Test of Exalt EX-5i

To: FCC 47 CFR Part 15.407 & IC RSS-210

Test Report Serial No.: EXLT18-A3 Rev A

opening wireless markets

TEST REPORT

FROM

Test of Exalt EX-5i

To: FCC 47 CFR Part 15.407 & IC RSS-210

Test Report Serial No.: EXLT18-A3 Rev A

Note: this report only contains data with regard to the 5,250 to 5,350 MHz & 5,470 to 5,725 MHz operational mode of the radio. 5.8 GHz test data is reported in MiCOM Labs test report EXLT02-A2

This report supersedes None

Manufacturer:	Exalt Communications, Inc 580 Division Street Campbell, California 95008 USA
Product Function:	5 GHz Point to Point Fixed Link Radio
Copy No:	pdf Issue Date: 24th April '07

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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ACCREDITATION & LISTINGS

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

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	24th April 2007	First issue.

1. TEST RESULT CERTIFICATE

Manufacturer:	Exalt Communications, Inc 580 Division Street Campbell, California 95008 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	EX-5i 5 GHz Point to Point Fixed Link Radio	Telephone:	+1 925 462 0304
Model:	EX-5i	Fax:	+1 925 462 0306
S/N:	001, SM44060052, SM44060043		
Test Date(s):	9th May to 1st June '06 & 13th to 16th April '07	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.407 & IC RSS-210	**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,

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 15.407	2006	Code of Federal Regulations
(ii)	FCC 06-96	June 2006	Memorandum Opinion and Order
(iii)	Industry Canada RSS-210	Issue 6 Sept. 2005	Low Power License-Exempt Radiocommunication Devices (All Frequency Bands): Category 1 Equipment
(iv)	Industry Canada RSS-Gen	Issue 1 Sept. 2005	General Requirements and Information for the Certification of Radiocommunication Equipment
(v)	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
(vi)	CISPR 22/ EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(vii)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(viii)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(ix)	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
(x)	A2LA	14th September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy
(xi)	FCC Public Notice – DA 02-2138	2002	Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices

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 Exalt Communications Inc Exalt EX-5i to FCC Part 15.407, FCC Memorandum Opinion and Order 06-96; and Industry Canada RSS-210 regulations.		
Applicant:	As Manufacturer		
Manufacturer:	Exalt Communications, Inc 580 Division Street Campbell, California 95008 USA		
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA		
Test report reference number:	EXLT18-A3 Rev A		
Standard(s) applied:	FCC 47 CFR Part 15.407 & IC RSS-210		
Dates of test (from - to):	9th May to 1st June '06 & 13th to 16th April '07		
No of Units Tested:	3		
Type of Equipment:	5 GHz Point to Point Fixed Link Radio		
Manufacturers Trade Name:	Model EX-5i		
Model:	EX-5i		
Software Rev	DFS 1.0		
Location for use:	Outdoors		
Declared Frequency Range(s):	5,250 to 5,350 MHz; 5,470 to 5,725 MHz		
Type of Modulation:	QPSK; 16QAM; 64QAM		
Declared Nominal Output Power:	5,250 to 5,350 MHz +13 dBm 5,470 to 5,725 MHz +13 dBm		
EUT Modes of Operation:	QPSK; 16QAM; and 64QAM modulation available at 8 MHz, 16 MHz, 32 MHz, & 64 MHz Bandwidths.		
Transmit/Receive Operation:	Time Division Duplex (TDD)		
Rated Input Voltage and Current:	48 Vdc 0.8 A and/or 24Vdc 1.6A. .		
Operating Temperature Range:	Declared range -25 to +65ºC		
ITU Emission Designator:	BW (MHz)	5,250 – 5,350	5,470 – 5,725
	8	7M8W7D	8M3W7D
	16	15M7W7D	16M7W7D
	32	30M9W7D	33M0W7D
	64	60M8W7D	65M0W7D
Microprocessor(s) Model:	MPC852T		
Clock/Oscillator(s):	25MHz, 1.544 MHz, 2.048 MHz, 12.880 MHz, 44.736 MHz, 34.368 MHz, 100 MHz, 120 MHz		
Frequency Stability:	±7 ppm		
Equipment Dimensions:	17” x 14” x 1¾”		
Weight:	11.3 lbs		
Primary function of equipment:	Point to Point Transmission of T1/E1/Ethernet Data		

3.2. Scope of Test Program

The scope of the test program was to test the Exalt Communications EX-5i radio in the frequency ranges 5,250 – 5,350 MHz and 5,470 – 5,725 MHz for compliance against FCC 47 CFR; DFS requirements per FCC Memorandum Opinion and Order FCC 06-96., and Industry Canada RSS-210 specifications

The Exalt Communications EX-5i employs QPSK, 16QAM & 64QAM modulation in the frequency ranges 5.250 to 5.350 GHz, and 5470 – 5725 MHz.

U-NII devices operating in the 5,250-5,350 MHz and 5,470 -5,725 MHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems.

The Exalt Communications EX-5i operates as a Master device with full radar detection and Dynamic Frequency Selection (DFS) capability.

System testing was performed with the Master device continuously transmitting the designated FCC MPEG (Testfile.mpg) streaming video test file to the client device using the NTIA specified media player (klcodec261f.exe).

For the 5250-5350 MHz and 5470 – 5725 MHz bands, the Master device provides, on aggregate, uniform loading of the spectrum across all devices by selecting an operating channel among the available channels using a random algorithm.

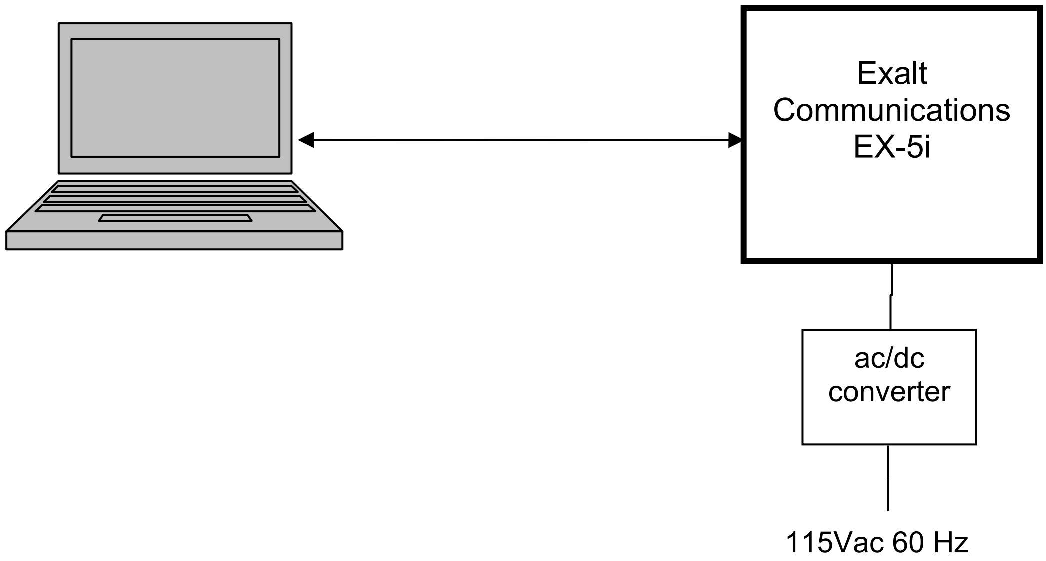
The test results for the 5,250 to 5,350 MHz band (excluding DFS) were previously reported for this product in MiCOM Labs Test report EXLT02-A5.

Exalt Communications Model EX-5i
5 GHz Point to Point Fixed Link Radio

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

Type (EUT/ Support)	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	5 GHz Point to Point Microwave Radio	Exalt Communications Inc	EX-5i	001
Support	Power supply	International Power Sources	CUP70-18 B2	70480-0000106

Test Measurement Set Up



3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Parabolic	37.5	Radio Waves	SP6-5.2	14734
Panel	28.0	MTI	MT-486001	00213

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 10/100 BT: 2 ports
2. T1/E1: 4 ports
3. DS3 (in and out)
4. Sync (in and out)
5. Console (RS-232)
6. Alarms

3.6. Test Configurations

Matrix of test configurations

Band	BW (MHz)	Modulation								
		QPSK			16QAM			64QAM		
		Low (MHz)	Mid (MHz)	High (MHz)	Low (MHz)	Mid (MHz)	High (MHz)	Low (MHz)	Mid (MHz)	High (MHz)
5.3	8	5260	5296	5332	5260	5296	5332	5260	5296	5332
	16	5265	5296	5327	5265	5296	5327	5265	5296	5327
	32	5272	5290	5308	5272	5290	5308	5272	5290	5308
	64		5290			5290			5290	
5.6	8	5488	5602	5715						
	16	5493	5602	5710						
	32	5512	5608	5703						
	64	5553	5618	5683						

It was established at the start of the test program that the QPSK modulation scheme has the highest Radiated Emission and Peak Emission levels. For the sake of brevity in reporting the test results the report includes results for all of the QPSK configurations shown in the table above, and selected worst case test results for 16QAM and 64QAM configurations.

Only worst case plots are provided for each test parameter identified within this report. A selection of test results for the alternate modulations has been included in Appendix A. Plots not included are held on file by the test laboratory and are available upon request with client permission.

DFS Test Configurations

The 99% Bandwidth was measured for all radio configuration (three modulations and four different bandwidths) with the radio set at the channel frequency closest to 5,600 MHz to determine the narrowest bandwidth measurement for which the DFS detection bandwidth should be measured at.

The narrowest bandwidth measurements were selected according to the following table. The bandwidth measurements are held on file.

X – Configuration selected for DFS detection bandwidth measurement.

	8 MHz	16 MHz	32 MHz	64 MHz
QPSK	X		X	X
16QAM		X		
64QAM				

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

Radiated emissions are tested below and verified above 1 GHz at TUV Rheinland of North America's 10m chamber located at the following address;-

2305 Mission College Blvd.
Santa Clara
California 95054
USA

TUV Rheinland of North America IC Registration Number: IC 4453-1

4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407** and **Industry Canada RSS-210**.and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(a) **A9.2(2)** **4.4**	26dB and 99% Emission BW	Emission bandwidth measurement	Conducted	Complies	5.1.1
15.407(a) **A9.2(2)** **4.6**	Peak Transmit Power	Peak Power Measurement	Conducted	Complies	5.1.2
15.407(a) **A9.2(2)**	Peak Power Spectral Density	PPSD	Conducted	Complies	5.1.3
15.407(a)(6)	Peak Excursion Ratio	<13dB in any 1MHz bandwidth	Conducted	Complies	5.1.4
15.407(g) **15.31** **A9.5 (e)** **4.5**	Frequency Stability	Limits: contained within band of operation at all times.	Verification Manufacturer declaration	Complies	5.1.5
15.407(f) **5.5**	Radio Frequency Radiation Exposure	Exposure to radio frequency energy levels, Maximum Permissible Exposure (MPE)	Calculation	Complies	5.1.6

List of Measurements (continued)

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(b)(2) **15.205(a)** **15.209(a)** **2.2, 2.6** **A9.3(2)** **4.7**	Radiated Emissions		Radiated		5.1.7
	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz		Complies	*5.1.7.1*
	Peak Field Strength Measurements				*5.1.7.2*
	Radiated Band Edge	Band edge results		Complies	*5.1.7.3*
Industry Canada only **RSS-Gen §4.8, §6**	Receiver Radiated Spurious Emissions	Emissions above 1 GHz		Complies	*5.1.7.4*
15.407(b)(6) **15.205(a)** **15.209(a)** **2.2**	Radiated Emissions	Emissions <1 GHz (30M-1 GHz)		Complies	*5.1.7.5*
15.407(b)(6) **15.207** **7.2.2**	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies	5.1.8

List of Measurements (continued)

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407(h)(2)** and **FCC Memorandum Opinion and Order FCC 06-96 (Compliance Measurement procedures for unlicensed national information infrastructure devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating dynamic frequency selection).**

DFS testing was perform on four different configurations; 8 MHz QPSK; 16MHz 16QAM; 32 MHz QPSK; 64 MHz QPSK.

Section	Test Items	Description	Condition	Result	Test Report Section
7.8.1	Detection Bandwidth	UNII Detection Bandwidth	Conducted	Complies	6.7.1
7.8.2.1	Performance Requirements Check	Initial Channel Availability Check Time	Conducted	Complies	6.7.2
7.8.2.2		Radar Burst at the Beginning of the Channel Availability Check Time	Conducted	Complies	6.7.3
7.8.2.3		Radar Burst at the End of the Channel Availability Check Time	Conducted	Complies	6.7.4
7.8.3	In-Service Monitoring	In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period	Conducted	Complies	6.7.5
7.8.4	Radar Detection	Statistical Performance Check	Conducted	Complies	6.7.6

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*

5. TEST RESULTS

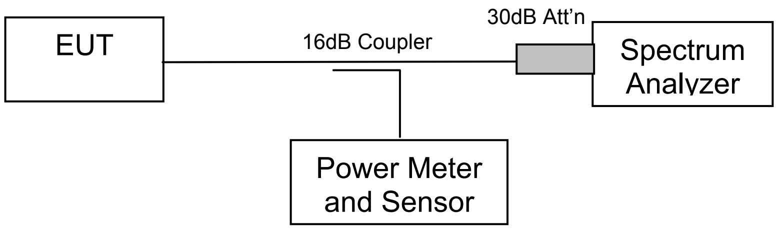
5.1. Device Characteristics

5.1.1. 26 dB and 99 % Bandwidth

FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 § A9.2(2)
Industry Canada RSS-Gen 4.4

Test Procedure
The bandwidth at 26 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The spectrum analyzer utilized the 6 dB resolution bandwidth filter for all measurements.

Test Measurement Set up



Measurement set up for 26 dB and 99 % bandwidth test

Radio parameters.
Power Level: maximum
Duty Cycle: 100% (test mode)

Measurement Results for 26 dB and 99 % Operational Bandwidth(s)

Ambient conditions.
Temperature: 17 to 23 °C   Relative humidity: 31 to 57 %   Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5.3 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,260	8.61723447	On File	7.71543086	On File
5,296	8.61723447	01	7.76553106	01
5,332	8.61723447	On File	7.71543086	On File

Plot 01
5,296 MHz 8 MHz QPSK 26 dB and 99% Bandwidth

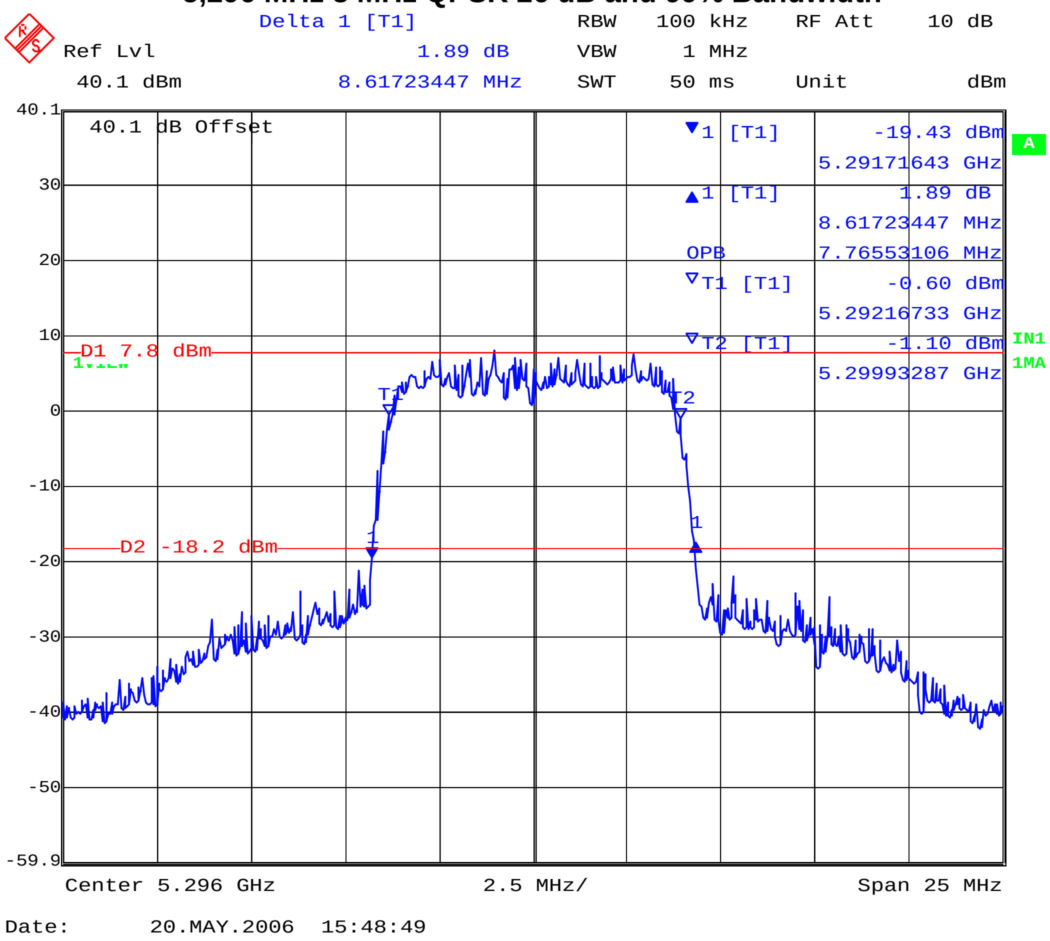


TABLE OF RESULTS – 5.3 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,265	17.15926854	On File	15.43086172	On File
5,296	17.16881263	02	15.63126253	02
5,327	17.03053607	On File	15.43086172	On File

Plot 02

5,296 MHz 16 MHz QPSK 26 dB and 99% Bandwidth

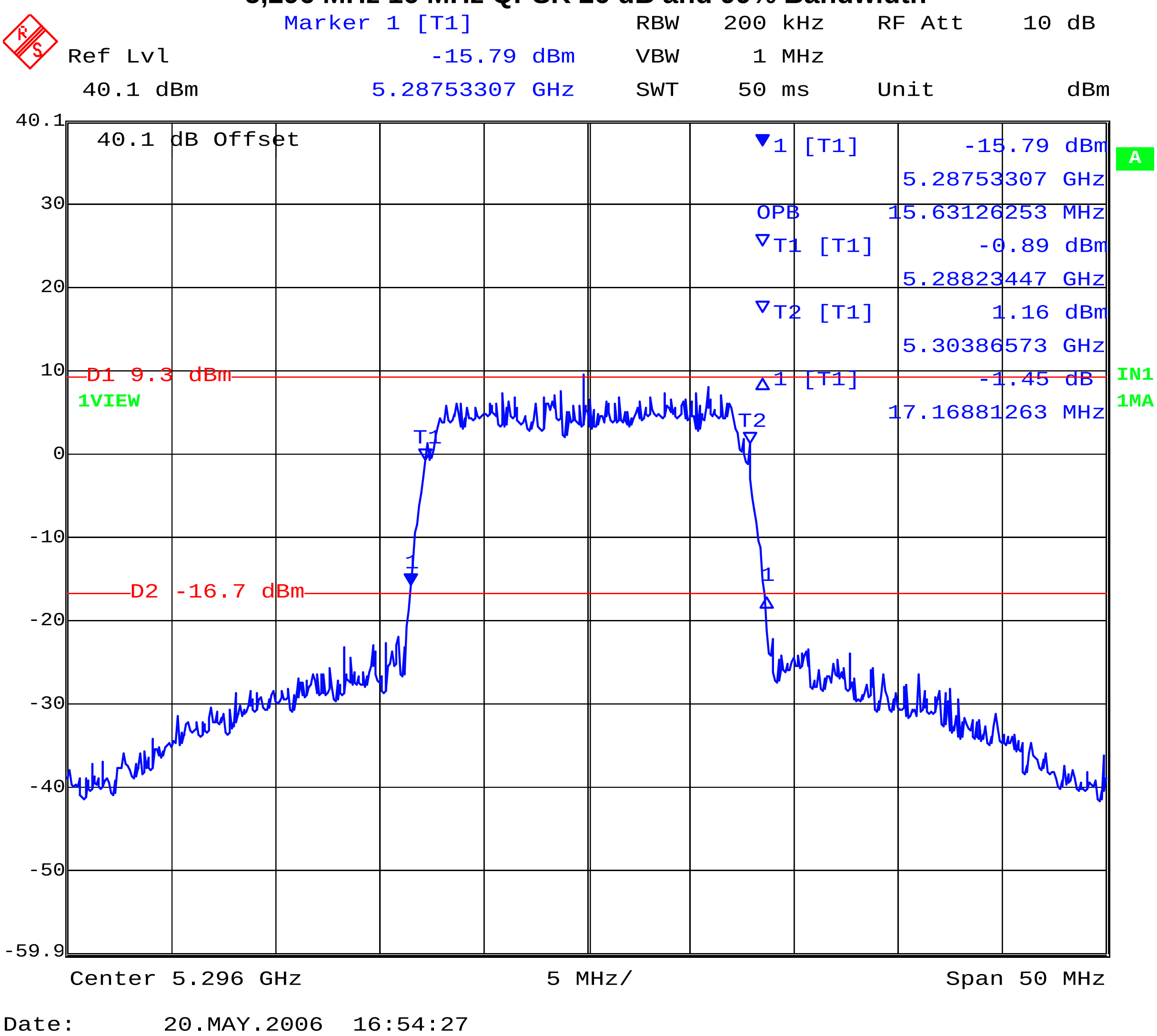


TABLE OF RESULTS – 5.3 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,272	34.11823647	On File	30.66132265	On File
5,290	34.41883768	On File	30.81162325	On File
5,308	34.41883768	03	30.81162325	03

Plot 03

5,308 MHz 32 MHz QPSK 26 dB and 99% Bandwidth

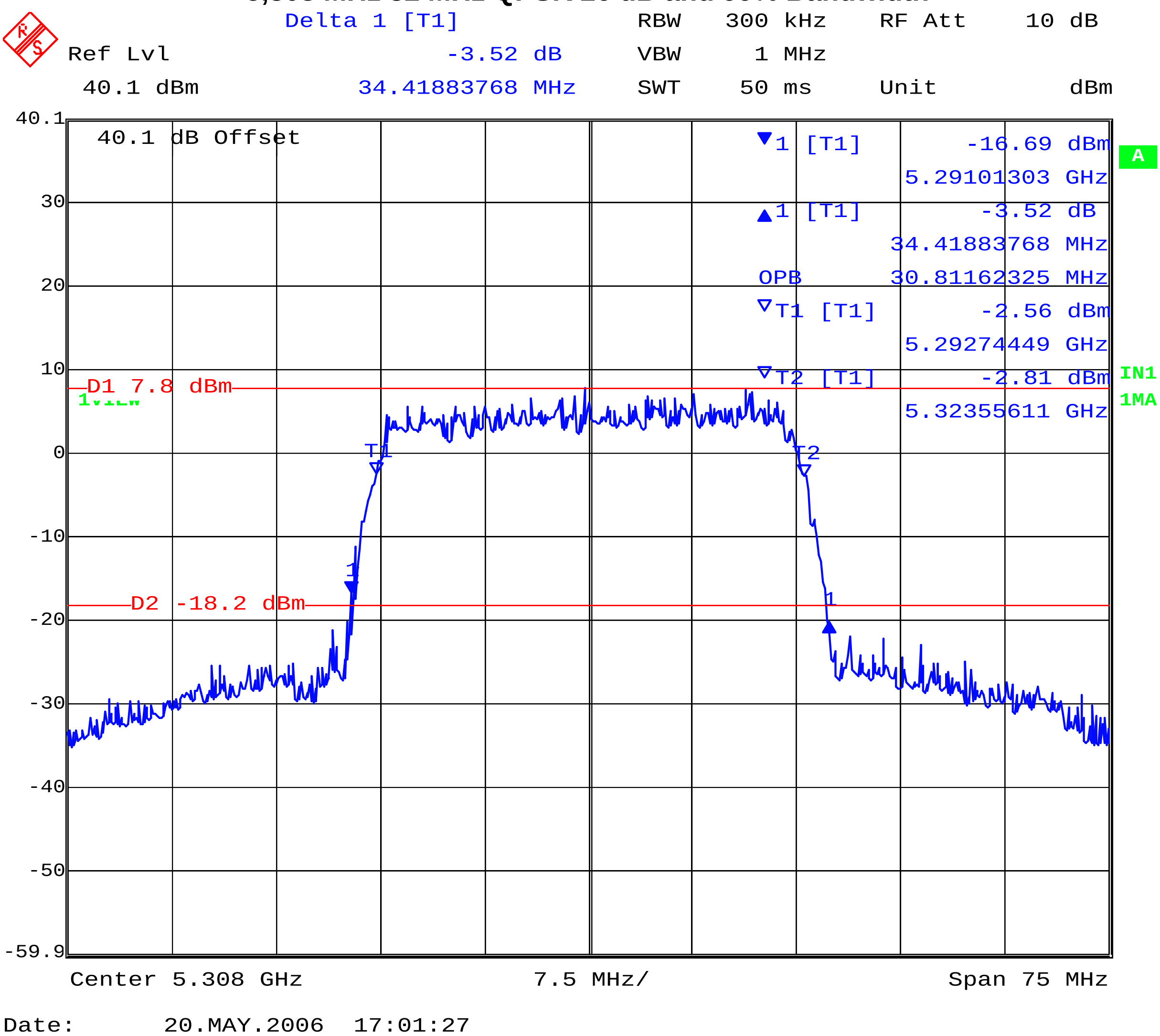
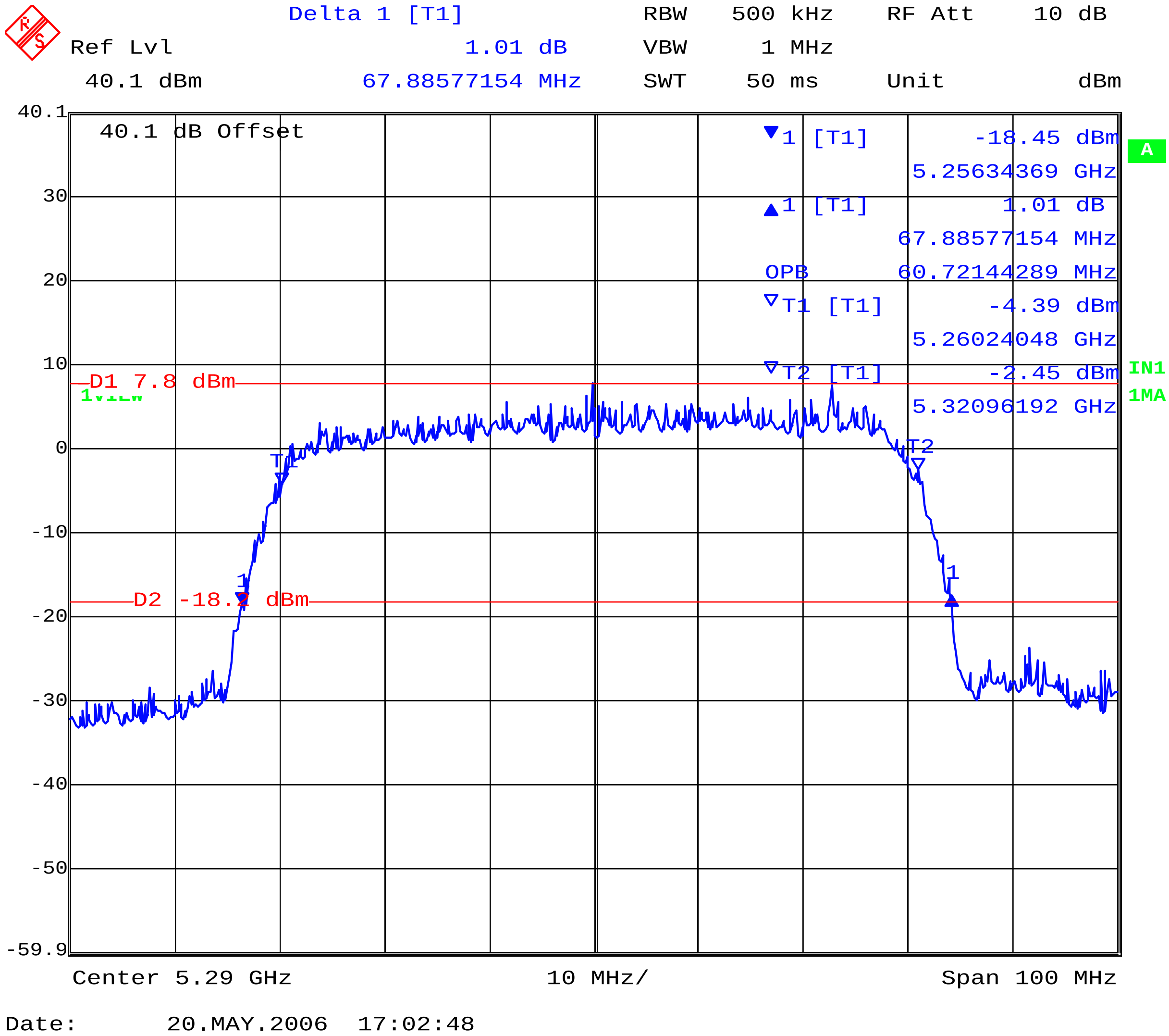


TABLE OF RESULTS – 5.3 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,290	67.88577154	04	60.72144289	04

Plot 04

5,290 MHz 64 MHz QPSK 26 dB and 99% Bandwidth



Measurement Results for 26 dB and 99 % Operational Bandwidth(s)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5.6 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,488	9.0681	On File	8.2665	On File
5,602	9.0681	05	8.2665	05
5,715	9.0681	On File	8.2665	On File

Plot 05
5,602 MHz 8 MHz QPSK 26 dB and 99% Bandwidth

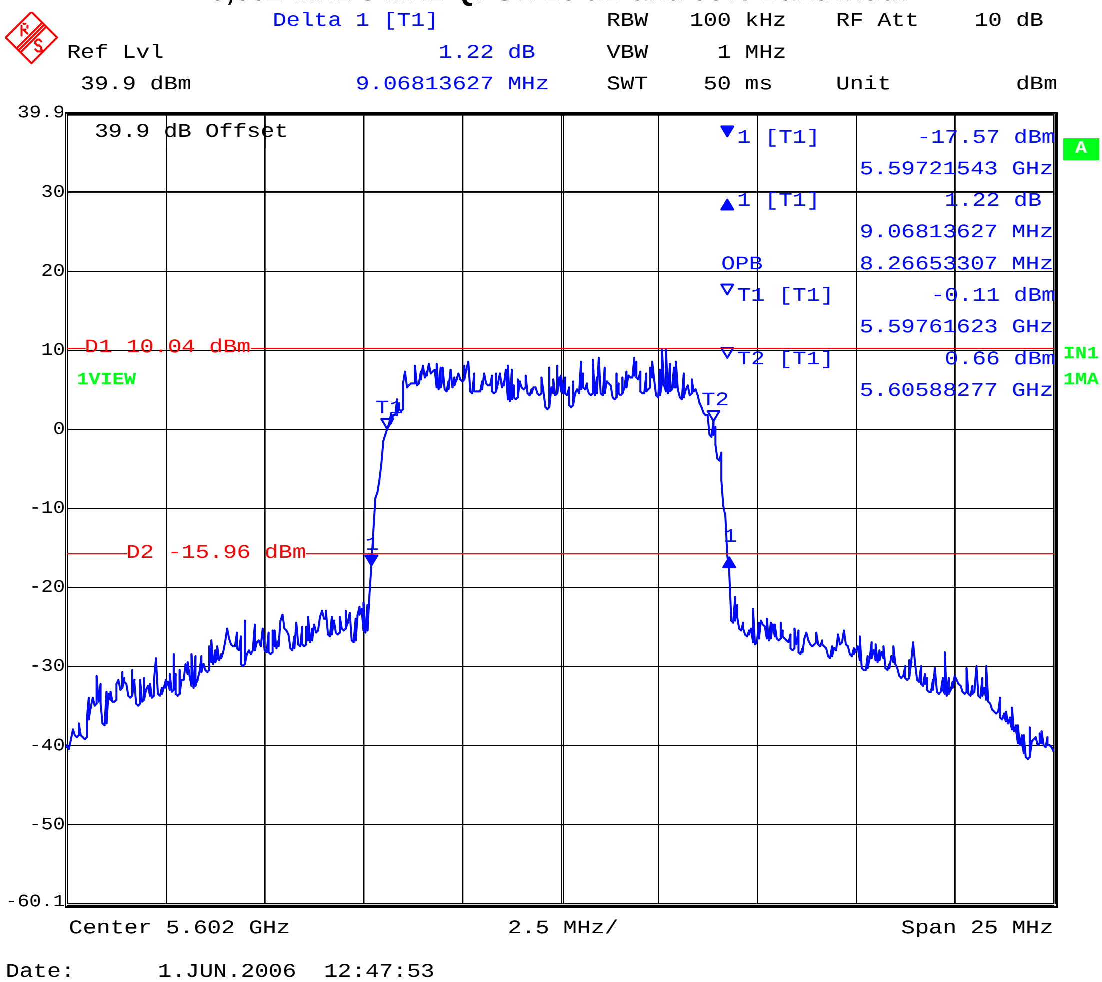


TABLE OF RESULTS – 5.6 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,493	18.0361	On File	16.6333	On File
5,602	18.0361	06	16.6333	06
5,710	18.1363	On File	16.5331	On File

Plot 06
5,602 MHz 16 MHz QPSK 26 dB and 99% Bandwidth

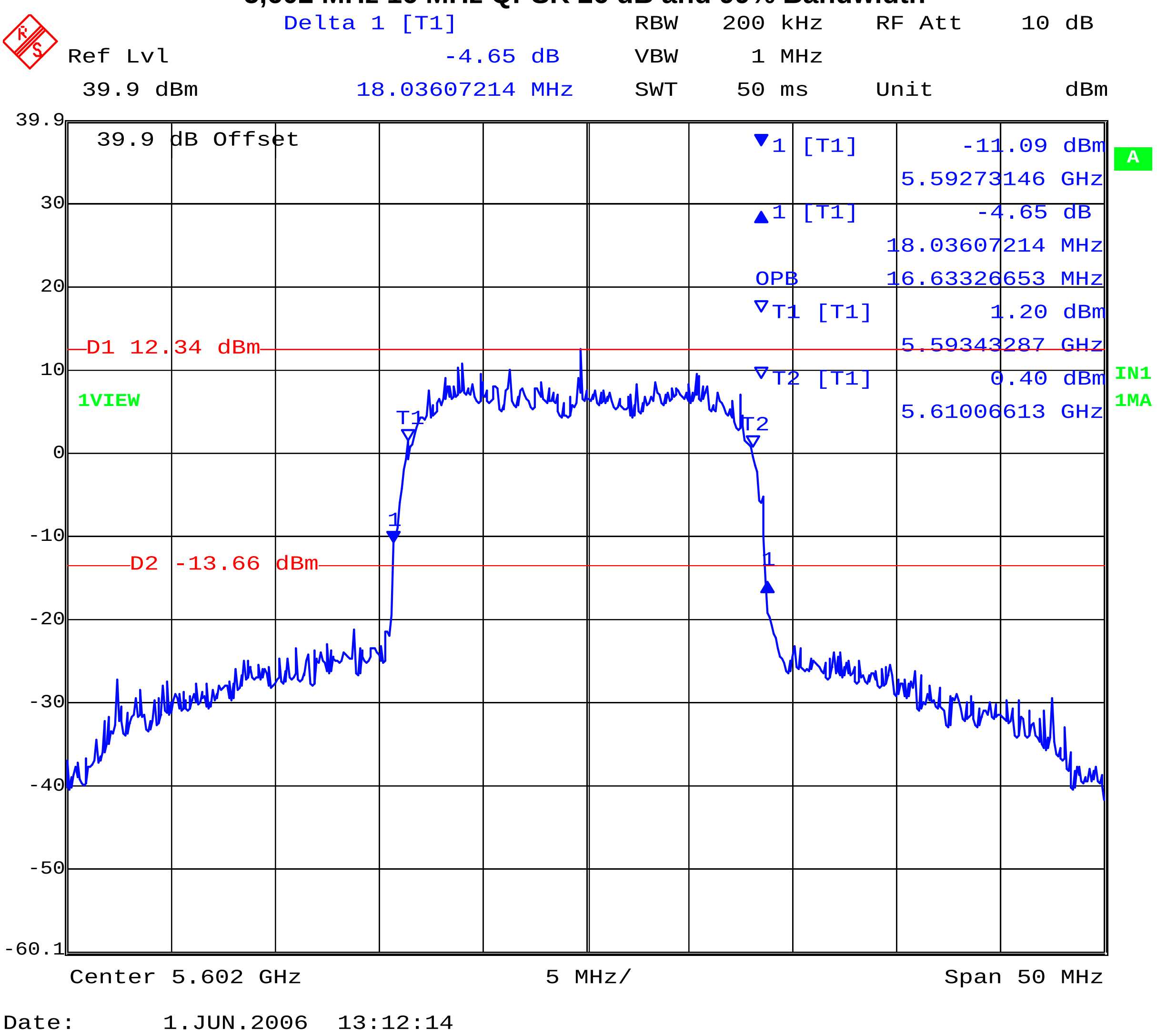


TABLE OF RESULTS – 5.6 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,512	35.9218	On File	32.9158	On File
5,608	35.9218	07	32.9158	07
5,703	35.7715	On File	32.7655	On File

Plot 07
5,608 MHz 32 MHz QPSK 26 dB and 99% Bandwidth

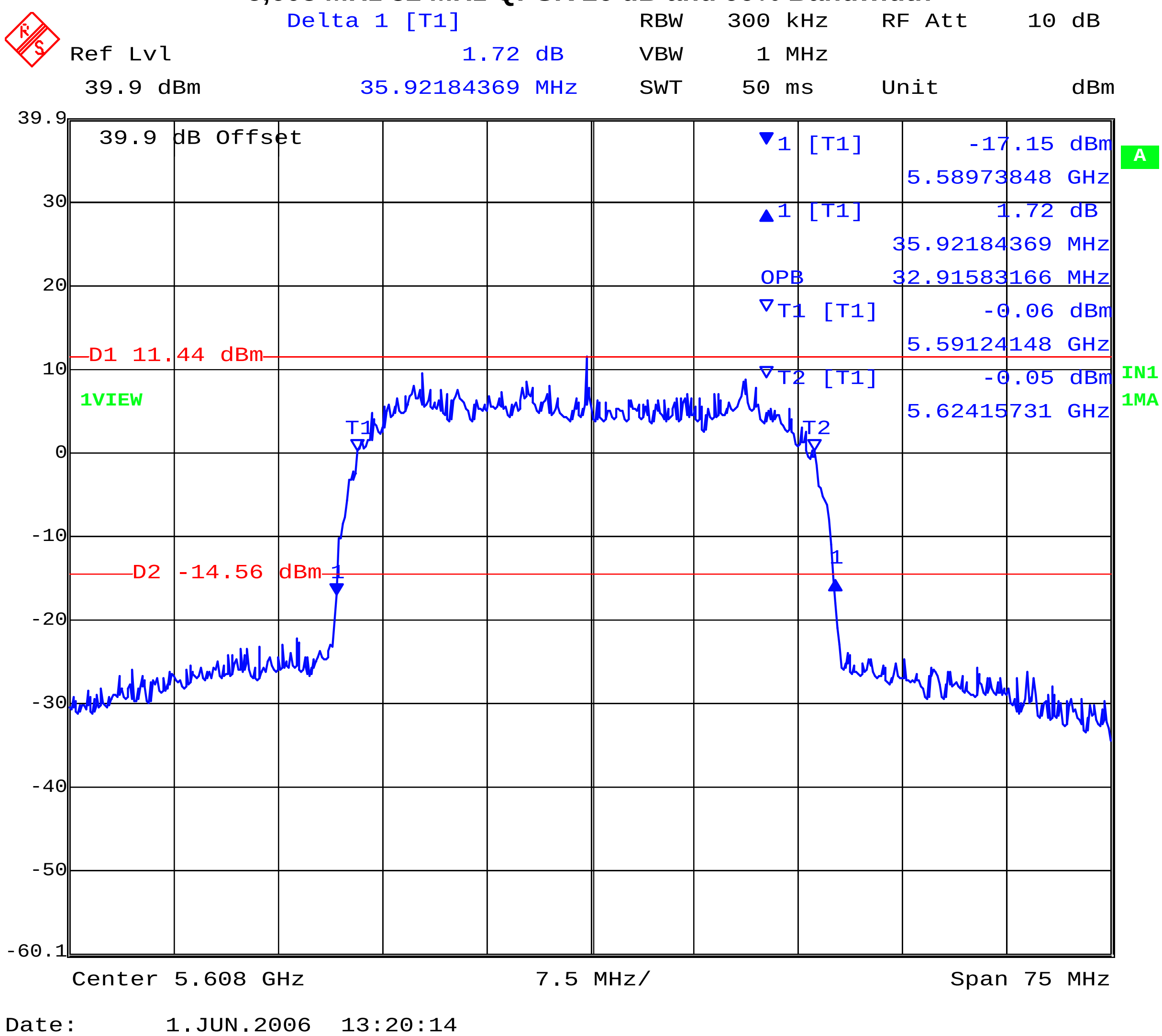
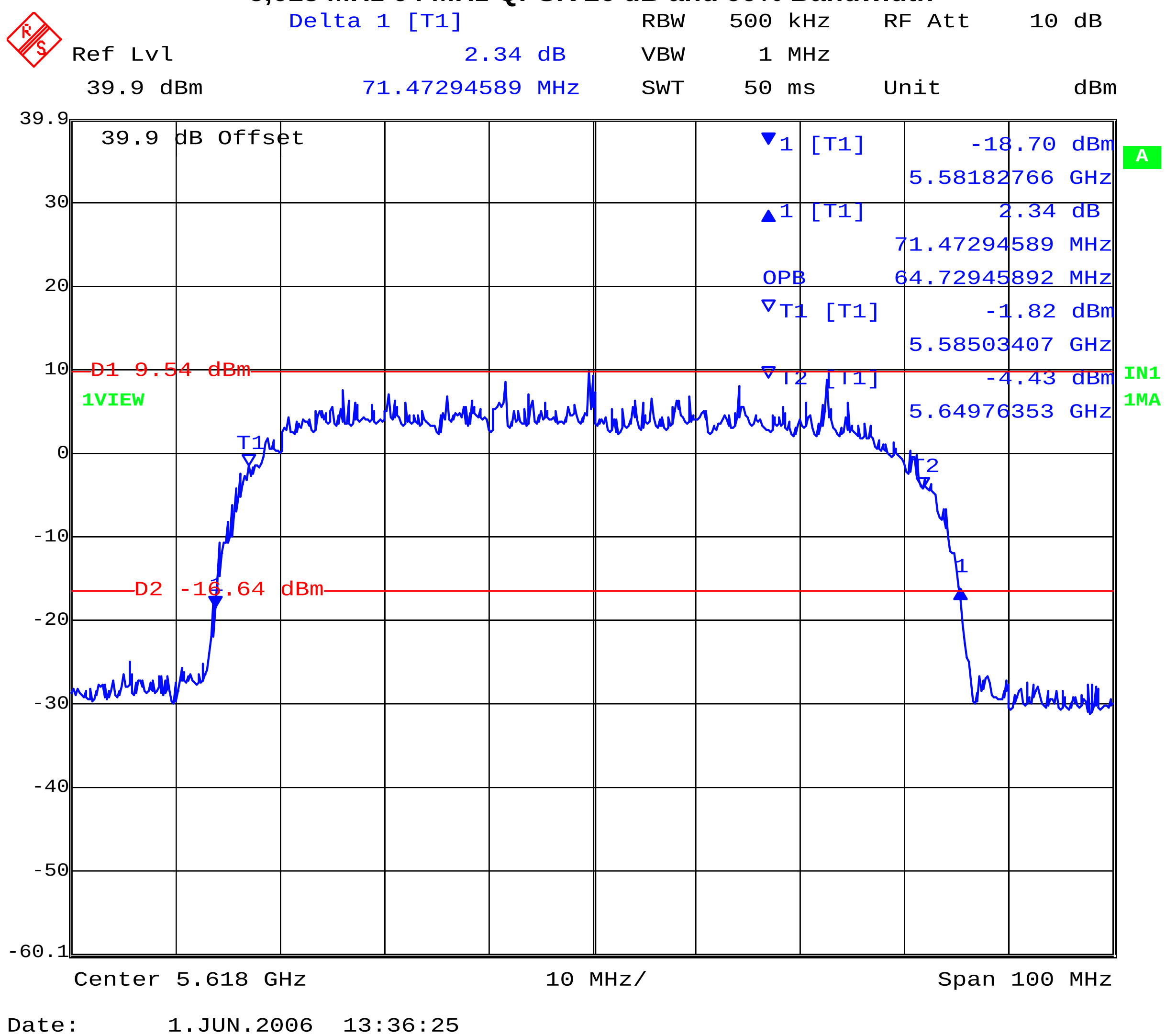


TABLE OF RESULTS – 5.6 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	26 dB Bandwidth (MHz)	26 dB Plot #	99 % BW (MHz)	99 % BW Plots
5,553	71.3427	On File	64.7295	On File
5,618	71.4729	08	64.7295	08
5,683	71.8036	On File	64.9299	On File

Plot 08

5,618 MHz 64 MHz QPSK 26 dB and 99% Bandwidth



Specification

Limits

FCC, Part 15 §15.407 (a)(2) and Industry Canada RSS-210 § A9.2(2)

For the 5.25-5.35 GHz band the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band.

Industry Canada RSS-Gen 4.4

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

5.1.2. Peak Output Power

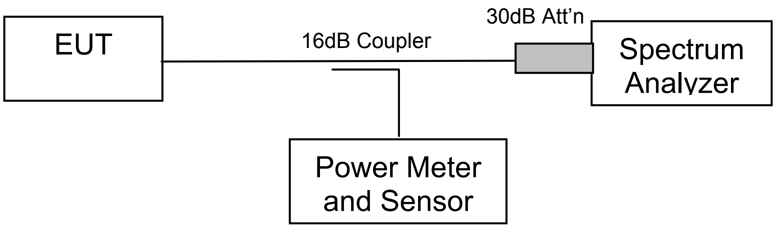
FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 §9.9(2)
Industry Canada RSS-Gen 4.6

Test Procedure

The transmitter terminal of EUT was connected to the input of the average power meter. The measurement results included all associated offsets.

Measurements were made while EUT was operating in a continuous transmission mode i.e. 100 % duty cycle at the appropriate center frequency.

Test Measurement Set up



Measurement set up for Transmitter Peak Output Power

§15.407(a)(2)

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26 dB emission bandwidth in megahertz.

Maximum Transmit Power

Limit 5250 – 5350: Lesser of 250 mW (+24dBm) or 11 + 10 Log (B) dBm

BW (MHz)	Maximum 26 dB Bandwidth (MHz)	Calculation of Limit 11 + 10 Log (B) (dBm)	Limit (dBm)
8	8.6172	+20.353	+20.35
16	17.1688	+23.347	+23.35
32	34.4188	+26.368	+24.00
64	67.8858	+29.318	+24.00

Maximum Transmit Power

Limit 5470 – 5725: Lesser of 250 mW (+24dBm) or 11 + 10 Log (B) dBm

BW (MHz)	Maximum 26 dB Bandwidth (MHz)	Calculation of Limit 11 + 10 Log (B) (dBm)	Limit (dBm)
8	9.0681	+20.57	+20.57
16	18.1363	+23.58	+23.58
32	35.9218	+26.55	+24.00
64	71.8036	+29.56	+24.00

Antenna Gain - Maximum Permissible Transmit Power

If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Type	Gain (dBi)	Bandwidth (MHz)	Antenna Gain >6dBi (dB)	Max. Allowable Conducted Power (dBm)	Max. EIRP (dBm)
Panel	28	8	22	20.57-22 = -1.43	+26.57
		16		23.58-22 = +1.58	+29.58
		32 & 64		24 – 22 = +2	+30.00
Parabolic	37.5	8	31.5	20.57–31.5 = -10.93	+26.57
		16		23.58–31.5 = -7.92	+29.58
		32 & 64		24.0–31.5 = -7.5	+30.00

Radio parameters.
Power Level: maximum
Duty Cycle: 100% (test mode)

Measurement Results for Peak Output Power

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS – 5.3 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,260	+14.78	+20.35	-5.57
5,296	+16.62	+20.35	-3.73
5,332	+17.38	+20.35	-2.97

TABLE OF RESULTS – 5.3 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,265	+15.23	+23.35	-8.12
5,296	+16.71	+23.35	-6.64
5,327	+17.38	+23.35	-5.97

TABLE OF RESULTS – 5.3 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,272	+15.69	+24.00	-8.31
5,290	+16.50	+24.00	-7.50
5,308	+16.98	+24.00	-7.02

TABLE OF RESULTS – 5.3 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,290	+15.90	+24.00	-8.10

TABLE OF RESULTS – 5.6 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,488	19.39	+20.57	-1.18
5,602	18.67	+20.57	-1.90
5,715	15.99	+20.57	-4.58

TABLE OF RESULTS – 5.6 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,493	19.23	+23.58	-4.35
5,602	18.62	+23.58	-4.96
5,710	16.06	+23.58	-7.52

TABLE OF RESULTS – 5.6 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,512	18.80	+24.00	-5.20
5,608	18.39	+24.00	-5.61
5,703	16.02	+24.00	-7.98

TABLE OF RESULTS – 5.6 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)	Margin (db)
5,553	18.17	+24.00	-5.83
5,618	17.35	+24.00	-6.65
5,683	15.58	+24.00	-8.42

Specification

Limits

FCC, Part 15 §15.407 (a)(2) and Industry Canada RSS-210 § A9.2(2)

For the 5.25-5.35 GHz band the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band.

Industry Canada RSS-Gen 4.4

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

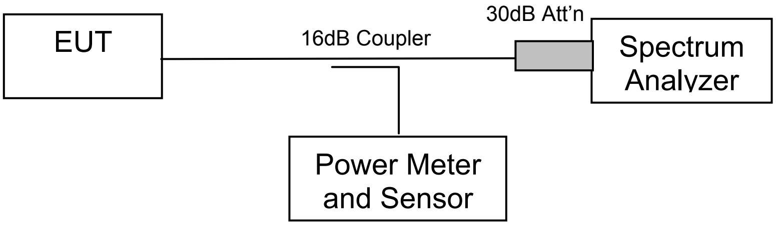
Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

5.1.3. Peak Power Spectral Density

FCC, Part 15 Subpart C §15.407(a)
Industry Canada RSS-210 § A9.2(2)

Test Procedure
The transmitter output was connected to a spectrum analyzer and the maximum level in a 3 kHz bandwidth was measured. A peak value was found over the full emission bandwidth and the frequency span reduced to obtain enhanced resolution. The Peak Power Spectral Density is the highest level found across the emission in a 1 MHz resolution bandwidth.

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

Antenna Gain - Maximum Permissible Peak Power Spectral Density
If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum allowable peak power in the 5250 – 5350 MHz frequency band is + 11 dBm.

Antenna Type	Gain (dBi)	Antenna Gain >6dBi (dB)	Max. Allowable Peak Power Spectral Density (dBm)
Panel	28.0	22.0	11 – 22 = -11.0
Parabolic	37.5	31.5	11 – 31.5 = -20.5

Measurement Results for Peak Power Spectral Density

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Radio parameters.
Power Level: maximum
Duty Cycle: 100% (test mode)

TABLE OF RESULTS – 5.3 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,260	5.25987475	+5.29	On File
5,296	5.29502305	+7.68	On File
5,332	5.33478056	+7.88	09

Plot 09

5,332 MHz 8 MHz Bandwidth QPSK Peak Power Spectral Density

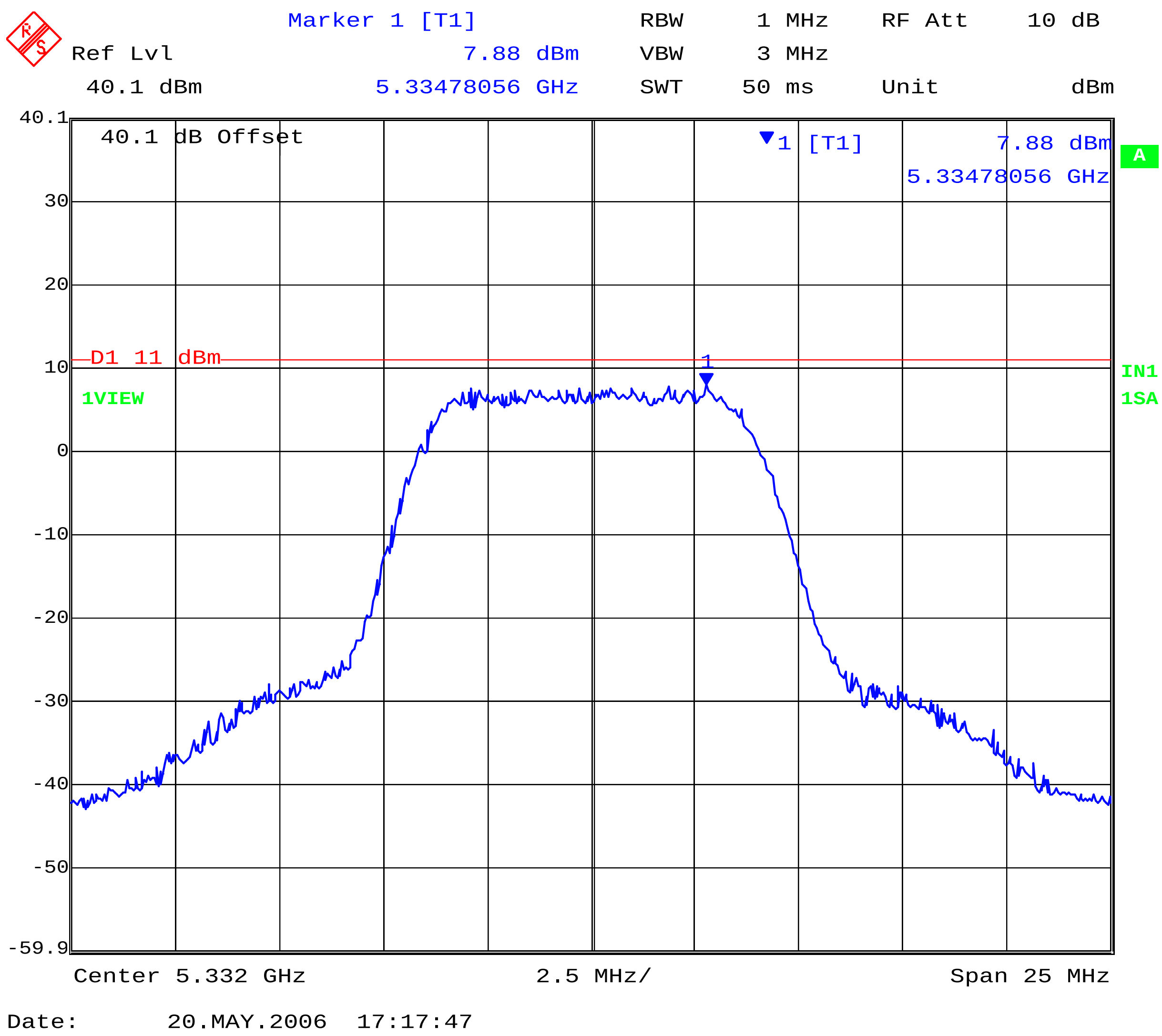


TABLE OF RESULTS – 5.3 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,265	5.26805611	+2.92	On File
5,296	5.30015832	+4.25	On File
5,327	5.32614830	+4.67	10

Plot 10

5,327 MHz 16 MHz Bandwidth QPSK Peak Power Spectral Density

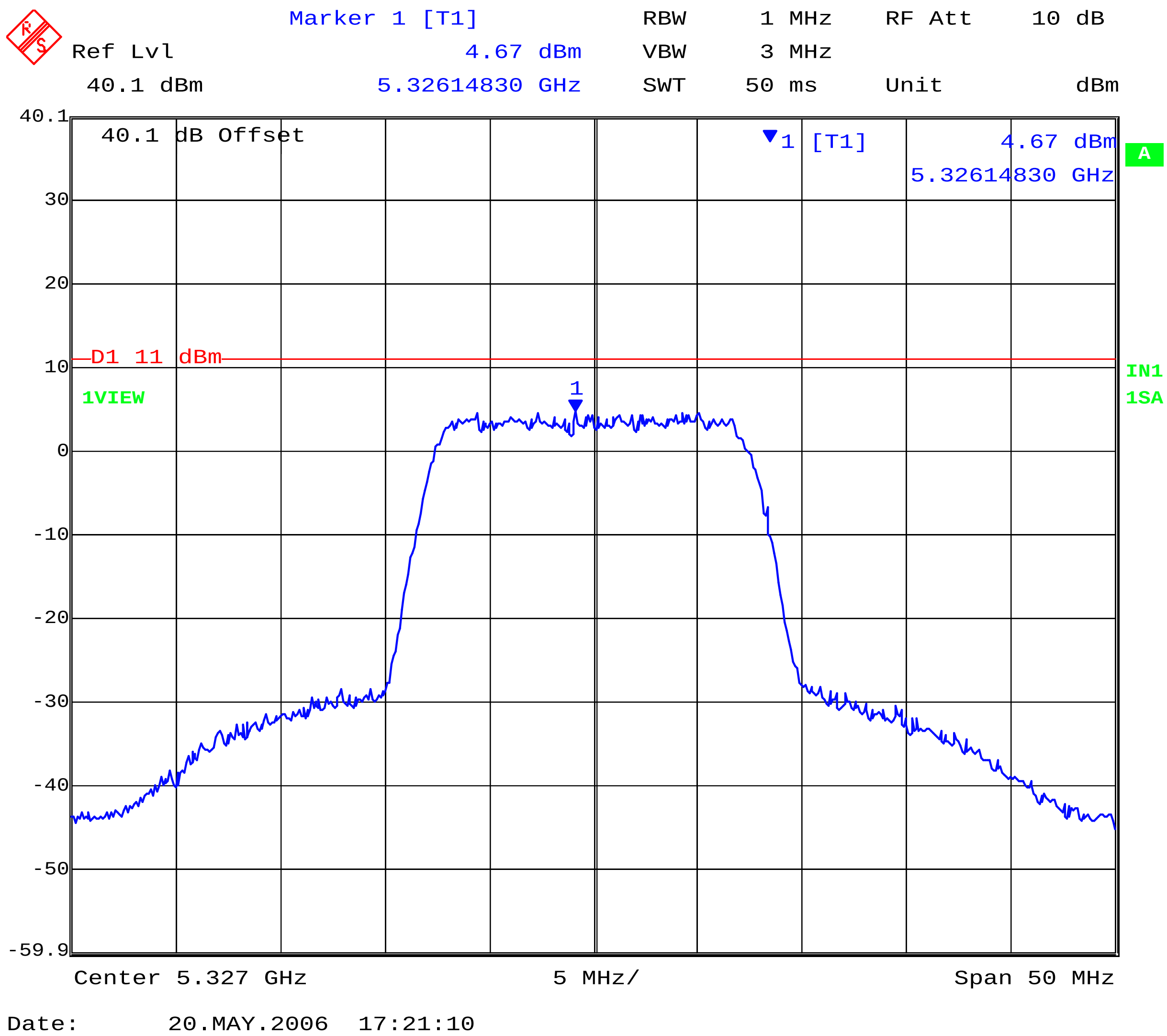


TABLE OF RESULTS – 5.3 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,272	5.28485070	+0.57	On File
5,290	5.29202906	+1.00	On File
5,308	5.31964830	+1.59	11

Plot 11

5,308 MHz 32 MHz Bandwidth QPSK Peak Power Spectral Density

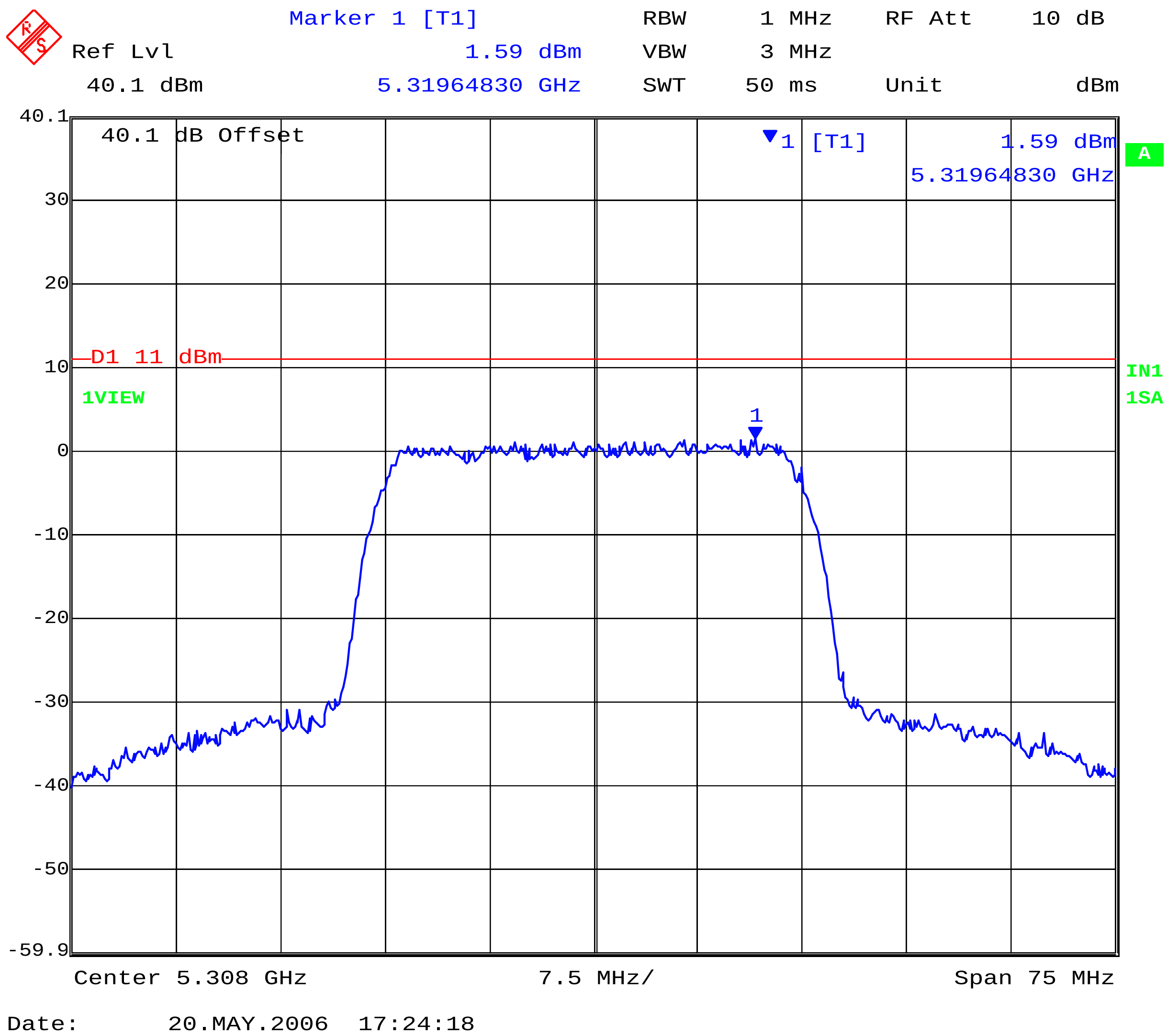


TABLE OF RESULTS – 5.3 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,290	5.30252505	-2.25	12

Plot 12

5,290 MHz 64 MHz Bandwidth QPSK Peak Power Spectral Density

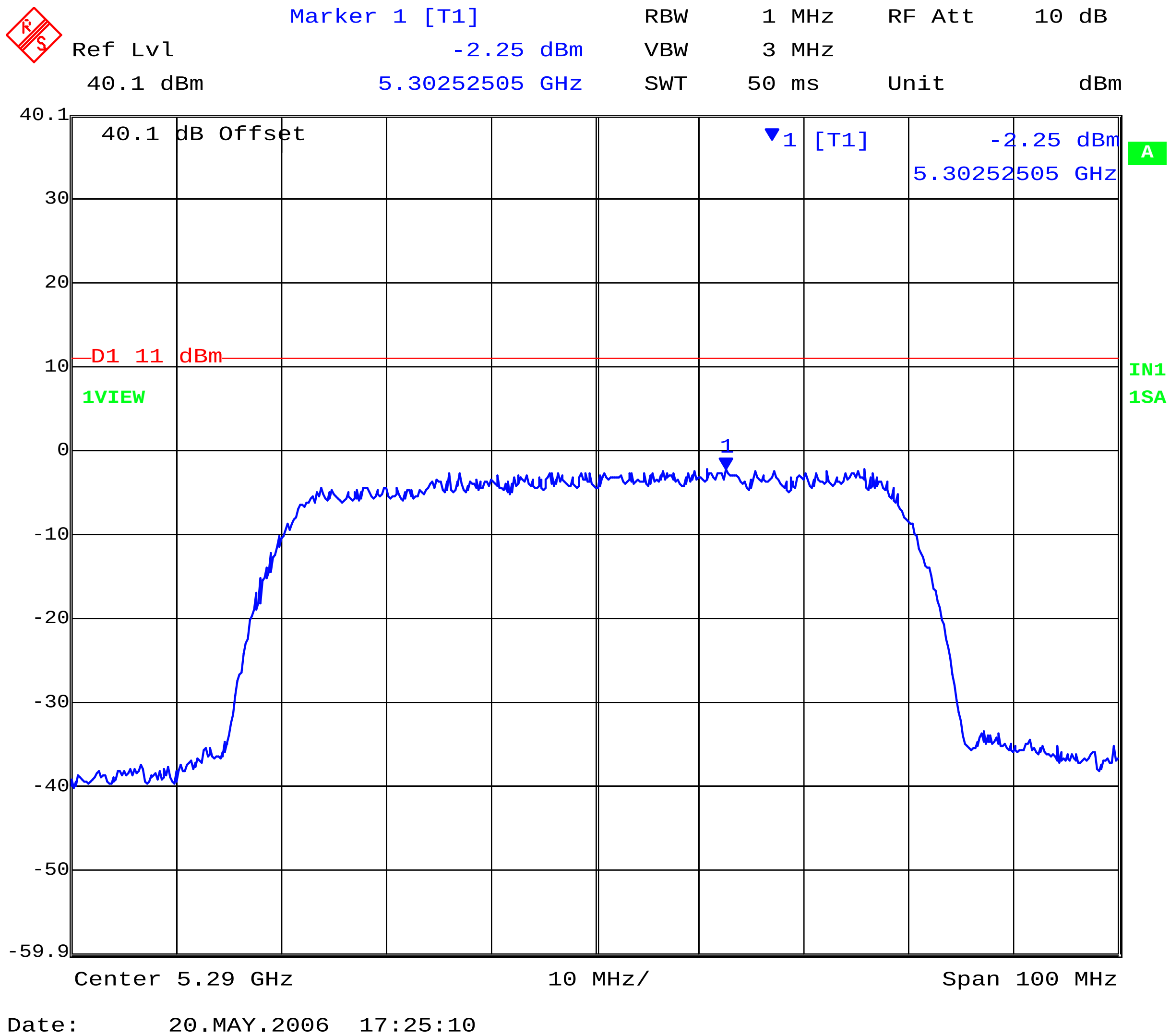


TABLE OF RESULTS – 5.6 GHz Band - 8 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,488	5485.120	+9.62	13
5,602	5598.969	+9.21	On File
5,715	5716.979	+6.40	On File

Plot 13

5,488 MHz 8 MHz Bandwidth QPSK Peak Power Spectral Density

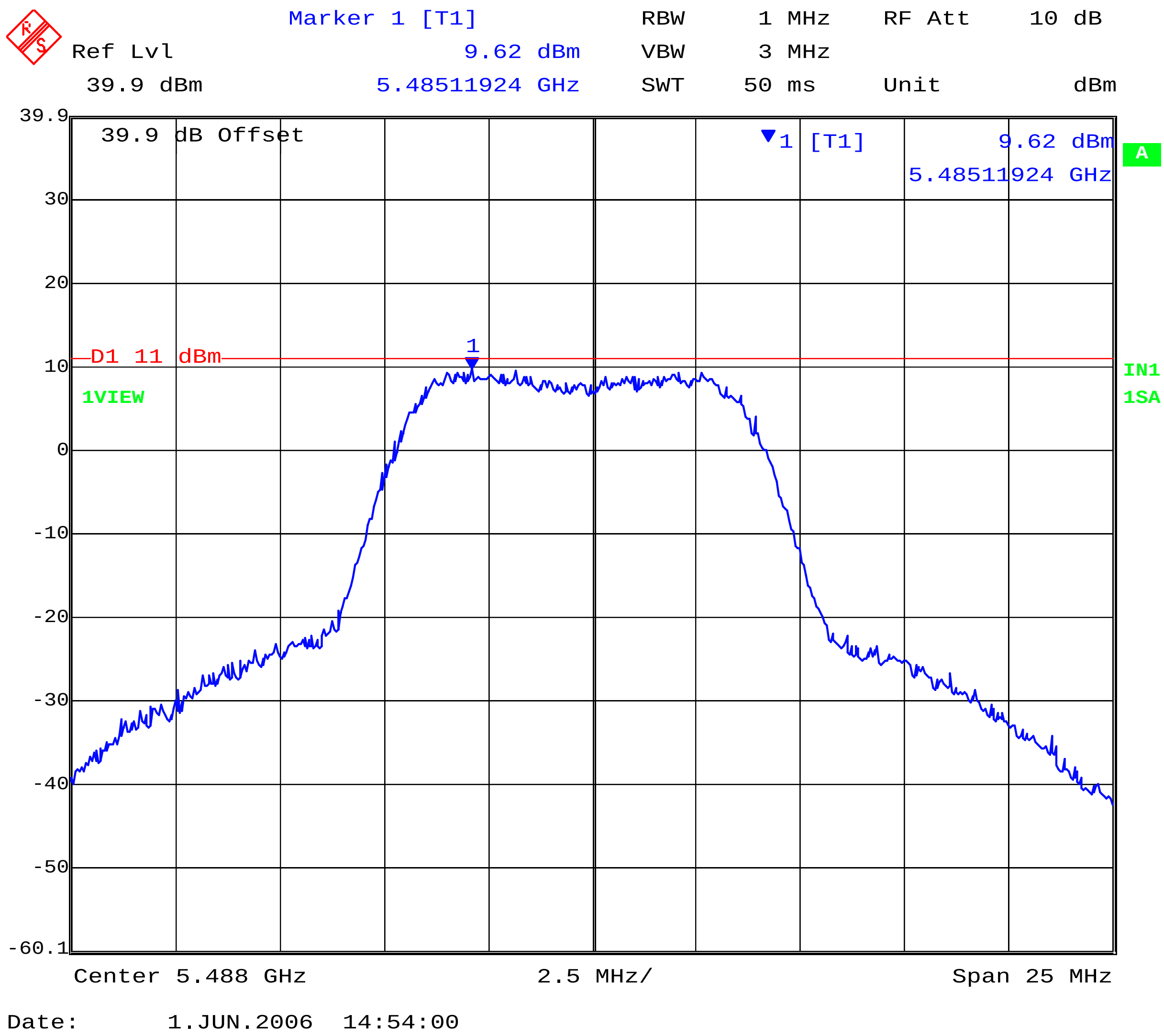


TABLE OF RESULTS – 5.6 GHz Band - 16 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,493	5486.737	+6.54	14
5,602	5595.637	+5.89	On File
5,710	5703.637	+3.08	On File

Plot 14

5,493 MHz 16 MHz Bandwidth QPSK Peak Power Spectral Density

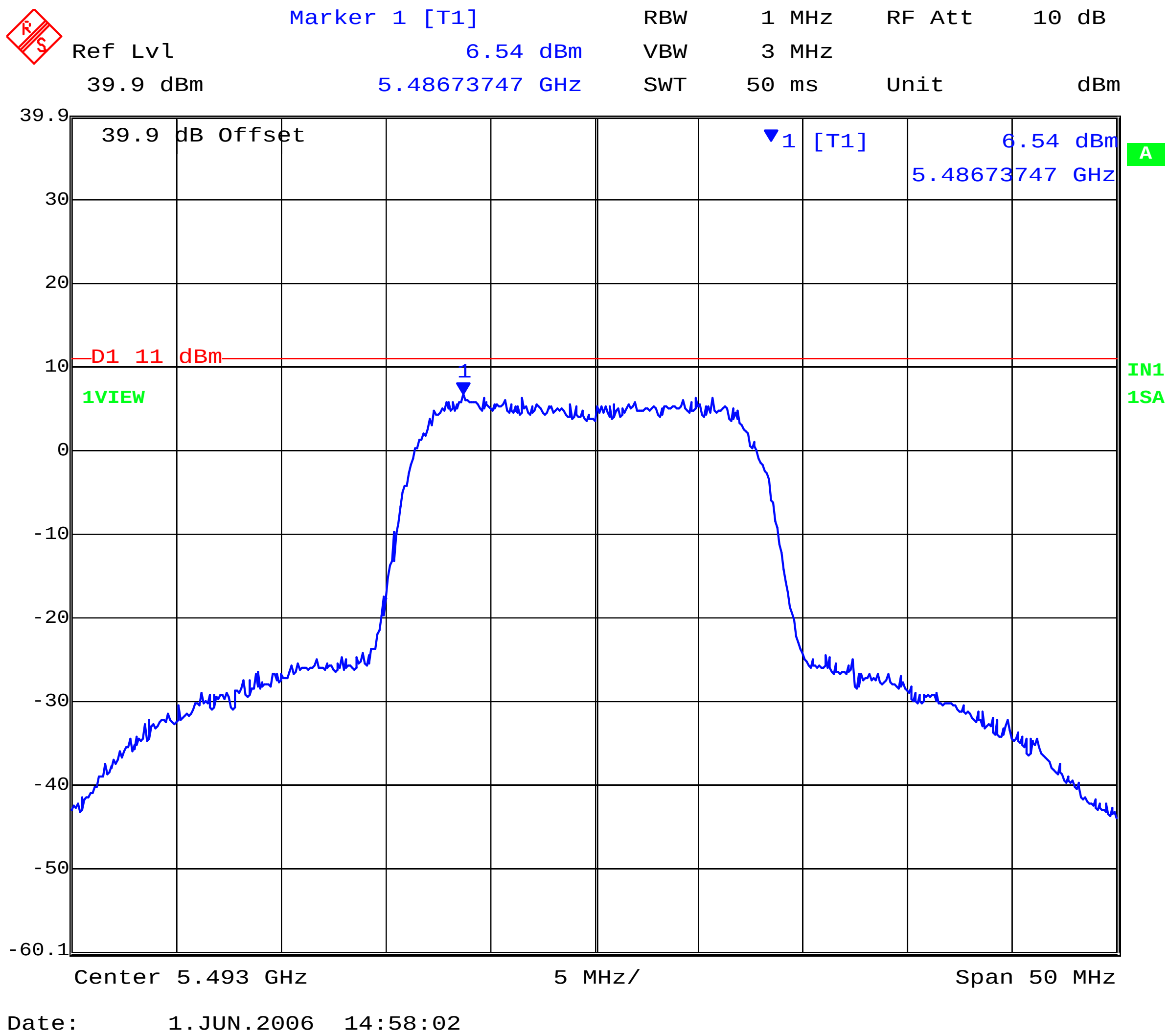


TABLE OF RESULTS – 5.6 GHz Band - 32 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,512	5498.849	+3.03	On File
5,608	5595.600	+3.16	15
5,703	5690.600	+0.45	On File

Plot 15

5,608 MHz 32 MHz Bandwidth QPSK Peak Power Spectral Density

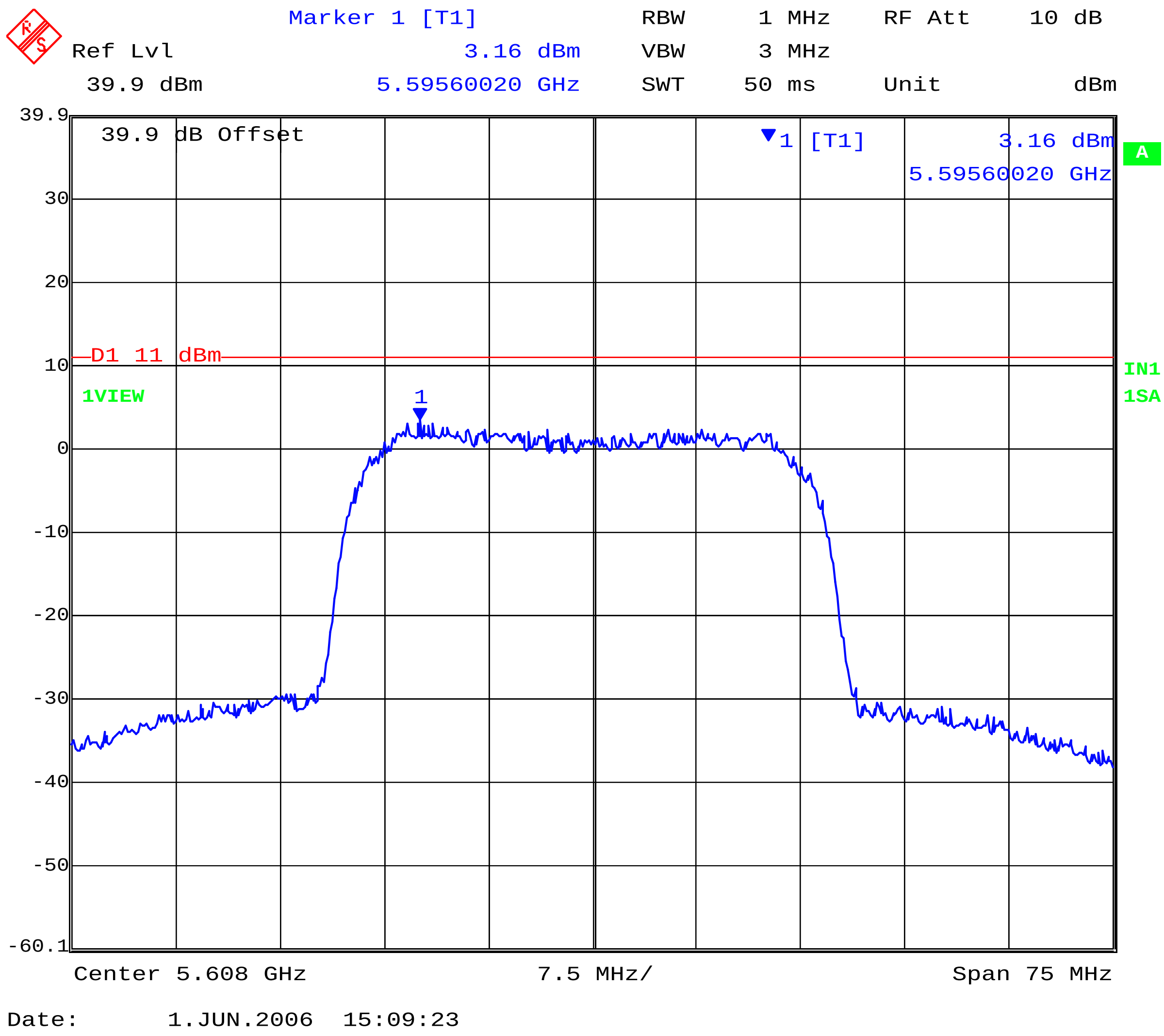
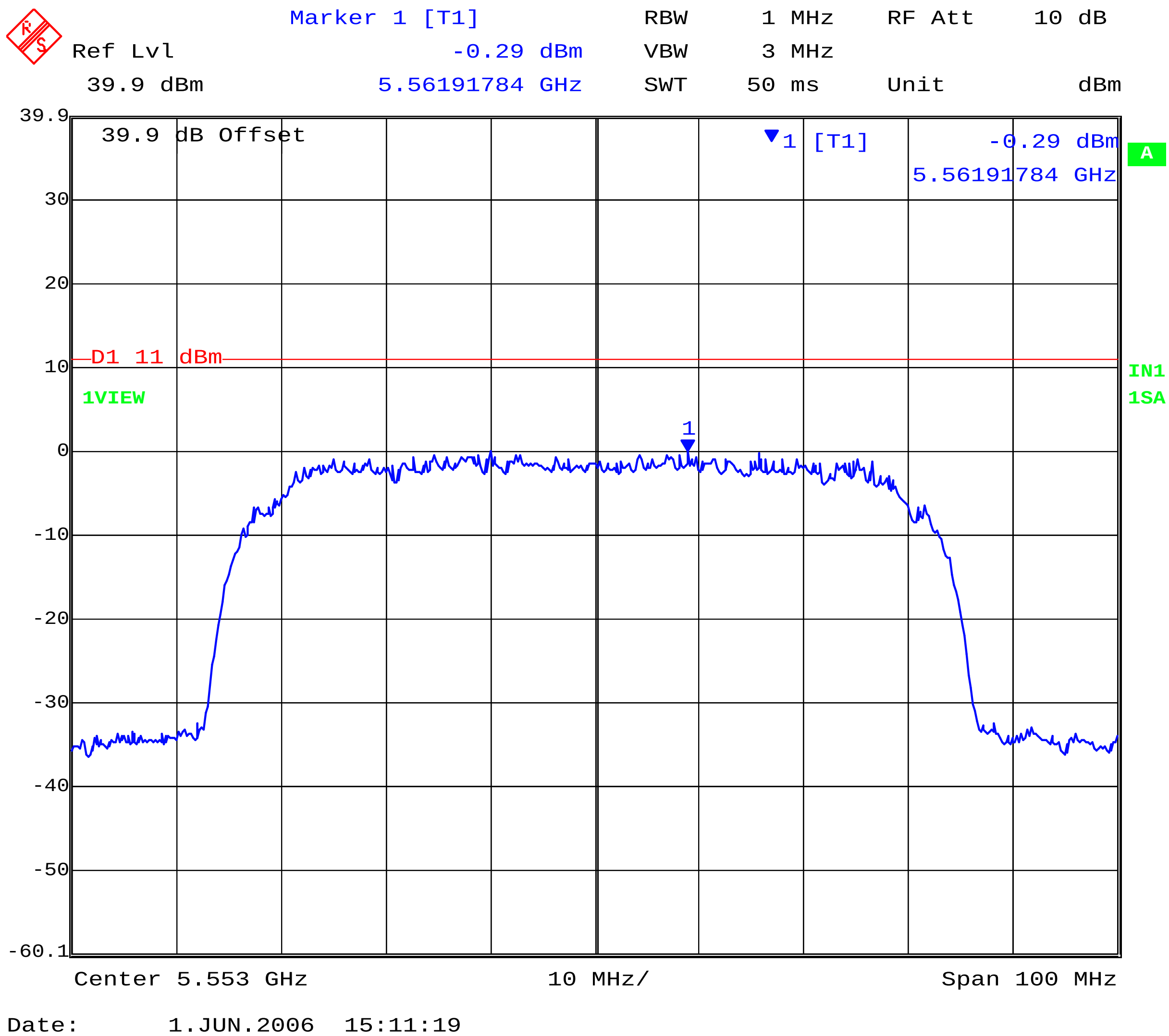


TABLE OF RESULTS – 5.6 GHz Band - 64 MHz Bandwidth QPSK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Plot #
5,553	5561.918	-0.29	16
5,618	5605.876	-1.24	On File
5,683	5694.723	-2.85	On File

Plot 16

5,553 MHz 64 MHz Bandwidth QPSK Peak Power Spectral Density



Specification

FCC, Part 15 §15.407 (a)(2) and Industry Canada RSS-210 § A9.2(2)

For the 5.25-5.35 GHz band the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed +11 dBm in any 1 megahertz band.

Laboratory Measurement Uncertainty for Spectral Density

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

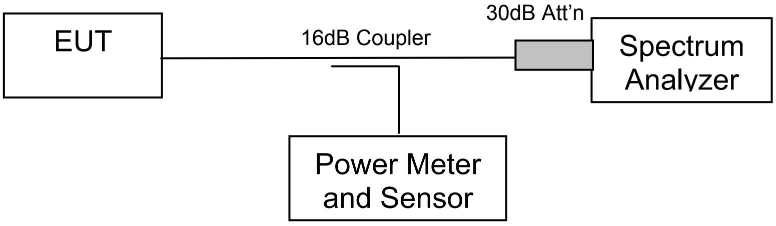
5.1.4. Peak Excursion Ratio

FCC, Part 15 Subpart C §15.407(a)(6)

Test Procedure

This is an antenna conducted measurement using a spectrum analyzer. Method 3 in Normative Reference (x) Section 2.1 was implemented to determine module Peak Excursion Ratio. The Peak Excursion Ratio is the difference in amplitude (dB) between the two traces.

Test Measurement Set up



Measurement set up for Peak Excursion Ratio

Measurement Results for Peak Excursion Ratio

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57% Pressure: 999 to 1012 mbar

Radio parameters.
Power Level: maximum
Duty Cycle: 100% (test mode)

TABLE OF RESULTS – 5.3 GHz Band - 8 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,260	+9.9	On File
5,296	+10.5	On File
5,332	+10.5	17

Plot 17

5,296 MHz - 8 MHz QPSK - Peak Excursion Ratio

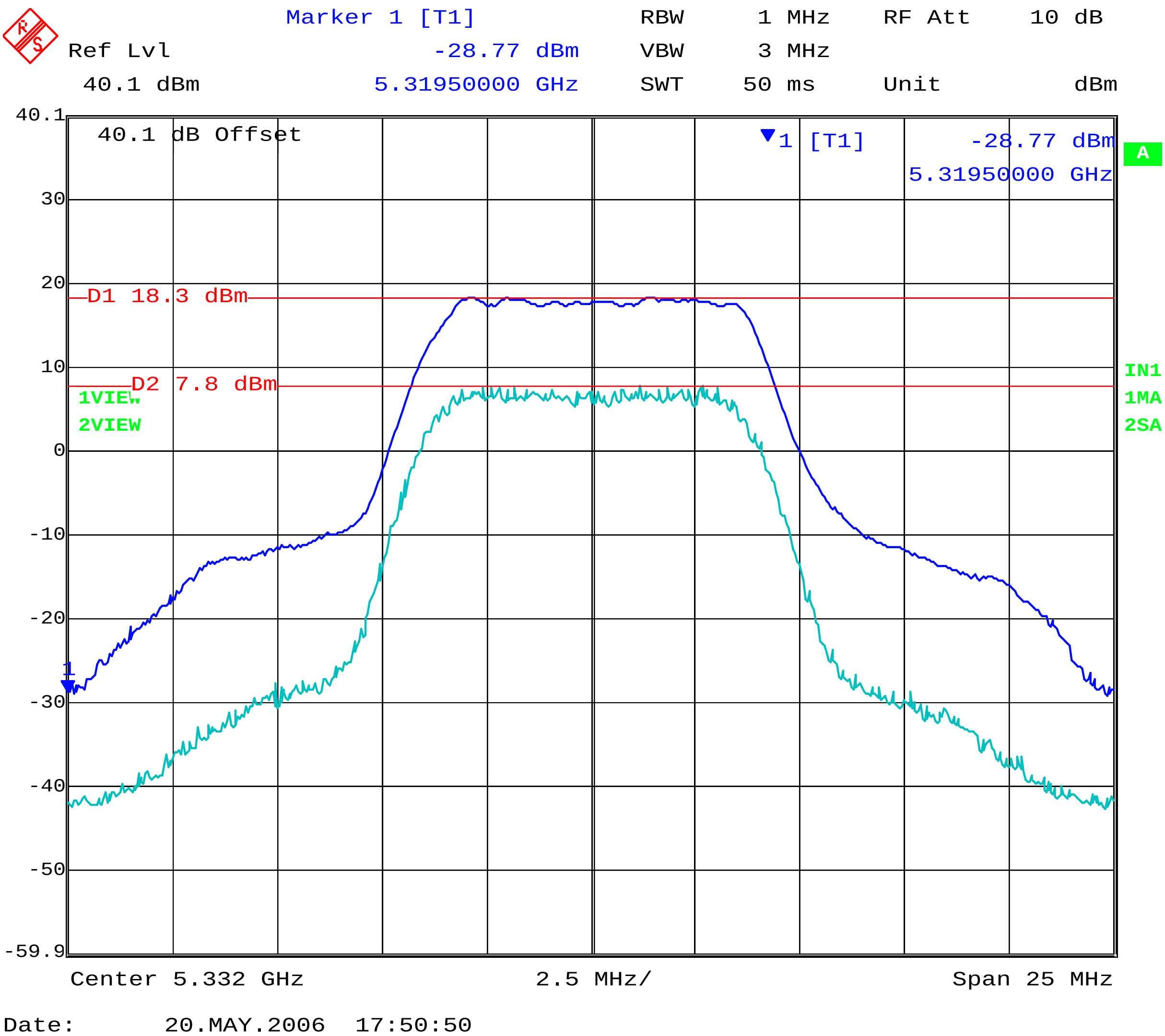


TABLE OF RESULTS – 5.3 GHz Band - 16 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,265	+12.0	On File
5,296	+10.7	On File
5,327	+12.1	18

Plot 18

5,265 MHz - 16 MHz QPSK - Peak Excursion Ratio

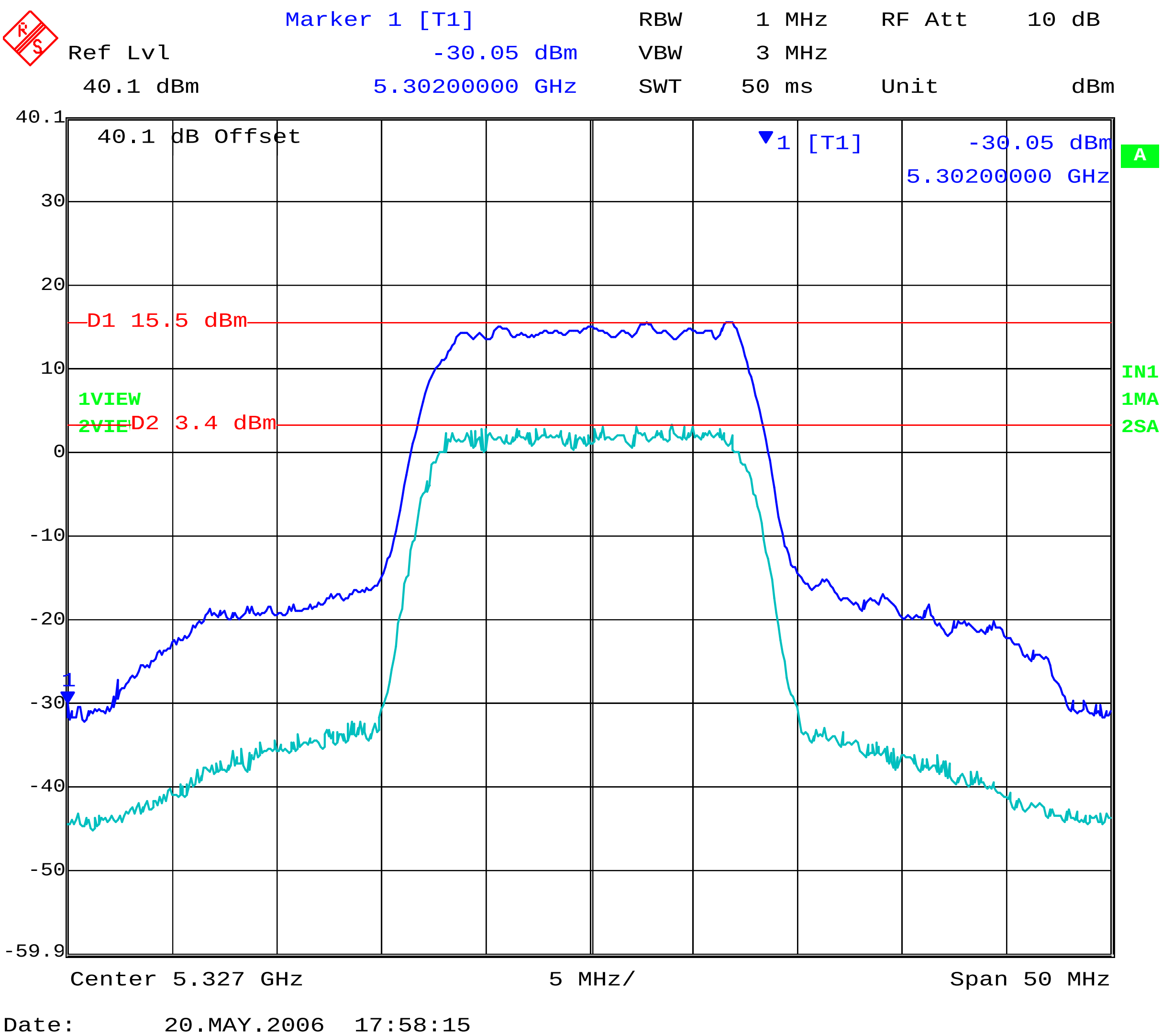


TABLE OF RESULTS – 5.3 GHz Band - 32 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,272	+12.3	On File
5,290	+12.4	19
5,308	+12.3	On File

Plot 19

5,290 MHz - 32 MHz QPSK - Peak Excursion Ratio

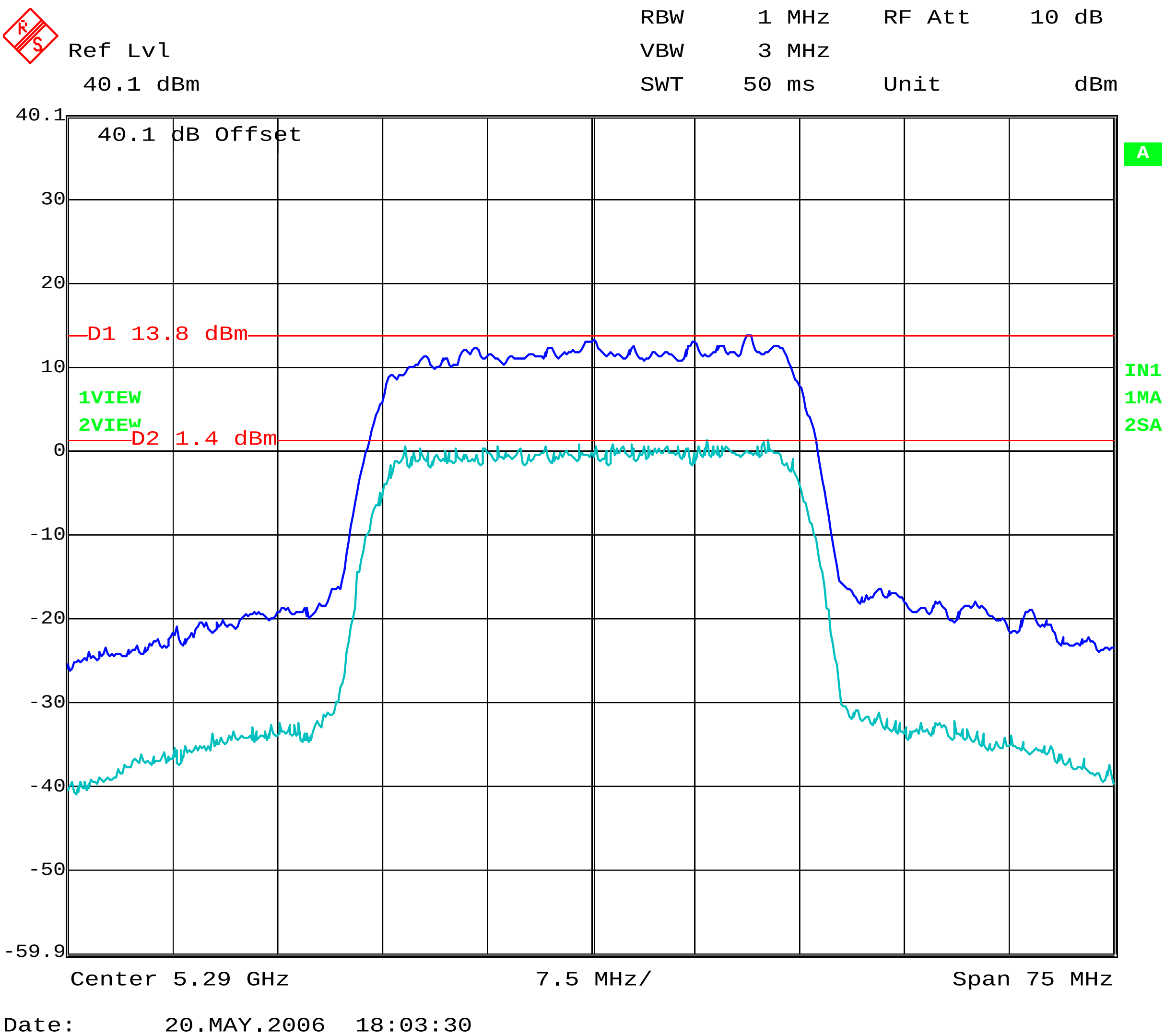


TABLE OF RESULTS – 5.3 GHz Band - 64 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,290	+12.8	20

Plot 20

5,290 MHz - 64 MHz QPSK - Peak Excursion Ratio

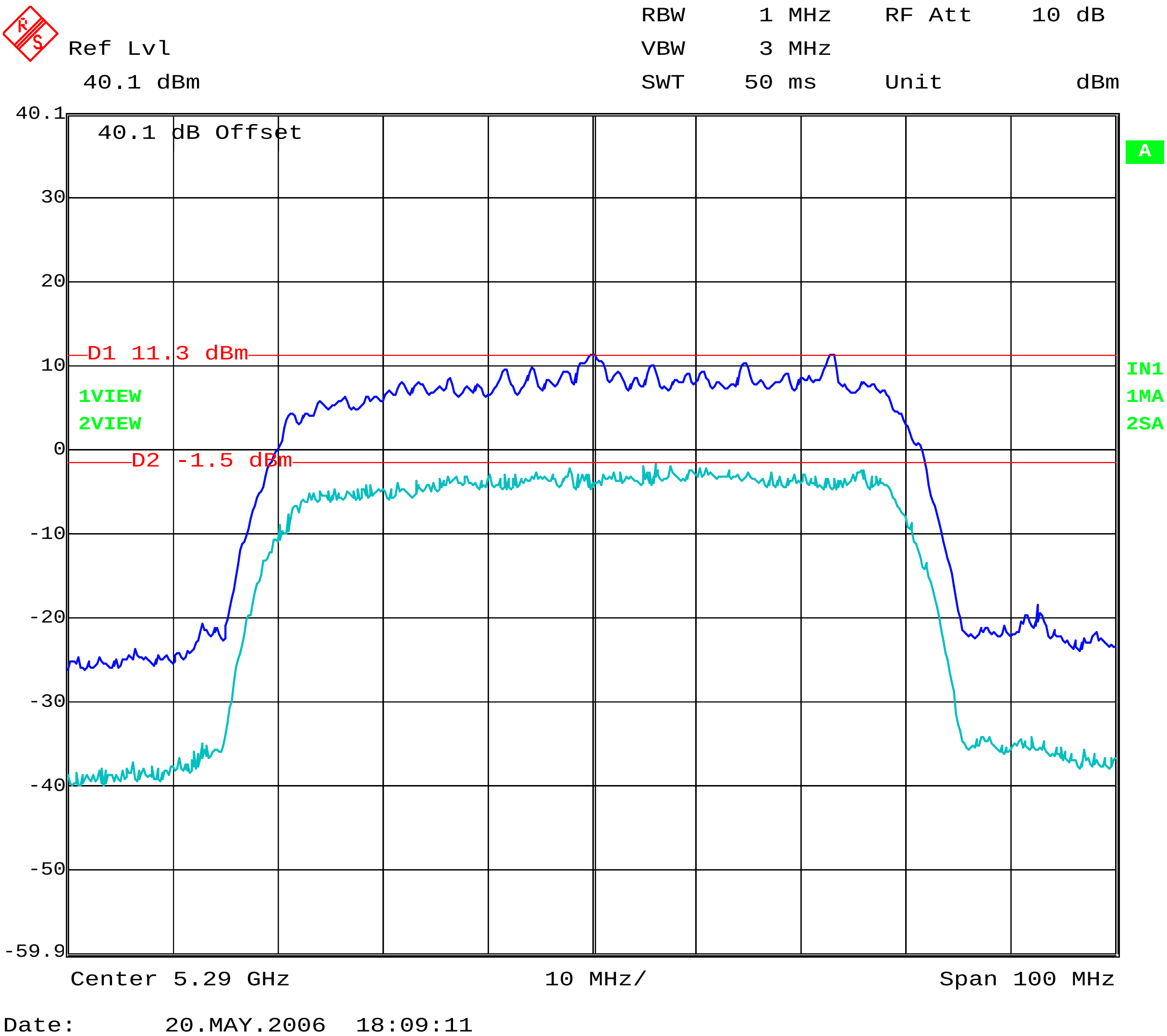


TABLE OF RESULTS – 5.6 GHz Band - 8 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,488	8.93	On File
5,602	8.65	On File
5,715	9.47	21

Plot 21

5,715 MHz - 8 MHz QPSK - Peak Excursion Ratio

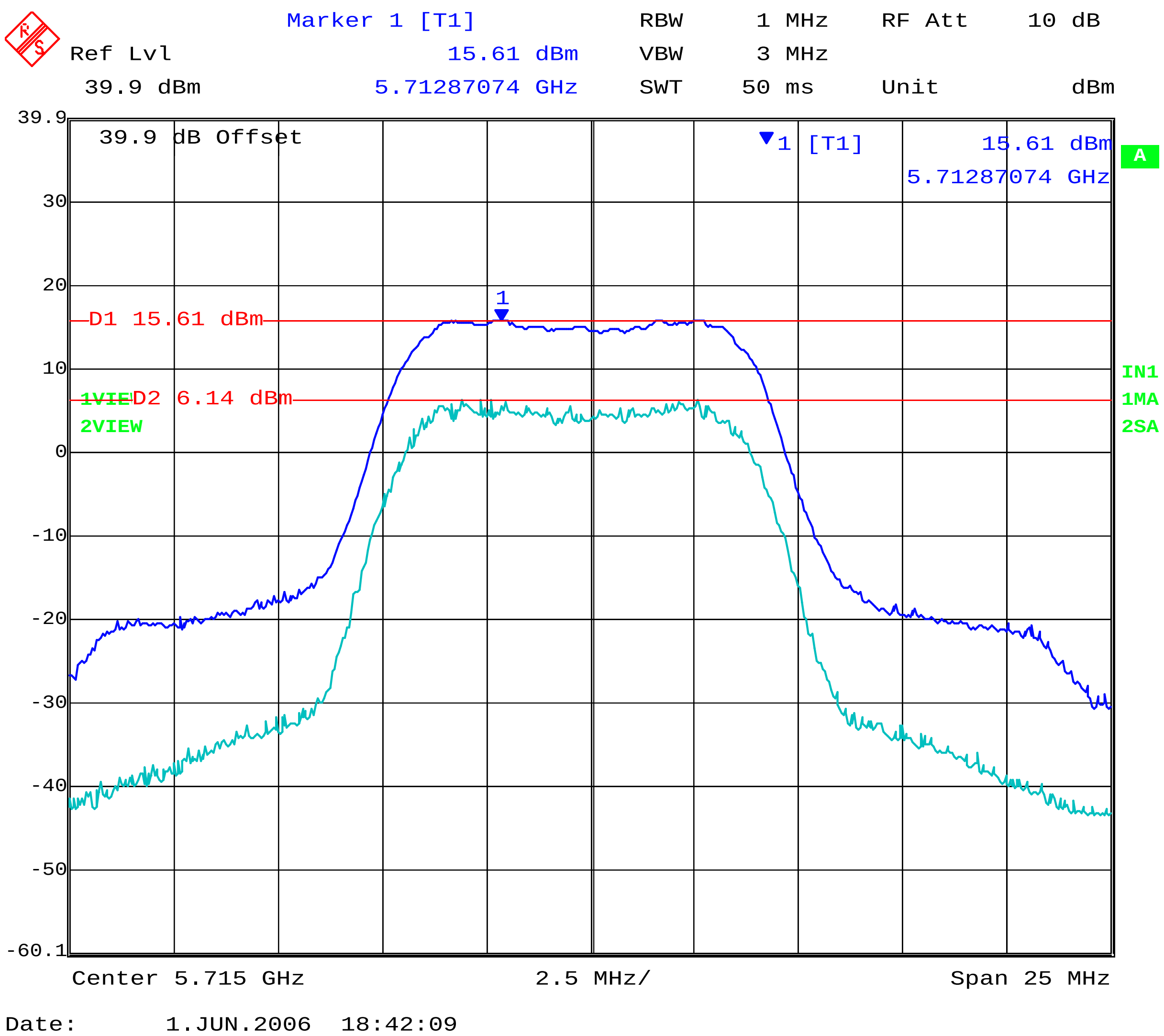


TABLE OF RESULTS – 5.6 GHz Band - 16 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,493	10.62	On File
5,602	10.77	On File
5,710	10.90	22

Plot 22

5,710 MHz - 16 MHz QPSK - Peak Excursion Ratio

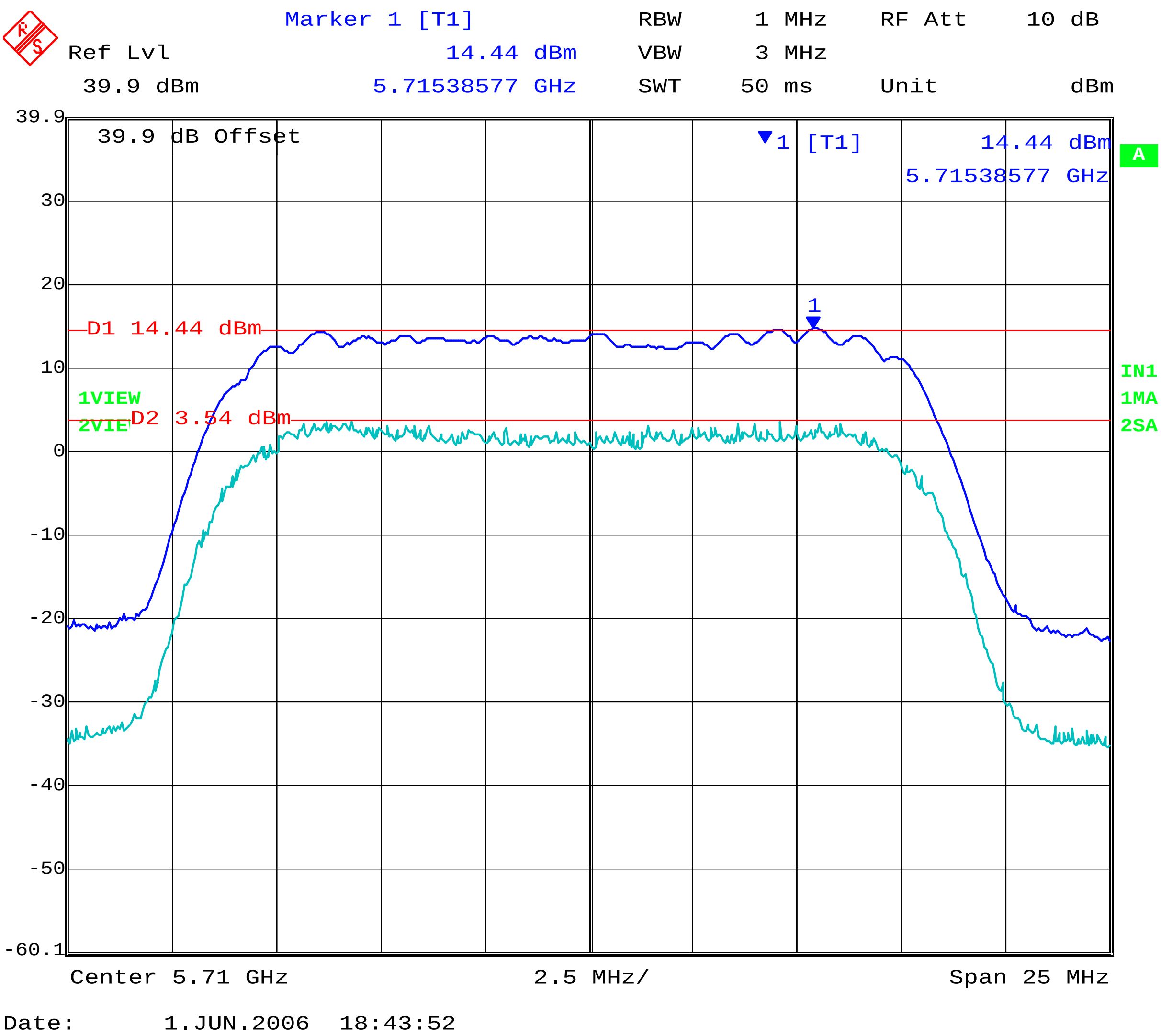


TABLE OF RESULTS – 5.6 GHz Band - 32 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,512	12.09	23
5,608	11.19	On File
5,703	11.14	On File

Plot 23

5,512 MHz - 32 MHz QPSK - Peak Excursion Ratio

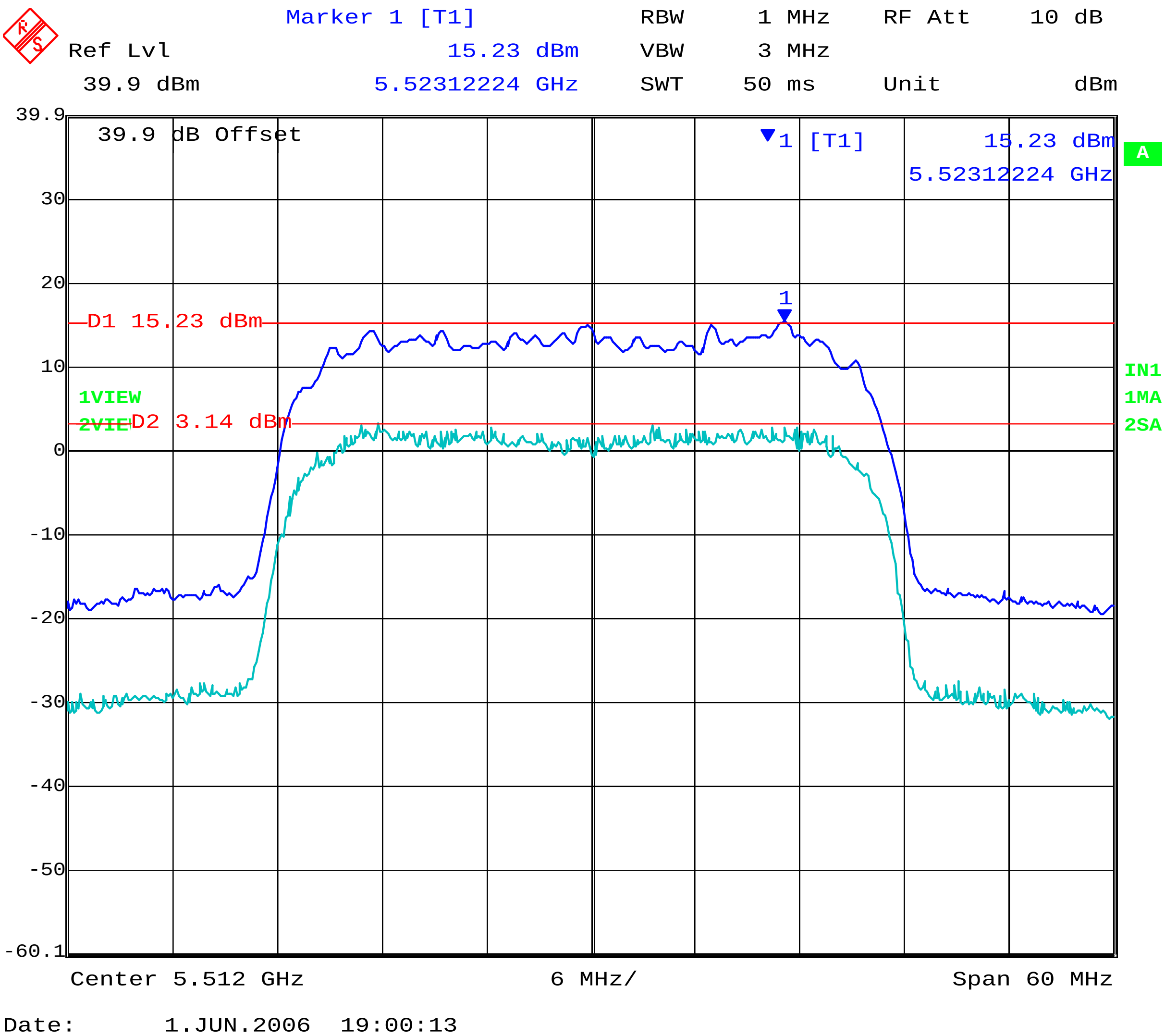
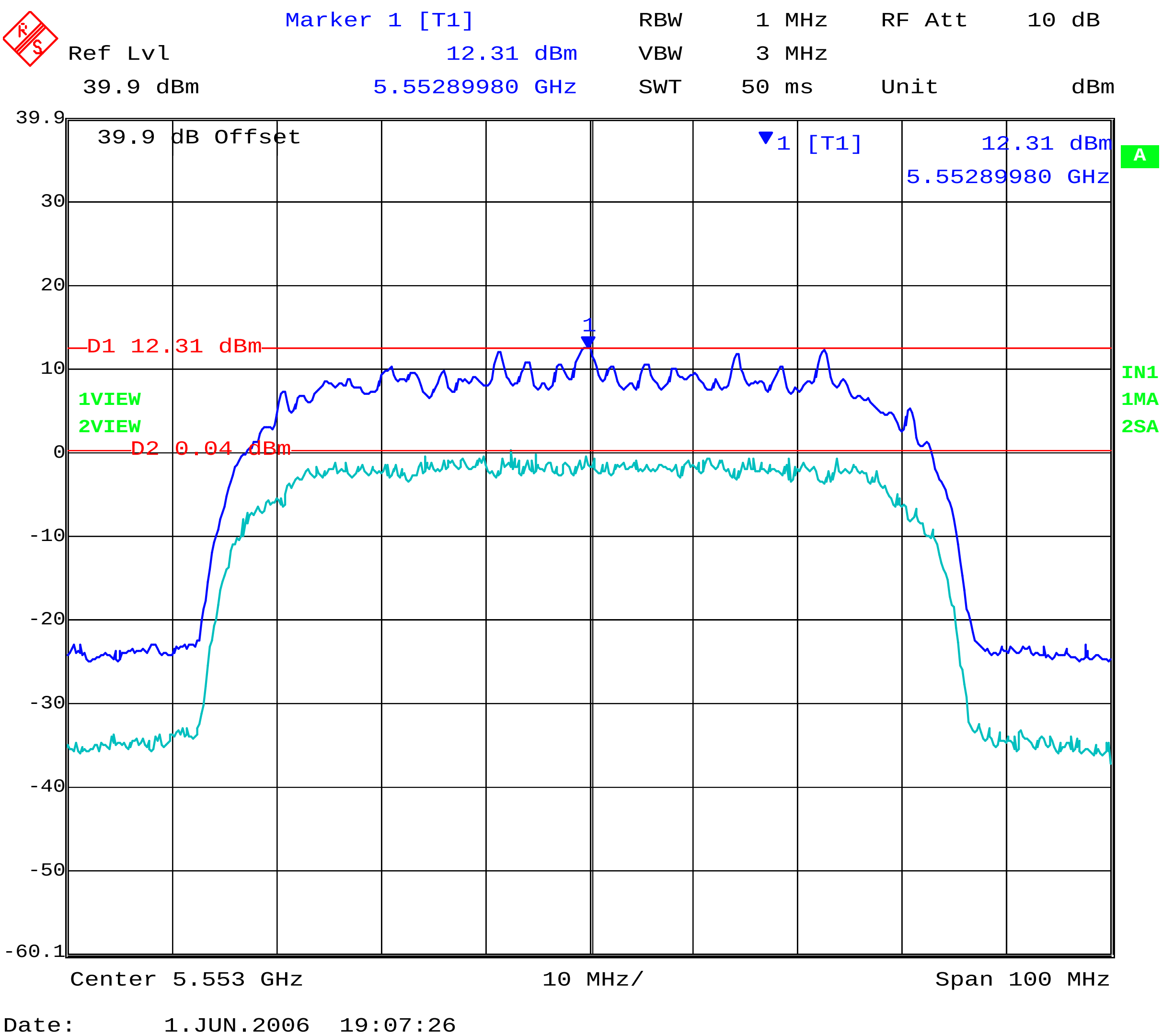


TABLE OF RESULTS – 5.6 GHz Band - 64 MHz Bandwidth QPSK

Centre Frequency (MHz)	Peak Excursion Ratio (dB)	Plot #
5,553	12.27	24
5,618	11.99	On File
5,683	12.30	On File

Plot 24

5,553 MHz - 64 MHz QPSK - Peak Excursion Ratio



Specification

Limits

§15.407 (a)(6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified in this paragraph) shall not exceed 13dB across any 1MHz bandwidth or the emission bandwidth whichever is less

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	± 2.81dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

5.1.5. Frequency Stability

FCC, Part 15 Subpart C §15.407(g)
Industry Canada RSS-210 A9.5(e)

Test Procedure

The manufacturer of the equipment is responsible for ensuring that the frequency stability is such that emissions are always maintained within the band of operation under all conditions.

Manufacturer Declaration

The manufacturer testifies that the frequency stability of the device is +/- 7ppm. This determination is based on the specifications of critical oscillator components in the RF transmitter stage, and these specifications have been adjusted to account for all multiplications or distortions that may occur in the upconversion process. Modulation within the EUT cannot be turned off. The center frequencies for all operational bandwidths are tuned several MHz away from the band edges to assure that out-of-band emissions are met, inclusive of any changes to frequency as a result of the frequency stability specification

The frequency stability of the reference oscillator sets the frequency stability of the RF transceiver signals. Therefore all of the RF signals should have ±7ppm stability.
This stability accounts for room temp tolerance of the crystal oscillator circuit, frequency variation across temperature, and crystal ageing.

±7ppm at 5.350 GHz translates to a maximum frequency shift of ±37.45 KHz. As the edge of the channels is at least one MHz from either of the band edges, ±37.45 KHz is more than sufficient to guarantee that the intentional emission will remain in the band over the entire operating range of the radio.

Specification

Limits

§15.407 (g) Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

RSS-210 §9.5(e)
The frequency stability shall be better than ±10 ppm. Alternatively, the applicant can show that the unwanted emission masks of the outermost channels are complied with when tested under all conditions of normal operation as specified in the user manual.

5.1.6. Maximum Permissible Exposure

FCC, Part 15 Subpart C §15.407(f)
Industry Canada RSS-Gen §5.5

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)

For 28 dBi (631 num.) antenna P (worst case) = +2 dBm (1.585)

For 37.5 dBi (6165 num.) antenna P(worst case) = -7.5 dBm (0.178)

Because the EUT belongs to the General Population / Uncontrolled Exposure the limit of power density is 1mW/cm^2

Antenna Gain (dBi)	Numeric Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Calculated safe distance @ max limit 1mW/ cm^2 (d=cm)
28.0	631	+2.0	1.585	8.9
37.5	5623	-7.5	0.178	8.9

Specification
Maximum Permissible Exposure Limits

§15.407 (f) U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307 (b), 2.1091 and 2.1093 as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment.

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

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

RSS-Gen §5.5 Before equipment certification is granted, the application requirements of RSS-102 shall be met.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

5.1.7. Radiated Emissions

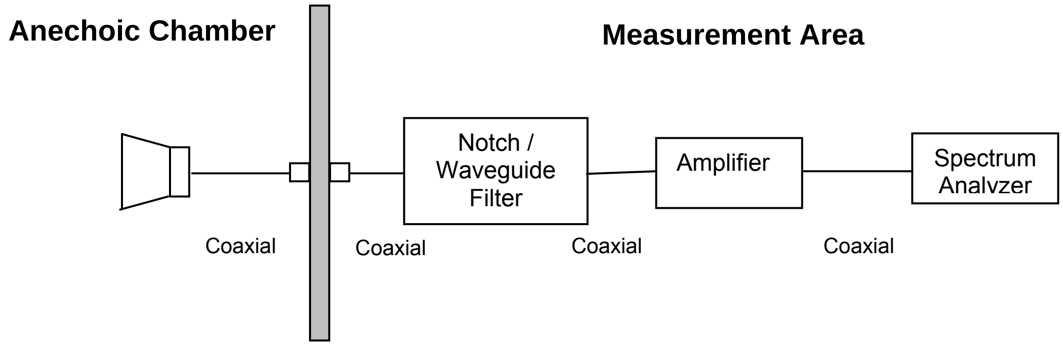
5.1.7.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

FCC, Part 15 Subpart C §15.407(b)(2), §15.205(a)/15.209(a)
Industry Canada RSS-210 §A9.3(2); §2.2; §2.6; RSS-Gen §4.7

Test Procedure
Radiated emissions above 1 GHz are 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 notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO
where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength

$$E = 1000000 \times \sqrt{30P} / 3 \ \mu\text{V/m}$$, where P is the EIRP in Watts

Therefore: -27 dBm/MHz = 68.23 dBuV/m

Measurement Results Transmitter Radiated Spurious Emissions above 1 GHz

Antenna Configuration
28 dBi Panel
37.5 dBi Parabolic

Radio parameters.
Duty Cycle: 100% (test mode)
Power Level: As specified by the following matrix, see Section 5.1.2 Peak Output Power

Peak Power V's Antenna Gain

Antenna Type	Gain (dBi)	Bandwidth (MHz)	Max. Allowable Conducted Power (dBm)
Panel	28	8	-1.43
		16	+1.58
		32 & 64	+2.0
Parabolic	37.5	8	-10.93
		16	-7.92
		32 & 64	-7.50

Measurement Results Transmitter Radiated Spurious Emissions above 1 GHz

Ambient conditions.
Temperature: 17 to 23°C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

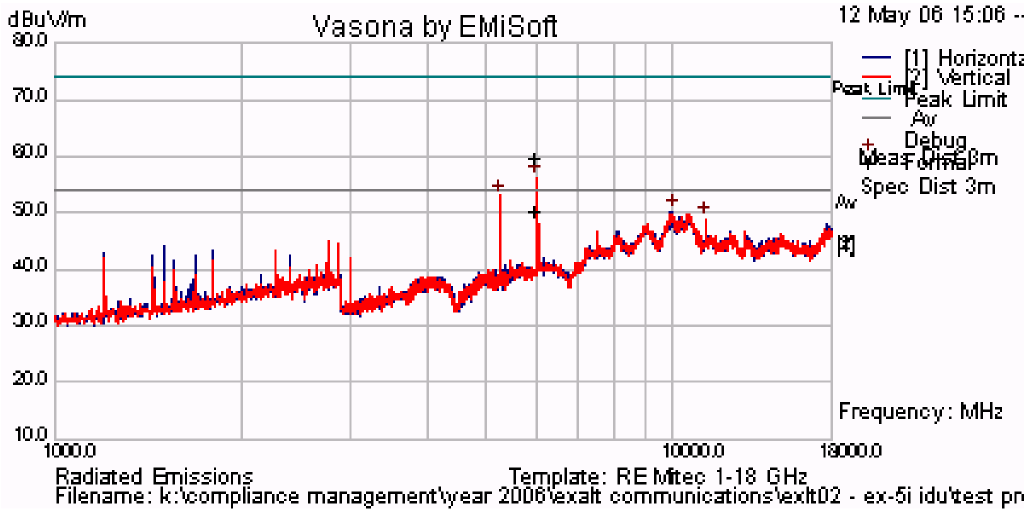
TABLE OF RESULTS – 5,260 MHz 28 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
6017.731	V	50.01	-1.85	48.16	54	-5.84

Note. The carrier in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 8 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,260 MHz Radiated Emissions for 28 dBi Antenna 8 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

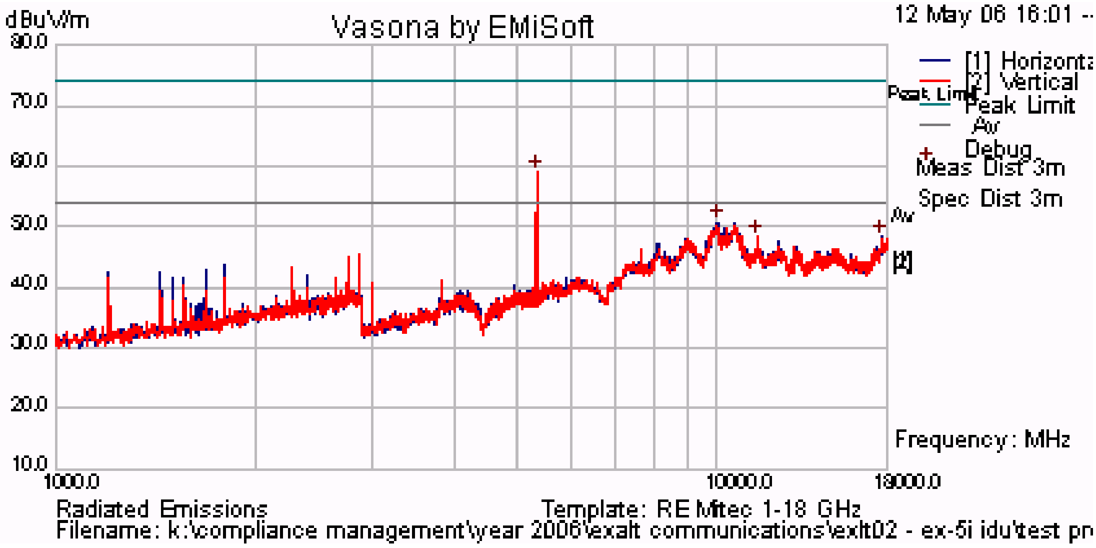
TABLE OF RESULTS – 5,327 MHz 28 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

Note. No emissions were observed above the limit. Note. The carrier in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 16 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,327 MHz Radiated Emissions for 28 dBi Antenna 16 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

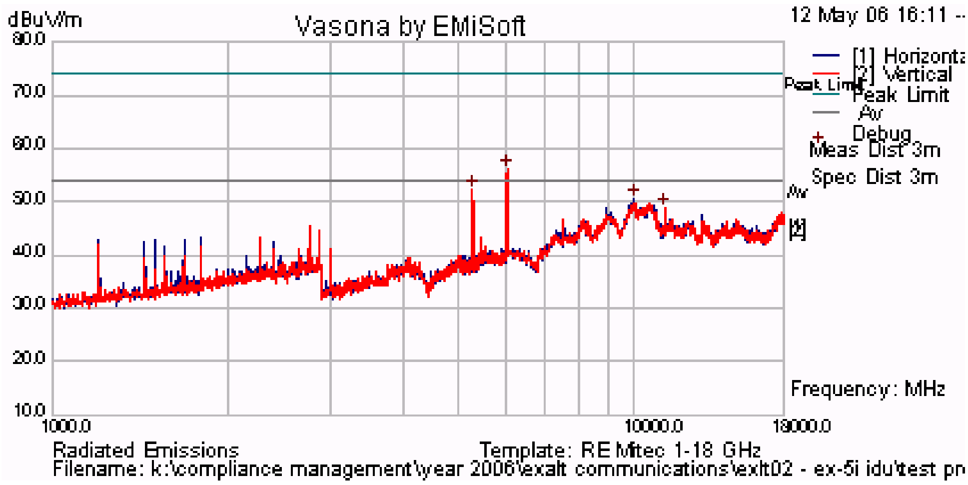
TABLE OF RESULTS – 5,272 MHz 28 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
6017.727	V	49.90	-1.85	48.05	54	-5.95

Note. The carrier in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 32 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,272 MHz Radiated Emissions for 28 dBi Antenna 32 MHz Bandwidth QPSK



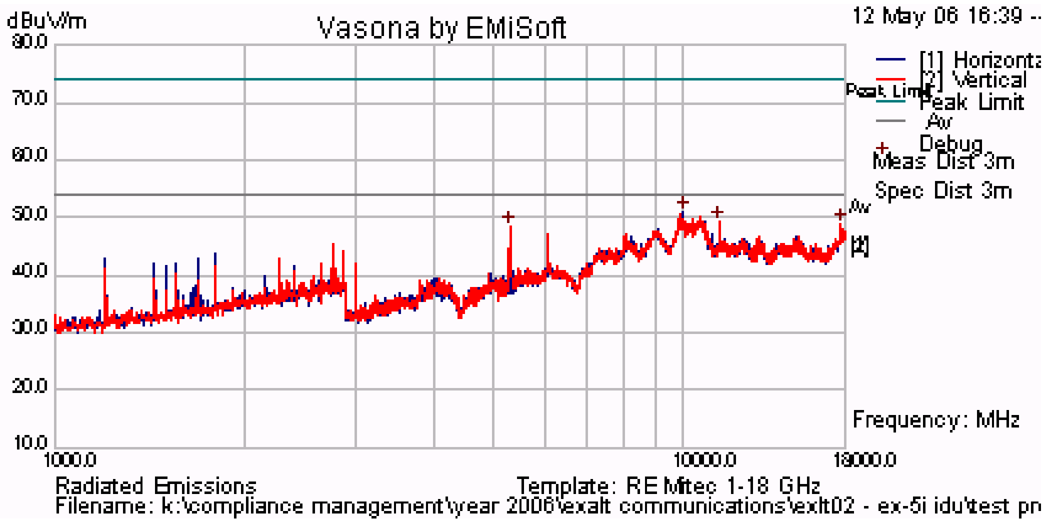
Radiated Spurious Emissions above 1 GHz (continued)

TABLE OF RESULTS –5,290 MHz 28 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

Note. No emissions were observed above the limit.

5,290 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

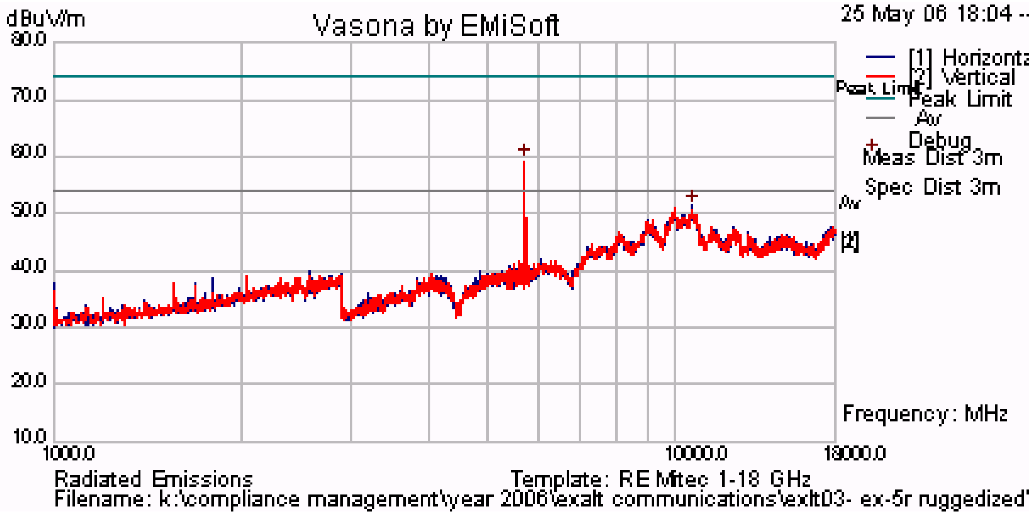
TABLE OF RESULTS –5,715 MHz 28 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

Note. The peak emission shown in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 8 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,715 MHz Radiated Emissions for 28 dBi Antenna 8 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

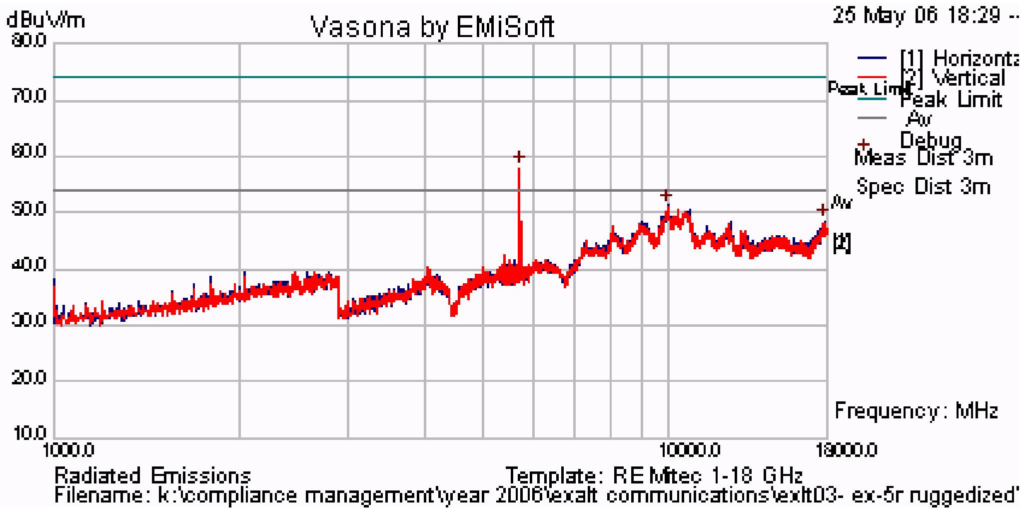
TABLE OF RESULTS –5,710 MHz 28 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

Note. The peak emission shown in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 16 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,710 MHz Radiated Emissions for 28 dBi Antenna 16 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

TABLE OF RESULTS – 5,703 MHz 28 dBi Antenna 32 MHz Bandwidth QPSK

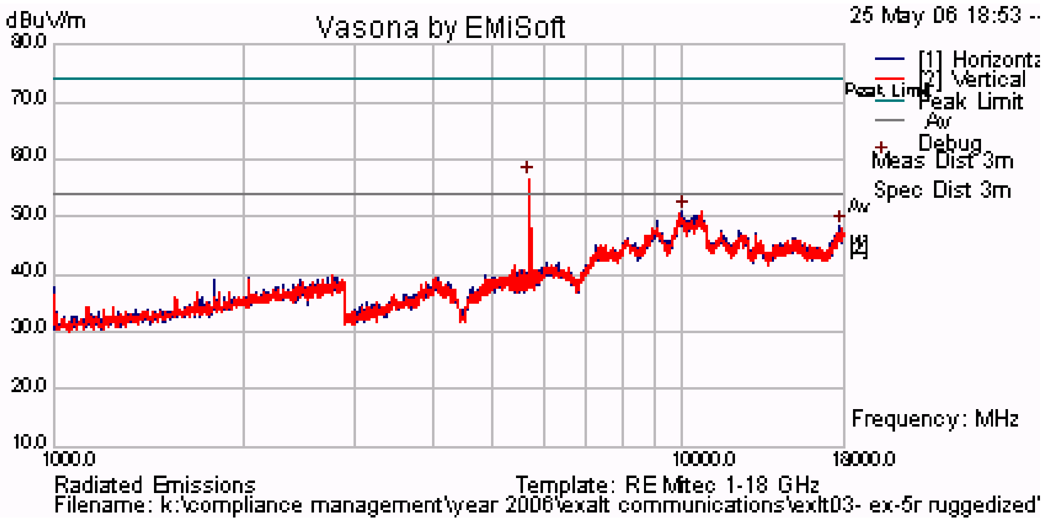
Freq. (MHz)	Pol. (H/V)	Measurement Type Peak/Avg	Field Strength (dBμV/m)	RB/ NRB	Limit (dBμV/m)	Margin (dB)
					54	

RB - Restricted Band / NRB – Non-Restricted Band.

Note. The peak emission shown in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 32 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,703 MHz Radiated Emissions for 28 dBi Antenna 32 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

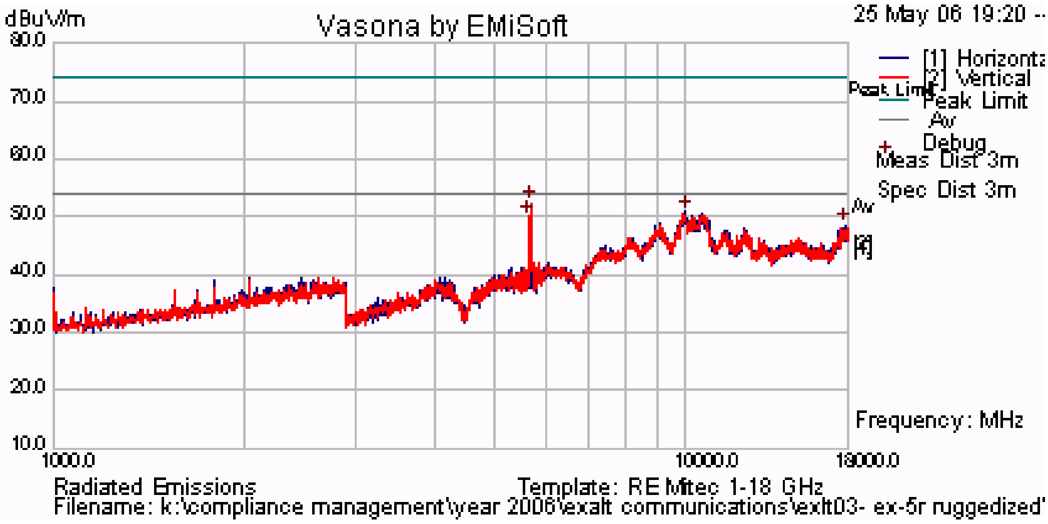
TABLE OF RESULTS – 5,683 MHz 28 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

Note. No emissions were observed above the limit.

Worst case plot shown for 64 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,683 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

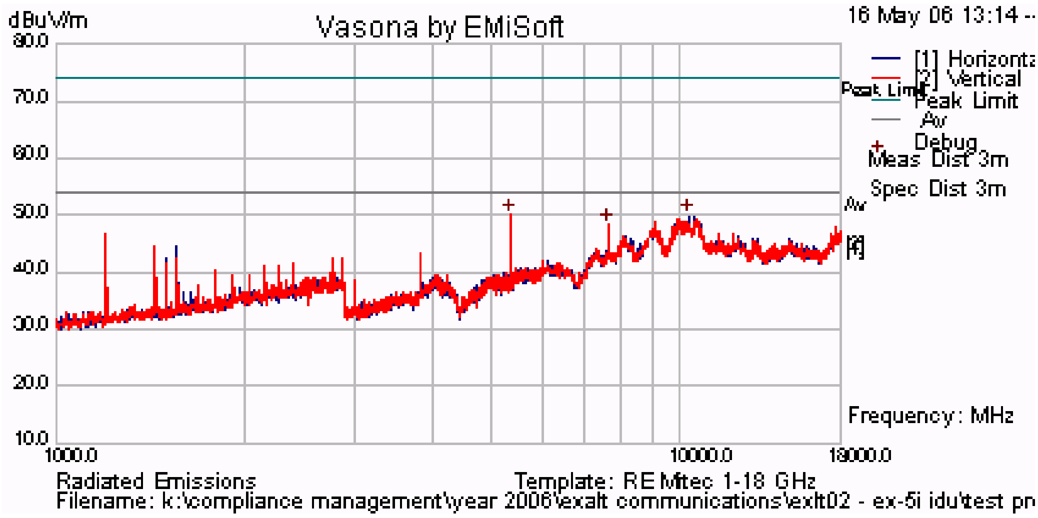
TABLE OF RESULTS – 5,332 MHz 37.5 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Worst case plot shown for 8 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,332 MHz Radiated Emissions for 37.5 dBi Antenna 8 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

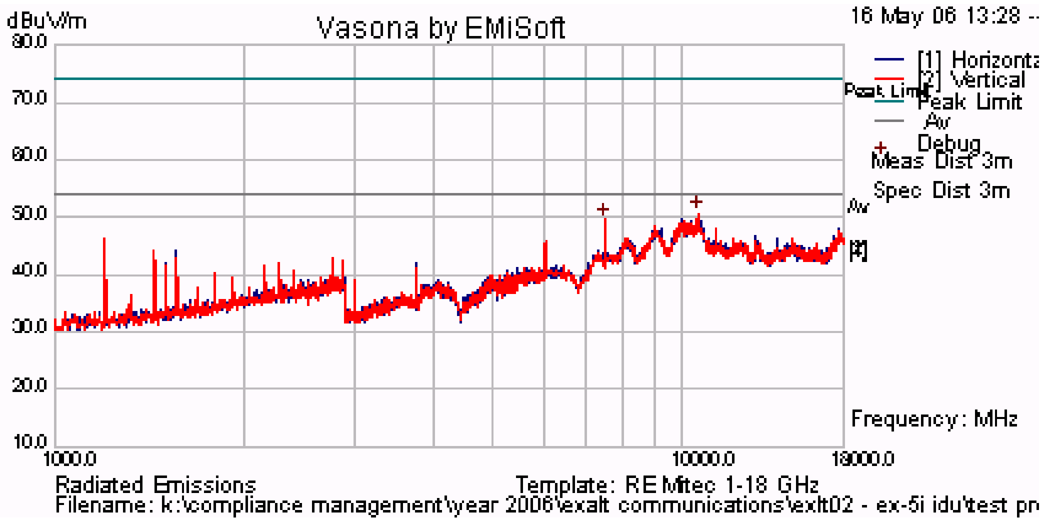
TABLE OF RESULTS – 5,265 MHz 37.5 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Worst case plot shown for 16 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,265 MHz Radiated Emissions for 37.5 dBi Antenna 16 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

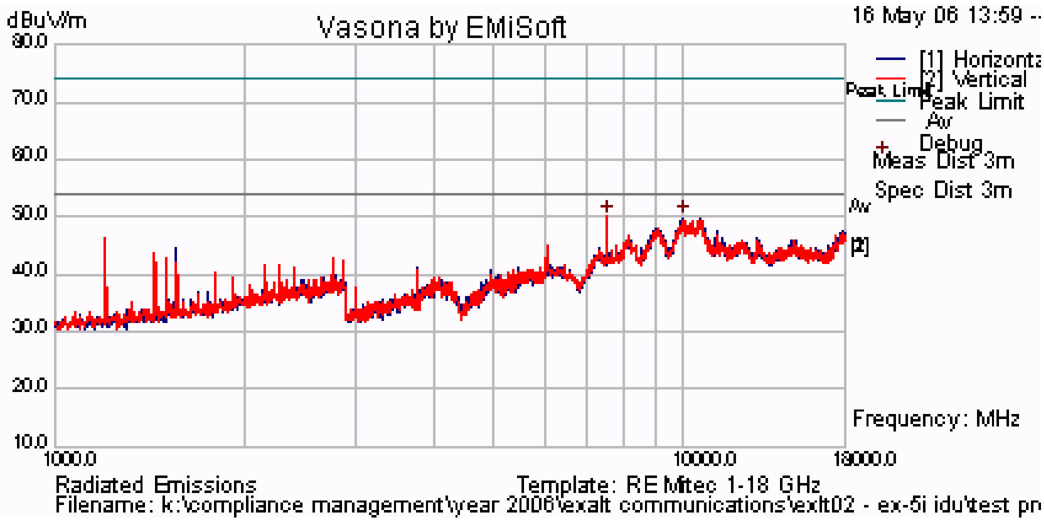
TABLE OF RESULTS – 5,272 MHz 37.5 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Worst case plot shown for 32 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5,272 MHz Radiated Emissions for 37.5 dBi Antenna 32 MHz Bandwidth QPSK



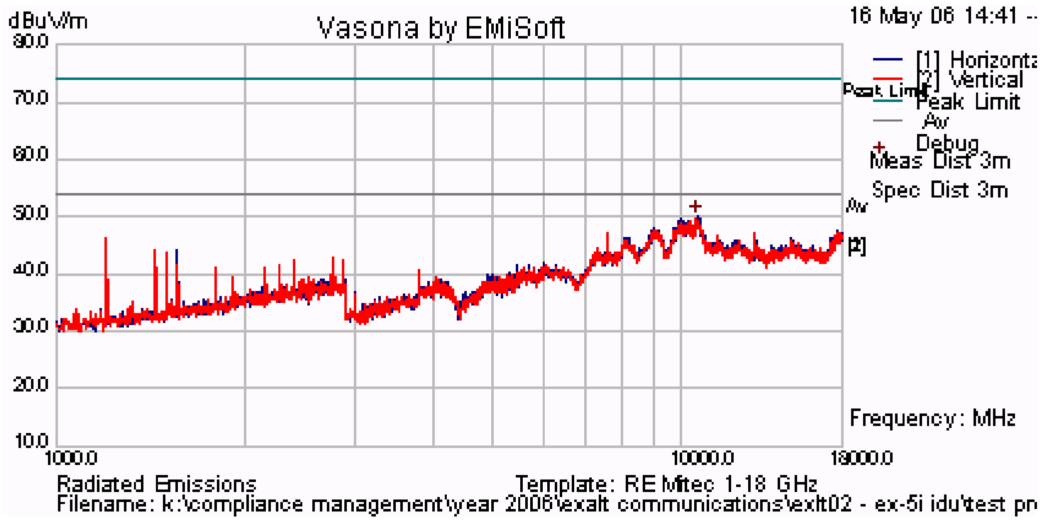
Radiated Spurious Emissions above 1 GHz (continued)

TABLE OF RESULTS – 5,290 MHz 37.5 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

5,290 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

TABLE OF RESULTS –5715 MHz 37.5 dBi Antenna 8 MHz Bandwidth QPSK

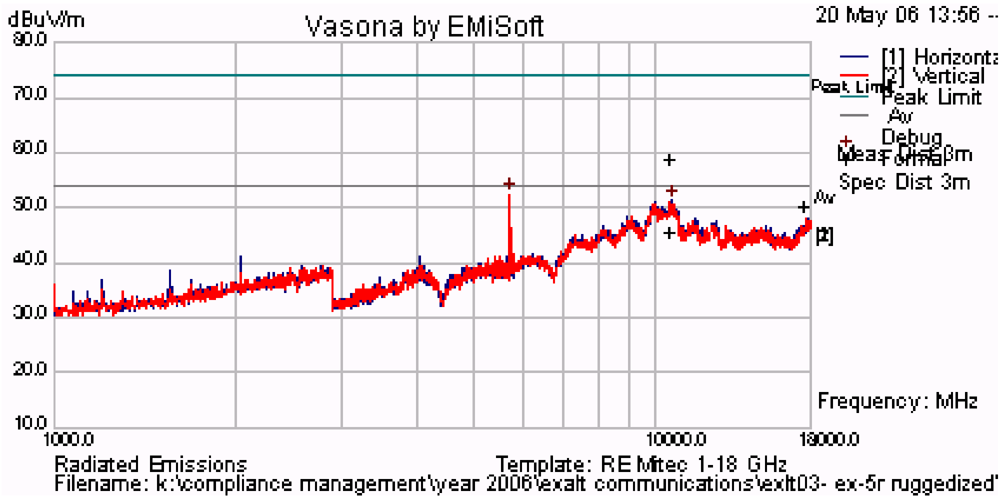
Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Note. The peak emission shown in the graph below is fundamental breaking through the notch filter.

Worst case plot shown for 8 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5715 MHz Radiated Emissions for 37.5 dBi Antenna 8 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

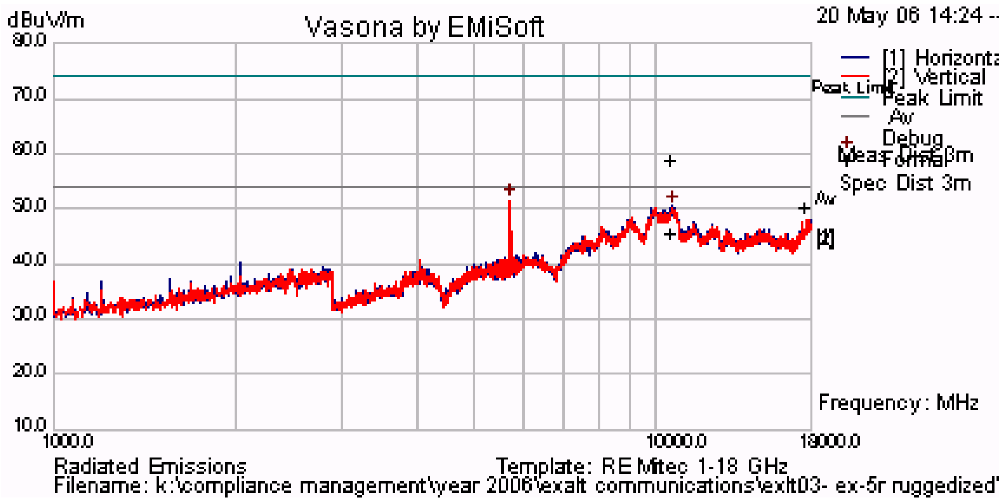
TABLE OF RESULTS –5710 MHz 37.5 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Worst case plot shown for 16 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5710 MHz Radiated Emissions for 37.5 dBi Antenna 16 MHz Bandwidth QPSK



Radiated Spurious Emissions above 1 GHz (continued)

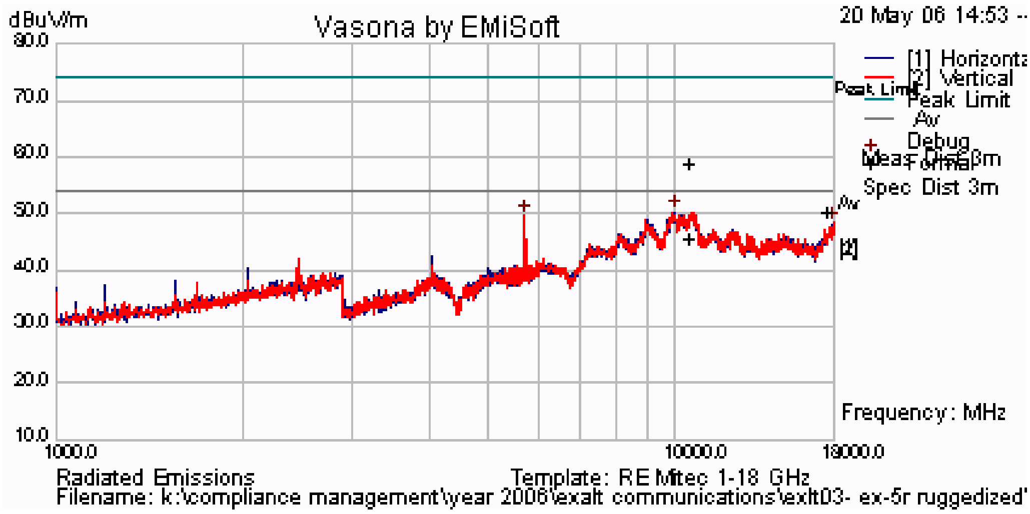
TABLE OF RESULTS –5703 MHz 37.5 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Worst case plot shown for 32 MHz Bandwidth QPSK Modulation. All other results for this bandwidth are held on file.

5703 MHz Radiated Emissions for 37.5 dBi Antenna 32 MHz Bandwidth QPSK



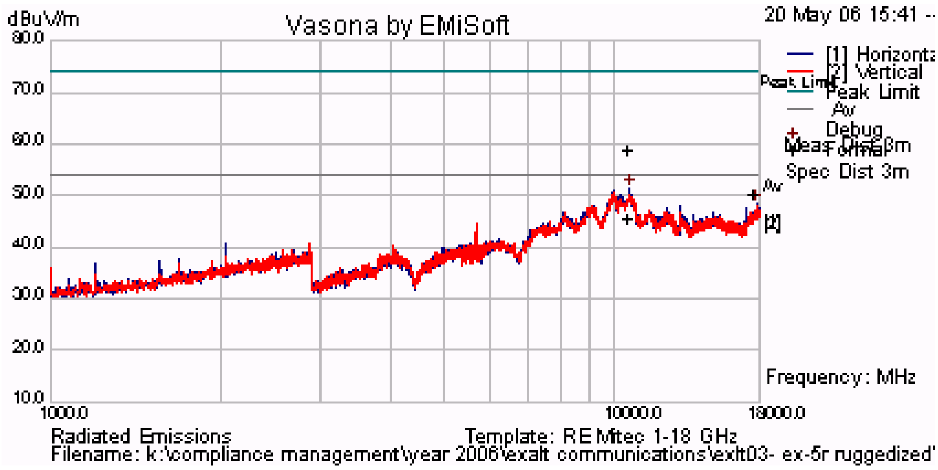
Radiated Spurious Emissions above 1 GHz (continued)

TABLE OF RESULTS –5683 MHz   37.5 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

5683 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth QPSK



Specification Limits

15.407 (b)(2). All emissions outside of the 5,150-5,350MHz band shall not exceed an EIRP of -27dBm/MHz.

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

RSS-210 §A9.3(2) For transmitters operating in the 5250-5350 MHz band, all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz e.i.r.p. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band shall not exceed out of band emission limit of 27 dBm/MHz e.i.r.p. in the 5150-5250 MHz band in order to operate indoor/outdoor, or alternatively shall comply with the spectral power density for operation within the 5150-5250 MHz band and shall be labeled “for indoor use only”.

RSS-Gen §4.7 The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

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, 0304, 0311, 0315, 0310, 0312

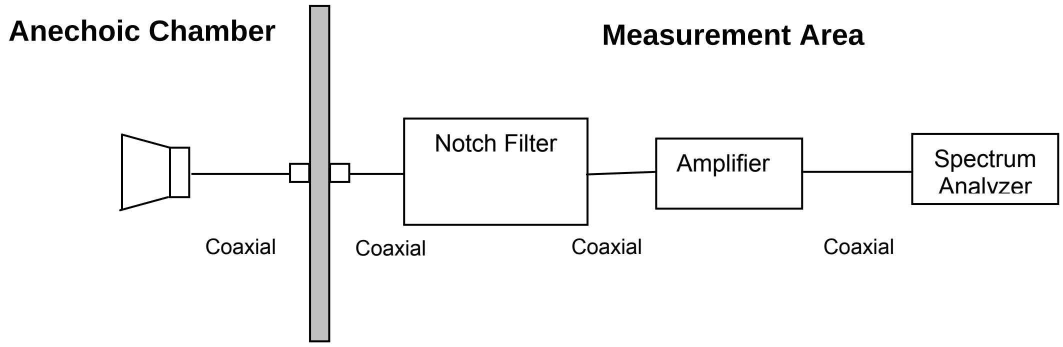
5.1.7.2. Radiated Band-Edge – Restricted Bands

Test Procedure

Radiated emissions above 1 GHz are 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.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO
where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Band-stop Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 \text{ dB}\mu\text{V/m}$$

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (}\mu\text{V/m))}$$

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

Radiated Band Edge - Test Configurations

Antennas
28 dBi Panel Antenna
37.5 dBi Parabolic Antenna

Radio parameters.
Duty Cycle: 100% (test mode)
Power Level: As specified by the following matrix, see Section 5.1.2 Peak Output Power

Peak Power V's Antenna Gain

Antenna Type	Gain (dBi)	Bandwidth (MHz)	Max. Allowable Conducted Power (dBm)
Panel	28	8	-1.43
		16	+1.58
		32 & 64	+2.00
Parabolic	37.5	8	-10.93
		16	-7.92
		32 & 64	-7.50

Radiated Band Edge Test Results for 28 dBi Panel Antenna

TABLE OF RESULTS - 5.3 GHz Band - 8 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,260_{PEAK}$	5,150	62.28	74.00	-11.72
$5,260_{AVE}$	5,150	40.99	54.00	-13.01
$5,332_{PEAK}$	5,350	66.85	74.00	-7.15
$5,332_{AVE}$	5,350	43.38	54.00	-10.62

TABLE OF RESULTS - 5.3 GHz Band - 16 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,265_{PEAK}$	5,150	62.55	74.00	-11.45
$5,265_{AVE}$	5,150	40.99	54.00	-13.01
$5,327_{PEAK}$	5,350	70.90	74.00	-3.10
$5,327_{AVE}$	5,350	45.03	54.00	-8.97

TABLE OF RESULTS - 5.3 GHz Band - 32 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,272_{PEAK}$	5,150	62.28	74.00	-11.72
$5,272_{AVE}$	5,150	40.99	54.00	-13.01
$5,308_{PEAK}$	5,350	73.01	74.00	-0.99
$5,308_{AVE}$	5,350	48.91	54.00	-5.09

Radiated Band Edge Test Results for 28 dBi Panel Antenna (continued)

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,290_{PEAK}$	5,150	62.82	74.00	-11.18
$5,290_{AVE}$	5,150	40.99	54.00	-13.01
$5,290_{PEAK}$	5,350	72.87	74.00	-1.13
$5,290_{AVE}$	5,350	52.13	54.00	-1.87

Radiated Band Edge Test Results for 28 dBi Panel Antenna

TABLE OF RESULTS - 5.6 GHz Band - 8 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}488_{PEAK}$	5460	64.26	74	-9.74
$5{,}488_{AVE}$	5460	43.45	54	-10.55

TABLE OF RESULTS - 5.6 GHz Band - 16 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}493_{PEAK}$	5460	64.55	74	-9.45
$5{,}493_{AVE}$	5460	42.74	54	-11.26

TABLE OF RESULTS - 5.6 GHz Band - 32 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}512_{PEAK}$	5460	64.12	74	-9.88
$5{,}512_{AVE}$	5460	42.74	54	-11.26

TABLE OF RESULTS - 5.6 GHz Band - 64 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}553_{PEAK}$	5460	66.11	74	-7.89
$5{,}553_{AVE}$	5460	44.46	54	-9.54

Radiated Band Edge Test Results for 37.5 dBi Parabolic Antenna

TABLE OF RESULTS - 5.3 GHz Band - 8 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}260_{PEAK}$	5,150	62.14	74.00	-11.86
$5{,}260_{AVE}$	5,150	41.10	54.00	-12.90
$5{,}332_{PEAK}$	5,350	62.50	74.00	-11.50
$5{,}332_{AVE}$	5,350	41.82	54.00	-12.18

TABLE OF RESULTS - 5.3 GHz Band - 16 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}265_{PEAK}$	5,150	62.28	74.00	-11.72
$5{,}265_{AVE}$	5,150	41.10	54.00	-12.90
$5{,}327_{PEAK}$	5,350	63.03	74.00	-10.97
$5{,}327_{AVE}$	5,350	41.82	54.00	-12.18

TABLE OF RESULTS - 5.3 GHz Band - 32 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}272_{PEAK}$	5,150	62.42	74.00	-11.58
$5{,}272_{AVE}$	5,150	41.10	54.00	-12.90
$5{,}308_{PEAK}$	5,350	64.43	74.00	-9.57
$5{,}308_{AVE}$	5,350	42.37	54.00	-11.63

Radiated Band Edge Test Results for 37.5 dBi Parabolic Antenna (continued)

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5{,}290_{PEAK}$	5,150	62.82	74.00	-11.18
$5{,}290_{AVE}$	5,150	41.10	54.00	-12.90
$5{,}290_{PEAK}$	5,350	63.31	74.00	-10.69
$5{,}290_{AVE}$	5,350	41.82	54.00	-12.18

Radiated Band Edge Test Results for 37.5 dBi Parabolic Antenna

TABLE OF RESULTS - 5.6 GHz Band - 8 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,488_{PEAK}$	5460	63.84	74	-10.16
$5,488_{AVE}$	5460	42.74	54	-11.26

TABLE OF RESULTS - 5.6 GHz Band - 16 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,493_{PEAK}$	5460	63.84	74	-10.16
$5,493_{AVE}$	5460	42.74	54	-11.26

TABLE OF RESULTS - 5.6 GHz Band - 32 MHz Bandwidth QPSK

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,512_{PEAK}$	5460	63.98	74	-10.02
$5,512_{AVE}$	5460	42.74	54	-11.26

TABLE OF RESULTS - 5.6 GHz Band - 64 MHz Bandwidth QPSK

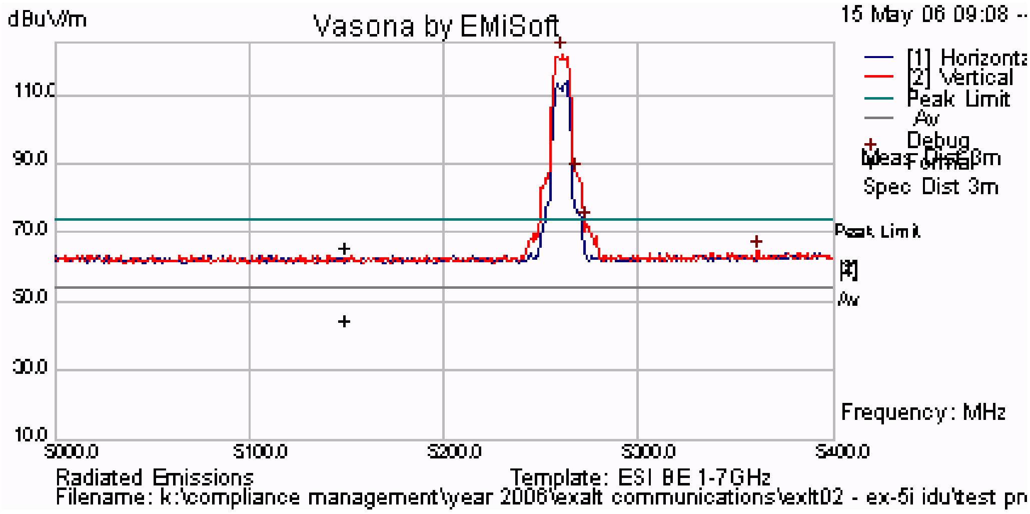
Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,553_{PEAK}$	5460	64.26	74	-9.74
$5,553_{AVE}$	5460	42.74	54	-11.26

Peak Field Strength Measurements

Peak Field Strength for 28 dBi Antenna

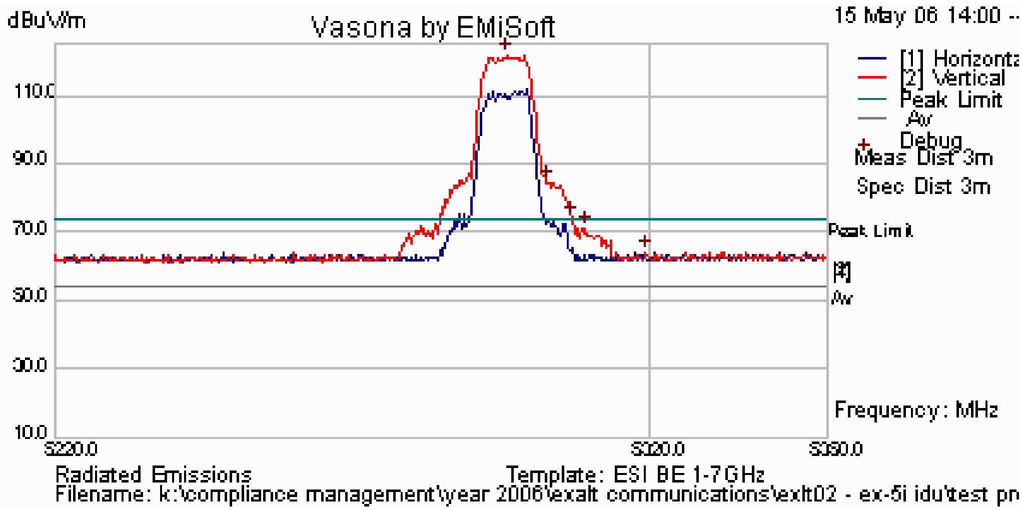
28 dBi Antenna 5,260 MHz 8 MHz Bandwidth QPSK

Peak Emission = 121.91 dBµV/m



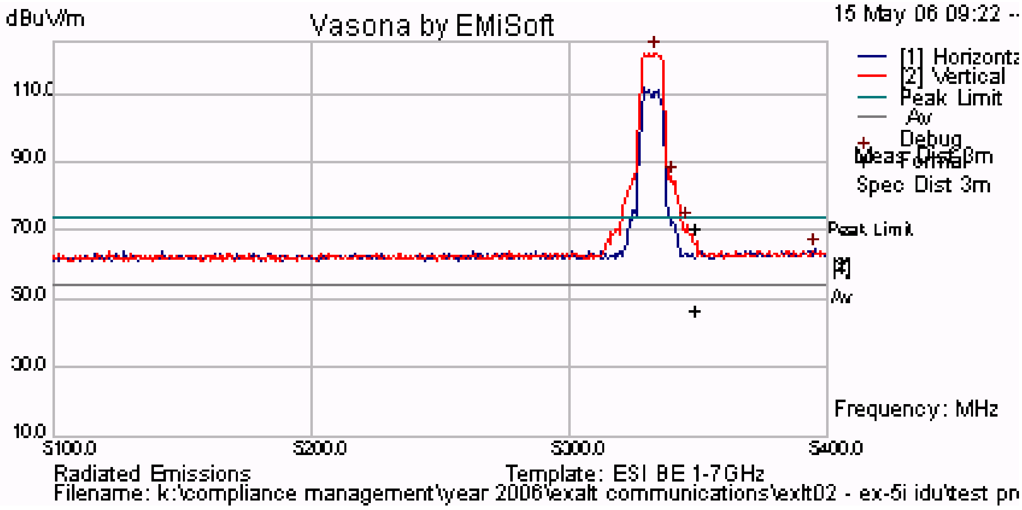
28 dBi Antenna 5,296 MHz 8 MHz Bandwidth QPSK

Peak Emission = 121.99 dBµV/m



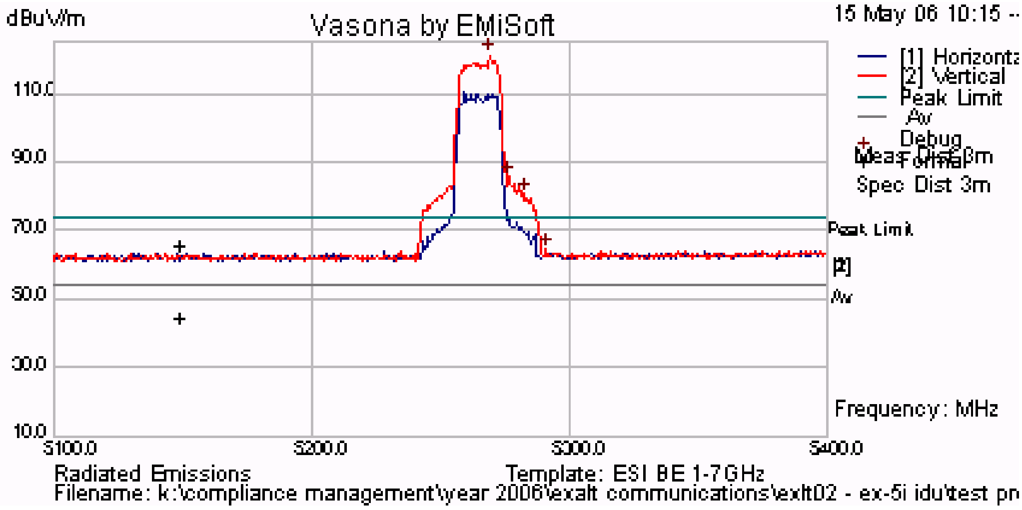
28 dBi Antenna 5,332 MHz 8 MHz Bandwidth QPSK

Peak Emission = 121.94 dBµV/m



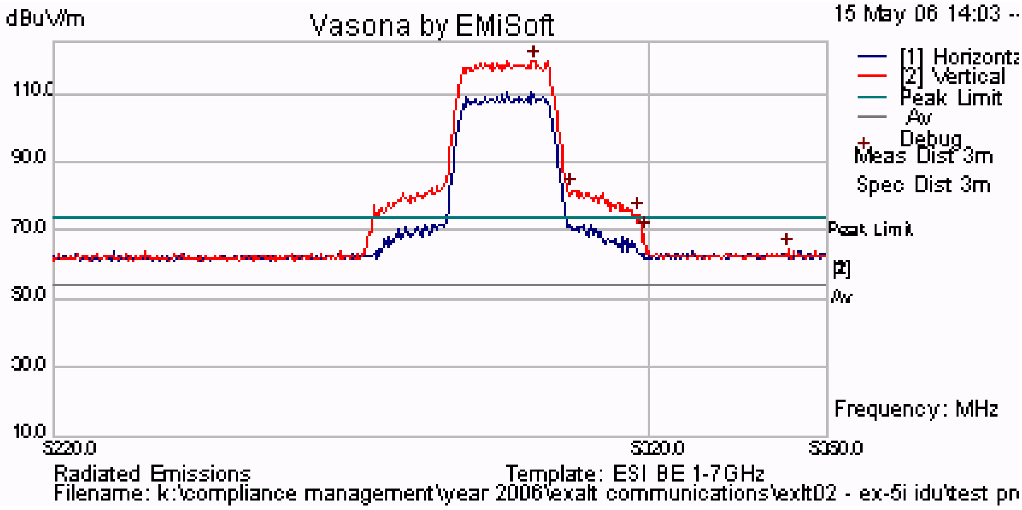
28 dBi Antenna 5,265 MHz 16 MHz Bandwidth QPSK

Peak Emission = 121.14 dBµV/m



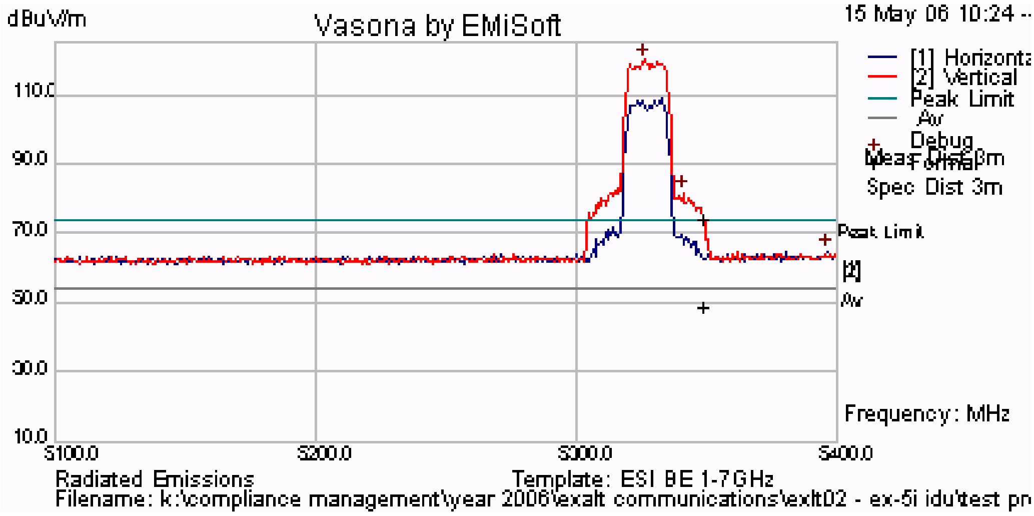
28 dBi Antenna 5,296 MHz 16 MHz Bandwidth QPSK

Peak Emission = 119.63 dBµV/m



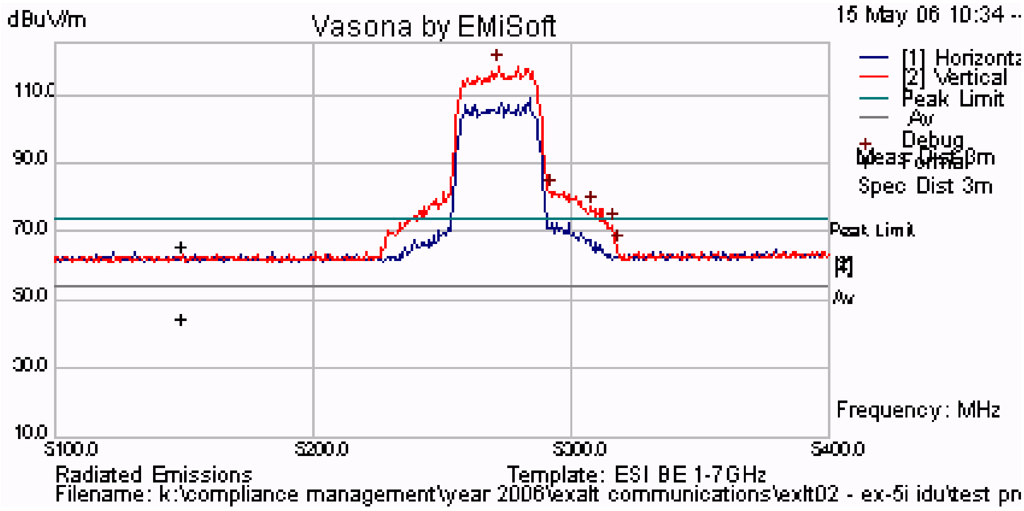
28 dBi Antenna 5,327 MHz 16 MHz Bandwidth QPSK

Peak Emission = 120.01 dBμV/m



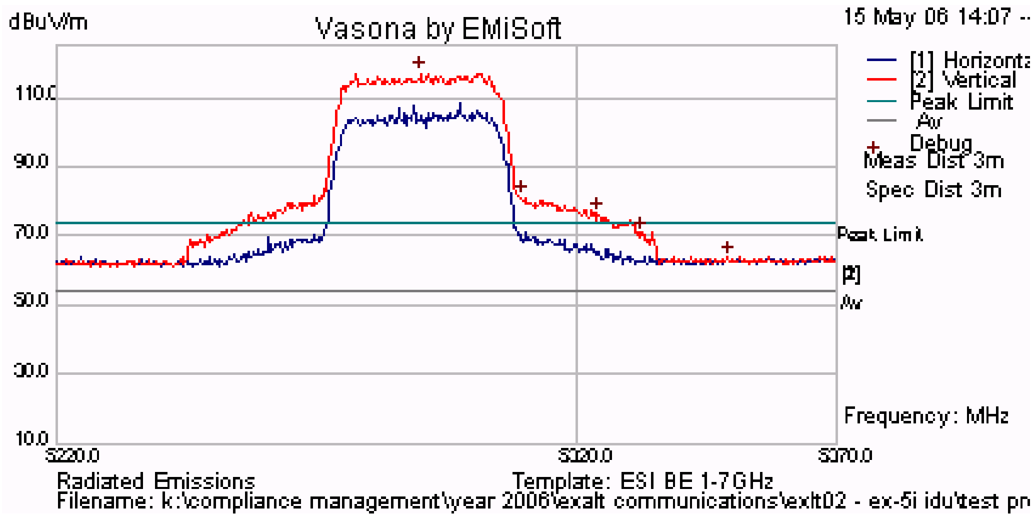
28 dBi Antenna 5,272 MHz 32 MHz Bandwidth QPSK

Peak Emission = 118.53 dBµV/m



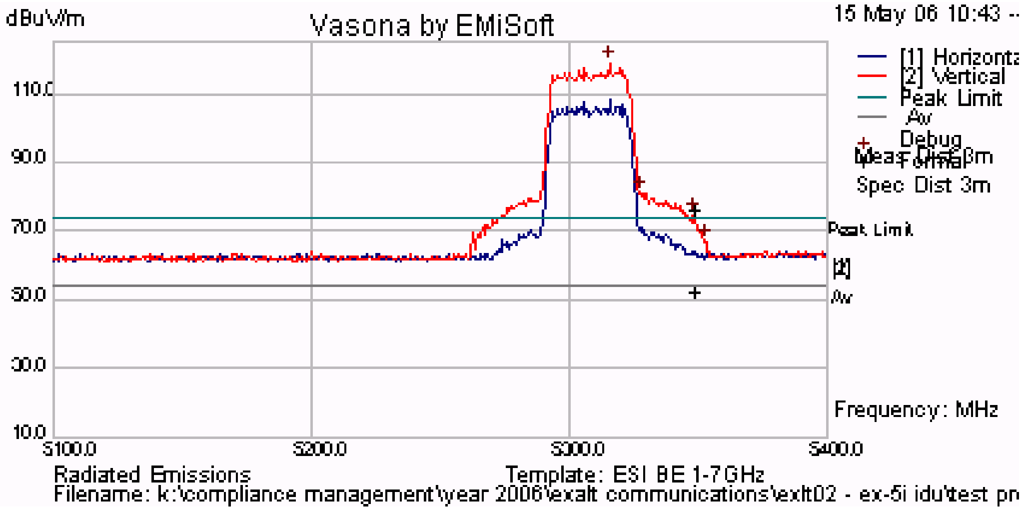
28 dBi Antenna 5,290 MHz 32 MHz Bandwidth QPSK

Peak Emission = 117.10 dBµV/m



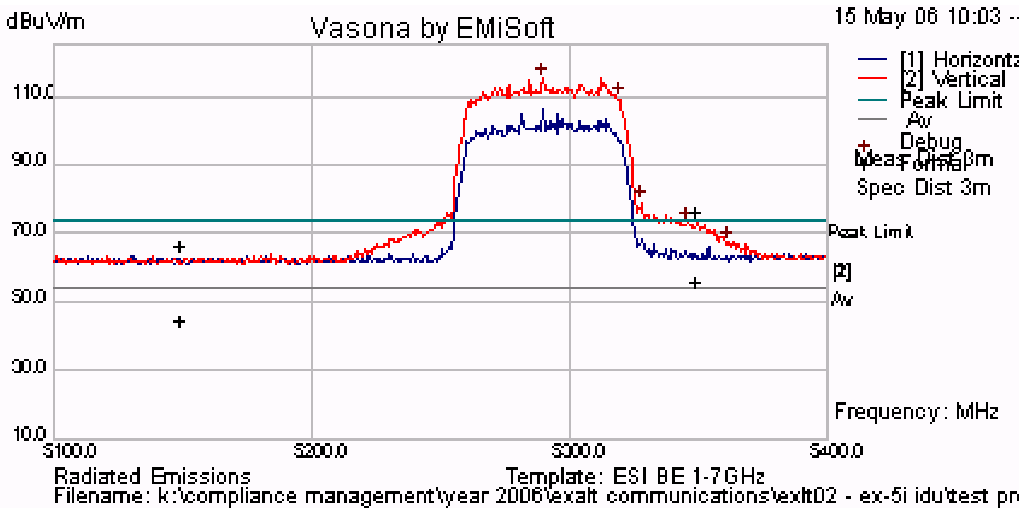
28 dBi Antenna 5,308 MHz 32 MHz Bandwidth QPSK

Peak Emission = 119.01 dBµV/m



28 dBi Antenna 5,290 MHz 64 MHz Bandwidth QPSK

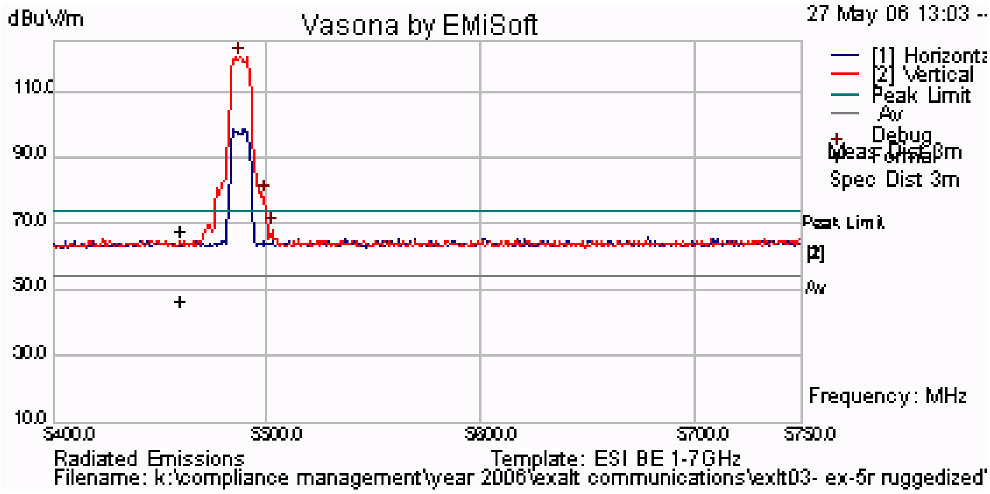
Peak Emission = 115.12 dBµV/m



Peak Field Strength for 28 dBi Antenna

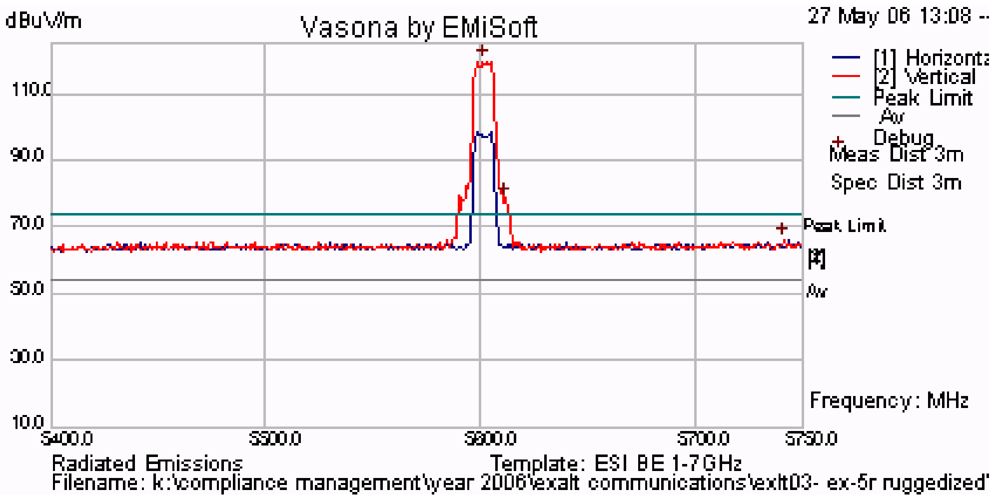
28 dBi Antenna 5,488 MHz 8 MHz Bandwidth QPSK

Peak Emission = 120.27 dBμV/m



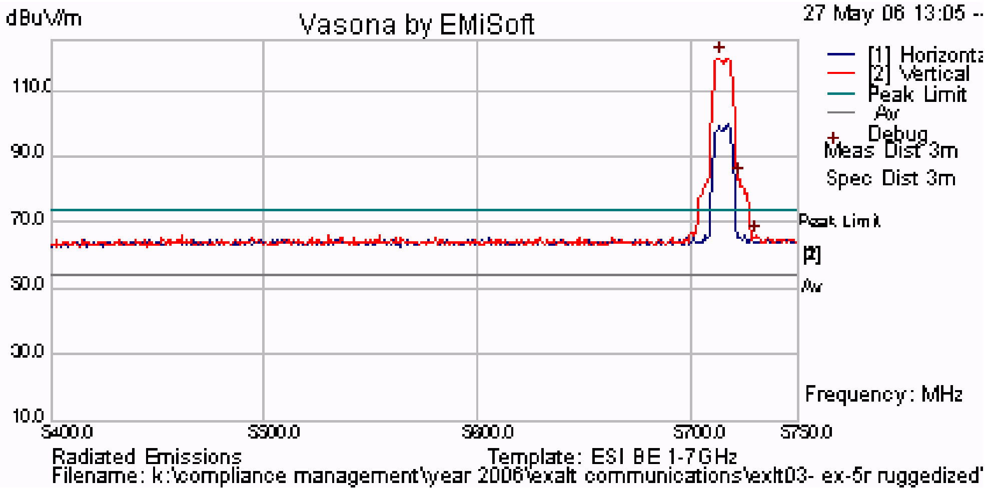
28 dBi Antenna 5,602 MHz 8 MHz Bandwidth QPSK

Peak Emission = 119.67 dBμV/m



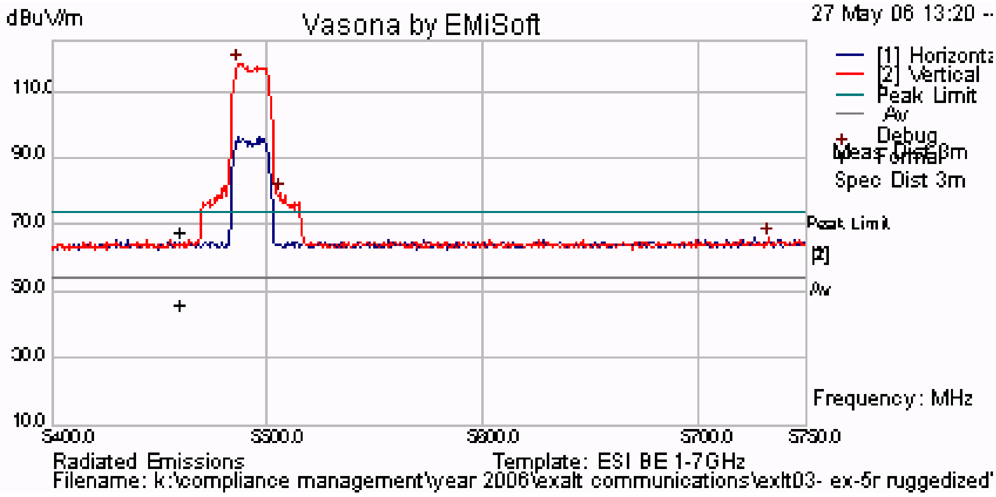
28 dBi Antenna 5,715 MHz 8 MHz Bandwidth QPSK

Peak Emission = 119.89 dBµV/m



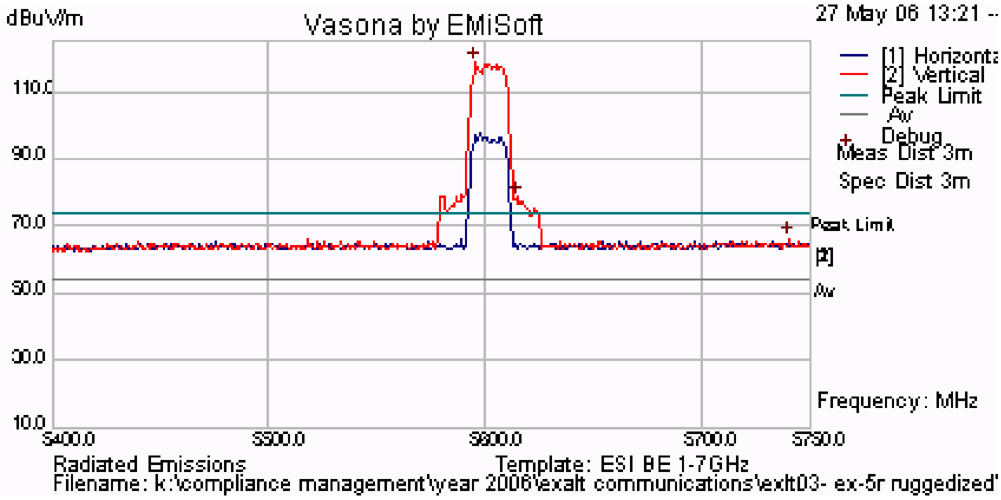
28 dBi Antenna 5,493 MHz 16 MHz Bandwidth QPSK

Peak Emission = 118.18 dBµV/m



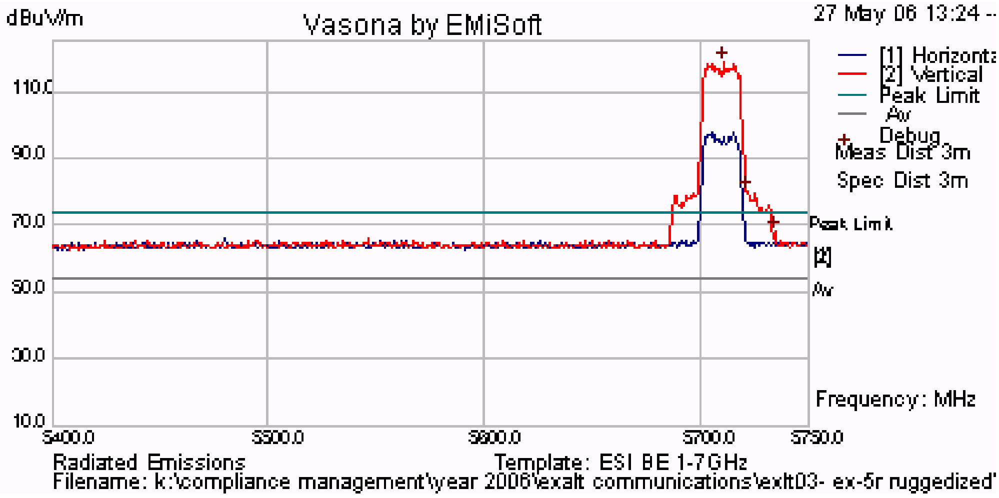
28 dBi Antenna 5,602 MHz 16 MHz Bandwidth QPSK

Peak Emission = 118.72 dBµV/m



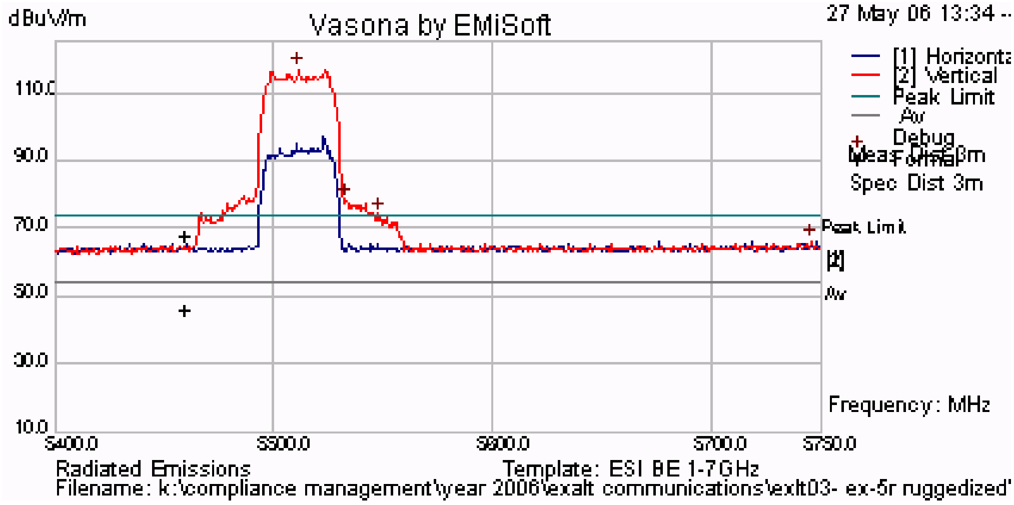
28 dBi Antenna 5,710 MHz 16 MHz Bandwidth QPSK

Peak Emission = 118.59 dBµV/m



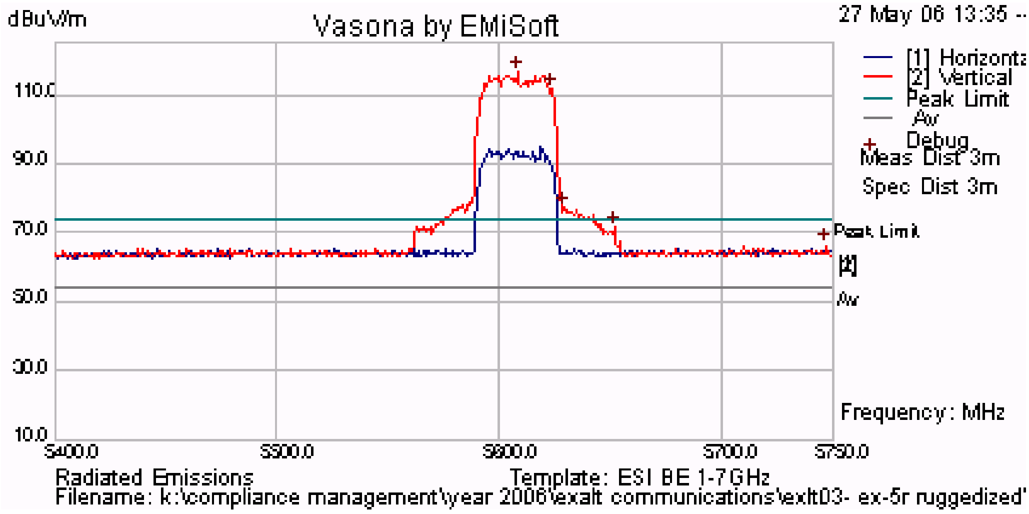
28 dBi Antenna 5,512 MHz 32 MHz Bandwidth QPSK

Peak Emission = 117.05 dBµV/m



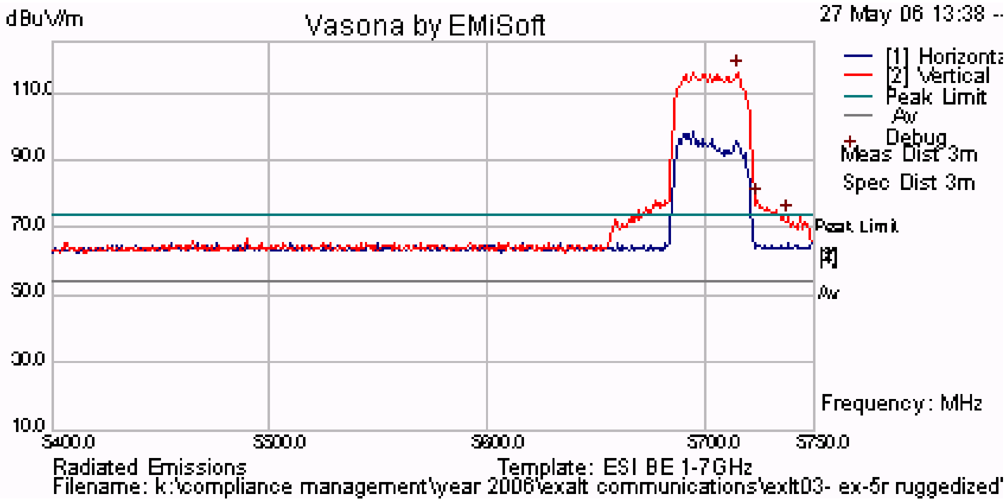
28 dBi Antenna 5,608 MHz 32 MHz Bandwidth QPSK

Peak Emission = 116.70 dBµV/m



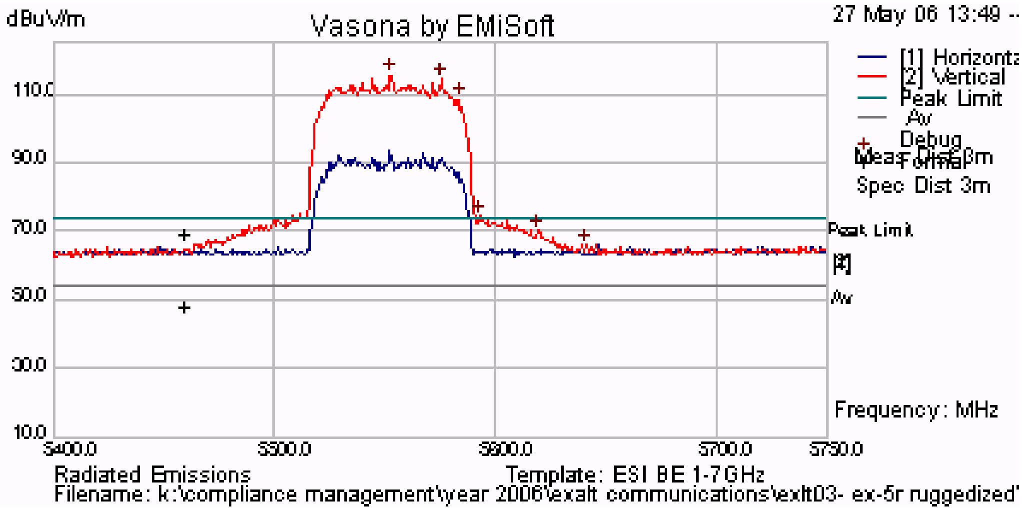
28 dBi Antenna 5,703 MHz 32 MHz Bandwidth QPSK

Peak Emission = 116.28 dBµV/m



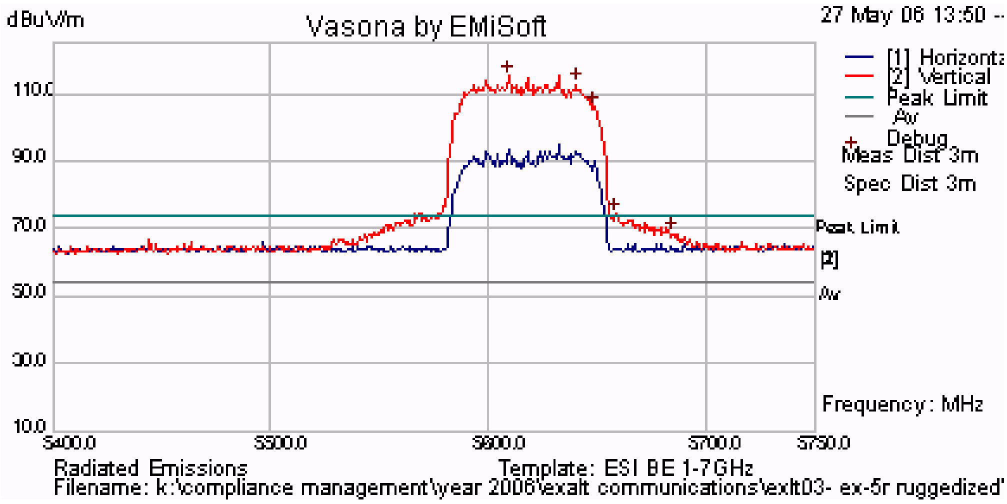
28 dBi Antenna 5,553 MHz 64 MHz Bandwidth QPSK

Peak Emission = 115.47 dBμV/m



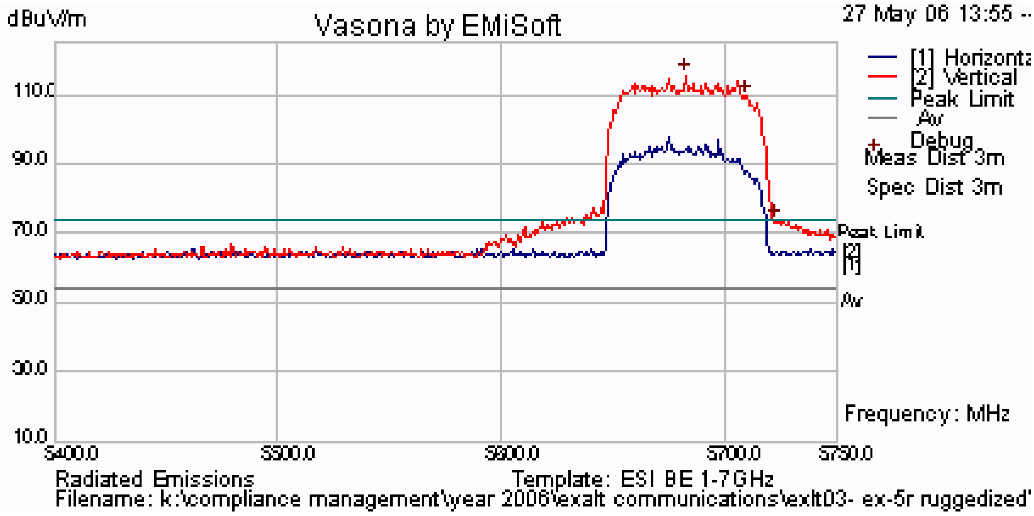
28 dBi Antenna 5,618 MHz 64 MHz Bandwidth QPSK

Peak Emission = 115.31 dBμV/m



28 dBi Antenna 5,683 MHz 64 MHz Bandwidth QPSK

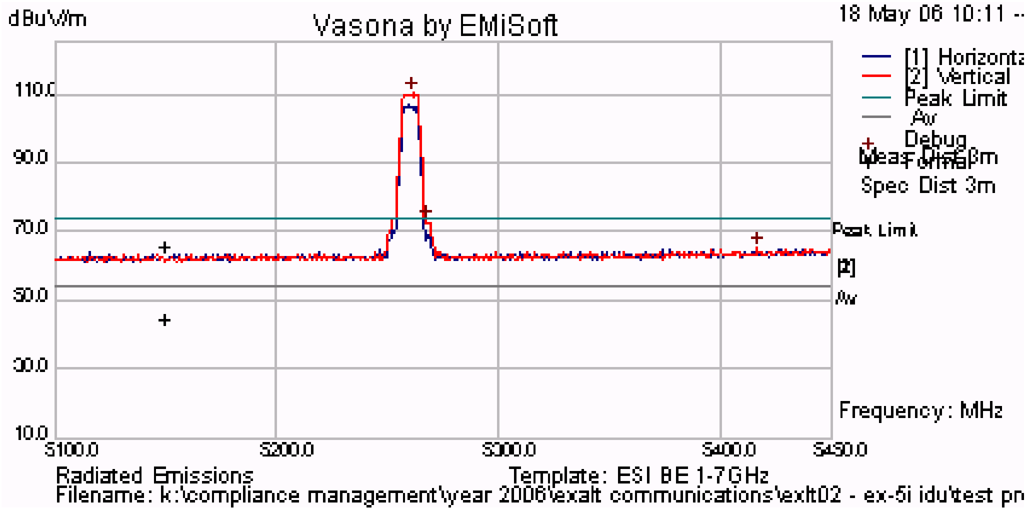
Peak Emission = 115.61 dBμV/m



Peak Field Strength for 37.5 dBi Antenna

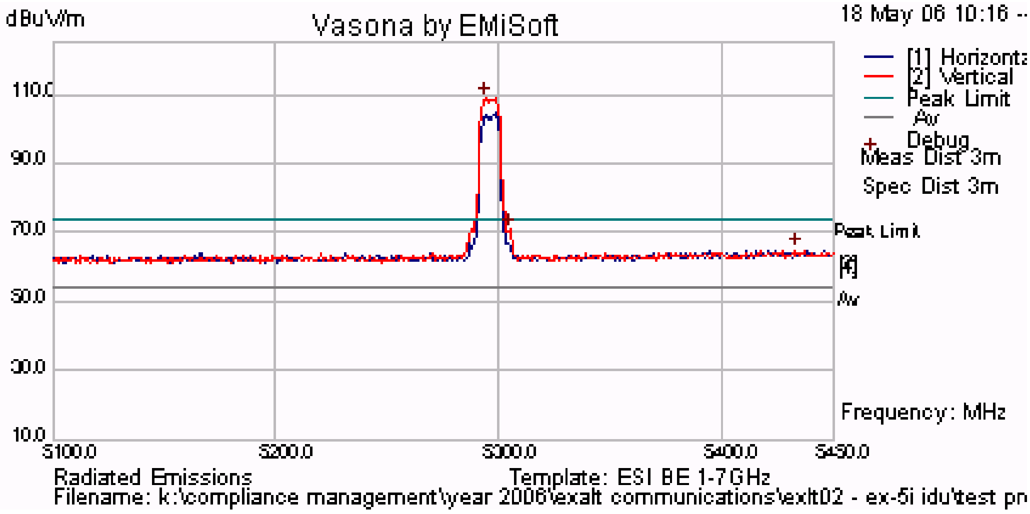
37.5 dBi Antenna 5,260 MHz 8 MHz Bandwidth QPSK

Peak Emission = 110.22 dBµV/m



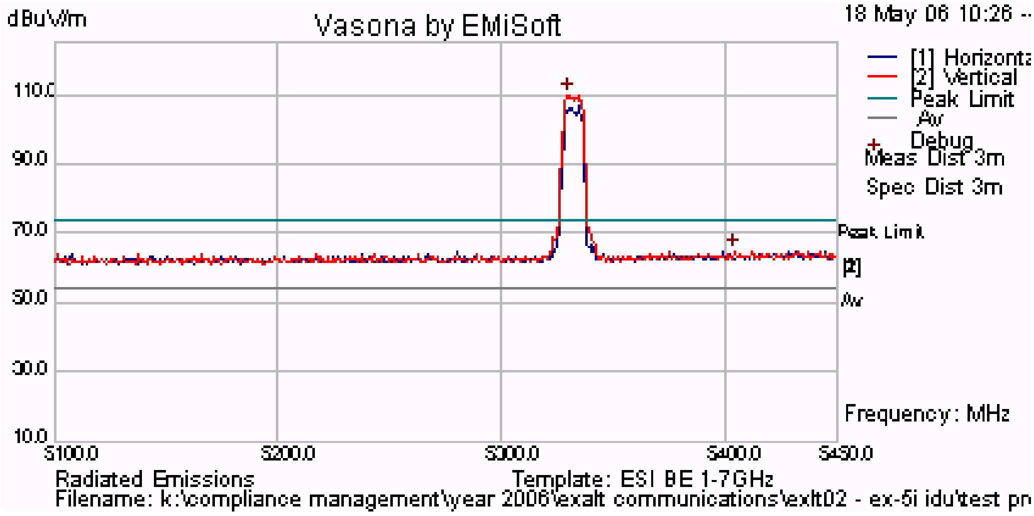
37.5 dBi Antenna 5,296 MHz 8 MHz Bandwidth QPSK

Peak Emission = 109.04 dBµV/m



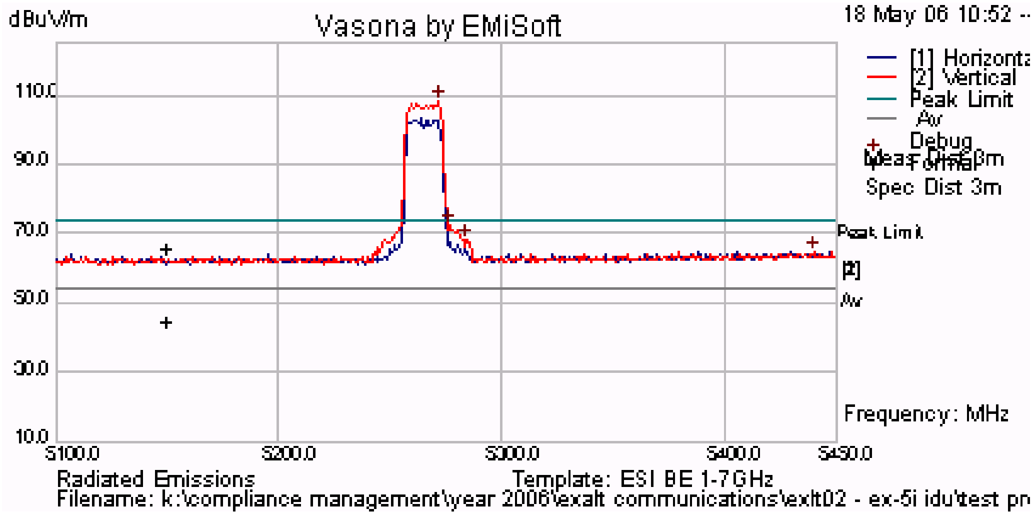
37.5 dBi Antenna 5,332 MHz 8 MHz Bandwidth QPSK

Peak Emission = 109.89 dBµV/m



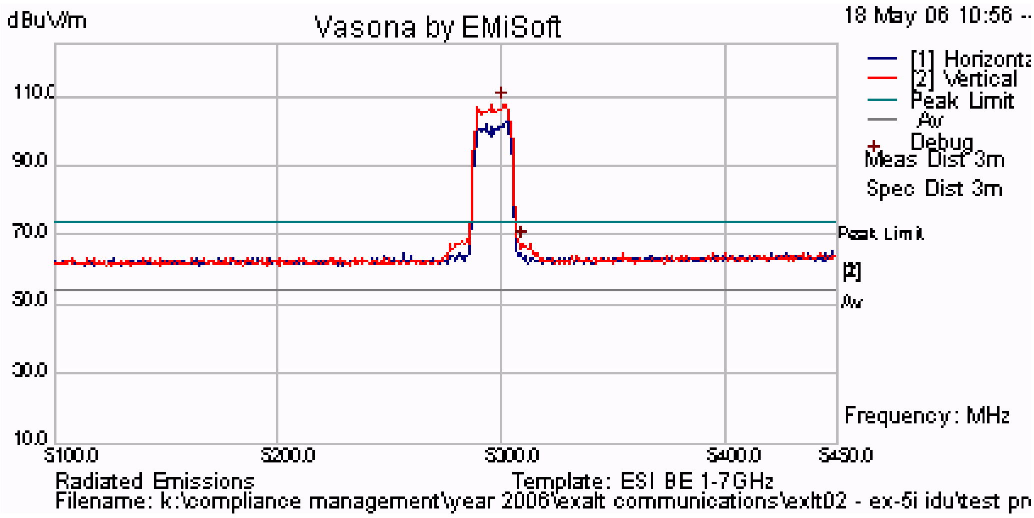
37.5 dBi Antenna 5,265 MHz 16 MHz Bandwidth QPSK

Peak Emission = 108.16 dBµV/m



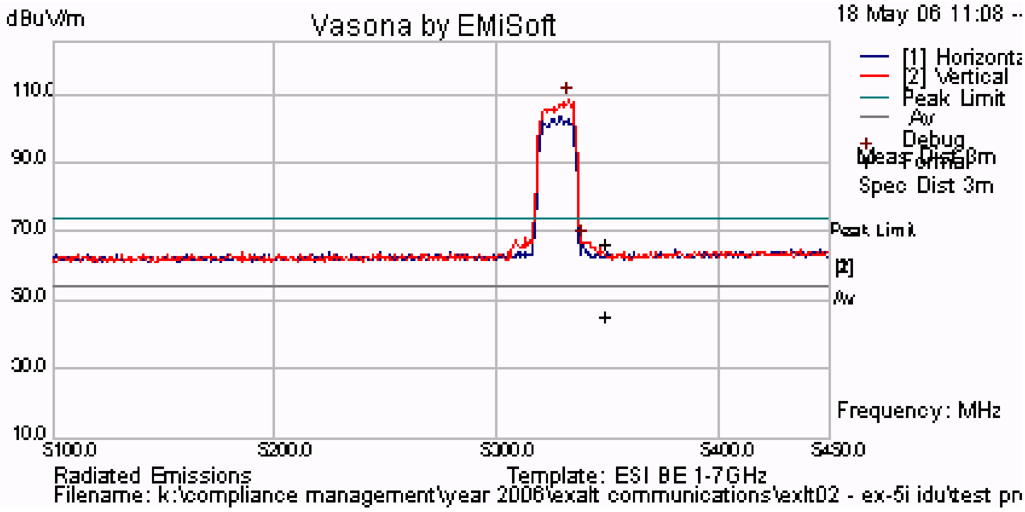
37.5 dBi Antenna 5,296 MHz 16 MHz Bandwidth QPSK

Peak Emission = 107.74 dBµV/m



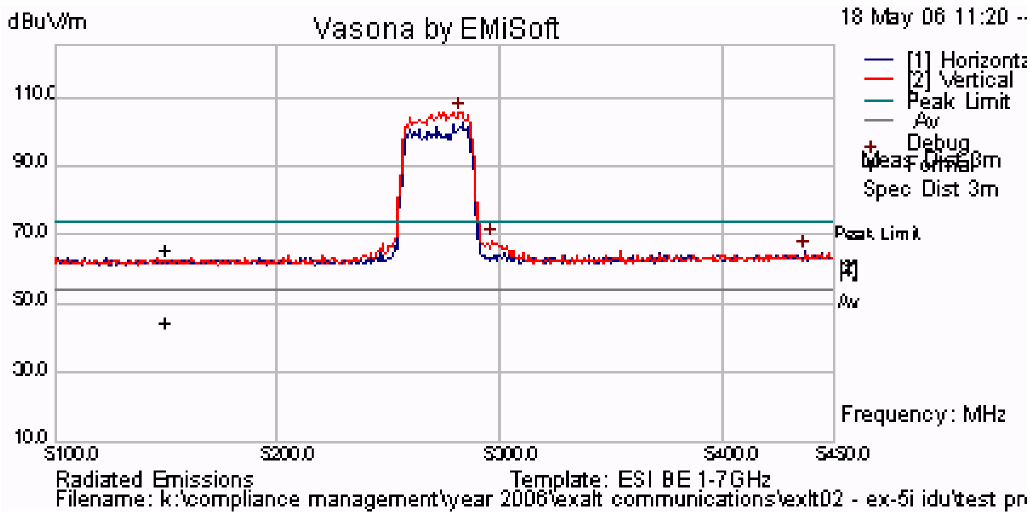
37.5 dBi Antenna 5,327 MHz 16 MHz Bandwidth QPSK

Peak Emission = 108.52 dBμV/m



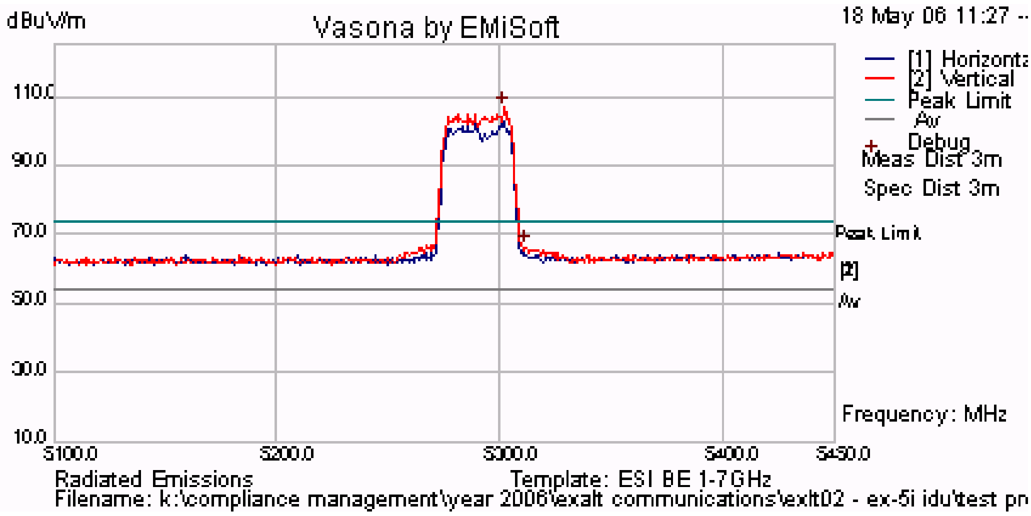
37.5 dBi Antenna 5,272 MHz 32 MHz Bandwidth QPSK

Peak Emission = 105.39 dBµV/m



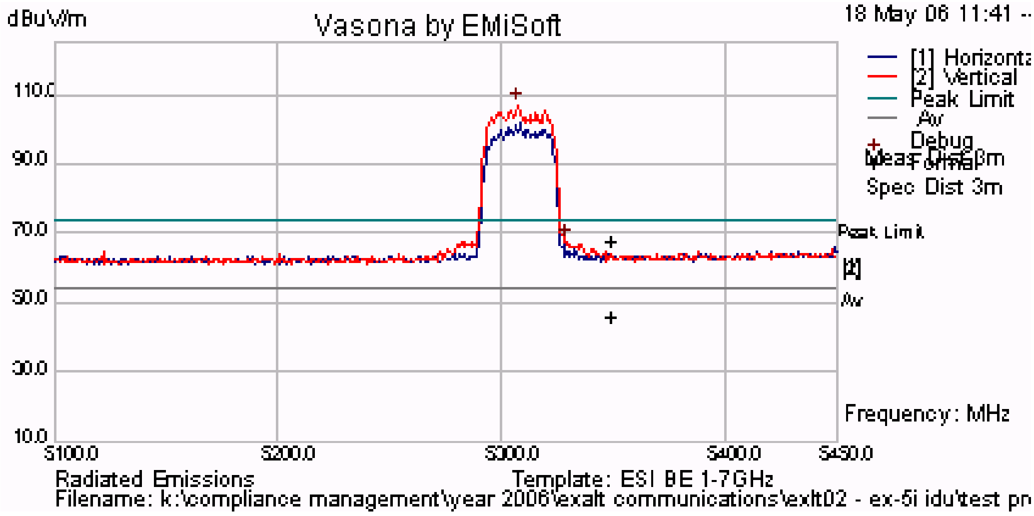
37.5 dBi Antenna 5,290 MHz 32 MHz Bandwidth QPSK

Peak Emission = 106.92 dBµV/m



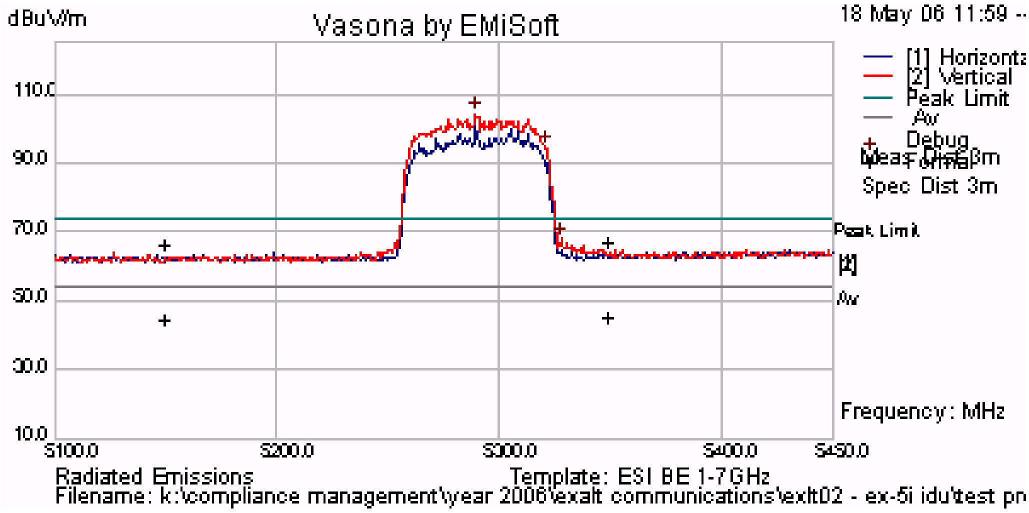
37.5 dBi Antenna 5,308 MHz 32 MHz Bandwidth QPSK

Peak Emission = 107.11 dBµV/m



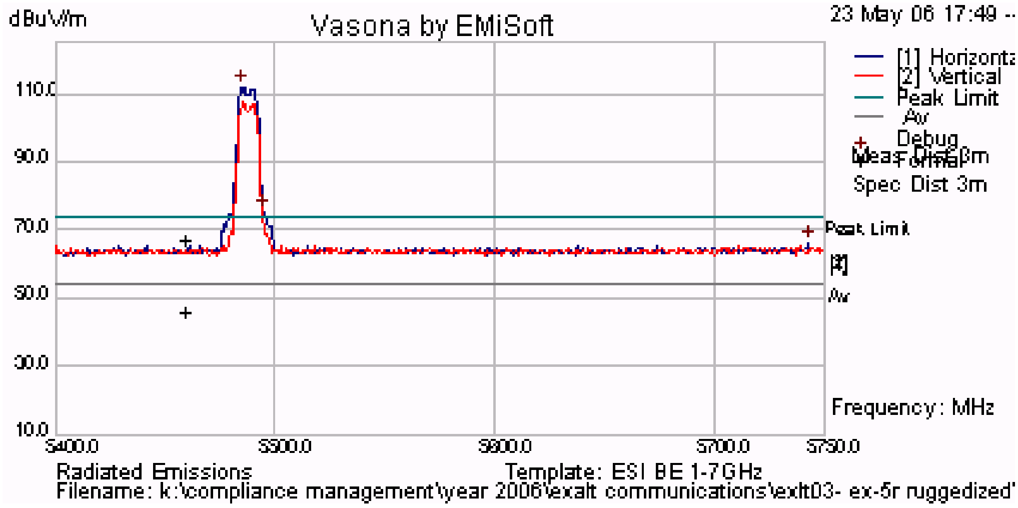
37.5 dBi Antenna 5,290 MHz 64 MHz Bandwidth QPSK

Peak Emission = 104.16 dBµV/m



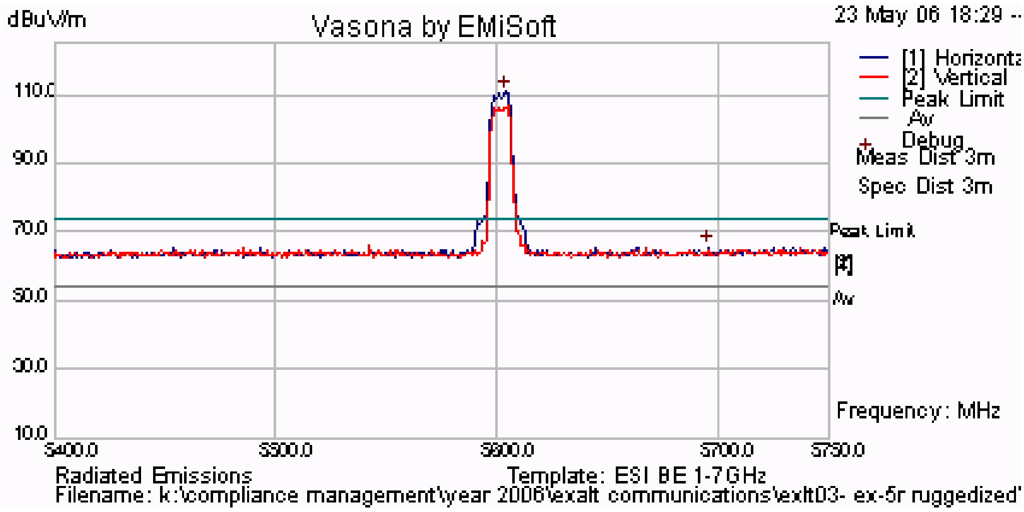
37.5 dBi Antenna 5,488 MHz 8 MHz Bandwidth QPSK

Peak Emission = 111.98 dBμV/m



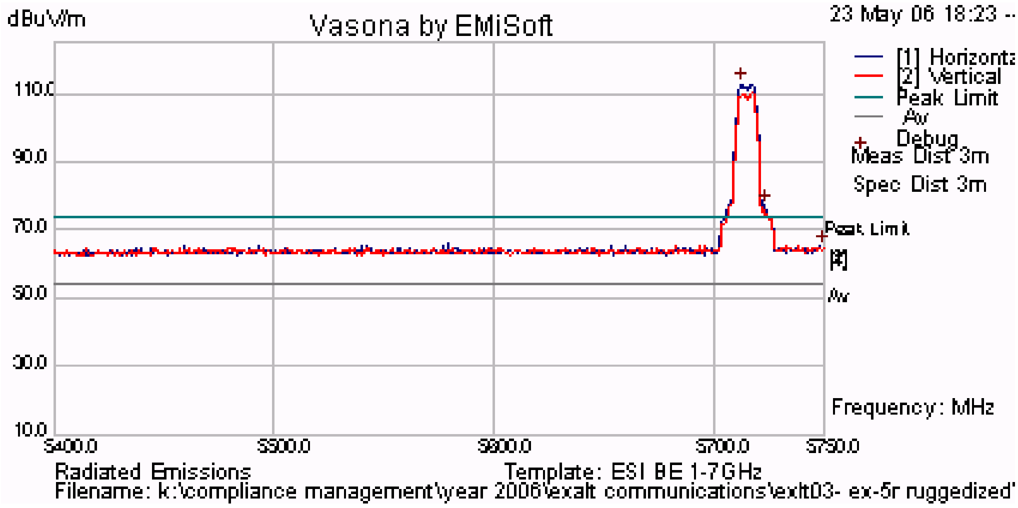
37.5 dBi Antenna 5,602 MHz 8 MHz Bandwidth QPSK

Peak Emission = 110.83 dBμV/m



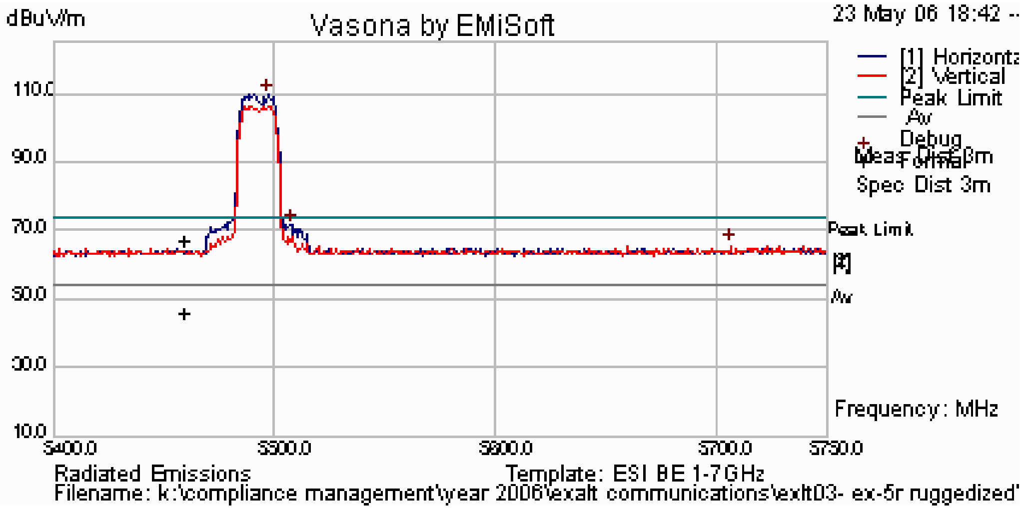
37.5 dBi Antenna 5,715 MHz 8 MHz Bandwidth QPSK

Peak Emission = 112.88 dBµV/m



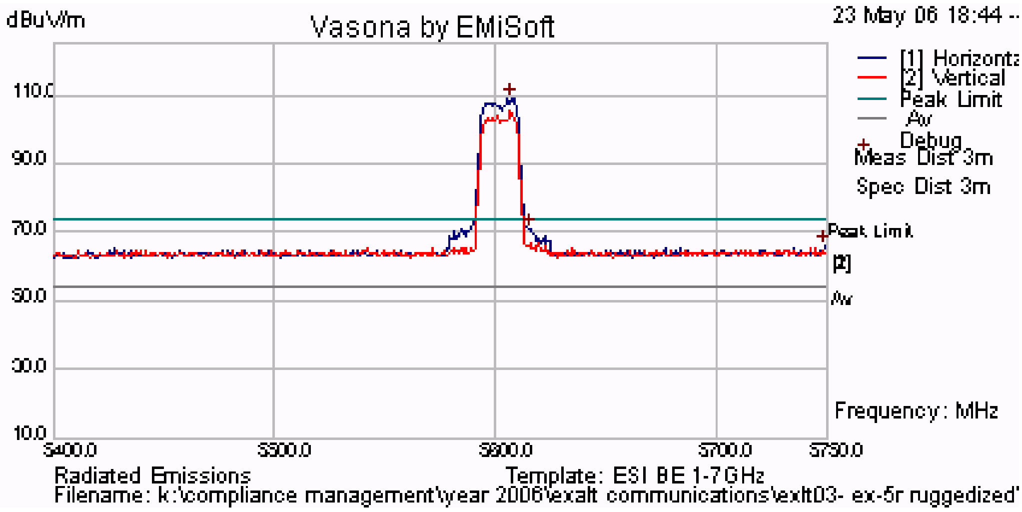
37.5 dBi Antenna 5,493 MHz 16 MHz Bandwidth QPSK

Peak Emission = 109.78 dBµV/m



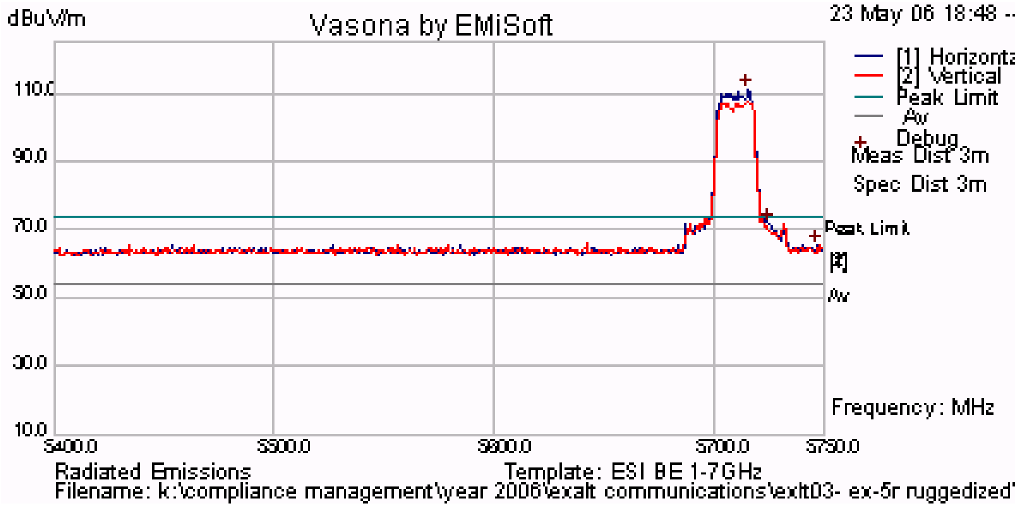
37.5 dBi Antenna 5,602 MHz 16 MHz Bandwidth QPSK

Peak Emission = 108.98 dBµV/m



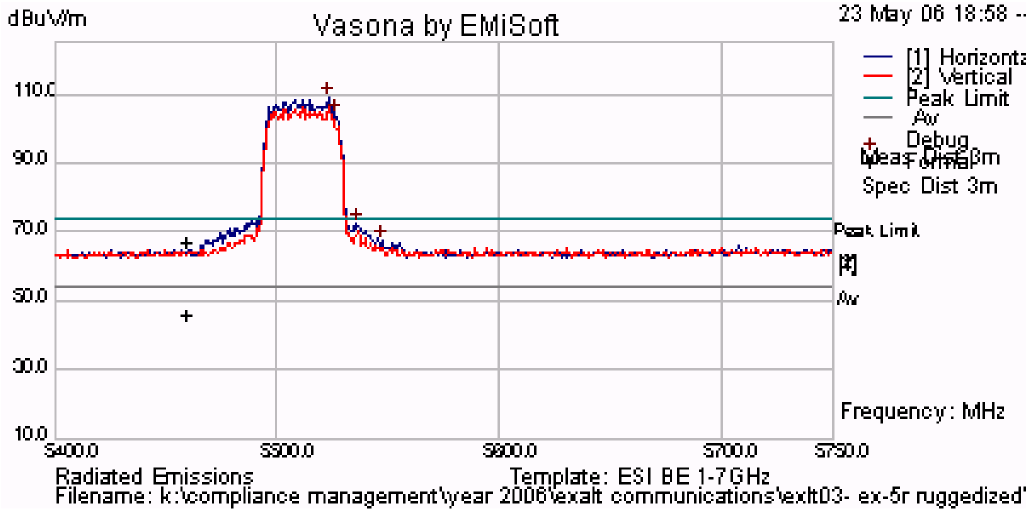
37.5 dBi Antenna 5,710 MHz 16 MHz Bandwidth QPSK

Peak Emission = 110.81 dBµV/m



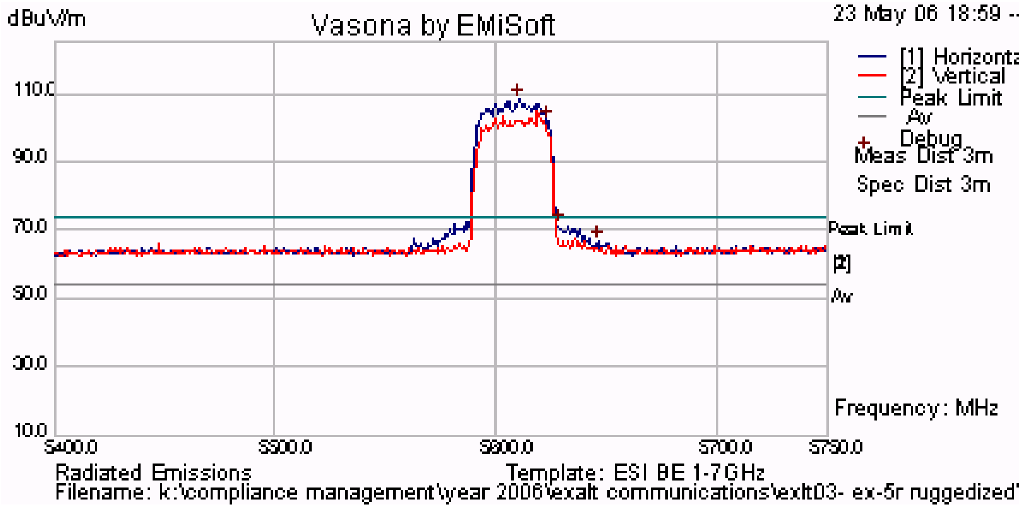
37.5 dBi Antenna 5,512 MHz 32 MHz Bandwidth QPSK

Peak Emission = 108.73 dBµV/m



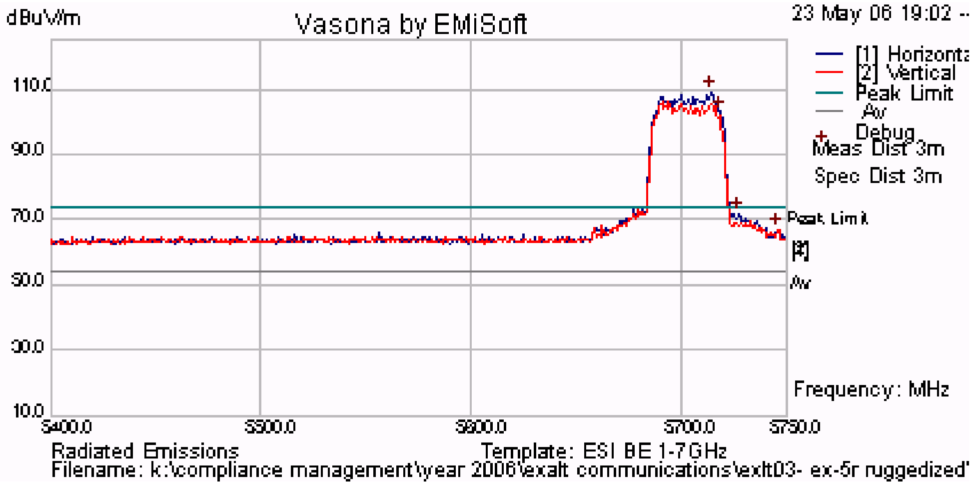
37.5 dBi Antenna 5,608 MHz 32 MHz Bandwidth QPSK

Peak Emission = 108.23 dBµV/m



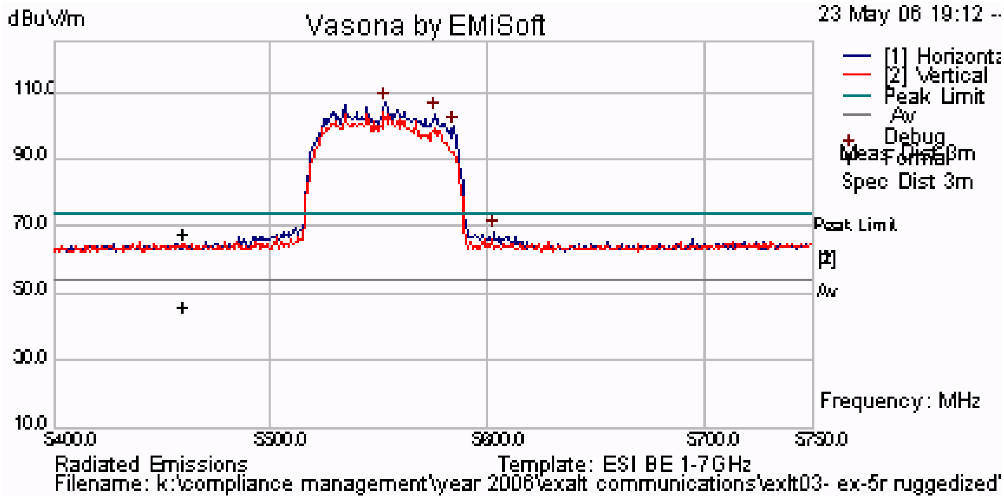
37.5 dBi Antenna 5,703 MHz 32 MHz Bandwidth QPSK

Peak Emission = 109.17 dBµV/m



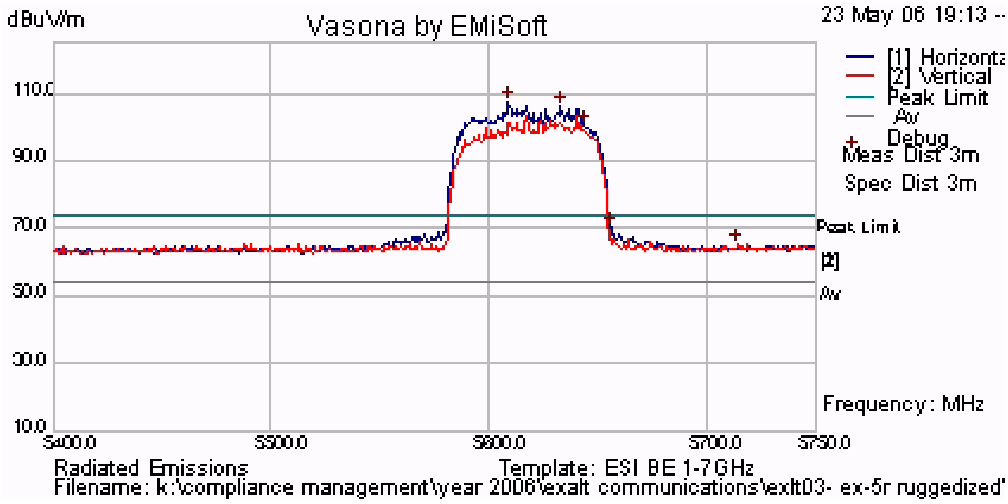
37.5 dBi Antenna 5,553 MHz 64 MHz Bandwidth QPSK

Peak Emission = 106.71 dBμV/m



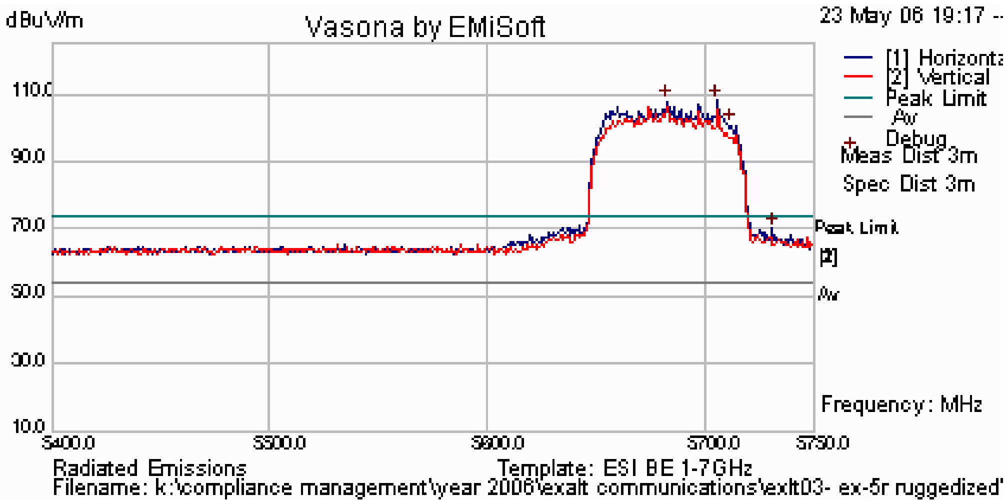
37.5 dBi Antenna 5,618 MHz 64 MHz Bandwidth QPSK

Peak Emission = 107.55 dBμV/m



37.5 dBi Antenna 5,683 MHz 64 MHz Bandwidth QPSK

Peak Emission = 108.16 dBµV/m



Specification

Limits

15.407 (b)(2). All emissions outside of the 5,150-5,350MHz band shall not exceed an EIRP of -27dBm/MHz.

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

RSS-210 §A9.3(2) For transmitters operating in the 5250-5350 MHz band, all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz e.i.r.p. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band shall not exceed out of band emission limit of 27 dBm/MHz e.i.r.p. in the 5150-5250 MHz band in order to operate indoor/outdoor, or alternatively shall comply with the spectral power density for operation within the 5150-5250 MHz band and shall be labeled “for indoor use only”.

RSS-Gen §4.7 The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5^{th} harmonic of the highest frequency generated without exceeding 40 GHz.

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

5.1.7.3. Receiver Radiated Spurious Emissions (above 1 GHz)

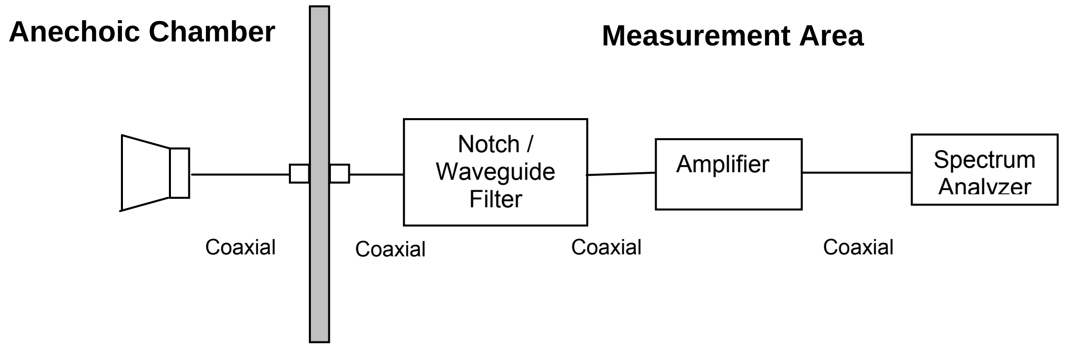
Industry Canada RSS-Gen §4.8, §6

Test Procedure

Radiated emissions above 1 GHz are 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 notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO
where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

Receiver Radiated Spurious Emissions above 1 GHz

Ambient conditions.
Temperature: 17 to 23°C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

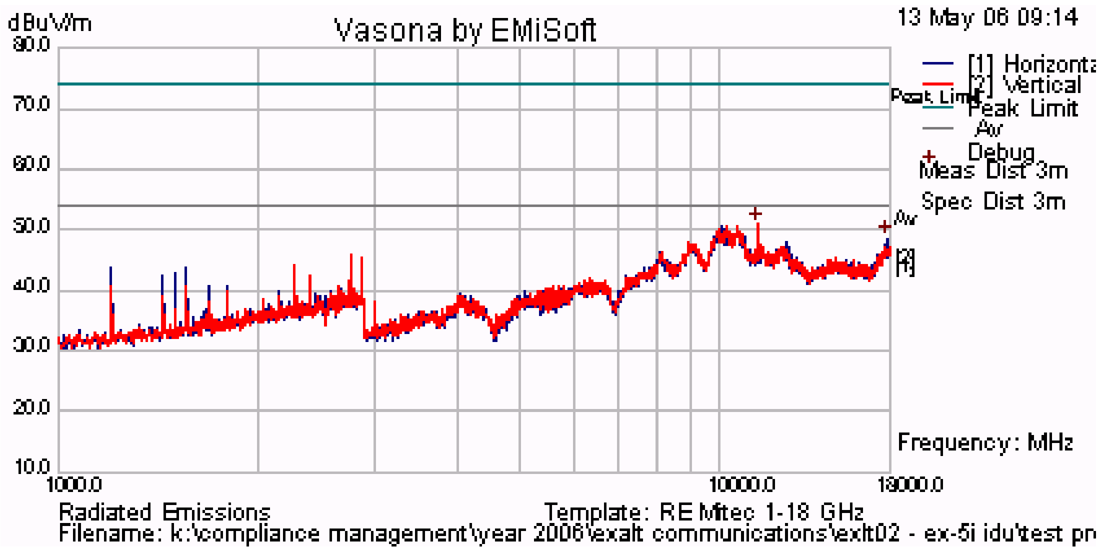
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,296 MHz 28 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,296 MHz Radiated Emissions for 28 dBi Antenna 8 MHz Bandwidth QPSK



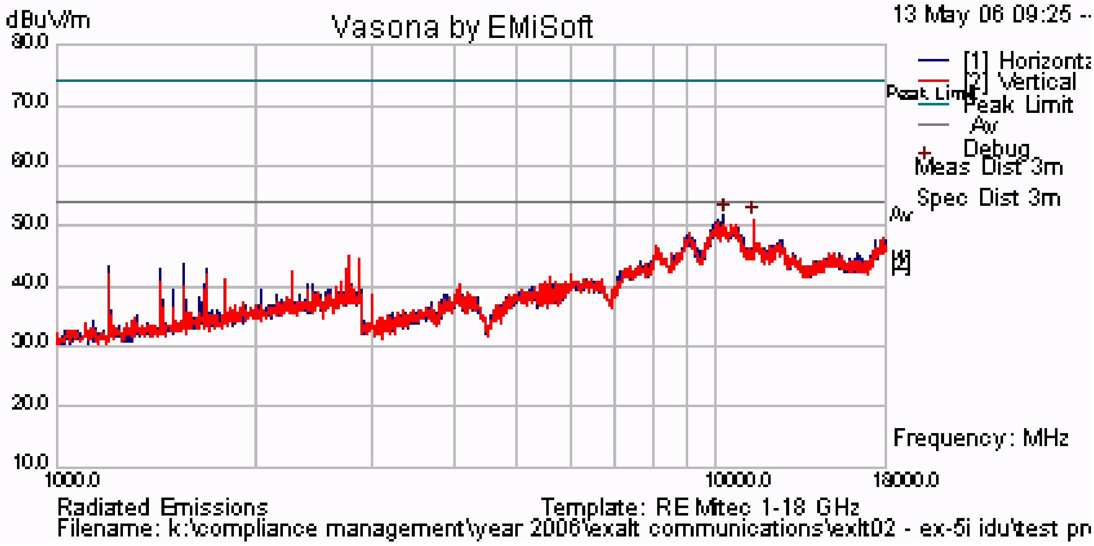
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,296 MHz 28 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,296 MHz Radiated Emissions for 28 dBi Antenna 16 MHz Bandwidth QPSK



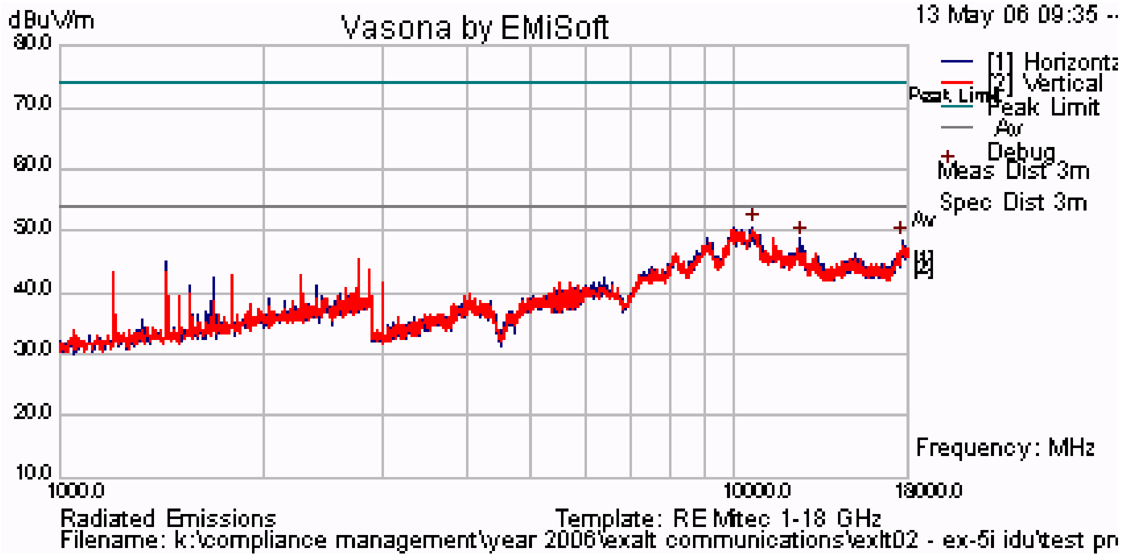
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,290 MHz 28 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBµV/m).

5,290 MHz Radiated Emissions for 28 dBi Antenna 32 MHz Bandwidth QPSK



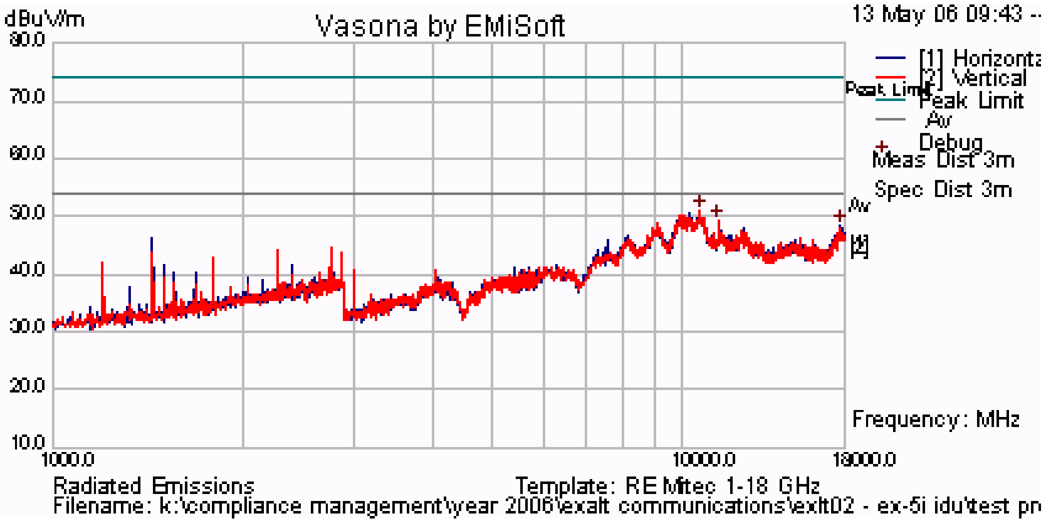
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,290 MHz 28 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBµV/m).

5,290 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth QPSK



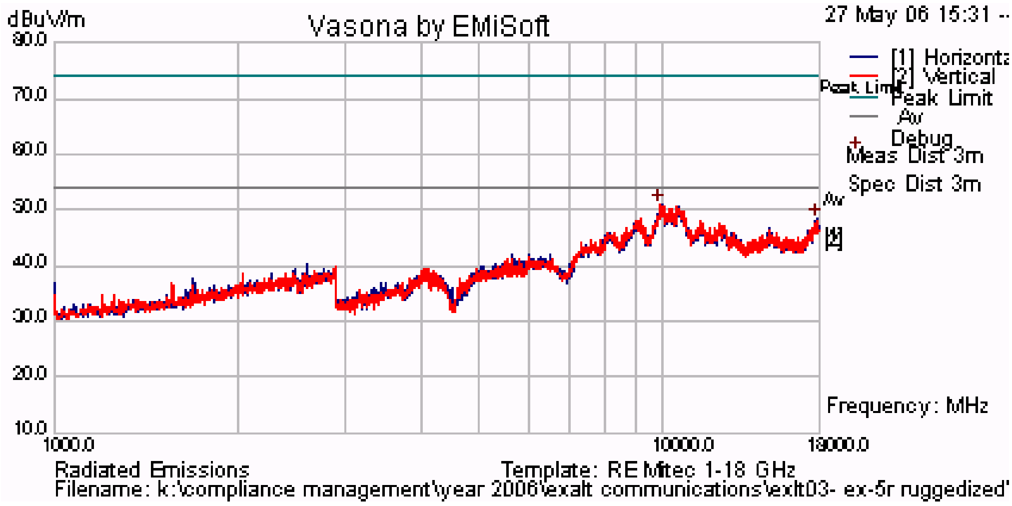
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,602 MHz 28 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBµV/m).

5,602 MHz Radiated Emissions for 28 dBi Antenna 8 MHz Bandwidth QPSK



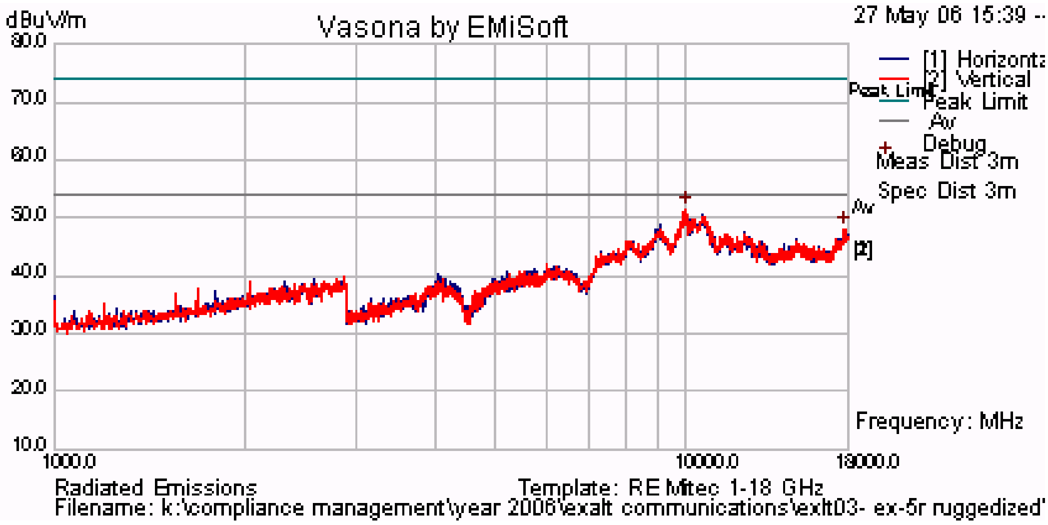
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,602 MHz 28 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,602 MHz Radiated Emissions for 28 dBi Antenna 16 MHz Bandwidth QPSK



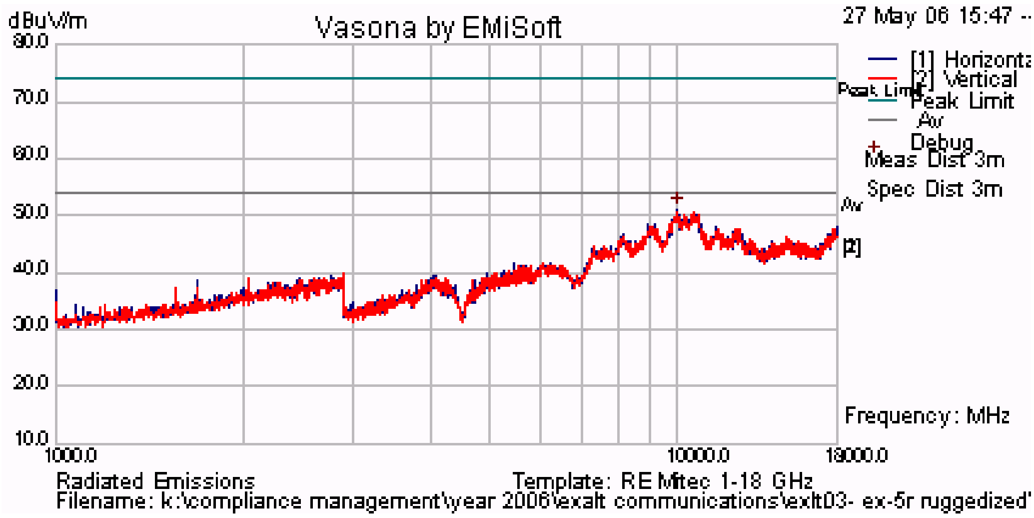
28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,608 MHz 28 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,608 MHz Radiated Emissions for 28 dBi Antenna 32 MHz Bandwidth QPSK

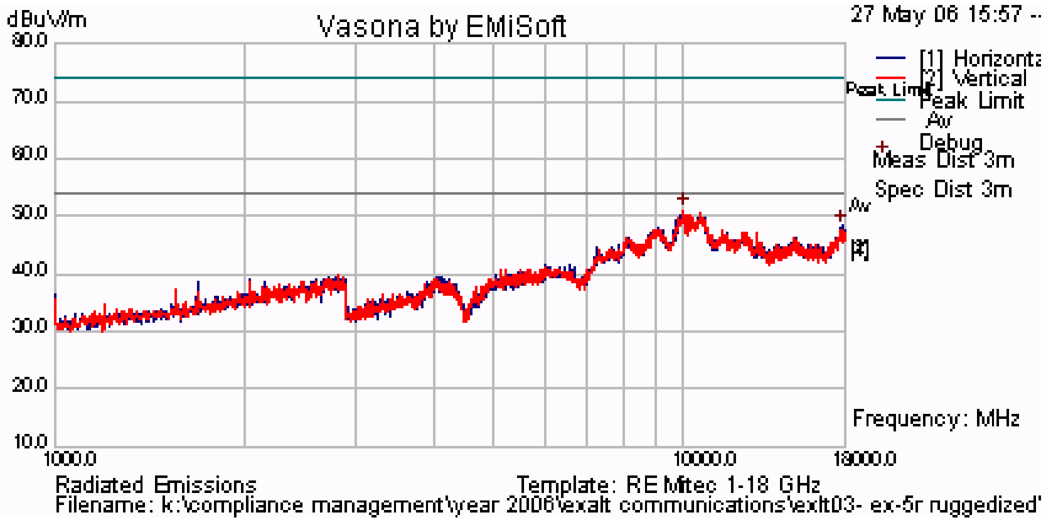


28 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,618 MHz 28 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

5,618 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth QPSK



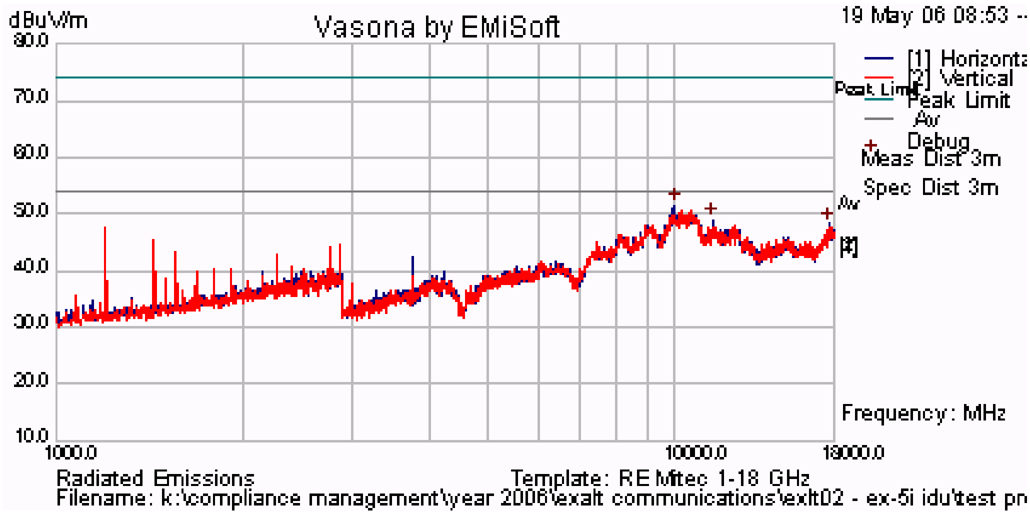
37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,296 MHz 37.5 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBµV/m).

5,296 MHz Radiated Emissions for 37.5 dBi Antenna 8 MHz Bandwidth QPSK



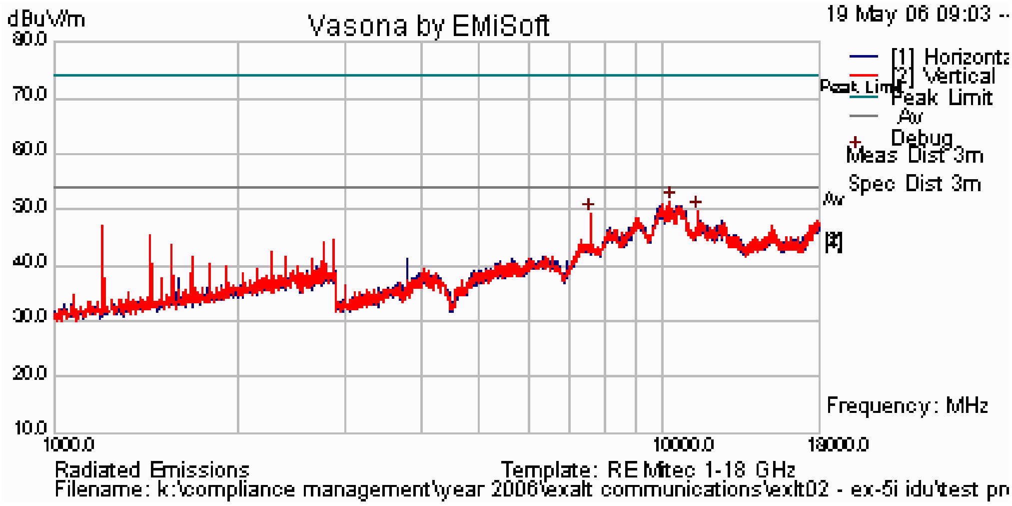
37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,296 MHz 37.5 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBµV/m).

5,296 MHz Radiated Emissions for 37.5 dBi Antenna 16 MHz Bandwidth QPSK



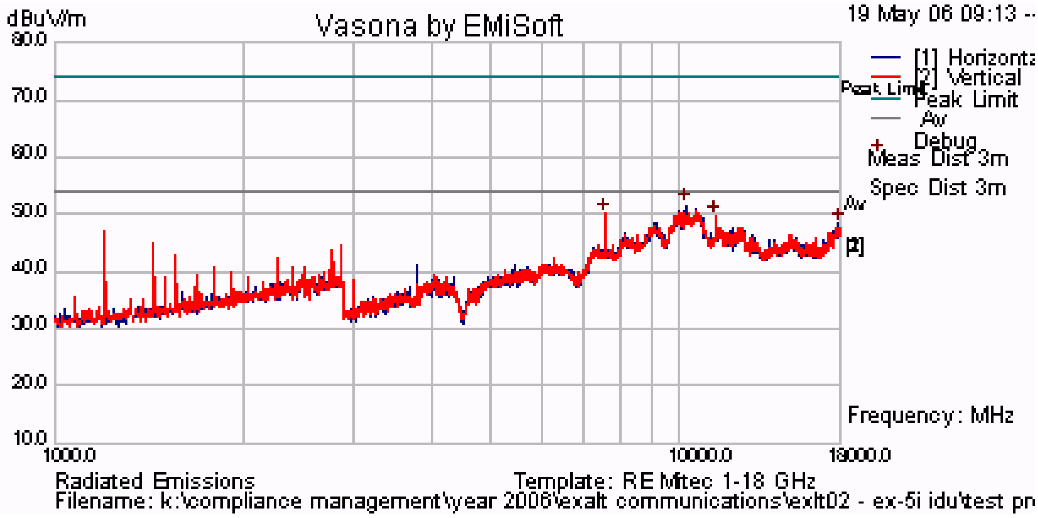
37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,290 MHz 37.5 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,290 MHz Radiated Emissions for 37.5 dBi Antenna 32 MHz Bandwidth QPSK



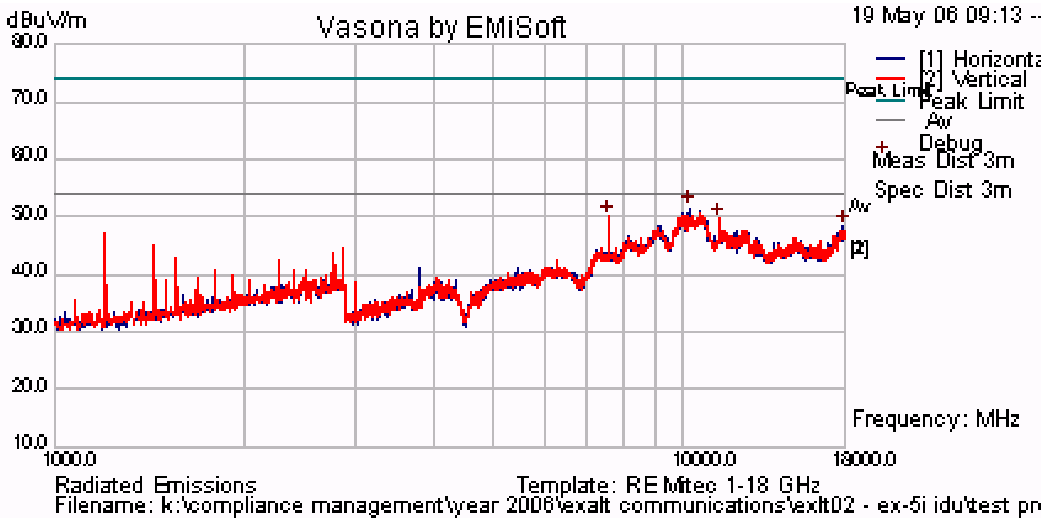
37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS – 5,290 MHz 37.5 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No peak emissions were greater than the Average Limit (54 dBμV/m).

5,290 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth QPSK

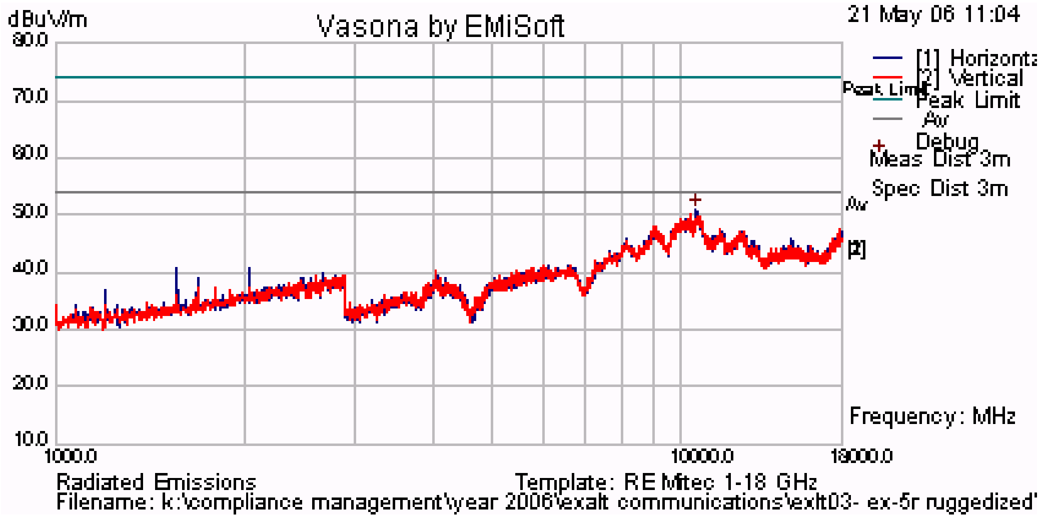


37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,602 MHz 37.5 dBi Antenna 8 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)

5,602 MHz Radiated Emissions for 37.5 dBi Antenna 8 MHz Bandwidth QPSK

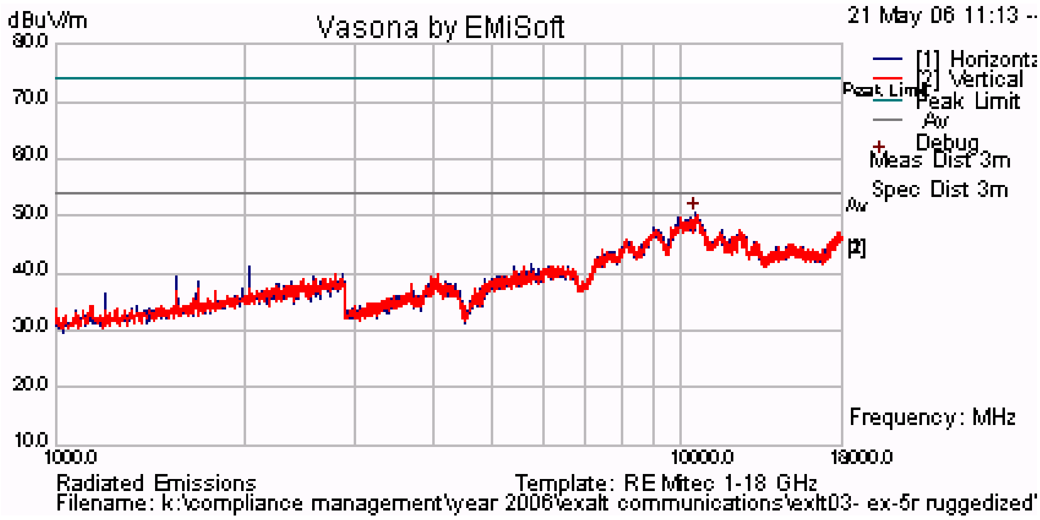


37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,602 MHz 37.5 dBi Antenna 16 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

5,602 MHz Radiated Emissions for 37.5 dBi Antenna 16 MHz Bandwidth QPSK

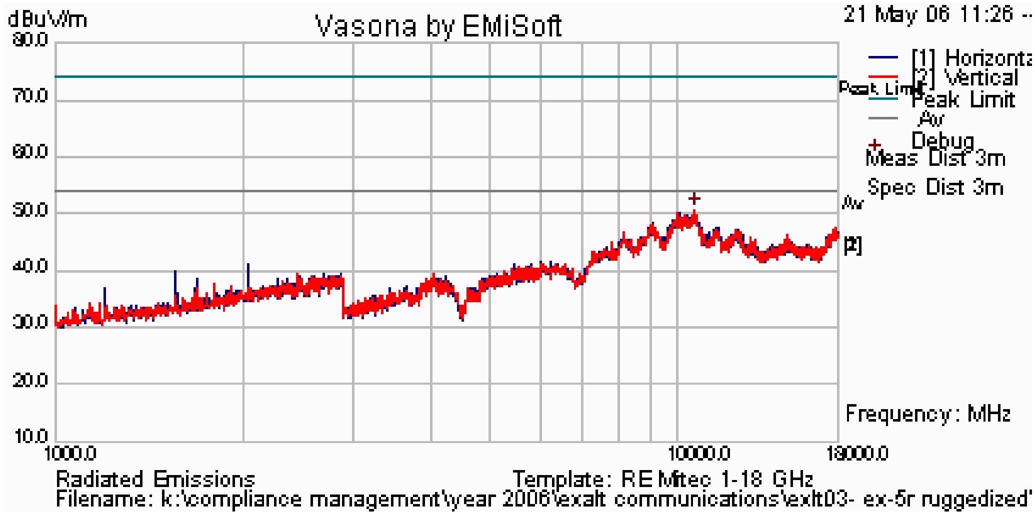


37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,608 MHz 37.5 dBi Antenna 32 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

5,608 MHz Radiated Emissions for 37.5 dBi Antenna 32 MHz Bandwidth QPSK



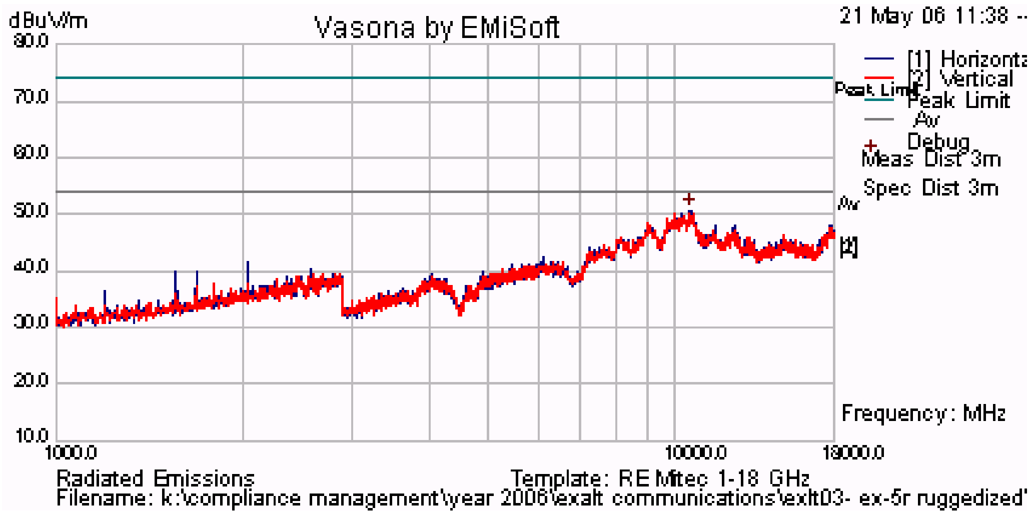
37.5 dBi Antenna - Receiver Radiated Spurious Emissions above 1 GHz

TABLE OF RESULTS –5,618 MHz 37.5 dBi Antenna 64 MHz Bandwidth QPSK

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

As no peak emissions were greater than the Average Limit (54 dBμV/m) peak emissions are reported in the above matrix.

5,618 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth QPSK



Specification

Receiver Radiated Spurious Emissions

Industry Canada RSS-Gen §4.8,
The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

RSS-Gen §6
The following receiver spurious emission limits shall be complied with;
(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 1.

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

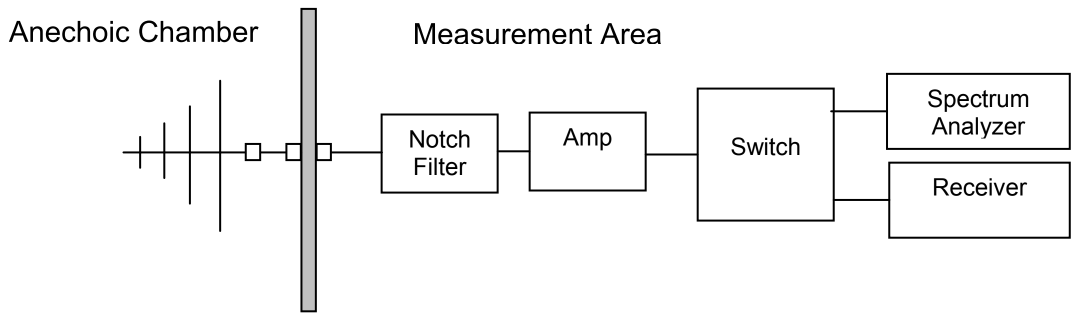
Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

5.1.7.4. Radiated Spurious Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.407(b)(6); §15.205(a); §15.209(a)
Industry Canada RSS-210 §2.2

Test Procedure
Testing 30M-1 GHz was subcontracted to the company identified in Section 3.9 Subcontracted Testing. Preliminary radiated emissions are measured in the anechoic chamber at a 10-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded with a spectrum analyzer in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

System operation was completed with five operational transmitters terminated in a 50Ω load at maximum power and one 2.4 GHz transmitter terminated in the 16.4 dBi Sector antenna.



Test Measurement Set up

Field Strength Calculation
The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

FS = R + AF + CORR

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBµV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 dB\mu V/m$$

Conversion between dBµV/m (or dBµV) and µV/m (or µV) are done as:

$$Level (dB\mu V/m) = 20 * Log (level (\mu V/m))$$

$$40\ dB\mu V/m = 100\mu V/m$$
$$48\ dB\mu V/m = 250\mu V/m$$

Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

Ambient conditions.
Temperature: 17 to 23 °C   Relative humidity: 31 to 57 %   Pressure: 999 to 1012 mbar

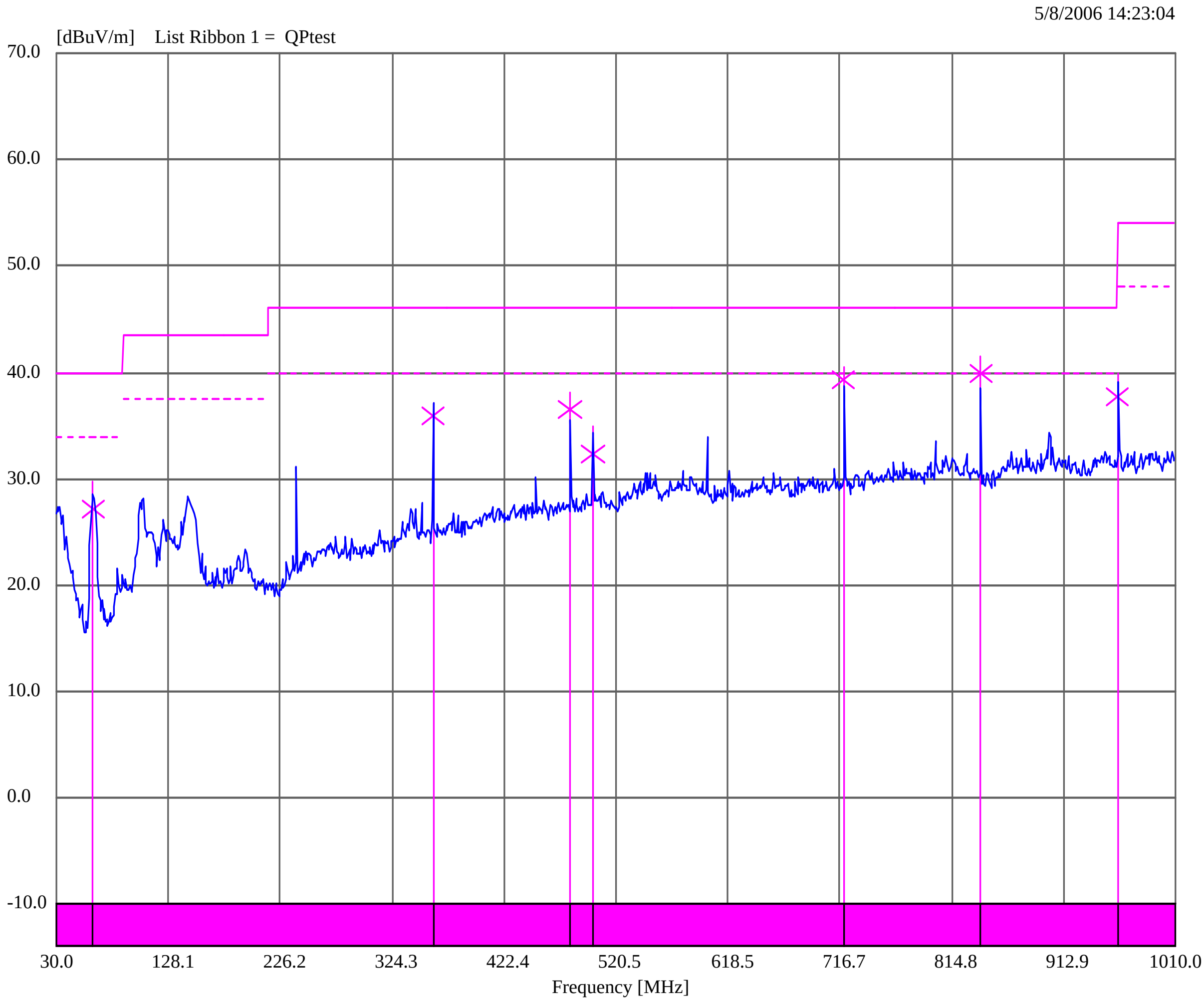
Radio parameters.

8 MHz BW
QPSK Modulation
Max. Power
EUT Antenna: 28 dBi Panel Antenna

TABLE OF RESULTS

Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity
62.348724	29.71	27.09	40.00	-12.91	348	196	Vert
359.990465	37.15	35.94	46.00	-10.06	11	396	Horz
479.992743	38.18	36.58	46.00	-9.42	4	300	Horz
499.982538	34.96	32.40	46.00	-13.60	338	332	Horz
720.007412	40.52	39.24	46.00	-6.76	86	294	Vert
840.004616	41.59	39.93	46.00	-6.07	129	200	Vert
960.011077	39.87	37.68	54.00	-16.32	41	200	Vert

Radiated Spurious Emissions 30 MHz to 1 GHz



Specification

Limits

§15.407(b)(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209.

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

RSS-210 §2.2 refers to Section 2.7 Table 2 below;-
.

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	**100**	**40.0**	**3**
88-216	**150**	**43.5**	**3**
216-960	**200**	**46.0**	**3**
Above 960	**500**	**54.0**	**3**

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	**Test Equipment Used**
Measurements were made per Sanmina work instruction	8546A HP Receiver and RF Filter, HP Pre-amp, Antenna EMCO Biconilog

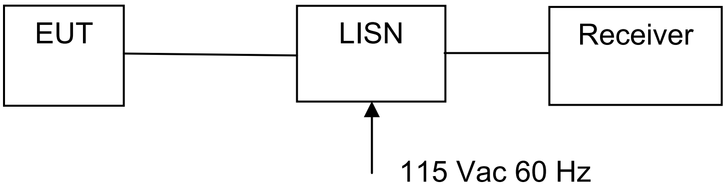
5.1.8. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.407(b)(6)/15.207
Industry Canada RSS-Gen §7.2.2

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

All six transmitters were operational and terminated in a 50Ω load.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

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

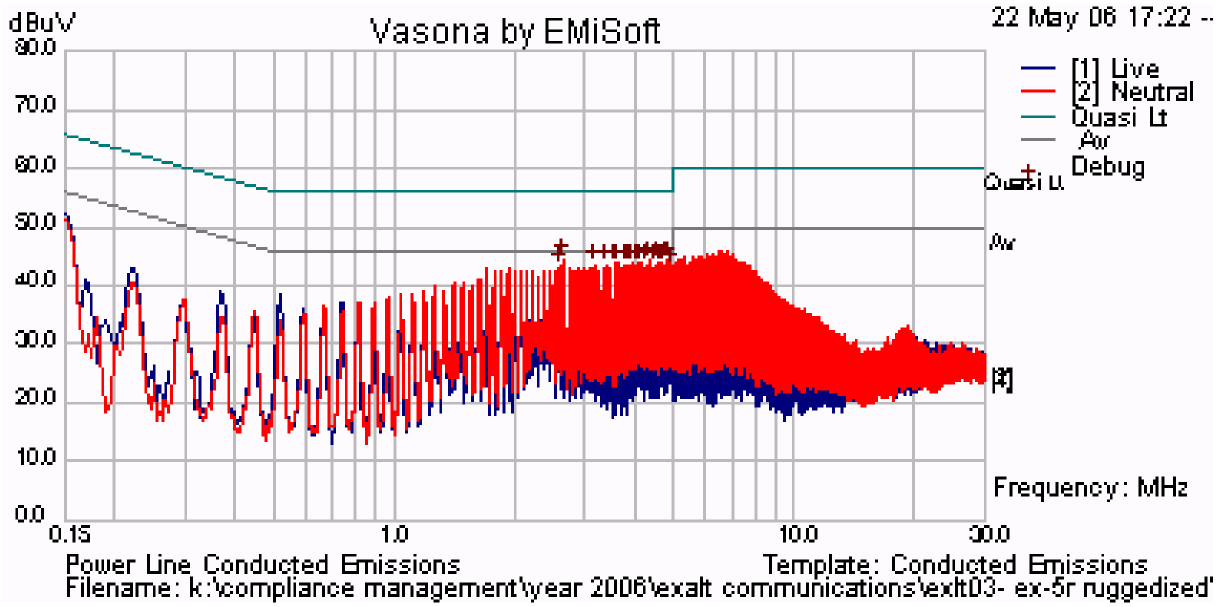
Ambient conditions.
Temperature: 17 to 23 °C   Relative humidity: 31 to 57 %   Pressure: 999 to 1012 mbar

Radio parameters.
Transmitter Port: Terminated in 50 Ohm load
Duty Cycle: 100%

TABLE OF RESULTS

Freq (MHz)	Line	Peak (dBµV)	QP (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Ave. (dBµV)	Ave. Limit (dBµV)	Ave. Margin (dB)
2.672	Neutr	44.59	42.81	56	-13.19	40.34	46	-5.66
4.377	Neutr	44.21	41.75	56	-14.25	37.86	46	-8.14
4.820	Neutr	44.18	36.68	56	-19.32	32.69	46	-13.31
4.885	Neutr	44.14	21.16	56	-34.84	15.90	46	-30.10
4.603	Neutr	44.10	43.35	56	-12.65	40.27	46	-5.73
4.158	Neutr	43.80	43.29	56	-12.71	40.10	46	-5.90

AC Wireline Conducted Emissions (150 kHz – 30 MHz)



Specification

Limit

§15.407 (b)(6); Any U-NII devices using an AC power line are required to comply also with the limits set forth in Section 15.207.

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

RSS-Gen §7.2.2
The radio frequency voltage that is conducted back into the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The tighter limit applies at the frequency range boundaries.

§15.207 (a) and **RSS-Gen §7.2.2** Limit Matrix
The lower limit applies at the boundary between frequency ranges

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

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	±2.64 dB

Traceability

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

6. Dynamic Frequency Selection (DFS)

Test Procedure and Setup

6.1. Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	**Value (see note)**
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna	

6.1.1. DFS Response requirement values

Parameter	**Value**
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 80% of the 99% power bandwidth See Note 3.

Note 1: The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows:

- For the Short pulse radar Test Signals this instant is the end of the *Burst*.
- For the Frequency Hopping radar Test Signal, this instant is the end of the last radar *Burst* generated.
- For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission.

Note 2: The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required to facilitate *Channel* changes (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 1 is used and for each frequency step the minimum percentage of detection is 90%. Measurements are performed with no data traffic.

6.2. Radar Test Waveforms

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

A minimum of 30 unique waveforms are required for each of the short pulse radar types 2 through 4. For short pulse radar type 1, the same waveform is used a minimum of 30 times. If more than 30 waveforms are used for short pulse radar types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. The aggregate is the average of the percentage of successful detections of short pulse radar types 1-4.

Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulses per *Burst*	Number of *Bursts*	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse radar test signal. If more than 30 waveforms are used for the Long Pulse radar test signal, then each additional waveform must also be unique and not repeated from the previous waveforms.

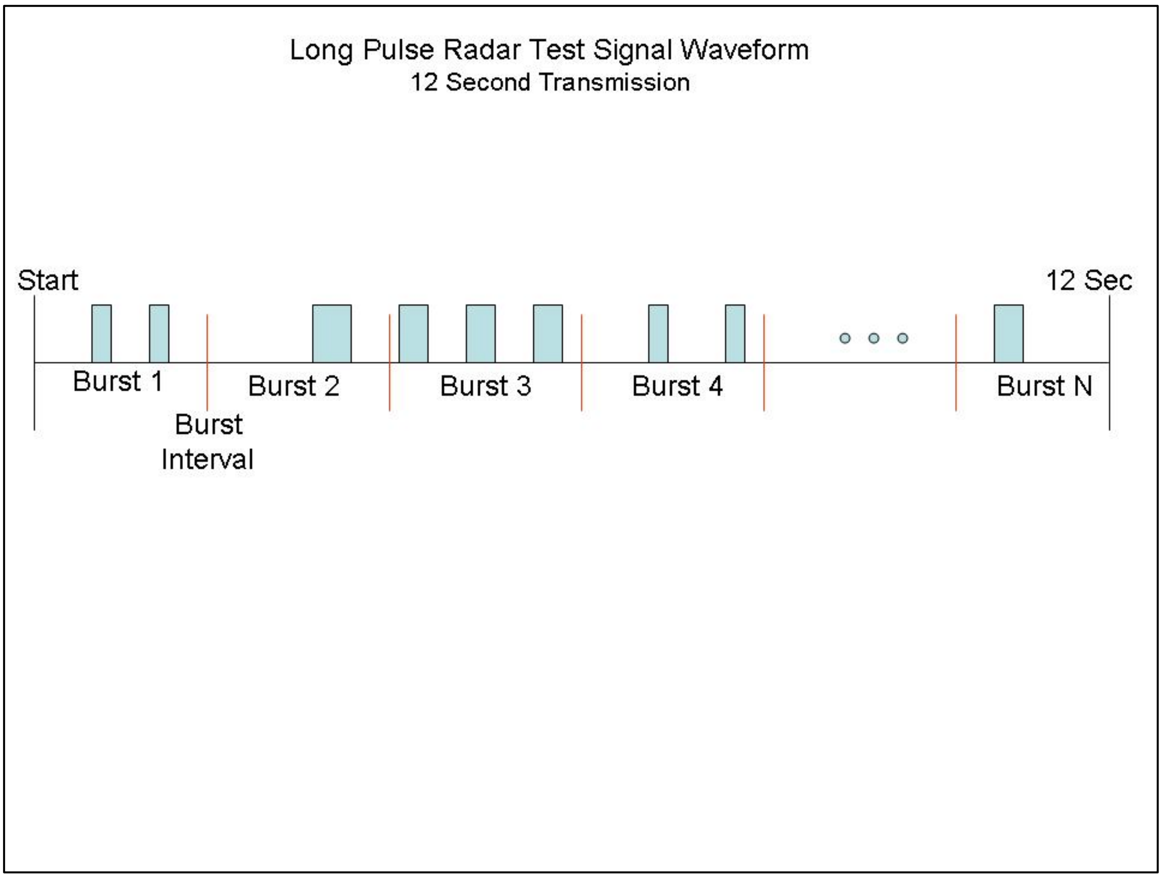
Each waveform is defined as follows:

1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 *Bursts* in the 12 second period, with the number of *Bursts* being randomly chosen. This number is *Burst_Count*.
3) Each *Burst* consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each *Burst* within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a *Burst* will have the same pulse width. Pulses in different *Bursts* may have different pulse widths.
5) Each pulse has a linear FM chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a *Burst* will have the same chirp width. Pulses in different *Bursts* may have different chirp widths. The chirp is centered on the pulse. For example, with a radar frequency of 5600 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
6) If more than one pulse is present in a *Burst*, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a *Burst*, the time between the first and second pulses is chosen independently of the time between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to *Burst_Count*. Each interval is of length (12,000,000 / *Burst_Count*) microseconds. Each interval contains one *Burst*. The start time for the *Burst*, relative to the beginning of the interval, is between 1 and [(12,000,000 / *Burst_Count*) – (Total *Burst* Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each *Burst* is chosen independently.

A representative example of a Long Pulse radar test waveform:

1) The total test signal length is 12 seconds.
2) 8 *Bursts* are randomly generated for the *Burst_Count*.
3) *Burst* 1 has 2 randomly generated pulses.
4) The pulse width (for both pulses) is randomly selected to be 75 microseconds.
5) The PRI is randomly selected to be at 1213 microseconds.
6) *Bursts* 2 through 8 are generated using steps 3 – 5.
7) Each *Burst* is contained in even intervals of 1,500,000 microseconds. The starting location for Pulse 1, *Burst* 1 is randomly generated (1 to 1,500,000 minus the total *Burst* 1 length + 1 random PRI interval) at the 325,001 microsecond step. *Bursts* 2 through 8 randomly fall in successive 1,500,000 microsecond intervals (i.e. *Burst* 2 falls in the 1,500,001 – 3,000,000 microsecond range).

Graphical representation of the Long Pulse radar Test Waveform.



6.3. Frequency Hopping Radar Test Waveform

Frequency Hopping Radar Test Waveform

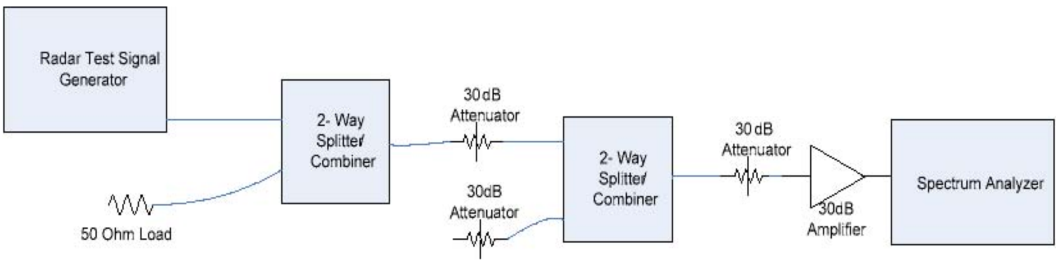
Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	9	.333	300	70%	30

For the Frequency Hopping Radar Type, the same *Burst* parameters are used for each waveform. The hopping sequence is different for each waveform and a 100-length segment is selected from the hopping sequence defined by the following algorithm:

The first frequency in a hopping sequence is selected randomly from the group of 475 integer frequencies from 5250 – 5724 MHz. Next, the frequency that was just chosen is removed from the group and a frequency is randomly selected from the remaining 474 frequencies in the group. This process continues until all 475 frequencies are chosen for the set. For selection of a random frequency, the frequencies remaining within the group are always treated as equally likely.

6.4. Radar Waveform Calibration

The following equipment setup was used to calibrate the conducted Radar Waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to 3 MHz.
The signal generator amplitude was set so that the power level measured at the spectrum analyzer was -46dBm (Ref Section 6.6). The 30dB amplifier gain was entered as an amplitude offset on the spectrum analyzer.

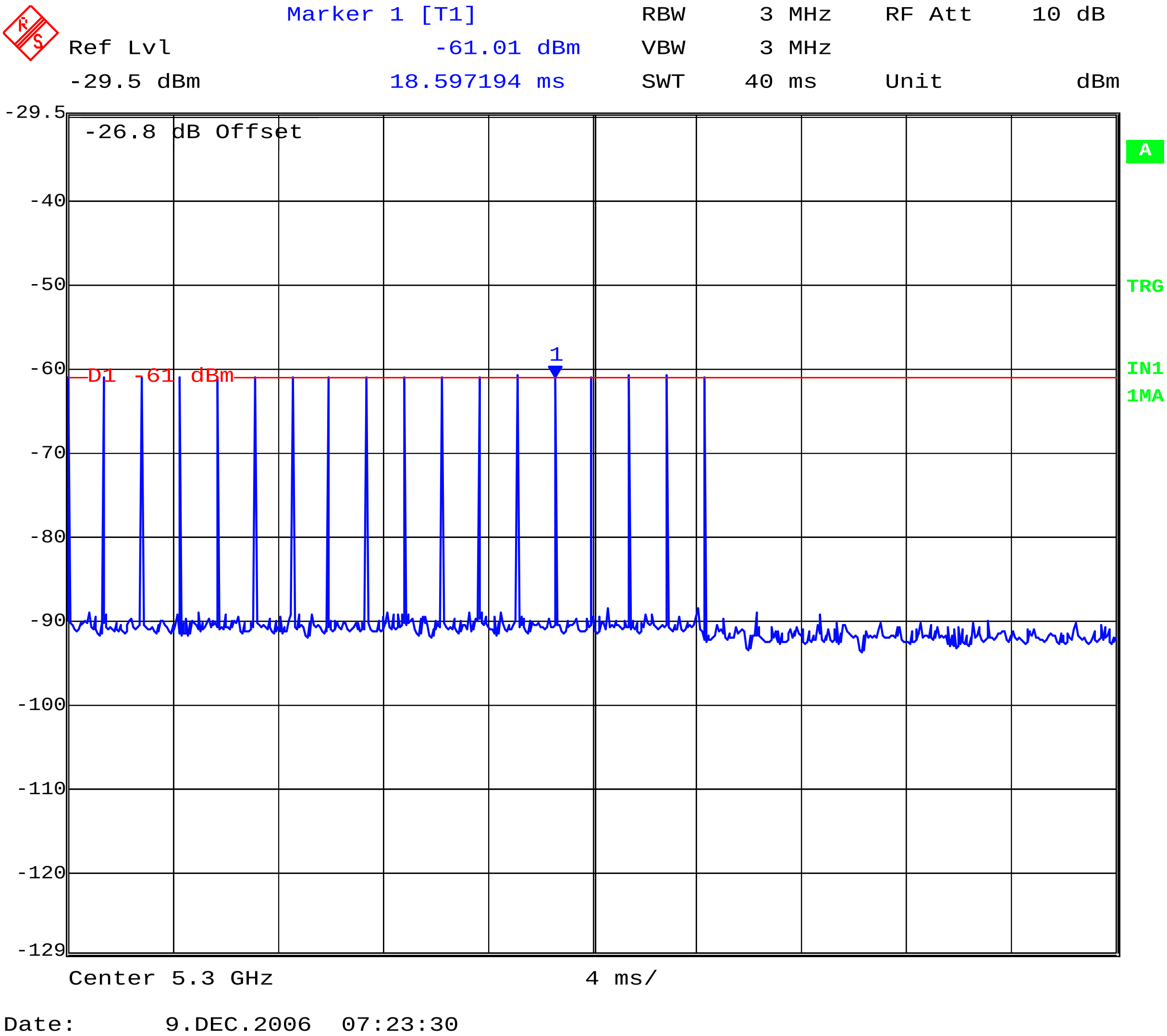


Conducted Calibration Setup

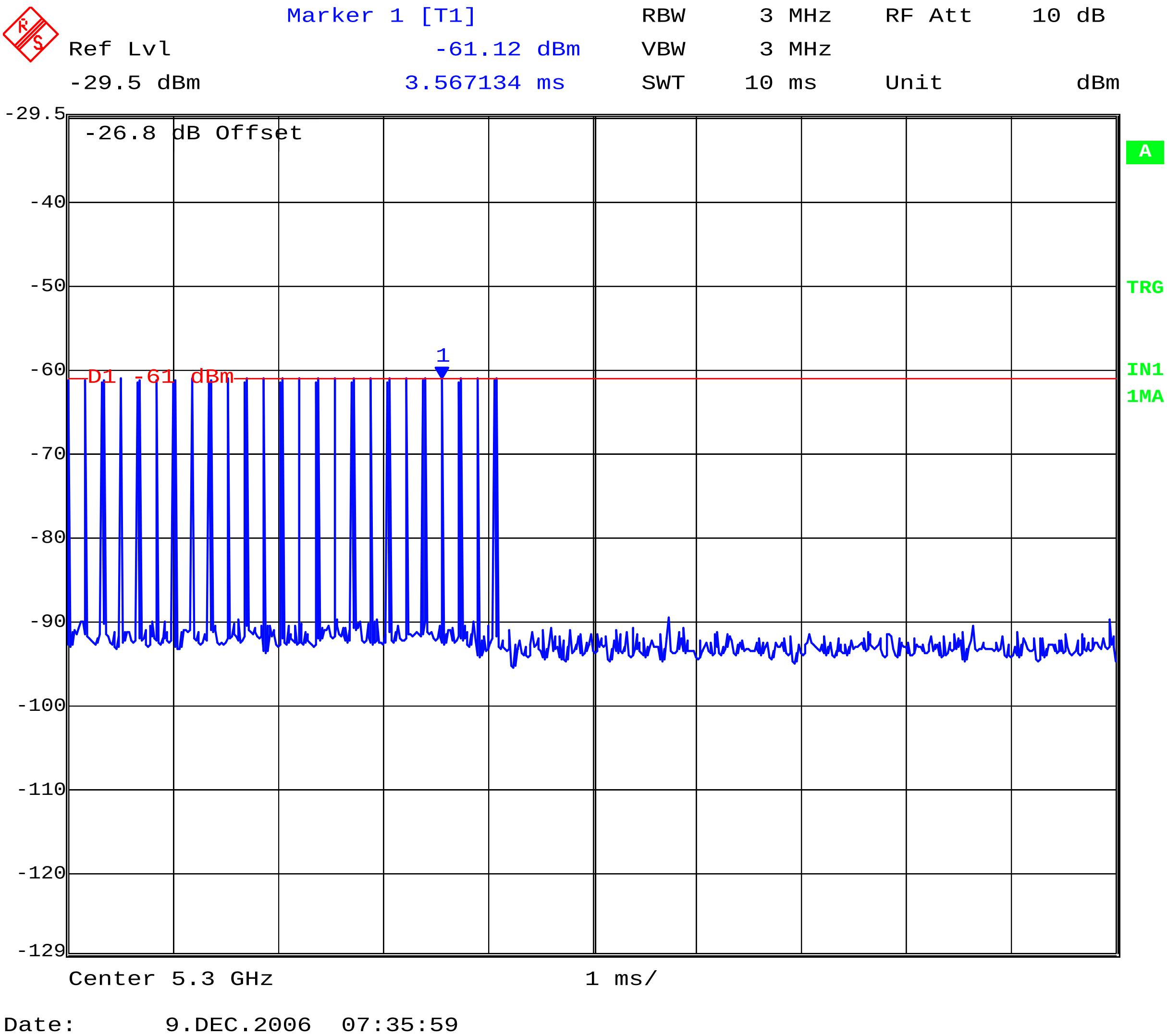
6.5. Radar Waveform Calibration Plots

The following are the calibration plots for required radar waveforms

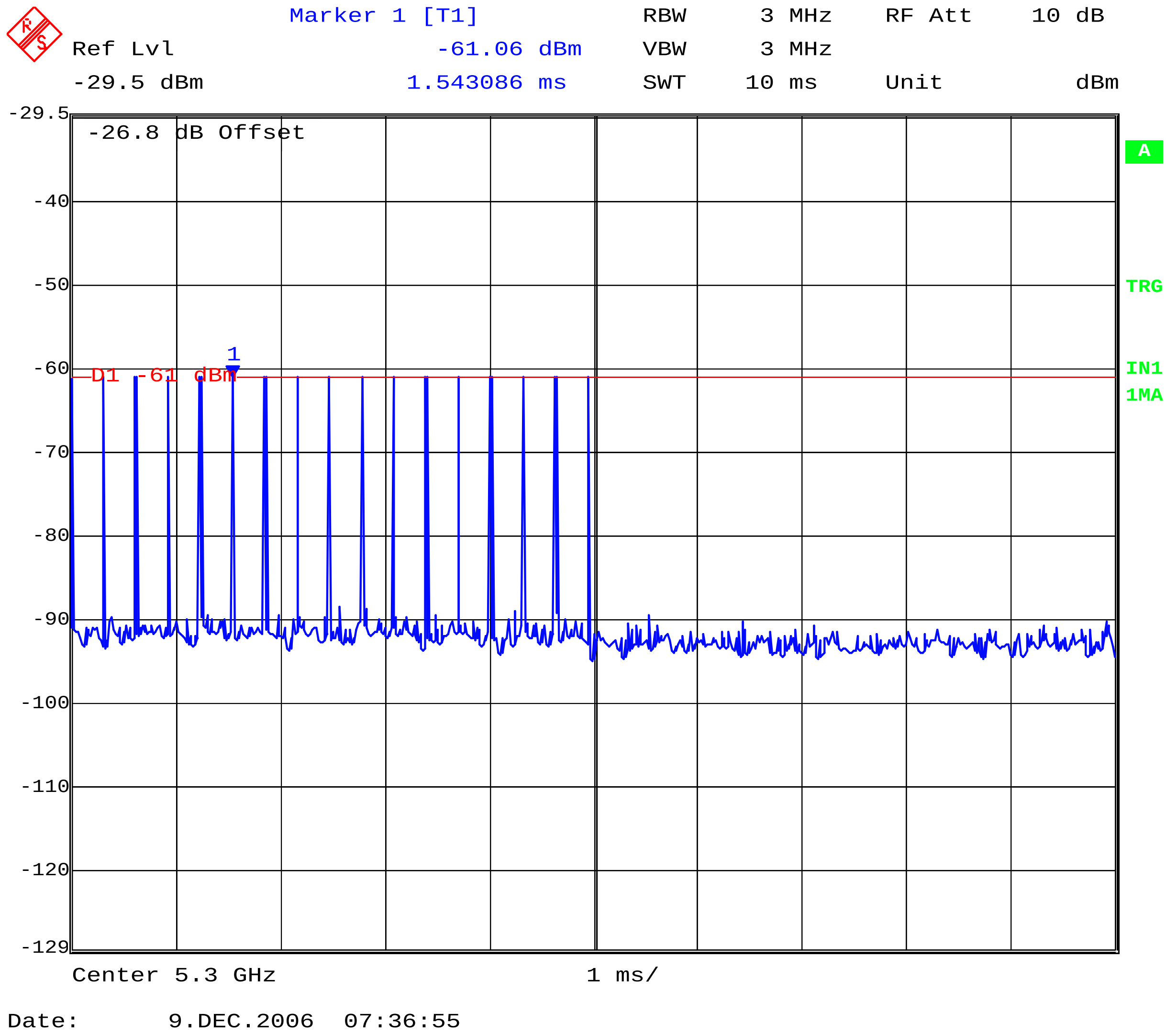
Radar Type 1 - 1uSec Pulse, 700prf, 18 pulses



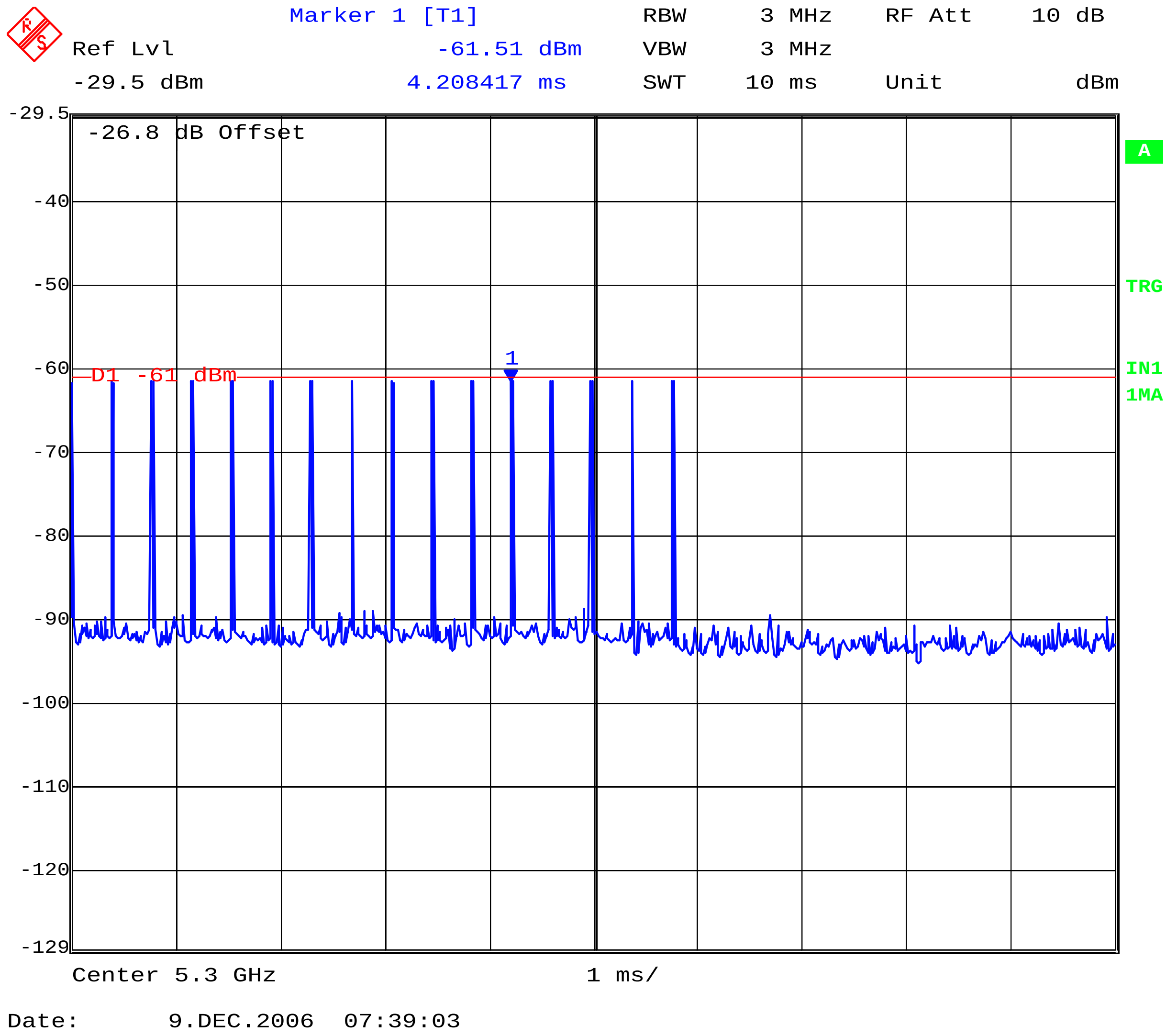
Radar Type 2 - 2.1uSec Pulse Width, 170prf, 25 pulses



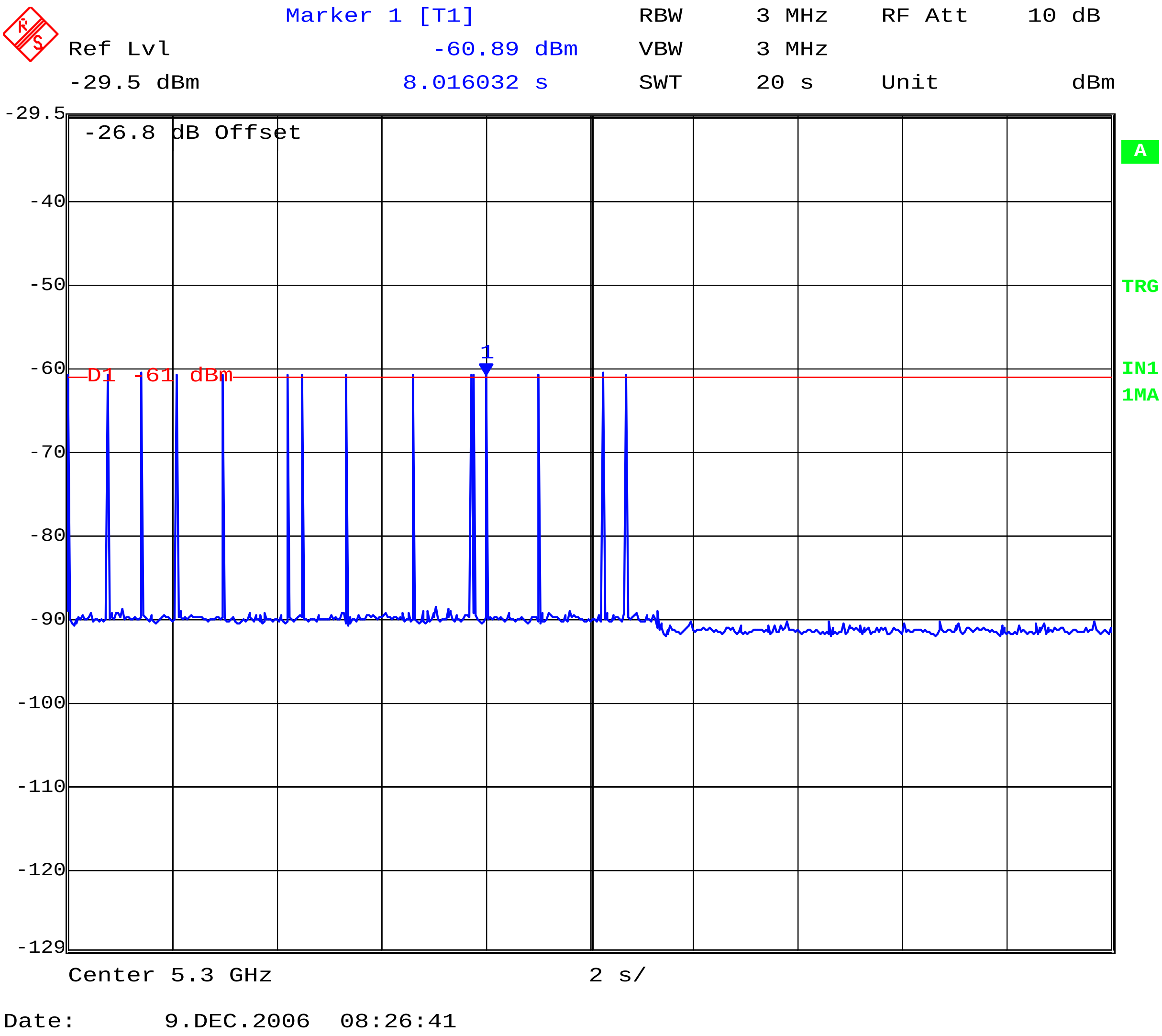
Radar Type 3 - 7.5uSec Pulse Width, 309prf, 17 pulses



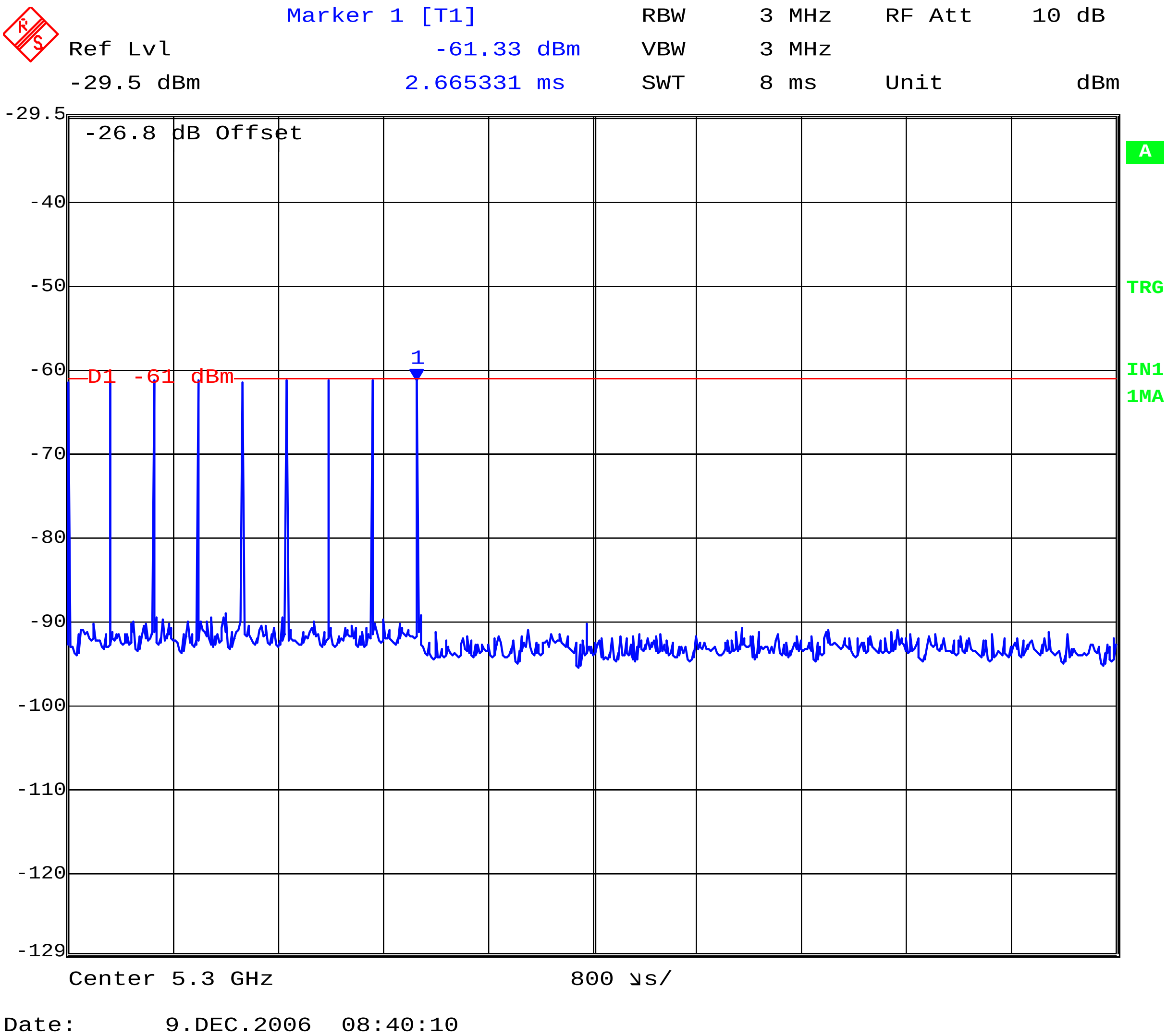
Radar Type 4 - 17.9uSec Pulse Width, 383prf, 16 pulses



Radar Type 5


Marker 1 [T1]
-60.89 dBm
8.016032 s
Ref Lvl
-29.5 dBm
RBW 3 MHz
VBW 3 MHz
SWT 20 s
RF Att 10 dB
Unit dBm
-26.8 dB Offset
D1 -61 dBm
A
TRG
IN1
1MA
-29.5
-40
-50
-60
-70
-80
-90
-100
-110
-120
-129
Center 5.3 GHz
2 s/
Date: 9.DEC.2006 08:26:41

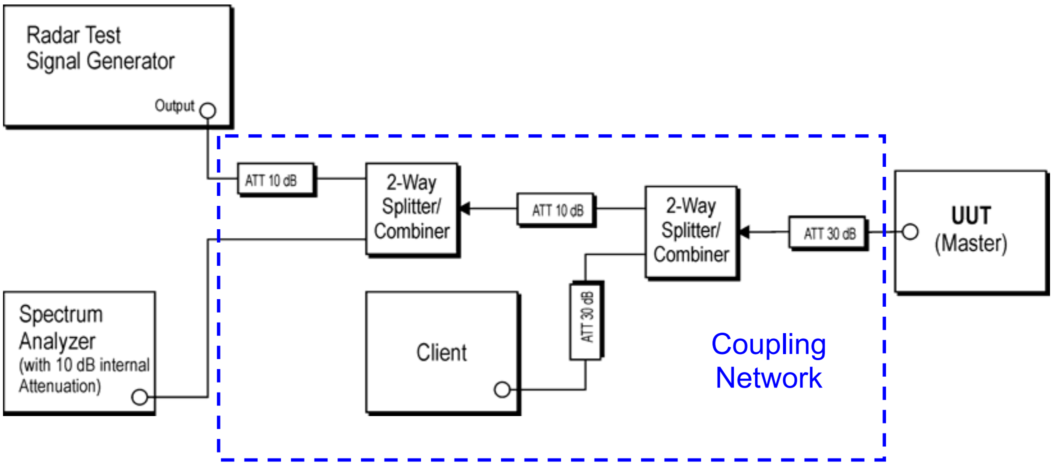
Radar Type 6


Marker 1 [T1]
RBW 3 MHz
RF Att 10 dB
Ref Lvl
-61.33 dBm
VBW 3 MHz
-29.5 dBm
2.665331 ms
SWT 8 ms
Unit dBm
-29.5
-26.8 dB Offset
-40
-50
-60
-70
-80
-90
-100
-110
-120
-129
D1 -61 dBm
1
A
TRG
IN1
1MA
Center 5.3 GHz
800 µs/
Date: 9.DEC.2006 08:40:10

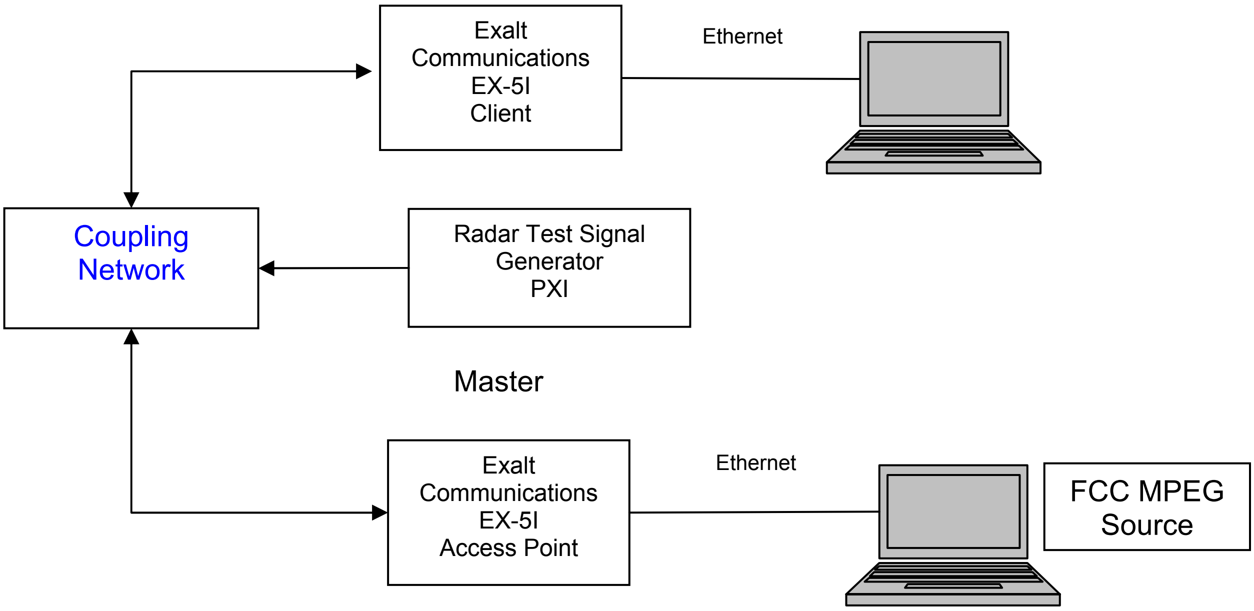
6.6. Test Set Up:

Block Diagram(s) of Test Setup

Setup for Conducted Measurements where the EUT is the Master with injection of Radar Test Waveforms at the Master.



Support Equipment Configuration



DFS Test Configurations

The 99% Bandwidth was measured for all radio configuration (three modulations and four different bandwidths) with the radio set at the channel frequency closest to 5,600 MHz to determine the narrowest bandwidth measurement for which the DFS detection bandwidth should be measured at.

The narrowest bandwidth measurements were selected according to the following table. The bandwidth measurements are held on file.

X – Configuration selected for DFS detection bandwidth measurement.

	8 MHz	16 MHz	32 MHz	64 MHz
QPSK	X		X	X
16QAM		X		
64QAM				

For the frequency bands 5,250 – 5,350 MHz, and 5,470-5,725 MHz the Master device provides, on aggregate, uniform loading of the spectrum across all devices by selecting an operating channel among the available channels using a random algorithm.

Exalt Communications declared a minimum gain antenna of 16 dBi. ;

Radar receive signal level = -62 dBm + minimum antenna gain + 1 dB

= -62 + 15 + 1

Radar receive signal level = -46 dBm

Measurement Results - Dynamic Frequency Selection (DFS)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57% Pressure: 999 to 1012 mbar

Radio parameters.
Test methodology: Conducted
Device Type: Master

6.7. DFS Test Results 8 MHz QPSK

6.7.1. UNII Detection Bandwidth: (8 MHz QPSK)

All UNII channels for this device have identical channel bandwidths and DFS testing was completed in the 5250 - 5350 MHz, & 5470 - 5725 MHz.

The generating equipment is configured as shown in the Conducted Test Setup above. A single Burst of the short pulse radar Type 1 through 6 was produced at 5500 MHz at a level of -46dBm (Ref Section 6.6). The EUT is set up as a standalone device (no associated Client and no traffic).

A single radar Burst is generated for a minimum of 10 trials, and the response of the EUT is noted. The EUT must detect the Radar Waveform 90% or more of the time.

The radar frequency is increased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The highest frequency at which detection is greater than or equal to 90% is denoted as F_H.

The radar frequency is decreased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The lowest frequency at which detection is greater than or equal to 90% is denoted as F_L.

The U-NII Detection Bandwidth is calculated as follows:

U-NII Detection Bandwidth = $F_H – F_L$

The U-NII Detection Bandwidth must be at least 80% of the EUT transmitter 99% power, otherwise, the EUT does not comply with DFS requirements.

EUT Frequency=5500MHz (8 MHz QPSK)											
Radar Frequency (MHz)	**DFS Detection Trials (1=Detection, Blank= No Detection)**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Detection Rate (%)**
											0%
5496	0	0	0	0	0	0	0	0	0	0	0%
5497(F_L)	1	1	1	1	1	1	1	1	1	1	100%
5498	1	1	1	1	1	1	1	1	1	1	100%
5499	1	1	1	1	1	1	1	1	1	1	100%
5500	1	1	1	1	1	1	1	1	1	1	100%
5501	1	1	1	1	1	1	1	1	1	1	100%
5502	1	1	1	1	1	1	1	1	1	1	100%
5503	1	1	1	1	1	1	1	1	1	1	100%
5504 (F_H)	1	1	1	1	1	1	1	1	1	1	100%
5505	0	0	0	0	0	0	0	0	0	0	0%
Detection Bandwidth = F_H-F_L = 5504 MHz - 5497 MHz = 7 MHz											
EUT 99% Bandwidth = 8.266 MHz											
8.266 MHz *80% = 6.613 MHz											

For each frequency step the minimum percentage detection is 90%

6.7.2. Initial Channel Availability Check Time (8 MHz QPSK)

This test verifies that the EUT does not emit pulse, control, or data signals on the test Channel until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. This test does not use any Radar Waveforms.

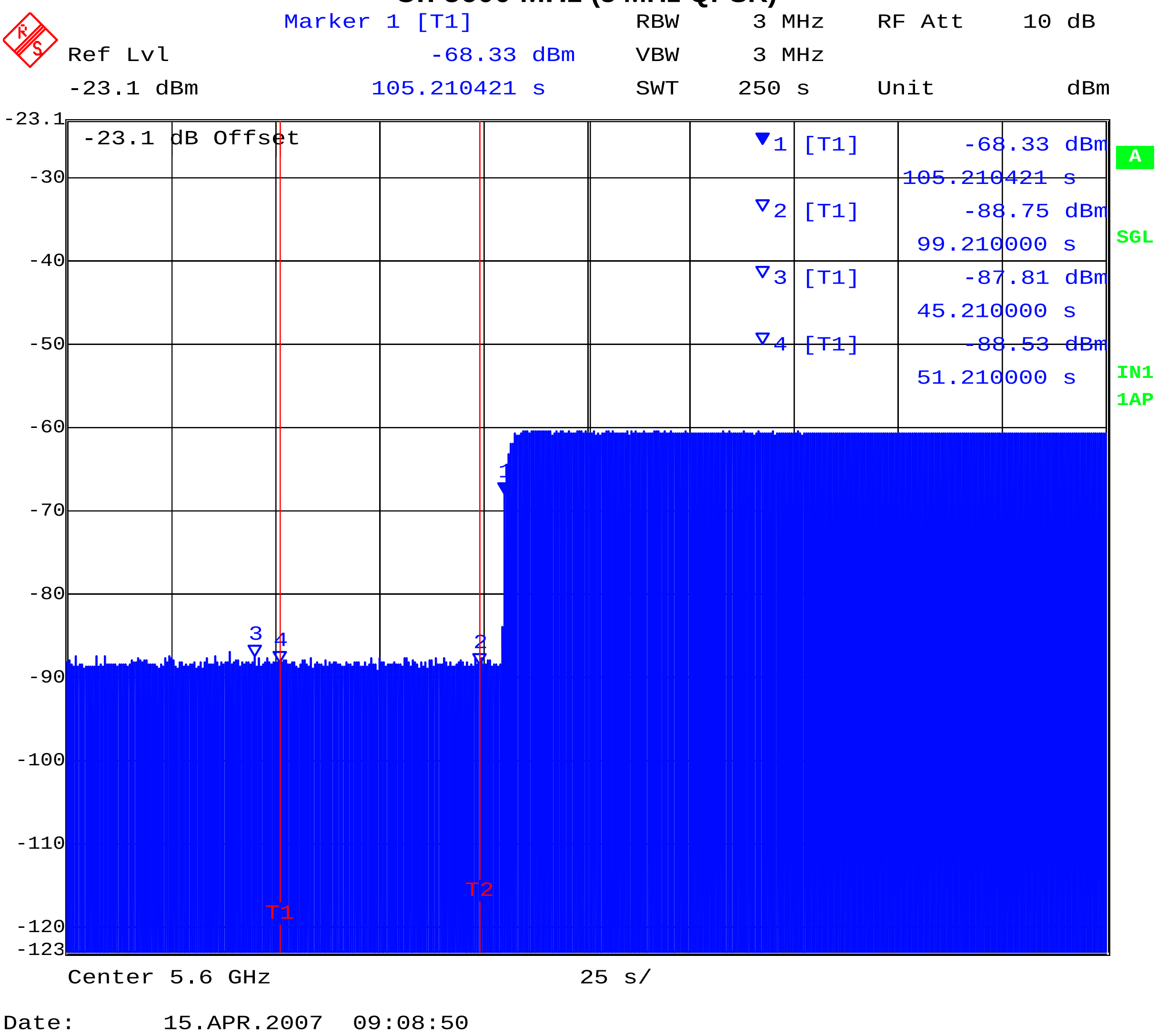
The U-NII device is powered on and be instructed to operate at 5600 MHz. At the same time the EUT is powered on, the spectrum analyzer is set for zero span with a 3 MHz resolution bandwidth at 5600 MHz with a 250 second sweep time. The analyzer's sweep will be started the same time power is applied to the U-NII device.

The EUT should not transmit any pulse or data transmissions until at least 1 minute after the completion of the power-on cycle.

The EUT is powered on at T0. Marker ▼3 denotes the instant when the EUT has completed its power-up sequence and the start of the Channel Availability Check Time that ends after a duration of ▼3 + 60 seconds i.e ▼1 on the following plot.

The Master device requires 45.21 seconds to complete its power-on cycle.

Initial Channel Availability Check Time during power up of EUT
Ch 5600 MHz (8 MHz QPSK)



6.7.3. Radar Burst at the Beginning of the Channel Availability Check Time (8 MHz QPSK)

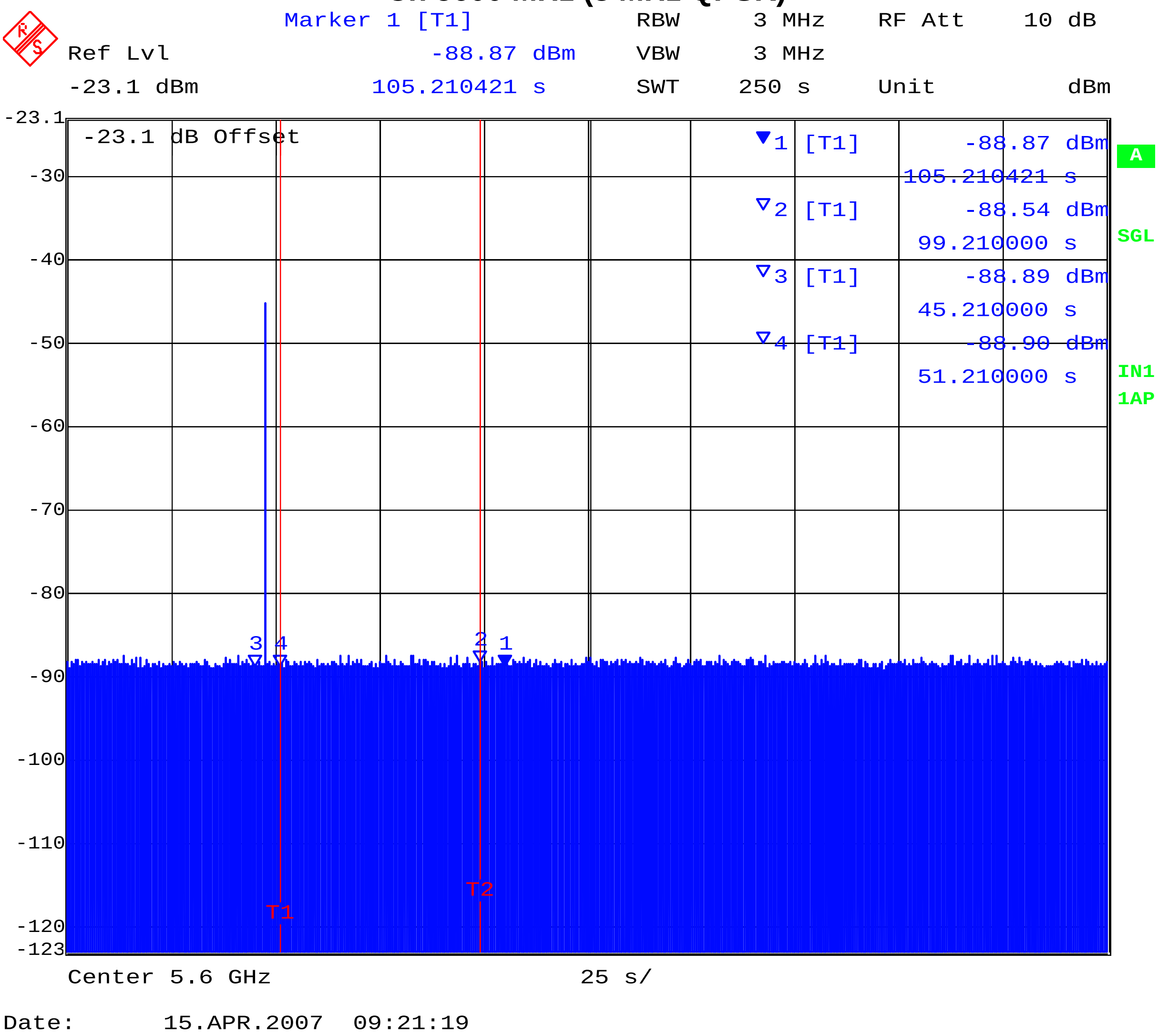
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-46 dBm Ref Section 6.6) occurs at the beginning of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single Burst of short pulse of radar type 1 will commence within a 6 second window starting at ▼3.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions have occurred at 5600MHz.

Channel Availability Check Time at the start of the 60 second Check Time
Ch 5600 MHz (8 MHz QPSK)



6.7.4. Radar Burst at the End of the Channel Availability Check Time: (8 MHz QPSK)

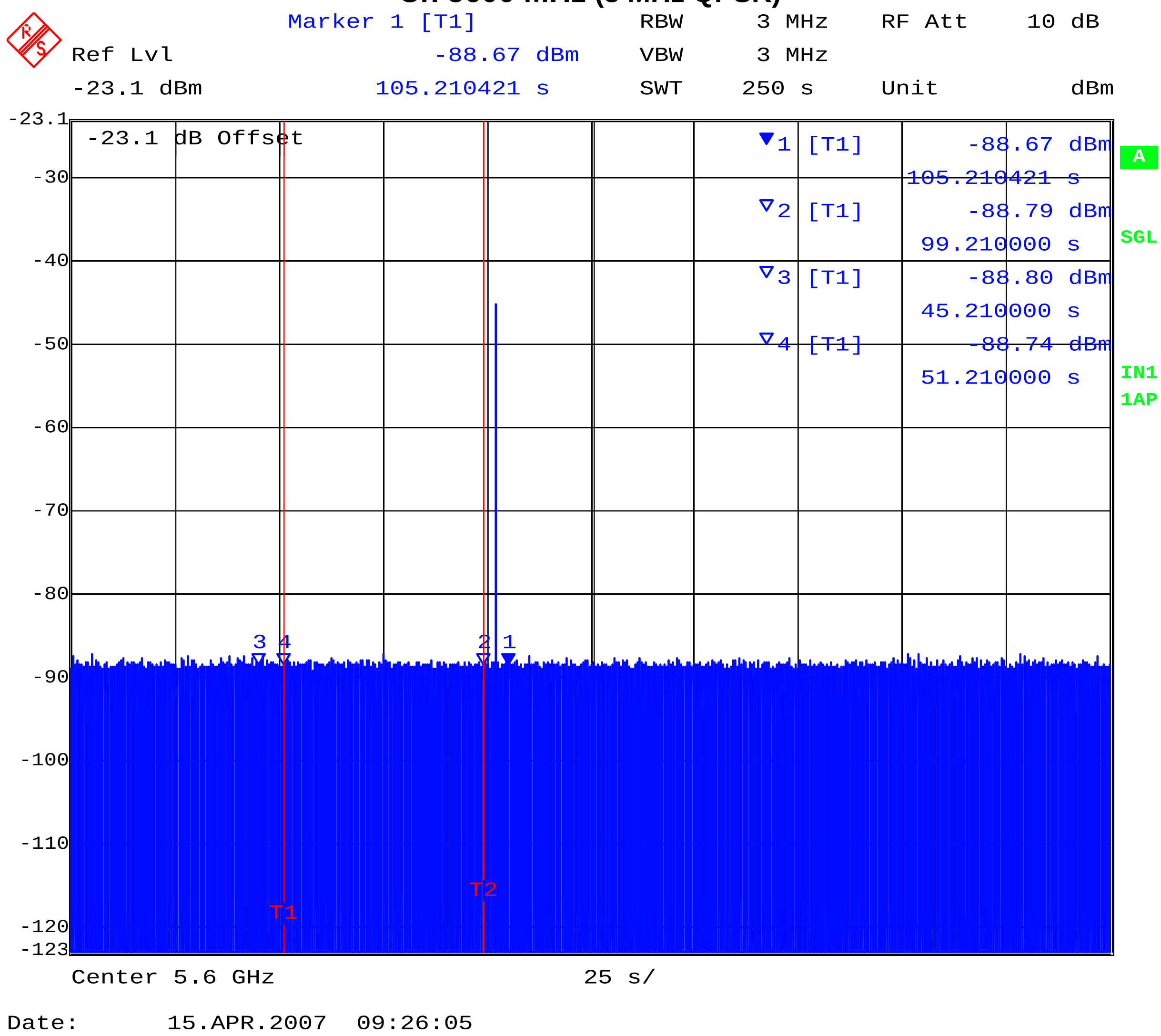
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold occurs at the end of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single burst of radar type 1 will commence within a 6 second window starting at marker ▼3+ 54 seconds.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions occurred at 5600MHz.

Channel Availability Check Time at the end of the 60 second Check Time
Ch 5600 MHz (8 MHz QPSK)



6.7.5. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period (8 MHz QPSK)
FCC §15.407(h)(2)(iii)

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the EUT (Master). The requisite MPEG video file ("TestFile.mpg" available on the NTIA website at the following link http://ntiacsd.ntia.doc.gov/dfs/) is streamed from the master device (AP) to the client.

Channel Closing Transmission Time - Measurement

A Type 1 waveform was introduced to the EUT, from which a 12 second transmission record was captured, collecting nearly 250M samples of data, which included 60ms of pre-trigger data. This Type 1 waveform had an integral marker built into its construction, marking the start of the waveform play, which directly triggered the PXI digitizer's data capture via the PXI backplane trigger bus.

The Aeroflex PXI was setup to capture data for all transmission events above a threshold level of -46dBm. The PXI time stamps all captured events with respect to T_0 (zero time indicating the start of the measurements sequence) starting the 60 ms pre-trigger period followed by the radar type 1 burst period.

Radar (Type 1) Pre-trigger period 60ms

Type 1 burst period 24.277ms

(The period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1µs pulse width for the final pulse.)

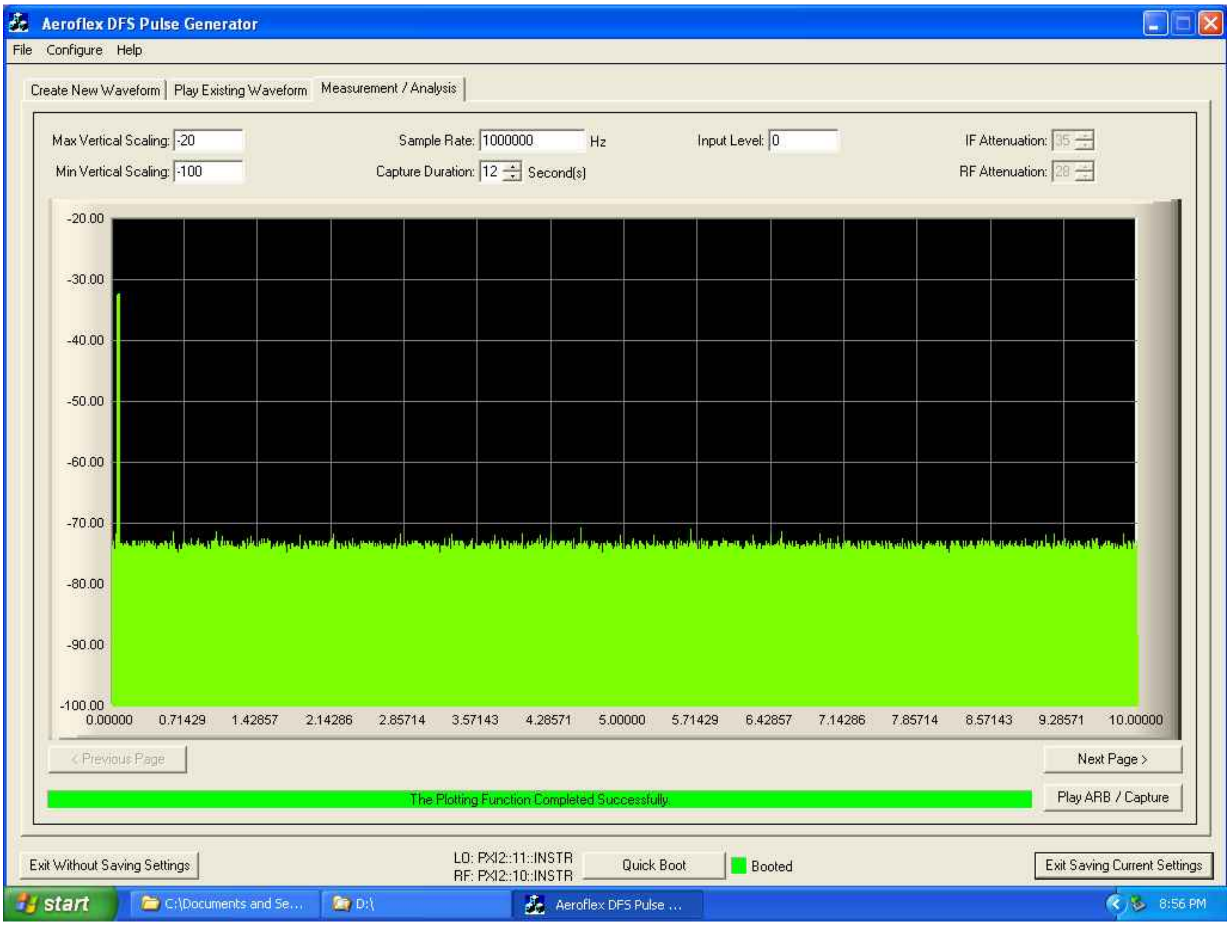
Channel Closing Transmission Time starts at 84.277ms after $T_{0.}$

Therefore, pulses seen after this 84.277ms boundary are identified and totaled to provide an aggregate total of transmissions in order to determine whether the EUT is compliant with the Channel Closing Transmission Time requirements as described in MO&O FCC 06-96. In this case, it was found that an aggregate total of 0 µs of transmission time accrued.

Channel Closing Transmission Time = 0Secs (limit 260 mSecs)

The EUT stopped transmitting data prior to the end of the Type 1 Radar burst, i.e. before the 84.277ms event marker in the measurement sequence, therefore by definition the Channel Closing Time is 0 Seconds.

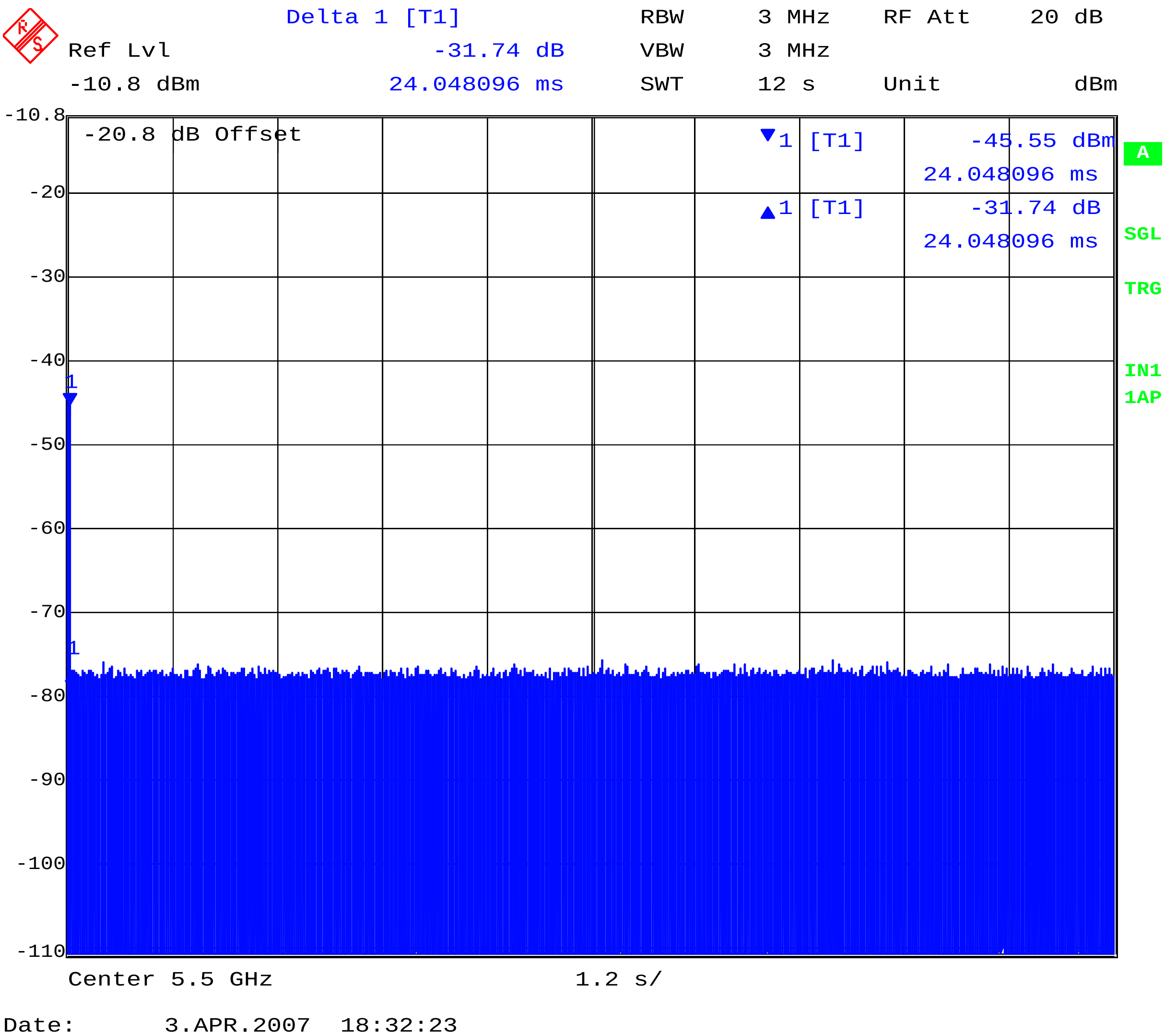
Channel Move Time, Channel Closing Time for Type 1 Radar(8 MHz QPSK) Captured by Aeroflex PXI Test System



Additionally, a redundant conventional spectrum analyzer screen capture is provided to correlate against the digitizer screen capture for verification purposes.

Note;- no pre-trigger data interval (60 mSecs) was included in the following Spectrum Analyzer plot

Channel Move Time, Channel Closing Time for Type 1 Radar(8 MHz QPSK) Captured by Spectrum Analyzer



The following data is the last set of transmission activity data captured by the Aeroflex PXI test System and is used to calculate the Channel Closing Transmission Time for the EUT (8 MHz QPSK) with the intervention of Radar Type 1.

Sample Number: 83699	Rising Edge, Sample Time Stamp	0.083699
Sample Number: 83713	Falling Edge, Sample Time Stamp	0.083713*

* Represents the last transmission activity of the EUT. The 0.083713*second time stamp is used to calculate Channel Move Time.

Channel Move Time (8 MHz QPSK)– Measurement & Calculation Type 1 Radar

The Channel Move Time is calculated using the data captured for the Channel Closing time as follows;-

Channel Move Time = Ft – Pt - Rt

Where;-

Ft = Final transmission activity occurred at 83.713 mSeconds

Pt = Pre-trigger information 60 mS

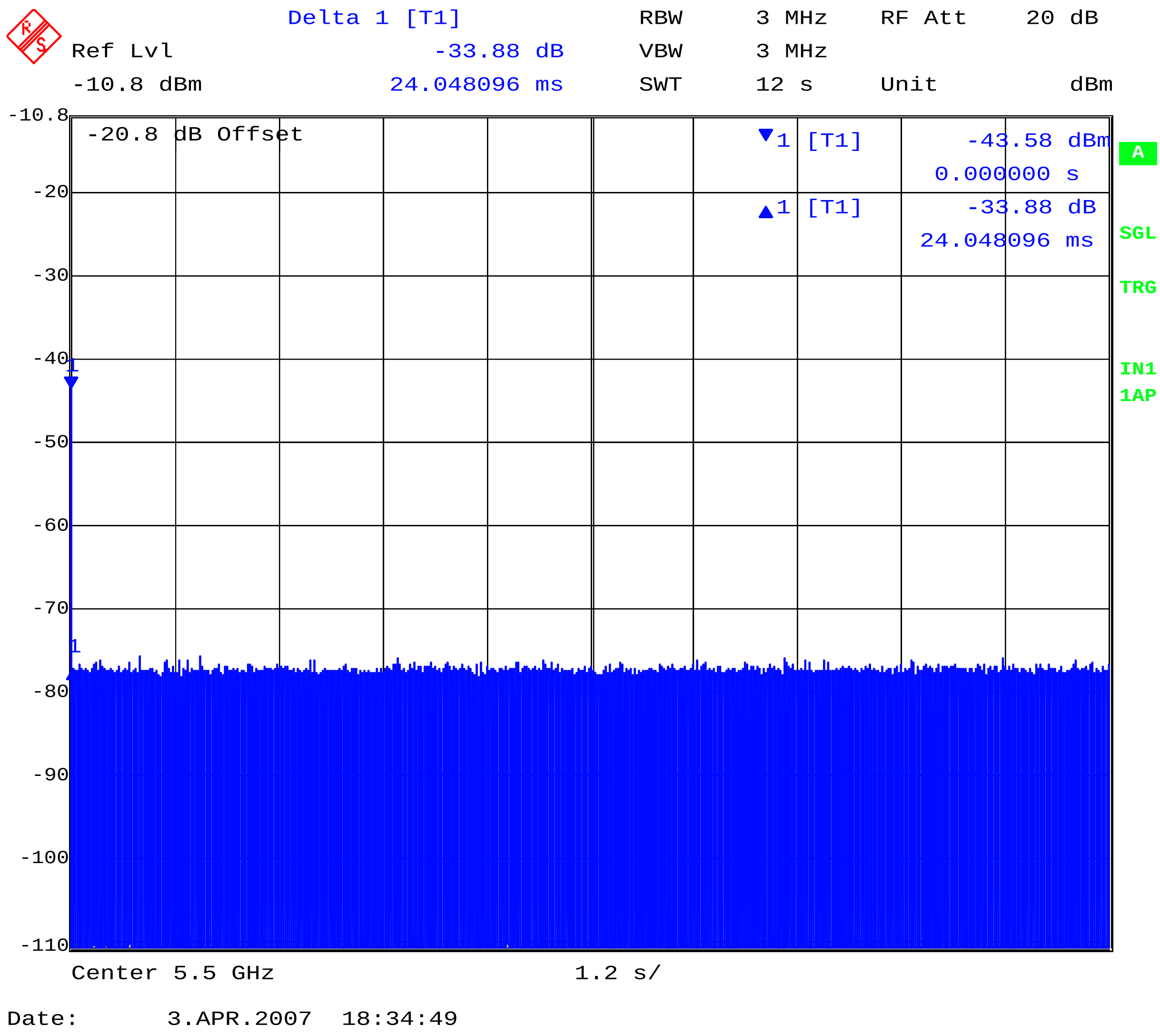
Rt = Type 1 burst period 24.277 mS

(Rt is the period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1µs pulse width for the final pulse.)

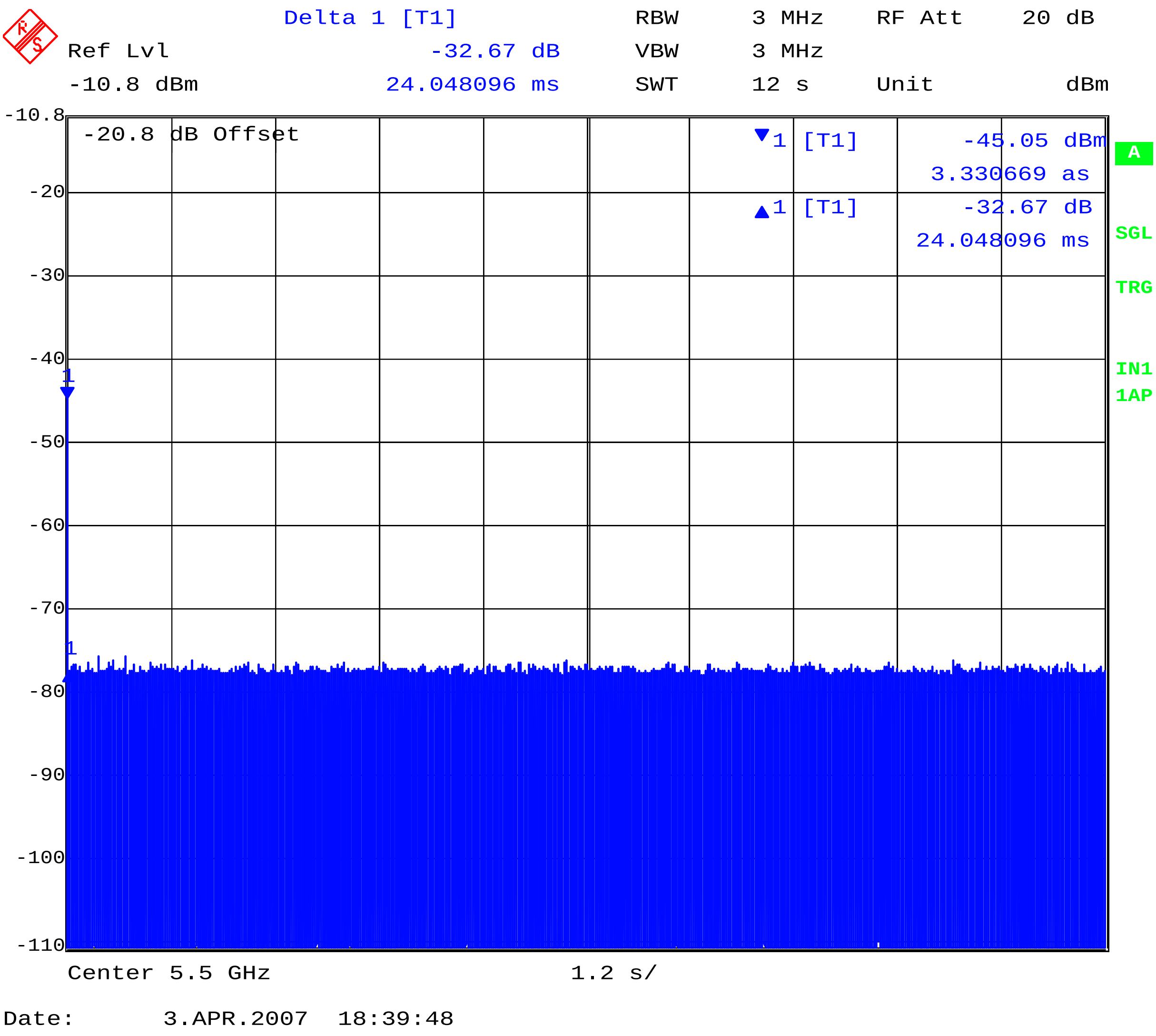
Channel Move Time = 83.713 – 60 – 24.277 = - 0.564 secs

i.e the EUT stopped transmitting data 0.564 mSecs prior to the end of the Type 1 radar burst. The Channel Move Time (by definition) is therefore 0 Seconds.

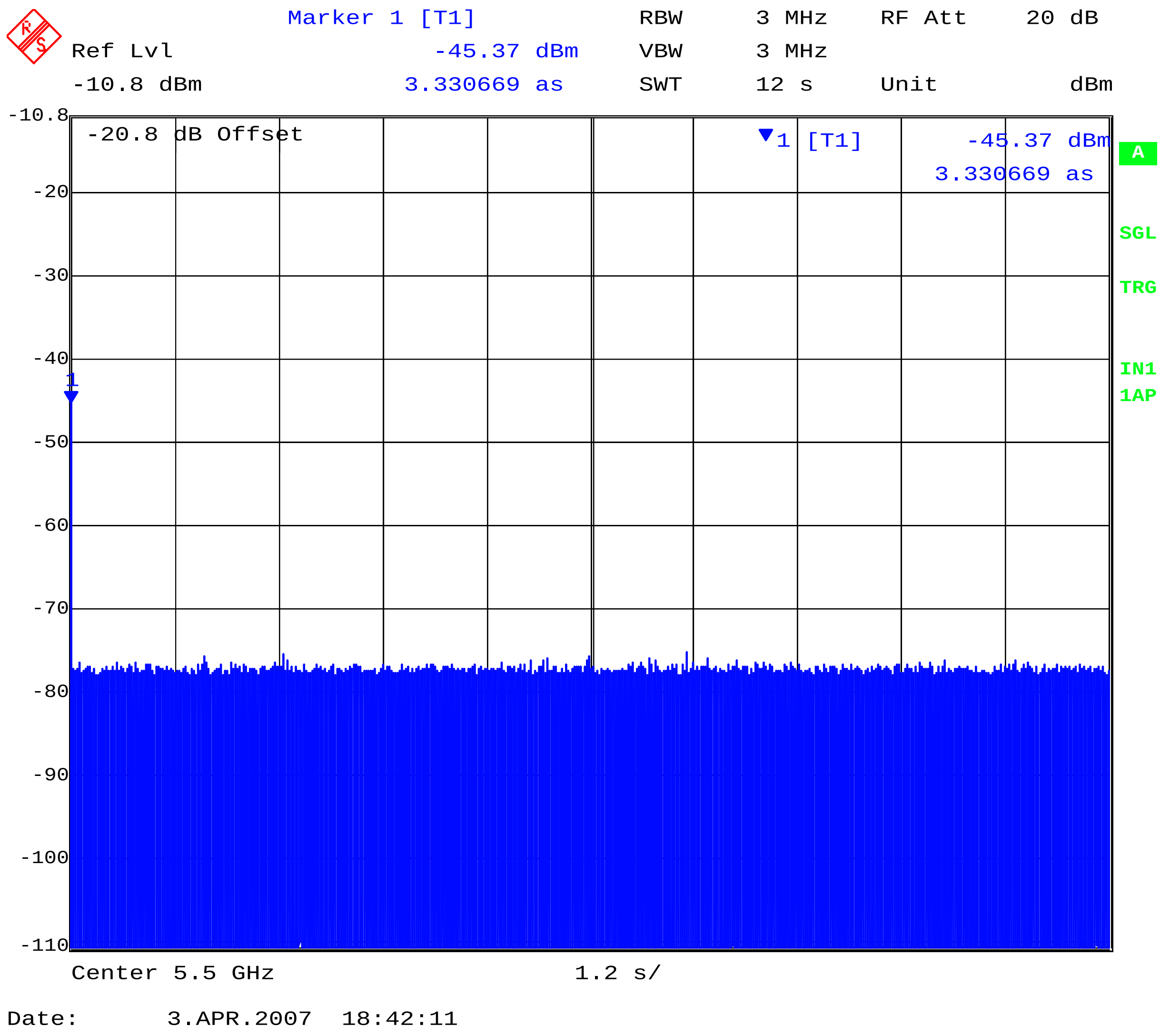
Channel Move Time, Channel closing Transmission Time for (8 MHz QPSK) Type 2 Radar 1.1μs, 197 prf, 24 pulses



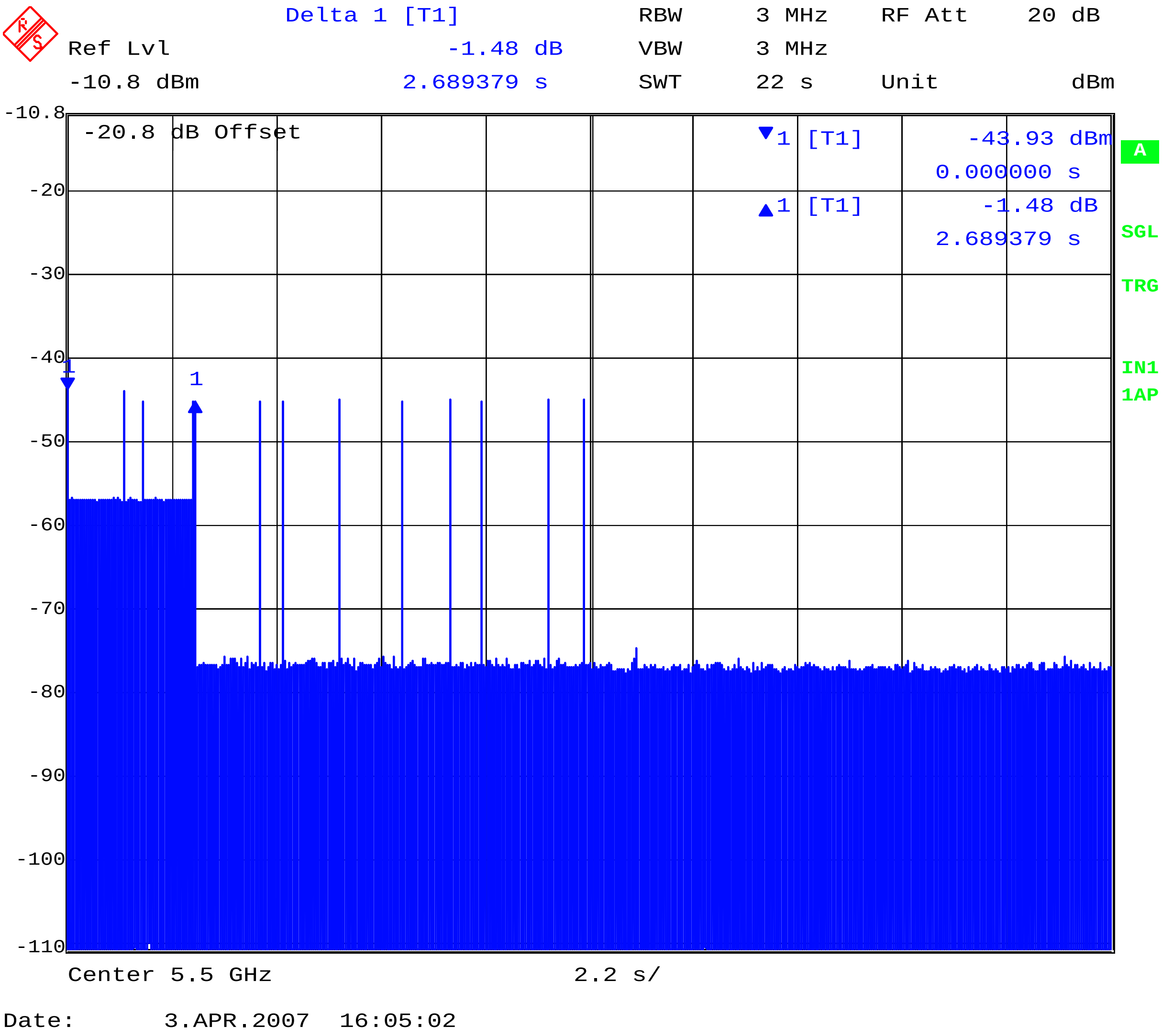
Channel Move Time, Channel closing Transmission Time (8 MHz QPSK) for Type 3 Radar
6.2 µs, 259 prf, 17 pulses



Channel Move Time, Channel closing Transmission Time (8 MHz QPSK) for Type 4 Radar
11.6 μs, 283 prf, 13 pulses

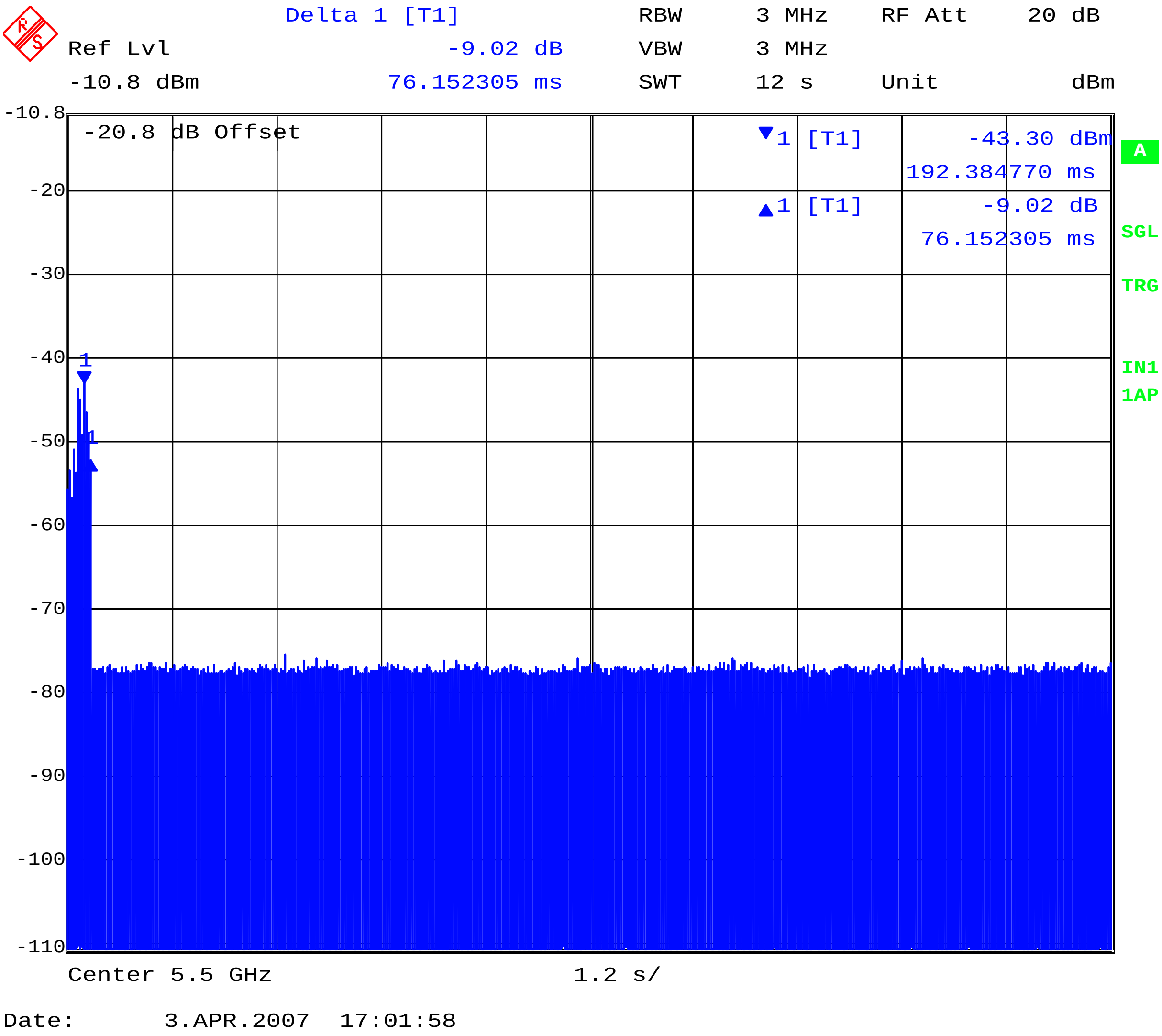


Channel Move Time, Channel closing Transmission Time (8 MHz QPSK) for Type 5 Radar



With reference to the requirements of FCC MO & O 06-96;- The instant that the Chanel Move Time and Channel Closing Time begins for the long Pulse Radar Test Signal is the instant at the end of the 12 Second period defining the Radar Waveform. From the above plot is can be seen that the EUT stopped transmitting data before completion of the Radar Test Signal, therefore the Channel Closing Time and Channel Move time complies with the requirements.

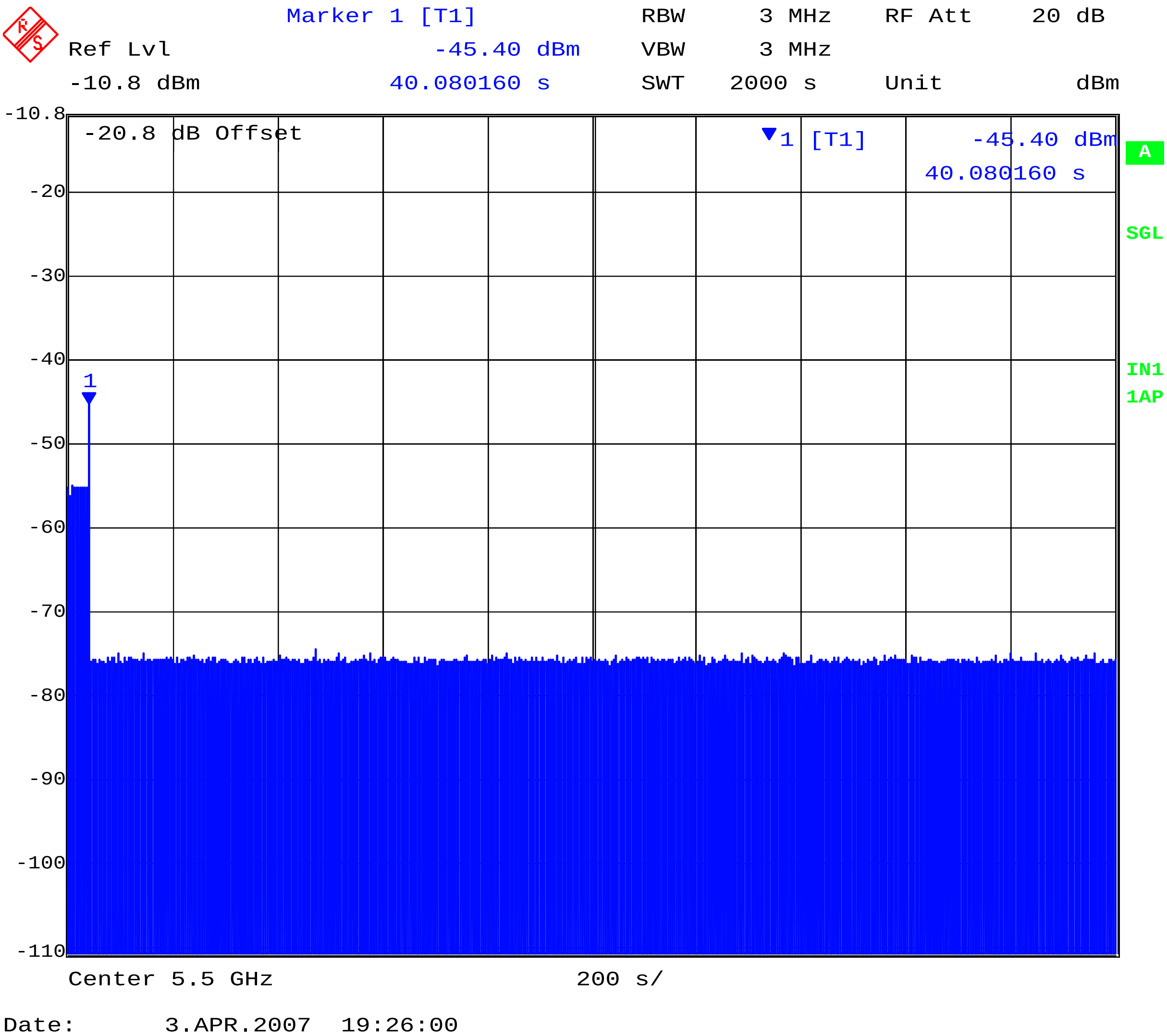
Channel Move Time, Channel closing Transmission Time (8 MHz QPSK) for Type 6 Radar



30 Minute Non-Occupancy Period

The EUT is monitored for more than 30 minutes following the channel close/move time to verify no transmissions resume on this Channel.

30 Minute Non-Occupancy Period (8 MHz QPSK) Type 1 Radar Ch 5500 MHz



6.7.6. Statistical Performance Check

The steps below define the procedure to determine the minimum percentage of detection when a radar burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5600 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

The Radar Waveform generator sends the individual waveform for each of the radar types 1-6. Statistical data will be gathered to determine the ability of the device to detect the radar test waveforms. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The percentage of successful detection is calculated by:

Total # of detections ÷ Total # of Trials × 100 = Probability of Detection

The Minimum number of trails, minimum percentage of successful detection and the average minimum percentage of successful detection are found in the Radar Test Waveforms section.

(8 MHz QPSK)- Verification of Detection

Trail #	Detection = 1, No Detection = 0			
	Type 1	Type 2	Type 3	Type 4
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12	1	1	1	1
13	1	1	1	1
14	1	1	1	1
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	1	1	1	1
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	1	1	1	1
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1
27	1	1	1	1
28	1	1	1	1
29	1	1	1	1
30	1	1	1	1
Detection Percentage	100% (>60%)	100% (>60%)	100% (>60%)	100% (>60%)

In addition an average minimum percentage of successful detection across all four Short pulse radar test waveforms is required and calculated as follows;

$\underline{P_d1 + P_d2 + P_d3 + P_d4} = \underline{(100\% + 100\% + 100\% + 100\%)} = 100\% \ (> 80\%)$

(8 MHz QPSK) Radar Type 5 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	100% (>60%)

(8 MHz QPSK) Radar Type 6 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	0
8	1
9	1
10	1
11	0
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	0
28	1
29	1
30	1
Detection Percentage	90% (>60%)

6.8. DFS Test Results 16 MHZ 16QAM

6.8.1. UNII Detection Bandwidth: (16 MHz 16QAM)

All UNII channels for this device have identical channel bandwidths and DFS testing was completed in the 5250 - 5350 MHz, & 5470 - 5725 MHz.

The generating equipment is configured as shown in the Conducted Test Setup above. A single Burst of the short pulse radar Type 1 through 6 was produced at 5500 MHz at a level of -46dBm (Ref Section 6.6). The EUT is set up as a standalone device (no associated Client and no traffic).

A single radar Burst is generated for a minimum of 10 trials, and the response of the EUT is noted. The EUT must detect the Radar Waveform 90% or more of the time.

The radar frequency is increased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The highest frequency at which detection is greater than or equal to 90% is denoted as F_H.

The radar frequency is decreased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The lowest frequency at which detection is greater than or equal to 90% is denoted as F_L.

The U-NII Detection Bandwidth is calculated as follows:

U-NII Detection Bandwidth = $F_H – F_L$

The U-NII Detection Bandwidth must be at least 80% of the EUT transmitter 99% power, otherwise, the EUT does not comply with DFS requirements.

EUT Frequency=5500MHz (16 MHz 16QAM)											
Radar Frequency (MHz)	**DFS Detection Trials (1=Detection, Blank= No Detection)**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Detection Rate (%)**
5491	0	0	0	0	0	0	0	0	0	0	0%
5492 (F_L)	1	1	1	1	1	1	1	1	1	1	100%
5493	1	1	1	1	1	1	1	1	1	1	100%
5494	1	1	1	1	1	1	1	1	1	1	100%
5495	1	1	1	1	1	1	1	1	1	1	100%
5496	1	1	1	1	1	1	1	1	1	1	100%
5497	1	1	1	1	1	1	1	1	1	1	100%
5498	1	1	1	1	1	1	1	1	1	1	100%
5499	1	1	1	1	1	1	1	1	1	1	100%
5500	1	1	1	1	1	1	1	1	1	1	100%
5501	1	1	1	1	1	1	1	1	1	1	100%
5502	1	1	1	1	1	1	1	1	1	1	100%
5503	1	1	1	1	1	1	1	1	1	1	100%
5504	1	1	1	1	1	1	1	1	1	1	100%
5505	1	1	1	1	1	1	1	1	1	1	100%
5506	1	1	1	1	1	1	1	1	1	1	100%
5507	1	1	1	1	1	1	1	1	1	1	100%
5508 (F_H)	1	1	1	1	1	1	1	1	1	1	100%
5509	0	0	0	0	0	0	0	0	0	0	0%
Detection Bandwidth = F_H-F_L = 5308 MHz-5292 MHz = 16 MHz											
EUT 99% Bandwidth = 16.633 MHz											
16.633 MHz *80% = 13.306 MHz											

For each frequency step the minimum percentage detection is 90%

6.8.2. Initial Channel Availability Check Time (16 MHz 16QAM)

This test verifies that the EUT does not emit pulse, control, or data signals on the test Channel until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. This test does not use any Radar Waveforms.

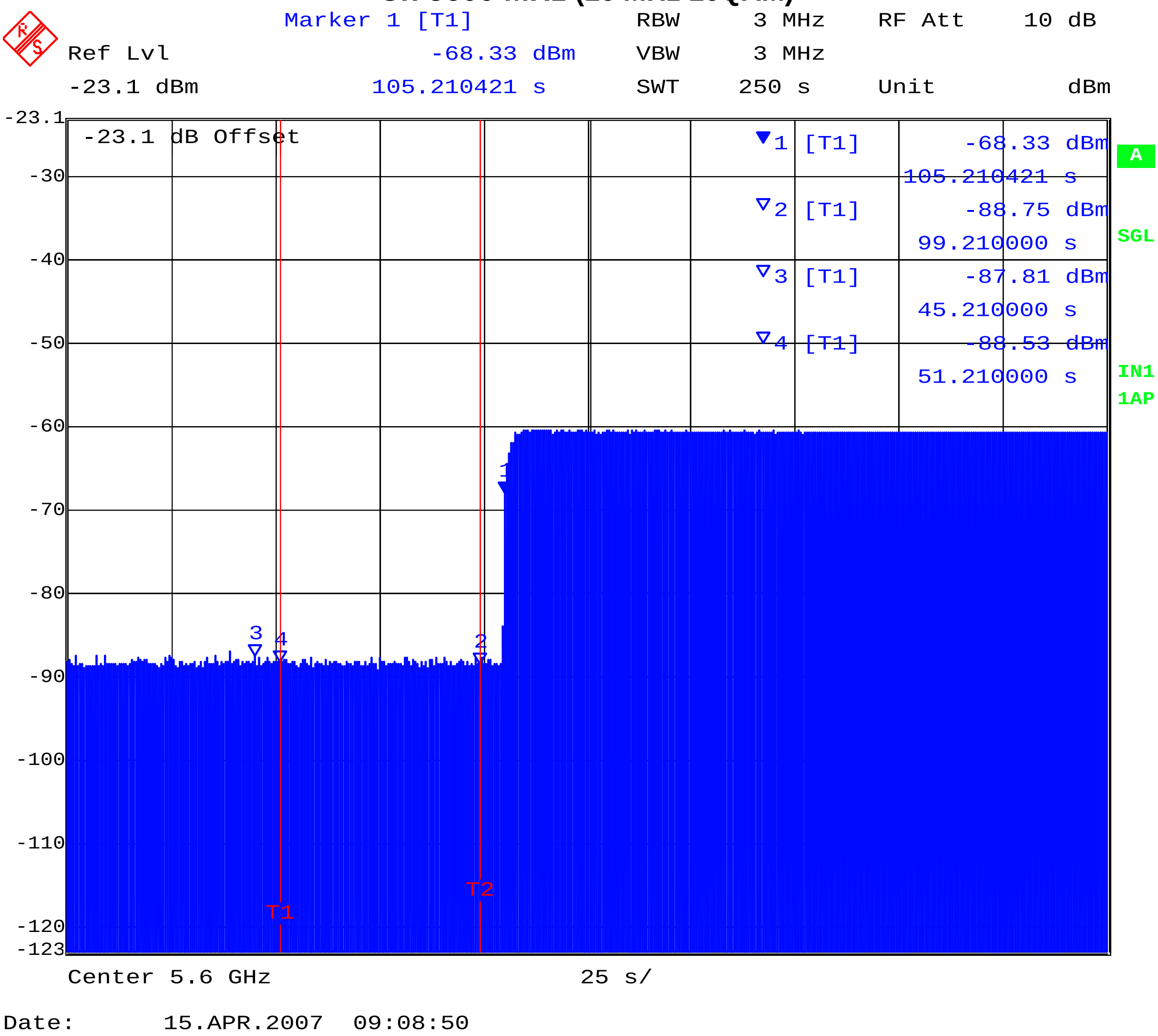
The U-NII device is powered on and be instructed to operate at 5600 MHz. At the same time the EUT is powered on, the spectrum analyzer is set for zero span with a 3 MHz resolution bandwidth at 5600 MHz with a 250 second sweep time. The analyzer's sweep will be started the same time power is applied to the U-NII device.

The EUT should not transmit any pulse or data transmissions until at least 1 minute after the completion of the power-on cycle.

The EUT is powered on at T0. Marker ▼3 denotes the instant when the EUT has completed its power-up sequence and the start of the Channel Availability Check Time that ends after a duration of ▼3 + 60 seconds i.e ▼1 on the following plot.

The Master device requires 45.21 seconds to complete its power-on cycle.

Initial Channel Availability Check Time during power up of EUT
Ch 5600 MHz (16 MHz 16QAM)



6.8.3. Radar Burst at the Beginning of the Channel Availability Check Time (16 MHz 16QAM)

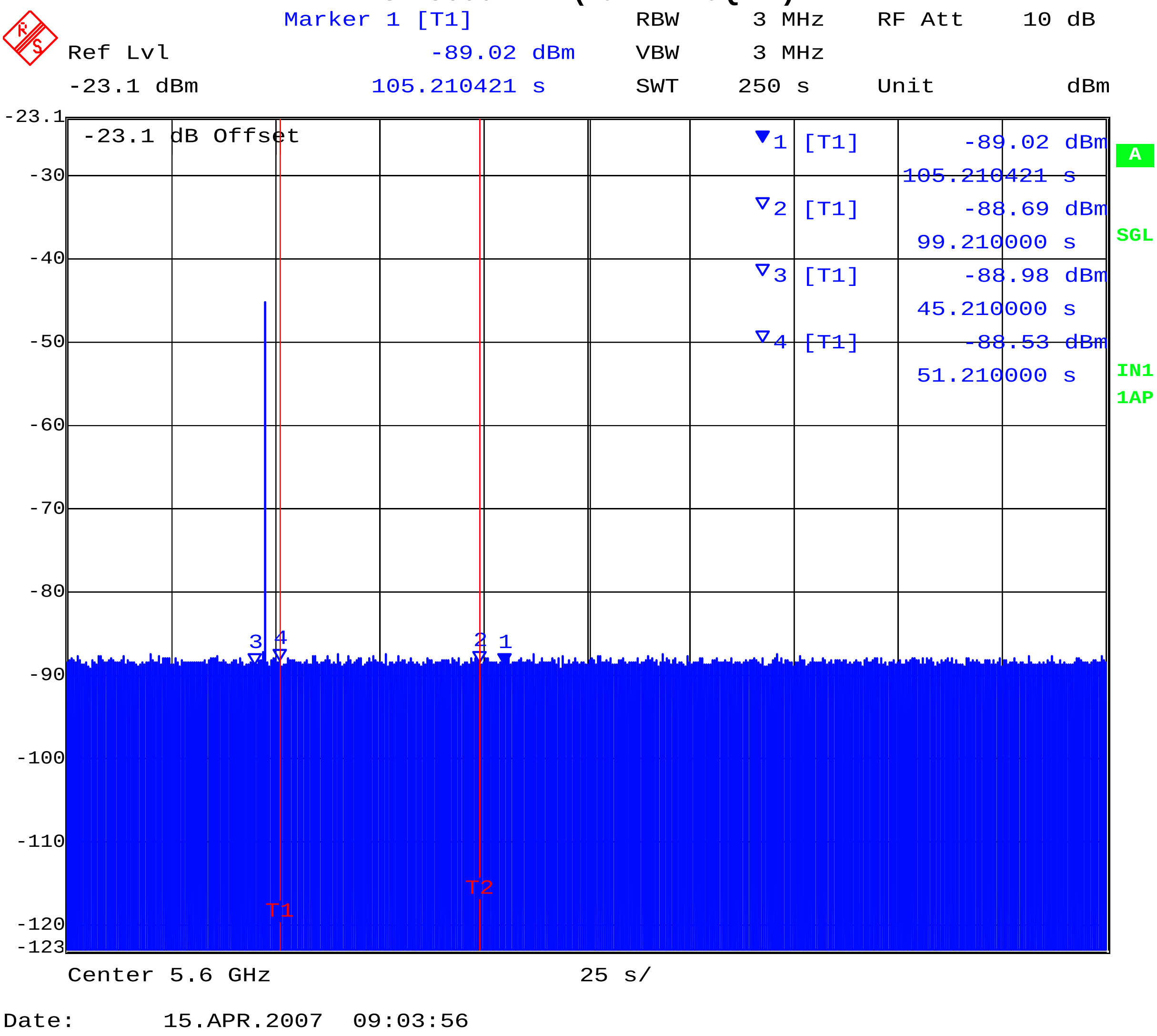
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-46 dBm Ref Section 6.6) occurs at the beginning of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single Burst of short pulse of radar type 1 will commence within a 6 second window starting at ▼3.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions have occurred at 5600MHz.

Channel Availability Check Time at the start of the 60 second Check Time
Ch 5600 MHz (16 MHz 16QAM)



6.8.4. Radar Burst at the End of the Channel Availability Check Time: (16 MHz 16QAM)

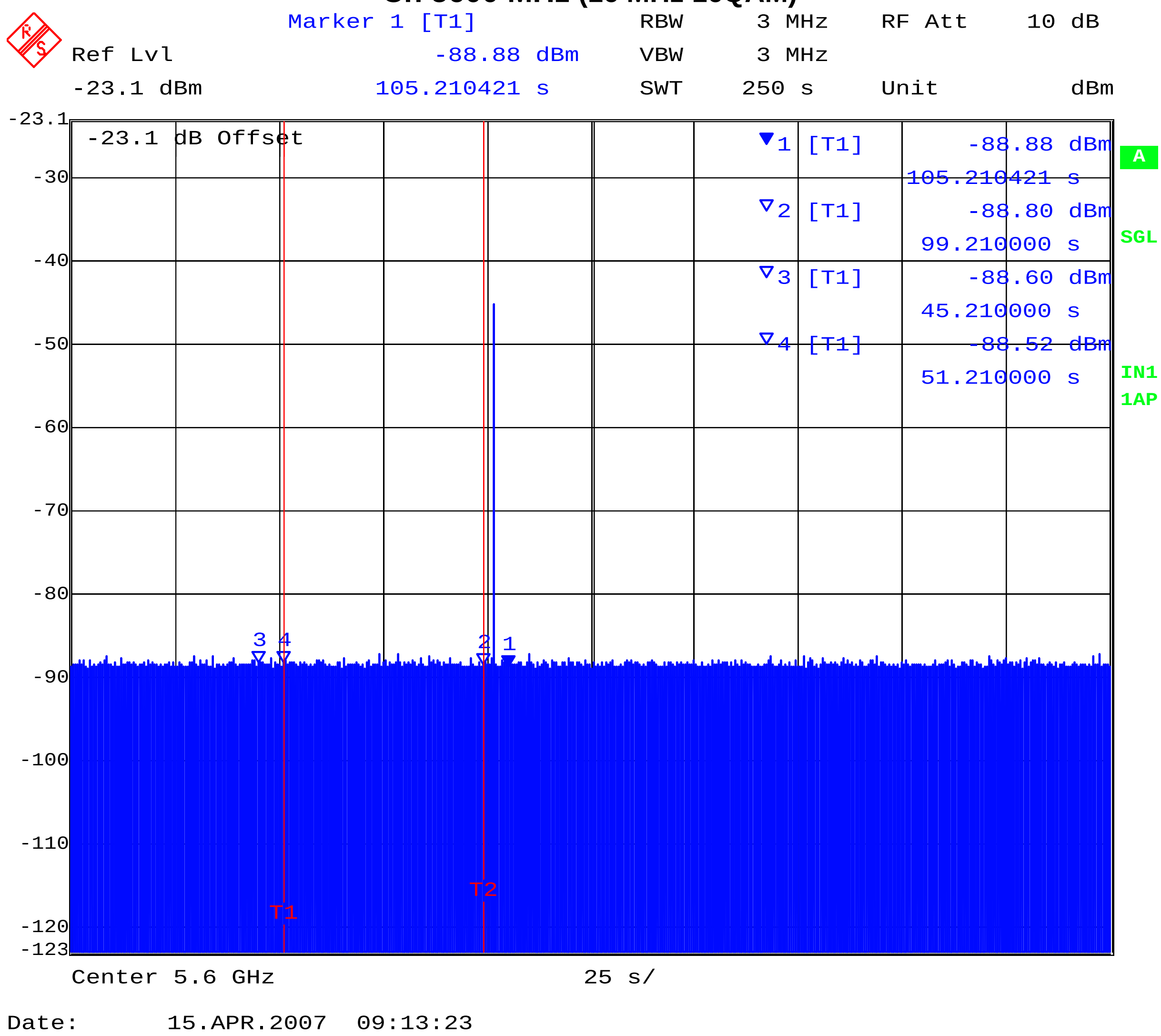
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold occurs at the end of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single burst of radar type 1 will commence within a 6 second window starting at marker ▼3+ 54 seconds.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions occurred at 5600MHz.

Channel Availability Check Time at the end of the 60 second Check Time
Ch 5600 MHz (16 MHz 16QAM)



6.8.5. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period (16 MHz 16QAM)

FCC §15.407(h)(2)(iii)

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the EUT (Master). The requisite MPEG video file ("TestFile.mpg" available on the NTIA website at the following link http://ntiacsd.ntia.doc.gov/dfs/) is streamed from the master device (AP) to the client.

Channel Closing Transmission Time - Measurement

A Type 1 waveform was introduced to the EUT, from which a 12 second transmission record was captured, collecting nearly 250M samples of data, which included 60ms of pre-trigger data. This Type 1 waveform had an integral marker built into its construction, marking the start of the waveform play, which directly triggered the PXI digitizer's data capture via the PXI backplane trigger bus.

The Aeroflex PXI was setup to capture data for all transmission events above a threshold level of -46dBm. The PXI time stamps all captured events with respect to T_0 (zero time indicating the start of the measurements sequence) starting the 60 ms pre-trigger period followed by the radar type 1 burst period.

Radar (Type 1) Pre-trigger period 60ms

Type 1 burst period 24.277ms

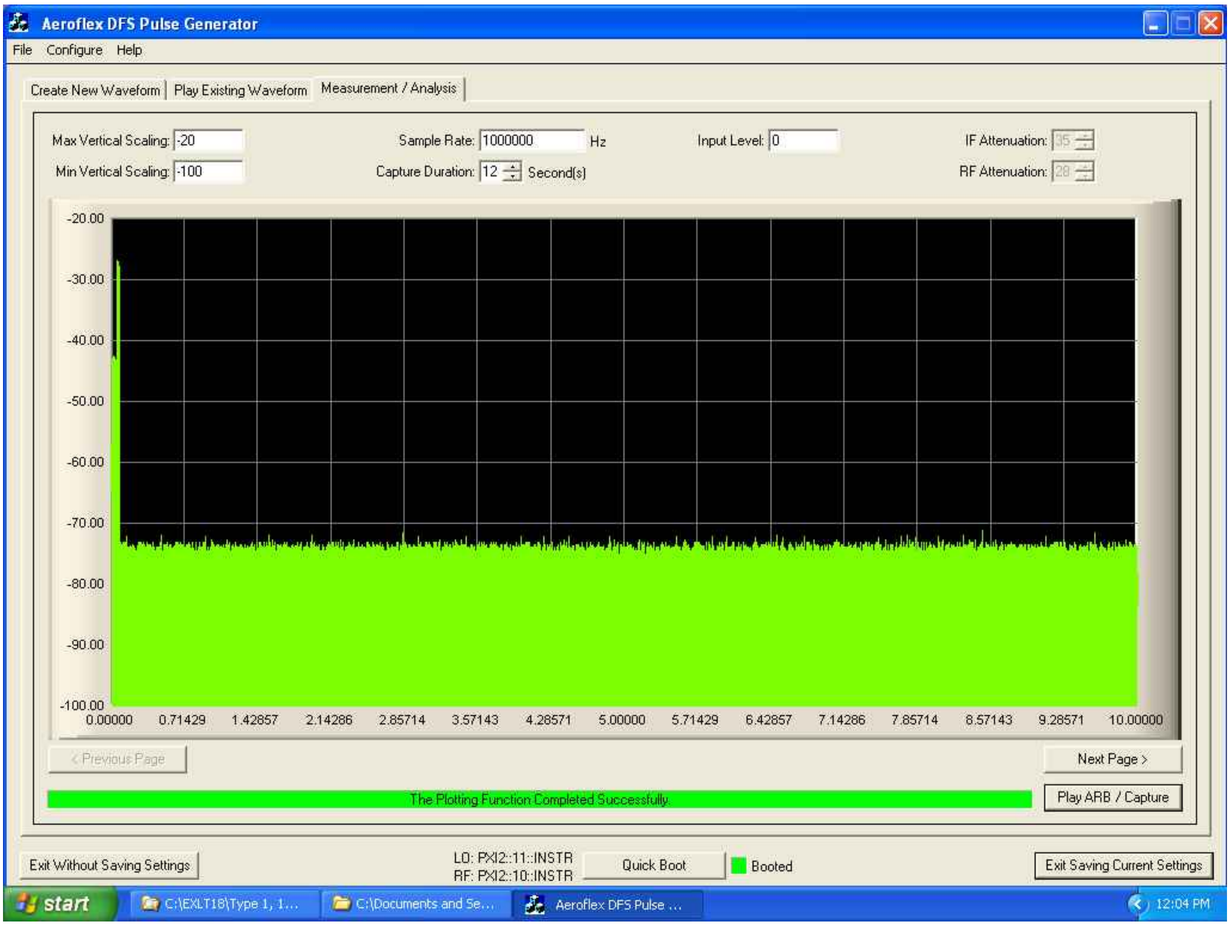
(The period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1µs pulse width for the final pulse.)

Channel Closing Transmission Time starts at 84.277ms after T_0.

Therefore, pulses seen after this 84.277ms boundary are identified and totaled to provide an aggregate total of transmissions in order to determine whether the EUT is compliant with the Channel Closing Transmission Time requirements as described in MO&O FCC 06-96. In this case, it was found that an aggregate total of 16 µs of transmission time accrued.

Channel Closing Transmission Time = 16 µSecs (limit 260 mSecs)

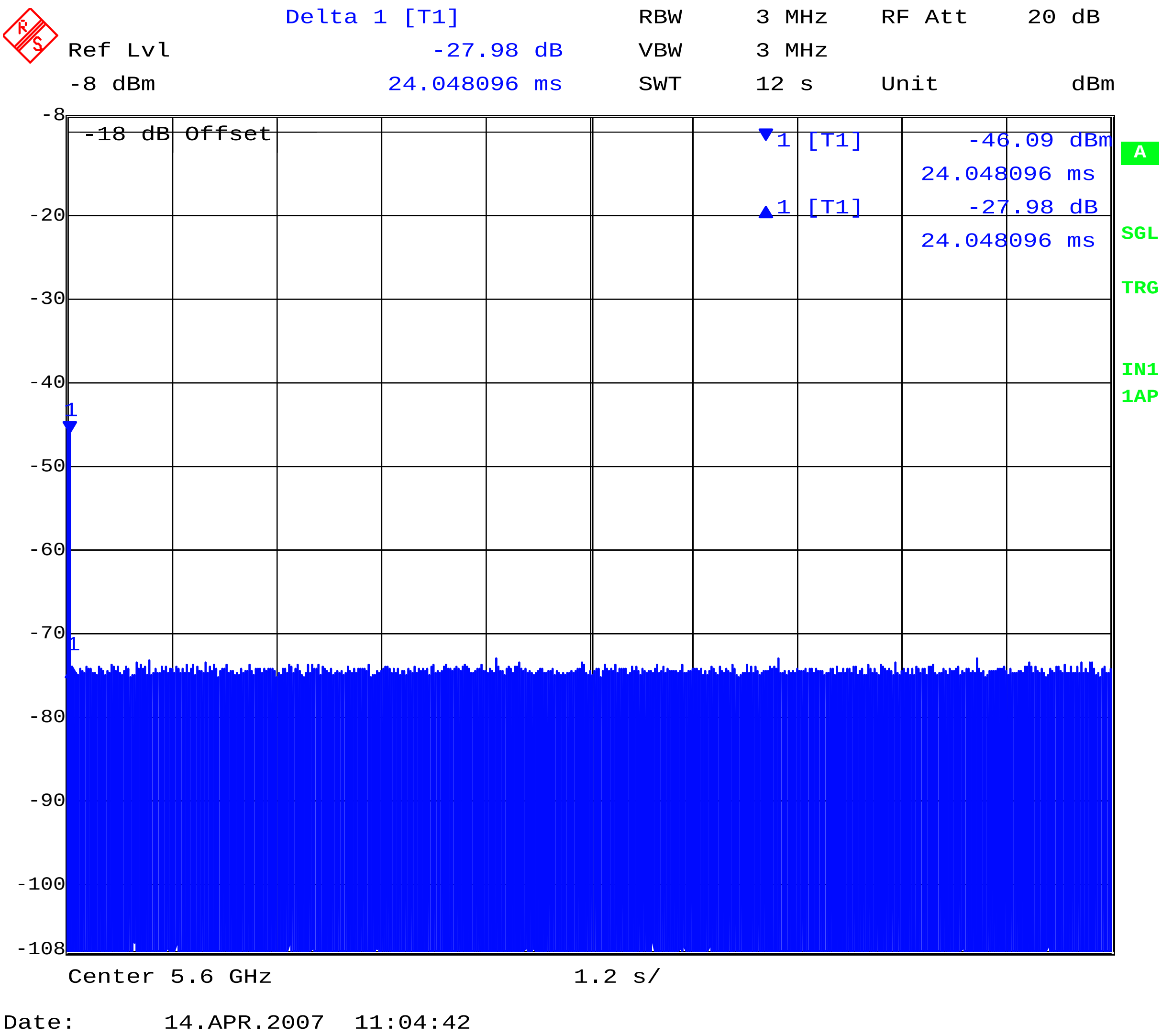
Channel Move Time, Channel Closing Time for Type 1 Radar(16 MHz 16QAM) Captured by Aeroflex PXI Test System



Additionally, a redundant conventional spectrum analyzer screen capture is provided to correlate against the digitizer screen capture for verification purposes.

Note;- no pre-trigger data interval (60 mSecs) was included in the following Spectrum Analyzer plot

Channel Move Time, Channel Closing Time for Type 1 Radar(16 MHz 16QAM) Captured by Spectrum Analyzer



The following data was captured by the Aeroflex PXI test System and is used to calculate the Channel Closing Transmission Time for the EUT (16 MHz 16QAM) with the intervention of Radar Type 1.

Sample Number: 84270	Rising Edge,	Sample Time Stamp	0.08427	
Sample Number: 84278	Falling Edge,	Sample Time Stamp	0.084278	8E-06
Sample Number: 85698	Rising Edge,	Sample Time Stamp	0.085698	
Sample Number: 85706	Falling Edge,	Sample Time Stamp	0.085706*	8E-06
			Total =	1.6E-05 Secs

* Represents the last transmission activity of the EUT. The 0.085706*second time stamp is used to calculate Channel Move Time.

Channel Move Time (16 MHz 16QAM)– Measurement & Calculation Type 1 Radar

The Channel Move Time is calculated using the data captured for the Channel Closing time as follows;-

Channel Move Time = Ft – Pt - Rt

Where;-

Ft = Final transmission activity occurred at 85.706 mSeconds

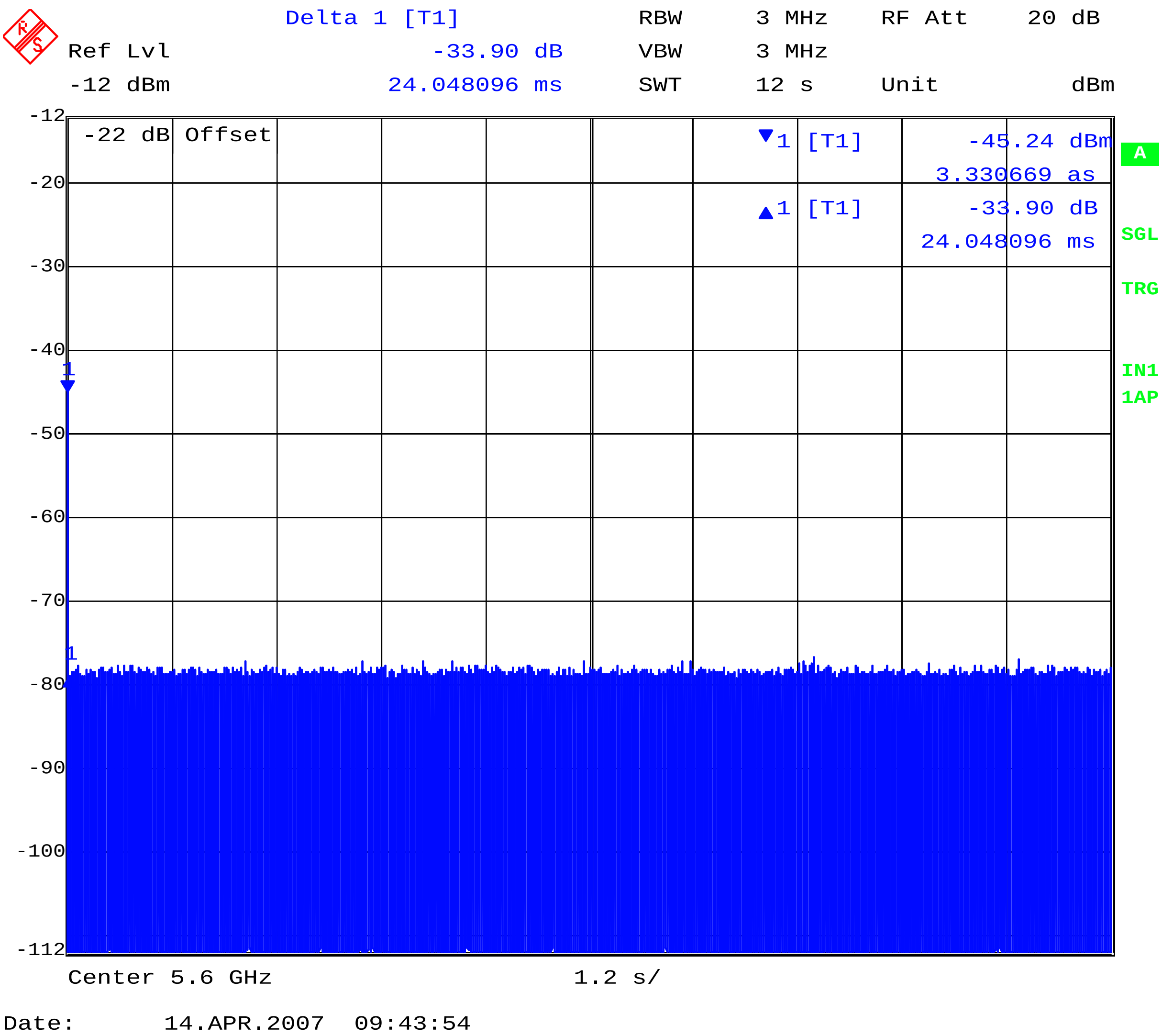
Pt = Pre-trigger information 60 mS

Rt = Type 1 burst period 24.277 mS

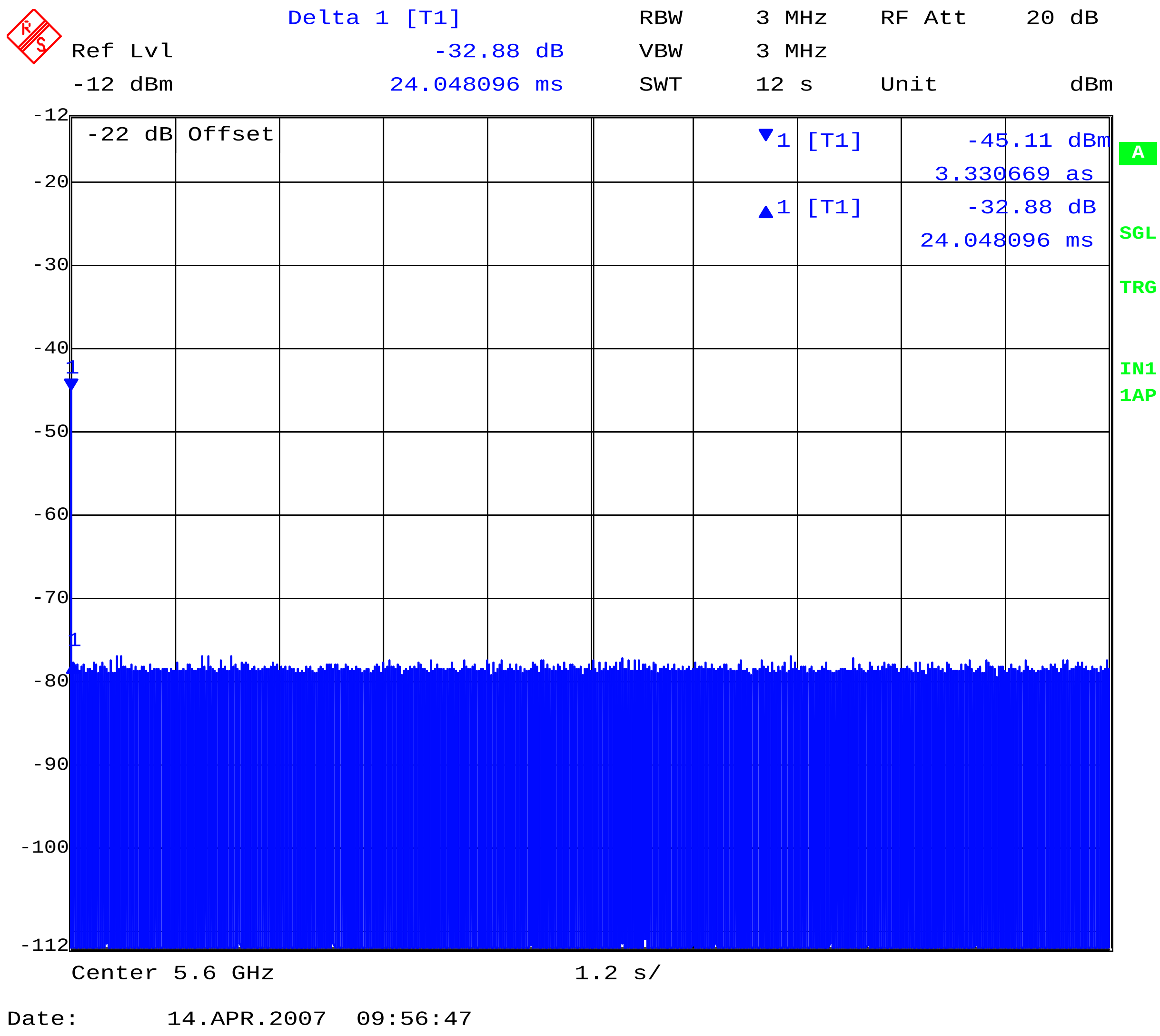
(Rt is the period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1μs pulse width for the final pulse.)

Channel Move Time = 85.706 – 60 – 24.277 = 1.429 mSecs

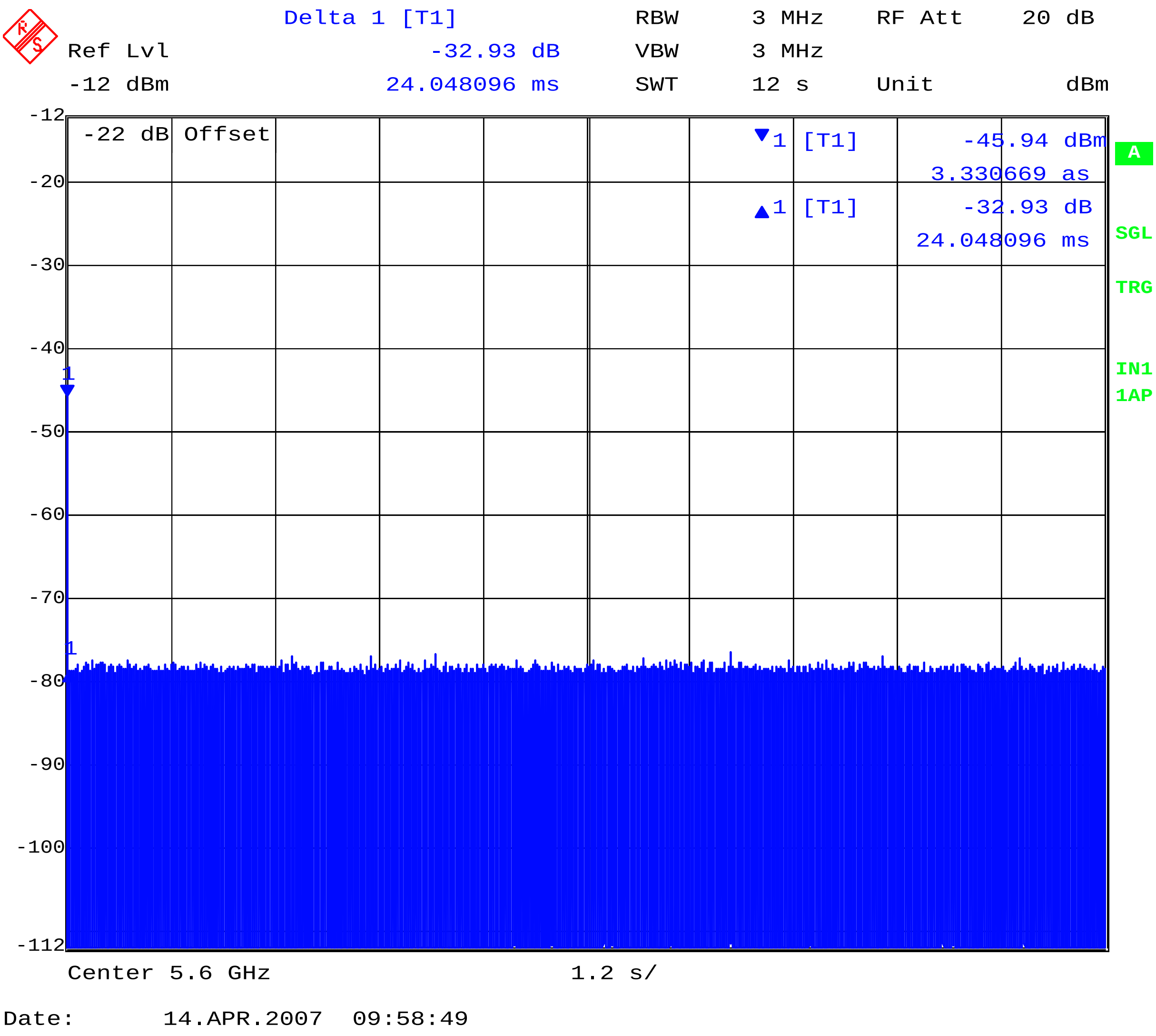
Channel Move Time, Channel closing Transmission Time for (16 MHz 16QAM) Type 2 Radar
1.1µs, 197 prf, 24 pulses



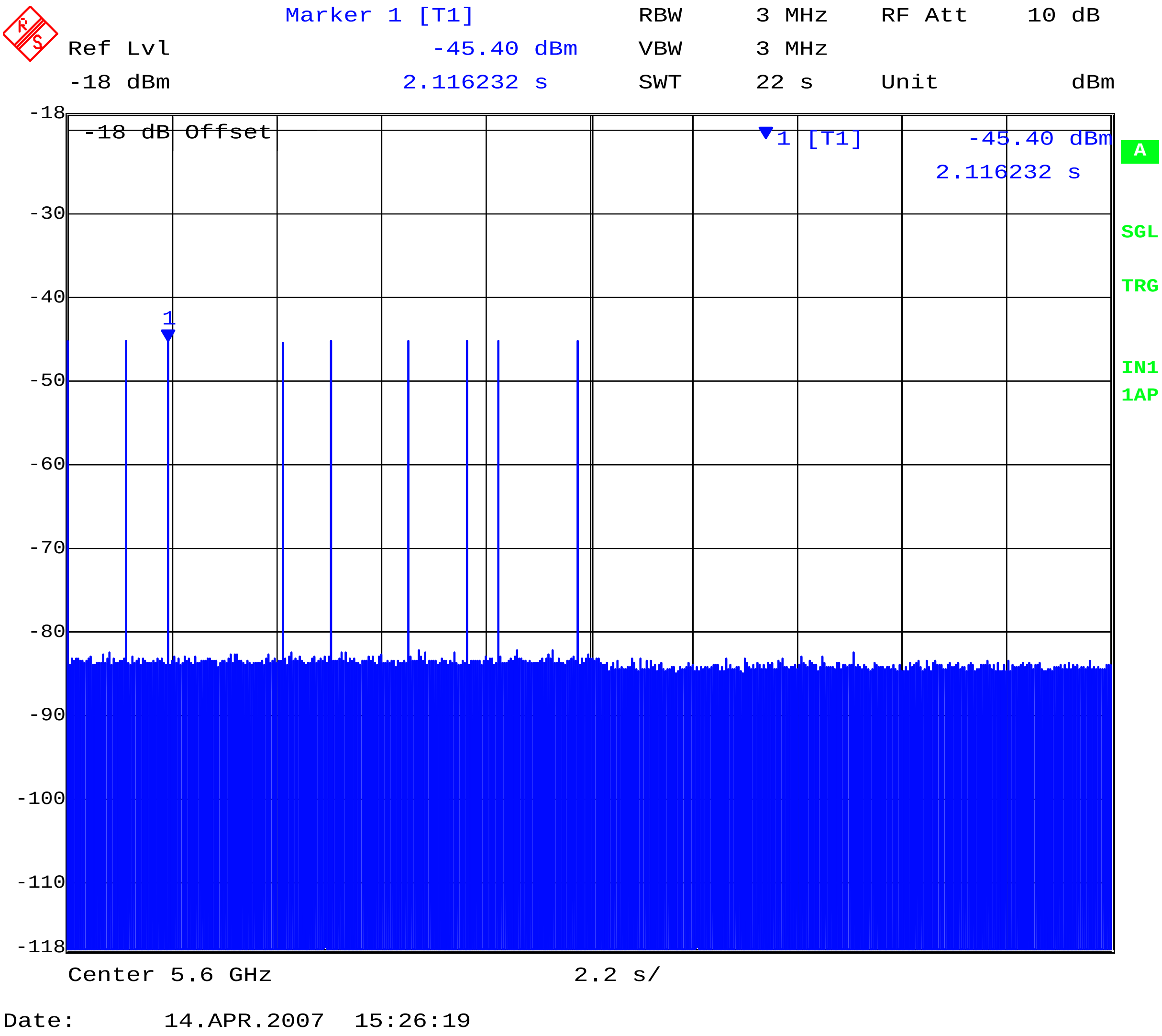
Channel Move Time, Channel closing Transmission Time (16 MHz 16QAM) for Type 3 Radar
6.2 µs, 259 prf, 17 pulses



Channel Move Time, Channel closing Transmission Time (16 MHz 16QAM) for Type 4 Radar
11.6 μs, 283 prf, 13 pulses

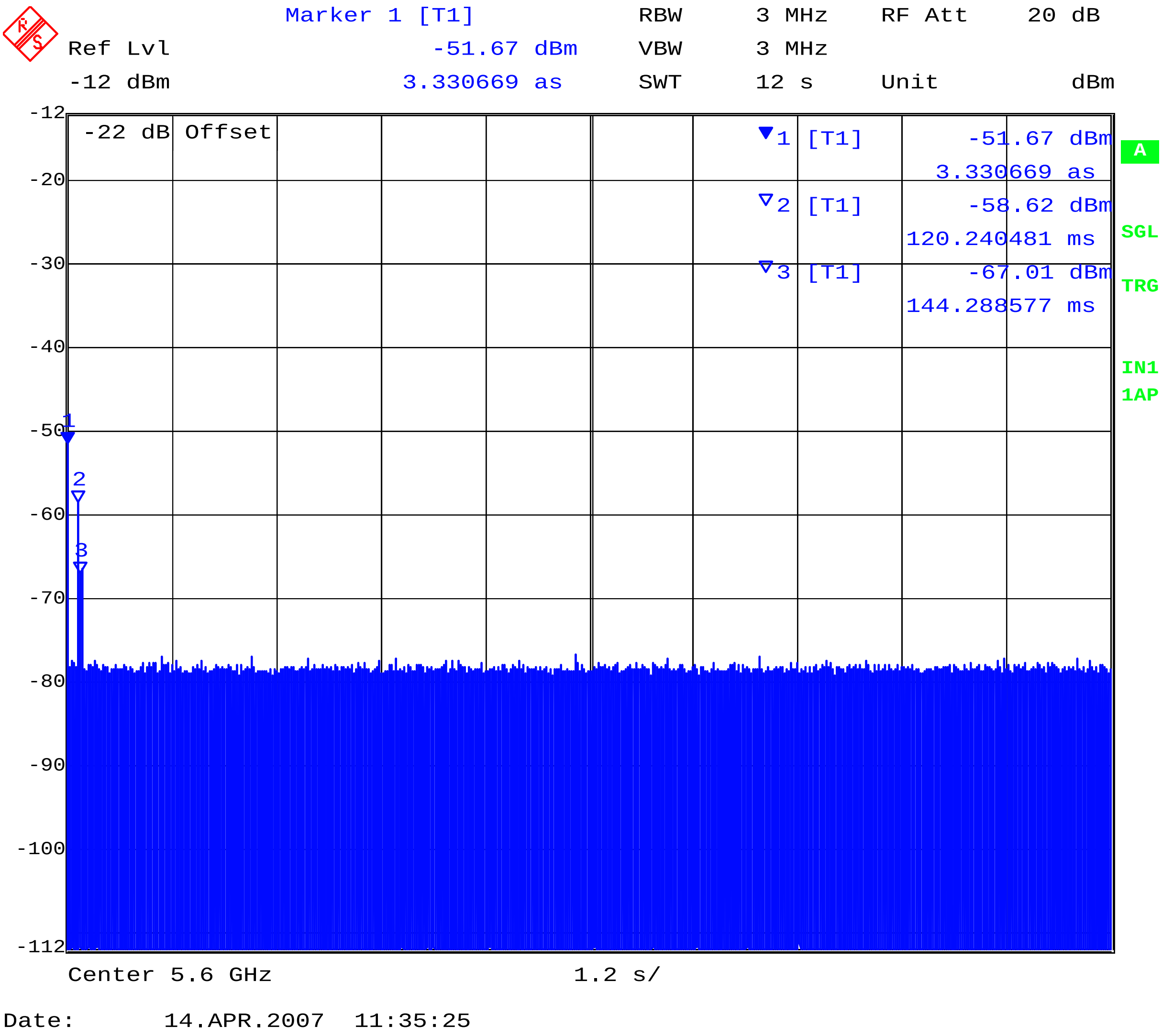


Channel Move Time, Channel closing Transmission Time (16 MHz 16QAM) for Type 5 Radar



With reference to the requirements of FCC MO & O 06-96;- The instant that the Chanel Move Time and Channel Closing Time begins for the long Pulse Radar Test Signal is the instant at the end of the 12 Second period defining the Radar Waveform. From the above plot is can be seen that the EUT stopped transmitting data before completion of the Radar Test Signal, therefore the Channel Closing Time and Channel Move time complies with the requirements.

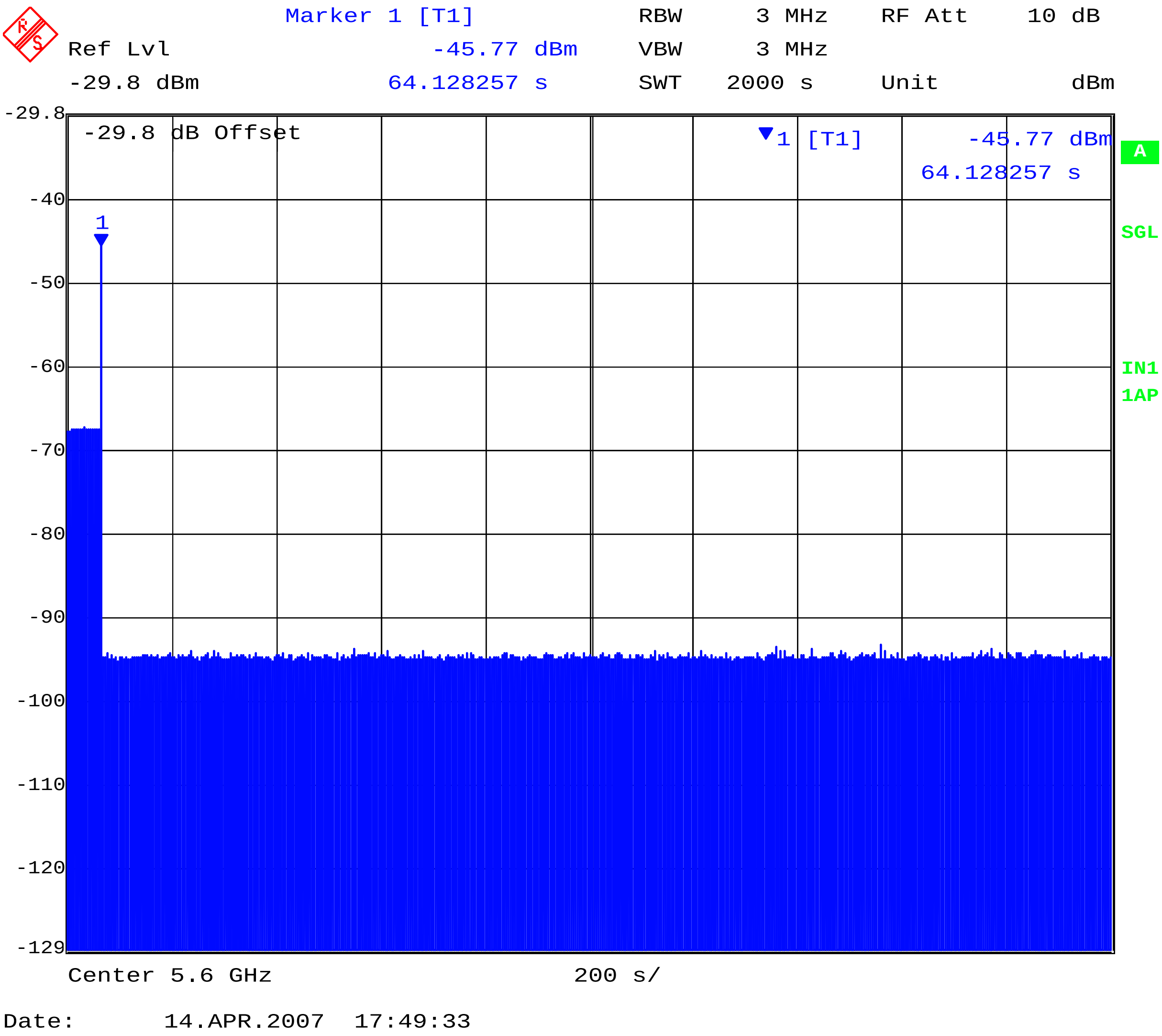
Channel Move Time, Channel closing Transmission Time (16 MHz 16QAM) for Type 6 Radar



30 Minute Non-Occupancy Period

The EUT is monitored for more than 30 minutes following the channel close/move time to verify no transmissions resume on this Channel.

30 Minute Non-Occupancy Period (16 MHz 16QAM) Type 1 Radar Ch 5500 MHz



6.8.6. Statistical Performance Check

The steps below define the procedure to determine the minimum percentage of detection when a radar burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5600 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

The Radar Waveform generator sends the individual waveform for each of the radar types 1-6. Statistical data will be gathered to determine the ability of the device to detect the radar test waveforms. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The percentage of successful detection is calculated by:

Total # of detections ÷ Total # of Trials × 100 = Probability of Detection

The Minimum number of trails, minimum percentage of successful detection and the average minimum percentage of successful detection are found in the Radar Test Waveforms section.

(16 MHz 16QAM)- Verification of Detection

Trail #	Detection = 1, No Detection = 0			
	Type 1	Type 2	Type 3	Type 4
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12	1	1	1	1
13	1	1	1	1
14	1	1	1	1
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	1	1	1	1
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	1	1	1	1
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1
27	1	1	1	1
28	1	1	1	1
29	1	1	1	1
30	1	1	1	1
Detection Percentage	100% (>60%)	100% (>60%)	100% (>60%)	100% (>60%)

In addition an average minimum percentage of successful detection across all four Short pulse radar test waveforms is required and calculated as follows;

$\frac{P_d1 + P_d2 + P_d3 + P_d4}{} = \frac{(100\% + 100\% + 100\% + 100\%)}{} = 100\%$ (> 80%)

(16 MHz 16QAM) Radar Type 5 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	100% (>60%)

(16 MHz 16QAM) Radar Type 6 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	0
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	96.7% (>60%)

6.9. DFS Test Results 32 MHz QPSK

6.9.1. UNII Detection Bandwidth: (32 MHz QPSK)

All UNII channels for this device have identical channel bandwidths and DFS testing was completed in the 5250 - 5350 MHz, & 5470 - 5725 MHz.

The generating equipment is configured as shown in the Conducted Test Setup above. A single Burst of the short pulse radar Type 1 through 6 was produced at 5600 MHz at a level of -46dBm (Ref Section 6.6). The EUT is set up as a standalone device (no associated Client and no traffic).

A single radar Burst is generated for a minimum of 10 trials, and the response of the EUT is noted. The EUT must detect the Radar Waveform 90% or more of the time.

The radar frequency is increased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The highest frequency at which detection is greater than or equal to 90% is denoted as F_H.

The radar frequency is decreased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The lowest frequency at which detection is greater than or equal to 90% is denoted as F_L.

The U-NII Detection Bandwidth is calculated as follows:

U-NII Detection Bandwidth = $F_H – F_L$

The U-NII Detection Bandwidth must be at least 80% of the EUT transmitter 99% power, otherwise, the EUT does not comply with DFS requirements.

EUT Frequency=5600MHz (32 MHz QPSK)											
Radar Frequency (MHz)	DFS Detection Trials (1=Detection, Blank= No Detection)										
	1	2	3	4	5	6	7	8	9	10	Detection Rate (%)
5585	0	0	0	0	0	0	0	0	0	0	0%
5586(F_L)	1	1	1	1	1	1	1	1	1	1	100%
5587	1	1	1	1	1	1	1	1	1	1	100%
5588	1	1	1	1	1	1	1	1	1	1	100%
5589	1	1	1	1	1	1	1	1	1	1	100%
5590	1	1	1	1	1	1	1	1	1	1	100%
5591	1	1	1	1	1	1	1	1	1	1	100%
5592	1	1	1	1	1	1	1	1	1	1	100%
5593	1	1	1	1	1	1	1	1	1	1	100%
5594	1	1	1	1	1	1	1	1	1	1	100%
5595	1	1	1	1	1	1	1	1	1	1	100%
5596	1	1	1	1	1	1	1	1	1	1	100%
5597	1	1	1	1	1	1	1	1	1	1	100%
5598	1	1	1	1	1	1	1	1	1	1	100%
5599	1	1	1	1	1	1	1	1	1	1	100%
5600	1	1	1	1	1	1	1	1	1	1	100%
5601	1	1	1	1	1	1	1	1	1	1	100%
5602	1	1	1	1	1	1	1	1	1	1	100%
5603	1	1	1	1	1	1	1	1	1	1	100%
5604	1	1	1	1	1	1	1	1	1	1	100%
5605	1	1	1	1	1	1	1	1	1	1	100%
5606	1	1	1	1	1	1	1	1	1	1	100%
5607	1	1	1	1	1	1	1	1	1	1	100%
5608	1	1	1	1	1	1	1	1	1	1	100%
5609	1	1	1	1	1	1	1	1	1	1	100%
5610	1	1	1	1	1	1	1	1	1	1	100%
5611	1	1	1	1	1	1	1	1	1	1	100%
5612	1	1	1	1	1	1	1	1	1	1	100%
5613	1	1	1	1	1	1	1	1	1	1	100%
5614(F_H)	1	1	1	1	1	1	1	1	1	1	100%
5615	0	0	0	1	1	1	1	1	1	1	70%
5616	0	0	0	0	0	0	0	0	0	0	0%
Detection Bandwidth = F_H-F_L = 5614 MHz - 5586 MHz = 28 MHz											
EUT 99% Bandwidth = 32.916 MHz											
32.916 MHz *80% = 26.333 MHz											

For each frequency step the minimum percentage detection is 90%

6.9.2. Initial Channel Availability Check Time (32 MHz QPSK)

This test verifies that the EUT does not emit pulse, control, or data signals on the test Channel until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. This test does not use any Radar Waveforms.

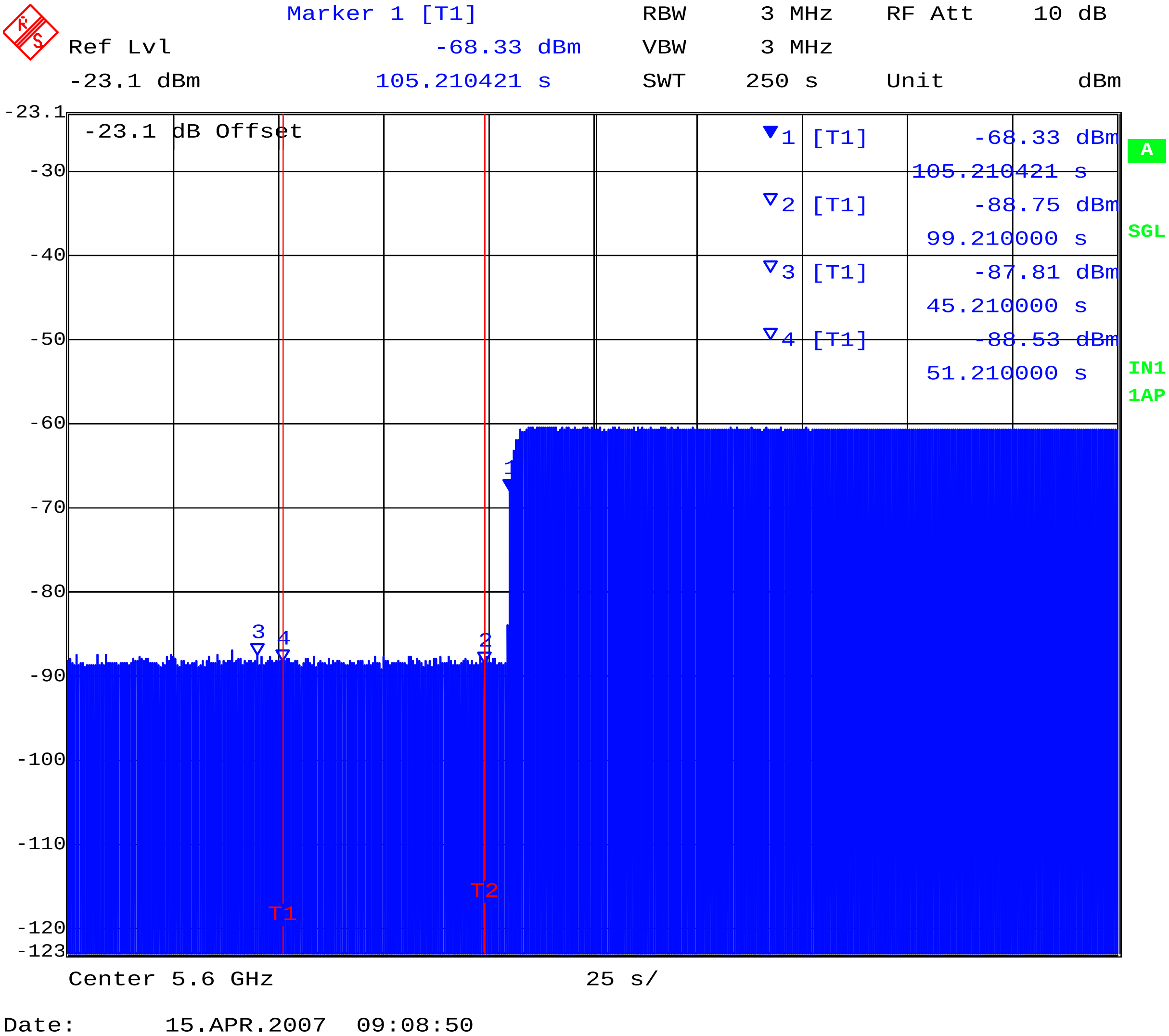
The U-NII device is powered on and be instructed to operate at 5600 MHz. At the same time the EUT is powered on, the spectrum analyzer is set for zero span with a 3 MHz resolution bandwidth at 5600 MHz with a 250 second sweep time. The analyzer's sweep will be started the same time power is applied to the U-NII device.

The EUT should not transmit any pulse or data transmissions until at least 1 minute after the completion of the power-on cycle.

The EUT is powered on at T0. Marker ▼3 denotes the instant when the EUT has completed its power-up sequence and the start of the Channel Availability Check Time that ends after a duration of ▼3 + 60 seconds i.e ▼1 on the following plot.

The Master device requires 45.21 seconds to complete its power-on cycle.

Initial Channel Availability Check Time during power up of EUT
Ch 5600 MHz (32 MHz QPSK)



6.9.3. Radar Burst at the Beginning of the Channel Availability Check Time (32 MHz QPSK)

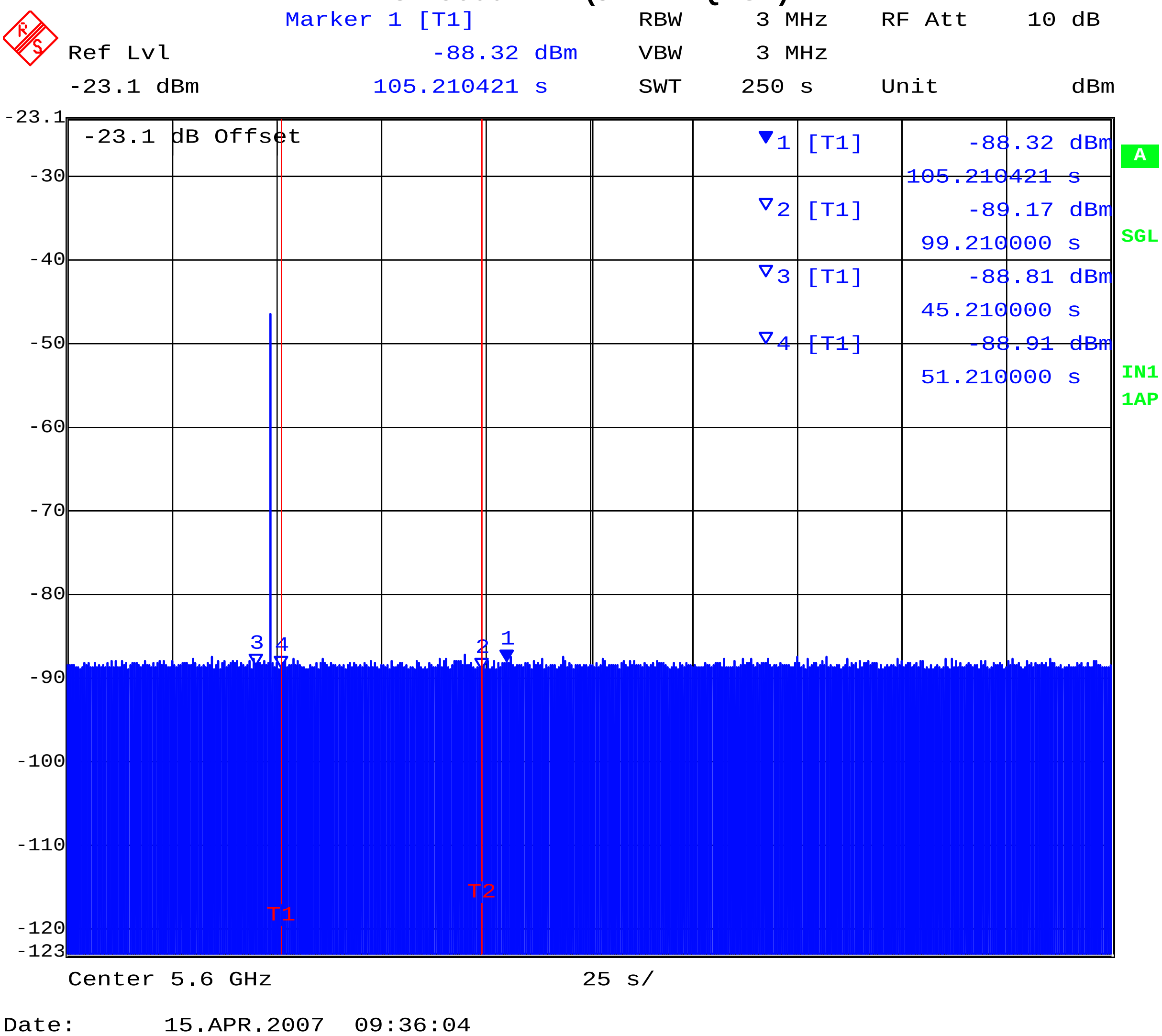
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-46 dBm Ref Section 6.6) occurs at the beginning of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single Burst of short pulse of radar type 1 will commence within a 6 second window starting at ▼3.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions have occurred at 5600MHz.

Channel Availability Check Time at the start of the 60 second Check Time
Ch 5600 MHz (32 MHz QPSK)



6.9.4. Radar Burst at the End of the Channel Availability Check Time: (32 MHz QPSK)

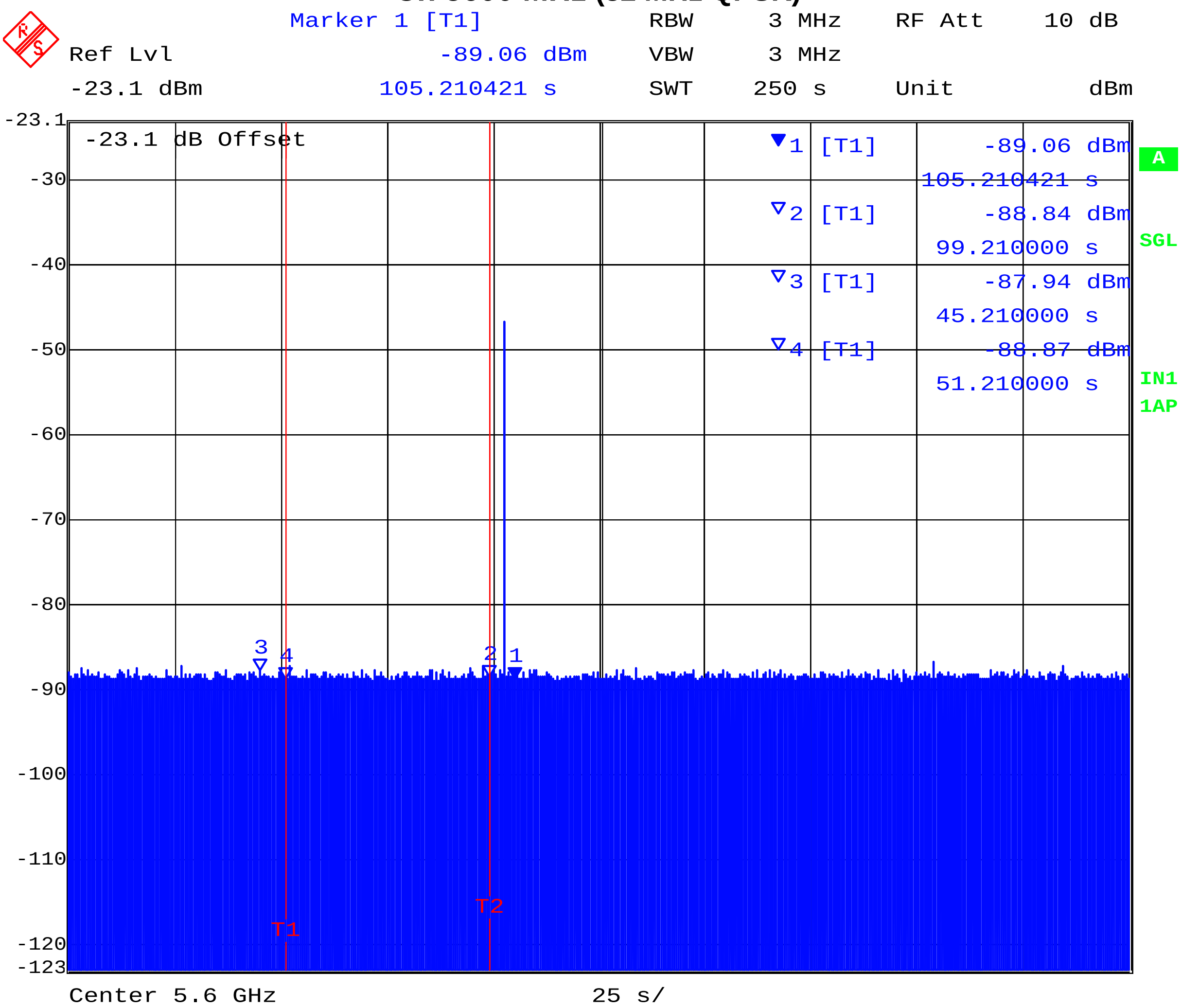
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold occurs at the end of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single burst of radar type 1 will commence within a 6 second window starting at marker ▼3+ 54 seconds.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions occurred at 5600MHz.

Channel Availability Check Time at the end of the 60 second Check Time
Ch 5600 MHz (32 MHz QPSK)



Date: 15.APR.2007 09:31:12

6.9.5. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period (32 MHz QPSK)

FCC §15.407(h)(2)(iii)

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the EUT (Master). The requisite MPEG video file ("TestFile.mpg" available on the NTIA website at the following link http://ntiacsd.ntia.doc.gov/dfs/) is streamed from the master device (AP) to the client.

Channel Closing Transmission Time - Measurement

A Type 1 waveform was introduced to the EUT, from which a 12 second transmission record was captured, collecting nearly 250M samples of data, which included 60ms of pre-trigger data. This Type 1 waveform had an integral marker built into its construction, marking the start of the waveform play, which directly triggered the PXI digitizer's data capture via the PXI backplane trigger bus.

The Aeroflex PXI was setup to capture data for all transmission events above a threshold level of -46dBm. The PXI time stamps all captured events with respect to T_0 (zero time indicating the start of the measurements sequence) starting the 60 ms pre-trigger period followed by the radar type 1 burst period.

Radar (Type 1) Pre-trigger period 60ms

Type 1 burst period 24.277ms

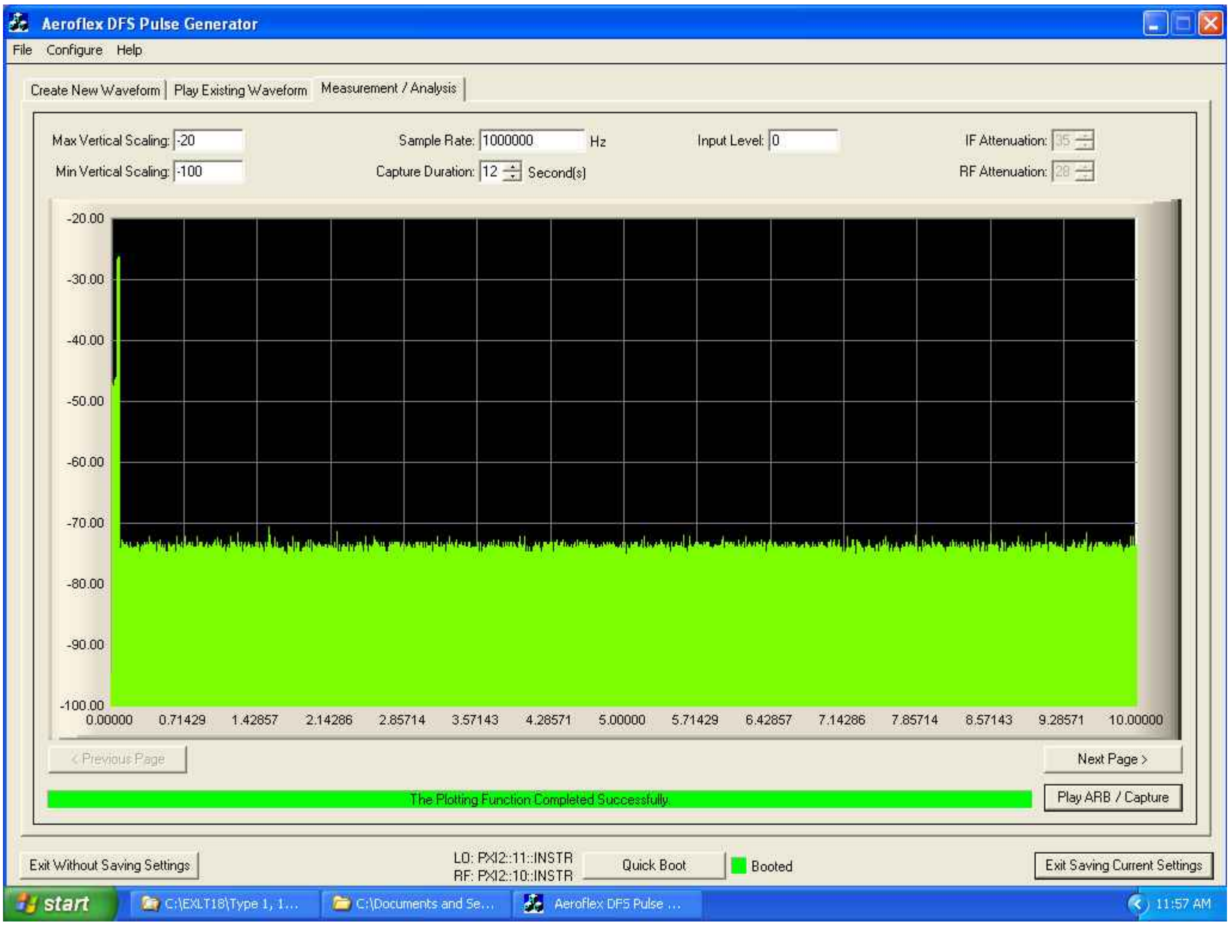
(The period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1μs pulse width for the final pulse.)

Channel Closing Transmission Time starts at 84.277ms after T_0.

Therefore, pulses seen after this 84.277ms boundary are identified and totaled to provide an aggregate total of transmissions in order to determine whether the EUT is compliant with the Channel Closing Transmission Time requirements as described in MO&O FCC 06-96. In this case, it was found that an aggregate total of 5 µs of transmission time accrued.

Channel Closing Transmission Time = 5 µSecs (limit 260 mSecs)

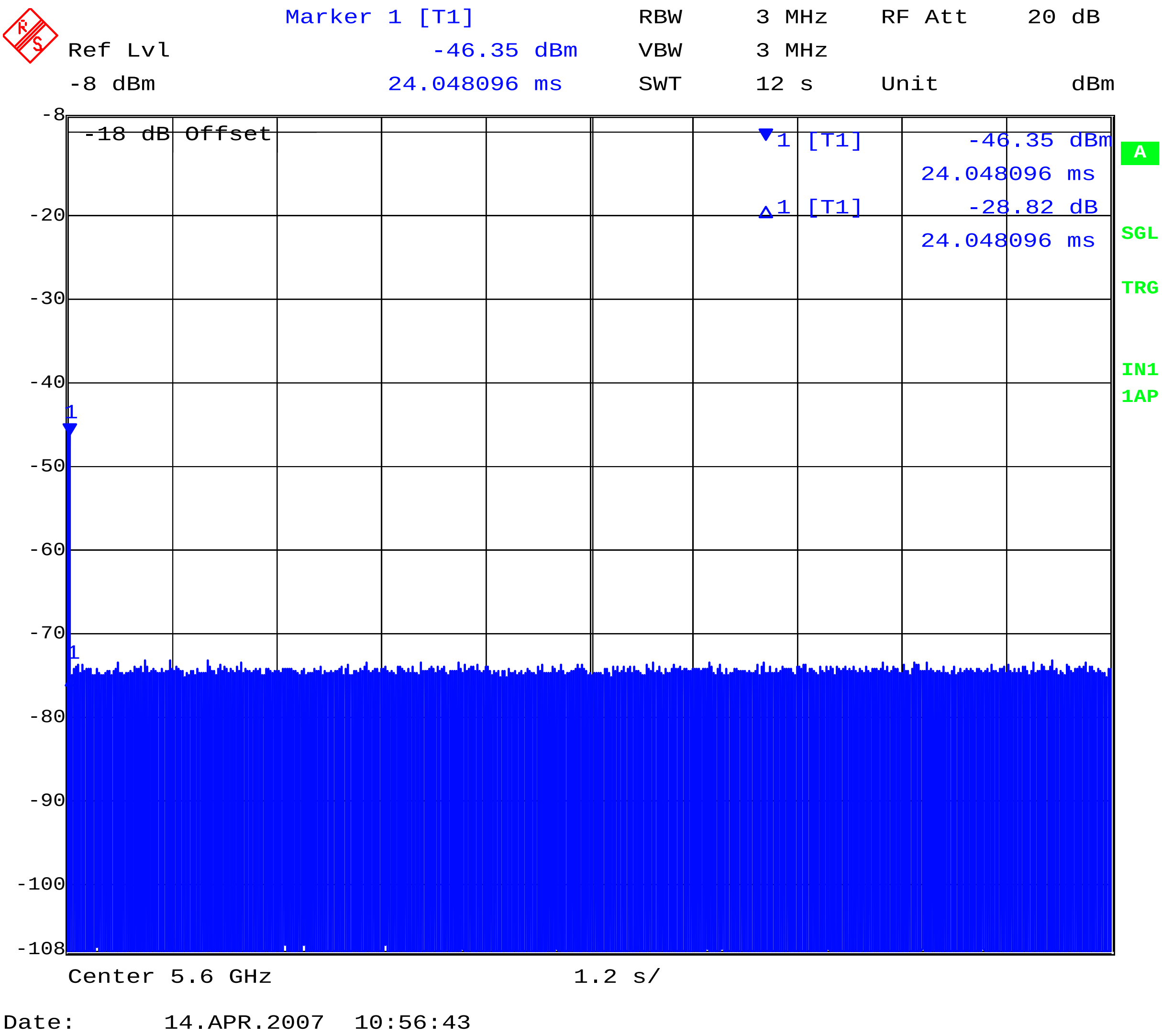
Channel Move Time, Channel Closing Time for Type 1 Radar(32 MHz QPSK) Captured by Aeroflex PXI Test System



Additionally, a redundant conventional spectrum analyzer screen capture is provided to correlate against the digitizer screen capture for verification purposes.

Note;- no pre-trigger data interval (60 mSecs) was included in the following Spectrum Analyzer plot

Channel Move Time, Channel Closing Time for Type 1 Radar(32 MHz QPSK) Captured by Spectrum Analyzer



The following data was captured by the Aeroflex PXI test System and is used to calculate the Channel Closing Transmission Time for the EUT **(32 MHz QPSK)** with the intervention of Radar Type 1.

Sample Number: 85699	Rising Edge,	Sample Time Stamp	0.085699	
Sample Number: 85704	Falling Edge,	Sample Time Stamp	0.085704*	5E-06
			Total =	5E-06 Secs

* Represents the last transmission activity of the EUT. The 0.085704*second time stamp is used to calculate Channel Move Time.

Channel Move Time (32 MHz QPSK)– Measurement & Calculation Type 1 Radar

The Channel Move Time is calculated using the data captured for the Channel Closing time as follows;-

Channel Move Time = Ft – Pt - Rt

Where;-

Ft = Final transmission activity occurred at 85.704 mSeconds

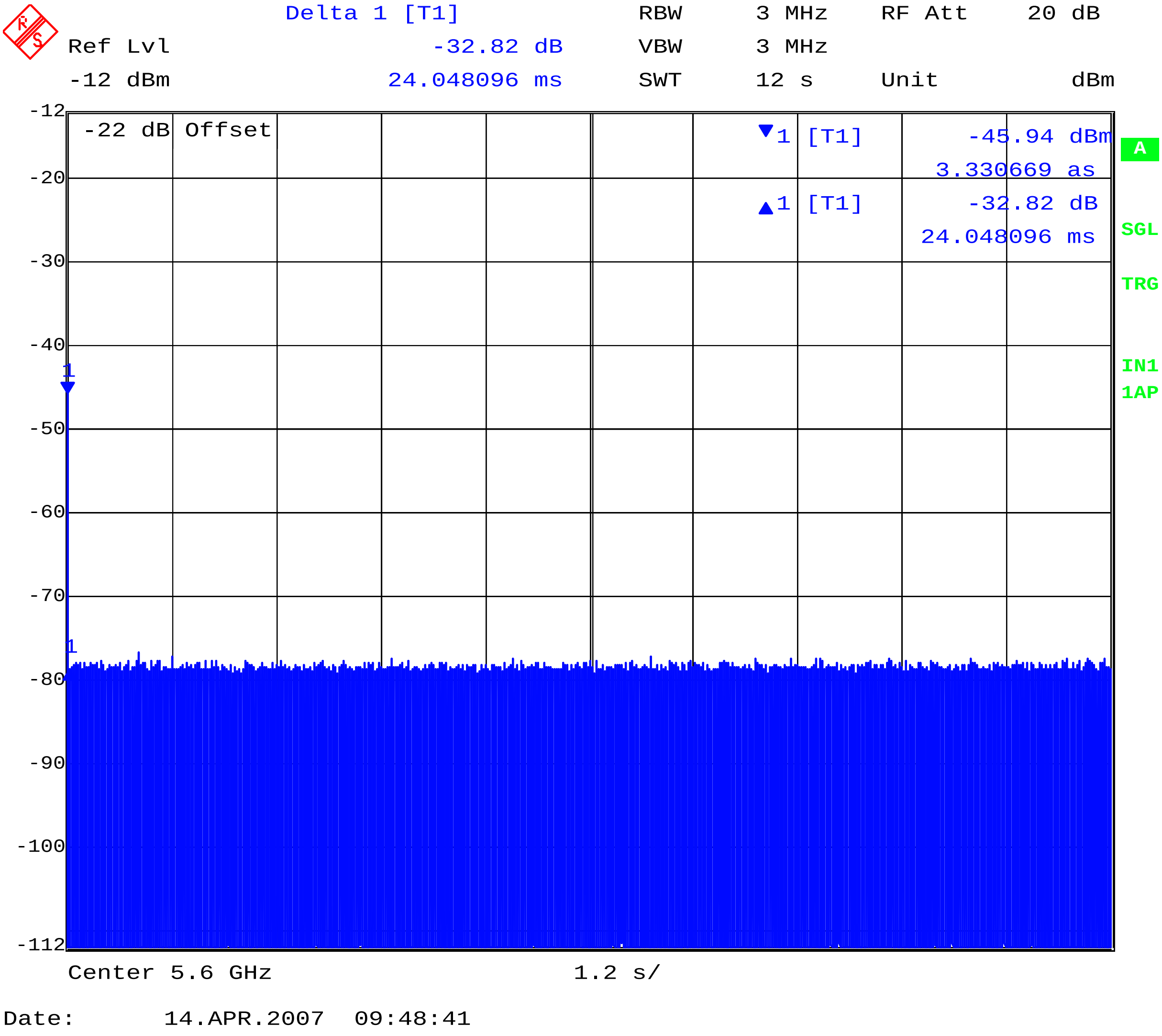
Pt = Pre-trigger information 60 mS

Rt = Type 1 burst period 24.277 mS

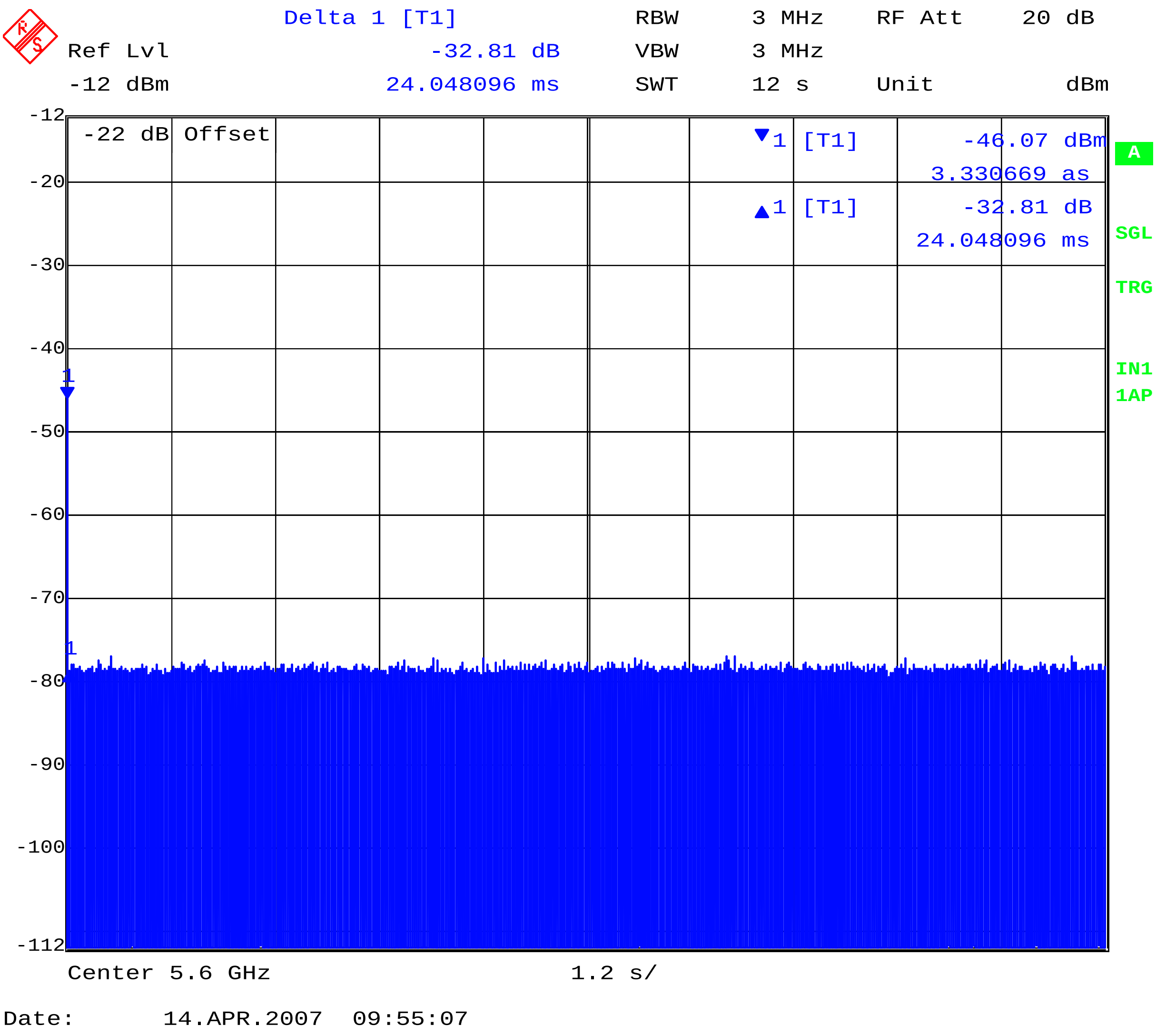
(Rt is the period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1μs pulse width for the final pulse.)

Channel Move Time = 85.704 – 60 – 24.277 = 1.427 mSecs

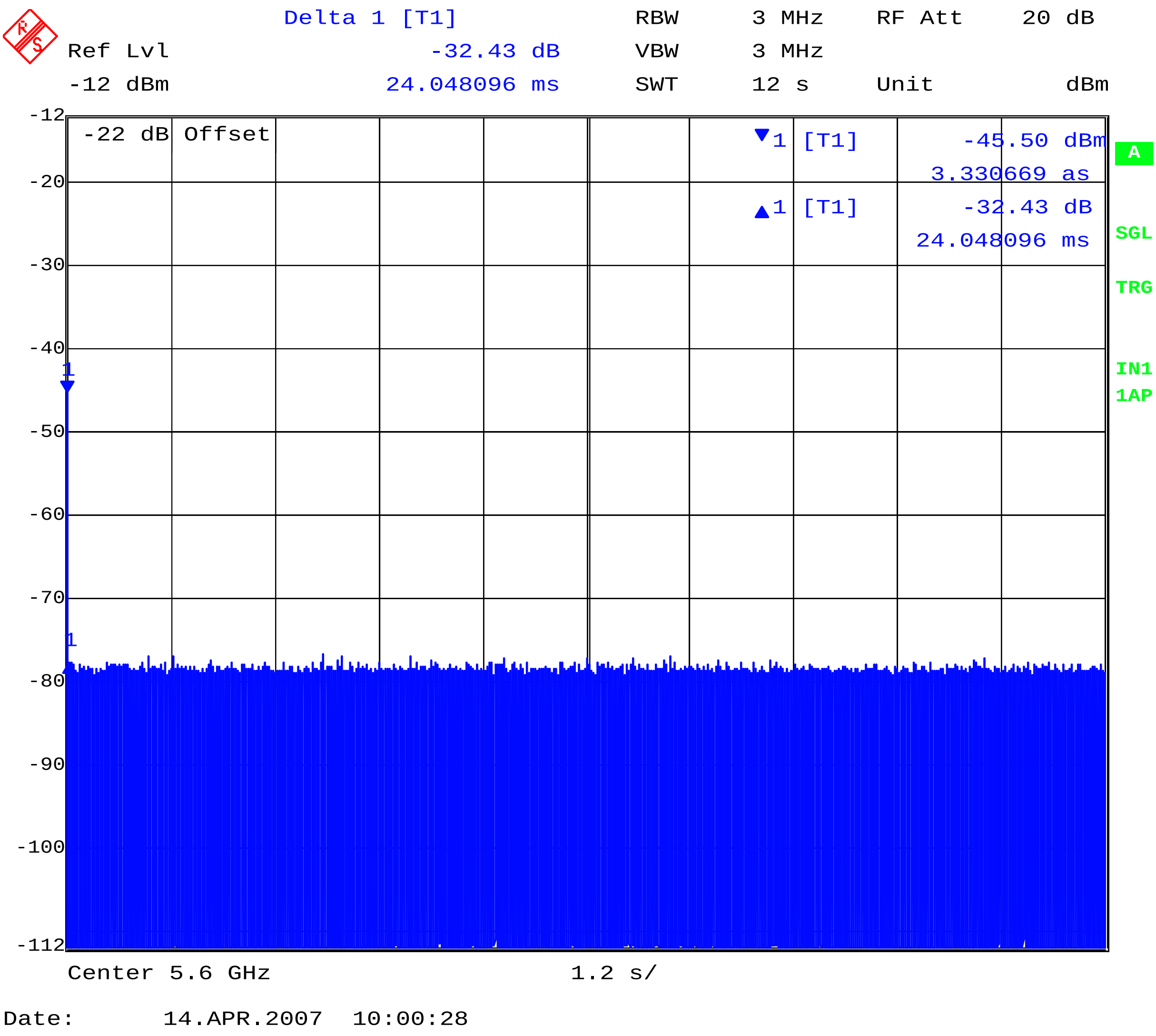
Channel Move Time, Channel closing Transmission Time for (32 MHz QPSK) Type 2 Radar 1.1µs, 197 prf, 24 pulses



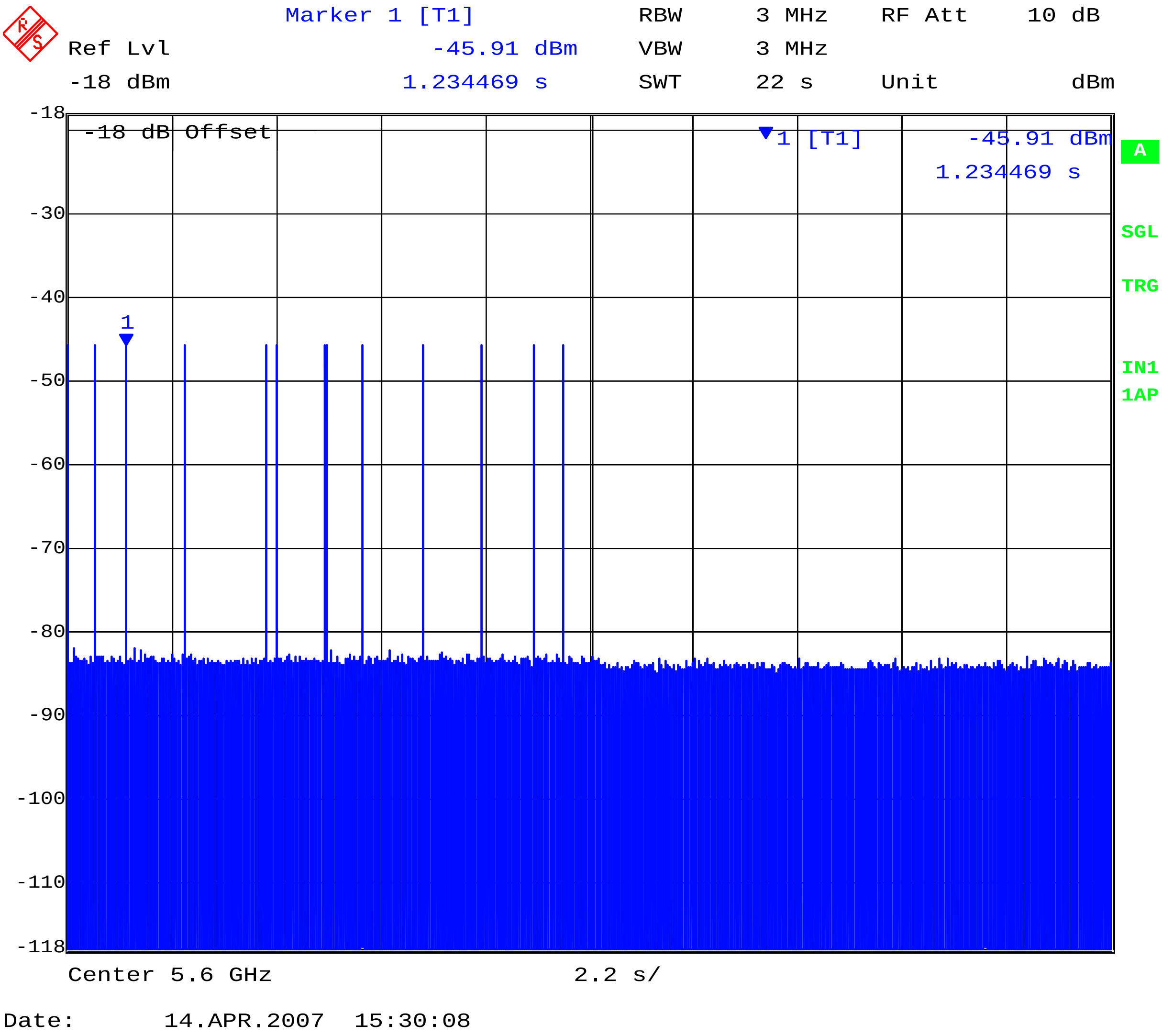
Channel Move Time, Channel closing Transmission Time (32 MHz QPSK) for Type 3 Radar
6.2 µs, 259 prf, 17 pulses



Channel Move Time, Channel closing Transmission Time (32 MHz QPSK) for Type 4 Radar
11.6 µs, 283 prf, 13 pulses

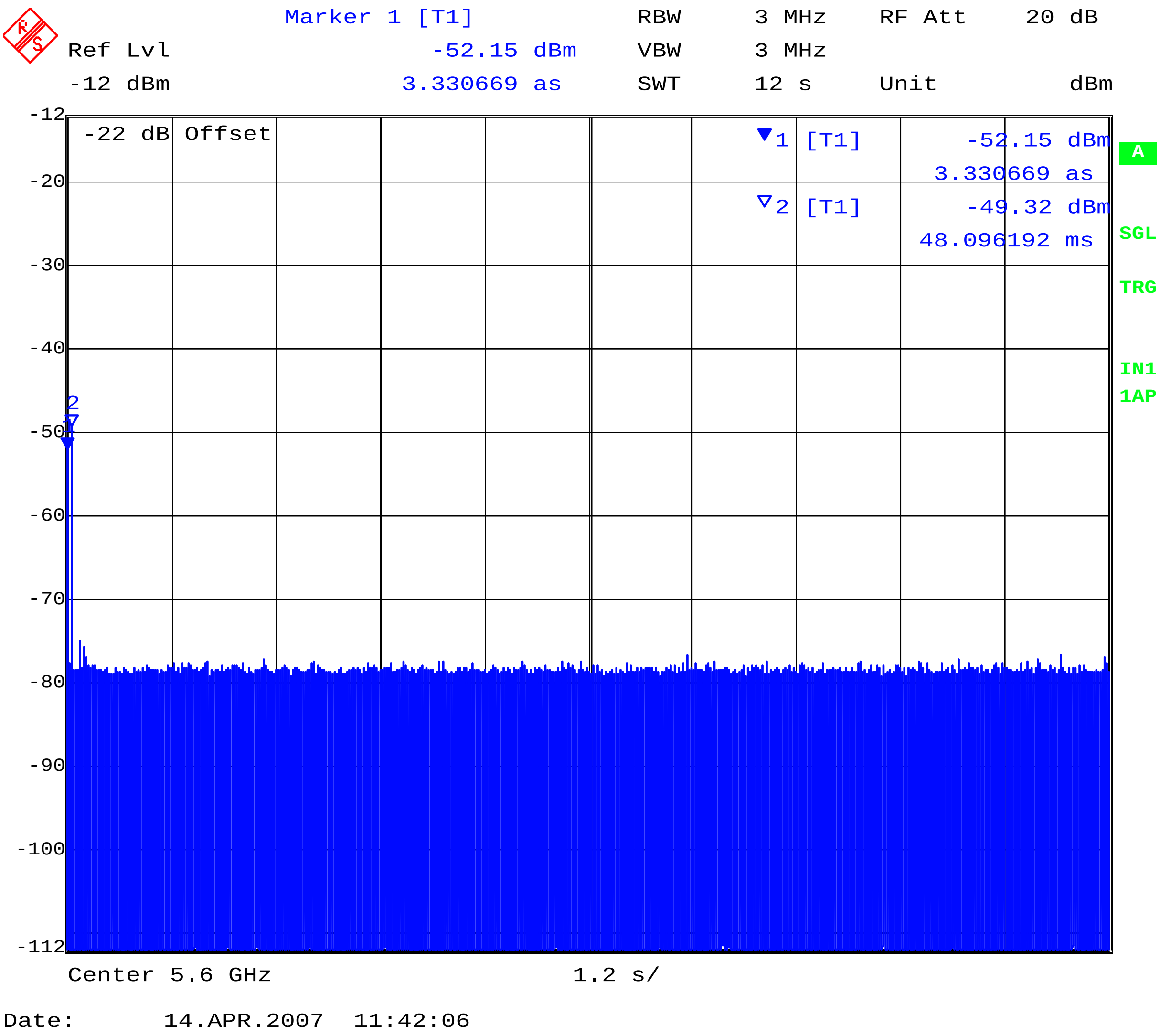


Channel Move Time, Channel closing Transmission Time (32 MHz QPSK) for Type 5 Radar



With reference to the requirements of FCC MO & O 06-96;- The instant that the Chanel Move Time and Channel Closing Time begins for the long Pulse Radar Test Signal is the instant at the end of the 12 Second period defining the Radar Waveform. From the above plot is can be seen that the EUT stopped transmitting data before completion of the Radar Test Signal, therefore the Channel Closing Time and Channel Move time complies with the requirements.

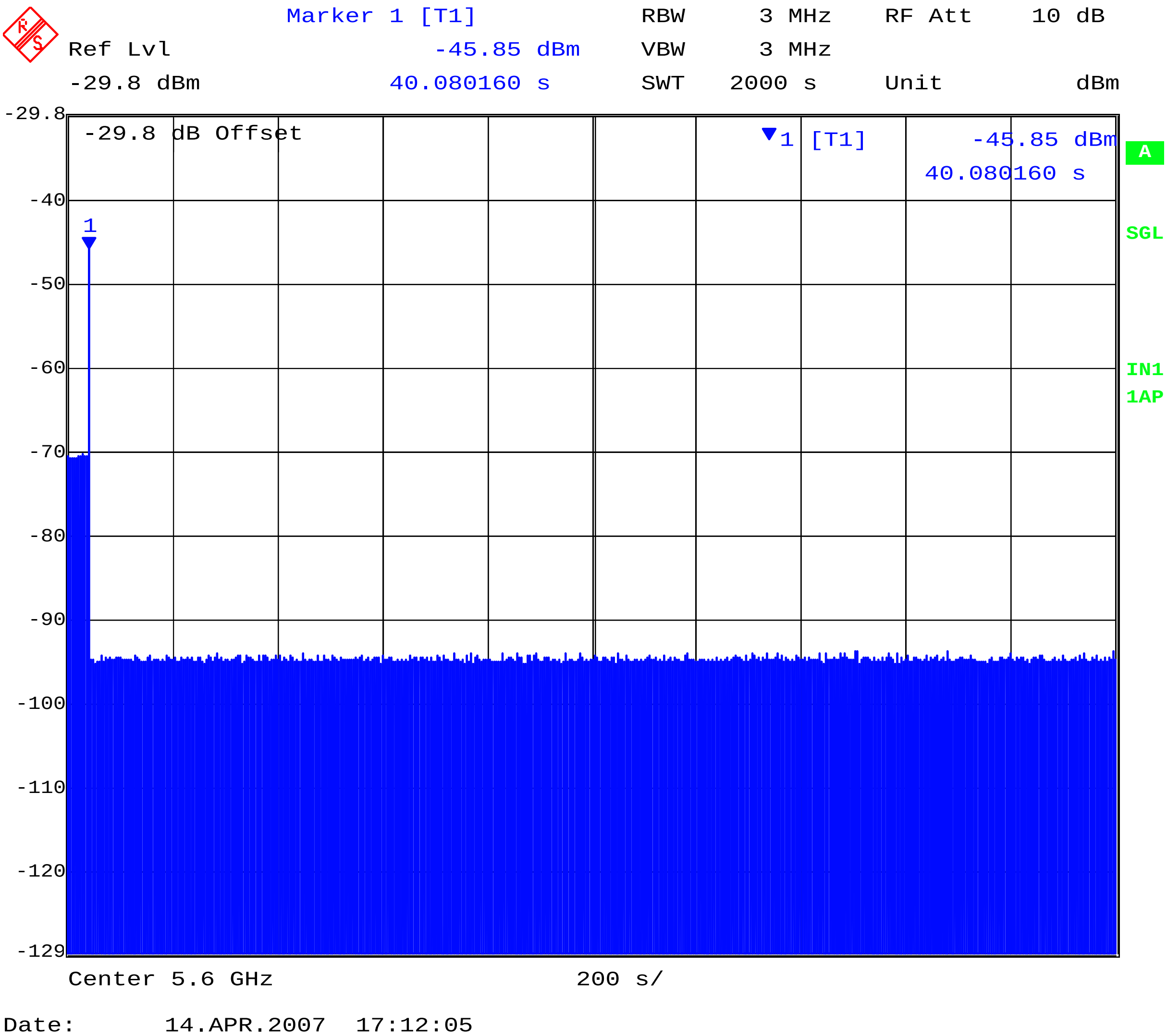
Channel Move Time, Channel closing Transmission Time (32 MHz QPSK) for Type 6 Radar



30 Minute Non-Occupancy Period

The EUT is monitored for more than 30 minutes following the channel close/move time to verify no transmissions resume on this Channel.

30 Minute Non-Occupancy Period (32 MHz QPSK) Type 1 Radar Ch 5500 MHz



6.9.6. Statistical Performance Check

The steps below define the procedure to determine the minimum percentage of detection when a radar burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5600 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

The Radar Waveform generator sends the individual waveform for each of the radar types 1-6. Statistical data will be gathered to determine the ability of the device to detect the radar test waveforms. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The percentage of successful detection is calculated by:

Total # of detections ÷ Total # of Trials × 100 = Probability of Detection

The Minimum number of trails, minimum percentage of successful detection and the average minimum percentage of successful detection are found in the Radar Test Waveforms section.

(32 MHz QPSK)- Verification of Detection

Trail #	Detection = 1, No Detection = 0			
	Type 1	Type 2	Type 3	Type 4
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12	1	1	1	1
13	1	1	1	1
14	1	1	1	1
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	1	1	1	1
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	1	1	1	1
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1
27	1	1	1	1
28	1	1	1	1
29	1	1	1	1
30	1	1	1	1
Detection Percentage	100% (>60%)	100% (>60%)	100% (>60%)	100% (>60%)

In addition an average minimum percentage of successful detection across all four Short pulse radar test waveforms is required and calculated as follows;

$\underline{P_d1 + P_d2 + P_d3 + P_d4} = \underline{(100\% + 100\% + 100\% + 100\%)} = 100\% \ (> 80\%)$

(32 MHz QPSK) Radar Type 5 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	**100% (>60%)**

(32 MHz QPSK) Radar Type 6 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	0
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	96.7% (>60%)

6.10. DFS Test Results 64 MHz QPSK

6.10.1. UNII Detection Bandwidth: (64 MHz QPSK)

All UNII channels for this device have identical channel bandwidths and DFS testing was completed in the 5250 - 5350 MHz, & 5470 - 5725 MHz.

The generating equipment is configured as shown in the Conducted Test Setup above. A single Burst of the short pulse radar Type 1 through 6 was produced at 5600 MHz at a level of -46dBm (Ref Section 6.6). The EUT is set up as a standalone device (no associated Client and no traffic).

A single radar Burst is generated for a minimum of 10 trials, and the response of the EUT is noted. The EUT must detect the Radar Waveform 90% or more of the time.

The radar frequency is increased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The highest frequency at which detection is greater than or equal to 90% is denoted as F_H.

The radar frequency is decreased in 1 MHz steps, repeating the above test sequence, until the detection rate falls below 90%. The lowest frequency at which detection is greater than or equal to 90% is denoted as F_L.

The U-NII Detection Bandwidth is calculated as follows:

U-NII Detection Bandwidth = $F_H – F_L$

The U-NII Detection Bandwidth must be at least 80% of the EUT transmitter 99% power, otherwise, the EUT does not comply with DFS requirements.

MiCOM Labs, 440 Boulder Court, Suite 200, Pleasanton, CA 94566 USA, Phone: 925.462.0304, Fax: 925.462.0306, www.micomlabs.com

EUT Frequency=5600MHz (64 MHz QPSK)											
Radar Frequency (MHz)	**DFS Detection Trials (1=Detection, Blank= No Detection)**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Detection Rate (%)**
											0%
5567	0	0	0	0	0	0	0	0	0	0	0%
5568 (F_L)	1	1	1	1	1	1	1	1	1	1	100%
5569	1	1	1	1	1	1	1	1	1	1	100%
5570	1	1	1	1	1	1	1	1	1	1	100%
↕	1	1	1	1	1	1	1	1	1	1	100%
	1	1	1	1	1	1	1	1	1	1	100%
5595	1	1	1	1	1	1	1	1	1	1	100%
5596	1	1	1	1	1	1	1	1	1	1	100%
5597	1	1	1	1	1	1	1	1	1	1	100%
5598	1	1	1	1	1	1	1	1	1	1	100%
5599	1	1	1	1	1	1	1	1	1	1	100%
5600	1	1	1	1	1	1	1	1	1	1	100%
5601	1	1	1	1	1	1	1	1	1	1	100%
5602	1	1	1	1	1	1	1	1	1	1	100%
5603	1	1	1	1	1	1	1	1	1	1	100%
5604	1	1	1	1	1	1	1	1	1	1	100%
5605	1	1	1	1	1	1	1	1	1	1	100%
↕	1	1	1	1	1	1	1	1	1	1	100%
	1	1	1	1	1	1	1	1	1	1	100%
5624	1	1	1	1	1	1	1	1	1	1	100%
5625	1	1	1	1	1	1	1	1	1	1	100%
5626	1	1	1	1	1	1	1	1	1	1	100%
5627	0	1	1	1	1	1	1	1	1	1	90%
5628 (F_H)	1	1	1	1	1	1	1	1	1	1	100%
5629	0	0	0	0	0	0	0	0	0	0	
Detection Bandwidth = F_H-F_L = 5628 MHz-5568 MHz = 60 MHz											
EUT 99% Bandwidth = 64.729 MHz											
64.729 MHz *80% = 51.783 MHz											

For each frequency step the minimum percentage detection is 90%

6.10.2. Initial Channel Availability Check Time (64 MHz QPSK)

This test verifies that the EUT does not emit pulse, control, or data signals on the test Channel until the power-up sequence has been completed and the U-NII device checks for Radar Waveforms for one minute on the test Channel. This test does not use any Radar Waveforms.

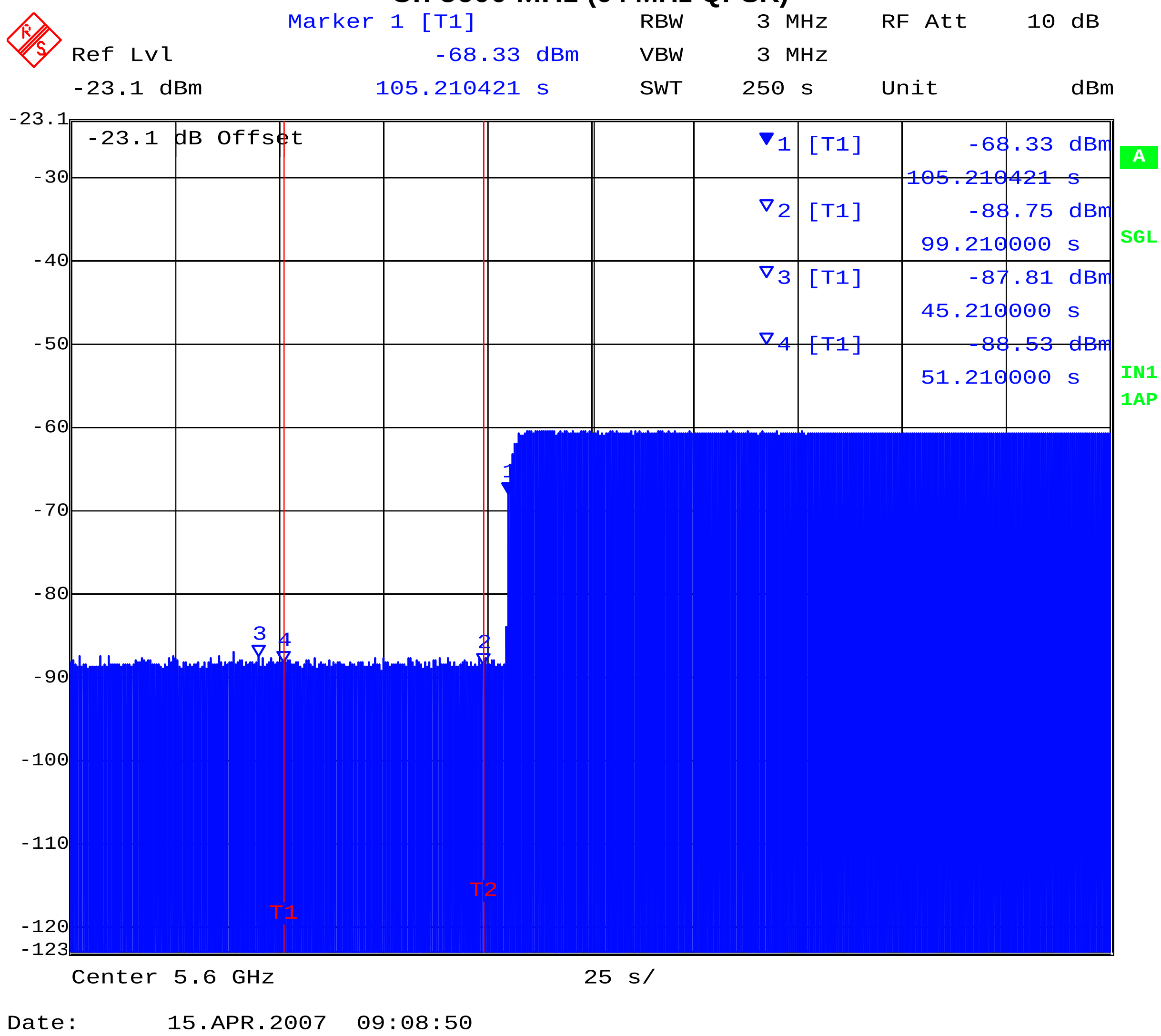
The U-NII device is powered on and be instructed to operate at 5600 MHz. At the same time the EUT is powered on, the spectrum analyzer is set for zero span with a 3 MHz resolution bandwidth at 5600 MHz with a 250 second sweep time. The analyzer's sweep will be started the same time power is applied to the U-NII device.

The EUT should not transmit any pulse or data transmissions until at least 1 minute after the completion of the power-on cycle.

The EUT is powered on at T0. Marker ▼3 denotes the instant when the EUT has completed its power-up sequence and the start of the Channel Availability Check Time that ends after a duration of ▼3 + 60 seconds i.e ▼1 on the following plot.

The Master device requires 45.21 seconds to complete its power-on cycle.

Initial Channel Availability Check Time during power up of EUT
Ch 5600 MHz (64 MHz QPSK)



6.10.3. Radar Burst at the Beginning of the Channel Availability Check Time (64 MHz QPSK)

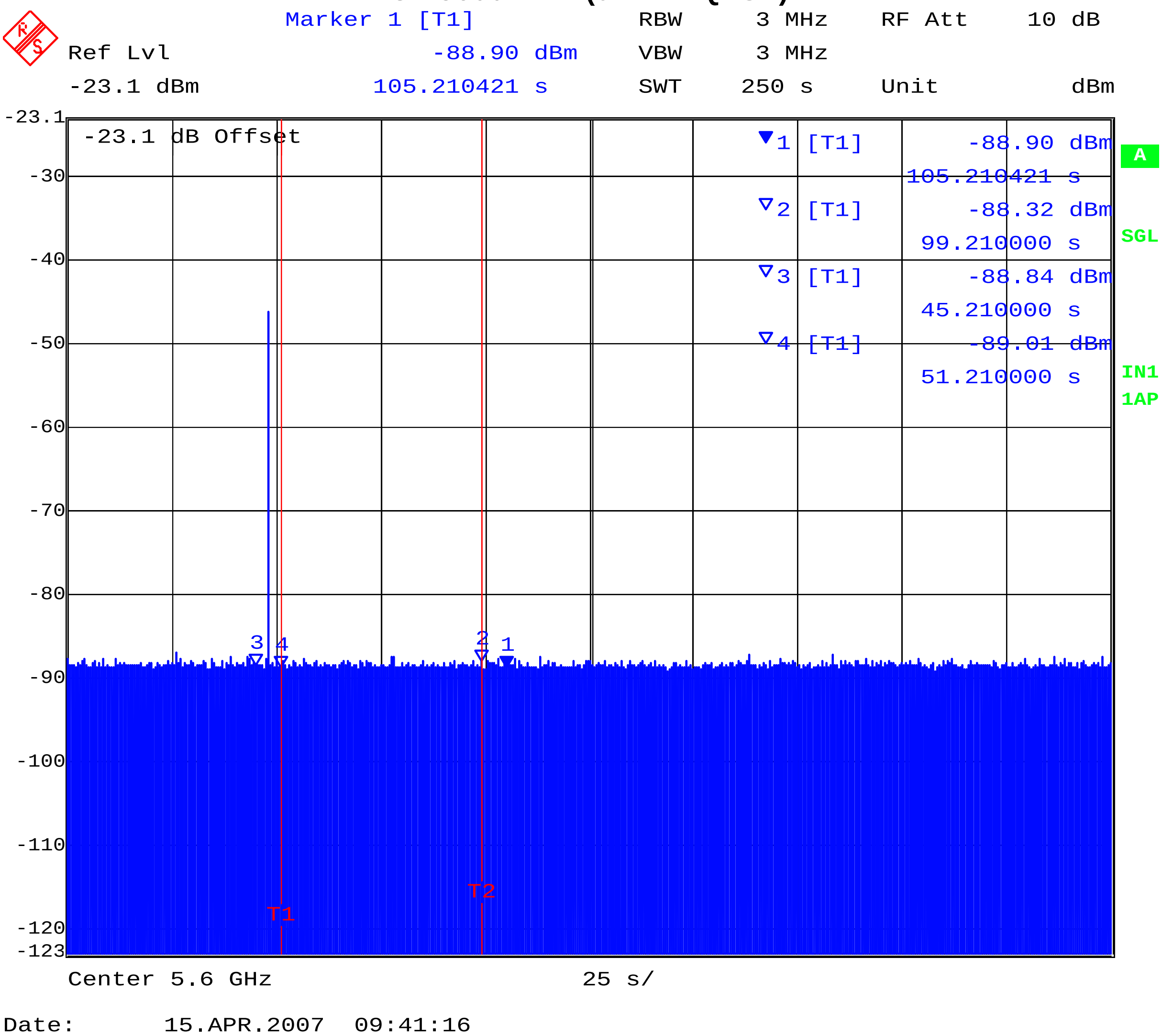
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold + 1 dB (-46 dBm Ref Section 6.6) occurs at the beginning of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single Burst of short pulse of radar type 1 will commence within a 6 second window starting at ▼3.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions have occurred at 5600MHz.

Channel Availability Check Time at the start of the 60 second Check Time
Ch 5600 MHz (64 MHz QPSK)



6.10.4. Radar Burst at the End of the Channel Availability Check Time: (64 MHz QPSK)

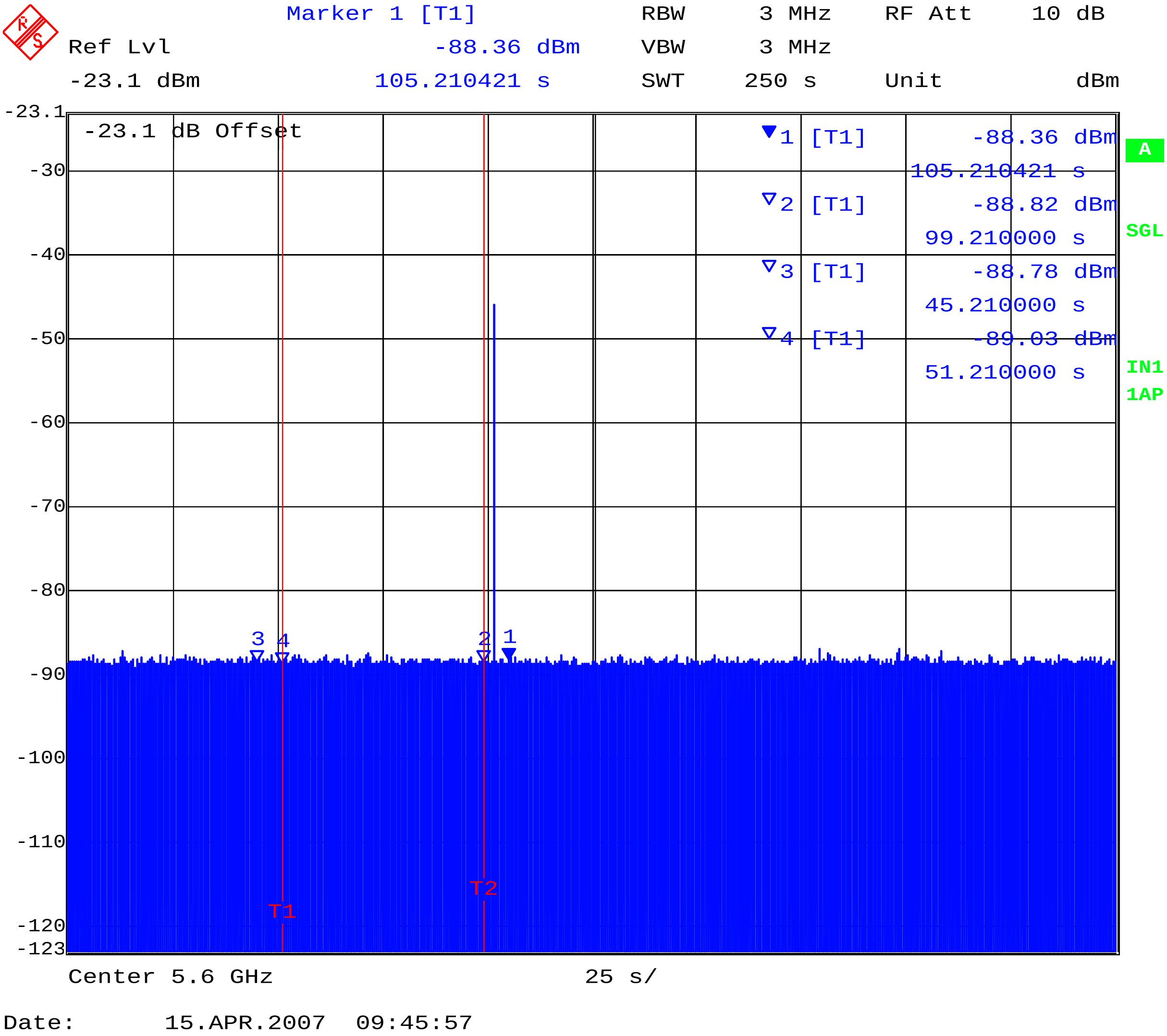
The steps below define the procedure to verify successful radar detection on the selected Channel during a period equal to the Channel Availability Check Time and avoidance of operation on that Channel when a radar Burst with a level equal to the DFS Detection Threshold occurs at the end of the Channel Availability Check Time.

The Channel Availability Check Time is defined on the following plot by the 60 second period starting at marker ▼3 and ending at ▼1. A single burst of radar type 1 will commence within a 6 second window starting at marker ▼3+ 54 seconds.

Visual indication on the EUT of successful detection of the radar Burst will be recorded and reported. Observation of emissions at 5600MHz will continue for 2.5 minutes after the radar burst has been generated.

Verify that during the 2.5 minute measurement window no EUT transmissions occurred at 5600MHz.

Channel Availability Check Time at the end of the 60 second Check Time Ch 5600 MHz (64 MHz QPSK)



6.10.5. In-Service Monitoring for Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period (64 MHz QPSK)

FCC §15.407(h)(2)(iii)

The steps below define the procedure to determine the above mentioned parameters when a radar Burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the EUT (Master). The requisite MPEG video file ("TestFile.mpg" available on the NTIA website at the following link http://ntiacsd.ntia.doc.gov/dfs/) is streamed from the master device (AP) to the client.

Channel Closing Transmission Time - Measurement

A Type 1 waveform was introduced to the EUT, from which a 12 second transmission record was captured, collecting nearly 250M samples of data, which included 60ms of pre-trigger data. This Type 1 waveform had an integral marker built into its construction, marking the start of the waveform play, which directly triggered the PXI digitizer's data capture via the PXI backplane trigger bus.

The Aeroflex PXI was setup to capture data for all transmission events above a threshold level of -46dBm. The PXI time stamps all captured events with respect to T_0 (zero time indicating the start of the measurements sequence) starting the 60 ms pre-trigger period followed by the radar type 1 burst period.

Radar (Type 1) Pre-trigger period 60ms

Type 1 burst period 24.277ms

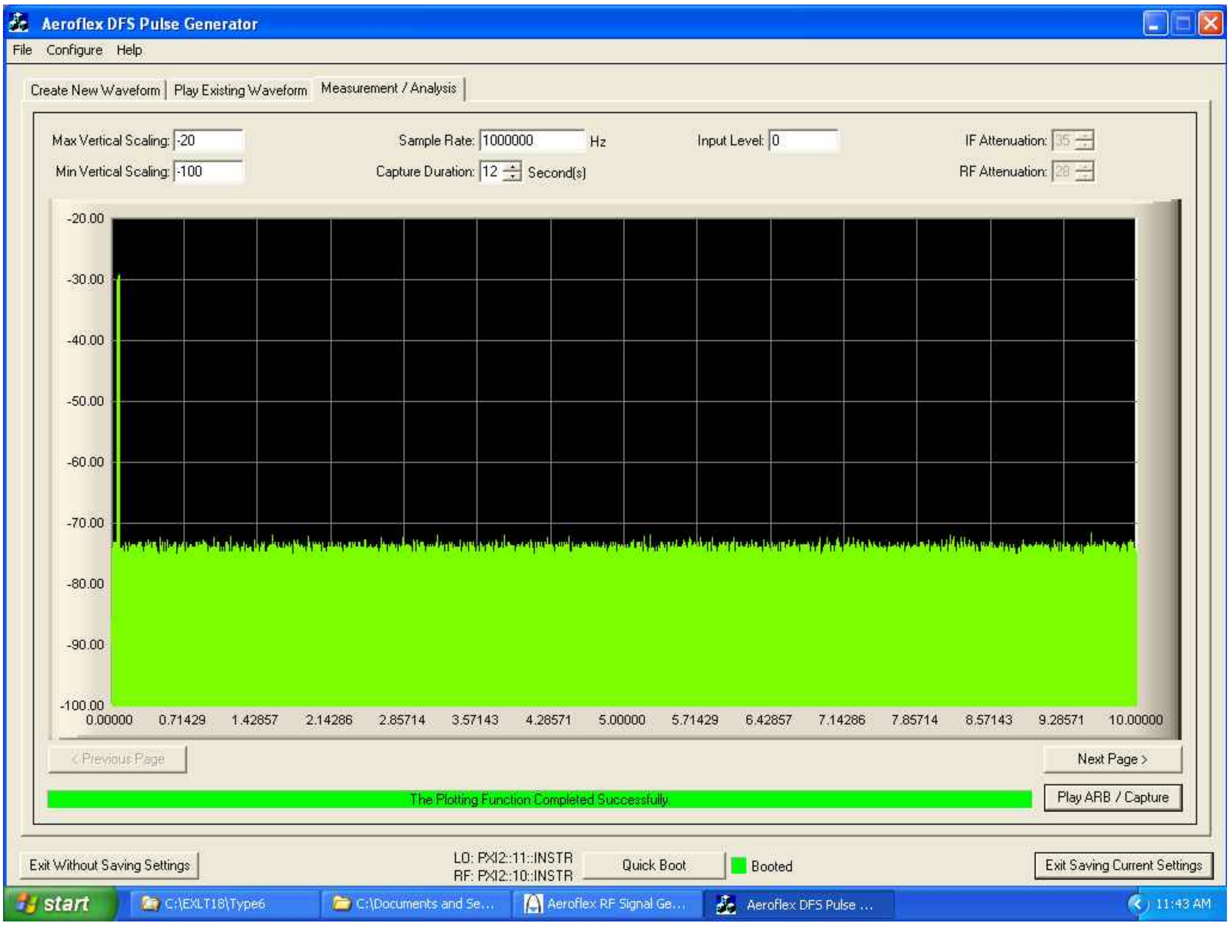
(The period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1µs pulse width for the final pulse.)

Channel Closing Transmission Time starts at 84.277ms after T_0.

Therefore, pulses seen after this 84.277ms boundary are identified and totaled to provide an aggregate total of transmissions in order to determine whether the EUT is compliant with the Channel Closing Transmission Time requirements as described in MO&O FCC 06-96. In this case, it was found that an aggregate total of 8 µs of transmission time accrued.

Channel Closing Transmission Time = 8 µSecs (limit 260 mSecs)

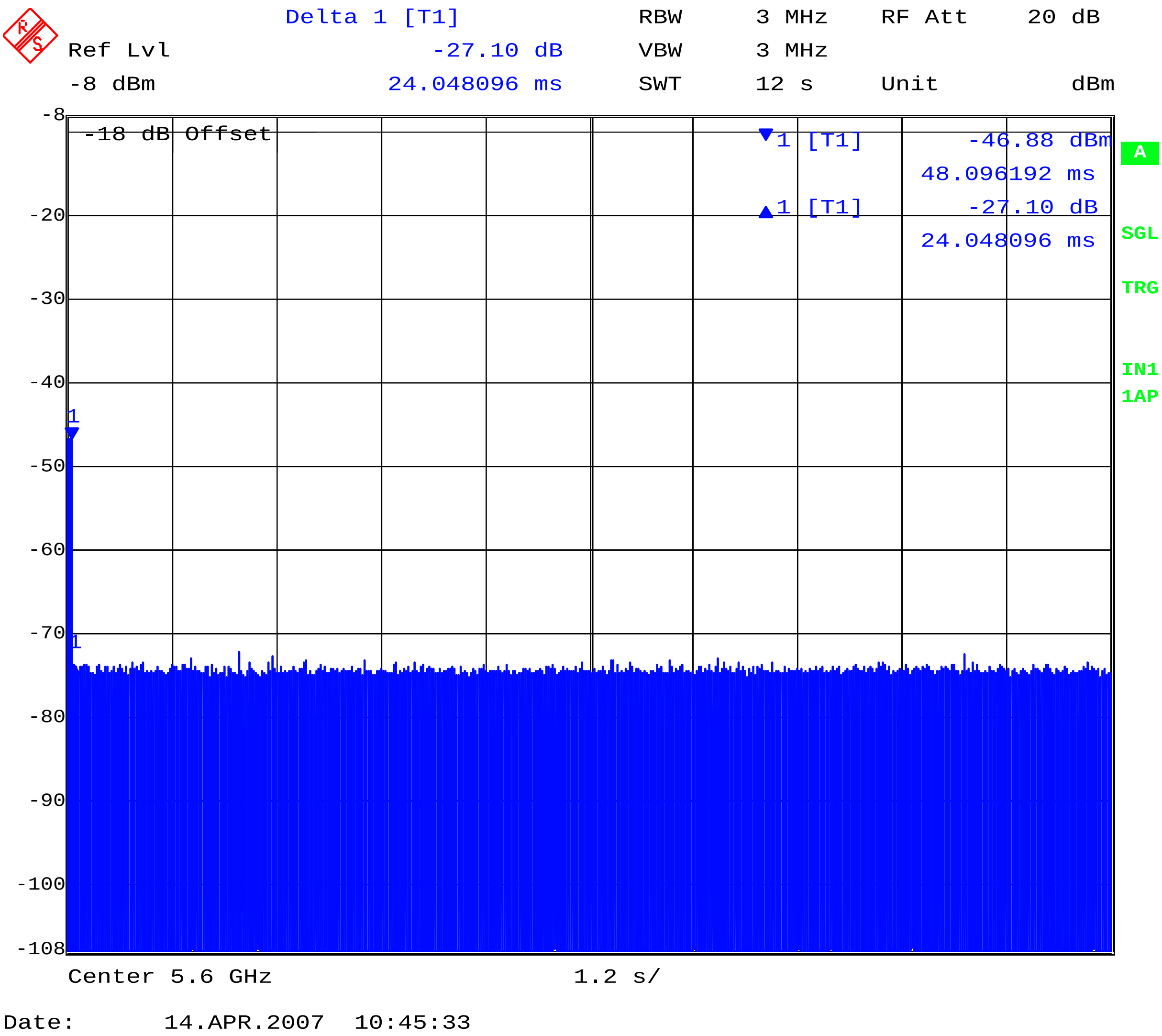
Channel Move Time, Channel Closing Time for Type 1 Radar(64 MHz QPSK) Captured by Aeroflex PXI Test System



Additionally, a redundant conventional spectrum analyzer screen capture is provided to correlate against the digitizer screen capture for verification purposes.

Note;- no pre-trigger data interval (60 mSecs) was included in the following Spectrum Analyzer plot

Channel Move Time, Channel Closing Time for Type 1 Radar(64 MHz QPSK) Captured by Spectrum Analyzer



The following data was captured by the Aeroflex PXI test System and is used to calculate the Channel Closing Transmission Time for the EUT **(64 MHz QPSK)** with the intervention of Radar Type 1.

Sample Number: 85698	Rising Edge,	Sample Time Stamp	0.085698	
Sample Number: 85706	Falling Edge,	Sample Time Stamp	0.085706*	8E-06
			Total =	8E-06 Secs

* Represents the last transmission activity of the EUT. The 0.085706*second time stamp is used to calculate Channel Move Time.

Channel Move Time (64 MHz QPSK)– Measurement & Calculation Type 1 Radar

The Channel Move Time is calculated using the data captured for the Channel Closing time as follows;-

Channel Move Time = Ft – Pt - Rt

Where;-

Ft = Final transmission activity occurred at 85.706 mSeconds

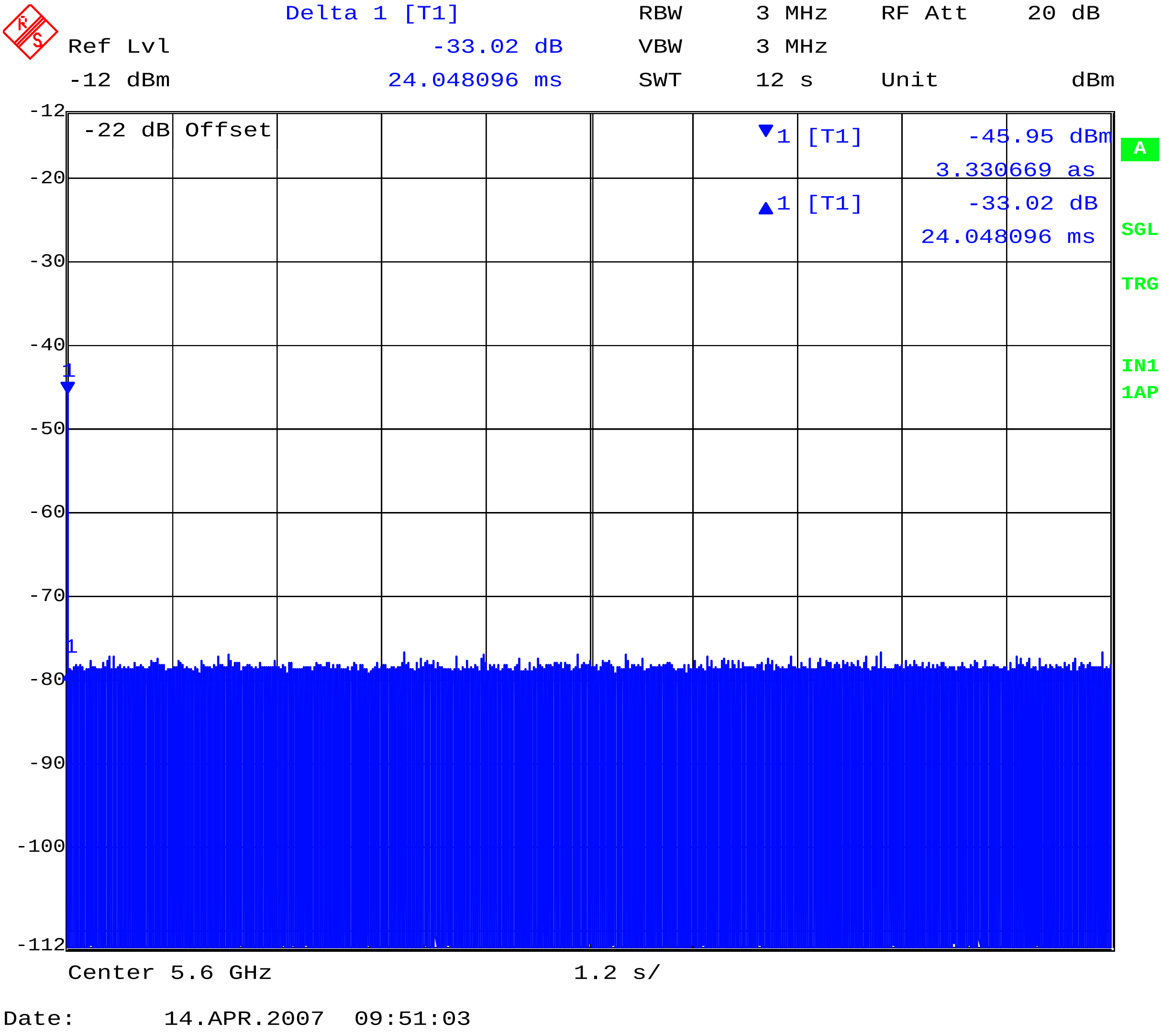
Pt = Pre-trigger information 60 mS

Rt = Type 1 burst period 24.277 mS

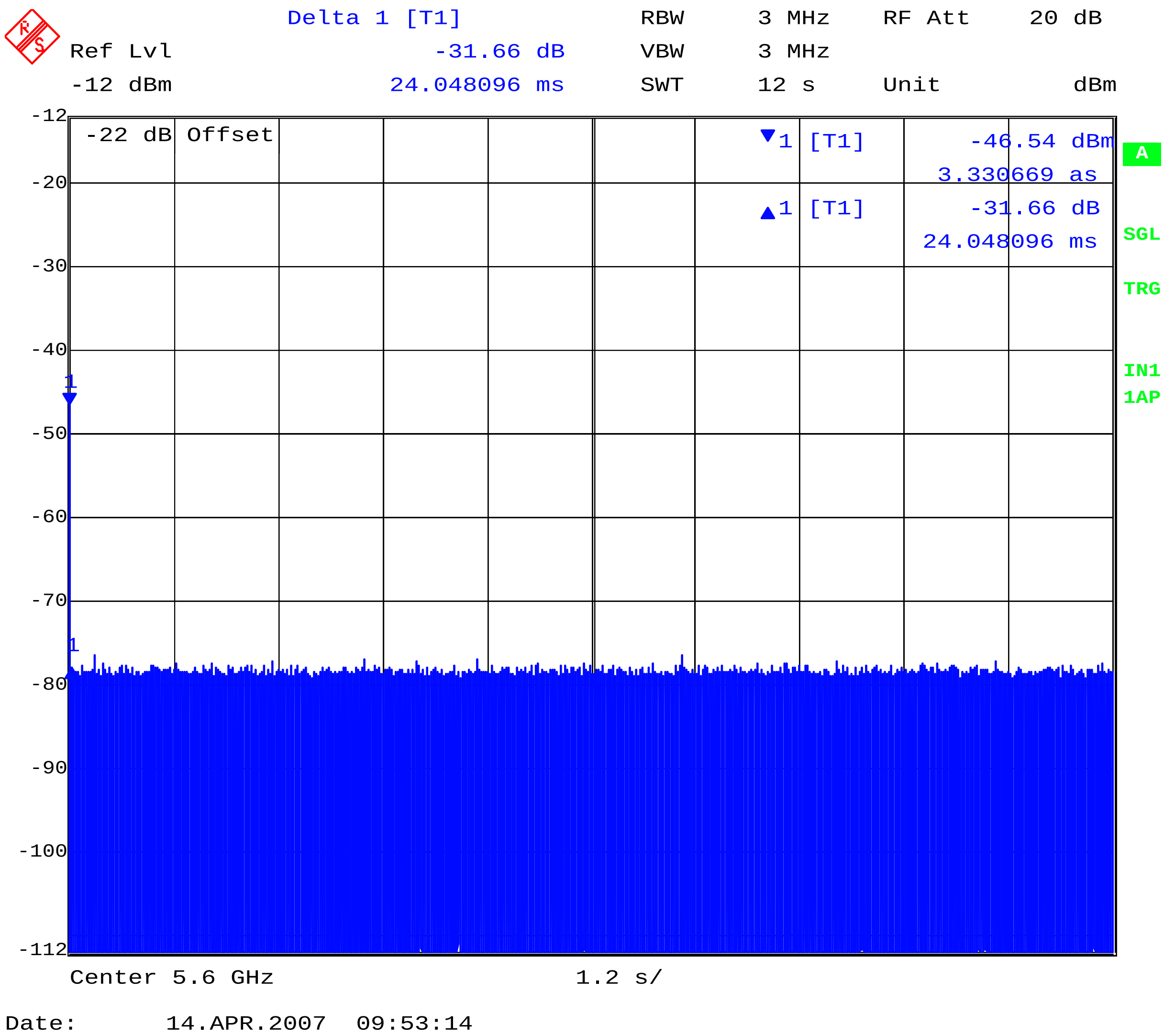
(Rt is the period of the 18 pulse burst includes [17 pulses *1.428mS PRI] = 24.276ms. Then add 1µs pulse width for the final pulse.)

Channel Move Time = 85.706 – 60 – 24.277 = 1.429 mSecs

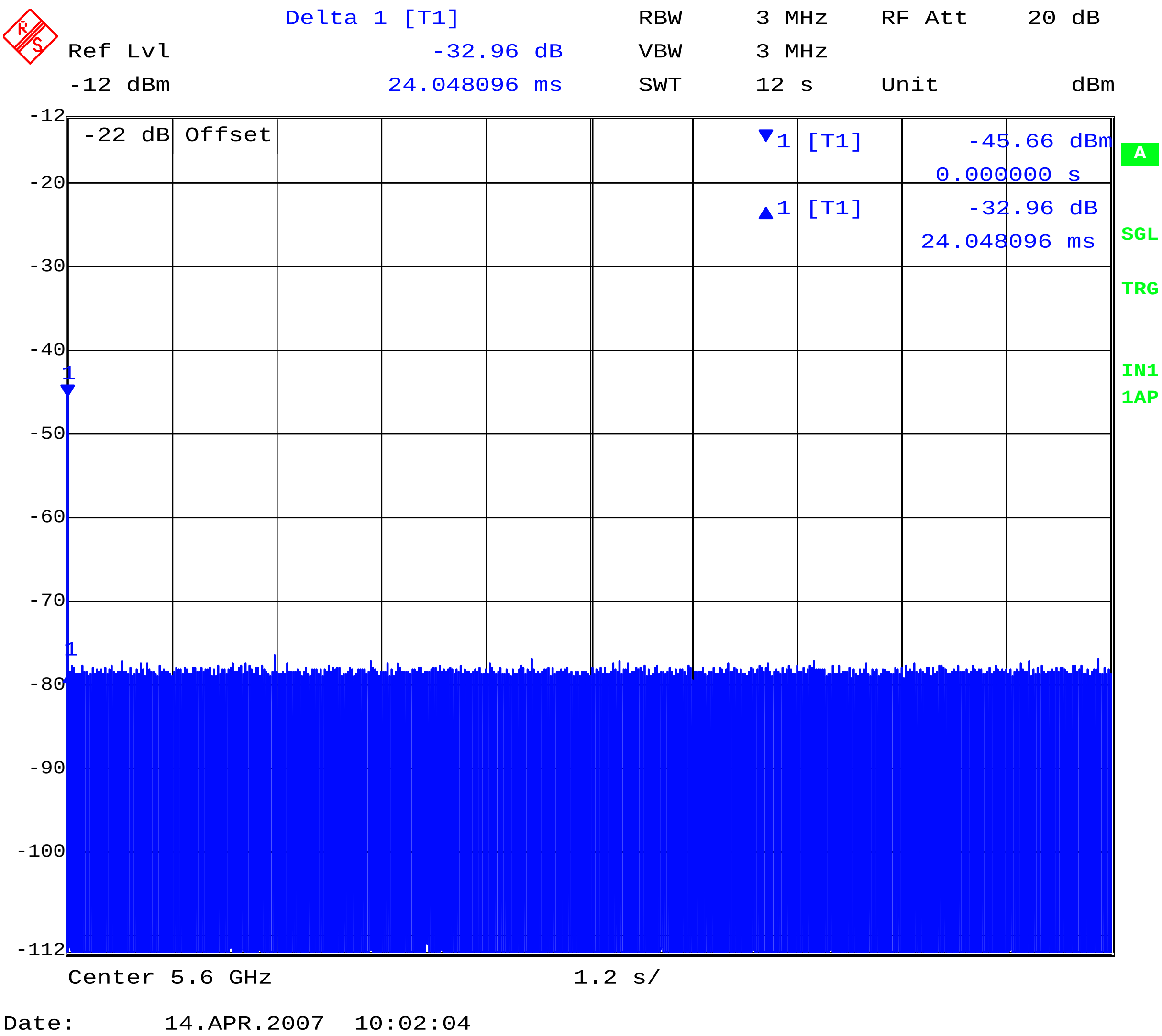
Channel Move Time, Channel closing Transmission Time for (64 MHz QPSK) Type 2 Radar
1.1µs, 197 prf, 24 pulses



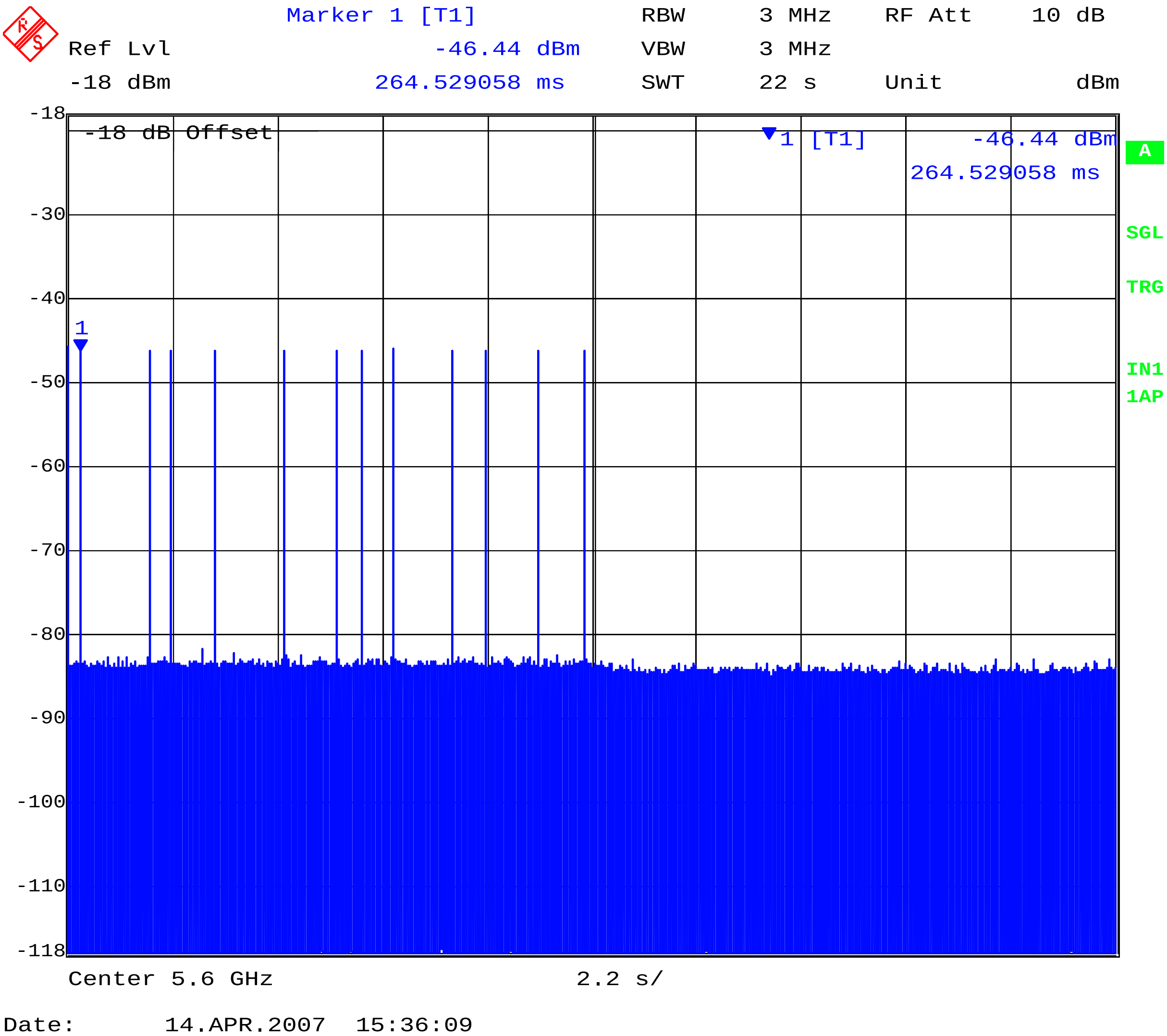
Channel Move Time, Channel closing Transmission Time (64 MHz QPSK) for Type 3 Radar
6.2 µs, 259 prf, 17 pulses



Channel Move Time, Channel closing Transmission Time (64 MHz QPSK) for Type 4 Radar
11.6 µs, 283 prf, 13 pulses

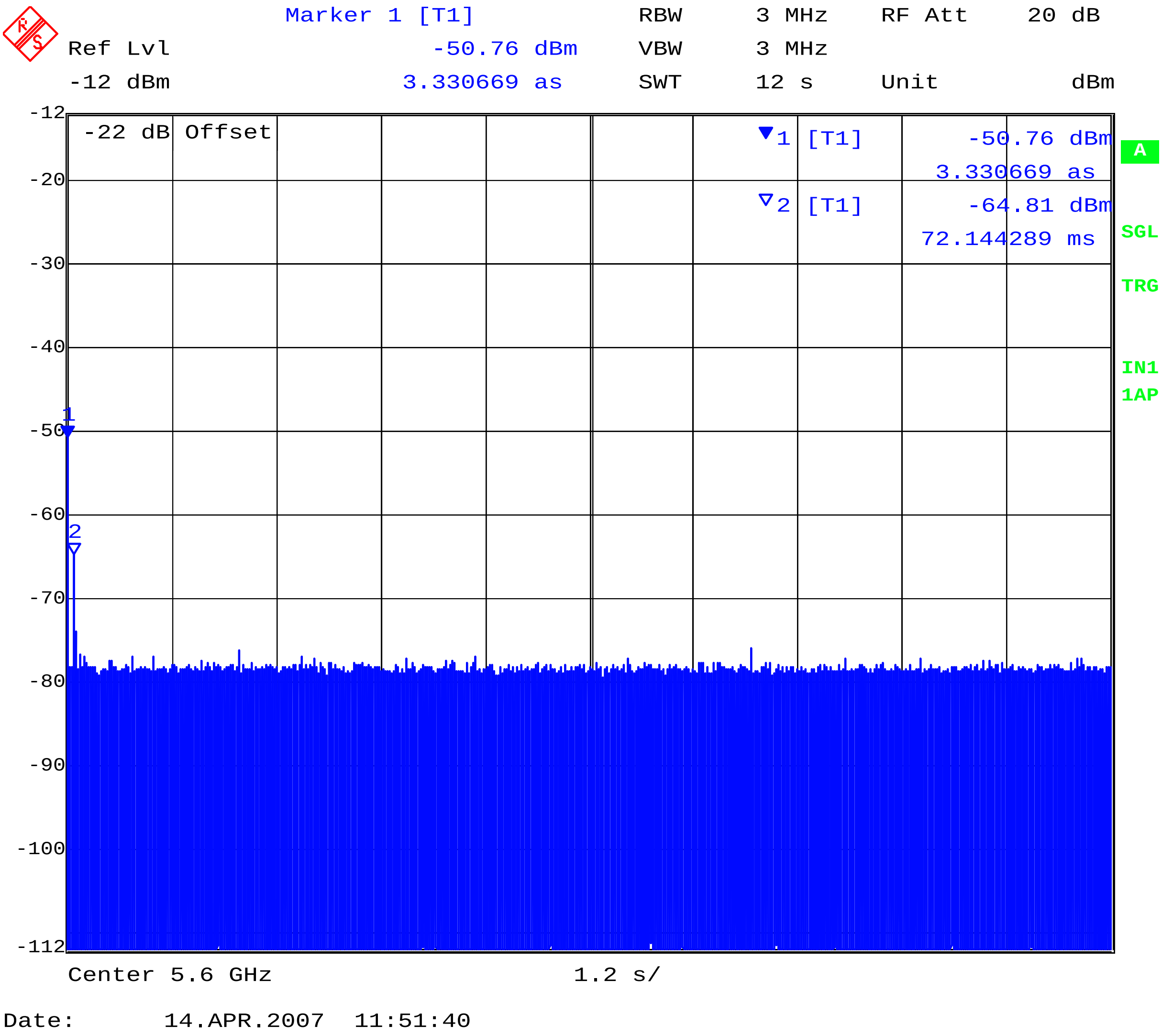


Channel Move Time, Channel closing Transmission Time (64 MHz QPSK) for Type 5 Radar



With reference to the requirements of FCC MO & O 06-96;- The instant that the Chanel Move Time and Channel Closing Time begins for the long Pulse Radar Test Signal is the instant at the end of the 12 Second period defining the Radar Waveform. From the above plot is can be seen that the EUT stopped transmitting data before completion of the Radar Test Signal, therefore the Channel Closing Time and Channel Move time complies with the requirements.

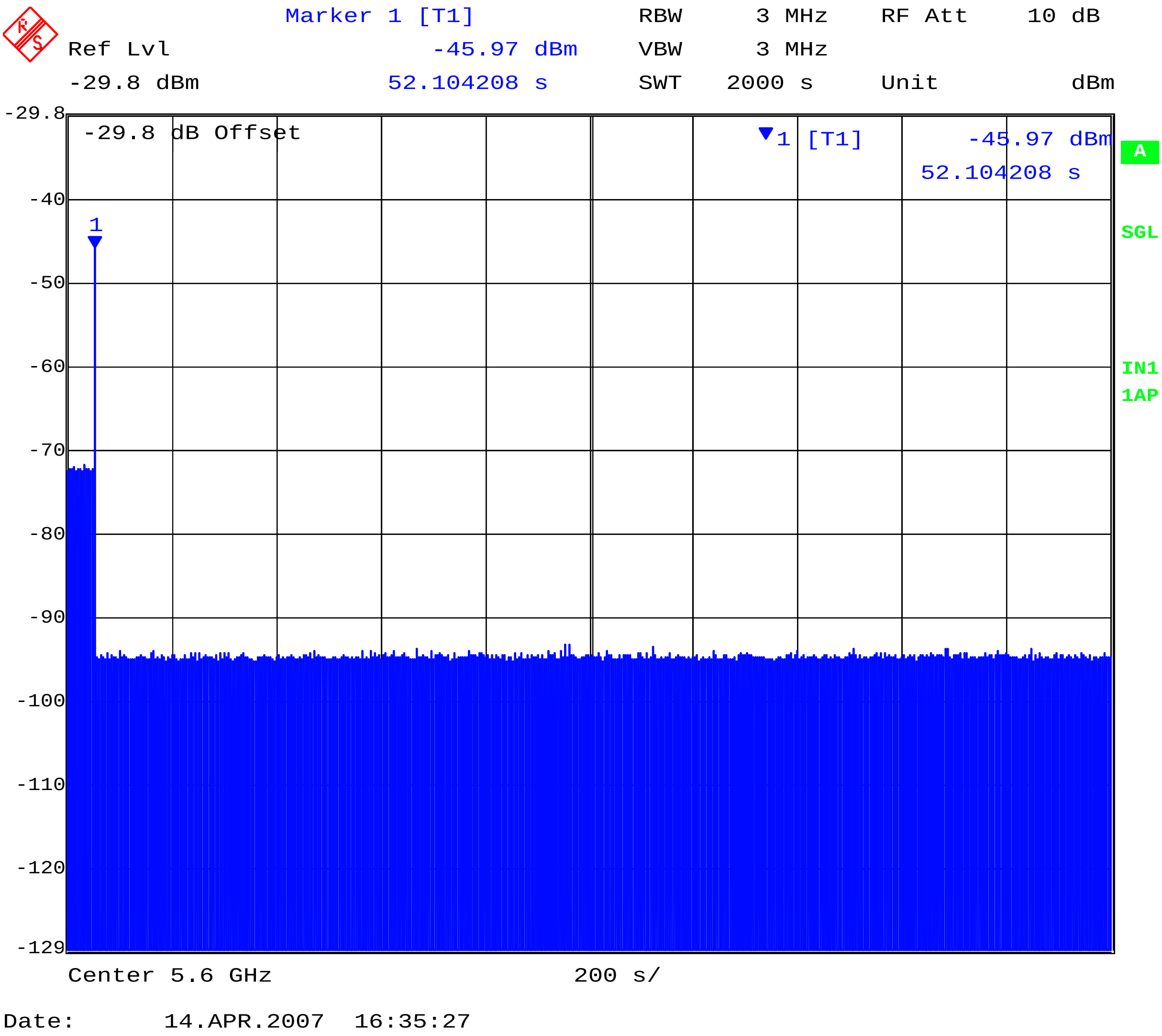
Channel Move Time, Channel closing Transmission Time (64 MHz QPSK) for Type 6 Radar



30 Minute Non-Occupancy Period

The EUT is monitored for more than 30 minutes following the channel close/move time to verify no transmissions resume on this Channel.

30 Minute Non-Occupancy Period (64 MHz QPSK) Type 1 Radar Ch 5500 MHz



6.10.6. Statistical Performance Check

The steps below define the procedure to determine the minimum percentage of detection when a radar burst with a level equal to the DFS Detection Threshold is generated on the Operating Channel of the U-NII device.

A U-NII device operating as a Client Device will associate with the UUT (Master) at 5600 MHz. Stream the MPEG test file from the Master Device to the Client Device on the selected Channel for the entire period of the test.

The Radar Waveform generator sends the individual waveform for each of the radar types 1-6. Statistical data will be gathered to determine the ability of the device to detect the radar test waveforms. The device can utilize a test mode to demonstrate when detection occurs to prevent the need to reset the device between trial runs. The percentage of successful detection is calculated by:

Total # of detections ÷ Total # of Trials × 100 = Probability of Detection

The Minimum number of trails, minimum percentage of successful detection and the average minimum percentage of successful detection are found in the Radar Test Waveforms section.

(64 MHz QPSK)- Verification of Detection

Trail #	Detection = 1, No Detection = 0			
	Type 1	Type 2	Type 3	Type 4
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12	1	1	1	1
13	1	1	1	1
14	1	1	1	1
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	1	1	1	1
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	1	1	1	1
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1
27	1	1	1	1
28	1	1	1	1
29	1	1	1	1
30	1	1	1	1
Detection Percentage	**100**% (>60%)	**100**% (>60%)	**100**% (>60%)	**100**% (>60%)

In addition an average minimum percentage of successful detection across all four Short pulse radar test waveforms is required and calculated as follows;

$\underline{P_d1 + P_d2 + P_d3 + P_d4} = \underline{(100\% + 100\% + 100\% + 100\%)} = 100\% \ (> 80\%)$

(64 MHz QPSK) Radar Type 5 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	100% (>60%)

(64 MHz QPSK) Radar Type 6 - Verification of Detection

Trail #	Detection = 1 No Detection = 0
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	1
20	1
21	1
22	1
23	1
24	1
25	1
26	1
27	1
28	1
29	1
30	1
Detection Percentage	**100% (>60%)**

Measurement Uncertainty Time/Power

Measurement uncertainty - Time - Power	 4% 1.33dB

Traceability

Test Equipment Used
0072, 0083, 0098, 0116, 0132, 0158, 0313, 0314, 0193, 0223, 0252, 0253, 0251, 0256, 0328, 0329

8. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0088	Spectrum Analyzer	Hewlett Packard	8564E	3410A00141
0104	1-18GHz Horn Antenna	The Electro-Mechanics Company	3115	9205-3882
0134	Amplifier	Com Power	PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	None
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	3140A01285
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623
0070	Power Meter	Hewlett Packard	437B	3125U11552
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002
	Radar Signal Generator	Aeroflex	3025, 3010, 3010/11 Opt 1	
	Analyzer	Aeroflex	3035, 3011, 3010/11 Opt 1	
	PXI Chassis	Aeroflex	82536	
	Coupler	Mini-Circuits		
	30dB N-Type Attenuator			
	10dB N-Type Attenuator			
	10dB N-Type Attenuator			

9. Appendix A

As mentioned previously in Section 3.6 “Test Configurations”, it was established at the start of the test program that the QPSK modulation scheme has the highest Radiated Emission and Peak Emission levels. The Test Report includes results for all of the QPSK configurations and selected worst case test results for 16QAM and 64QAM configurations.

The worst case test results for 16QAM and 64QAM configurations are reported in this appendix.

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.407** and **Industry Canada RSS-210**.and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.407(b)(2) **15.205(a)** **15.209(a)** **2.2, 2.6** **A9.3(2)** **4.7**	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz	Radiated	Complies	*9.1.1.1*
	Radiated Band Edge	Band edge results	Radiated	Complies	*9.1.1.2*
	Peak Field Strength Measurements		Radiated	Complies	*9.1.1.3*

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*

Band	BW (MHz)	Modulation					
		16QAM			64QAM		
		Low (MHz)	Mid (MHz)	High (MHz)	Low (MHz)	Mid (MHz)	High (MHz)
5.3	8	5260	5296	5332	5260	5296	5332
	16	5265	5296	5327	5265	5296	5327
	32	5272	5290	5308	5272	5290	5308
	64		5290			5290	

9.1.1. Radiated Emissions

9.1.1.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

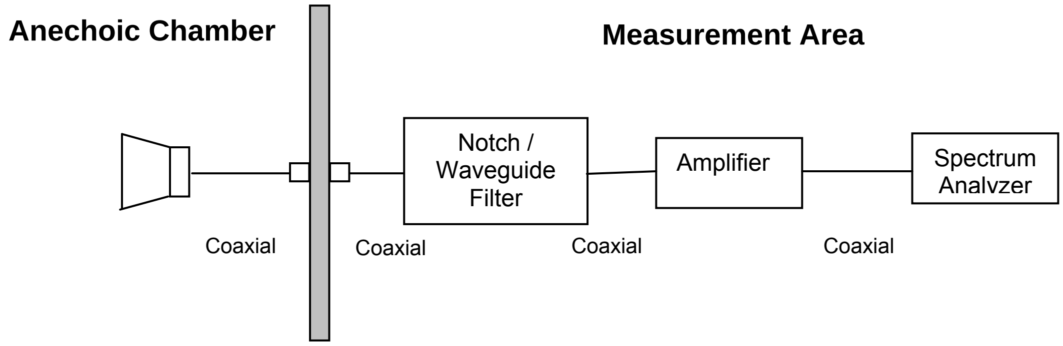
FCC, Part 15 Subpart C §15.407(b)(2), §15.205(a)/15.209(a)
Industry Canada RSS-210 §A9.3(2); §2.2; §2.6; RSS-Gen §4.7

Test Procedure

Radiated emissions above 1 GHz are 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 notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO
where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength

$$E = 1000000 \times \sqrt{30P} / 3 \ \mu V/m$$, where P is the EIRP in Watts

Therefore: -27 dBm/MHz = 68.23 dBuV/m

Measurement Results Transmitter Radiated Spurious Emissions above 1 GHz

Antenna Configuration
28 dBi Panel
37.5 dBi Parabolic

Radio parameters.
Power Level: maximum 28 dBi antenna +2 dBm, 37.5 dBi antenna -7.5dBm
Duty Cycle: 100% (test mode)

Radiated Spurious Emissions above 1 GHz (continued)

16QAM Radiated Emissions 28 dBi Antenna

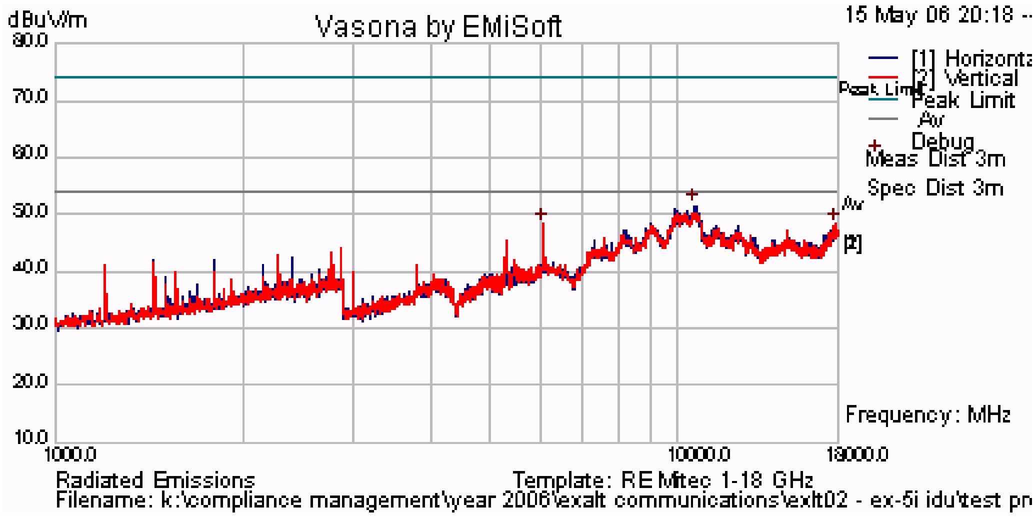
TABLE OF RESULTS – 5,290 MHz 28 dBi Antenna 64 MHz Bandwidth 16QAM

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

Note. No emissions were observed above the limit.

Plot A01

5,290 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth 16QAM



Radiated Spurious Emissions above 1 GHz (continued)

64QAM Radiated Emissions 28 dBi Antenna

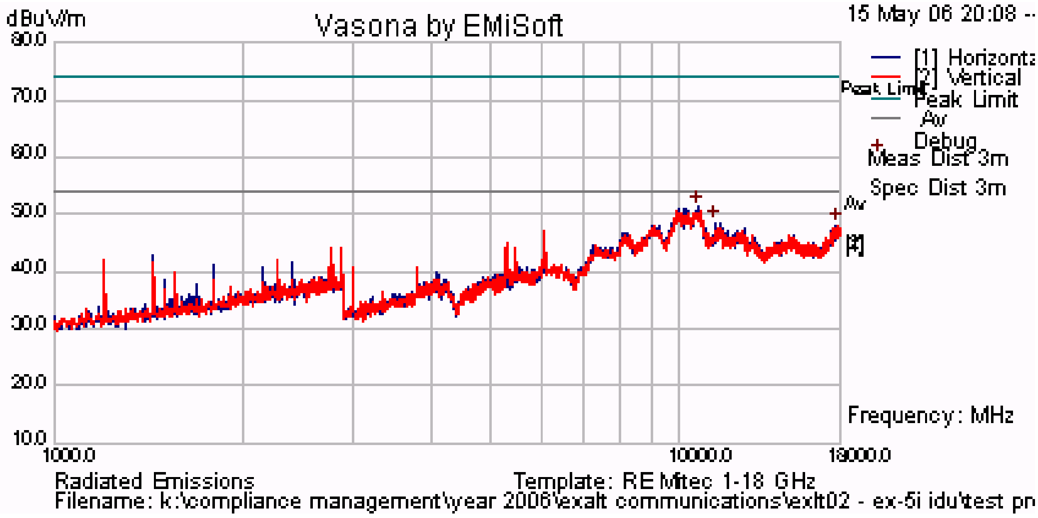
TABLE OF RESULTS – 5,290 MHz 28 dBi Antenna 64 MHz Bandwidth 64QAM

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

Note. No emissions were observed above the limit.

Plot A02

5,290 MHz Radiated Emissions for 28 dBi Antenna 64 MHz Bandwidth 64QAM



Radiated Spurious Emissions above 1 GHz (continued)

16QAM Radiated Emissions 37.5 dBi Antenna

TABLE OF RESULTS –5,290 MHz 37.5 dBi Antenna 64 MHz Bandwidth 16QAM

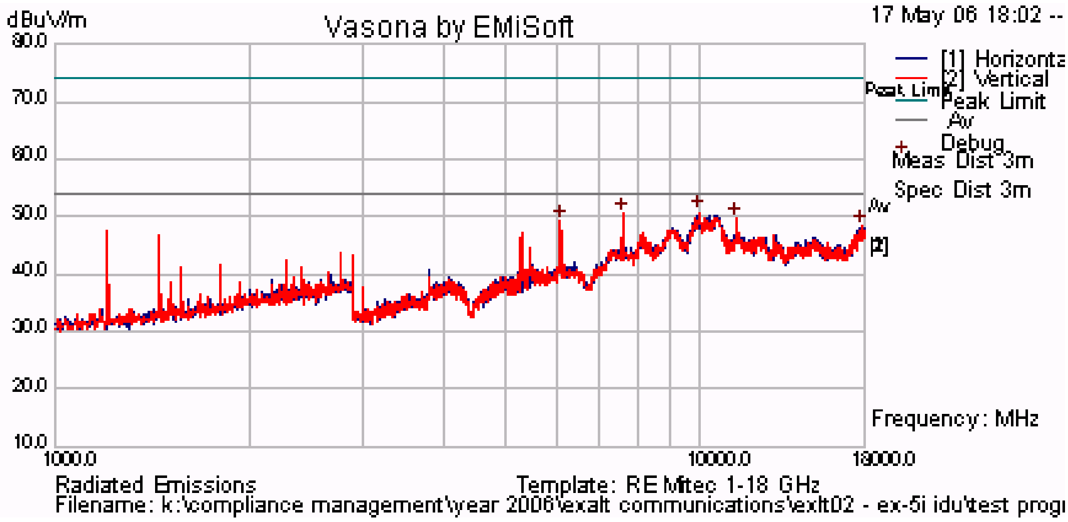
Freq. (MHz)	Pol. (H/V)	Raw Reading (dBµV/m)	Correction Factor (dB)	Corrected Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Radiated Emissions for 37.5 dBi Antenna

Plot A03

5,290 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth 16QAM



64QAM Radiated Emissions 37.5 dBi Antenna

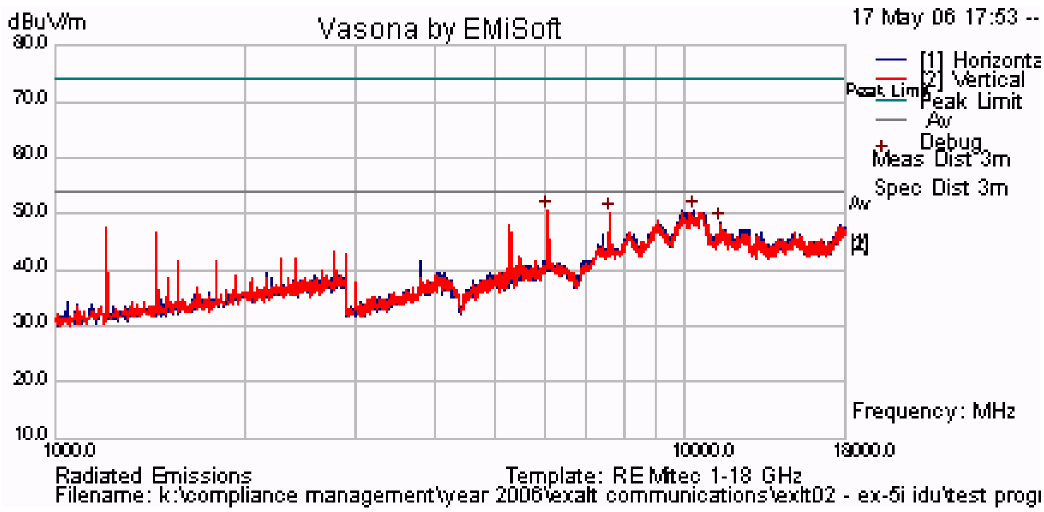
TABLE OF RESULTS – 5,290 MHz 37.5 dBi Antenna 64 MHz Bandwidth 64QAM

Freq. (MHz)	Pol. (H/V)	Raw Reading (dBμV/m)	Correction Factor (dB)	Corrected Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
					54	

No emissions were observed above the limit.

Plot A04

5,290 MHz Radiated Emissions for 37.5 dBi Antenna 64 MHz Bandwidth 64QAM



Specification Limits

15.407 (b)(2). All emissions outside of the 5,150-5,350MHz band shall not exceed an EIRP of -27dBm/MHz.

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

RSS-210 §A9.3(2) For transmitters operating in the 5250-5350 MHz band, all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz e.i.r.p. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band shall not exceed out of band emission limit of 27 dBm/MHz e.i.r.p. in the 5150-5250 MHz band in order to operate indoor/outdoor, or alternatively shall comply with the spectral power density for operation within the 5150-5250 MHz band and shall be labeled “for indoor use only”.

RSS-Gen §4.7 The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

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, 0304, 0311, 0315, 0310, 0312

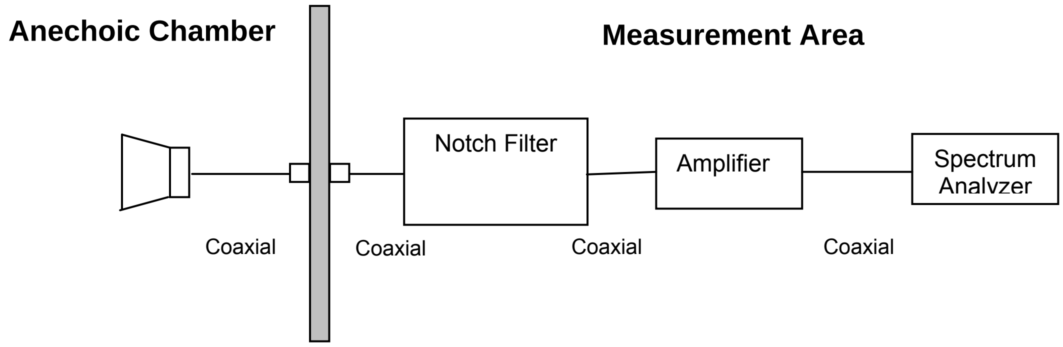
9.1.1.2. Radiated Band-Edge – Restricted Bands

Test Procedure

Radiated emissions above 1 GHz are 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.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO
where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Band-stop Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

Radiated Band Edge - Test Configurations

Antennas

28 dBi Panel Antenna

37.5 dBi Parabolic Antenna

Radiated Band Edge Test Results for 28 dBi Panel Antenna

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth 16QAM

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,290_{PEAK}$	5,150	62.42	74.00	-11.58
$5,290_{AVE}$	5,150	40.87	54.00	-13.13
$5,290_{PEAK}$	5,350	72.33	74.00	-1.67
$5,290_{AVE}$	5,350	51.29	54.00	-2.71

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth 64QAM

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,290_{PEAK}$	5,150	62.69	74.00	-11.31
$5,290_{AVE}$	5,150	40.87	54.00	-13.13
$5,290_{PEAK}$	5,350	72.60	74.00	-1.40
$5,290_{AVE}$	5,350	53.97	54.00	-0.03

Radiated Band Edge Test Results for 37.5 dBi Parabolic Antenna

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth 16QAM

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,290_{PEAK}$	5,150	62.69	74.00	-11.31
$5,290_{AVE}$	5,150	40.99	54.00	-13.01
$5,290_{PEAK}$	5,350	66.00	74.00	-8.00
$5,290_{AVE}$	5,350	44.20	54.00	-9.80

TABLE OF RESULTS - 5.3 GHz Band - 64 MHz Bandwidth 64QAM

Tx Freq. (MHz)	Restricted Band Frequency (MHz)	Measured (dBuV/m)	Limit (dBuV/m)	Margin (dB)
$5,290_{PEAK}$	5,150	62.01	74.00	-11.99
$5,290_{AVE}$	5,150	40.99	54.00	-13.01
$5,290_{PEAK}$	5,350	66.28	74.00	-7.72
$5,290_{AVE}$	5,350	45.86	54.00	-8.14

9.1.1.3. Peak Field Strength Measurements

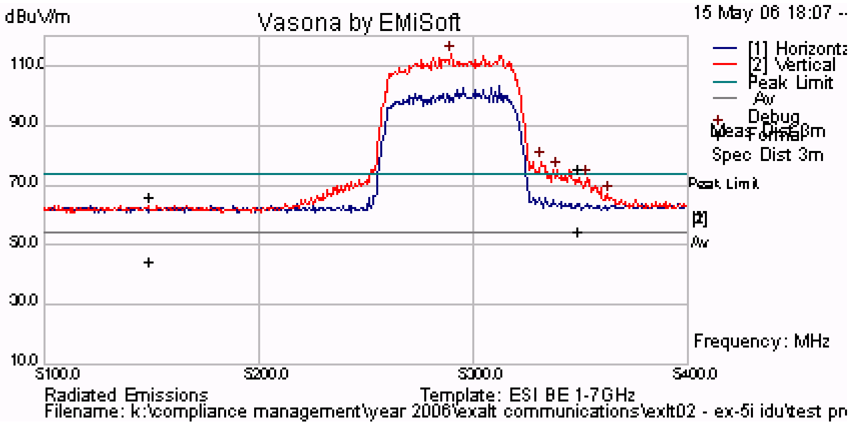
Peak Field Strength Measurements for 28 dBi Antenna

28 dBi Antenna 5,290 **MHz** **64 MHz Bandwidth 16QAM**

Plot A05

28 dBi Antenna 5,290 MHz 64 MHz Bandwidth 16QAM

Peak Emission = 114.95 dBµV/m

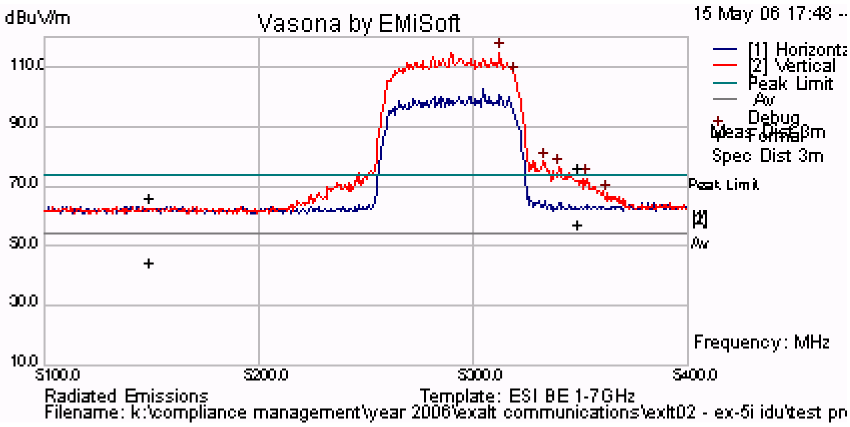


28 dBi Antenna 5,290 **MHz** **64 MHz Bandwidth 64QAM**

Plot A06

28 dBi Antenna 5,290 MHz 64 MHz Bandwidth 64QAM

Peak Emission = 115.02 dBµV/m



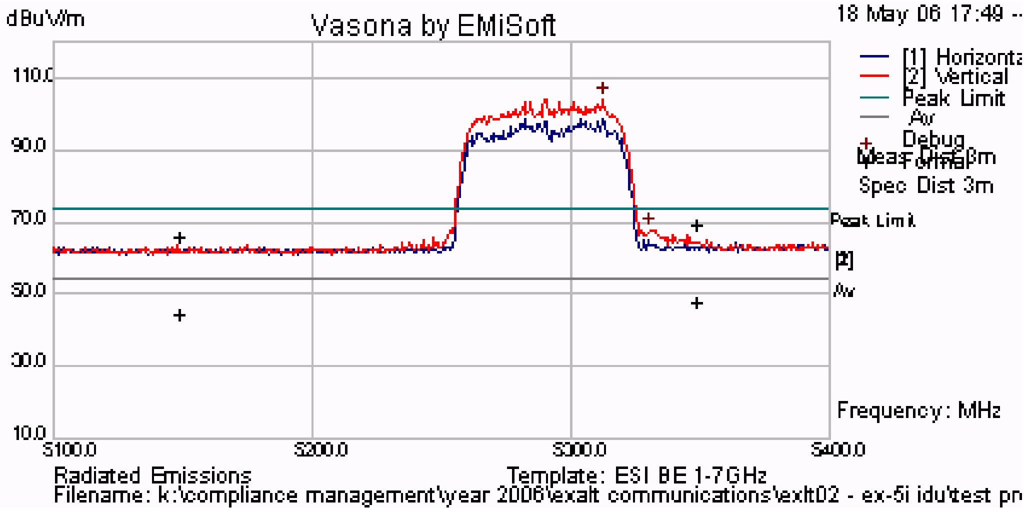
Peak Field Strength Measurements for 37.5 dBi Antenna

37.5 dBi Antenna 5,290 MHz 64 MHz Bandwidth 16QAM

Plot A07

37.5 dBi Antenna 5,290 MHz 64 MHz Bandwidth 16QAM

Peak Emission = 104.31 dBµV/m

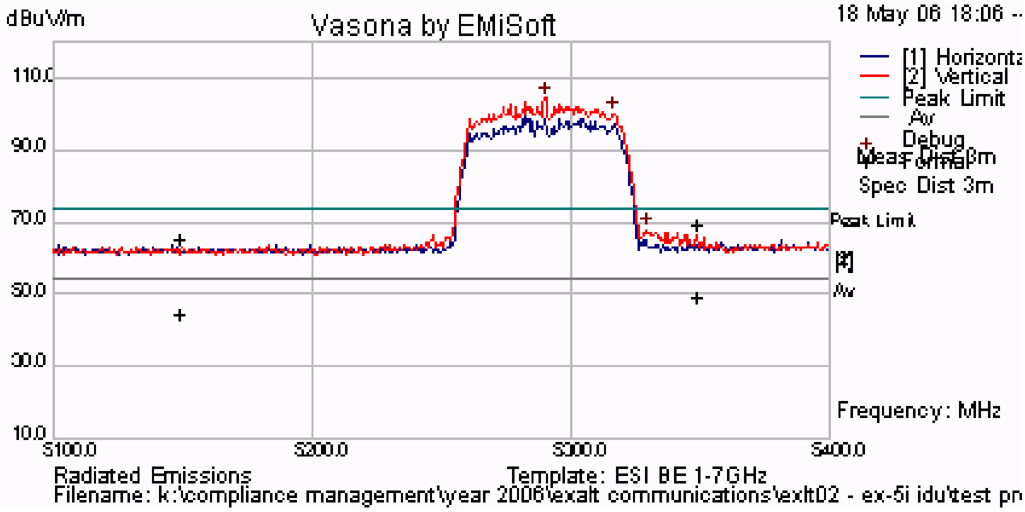


37.5 dBi Antenna 5,290 MHz 64 MHz Bandwidth 64QAM

Plot A08

37.5 dBi Antenna 5,290 MHz 64 MHz Bandwidth 64QAM

Peak Emission = 104.48 dBµV/m



Specification

Limits

15.407 (b)(2). All emissions outside of the 5,150-5,350MHz band shall not exceed an EIRP of -27dBm/MHz.

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

RSS-210 §A9.3(2) For transmitters operating in the 5250-5350 MHz band, all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz e.i.r.p. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band shall not exceed out of band emission limit of 27 dBm/MHz e.i.r.p. in the 5150-5250 MHz band in order to operate indoor/outdoor, or alternatively shall comply with the spectral power density for operation within the 5150-5250 MHz band and shall be labeled “for indoor use only”.

RSS-Gen §4.7 The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5^{th} harmonic of the highest frequency generated without exceeding 40 GHz.

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

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