TIMCO ENGINEERING, Inc.

An IIA Company

FCC CFR 47 Part 80 Radar Test Report

APPLICANT	KELVIN HUGHES LIMITED
ADDRESS	VOLTAGE, MOLLISON AVENUE ENFIELD EN3 7XQ UNITED KINGDOM
FCC ID	CICDTX-A613-SF
MODEL NUMBER	DTX-A3-AMMA
PRODUCT DESCRIPTION	SHARPEYE RADAR TRANSCEIVER
DATE SAMPLE RECEIVED	12/29/2019
FINAL TEST DATE	01/27/2020
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

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

ACCREDITED
Certificate #0955.01

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SIGNATURE PAGE

Timco Engineering, Inc. attests that:

☒	The EUT tested herein **fulfills** all approval requirements and/or the customer requirements as identified in this test report.
☐	The EUT tested herein **does not fulfill** 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

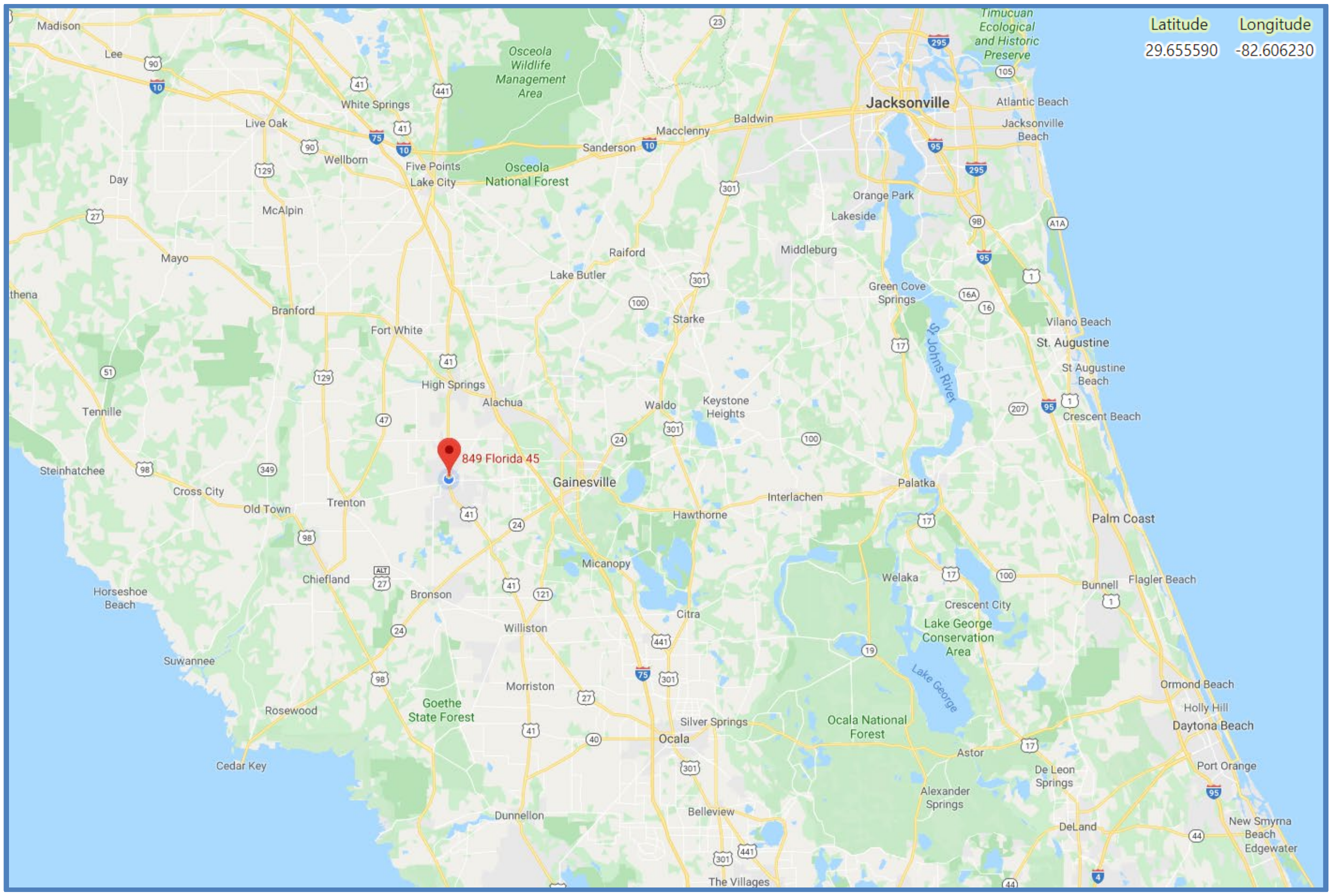
Name and Title Tim Royer, Project Manager / EMC Engineer

Name and Title Sharon Hoffman, Senior Marketing Director

Date FEB 04, 2020

TEST LABORATORY INFORMATION

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



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

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TEST INFORMATION

Report Version	Description	Issue Date
Rev1	Initial Issue	FEB 4 2020
Rev2	Corrected Power Output	FEB 19 2020
Rev3	Clerical Updates	FEB 24 2020
Rev4	Clerical Updates	FEB 24 2020
Rev5	Clerical Updates	AUG 20 2020
Rev6	Update Model Number	SEP 8 2020

Test Conditions	Temperature during testing: 26ºC, Humidity during testing: 50%
Test Exercise	The EUT was operated in accordance with the service manual using software supplied by the manufacturer.
Applicable Standards	ANSI C63.26, December 11, 2015 FCC CFR 47 Part 2, 2019 FCC CFR 47 Part 80, 2019 ITU-R M.1177-4, April 2011
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA

EUT INFORMATION

KELVIN HUGHES
A Hensoldt Company

Definitions: FCC Part 80.5

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.

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

EUT Description	SHARPEYE RADAR TRANSCEIVER		
Model Number	DTX-A3-AMMA		
Emission Designator	62M5P0N		
Measurement Method	40dB Occupied Bandwidth		
Modulation	FM Pulse/FM Chirp		
Modified for Testing	☐		
Modification	n/a		
Antenna Connector	☐ UHF	☐ BNC	☐ N
	☐ TNC	☐ SMA	☒ WR-90 Waveguide
EUT Power Source	☒ AC Power (110-120 V)	☐ DC Power (13.8 V)	☐ DC Battery (13.8 V)
Test Item	☐ Engineering Prototype	☐ Pre-Production	☒ Production
Type of Equipment	☒ Fixed	☐ Mobile	☐ Portable

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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	KELVIN HUGHES LIMITED VOLTAGE, MOLLISON AVENUE ENFIELD EN3 7XQ UNITED KINGDOM
2.1033(c)(2)	FCC Identifier	CICDTX-A613-SF
2.1033(c)(4) 2.1033(c)(13)	Type(s) of Emission & description of Digital Modulation Techniques	☒
2.1033(c)(5)	Frequency Range	9300 - 9500 MHz
2.1033(c)(6),(7)	Range of operating power or specific operating power levels, and Maximum Power Rating.	34.8 W (mean)
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	240 VAC * ~3 A = 750 W
2.1033(c)(14)	Test Results satisfying 2.1046 – 2.1057	☒
2.1033(c)(21)	Contain > 1 Drawing or Photograph of each test setup applicable to the device	☒

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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.

§80.273 Radar standards.

(a) Radar installations on board ships that are required by the Safety Convention or the U.S. Coast Guard to be equipped with radar must comply with the following standards (all incorporated by reference, *see* §80.7):

(1) IEC 60945;

(2) IEC 62388;

(3) IMO Resolution A.694(17), as revised by IMO Resolution MSC.149(77);

(4) IMO Resolution MSC.191(79);

(5) IMO Resolution MSC.192(79); and

(6) ITU-R M.1177-3.

Note: Only ITU-R M.1177-3 (newest version -4) is covered here.

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2.1046 – 2.1055 TECHNICAL REQUIREMENTS

General Requirement (FCC PT 2)	Specific Requirement (FCC PT 90)	Requirement	Complies	N/A
2.1033(c)(4)	80.205, 80.207	Modulation Characteristics	☒	☐
2.1046	80.215	RF Power Output	☒	☐
2.1047		Audio Frequency Response	☐	☒
2.1047		Audio Low Pass Filter Response	☐	☒
2.1047		Modulation Limiting	☐	☒
2.1049	80.205	Occupied Bandwidth	☒	☐
	80.211	Emission Masks	☒	☐
2.1051	80.211	Conducted Spurious Emissions at Antenna Terminals	☒	☐
2.1053	80.211	Radiated Field Strength of Spurious Emissions	☒	☐
2.1055	80.209	Frequency Stability	☒	☐

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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)[25]

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.

[25] Use of the procedures in 5.1.2.2 is subject to the discretion of the regulatory authority.

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80.375 FREQUENCY BAND

§80.375 Radiodetermination frequencies.

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

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

(i) The 2450-2500 MHz band may be used only for radiolocation on the condition that harmful interference must not be caused to the fixed and mobile services. No protection is provided from interference caused by emissions from industrial, scientific, or medical equipment;

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

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

(iv) Non-Government radiolocation stations may be authorized in the 5460-5470 MHz band on the condition that harmful interference shall not be caused to the aeronautical or maritime radionavigation services or to Government radiolocation service;

(v) The use of the 5460-5650 MHz band for radionavigation is limited to shipborne radar.

EUT Intended Band(s) of Operation

Band 1: 9.3 – 9.5 GHz

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2.1033 MODULATION CHARACTERISTICS

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

Operating Modes

There are 3 different range modes:

P0N Emission, 6NM (SR) mode

P0N Emission, 24NM (MR) mode

P0N Emission, 48NM (LR) mode

Note: Technical details of the emission are considered proprietary information, and as such they have not been included in this report.

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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.

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80.215 RF POWER OUTPUT

Requirements:

§80.215 Transmitter power.

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

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

(n) For radiodetermination stations operating above 2400 MHz the output power must be as follows:

(3) For all other transponder stations the output power must not exceed 20 watts peak e.i.r.p. Licensees of non-selectable transponder coast stations operating in the 2920-3100 MHz and 9320-9500 MHz bands must notify in writing the USCG District Commander of any incremental increase of their station's output power above 5 watts peak e.i.r.p.

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 $\geq 10 \times$ (number of points in sweep) $\times$ (transmission symbol period).

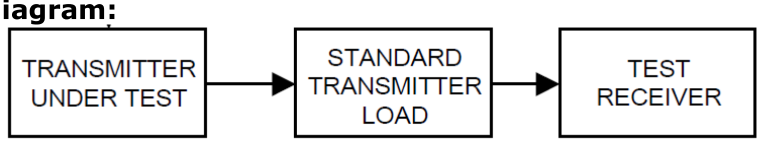
e) Detector = peak.

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:



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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.

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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.

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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.

80.205 OCCUPIED BANDWIDTH

Rule Part No.: Part 80.205(a), (d), (g), ITU-R M.1177-4

§80.205 Bandwidths.

(a) An emission designator shows the necessary bandwidth for each class of emission of a station except that in ship earth stations it shows the occupied or necessary bandwidth, whichever is greater. The following table gives the class of emission and corresponding emission designator and authorized bandwidth:

Class of emission	Emission designator	Authorized bandwidth (kHz)
PON	([12])	([12])

[12]Applicable to radiolocation and associated telecommand ship stations operating on 154.585 MHz, 159.480 MHz, 160.725 MHz. 160.785 MHz, 454.000 MHz, and 459.000 MHz; emergency position indicating radiobeacons operating in the 406.000-406.1000 MHz frequency bank; and data transmissions in the 156-162 MHz band.

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

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

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

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

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).

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80.211 EMISSION MASK

Rule Part No.: 80.211(f)(1), (2)

Requirements:

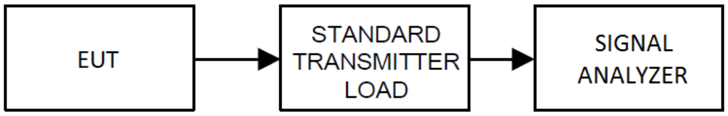
(f) The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:

(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and

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).

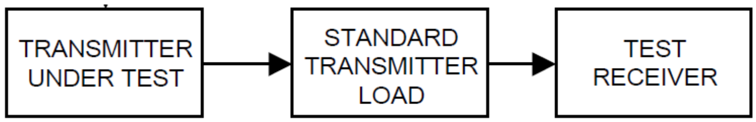
e) Detector = peak.

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:



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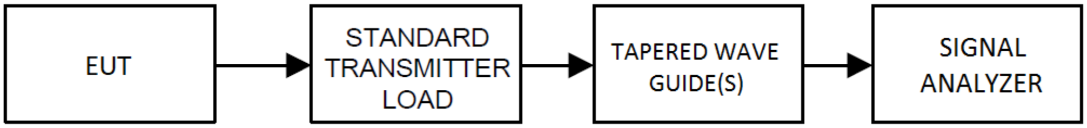
80.211 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Rule Part No.: 80.211(f)(3)

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

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

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 (μs) (e.g. if the FM is from 1 250 MHz to 1 280 MHz or 30 MHz during the pulse of 10 μs, then the reference bandwidth is $(30\ \text{MHz}/10\ \mu\text{s})^{1/2} = 1.73$ MHz);

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

3 Measurement bandwidth and detector parameters

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

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

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

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

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

Video bandwidth ≥ measurement system bandwidth.

Detector positive peak.

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

UNWANTED SPURIOUS EMISSIONS

Test Procedures, Con't.

3.2 Measurements within the spurious domain

3.2.1 Correction of the measurement within the spurious domain

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

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

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

Test Data: Offset Calculation Tables

9.02 GHz

	Peak Power Output (dBm):		56.29
FCC Emission Mask	Frequency (MHz)	dBc	dBm
	0.03	69.29	-13.00
	8752.00	69.29	-13.00
	8752.00	35	21.29
	8907.00	35	21.29
	8907.00	25	31.29
	8969.00	25	31.29
	8969.00	0	56.29
	9000.00	0	56.29
	9062.00	0	56.29
	9093.00	0	56.29
	9093.00	25	31.29
	9155.00	25	31.29
	9155.00	35	21.29
	9310.00	35	21.29
	9310.00	69.29	-13.00
	40000.00	69.29	-13.00

9.24 GHz

	Peak Power Output (dBm):		56.29
FCC Emission Mask	Frequency (MHz)	dBc	dBm
	0.03	69.29	-13.00
	8961.00	69.29	-13.00
	8961.00	35	21.29
	9116.00	35	21.29
	9116.00	25	31.29
	9178.00	25	31.29
	9178.00	0	56.29
	9209.00	0	56.29
	9271.00	0	56.29
	9302.00	0	56.29
	9302.00	25	31.29
	9364.00	25	31.29
	9364.00	35	21.29
	9519.00	35	21.29
	9519.00	69.29	-13.00
	40000.00	69.29	-13.00

9.48 GHz

	Peak Power Output (dBm):		56.29
FCC Emission Mask	Frequency (MHz)	dBc	dBm
	0.03	69.29	-13.00
	9190.00	69.29	-13.00
	9190.00	35	21.29
	9345.00	35	21.29
	9345.00	25	31.29
	9407.00	25	31.29
	9407.00	0	56.29
	9438.00	0	56.29
	9500.00	0	56.29
	9531.00	0	56.29
	9531.00	25	31.29
	9593.00	25	31.29
	9593.00	35	21.29
	9748.00	35	21.29
	9748.00	69.29	-13.00
	40000.00	69.29	-13.00

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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.

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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.

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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

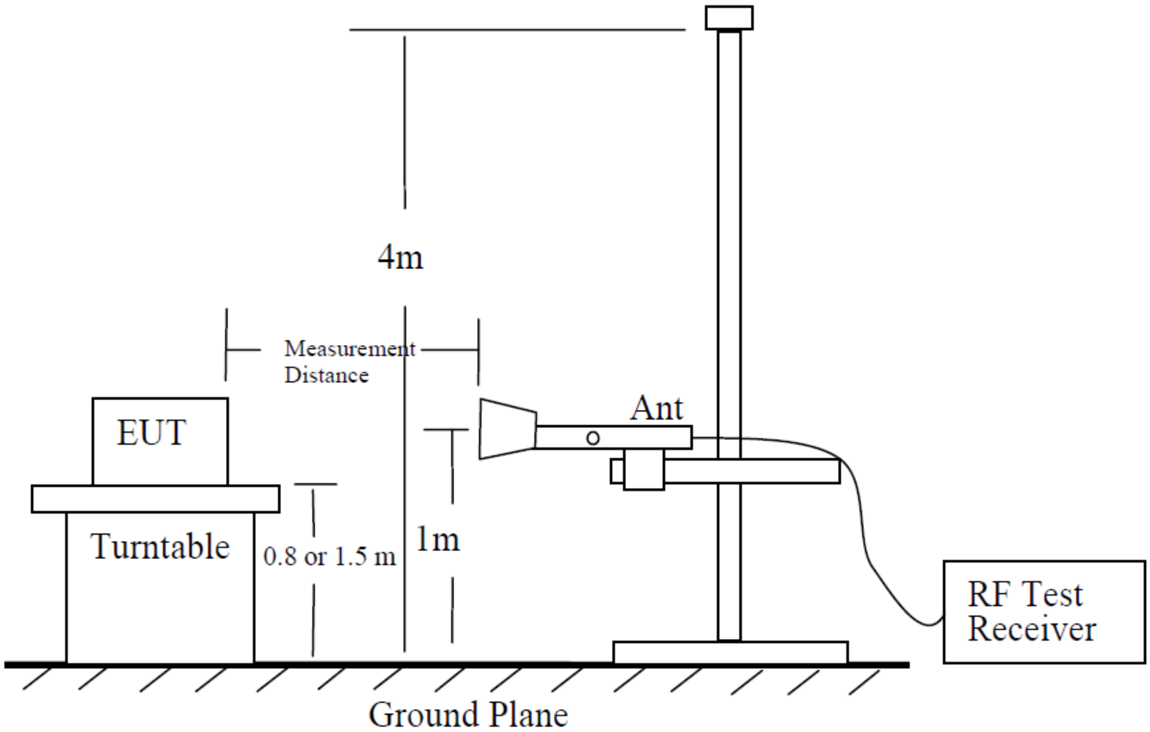

Figure 4 —Test set-up for radiated spurious measurements

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.

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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 ≥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.

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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.

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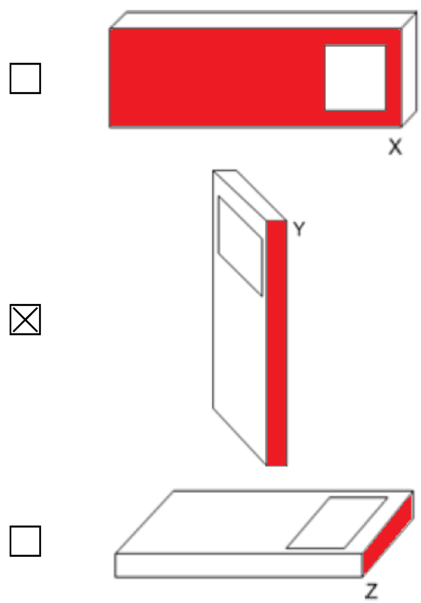
FIELD STRENGTH OF SPURIOUS EMISSIONS

5.5.5 Recording test results

A minimum of six data points representing the highest identified unwanted emission amplitude levels revelant 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



80.211 FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Part No.: 80.211(f)(3)

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

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

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

2 Reference bandwidth

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

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

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

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

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

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° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

☒ (2) From −20° to + 50° 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° to + 50° 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° 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° centigrade and + 30° 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° 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.

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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.)

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80.209 FREQUENCY STABILITY

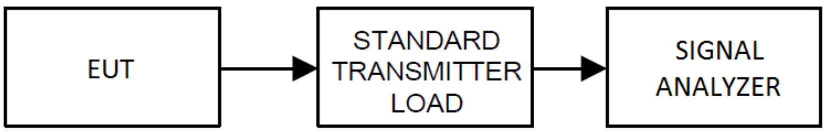
Rule Part No.: 80.209(b)

§80.209 Transmitter frequency tolerances.

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

Test Procedure: TIA 603-E, 2.2.2

Test Setup Block Diagram:



Note: This EUT is designed to operate within FCC Parts 80, 87, 90, and in accordance with ISED RSS-238. Therefore, in lieu of FCC Part 90 unspecified stability limit, the EUT shall meet Frequency Stability limits from the appropriate standards (1250 ppm).

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.

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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	01/30/17	01/30/20
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
Power Sensor	Boonton	51072A	34647	01/12/17	01/12/20
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

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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.

Test Item	☐ Prototype	☐ Pre-Production	☒ Production
Type of Equipment	☒ Fixed	☐ Mobile	☐ Portable
Modulation	FM Pulse/FM Chirp		
Modified for Testing	☐		
Modification	n/a		
Modification to the EUT	The EUT was not modified.		

Power at the Final Amplifier

240 VAC * ~3 A = 750 W

Duty Cycle

Pulse Data

Frequency Range

Misc. EUT Information

ANNEX II – MEASUREMENT DATA

80.215 RF POWER OUTPUT

Test Engineer: FR
Test Date: 01/14/2020

Low Band, Mean Power Output

Mode	Nominal Frequency (MHz)	Measured PK Output Power (dBm)	Adjusted Loss (dBm)	Measured Loss (dBm)	Actual PK Output Power (dBm)	PK Power Output (W)	Calculated Duty Cycle (%)	Mean Power Output (W)	Mean Power Output (dBm)
SR	9320	55.46	54.3	54.66	55.82	381.94	2.8125%	10.742	40.311
MR	9320	55.66	54.3	54.66	56.02	399.94	8.3507%	33.398	45.237
LR	9320	55.66	54.3	54.66	56.02	399.94	7.2140%	28.852	44.602

Maximum Mean Power: **33.4W**

Mid Band, Mean Power Output

Mode	Nominal Frequency (MHz)	Measured PK Output Power (dBm)	Adjusted Loss (dBm)	Measured Loss (dBm)	Actual PK Output Power (dBm)	PK Power Output (W)	Calculated Duty Cycle (%)	Mean Power Output (W)	Mean Power Output (dBm)
SR	9360	55.51	54.3	54.86	56.07	404.58	2.8125%	11.379	40.561
MR	9360	55.61	54.3	54.86	56.17	414.00	8.3507%	34.572	45.387
LR	9360	55.73	54.3	54.86	56.29	425.60	7.2140%	30.703	44.872

Maximum Mean Power: **34.6 W**

High Band, Mean Power Output

Mode	Nominal Frequency (MHz)	Measured PK Output Power (dBm)	Adjusted Loss (dBm)	Measured Loss (dBm)	Actual PK Output Power (dBm)	PK Power Output (W)	Calculated Duty Cycle (%)	Mean Power Output (W)	Mean Power Output (dBm)
SR	9480	55.41	54.3	54.77	55.88	387.26	2.8125%	10.892	40.371
MR	9480	55.57	54.3	54.77	56.04	401.79	8.3507%	33.552	45.257
LR	9480	55.63	54.3	54.77	56.1	407.38	7.2140%	29.388	44.682

Maximum Mean Power: **33.6 W**

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80.205 OCCUPIED BANDWIDTH

Test Engineer: FR
Test Date: 01/14/2020

Occupied Bandwidth Measurement Table

Mode	99% Occupied Bandwidth (MHz)	40 dB Occupied Bandwidth (MHz)
SR	17.63	62.5
MR	18.11	61.7
LR	18.35	60.9

Max Occupied Bandwidth of EUT = **62.5 MHz**

Emission Designator = **62M5P0N**

Method of Measurement = **40 dB Down**

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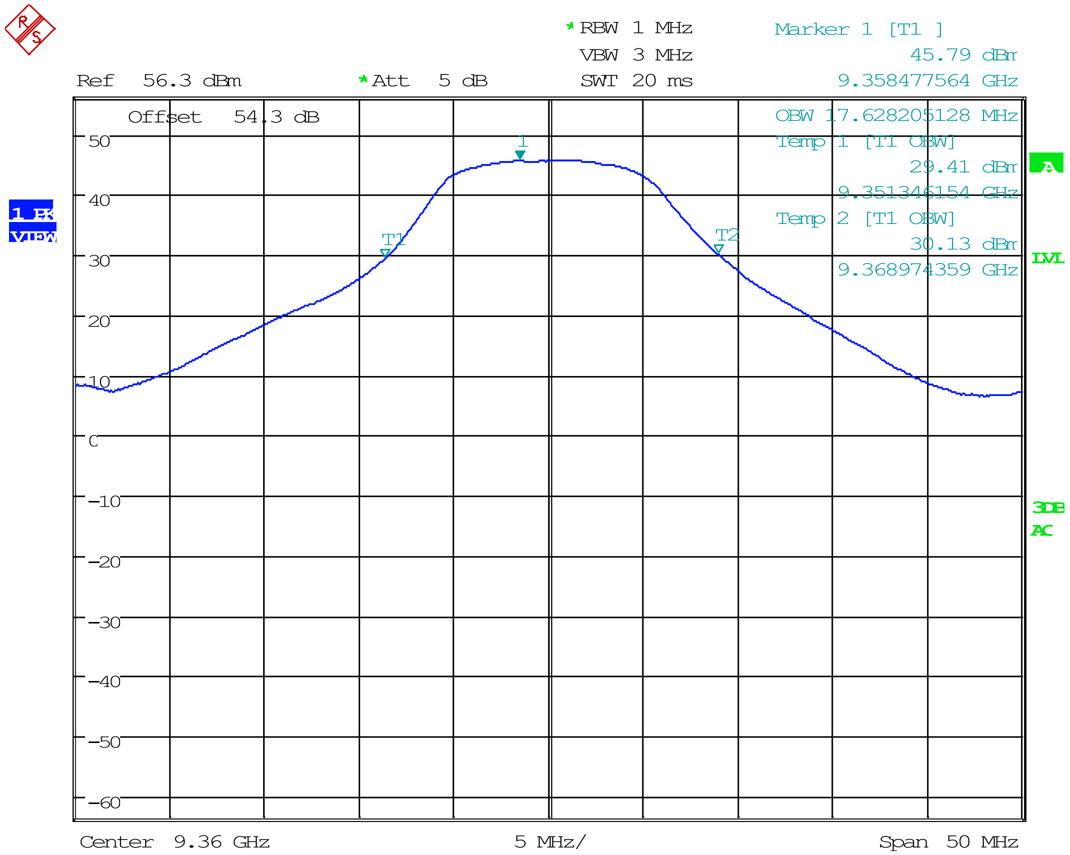
OCCUPIED BANDWIDTH

Mode SR, 99% OBW Plot



Date: 16.JAN.2020 16:20:54

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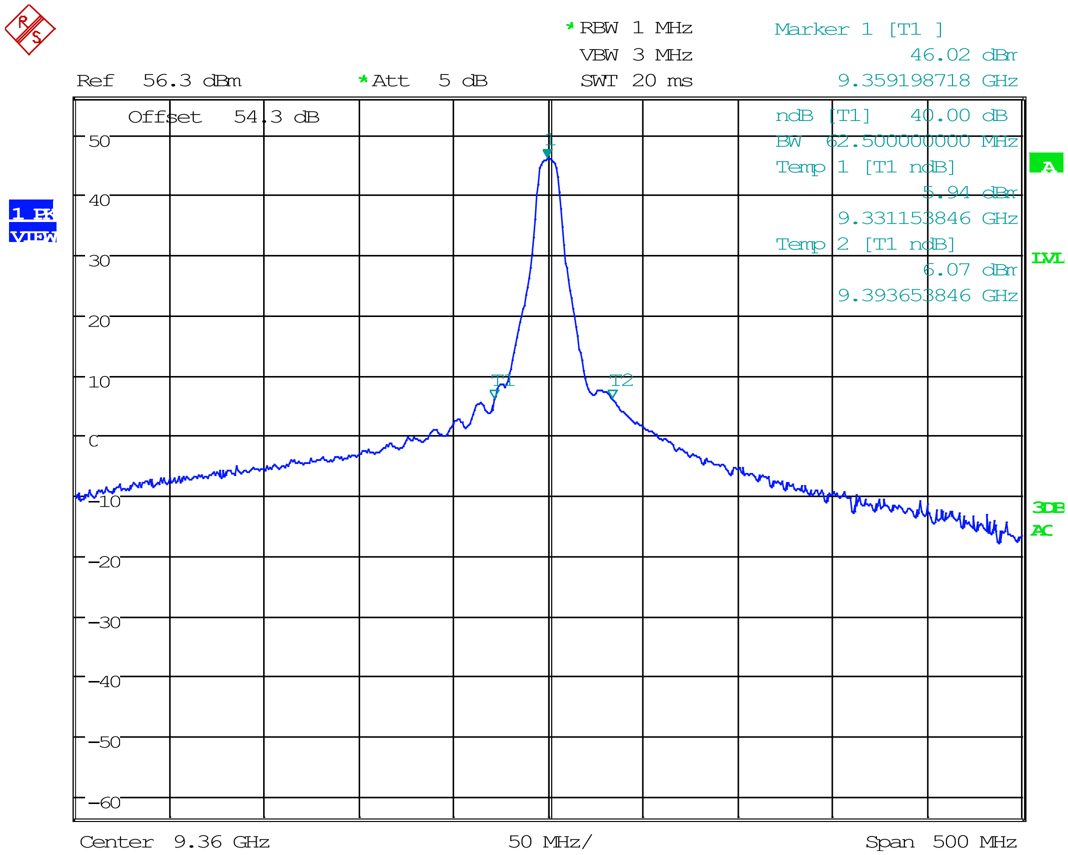
OCCUPIED BANDWIDTH

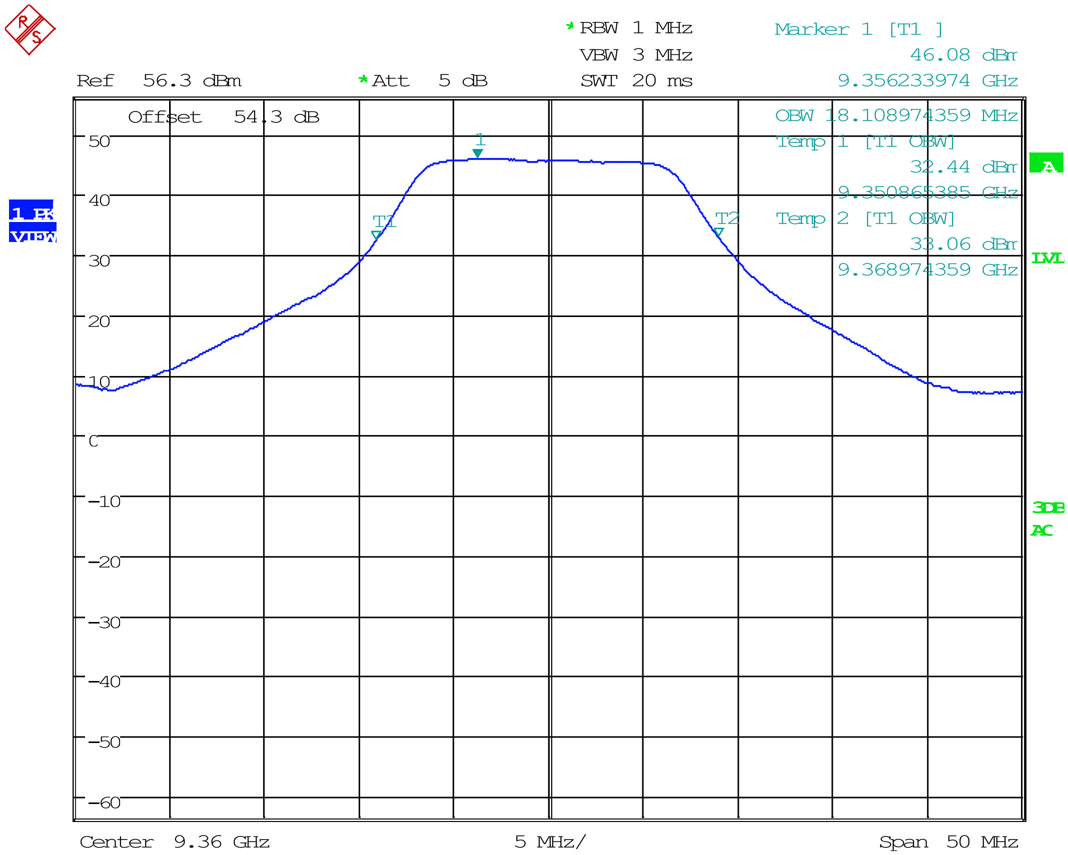
Mode SR, 40dB OBW Plot



Date: 16.JAN.2020 16:25:36

OCCUPIED BANDWIDTH

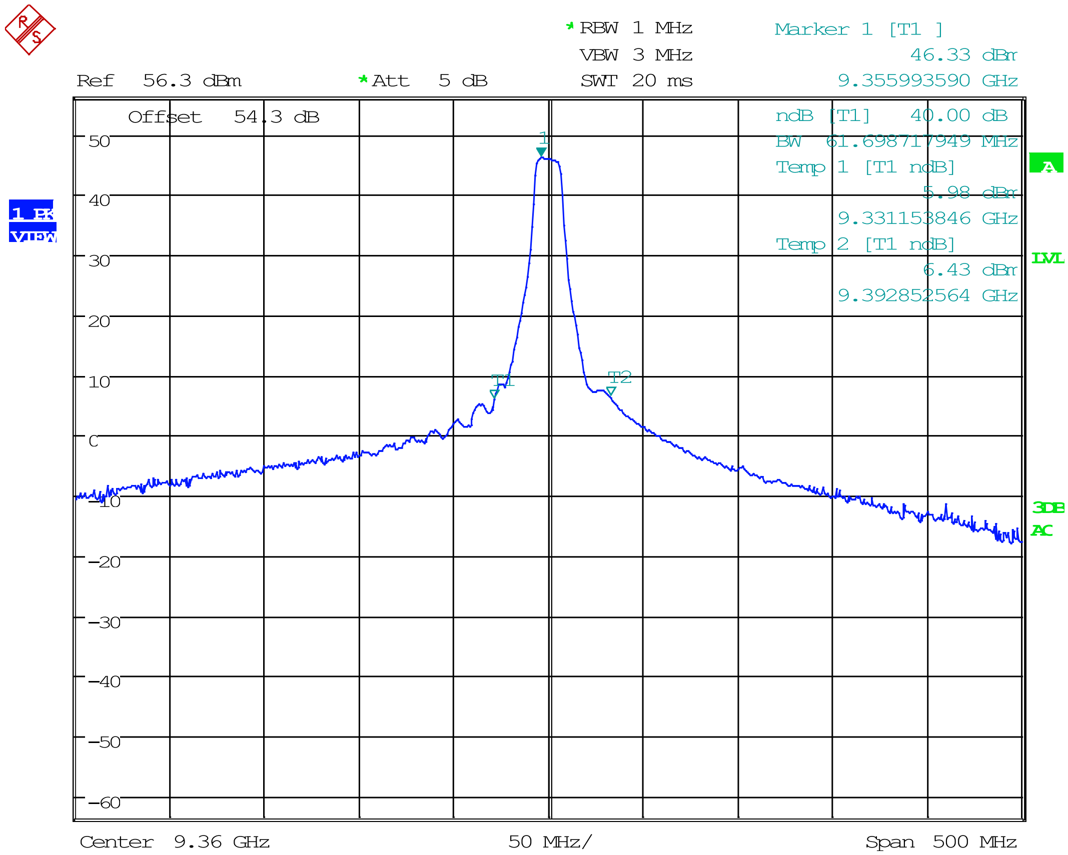
Mode MR, 99% OBW Plot



Date: 16.JAN.2020 16:21:29

OCCUPIED BANDWIDTH

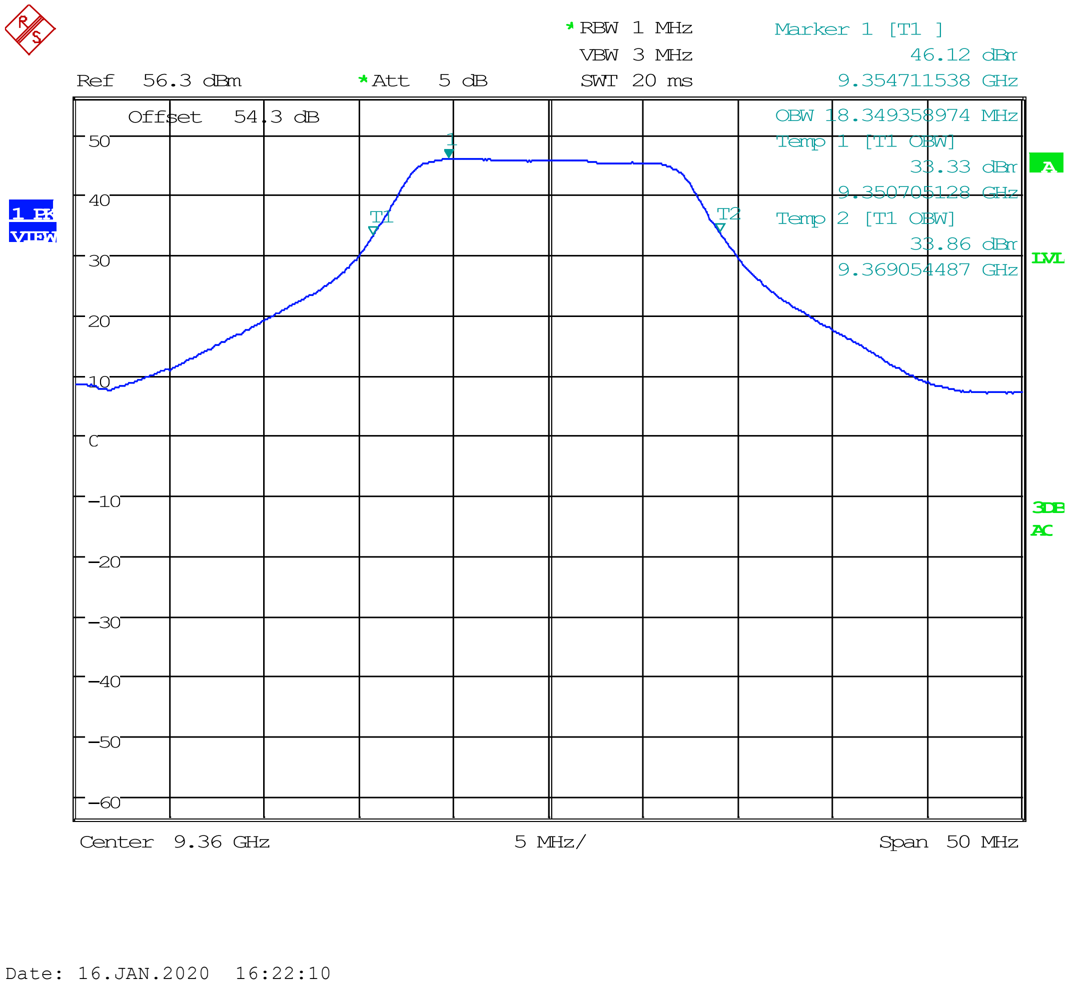
Mode MR, 40dB OBW Plot



Date: 16.JAN.2020 16:24:59

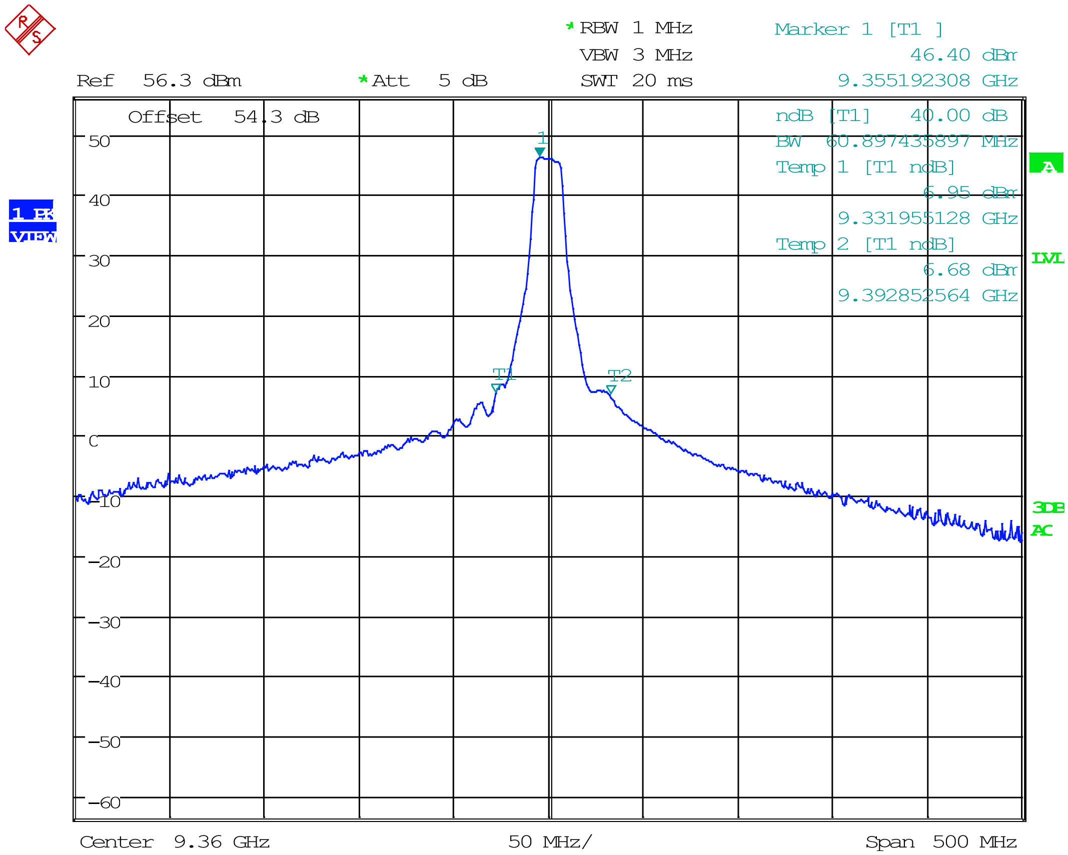
OCCUPIED BANDWIDTH

Mode LR, 99% OBW Plot



OCCUPIED BANDWIDTH

Mode LR, 40dB OBW Plot

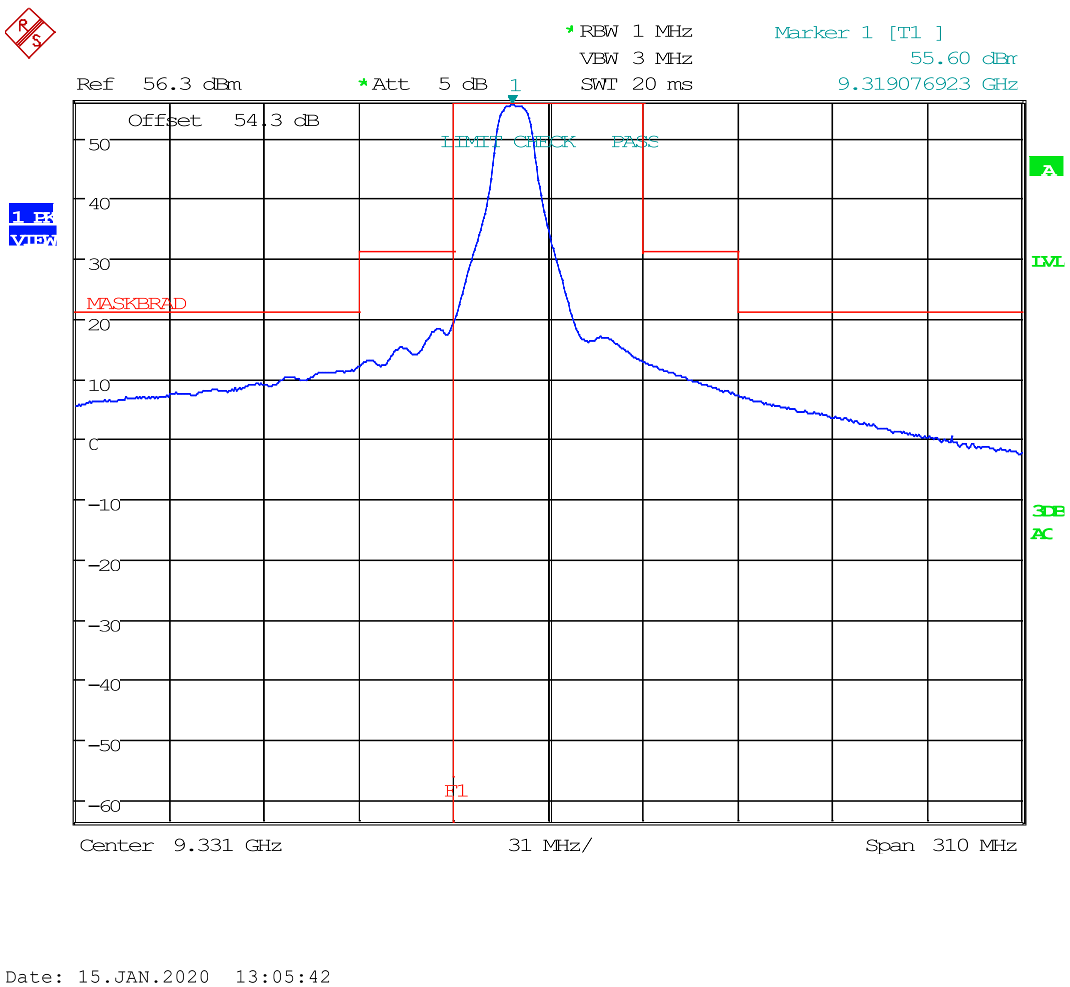


Date: 16.JAN.2020 16:24:10

80.211 EMISSION MASK

Test Engineer: FR
Test Date: 01/15/2020

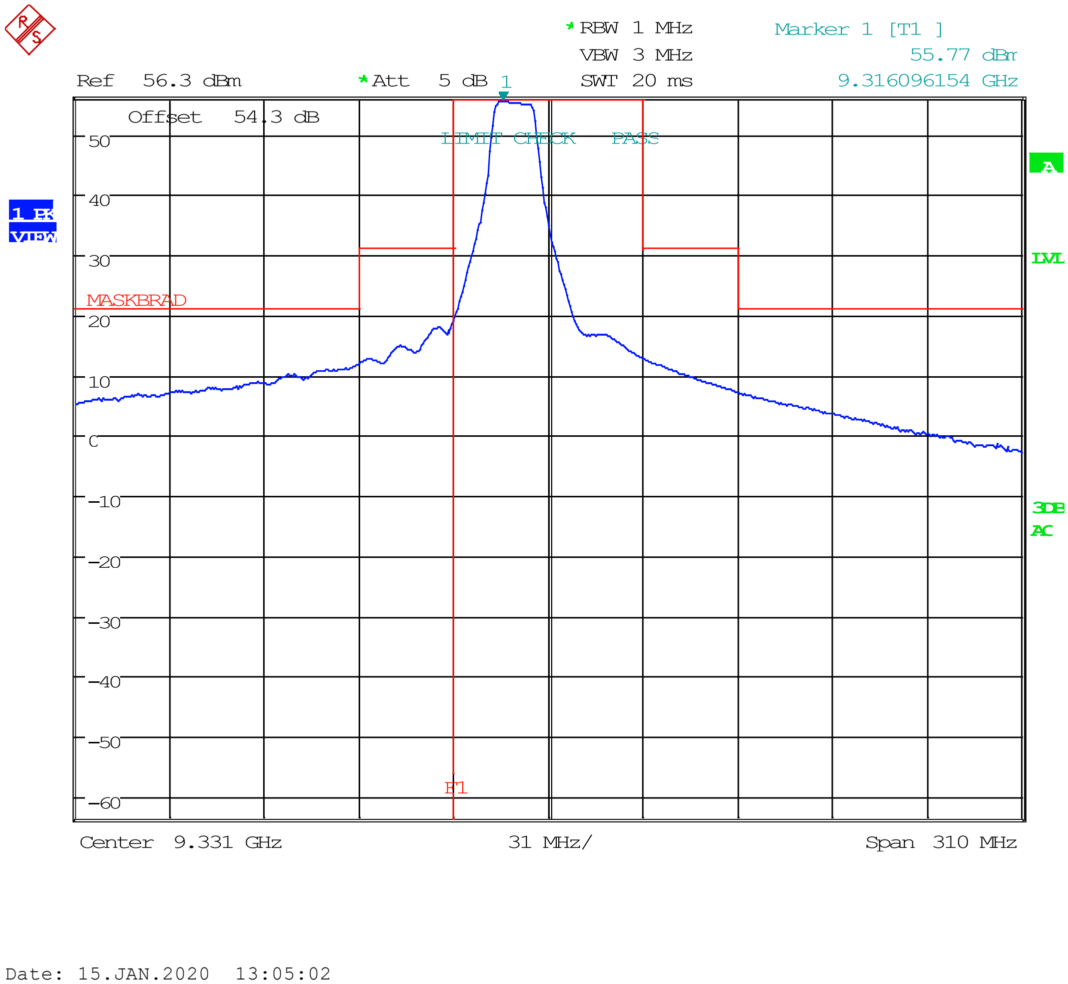
Low Band Mode SR, Emission Mask Plot



Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

EMISSION MASK

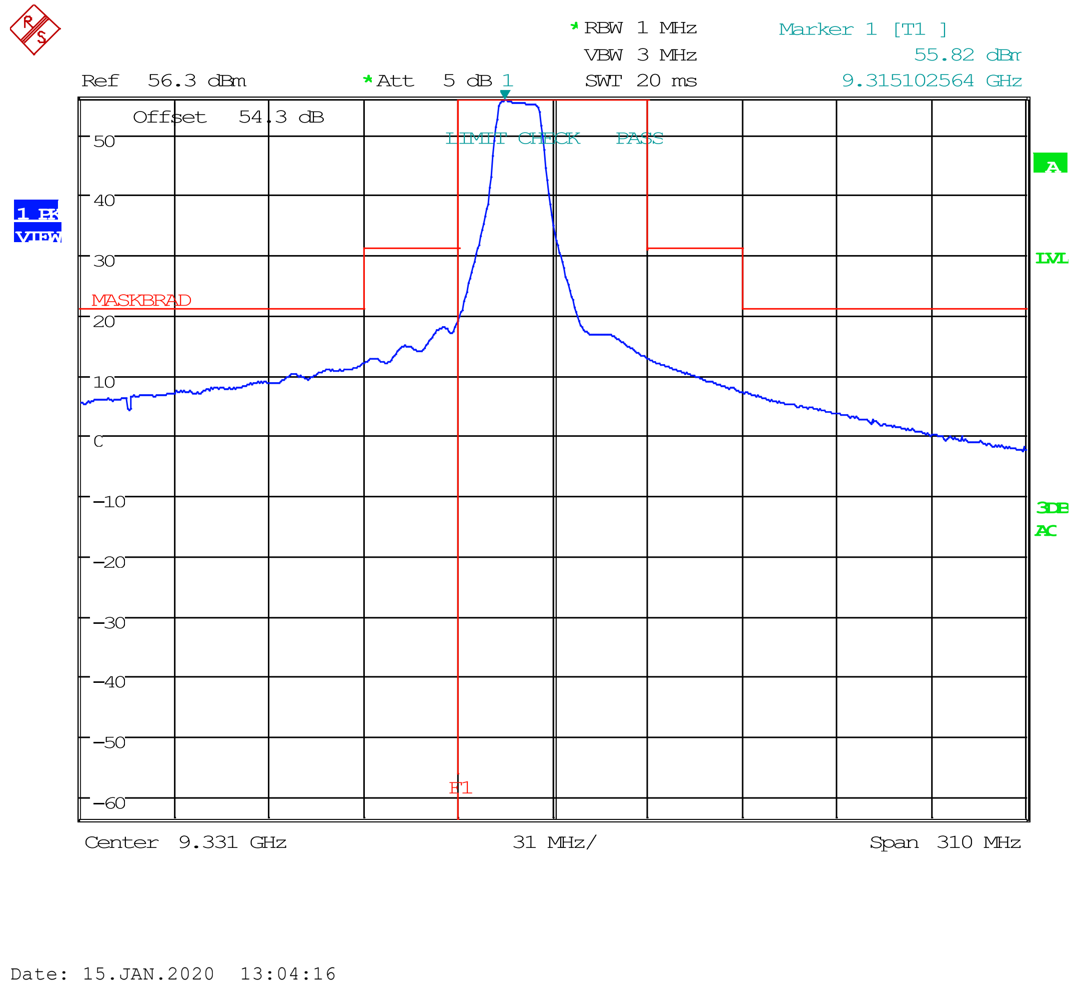
Low Band Mode MR, Emission Mask Plot



Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

EMISSION MASK

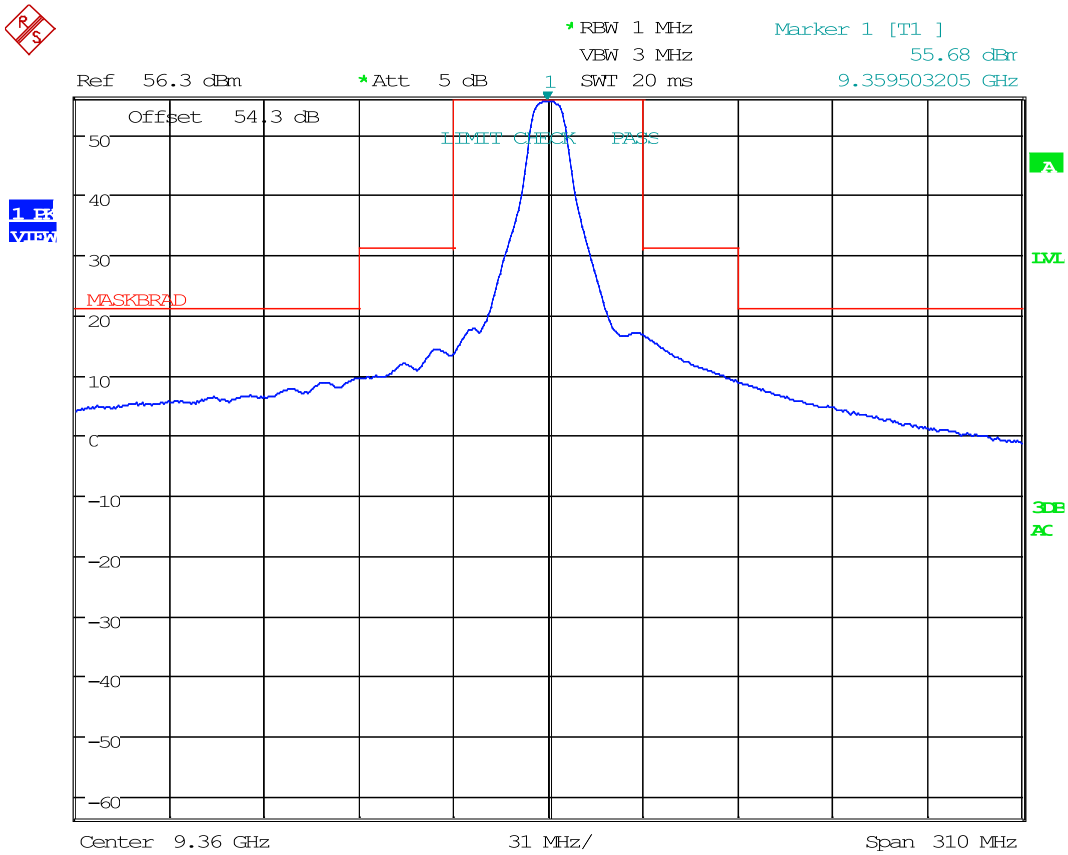
Low Band Mode LR, Emission Mask Plot



Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

EMISSION MASK

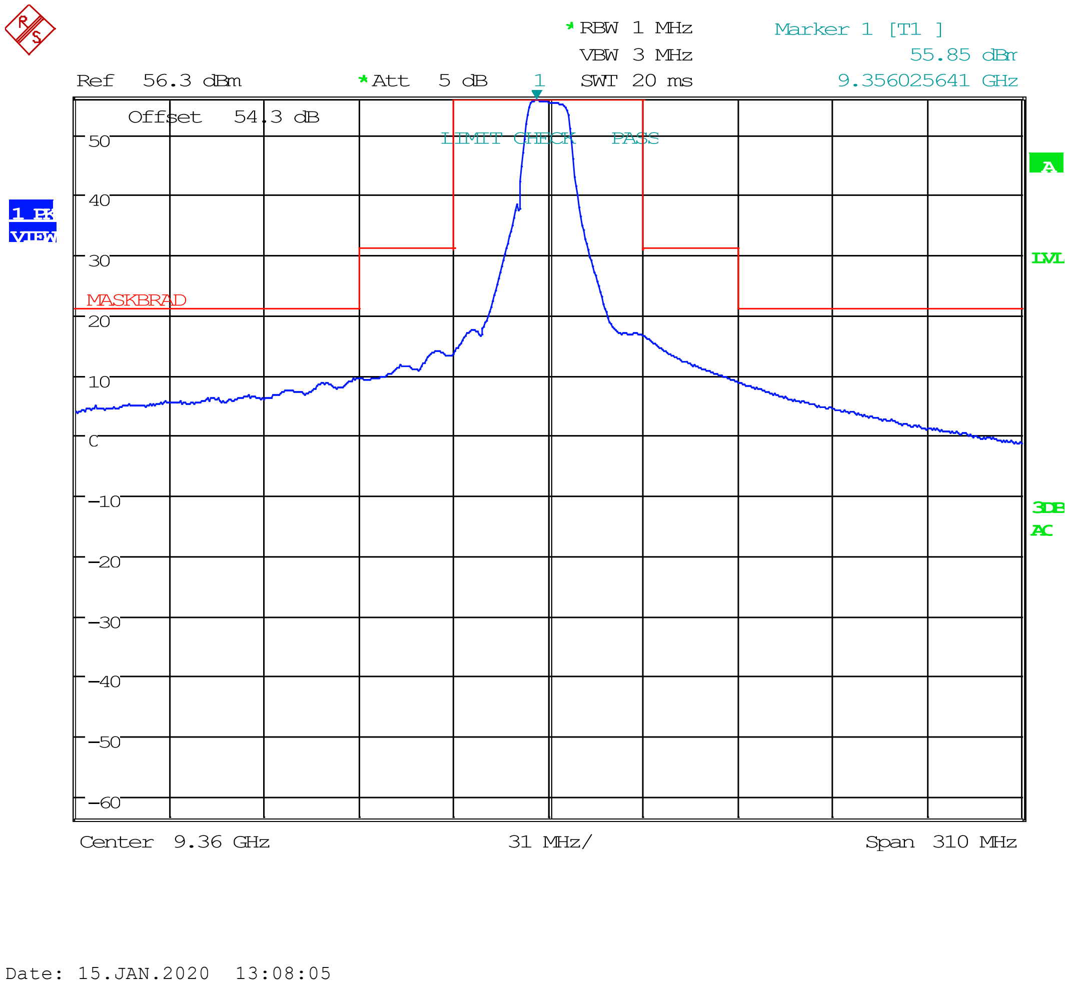
Mid Band Mode SR, Emission Mask Plot



Date: 15.JAN.2020 13:07:09

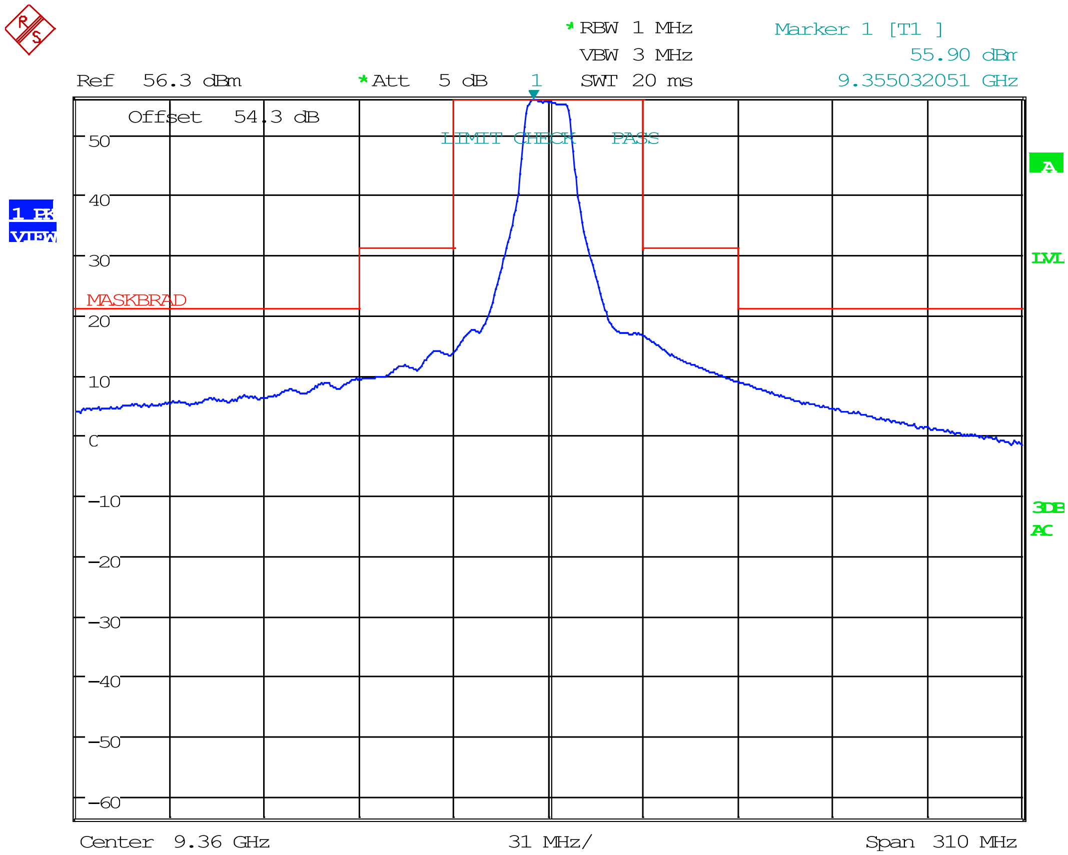
EMISSION MASK

Mid Band Mode MR, Emission Mask Plot



EMISSION MASK

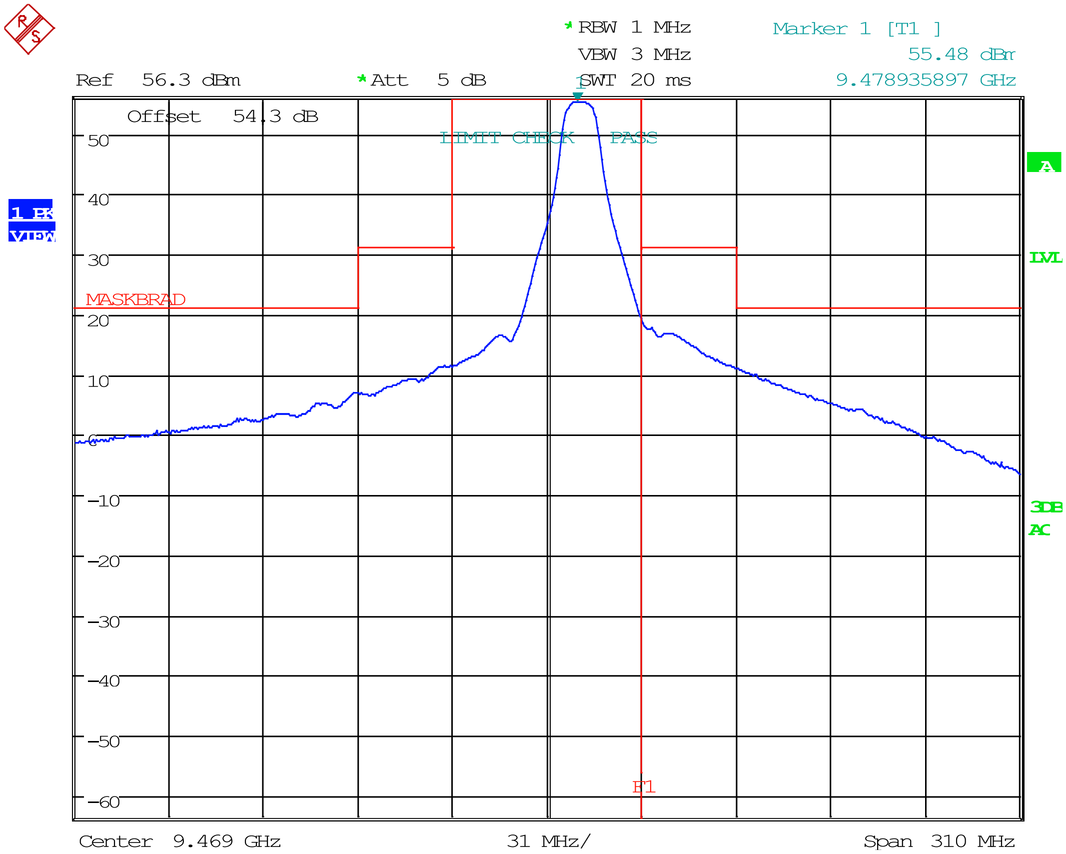
Mid Band Mode LR, Emission Mask Plot



Date: 15.JAN.2020 13:09:06

EMISSION MASK

High Band Mode SR, Emission Mask Plot

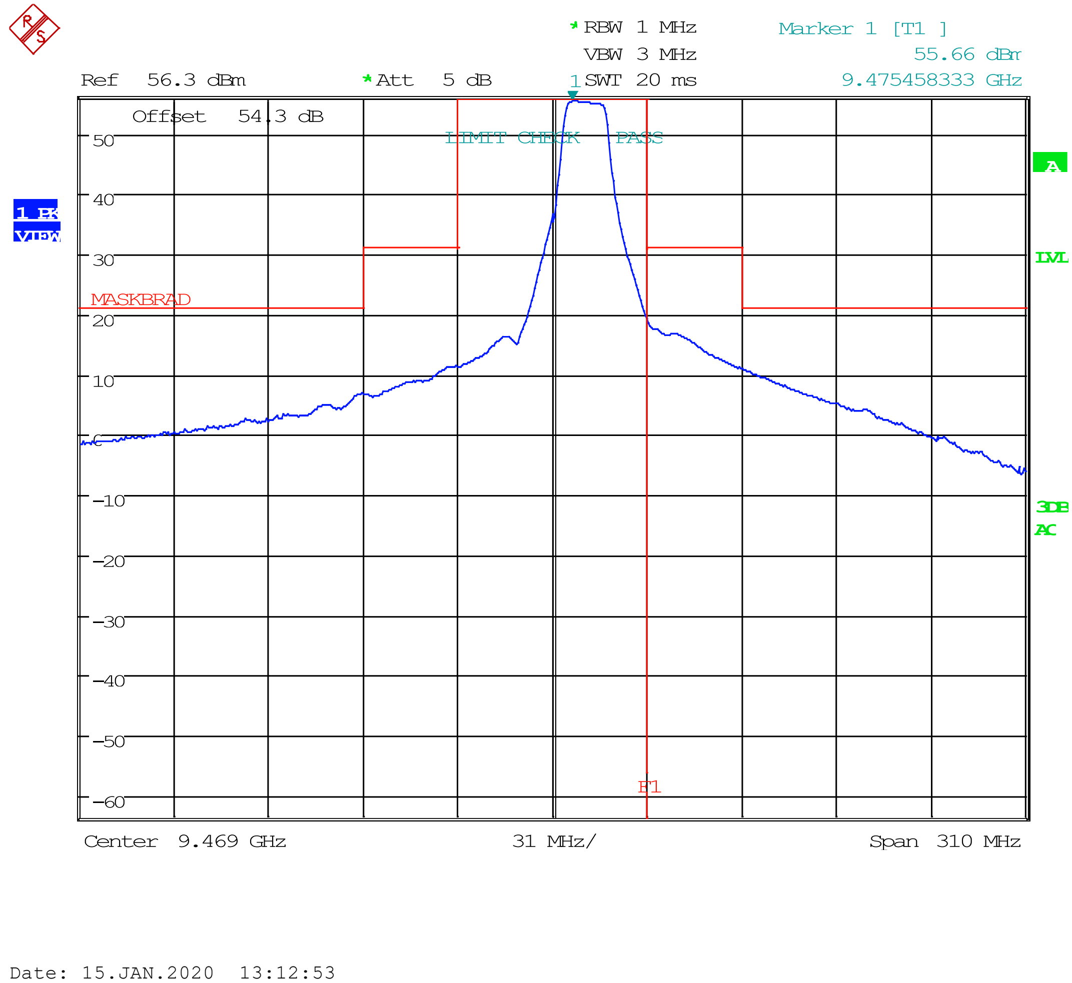


Date: 15.JAN.2020 13:13:40

Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

EMISSION MASK

High Band Mode MR, Emission Mask Plot



Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

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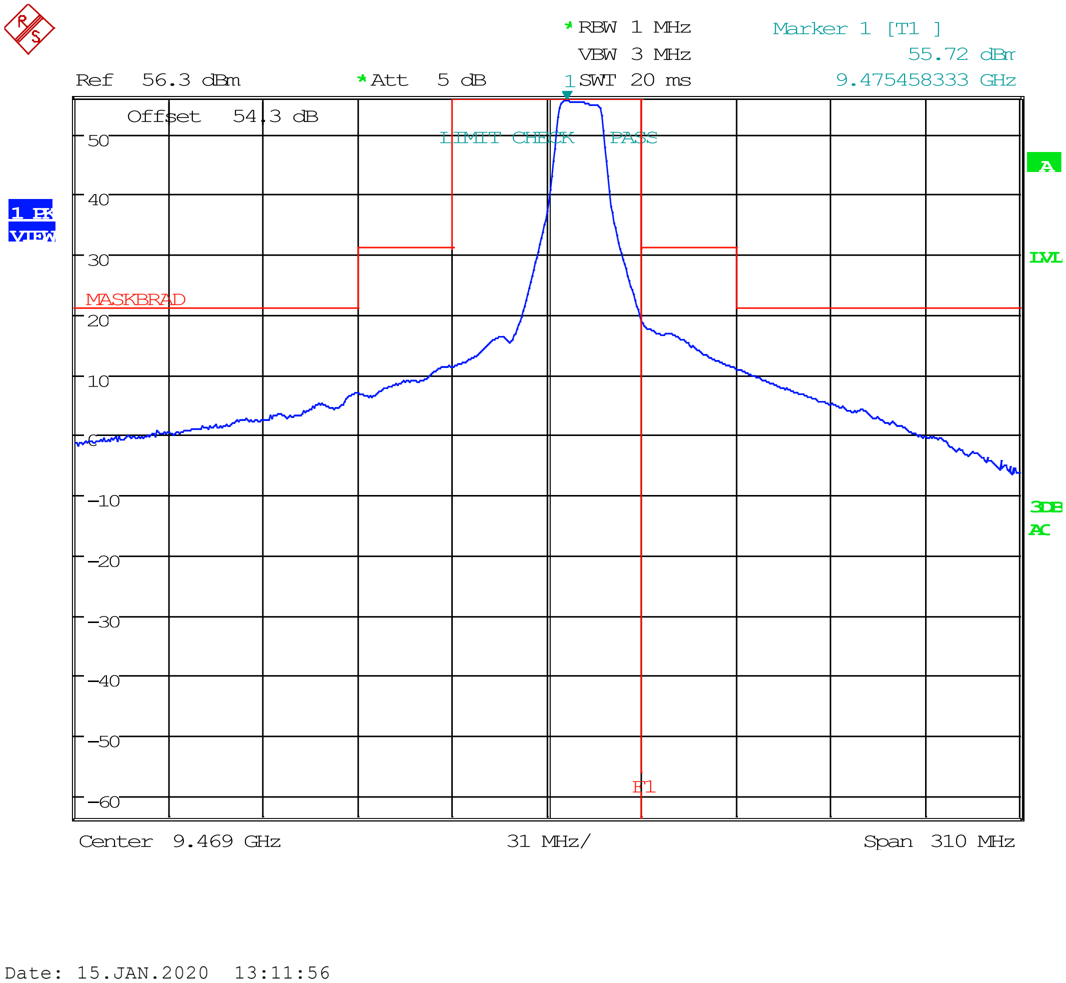
EMISSION MASK

High Band Mode LR, Emission Mask Plot



Note: Emission was transmitted as close to the band edge as possible, while conforming to the mask placed before the band edge. This is not required, but was done to show compliance in the worst-possible case.

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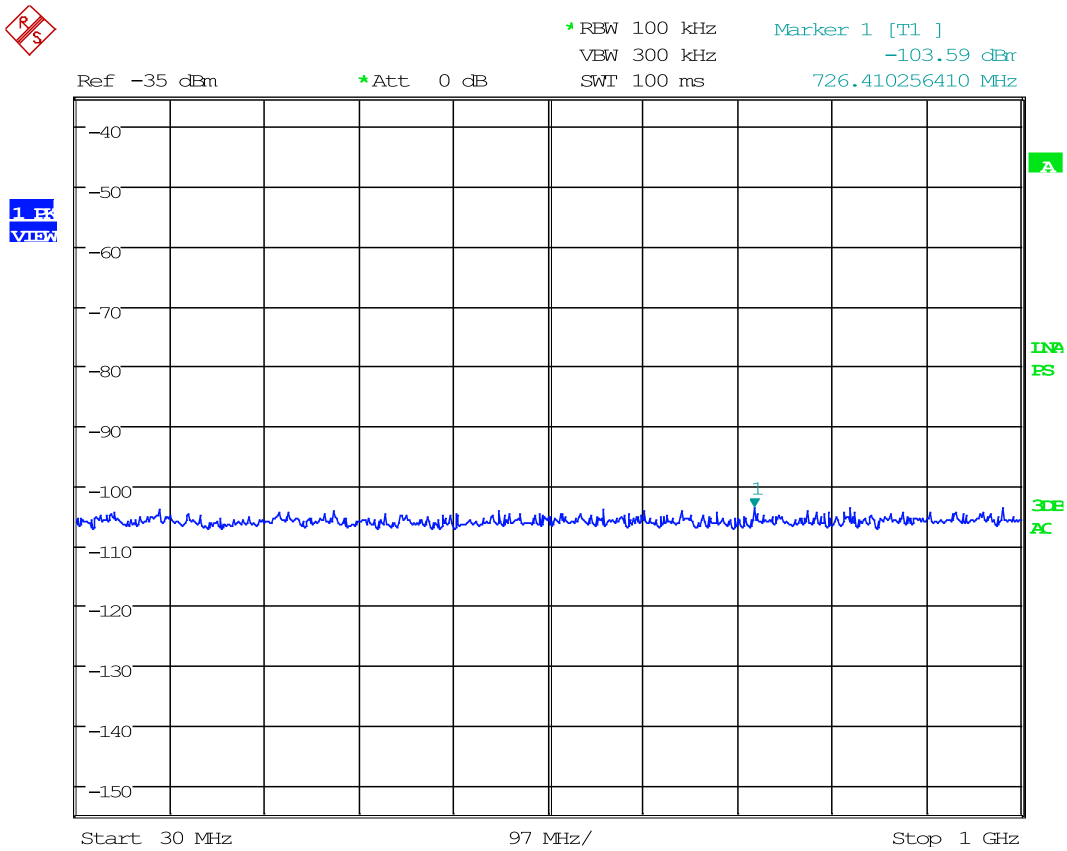
80.211 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Engineer: FR
Test Date: 01/16/2020

30 MHz - 1 GHz Plot

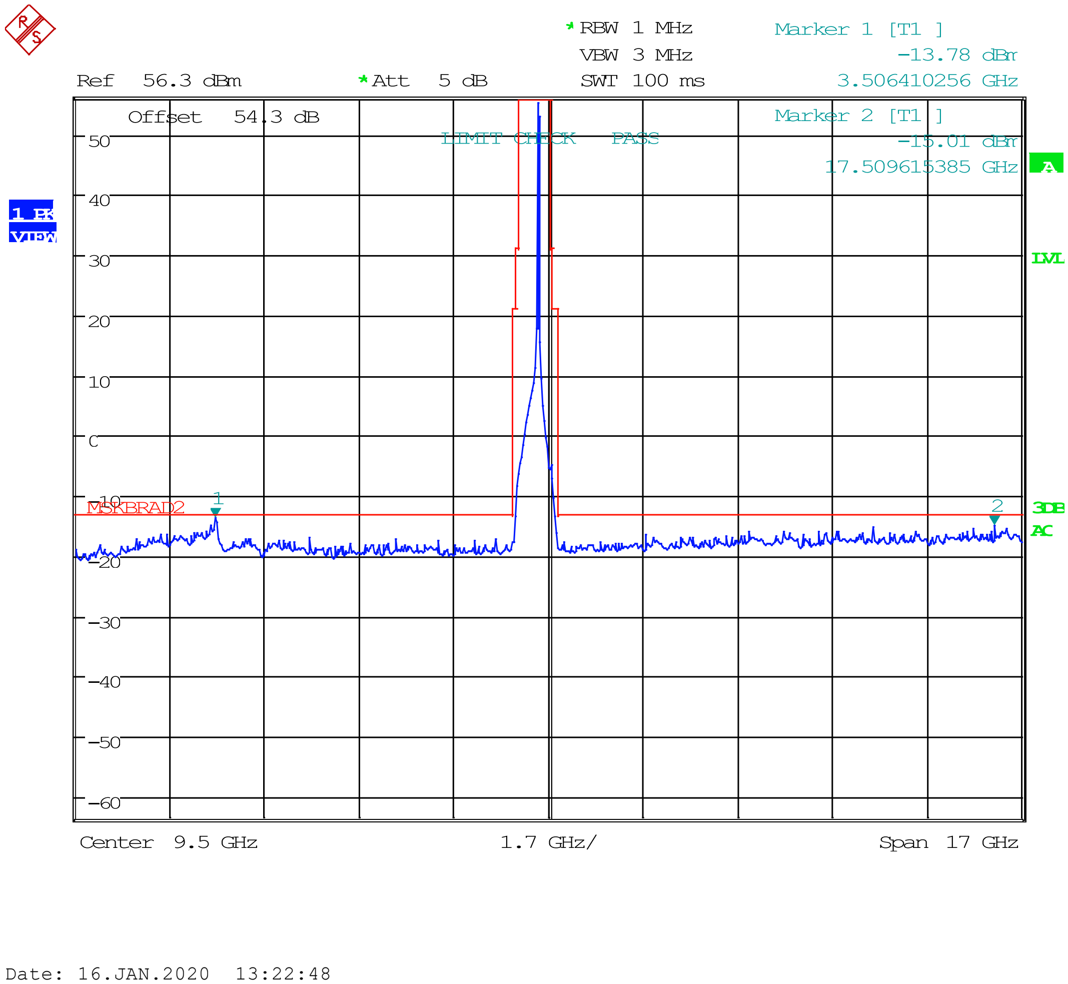


Date: 16.JAN.2020 16:42:45

Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

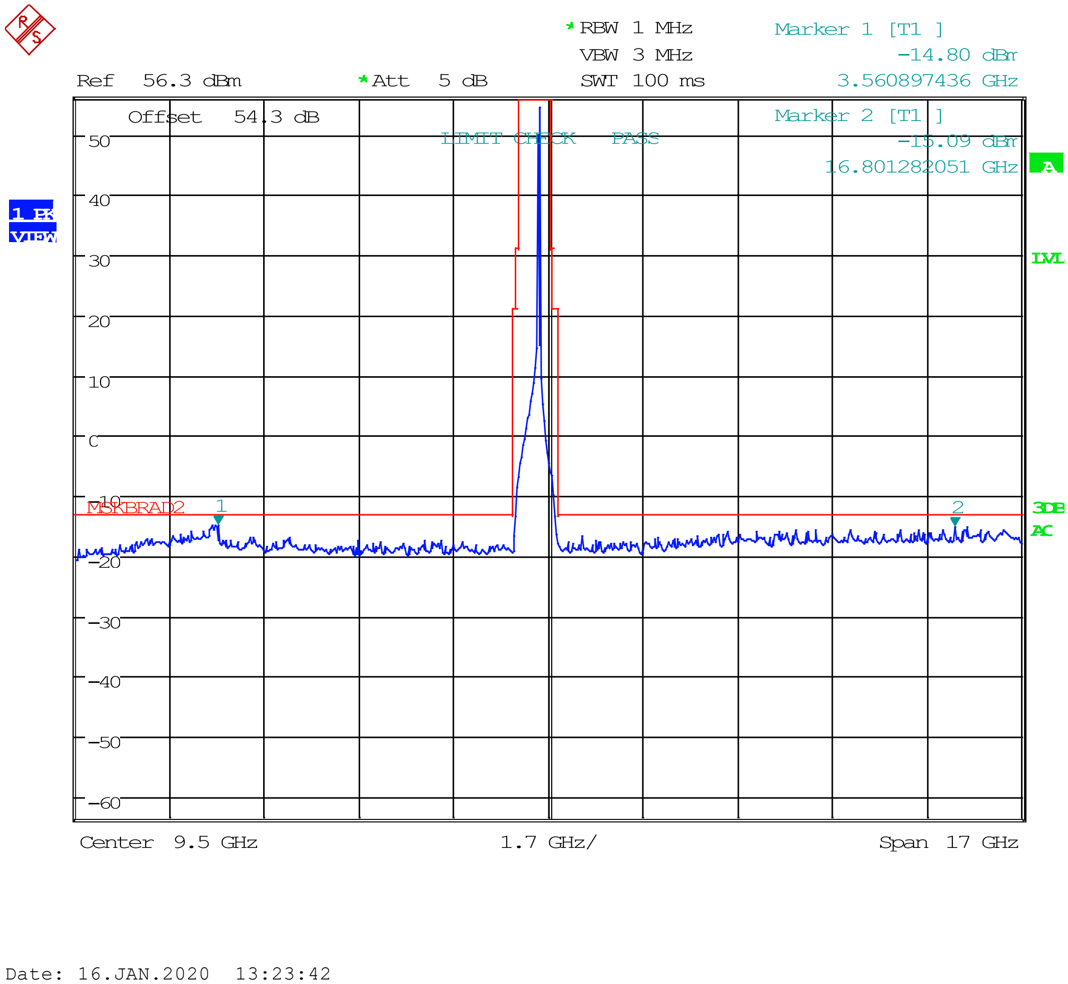
UNWANTED SPURIOUS EMISSIONS

Low Band Mode SR, 1-18 GHz Plot



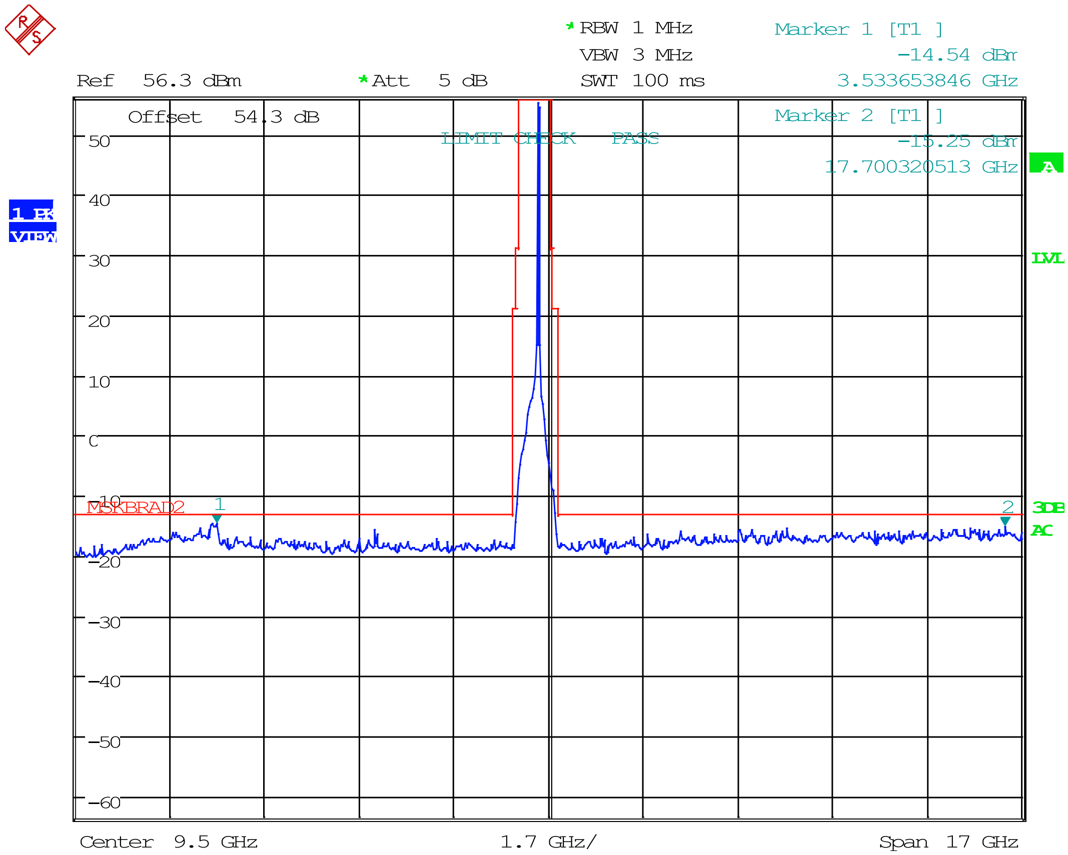
UNWANTED SPURIOUS EMISSIONS

Low Band Mode MR, 1-18 GHz Plot



UNWANTED SPURIOUS EMISSIONS

Low Band Mode LR, 1-18 GHz Plot

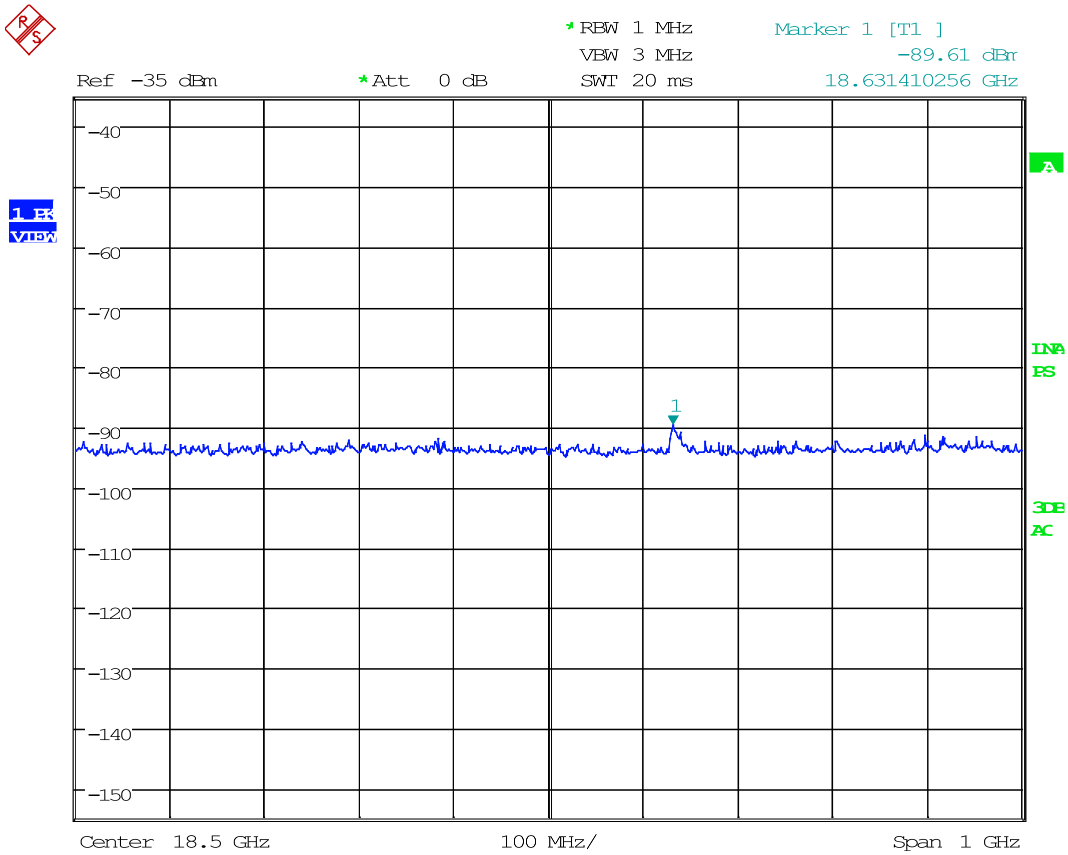


Date: 16.JAN.2020 13:24:45

UNWANTED SPURIOUS EMISSIONS

Low Band, 2nd Harmonic Plot

Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.



Date: 17.JAN.2020 13:18:41

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
18.6314	-89.61	-102.674	23.229	-79.445	-13.00	66.44

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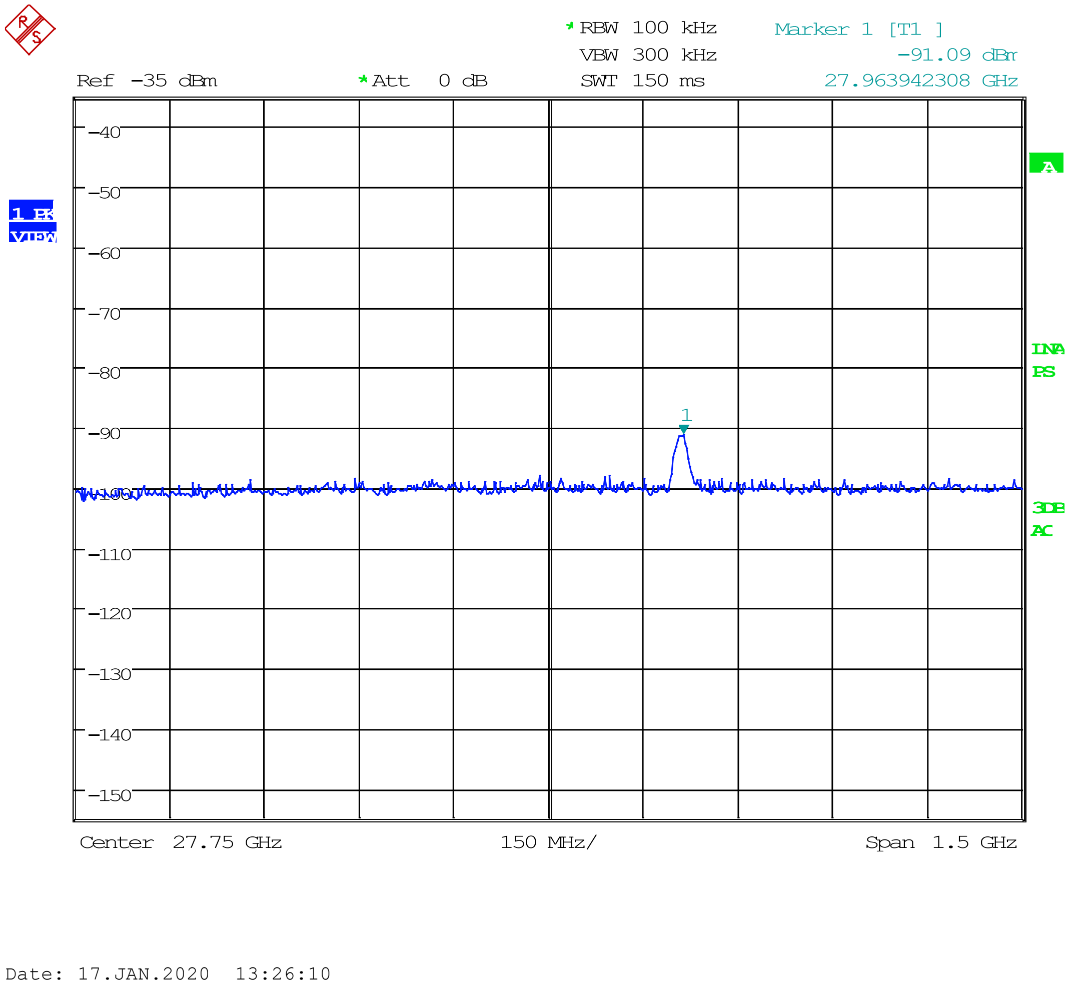
UNWANTED SPURIOUS EMISSIONS

Low Band, 3rd Harmonic Plot

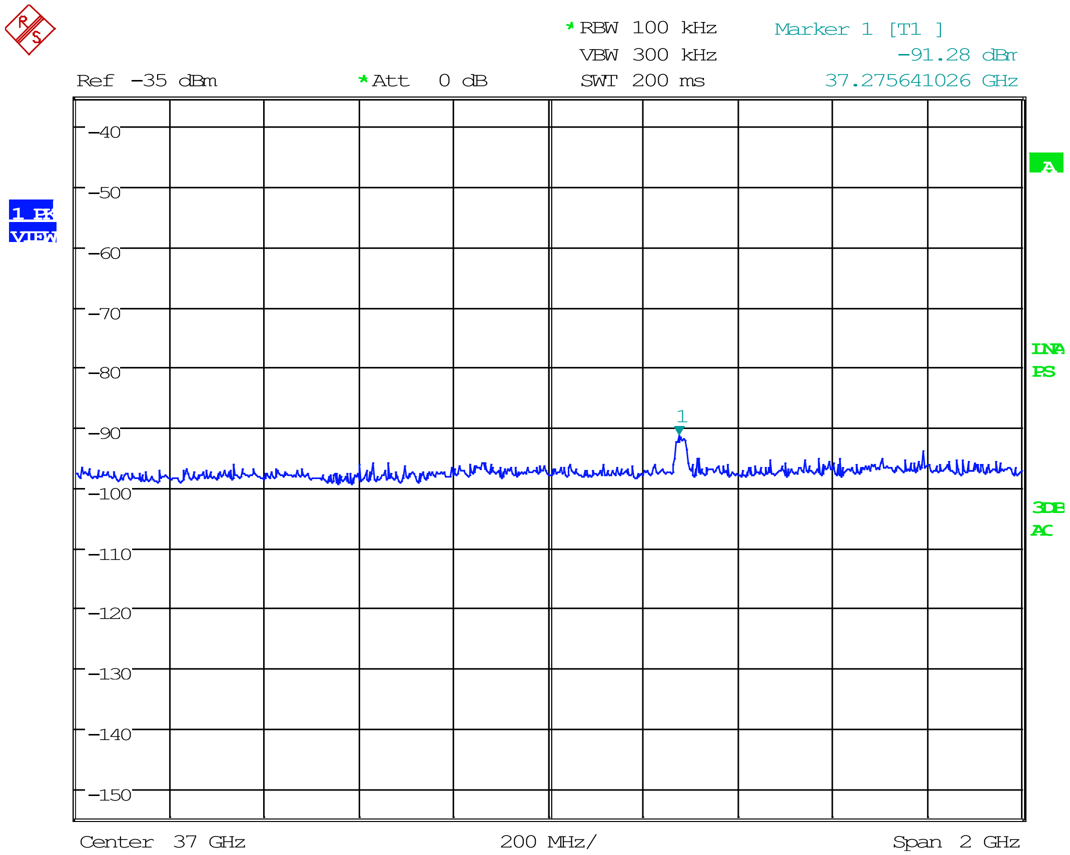


Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
27.9639	-91.09	-104.154	42.635	-61.519	-13.00	48.52

UNWANTED SPURIOUS EMISSIONS

Low Band, 4th Harmonic Plot



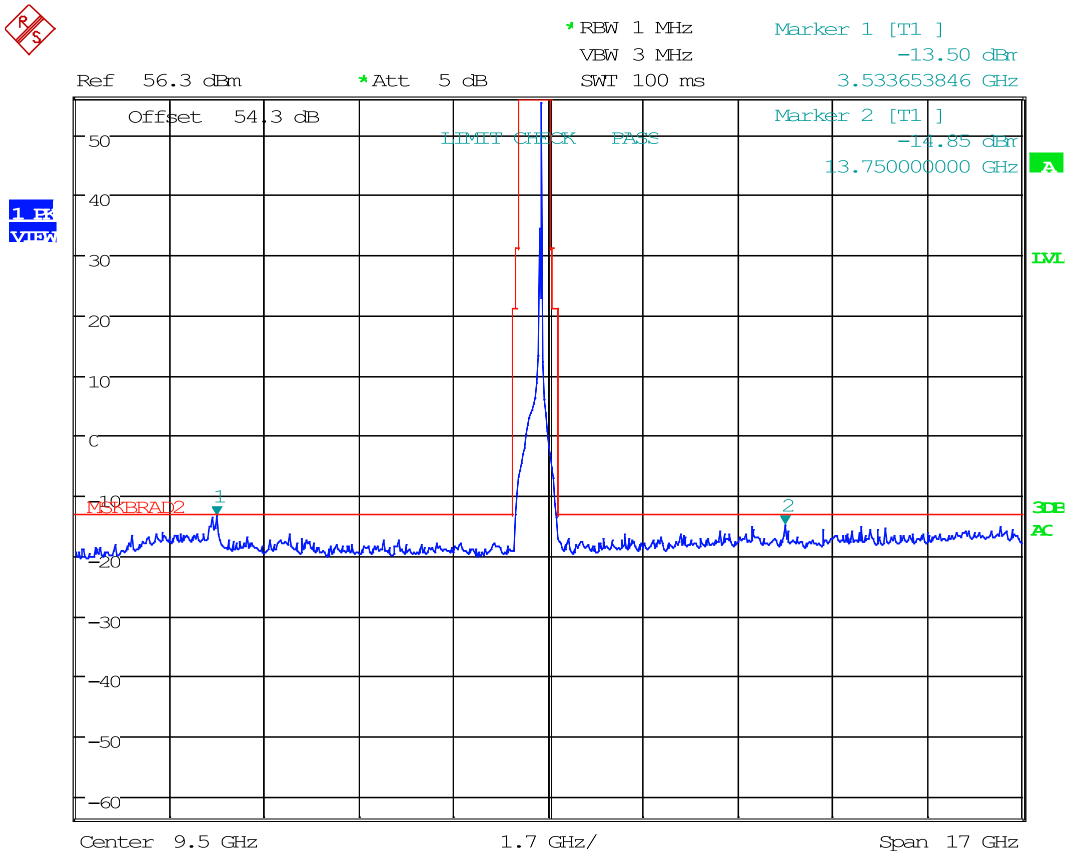
Date: 17.JAN.2020 13:40:04

Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
37.2756	-91.28	-104.344	29.049	-75.295	-13.00	62.30

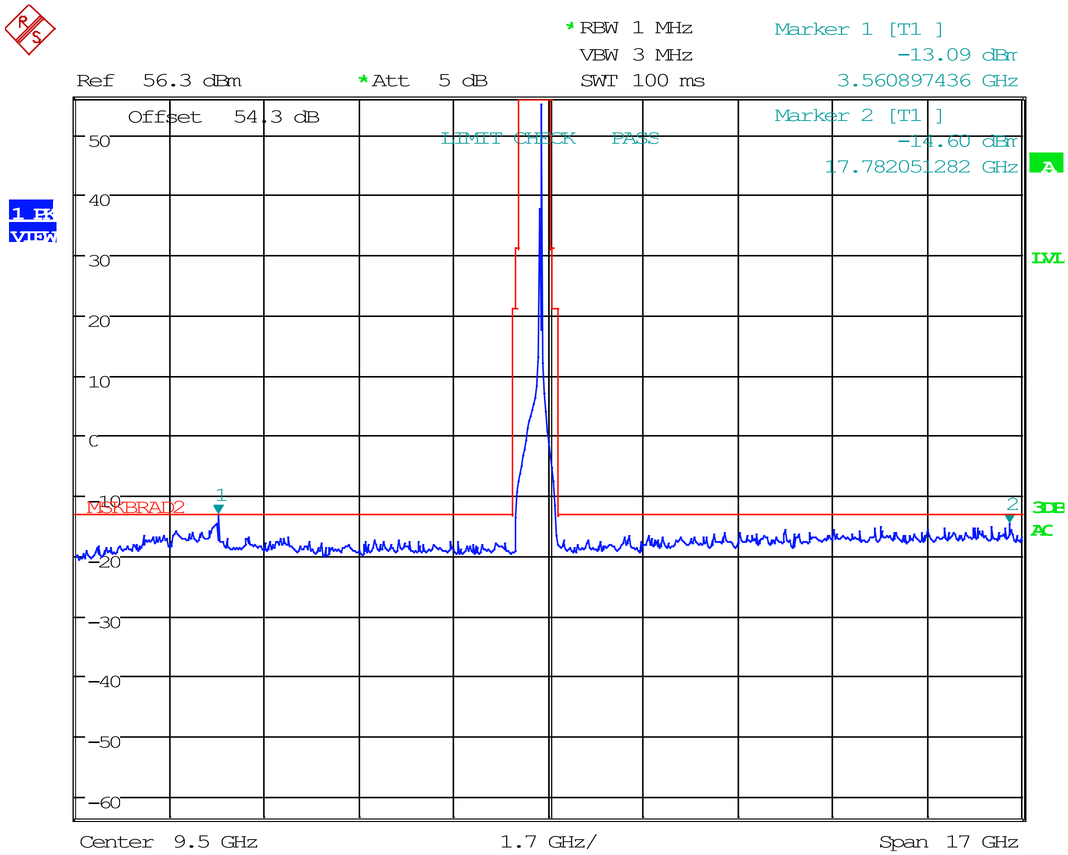
UNWANTED SPURIOUS EMISSIONS

Mid Band Mode SR, 1-18 GHz Plot



UNWANTED SPURIOUS EMISSIONS

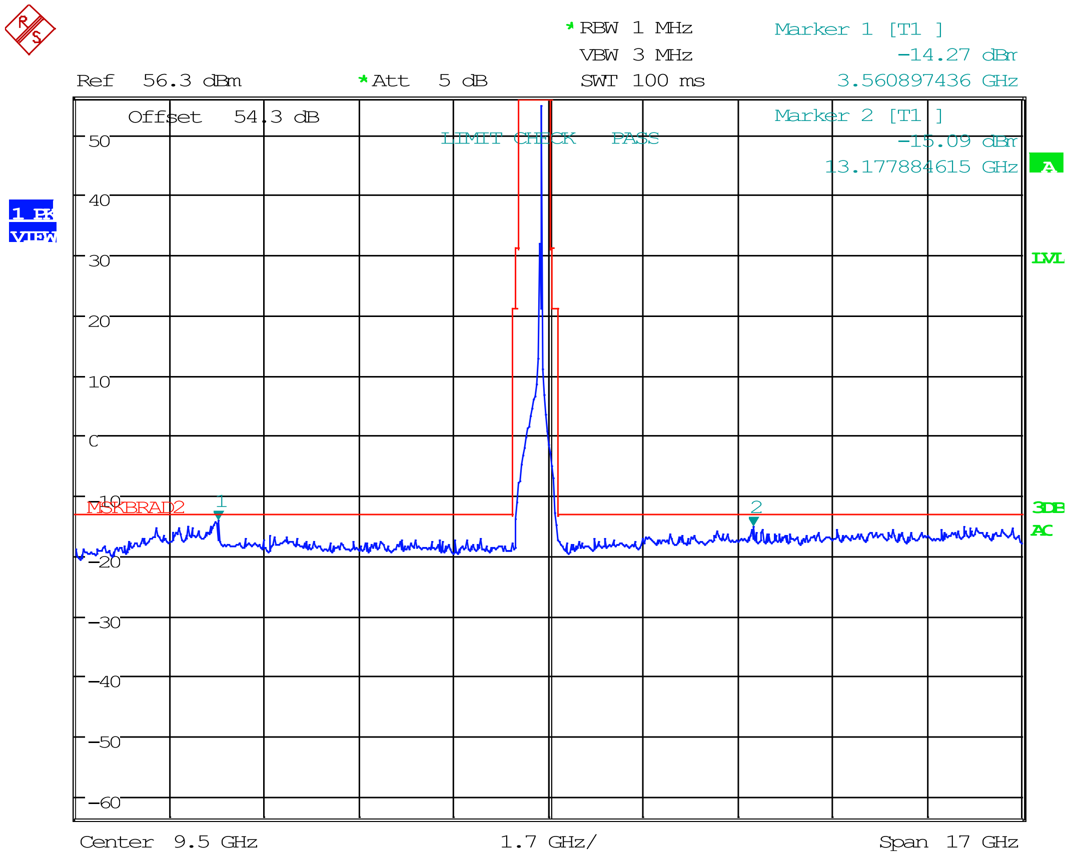
Mid Band Mode MR, 1-18 GHz Plot



Date: 16.JAN.2020 13:27:49

UNWANTED SPURIOUS EMISSIONS

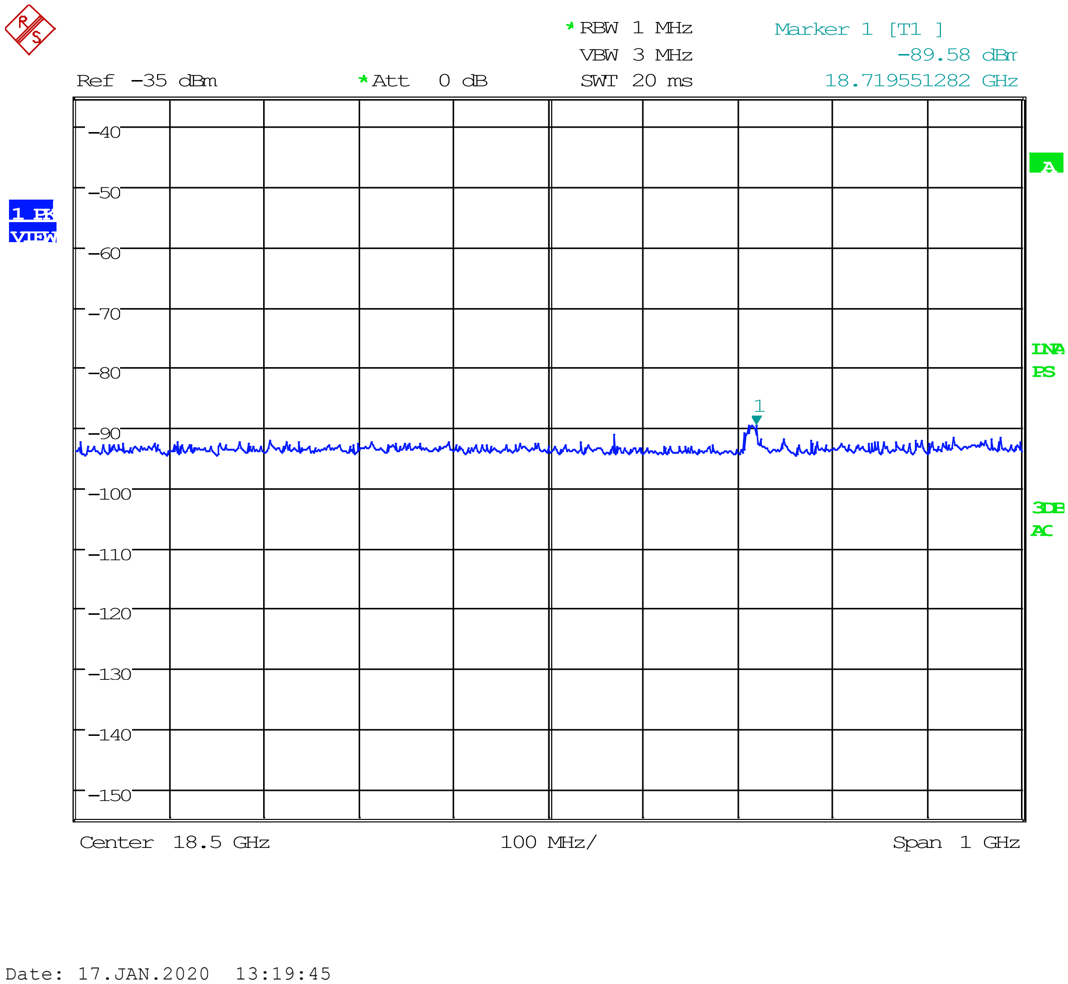
Mid Band Mode LR, 1-18 GHz Plot



Date: 16.JAN.2020 13:25:45

UNWANTED SPURIOUS EMISSIONS

Mid Band, 2nd Harmonic Plot

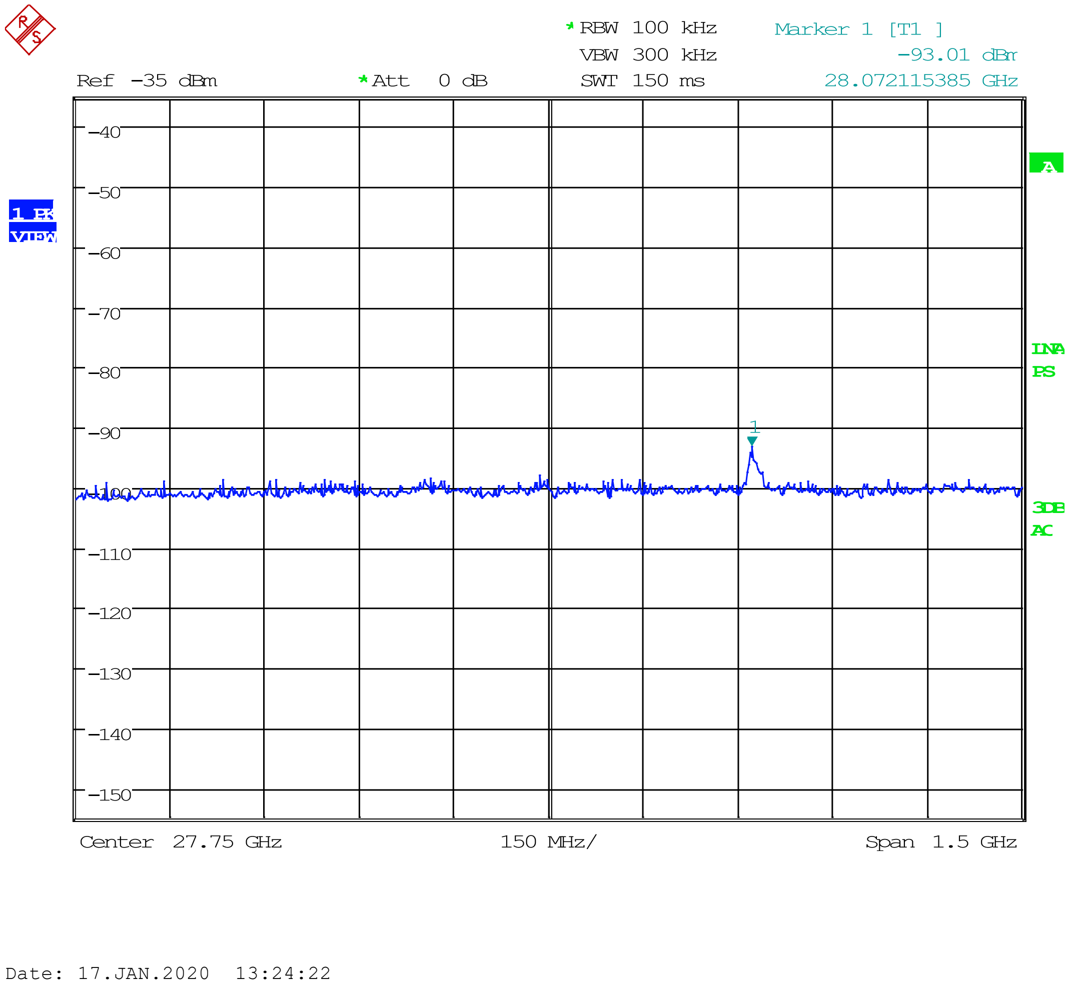


Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
18.7196	-89.58	-102.644	29.923	-72.722	-13.00	59.72

UNWANTED SPURIOUS EMISSIONS

Mid Band, 3rd Harmonic Plot

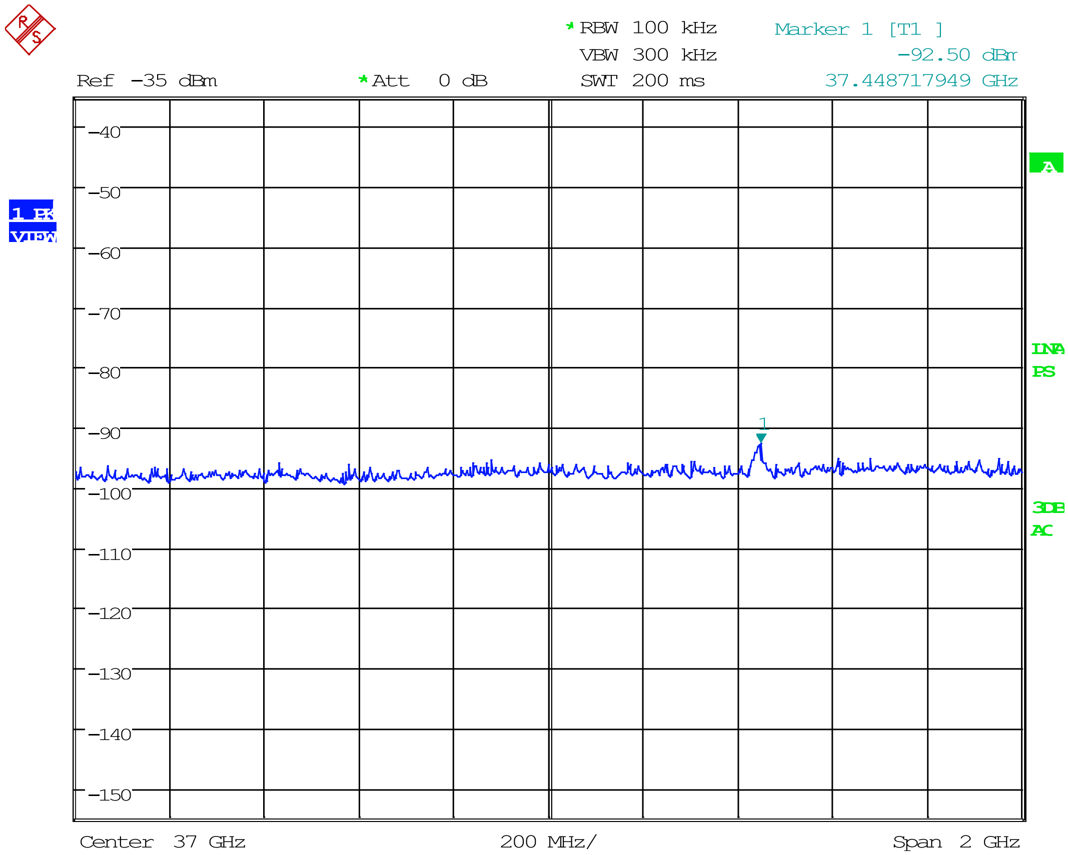


Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
28.0721	-93.01	-106.074	38.946	-67.128	-13.00	54.13

UNWANTED SPURIOUS EMISSIONS

Mid Band, 4th Harmonic Plot



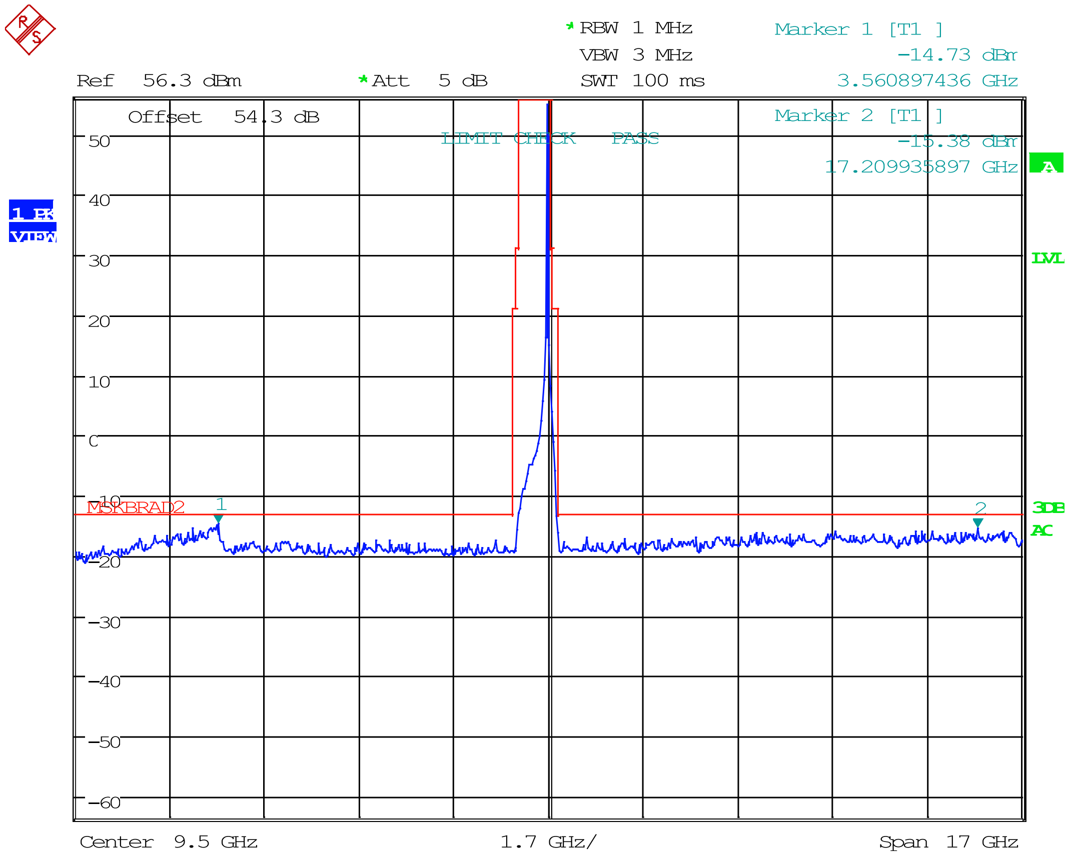
Date: 17.JAN.2020 13:41:04

Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
37.45	-92.50	-105.564	27.098	-78.466	-13.00	65.47

UNWANTED SPURIOUS EMISSIONS

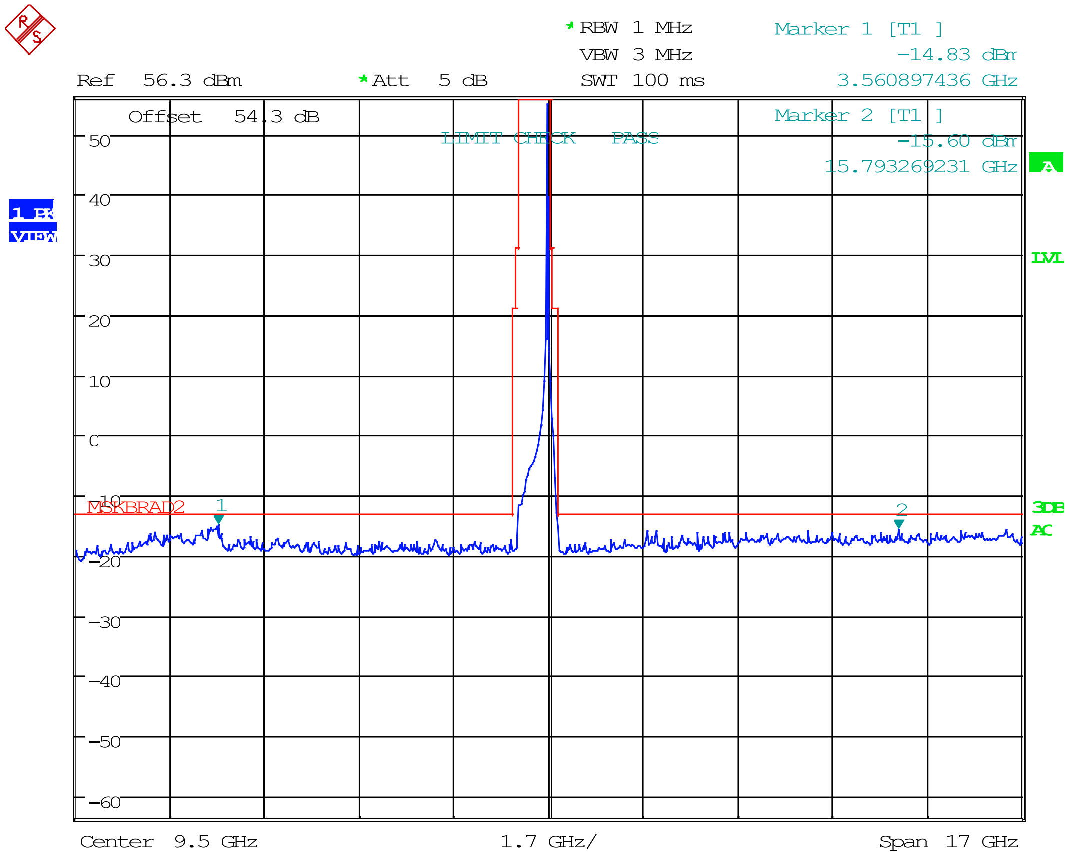
High Band Mode SR, 1-18 GHz Plot



Date: 16.JAN.2020 12:21:15

UNWANTED SPURIOUS EMISSIONS

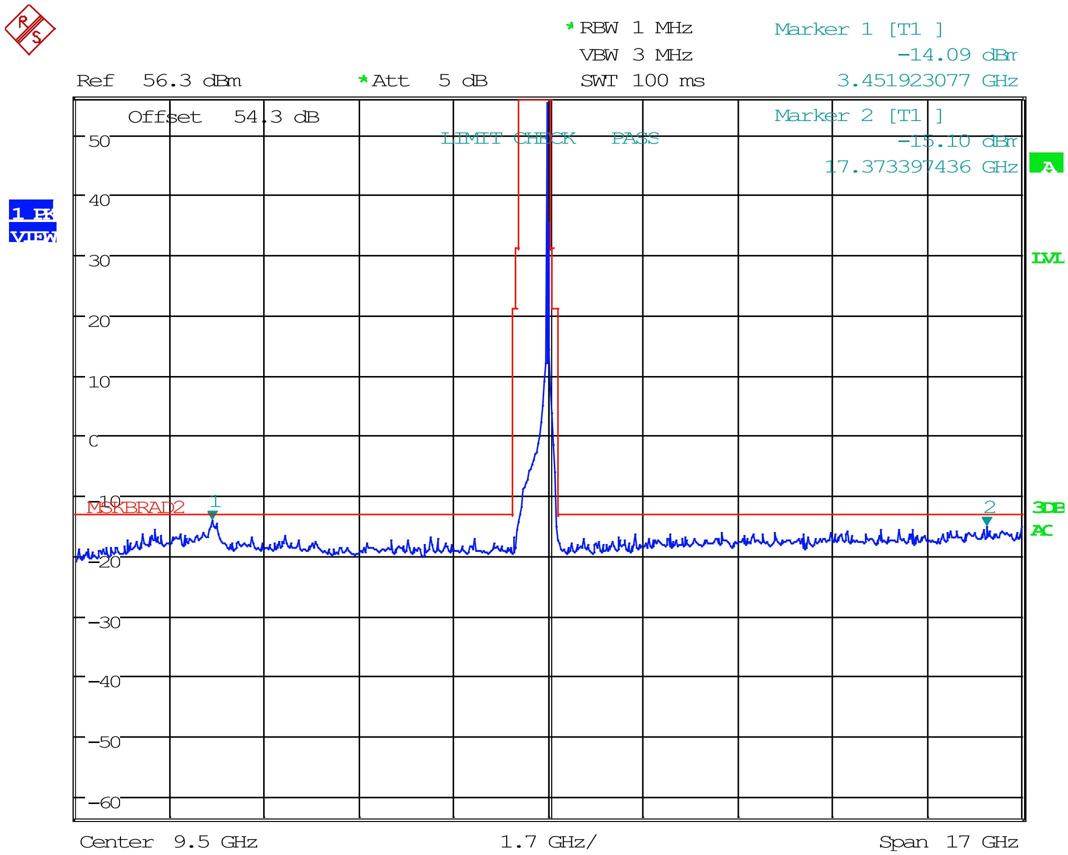
High Band Mode MR, 1-18 GHz Plot



Date: 16.JAN.2020 12:22:14

UNWANTED SPURIOUS EMISSIONS

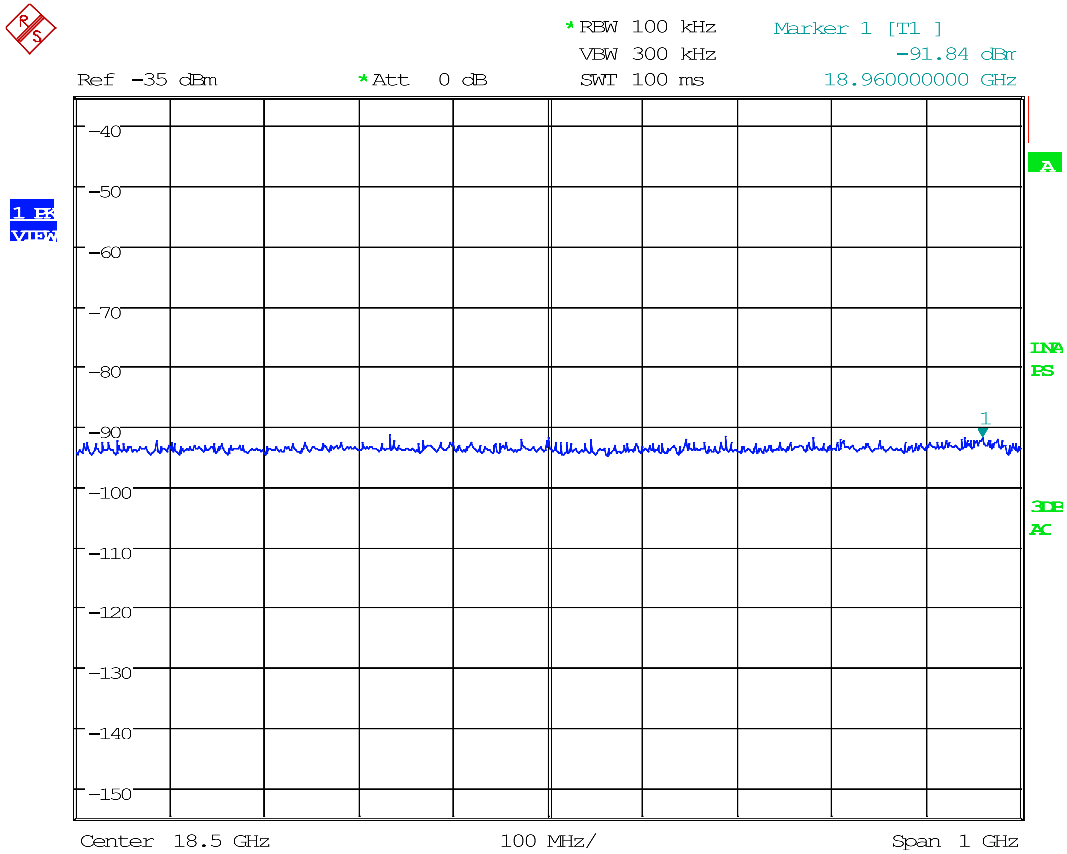
High Band Mode LR, 1-18 GHz Plot



Date: 16.JAN.2020 12:23:06

UNWANTED SPURIOUS EMISSIONS

High Band, 2nd Harmonic Plot



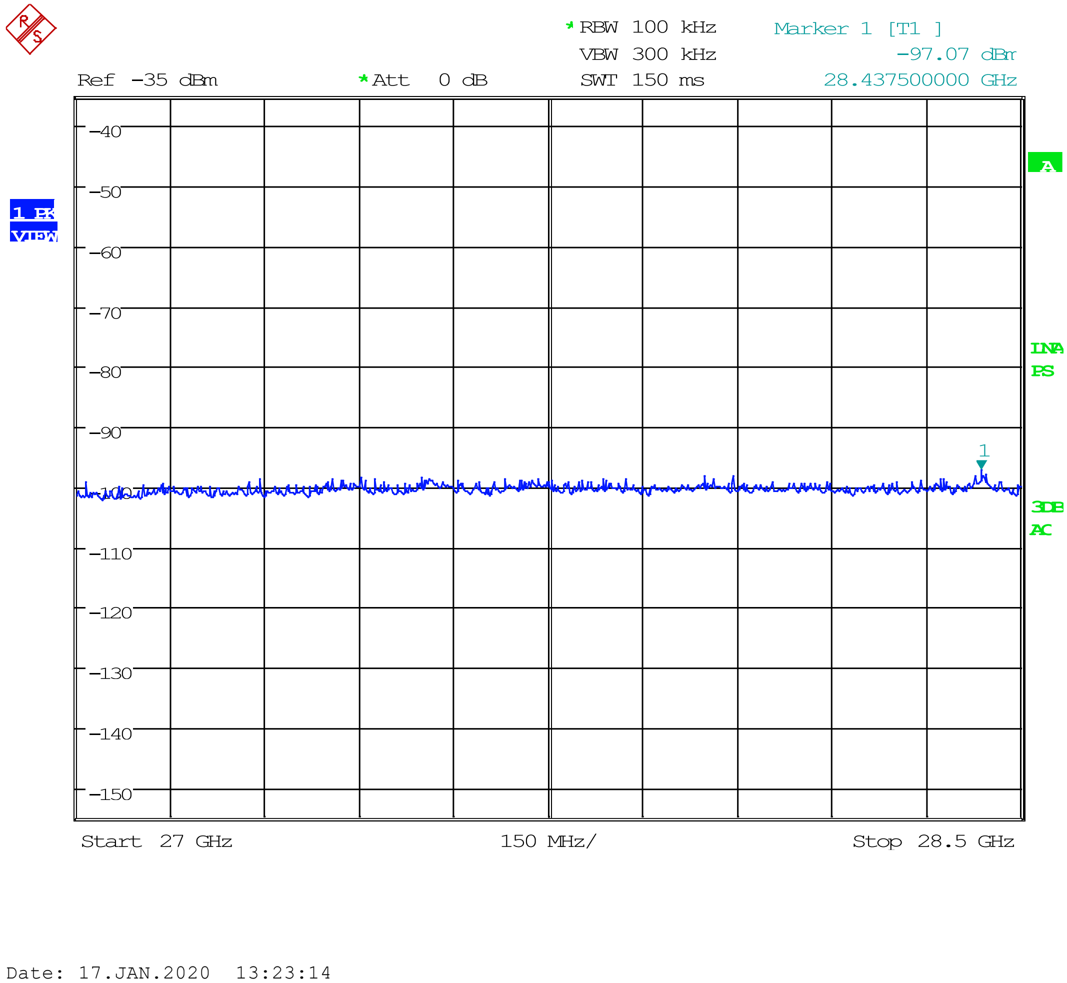
Date: 17.JAN.2020 13:21:37

Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
18.960	-91.84	-104.904	21.631	-83.273	-13.00	70.27

UNWANTED SPURIOUS EMISSIONS

High Band, 3rd Harmonic Plot

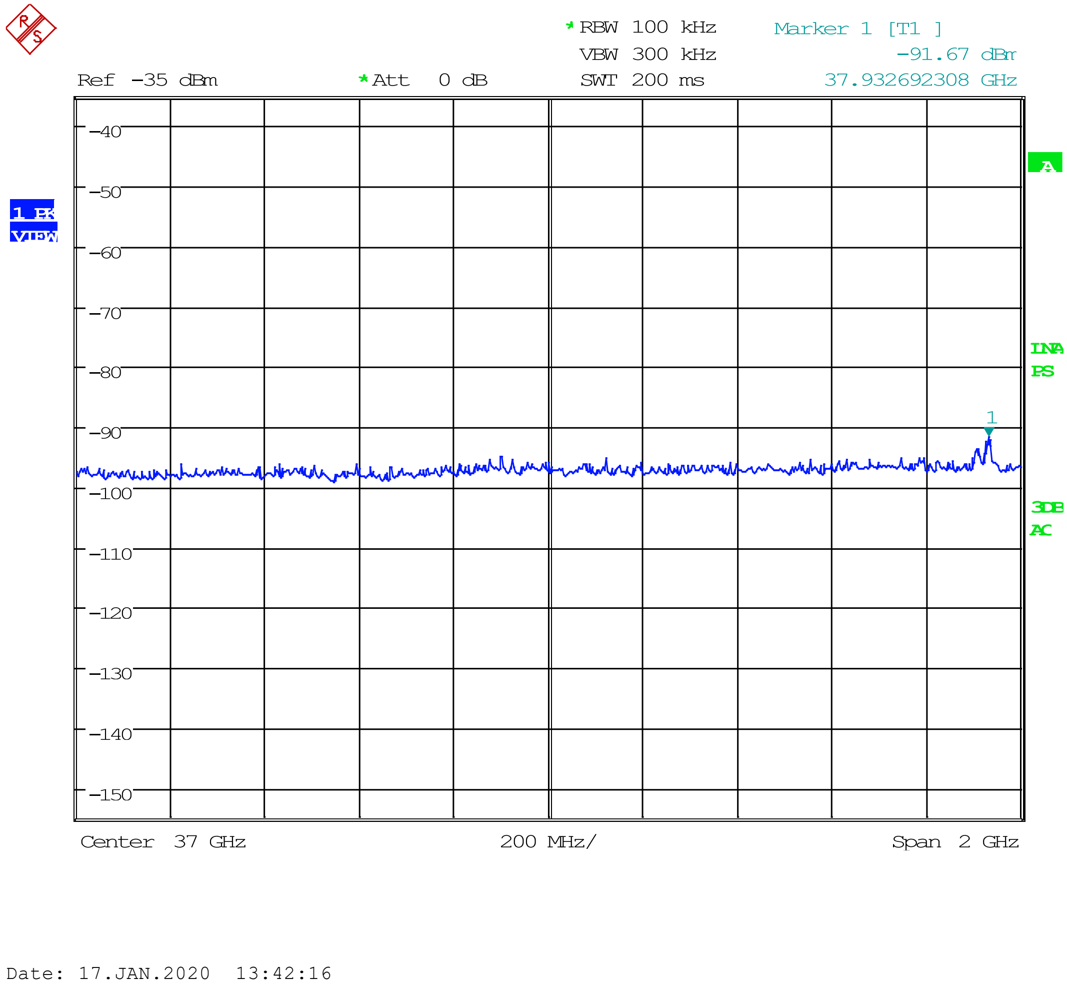


Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
28.438	-97.07	-110.134	60.636	-49.498	-13.00	36.50

UNWANTED SPURIOUS EMISSIONS

High Band, 4th Harmonic Plot



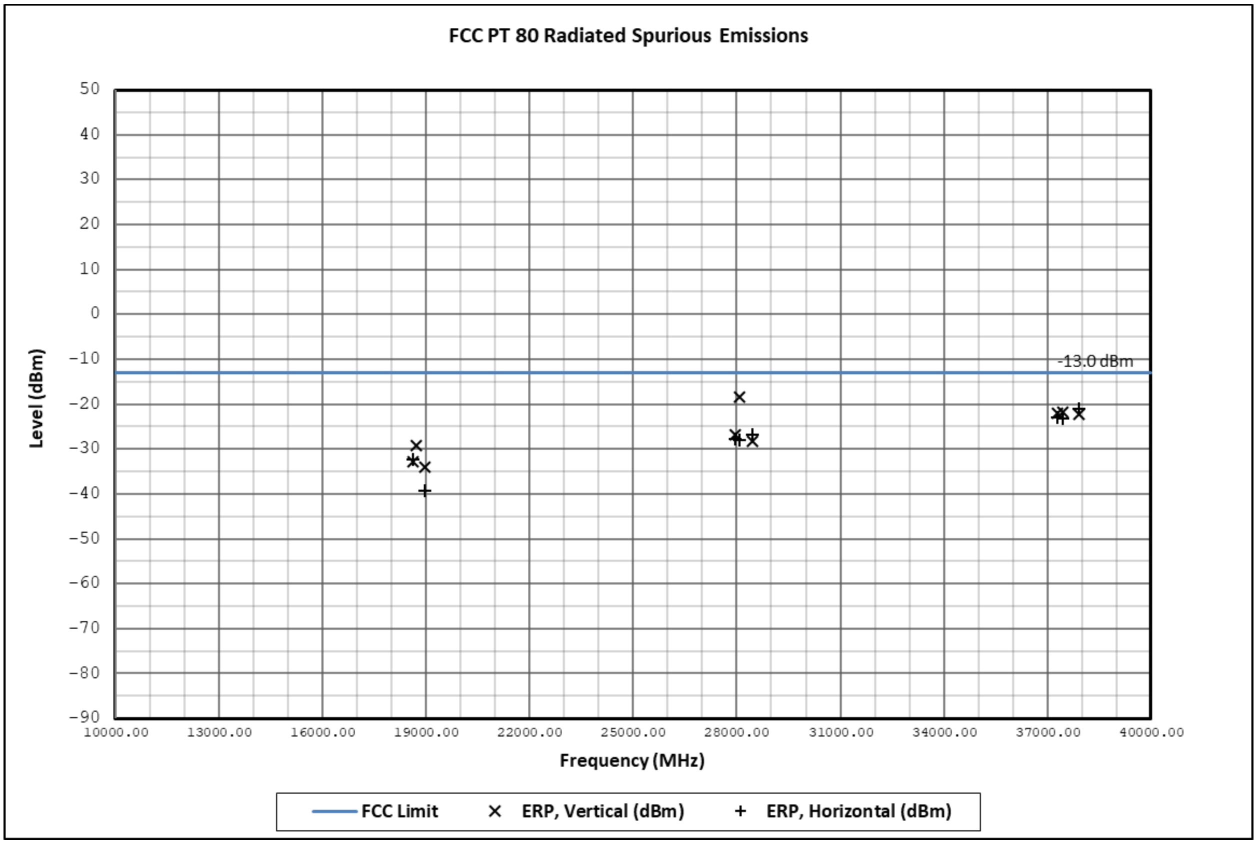
Note: All 3 operation modes (SR, MR, LR) at each test frequency were exercised during this scan.

Harmonic Frequency (GHz)	Measured Peak in Bref (dBm)	Corrected to Bm (dBm)	Meas. Loss (dB)	Actual Peak (dBm)	43+10 x Log(P) Limit (dBm)	Margin (dB)
37.933	-91.67	-104.734	30.612	-74.123	-13.00	61.12

80.211 FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Engineer: TR
Test Date: 01/20/2020

Radiated Spurious Emissions Plot



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

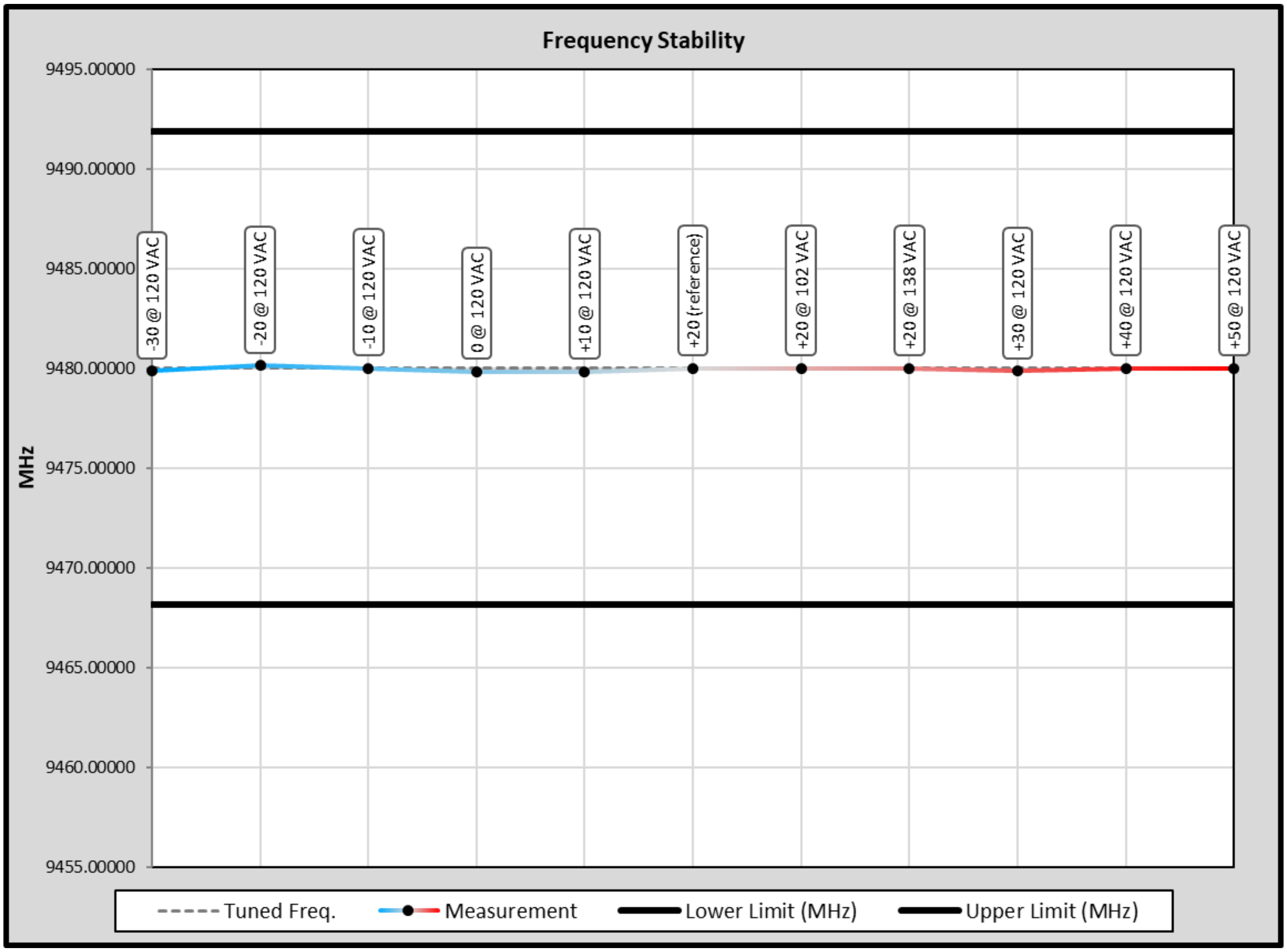
Radiated Spurious Emissions Table

Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Distance (m)	Field Strength (dBµV/m)	ERP, Vertical (dBm)	Bandwidth Corrected (dBm)	Limit (dBm)	Margin (dBm)
9320	18640.00	17.32	V	15.53	44.74	3.00	77.59	-19.79	-32.85	-13.00	19.85
9320	18640.00	17.91	H	15.53	44.74	3.00	78.18	-19.20	-32.26	-13.00	19.26
9320	27960.00	17.27	V	19.53	46.89	3.00	83.69	-13.69	-26.75	-13.00	13.75
9320	27960.00	16.23	H	19.53	46.89	3.00	82.65	-14.73	-27.79	-13.00	14.79
9320	37280.00	20.20	V	22.34	45.97	3.00	88.51	-8.87	-21.93	-13.00	8.93
9320	37280.00	19.26	H	22.34	45.97	3.00	87.57	-9.81	-22.87	-13.00	9.87
9360	18720.00	21.00	V	15.43	44.74	3.00	81.17	-16.21	-29.27	-13.00	16.27
9360	28080.00	25.96	V	19.13	46.88	3.00	91.97	-5.41	-18.47	-13.00	5.47
9360	28080.00	16.52	H	19.13	46.88	3.00	82.53	-14.85	-27.91	-13.00	14.91
9360	37440.00	20.39	V	22.39	45.84	3.00	88.62	-8.76	-21.82	-13.00	8.82
9360	37440.00	19.00	H	22.39	45.84	3.00	87.23	-10.15	-23.21	-13.00	10.21
9480	18960.00	16.23	V	15.52	44.74	3.00	76.49	-20.89	-33.95	-13.00	20.95
9480	18960.00	10.89	H	15.52	44.74	3.00	71.15	-26.23	-39.29	-13.00	26.29
9480	28440.00	16.43	V	19.03	46.75	3.00	82.21	-15.17	-28.23	-13.00	15.23
9480	28440.00	17.86	H	19.03	46.75	3.00	83.64	-13.74	-26.80	-13.00	13.80
9480	37920.00	19.61	V	22.94	45.72	3.00	88.27	-9.10	-22.16	-13.00	9.16
9480	37920.00	20.81	H	22.94	45.72	3.00	89.47	-7.90	-20.96	-13.00	7.96

80.209 FREQUENCY STABILITY

Test Engineer: TR
Test Date: 01/30/2020

Frequency Error Measurement Plot



FREQUENCY STABILITY

Frequency Error Measurement Table

	Limit (ppm)	1250.00	
	Limit (Hz)	11850000.000	
	Lower Limit (MHz)	9468.150000	
	Upper Limit (MHz)	9491.850000	
	Rated Supply Voltage	120.0	◉ AC ◯ DC

Temperature / Voltage Variation

Temperature (°C)	Supplied Voltage (V)	Frequency (MHz)	Deviation (kHz)
-30	120.0	9479.871795	128.205
-20	120.0	9480.128205	-128.205
-10	120.0	9480.000000	0.000
0	120.0	9479.839640	160.360
+10	120.0	9479.839640	160.360
+20 (reference)	120.0	9480.000000	0.000
+20	102.0	9480.000000	0.000
+20	138.0	9480.000000	0.000
+30	120.0	9479.871795	128.205
+40	120.0	9480.000000	0.000
+50	120.0	9480.000000	0.000

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END OF TEST REPORT

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