FCC ID: NUC-BW125IS

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DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

ID Number:

31040 / SIT

1300F2

" The site referenced above has been found to comply with the test site criteria found in ANSI C63.4-1992 and Title 47CFR, FCC Part 15 Section 2.948."

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COMPLIANCE TESTING

OF

BRADY READER

- TEST REPORT -

80066A

Prepared for:

Peter Scharpf

Brady Worldwide, Inc.

FCC ID: NUC-BW125IS

Milwaukee, WI 53209

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SIGNATURE PAGE

Prepared By:

Kenneth L Boston	18 sept 1998
Kenneth L. Boston	Date

Approved By:

Kenneth L Boston	18 sept 1998
Kenneth L. Boston, EMC Lab Manager PE #31926 Registered Professional Engineer (State of Wisconsin)	Date

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1.3 SUMMARY OF TEST REPORT

MANUFACTURER:	W.H.Brady
MODEL:	Brady Wand RF/ID Reader
SERIAL:	"pre-production"
DESCRIPTION:	LO FREQUENCY TAG READER, TRANSCEIVER
FREQUENCY RANGE:	TRANSMITTER; 125 kHz

The Transmitter was found to **"meet"** the radiated emission specification of Title 47 CFR, FCC Part 15, subpart C.

The Brady Wand RF/ID reader was also found to **"meet"** the radiated emission specification of Title 47 CFR FCC Part 15, subpart A for emissions with regards to the class A digital sections of the product.

This product is a composite device, with the digital section subject to verification. Therefore this technical report will primary contain data that is pertinent to the certification of the transmitter section of the product.

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1.4 INTRODUCTION

On July 27th of 1998, a series of Radiated Emissions tests were performed on a sample model of the Brady Wand RFID reader unit. This is a transmitter, which is designed to send out a polling signal to a small passive tag transponder, which then responds with a short burst of data transmission which comprises an I.D. code. This data burst is received by the tag reader and recognized by the internal programming of the tag reader processor. These tests were performed using the test procedures outlined in ANSI C63.4-1992 for intentional radiators, and in accordance with the general limits set forth in FCC Part 15.209 for a low power transmitter. Tests were also performed as outlined in ANSI C63.4-1992 for non-intentional radiators, in order to allow verification of emissions from the digital section of the product. These tests were performed by Kenneth L. Boston, PE, of L. S. Compliance, Inc. and witnessed by Peter Scharpf of Brady Worldwide, Inc.

1.5 PURPOSE

The above mentioned tests were performed in order to determine the compliance of the product with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.109 15.209
15.205

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure described in the 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 (ANSI C63.4-1992). Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference (CISPR) number 16-1 (1993).

1.6 RADIATED EMISSIONS TEST SETUP

The test sample was operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. and also on the 10 meter Open Air Test Site located outside the L.S. Compliance facility. The test sample was operated with power supplied by an internal DC rechargeable battery. The test sample was positioned upon an 80 cm high wooden table, which was positioned upon the 2 meter turntable within the chamber. The measurement antenna, mounted upon a motorized mast was then placed 3 meters from the product perimeter. This allowed the reader to be scanned in both azimuth and elevation. For low frequency measurements, the product was operated while positioned upon the same table, positioned upon the 2 meter turntable located on the 10 meter OATS facility. The measurement antenna, an active loop antenna, was positioned 10 meters away, and oriented to give maximum signal levels.

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Readings were also taken at a 30 meter separation distance upon the site to establish the range factor needed to correct the limits for the 10 meter distance. These 10 meter OATS measurements were performed for the transmitter fundamental, and harmonics up through the 10th harmonic, plus various spurious emissions up to 1000 MHz.

Please refer to Section 1.10 for pictures of the test setup.

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1.7 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to the general limits given in Title 47 CFR, FCC Part 15.209. For the calculations used to determine the limits applicable for the test sample, refer to Appendix A. These limits are expressed in decibels (dB) above 1 microvolt per meter (μV / m). The samples were tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when the fundamental or spurious signals were located within any of the restricted bands as described in Part 15.205a. These frequencies, and their associated limits, are referenced in Section 1.9. The test sample was activated, by means of placing a passive tag near the tag reader probe section of the product, and while positioned on an 80 cm high non-conductive table. The test sample was setup in the 3 Meter FCC listed Semi-Anechoic chamber located at L. S. Compliance, upon the 2 meter turntable in the chamber, and an antenna mast was placed 3 meters from the test object perimeter. A biconical antenna was used to measure emissions from 30 to 200 MHz, a log periodic was used to measure emissions from 200 to 1000 MHz. The test object was placed in continuous transmit, and the spurious signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters, and was tested using both horizontal and vertical antenna polarities. Brief scans below 30 MHz were also performed in the chamber, using an active loop antenna as the sensing antenna. Information from this 3 meter test was used to identify frequencies for further investigation, during the emissions tests on the 10 meter OATS. For measurement of the transmitter fundamental, harmonics, and low frequency spurious signals, a magnetic loop antenna was used, which was placed at a separation distance of 10 meters upon an FCC listed OATS located at the L. S. Compliance facility in Cedarburg , WI. The fixture was set up on top of the 2 meter flush mounted turntable installed at the 10 meter OATS. The loop and fixture orientation were then varied to obtain the maximum signal levels and then readings were taken. Above 30 MHz, suspect frequencies were also measured using the biconical or log periodic antennas, mounted on a 4 meter adjustable mast, at 10 meters separation on the OATS. The results are tabulated in the charts found in Appendix B.

The unit was scanned for emissions in both transmit and standby modes, over the range 125 kHz to 1000 MHz to establish compliance with Part 15.109 for the transmitter. Also, the scans were performed to evaluate the digital controller section of the product, which is subject to verification as a Class A digital device. Any significant spurious signals, other than the noise floor of the system, are tabulated in the data section found in Appendix B. Signature scans (taken at 3 meters) can be found in Appendix C.

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1.8 TEST EQUIPMENT UTILIZED FOR THE RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 1.12, which includes the calibration information as well as the equipment description. All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database. The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic changes in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. The HP 8546A EMI receiver was operated with a bandwidth of 9 kHz when receiving signals below 30 MHz; with a bandwidth of 120 kHz when receiving signals above 30 MHz and below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16. The peak, Quasi-peak, and Average detector functions were used.

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Manufacturer: Brady Worldwide, Inc.
Model: Wand RF ID reader
Serial Number(s): pre-production

1.9 - Restricted Bands affecting this product (transmitter)

0.090 kHz- 0.110 kHz

0.495 kHz- 0.505 kHz

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1.10 – Photos taken during testing

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Front view of the Brady portable card reader during the Radiated Emissions tests.

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Close up view of the Brady portable card reader during the Radiated Emissions tests.

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1.11 SUMMARY OF RESULTS AND CONCLUSIONS

Based on the procedures outlined in this report, and the test results included in appendices B and C, it can be determined that the Wand RF ID reader does **"meet"** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. The Wand RF ID reader was also found to "meet" the emission requirements of Part 15, subpart B for unintentional radiators with regards to the Digital section of the Control unit.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

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1.12 - Test Equipment

Asset #	Manufacturer	Model #	Serial #	Description	Due Date
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	9/9/98
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	9/9/98
AA96006	EMCO	6502	2753	Active loop antenna	7/22/99
AA960032	HP	11947A	3107A01708	Transient Limiter	I.O
EE960004	EMCO	2090	9607-1164	Mast/Ttable Controller	I.O
EE960013	HP	8546A	3617A00320	Receiver RF Section W/Display and RF filter section	7/30/98
EE960014	HP	85460A	3448A00296	Receiver RF Section Preselector	7/30/98

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APPENDIX A:

SAMPLE CALCULATIONS

FCC ID: NUC-BW125IS
Manufacturer: W H Brady
Model: Wand RF ID reader
Serial Number(s): "pre-production"

Calculation of Radiated Emissions limits for FCC Part 15.209; general limits for intentional radiators.

FIELD STRENGTH OF TRANSMITTER FUNDAMENTAL AND HARMONIC FREQUENCIES:

For the frequency range of 9 kHz to 490 kHz the limit (at 10 meters) is found by:
LIMIT (dBuV / m)= 20log(2400 / F in kHz) + 88.62

For the frequency range of 490 kHz to 1705 kHz the limit (at 10 meters) is found by:
LIMIT (bDuV / m)= 20log(24000 / F in kHz) + 28.62

For the frequency range of 1705 kHz to 30 MHz the limit (at 10 meters) is found by:
LIMIT (bDuV / m)= 20log(30) + 28.62

For the frequency range of 30 MHz to 88 MHz the limit (at 10 meters) is found by:
LIMIT (dBuV / m) = 20log(90)

For the frequency range of 88 MHz to 216 MHz the limit (at 10 meters) is found by:
LIMIT (dBuV / m) = 20log(150)

For the frequency range of 216 MHz to 960 MHz the limit (at 10 meters) is found by:
LIMIT (dBuV / m) = 20log(210)

For the frequency range of 960 MHz to 40 GHz the limit (at 10 meters) is found by:
LIMIT (dBuV / m) = 20log(300)

Where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance of 10 meters. In accordance with part 15.31(f)(2), the scaling factor was determined by taking measurements at two distances on the radial comprising the maximum signal level, and using the results to derive a scaling factor. The measurement values are shown in Appendix B, for readings taken at 10 and 30 meters; this resulted in a scaling factor determined to be the cube of an inverse linear distance extrapolation factor. (1 / D^3), which derives the scaling factors shown below, which were used in performing the conversions shown above.

From 300 meters down to 10 meters: FACTOR(dB) = 60log(300 / 10) = 88.62dB

FCC ID: NUC-BW125IS

From 30 meters down to 10 meters: FACTOR(dB) = 60log(30 / 10) = 28.62 dB

From 300 meters down to 30 meters: FACTOR(dB) = 60log(300 / 30) = 60 dB

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Manufacturer: Brady
Model: Wand RF ID reader
Serial Number(s):

LIMITS FOR READINGS TAKEN AT 10 METERS

Frequency (MHz)	FCC limit (uV/m)	FCC limit (dBuV/m)	Scaling factor	Adjusted limit (dBuV/m)
0.125	19.20 @300m	25.67	88.62	114.29
0.250	9.60 @300m	19.64	88.62	108.26
0.375	6.40 @300m	16.12	88.62	104.74
0.500	48.0 @ 30m	33.62	28.62	62.24
0.625	38.40 @30m	31.69	28.62	60.31
0.750	32.00 @30m	30.10	28.62	58.72
0.875	27.43 @30m	28.76	28.62	57.38
1.000	24.00 @30m	27.60	28.62	56.22
1.125	21.33 @30m	26.58	28.62	55.20
1.250	19.20 @30m	25.67	28.62	54.29
1.705-30.0	30.00 @30m	29.54	28.62	58.16

For a frequency of 0.125 MHz, the 30 meter limit is: 25.67dBuV/m+ 60.0 dB = 85.67 dBuV

Class A limits are given in uV/m in 15.109b, and can be converted into dBuV/m using the formulas given on the preceding page.

Frequency (MHz)	FCC limit (uV/m)	FCC limit (dBuV/m)
30-88	90	39.08
88-216	150	43.52
216-960	210	46.44
960-40000	300	49.54

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APPENDIX B:

DATA CHARTS

FCC ID: NUC-BW125IS

Measurement of Radiated Emissions upon the 10 Meter FCC Listed OATS

Frequency Range inspected: 30 to 1000 MHz

Date of Test:	July 27, 1998	Manufacturer:	Brady Worldwide, Inc
Location:	L.S. Compliance, Inc.	Model No.:	Wand RF ID reader
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	Title 47CFR, FCC Part 15.109	Serial No.:	Pre-production
Distance:	10 meters	Configuration:	Active, transmitting
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Quasi-Peak
	EMCO 3115 Double Ridged Waveguide		
	EMCO 3146A Log Periodic		
	EMCO 3110B Biconical		

The following table depicts the level of significant Class A spurious emissions

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Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Q-Peak Reading (dBuV/m)	15.109 Limit(dBuV/m)	Margin (dB)
59.02	vert	1	0	26.1	39.08	12.98
73.78	vert	2.7	0	18.6	39.08	20.48
74.6	horiz	4	290	24	39.08	15.08
86.08	horiz	4	275	29.6	39.08	9.48
88.55	horiz	3	270	23.4	43.52	20.12
91	horiz	3.2	260	18.9	43.52	24.62
93.47	horiz	3.3	285	19.3	43.52	24.22
157.41	horiz	3.4	275	26.2	43.52	17.32
159.88	horiz	4	275	28.6	43.52	14.92
162.33	horiz	4	280	26	43.52	17.52
167.26	horiz	4	280	24.2	43.52	19.32
195	horiz	4	40	27.6	43.52	15.92
209.1	horiz	2.6	40	25.7	43.52	17.82
211.53	horiz	4	100	28.8	43.52	14.72
415.68	vert	1	340	29.4	46.44	17.04
415.68	horiz	1.5	105	38.4	46.44	8.04
418.14	vert	1	350	28.3	46.44	18.14
418.14	horiz	1.5	100	37.9	46.44	8.54

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Measurement of Radiated Emission upon the 10 Meter FCC Listed OATS

Frequency range inspected: 0.009 MHz to 30 MHz

Date of Test:	July 27,1998	Manufacturer:	Brady Worldwide, Inc
Location:	L.S. Compliance, Inc.	Model No.:	Wand RF ID reader
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	Title 47CFR, FCC Part 15.209	Serial No.:	Pre-production
Distance:	10 meters	Configuration:	Active, transmitting
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Quasi-peak, average
	EMCO 6502 Active Loop		

Readings taken at 10 meters:

Frequency (MHz)	Reading (dBuV/m)	Detectors	15.209 Limit(dBuV/m)	Margin (dB)
0.125	55.23	Avg Amp	114.29	59.06
0.25	42.6	Avg Amp	103.86	61.26
0.375	30.46	Avg Amp	104.34	73.88
0.5	34.4	QP **	61.85	27.45
0.625	44.64	QP **	59.91	15.27
0.75	55.3	QP **	58.32	3.02
0.875	28.32	QP **	57	28.68
1	48.4	QP **	55.83	7.43
1.125	37.54	QP **	54.8	17.26
1.25	40	QP **	53.89	13.89

Use of the characters ** in the detector column indicates noise and ambient signals seen during the measurement procedure.

Readings taken at 30 meters :

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Frequency (MHz)	Reading (dBuV/m)	Detectors	15.209 @30m Limit(dBuV/m)	Margin (dB)
0.131	29.64	ave	85.26	55.62

The 30 meter reading taken above is used to confirm the 1 / dist^3 scaling factor.

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APPENDIX C:

GRAPHS

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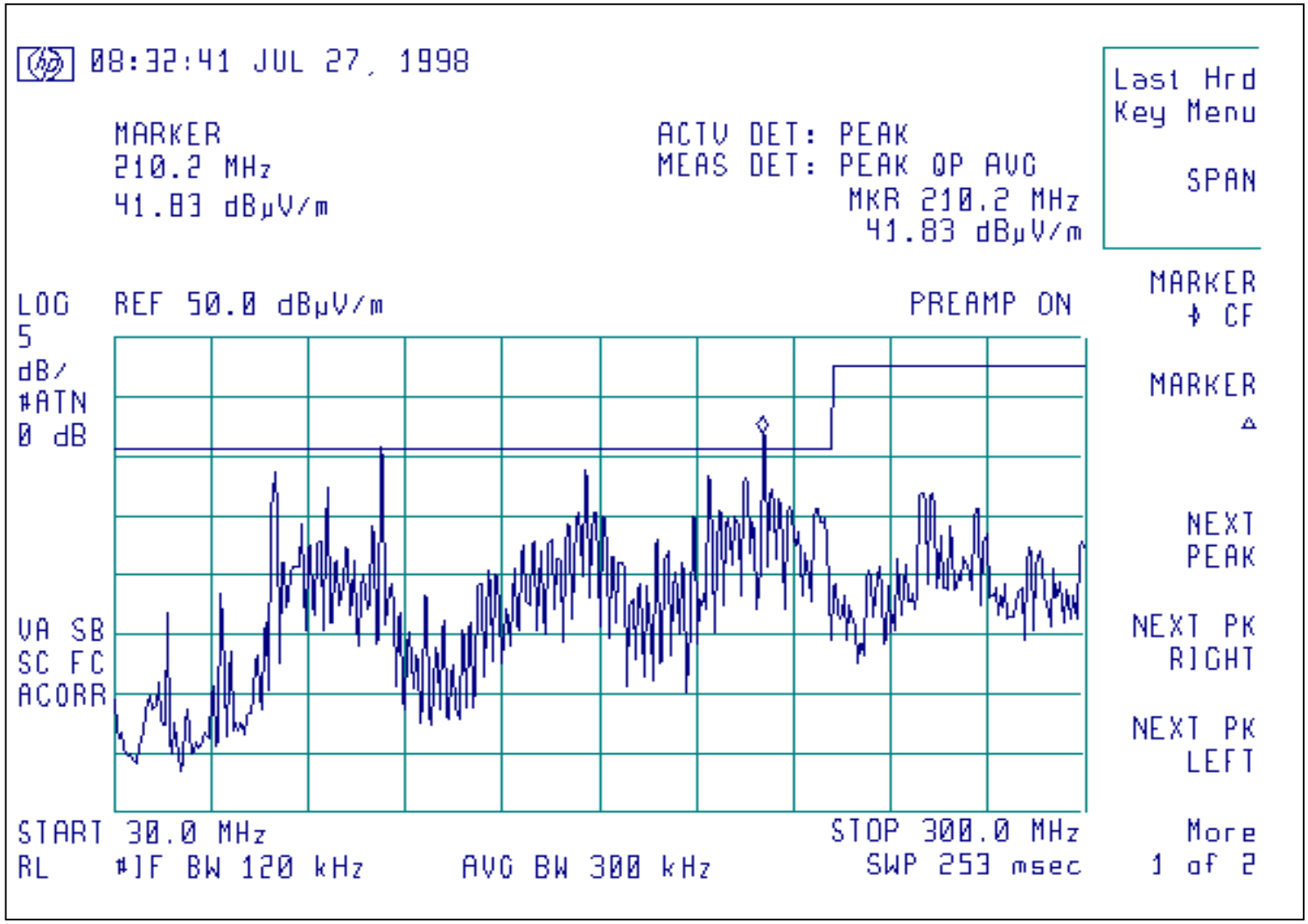
Signature Scan of the Radiated Emissions of the Brady reader, horizontal polarity, 30-300 MHz

Inside 3 meter Chamber, Peak hold scan, CISPR B limit displayed

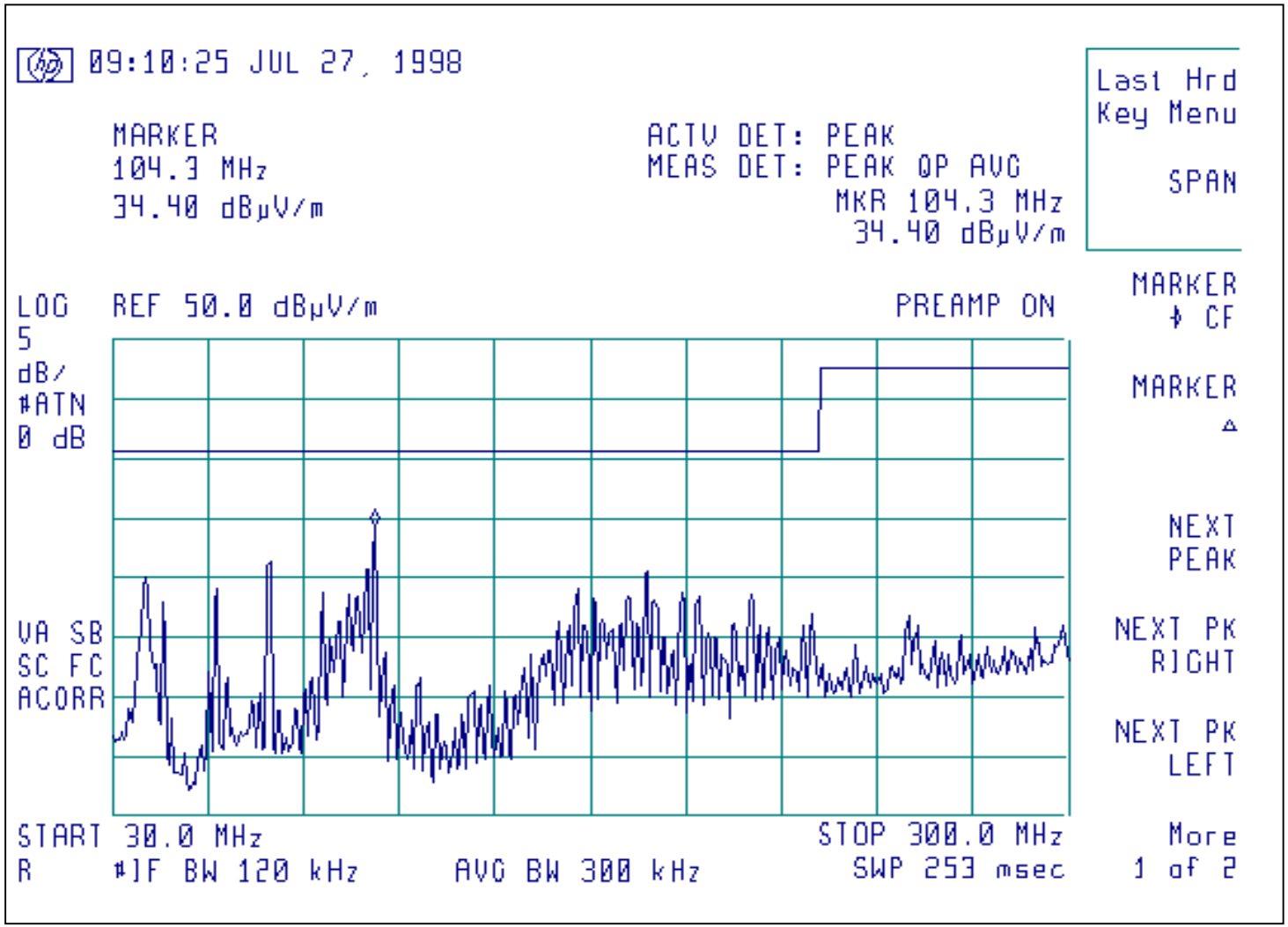


FCC ID: NUC-BW125IS

Signature Scan of the Radiated Emissions of the Brady reader, vertical polarity, 30-300 MHz

Inside 3 meter Chamber, Peak hold scan, CISPR B limit displayed

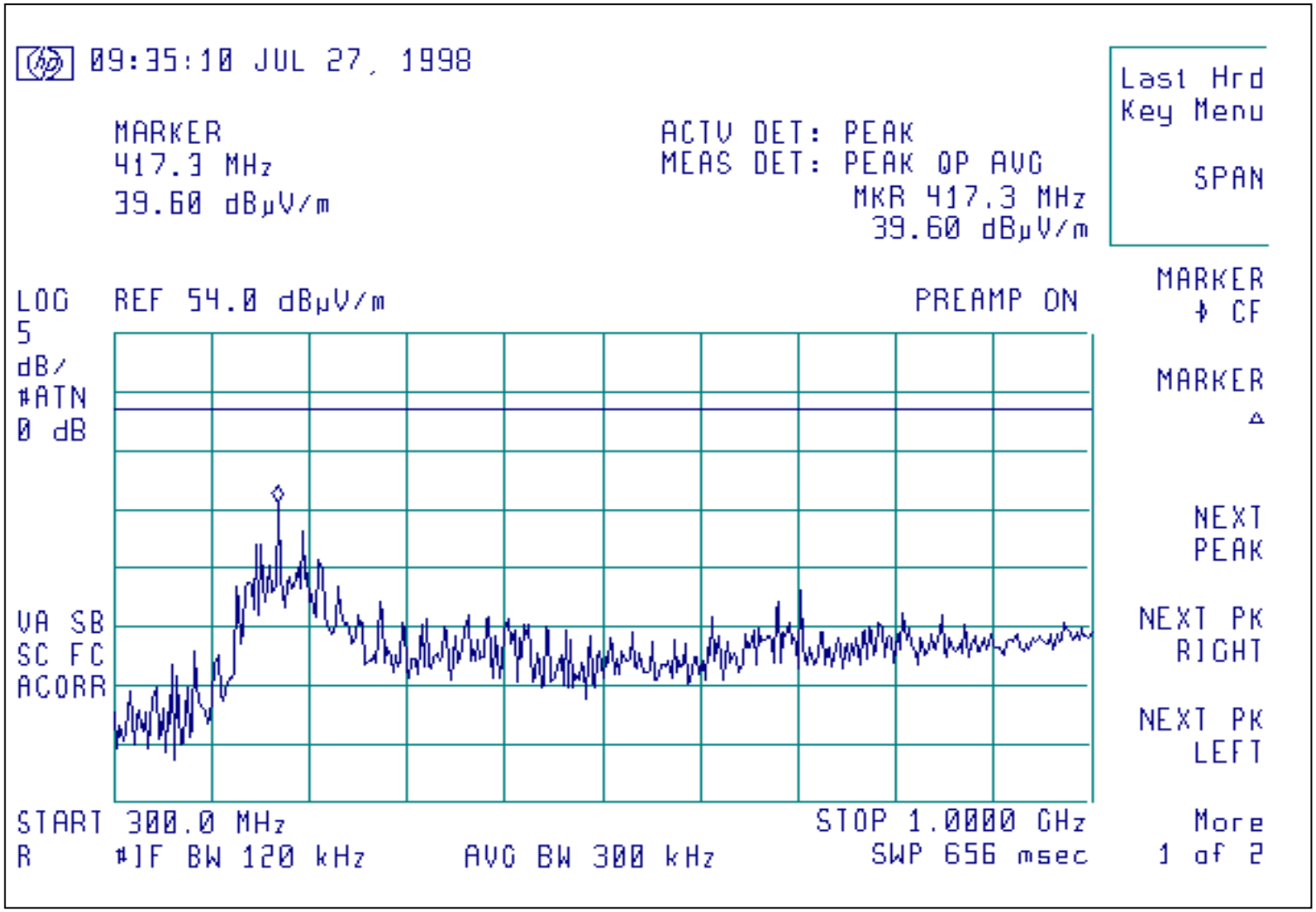
FCC ID: NUC-BW125IS



Signature Scan of the Emissions of the Brady Wand, Vertical polarity, from 300 MHz to 1000 MHz

Inside 3 meter Chamber, Peak hold scan, CISPR B limit displayed

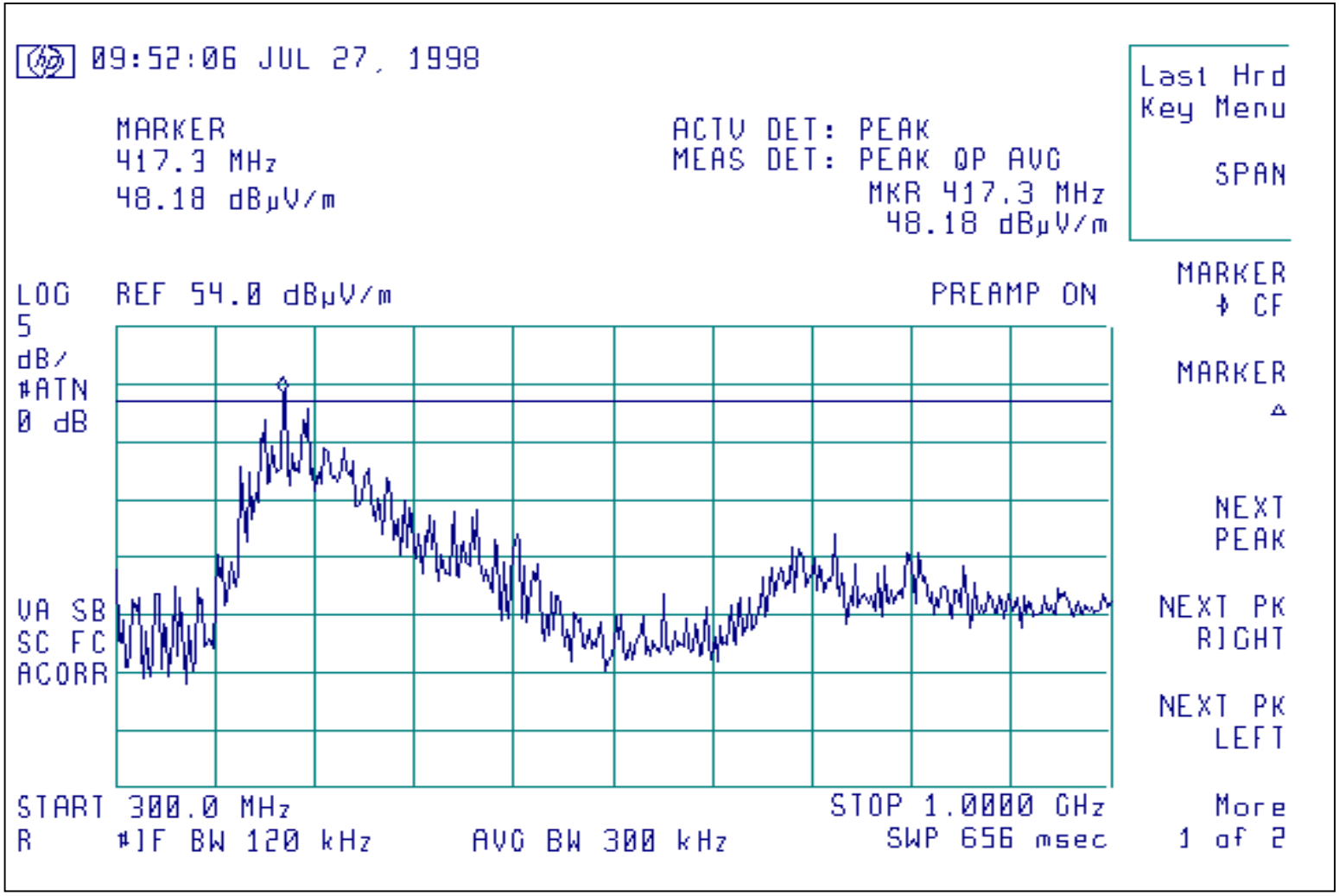
FCC ID: NUC-BW125IS



FCC ID: NUC-BW125IS

Signature Scan of the Emissions of the Brady Wand, Horizontal polarity, from 300 MHz to 1000 MHz

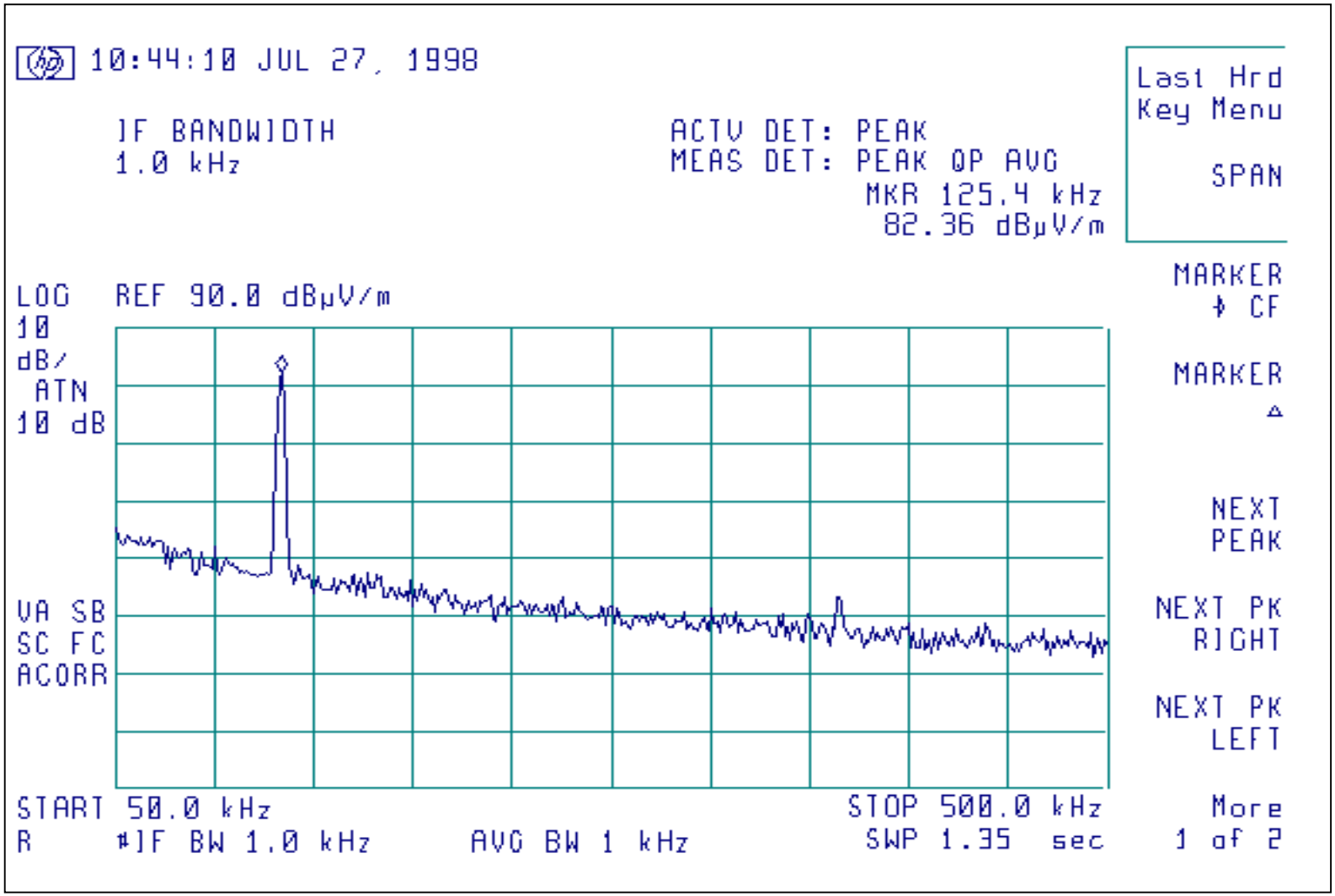
Inside 3 meter Chamber, Peak hold scan, CISPR B limit displayed



FCC ID: NUC-BW125IS

FCC ID: NUC-BW125IS

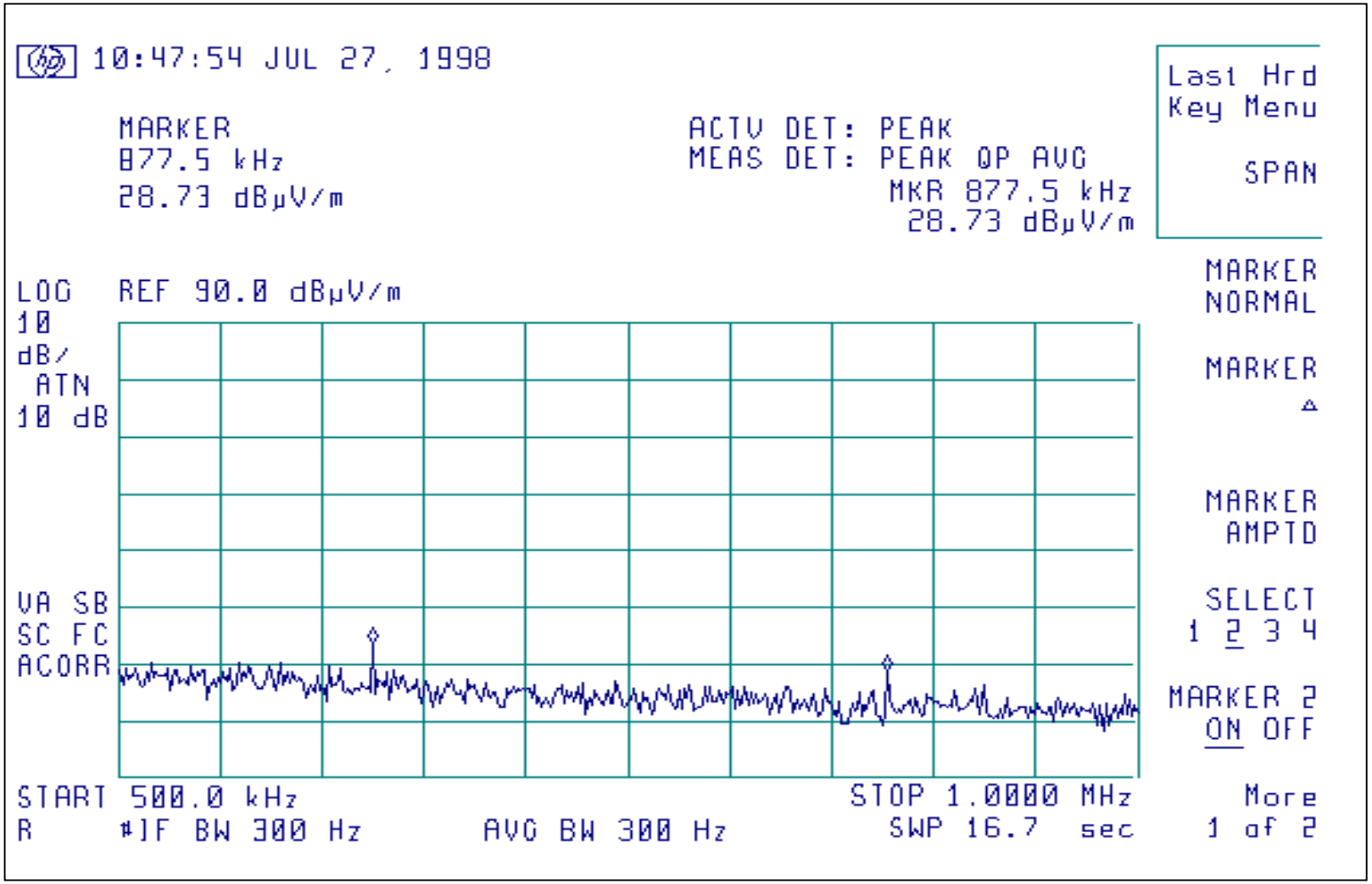
Signature scan of emissions from 50 to 500 KHz, performed at 3 meter distance, in 3 meter chamber



FCC ID: NUC-BW125IS

FCC ID: NUC-BW125IS

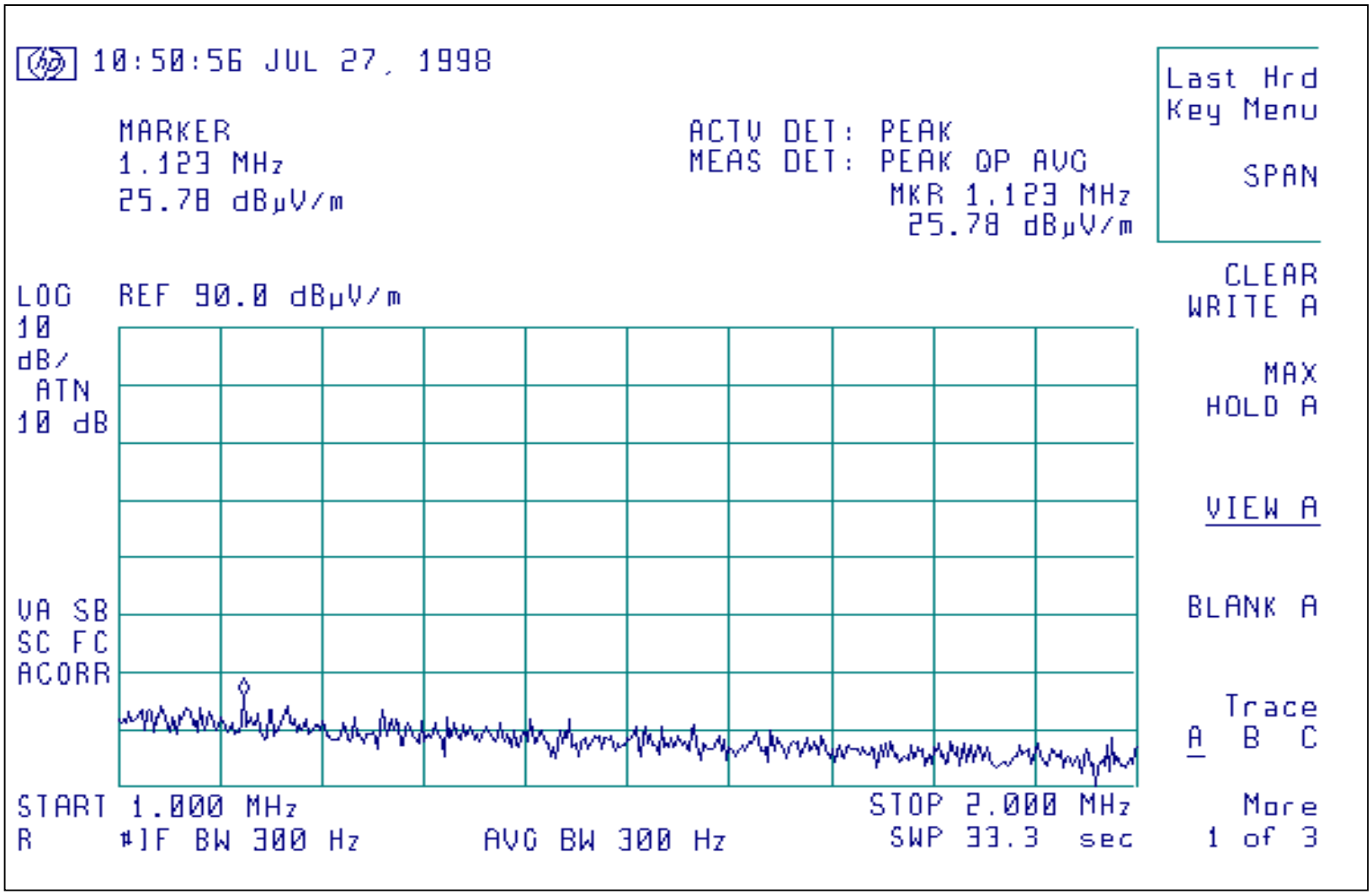
Signature scan of emissions from 500 to 1000 KHz, performed at 3 meter distance, in 3 meter chamber



FCC ID: NUC-BW125IS

FCC ID: NUC-BW125IS

Signature scan of emissions from 1 to 2 MHz, performed at 3 meter distance, in 3 meter chamber



FCC ID: NUC-BW125IS