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Motorola Inc.

Application
For Certification
GMRS/FRS Transmitter, Model T5800 and T5820

FCC ID: AWWT5800

May 14, 2002

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TABLE OF CONTENTS

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1.0 GENERAL DESCRIPTION

1.1 Related Submittals Grants

This is single application of the T5800 and T5820, GMRS/FRS Transmitter for Certification under FCC Part 95, Subpart A and B.
There are no other simultaneous applications.

1.2 Product Description

The *T5800 and T5820 GMRS/FRS Transmitters* are two-way radio, which contains a transmitter and a receiver. The *T5800 and T5820 GMRS/FRS Transmitters* are used a permanently attached antenna. The *T5800 and T5820 GMRS/FRS Transmitters* share the same RF circuitry and RF output power. The Model T5820 has more users interface options. Testing of the Model T5800 was covered in this Report.

The *T5800 GMRS/FRS Transmitter* operates in following frequency ranges:

GMRS Channels 1 –7 and 15 - 22:
From 462.5500 to 462.7250MHz, Channel spacing 12.5kHz (Emission Designator 11K0F3E)

FRS Channels 8 - 14:
From 476.5625 to 467.7125MHz, Channel spacing 25.0kHz (Emission Designator 11K0F3E)

Operating Power Level:

1.0 Watt maximum (30.00dBm) at GMRS Channels
0.5 Watt maximum (26.99dBm) at FRS Channels

The T5800 GMRS/FRS Transmitter uses the omni directional non-detachable antenna.

Antenna Length: 57.3mm
Frequency: 465MHz ±3%
Impedance: 50Ω

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1.3 Test Methodology

Emission measurements were performed according to the procedures in specified by ANSI/TIA/EIA-603-1992. All field strength radiated emissions measurements were performed in the semi-anechoic chamber using a substitution antenna method. All field strength radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

1.4 Test Facility

The test site facility used to collect the radiated and conducted measurement data is located at 7250 Hudson Blvd., Suite 100, Oakdale, Minnesota. This test facility has been fully described in a report dated on January 2000 submitted to your office. Please reference the site registration number: 90706, dated May 19, 2000.

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2.0 SYSTEM TEST CONFIGURATION

2.1 Justification

None.

2.2 EUT Exercising Software

No software was used to exercise the *T5800 GMRS/FRS Transmitter*.

2.3 Special Accessories

There are no special accessories necessary for compliance of these products.

2.4 Equipment Modification

No modifications were installed during the testing.

2.5 Support Equipment List and Description

1611A BK Precision DC Power Supply, s/n 241-00988

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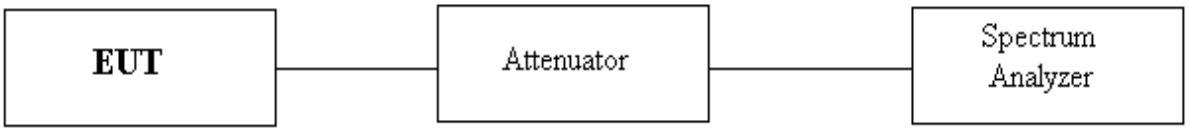
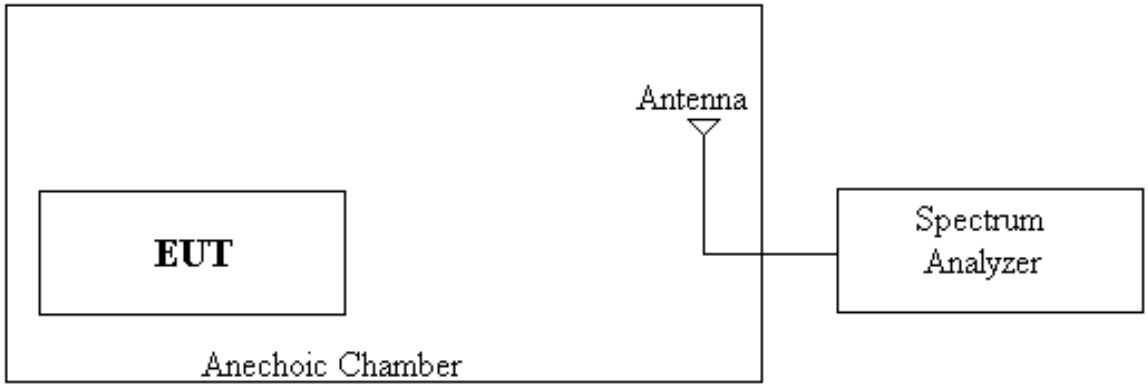
2.6 Test Configuration Block Diagrams

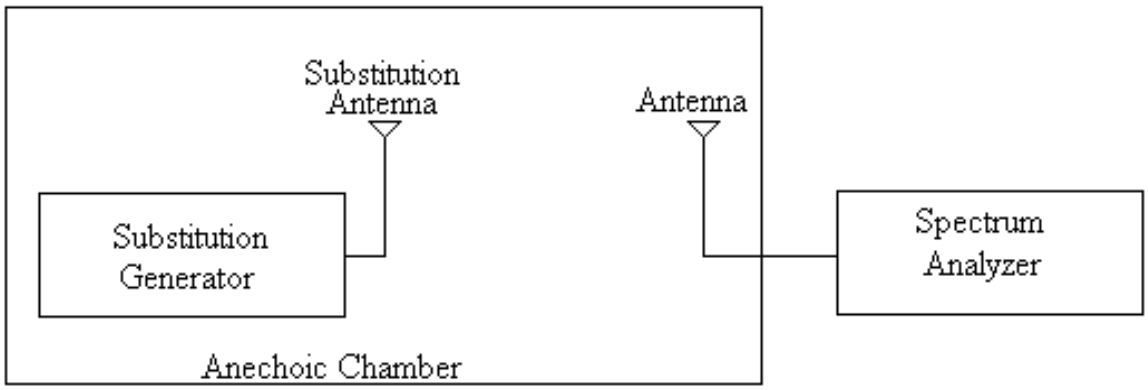
The EUT was powered from three AA-size NiCd rechargeable internal batteries. The EUT was set up as tabletop equipment.

Measurements at Antenna Terminal



Field Strength Measurements





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3.0 TEST RESULTS

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and graphical representations of the emissions are included.

The EUT is intended for operation under the requirements of Part 95 (Subpart A and B). Specific test requirements include the following:

47 CFR 95.639, 2.1046	RF Power Output
47 CFR 95.635, 2.1053	Field Strength of Spurious Radiation
47 CFR 2.1055	Frequency Stability
47 CFR 95.633, 95.635, 2.1049	Emissions Mask, Occupied Bandwidth
47 CFR 2.1051	Spurious Emissions at Antenna Terminal
47 CFR 95.637, 2.1047	Audio Frequency Response
47 CFR 95.637, 2.1047	Deviation Limiting

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3.1 RF Power Output, FCC Parts 95.639, 2.1046

3.1.1 Conducted Transmitted Power at antenna Terminal

RF Output measurements were made for GMRS Channel 1 and Channel 22 and FRS Channel 11.

Table # 3-1-1 and Graphs ## 3-1-1, 3-1-2, and 3-1-3 below show the RF Power Output at antenna terminal.

Table # 3-1-1

Output Freq. MHz	Measured Power dBm	Attaenuat. and cable loss (dB)	Total Power dBm	Maximum Power W	Maximum Power dBm	Margin dB	Comments
462.55 (Ch. 1)	18.56	10.2	28.76	1.0	30.00	-1.24	GMRS
462.54 (Ch. 22)	18.54	10.2	28.74	1.0	30.00	-1.26	GMRS
467.61 (Ch. 11)	16.77	10.2	26.97	0.5	26.99	-0.02	FRS

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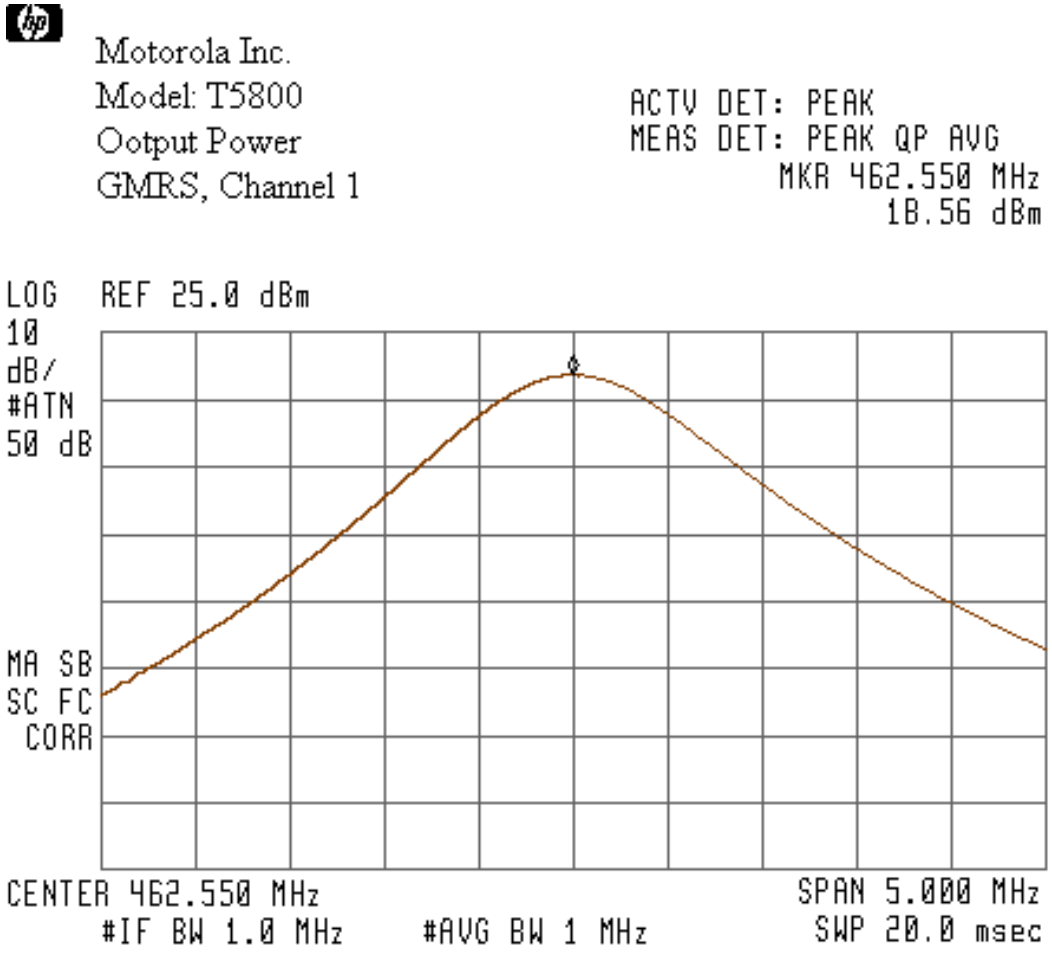
Graph # 3-1-1


Motorola Inc.
Model: T5800
Ootput Power
GMRS, Channel 1
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 462.550 MHz
18.56 dBm
LOG REF 25.0 dBm
10
dB/
#ATN
50 dB
MA SB
SC FC
CORR
CENTER 462.550 MHz
#IF BW 1.0 MHz
#AVG BW 1 MHz
SPAN 5.000 MHz
SWP 20.0 msec

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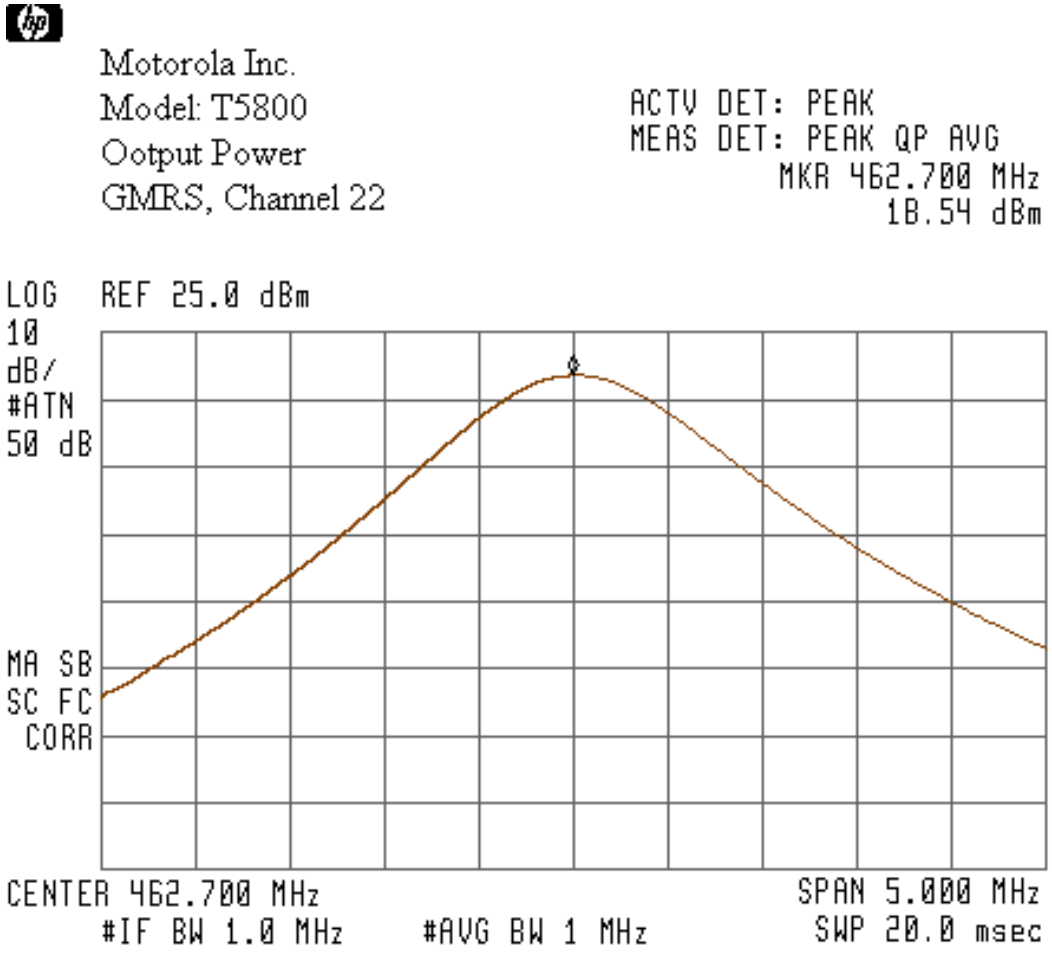
Graph # 3-1-2


Motorola Inc.
Model: T5800
Ootput Power
GMRS, Channel 22
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 462.700 MHz
18.54 dBm
LOG REF 25.0 dBm
10
dB/
#ATN
50 dB
MA SB
SC FC
CORR
CENTER 462.700 MHz
#IF BW 1.0 MHz
#AVG BW 1 MHz
SPAN 5.000 MHz
SWP 20.0 msec

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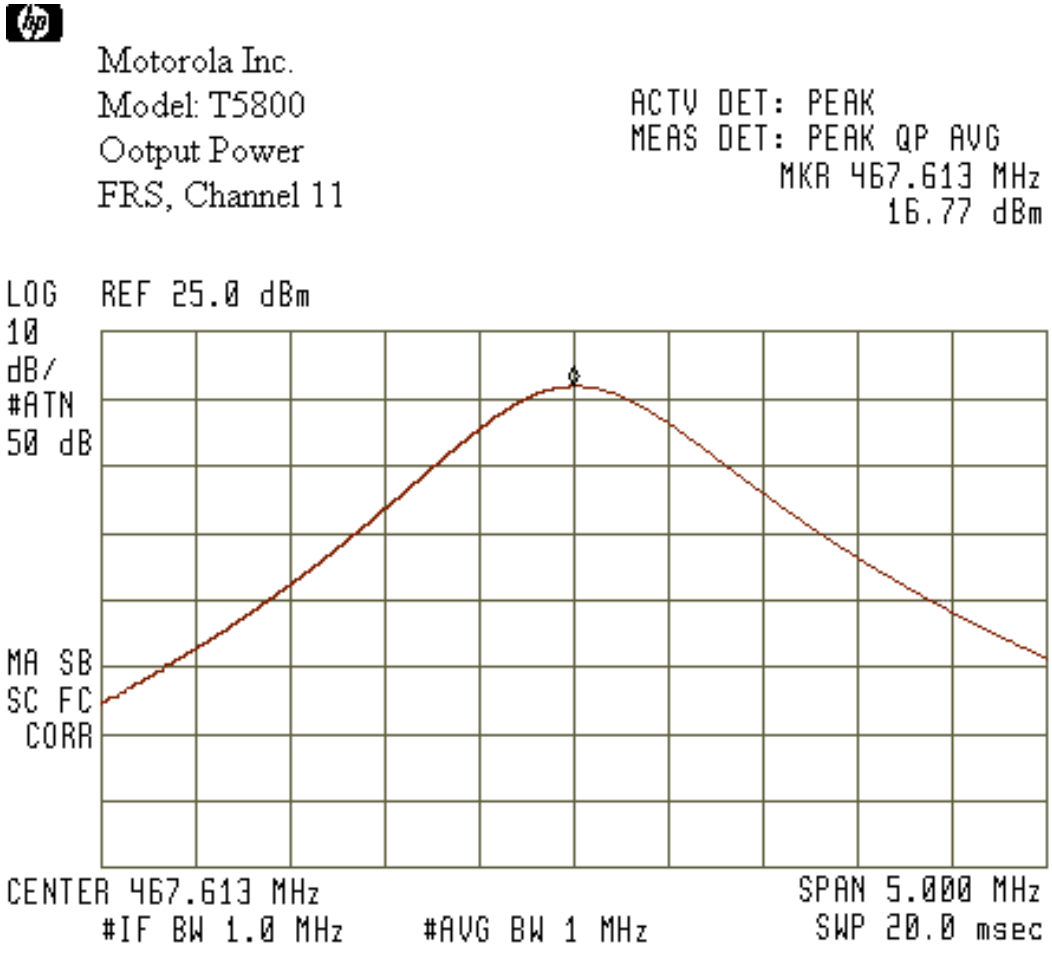
Graph # 3-1-3


Motorola Inc.
Model: T5800
Ootput Power
FRS, Channel 11
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 467.613 MHz
16.77 dBm
LOG
10
dB/
#ATN
50 dB
REF 25.0 dBm
MA SB
SC FC
CORR
CENTER 467.613 MHz
#IF BW 1.0 MHz
#AVG BW 1 MHz
SPAN 5.000 MHz
SWP 20.0 msec

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3.1.2 Radiated Transmitted Power (ERP)

Radiated transmitted power (ERP) measurements were made for GMRS Channel 4 and FRS Channel 11. Radiated transmitted power (ERP) was measured in the Anechoic Chamber using substitution method.

The Table # 3-1-2 shows the Radiated transmitted power (ERP)

Table # 3-1-2

Frequency MHz	Measured EUT Emissions dBm	Substitution Antenna Power dBm	Antenna Gain dBi	Cable Loss dB	Substitution Antenna EIPR Power (dBm)	Limit dBm	Margin dB
462.64 (GMRS, Ch. 4)	-2.11	26.8	2.1	0.2	28.7	30.0	-1.3
467.64 (FRS, Ch. 11)	-5.73	23.9	2.1	0.2	25.8	27.0	-1.2

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3.2 Field Strength of Spurious Emissions, FCC Parts 95.635, 2.1053

Field Strength of Spurious Emissions was measured in the Anechoic Chamber in the frequency range up to 4.63 GHz (10^{th} harmonic).
The substitution method of measurement was used.
The substitution method of measurement is based on the calculation of the minimum attenuation of the spurious emissions power of the EUT and spurious emissions limit.

Calculation of the minimum attenuation and spurious emissions for GMRS Channels
Minimum Attenuation = 43 + 10log (Transmitted Power) = 43 + 10log(1Watt) = 43dB
Spurious Emissions Limit = Transmitted Power – Minimum Attenuation = 30dBm –43dB = -13dBm

Calculation of the minimum attenuation and spurious emissions for FRS Channels
Minimum Attenuation = 43 + 10log (Transmitted Power) = 43 + 10log(0.5Watt) = 40dB
Spurious Emissions Limit = Transmitted Power – Minimum Attenuation = 27dBm –40dB = -13dBm

The Table # 3-2-1 shows the Field Strength of Spurious Radiation.

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Table # 3-2-1

Frequency MHz	Measured EUT Emissions $dB_{\mu}V$	Substitution Antenna Power dBm	Antenna Gain dBi	Cable Loss dB	Substitution Antenna EPR Power (dBm)	Limit dBm	Margin dB
Channel 4 (GMRS) Spurious Emissions, Vertical Antenna Polarization							
925.270	40.2	-30.0	1.0	0.3	-29.3	-13.0	-16.3
1387.910	38.8	-31.8	3.9	0.3	-28.2	-13.0	-15.2
1850.540	38.5	-24.2	3.5	0.4	-21.1	-13.0	-8.1
2313.173	68.2	-28.7	8.3	0.4	-20.8	-13.0	-7.8
2775.805	66.4	-31.8	8.8	0.5	-23.5	-13.0	-10.5
Channel 4 (GMRS) Spurious Emissions, Horizontal Antenna Polarization							
925.270	38.7	-30.7	1.0	0.3	-30.0	-13.0	-17.0
1387.910	37.2	-34.6	3.9	0.3	-31.0	-13.0	-18.0
1850.540	37.1	-28.6	3.5	0.4	-25.5	-13.0	-12.5
2313.173	74	-30.3	8.3	0.4	-22.4	-13.0	-9.4
2775.805	66.1	-32.4	8.8	0.5	-24.1	-13.0	-11.1
Channel 11 (FRS) Spurious Emissions, Vertical Antenna Polarization							
935.266	30.7	-38.5	1.0	0.3	-37.8	-13.0	-24.8
1402.910	31.4	-40.1	3.7	0.3	-36.7	-13.0	-23.7
1870.543	41.2	-24.6	3.5	0.4	-21.5	-13.0	-8.5
2338.178	70.4	-29.2	8.4	0.4	-21.2	-13.0	-8.2
2805.813	61.5	-34.3	8.8	0.5	-26.0	-13.0	-13.0
Channel 11 (FRS) Spurious Emissions, Horizontal Antenna Polarization							
935.266	35.6	-34.8	1.0	0.3	-34.1	-13.0	-21.1
1402.910	27.6	-30.6	3.7	0.3	-27.2	-13.0	-14.2
1870.543	43	-24.7	3.5	0.4	-21.6	-13.0	-8.6
2338.178	73.2	-31.3	8.4	0.4	-23.3	-13.0	-10.3
2805.813	64.2	-34.9	8.8	0.5	-26.6	-13.0	-13.6

Limit calculation for GMRS. Limit = 30dBm - (43 + 10log(1)) = 30 - 43 = -13dBm
Limit calculation for FRS. Limit = 27dBm - (43 + 10log(0.5)) = 27 - 40 = -13dBm

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3.3 Frequency Stability, FCC Part 2.1055

Frequency Stability with variation of ambient temperature was measured from –30 degrees C to +50 degrees C at frequency 467.64MHz (FRS Channel 11) and rated power input 4.5VDC.

Frequency Stability with variation of DC power input was measured from 4.8 to 3.5VDC at frequency 467.64MHz (FRS Channel 11).

Table # 3-3-1 shows the frequency stability vs. temperature ambient and supply voltage.

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Table # 3-3-1

Temperature Degree C	Output Frequency MHz	Frequency Deviation Hz	Frequency Stability ppm	Limit of Freq. Stability ppm	Test Result
-30	467.64	910	1.9	2.5	Pass
-20	467.64	840	1.8	2.5	Pass
-10	467.64	750	1.6	2.5	Pass
0	467.64	660	1.4	2.5	Pass
10	467.64	240	0.5	2.5	Pass
20	467.64	45	0.1	2.5	Pass
25	467.64	0	0.0	2.5	Pass
30	467.64	150	0.3	2.5	Pass
40	467.64	580	1.2	2.5	Pass
50	467.64	660	1.4	2.5	Pass
Input Power DC Voltage V	Output Frequency MHz	Frequency Deviation Hz	Frequency Stability ppm	Limit of Freq. Stability ppm	Test Result
4.8	467.64	0	0.0	2.5	Pass
4.5	467.64	0	0.0	2.5	Pass
4.0	467.64	18	0.04	2.5	Pass
3.5	467.64	94	0.2	2.5	Pass

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3.4 Emissions Mask, Occupied Bandwidth, FCC Parts 95.633, 95.635, 2.1055

Emissions mask and occupied bandwidth measurements were made for GMRS Channel 18 and FRS Channel 10.

Graphs ## 3-4-1, 3-4-2, 3-4-3, and 3-4-4 below show the emissions mask and occupied bandwidth.

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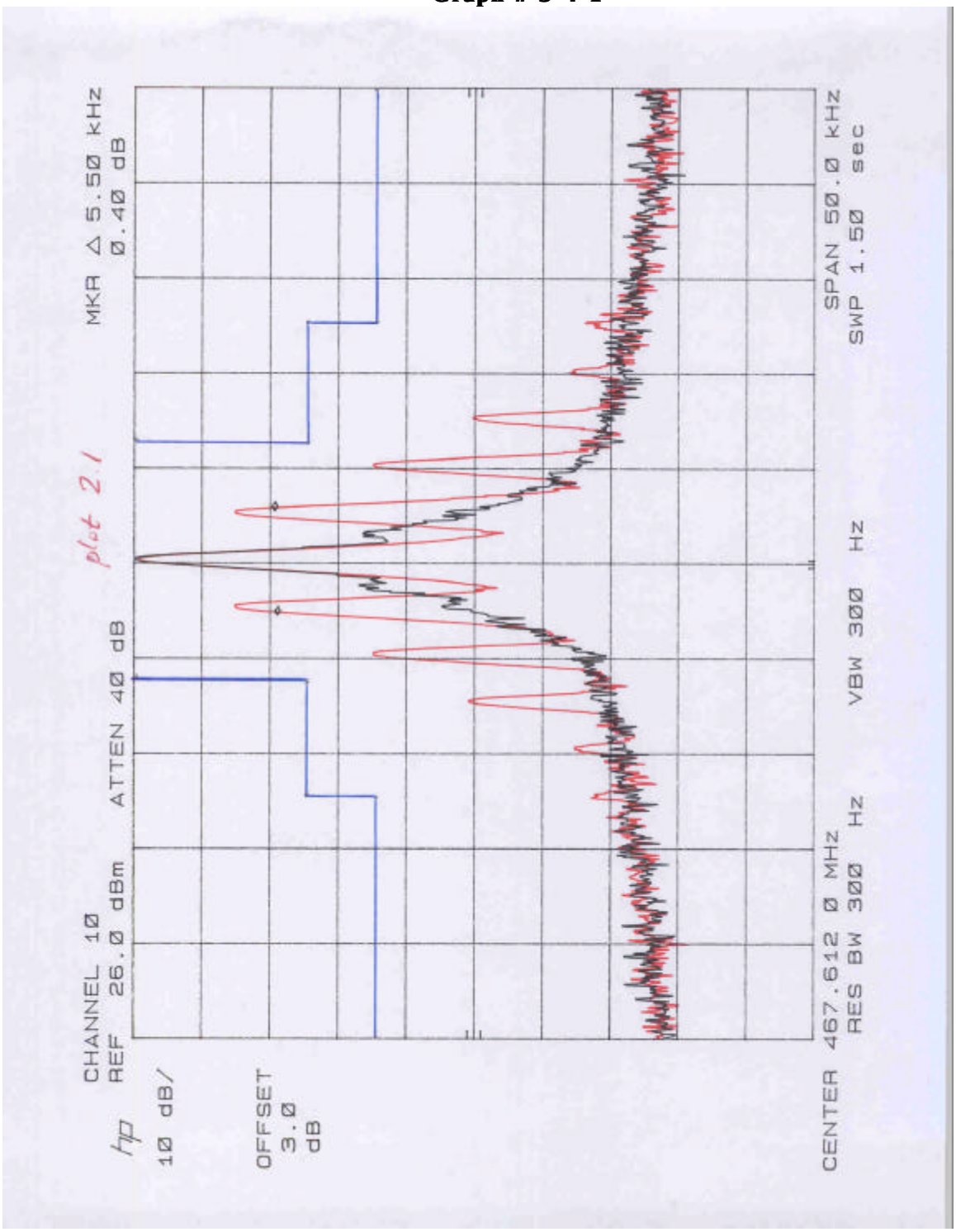
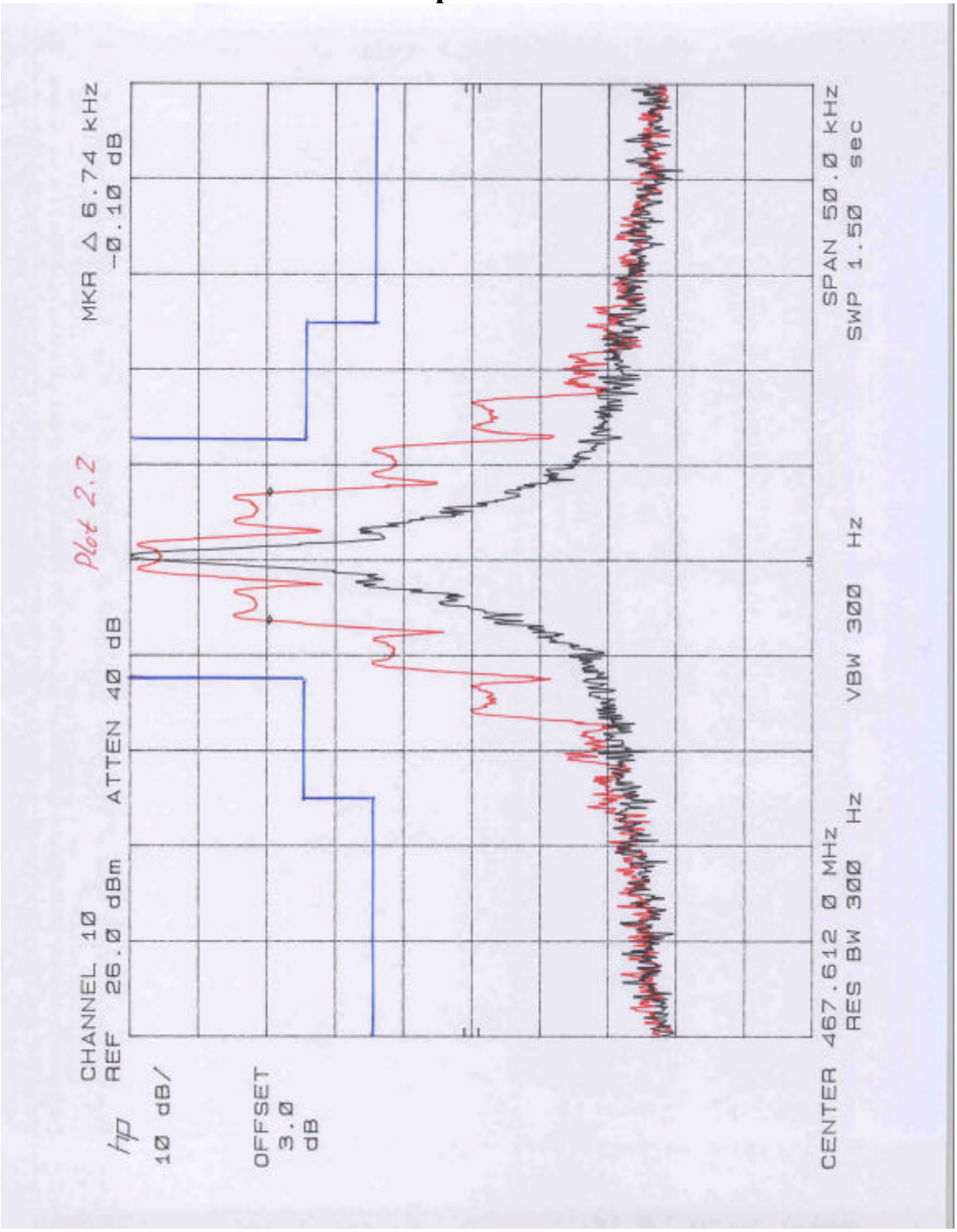
Graph # 3-4-1


CHANNEL 10
REF 26.0 dBm
ATTEN 40 dB
MKR Δ 5.50 kHz
0.40 dB
plot 2.1
10 dB/
OFFSET
3.0
dB
CENTER 467.612 0 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 50.0 kHz
SWP 1.50 sec

A

Graph # 3-4-2


MKR Δ 6.74 kHz
-0.10 dB
Plot 2.2
CHANNEL 10
REF 26.0 dBm
ATTEN 40 dB
hp
10 dB/
OFFSET
3.0
dB
SPAN 50.0 kHz
SWP 1.50 sec
CENTER 467.612 0 MHz
RES BW 300 Hz
VBW 300 Hz

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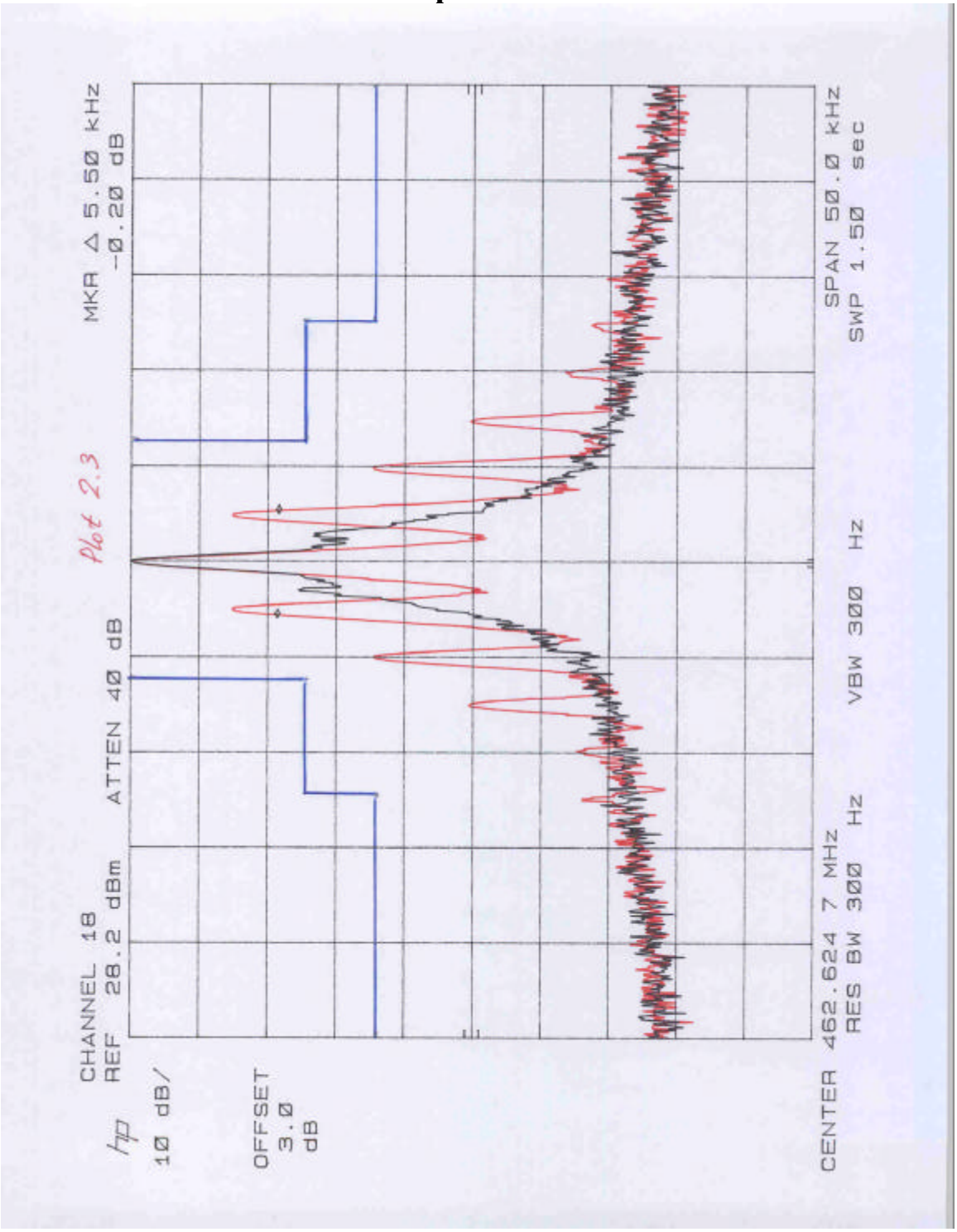
Graph # 3-4-3


MKR Δ 5.50 kHz
-0.20 dB
Plot 2.3
CHANNEL 18
REF 28.2 dBm
ATTEN 40 dB
hp
10 dB/
OFFSET
3.0
dB
SPAN 50.0 kHz
SWP 1.50 sec
VBW 300 Hz
CENTER 462.624 7 MHz
RES BW 300 Hz

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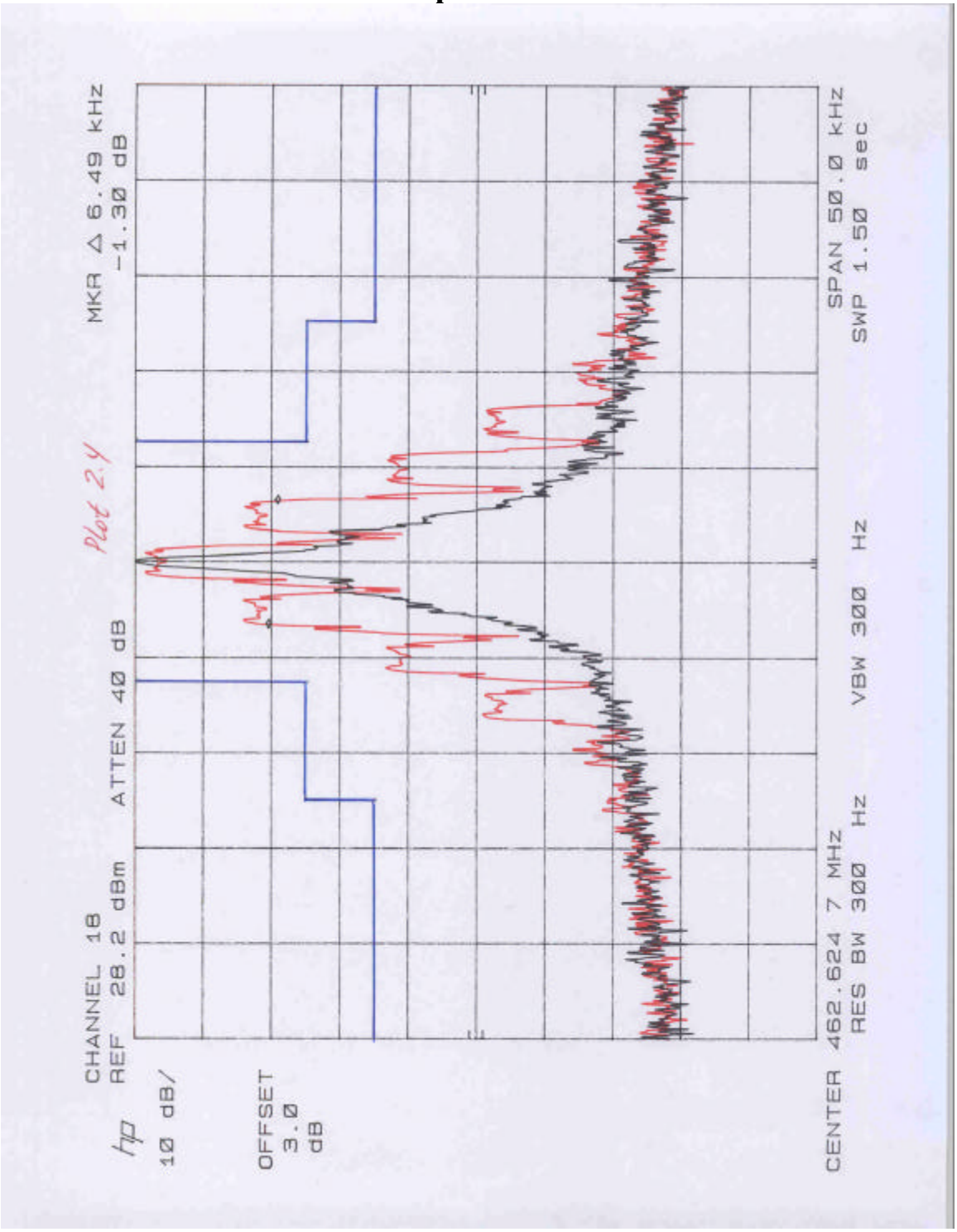
Graph # 3-4-4


CHANNEL 18
REF 28.2 dBm
ATTEN 40 dB
10 dB/
OFFSET
3.0
dB
MKR Δ 6.49 kHz
-1.30 dB
Plot 2.4
CENTER 462.624 7 MHz
RES BW 300 Hz
VBW 300 Hz
SPAN 50.0 kHz
SWP 1.50 sec

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3.5 Spurious Emissions at Antenna Terminal, FCC Part 2.1051

Spurious emissions at antenna terminal measurements were made for GMRS Channel 18 and FRS Channel 10.

Graphs ## 3-5-1, 3-5-2, 3-5-3, 3-5-4, 3-5-5 and 3-5-6 below show the spurious emissions at antenna terminal.

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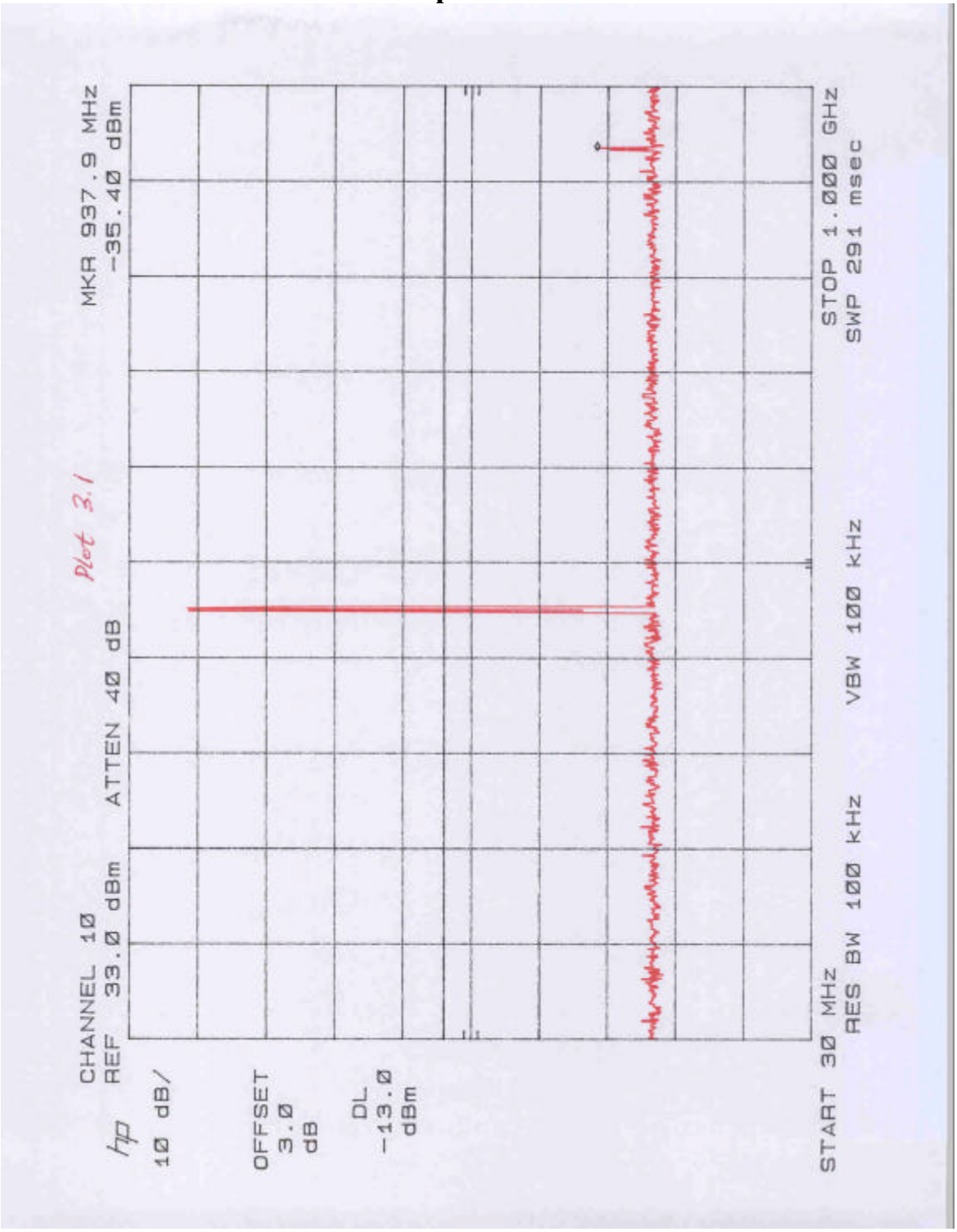
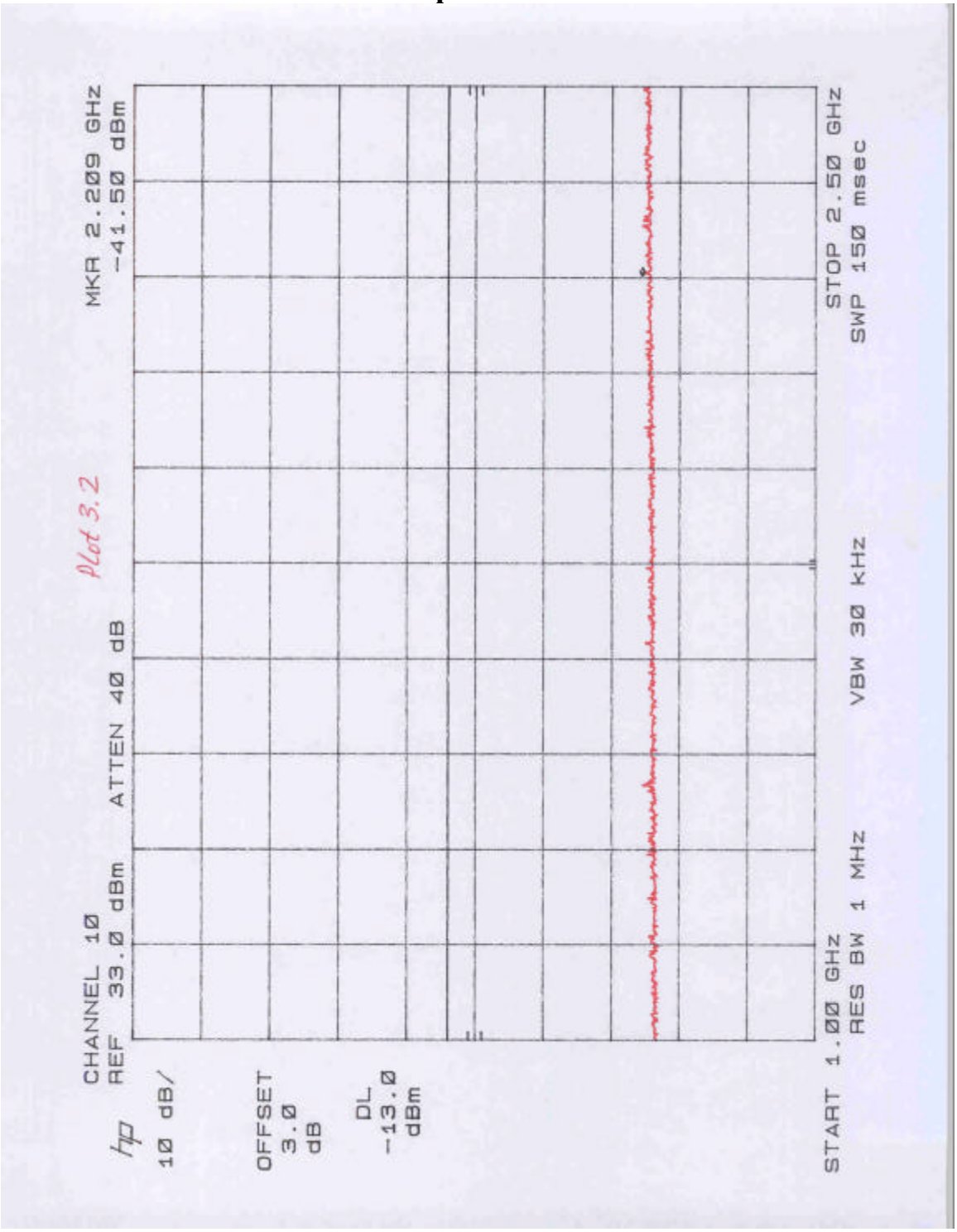
Graph # 3-5-1


Plot 3.1
CHANNEL 10
REF 33.0 dBm
ATTEN 40 dB
MKR 937.9 MHz
-35.40 dBm
hp
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 30 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 1.000 GHz
SWP 291 msec

A

Graph # 3-5-2


CHANNEL 10
REF 33.0 dBm
ATTEN 40 dB
MKR 2.209 GHz
-41.50 dBm
Plot 3.2
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 1.00 GHz
RES BW 1 MHz
VBW 30 kHz
STOP 2.50 GHz
SWP 150 msec

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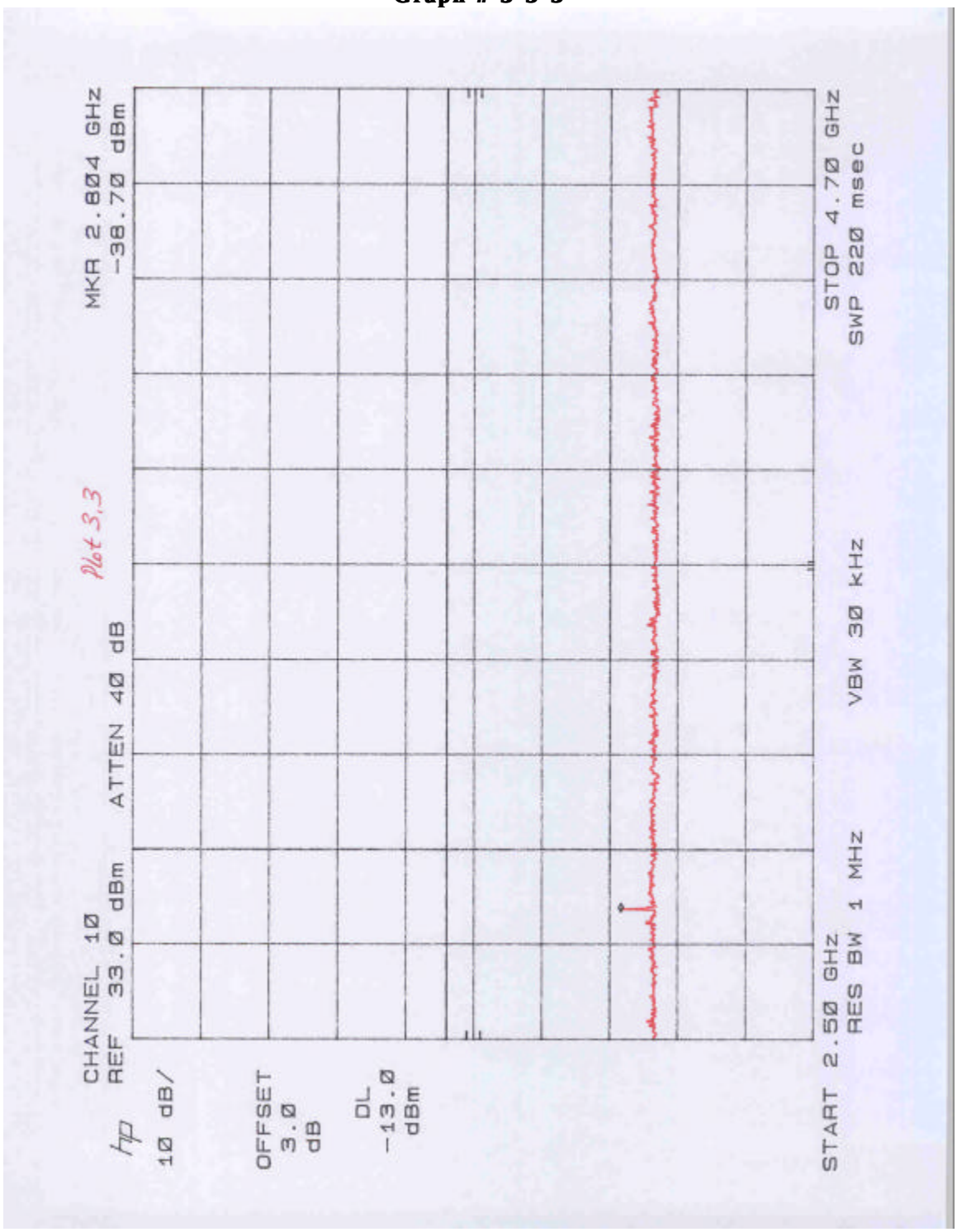
Graph # 3-5-3


CHANNEL 10
REF 33.0 dBm
ATTEN 40 dB
Plot 3,3
MKR 2.804 GHz
-38.70 dBm
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 2.50 GHz
RES BW 1 MHz
VBW 30 kHz
STOP 4.70 GHz
SWP 220 msec

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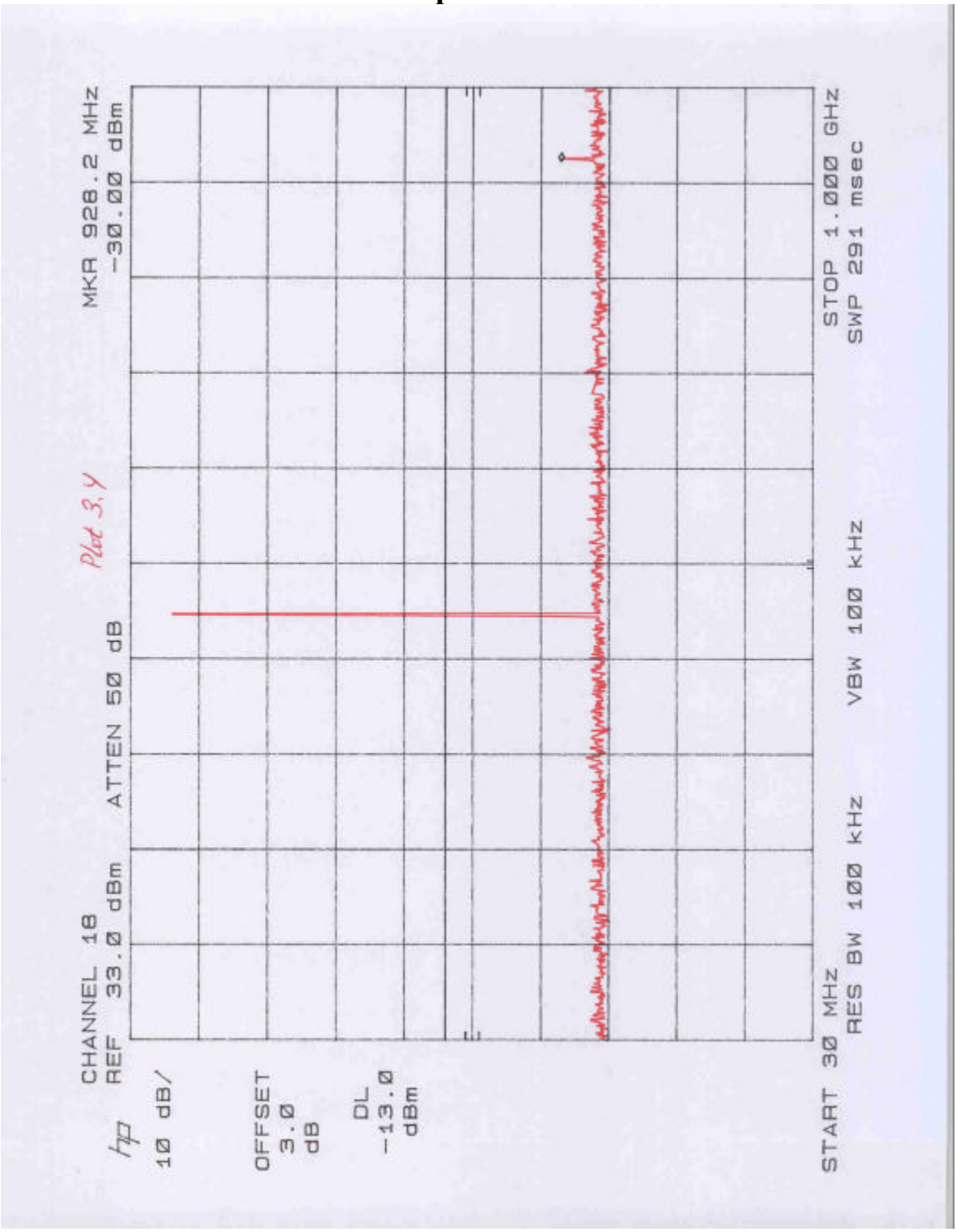
Graph # 3-5-4


CHANNEL 18
REF 33.0 dBm
ATTEN 50 dB
MKR 928.2 MHz
-30.00 dBm
Plot 3,Y
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 30 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 1.000 GHz
SWP 291 msec

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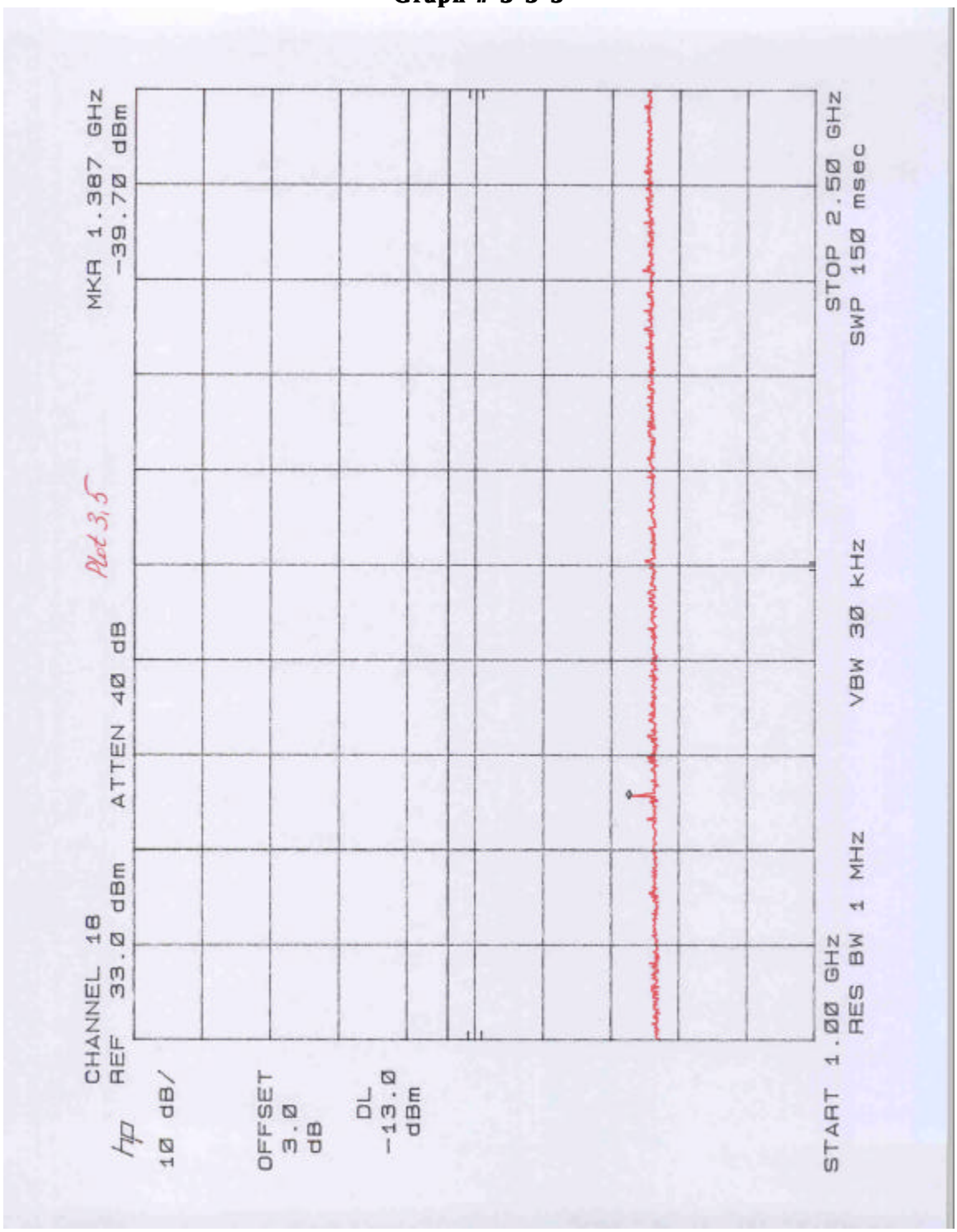
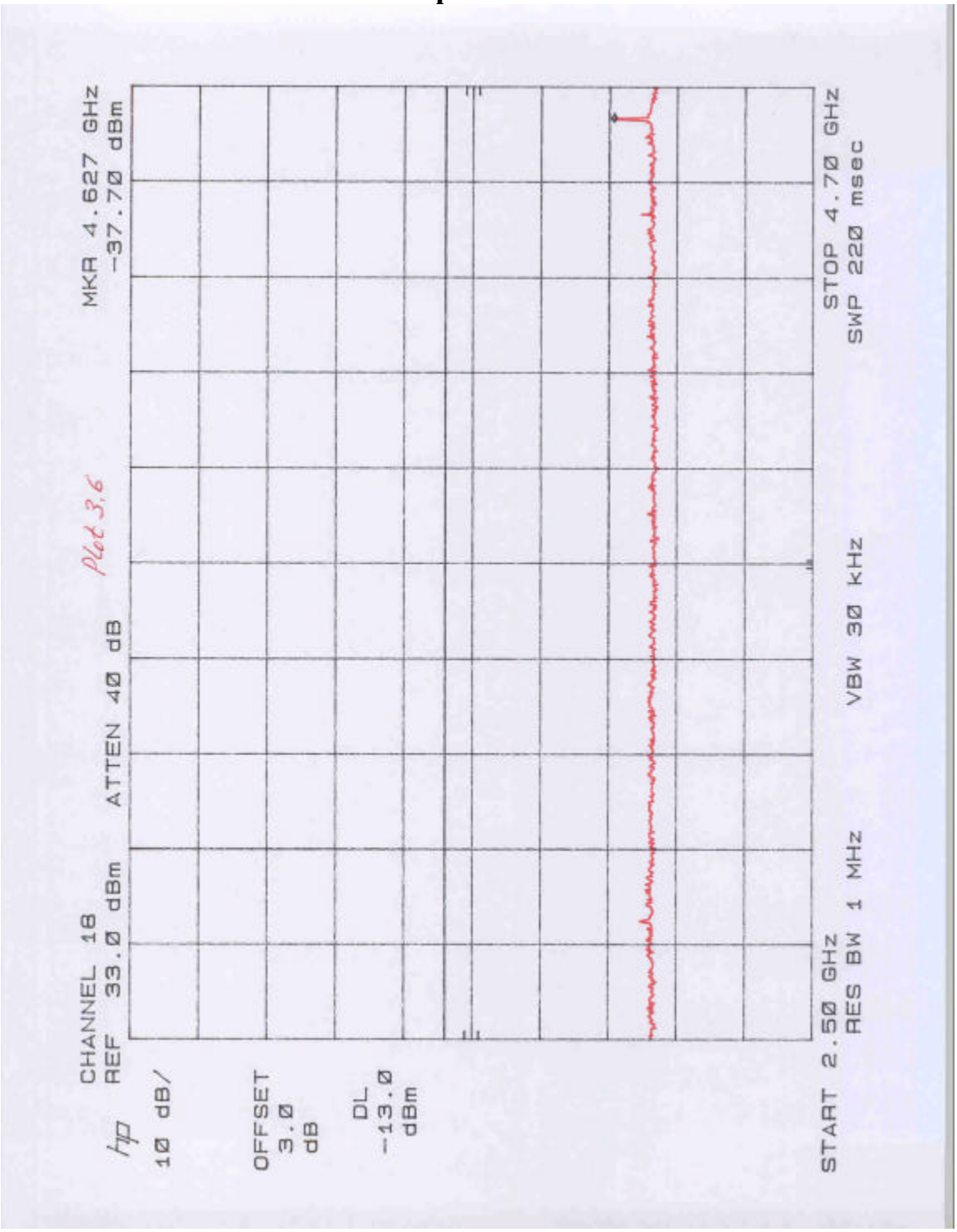
Graph # 3-5-5


CHANNEL 18
REF 33.0 dBm
ATTEN 40 dB
MKR 1.387 GHz
-39.70 dBm
Plot 3,5
hp
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 1.00 GHz
RES BW 1 MHz
VBW 30 kHz
STOP 2.50 GHz
SWP 150 msec

A

Graph # 3-5-6


CHANNEL 18
REF 33.0 dBm
ATTEN 40 dB
Plot 3.6
MKR 4.627 GHz
-37.70 dBm
hp
10 dB/
OFFSET
3.0
dB
DL
-13.0
dBm
START 2.50 GHz
RES BW 1 MHz
VBW 30 kHz
STOP 4.70 GHz
SWP 220 msec

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3.6 Audio Frequency Response, FCC Parts95.637, 2.1047

Audio frequency response measurements were made for GMRS Channel 18 and FRS Channel 10.

Graphs ## 3-6-1 and 3-6-2 below show the audio frequency response.

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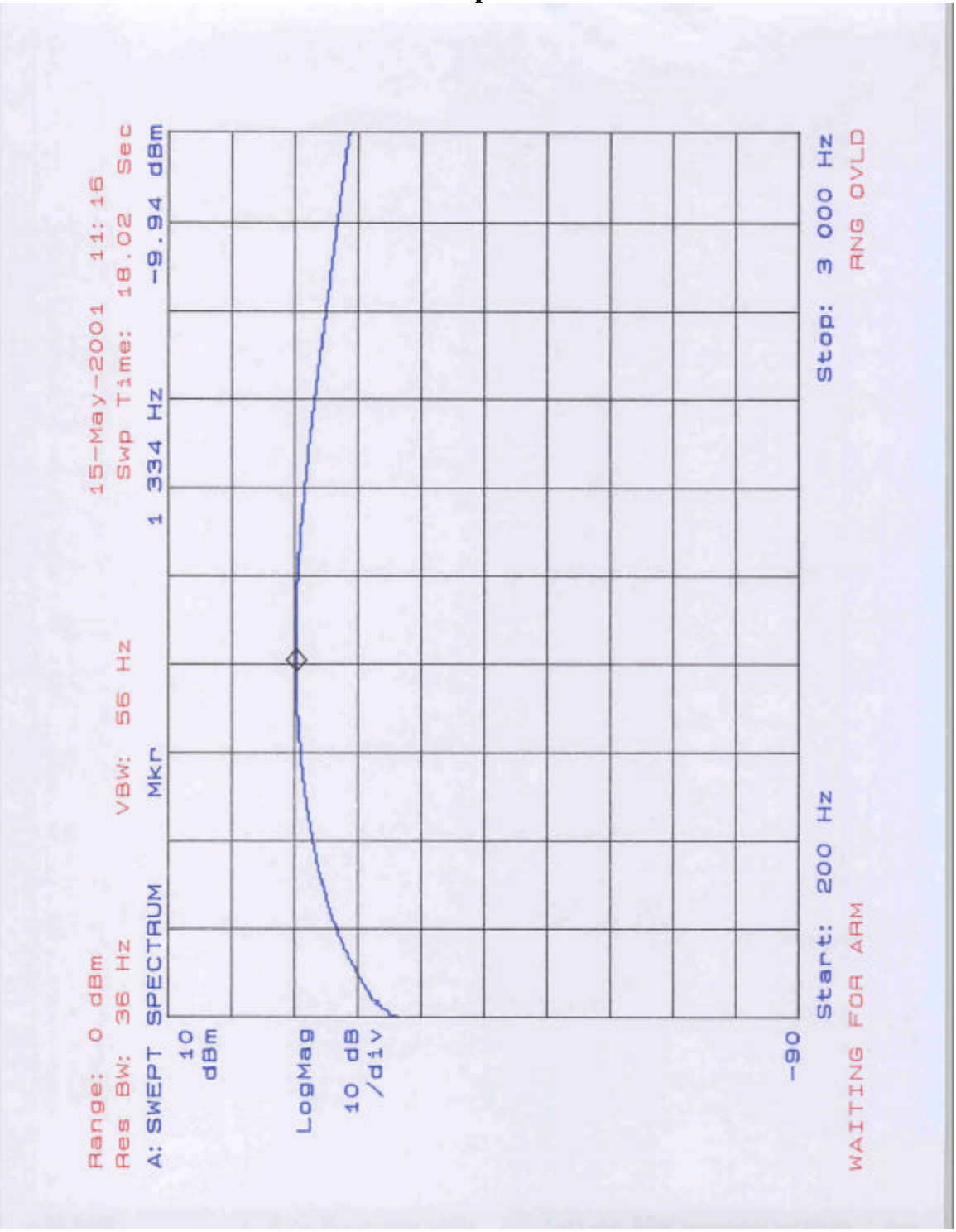
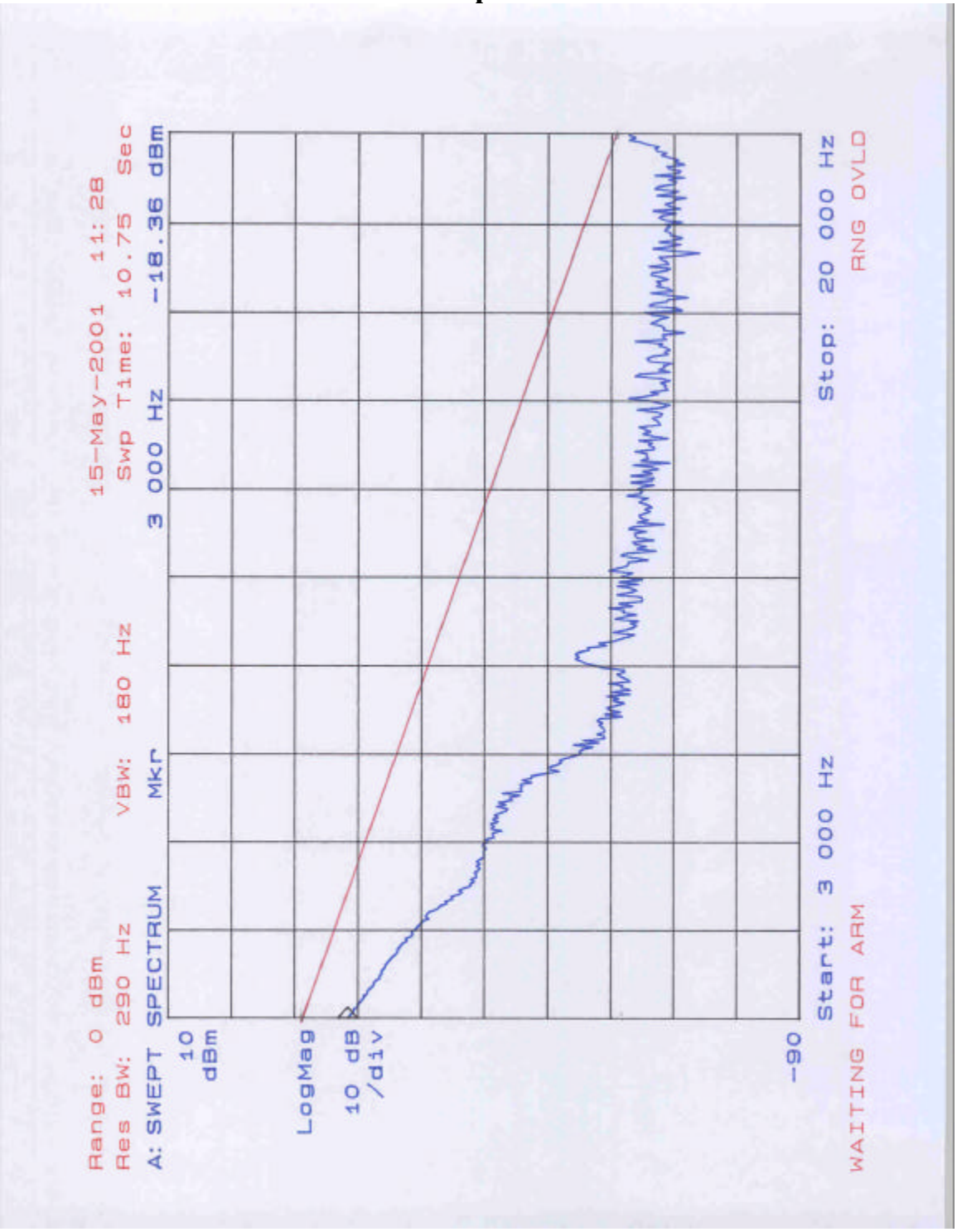
Graph # 3-6-1


Range: 0 dBm
Res BW: 36 Hz
VBW: 56 Hz
Swp Time: 18.02 Sec
15-May-2001 11:16
A: SWEPT SPECTRUM
Mkr
1 334 Hz
-9.94 dBm
10 dBm
LogMag
10 dB /div
-90
Start: 200 Hz
Stop: 3 000 Hz
WAITING FOR ARM
RNG OVLD

A

Graph # 3-6-2


Range: 0 dBm
Res BW: 290 Hz
VBW: 180 Hz
15-May-2001 11:28
Swp Time: 10.75 Sec
A: SWEPT SPECTRUM
Mkr
3 000 Hz
-18.36 dBm
10 dBm
LogMag
10 dB /div
-90
Start: 3 000 Hz
Stop: 20 000 Hz
RNG OVLD
WAITING FOR ARM

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3.7 Deviation Limiting, FCC Parts 95.637, 2.1047

Deviation limiting measurements were made for GMRS Channel 18 and FRS Channel 10.

Charts ## 3-7-1 and 3-7-2 below show the deviation limiting.

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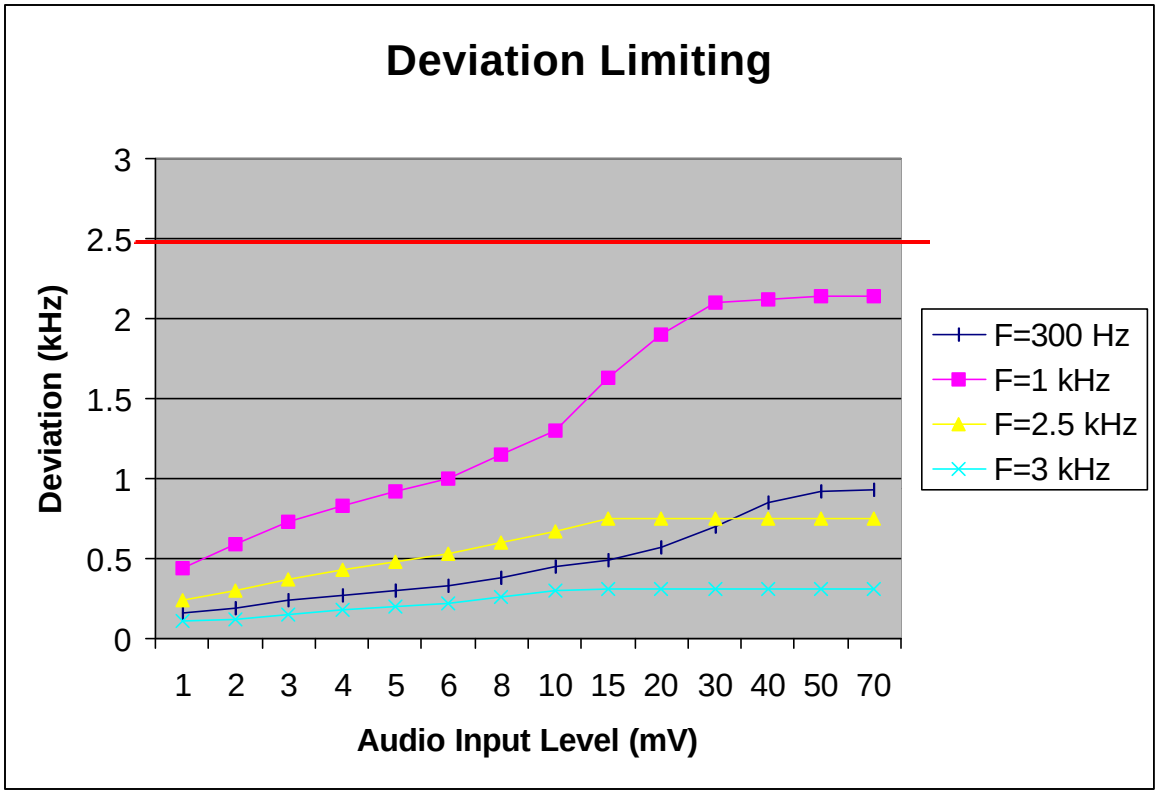
Chart # 3-7-1
FRS, Channel 10



level, mV	F=300 Hz	F=1 kHz	F=2.5 kHz	F=3 kHz
1	0.16	0.44	0.24	0.11
2	0.19	0.59	0.3	0.12
3	0.24	0.73	0.37	0.15
4	0.27	0.83	0.43	0.18
5	0.3	0.92	0.48	0.2
6	0.33	1	0.53	0.22
8	0.38	1.15	0.6	0.26
10	0.45	1.3	0.67	0.3
15	0.49	1.63	0.75	0.31
20	0.57	1.9	0.75	0.31
30	0.7	2.1	0.75	0.31
40	0.85	2.12	0.75	0.31
50	0.92	2.14	0.75	0.31
70	0.93	2.14	0.75	0.31

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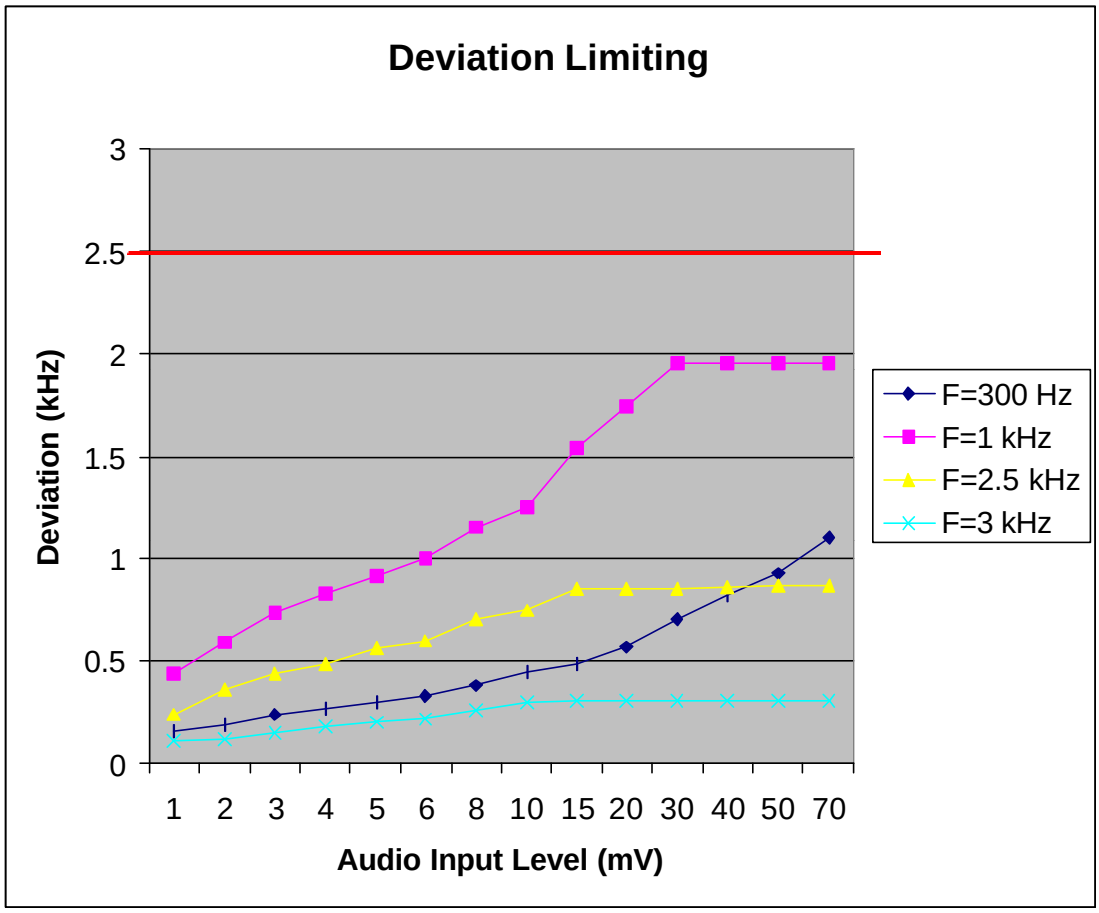
Chart # 3-7-2
GMRS, Channel 18



level, mV	F=300 Hz	F=1 kHz	F=2.5 kHz	F=3 kHz
1	0.16	0.44	0.24	0.11
2	0.19	0.59	0.36	0.12
3	0.24	0.73	0.44	0.15
4	0.27	0.83	0.49	0.18
5	0.3	0.91	0.56	0.2
6	0.33	1	0.6	0.22
8	0.38	1.15	0.7	0.26
10	0.45	1.25	0.75	0.3
15	0.49	1.54	0.85	0.31
20	0.57	1.74	0.85	0.31
30	0.7	1.95	0.85	0.31
40	0.82	1.95	0.86	0.31
50	0.93	1.95	0.87	0.31
70	1.1	1.95	0.87	0.31

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3.8 Test Procedure

Measurements at Antenna Terminal

Measurements at antenna terminal were taken at the maximum transmitting power. The antenna port of the transmitter was connected to the Spectrum analyzer via the attenuator.

Total Power was calculated from Measured Power by adding attenuation of the external attenuator and cable loss.

Field Strength Measurements (Substitution Method)

The EUT was placed on a non-conductive table 0.8m above the ground plane inside the Anechoic Chamber. The table was centered on a motorized turntable, which allows 360-degree rotation. The measurement antenna was positioned at 3m distance. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, by changing antenna polarization, and by changing antenna height from 1 to 4m. Method of the direct Field Strength Calculation is shown in Section 3.9.

For substitution method the substitution antenna with the signal generator was placed instead of the EUT with the center of substitution antenna was at the same location as the center of transmitter. The substitution antenna was faced to measurement antenna with the same polarization as the measuring antenna. The level of the generator output was adjusted until the previously recorded maximum emission reading for this set of conditions is obtained. Method of the substitution method Field Strength Calculation is shown in Section 3.9.

Frequency Stability

The EUT was located in an environmental test chamber. The Chamber was programmed with temperature to minus 30 degrees C and then step up 10-degree increments to plus 50 degrees C.

For Frequency Stability testing with variation of primary supply voltage the EUT was powered at rated supply voltage at 4.5VDC and then at 4.8, 4.5, 4.0 and 3.5VDC.

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3.9 Field Strength Calculation

Straight method
The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured emissions reading on the EMI Receiver.
The basic equation with a sample calculation is as follows:
FS = RA + AF + CF - AG

Where: FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude in dB(μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(m^{-1})
AG = Amplifier Gain in dBi

Assume a receiver reading of 48.1 dB(μV) is obtained. The antenna factor of 7.4 dB(m^{-1}) and cable factor of 1.6 dB is added and amplifier gain of 16.0 dBi is subtracted giving field strength of 41.1 dB(μV/m). The antenna factor and cable factor combined to the Total CF.

Substitution method
The field strength is calculated by adding the power reading on the substitution generator to the antenna gain associated with substitution antenna, and cables. A sample calculation is included below.

FS = GP + AG - CF

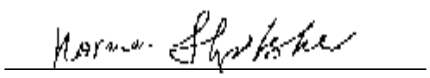
Where FS = Field Strength in dBm
GP = Generator Output Power in dBm
AG = Antenna Gain in dBi
CF = Cable Attenuation Factor in dB

Assume a generator output power reading of -40 dBm is obtained. The antenna gain is 13 dBi is added. The cable factor of 0.5 dB is subtracted. The field strength for comparison to the limit is –27.5 dBm.

Tested by:

Norman Shpilsher
EMC Project Engineer
Intertek Testing Services NA, Inc.

Signature



Signature

Date: May 14, 2002

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EXHIBIT I

TEST SET UP PHOTOS

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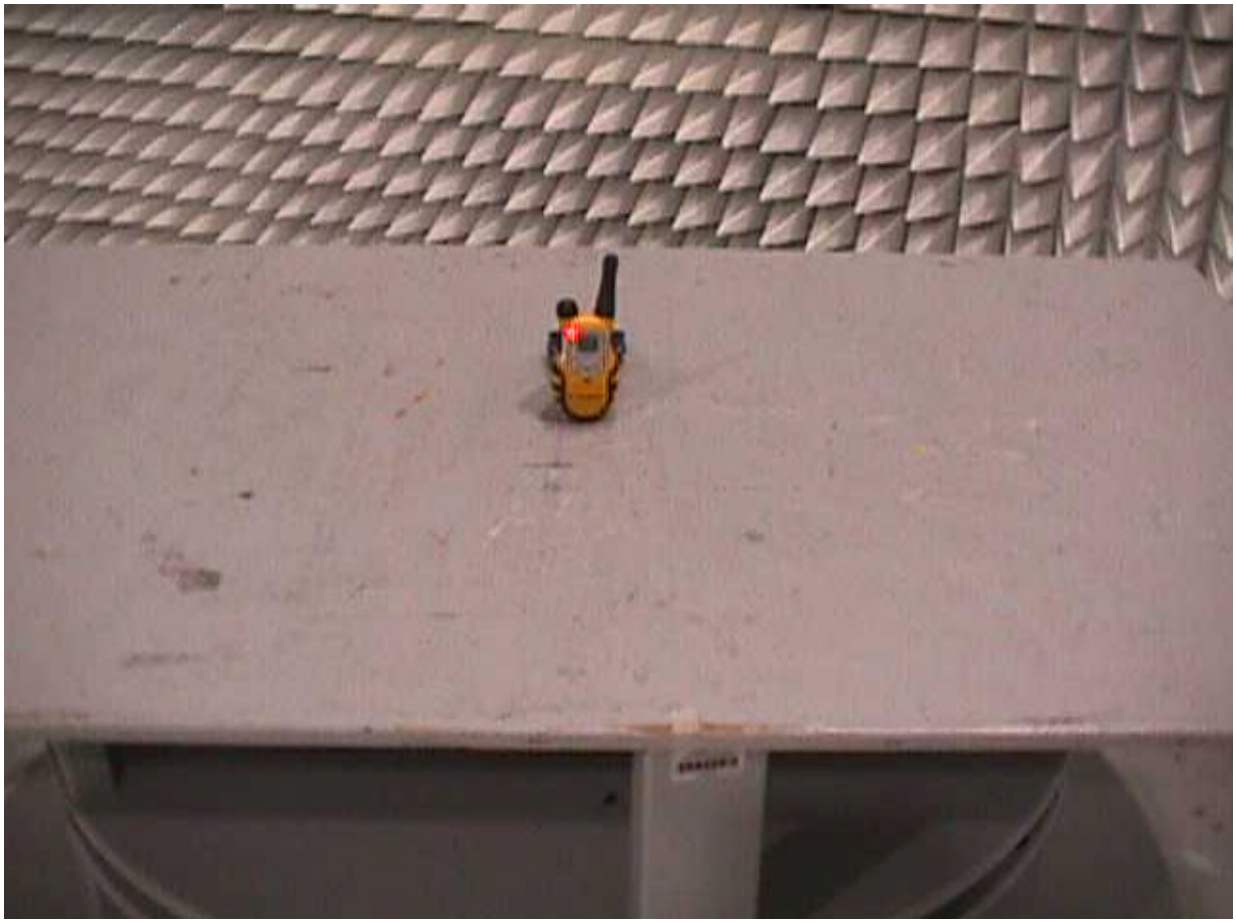

Radiated Emissions Test Configuration

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Radiated Emissions Test Configuration

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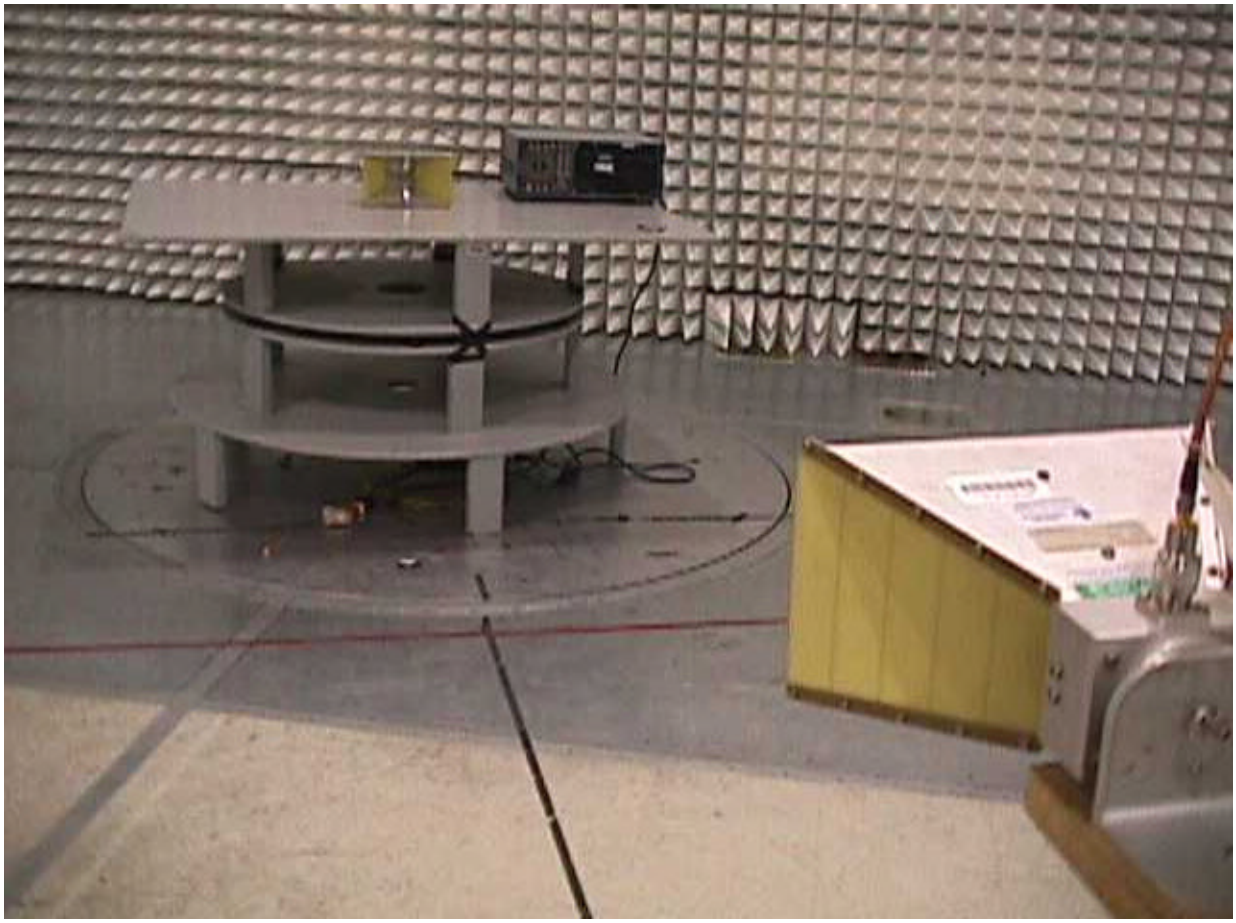

Radiated Emissions Test Configuration

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EXHIBIT II

FCC ID LABEL LOCATION

(See ID Label/Location Info. Attachments)

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EXHIBIT III

EXTERNAL PHOTOS

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EXHIBIT IV

INTERNAL PHOTOS

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EXHIBIT V

ELECTRICAL SCHEMATICS AND BLOCK DIAGRAM

(See Block Diagram and Schematic Attachments)

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EXHIBIT VI

USER MANUAL AND OPERATIONAL DESCRIPTION

(See User Manual and Operational Description Attachments)