Test of Arwest Communications AW435

To FCC 47 CFR Part 90 & IC RSS-119

Test Report Serial No.: ARWT02-A2 Rev B

TEST REPORT

FROM

Test of AlphaWave AW435

To FCC 47 CFR Part 90 & IC RSS-119

Test Report Serial No.: ARWT02-A2 Rev B

This report supersedes ARWT02-A2 Rev A

Manufacturer: ArWest Communications Corp.
300 Orchard City Drive, Suite #126
Campbell, California 95008
USA

Product Function: System Monitoring and Control Applications

Copy No: pdf **Issue Date:** 29th April 2006

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
3922 Valley Avenue, Suite B
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
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CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

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

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	13th March 06	First issue.
Rev B	29th April 06	Review Of Section 5.1.2 Occupied Bandwidth and Emission Mask

1. TEST RESULT CERTIFICATE

Manufacturer:	ArWest Communications Corp. 300 Orchard City Drive, Suite #126, Campbell, California 95008 USA	Tested By:	MiCOM Labs, Inc. 3922 Valley Avenue Suite 'B' Pleasanton California, 94566 USA
EUT:	AlphaWave Narrowband Radio Modem	Telephone:	+1 925 462 0304
Model:	AW435	Fax:	+1 925 462 0306
S/N:	Unit #5		
Test Date(s):	4th Jan. - 13th Feb. 2006	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 90 & IC RSS-119	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.

ACCREDITED
CERTIFICATE #2381.01

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	2001	Code of Federal Regulations
(ii)	Industry Canada RSS-119	Issue 6 March 25th 2000	Land Mobile and Fixed Radio Transmitters and Receivers, 27.41 to 960 MHz
(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)	A2LA	14th Sept. 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy

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 AlphaWave AW435 to FCC and Industry Canada regulations
Applicant:	As manufacturer
Manufacturer:	ArWest Communications Corp. 300 Orchard City Drive, Suite #126 Campbell, California 95008 USA
Test Laboratory:	MiCOM Labs, Inc. 3922 Valley Avenue, Suite "B" Pleasanton, California 94566 USA
Test report number:	ARWT02-A2 Rev B
Date EUT received:	4th January 2006
Dates of test (from - to):	4th Jan. - 13th Feb. 2006
Standard(s) applied:	FCC 47 CFR Part 90 & IC RSS-119
No of Units Tested:	2
Type of Equipment:	Land Mobile
Manufacturers Trade Name:	AlphaWave
Model:	AW435
Location for use:	Indoor and Outdoor
Declared Frequency Range:	430 to 470 MHz
Type of Modulation:	GMSK,DBPSK, DQPSK, D8PSK, D16 QAM
Declared Nominal Output Power:	+33 dBm/2 W to +45dBm/ 35W in 1 dB steps (for GMSK/DBPSK) +30 dBm/1 W to +42dBm/ 16W in 1 dB steps (for DQPSK) +28 dBm/650 mW to +40dBm/ 10W in 1 dB steps (for D8PSK) +25 dBm/320 mW to 37 dBm/5W in 1 dBm steps (for D16 QAM)
EUT Modes of Operation:	Channel Spacing's: • 25 KHz • 12.5 KHz
Transmit/Receive Operation:	Half Duplex and Simplex Device
Rated Input Voltage and Current:	+12 Vdc - Nominal: +10V to +14Vdc Extremes:
Operating Temperature Range:	-30ºC to +50ºC

ITU Emission Designator:	PSK & 16 QAM Modulation 25 kHz Channel Spacing - 10K4G1D 12.5 kHz Channel Spacing – 5K21G1D GMSK Modulation 25 kHz Channel Spacing – 10K4F1D 12.5 kHz Channel Spacing – 5K21F1D
Microprocessor(s) Model:	BF532SBBC-400
Clock/Oscillator(s):	12.288 MHz
Frequency Stability:	1).. ± 1.5ppm initial (temperature variation) 2).. ± 3ppm aging/year
Equipment Dimensions:	6” x 2.9” X 2.5” (150mm X 75mm x 27mm)
Weight:	27oz (1000g)
Primary function of equipment:	System Monitoring and Control Applications

3.2. Scope of Test Program

The scope of the test program was to test the AlphaWave AW400 Narrowband Radio Modem for compliance against appropriate FCC and Industry Canada regulatory requirements;

FCC CFR 47 Part 90, Subsection I frequency band 430 – 470 MHz

Industry Canada RSS-119

The AW400 employs several modulation schemes in the frequency range 430 –470 MHz;

- DBPSK
- DQPSK
- D8PSK
- D16QAM
- GMSK

Note: for compliance purposes manufacturer declared that the DBPSK and GMSK modulation types are the same and unless otherwise mentioned each modulation scheme will be tested for compliance against the stated regulations.

EUT Photographs

AW435 BNC RF Connector	AW435 Side
	
AW435 Heatsink	AW435 Rear Connectors
	

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

Name	Manufacturer	Model No.	Serial No.
AlphaWave	ArWest Communications Corp.	Unit #1 AW435	Not Available
AlphaWave	ArWest Communications Corp.	Unit #2 AW435	Not Available

3.4. Antenna Details

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

Antenna was not tested as part of the compliance test program

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 15 pin D-Type Female
2. Alden Pulse Lok two pin dc power connector V142TC12

3.6. Test Configurations

Matrix of test configurations

Parameter	Operational Mode	Test Conditions	Frequencies (MHz)
Output power	CW & Modulated	Ambient	430, 450, 470
Occupied BW & Emission Mask	CW & Modulated	Ambient	430, 450, 470
Frequency Stability	CW	Ambient, temperature and voltage extremes	430, 450, 470
Conducted Emissions	Modulated	Ambient	430, 450, 470
Transmitter Transient	CW	Ambient	450
Unwanted Emissions	Modulated	Ambient	430, 450, 470

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:

Spurious Emissions

1. Problem with non-compliant spurious emissions, harmonics of the fundamental were non-compliant. Final measurement proving compliance was made with a high pass filter which removed the energy from the fundamental carrier.

   To bring the equipment into compliance the following fix was implemented;

   > To resolve undesirable spurious emissions a 5.6 pF capacitor was installed between the RF output trace and analog ground. The capacitor acts as an additional low pass filter on the RF output.

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** and **Industry Canada RSS-119**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
90.205(g) **5.4**	Output Power	Average unmodulated and modulated Output Power	Conducted	Complies	5.1.1
90.209(b)(5) **90.210(d)** **5.5 & 6.4**	Occupied BW & Emission Mask	Plot includes emission mask and bandwidth measurement	Conducted	Complies	5.1.2
90.213 **7**	Frequency Stability	Includes temperature and voltage variations	Conducted	Complies	5.1.3
90.210 **6.3**	Conducted Spurious Emissions Transmitter Receiver	Emissions from the antenna port 30MHz – 5 GHz 30MHz – 2 GHz	Conducted	Complies	5.1.4 *5.1.4.1* *5.1.4.2*
90.214 **6.5**	Transmitter Transient Behavior	Stabilization of RF frequency	Conducted	Complies	5.1.5
90.210 **6.3**	Unwanted Emissions	Spurious emissions 30MHz–5GHz	Radiated	Complies	5.1.6
2.1033 (8)	Final Amp. dc Voltage & Current	Power consumption at final stage amp	Manufacturer Declaration	No limit	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

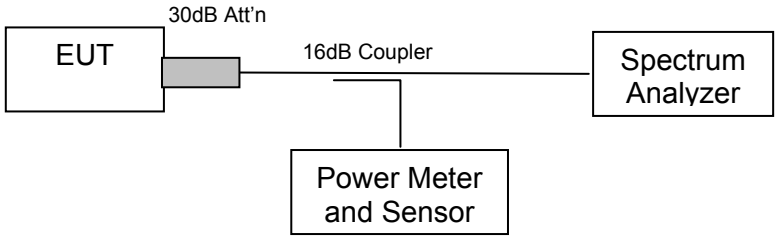
5.1.1. Output Power

FCC Part §90.205(g)
Industry Canada RSS-119 §5.4

Test Procedure
Power measurements via the power meter were recorded with;
1).. modulation OFF (i.e. CW operation mode), and
2).. modulation ON

Modulation ON was measured in a system test mode with a 100% duty cycle.

Test Measurement Set up



Test set up for un-modulated and modulated output power measurement

Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

TABLE OF RESULTS – Unmodulated Carrier (CW)

Center Frequency (MHz)	CW Power (+dBm)				
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK
430	44.83	44.31	37.81	33.54	44.83
450	44.46	43.65	36.51	33.71	44.46
470	44.37	43.88	37.92	34.95	44.37

TABLE OF RESULTS – 25 KHz Channel Spacing Modulated Carrier

Center Frequency (MHz)	Power (+dBm) V's Modulation				
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK
430	44.52	44.15	37.42	33.18	44.52
450	44.19	43.40	36.23	33.33	44.19
470	44.15	43.50	37.20	34.69	44.15

TABLE OF RESULTS – 12.5 KHz Channel Spacing Modulated Carrier

Center Frequency (MHz)	Power (+dBm) V's Modulation				
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK
430	44.10	44.05	37.42	33.36	44.10
450	44.02	43.15	36.13	33.25	44.02
470	44.20	43.80	37.90	33.76	44.20

Specification

Limits

FCC Part §90.205(g)
Power limit according to 90.205(g) 450–470 MHz. The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2. (i.e. 2W for service area less than 3 km.)

Industry Canada RSS-119 §5.4
Typical output powers for base and/or fixed stations (paging transmitters excepted) are 100 watts and for mobiles they are 30 watts.

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'	0156, 0116, 0070, 0252, 0313, 0314

5.1.2. Occupied Bandwidth and Emission Mask

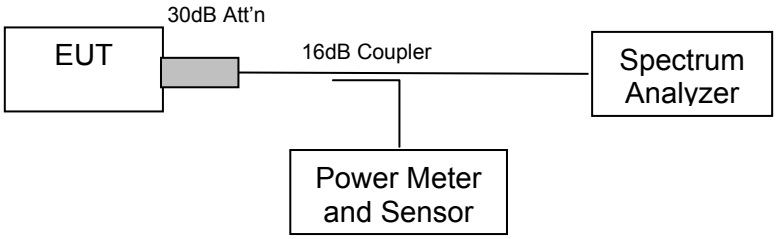
FCC, Part §90.209(b)(5), Part §90.210
Industry Canada RSS-119 §5.5 & 6.4

Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure occupied bandwidth and emission mask. The resolution filter bandwidth was set to 6 dB, peak detector selected and the analyzer built-in bandwidth function was used to measure emission mask and 99 % bandwidth.

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

Test Measurement Set up



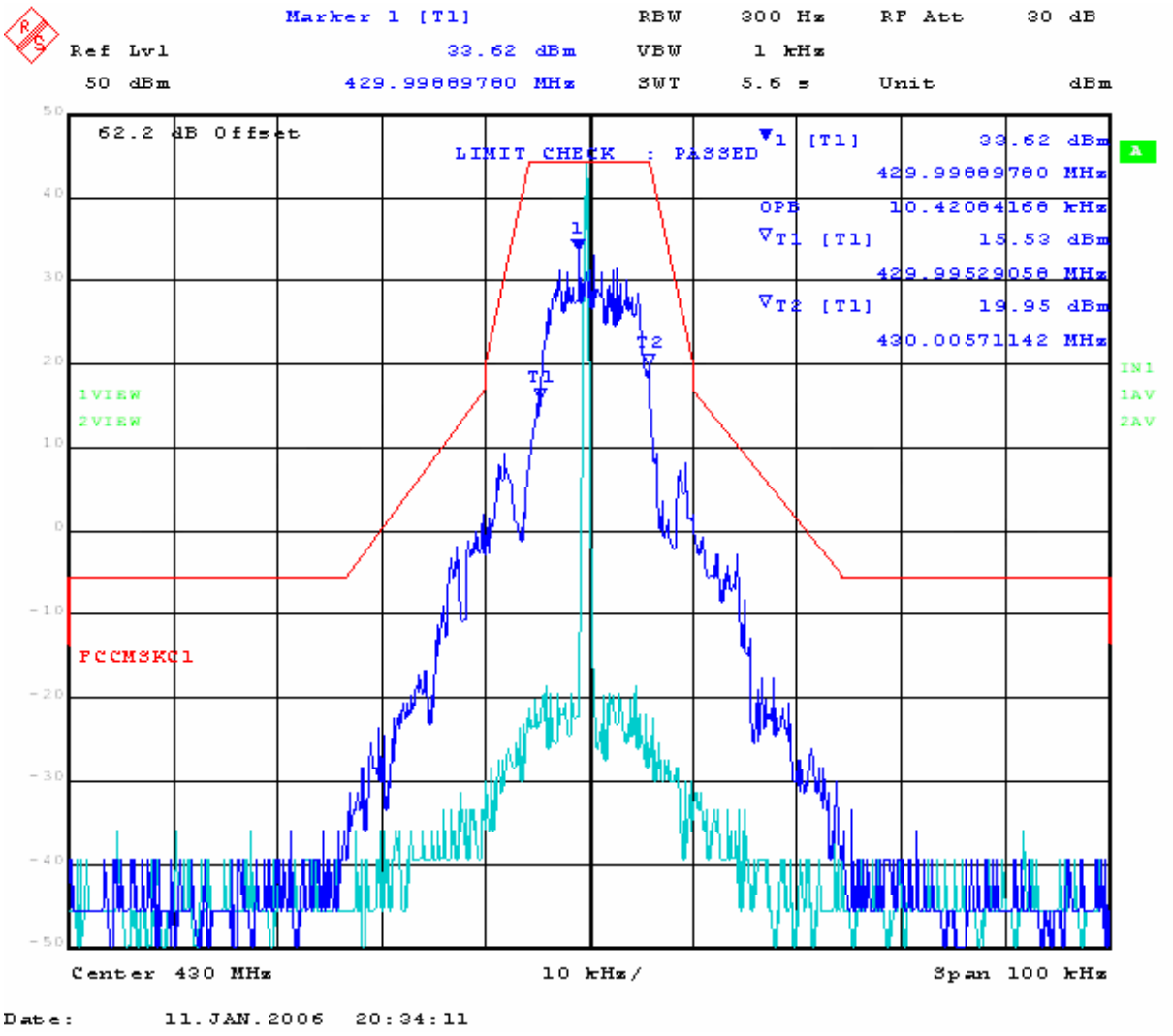
Test set up for Occupied Bandwidth and Emission Mask measurement

Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

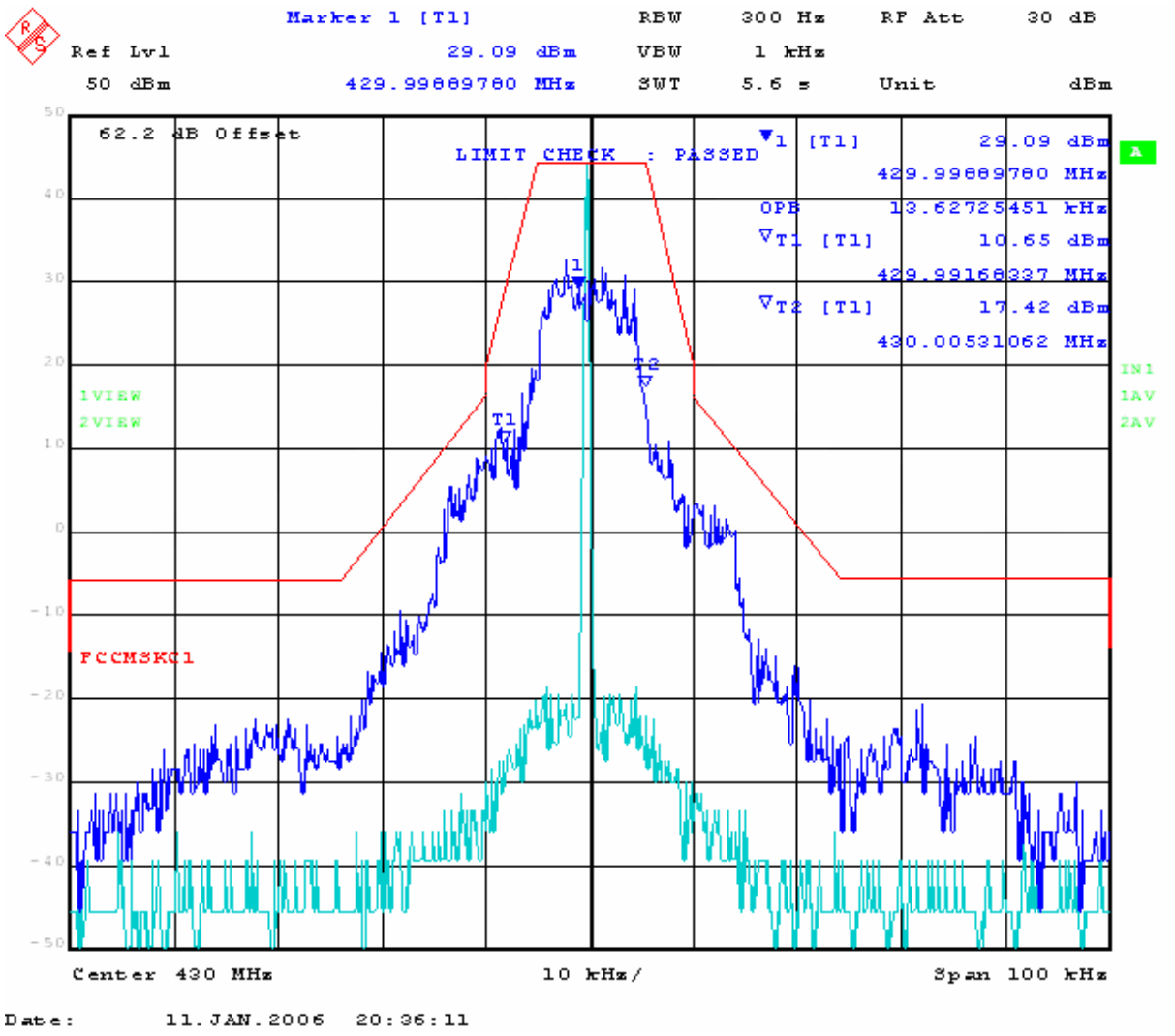
TABLE OF RESULTS – 25 KHz Channel Spacing

Frequency (MHz)	99% Bandwidth (KHz)			
	Modulation			
	DBPSK	DQPSK	D8PSK	16 QAM
430	10.4208[1]	13.6273[1]	10.0200[1]	10.4208[1]
450	10.0200	11.6232[1]	9.8196	10.2204
470	10.2204	10.6212[1]	9.8196	10.2204

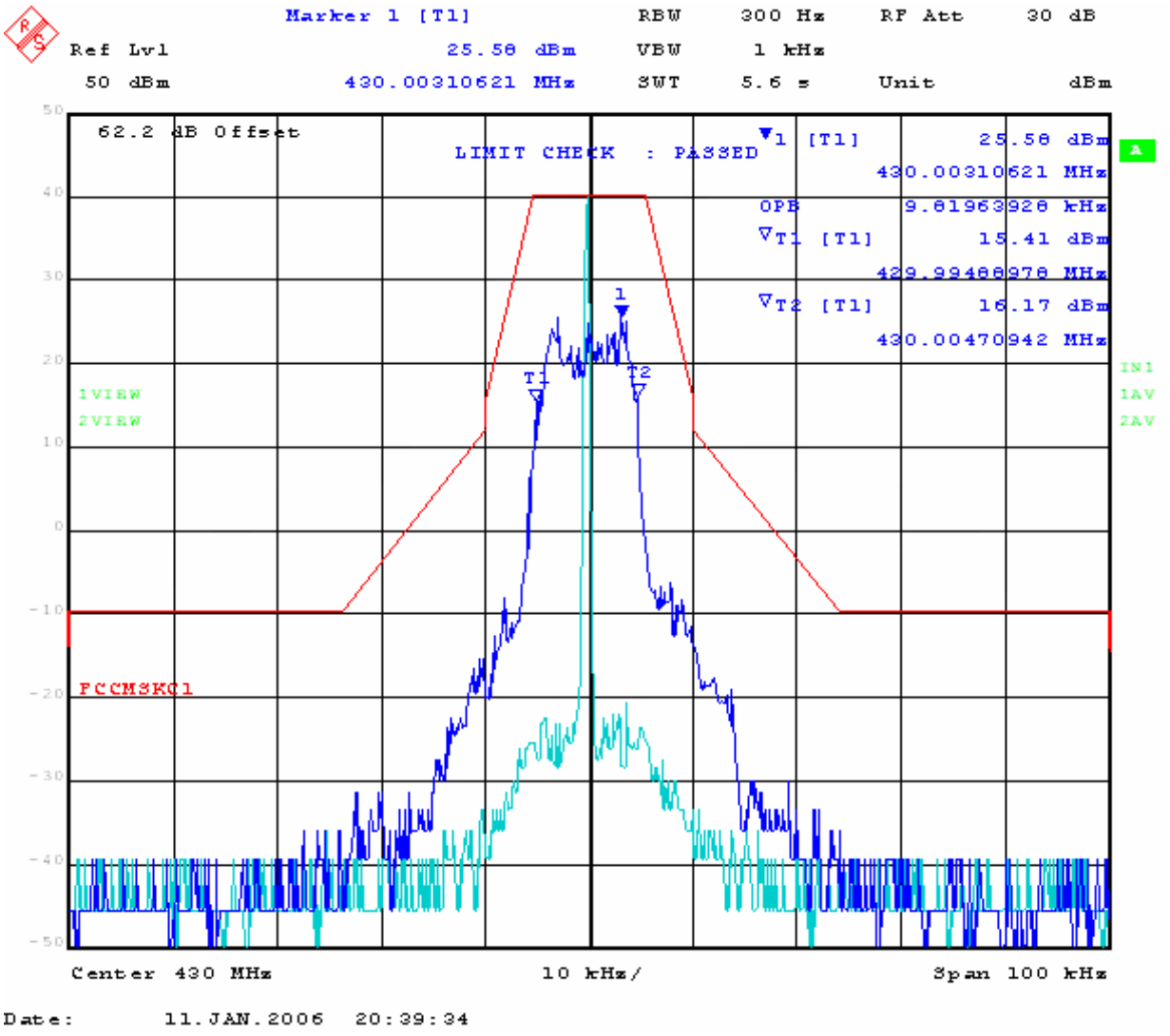
[1] Plot provided



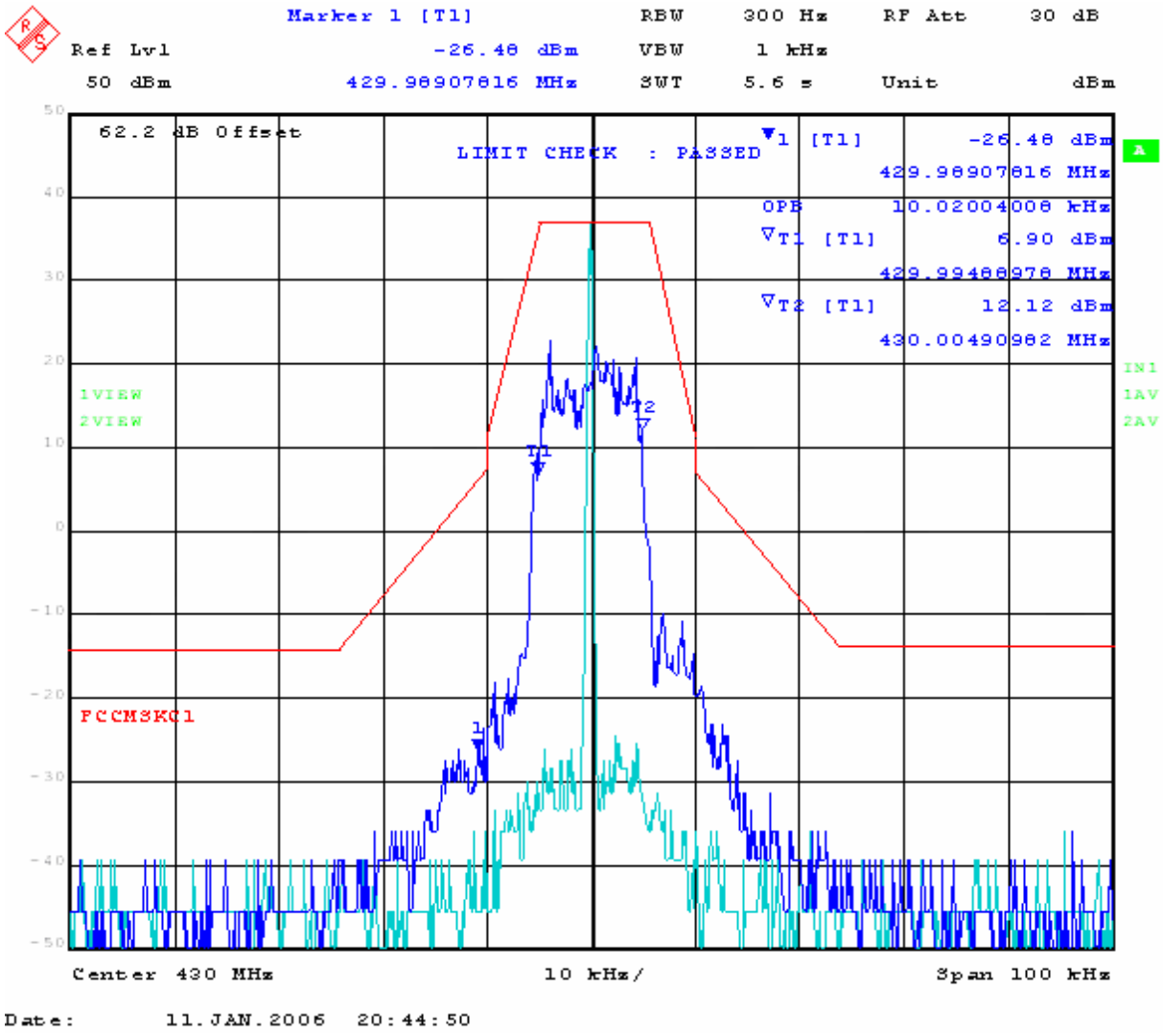
25 KHz Channel Spacing DBPSK 430 MHz – Emission Mask C



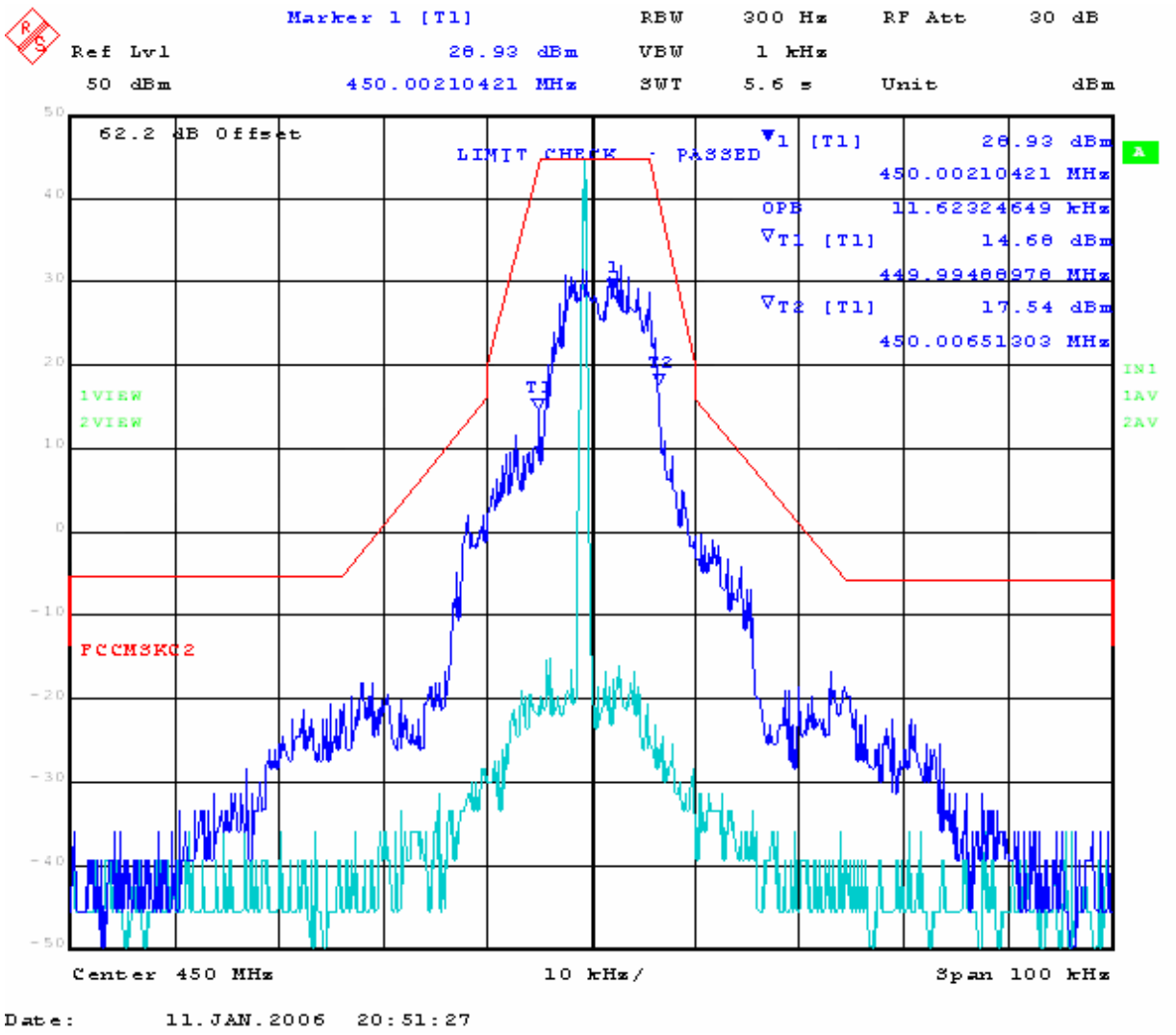
25 KHz Channel Spacing DQPSK 430 MHz – Emission Mask C



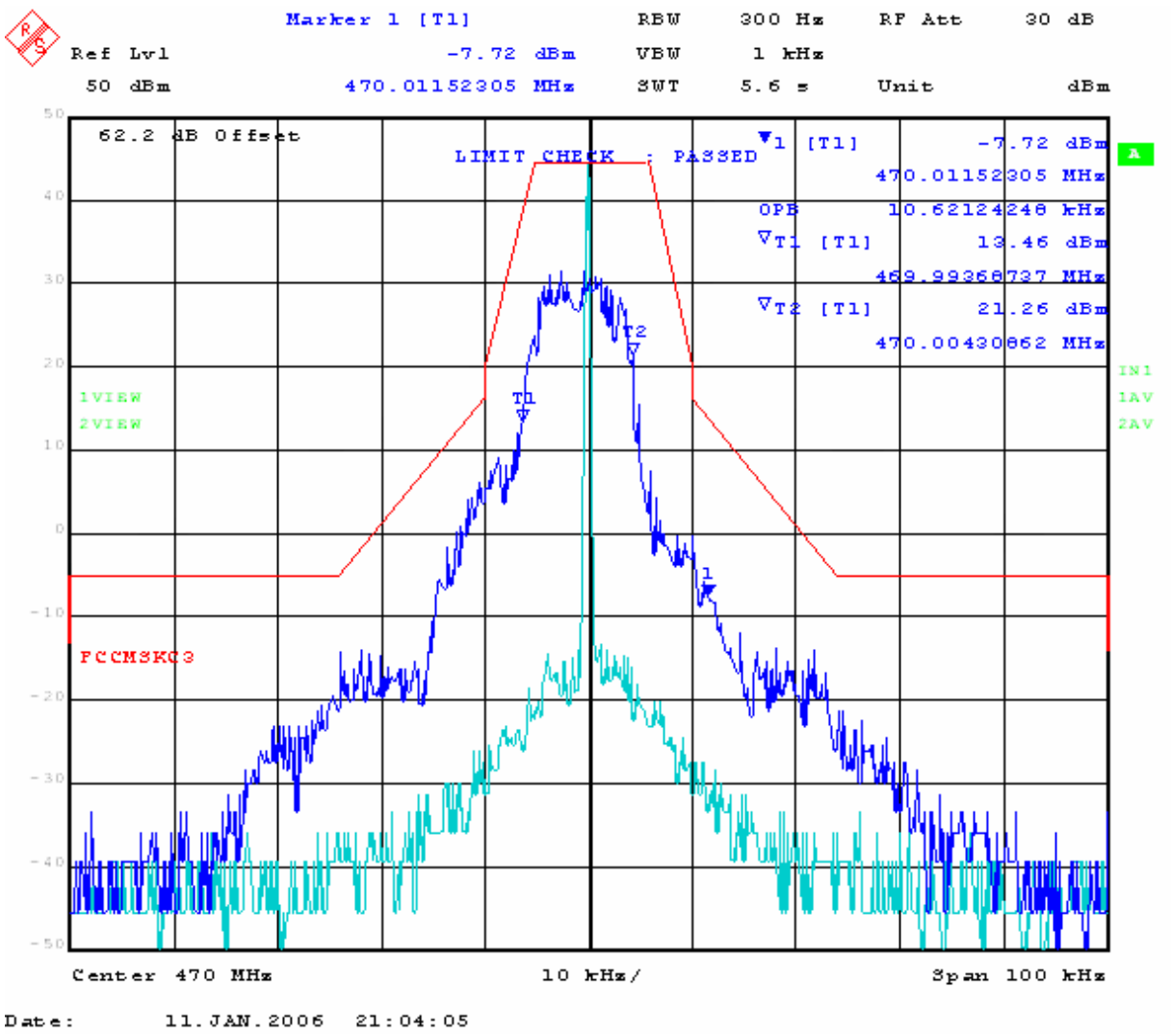
25 KHz Channel Spacing D8PSK 430 MHz – Emission Mask C



25 KHz Channel Spacing 16QAM 430 MHz – Emission Mask C



25 KHz Channel Spacing DQPSK 450 MHz – Emission Mask C

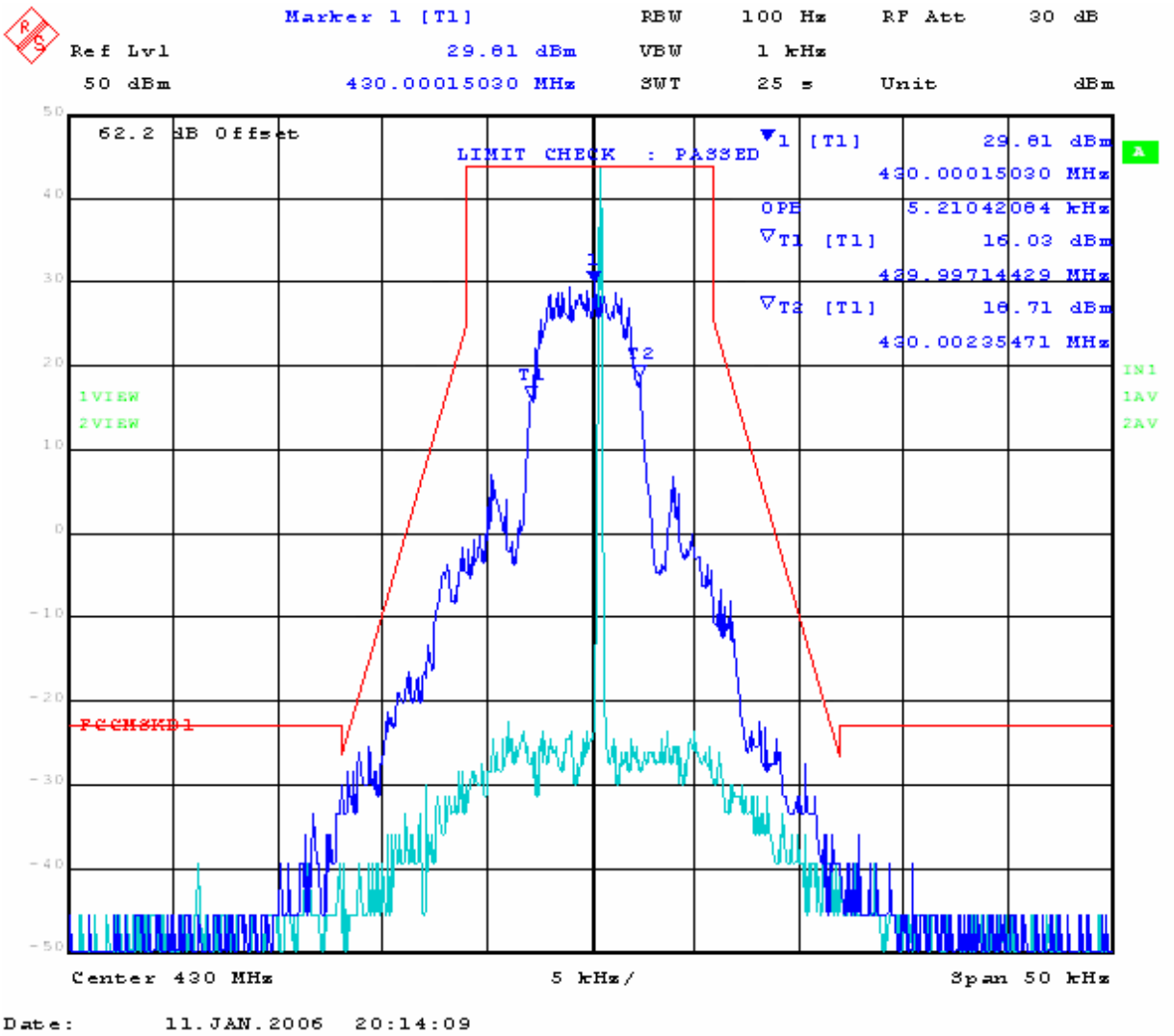


25 KHz Channel Spacing DQPSK 470 MHz – Emission Mask C

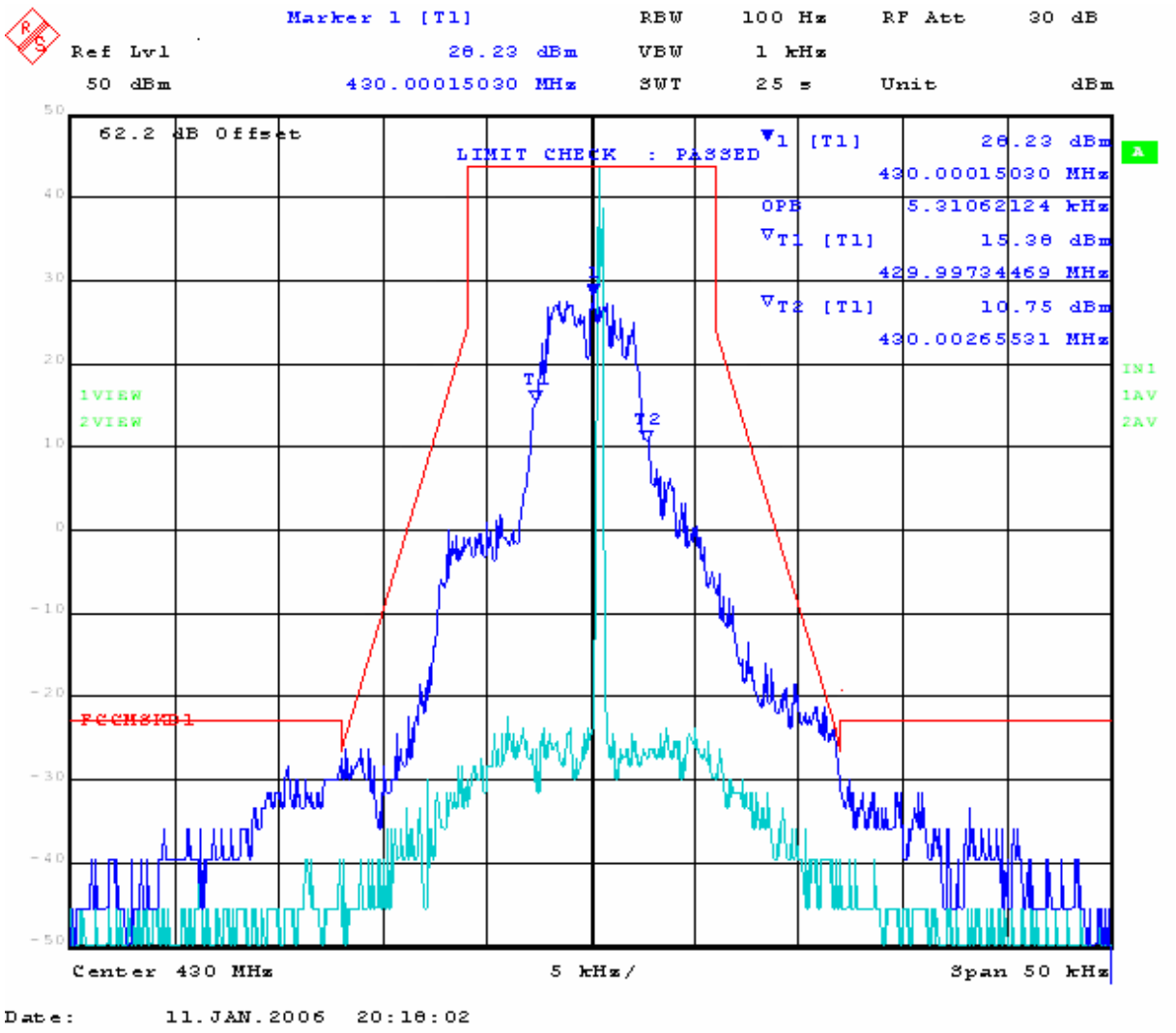
TABLE OF RESULTS – 12.5 KHz Channel Spacing

Frequency (MHz)	99% Bandwidth (KHz) Modulation			
	DBPSK	DQPSK	D8PSK	16 QAM
430	5.2104[1]	5.3106[1]	4.9098	5.0100
450	5.0100	5.5110[1]	4.9098	5.0100
470	5.0100	5.1102	4.9098[1]	5.1102[1]

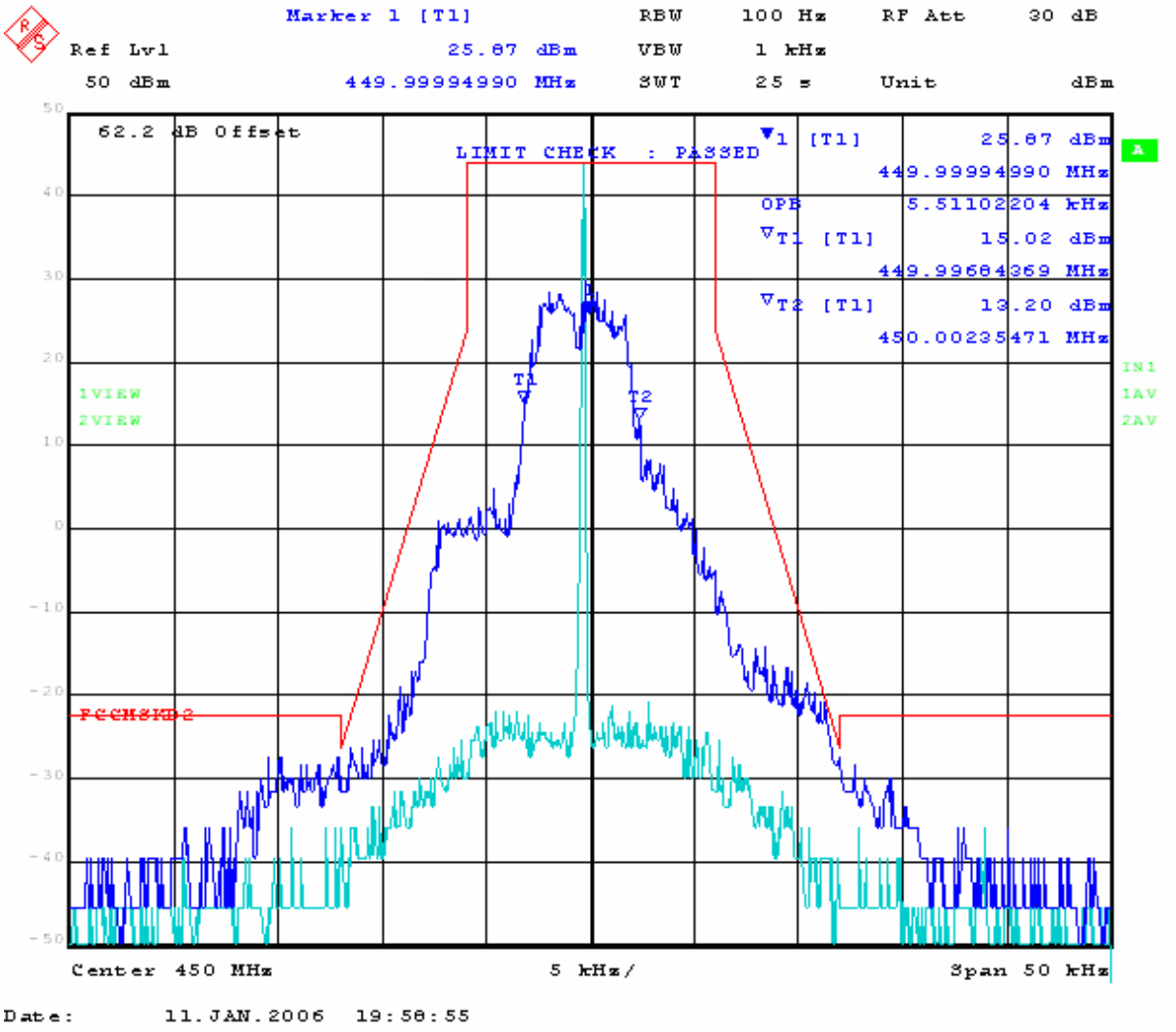
[1] Plot provided



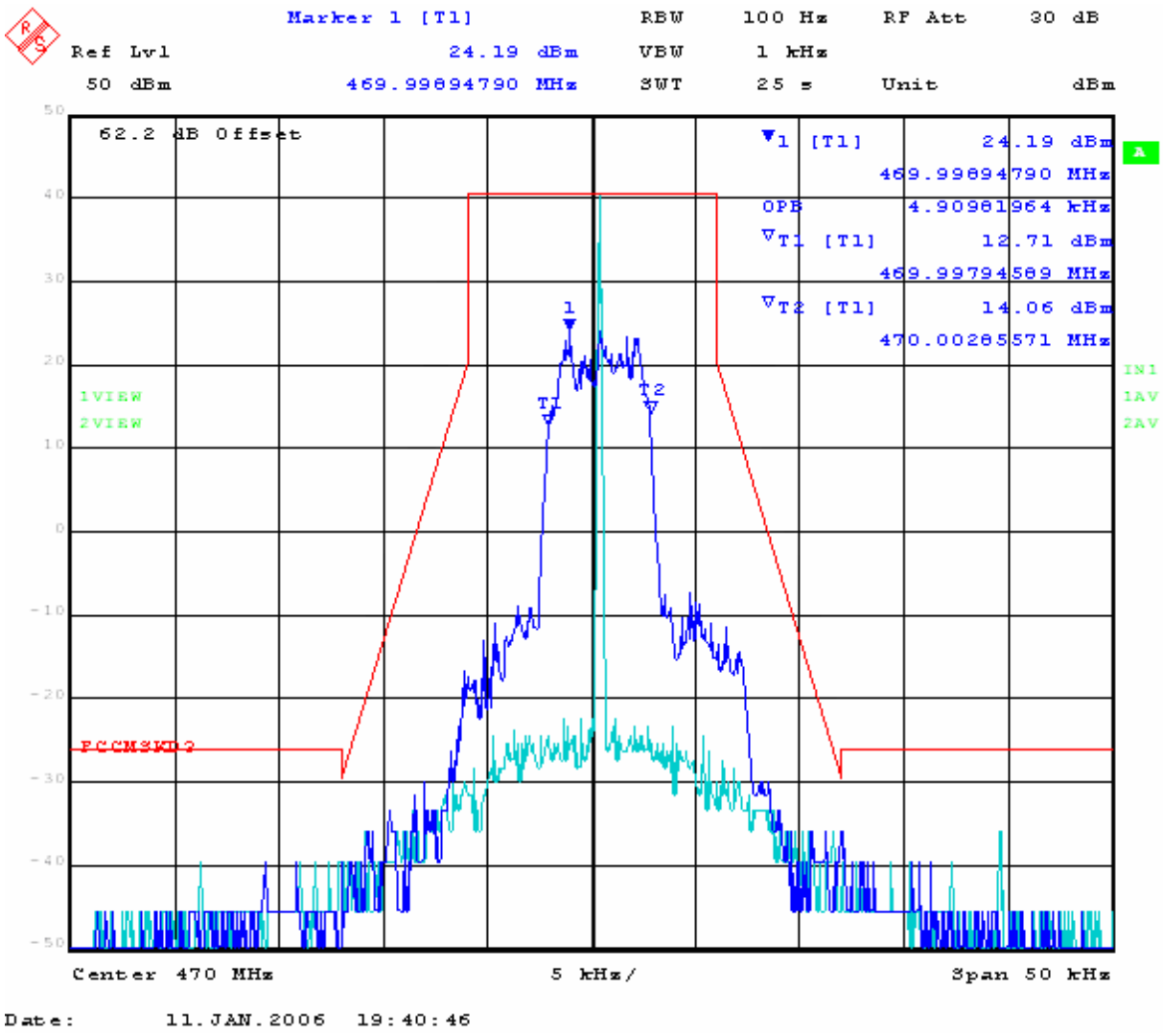
12.5 KHz Channel Spacing DBPSK 430 MHz – Emission Mask D



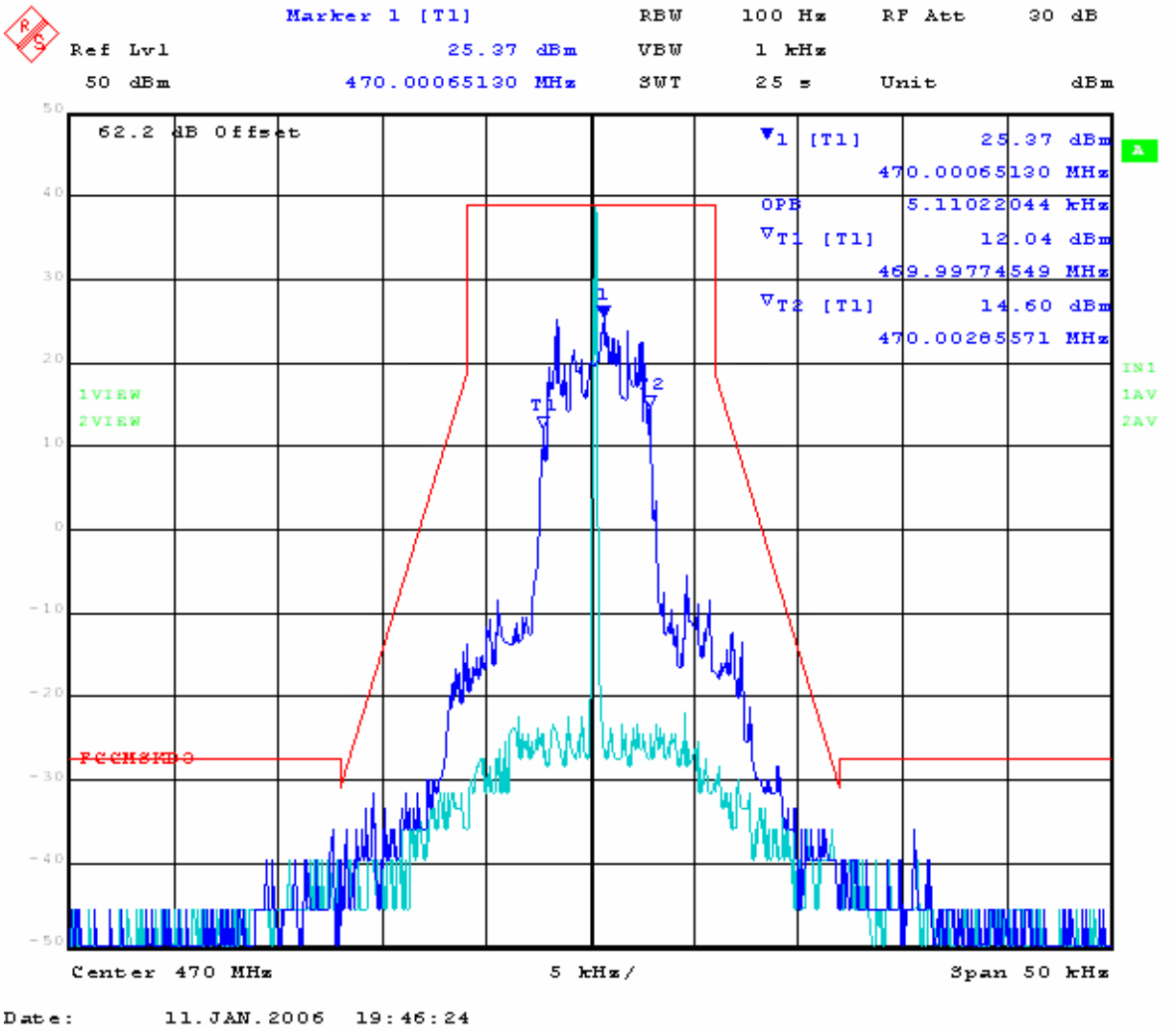
12.5 KHz Channel Spacing DQPSK 430 MHz – Emission Mask D



12.5 KHz Channel Spacing DQPSK 450 MHz – Emission Mask D



12.5 KHz Channel Spacing D8PSK 470 MHz – Emission Mask D



12.5 KHz Channel Spacing 16 QAM 470 MHz – Emission Mask D

Specification

The limits for **FCC (Part §90.210)** and **Industry Canada RSS-119 (§6.4)** are numerically identical and therefore only the FCC rules are quoted in this section. The masks implemented are those "Without Audio Filter".

Limits for Authorized Bandwidth

Frequency Band (MHz) and Related Documents	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Spectrum Masks with Audio Filter	Without Audio Filter
406.1-430 and 450-470 MHz	25	20	B	C[1]
	12.5	11.25	D[1]	D[1]
	6.25	6	E[1]	E[1]

[1] Reference to the emission masks are provided below

Limits Emission Masks

90.210(c), Emission Mask C 25 kHz channel bandwidth equipment. For transmitters that are not equipment with an audio low-pass filter pursuant to 90.211(b), 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 (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;

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

(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)

90.210(d) Emission Mask D 12.5 kHz channel bandwidth equipment. For transmitters designed to operate with 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1).. On any frequency from the center of the authorized bandwidth f_o to 5.625 KHz removed from f_o: Zero dB.

(2).. On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 5.625 KHz but no more than 12.5 KHz: At least 7.27 (fd – 2.88 KHz) dB.

(3).. On any frequency removed from the center of the authorized bandwidth by displacement frequency (fd in KHz) of more than 12.5 KHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

(4).. The reference level for showing shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 KHz removed from the edge of the authorized bandwidth; adjust the resolution the bandwidth 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must

be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 KHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, an alternate procedure may be used provided prior Commission approval is obtained.

90.210(e) Emission Mask E, 6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1).. On any frequency from the center of the authorized bandwidth f0 to 3.0 kHz removed from f_0: Zero dB.

(2).. On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(fd - 3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(3).. On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

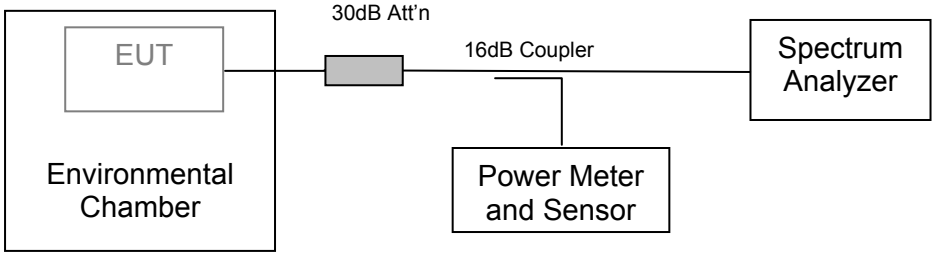
Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0156, 0193, 0252, 0313, 0314.

5.1.3. Frequency Stability

FCC, Part 15 Subpart C §90.213
Industry Canada RSS-210 §7

Test Procedure
The transmitter output was connected to a spectrum analyzer and the frequency stability was measured in CW mode. Frequency stability was measured both at ambient and extremes of temperature on three channels. At each temperature the equipment was switched on and left for 30 minutes for thermal balance to be obtained before measurements were taken.

Test Measurement Set up



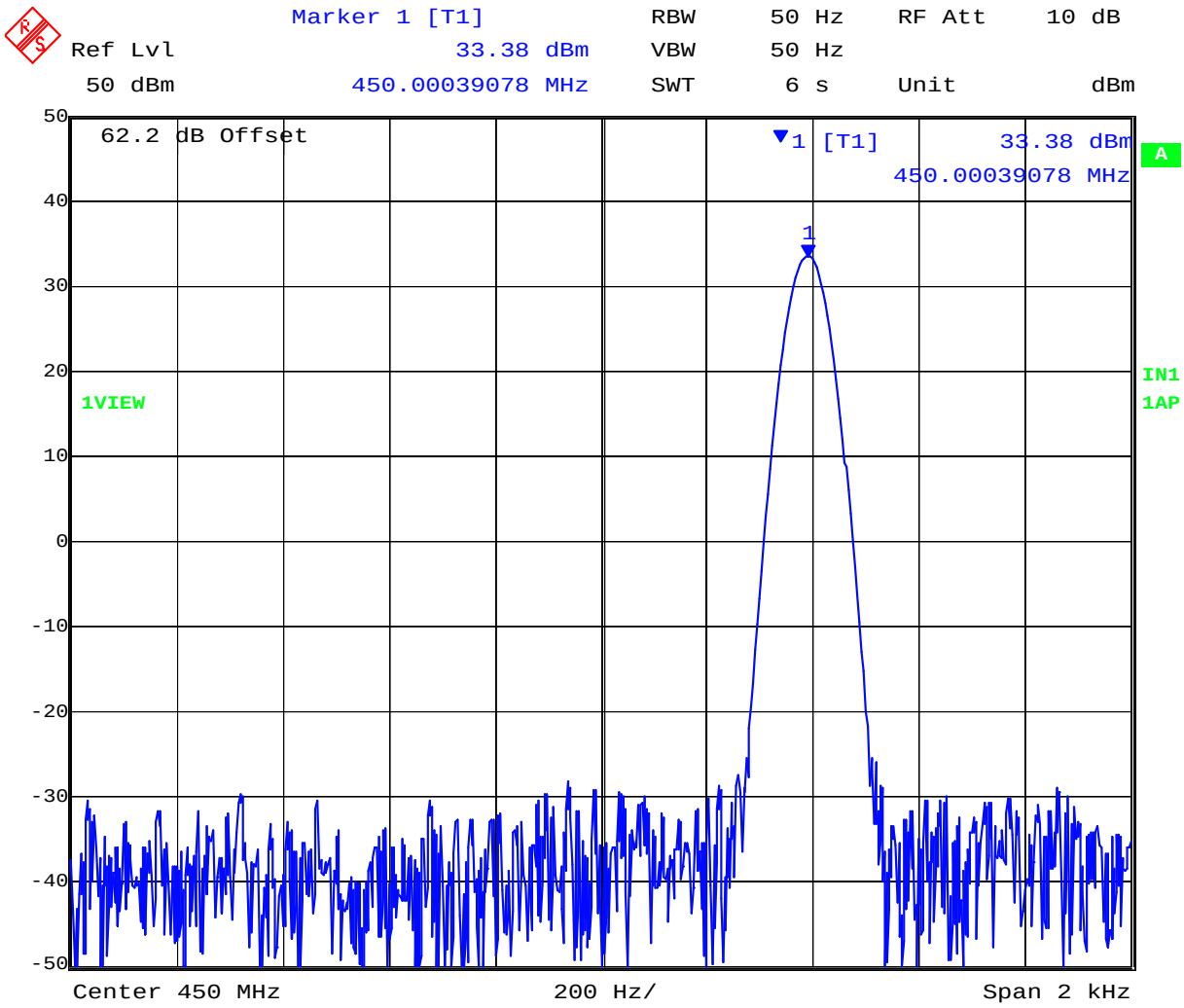
Measurement set up for Frequency Stability

Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

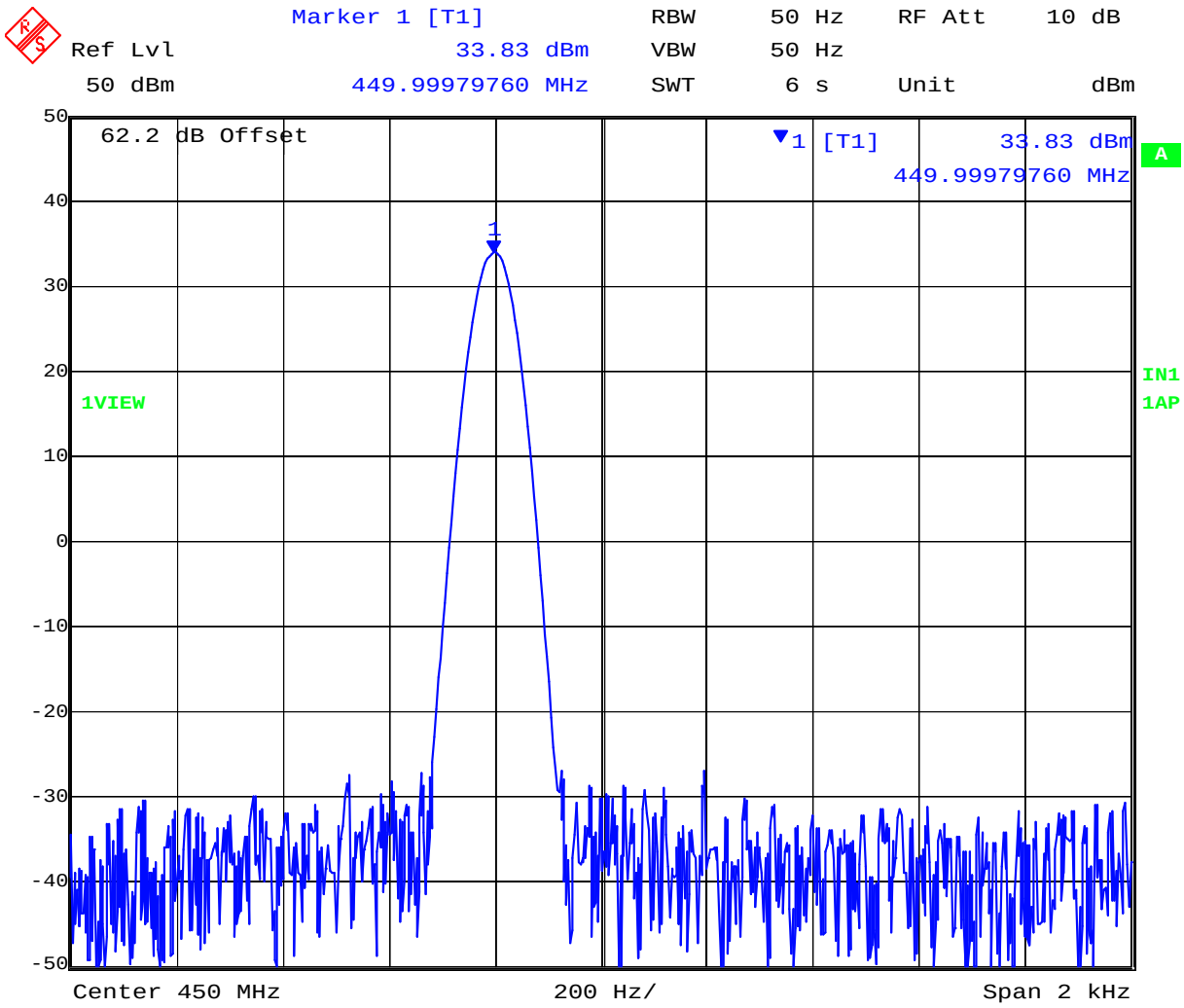
TABLE OF RESULTS

Temperature	Voltage	FREQUENCY (MHz)		
		Channel 430 MHz	Channel 450 MHz	Channel 470 MHz
Ambient	+12 Vdc	430.00003808	450.00005812	470.00008617
	+10.8 Vdc	430.00003808	450.00015431	470.00003006
	+13.2 Vdc	430.00007014	450.00011824	470.00001002
-30°C	+12 Vdc	429.99988577	449.99983567	469.99986172
-20°C	+12 Vdc	--	449.99992585	--
-10°C	+12 Vdc	--	449.99992585	--
0°C	+12 Vdc	--	450.0002958	--
+10°C	+12 Vdc	--	450.00039078[1]	--
+20°C	+12 Vdc	--	450.00025451	--
+30°C	+12 Vdc	--	449.99997796	--
+40°C	+12 Vdc	--	449.99979760[2]	--
+50°C	+12 Vdc	429.99988577	449.99988507	470.00016232
Maximum Frequency Drift (±ppm)		+0.868[1] / -0.45[2]		
Limit (±ppm)		2.5 for Fixed and Base Station		

[1, 2] – MAXIMUM FREQUENCY DRIFT EXTREMES (UPPER & LOWER)



Frequency Stability – CW Mode +10°C, 12Vdc



Frequency Stability – CW Mode +40°C, 12Vdc

Specification

FCC, Part 15 Subpart C §90.213

(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
Below 25	[1,2,3] 100	100	200
25–50	20	20	50
72–76	5	.....	50
150–174	[5,11] 5	[6] 5	[4,6] 50
216–220	1 .0	.....	1 .0
220–222 [12]	0 .1	1 .5	1 .5
421–512	[7,11,14] 2 .5	[8] 5	[8] 5
806–821	[14] 1 .5	2 .5	2 .5
821–824	[14] 1 .0	1 .5	1 .5
851–866	1 .5	2 .5	2 .5
866–869	1 .0	1 .5	1 .5
896–901	[14] 0 .1	1 .5	1 .5
902–928	2 .5	2 .5	2 .5
902–928 [13]	2 .5	2 .5	2 .5
929–930	1 .5	.....	.....
935–940	0 .1	1 .5	1 .5
1427–1435	[9] 300	300	300
Above 2450 [10]	.....	.....	.....

1 Fixed and base stations with over 200 watts transmitter power must have a frequency stability of 50 ppm except for equipment used in the Public Safety Pool where the frequency stability is 100 ppm.

2 For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.

3 Travelers information station transmitters operating from 530–1700 kHz and transmitters exceeding 200 watts peak envelope power used for disaster communications and long distance circuit operations pursuant to §§ 90.242 and 90.264 must maintain the carrier frequency to within 20 Hz of the authorized frequency.

4 Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.

5 In the 150–174 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

6 In the 150–174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth or designed to operate on a frequency specifically designated for itinerant use or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.

.

7 In the 421–512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

8 In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

9 Fixed stations with output powers above 120 watts and necessary bandwidth less than 3 kHz must operate with a frequency stability of 100 ppm. Fixed stations with output powers less than 120 watts and using time-division multiplex, must operate with a frequency stability of 500 ppm.
10 Frequency stability to be specified in the station authorization.

11 Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150–174 MHz band and 2.5 ppm in the 421–512 MHz band.

12 Mobile units may utilize synchronizing signals from associated base stations to achieve the specified carrier stability.

13 Fixed non-multilateration transmitters with an authorized bandwidth that is more than 40 kHz from the band edge, intermittently operated hand-held readers, and mobile transponders are not subject to frequency tolerance restrictions.

14 Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

Industry Canada RSS-210 §7

The unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement:

(a) at temperatures of -30ºC, +20ºC and +50ºC at the manufacturer's rated supply voltage, and
(b) at 85% and at 115% of the manufacturer's rated supply voltage, when the temperature is at 20ºC

The frequency stabilities can be maintained to a lesser temperature range, provided that the transmitter is automatically inhibited from operating outside the lesser temperature range.

For hand-held equipment that is only capable of operating from internal batteries, the frequency stability tests shall be performed using a new battery without any further requirement to vary the supply voltage. Alternatively, an external supply voltage can be used and set at the battery nominal voltage, and again at the battery-operating end point voltage which shall be specified by the equipment manufacturer. If an unmodulated carrier is not available, the mean frequency of a modulated carrier can be obtained by using a frequency counter with gating time set to an appropriately large multiple of symbol periods (gating time depending on the required accuracy). Full details on the choice of values shall be included in the test report.

Minimum Standard

(i) The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at +20ºC and rated supply voltage) in excess of the values given in the Table below.

(ii) The frequency stability of transmitters whose output powers do not exceed 120 mW's may comply with the limits listed in the table below, or alternatively see section 6.7 of the test standard.

Frequency Band (MHz)	Authorized Bandwidth (kHz)	Frequency Tolerance (ppm)		
		Base/Fixed	Mobile Station	
			> 2 Watts	2 Watts
406.1-430 and 450-470 MHz	20	2.5	5.0	5.0
	11.25	1.5	2.5	2.5
	6.25	0.1	0.5	0.5

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'	0156, 0193, 0252, 0313, 0314

5.1.4. Conducted Spurious Emissions

5.1.4.1. Transmitter Spurious

FCC Part §90.210
Industry Canada RSS-210 §6.3

Test Procedure
Transmitter emissions were measured while the EUT was operating in a CW operational mode at the appropriate center frequency on three channels low, mid and high. Limits were calculated dependent on channel spacing and transmit power. Emissions were measured to beyond the 10th harmonic of the fundamental (5 GHz).

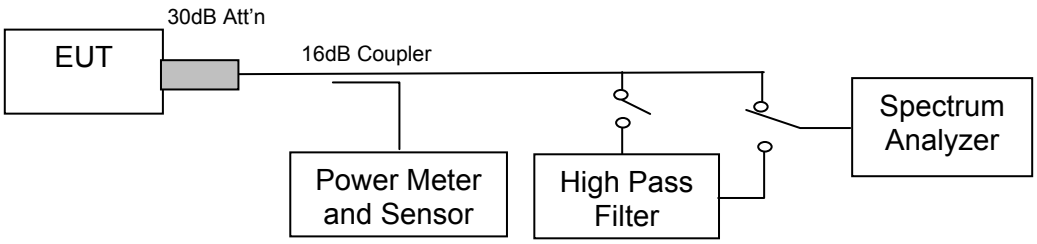
Limit Calculation
As the spurious emissions were measured in CW mode tighter limits apply between 25 kHz and 12.5 kHz. Device output power - 35 Watts (+45 dBm) but actual measurement value = +44 dBm)

25 kHz attenuation = 43 + 10Log (P) = 58.4 dB
Limit (dBm) = 44.1 – 58.4 = -14.3 dBm

12.5 kHz attenuation = 50 +10Log (P) = 65.4 dB
Limit (dBm) = 44.1 – 65.4 = -21.3 dBm

Limit used to prove compliance -21.3 dBm

Test Measurement Set up



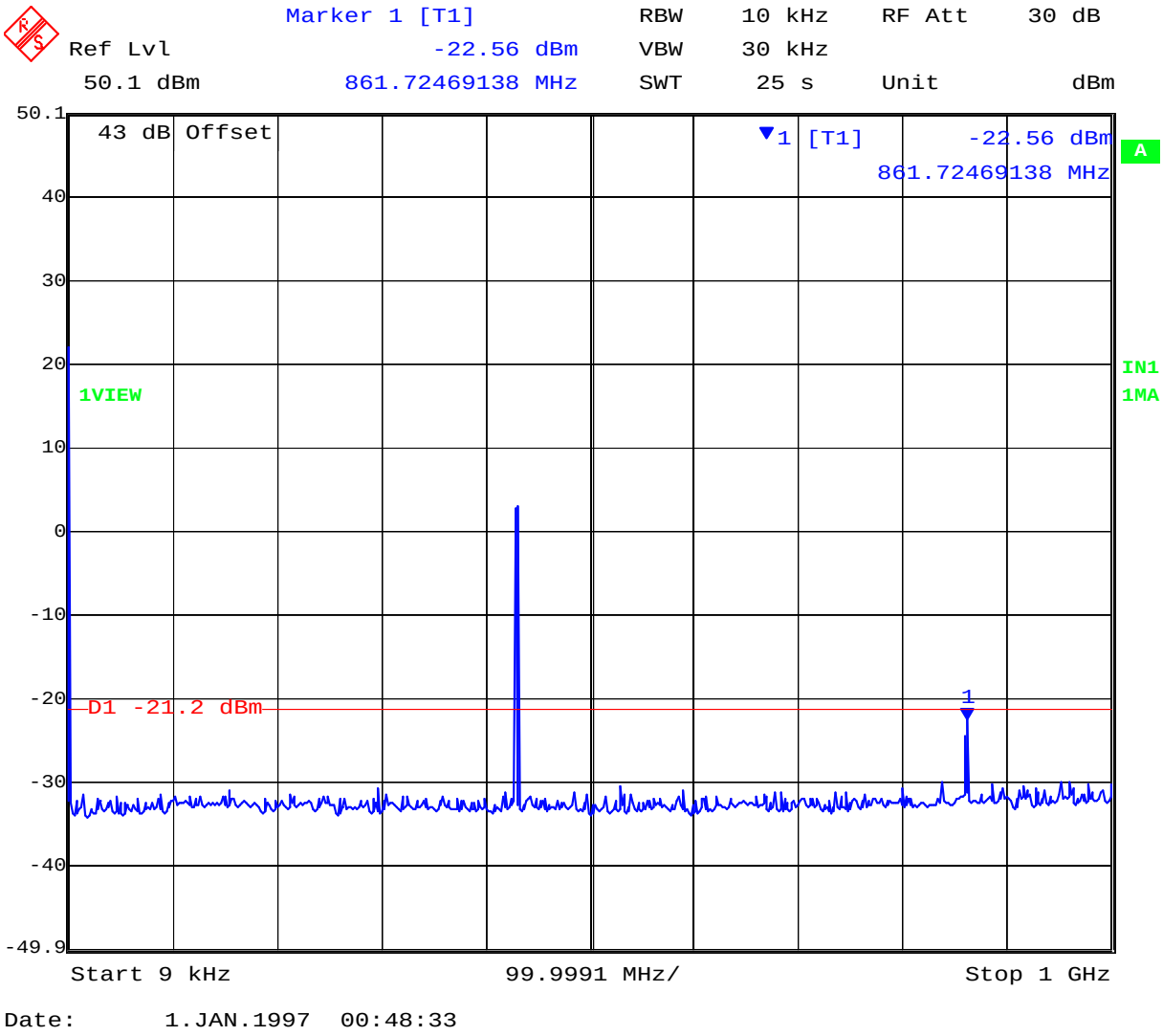
Conducted spurious emission test configuration (transmitter)

Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

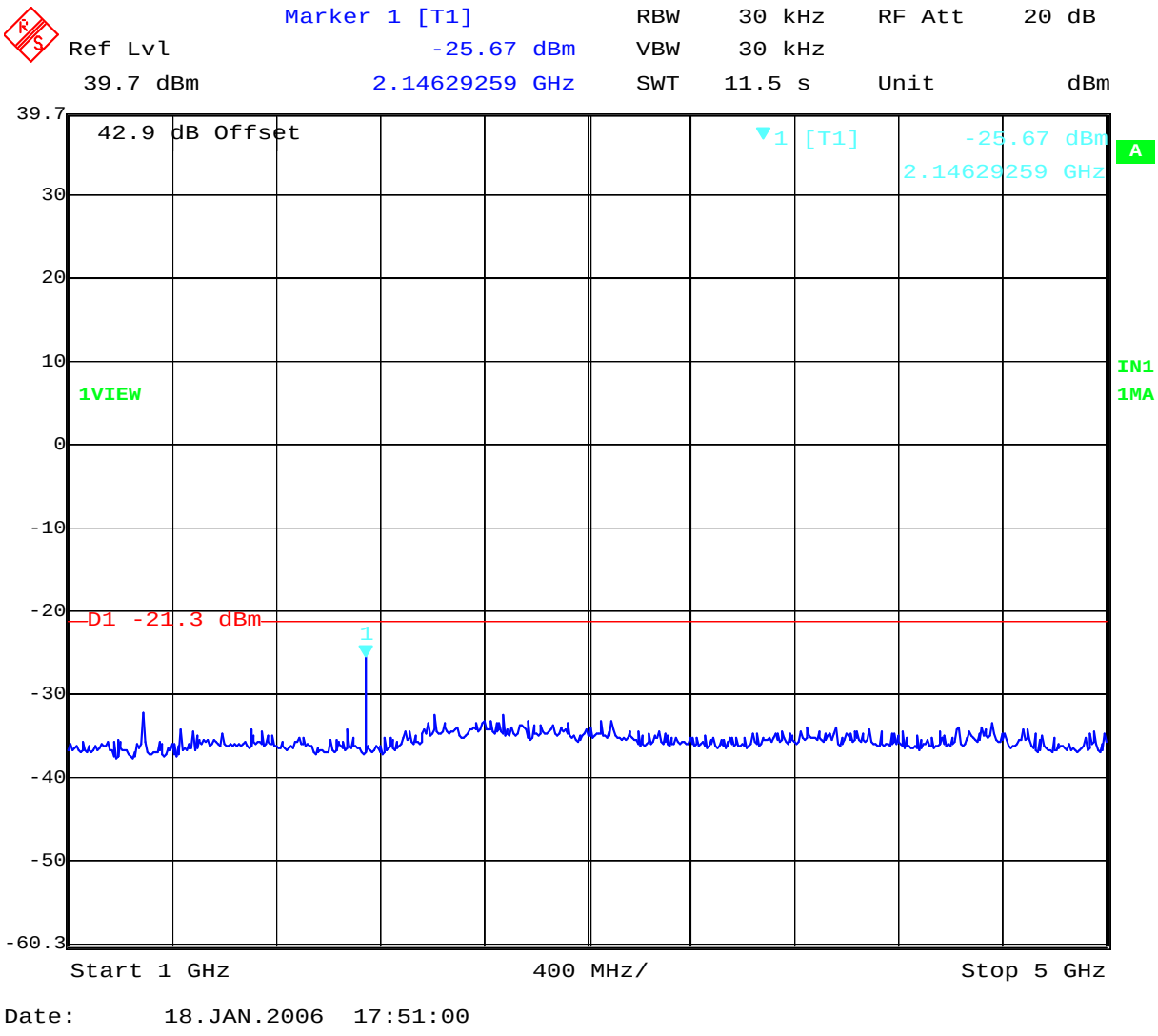
Channel Spacing: 25 kHz
Limit: -21.3 dBm

		Frequency (MHz)					
Channel (MHz)	**Modulation**	**Start**	**Stop**	**Maximum Emission**	**Emission Amplitude (dBm)**	**dBc**	**Margin (dB)**
430	CW Mode	30	1,000	861.72469	-22.56[1]	66.7	-1.26
430	"	1,000	5,000	2,146.2926	-25.67	69.8	-4.37
450	"	30	1,000	900.98196	-22.74	65.5	-1.44
450	"	1,000	5,000	1,344.6894	-23.08	65.8	-1.78
470	"	30	1,000	942.35472	-27.94	71.9	-6.64
470	"	1,000	5,000	2,349.8096	-25.40	69.4	-4.10

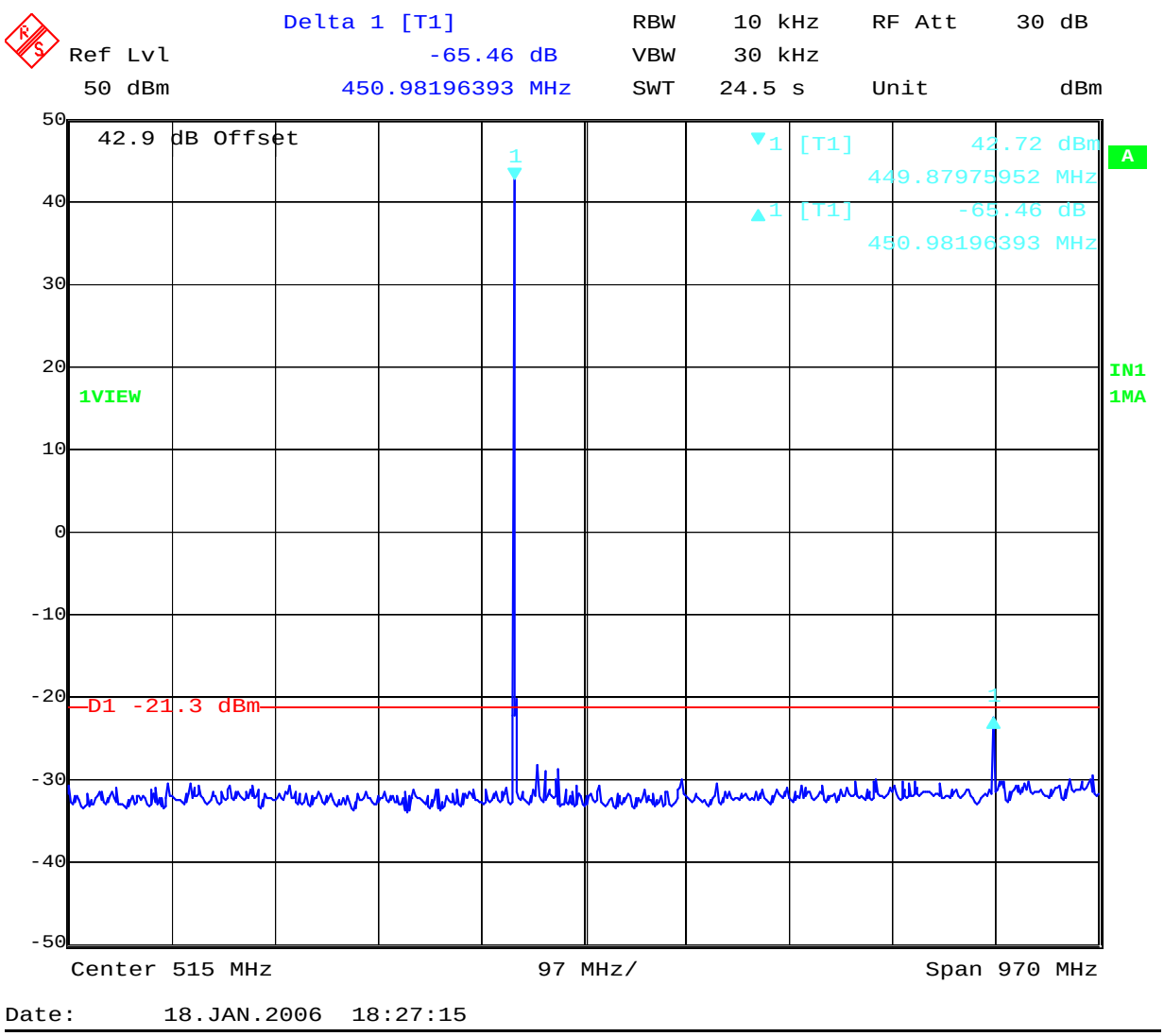
[1] - measured with high pass filter (HPF) in circuit



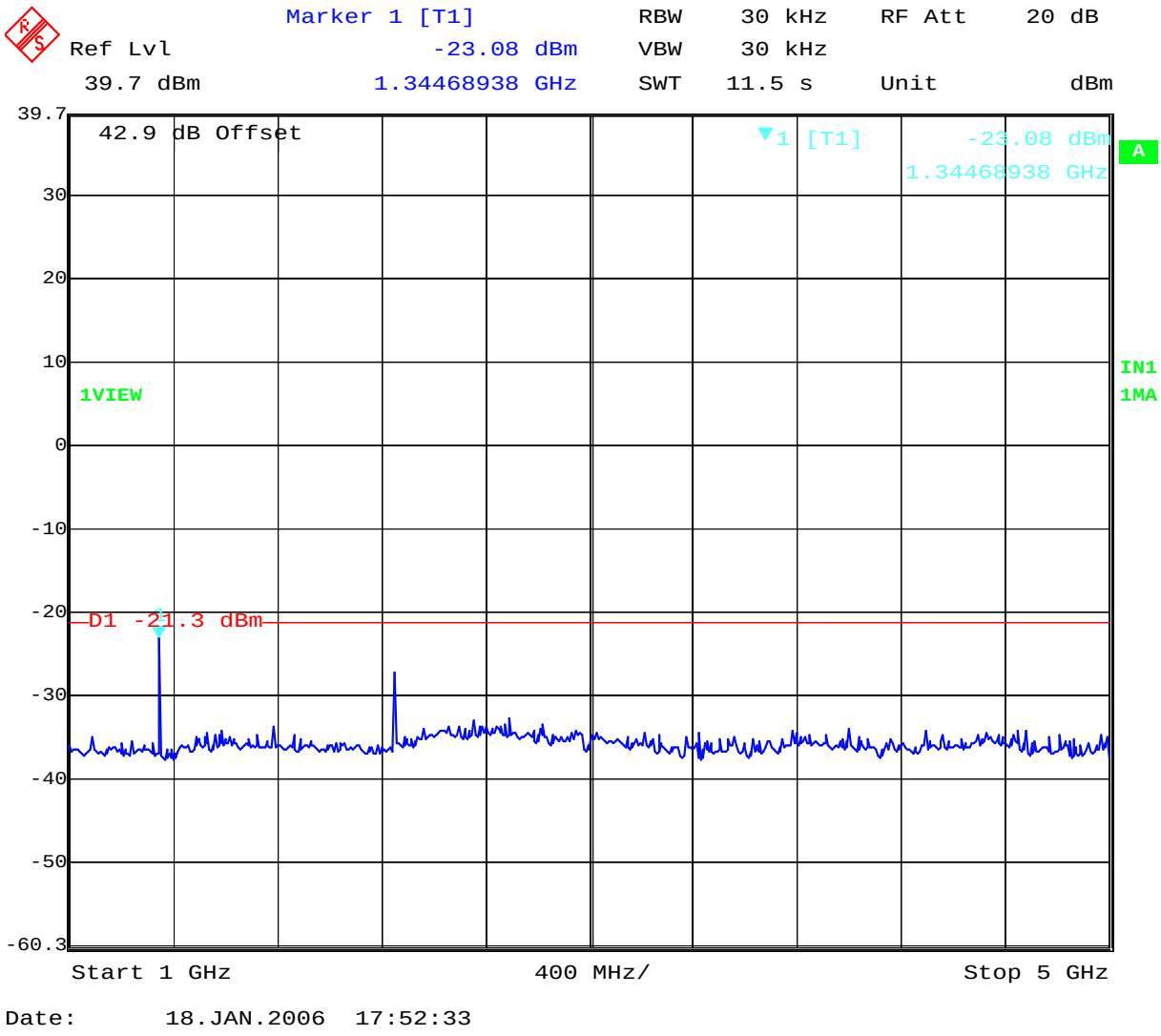
Channel 430 MHz CW Mode 30MHz – 1 GHz



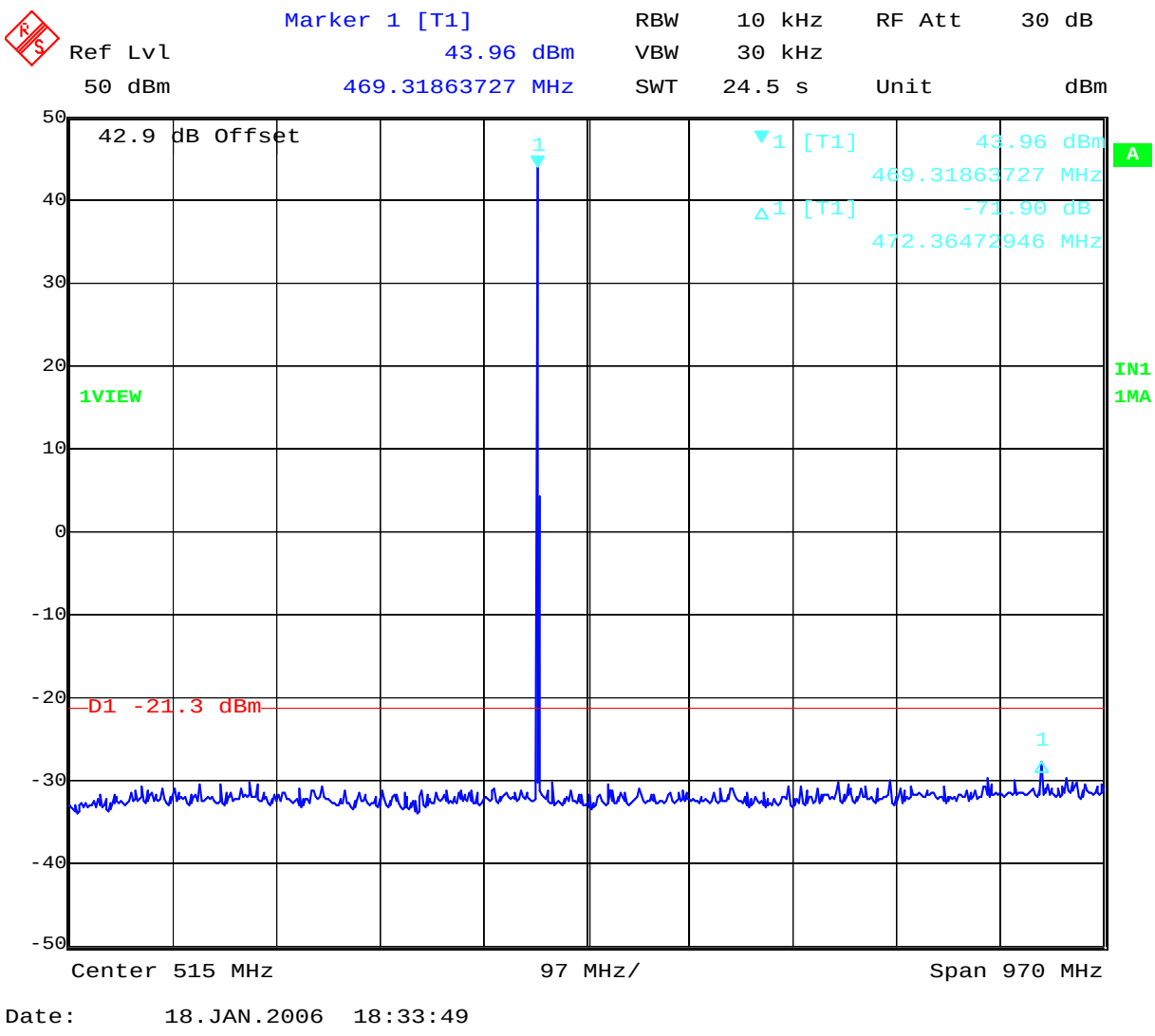
Channel 430 MHz CW Mode 1 – 5 GHz



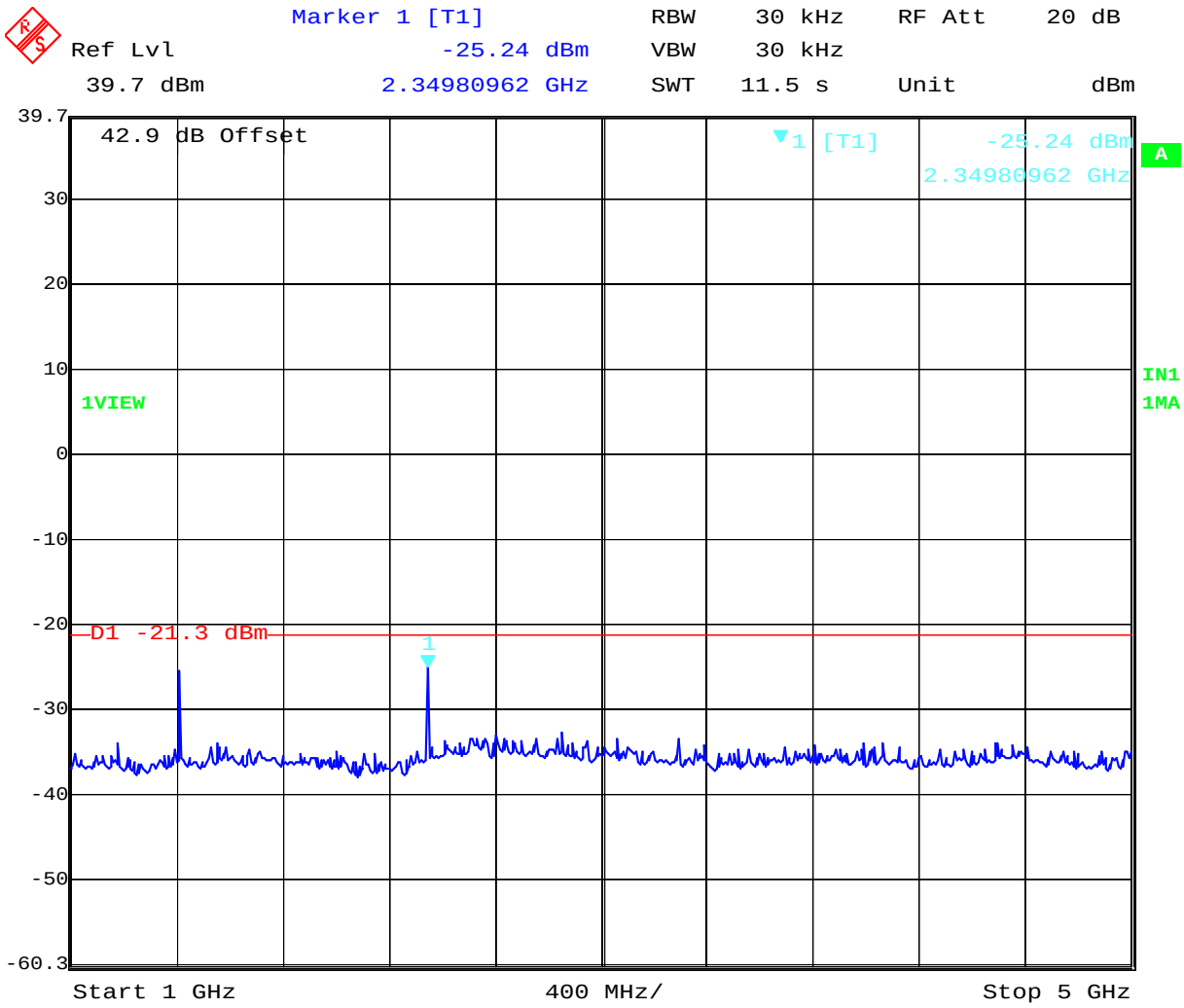
Channel 450 MHz CW Mode 30MHz – 1 GHz



Channel 450 MHz CW Mode 1 -5 GHz



Channel 470 MHz CW Mode 30MHz – 1 GHz



Date: 18.JAN.2006 17:49:13

Channel 470 MHz CW Mode 1 - 5 GHz

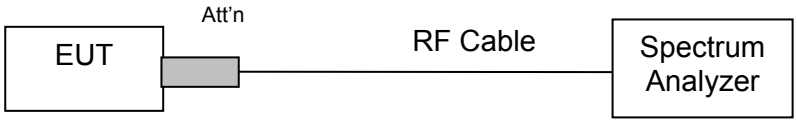
5.1.4.2. Receiver Spurious Emissions

Industry Canada RSS-210 §8

Test Procedure
Receiver conducted emissions were measured on each channel up to beyond the 4th harmonic of the local oscillator frequency. The unit was set to receive only mode.

Receiver Limits
2 nW (-57 dBm) below 1 GHz
5 nW (-53 dBm) above 1 GHz

Test Measurement Set up

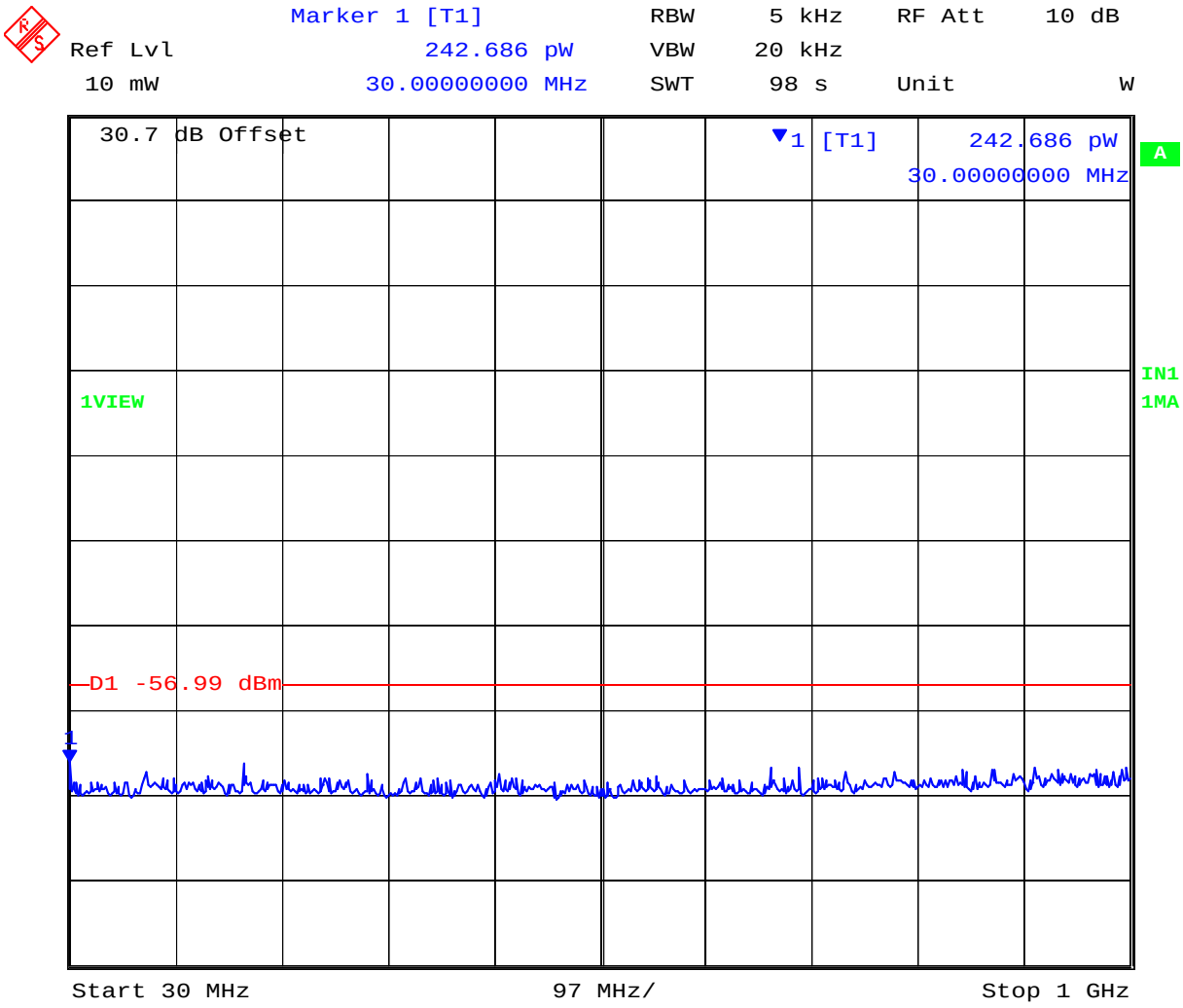


Conducted spurious emission test configuration (receiver)

Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

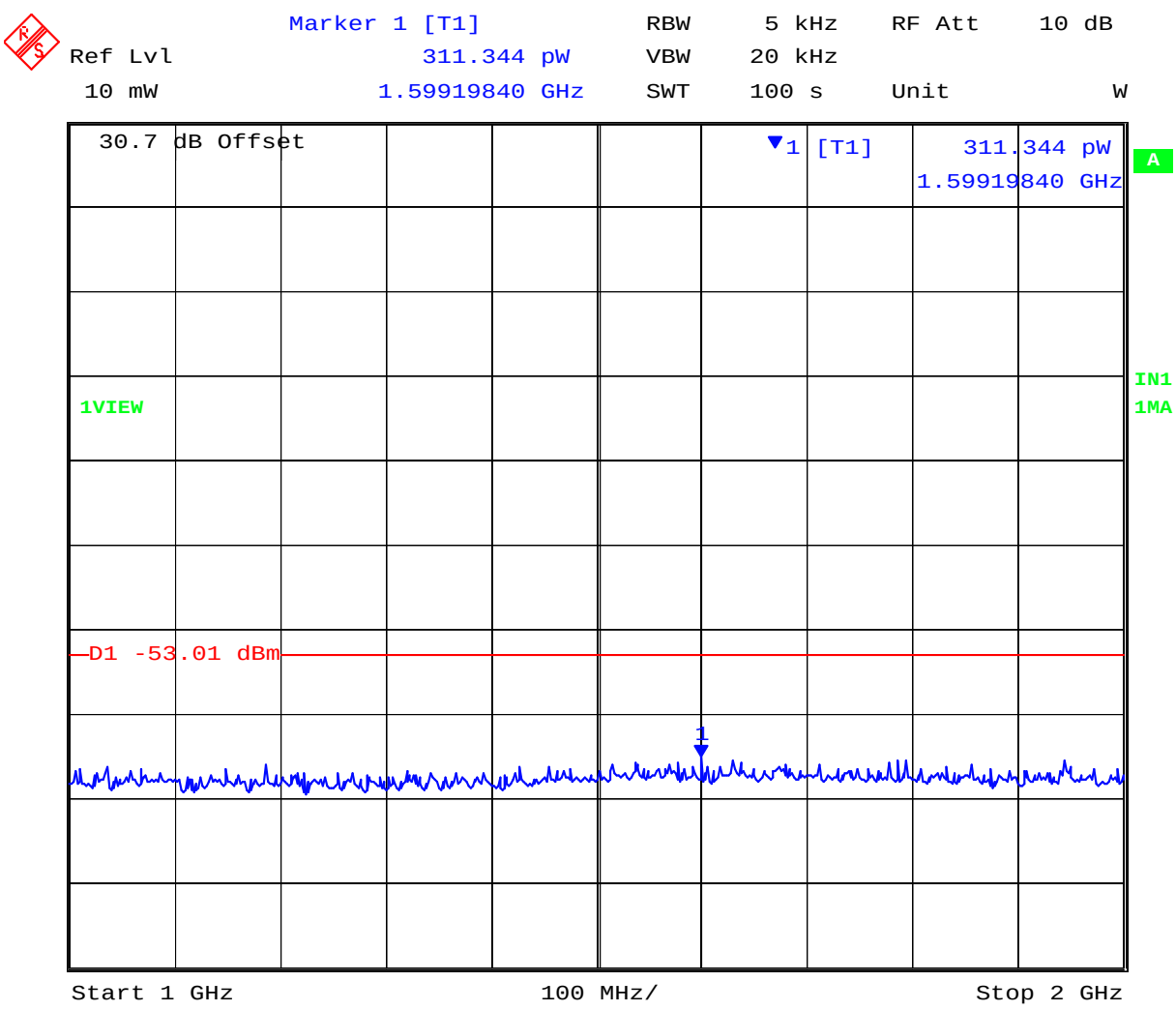
Limit: 30 MHz – 1 GHz 2nW; >1 GHz 5 nW

Channel (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Emission Frequency (MHz)	Emission Amplitude (dBm)	Margin (dB)
430	30	1,000	No Emissions Observed		
	1,000	2,000	No Emissions Observed		
450	30	1,000	No Emissions Observed		
	1,000	2,000	No Emissions Observed		
470	30	1,000	No Emissions Observed		
	1,000	2,000	No Emissions Observed		



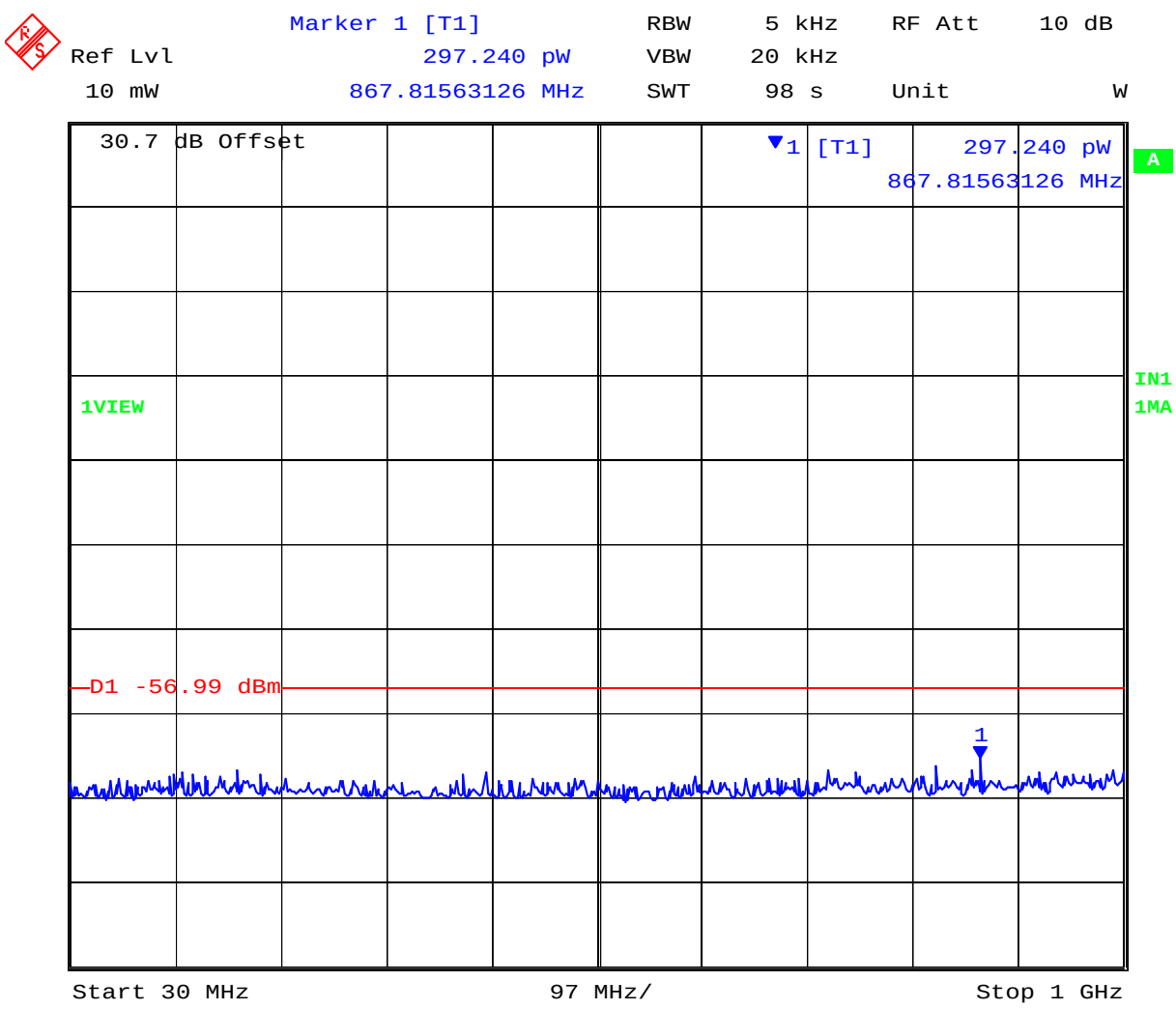
Date: 10.FEB.2006 14:01:46

Receiver Channel 430 MHz 30 MHz – 1 GHz



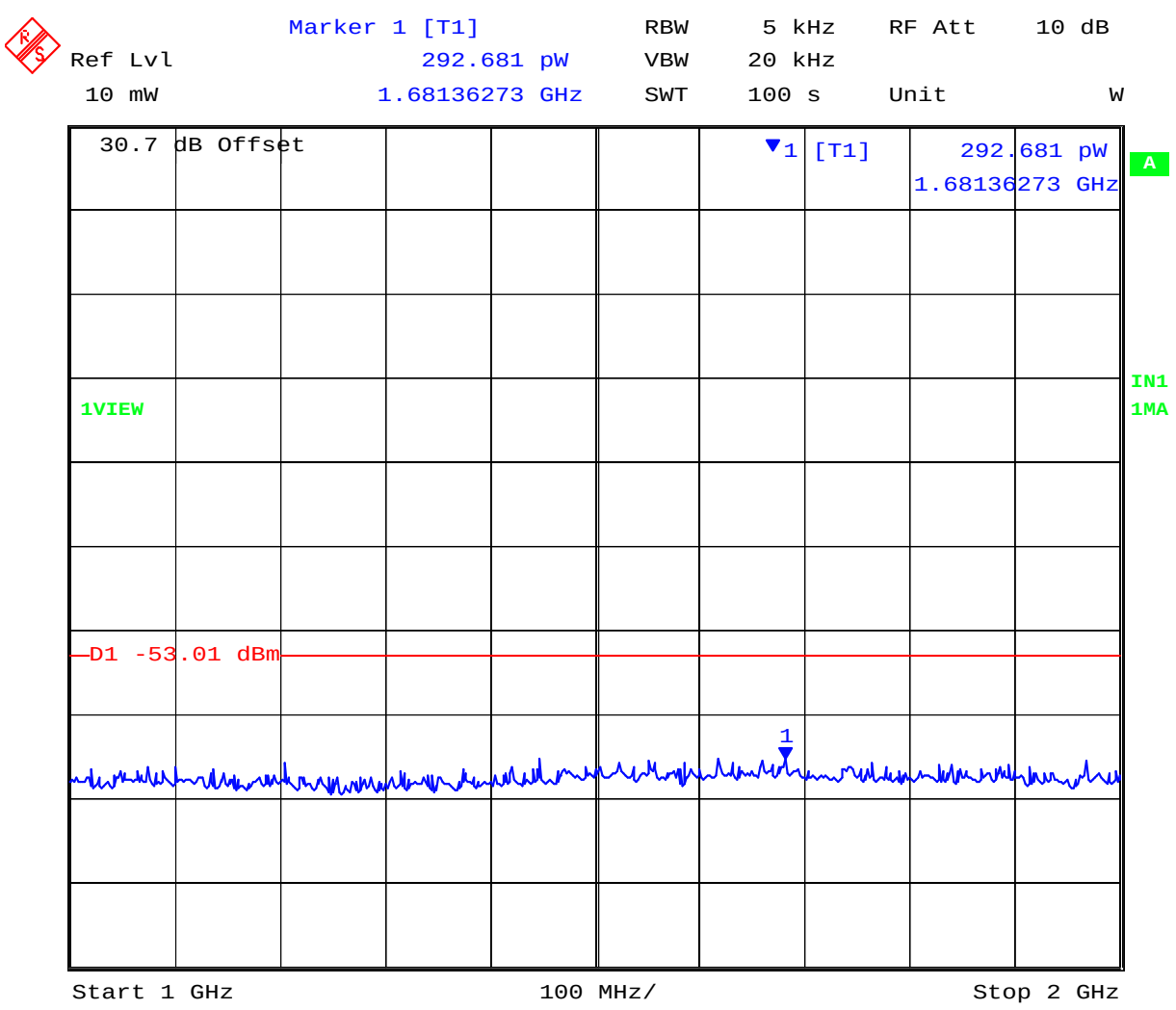
Date: 10.FEB.2006 14:15:08

Receiver Channel 430 MHz 1 – 2 GHz

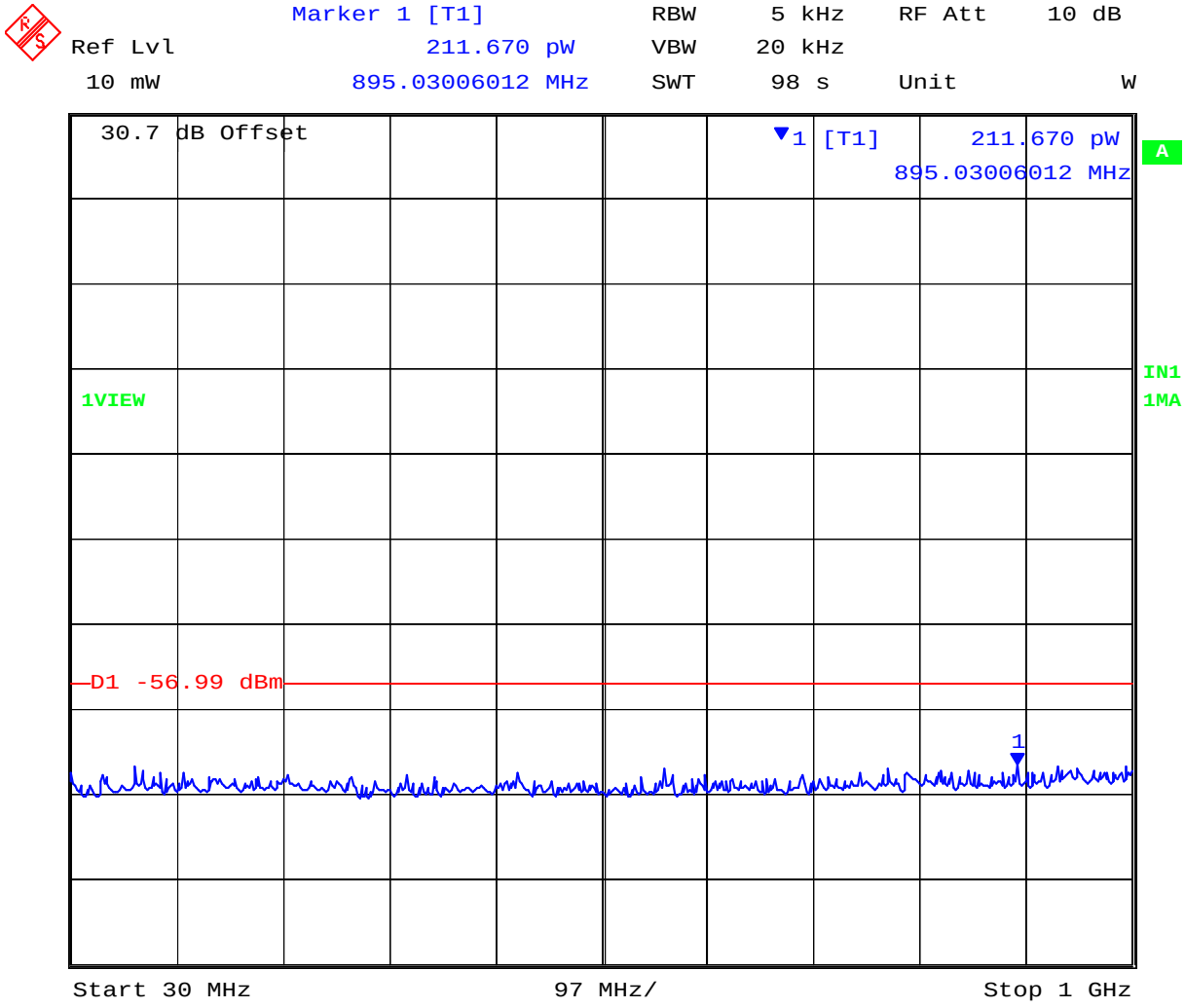


Date: 10.FEB.2006 13:41:06

Receiver Channel 450 MHz 30 MHz – 1 GHz

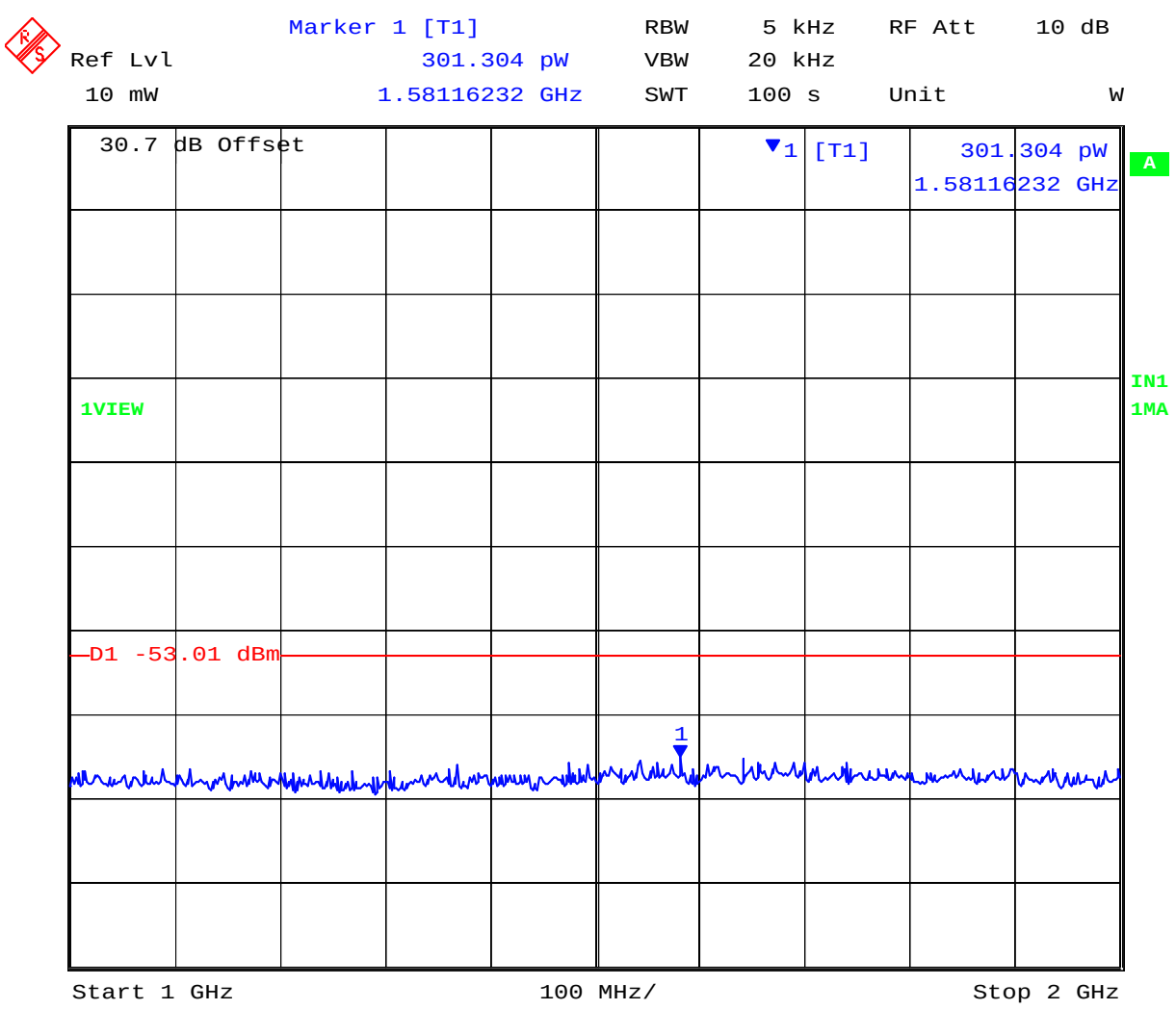


Receiver Channel 450 MHz 1 – 2 GHz



Date: 10.FEB.2006 14:04:14

Receiver Channel 470 MHz 30 MHz – 1 GHz



Receiver Channel 470 MHz 1 – 2 GHz

Specification
Transmitter Limits
Limits FCC Part §90.210
Industry Canada RSS-210 §6.3

25 kHz Channel Spacing: Emission Mask C
On any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth: At least 43 + 10 Log_{10} (P)

12.5 kHz Channel Spacing: Emission Mask D
On any frequency removed from the carrier frequency by a displacement frequency of than 12.5 kHz: At least 50 + 10 Log_{10} (P) or 70 dB, whichever is the lesser attenuation.

6.25 kHz Channel Spacing: Emission Mask E
On any frequency removed from the carrier frequency by more than 4.6 kHz: At least 55 + 10 Log_{10} (P) or 65 dB, whichever is the lesser attenuation.

Receiver Limits
Industry Canada RSS-210 §8(ii)

Receiver Conducted Spurious Emission Limits
If spurious emissions are to be measured at the antenna connector, the emission power in any 4 kHz shall not exceed 2 nanowatts in the band 30 – 1,000 MHz or 5 nanowatts above 1 GHz.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB

Traceability

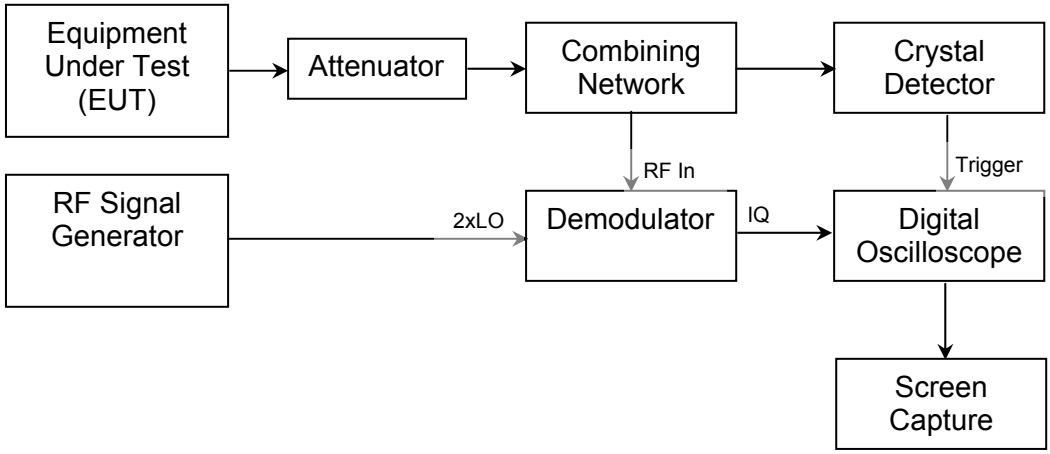
Method	**Test Equipment Used**
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0156, 0193, 0252, 0313, 0314, HPF

5.1.5. Transient Frequency Behavior

FCC, Part 15 Subpart C §90.214
Industry Canada RSS-210 §6.5

Test Procedure
Transmitters designed to operate in the 421 to 512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated. The transient frequency behavior of the EUT was investigated using the recommended test methodology identified in EIA/TIA Standard 603. Testing which was performed on an unmodulated carrier on the mid channel frequency (450 MHz) to the limits specified for 6.25 kHz channel spacing operation, worst case or tightest limits. Compliance to these limits implies the EUT will meet the 12.5 and 25 kHz limits given the same conditions.

Test Measurement Set up



Transient Frequency Behavior Test Configuration

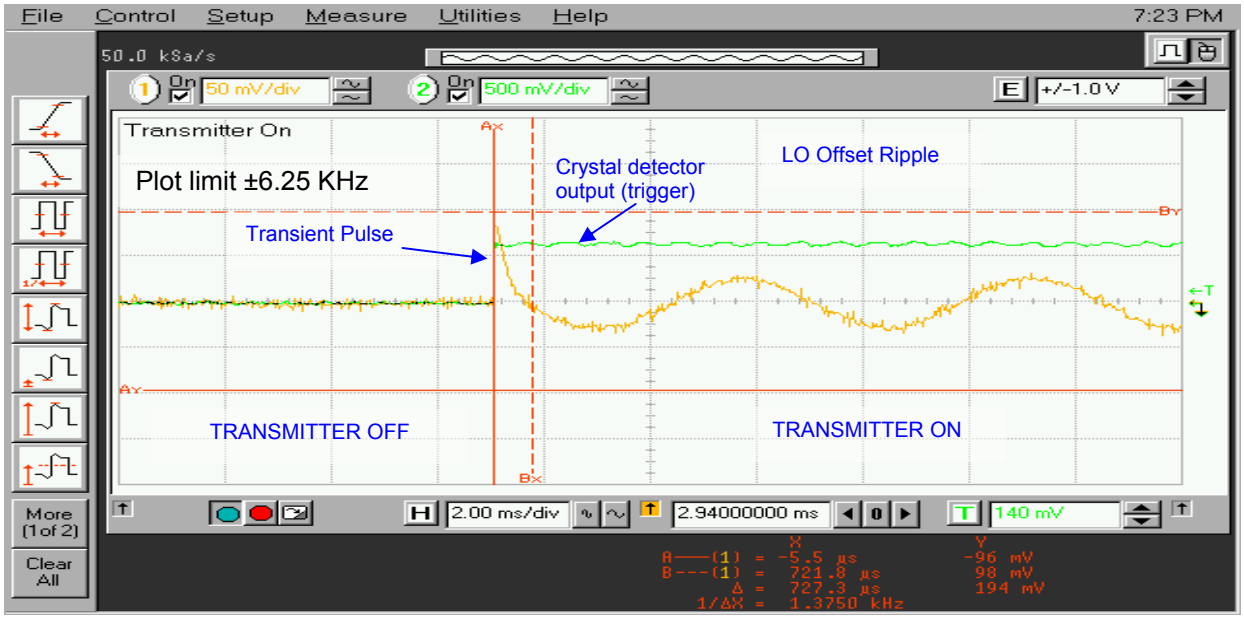
Summary of Circuit Operation
EUT output (CW Mode) was fed to the demodulator via an attenuator and combining network. EUT level at the demodulator was fixed at -40 dBm. The frequency of the RF signal generator was set to provide 2 * EUT fundamental frequency at a level of –10 dBm on the demodulator LO input. The second output on the combining network was fed to a crystal detector to be used as the oscilloscope trigger input.

The oscilloscope was set to trigger when the transmitter was switched ON and the oscilloscope screen was captured electronically. This process was also repeated for the transmitter OFF condition.

Unfortunately as this device was designed for data monitoring and control purposes there was no provision to monitor a 1 kHz tone mentioned in the EIA/TIA Standard 603. In order to provide a visible indication of both the ON and OFF transmitter transient condition the frequency output of the signal generator was slightly offset. This offset appears as ripple on the demodulator output and captured electronically. The screen capture clearly identifies the transient behavior of both the transmitter ON and OFF conditions.

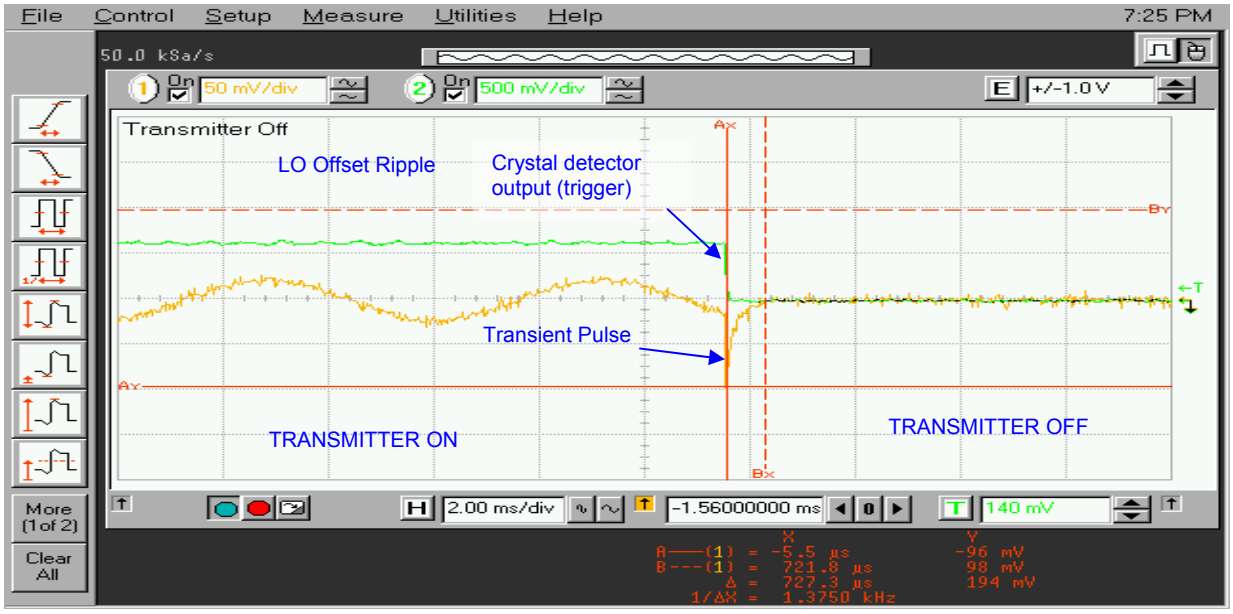
Ambient conditions.
Temperature: 19 to 22 °C Relative humidity: 31 to 46 % Pressure: 999 to 1010 mbar

TRANSMITTER ON – Plot limits ±6.25 KHz



Pulse width of the transient ON pulse (approximately) 0.7273 mS = 1.375 kHz

TRANSMITTER OFF – Plot limits ±6.25 KHz



Pulse width of the transient OFF pulse (approximately) 0.7273 mS = 1.375 kHz

Specification

Limits FCC Part §90.214
Industry Canada RSS-210 §6.5

Frequency (MHz)	Channel Bandwidth (kHz)	Transient Period	Transient Behavior
450	6.25	t_1 = 10 ms	< ± 6.25 kHz
		t_2 = 25 ms	< ± 3.15 kHz
		t_3 = 10 ms	< ± 6.25 kHz
	12.5	t_1 = 10 ms	< ±12.5 kHz
		t_2 = 25 ms	< ± 6.25 kHz
		t_3 = 10 ms	< ±12.5 kHz
	25	t_1 = 10 ms	< ± 25.0 kHz
		t_2 = 25 ms	< ±12.5 kHz
		t_3 = 10 ms	< ± 25.0 kHz

Laboratory Measurement Uncertainty for Frequency

Measurement uncertainty	±0.25 ppm

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-02 'Frequency Measurement'	0070, 0090, 0098, 0116, 0135, 0156, 0252, 0307, 0310, 0312, 0313, 0314, Det1, Demodulator,

5.1.6. Unwanted Emissions

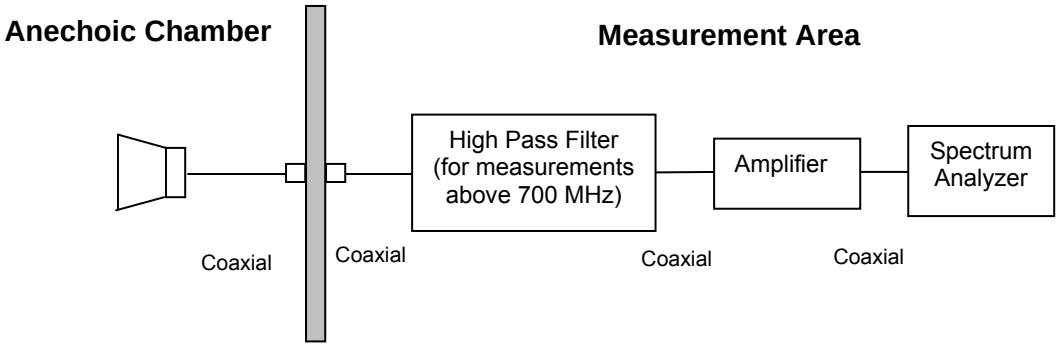
FCC, Part 15 Subpart C §90.210
Industry Canada RSS-210 §6.3

Test Procedure

Radiated emissions from 30 MHz to the 10th harmonic of the fundamental i.e. 5 GHz were measured in a modulated pulse mode. As conducted emissions were performed at the antenna port only cabinet radiation was monitored for unwanted emissions. The antenna port was attenuated by 76 dB and terminated in a 50 Ω load.

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. Substitution per TIA 603 was performed on the highest emissions found during the scan. The highest emissions relative to the limit are listed for each frequency band spanned.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Limits
For 25 kHz channel limit = -13 dBm
For 12.5 kHz channel limit = -20 dBm

As the 12.5 kHz channel spacing has tighter limits(7 dB) only these results are reported.

Unwanted Emission Limits;

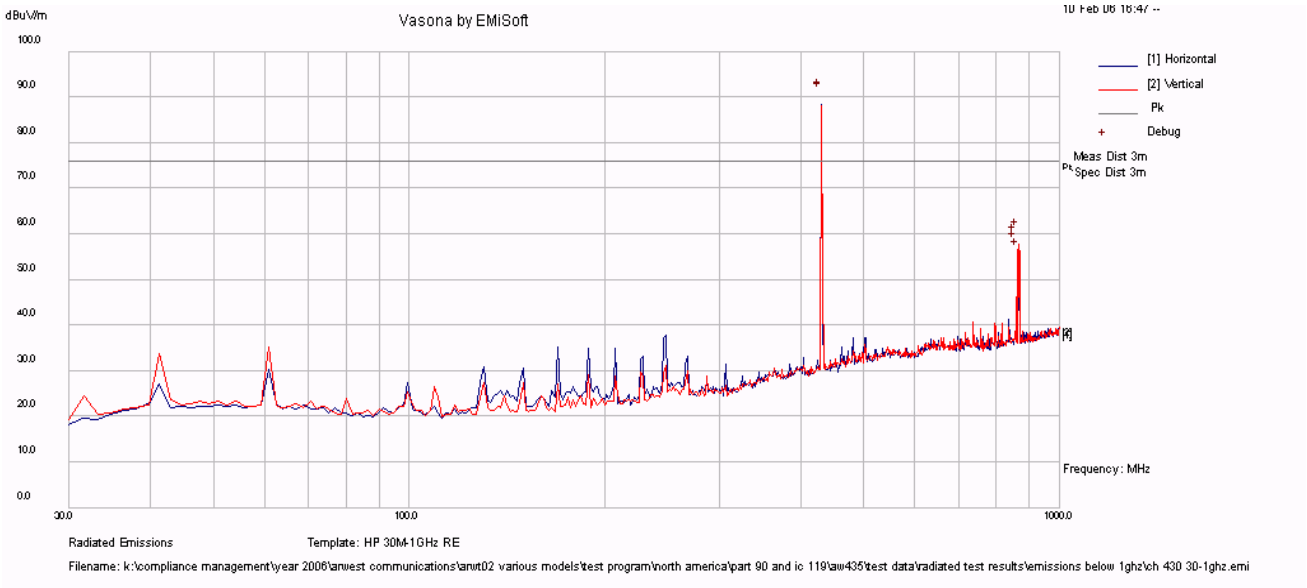
25 kHz Channel Spacing: Emission Mask C
On any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth: At least 43 + 10 Log_{10} (P)

12.5 kHz Channel Spacing: Emission Mask D
On any frequency removed from the carrier frequency by a displacement frequency of than 12.5 kHz: At least 50 + 10 Log_{10} (P) or 70 dB, whichever is the lesser attenuation.

6.25 kHz Channel Spacing: Emission Mask E
On any frequency removed from the carrier frequency by more than 4.6 kHz: At least 55 + 10 Log_{10} (P) or 65 dB, whichever is the lesser attenuation.

12.5 kHz Channel Spacing

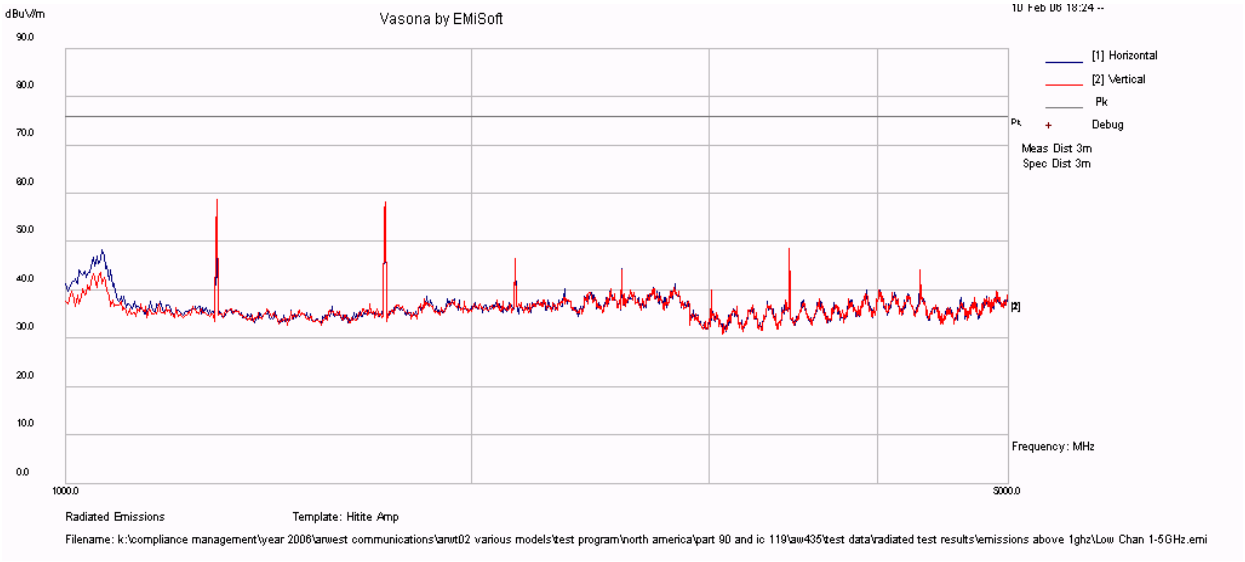
Channel 430 MHz 30 MHz – 1 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
430.933	-..-	-..-	100	-..-		-..-		-..-
867.433	V	-33.2	100	-37.5	1.0	-36.5	-20	-16.5
860.967	V	-34.5	100	-38.6	1.0	-37.6	-20	-16.6
860.967	H	-32.3	100	-38.9	1.0	-37.9	-20	-17.9
867.433	H	-30.9	100	-39.2	1.0	-38.2	-20	-18.2

12.5 kHz Channel Spacing

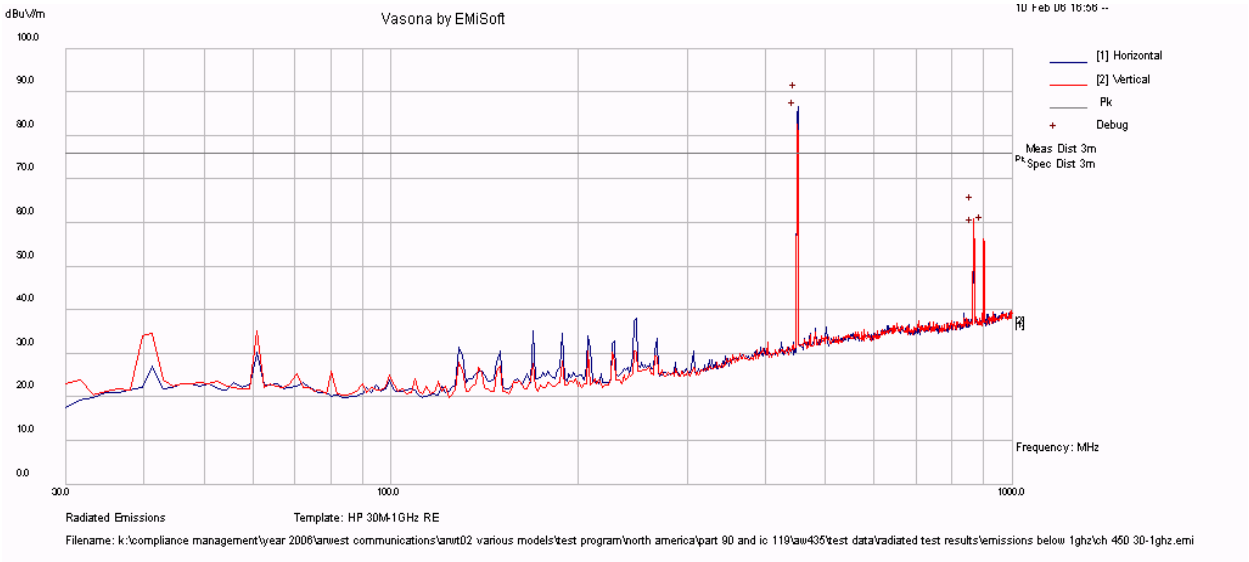
Channel 430 MHz 1 - 5 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1292.79	V	-30.4	1000	-34.5	4.7	-29.8	-20	-9.8
1722.68	V	-31.2	1000	-34.9	4.5	-30.4	-20	-10.4

12.5 kHz Channel Spacing

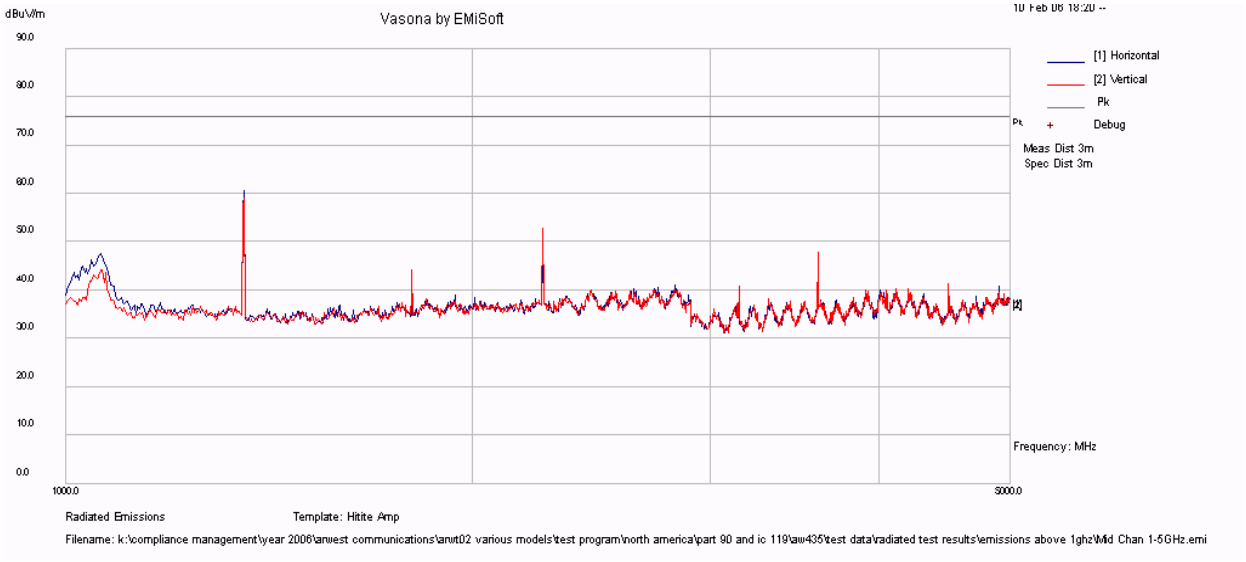
Channel 450 MHz 30 MHz – 1 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
450.95	-..-	-..-	100	-..-		-..-		-..-
867.433	V	-32.3	100	-35.5	1.0	-34.5	-20	-14.5
899.767	V	-37.6	100	-41.2	1.0	-40.2	-20	-20.2
867.433	H	-35.9	100	-38.4	1.0	-37.4	-20	-17.4

12.5 kHz Channel Spacing

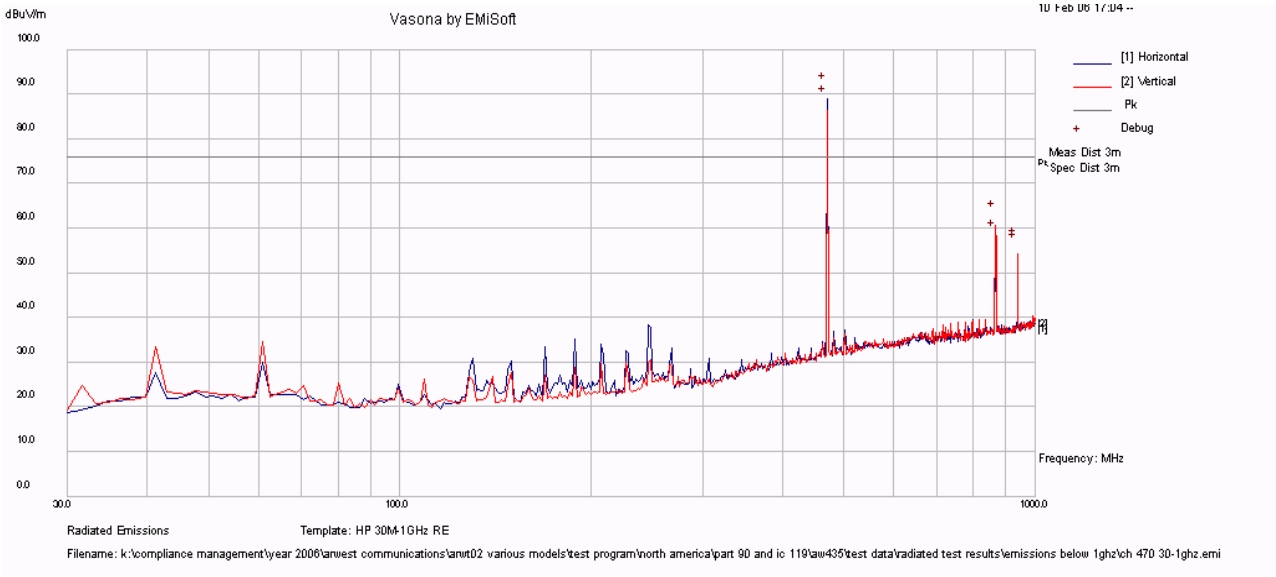
Channel 450 MHz 1 - 5 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1352.61	H	-28.4	1000	-32.1	4.7	-27.4	-20	-7.4
1352.61	V	-30.6	1000	-35.3	4.5	-30.8	-20	-10.8

12.5 kHz Channel Spacing

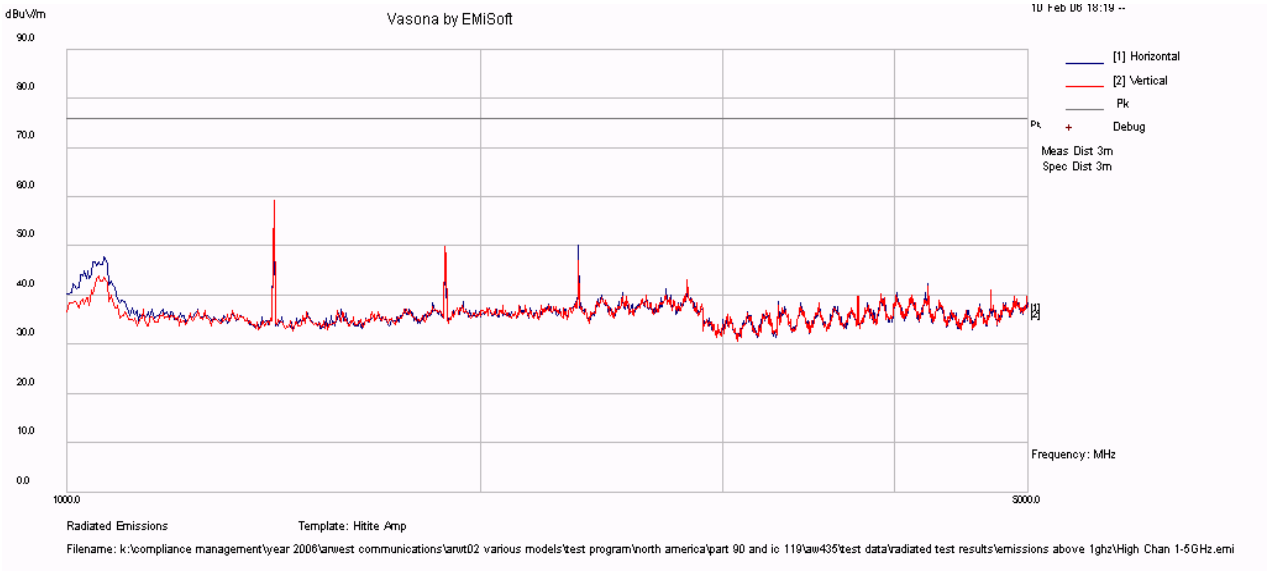
Channel 470 MHz 30 MHz – 1 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
471.35	-..-	-..-	100	-..-		-..-		-..-
867.433	V	-32.6	100	-35.8	1.0	-34.8	-20	-14.8
867.433	H	-36.7	100	-38.9	1.0	-37.9	-20	-17.9
940.183	V	-37.6	100	-39.6	1.0	-38.6	-20	-18.6
940.183	H	-37.9	100	-39.8	1.0	-38.8	-20	-18.8

12.5 kHz Channel Spacing

Channel 470 MHz 1 - 5 GHz



INVESTIGATION				SUBSTITUTION RESULTS				
Freq. (MHz)	Pol	Raw (dBm)	Res BW (KHz)	Pwr @ Antenna (dBm)	Ant. Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1414.05	V	-30.4	1000	-35.4	4.5	-30.9	-20	-10.9

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, 0156, 0134, 0304, 0305, 0310, 0311, 0312, 0315

5.1.7. dc Voltage(s) and Current(s)

FCC, Part 2.1033 (8)

Manufactures Declaration
The dc voltage and corresponding current at the final stage amplifier is;

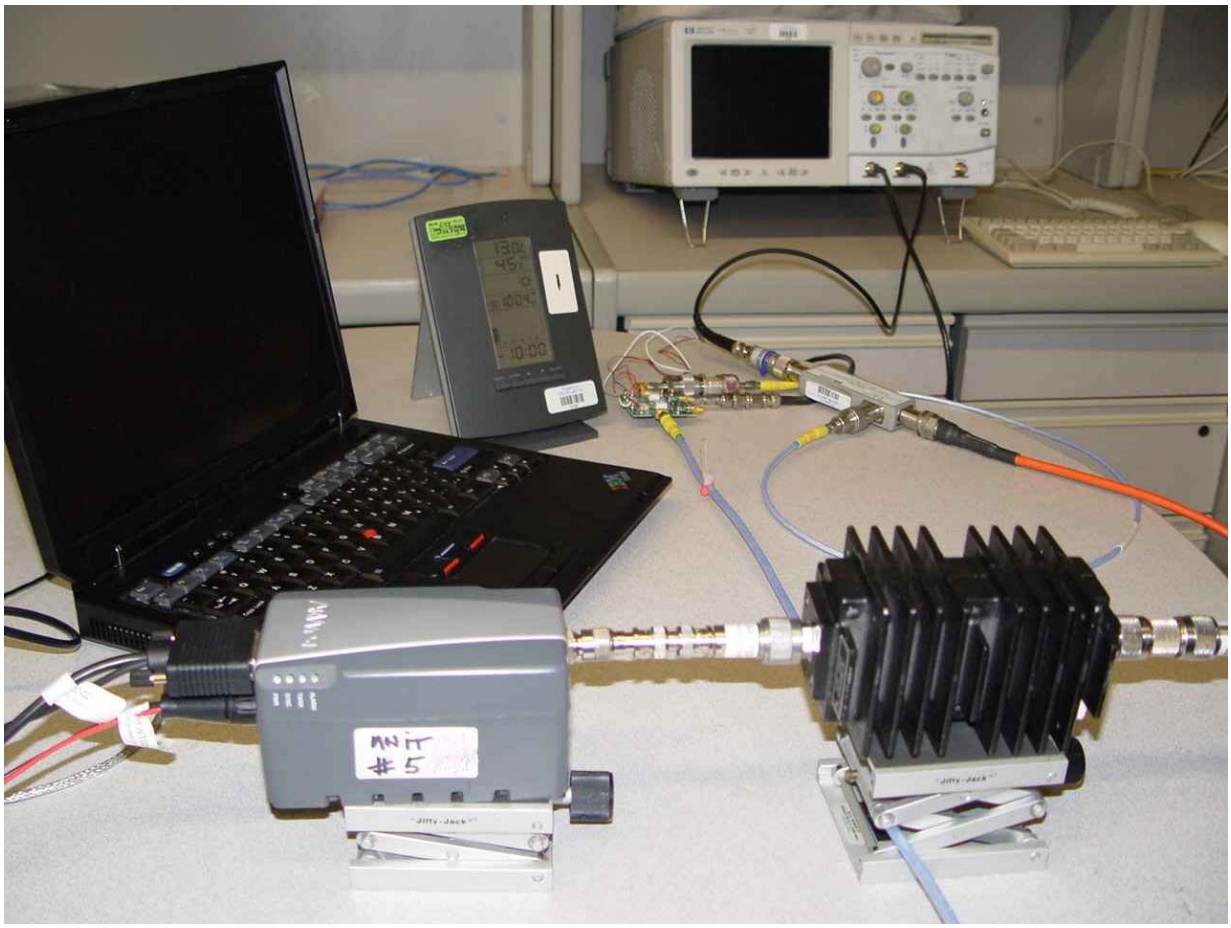
Input Power – High : 12 Vdc, 9 A = 108 W
.
Input Power – Low : 12 Vdc, 2 A = 24 W

6. TEST SET-UP PHOTOGRAPHS

6.1. General Measurement Test Set-Up

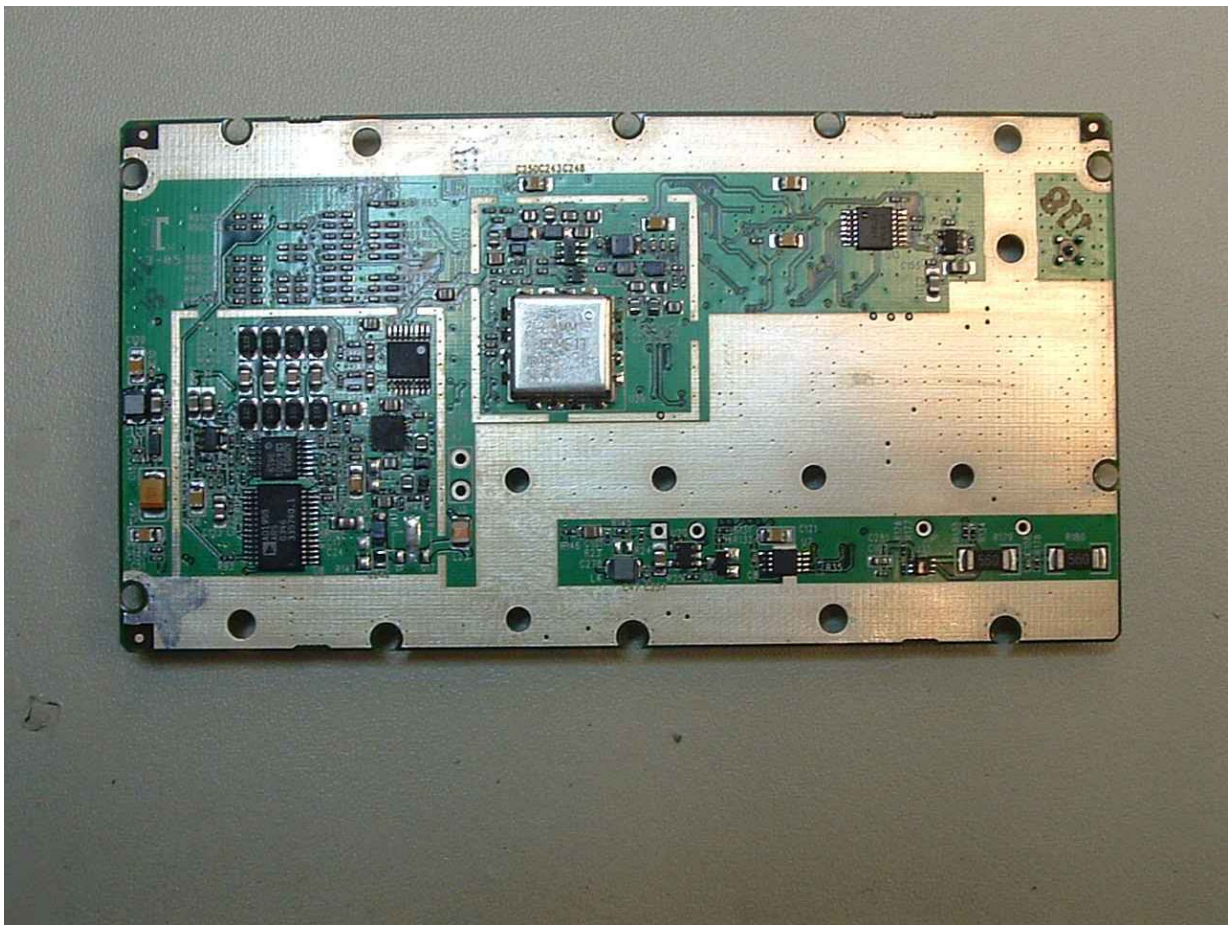
6.2. Unwanted Emissions (30 MHz - 5 GHz)

6.3. Transmitter Frequency Transient Test Setup

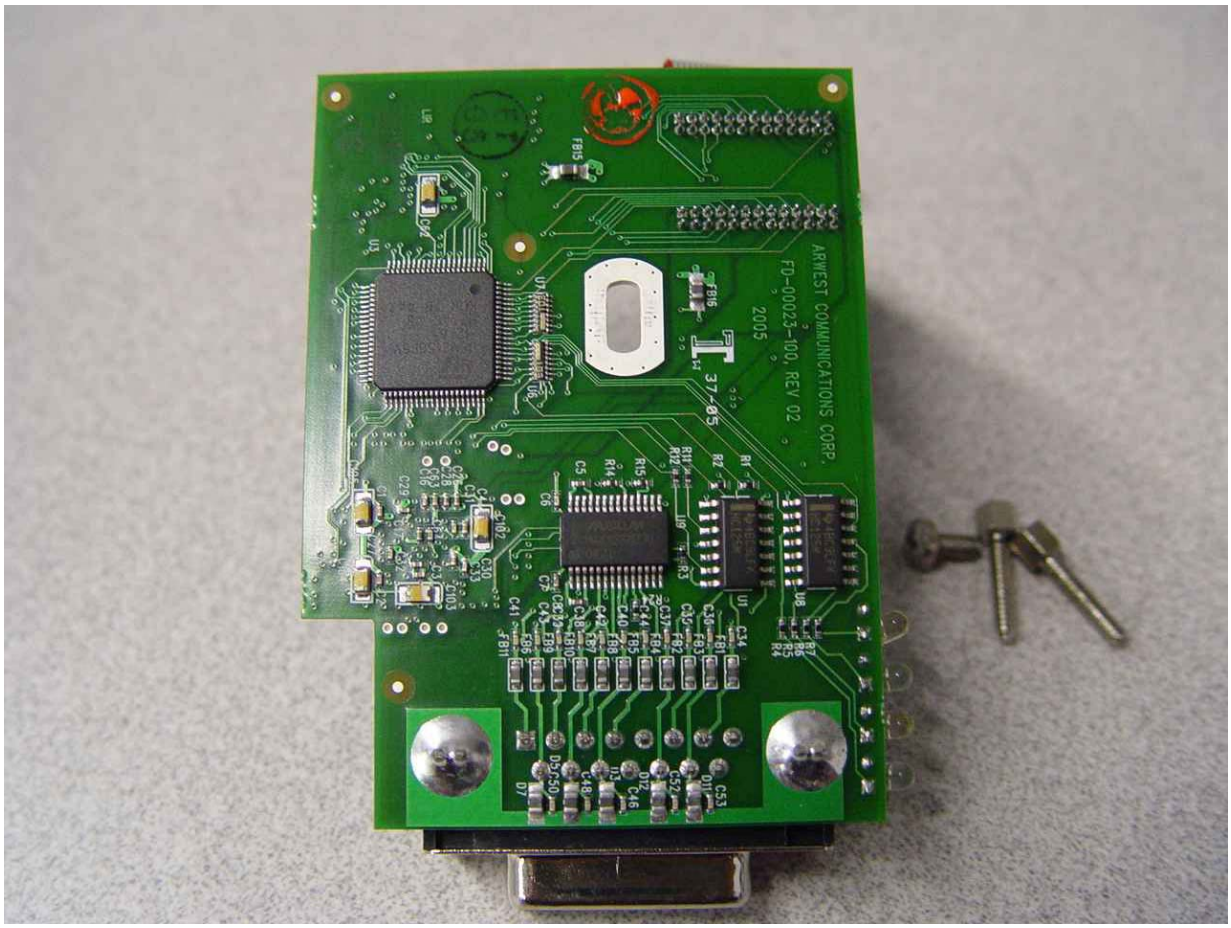


6.4. Internal Photographs – pcb's

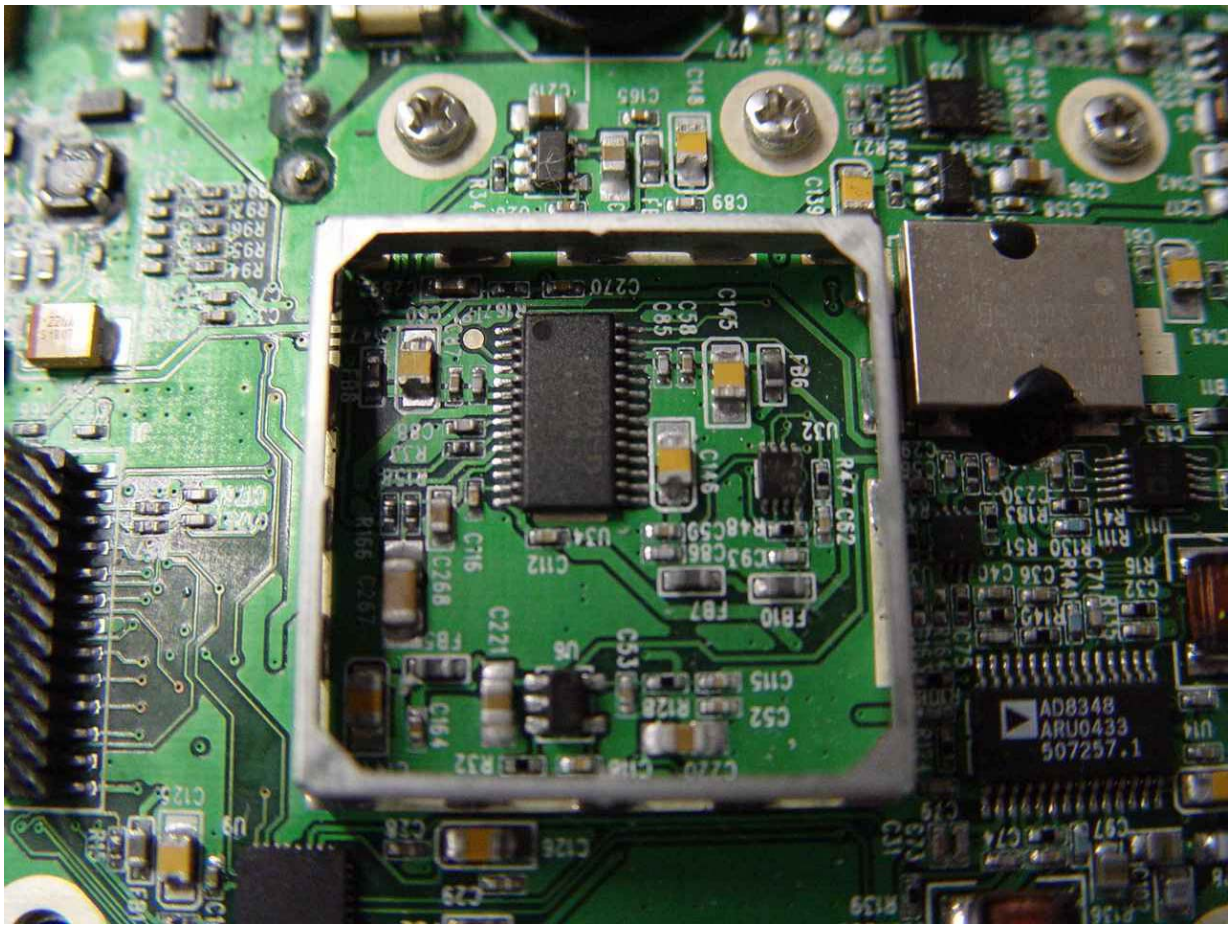
6.5. Internal Photographs – Main pcb underside



6.6. Internal Photographs – Daughter pcb underside



6.7. Internal Photographs – RF Screen Removed



7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0070	Power Meter	Hewlett Packard	437B	3125U13554
0073	Power Supply	Hewlett Packard	HP 6574A	US36340203
0078	Antenna (30M-2GHz)	Schaffner and Chase	CBLG140A	1195
0090	Synthesized Signal Generator	Hewlett Packard	83640A	3036A00294
0098	Digital Oscilloscope	Hewlett Packard	HP 54810A	US38100105
0104	1-18GHz Horn Antenna	The Electro-Mechanics Company	3115	9205-3882
0116	Power Sensor	Hewlett Packard	R8485A	3318A19694
0134	Amplifier	Com Power	PA 122	181910
0135	Attenuator	Weinschel	940-60-33	A6595
0156	Barometer /Thermometer	Control Co.	4196	E2844
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0251	SMA Cable	Megaphase	Sucoflex 104	Unknown
0252	SMA Cable	Megaphase	Sucoflex 104	Unknown
0253	SMA Cable	Megaphase	Sucoflex 104	Unknown
0256	SMA Cable	Megaphase	Sucoflex 104	Unknown
0293	BNC Cable	Megaphase	Unknown	Unknown
0305	Amplifier	ML	ML001	001
0307	BNC Cable	Megaphase	Unknown	Unknown
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001
0313	Coupler	Hewlett Packard	86205A	1623
0314	30dB N-Type Attenuator	NARDA	32319	--
Det1	Diode Detector	Hewlett Packard	HP423A	--
--	Demodulator	Linear Technology	DC468A	--
--	High Pass Filter	Mini Circuits	SHP - 700	--

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