Measurement of RF Emissions from a 50T0157 Trapeze Mobile Ticketing Device

For	Trapeze 5265 Rockwell Drive Northeast Cedar Rapids, IA 52402
P.O. Number	PO0011716
Date Tested	June 16, 2014 through June 20, 2014
Test Personnel	Mark Longinotti
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C, §225 Industry Canada RSS-210

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Trapeze

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REVISION HISTORY

Revision	Date	Description
—	1 Aug 2014	Initial release

Measurement of RF Emissions from a Trapeze Mobile Ticketing Device, Model No.: 50T0157

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Trapeze Mobile Ticketing Device, M/N: 50T0157, hereinafter referred to as the Equipment Under Test (EUT). No Serial Number was assigned to the EUT. The EUT was designed to transmit at approximately 13.559MHz using a DUALi antenna, P/N: DE-ACBM3. The EUT was manufactured and submitted for testing by Trapeze located in Cedar Rapids, IA.

1.2. Purpose

The test series was performed to determine if the EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 207 and 225 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2009.

The test series was also performed to determine if the EUT meets the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.4 and RSS-210 Annex 2 for transmitters.

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 American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 23°C and the relative humidity was 45%.

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 2013
- ANSI C63.4-2009, "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 Radio Standards Specification, RSS-210, “Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment”, Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Trapeze Mobile Ticketing Device, Model No. 50T0157. A block diagram of the EUT setup is

shown as Figure 1.

3.1.1.Power Input

The EUT obtained 13.5VDC through 4 leads of the 24 wire, 50 foot long wiring harness.

3.1.2.Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Termination Box	Used to provide loopback for the Ethernet, grounding for the discrete I/O, and resistive termination of the serial communication lines. The Termination Box was external to the test chamber for all tests.
Laptop Computer	Used to program the EUT to operate in the proper test mode.
Micro SD card	Installed in the EUT. The card has all the test application software loaded onto it.

3.1.3.Signal Input/Output Leads

The following interconnect cables were submitted with the EUT:

Item	Description
Ethernet Cable	50 foot long – terminated at Termination Box
Serial Cable	50 foot long – terminated at Termination Box
Discrete I/O Cable	50 foot long – terminated at Termination Box
WiFi Programming Cable	1 foot long - unterminated

3.1.4.Grounding

The EUT was not grounded during the tests.

3.2. Software

For all tests the EUT had Firmware Version DE-ABCM_F103_110629 loaded onto the device to provide correct load characteristics.

3.3. Operational Mode

For all tests the EUT was placed on an 80cm high non-conductive stand. The EUT and all peripheral equipment were energized. Once the EUT was energized, all installed components of the EUT were exercised. The laptop computer was connected to the EUT and the “DeParameter” software was used to start the EUT transmitting at 13.559MHz.

3.4. EUT Modifications

The following modifications were performed to the EUT:

- A shield was added to the NFC daughter board
- Wavexorb material SB033-010-S-A was placed over the cable between the NFC daughter board and the NFC antenna
- 2 each 66pF capacitors were added to the NFC daughter board in position C12 and C16

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 C63.4-2009 for site attenuation.

4.2. Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified in the requirements.

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 Emissions Measurements		
Combined Standard Uncertainty	1.06	-1.06
Expanded Uncertainty (95% confidence)	2.12	-2.12

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.09	-2.09
Expanded Uncertainty (95% confidence)	4.19	-4.19

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1.Requirements

In normal operation, the EUT is powered by 8 – 36 VDC from the vehicle battery in which it is installed. Since the EUT does not connect to AC power , no conducted emission measurements are required.

5.2. Radiated Measurements

5.2.1.Requirements

The EUT must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.225.

Paragraph 15.225 has the following radiated emission limits:

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

5.2.2. 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 C63.4-2009 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.

5.2.2.1 150kHz to 30MHz Frequency Range

A preliminary radiated emissions test was performed to determine the emission characteristics of the EUT. For the preliminary test, an active loop measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 150kHz to 30MHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 150kHz to 30MHz using an active loop antenna. All significant broadband and narrowband signals were measured and recorded using a quasi-peak detector with a 9kHz bandwidth.

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

1) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
2) The active loop antenna was placed at a height of 1 meter.
3) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
4) With the loop antenna in the vertical polarization, the loop antenna was rotated through 360 degrees.

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external pre-amplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total. (Per 15.231(f)(2), at frequencies below 30MHz, measurements may be made at a distance closer than that specified. When performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by using the square of an inverse linear distance extrapolation factor (40 dB/decade).)

Formula 1: FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

Formula 2: FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

5.2.2.2 30MHz to 1000MHz Frequency Range

Since a quasi-peak detector requires long integration times, it is not practical to automatically sweep through the quasi-peak levels. Therefore, radiated emissions from the EUT 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.

The broadband measuring antenna was positioned at a 3 meter distance from the EUT. The frequency range from 30MHz to 1GHz was investigated using a peak detector function with the bilog antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The maximum levels for each antenna polarization were plotted. The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external pre-amplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

Formula 1: FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

Formula 2: FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

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

1) Measurements from 30MHz to 1GHz were made using a quasi-peak detector and a broadband bilog antenna.

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

    a) The EUT 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.

5.2.3.Results

The preliminary plots, with the EUT transmitting at 13.559MHz, are presented on data pages15 through 18. The plots are presented for a reference only, and are not used to determine compliance.

The final open area radiated levels, with the EUT transmitting at 13.559MHz, are presented on data page 19 and 20. As can be seen from the data, all emissions measured from the EUT were within the specification limits. The emissions level closet to the limit (worst case) occurred at 569.48MHz. The emissions level at this frequency was 0.2dB within the limit. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2 and Figure 3.

5.3. Frequency Stability

5.3.1.Requirement

Per 15.225(e), the frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.3.2.Procedures

The EUT was placed inside a temperature chamber. A near-field loop antenna was placed next to the EUT. The near-field loop antenna was connected to a frequency counter.

a) The nominal frequency of the transmitter was measured and recorded.

b) The temperature chamber was then set to -20ºC.

c) Once the temperature had reached -20ºC the EUT was allowed to soak for 30 minutes.

d) After soaking at -20ºC for thirty minutes the EUT was turned on and the transmit frequency was measured and recorded.

e) Steps (b) through (d) were repeated for each temperature in 10ºC steps from -10ºC to +50ºC.

f) The temperature chamber was then set to +20ºC and the EUT was allowed to soak for 30 minutes.

g) The input voltage was checked and adjusted to the nominal level. The frequency was measured and recorded.

h) The input voltage was then varied to 85% of its nominal level. The frequency was measured and recorded.

i) The input voltage was then varied to 115% of its nominal level. The frequency was measured and recorded.

5.3.3.Results

The frequency stability measurements are presented on pages 21 and 22. As can be seen from the data the test frequency deviation was within the ±0.01% limit. A photograph of the test set-up is shown in Figure 4.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Trapeze upon completion of the tests.

7. CONCLUSIONS

It was determined that, with the following modifications, the Trapeze Mobile Ticketing Device, Model No. 50T0157, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 205 and 225 for Intentional Radiators, when tested per ANSI C63.4-2009:

- A shield was added to the NFC daughter board
- Wavexorb material SB033-010-S-A was placed over the cable between the NFC daughter board and the NFC antenna
- 2 each 66pF capacitors were added to the NFC daughter board in position C12 and C16

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 EUT at the test date. Any electrical or mechanical modification made to the EUT 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 certification, approval, or endorsement by NVLAP, NIST or any agency of the Federal Government.

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
ETD0	ENV Chambers For Auto Dept Use Only	Thermotron	S-8	15461	-70 to 150 degrees C	NOTE 1	
ETDA	HONEYWELL CHART RECORDER	HONEYWELL	DR45AT-1100	0825Y878133300009	PROGRAMMABLE	4/28/2014	4/28/2015
ETDC	Temperature Controller	Thermotron	2800	753726	Programmable	NOTE 1	
MFC0	MICROWAVE FREQ. COUNTER	HEWLETT PACKARD	5343A	2133A00591	10HZ-26GHZ	8/12/2013	8/12/2014
NLS0	24" ACTIVE LOOP ANTENNA	EMCO	6502	89979	10KHZ-30MHZ	7/7/2014	7/7/2015
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/19/2014	2/19/2015
PHA0	MAGNETIC FIELD PROBE	ELECTRO-METRICS	EM-6882	134	22-230MHZ	NOTE 1	
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/7/2014	3/7/2015

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.

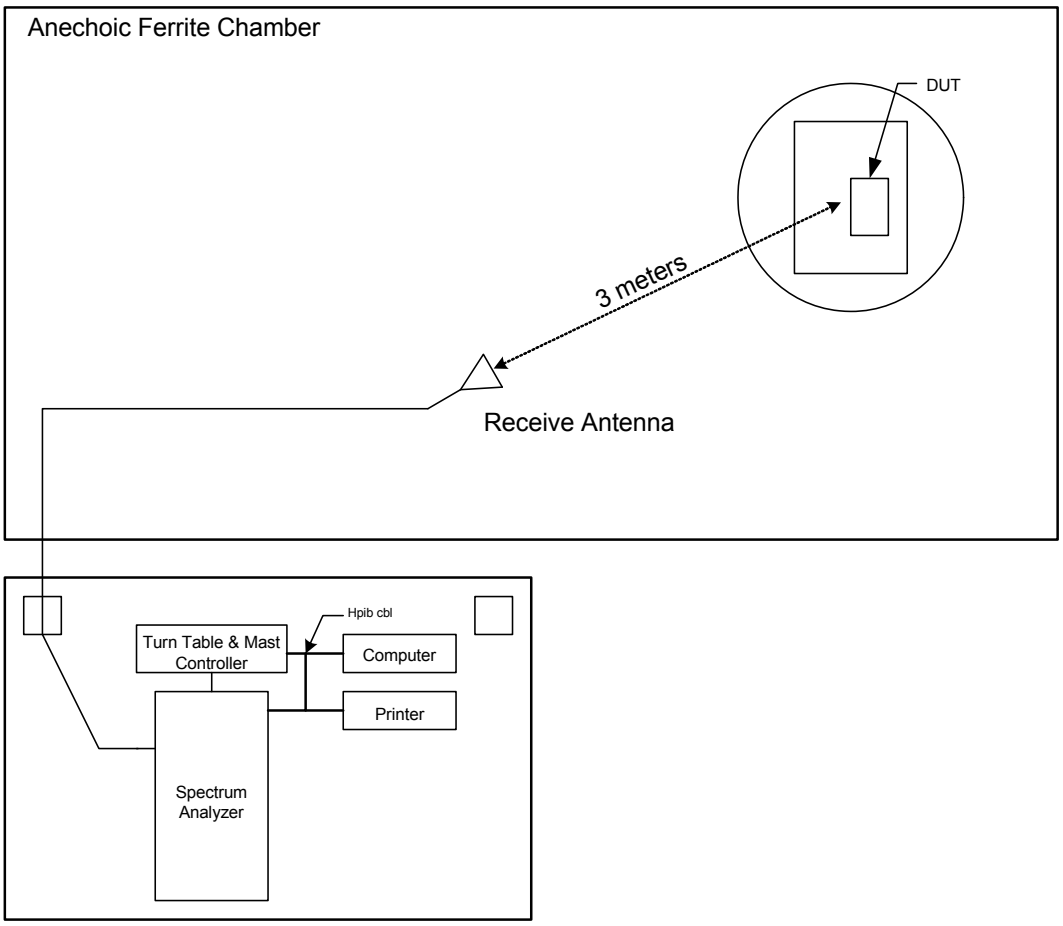
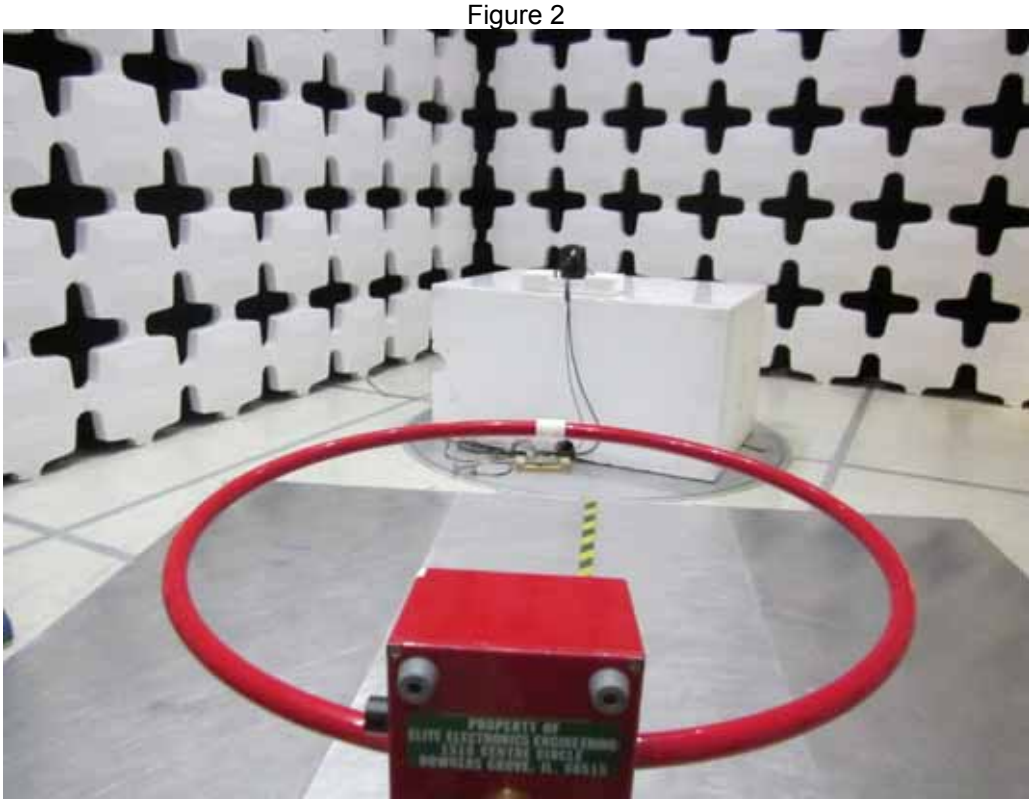
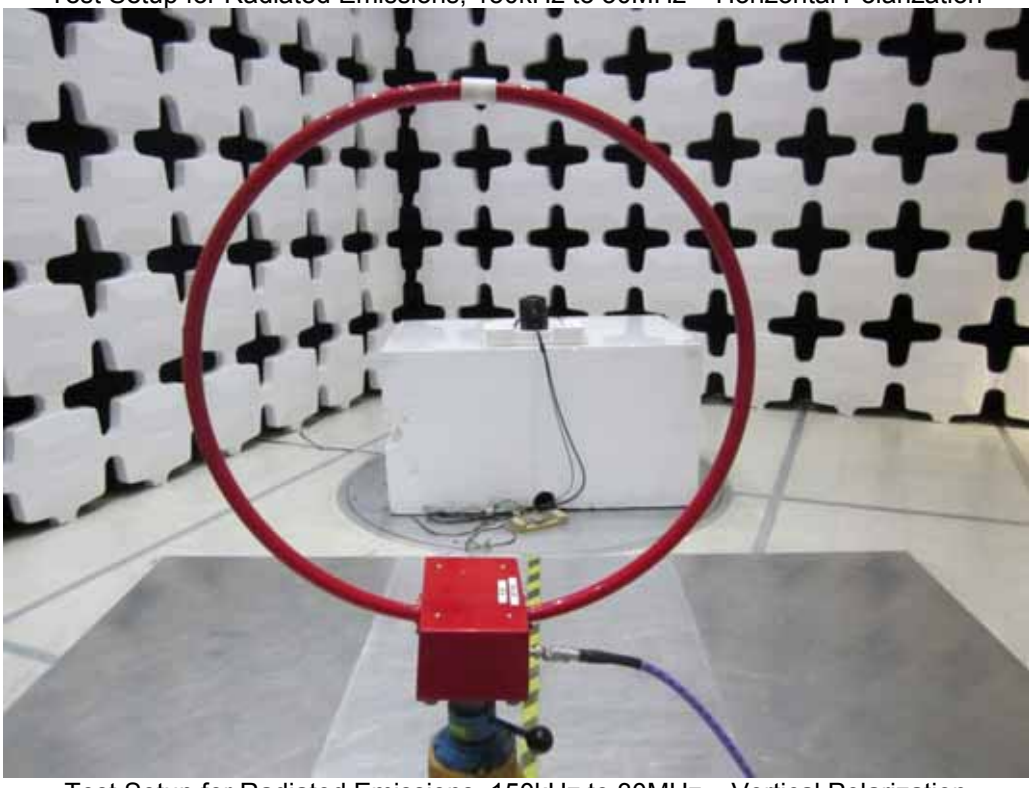


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2



Test Setup for Radiated Emissions, 150kHz to 30MHz – Horizontal Polarization



Test Setup for Radiated Emissions, 150kHz to 30MHz – Vertical Polarization

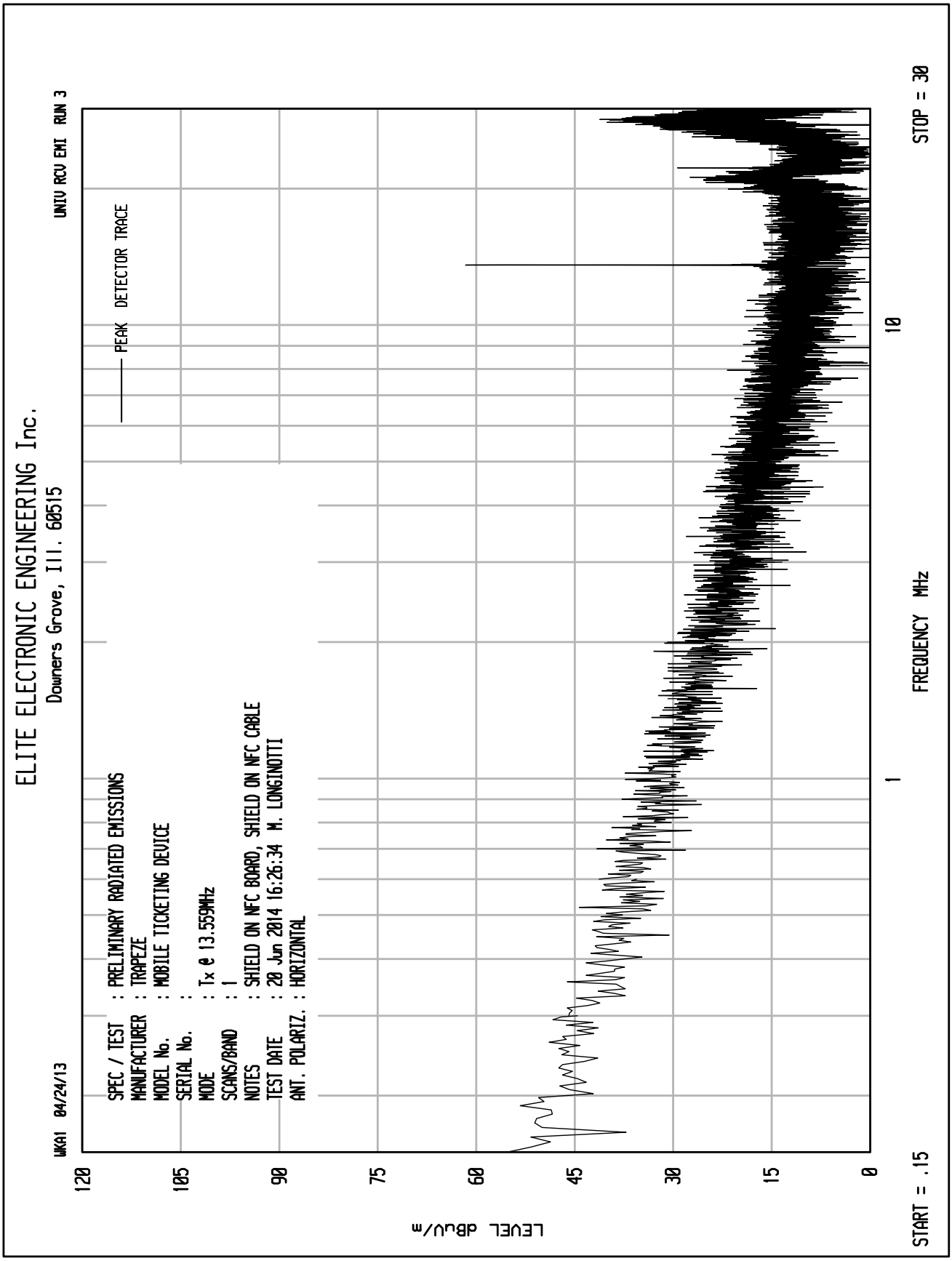
Figure 3

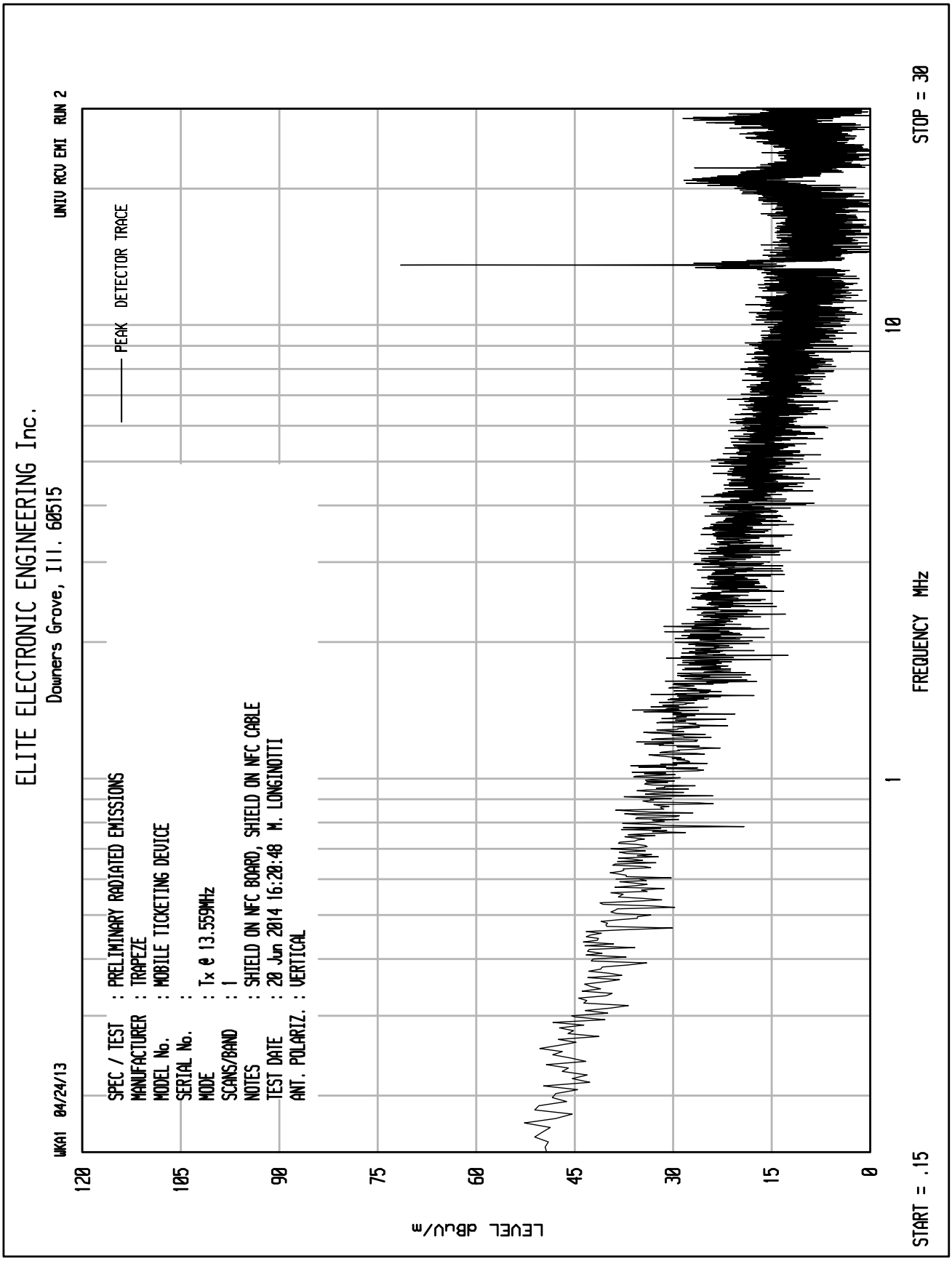
Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization

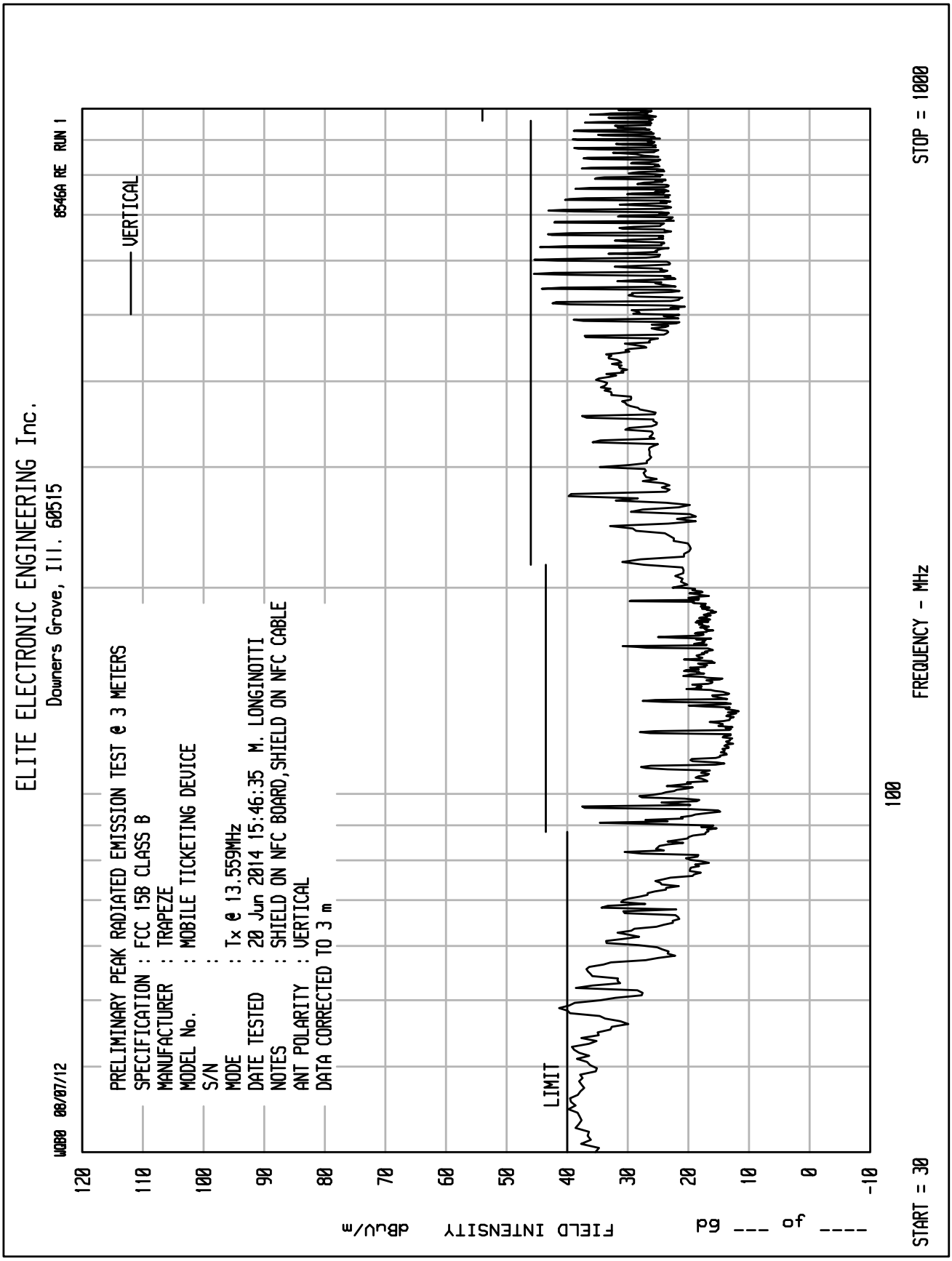
Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

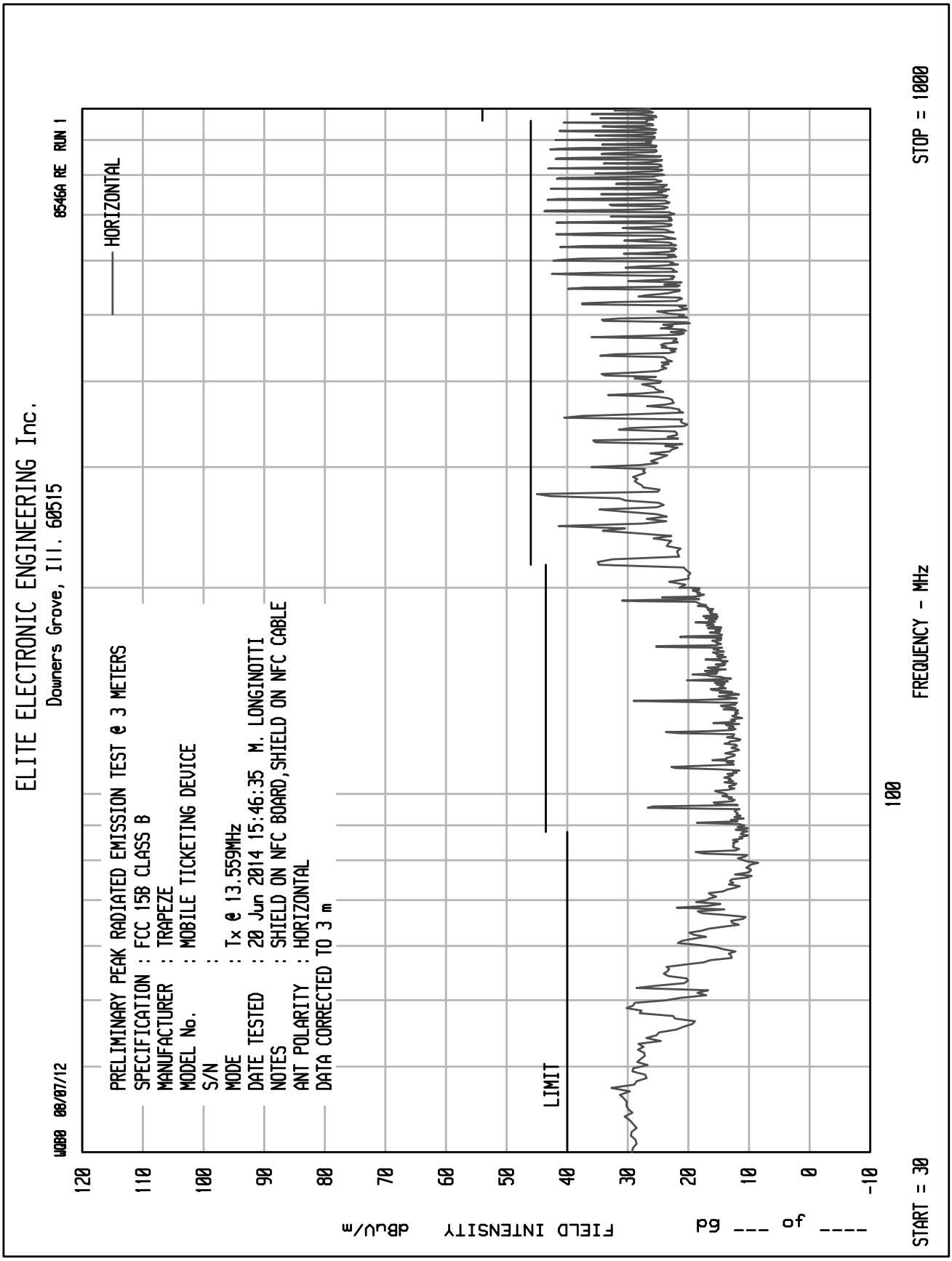
Figure 4

Test Setup for Frequency Stability Tests


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRAPEZE
MODEL No. : MOBILE TICKETING DEVICE
SERIAL No. : :
MODE : Tx @ 13.559MHz
SCANS/BAND : 1
NOTES : SHIELD ON NFC BOARD, SHIELD ON NFC CABLE
TEST DATE : 20 Jun 2014 16:26:34 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .15
1
10
STOP = 30
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRAPEZE
MODEL No. : MOBILE TICKETING DEVICE
SERIAL No. : :
MODE : Tx @ 13.559MHz
SCANS/BAND : 1
NOTES : SHIELD ON NFC BOARD, SHIELD ON NFC CABLE
TEST DATE : 20 Jun 2014 16:20:48 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .15
1
10
STOP = 30
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 1
W080 08/07/12
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : TRAPEZE
MODEL No. : MOBILE TICKETING DEVICE
S/N :
MODE : Tx @ 13.559MHz
DATE TESTED : 20 Jun 2014 15:46:35 M. LONGINOTTI
NOTES : SHIELD ON NFC BOARD,SHIELD ON NFC CABLE
ANT POLARITY : VERTICAL
DATA CORRECTED TO 3 m
VERTICAL
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
START = 30
100
STOP = 1000
FREQUENCY - MHz
pg ___ of ____


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8546A RE RUN 1
W080 08/07/12
PRELIMINARY PEAK RADIATED EMISSION TEST @ 3 METERS
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : TRAPEZE
MODEL No. : MOBILE TICKETING DEVICE
S/N :
MODE : Tx @ 13.559MHz
DATE TESTED : 20 Jun 2014 15:46:35 M. LONGINOTTI
NOTES : SHIELD ON NFC BOARD,SHIELD ON NFC CABLE
ANT POLARITY : HORIZONTAL
DATA CORRECTED TO 3 m
HORIZONTAL
LIMIT
FIELD INTENSITY dBuV/m
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
pg --- of ---- pg
START = 30
100
FREQUENCY - MHz
STOP = 1000

DATA SHEET

RADIATED QP EMISSION MEASUREMENTS in a 3 m SEMI-ANECHOIC ROOM
SPECIFICATION : FCC 15B CLASS B
MANUFACTURER : TRAPEZE
MODEL NO. : MOBILE TICKETING DEVICE (M/N: 50T0157)
SERIAL NO. :
TEST MODE : Tx @ 13.559MHz
NOTES : SHIELD ON NFC BOARD,SHIELD ON NFC CABLE, 66pF CAPS ON NFC BOARD
TEST DATE : 20 Jun 2014 15:46:35
TEST DISTANCE : 3 m

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Dist. Corr. (dB)	Total (dBuV/m)	Total (uV/m)	Limit (uV/m)	Specified Test Distance (meters)	Margin (dB)
13.559	H	51.2	0.2	10.6	0.0	-40.0	22.0	12.54870	15848.0	30.0	-62.0
13.559	V	60.9	0.2	10.6	0.0	-40.0	31.7	38.33528	15848.0	30.0	-52.3
27.118	H	19.8	0.3	9.0	0.0	-40.0	-10.9	0.28553	30.0	30.0	-40.4
27.118	V	16.3	0.3	9.0	0.0	-40.0	-14.4	0.19083	30.0	30.0	-43.9
40.677	H	13.7	0.3	12.4	0.0	0.0	26.5	21.06261	100.0	3.0	-13.5
40.677	V	25.3	0.3	12.4	0.0	0.0	38.1	80.07782	100.0	3.0	-1.9
54.236	H	12.1	0.4	6.6	0.0	0.0	19.1	9.03749	100.0	3.0	-20.9
54.236	V	26.2	0.4	6.6	0.0	0.0	33.2	45.81925	100.0	3.0	-6.8
67.795	H	14.8	0.4	6.3	0.0	0.0	21.5	11.88890	100.0	3.0	-18.5
67.795	V	27.0	0.4	6.3	0.0	0.0	33.7	48.43305	100.0	3.0	-6.3
81.354	H	10.3	0.5	7.3	0.0	0.0	18.1	8.05320	100.0	3.0	-21.9
81.354	V	20.6	0.5	7.3	0.0	0.0	28.4	26.36139	100.0	3.0	-11.6
94.913	H	14.5	0.5	9.9	0.0	0.0	24.9	17.54937	150.0	3.0	-18.6
94.913	V	28.6	0.5	9.9	0.0	0.0	39.0	88.97365	150.0	3.0	-4.5
108.472	H	12.5	0.5	11.8	0.0	0.0	24.8	17.41522	150.0	3.0	-18.7
108.472	V	17.1	0.5	11.8	0.0	0.0	29.4	29.57529	150.0	3.0	-14.1
122.031	H	13.3	0.6	12.1	0.0	0.0	26.0	19.93903	150.0	3.0	-17.5
122.031	V	17.9	0.6	12.1	0.0	0.0	30.6	33.86134	150.0	3.0	-12.9
135.590	H	17.6	0.6	11.4	0.0	0.0	29.6	30.10869	150.0	3.0	-13.9
135.590	V	16.9	0.6	11.4	0.0	0.0	28.9	27.77742	150.0	3.0	-14.6

ETR No. 8546A
DATA SHEET TEST NO. 1

RADIATED QP EMISSION MEASUREMENTS in a 3 m SEMI-ANECHOIC ROOM
SPECIFICATION : FCC 15C
MANUFACTURER : TRAPEZE
MODEL NO. MOBILE TICKETING DEVICE (M/N: 50T0157)
SERIAL NO. :
TEST MODE : Tx @ 13.559MHz
NOTES : SHIELD ON NFC BOARD,SHIELD ON NFC CABLE, 66pF CAPS ON NFC BOARD
TEST DATE : 20 Jun 2014 15:46:35
TEST DISTANCE : 3 m (DATA EXTRAPOLATED TO 3 m)

FREQUENCY	QP READING	ANT FAC	CBL FAC	EXT ATTN	DIST FAC	TOTAL	QP LIMIT	AZ	ANT HT	POLAR
MHz	dBuV	dB	dB	dB	dB	dBuV/m	dBuV/m	deg	cm	
49.05	28.8	8.5	.4	0.0	0.0	37.7	40.0	225	120	V
55.27	29.3	7.0	.4	0.0	0.0	36.6	40.0	315	120	V
94.91	27.4	10.0	.4	0.0	0.0	37.8	43.5	225	120	V
99.31	10.9	11.0	.4	0.0	0.0	22.3	43.5	0	120	V
135.59	18.4	10.3	.5	0.0	0.0	29.3	43.5	90	200	H
162.71	18.6	9.9	.6	0.0	0.0	29.1	43.5	0	120	V
168.00	13.0	9.8	.7	0.0	0.0	23.5	43.5	90	120	V
244.06	28.7	11.2	.8	0.0	0.0	40.7	46.0	0	120	H
271.18	31.5	12.1	.8	0.0	0.0	44.4	46.0	0	120	H
461.01	19.6	16.5	1.1	0.0	0.0	37.2	46.0	180	120	V
569.48	26.5	18.2	1.1	0.0	0.0	45.8	46.0	180	200	V
596.60	25.8	18.6	1.1	0.0	0.0	45.5	46.0	135	200	V
705.07	24.2	18.6	1.4	0.0	0.0	44.1	46.0	315	120	H
813.54	21.6	20.0	1.5	0.0	0.0	43.2	46.0	315	120	H
922.02	18.3	21.0	1.5	0.0	0.0	40.8	46.0	0	120	H

Manufacturer: Trapeze
Model No.: Mobile Ticketing Device (M/N: 50T0157)
Serial no.:
Test Mode: Tx @ 13.559MHz
Test Date: June 27, 2014
Test Performed: Frequency Stability vs. temperature

Temperature °C	Input Voltage	Nominal Frequency Hz	Measured Frequency Hz	Frequency Variation in %			Pass/Fail
				Lower Limit %	Measured Variation %	Upper Limit %	
-20	13.5	13,559,000	13,559,086	-0.01000	0.00063	0.01000	Pass
-10	13.5	13,559,000	13,559,120	-0.01000	0.00089	0.01000	Pass
0	13.5	13,559,000	13,559,082	-0.01000	0.00060	0.01000	Pass
+10	13.5	13,559,000	13,559,044	-0.01000	0.00032	0.01000	Pass
+20	13.5	13,559,000	13,559,009	-0.01000	0.00007	0.01000	Pass
+30	13.5	13,559,000	13,558,994	-0.01000	-0.00004	0.01000	Pass
+40	13.5	13,559,000	13,558,993	-0.01000	-0.00005	0.01000	Pass
+50	13.5	13,559,000	13,559,015	-0.01000	0.00011	0.01000	Pass

Manufacturer: Trapeze
Model No.: Mobile Ticketing Device (M/N: 50T0157)
Serial no.:
Test Mode: Tx @ 13.559MHz
Test Date: June 27, 2014
Test Performed: Frequency stability vs. input voltage

Temperature °C	Input Voltage*	Nominal Frequency Hz	Measured Frequency Hz	Frequency Variation in %			Pass/Fail
				Lower Limit	Measured Variation	Upper Limit	
+20	6.8	13,559,000	does not turn on	-0.01000	N/A	0.01000	Pass
+20	8.0	13,559,000	13,559,012	-0.01000	0.000088502	0.01000	Pass
+20	13.5	13,559,000	13,559,009	-0.01000	0.000066377	0.01000	Pass
+20	36.0	13,559,000	13,559,036	-0.01000	0.000265506	0.01000	Pass
+20	41.4	13,559,000	does not turn on	-0.01000	N/A	0.01000	Pass

* - The EUT has an input voltage range of 8VDC to 36VDC