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## FCC CFR 47 Part 90 Radar Test Report

|                            |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| <b>APPLICANT</b>           | Enterprise Electronics Corporation                                     |
| <b>ADDRESS</b>             | 128 South Industrial Blvd.<br>Enterprise , Alabama 36330 USA           |
| <b>FCC ID</b>              | BUV-MAVERICK                                                           |
| <b>MODEL NUMBER</b>        | MAVERICK                                                               |
| <b>PRODUCT DESCRIPTION</b> | X-BAND WEATHER RADAR                                                   |
| <b>FINAL TEST DATE</b>     | 03/15/2020                                                             |
| <b>TESTED BY</b>           | Franklin Rose                                                          |
| <b>APPROVED BY</b>         | Tim Royer                                                              |
| <b>TEST RESULTS</b>        | <input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL |

**AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION  
UNDER ISO/IEC 17025, AND ISO/IEC 17065**



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**SIGNATURE PAGE**

Timco Engineering, Inc. attests that:

|                                     |                                                                                                                                             |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | The EUT tested herein <b>fulfills</b> all approval requirements and/or the customer requirements as identified in this test report.         |
| <input type="checkbox"/>            | The EUT tested herein <b>does not fulfill</b> all approval requirements and/or the customer requirements as identified in this test report. |

This report relates only to the Equipment Under Test (EUT) sample(s) tested.

This report shall not be reproduced except in full without the written approval of Timco Engineering, Inc.

To the best of my knowledge and belief, this device has been tested in accordance with the standards identified in this test report, and 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 measurements were made at:

Timco Engineering Inc.  
849 NW State Road 45  
Newberry, FL 32669



**Name and Title** Franklin Rose, Project Manager / EMC Specialist



**Name and Title** Tim Royer, Project Manager / EMC Engineer

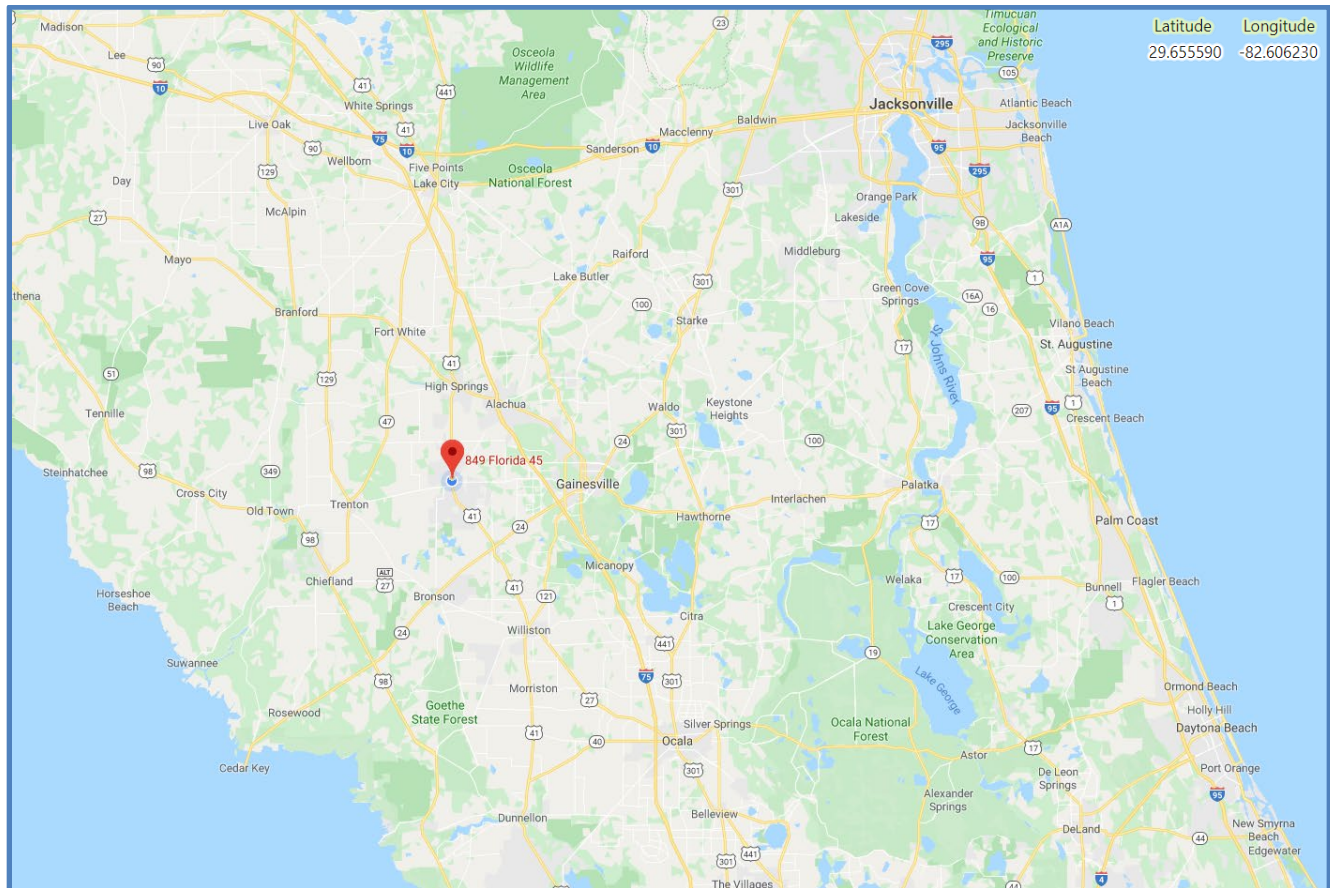


**Name and Title** Sharon Hoffman, Senior Marketing Director

**Date** MAR 15, 2020

## TEST LABORATORY INFORMATION

**Timco Engineering Inc.**  
**849 NW State Road 45**  
**Newberry, FL 32669, USA**



|                                |                                                                                                                  |
|--------------------------------|------------------------------------------------------------------------------------------------------------------|
| <b>United States</b>           | FCC Accredited and Recognized Test <a href="#">Lab</a> & <a href="#">TCB</a> # US1070                            |
|                                | DHS Recognized P25 <a href="#">CAP</a> Test Facility # P25CAPTIMCO081016                                         |
| <b>Australia / New Zealand</b> | U.S. CABs Recognized by Australia ACMA Under MRA                                                                 |
| <b>Canada</b>                  | U.S. <a href="#">Lab</a> & <a href="#">CB</a> Recognized by Canada ISED, Designation # US0111, Test Site # 2056A |
| <b>Chinese Taipei</b>          | U.S. CABs Recognized by Chinese Taipei BSMI/NCC Under MRA                                                        |
| <b>European Union</b>          | U.S. <a href="#">EMC</a> & <a href="#">RE</a> Directive NB's, Designation # US0111, Notified Body # 1177         |
| <b>Hong Kong</b>               | U.S. Labs & CBs Recognized by Hong Kong OFCA Under MRA                                                           |
| <b>Israel</b>                  | U.S. CABs Recognized by Israel MOE/MOC Under MRA                                                                 |
| <b>Japan</b>                   | U.S. <a href="#">RCBs</a> Recognized by Japan MIC                                                                |
| <b>Korea</b>                   | U.S. CABs Recognized by Korea RRA Under MRA                                                                      |
| <b>Mexico</b>                  | U.S. CABs Recognized by Mexico IFT Under MRA                                                                     |
| <b>Singapore</b>               | U.S. Labs & CBs Recognized by Singapore IMDA Under MRA                                                           |
| <b>Vietnam</b>                 | U.S. CABs Recognized by Vietnam MIC Under MRA                                                                    |

**TEST INFORMATION**

| Report Version | Description      | Issue Date  |
|----------------|------------------|-------------|
| Rev1           | Initial Issue    | MAR 15 2020 |
| Rev2           | Clerical Updates | APR 23 2020 |
| Rev3           |                  |             |
| Rev4           |                  |             |
| Rev5           |                  |             |
| Rev6           |                  |             |

|                             |                                                                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Test Conditions</b>      | Temperature during testing: 26°C, Humidity during testing: 50%                                                                               |
| <b>Test Exercise</b>        | The EUT was operated in accordance with the service manual using software supplied by the manufacturer.                                      |
| <b>Applicable Standards</b> | ANSI C63.26, December 11, 2015<br>FCC CFR 47 Part 2, December 5, 2019<br>FCC CFR 47 Part 90, November 25, 2019<br>ITU-R M.1177-4, April 2011 |
| <b>Test Facility</b>        | Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA                                                                        |

**EUT INFORMATION**

PROTECTING PEOPLE AND ASSETS™

**Definitions:** FCC Part 90.7

**The EUT is a Radar Station executing radiodetermination, performing radiolocation and/or radionavigation.**

*Radiodetermination.* The determination of position, or the obtaining of information relating to position, by means of the propagation of radio waves.

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

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

|                             |                                                                                                                                          |                                                       |                                                         |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------|
| <b>EUT Description</b>      | X-BAND WEATHER RADAR                                                                                                                     |                                                       |                                                         |
| <b>Model Number</b>         | MAVERICK                                                                                                                                 |                                                       |                                                         |
| <b>Emission Designator</b>  | 30M1P0N                                                                                                                                  |                                                       |                                                         |
| <b>Measurement Method</b>   | 40dB Occupied Bandwidth                                                                                                                  |                                                       |                                                         |
| <b>Modulation</b>           | CW Pulse                                                                                                                                 |                                                       |                                                         |
| <b>Modified for Testing</b> | <input type="checkbox"/>                                                                                                                 |                                                       |                                                         |
| <b>Note</b>                 | A customer-provided 30 dB coupler was characterized for testing and introduced into the transmit path before performing conducted tests. |                                                       |                                                         |
| <b>Antenna Connector</b>    | <input type="checkbox"/><br>UHF                                                                                                          | <input type="checkbox"/><br>BNC                       | <input type="checkbox"/><br>N                           |
|                             | <input type="checkbox"/><br>TNC                                                                                                          | <input type="checkbox"/><br>SMA                       | <input checked="" type="checkbox"/><br>WR-112 Waveguide |
| <b>EUT Power Source</b>     | <input checked="" type="checkbox"/><br>AC Power (220 V)                                                                                  | <input type="checkbox"/><br>DC Power (13.8 V)         | <input type="checkbox"/><br>DC Battery (13.8 V)         |
| <b>Test Item</b>            | <input type="checkbox"/><br>Engineering Prototype                                                                                        | <input checked="" type="checkbox"/><br>Pre-Production | <input type="checkbox"/><br>Post-Production             |
| <b>Type of Equipment</b>    | <input checked="" type="checkbox"/><br>Fixed                                                                                             | <input type="checkbox"/><br>Mobile                    | <input type="checkbox"/><br>Portable                    |

## 2.1033 APPLICATION REQUIREMENTS

### §2.1033 Application for certification.

(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:

| Application Requirement       | Requirement                                                                            | Information                                                                                        |
|-------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| 2.1033(c)(1)                  | The full name and mailing address of the applicant for certification                   | Enterprise Electronics Corporation<br>128 South Industrial Blvd.<br>Enterprise , Alabama 36330 USA |
| 2.1033(c)(2)                  | FCC Identifier                                                                         | BUV-MAVERICK                                                                                       |
| 2.1033(c)(4)<br>2.1033(c)(13) | Type(s) of Emission & description of Digital Modulation Techniques                     | <input checked="" type="checkbox"/>                                                                |
| 2.1033(c)(5)                  | Frequency Range                                                                        | 8500 - 9600 MHz                                                                                    |
| 2.1033(c)(6),(7)              | Range of operating power or specific operating power levels, and Maximum Power Rating. | 100,000 W                                                                                          |
| 2.1033(c)(6)                  | Description of means to vary power                                                     | n/a                                                                                                |
| 2.1033(c)(8)                  | The DC voltage & current at the final amplifier for normal operation                   | 220 VAC * 12 A = 2640 W                                                                            |
| 2.1033(c)(14)                 | Test Results satisfying 2.1046 – 2.1057                                                | <input checked="" type="checkbox"/>                                                                |
| 2.1033(c)(21)                 | Contain > 1 Drawing or Photograph of each test setup applicable to the device          | <input checked="" type="checkbox"/>                                                                |

**90.203, 90.217 EXEMPTION FROM REQUIREMENTS****§90.217 Exemption from technical standards.**

Except as noted herein, transmitters used at stations licensed below 800 MHz on any frequency listed in subparts B and C of this part or licensed on a business category channel above 800 MHz which have an output power not exceeding 120 milliwatts are exempt from the technical requirements set out in this subpart, but must instead comply with the following:

(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

(b) For equipment designed to operate with a 12.5 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 25 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

(c) For equipment designed to operate with a 6.25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 12.5 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

(d) Transmitters may be operated in the continuous carrier transmit mode.

(e) Transmitters used for wireless microphone operations and operating on frequencies allocated for Federal use must comply with the requirements of §90.265(b).

## 2.1041 MEASUREMENT PROCEDURE

### §2.1041 Measurement procedure.

(a) For equipment operating under parts 15 and 18, the measurement procedures are specified in the rules governing the particular device for which certification is requested.

(b) For equipment operating in the authorized radio services, measurements are required as specified in §§2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055 and 2.1057. The measurement procedures in ANSI C63.26-2015 (incorporated by reference, see §2.910) are acceptable for performing compliance measurements for equipment types covered by the measurement standard. See also §2.947 for acceptable measurement procedures.

## 2.1046 – 2.1055 TECHNICAL REQUIREMENTS

| General Requirement (FCC PT 2) | Specific Requirement (FCC PT 90) | Requirement                                       | Complies                            | N/A                                 |
|--------------------------------|----------------------------------|---------------------------------------------------|-------------------------------------|-------------------------------------|
| 2.1033(c)(4)                   |                                  | Modulation Characteristics                        | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| 2.1046                         | 90.205                           | RF Power Output                                   | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| 2.1047                         |                                  | Audio Frequency Response                          | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |
| 2.1047                         |                                  | Audio Low Pass Filter Response                    | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |
| 2.1047                         |                                  | Modulation Limiting                               | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |
| 2.1049                         | 90.209                           | Occupied Bandwidth                                | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
|                                | 90.210                           | Emission Masks                                    | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| 2.1051                         | 90.210                           | Conducted Spurious Emissions at Antenna Terminals | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| 2.1053                         | 90.210                           | Radiated Field Strength of Spurious Emissions     | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| 2.1055                         | 90.213                           | Frequency Stability                               | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |

## 2.1057 FREQUENCY SPECTRUM TO BE INVESTIGATED

**Requirements:** 2.1057, ANSI C63.26 S 5.1.2

### §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.

(2) If the equipment operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

(3) If the equipment operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower.

(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

## 5.1.2 Number of fundamental frequencies to be tested in EUT transmit band

### 5.1.2.1 General requirement

Measurements of transmitters shall be performed and, if required, reported for each frequency band in which the EUT can be operated with the device transmitting at the number of frequencies in each band specified in Table 2.

**Table 2—Number of frequencies to be tested**

| Frequency range over which EUT operates | Number of frequencies | Location in frequency range of operation     |
|-----------------------------------------|-----------------------|----------------------------------------------|
| 1 MHz or less                           | 1                     | Middle                                       |
| 1 MHz to 10 MHz                         | 2                     | 1 near top and 1 near bottom                 |
| More than 10 MHz                        | 3                     | 1 near top, 1 near middle, and 1 near bottom |

### 5.1.2.2 Test channels and test modes (streamlined test requirements)<sup>25</sup>

Measurement of all modes and all channels is not always necessary to demonstrate compliance. Regardless of the test reduction methods selected, a device must comply with all the applicable rule parts under all modes of operation. A detailed technical rationale must be provided as justification for the selection of a subset of operational modes as being representative of “worst case” conditions.

<sup>25</sup> Use of the procedures in 5.1.2.2 is subject to the discretion of the regulatory authority.

### 90.103 FREQUENCY BAND

#### §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         |                     |            |
| 8500 to 9000      | .....do             | 12, 17     |
| 9000 to 9200      | .....do             | 10, 14     |
| 9200 to 9300      | .....do             | 12         |
| 9300 to 9500      | .....do             | 10, 15, 18 |
| 9500 to 10,000    | .....do             | 12         |

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

(12) This frequency is shared with and is on a secondary basis to the Government Radiolocation Service.

(14) This frequency band is shared with and is on a secondary basis to the Aeronautical Radionavigation Service (part 87) and to the Government Radiolocation Service.

(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.

(17) Operation in this frequency band is on a secondary basis to airborne Doppler radars at 8800 MHz.

(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.

### EUT Intended Band(s) of Operation

Band 1: 8.5 – 9.6 GHz

## **2.1033 MODULATION CHARACTERISTICS**

**Requirements:** 2.1033(c)(4), 2.1033(c)(13)

### **Operating Modes**

**30M1P0N Emission**, utilises a range of pulses. The worst-case identified by the manufacturer:

**Pulse Width:** 0.5  $\mu$ s

**Pulse Repetition Rate:** 1500 Hz (666.67  $\mu$ s)

**Duty Cycle:** 0.075 %

## 2.1046 RF POWER OUTPUT

### §2.1046 Measurements required: RF power output.

- ☒ (a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.
- ☐ (b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as follows. In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.
- ☐ (1) Single sideband transmitters in the A3A or A3J emission modes—by two tones at frequencies of 400 Hz and 1800 Hz (for 3.0 kHz authorized bandwidth), or 500 Hz and 2100 Hz (3.5 kHz authorized bandwidth), or 500 Hz and 2400 Hz (for 4.0 kHz authorized bandwidth), applied simultaneously, the input levels of the tones so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.
- ☐ (2) Single sideband transmitters in the A3H emission mode—by one tone at a frequency of 1500 Hz (for 3.0 kHz authorized bandwidth), or 1700 Hz (for 3.5 kHz authorized bandwidth), or 1900 Hz (for 4.0 kHz authorized bandwidth), the level of which is adjusted to produce a radio frequency signal component equal in magnitude to the magnitude of the carrier in this mode.
- ☐ (3) As an alternative to paragraphs (b) (1) and (2) of this section other tones besides those specified may be used as modulating frequencies, upon a sufficient showing of need. However, any tones so chosen must not be harmonically related, the third and fifth order intermodulation products which occur must fall within the -25 dB step of the emission bandwidth limitation curve, the seventh and ninth order intermodulation product must fall within the 35 dB step of the referenced curve and the eleventh and all higher order products must fall beyond the -35 dB step of the referenced curve.
- ☐ (4) Independent sideband transmitters having two channels by 1700 Hz tones applied simultaneously in both channels, the input levels of the tones so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.
- ☐ (5) Independent sideband transmitters having more than two channels by an appropriate signal or signals applied to all channels simultaneously. The input signal or signals shall simulate the input signals specified by the manufacturer for normal operation.
- ☐ (6) Single-channel controlled-carrier transmitters in the A3 emission mode—by a 2500 Hz tone.
- ☐ (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

## 90.205 RF POWER OUTPUT

### Requirements:

#### §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 9.0 – 9.5 GHz. These frequencies are covered by clause (r).

**Test Procedure:** ANSI C63.26 5.2

### 5.2 RF output power measurement procedures

This subclause provides guidance for performing the power measurements necessary to demonstrate compliance to the RF output power limits imposed by regulatory authorities on transmitters. In addition, these procedures can also be utilized to collect the data necessary to demonstrate compliance to regulatory limits placed on unwanted (out-of-band and spurious) emissions.

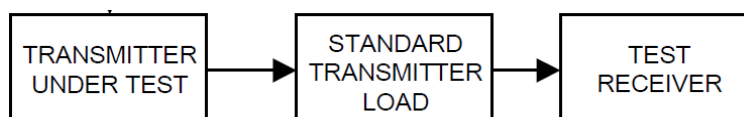
**Test Procedure:** ANSI C63.26 S 5.2.3.3

#### 5.2.3.3 Measurement of peak power in a narrowband signal with a spectrum/signal analyzer or EMI receiver

This procedure can be used to measure the peak power in either a CW-like or noise-like narrowband RF signal. The measurement instrument must have a RBW that is greater than or equal to the OBW of the signal to be measured and a  $VBW \geq 3 \times RBW$ .

- a) Set the  $RBW \geq OBW$ .
- b) Set  $VBW \geq 3 \times RBW$ .
- c) Set  $span \geq 2 \times OBW$ .
- d) Sweep time  $\geq 10 \times (\text{number of points in sweep}) \times (\text{transmission symbol period})$ .
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the peak amplitude level.

### Test Setup Block Diagram:



**2.1047 AUDIO FREQUENCY RESPONSE****2.1047 LOW PASS FILTER RESPONSE**

- ☐ (a) *Voice modulated communication equipment.* A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.
- ☐ (c) *Single sideband and independent sideband radiotelephone transmitters which employ a device or circuit to limit peak envelope power.* A curve showing the peak envelope power output versus the modulation input voltage shall be supplied. The modulating signals shall be the same in frequency as specified in paragraph (c) of §2.1049 for the occupied bandwidth tests.

**N/A. The device is not modulated using audio, and does not carry audio.**

## 2.1047 MODULATION LIMITING

(b) *Equipment which employs modulation limiting.* A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

**N/A. The device does not employ modulation limiting techniques.**

## 2.1049 OCCUPIED BANDWIDTH

### §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:

- ☐ (a) Radiotelegraph transmitters for manual operation when keyed at 16 dots per second.
- ☐ (b) Other keyed transmitters—when keyed at the maximum machine speed.
- ☐ (c) Radiotelephone transmitters equipped with a device to limit modulation or peak envelope power shall be modulated as follows. For single sideband and independent sideband transmitters, the input level of the modulating signal shall be 10 dB greater than that necessary to produce rated peak envelope power.
  - ☐ (1) Other than single sideband or independent sideband transmitters—when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.
  - ☐ (2) Single sideband transmitters in A3A or A3J emission modes—when modulated by two tones at frequencies of 400 Hz and 1800 Hz (for 3.0 kHz authorized bandwidth), or 500 Hz and 2100 Hz (for 3.5 kHz authorized bandwidth), or 500 Hz and 2400 Hz (for 4.0 kHz authorized bandwidth), applied simultaneously. The input levels of the tones shall be so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.
  - ☐ (3) Single sideband transmitters in the A3H emission mode—when modulated by one tone at a frequency of 1500 Hz (for 3.0 kHz authorized bandwidth), or 1700 Hz (for 3.5 kHz authorized bandwidth), or 1900 Hz (for 4.0 kHz authorized bandwidth), the level of which is adjusted to produce a radio frequency signal component equal in magnitude to the magnitude of the carrier in this mode.
  - ☐ (4) As an alternative to paragraphs (c) (2) and (3) of this section, other tones besides those specified may be used as modulating frequencies, upon a sufficient showing of need. However, any tones so chosen must not be harmonically related, the third and fifth order intermodulation products which occur must fall within the –25 dB step of the emission bandwidth limitation curve, the seventh and ninth order products must fall within the –35 dB step of the referenced curve and the eleventh and all higher order products must fall beyond the –35 dB step of the referenced curve.
  - ☐ (5) Independent sideband transmitters having two channels—when modulated by 1700 Hz tones applied simultaneously to both channels. The input levels of the tones shall be so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.
- ☐ (d) Radiotelephone transmitters without a device to limit modulation or peak envelope power shall be modulated as follows. For single sideband and independent sideband transmitters, the input level of the modulating signal should be that necessary to produce rated peak envelope power.
  - ☐ (1) Other than single sideband or independent sideband transmitters—when modulated by a 2500 Hz tone of sufficient level to produce at least 85 percent modulation. If 85 percent modulation is unattainable, the highest percentage modulation shall be used.

## OCCUPIED BANDWIDTH



(f) Transmitters for which peak frequency deviation (D) is determined in accordance with §2.202(f), and in which the modulating baseband comprises more than 3 independent speech channels—when modulated by a test signal determined in accordance with the following:

(1) A modulation reference level is established for the characteristic baseband frequency. (Modulation reference level is defined as the average power level of a sinusoidal test signal delivered to the modulator input which provides the specified value of per-channel deviation.)

(2) Modulation reference level being established, the total rms deviation of the transmitter is measured when a test signal consisting of a band of random noise extending from below 20 kHz to the highest frequency in the baseband, is applied to the modulator input through any preemphasis networks used in normal service. The average power level of the test signal shall exceed the modulation reference level by the number of decibels determined using the appropriate formula in the following table:

| Number of message circuits that modulate the transmitter | Number of dB by which the average power ( $P_{avg}$ ) level test signal shall exceed the modulation reference level | Limits of $P_{avg}$ (dBm0) |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------|
| More than 3, but less than 12                            | To be specified by the equipment manufacturer subject to FCC approval                                               |                            |
| At least 12, but less than 60                            | $X + 2 \log_{10} N_c$                                                                                               | X: -2 to +2.6              |
| At least 60, but less than 240                           | $X + 4 \log_{10} N_c$                                                                                               | X: -5.6 to -1.0            |
| 240 or more                                              | $X + 10 \log_{10} N_c$                                                                                              | X: -19.6 to -15.0          |

Where X represents the average power in a message circuit in dBm0;  $N_c$  is the number of circuits in the multiplexed message load.  $P_{avg}$  shall be selected by the transmitter manufacturer and included with the technical data submitted with the application for type acceptance. (See §2.202(e) in this chapter.)



(g) Transmitters in which the modulating baseband comprises not more than three independent channels—when modulated by the full complement of signals for which the transmitter is rated. The level of modulation for each channel should be set to that prescribed in rule parts applicable to the services for which the transmitter is intended. If specific modulation levels are not set forth in the rules, the tests should provide the manufacturer's maximum rated condition.



(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.



(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.

**Note: The device is not modulated using an input signal.**

**90.209 OCCUPIED BANDWIDTH****Rule Part No.:** 90.207(k), (n), 90.209(b)(5), ITU-R M.1177-4**§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 <sup>2</sup> |                       |                            |

<sup>2</sup>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).

## 90.210 EMISSION MASK

**Rule Part No.:** 90.210(n), 90.210(b)(1), (2)

### Requirements:

(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.

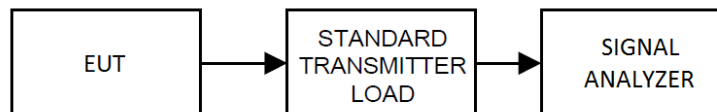
(b) *Emission Mask B.* For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(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.

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

### Test Setup Block Diagram:



## 2.1051 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

### §2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

## 5.2 RF output power measurement procedures

This subclause provides guidance for performing the power measurements necessary to demonstrate compliance to the RF output power limits imposed by regulatory authorities on transmitters. In addition, these procedures can also be utilized to collect the data necessary to demonstrate compliance to regulatory limits placed on unwanted (out-of-band and spurious) emissions.

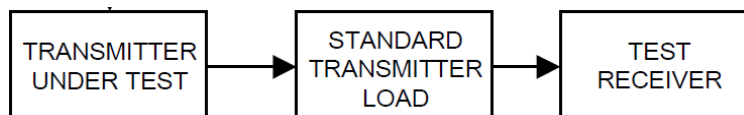
**Test Procedure:** ANSI C63.26 S 5.2.3.3

### 5.2.3.3 Measurement of peak power in a narrowband signal with a spectrum/signal analyzer or EMI receiver

This procedure can be used to measure the peak power in either a CW-like or noise-like narrowband RF signal. The measurement instrument must have a RBW that is greater than or equal to the OBW of the signal to be measured and a VBW  $\geq 3 \times$  RBW.

- a) Set the RBW  $\geq$  OBW.
- b) Set VBW  $\geq 3 \times$  RBW.
- c) Set span  $\geq 2 \times$  OBW.
- d) Sweep time  $\geq 10 \times$  (number of points in sweep)  $\times$  (transmission symbol period).
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the peak amplitude level.

### Test Setup Block Diagram:

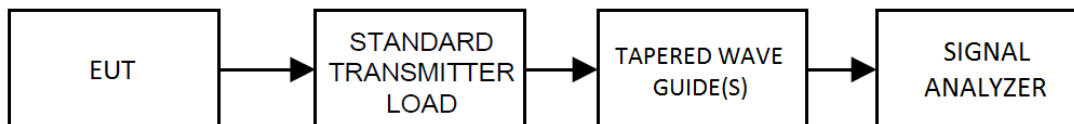


**90.210 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS****Rule Part No.:** 90.210(n), 90.210(b)(3)

(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.

**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.

## 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 ( $\mu$ s) (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10  $\mu$ s, 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  $B_m^1 \leq (B_c/T)^{1/2}$  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  $\mu$ s, 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 <sup>1</sup> a measurement bandwidth close to but less than or equal to 1 MHz should be used in this example.

Video bandwidth  $\geq$  measurement system bandwidth.

Detector positive peak.

<sup>1</sup> 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.

## 2.1053 FIELD STRENGTH OF SPURIOUS EMISSIONS

### §2.1053 Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

## 5.5.2 Common requirements

### 5.5.2.1 General

This subclause details the common requirements applicable to all radiated measurements, except for performing radiated output power measurements per 5.2.7. When conducted measurements cannot be performed (e.g., the EUT utilizes an integrated antenna), then a radiated test configuration must be used to measure the compliance-related technical parameters. Such radiated measurements shall use substitution methods unless a test site validated to ANSI C63.4 requirements is utilized, in which case, radiated fundamental and/or unwanted emissions can be measured using the direct radiated field strength method.

When performing radiated measurements, regardless of whether substitution or direct field strength methods are utilized, the EUT shall be rotated through three axes and the receive (measurement) antenna shall be oriented in both horizontal and vertical polarization. When the direct field strength method is used, then the equations provided in 5.2.7 can be used to determine the radiated output power from either a field strength or received power measurement. Detailed guidance with respect to performing band-edge compliance testing is provided in 5.7.3.

Pre-scan measurements are often performed to identify unwanted emission frequencies and to isolate the associated test variables (e.g., measurement antenna height and polarization, axis orientation, etc.) as discussed in 5.5.2.5. Final compliance tests are performed subsequently using the specified detector(s) at the frequencies and EUT and measurement antenna orientations identified in the pre-scan.

## **FIELD STRENGTH OF SPURIOUS EMISSIONS**

### **5.5.2.2 Instrumentation**

#### **5.5.2.2.1 General considerations**

In addition to the following considerations, the instrumentation and associated guidance provided in Clause 4 shall be applied when performing radiated emissions measurements.

The RF sensitivity of the complete measurement system, relative to the applicable regulatory limit, shall be adequate to permit the anticipated signals (and their related power levels) to be detected and measured. For such purposes, a system noise floor established at 10 dB or more below the relevant power or emission limit is typically adequate. Low-noise preamplifiers, high gain antennas, or reduced test distances (while still maintaining measurement antenna beamwidth coverage of the EUT and a far-field measurement distance relationship) may be required to improve the noise floor-to-limit ratio. These specifics regarding the measurement conditions shall be thoroughly explained in the test report. The use of external band-pass, band-stop, low-pass, and/or high pass filters may be required to provide adequate protection of the measurement instrumentation from overload (see 4.2.3). The insertion losses associated with these external peripherals, to include connecting cables, shall be accounted for in the final measurement data.

#### **5.5.2.2.2 Measurement antenna**

Radiated measurements shall be made using antenna(s) as specified in 4.4. The measurement antenna shall be positioned at a suitable test distance from the periphery of the EUT such that the measurement is performed in the far field of the transmitting (EUT) antenna. A practical limitation on test distance can also be set by the available antenna calibration data. The main “beam” or main lobe of the pattern for any antenna used shall be large enough to encompass the physical size of the EUT, or system arrangement, when located at the measurement distance. If the 3 dB beamwidth of the antenna at the specified measurement distance is not large enough to encompass the physical size of the EUT or system arrangement, then multiple radiated scans with the 3 dB beamwidth of the antenna focused on different portions of the EUT or system arrangement will be necessary to ensure that the entirety of the EUT or system arrangement has been measured.

#### **5.5.2.2.3 Test site**

The test site shall satisfy the applicable requirements specified in 4.6.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### 5.5.2.3 Test arrangement for EUT and antenna positioning

#### 5.5.2.3.1 Test arrangements for tabletop EUTs

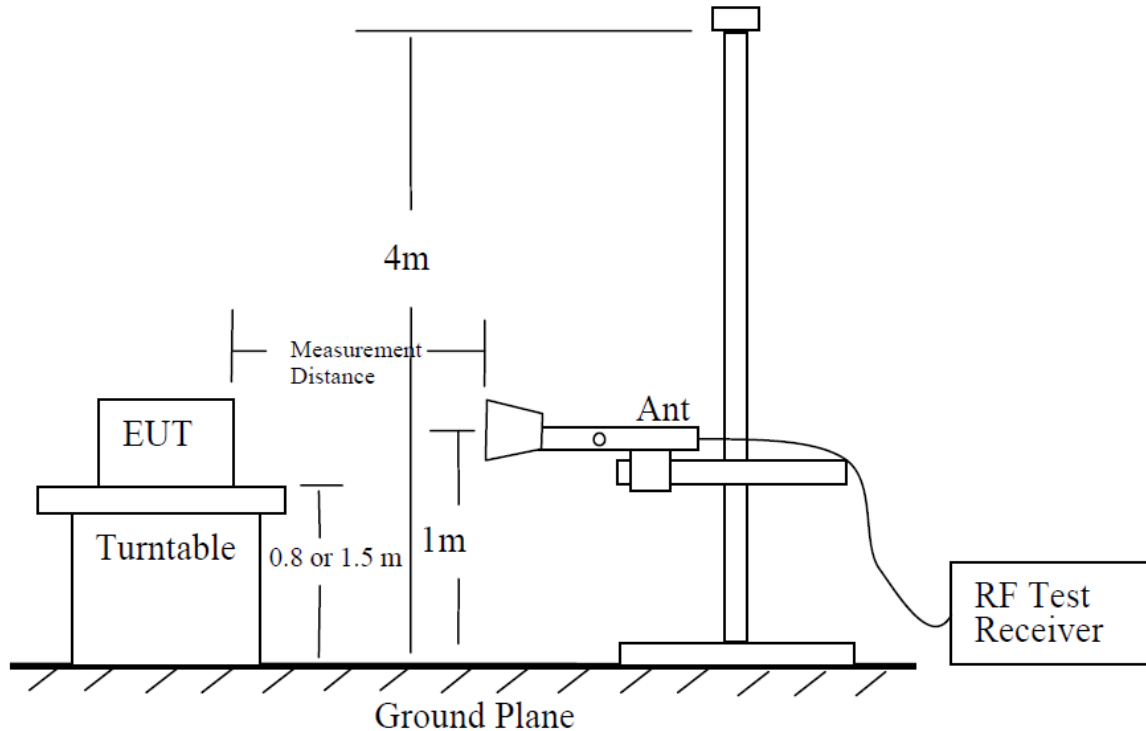
For radiated emissions measurements performed at frequencies less than or equal to 1 GHz, the EUT shall be placed on a RF-transparent table or support at a nominal height of 80 cm above the reference ground plane. Radiated measurements shall be made with the measurement antenna positioned in both horizontal and vertical polarization. The measurement antenna shall be varied from 1 m to 4 m in height above the reference ground in a search for the relative positioning that produces the maximum radiated signal level (i.e., field strength or received power). When orienting the measurement antenna in vertical polarization, the minimum height of the lowest element of the antenna shall clear the site reference ground plane by at least 25 cm.

Figure 4 shows a typical EUT configuration with a wireless device placed on a tabletop on an appropriate radiated test site. The measurement antenna shall be placed at the specified distance from the closest point of the EUT. Tabletop devices shall be placed on a RF transparent platform with nominal top surface dimensions of 1 m by 1.5 m. Any necessary support equipment shall be placed far enough away from the EUT, such that changes in relative position of the EUT and support equipment do not influence the measured values. If the EUT requires a connection to a server or computer, via control/data cable(s), to exercise the product, then the controlling server or computer may be placed outside of the test area.

For radiated measurements performed at frequencies above 1 GHz, the EUT shall be placed on an RF transparent table or support at a nominal height of 1.5 m above the ground plane. Radiated measurements shall be made with the measurement antenna positioned in both horizontal and vertical polarization. The height scan of the measurement antenna shall be varied from 1 m to 4 m in a search for the relative positioning that produces the maximum radiated signal level (i.e., field strength or received power). When using the direct field strength method and the EUT is manipulated through three different orientations, then the scan height range of the measurement antenna is limited to 2.5 m, or 0.5 m above the top of the EUT, whichever is higher.

NOTE—The use of waveguide and/or flexible waveguide may be necessary when performing measurements at frequencies above 10 GHz to achieve usable signal-to-noise ratios at acceptable measurement distances. If so, it may be necessary to restrict the height search of the antenna, or conversely to raise or lower the EUT relative to the elevation of the measurement antenna, including its relative angle with respect to the ground plane. In any case, special care should be exercised to ensure that the maximum emissions are identified and measured.

## FIELD STRENGTH OF SPURIOUS EMISSIONS



**Figure 4—Test set-up for radiated spurious measurements**

Radiated unwanted emissions measurements shall be made over the frequency range specified in 5.1, dependent upon the relevant operational frequency band. These radiated measurements shall be made around the EUT (or alternatively, with the EUT rotated on a turntable), while varying the measurement antenna height and examining both horizontal and vertical polarization of the measurement antenna, as described above. Ordinarily, this will require the use of a turntable and an antenna positioner.

The EUT shall be set up in its typical configuration and arrangement and operated in its various modes of operation. Unless the EUT uses an integral antenna, the EUT shall be terminated with a non-radiating transmitter load. In cases where the EUT uses an adjustable antenna, the antenna shall be adjusted through typical positions and lengths to maximize emissions levels. EUTs with integral antennas shall be evaluated in their normal orientation. Where EUTs are designed to be installed in one of two distinct orientations, they shall be tested in both of their possible orientations. EUTs that can be operated in one of multiple orientations (e.g., handheld, portable, or modular devices) shall be tested in a minimum of three orientations. See Figure 5. When large antennas (e.g., high gain) or antennas not structurally supported by the EUT are utilized, a RF transparent supporting structure shall be used to facilitate the compliance testing. In all cases, the EUT, including the transmit antenna, shall be orientated such that the measurement of the emission is maximized.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

Cables or wires inclusive to the EUT shall be configured so as to maximize the measured emission levels. The EUT controls shall also be adjusted to maximize the emission according to the manufacturer's specifications. The modulation applied shall be based on the guidance provided in the manufacturer's specifications. When necessary, field strength measurements shall be converted to ERP or EIRP for comparison to the applicable regulatory limits. See 5.2.7 for additional guidance.

### 5.5.2.3.2 Test arrangements for floor-standing EUTs

The floor standing EUT should be installed and tested as described in the manufactures instruction manual. If the installation methods are described for indoor and outdoor installations, one of the more typically used installation methods shall be tested. If the installation method provided in the manufacturer's instruction is not practical for testing, then EUT installation method provided in the latest edition of ANSI C63.4 may be used. The grounding of EUT must be achieved in accordance with manufacturer's instructions. However, if grounding studs are provided only at the top of EUT, grounding(s) of EUT may be achieved within 20 cm from the bottom of the EUT cabinet. Grounding of the EUT arbitrarily at middle of the cabinet is not allowed. The grounding material and size should be in accordance with manufacturer's instructions. Electromagnetically shielded ground wires shall not be used. If installation requires use of metal conduits for data, RF, and power cables, then typical or equivalent conduits may be used during the tests. The conduits should be elevated at least 1 cm above the ground plane and can be grounded only at the end of the conduit. All exposed cables shall be routed in accordance with latest edition of ANSI C63.4. The body of the loads connected to the RF ports should be electrically isolated from the cabinet or ground-plane. RF loads can be located outside the measurement area. Leakage radiation from the loads shall not overload the measurement receiver/analyzer.

### 5.5.2.4 Operational configurations

The EUT shall be tested while operating on the frequency per manufacturer specification. For EUTs that can operate on more than one frequency, unless otherwise specified, measurements shall be performed with the EUT transmitting on a frequency or frequencies as specified in 5.1 for each frequency band of operation.

- a) Set the transmitter to operate in continuous transmit mode. For transmitters unable to be configured for  $\geq 98\%$  duty cycle even in a test mode, configure the system to transmit at the maximum duty cycle supported.
- b) Compliance testing shall be performed with the minimum number of channels specified in 5.1 for each supported frequency band. A compliance test shall be performed on all channel sets supported by the EUT and permitted under the applicable regulatory requirements.
- c) Compliance testing shall be performed for each supported frequency/channel using every available modulation supported by the transmitter, and at minimum and maximum data rate, in an effort to examine all possible combinations with the potential for producing the maximum emission amplitude. The test report shall clearly indicate how the various combinations were examined and a technical justification for any applied streamlining of test requirements. See 5.1.2.2 for guidance with regards to potential streamlined test requirement guidance.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### 5.5.2.5 Pre-scan testing

Exploratory radiated measurements (pre-scans) may be performed to determine the general EUT radiated emissions characteristics and, when necessary, the EUT-to-measurement antenna orientation that produces the maximum emission amplitude. Pre-scans shall only be used to determine the emission frequencies (i.e., not amplitude levels). The information garnered from a pre-scan can then be used to perform final compliance measurements using either the substitution or direct field strength method.

Pre-scan tests shall be performed following the test procedures provided in 5.5.2.3 and 5.5.2.4. When maximizing the emissions from the EUT for measurement, the EUT and its transmitting antenna(s) shall be rotated through 360°. For each mode of operation to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

### 5.5.4 Radiated measurement using the field strength method

#### 5.5.4.1 General

Using the test configuration shown in Figure 6, measure the radiated emissions directly from the EUT and convert the measured field strength or received power to ERP or EIRP, as required, for comparison to the applicable limits. As stated in 5.5.1, the field strength measurement method using a test site validated to the requirements of ANSI C63.4 is an alternative to the substitution measurement method described in 5.5.3.

The test site shall satisfy the requirements in 4.6.3. The measurements shall be performed using the instrumentation specified in Clause 4, and using the common procedures in 5.5.2.

#### 5.5.4.2 Radiated measurements for acquiring final compliance data

Final compliance data (i.e., data to be reported to the regulatory agency in support of an application for an equipment authorization) shall be collected in accordance with the procedures provided in 5.5.2, with the EUT transmitting for each frequency specified in 5.1.2. The emission characteristics of the EUT can be identified from the pre-scan measurement information obtained as specified in 5.5.2.5. Final measurements shall be performed for the worst case combination(s) of variable technical parameters that result in the maximum measured emission amplitude as per the guidelines provided in 5.1.2. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), and the frequency and amplitude data for the six highest-amplitude spurious emissions.

When reduced measurement distances or higher gain antennas are used in the measurement, a far-field measurement distance relationship and measurement antenna beamwidth coverage of the EUT must be maintained. When preamplifiers are used to improve the measurement system noise floor, overload protection shall be ensured (see guidance in 4.2). Any deviations from the specific measurement conditions or requirements shall be fully described in the test report.

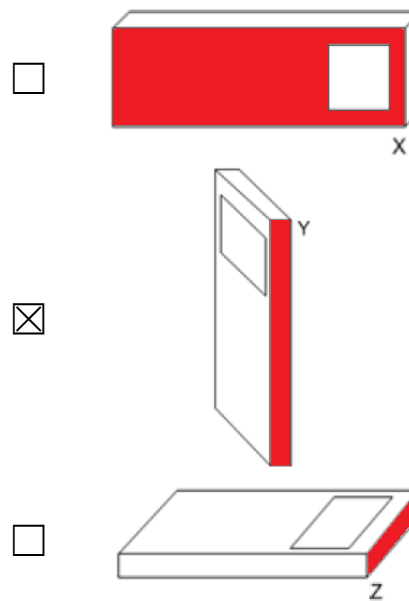
See 5.5.2.5 and/or Annex C for guidance on converting measured field strength or received power data to ERP or EIRP, as applicable, for comparison with the applicable regulatory limits.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### 5.5.5 Recording test results

A minimum of six data points representing the highest identified unwanted emission amplitude levels relevant to the limit and associated frequencies must be included in the test report. This information shall be reported in a combination of both plots and tabular data as necessary to demonstrate compliance to the applicable technical requirement(s). When multiple operating modes are evaluated, only the “worst case” plots for each mode in each operating band need to be provided in the test report, along with an explanation and technical rationale supporting the identification of the “worst case.” Test set-up photos shall be included and shall be of a sufficient quantity and detail as to allow for replication of the tests (i.e., a single photograph made from several meters away from the EUT is typically not sufficient). Data content and format shall conform to the requirements specified in Clause 8. While it is recognized that a graphical format is not applicable to final tests that utilize the traditional two-stage substitution measurement for every emission, graph(s) of preliminary swept measurement(s) that identify the emissions to be measured during final testing shall be presented in the report.

#### Worst-Case EUT Orientation



Note: Due to design, the EUT is limited to this configuration.

## 90.210 FIELD STRENGTH OF SPURIOUS EMISSIONS

**Rule Part No.:** 90.210(n), 90.210(b)(3)

(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.

**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 ( $\mu$ s) (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10  $\mu$ s, 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.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### 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  $B_m^1 \leq (B_c/T)^{1/2}$  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  $\mu$ s, 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 <sup>1</sup> a measurement bandwidth close to but less than or equal to 1 MHz should be used in this example.

Video bandwidth  $\geq$  measurement system bandwidth.

Detector positive peak.

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

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### 3.2 Measurements within the spurious domain

#### 3.2.1 Correction of the measurement within the spurious domain

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

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

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

**Note:** Mode LR was selected for radiated testing.

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

## 2.1055 FREQUENCY STABILITY

### §2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:



(1) From  $-30^{\circ}$  to  $+50^{\circ}$  centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.



(2) From  $-20^{\circ}$  to  $+50^{\circ}$  centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.



(3) From  $0^{\circ}$  to  $+50^{\circ}$  centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}$  centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.



(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit,  $0^{\circ}$  centigrade and  $+30^{\circ}$  centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than  $10^{\circ}$  centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

(4) When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

## FREQUENCY STABILITY

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

**Note:** The EUT is designed to be used within a strict climate controlled area providing an environment of 20 degrees Centigrade, and therefore the standard range is outside the operating range of the device.

**Note:** The EUT has been designed to operate at 20 C, but has measurement data from 20 degrees to 115 degrees Centigrade.

**Note:** The EUT utilizes a magnetron radar transmitter, and is not susceptible to frequency drift due to temperature fluctuation. The frequency determining element is an adjustable physical cavity.

### 90.213 FREQUENCY STABILITY

**Rule Part No.:** 90.213(a)

**§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.

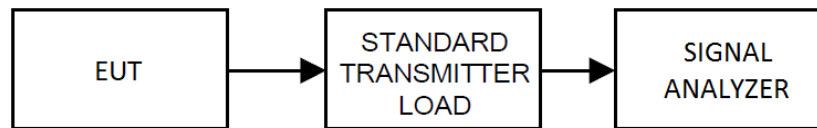
**MINIMUM FREQUENCY STABILITY**  
[Parts per million (ppm)]

| Frequency range (MHz)    | Fixed and base stations | Mobile stations           |                              |
|--------------------------|-------------------------|---------------------------|------------------------------|
|                          |                         | Over 2 watts output power | 2 watts or less output power |
| Above 2450 <sup>10</sup> |                         |                           |                              |

<sup>10</sup>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.

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

**Test Setup Block Diagram:**



**Note:** The EUT's built-in power supply is designed to run stable, and eliminated voltage differences from AC Mains. Input voltage variation was assessed, but had no effect on the testing.

## 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 EN TR 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 |
|------------------------------------------------------------------------------|-------------------------|-------|
| TR 100 028 PARAGRAPH 7.1.1 – FREQUENCY ERROR < 30 MHz                        | ± 0.063 ppm             | (1)   |
| TR 100 028 PARAGRAPH 7.1.1 - FREQUENCY ERROR < 200 MHz                       | ± 0.051 ppm             | (1)   |
| TR 100 028 PARAGRAPH 7.1.1 - FREQUENCY ERROR < 1 GHz                         | ± 0.051 ppm             | (1)   |
| TR 100 028 PARAGRAPH 7.1.1 - FREQUENCY ERROR ≤ 18 GHz                        | ± 0.051 ppm             | (1)   |
| TR 100 028 PARAGRAPH 7.1.1 - FREQUENCY ERROR ≤ 40 GHz                        | ± 0.051 ppm             | (1)   |
| TR 100 028 PARAGRAPH 7.1.2 - CONDUCTED POWER MEASUREMENT                     | ±0.643 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.1.4.1 - CONDUCTED SPURIOUS EMISSIONS 9 kHz – 150 kHz  | ± 3.14 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.1.4.1 - CONDUCTED SPURIOUS EMISSIONS 150 kHz – 30 MHz | ± 3.08 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.2 – RADIATED EMISSIONS < 200 MHz                      | ± 2.16 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.2 – RADIATED EMISSIONS < 1 GHz                        | ± 2.15 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.2 – RADIATED EMISSIONS < 18 GHz                       | ± 2.14 dB               | (1)   |
| TR 100 028 PARAGRAPH 7.2 – RADIATED EMISSIONS ≤ 40 GHz                       | ± 2.31 dB               | (1)   |
| FLUKE Multimeter AC Voltage Uncertainty                                      | ± 2.263 %               | (1)   |
| FLUKE Multimeter DC Voltage Uncertainty                                      | ± 0.453 %               | (1)   |
| Temperature (C°)                                                             | ± 0.81 C°               |       |

**Notes:** (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 |
|-----------------------------------------------|--------------------|------------------------------|----------------------------------------|---------------|----------|
| CHAMBER                                       | Panashield         | 3M                           | N/A                                    | 03/12/19      | 03/12/21 |
| Antenna: Biconical 1057                       | Eaton              | 94455-1                      | 1057                                   | 12/13/17      | 12/13/20 |
| Antenna: Log-Periodic 1243                    | Eaton              | 96005                        | 1243                                   | 04/20/18      | 04/20/21 |
| Antenna: Double-Ridged Horn/ETS Horn 1        | ETS-Lindgren       | 3117                         | 00035923                               | 02/25/20      | 02/25/23 |
| Antenna: Double-Ridged Horn 18-40 GHz         | EMCO               | 3116                         | 9011-2145                              | 12/08/17      | 12/08/20 |
| Coaxial Cable - Chamber 3 cable set (backup)  | Micro-Coax         | Chamber 3 cable set (backup) | KMKM-0244-02 KMKM-0670-01 KFKF-0197-00 | 02/27/19      | 02/27/21 |
| Chamber Pre-amplifier                         | RF-LAMBDA          | RLNA00M45GA                  | NA                                     | 02/27/19      | 02/27/21 |
| Software: Field Strength Program              | Timco              | N/A                          | Version 4.10.7.0                       | N/A           | N/A      |
| EMI Test Receiver R & S ESU 40                | Rohde & Schwarz    | ESU 40                       | 100320                                 | 08/28/18      | 08/28/20 |
| Comb Generator                                | Com-Power Corp     | CGO-515                      | 291728                                 | NA            | NA       |
| Temperature Chamber LARGE                     | Tenney Engineering | TTRC                         | 11717-7                                | NA            | NA       |
| Type K J Thermometer                          | Martel             | 303                          | 080504494                              | 11/06/17      | 11/06/20 |
| Attenuator N 30dB 100W DC-6G                  | Pasternack         | PE7214-30                    | #110                                   | 07/16/19      | 07/16/21 |
| Attenuator N 3dB 10W DC-18G                   | Pasternack         | PE7015-3                     | #21                                    | 07/16/19      | 07/16/21 |
| Coaxial Cable #101 - NMNM-0180-01 Aqua DC-40G | Micro-Coax         | UFB311A-0-0720-50U50U        | 225362-002 (#101)                      | 07/16/19      | 07/16/21 |
| Coaxial Cable #102 - KMKM-0180-00 Aqua        | Micro-Coax         | UFB142A-0-0720-200200        | 225363-001 (#102)                      | 07/16/19      | 07/16/21 |
| Terminator N 20W DC-18G                       | Narda              | 8205                         | #14                                    | 07/16/19      | 07/16/21 |
| Load WR-90 90W                                | Pasternack         | PE6824                       | NA                                     | 07/16/19      | 07/16/21 |
| Adapter WR-90 to SMA                          | Pasternack         | PE9804                       | NA                                     | 07/16/19      | 07/16/21 |
| Adapter WR-90 to N                            | HP                 | X281A                        | 334                                    | 07/16/19      | 07/16/21 |
| Adapter WR-90 to N                            | Narda              | 601A                         | 236                                    | 07/16/19      | 07/16/21 |

**\*EMI RECEIVER SOFTWARE VERSION**

The receiver firmware used was version 4.43 Service Pack 3

## **ANNEX I – MANUFACTURER-PROVIDED INFORMATION**

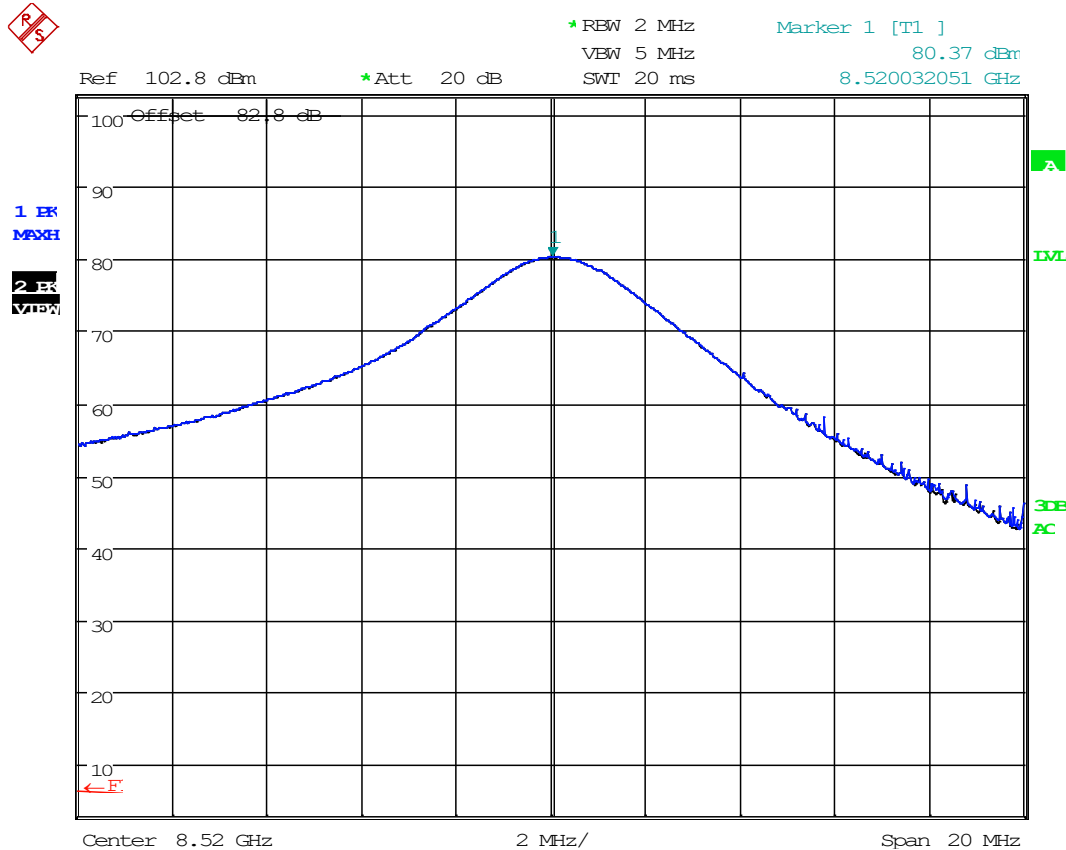
**Note:** The accuracy and precision of the following information provided by the manufacturer of the equipment under test has not been verified using test methods, cannot be verified, or is not necessary to verify.

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Frequency Range

Temperature Specifications

Antenna Information

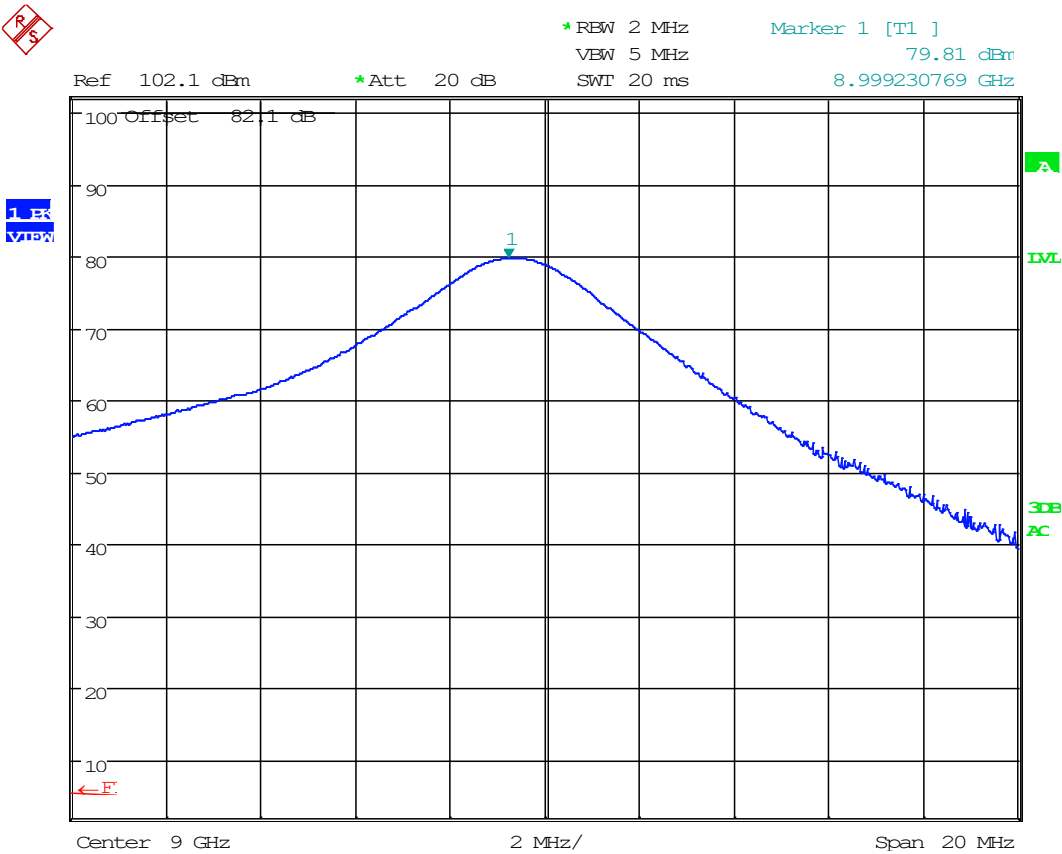
**ANNEX II – MEASUREMENT DATA****90.205 RF POWER OUTPUT**Test Engineer: TR, FRTest Date: 03/13/2020**Low Band, Power Output**

Date: 13.MAR.2020 18:10:23

**Maximum Power: 80.37 dBm = 108,893 W**

**POWER OUTPUT**

**Mid Band, Power Output**

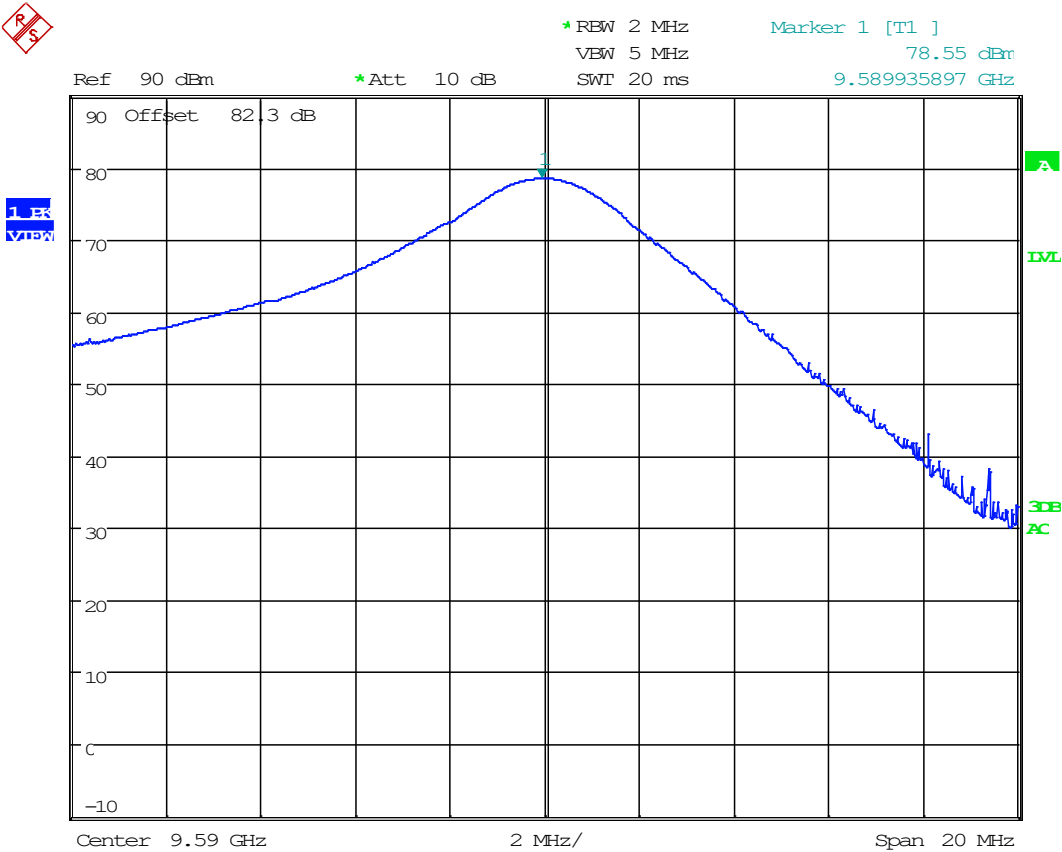


Date: 13.MAR.2020 18:04:46

Maximum Mean Power: **79.81 dBm = 95,719 W**

POWER OUTPUT

High Band, Mean Power Output



Date: 13.MAR.2020 19:20:05

Maximum Mean Power: **78.55 dBm = 71,614 W**

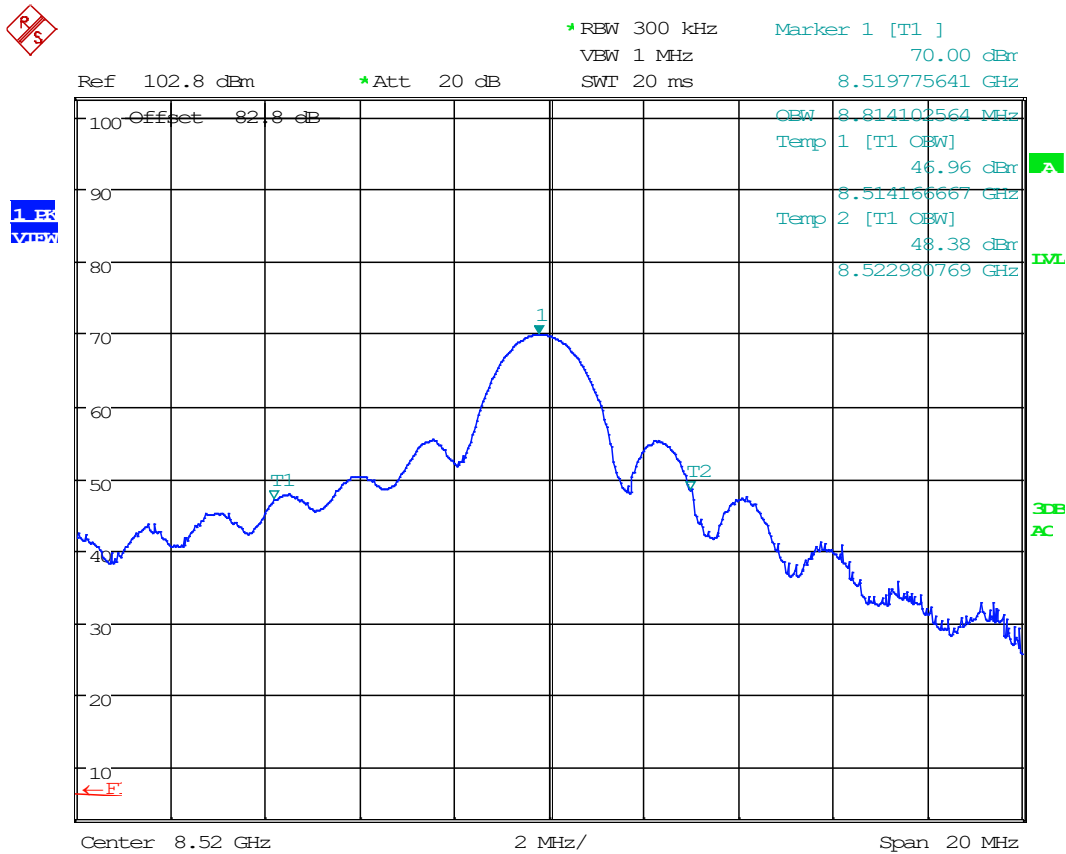
**90.209 OCCUPIED BANDWIDTH**Test Engineer: TR, FRTest Date: 03/13/2020**Occupied Bandwidth Measurement Table**

| Frequency | 99% Occupied Bandwidth (MHz) | 40 dB Occupied Bandwidth (MHz) |
|-----------|------------------------------|--------------------------------|
| Low       | 8.814                        | 27.724                         |
| Mid       | 9.103                        | 28.846                         |
| High      | 10.064                       | 30.128                         |

Max Occupied Bandwidth of EUT = **30.13 MHz**Emission Designator = **30M1P0N**Method of Measurement = **40 dB Down**

OCCUPIED BANDWIDTH

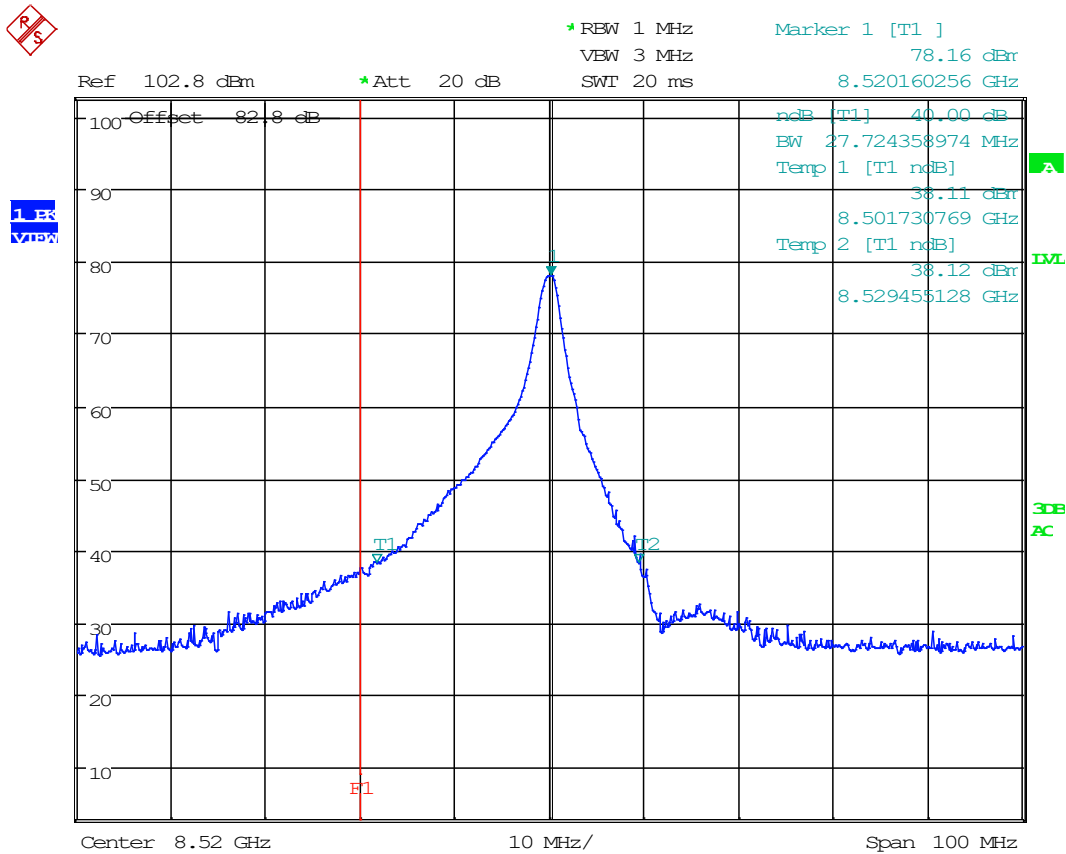
Low Band, 99% OBW Plot



Date: 13.MAR.2020 18:21:07

OCCUPIED BANDWIDTH

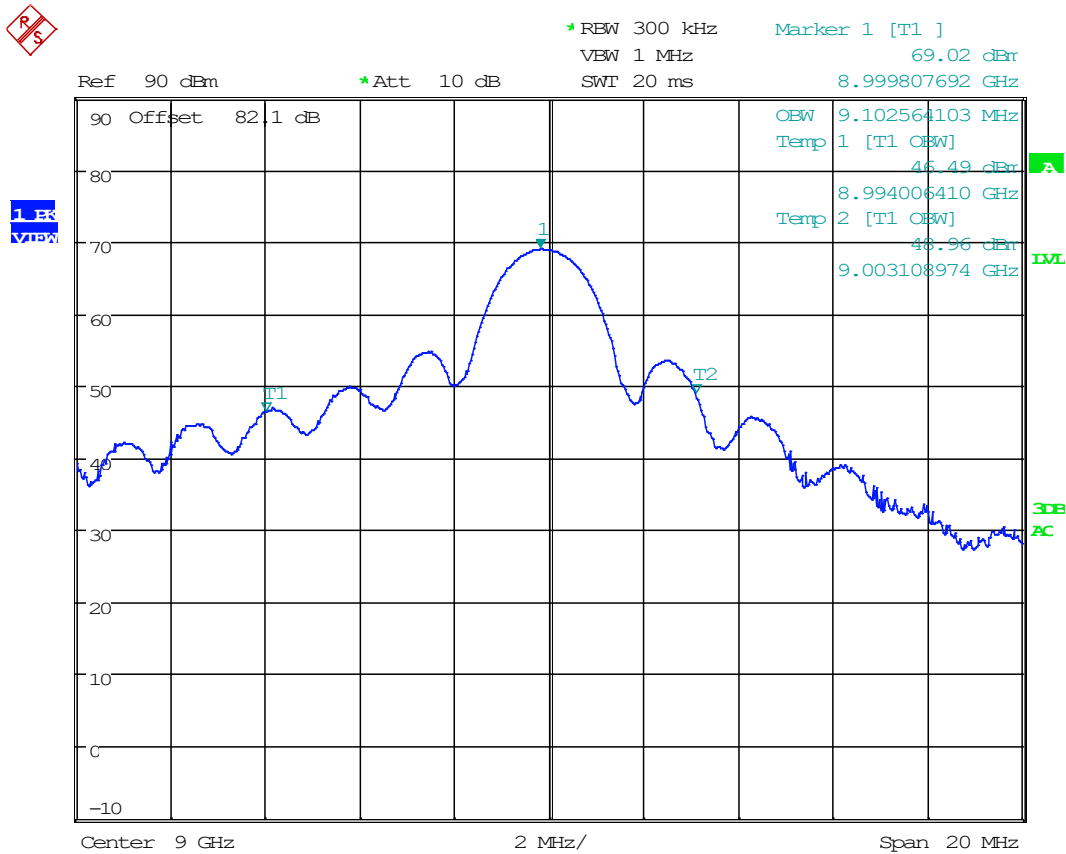
Low Band, 40dB OBW Plot



Date: 13.MAR.2020 18:11:45

OCCUPIED BANDWIDTH

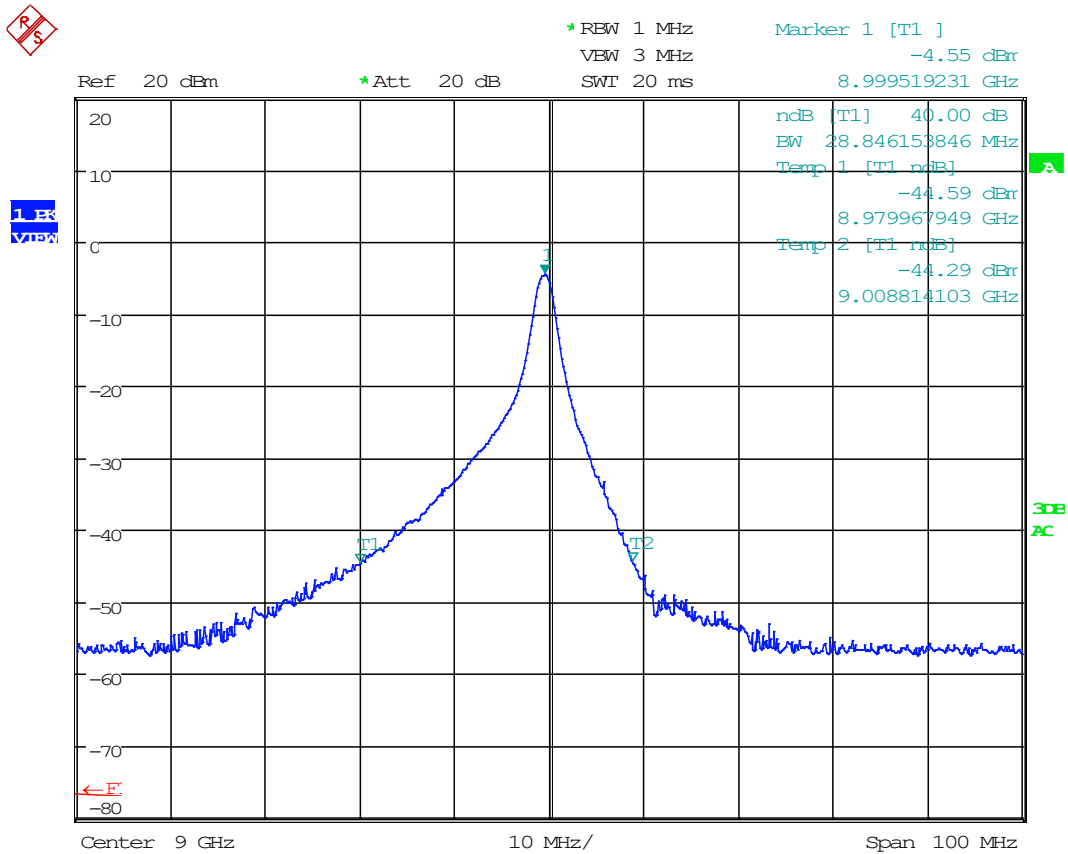
Mid Band, 99% OBW Plot



Date: 13.MAR.2020 18:51:00

OCCUPIED BANDWIDTH

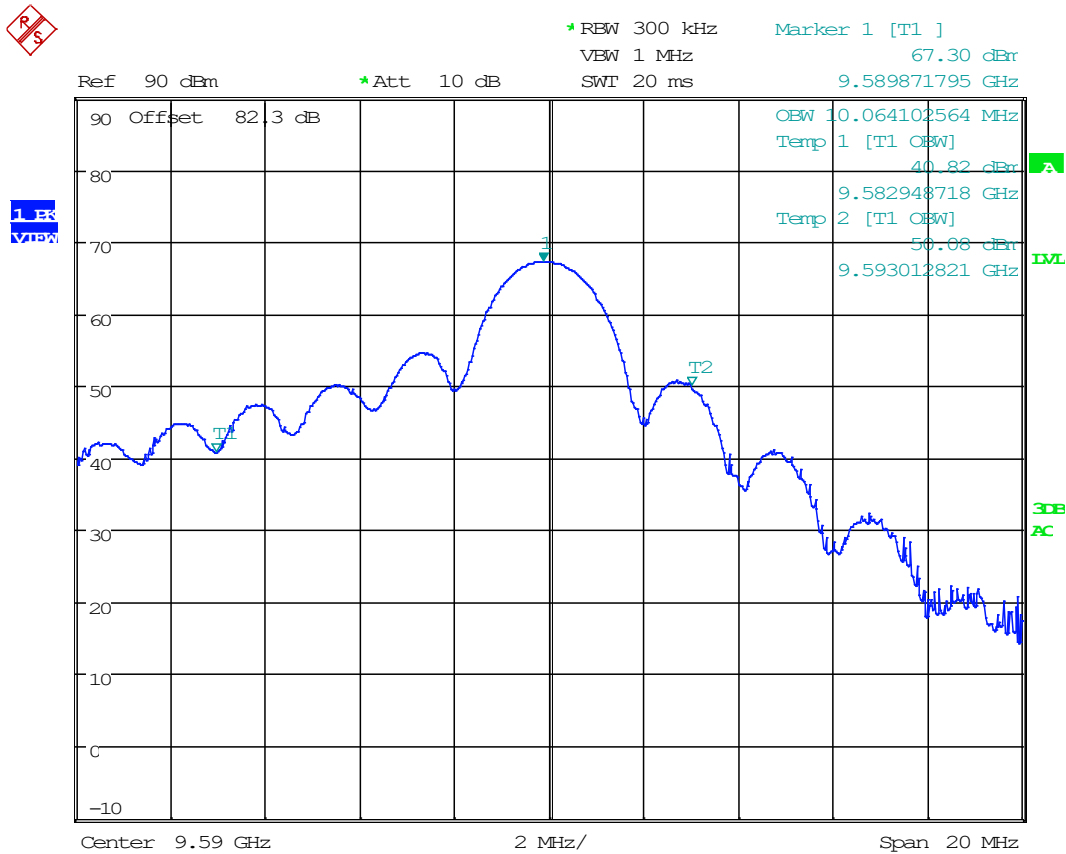
Mid Band, 40dB OBW Plot



Date: 13.MAR.2020 17:52:47

OCCUPIED BANDWIDTH

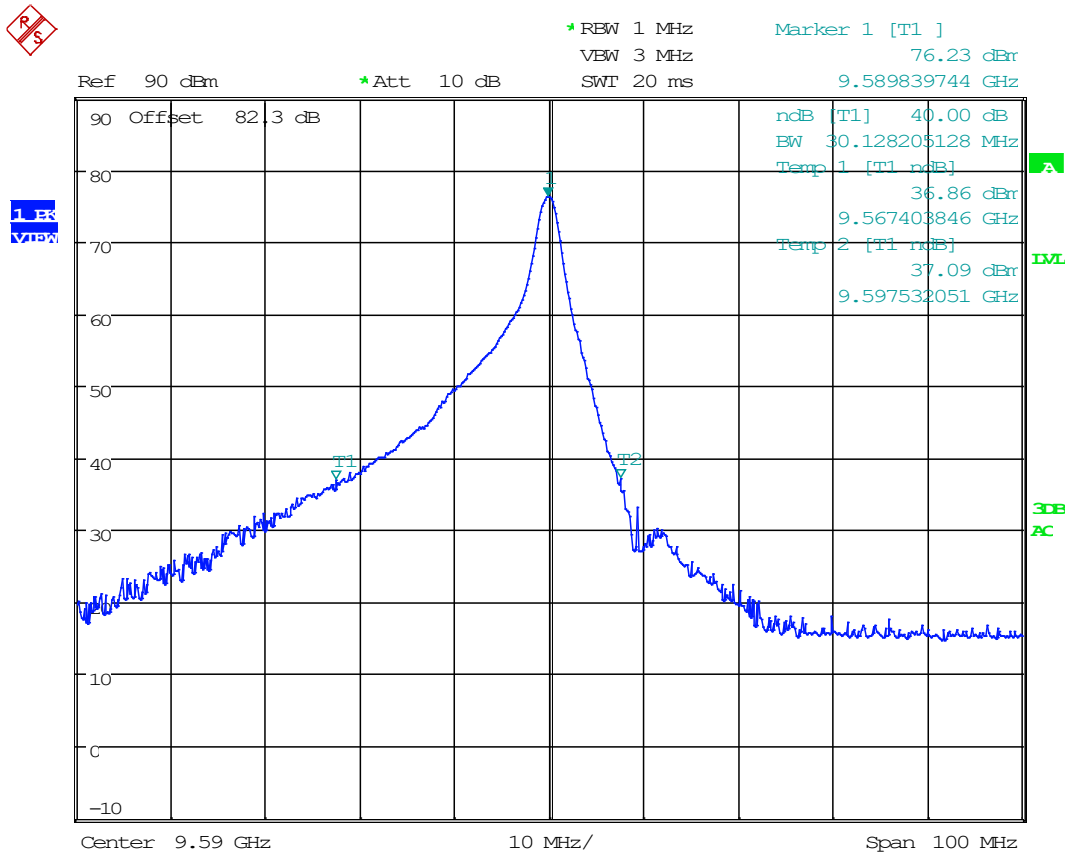
High Band, 99% OBW Plot



Date: 13.MAR.2020 19:20:55

OCCUPIED BANDWIDTH

High Band, 40dB OBW Plot

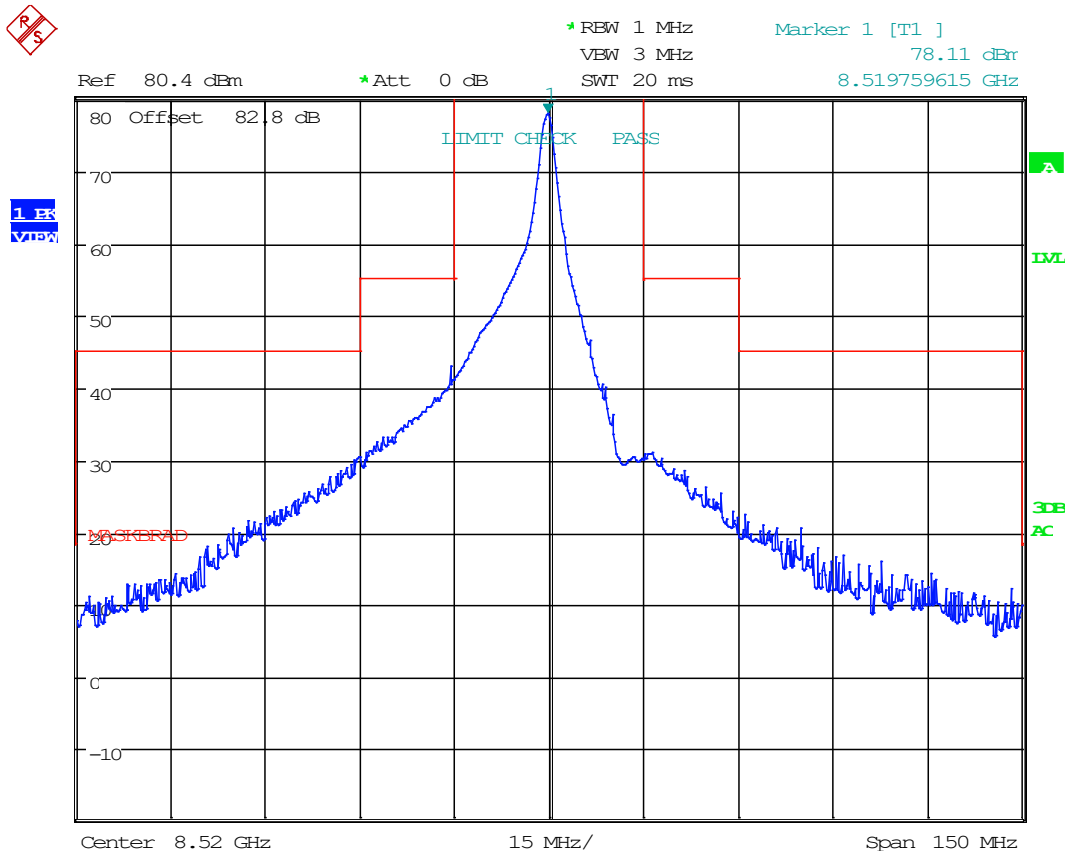


Date: 13.MAR.2020 19:21:56

90.210 EMISSION MASK

Test Engineer: TR, FR  
Test Date: 03/13/2020

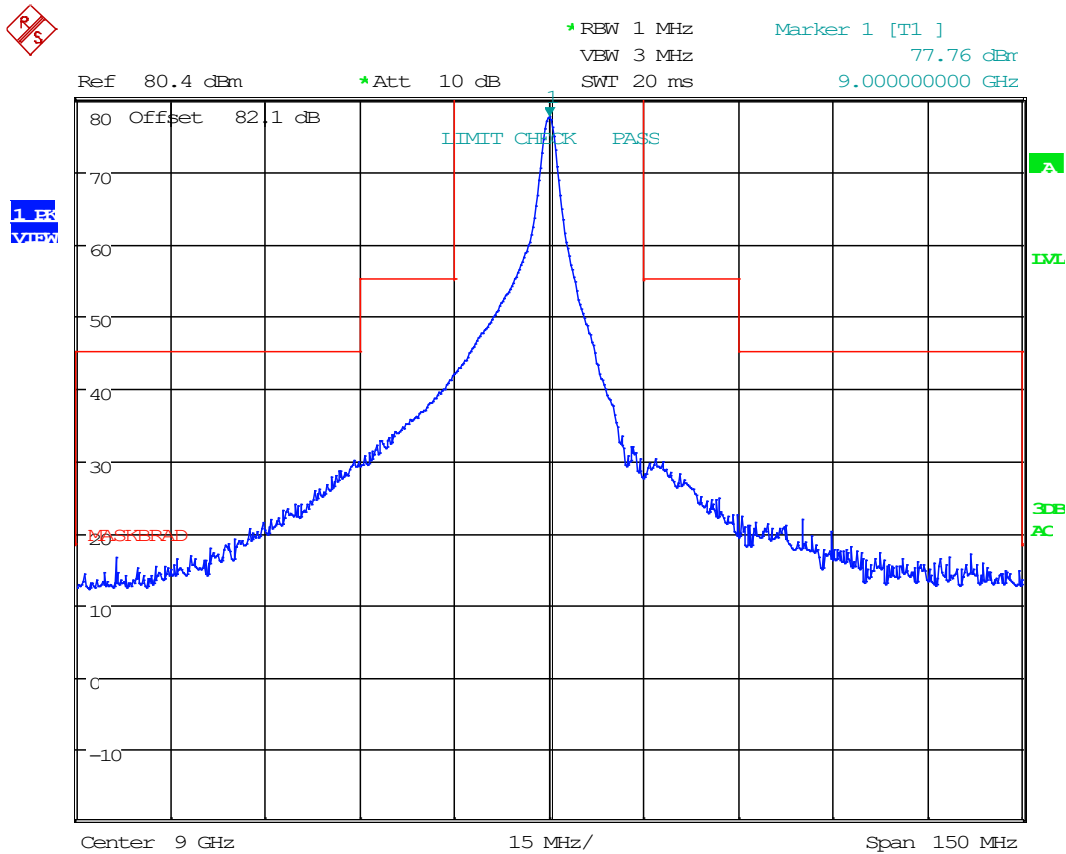
Low Band, Emission Mask Plot



Date: 13.MAR.2020 18:32:24

EMISSION MASK

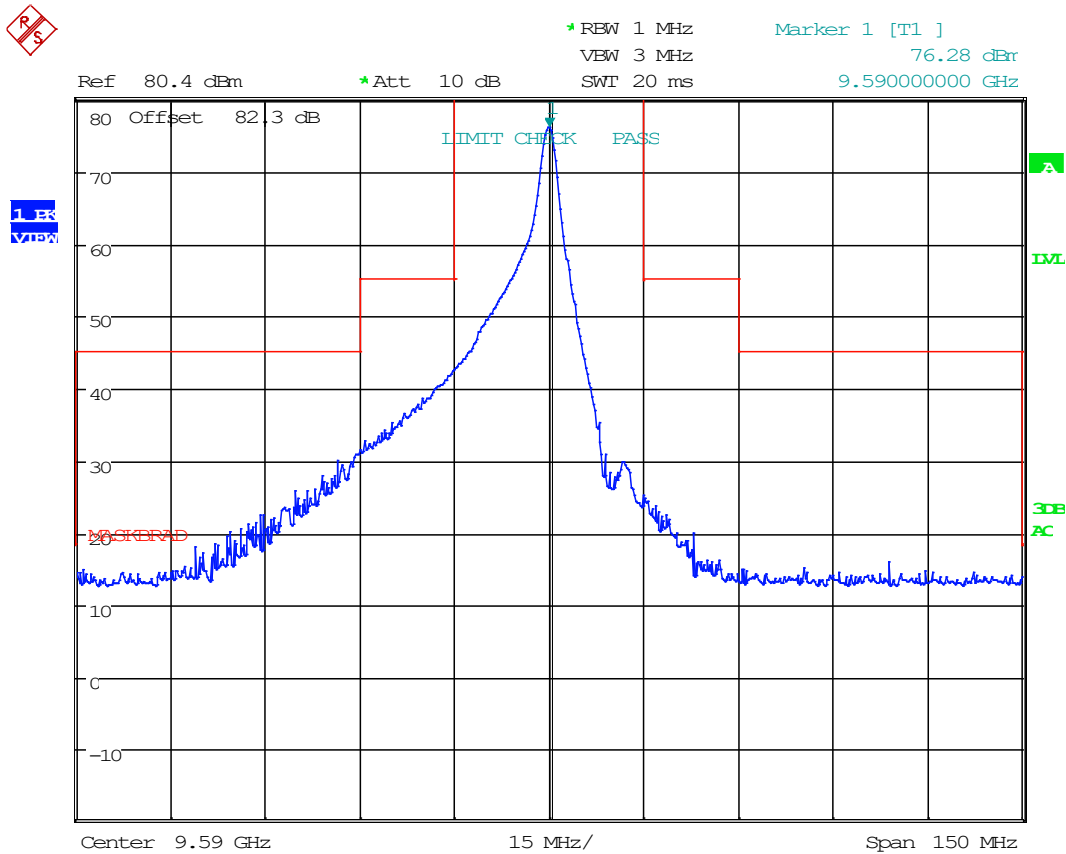
Mid Band, Emission Mask Plot



Date: 13.MAR.2020 18:52:17

EMISSION MASK

High Band, Emission Mask Plot

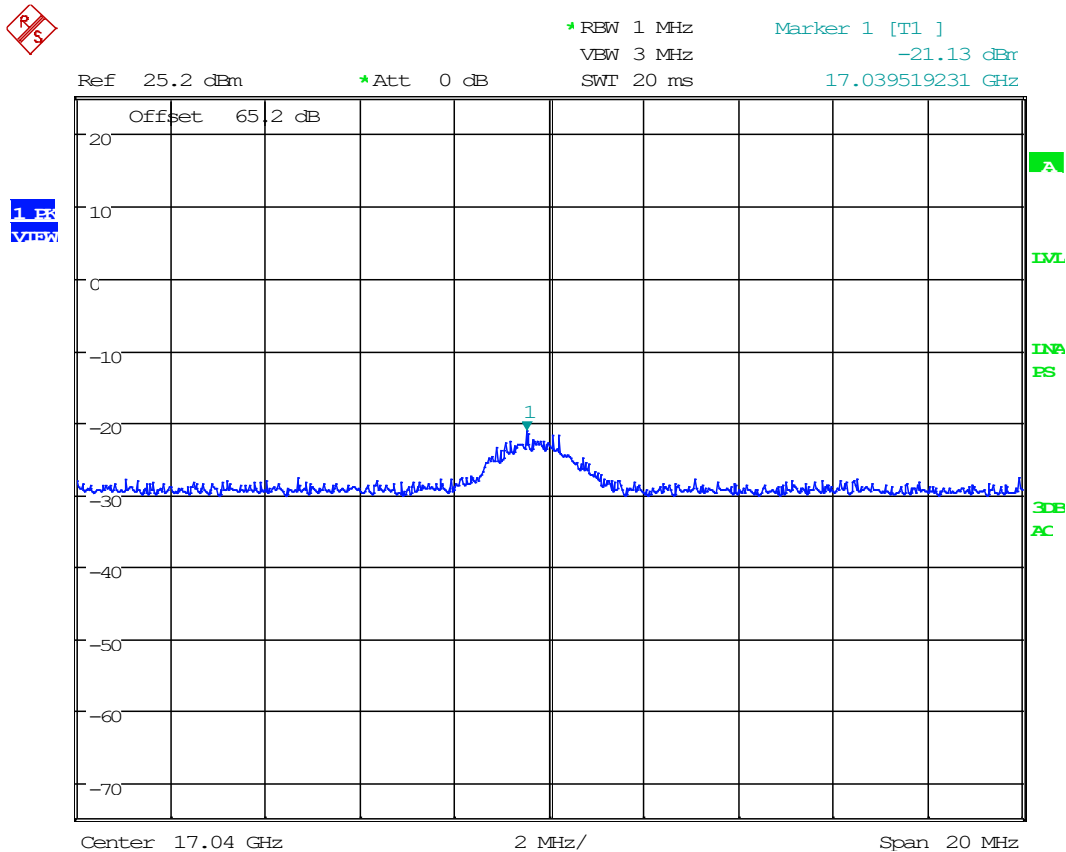


Date: 13.MAR.2020 19:23:36

90.210 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Engineer: TR, FR  
Test Date: 03/13/2020

Low Band, 2<sup>nd</sup> Harmonic Plot



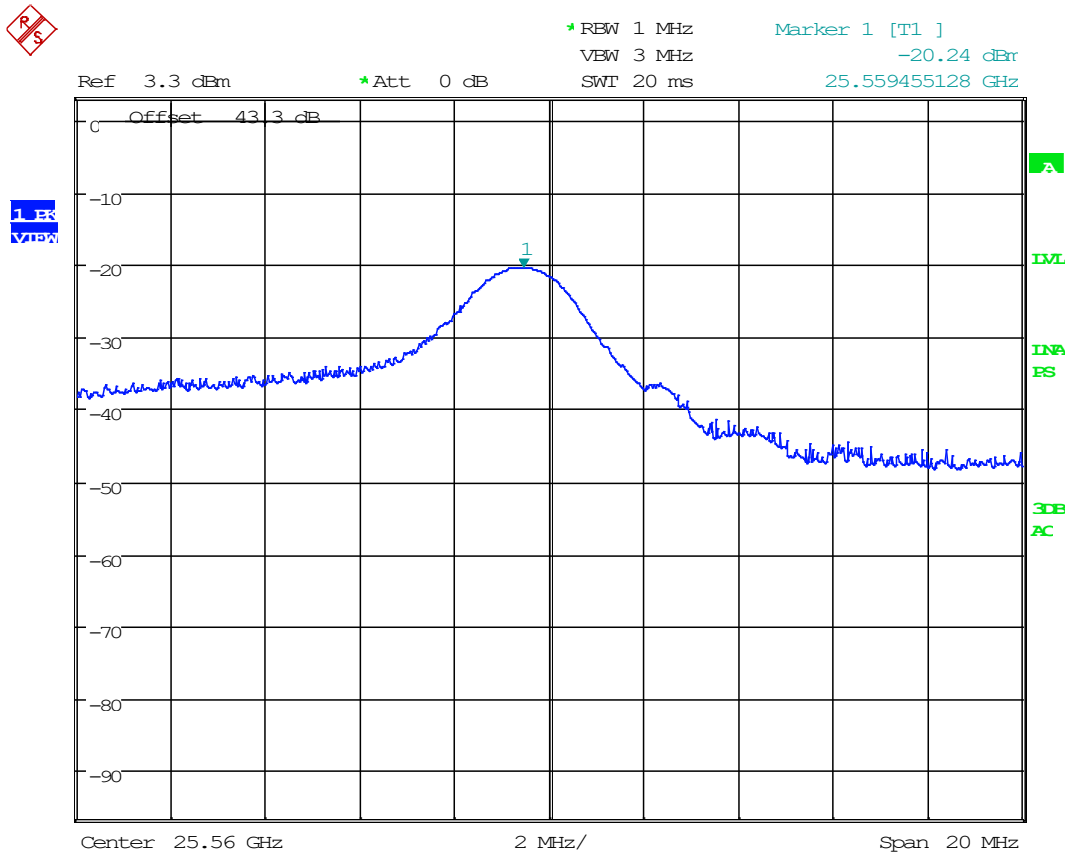
Date: 13.MAR.2020 18:41:21

Limit = -13 dBm

Margin = 8.13 dBm

**UNWANTED SPURIOUS EMISSIONS**

**Low Band, 3<sup>rd</sup> Harmonic Plot**



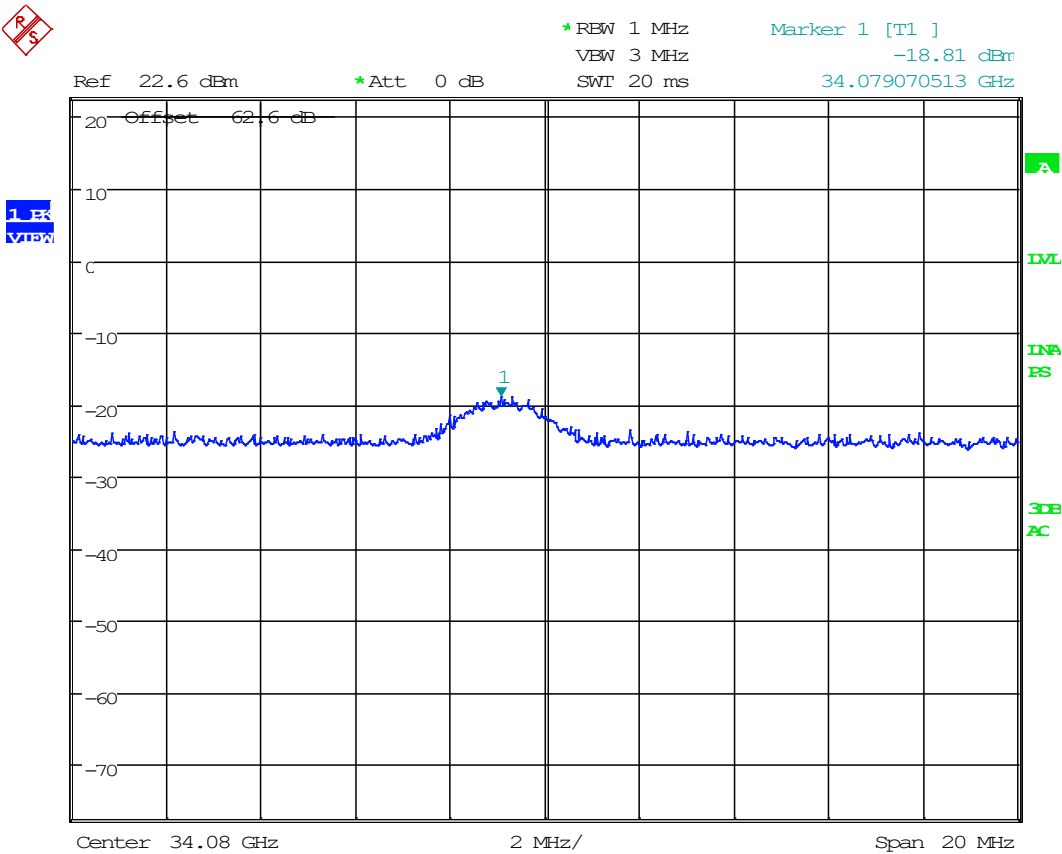
Date: 13.MAR.2020 18:43:01

**Limit = -13 dBm**

**Margin = 7.24 dBm**

UNWANTED SPURIOUS EMISSIONS

Low Band, 4<sup>th</sup> Harmonic Plot



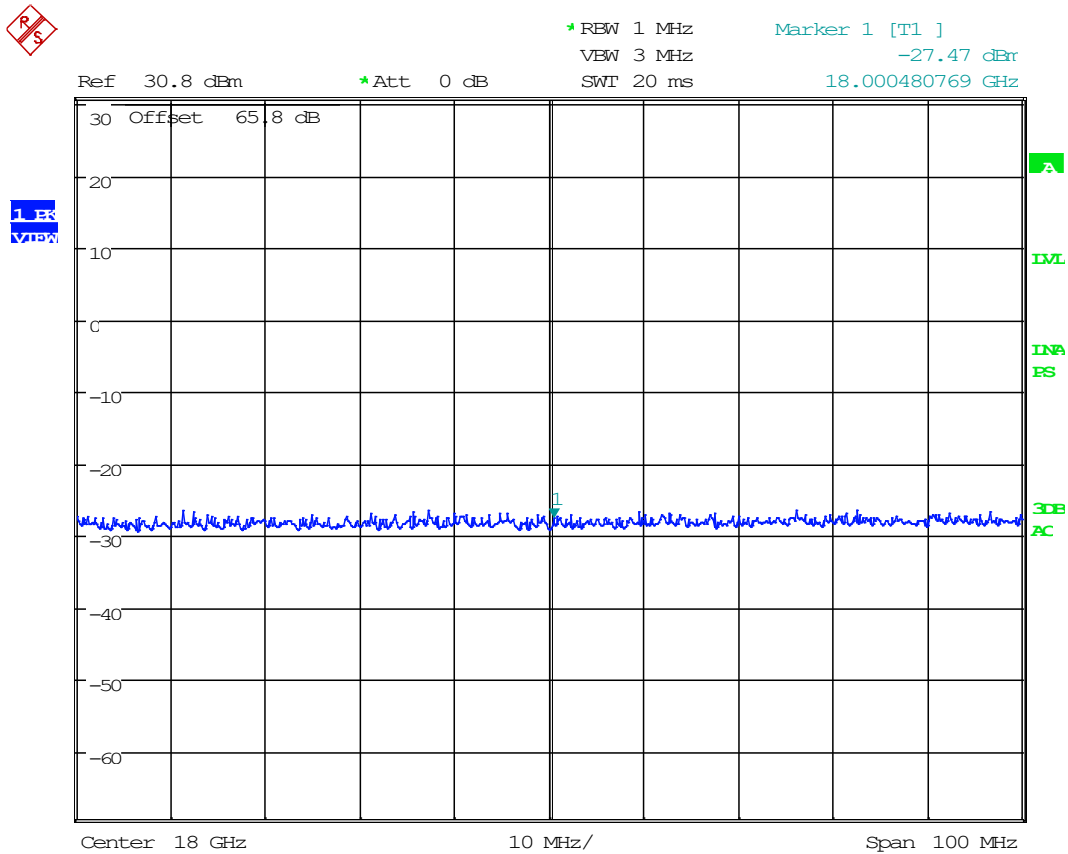
Date: 13.MAR.2020 18:44:57

Limit = -13 dBm

Margin = 5.81 dBm

**UNWANTED SPURIOUS EMISSIONS**

**Mid Band, 2<sup>nd</sup> Harmonic Plot**



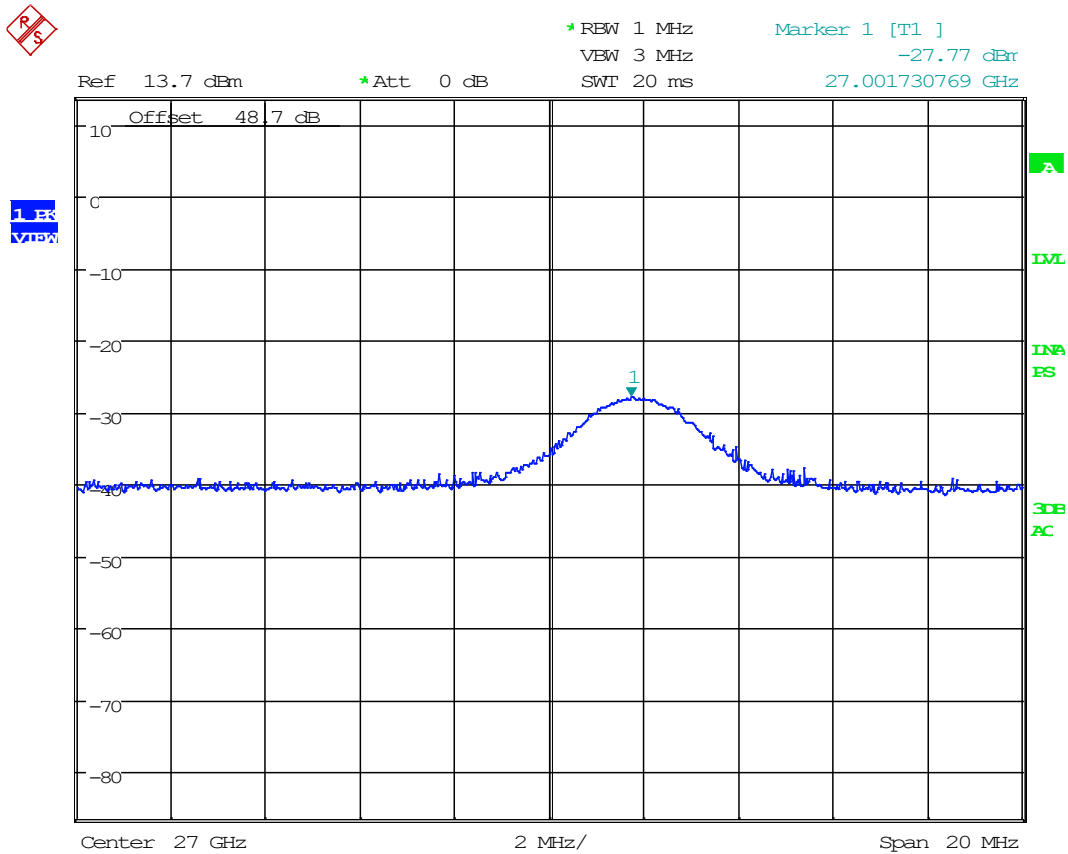
Date: 13.MAR.2020 20:30:56

**Limit = -13 dBm**

**Margin = 14.47 dBm**

**UNWANTED SPURIOUS EMISSIONS**

**Mid Band, 3<sup>rd</sup> Harmonic Plot**



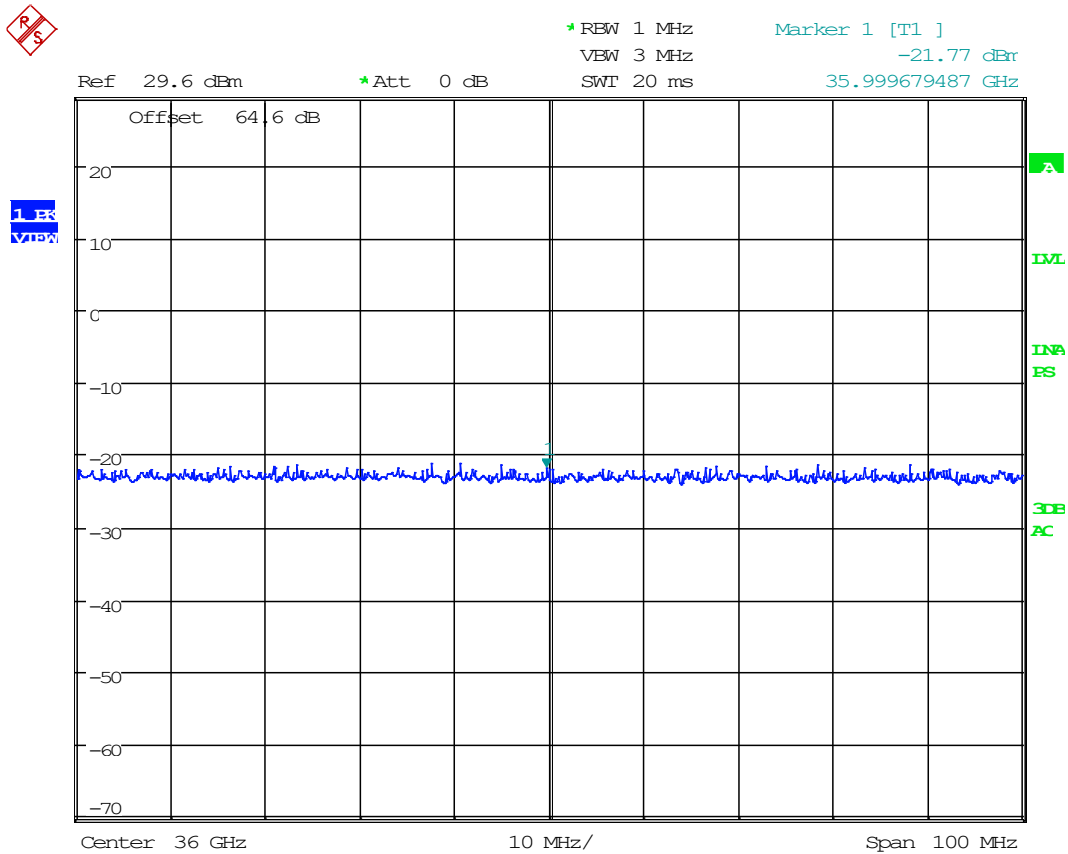
Date: 13.MAR.2020 19:09:16

**Limit = -13 dBm**

**Margin = 14.77 dBm**

**UNWANTED SPURIOUS EMISSIONS**

**Mid Band, 4<sup>th</sup> Harmonic Plot**



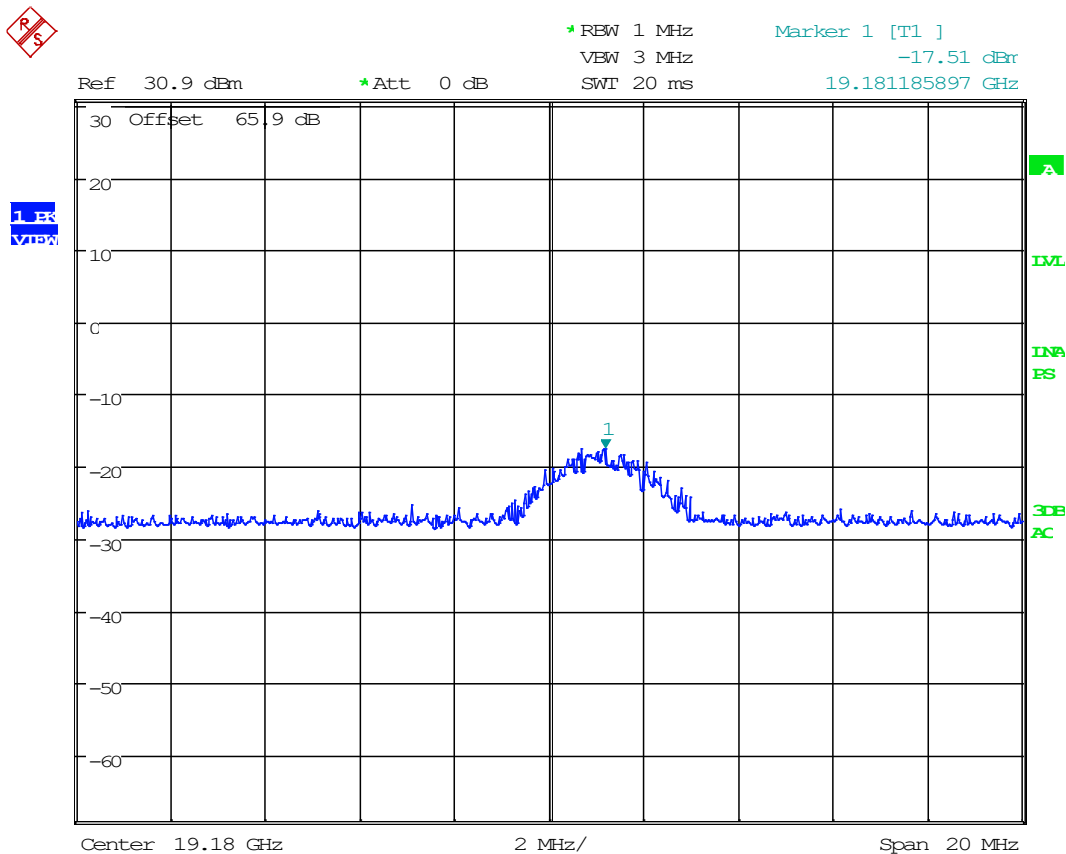
Date: 13.MAR.2020 20:32:05

**Limit = -13 dBm**

**Margin = 8.77 dBm**

UNWANTED SPURIOUS EMISSIONS

High Band, 2<sup>nd</sup> Harmonic Plot



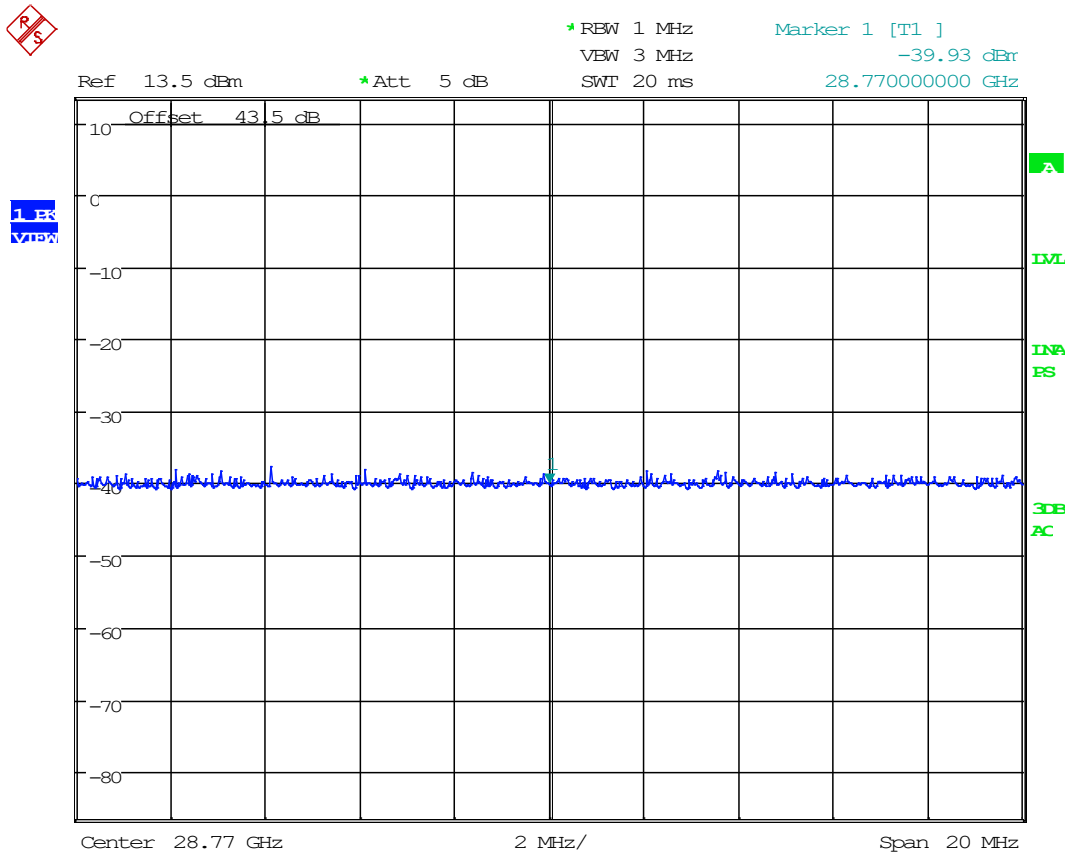
Date: 13.MAR.2020 20:26:08

Limit = -13 dBm

Margin = 4.51 dBm

**UNWANTED SPURIOUS EMISSIONS**

**High Band, 3<sup>rd</sup> Harmonic Plot**



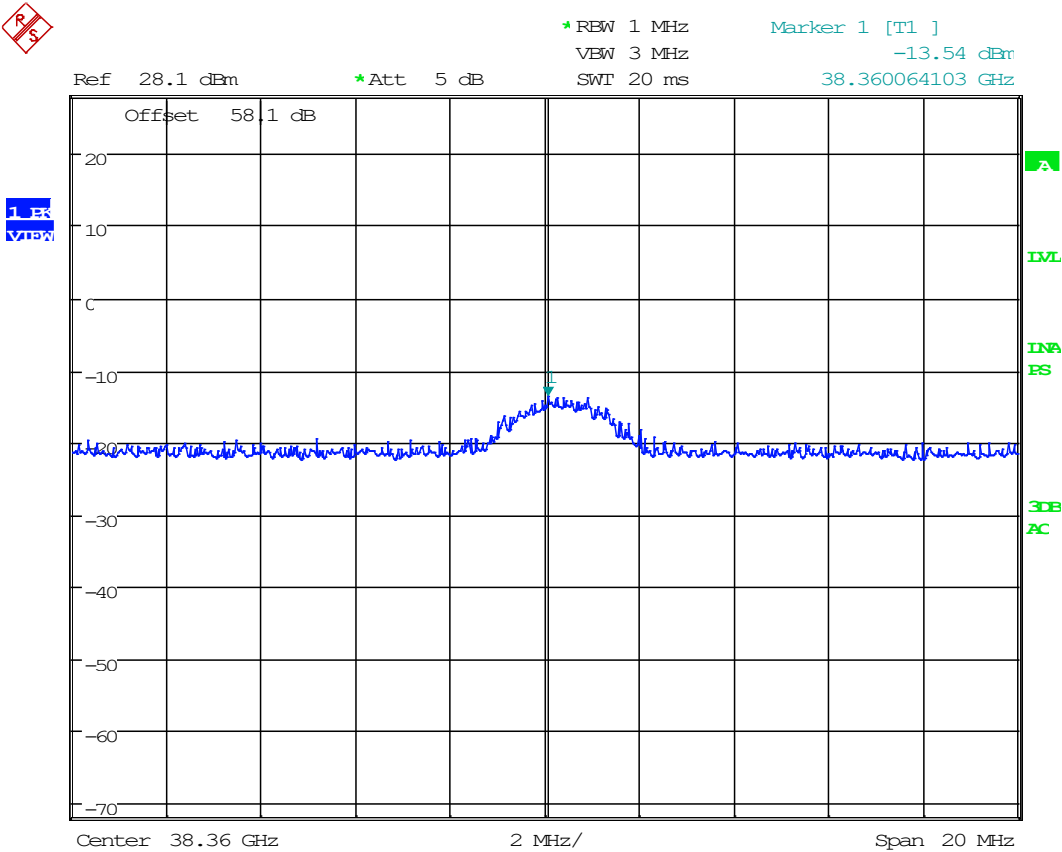
Date: 13.MAR.2020 19:30:52

**Limit = -13 dBm**

**Margin = 26.93 dBm**

UNWANTED SPURIOUS EMISSIONS

High Band, 4<sup>th</sup> Harmonic Plot



Date: 13.MAR.2020 19:31:41

Limit = -13 dBm

Margin = 0.54 dBm

**90.210 FIELD STRENGTH OF SPURIOUS EMISSIONS**

Test Engineer: TR, FR  
 Test Date: 03/14/2020

**Low Band**

| Tuned Frequency (MHz) | Emission Frequency (MHz) | Detector | Meter Reading (dBm) | Antenna Polarity | Coax Loss (dB) | Antenna Correction Factor (dB/m) | Distance (m) | Field Strength (dBμV/m) | ERP (dBm) | Spurious Limit (dBm) | Margin (dBm) |
|-----------------------|--------------------------|----------|---------------------|------------------|----------------|----------------------------------|--------------|-------------------------|-----------|----------------------|--------------|
| 8520.00               | 189.30                   | PK       | 21.81               | V                | 1.59           | 13.76                            | 3.00         | 37.16                   | -60.22    | -13.00               | 47.22        |
| 8520.00               | 62.15                    | PK       | 31.95               | V                | 0.93           | 6.86                             | 3.00         | 39.73                   | -57.65    | -13.00               | 44.65        |
| 8520.00               | 121.30                   | PK       | 23.03               | V                | 1.26           | 10.96                            | 3.00         | 35.25                   | -62.13    | -13.00               | 49.13        |
| 8520.00               | 165.13                   | PK       | 18.45               | V                | 1.49           | 15.89                            | 3.00         | 35.82                   | -61.55    | -13.00               | 48.55        |
| 8520.00               | 80.12                    | PK       | 19.95               | H                | 1.08           | 8.45                             | 3.00         | 29.48                   | -67.90    | -13.00               | 54.90        |
| 8520.00               | 143.00                   | PK       | 32.24               | H                | 1.36           | 15.70                            | 3.00         | 49.30                   | -48.08    | -13.00               | 35.08        |
| 8520.00               | 170.00                   | PK       | 18.12               | H                | 1.52           | 15.30                            | 3.00         | 34.94                   | -62.44    | -13.00               | 49.44        |
| 8520.00               | 996.15                   | PK       | 14.36               | H                | 3.72           | 23.67                            | 3.00         | 41.75                   | -55.63    | -13.00               | 42.63        |
| 8520.00               | 843.60                   | PK       | 8.85                | H                | 3.46           | 22.10                            | 3.00         | 34.41                   | -62.96    | -13.00               | 49.96        |
| 8520.00               | 662.80                   | PK       | 10.17               | H                | 3.01           | 19.62                            | 3.00         | 32.80                   | -64.57    | -13.00               | 51.57        |
| 8520.00               | 460.30                   | PK       | 12.33               | H                | 2.49           | 15.63                            | 3.00         | 30.45                   | -66.93    | -13.00               | 53.93        |
| 8520.00               | 274.40                   | PK       | 15.28               | H                | 2.06           | 12.54                            | 3.00         | 29.88                   | -67.50    | -13.00               | 54.50        |
| 8520.00               | 348.70                   | PK       | 14.16               | V                | 2.11           | 13.92                            | 3.00         | 30.19                   | -67.18    | -13.00               | 54.18        |
| 8520.00               | 547.40                   | PK       | 9.33                | V                | 2.82           | 17.64                            | 3.00         | 29.80                   | -67.58    | -13.00               | 54.58        |
| 8520.00               | 792.30                   | PK       | 10.17               | V                | 3.32           | 20.66                            | 3.00         | 34.15                   | -63.23    | -13.00               | 50.23        |
| 8520.00               | 17040.00                 | PK       | 23.76               | H                | 14.78          | 42.45                            | 3.00         | 80.99                   | -16.38    | -13.00               | 3.38         |
| 8520.00               | 17040.00                 | PK       | 24.19               | V                | 14.78          | 42.45                            | 3.00         | 81.42                   | -15.95    | -13.00               | 2.95         |
| 8520.00               | 25560.00                 | PK       | 5.10                | H                | 18.50          | 45.87                            | 3.00         | 69.47                   | -27.90    | -13.00               | 14.90        |
| 8520.00               | 25560.00                 | PK       | 3.11                | V                | 18.50          | 45.87                            | 3.00         | 67.48                   | -29.89    | -13.00               | 16.89        |
| 8520.00               | 34080.00                 | PK       | 4.61                | H                | 21.28          | 50.33                            | 3.00         | 76.22                   | -21.16    | -13.00               | 8.16         |
| 8520.00               | 34080.00                 | PK       | 5.44                | V                | 21.28          | 50.33                            | 3.00         | 77.05                   | -20.33    | -13.00               | 7.33         |

**Mid Band**

| Tuned Frequency (MHz) | Emission Frequency (MHz) | Detector | Meter Reading (dBm) | Antenna Polarity | Coax Loss (dB) | Antenna Correction Factor (dB/m) | Distance (m) | Field Strength (dBμV/m) | ERP (dBm) | Spurious Limit (dBm) | Margin (dBm) |
|-----------------------|--------------------------|----------|---------------------|------------------|----------------|----------------------------------|--------------|-------------------------|-----------|----------------------|--------------|
| 9000.00               | 181.70                   | PK       | 17.05               | V                | 1.57           | 13.56                            | 3.00         | 32.18                   | -65.20    | -20.00               | 45.20        |
| 9000.00               | 121.20                   | PK       | 16.52               | V                | 1.25           | 10.94                            | 3.00         | 28.71                   | -68.66    | -20.00               | 48.66        |
| 9000.00               | 63.20                    | PK       | 26.92               | V                | 0.94           | 6.56                             | 3.00         | 34.42                   | -62.96    | -20.00               | 42.96        |
| 9000.00               | 37.90                    | PK       | 22.75               | H                | 0.69           | 13.40                            | 3.00         | 36.84                   | -60.54    | -20.00               | 40.54        |
| 9000.00               | 81.20                    | PK       | 20.88               | H                | 1.09           | 8.84                             | 3.00         | 30.81                   | -66.57    | -20.00               | 46.57        |
| 9000.00               | 139.80                   | PK       | 17.98               | H                | 1.34           | 15.18                            | 3.00         | 34.50                   | -62.88    | -20.00               | 42.88        |
| 9000.00               | 193.70                   | PK       | 16.58               | H                | 1.60           | 14.71                            | 3.00         | 32.89                   | -64.49    | -20.00               | 44.49        |
| 9000.00               | 215.90                   | PK       | 18.17               | H                | 1.67           | 10.38                            | 3.00         | 30.22                   | -67.15    | -20.00               | 47.15        |
| 9000.00               | 287.40                   | PK       | 21.02               | H                | 2.07           | 13.15                            | 3.00         | 36.24                   | -61.14    | -20.00               | 41.14        |
| 9000.00               | 550.80                   | PK       | 15.77               | H                | 2.84           | 17.88                            | 3.00         | 36.49                   | -60.89    | -20.00               | 40.89        |
| 9000.00               | 700.14                   | PK       | 15.26               | H                | 3.10           | 20.60                            | 3.00         | 38.96                   | -58.42    | -20.00               | 38.42        |
| 9000.00               | 909.90                   | PK       | 16.31               | H                | 3.55           | 22.59                            | 3.00         | 42.45                   | -54.93    | -20.00               | 34.93        |
| 9000.00               | 959.80                   | PK       | 11.18               | V                | 3.64           | 23.20                            | 3.00         | 38.02                   | -59.36    | -20.00               | 39.36        |
| 9000.00               | 813.60                   | PK       | 10.00               | V                | 3.39           | 20.47                            | 3.00         | 33.86                   | -63.52    | -20.00               | 43.52        |
| 9000.00               | 486.50                   | PK       | 10.86               | V                | 2.61           | 16.80                            | 3.00         | 30.27                   | -67.11    | -20.00               | 47.11        |
| 9000.00               | 383.94                   | PK       | 11.16               | V                | 2.25           | 14.64                            | 3.00         | 28.05                   | -69.33    | -20.00               | 49.33        |
| 9000.00               | 6383.80                  | PK       | 7.44                | h                | 8.95           | 35.43                            | 3.00         | 51.83                   | -45.55    | -20.00               | 25.55        |
| 9000.00               | 6438.30                  | PK       | 8.32                | V                | 8.95           | 35.51                            | 3.00         | 52.78                   | -44.60    | -20.00               | 24.60        |
| 9000.00               | 18000.00                 | PK       | 11.49               | H                | 15.37          | 44.72                            | 3.00         | 71.58                   | -25.80    | -20.00               | 5.80         |
| 9000.00               | 18000.00                 | PK       | 12.75               | V                | 15.37          | 44.72                            | 3.00         | 72.84                   | -24.54    | -20.00               | 4.54         |
| 9000.00               | 27000.00                 | PK       | 3.91                | H                | 18.97          | 46.65                            | 3.00         | 69.53                   | -27.85    | -20.00               | 7.85         |
| 9000.00               | 27000.00                 | PK       | 2.62                | V                | 18.97          | 46.65                            | 3.00         | 68.24                   | -29.14    | -20.00               | 9.14         |
| 9000.00               | 36000.00                 | PK       | 3.74                | H                | 22.35          | 48.61                            | 3.00         | 74.69                   | -22.68    | -20.00               | 2.68         |
| 9000.00               | 36000.00                 | PK       | 6.05                | V                | 22.35          | 48.61                            | 3.00         | 77.00                   | -20.37    | -20.00               | 0.37         |

## Radiated Emissions

### High Band

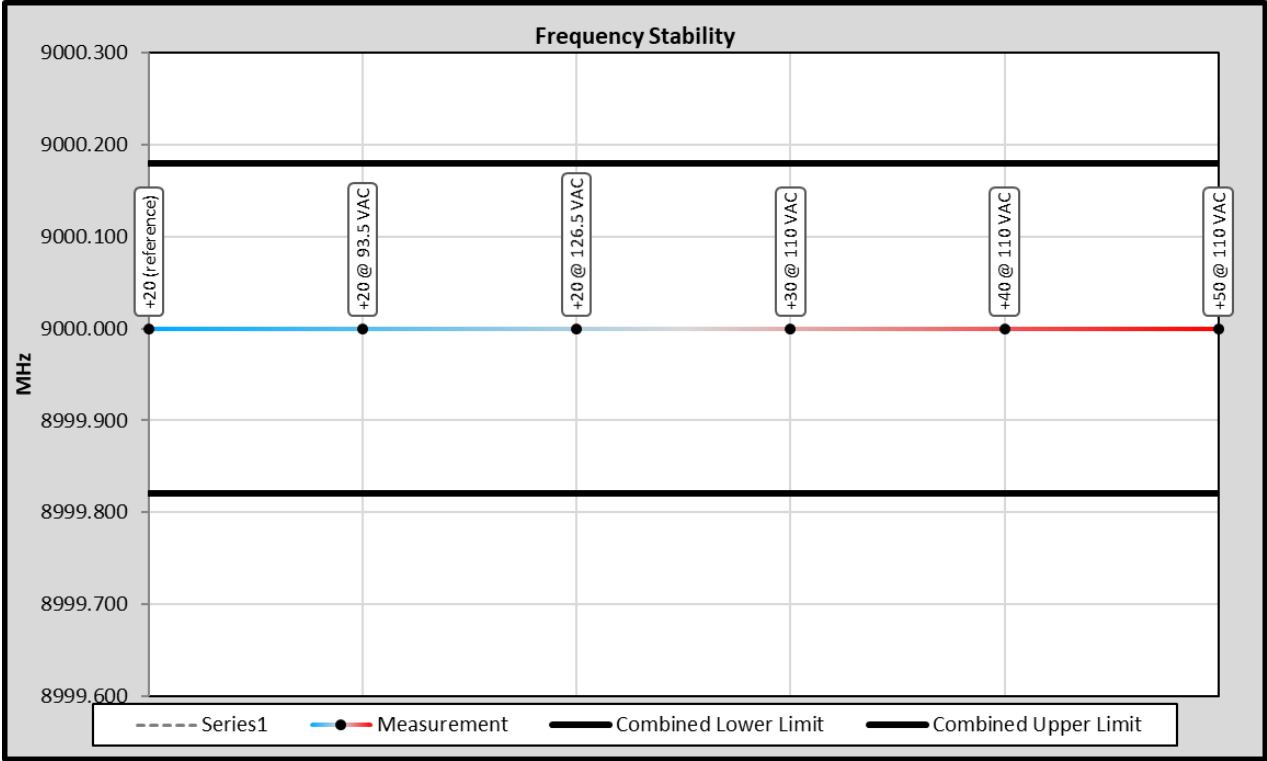
| Tuned Frequency (MHz) | Emission Frequency (MHz) | Detector | Meter Reading (dBm) | Antenna Polarity | Coax Loss (dB) | Antenna Correction Factor (dB/m) | Distance (m) | Field Strength (dBμV/m) | ERP (dBm) | Spurious Limit (dBm) | Margin (dBm) |
|-----------------------|--------------------------|----------|---------------------|------------------|----------------|----------------------------------|--------------|-------------------------|-----------|----------------------|--------------|
| 9590.00               | 162.70                   | PK       | 17.00               | H                | 1.47           | 16.33                            | 3.00         | 34.80                   | -62.58    | -20.00               | 42.58        |
| 9590.00               | 133.80                   | PK       | 19.18               | H                | 1.31           | 13.96                            | 3.00         | 34.45                   | -62.93    | -20.00               | 42.93        |
| 9590.00               | 82.00                    | PK       | 26.14               | H                | 1.09           | 9.00                             | 3.00         | 36.23                   | -61.15    | -20.00               | 41.15        |
| 9590.00               | 86.12                    | PK       | 23.54               | V                | 1.12           | 9.92                             | 3.00         | 34.58                   | -62.80    | -20.00               | 42.80        |
| 9590.00               | 132.90                   | PK       | 20.27               | V                | 1.30           | 13.77                            | 3.00         | 35.34                   | -62.03    | -20.00               | 42.03        |
| 9590.00               | 176.57                   | PK       | 17.59               | V                | 1.55           | 14.34                            | 3.00         | 33.48                   | -63.90    | -20.00               | 43.90        |
| 9590.00               | 262.80                   | PK       | 17.85               | H                | 2.03           | 11.86                            | 3.00         | 31.73                   | -65.64    | -20.00               | 45.64        |
| 9590.00               | 484.60                   | PK       | 14.20               | H                | 2.60           | 16.81                            | 3.00         | 33.61                   | -63.77    | -20.00               | 43.77        |
| 9590.00               | 567.90                   | PK       | 17.90               | H                | 2.86           | 18.18                            | 3.00         | 38.94                   | -58.44    | -20.00               | 38.44        |
| 9590.00               | 938.50                   | PK       | 17.87               | H                | 3.59           | 22.60                            | 3.00         | 44.06                   | -53.32    | -20.00               | 33.32        |
| 9590.00               | 791.00                   | PK       | 14.70               | V                | 3.31           | 20.74                            | 3.00         | 38.75                   | -58.62    | -20.00               | 38.62        |
| 9590.00               | 570.50                   | PK       | 13.23               | V                | 2.86           | 18.09                            | 3.00         | 34.18                   | -63.20    | -20.00               | 43.20        |
| 9590.00               | 485.90                   | PK       | 12.12               | V                | 2.61           | 16.80                            | 3.00         | 31.53                   | -65.85    | -20.00               | 45.85        |
| 9590.00               | 269.20                   | PK       | 17.45               | V                | 2.07           | 12.07                            | 3.00         | 31.58                   | -65.79    | -20.00               | 45.79        |
| 9590.00               | 10099.00                 | PK       | 6.81                | H                | 11.04          | 37.21                            | 3.00         | 55.06                   | -42.32    | -20.00               | 22.32        |
| 9590.00               | 16828.50                 | PK       | 8.04                | V                | 14.61          | 42.36                            | 3.00         | 65.01                   | -32.37    | -20.00               | 12.37        |
| 9590.00               | 19180.00                 | PK       | -1.10               | H                | 15.88          | 44.73                            | 3.00         | 59.50                   | -37.87    | -20.00               | 17.87        |
| 9590.00               | 19180.00                 | PK       | 9.18                | V                | 15.88          | 44.73                            | 3.00         | 69.78                   | -27.59    | -20.00               | 7.59         |
| 9590.00               | 28770.00                 | PK       | 4.21                | H                | 19.71          | 46.62                            | 3.00         | 70.54                   | -26.83    | -20.00               | 6.83         |
| 9590.00               | 28770.00                 | PK       | -1.23               | V                | 19.71          | 46.62                            | 3.00         | 65.10                   | -32.27    | -20.00               | 12.27        |
| 9590.00               | 38360.00                 | PK       | 2.86                | H                | 22.93          | 45.68                            | 3.00         | 71.47                   | -25.91    | -20.00               | 5.91         |
| 9590.00               | 38360.00                 | PK       | 3.58                | V                | 22.93          | 45.68                            | 3.00         | 72.19                   | -25.19    | -20.00               | 5.19         |



90.213 FREQUENCY STABILITY

Test Engineer: TR, FR  
Test Date: 03/14/2020

Frequency Error Measurement Plot



## FREQUENCY STABILITY

### Frequency Error Measurement Table

|                                 |                      |                                                              |                 |
|---------------------------------|----------------------|--------------------------------------------------------------|-----------------|
| FCC Part 90 Limit               | 20.0                 | ppm                                                          |                 |
| FCC Part 90 Limit, as ppb       | 20000                | ppb (Parts per Billion)                                      |                 |
| FCC Part 90 Limit, as %         | 0.00200              | %                                                            |                 |
| Strictest Combined Limit, as Hz | 180000.000           | Hz                                                           |                 |
| Combined Lower Limit            | 8999.820000          | MHz                                                          |                 |
| Combined Upper Limit            | 9000.180000          | MHz                                                          |                 |
| Rated Supply Voltage            | 110.0                | <input checked="" type="radio"/> AC <input type="radio"/> DC |                 |
| Temperature / Voltage Variation |                      |                                                              |                 |
| Temperature (°C)                | Supplied Voltage (V) | Frequency (MHz)                                              | Deviation (kHz) |
| +20 (reference)                 | 110.0                | 9000.000000                                                  | 0.000           |
| +20                             | 93.5                 | 9000.000000                                                  | 0.000           |
| +20                             | 126.5                | 9000.000000                                                  | 0.000           |
| +30                             | 110.0                | 9000.000000                                                  | 0.000           |
| +40                             | 110.0                | 9000.000000                                                  | 0.000           |
| +50                             | 110.0                | 9000.000000                                                  | 0.000           |

**END OF TEST REPORT**