

TEST REPORT LM04178A AMENDMENT

Date: Tue 27 Oct, 1998

To: Rich Fabina, FCC lab.

Subject: Lab tests on modified NBI-PAD1000

This Report supplements the original Certification filing for Electronic Tracking Systems, Inc., subsidiary of PRONET, Inc. and addresses the compliance issues raised by your correspondence 3047.

The client has reworked the transmitter section and provided three test units that comply with the requirement to test low, mid and high operating frequency with the hopping stopped (he actually provided four units). The RF PC board is a different layout from the one pictured in Photo 6 through 8 of the original test report. New photographs of the PCB and the modifications made to bring the NBI-PAD1000 into compliance are provided herein.

I have included the spreadsheet that I used to calculate the 15.209 emission limit line for use in logging on the OATS. As you see the 2.4 dB pulse correction factor, antenna, and other conversions have been used to construct the three meter emission limit for this particular FHSS transmitter. This presentation shows radiated peak and average emissions for the fundamental as well as harmonics when measured at three meters for each of the four transmitters supplied. Each **EUT** now appears to meet the Commissions requirements for harmonic emissions.

Also included are the field notes using the calculated limits. The sa readings are raw (uncompensated for anything) which makes error analysis a bit easier for us. The antenna factors and amp gain were checked for minimum variation over each band. Low frequency emissions (10 KHz - 1GHz) were verified to be within the limits of 15.209 for the hopper and the high band CW **EUT**.

I believe that all other compliance issues have been satisfactorily answered in the original application or previous correspondence.

REPORT APPROVED 27 October, 1998 BY:



Ben Bibb, NARTE EMC-001970-NE,
President, **LambdaMetrics, Inc.**

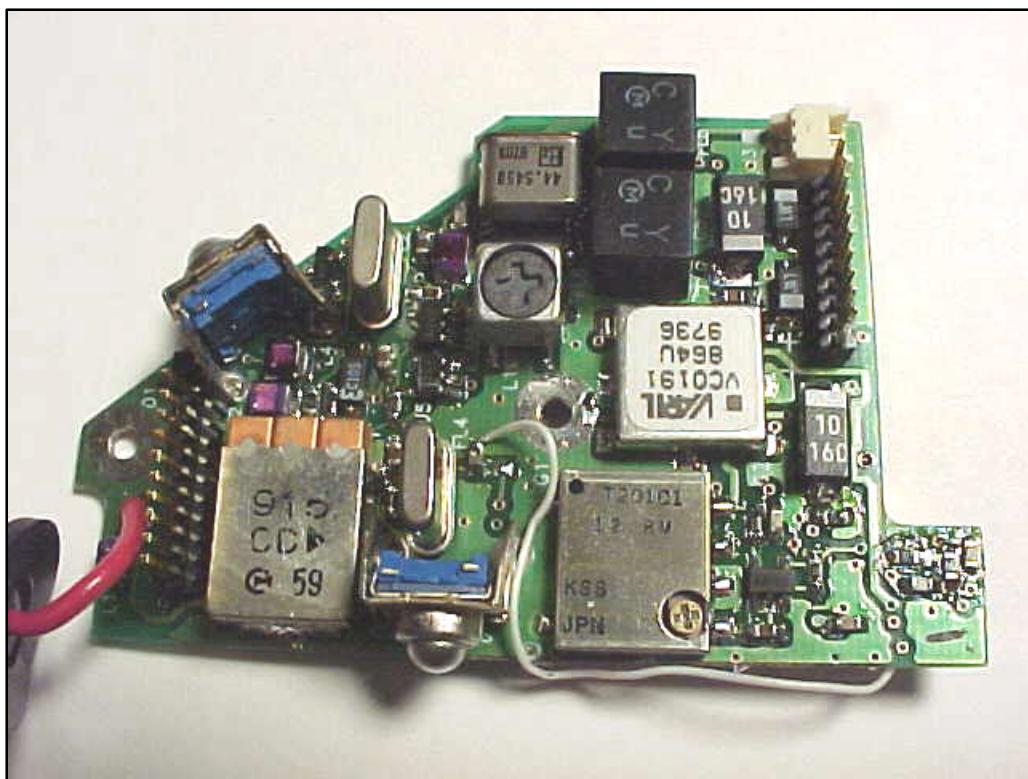


Photo 1: RF Board, Top View, PAD-1000, Modified

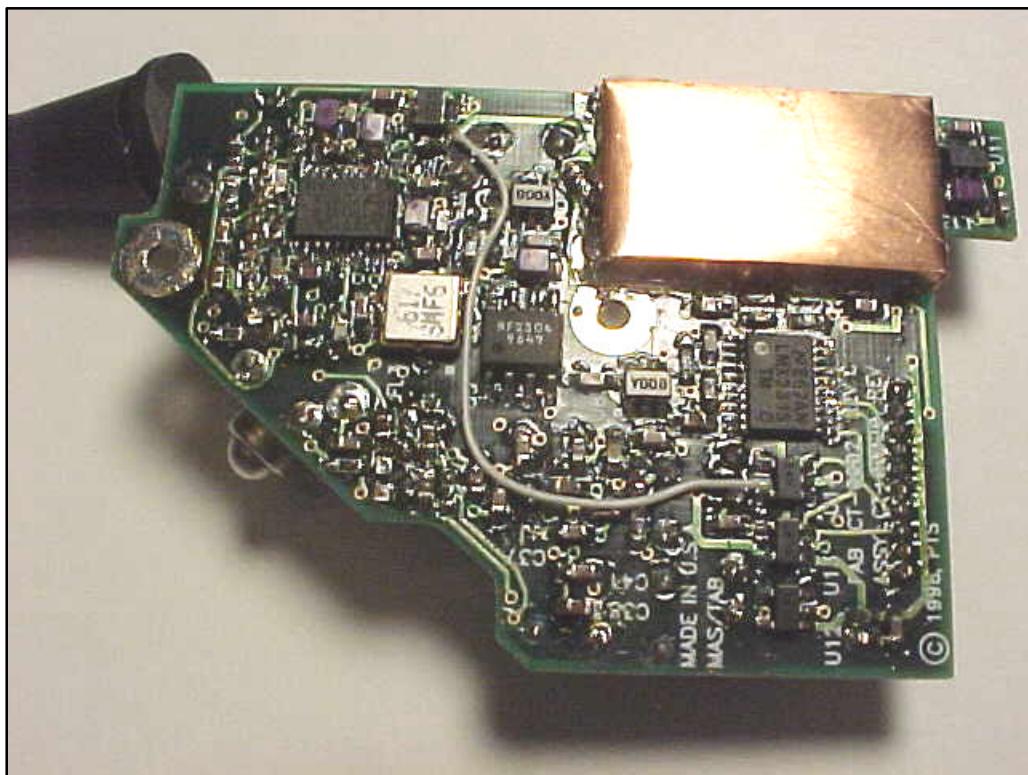


Photo 2: RF Board, Bottom View, PAD-1000, Modified

Meas.	Meas.	Meas.	Meas.	Meas.	Meas.	Calc.	FCC
Freq	At s/a	Amp K	Cab & Attn.	HPF	Ant. Fact.	Pulse Cor.	Limit
MHz	dBm	Gain dB	Loss dB	Loss, dB	dB 1/m	Fact. dB	@ 3 mtrs
906.8	0.0	6.5	-	22.7	-	-	
1813.6	-53.0	32.6	6.6	0.8	27.6	2.4	54 dBuV/m
2720.4	-57.1	30.5	6.7	0.7	29.6	2.4	54 dBuV/m
3627.2	-60.1	29.9	6.8	0.7	31.9	2.4	54 dBuV/m
4534.0	-58.4	31.8	7.0	0.6	32.0	2.4	54 dBuV/m
5440.8	-60.6	32.3	7.1	0.6	34.6	2.4	54 dBuV/m
6347.6	-61.1	32.0	7.2	0.7	34.6	2.4	54 dBuV/m
7254.4	-63.3	32.1	7.4	0.6	36.8	2.4	54 dBuV/m
8161.2	-63.2	32.4	7.5	0.7	36.8	2.4	54 dBuV/m
9068.0	-65.1	31.6	7.7	0.7	37.7	2.4	54 dBuV/m

Prob. of Low error	Prob. of Hi error	R3265 noise floor
-54.8	-51.1	-81.0
-59.0	-55.3	-80.7
-62.0	-58.3	-81.0
-60.3	-56.6	-80.0
-62.5	-58.8	-79.5
-63.0	-59.3	-79.2
-65.2	-61.5	-82.0
-65.1	-61.4	-84.0
-67.0	-63.3	-78.0

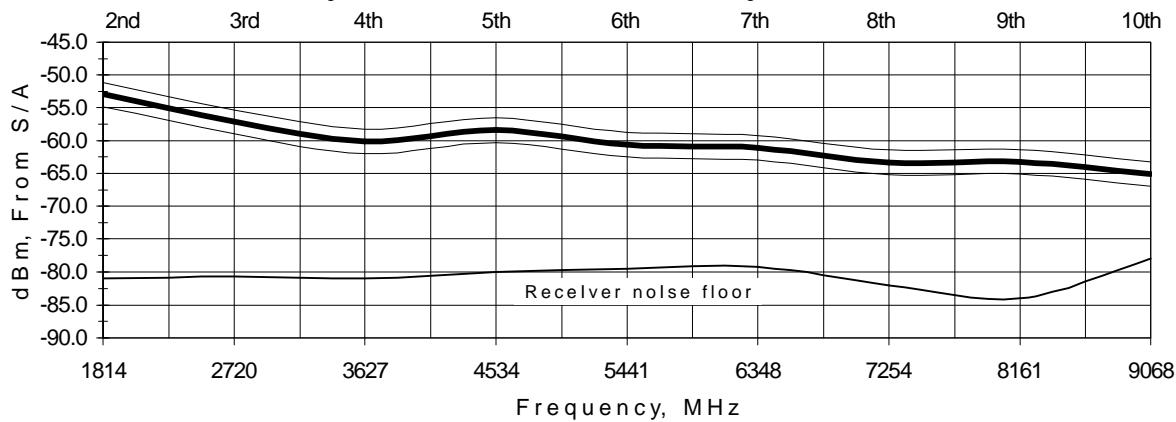
Valid only with the following configuration:

- (a) Antenna, Horn, DRG, LM 1 - 18 GHz
- (b) 6 dB Attenuator, 8491B-6
- (c) N-m : SMA-f Adapt.
- (d) SMT HPF, SMA-m-f
- (e) SMA-f : N-f Adapt
- (f) LM897-2 4 ft Cable, APC N-m
- (g) UG-27D/U Adapt, right. angle
- (h) MITEQ "30 dB" Amp, APC N-m
- (i) Gore 16" Cable, APC N-m
- (j) Advantest R3265 Spect. Ana. APC N-f

Limit, s/a signal for 3 m OATS emissions, FCC 15.209, PEAK & Average

Low Frequency Range (906.800 MHz) PAD. The 2.4 dB duty factor correction is included in the limit.

All readings taken in 1 MHz RBW, Peak taken in 1 MHz VBW, Average taken in 10 Hz RBW.



Uncertainty limits are shown for substitution measurements.

Traceable to NIST via HP 436A / 8481D.

FCC limit line, noise floor, and error limits include the effects of the attenuator, pre-amplifier, and receiver.

Figure 1: EXCEL® Spreadsheet used to calculate emission limit

This sheet was duplicated for each EUT and used during testing on the OATS to manually document the emission levels.

MAXIMUM RADIATED EMISSIONS, NBI-PAD1000
- "LOW Frequency" EUT (906.8 MHz) Measured at 3.0 meters -

Meas.	Peak	"Avg."	Meas.	Meas.	Meas.	Meas.	Calc.	Calc. Avg.	Avg.	Limit
Freq	At s/a	At s/a	Amp K	Cab & Attn.	HPF	Ant. Fact.	Pulse Cor.	3 m Field	Limit	Margin
MHz	(1 MHz) dBm	(10 Hz) dBm	Gain dB	Loss dB	Loss, dB	dB 1/m	Fact. dB	dBuV/m	dBuV/m	dB
906.9	-27.4	-29.0	0.0	6.5	-	22.7	-	107.2	-	-
1813.7	-69.9	-69.1	32.6	6.6	0.8	27.6	2.4	37.9	54	16.2
2720.6	-72.8	-71.3	30.5	6.7	0.7	29.6	2.4	39.8	54	14.2
3627.4	-78.0	-76.0	29.9	6.8	0.7	31.9	2.4	38.1	54	15.9
4534.3	-74.5	-77.3	31.8	7.0	0.6	32.0	2.4	35.1	54	18.9
5441.1	-74.4	-75.0	32.3	7.1	0.6	34.6	2.4	39.6	54	14.4
6348.0	-	-80.0	32.0	7.2	0.7	34.6	2.4	35.1	54	18.9
7254.8	-83.0	-82	32.1	7.4	0.6	36.8	2.4	35.3	54	18.7
8161.7	-	-84	32.4	7.5	0.7	36.8	2.4	33.2	54	20.8
9068.5	-	-78	31.6	7.7	0.7	37.7	2.4	41.1	54	12.9

Maximum emissions were always vertical

Figure 2: OATS Measured Harmonic Emissions, Low-Band CW EUT

Emissions over the 100 KHz to 1000 MHz band were verified to be greater than 12 dB below the Commissions' limits.

MAXIMUM RADIATED EMISSIONS, NBI-PAD1000
- "MID Freq. Hopper" EUT (909.8 MHz) Measured at 3.0 meters -

Meas.	Peak	"Avg."	Meas.	Meas.	Meas.	Meas.	Calc.	Calc. Avg.	Avg.	Limit
Freq	At s/a	At s/a	Amp K	Cab & Attn.	HPF	Ant. Fact.	Pulse Cor.	3 m Field	Limit	Margin
MHz	(1 MHz) dBm	(10 Hz) dBm	Gain dB	Loss dB	Loss, dB	dB 1/m	Fact. dB	dBuV/m	dBuV/m	dB
909.8	-26.8	-28.1	0.0	6.5	-	22.7	-	108.1	-	-
1819.6	-71.7	-70.0	32.6	6.6	0.8	27.6	2.4	37.0	54	17.1
2729.4	-77.1	-75.0	30.5	6.7	0.7	29.6	2.4	36.1	54	17.9
3639.2	-77.8	-75.2	29.9	6.8	0.7	31.9	2.4	38.9	54	15.1
4549.0	-78.6	-77.6	31.8	7.0	0.6	32.0	2.4	34.8	54	19.2
5458.8	-78.0	-80.0	32.3	7.1	0.6	34.6	2.4	34.6	54	19.4
6368.6	-	-79.0	32.0	7.2	0.7	34.6	2.4	36.1	54	17.9
7278.4	-	-82	32.1	7.4	0.6	36.8	2.4	35.3	54	18.7
8188.2	-	-84	32.4	7.5	0.7	36.8	2.4	33.2	54	20.8
9098.0	-	-78	31.6	7.7	0.7	37.7	2.4	41.1	54	12.9

Maximum emissions were always vertical

Figure 3: OATS Measured Harmonic Emissions, Mid-Band Hopping EUT

MAXIMUM RADIATED EMISSIONS, NBI-PAD1000
- "MID Frequency" EUT (909.8 MHz) Measured at 3.0 meters -

Meas.	Peak	"Avg."	Meas.	Meas.	Meas.	Meas.	Calc.	Calc. Avg.	Avg.	Limit
Freq	At s/a	At s/a	Amp K	Cab & Attn.	HPF	Ant. Fact.	Pulse Cor.	3 m Field	Limit	Margin
MHz	(1 MHz) dBm	(10 Hz) dBm	Gain dB	Loss dB	Loss, dB	dB 1/m	Fact. dB	dBuV/m	dBuV/m	dB
909.8			0.0	6.5	-	22.7	-	136.2	-	-
1819.6			32.6	6.6	0.8	27.6	2.4	107.0	54	-53.0
2729.4			30.5	6.7	0.7	29.6	2.4	111.1	54	-57.1
3639.2			29.9	6.8	0.7	31.9	2.4	114.1	54	-60.1
4549.0			31.8	7.0	0.6	32.0	2.4	112.4	54	-58.4
5458.8			32.3	7.1	0.6	34.6	2.4	114.6	54	-60.6
6368.6			32.0	7.2	0.7	34.6	2.4	115.1	54	-61.1
7278.4			32.1	7.4	0.6	36.8	2.4	117.3	54	-63.3
8188.2			32.4	7.5	0.7	36.8	2.4	117.2	54	-63.2
9098.0			31.6	7.7	0.7	37.7	2.4	119.1	54	-65.1

Maximum emissions were always vertical

Figure 4: OATS Measured Harmonic Emissions, Mid-Band EUT

MAXIMUM RADIATED EMISSIONS, NBI-PAD1000
- "HIGH Frequency" EUT (914.750 MHz) Measured at 3.0 meters -

Meas.	Peak	"Avg."	Meas.	Meas.	Meas.	Meas.	Calc.	Calc. Avg.	Avg.	Limit
Freq	At s/a	At s/a	Amp K	Cab & Attn.	HPF	Ant. Fact.	Pulse Cor.	3 m Field	Limit	Margin
MHz	(1 MHz) dBm	(10 Hz) dBm	Gain dB	Loss dB	Loss, dB	dB 1/m	Fact. dB	dBuV/m	dBuV/m	dB
914.8	25.5	-26.6	0.0	6.5	-	22.7	-	109.6	-	-
1829.5	-72.5	-71.0	32.6	6.6	0.8	27.6	2.4	36.0	54	18.1
2744.3	-76.9	-76.5	30.5	6.7	0.7	29.6	2.4	34.6	54	19.4
3659.0	-74.1	-72.0	29.9	6.8	0.7	31.9	2.4	42.1	54	11.9
4573.8	-78.5	-77.3	31.8	7.0	0.6	32.0	2.4	35.1	54	18.9
5488.5	-79.0	-78.2	32.3	7.1	0.6	34.6	2.4	36.4	54	17.6
6403.3	-79.0	-79.5	32.0	7.2	0.7	34.6	2.4	35.6	54	18.4
7318.0	-	-82	32.1	7.4	0.6	36.8	2.4	35.3	54	18.7
8232.8	-	-84	32.4	7.5	0.7	36.8	2.4	33.2	54	20.8
9147.5	-	-78	31.6	7.7	0.7	37.7	2.4	41.1	54	12.9

Maximum emissions were always vertical

Figure 5: OATS Measured Harmonic Emissions, High-Band EUT

MODIFICATIONS MADE TO THE PAD-1000

October 27, 1998

Ben Bibb, President
LambdaMetrics, Inc.
P.O. Box 1029
Cedar Park, TX 78630

Dear Ben,

The changes we made to the original PAD to address the out-of-spec harmonic emissions include:

- 1) moved the SAW filter, power amp, matching network and passive low-pass filter underneath a grounded metal shield can.
- 2) put an emi feedthrough filter on the power amp power supply line where it enters the can and ran the power supply to the amp through a ferrite Pi filter to prevent rf energy from being coupled back into the power supply traces
- 3) replaced discrete low-pass filter with monolithic low-pass filter having lower radiation and better harmonic suppression characteristics
- 4) increased voltage supply to transmit/receive switch from 3V to 4V to increase its headroom thus reducing its nonlinear distortion
- 5) adjusted power level ahead of power amp by means of a T-pad to ensure T/R switch is not in compression
- 6) poured ground plane on the top board layer under the power amp as much as possible

The two white wires on the pre-production units are incorporated in the artwork for the production boards.

Please let me know if you need any additional information or any elaboration on any of the above. Again, thanks for all of your help.

Sincerely,

Tom Boren
Sr. Project Engineer
ProNet Tracking Systems
6340 LBJ Freeway
Dallas, TX 75240
(972) 687-2188
tboren@pronetracking.com

how BAND CW
CF = 906.8

NO AMP/HPF
Pk = -27.44 dBm
Avg = -29.0 dBm

LO -80 dBm, 816.93 MHz 861.8 -78.6 dBm

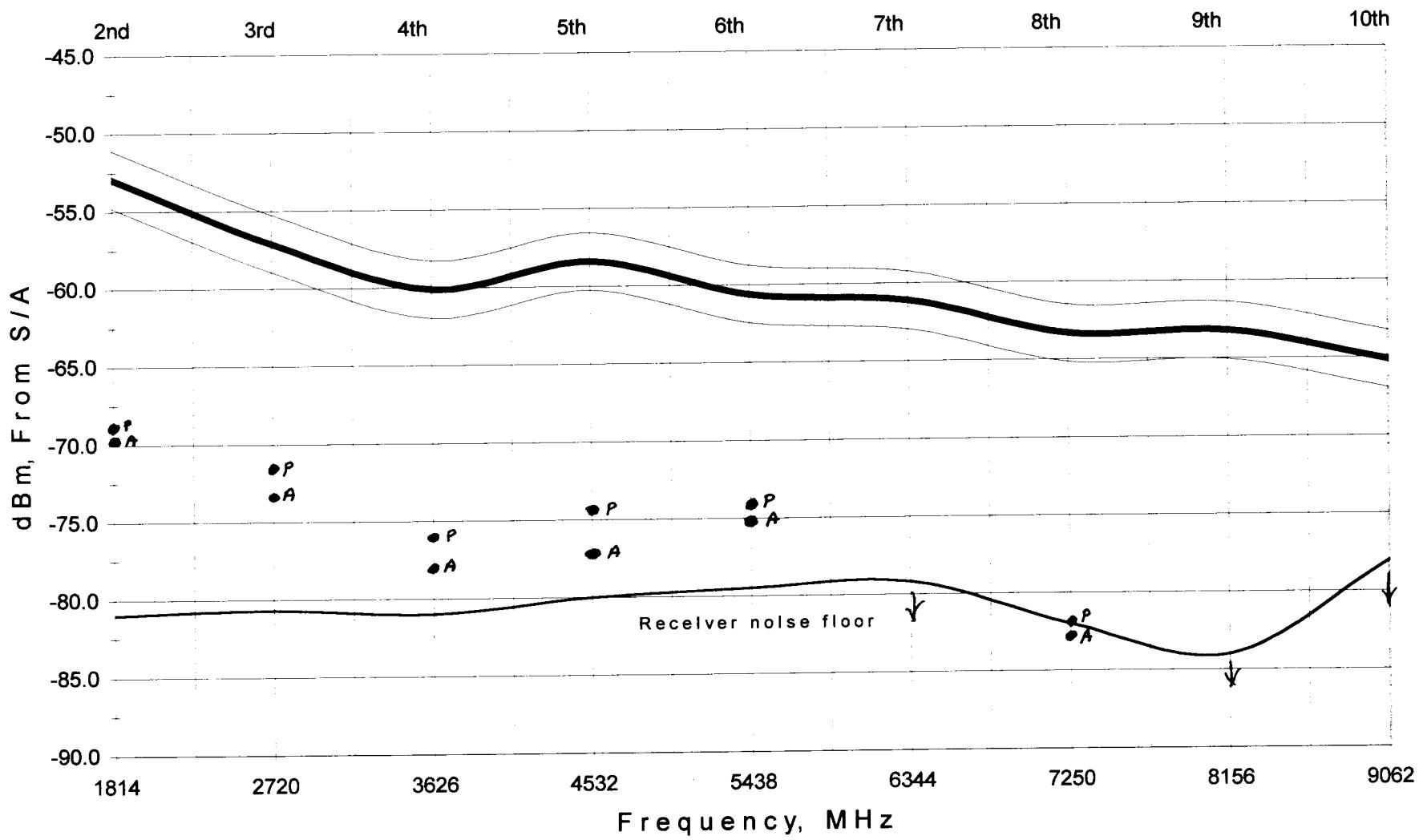
Engineer B. B. B.

Date 27 Oct 1998

Limit, s/a signal for 3 m OATS emissions, FCC 15.209, PEAK & Average

Low Frequency Range (906.8 MHz) PAD. The 2.4 dB duty factor correction is included in the limit.

All readings taken in 1 MHz RBW, Peak taken in 1 MHz VBW, Average taken in 10 Hz RBW.



Uncertainty limits are shown for substitution measurements.
Traceable to NIST via HP 436A / 8481D.

FCC limit line, noise floor, and error limits include the effects of
the attenuator, pre-amplifier, and receiver.

MID BAND

$$CF = 909.8 \text{ MHz}$$

HOPPER
NO AMP HOPPER
PK = -26.81 dBm
Avg = -28.12 dBm

LO -80 dBm, 864.8 MHz

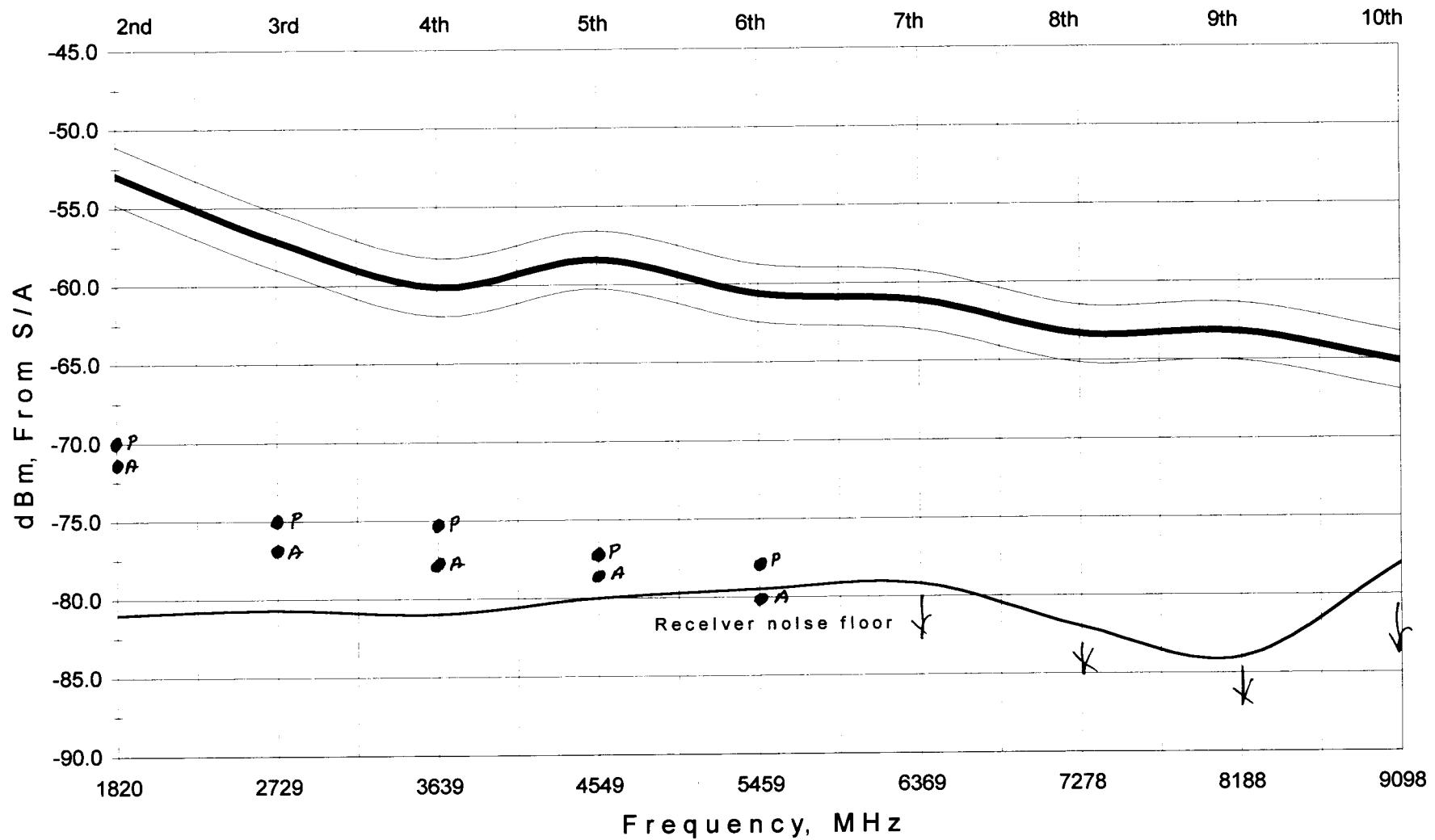
Engineer Depp

Date 27 Oct 1998

Limit, s/a signal for 3 m OATS emissions, FCC 15.209, PEAK & Average

Mid Freq. Hopper (909.8 MHz) PAD. The 2.4 dB duty factor correction is included in the limit.

All readings taken in 1 MHz RBW, Peak taken in 1 MHz VBW, Average taken in 10 HZ RBW.



Uncertainty limits are shown for substitution measurements.
Traceable to NIST via HP 436A / 8481D.

FCC limit line, noise floor, and error limits include the effects of the attenuator, pre-amplifier, and receiver.

HIGH BAND-CA

$FC = 914.50 \text{ MHz}$	NO AMPL/HPF $P_{tR} = -25.53 \text{ dBm}$ $Avg = -26.56 \text{ dBm}$
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LO - 78dBm, 869.75MHz

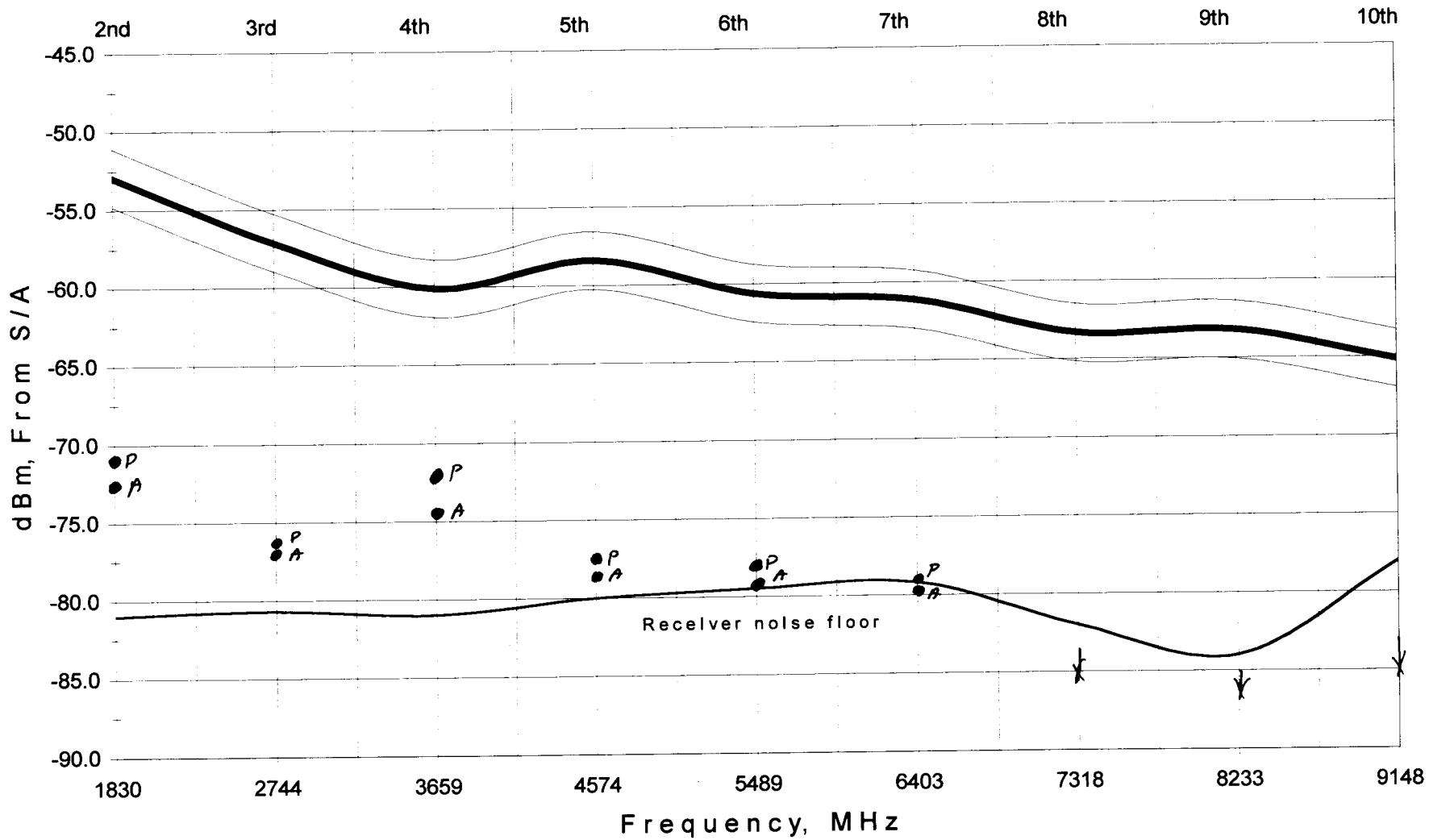
Engineer

Date 27 Oct, 1998

Limit. s/a signal for 3 m OATS emissions, FCC 15.209, PEAK & Average

High Frequency Range (914.75 MHz) PAD. The 2.4 dB duty factor correction is included in the limit.

All readings taken in 1 MHz RBW, Peak taken in 1 MHz VBW, Average taken in 10 HZ RBW.



Uncertainty limits are shown for substitution measurements.
Traceable to NIST via HP 436A / 8481D.

FCC limit line, noise floor, and error limits include the effects of the attenuator, pre-amplifier, and receiver.