FCC Certification Test Report

FCC Certification Test Report
for
ADTRAN, Inc.
Tracer 4205L1
FCC ID: HDCTRC4205L1

May 24, 2004

Prepared for:

ADTRAN, Inc.
901 Explorer Blvd
Huntsville, AL 35806

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Report
for the
ADTRAN, Inc.
TRACER 4205L1

WLL JOB# 8030

Prepared by:
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Abstract

This report has been prepared on behalf of ADTRAN, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digitally Modulated Transmitter under Part 15.247 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for an ADTRAN, Inc. TRACER 4205L1 Transceiver.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The ADTRAN, Inc. TRACER 4205L1 Transceiver complies with the requirements for a Digitally Modulated Transmitter device under Part 15.247 of the FCC Rules and Regulations.

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The ADTRAN, Inc. TRACER 4205L1 System complies with the requirements for a Digitally Modulated Transmitter device under Part 15.247 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2001 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	ADTRAN, Inc. 901 Explorer Blvd Huntsville, AL 35806
Purchase Order Number:	416542
Quotation Number:	60182-A

1.4 Test Dates

Testing was performed from April 25 to May 6, 2004.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Ken Gemmell, Greg Snyder, James Ritter

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	Centimeter
CW	Continuous Wave
dB	Decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
LISN	Line Impedance Simulation Network
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The 12804205L1 (Tracer 4205 DS3 Radio) is a digital radio device that accepts a single 44.736 Mb/s DS3 signal and transports it over a wireless carrier. A pair of these radios form a wireless transport for DS3 digital services in the 5.8 GHz ISM radio band. The 12804205L1 provides the network, antenna a control/status interface to the customer. The DS3 interface is network-timed.

A single coaxial cable connects the Tracer 4205L1 to the antenna.

The Tracer 4205L1 operates in the 5725-5850 MHz band using digital modulation.

I/O Ports and Cables available on the TRACER 4205L1 DS3 Radio:

Signal/Port Name	Signal/Port Type	Cable Type	NOTES
DS3 IN	I/O	Shielded Coax	75 Ohm impedance (RG59)
DS3 OUT	I/O	Shielded Coax	75 Ohm impedance (RG59)
RS232	I/O	Shielded 25 Wire	
ALARM	CONTROL	Unshielded TP	Alarm contacts – no active power or signal
ANTENNA	I/O	Shielded Coax	50 Ohm impedance, 5.8GHz signal only
MANAGEMENT	I/O	Shielded TP	Unused in this product version (no SNMP)

The TRACER 4205L1 contains the sources in Table 2.

Table 1. Assembly Information

Item	Number
Top Assembly:	12804205L1A and B
Subassemblies:	2280030-2, 2280018-5
Circuit Boards:	5280030-2, 5280018-5
Schematics:	2280030-2, 2280018-5

2.2 Test Configuration

Tracer 4205L1 DS3 Plan A w/o SNMP, P/N: 12804205L1A

Tracer 4205L1 DS3 Plan B w/o SNMP, P/N: 12804205L1B

The EUT was configured with an external power adapter, loopback connections on Channels A and B, unshielded wires connected to the alarm I/O, and a 50 ohm coaxial cable connected to the antenna port.

2.3 Testing Algorithm

The TRACER 4205L1 was operated continuously by firmware test sequence that provided a modulated RF data stream to the output port.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The measurement uncertainty of the data contained herein is ±2.3 dB.

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

Total Uncertainty = $(A^2 + B^2 + C^2)^{1/2}/(n-1)$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, total uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2}$ = ±2.3 dB.

3 Test Results

3.1 Peak Power Output

For devices within the scope of FCC §15.247, the peak power conducted from the intentional radiator to the antenna shall not be greater than one watt (30 dBm).

The diode detector substitution method for measuring peak power was used since the spectrum analyzer used for testing does not have a measurement bandwidth greater than the 6dB bandwidth of the EUT.

The output from the transmitter was connected to a diode detector and the output of the diode connected to the input of an oscilloscope. The peak deflection was measured on the oscilloscope and recorded. A signal generator was then substituted in place of EUT and set to the same frequency as the transmitter. The CW output of the signal generator was increased until the same deflection was noted on the oscilloscope. A power meter was then connected to the output of the signal generator to determine the output power produced by the signal generator. This level is then recorded as the output power of the EUT at the specified frequency.

The EUT carrier was modulated during this test.

Table 2. RF Output Power Conducted

RF Channel	Measured Power (dBm)	FCC Limit (dBm)
Channel A: 5747 MHz	18.9	30
Channel B: 5827 MHz	19.7	30

3.2 Power Spectral Density

For Digitally Modulated devices under Part 15.247, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band.

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system. The spectrum analyzer had the following settings:

- 3 kHz RBW
- 10kHz VBW
- 300kHz span
- 100 second sweep time

The carrier was modulated internally via firmware that provided loop-back data to the rear-panel T1 connectors.

Plots of the Power Spectral Density are shown in Figure 1 and Figure 2. Table 3 lists the results of the Power Spectral Density testing.

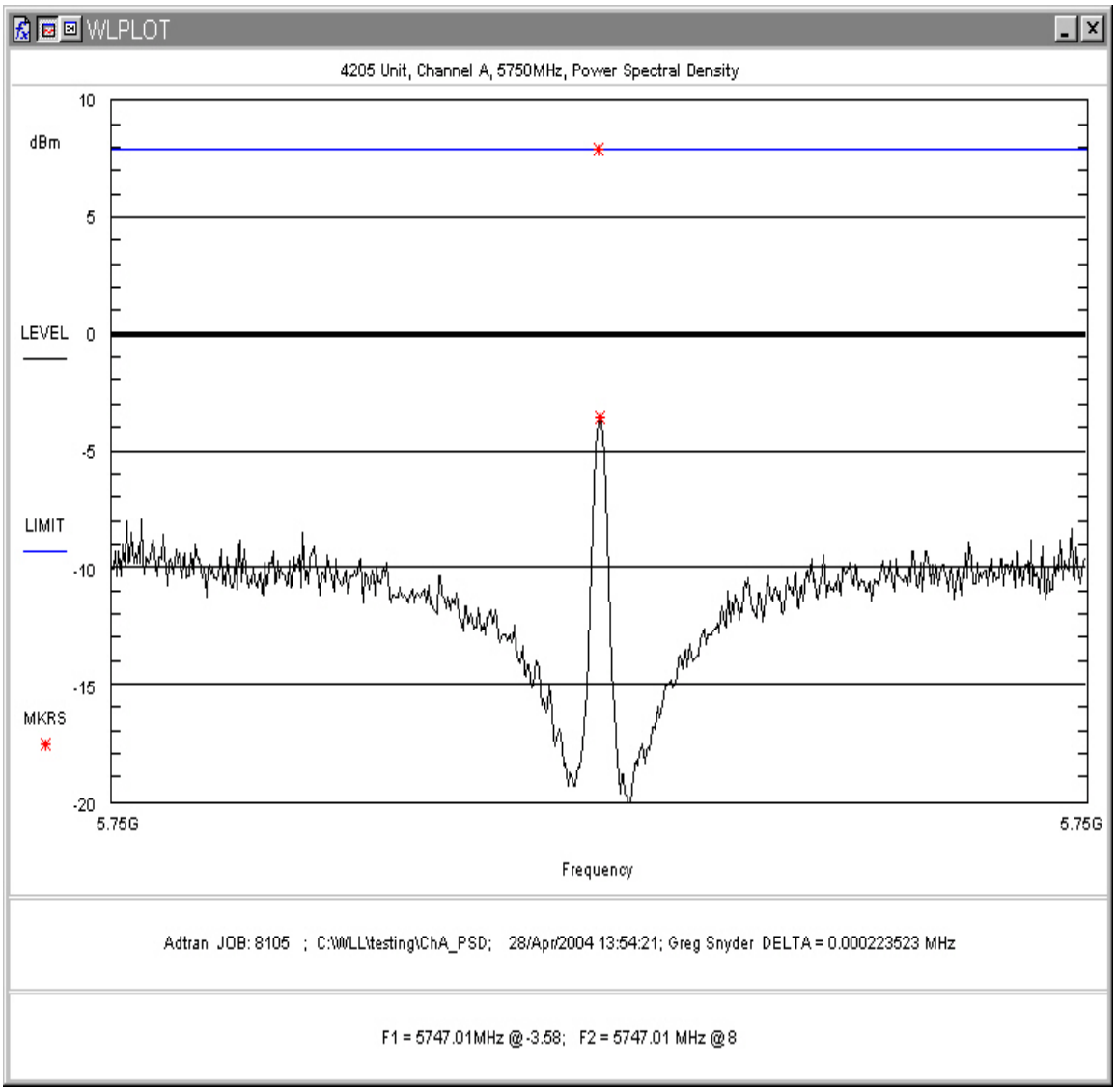

Figure 1: Power Spectral Density, Channel A

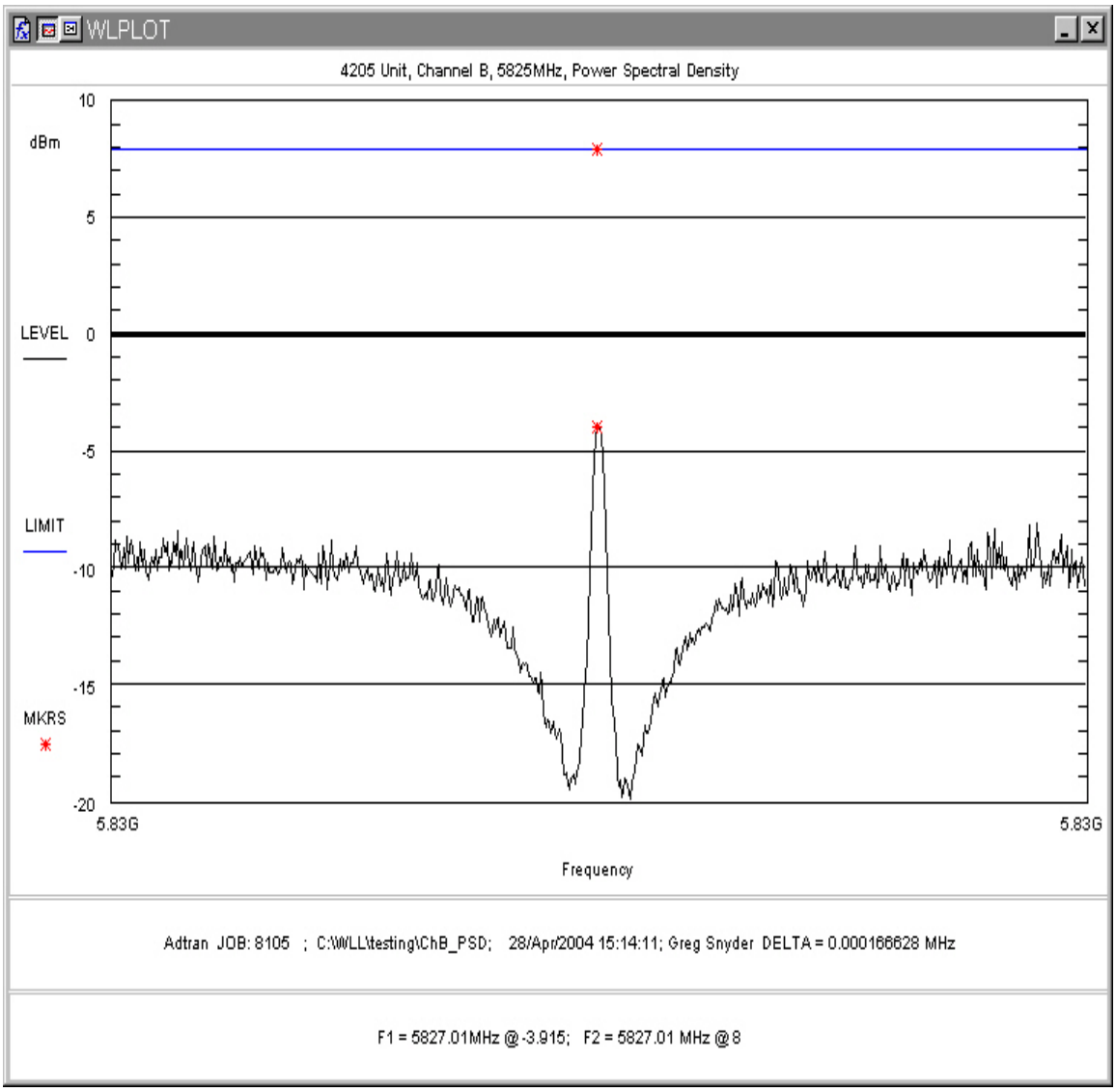

Figure 2: Power Spectral Density, Channel B

Table 3. Power Spectral Density

Frequency	Level (dBm)	Limit (dBm)	Pass/Fail
Channel A 5747 MHz	-3.58	8	Pass
Channel B 5827 MHz	-3.92	8	Pass

3.3 Occupied Bandwidth

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For Digitally Modulated Systems, FCC Part 15.247 requires that the minimum 6 dB bandwidth be at least 500 kHz.

Table 4 provides a summary of the Occupied Bandwidth Results. Figure 3 and Figure 4 are plots of the Occupied Bandwidths.

Table 4. Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Channel A: 5747 MHz	26.5 MHz	> 500 kHz	Pass
Channel B: 5827 MHz	24.3 MHz	> 500 kHz	Pass

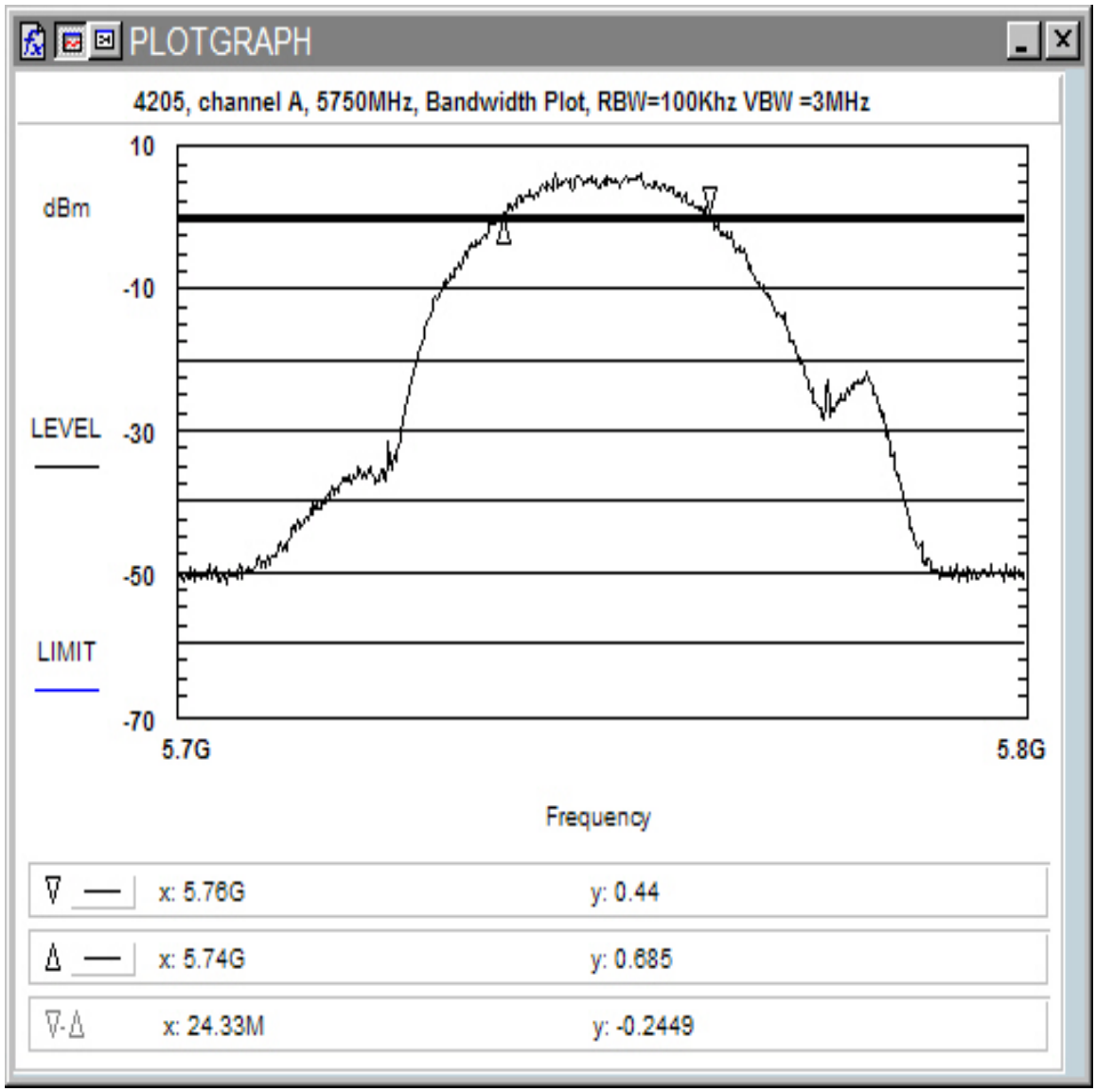

Figure 3. Occupied Bandwidth Channel A

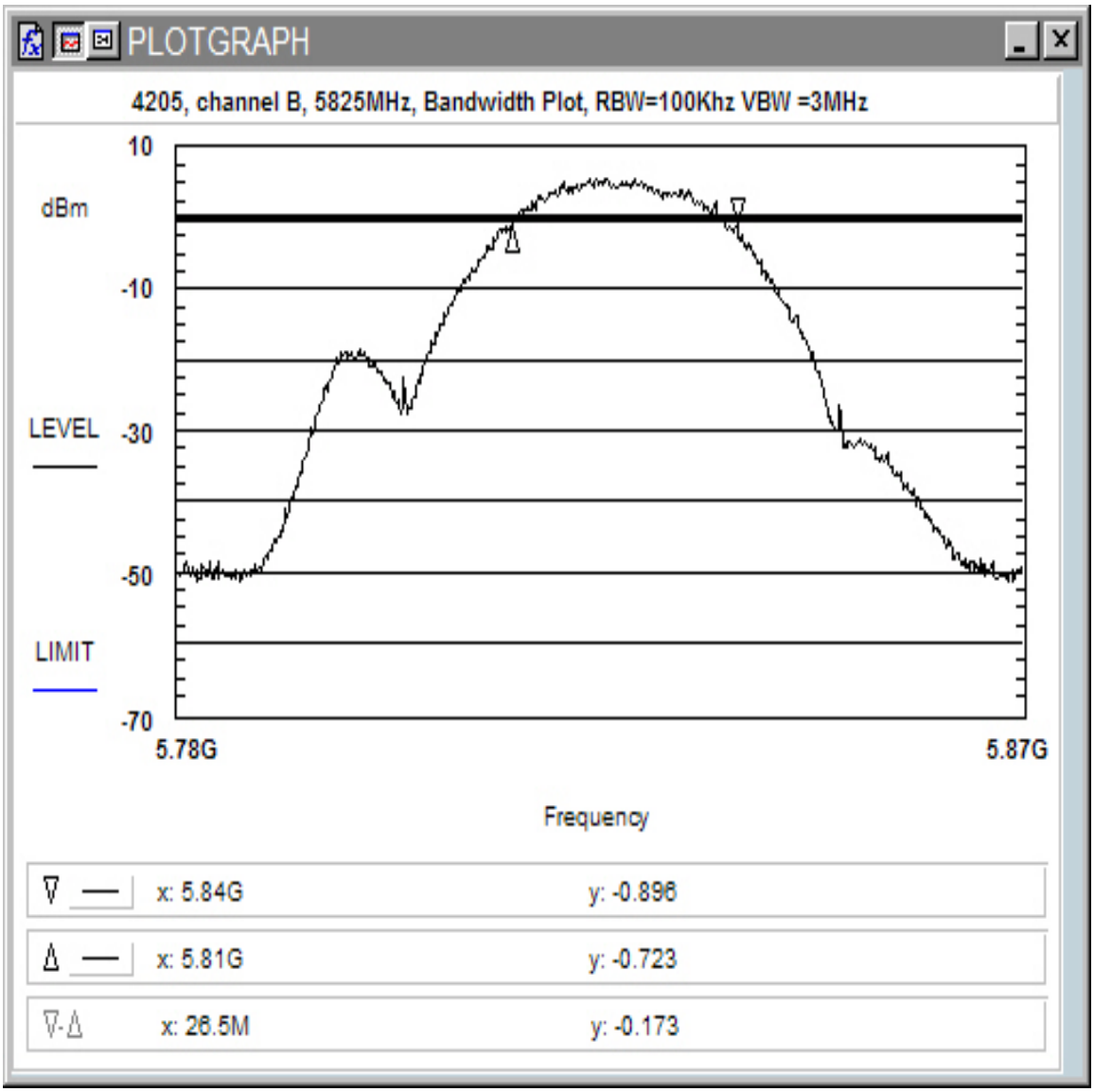

Figure 4. Occupied Bandwidth Channel B

3.4 Spurious Emissions at Antenna Terminals (FCC Part §15.247(b))

In any 100 kHz band outside the frequency band in which the system is operating, the RF power shall be at least 20dB below that in the 100 kHz bandwidth that contain the highest level of the desired power.

Table 5: Conducted Spurious Emissions Limits

Frequency	Highest Power in 100kHz Band (dBm)	Limit (20dBc) (dBm)
Channel A 5747 MHz	7.2	-12.8
Channel B 5827 MHz	5.6	-14.4

Figure 5 through Figure 12 are plots of the conducted spurious emissions as measured at the antenna terminal. Band edge plots are included for Channel A and Channel B as these are the frequencies which fall closest to the frequency band of 15.247.

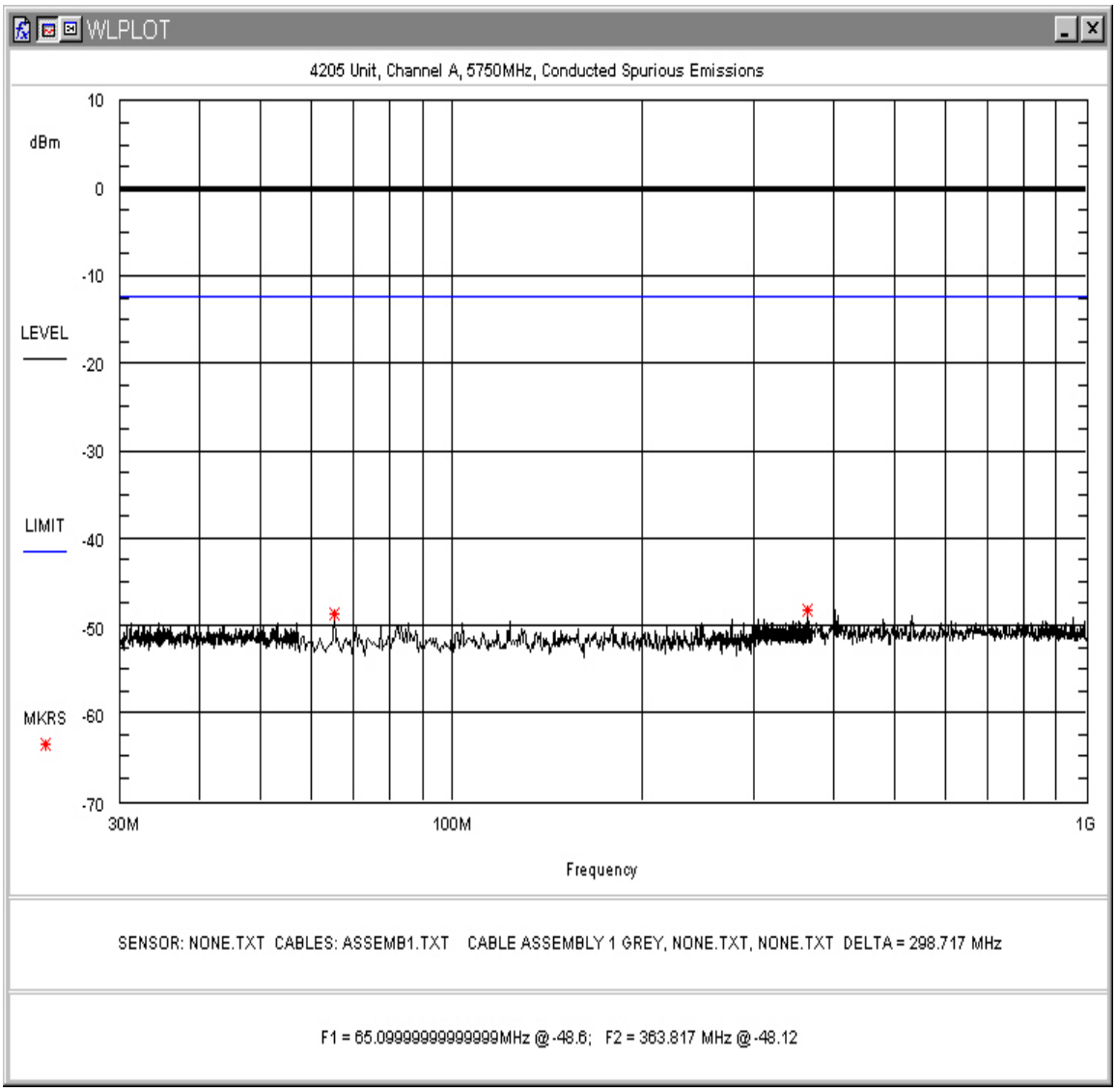

Figure 5. Conducted Spurious Emissions, Channel A, 30M – 1.0GHz

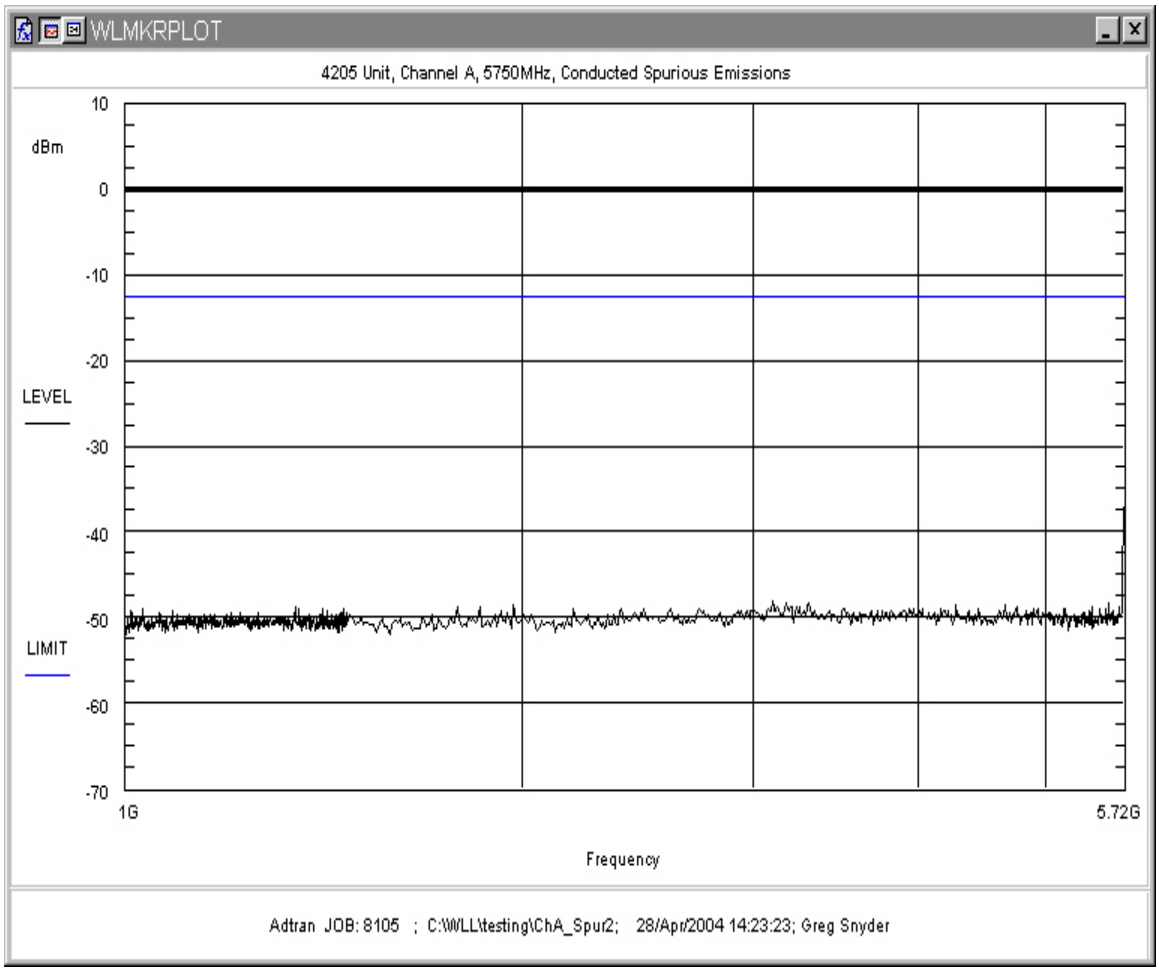

Figure 6. Conducted Spurious Emissions, Channel A, 1GHz – 5.725GHz

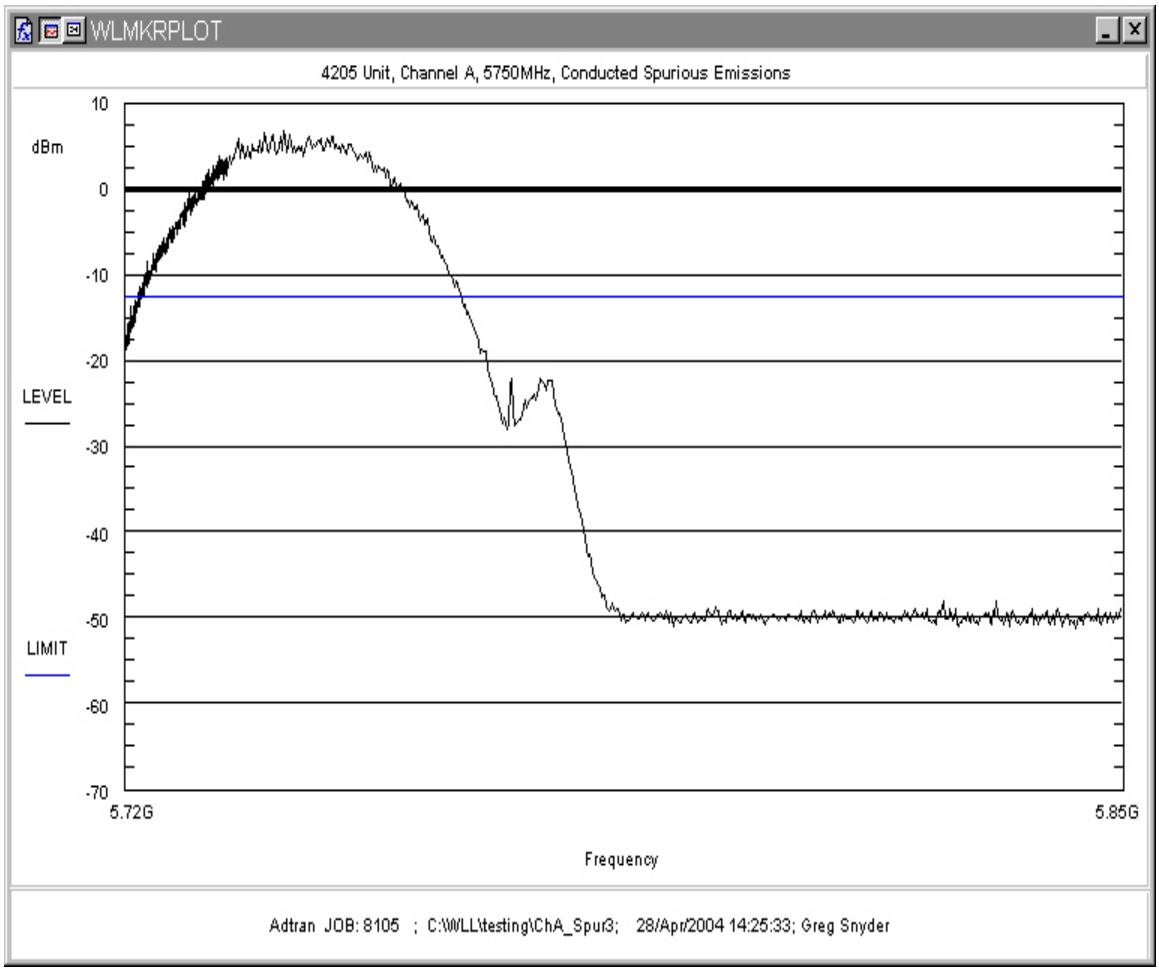

Figure 7. Conducted Spurious Emissions, Channel A, 5.725GHz - 5.85GHz

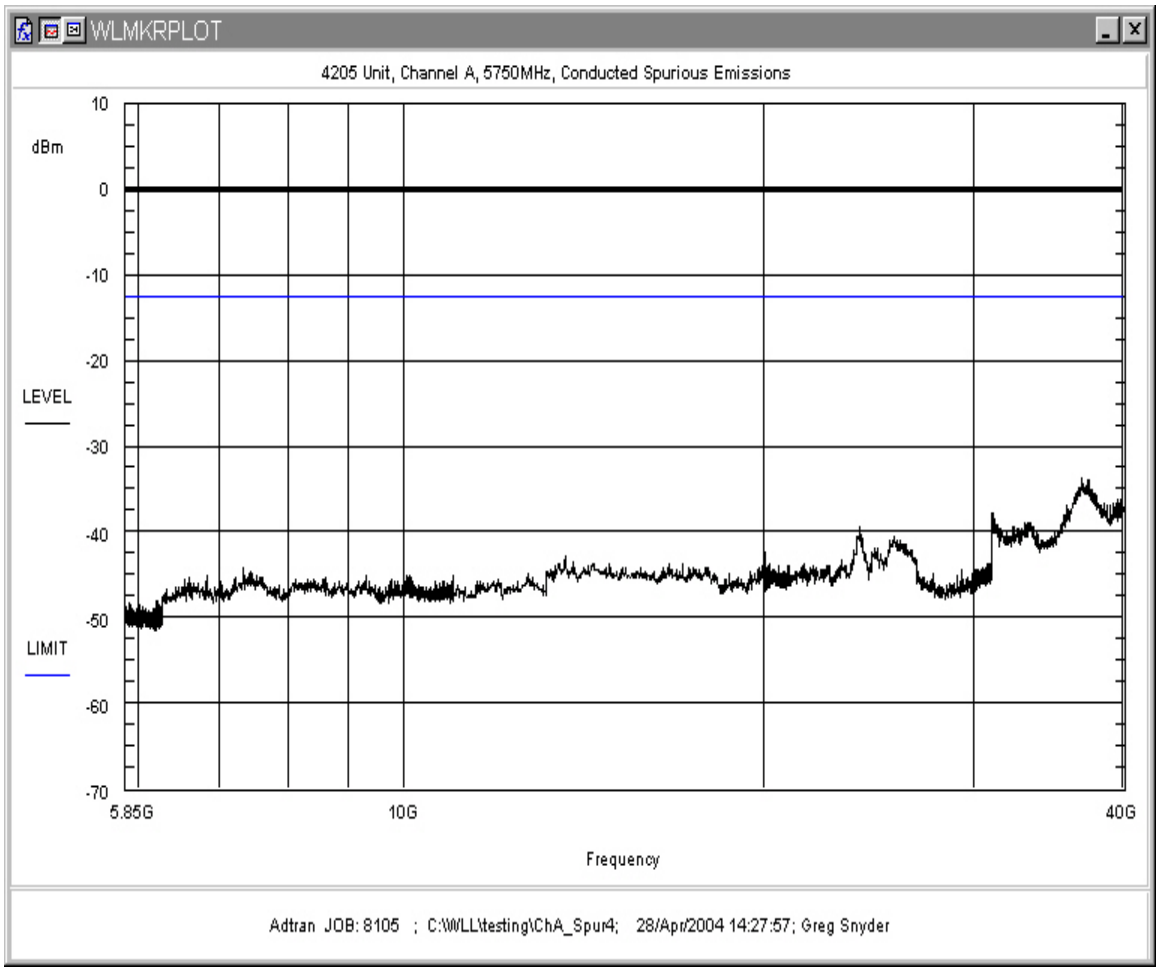

Figure 8. Conducted Spurious Emissions, Channel A, 5.85GHz - 40GHz

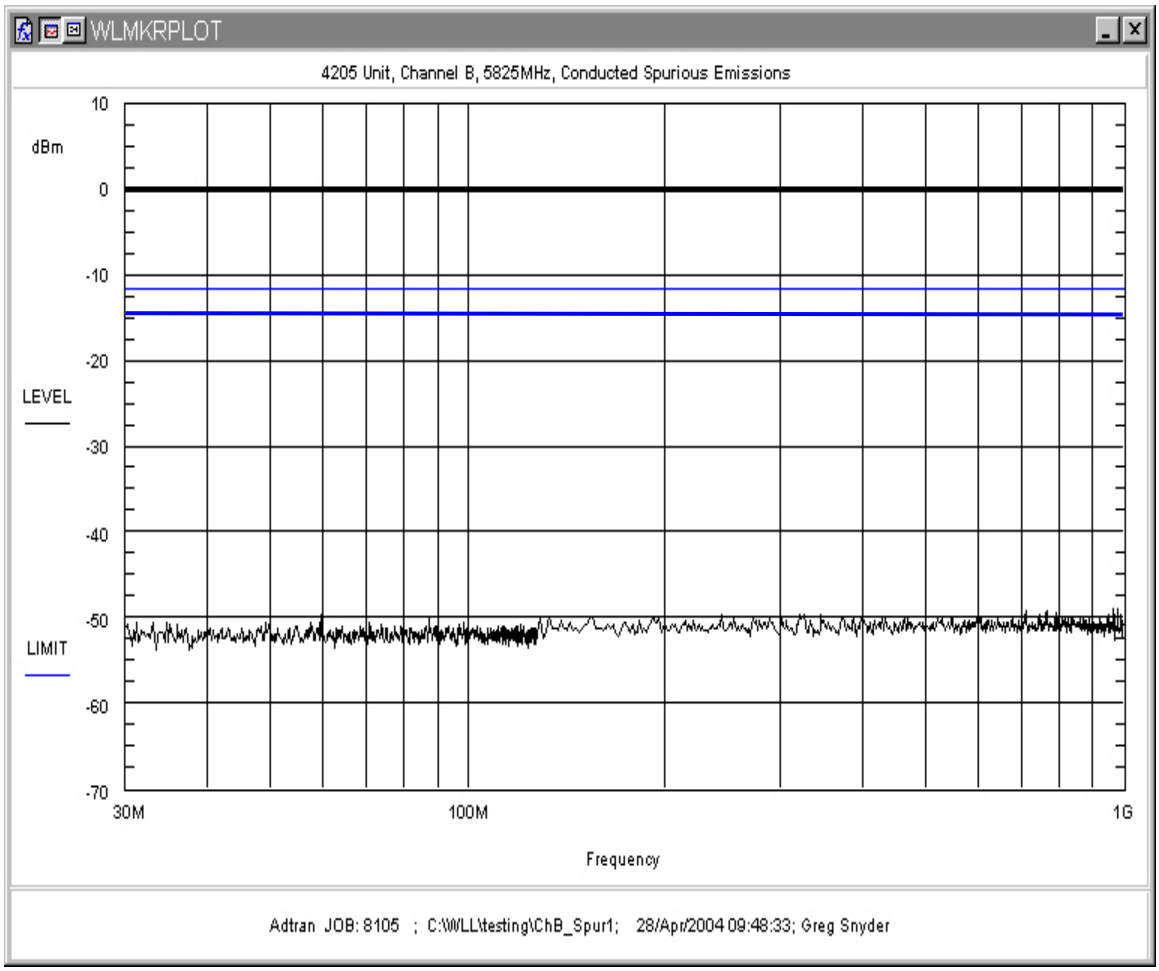

Figure 9. Conducted Spurious Emissions, Channel B, 30MHz – 1GHz

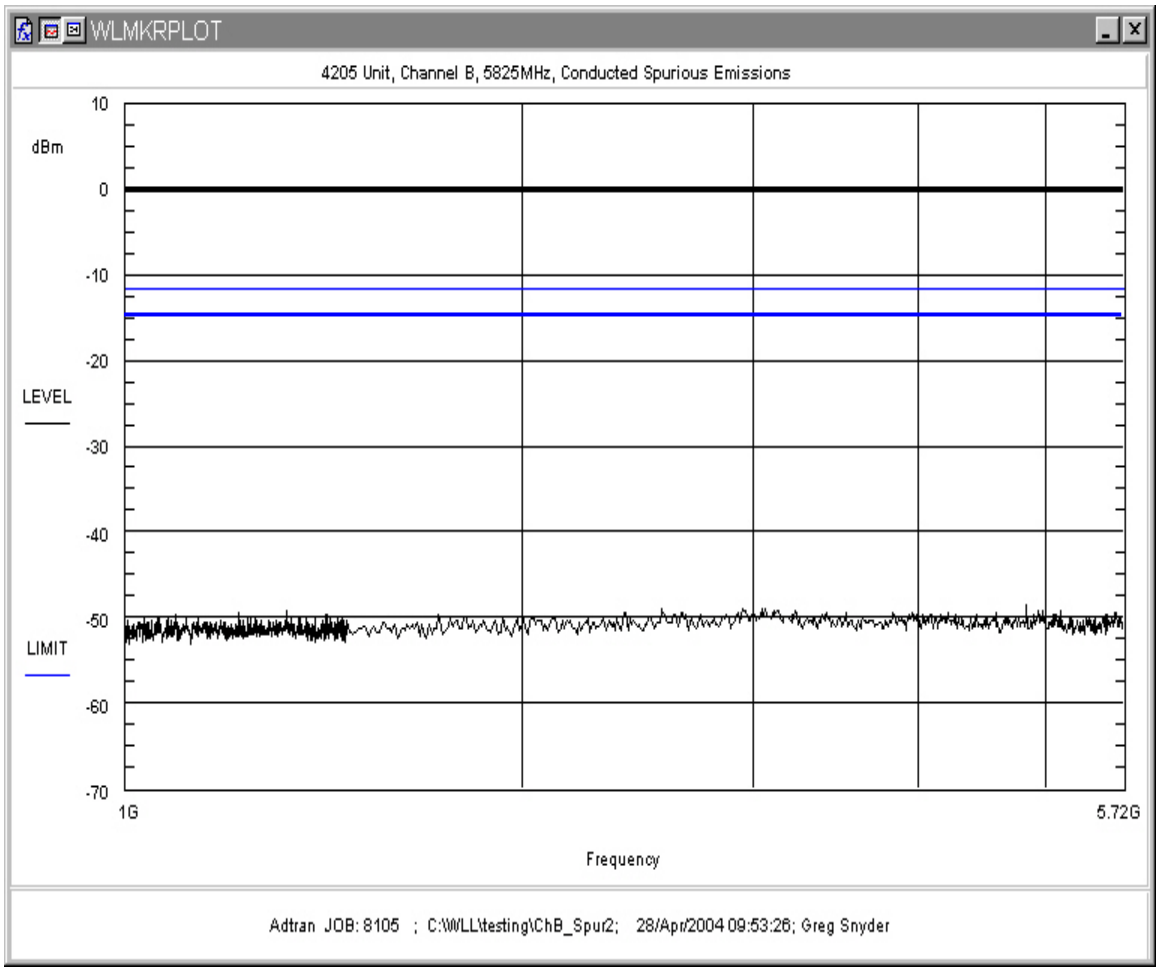

Figure 10. Conducted Spurious Emissions, Channel B, 1GHz – 5.725GHz

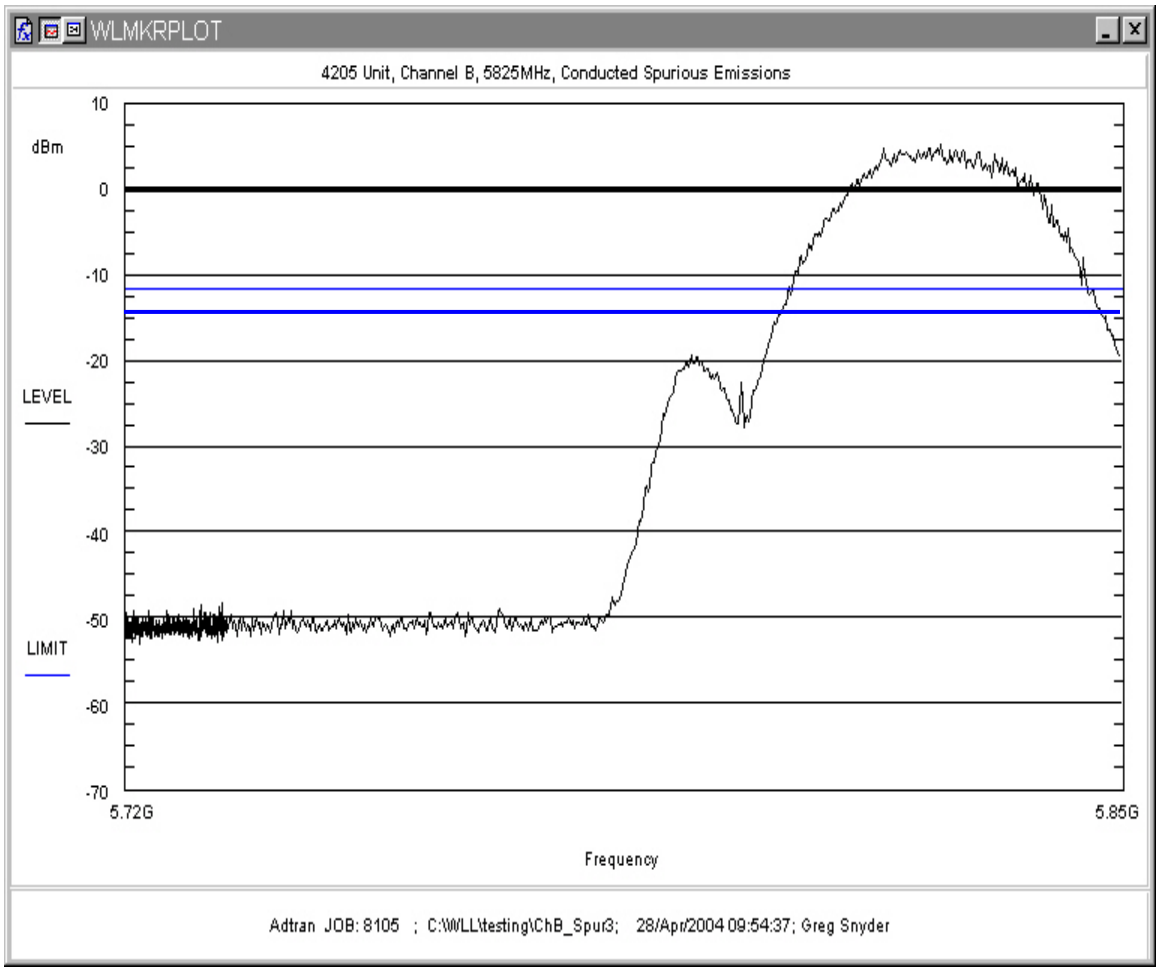

Figure 11. Conducted Spurious Emissions, Channel B, 5.725GHz – 5.85GHz

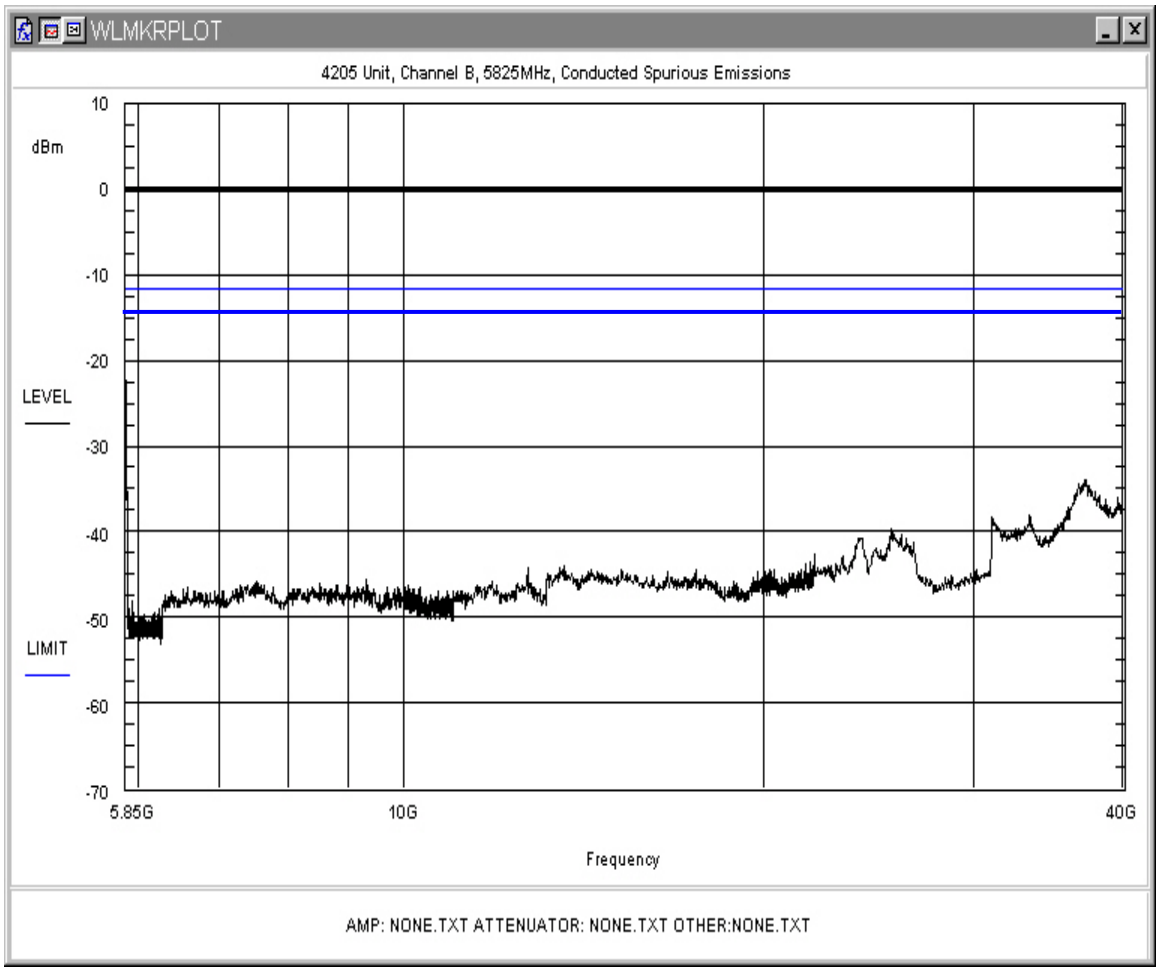

Figure 12. Conducted Spurious Emissions, Channel B, 5.85GHz - 40GHz

3.5 Radiated Spurious Emissions: (FCC Part §15.247(c))

Radiated emissions that fall in the restricted bands must comply with the general emissions limits in 15.209(a).

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>30 kHz
>1000 MHz	1 MHz	10 Hz (1MHz for Peak)

Harmonic and spurious emissions that were identified as coming from the EUT were checked in Peak and in Average Mode. It was verified that the peak-to-average ratio did not exceed 20dB for the restricted bands.

3.5.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Note that measurements were taken at a closer distance above 18 GHz because of sensitivity restrictions on the measurement system.

The EUT was tested in the following configurations and modes:

Antenna	Channel
Dish	A&B

Emissions were scanned up to 40GHz.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level):	V dBμV
Antenna Factor (Ant Corr):	AFdB/m
Cable Loss Correction (Cable Corr):	CCdB
Amplifier Gain:	GdB
Electric Field (Corr Level):	EdBμV/m = VdBμV + AFdB/m + CCdB - GdB
To convert to linear units:	EμV/m = antilog (EdBμV/m/20)

Data are supplied in the following tables. Testing was performed to 40GHz. No emissions were detected above 12GHz. All detected emissions are reported in the following tables. Both peak and average measurements are listed.

Table 6: Radiated Emission Test Data-Dish Antenna—Channel A

CLIENT:	Adtran	DATE:	5/6/2004
TESTER:	James Ritter	JOB #:	8030
EUT Information:		**Test Requirements:**	
EUT:	Tracer 4205	TEST STANDARD:	FCC Part 15
CONFIGURATION:	Transmit Plan A - 5.750GHz	DISTANCE:	3m
CLASS:	B		
Test Equipment/Limit:			
ANTENNA:	A_00425	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE1_HF	AMPLIFIER:	A_00066

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level dBµV	Ant. Corr. dB/m	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level dBµV/m	Corr. Level µV/m	Limit µV/m	Margin dB
AVG.											
1073.90	V	190.0	1.0	41.3	25.5	2.2	36.4	32.7	43.2	500.0	-21.3
1073.90	H	180.0	1.0	41.0	25.5	2.2	36.4	32.4	41.6	500.0	-21.6
1301.40	V	270.0	1.0	40.5	26.7	2.3	36.1	33.4	46.5	500.0	-20.6
1301.40	H	75.0	1.0	43.3	26.7	2.3	36.1	36.2	64.5	500.0	-17.8
2733.74	V	0.0	1.0	36.8	30.4	3.2	35.6	34.7	54.4	500.0	-19.3 **a**
2733.74	H	0.0	1.0	36.8	30.4	3.2	35.6	34.7	54.4	500.0	-19.3 **a**
4100.25	V	0.0	1.0	37.2	31.5	3.9	35.5	37.0	71.2	500.0	-16.9 **a**
4100.25	H	0.0	1.0	37.0	31.5	3.9	35.5	36.9	69.8	500.0	-17.1 **a**
8200.50	V	0.0	1.0	34.8	38.4	5.3	36.1	42.4	132.3	500.0	-11.5 **a**
8200.50	H	0.0	1.0	35.4	38.4	5.3	36.1	43.0	141.3	500.0	-11.0 **a**
11500.00	V	0.0	1.0	35.5	40.9	6.4	35.6	47.1	226.3	500.0	-6.9 **a**
11500.00	H	0.0	1.0	34.2	40.9	6.4	35.6	45.8	194.8	500.0	-8.2 **a**
PEAK											
1073.90	V	190.0	1.0	52.3	25.5	2.2	36.4	43.7	153.3	5000.0	-30.3
1073.90	H	180.0	1.0	53.8	25.5	2.2	36.4	45.2	182.1	5000.0	-28.8
1301.40	V	270.0	1.0	51.5	26.7	2.3	36.1	44.4	165.1	5000.0	-29.6
1301.40	H	75.0	1.0	56.0	26.7	2.3	36.1	48.9	277.2	5000.0	-25.1
2733.74	V	0.0	1.0	48.3	30.4	3.2	35.6	46.2	204.4	5000.0	-27.8 **a**
2733.74	H	0.0	1.0	46.1	30.4	3.2	35.6	44.0	158.1	5000.0	-30.0 **a**
4100.25	V	0.0	1.0	47.0	31.5	3.9	35.5	46.9	220.8	5000.0	-27.1 **a**
4100.25	H	0.0	1.0	47.3	31.5	3.9	35.5	47.2	229.3	5000.0	-26.8 **a**
8200.50	V	0.0	1.0	45.7	38.4	5.3	36.1	53.3	460.8	5000.0	-20.7 **a**
8200.50	H	0.0	1.0	45.9	38.4	5.3	36.1	53.5	473.2	5000.0	-20.5 **a**
11500.00	V	0.0	1.0	46.5	40.9	6.4	35.6	58.1	802.8	5000.0	-15.9 **a**
11500.00	H	0.0	1.0	45.3	40.9	6.4	35.6	56.9	699.2	5000.0	-17.1 **a**

Note: a = ambient. No emissions detected above 11.500GHz.

Table 7: Radiated Emission Test Data-Dish Antenna—Channel B

CLIENT:	Adtran	DATE:	5/6/2004
TESTER:	James Ritter	JOB #:	8030
EUT Information:		**Test Requirements:**	
EUT:	Tracer 4205	TEST STANDARD:	FCC Part 15
CONFIGURATION:	Transmit Plan B-5.825GHz	DISTANCE:	3m
CLASS:	B		
Test Equipment/Limit:			
ANTENNA:	A_00425	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE1_HF	AMPLIFIER:	A_00066

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Height (m)	SA Level dBµV	Ant. Corr. dB/m	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level dBµV/m	Corr. Level µV/m	Limit µV/m	Margin dB
AVG.											
1073.90	H	250.0	1.0	37.7	25.5	2.2	36.4	29.1	28.4	500.0	-24.9
1073.90	V	250.0	1.0	38.7	25.5	2.2	36.4	30.1	31.9	500.0	-23.9
1301.40	H	180.0	1.0	41.3	26.7	2.3	36.1	34.2	51.2	500.0	-19.8
1301.40	V	270.0	1.0	43.5	26.7	2.3	36.1	36.4	65.7	500.0	-17.6
1379.42	H	0.0	1.0	37.7	27.0	2.3	36.0	31.0	35.4	500.0	-23.0
1379.42	V	180.0	1.0	37.8	27.0	2.3	36.0	31.1	36.0	500.0	-22.8
2773.49	H	0.0	1.0	36.1	30.4	3.2	35.7	34.1	50.5	500.0	-19.9 **a**
2773.49	V	0.0	1.0	36.2	30.4	3.2	35.7	34.2	51.0	500.0	-19.8 **a**
8320.50	H	0.0	1.0	31.7	38.5	5.3	36.1	39.4	93.1	500.0	-14.6 **a**
8320.50	V	0.0	1.0	31.9	38.5	5.3	36.1	39.6	95.6	500.0	-14.4 **a**
11650.00	H	0.0	1.0	33.2	41.1	6.4	35.7	45.0	177.1	500.0	-9.0 **a**
11650.00	V	0.0	1.0	33.0	41.1	6.4	35.7	44.8	173.7	500.0	-9.2 **a**
PEAK											
1073.90	H	250.0	1.0	48.1	25.5	2.2	36.4	39.5	94.2	5000.0	-34.5
1073.90	V	250.0	1.0	50.2	25.5	2.2	36.4	41.5	119.5	5000.0	-32.4
1301.40	H	180.0	1.0	55.5	26.7	2.3	36.1	48.4	261.7	5000.0	-25.6
1301.40	V	270.0	1.0	53.5	26.7	2.3	36.1	46.4	207.9	5000.0	-27.6
1379.42	H	0.0	1.0	49.3	27.0	2.3	36.0	42.6	135.4	5000.0	-31.3
1379.42	V	180.0	1.0	49.9	27.0	2.3	36.0	43.2	144.6	5000.0	-30.8
2773.49	H	0.0	1.0	47.3	30.4	3.2	35.7	45.3	183.7	5000.0	-28.7 **a**
2773.49	V	0.0	1.0	47.2	30.4	3.2	35.7	45.2	180.9	5000.0	-28.8 **a**
8320.50	H	0.0	1.0	41.5	38.5	5.3	36.1	49.2	288.8	5000.0	-24.8 **a**
8320.50	V	0.0	1.0	41.6	38.5	5.3	36.1	49.3	292.1	5000.0	-24.7 **a**
11650.00	H	0.0	1.0	44.0	41.1	6.4	35.7	55.8	616.3	5000.0	-18.2 **a**
11650.00	V	0.0	1.0	45.1	41.1	6.4	35.7	56.9	699.5	5000.0	-17.1 **a**

Note: a = ambient. No emissions detected above 11.650GHz.

3.6 AC Powerline Conducted Emissions: (FCC Part §15.207)

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 μH Line Impedance Stabilization Network bonded to a 3 x 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

Data is recorded in Table 8.

Table 8: Conducted Emissions Test Data Sheet

CLIENT:	Adtran	DATE:	5/6/04
TEST STANDARD:	FCC Part 15	MODEL:	Tracer 4205
JOB #:	8030	CLASS:	FCC_B
TESTER:	J. Ritter	Plan B	
TEST VOLTAGE:	120 VAC		

LINE 1 - NEUTRAL

Frequency MHz	Level QP dBuV	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Limit AVG dBuV	Margin AVG dB
0.16	59.3	65.5	-6.2	39.2	55.5	-16.3
0.66	38.8	56.0	-17.2	38.8	46.0	-7.2
1.93	37.6	56.0	-18.4	37.6	46.0	-8.4
2.68	38.2	56.0	-17.8	38.2	46.0	-7.8
17.11	38.6	60.0	-21.4	38.6	50.0	-11.4
26.25	31.8	60.0	-28.2	31.8	50.0	-18.2

LINE 2 - PHASE

Frequency MHz	Level QP dBuV	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Limit AVG dBuV	Margin AVG dB
0.16	59.3	65.5	-6.2	40.1	55.5	-15.4
0.66	38.5	56.0	-17.5	38.5	46.0	-7.5
1.93	38.1	56.0	-17.9	38.1	46.0	-7.9
2.68	37.8	56.0	-18.2	37.8	46.0	-8.2
17.11	37.9	60.0	-22.1	37.9	50.0	-12.1
26.25	32.5	60.0	-27.5	32.5	50.0	-17.5

4 Test Equipment

Table 9 shows a list of the test equipment used for measurements along with the calibration information.

Table 9: Test Equipment List

Manufacturer	Model/Type	Function	Identification	Cal. Due
HP	8568B	Spectrum Analyzer	2634A02888	7/07/04
HP	85650A	Quasi-Peak Adapter	3303A01786	7/08/04
HP	HP 8593A	Spectrum Analyzer	3009A00739	6/25/04
HP	8449B	Microwave Preamp	3008A00385	9/29/05
Solar	8012-50-R-24BNC	LISN	8379493	6/30/04
Narda	V638	Horn Antenna	210	7/22/04
ARA	LPB-2520	BiconiLog Antenna	1044	6/20/04
ARA	DRG118/A	Microwave Horn Antenna	1236	4/17/04
HP	85685A	RF Preselector	3221A01395	7/07/04
Tektronix	TDS 220	Oscilloscope	00333	8/18/04
HP	8672A	Generator	00080	3/25/05
Agilent	8474B	Diode Detector	00416	12/19/04
HP	438A	Power Meter	00394	3/10/05