FCC Certification Test Report

FCC Certification Test Report
for
Codan Limited
DYYNGT-2

April 25, 2003

Revision 1 June 24, 2003

Prepared for:

Codan Limited
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Newton, South Australia 5074
AUSTRALIA

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

FCC Certification Test Report
for the
Codan Limited
NGT Transceiver
DYYNGT-2

April 17, 2003

Revision 1 June 24, 2003

WLL JOB# 7314

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Abstract

This report has been prepared on behalf of Codan Limited to support the attached Application for Equipment Authorization under Part 90 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Codan Limited NGT SSB 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 Codan Limited NGT SSB Transceiver complies with the technical requirements of Part 90 of the FCC Rules and Regulations.

Revision 1 June 24, 2003

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1 Introduction

1.1 Compliance Statement

The Codan Limited NGT Transceiver complies with the technical requirements under Part 90 of the FCC Rules and Regulations.

1.2 Test Scope

Measurements were made on the Equipment Under Test in accordance with FCC Rule Part 2, specifically the requirements stipulated in:

2.1046 RF Power Output

2.1047 Modulation Characteristics

2.1049 Occupied Bandwidth

2.1051 Spurious Emissions at Antenna Terminals

2.1053 Field Strength of Spurious Radiation

2.1055 Frequency Stability

1.3 Contract Information

Customer: Codan Limited
81 Graves Street
Newton, South Australia 5074
AUSTRALIA

Purchase Order Number: 38041

Quotation Number: 60393

1.4 Test Dates

Testing was performed from November 2002 through March 2003.

1.5 Test and Support Personnel

Washington Laboratories, LTD James Ritter, Ken Gemmell

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
SSB	Single Side Band
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Codan Limited NGT Transceiver is a Single Side Band (SSB) transceiver that can be installed in a vehicle, or used as a base station. The NGT system is comprised of a 2020 Handset, 2030 Junction Box, and the 2010 RF Unit. The handset is a hand-held device with a microphone, Push-To-Talk (PTT) button, display, and keypad.

Three models of the NGT 2010 are available. The models incorporate identical hardware, and differ only in the software features of each. The VR only has 15 channels and ALE is not available. The ASR is the same as the SR model but has enhanced ALE capabilities and user interface.

The Junction Box is a unit to which the handset, RF unit, speaker, and related items are connected. The units are connected together via the use of the Codan Interconnector Bus (CIB).

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Codan Limited
FCC ID Number	DYYNGT-2
EUT Name:	SSB HF Transceiver
Model:	NGT
FCC Rule Parts:	§90
Frequency Range:	1.6 -30MHz
Maximum Output Power:	100W PEP
Modulation:	SSB
Necessary Bandwidth:	2.8kHz
Keying:	Manual
Type of Information:	Voice, ALE, Selcall
Number of Channels:	SR=400 VR=15
Power Output Level	Fixed
Antenna Type	Connector
Frequency Tolerance:	50Hz and 20ppm
Emission Type(s):	2K80J3E, 2K80H3E, 2K80J2B
Power Source & Voltage:	13.6Vdc via vehicle power or adapter

2.2 Test Configuration

The NGT was configured the 2020 Handset and speaker connected to the 2030 Junction Box which was connected to the 2010 RF Unit. Power was supplied via the Codan 3020 DC Power Supply. The transmitter was tested at 1.65 MHz (low channel), 15.6 MHz (mid channel), and 29.9 MHz (high channel).

Table 2. Interface Cables

Port/Interface	Cable	Connected from/to:
DC Power Port (Battery)	Non-shielded 2m cable	RF Unit to DC Power Supply
CIB Port (8-pin DIN)	Shielded 5m cable	RF Unit to Junction Box
Antenna Port	Shielded RG8 2m coaxial cable	RF Unit to RF Terminator
Antenna Control Port (6-pin DIN)	Shielded 1m cable	Unterminated
Junction Box Handset Port (7-pin DIN)	Shielded handset cable (attached to handset) (~ 3m)	Handset to Junction Box
Junction Box Speaker Port	Non-shielded speaker cable (attached to speaker) (~ 3m)	Speaker to Junction Box

2.3 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.

2.4 Measurements

2.4.1 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)

2.5 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 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Site 1 List:

Equipment	**Serial Number**	**Calibration Due**
Sunol Science JB1 Biconilog Antenna	A090501	10/03/03
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

4 Test Results

4.1 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to a 50dB 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. Two tones (500Hz and 2400Hz) with equal audio levels were provided and adjusted to produce the full PEP. The RF output power across a 50 ohm load termination was measured by an oscilloscope to measure RMS voltage. The following formula was used to convert the measured RMS voltage to power:

$P_p = (Vpk(rms))^2 / Z_o$

Table 4. RF Power Output

Frequency	Level
Low Channel 1.65 MHz	108 Watts
Mid Channel 15.6 MHz	104.7 Watts
High Channel 29.9 MHz	117.5 Watts

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

A curve of the transmit audio frequency response from 0Hz to 5000Hz is included in Figure 4-1. This data was obtained at the audio output test point located on the Audio Interface Board at TXAUD102. The Single Sideband filter frequency response is included as Figure 4-2. A curve is also included in Figure 4-3 which shows the RF power output limiting over the modulation input voltage. This testing was performed while in the 15.6MHz (Mid) channel.

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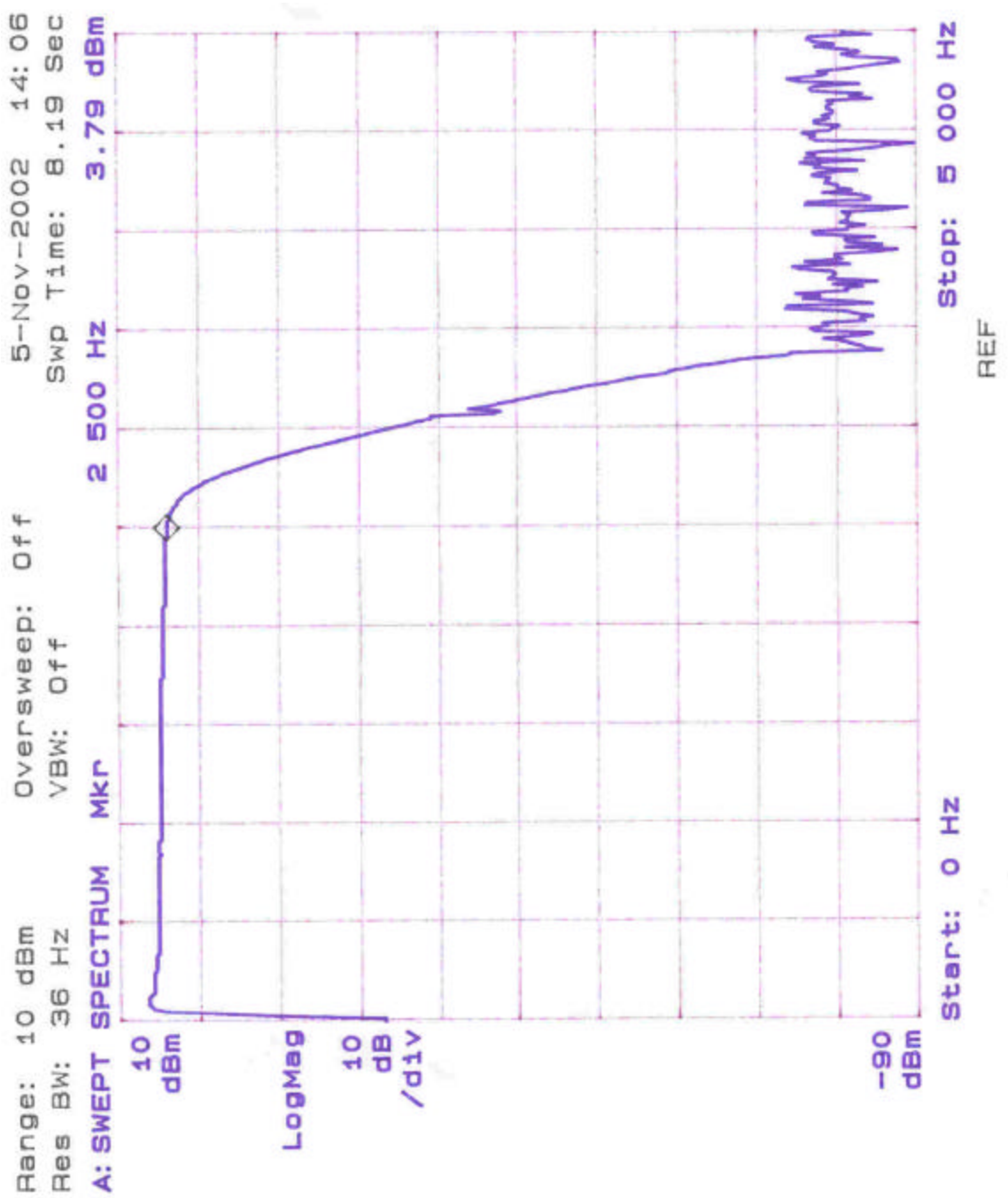

Figure 4-1. Audio Frequency Response

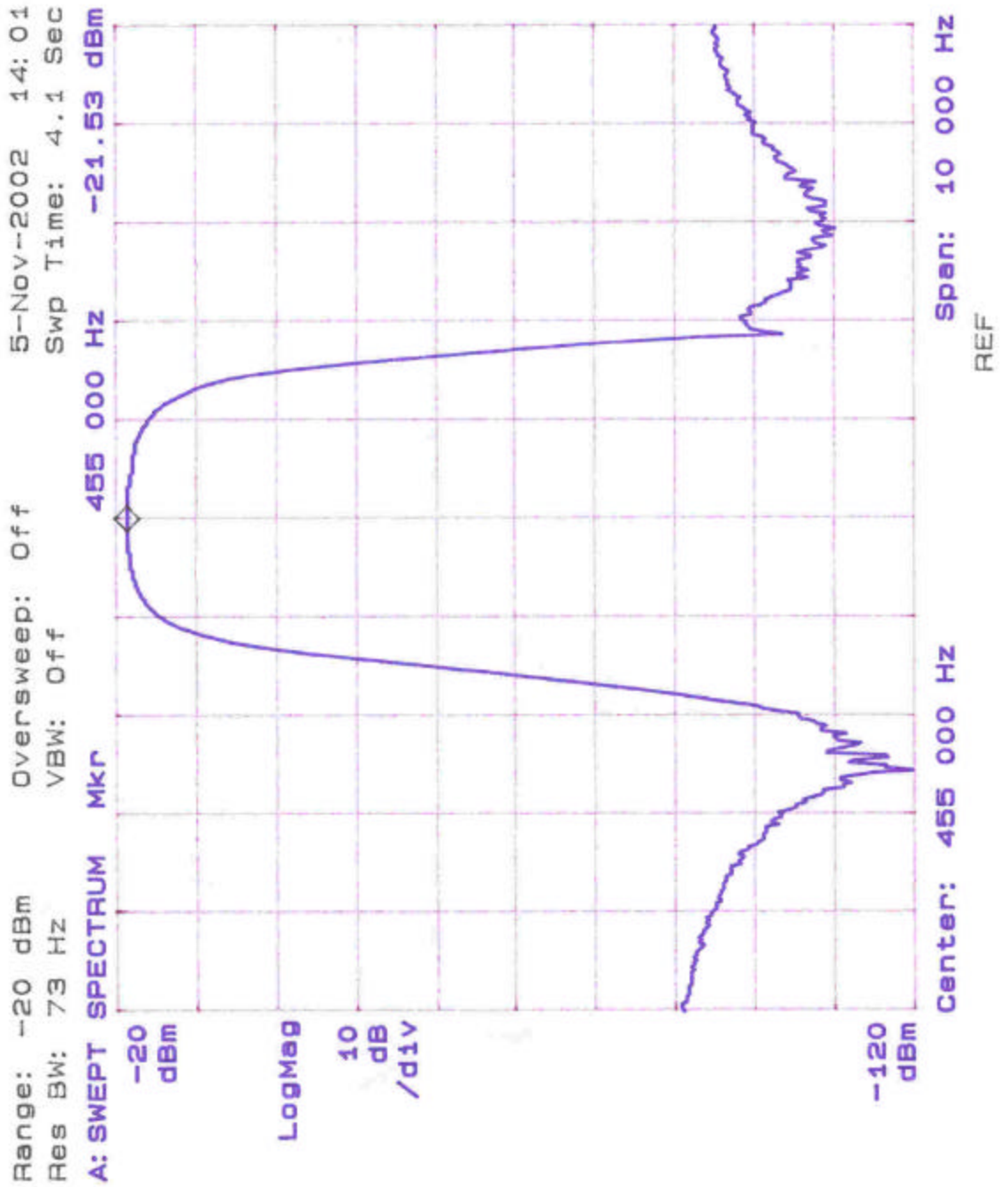

Figure 4-2. Single Sideband Filter Frequency Response

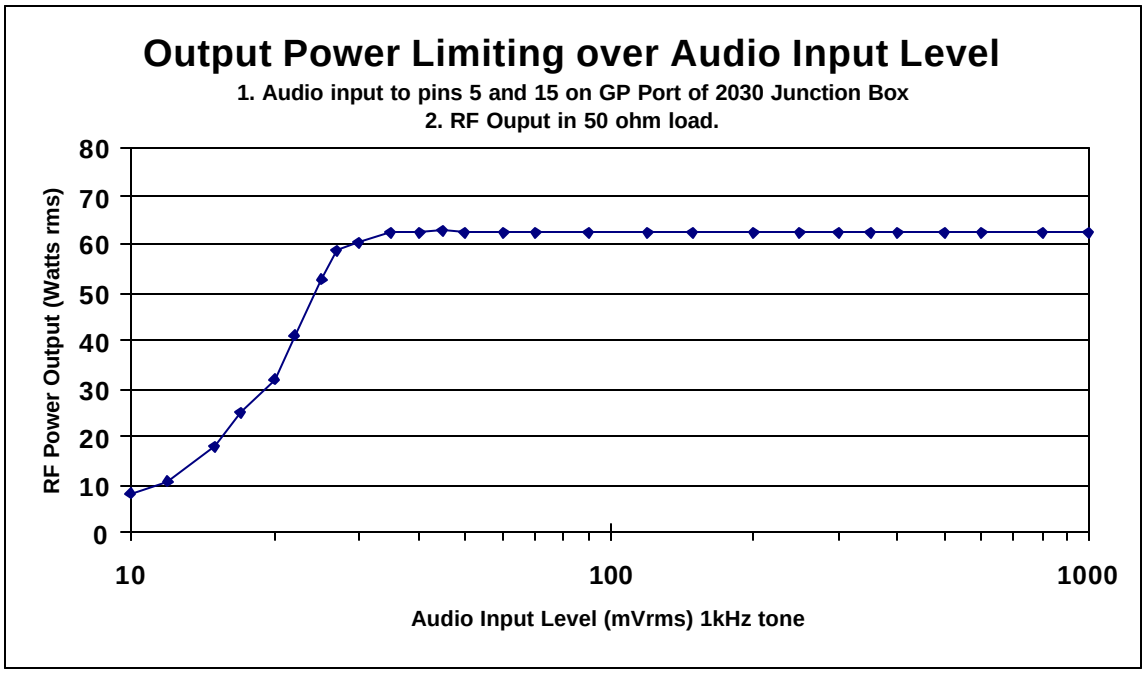

Figure 4-3. RF Output Power Limiting

4.3 Emission Mask and Occupied Bandwidth: (FCC Part §2.1049)

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

The occupied bandwidth was measured by supplying the EUT with two audio tones (400Hz and 1800Hz). The occupied bandwidth of the transceiver was measured at 1.65MHz (Low), 15.6MHz (Mid) and 29.9MHz (High) channels. The RF output of the EUT was connected to the Hewlett Packard Spectrum Analyzer (M/N: HP 8564E) via a 50dB attenuator. The spectrum analyzer measurement resolution bandwidth was set to 100 Hz.

Per Section 90.210(a) of the FCC Rules, the power of any emission shall be attenuated below the unmodulated carrier power by the following:

1) On any frequency removed from the assigned frequency by more than 50%, but not more than 150% of the authorized bandwidth: at least 25 dB.

2) On any frequency removed from the assigned frequency by more than 150%, but not more than 250% of the authorized bandwidth: At least 35 dB

3) On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth: At least 43 + 10 log P dB.

For the EUT:

$$43 + 10 \text{ Log } (100) \text{ W} = 63 \text{ dB}$$

The emissions were checked up to the tenth harmonic of the carrier frequency. Results for emissions detected outside the 250% of the authorized bandwidth are given in Section 4.4.

Results of the bandwidth and emission mask testing are shown in Figure 4-4 through Figure 4-6.

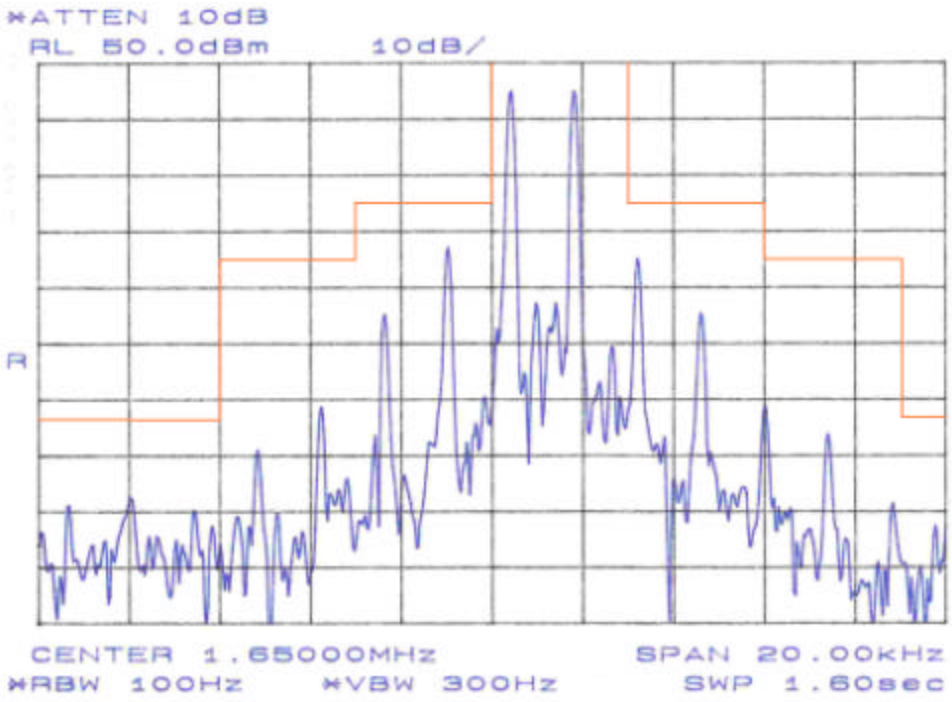

Figure 4-4. Emission Mask and Occupied Bandwidth, Low Channel

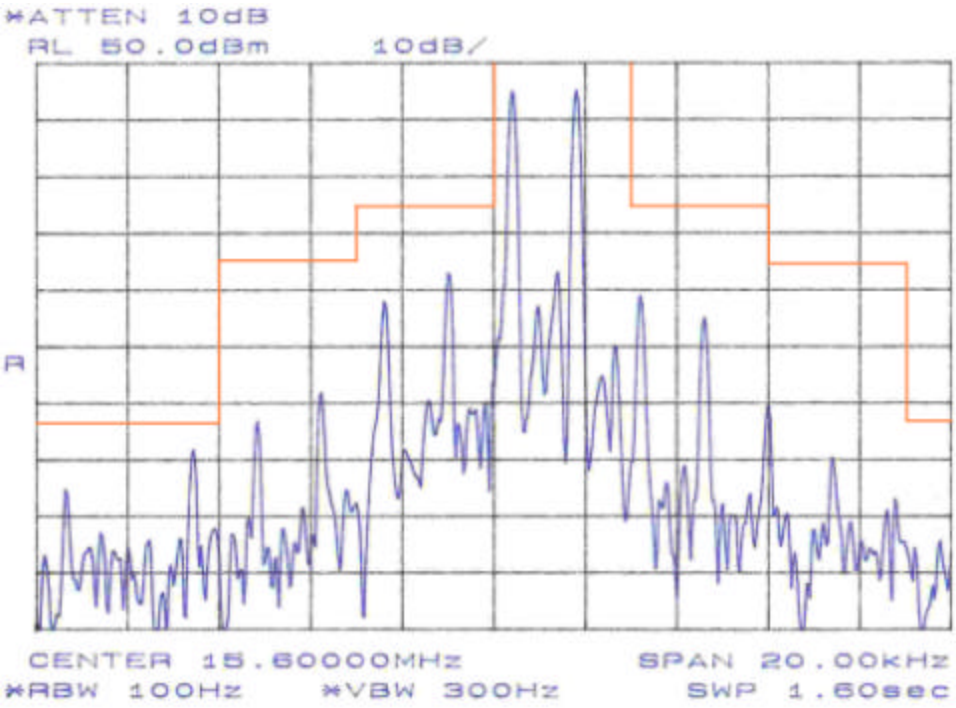

Figure 4-5. Emission Mask and Occupied Bandwidth, Mid Channel

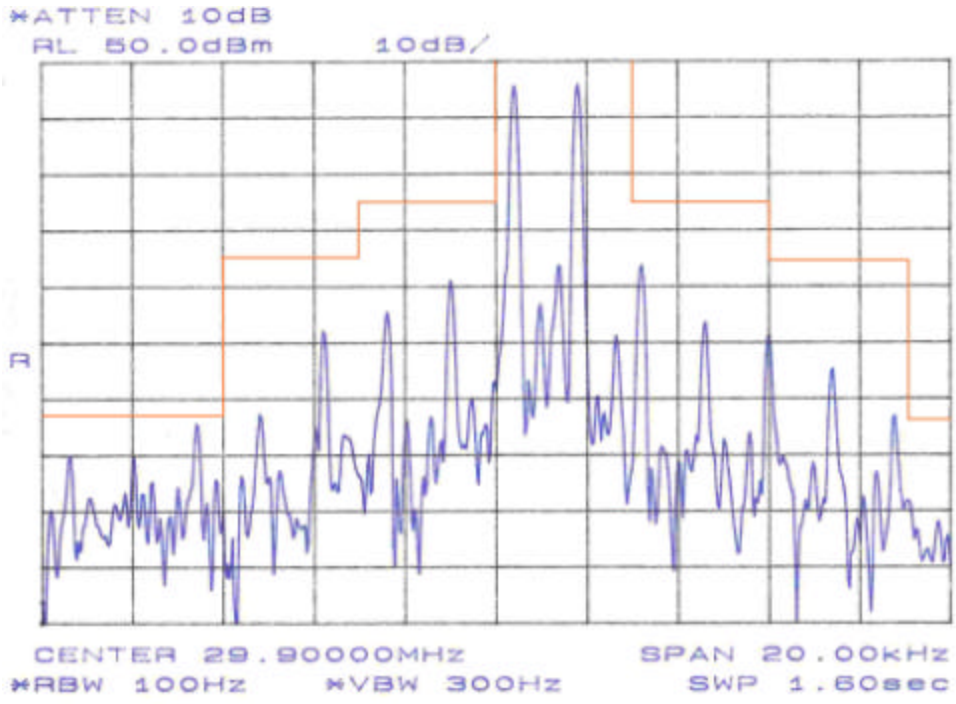

Figure 4-6. Emission Mask and Occupied Bandwidth, High Channel

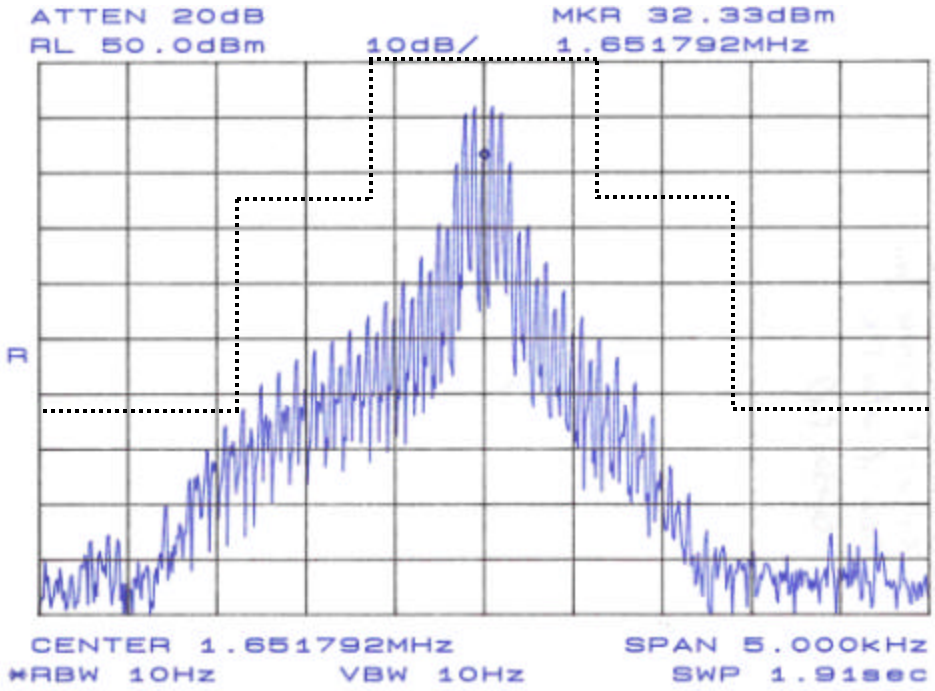

Figure 4-7, Emission Mask and Occupied Bandwidth, Low Channel, J2B

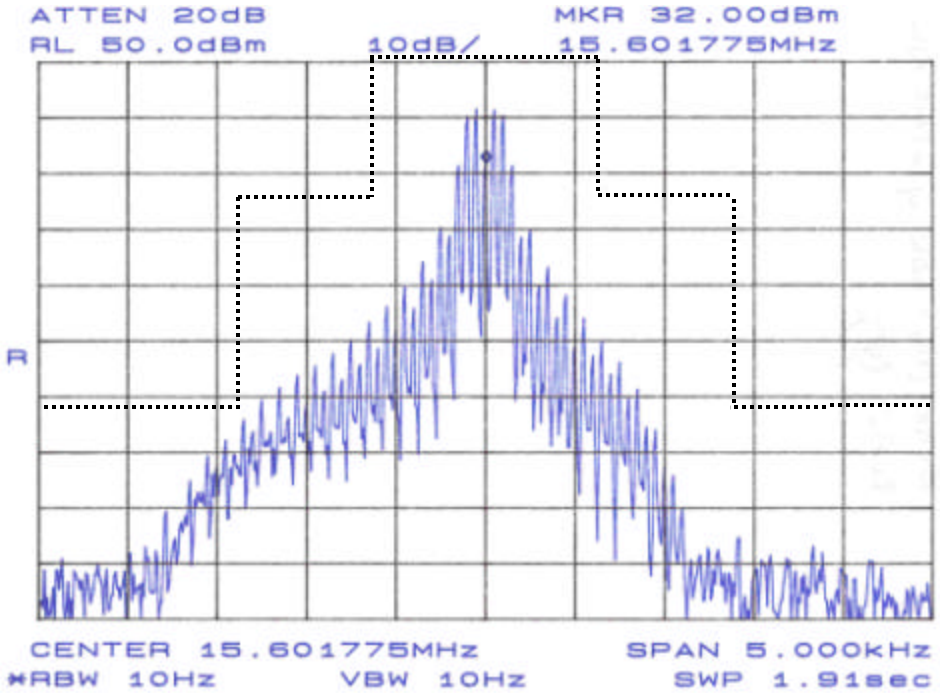

Figure 4-8, Emission Mask and Occupied Bandwidth, Mid Channel, J2B

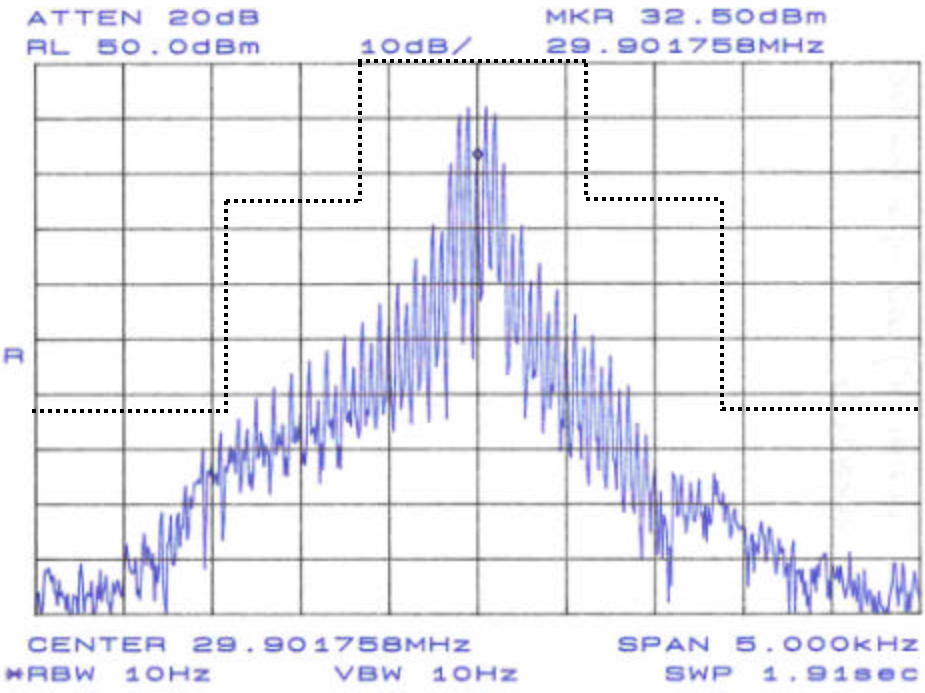

Figure 4-9, Emission Mask and Occupied Bandwidth, High Channel, J2B

4.4 Spurious Emissions at Antenna Terminals (FCC Part §2.1051

Spurious emissions were measured by connecting the antenna terminals to the input of an HP 8564E spectrum analyzer via a 70dB attenuator. The unit was supplied with two audio tones (400Hz and 1800Hz). The limit for the spurious emissions is 63dB below the unmodulated carrier power.

Results of the conducted spurious emissions are shown in Figure 4-10 through Figure 4-12.

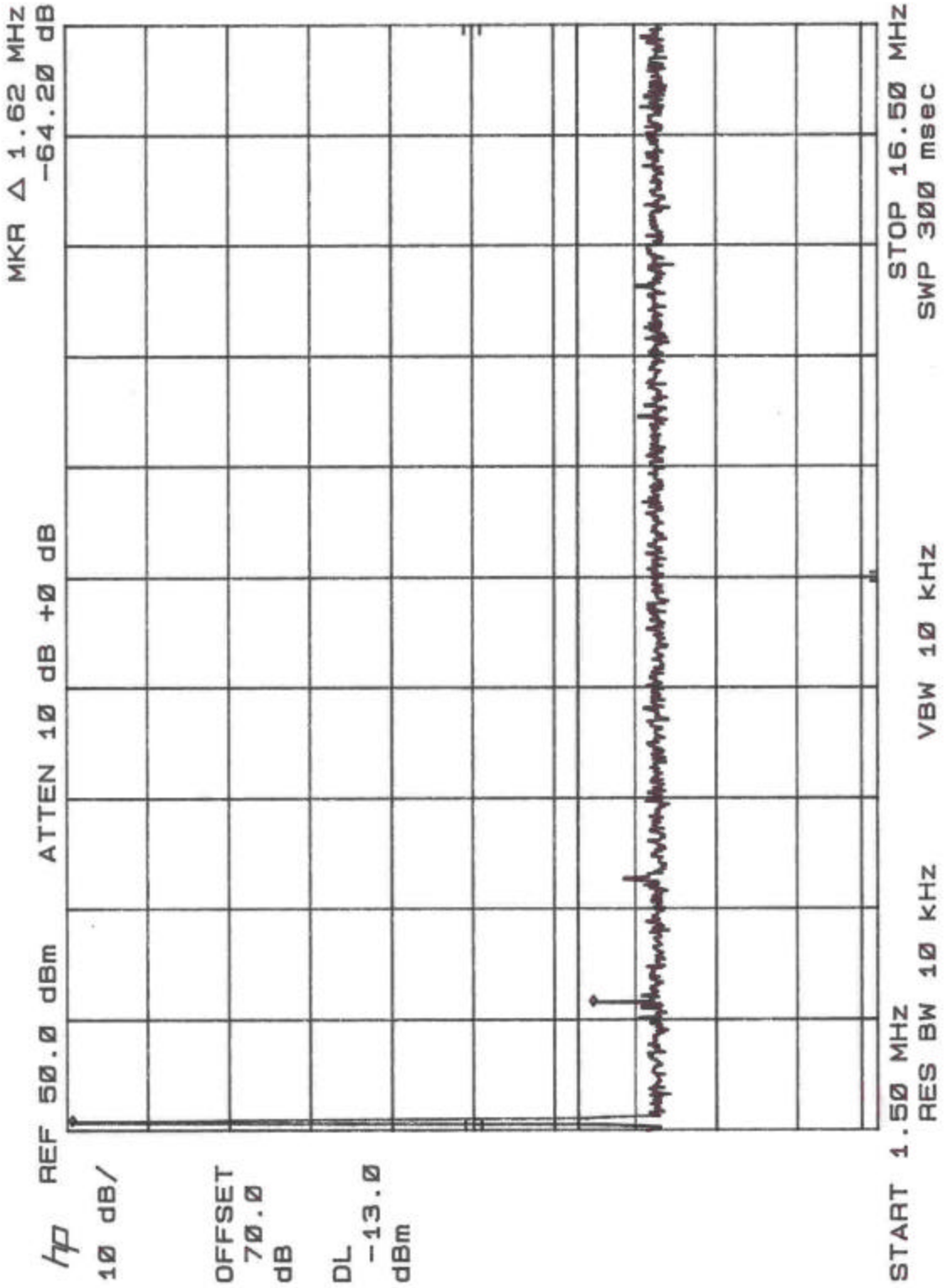

Figure 4-10. Conducted Spurious Emissions, Low Channel

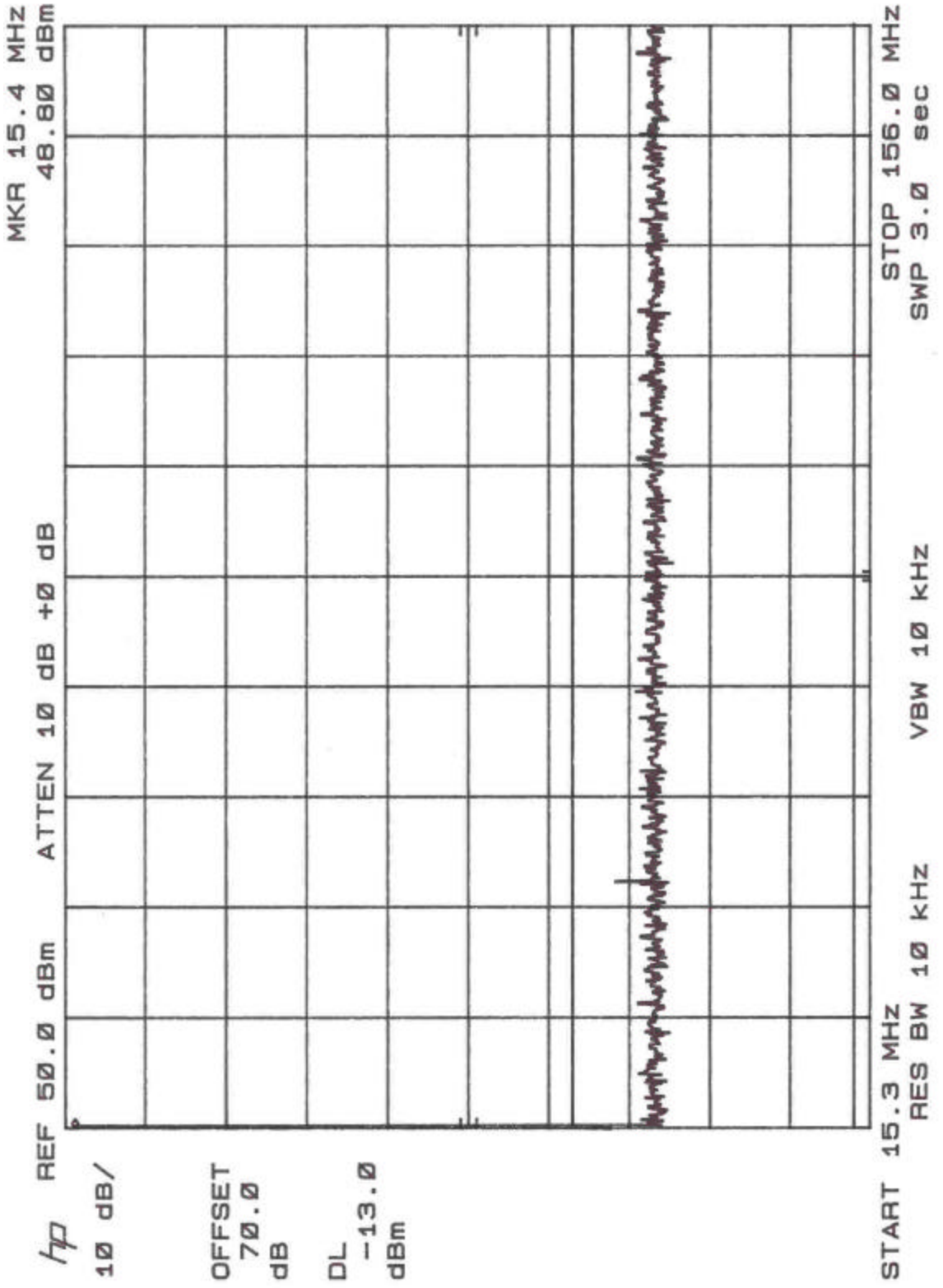

Figure 4-11. Conducted Spurious Emissions, Mid Channel

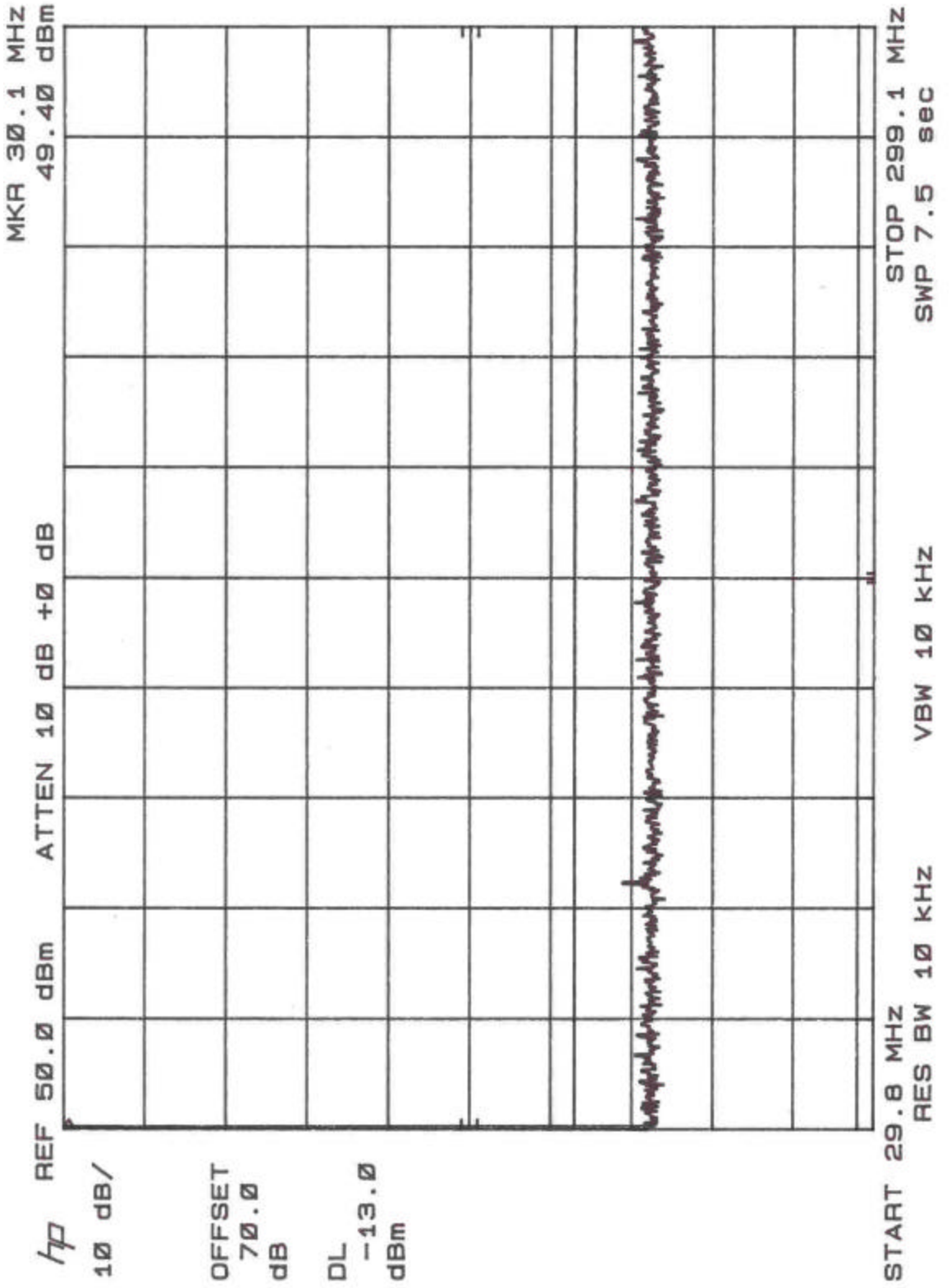

Figure 4-12. Conducted Spurious Emissions, High Channel

4.5 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with requirements for radiated spurious emissions. During this test the output of the EUT is to be connected into a 50 ohm load capable of handling the maximum power of the EUT.

4.5.1 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.

The EUT was setup with two audio tones at 400Hz and 1800Hz supplied to the input.

Two methods of testing were performed for the radiated spurious emissions. For the Mid and High frequency channel, the substitution method was used and the EIRP level was computed and compared with the limit (-13dBm). For the Low channel, which operates at 1.65MHz, resultant E-field levels were obtained and compared to the equivalent E-field limit of 84.4dBuV/m. This limit was calculated using the following formula:

$$E(V/m) = \frac{1}{r}\sqrt{30 \times P(W) \times G(t)}$$

substituting with the following values:

r = 3

P(W) = Limit = -13dBm (50.12µW)

G(t) = 1.64 (Unity gain dipole)

Results in E(V/m) = 16.55 mV/m = 84.4 dBµV/m

Table 5: Radiated Emission Test Data, Channel 3 29.9 MHz

CLIENT:	CODAN	DATE:	3/13/03
TESTER:	James Ritter	JOB #:	7314
EUT Information:		**Test Requirements:**	
EUT:	NGT Transceiver	TEST STD:	FCC Part 15
CONFIGURATION:	Transmit into load	DISTANCE:	3m
CLOCKS:	see channel frequencies below	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_00382	LIMIT:	Part 90
CABLE:	CSITE1_3m	AMPLIFIER (dB)	None

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBµV)	SA Level dBm	Ant. Gain dBi	Sig. Gen. Level dBm	EIRP Level dBm	Limit (dBm)	Margin dB
59.80	H	180.0	2.0	57.2	-49.8	-5.3	-23.2	-28.5	-13.0	-15.5
89.73	H	270.0	2.0	58.8	-48.2	0.9	-26.5	-25.6	-13.0	-12.6
119.60	H	160.0	2.5	62.7	-44.3	-1.8	-16.6	-18.4	-13.0	-5.4
149.50	H	190.0	2.0	56.7	-50.3	0.5	-28.0	-27.5	-13.0	-14.5
179.40	H	90.0	2.0	61.2	-45.8	-1.1	-22.0	-23.1	-13.0	-10.1
209.30	H	270.0	2.3	58.3	-48.7	-0.2	-26.5	-26.7	-13.0	-13.7
239.20	H	170.0	2.0	57.4	-49.6	3.0	-23.4	-20.4	-13.0	-7.4
269.10	H	270.0	2.4	41.0	-66.0	0.2	-25.6	-25.4	-13.0	-12.4
299.00	H	190.0	2.4	48.5	-58.5	-0.6	-24.2	-24.8	-13.0	-11.8
59.80	V	245.0	1.0	59.8	-47.2	-5.3	-22.9	-28.2	-13.0	-15.2
89.73	V	190.0	1.0	68.3	-38.7	0.9	-16.8	-15.9	-13.0	-2.9
119.60	V	270.0	1.0	60.6	-46.4	-1.8	-15.5	-17.3	-13.0	-4.3
149.50	V	340.0	1.0	53.3	-53.7	0.5	-22.2	-21.7	-13.0	-8.7
179.40	V	180.0	1.0	60.0	-47.0	-1.1	-14.4	-15.5	-13.0	-2.5
209.30	V	180.0	1.0	58.7	-48.3	-0.2	-18.4	-18.6	-13.0	-5.6
239.20	V	190.0	1.0	58.9	-48.1	3.0	-19.5	-16.5	-13.0	-3.5
269.10	V	260.0	1.0	40.8	-66.2	0.2	-23.4	-23.2	-13.0	-10.2
299.00	V	180.0	1.0	46.2	-60.8	-0.6	-25.8	-26.4	-13.0	-13.4

Table 6: Radiated Emission Test Data, Channel 2 15.6 MHz

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBµV)	SA Level dBm	Ant. Gain dBi	Sig. Gen. Level dBm	EIRP Level dBm	Limit (dBm)	Margin dB
31.20	H	100.0	4.0	46.2	-60.8	-12.0	-17.8	-29.8	-13.0	-16.8
46.80	H	0.0	4.0	42.7	-64.3	-10.8	-27.3	-38.1	-13.0	-25.1
62.40	H	0.0	4.0	66.7	-40.3	-4.6	-15.8	-20.4	-13.0	-7.4
78.00	H	0.0	4.0	46.1	-60.9	0.8	-40.4	-39.6	-13.0	-26.6
93.60	H	100.0	4.0	46.1	-60.9	0.6	-36.7	-36.1	-13.0	-23.1
109.20	H	180.0	4.0	55.0	-52.0	-2.7	-22.9	-25.6	-13.0	-12.6
124.80	H	180.0	4.0	58.7	-48.3	-1.3	-21.2	-22.5	-13.0	-9.5
140.40	H	180.0	4.0	54.1	-52.9	0.5	-27.1	-26.6	-13.0	-13.6
156.00	H	180.0	4.0	56.9	-50.1	-1.5	-23.4	-24.9	-13.0	-11.9
31.20	V	100.0	1.0	58.9	-48.1	-12.0	-7.3	-19.3	-13.0	-6.3
46.80	V	0.0	1.0	52.6	-54.4	-10.8	-13.6	-24.4	-13.0	-11.4
62.40	V	0.0	1.0	70.8	-36.2	-4.6	-11.8	-16.4	-13.0	-3.4
78.00	V	0.0	1.0	55.6	-51.4	0.8	-27.4	-26.6	-13.0	-13.6
93.60	V	100.0	1.0	52.9	-54.1	0.6	-30.2	-29.6	-13.0	-16.6
109.20	V	180.0	1.0	57.0	-50.0	-2.7	-20.8	-23.5	-13.0	-10.5
124.80	V	180.0	1.0	63.7	-43.3	-1.3	-14.2	-15.5	-13.0	-2.5
140.40	V	180.0	1.0	58.4	-48.6	0.5	-22.5	-22.0	-13.0	-9.0
156.00	V	180.0	1.0	59.8	-47.2	-1.5	-14.2	-15.7	-13.0	-2.7

Table 7: Radiated Emission Test Data, Channel 1 1.65 MHz

Test Equipment/Limit:

ANTENNA:	A_00031 Loop Antenna Field Strength	LIMIT:	Part 90
CABLE:	CSITE1_3m	AMPLIFIER (dB)	None

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin dB
3.30	X	180.0	1.0	23.4	10.4	0.3	34.1	50.8	84.4	-4.4
4.95	X	320.0	1.0	24.5	10.5	0.4	35.4	59.0	84.4	-3.1
6.60	X	180.0	1.0	17.9	10.5	0.5	28.9	27.9	84.4	-9.6
8.25	X	0.0	1.0	15.8	10.6	0.6	27.0	22.4	84.4	-11.5
9.90	X	0.0	1.0	21.4	10.7	0.6	32.7	43.1	84.4	-5.8
11.55	X	270.0	1.0	17.7	10.7	0.7	29.1	28.4	84.4	-9.5
13.20	X	10.0	1.0	17.0	10.8	0.7	28.5	26.7	84.4	-10.0
14.85	X	0.0	1.0	16.8	10.8	0.8	28.4	26.2	84.4	-10.2
16.50	X	0.0	1.0	24.6	10.7	0.8	36.1	63.9	84.4	-2.4
3.30	Y	0.0	1.0	25.4	10.4	0.3	36.1	64.0	84.4	-2.4
4.95	Y	270.0	1.0	23.4	10.5	0.4	34.3	52.0	84.4	-4.2
6.60	Y	10.0	1.0	18.8	10.5	0.5	29.8	31.0	84.4	-8.7
8.25	Y	270.0	1.0	16.3	10.6	0.6	27.5	23.7	84.4	-11.0
9.90	Y	80.0	1.0	18.2	10.7	0.6	29.5	29.8	84.4	-9.0
11.55	Y	90.0	1.0	10.2	10.7	0.7	21.6	12.0	84.4	-17.0
13.20	Y	0.0	1.0	8.7	10.8	0.7	20.2	10.3	84.4	-18.3
14.85	Y	290.0	1.0	13.5	10.8	0.8	25.1	17.9	84.4	-13.5
16.50	Y	80.0	1.0	21.8	10.7	0.8	33.3	46.3	84.4	-5.2

4.6 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 with the unit in an environmental 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 EUT is powered by DC voltage supplied externally. The manufacturers power requirements for the EUT include the following:

Low DC Voltage of 10.8 VDC (manufacturer's specification)

High DC Voltage of 15 VDC (manufacturer's specifications)

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. The following are the reference frequencies at ambient for the Low, Middle, and High channels.

Low Channel: 1.65 MHz

Mid Channel: 15.6 MHz

High Channel: 29.9 MHz

Table 8. Frequency Deviation as a Function of Temperature

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)
Low Channel			
Ambient (19.3C)	1.6499989	0.0	50Hz
50°C	1.6499987	0.2	50Hz
40°C	1.6499990	0.1	50Hz
30°C	1.6499991	0.2	50Hz
20°C	1.6499990	0.1	50Hz
10°C	1.6499992	0.3	50Hz
0°C	1.6499997	0.8	50Hz
-10°C	1.6499997	0.8	50Hz
-20°C	1.6500000	1.1	50Hz
Mid Channel			
Ambient (19.3C)	15.599990	0.0	50 Hz
50°C	15.599988	2.0	50 Hz
40°C	15.599990	0.0	50 Hz
30°C	15.599992	2.0	50 Hz
20°C	15.599991	1.0	50 Hz
10°C	15.599994	4.0	50 Hz
0°C	15.599997	7.0	50 Hz
-10°C	15.599999	9.0	50 Hz
-20°C	15.600001	11.0	50 Hz

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)
High Channel			(20ppm)
Ambient (19.3C)	29.899988	0.0	598
50°C	29.899978	10.0	598
40°C	29.899984	4.0	598
30°C	29.899985	3.0	598
20°C	29.899987	1.0	598
10°C	29.899991	3.0	598
0°C	29.899995	7.0	598
-10°C	29.899996	8.0	598
-20°C	29.900001	13.0	598

Table 9. Frequency Deviation as a Function of Voltage

Channel	Voltage (Volts DC)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)
Low Channel	13.6	1.6499988	0.00	50
	10.8	1.6499990	-0.20	50
	15	1.6499989	-0.10	50
Mid Channel	13.6	15.5999903	0.00	50
	10.8	15.5999900	0.30	50
	15	15.5999895	0.80	50
High Channel	13.6	29.8999900	0.00	598
	10.8	29.8999902	-0.20	598
	15	29.8999907	-0.70	598