Measurement of RF Interference from a Transceiver, Model 400LRS

For : Free Wave Technologies
Boulder, CO

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Specification : FCC "Code of Federal Regulations" Title 47
Part 15, Subpart B and Part 90, Subpart I

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REVISION HISTORY

Revision	Date	Description
—	03/07/2007	Initial release

Measurement of RF Emissions from a

Transceiver, Model 400LRS

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of the series of radio interference measurements performed on a Transceiver, Model No.400LRS (hereinafter referred to as the test item). Serial No. 400-0012 was assigned to the test item used for the receiver portion of the test. Serial Nos. 400-0017 and 400-0019 were assigned to the test items used for the transmitter portion of the test. The test item is designed to transmit and receive in the frequency range of 421MHz to 512MHz using an external antenna. The receiver contained one local oscillator at 133.2MHz below the carrier. The test item was submitted for testing by Free Wave Technologies located in Boulder, CO.

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 for receivers, and the RF power output, emissions mask, spurious emissions at antenna terminal, field strength of spurious emissions, frequency stability, and transient frequency behavior requirements of Part 90, Subpart I. Testing was performed in accordance with ANSI C63.4-2003 and 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 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 2006

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 90, dated 1 October 2006

- 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"

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

1.5 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.

1.6 Laboratory Conditions The temperature at the time of the test was 22°C and the relative humidity was 24%.

2.0 TEST ITEM SET-UP AND OPERATION:

The test item is a Transceiver, Model 400LRS. The test item is designed to transmit and receive in the 421MHz to 512MHz frequency range. Photographs of the test item are shown as Figure 2.

2.1 Power Input - A Sceptre AC Adaptor, P/N: PS-1230APL05, M/N: SA-036121A-3, was used to provide 12VDC to the test item via a 1.85 meter long 2 wire power cable. The Sceptre AC Adaptor was powered with 115V, 60Hz via a 1.7 meter long 3 wire power cable.

2.2 Grounding - The test item was ungrounded during testing.

2.3 Peripheral Equipment - The test item was submitted for testing with the following peripheral equipment:

- Toshiba M/N: PS214U Laptop Computer, P/N: PS214U-D81J08, S/N: 10405719U-1

2.4 Interconnect Cables - The test item was submitted for testing with a 10 wire, 85 cm long cable. Eight (8) of those wires went to the serial port of the Toshiba laptop computer. The other two (2) wires went to the output of the Sceptre AC Adaptor and were used to provide 12VDC power to the test item.

2.5 Operational Mode - For all receiver tests, the test item was set to receive separately at 421MHz, 450MHz, and 510MHz.

For all transmitter tests, the test item was set to transmit separately at 421MHz, 450MHz, and 510MHz.

2.6 Test Item Modifications - No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B for receivers, and Part 90, Subpart I for licensed transmitters.

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 for these tests is presented below:

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

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

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Receiver:

4.1.1 Powerline Conducted Emissions:

4.1.1.1 Requirements - All radio frequency voltages on the power lines of a Receiver shall be below the values shown below when using a quasi-peak detector:

CONDUCTED LIMITS FOR RECEIVERS

Frequency MHz	RFI Voltage dBuV(QP)	RFI Voltage dBuV(Average)
0.15-0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5-5	56	46
5-30	60	50

Note 1: The lower limit shall apply at the transition frequencies.
Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the test item is considered to have met both requirements and measurements do not need to be performed using the Average detector.

4.1.1.2 Procedures - The interference on each input power lead of the Sceptre AC Adaptor was measured by connecting the measuring equipment to the appropriate meter terminal of the LISN. The meter terminal of the LISN not under test was terminated with 50 ohm. Measurements were first made over the entire frequency range from 150kHz through 30MHz with a peak detector and the results were automatically plotted. The data thus obtained was then searched by the computer for the highest levels. Quasi-peak measurements were automatically performed at the frequencies selected from

the highest peak measurements, and the results printed.

4.1.1.3 Results - The plots of the peak preliminary conducted voltage levels on each power line, with the test item set to receive at 421MHz, are presented on pages 24 and 25. The conducted limits for Receivers are shown as a reference. The final quasi-peak results are presented on pages 26 and 27. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closest to the limit (worst case) occurred at 476kHz. The emissions level at this frequency was 9.5dB within the limit.

The plots of the peak preliminary conducted voltage levels on each power line, with the test item set to receive at 450MHz, are presented on pages 28 and 29. The conducted limits for Receivers are shown as a reference. The final quasi-peak results are presented on pages 30 and 31. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closest to the limit (worst case) occurred at 457kHz. The emissions level at this frequency was 9.6dB within the limit.

The plots of the peak preliminary conducted voltage levels on each power line, with the test item set to receive at 510MHz, are presented on pages 32 and 33. The conducted limits for Receivers are shown as a reference. The final quasi-peak results are presented on pages 34 and 35. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closest to the limit (worst case) occurred at 468kHz. The emissions level at this frequency was 9.2dB within the limit.

4.1.2 Antenna Conducted Emissions Measurements:

4.1.2.1 Requirements - This test is performed to determine the test item configuration during the radiated RF emissions tests. The power at the antenna terminal over the frequency range 30MHz to 2000MHz may be measured. If the emissions at the antenna terminal exceed 2 nanowatts, it is necessary to perform the radiated RF emissions tests with the antenna port terminated with an equivalent antenna. If the test item does meet the 2 nanowatt requirement, the radiated emissions tests can be performed with the antenna port terminated with a shielded load.

4.1.2.2 Procedures - The measuring equipment was connected to the test item's antenna port. The emissions in the frequency range from 30MHz to 2000MHz were observed and then plotted.

4.1.2.3 Results - The results of the antenna conducted measurements are presented on data pages 37 through 39. The reference line shown on the data pages represents the 2

nanowatt requirement. As can be seen from the data pages, all emissions from the test item were below the 2 nanowatt requirement. Since the emissions were below the 2 nanowatt limit, the antenna port was terminated with a shielded load for radiated emissions measurements. Photographs of the test setup are shown on Figure 2.

4.1.3 Radiated Measurements:

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

RADIATION LIMITS FOR RECIEVERS

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

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

4.1.3.2 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 C63.4-2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All power lines and signal lines entering the enclosure pass through filters on the enclosure wall. The power line filters prevent extraneous signals from entering the enclosure on these leads.

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 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.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 2000MHz was investigated using a peak detector function with a bilog antenna. 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) For all frequencies 1GHz and below, measurements were made using a broadband bi-log antenna.

2) For all frequencies above 1GHz, measurements were made using a waveguide antenna.

3) To ensure that the 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.

4.1.3.3 Results - The preliminary plots are presented on pages 40 through 42. These plots are presented for a reference only, and are not used to determine compliance. The final radiated levels are presented on pages 43 through 45.

As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closest to the limit (worst case) occurred at 1266.96MHz. The emissions level at this frequency was 4.0dB within the limit. A block diagram of the radiated emissions test setup is shown on Figure 1. Photographs of the test configuration which yielded the highest or worst case radiated emission levels are shown on Figures 3 and 4.

4.2 Transmitter:

4.2.1 RF Power Output:

4.2.1.1 Requirements - In accordance with paragraph 90.205(r), the output power shall not exceed by more than 20 percent the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

4.2.1.2 Procedures – With the test item transmitting at 421MHz, the antenna port of the test item was connected to a spectrum analyzer through a 50 dB attenuator. The resolution bandwidth of the spectrum analyzer was set wider than the bandwidth of the test item. The output power of the item was then measured. This procedure was repeated separately with the test item transmitting at 450MHz and 510MHz.

4.2.1.3 Results - The output power plots are shown on pages 46 through 48. The output power measurements are shown in a tabular form on page 49. As can be seen from the data, the power output at each frequency is below the maximum allowable power of 20% above the manufacturer's

rated output power.

4.2.2 Emission Mask

4.2.2.1 Requirements - Per 90.210, for equipment operating in the frequency band of 421MHz to 512MHz with a 12.5kHz channel bandwidth, any emissions must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth fo to 5.625kHz removed from fo: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625kHz but no more than 12.5kHz: At least 7.25(fd – 2.88kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz; At least 50 + 10log (P) dB or 70dB whichever is the lesser attenuation.

4.2.2.2 Procedures - The test item was set to transmit at 421MHz.

(a) The antenna port of the test item was connected to a spectrum analyzer through a 50dB attenuator.
(b) The following spectrum analyzer settings were employed:
- trace 1 = on
- center frequency = transmit frequency of the test item
- resolution bandwidth = 1MHz
- video bandwidth > resolution bandwidth
- frequency span = 67.5kHz
- sweep = Auto
- detector function = peak
- trace = max hold

(c) Several sweeps were made with the settings listed above.
(d) Trace 1 was changed from max hold to view
(e) The following spectrum analyzer settings were employed:
- trace 2 = on
- resolution bandwidth = 100Hz
- video bandwidth = 1kHz
- sweep = Auto
- detector function = peak
- trace = max hold

(f) Several sweeps were made with the settings listed above.
(g) Steps (a) through (f) were repeated with the test item set to transmit at 450MHz.
(h) Steps (a) through (f) were repeated with the test item set to transmit at 510MHz.

4.2.2.3 Results - The spectrum analyzer plots of the emissions of the test item are shown on pages 50 through 52. The limits, shown on the plots, are referenced to the power measured with a 1MHz resolution bandwidth. As can be seen from the data, the test item did not produce spurious

emissions in excess of the limit.

The 99% bandwidth was measured to be 86.5kHz.

4.2.3 Spurious Emissions At Antenna Terminal

4.2.3.1 Requirements - Per 90.210, on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz the emissions must be attenuated by at least 50 + 10log (P) dB or 70dB whichever is the lesser attenuation.

4.2.3.2 Procedures - The test item was set to transmit at 421MHz.

(a) The antenna port of the test item was connected to a spectrum analyzer through a 50dB attenuator.
(b) The resolution bandwidth of the spectrum analyzer was set to 100kHz.
(c) A sweep was made from 30MHz to 1GHz.
(d) The resolution bandwidth of the spectrum analyzer was set to 1MHz.
(e) A sweep was made from 1GHz to 5GHz.
(f) Steps (a) through (e) were repeated with the test item set to transmit at 450MHz.
(g) Steps (a) through (e) were repeated with the test item set to transmit at 510MHz with the following modification:
- for step (e) a sweep was made from 1GHz to 6GHz.

4.2.3.3 Results - The plots of the antenna conducted output measurements are presented on pages 53 through 58. The limits, shown on the plots, are referenced to the RF power output measurements made on the test item (see section 4.2.1 for more information). The limits were calculated as follows:

For 421MHz: RF Output Power = 3.97 Watts or 35.99dBm. The emissions from the spurious emissions at the antenna terminal for any frequency removed from the center of the authorized bandwidth by more than 12.5kHz must be attenuated by: 50 + 10*log(P) dB = 50 + 10*log(3.97) = 55.99dB. Therefore all spurious emissions at the antenna terminal must be less than -20dBm (-20dBm = 35.99dBm – 55.99dB).

For 450MHz: RF Output Power = 4.80 Watts or 36.81dBm. The emissions from the spurious emissions at the antenna terminal for any frequency removed from the center of the authorized bandwidth by more than 12.5kHz must be attenuated by: 50 + 10*log(P) dB = 50 + 10*log(4.80) = 56.81dB. Therefore all spurious emissions at the antenna terminal must be less than -20dBm (-20dBm = 36.81dBm – 56.81dB).

For 510MHz: RF Output Power = 3.80 Watts or 35.80dBm. The emissions from the spurious emissions at the antenna terminal for any frequency removed from the center of the authorized bandwidth by more than 12.5kHz must be attenuated by: 50 + 10*log(P) dB = 50 + 10*log(3.80) = 55.80dB. Therefore all spurious emissions at the antenna terminal must be less than -20dBm (-20dBm = 35.80dBm – 55.80dB).

As can be seen from the data, the test item did not produce spurious emissions in excess of the limit.

4.2.4 Field Strength of Spurious Emissions:

4.2.4.1 Requirements - Per 90.210, on any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz the emissions must be attenuated by at least 50 + 10log (P) dB or 70dB whichever is the lesser attenuation.

4.2.4.2 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 chamber complies with ANSI C63.4 2003 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.

1. 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 test item. The entire frequency range from 30MHz to 6GHz was investigated using a peak detector function. All preliminary tests were performed separately with the test item operating in the transmit at 421MHz mode, transmit at 450MHz mode, and transmit at 510MHz mode.

2. 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 tuned dipole or double ridged waveguide antenna over the frequency range of 30MHz to 6GHz.

3. To ensure that maximum 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 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.

4. 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 or double ridged waveguide antenna was set in place of the test item 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.

4.2.4.3 Results - The preliminary radiated emissions plots are presented on pages 60 through 65. 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 pages 67 through 69. The radiated emissions were measured through the 10th harmonic. As can be seen from the data, all emissions measured from the test item were within the specification limits. Photographs of the test configuration are shown on Figures 3 and 4.

4.2.5 Frequency Stability :

4.2.5.1 Requirements - In accordance with paragraph 90.213(a), fixed and base stations operating in the 421MHz to 512MHz band with a 12.5kHz channel bandwidth must have a frequency stability of 1.5ppm.

4.2.5.2 Procedures - The antenna port of the test item was connected to a frequency counter through a 50dB attenuator. The test item was then placed in a humidity temperature chamber.

(a) The test item was set to transmit at 421MHz. The transmit frequency was measured and recorded at ambient temperature.
(b) The temperature chamber was then set to -30ºC.
(c) Once the temperature chamber had reached -30ºC, the test item was allowed to soak for 30 minutes.
(d) After soaking at -30ºC for thirty minutes, the test item was turned on and set to transmit at 421MHz and the transmit frequency was measured and recorded.
(e) Steps (b) through (d) were repeated at -20ºC.
(f) Steps (b) through (d) were repeated at -10ºC.
(g) Steps (b) through (d) were repeated at 0ºC.
(h) Steps (b) through (d) were repeated at +10ºC.
(i) Steps (b) through (d) were repeated at +20ºC.
(j) Steps (b) through (d) were repeated at +30ºC.
(k) Steps (b) through (d) were repeated at +40ºC.
(l) Steps (b) through (d) were repeated at +50ºC.
(m) Steps (b) through (l) were repeated with the test item set to transmit at 450MHz.
(n) Steps (b) through (l) were repeated with the test item set to transmit at 510MHz.
(o) The test item was then removed from the temperature chamber and allowed to adjust to nominal room temperature.
(p) The supply voltage was checked and adjusted to the nominal level (12.0VDC). The test item was turned on and set to transmit at 421MHz. The transmit frequency was measured and recorded at ambient temperature.
(q) The supply voltage was then varied to 85% of its nominal level (10.2VDC). The test item was turned on and set to transmit at 421MHz. The transmit frequency was measured and recorded at ambient temperature.
(r) The supply voltage was then varied to 115% of its nominal level (13.8VDC). The test item was turned on and set to transmit at 421MHz. The transmit frequency was measured and

recorded at ambient temperature.

(s) Steps (p) through (r) were repeated with the test item set to transmit at 450MHz.

(t) Steps (p) through (r) were repeated with the test item set to transmit at 510MHz.

4.2.5.3 Results - The frequency stability measurements are presented on pages 70 through 76. As can be seen from the data, all frequency deviations were within the 1.5 ppm limit. A photograph of the test configuration is shown on Figure 5.

4.2.6 Transient Frequency Behavior

4.2.6.1 Requirements - Per 90.214, transmitters designed to operate in the 421MHz to 512MHz frequency band with 12.5kHz channel spacing must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals	Maximum Frequency Difference	Time (ms)
t_1	+/-12.5kHz	10.0
t_2	+/-6.25kHz	25.0
t_3	+/-12.5kHz	10.0

Where:

t_1 is the time period immediately following t_{on}

t_2 is the time period immediately following t_1

t_3 is the time period from the instant when the transmitter is turned off until t_{off}

4.2.6.2 Procedures - Two test signals were connected to the test discriminator via a combining network. The transmitter was connected to a 50 ohm power attenuator. The output of the power attenuator was connected to the test discriminator via one input of the combining network. A test signal was connected to the second input of the combining network.

(a) The test signal was adjusted to the nominal frequency of the transmitter.

(b) The test signal was modulated by a 1 kHz signal with a deviation equal to the value of the relevant channel separation (12.5kHz).

(c) The test signal was adjusted to correspond to 0.5% of the power of the transmitter under test measured at the input of the test discriminator. This level was maintained throughout the measurement.

(d) The amplitude difference (ad) and the frequency difference (fd) output of the test discriminator

were connected to a storage oscilloscope.

(e) The storage oscilloscope was set to display the channel corresponding to the (fd) input up to ±1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

(f) The storage oscilloscope was set to a rate of 5 ms/div and set so that the triggering occurs at 1 div from the left edge of the display.

(g) The 1 kHz test signal was shown continuously. The storage oscilloscope was set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

(h) The transmitter was then switched on, without modulation, to produce the trigger pulse and a picture on the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

(i) The transmit signal suppresses the 1 kHz test signal and produces the start of the test or t_{on}. During this test time the frequency difference was measured and recorded verses time.

(j) The transmitter was then switched off to produce the trigger pulse and a picture of the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the frequency difference of the transmitter versus time and the other showing the 1 kHz test signal.

(k) The transmitter signal no longer suppresses the 1 kHz test signal and produces t_3.

4.2.6.3 Results - The plots of the transient frequency behavior are shown on pages 77 and 78. As can be seen from the data, all transient frequencies were within the maximum frequency difference limits specified by 90.214.

5.0 CONCLUSIONS:

It was determined that the Free Wave Technologies, Transceiver, Model No.400LRS, Serial Number 400-0012, 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 when tested per ANSI C63.4-2003.

It was determined that the Free Wave Technologies Transceiver, Model No.400LRS, Serial Numbers 400-0017 and 400-0019 did fully meet the RF power output, emissions mask, spurious emissions at antenna terminal, field strength of spurious emissions, frequency stability, and transient frequency behavior, requirements of the FCC "Code of Federal Regulations" Title 47, Part 90, Subpart I, when tested per TIA-603-C-2004.

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	03/06/06	12	03/06/07
Equipment Type: ANTENNAS								
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	02/16/06	12	02/16/07
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	03/10/06	12	03/10/07
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	08/21/06	12	08/21/07
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/09/06	12	10/09/07
NWG0	RIDGED WAVE GUIDE (DCC-MAT	AEL	H1479	104	1-12.4GHZ	10/09/06	12	10/09/07
Equipment Type: ATTENUATORS								
T1E8	10DB, 25W ATTENUATOR	WEINSCHEL CORP.	46-10-34	BH7996	DC-18GHZ	12/04/06	12	12/04/07
T2DA	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BH5446	DC-18GHZ	10/04/06	12	10/04/07
T2DJ	25W 20DB ATTENUATOR	WEINSCHEL	46-20-34	BS0923	DC-18GHZ	12/04/06	12	12/04/07
Equipment Type: CHAMBERS (ENV)								
ETC0	TEMPERATURE CHAMBER	TENNEY	BTR-100350	9145-17	-60C TO 100C		NOTE 1	
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: METERS								
MFC0	MICROWAVE FREQ. COUNTER	HEWLETT PACKARD	5343A	2133A00591	10HZ-26GHZ	05/17/06	12	05/17/07
MSV1	DIGITAL OSCILLOSCOPE	LECROY	WR6051	LCRY0602P135	DC-500MHZ	11/06/06	12	11/06/07
Equipment Type: PROBES; CLAMP-ON & LISNS								
PLL9	50UH LISN 462D	ELITE	462D/70A	010	0.01-400MHZ	03/06/06	12	03/06/07
PLLA	50UH LISN 462D	ELITE	462D/70A	011	0.01-400MHZ	03/06/06	12	03/06/07
Equipment Type: POWER SUPPLIES								
SBA1	DC POWER SUPPLY	APLAB	ZS3205	99071032	0-32VDC;0-5A		NOTE 1	
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	02/21/07	12	02/21/08
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	02/21/07	12	02/21/08
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	02/21/07	12	02/21/08
RBB0	EMI TEST RECEIVER 20HZ TO	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	09/29/06	12	09/29/07
RYE0	MODULATION ANALYZER	HEWLETT PACKARD	8901B	3104A03410	0.15-1300MHZ	03/08/06	12	03/08/07
Equipment Type: SIGNAL GENERATORS								
GBN9	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMY 02	61400238	9KHZ-2.080GHZ	11/08/06	12	11/08/07
GBU0	SIGNAL GENERATOR (DCC-MATC	ROHDE & SCHWARZ	SMHU52	894597/002	0.1-4320MHZ	08/11/06	12	08/11/07
GDJ1	SYNTHESIZED GENERATOR	HEWLETT PACKARD	8672A	2132A02171	2-18GHZ	04/19/06	12	04/19/07

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.

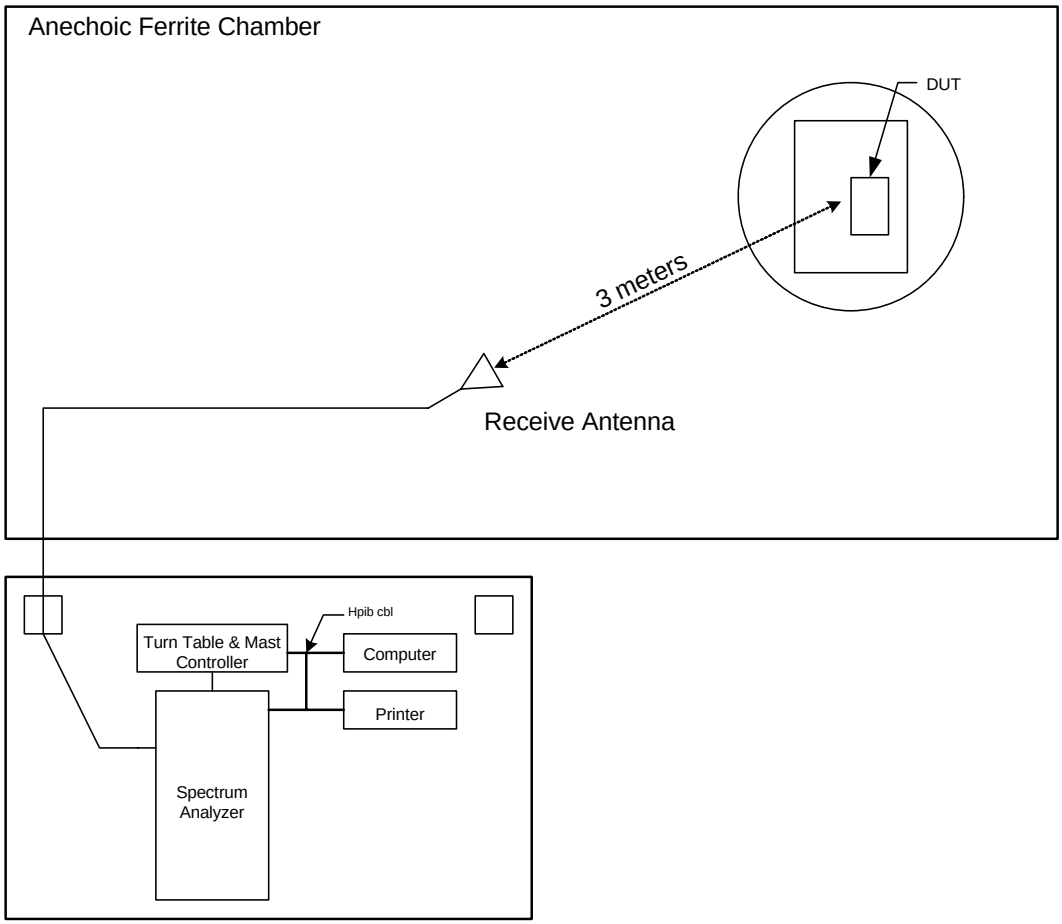


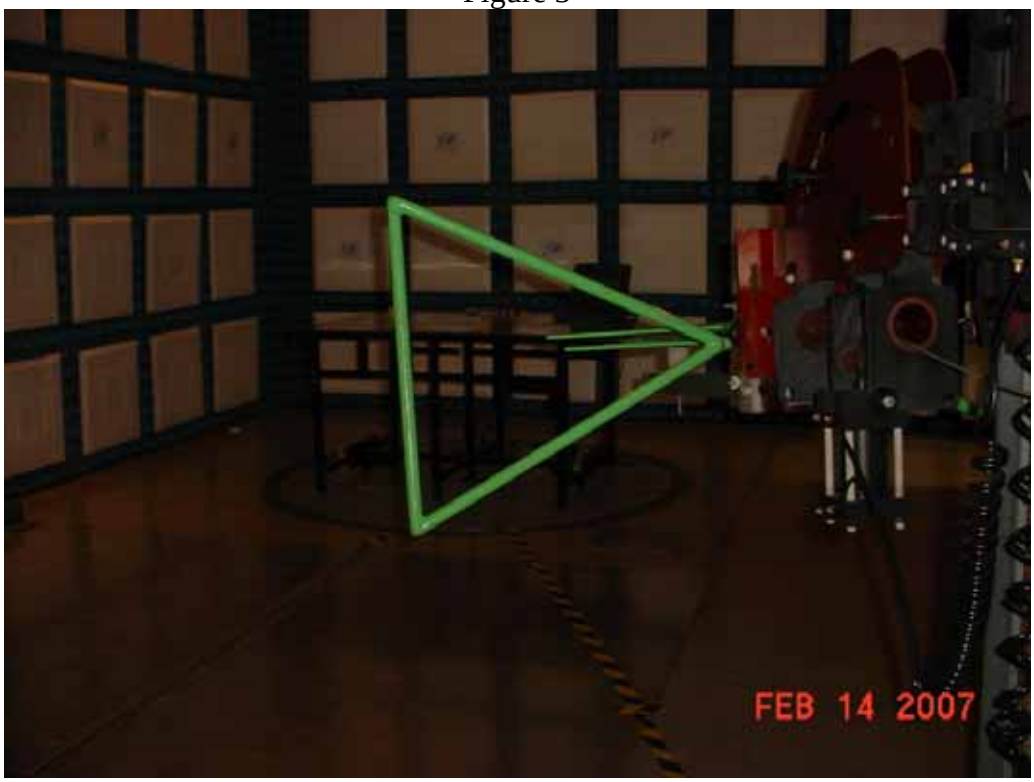
FIGURE 1 BLOCK DIAGRAM OF RADIATED EMISSIONS TEST SETUP

Figure 2

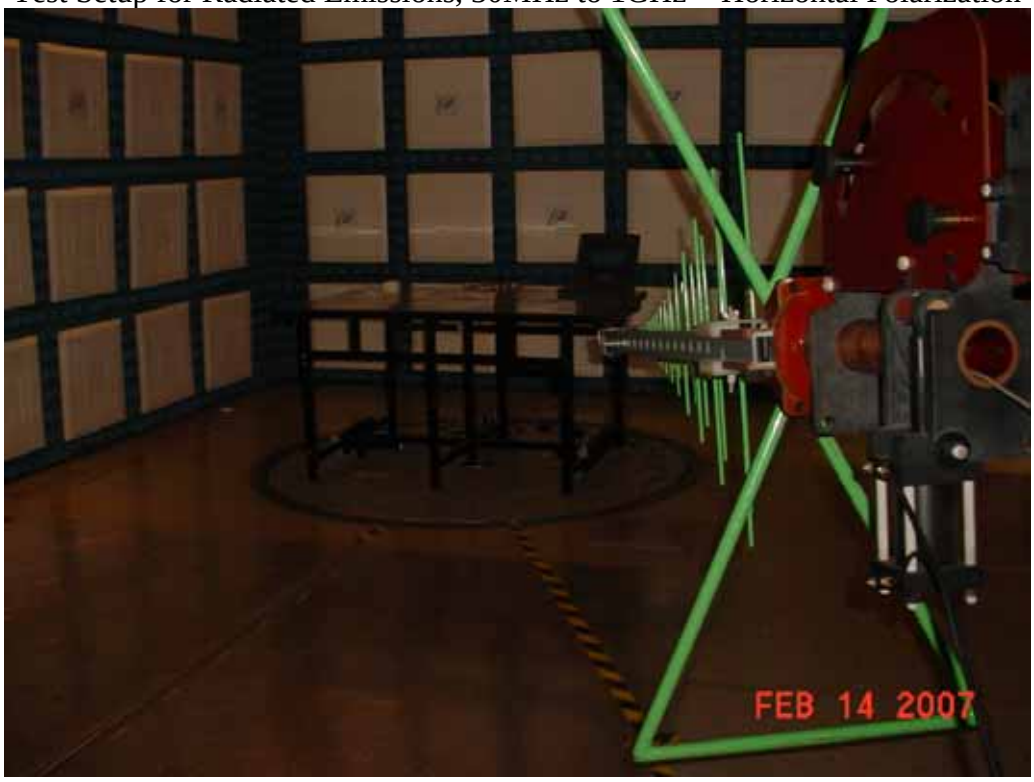
Test Item Setup for Radiated Emissions Test - Receiver

Test Item Setup for Radiated Emissions Test - Transmitter

Figure 3

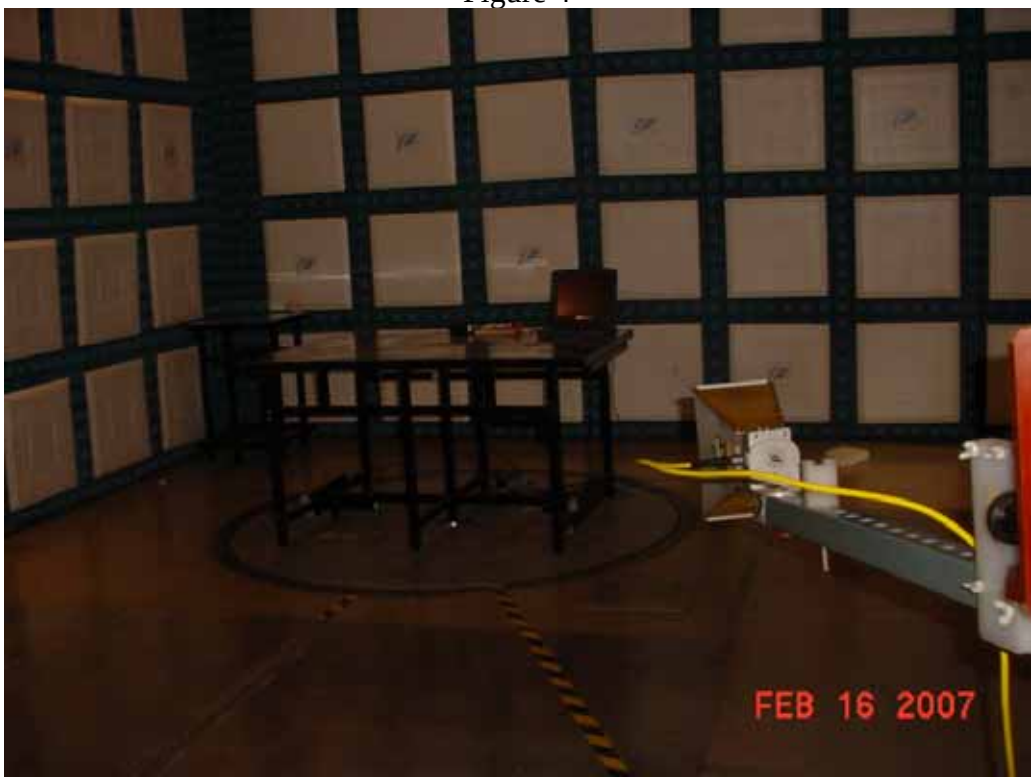


Test Setup for Radiated Emissions, 30MHz to 1GHz - Horizontal Polarization

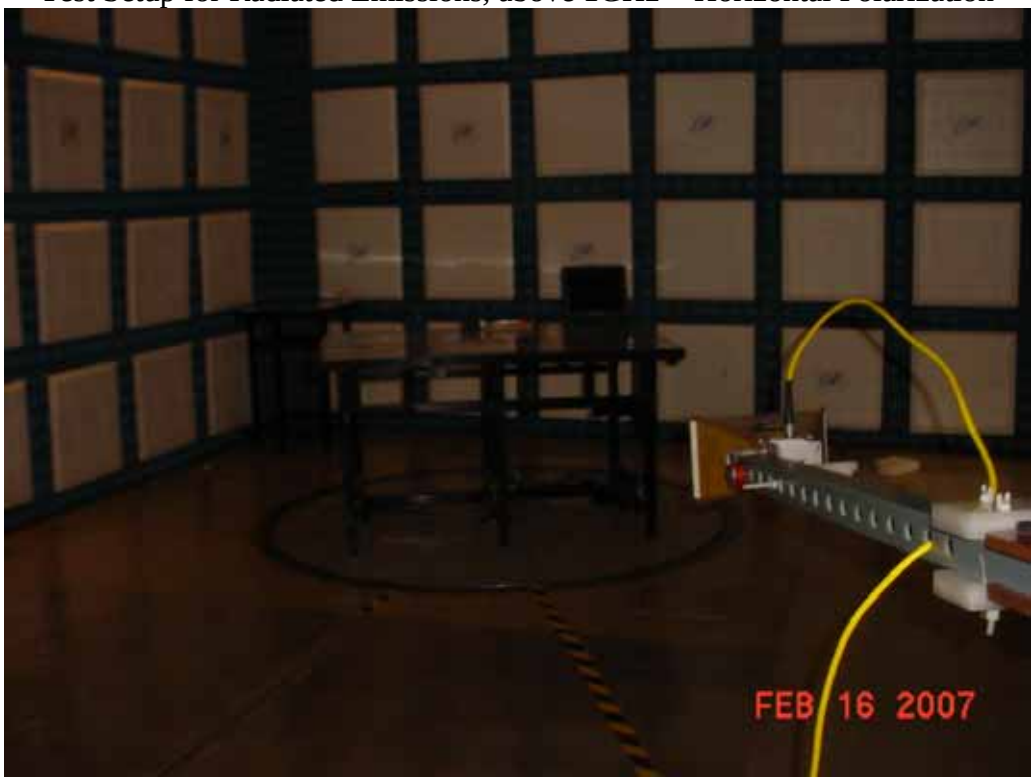


Test Setup for Radiated Emissions, 30MHz to 1GHz - Vertical Polarization

Figure 4



Test Setup for Radiated Emissions, above 1GHz - Horizontal Polarization

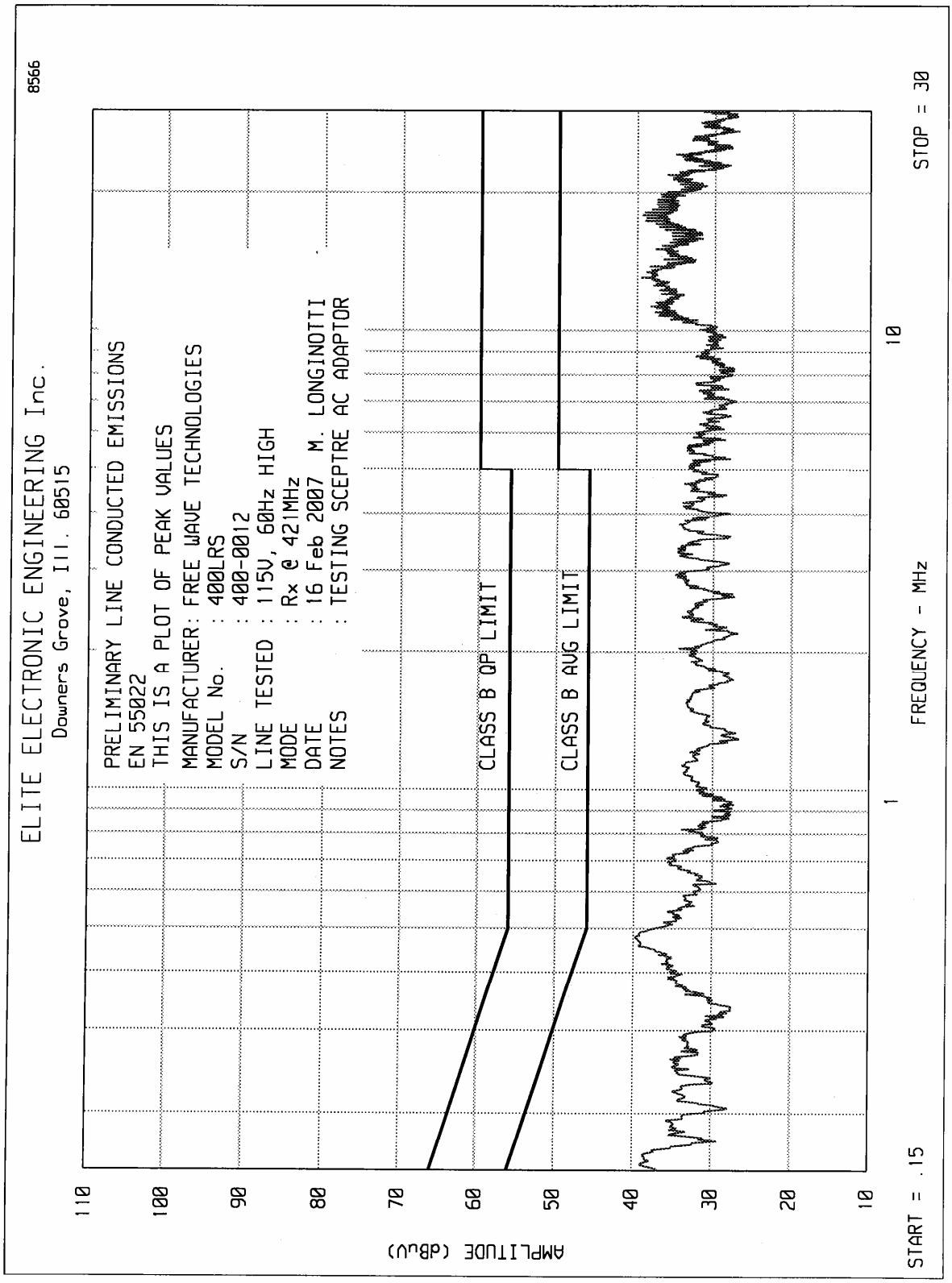


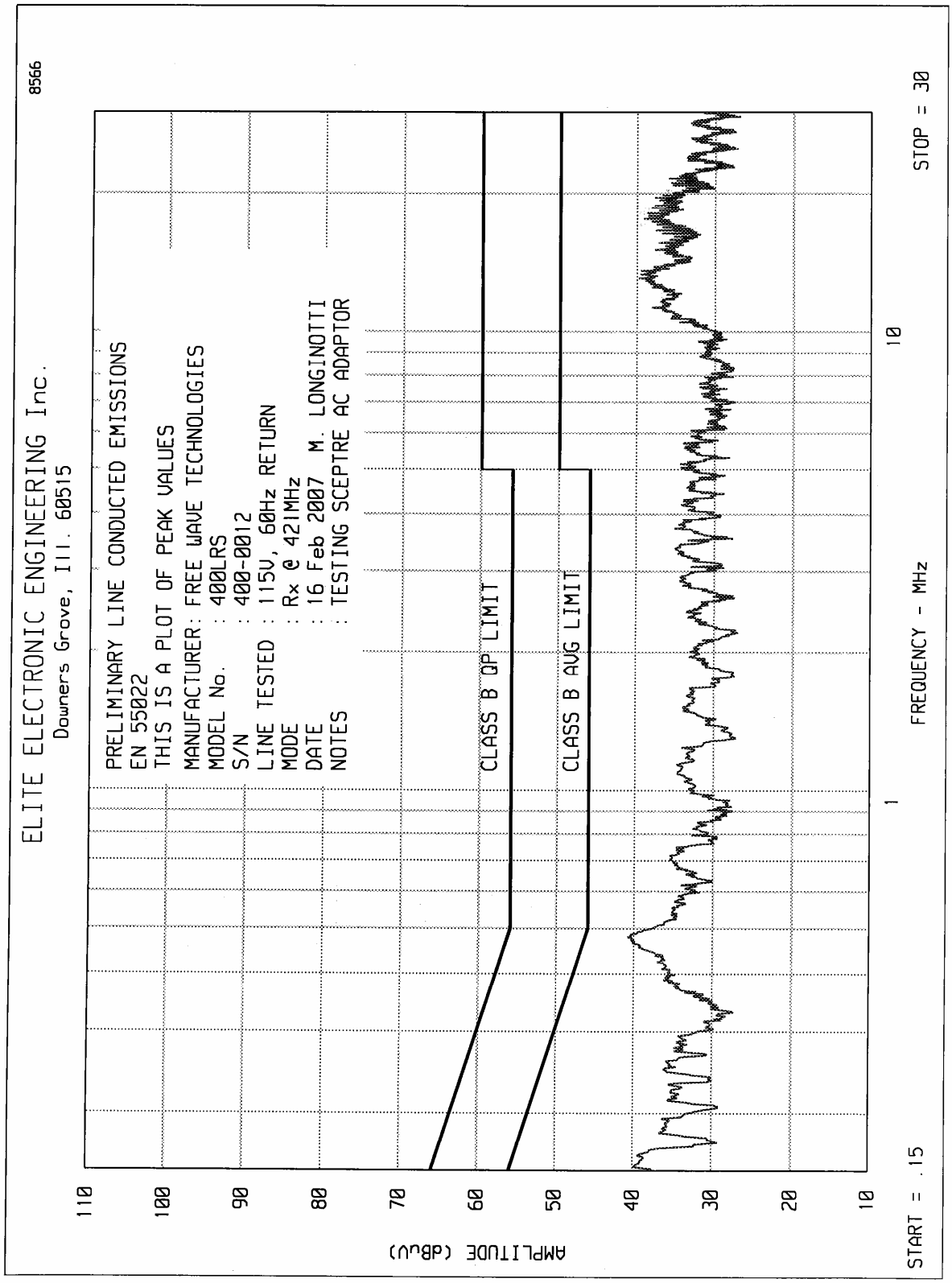
Test Setup for Radiated Emissions, above 1GHz - Vertical Polarization

Figure 5

Test Setup for Frequency Stability – Frequency vs. Temperature

Test Setup for Frequency Stability – Frequency vs. Temperature


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8566
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 421MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz


8566
ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 421MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz

ETR No.
ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 421MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.150	33.9	66.0		56.0	
.444	33.0	57.0		47.0	
.459	36.1	56.7		46.7	
.474	36.3	56.5		46.5	
.698	31.4	56.0		46.0	
.820	28.2	56.0		46.0	
1.114	29.4	56.0		46.0	
1.876	28.3	56.0		46.0	
2.023	28.9	56.0		46.0	
2.955	29.7	56.0		46.0	
3.306	30.6	56.0		46.0	
3.360	30.6	56.0		46.0	
4.217	29.1	56.0		46.0	
5.498	29.0	60.0		50.0	
7.639	27.0	60.0		50.0	
11.272	33.5	60.0		50.0	
13.037	34.0	60.0		50.0	
13.344	33.6	60.0		50.0	
15.003	34.0	60.0		50.0	
17.800	35.3	60.0		50.0	
18.802	34.5	60.0		50.0	
20.056	33.3	60.0		50.0	
24.317	29.1	60.0		50.0	
28.168	27.5	60.0		50.0	

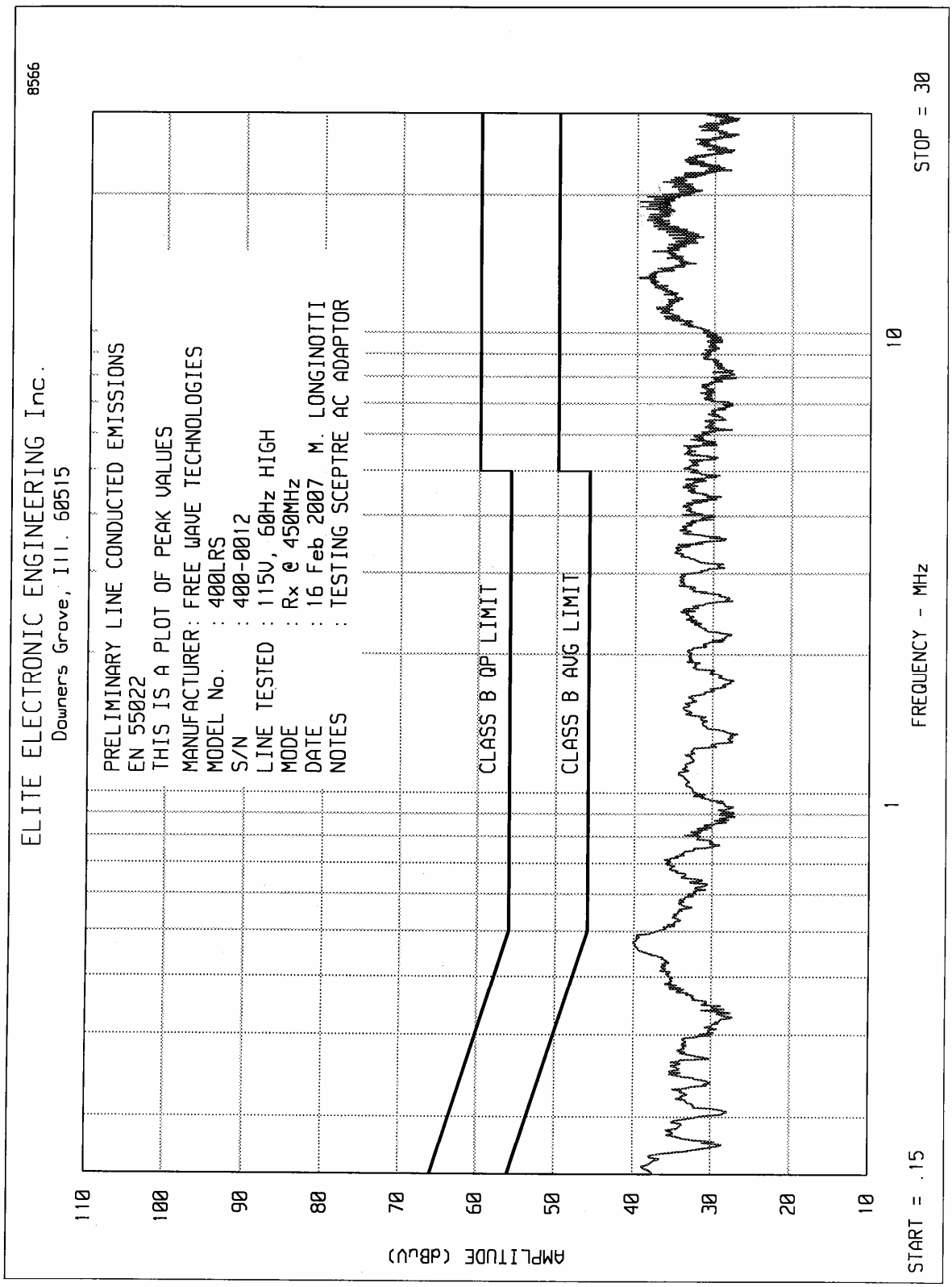
CHECKED BY: Mark E Longinotti
M. LONGINOTTI

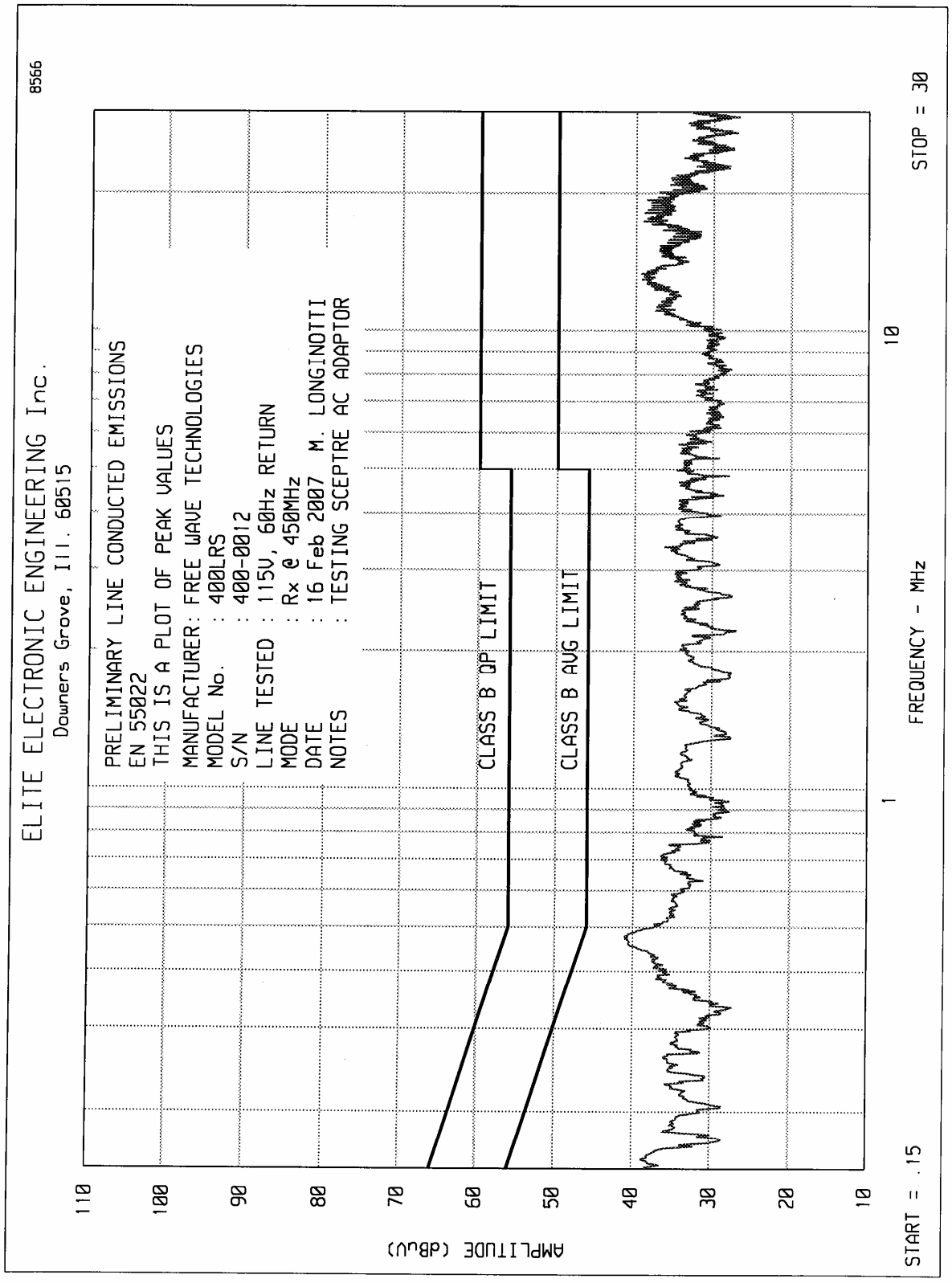
ETR No.
ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 421MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.150	34.9	66.0		56.0	
.457	36.2	56.7		46.7	
.476	36.9	56.4		46.4	
.708	31.8	56.0		46.0	
.729	30.5	56.0		46.0	
1.125	30.0	56.0		46.0	
1.948	28.7	56.0		46.0	
2.850	30.0	56.0		46.0	
3.745	30.4	56.0		46.0	
4.195	29.7	56.0		46.0	
7.243	27.0	60.0		50.0	
9.479	27.3	60.0		50.0	
11.307	33.5	60.0		50.0	
13.035	34.9	60.0		50.0	
13.537	33.9	60.0		50.0	
15.007	34.4	60.0		50.0	
17.550	35.2	60.0		50.0	
17.801	35.7	60.0		50.0	
18.552	34.8	60.0		50.0	
21.561	31.3	60.0		50.0	
24.168	28.6	60.0		50.0	
28.151	28.2	60.0		50.0	

CHECKED BY: Mark E Longinotti
M. LONGINOTTI


8566
ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 450MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8566
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 450MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz

ETR No.
ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 450MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.458	36.2	56.7		46.7	
.466	36.5	56.6		46.6	
.715	31.5	56.0		46.0	
.805	28.1	56.0		46.0	
1.089	29.8	56.0		46.0	
1.494	29.5	56.0		46.0	
1.914	28.7	56.0		46.0	
2.814	30.0	56.0		46.0	
3.341	30.6	56.0		46.0	
4.069	28.6	56.0		46.0	
6.041	27.3	60.0		50.0	
8.575	27.0	60.0		50.0	
11.271	33.0	60.0		50.0	
11.474	32.5	60.0		50.0	
13.142	33.2	60.0		50.0	
13.316	33.5	60.0		50.0	
15.007	34.4	60.0		50.0	
17.548	35.6	60.0		50.0	
18.802	35.1	60.0		50.0	
20.056	33.6	60.0		50.0	
23.813	30.0	60.0		50.0	
27.879	27.4	60.0		50.0	

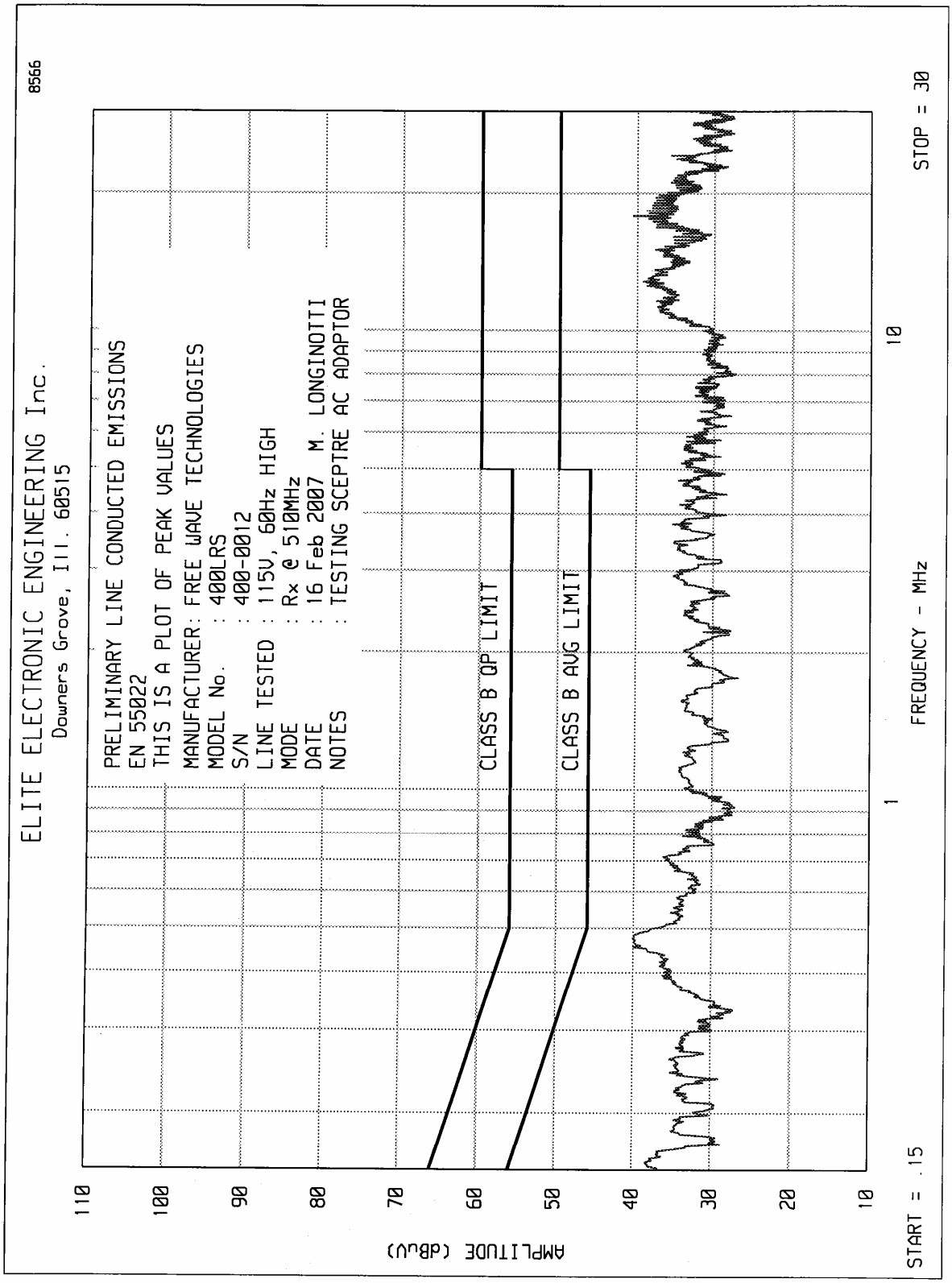
CHECKED BY: Mark E Longinotti
M. LONGINOTTI

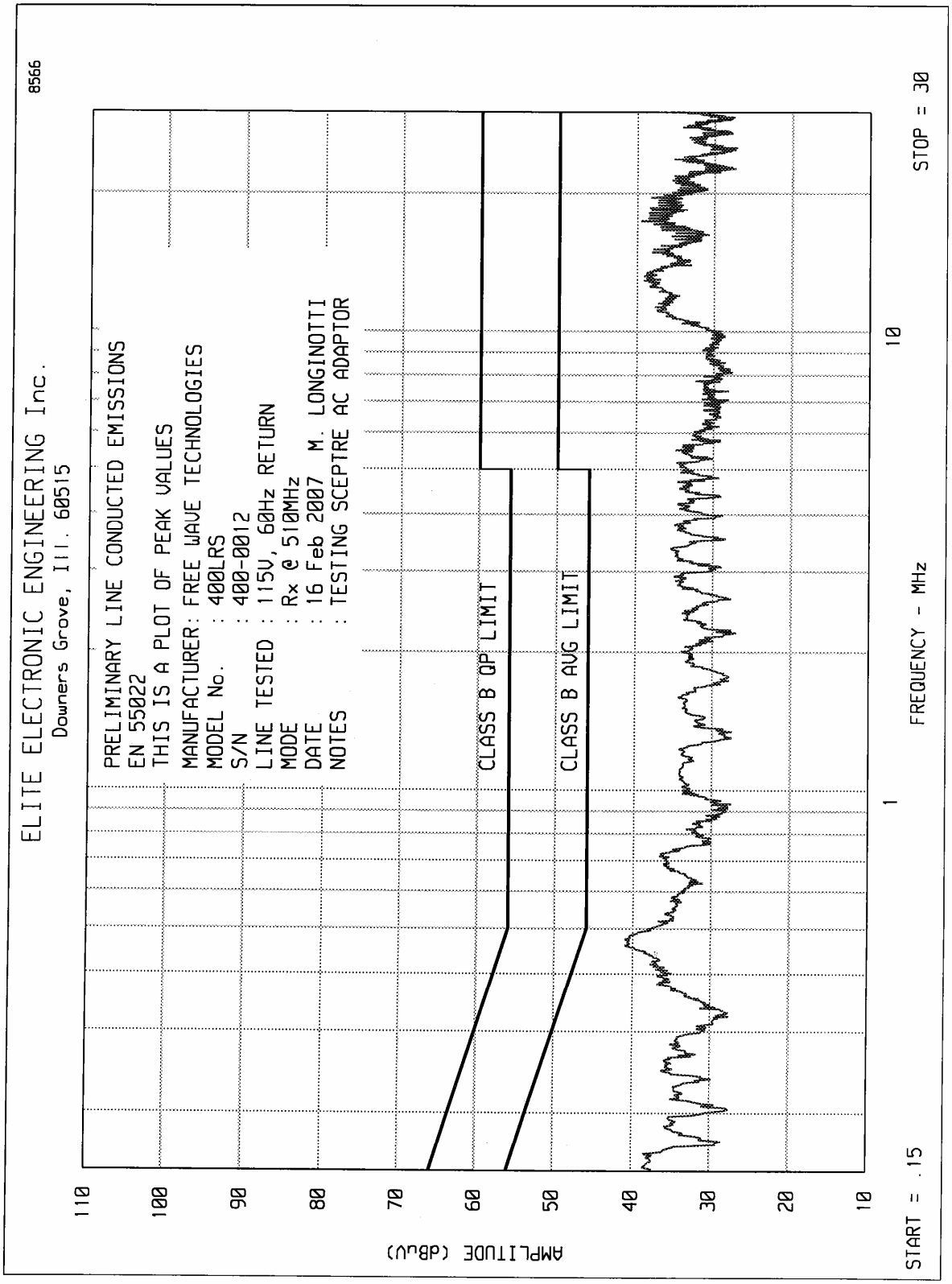
ETR No.
ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 450MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.265	30.6	61.3		51.3	
.457	37.1	56.7		46.7	
.467	37.4	56.6		46.6	
.703	32.5	56.0		46.0	
1.114	30.4	56.0		46.0	
1.534	29.9	56.0		46.0	
2.012	29.5	56.0		46.0	
2.826	30.4	56.0		46.0	
3.328	31.1	56.0		46.0	
5.003	29.7	60.0		50.0	
5.628	27.8	60.0		50.0	
7.590	27.3	60.0		50.0	
11.029	32.6	60.0		50.0	
13.286	34.6	60.0		50.0	
13.429	33.5	60.0		50.0	
15.006	34.4	60.0		50.0	
17.299	35.2	60.0		50.0	
19.303	34.6	60.0		50.0	
20.054	33.2	60.0		50.0	
23.870	28.6	60.0		50.0	
28.004	28.2	60.0		50.0	

CHECKED BY: Mark E. Longinotti
M. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8566
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 510MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
8566
PRELIMINARY LINE CONDUCTED EMISSIONS
EN 55022
THIS IS A PLOT OF PEAK VALUES
MANUFACTURER: FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 510MHz
DATE : 16 Feb 2007 M. LONGINOTTI
NOTES : TESTING SCEPTRE AC ADAPTOR
CLASS B QP LIMIT
CLASS B AVG LIMIT
AMPLITUDE (dBuV)
110
100
90
80
70
60
50
40
30
20
10
START = .15
1
10
STOP = 30
FREQUENCY - MHz

ETR No.
ELITE ELECTRONIC ENGINEERING CO.

MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz HIGH
MODE : Rx @ 510MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.416	32.7	57.5		47.5	
.460	36.5	56.7		46.7	
.702	31.6	56.0		46.0	
.729	29.5	56.0		46.0	
.815	28.7	56.0		46.0	
1.093	30.1	56.0		46.0	
1.194	29.3	56.0		46.0	
2.009	29.3	56.0		46.0	
2.920	30.4	56.0		46.0	
2.998	29.5	56.0		46.0	
3.792	30.1	56.0		46.0	
4.705	28.7	56.0		46.0	
6.634	26.9	60.0		50.0	
8.883	27.6	60.0		50.0	
11.617	32.5	60.0		50.0	
12.471	32.7	60.0		50.0	
12.785	33.1	60.0		50.0	
13.565	32.4	60.0		50.0	
15.008	34.5	60.0		50.0	
17.798	35.3	60.0		50.0	
18.548	34.4	60.0		50.0	
20.055	33.4	60.0		50.0	
24.066	29.8	60.0		50.0	
28.075	28.2	60.0		50.0	

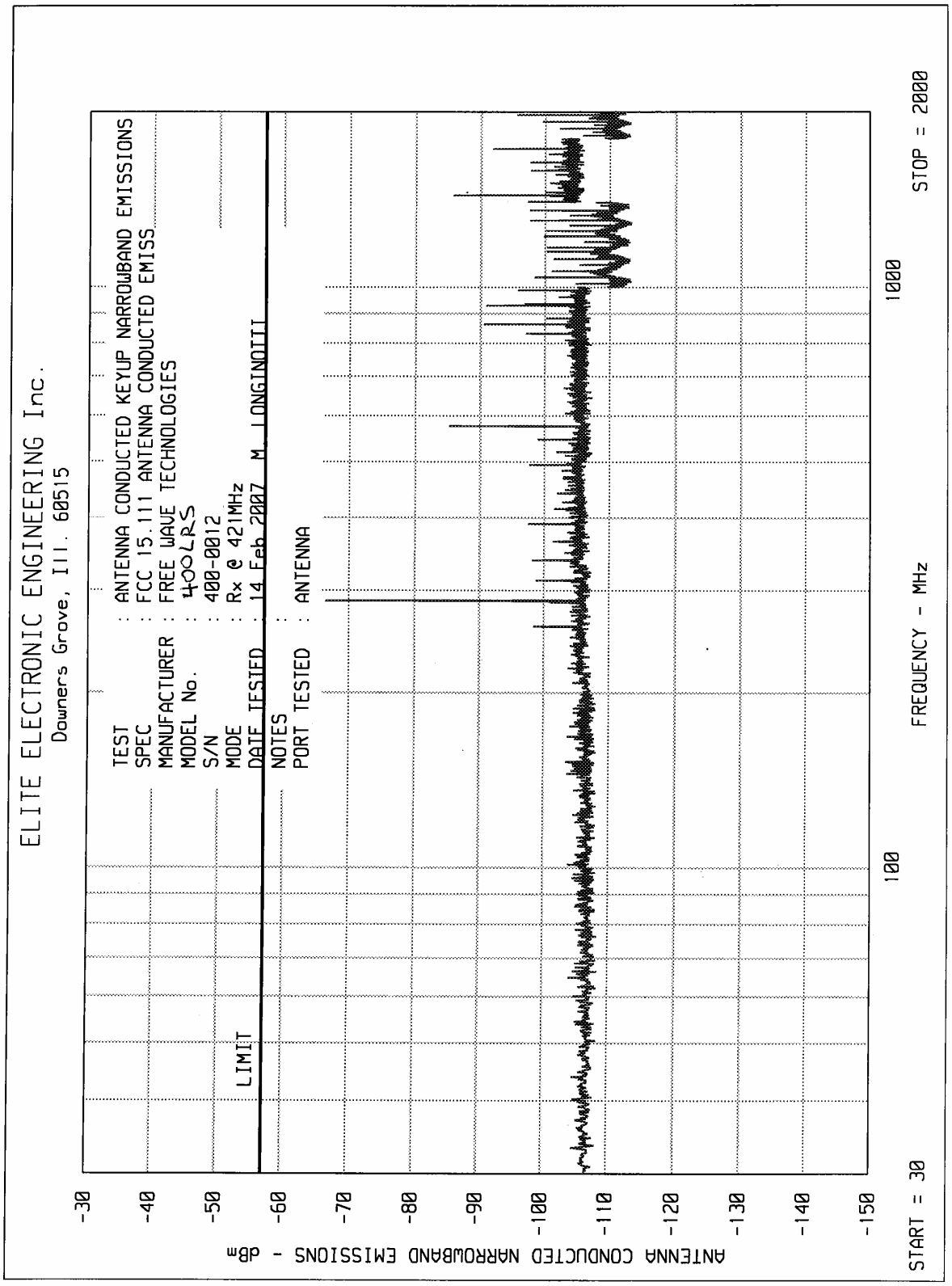
CHECKED BY: Mark E. Longinotti
M. LONGINOTTI

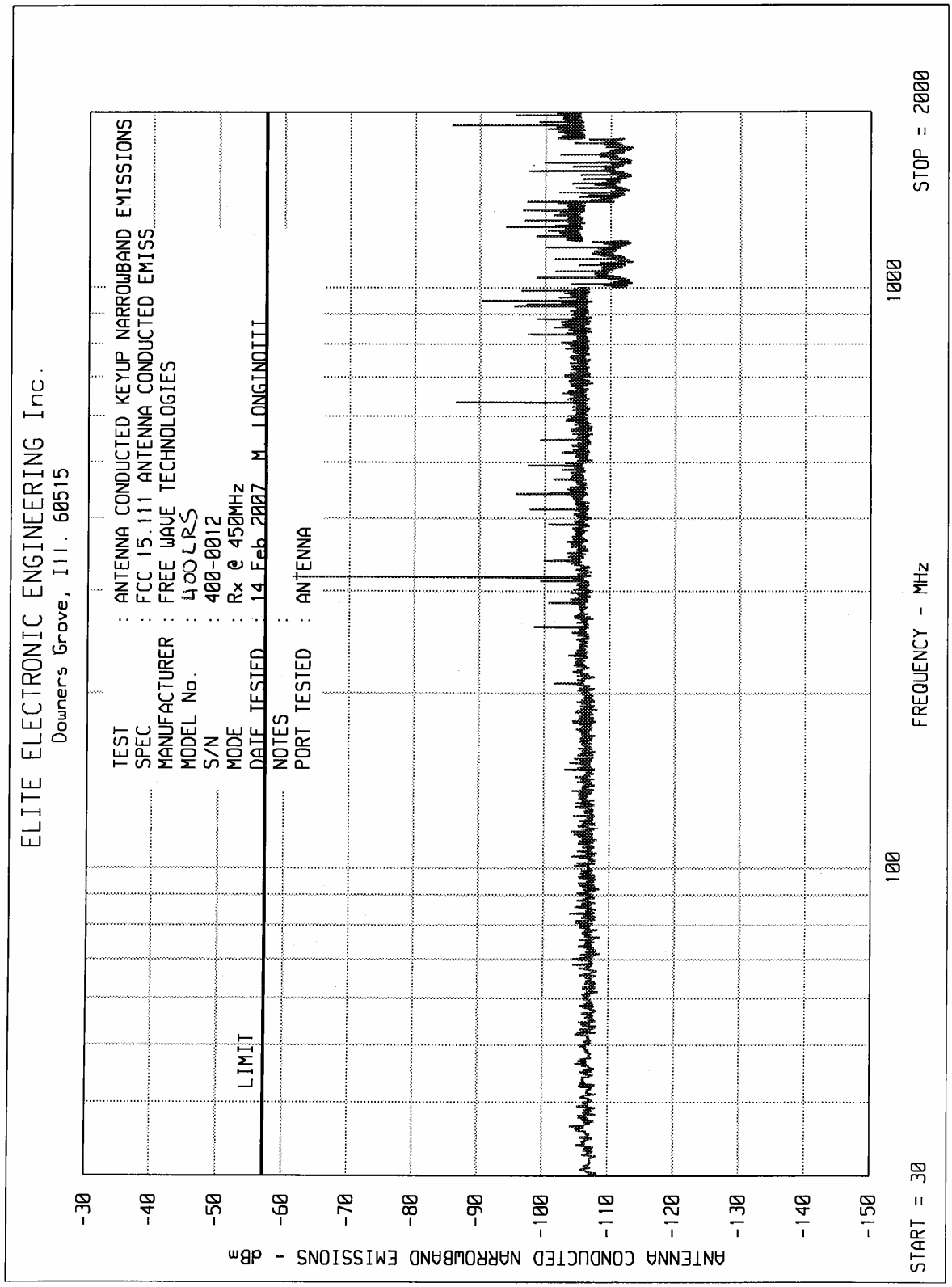
ETR No.
ELITE ELECTRONIC ENGINEERING CO.

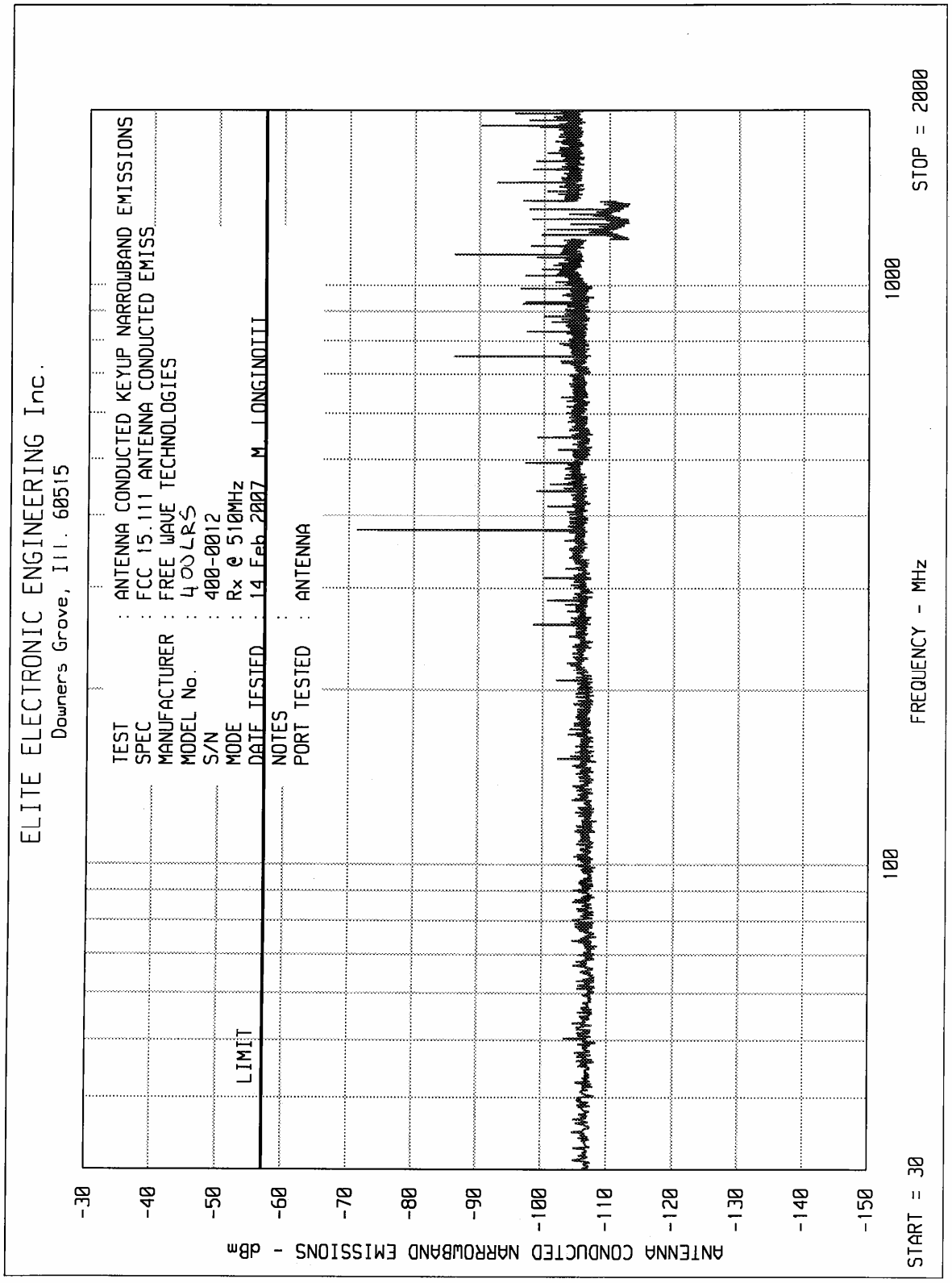
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL : 400LRS
S/N : 400-0012
SPECIFICATION : EN 55022, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : 115V, 60Hz RETURN
MODE : Rx @ 510MHz
DATE : 16 Feb 2007
NOTES : TESTING SCEPTRE AC ADAPTOR
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

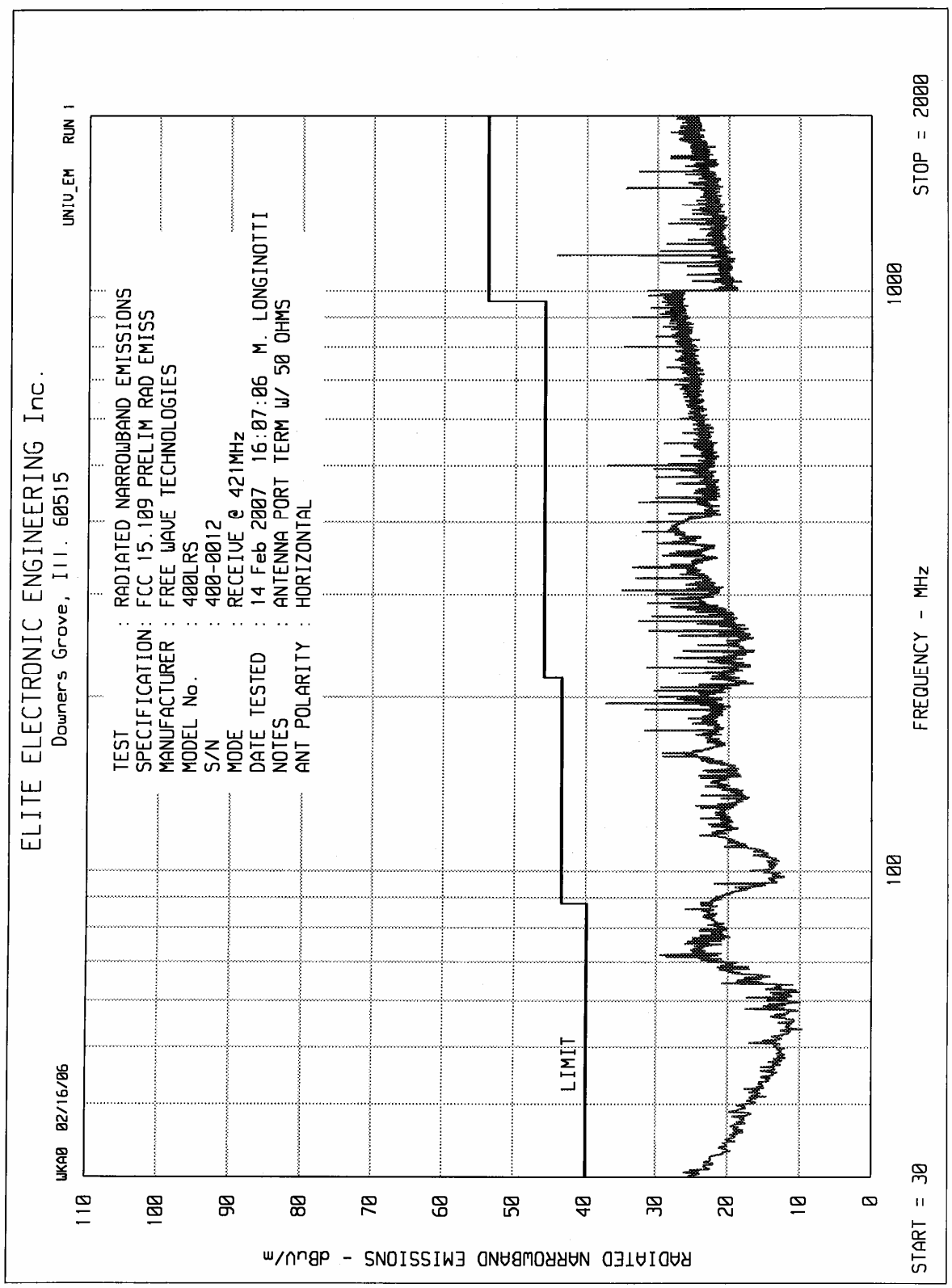
FREQUENCY MHz	METER RDG. dBuV	QP LIMIT dBuV	AVG RDG dBuV	AVG LIMIT dBuV	NOTES
.249	32.7	61.8		51.8	
.468	37.3	56.5		46.5	
.704	32.4	56.0		46.0	
.732	30.6	56.0		46.0	
.986	28.2	56.0		46.0	
1.571	29.8	56.0		46.0	
2.001	29.6	56.0		46.0	
2.928	30.4	56.0		46.0	
3.338	31.1	56.0		46.0	
4.654	29.7	56.0		46.0	
4.671	29.7	56.0		46.0	
5.998	28.3	60.0		50.0	
8.847	27.6	60.0		50.0	
11.281	33.5	60.0		50.0	
11.532	32.5	60.0		50.0	
12.870	33.3	60.0		50.0	
13.383	33.4	60.0		50.0	
15.008	34.7	60.0		50.0	
17.296	35.6	60.0		50.0	
18.548	34.0	60.0		50.0	
21.056	31.6	60.0		50.0	
23.990	28.5	60.0		50.0	
27.826	28.8	60.0		50.0	

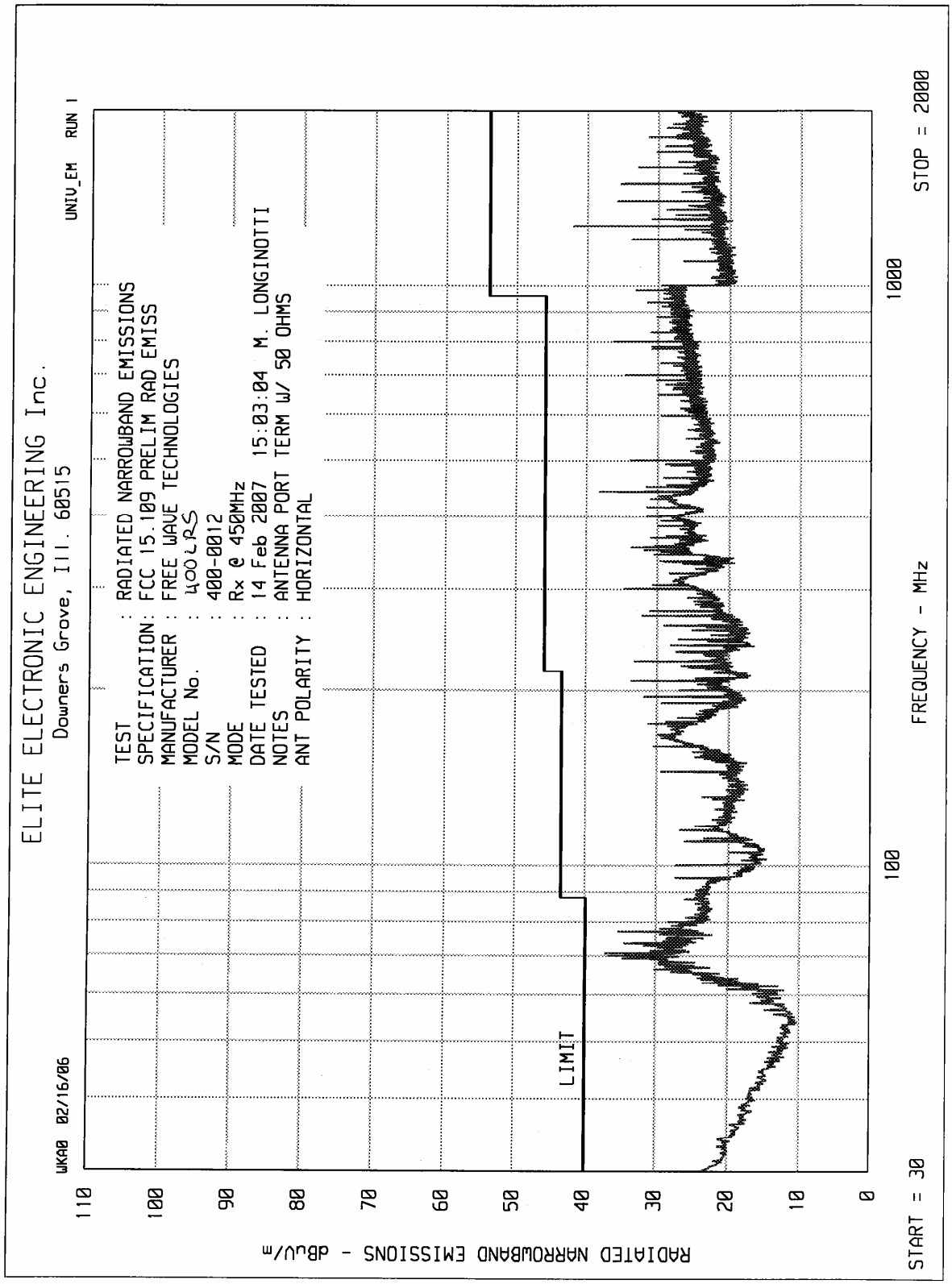
CHECKED BY: Mark E. Longinotti
M. LONGINOTTI

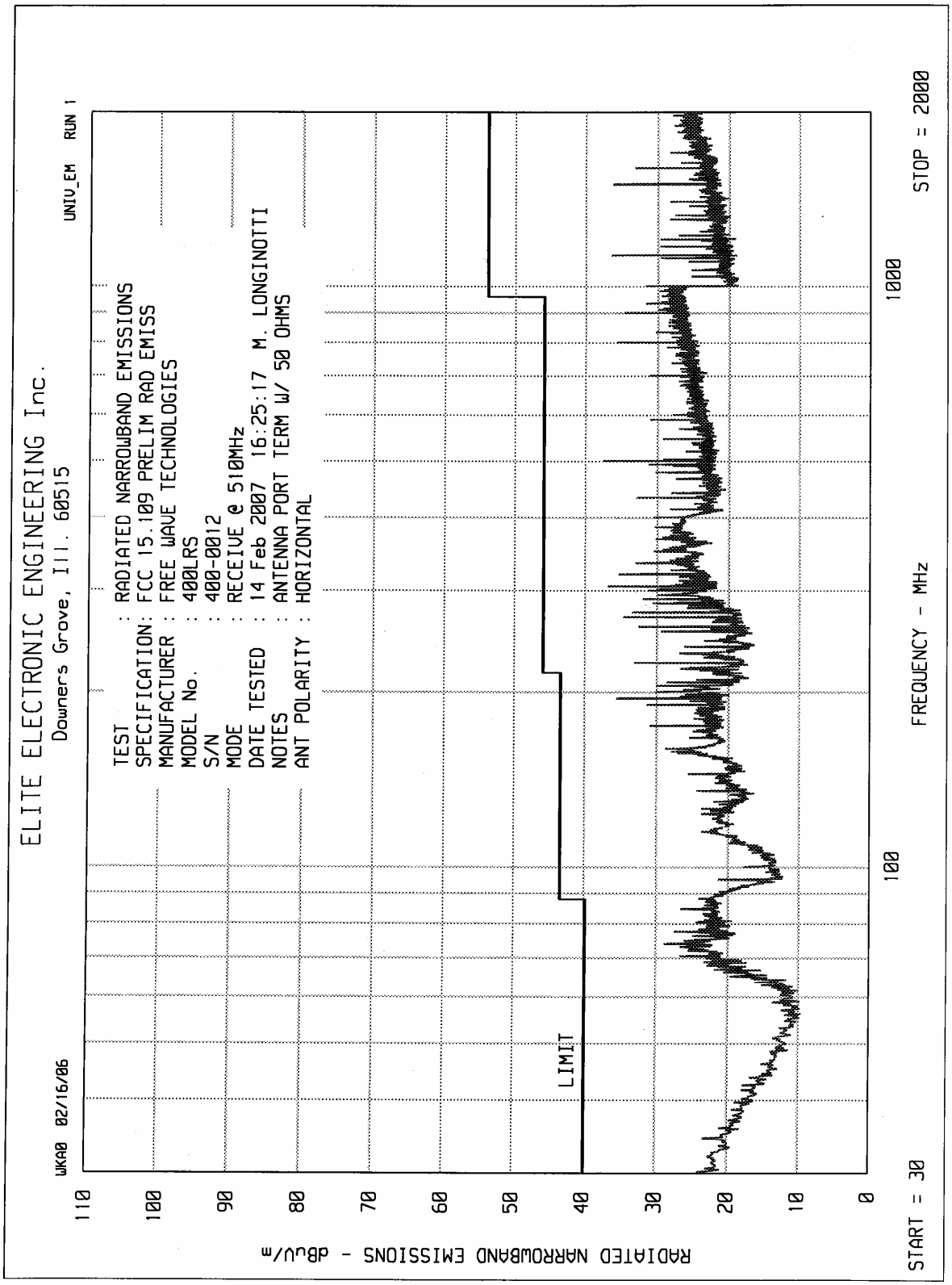

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15.111 ANTENNA CONDUCTED EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : Rx @ 421MHz
DATE TESTED : 14 Feb 2007 M. LONGINOTTI
LIMIT
NOTES :
PORT TESTED : ANTENNA
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15.111 ANTENNA CONDUCTED EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : Rx @ 450MHz
DATE TESTED : 14 Feb 2007 M. LONGINOTTI
LIMIT
NOTES :
PORT TESTED : ANTENNA
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15.111 ANTENNA CONDUCTED EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : Rx @ 510MHz
DATE TESTED : 14 Feb 2007 M LONGINOTTI
LIMIT
NOTES :
PORT TESTED : ANTENNA
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.109 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : RECEIVE @ 421MHz
DATE TESTED : 14 Feb 2007 16:07:06 M. LONGINOTTI
NOTES : ANTENNA PORT TERM W/ 50 OHMS
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.109 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : Rx @ 450MHz
DATE TESTED : 14 Feb 2007 15:03:04 M. LONGINOTTI
NOTES : ANTENNA PORT TERM W/ 50 OHMS
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.109 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0012
MODE : RECEIVE @ 510MHz
DATE TESTED : 14 Feb 2007 16:25:17 M. LONGINOTTI
NOTES : ANTENNA PORT TERM W/ 50 OHMS
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0012
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : February 14, 2007
NOTES : Receive at 421MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
287.75	H	15.3		1.3	13.5	0.0	30.0	31.7	200.0
287.75	V	13.7		1.3	13.5	0.0	28.4	26.4	200.0
575.50	H	6.1	Ambient	1.7	18.8	0.0	26.6	21.5	200.0
575.50	V	6.0	Ambient	1.7	18.8	0.0	26.5	21.2	200.0
863.25	H	4.9	Ambient	1.9	22.1	0.0	28.9	27.8	200.0
863.25	V	5.6	Ambient	1.9	22.1	0.0	29.6	30.1	200.0
1151.00	H	56.7		2.2	26.2	-37.1	48.0	250.7	500.0
1151.00	V	55.1		2.2	26.2	-37.1	46.4	208.6	500.0
1438.75	H	50.6		2.5	26.6	-36.8	43.0	140.7	500.0
1438.75	V	49.7		2.5	26.6	-36.8	42.1	126.9	500.0
1726.50	H	46.3	Ambient	2.8	27.7	-36.4	40.4	104.5	500.0
1726.50	V	45.7	Ambient	2.8	27.7	-36.4	39.8	97.5	500.0

V - Vertical

H - Horizontal

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0012
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : February 14, 2007
NOTES : Receive at 450MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
316.74	H	10.5		1.3	14.2	0.0	26.0	20.0	200.0
316.74	V	11.9		1.3	14.2	0.0	27.4	23.4	200.0
633.48	H	5.6	Ambient	1.8	19.7	0.0	27.1	22.5	200.0
633.48	V	11.6		1.8	19.7	0.0	33.1	44.9	200.0
950.22	H	6.2	Ambient	2.0	22.9	0.0	31.1	35.8	200.0
950.22	V	5.8	Ambient	2.0	22.9	0.0	30.7	34.2	200.0
1266.96	H	56.9		2.3	26.4	-36.9	48.7	270.7	500.0
1266.96	V	58.2		2.3	26.4	-36.9	50.0	314.4	500.0
1583.70	H	46.6	Ambient	2.7	27.1	-36.6	39.8	97.2	500.0
1583.70	V	47.3	Ambient	2.7	27.1	-36.6	40.5	105.4	500.0
1900.44	H	45.6	Ambient	2.9	28.4	-36.2	40.7	108.6	500.0
1900.44	V	46.1	Ambient	2.9	28.4	-36.2	41.2	115.0	500.0

V - Vertical

H - Horizontal

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0012
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : February 14, 2007
NOTES : Receive at 510MHz
: Test Distance is 3 meters

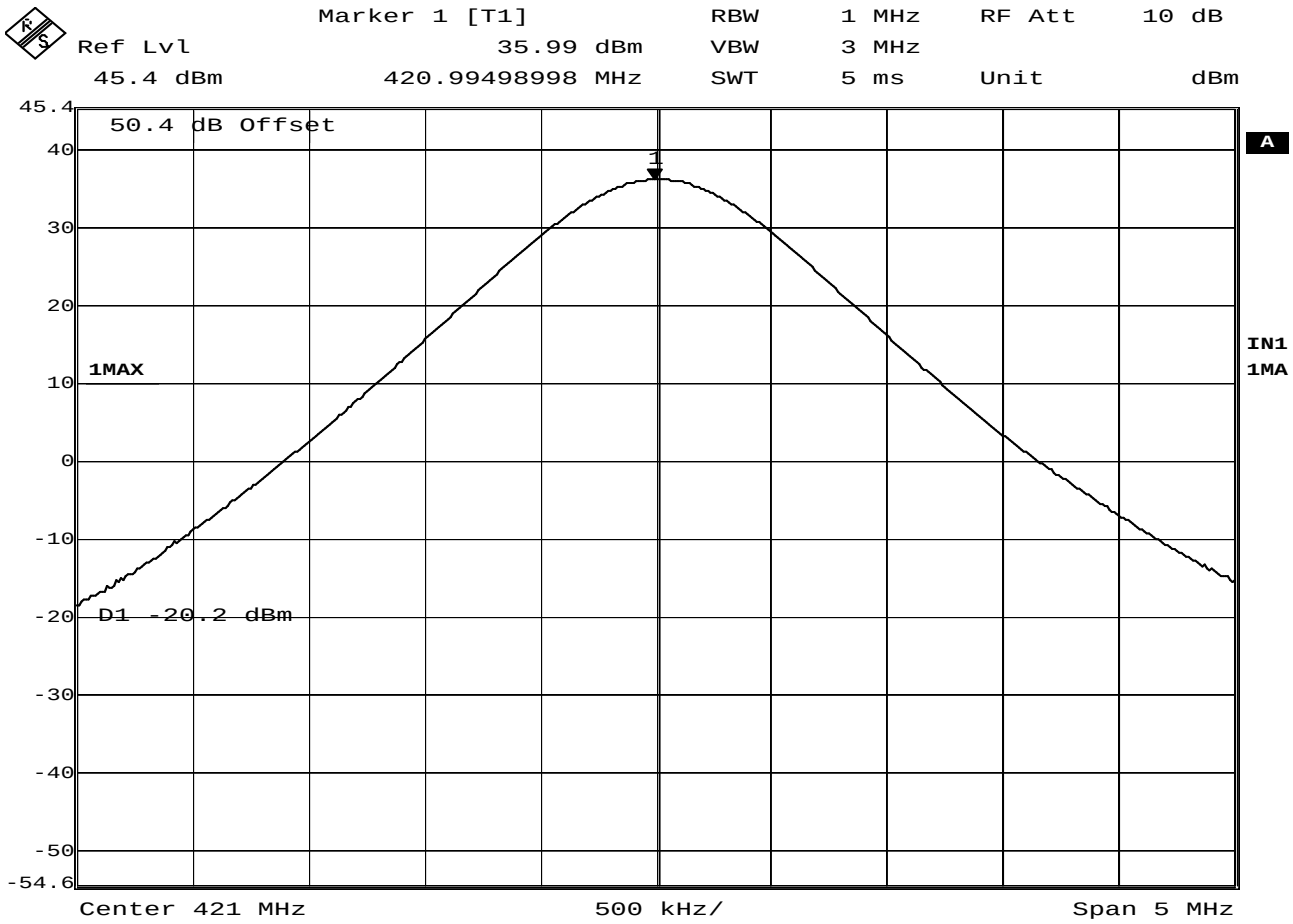
Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
376.73	H	17.5		1.5	15.7	0.0	34.7	54.3	200.0
376.73	V	13.3		1.5	15.7	0.0	30.5	33.5	200.0
753.46	H	5.7	Ambient	1.8	20.7	0.0	28.3	26.0	200.0
753.46	V	8.0	Ambient	1.8	20.7	0.0	30.6	33.8	200.0
1130.19	H	52.2		2.2	23.8	-37.1	41.1	112.9	200.0
1130.19	V	49.6		2.2	23.8	-37.1	38.5	83.7	200.0
1506.92	H	57.2		2.6	26.7	-36.7	49.8	309.8	500.0
1506.92	V	56.2		2.6	26.7	-36.7	48.8	276.1	500.0
1883.65	H	46.2	Ambient	2.9	28.3	-36.2	41.2	115.0	500.0
1883.65	V	46.8	Ambient	2.9	28.3	-36.2	41.8	123.3	500.0

V - Vertical

H - Horizontal

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

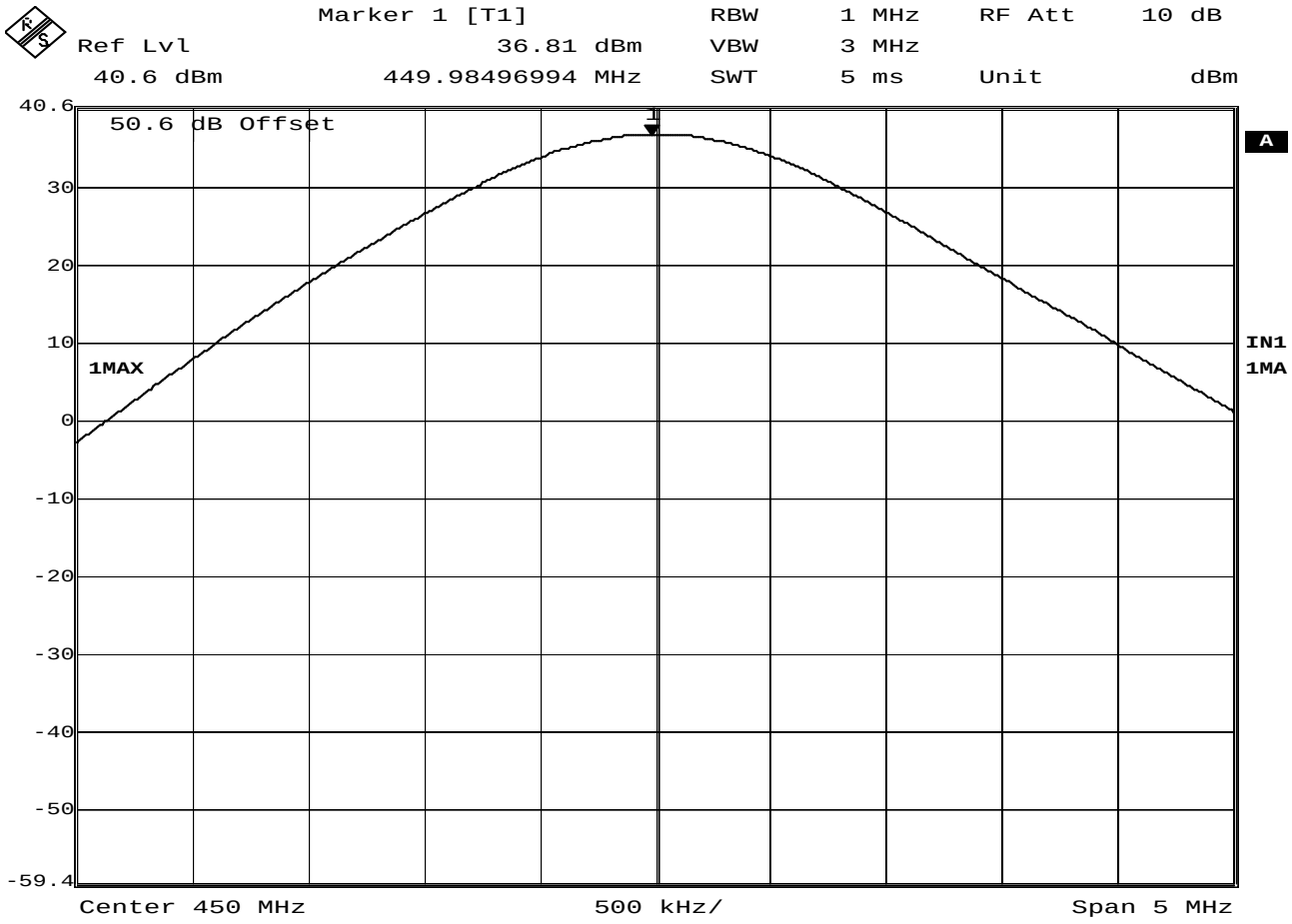
Checked By: MARK E. LONGINOTTI



FCC Part 90 Peak Output Power

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 421MHz
TEST PARAMETERS : Peak Output Power
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

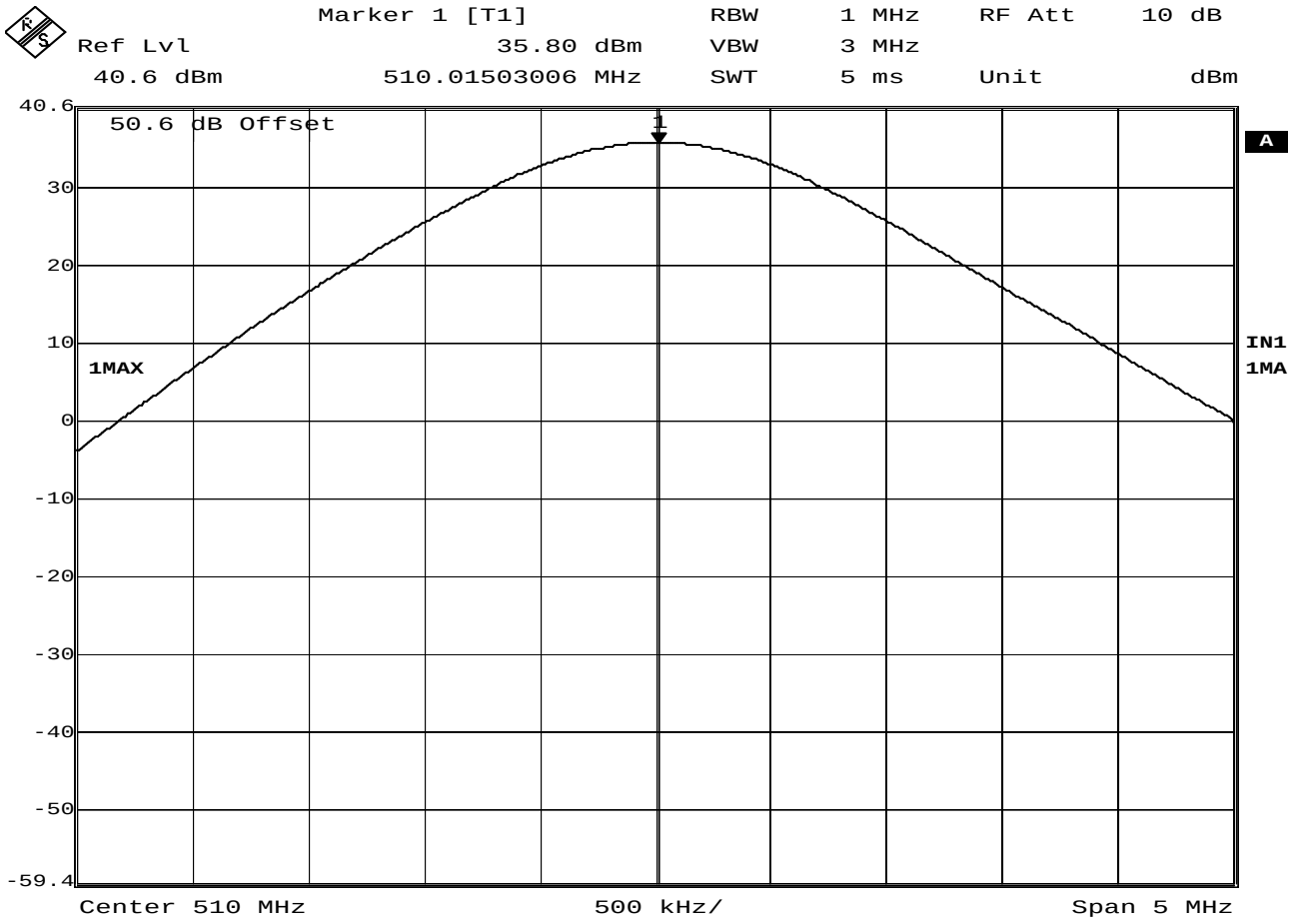
NOTES



FCC Part 90 Peak Output Power

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 450MHz
TEST PARAMETERS : Peak Output Power
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES



Date: 26.FEB.2007 16:26:48

FCC Part 90 Peak Output Power

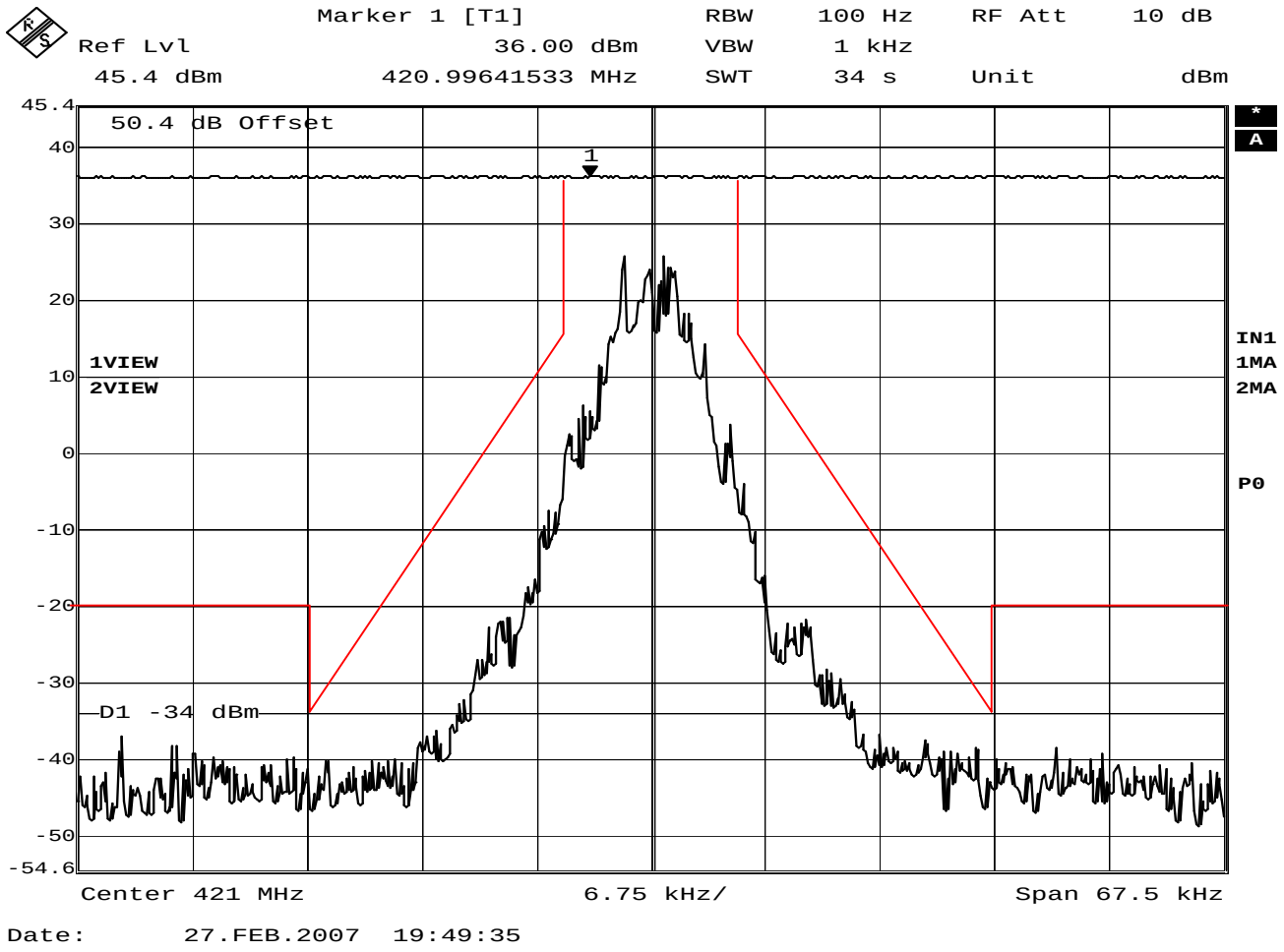
MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 510MHz
TEST PARAMETERS : Peak Output Power
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES

MANUFACTURER : Free Wave Technologies
MODEL : 400-0019
SERIAL NO. : See Below
SPECIFICATION : FCC 90.205 Power Output
DATE : February 26, 2007

Frequency MHz	Measured Output Power dBm	Measured Output Power Watts	Manufacturer's Rated Power Watts	Manufacturer's Rated Power + 20% Watts
421	35.99	3.97	4.0	4.8
450	36.81	4.80	5.0	6.0
510	35.80	3.80	4.0	4.8

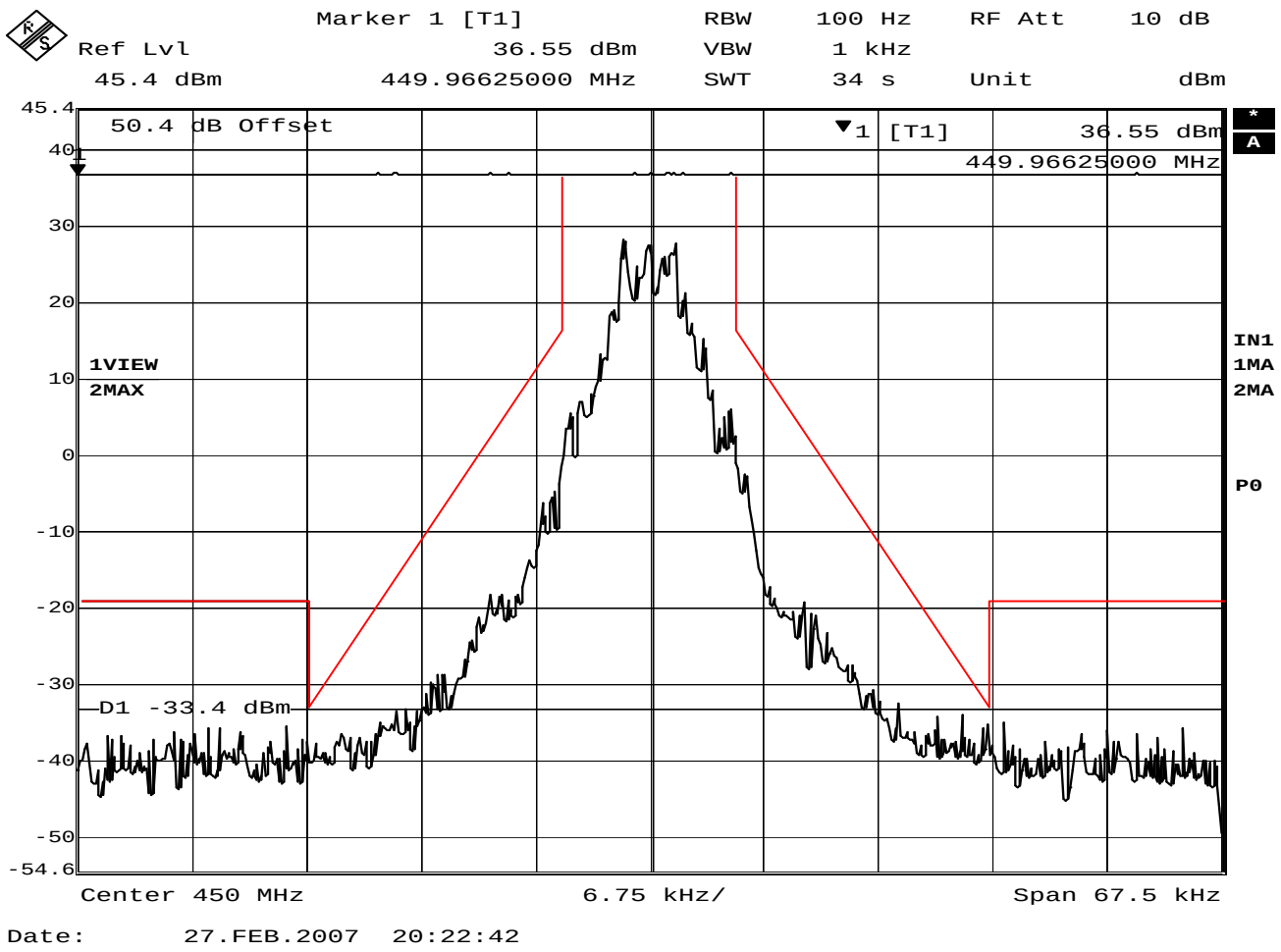
Checked By: MARK E. LONGINOTTI



FCC Part 90 Occupied Bandwidth

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 421MHz
TEST PARAMETERS : Occupied Bandwidth
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

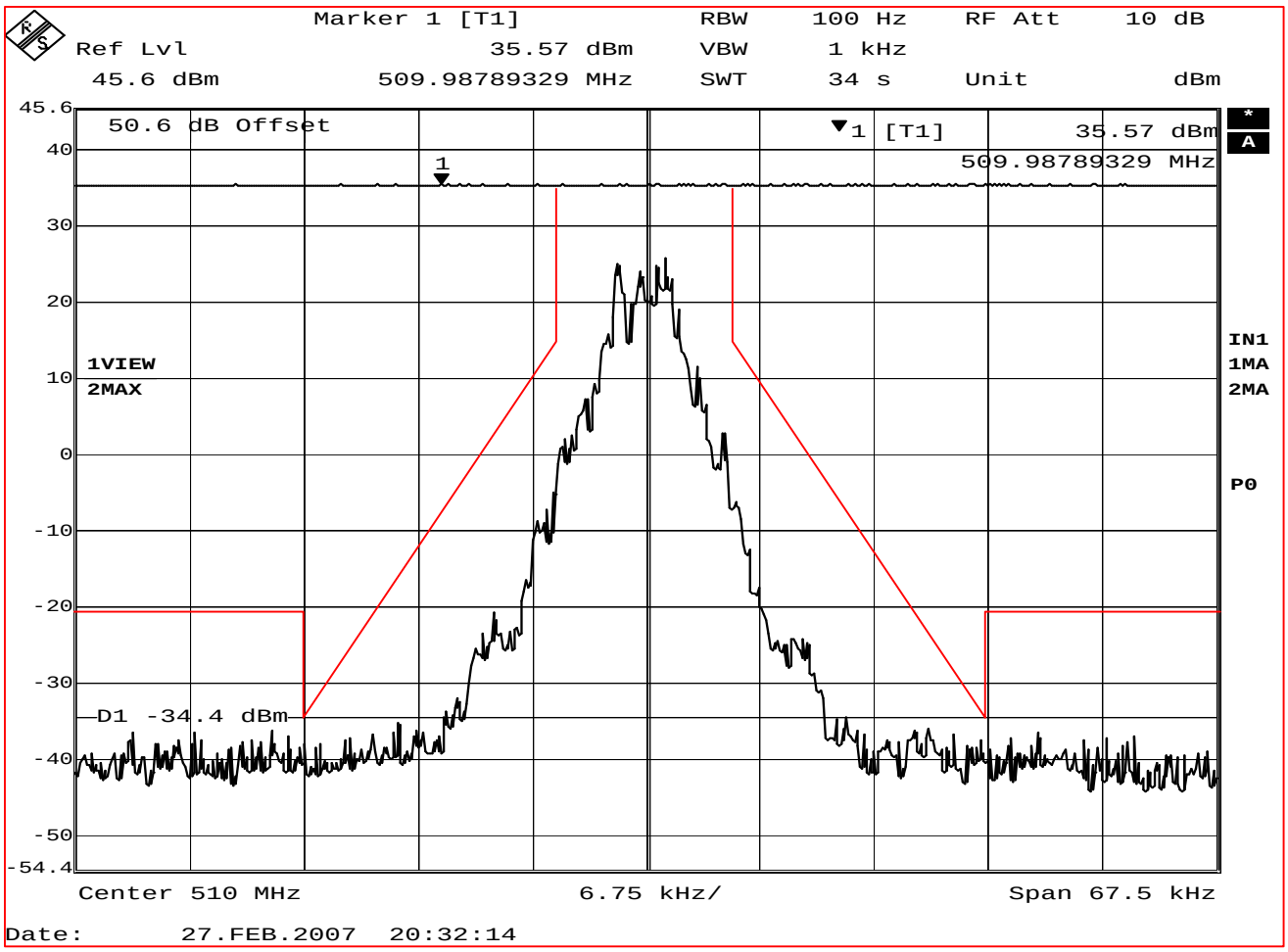
NOTES



FCC Part 90 Occupied Bandwidth

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 450MHz
TEST PARAMETERS : Occupied Bandwidth
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

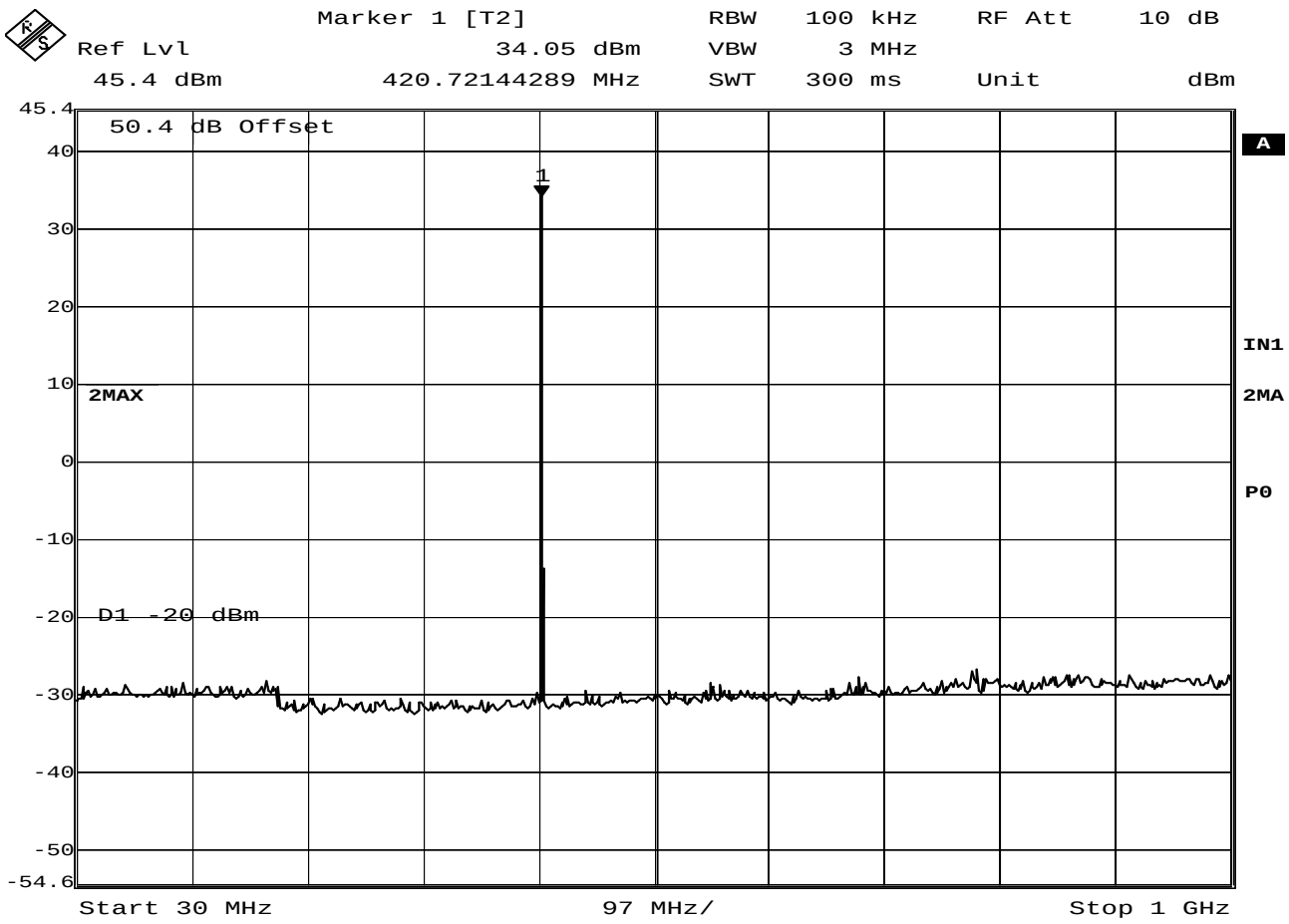
NOTES



FCC Part 90 Occupied Bandwidth

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 510MHz
TEST PARAMETERS : Occupied Bandwidth
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

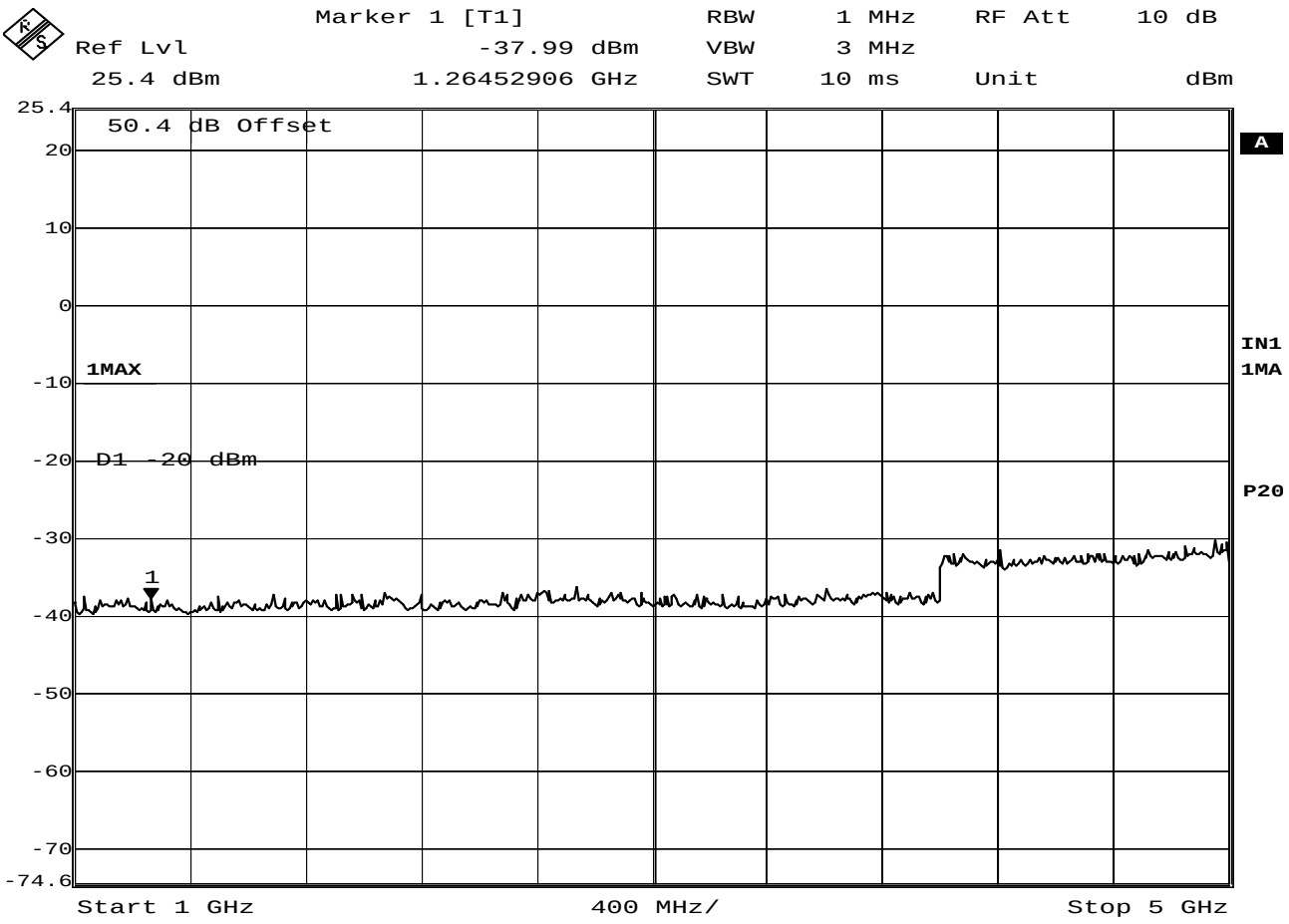
NOTES



FCC Part 90 Antenna Conducted Emissions

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 421MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES

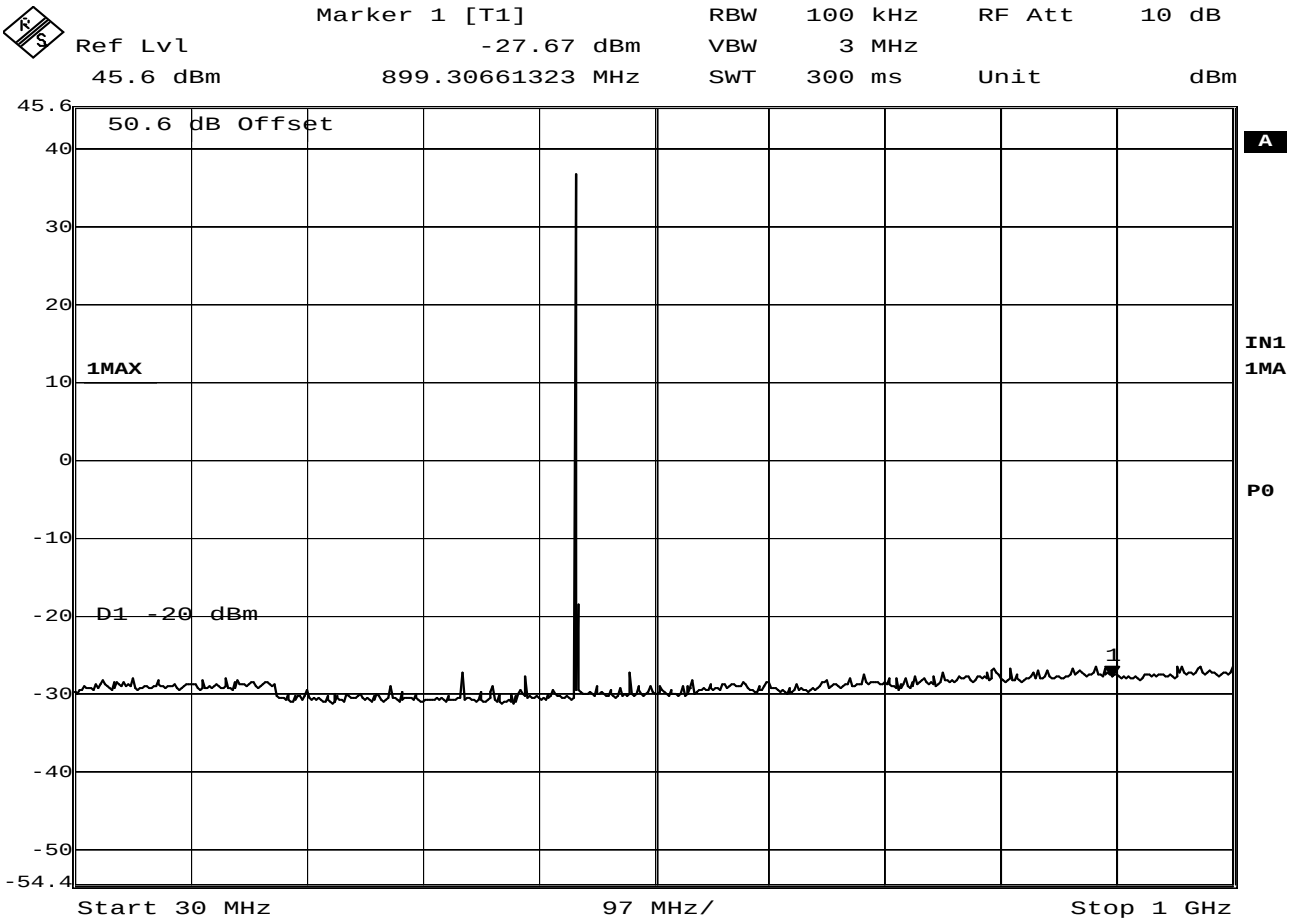


Date: 26.FEB.2007 18:07:30

FCC Part 90 Antenna Conducted Emissions

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 421MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES

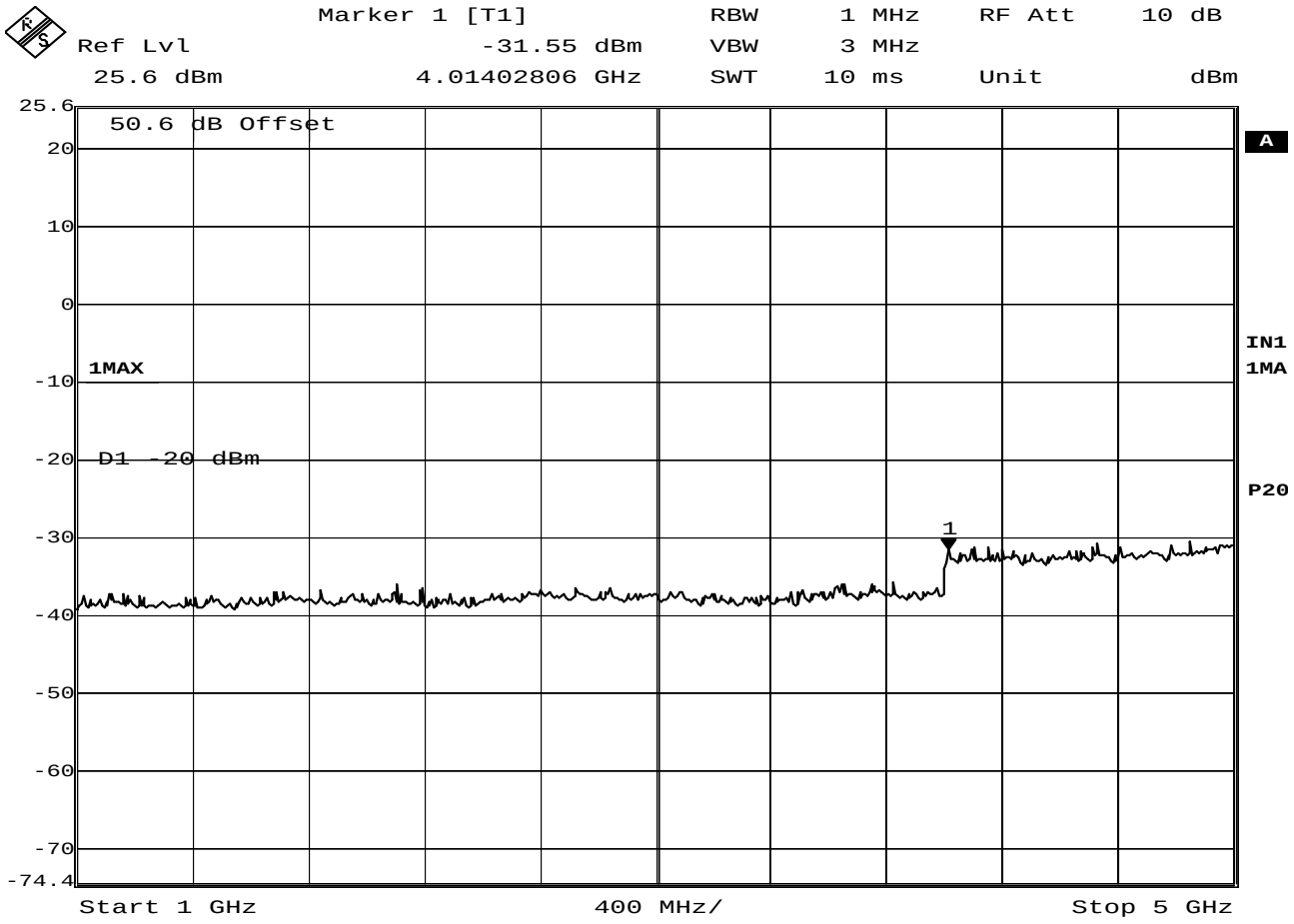


Date: 26.FEB.2007 16:59:33

FCC Part 90 Antenna Conducted Emissions

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 450MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES

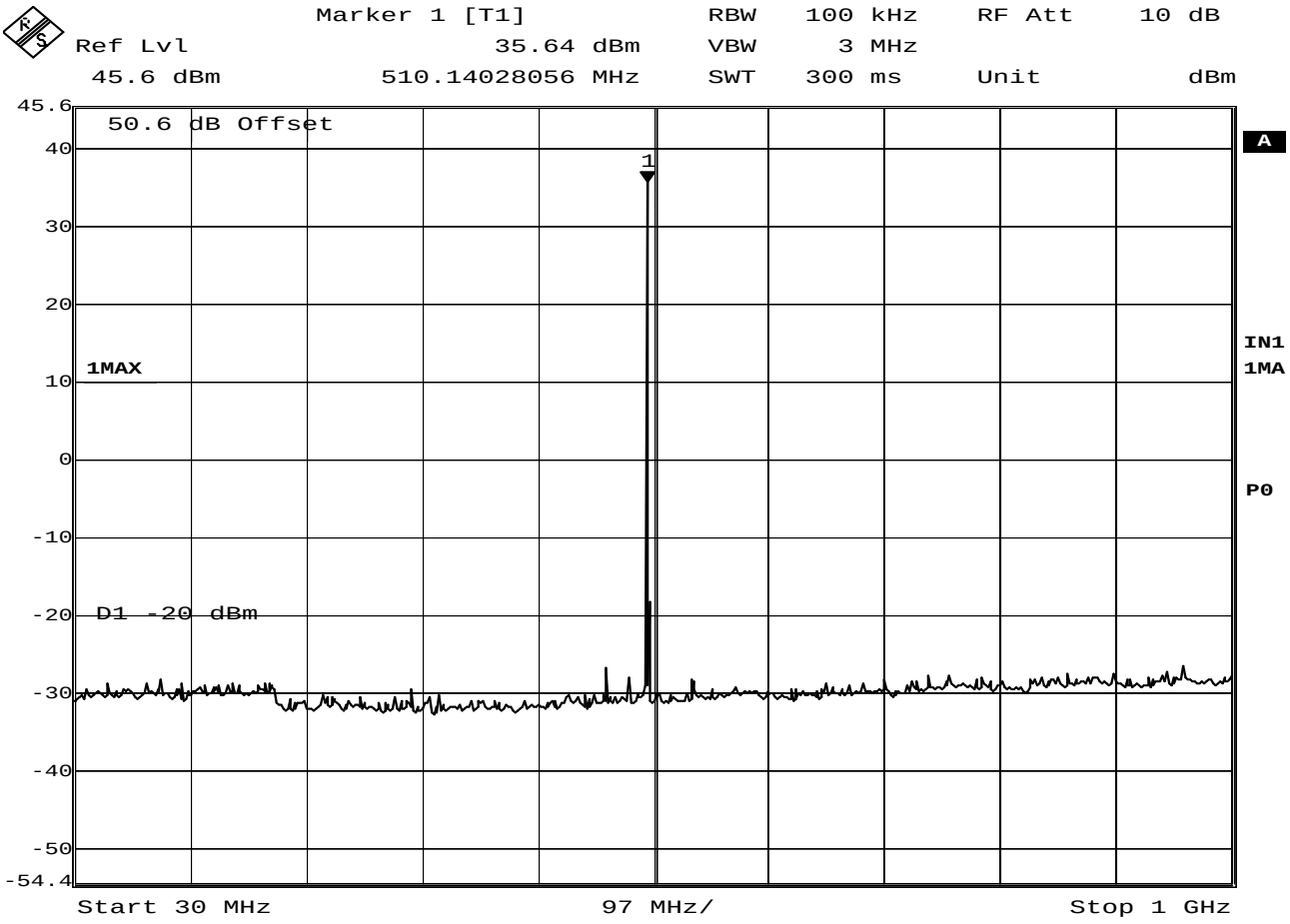


Date: 26.FEB.2007 17:03:30

FCC Part 90 Antenna Conducted Emissions

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0017
TEST MODE : Transmit @ 450MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBA0,T1E8,T2DA,T2DJ

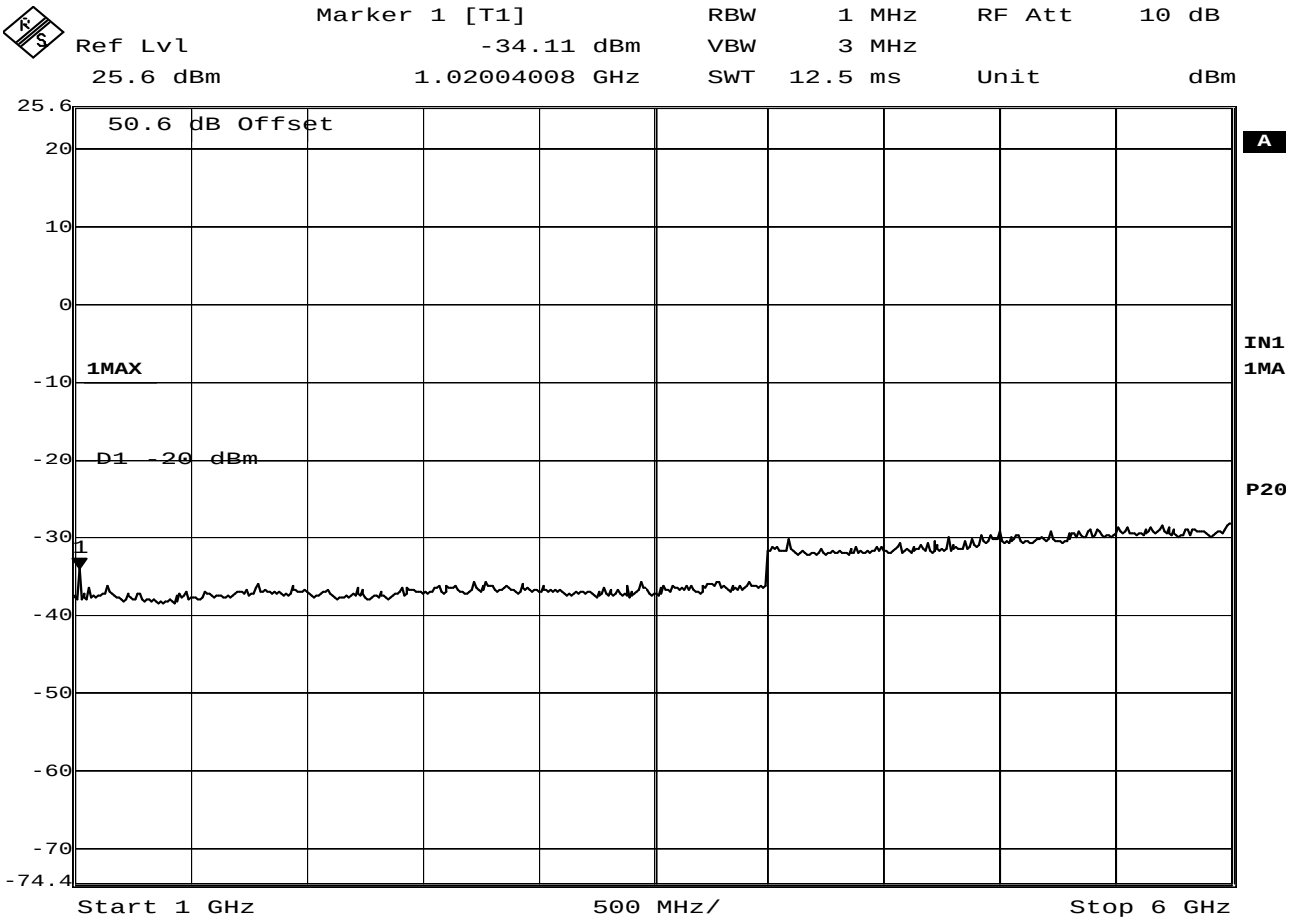
NOTES



FCC Part 90 Antenna Conducted Emissions

MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0017
TEST MODE : Transmit @ 510MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

NOTES

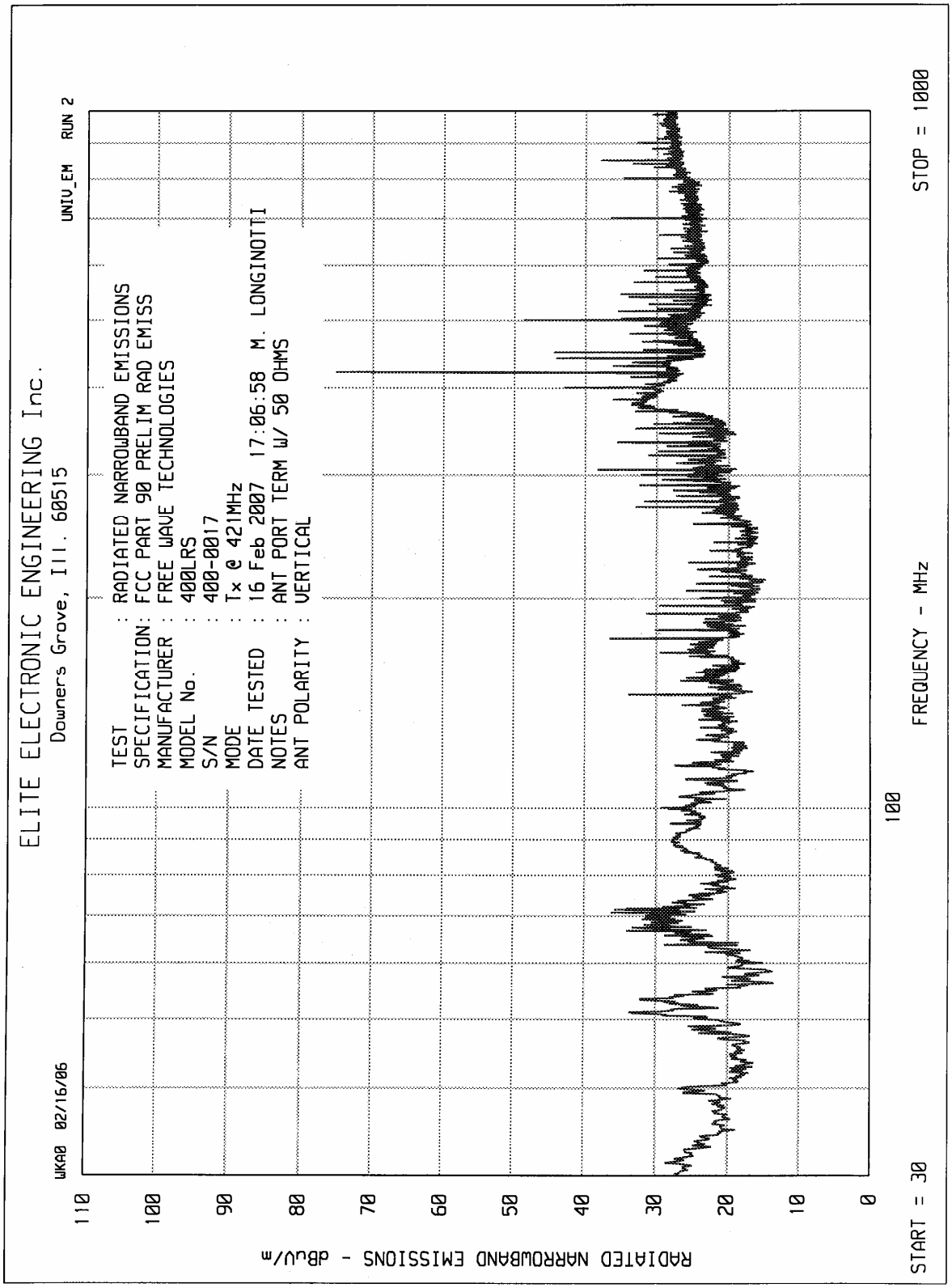


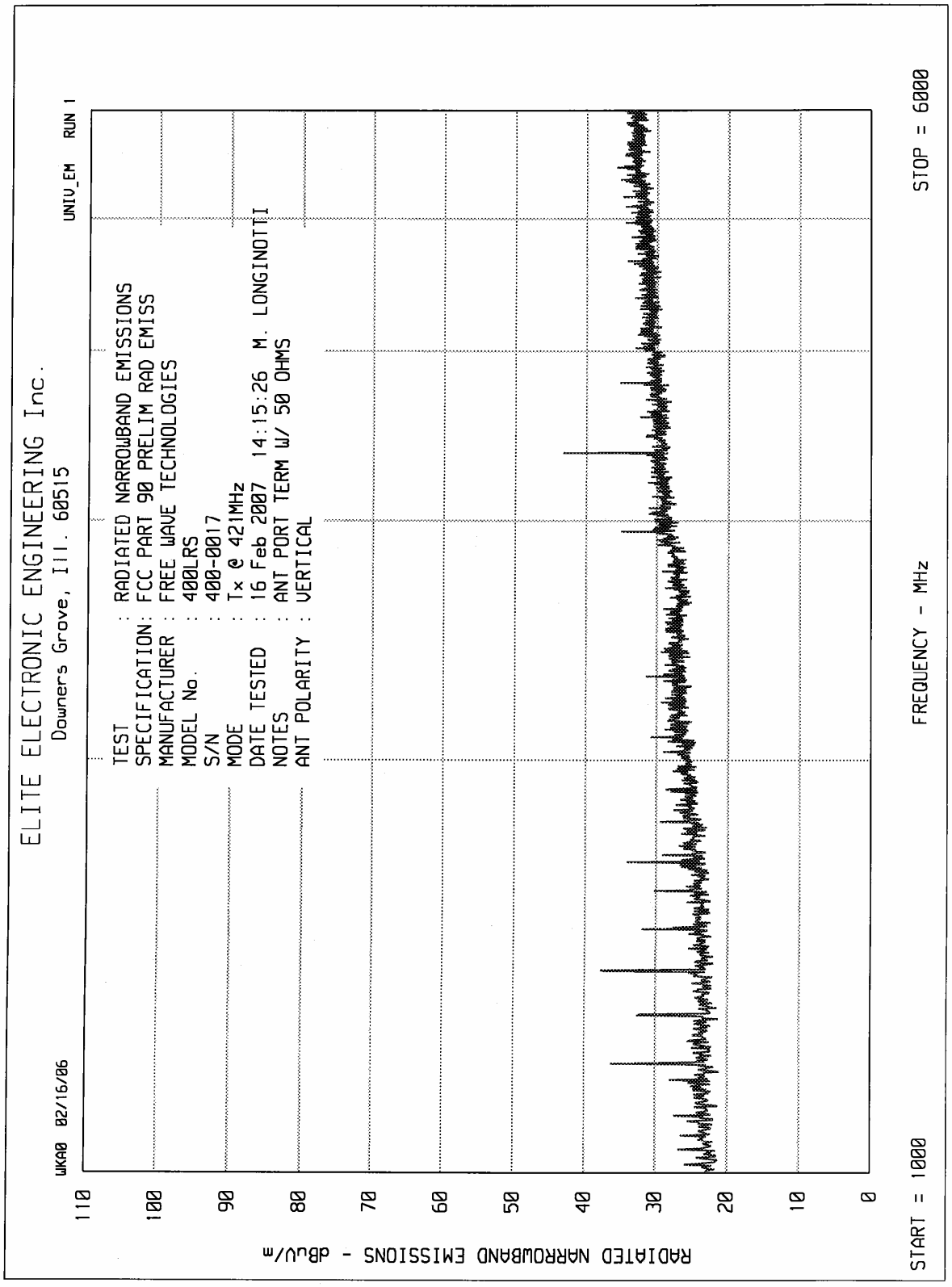
Date: 26.FEB.2007 16:52:52

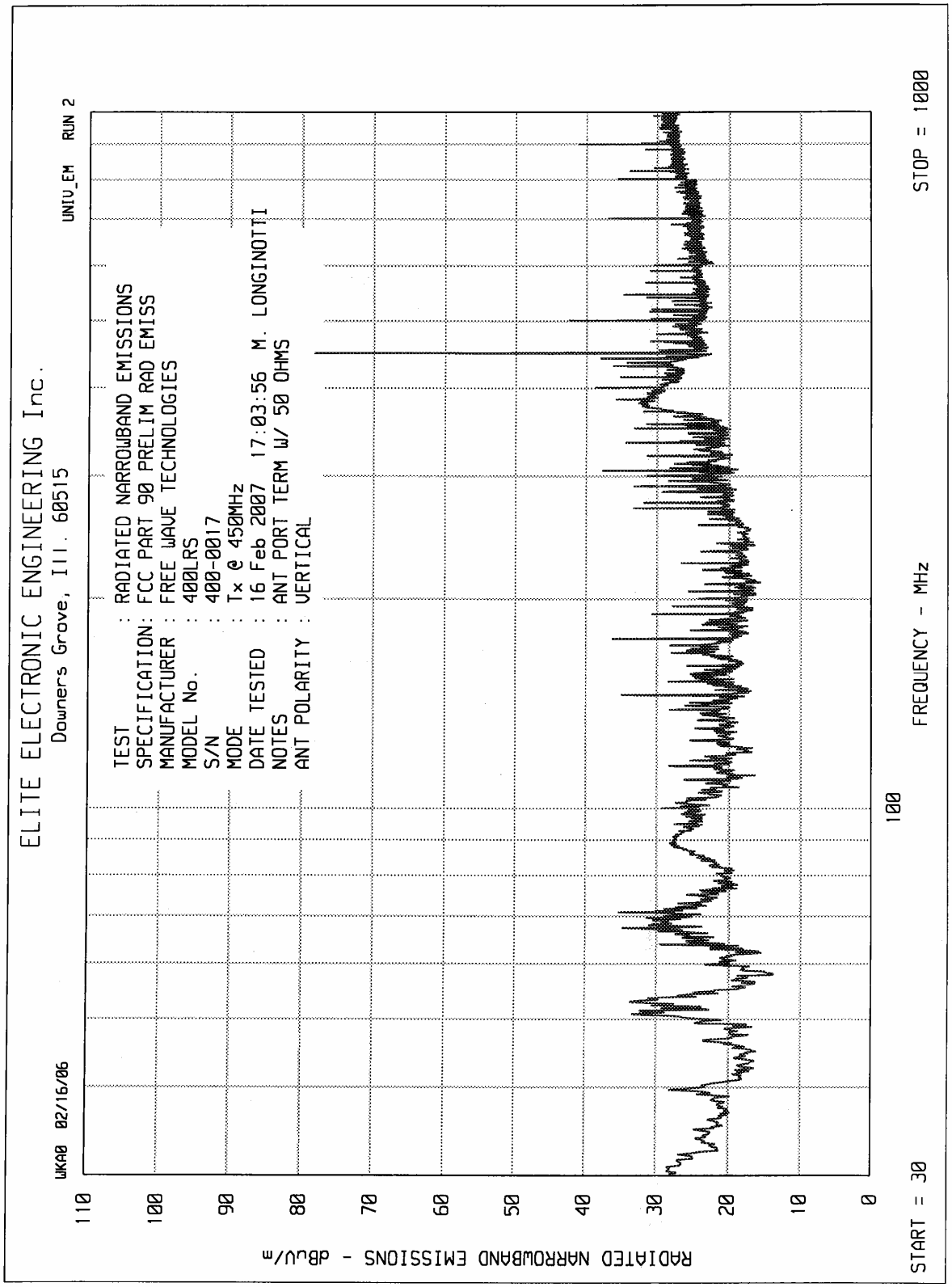
FCC Part 90 Antenna Conducted Emissions

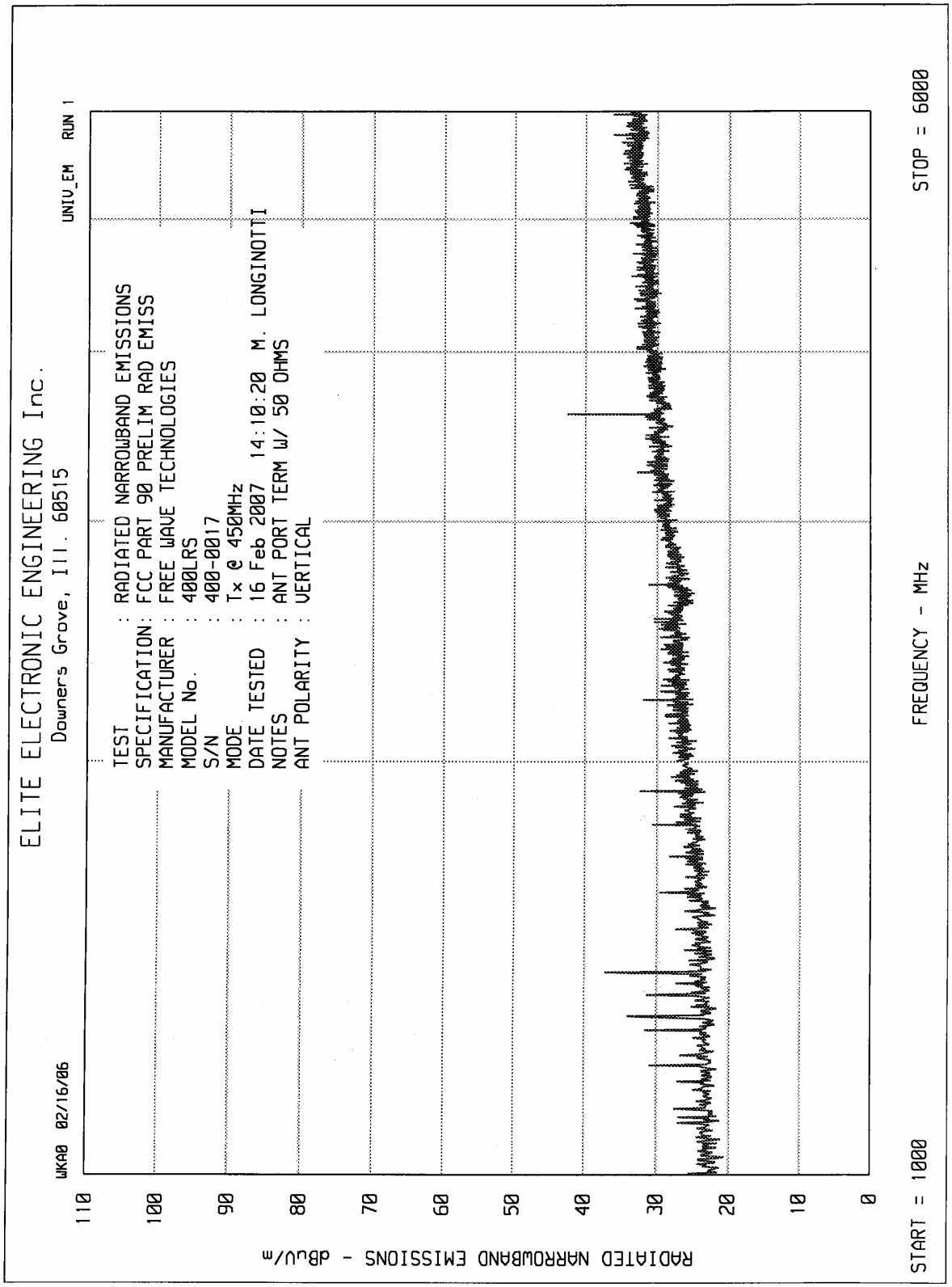
MANUFACTURER : Free Wave
MODEL NUMBER : 400LRS
SERIAL NUMBER : 400-0019
TEST MODE : Transmit @ 510MHz
TEST PARAMETERS : Antenna Conducted Emissions
NOTES :
EQUIPMENT USED : RBB0,T1E8,T2DA,T2DJ

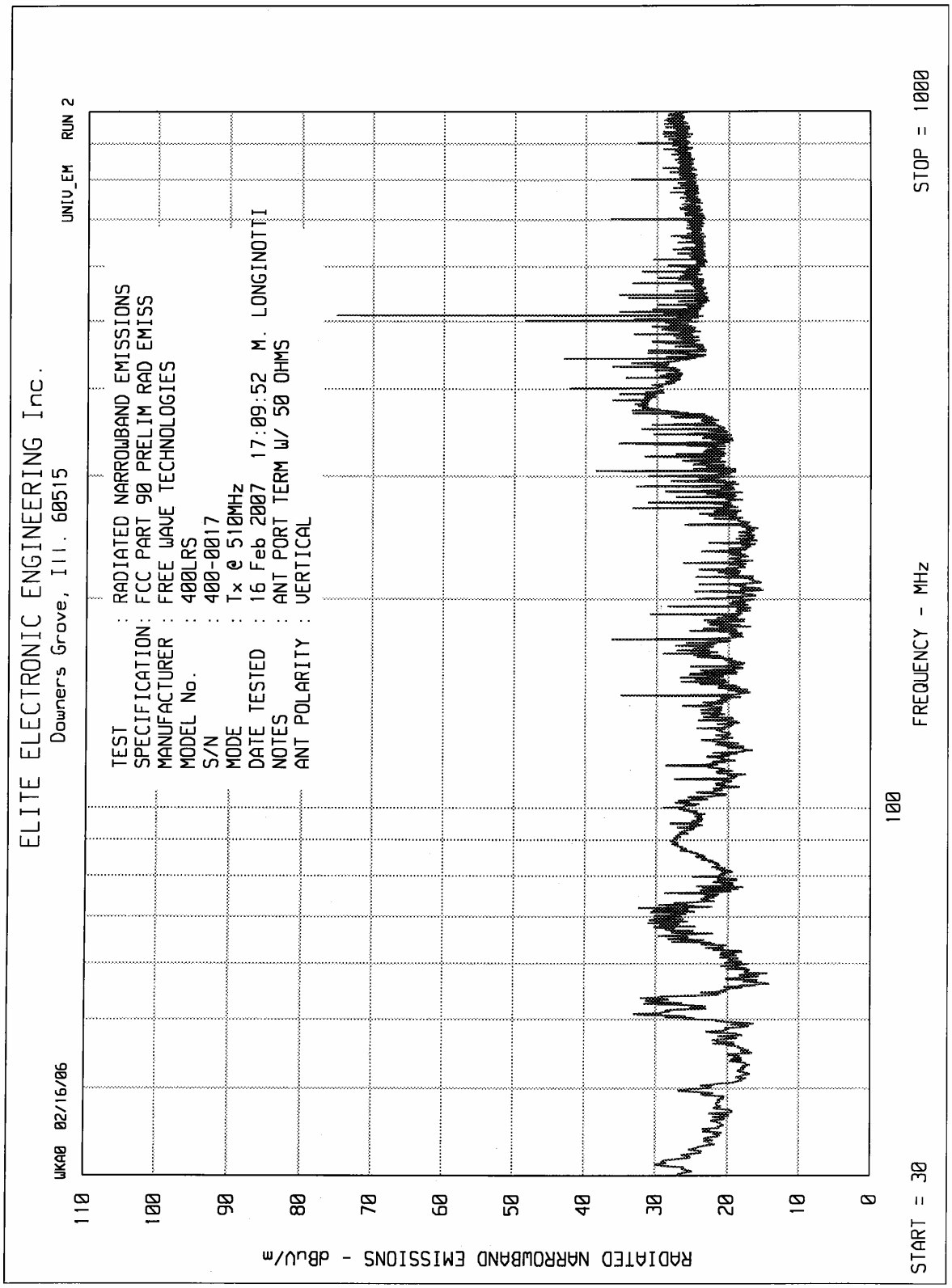
NOTES

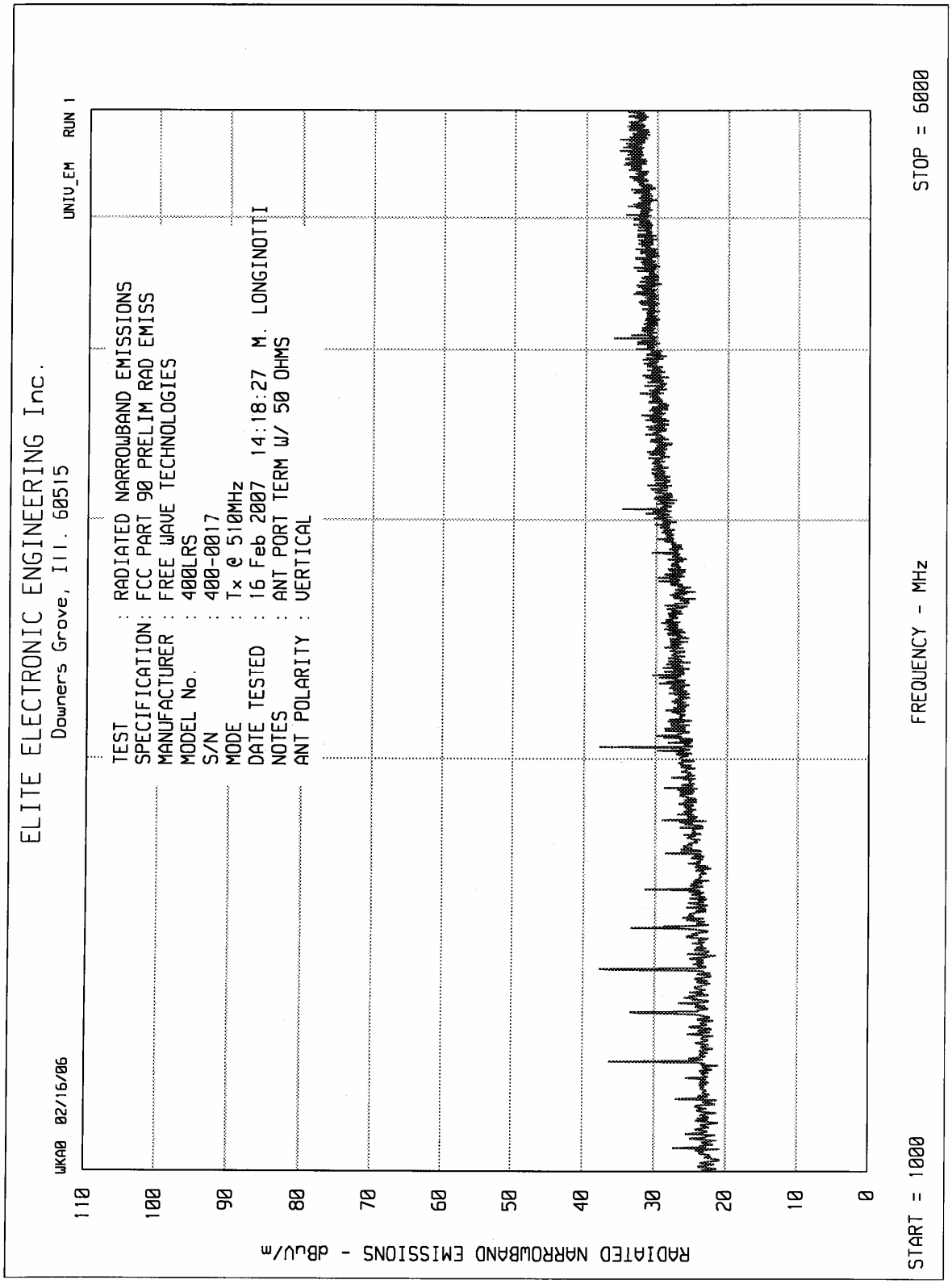

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
UKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 421MHz
DATE TESTED : 16 Feb 2007 17:06:58 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 421MHz
DATE TESTED : 16 Feb 2007 14:15:26 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 450MHz
DATE TESTED : 16 Feb 2007 17:03:56 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 450MHz
DATE TESTED : 16 Feb 2007 14:10:20 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 510MHz
DATE TESTED : 16 Feb 2007 17:09:52 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 90 PRELIM RAD EMISS
MANUFACTURER : FREE WAVE TECHNOLOGIES
MODEL No. : 400LRS
S/N : 400-0017
MODE : Tx @ 510MHz
DATE TESTED : 16 Feb 2007 14:18:27 M. LONGINOTTI
NOTES : ANT PORT TERM W/ 50 OHMS
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 6000

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0017
SPECIFICATION : FCC Part 90 Spurious Radiated Emissions
DATE : February 16, 2007
NOTES : Transmit at 421MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV		Matched Signal dBm	Cable Loss dB	Antenna Gain dB	ERP dBm	Limit dBm
842	H	9.7		-59.4	6.6	0.0	-66.0	-20
842	V	13.7		-53.2	6.6	0.0	-59.8	-20
1263	H	15.2		-60.3	2.0	4.6	-57.7	-20
1263	V	15.0		-61.1	2.0	4.6	-58.5	-20
1684	H	15.6		-59.6	2.3	5.7	-56.2	-20
1684	V	15.2		-60.0	2.3	5.7	-56.6	-20
2105	H	15.9		-59.0	2.6	5.9	-55.7	-20
2105	V	16.5		-56.9	2.6	5.9	-53.6	-20
2526	H	15.3		-57.0	2.9	6.3	-53.6	-20
2526	V	14.7		-56.0	2.9	6.3	-52.6	-20
2947	H	14.6		-56.9	3.2	6.3	-53.8	-20
2947	V	15.5		-54.4	3.2	6.3	-51.3	-20
3368	H	17.1		-52.1	3.4	6.6	-48.9	-20
3368	V	19.5		-47.2	3.4	6.6	-44.0	-20
3789	H	17.3		-51.9	3.6	6.9	-48.5	-20
3789	V	15.1		-52.3	3.6	6.9	-48.9	-20
4210	H	15.6		-52.9	3.8	7.6	-49.0	-20
4210	V	16.0		-50.2	3.8	7.6	-46.3	-20

ERP = matched signal + antenna gain - cable loss
limit = power (dBm) - (50+ 10*log(Power in watts))

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0017
SPECIFICATION : FCC Part 90 Spurious Radiated Emissions
DATE : February 16, 2007
NOTES : Transmit at 450MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV		Matched Signal dBm	Cable Loss dB	Antenna Gain dB	ERP dBm	Limit dBm
900	H	14.3		-53.0	6.9	0.0	-59.9	-20
900	V	16.7		-48.7	6.9	0.0	-55.6	-20
1350	H	15.0		-60.1	2.1	5.0	-57.1	-20
1350	V	17.7		-56.8	2.1	5.0	-53.8	-20
1800	H	17.7		-55.6	2.4	5.7	-52.2	-20
1800	V	27.9		-44.8	2.4	5.7	-41.4	-20
2250	H	13.6		-60.8	2.7	6.0	-57.5	-20
2250	V	14.4		-57.7	2.7	6.0	-54.4	-20
2700	H	14.9		-59.0	3.0	6.3	-55.7	-20
2700	V	15.4		-56.2	3.0	6.3	-52.9	-20
3150	H	15.6		-54.4	3.3	6.4	-51.3	-20
3150	V	17.1		-50.9	3.3	6.4	-47.8	-20
3600	H	16.7		-52.9	3.5	6.8	-49.6	-20
3600	V	18.7		-48.3	3.5	6.8	-45.0	-20
4050	H	15.8		-53.2	3.7	7.2	-49.7	-20
4050	V	14.9		-52.5	3.7	7.2	-49.0	-20
4500	H	14.5		-53.1	3.9	8.4	-48.6	-20
4500	V	15.1		-51.8	3.9	8.4	-47.3	-20

ERP = matched signal + antenna gain - cable loss
limit = power (dBm) - (50+ 10*log(Power in watts))

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0017
SPECIFICATION : FCC Part 90 Spurious Radiated Emissions
DATE : February 16, 2007
NOTES : Transmit at 510MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV		Matched Signal dBm	Cable Loss dB	Antenna Gain dB	ERP dBm	Limit dBm
1020	H	18.9		-55.4	1.8	3.3	-53.9	-20
1020	V	22.0		-53.4	1.8	3.3	-51.9	-20
1530	H	16.3		-59.9	2.2	5.7	-56.4	-20
1530	V	18.4		-58.1	2.2	5.7	-54.6	-20
2040	H	18.2		-55.5	2.5	5.8	-52.2	-20
2040	V	17.9		-55.0	2.5	5.8	-51.7	-20
2550	H	15.3		-58.1	2.9	6.3	-54.7	-20
2550	V	15.1		-56.0	2.9	6.3	-52.6	-20
3060	H	19.1		-51.6	3.2	6.3	-48.5	-20
3060	V	19.5		-47.6	3.2	6.3	-44.5	-20
3570	H	16.1		-53.5	3.5	6.8	-50.2	-20
3570	V	16.1		-51.5	3.5	6.8	-48.2	-20
4080	H	15.5		-53.7	3.7	7.3	-50.1	-20
4080	V	16.2		-51.1	3.7	7.3	-47.5	-20
4590	H	15.7		-50.5	4.0	8.3	-46.2	-20
4590	V	15.4		-51.5	4.0	8.3	-47.2	-20
5100	H	16.6		-46.6	4.2	7.3	-43.5	-20
5100	V	16.0		-49.0	4.2	7.3	-45.9	-20

ERP = matched signal + antenna gain - cable loss
limit = power (dBm) - (50+ 10*log(Power in watts))

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Temperature
DATE : February 26 and 27, 2007
EQUIPMENT USED : ETC0, T2DJ,T2DA, T1E8, MFC0
NOTES : Transmit at 421MHz

Temperature °C	Measured Frequency Hz	Frequency Error Hz	Limit Hz
+23	420,999,918		
-30	420,999,349	569	631.5
-20	420,999,521	397	631.5
-10	420,999,766	152	631.5
0	420,999,919	1	631.5
+10	420,999,925	7	631.5
+20	420,999,916	2	631.5
+30	420,999,898	20	631.5
+40	421,000,038	120	631.5
+50	421,000,210	292	631.5

Limit = 1.5ppm = 420,999,918Hz * 1.5ppm = 631.5Hz

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Voltage
DATE : February 27, 2007
EQUIPMENT USED : SBA1, T2DJ,T2DA, T1E8, MFC0
NOTES : Transmit at 421MHz

Supply Voltage VDC	Measured Frequency Hz	Frequency Error Hz	Limit Hz
10.2 (85%)	421,000,151	30	631.5
12.0	421,000,081		631.5
13.8 (115%)	421,000,180	99	631.5

Limit = 1.5ppm = 420,999,918Hz * 1.5ppm = 631.5Hz

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Temperature
DATE : February 26 and 27, 2007
EQUIPMENT USED : ETC0, T2DJ,T2DA, T1E8, MFC0
NOTES : Transmit at 450MHz

Temperature °C	Measured Frequency Hz	Frequency Error Hz	Limit Hz
+23	449,999,900		
-30	449,999,290	610	675
-20	449,999,457	443	675
-10	449,999,782	118	675
0	449,999,866	34	675
+10	449,999,907	7	675
+20	449,999,900	0	675
+30	449,999,874	26	675
+40	450,000,043	143	675
+50	450,000,220	320	675

Limit = 1.5ppm = 449,999,900* 1.5ppm = 675Hz

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Voltage
DATE : February 27, 2007
EQUIPMENT USED : SBA1, T2DJ,T2DA, T1E8, MFC0
NOTES : Transmit at 450MHz

Supply Voltage VDC	Measured Frequency Hz	Frequency Error Hz	Limit Hz
10.2(85%)	450,000,210	60	675
12.0	450,000,150		675
13.8(115%)	450,000,219	69	675

Limit = 1.5ppm = 449,999,900* 1.5ppm = 675Hz

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Temperature
DATE : February 26 and 27, 2007
EQUIPMENT USED : ETC0, T2DJ,T2DA, T1E8, MFC0
NOTES : Transmit at 510MHz

Temperature °C	Measured Frequency Hz	Frequency Error Hz	Limit Hz
+23	509,999,908		
-30	509,999,250	658	765
-20	509,999,217	691	765
-10	509,999,708	200	765
0	509,999,866	42	765
+10	509,999,910	2	765
+20	509,999,903	5	765
+30	509,999,866	42	765
+40	509,999,983	75	765
+50	510,000,261	353	765

Limit = 1.5ppm = 509,999,908Hz * 1.5ppm = 765Hz

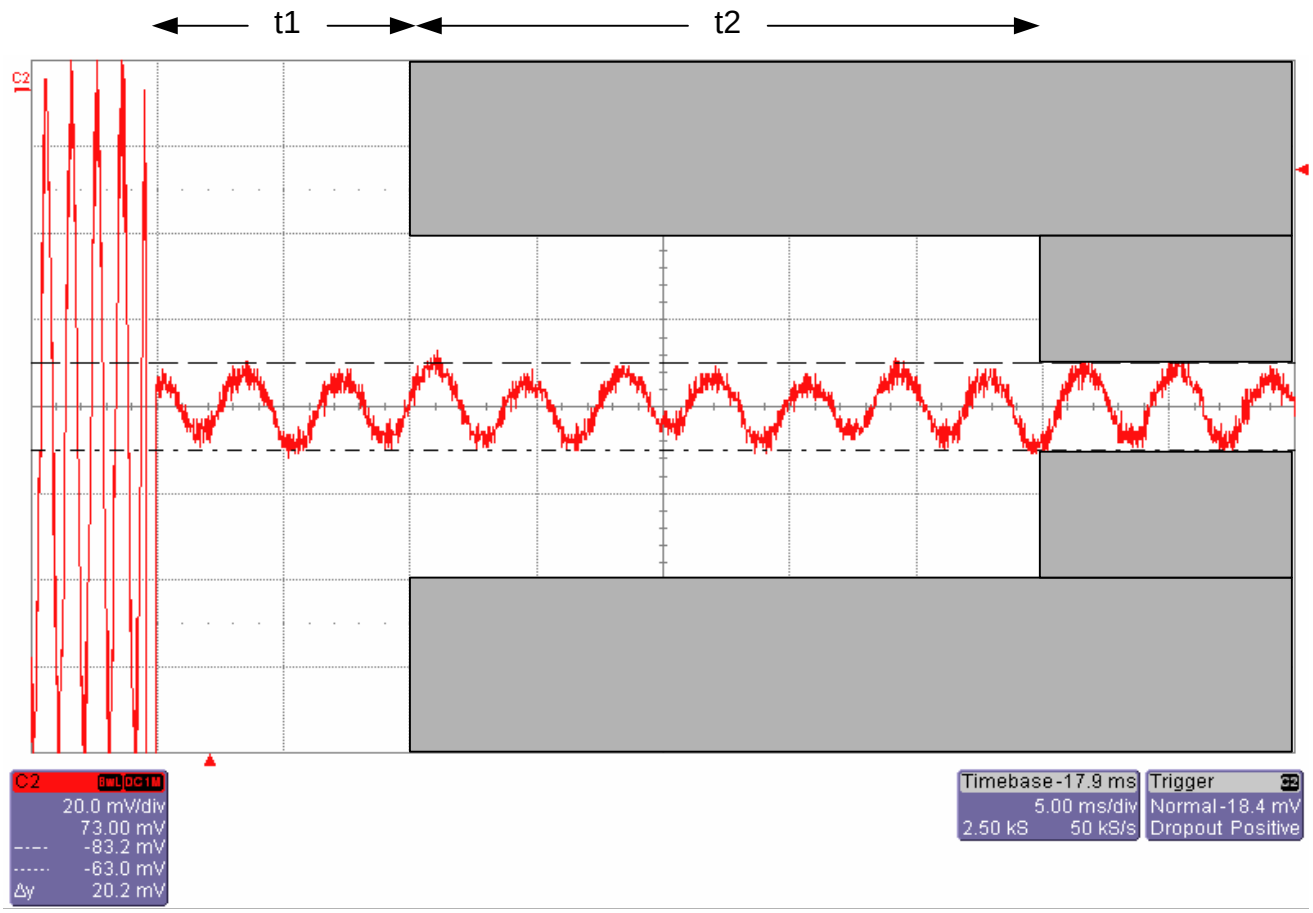
Checked By: MARK E. LONGINOTTI

MANUFACTURER : Free Wave Technologies
MODEL : 400LRS
SERIAL NO. : 400-0019
SPECIFICATION : FCC Part 90 Frequency Stability vs. Voltage
DATE : February 27, 2007
EQUIPMENT USED : SBA1, T2DJ, T2DA, T1E8, MFC0
NOTES : Transmit at 510MHz

Supply Voltage VDC	Measured Frequency Hz	Frequency Error Hz	Limit Hz
10.2 (85%)	510,000,060	229	765
12.0	509,999,831		765
13.8 (115%)	510,000,208	377	765

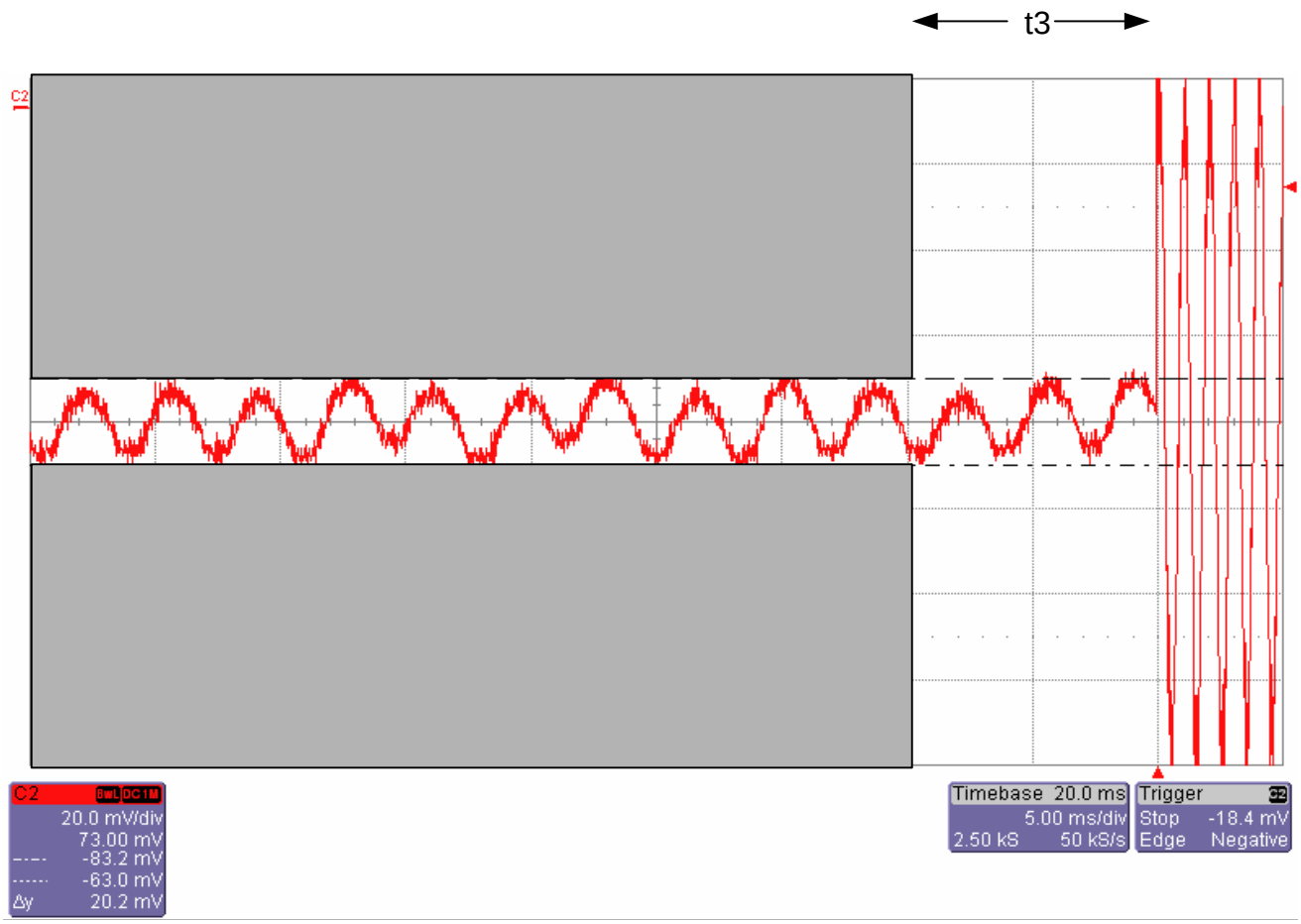
Limit = 1.5ppm = 509,999,908Hz * 1.5ppm = 765Hz

Checked By: MARK E. LONGINOTTI



PART 90 - TRANSIENT FREQUENCY BEHAVIOR , ON

MANUFACTURER	: Free Wave Technologies
MODEL NUMBER	: 400LRS
SERIAL NO.	: 400-0019
TEST	: Transient Frequency Behavior, On
TEST MODE	: Tx @ 450MHz, 12.5kHz channel spacing
TEST	: Transmit on Time, t1= 10ms, t2=25ms
EQUIPMENT USED	: MSV1,GBU0, RYE0, T2DJ,T2DA



PART 90 - TRANSIENT FREQUENCY BEHAVIOR , OFF

MANUFACTURER : Free Wave Technologies
MODEL NUMBER : 400LRS
SERIAL NO. : 400-0019
TEST : Transient Frequency Behavior, Off
TEST MODE : Tx @ 450MHz, 12.5kHz channel spacing
TEST : Transmit off Time, t3=10msec
EQUIPMENT USED : MSV1,GBU0, RYE0, T2DJ,T2DA