Measurement of RF Interference from a Model M190 Transmitter

For : TouchTronics, Inc.
57315 Nagy Drive
Elkhart, IN 46517

P.O. No. : 9559
Date Tested : February 17, 2009
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C
: Industry Canada RSS-210
: Industry Canada RSS-GEN

Test Report By : MARK E. LONGINOTTI
Mark E. Longinotti

Witnessed by :
David Evans
TouchTronics, Inc.

Approved By : Raymond J Klouda
Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

Elite Electronic Engineering Inc.
1516 Centre Circle
Downers Grove, IL 60515
Tel : (630) 495-9770
Fax: (630) 495-9785
www.elitetest.com

TABLE OF CONTENTS

REVISION HISTORY

Revision	Date	Description
—	March 4, 2009	Initial release

Measurement of RF Emissions from an M190 Transmitter

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a TouchTronics, Inc., M190 transmitter, (hereinafter referred to as the test item). Two versions of the test item were submitted for testing, one with an integrated antenna driver board and one with an external antenna driver board. No serial number was assigned to either test item. The test item was designed to transmit at approximately 125kHz using an internal antenna. The test item was manufactured and submitted for testing by TouchTronics, Inc. located in Elkhart, IN.

1.2 Purpose

The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.209 for Intentional Radiators and the Industry Canada RSS-Gen section 7.2.2 and Industry Canada RSS-210 Table 3. Testing was performed in accordance with ANSI C63.4-2003.

1.3 Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.5 Laboratory Conditions

The temperature at the time of the test was 21°C and the relative humidity was 17%.

2 APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2008

- ANSI C63.4-2003, "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"

- Industry Canada RSS-210, Issue 7, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”

- Industry Canada RSS-GEN, Issue 2, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 TEST ITEM SETUP AND OPERATION

3.1 General Description

The test item is an M190 Transmitter. A block diagram of the test item setup is shown as Figure 1.

3.1.1 Power Input

The test item obtained 13.5VDC power via a 3 meter long wiring harness.

3.1.2 Peripheral Equipment

For the test item with the external antenna driver board, the test item was connected to the external antenna driver board via a 60 cm long wiring harness.

3.1.3 Interconnect Cables

For the test item with the external antenna driver board, the test item was connected to the external antenna driver board via a 60 cm long wiring harness. The external antenna driver board received 13.5VDC via a 3 meter long wiring harness. For the test item was the integrated antenna driver board, the test item was powered with 13.5VDC via a 3 meter long wiring harness.

3.1.4 Grounding

The test item was not grounded during the test.

3.2 Operational Mode

For all tests the test item and all peripheral equipment were placed on an 80cm high non-conductive stand. The test item and all peripheral equipment were energized. The test item was programmed to continuously transmit an unmodulated (CW) signal.

3.3 Test Item Modifications

No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.209 and the Industry Canada RSS-Gen section 7.2.2 and Industry Canada RSS-210 Table 3.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted emission tests were performed with a spectrum analyzer in conjunction with a quasi-peak adapter.

Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths specified by the FCC and with the quasi-peak detector function. The receiver bandwidth was

200Hz for the radiated emissions data below 150kHz, 9kHz for the radiated emissions data from 150kHz to 30MHz and 120kHz for the 30MHz to 1000MHz radiated emissions data.

4.3 Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4 Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emission Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emission Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5 TEST PROCEDURES

5.1 Powerline Conducted Emissions

5.1.1 Requirements

Since the test item is normally powered by 13.5VDC from a vehicle battery, no conducted emissions tests were required.

5.2 Propagation Loss Measurements

5.2.1 Requirements

Per 15.209(e), the provisions of 15.31 shall apply for measuring emissions at distances other than the distances specified in the table in 15.209(a). Per 15.31(f)(2) at frequencies below 30MHz, measurements may be performed at a distance closer than that specified in the regulations. However when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by making measurements at a minimum of two distances to determine the proper extrapolation factor.

5.2.2 Procedures

The test item was placed on an 80cm high non-conductive test stand. The active loop antenna was placed 2 meters away from the test item. The test item was programmed to transmit continuously. The field strength measurement was taken at the 2 meter distance. This process was repeated with the active loop antenna 3 meters, 4 meters and 5 meters away.

5.2.3 Results

The results of the propagation loss measurements are shown on data pages 13 and 14. The propagation loss for the M190 Transmitter with external antenna drive board was 57.2dB to convert readings taken at 3 meters to the 30 meter limit and 114.5dB to convert readings taken at 3 meters to the 300 meter limit.

The propagation loss for the M190 Transmitter with integrated antenna drive board was 55.5dB to convert readings taken at 3 meters to the 30 meter limit and 111.1dB to convert readings taken at 3 meters to the 300 meter limit.

5.3 Radiated Measurements

5.3.1 Requirements

The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.209 and the Industry Canada RSS-210 Table 3. These standards have the following limits:

Frequency MHz	Field Intensity uV/m	Measurement Distance meters
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

5.3.2 Procedures

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the test item. For the preliminary test, an active loop antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 10kHz to 30MHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 125kHz to 1.25MHz using an active loop antenna. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

1) The test item was rotated so that all of its sides were exposed to the receiving antenna.
2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured. In the vertical polarization, the active loop antenna was rotated 360 degrees about its vertical axis
3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
4) For hand-held or body-worn devices, the test item was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.3.3 Results

The preliminary plot, with the external antenna driver board is shown on data page 15. The final radiated levels, with the test item transmitting at 125kHz, are presented on data page 16. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet

to the limit (worst case) occurred at 625kHz. The emissions level at this frequency was 25dB within the limit. See data page 16 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

The preliminary plot, with the integrated antenna driver board is shown on data page 17. The final radiated levels, with the test item transmitting at 125kHz, are presented on data page 18. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 625kHz. The emissions level at this frequency was 22.7dB within the limit. See data page 18 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 3.

6 OTHER TEST CONDITIONS

6.1 Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by TouchTronics, Inc. personnel.

6.2 Disposition of the Test Item

The test item and all associated equipment were returned to TouchTronics, Inc. upon completion of the tests.

7 CONCLUSIONS

It was determined that the TouchTronics, Inc. M190 Transmitter with an external antenna driver board, Serial No. none assigned, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.207 and 15.209 and the Industry Canada RSS-Gen section 7.2.2 and Industry Canada RSS-210 Table 3. Testing was performed in accordance with ANSI C63.4-2003.

It was determined that the TouchTronics, Inc. M190 Transmitter with an integrated antenna driver board, Serial No. none assigned, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.207 and 15.209 and the Industry Canada RSS-Gen section 7.2.2 and Industry Canada RSS-210 Table 3. Testing was performed in accordance with ANSI C63.4-2003.

8 CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date as operated by TouchTronics, Inc. personnel. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

9 EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ 500L	0028483108	1.8GHZ	N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
NLS1	24" ACTIVE LOOP ANTENNA	EMCO	6502	8903-2329	0.01-30MHZ	4/9/2008	4/9/2009
RAC0	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2449A01117	100HZ-22GHZ	8/21/2008	8/21/2009
RACE	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	8/20/2008	8/20/2009
RAF1	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00271	0.01-1000MHZ	2/27/2008	2/27/2009
T2D5	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-43	AY9244	DC-18GHZ	1/22/2009	1/22/2010
XZG2	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01751	---	N/A	

N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

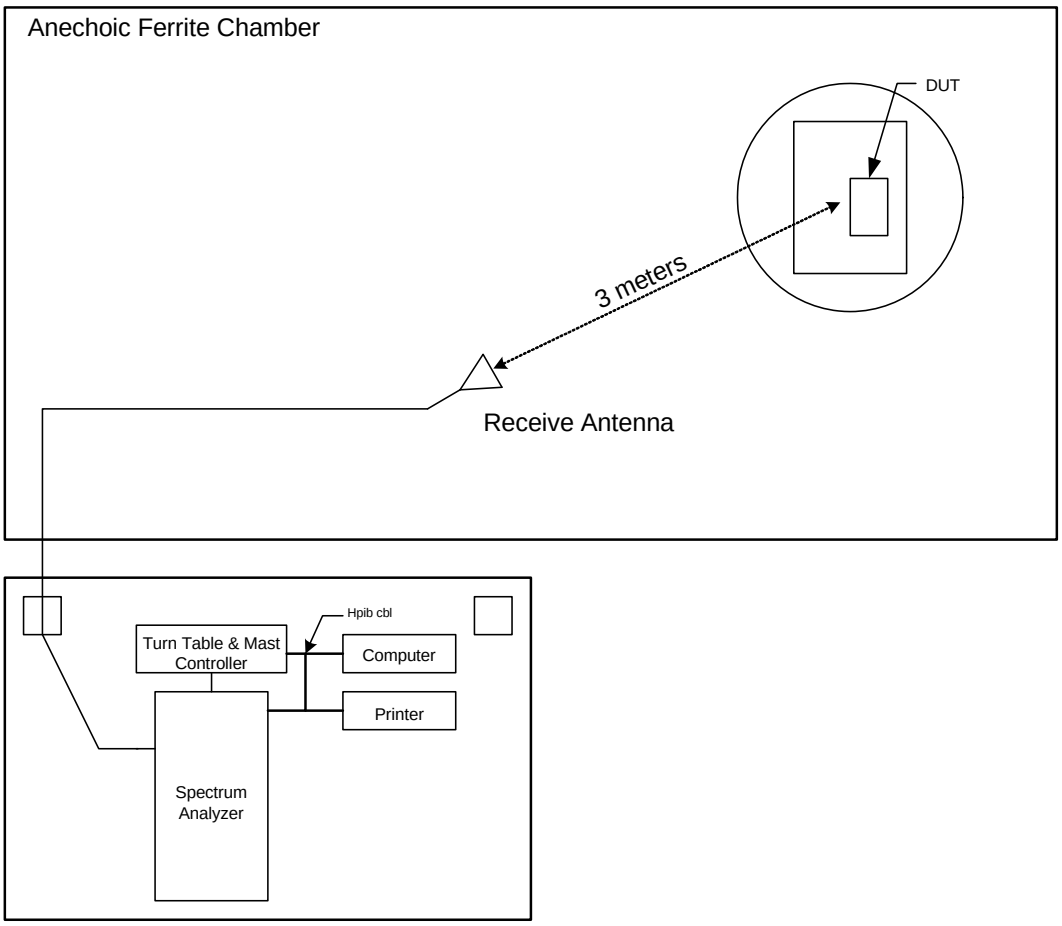
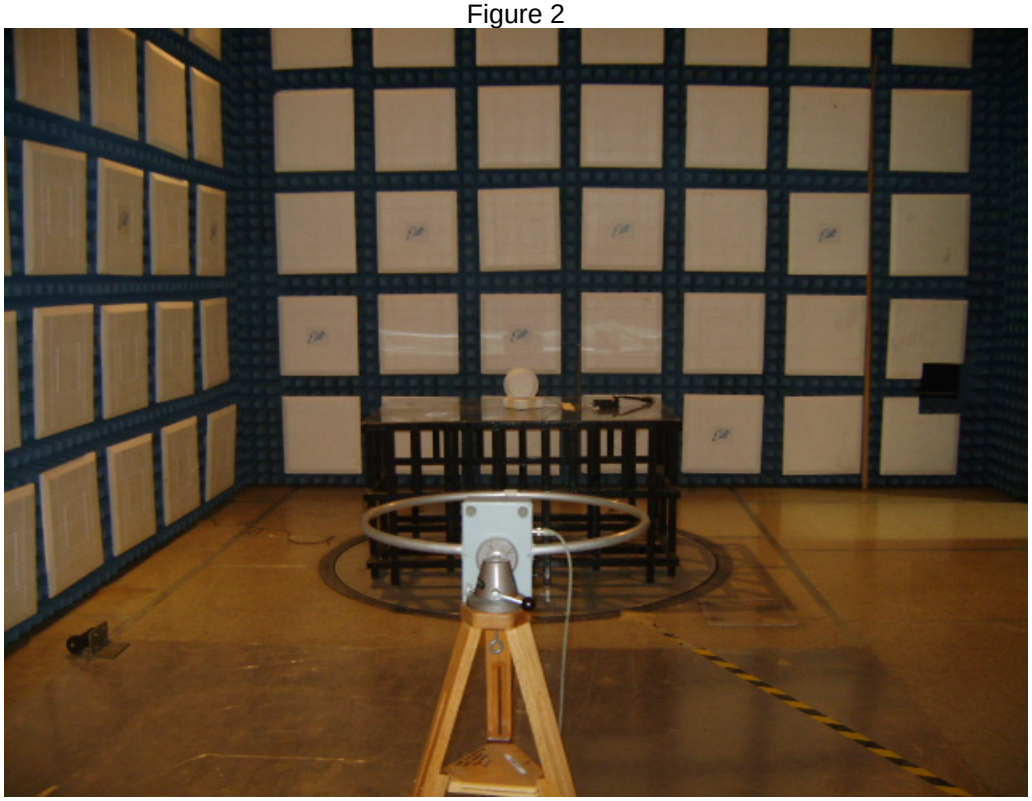
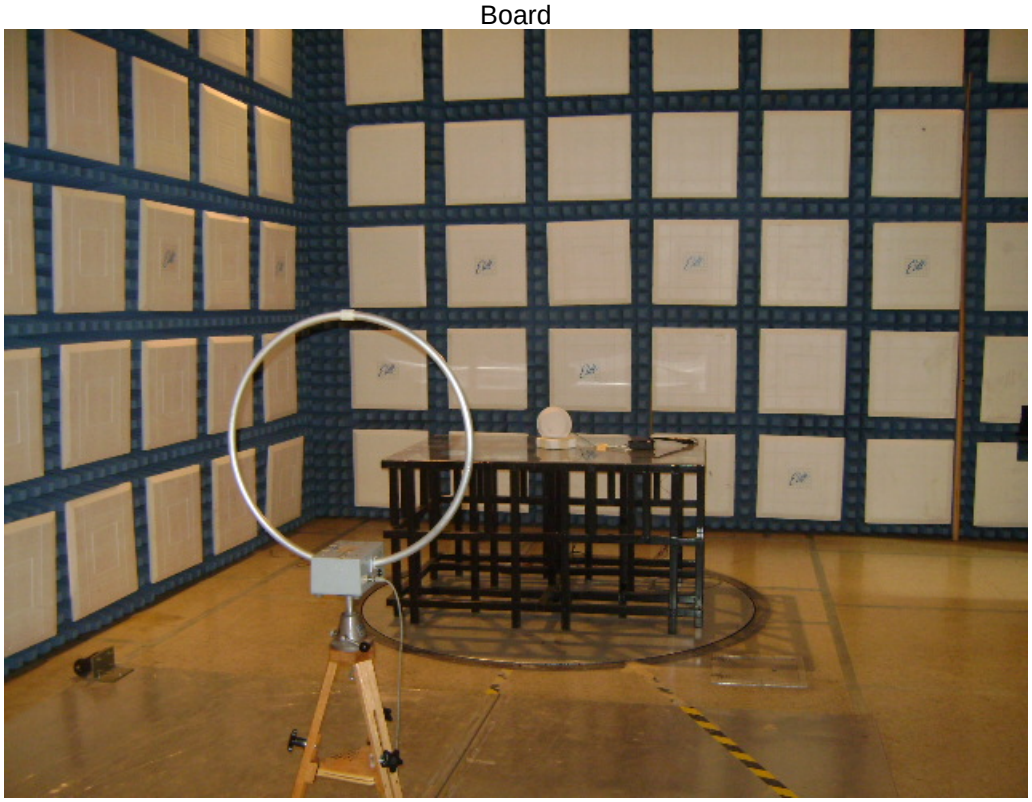


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

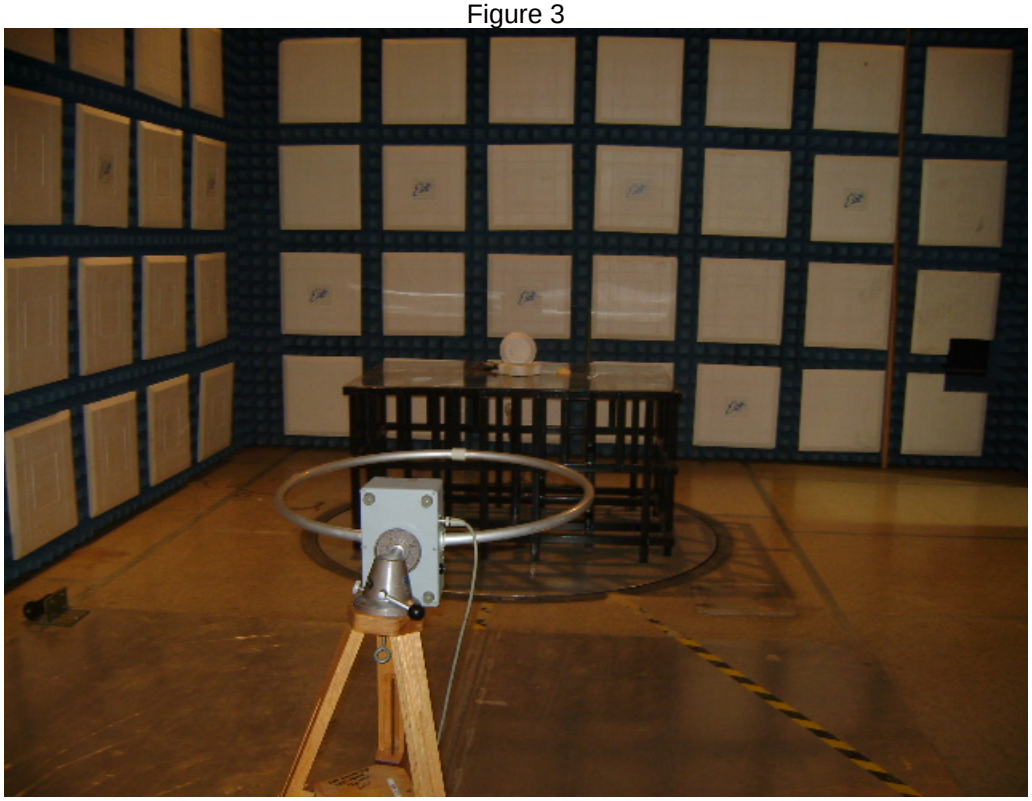


Test Setup for Radiated Emissions – Horizontal Polarization, External Antenna Driver Board

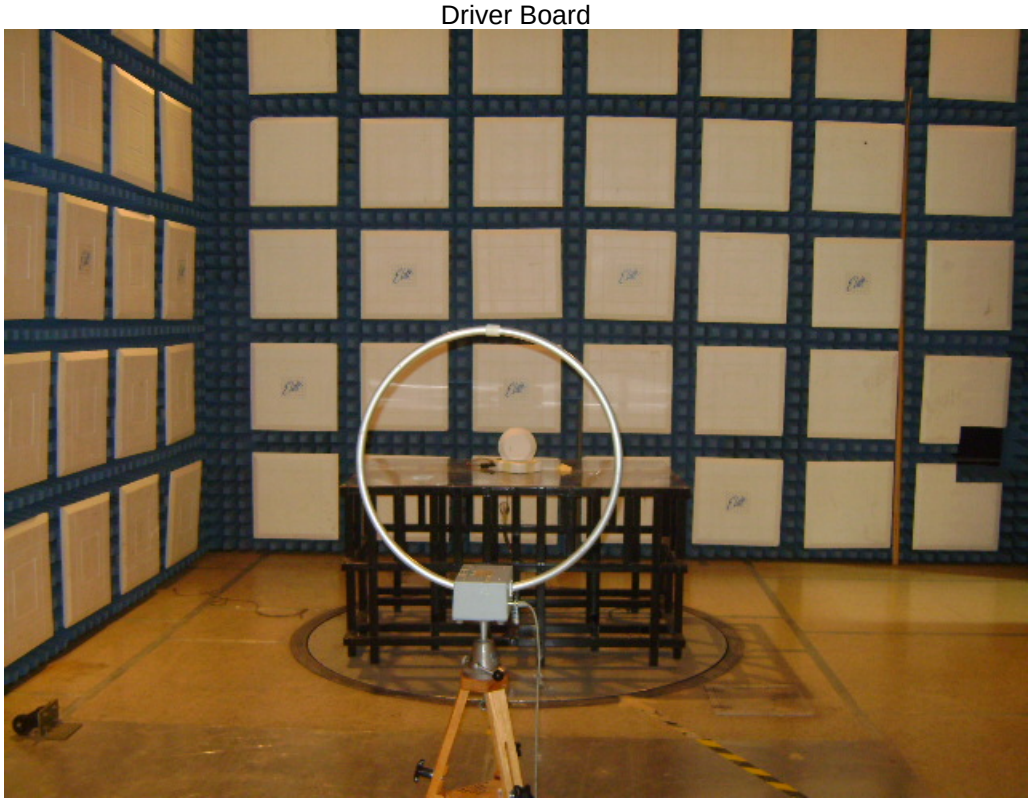


Test Setup for Radiated Emissions – Vertical Polarization, External Antenna Driver Board

Figure 3



Test Setup for Radiated Emissions – Horizontal Polarization, Integrated Antenna Driver Board



Test Setup for Radiated Emissions – Vertical Polarization, Integrated Antenna Driver Board

PROPAGATION LOSS MEASUREMENTS AND CALCULATIONS FOR M190 TRANSMITTER WITH EXTERNAL ANTENNA DRIVER BOARD

TEST DISTANCE (meters)	METER READING (dBuV)
2	108.6
5	86.8

PROPAGATION LOSS = 20 * LOG (Dm/Dl)^N
WHERE : Dm = DISTANCE OF MEASUREMENT
: Dl = LIMIT DISTANCE
: N = SLOPE OF THE LINE

SOLVING FOR N:
N = (dBV2 – dBV1)/(20*LOG(D2/D1))
N = (86.8 – 108.6)/(20 * LOG(5/2))
N = -2.74

PLACING THE SLOPE (N) INTO THE PROPAGATION LOSS EQUIATION GIVES YOU:

PROPAGATION LOSS = 20 * LOG(3/30)^(-2.74)

= 54.8 AT 30 METER TEST DISTANCE

PROPAGATION LOSS = 20 * LOG(3/300)^(-2.74)

= 109.6dB AT 300 METER TEST DISTANCE

PROPAGATION LOSS MEASUREMENTS AND CALCULATIONS FOR M190 TRANSMITTER WITH INTEGRATED ANTENNA DRIVER BOARD

TEST DISTANCE (meters)	METER READING (dBuV)
2	109.3
5	87.2

PROPAGATION LOSS = 20 * LOG (Dm/Dl)^N
WHERE : Dm = DISTANCE OF MEASUREMENT
: Dl = LIMIT DISTANCE
: N = SLOPE OF THE LINE

SOLVING FOR N:
N = (dBV2 – dBV1)/(20*LOG(D2/D1))
N = (87.2 – 109.3)/(20 * LOG(5/2))
N = -2.75

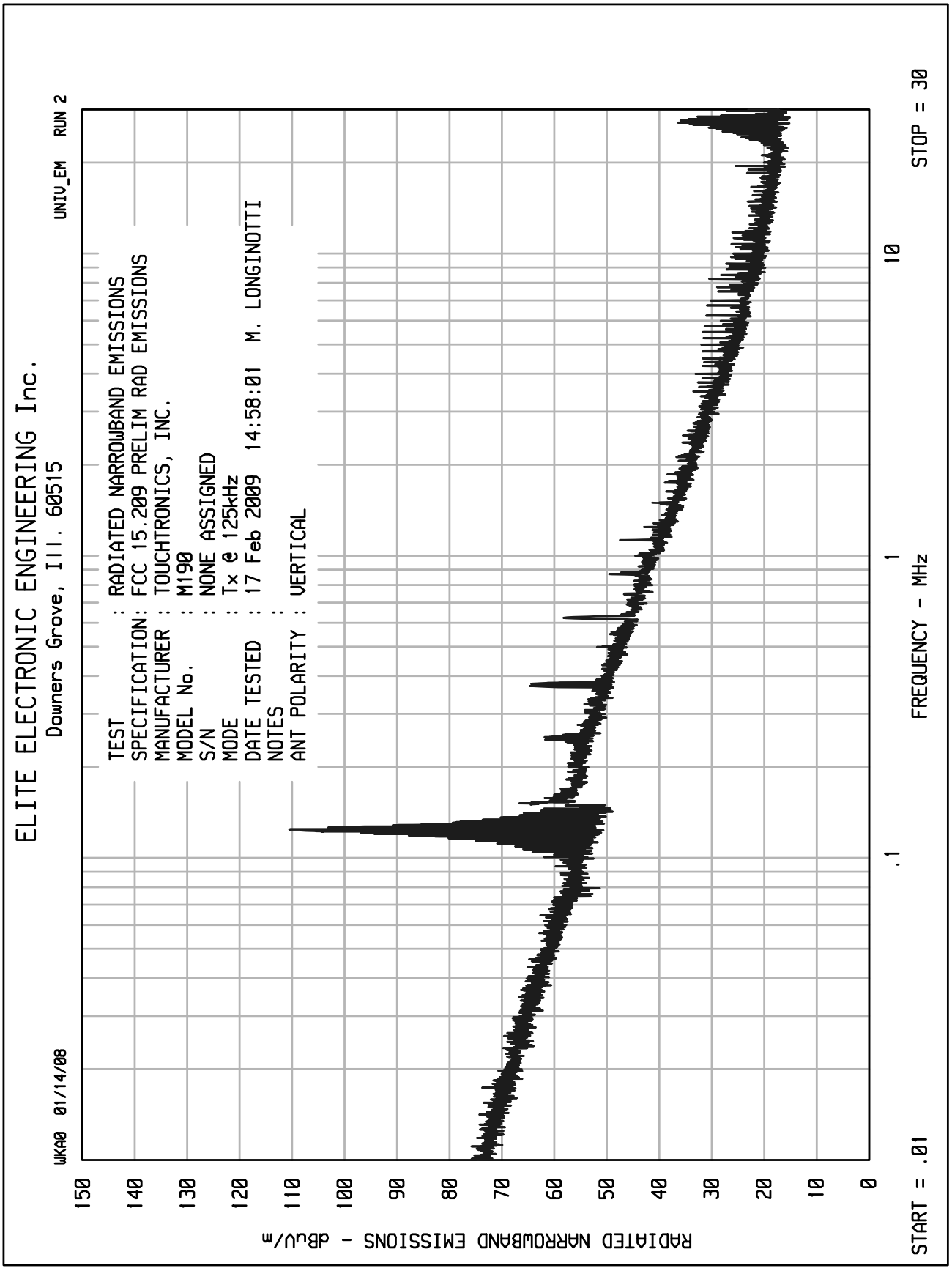
PLACING THE SLOPE (N) INTO THE PROPAGATION LOSS EQUIATION GIVES YOU:

PROPAGATION LOSS = 20 * LOG(3/30)^(-2.75)

= 55.5dB AT 30 METER TEST DISTANCE

PROPAGATION LOSS = 20 * LOG(3/300)^(-2.75)

= 111.1dB AT 300 METER TEST DISTANCE


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 01/14/08
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.209 PRELIM RAD EMISSIONS
MANUFACTURER : TOUCHTRONICS, INC.
MODEL No. : M190
S/N : NONE ASSIGNED
MODE : Tx @ 125kHz
DATE TESTED : 17 Feb 2009 14:58:01 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
START = .01
.1
1
10
STOP = 30
FREQUENCY - MHz

Manufacturer : TouchTronics
Model No. : M190
Serial No. : None Assigned
Mode : Tx @ 125kHz
Date Tested : February 17, 2009
Test Distance : 3 meters
Test Performed : FCC 15.209 Radiated Emissions
Notes : External Antenna Driver Board

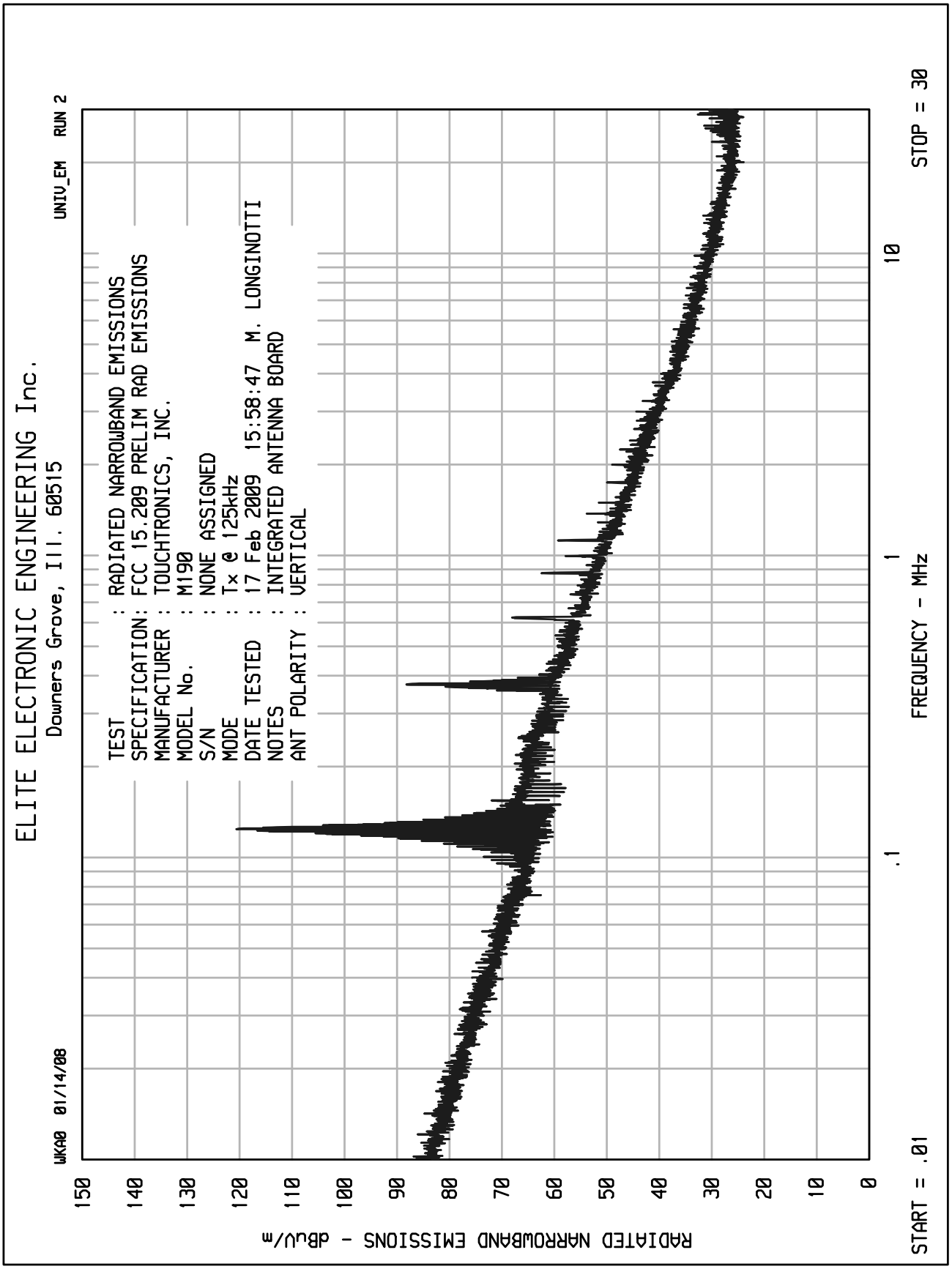
Frequency (MHz)	Ant Pol	Meter Reading (dBuV)	Amb	Cable Fac (dB)	Ant Fac (dB)	Propagation Loss (dB)	Total dBuV/m at 300m/30m	Total uV/m at 300m/30m	Limit uV/m at 300m/30m	Margin (dB)
0.125	H	88.1		0.0	10.7	-109.6	-10.8	0.2897	19.2	-36.4
0.125	V	99.6		0.0	10.7	-109.6	0.7	1.0888	19.2	-24.9
0.250	H	47.9		0.0	10.4	-109.6	-51.3	0.0027	9.6	-70.9
0.250	V	49.3		0.0	10.4	-109.6	-49.9	0.0032	9.6	-69.5
0.375	H	47.3		0.0	10.4	-109.6	-51.9	0.0025	6.4	-68.0
0.375	V	66.3		0.0	10.4	-109.6	-32.9	0.0226	6.4	-49.0
0.500	H	40.5		0.0	10.4	-54.8	-3.9	0.6383	48.0	-37.5
0.500	V	44.7		0.0	10.4	-54.8	0.3	1.0351	48.0	-33.3
0.625	H	40.7		0.0	10.5	-54.8	-3.6	0.6587	38.4	-35.3
0.625	V	47.4		0.0	10.5	-54.8	3.1	1.4245	38.4	-28.6
0.750	H	36.6		0.0	10.5	-54.8	-7.7	0.4098	32.0	-37.9
0.750	V	37.8		0.0	10.5	-54.8	-6.5	0.4705	32.0	-36.7
0.875	H	36.2		0.0	10.6	-54.8	-8.0	0.3970	27.4	-36.8
0.875	V	42.5		0.0	10.6	-54.8	-1.7	0.8200	27.4	-30.5
1.000	H	33.3		0.0	10.6	-54.8	-10.9	0.2851	24.0	-38.5
1.000	V	35.0		0.0	10.6	-54.8	-9.2	0.3467	24.0	-36.8
1.125	H	33.6		0.0	10.6	-54.8	-10.6	0.2957	21.3	-37.2
1.125	V	38.8		0.0	10.6	-54.8	-5.4	0.5381	21.3	-32.0
1.250	H	31.9		0.0	10.6	-54.8	-12.3	0.2436	19.2	-37.9
1.250	V	32.3		0.0	10.6	-54.8	-11.9	0.2550	19.2	-37.5

Total (dBuV/m) = Meter Reading + Cable Factor + Ant Factor + Propagation Loss

Limit distance is 300 meters from 9kHz to 490kHz. Limit distance is 30 meters from 490kHz to 1.705MHz

Checked By: MARK E. LONGINOTTI

Mark E. Longinotti


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 01/14/08
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.209 PRELIM RAD EMISSIONS
MANUFACTURER : TOUCHTRONICS, INC.
MODEL No. : M190
S/N : NONE ASSIGNED
MODE : Tx @ 125kHz
DATE TESTED : 17 Feb 2009 15:58:47 M. LONGINOTTI
NOTES : INTEGRATED ANTENNA BOARD
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
START = .01
.1
1
10
STOP = 30
FREQUENCY - MHz

Manufacturer : TouchTronics
Model No. : M190
Serial No. : None Assigned
Mode : Tx @ 125kHz
Date Tested : February 17, 2009
Test Distance : 3 meters
Test Performed : FCC 15.209 Radiated Emissions
Notes : Integrated Antenna Driver Board

Frequency (MHz)	Ant Pol	Meter Reading (dBuV)	Amb	Cable Fac (dB)	Ant Fac (dB)	Propagation Loss (dB)	Total dBuV/m at 300m/30m	Total uV/m at 300m/30m	Limit uV/m at 300m/30m	Margin (dB)
0.125	H	91.2		0.0	10.7	-111.1	-9.2	0.3483	19.2	-34.8
0.125	V	100.1		0.0	10.7	-111.1	-0.3	0.9704	19.2	-25.9
0.250	H	46.2		0.0	10.4	-111.1	-54.5	0.0019	9.6	-74.1
0.250	V	51.6		0.0	10.4	-111.1	-49.1	0.0035	9.6	-68.7
0.375	H	49.9		0.0	10.4	-111.1	-50.8	0.0029	6.4	-66.9
0.375	V	56.1		0.0	10.4	-111.1	-44.6	0.0059	6.4	-60.7
0.500	H	40.3		0.0	10.4	-55.5	-4.8	0.5754	48.0	-38.4
0.500	V	43.7		0.0	10.4	-55.5	-1.4	0.8511	48.0	-35.0
0.625	H	41.4		0.0	10.5	-55.5	-3.6	0.6587	38.4	-35.3
0.625	V	48.0		0.0	10.5	-55.5	3.0	1.4082	38.4	-28.7
0.750	H	35.4		0.0	10.5	-55.5	-9.6	0.3293	32.0	-39.8
0.750	V	38.2		0.0	10.5	-55.5	-6.8	0.4546	32.0	-37.0
0.875	H	37.2		0.0	10.6	-55.5	-7.7	0.4110	27.4	-36.5
0.875	V	42.5		0.0	10.6	-55.5	-2.4	0.7565	27.4	-31.2
1.000	H	34.1		0.0	10.6	-55.5	-10.8	0.2884	24.0	-38.4
1.000	V	37.1		0.0	10.6	-55.5	-7.8	0.4074	24.0	-35.4
1.125	H	33.4		0.0	10.6	-55.5	-11.5	0.2666	21.3	-38.1
1.125	V	38.2		0.0	10.6	-55.5	-6.7	0.4633	21.3	-33.3
1.250	H	30.8		0.0	10.6	-55.5	-14.1	0.1980	19.2	-39.7
1.250	V	33.7		0.0	10.6	-55.5	-11.2	0.2764	19.2	-36.8

Total (dBuV/m) = Meter Reading + Cable Factor + Ant Factor + Propagation Loss

Limit distance is 300 meters from 9kHz to 490kHz. Limit distance is 30 meters from 490kHz to 1.705MHz

Checked By: MARK E. LONGINOTTI
Mark E. Longinotti