FCC Certification Test Report

FCC Certification Test Report

for

ADTRAN, Inc.

Direct Sequence Spread Spectrum Transceiver

FCC ID: HDCTRC4203

October 16, 2001

Prepared for:

ADTRAN, Inc.
901 Explorer Blvd
Huntsville, AL 35806

Prepared By:

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

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for the
ADTRAN, Inc.
TRACER 4203
Direct Sequence Spread Spectrum Transceiver

WLL JOB# 6794

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President

Reviewed by: Greg Snyder
Chief EMC Engineer

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 Spread Spectrum Transceiver 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 4203 Direct Sequence Spread Spectrum 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 4203 Spread Spectrum Transceiver complies with the limits for a Spread Spectrum Transceiver device under Part 15.247 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The ADTRAN, Inc. TRACER 4203 Spread Spectrum System complies with the limits for a Spread Spectrum Transceiver 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 1992 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:	59480

1.4 Test Dates

Testing was performed from September 25 to September 26, 2001.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Mike Violette
Customer Representative	Derek Foster

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
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 Tracer provides dual T1 transport via a spread spectrum microwave link for distances over 20 miles. System performance is determined, in part, by the engineering of the microwave link. Each end of a Tracer link is comprised of the baseband processor and the radio frequency converter (RFC). The DS-1 (T1) interfaces are provided on the rear of the Tracer 4203, which is mounted in a nineteen-inch rack. The DS-1 interface provides connections up to 6000 feet from T1 equipment.

A single coaxial cable connects the Tracer 4203 to the antenna.

The Tracer 4203 operates in the 5725-5850 MHz band using direct sequence spread spectrum transmission.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	ADTRAN, Inc.
FCC ID Number	HDCTRC4203
EUT Name:	Spread Spectrum Transceiver
Model:	TRACER 4203
FCC Rule Parts:	§15.247
Frequency Range:	5747 & 5827 MHz
Maximum Output Power:	20 dBm
Modulation:	Direct Sequence Spread Spectrum
Necessary Bandwidth:	N/A
Keying:	Automatic
Type of Information:	Data
Number of Channels:	2
Power Output Level	Fixed
Antenna Type	28.5 dBi Dish
Frequency Tolerance:	N/A
Emission Type(s):	N/A
Power Source & Voltage:	21 to 60 Vdc

The TRACER 4203 contains the sources in Table 2.

Table 2. Oscillators

FREQUENCY (MHz)	DESCRIPTION
50.432	U27 on PCB 2280017-1
50.432	U4 on PCB 2280017-1
12	U35 on PCB 2280018-2
5467	TX LO Plan A on PCB 2280018-2
5687	RX LO Plan A on PCB 2280018-2
5547	TX LO Plan B on PCB 2280018-2
5607	RX LO Plan B on PCB 2280018-2
5747	TX frequency Plan A
5827	RX frequency Plan B
280	TX & RX IF modulation and demodulation oscillator

2.2 Test Configuration

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.

The EUT firmware was set up to provide continuous random data for Direct Sequence modulation to the output connector.

Two channels are available: “A” and “B”. The channels were changed by swapping an internal cable on the transmit module.

2.3 Testing Algorithm

The TRACER 4203 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

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

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 DSSS devices, the peak output power from the intentional radiator to the antenna shall not be greater than 1 watt.

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

The peak power measured:

Channel A: 20.2dBm

Channel B: 19.9dBm

3.2 Power Spectral Density

For DSSS devices, 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 carrier was modulated internally via firmware that provided loop-back data to the rear-panel T1 connectors.

Table 3. Power Spectral Density

Frequency	Level	Limit	Pass/Fail
Channel A 5747 MHz	-6.63 dBm	8 dBm	Pass
Channel B 5827 MHz	-7.8 dBm	8 dBm	Pass

3.3 Occupied Bandwidth

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

For Direct Sequence Spread Spectrum Systems, FCC Part 15.247 requires that the minimum 6 dB bandwidth be at least 500 kHz.

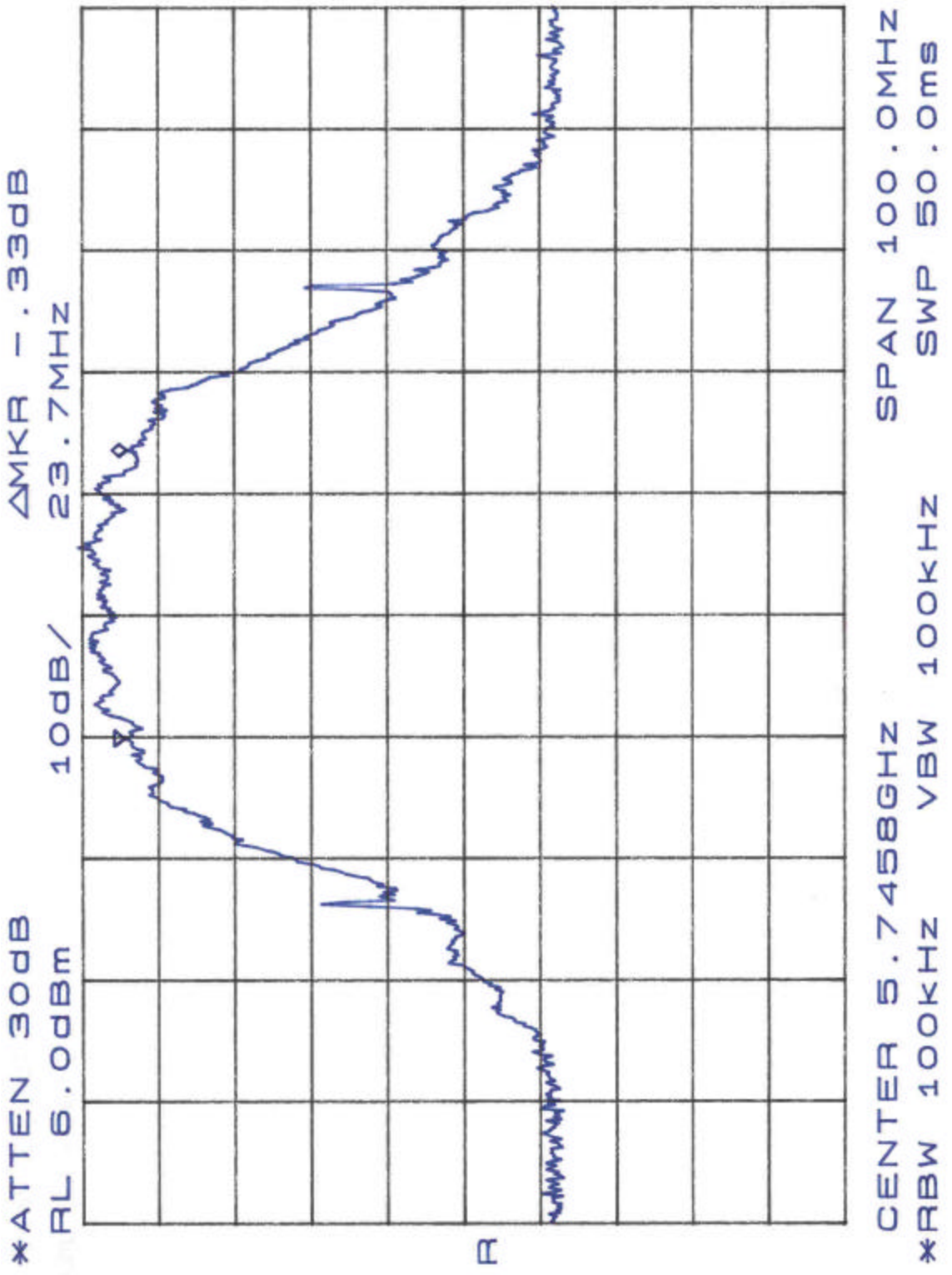

Figure 1. Occupied Bandwidth Channel A

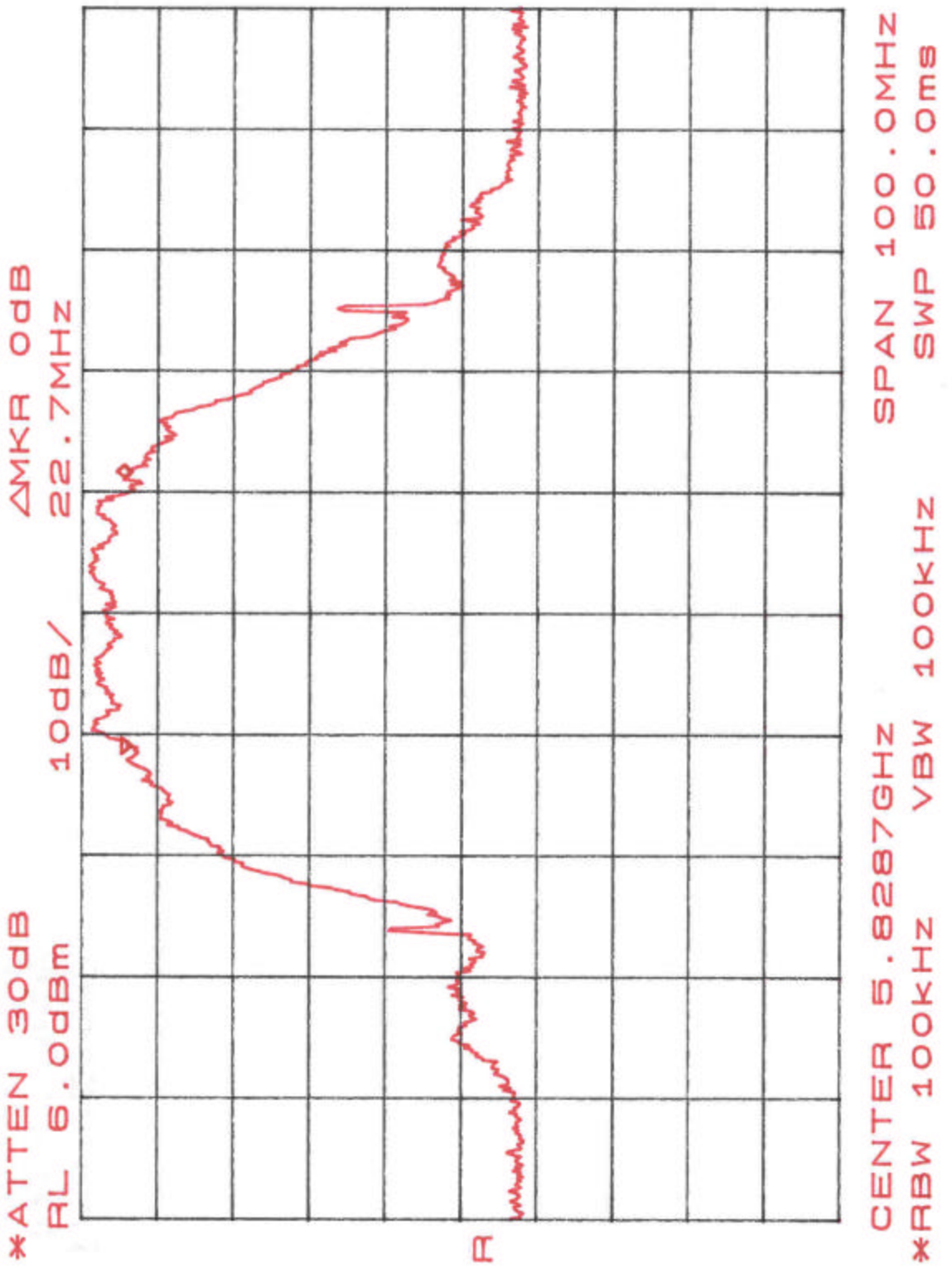

Figure 2. Occupied Bandwidth Channel B

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4. Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Channel A 5747 MHz	23.7 MHz	> 500 kHz	Pass
Channel B 5827 MHz	22.7 MHz	> 500 kHz	Pass

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.

See the plots of conducted emissions plots below.

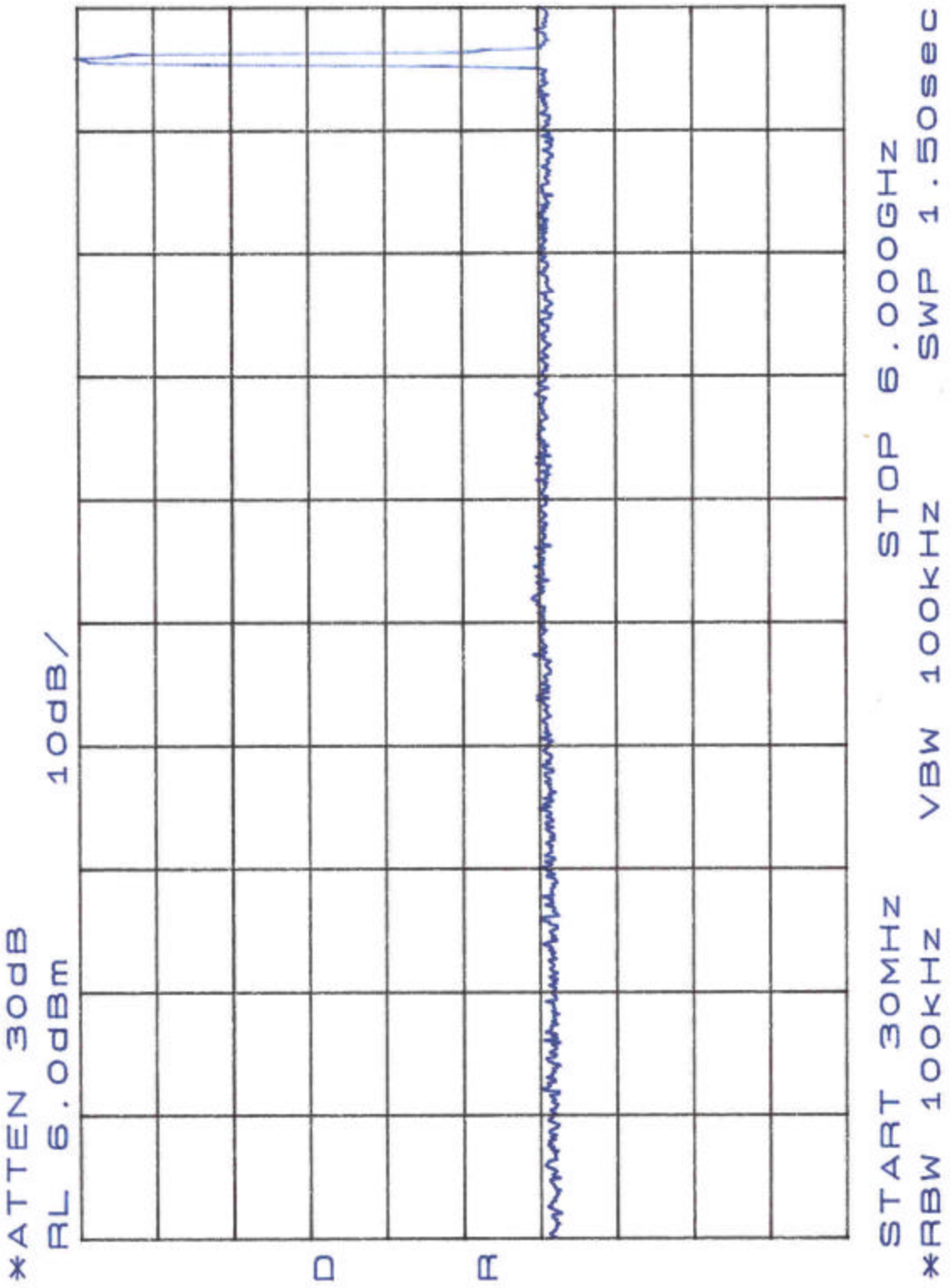

Figure 3. Conducted Spurious Emissions, Channel A, 30M – 6.0GHz

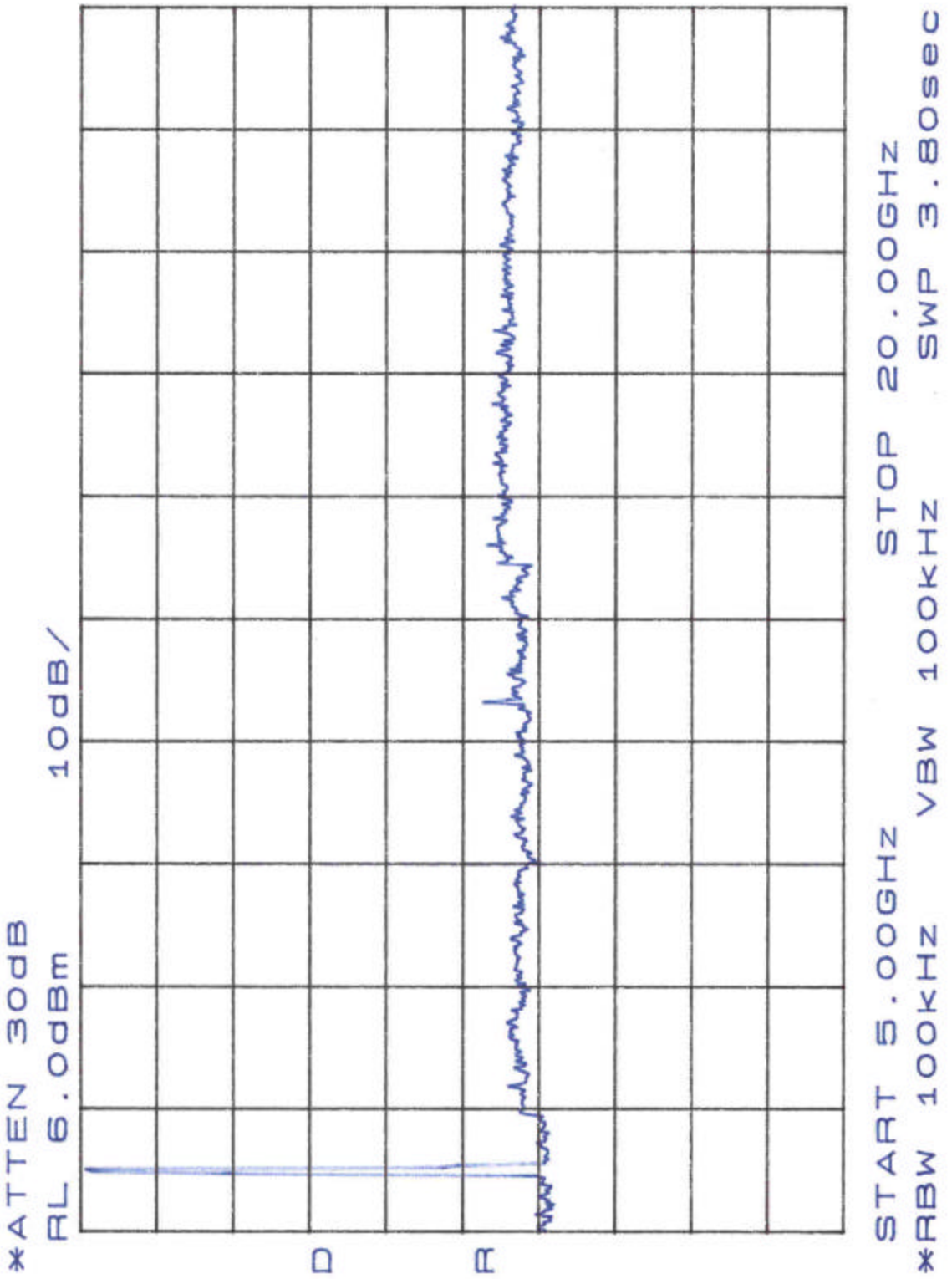

Figure 4. Conducted Spurious Emissions, Channel A, 5GHz 20GHz

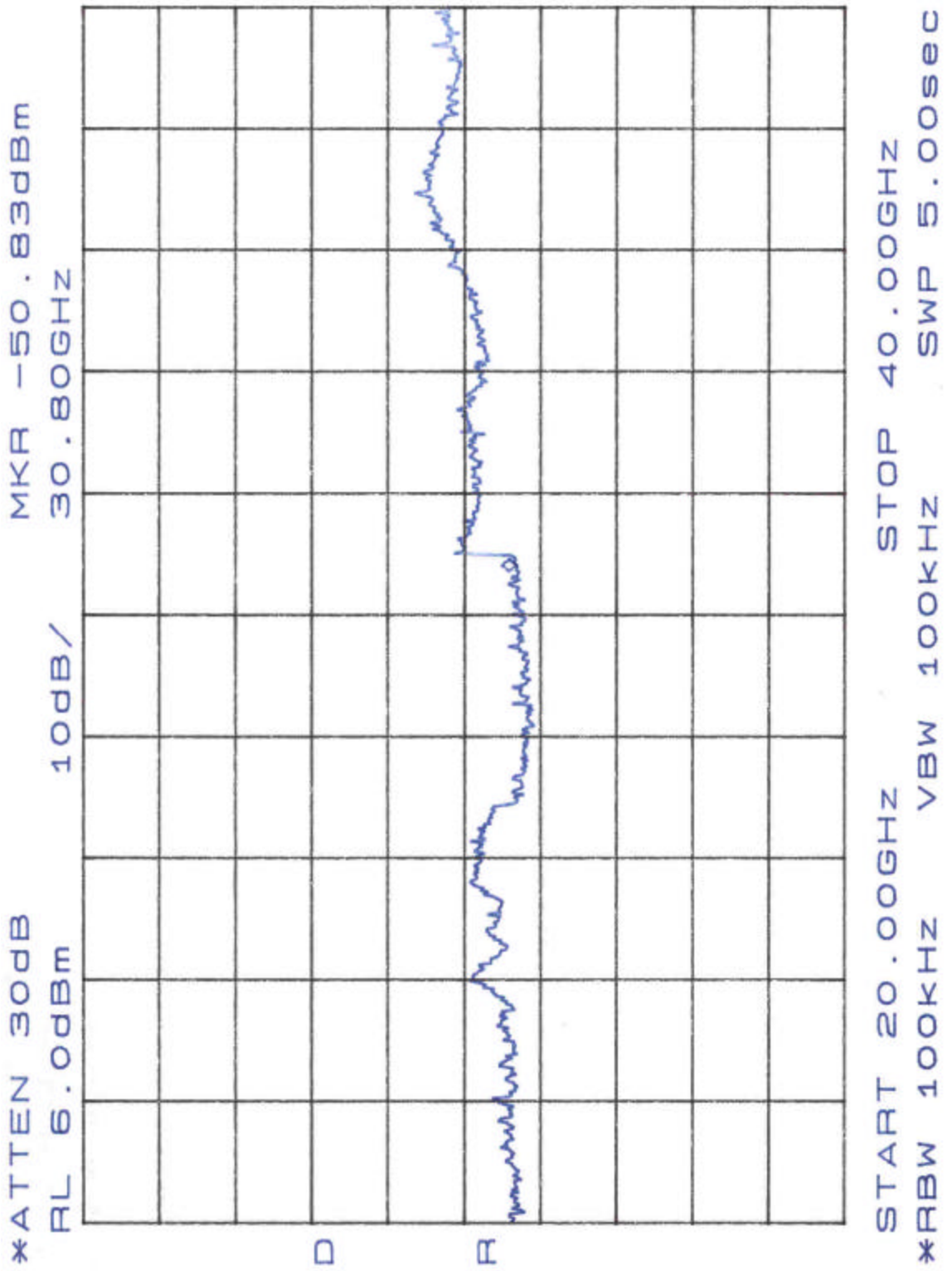

Figure 5. Conducted Spurious Emissions, Channel A, 20GHz - 40GHz

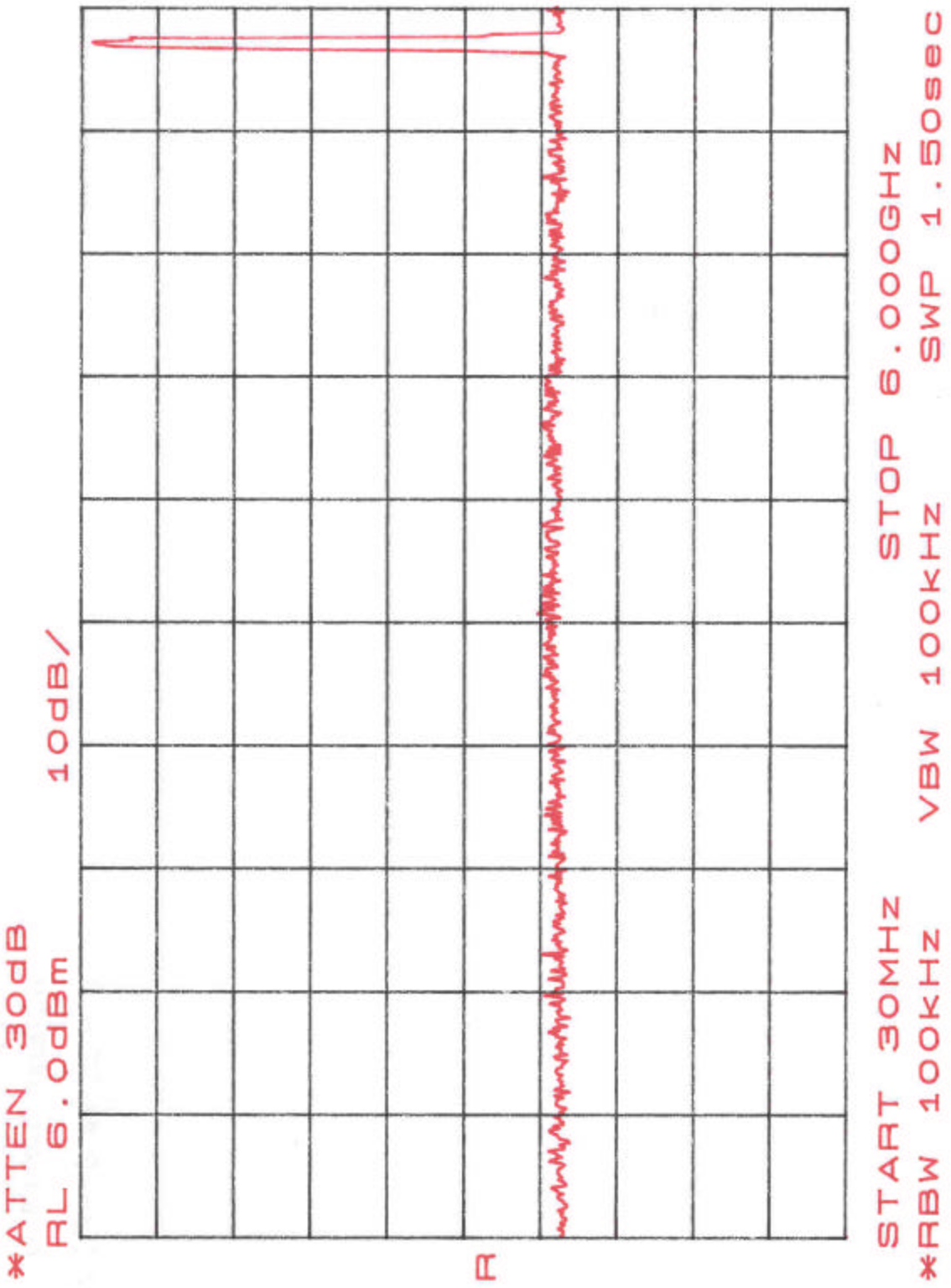

Figure 6. Conducted Spurious Emissions, Channel B, 30MHz – 6.0GHz

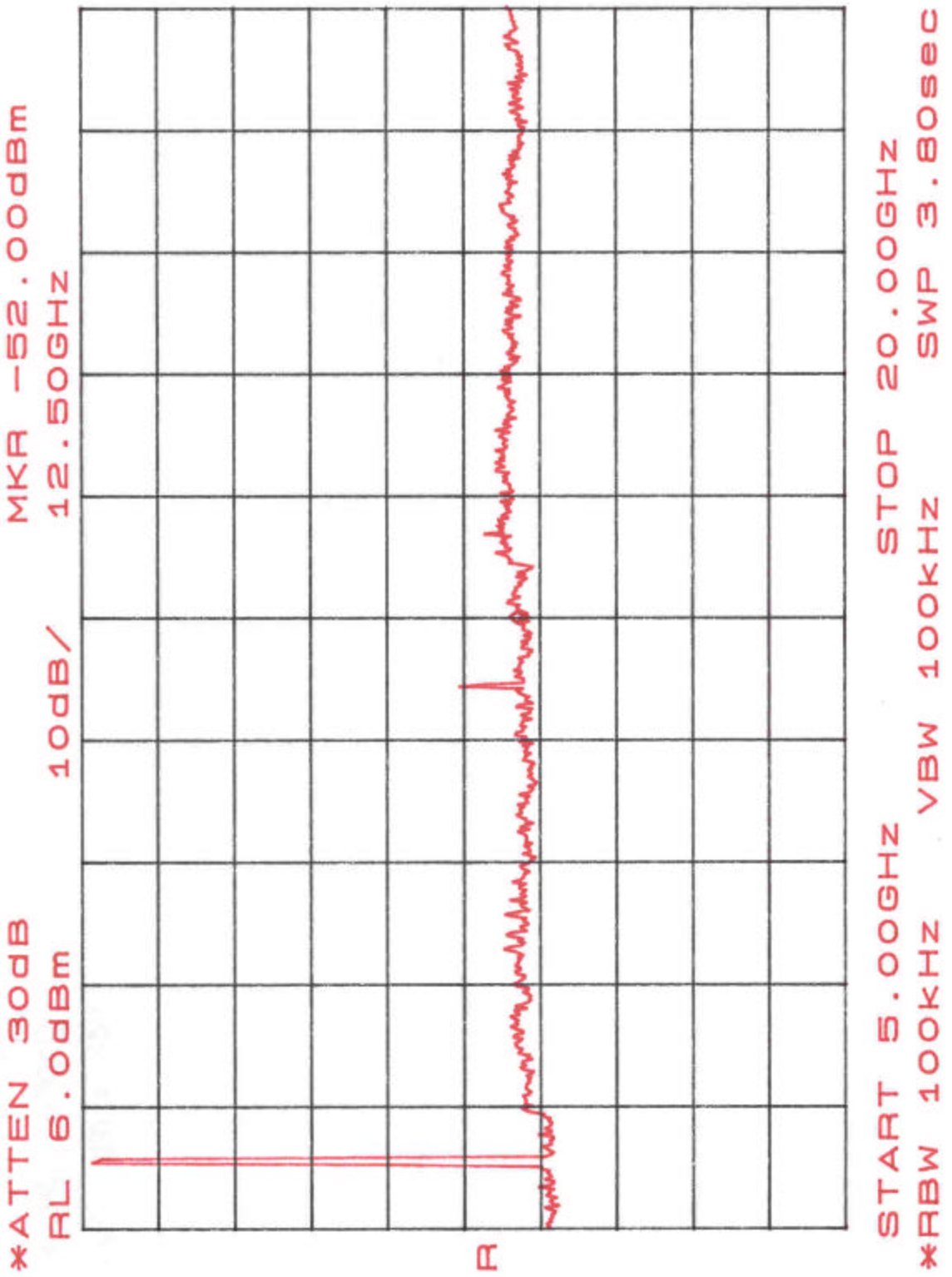

Figure 7. Conducted Spurious Emissions, Channel B, 5GHz - 20GHz

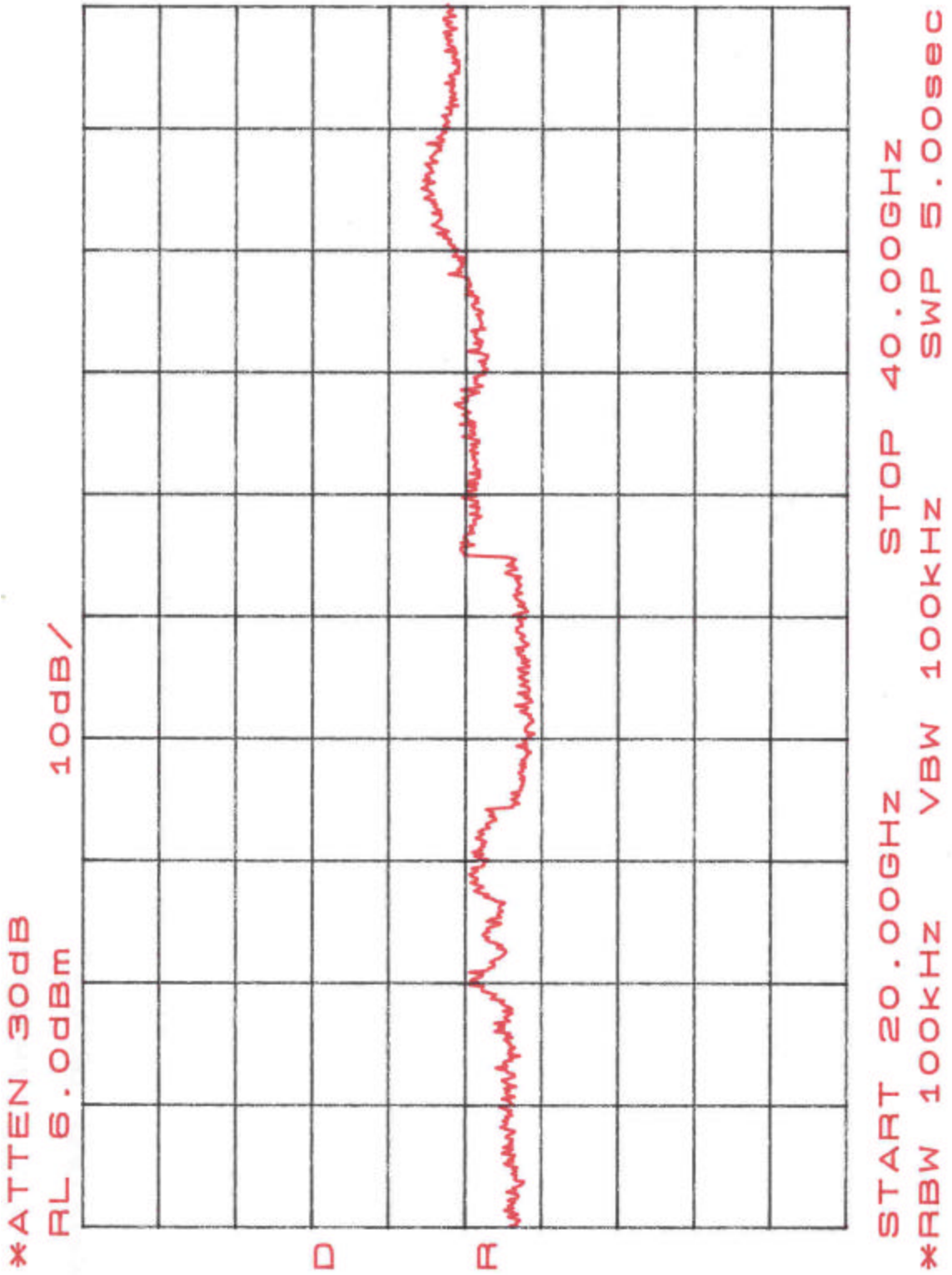

Figure 8. Conducted Spurious Emissions, Channel B, 20GHz - 40GHz

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	<30 Hz

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.

Emissions were measured to the 10^{th} harmonic of the transmit frequency.

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 C63.4-1992. 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

These data are supplied in the following tables.

Table 5: Radiated Emission Test Data-Dish Antenna—Channel A

CLIENT: ADTRAN, Inc
MODEL NO: Tracer 4203
DATE: 25-Sep-01
BY: Mike Violette
JOB #: 6794
Tx Frequency: 5.7458 GHz
Channel: A
Antenna: Dish Antenna; Gain: 28.5 dBi

Frequency MHz	Polarity H/V	Azimuth Degree	Antenna Height m	SA Level (QP) dBuV	Afc dB/m	E-Field dBuV/m	E-Field uV/m	Limit uV/m	Margin dB	
11519.00	V	0	1.0	51.5	5.0	56.5	671.4	5000.0	-17.4	PEAK
11519.00	H	0	1.0	52.8	5.0	57.8	779.8	5000.0	-16.1	PEAK

Average Measurements Above 1 GHz (Restricted Bands)

Frequency MHz	Polarity H/V	Azimuth Degree	Antenna Height m	SA Level (AVG) dBuV	Afc dB/m	E-Field dBuV/m	E-Field uV/m	Limit uV/m	Margin dB	
@3 meter										
11519.00	H	0	1.0	43.5	5.0	48.5	267.3	500.0	-5.4	
13325.00	H	0	1.0	37.5	6.7	44.2	162.5	500.0	-9.8	AMB
14485.00	H	0	1.0	38.0	6.6	44.6	169.6	500.0	-9.4	AMB
17800.00	H	0	1.0	37.0	12.6	49.6	301.8	500.0	-4.4	AMB
@1 meter										
22985.00	H	0	1.0	24.5	36.0	60.5	1059.3	1500.0	-3.0	AMB
@0.5 meter										
31500.00	H	0	1.0	26.5	37.0	63.5	1496.2	3000.0	-6.0	AMB
36449.00	H	0	1.0	30.0	37.5	67.5	2371.4	3000.0	-2.0	AMB
@3 meter										
11519.00	V	0	1.0	41.5	5.0	46.5	212.3	500.0	-7.4	
13325.00	V	0	1.0	37.3	6.7	44.0	158.8	500.0	-10.0	AMB
14485.00	V	0	1.0	38.2	6.6	44.8	173.6	500.0	-9.2	AMB
17800.00	V	0	1.0	37.8	12.6	50.4	330.9	500.0	-3.6	AMB
@1 meter										
22985.00	V	0	1.0	24.3	36.0	60.3	1035.1	1500.0	-3.2	AMB
@0.5 meter										
31500.00	V	0	1.0	26.4	37.0	63.4	1479.1	3000.0	-6.1	AMB
36449.00	V	0	1.0	30.2	37.5	67.7	2426.6	3000.0	-1.8	AMB

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

CLIENT: ADTRAN, Inc
MODEL NO: Tracer 4203
DATE: 25-Sep-01
BY: Mike Violette
JOB #: 6794
Tx Frequency: 5.7458 GHz
Channel: A Antenna: Dish Antenna; Gain: 28.5 dBi

Frequency MHz	Polarity H/V	Azimuth Degree	Antenna Height m	SA Level (QP) dBuV	Afc dB/m	E-Field dBuV/m	E-Field uV/m	Limit uV/m	Margin dB	
11654.00	V	0	1.0	54.7	5.2	59.9	985.6	5000.0	-14.1	PEAK
11654.00	H	0	1.0	49.8	5.2	55.0	560.7	5000.0	-19.0	PEAK

Average Measurements Above 1 GHz (Restricted Bands)

Frequency MHz	Polarity H/V	Azimuth Degree	Antenna Height m	SA Level (AVG) dBuV	Afc dB/m	E-Field dBuV/m	E-Field UV/m	Limit uV/m	Margin dB	
@3 meters										
11654.00	H	0	1.0	41.7	5.2	46.9	220.7	500.0	-7.1	
13325.00	H	0	1.0	35.5	6.7	42.2	129.1	500.0	-11.8	AMB
14485.00	H	0	1.0	38.3	6.6	44.9	175.6	500.0	-9.1	AMB
17800.00	H	0	1.0	38.0	12.6	50.6	338.6	500.0	-3.4	AMB
@ 1 meter										
22118.00	H	0	1.0	22.2	36.0	58.2	812.8	1500.0	-5.3	AMB
@ 0.5 meter										
31500.00	H	0	1.0	27.3	37.0	64.3	1640.6	3000.0	-5.2	AMB
36449.00	H	0	1.0	30.3	37.5	67.8	2454.7	3000.0	-1.7	AMB
@ 3 meters										
11654.00	V	0	1.0	47.6	5.2	52.8	435.2	500.0	-1.2	
13325.00	V	0	1.0	38.3	6.7	45.0	178.2	500.0	-9.0	AMB
14485.00	V	0	1.0	38.0	6.6	44.6	169.6	500.0	-9.4	AMB
17800.00	V	0	1.0	37.7	12.6	50.3	327.1	500.0	-3.7	AMB
22118.00	V	0	1.0	22.2	36.0	58.2	812.8	1500.0	-5.3	AMB
@ 0.5 meter										
31500.00	V	0	1.0	27.3	37.0	64.3	1640.6	3000.0	-5.2	AMB
36449.00	V	0	1.0	30.2	37.5	67.7	2426.6	3000.0	-1.8	AMB

4 Test Equipment

Table 7 shows a list of the test equipment used for measurements along with the calibration information.

Table 7: Test Equipment List

Manufacturer & Model	Description	Serial Number	Property Number	Date Calibrated	Calibration Due Date
Antenna Research Associates DRG-118/A	Horn Antenna	1010	00004	10/10/99	10/10/01
Antenna Research Associates LPB-2520	Biconilog Antenna	1044	00007	6/13/01	6/13/02
Hewlett Packard 11970W	Harmonic Mixer	2521A01455	00055	8/27/98	8/27/03
Hewlett Packard 11970U	Harmonic Mixer	3003A01626	00083	7/30/98	7/30/03
Hewlett Packard 11970V Harmonic Mixer	Harmonic Mixer	2521A01269	00054	9/10/98	9/10/03
Hewlett Packard 8449B	Pre-Amplifier	3008A00729	00066	12/7/00	12/7/01
Hewlett Packard 8564E	Spectrum Analyzer	3643A00657	00067	4/11/01	4/11/02
Hewlett Packard 85650A	Q.P. Adapter	2811A01283	00068	6/29/01	6/29/02
Hewlett Packard 85685A	RF Preselector	3221A01395	00071	6/28/01	6/28/02
Hewlett Packard 8568B	Spectrum Analyzer	2928A04750	00072	6/29/01	6/29/02