FCC Certification Test Report

FCC Certification Test Report
for
ComSonics, Inc.
PYN12002A

Revision 1

July 18, 2002

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Prepared for:

ComSonics, Inc.
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Harrisonburg, VA 22801

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FCC Certification Test Program

FCC Certification Test Report
for the
ComSonics, Inc.
27 MHz Ingression Measurement Transmitter
PYN12002A

Revision 1

July 18, 2002

WLL JOB# 6880

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Abstract

This report has been prepared on behalf of ComSonics, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Transmitter under Part 90.35 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a ComSonics, Inc. 27 MHz Ingression Measurement 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 ComSonics, Inc. 27 MHz Ingression Measurement Transmitter complies with the limits for a Licensed Transmitter device under Part 90.35 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The ComSonics, Inc. 27 MHz Ingression Measurement Transmitter complies with the limits for a Licensed Transmitter device under Part 90.35 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:	ComSonics, Inc. 1350 Port Republic Road Harrisonburg, VA 22801
Purchase Order Number:	G0882
Quotation Number:	59576

1.4 Test Dates

Testing was performed on December 3 and 5, 2001.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Chad Beattie

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 ComSonics, Inc. 27 MHz Ingression Measurement Transmitter (IMT) is one part of the two-part CyberTek™ Qualifier system for verifying home return path integrity. The return path integrity is measured by connecting the F-Type connector on the Qualifier to the existing cable of the house at the grounding block. The Qualifier, when manually activated, sends a request to the vehicle-mounted 27 MHz transponder unit (second part of the system). Once the house wiring is illuminated by the transponder, the Qualifier measures the ingress.

Figure 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	ComSonics, Inc.
FCC ID Number	PYN12002A
EUT Name:	Ingression Measurement Transmitter (IMT)
Model:	27 MHz
FCC Rule Parts:	§90.35
Frequency Range:	27.45 MHz, 27.47 MHz & 27.49 MHz
Maximum Output Power:	20W Peak (rated); 1 W Average
Modulation:	GMSK
Necessary Bandwidth:	50.4 KHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	1
Power Output Level:	Fixed
Antenna Type:	Connector
Frequency Tolerance:	0.002%
Emission Type(s) 2.201:	50K4G1D
Interface Cables:	RS-232
Power Source & Voltage:	12VDC

2.2 Test Configuration

The 27 MHz IMT was powered by a 12VDC source, and configured with an RF load. Operation was controlled by a support PC via the DB9 connection.

2.3 Testing Algorithm

The 27 MHz was operated continuously by enabling the RF output via the serial DB9 port connected to the support PC. The output transmitted into a representative load. A jumper was utilized to control the on/off modulation operation.

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

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

Figure 2: Test Equipment List

Manufacturer & Model	Description	Serial Number	Date Calibrated	Calibration Due Date
Hewlett Packard 8564E	Spectrum Analyzer	3643A00657	4/11/01	4/11/02
Hewlett Packard 85650A	Q.P. Adapter	3303A01786	6/29/01	6/29/02
Hewlett Packard 85685A	RF Preselector	3221A01395	6/28/01	6/28/02
Hewlett Packard 8568B	Spectrum Analyzer	2634A02888	6/28/01	6/28/02
Hewlett Packard 8449B	Pre-Amplifier	3008A00729	12/7/00	12/7/01
Antenna Research Associates DRG-118/A	Horn Antenna	1010	10/20/01	10/20/02
Antenna Research Associates LPB-2520	Biconilog Antenna Site 2	1118	5/15/01	5/15/02

4 Test Results

4.1 Emission Designation Calculation

The following formula was used to calculate the necessary bandwidth and emission designator.

Necessary Bandwidth:

Based on FCC Part 90.209 the Authorized Bandwidth is specified as 20kHz.

Type of emission: G1D

Therefore:

Emissions Designator = 20K4G1D

4.2 RF Power Output: (FCC Part §2.1046)

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 peak power was measured unmodulated.

Figure 3. RF Power Output

Frequency	Level
27.45 MHz	42.1 dBm peak

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

The device is modulated by GMSK data.

Figure 4 summarizes the modulation parameters.

Figure 4. Modulation Parameters

Parameter	Result
M (from audio response)	
D (from modulation limiting)	

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 via an attenuator. The emissions must conform to the mask of 90.210(c).

At full modulation, the occupied bandwidth was measured as shown:

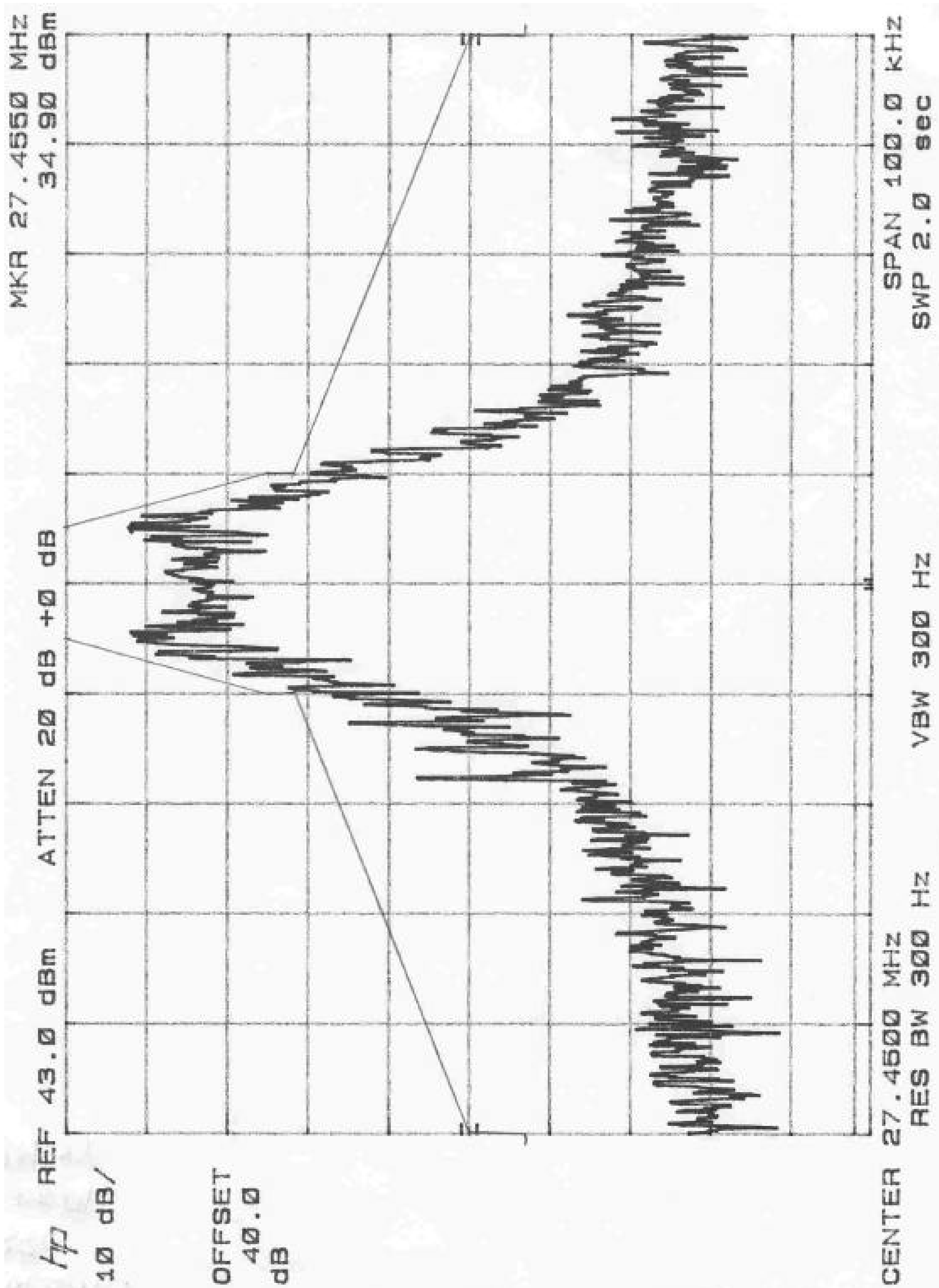

Figure 5. Occupied Bandwidth

Figure 6 provides a summary of the Occupied Bandwidth Results.

Figure 6. Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
27.45 MHz	See Figure 5	90.210(c)	Pass

4.5 Spurious Emissions at Antenna Terminals (FCC Part §2.1051

The EUT must comply with requirements for spurious emissions at antenna terminals. The limits are shown in the following table.

Figure 7. Conducted Spurious Emission Limits

Frequency	Fundamental	Harmonic Limit (-dBc)
Fundamental		
Harmonics		Mask: 90.210(c)

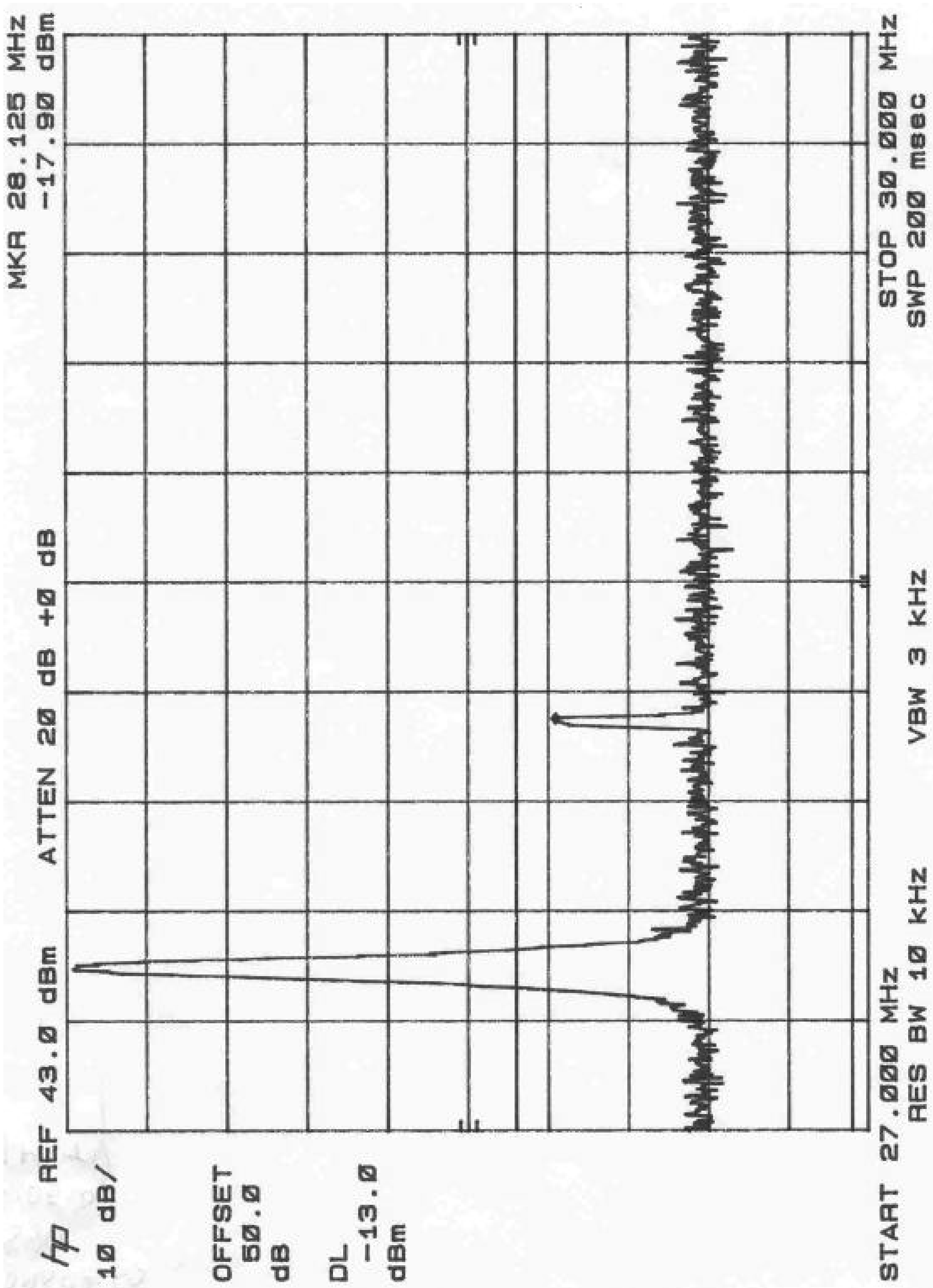

Figure 8. Conducted Spurious Emissions

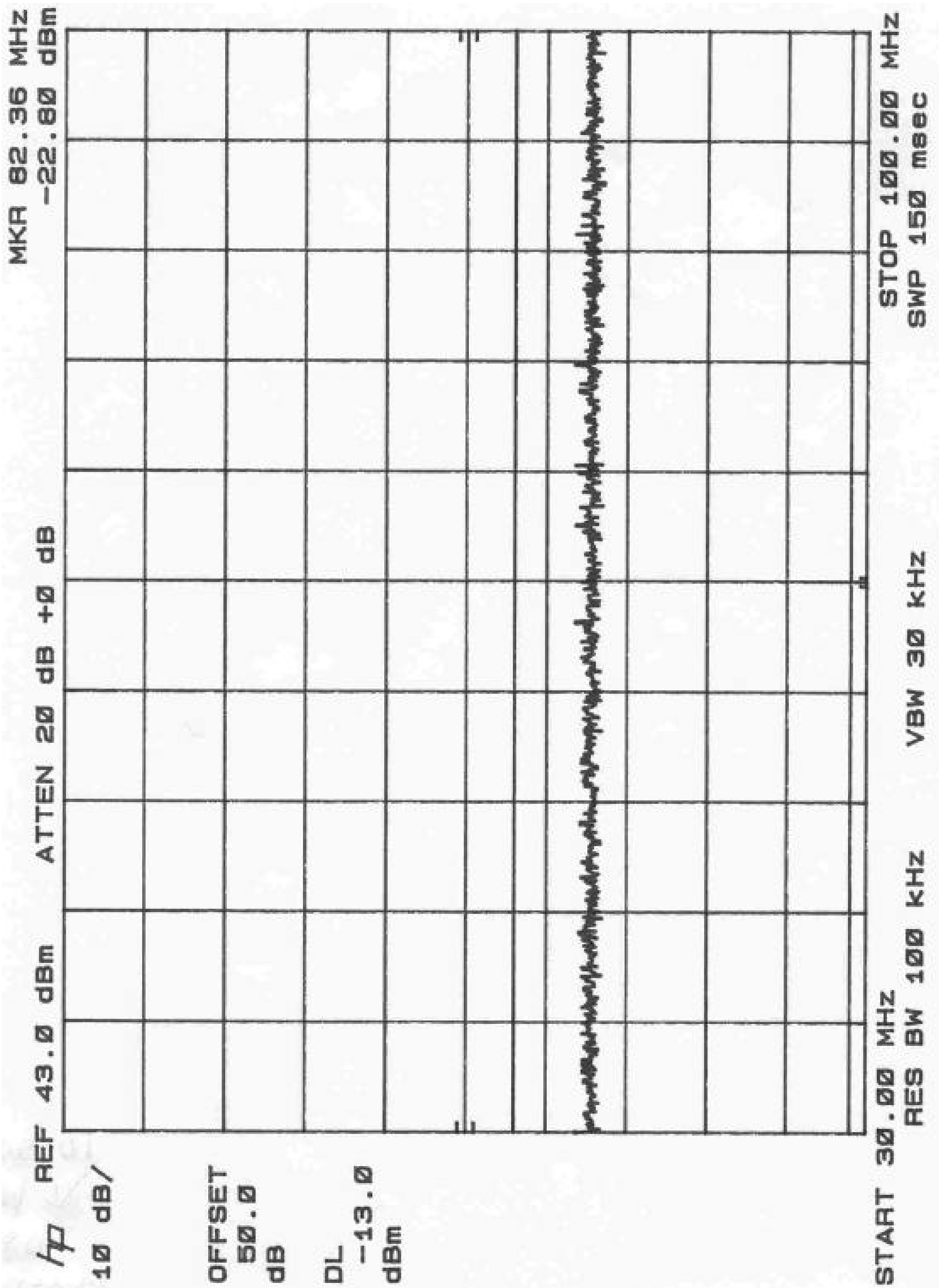

Figure 9. Conducted Spurious Emissions

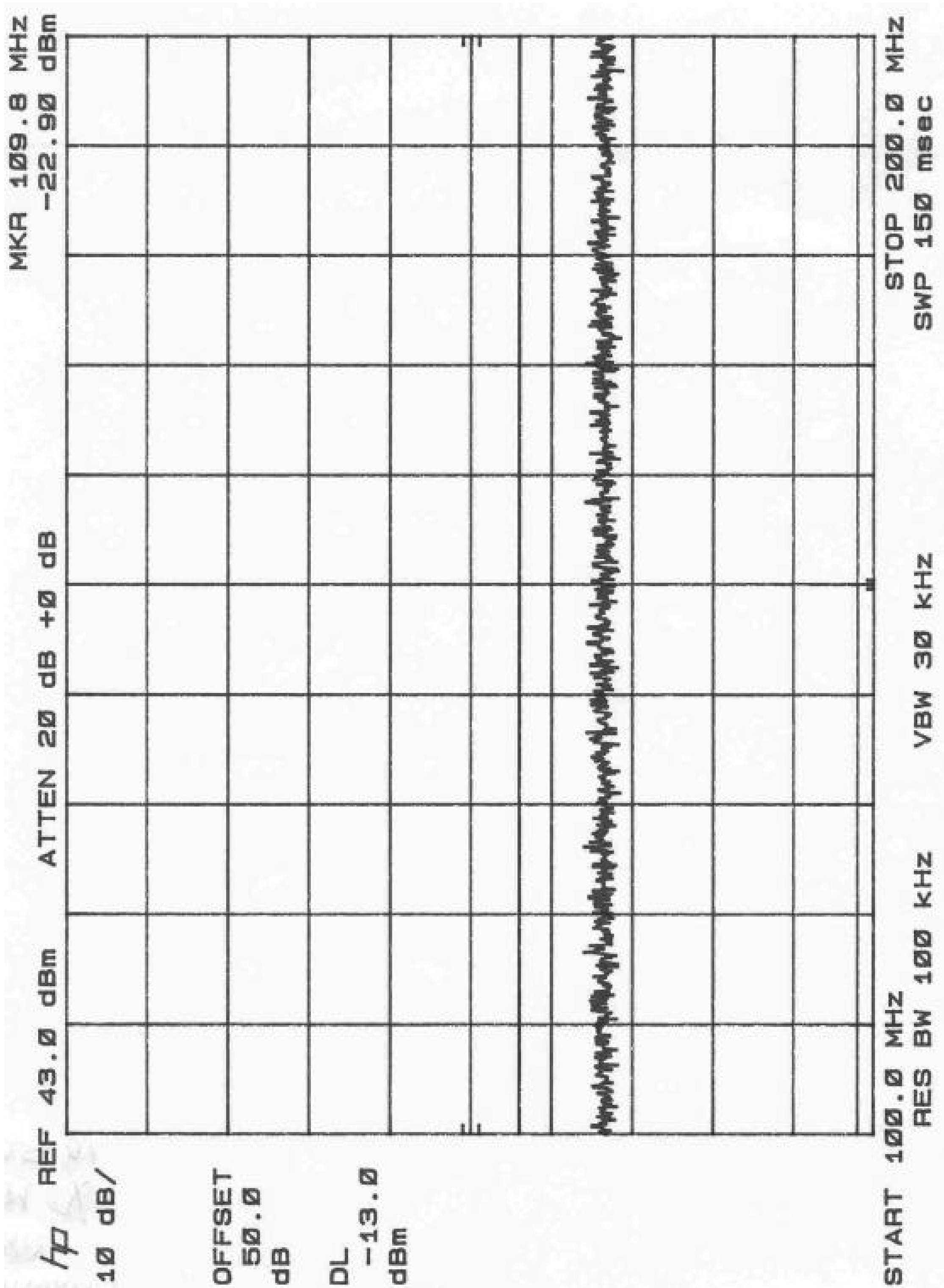

Figure 10. Conducted Spurious Emissions

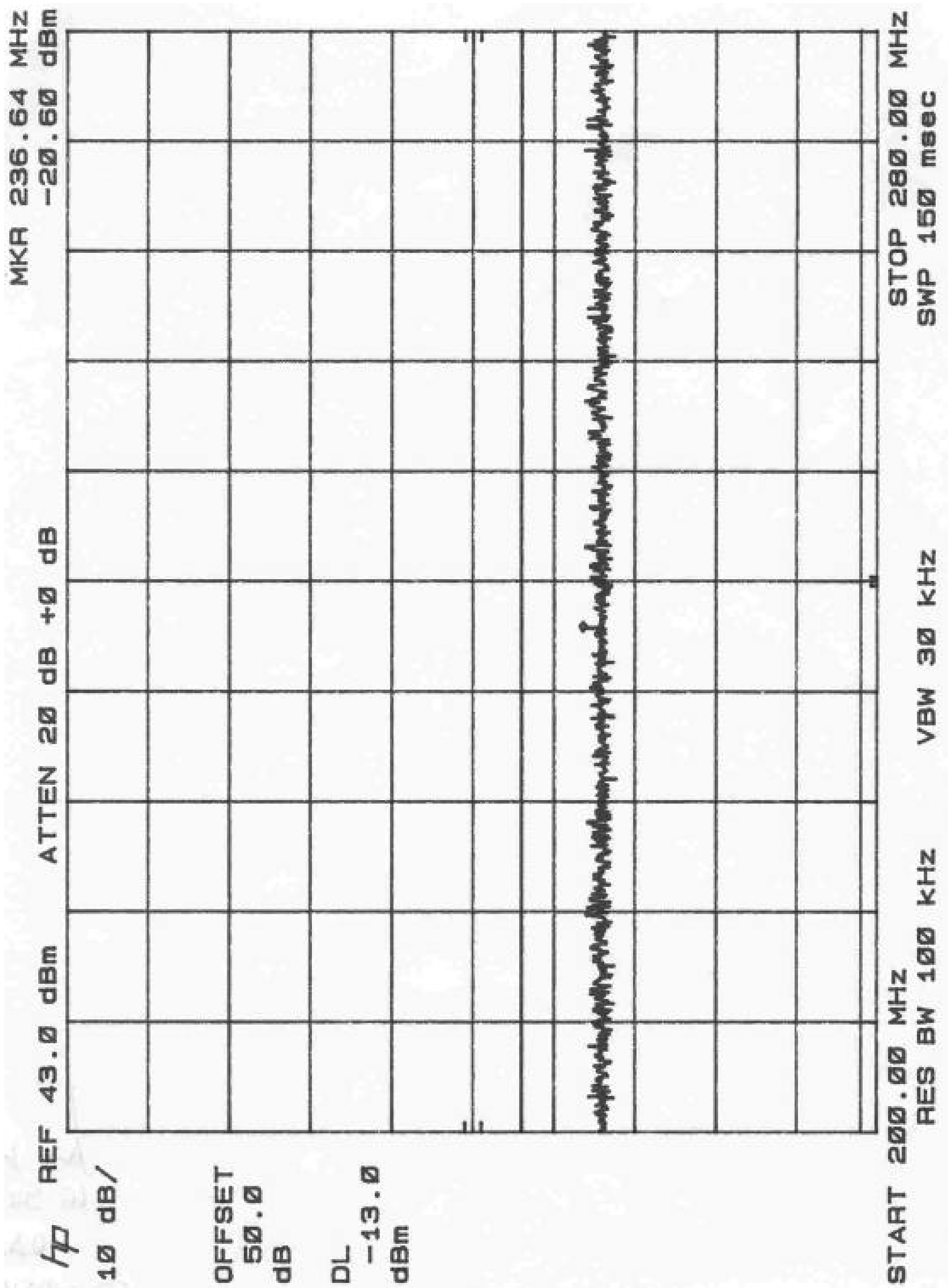

Figure 11. Conducted Spurious Emissions

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.

Figure 12. Radiated Spurious Emissions Limits

Frequency	Fundamental	Harmonic Level (-dBc or E-Field)
Fundamental	--	
FCC Mask	90.210 (c)	90.210 (c)

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.

Substitution Method:

For each of the detected emissions, the EUT was replaced with a transmitting antenna and signal generator. The signal was tuned to the frequency of the detected signal and the amplitude was increased up to the maximum E-Field level of the measured emission. The output power applied to the substitution antenna was measured and added to the gain (in dBi) of the substitution antenna. This power level in EIRP is then converted to ERP and compared to the appropriate FCC limit.

Sample Calculation:

Signal Generator Level (dBm) + Substitution Antenna Gain (dBi) -2.1 dB = EIRP

The levels recorded in the test data sheet are corrected for the ERP reading.

Figure 13: Radiated Emission Test Data-ERP Measurements

CLIENT: Comsonics
MODEL NO: 27 MHz TX
DATE: 12/06/01
CLK SPEED(S): 27.45 MHz TX
BY: Chad M. Beattie
JOB #: 6880X

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	E-FIELD dBuV/m	ERP Level (dBm)	LIMIT dBm	MARGIN dB
27.45	V	225.00	1.0	31.4	18.7	50.1	-36.3	-13.0	-23.3
54.90	V	270.00	1.0	14.3	13.2	27.5	-64.9	-13.0	-51.9
82.35	V	135.00	1.0	28.9	9.5	38.4	-60.5	-13.0	-47.5
109.80	V	315.00	1.0	32.4	12.5	44.9	-46.0	-13.0	-33.0
137.25	V	0.00	1.0	40.2	11.0	51.2	-43.6	-13.0	-30.6
164.70	V	180.00	1.0	36.7	10.8	47.5	-38.7	-13.0	-25.7
192.15	V	0.00	1.0	24.9	11.7	36.6	-56.6	-13.0	-43.6
219.60	V	0.00	1.0	10.0	13.7	23.7	-68.3	-13.0	-55.3
247.05	V	137.00	1.0	11.4	14.4	25.8	-65.7	-13.0	-52.7
274.50	V	50.00	1.0	10.0	15.2	25.2	-57.4	-13.0	-44.4
27.45	H	315.00	4.0	23.2	18.7	41.9	-30.5	-13.0	-17.5
54.90	H	180.00	4.0	17.7	13.2	30.9	-52.7	-13.0	-39.7
82.35	H	90.00	4.0	32.0	9.5	41.5	-53.0	-13.0	-40.0
109.79	H	360.00	4.0	27.9	12.5	40.4	-51.6	-13.0	-38.6
137.25	H	270.00	2.8	44.9	11.0	55.9	-41.6	-13.0	-28.6
164.70	H	270.00	2.2	41.2	10.8	52.0	-44.4	-13.0	-31.4
192.15	H	135.00	2.0	33.5	11.7	45.2	-51.2	-13.0	-38.2
219.60	H	270.00	2.2	23.6	13.7	37.3	-59.9	-13.0	-46.9
247.05	H	270.00	1.5	17.5	14.4	31.9	-65.0	-13.0	-52.0
274.50	H	225.00	1.5	11.7	15.2	26.9	-68.1	-13.0	-55.1

4.7 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured wih the unit in an enviromental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

Figure 14. Frequency Deviation as a Function of Temperature

Temperature Degrees C	Frequency MHz	Difference Hz	Limit (0.002% of Baseline)	Result
23.5 (ambient)	27.44984090	0.0	549.0	--
-30	27.45008540	-244.5	549.0	Pass
-20	27.45018500	-344.1	549.0	Pass
-10	27.45019210	-351.2	549.0	Pass
0	27.45014330	-302.4	549.0	Pass
10	27.45005150	-210.6	549.0	Pass
20	27.44994420	-103.3	549.0	Pass
30	27.44981250	28.4	549.0	Pass
40	27.44967210	168.8	549.0	Pass
50	27.44955310	287.8	549.0	Pass

The EUT is powered by an externally-supplied DC voltage. The maximum voltage is specified to be 13.8VDC. The lowest operated voltage was determined by adjusting the DC supply to a level where the transmitter ceases to operate. For this test, the voltage is adjusted just above this level and the frequency of the transmitter measured.

Low DC Voltage of 5.5 VDC (low threshold of operation)

High DC Voltage of 13.8 VDC (manufacturer's specifications)

Figure 15. Frequency Deviation as a Function of Voltage

Voltage Volts	Frequency MHz	Difference Hz	Limit (0.002% of Baseline)	Test Level Volts
12VDC	27.4498409	---	549.0	Rated
13.8VDC	27.4498409	0	549.0	Max
5.5 VDC	27.4497924	48.5	549.0	Threshold

4.8 Transient Frequency Response (Part 90.214)

Transmitters designed top operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated in section 90.214.

This section is not applicable to the EUT.

5 Transmitter Environmental Assessment, Maximum Permissible Exposure (MPE)

5.1 SCOPE

This testing applies to RF transmitters used more than 20 cm of a human body.

5.2 REFERENCE

OET Bulletin 65

FCC § 1.1307, Radio Frequency Exposure

The EUT described in this report has been evaluated to the MPE limits for **General Population/Uncontrolled Environment**.

According to Section 1.1310 of the FCC rules, the uncontrolled RF exposure limit for this frequency range is $180/f^2$ (mW/cm^2). To comply with the exposure limits for this section, humans must not be too close to the transmit antenna. The following formula was used to calculate the minimum safe distance from the antenna that must be maintained during use (no time averaging was used):

$$S = (PG)/(4\pi R^2)$$

Where,

S = Power Density

P = Output Power at the Antenna Terminals in mW

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna in cm

For this device, the calculation is as follows: (Based on worst case power and frequency)

S = FCC Limit = $180/(27.45)^2$ mW/ cm^2 = 0.24 mW/ cm^2

P = Output Power = 20000 mW

G = Antenna Gain = 0 dBi = INVLOG(0/10) = 1

Therefore:

$$R = \sqrt{\left(20000mW \times 1.\ \right) \div \left(4 \times \boldsymbol{p} \times 0.24\right)}$$

R = 81cm (Continuous operation)

From this calculation, the minimum safe distance is 81 cm for continuous operation. Based on the worst-case usage of the device as described in the theory of operation the source-based time averaging would be at worst case 10% duty cycle. This would reduce the minimum safe distance to 8.1 cm.

R = 8.1 cm (Source-based time-averaging)

The antenna for this radio is located on top of a utility truck or van and is only in use while the operator is located a fair distance from the truck or van. For this reason the minimum safe distance is met by the typical mounting of the antenna.