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TIMCO ENGINEERING, Inc.

An IIA Company

FCC CFR 47 Part 87 Radar Test Report

APPLICANT	TERMA A/S
ADDRESS	HOVMARKEN 4 LYSTRUP DK-8520
FCC ID	N9MSC5000
MODEL NUMBER	SCANTER 5602
PRODUCT DESCRIPTION	RADIODETERMINATION RADAR
DATE SAMPLE RECEIVED	07/15/2019
FINAL TEST DATE	07/18/2019
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
1800AUT19_PT87 Radar TestReport_	Rev1	Initial Issue	07/19/2019
1800AUT19_PT87 Radar TestReport_	Rev2	Clerical Revision	07/29/2019
1800AUT19_PT87 Radar TestReport_	Rev3	FCC ID Update and added model	08/02/2019
1800AUT19_PT87 Radar TestReport_	Rev4	Duty Cycle Updated	08/19/2019
1800AUT19_PT87 Radar TestReport_	Rev5	Clerical Update	10/01/2019

TABLE OF CONTENTS

GENERAL REMARKS **2**

Testing Information 4

Operating Frequencies 5

Operating Modes 6

SUMMARY OF TESTING **7**

RF POWER OUTPUT **8**

Test Data: Low Band, Mean Power Output 8

Test Data: Power at the Final Amplifier 9

OCCUPIED BANDWIDTH **10**

99% Occupied Bandwidth Rule Parts 10

40dB Occupied Bandwidth Rule Parts 11

Test Data: Occupied Bandwidth Measurement Table 11

Test Data: Low Band 99% OBW Plot 12

Test Data: Low Band 40dB OBW Plot 13

EMISSION MASK **14**

Test Data: Low Band Emission Mask B Plot, In-Band 15

Test Data: Low Band Emission Mask B Plot, Out-of-Band 16

SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED) **17**

Bandwidth Compensation Calculation Table 19

Test Data: Offset Calculation Tables 20

Test Data: Low Band, 30 MHz - 1 GHz Plot 21

Test Data: Low Band, 1-9 GHz Plot 22

Test Data: Low Band, 2ND Harmonic Plot 23

Test Data: Low Band, 3RD Harmonic Plot 24

Test Data: Low Band, 4TH Harmonic Plot 25

FIELD STRENGTH OF SPURIOUS EMISSIONS **26**

Bandwidth Compensation Calculation Table 29

Test Data: Low Band, Radiated Spurious Emissions Plot 30

Test Data: Low Band, Radiated Spurious Emissions Table 30

FREQUENCY STABILITY **31**

STATEMENT OF MEASUREMENT UNCERTAINTY **34**

EMC EQUIPMENT LIST **35**

GENERAL REMARKS

Summary

The device under test does:

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

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

Attestations

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

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

I attest that the necessary measurements were made at:

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

Tested by:

Name and Title	Franklin Rose, Project Manager / EMC Specialist
Date	07/19/2019

Reviewed and Approved by:

Name and Title	Tim Royer, Project Manager / EMC Testing Engineer
Date	07/22/2019

GENERAL INFORMATION

Definitions: FCC Part 90.7

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

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

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

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

Surveillance radar station. A radionavigation land station in the aeronautical radionavigation service employing radar to detect the presence of aircraft within its range.

GENERAL INFORMATION

Testing Information

EUT Description	RADIODETERMINATION RADAR		
FCC ID	N9MSC5000		
Model Number	SCANTER 5602		
Operating Band(s)	Band 1: 9.0 – 9.5 GHz		
Emission Designator	220MP0N		
Measurement Method	40dB Occupied Bandwidth		
Modulation	FM Pulse/FM Chirp		
EUT Power Source	☒110–120 VAC	☐ DC Power (12 V)	☐ Battery Operated
Test Item	☐ Prototype	☒ Pre-Production	☐ Production
Type of Equipment	☒ Fixed	☐ Mobile	☐ Portable
Antenna Connector	Proprietary to WR-90 Waveguide output		
Modification to the EUT	The EUT was not modified.		
Test Exercise	The EUT was operated using control software provided by the manufacturer in accordance with the user manual.		
Applicable Standards	FCC CFR 47 Part 2, Part 87, using ANSI C63.26-2015 Referencing: ITU-R M.1177-4		
Test Conditions	Laboratory temperature: 26ºC, Relative humidity: 50%		
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070		

GENERAL INFORMATION

Operating Frequencies

EUT Intended Band(s) of Operation

Band 1: 9.0 – 9.2 GHz

Rule Part No.: FCC Part 87.173(b), 87.471(a), 87.475(b)(12), 87.477

§87.173 Frequencies.

(a) The table in paragraph (b) of this section lists assignable carrier frequencies or frequency bands.

(1) The single letter symbol appearing in the "Subpart" column indicates the subpart of this part which contains additional applicable regulations.

(2) The two or three letter symbol appearing in the "Class of Station" column indicates the class of station to which the frequency is assignable.

(b) Frequency table:

Frequency or frequency band	Subpart	Class of station	Remarks
9000-9200 MHz	Q	RLS, RLD	Land-based radar.

§87.471 Scope of service.

Stations in the aeronautical radiodetermination service provide radionavigation and radiolocation services.

(a) Transmission by radionavigation land stations must be limited to aeronautical navigation, including obstruction warning.

§87.475 Frequencies.

(a) *Frequency coordination.* The Commission will assign frequencies to radionavigation land stations and radionavigation land test stations after coordination with the FAA. The applicant must notify the appropriate Regional Office of the FAA prior to submission to the Commission of an application for a new station or for modification of an existing station to change frequency, power, location or emission. Each application must include the FAA Regional Office notified and date of notification.

(b) *Frequencies available for radionavigation land stations.*

(12) 9000-9200 MHz: This band is available to land-based radars. Stations operating in this band may receive interference from stations operating in the radiolocation service.

§87.477 Condition of grant for radionavigation land stations.

Radionavigation land stations may be designated by the FAA as part of the National Airspace System. Stations so designated will be required to serve the public under IFT conditions. This condition of grant is applicable to all radionavigation land stations.

GENERAL INFORMATION

Operating Modes

The EUT operates using variable length pulse chirps, staggered, repeated over a variable period, shifting between each “emission” within the full product of the radar’s transmitter at a variable pulse repetition factor. As such, there is not a traditional set Pulse Width, or Pulse Train as is customary in current CW Pulsed systems.

The radar’s transmitter also utilizes inaccessible factory software, pre-programmed to operate in one of two ranges, which are assigned corresponding model numbers:

Model 5202, 5602, 6002 – Low Band (9.0 – 9.2 GHz)

For the purpose of FCC Compliance Testing, the EUT was programmed to operate in the worst-case, which utilizes settings unavailable to the user. This testing reflects the worst-possible installed emissions from this radar system.

SUMMARY OF TESTING

FCC Rule Parts	Testing Performed	Result
2.1046(a), 87.131	RF Power Output	**PASS**
2.1033(c)(4), 2.1049(i), 87.135(a)-(c), 87.137(a)	Occupied Bandwidth & Modulation Characteristics	**PASS**
87.139(a)(1), (2)	Emission Masks	**PASS**
2.1051(a), 2.1057(a)(1), 87.139(a)(3)	Spurious Emissions at Antenna Terminals	**PASS**
2.1053(a), 2.1057(a)(1), 87.139(a)(3)	Field Strength of Spurious Emissions	**PASS**
2.1055(a)(2), 87.133(a)	Frequency Stability	**PASS**

RF POWER OUTPUT

Rule Part No.: FCC Part 2.1046(a), 87.131

Requirements:

§87.131 Power and emissions.

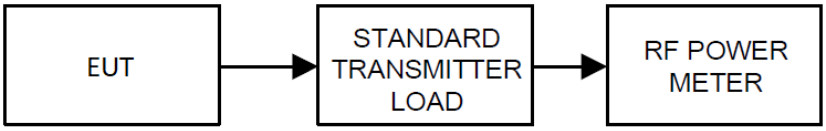
The following table lists authorized emissions and maximum power. Power must be determined by direct measurement.

Class of station	Frequency band/frequency	Authorized emission(s)[9]	Maximum power[1]
Radionavigation land	Various[4]	Various[4]	Various.[4]

[4]Frequency, emission, and maximum power will be determined after coordination with appropriate Government agencies.

Test Procedure: ANSI C63.26

Test Setup Block Diagram:



Test Data: Low Band, Mean Power Output

Mode	Nominal Frequency (MHz)	Measured Mean Output Power (dBm)	Loss (dB)	Mean Power Output (dBm)	Mean Power Output (W)	Calculated Duty Cycle (%)	Peak Power Output (W)	Peak Power Output (dBm)
LOW	9100	-8.998	-55.080	46.082	40.57	20.0%	202.848	53.072

Maximum Mean Power: **40.57 W**

Maximum Peak Power: **202.85 W**

POWER AT THE FINAL AMPLIFIER

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

Requirement:

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

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

Test Data: Power at the Final Amplifier

INPUT POWER: (100 VAC) (10.5 A) = **1050 Watts Max**

INPUT POWER: (230 VAC) (4.57 A) = **1050 Watts Max**

OCCUPIED BANDWIDTH

Rule Part No.: Part 2.1033(c)(4), 2.1049(i)

99% Occupied Bandwidth Rule Parts

Rule Part No.: 87.135(a)-(c), 87.137(a)

§2.1049 Measurements required: Occupied bandwidth.

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

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

§87.135 Bandwidth of emission.

(a) Occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 percent of the total mean power of a given emission.

(b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.

(c) The necessary bandwidth for a given class of emission is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

§87.137 Types of emission.

(a) The assignable emissions, corresponding emission designators and authorized bandwidths are as follows:

Class of emission	Emission designator	Authorized bandwidth (kilohertz)		
		Below 50 MHz	Above 50 MHz	Frequency deviation
PON[13]	[9]		9	

[9]To be specified on license.

[13]The letters "K, L, M, Q, V, W, and X" may also be used in place of the letter "P" for pulsed radars.

Note: 87.141 does not contain Modulation Requirements which pertain to this EUT.

Test Procedure: ANSI C63.26, 5.4.4

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

OCCUPIED BANDWIDTH

40dB Occupied Bandwidth Rule Parts

Rule Part No.: ITU-R M.1177-4

Test Procedure: ANSI C63.26, 5.4.3

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

Test Data: Occupied Bandwidth Measurement Table

Mode	99% Occupied Bandwidth (MHz)	40 dB Authorized Bandwidth (MHz)
Low Band	145.19	219.71

Max Occupied Bandwidth of EUT = **145.19 MHz**

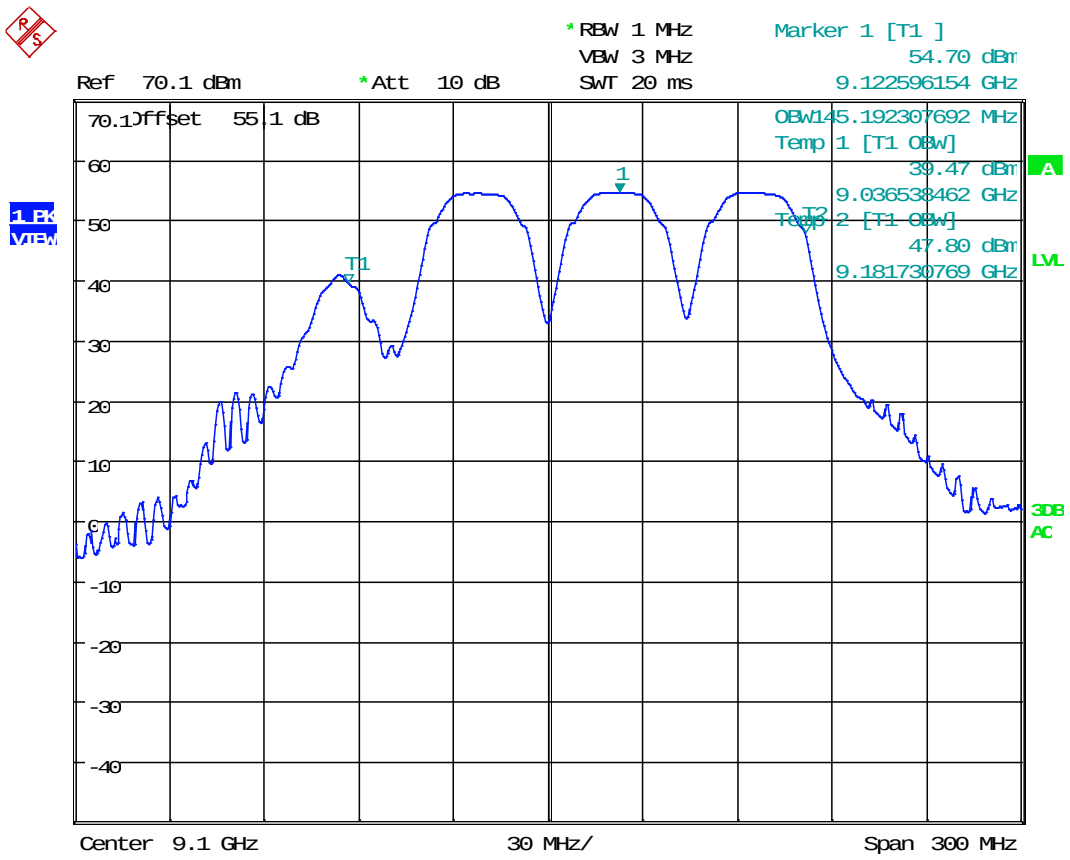
Max Authorized Bandwidth of EUT = **219.71 MHz**

Emission Designator = **220MP0N**

Method of Measurement = **40 dB Down**

OCCUPIED BANDWIDTH

Test Data: Low Band 99% OBW Plot



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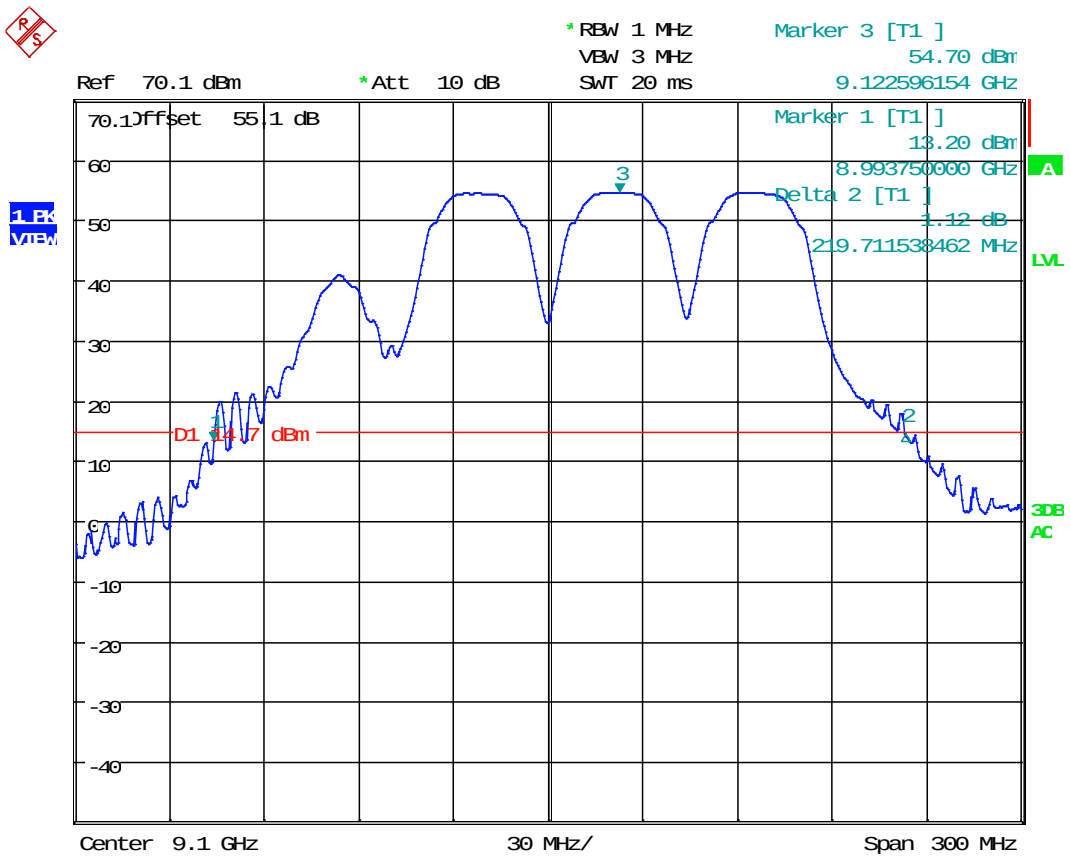
OCCUPIED BANDWIDTH

Test Data: Low Band 40dB OBW Plot



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EMISSION MASK

Rule Part No.: 87.139(a)(1), (2)

Requirements:

§87.139 Emission limitations.

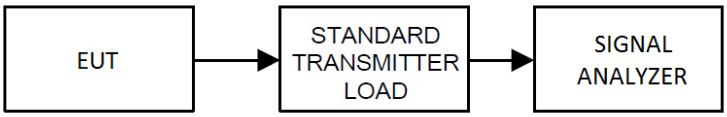
(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

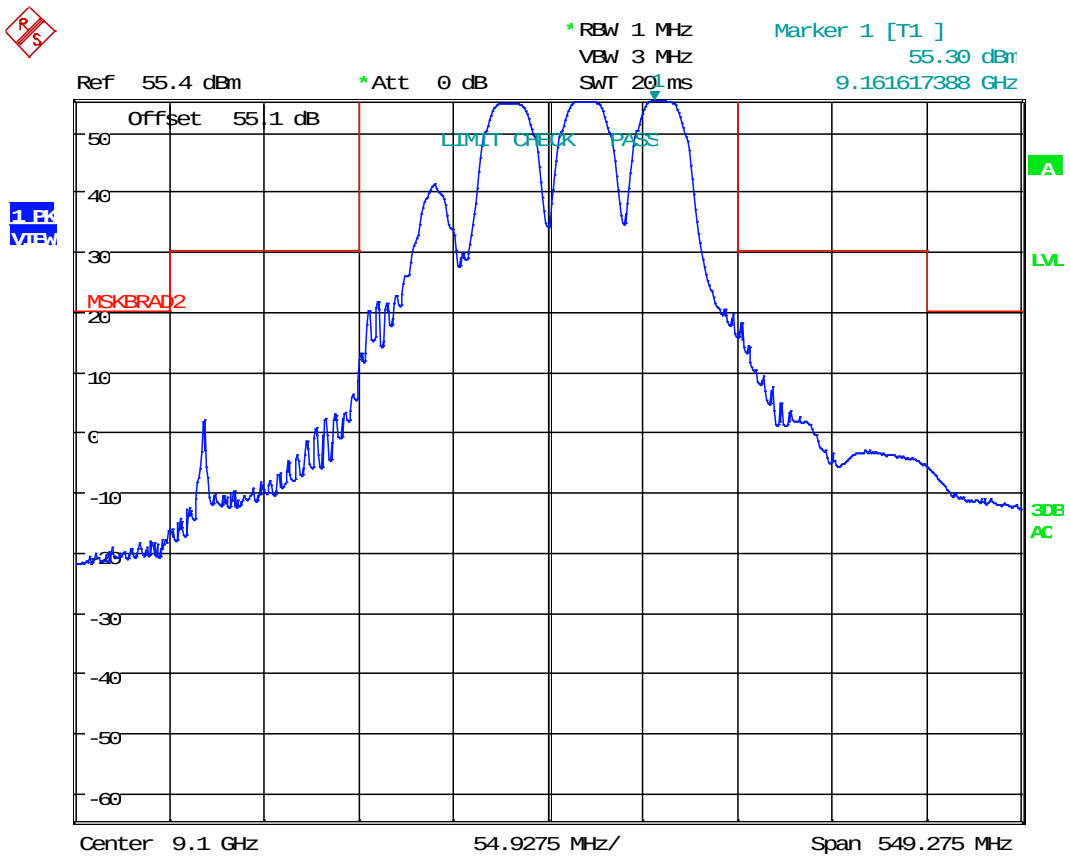
Test Procedure: ANSI C63.26, 5.4.4; ITU-R M.1177-4

Test Setup Block Diagram:



EMISSION MASK

Test Data: Low Band Emission Mask B Plot, In-Band



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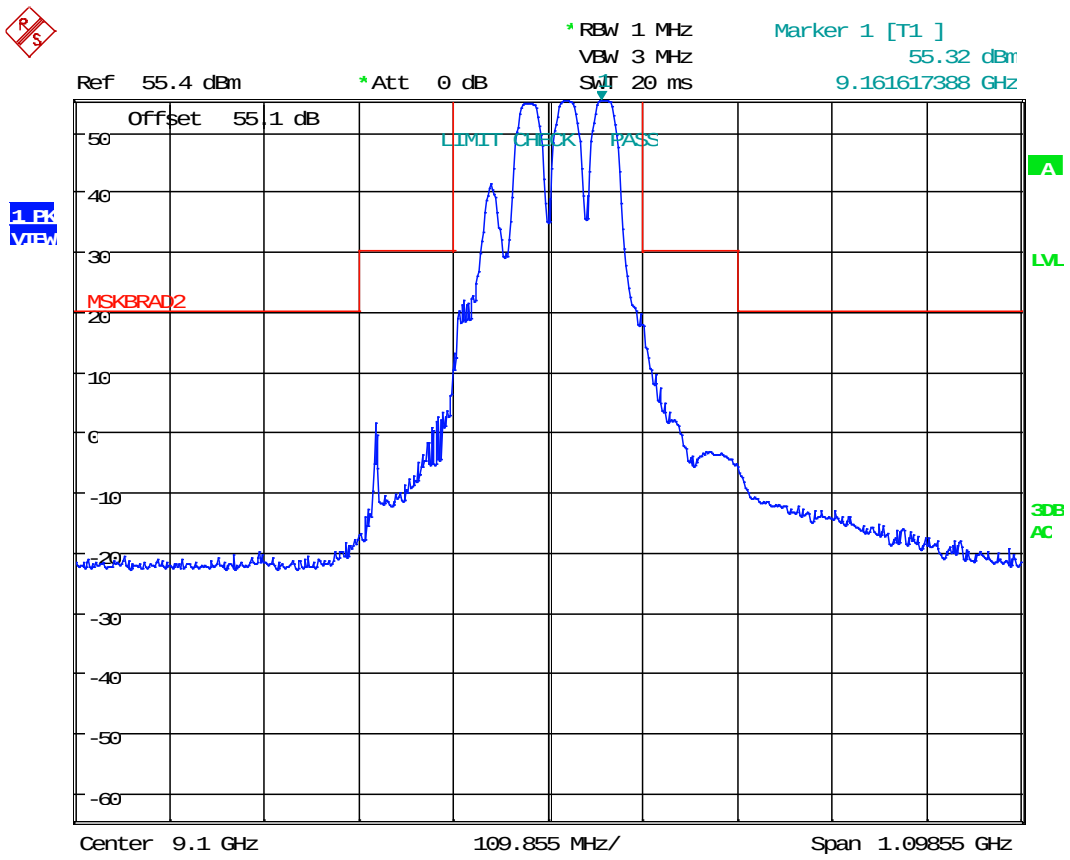
EMISSION MASK

Test Data: Low Band Emission Mask B Plot, Out-of-Band



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SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED)

Rule Part No.: Part 2.1051(a), 2.1057(a)(1), 87.139(a)(3)

§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.

§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.

§87.139 Emission limitations.

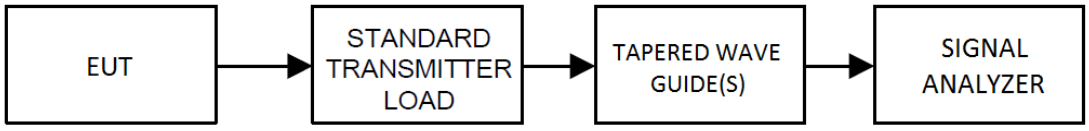
(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10}$ pY 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.

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

UNWANTED SPURIOUS EMISSIONS

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

2 Reference bandwidth

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

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

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

3 Measurement bandwidth and detector parameters

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

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

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

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

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

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

UNWANTED SPURIOUS EMISSIONS

Test Procedures, Con't.

3.2 Measurements within the spurious domain

3.2.1 Correction of the measurement within the spurious domain

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

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

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

Bandwidth Compensation Calculation Table

Mode	40 dB Occupied Bandwidth (MHz)	40dB Bref (MHz)		MBR (MHz)	Bm (MHz)	Spurious Noise Correction (dBm)	Spurious Emissions Correction (dBm)
		(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bif x MBR = Bm (MHz)	If Bm > 1, 10 x Log(Bref/Bm)	If Bm > 1, 20 x Log(Bref/Bm)
LOW	219.710	104.81	1.00	1.50	4.50	-6.53	-13.06
HIGH	200.321	642.08	1.00	1.50	4.50	-6.53	-13.06

Limit Calculation 87.139(a)(3)

43 + 10 x Log(Power, in Watts)

Mode	Maximum Mean Power Output (W)	Relative Limit (dBc)	Absolute Limit (dBm)
LOW	40.57	53.57	-13.00
HIGH	40.35	53.35	-13.00

Note: The offset in the measurement equipment represents all losses and compensation factors. The following plots show corrected data.

UNWANTED SPURIOUS EMISSIONS

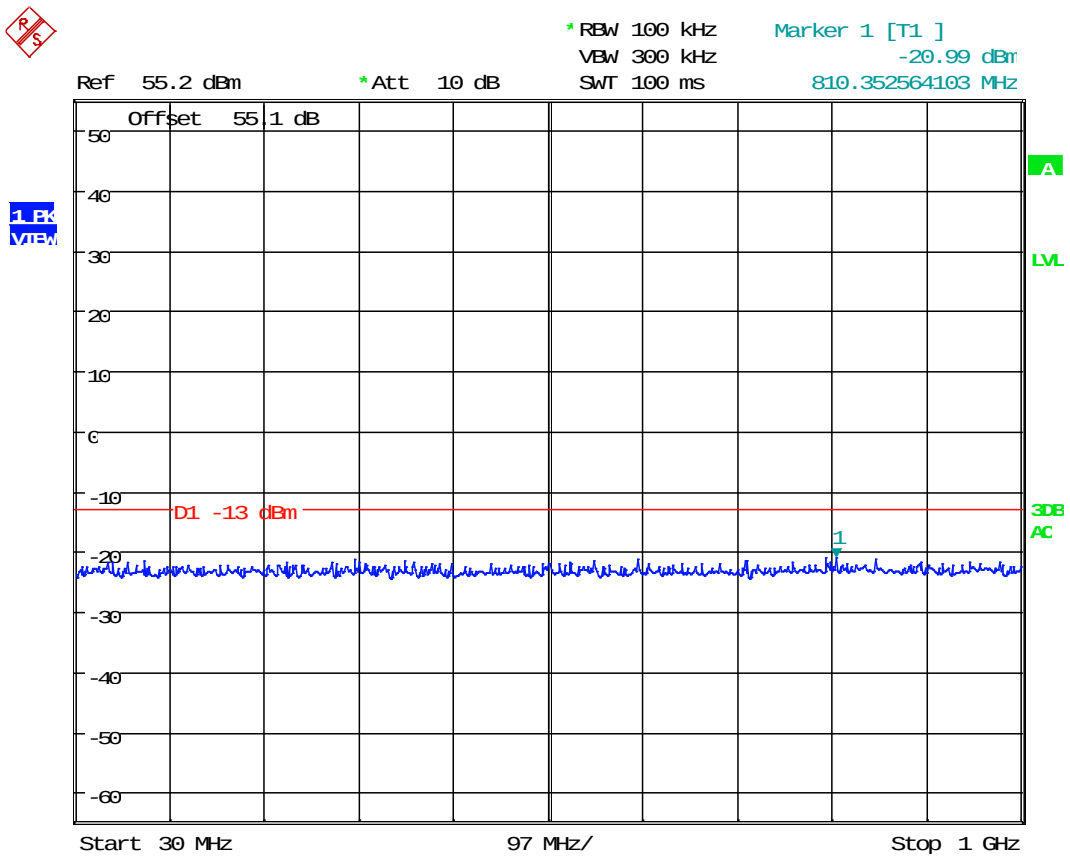
Test Data: Offset Calculation Tables

Low Band			
Frequency (MHz)	**Measurement Loss**	**Compensation**	**Offset**
30 - 1000	55.08		55.08
1000 - 9000	55.08		55.08
9100.00	55.08		55.08
18200.00	52.03	13.06	38.97
27300.00	38.8	13.06	25.74
36400.00	38.85	13.06	25.79

High Band			
Frequency (MHz)	**Measurement Loss**	**Compensation**	**Offset**
30 - 1000	54.55	-	54.55
1000 - 9000	54.55	-	54.55
9363.00	54.55		54.55
18726.00	52.03	13.06	38.97
28089.00	38.8	13.06	25.74
37452.00	38.85	13.06	25.79

UNWANTED SPURIOUS EMISSIONS

Test Data: Low Band, 30 MHz - 1 GHz Plot



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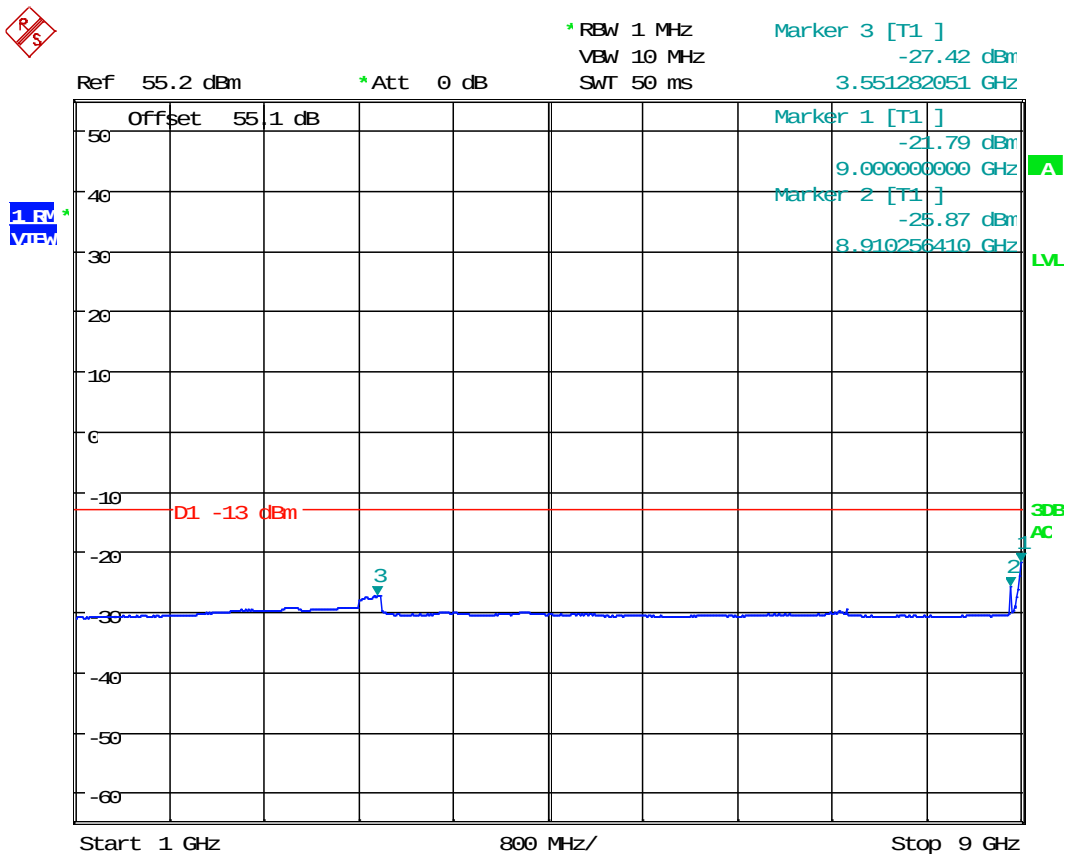
UNWANTED SPURIOUS EMISSIONS

Test Data: Low Band, 1-9 GHz Plot



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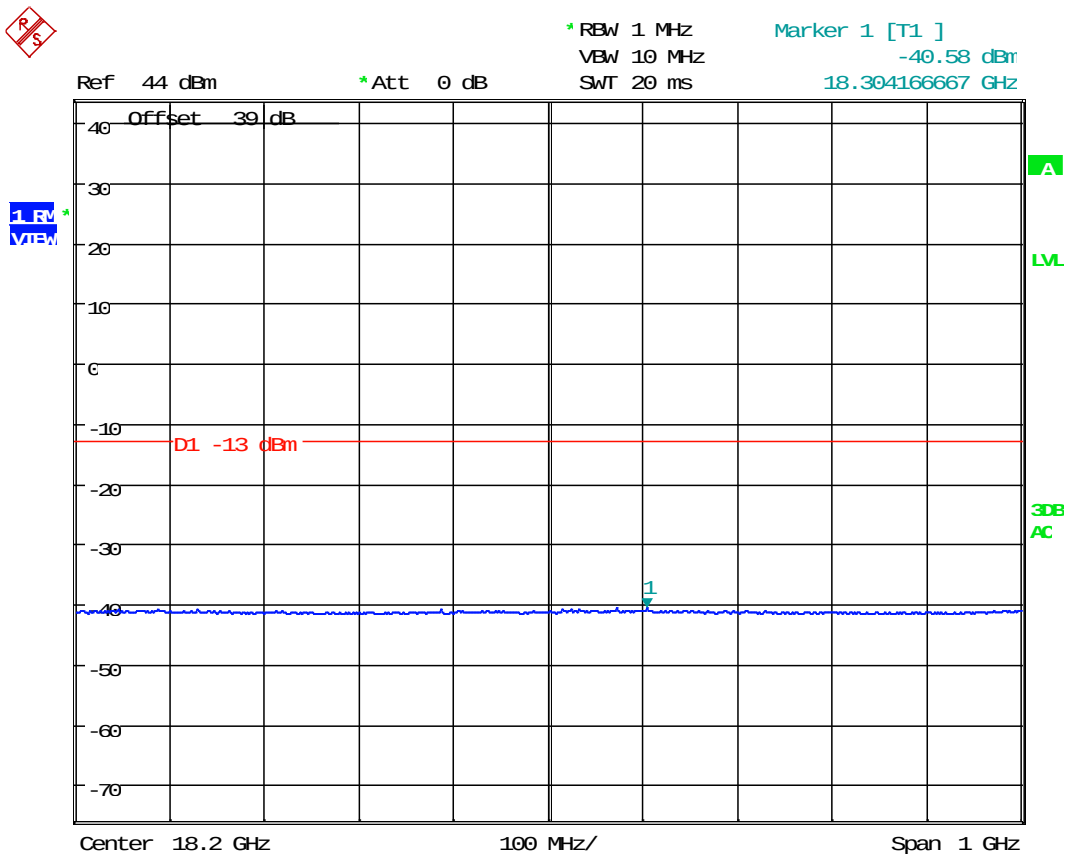
UNWANTED SPURIOUS EMISSIONS

Test Data: Low Band, 2nd Harmonic Plot



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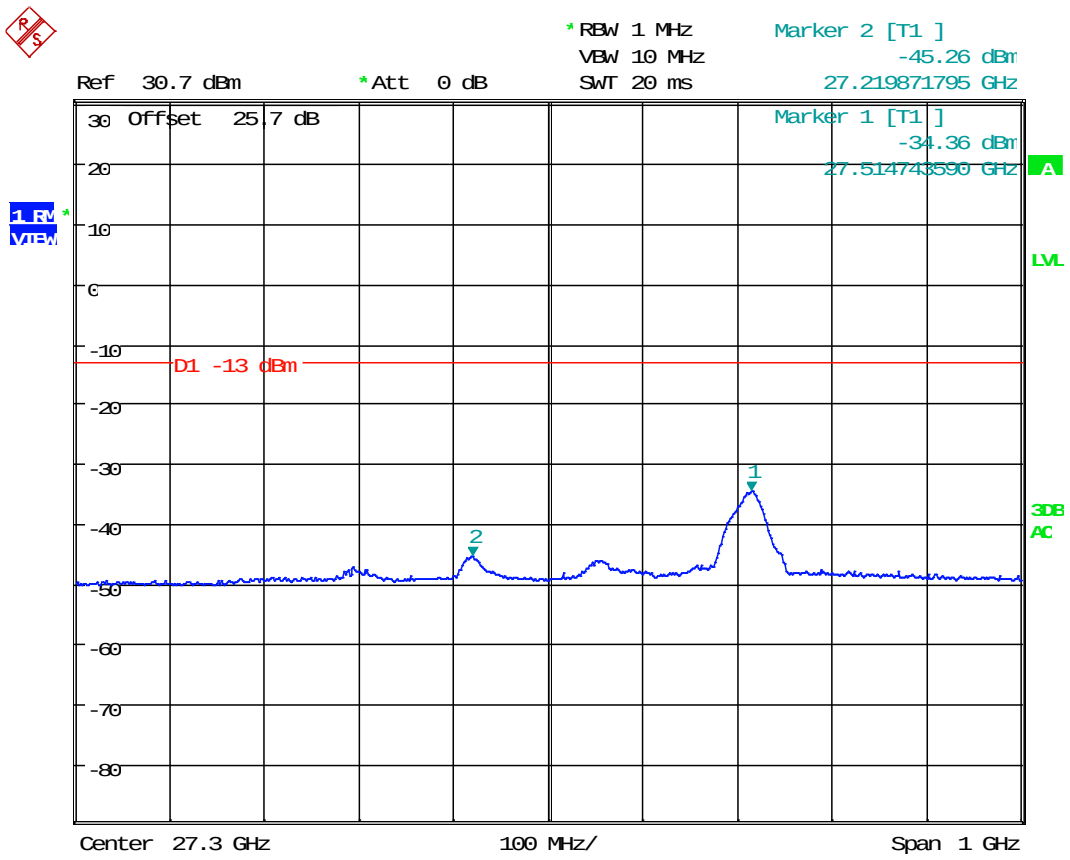
UNWANTED SPURIOUS EMISSIONS

Test Data: Low Band, 3rd Harmonic Plot



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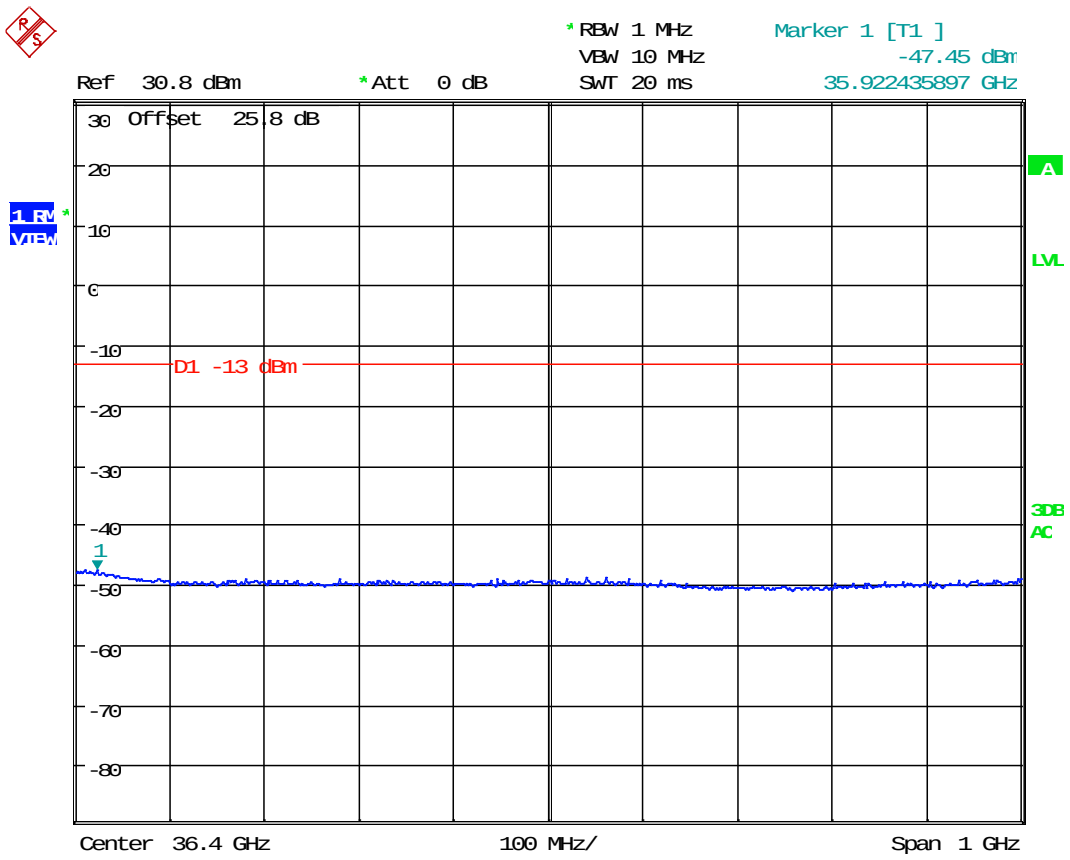
UNWANTED SPURIOUS EMISSIONS

Test Data: Low Band, 4th Harmonic Plot



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FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Part No.: Part 2.1053(a), 2.1057(a)(1), 87.139(a)(3)

Requirements:

§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.

§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.

§87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

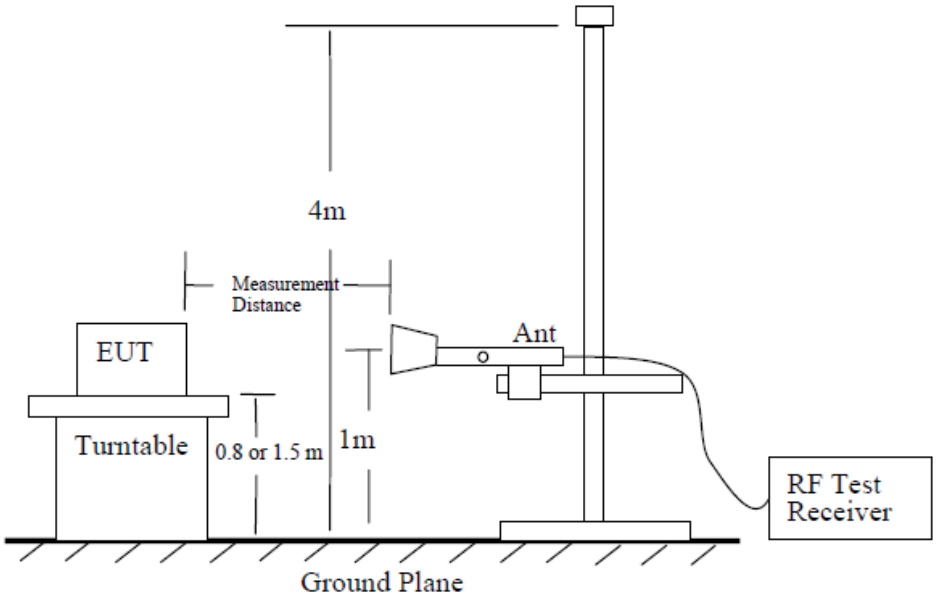
(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10}$ pY dB.

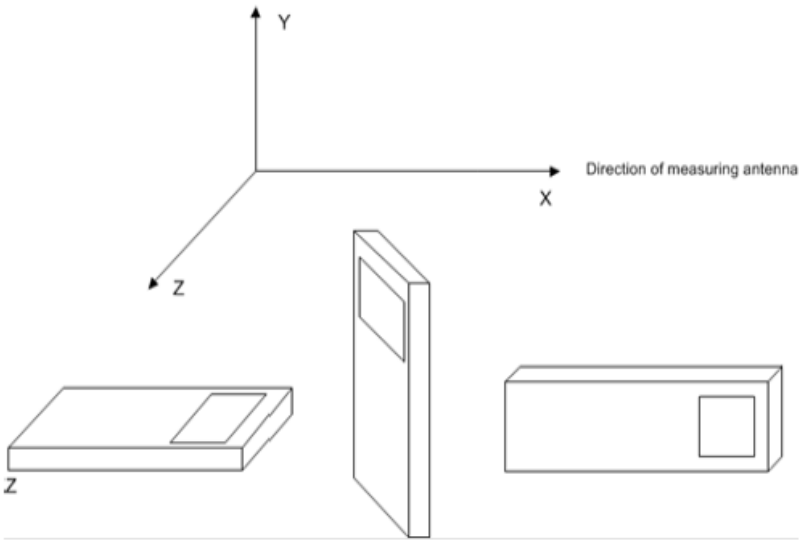
FIELD STRENGTH OF SPURIOUS EMISSIONS

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

Test Site Setup:



EUT Orientation(s):



FIELD STRENGTH OF SPURIOUS EMISSIONS

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

2 Reference bandwidth

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

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

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

3 Measurement bandwidth and detector parameters

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

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

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

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

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

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

3.2 Measurements within the spurious domain

3.2.1 Correction of the measurement within the spurious domain

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

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

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

Bandwidth Compensation Calculation Table

Mode	40 dB Occupied Bandwidth (MHz)	40dB Bref (MHz)		MBR (MHz)	Bm (MHz)	Spurious Noise Correction (dBm)	Spurious Emissions Correction (dBm)
		(Bc/T)^0.5 = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)	If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bif x MBR = Bm (MHz)	If Bm > 1, 10 x Log(Bref/Bm)	If Bm > 1, 20 x Log(Bref/Bm)
LOW	219.710	104.81	1.00	1.50	4.50	-6.53	-13.06

Limit Calculation 90.210(c)(3), 90.210(n), 90.210(b)(3)

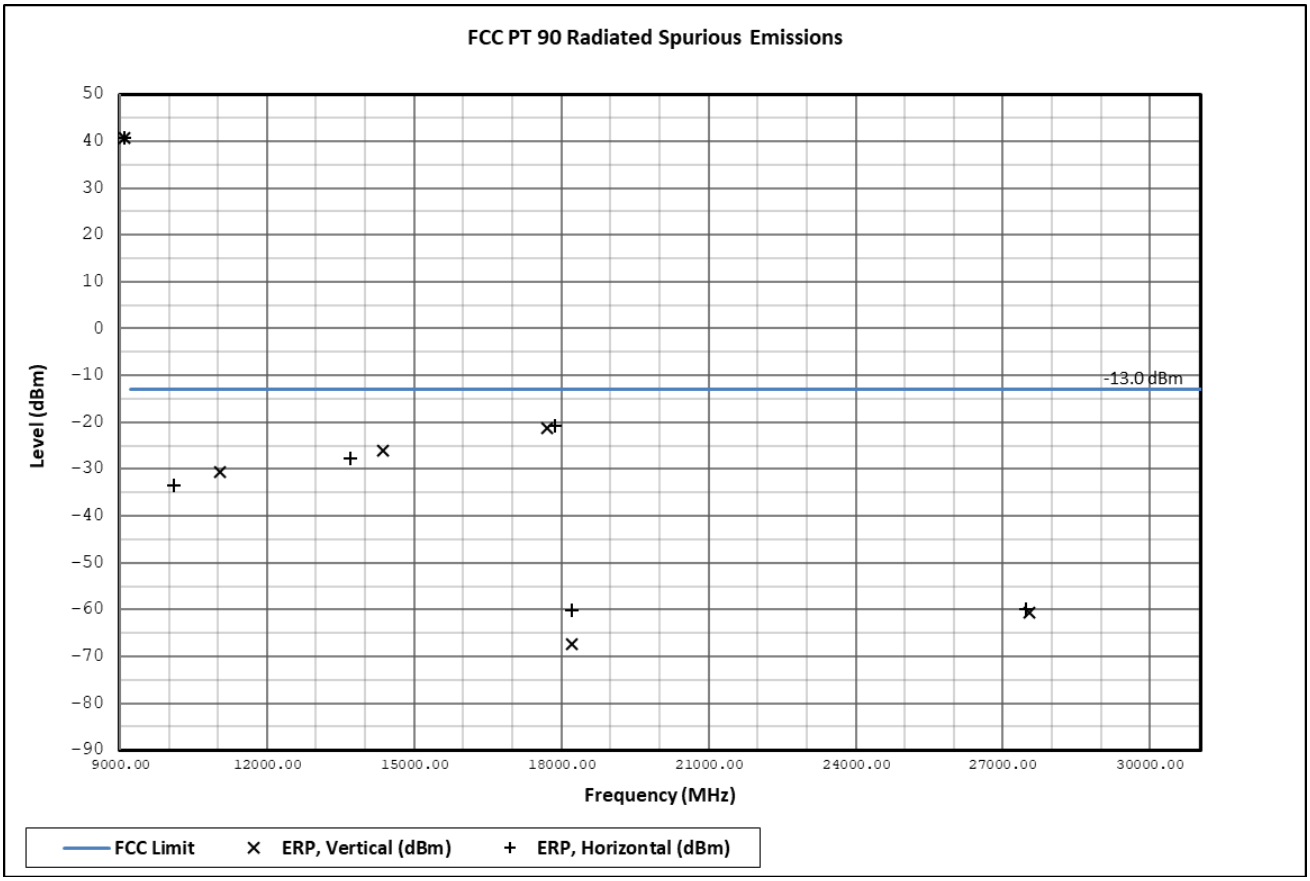
43 + 10 x Log(Power, in Watts)

Mode	Maximum Mean Power Output (W)	Relative Limit (dBc)	Absolute Limit (dBm)
LOW	40.57	53.57	-13.00

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

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Low Band, 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.

Test Data: Low Band, 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 Correction (dBm)	Limit (dBm)	Margin (dBm)	FCC Limit
9100	10102.60	28.80	H	11.00	37.21	3.00	77.01	-20.37	-33.43	-13.00	20.43	-13.00
9100	11033.30	29.90	V	11.76	38.07	3.00	79.73	-17.65	-30.71	-13.00	17.71	-13.00
9100	13698.70	31.00	H	12.66	39.11	3.00	82.77	-14.61	-27.67	-13.00	14.67	-13.00
9100	14361.50	31.39	V	13.32	39.67	3.00	84.38	-13.00	-26.06	-13.00	13.06	-13.00
9100	17703.90	32.23	V	14.71	42.24	3.00	89.18	-8.19	-21.25	-13.00	8.25	-13.00
9100	17873.10	32.53	H	15.16	41.91	3.00	89.60	-7.77	-20.83	-13.00	7.83	-13.00
9100	18203.90	-16.79	V	15.22	44.76	3.00	43.19	-54.19	-67.25	-13.00	54.25	-13.00
9100	18211.50	-9.76	H	15.19	44.76	3.00	50.19	-47.19	-60.25	-13.00	47.25	-13.00
9100	27476.30	-14.87	H	18.84	46.57	3.00	50.54	-46.84	-59.90	-13.00	46.90	-13.00
9100	27546.80	-15.82	V	18.91	46.61	3.00	49.70	-47.67	-60.73	-13.00	47.73	-13.00
9100	34601.90	-14.38	H	22.00	51.01	3.00	58.63	-38.75	-51.81	-13.00	38.81	-13.00
9100	36752.60	-15.62	V	22.71	46.70	3.00	53.79	-43.59	-56.65	-13.00	43.65	-13.00

FREQUENCY STABILITY

Rule Part No.: Part 2.1055(a)(2), 87.133(a)

§87.133 Frequency stability.

(a) Except as provided in paragraphs (c), (d), (f), and (g) of this section, the carrier frequency of each station must be maintained within these tolerances:

Frequency band (lower limit exclusive, upper limit inclusive), and categories of stations	Tolerance[1]	Tolerance[2]
(8) Band-2450 to 10500 MHz:		
Radionavigation stations	[6 9]1250	1250[6 9]

[1]This tolerance is the maximum permitted until January 1, 1990, for transmitters installed before January 2, 1985, and used at the same installation. Tolerance is indicated in parts in 10^6 unless shown as Hertz (Hz).

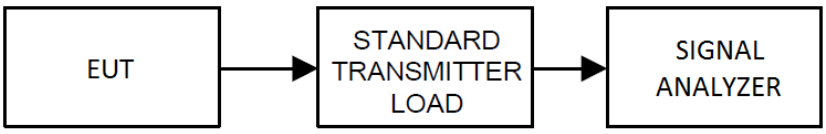
[2]This tolerance is the maximum permitted after January 1, 1985 for new and replacement transmitters and to all transmitters after January 1, 1990. Tolerance is indicated in parts in 10^6 unless shown as Hertz (Hz).

[6]In the 5000 to 5250 MHz band, the FAA requires a tolerance of ±10 kHz for Microwave Landing System stations which are to be a part of the National Airspace System (FAR 171).

[9]Where specific frequencies are not assigned to radar stations, the bandwidth occupied by the emissions of such stations must be maintained within the band allocated to the service and the indicated tolerance does not apply.

Test Procedure: TIA 603-E, 2.2.2

Test Setup Block Diagram:



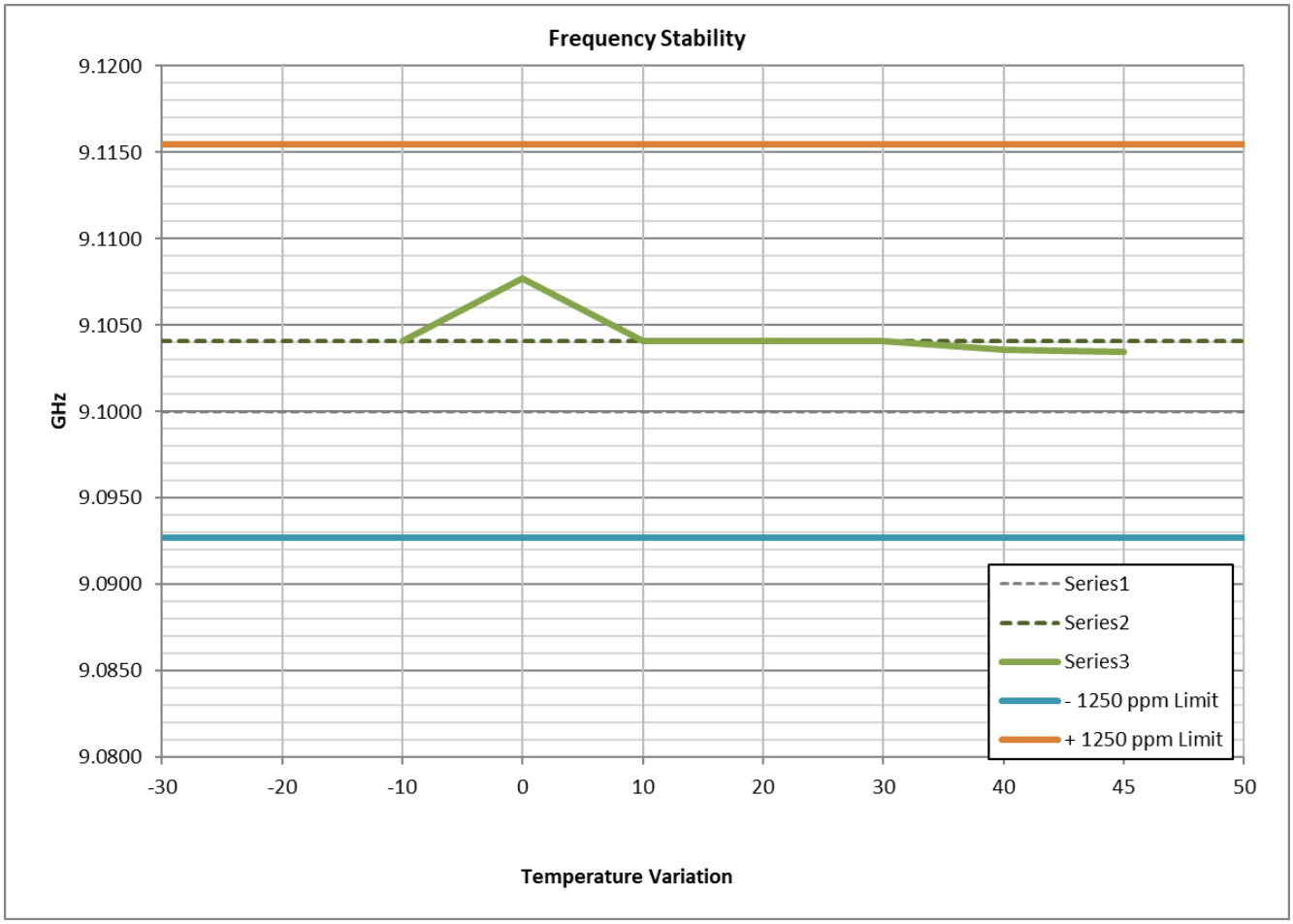
Note: This EUT is designed to operate within FCC Parts 80, 87, 90, and in accordance with ISED RSS-238. Therefore, the EUT shall meet the strictest Frequency Stability limits from the appropriate standards (1250 ppm).

Note: The operational range of the EUT is -10 degrees C to +45 degrees C. Operation outside this range is not possible, due to the EUT's built-in limitation. The EUT has been tested to show compliance within this temperature range.

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

FREQUENCY STABILITY

Test Data: Frequency Error Measurement Plot



FREQUENCY STABILITY

Test Data: Frequency Error Measurement Table

RSS-238 4.1 Limit:	1250	ppm		
87.133(a) Limit:	1250	ppm		
80.209(b) Limit in PPM:	1250	ppm		
Most Strict Limit:	1250	ppm		
Temperature (°C)	**Supplied Voltage (VAC)**	**Intended Frequency (GHz)**	**Measured Reference Frequency (GHz)**	**Deviation (Hz)**
20°C (reference)	120	9.1	9.104085	0
Over Temperature Range				
Temperature (°C)	**Supplied Voltage (VDC)**	**Frequency (GHz)**	**Deviation (GHz)**	**PPM**
+45	120	9.103445	0.00064	70.298
+40	120	9.103605	0.00048	52.724
+30	120	9.104085	0.00000	0.000
+20	120	9.104085	0.00000	0.000
+10	120	9.104085	0.00000	0.000
0	120	9.10769	0.00360	-395.976
-10	120	9.10769	0.00360	-395.976
-20	120			
-30	120			

STATEMENT OF MEASUREMENT UNCERTAINTY

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

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

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

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

EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
CHAMBER	Panashield	3M	N/A	03/12/19	03/12/21
Antenna: Biconical 1057	Eaton	94455-1	1057	12/13/17	12/13/19
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	12/08/19
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	11/06/19
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

END OF REPORT