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 RBU ITALIA S.R.L. |
| **ADDRESS** | VIA ROMITA, 26<br>MONTAGNANA VAL di PESA, MONTESPERTOLI, FIRENZE<br>50025 ITALY |
| **FCC ID** | 2AJJ3SRTLAN30S |
| **IC** | 21849-SRTLAN30S |
| **MODEL NUMBER** | SRTLAN30S |
| **PRODUCT DESCRIPTION** | S-BAND RADAR |
| **DATE SAMPLE RECEIVED** | 10/31/2018 |
| **FINAL TEST DATE** | 02/04/2019 |
| **TESTED BY** | Franklin Rose |
| **APPROVED BY** | Tim Royer |
| **TEST RESULTS** | ☒ PASS ☐ FAIL |

| Report Number | Report Version | Description | Issue Date |
|---|---|---|---|
| 2004AUT18TestReport_ | Rev1 | Initial Issue | 02/18/2019 |
| 2004AUT18TestReport_ | Rev2 | Update emission Masks | 02/27/2019 |

***THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.***

# TABLE OF CONTENTS


**GENERAL REMARKS** ..... **2**

**GENERAL INFORMATION** ..... **3**

TESTING INFORMATION ..... 4
OPERATING FREQUENCIES ..... 5
OPERATING MODES ..... 6
MODELS ..... 6

**SUMMARY OF TESTING** ..... **7**

**MODULATION CHARACTERISTICS** ..... **8**

FCC BANDWIDTH ..... 8
ISED BANDWIDTH ..... 8

**PULSE CHARACTERISTICS** ..... **9**

TEST DATA: PULSE MEASUREMENT TABLE ..... 9
TEST DATA: MODE 1 PULSE PLOT ..... 10
TEST DATA: MODE 2 PULSE PLOT ..... 10
TEST DATA: MODE 3 PULSE PLOT ..... 11

**PULSE TRAIN CHARACTERISTICS** ..... **12**

TEST DATA: PULSE TRAIN MEASUREMENT TABLE ..... 12
TEST DATA: MODE 1 PULSE TRAIN PLOT ..... 13
TEST DATA: MODE 2 PULSE TRAIN PLOT ..... 13
TEST DATA: MODE 3 PULSE TRAIN PLOT ..... 14

**RF POWER OUTPUT** ..... **15**

TEST DATA: POWER MEASUREMENT TABLE ..... 16
TEST DATA: POWER AT THE FINAL AMPLIFIER ..... 17

**OCCUPIED BANDWIDTH & EMISSION MASK** ..... **18**

99% OCCUPIED BANDWIDTH RULE PARTS ..... 18
40DB OCCUPIED BANDWIDTH RULE PARTS ..... 19
EMISSION MASK RULE PARTS ..... 20
TEST DATA: OCCUPIED BANDWIDTH MEASUREMENT TABLE ..... 21
TEST DATA: MODE 1 99% OBW PLOT ..... 22
TEST DATA: MODE 1 40DB OBW PLOT ..... 23
TEST DATA: MODE 2 99% OBW PLOT ..... 24
TEST DATA: MODE 2 40DB OBW PLOT ..... 25
TEST DATA: MODE 3 99% OBW PLOT ..... 26
TEST DATA: MODE 3 40DB OBW PLOT ..... 27

**SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED) ..... 28**

BANDWIDTH COMPENSATION CALCULATION TABLE: ..... 30

TEST DATA: SPURIOUS CONDUCTED EMISSIONS PLOT ..... 31

TEST DATA: 2ND HARMONIC PEAK TABLE ..... 32

TEST DATA: 3RD HARMONIC PEAK TABLE ..... 32

TEST DATA: 4TH HARMONIC PEAK TABLE ..... 33

TEST DATA: 5TH HARMONIC PEAK TABLE ..... 33

TEST DATA: 6TH HARMONIC PEAK TABLE ..... 34

TEST DATA: 7TH HARMONIC PEAK TABLE ..... 34

TEST DATA: 8TH HARMONIC PEAK TABLE ..... 35

TEST DATA: 9TH HARMONIC PEAK TABLE ..... 35

TEST DATA: 10TH HARMONIC PEAK TABLE ..... 36

**FIELD STRENGTH OF SPURIOUS EMISSIONS ..... 37**

BANDWIDTH COMPENSATION CALCULATION TABLE: ..... 40

TEST DATA: RADIATED SPURIOUS EMISSIONS PLOT ..... 41

TEST DATA: RADIATED SPURIOUS EMISSIONS TABLE ..... 42

**FREQUENCY STABILITY ..... 43**

**STATEMENT OF MEASUREMENT UNCERTAINTY ..... 46**

**EMC EQUIPMENT LIST ..... 47**

## 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** | 02/04/2019 |

### Reviewed and Approved by:

| | |
|---|---|
| **Name and Title** | Tim Royer, Project Manager / EMC Testing Engineer |
| **Date** | 2/7/2019 |

## GENERAL INFORMATION

**Definitions:** FCC Part 80.5, 87.3, 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** | 2AJJ3SRTLAN30S | | |
| **IC** | 21849-SRTLAN30S | | |
| **Model Number** | SRTLAN30S | | |
| **Operating Band(s)** | Band 1: 2.9 – 3.1 GHz | | |
| **Test Frequencies** | Band 1: 3060 MHz | | |
| **FCC Emission Designator** | 66M5P0N | | |
| **Measurement Method** | 99% Occupied Bandwidth | | |
| **IC Emission Designator** | 141MP0N | | |
| **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** | 7/16 DIN | | |
| **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.<br>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.

## GENERAL INFORMATION

### Operating Modes

The EUT operates in the following modes. Based on the technical operation of the radar system, the modes have been divided according to their pulse widths into the three modes, below:

| User Selected Range (nm) | Test Mode |
|---|---|
| 1/8 nm | 1 |
| 1/4 nm | |
| 1/2 nm | |
| 3/4 nm | |
| 1.5 nm | |
| 3 nm | |
| 6 nm | 2 |
| 12 nm | |
| 24 nm | 3 |
| 36 nm | |
| 48 nm | |
| 64 nm | |
| 72 nm | |

### Models

The EUT is to be manufactured in two models, the “Upmast” and “Downmast” model. These models are electrically identical, save a waveguide and antenna pedestal added to the Downmast, to reach a remote-mount antenna, as the unit itself will be enclosed indoors. All data in this report reflects both models, and “cable loss” has been added where necessary to compensate for the waveguide and antenna pedestal losses.

## 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: **66.506 MHz**
Emission Designation: **66M5P0N**

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

**ISED Bandwidth**

Worst-case 40 dB-down Occupied Bandwidth: **141.024 MHz**
Emission Designation: **141MP0N**

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

## PULSE CHARACTERISTICS

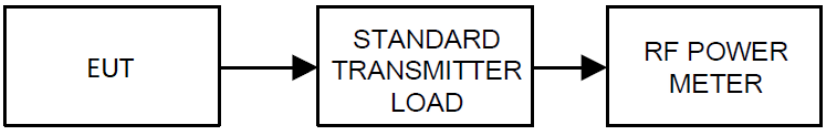
**Rule Part No.:** RSS-238 s.3.2(a)

### 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:**



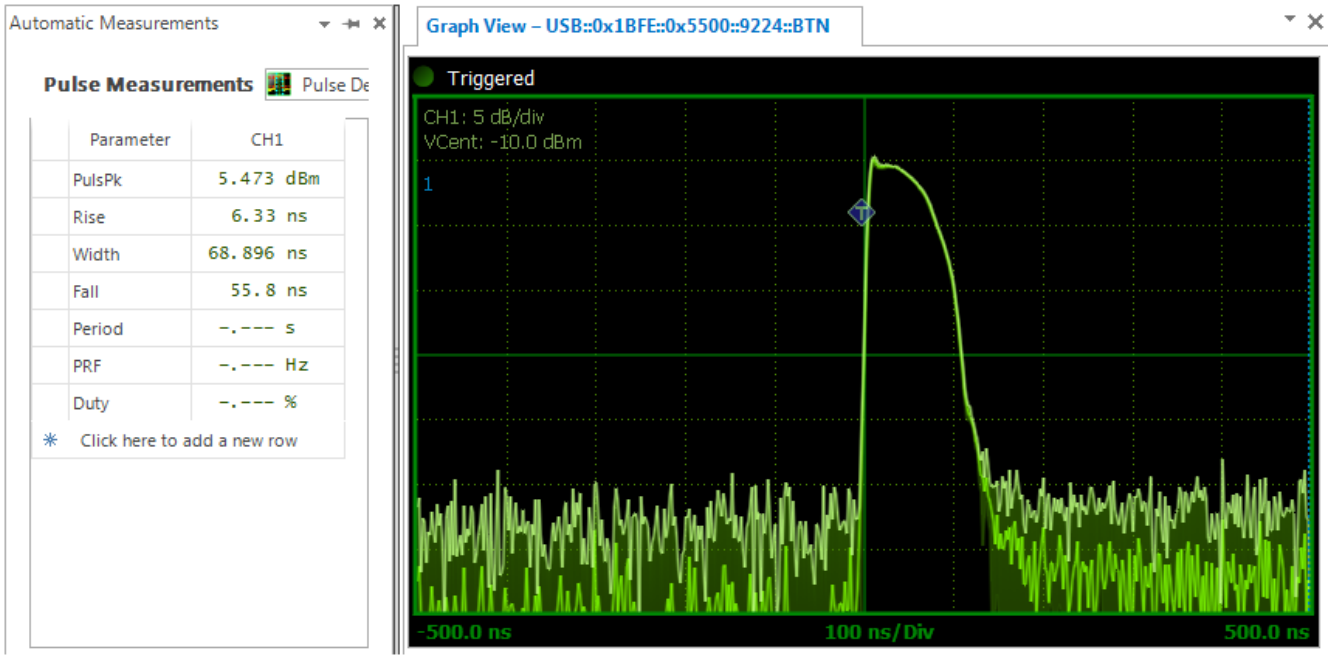

**Test Data: Pulse Measurement Table**

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

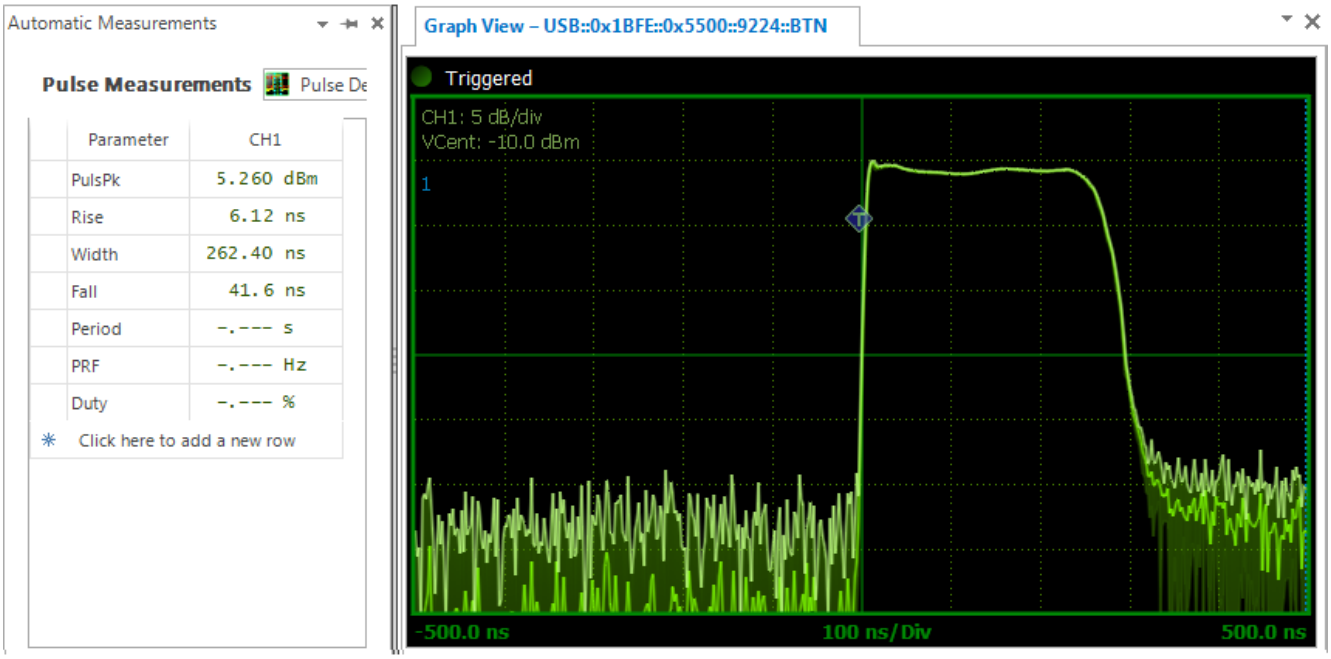
| Test Mode | Rated Width (ns) | Measured Width (ns) | Rise Time (ns) | Peak Power (dBm) |
|---|---|---|---|---|
| 1 | 60 | 68.896 | 6.33 | 74.723 |
| 2 | 250 | 262.4 | 6.12 | 74.510 |
| 3 | 800 | 791.59 | 6.61 | 74.292 |

## PULSE CHARACTERISTICS

**Test Data: Mode 1 Pulse Plot**

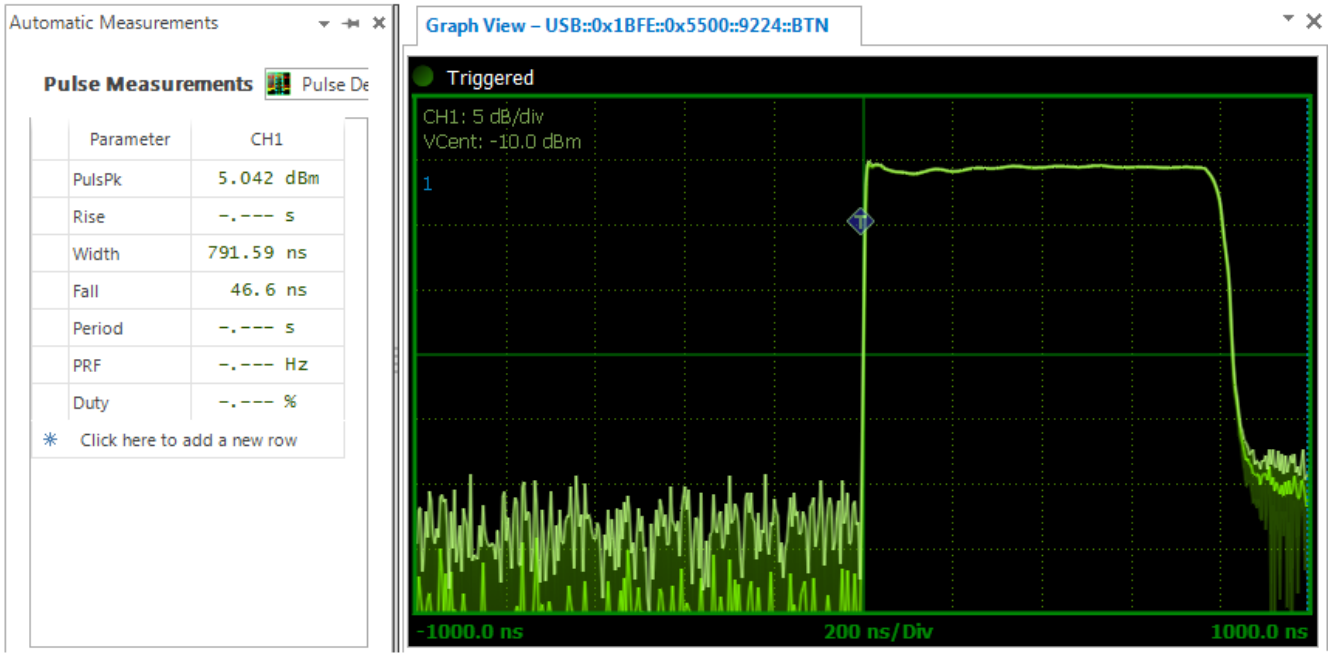



**Test Data: Mode 2 Pulse Plot**



## PULSE CHARACTERISTICS

**Test Data: Mode 3 Pulse Plot**



## 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;

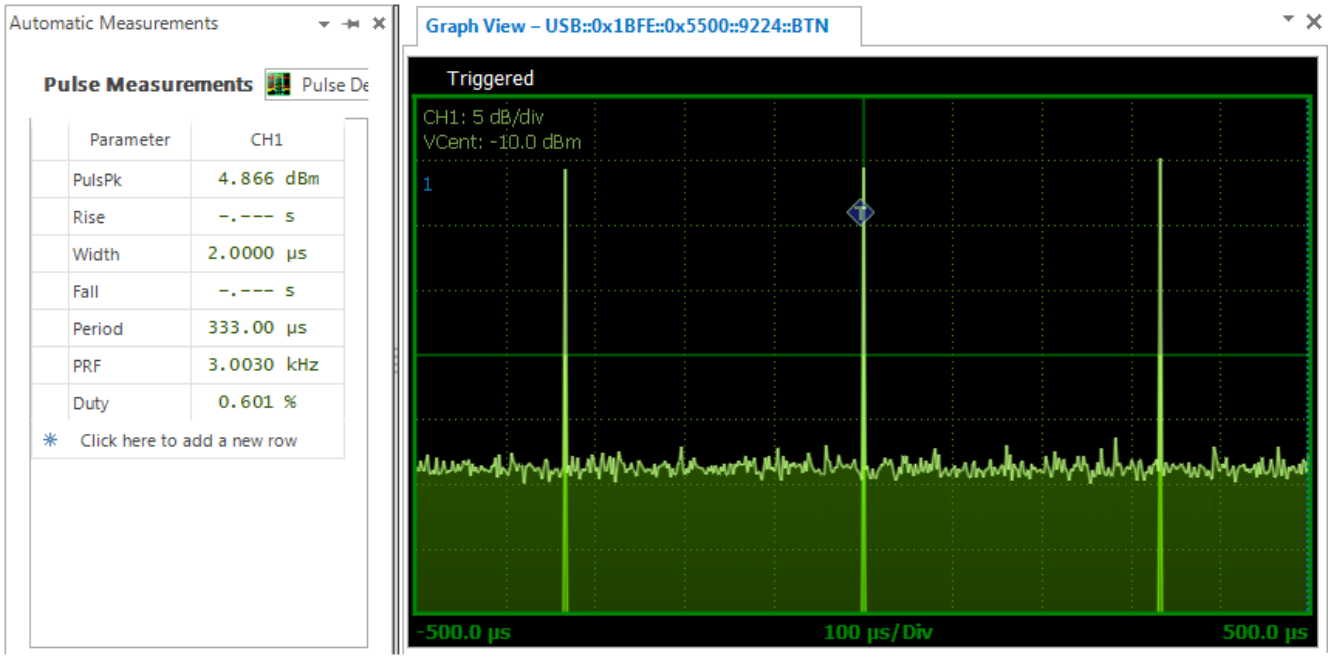
Only one pulse is present in each mode's pulse train.

**Test Data: Pulse Train Measurement Table**

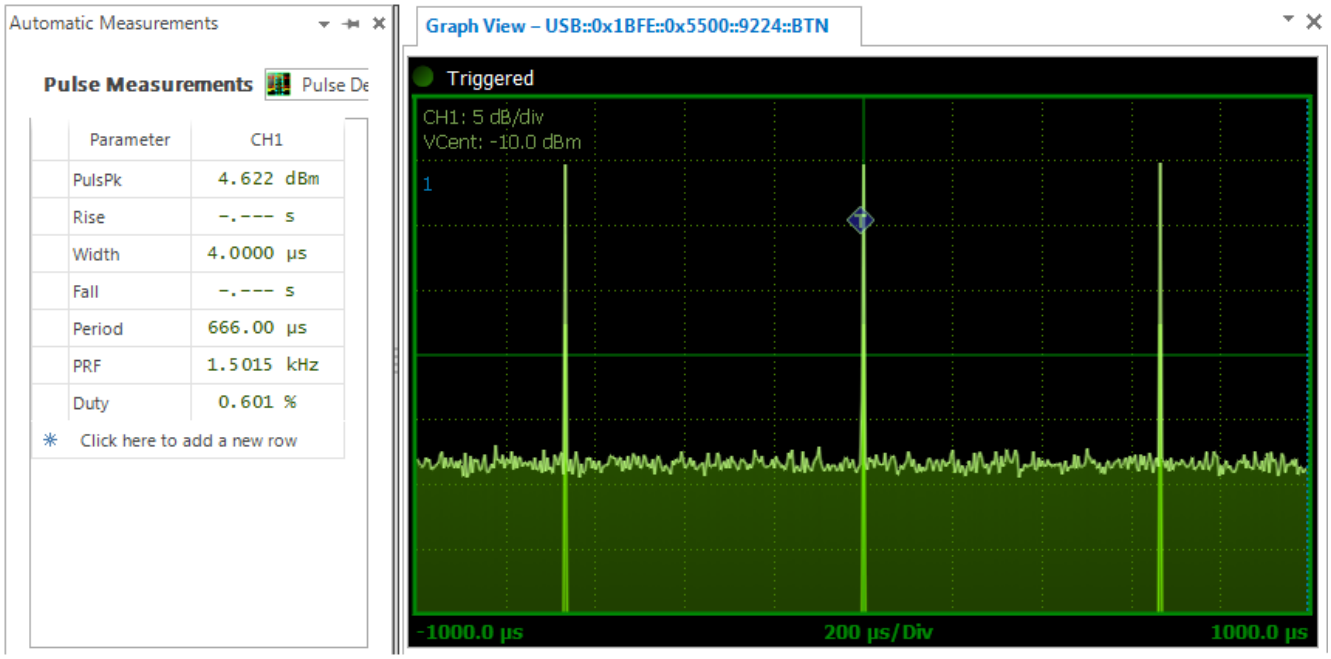
| Test Mode | Rated Width (ns) | Measured Width (ns) | Rep Rate (ms) | Rep Rate (Hz) | Duty Cycle % |
|---|---|---|---|---|---|
| 1 | 60 | 68.896 | 0.333 | 3003.0 | 0.021% |
| 2 | 250 | 262.4 | 0.666 | 1501.5 | 0.039% |
| 3 | 800 | 791.59 | 1.335 | 749.1 | 0.059% |

## PULSE TRAIN CHARACTERISTICS

**Test Data: Mode 1 Pulse Train Plot**

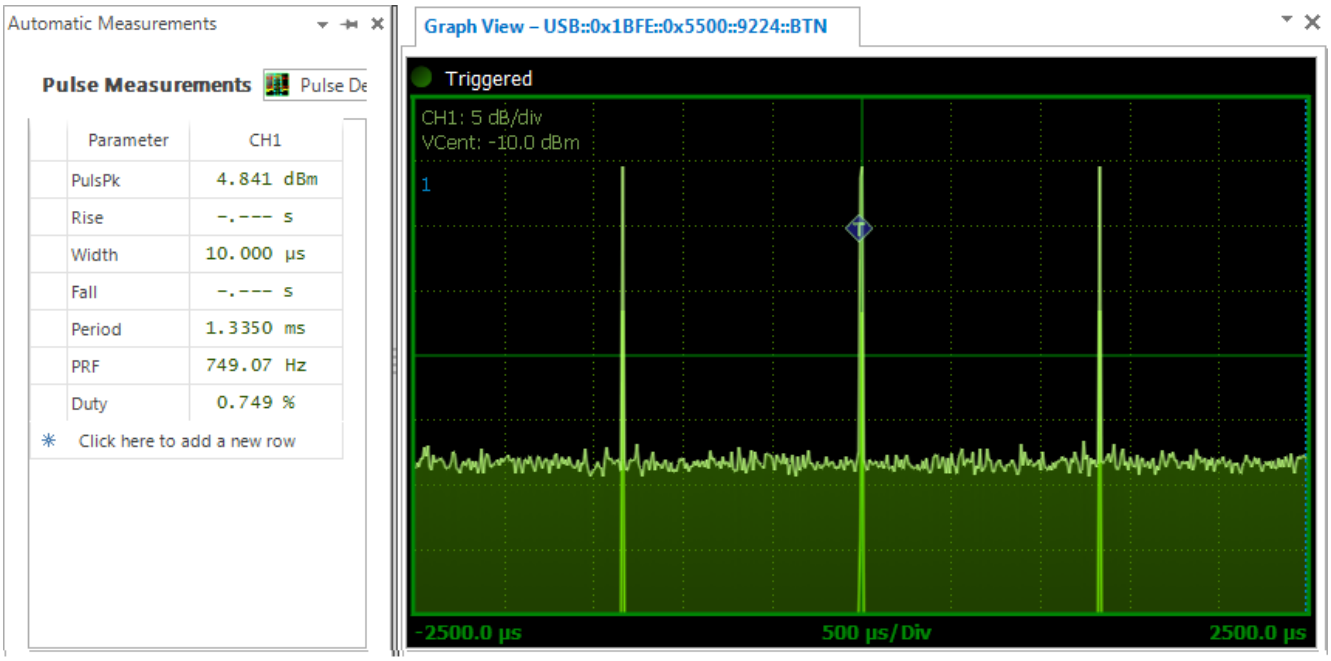



**Test Data: Mode 2 Pulse Train Plot**



## PULSE TRAIN CHARACTERISTICS

**Test Data: Mode 3 Pulse Train Plot**



## 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

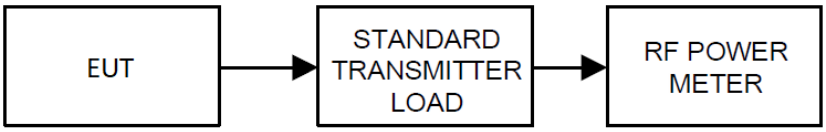
The mean power was calculated based on formula:

**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**

| Test Mode | Peak Frequency (MHz) | Meas. Pulse Length (ns) | Meas. Repetition Period (ms) | Duty Cycle (%) | Meas. Peak Output (dBm) | Meas. Loss (dB) | Antenna Gain (dBi) | Coax Loss (dB) | Peak Power Output (dBm) | Peak Power Output (W) | Mean Power Output (W) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Upmast 1 | 3060.000 | 68.896 | 0.333 | 0.021% | 5.473 | -69.25 | 0.0 | 0.0 | 72.881 | 29668.80 | 6.14 |
| Upmast 2 | 3061.602 | 262.4 | 0.666 | 0.039% | 5.26 | -69.25 | 0.0 | 0.0 | 73.911 | 28248.80 | 11.13 |
| Upmast 3 | 3060.801 | 791.59 | 1.335 | 0.059% | 5.042 | -69.25 | 0.0 | 0.0 | 73.685 | 26865.81 | 15.93 |
| Downmast 1 | 3060.000 | 68.896 | 0.333 | 0.021% | 3.3 | -69.25 | 0.0 | 2.20 | 72.523 | 17877.22 | 3.70 |
| Downmast 2 | 3061.602 | 262.4 | 0.666 | 0.039% | 3.1 | -69.25 | 0.0 | 2.20 | 72.310 | 17021.59 | 6.71 |
| Downmast 3 | 3060.801 | 791.59 | 1.335 | 0.059% | 2.8 | -69.25 | 0.0 | 2.20 | 72.092 | 16188.25 | 9.60 |

**Note:** The "Downmast" model employs an RF waveguide to pass signals from the cabinet antenna port to the antenna pedestal antenna port, to the antenna itself. The loss of this system at the fundamental was measured at: **2.20 dB**

Maximum Peak Power: **Mode 1, 29.67 kW**

Maximum Mean Power: **Mode 3, 15.93 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) (4.727 A) = **520 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

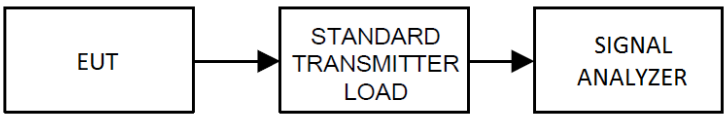
The unwanted emission and the transmitter power shall be measured using a peak detector.

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**

| Test Mode | Peak Frequency (MHz) | 99% Occupied Bandwidth (MHz) | 40dB Occupied Bandwidth (MHz) |
|---|---|---|---|
| 1 | 3060.000 | 66.506 | 141.024 |
| 2 | 3061.602 | 32.853 | 99.359 |
| 3 | 3060.801 | 16.026 | 61.699 |

Max 99% Occupied Bandwidth of EUT = **66.506 MHz**

FCC Emission Designator = **66M5P0N**

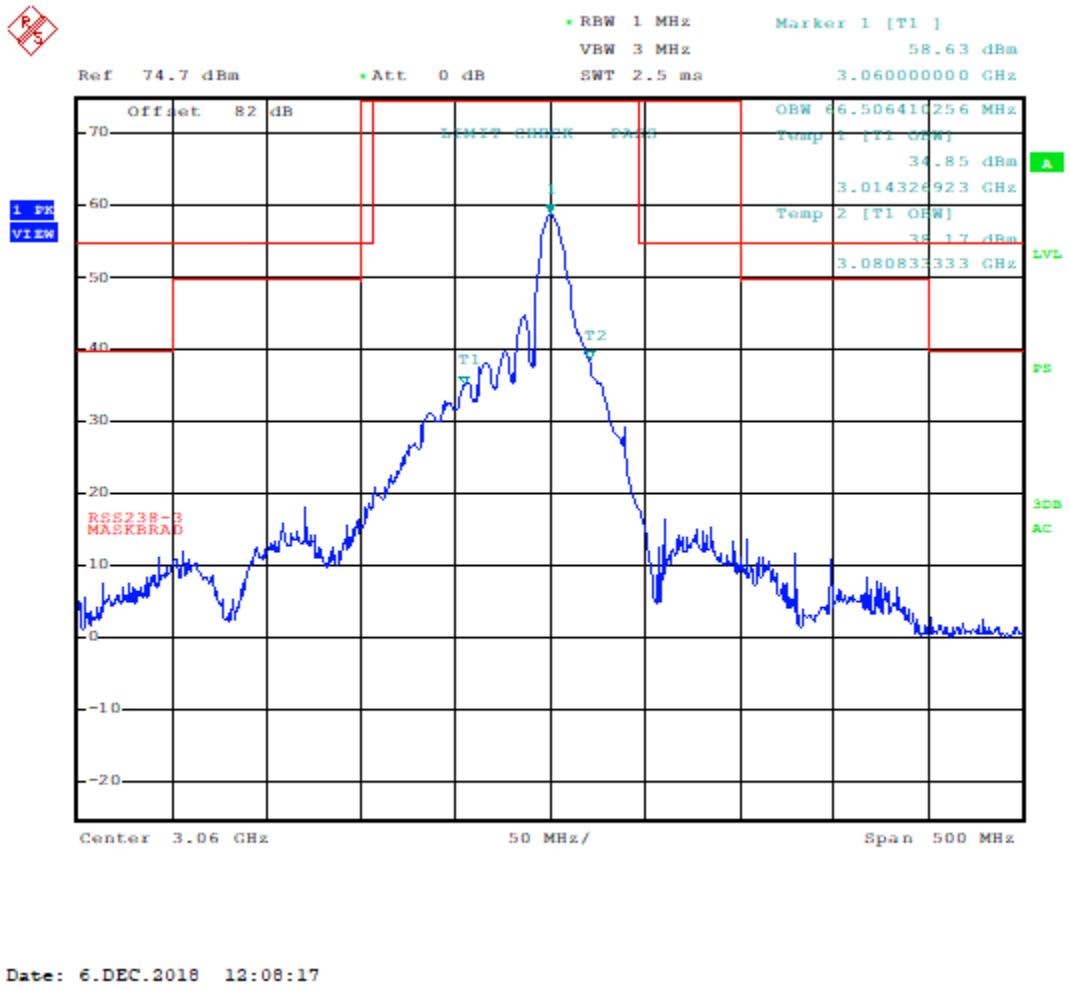
Max 40dB Occupied Bandwidth of EUT = **141.024 MHz**

ISED Emission Designator = **141MP0N**

## OBW & EMISSION MASK

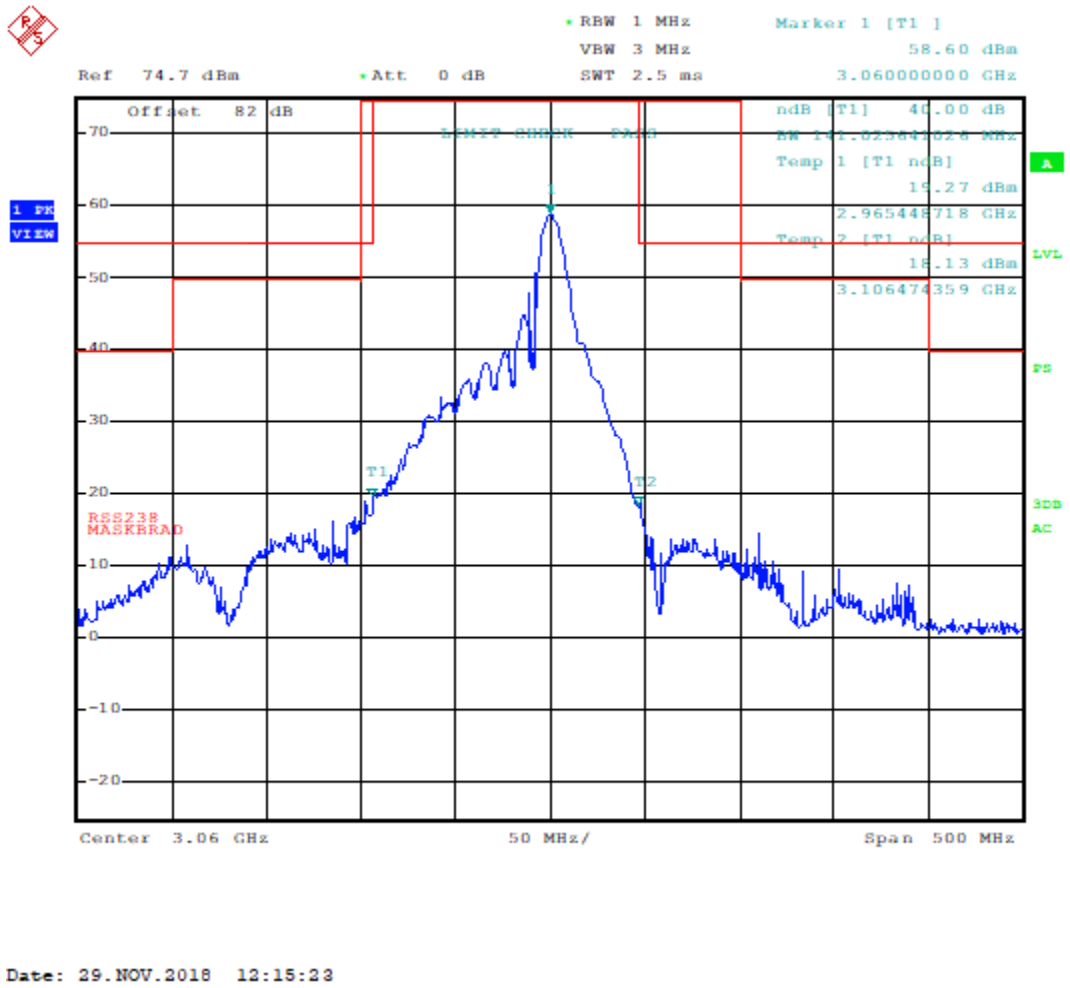
**Note:** OBW and Emission Mask plots are compatible, and the data has been combined in the plots below.
**Note:** The FCC Emission Mask and the ISED Emission Mask are shown simultaneously in the plots below, to demonstrate compliance.

**Test Data: Mode 1 99% OBW Plot**



## OBW & EMISSION MASK

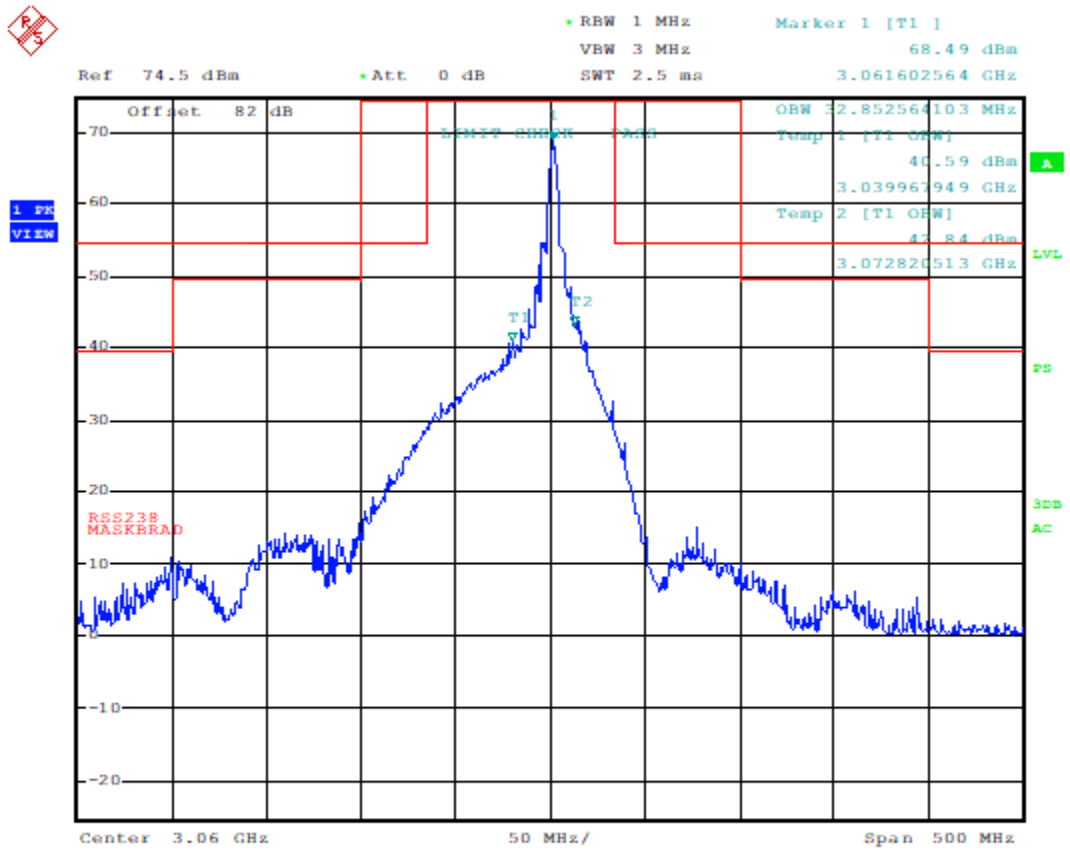
**Test Data: Mode 1 40dB OBW Plot**




Date: 29.NOV.2018 12:15:23

## OBW & EMISSION MASK

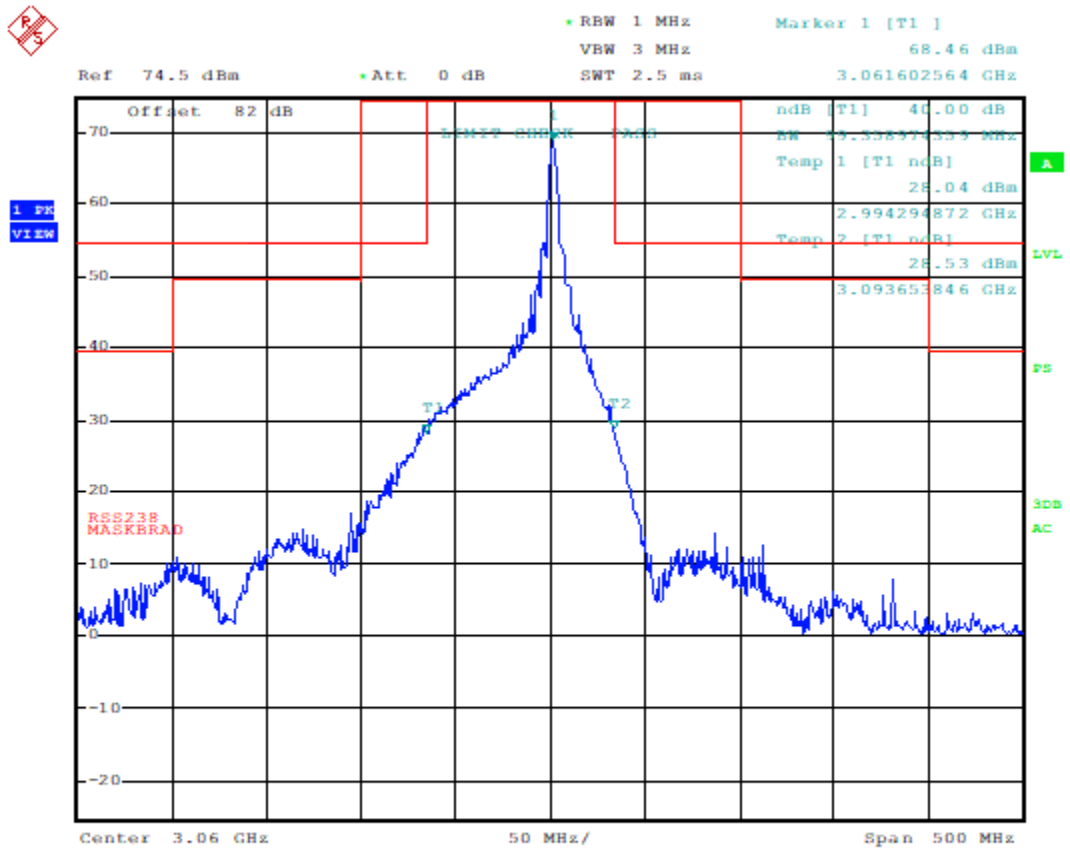
**Test Data: Mode 2 99% OBW Plot**




Date: 29.NOV.2018 12:11:25

## OBW & EMISSION MASK

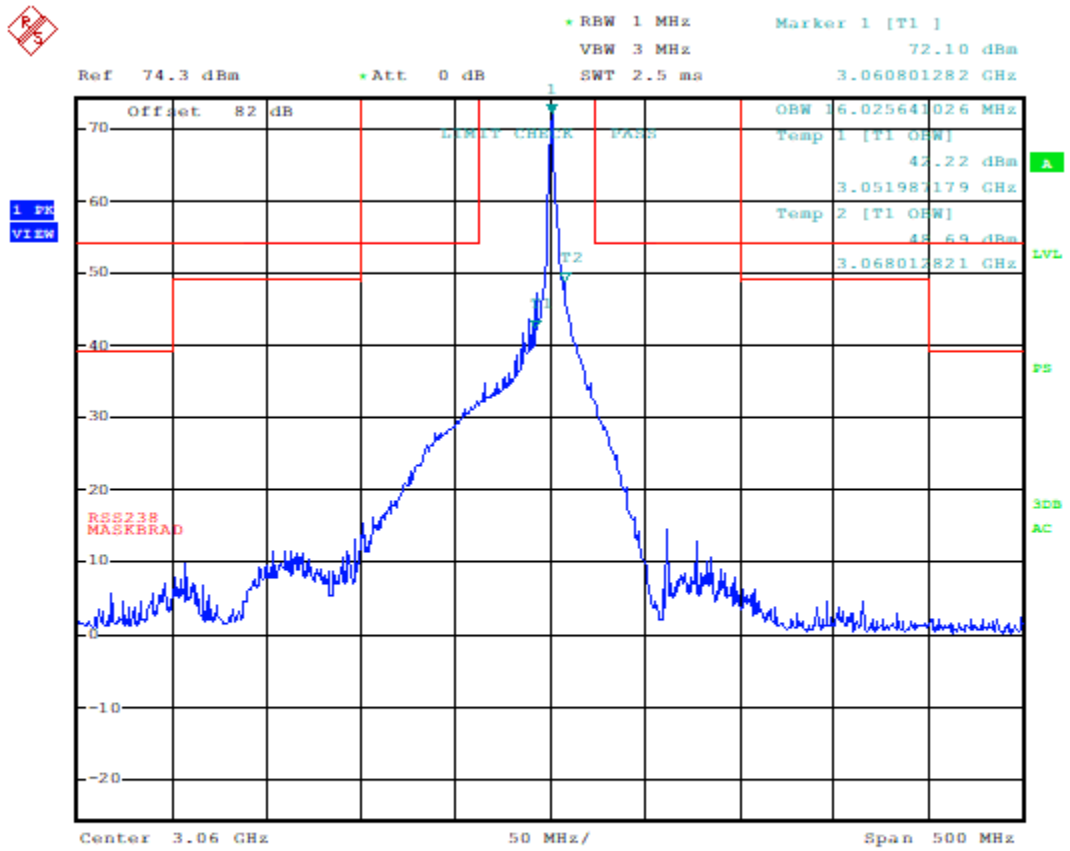
**Test Data: Mode 2 40dB OBW Plot**




Date: 29.NOV.2018 12:14:25

## OBW & EMISSION MASK

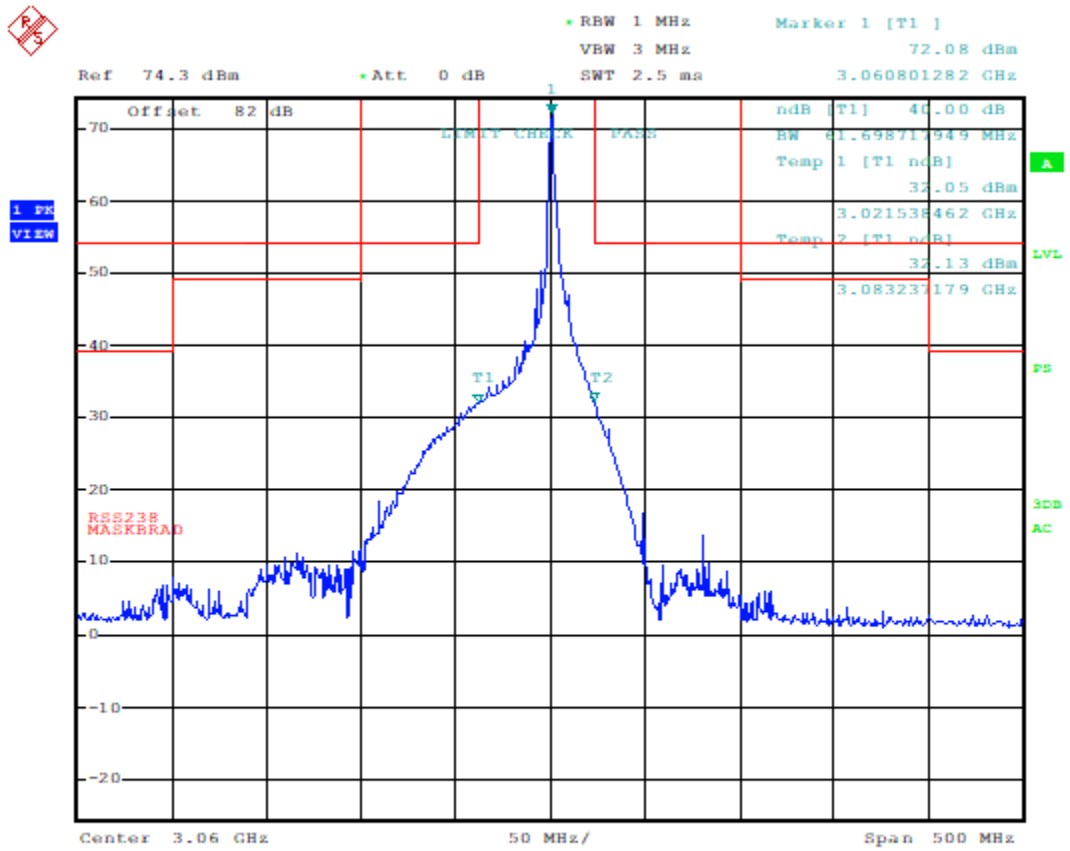
**Test Data: Mode 3 99% OBW Plot**




Date: 29.NOV.2018 12:34:57

## OBW & EMISSION MASK

**Test Data: Mode 3 40dB OBW Plot**




Date: 29.NOV.2018 12:33:47

## 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.

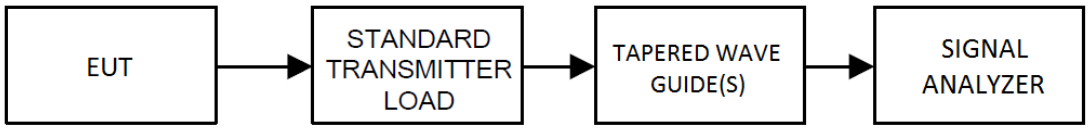
### 4.3 Transmitter Unwanted Emissions

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 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 $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73$ 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 $\leq ((30\ \text{MHz})/(10\ \mu\text{s}))^{1/2} = \sqrt{3}$ MHz ≈ 1.73 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:**

| Test Mode | T (µs) | Bc (MHz) | Bref (MHz) | | MBR (MHz) | Bm (MHz) | Correction (dBm) | Correction (dBm) |
|---|---|---|---|---|---|---|---|---|
| | Total Pulse Length (ns) | 40dB OBW (MHz) | (Bc/T)^0.5 = Bref | If Bref > 1, Bref = 1 (for measuring) | If 3/2 > Bref, MBR = Bref, Else MBR = 3/2 | Bif x MBR = Bm | Noise: If Bm > 1, 10 x Log(Bref/Bm) | Emission: If Bm > 1, 20 x Log(Bref/Bm) |
| 1 | 68.896 | 141.024 | 149.26 | 1.0 | 1.500 | 4.50 | -6.53 | -13.06 |
| 2 | 262.4 | 99.359 | 151.80 | 1.0 | 1.500 | 4.50 | -6.53 | -13.06 |
| 3 | 791.59 | 61.699 | 146.06 | 1.0 | 1.500 | 4.50 | -6.53 | -13.06 |

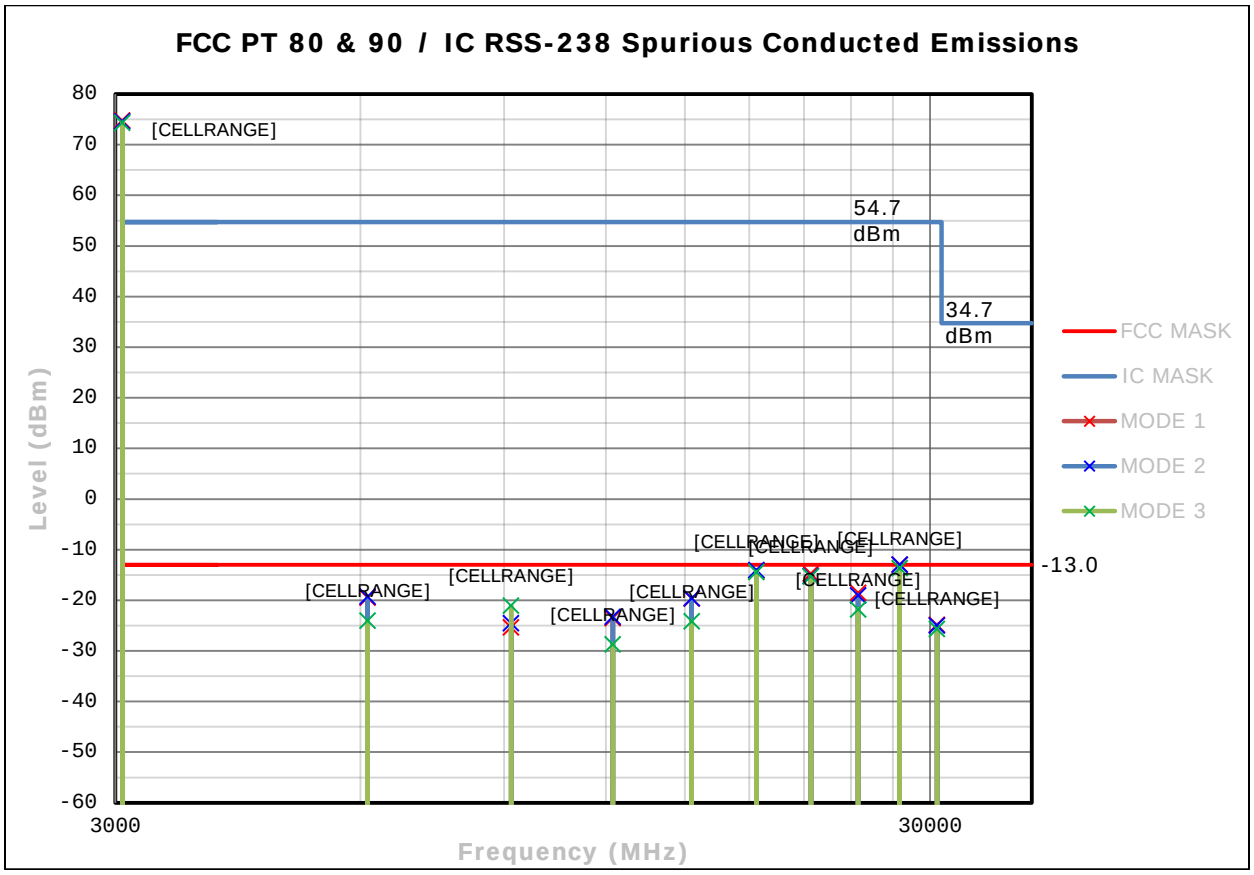
**Limit Calculation** Part 80.211(f)(3)

43 + 10 x Log(Power, in Watts)

| Mode | Measured Output (dBm) | 43+10 x Log(P) Limit (dBm) |
|---|---|---|
| 1 | 74.723 | -13.00 |
| 2 | 74.510 | -13.00 |
| 3 | 74.292 | -13.00 |

## UNWANTED SPURIOUS EMISSIONS

**Test Data: Spurious Conducted Emissions Plot**



**Test Data: 2nd Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 2nd Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 6120.0 | -6.48 | -19.544 | -13.00 | 6.54 |
| 2 | 3061.602 | 74.510 | -13.06 | 6123.2 | -6.28 | -19.344 | -13.00 | 6.34 |
| 3 | 3060.801 | 74.292 | -13.06 | 6121.6 | -11.03 | -24.094 | -13.00 | 11.09 |

Worst-case Emission: **Test Mode 2**

**Test Data: 3rd Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 3rd Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 9180.0 | -12.37 | -25.434 | -13.00 | 12.43 |
| 2 | 3061.602 | 74.510 | -13.06 | 9184.8 | -11.52 | -24.584 | -13.00 | 11.58 |
| 3 | 3060.801 | 74.292 | -13.06 | 9182.4 | -8.07 | -21.134 | -13.00 | 8.13 |

Worst-case Emission: **Test Mode 3**

## UNWANTED SPURIOUS EMISSIONS

**Test Data: 4th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 4th Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 12240.0 | -10.51 | -23.574 | -13.00 | 10.57 |
| 2 | 3061.602 | 74.510 | -13.06 | 12246.4 | -10.24 | -23.304 | -13.00 | 10.30 |
| 3 | 3060.801 | 74.292 | -13.06 | 12243.2 | -15.67 | -28.734 | -13.00 | 15.73 |

Worst-case Emission: **Test Mode 2**

**Test Data: 5th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 3rd Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 15300.0 | -6.68 | -19.744 | -13.00 | 6.74 |
| 2 | 3061.602 | 74.510 | -13.06 | 15308.0 | -6.57 | -19.634 | -13.00 | 6.63 |
| 3 | 3060.801 | 74.292 | -13.06 | 15304.0 | -11.14 | -24.204 | -13.00 | 11.20 |

Worst-case Emission: **Test Mode 2**

## UNWANTED SPURIOUS EMISSIONS

**Test Data: 6th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 4th Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 18360.0 | -1.14 | -14.204 | -13.00 | 1.20 |
| 2 | 3061.602 | 74.510 | -13.06 | 18369.6 | -1.03 | -14.094 | -13.00 | 1.09 |
| 3 | 3060.801 | 74.292 | -13.06 | 18364.8 | -1.42 | -14.484 | -13.00 | 1.48 |

Worst-case Emission: **Test Mode 2**

**Test Data: 7th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 3rd Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 21420.0 | -1.75 | -14.814 | -13.00 | 1.81 |
| 2 | 3061.602 | 74.510 | -13.06 | 21431.2 | -2.19 | -15.254 | -13.00 | 2.25 |
| 3 | 3060.801 | 74.292 | -13.06 | 21425.6 | -2.27 | -15.334 | -13.00 | 2.33 |

Worst-case Emission: **Test Mode 1**

## UNWANTED SPURIOUS EMISSIONS

**Test Data: 8th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 4th Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 24480.0 | -5.53 | -18.594 | -13.00 | 5.59 |
| 2 | 3061.602 | 74.510 | -13.06 | 24492.8 | -6.04 | -19.104 | -13.00 | 6.10 |
| 3 | 3060.801 | 74.292 | -13.06 | 24486.4 | -8.78 | -21.844 | -13.00 | 8.84 |

Worst-case Emission: **Test Mode 1**

**Test Data: 9th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 3rd Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 27540.0 | 0.04 | -13.024 | -13.00 | 0.02 |
| 2 | 3061.602 | 74.510 | -13.06 | 27554.4 | 0.03 | -12.030 | -13.00 | 0.03 |
| 3 | 3060.801 | 74.292 | -13.06 | 27547.2 | -0.68 | -13.744 | -13.00 | 0.74 |

Worst-case Emission: **Test Mode 1**

## UNWANTED SPURIOUS EMISSIONS

**Test Data: 10th Harmonic Peak Table**

| Mode | Center Freq (MHz) | Peak Output Power (dBm) | Spurious Emission Correction (dBm) | 4th Harmonic | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | If Bm > 1, 20 x Log(Bref/Bm) | Harmonic Frequency (MHz) | Measured Peak in Bref (dBm) | Corrected to Bm (dBm) | 43+10 x Log(P) Limit (dBm) | Margin (dB) |
| 1 | 3060.000 | 74.723 | -13.06 | 30600.0 | -11.82 | -24.884 | -13.00 | 11.88 |
| 2 | 3061.602 | 74.510 | -13.06 | 30616.0 | -11.99 | -25.054 | -13.00 | 12.05 |
| 3 | 3060.801 | 74.292 | -13.06 | 30608.0 | -12.69 | -25.754 | -13.00 | 12.75 |

Worst-case Emission: **Test Mode 1**

## 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.

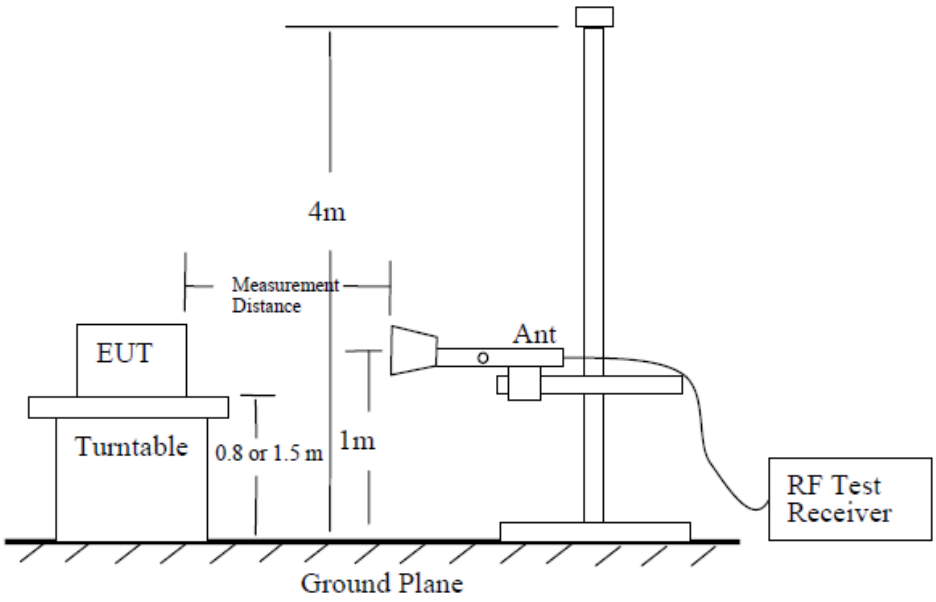
The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40 dB bandwidth and beyond.

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

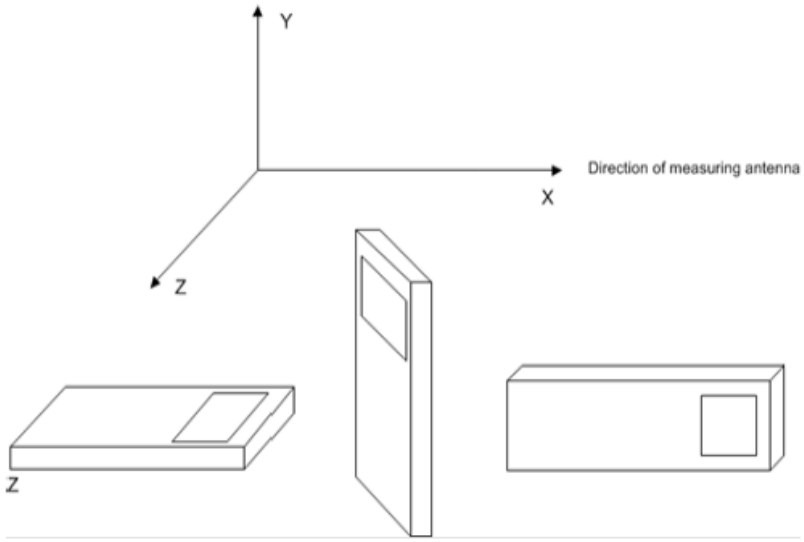
**Test Procedure:** ANSI C63.26, 5.5.4; ITU-R M.1177-4, ANNEX 1

## 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 $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73$ 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 $\leq ((30\ \text{MHz})/(10\ \mu\text{s}))^{1/2} = \sqrt{3}$ MHz ≈ 1.73 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:**

| Test Mode | T (µs) | Bc (MHz) | Bref (MHz) | | MBR (MHz) | Bm (MHz) | Correction (dBm) | Correction (dBm) |
|---|---|---|---|---|---|---|---|---|
| | Total Pulse Length (ns) | 40dB OBW (MHz) | (Bc/T)^0.5 = Bref | If Bref > 1, Bref = 1 (for measuring) | If 3/2 > Bref, MBR = Bref, Else MBR = 3/2 | Bif x MBR = Bm | Noise: If Bm > 1, 10 x Log(Bref/Bm) | Emission: If Bm > 1, 20 x Log(Bref/Bm) |
| 1 | 68.896 | 141.024 | 149.26 | 1.0 | 1.500 | 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 | 74.723 | -13.00 |

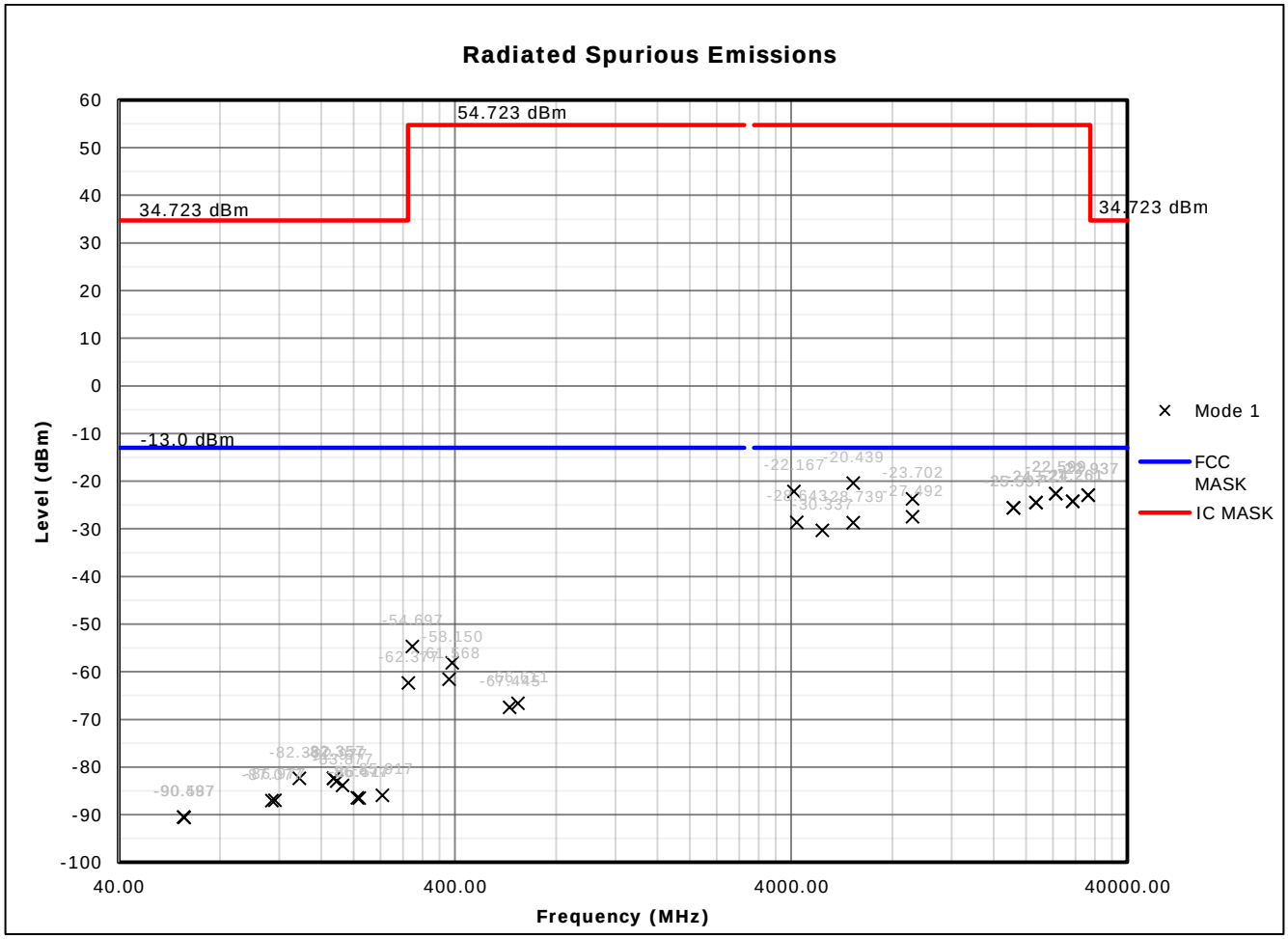
**Note:** The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from the lowest frequency generated internally to the tenth harmonic of the fundamental frequency or 40 GHz, whichever is less. This test was conducted in accordance with the referenced 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 Mode 1**

## FIELD STRENGTH OF SPURIOUS EMISSIONS

**Test Data: Radiated Spurious Emissions Plot**



## 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) | Field Strength (dBµV/m) | Distance (m) | Field Strength (dBµV/m) | ERP (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3060 | 62.41 | 31.19 | V | 0.93 | 6.88 | 39.00 | 3.000 | 38.999 | -58.378 | 45.38 |
| 3060 | 62.69 | 22.29 | H | 0.93 | 6.79 | 30.01 | 3.000 | 30.012 | -67.366 | 54.37 |
| 3060 | 114.15 | 17.25 | H | 1.22 | 10.30 | 28.77 | 3.000 | 28.771 | -68.606 | 55.61 |
| 3060 | 116.63 | 19.55 | H | 1.23 | 10.40 | 31.18 | 3.000 | 31.183 | -66.194 | 53.19 |
| 3060 | 137.88 | 21.00 | V | 1.33 | 14.99 | 37.32 | 3.000 | 37.319 | -60.058 | 47.06 |
| 3060 | 174.39 | 18.59 | H | 1.54 | 15.02 | 35.15 | 3.000 | 35.148 | -62.230 | 49.23 |
| 3060 | 174.41 | 29.65 | V | 1.54 | 15.02 | 46.21 | 3.000 | 46.208 | -51.170 | 38.17 |
| 3060 | 178.00 | 21.16 | H | 1.55 | 14.40 | 37.11 | 3.000 | 37.112 | -60.265 | 47.27 |
| 3060 | 185.28 | 15.47 | V | 1.58 | 13.50 | 30.55 | 3.000 | 30.546 | -66.831 | 53.83 |
| 3060 | 205.12 | 17.91 | H | 1.63 | 10.90 | 30.44 | 3.000 | 30.435 | -66.942 | 53.94 |
| 3060 | 207.60 | 29.06 | V | 1.63 | 10.86 | 41.55 | 3.000 | 41.548 | -55.830 | 42.83 |
| 3060 | 243.58 | 23.68 | H | 1.81 | 11.46 | 36.95 | 3.000 | 36.953 | -60.424 | 47.42 |
| 3060 | 291.02 | 19.02 | V | 2.08 | 13.90 | 35.00 | 3.000 | 35.000 | -62.377 | 49.38 |
| 3060 | 298.71 | 26.90 | H | 2.08 | 13.70 | 42.68 | 3.000 | 42.680 | -54.697 | 41.70 |
| 3060 | 384.61 | 18.76 | V | 2.25 | 14.80 | 35.81 | 3.000 | 35.809 | -61.568 | 48.57 |
| 3060 | 392.30 | 21.86 | H | 2.27 | 15.10 | 39.23 | 3.000 | 39.227 | -58.150 | 45.15 |
| 3060 | 582.05 | 8.17 | H | 2.86 | 18.90 | 29.93 | 3.000 | 29.932 | -67.445 | 54.45 |
| 3060 | 616.66 | 9.07 | V | 2.90 | 18.80 | 30.77 | 3.000 | 30.767 | -66.611 | 53.61 |
| 3060 | 4078.50 | 34.19 | V | 7.63 | 33.39 | 75.21 | 3.000 | 75.211 | -22.167 | 9.17 |
| 3060 | 4160.25 | 27.63 | H | 7.70 | 33.40 | 68.73 | 3.000 | 68.734 | -28.643 | 15.64 |
| 3060 | 4950.00 | 24.71 | H | 8.39 | 33.94 | 67.04 | 3.000 | 67.040 | -30.337 | 17.34 |
| 3060 | 6120.00 | 23.91 | V | 9.45 | 35.28 | 68.64 | 3.000 | 68.638 | -28.739 | 15.74 |
| 3060 | 6120.00 | 32.21 | H | 9.45 | 35.28 | 76.94 | 3.000 | 76.938 | -20.439 | 7.44 |
| 3060 | 9180.00 | 22.31 | V | 11.35 | 36.22 | 69.88 | 3.000 | 69.885 | -27.492 | 14.49 |
| 3060 | 9180.00 | 26.10 | H | 11.35 | 36.22 | 73.67 | 3.000 | 73.675 | -23.702 | 10.70 |
| 3060 | 18360.00 | 10.59 | H | 16.44 | 44.75 | 71.78 | 3.000 | 71.780 | -25.597 | 12.60 |
| 3060 | 18360.00 | 10.59 | V | 16.44 | 44.75 | 71.78 | 3.000 | 71.780 | -25.597 | 12.60 |
| 3060 | 21420.00 | 10.59 | H | 17.89 | 44.38 | 72.86 | 3.000 | 72.856 | -24.521 | 11.52 |
| 3060 | 21420.00 | 10.59 | V | 17.89 | 44.38 | 72.86 | 3.000 | 72.856 | -24.521 | 11.52 |
| 3060 | 24480.00 | 10.59 | V | 18.90 | 45.29 | 74.78 | 3.000 | 74.778 | -22.599 | 9.60 |
| 3060 | 24480.00 | 10.59 | H | 18.90 | 45.29 | 74.78 | 3.000 | 74.778 | -22.599 | 9.60 |
| 3060 | 27540.00 | 6.29 | H | 20.23 | 46.60 | 73.12 | 3.000 | 73.116 | -24.261 | 11.26 |
| 3060 | 27540.00 | 6.29 | V | 20.23 | 46.60 | 73.12 | 3.000 | 73.116 | -24.261 | 11.26 |
| 3060 | 30600.00 | 6.29 | V | 21.44 | 46.71 | 74.44 | 3.000 | 74.440 | -22.937 | 9.94 |
| 3060 | 30600.00 | 6.29 | H | 21.44 | 46.71 | 74.44 | 3.000 | 74.440 | -22.937 | 9.94 |

## 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)]

| 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.

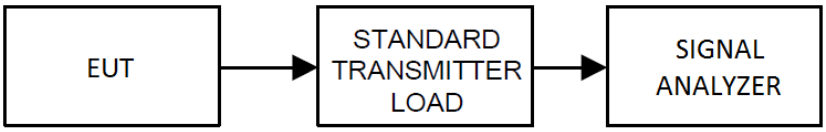
**IC Rule Parts:** RSS-238 s.4.1

### 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.

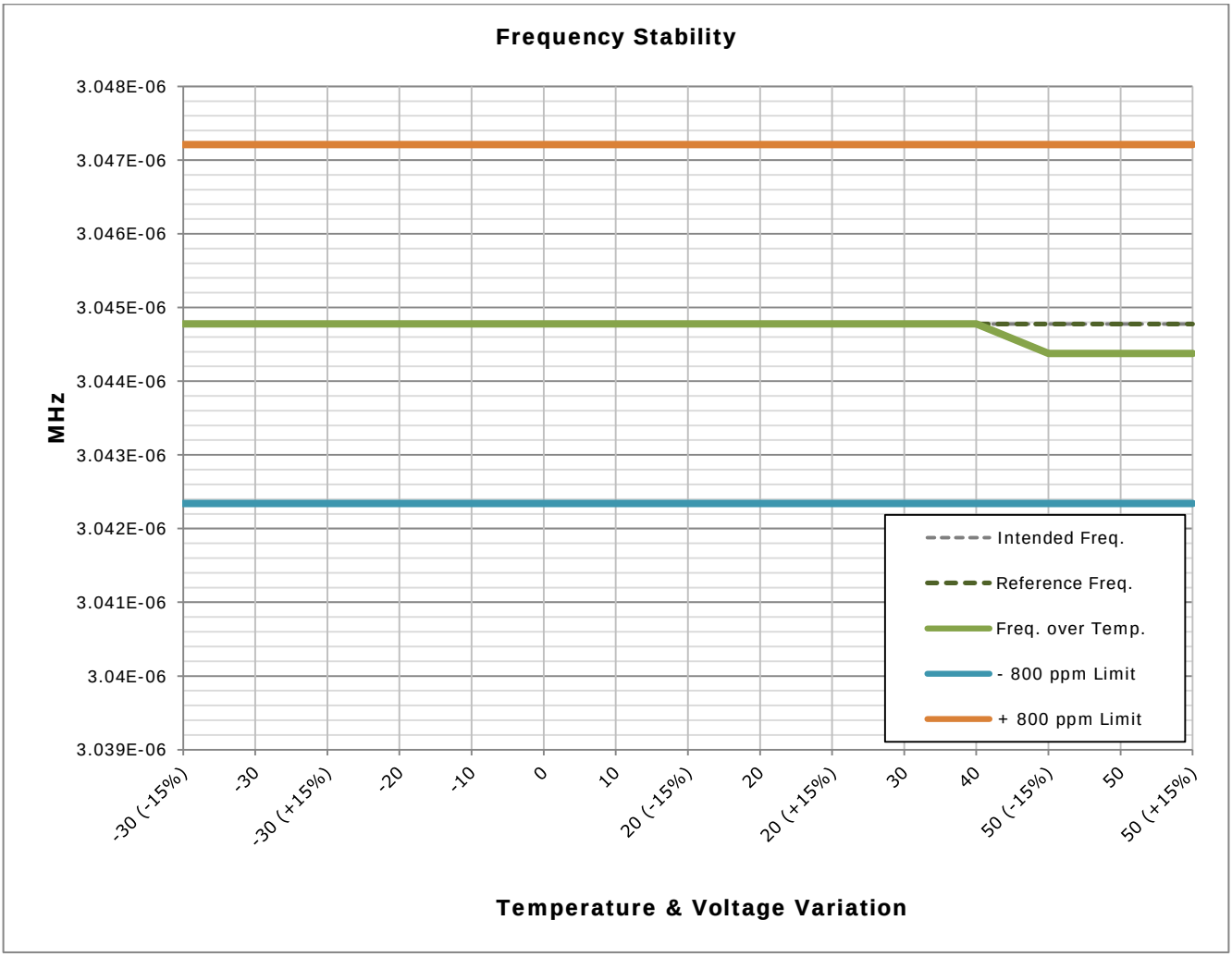
**Test Procedure:** TIA 603-E, 2.2.2

**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**

| | | | | |
|---|---|---|---|---|
| | RSS-238 4.1 Limit: | 800 | ppm | |
| | Shortest Pulse Duration: | 0.0068896 | µs | |
| | Limit: | 217.7194612 | MHz from Auth. BW | |
| | Authorized Bandwidth | 200 | MHz | |
| | 80.209(b) Limit: | 2682 | MHz (upper) | |
| | | 3317.719461 | MHz (lower) | |
| | 80.209(b) Limit in PPM: | 400,000 | ppm | |
| | Most Strict Limit: | 800 | ppm | |
| **Temperature (°C)** | **Supplied Voltage (VAC)** | **Intended Frequency (GHz)** | **Measured Reference Frequency (GHz)** | **Deviation (Hz)** |
| 20°C (reference) | 120 | 3.044775641 | 3.044775641 | 0 |
| **Over Voltage Range** | | | | |
| **Temperature (°C)** | **Supplied Voltage (VDC)** | **Frequency (GHz)** | **Deviation (GHz)** | **PPM** |
| +20 | 102 | 3.044775641 | 0.00000 | 0.000 |
| +20 | 138 | 3.044775641 | 0.00000 | 0.000 |
| -30 | 102 | 3.044775641 | 0.00000 | 0.000 |
| -30 | 138 | 3.044775641 | 0.00000 | 0.000 |
| +50 | 102 | 3.044375 | 0.00040 | 131.583 |
| +50 | 138 | 3.044375 | 0.00040 | 131.583 |
| **Over Temperature Range** | | | | |
| **Temperature (°C)** | **Supplied Voltage (VDC)** | **Frequency (GHz)** | **Deviation (GHz)** | **PPM** |
| +50 | 120 | 3.044375 | 0.00040 | 131.583 |
| +40 | 120 | 3.044775641 | 0.00000 | 0.000 |
| +30 | 120 | 3.044775641 | 0.00000 | 0.000 |
| +20 | 120 | 3.044775641 | 0.00000 | 0.000 |
| +10 | 120 | 3.044775641 | 0.00000 | 0.000 |
| 0 | 120 | 3.044775641 | 0.00000 | 0.000 |
| -10 | 120 | 3.044775641 | 0.00000 | 0.000 |
| -20 | 120 | 3.044775641 | 0.00000 | 0.000 |
| -30 | 120 | 3.044775641 | 0.00000 | 0.000 |

**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 | 03/01/19 |
| 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 | 04/01/16 | 04/01/19 |
| Bore-sight Antenna Positioning Tower | Sunol Sciences | TLT2 | N/A | N/A | N/A |
| Terminator N 20W DC-18G | Narda | 8205 | #14 | 04/06/17 | 04/06/19 |
| 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 |
| Coaxial Cable - SMSM-0019-00 Black | N/A | N/A | SMSM-0019-00 | 05/16/17 | 05/16/19 |
| 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 |
| Coaxial Cable - KMKM-0180-01 Aqua | Micro-Coax | N/A | KMKM-0180-00 | 07/21/16 | 07/21/19 |
| 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 | 04/06/17 | 04/06/19 |
| 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