Test of Topcon Positioning Systems
GR-3 Global Positioning System (GPS)

To: FCC 47 CFR Part 90 & IC RSS-119

Test Report Serial No.: TOPC01-A2 Rev B

TEST REPORT

FROM

Test of GR-3 Global Positioning System (GPS)

To FCC 47 CFR Part 90 & IC RSS-119

Test Report Serial No.: TOPC01-A2 Rev B

This report supersedes TOPC01-A2 Rev A

Manufacturer: Topcon Positioning Systems
7400 National Drive
Livermore, California 94566
USA

Product Function: Global Positioning System

Copy No: pdf **Issue Date:** 29th May 2007

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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TABLE OF CONTENTS

ACCREDITATION, LISTINGS and RECOGNITION

ACCREDITATION

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

MICOM LABS
Pleasanton, CA

for technical competence in the field of

Electrical Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing.

Presented this 14th day of September 2005.

American Association for Laboratory Accreditation
Corporate SEAL 1978 District of Columbia
A2LA

President
For the Accreditation Council
Certificate Number 2381.01
Valid to: November 30, 2007

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

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

RECOGNITION

APEC MRA (Asia-Pacific Economic Community Mutual Recognition Agreement)

Conformity Assessment Body (CAB) – MiCOM Labs

Test data generated by MiCOM Labs is accepted in the following countries under the APEC MRA. No additional in-country testing is required to satisfy in-country certification requirements.

Country	Recognition Body	Phase	CAB Identification No.
Australia	Australian Communications and Media Authority (ACMA)	I	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	I	
Korea	Ministry of Information and Communication Radio Research Laboratory (MIC)	I	
Singapore	Infocomm Development Authority (IDA)	I	
Taiwan	Directorate General of Telecommunications (DGT)	I	
	Bureau of Standards, Metrology and Inspection (BSMI)	I	

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	21st May 2007	First issue.
Rev B	29th May 2007	Add MPE calculation.

1. TEST RESULT CERTIFICATE

Manufacturer:	Topcon Positioning Systems 7400 National Drive, Livermore, California 94566 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton California, 94566, USA
EUT:	GR-3 Global Positioning System	Telephone:	+1 925 462 0304
Model:	01-050901-21	Fax:	+1 925 462 0306
S/N:	#11 FH915 US GSM		
Test Date(s):	26th to 29th December 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	2004	Code of Federal Regulations
(ii)	Industry Canada RSS-119	Issue 8 September 2006	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 September 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 GR-3 Global Positioning System (GPS) to FCC and Industry Canada regulations
Applicant:	As manufacturer
Manufacturer:	Topcon Positioning Systems 7400 National Drive Livermore, California 94566 USA
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	TOPC01-A2 Rev B
Date EUT received:	18th December 2006
Dates of test (from - to):	26th - 29th December 2006
Standard(s) applied:	FCC 47 CFR Part 90 & IC RSS-119
No of Units Tested:	1
Type of Equipment:	GPS (Global Positioning System)
Manufacturers Trade Name:	GR-3
Model:	01-050901-21
Location for use:	Outdoor
Declared Frequency Range(s):	410 to 470 MHz
Type of Modulation:	DBPSK,DQPSK,D8PSK,D16 QAM,GMSK, 4PSK
Declared Nominal Output Power:	+10 to +30dBm (1 Watts) in 1dB steps
EUT Modes of Operation:	Channel Spacing's: • 25 KHz • 12.5 KHz
Transmit/Receive Operation:	Time Division Duplex (TDD)
Rated Input Voltage and Current:	Nominal Battery (Lithium Ion): +7.4 Vdc, 0.35A Voltage Extremes: Battery: +6.29 to 15 Vdc External Applied: 7 to 21 Vdc
Operating Temperature Range:	-20ºC to +55ºC
Microprocessor(s) Model:	ADSP-BF 522
ITU Emission Designator:	PSK & 16 QAM Modulation 25 kHz Channel Spacing - 12K7G1D 12.5 kHz Channel Spacing – 6K32G1D GMSK Modulation 25 kHz Channel Spacing - 12K7F1D 12.5 kHz Channel Spacing – 6K22F1D

Clock/Oscillator(s):	32.768 kHz; 100-500 kHz (dc – dc converter) ; 4/20/25/50/56/96/100/188/376/419/1002/1401 MHz
Frequency Stability:	1).. ± 1.5ppm initial (temperature variation) 2).. ± 0.8ppm aging/year
Equipment Dimensions:	156.6mm X 234.5mm x 156.6mm
Weight:	1.78 kg
Primary function of equipment:	Global Positioning Applications

3.2. Scope of Test Program

The scope of the test program was to test the Topcon Positioning Systems GR-3 Global Positioning System for compliance against appropriate FCC and Industry Canada regulatory requirements;

FCC CFR 47 Part 90, Subsection I frequency band 410 – 470 MHz

Industry Canada RSS-119

The GR-3 employs several modulation schemes in the frequency range 410 –470 MHz;

- DBPSK
- DQPSK
- D8PSK
- 16 QAM
- GMSK
- 4PSK

Unless otherwise mentioned each modulation scheme will be tested for compliance against the stated regulations.

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

Name	Manufacturer	Model No.	Serial No.
GR-3	Topcon Positioning Systems	01-050901-21	#11 FH915 US GSM

3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
½ Wave	2.5	Antenex	DEXR450BN	Not Supplied
½ Wave	2.5	Antenex	DEXR420BN	Not Supplied

Antenna details are for information purposes only. Antennae were not utilized as part of the test program.

3.5. Cabling and I/O Ports

Number and type of I/O ports

1).. Radio (modem) BNC connector

2).. Power ODU connector (G80F1C-T05QF00-0000)

3).. Serial RS-232 (ODU G80F-1C-T07QC00-0000)

4).. USB Connector (ODU G80F1C-T04QF00-0000

3.6. Test Configurations

Matrix of test configurations

Parameter	Operational Mode	Test Conditions	Frequencies (MHz)
Output power	CW & Modulated	Ambient	410, 440, 470
Occupied BW & Emission Mask	CW & Modulated	Ambient	410, 440, 470
Frequency Stability	CW	Ambient, temperature and voltage extremes	410, 440, 470
Conducted Emissions	Modulated	Ambient	410, 440, 470
Transmitter Transient	CW	Ambient	440
Unwanted Emissions	CW	Ambient	410, 440, 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:

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

Section(s)	Test Items	Description	Condition	Result	Test Report Section
90.205(g) **5.4**	Output Power	Average un-modulated 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
90.1217	Maximum Permissible Exposure	Exposure to radio frequency energy levels	Radiated	Complies	5.1.4
90.210 **6.3**	Conducted Spurious Emissions Transmitter Receiver	Emissions from the antenna port 9kHz – 5 GHz 9kHz – 3 GHz	Conducted	Complies	5.1.5 *5.1.5.1* *5.1.5.2*
90.214 **6.5**	Transmitter Transient Behavior	Stabilization of RF frequency	Conducted	Complies	5.1.6
90.210 **6.3**	Unwanted Emissions	Spurious emissions 30MHz–5GHz	Radiated	Complies	5.1.7
2.1033 (8)	dc Voltage & Current	Power consumption	Conducted	No limit	5.1.8

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

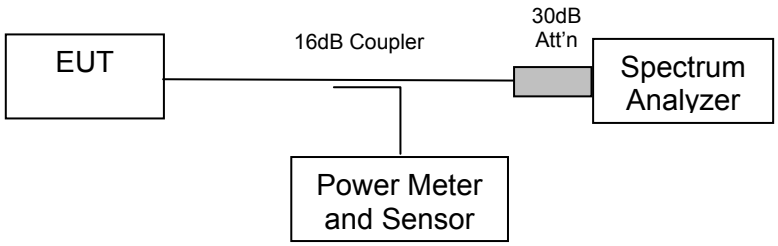
5.1.1. Output Power

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 unmodulated and modulated output power measurement

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

TABLE OF RESULTS – UNMODULATED CARRIER

Center Frequency (MHz)	Power (dBm)
410	+30.53
440	+30.60
470	+31.13

TABLE OF RESULTS – 25 KHz Channel Spacing Modulated Carrier

Center Frequency (MHz)	Power (dBm) V's Modulation					
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK	4PSK
410	+27.22	+27.80	+27.63	+26.37	+27.29	+27.22
440	+27.30	+27.30	+27.16	+25.82	+26.64	+26.61
470	+28.15	+28.02	+27.92	+26.54	+27.40	+27.33

TABLE OF RESULTS – 12.5 KHz Channel Spacing Modulated Carrier

Center Frequency (MHz)	Power (dBm) V's Modulation					
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK	4PSK
410	+27.88	+27.72	+27.62	+26.22	+27.13	+27.28
440	+27.33	+27.27	+27.20	+25.82	+26.68	+26.60
470	+28.06	+27.88	+27.80	+26.40	+27.36	+27.33

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'	0158, 0116, 0070, 0252, 0313, 0314

5.1.2. Occupied Bandwidth and Emission Mask

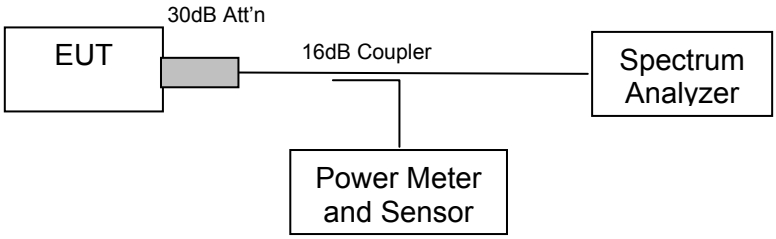
FCC, Part §90.209(b)(5), Part §90.210
Industry Canada RSS-119 §5.5 & 6.4

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 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

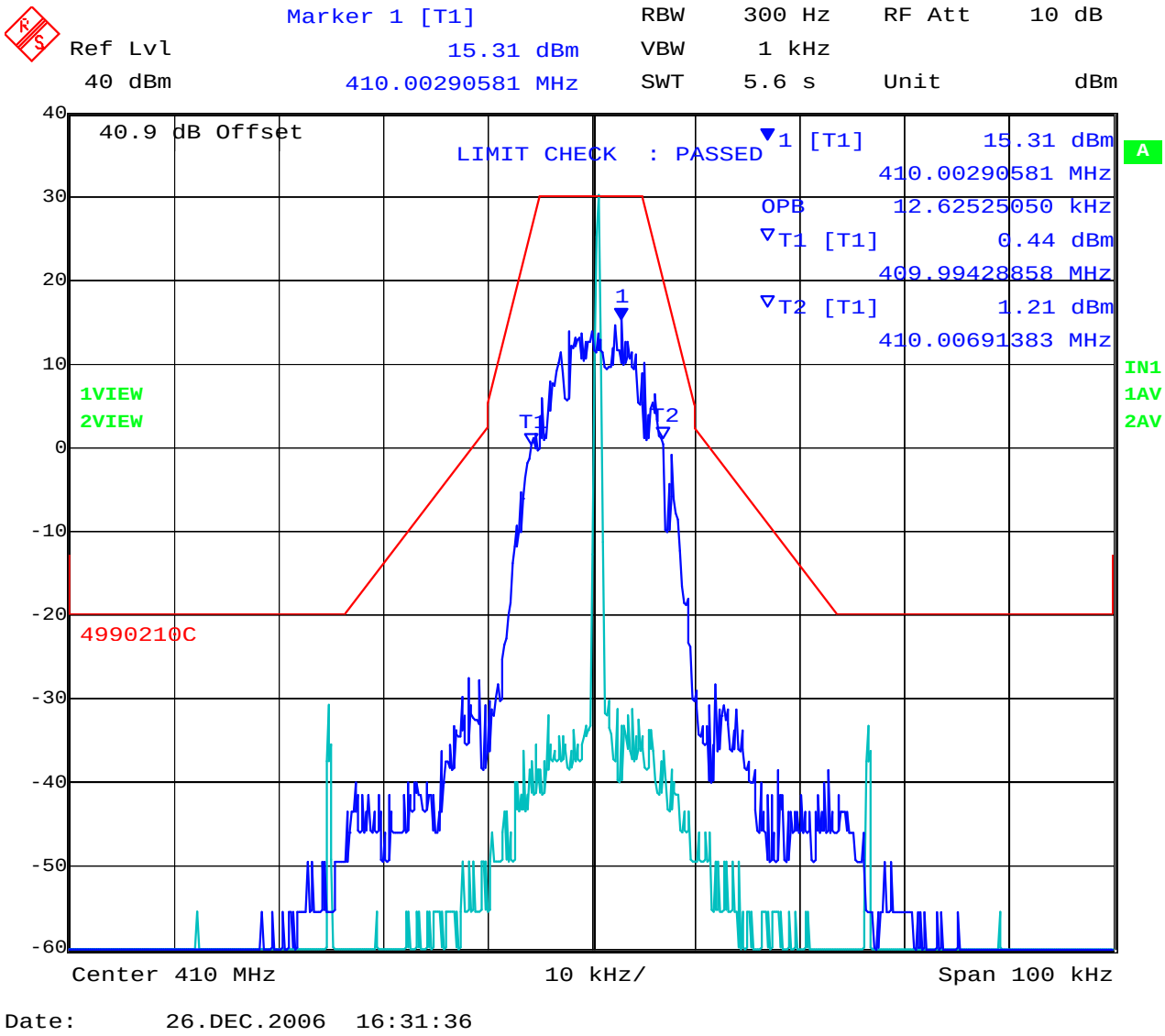
EMISSION MASK ATTENUATION CALCULATIONS

Emission Mask C			Emission Mask D	
Frequency (MHz)	**Attenuation (dB)**		**Frequency (MHz)**	**Attenuation (dB)**
-50.0	-43			
-50.0	-50		-25.0	-50
-23.45	-50		-12.5	-50
-10.0	-27.8		-12.5	-69.94
-10.0	-24.99		-5.625	-19.96
-5.0	0		-5.625	0
5.0	0		5.625	0
10.0	-24.99		5.625	-19.96
10.0	-27.8		12.5	-69.94
23.45	-50		12.5	-50
50.0	-50		25.0	-50
50.0	-43			

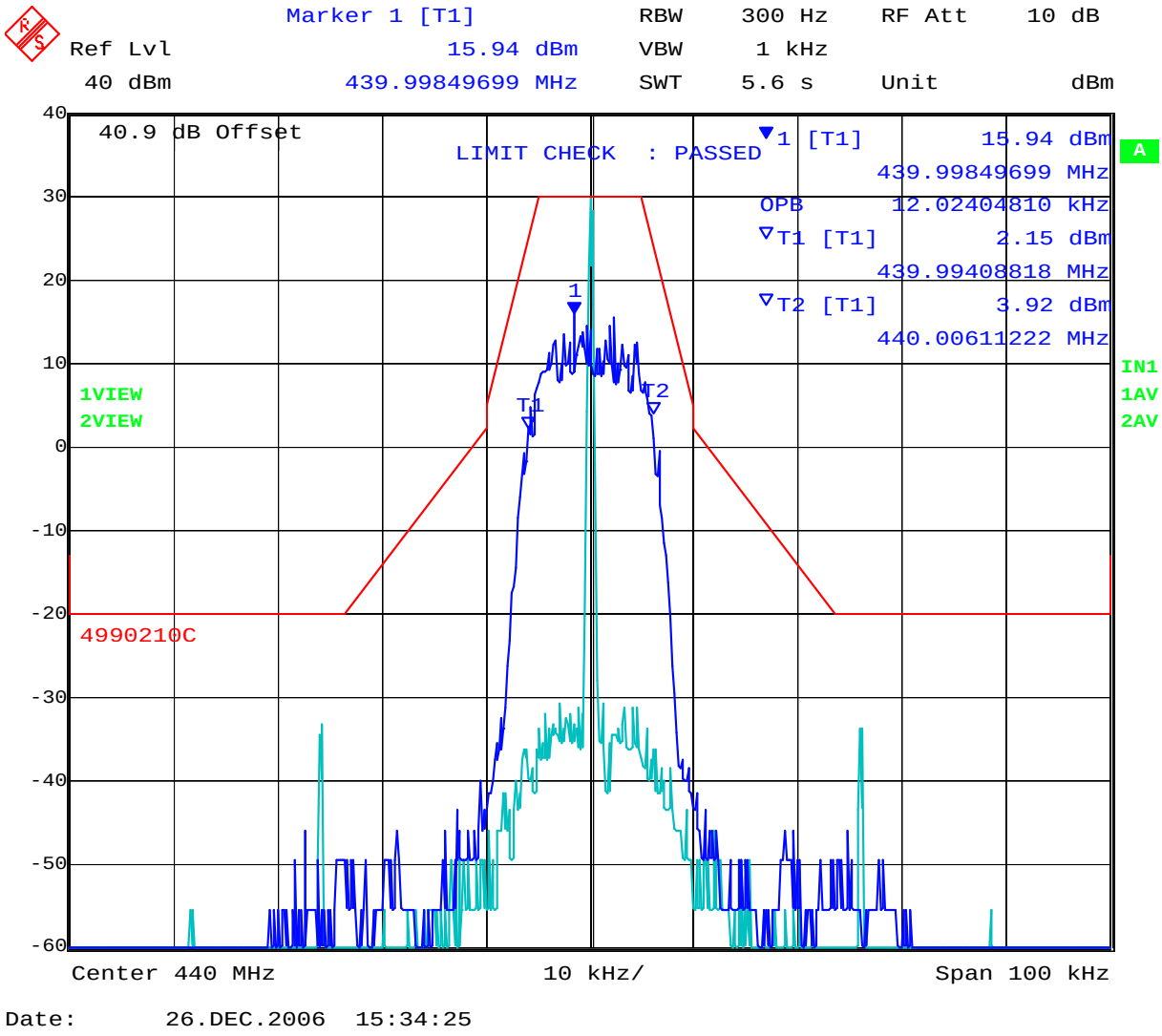
EMISSION MASK C

TABLE OF RESULTS – 25 KHz Channel Spacing

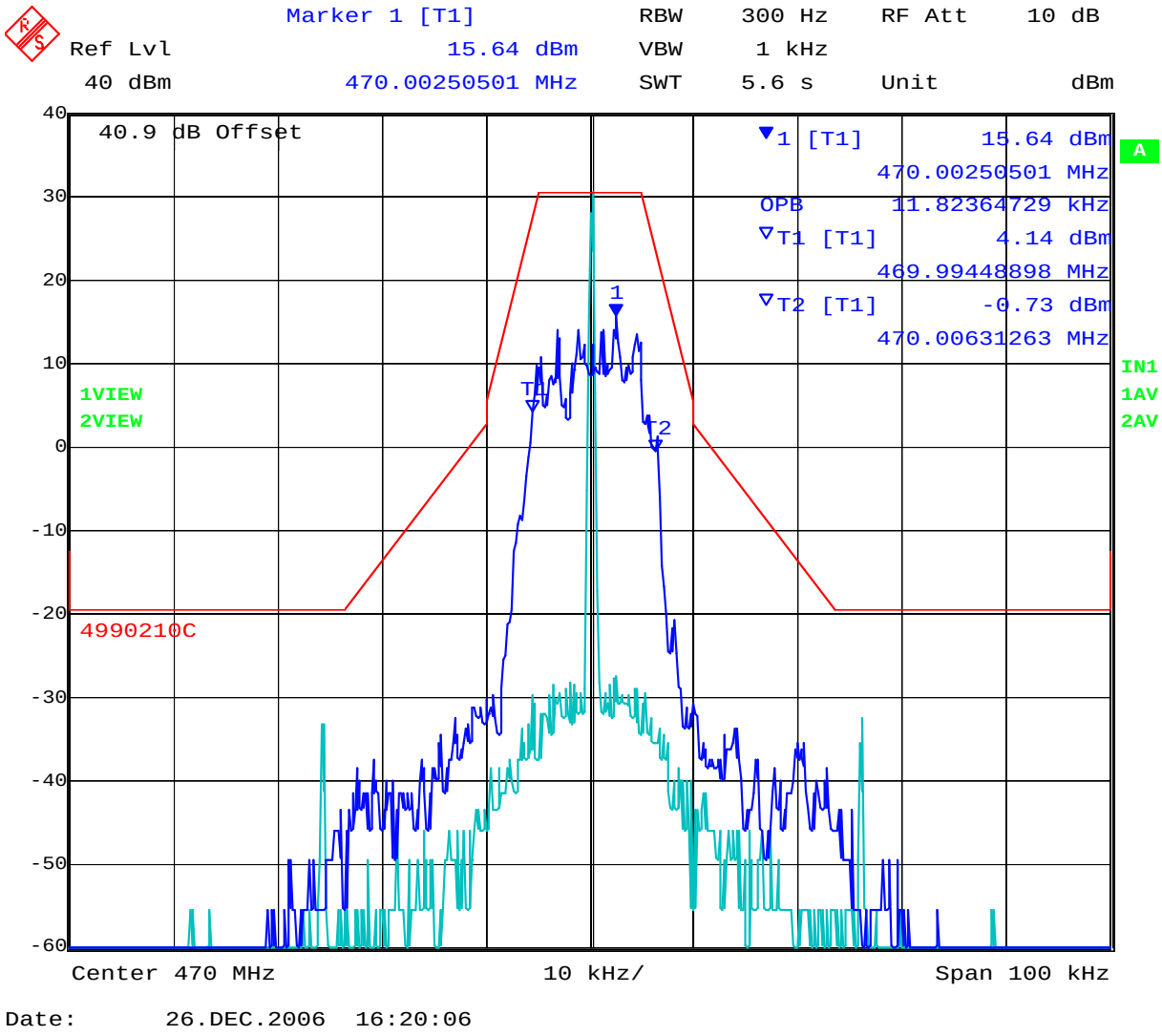
Center Frequency (MHz)	99% Bandwidth (KHz) V's Modulation					
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK	4PSK
410	12.625	12.024	12.024	11.824	12.425	12.425
440	12.024	12.024	12.024	12.024	12.625	12.224
470	11.824	11.824	12.024	12.024	12.625	12.224



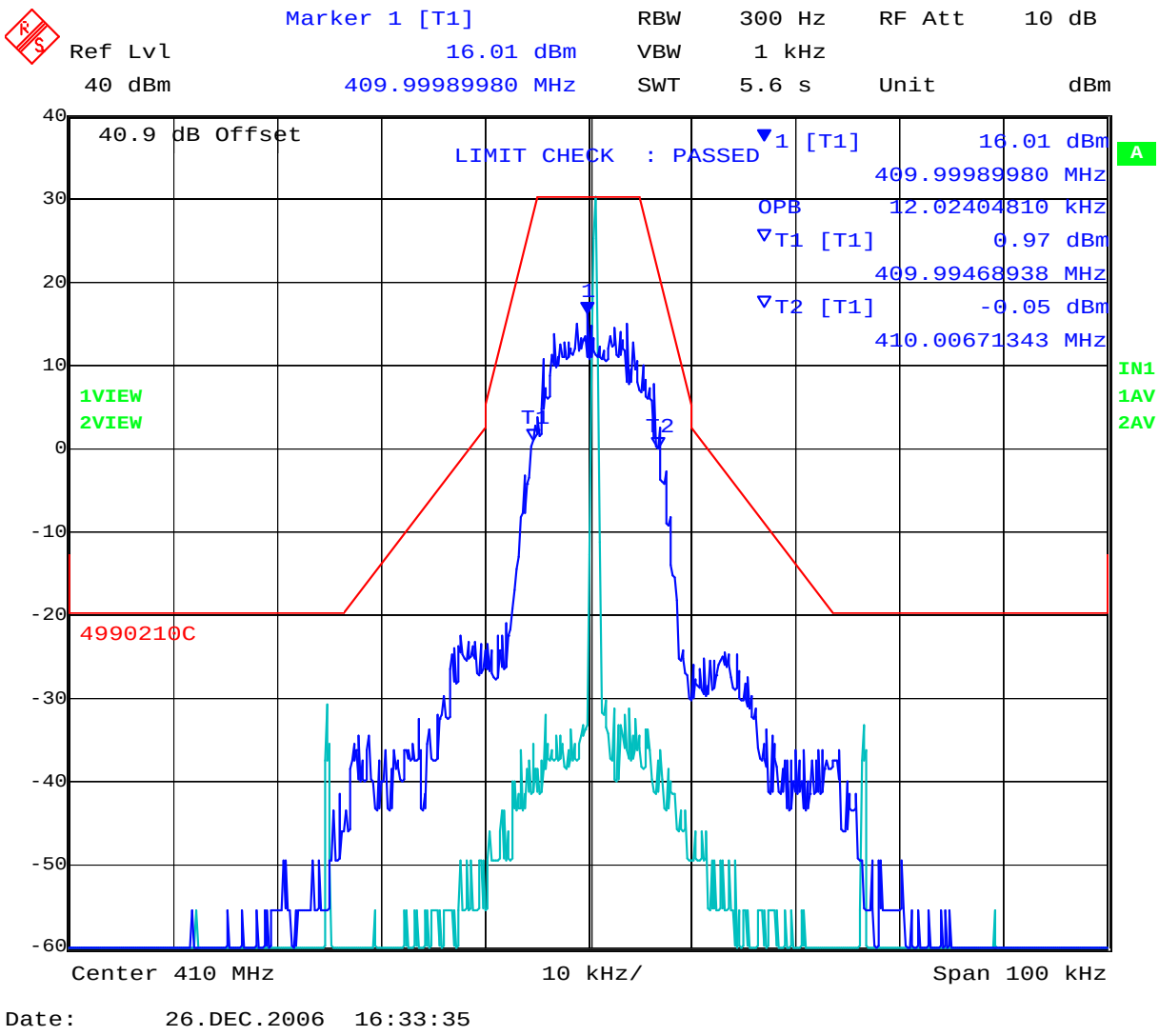
25 KHz Channel Spacing DBPSK 410 MHz – Emission Mask C



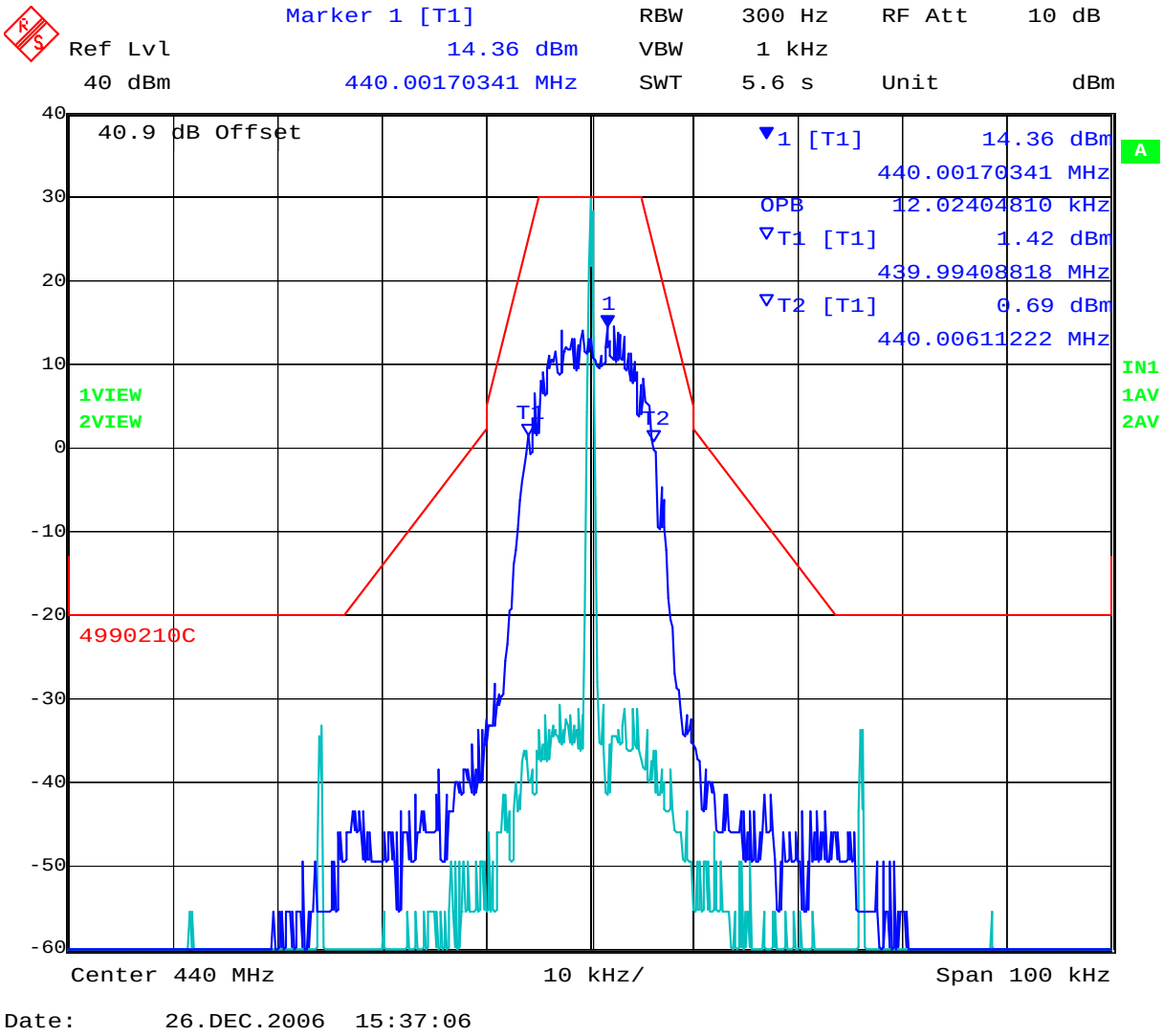
25 KHz Channel Spacing DBPSK 440 MHz – Emission Mask C



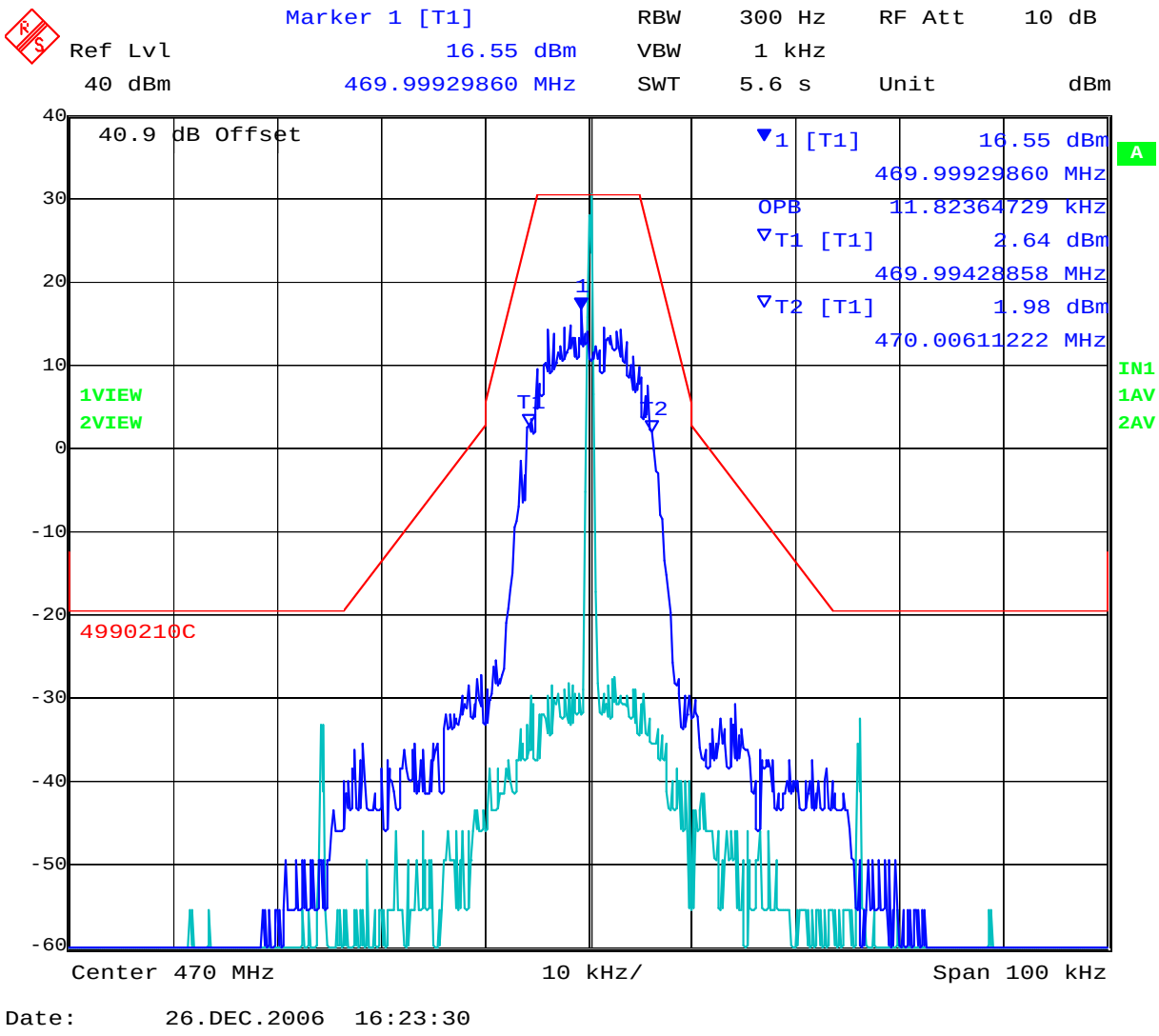
25 KHz Channel Spacing DBPSK 470 MHz – Emission Mask C



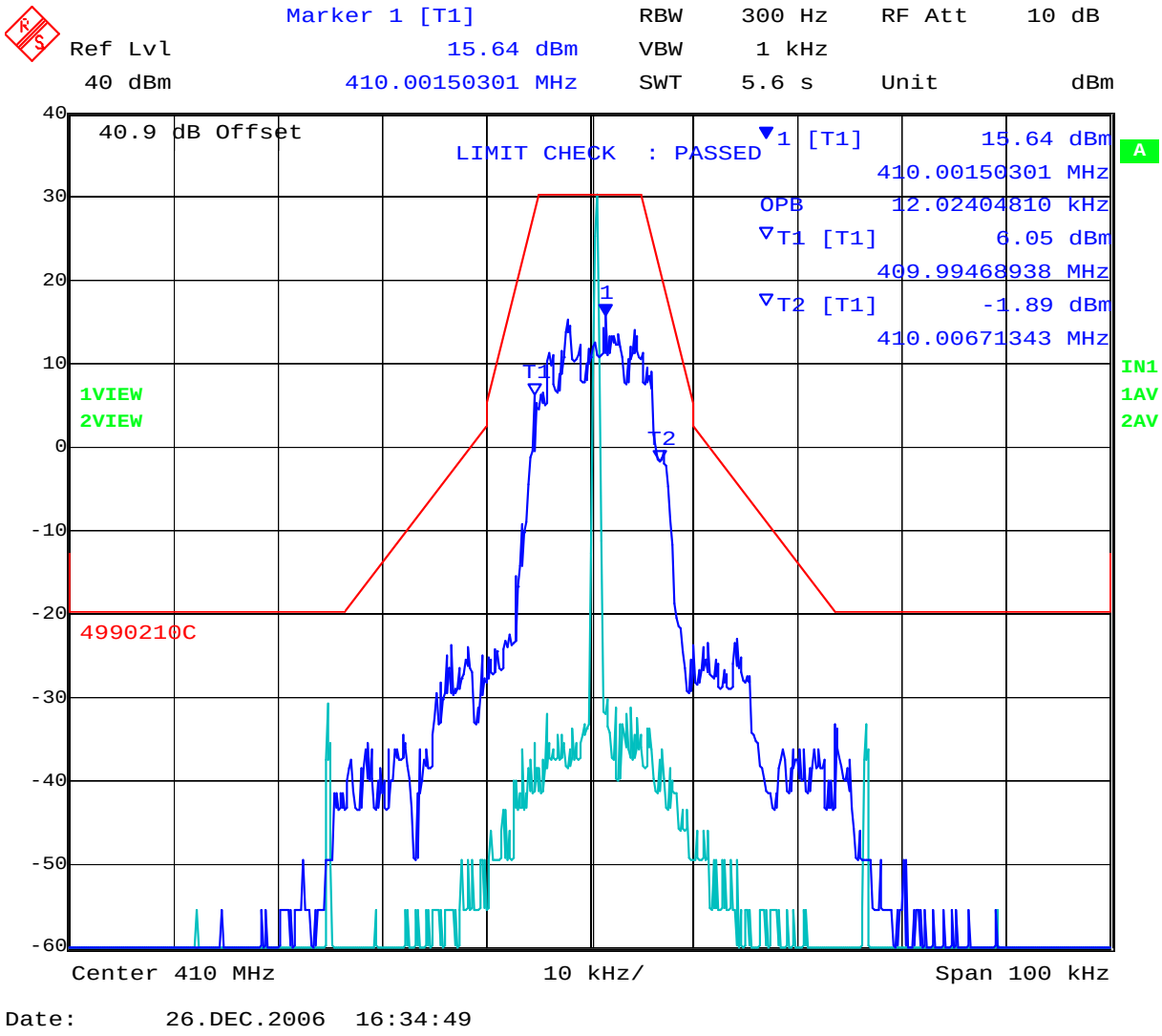
25 KHz Channel Spacing DQPSK 410 MHz – Emission Mask C



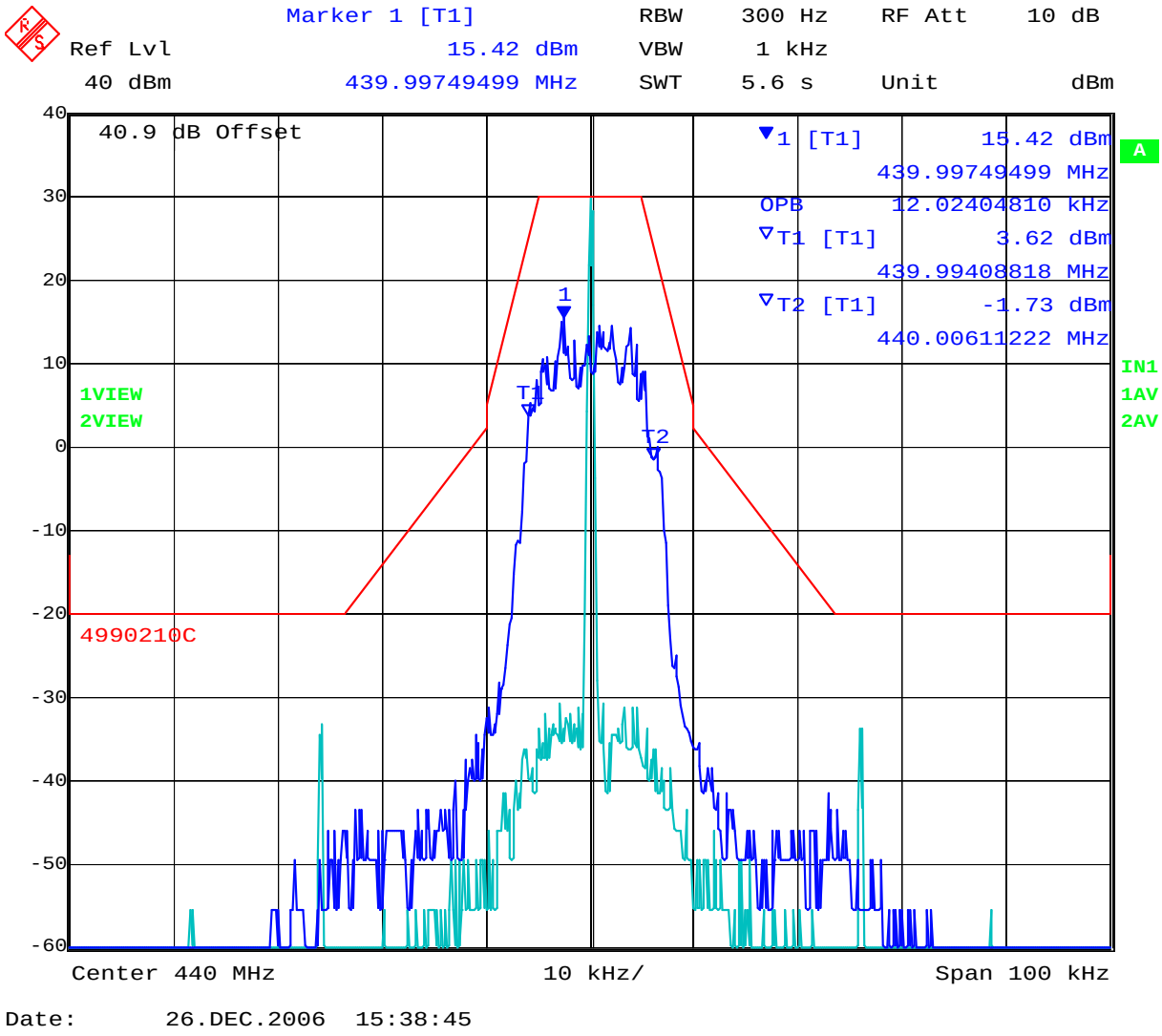
25 KHz Channel Spacing DQPSK 440 MHz – Emission Mask C



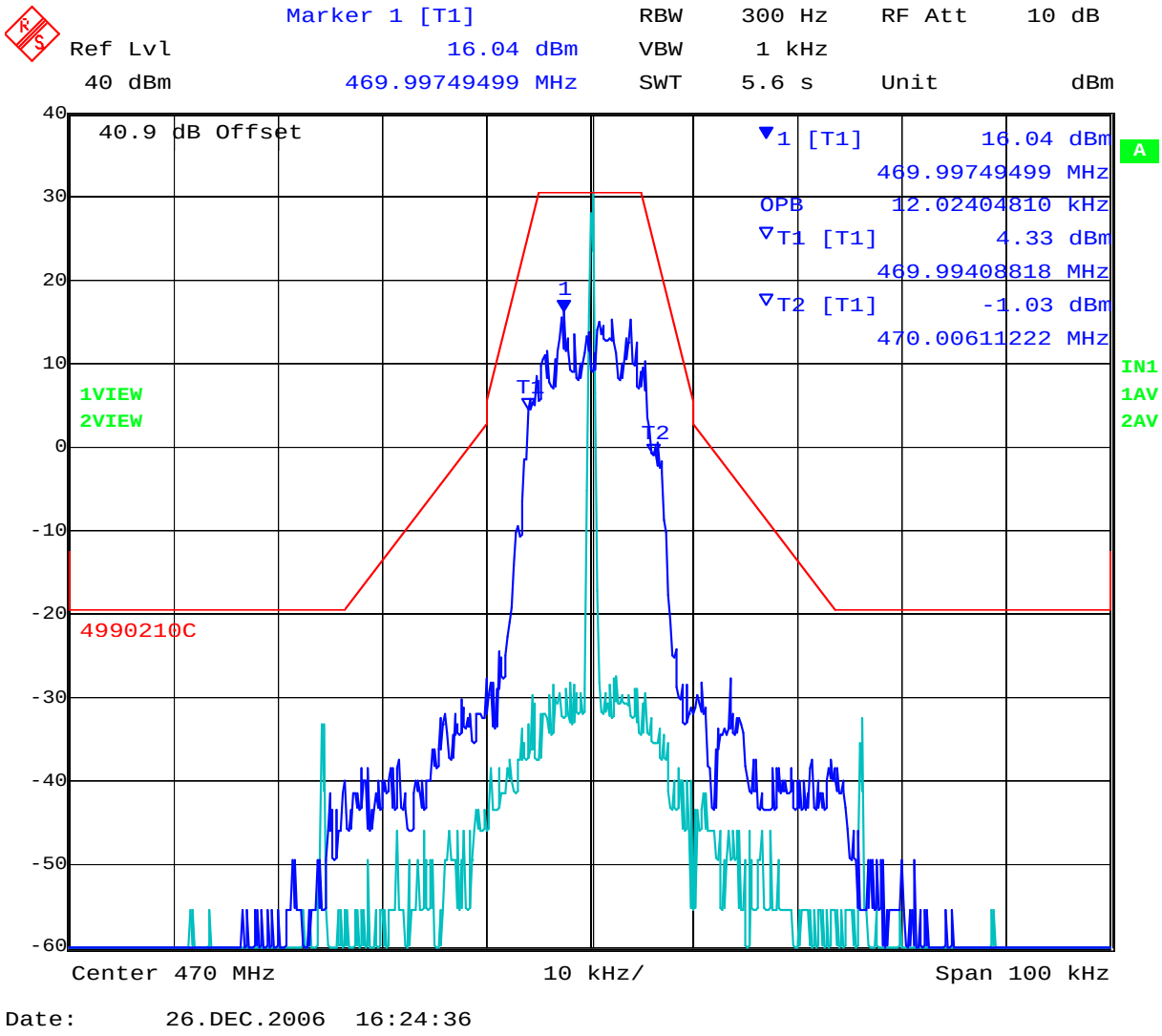
25 KHz Channel Spacing DQPSK 470 MHz – Emission Mask C



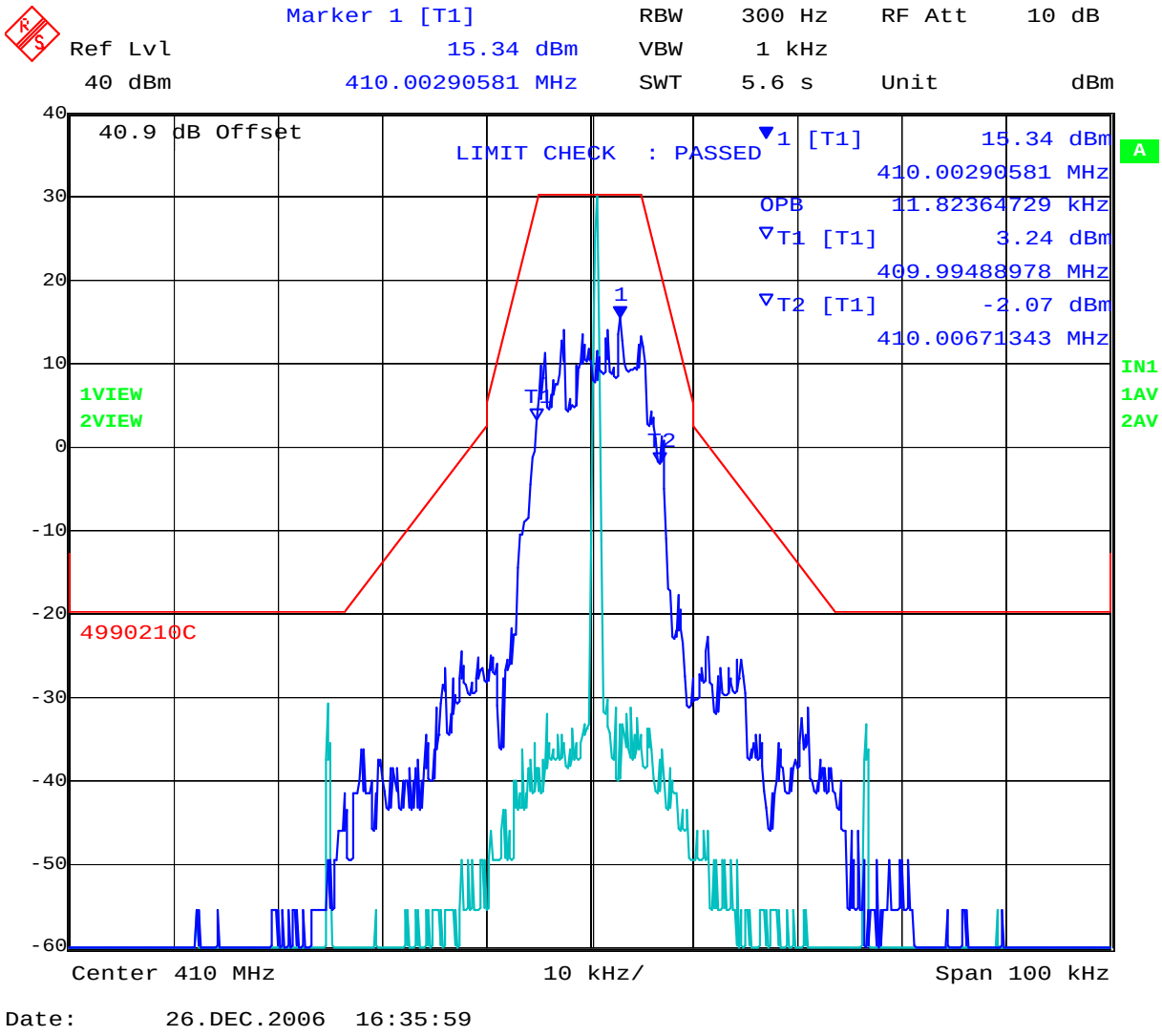
25 KHz Channel Spacing D8PSK 410 MHz – Emission Mask C



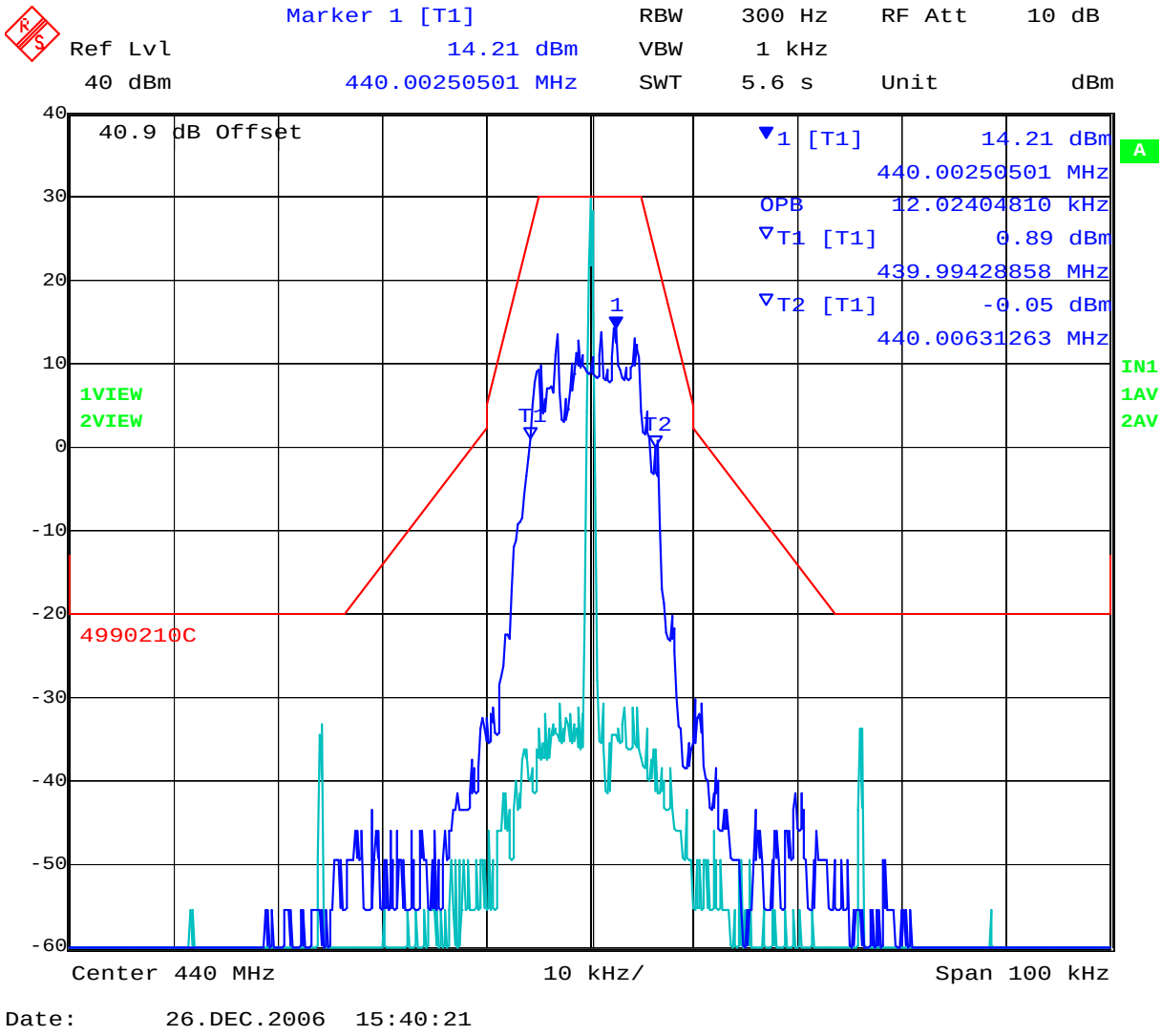
25 KHz Channel Spacing D8PSK 440 MHz – Emission Mask C



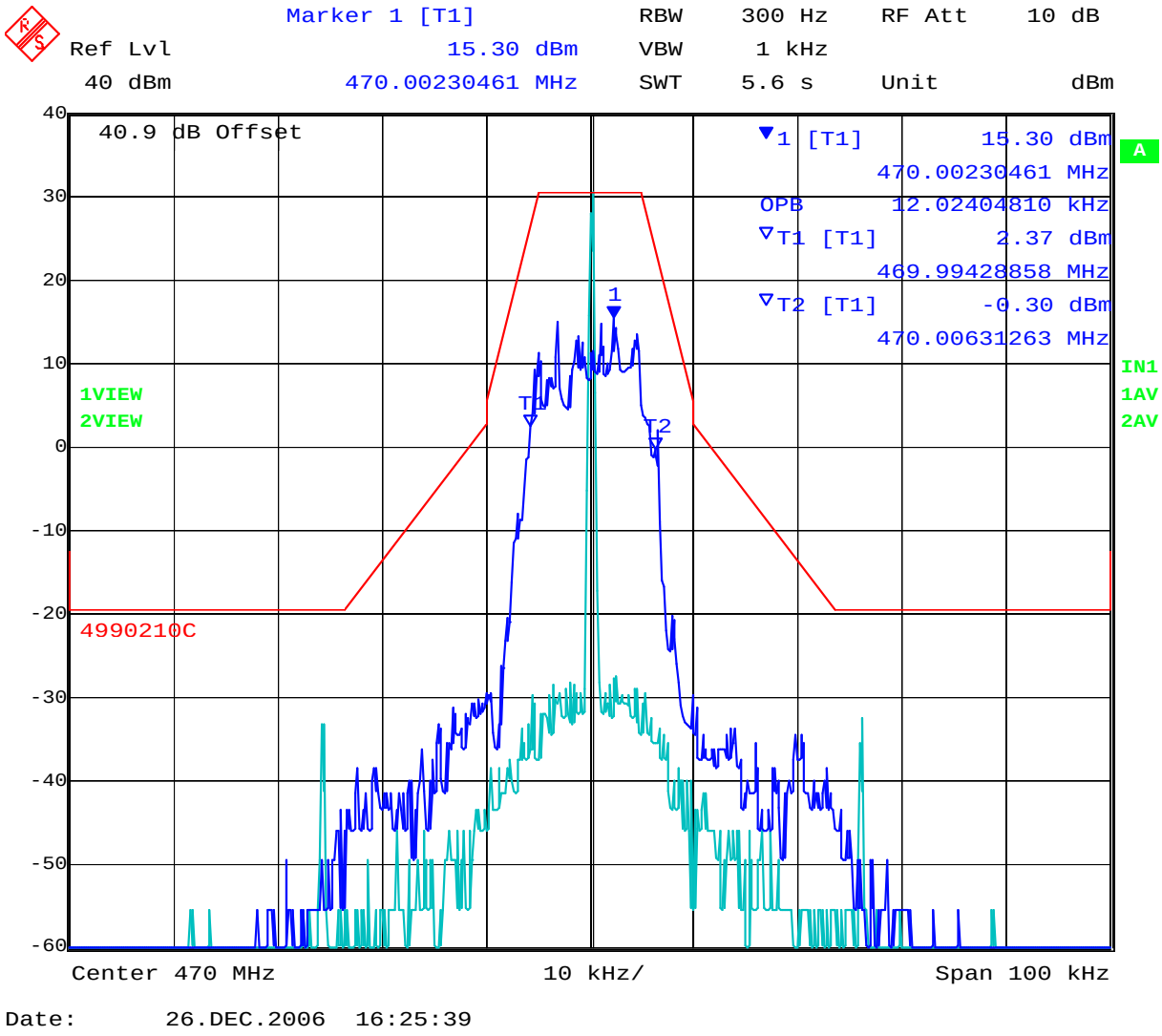
25 KHz Channel Spacing D8PSK 470 MHz – Emission Mask C



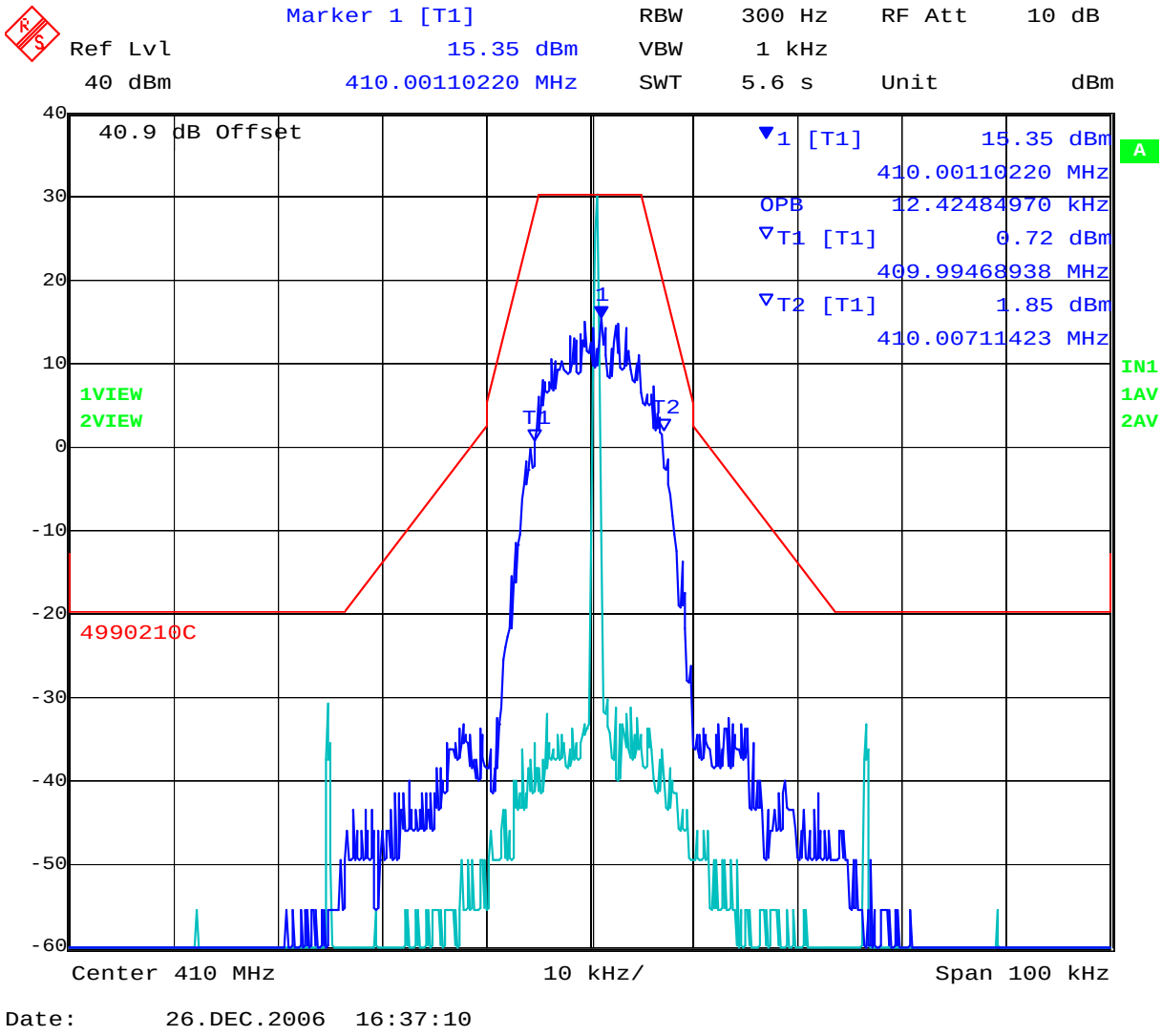
25 KHz Channel Spacing 16QAM 410 MHz – Emission Mask C



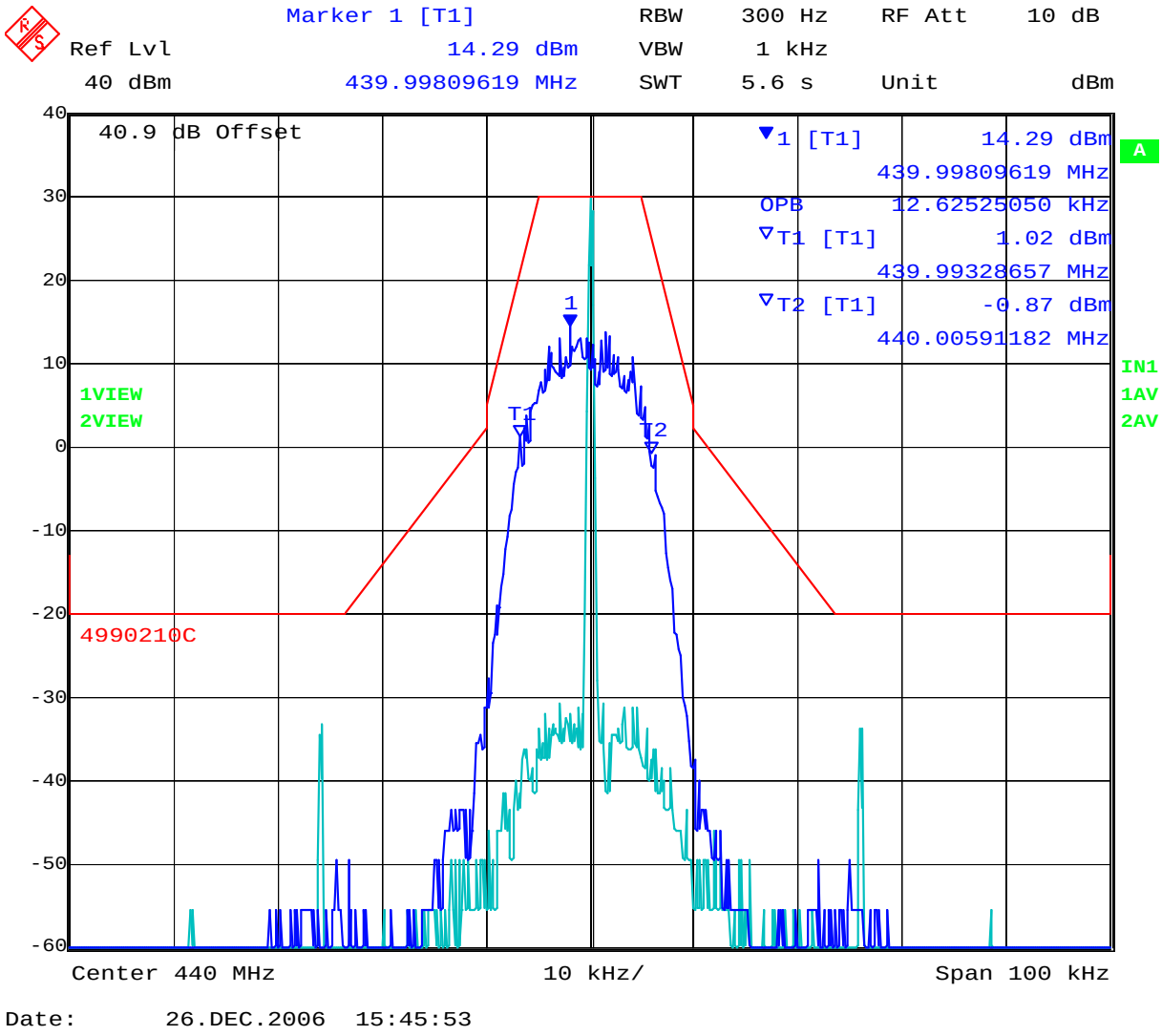
25 KHz Channel Spacing 16QAM 440 MHz – Emission Mask C



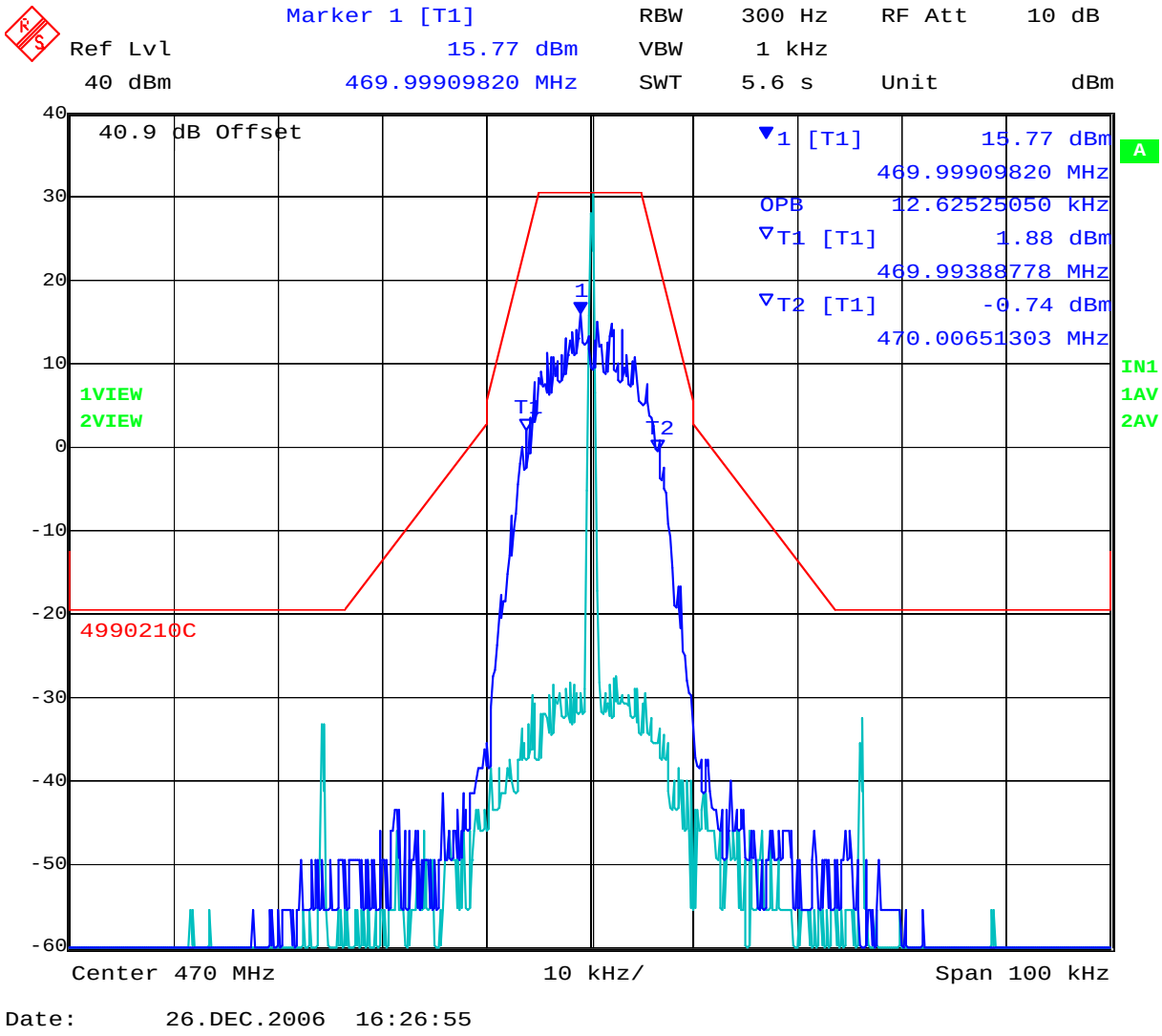
25 KHz Channel Spacing 16QAM 470 MHz – Emission Mask C



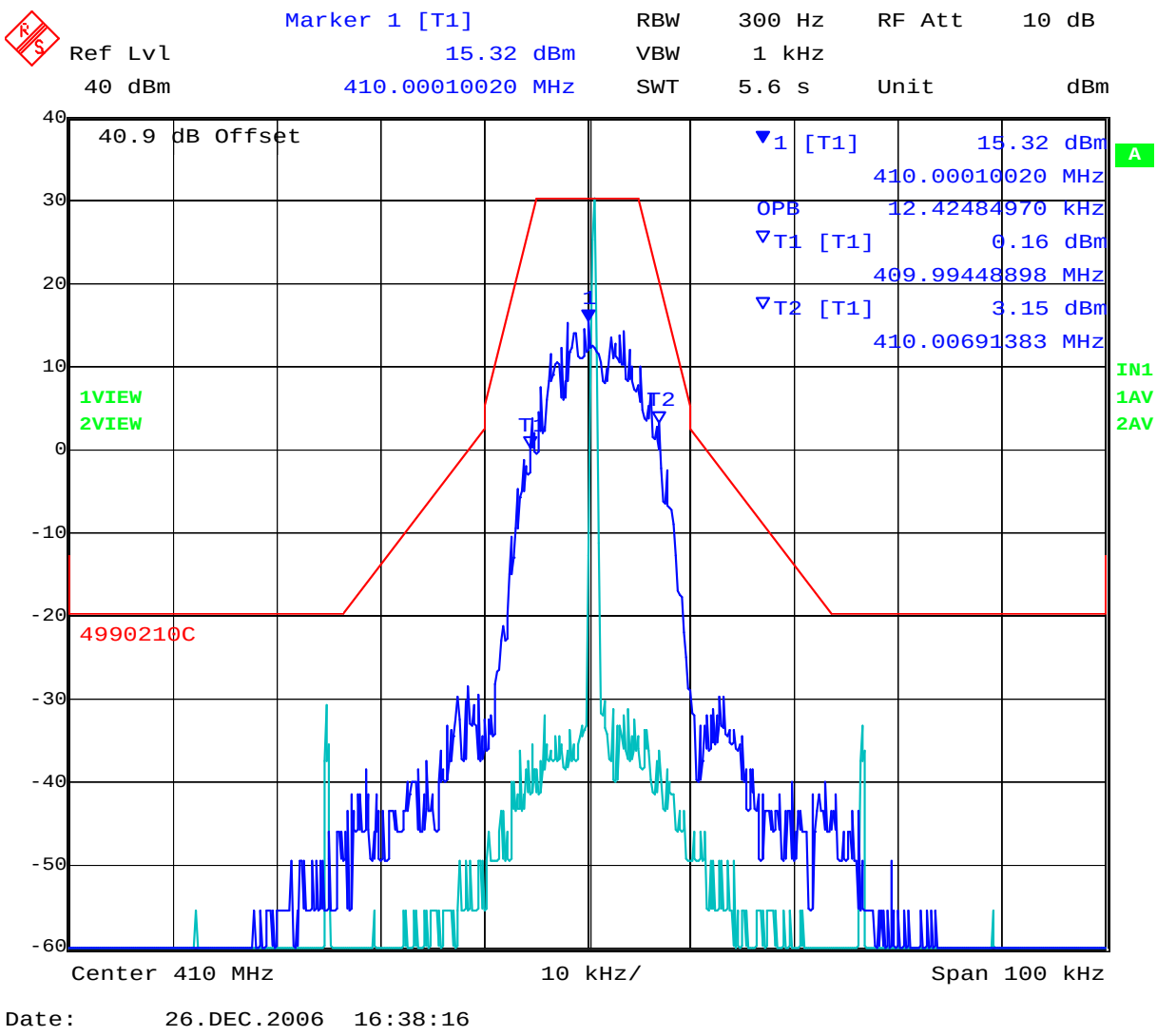
25 KHz Channel Spacing GMSK 410 MHz – Emission Mask C



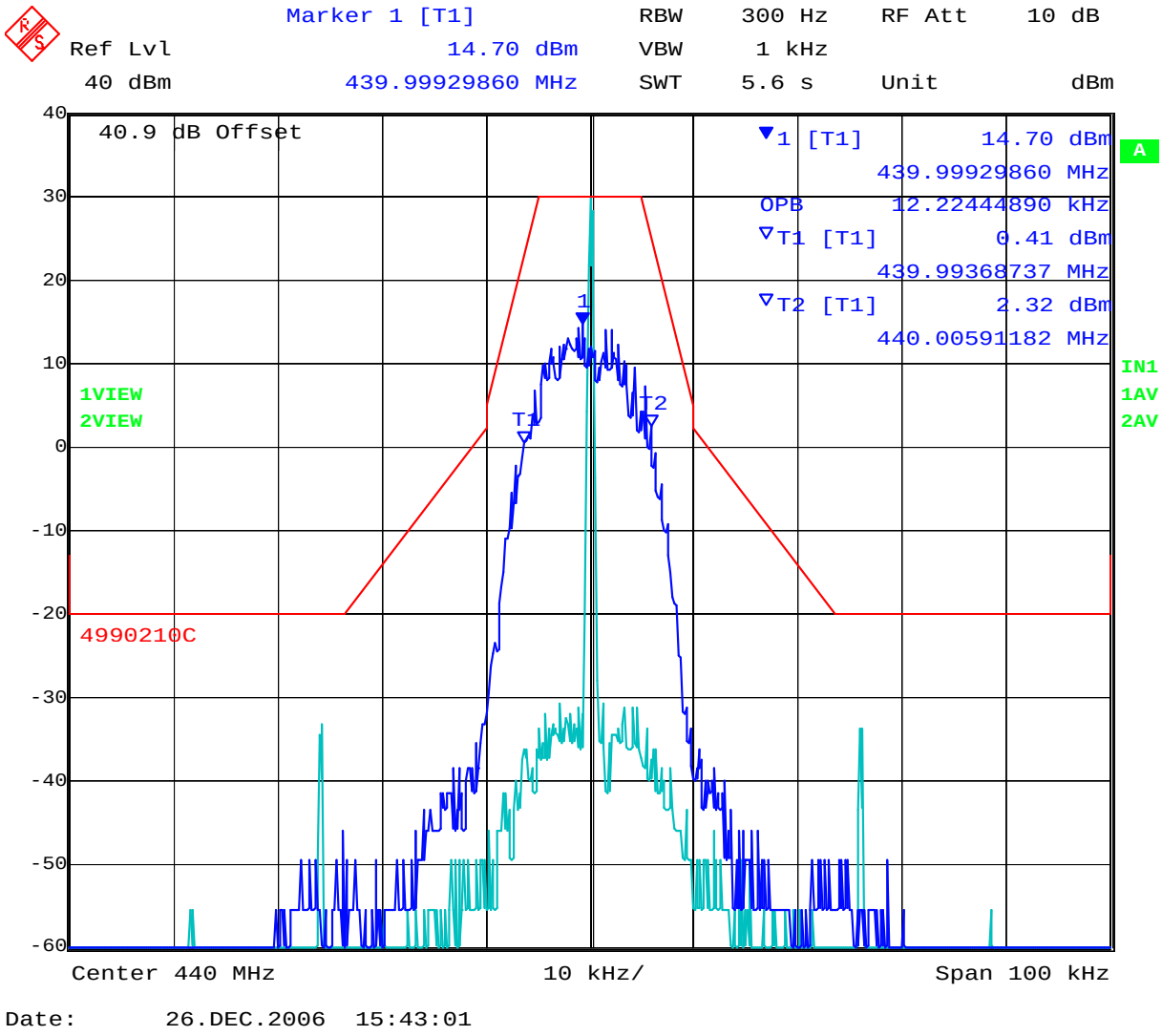
25 KHz Channel Spacing GMSK 440 MHz – Emission Mask C



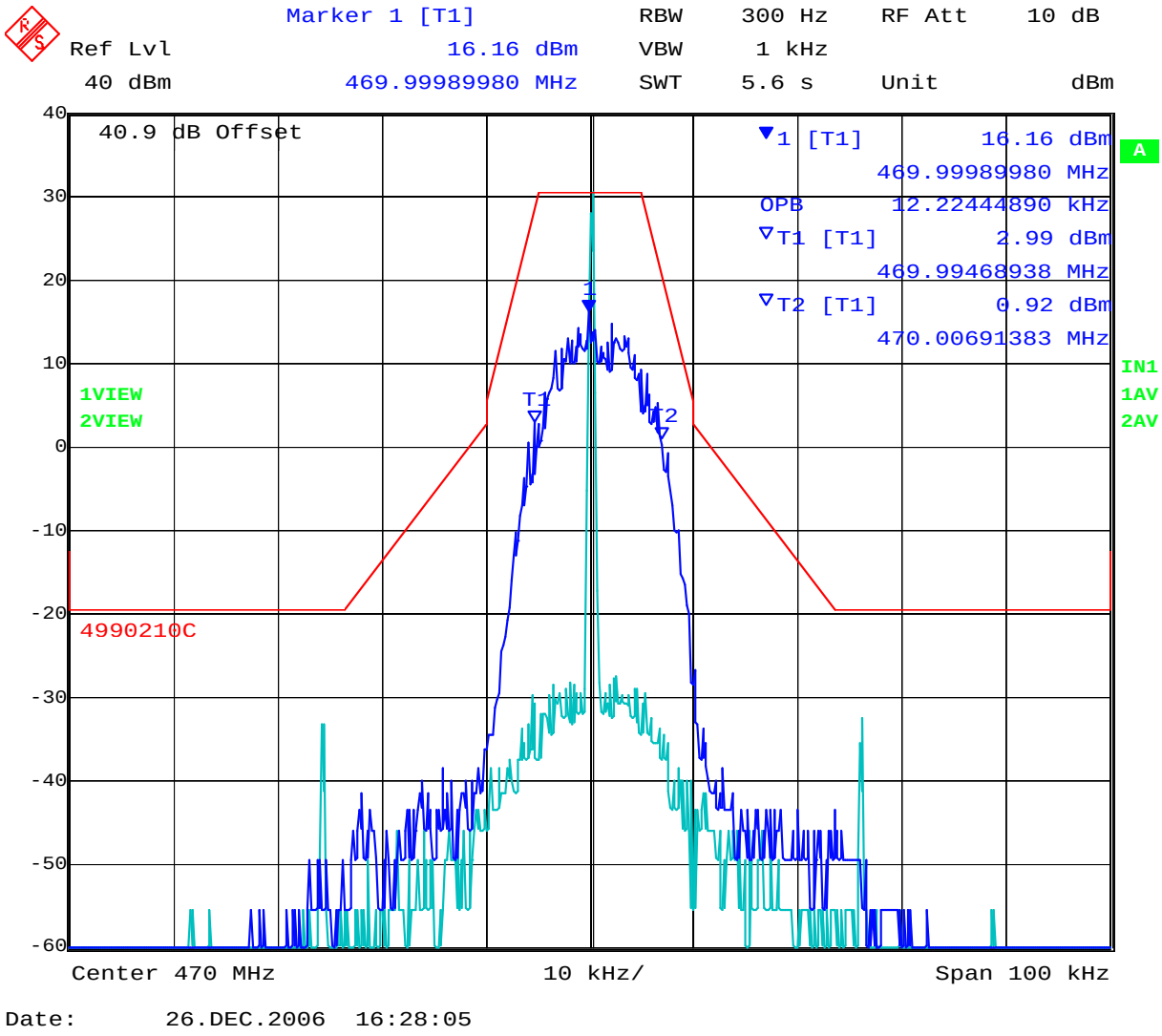
25 KHz Channel Spacing GMSK 470 MHz – Emission Mask C



25 KHz Channel Spacing 4PSK 410 MHz – Emission Mask C



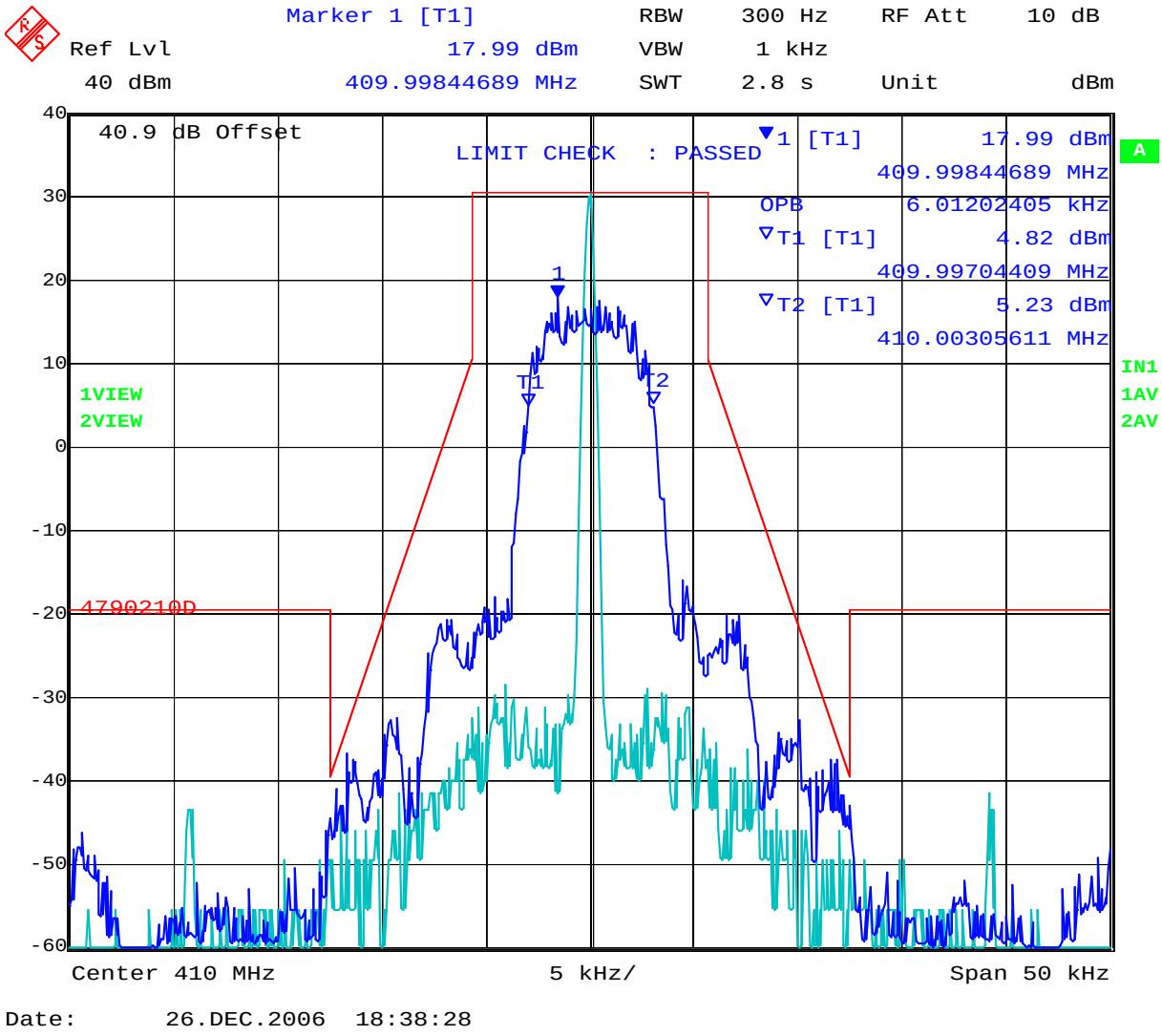
25 KHz Channel Spacing 4PSK 440 MHz – Emission Mask C



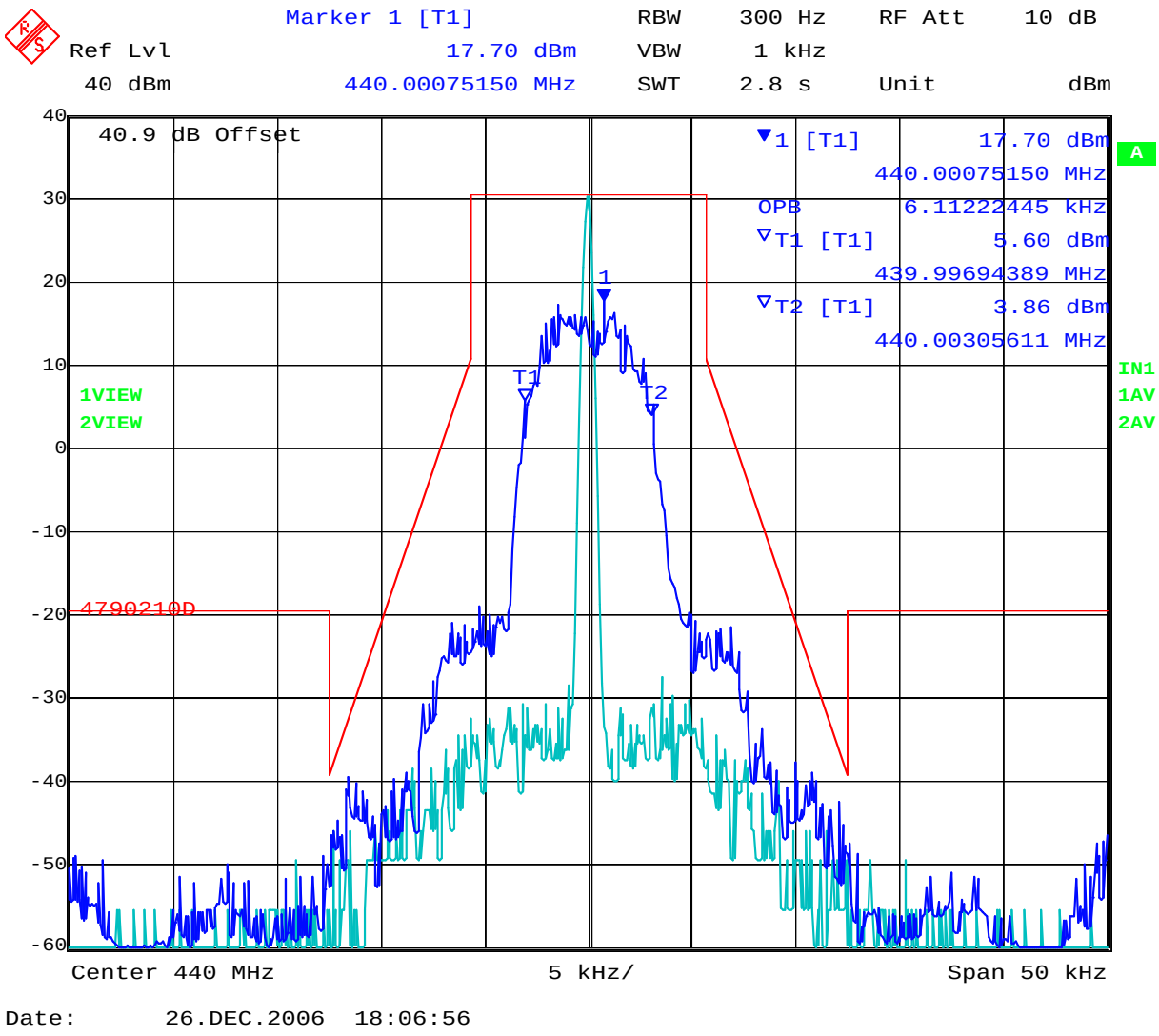
25 KHz Channel Spacing 4PSK 470 MHz – Emission Mask C

TABLE OF RESULTS – 12.5 KHz Channel Spacing

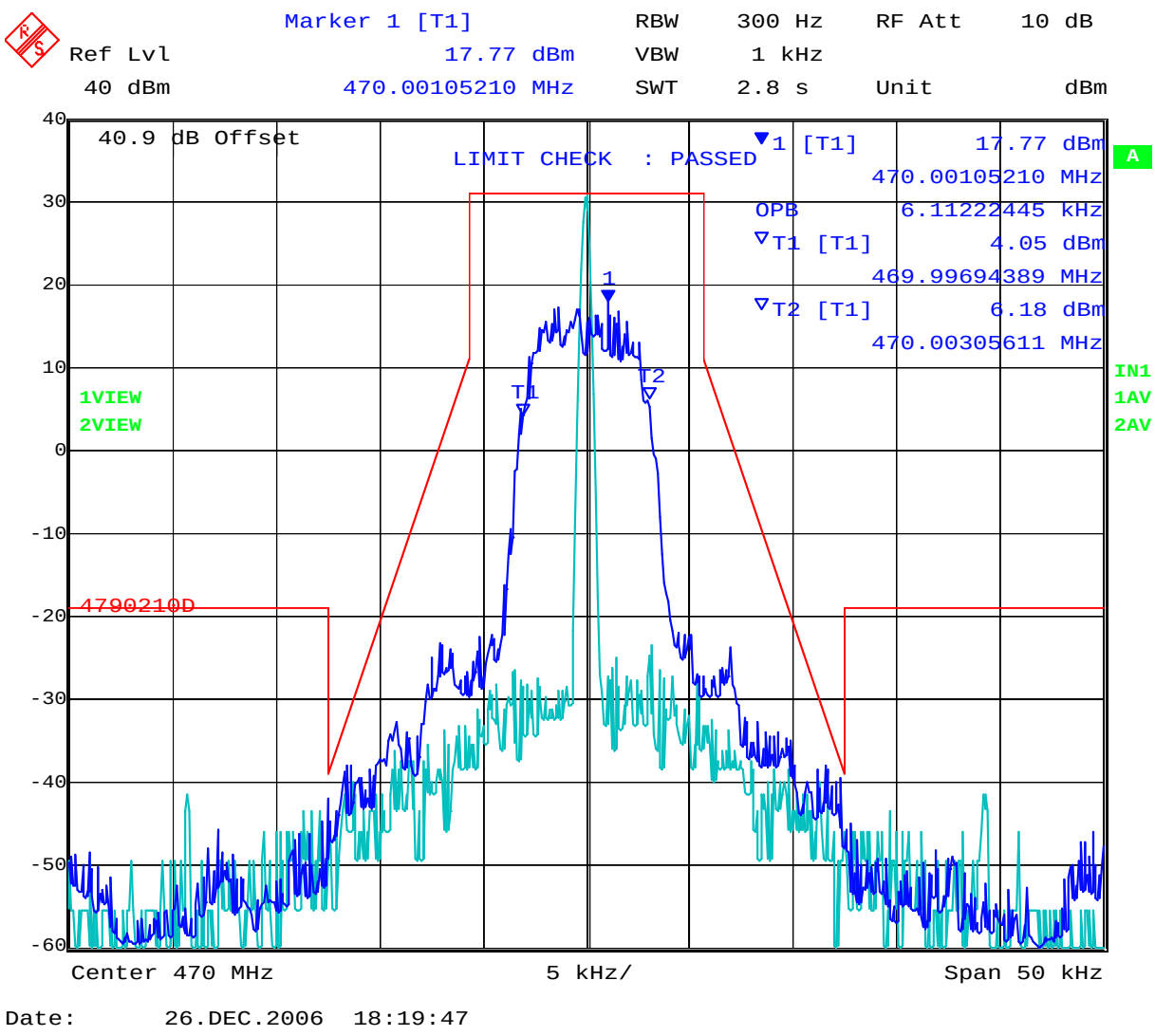
Center Frequency (MHz)	99% Bandwidth (KHz) V's Modulation					
	DBPSK	DQPSK	D8PSK	16 QAM	GMSK	4PSK
410	6.012	6.112	6.112	6.012	6.212	6.313
440	6.112	6.112	6.012	6.112	6.212	6.212
470	6.112	6.112	6.112	6.112	6.212	6.212



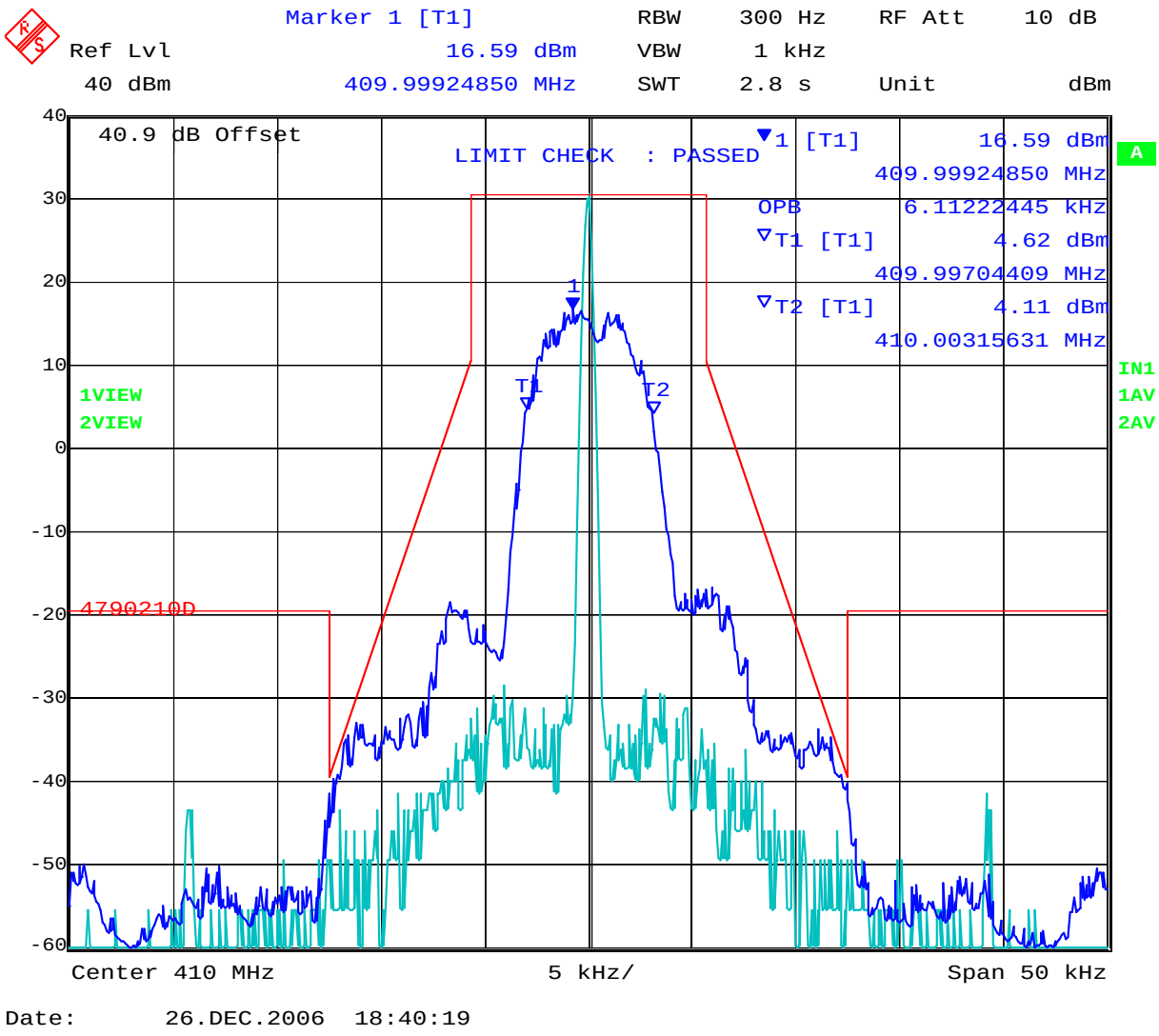
12.5 KHz Channel Spacing DBPSK 410 MHz – Emission Mask D



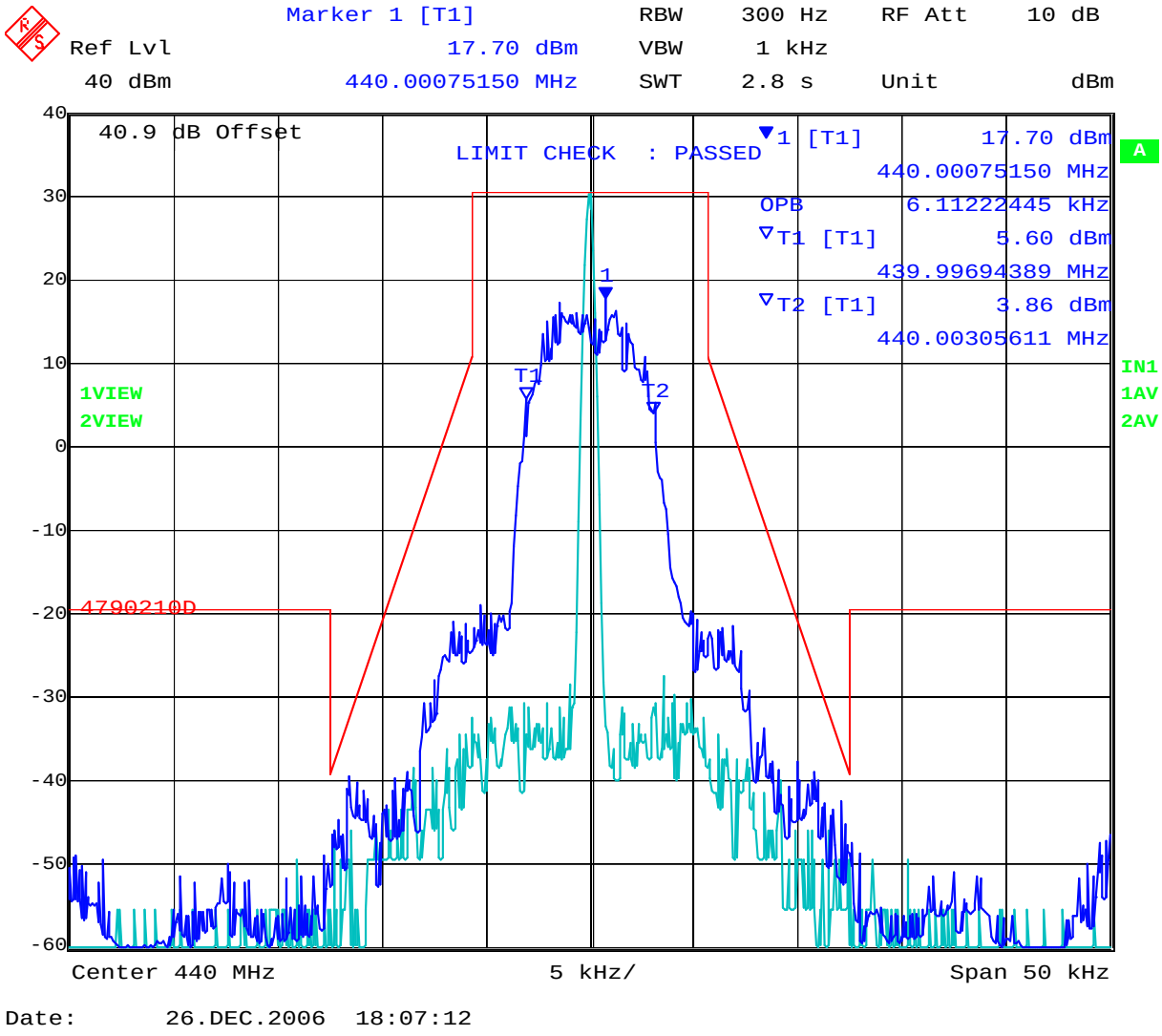
12.5 KHz Channel Spacing DBPSK 440 MHz – Emission Mask D



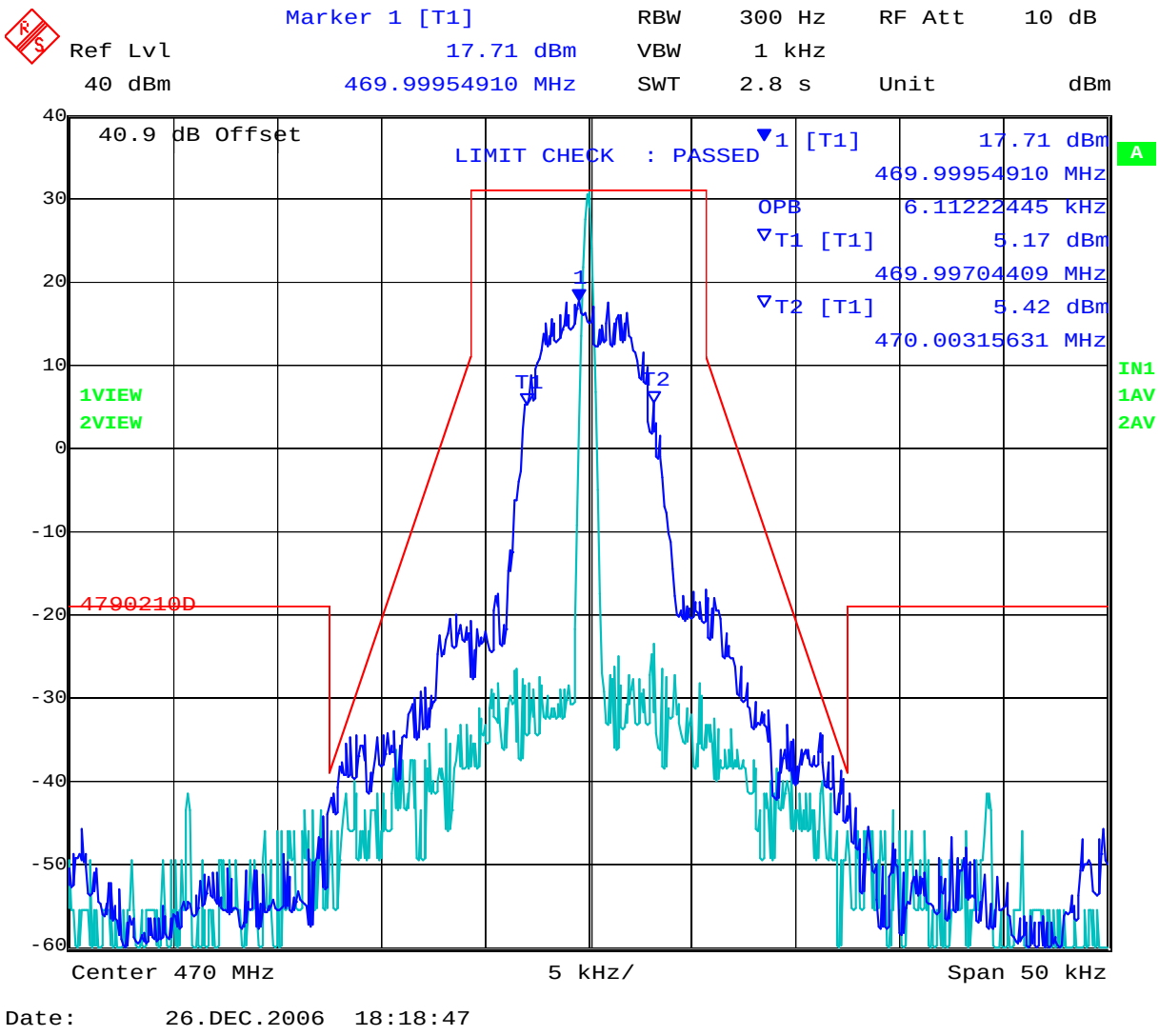
12.5 KHz Channel Spacing DBPSK 470 MHz – Emission Mask D



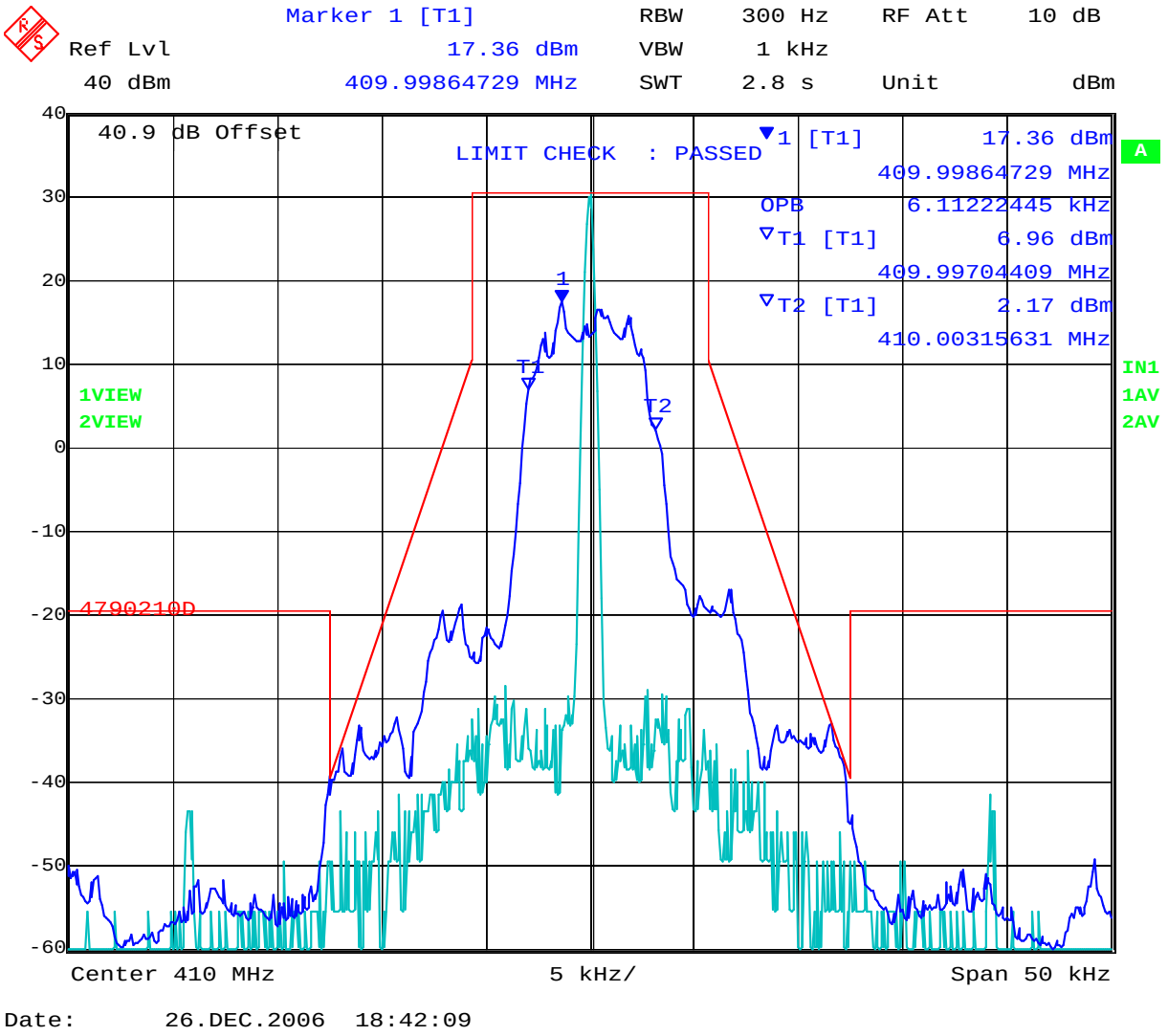
12.5 KHz Channel Spacing DQPSK 410 MHz – Emission Mask D



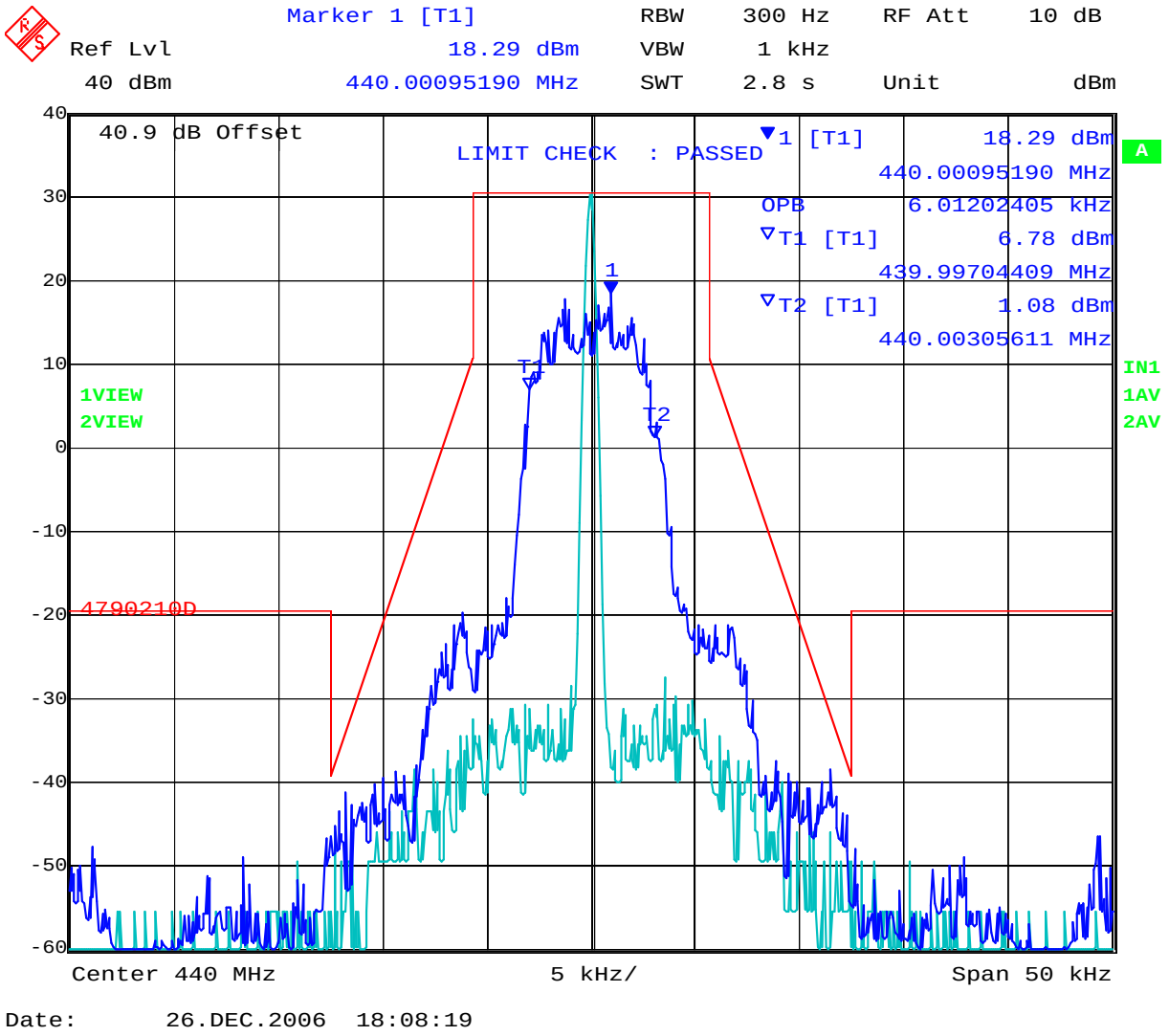
12.5 KHz Channel Spacing DQPSK 440 MHz – Emission Mask D



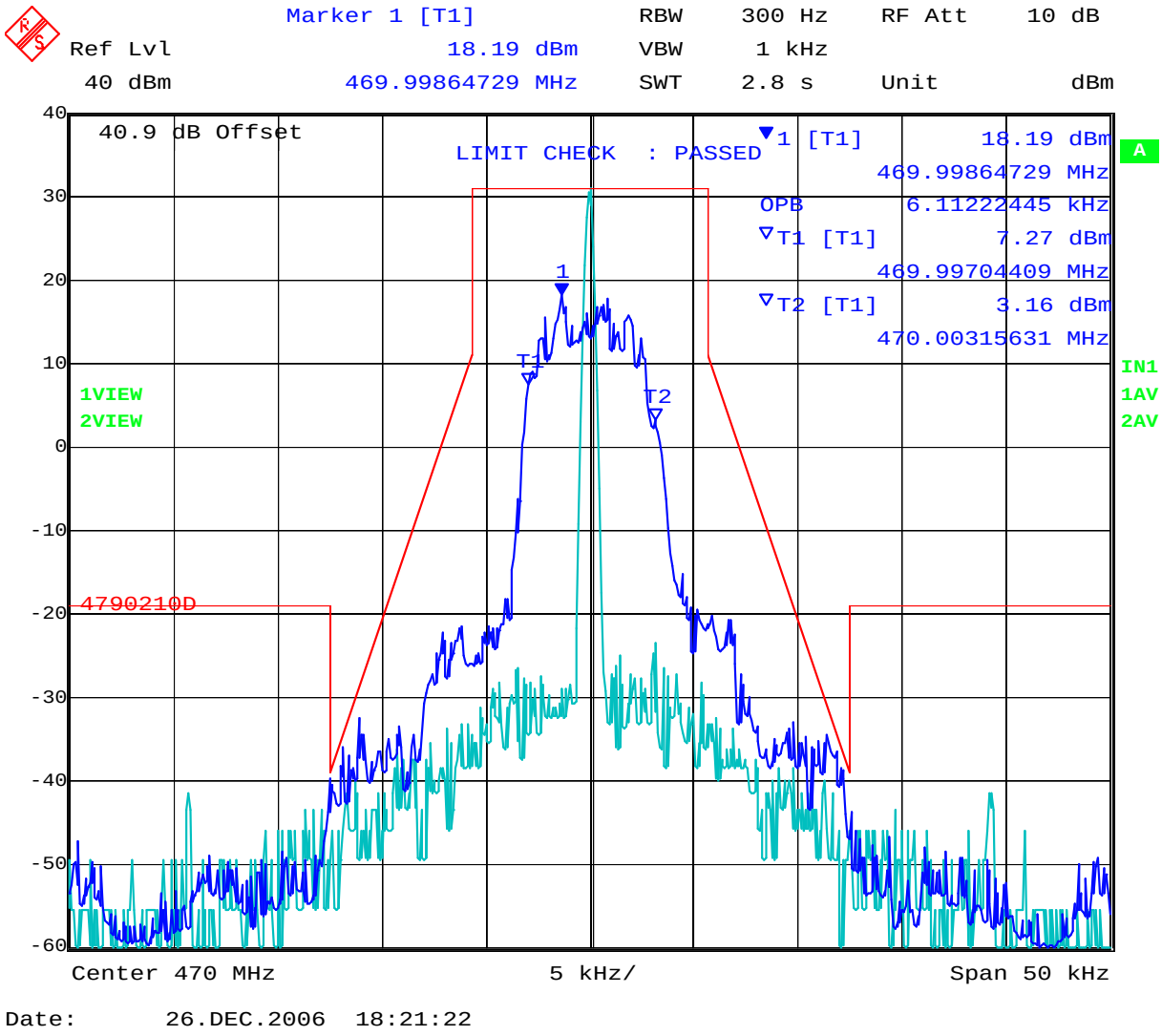
12.5 KHz Channel Spacing DQPSK 470 MHz – Emission Mask D



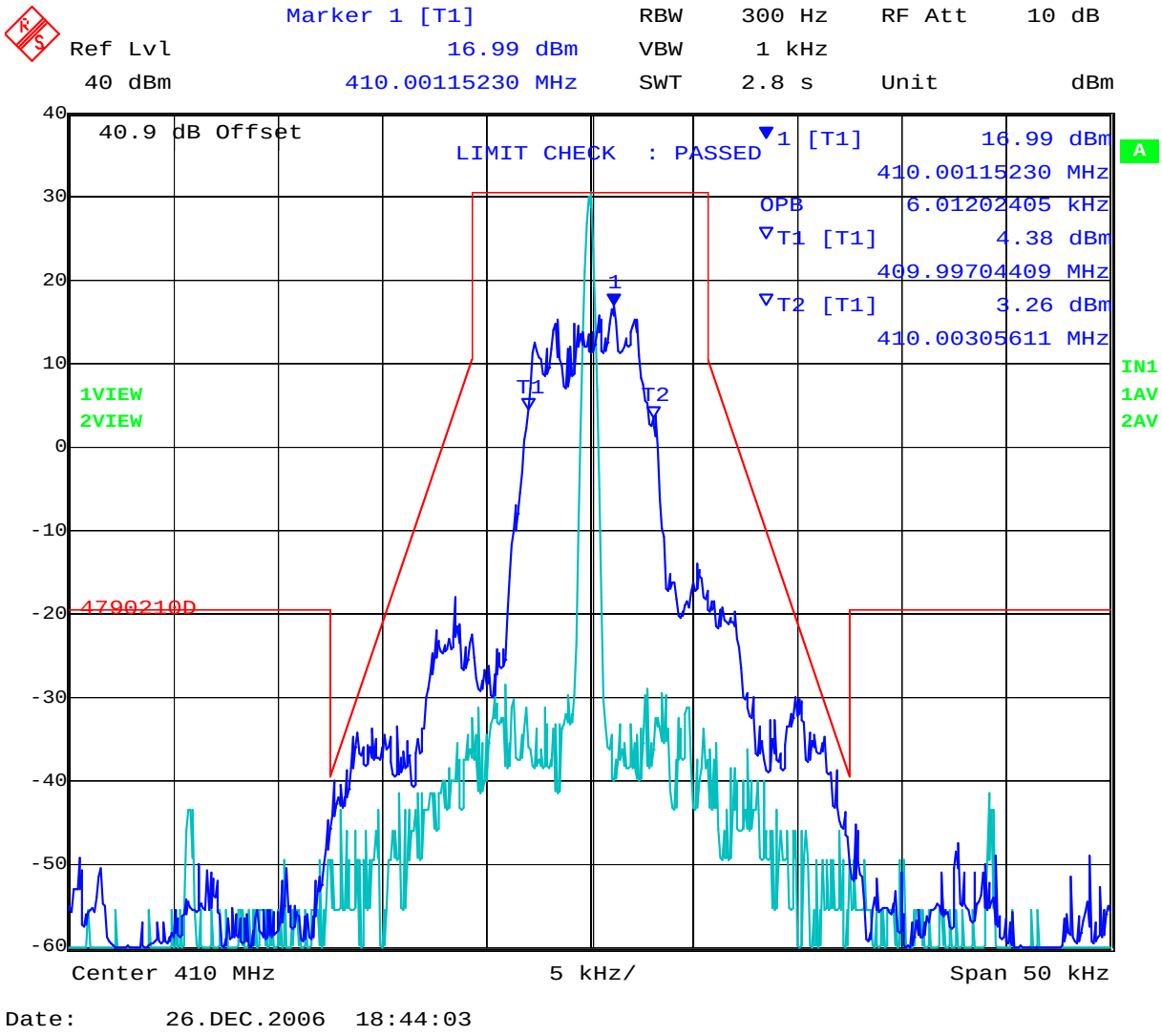
12.5 KHz Channel Spacing D8PSK 410 MHz – Emission Mask D



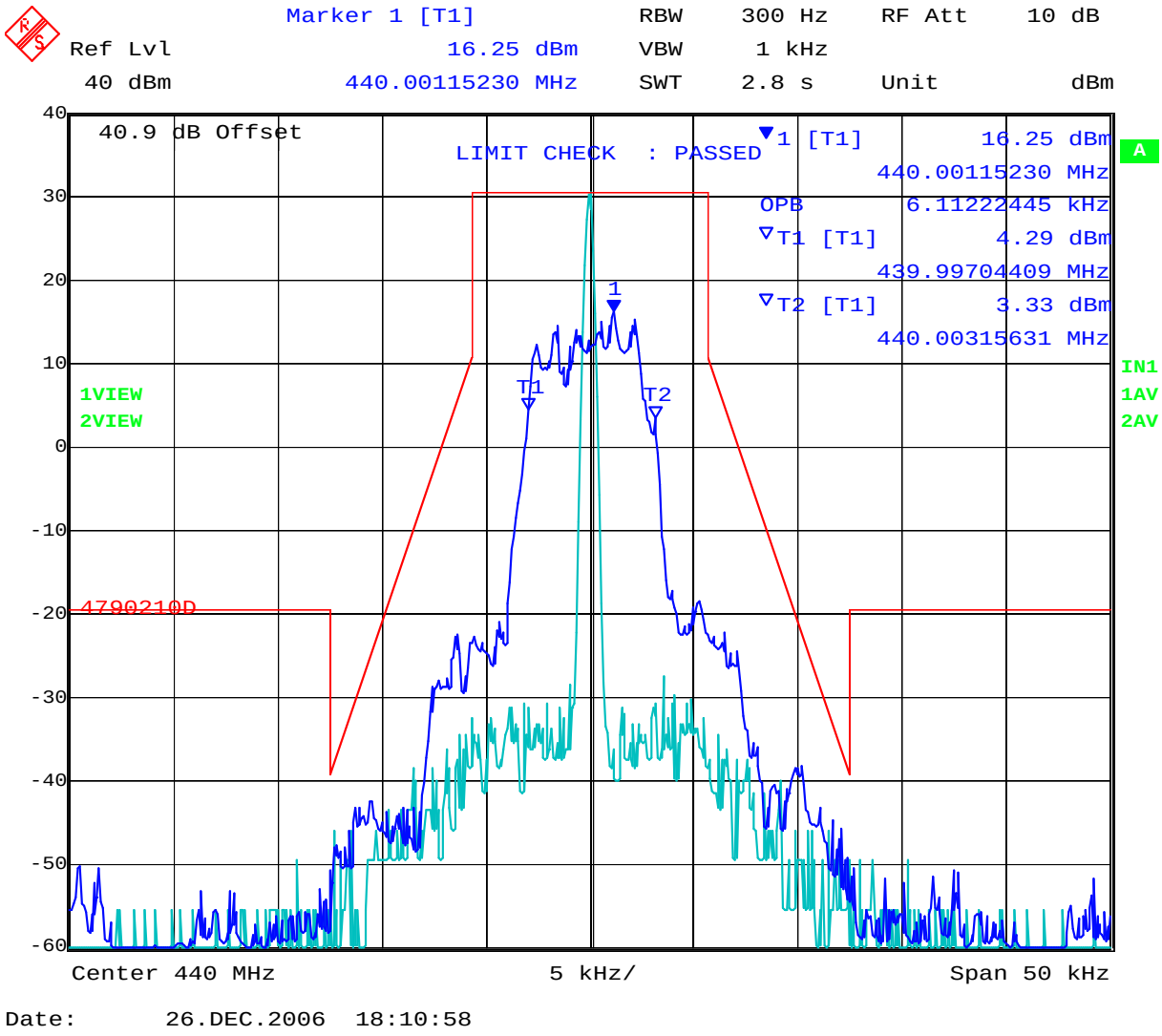
12.5 KHz Channel Spacing D8PSK 440 MHz – Emission Mask D



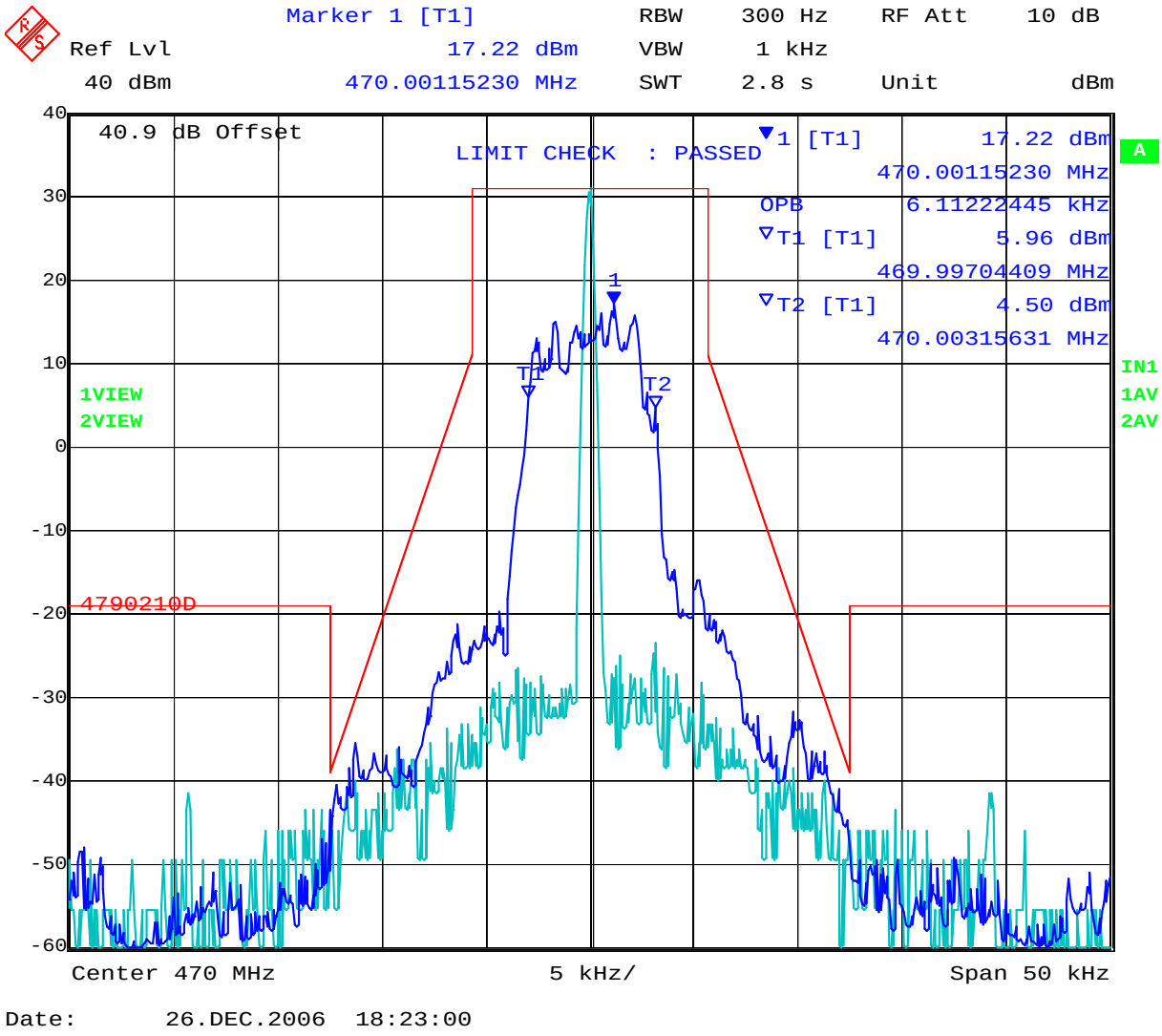
12.5 KHz Channel Spacing D8PSK 470 MHz – Emission Mask D



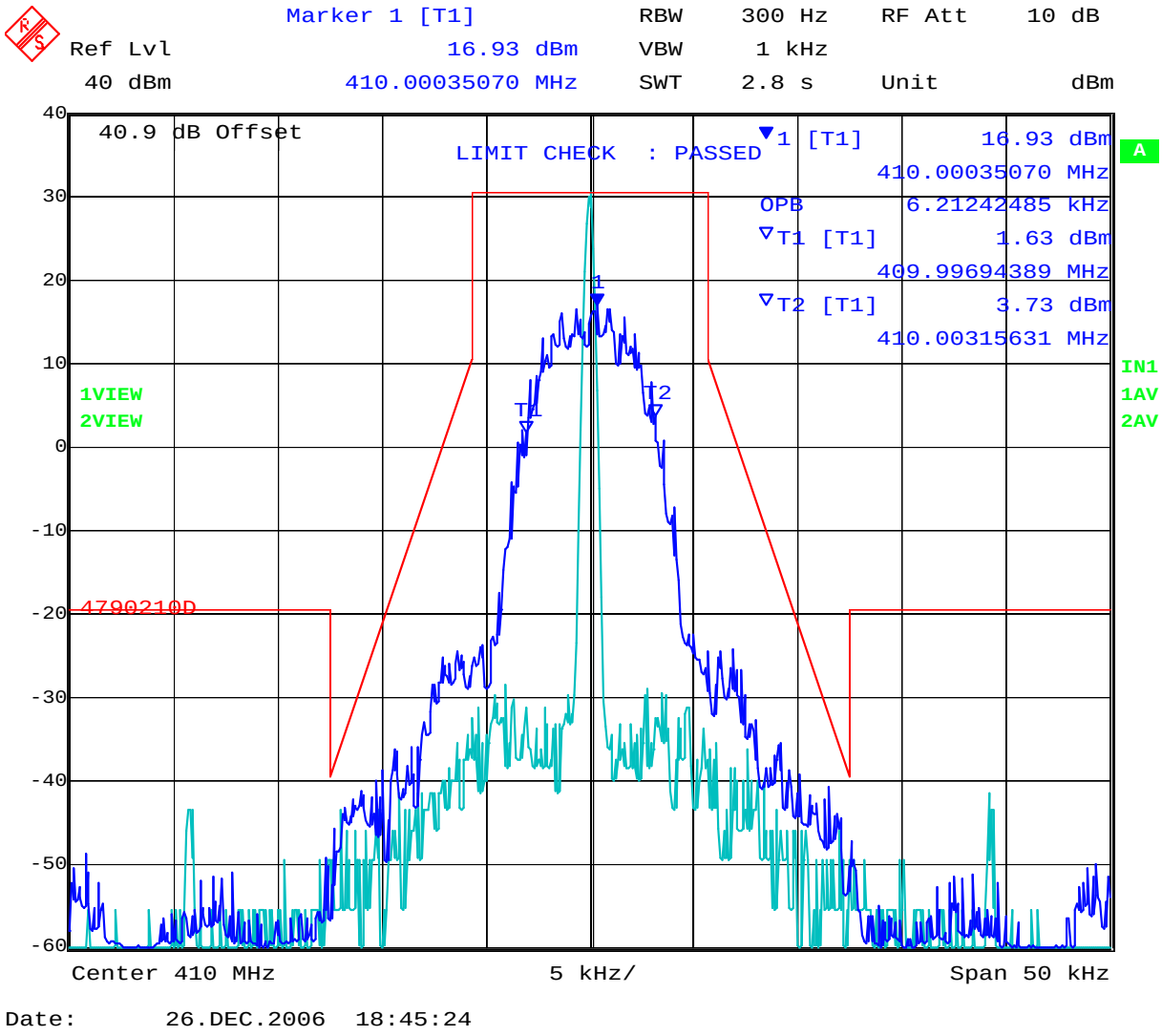
12.5 KHz Channel Spacing 16QAM 410 MHz – Emission Mask D



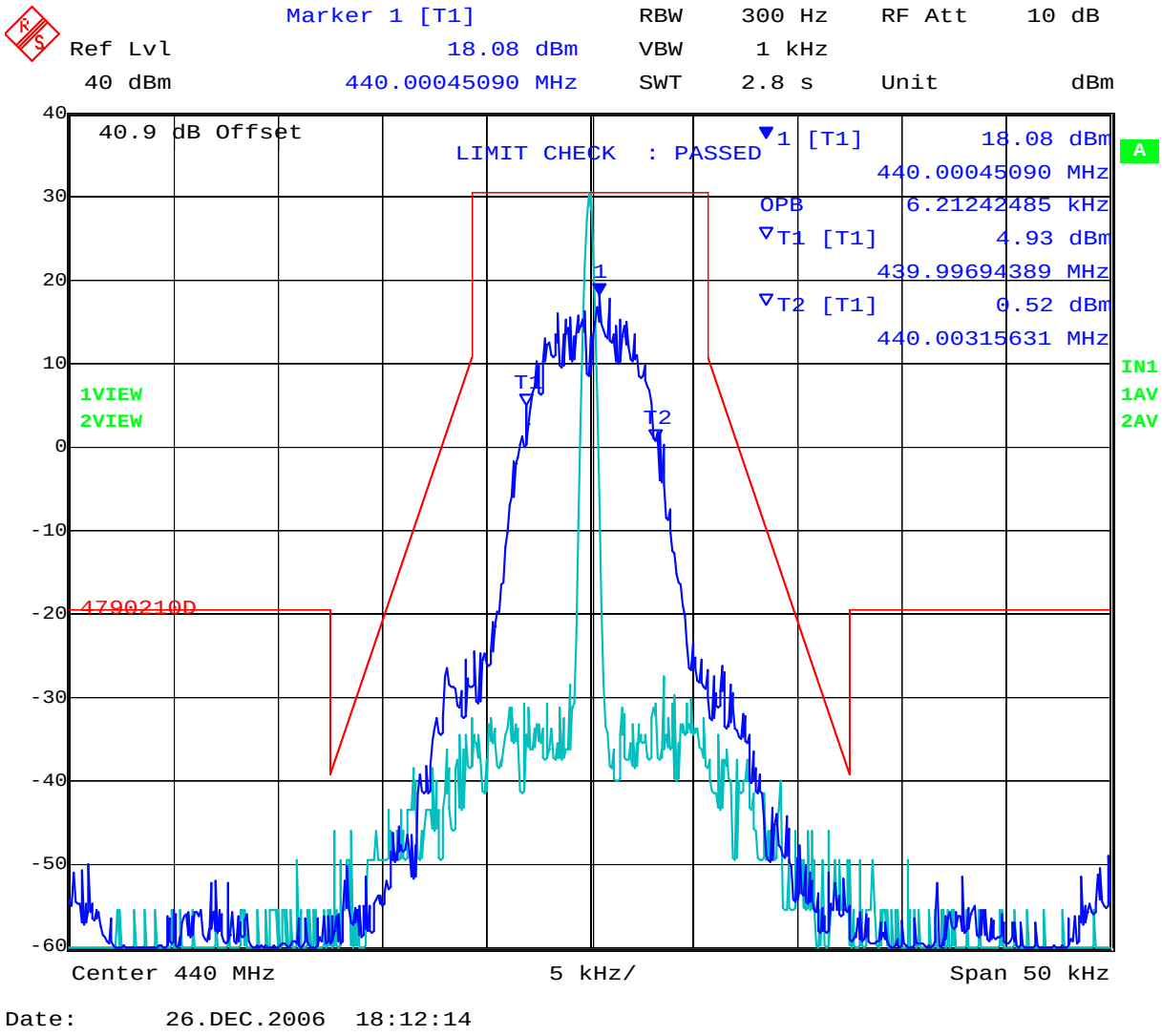
12.5 KHz Channel Spacing 16QAM 440 MHz – Emission Mask D



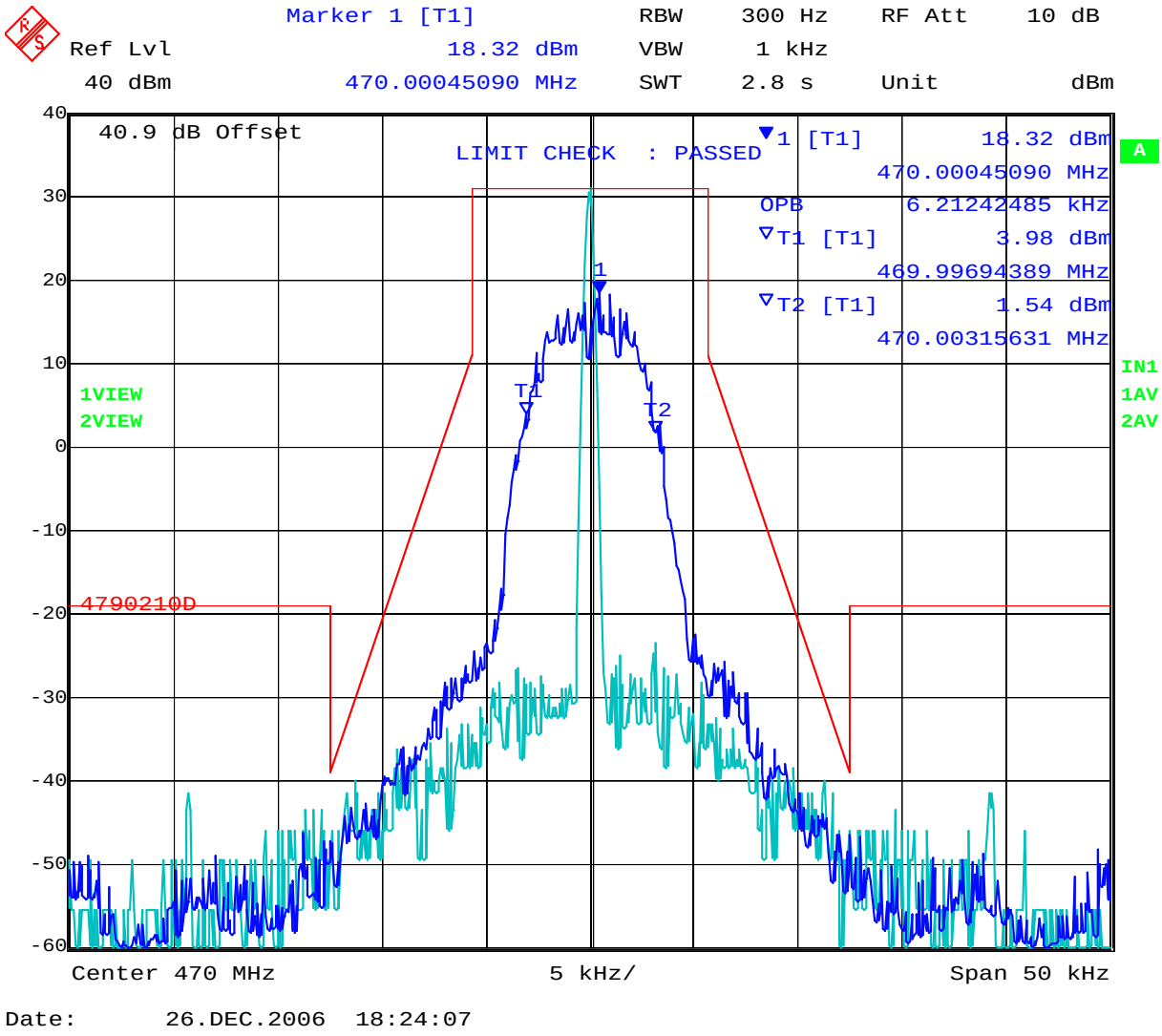
12.5 KHz Channel Spacing 16QAM 470 MHz – Emission Mask D



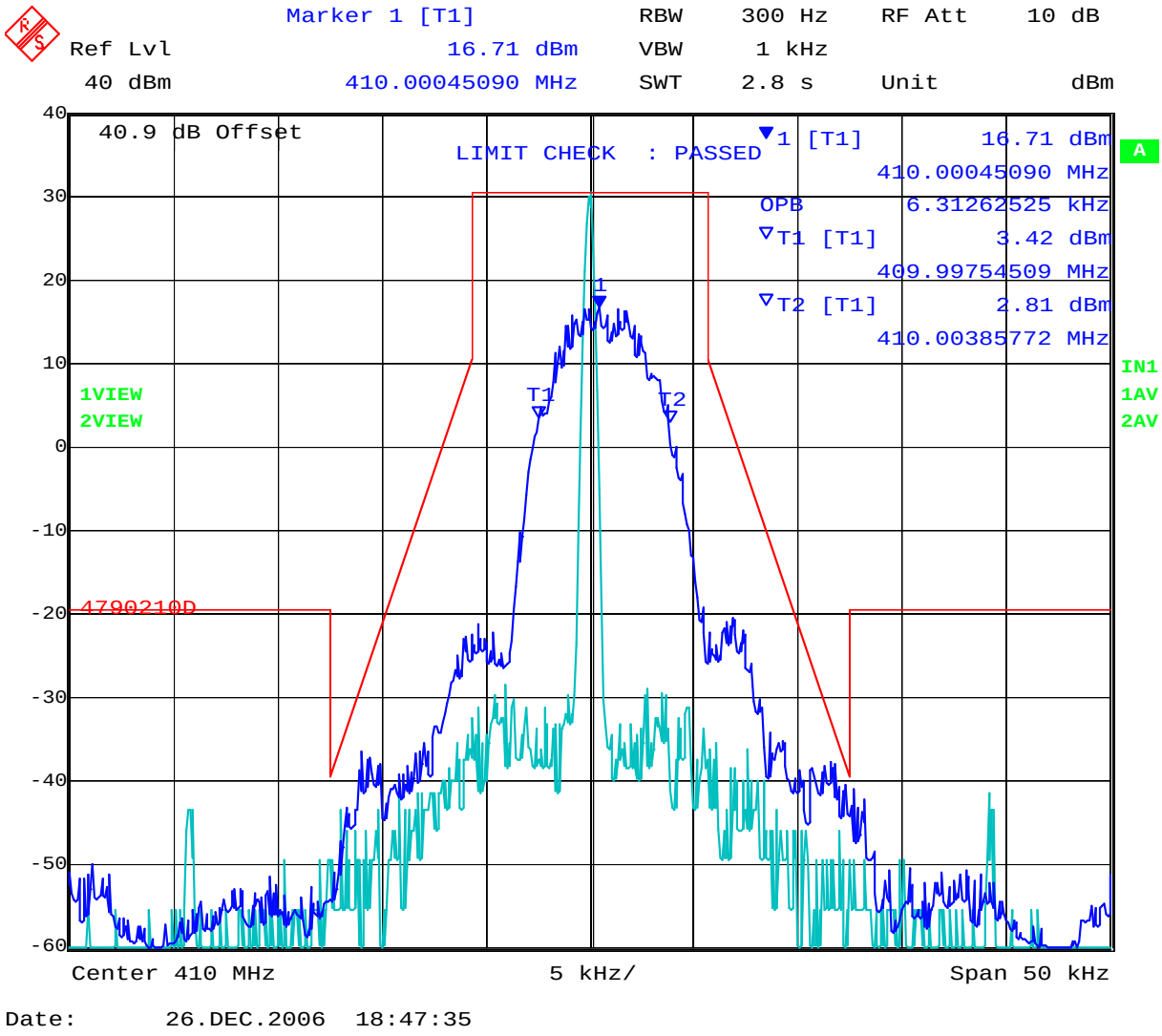
12.5 KHz Channel Spacing GMSK 410 MHz – Emission Mask D



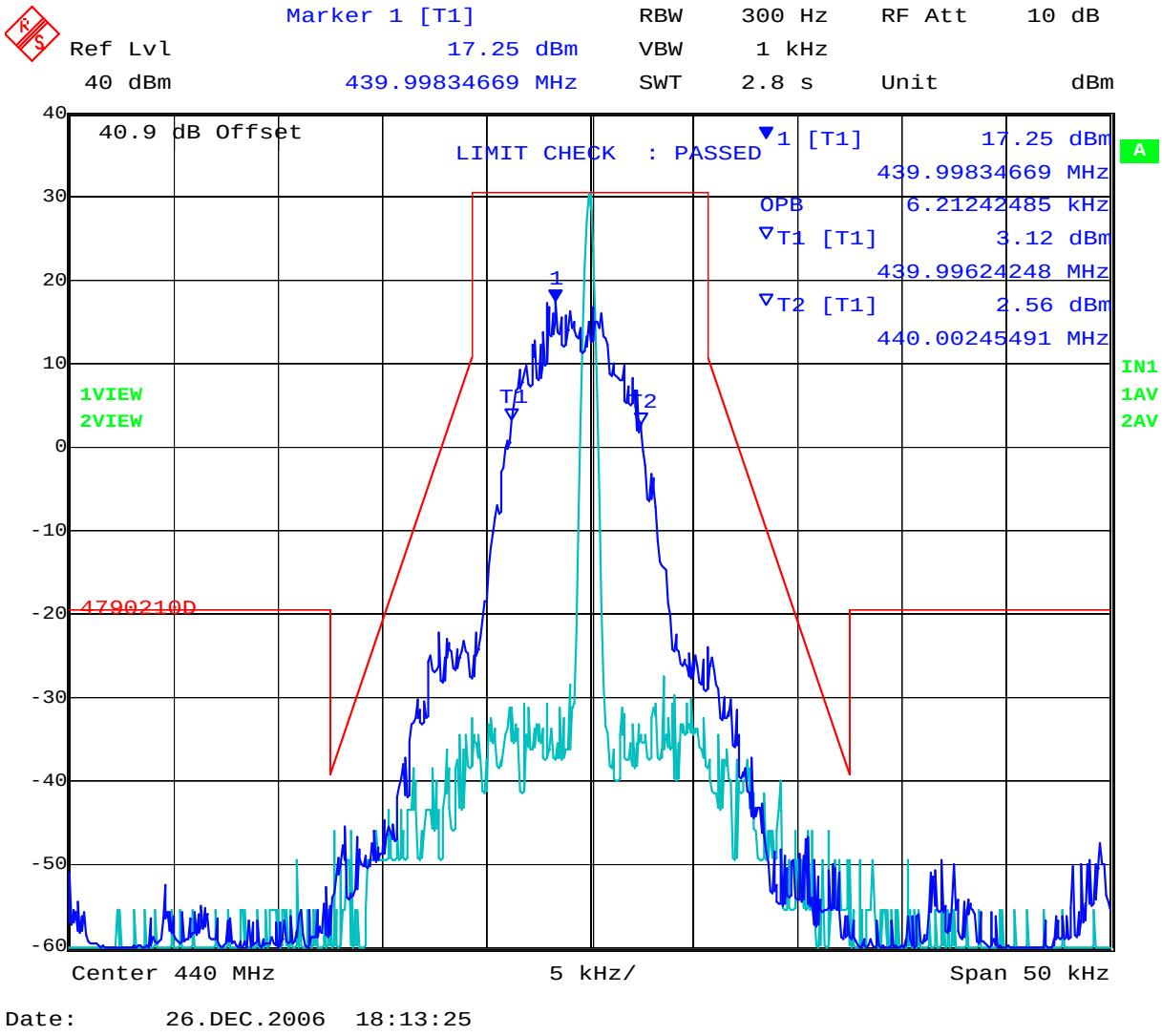
12.5 KHz Channel Spacing GMSK 440 MHz – Emission Mask D



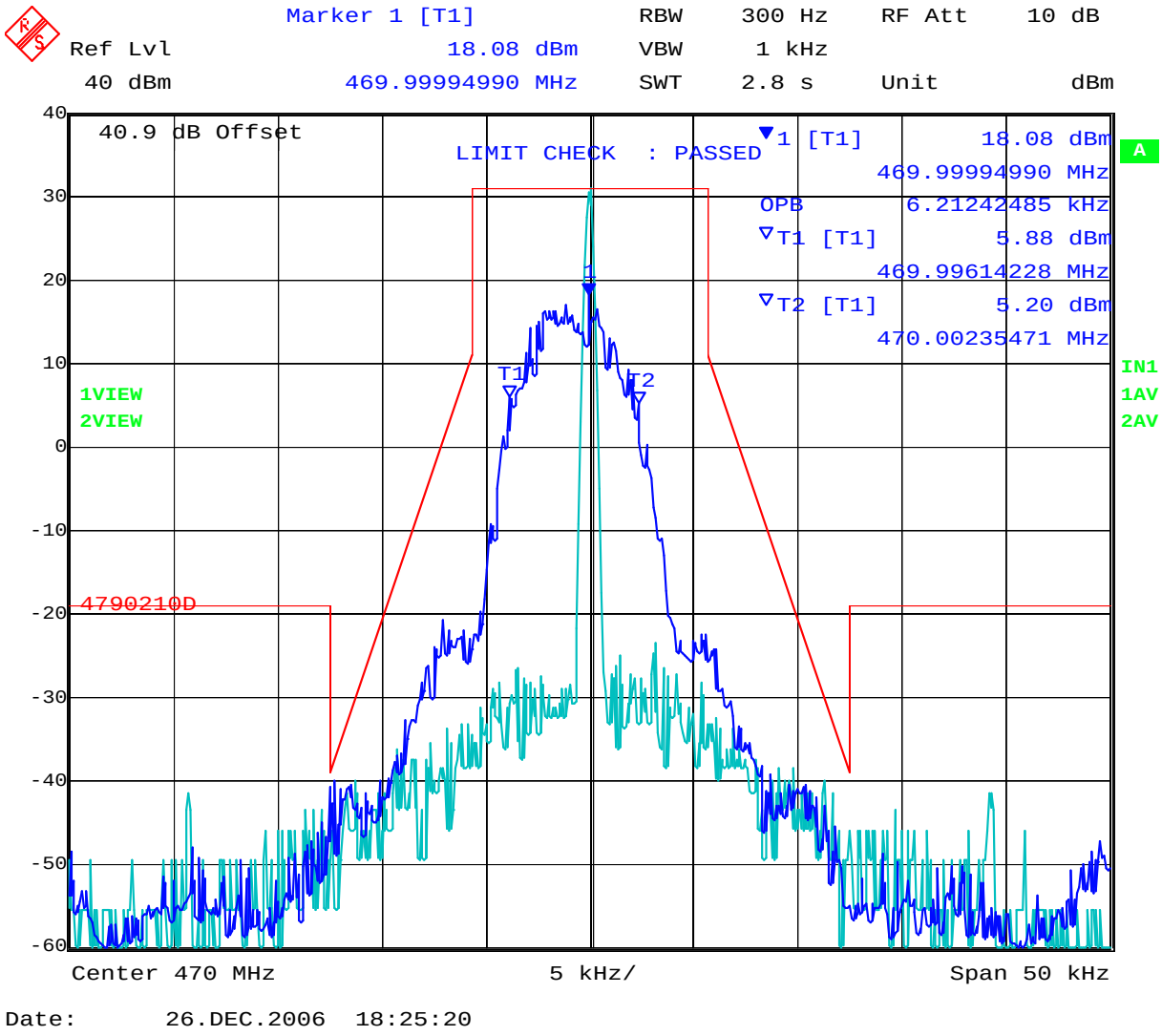
12.5 KHz Channel Spacing GMSK 470 MHz – Emission Mask D



12.5 KHz Channel Spacing 4PSK 410 MHz – Emission Mask D



12.5 KHz Channel Spacing 4PSK 440 MHz – Emission Mask D



12.5 KHz Channel Spacing 4PSK 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

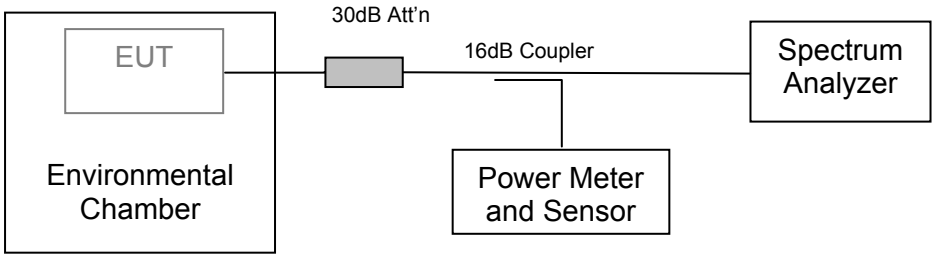
Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314.

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 at 10°C intervals at both at ambient and extremes of temperature on a single channel. 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



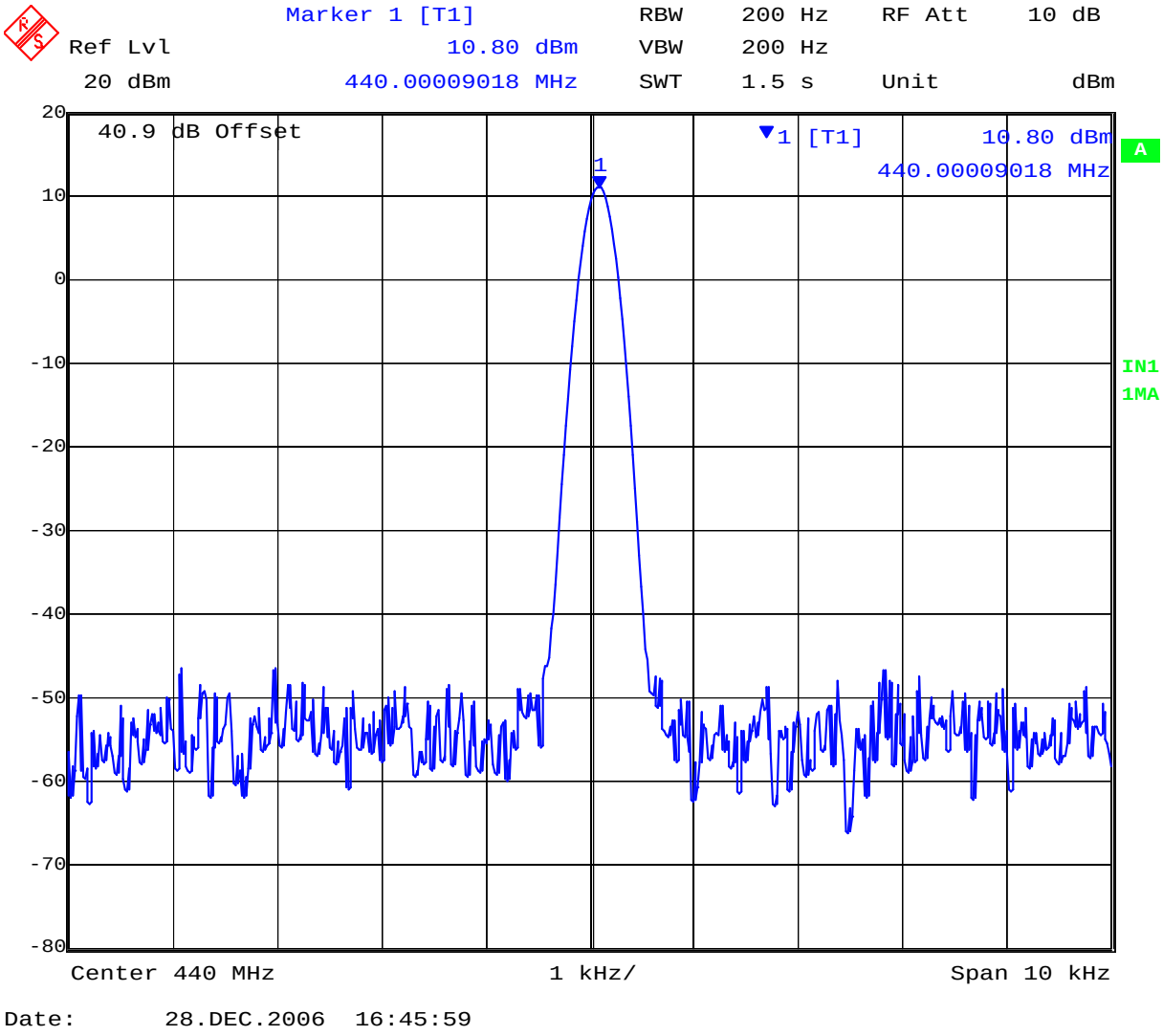
Measurement set up for Frequency Stability

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

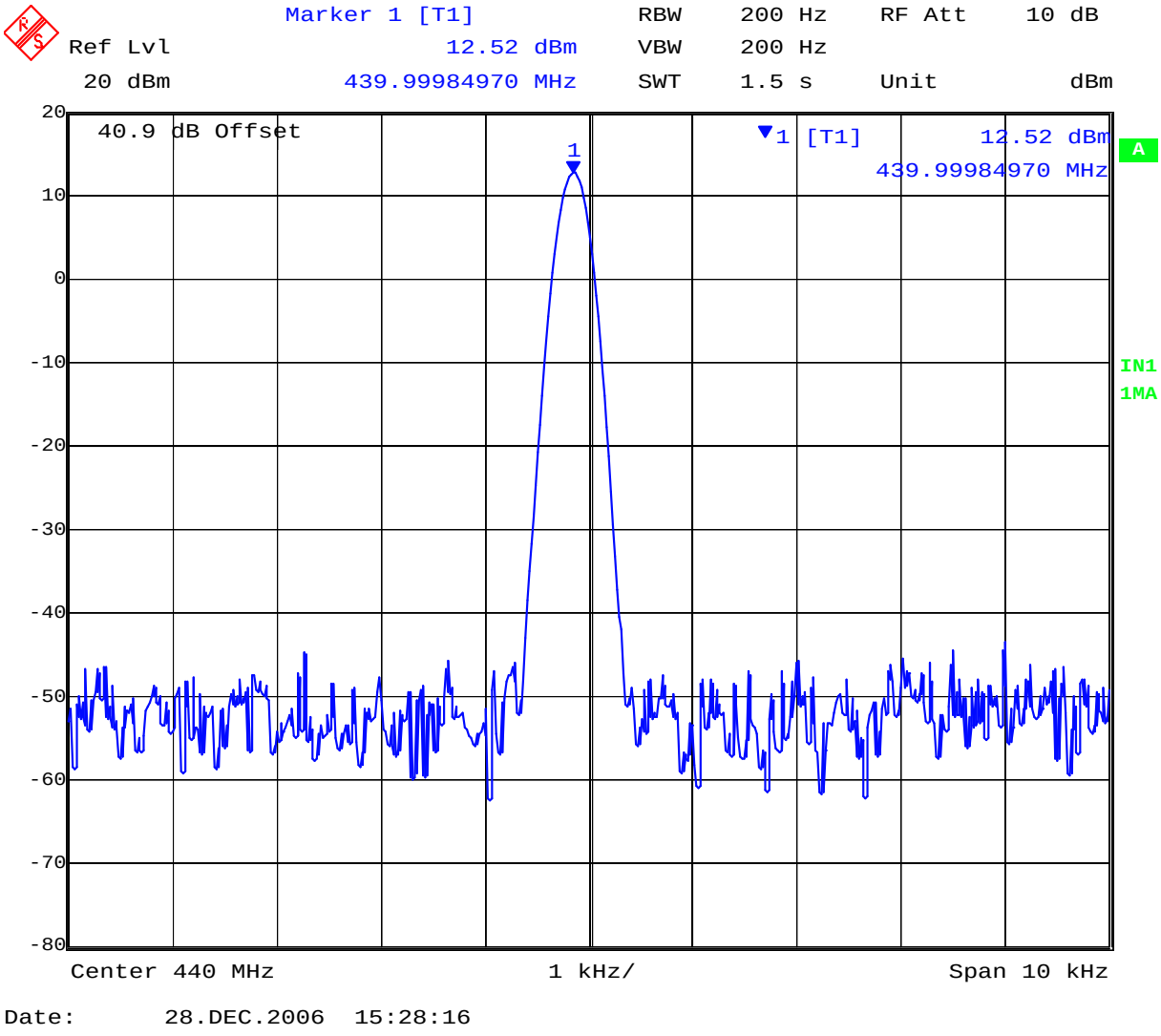
TABLE OF RESULTS

Temperature	Voltage	FREQUENCY (MHz)
		Channel 440 MHz
Ambient	+7.4 Vdc	440.00009018[2]
	+6.29 Vdc	439.99984970[1]
	+21.0 Vdc	439.99986974
-20°C	+7.4 Vdc	439.99986974
-10°C	+7.4 Vdc	439.99990982
+0°C	+7.4 Vdc	440.00001002
+10°C	+7.4 Vdc	440.00009018[2]
+20°C	+7.4 Vdc	440.00009018[2]
+30°C	+7.4 Vdc	440.00003006
+40°C	+7.4 Vdc	439.99998998
+50°C	+7.4 Vdc	439.99994990
Maximum Frequency Drift (±ppm)		-0.431/+0.205

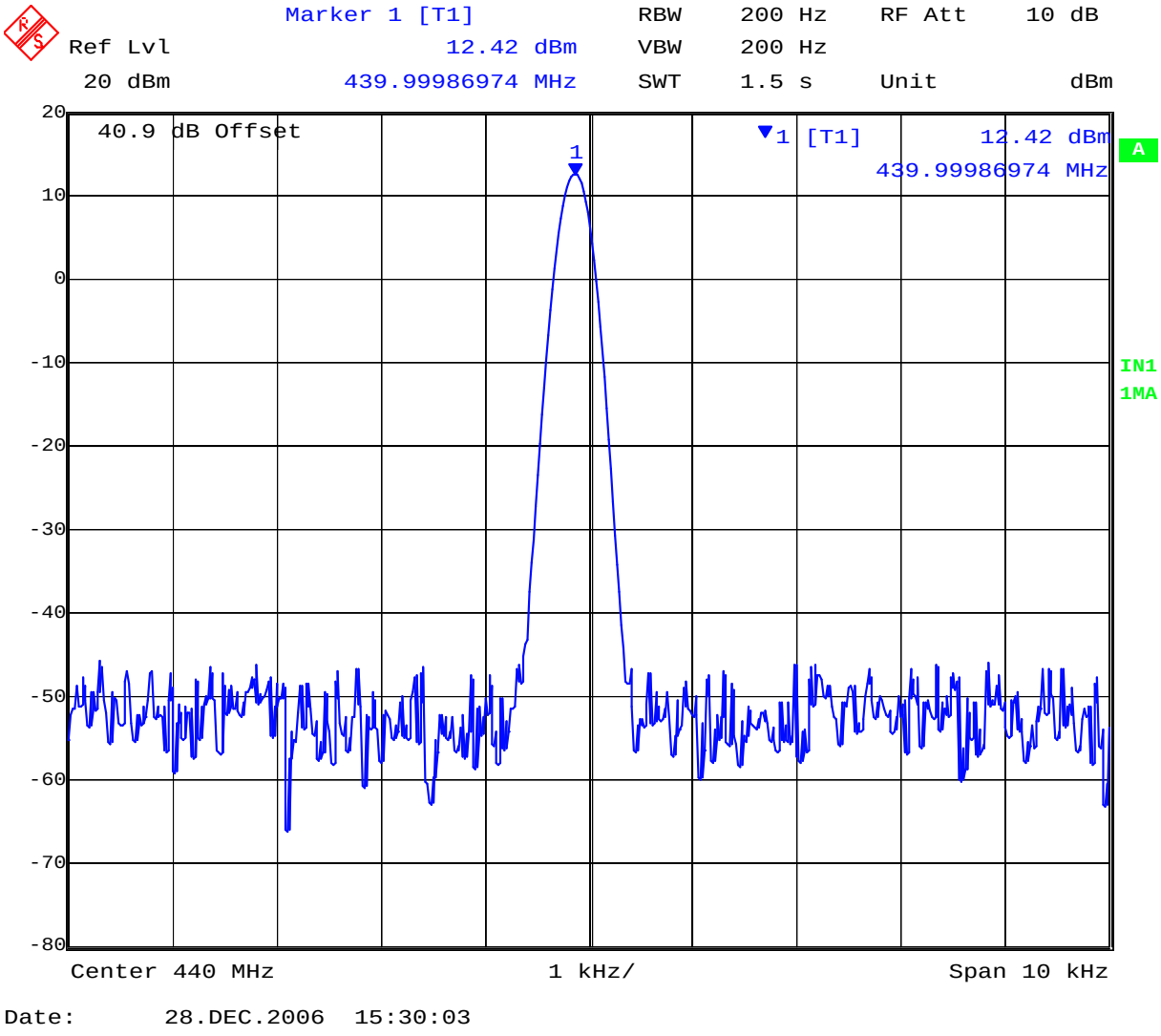
[1, 2] – MAXIMUM FREQUENCY DRIFT EXTREMES (UPPER & LOWER)



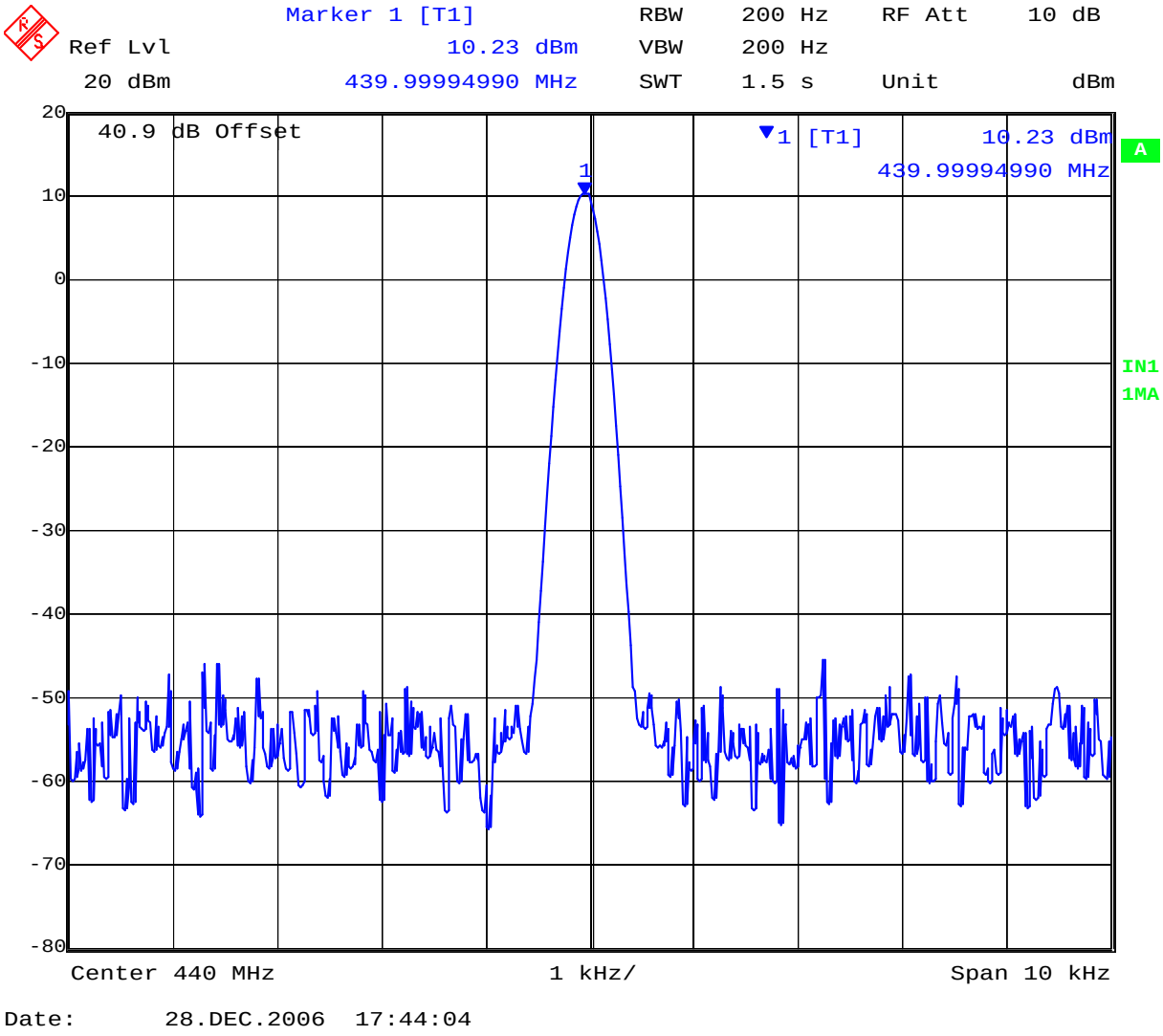
FREQUENCY STABILITY CHANNEL 440 MHz, Ambient 7.4 Vdc



FREQUENCY STABILITY CHANNEL 440 MHz, Ambient 6.29 Vdc



FREQUENCY STABILITY CHANNEL 440 MHz, -20C 7.4 Vdc



FREQUENCY STABILITY CHANNEL 440 MHz, +50C 7.4 Vdc

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.

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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'	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)

Antenna Gain (dBi)	Numeric Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Calculated safe distance @ max limit 1mW/ cm^2 (d=cm)
2.5	1.78	+28.15	653.13	9.62

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 = 5mW / 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. Conducted Spurious Emissions

5.1.5.1. Transmitter Spurious

FCC Part §90.210
Industry Canada RSS-210 §6.3

Test Procedure
Transmitter conducted emissions were measured for each channel spacing and modulation type. Measurement were made while EUT was operating un-modulated transmit mode of operation at the appropriate center frequency with limits calculated depending on channel spacing and transmit power. Emissions were measured to beyond the 10th harmonic of the fundamental. For measurements above 1GHz a high pass filter was utilized to remove the carrier.

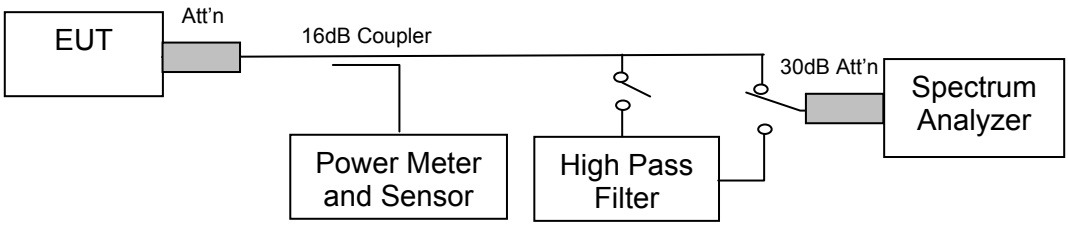
Lowest un-modulated power level = 30.53 dBm (worst case limit)

Limits
25 kHz Channel Spacing Attenuation Calculation
43 + 10*Log[30.53] = 57.85 dB
Limit = 30.53 – 57.85 = -27.32 dBm

12.5 kHz Channel Spacing Attenuation Calculation
50 + 10*Log[30.53] = 64.85 dB
Limit = 30.53 – 64.85 = -34.32 dBm

As spurious emissions were measured in the un-modulated transmit mode the tighter limit (-34.32 dBm) was used in order to prove compliance.

Test Measurement Set up

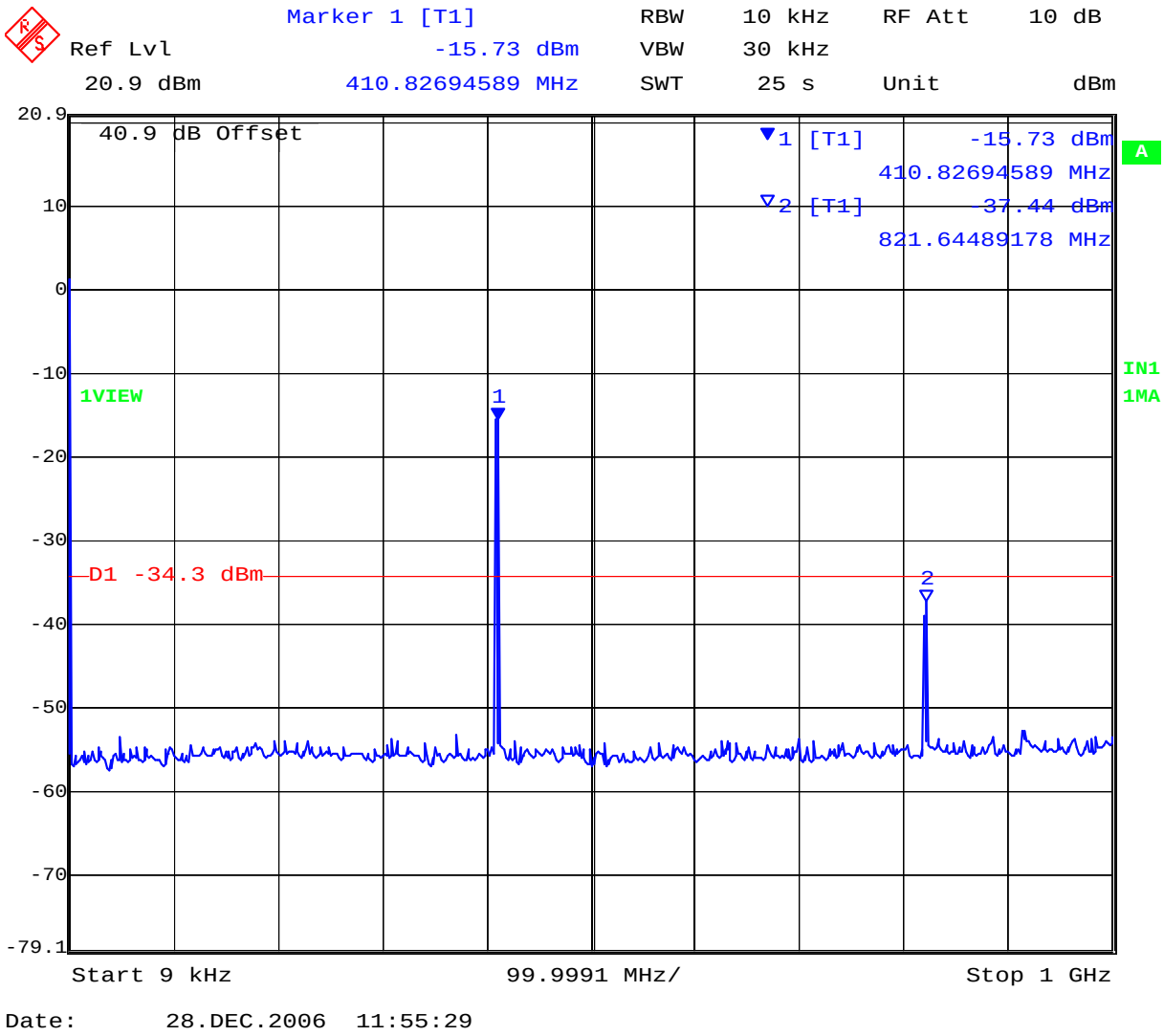


Conducted spurious emission test configuration (transmitter)

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

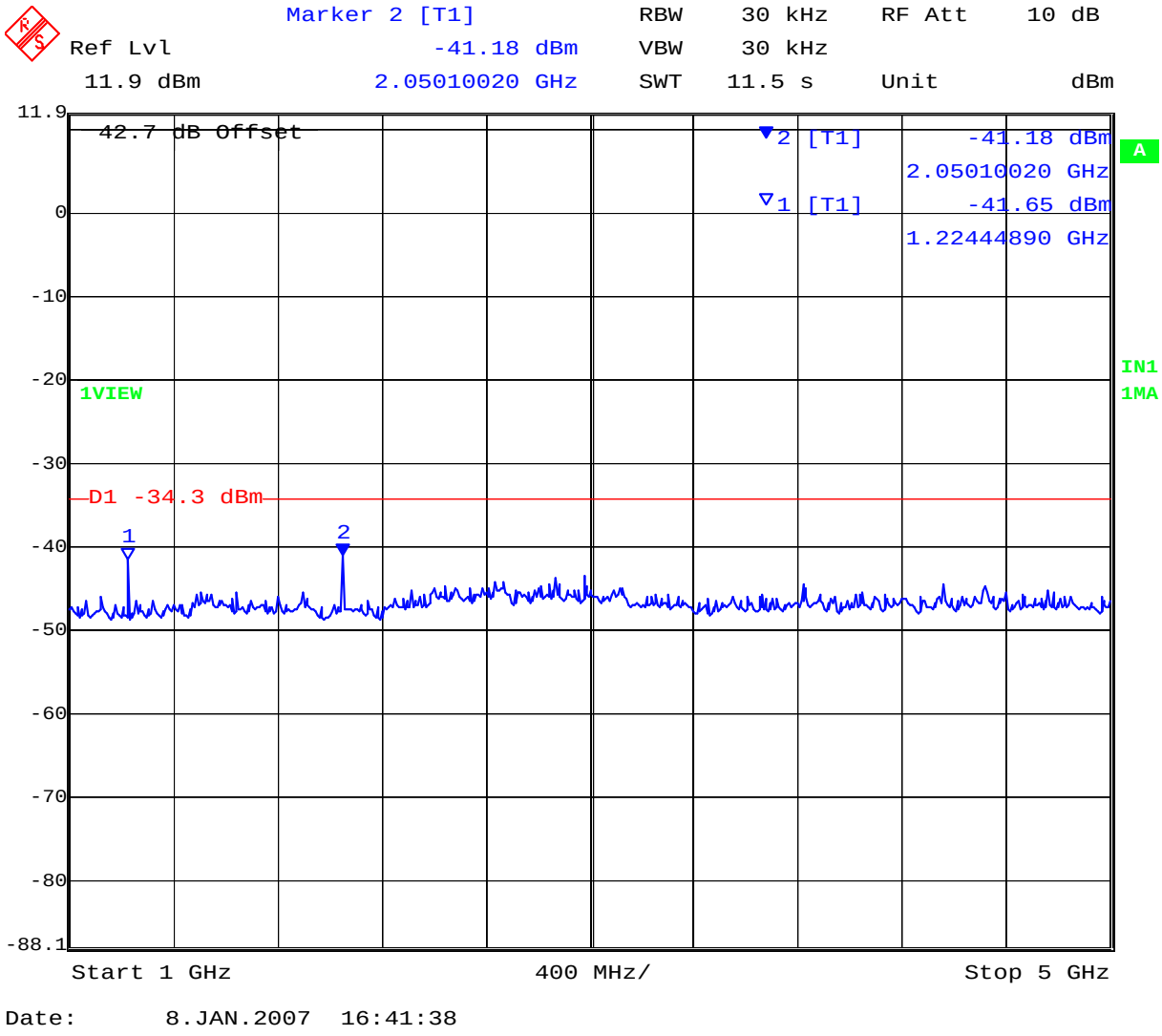
Channel Spacing: 12.5 & 25 kHz
Limit: -34.32 dBm

		Frequency (MHz)					
Channel (MHz)	**Modulation**	**Start**	**Stop**	**Maximum Emission**	**Emission Amplitude (dBm)**	**dBc**	**Margin (dB)**
410	CW	30	1,000	821.645	-37.44	67.97	-3.12
		1,000	5,000	1224.449	-41.18	71.71	-6.86
440	CW	30	1,000	881.765	-37.99	68.52	-3.67
		1,000	5,000	2643.287	-35.82	66.35	-1.50
470	CW	30	1,000	941.884	-38.13	68.66	-3.81
		1,000	5,000	2819.639	-37.79	68.32	-3.47

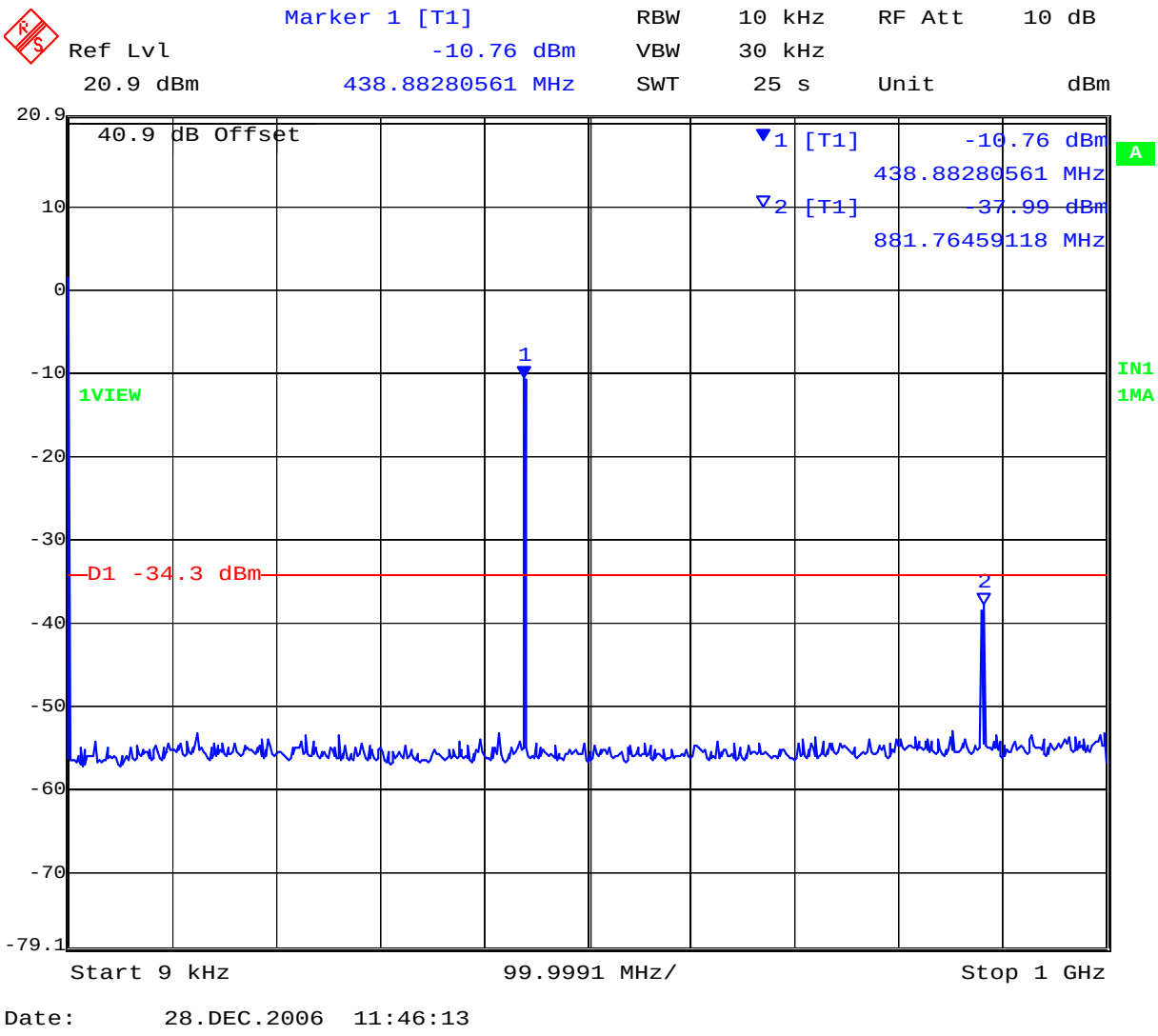


Spurious Emissions 410 MHz, 9kHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test

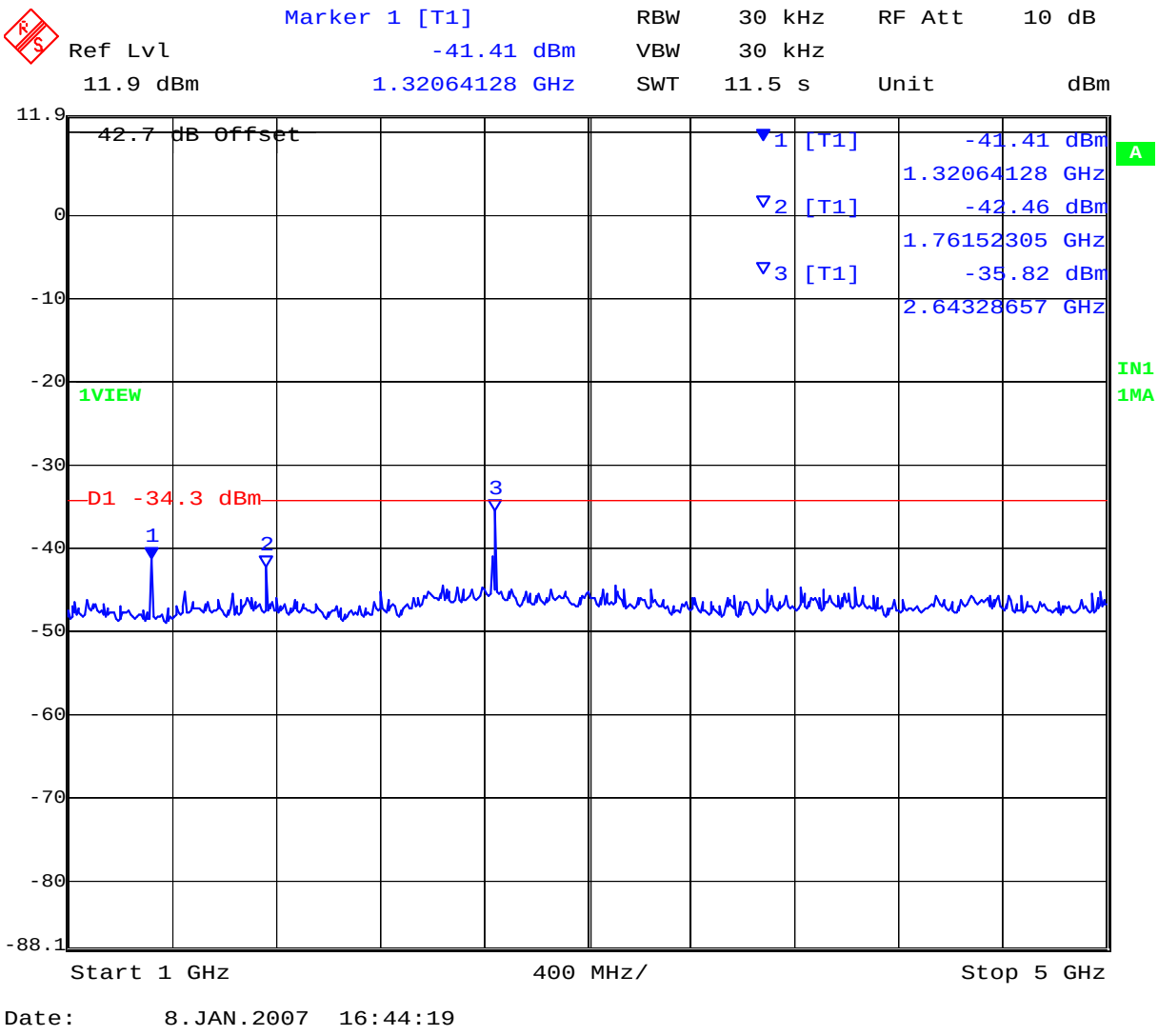


Spurious Emissions 410 MHz, 1 - 5 GHz

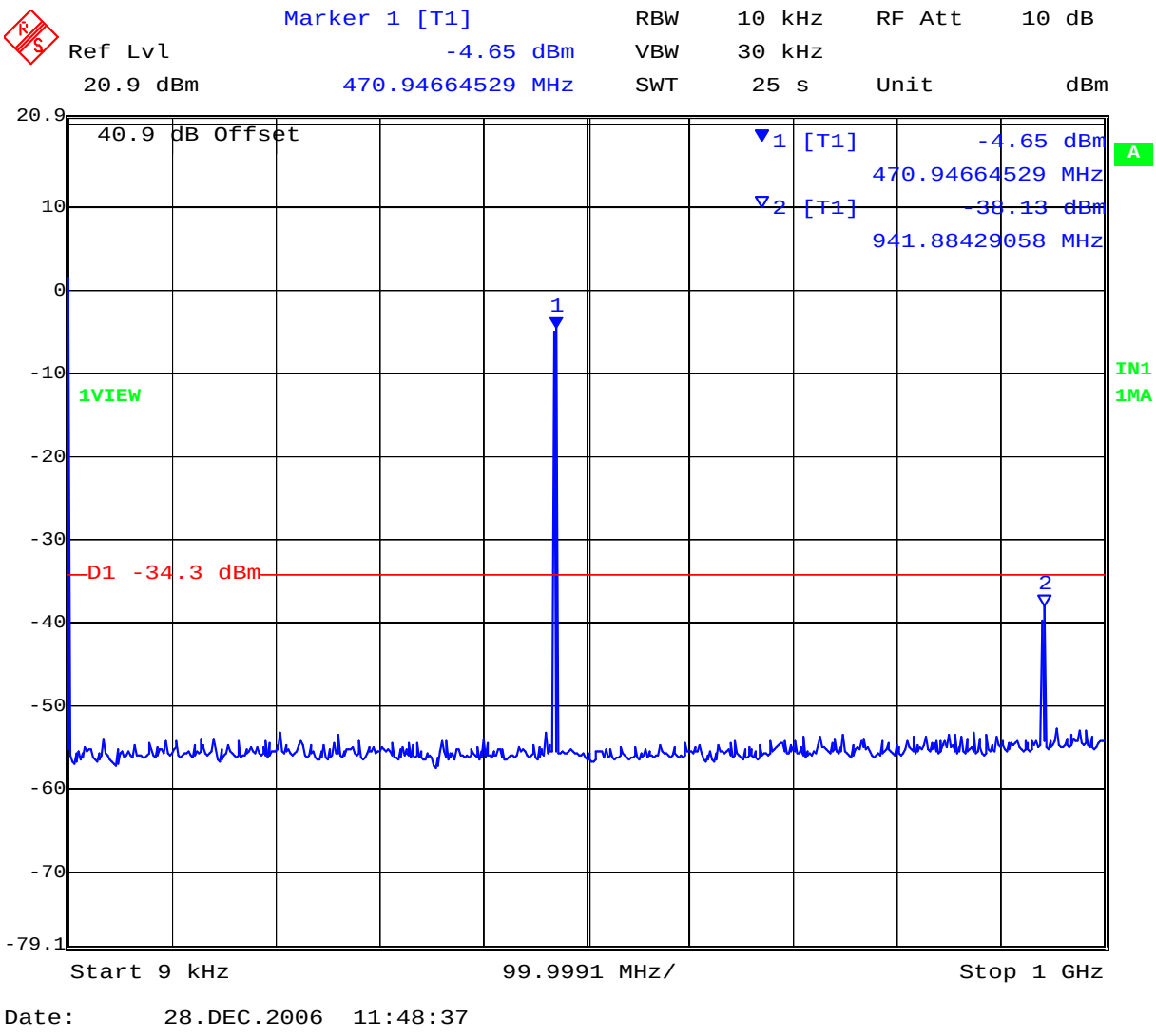


Spurious Emissions 440 MHz, 9kHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test

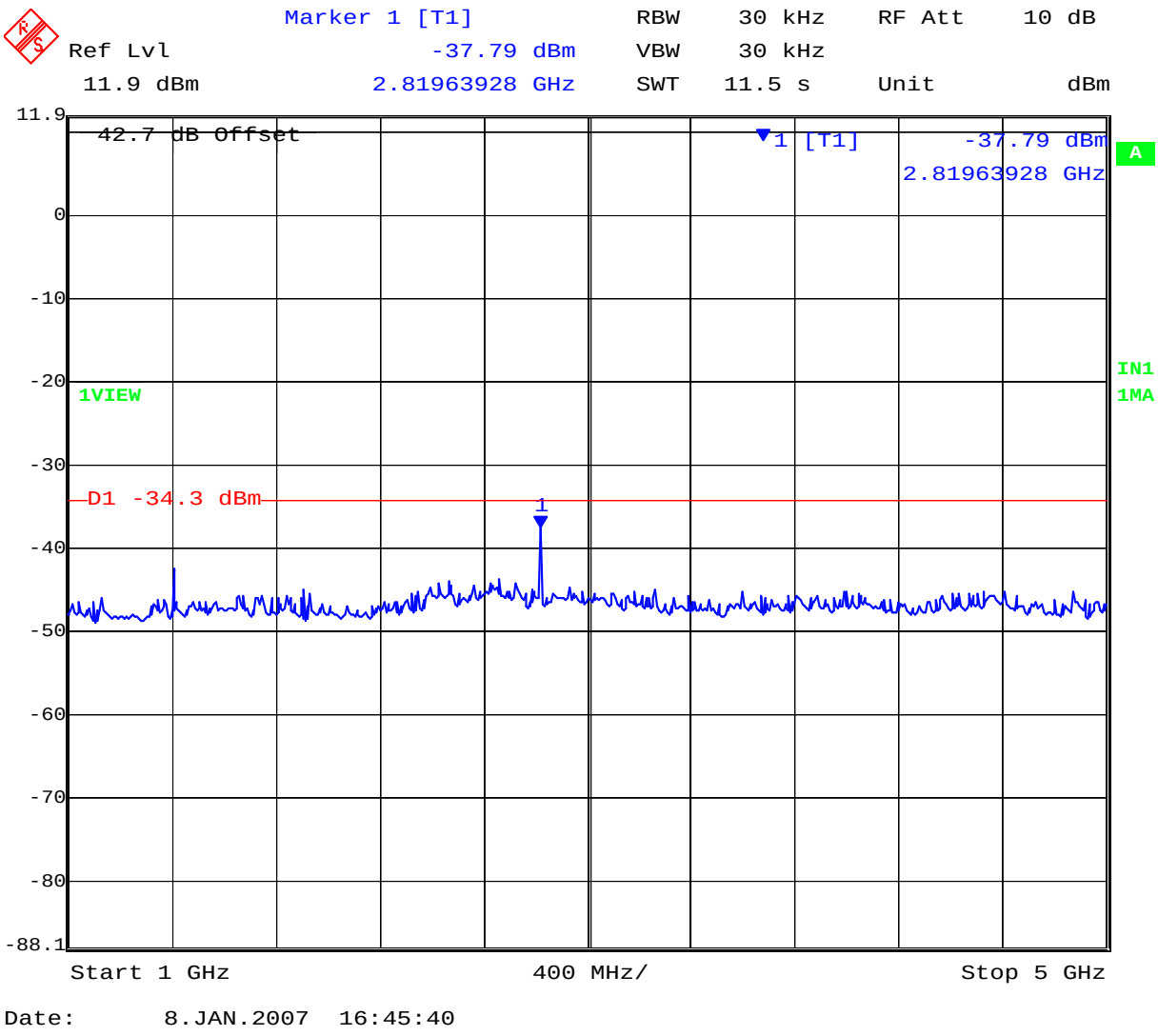


Spurious Emissions 440 MHz, 1 - 5 GHz



Spurious Emissions 470 MHz, 9kHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test



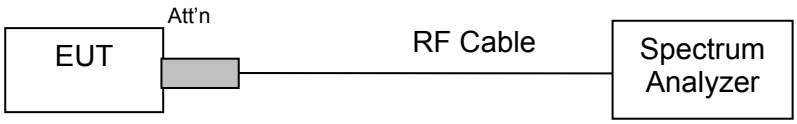
Spurious Emissions 470 MHz, 1 - 5 GHz

5.1.5.2. Receiver Spurious Emissions

Industry Canada RSS-210 §8

Test Procedure
Receiver conducted emissions were measured for each channel of interest. Emissions were measured to at least four times the local oscillator frequency.

Test Measurement Set up

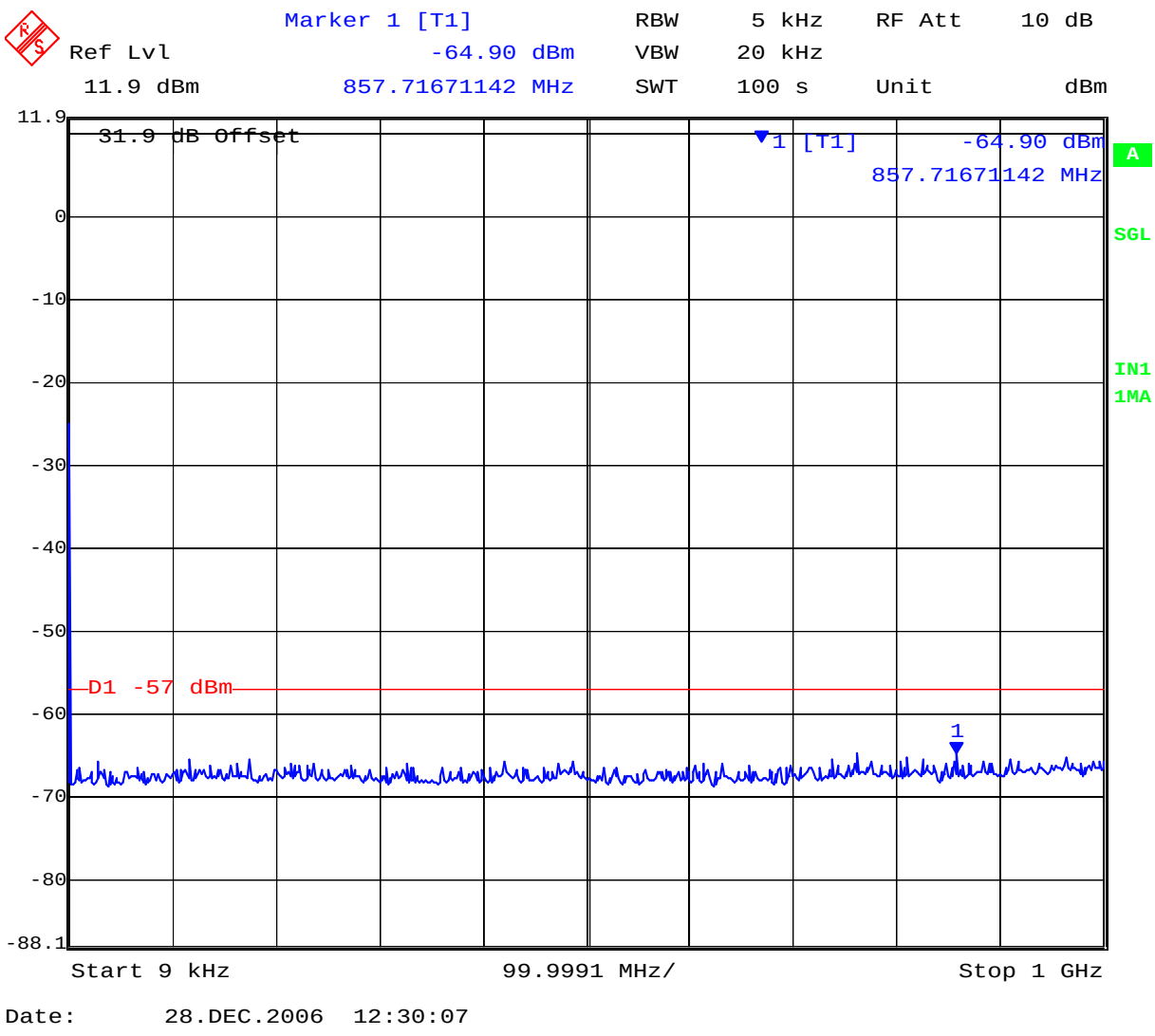


Conducted spurious emission test configuration (receiver)

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

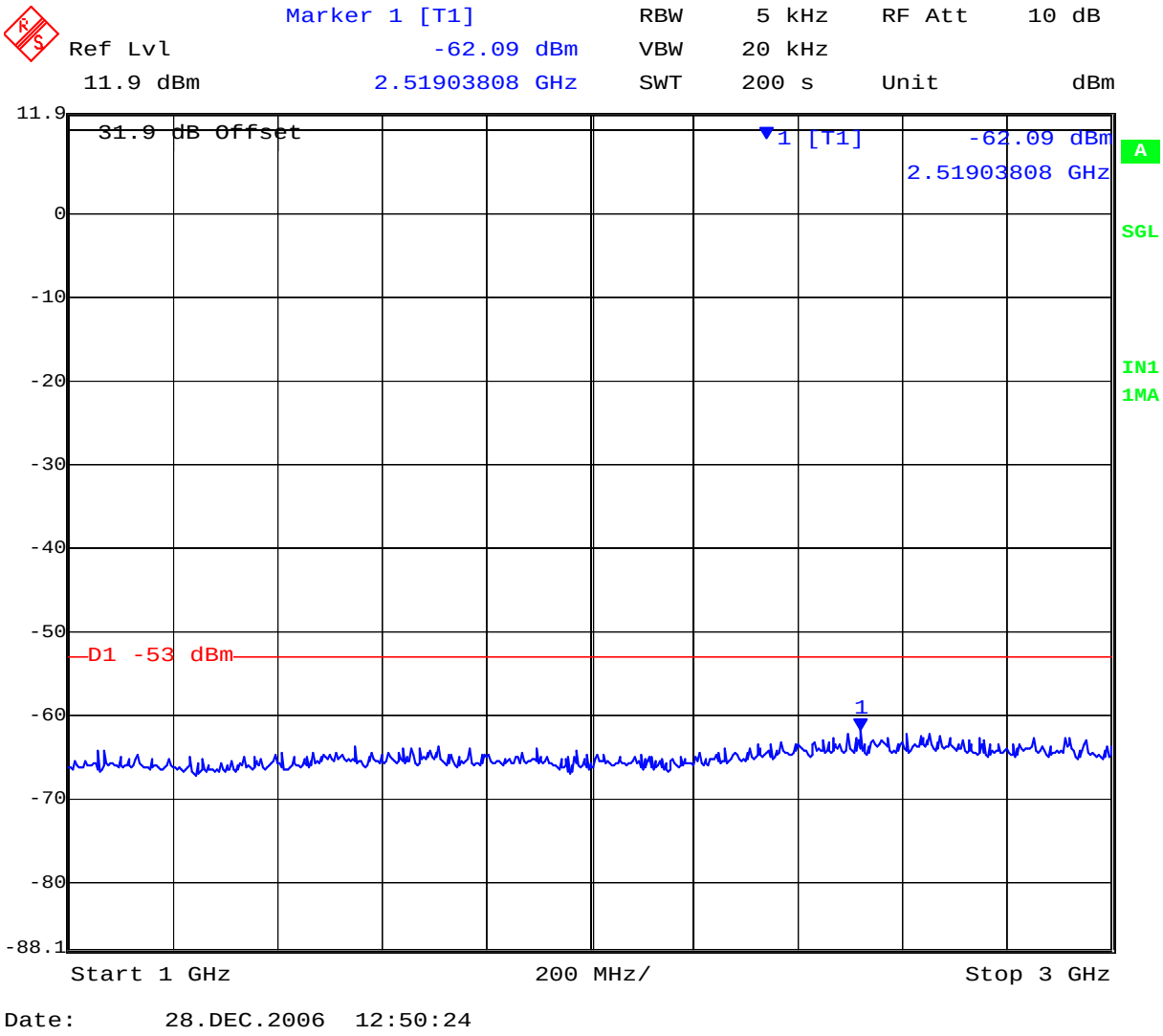
Channel Spacing: 12.5 & 25 kHz
Limit: 9 kHz – 1 GHz 2nW; >1 GHz 5 nW

Channel (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Emission Frequency (MHz)	Emission Amplitude (dBm)	Margin (dB)
410	0.009	1,000	No Emissions Observed		
	1,000	3,000	No Emissions Observed		
440	0.009	1,000	No Emissions Observed		
	1,000	3,000	No Emissions Observed		
470	0.009	1,000	No Emissions Observed		
	1,000	3,000	No Emissions Observed		

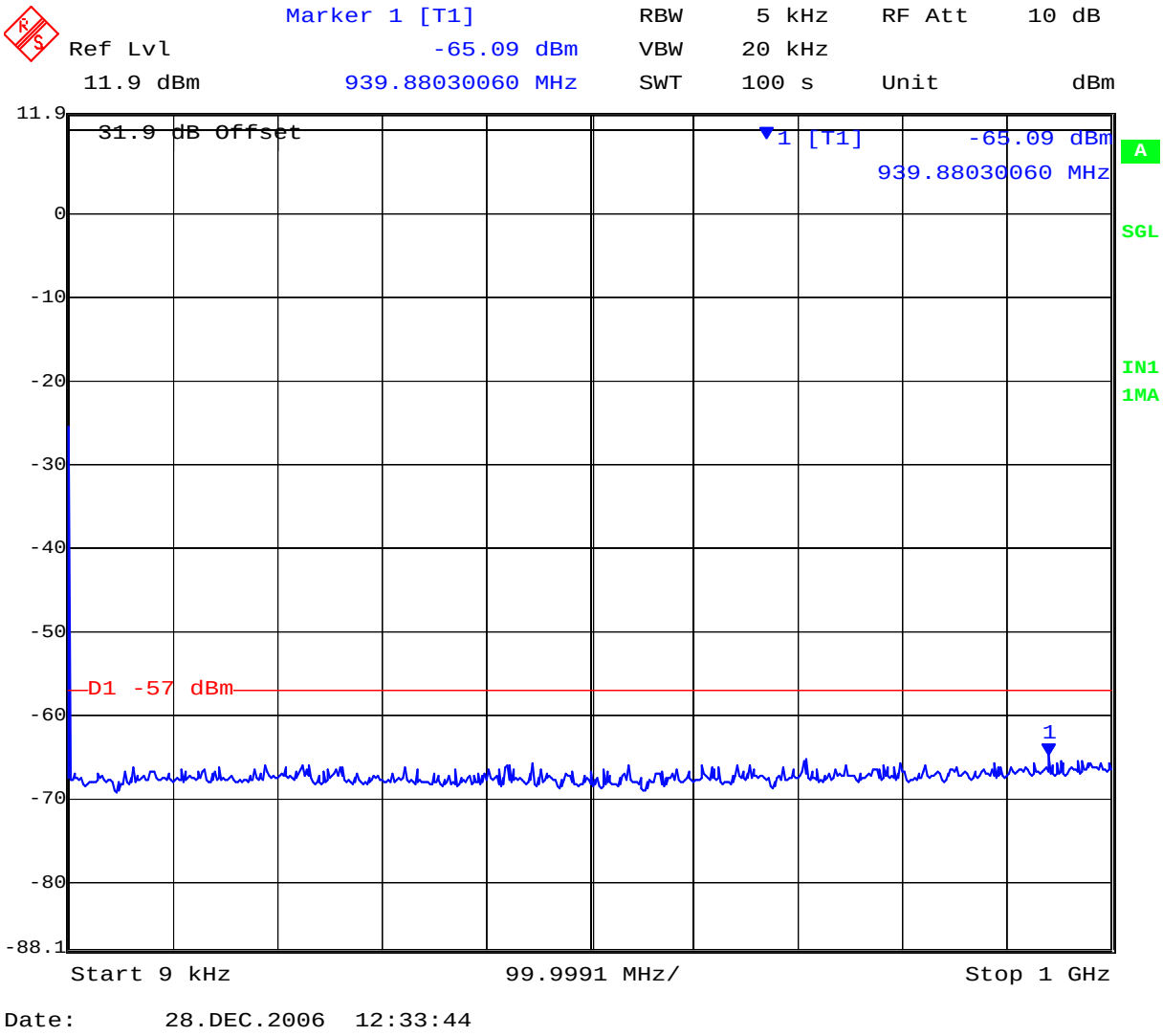


Receiver channel 410 MHz 9 kHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test

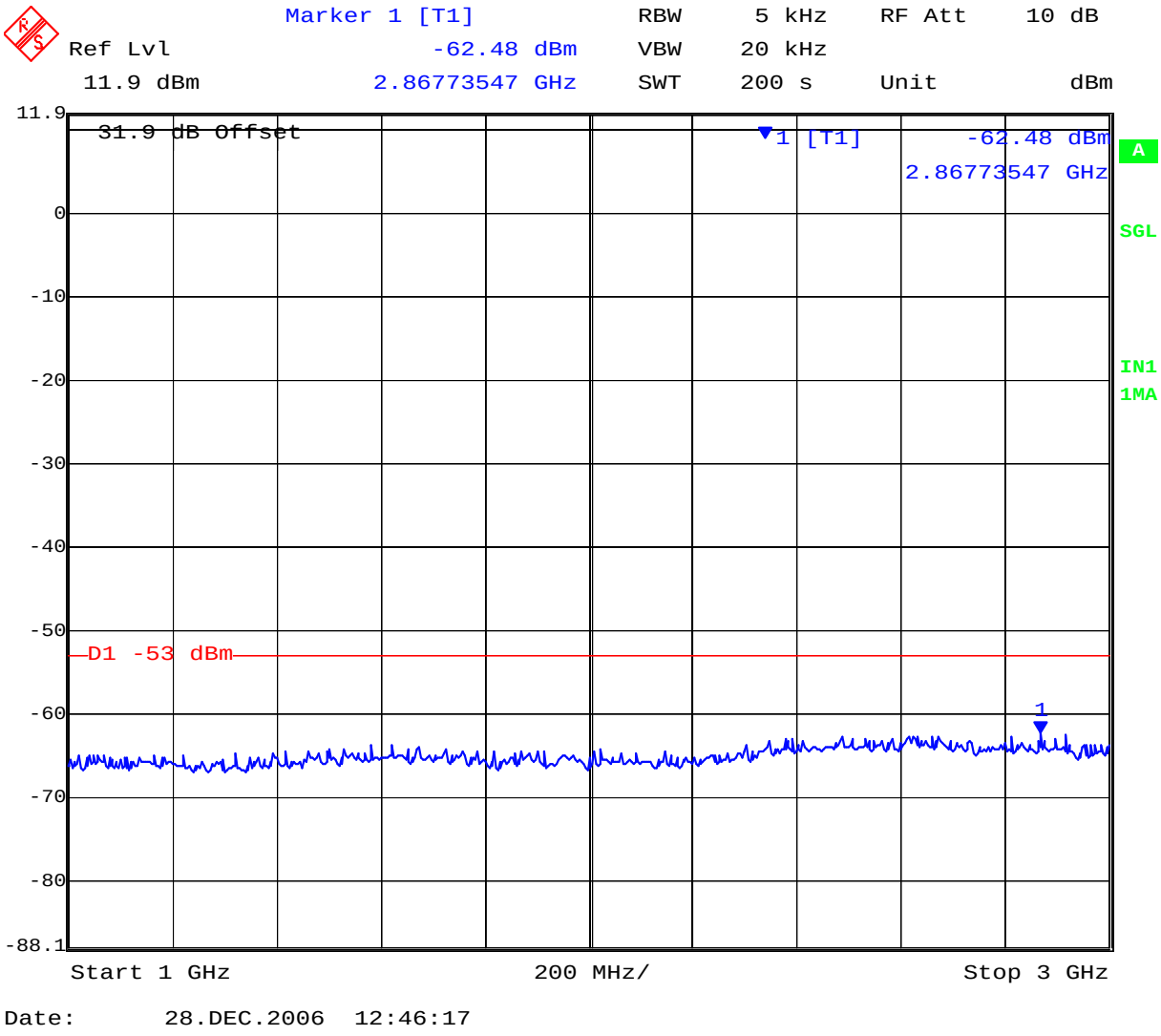


Receiver channel 410 MHz 1 - 3 GHz

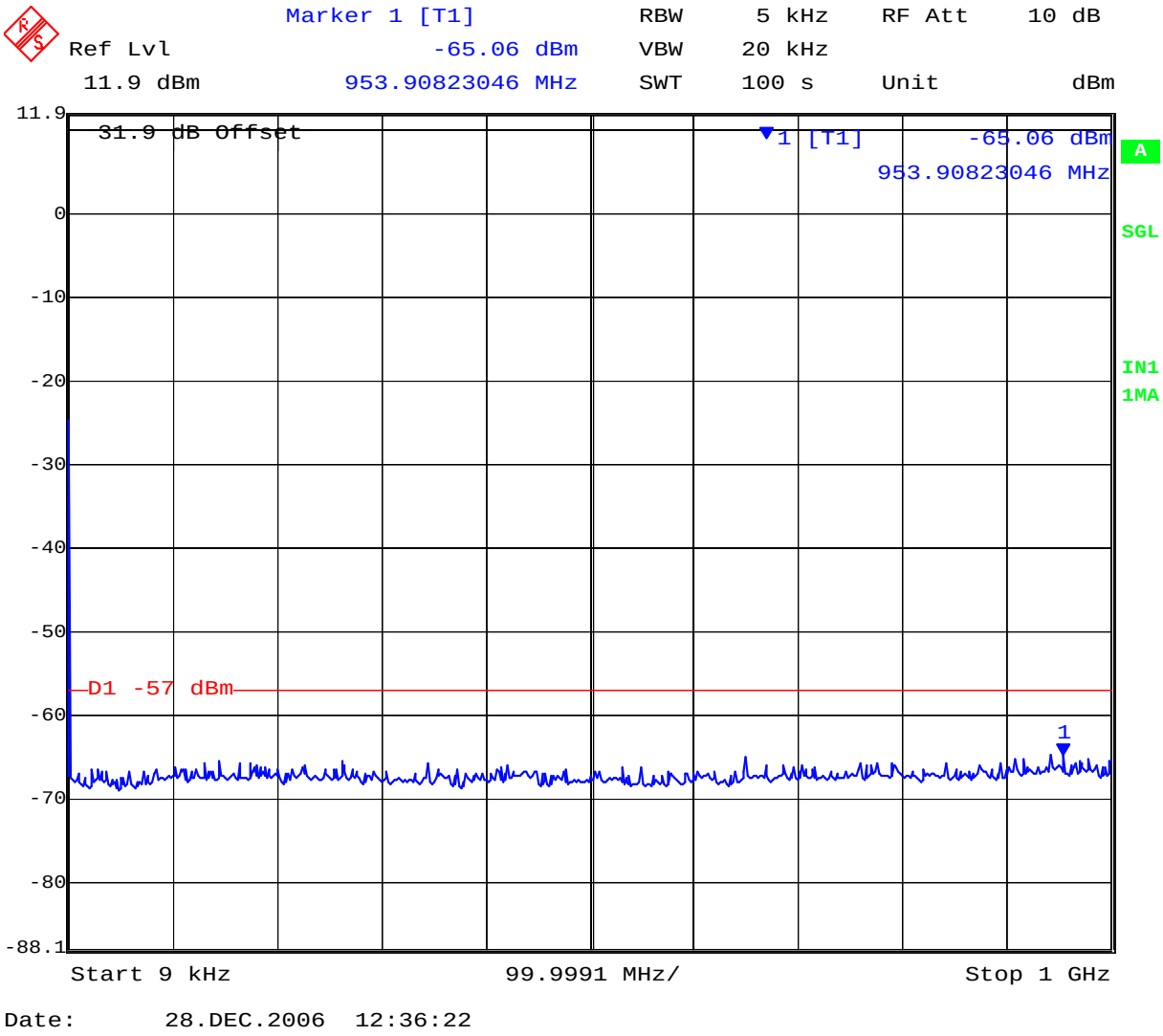


Receiver channel 440 MHz 30 MHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test

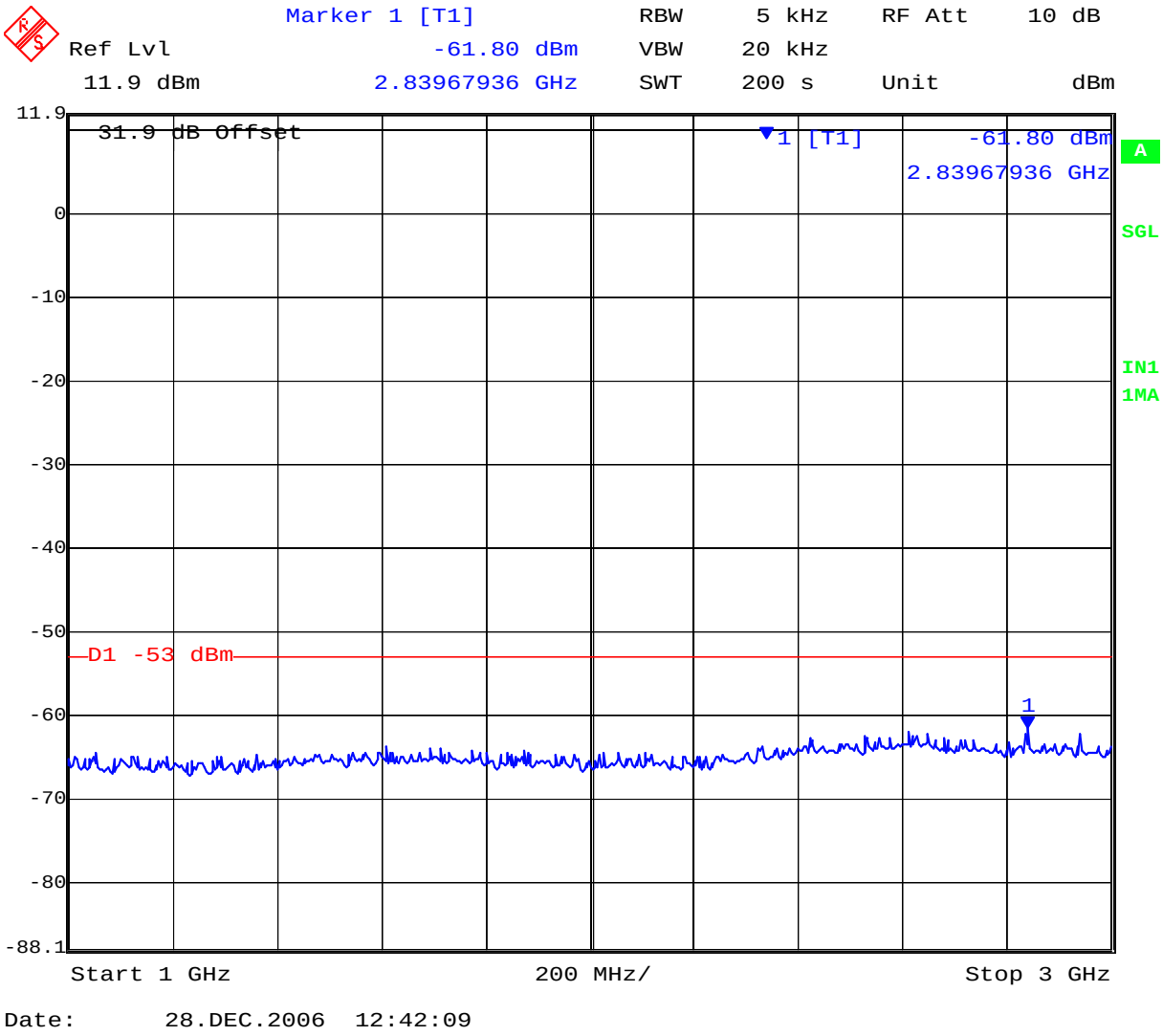


Receiver channel 440 MHz 1 - 3 GHz



Receiver channel 470 MHz 30 MHz – 1 GHz

*Note the large emission at 9 kHz is from the spectrum analyzer and not the equipment under test



Receiver channel 470 MHz 1 - 3 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) P = +33 dBm, Attenuation = 46 dB Limit = 33 - 46 = -13 dBm

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. P = +33 dBm, Attenuation = 53 dB Limit = 33 - 53 = -20 dBm

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. P = +33 dBm, Attenuation = 58 dB Limit = 33 - 58 = -25 dBm

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

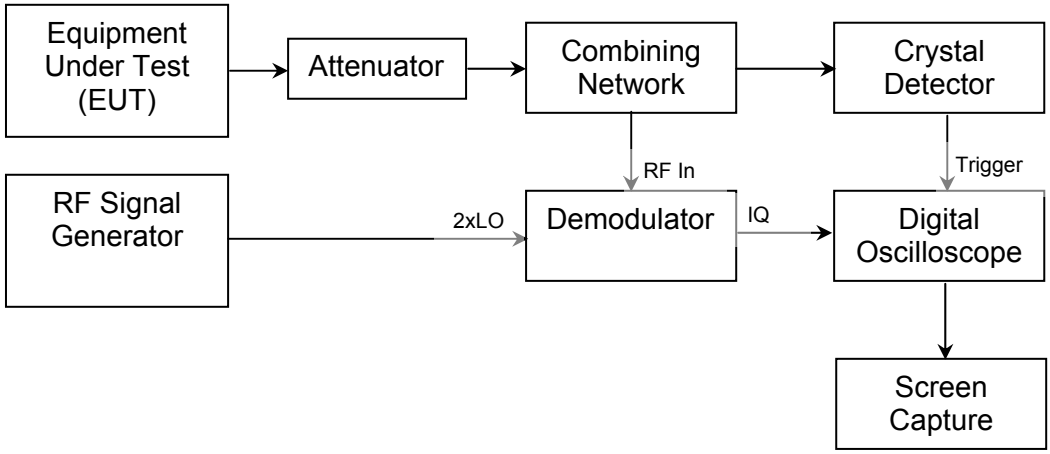
Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0158, 0193, 0252, 0313, 0314, HPF

5.1.6. 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 un-modulated 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

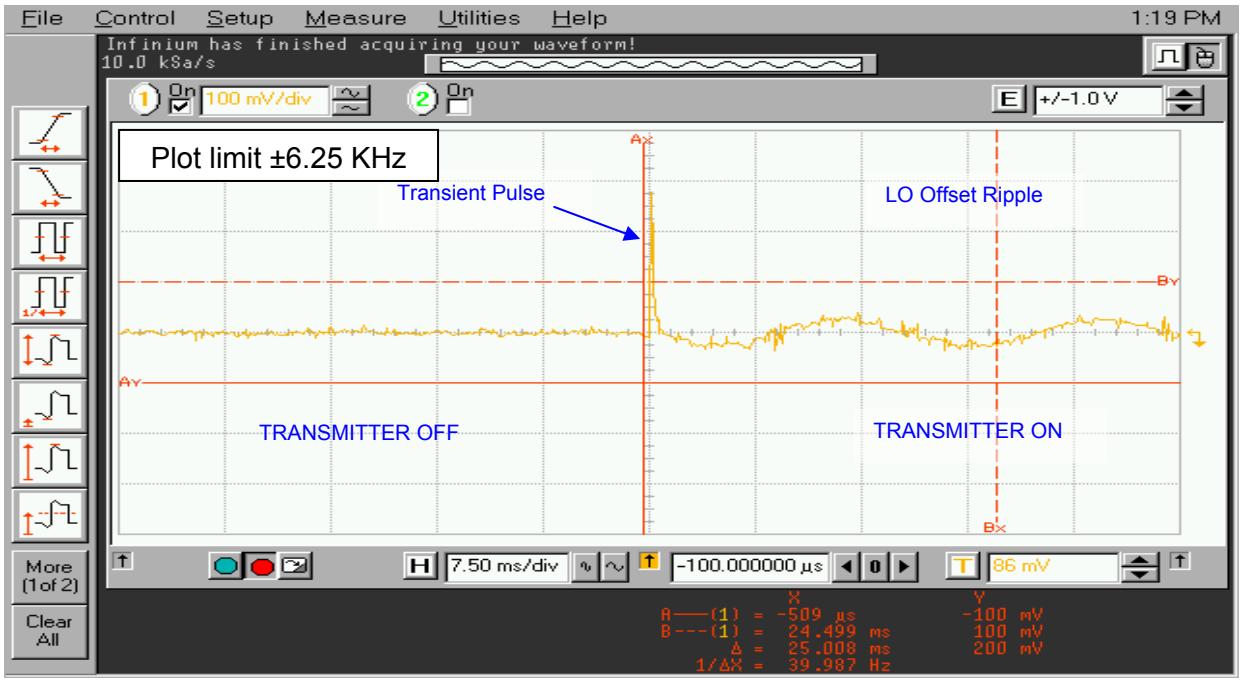
Summary of Circuit Operation
EUT output (CW Mode) was fed to the demodulator via an attenuator and combining network. EUT level at the demodulator was fixed at -40 dBm. The frequency of the RF signal generator was set to provide 2 * EUT fundamental frequency at a level of –10 dBm on the demodulator LO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

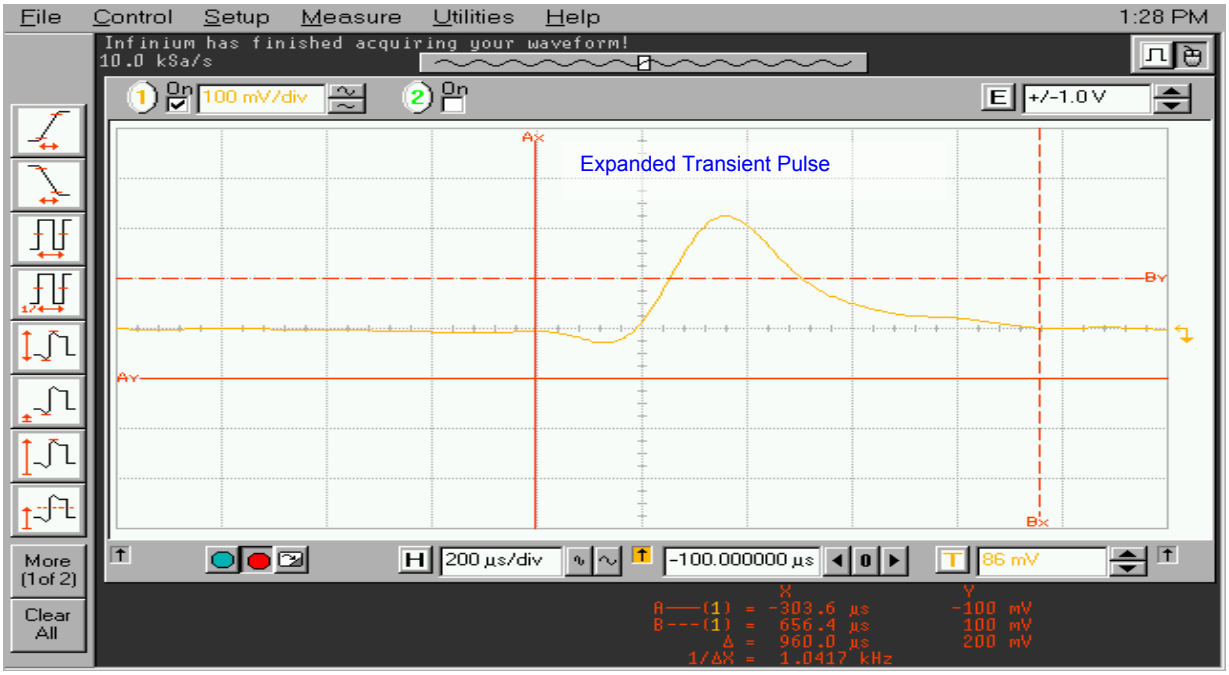
The oscilloscope was set to trigger when the transmitter was switched ON and the oscilloscope screen was captured electronically. This process was also repeated for the transmitter OFF condition.

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 26 °C Relative humidity: 31 to 57 % Pressure: 999 to 1009 mbar

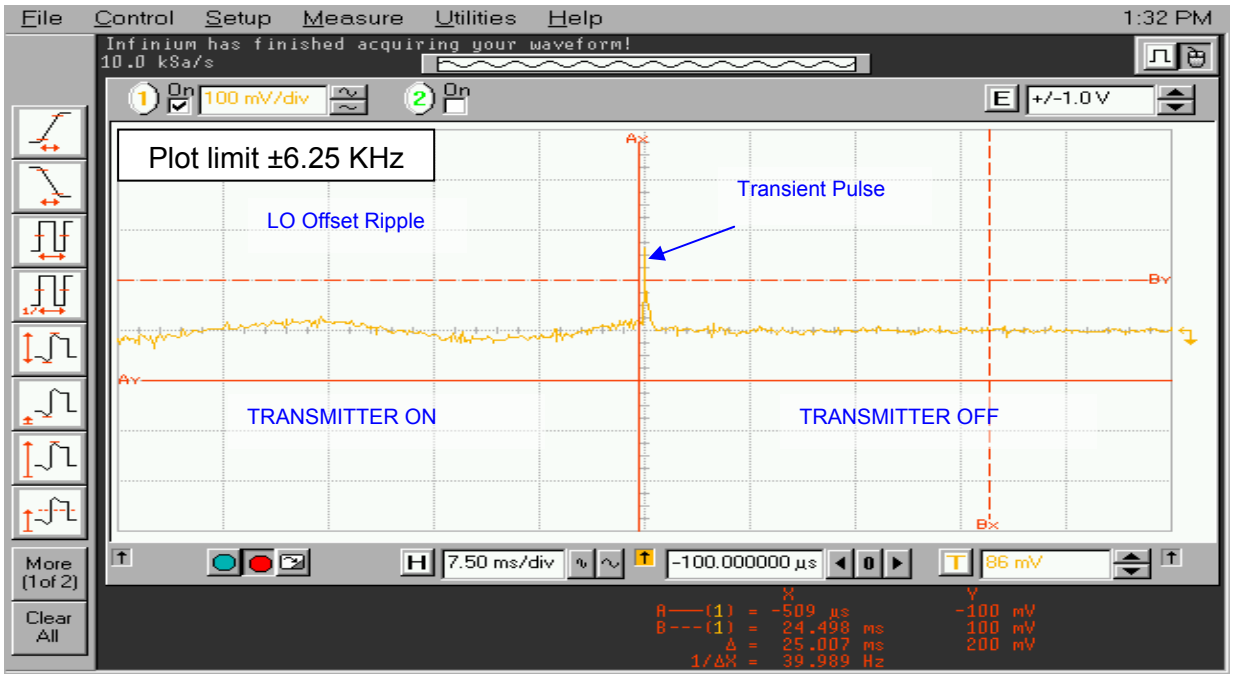
TRANSMITTER ON CONDITION – Plot limits ±6.25 KHz

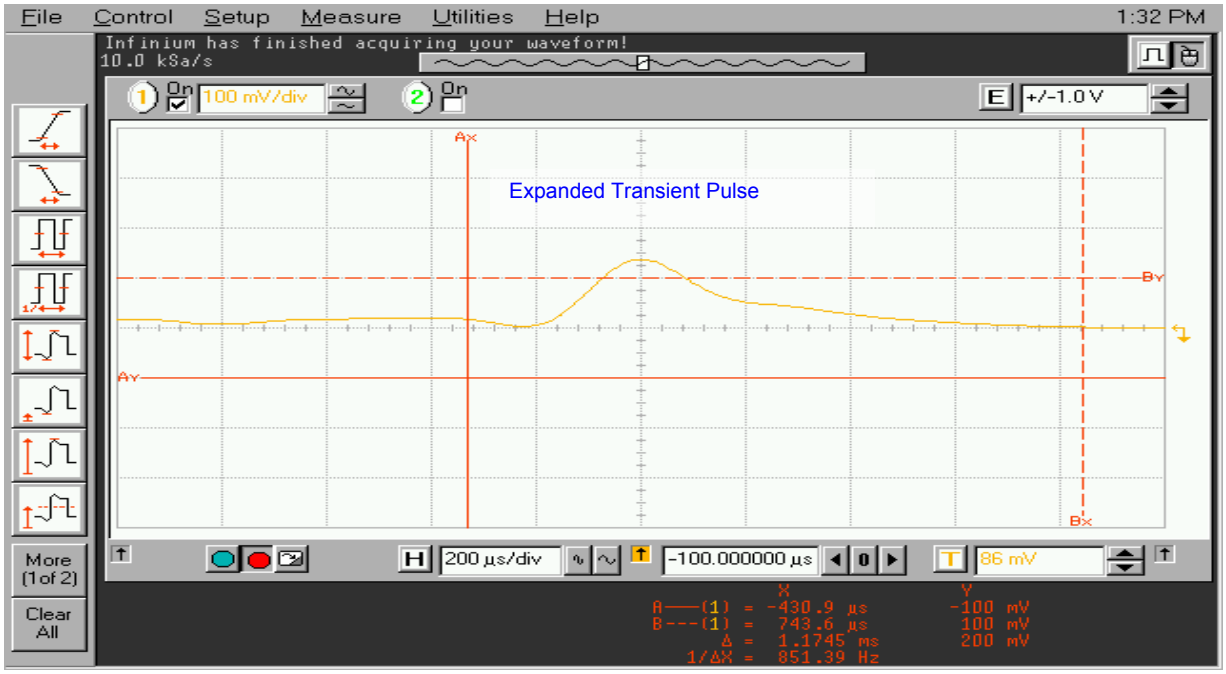




Pulse width of the transient pulse (approximately) 1mS = 1 kHz

TRANSMITTER OFF CONDITION – Plot limits ±6.25 KHz





Pulse width of the transient pulse OFF condition (approximately) 1.2mS = 0.83 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, 0158, 0252, 0307, 0310, 0312, 0313, 0314, 0278, Demodulator,

5.1.7. Unwanted Emissions

FCC, Part 15 Subpart C §15.247(c)
Industry Canada RSS-210 §6.3

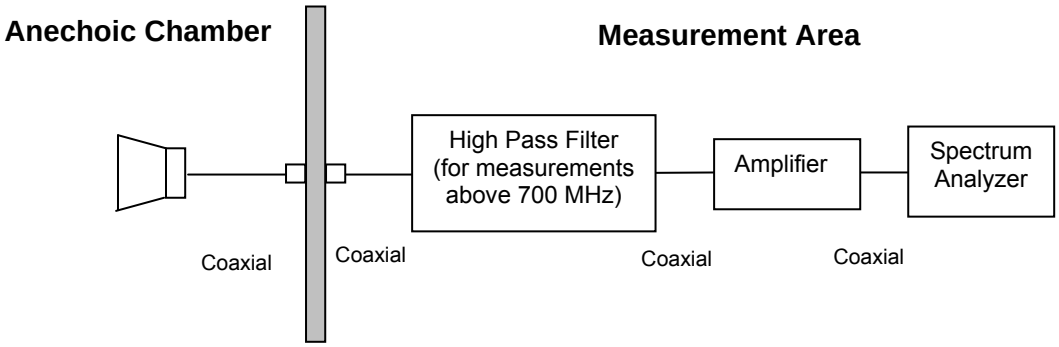
Test Procedure

Radiated emissions from 30 MHz to the 10th harmonic of the fundamental i.e. 5 GHz were measured in a CW operational mode. No antenna was installed during all measurements taken, the transmitter was terminated in 50 Ω. The measurement equipment was set to measure in peak hold mode. The total transmitter output power was measured and expressed in similar units. 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. Depending on the frequency band spanned a high pass filter was used to remove the fundamental frequency. 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.

The limit of -34.3 dBm was used in order to prove compliance, see Section 5.1.4 'Conducted Spurious Emissions' for calculation of limits.

Test Measurement Set up



Measurement set up for Radiated Emission Test

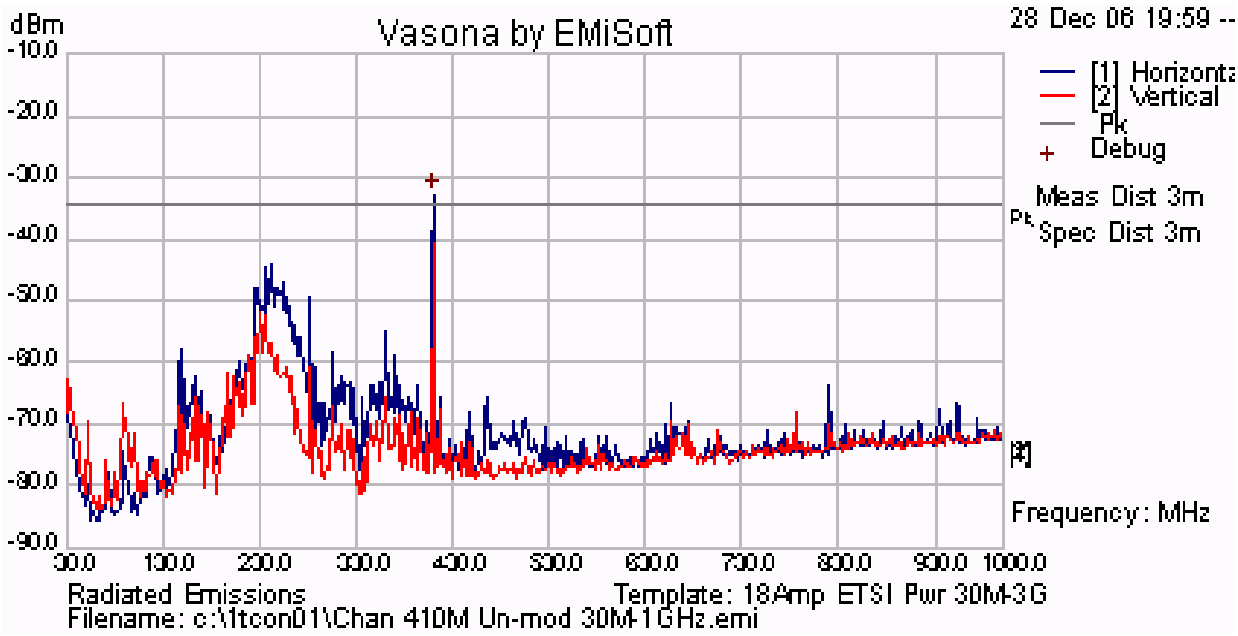
Unwanted Emission Limits;

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) P = +33 dBm, Attenuation = 46 dB

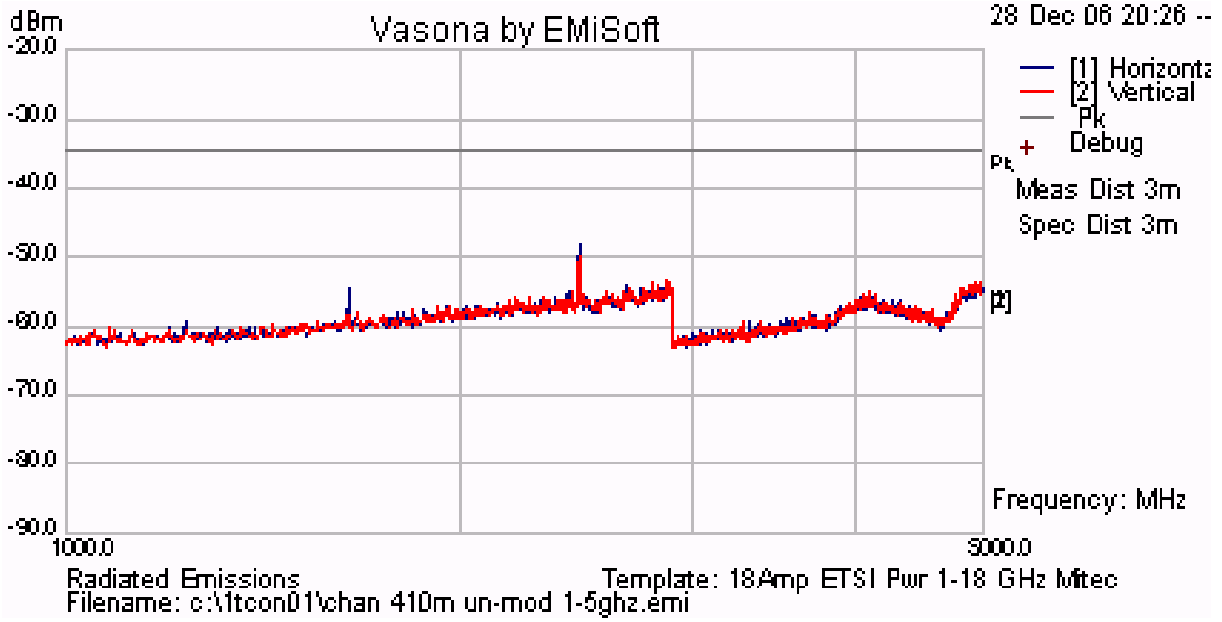
12.5 kHz Channel Spacing: Emission Mask D
On any frequency removed from the carrier frequency by a displacement frequency of than 12.5 kHz: At least 50 + 10 Log_{10} (P) or 70 dB, whichever is the lesser attenuation. P = +33 dBm, Attenuation = 53 dB

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. P = +33 dBm, Attenuation = 58 dB

Channel 410 MHz

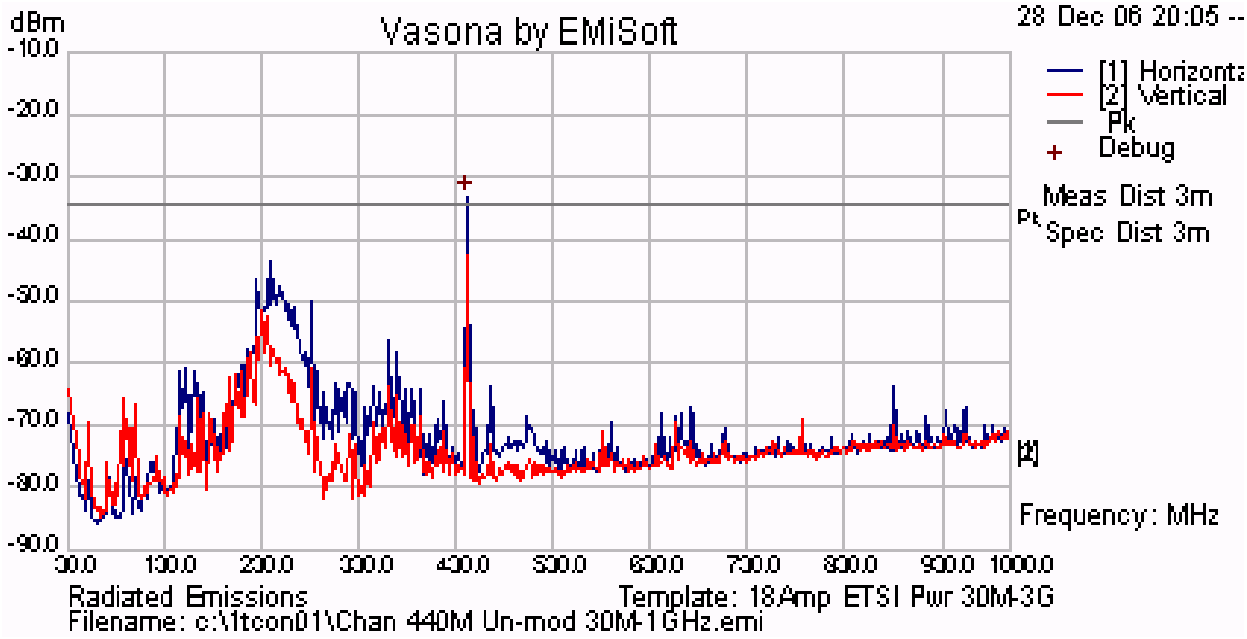


*Note – The emission breaking the limit line is the carrier at 410 MHz

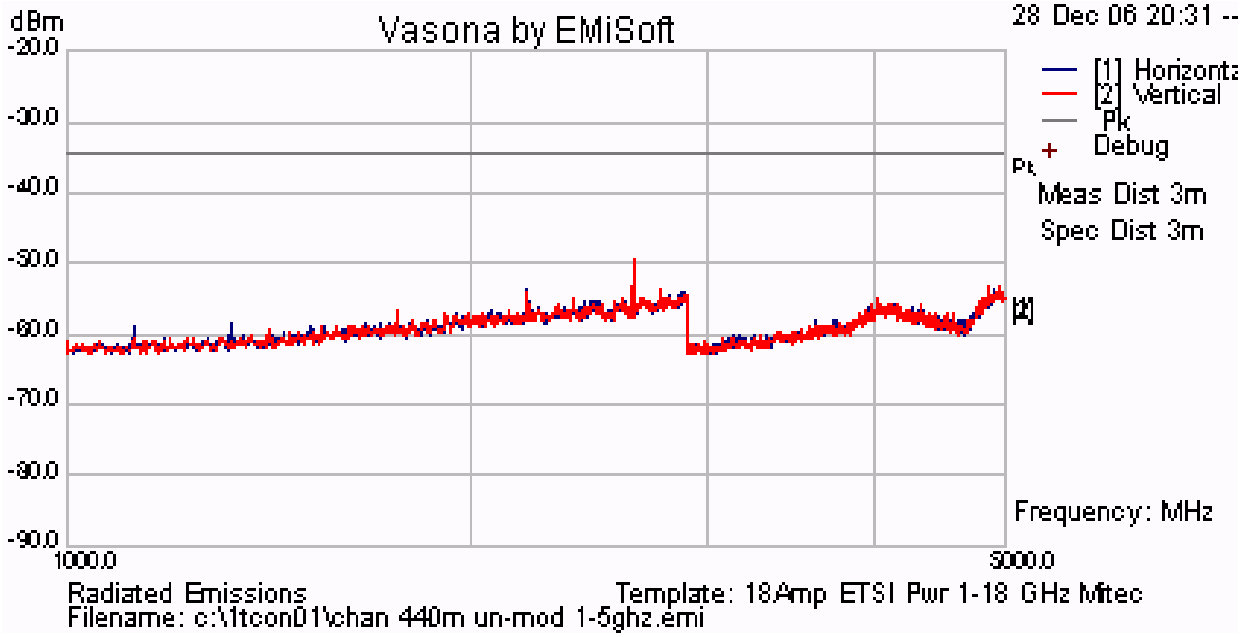


No emissions found within 6 dB of the limit

Channel 440 MHz

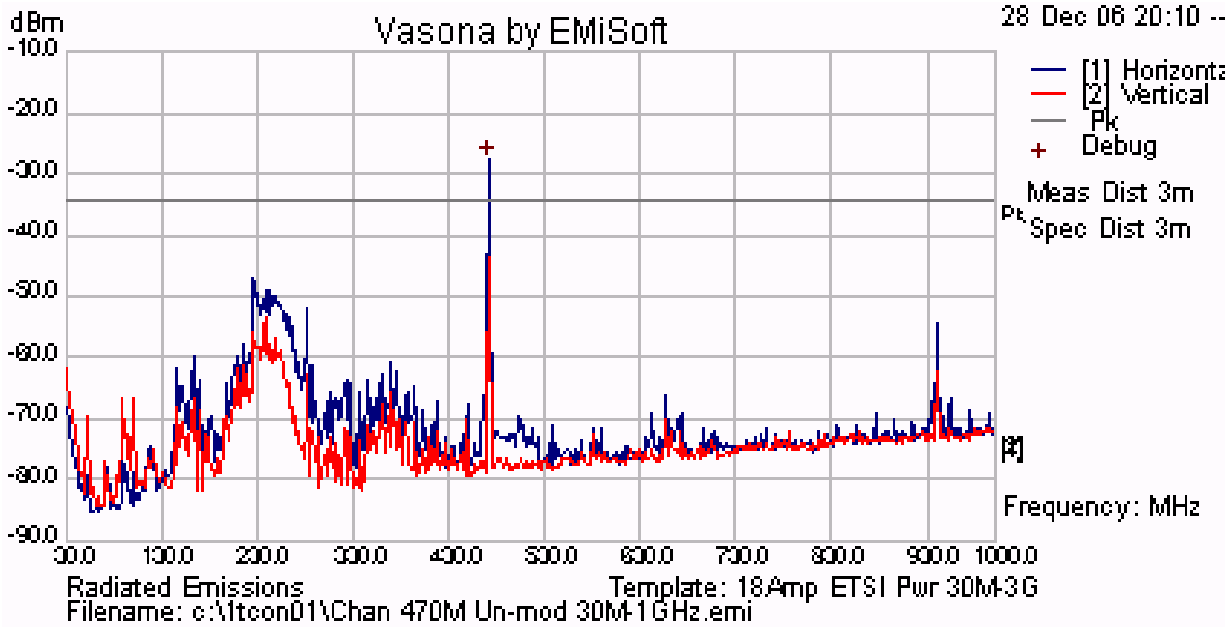


*Note – The emission breaking the limit line is the carrier at 440 MHz

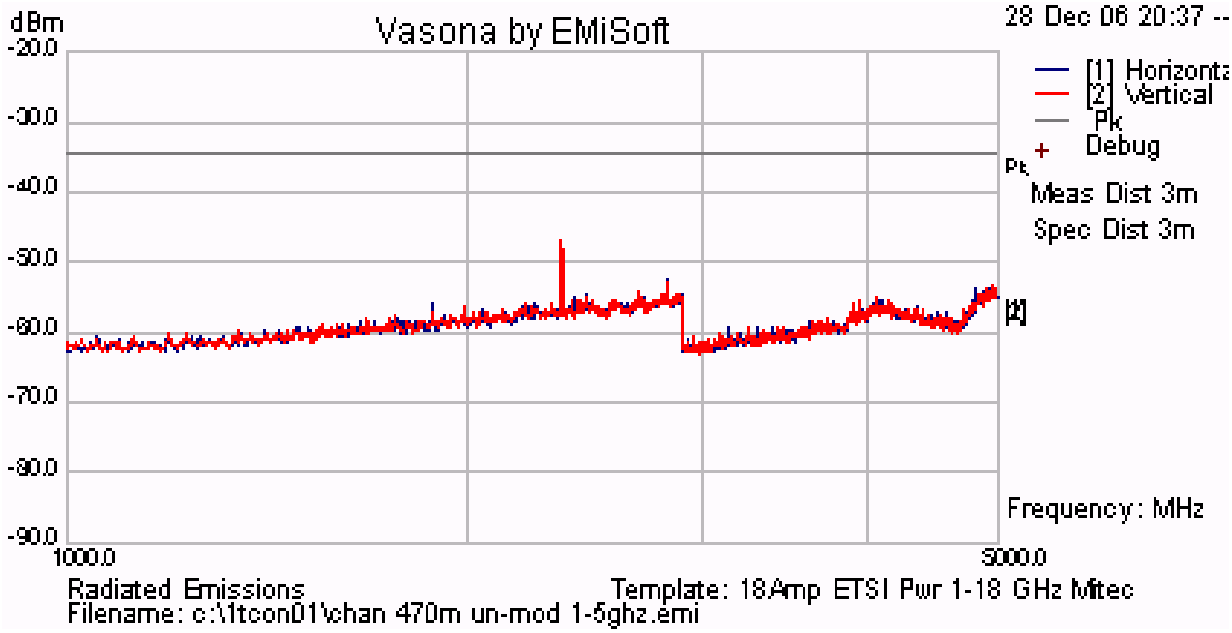


No emissions found within 6 dB of the limit

Channel 440 MHz



*Note – The emission breaking the limit line is the carrier at 440 MHz



No emissions found within 6 dB of the limit

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, 0158, 0134, 0193, 0305, 0310, 0311, 0312, 0104

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

FCC, Part 2.1033 (8)

Test Procedure
The dc voltage and current to the final amplifier stage of the radio at ambient temperature is as follows;

TABLE OF RESULTS

Final Stage Power	dc Voltage	Current (Amps)	Power (Watts)
Up to +26 dBm	+3.3	0.35	1.155
+26 to +30 dBm	+3.6	0.50	1.800

Limits

FCC, Part 2.1033 (8)

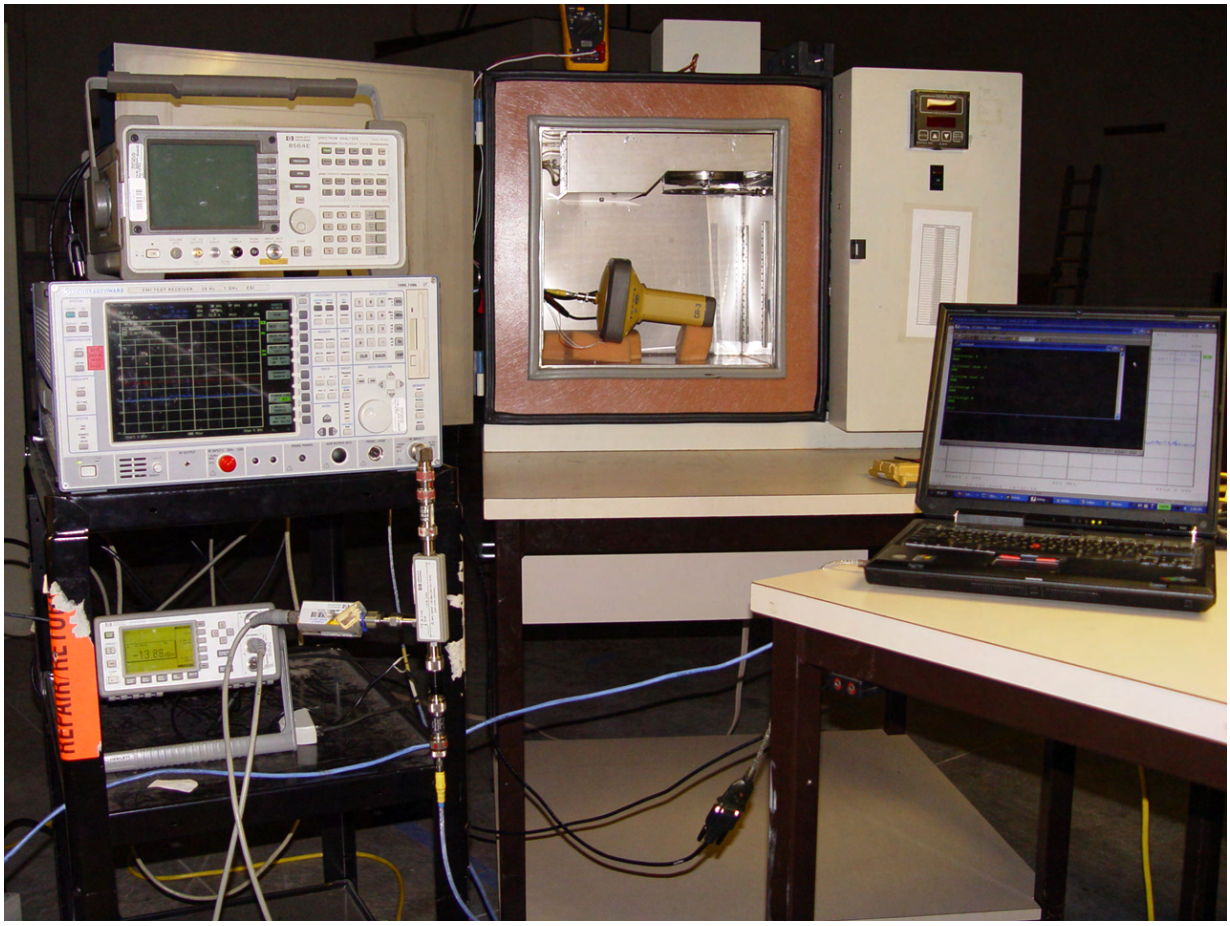
NONE

Traceability

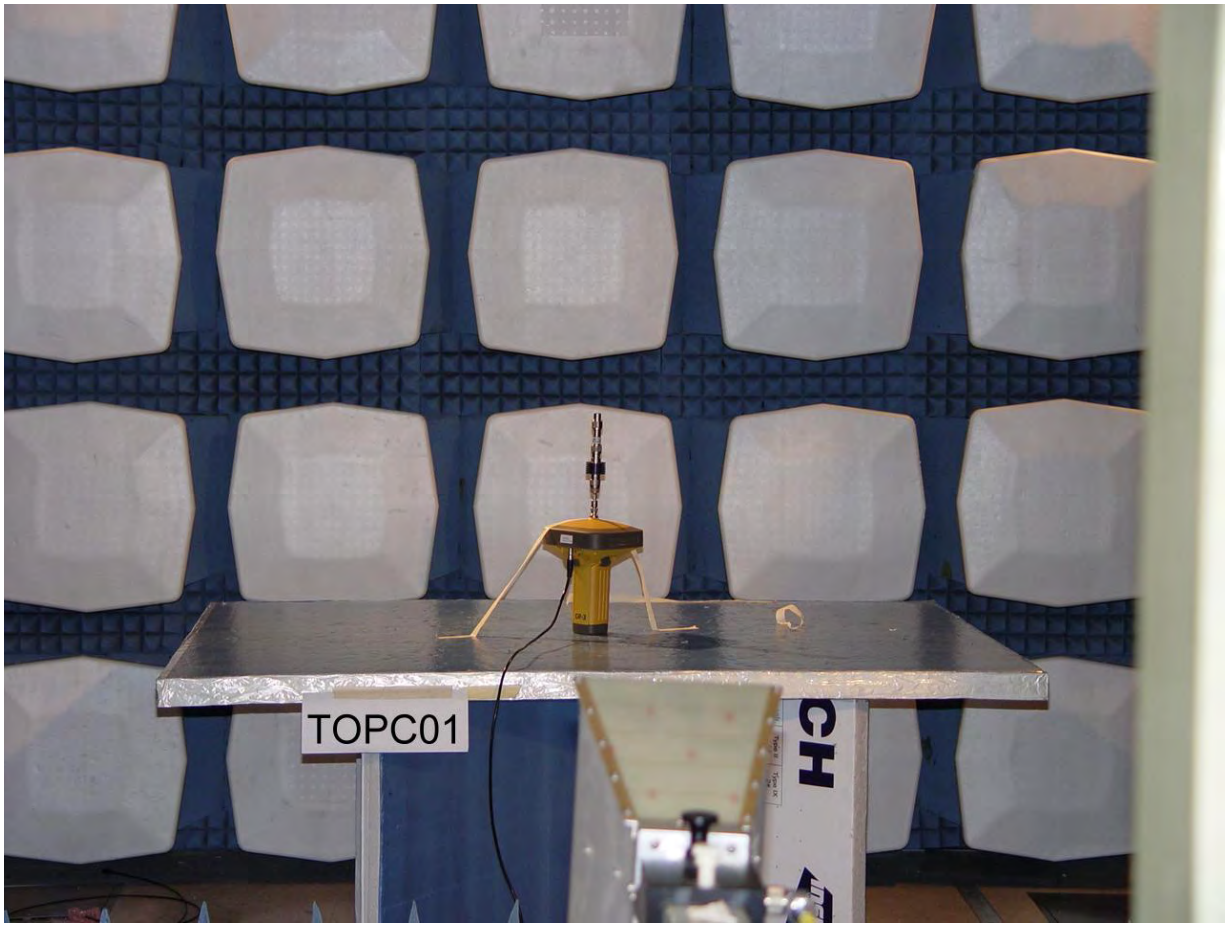
Test Equipment Used
0073

6. TEST SET-UP PHOTOGRAPHS

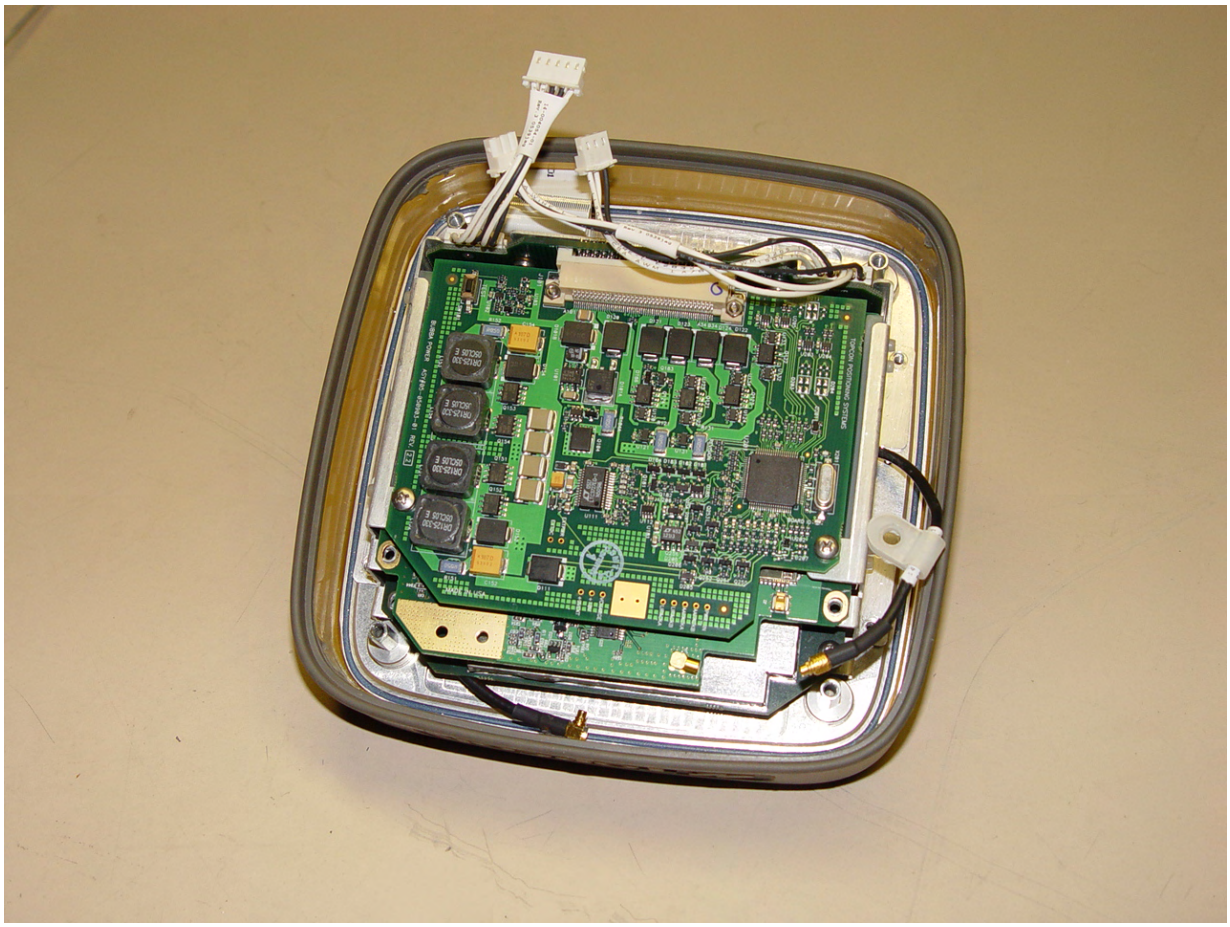
6.1. General Measurement Test Set-Up



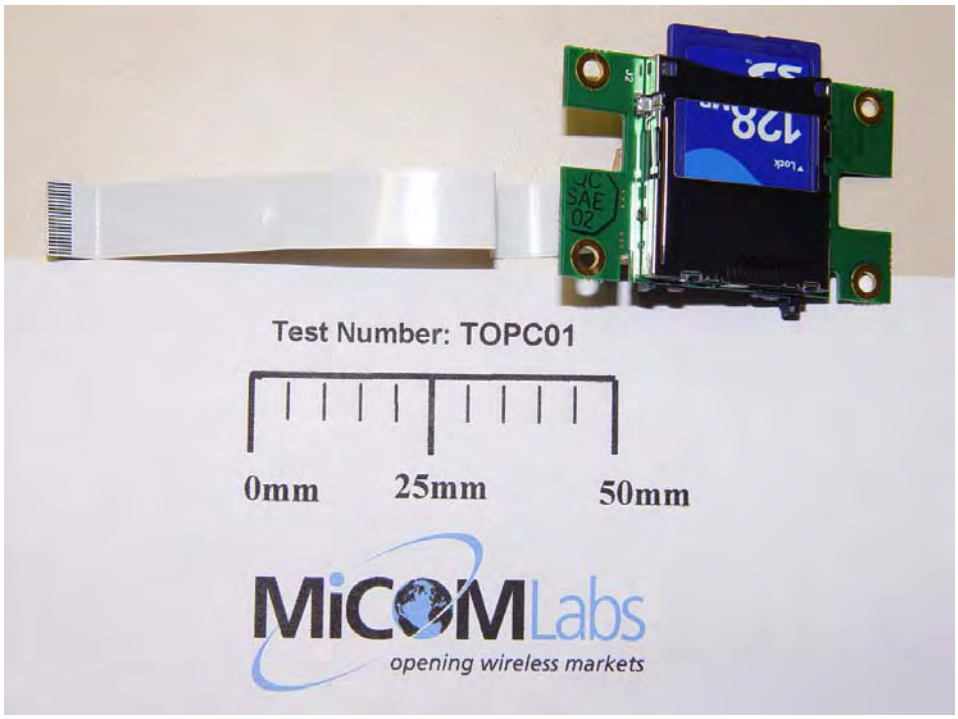
6.2. Unwanted Emissions (30 MHz - 5 GHz)

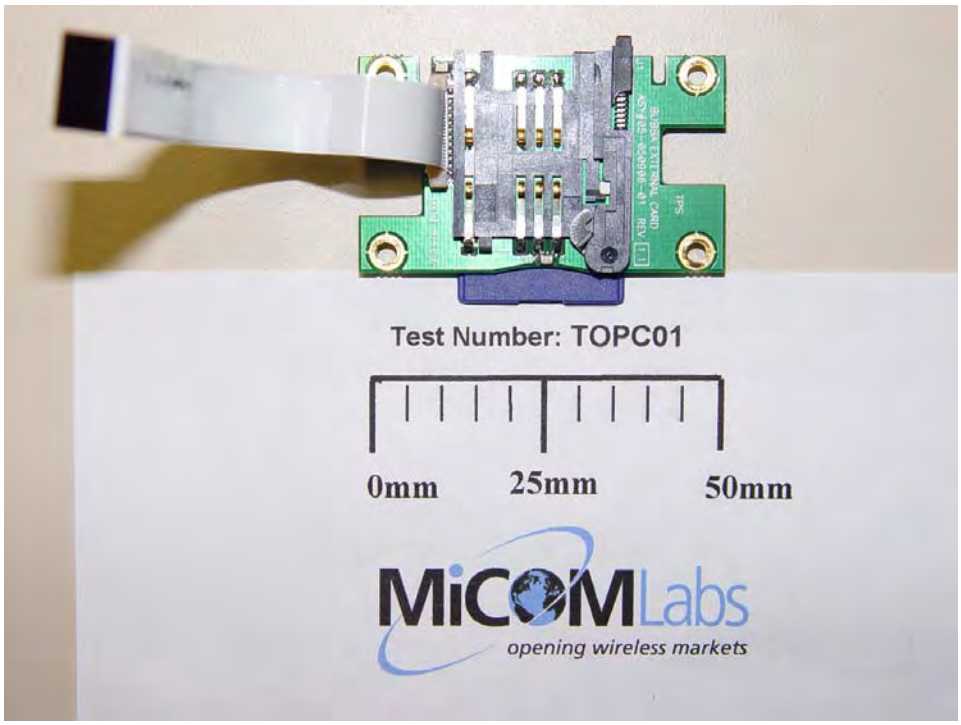


6.3. GR-3 Internal Photographs



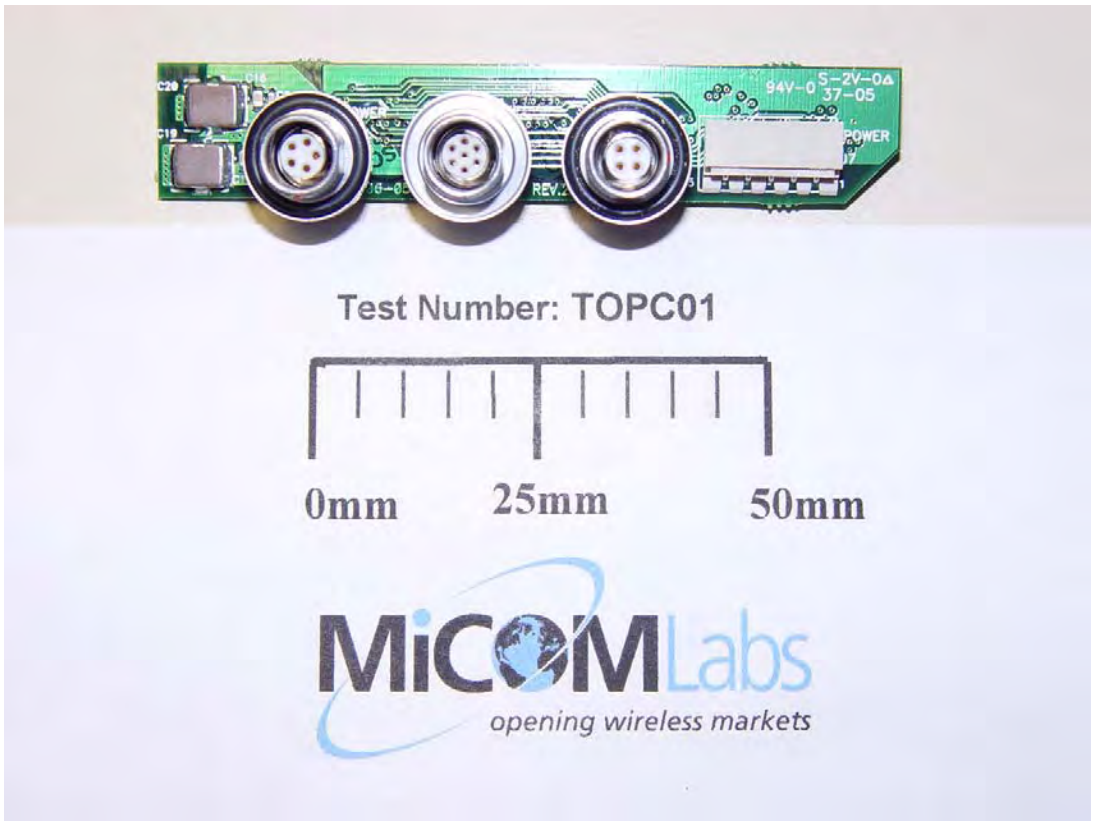
6.4. SD Card Slot Top & Bottom

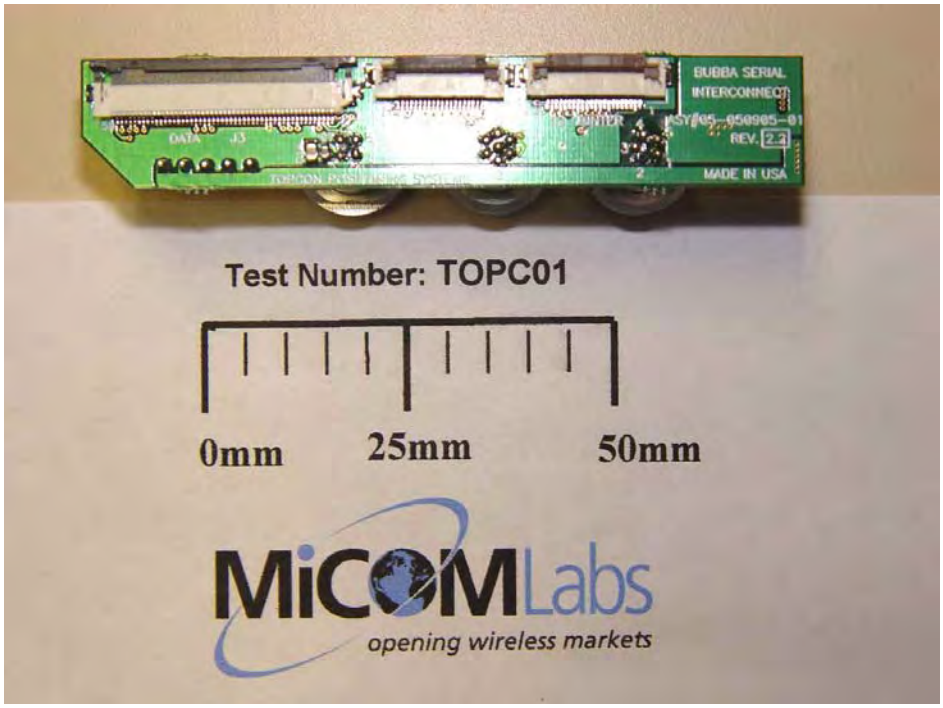




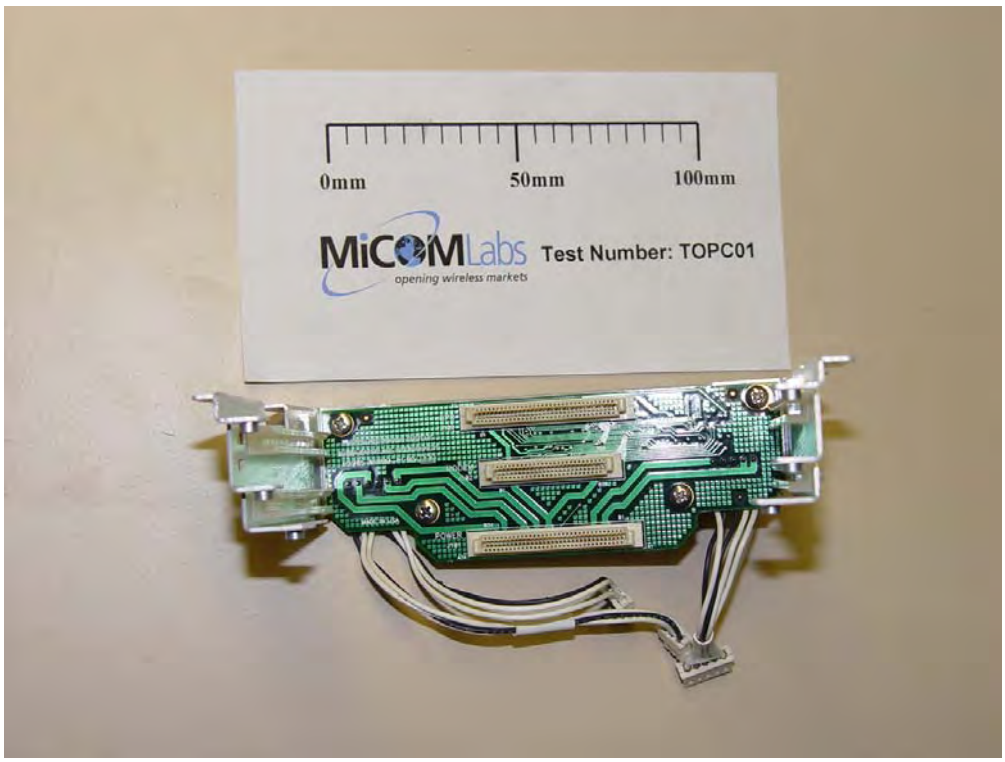
6.5. GPS Main Board Top and Bottom

6.6. Interconnect Board Top and Bottom



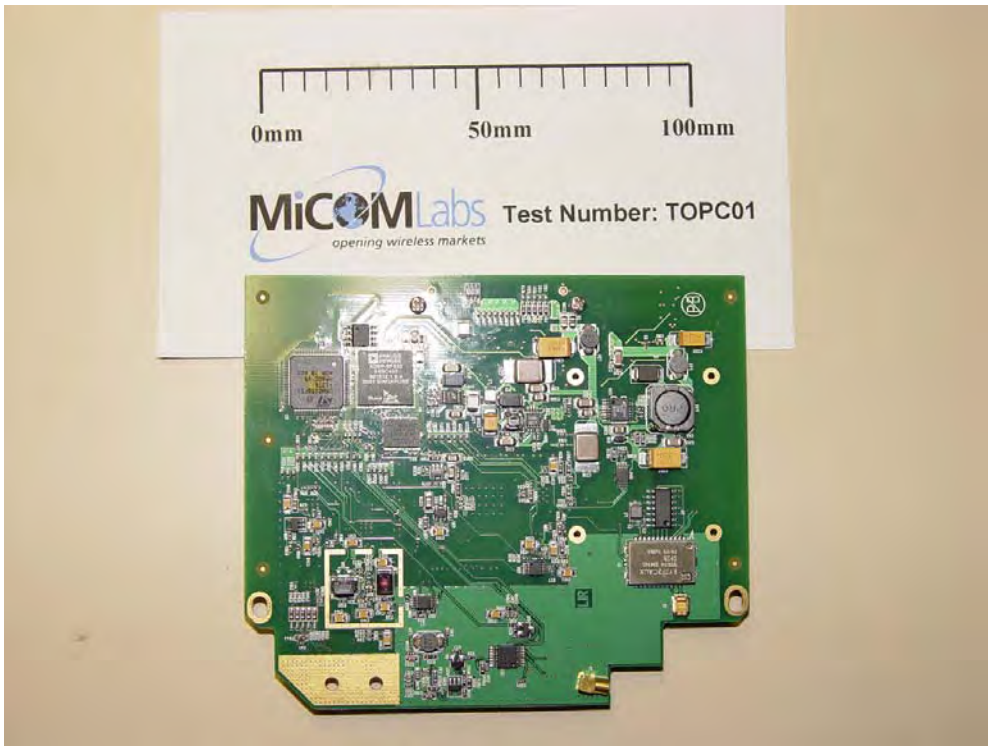


6.7. Main Assembly Top and Bottom



6.8. Power Board Top and Bottom

6.9. Radio Modem Board Top and Bottom



6.10. GPS Casing Shell

7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0070	Power Meter	Hewlett Packard	437B	3125U13554
0073	Power Supply	Hewlett Packard	HP 6574A	US36340203
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
0158	Barometer /Thermometer	Control Co.	4196	E2844
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	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	--
0278	Diode Detector	Hewlett Packard	HP423A	--
--	Demodulator	Linear Technology	DC468A	--
HPF	High Pass Filter	Mini Circuits	SHP - 700	--

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