FCC Certification Test Report

FCC Certification Test Report
for
Adtran, Inc.
HDCTRC4106

January 16, 2003

Prepared for:

Adtran, Inc.
901 Explorer Blvd
Huntsville, AL 35806

Prepared By:

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FCC Certification Test Report
for the
Adtran, Inc.
TRACER 4106 DSSS
HDCTRC4106

WLL JOB# 7327

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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 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 a Adtran, Inc. TRACER 4106.

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 4106 DSSS complies with the limits for a Spread Spectrum Transceiver 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 4106 DSSS 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:	419587
Quotation Number:	60443

1.4 Test Dates

Testing was performed from November 19, 2002 to December 10, 2002.

1.5 Test and Support Personnel

Washington Laboratories, LTD Steve Koster, 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
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

ADTRAN Part #	Product Name/Description
12804106L1A	TRACER 4206 Plan A
12804106L1B	TRACER 4206 Plan B

Top Assembly #:	12804106L1A and B
Sub Assembly #(s):	2280003-20, 2280018-10
Circuit Board #(s):	5280003-20, 2280018-10

The 12804106L1 (TRACER 4106 Radio) is a digital radio device that accepts four 1.544 Mb/sec T1 signals and transports them over a wireless carrier. A pair of these radios forms a wireless transport for T1 digital services in the 2.4 GHz Industrial, Scientific, and Medical (ISM) radio band. The 12804106L1 provides the network, antenna, and control/status interface to the customer. The T1 interfaces are network timed. No internal timing is available.

The TRACER 4106 operates in the 2416-2468 MHz band using direct sequence spread spectrum transmission. Two channels are available: "A" and "B". The channels are determined by internal cable routing on the transmit module during manufacture.

I/O Ports and Cables available on the TRACER 4106 DS3 Radio:

#	Signal/ Port Name	Signal/ Port Type	Cable Type	NOTES
1	RS232	Control	Shielded 25 wire	VT100/modem port
2	TEST	I/O	Unshielded TP	¼ inch stereo jack, I/Q Constellation plot
3	T1A	I/O	Unshielded	100 ohm impedance
4	T1B	I/O	Unshielded	100 ohm impedance
5	T1C	I/O	Unshielded	100 ohm impedance
6	T1D	I/O	Unshielded	100 ohm impedance
7	ALARM	Control	Unshielded TP	Major and minor alarm contacts
8	DC Power	Power	Unshielded pair	DC Power input, 21-60 VDC
9	ANTENNA	I/O	Shielded Coax	Connection to 2.4GHz antenna, 50 ohm
10	RSSI	I/O	Unshielded wire	Mono jack, Receive Signal Strength
11	TX PWR	I/O	Unshielded wire	Mono jack, Transmit Power
12	GND	Output	Unshielded wire	Mono jack, Circuit ground
EX:	HDSL Loop 1	Span Pwr-I/O	Twisted Pair	137V Span Voltage

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Adtran, Inc.
FCC ID Number	HDCTRC4106
EUT Name:	Spread Spectrum Transceiver
Model:	TRACER 4106
FCC Rule Parts:	§15.247
Frequency Range:	2416 – 2468 MHz
Maximum Output Power:	100mW (20.1dBm conducted at antenna terminal)
Modulation:	Digital (QPSK)
Necessary Bandwidth:	N/A
Keying:	Automatic
Type of Information:	Data
Number of Channels:	3 on Band A and 3 on Band B
Antenna Type	Parabolic
Frequency Tolerance:	N/A
Emission Type(s):	N/A
Power Source & Voltage:	21-60 VDC

The TRACER 4106 DSSS contains the following sources:

Frequency (MHz)	Description
51.536	Master clock of digital transmit and receive (XO)
1.544	T1 rate clock for framer operation (XO)
12	RF reference XO
280	IF XO
2416	RF center frequency, Channel A Bandplan 1
2422	RF center frequency, Channel A Bandplan 2
2428	RF center frequency, Channel A Bandplan 3
2456	RF center frequency, Channel B Bandplan 1
2462	RF center frequency, Channel B Bandplan 2
2468	RF center frequency, Channel B Bandplan 3
2XXX	Another frequency 140 MHz below and 280 MHz below all RF center frequencies

2.2 Test Configuration

The EUT was configured with the following support equipment:

ITE Model PW102 Power Supply

HP Pavilion Laptop PC S/N: TW02810306

Radio Waves Model SP2-2.4, 2.4 GHz Parabolic Antenna

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". Each channel has three "Plans" or frequencies. Changing between the plans is accomplished by switching the internal cables. The channels are then programmed within the plan.

2.3 Testing Algorithm

The TRACER 4106 DSSS 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 ± 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 Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Equipment	Serial Number	Calibration Due
ARA BiconiLog Antenna: LPB-2520	1044	6/19/03
Hewlett-Packard Spectrum Analyzer: HP 8568B (Site 1)	2928A04750	7/02/03
Hewlett-Packard Quasi-Peak Adapter: HP 85650A (Site 1)	3303A01786	7/05/03
Hewlett-Packard RF Preselector: HP 85685A (Site 1)	3146A01296	7/02/03
Solar Electronics LISN 8012-50-R-24-BNC	8379493	6/20/03
A.R.A DRG-118/A Horn Antenna	1236	8/29/03
Hewlett-Packard Spectrum Analyzer: HP 8593	3009A00739	6/6/03
Hewlett-Packard Pre Amplifier: HP 8449B	3008A00729	1/31/03
ARA Horn Antenna:	1010	11/28/03
Narda Standard Gain Horn: V638	00210	7/22/04
Hewlett-Packard Spectrum Analyzer: HP 8564E	3643A00657	4/18/03

4 Test Results

4.1 RF 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 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 of 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 3. RF Power Output

Frequency	Level	Limit	Pass/Fail
Plan A			
Channel 1 2416.00 MHz	20.08dBm	30 dBm	Pass
Channel 2 2422.00 MHz	20.10dBm	30 dBm	Pass
Channel 3 2428.00 MHz	20.01dBm	30 dBm	Pass
Plan B			
Channel 1 2456.00 MHz	19.98dBm	30 dBm	Pass
Channel 2 2462.00 MHz	20.01dBm	30 dBm	Pass
Channel 3 2468.00 MHz	19.72dBm	30 dBm	Pass

4.2 RF Peak 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.

Table 4. Power Spectral Density

Frequency	Level	Limit	Pass/Fail
Plan A			
Channel 1 2416.00 MHz	-1.12dBm	8 dBm	Pass
Channel 2 2422.00 MHz	-1.97dBm	8 dBm	Pass
Channel 3 2428.00 MHz	-1.87dBm	8 dBm	Pass
Plan B			
Channel 1 2456.00 MHz	-1.78dBm	8 dBm	Pass
Channel 2 2462.00 MHz	-2.76dBm	8 dBm	Pass
Channel 3 2468.00 MHz	-2.03dBm	8 dBm	Pass

4.3 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.

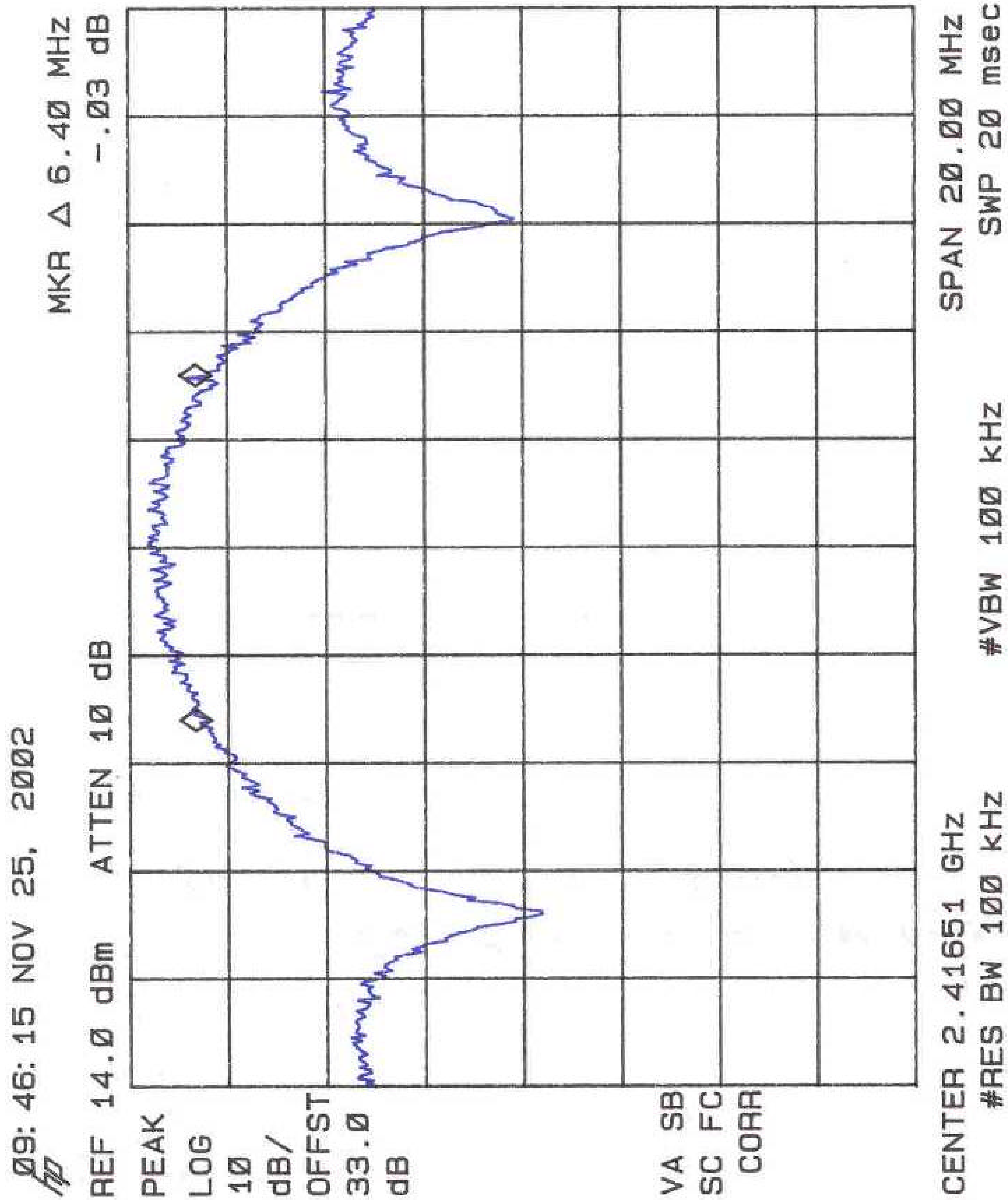

Figure 1. Occupied Bandwidth, Channel A Plan 1

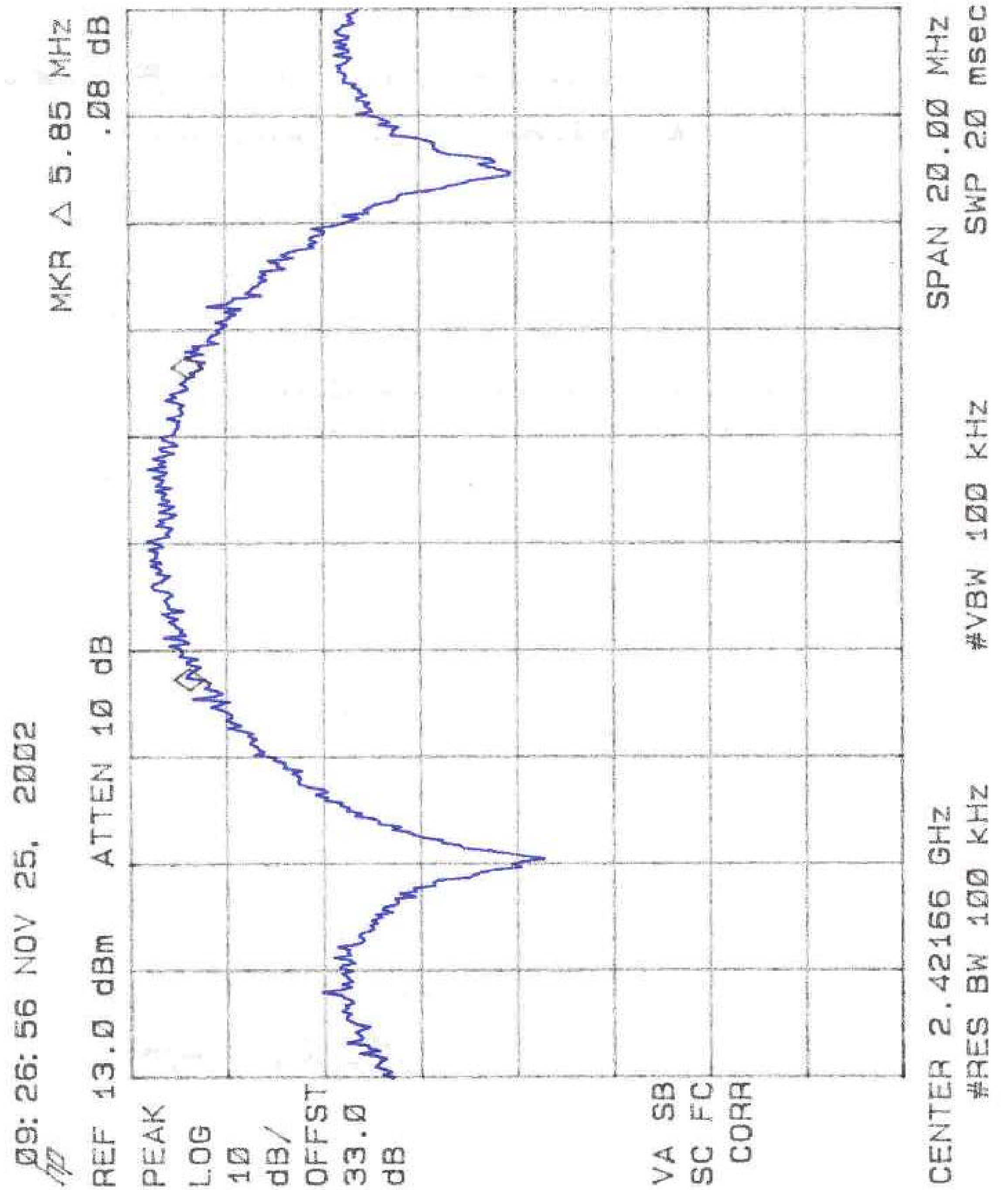

Figure 2. Occupied Bandwidth, Channel A Plan 2

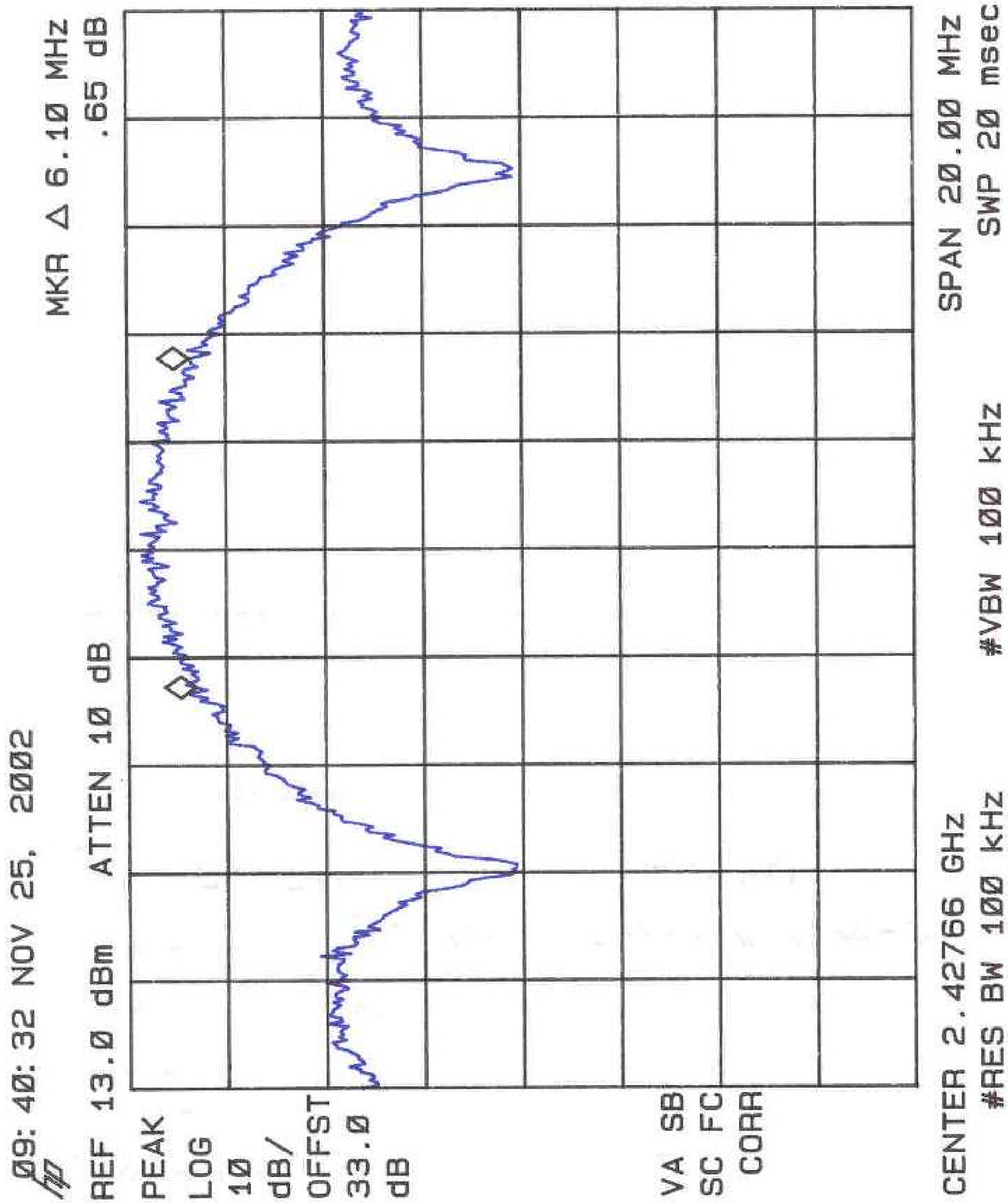

Figure 3. Occupied Bandwidth, Channel A Plan 3

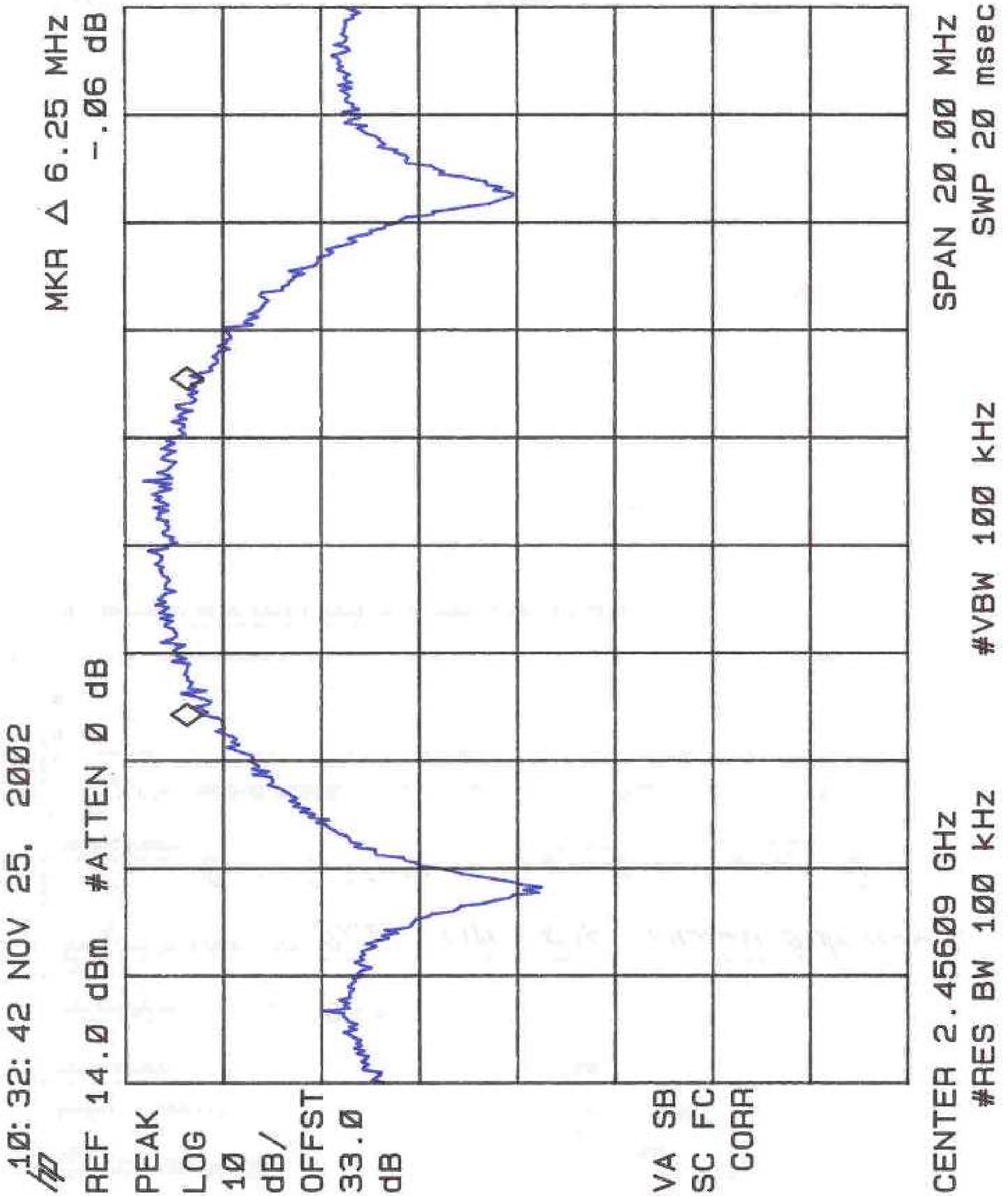

Figure 4. Occupied Bandwidth, Channel B Plan 1

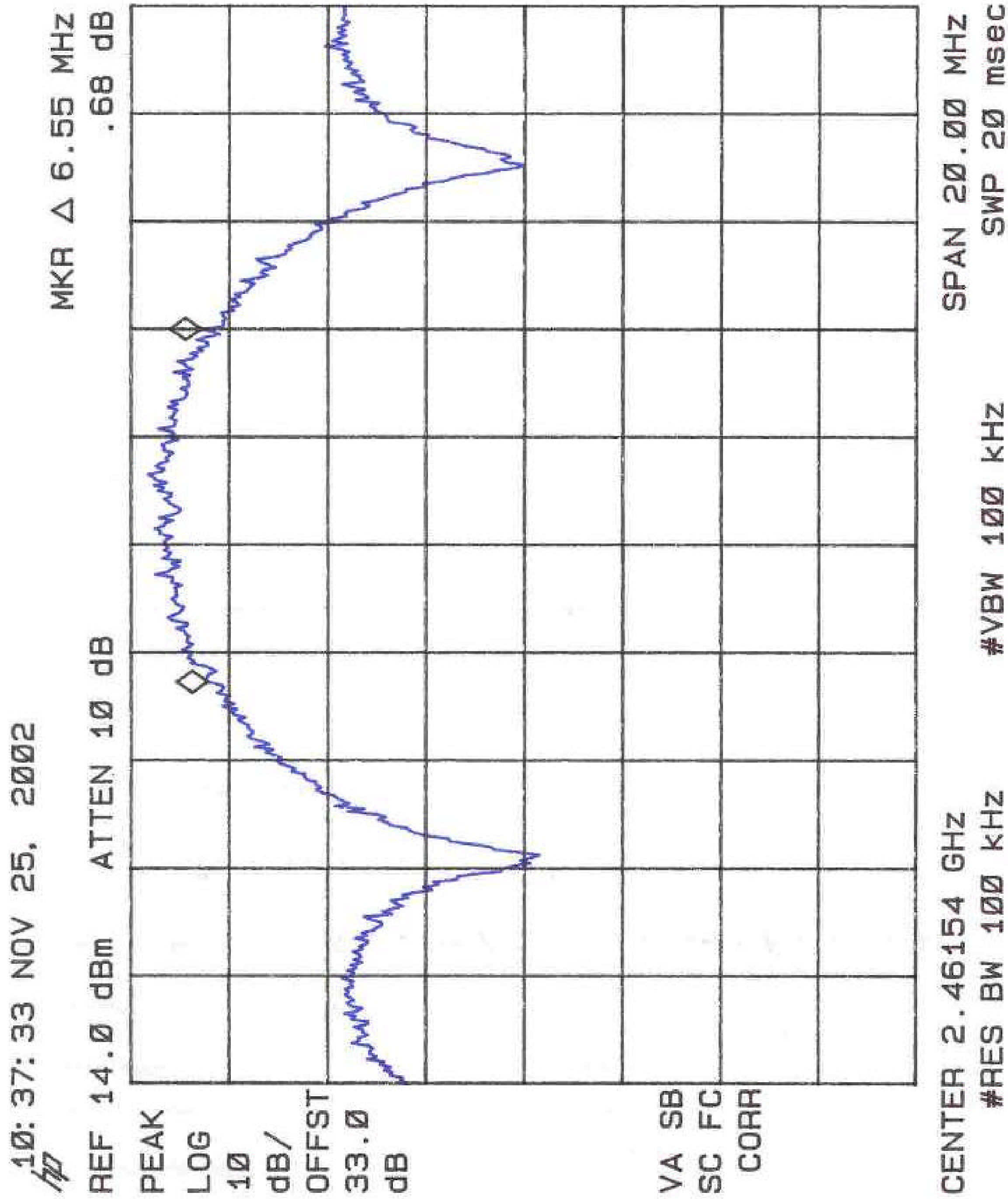

Figure 5. Occupied Bandwidth, Channel B Plan 2

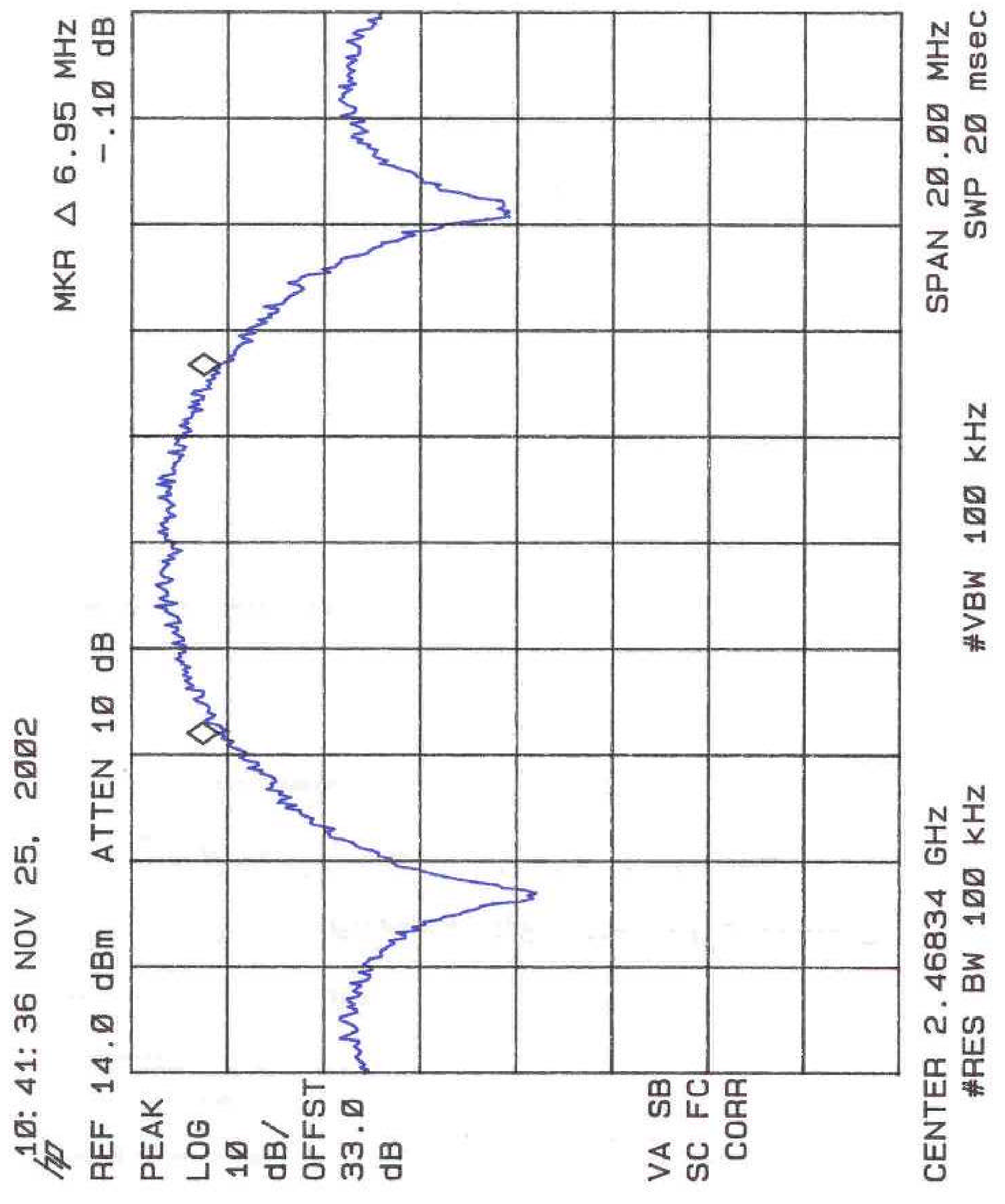

Figure 6. Occupied Bandwidth, Channel B Plan 3

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5. Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Channel A Plan 1 2416 MHz Plan 2 2422 MHz Plan 3 2428 MHz	 6.40 MHz 5.85 MHz 6.10 MHz	> 500 kHz	Pass
Channel B Plan 1 2456 MHz Plan 2 2462 MHz Plan 3 2468 MHz	 6.25 MHz 6.55 MHz 6.95 MHz	> 500 kHz	Pass

4.4 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.

Figure 7 through Figure 38 are plots of the conducted spurious emissions as measured at the antenna terminal. Band edge plots are included for Channel A, Band 1 and Channel B, Band 3 as these are the frequencies which fall closest to the frequency band of 15.247.

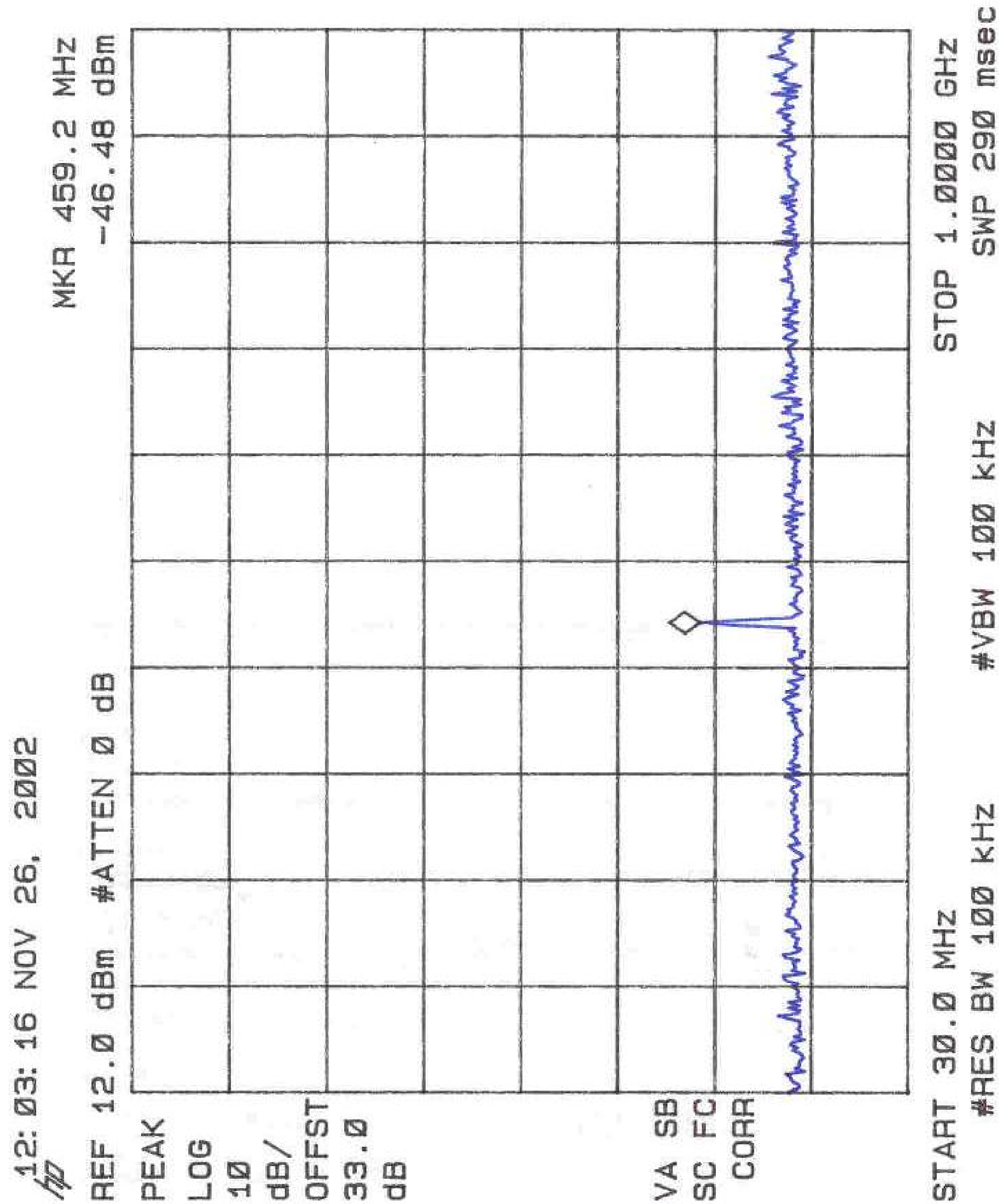

Figure 7. Conducted Spurious: Channel A Plan 1 30MHz – 1GHz