L. S. Compliance, Inc.
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Cedarburg, Wisconsin 53012

Phone: 414 - 375 - 4400 Fax: 414 - 375 - 4248

L. S. Compliance, Inc.

Compliance Testing of:

BRAVO pH System

Probe transmitter

Prepared for:

Endonetics, Incorporated

San Diego, CA

Test Report Number: 301126TX

Date(s) of Testing:

March 5, 2001

Table of Contents

FCC ID:PHZ-BRAVO100

DESCRIPTION OF MEASUREMENT FACILITIES

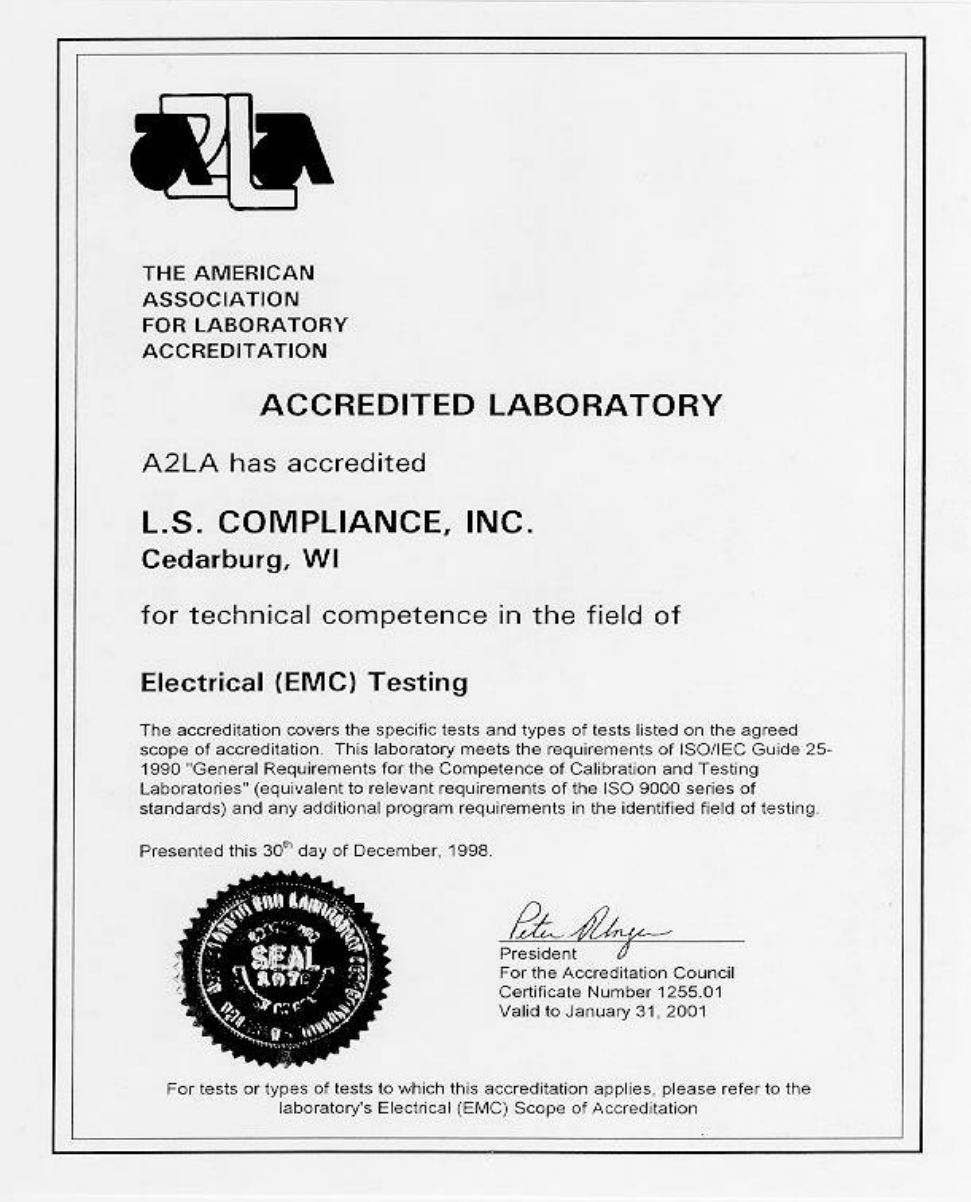
Site on File with the FCC

ID Number: 31040/SIT 1300F2

Site on file with Industry Canada:

ID Number: IC 3088

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



THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical (EMC) Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.

Presented this 30th day of December, 1998.

SEAL

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2001

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical (EMC) Scope of Accreditation

1.2

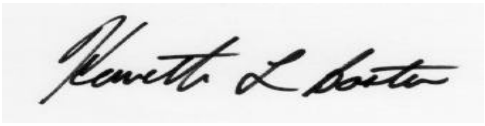
SIGNATURE PAGE

Tests performed by:

10 April, 2001

Thomas T. Lee, EMC engineer — Date

Prepared By:
Approved By:



10 April, 2001

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

1.3 SUMMARY OF TEST REPORT

MANUFACTURER:	Endonetics, Incorporated
MODEL:	BRAVO 100
SERIAL:	engineering unit
DESCRIPTION:	433.9 MHz miniature sensor transmitter
FREQUENCY RANGE:	433.9 MHz fixed frequency

The BRAVO 100 probe transmitter was found to **meet** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

1.4 INTRODUCTION

On March 5 of 2001, a series of Radiated Emissions tests were performed on two sample models of the Endonetics pH system probe, a small invasive 'pill' which is designed to transmit a coded signal used to measure pH while deposited in the human trachea via an outpatient medical procedure. The 'pill' transmitter is utilized in studies of GERD, (Gastroesophageal Reflux Disease), and runs at extremely low power due to its' proximity to human tissue. These tests were performed using the test procedures outlined in ANSI C63.4-1992 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.249 for a low powered transmitter. These tests were performed by Kenneth L. Boston PE, of L. S. Compliance, Inc.

1.5 PURPOSE

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

15.109	15.209	15.231c
15.205	15.231e	

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

Several test samples were operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. The sample was placed on an 80cm high wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test samples were operated on its own [new] internal battery. The battery voltage at the beginning of the tests was measured to be 6.5 volts. Since the battery was encapsulated within the pill structure, and shut off via a magnet and reed switch, several samples were needed because they were exhausted relatively quickly and became unusable for measurement. Several of the test samples contained modified software, allowing them to transmit a continuous dead carrier, in order to facilitate measurement of the fundamental, spurious and harmonic emissions. Other test samples were left as manufactured, with the transmitter sending out short bursts at a 12 second repetition interval, in order to check peak emissions, bandwidth and duty cycle.

Please refer to Section 1.11 for pictures of the test setup.

1.7 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 15.231e limits for low powered automatically timed periodic devices. For the calculations used to determine the limits applicable for the test samples, 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 any 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 1.10. The samples were placed on a nonconductive (wooden) pedestal in the 3 Meter chamber and the antenna mast was placed such that the antenna was 3m (1 meter from 1 to 5 ghz) from the test object. A biconical antenna or tuned dipole was used to measure emissions from 30 to 200 MHz, a log periodic or tuned dipole was used to measure emissions from 200 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1 GHz. The test object was programmed to operate in continuous transmit, and the resultant signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters. The test object was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities.

No significant emissions were found aside from the transmitter fundamental and several harmonics. The unit was scanned for emissions while in continuous transmit, over the range 30 to 5000 MHz to establish compliance with Part 15.209 and 15.231e.

In addition to measuring the levels of radiated emissions, the occupied bandwidth of the transmitters were measured. In accordance with FCC Part 15.231c, the 20dB bandwidth of the transmitted signal should be within a window of 0.25% of the center carrier frequency. The calculation for this bandwidth can be found in Appendix A, which for this product is 1085 kHz. The resolution bandwidth was set either to 120 kHz or to the closest available filter setting on the HP8546A EMI system that corresponded to 5% of the allowable bandwidth determined in the calculation mentioned above, without going below the resolution bandwidth of 10kHz, as dictated in ANSI C63.4-1992 section 13.1.7.

The samples were activated to transmit in a continuous mode and were placed on the aforementioned pedestal within the 3 meter chamber. The transmitted signal was received on a log periodic antenna and fed to the HP8546A EMI System, where the fundamental frequency was displayed, and a plot of the occupied bandwidth was produced. These plots are included in Appendix C.

From the data supplied; and an indicated –20dBc bandwidth of 448 kHz, it can be seen that the test samples do indeed **meet** the bandwidth requirement established by FCC Part 15.231(c).

1.8 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment, cables and antennas used for the tests can be found in Section 1.13, 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 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16. Both the Quasi-peak and Average detector functions were used.

1.9 CONDUCTED EMISSION TEST

Due to the fact that this product operated on its own internal battery power, as opposed to using a power cord, it was not necessary to perform a test for Conducted Emissions.

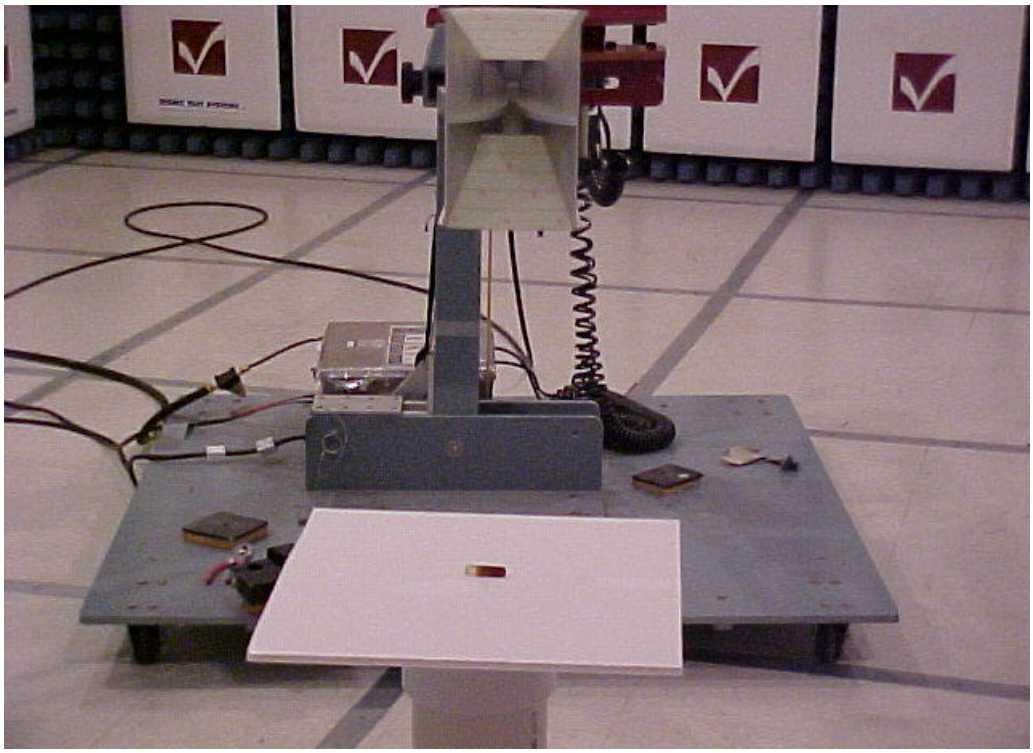
FCC ID:PHZ-BRAVO100

Manufacturer: Endonetics Incorporated
Model: BRAVO 100
Serial Number(s): not applied

1.10 - Restricted Bands affecting this product

Frequency (MHz)	Limit (μV)	Limit (dB/μV/m)
960-1240	500	54.0
1300-1427	500	54.0
1435-1626.5	500	54.0
1645.5-1646.5	500	54.0
1660-1710	500	54.0
1718.8-1722.2	500	54.0
2200-2300	500	54.0
2310-2390	500	54.0
2483.5-2500	500	54.0
2655-2900	500	54.0
3260-3267	500	54.0
3332-3339	500	54.0
3345.8-3358	500	54.0
3600-4400	500	54.0

1.11 – Photos taken during testing



View of the Endonetics Pill transmitter during the Radiated Emissions tests.

Close up of the Pill transmitter

1.12 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 Endonetics Pill transmitter does **meet** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator.

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.

1.13 - Test Equipment, cables used

Asset #	Manufacturer	Model #	Serial#	Description	Due Date
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	21aug2001
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	28sept2001
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	18sept2001
EE960004	EMCO	2090	9607-1164	Mast/Ttable controller	I.O.
EE960014	HP	85460	3617A00320	EMI receiver Display section	1nov2001
EE960013	HP	85462	3205A00103	EMI receiver Preselector section	1nov2001
CC000221	HP	E4407b	Us39160256	26.5 GHz Spectrum Analyzer	8nov2001
N/a	LSC	Cable	0011	3 meter 1/2 " heliax Cable	23 Aug 2001
N/a	LSC	Cable	0038	1 meter RG214 Cable	7 June 2001
N/a	LSC	cable	0050	10 meter RG214 Cable	7 June 2001
N/a	LSC	attenuator	--	10 db attenuator	7 June 2001

APPENDIX A:

CALCULATIONS

FCC ID:PHZ-BRAVO100

Manufacturer: Endonetics, Inc.
Model: BRAVO100
Serial Number(s):engineering sample

Calculation of Radiated Emissions limits for FCC Part 15.231(e) (260-470 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The calculation involves a linear interpolation of 3750 to 12500 µV/m over 260-470 MHz,
Where field strength of the fundamental frequency (f_0) when, $260 \leq f_0 \leq 470$ MHz, can be found by: $3750.0+41.667(f_0-260)$, where f_0 is in MHz.

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES:

The calculation involves a linear interpolation of 375 to 1250 µV/m over 260 to 470 MHz,
Where field strength of the harmonic frequencies ($2f_0$, $3f_0$..), when $260 \leq f_0 \leq 470$ MHz, can be found by: $375.0+4.1667(f_0-260)$, where f_0 is in MHz.

- Where f_0 = 433.9 MHz
-

Fundamental: 3750+41.667(433.9-260) = 6041.7 µV/m: 20log(6042) = 72.9 dBuV/m
Harmonic: 375+4.1667(433.9-260) = 604.17 µV/m 20log(604.2) = 52.9 dBuV/m

Occupied Bandwidth Calculations

FCC Part 15.231(c) states that the bandwidth of the periodic device shall be no wider than 0.25% of the center frequency for devices operating between 70 and 900 MHz. Said bandwidth is determined at the **-20 dB** reference to peak carrier points.

For 433.9 MHz, the 20 dB bandwidth is 0.0025 X 433.9= 1085 kHz

Refer to Appendix C for the set of graphs that show the actual occupied bandwidth of the test sample.

FCC ID:PHZ-BRAVO100

Manufacturer: Endonetics, Inc.
Model: BRAVO100
Serial Number(s):engineering sample

Calculation of Duty Cycle, and Relaxation value

Two types of data message structure are sent as packets, as on-off keying transmissions, with a spacing of 12 seconds between packets. The first type is a pH measurement, which is sent once every 12 seconds; the second type is a transmitter status message, which is sent once an hour, in lieu of a pH measurement. The bit length for all of these transmissions is 1.070 milliseconds, and the message length for the pH measurement is 59 bits, (63.13 ms) and 91 bits (97.37 ms) for the transmitter status. The individual bits are represented as a bit timing of 0.36 ms representing a logic '0', and 0.711 ms representing a logic '1'. This is a 1/3-2/3 type of data modulation. Although the vast majority of the transmissions are of the pH measurement type (bit length of 63 ms), the duty cycle calculation made below uses the worst case scenario, of a data packet for the transmitter status, with all logic 'ones' in the data fields that are variable.

The message structure for the transmitter status message is as follows;

Preamble:	10 bits	10 X 0.535 ms	=	5.35 ms
Transmitter ID:	16 bits	16 X 0.711	=	11.37 ms
Message ID:	8 bits	5 X 0.360 ms	=	1.80 ms
		3 X 0.711 ms	=	2.13 ms
pH Data	16 bits	16 X 0.711 ms	=	11.37 ms
TX status	32 bits	32 X 0.711 ms	=	22.73 ms
Trailer	8 bits	8 X 0.711 ms	=	5.68 ms
Postamble	1 bit	1 X 0.535 ms	=	0.54 ms
	91 bits			60.97 ms

Therefore, the maximum on-time during any 100 ms window is 60.97 ms, and the resultant duty cycle factor (relaxation factor) is: **20 Log (.6097) = -4.3 dB**

Note; In the message ID section of the message, the first 5 bits are always zero.
Also the preamble and postamble are fixed at a bit timing of 50 %.
All of the other fields are variable.

APPENDIX B:

DATA CHARTS

FCC ID:PHZ-BRAVO100

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 3500 MHz

Date of Test:	March 5, 2001	Manufacturer:	Endonetics, Inc.
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	BRAVO-100
Specifications:	Title 47CFR, FCC Part 15.231b	Serial No.:	Not applied
Distance:	3 meters, 1 meter above 1 GHz	Configuration:	Active, continuous modulated carrier
Equipment:	HP 8546A EMI Receiver EMCO 3115 Double Ridged Waveguide EMCO 3146A Log Periodic	Detector(s) Used:	Peak detector
Laboratory Conditions:	Temperature: 68-74 deg F Humidity: 35-50% ,		Pressure; 680-1060mbr

The following table depicts the level of significant fundamental and harmonic emissions found:

Harmonics greater than 20 dB below the limit were not reported.:

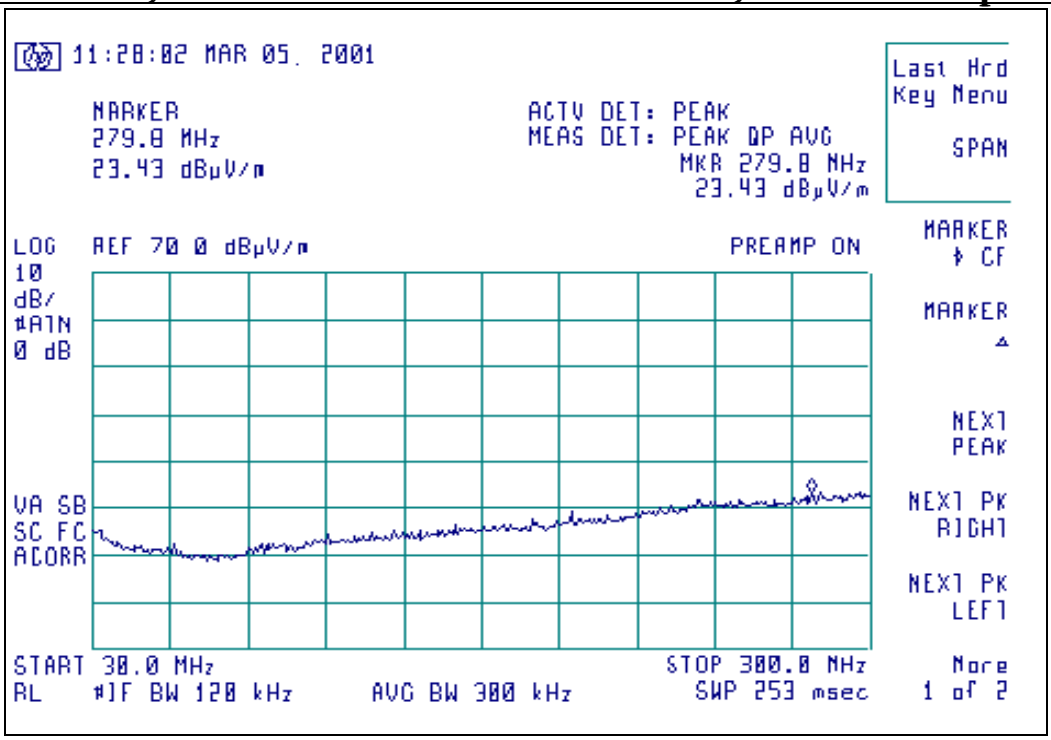
Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB µV/m)	Duty Cycle Factor	corrected (dB µV/m)	15.231e Limit (dB µV/m)	Margin (dB)
433.9	V	1.0	150	52.0	4.3	47.7	72.9	25.2
867.8	H	2.0	150	35.3	4.3	31.0	52.9	21.9
1301.8	H	1.0	0	49.1	4.3	44.8	63.5	18.7
1735.7	H	1.0	90	50.8	4.3	46.5	63.5	17.0
2169.6	H	1.0	180	60.4	4.3	56.1	63.5	7.4
2603.5	H	1.0	90	51.5	4.3	47.2	63.5	16.3
3037.5	H	1.0	0	55.6	4.3	51.3	63.5	12.2
3471.4	H	1.0	0	56.2	4.3	51.9	63.5	11.6
3905.3	H	1.0	0	55.7	4.3	51.4	63.5	12.1
4339.2	H	1.0	0	55.1	4.3	50.8	63.5	12.7

APPENDIX C:

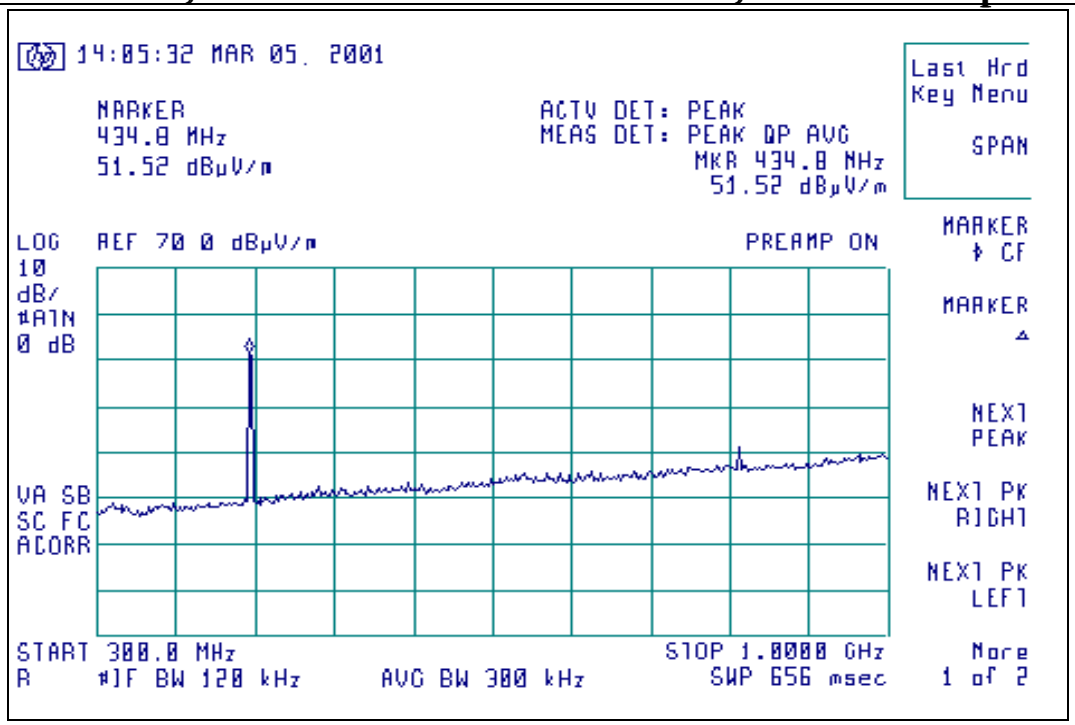
GRAPHS

FCC ID:PHZ-BRAVO100

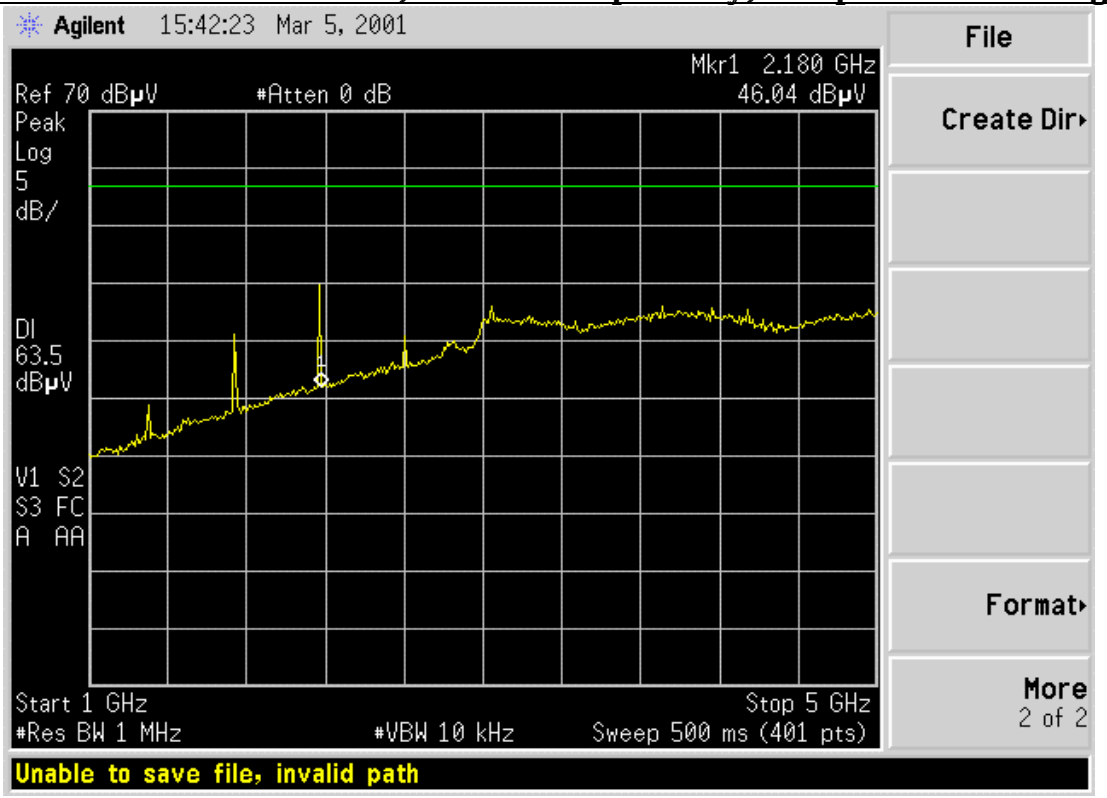
Transmitter, emissions from 30-300 MHz, horizontal polarity



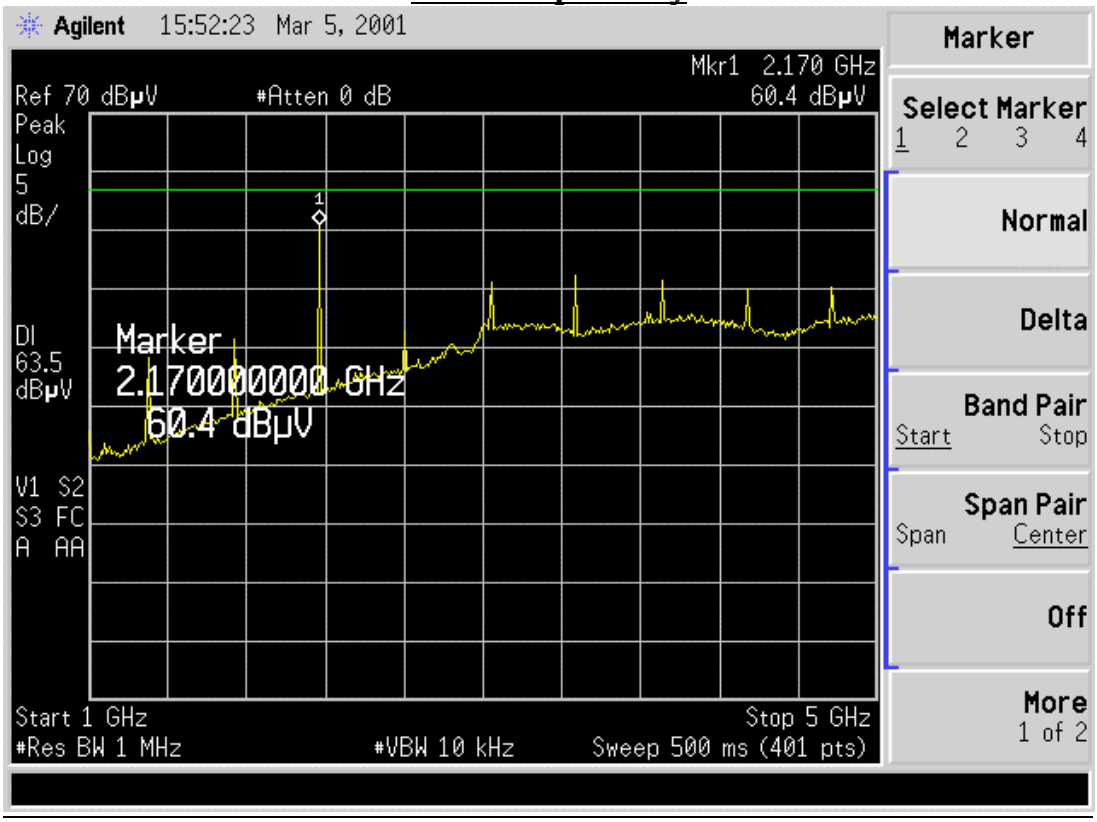
Transmitter, emissions 300 MHz-1 GHz, horizontal polarity



Transmitter emissions 1-5 GHz, horizontal polarity, sample transmitting carrier

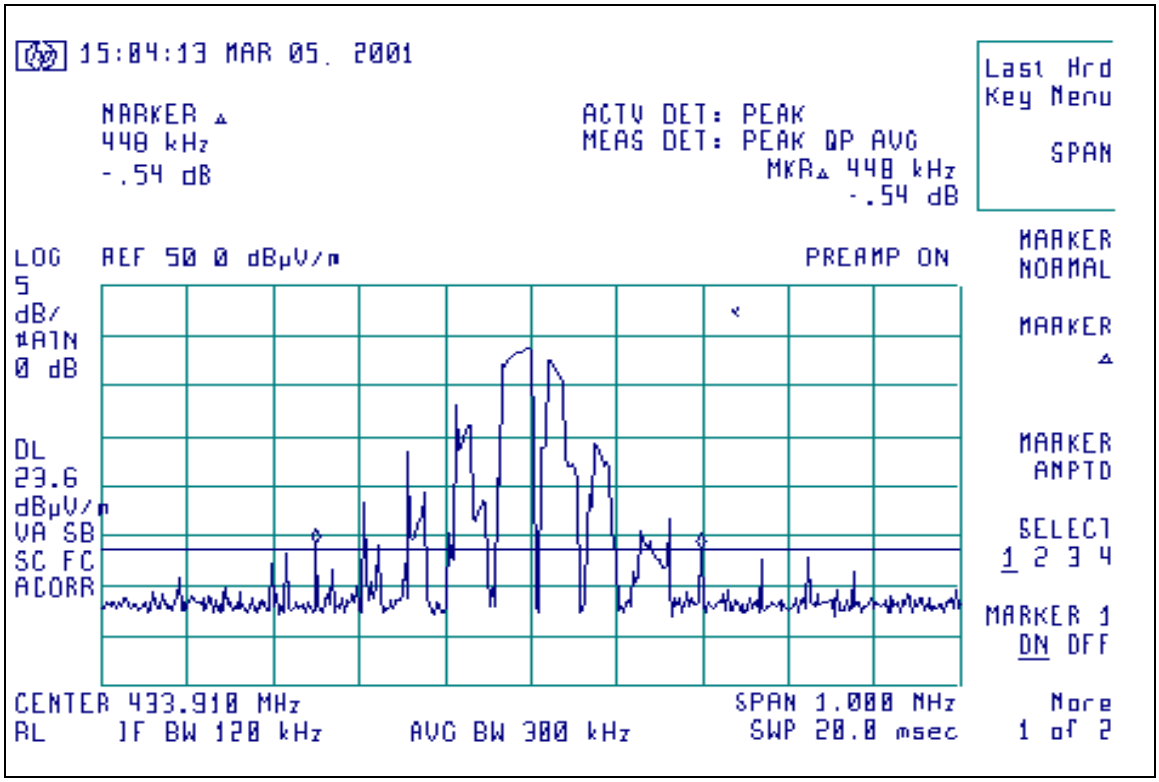


vertical polarity

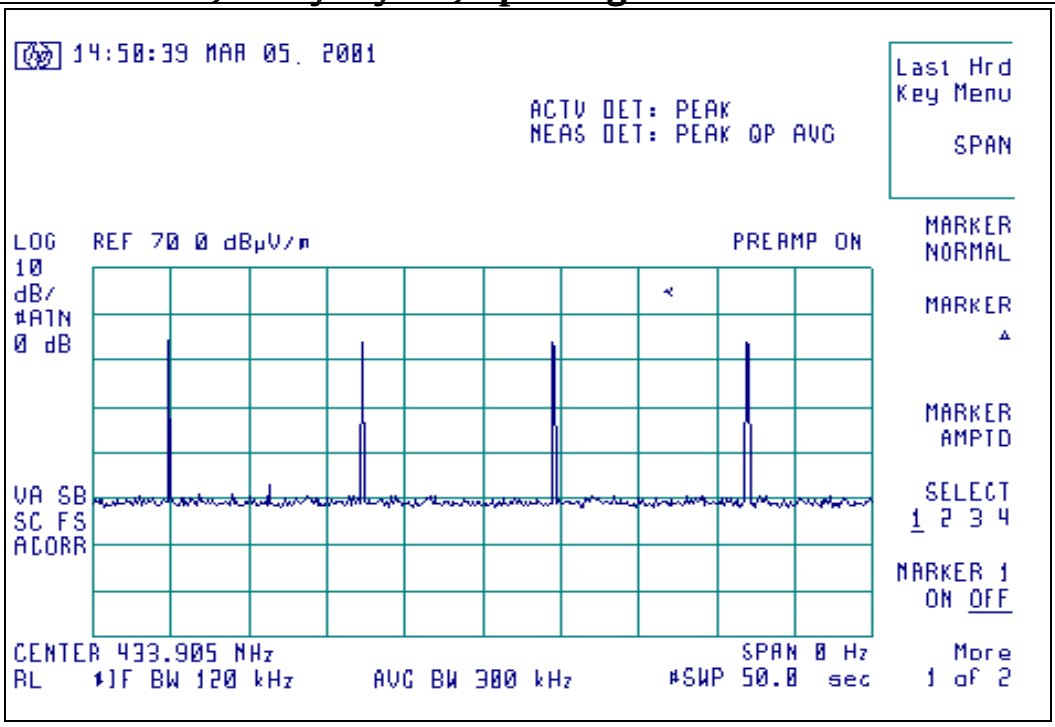


FCC ID:PHZ-BRAVO100

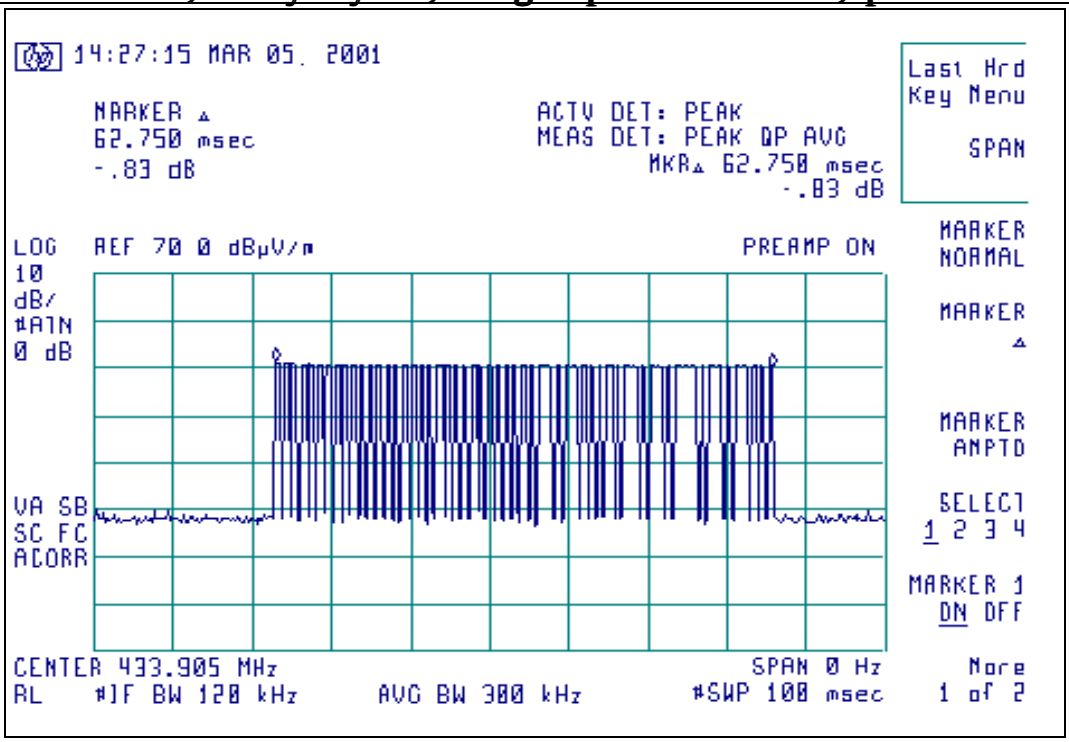
Occupied bandwidth



Pill Transmitter, Duty Cycle, spacing of automatic transmissions



Pill Transmitter, Duty Cycle, single packet detail, pH measurement



Transmitter, Duty Cycle Detail, 50 and 20 ms wide sweeps