Nemko

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EMC, Radio and Telecommunications

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Test report no. : 95209-3

Item tested : Radar in Tx mode

Type of equipment : Aeronautical Radar 1300 –1350 MHz
(Part of Obstacle Collision Avoidance System)

FCC ID : VE8100001

Client : OCAS AS

FCC Part 87.131
Aviation Services

17 June 2008

Authorized by : .....
Frode Sveinsen
Technical Verificator

CONTENTS

1 GENERAL INFORMATION

1.1 Testhouse Info

Name :	Nemko AS
Address :	Nemko Comlab Gåsevikveien 8, Box 96 N-2027 Kjeller, NORWAY
Telephone :	+47 64 84 57 00
Fax :	+47 64 84 57 05
E-mail:	post@comlab.no
FCC test firm registration # :	994405
IC OATS registration # :	2040D-1
Total Number of Pages:	63

1.2 Client Information

Name :	OCAS AS
Address :	Box 434 Økern, N-0513 Oslo, Norway
Telephone :	+47 22 071 000
Fax :	+47 22 071 009

Contact:

Name :	Jostein Sund Jensen
e-mail:	jostein.sund.jensen@ocas-as.no

1.2.1 Manufacturer (same as client)

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2 Test Information

2.1 Test Item

Name :	Radar
Model/version :	Radar unit 100001
Serial number :	WO0750142004
Hardware identity and/or version:	Radar unit 100001 rev 12
Software identity and/or version :	Main release 2.0
Frequency Range :	1307.5 – 1342.5 MHz
Tunable Bands :	Yes*
Emission designator:	1M20P0N
Number of Channels :	-
Operating Modes :	TX & RX
Channel separation:	NA
Type of Modulation :	Interrupted CW and Interrupted FMCW,CW and FMCW
User Frequency Adjustment :	NO
Rated Output Power (TX) :	73 W
Type of Power Supply :	15 V DC
Antenna Connector :	None (Active antenna panels)

* Separate document is attached “Content SW rel 2.0”

Description of Test Item

This radar unit is a part of a system called Obstacle Collision Avoiding System (OCAS)
The OCAS is a warning system for traffic obstacles for aircrafts. The radar placed near the obstacle detects aircrafts with course towards the obstacle. A configurable set of rules is applied to define whether the aircraft must be alarmed or not, select warning signals, light and audio, depending on time-to-impact with obstacle(s) speed, course, and altitude.
This unit consists of three major units VHF aeronautical warning unit, radar unit for detecting aircrafts and UHF internal link to communicate between nearby OCAS systems.

The power is supplied by a separate power unit.

Theory of Operation (Complete theory of operation is attached as separate document)

Signal modes

5 signal modes have been defined:

- Signal Mode 1: Interrupted-CW
- Signal Mode 2: Interrupted-FMCW
- Signal Mode 3: Combined Interrupted-CW / Interrupted-FMCW
- Signal Mode 4: FMCW
- Signal Mode 5: CW

Signal Modes 1-3 are available in Scan Mode1 and Scan Mode2 and Signal Mode 1-5 are available in Scan Mode3.

The timing intervals for each mode shall be software configurable.

Interrupted-CW

The purpose of the I-CW signal mode is to estimate radial target speed unambiguously. Consequently, fighter planes moving at high radial target speed can be estimated unambiguously. This property is also very favourable for detection of targets at moderate and high speeds where no volume and area clutter will be present.

The disadvantage of this mode is that no range information to the target is provided. As a consequence tracking with range information can not be performed, volume clutter with the same velocity will not be resolved in range and Radar Cross Section can not be estimated.

Interrupted-FMCW

The purpose of the I-FMCW signal mode is to estimate both range and radial speed of the target and true Radar Cross Section. Handling volume clutter is also easier due to the separation of reflected energy into discrete range-Doppler cells.

The disadvantage of this mode is the fact that radial target speed can not be estimated unambiguously without using a scheme with several PRFs (Pulse-Repetition-Frequency). The target may then be moving at a blind-speed of the radar receiver. Also, if the speed is estimated ambiguously, there is an additional error on the range measurement. In addition the modulated bandwidth is limited compared to traditional FMCW due to the transmitter/receiver switching. The consequence is limited range resolution and range accuracy.

Combined Interrupted CW / Interrupted-FMCW

The purpose of the combined I-CW / I-FMCW signal mode is to estimate both range and radial speed of the targets unambiguously. The unambiguous radial target speed measurements from the I-CW signal mode is combined with range and ambiguous speed measurements from the I-FMCW mode. The detections from I-CW mode could also be used to control the parameters of the I-FMCW in a way that target blind-speeds are entirely avoided.

The disadvantage of this mode is that Doppler resolution is reduced compared to I-CW and I-FMCW as a consequence of the time sharing between the modes.

FMCW

The purpose of the FMCW signal mode is to test the functionality/quality of the total transceiver chain in an analog loop-back test. The same signal mode may be used for the antenna calibration test.

CW

The purpose of the CW signal mode is to test the functionality/quality of the total transceiver chain in an analog loop-back test. The same signal mode may be used for the antenna calibration test.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	15 V DC

The values are the limit registered during the test period.

2.3 Test Period

Item received date:	2008-04-07
Test period :	from 2008-04-07 to 2008-04-25

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: OCAS AS

Model No.: 100001

Serial No.: WO0750142004

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC Part 87 subpart D.

Radiated tests were conducted in accordance with ANSI C63.4-2003. The radiated tests were made in a semi-anechoic chamber at measuring distances of 3 and 10metres.

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-production Unit

TNB Equipment Code ☐ Family Listing

THIS TEST REPORT RELATES ONLY TO THE ITEMS AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

TEST REPORT #: 95209 - 3

TESTED BY: _____ DATE: 06.05.2008

G.Suhanthakumar, Test engineer

3.2 Test Summary

Name of test	FCC part 87 paragraph	Result
RF Power Output	87.131 / 2.1046	Complies[1]
Frequency stability	87.133(7)2.1047	Complies
Bandwidth of emission	87.135/2.1047	Complies
Emission limitations	87.139 / 2.1047	Complies
Modulation Limiting	87.141	N/A
Spurious Emissions at Antenna Terminals (conducted)	87.139(a)(3) / 2.1051/2.1057	NA[3]
Spurious Emissions radiated, Transmitter only	87.139(a)(3) / 2.1053/2.1057	Non-Complies

[1] The output power radiated.

[2] The manufacturer specified voltage range is 15V DC

[3] 50 ohm connector is not accessible, the out-put power is transmitted via Radar active panels.

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3.3 Description of modification for Modification Filing

Not applicable.

3.4 Comments

The measurements were done with the EUT powered by 15V DC.

All ports were populated during spurious emission measurements.

3.5 Family List Rational

Not Applicable.

4 TEST RESULTS

5 RF Power Output

Para. No.: 87.131/ 2.1046

Test Performed By: G.Suhanthakumar	**Date of Test: 21.04.2008**

Test Results:

The maximum RF radiated peak output power in vertical polarization is 73,4W.

Measurement Data:

Maximum Conducted Peak Output Power at active antenna panel:

RF channel	**Lower frequency (1310MHz)**	**Middle frequency (1320MHz)**	**Upper frequency (1340MHz)**
Measured value (mW)	9.79	13.18	15.85

Maximum EIRP

RF channel	**Lower frequency (1310MHz)**	**Middle frequency (1320MHz)**	**Upper frequency (1340MHz)**
Measured EIRP (W)	69.8	71.3	73.4
Antenna gain dBi	30.53	37.33	36.66

Antenna gain = 10*log(EIRP/Conducted power) dBi

The EIRP is measured using substitution method. The maximum eirp is obtained in vertical polarization.

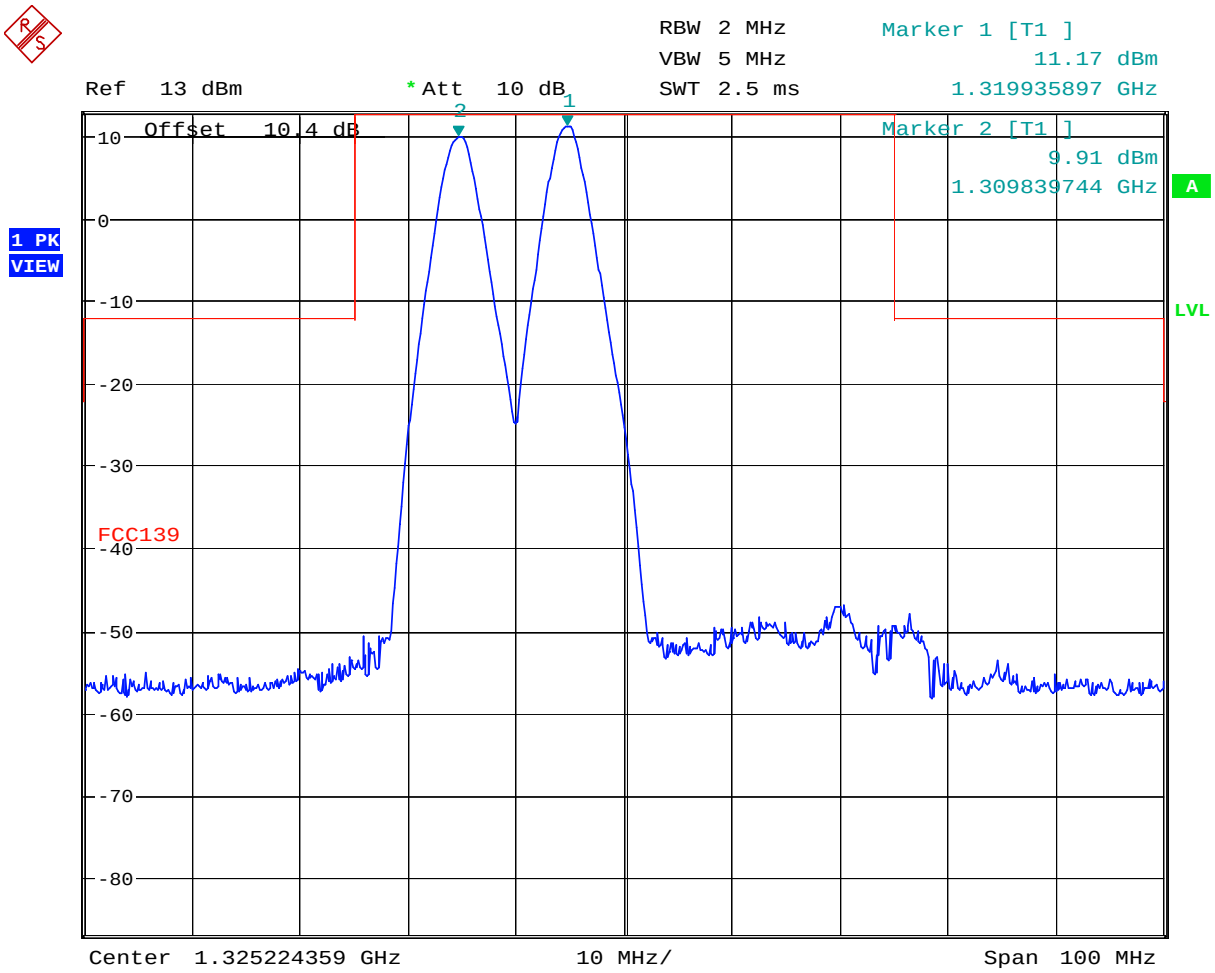
Note:

The average transmit power is reduced compared to the maximum peak power measured above through the manner of operation.
1) Transmit/receive interrupting:
The signal scheme is a 50 % transmit/receive duty cycle with a cycle period of 61 us (30.5 Tx, 30.5 Rx). The average no-scanning transmit power is thus 3 dB below the max power measured in the procedure above.

2) Antenna scanning:
The antenna is 3D electronic scanning a volume of 360 degrees azimuth and 42 degrees elevation in typical 2.5 s. Two out of eight neighbouring panels are active at a time which corresponds to a spatial duty cycle of 25 %. The average scanning transmit power spatial duty cycle is thus 9 dB (3 dB Tx/Rx+6 dB scanning) below the max power measured above.

Requirement (87.131):

Frequency, emission, and maximum power will be determined by appropriate standards during the certification process



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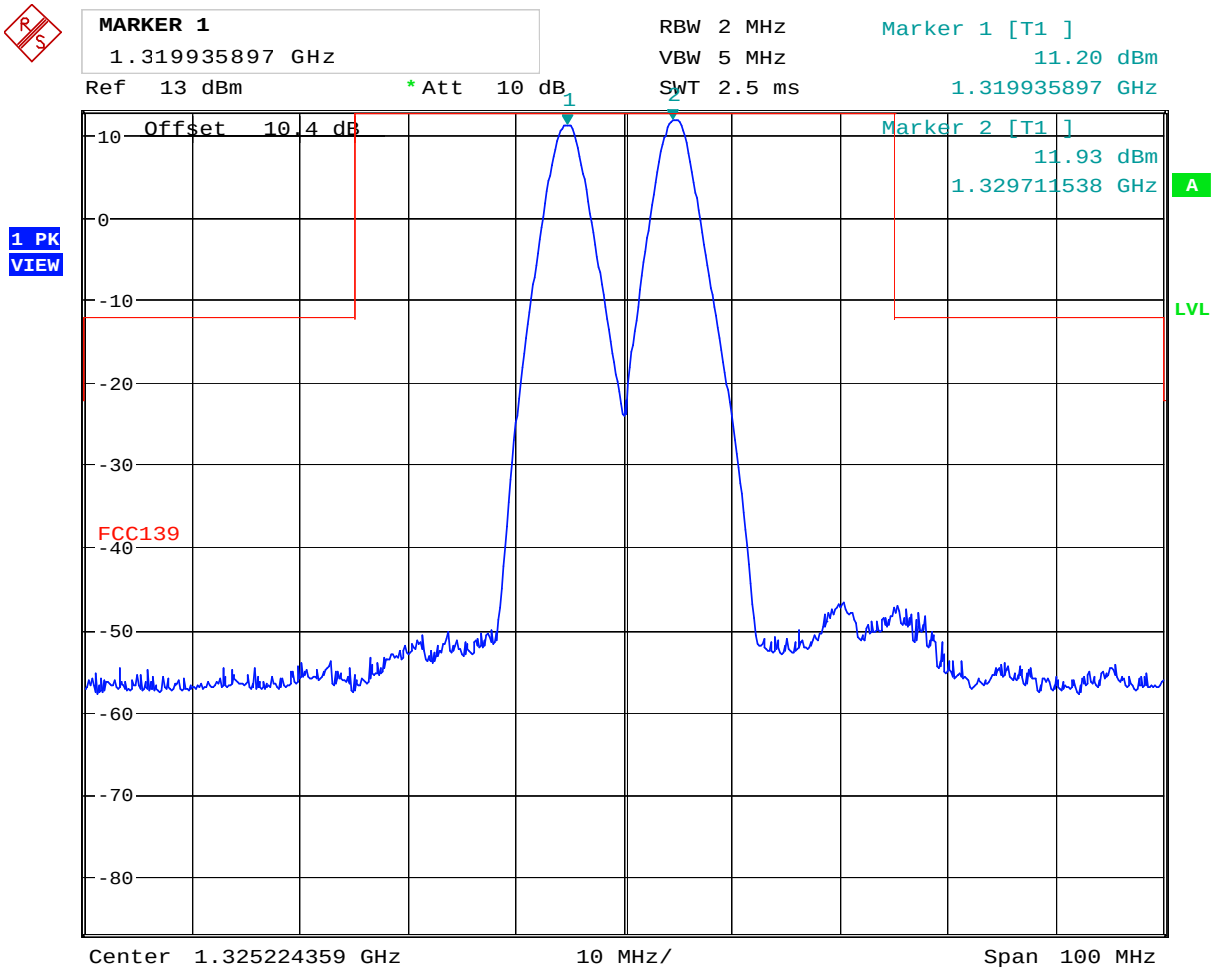
Lower frequency band – Conducted power



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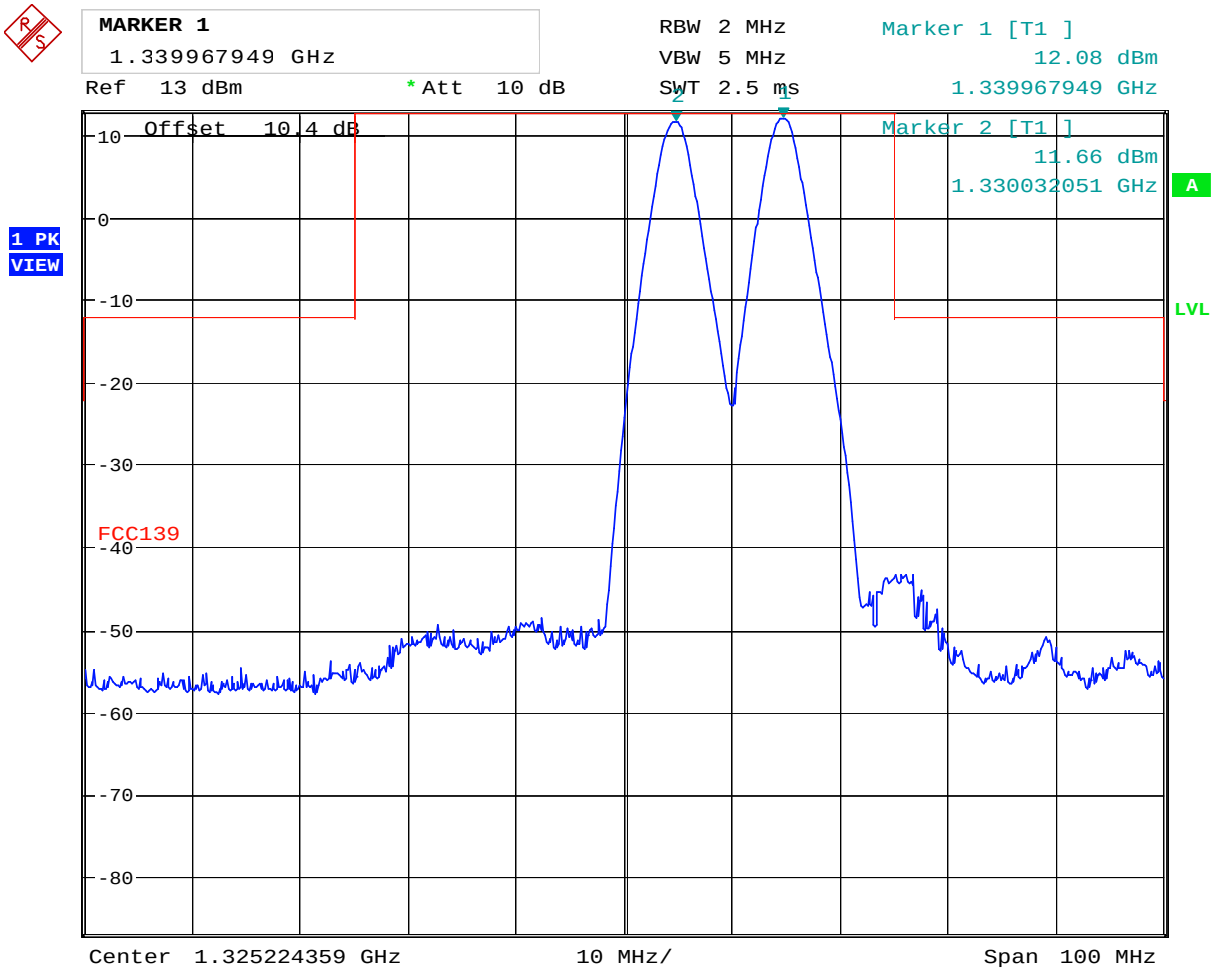
Middle Frequency band – Conducted power



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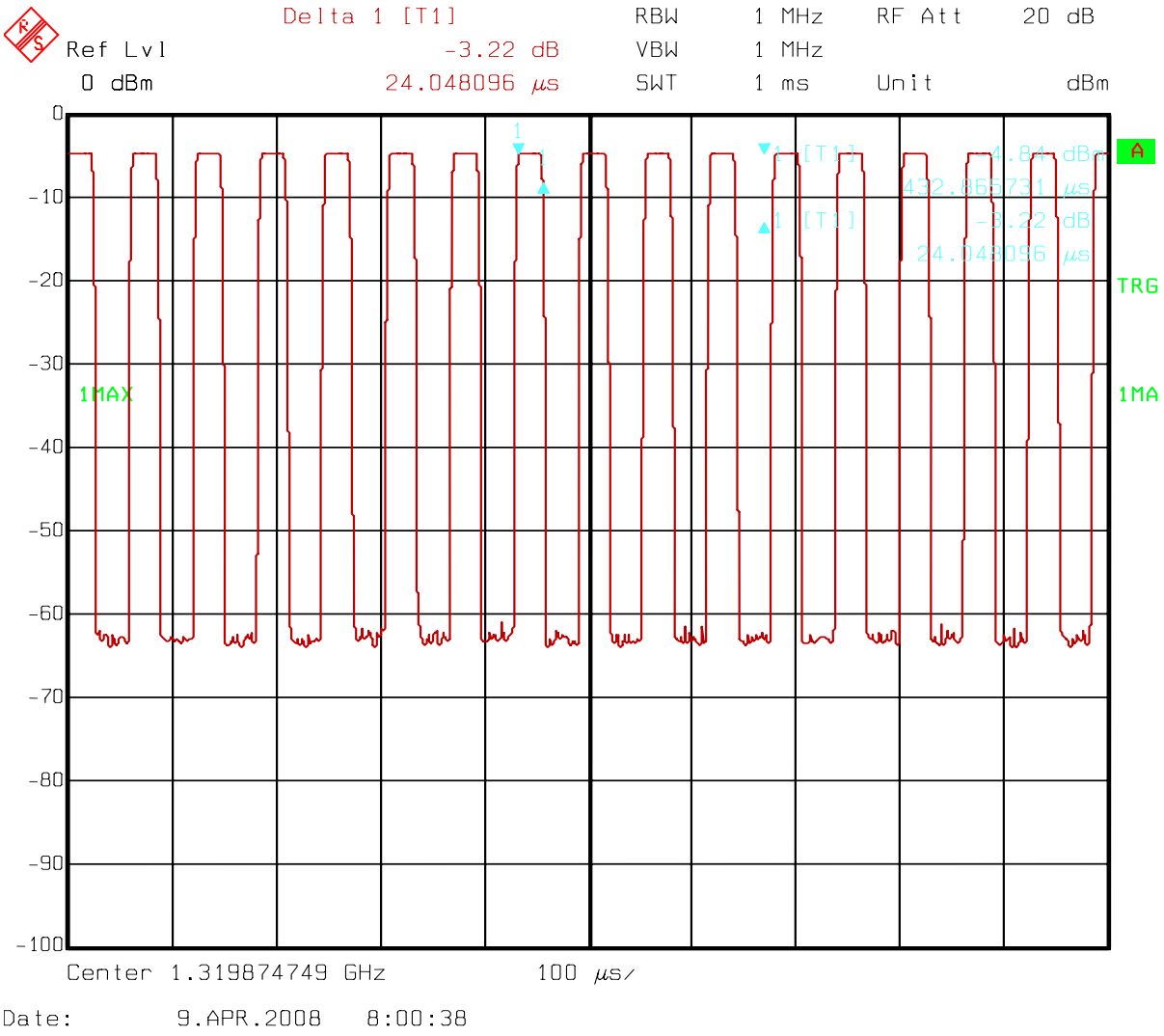
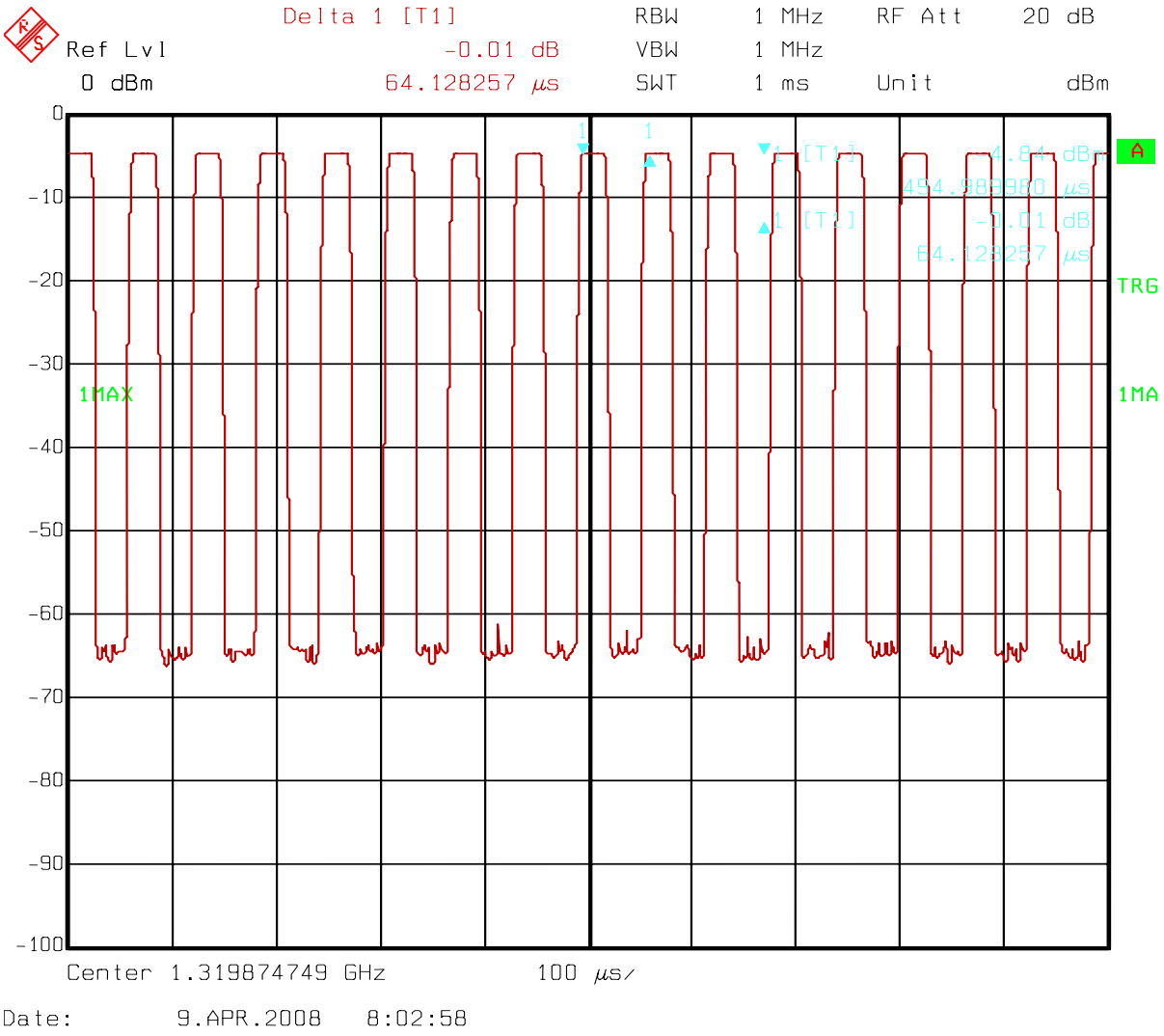
Upper frequency band – Conducted power



Duty cycle ON time



Duty cycle On+Off time

6 Frequency Stability

Para. No.: 87.133(7)/2.1055

Test Performed By: G.Suhanthakumar	**Date of Test: 2008.04.16 – 2008.04.17**

Test Results: Complies.

The maximum frequency drift is 171 ppm.

Test Data:

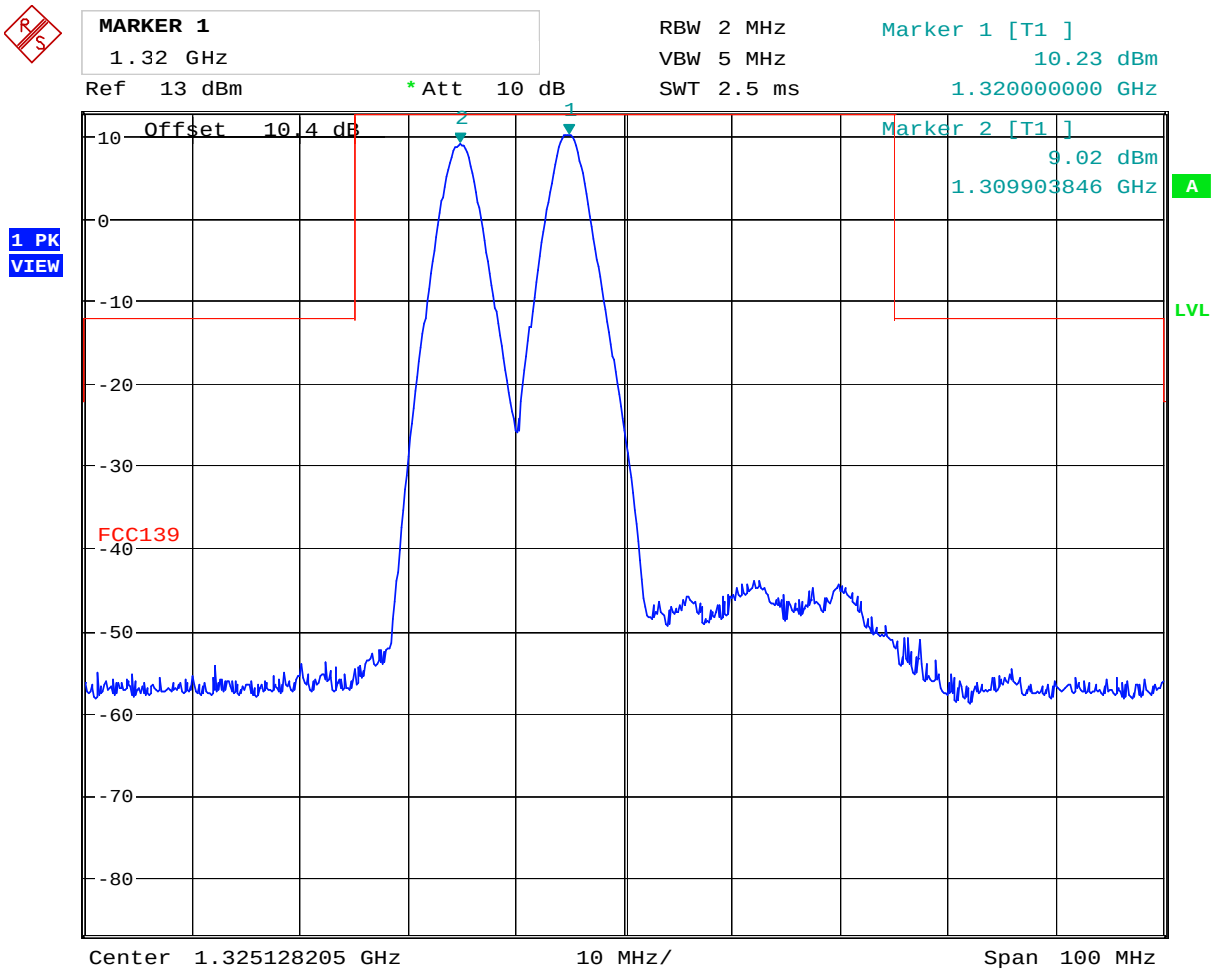
Test Condition	Frequency (1310MHz)	Frequency Drift (ppm)	Frequency (1320MHz)	Frequency Drift (ppm)	Frequency (1340MHz)	Frequency Drift (ppm)
50°C	1309.90384	-73.43	1320.00000	0	1339.871783	-95.68
40°C	1310.00641	4.89	1320.00000	0	1340.019230	14.35
30°C	1310.00000	0	1320.00961	7.28	1339.967949	-23.92
20°C, 15 Vdc	1309.83974	-122.33	1319.93589	-48.56	1340.000000	0
10°C	1310.224359	171.26	1320.000000	0	1340.003205	2.39
0°C	1310.224359	171.26	1320.000000	0	1340.003205	2.39
-10°C	1310.064103	48.93	1320.000000	0	1340.003205	2.39
-20°C	1309.903846	-73.4	1320.000000	0	1340.003205	2.39
-30°C	1309.903846	-73.4	1320.000000	0	1339.871795	-95.67
Maximum frequency drift (ppm)	171.26		-48.56		-95.68	

The equipment's voltage can not be varied.

See the attached graphs

Requirement 87.133(a):

The tolerance for transmitters is less than 500 ppm.



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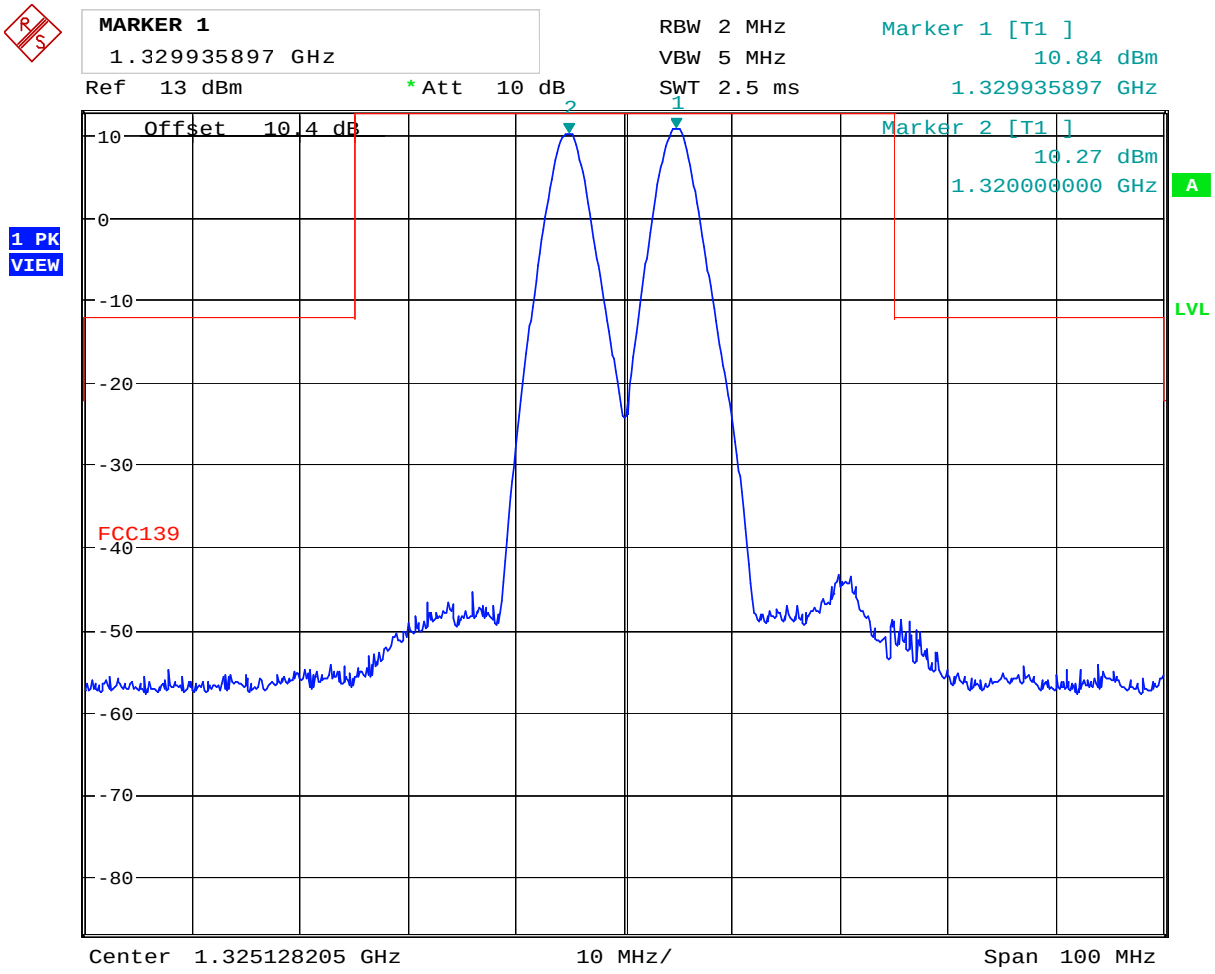
+50 °C – Lower Frequency



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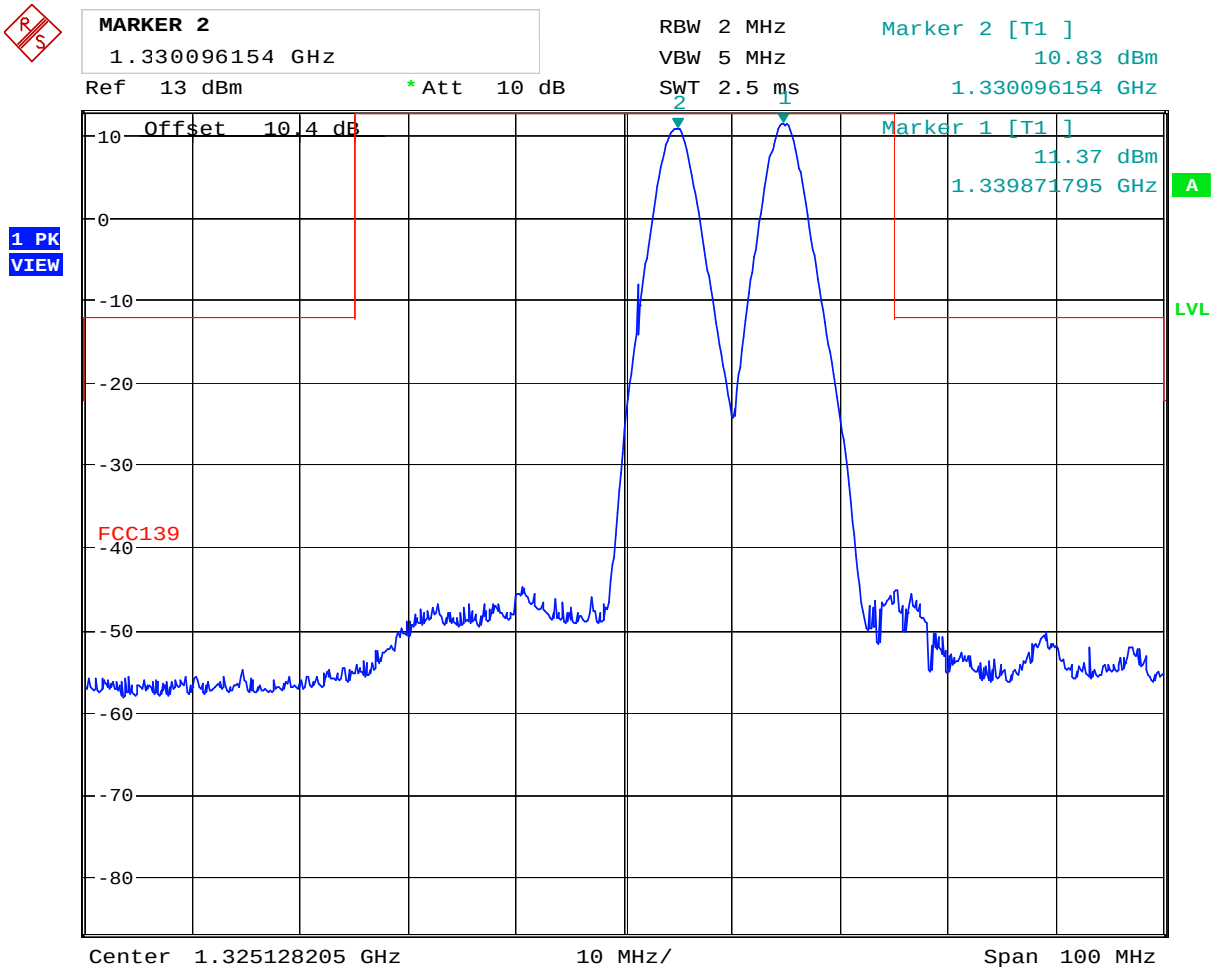
+50 °C – Middle Frequency



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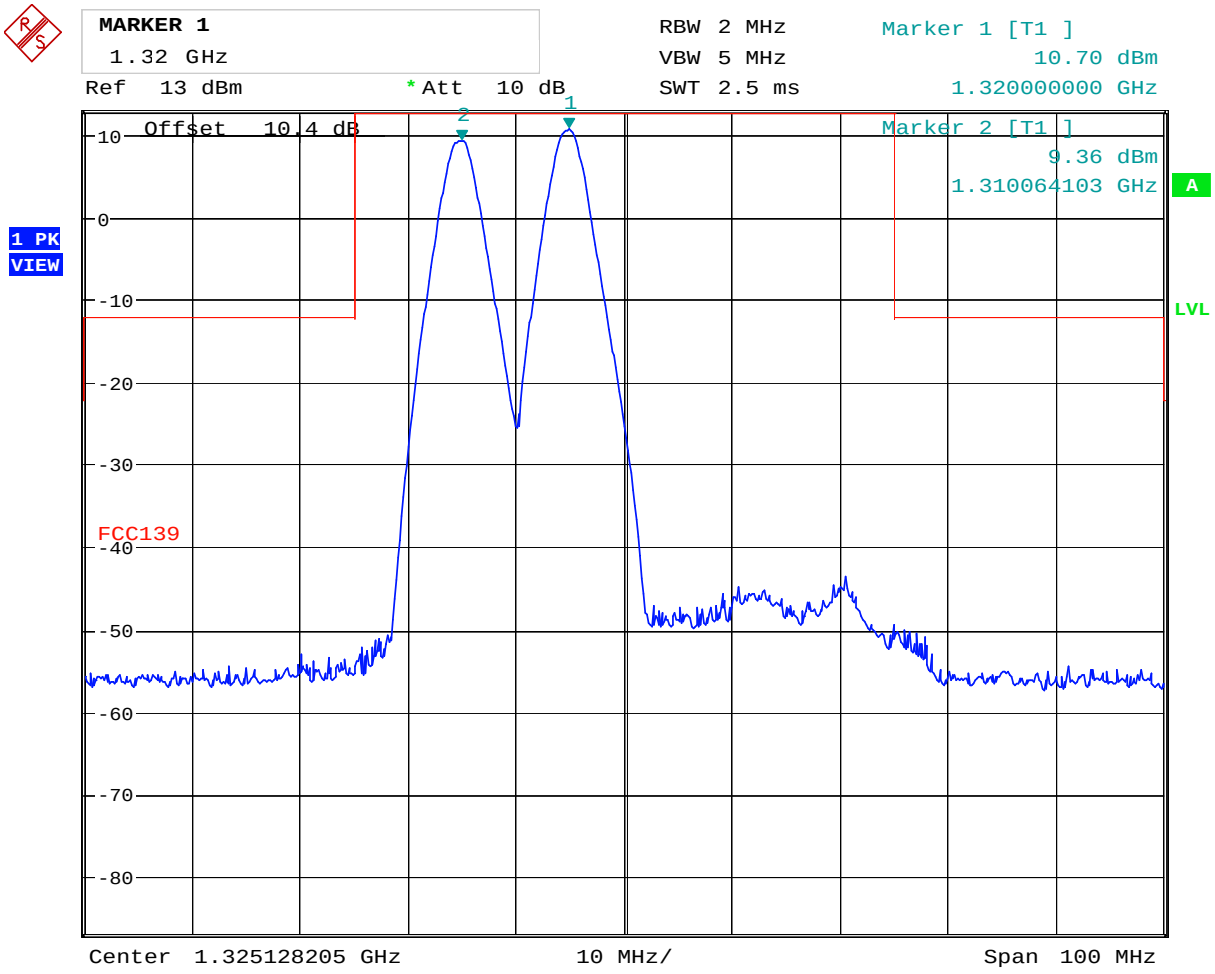
+50 °C – upper Frequency



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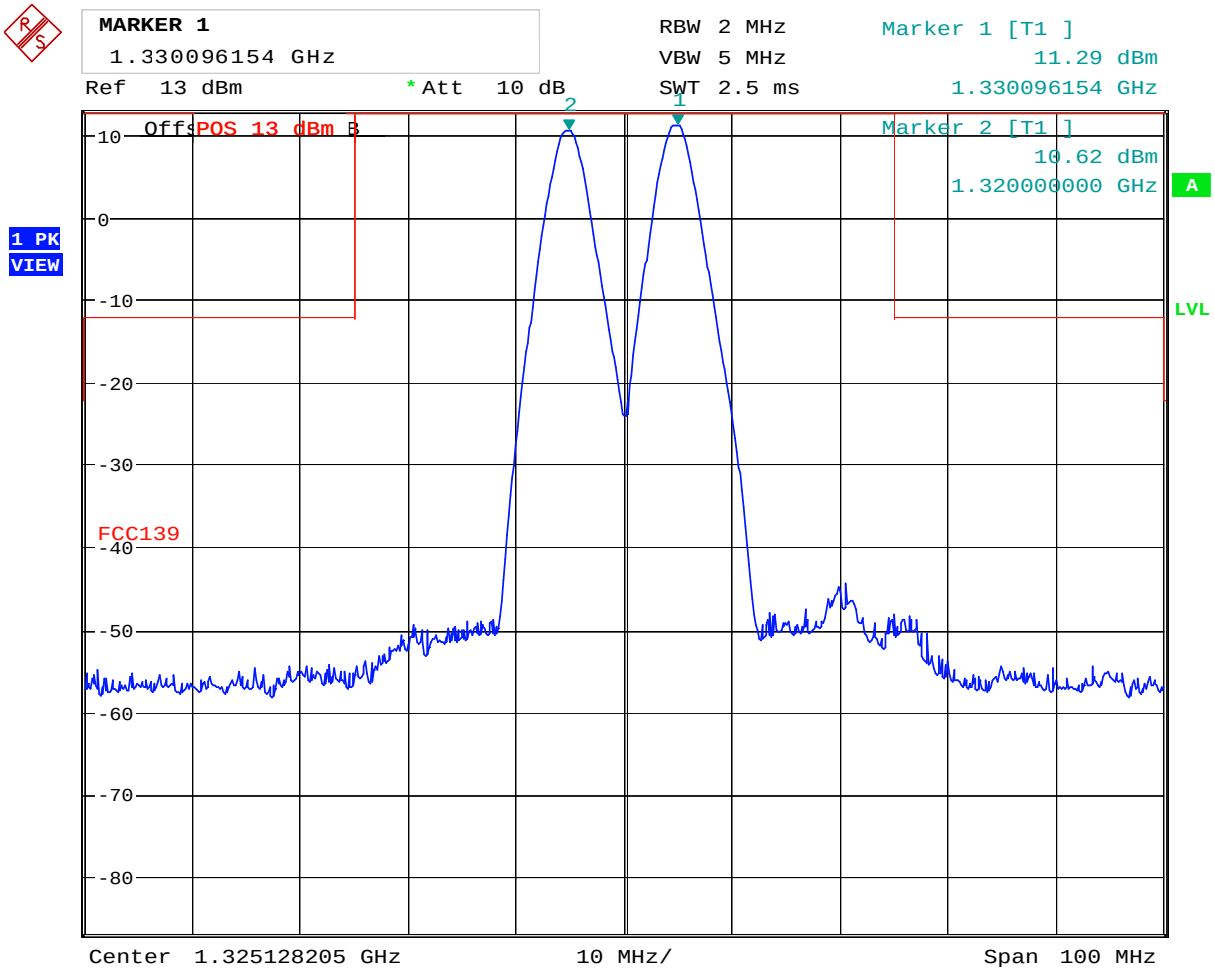
+40 °C – Lower Frequency



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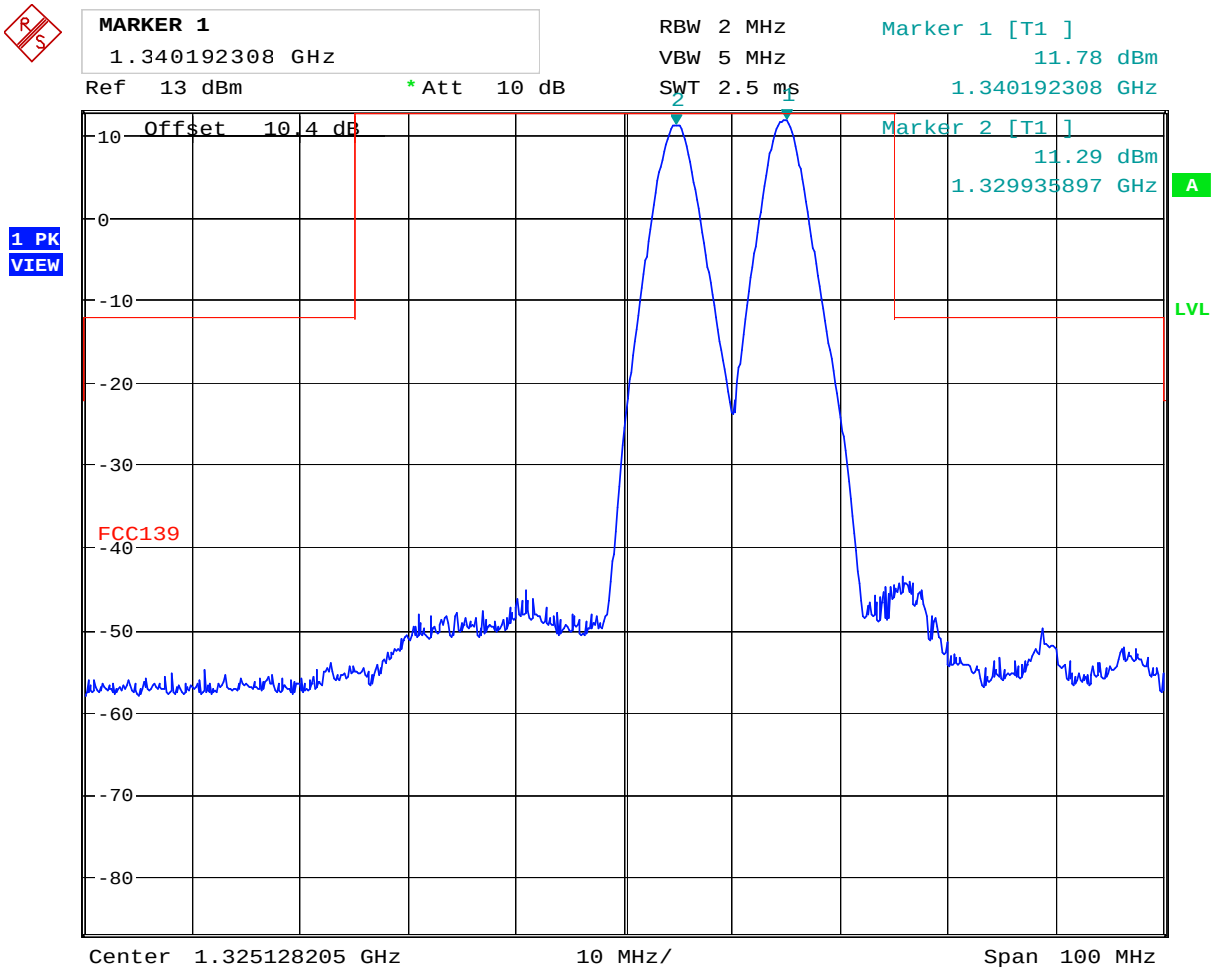
+40 °C – Middle Frequency



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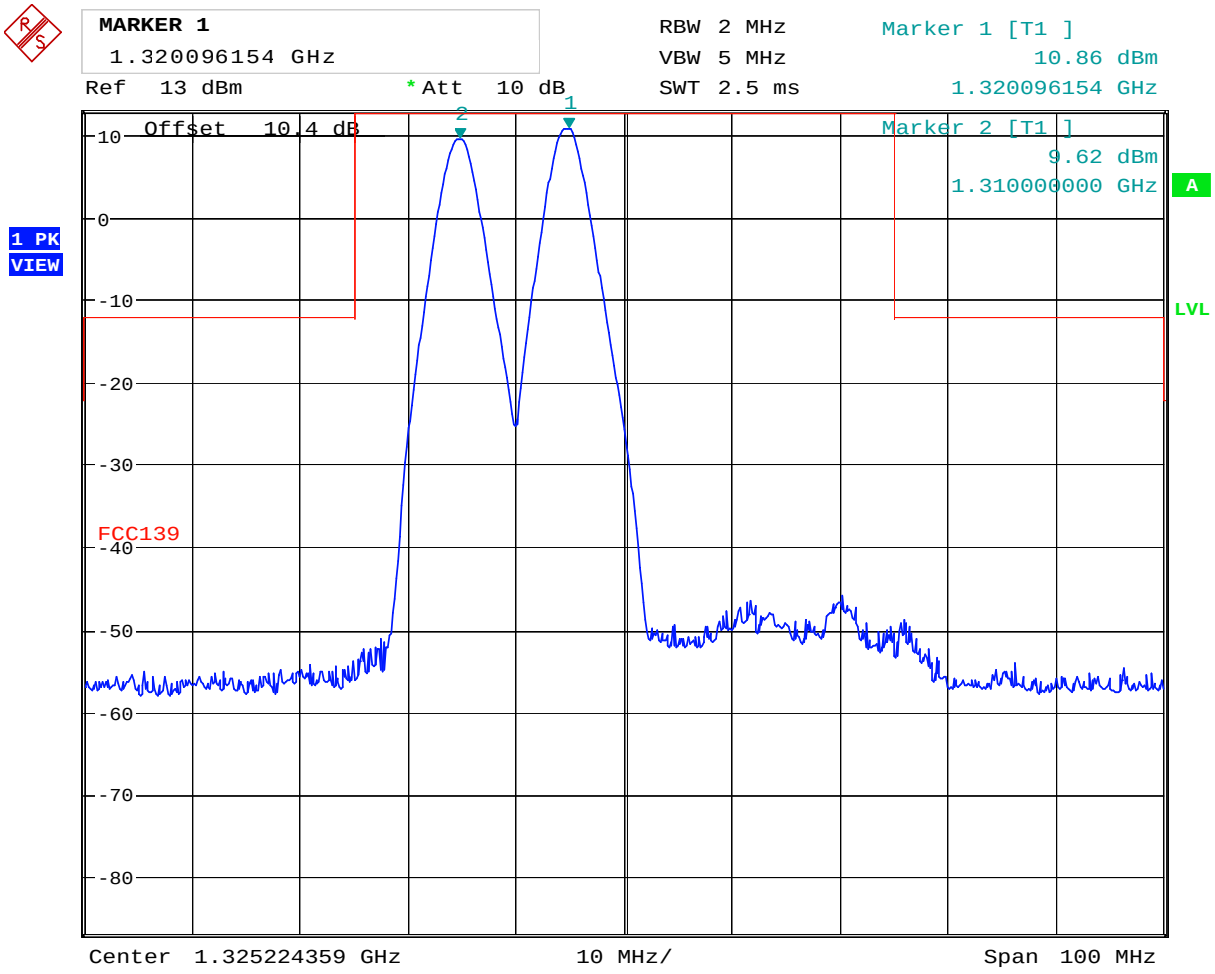
+40 °C – Upper Frequency



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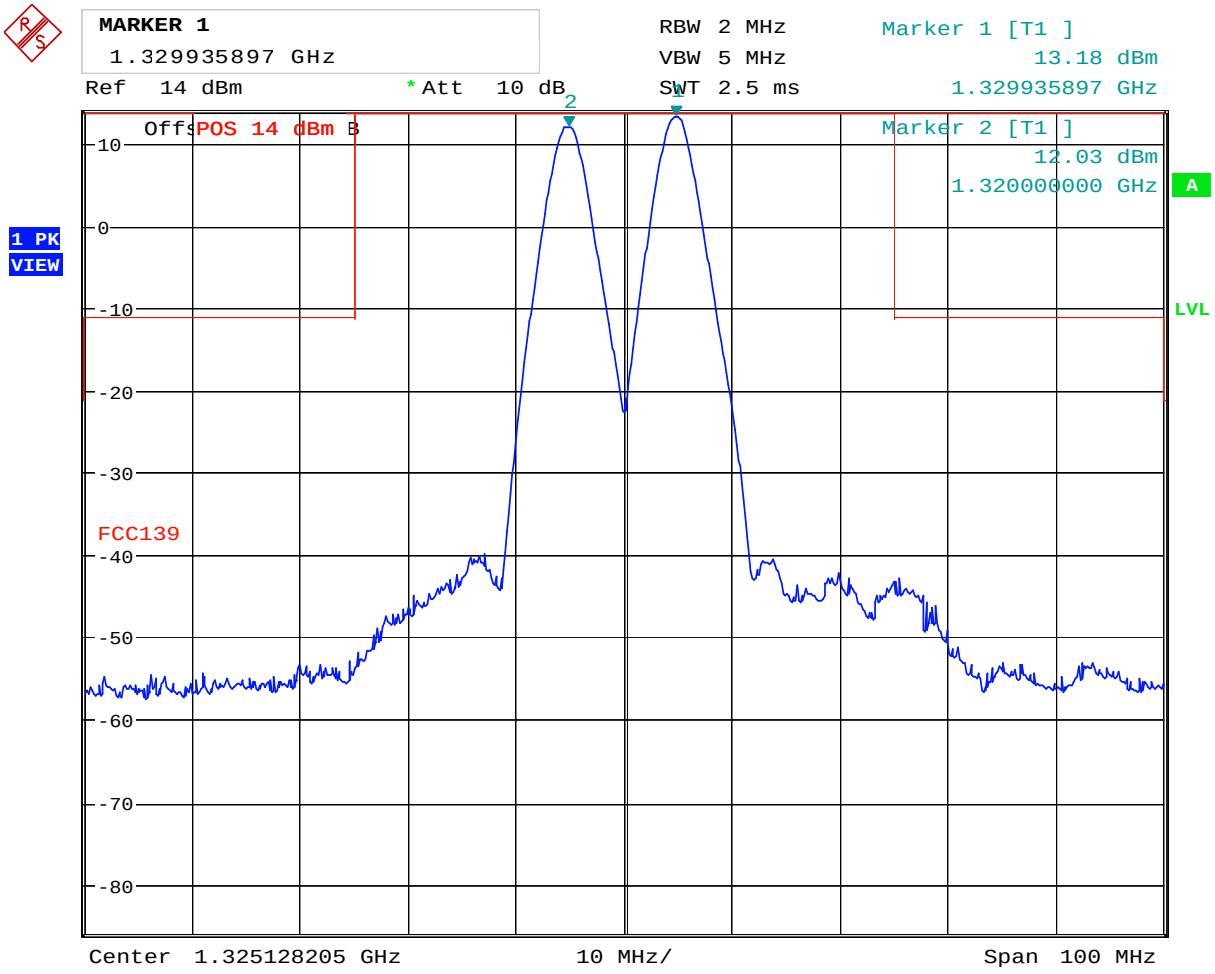
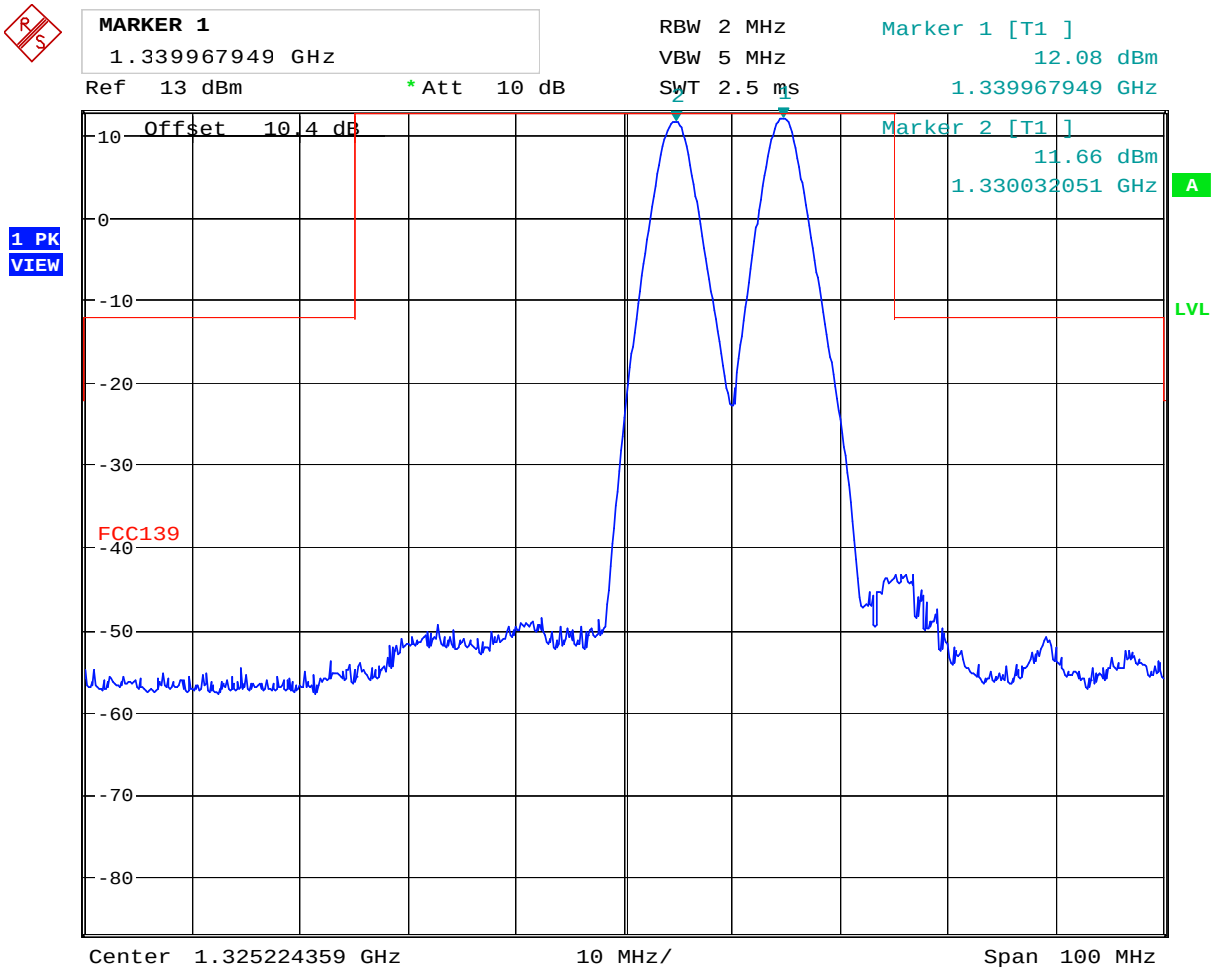
+30 °C – Lower Frequency



Date: 17.APR.2008 09:53:47

+30 °C – Middle Frequency



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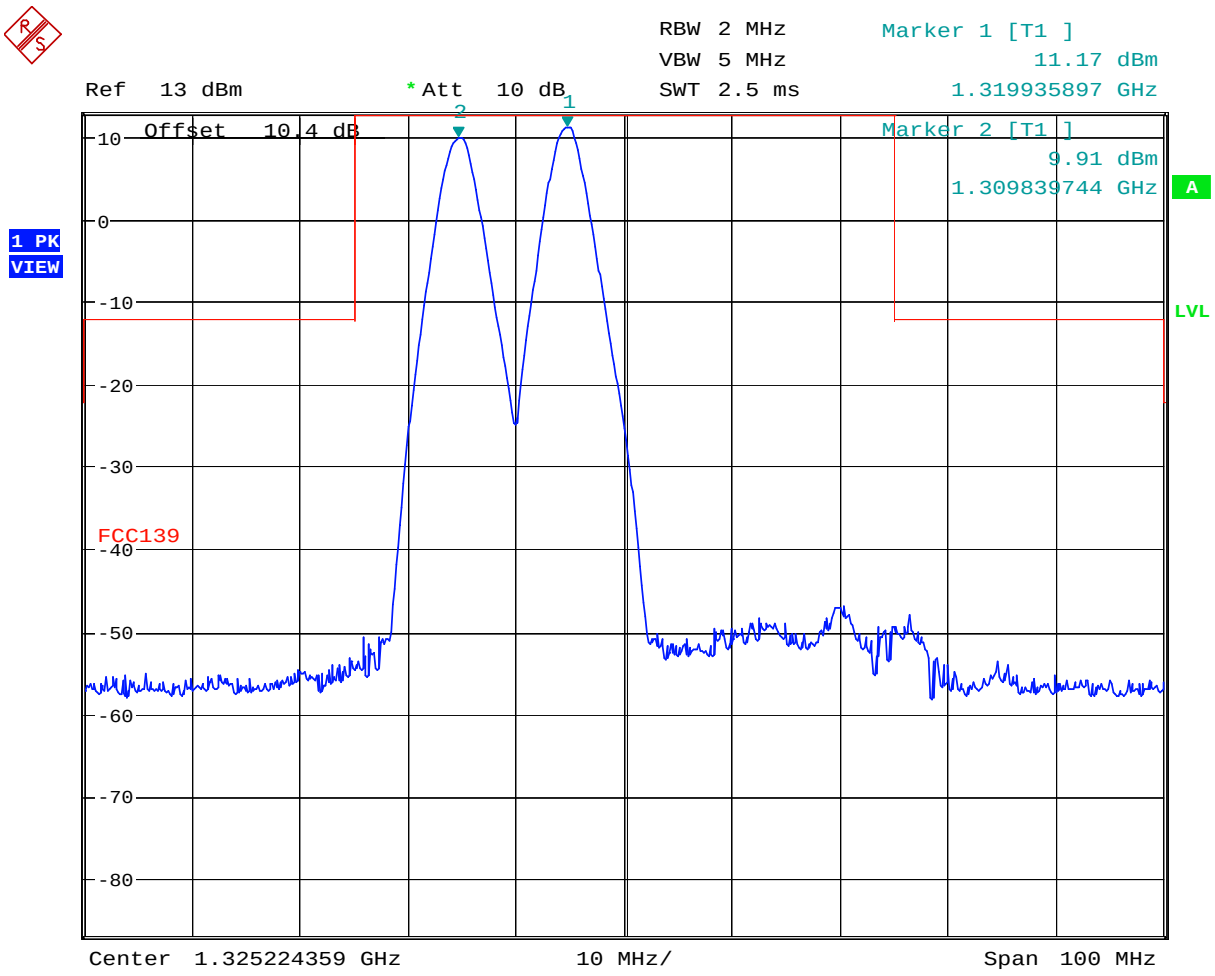
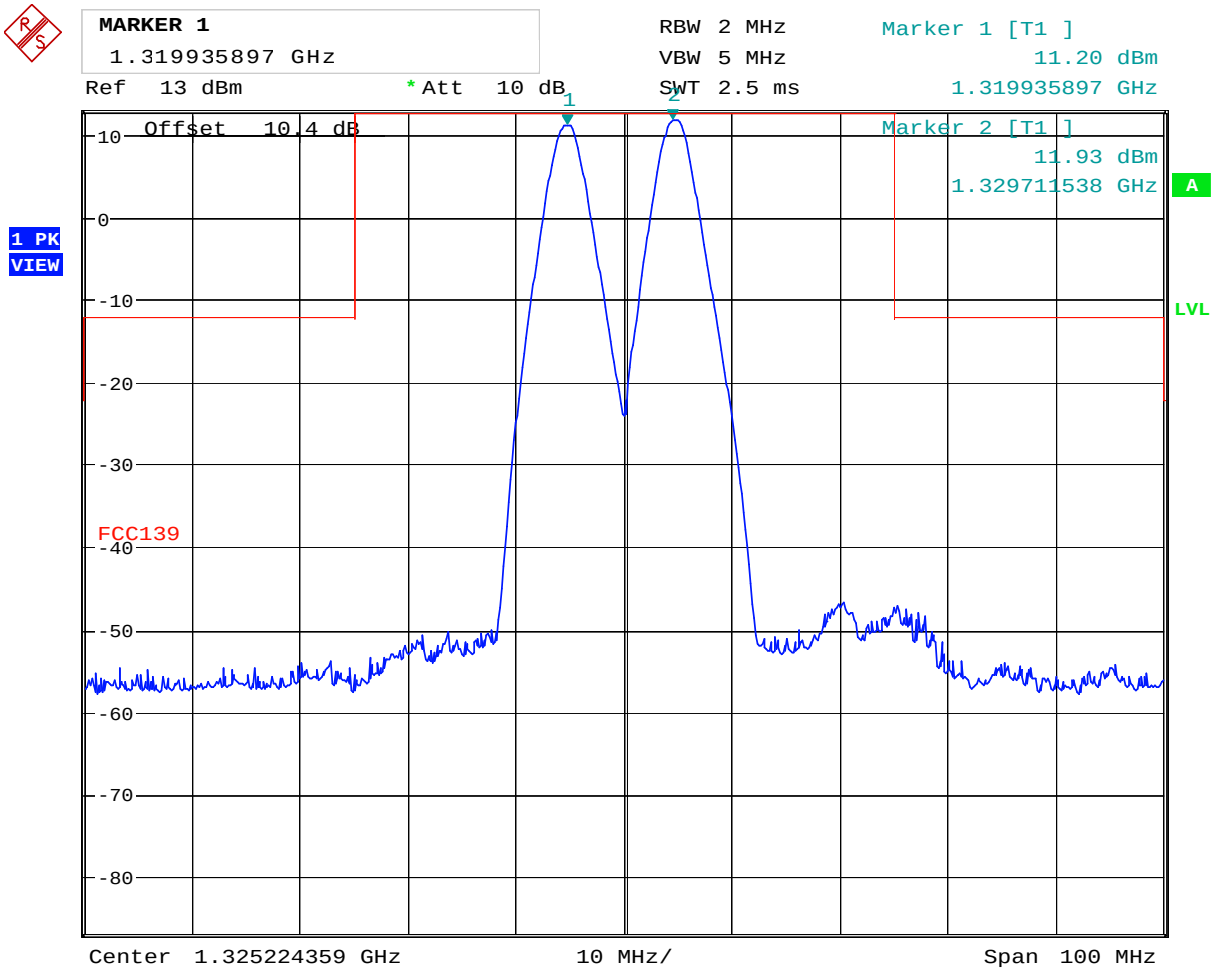
+30 °C – Upper Frequency



Date: 16.APR.2008 09:21:43

+20 °C – Lower Frequency



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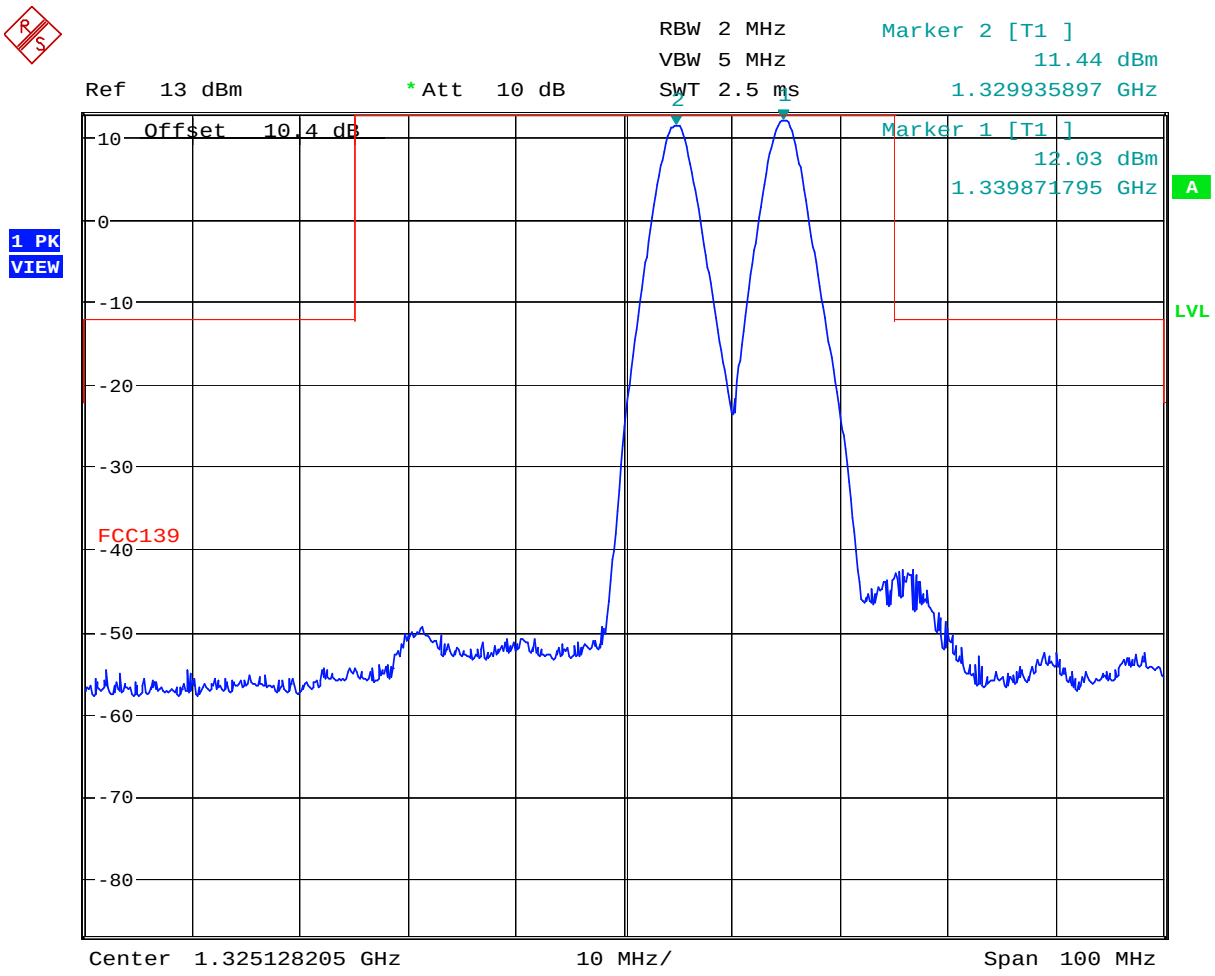
+20 °C – Middle Frequency



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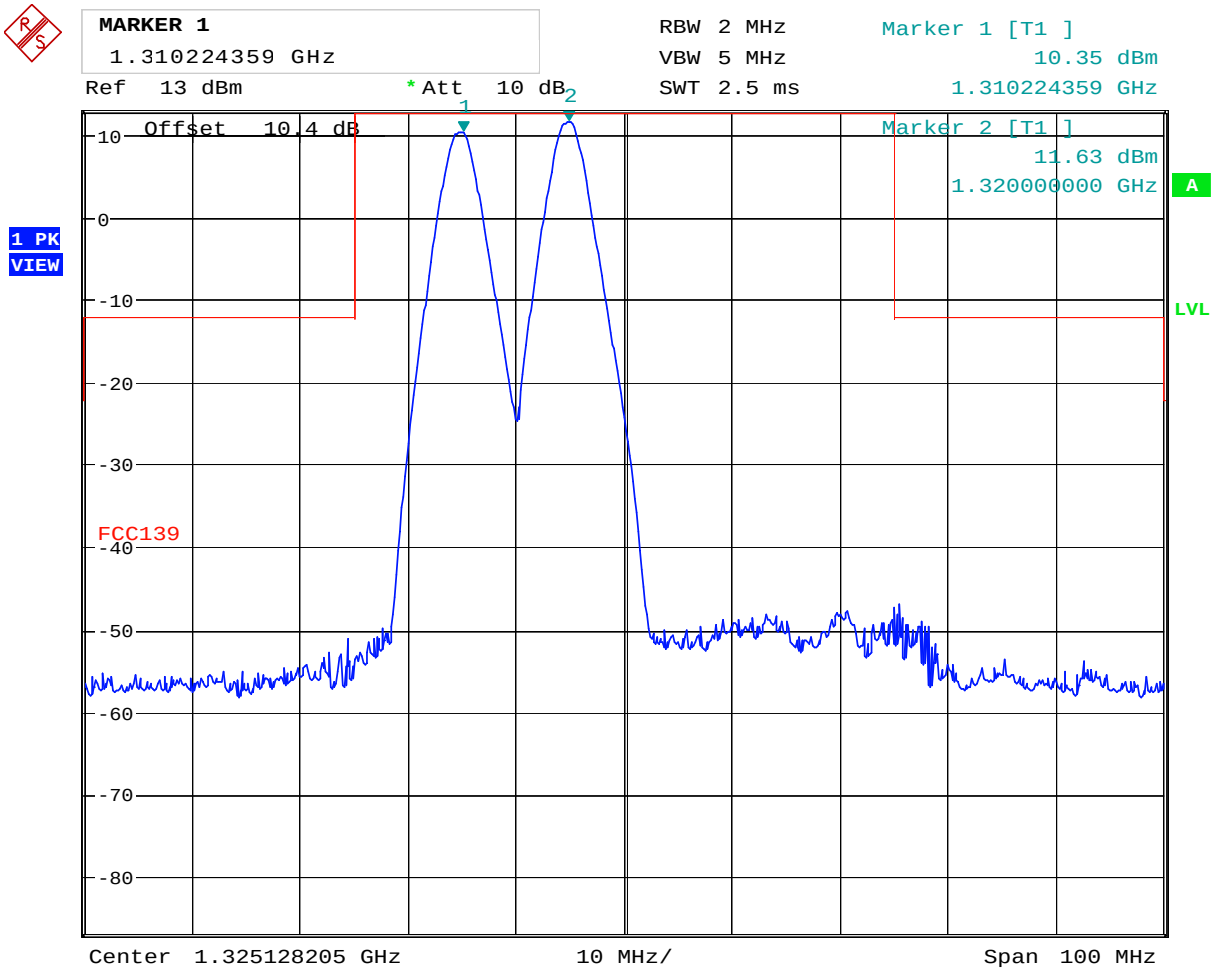
+20 °C – Upper Frequency



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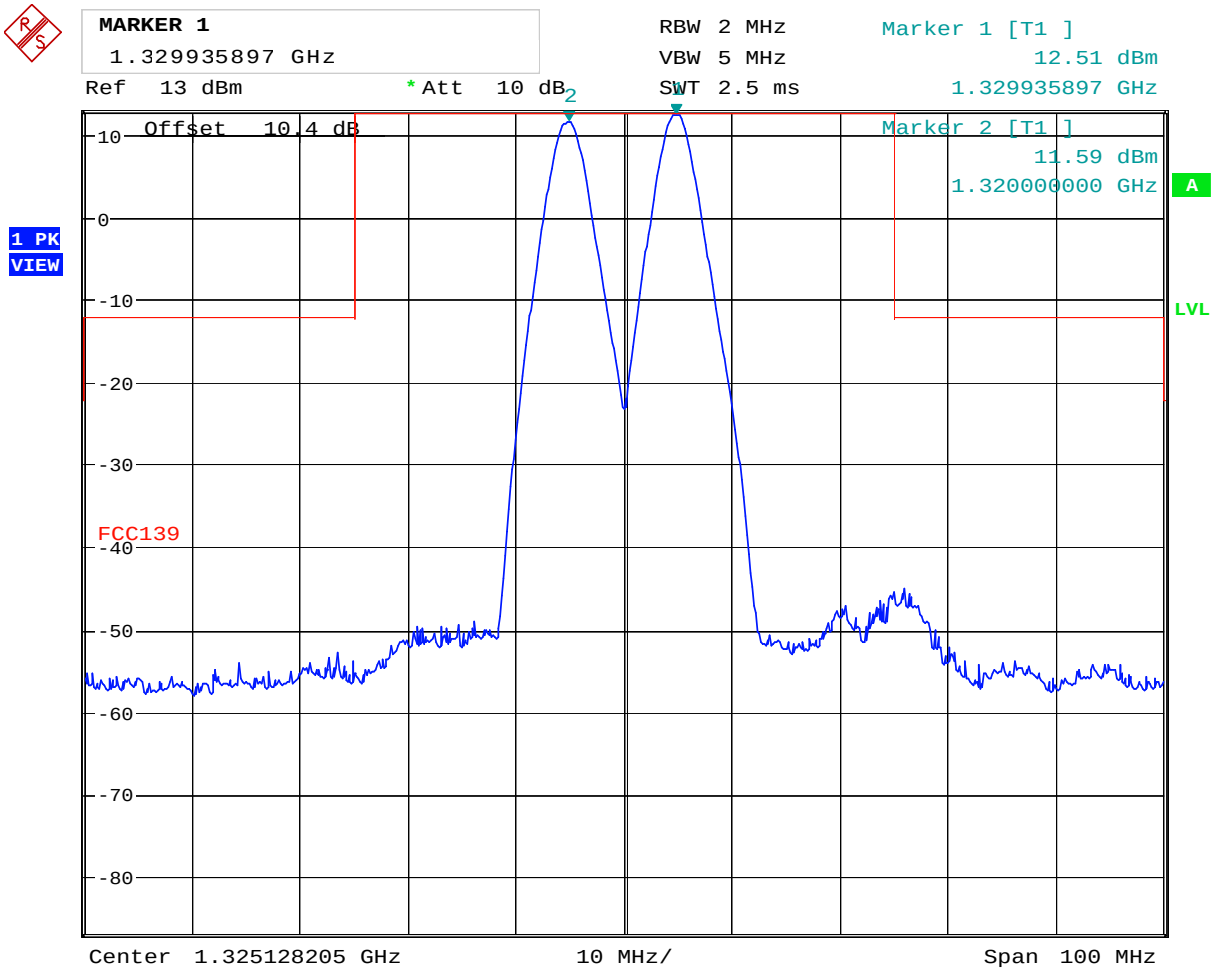
0 °C – Lower Frequency



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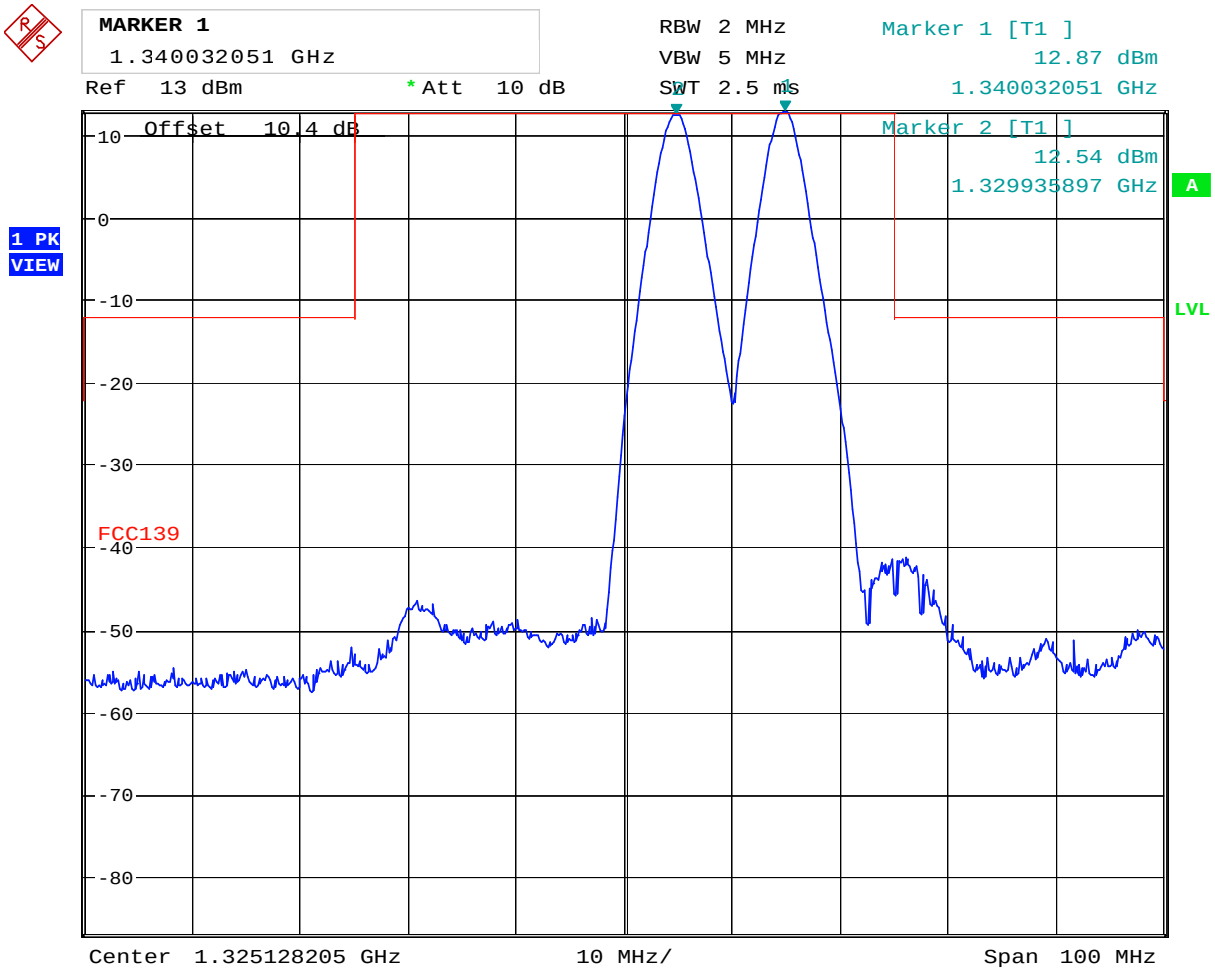
0 °C – Middle Frequency



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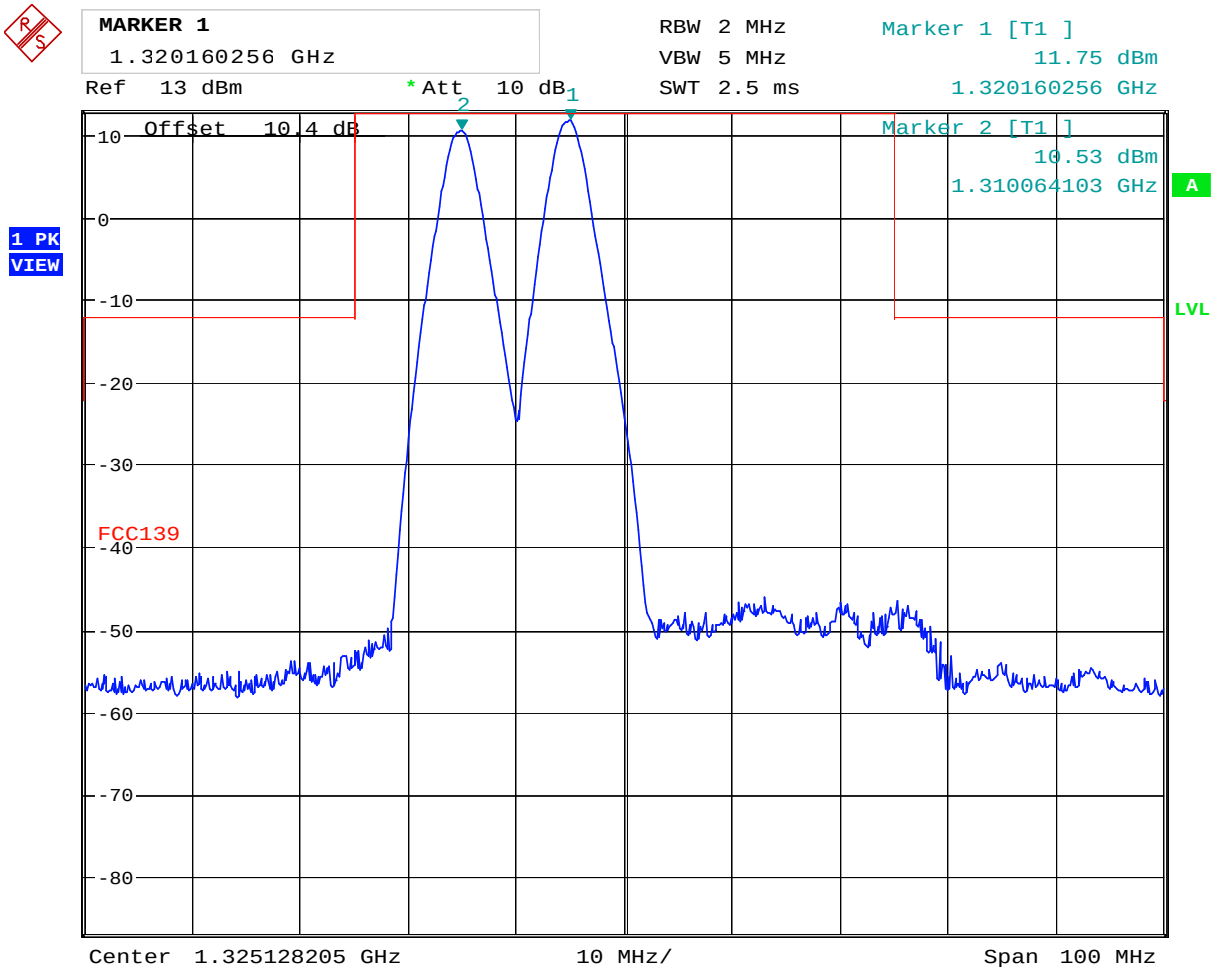
0 °C – Upper Frequency



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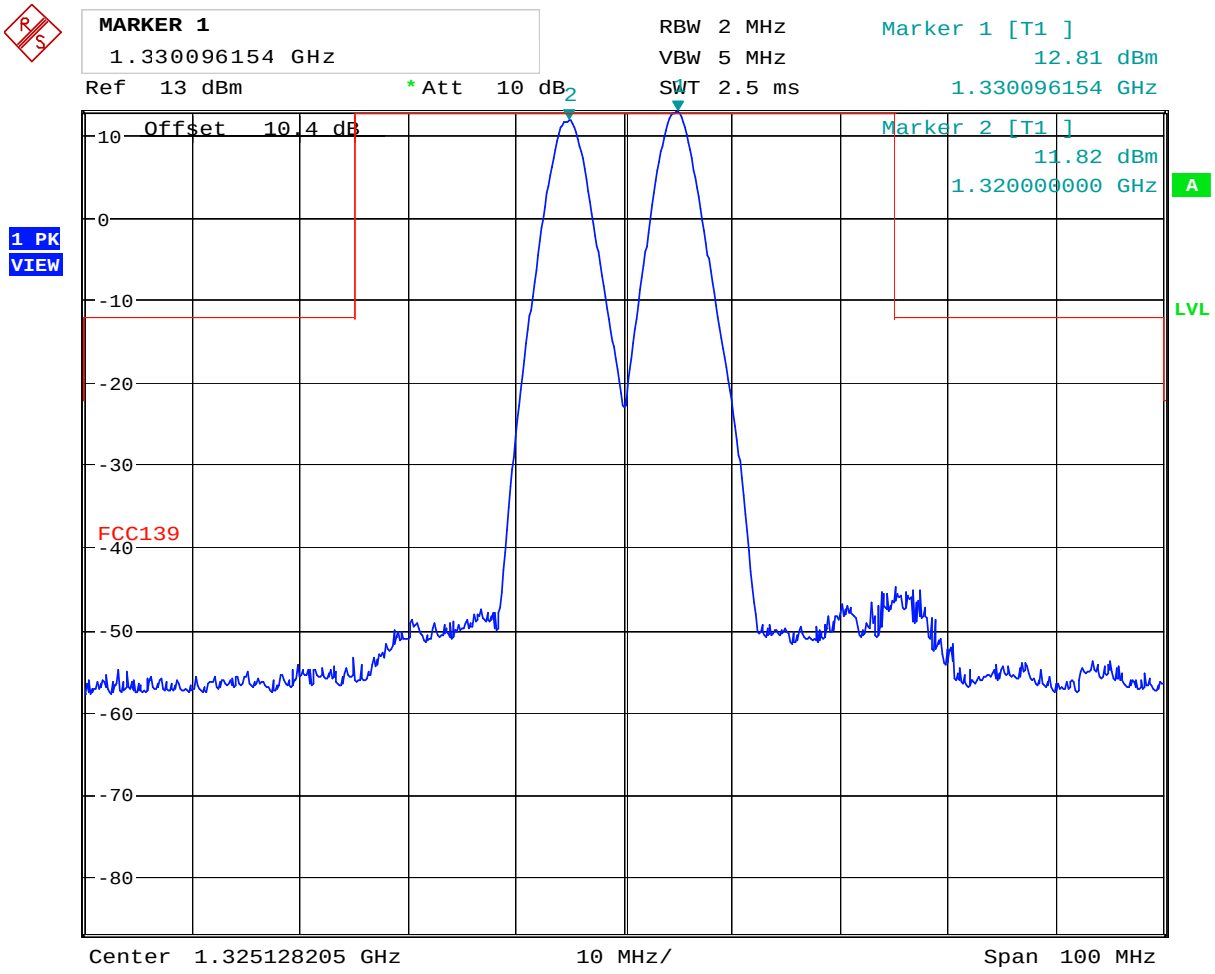
-10 °C – Lower Frequency



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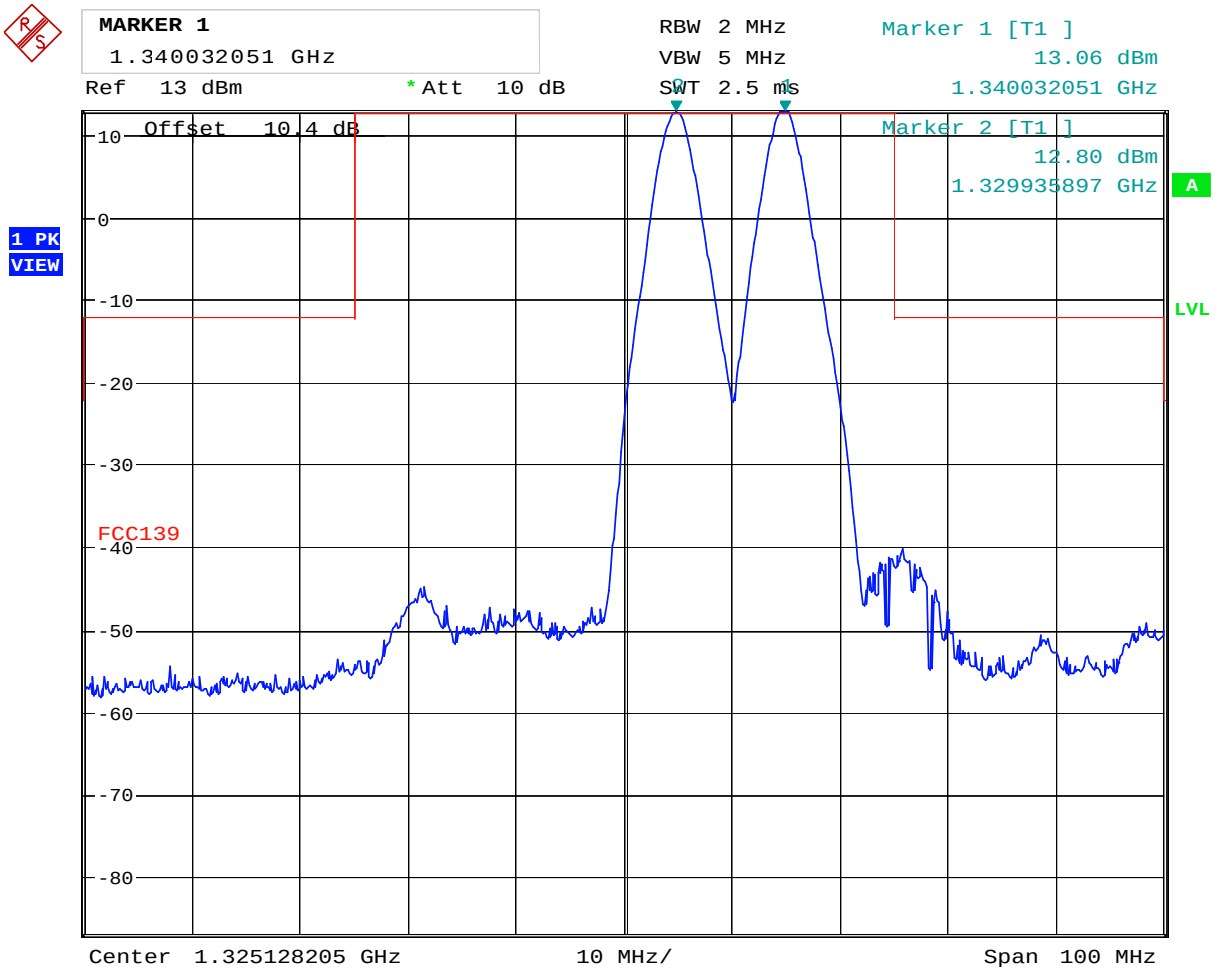
-10 °C – Middle Frequency



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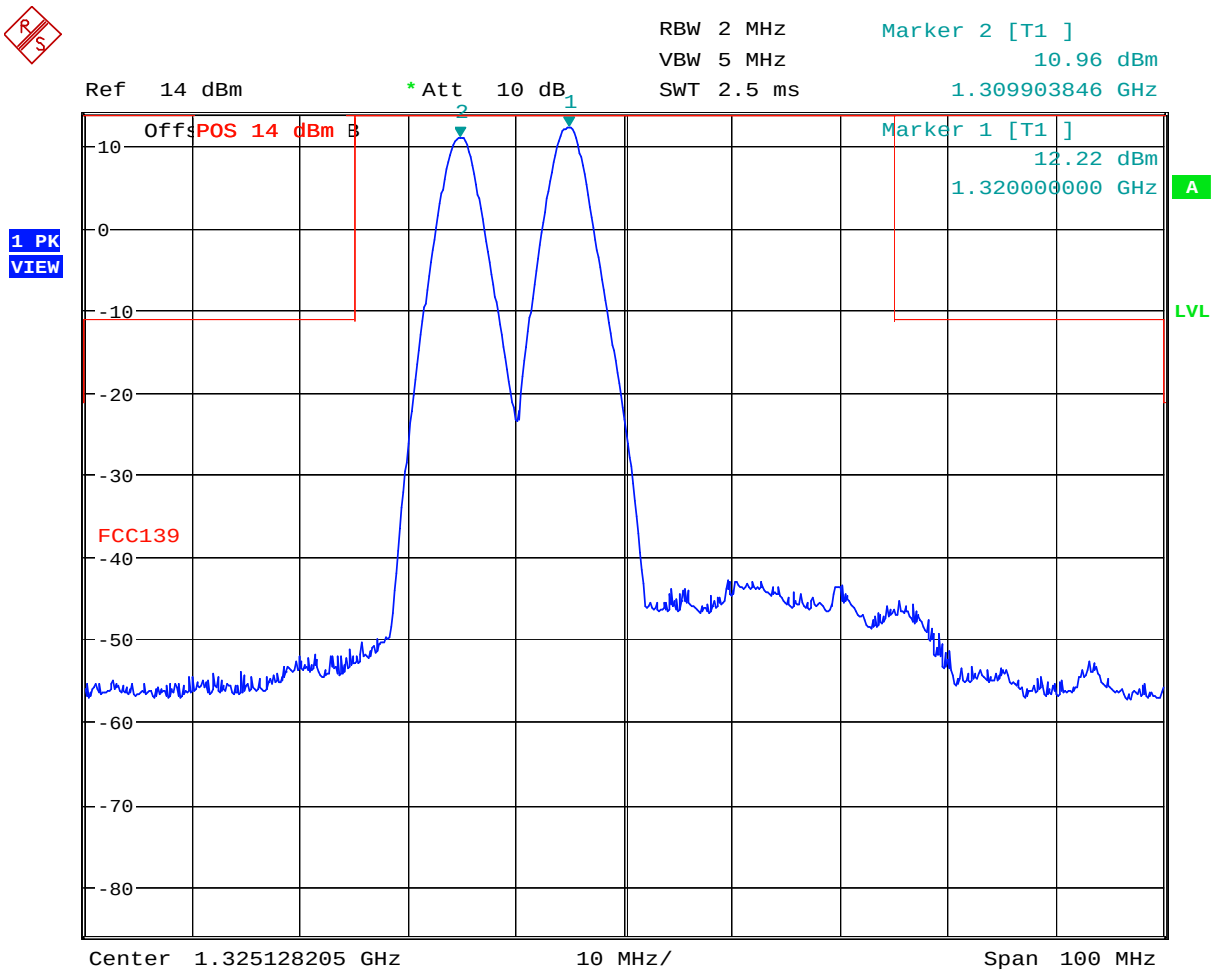
-10 °C – Upper Frequency



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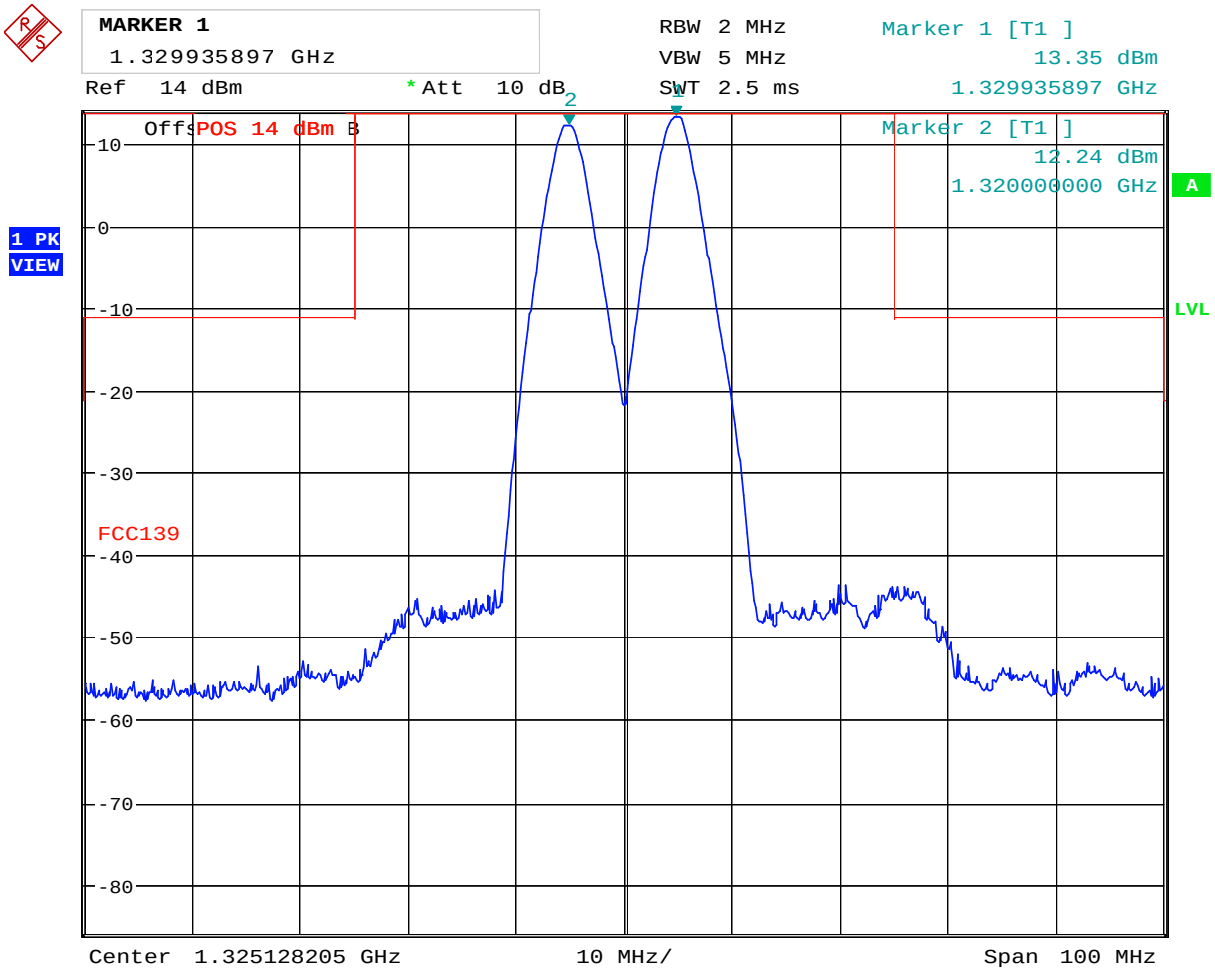
-20 °C – Lower Frequency



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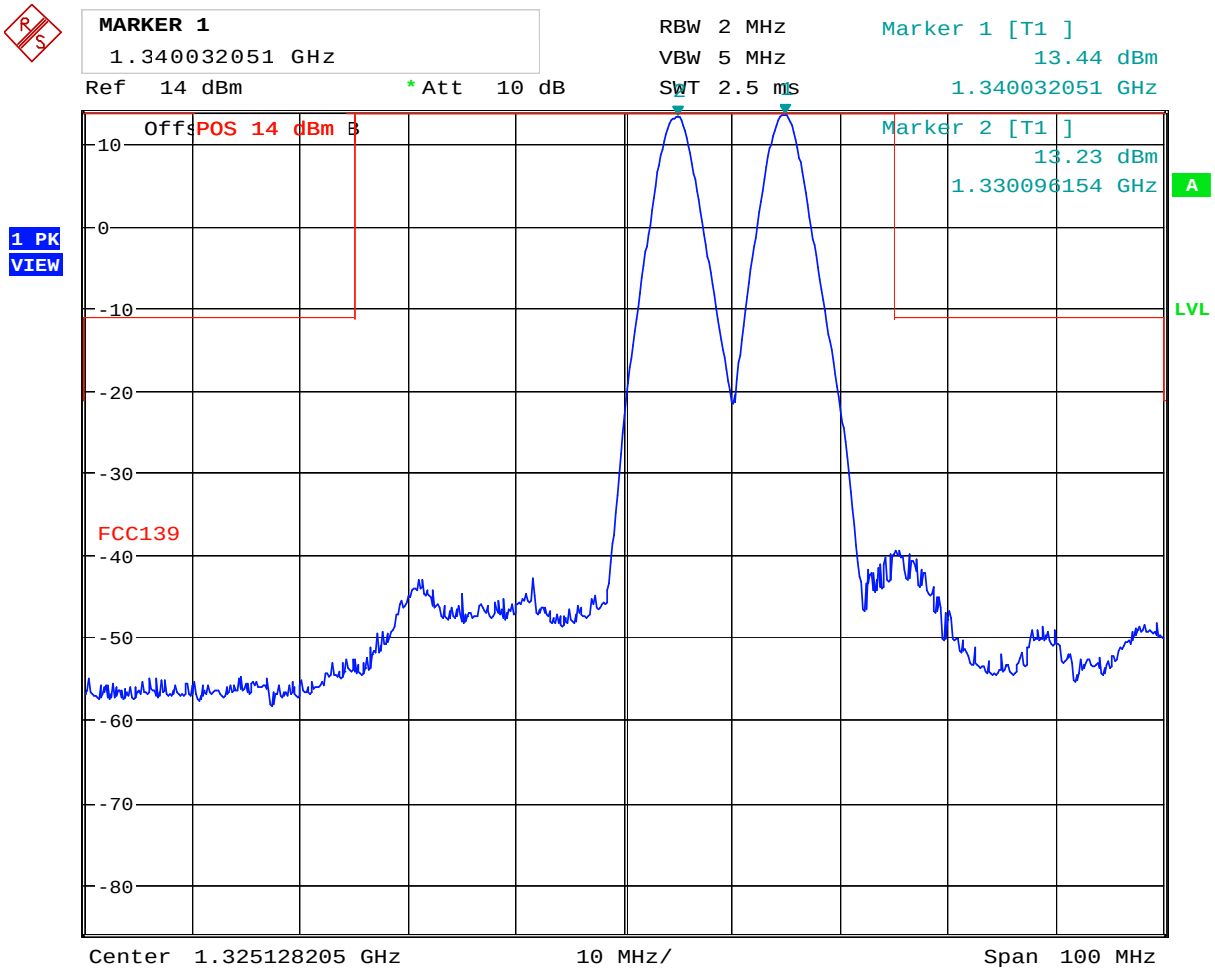
-20 °C – Middle Frequency



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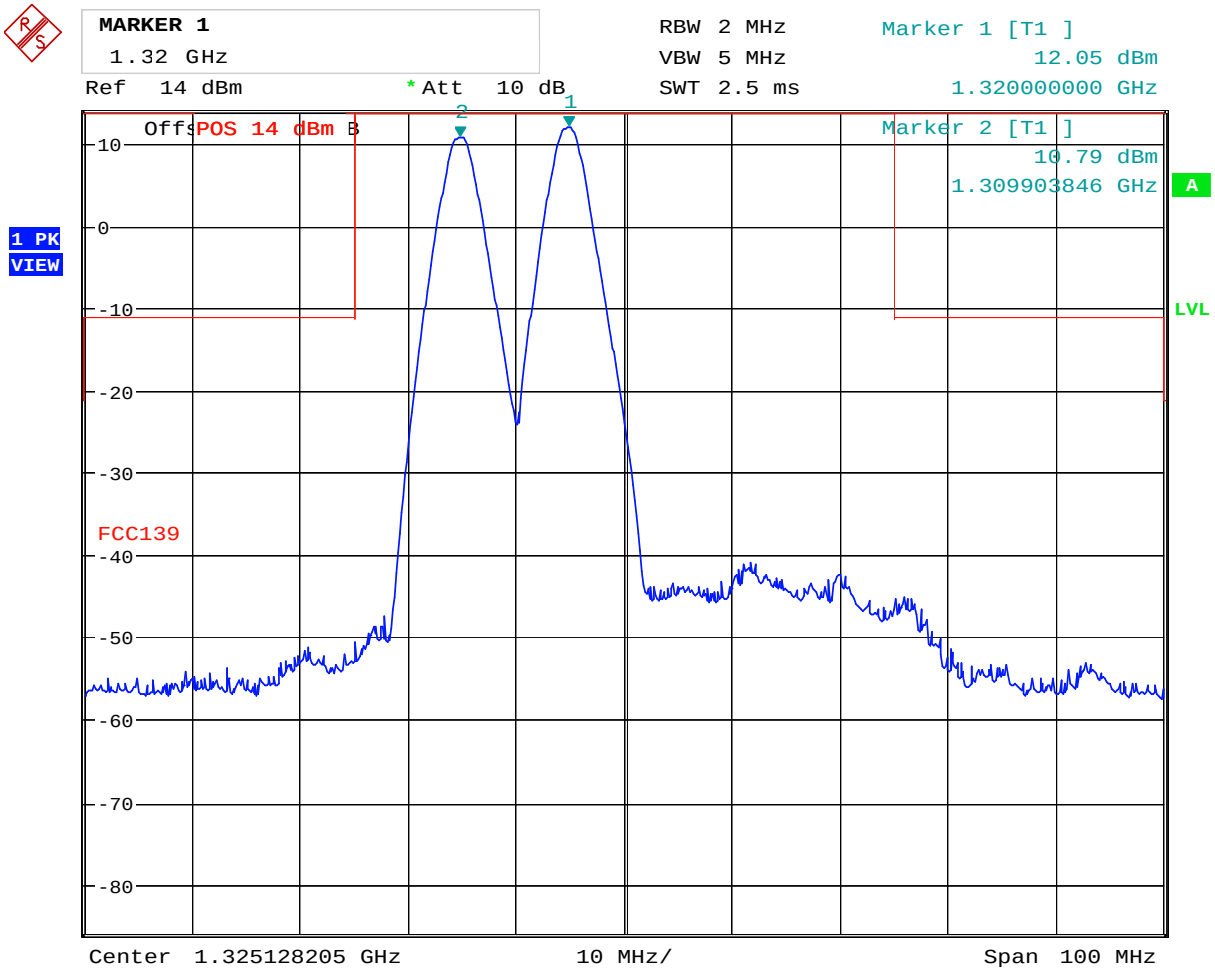
-20 °C – Upper Frequency



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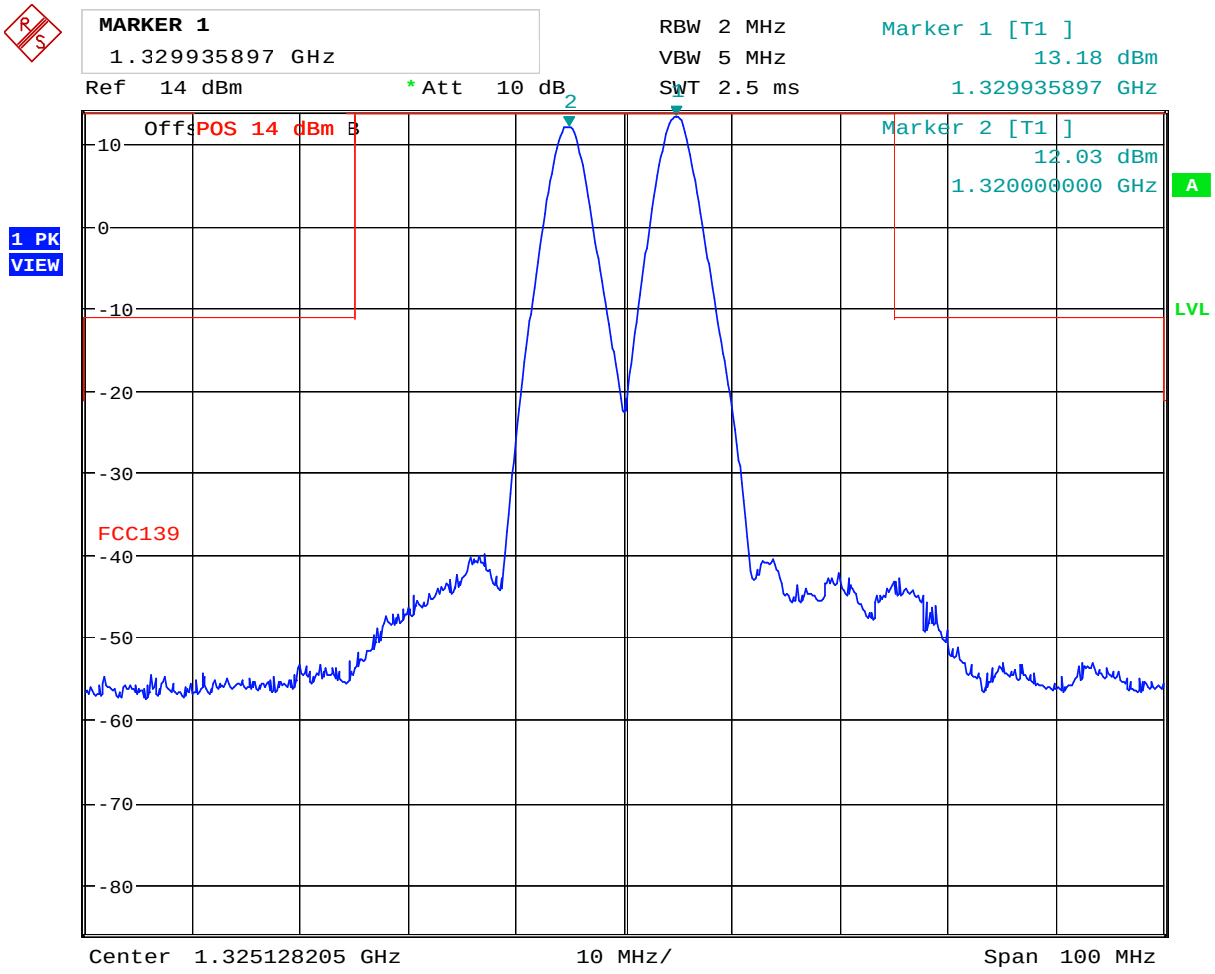
-30 °C – Lower Frequency



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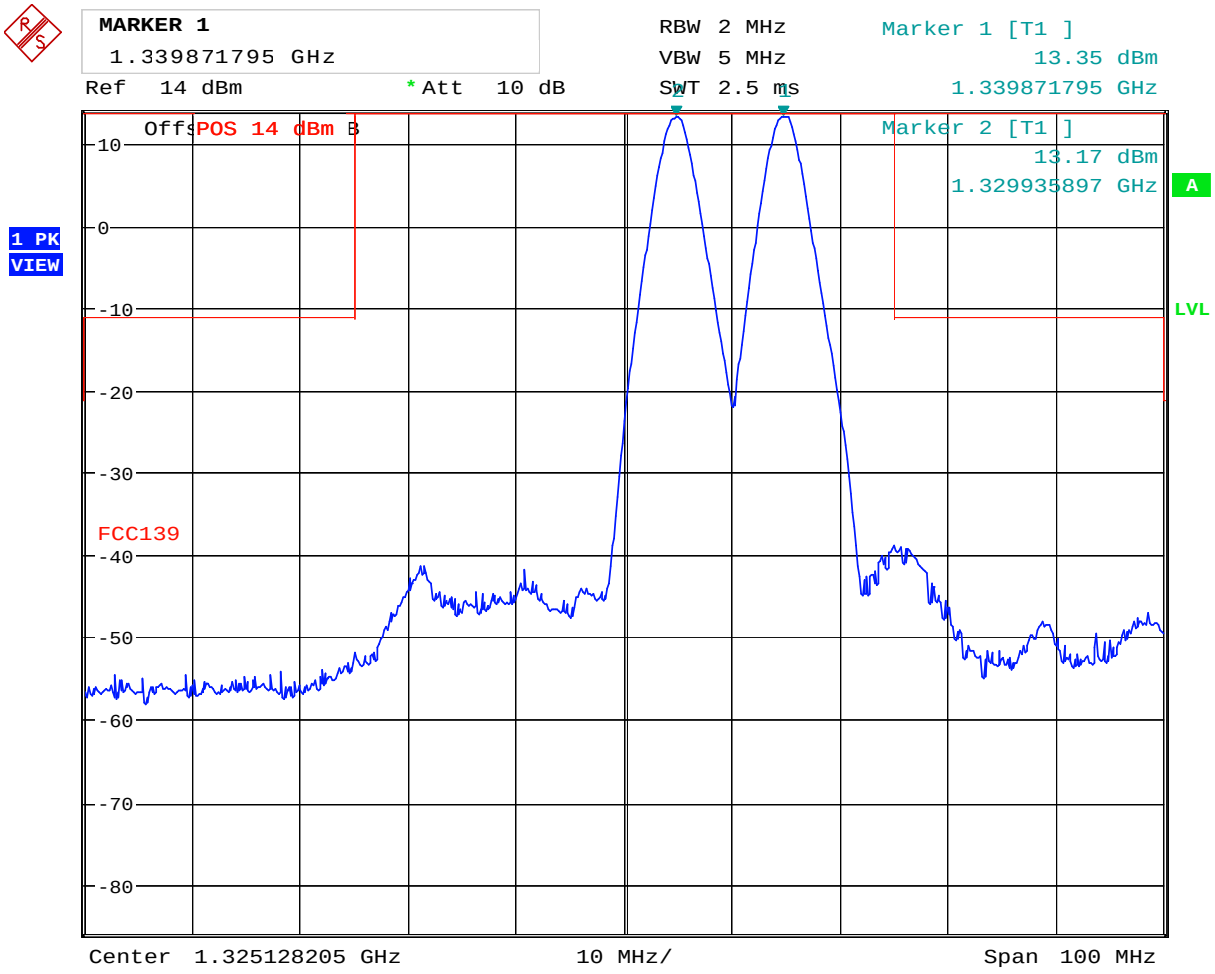
-30 °C – Middle Frequency



Date: 17.APR.2008 09:58:46

-30 °C – Upper Frequency

7 Bandwidth of emission

Para. No.: 87.135

Test Performed By: G.Suhanthakumar	Date of Test: 07.04.2008

Test Results: see attached graphs

Measurement Data:

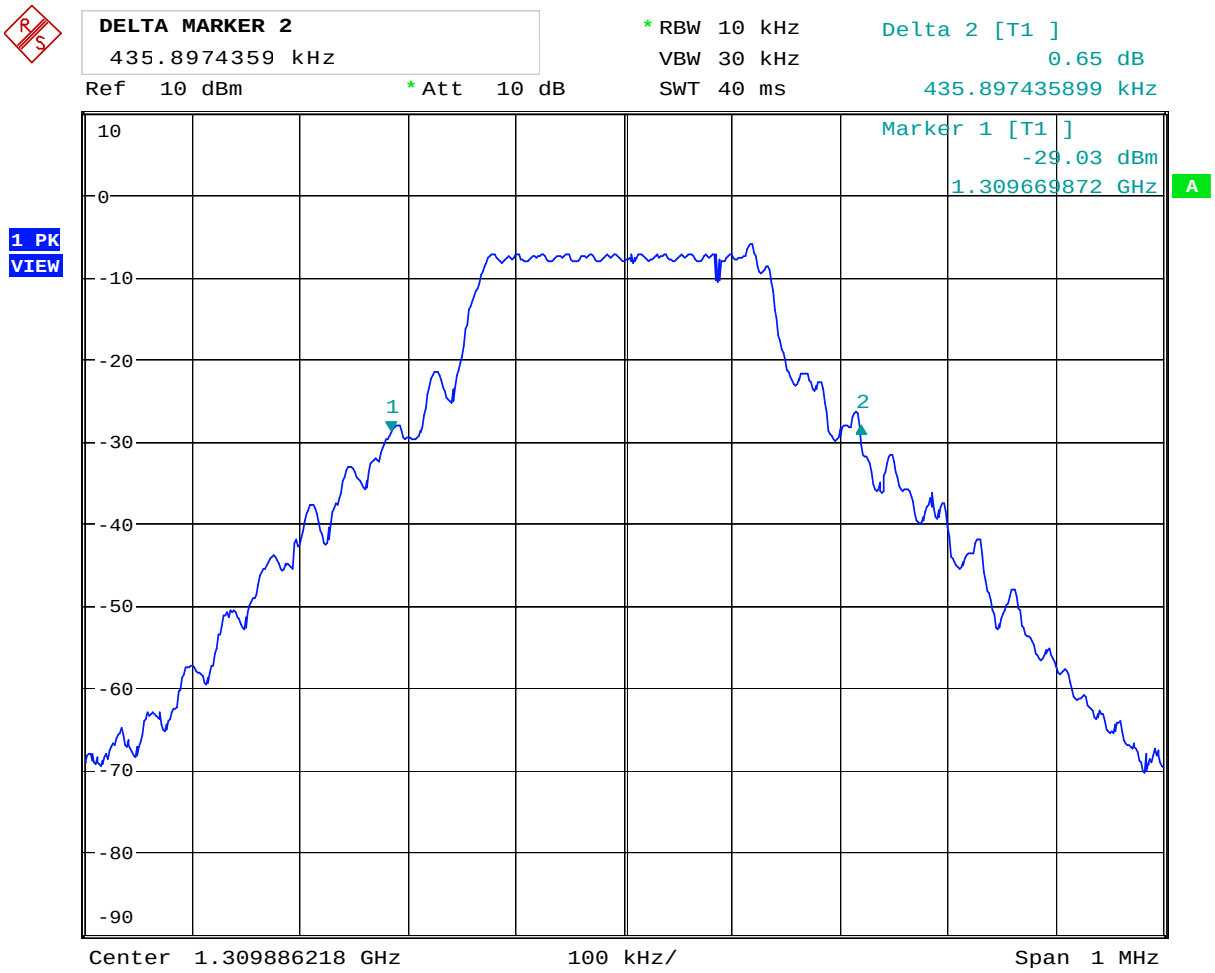
20 dB Bandwidth (kHz)		
Lower frequency (1310MHz)	**Middle frequency (1320MHz)**	**Upper frequency (1340MHz)**
435.89	430.40	441.15

Requirement 87.135:

(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.



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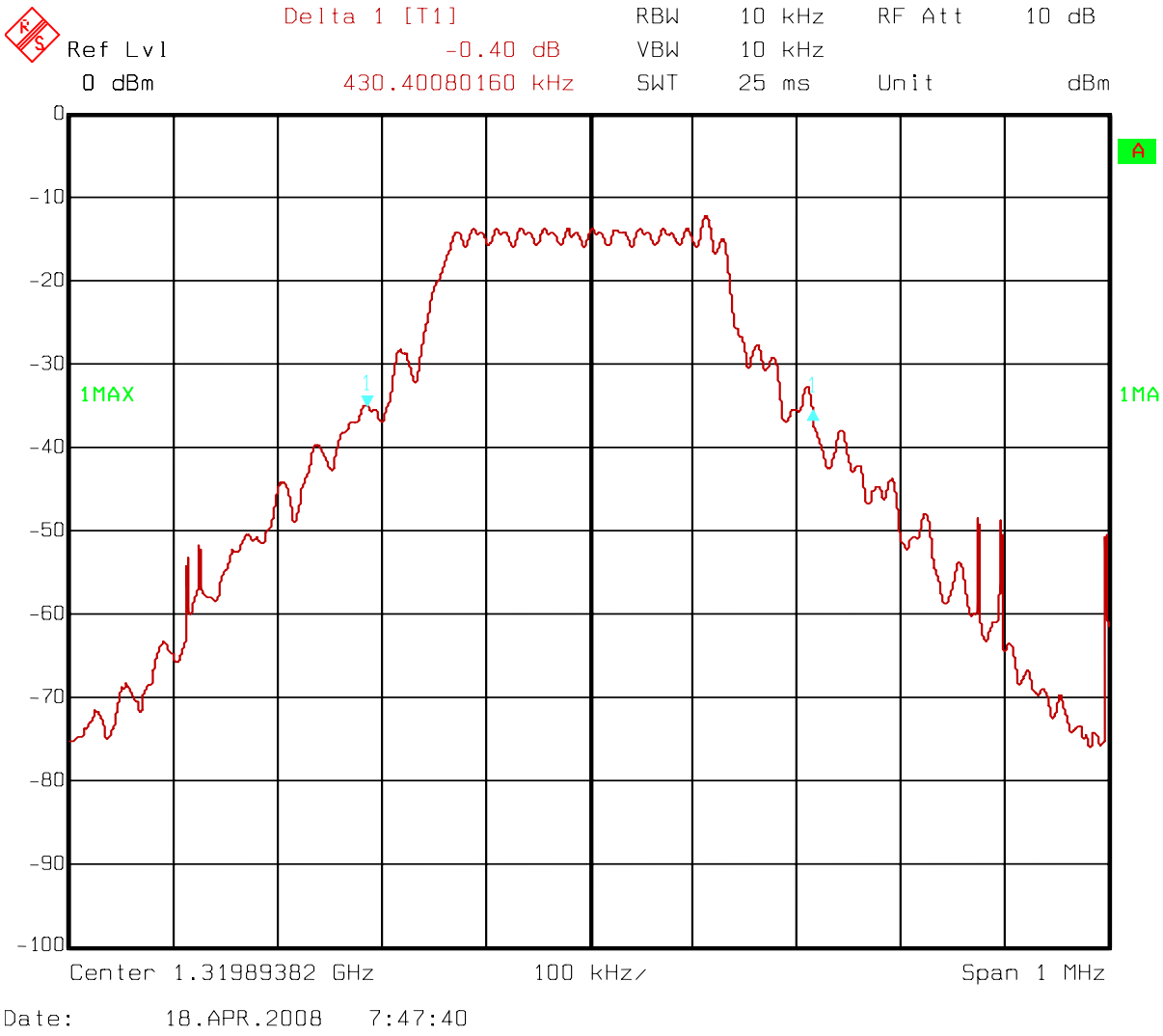
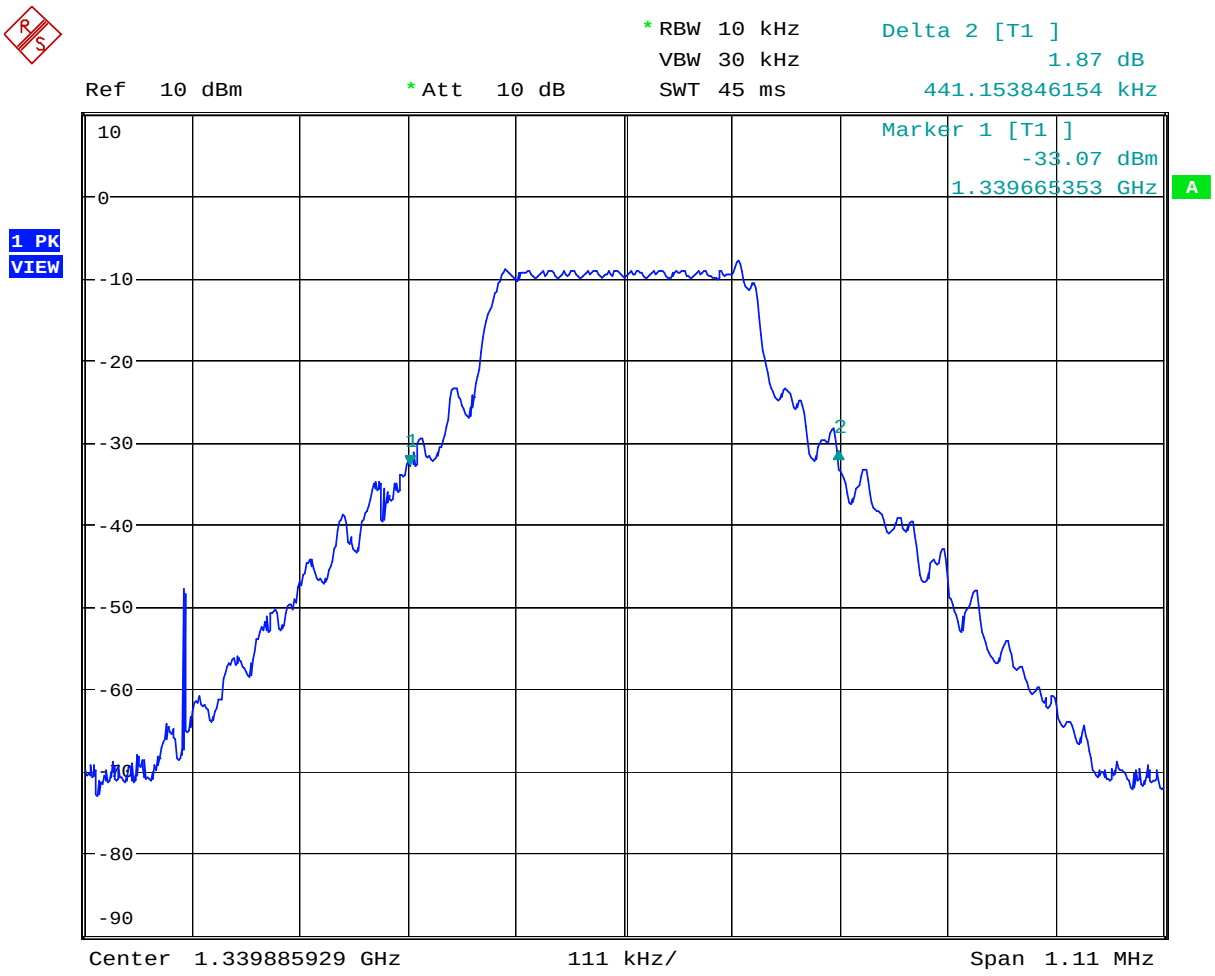
Lower frequency band - Bandwidth



Middle frequency band – Bandwidth



Date: 18.APR.2008 15:26:04

Upper frequency band - Bandwidth

8 Modulation Limiting

Para. No.: 87.141(b)/ 2.1047

Test Performed By: -	**Date of Test: -**

Test Results: Not applicable

Requirement 87.141:

Not applicable

9 Emission Limitations

Para. No.: 87.139(a)/ 2.1049

Test Performed By: G.Suhanthakumar	**Date of Test: 08.04.2008**

Test Results: Complies.

Test Data: See attached graphs.

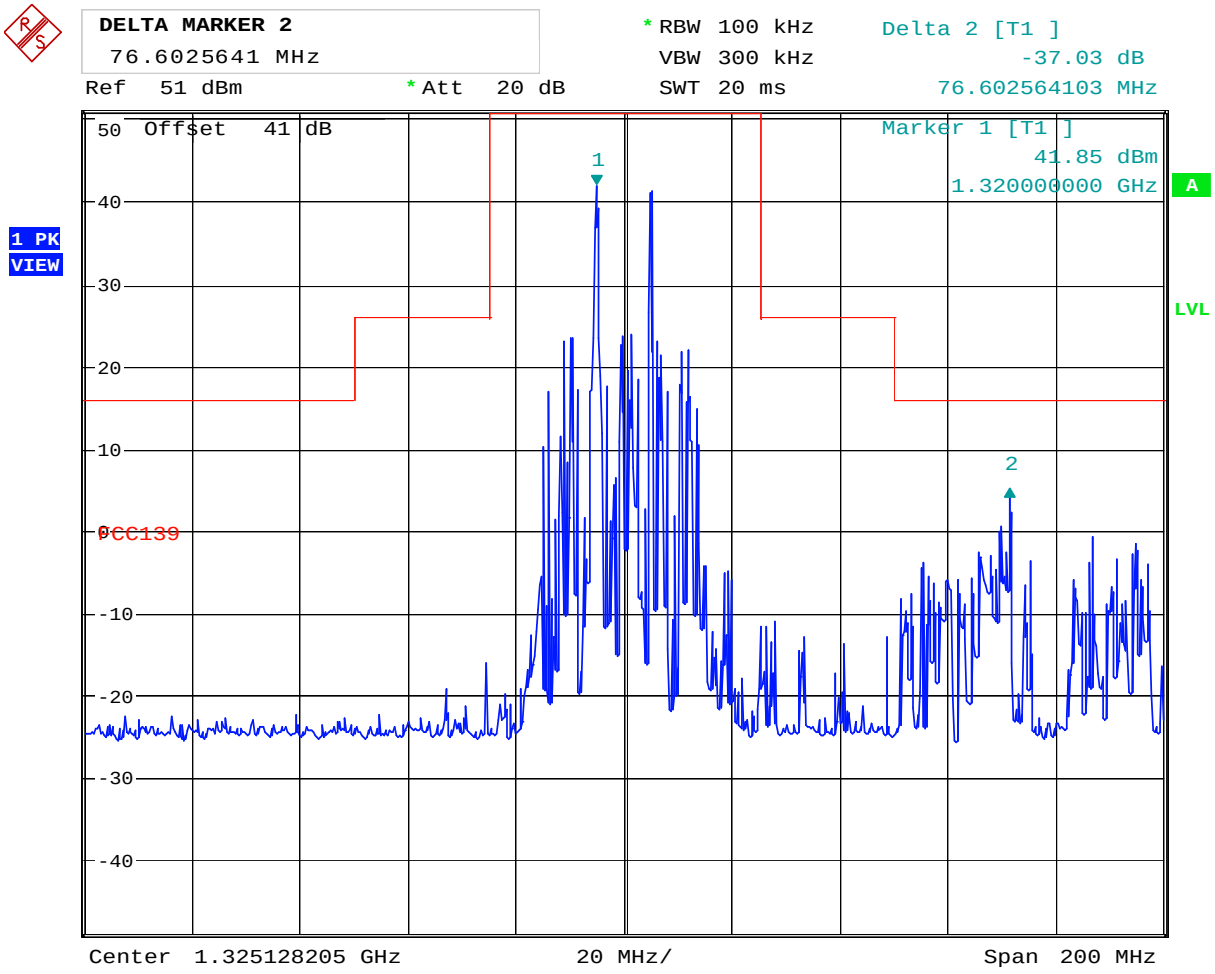
Requirement (87.139(a)):

(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 frequency bands 1435-1535 MHz and 2310-2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission 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;

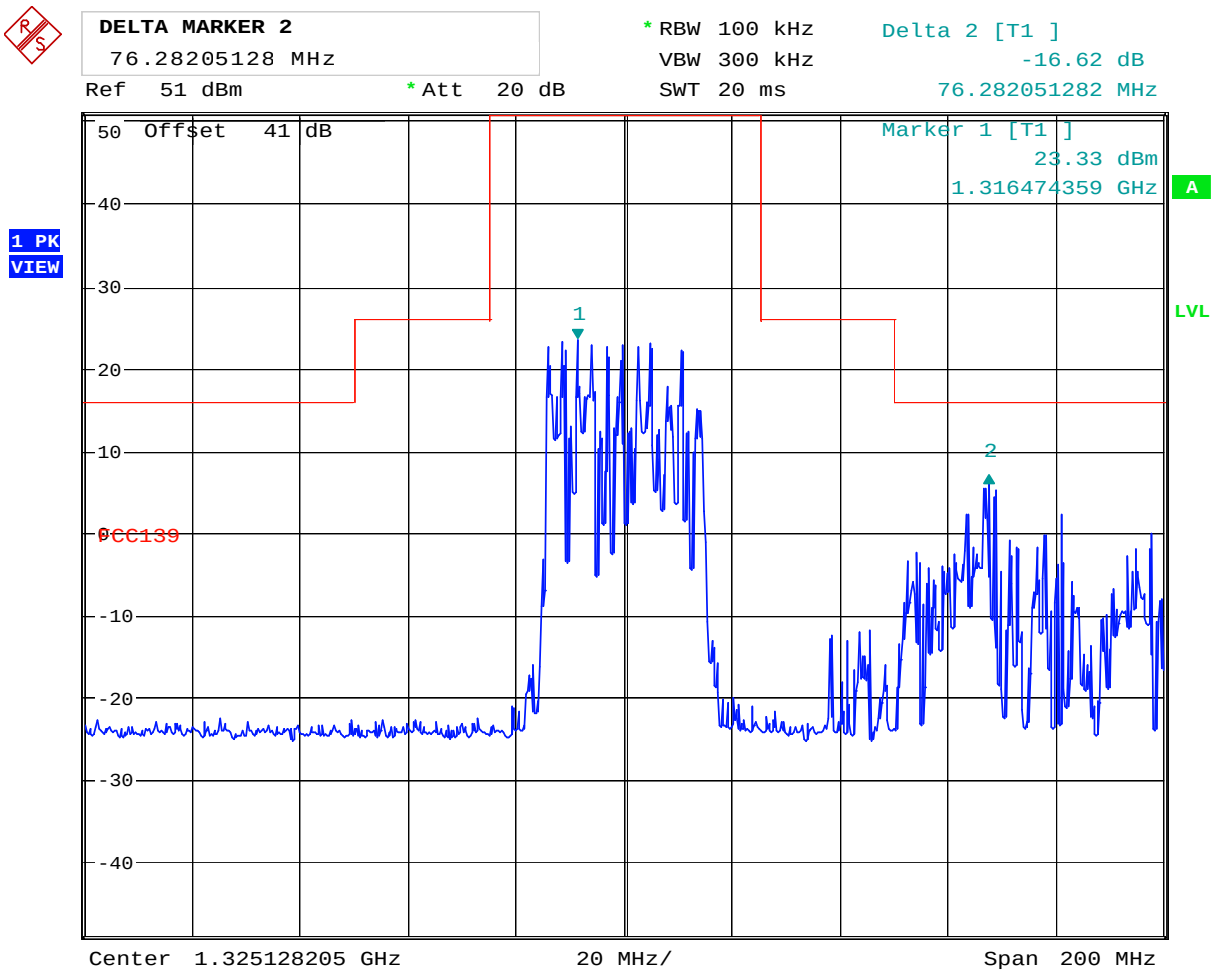
(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(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 log10 pY dB



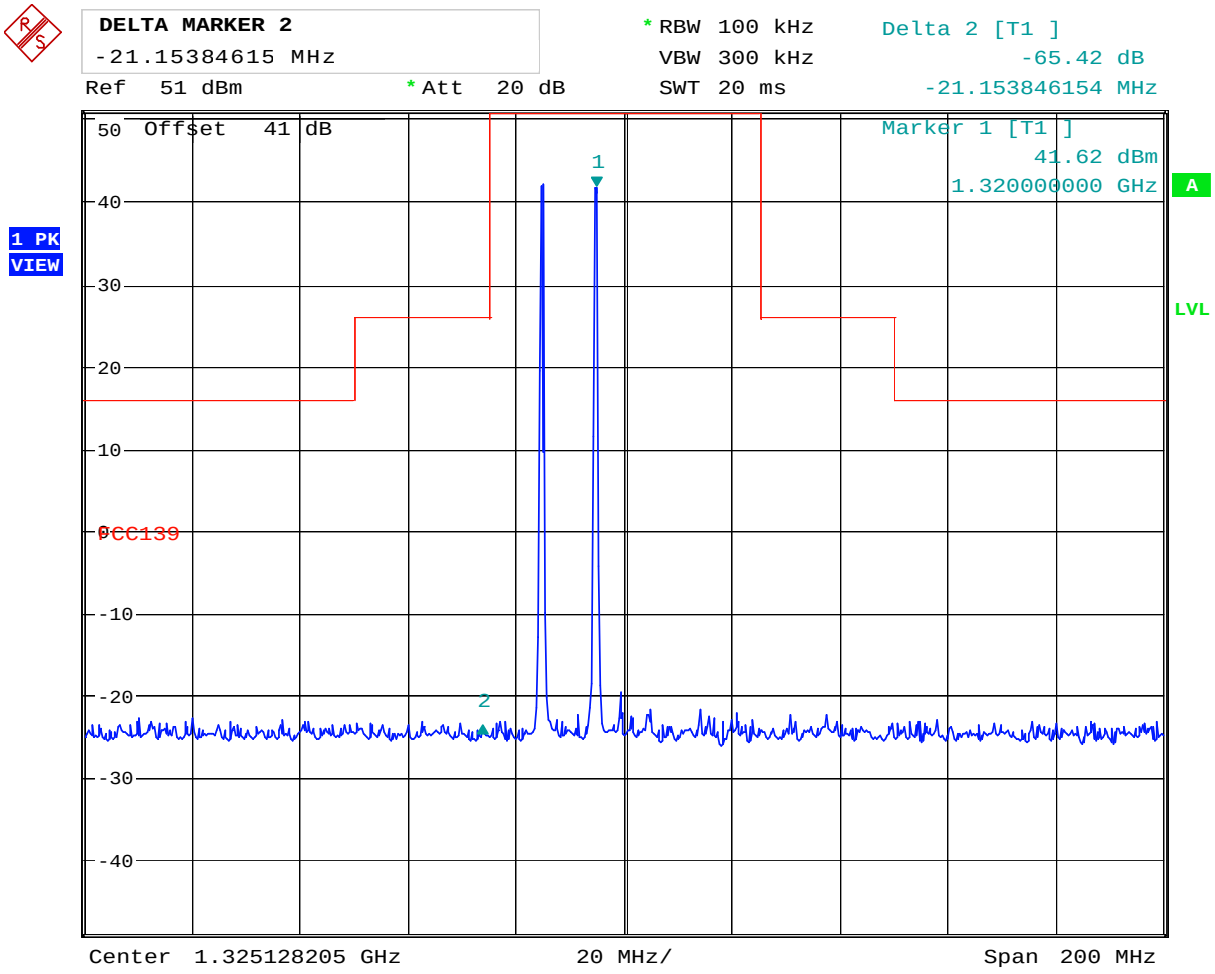
Date: 18.APR.2008 15:14:13

Emission limitation - M3 Fullscan



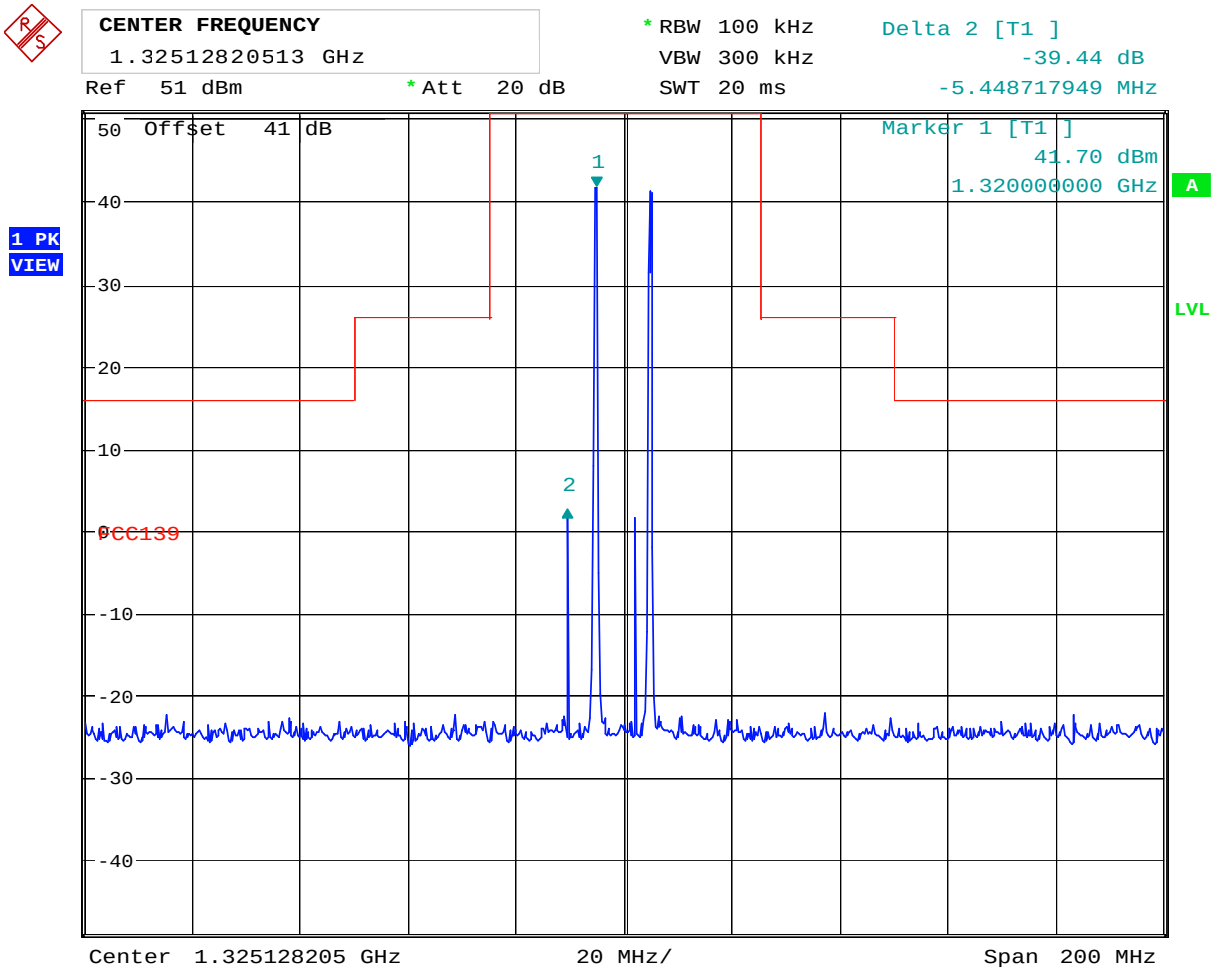
Date: 18.APR.2008 15:20:28

Emission limitation - M3_Fixed



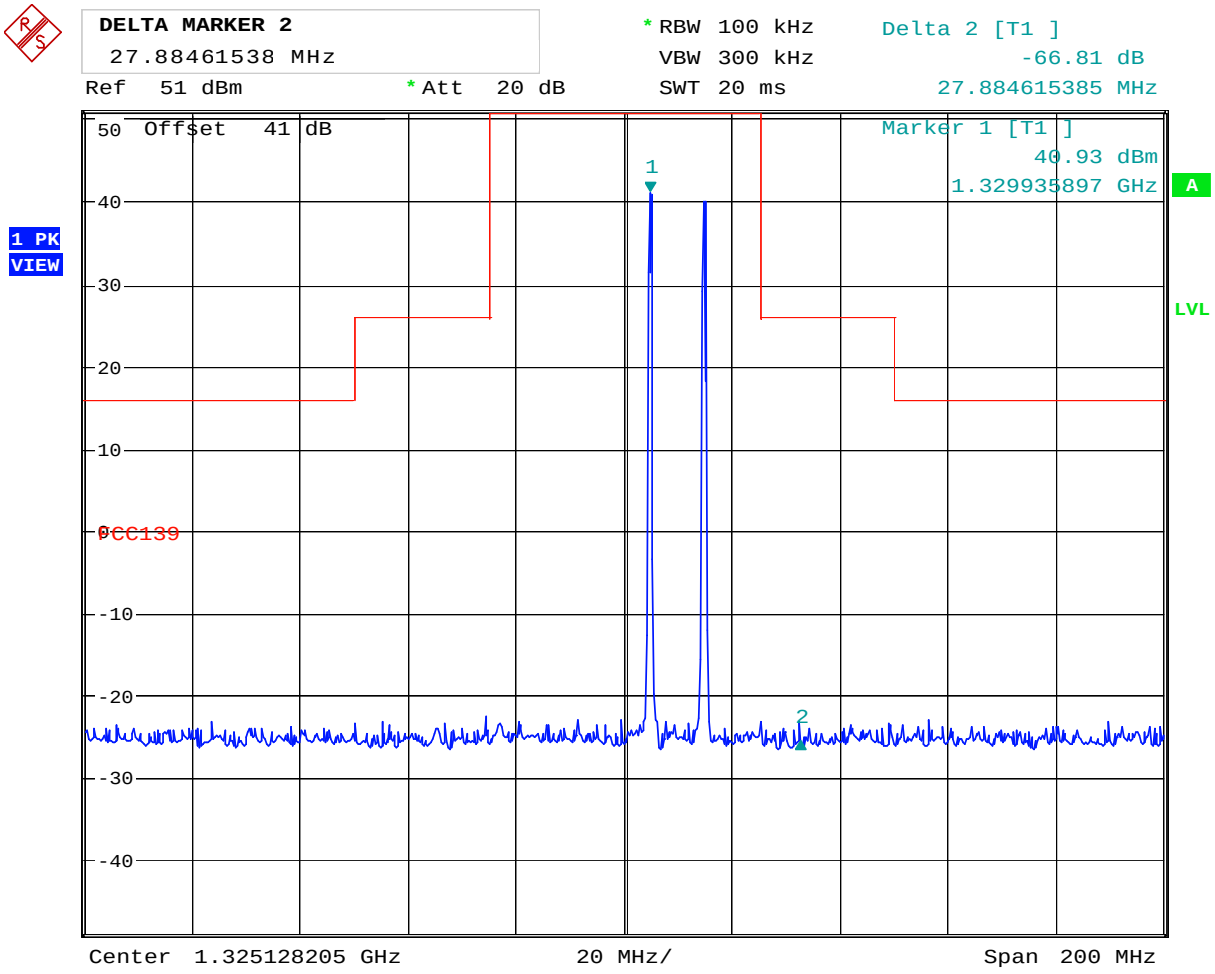
Date: 18.APR.2008 15:11:06

Emission limitation – M1M2-Fixed Low frequency band



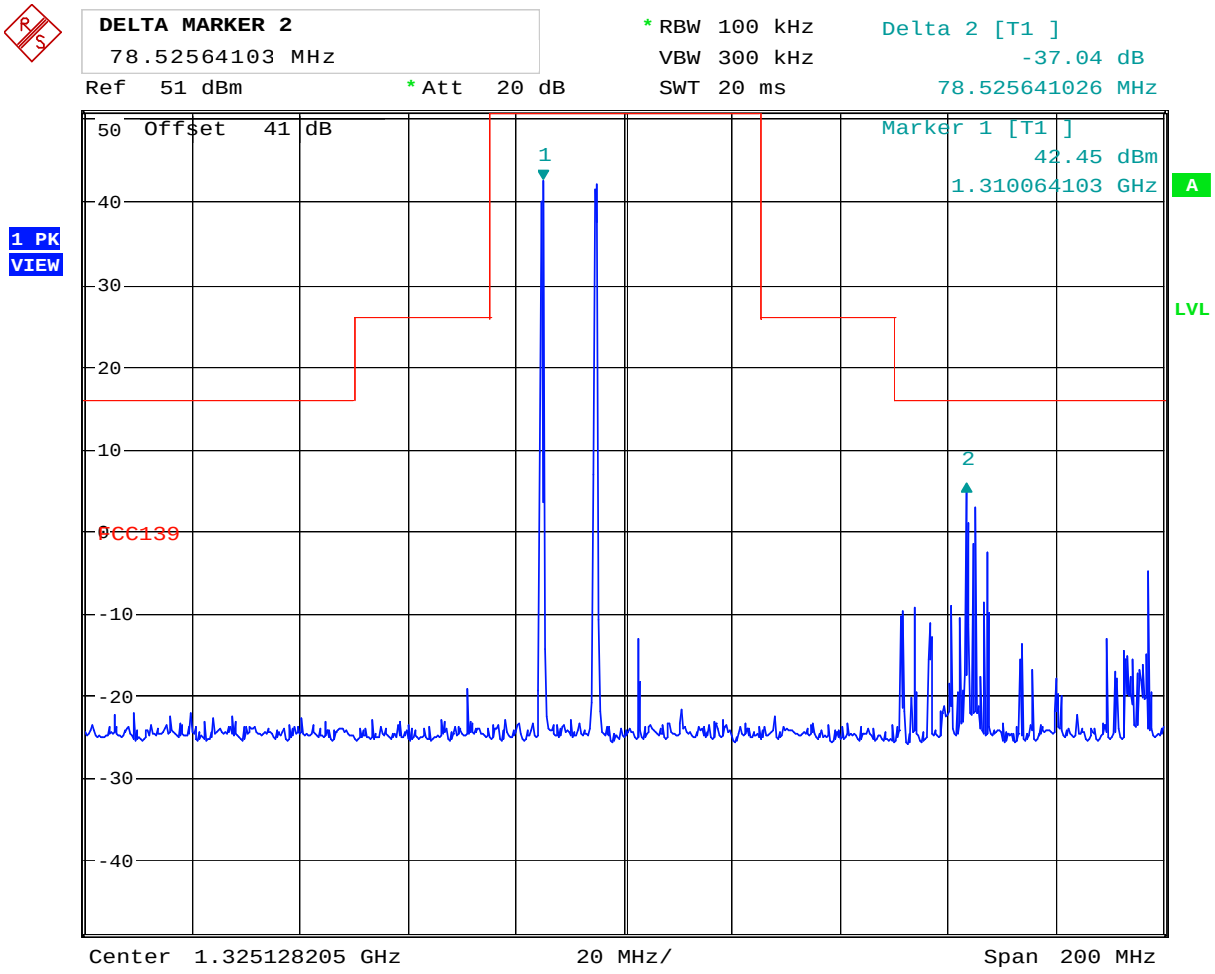
Date: 18.APR.2008 15:09:49

Emission limitation – M1M2-Fixed Middle frequency band



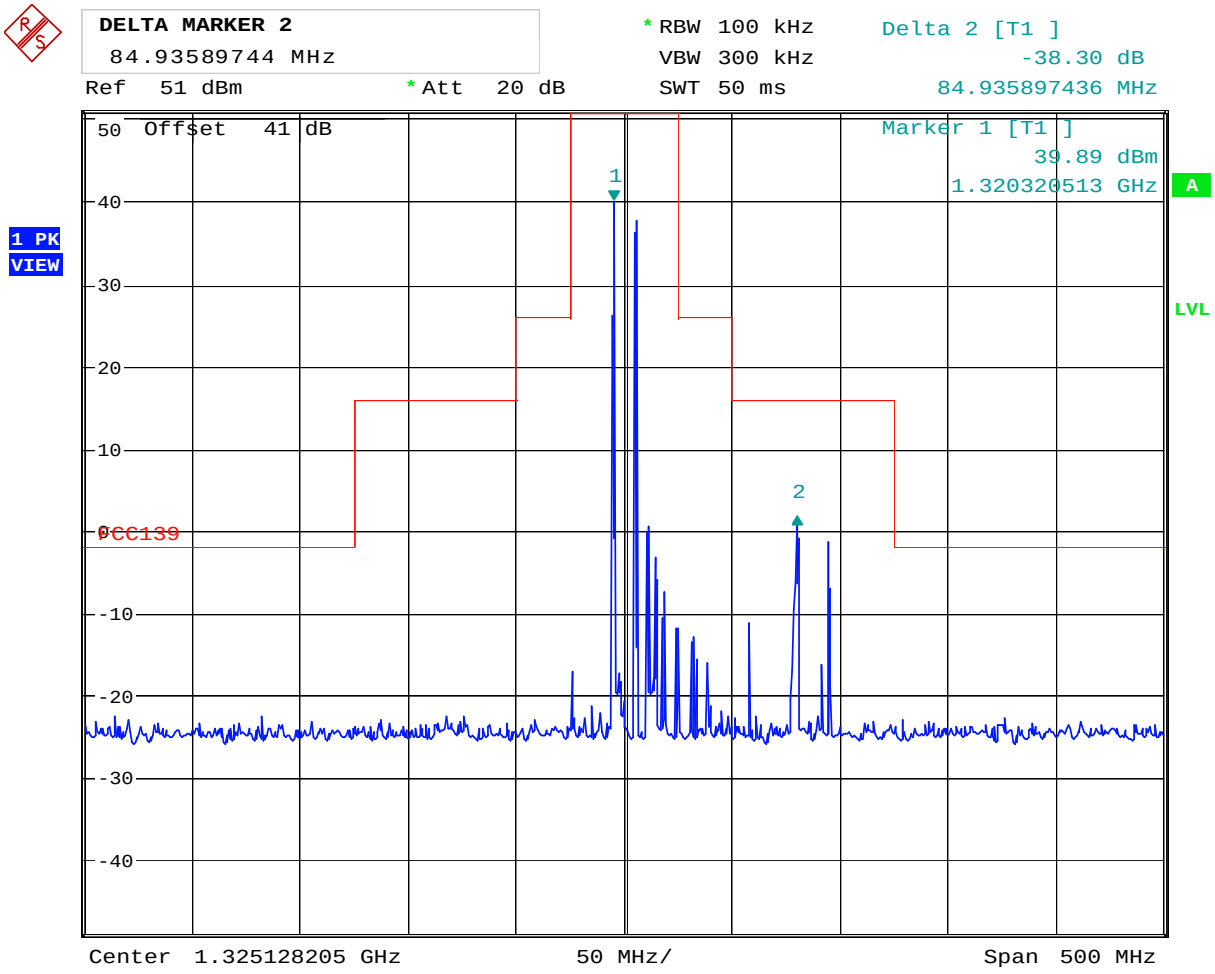
Date: 18.APR.2008 15:12:40

Emission limitation – M1M2-Fixed Upper frequency band



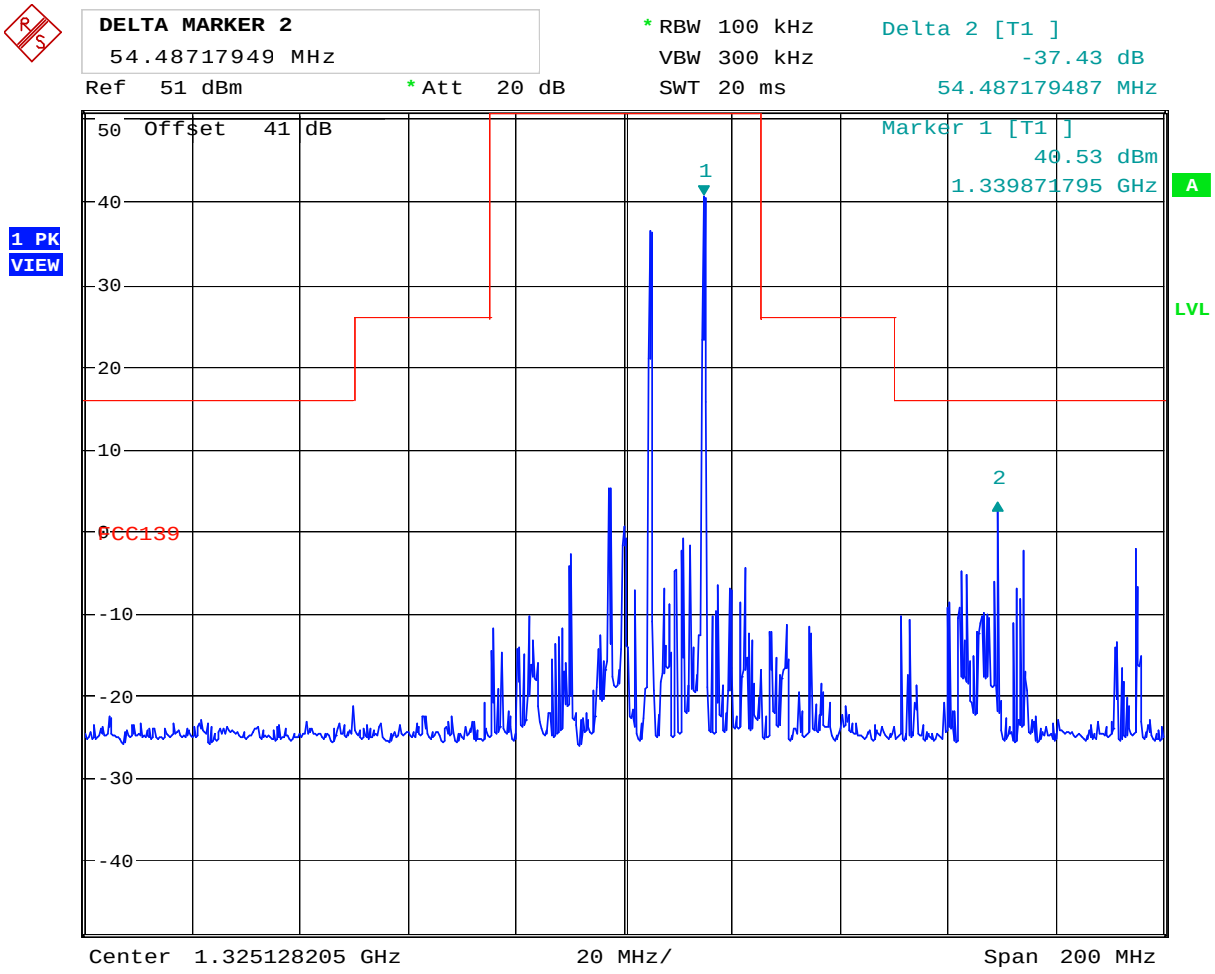
Date: 18.APR.2008 15:15:33

Emission limitation – M2off Low frequency band



Date: 18.APR.2008 15:18:43

Emission limitation – M2off Middle frequency band



Date: 18.APR.2008 15:16:42

Emission limitation – M2off upper frequency band

10 Radiated Spurious Emissions

Para. No.: 87.139(a)(3)/2.1053

Test Performed By: G.Suhanthakumar	Date of Test: 2008.04.08 - 2008.04.18

Test Results: Complies.

The spectrum was searched from 30MHz to 14GHz.

The worst case spurious emissions are observed in VP.

Test Data:

Frequency of Emission (MHz)	Measured Emission Level (dBm)	Polarization	Limit (dBm)	Margin (dB)
36.5	-59.5	VP	-13	46.5
60	-56.7	VP	-13	43.7
100	-58.7	VP	-13	45.7
115	-58.7	VP	-13	45.7
174.2	-67.5	VP	-13	52.7
121.25	-62.5	HP	-13	49.5
221.2	-66	HP	-13	53
2660	-14.32	VP	-13	1.32

Requirement (87.139(a)(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 log10 pY dB, < (-13 dBm)

Spurious emission graphs

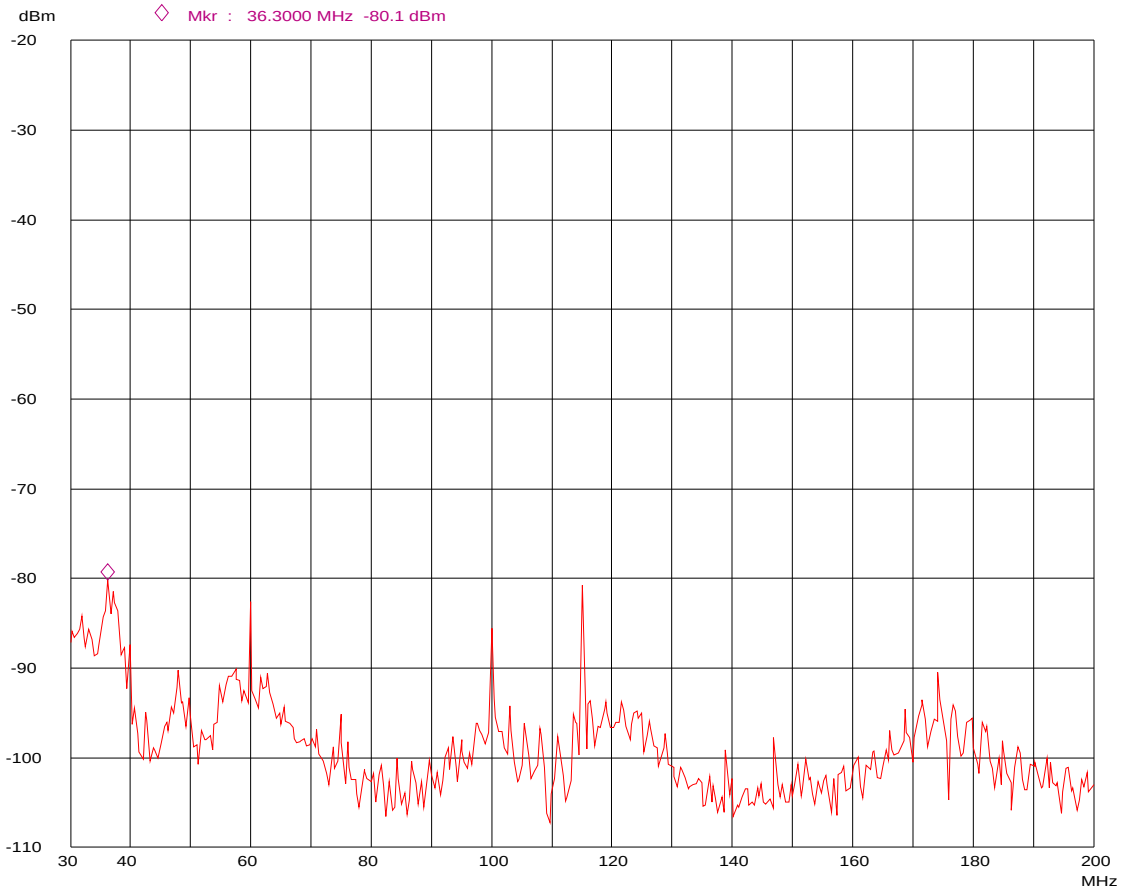
Nemko
Peak

08. Apr 08 12:52

EUT: OCAS Ba
Manuf: OCAS AS
Op Cond: 1m VPP
Operator: gns
Test Spec: FCC part87.131
Comment: Radar

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	200M	50k	120k	PK	50ms	0dBLN	ON	60dB



Radiated Spurious Emissions Scan, VP, 30- 200MHz

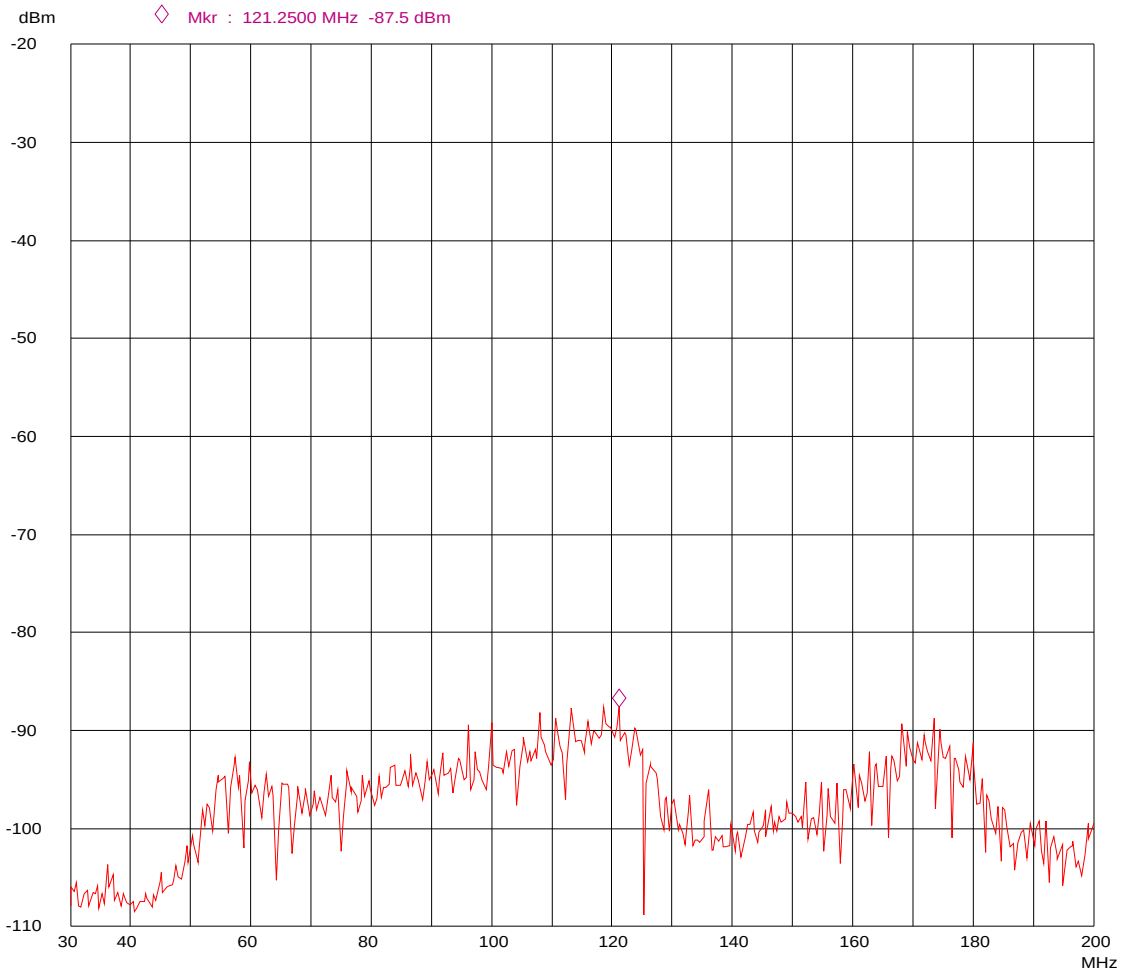
Nemko
Peak

08. Apr 08 12:59

EUT: OCAS Ba
Manuf: OCAS AS
Op Cond: 4m hp
Operator: gns
Test Spec: FCC part87.131
Comment: Radar

Scan Settings (1 Range)
|--------- Frequencies ----------||---------- Receiver Settings ----------|

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	200M	50k	120k	PK	50ms	0dBLN	ON	60dB



Radiated Spurious Emissions Scan, HP, 30- 200MHz

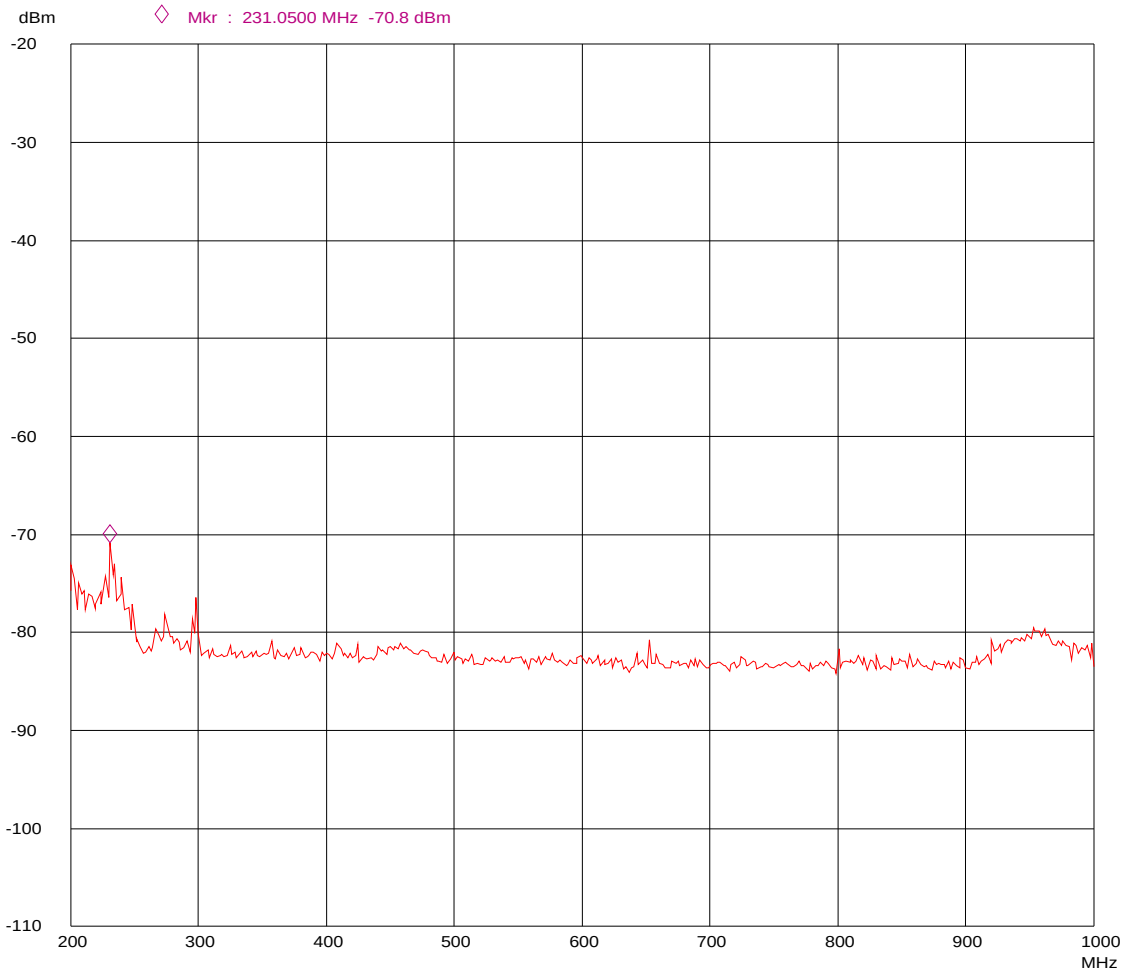
Nemko
Peak

08. Apr 08 14:39

EUT: OCAS Ba
Manuf: OCAS AS
Op Cond: 1m vp
Operator: gns
Test Spec: FCC part87.131
Comment: Radar
M3 fullscan

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
200M	1000M	50k	120k	PK	50ms	AUTO	LN ON	60dB



Radiated Spurious Emissions Scan, VP, 200 - 1000MHz

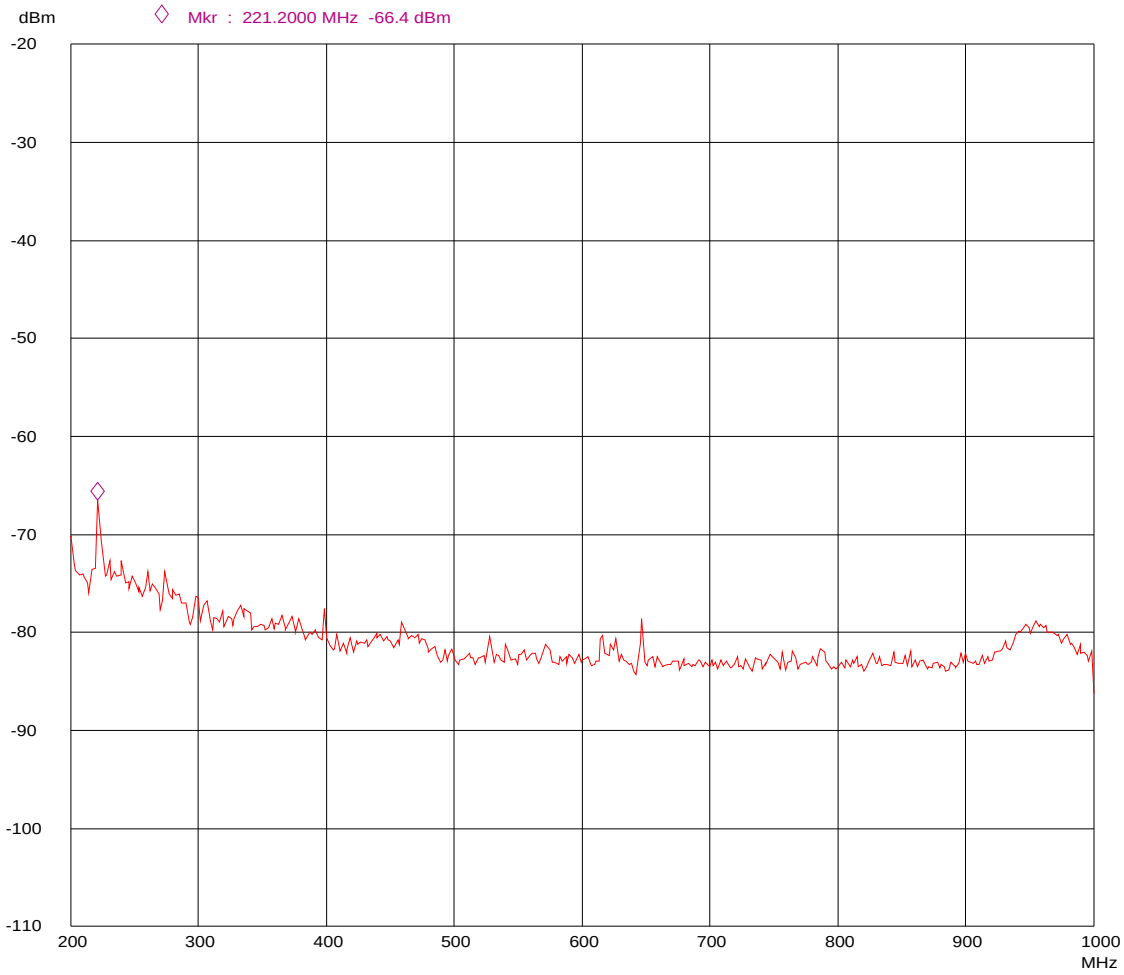
Nemko
Peak

08. Apr 08 14:56

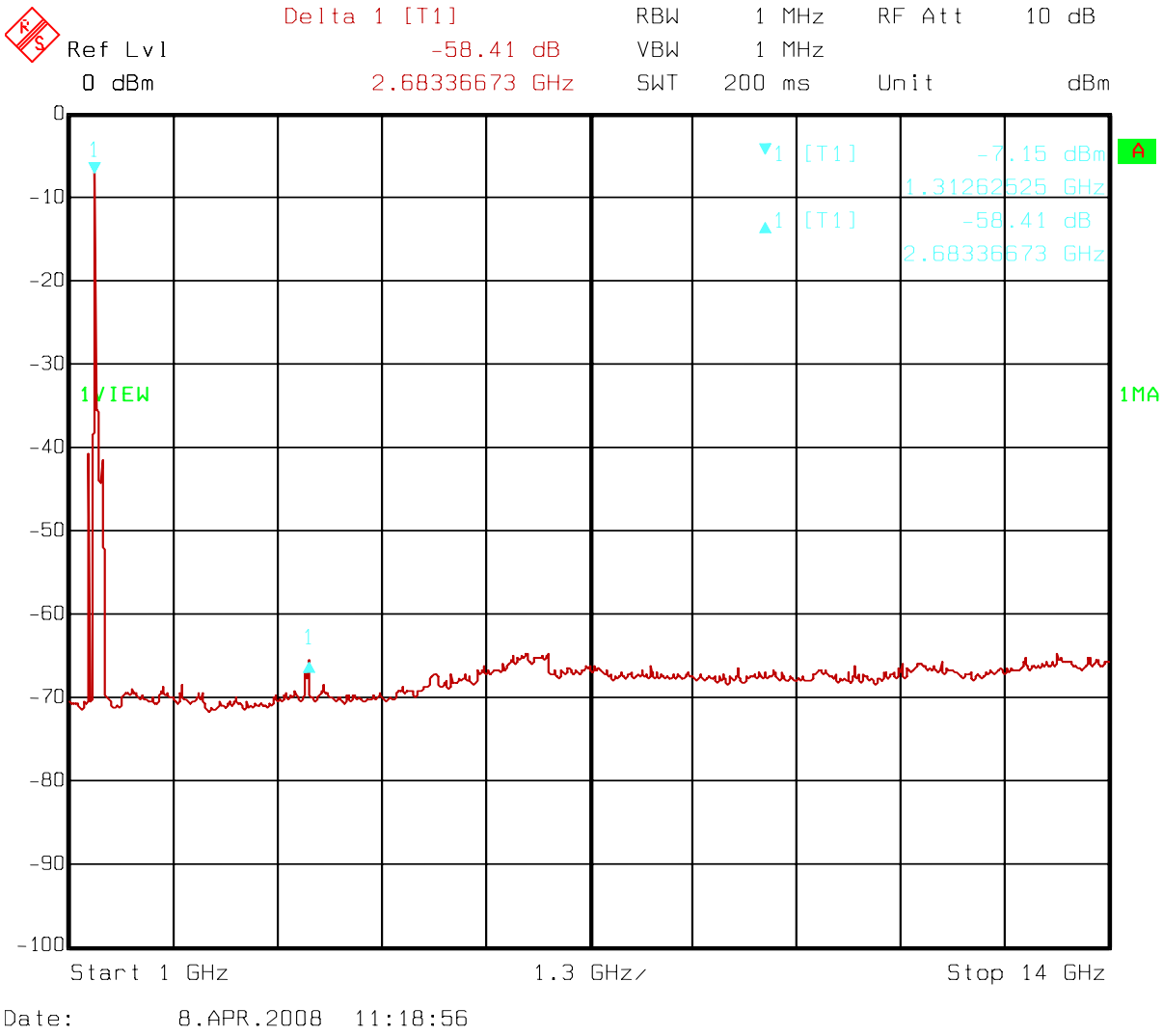
EUT: OCAS Ba
Manuf: OCAS AS
Op Cond: 4m hp
Operator: gns
Test Spec: FCC part87.131
Comment: Radar
M3 fullscan

Scan Settings (1 Range)

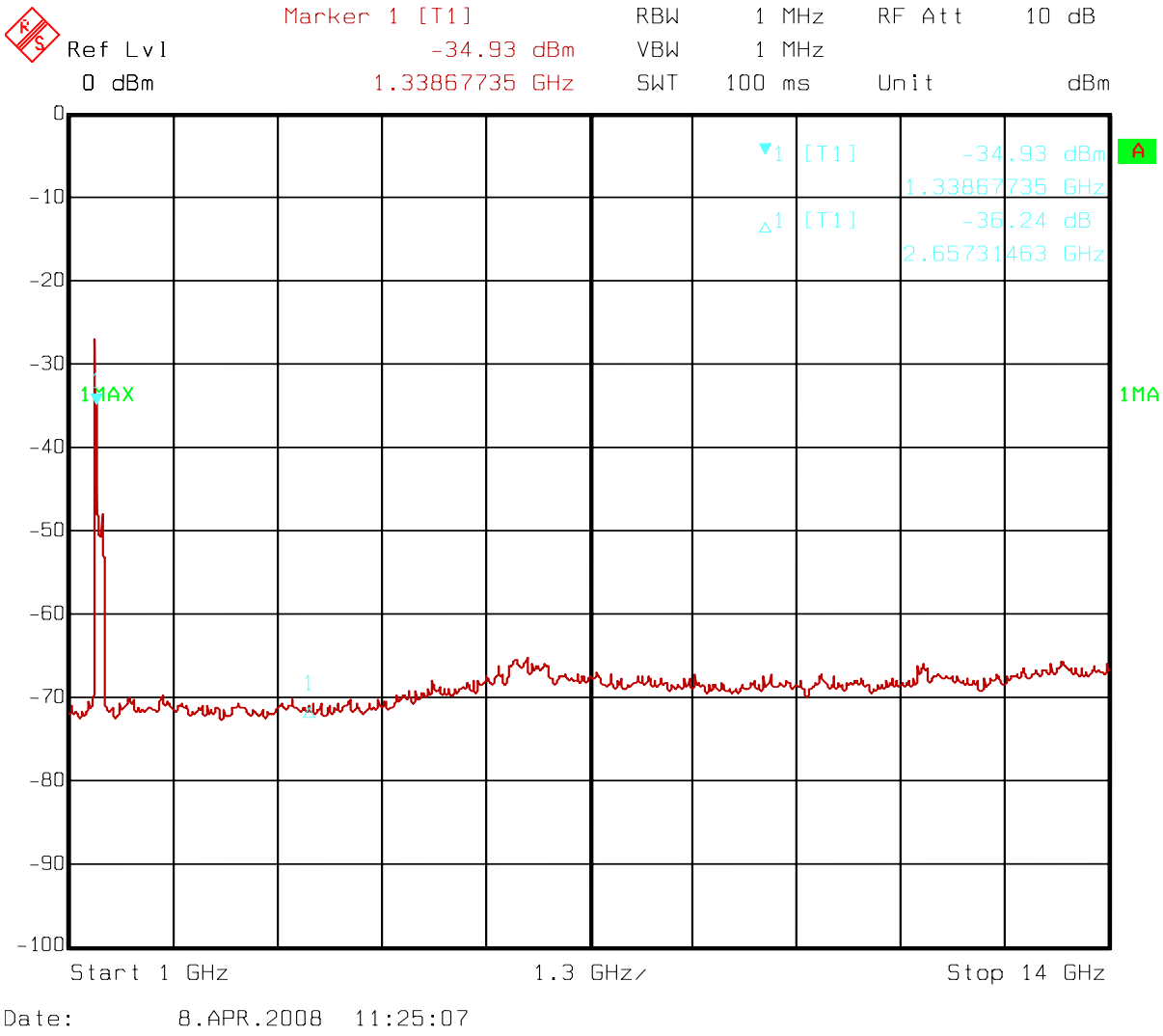
Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
200M	1000M	50k	120k	PK	50ms	AUTO	LN ON	60dB



Radiated Spurious Emissions Scan, HP, 200 - 1000MHz



Radiated Spurious Emissions Scan, VP, 1 - 14 GHz



Radiated Spurious Emissions Scan, HP, 1 - 14GHz

11 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No	Description	Manufacturer	Type
1101	EMI-Receiver	R&S	ESVS30
1261	Antenna Log-periodic	R&S	HL 223
1410	Shielded room	ETS Euroshield	Semi-anechoic
61	Attenuator	Bird	8321
1087	Radio Communications Analyzer	R&S	CMTA 54
1079	Generator, AF/../UHF	R&S	SMHU56
1337	Spectrum Analyzer	R&S	FSEK 1088,3494,30
1336	Generator, RF	R&S	SMP04 1035,5005,04
1260	Antenna, Biconical	R&S	HK 116
1338	Probe, RF	HP	8481H
181	Power meter	HP	436A
1014	Counter Freq	HP	5386A
1195	Attenuator	Narda	768-30
1007	Attenuator	Narda	765-10
1020	Multimeter, Digital	Fluke	87
257	Hybrid	Anzac	H-9
1504	EMI Receiver	R&S	FSU26
1167	Filter Band Pass	Trilithic	5VF95/190
46	Filter Band Pass	Texscan	5VF190/375
1169	Filter Band Pass	Trilithic	5VF250/500
1173	Filter Band Pass	Trilithic	5VF24/48
1174	Filter Band Pass	Trilithic	5VF1000/2000
5099	Spectrum Analyzer	HP	3588A
1083	Climatic chamber	ACS	TY80

12 TEST SET-UP

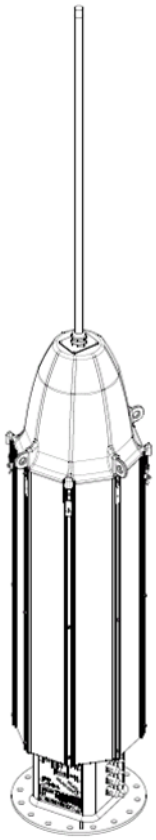


Figure 1 Radar Unit containing Antenne Module, Radar Module and Control Module

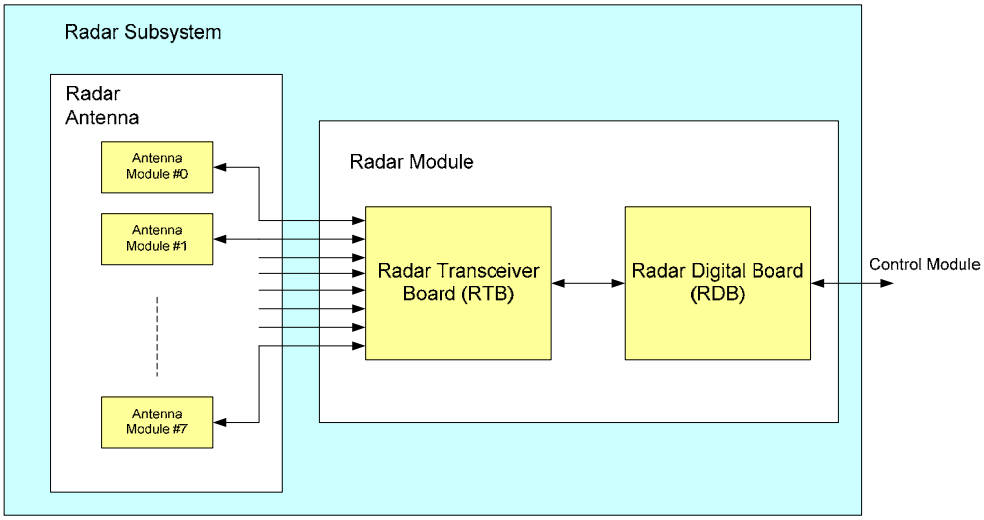


Figure 2 Antenne Module and Radar Module

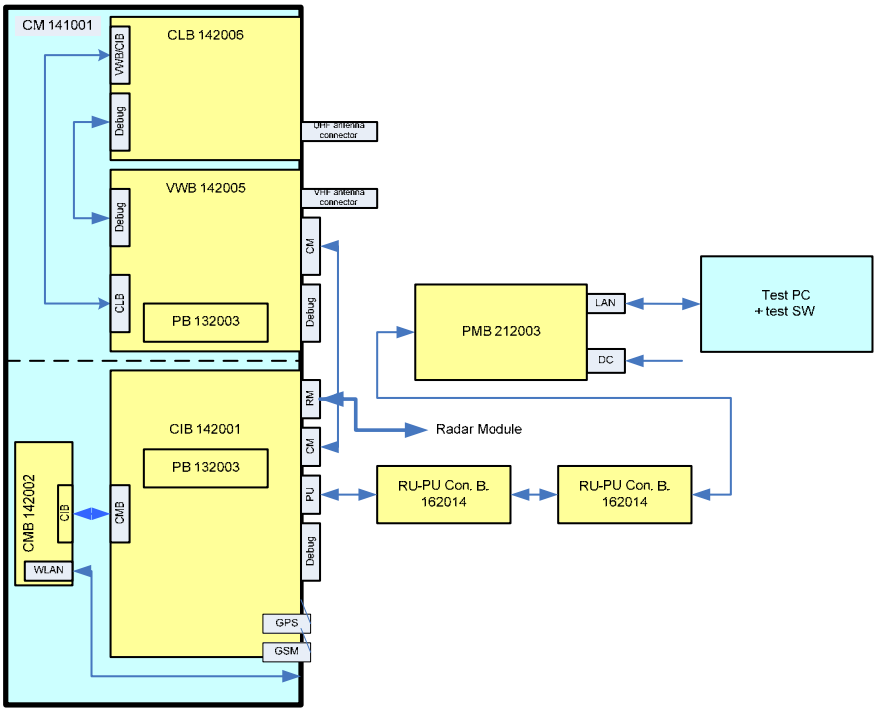
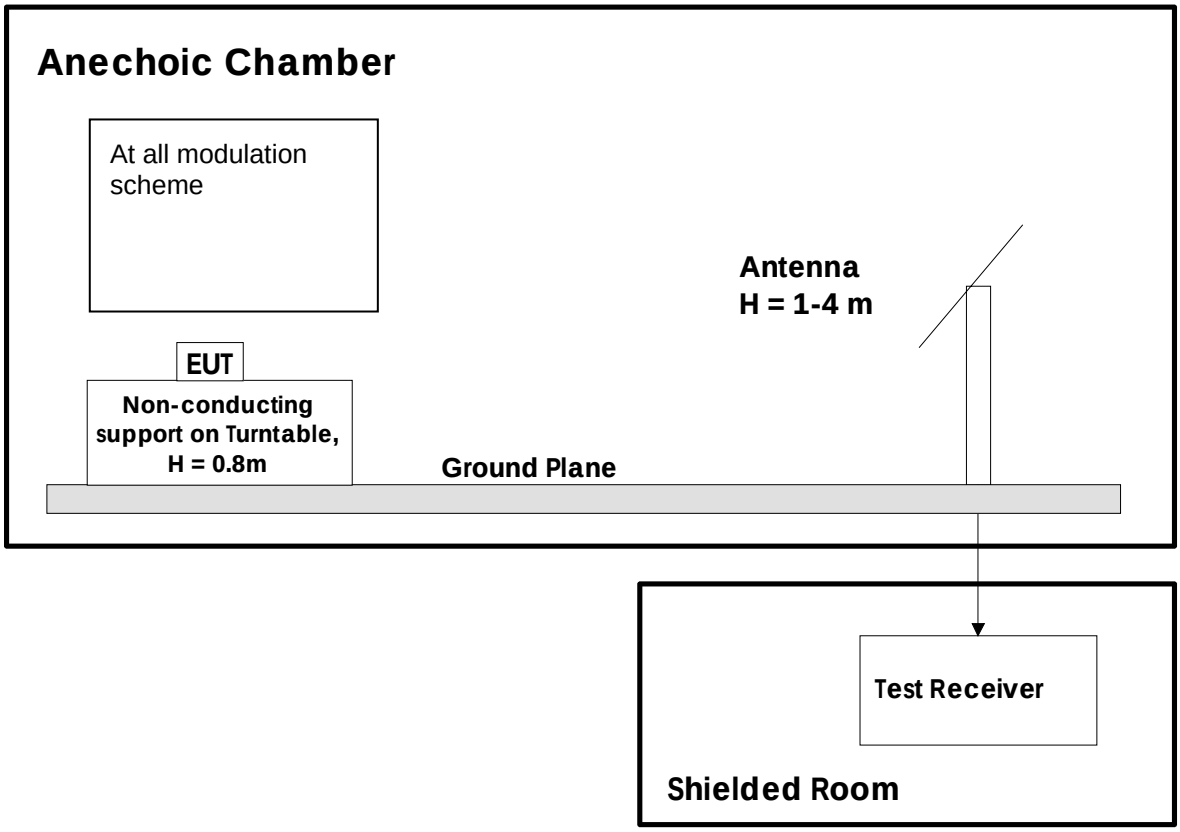


Figure 3 Control Module + interface to Test PC

Block diagram of the System set-up



Emission levels are measured in terms of ERP & EIRP. All emissions within 20 dB of the specification limit are maximized along 360° azimuth and further maximized by raising and lowering the search antenna from 1 to 4 m. The transmitter under test is replaced with a dipole antenna and calibrated signal generator. The level and frequency of the signal generator are adjusted in order to reproduce the previously detected emission and maximized by varying the height of the search antenna. This procedure is performed both horizontal and vertical polarization of the detected signal.

Radiated spurious emissions