Measurement of RF Interference from a Model STXe 500, 500W FM Broadcast Transmitter

For : Broadcast Electronics
4100 N. 24th Street
Quincy, IL 62305

P.O. No. : 145234
Date Tested : October 31, 2013 through November 13, 2013
Test Personnel : Mark Longinotti
Specification : FCC "Code of Federal Regulations" Title 47
Part 73, Subpart G

Test Report By : MARK E. LONGINOTTI
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Approved By : Raymond J Klouda
Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

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REVISION HISTORY

Revision	Date	Description
—	03 Dec 2013	Initial release

Measurement of RF Emissions from a Model STXe 500, 500W FM Broadcast Transmitter

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a model STXe 500, 500W FM Broadcast Transmitter, (hereinafter referred to as the EUT). No serial number was assigned to the EUT. The EUT was designed to transmit in the range of 87.5MHz to 108.0MHz using an external, removable antenna. The EUT was manufactured and submitted for testing by Broadcast Electronics located in Quincy, IL.

1.2 Purpose

The test series was performed to determine if the EUT meets the requirements of the FCC "Code of Federal Regulations" Title 47, Part 73, for Radio Broadcast Services, Subpart G for Low Power FM Broadcast Stations. Testing was performed in accordance with TIA/EIA-603.

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.

1.5 Laboratory Conditions

The temperature at the time of the test was 22°C and the relative humidity was 55%.

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 73, Subpart B, dated 1 October 2013
- TIA-603-C-2004, "Land Mobile FM or PM Communications Equipment - Measurement and Performance Standards"

3 EUT SET-UP AND OPERATION

3.1 General Description

The EUT is a 500W FM Broadcast Transmitter, Part No. STXe 500. A block diagram of the EUT set-up is shown as Figure 1.

3.1.1 Power Input

The EUT obtained 115V 60Hz single-phase power via a 3 wire, 1.8 meter long, unshielded power cord.

3.1.2 Peripheral Equipment

No peripheral equipment was submitted with the EUT.

3.1.3 Interconnect Cables

The EUTs signal input and output ports were filled as follows:
The EUTs signal input and output ports were filled as follows:

EUT Port	Cable
1 PPS IN	1 meter long coaxial cable (unterminated)
10MHz IN	1 meter long coaxial cable (unterminated)
Ethernet	2 meter long CAT 5 cable (unterminated)
COM IN	2 meter long CAT 5 cable (unterminated)
COM OUT	2 meter long CAT 5 cable (unterminated)
PA RF IN to EXC RF OUT	Via 30cm long coaxial cable
AES1	2.3 meter long XLR cable (unterminated)
LEFT	2.3 meter long XLR cable (unterminated)
RIGHT	2.3 meter long XLR cable (unterminated)
SCA2	1.8 meter long coaxial cable (unterminated)
19kHz OUT	1.8 meter long coaxial cable (unterminated)
SCA1	1.8 meter long coaxial cable (unterminated)
RDS	1.8 meter long coaxial cable (unterminated)
RF OUT	Connected to an RF Captain 50 ohm, 1500W termination, Model No. CPTN-1500-LC, via a 50 dB directional coupler.

3.1.4 Grounding

The EUT was grounded only through the ground wire of its input power cord.

3.2 Operational Mode

For all tests the EUT and all peripheral equipment were energized. The EUT was set to transmit at 97.75MHz, 500W output power. The output of the EUT was unmodulated for all tests except for occupied bandwidth tests. For occupied bandwidth tests, the EUT was modulated with a 2500Hz audio signal with an amplitude of 16dB above that necessary to produce 50% of the rated system deviation.

3.3 EUT Modifications

No modifications were required for compliance to the FCC requirements.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

The radiated emissions 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.

4.2 Test Instrumentation

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

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).

5 TEST PROCEDURES

5.1 Power Output Rating

5.1.1 Requirements

The power output rating of the transmitting equipment is the carrier power at which the transmitting equipment may be operated continuously into the test load.

5.1.2 Procedures

The EUT was set to transmit at 97.75MHz.

a) The antenna port of the EUT was connected to a power sensor through a 50dB directional coupler.
b) The following power meter settings were employed:
   Center Frequency = transmit frequency of the EUT
c) The output power reading on the power meter was recorded.

5.1.3 Results

The output power measurements are shown in a tabular form on page 13.

5.2 Occupied Bandwidth Emissions

5.2.1 Requirements

Per CFR 47 Section 72.845, Low Power FM Broadcast Stations must comply with the technical rules set forth elsewhere in the rule parts.

Per CFR 47 Section 73.317, FM broadcast stations employing transmitters authorized after January 1, 1960, must maintain the bandwidth occupied by their emissions in accordance with the specification detailed below. FM broadcast stations employing transmitters installed or type accepted before January 1, 1960, must achieve the highest degree of compliance with these specifications practicable with their existing equipment. In either case, should harmful interference to other authorized stations occur, the licensee shall correct the problem promptly or cease operation.

Any emission appearing on a frequency removed from the carrier by between 120 kHz and 240 kHz inclusive must be attenuated at least 25 dB below the level of the unmodulated carrier. Compliance with this requirement will be deemed to show the occupied bandwidth to be 240 kHz or less.

Any emission appearing on a frequency removed from the carrier by more than 240 kHz and up to and including 600 kHz must be attenuated at least 35 dB below the level of the unmodulated carrier.

Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log10(Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

5.2.2 Procedures

a. The EUT was set to transmit a 500W unmodulated signal at 97.75MHz.
b. The antenna port of the EUT was connected to a spectrum analyzer through a 50dB directional

coupler and 20dB of attenuation.

c. The following spectrum analyzer settings were employed:

- center frequency = transmit frequency of the EUT
- resolution bandwidth = 1kHz
- video bandwidth > resolution bandwidth
- frequency span = 2kHz
- sweep = Auto
- detector function = peak
- trace = max hold
- Several sweeps were made with the settings listed above.

d. The reference level on the spectrum analyzer was set to the peak of the unmodulated output of the EUT.

e. The EUT was then modulated with a 2500Hz audio signal with an amplitude 16dB above that necessary to produce 50% of the rated system deviation.

f. The following spectrum analyzer settings were employed:

- center frequency = transmit frequency of the EUT
- resolution bandwidth = 1kHz
- video bandwidth > resolution bandwidth
- frequency span = 1MHz
- sweep = Auto
- detector function = peak
- trace = max hold
- Several sweeps were made with the settings listed above.

g. Steps (e) and (f) were repeated with the frequency span set to 2MHz.

5.2.3 Results

As can be seen from the data, all emissions measured from the EUT were within the specification limits. The plots of the emission mask are presented on pages 14 through 16.

5.3 Spurious Emissions at Antenna Terminal

5.3.1 Requirements

Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log10(Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

5.3.2 Procedures

The EUT was set to transmit at 97.75MHz.

a) The antenna port of the EUT was connected to a spectrum analyzer through a directional coupler and 10dB of attenuation
b) The resolution bandwidth of the spectrum analyzer was set to 100kHz.
c) A sweep was made from 30MHz to 1GHz.

5.3.3 Results

The plot of the antenna conducted output measurement is presented on page17. As can be seen from the data, the EUT's spurious emissions were within the limit.

5.4 Field Strength of Spurious Emissions

5.4.1 Requirements

Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log10(Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

5.4.2 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.

a) Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 1GHz was investigated using a peak detector function. All preliminary tests were performed with the EUT operating in the transmit mode at 97.75MHz.

b) 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.

c) To ensure that maximum 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. Since the measuring antennas are 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.

d) The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a tuned dipole was set in place of the EUT and connected to a calibrated signal generator. 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 when the double ridged waveguide antenna was used, increased by the difference in gain between the dipole and the waveguide antenna.

5.4.3 Results

The preliminary plots with the EUT transmitting at 97.75MHz are presented on data pages 18 and 19. 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 97.75MHz, are presented on data page 20. 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.

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 Broadcast Communication upon completion of the tests.

7 CONCLUSIONS

It was determined that the Broadcast Electronics model STXe 500 500W FM Broadcast Transmitter, did fully meet the requirements of the FCC "Code of Federal Regulations" Title 47, Part 73, Subpart G, Section 73.845 (and 73.317) FM Transmission System Requirements for Low Power FM Broadcast Stations, when tested per TIA-603.

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 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
CDX5	COMPUTER	ELITE	WORKSTATION			N/A	
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
GCR0	SIGNAL GENERATOR	HEWLETT PACKARD	8647A	3414U00454	0.25-1000MHZ	8/12/2013	8/12/2014
GWH8	10MHZ DDS FUNCTION GENERATOR	WAVETEK	29	053221	0.0001HZ-10MHZ	10/7/2013	10/7/2014
MPCP	POWER SENSOR	HEWLETT PACKARD	8482A	2652A15345	0.1-4200MHZ	2/28/2013	2/28/2014
MPE3	DUAL POWER METER	AGILENT	E4419B	GB39511117	0.1MHZ-50GHZ	2/20/2013	2/20/2014
NDP0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	311	140-400MHZ	4/4/2013	4/4/2014
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	4/4/2013	4/4/2014
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/15/2013	2/15/2014
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/12/2013	3/12/2014
RBB0	EMI TEST RECEIVER 20HZ TO 40GHZ		ESIB40	100250	20 HZ TO 40GHZ	3/7/2013	3/7/2014
RYE0	MODULATION ANALYZER	HEWLETT PACKARD	8901B	3104A03410	0.15-1300MHZ	9/6/2013	9/6/2014
T1E8	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BH7996	DC-18GHZ	1/7/2013	1/7/2014
T2SK	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	CD5022	DC-18GHZ	1/2/2013	4/2/2014
XDJ2	50DB, 2500W BIDIR. COUPLER	AMPLIFIER RESEARCH	DC2500	24150	.01-220MHZ	3/14/2013	3/14/2014
XDW0	50DB, 600W BIDIR COUPLER	AMPLIFIER RESEARCH	DC6180	303349	80-1000MHZ	7/12/2013	7/12/2014
XDW0	50DB, 600W BIDIR COUPLER	AMPLIFIER RESEARCH	DC6180	303349	80-1000MHZ	7/12/2013	7/12/2014
XLQP	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	55	DC-2GHZ	8/8/2013	8/8/2014
XRP0	50 OHM 1500W TERMINATION	RF CAPTAIN	CPTN-1500-LC	001	DC-3000MHZ	4/10/2013	4/10/2014

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.

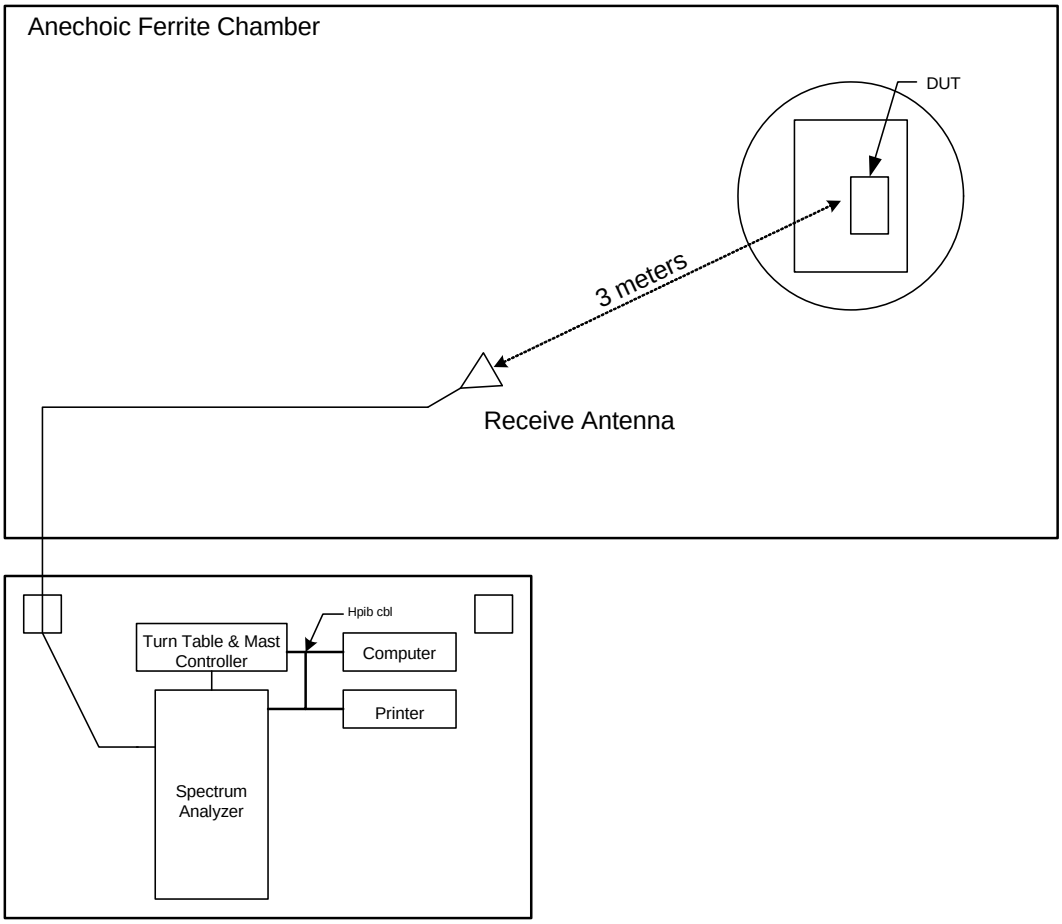


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

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

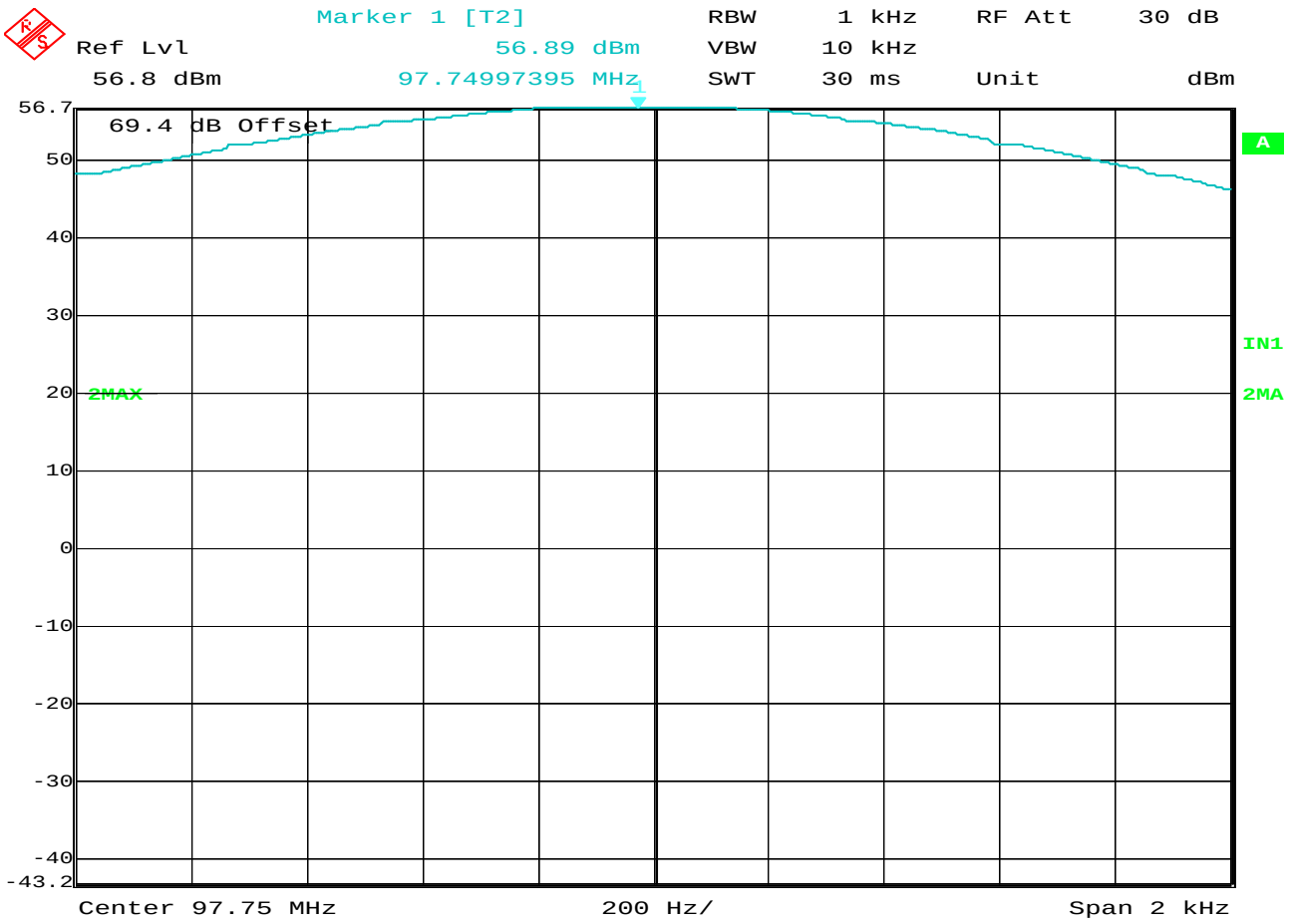
Test Setup for Radiated Emissions, 30MHz to 1GHz - Vertical Polarization

DATA PAGE

MANUFACTURER : Broadcast Electronics
MODEL : STXe 500
SERIAL NO. : None Assigned
SPECIFICATION : FCC 2.1046 Power Output
DATE : October 31, 2013
TEST EQUIPMENT : MPE3, MPCP, XLQP, XDW0, XRP0

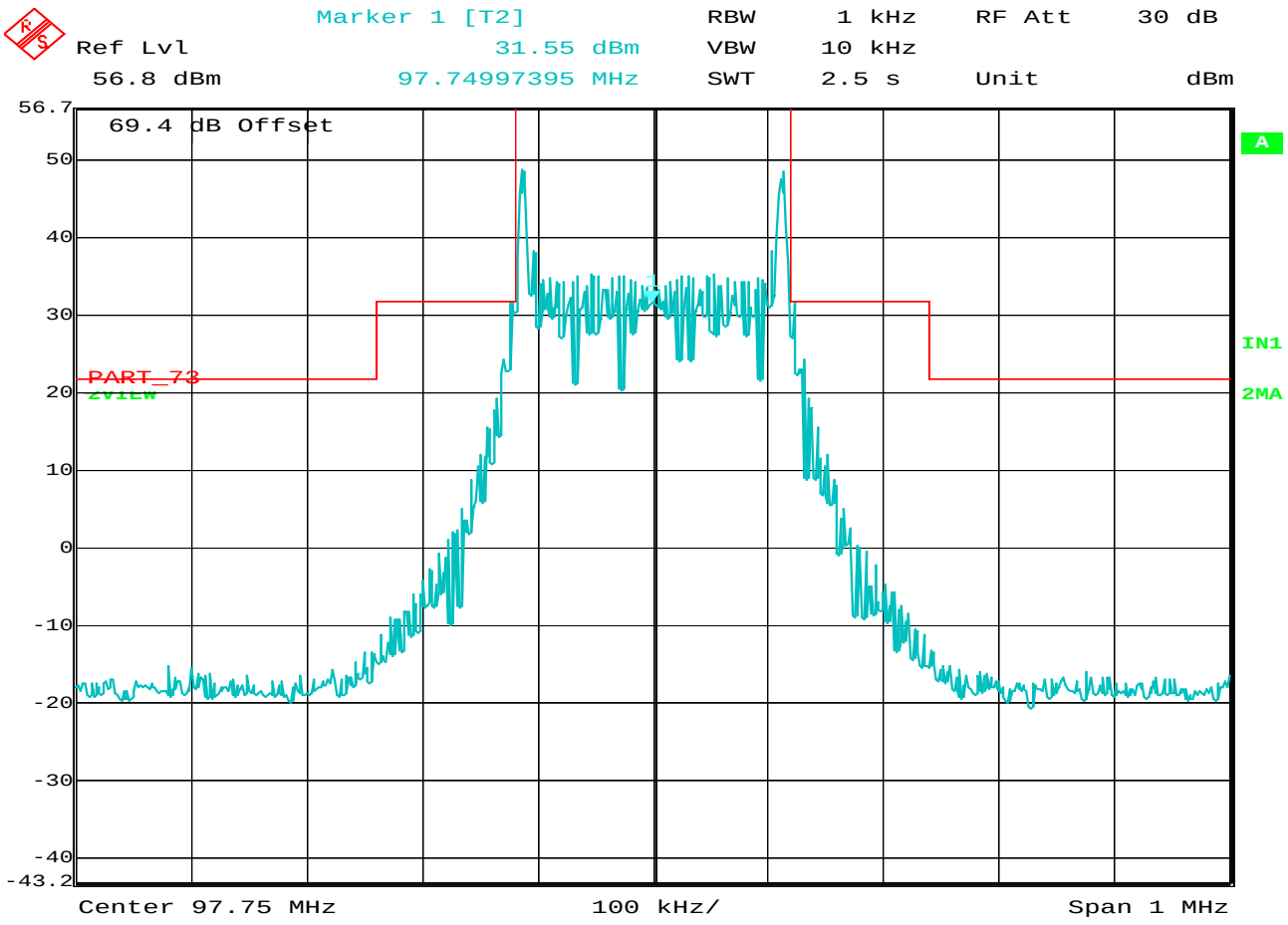
Frequency MHz	Measured Output Power dBm	Measured Output Power Watts	Manufacturer's Rated Power Watts
97.75	57.17	521.2	500

Checked By: Mark E. Longinotti



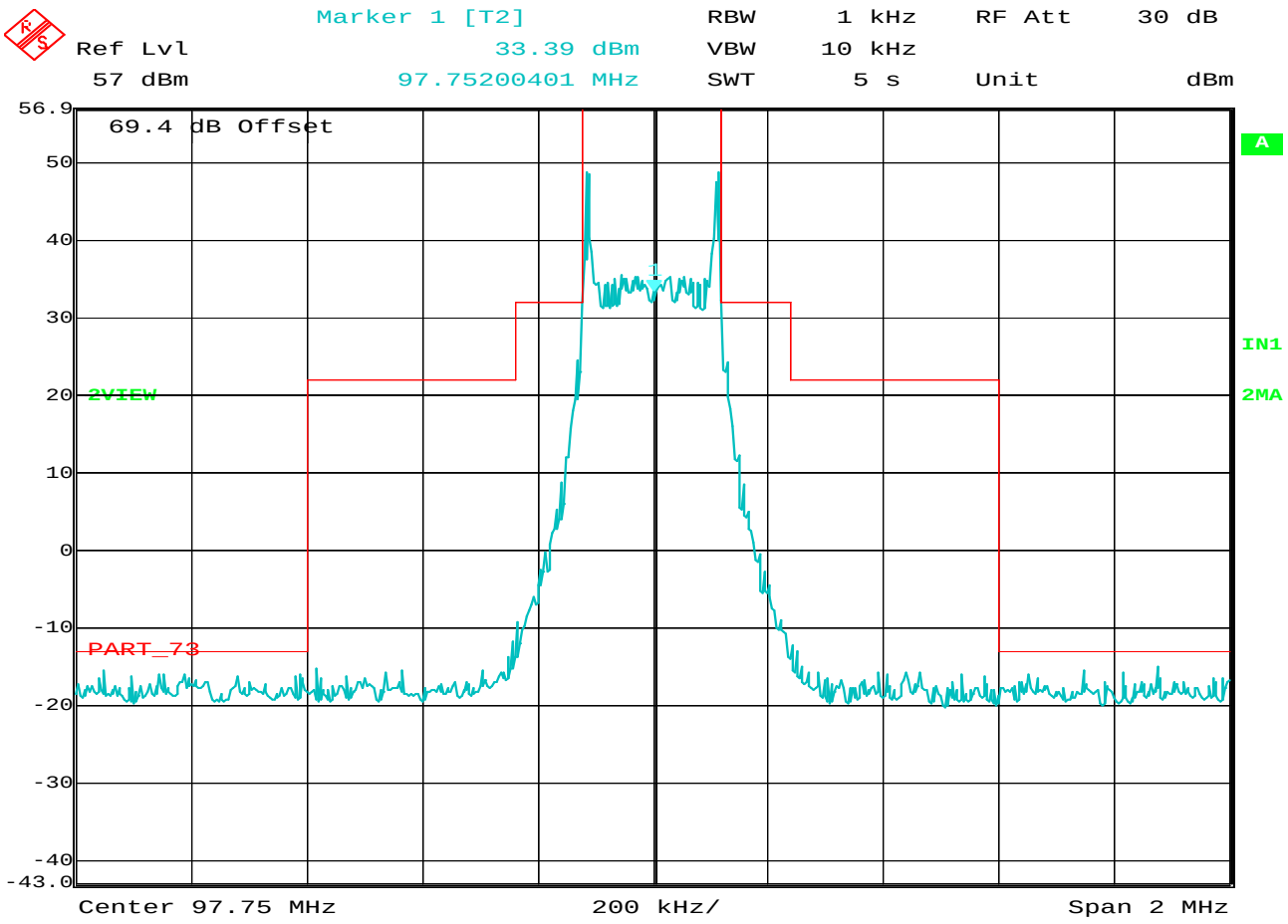
CFR 47, Section 73.317 Occupied Bandwidth

MANUFACTURER	:	Broadcast Electronics, Inc.
MODEL NUMBER	:	STXe 500
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 97.75MHz
TEST DATE	:	October 31, 2013
TEST PARAMETERS	:	unmodulated 500W output power
NOTES	:	unmodulated 500W output power set to reference level
EQUIPMENT USED	:	RBB0, T2SK, XDW0, XLQP



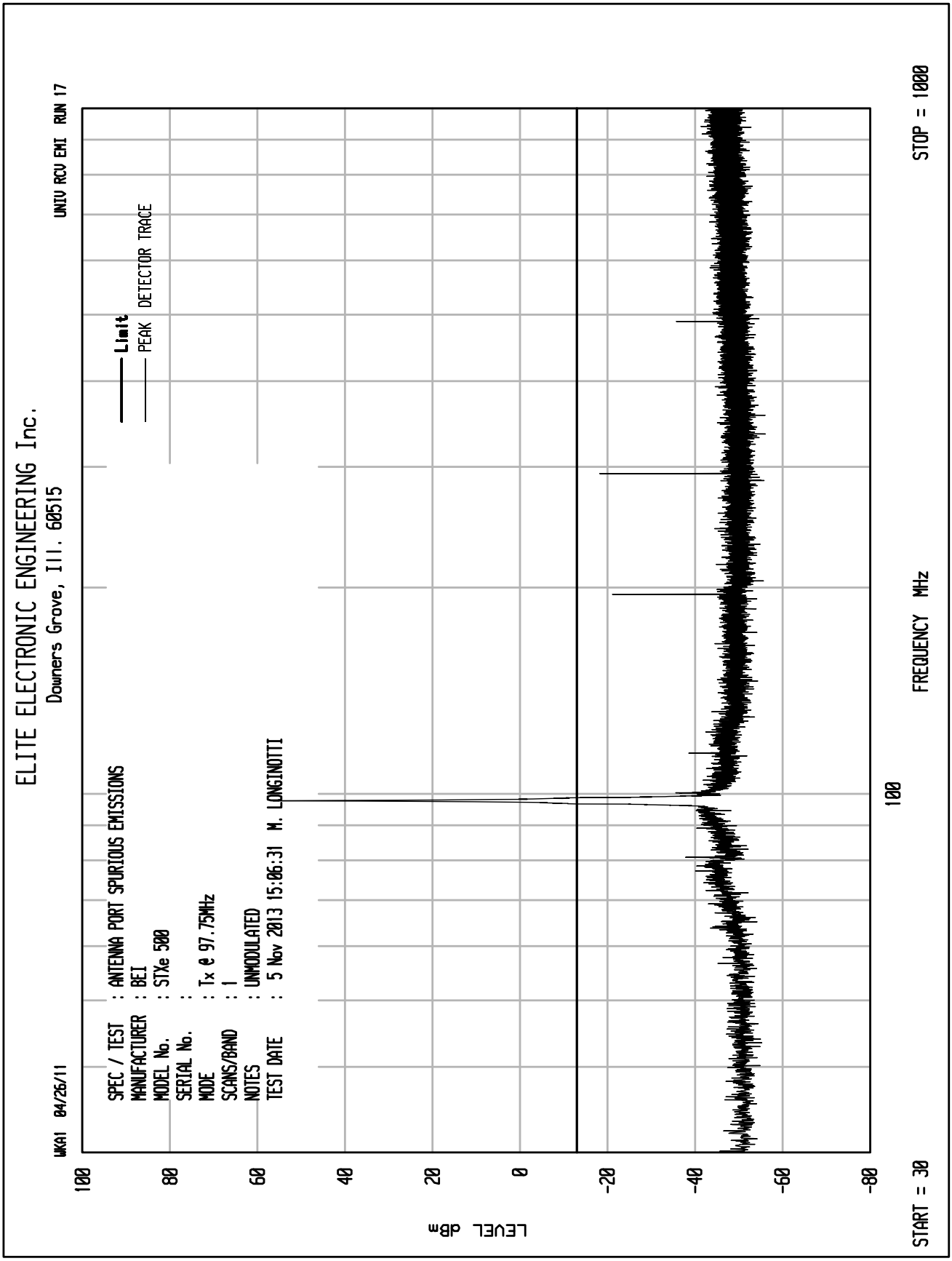
CFR 47, Section 73.317 Occupied Bandwidth

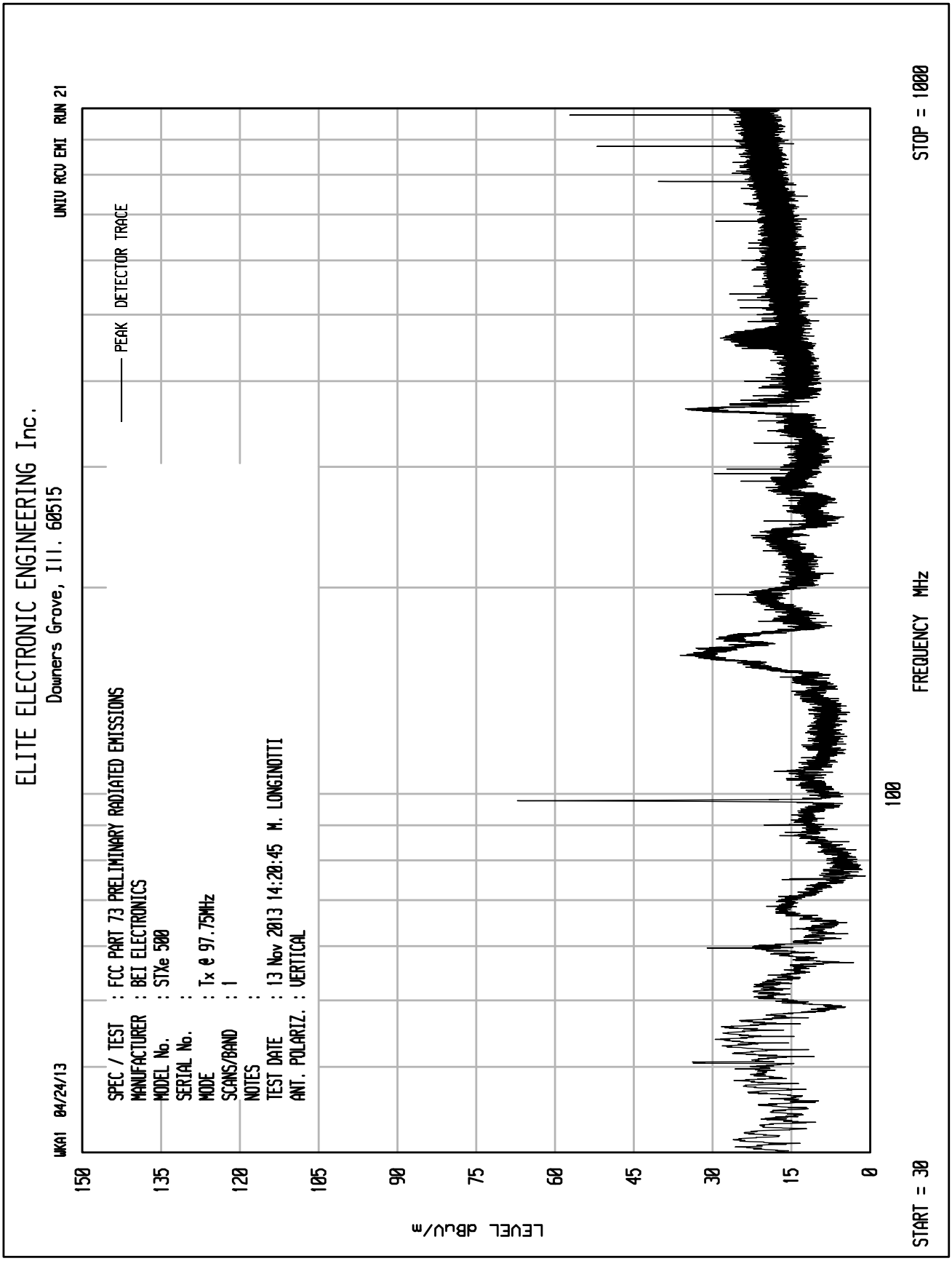
MANUFACTURER	:	Broadcast Electronics, Inc.
MODEL NUMBER	:	STXe 500
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 97.75MHz
TEST DATE	:	October 31, 2013
TEST PARAMETERS	:	Occupied Bandwidth
NOTES	:	2500Hz modulation signal to produce 16dB above that necessary to produce 50% of the system rated deviation
EQUIPMENT USED	:	RBB0, T2SK, XDW0, XLQP, RYE0, GWH8

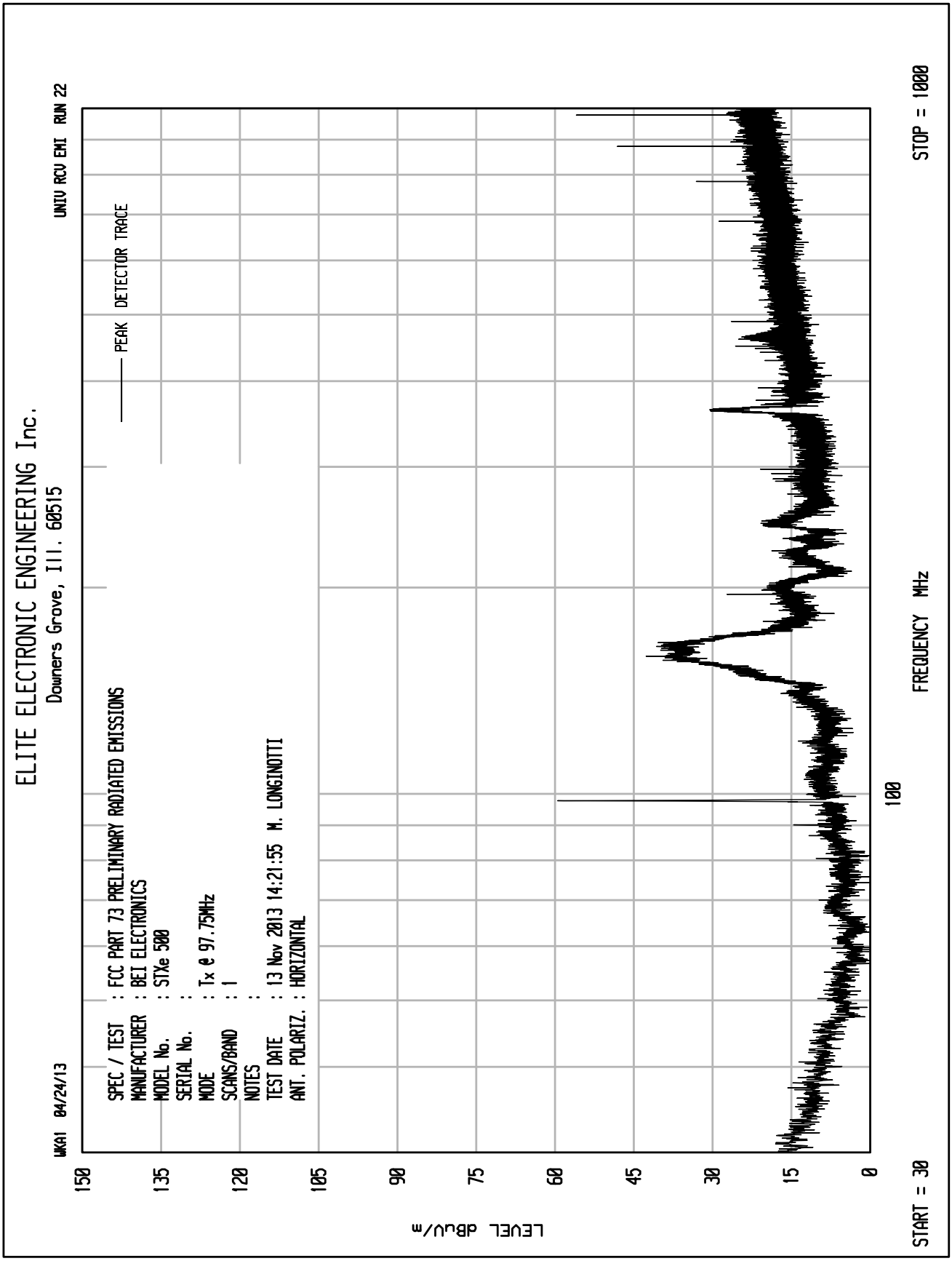


CFR 47, Section 73.317 Occupied Bandwidth

MANUFACTURER	:	Broadcast Electronics, Inc.
MODEL NUMBER	:	STXe 500
SERIAL NUMBER	:	None Assigned
TEST MODE	:	Tx @ 97.75MHz
TEST DATE	:	October 31, 2013
TEST PARAMETERS	:	Occupied Bandwidth
NOTES	:	2500Hz modulation signal to produce 16dB above that necessary to produce 50% of the system rated deviation
EQUIPMENT USED	:	RBB0, T2SK, XDW0, XLQP, RYE0, GWH8


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 17
WKA1 04/26/11
SPEC / TEST : ANTENNA PORT SPURIOUS EMISSIONS
MANUFACTURER : BEI
MODEL No. : STXe 500
SERIAL No. : :
MODE : Tx @ 97.75MHz
SCANS/BAND : 1
NOTES : UNMODULATED
TEST DATE : 5 Nov 2013 15:06:31 M. LONGINOTTI
Limit
PEAK DETECTOR TRACE
LEVEL dBm
100
80
60
40
20
0
-20
-40
-60
-80
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNTU RCV EMI RUN 21
WKA1 04/24/13
SPEC / TEST : FCC PART 73 PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BEI ELECTRONICS
MODEL No. : STXe 500
SERIAL No. :
MODE : Tx @ 97.75MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Nov 2013 14:20:45 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
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 22
WKA1 04/24/13
SPEC / TEST : FCC PART 73 PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BEI ELECTRONICS
MODEL No. : STXe 500
SERIAL No. :
MODE : Tx @ 97.75MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 13 Nov 2013 14:21:55 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
150
135
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

DATA PAGE

MANUFACTURER	Broadcast Electronics
EUT	500W FM Broadcast Transmitter
MODEL NO.	STXe 500
SERIAL NO.	None Assigned
SPECIFICATION	FCC-73 Spurious Radiated Emissions
TEST	Cabinet Radiated Emissions
TEST EQUIPMENT	NTA3, RBA0, NDP0, NDQ0,GCR0
MODE	Transmit at 97.75MHz, 500W, unmodulated
DATE TESTED	November 13, 2013 and November 14, 2013
NOTES	Peak Readings

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	ERP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
195.50	H	24.2		-64.8	0.0	1.0	-65.8	122.7	70.0
195.50	V	21.3		-62.4	0.0	1.0	-63.4	120.3	70.0
293.25	H	15.9		-68.1	0.0	1.2	-69.3	126.3	70.0
293.25	V	16.2		-64.3	0.0	1.2	-65.5	122.5	70.0
391.00	H	10.2		-71.5	0.0	1.3	-72.8	129.8	70.0
391.00	V	11.3		-68.0	0.0	1.3	-69.3	126.3	70.0
488.75	H	12.0		-66.8	0.0	1.5	-68.3	125.3	70.0
488.75	V	16.7		-62.3	0.0	1.5	-63.8	120.8	70.0
586.50	H	6.2		-73.2	0.0	1.6	-74.8	131.8	70.0
586.50	V	9.1		-69.5	0.0	1.6	-71.1	128.1	70.0
684.25	H	13.7		-63.5	0.0	1.8	-65.3	122.3	70.0
684.25	V	12.8		-64.2	0.0	1.8	-66.0	123.0	70.0
782.00	H	17.2		-59.2	0.0	1.9	-61.1	118.1	70.0
782.00	V	24.4		-51.5	0.0	1.9	-53.4	110.4	70.0
879.75	H	36.8		-39.2	0.0	2.0	-41.2	98.2	70.0
879.75	V	38.2		-36.9	0.0	2.0	-38.9	95.9	70.0
977.50	H	43.4		-30.9	0.0	2.1	-33.0	90.0	70.0
977.50	V	39.9		-31.7	0.0	2.1	-33.8	90.8	70.0

Output Power = 500W = 57dBm

Attenuation at least 43 + 10*Log (Power in watts) = 43 + 10 X Log (500) = 70dB.

ERP = Matched Signal Generator Reading (dBm) + Equivalent Antenna Gain (dB) – Cable Loss (dB)

Attenuation Below Output Power (dB) = Output Power (dB) – ERP (dBm) = 57dBm – ERP (dBm)

Checked By: MARK E. LONGINOTTI