



FCC Certification Test Report
for
DK Technologies, Inc.
NN7NT2000T

May 22, 2002

Prepared for:

DK Technologies, Inc.
9 Regola Drive
Irwin, PA 15642

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879



FCC Certification Test Program

FCC Certification Test Report for the DK Technologies, Inc. MT1 Transmitter NN7NT2000T

May 22, 2002

WLL JOB# 6406

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Abstract

This report has been prepared on behalf of DK Technologies, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Periodic Intentional Radiator under Part 15.231 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a DK Technologies, Inc. MT1 Transmitter.

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 DK Technologies, Inc. MT1 Transmitter complies with the limits for a Periodic Intentional Radiator device under Part 15.231 of the FCC Rules and Regulations.

Table of Contents

Abstract.....	ii
1 Introduction.....	1
1.1 Compliance Statement.....	1
1.2 Test Scope	1
1.3 Contract Information.....	1
1.4 Test Dates	1
1.5 Test and Support Personnel.....	1
1.6 Abbreviations.....	2
2 Equipment Under Test.....	3
2.1 EUT Identification & Description.....	3
2.2 Test Configuration.....	3
2.3 Testing Algorithm.....	3
2.4 Test Location.....	3
2.5 Measurements.....	4
2.5.1 References.....	4
2.6 Measurement Uncertainty.....	4
3 Test Equipment	5
4 Test Results	5
4.1 Duty Cycle Correction	5
4.2 RF Power Output: (FCC Part §2.1046)	10
4.3 Modulation Characteristics: (FCC Part §2.1047); Audio Frequency Response.....	10
4.4 Occupied Bandwidth: (FCC Part §2.1049)	10
4.5 Spurious Emissions at Antenna Terminals (FCC Part §2.1051.....	12
4.6 Radiated Spurious Emissions: (FCC Part §2.1053).....	12
4.6.1 Test Procedure	12
4.7 Frequency Stability: (FCC Part §2.1055)	15
4.8 Transient Frequency Response (Part 90.214)	Error! Bookmark not defined.
5 Transmitter Environmental Assessment, Maximum Permissible Exposure (MPE).....	Error! Bookmark not de
5.1 SCOPE.....	Error! Bookmark not defined.
5.2 REFERENCE.....	Error! Bookmark not defined.

List of Tables

Table 1. Device Summary3

Table 2: Test Equipment List5

Table 3. Duty Cycle Correction.....10

Table 4. Radiated Spurious Emissions Limits.....12

Table 5: Radiated Emission Test Data.....13

List of Figures

Figure 1. Duty Cycle Plots Full Period7

Figure 2. Duty Cycle Plot "Narrow Pulses"8

Figure 3. Duty Cycle Plot "Wide Pulses"9

Figure 4. Occupied Bandwidth.....11

1 Introduction

1.1 Compliance Statement

The DK Technologies, Inc. MT1 Transmitter complies with the limits for a Periodic Intentional Radiator device under Part 15.231 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated 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: DK Technologies, Inc.
9 Regola Drive
Irwin, PA 15642

Quotation Number: 59024

1.4 Test Dates

Testing was performed on March 14, 2002.

1.5 Test and Support Personnel

Washington Laboratories, LTD	John Lam
Customer	Dan Janicik

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

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	DK Technologies, Inc.
FCC ID Number	NN7NT2000T
EUT Name:	Transmitter
Model:	MT1
FCC Rule Parts:	§15.231
Frequency Range:	433.88 MHz
Maximum Output Power:	8 uW
Modulation:	OOK
Bandwidth:	278 kHz
Keying:	Manual
Type of Information:	Control
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral
Frequency Tolerance:	N/A
Emission Type(s):	N/A
Interface Cables:	None
Power Source & Voltage:	3.6VDC Lithium Battery

2.2 Test Configuration

The MT1 was configured in a constant transmit mode. Conducted emissions testing was not performed as the unit is battery powered.

2.3 Testing Algorithm

The MT1 was operated continuously by being set to transmit.

Worst case emission levels are provided in the test results data.

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. 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:

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

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 = $0.5 (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ 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	Date Calibrated	Calibration Due
Sunol Science, Inc. Biconical Log Periodic Antenna JB1	A090501	9/21/01	9/21/02
Hewlett-Packard Spectrum Analyzer: HP 8568B	2928A04750	6/29/01	6/29/02
Hewlett-Packard Quasi-Peak Adapter: HP 85650A	3303A01786	6/29/01	6/29/02
Hewlett-Packard RF Preselector: HP 85685A	2817A00744	6/29/01	6/29/02
Solar Electronics LISN 8012-50-R-24-BNC	8379493	9/18/01	9/18/02
Solar Electronics LISN 8028-50-TS-24-BNC	N/A	9/18/01	9/18/02
Solar Electronics LISN 8028-50-TS-24-BNC	N/A	9/18/01	9/18/02
Hewlett-Packard Spectrum Analyzer: HP 8564E	3643A00657	4/11/01	4/11/02
Hewlett-Packard RF Pre-Amplifier: HP 8449B	3008A00385	9/24/01	9/24/02
ARA DRG-118/A Antenna	1010	11/28/01	11/28/02

4 Test Results

4.1 Duty Cycle Correction

Measurements may be adjusted where pulsed RF is utilized to find the average level associated with a quantity. This calculation is applied to limits for pulsed licensed and unlicensed devices.

On time = $N_1L_1 + N_2L_2 + \dots + N_{N-1}L_{N-1} + N_NL_N$, where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.

- For Licensed Transmitters basic formula can be stated as $20\log[\text{Duty Cycle}]$
- For Unlicensed Intentional Radiators under 47CFR Part 15, all duty cycle measurements compared to a 100 millisecond period
- i.e. duty cycle = on time/100 milliseconds or period, whichever is less
- Restating the basic formula:
 - o Duty cycle = $(N_1L_1 + N_2L_2 + \dots + N_{N-1}L_{N-1} + N_NL_N)/100$ or T, whichever is less

Where T is the period of the pulse train.

The following Figures show the plots of the modulated carrier. The spectrum analyzer was set to Zero Span and the video triggered to collect the pulse train of the modulation. Calculations of the duty cycle correction factor were obtained from time data provided by the plots.

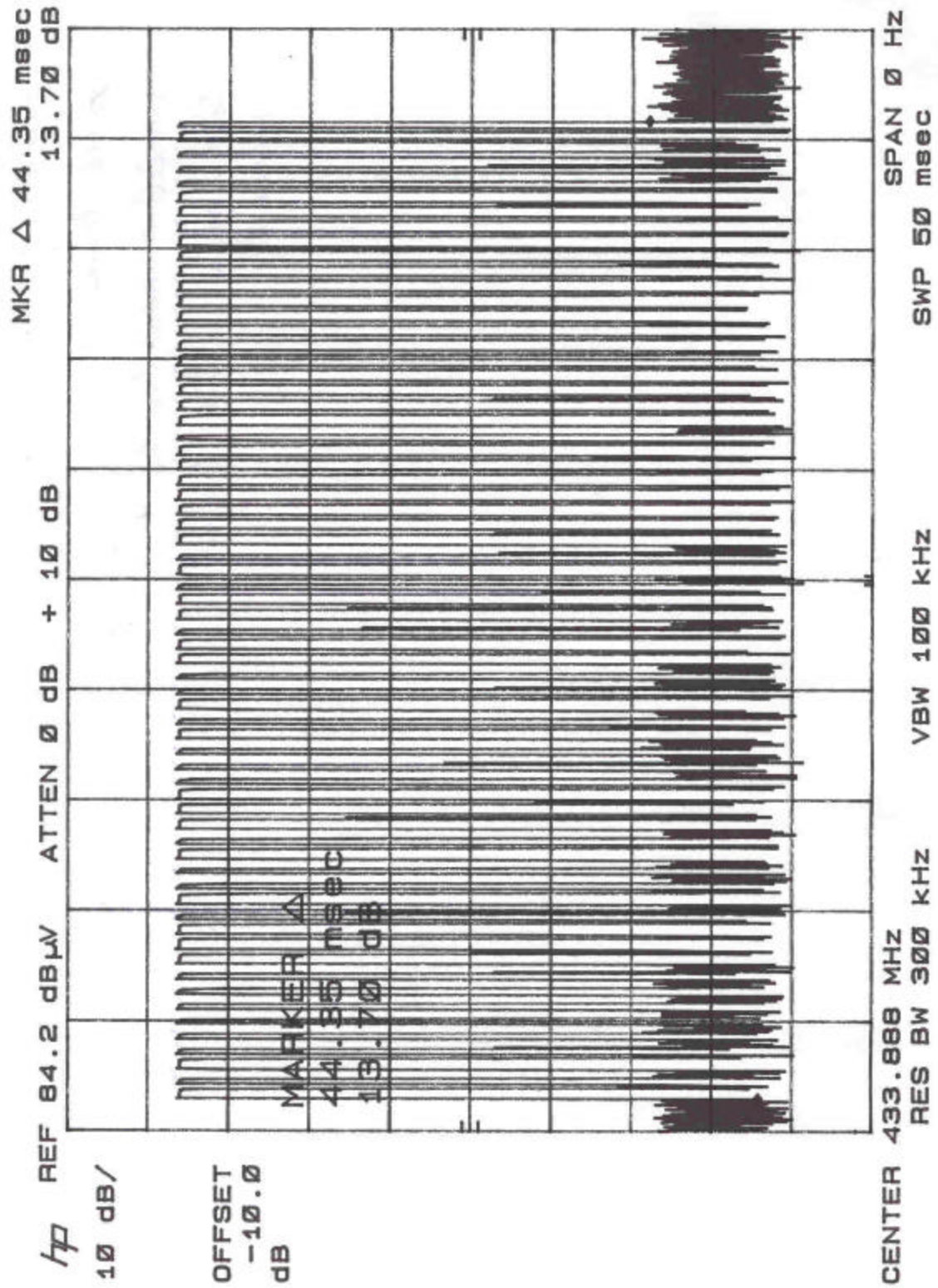


Figure 1. Duty Cycle Plots Full Period

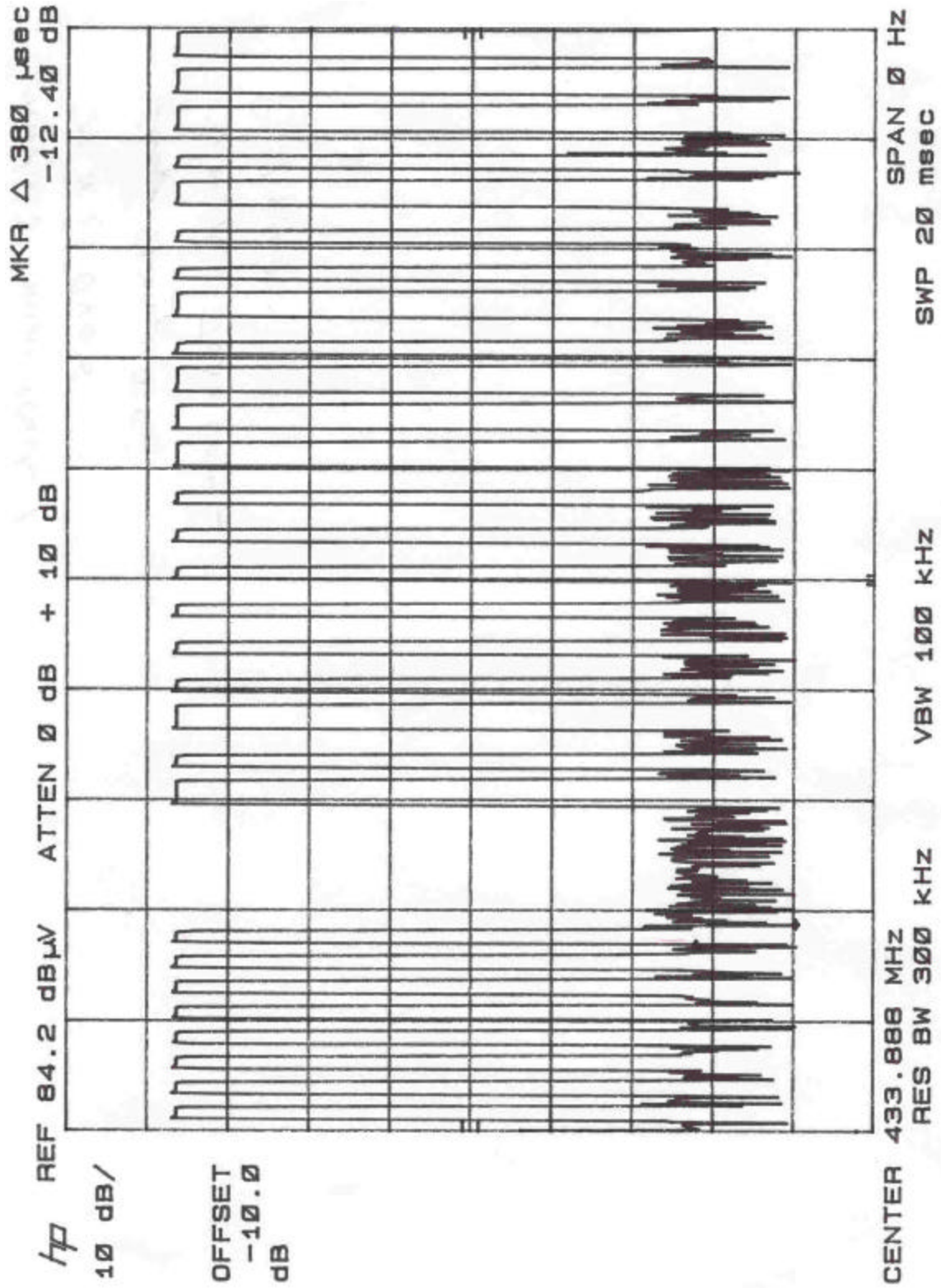


Figure 2. Duty Cycle Plot "Narrow Pulses"

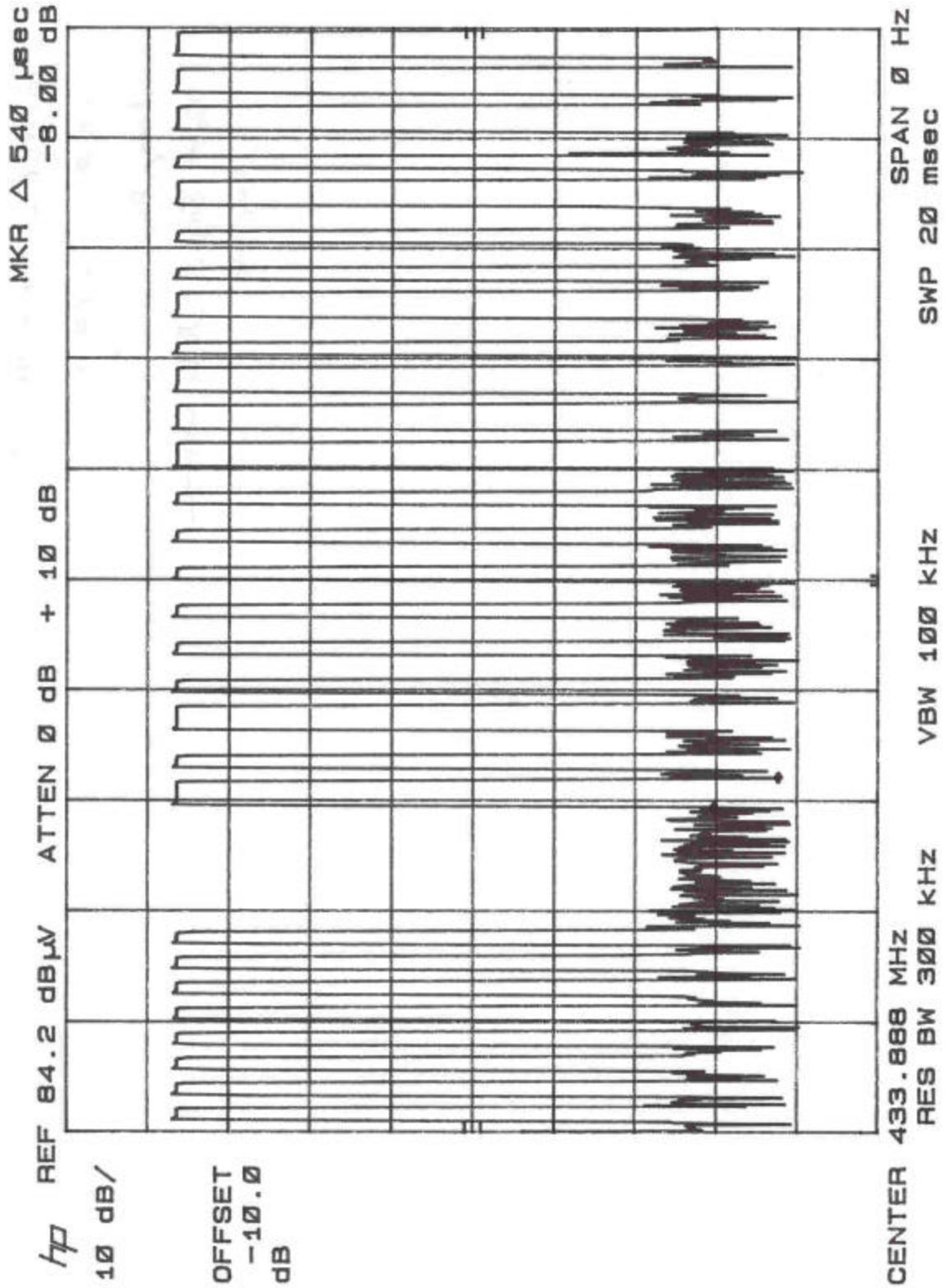


Figure 3. Duty Cycle Plot "Wide Pulses"

The pulse train repeats every 120 ms thereby only occurring once in a 100ms time frame. From the data in Figure 1, Figure 2, and Figure 3 the following calculations are made.

On Time Per Code Group/100ms:

$$25(380\mu s) + 41(540\mu s) = 31.64\text{ms}$$

The data are summarized in the following table.

Table 3. Duty Cycle Correction

Measurement Time	Total ON Time	Duty Cycle (%)	Duty Cycle (dB)
100ms	31.64ms	31.64%	9.9

4.2 RF Power Output: (FCC Part §2.1046)

N/A – Integral Antenna

4.3 Modulation Characteristics: (FCC Part §2.1047); Audio Frequency Response

N/A

4.4 Occupied Bandwidth: (FCC Part §2.1049)

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

FCC Part 15.231 states that the 20 dB bandwidth of the modulated carrier shall be as follows:

Frequency Range (MHz)	Occupied Bandwidth Limit
70-900 MHz	0.25%
> 900 MHz	0.5%

At full modulation, the occupied bandwidth was measured as shown in Figure 1.

Results: Limit 1.08 MHz
 Measured 278 kHz

Figure 4 provides a summary of the Occupied Bandwidth Results.

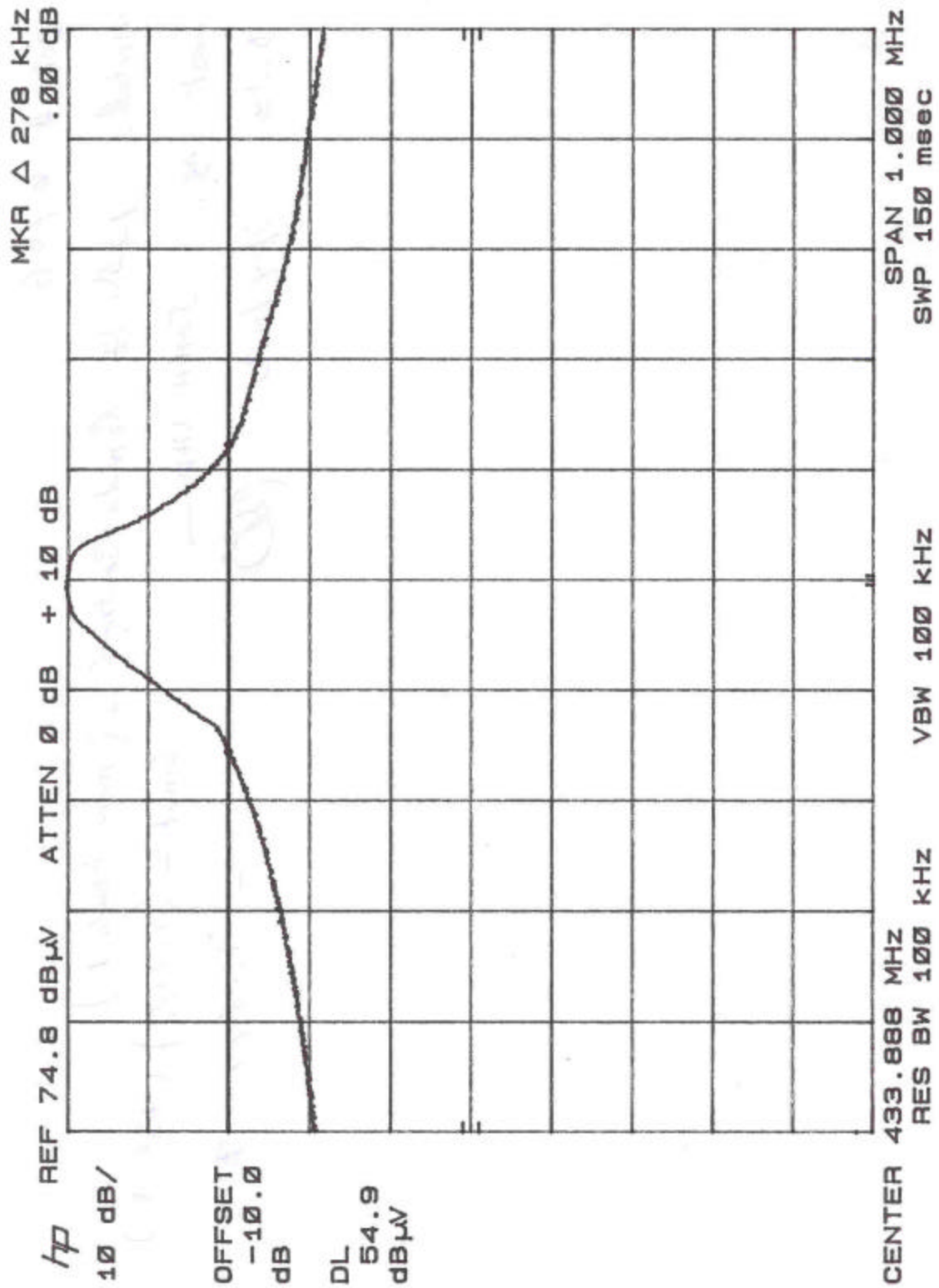


Figure 4. Occupied Bandwidth

4.5 Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

N/A

4.6 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with requirements for radiated spurious emissions. The limits are as shown in the following table.

Table 4. Radiated Spurious Emissions Limits

Frequency	Fundamental	Harmonic Level (-dBc or E-Field)
Fundamental	10995 uV/m	
Harmonics		1099.5 uV/m
Restricted Bands		500 uV/m

4.6.1 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.

Table 5: Radiated Emission Test Data

CLIENT: DK Technologies
MODEL NO: Mini Touch 1
ORIENTATION: X.Axis
DATE: 3/14/02
BY: John Lam
JOB #: 6406
Tx Frequency: 433.88 Mhz
Battery Voltage at 3.4 VDC under load
Antenna: SPLATCH

Frequency	Polarity	Azimuth	Ant	SA Level	AFc	Duty	E-Field	E-Field	Limit	Margin	Notes
MHz	H/V	Degree	Height m	(Peak) dBuV	dB/m	Cycle dB	dBuV/m	uV/m	uV/m	dB	
433.88	V	135.00	1.4	54.6	19.4	0.000	74.0	5000.4	10995.0	-6.8	
867.78	V	45.00	2.0	9.0	27.5	0.000	36.5	66.9	1099.5	-24.3	
1301.56	V	0.00	1.0	51.5	-10.3	-9.900	31.3	36.8	500.0	-22.7	
1735.56	V	225.00	1.0	64.3	-7.5	-9.900	46.9	221.3	1099.5	-13.9	
2169.64	V	90.00	1.0	61.0	-5.8	-9.900	45.3	183.8	1099.5	-15.5	
2603.30	V	0.00	1.0	64.0	-5.1	-9.900	49.0	283.1	1099.5	-11.8	amb
3037.40	V	0.00	1.0	44.8	-4.4	-9.900	30.5	33.5	1099.5	-30.3	amb
3471.10	V	0.00	1.0	45.3	-3.9	-9.900	31.5	37.7	1099.5	-29.3	amb
3904.95	V	0.00	1.0	44.9	-3.4	-9.900	31.6	37.8	500.0	-22.4	
4338.80	V	0.00	1.0	42.8	-3.0	-9.900	30.0	31.5	500.0	-24.0	amb
433.88	H	315.00	1.0	47.5	19.4	0.000	66.9	2208.0	10995.0	-13.9	
867.78	H	270.00	1.6	13.5	27.5	0.000	41.0	112.4	1099.5	-19.8	
1301.56	H	45.00	1.0	52.0	-10.3	-9.900	31.8	39.0	500.0	-22.2	
1735.56	H	180.00	1.0	55.5	-7.5	-9.900	38.1	80.1	1099.5	-22.8	
2169.64	H	180.00	1.0	58.8	-5.8	-9.900	43.1	143.2	1099.5	-17.7	
2603.50	H	0.00	1.0	45.7	-5.1	-9.900	30.7	34.4	1099.5	-30.1	
3037.40	H	0.00	1.0	43.9	-4.4	-9.900	29.6	30.1	1099.5	-31.2	amb
3471.10	H	0.00	1.0	45.3	-3.9	-9.900	31.6	37.8	1099.5	-29.3	
3904.95	H	0.00	1.0	45.8	-3.4	-9.900	32.5	42.2	500.0	-21.5	
4338.80	H	0.00	1.0	42.0	-3.0	-9.900	29.1	28.7	500.0	-24.8	amb

Table 5: Radiated Emission Test Data (continued)

CLIENT: DK Technologies
MODEL NO: Mini Touch 1
ORIENTATION: Y-axis
DATE: 3/14/02
BY: John Lam
JOB #: 6406
Tx Frequency: 433.88 Mhz
Battery Voltage at 3.4 VDC under load
Antenna: SPLATCH

Frequency	Polarity	Azimuth	Ant	SA Level	AFc	Duty	E-Field	E-Field	Limit	Margin	Notes
MHz	H/V	Degree	Height m	(Peak) dBuV	dB/m	Cycle dB	dBuV/m	uV/m	uV/m	dB	
433.88	V	90.00	1.4	47.1	19.4	0.000	66.5	2108.7	10995.0	-14.3	
867.78	V	90.00	1.5	17.0	27.5	0.000	44.5	168.1	1099.5	-16.3	
1301.56	V	0.00	1.0	57.2	-10.3	-9.900	37.0	70.7	500.0	-17.0	
1735.56	V	270.00	1.0	62.3	-7.5	-9.900	44.9	175.7	1099.5	-15.9	
2169.64	V	90.00	1.0	61.3	-5.8	-9.900	45.6	190.9	1099.5	-15.2	
2603.30	V	0.00	1.0	62.0	-5.1	-9.900	47.0	224.8	1099.5	-13.8	amb
3037.40	V	0.00	1.0	43.8	-4.4	-9.900	29.5	29.9	1099.5	-31.3	amb
3471.10	V	0.00	1.0	44.7	-3.9	-9.900	30.9	35.1	1099.5	-29.9	amb
3904.95	V	0.00	1.0	44.0	-3.4	-9.900	30.7	34.3	500.0	-23.3	amb
4338.80	V	0.00	1.0	42.8	-3.0	-9.900	30.0	31.5	500.0	-24.0	amb
433.88	H	135.00	1.0	54.8	19.4	0.000	74.2	5116.9	10995.0	-6.6	
867.78	H	45.00	1.3	5.5	27.5	0.000	33.0	44.7	1099.5	-27.8	
1301.56	H	180.00	1.0	47.2	-10.3	-9.900	27.0	22.4	500.0	-27.0	
1735.56	H	135.00	1.0	55.7	-7.5	-9.900	38.2	81.6	1099.5	-22.6	
2169.64	H	180.00	1.0	59.7	-5.8	-9.900	44.0	157.7	1099.5	-16.9	
2603.50	H	0.00	1.0	46.0	-5.1	-9.900	31.0	35.6	1099.5	-29.8	
3037.40	H	180.00	1.0	44.2	-4.4	-9.900	29.9	31.2	1099.5	-30.9	
3471.10	H	0.00	1.0	45.2	-3.9	-9.900	31.4	37.3	1099.5	-29.4	amb
3904.95	H	45.00	1.0	44.3	-3.4	-9.900	31.0	35.5	500.0	-23.0	
4338.80	H	0.00	1.0	42.0	-3.0	-9.900	29.1	28.7	500.0	-24.8	amb

Table 5: Radiated Emission Test Data (continued)

CLIENT: DK Technologies
MODEL NO: Mini Touch 1
ORIENTATION: Z-axis
DATE: 3/14/02
BY: John Lam
JOB #: 6406
Tx Frequency: 433.88 Mhz
Battery Voltage at 3.4 VDC under load
Antenna: SPLATCH

Frequency	Polarity	Azimuth	Ant	SA Level	AFc	Duty	E-Field	E-Field	Limit	Margin	Notes
MHz	H/V	Degree	Height m	(Peak) dBuV	dB/m	Cycle dB	dBuV/m	uV/m	uV/m	dB	
433.88	V	225.00	1.6	50.4	19.4	0.000	69.8	3083.2	10995.0	-11.0	amb
867.78	V	270.00	1.3	8.3	27.5	0.000	35.8	61.8	1099.5	-25.0	
1301.56	V	45.00	1.0	52.7	-10.3	-9.900	32.5	42.1	500.0	-21.5	
1735.56	V	180.00	1.0	60.3	-7.5	-9.900	42.9	139.1	1099.5	-18.0	
2169.64	V	90.00	1.0	59.0	-5.8	-9.900	43.3	146.0	1099.5	-17.5	
2603.50	V	0.00	1.0	65.5	-5.1	-9.900	50.5	336.4	1099.5	-10.3	
3037.40	V	0.00	1.0	42.0	-4.4	-9.900	27.7	24.2	1099.5	-33.1	
3471.10	V	0.00	1.0	45.0	-3.9	-9.900	31.2	36.4	1099.5	-29.6	
3904.95	V	180.00	1.0	45.0	-3.4	-9.900	31.7	38.5	500.0	-22.3	
4338.80	V	0.00	1.0	45.2	-3.0	-9.900	32.3	41.4	500.0	-21.6	
433.88	H	315.00	1.0	53.7	19.4	0.000	73.1	4508.2	10995.0	-7.7	amb
867.78	H	90.00	1.3	19.0	27.5	0.000	46.5	211.7	1099.5	-14.3	
1301.56	H	270.00	1.0	51.7	-10.3	-9.900	31.5	37.7	500.0	-22.5	
1735.56	H	225.00	1.0	57.5	-7.5	-9.900	40.1	100.8	1099.5	-20.8	
2169.64	H	90.00	1.0	61.0	-5.8	-9.900	45.3	183.8	1099.5	-15.5	
2603.50	H	0.00	1.0	47.2	-5.1	-9.900	32.2	40.9	1099.5	-28.6	
3037.40	H	0.00	1.0	44.0	-4.4	-9.900	29.7	30.5	1099.5	-31.1	
3471.10	H	0.00	1.0	44.7	-3.9	-9.900	30.9	35.1	1099.5	-29.9	
3904.95	H	0.00	1.0	43.3	-3.4	-9.900	30.0	31.8	500.0	-23.9	
4338.80	H	0.00	1.0	42.3	-3.0	-9.900	29.5	29.8	500.0	-24.5	

4.7 Frequency Stability: (FCC Part §2.1055)

N/A

5 Transmitter Environmental Assessment, Maximum Permissible Exposure (MPE)

Not applicable.