Measurement of RF Emissions from an AT71-250 250W Broadcast Transmitter

For	Linear Industries, Inc. 2531 Technology Drive Elgin, IL 60124
P.O. Number	082-LII-11
Date Tested	February 25, 2013
Test Personnel	Dayne Putnam
Test Specification	FCC "Code of Federal Regulations" Title 47 Part74, Subpart G

Test Report By:

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REVISION HISTORY

Revision	Date	Description
—	19 March 2013	Initial release

Measurement of RF Emissions from a 250W Broadcast Transmitter, Model No. AT71-250

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a 250W Broadcast Transmitter, Model No. AT71-250, Serial No. 031, (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Linear Industries, Inc. located in Elgin, IL.

1.2. Purpose

The test series was performed to determine if the EUT meets the radiated spurious emissions requirements of the Code of Federal Regulations Title 47, Part 74, Subpart G. Testing was performed in accordance with TIA-603-C-2004.

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 21^{o}C and the relative humidity was 25%.

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 74, dated 1 October 2012
- TIA-603-C-2004, “Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards”

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Linear Industries, Inc., 250W Broadcast Transmitter, Model No. AT71-250. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT obtained 120V, 60Hz single phase power via 3 unshielded wires.

3.1.2. Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Dummy Load	Termaline Model No. 8862D, 500W 50 ohm load The RF output port of the UHF bandpass filter was connected to the dummy load via coaxial cable.

3.1.3. Signal Input/Output Leads

No interconnect cables were submitted with the EUT.

3.1.4. Grounding

The EUT was connected to earth ground through the third wire of its input power.

3.2. Operational Mode

For all tests the EUT was placed on the turntable of the test chamber. The turntable is flush with the floor of the test chamber. The EUT was energized. The test was performed with the EUT transmitting at 521MHz (Channel 22) with an output power of 250 Watts.

3.3. EUT Modifications

No modifications were required to comply with the test series.

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.

Radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC.

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	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

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

5. TEST PROCEDURES

5.1. Field Strength of Spurious Emissions

5.1.1. Requirements

Per 74.750(2), Radio frequency harmonics of the visual and aural carriers, measured at the output terminals of the transmitter, shall be attenuated no less than 60 dB below the peak visual output power within the assigned channel. All other emissions appearing on frequencies more than 3 megacycles above or below the upper and lower edges, respectively, of the assigned channel shall be attenuated no less than:

1) 30 dB for transmitters rated at no more than 1 watt power output.
2) 50 dB for transmitters rated at more than 1 watt power output.
3) 60 dB for transmitters rated at more than 100 watts power output.

5.1.2. 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 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.

1. In order to verify that the transmitter's output power, a 50dB directional coupler was placed in the coaxial cable between the UHF filter and the RF dummy load. The RF output port of the 50dB directional coupler was connected to a spectrum analyzer through 40 dB of attenuation. The EUT was powered up and the output power reading was noted on the spectrum analyzer.
2. Preliminary radiated measurements were performed to determine the frequencies where the significant emissions might be found. With the EUT at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using a peak detector and automatically plotted. The broadband measuring antenna was positioned at a 3 meter distance from the EUT. This data was then automatically plotted. All preliminary tests were performed separately with the EUT operating in the mode listed in Para. 3.2.
3. All significant broadband and narrowband signals found in the preliminary sweeps were then measured using a peak detector at a test distance of 3 meters. The measurements were made with a bilog antenna over the frequency range of 30MHz to 1GHz, and a double ridged waveguide antenna was used for frequencies above 1GHz.
4. To ensure that maximum 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 antennas are 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.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, another antenna was set in place of the EUT and connected to a calibrated signal generator. (A tuned dipole was used for all measurements below 1GHz and a double ridged waveguide antenna was used for all measurements above 1GHz.) The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was corrected to compensate for cable loss, as required, and for frequencies above 1GHz, increased by the gain of the waveguide.

5.1.3.Results

The preliminary radiated emissions plots are presented on pages 11 through 14. Factors for the antennas and cables were added to the data before it was plotted. This data is only presented for a reference, and is not used as official data.

The final radiated levels are presented on page 15. The radiated emissions were measured through the 10th harmonic. As can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figure 2 and 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 Linear Industries, Inc. personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Linear Industries, Inc. upon completion of the tests.

7. CONCLUSIONS

It was determined that the Linear Industries, Inc. 250W Broadcast Transmitter, Model No. AT71-250, Serial No. 031 did fully meet the spurious radiated emissions requirements of the FCC “Code of Federal Regulations” Title 47, Part 74, Subpart G, when tested per TIA-603-C-2004.

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 as operated by Linear Industries, Inc. personnel. 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 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
GSD3	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMB100A	104454	9KHZ-6GHZ	8/20/2012	8/20/2013
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/15/2013	2/15/2014
NWP0	DOUBLE RIDGED WAVEGUIDE ANTENNA	EATON	3115	2099	1GHZ-18GHZ	1/26/2013	1/26/2014
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/12/2012	3/12/2013
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	3/15/2012	3/15/2013
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	3/15/2012	3/15/2013
XLJH	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	18	DC-2GHZ	1/8/2013	1/8/2014
XLTF	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	016	DC-2GHZ	1/7/2013	1/7/2014

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.

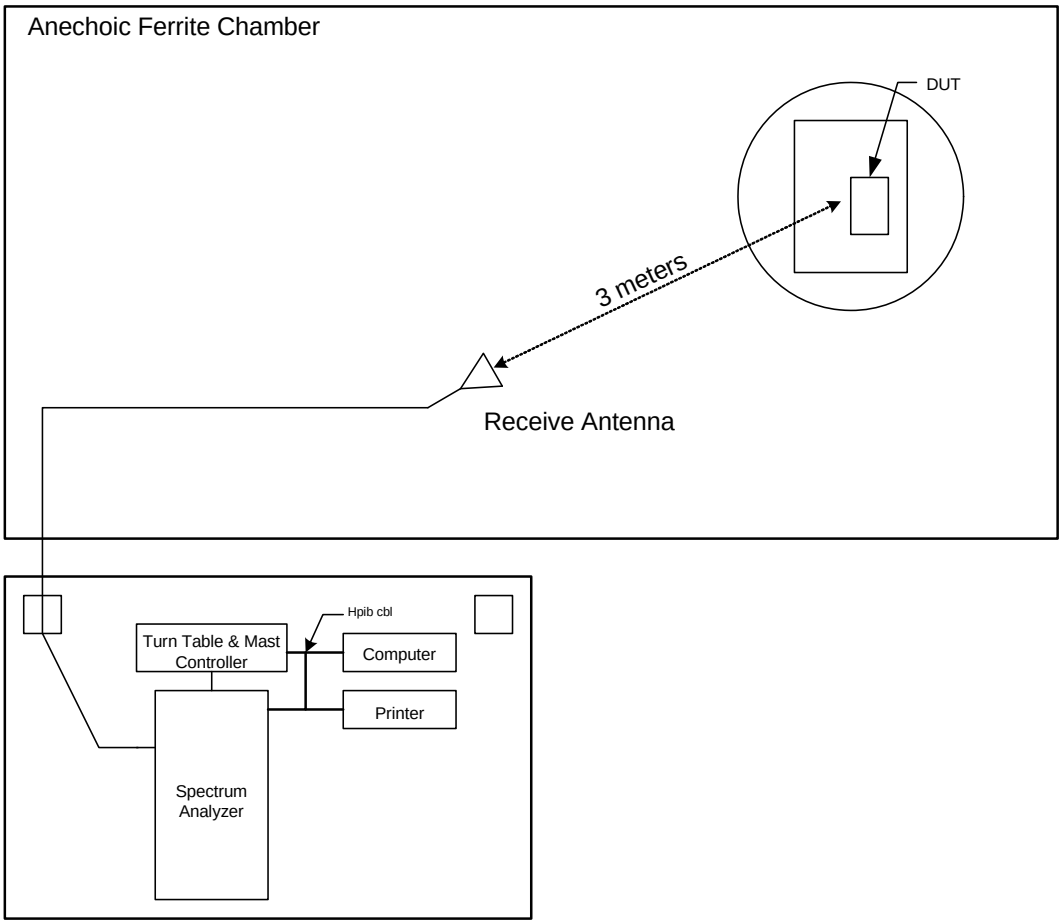
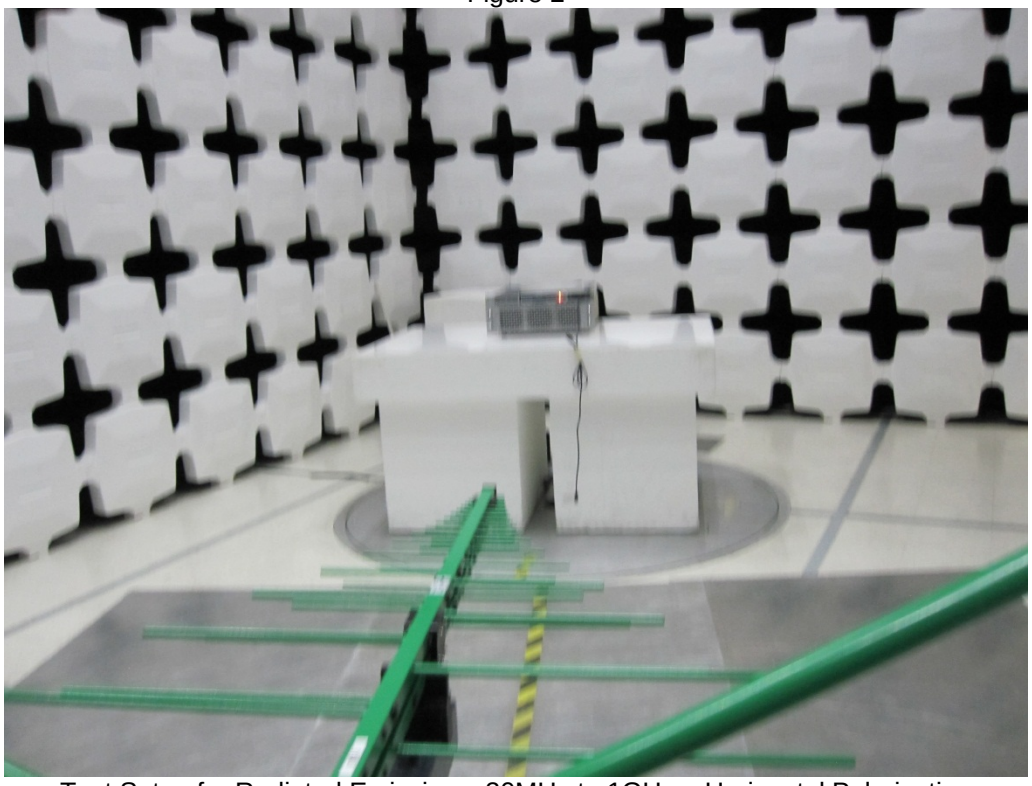


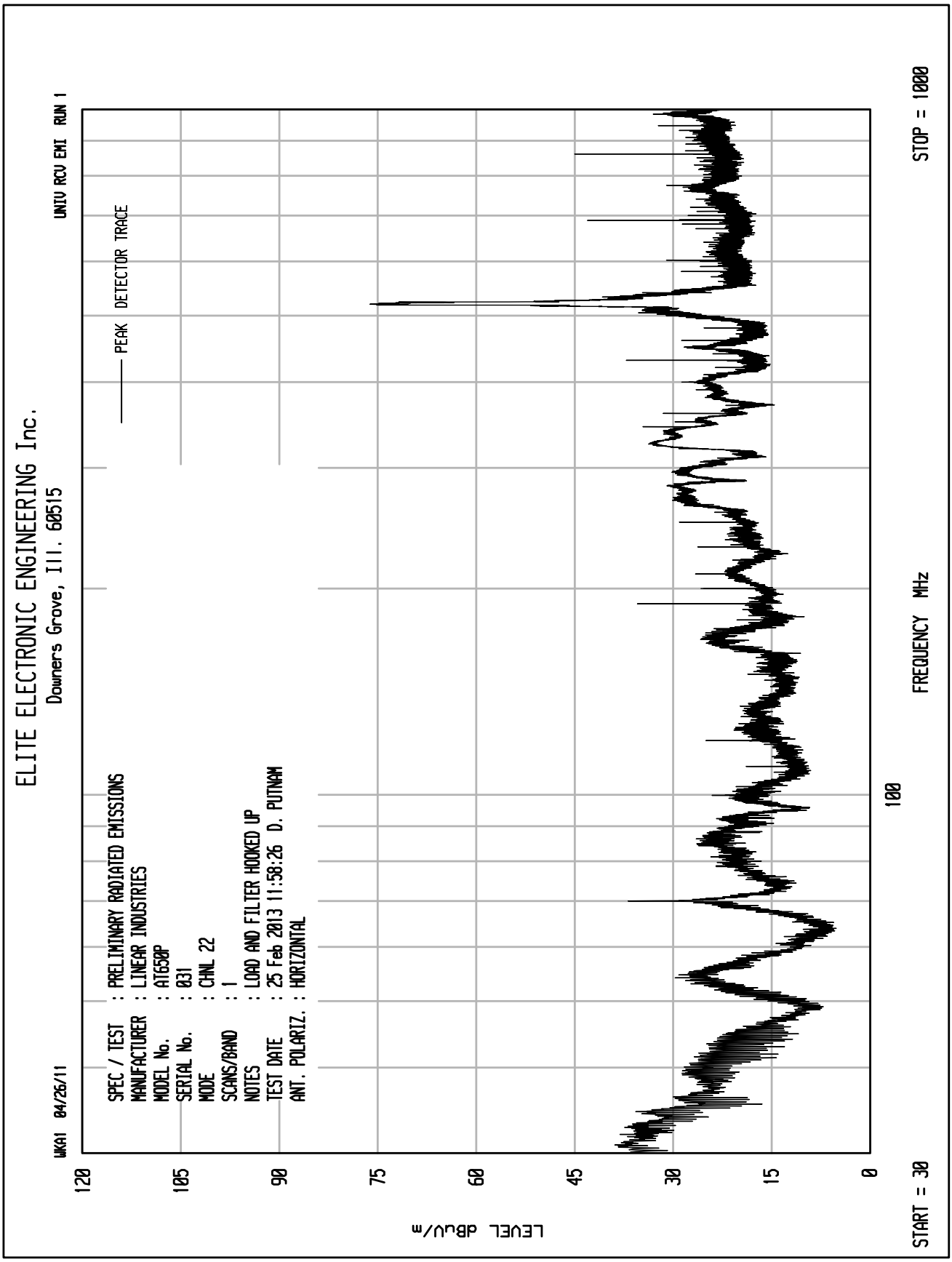
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

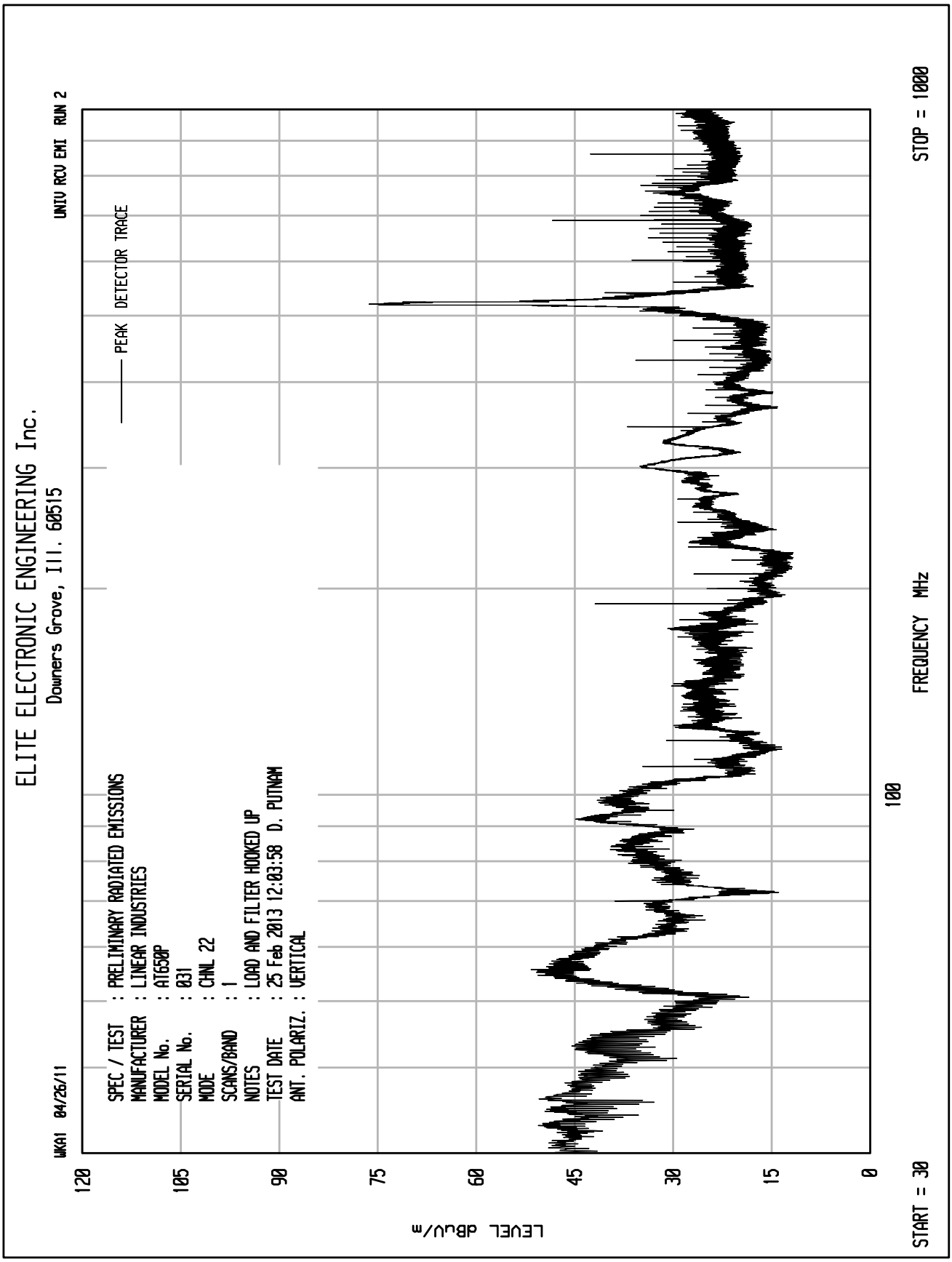
Figure 2

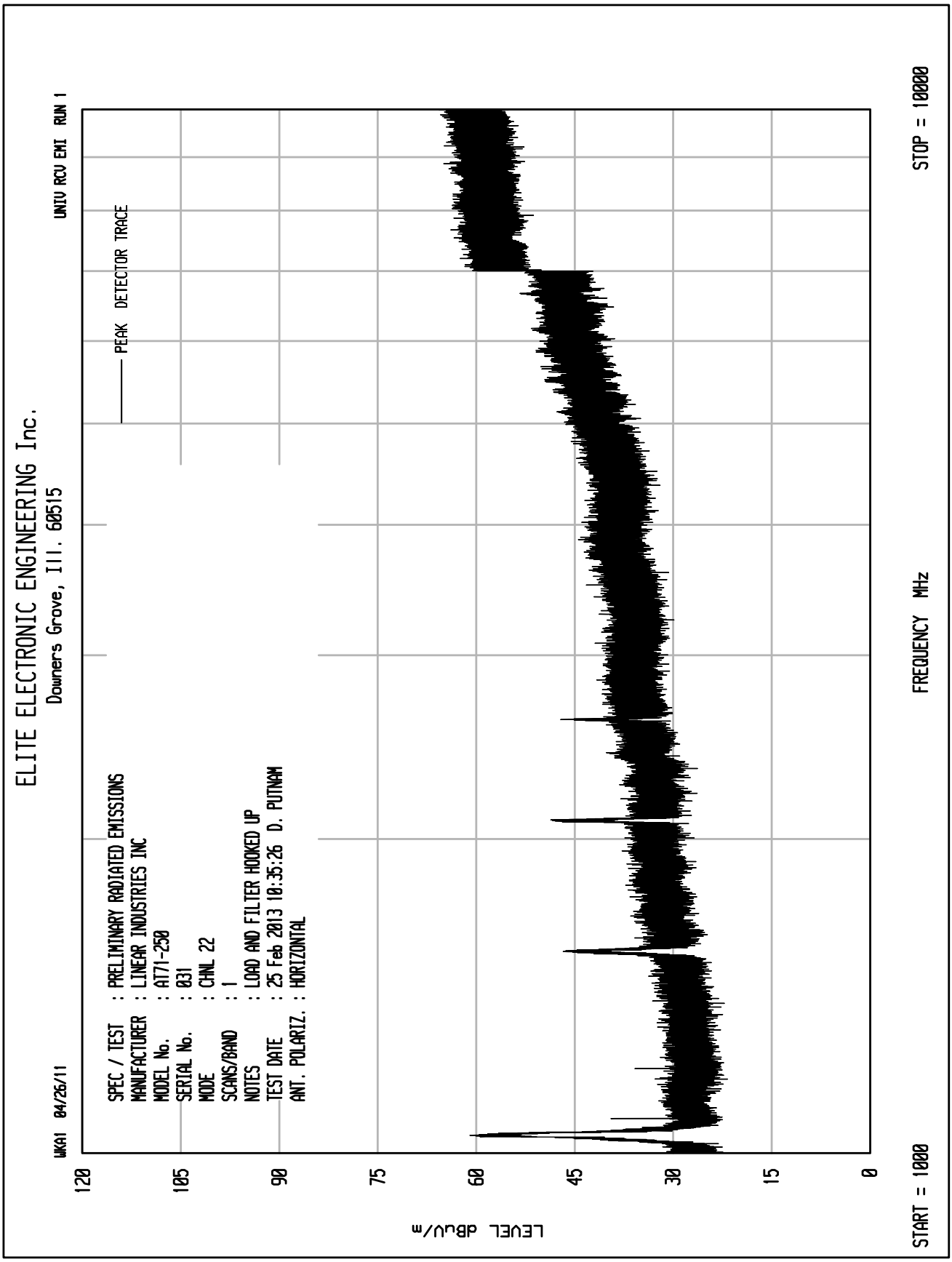


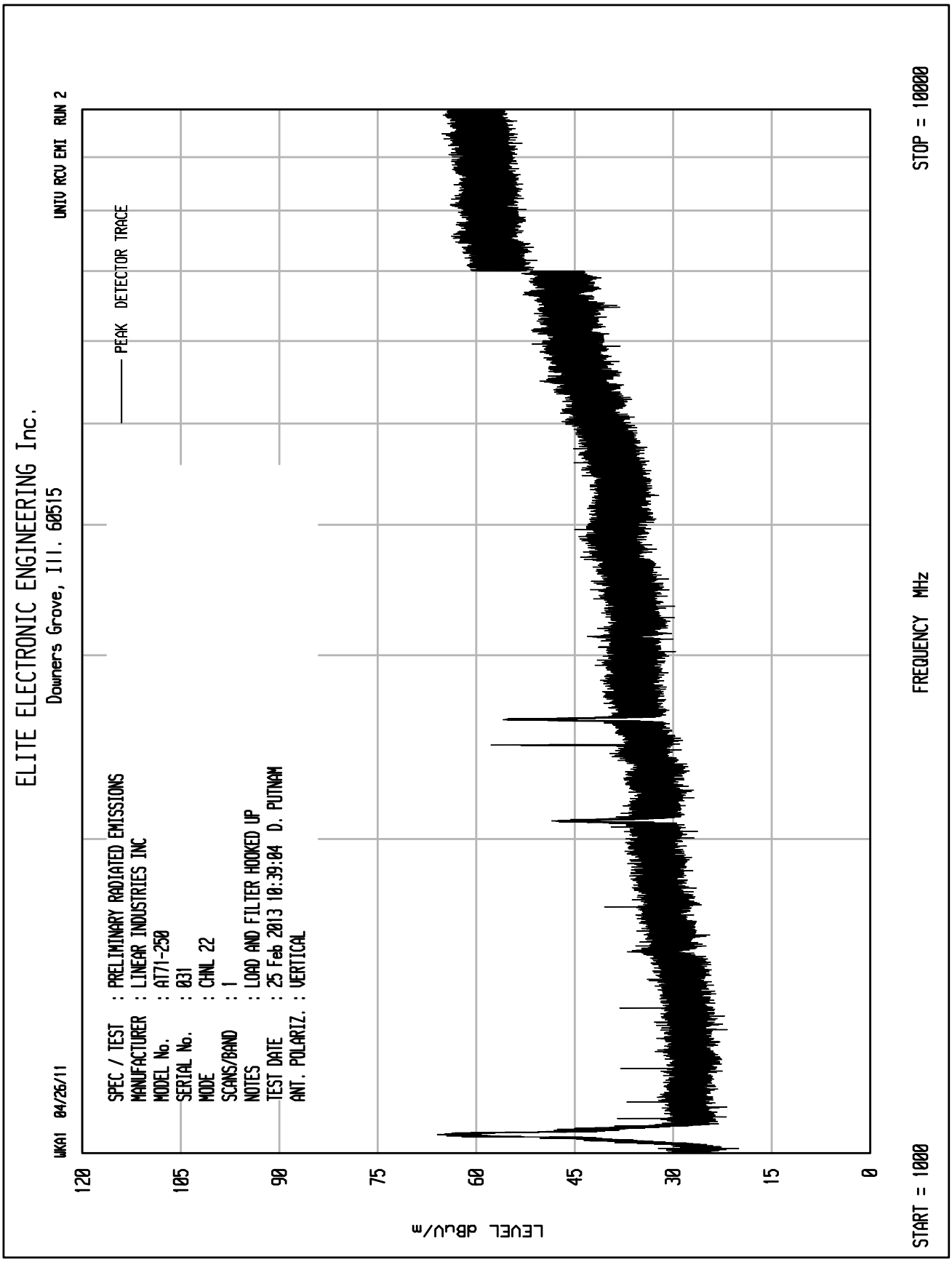
Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization

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


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : LINEAR INDUSTRIES
MODEL No. : AT650P
SERIAL No. : 031
MODE : CHNL 22
SCANS/BAND : 1
NOTES : LOAD AND FILTER HOOKED UP
TEST DATE : 25 Feb 2013 11:58:26 D. PUTNAM
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : LINEAR INDUSTRIES
MODEL No. : AT650P
SERIAL No. : 031
MODE : CHNL 22
SCANS/BAND : 1
NOTES : LOAD AND FILTER HOOKED UP
TEST DATE : 25 Feb 2013 12:03:58 D. PUTNAM
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : LINEAR INDUSTRIES INC
MODEL No. : AT71-250
SERIAL No. : 031
MODE : CHNL 22
SCANS/BAND : 1
NOTES : LOAD AND FILTER HOOKED UP
TEST DATE : 25 Feb 2013 10:35:26 D. PUTNAM
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : LINEAR INDUSTRIES INC
MODEL No. : AT71-250
SERIAL No. : 031
MODE : CHNL 22
SCANS/BAND : 1
NOTES : LOAD AND FILTER HOOKED UP
TEST DATE : 25 Feb 2013 10:39:04 D. PUTNAM
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 10000

MANUFACTURER : Linear Industries, Inc.
MODEL : AT71-250 250W Broadcast Transmitter
SERIAL NO. : 031
SPECIFICATION : FCC Part 74 Spurious Radiated Emissions
DATE : February 25, 2013
NOTES : Transmit at Channel 22 (521MHz), 250 watts into a load
: Test Distance is 3 meters

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dB)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	ERP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
1042.00	H	50.5		-23.0	4.7	2.2	-20.5	74.5	60.0
1042.00	V	55.2		-19.0	4.7	2.2	-16.5	70.5	60.0
1563.00	H	34.3		-46.0	6.8	2.7	-41.9	95.9	60.0
1563.00	V	32.0		-48.0	6.8	2.7	-43.9	97.9	60.0
2084.00	H	40.0		-33.0	6.7	3.1	-29.4	83.4	60.0
2084.00	V	38.1		-32.0	6.7	3.1	-28.4	82.4	60.0
2605.00	H	37.9		-35.0	6.8	3.6	-31.8	85.8	60.0
2605.00	V	41.0		-33.0	6.8	3.6	-29.8	83.8	60.0
3126.00	H	34.0		-35.0	6.8	4.0	-32.1	86.1	60.0
3126.00	V	34.0		-35.0	6.8	4.0	-32.1	86.1	60.0
3647.00	H	34.5		-37.0	7.2	4.3	-34.1	88.1	60.0
3647.00	V	34.5		-36.5	7.2	4.3	-33.6	87.6	60.0
4168.00	H	35.0		-35.0	7.6	4.6	-32.0	86.0	60.0
4168.00	V	34.3		-34.0	7.6	4.6	-31.0	85.0	60.0
4689.00	H	34.1		-33.0	8.0	4.8	-29.8	83.8	60.0
4689.00	V	34.2		-34.0	8.0	4.8	-30.8	84.8	60.0
5210.00	H	34.9		-31.0	7.7	5.0	-28.3	82.3	60.0
5210.00	V	34.8		-31.0	7.7	5.0	-28.3	82.3	60.0

* - Ambient

ERP Total (dBm) = Matched Sig Gen (dBm) + Antenna Gain (dB) – Cable Factor (dB)

Atten. (dB) = Output Power (dBm) – ERP (dBm)

Checked By: