Bookmarks are enabled in this document

Test of SPEEDLAN 9200

To FCC 47 CFR Part 90, Subpart Y

Test Report Serial No.: PCOM08-A1 Rev B

TEST REPORT

FROM

Test of SPEEDLAN 9200

To FCC 47 CFR Part 90, Subpart Y

Test Report Serial No.: PCOM08-A1 Rev B

This report supersedes PCOM08-A1 Rev A

Manufacturer: Wave Wireless Corporation
1996 Lundy Ave
San Jose, CA 95131
USA

Product Function: Wireless Mesh Router Operating at 4.9 GHz

Copy No: pdf **Issue Date:** 21st Oct 2005

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
3922 Valley Avenue, Suite B
Pleasanton, California 94566, USA
Phone: 925.462.0304
Fax: 925.462.0306
www.micomlabs.com

This page has been left intentionally blank

TABLE OF CONTENTS

LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

United States of America
Federal Communications Commission (FCC) Listing #: 102167

Canada
Industry Canada (IC) Listing #: 4143

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	8th September 2005	First release.
Rev B	21st October 2005	Update product name. Add Power Line Conducted Emissions & Maximum Permissible Exposure.

1. TEST RESULT CERTIFICATE

Manufacturer:	Wave Wireless Corporation 1996 Lundy Ave, San Jose, CA 95131 USA	Tested By:	MiCOM Labs, Inc. 3922 Valley Avenue 'B' Pleasanton California, 94566, USA
EUT:	Wireless Mesh Router Operating at 4.9 GHz	Telephone:	+1 925 462 0304
Model:	SPEEDLAN 9200	Fax:	+1 925 462 0306
S/N:	1430544		
Test Date(s):	22nd - 24th August 2005	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 90, Subpart Y	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 90	2004	Code of Federal Regulations
(ii)	FCC 47 CFR Part 90 Sect 90.210 Sect 90.1215	18th May 2005	90.210 Emission Masks (Revised requirements) 90.1215 Power Limits (Revised requirements)
(iii)	ANSI C63.4	2003	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(iv)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(v)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(vi)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(vii)	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(viii)	UKAS LAB 1	Edition 4 May 2004	Reference to Accreditation for Laboratories.
(ix)	DTI URN 98/997	2003	Conditions for the use of National Accreditation Marks by UKAS and UKAS Accredited Organizations.

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the SPEEDLAN 9200 to FCC 47 CFR Part 90 Subpart Y regulations.
Applicant:	As manufacturer
Manufacturer:	Wave Wireless Corporation 1996 Lundy Ave San Jose, CA 95131, USA
Laboratory performing the tests:	MiCOM Labs, Inc. 3922 Valley Avenue, Suite "B" Pleasanton, California 94566 USA
Test report reference number:	PCOM08-A1
Date EUT received:	22nd August 2005
Dates of test (from - to):	22nd to 24th August 2005.
Standard(s) applied:	FCC 47 CFR Part 90, Subpart Y
No of Units Tested:	1
Type of Equipment:	WLAN 4.9 GHz Public Safety Band Radio
Manufacturers Trade Name:	Wave Wireless Corporation
Model:	SPEEDLAN 9200
Location for use:	Indoor and Outdoor
Declared Frequency Range(s):	4940 to 4990 MHz
Type of Modulation:	OFDM;- BPSK, QPSK, 16QAM, 64QAM
Declared Maximum Output Power:	+23 dBm
EUT Modes of Operation:	OFDM
ITU Emission Designator:	5 MHz: 5M7W7D 10 MHz: 10M9W7D 20 MHz: 21M8W7D
Transmit/Receive Operation:	Simplex
Rated Input Voltage and Current:	100 – 240 VAC, 0.7 A
Operating Temperature Range:	-33ºC to +55ºC
Microprocessor(s) Model:	AMD Elan SC520
Clock/Oscillator(s):	32.768 kHz, 25 MHz, 33.333 MHz, 66.666 MHz, 133.333 MHz, 40MHz
Frequency Stability:	± 20ppm
Equipment Dimensions:	9" x 7" x 3.5"
Weight:	5.5 lbs
Primary function of equipment:	Wireless Local Area Network (WLAN)

3.2. Scope of Test Program

The scope of the test program was to test the Wave Wireless Corporation SPEEDLAN 9200 for compliance against;-

FCC 47 CFR Part 90, Subpart Y regulatory requirements.

18th May 2005 revision of FCC 47 CFR Part 90;-

Sub Section 90.210	Emission Masks (revised requirements)
Sub Section 90.1215	Power Limits (revised requirements)

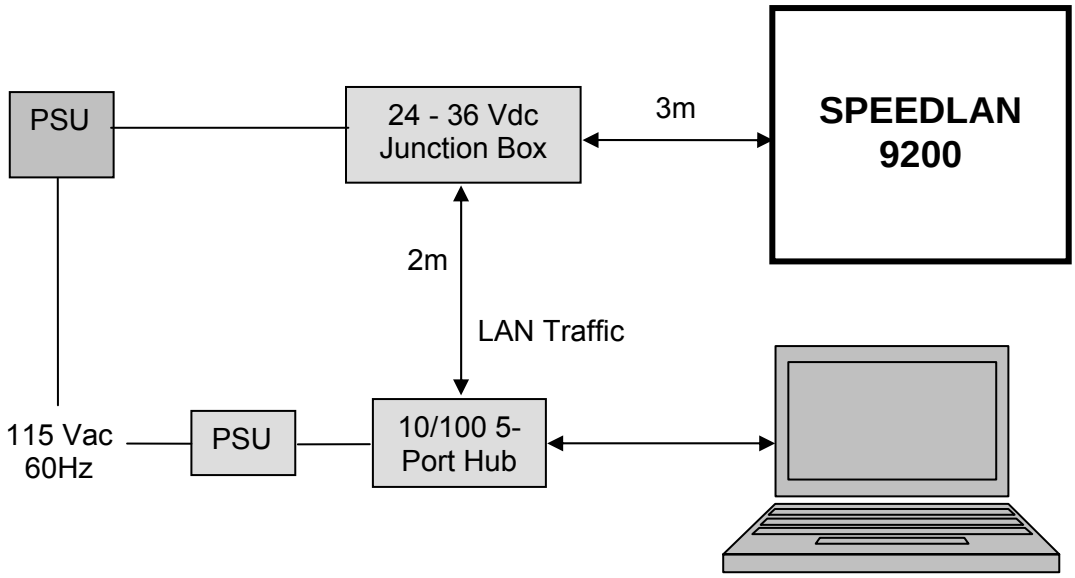
The SPEEDLAN 9200 part of the SPEEDLAN 9200 series of products is a WLAN 4.9 GHz Public Safety Band Radio employing OFDM modulation at 5, 10, and 20 MHz bandwidths in the frequency range 4940 to 4990 MHz;

Wave Wireless Corporation

SPEEDLAN 9200 4.9 GHz Public Safety Band Radio

3.3. Equipment Model(s) and Serial Number(s)

EUT/ Support	Name	Manufacturer	Model No.	Serial No.
EUT	4.9 GHz Public Safety Band Radio	Wave Wireless Corporation	SPEEDLAN 9200	1430544
EUT	24-36 Volt Junction Box	Wave Wireless Networking	--	--
EUT	Class 1 PSU 100-250V 47-63 Hz 0.9 A / 24 Vdc 1.5A	Sceptre	PS-2415APL05	034493
EUT	IP Recover	Wave Wireless Corporation	Software Utility	REV 2.2.1b
Support	10/100 5-Port Workgroup Hub	Cisco	EFAH05W	RA1304B0 00738
Support	Power Supply	I.T.E.	D75-07A-950	R0410200 00420
Support	Laptop computer	IBM	Thinkpad R40	FX 05793



3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.

No antennas were submitted for test purposes

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. ODU - single cable for power, data and maintenance functions
2. Junction box – to ODU cable, LAN traffic and 24-36V dc power

3.6. Test Configurations

Matrix of test configurations

Parameter	Operational Mode	Test Conditions	Bandwidths (MHz)
Occupied BW & Emission Mask	Modulated	Ambient	5, 10, 20
Peak Output power	Modulated	Ambient	5, 10, 20
Peak Power Spectral Density	Modulated	Ambient	5, 10, 20
Frequency Stability	Modulated	Temperature Variations and Voltage Variations	20
Conducted Emissions	Modulated	Ambient	5, 10, 20
Radiated Emissions	Modulated	Ambient	5, 10, 20

Only worst case plots are provided for each test parameter are identified within this report. Plots not included are held on file by the test laboratory and available upon request with client permission.

3.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. NONE

3.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

3.9. Subcontracted Testing or Third Party Data

1. NONE

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 90**, **Subpart Y (except Section 5.1.4)**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
2.1049; 90.210(m)	26 dB Occupied BW & Emission Mask	Emission mask and bandwidth measurement(s)	Conducted	Complies	5.1.1
2.1046; 90.1215 (a)	Peak Output Power	Modulated Output Power	Conducted	Complies	5.1.2
2.1046; 90.1215 (a)	Peak Power Spectral Density	Maximum Spectral Density	Conducted	Complies	5.1.3
Subpart C 90.1217	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Radiated	Complies	5.1.4
2.1055(a)(1); 90.213	Frequency Stability	Includes temperature and voltage variations	Conducted	Complies	5.1.5
2.1051; 90.210(m)	Conducted Spurious Emissions at Antenna Port	Emissions from the antenna port 30 MHz – 40 GHz	Conducted	Complies	5.1.6
2.1053; 90.210(m)	Radiated Spurious Emissions	Spurious emissions 30 MHz – 40 GHz	Radiated	Complies	5.1.7

Note 1: *Test results reported in this document relate only to the items tested*
Note 2: *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria*
Note 3: *Section 3.7 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix*

5. TEST RESULTS

5.1. Device Characteristics

5.1.1. Occupied Bandwidth and Emission Mask

FCC 47 CFR Part 90, Subpart Y; 2.1049; §90.210(m)

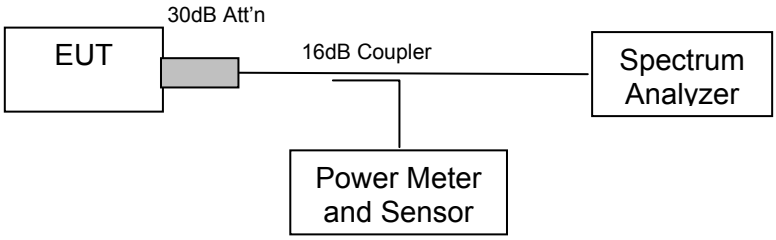
Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure the 26 dB occupied bandwidth and emission mask for the radio. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

For emission masks the zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

The EUT is not equipped with an audio low-pass filter.

Test Measurement Set up

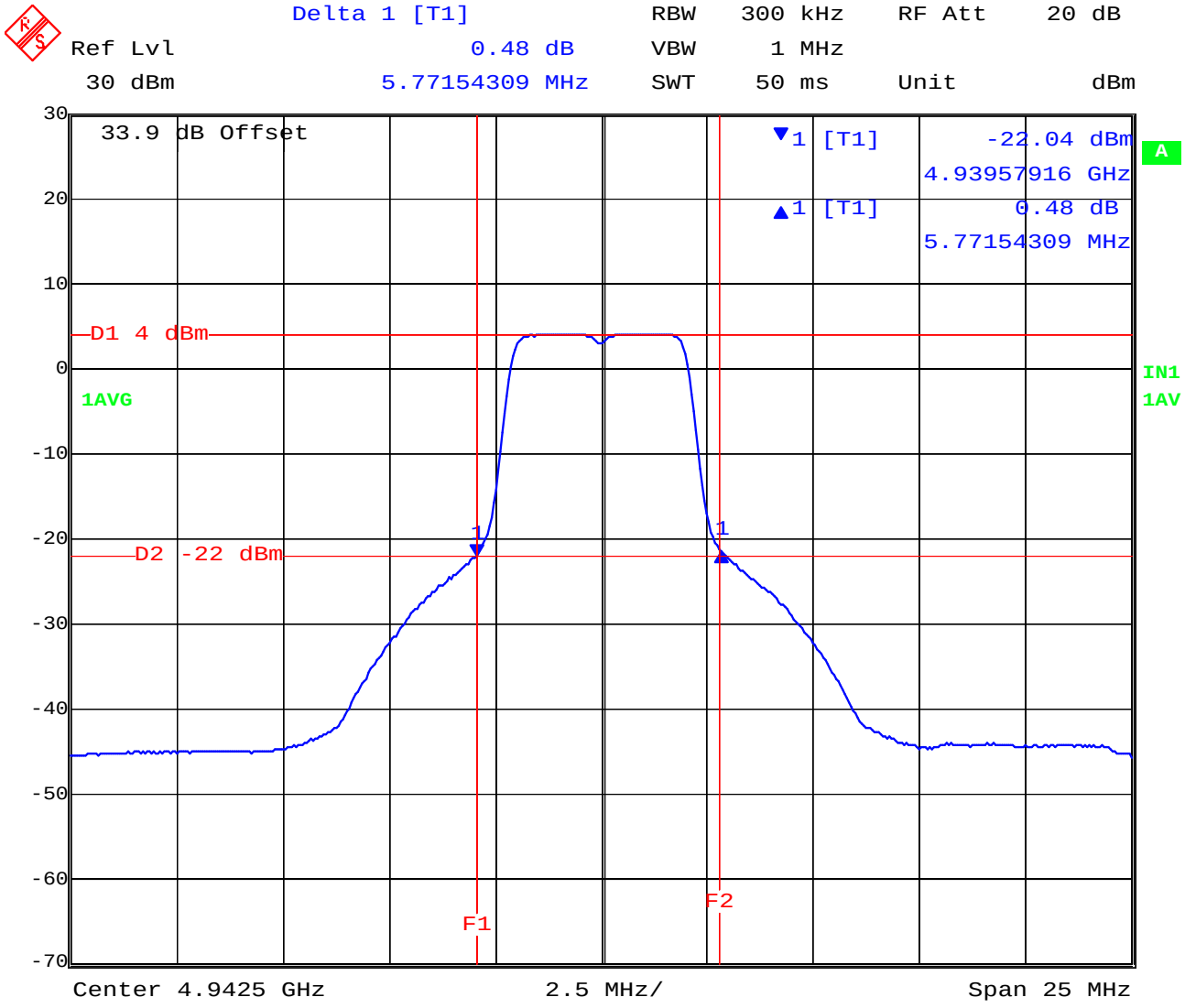


Test set up for Occupied Bandwidth and Emission Mask measurement

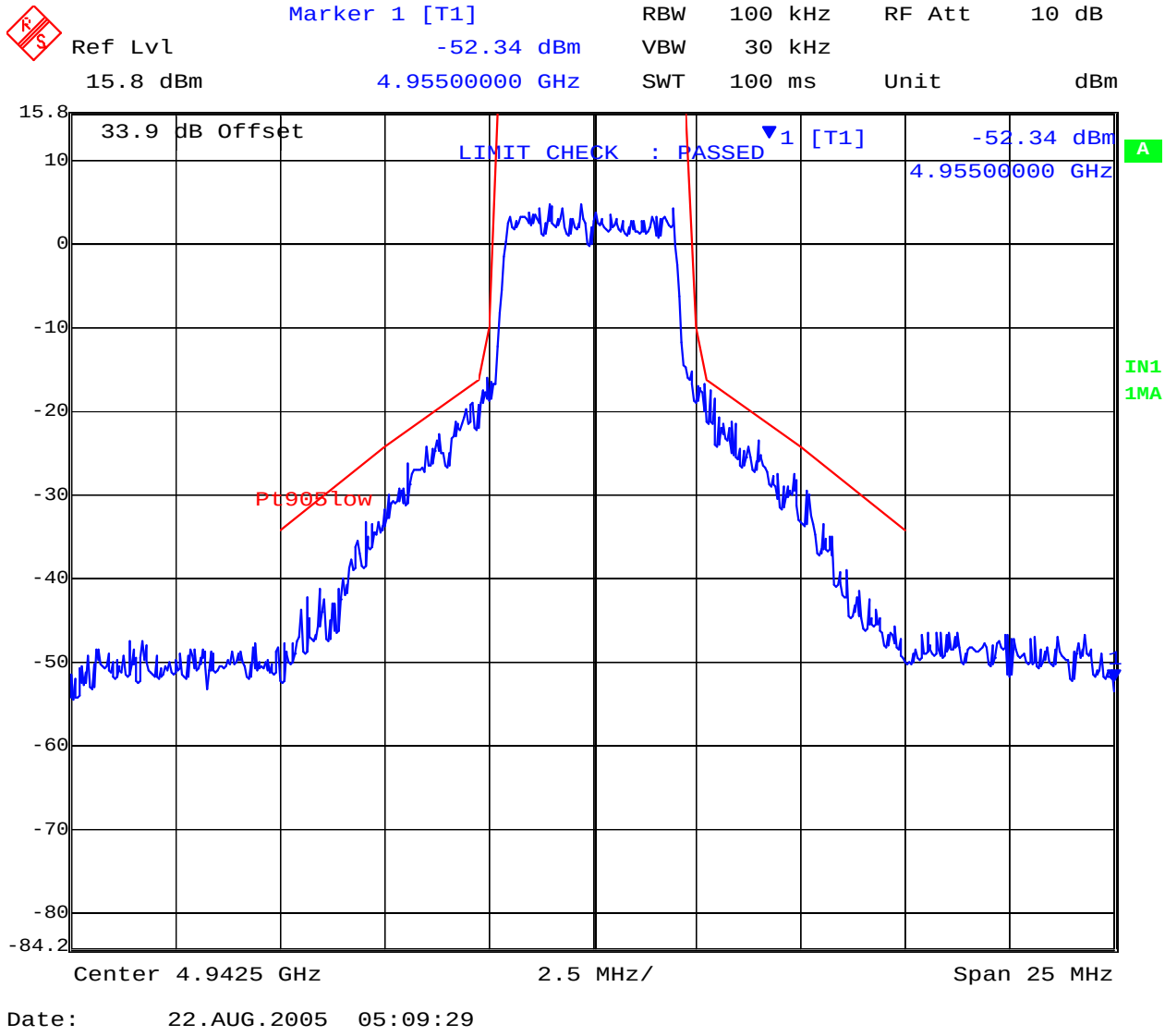
Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS – 5 MHz 26 dB Bandwidth(s)

Center Frequency (MHz)	26 dB Bandwidth (MHz)
4942.5	5.7715
4967.5	5.6613
4987.5	5.6613



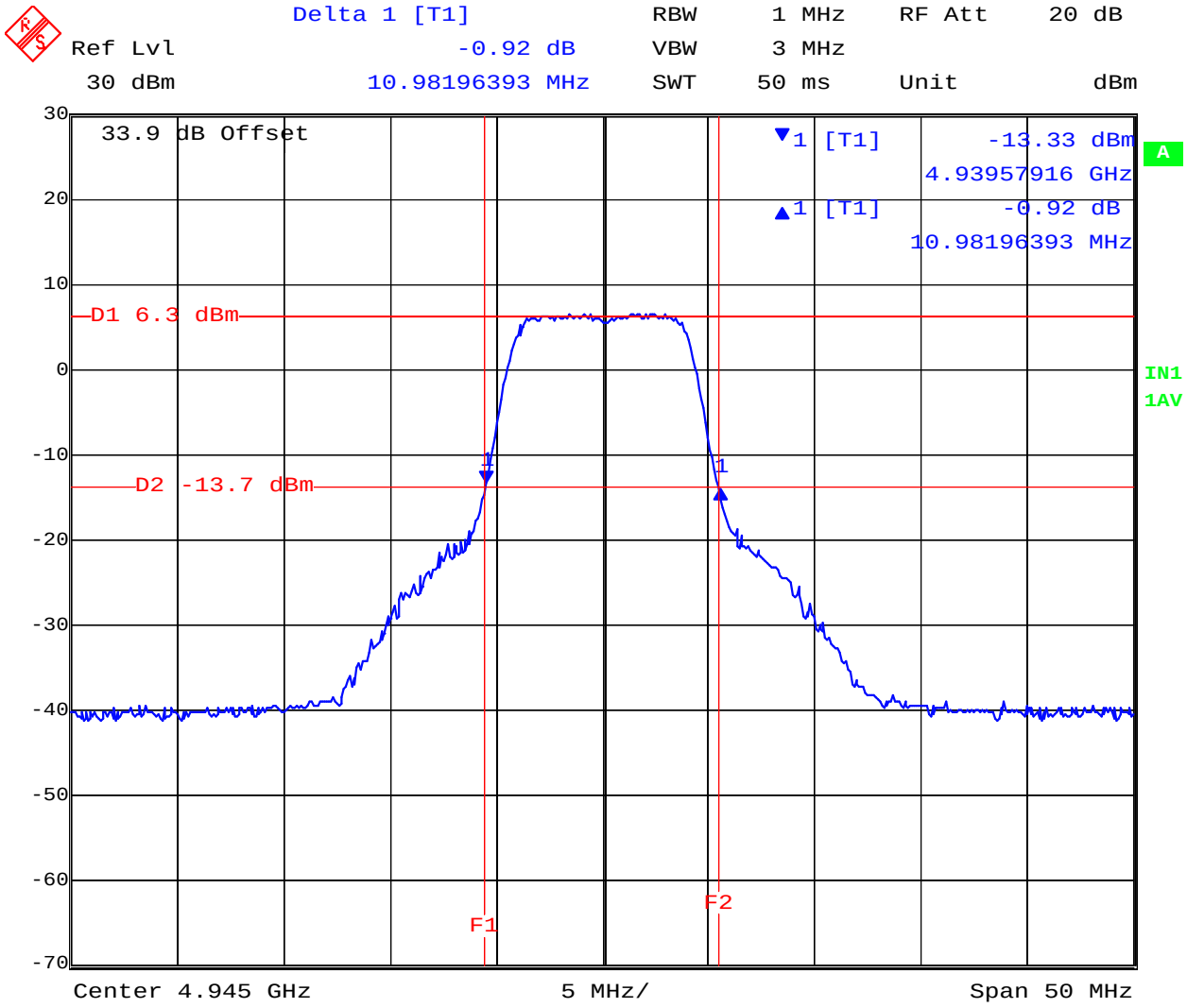
26 dB Bandwidth 5 MHz Channel Freq 4942.5 MHz



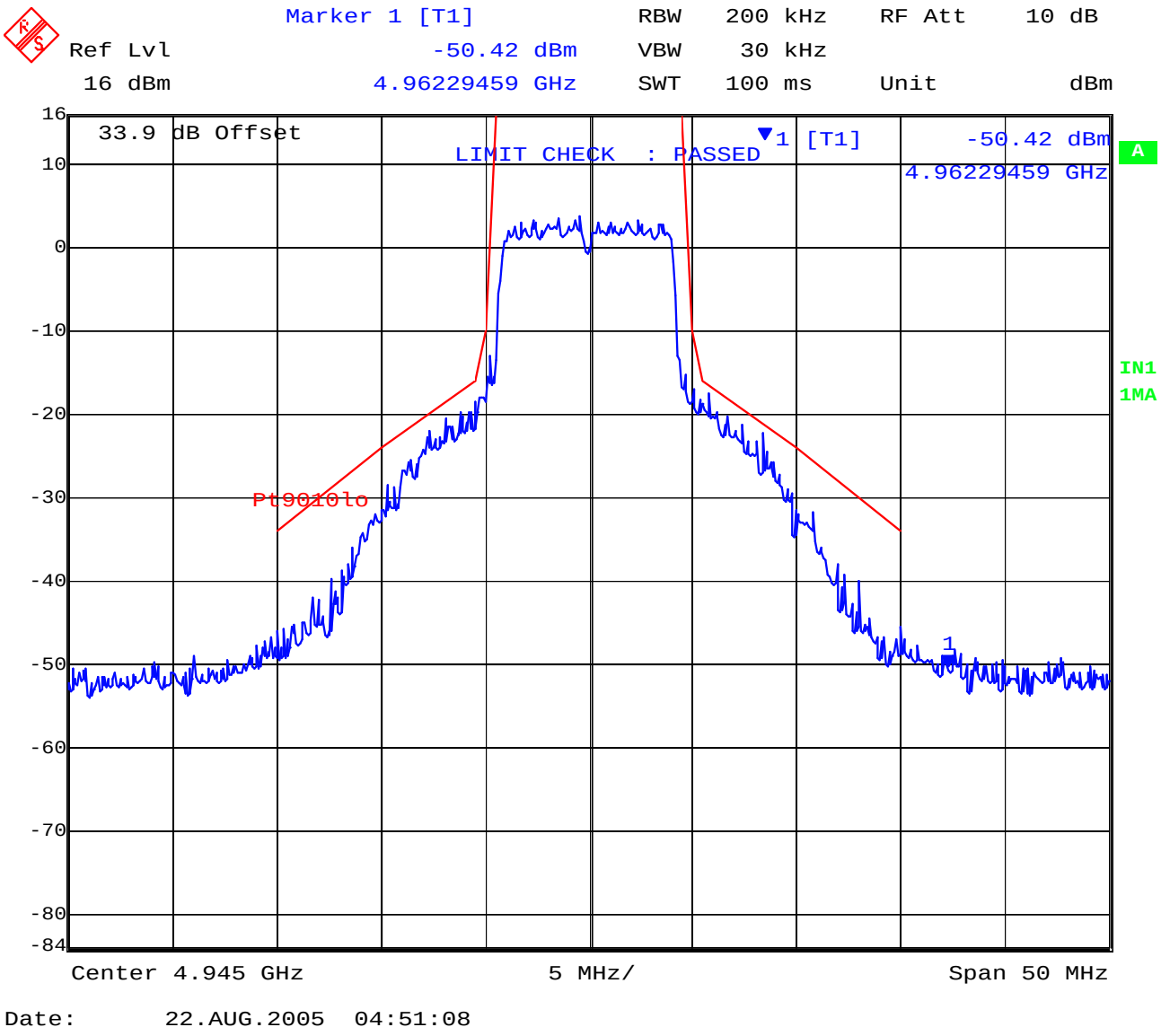
Emission Mask for 5 MHz BW Channel Freq 4942.5 MHz

TABLE OF RESULTS – 10 MHz Bandwidth

Center Frequency (MHz)	26 dB Bandwidth (MHz)
4945.0	10.9820
4965.0	10.8417
4985.0	10.8216



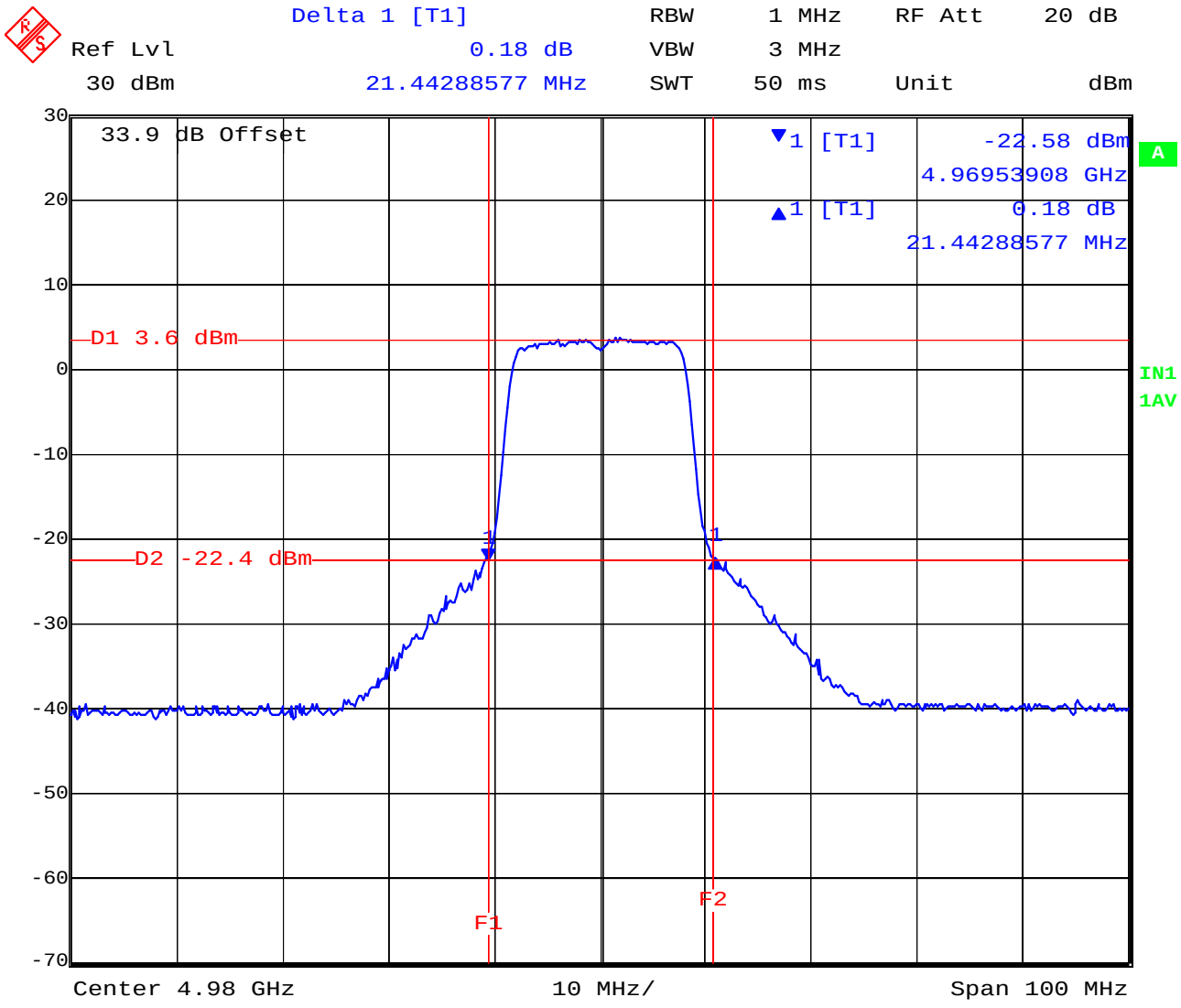
26 dB Bandwidth 10 MHz Channel Freq 4945 MHz



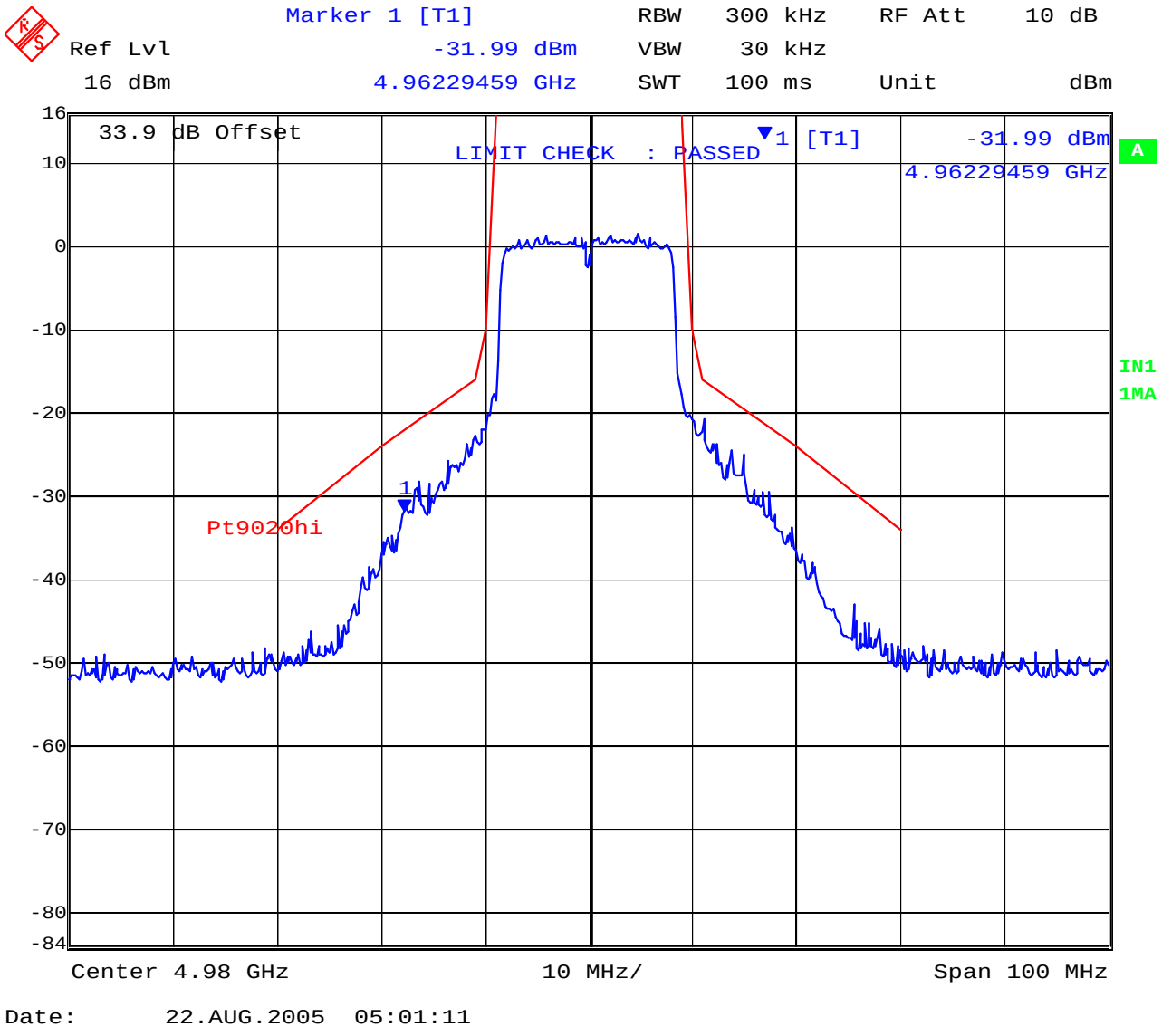
Emission Mask for 10 MHz BW Channel Freq 4945 MHz

TABLE OF RESULTS – 20 MHz Bandwidth

Center Frequency (MHz)	26 dB Bandwidth
4950.0	20.8437
4965.0	20.8417
4980.0	21.4429



26 dB Bandwidth 20 MHz Channel Freq 4980 MHz



Emission Mask for 20 MHz BW Channel Freq 4980 MHz

Specification Limits
FCC Part §90.210

Limits for Authorized Bandwidth

Frequency Band (MHz) and Related Documents	Spectrum Masks with Audio Filter	Without Audio Filter
4950 – 4990 MHz	L or M	L or M

Reference to the emission masks are provided below

Limits Emission Masks
90.210(L), Emission Mask L. For low power transmitters (20 dBm of less) operating in the 4940 – 4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0 – 45% of the authorized bandwidth (BW) : 0dB.

(2) On any frequency removed from the assigned frequency between 45 – 50 % of the authorized bandwidth: 219 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50 – 55 % of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55 – 100 % of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100 – 150 % of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency above 150 % of the authorized bandwidth: 50 dB.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Limits Emission Masks (continued)

90.210(m), Emission Mask M. For high power transmitters (greater than 20 dBm) operating in the 4940 – 4900 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0 – 45% of the authorized bandwidth (BW) : 0dB.

(2) On any frequency removed from the assigned frequency between 45 – 50 % of the authorized bandwidth: 568 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50 – 55 % of the authorized bandwidth: 26 + 145 log (% of (BW)/50) dB.

(4) On any frequency removed from the assigned frequency between 55 – 100 % of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100 – 150 % of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Note to paragraph m: Low power devices may as an option, comply with paragraph (m).

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

5.1.2. Peak Output Power

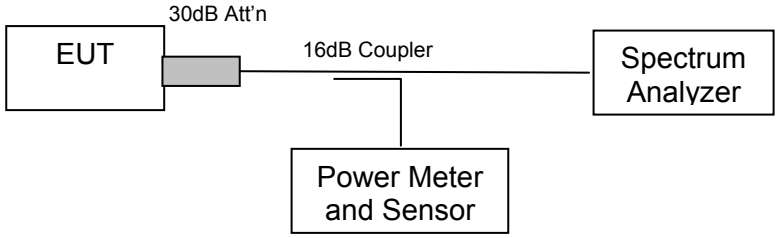
FCC 47 CFR Part 90, Subpart Y; 2.1046; §90.1215

Test Procedure

Average power measurements were measured with the use of an average power head. Peak power measurements were recorded via the spectrum analyzer. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

The 26 dB emission bandwidth (see Section 5.1.1) was used by the spectrum analyzer to measure the peak output power.

Test Measurement Set up

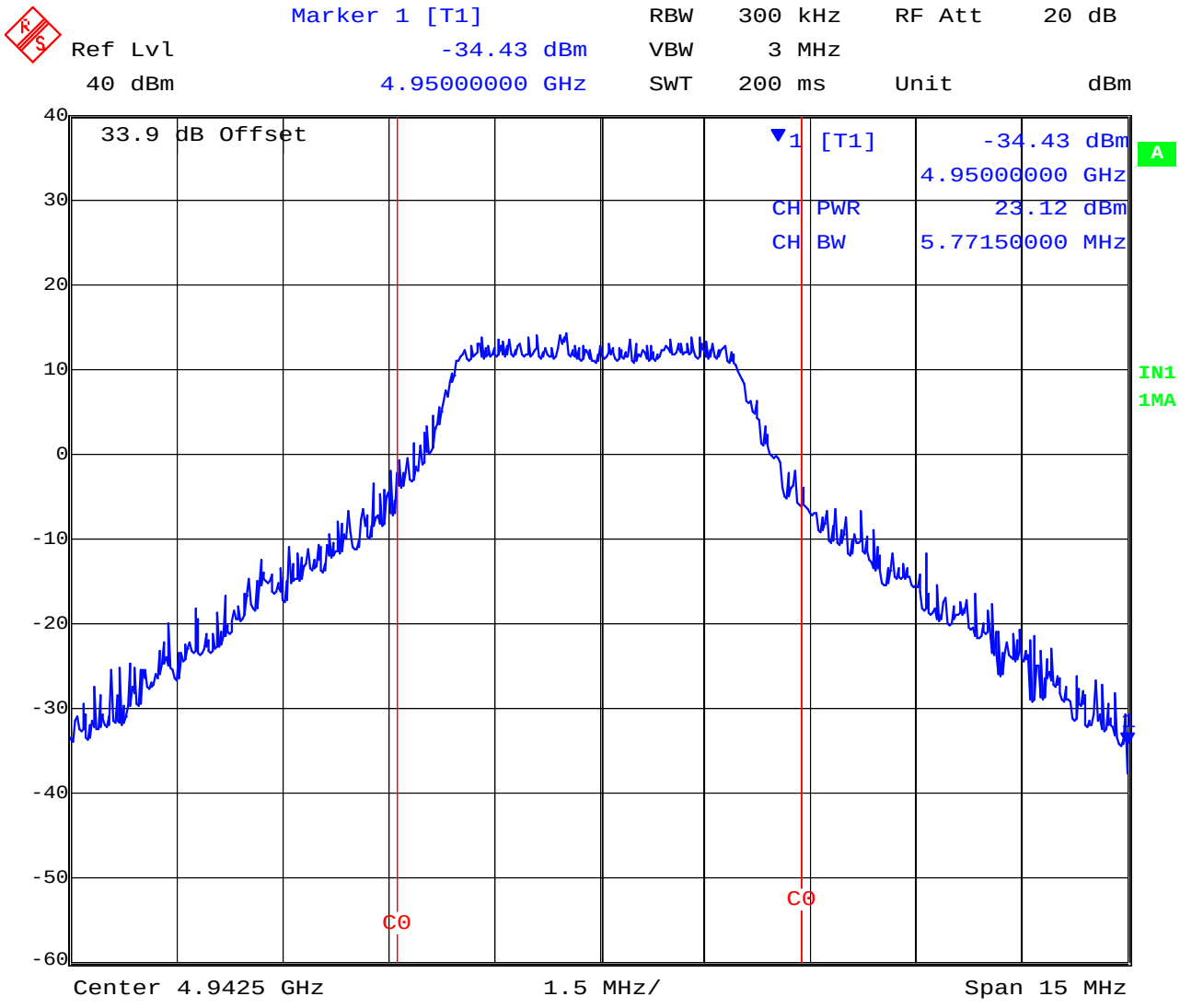


Test set up for modulated output power measurement

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS – 5 MHz Bandwidth Modulated Carrier

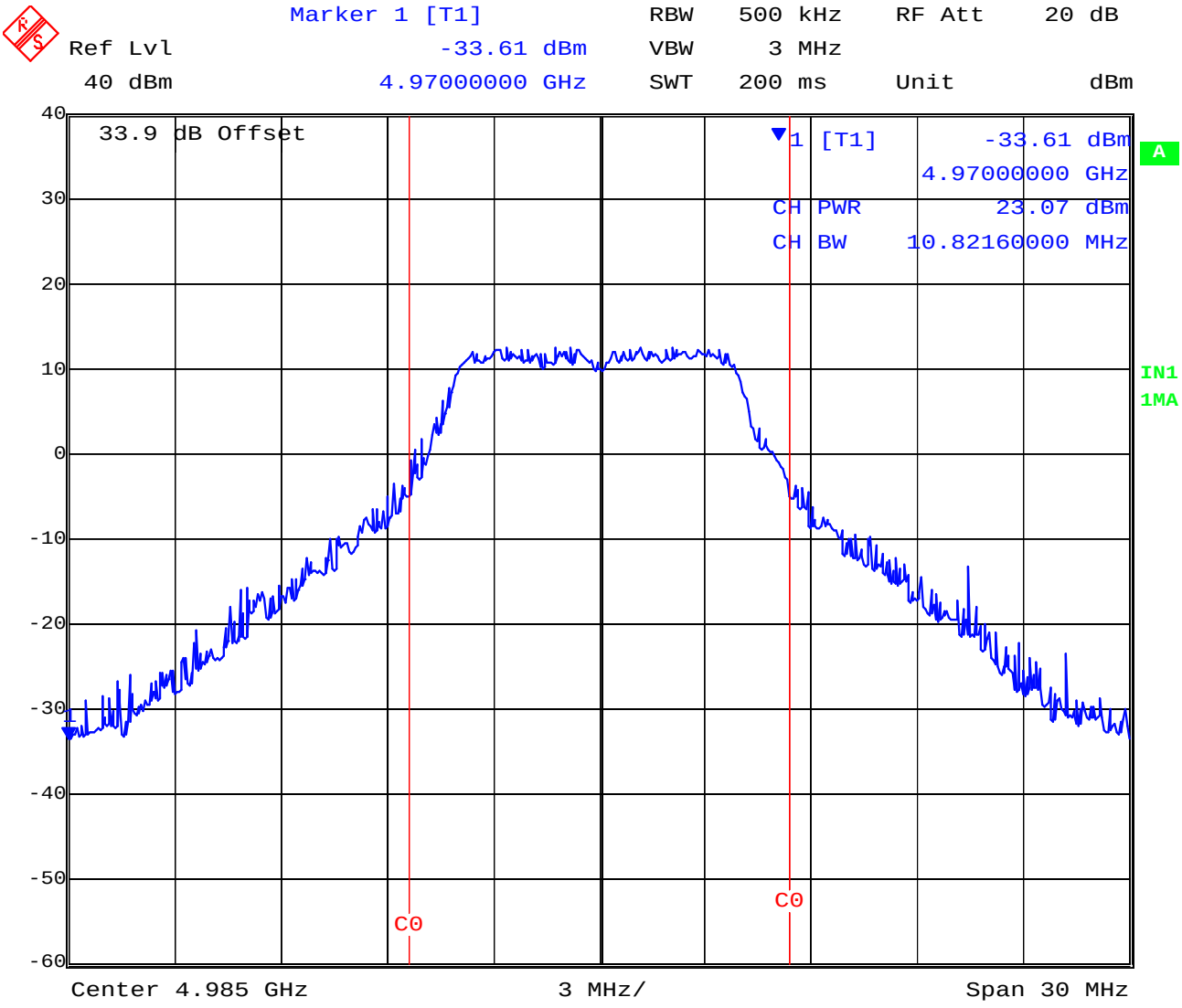
Center Frequency (MHz)	Peak Power (+dBm)	Average Power (+dBm)
4942.5	23.12	15.71
4967.5	23.11	15.43
4987.5	23.09	15.81



Peak Power 5 MHz BW Channel Freq 4,942.5 MHz

TABLE OF RESULTS – 10 MHz Bandwidth Modulated Carrier

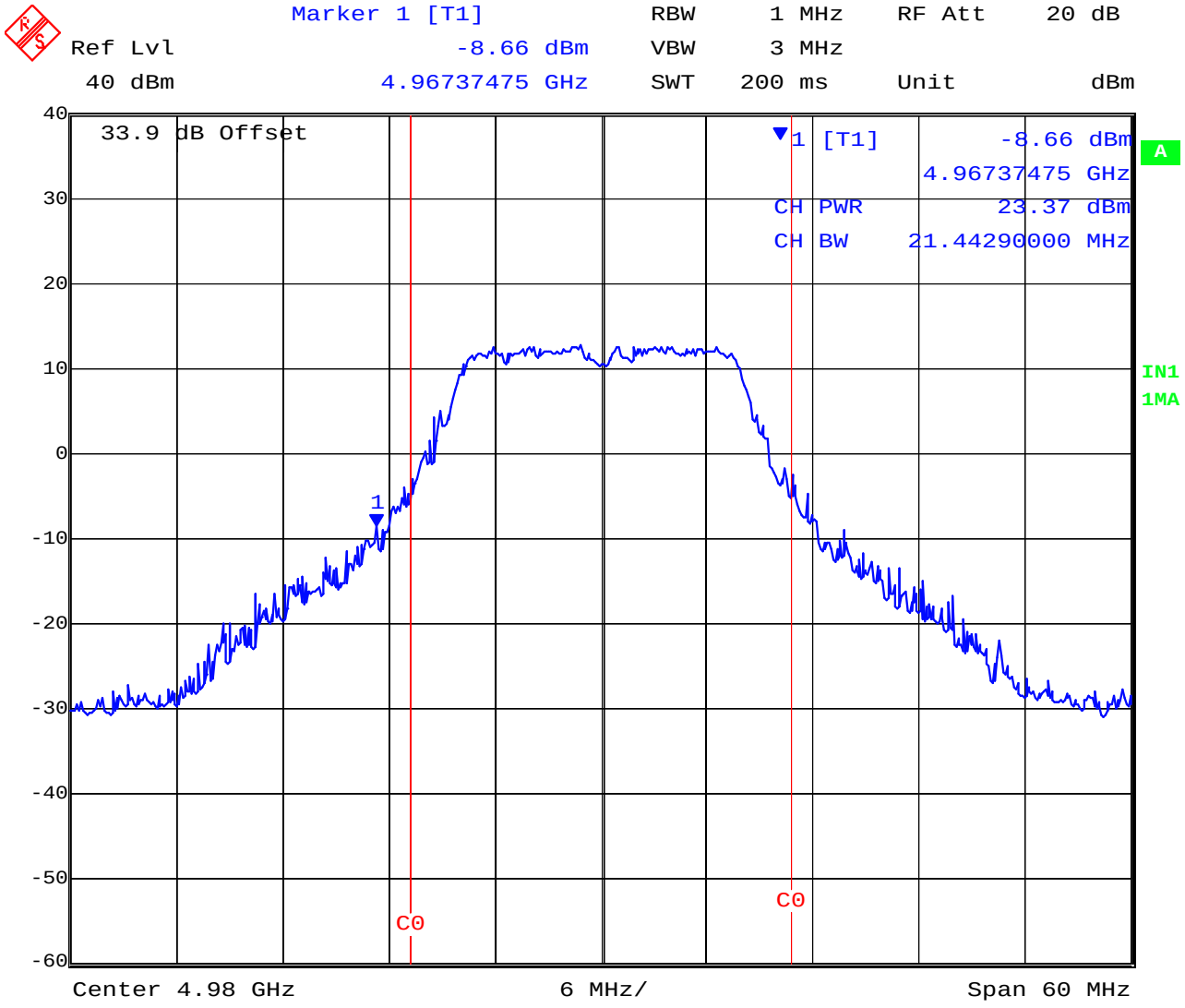
Center Frequency (MHz)	Peak Power (+dBm)	Average Power (+dBm)
4945.0	22.95	16.09
4965.0	22.97	15.76
4985.0	23.07	15.67



Peak Power 10 MHz BW Channel Freq 4,985 MHz

TABLE OF RESULTS – 20 MHz Bandwidth Modulated Carrier

Center Frequency (MHz)	Peak Power (+dBm)	Average Power (+dBm)
4950.0	23.37	16.06
4965.0	22.95	16.00
4980.0	23.37	15.90



Peak Power 20 MHz BW Channel Freq 4,985 MHz

Specification Limits

FCC Part §90.1215(a)

Power limits.

The transmitting power of stations operating in the 4940-4990 MHz band must not exceed the maximum limits in this section.

(a) The peak transmit power should not exceed:

Channel Bandwidth (MHz)	Low power peak transmitter power (dBm)	High power peak transmitter power (dBm)
1	7	20
5	14	27
10	17	30
15	18.8	31.8
20	20	33

High power devices are also limited to a peak power spectral density of 21 dBm per one MHz. High power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 21 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi. However, high power point-to-point or point-to-multipoint operation (both fixed and temporary-fixed rapid deployment) may employ transmitting antennas with directional gain up to 26 dBi without any corresponding reduction in the transmitter power or spectral density. Corresponding reduction in the peak transmit power and peak power spectral density should be the amount in decibels that the directional gain of the antenna exceeds 26 dBi.

(b) Low power devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

(c) The peak transmit power is measured as a conducted emission over any interval of continuous transmission calibrated in terms of an RMS-equivalent voltage. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement conforming to the definitions in this paragraph for the emission in question.

(d) The peak power spectral density is measured as conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected

directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of one MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

5.1.3. Peak Power Spectral Density (PPSD)

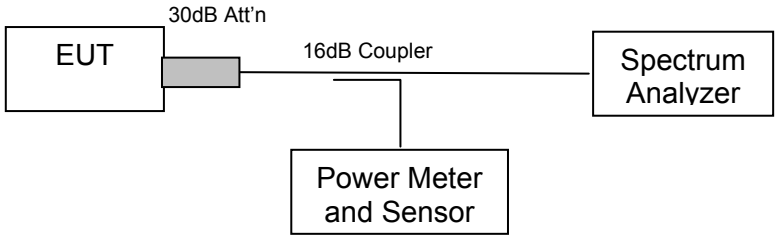
FCC 47 CFR Part 90, Subpart Y; 2.1046; §90.1215

Test Procedure

The test methodology used for this measurement was determined to provide the highest possible PPSD readings.

Peak power spectral density measurements were performed via the spectrum analyzer and plots were recorded. Modulation was ON and the system duty cycle was set for 100% i.e. continuous operation at all times. The system highest power setting was selected with modulation ON and duty cycle set for 100% i.e. continuous operation at all times.

Test Measurement Set up

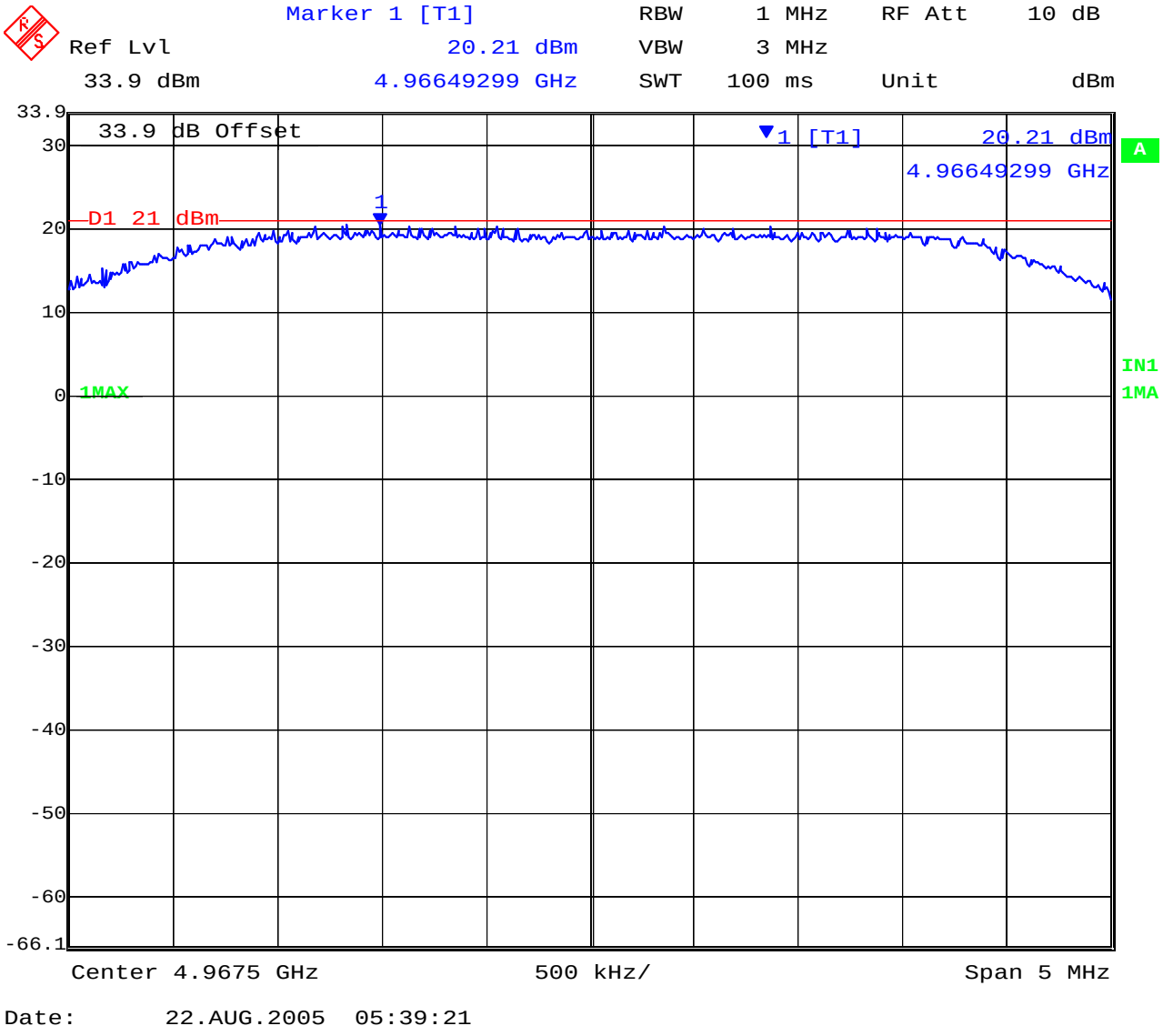


Test set up for Peak Power Spectral Density measurement(s)

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS – PPSD 5 MHz Bandwidth Modulated Carrier

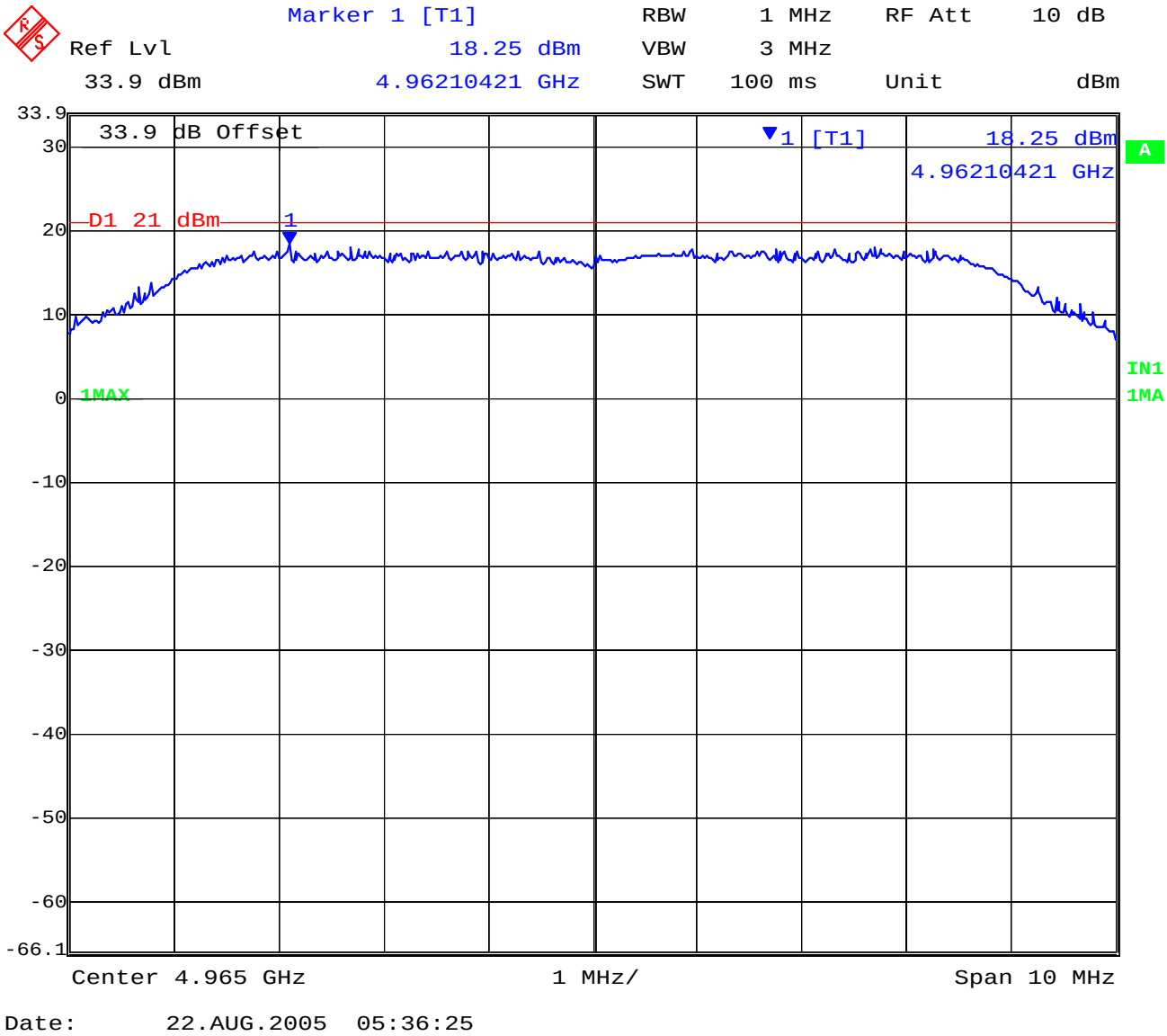
Center Frequency (MHz)	Peak Power Spectral Density (dBm/ MHz)
4942.5	20.10
4967.5	20.21
4987.5	20.05



Peak Power Spectral Density 5 MHz BW Channel Freq 4,967.5 MHz

TABLE OF RESULTS – PPSD 10 MHz Bandwidth Modulated Carrier

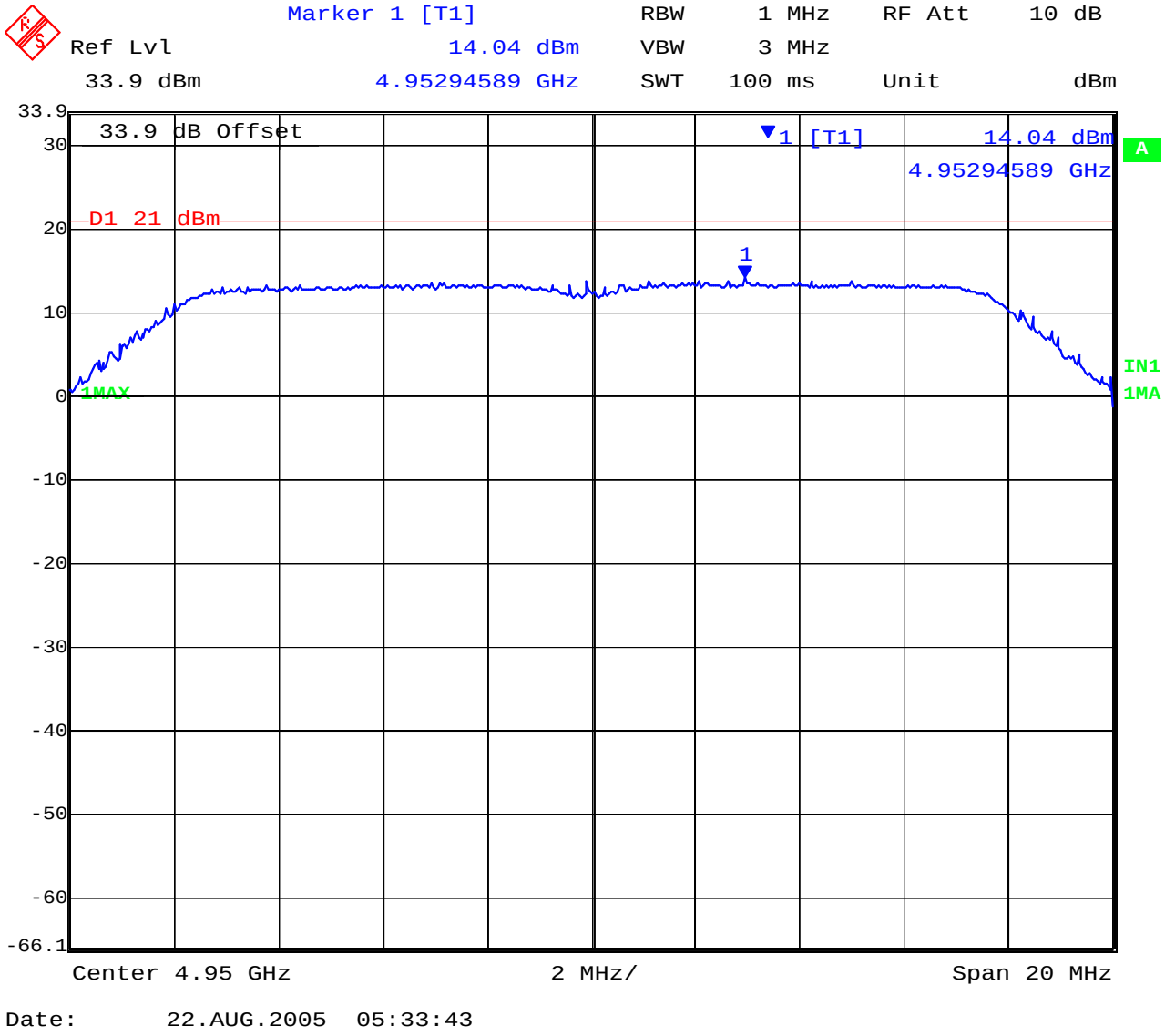
Center Frequency (MHz)	Peak Power Spectral Density (dBm/ MHz)
4945.0	17.55
4965.0	18.25
4985.0	17.68



Peak Power Spectral Density 10 MHz BW Channel Freq 4965 MHz

TABLE OF RESULTS – PPSD 20 MHz Bandwidth Modulated Carrier

Center Frequency (MHz)	Peak Power Spectral Density (dBm/ MHz)
4950.0	14.04
4965.0	13.17
4980.0	13.21



Peak Power Spectral Density 20 MHz BW Channel Freq 4950 MHz

Specification Limits
FCC Part §90.1215

Refer to the Power Limits Specification in Section 5.1.2 of this report.

Laboratory Measurement Uncertainty for Power Measurement

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Output Power'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

5.1.4. Maximum Permissible Exposure
FCC, Part 90 Subpart C §90.1217

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm^2) = EIRP/(4πd^2)

EIRP = P * G

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

Numeric Gain = 10 ^ (G (dBi)/10)

4 9 GHz 20 MHz Channel = Max. Output Power +23.37 dBm, 217.3 mW
Max. Antenna Gain = 26 dBi, **398.1 numeric**
Min. Antenna Gain = 9 dBi, **7.9 numeric**

The EUT belongs to the General Population/Uncontrolled Exposure, power density limit is 1.0mW/cm^2

Antenna Gain (Numeric)	Peak Output Power (mW)	Calculated RF Exposure at d=20cm (mW/cm^2)	Limit (mW/cm^2)
7.9	217.3	0.34	1.0

Maximum Gain Antennas – Calculated Safe Distance @ 1 mW/cm^2

Antenna Gain (Numeric)	Peak Output Power (mW)	Calculated Safe Distance at 1 mW/cm^2 (cm)	Limit (mW/cm^2)
398.1	217.3	83.0	1.0

Specification
Maximum Permissible Exposure Limits

§90.1217 Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency levels in excess of the Commission's guidelines. See §1.1307 (b)(1) of this chapter.

Limit S = 1mW / cm^2 from 1.310 Table 1

Note: for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33dB

5.1.5. Frequency Stability; Temperature Variations, and Voltage Variations

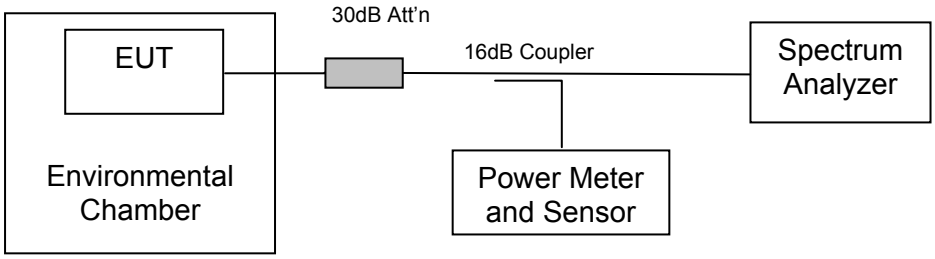
FCC 47 CFR Part 90, Subpart Y; 2.1055(a)(1); §90.213

Test Procedure

The transmitter output was connected to a spectrum analyzer and the frequency stability was measured in modulated mode. Frequency stability was measured through the extremes of temperature on the mid channel only. Before measurements were taken at each temperature the equipment waited until thermal balance was obtained.

As the system utilized a common clock circuit only the 20 MHz bandwidth variant was measured over the range of temperature.

Test Measurement Set up



Measurement set up for Frequency Stability

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS Frequency Stability;-

Temperature Variations for 20MHz Bandwidth

Voltage (Vac, 60 Hz)	Temperature(°C)	FREQUENCY (MHz)
		Channel 4965 MHz
115	-33	4,964.97029
	-30	4,964.96849
	-20	4,964.97029
	-10	4,964.97230
	0	4,964.96909
	+10	4,964.98192
	+20	4,964.97029
	+30	4,964.97510
	+40	4,964.97891
	+55	4,965.00516
	+55°C	4,965.03031
Maximum Frequency Drift		-31.51kHz / +30.31kHz -6.35ppm / +6.10ppm

TABLE OF RESULTS Frequency Stability;-

Voltage Variations at Ambient for 20MHz Bandwidth

Temperature	Voltage (Vac, 60 Hz)	FREQUENCY (MHz)		
		Channel 4950 MHz	Channel 4965 MHz	Channel 4980 MHz
Ambient	+100	4949.97501	4964.97701	4979.97701
	+115	4949.97501	4964.97701	4979.97701
	+240	4949.97501	4964.97701	4979.97701
Maximum Frequency Drift		-0.00 / +0.00		

Frequency stability did not change with voltage variation per the voltages identified in the above table.

Manufacturers Specification for Frequency Stability

As no apparent frequency stability limits were provided the manufacturer's specification was used ±20 ppm.

Laboratory Measurement Uncertainty for Frequency Stability

Measurement uncertainty	±0.866 ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement'	0070, 0116, 0158, 0193, 0252, 0313, 0314.

5.1.6. Spurious Emissions at Antenna Terminals - Transmitter

FCC 47 CFR Part 90, Subpart Y; 2.1051; §90.210(m)

Test Procedure
Transmitter conducted spurious emissions were measured for each bandwidth. Measurement were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Conducted spurious emissions were measured to 40 GHz.

Limits were calculated which depended on average transmit power level(s).

See test report Section 5.1.1 for average power level measurements
5 MHz average power (worst case minimum value): + 15.43 dBm
10 MHz average power (worst case minimum value): + 15.67 dBm
20 MHz average power (worst case minimum value): + 15.90 dBm

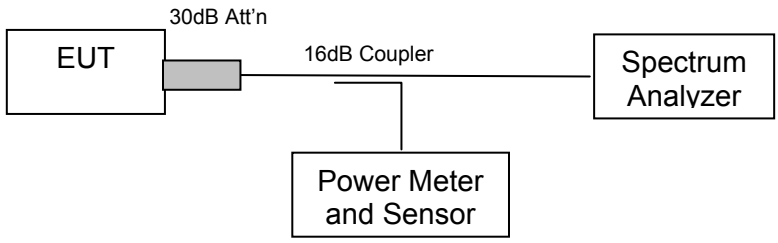
From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Attenuation
55 + 10 log (P) dB for 5 MHz bandwidth = 70.4 dB attenuation (P is in mW)
55 + 10 log (P) dB for 10 MHz bandwidth = 70.7 dB attenuation
55 + 10 log (P) dB for 20 MHz bandwidth = 70.9 dB attenuation

Therefore maximum attenuation for any channel spacing is = 50 dB

5 MHz bandwidth limit: +15.43 – 50 = -34.6 dBm
10 MHz bandwidth limit: +15.67 –50 = -34.3 dBm
20 MHz bandwidth limit: +15.90 – 50 = -34.1 dBm

Test Measurement Set up



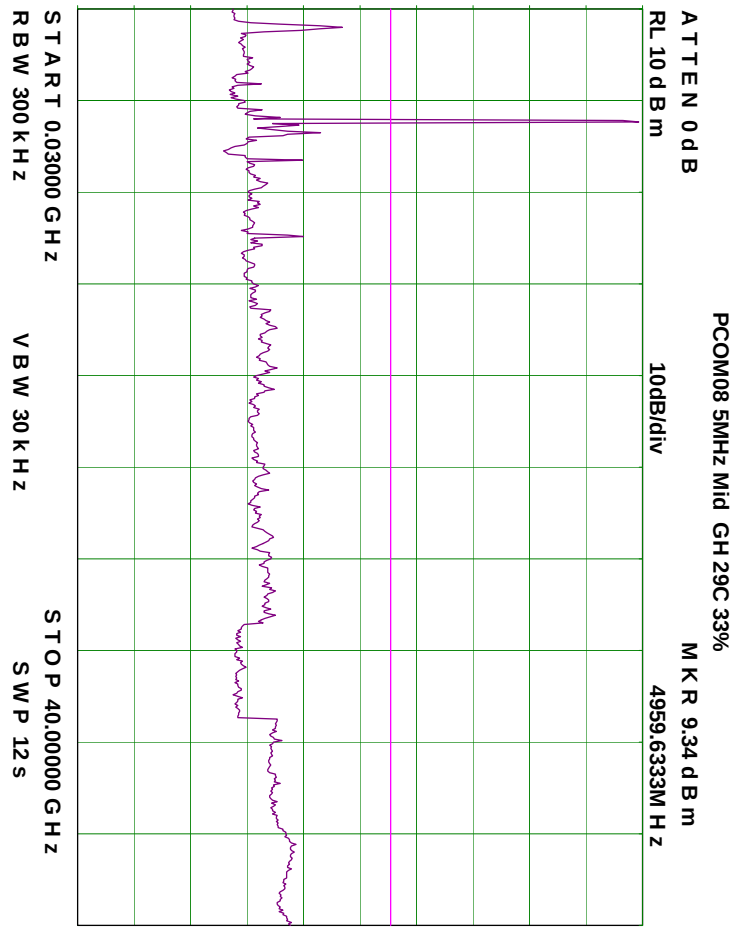
Conducted spurious emission test configuration

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

TABLE OF RESULTS – 5 MHz Bandwidth

Limit: -34.6 dBm

	Frequency (MHz)				
Channel (MHz)	**Start (MHz)**	**Stop (MHz)**	**Freq of Maximum Emission (MHz)**	**Emission Amplitude (dBm)**	**Margin (dB)**
4942.5	30	40.000	833.33	-43.8	-9.2
4967.5	30	40.000	833.33	-42.9	-8.3
4987.5	30	40.000	833.33	-43.0	-8.4



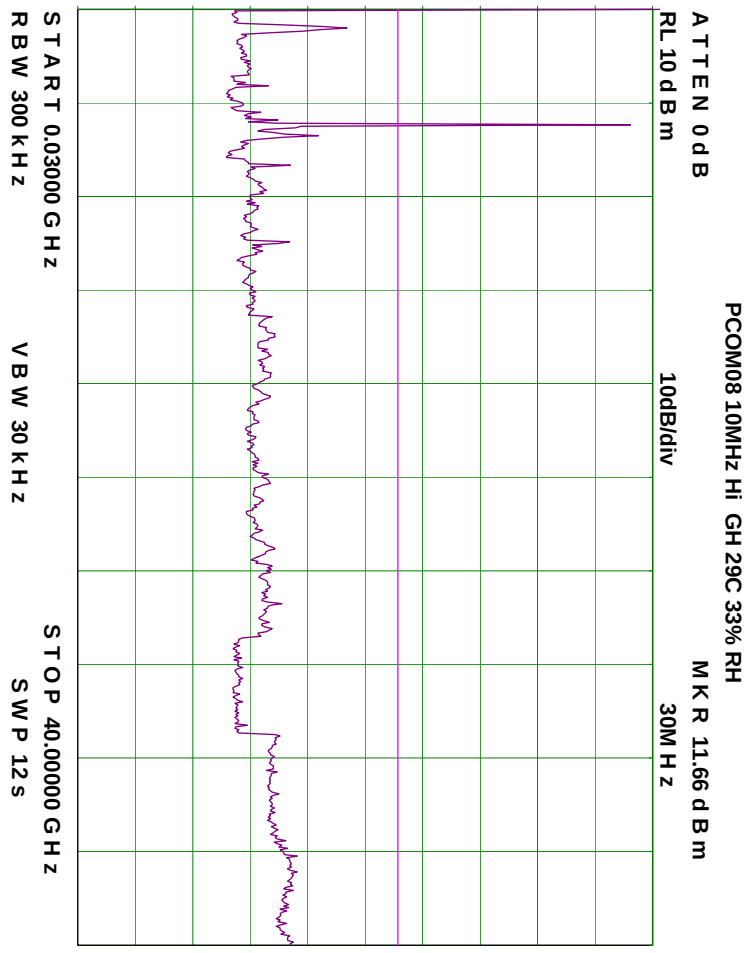
Transmitter Channel 4967.5 MHz 5 MHz Spacing, 30 – 40,000 MHz

Worst case Conducted Spurious Emissions shown. All other Conducted Spurious Emissions are held on file.

TABLE OF RESULTS – 10 MHz Bandwidth

Limit: -34.3 dBm

	Frequency (MHz)				
Channel (MHz)	**Start (MHz)**	**Stop (MHz)**	**Freq of Maximum Emission (MHz)**	**Emission Amplitude (dBm)**	**Margin (dB)**
4945.0	30	40,000	833.33	-43.1	-8.8
4965.0	30	40,000	833.33	-44.1	-9.8
4985.0	30	40,000	833.33	-43.0	-8.7



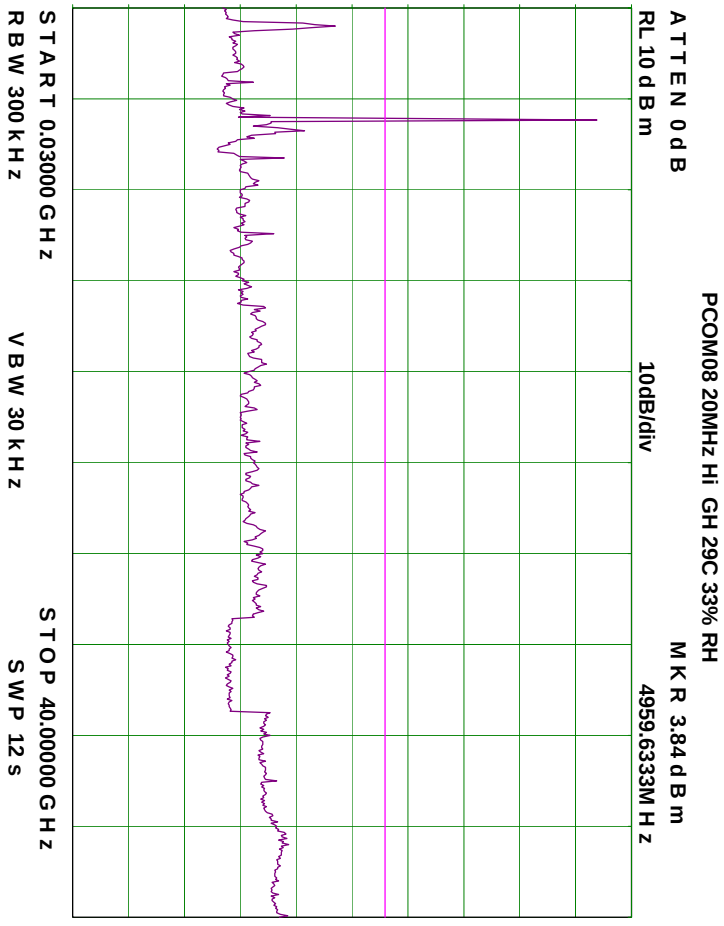
Transmitter Channel 4985 MHz 10 MHz Spacing, 30 – 40,000 MHz

Worst case Conducted Spurious Emissions shown. All other Conducted Spurious Emissions are held on file.

TABLE OF RESULTS – 20 MHz Bandwidth

Limit: -34.1 dBm

	Frequency (MHz)				
Channel (MHz)	**Start (MHz)**	**Stop (MHz)**	**Freq of Maximum Emission (MHz)**	**Emission Amplitude (dBm)**	**Margin (dB)**
4950.0	30	40,000	833.33	-43.1	-9.0
4965.0	30	40,000	833.33	-42.9	-8.8
4980.0	30	40,000	833.33	-42.9	-8.8



Transmitter Channel 4980 MHz 20 MHz Spacing, 30 – 40,000 MHz

Worst case Conducted Spurious Emissions shown. All other Conducted Spurious Emissions are held on file.

Specification Limits

Conducted Spurious Emission at Antenna Terminals – Transmitter Limits FCC Part §90.210

Emission Mask (m)
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10log(P) dB, whichever is the lesser attenuation.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0070, 0116, 0158, 0088, 0252, 0313, 0314

5.1.7. Radiated Spurious Emissions

FCC 47 CFR Part 90, Subpart Y; 2.1053; §90.210(m)

Test Procedure
Measurements were made while EUT was operating in a modulated transmit mode of operation, at the appropriate center frequency, 100% duty cycle and maximum power at all times. Radiated spurious emissions were measured to 40 GHz. Substitution was performed on any emissions observed. The antenna port was attenuated with 50 dB attenuation plus a 50 Ω terminator.

The measurement equipment was set to measure in peak hold mode. The emissions were measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode.

The highest emissions relative to the limit are listed for each frequency spanned.

Measurements below 1 GHz utilized 100 KHz RBW, measurements above 1 GHz were performed using a minimum RBW of 1 MHz.

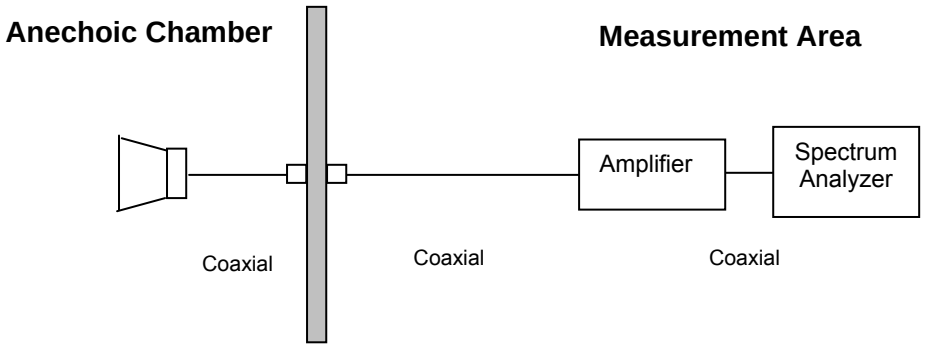
From FCC Part 90.210 (m)
On any frequency removed from the assigned frequency between above 150 % of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Attenuation
55 + 10 log (P) dB for 5 MHz bandwidth = 70.4 dB attenuation (P is in mW)
55 + 10 log (P) dB for 10 MHz bandwidth = 70.7 dB attenuation
55 + 10 log (P) dB for 20 MHz bandwidth = 70.9 dB attenuation

Therefore maximum attenuation for any channel spacing is = 50 dB

5 MHz bandwidth limit: +15.43 – 50 = -34.6 dBm
10 MHz bandwidth limit: +15.67 –50 = -34.3 dBm
20 MHz bandwidth limit: +15.90 – 50 = -34.1 dBm

Test Measurement Set up



Measurement set up for Radiated Emission Test

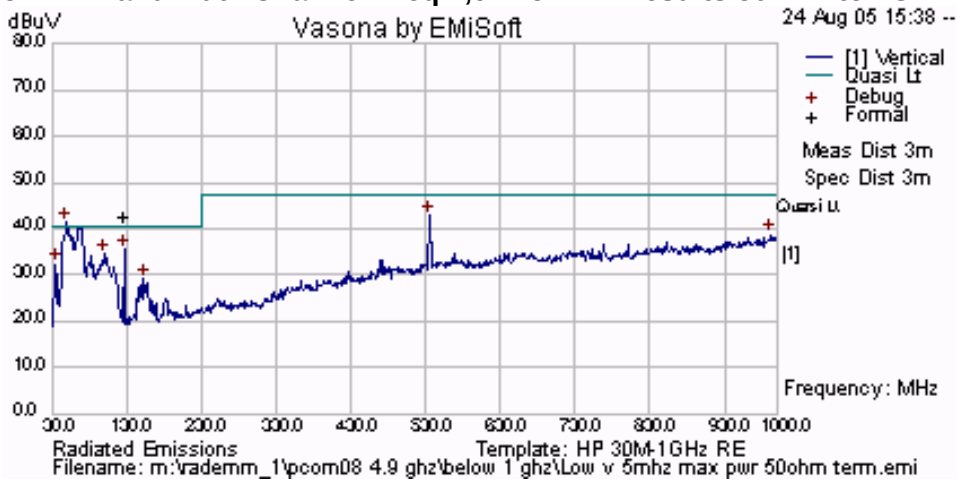
Radio parameters.

5 MHz Bandwidth Channel Freq 4,942.5 MHz Results 30MHz to 1GHz

Worst case results shown. All other test results are held on file.

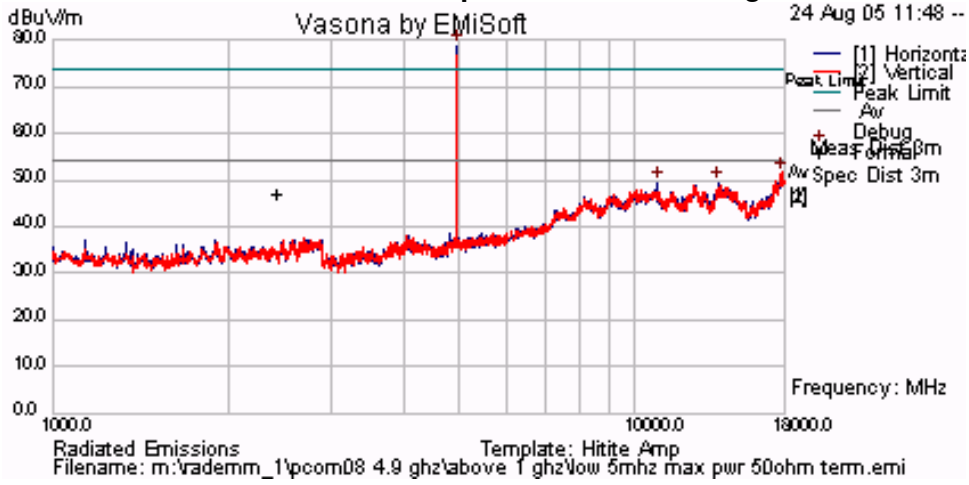
INITIAL INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol.	Raw (dBuV)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
34.850	V	45.67	30	-63.7	2.0	-61.7	-34.6	-27.1
49.400	V	52.67	30	-54.4	2.0	-52.4	-34.6	-17.8
99.517	V	46.50	30	-58.3	1.0	-57.3	-34.6	-22.7
127.000	V	48.50	30	-58.2	1.7	-56.5	-34.6	-21.9
152.867	V	41.67	30	-62.5	1.5	-61.0	-34.6	-26.4
536.017	V	43.34	30	-52.1	1.9	-50.2	-34.6	-15.6

5 MHz Bandwidth Channel Freq 4,942.5 MHz Results 30MHz to 1GHz



5 MHz Bandwidth Channel Freq 4,942.5 MHz Results 1GHz to 18GHz

There were no emissions that required further investigation above 1GHz

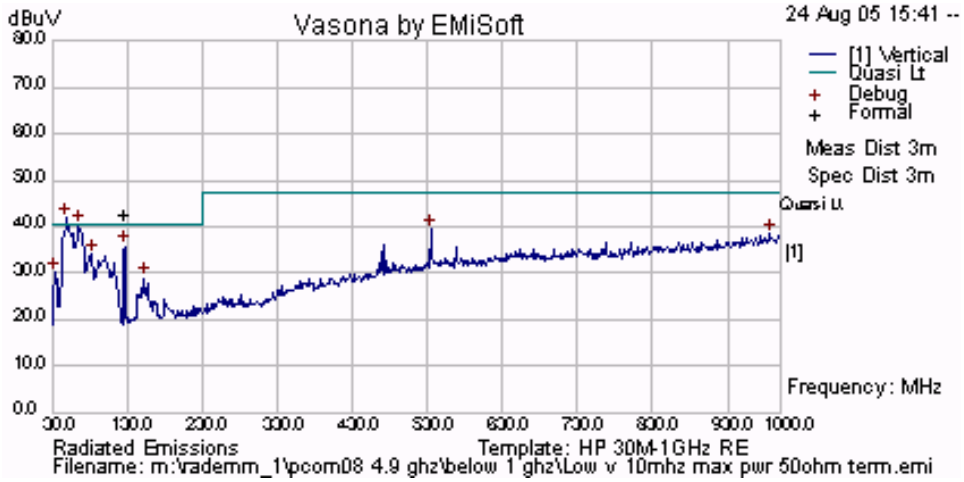


10 MHz Bandwidth Channel Freq 4,945 MHz Results 30MHz to 1GHz

Worst case results shown. All other test results are held on file.

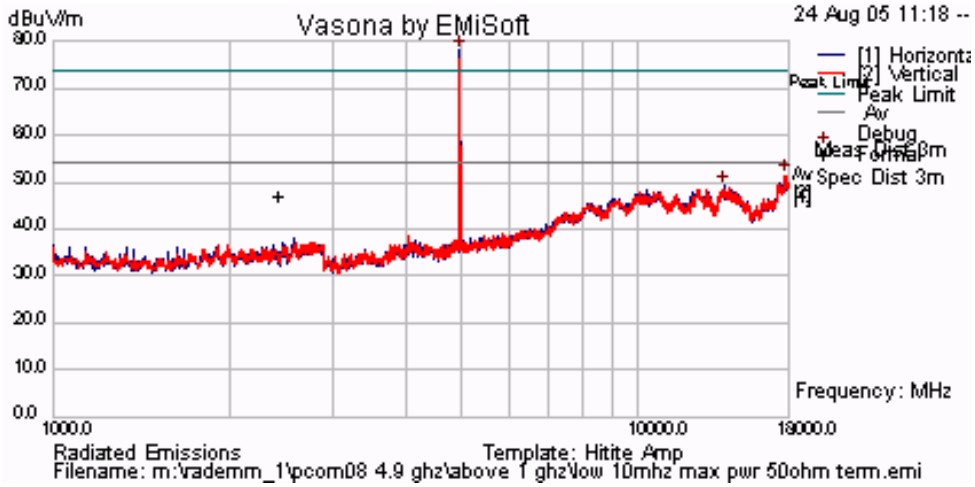
INITIAL INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol.	Raw (dBuV)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
49.400	V	53.17	30	-50.9	1.9	-49.0	-34.3	-14.7
65.567	V	51.34	30	-52.1	1.9	-50.2	-34.3	-15.9
83.350	V	47.34	30	-57.7	1.4	-56.3	-34.3	-22.0
127.000	V	48.67	30	-55.5	1.7	-53.8	-34.3	-19.5
534.400	V	40.00	30	-59.0	1.0	-58.0	-34.3	-24.0
987.067	V	34.34	30	-61.0	0.3	-60.7	-34.3	-26.4

10 MHz Bandwidth Channel Freq 4,945 MHz Results 30MHz to 1GHz



10 MHz Bandwidth Channel Freq 4,945 MHz Results 1GHz to 18GHz

There were no emissions that required further investigation above 1GHz

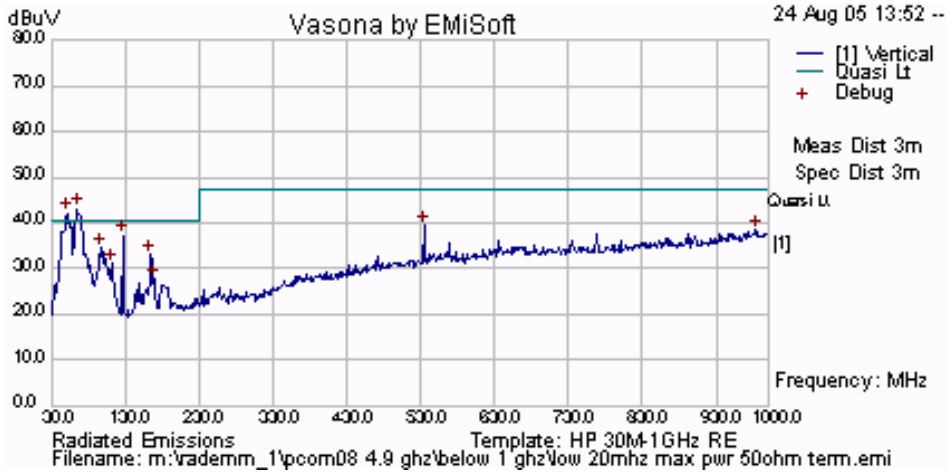


20 MHz Bandwidth Channel Freq 4,950 MHz Results 30MHz to 1GHz

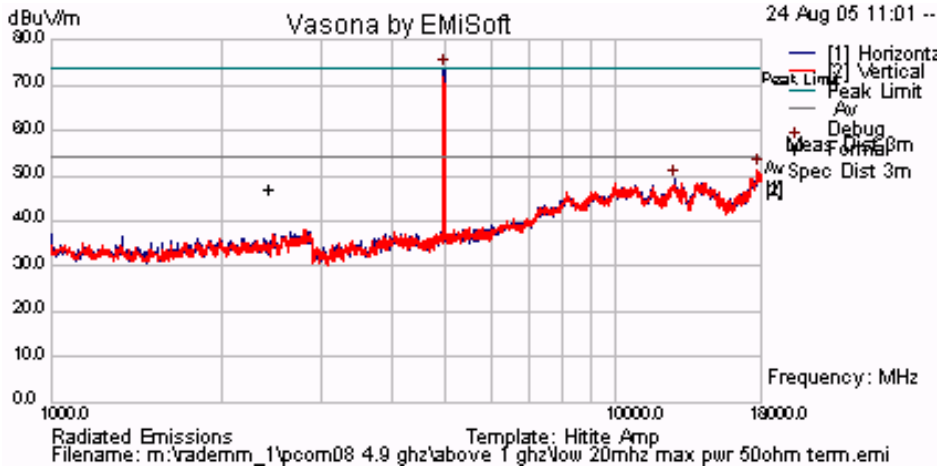
Worst case results shown. All other test results are held on file.

INITIAL INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol.	Raw (dBuV)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
52.633	V	53.50	30	-50.6	1.9	-48.7	-34.1	-14.6
65.567	V	54.34	30	-51.9	1.9	-49.8	-34.1	-15.7
96.283	V	46.50	30	-57.5	1.0	-56.5	-34.1	-22.4
127.000	V	50.17	30	-55.9	1.8	-54.1	-34.1	-20.0
164.183	V	45.17	30	-59.7	1.7	-58.0	-34.1	-23.9
534.400	V	40.00	30	-55.5	1.0	-54.5	-34.1	-20.4

20 MHz Bandwidth Channel Freq 4,950 MHz Results 30MHz to 1GHz



20 MHz Bandwidth Channel Freq 4,950 MHz Results 1GHz to 18GHz
There were no emissions that required further investigation above 1GHz



Radiated Spurious Emission Limits;

Transmitter Limits
Limits FCC Part §90.210 (m)

Emission Mask M
(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 50 dB or 55 + 10 log(P) dB, whichever is the lesser attenuation.

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0104, 0158, 0134, 0310, 0312, Dipole.

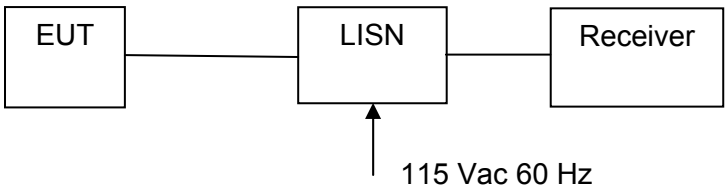
5.1.8. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.207

Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

Ambient conditions.
Temperature: 19 to 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

Radio parameters.
Data Rate(s): 802.11a, 6 MBit/s, +17 dBm output power

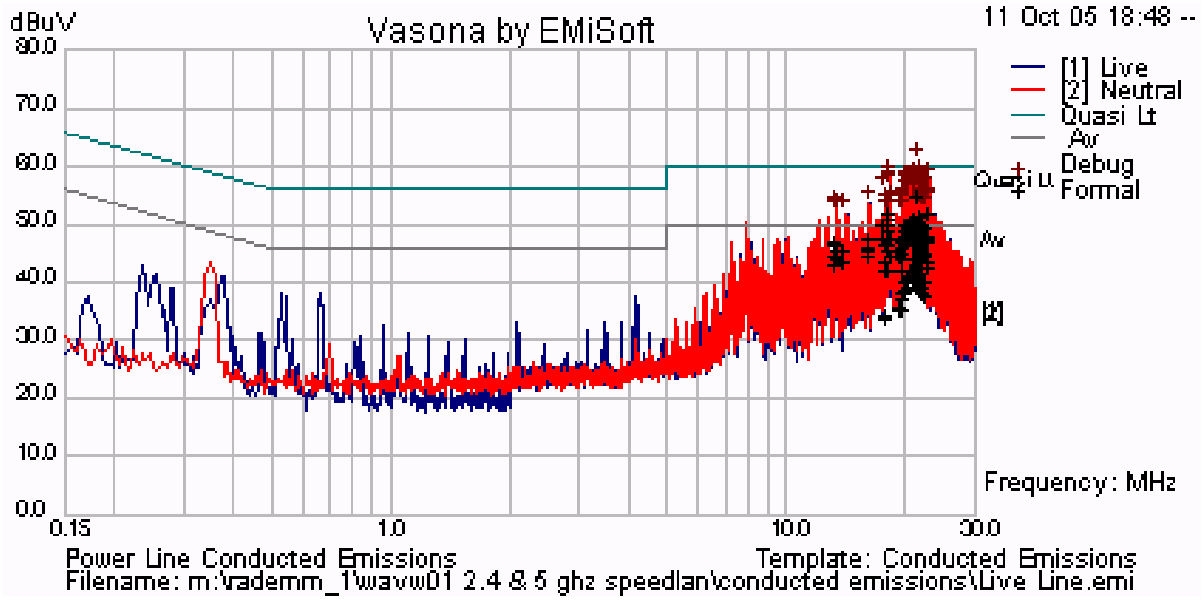
TABLE OF RESULTS

LINE - LIVE

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
17.694	55.91	47.68	60	-12.32	45.07	50	-4.93
18.244	57.96	49.67	60	-10.33	46.59	50	-3.41

LINE - NEUTRAL

Frequency (MHz)	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
18.304	56.85	48.46	60	-11.54	45.38	50	-4.62
20.807	57.03	47.74	60	-12.26	45.00	50	-5.00
21.663	60.80	52.41	60	-7.59	47.88	50	-2.12
23.129	57.60	49.46	60	-10.54	45.13	50	-4.87



Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

§15.207 (a) Limit Matrix

The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

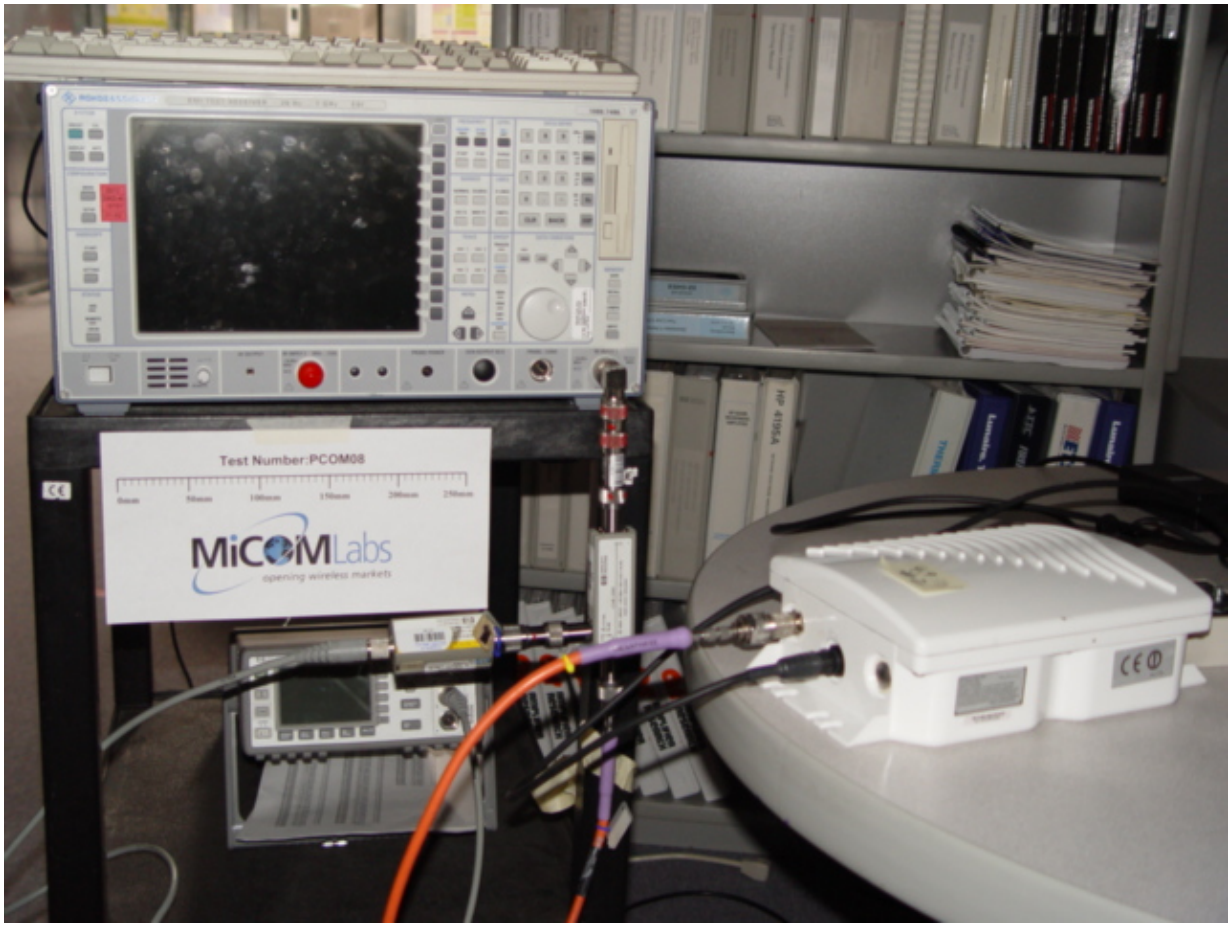
Measurement uncertainty	±2.64 dB

Traceability

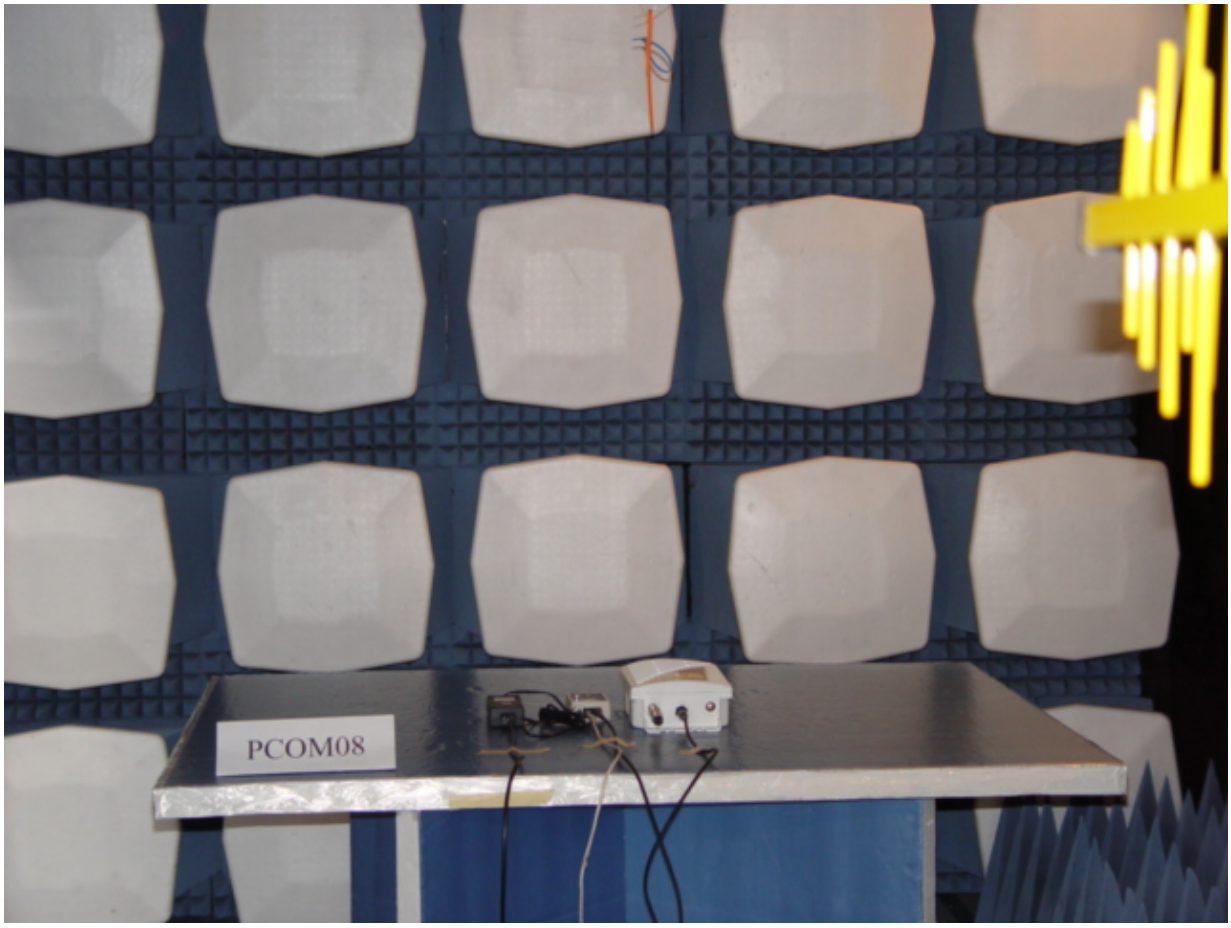
Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0158, 0184, 0193, 0190, 0293, 0307

6. TEST SET-UP PHOTOGRAPHS

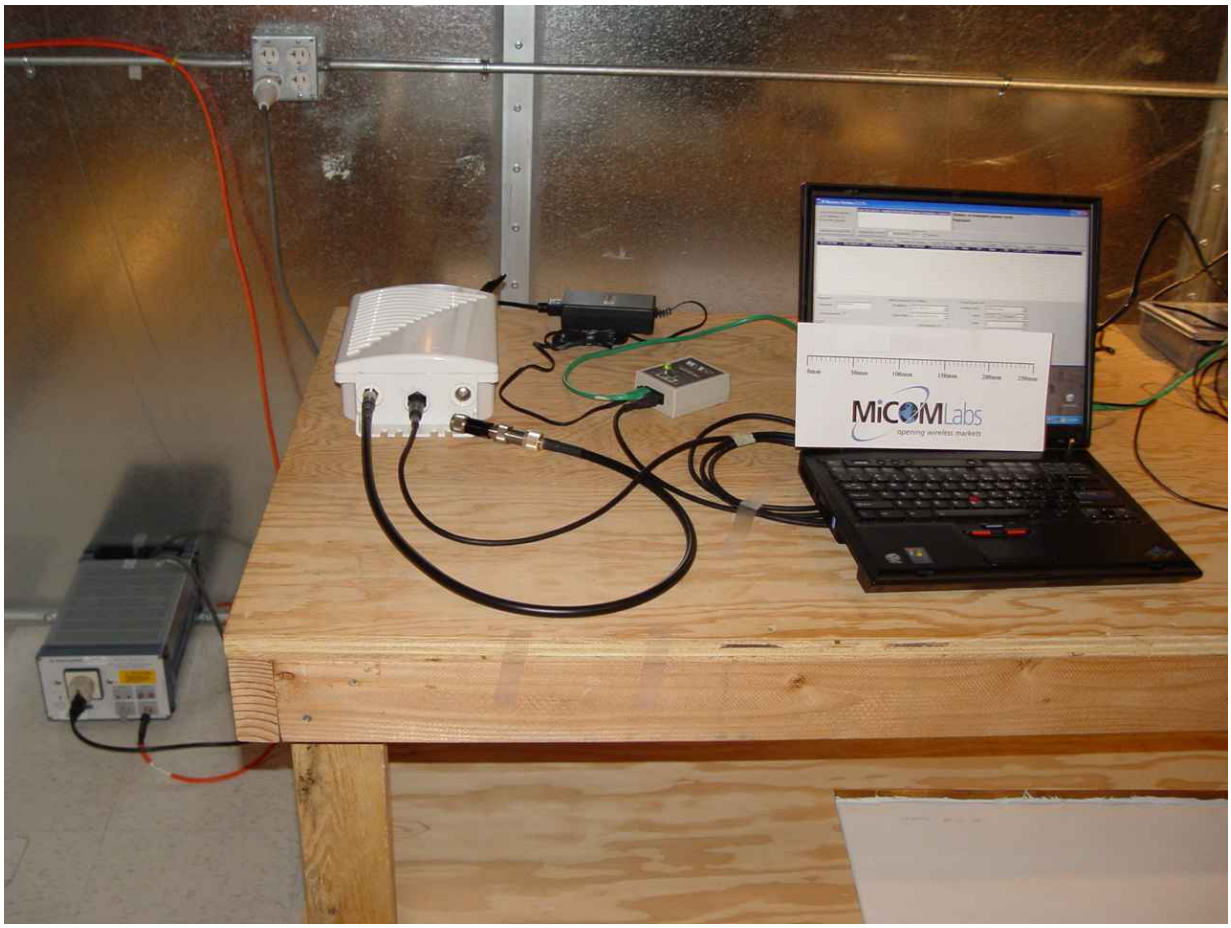
6.1. General Measurement Test Set-Up



6.2. Radiated Spurious Emissions



6.3. Conducted Emissions (150 kHz - 30 MHz)



7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Calibration Due Date	Serial #
0088	Spectrum Analyzer	Hewlett Packard	8564E	20th June '06	3410A00141
0104	1-18GHz Horn Antenna	The Electro-Mechanics Company	3115	21st Oct '06	9205-3882
0134	Amplifier	Com Power	PA 122	1st Dec '05	181910
0158	Barometer /Thermometer	Control Co.	4196	25th Aug '06	E2846
0193	EMI Receiver	Rhode & Schwartz	ESI 7	8th Apr '06	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	11th Jun '06	None
0304	2.4GHzHz Notch Filter	Micro-Tronics	--	1st Dec 05	001
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	7th Dec '05	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	9h Dec '05	209092-001
0313	Coupler	Hewlett Packard	86205A	N/A	3140A01285
0314	30dB N-Type Attenuator	ARRA	N9444-30	N/A	1623
0070	Power Meter	Hewlett Packard	437B	13th May 06	3125U11552
0116	Power Sensor	Hewlett Packard	8485A	7th April 06	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	20th June 06	3318A00371
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	3RD Oct 06	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	22nd Jun 07	836679/006
0293	BNC Cable	Megaphase	1689 1GVT4	13TH Jul 06	15F50B001
0307	BNC Cable	Megaphase	1689 1GVT4	13th Jul 06	15F50B002
	Dipole Antenna	EMCO	3121C		9009 - 605

3922 Valley Avenue, Suite “B”
Pleasanton, CA 94566, USA
Tel: 1.925.462.0304
Fax: 1.925.462.0306
www.micomlabs.com