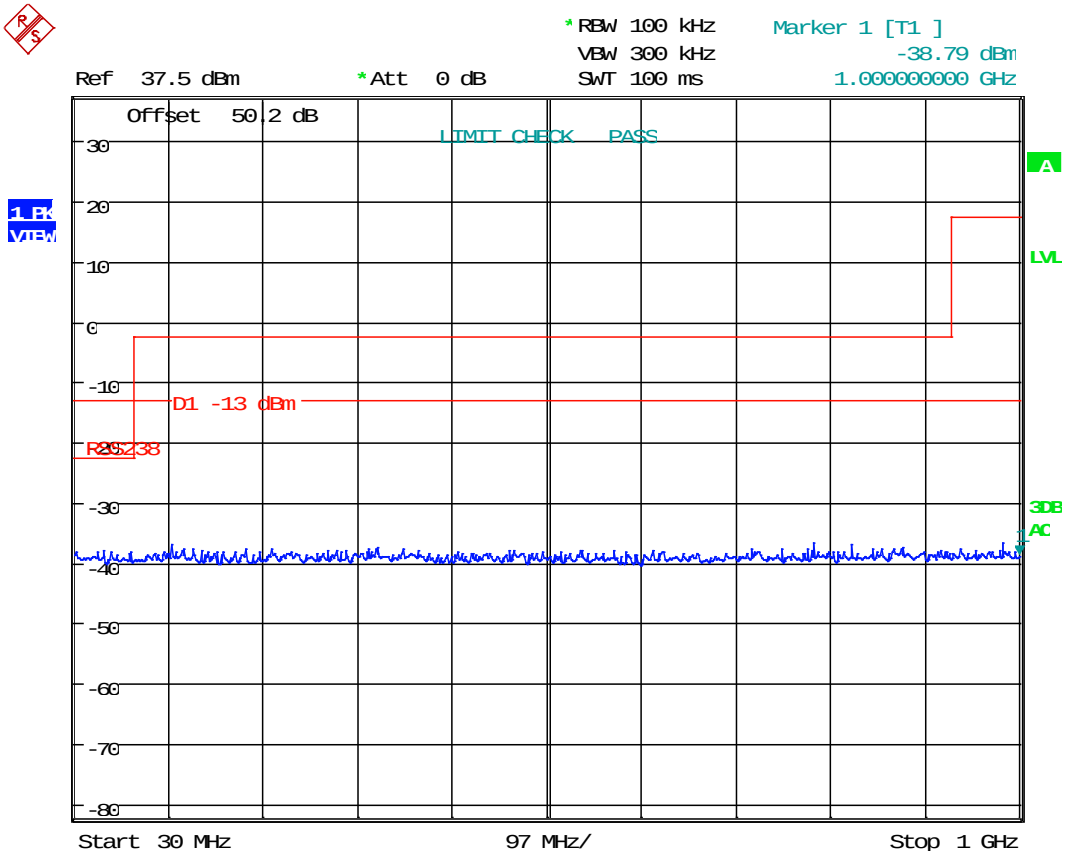
43 + 10 x Log(Power, in Watts)

Mode	Measured Output (dBm)	43+10 x Log(P) Limit (dBm)
1	14.12	-13.00
5	32.12	-13.00

UNWANTED SPURIOUS EMISSIONS

Test Data: Below 1 GHz

Mode 1

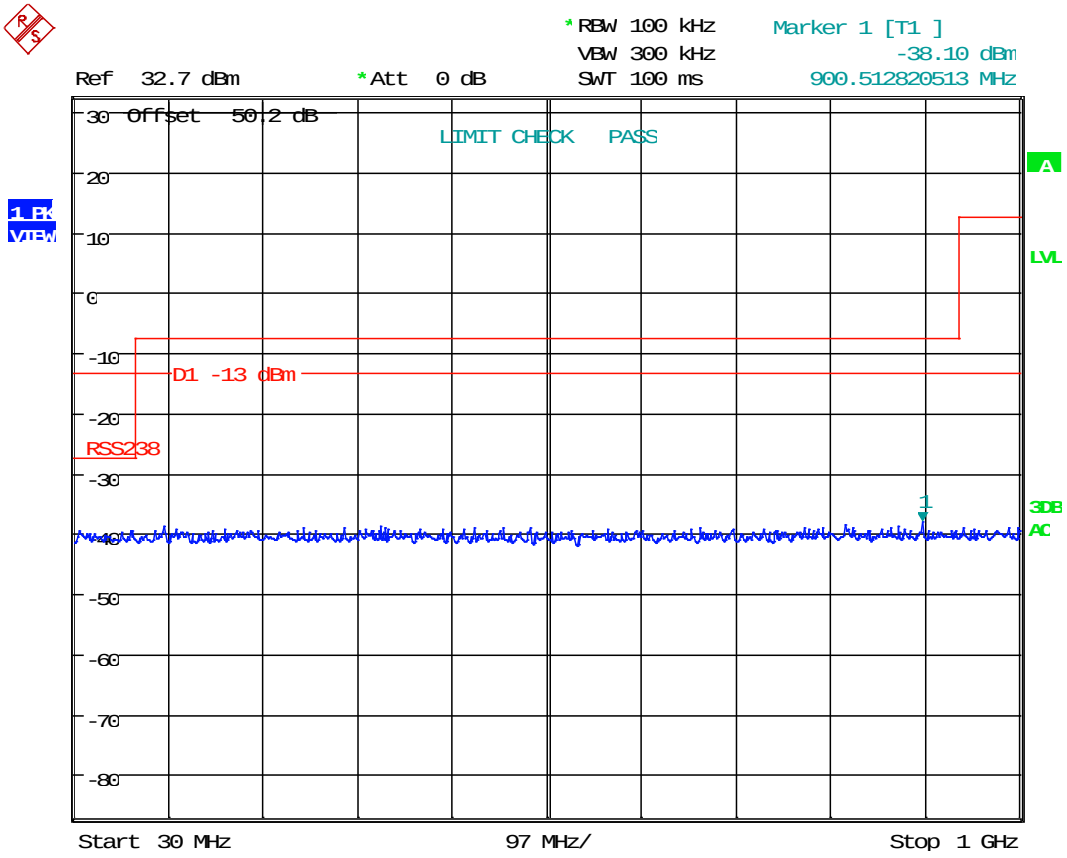


Date: 19.JUL.2019 16:00:47

UNWANTED SPURIOUS EMISSIONS

Test Data: Below 1 GHz

Mode 5

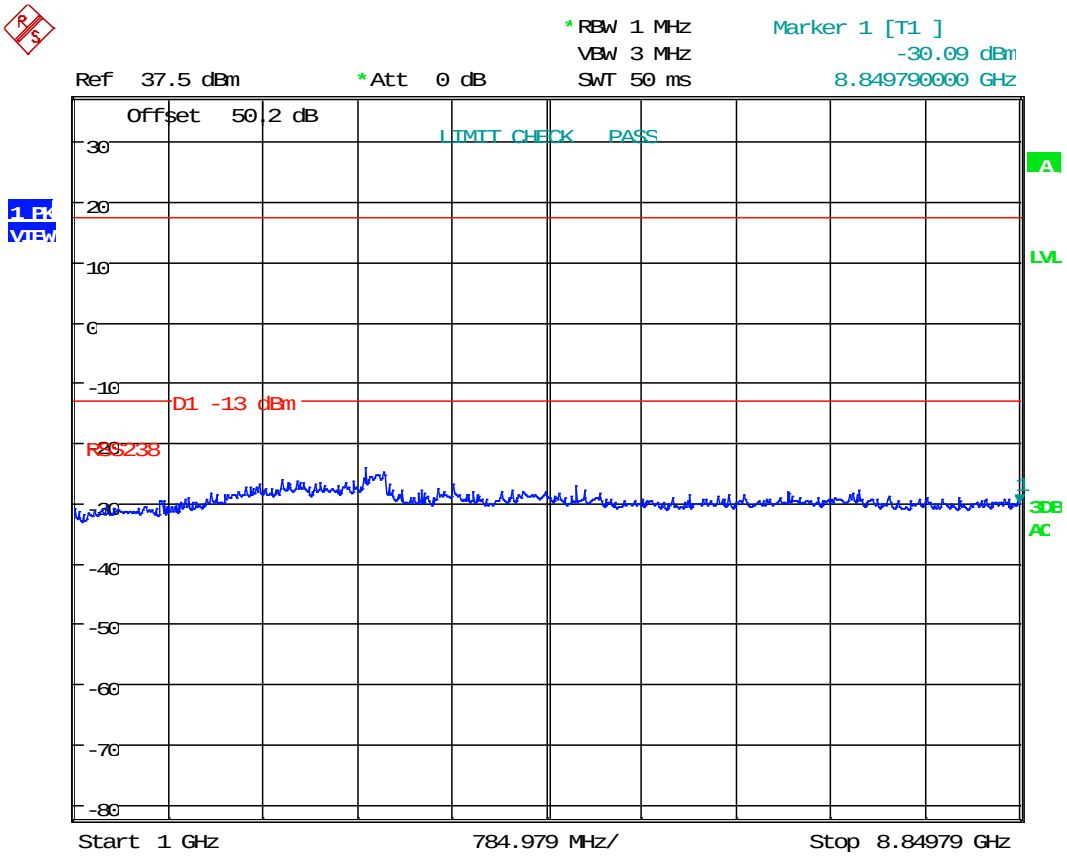


Date: 19.JUL.2019 16:56:28

UNWANTED SPURIOUS EMISSIONS

Test Data: 1 GHz – 9.3 GHz

Mode 1

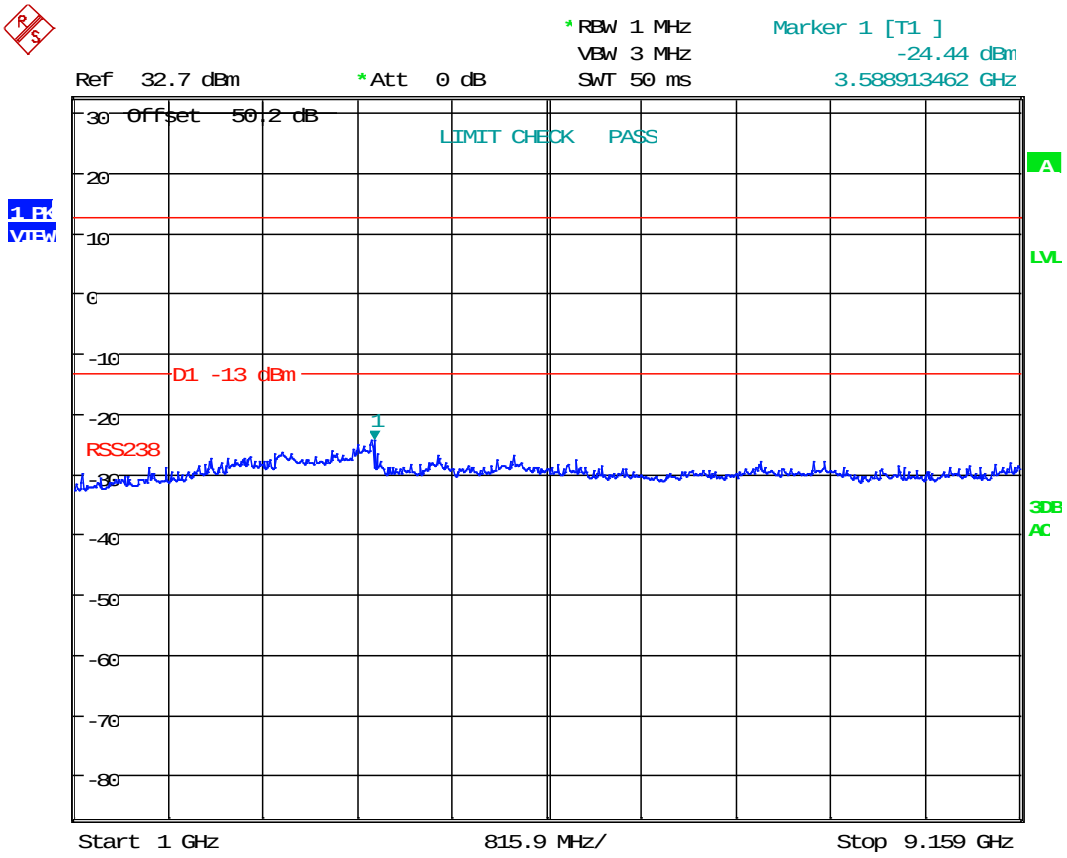


Date: 19.JUL.2019 15:59:55

UNWANTED SPURIOUS EMISSIONS

Test Data: 1 GHz – 9.3 GHz

Mode 5

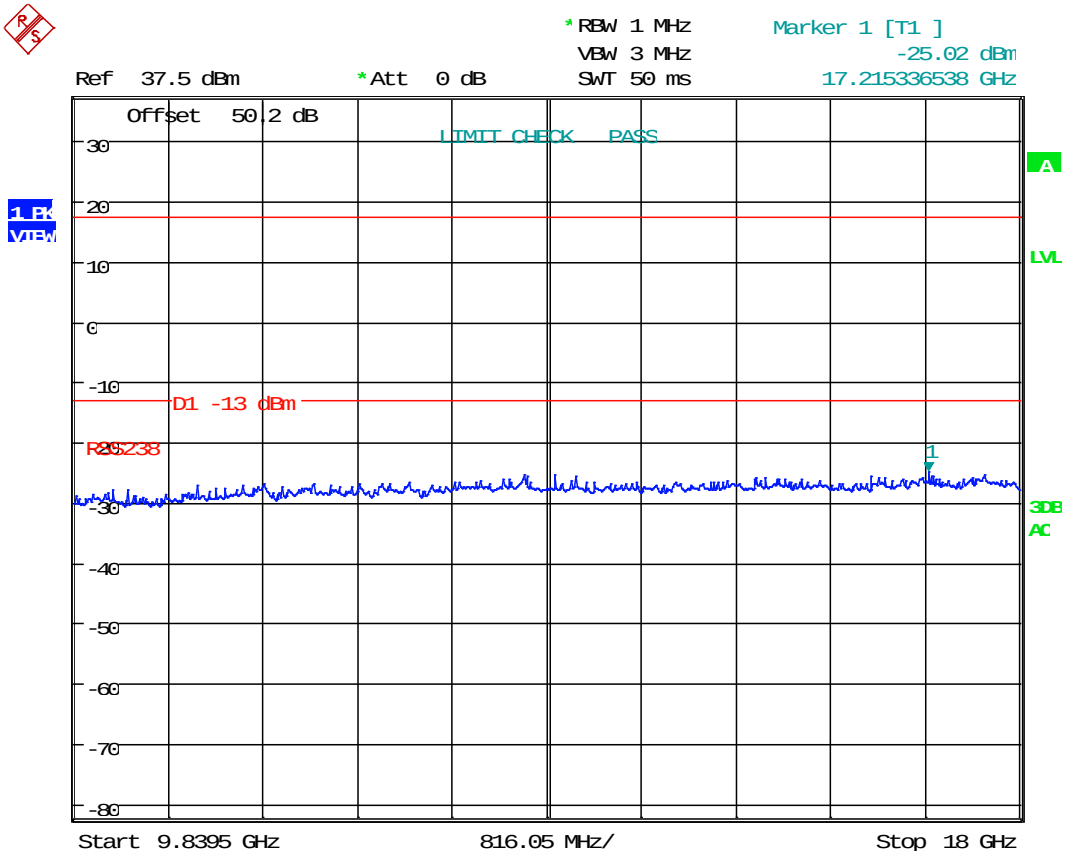


Date: 19.JUL.2019 16:55:45

UNWANTED SPURIOUS EMISSIONS

Test Data: 9.5 GHz – 18 GHz (Non-Harmonics)

Mode 1

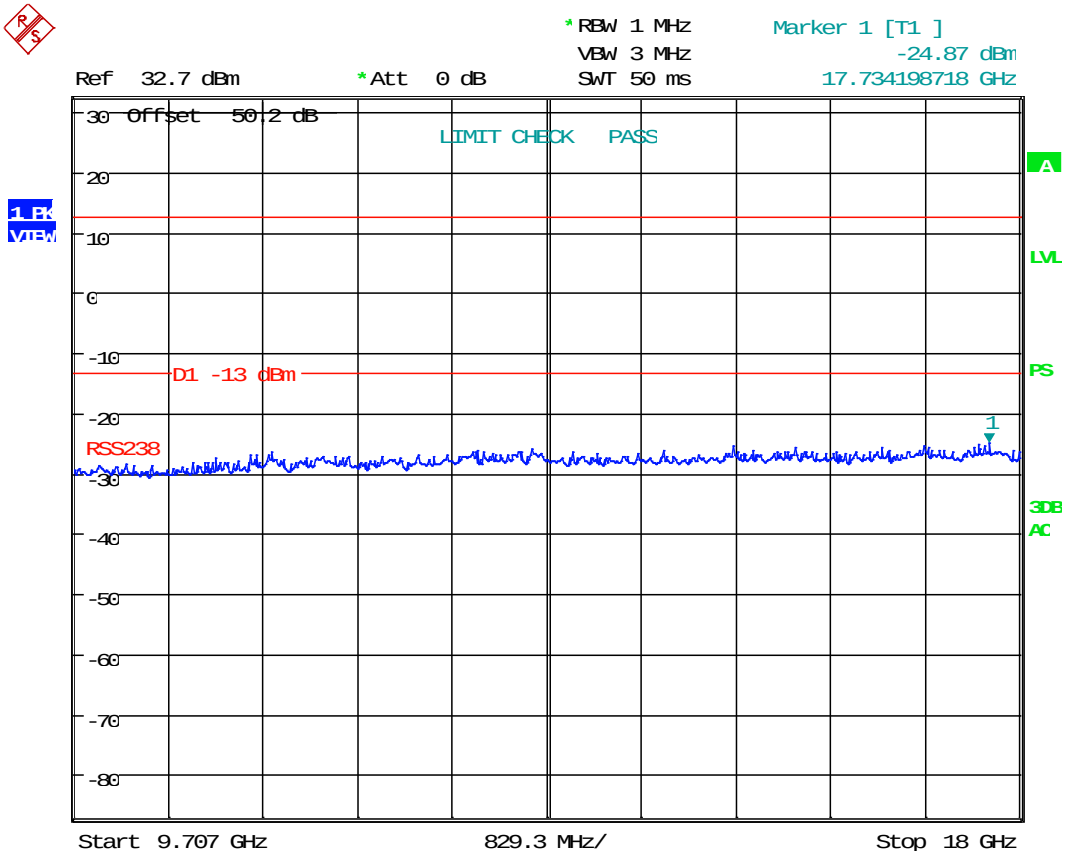


Date: 19.JUL.2019 17:55:28

UNWANTED SPURIOUS EMISSIONS

Test Data: 9.5 GHz – 18 GHz (Non-Harmonics)

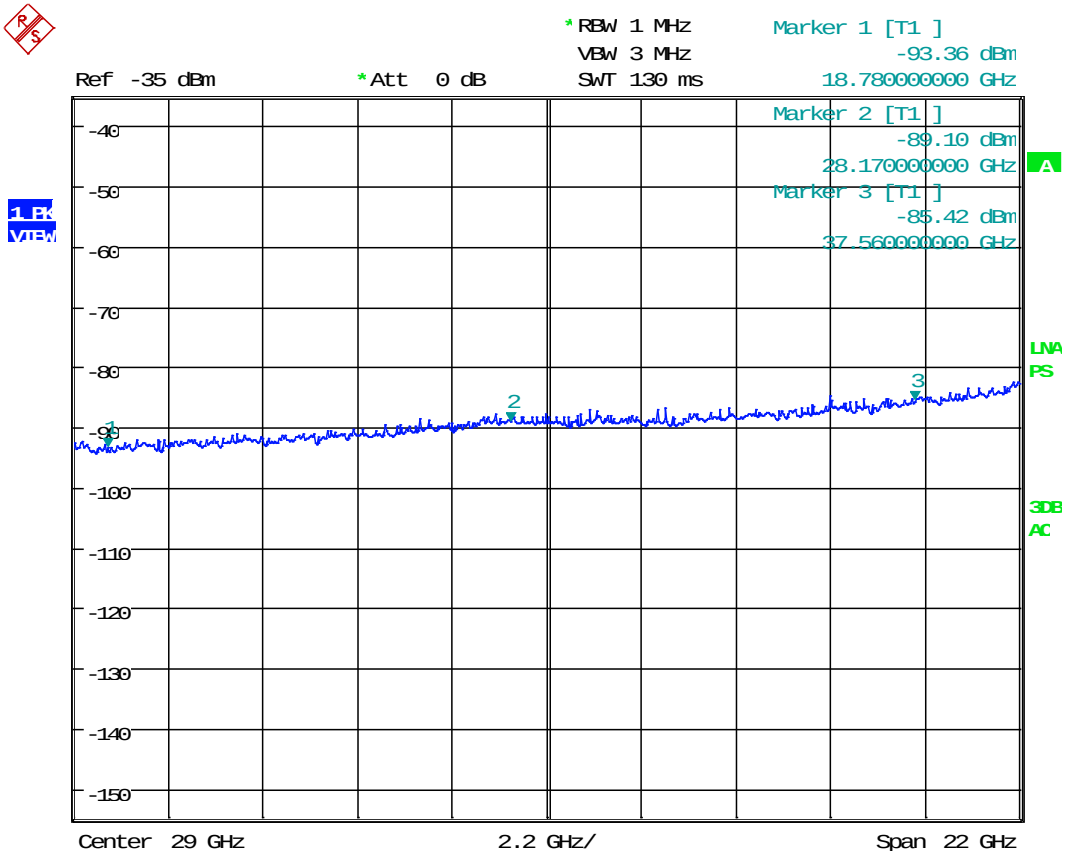
Mode 5



Date: 19.JUL.2019 17:00:08

UNWANTED SPURIOUS EMISSIONS

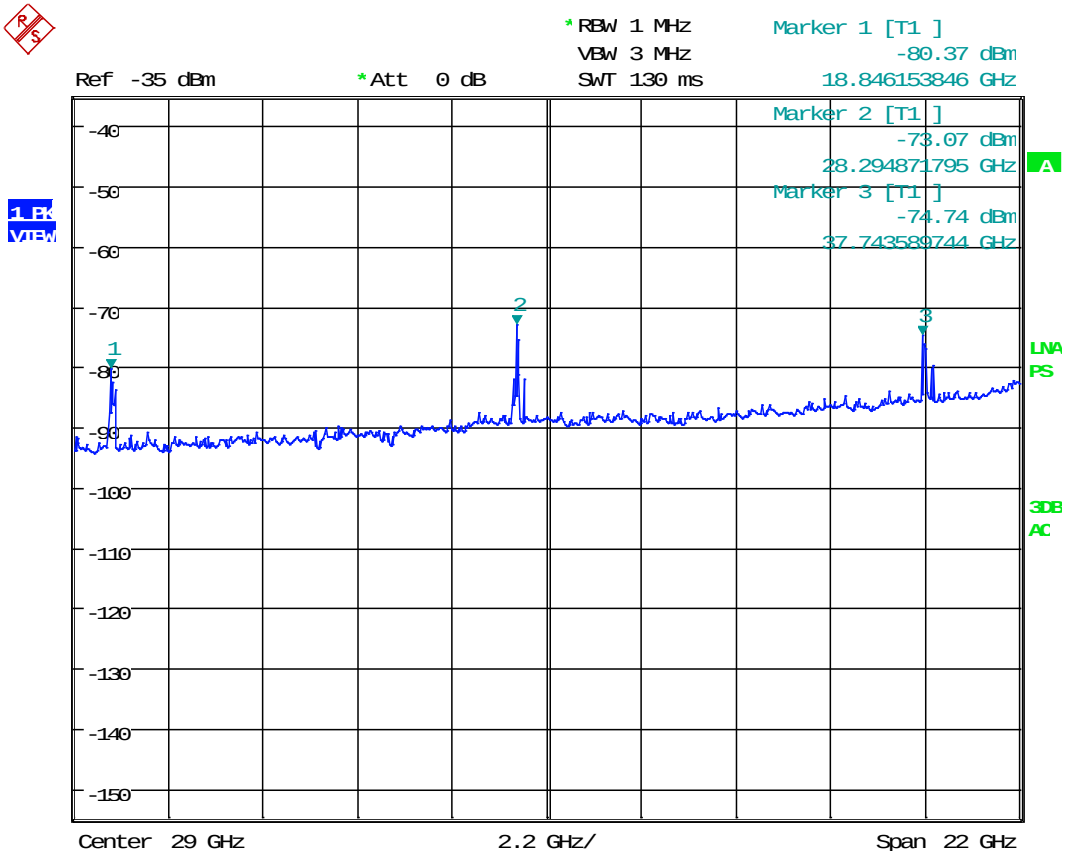
Mode 1 Harmonics



Date: 19.JUL.2019 17:20:30

UNWANTED SPURIOUS EMISSIONS

Mode 5 Harmonics



Date: 19.JUL.2019 17:11:49

UNWANTED SPURIOUS EMISSIONS

Test Data: 2nd Harmonic Peak Table

2nd Harmonic							
Mode	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)
1	18598.6	-93.36	-106.424	54.580	-51.844	-13.00	38.84
5	18868.8	-80.37	-93.434	54.580	-38.854	-13.00	25.85

Test Data: 3rd Harmonic Peak Table

3rd Harmonic							
Mode	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)
1	27897.9	-67.69	-80.754	45.980	-34.774	-13.00	21.77
5	28303.2	-73.07	-86.134	45.980	-40.154	-13.00	27.15

Test Data: 4th Harmonic Peak Table

4th Harmonic							
Mode	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)
1	37197.2	-85.42	-98.484	34.100	-64.384	-13.00	51.38
5	37737.6	-74.74	-87.804	34.100	-53.704	-13.00	40.70

UNWANTED SPURIOUS EMISSIONS

FIELD STRENGTH OF SPURIOUS EMISSIONS

FCC Rule Parts: 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.

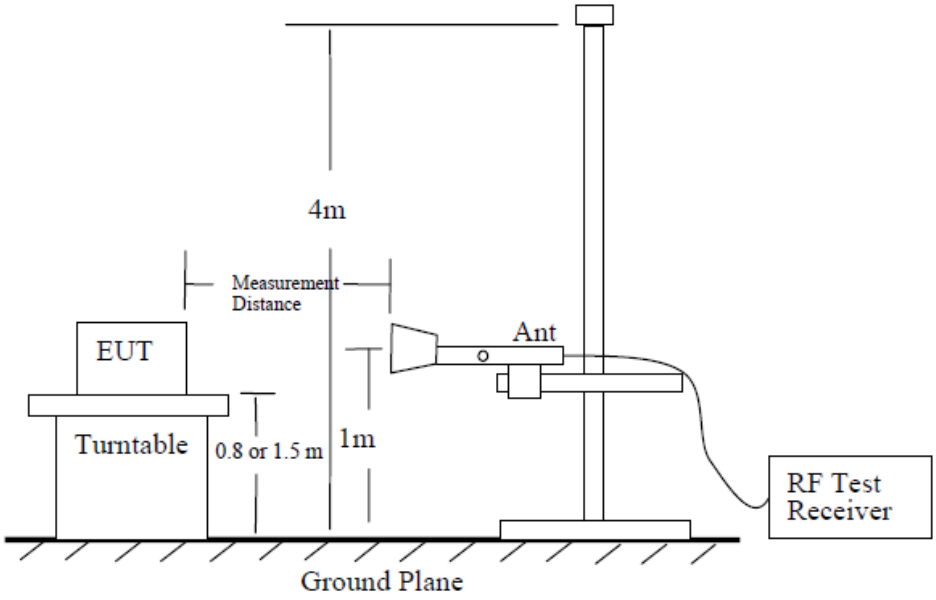
The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40 dB bandwidth and beyond.

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

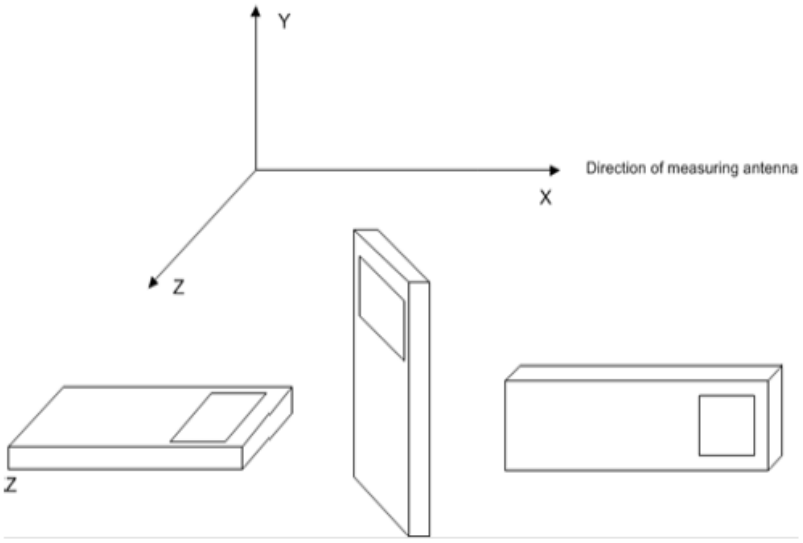
Test Procedure: ANSI C63.26, 5.5.4; ITU-R M.1177-4, ANNEX 1

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.

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	T (µs) Pulse Length (µs)	Bc (MHz) 40 dB BW (MHz)	40dB Bref (MHz)		MBR (MHz)	Bm (MHz)	Spurious Noise Correction (dBm)	Spurious Emissions Correction (dBm)
			(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	1.59	179.81	94.82	1.00	1.50	4.50	-6.53	-13.06
5	86.813	125.00	94.82	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	Measured Output (dBm)	43+10 x Log(P) Limit (dBm)
1	14.12	-13.00
5	32.12	-13.00

Note: The tabulated 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.

Note: The six (6) highest emissions or more of each worst-case operational modes of the EUT are represented below. Emissions 20 dB below the limit are not required to be reported.

Worst-case Mode of Operation to be Investigated = **Test Modes 1, 5**

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Mode 1 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)	Limit (dBm)	Margin (dB)
9299.00	18598.00	-9.40	H	15.50	44.74	3.000	50.845	-46.533	-13.000	33.53
9299.00	18598.00	-9.50	V	15.50	44.74	3.000	50.745	-46.633	-13.000	33.63
9299.00	27897.00	-5.30	H	19.69	46.86	3.000	61.245	-36.132	-13.000	23.13
9299.00	27897.00	-5.30	V	19.69	46.86	3.000	61.245	-36.132	-13.000	23.13
9299.00	37196.00	-2.56	H	22.50	46.05	3.000	65.989	-31.388	-13.000	18.39
9299.00	37196.00	-2.20	V	22.50	46.05	3.000	66.349	-31.028	-13.000	18.03

Test Data: Mode 5 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)	Limit (dBm)	Margin (dB)
9434.00	18868.00	-9.40	H	15.35	44.74	3.00	50.692	-46.685	-13.000	33.68
9434.00	18868.00	-9.34	V	15.35	44.74	3.00	50.752	-46.625	-13.000	33.62
9434.00	28302.00	-5.40	H	18.89	46.79	3.00	60.284	-37.093	-13.000	24.09
9434.00	28302.00	-5.32	V	18.89	46.79	3.00	60.364	-37.013	-13.000	24.01
9434.00	37736.00	-1.30	V	22.72	45.68	3.00	67.099	-30.278	-13.000	17.28
9434.00	37736.00	-1.23	H	22.72	45.68	3.00	67.169	-30.208	-13.000	17.21

FREQUENCY STABILITY

FCC Rule Parts: 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)]

		Mobile stations	
Frequency range (MHz)	**Fixed and base 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.

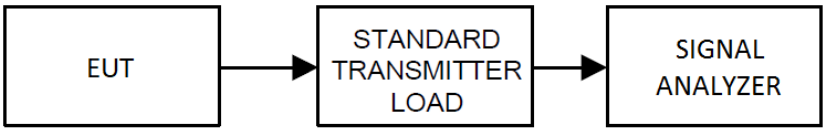
IC Rule Parts: RSS-238 s.4.1

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.

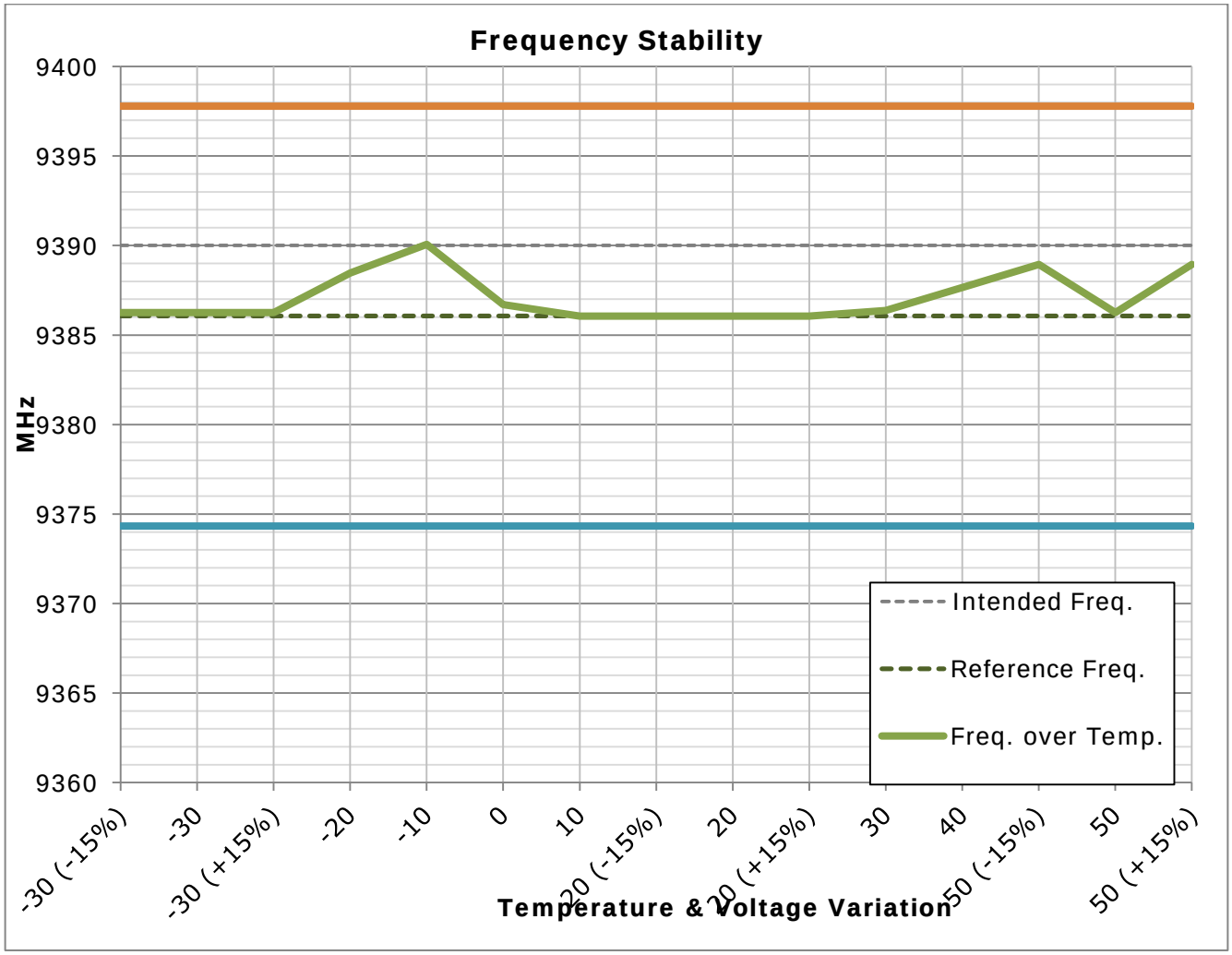
Test Procedure: TIA 603-E, 2.2.2

Test Setup Block Diagram:



FREQUENCY STABILITY

Test Data: Frequency Error Measurement Plot



Note: The EUT is intended for use also within Canada. The more strict frequency stability limit of 800 ppm from RSS-238 has been applied to the data.

FREQUENCY STABILITY

Test Data: Frequency Error Measurement Table

Operating on 9390 MHz				
RSS-238 4.1 Limit:	1250	ppm		
Shortest Pulse Duration:	0.025	µs		
Limit:	60	MHz from Auth. BW		
Authorized Bandwidth	200	MHz		
80.209(b) Limit:	9440	MHz (upper)		
	9360	MHz (lower)		
80.209(b) Limit in PPM:	400,000	ppm		
Most Strict Limit:	1250	ppm		
Temperature (°C)	**Supplied Voltage (VDC)**	**Intended Frequency (Hz)**	**Measured Reference Frequency (Hz)**	**Deviation (Hz)**
20°C (reference)	12	9390000000	9386057686	3942314

@ 20°C (reference)				
Supplied Voltage (%)	**Supplied Voltage (VDC)**	**Frequency (Hz)**	**Deviation (Hz)**	**PPM**
-15%	10.20	9386057686	0	0.000
15%	13.80	9386057686	0	0.000

@ -30°C				
Supplied Voltage (%)	**Supplied Voltage (VDC)**	**Frequency (Hz)**	**Deviation (Hz)**	**PPM**
-15%	10.20	9386247940	-190254	-20.270
15%	13.80	9386247948	-190262	-20.271

@ 50°C				
Supplied Voltage (%)	**Supplied Voltage (VDC)**	**Frequency (Hz)**	**Deviation (Hz)**	**PPM**
-15%	10.20	9388942300	-2884614	-307.330
15%	13.80	9388942301	-2884615	-307.330

Temperature (°C)	**Supplied Voltage (VDC)**	**Frequency (Hz)**	**Deviation (Hz)**	**PPM**
50	12	9388942301	-2884615.00000	-307.330
40	12	9387660237	-1602551.00000	-170.737
30	12	9386378199	320513.00000	-34.148
20	12	9386057686	0.00000	0.000
10	12	9386057673	13.00000	0.001
0	12	9386698699	641013.00000	-68.294
-10	12	9390064065	4006379.00000	-426.844
-20	12	9388461526	2403840.00000	-256.108
-30	12	9386247948	190262.00000	-20.271

RESULT: Meets Requirements

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
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 KMKM-0670-01 KFKF-0197-00	N/A	N/A
CHAMBER	Panashield	3M	N/A	12/31/17	12/31/19
Antenna: Double-Ridged Horn/ETS Horn 1	ETS-Lindgren	3117	00035923	03/01/17	03/01/20
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	08/29/18	08/29/20
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	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	07/21/18	07/21/20
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
Coaxial Cable - KMKM-0180-01 Aqua	Micro-Coax	N/A	KMKM-0180-00	07/15/19	07/15/21
Antenna: Double-Ridged Horn 18-40 GHz	EMCO	3116	9011-2145	12/08/17	12/08/19
Attenuator N 20dB 20W DC-12G	Narda	768-20-SP	344	07/15/19	07/15/21
HP Directional Coupler	HP	X752D	1829A24209	07/15/19	07/15/21

***EMI RECEIVER SOFTWARE VERSION**

The receiver firmware used was version 4.43 Service Pack 3

END OF REPORT