



FCC CFR 47 Part 90 Radar Test Report

APPLICANT	TERMA A/S
ADDRESS	HOVMARKEN 4 LYSTRUP DK-8520
FCC ID	N9MSC5000
MODEL NUMBER	SCANTER 5202, SCANTER 5602, SCANTER 6002
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	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL

Report Number	Report Version	Description	Issue Date
1800AUT19_PT90 Radar TestReport_	Rev1	Initial Issue	07/19/2019
1800AUT19_PT90 Radar TestReport_	Rev2	Clerical Revision	07/29/2019
1800AUT19_PT90 Radar TestReport_	Rev3	Corrected FCC ID and Model Numbers	08/02/2019
1800AUT19_PT90 Radar TestReport_	Rev4	Updated Duty Cycle	08/19/2019

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



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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 07/25/2019

GENERAL INFORMATION

Definitions: FCC Part 90.7

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

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

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

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

Testing Information

EUT Description	RADIODETERMINATION RADAR		
FCC ID	N9MSC5000		
Model Number	SCANTER 5202, SCANTER 5602, SCANTER 6002		
Operating Band(s)	Band 1: 9.0 – 9.5 GHz		
Emission Designator	276MP0N		
Measurement Method	40dB Occupied Bandwidth		
Modulation	FM Pulse/FM Chirp		
EUT Power Source	<input checked="" type="checkbox"/> 110–120 VAC	<input type="checkbox"/> DC Power (12 V)	<input type="checkbox"/> Battery Operated
Test Item	<input type="checkbox"/> Prototype	<input checked="" type="checkbox"/> Pre-Production	<input type="checkbox"/> Production
Type of Equipment	<input checked="" type="checkbox"/> Fixed	<input type="checkbox"/> Mobile	<input type="checkbox"/> 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 90, using ANSI C63.26-2015 Referencing: ITU-R M.1177-4		
Test Conditions	Laboratory temperature: 26°C, 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 – 9.5 GHz

Rule Part No.: FCC Part 90.103

§90.103 Radiolocation Service.

(b) *Frequencies available.* The following table indicates frequencies available for assignment to stations in the Radiolocation Service, together with the class of station(s) to which they are normally assigned, and the specific assignment limitations, which are explained in paragraph (c) of this section:

RADIOLOCATION SERVICE FREQUENCY TABLE

Frequency or band	Class of station(s)	Limitation
Megahertz		
9000 to 9200do	10, 14
9200 to 9300do	12
9300 to 9500do	10, 15, 18

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

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

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

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

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

GENERAL INFORMATION

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)

Model 5202, 6002 – High Band (9.2 – 9.5 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), 90.205(r)	RF Power Output	PASS
2.1033(c)(4), 2.1049(i), 90.207(k), (n), 90.209(b)(5)	Occupied Bandwidth & Modulation Characteristics	PASS
90.210(n), (b)(1), (2)	Emission Masks	PASS
2.1051(a), 2.1057(a)(1), 90.210(n), (b)(3)	Spurious Emissions at Antenna Terminals	PASS
2.1053(a), 2.1057(a)(1), 90.210(n), (b)(3)	Field Strength of Spurious Emissions	PASS
2.1055(a)(2), 90.213(a)	Frequency Stability	PASS

RF POWER OUTPUT

Rule Part No.: FCC Part 2.1046(a), 90.205(r)

Requirements:

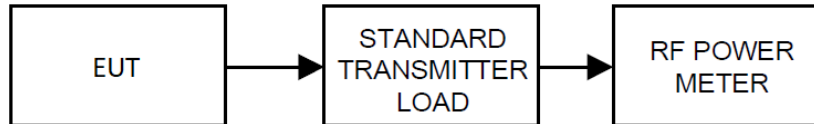
§90.205 Power and antenna height limits.

(r) All other frequency bands. Requested transmitter power will be considered and authorized on a case by case basis.

Note: the frequency bands referred to in 90.205 do not include 9.0 – 9.5 GHz. These frequencies are covered by clause (r).

Test Procedure: ANSI C63.26

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**

Test Data: High 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)
HIGH	9363	-8.492	-54.550	46.06	40.35	20.00%	201.730	53.048

Maximum Mean Power: **40.35 W**

Maximum Peak Power: **201.73 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.: 90.207(k), (n), 90.209(b)(5)

§2.1049 Measurements required: Occupied bandwidth.

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

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

§90.207 Types of emissions.

(k) For radiolocation operations as may be authorized in accordance with subpart F, unless otherwise provided for any type of emission may be authorized upon a satisfactory showing of need.

(n) *Other emissions.* Requests for emissions other than those listed in paragraphs (c) through (e) of this section will be considered on a case-by-case basis to ensure that the requested emission will not cause more interference than other currently permitted emissions.

§90.209 Bandwidth limitations.

(b) The maximum authorized single channel bandwidth of emission corresponding to the type of emission specified in §90.207 is as follows:

STANDARD CHANNEL SPACING/BANDWIDTH

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
Above 2500 ²		

²Bandwidths for radiolocation stations in the 420-450 MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by-case basis.

Test Procedure: ANSI C63.26, 5.4.4

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

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 Occupied Bandwidth (MHz)
Low Band	145.19	219.71
High Band	222.16	275.96

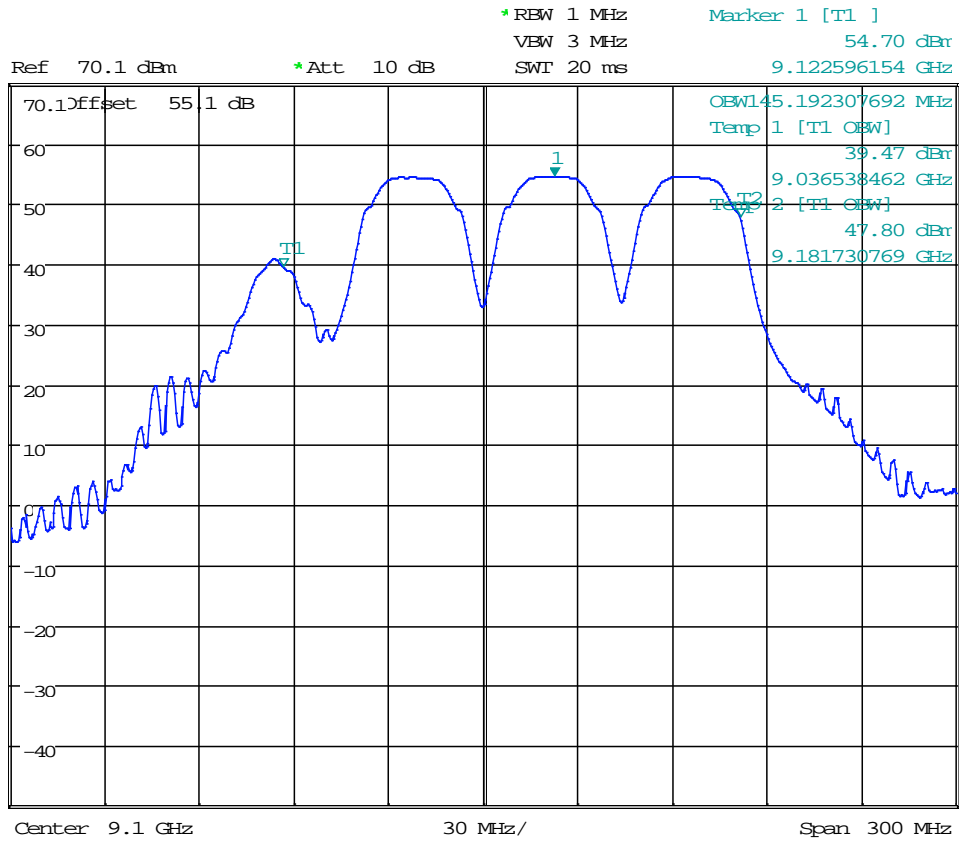
Max Occupied Bandwidth of EUT = **275.96 MHz**

Emission Designator = **276MP0N**

Method of Measurement = **40 dB Down**

OCCUPIED BANDWIDTH

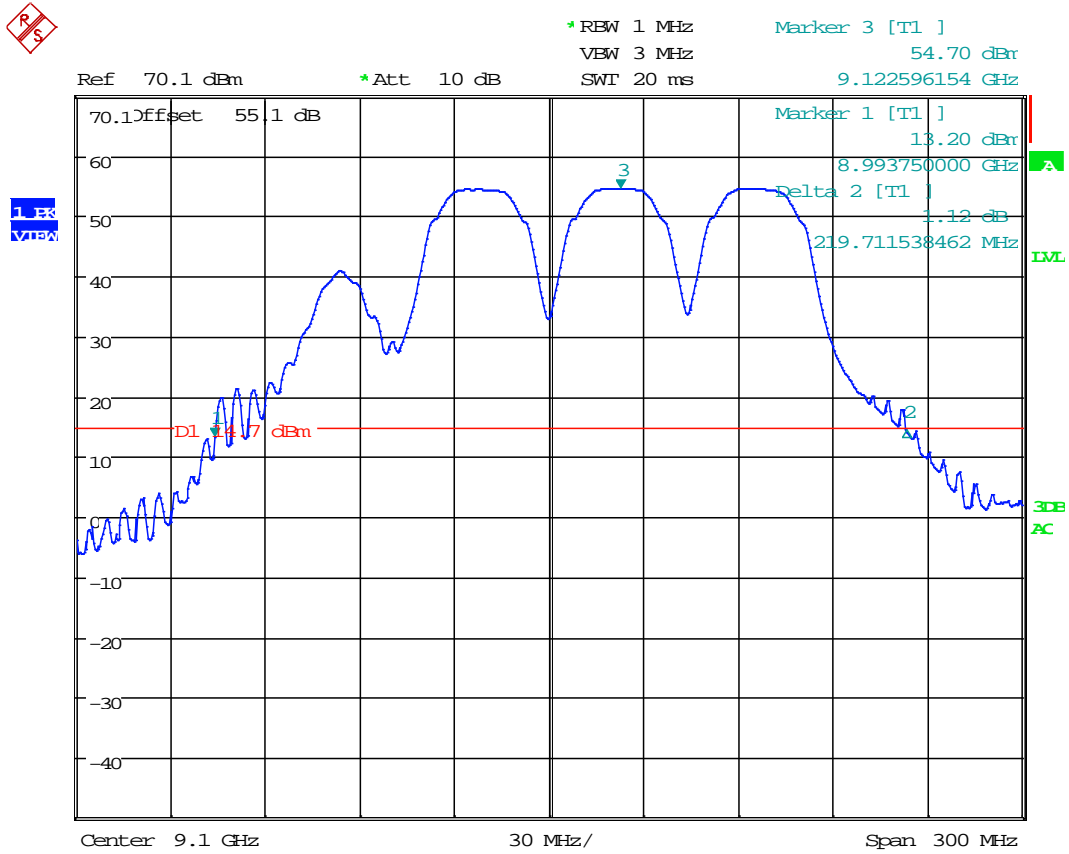
Test Data: Low Band 99% OBW Plot



Date: 17.JUL.2019 12:40:37

OCCUPIED BANDWIDTH

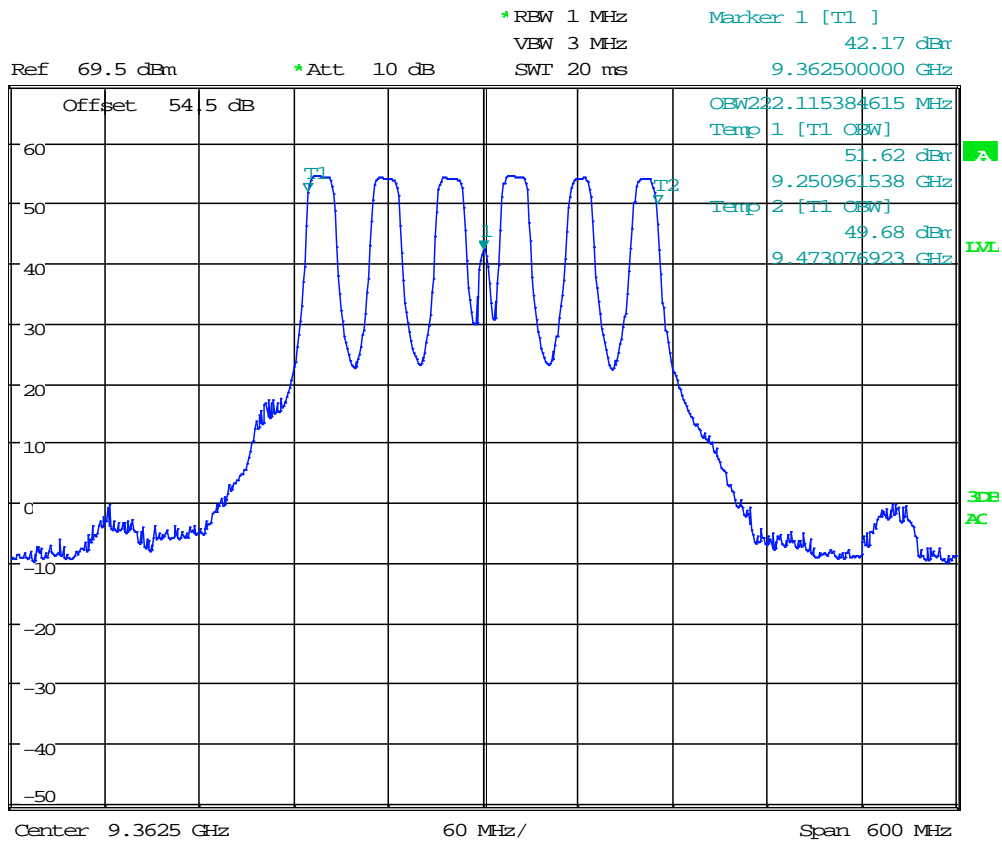
Test Data: Low Band 40dB OBW Plot



Date: 17.JUL.2019 12:41:35

OCCUPIED BANDWIDTH

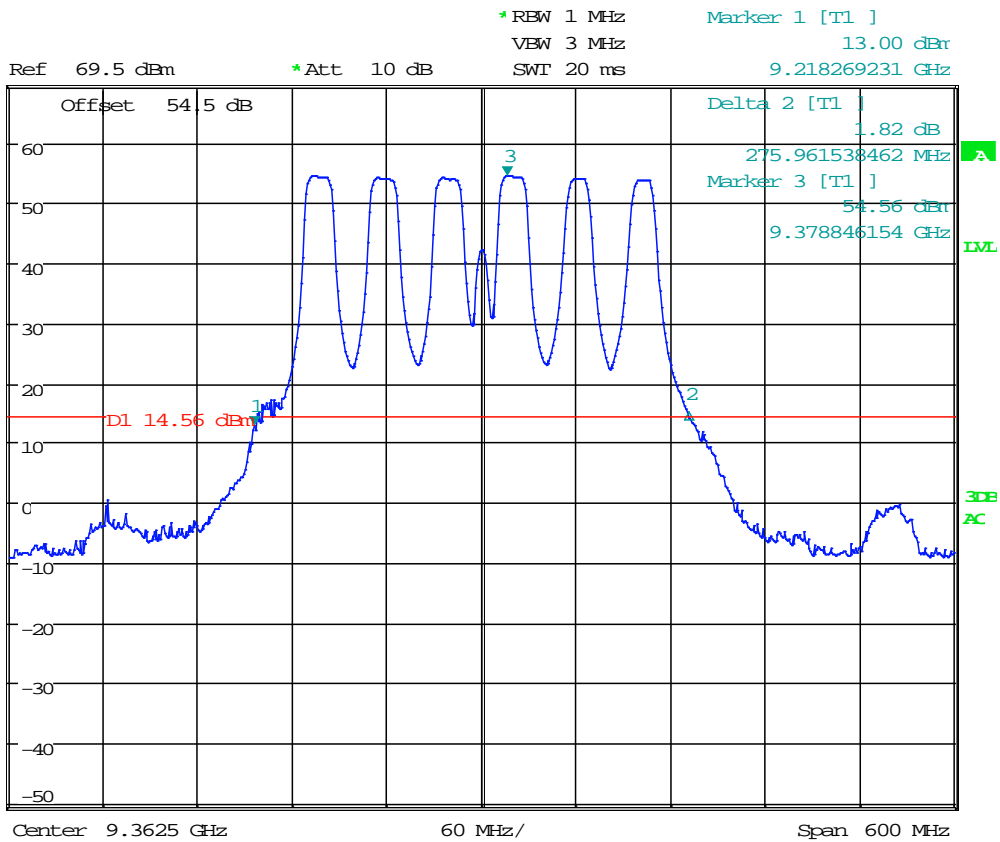
Test Data: High Band 99% OBW Plot



Date: 16.JUL.2019 14:30:56

OCCUPIED BANDWIDTH

Test Data: High Band 40dB OBW Plot



Date: 16.JUL.2019 14:33:22

EMISSION MASK

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

Requirements:

(c) *Emission Mask C.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least $83 \log (f_d/5)$ dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least $29 \log (f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation;

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

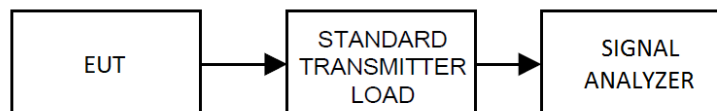
(b) *Emission Mask B.* For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

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

Test Setup Block Diagram:



EMISSION MASK

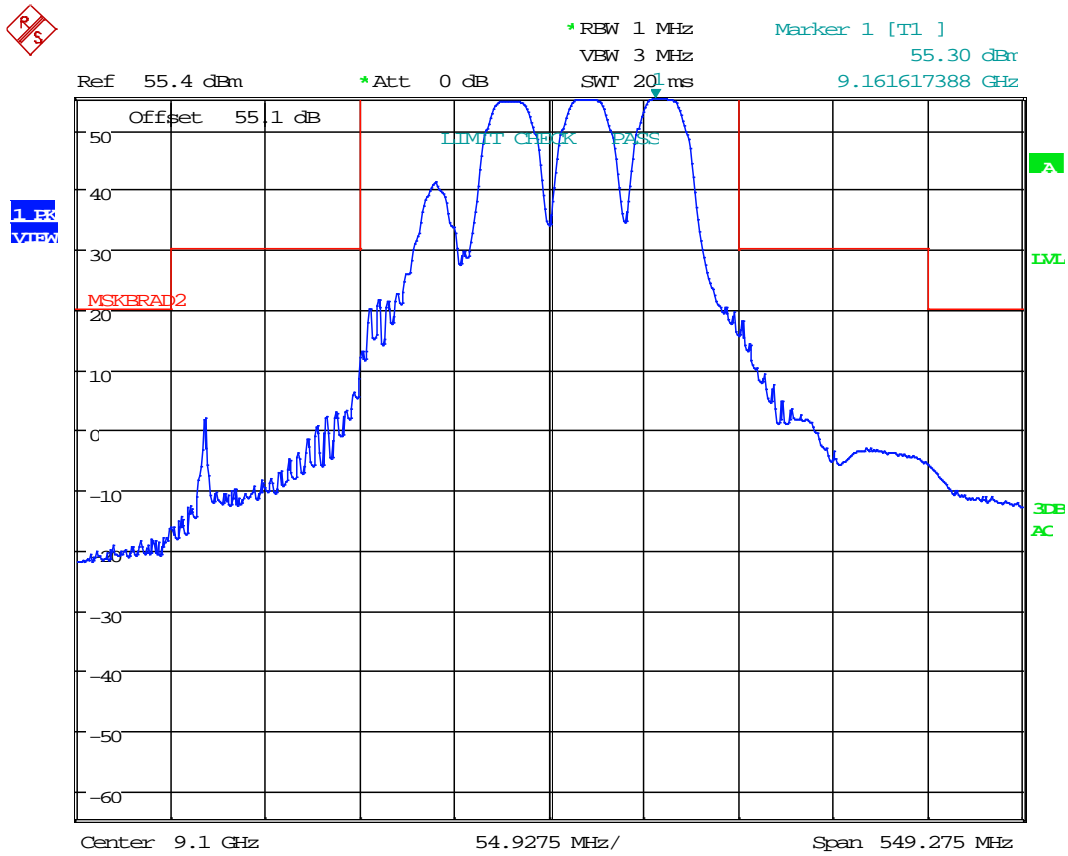
Test Data: Emission Mask Calculations

FCC CFR 47 Part 90 Emission Masks						
Frequency Band (MHz)	Mask for equipment with audio low pass filter			Mask for equipment without audio low pass filter		
	6.25 kHz	12.5 kHz	25 kHz	6.25 kHz	12.5 kHz	25 kHz
<25	A (J3E emission only), B			A (J3E emission only), C		
25 - 50	B, 20 kHz ABW			C, 20 kHz ABW		
72 - 76	B, 20 kHz ABW			C, 20 kHz ABW		
150 - 174	E, 6 kHz ABW	D, 11.25 kHz ABW	B, 20 kHz ABW	E, 6 kHz ABW	D, 11.25 kHz ABW	C, 20 kHz ABW
150 PAGING ONLY	B, 6 kHz ABW	B, 11.25 kHz ABW	B, 20 kHz ABW	C, 6 kHz ABW	C, 11.25 kHz ABW	C, 20 kHz ABW
220 - 222	F, 4 kHz ABW, (see Aggregation allowances)					
406 - 421	B, 6 kHz ABW	B, 11.25 kHz ABW	B, 20 kHz ABW	C, 6 kHz ABW	C, 11.25 kHz ABW	C, 20 kHz ABW
421 - 512	E, 6 kHz ABW	D, 11.25 kHz ABW	B, 20 kHz ABW	E, 6 kHz ABW	D, 11.25 kHz ABW	C, 20 kHz ABW
450 PAGING ONLY	B, 6 kHz ABW	B, 11.25 kHz ABW	B, 20 kHz ABW	G, 6 kHz ABW	G, 11.25 kHz ABW	G, 20 kHz ABW
806 - 809	B, 20 kHz ABW			H, 20 kHz ABW		
809 - 817	D, 11.25 kHz ABW		B, 20 kHz ABW	D, 11.25 kHz ABW		G, 20 kHz ABW
817 - 824	D, 20 kHz ABW		B, 20 kHz ABW	D, 20 kHz ABW		G, 20 kHz ABW
851 - 854	B, 20 kHz ABW			H, 20 kHz ABW		
854 - 862	D, 11.25 kHz ABW		B, 20 kHz ABW	D, 11.25 kHz ABW		G, 20 kHz ABW
862 - 869	D, 20 kHz ABW		B, 20 kHz ABW	D, 20 kHz ABW		G, 20 kHz ABW
854 - 869 EA	90.691					
896 - 901	I, 13.6 kHz ABW			J, 13.6 kHz ABW		
902 - 928	K, see 90.209(b) note 4					
929 - 930	B, 20 kHz ABW			G, 20 kHz ABW		
935 - 940	I, 13.6 kHz ABW			J, 13.6 kHz ABW		
1427 - 1432	B, see 90.259(b)			C, see 90.259(b)		
2450 - 2483.5	B, see 90.209(b) note 3, 2			C, see 90.209(b) note 3, 2		
4940 - 4990	M, for Output Power > 20 dBm; L, for < 20 dBm					
5850 - 5925	K, see Part 90 subpart M, Intelligent Transportation Systems Radio Service					
All other bands	B			C		
Shared with Federal Bands	90.210(n) Must meet Federal Government Technical Standards					

Calculation	Limit (dBc)	dBc	dBm
#1 (Mask A, B, C, G, H)	$43 + 10 * \text{Log}(P)$	68.40	-13.00
#2 (Mask C)	$83 * \text{Log}(5 / 5)$	0.00	55.40
	$83 * \text{Log}(10 / 5)$	24.99	30.41
	Min dBc of: $50 \text{ or } 29 * \text{Log}(10^2 / 11)$	27.80	27.60
	Min dBc of: $50 \text{ or } 29 * \text{Log}((250\% \text{ ABW})^2 / 11)$	50.00	5.40

EMISSION MASK

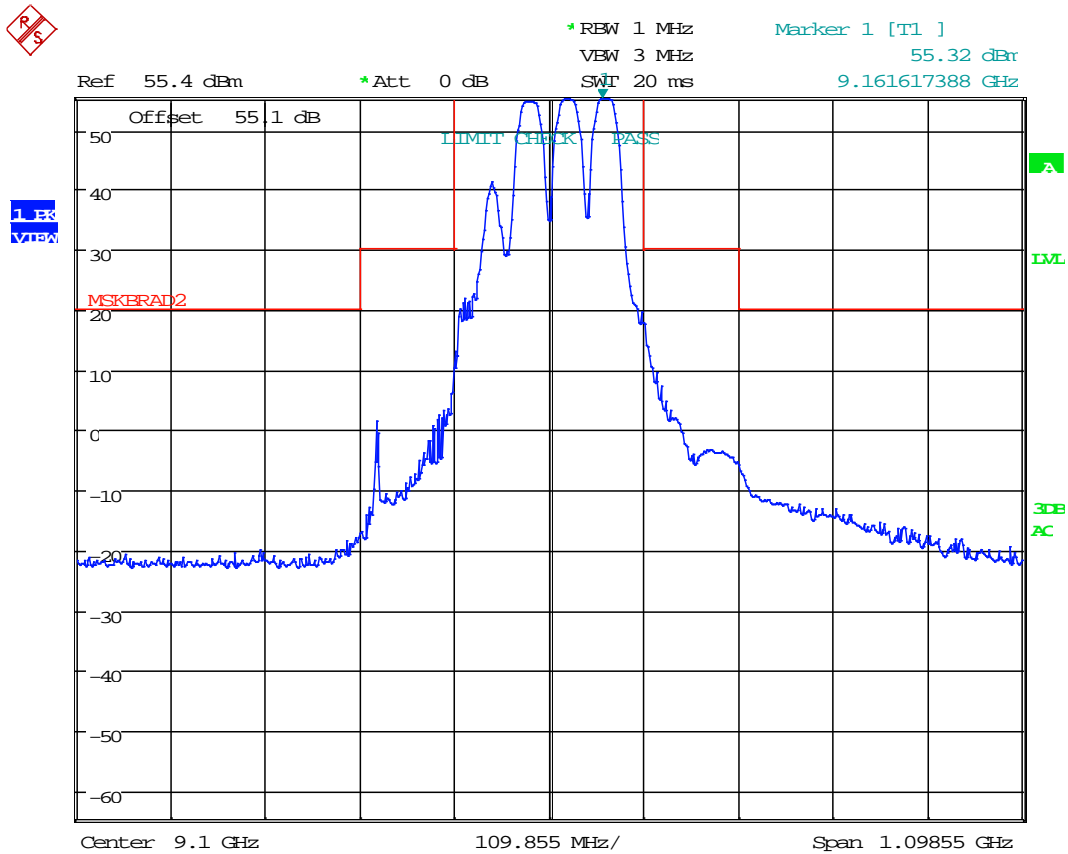
Test Data: Low Band Emission Mask B Plot, In-Band



Date: 17.JUL.2019 13:18:16

EMISSION MASK

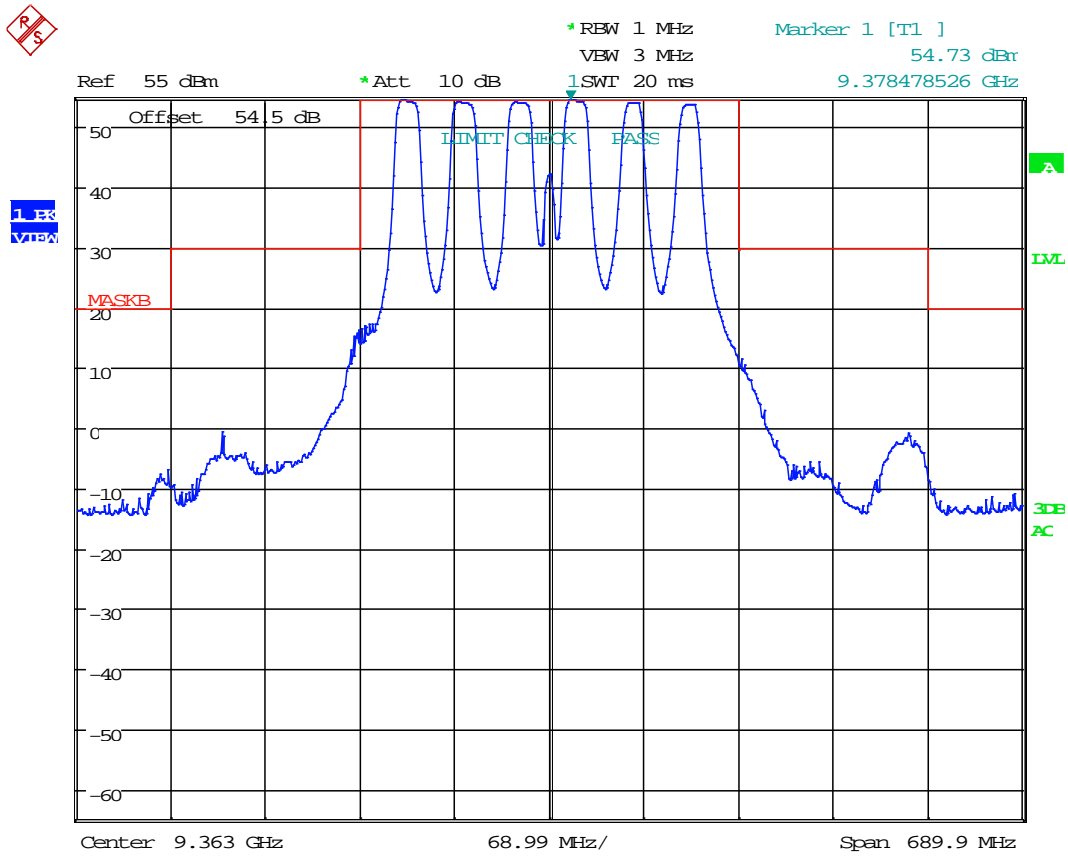
Test Data: Low Band Emission Mask B Plot, Out-of-Band



Date: 17.JUL.2019 13:23:20

EMISSION MASK

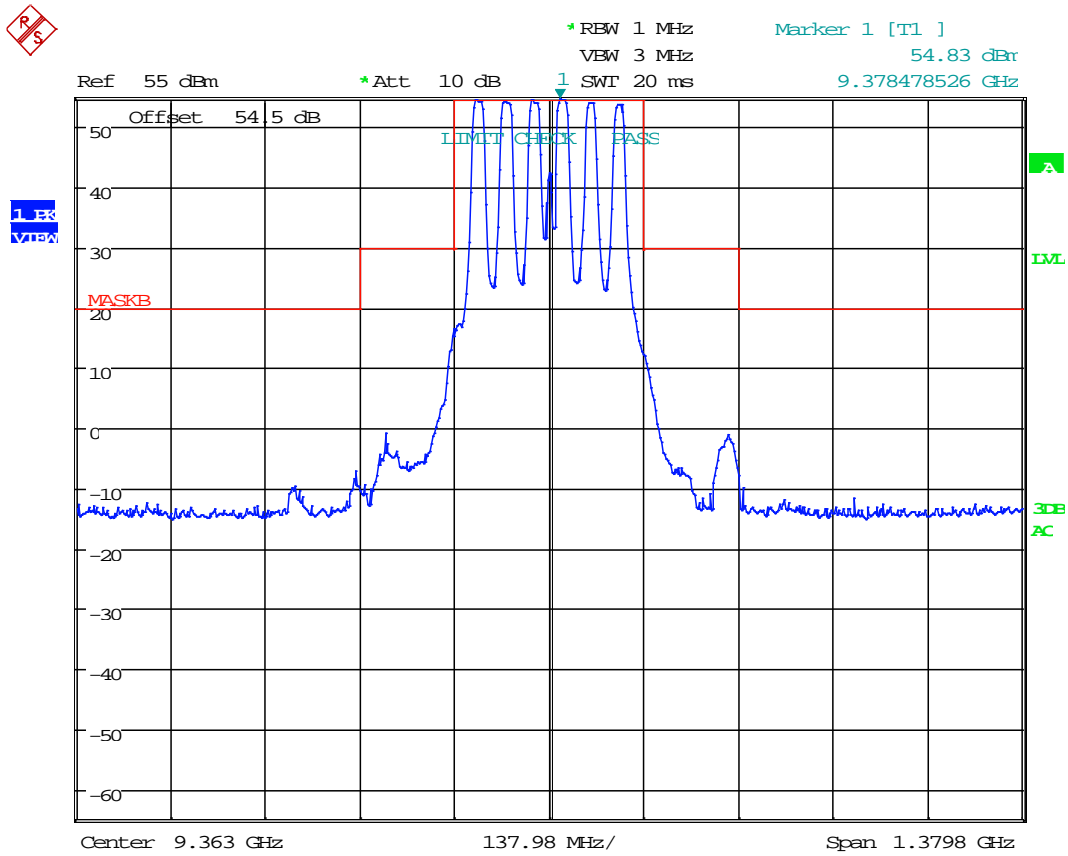
Test Data: High Band Emission Mask B Plot, In-Band



Date: 16.JUL.2019 16:56:54

EMISSION MASK

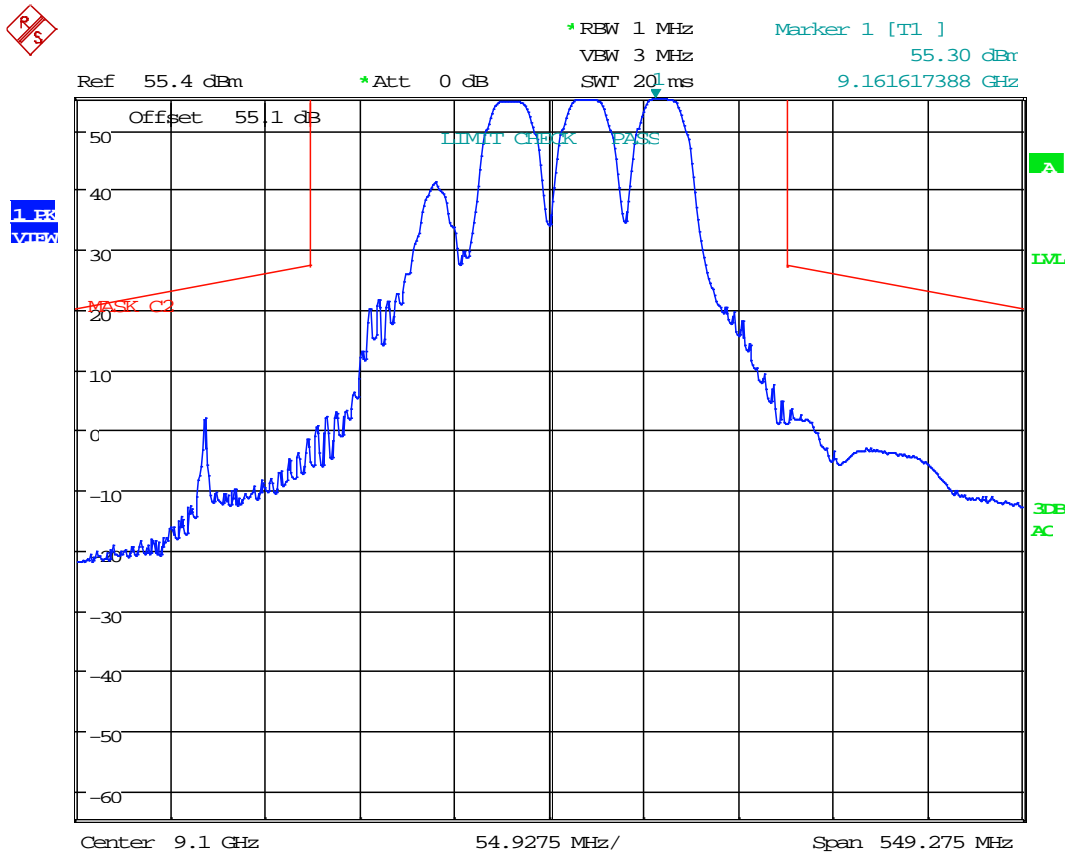
Test Data: High Band Emission Mask B Plot, Out-of-Band



Date: 16.JUL.2019 17:12:32

EMISSION MASK

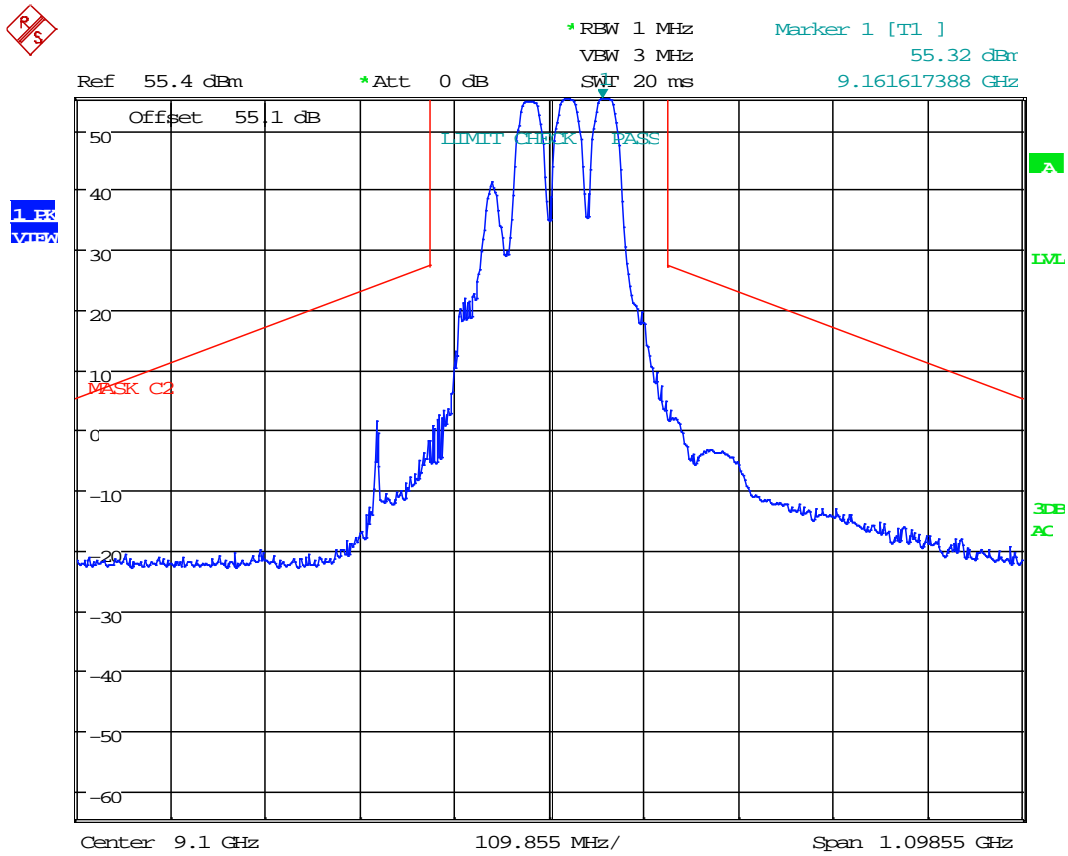
Test Data: Low Band Emission Mask C Plot, In-Band



Date: 17.JUL.2019 13:20:26

EMISSION MASK

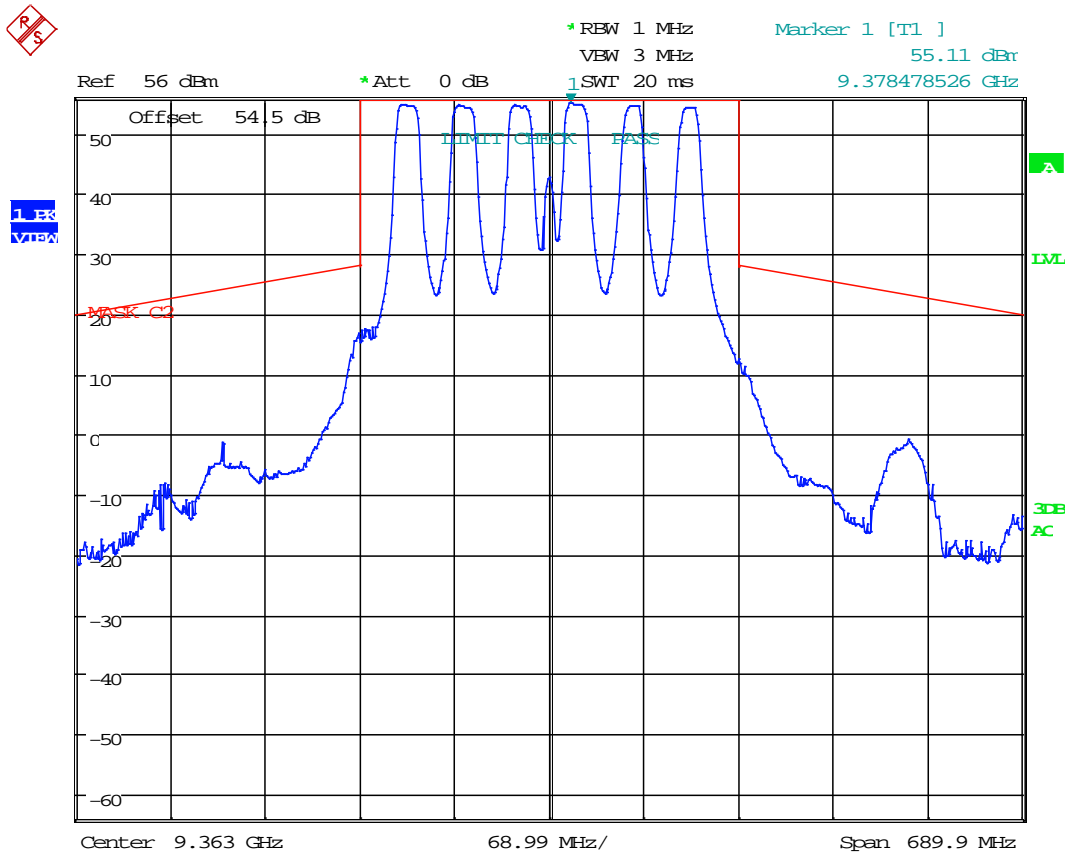
Test Data: Low Band Emission Mask C Plot, Out-of-Band



Date: 17.JUL.2019 13:24:03

EMISSION MASK

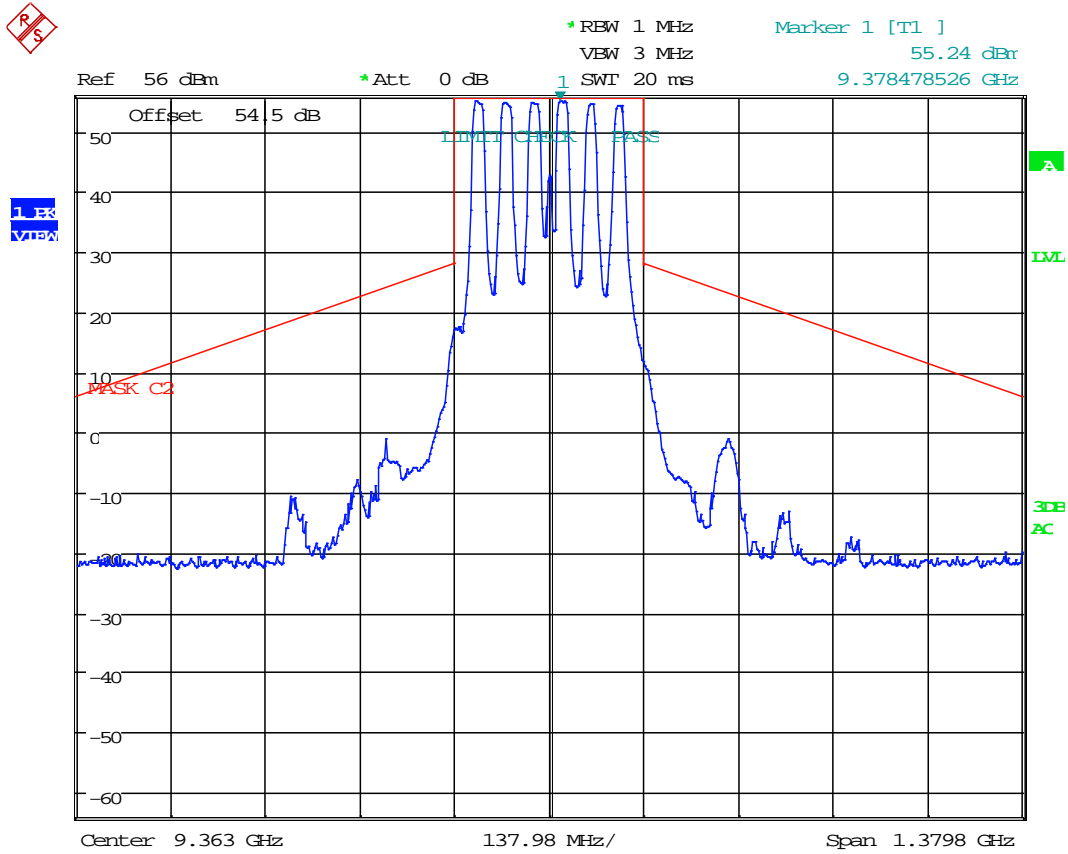
Test Data: High Band Emission Mask C Plot, In-Band



Date: 16.JUL.2019 19:13:51

EMISSION MASK

Test Data: High Band Emission Mask C Plot, Out-of-Band



Date: 16.JUL.2019 19:15:20

SPURIOUS EMISSIONS AT ANTENNA TERMINAL (CONDUCTED)

Rule Part No.: Part 2.1051(a), 2.1057(a)(1), 90.210(c)(3), 90.210(n), 90.210(b)(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.

(c) *Emission Mask C.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

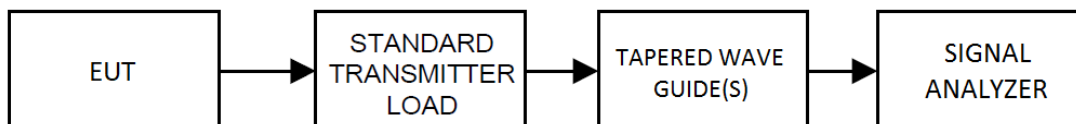
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

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

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

Test Setup Block Diagram:



Note: The spectrum was pre-scanned from 30 kHz to 40 GHz, and frequencies of interest (particularly harmonic emissions) have been provided below in tabular format, using the bandwidth compensation formulae, found in ITU-R M.1177, Annex 1 (cited below) with the limit.

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

Applicant: TERMA A/S
 FCC ID: N9MSC5000
 Report: 1800AUT19_PT90 Radar TestReport_Rev4

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

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

3 Measurement bandwidth and detector parameters

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

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

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

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

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

Video bandwidth \geq measurement system bandwidth.

Detector positive peak.

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) If $3/2 > \text{Bref}$, MBR = Bref; Else MBR = $3/2$ (MHz)	B_m (MHz) Bif \times MBR = B_m (MHz)	Spurious Noise Correction (dBm) If $B_m > 1$, $10 \times$ $\text{Log}(B_{ref}/B_m)$	Spurious Emissions Correction (dBm) If $B_m > 1$, $20 \times$ $\text{Log}(B_{ref}/B_m)$
		$(B_c/T)^{0.5} =$ Bref (MHz)	If $\text{Bref} > 1$, Bref = 1 (MHz)				
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 90.210(c)(3), 90.210(n), 90.210(b)(3)

$$43 + 10 \times \text{Log}(\text{Power, in Watts})$$

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

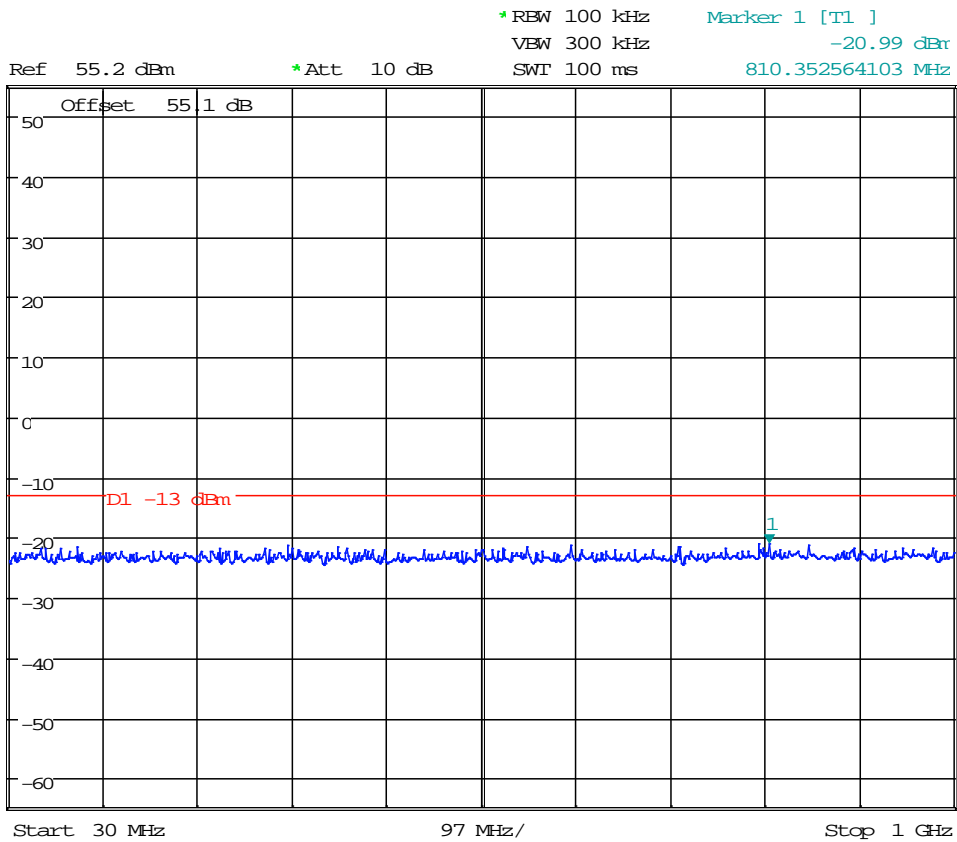
Test Data: Offset Calculation Tables

<i>Low Band</i>			
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

<i>High Band</i>			
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

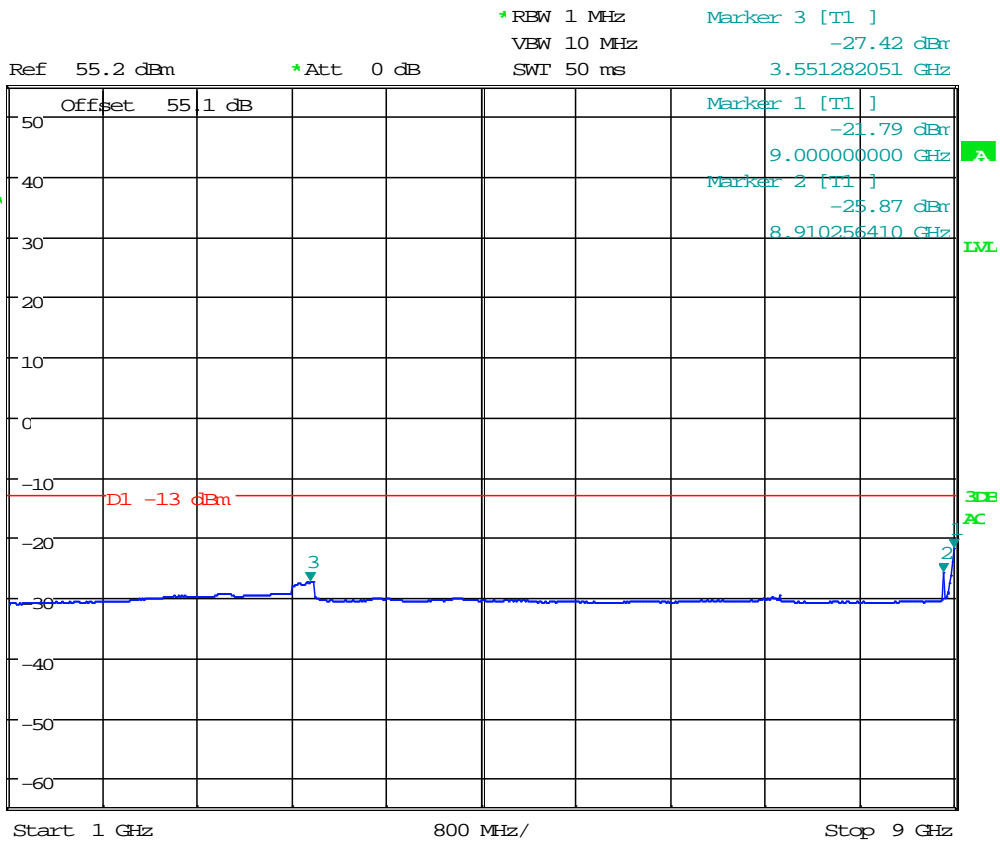
Test Data: Low Band, 30 MHz - 1 GHz Plot



Date: 17.JUL.2019 13:03:07

UNWANTED SPURIOUS EMISSIONS

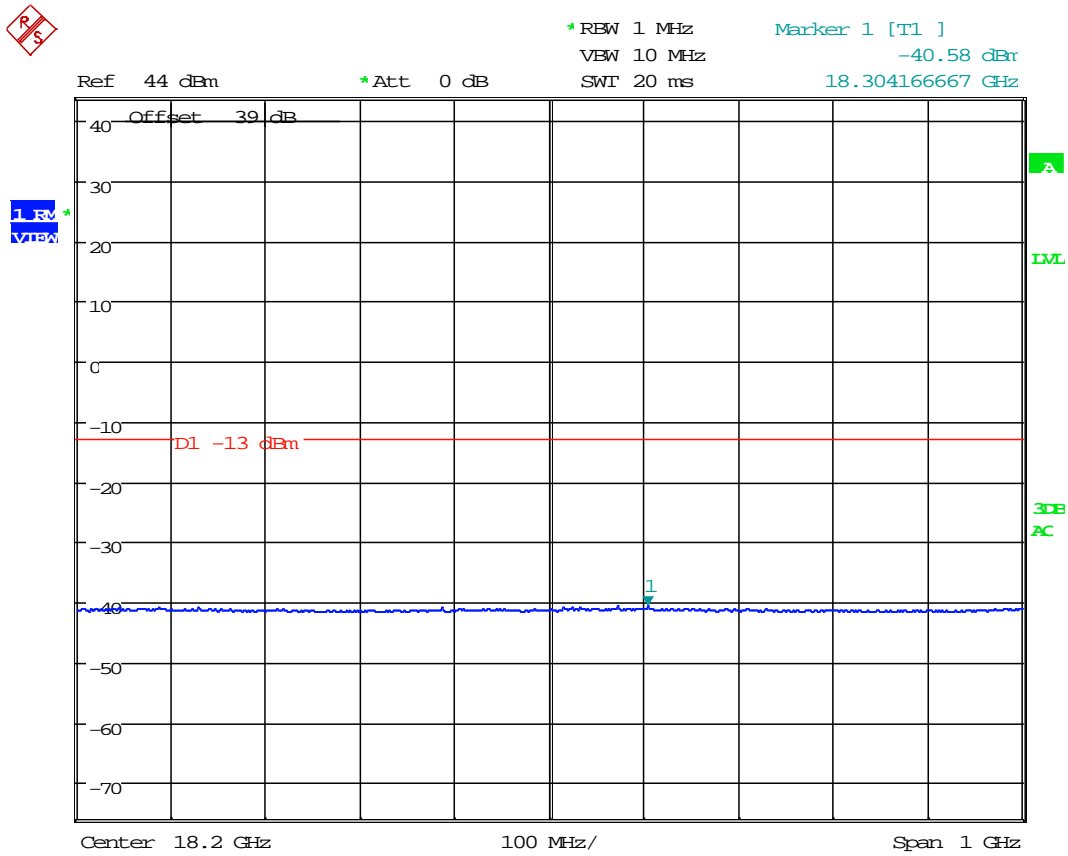
Test Data: Low Band, 1-9 GHz Plot



Date: 17.JUL.2019 13:05:31

UNWANTED SPURIOUS EMISSIONS

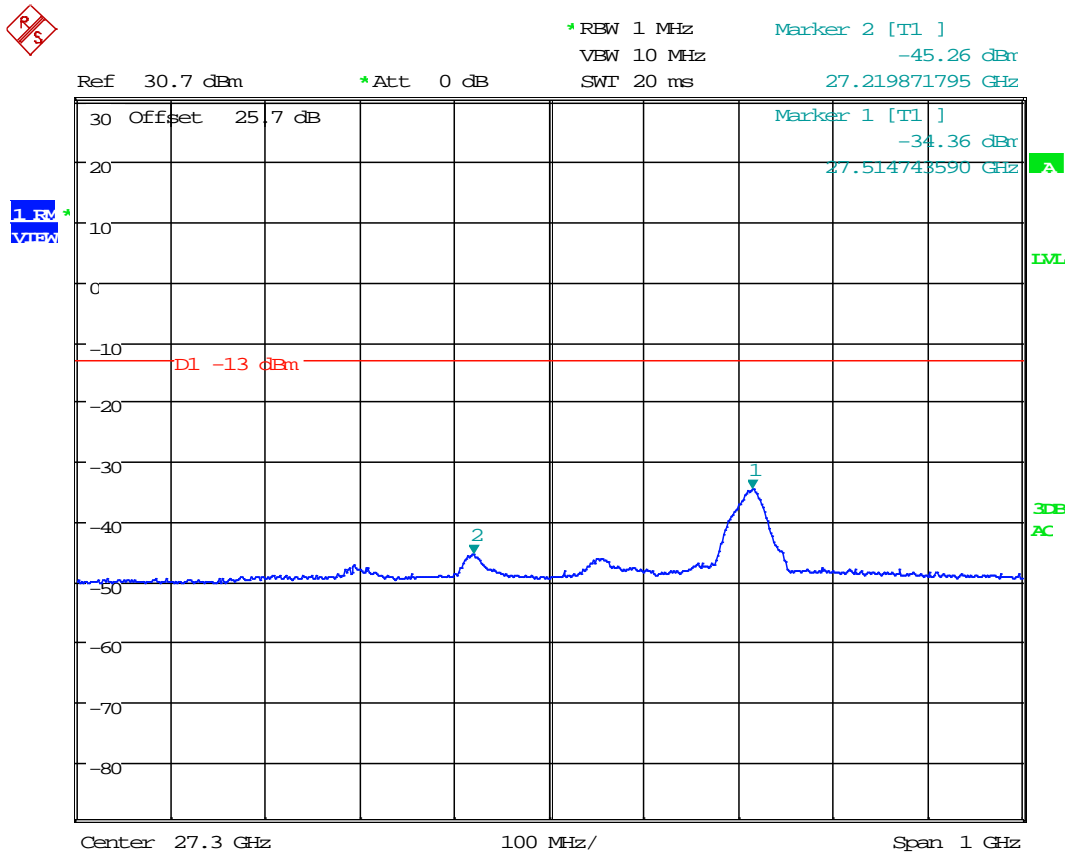
Test Data: Low Band, 2nd Harmonic Plot



Date: 17.JUL.2019 13:54:43

UNWANTED SPURIOUS EMISSIONS

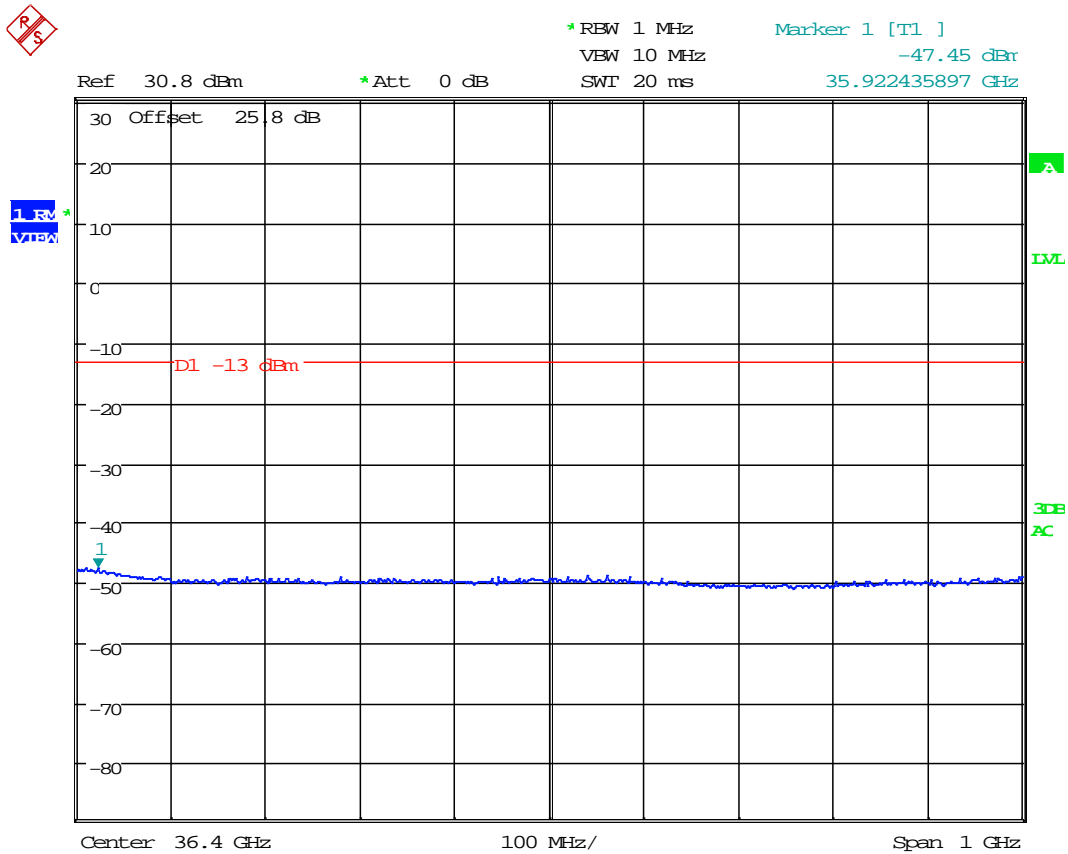
Test Data: Low Band, 3rd Harmonic Plot



Date: 17.JUL.2019 13:41:15

UNWANTED SPURIOUS EMISSIONS

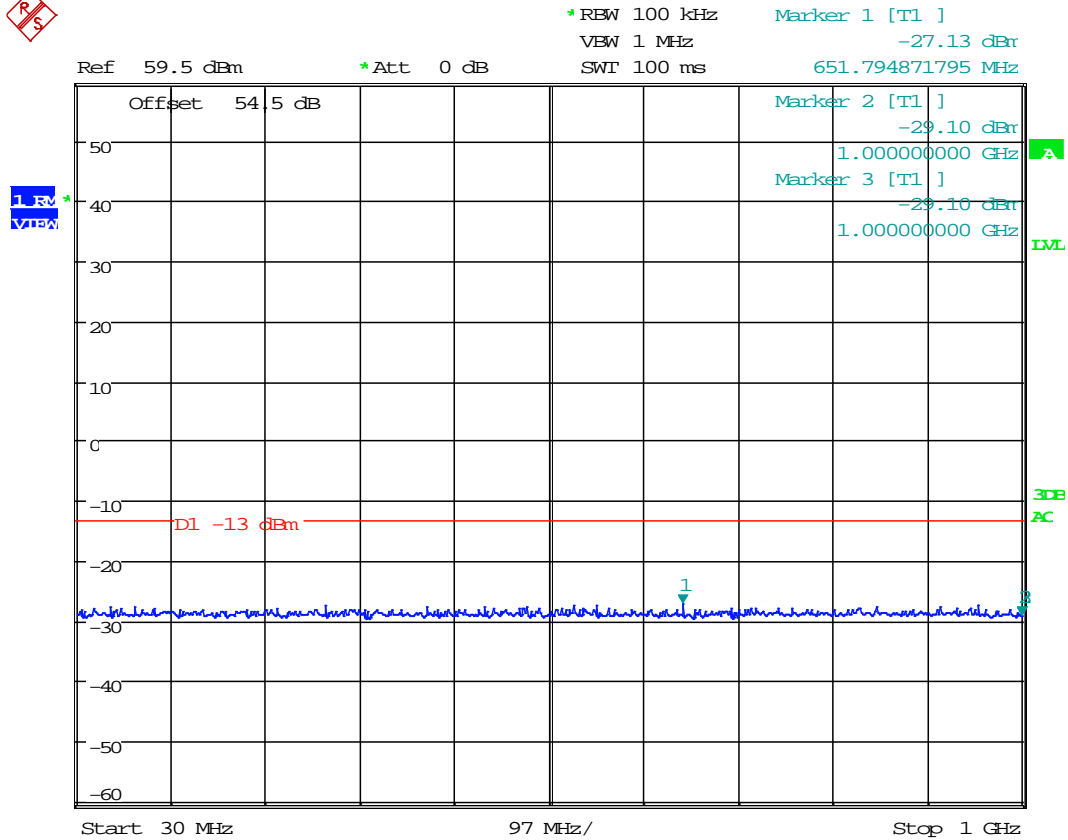
Test Data: Low Band, 4th Harmonic Plot



Date: 17.JUL.2019 13:44:11

UNWANTED SPURIOUS EMISSIONS

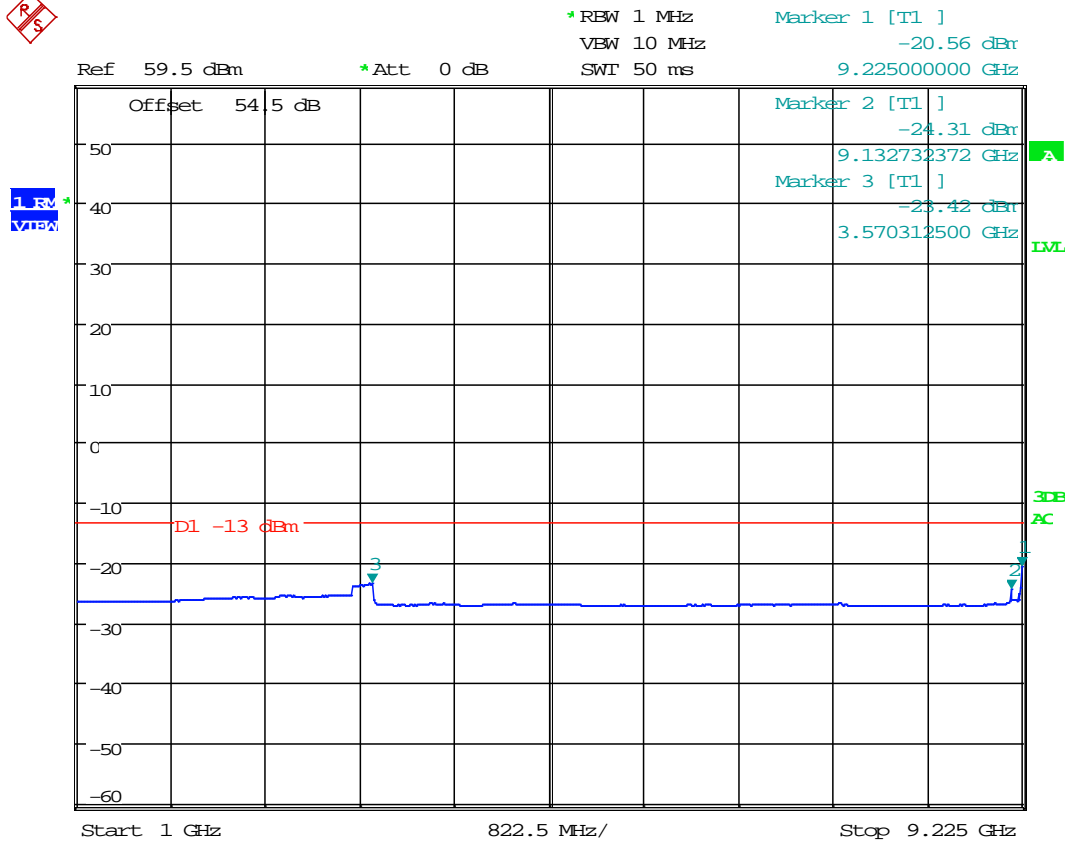
Test Data: High Band, 30 MHz - 1 GHz Plot



Date: 17.JUL.2019 15:39:49

UNWANTED SPURIOUS EMISSIONS

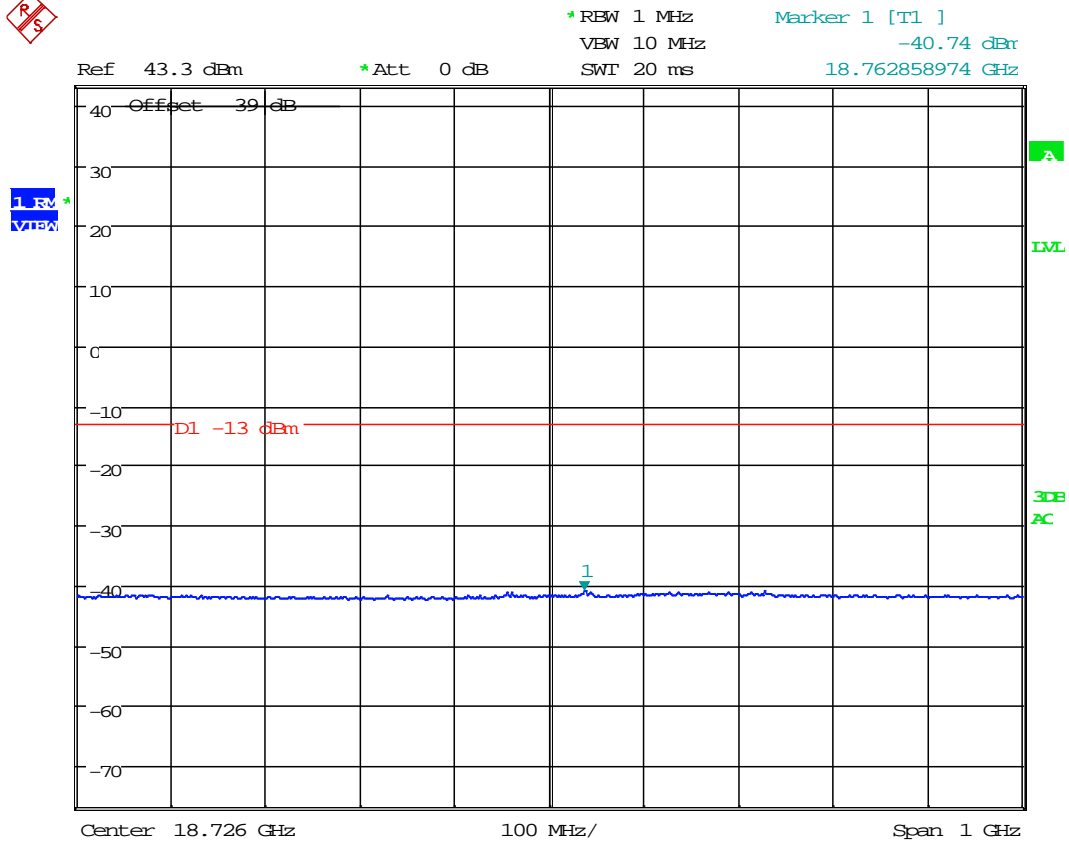
Test Data: High Band, 1-9 GHz Plot



Date: 17.JUL.2019 15:38:10

UNWANTED SPURIOUS EMISSIONS

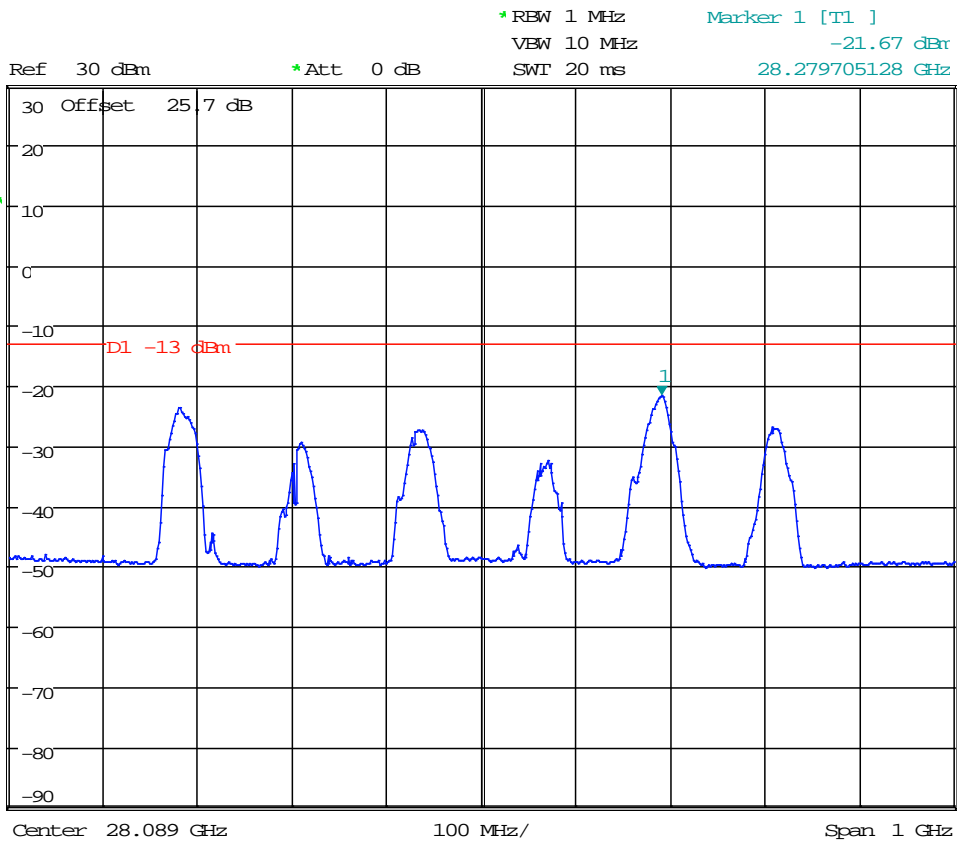
Test Data: High Band, 2nd Harmonic Plot



Date: 16.JUL.2019 18:34:42

UNWANTED SPURIOUS EMISSIONS

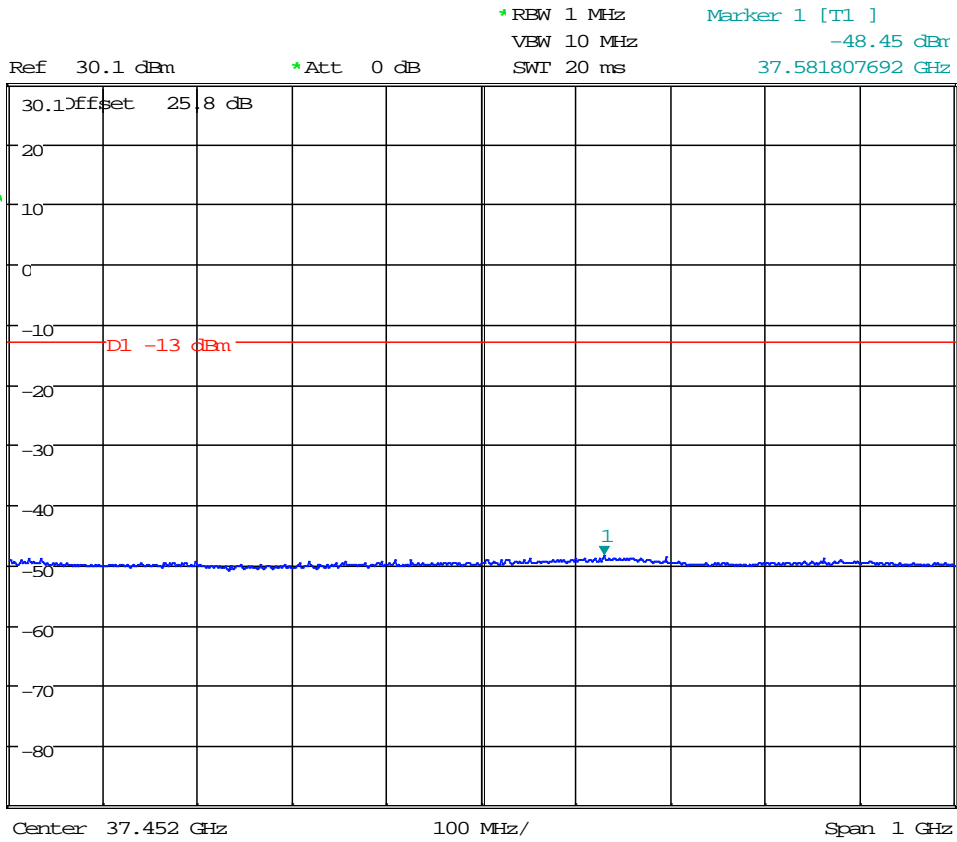
Test Data: High Band, 3rd Harmonic Plot



Date: 16.JUL.2019 18:18:00

UNWANTED SPURIOUS EMISSIONS

Test Data: High Band, 4th Harmonic Plot



Date: 16.JUL.2019 18:26:37

FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Part No.: Part 2.1053(a), 2.1057(a)(1), 90.210(c)(3), 90.210(n), 90.210(b)(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.

(c) *Emission Mask C.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

(n) *Other frequency bands.* Transmitters designed for operation under this part on frequencies other than listed in this section must meet the emission mask requirements of Emission Mask B. Equipment operating under this part on frequencies allocated to but shared with the Federal Government, must meet the applicable Federal Government technical standards.

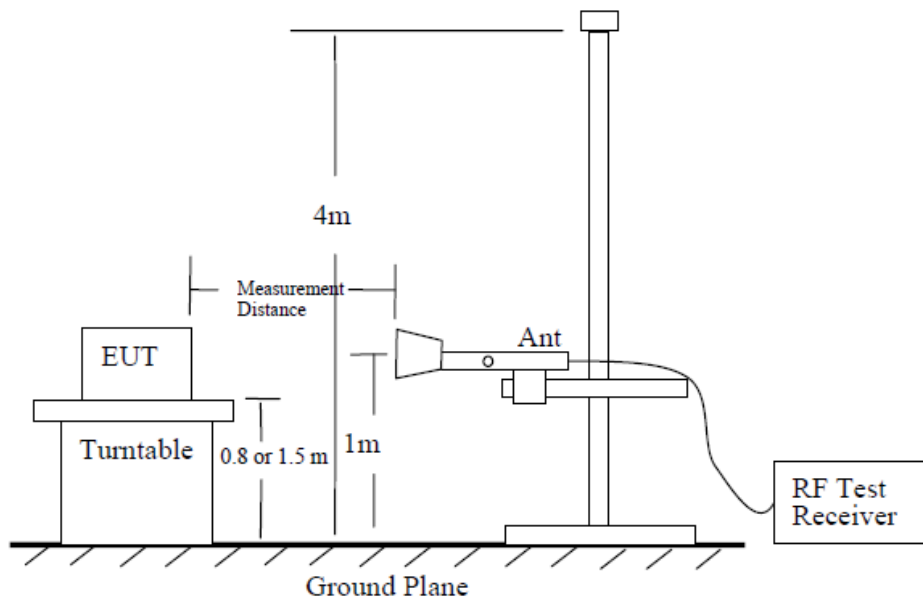
FIELD STRENGTH OF SPURIOUS EMISSIONS

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

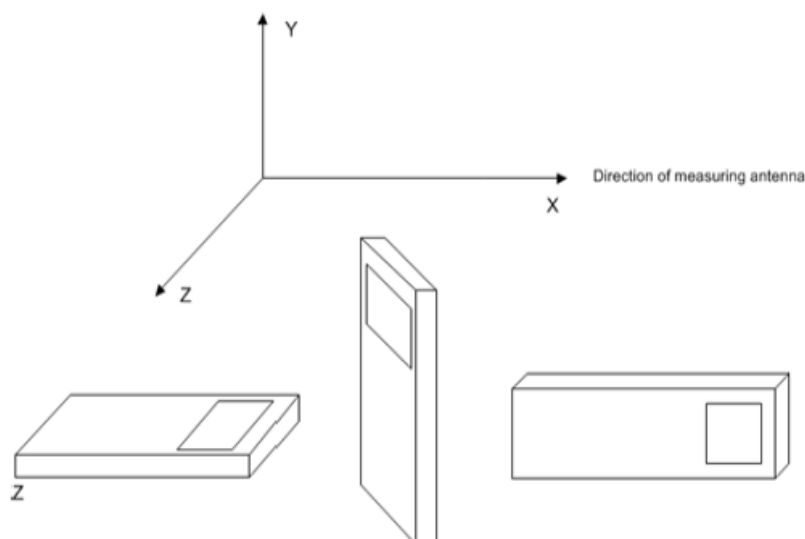
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

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

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

3 Measurement bandwidth and detector parameters

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

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

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

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

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

Video bandwidth \geq measurement system bandwidth.

Detector positive peak.

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.

Bandwidth Compensation Calculation Table

Mode	40 dB Occupied Bandwidth (MHz)	40dB Bref (MHz)		MBR (MHz) If 3/2 > Bref, MBR = Bref; Else MBR = 3/2 (MHz)	Bm (MHz) Bif x MBR = Bm (MHz)	Spurious Noise Correction (dBm) If Bm > 1, 10 x Log(Bref/Bm)	Spurious Emissions Correction (dBm) If Bm > 1, 20 x Log(Bref/Bm)
		(Bc/T) ^{0.5} = Bref (MHz)	If Bref > 1, Bref = 1 (MHz)				
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 90.210(c)(3), 90.210(n), 90.210(b)(3)

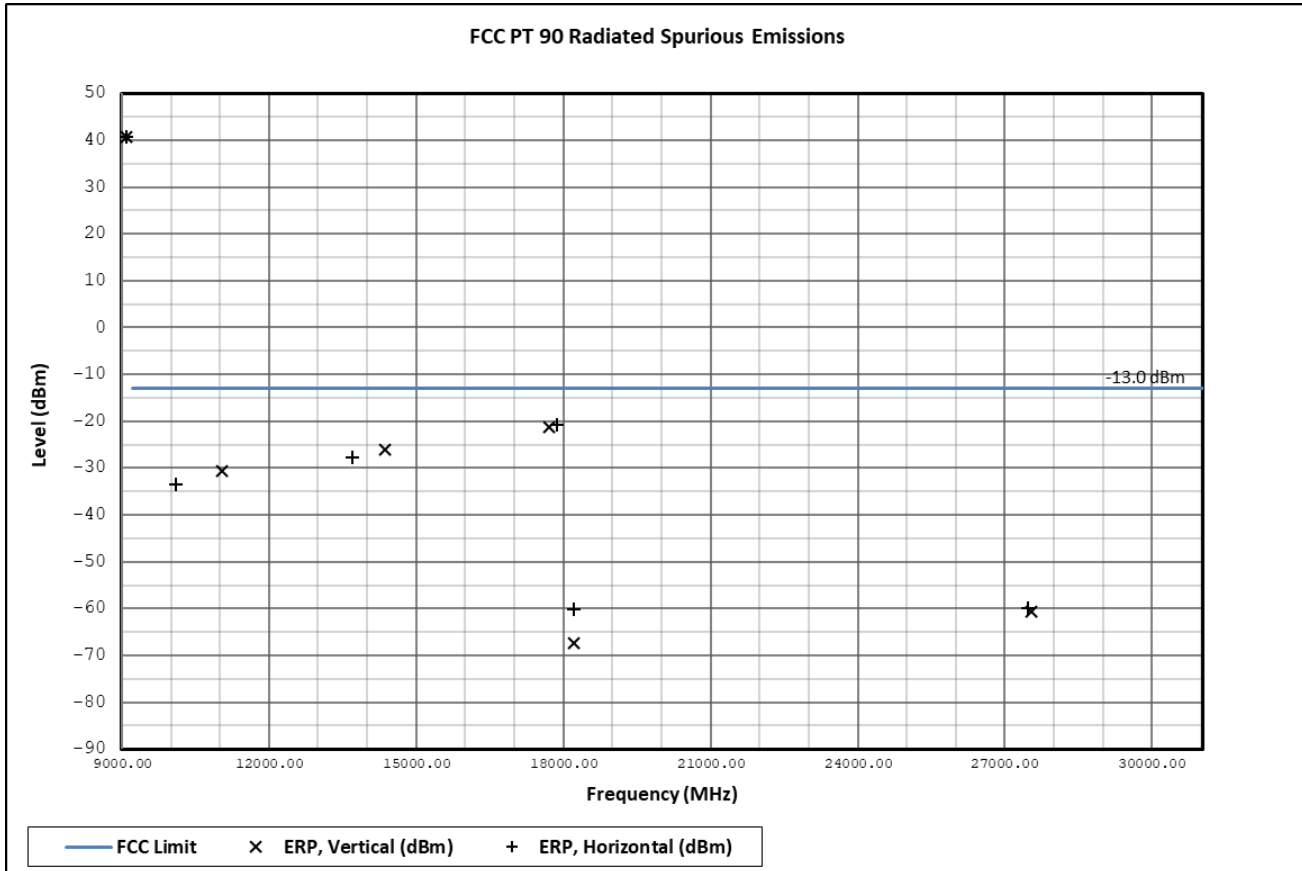
$$43 + 10 \times \text{Log}(\text{Power, in Watts})$$

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 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



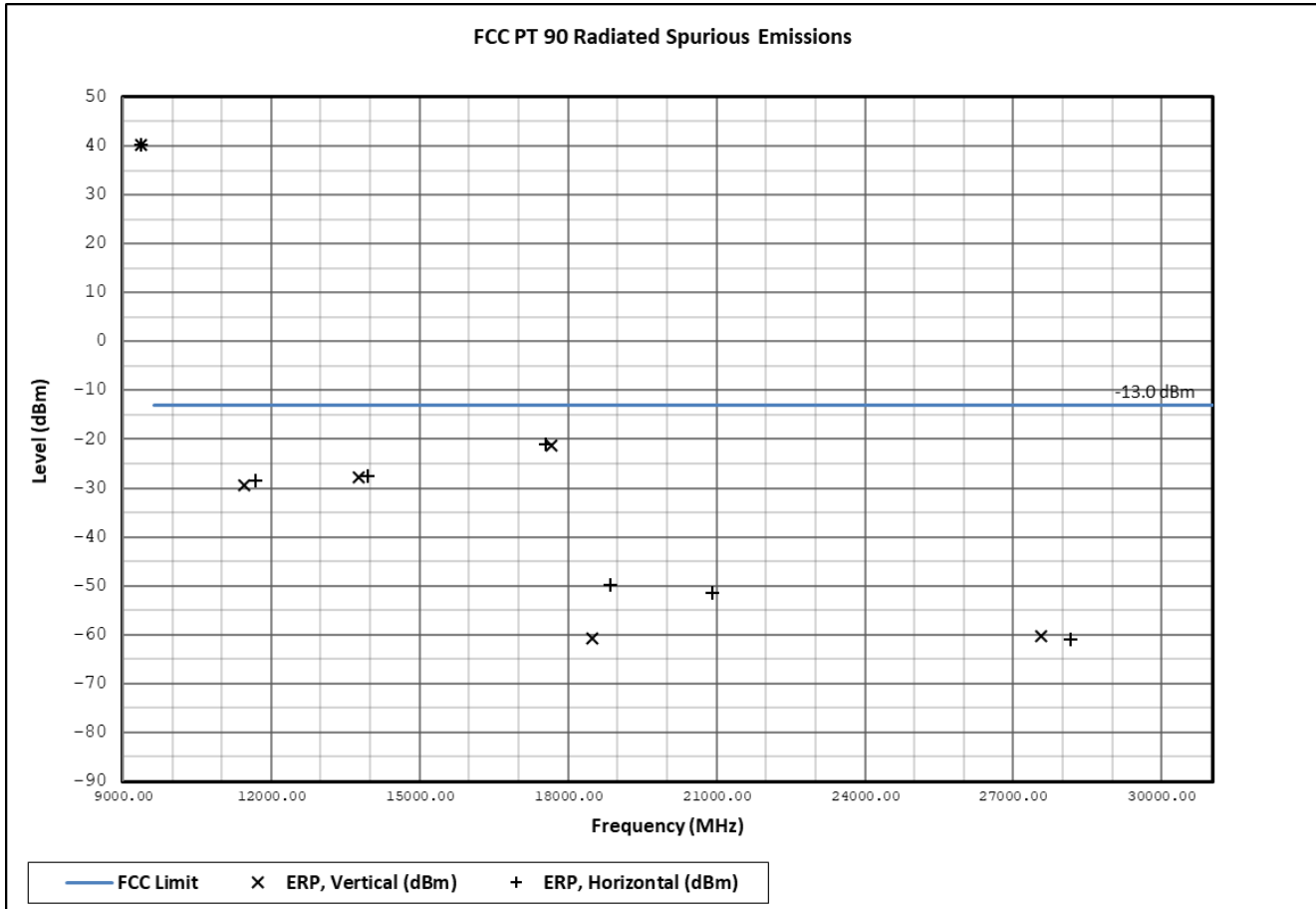
Note: All recorded data was plotted. Six (6) or more of the highest emissions of the worst-case operational mode of the EUT are represented below in tabular format. Emissions 20 dB below the limit are not required to be reported.

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

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: High 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: High 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
9363	11461.00	30.09	V	12.08	38.96	3.00	81.13	-16.25	-29.31	-13.00	16.31	-13.00
9363	11693.10	30.87	H	12.20	38.97	3.00	82.04	-15.34	-28.40	-13.00	15.40	-13.00
9363	13763.60	30.83	V	12.80	39.00	3.00	82.63	-14.75	-27.81	-13.00	14.81	-13.00
9363	13954.30	30.96	H	13.05	38.88	3.00	82.89	-14.49	-27.55	-13.00	14.55	-13.00
9363	17550.50	31.91	H	14.99	42.39	3.00	89.29	-8.09	-21.15	-13.00	8.15	-13.00
9363	17659.00	32.36	V	14.59	42.29	3.00	89.24	-8.13	-21.19	-13.00	8.19	-13.00
9363	18493.60	-10.43	V	15.34	44.73	3.00	49.64	-47.73	-60.79	-13.00	47.79	-13.00
9363	18846.20	0.43	H	15.36	44.74	3.00	60.53	-36.85	-49.91	-13.00	36.91	-13.00
9363	20926.30	-2.20	H	16.60	44.52	3.00	58.92	-38.46	-51.52	-13.00	38.52	-13.00
9363	27560.20	-15.39	V	18.97	46.62	3.00	50.20	-47.17	-60.23	-13.00	47.23	-13.00
9363	28159.50	-16.20	H	18.93	46.84	3.00	49.57	-47.81	-60.87	-13.00	47.87	-13.00
9363	39285.30	-10.89	V	23.04	46.57	3.00	58.72	-38.66	-51.72	-13.00	38.72	-13.00
9363	39602.60	-11.34	H	23.12	47.03	3.00	58.81	-38.56	-51.62	-13.00	38.62	-13.00

FREQUENCY STABILITY

Rule Part No.: Part 2.1055(a)(2), 90.213(a)

§90.213 Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

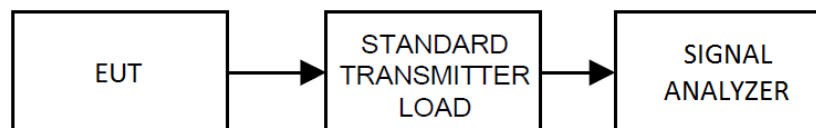
MINIMUM FREQUENCY STABILITY
[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Above 2450 ¹⁰			

¹⁰Except for DSRCs equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCs equipment in the 5850-5925 MHz band is specified in subpart M of this part.

Test Procedure: TIA 603-E, 2.2.2

Test Setup Block Diagram:



Note: 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).

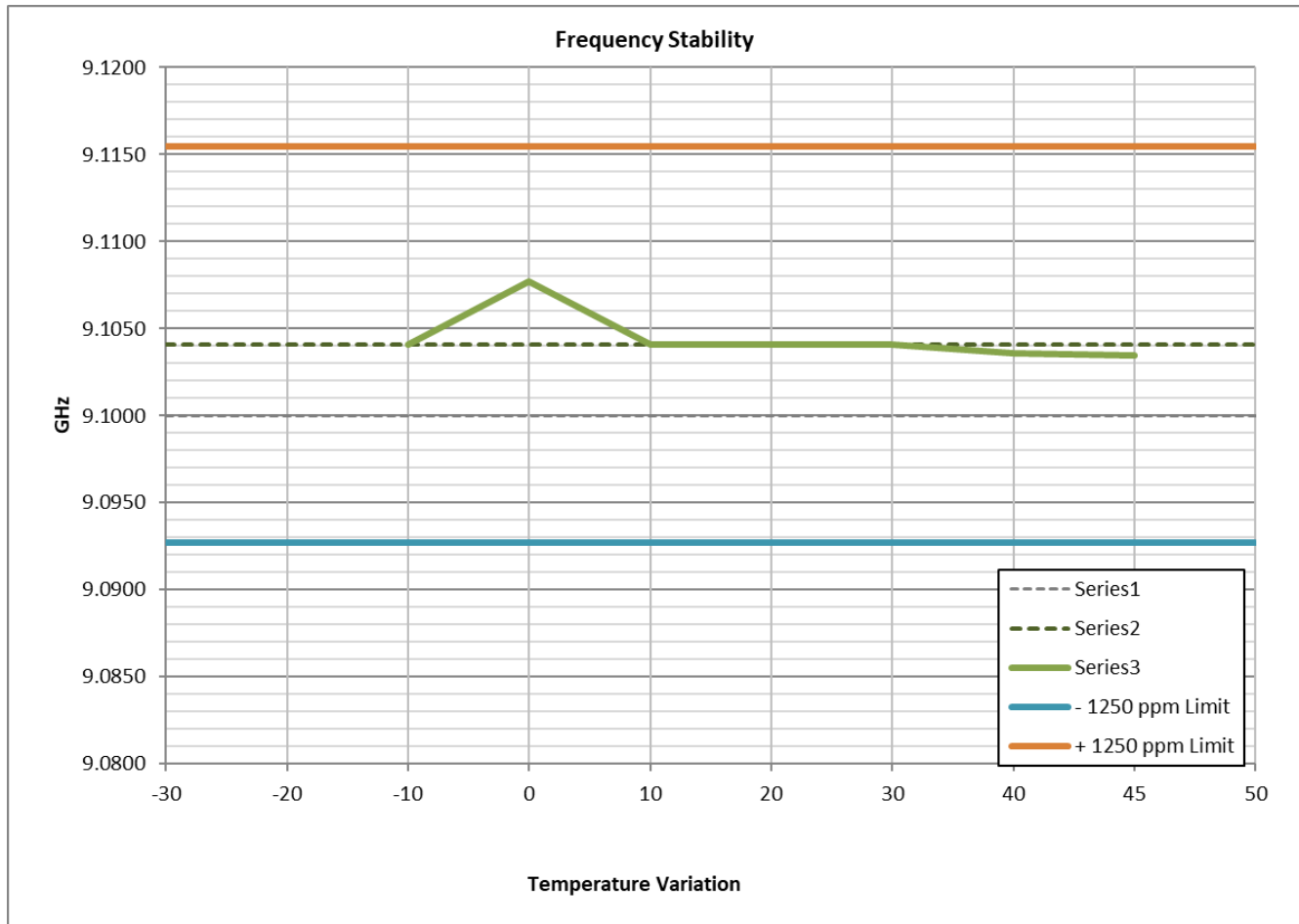
Note: The frequency determining element is the same component for both low and high ranges. The Frequency Stability testing was not repeated for both bands.

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	± 0.93 dB	(1)
Conducted spurious emission of transmitter to 40GHz	± 1.86 dB	
Occupied Bandwidth	± 2.65 %	
Radiated RF Power	± 1.4 dB	
Rad Emissions of transmitter up to 26.5GHz	± 2.14 dB	
Rad Emissions of transmitter to 40GHz	± 2.36 dB	
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 - NMMN-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