Measurement of RF Interference from a Model PE950 Transceiver

For : Delta Mobile Software, Inc.
Hoffman Estates, IL

P.O. No. : DMS-196
Date Received : September 19, 2005
Date Tested : September 19, 2005 through September 27, 2005
Test Personnel : Mark E. Longinotti, NARTE® Certified EMC Test
: Engineer, ATL-0154-E
Specification : FCC "Code of Federal Regulations" Title 47
Part 15, Subpart B and Subpart C,
Section 15.249 for Intentional Radiators
Operating within the 902MHz to 928MHz band

Test Report By : Mark E. Longinotti

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Measurement of RF Emissions from a PE950 Transceiver

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of the series of radio interference measurements performed on a PE950 Transceiver, (hereinafter referred to as the test item). The test item was designed to transmit and receive at approximately 908MHz using an internal antenna. The test item was set up to transmit at approximately 908.4MHz for 60 seconds after a button on the front panel of the test item was pushed was designated as Sample A The test item set up to receive at approximately 908.3MHz for 60 seconds after a button on the front panel of the test item was pushed was designated as Sample B. The test item was submitted for testing by Delta Mobile Software, Inc. located in Hoffman Estates, IL.

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 B, Sections 15.107 and 15.109, and Subpart C, Sections 15.207 and 15.249 for Intentional Radiators Operating within the 902MHz -928MHz band. Testing was performed in accordance with ANSI C63.4-2001.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 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, dated 1 October 2004

- ANSI C63.4-2001, "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"

1.5 Subcontractor 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.

1.6 Laboratory Conditions The temperature at the time of the test was 22°C and the relative humidity was 60%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a PE950 Transceiver. A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item obtained 4.5 VDC power via 3 “AA” batteries.

2.2 Grounding - The test item was ungrounded during the tests.

2.3 Peripheral Equipment - No peripheral equipment was submitted with the test item.

2.4 Interconnect Cables - No interconnect cables were submitted with the test item.

2.5 Operational Mode - For all tests, the test item was placed on an 80cm high non-conductive stand. For transmitter tests, the test item was set up to transmit at approximately 908.4MHz for 60 seconds after a button on the front panel of the test item was pushed. For receiver tests, the test item was set up to receive at approximately 908.3MHz for 60 seconds after a button on the front panel of the test item was pushed.

2.6 Test Item Modifications - No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109, and Subpart C, Sections 15.207 and 15.249 requirements.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

3.2 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).

3.3 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 budgets were based on guidelines in "ISO Guide to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

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

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Powerline Conducted Emissions

Since the test item was powered by internal batteries, no conducted emissions tests were performed.

4.2 Radiated Measurements

4.2.1 Receiver

4.2.1.1 Requirements - All emanations from a receiver shall be below the levels shown on the following table:

RADIATION LIMITS FOR CLASS B DEVICE

Frequency MHz	Distance between Test Item And Antenna in Meters	Field Strength uV/m	Field Strength dBuV/m
30-88	3	100	40
88-216	3	150	43.5
216-960	3	200	46
Above 960	3	500	54

Note: The tighter limit shall apply at the edge between the two frequency bands.

4.2.1.2 Procedures - All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. 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 2001 for site attenuation.

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.

Since quasi-peak and average measurements require long integration times, it is not practical to automatically sweep through the quasi-peak or average levels. Therefore, radiated emissions from the test item were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector.

For preliminary radiated emissions sweeps from 30MHz to 5GHz, the broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 5GHz was investigated using a peak detector function with the bilog antenna below 1GHz and the double-ridged waveguide antenna above 1GHz. The maximum levels were plotted.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the preliminary sweeps using the following methods:

1) Measurements below 1GHz were made using a quasi-peak detector and a bilog antenna. Measurements above 1GHz were made using an average detector and a double ridged waveguide

antenna.

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

a) The test item was rotated so that all of its sides were exposed to the receiving antenna.

b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

d) 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.

4.2.1.3 Results - The preliminary plots are presented on pages 16 and 17. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on 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 908.3MHz. The emissions level at this frequency was 0.8dB 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 2.

4.2.2 Transmitters -

4.2.2.1 Requirements - The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq.

Paragraph 15.249(a) has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity mV/m @ 3 meters	Field Strength Harmonics and Spurious uV/m @ 3 meters
902 to 928	50	500

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.205(a) shall not exceed the general requirements shown in paragraph 15.209.

4.2.2.2 Procedures - All 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. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2001 for site attenuation.

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

The final emission tests were then manually performed over the frequency range of 30MHz to 9.1GHz. Between 30MHz and 1000MHz, a tuned dipole antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded.

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.
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.

4.2.2.3 Results - The preliminary plots, with the test item transmitting at 908.42MHz, are presented on data pages 19 and 20. The plots are presented for a reference only, and are not used to determine compliance. The final radiated levels, with the test item transmitting at 908.42MHz, are presented on data page 21. 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 908.4MHz. The emissions level at this frequency was 4.1dB within the limit. See data page 21 for details. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figure 3.

4.3 Occupied Bandwidth Measurements

4.3.1 Requirement - In accordance with paragraph 15.249(d), all emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuate by at least 50dB below the level of the fundamental or to the general radiated emissions limits in 15.209, which ever is the lesser attenuation.

4.3.2 Procedures - The test item was placed on an 80cm high non-conductive stand. The unit

was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 100 kHz and span was set to 30 MHz. The frequency spectrum near the fundamental was plotted.

4.3.3 Results - The plot of the emissions near the fundamental frequency is presented on data page 22. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSIONS:

It was determined that the Delta Mobile Software, Inc. PE950 Transceiver, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for receivers, and Subpart C, Sections 15.207 and 15.249 for Intentional Radiators Operating within the 902MHz -928MHz band, when tested per ANSI C63.4-2001.

6.0 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. 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.

7.0 ENDORSEMENT DISCLAIMER:

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

TABLE I: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC. Page: 1

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XZG0	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---		N/A	
Equipment Type: AMPLIFIERS								
APK0	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	02/07/05	12	02/07/06
Equipment Type: ANTENNAS								
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	02/01/05	12	02/01/06
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2054	0.03-2GHZ	08/08/05	12	08/08/06
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	09/05/04	13	10/05/05
Equipment Type: CONTROLLERS								
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ	0028483108	1.8GHZ		N/A	
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---		N/A	
Equipment Type: RECEIVERS								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	02/04/05	12	02/04/06
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	02/07/05	12	02/07/06
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	02/04/05	12	02/04/06

Cal. Interval: Listed in Months I/O: Initial Only 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.

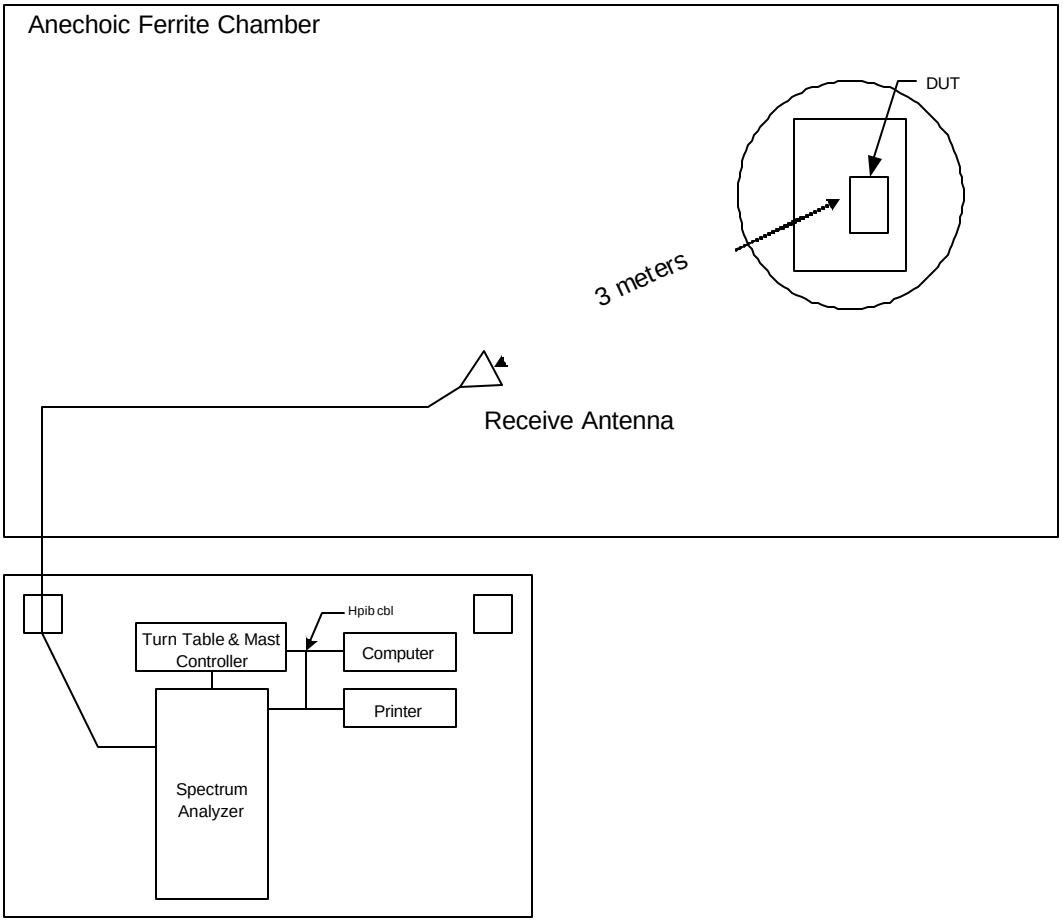
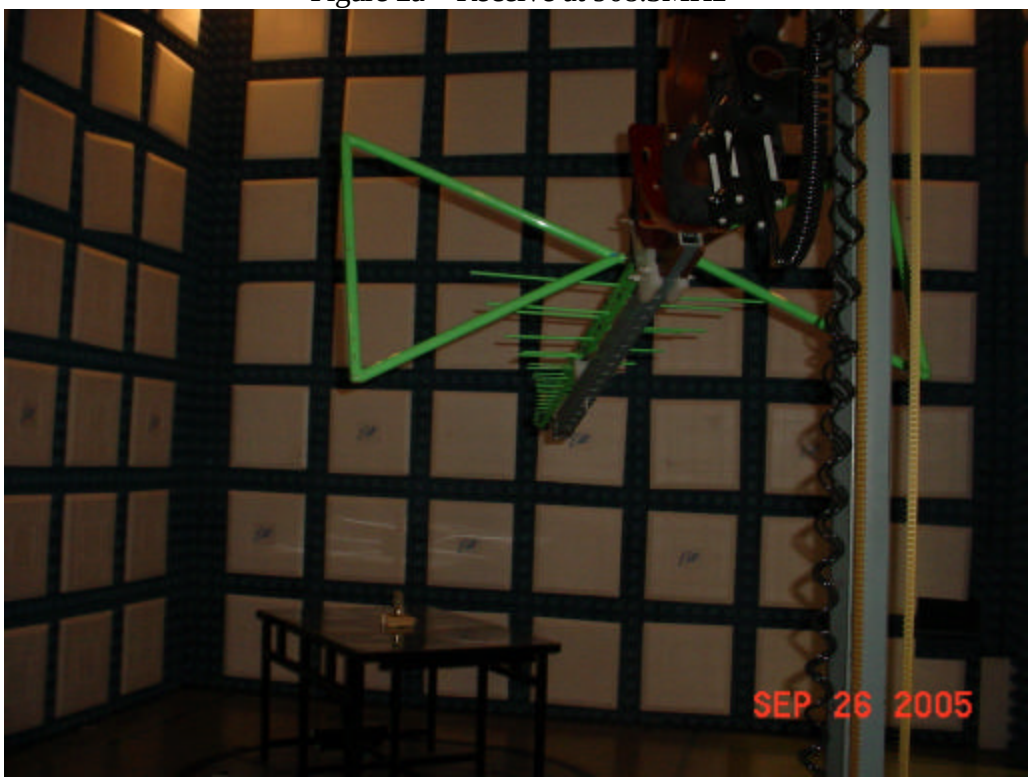
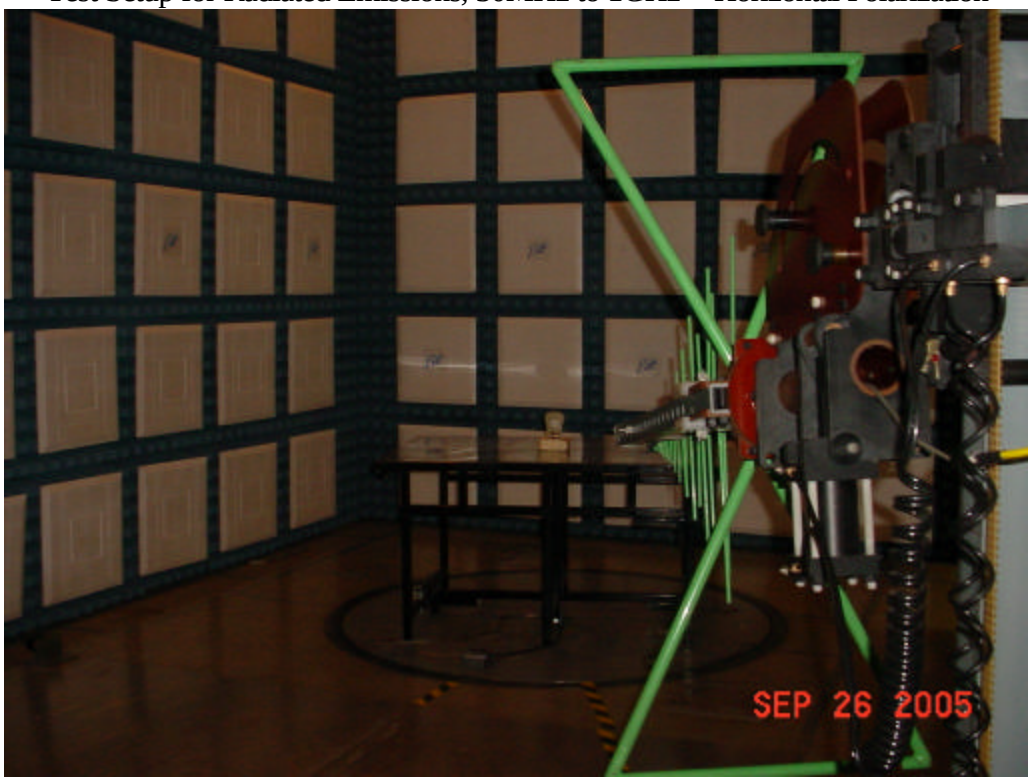


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2a – Receive at 908.3MHz



Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

Figure 2b – Receive at 908.3MHz

Test Setup for Radiated Emissions, 1GHz to 5GHz – Horizontal Polarization

Test Setup for Radiated Emissions, 1GHz to 5GHz – Vertical Polarization

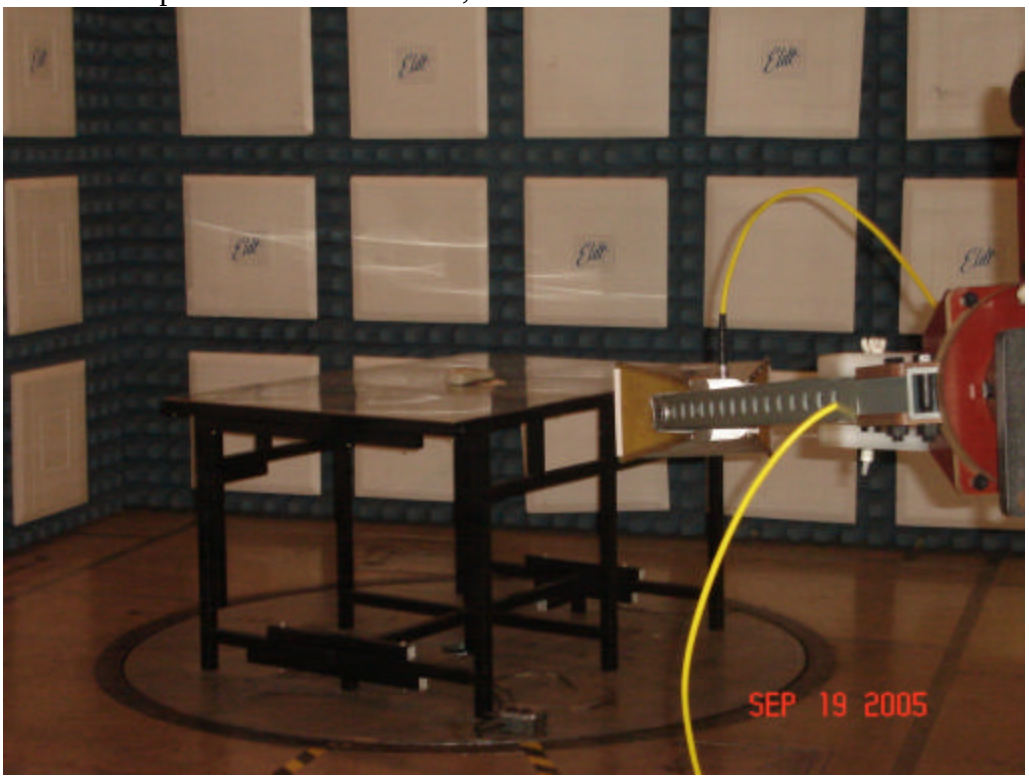
Figure 3a – Transmit at 908.4MHz

Test Setup for Radiated Emission, 908.4MHz – Horizontal Polarization

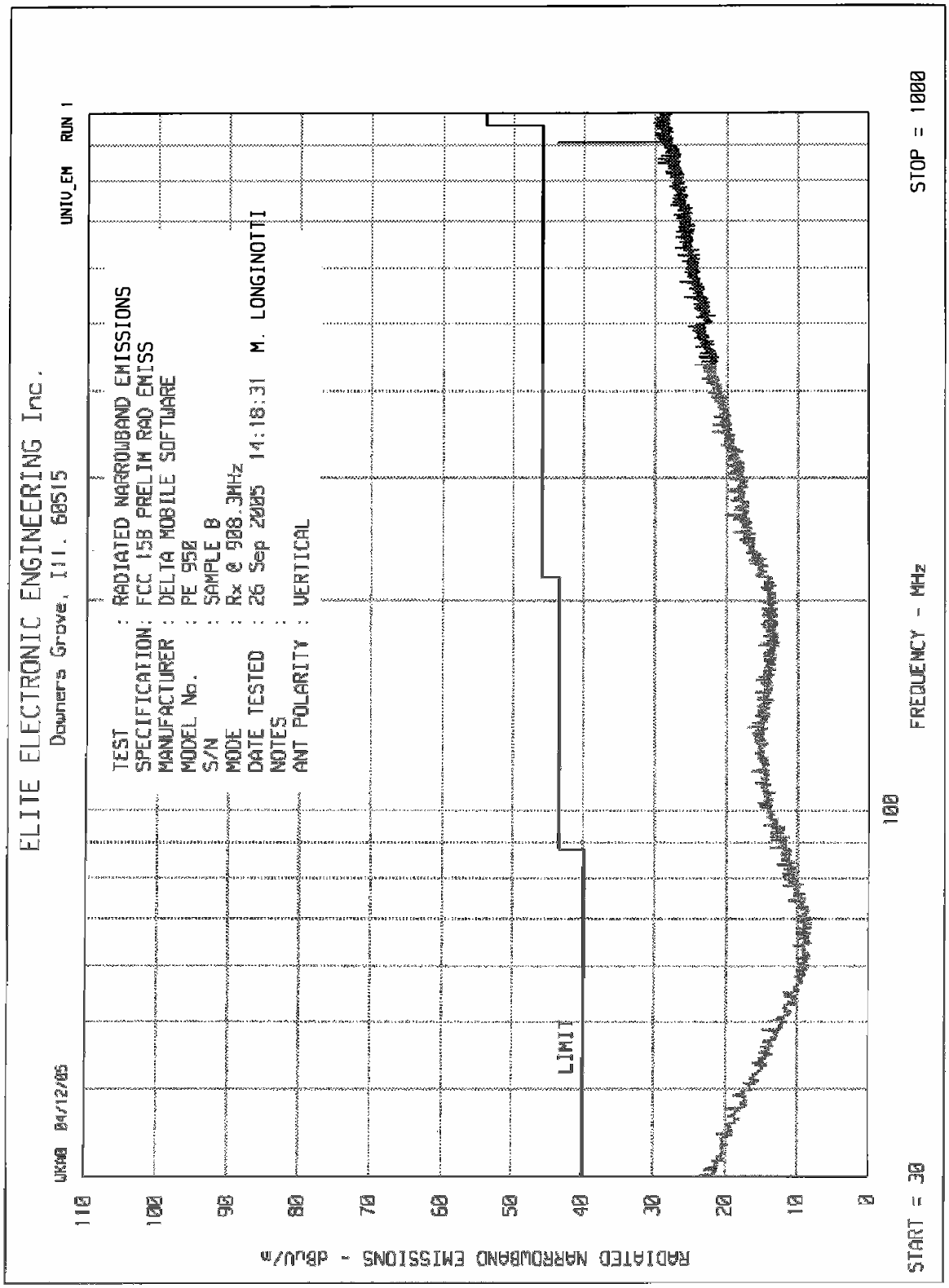
Test Setup for Radiated Emissions, 908.4MHz – Vertical Polarization

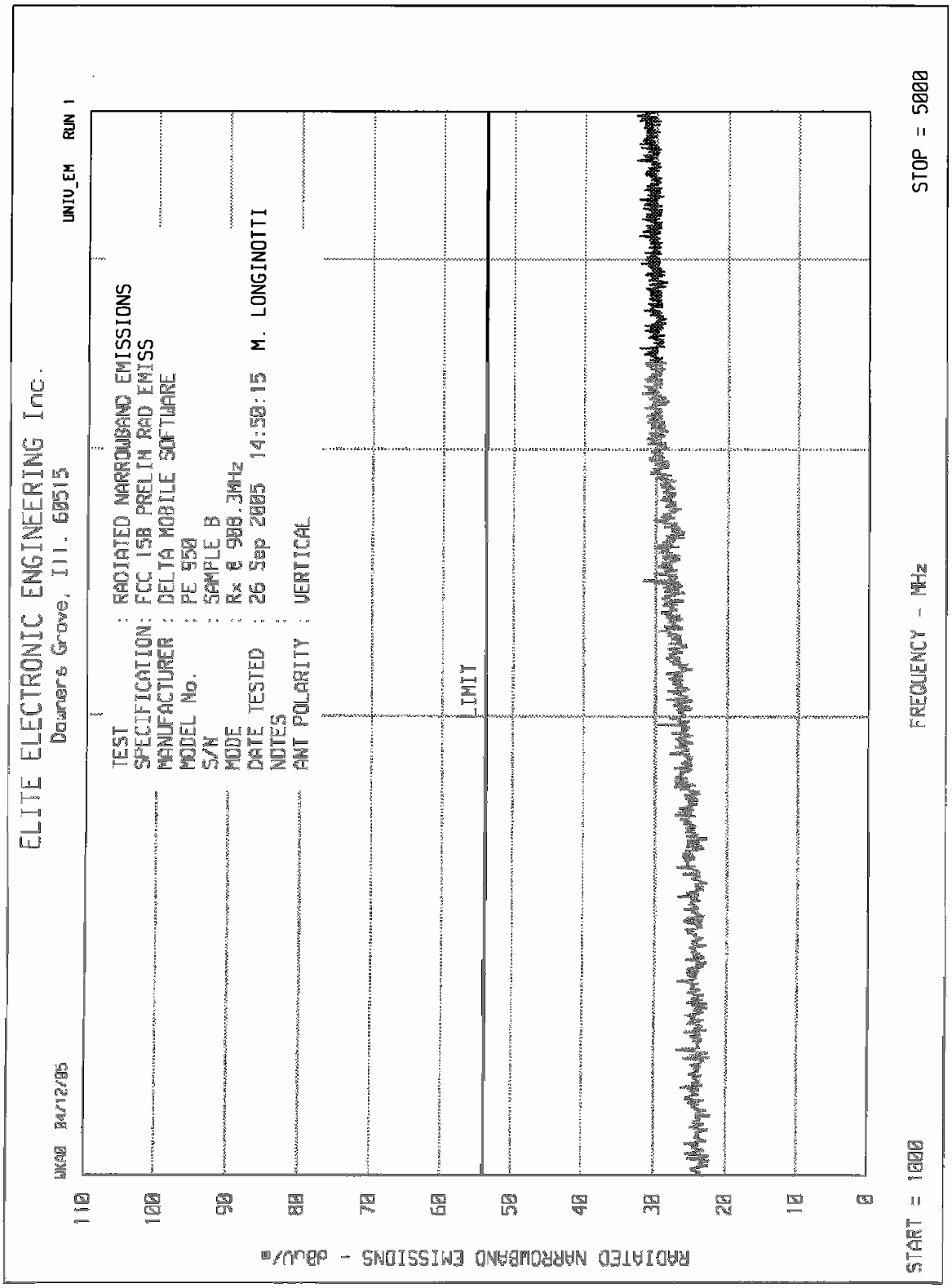
Figure 3b – Transmit at 908.4MHz

Test Setup for Radiated Emissions, 1GHz to 10GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 1GHz to 10GHz – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
UKNA 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15B PRELIM RAD EMISS
MANUFACTURER : DELTA MOBILE SOFTWARE
MODEL No. : PE 950
S/N : SAMPLE B
MODE : Rx @ 908.3MHz
DATE TESTED : 26 Sep 2005 14:18:31 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
STOP = 1000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKAB 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15B PRELIM RAD EMISS
MANUFACTURER : DELTA MOBILE SOFTWARE
MODEL No. : PE 950
S/N : SAMPLE B
MODE : Rx @ 908.3MHz
DATE TESTED : 26 Sep 2005 14:58:15 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 5000

MANUFACTURER : Delta Mobile Software, Inc.
TEST ITEM : Transceiver
MODEL NO. : PE 950
SERIAL NO. : Sample B
TEST SPECIFICATION : FCC 15.109(a), Radiated Emissions
MODE : Receive @ 908.3MHz
TEST DATE : September 26, 2005
TEST DISTANCE : 3 meters

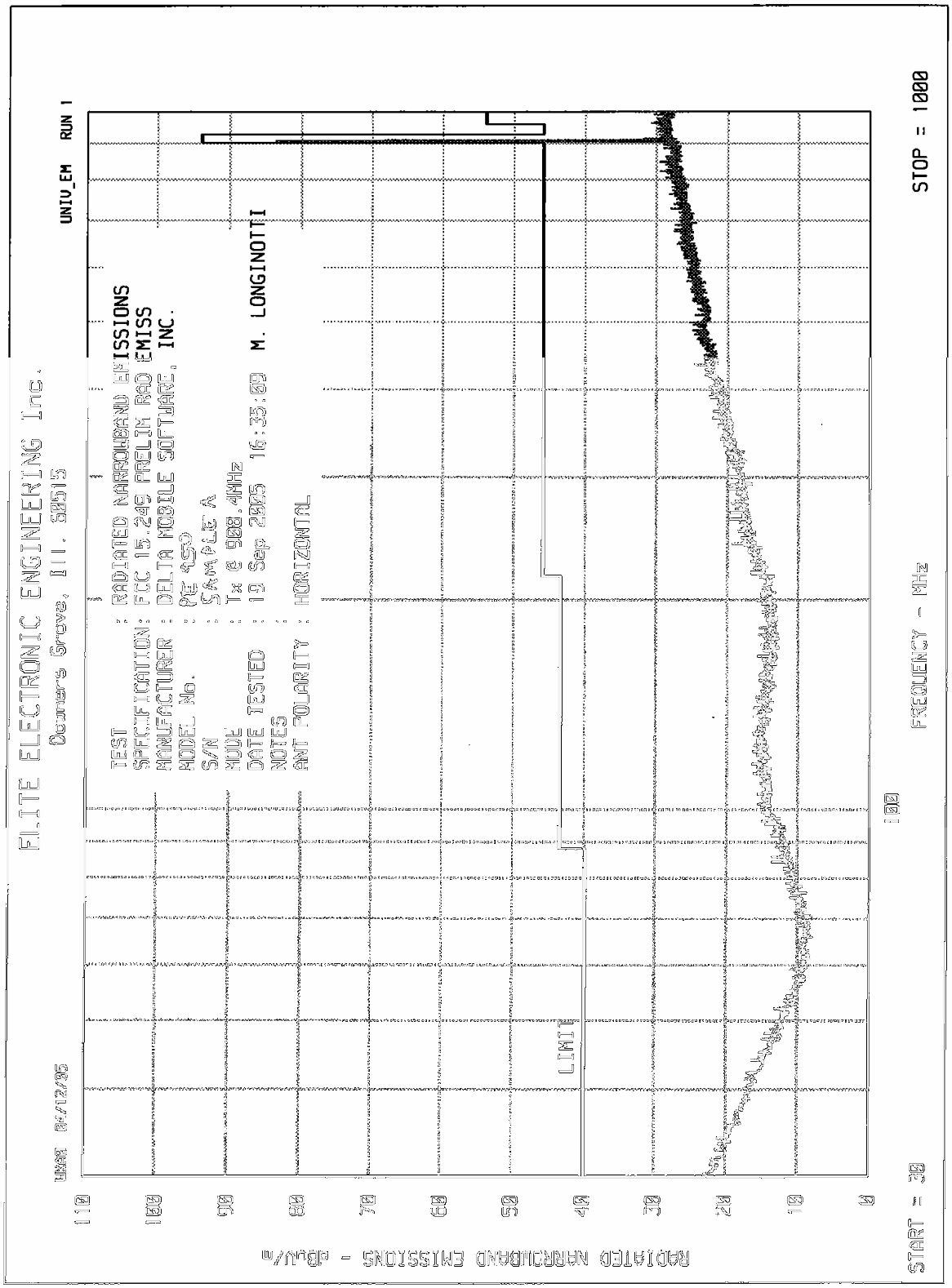
Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
908.3	H	11.6		1.9	23.0	0.0	36.5	66.9	200.0
908.3	V	20.3		1.9	23.0	0.0	45.2	182.3	200.0
1816.6	H	45.6	Ambient	2.9	28.1	-36.3	40.2	102.7	500.0
1816.6	V	45.3	Ambient	2.9	28.1	-36.3	39.9	99.2	500.0
2724.9	H	42.8	Ambient	3.8	31.4	-35.9	42.1	127.0	500.0
2724.9	V	42.8	Ambient	3.8	31.4	-35.9	42.1	127.0	500.0
3633.2	H	42.6	Ambient	4.4	32.5	-35.6	43.9	157.4	500.0
3633.2	V	42.5	Ambient	4.4	32.5	-35.6	43.8	155.6	500.0
4541.5	H	42.6	Ambient	4.8	32.9	-35.3	45.0	178.8	500.0
4541.5	V	42.1	Ambient	4.8	32.9	-35.3	44.5	168.8	500.0

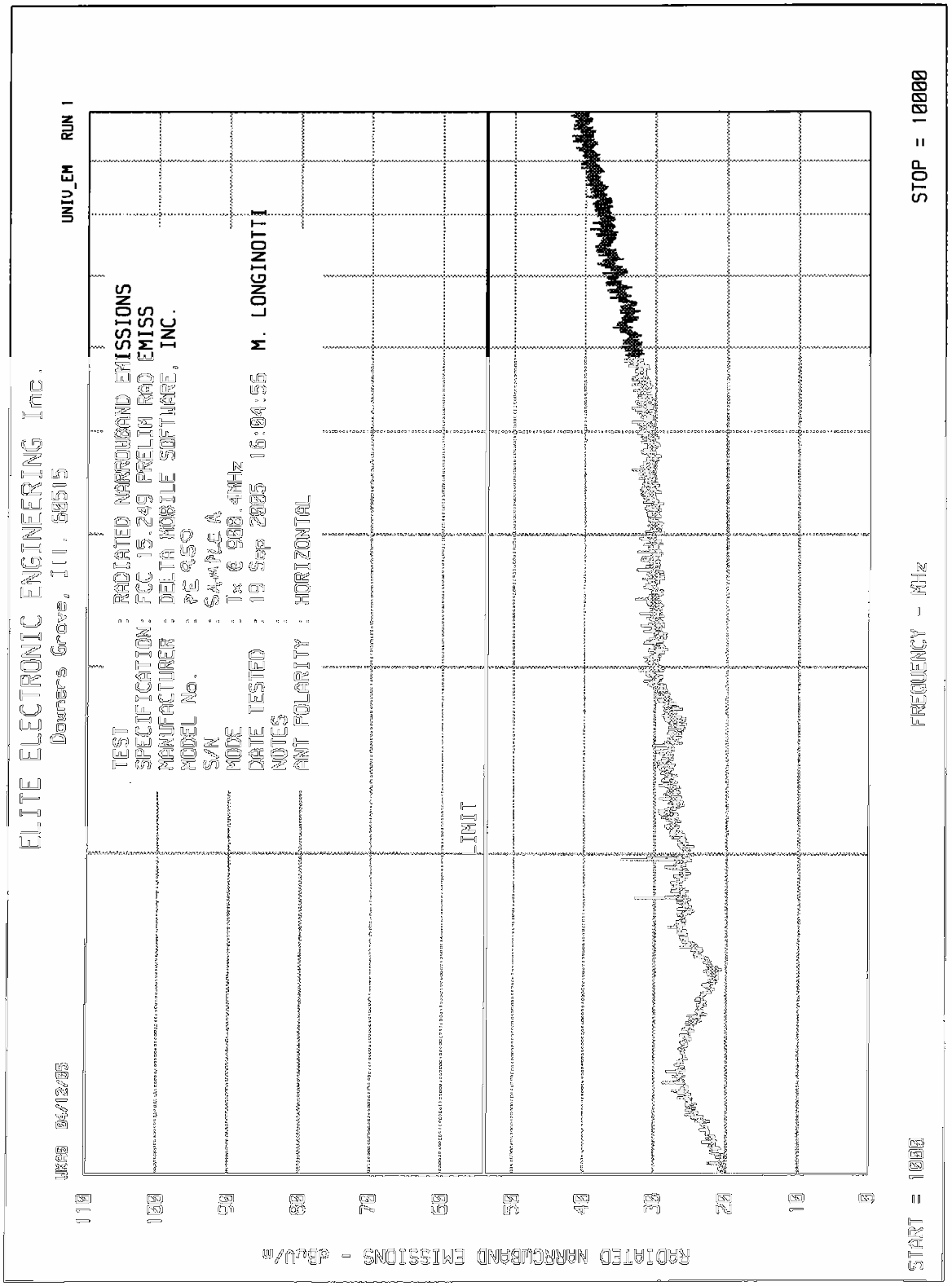
H – Horizontal

V = Vertical

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

Checked By : MARK E. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.249 PRELIM RAD EMISS
MANUFACTURER : DELTA MOBILE SOFTWARE, INC.
MODEL No. : PE 450
S/N : Sample A
MODE : Tx @ 908.4MHz
DATE TESTED : 19 Sep 2005 16:33:09 M. LONGINOTTI
NOTES :
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
FREQUENCY - MHz
START = 30
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.249 DELTA RAD EMISS
MANUFACTURER : DELTA MOBILE SOFTWARE, INC.
MODEL No. : PC 650
S/N : Sample A
MODE : Tx @ 900.4MHz
DATE TESTED : 19 Sep 2005 16:04:56 M. LONGINOTTI
NOTES :
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 10000

MANUFACTURER : Delta Mobile Software, Inc.
TEST ITEM : Transceiver
MODEL NO. : PE 950
SERIAL NO. : Sample A
TEST SPECIFICATION : FCC 15.249(a), Radiated Emissions
MODE : Transmit @ 908.42MHz
TEST DATE : September 19, 2005
TEST DISTANCE : 3 meters

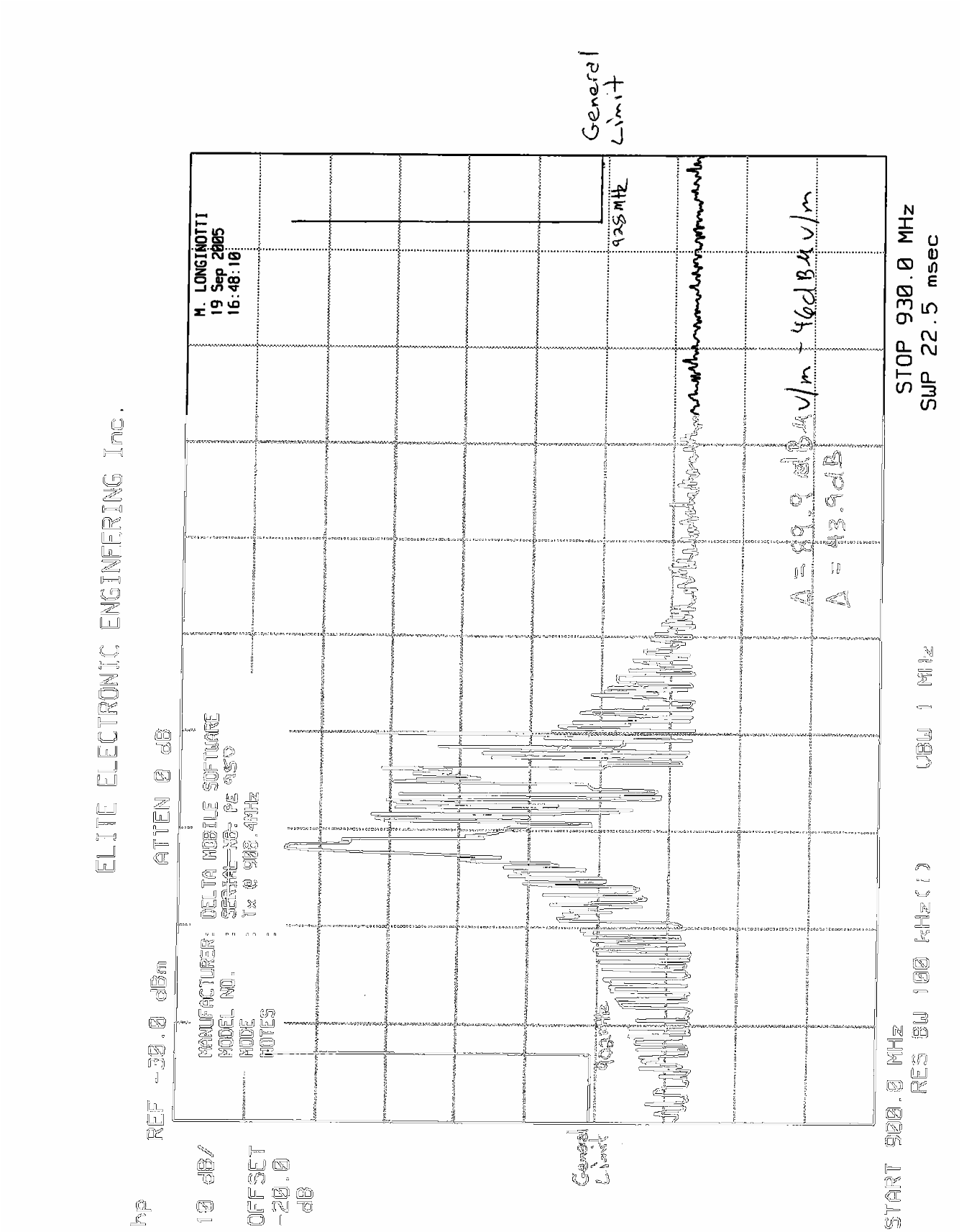
Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
908.4	H	60.2		1.9	27.8	0.0	89.9	31439.6	50000.0
908.4	V	50.9		1.9	27.8	0.0	80.6	10776.2	50000.0
1816.8	H	54.1		2.9	28.1	-36.3	48.7	273.2	500.0
1816.8	V	50.9		2.9	28.1	-36.3	45.5	189.0	500.0
2725.3	H	49.6		3.8	31.4	-35.9	48.9	277.8	500.0
2725.2	V	46.6		3.8	31.4	-35.9	45.9	196.7	500.0
3633.7	H	43.9	Ambient	4.4	32.5	-35.6	45.2	182.8	500.0
3633.6	V	44.4	Ambient	4.4	32.5	-35.6	45.7	193.7	500.0
4542.1	H	43.0	Ambient	4.8	32.9	-35.3	45.4	187.2	500.0
4542.0	V	42.7	Ambient	4.8	32.9	-35.3	45.1	180.9	500.0
5450.5	H	40.2	Ambient	5.2	35.3	-35.2	45.6	189.8	500.0
5450.4	V	40.2	Ambient	5.2	35.3	-35.2	45.6	189.8	500.0
6358.9	H	29.2	Ambient	5.9	36.1	-35.3	35.9	62.6	500.0
6358.8	V	29.3	Ambient	5.9	36.1	-35.3	36.0	63.3	500.0
7267.4	H	28.8	Ambient	6.6	37.7	-35.6	37.5	75.4	500.0
7267.2	V	28.8	Ambient	6.6	37.7	-35.6	37.5	75.3	500.0
8175.8	H	29.8	Ambient	7.1	37.7	-35.8	38.8	86.9	500.0
8175.6	V	29.9	Ambient	7.1	37.7	-35.8	38.9	87.9	500.0
9084.2	H	30.5	Ambient	7.5	38.0	-36.2	39.8	97.7	500.0
9084.0	V	30.5	Ambient	7.5	38.0	-36.2	39.8	97.7	500.0

H – Horizontal

V = Vertical

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

Checked By : MARK E. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF -30.0 dBm
ATTEN 0 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER: DELTA MOBILE SOFTWARE
MODEL NO. SERIAL NO. 62 050
MODE
NOTES
Tx @ 908.4MHz
M. LONGINOTTI
19 Sep 2005
16:48:10
General Limit
925 MHz
A = 89.0 dBµV/m + 46dB µV/m
A = 43.9dB
General Limit
START 920.0 MHz
RES BW 100 kHz
VBW 1 MHz
STOP 930.0 MHz
SWP 22.5 msec