CLASS TWO CHANGE MEASUREMENT AND TECHNICAL REPORT ON THE 5.5 MHz UNIVERSAL ELECTRONICS QS 4000 XT ANTENNAS

TEST REPORT

Southwest Research Institute Project 10-1853-001
Report Number EMCR 98/033

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September 1998

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1.0 GENERAL INFORMATION

1.1 Product Description

The 5.5 MHz Universal Electronics is designed to detect 5.5 MHz tuned circuit labels which are being used in an anti-pilferage system. The electronics were tested with QS 4000 XT antennas for a Class Two Change. The QS 4000 XT 5.5 MHz system sweeps over a frequency range of 5 MHz to 6 MHz to detect the tuned circuit labels. The system operates under FCC Part 15, Subpart C, "Intentional Radiator," paragraphs 15.207, 15.209, and 15.223. Checkpoint's technical documentation provides a detailed description of the transmitter and receiver anti-pilferage system. The technical documentation is provided in Attachments A, B, C, and D of this report.

1.2 Related Grants

No other host equipment was used in the test configuration.

1.3 Tested System Details

The 5.5 MHz Universal Electronics were tested with a QS 4000 XT antenna configuration. The antenna configuration has a transmit pedestal and a receive pedestal. The Model Number and FCC ID of the test configuration is in the following table:

TABLE 1.1
COMPONENTS IN THE TEST CONFIGURATION

Model No.	Serial No.	FCC ID	Cable Description
R3505 Universal Receiver	480851P00038960012	DO4UNV55	Shielded DC leads
T3605 Universal Transmitter	443151P00038960015	DO4UNV55	Shielded DC leads
Model CP663-02 Power Supply	P06314	DO4UNV55	Shielded power cord with line filter, and shielded DC leads
QS 4000 XT Antennas	005-15743-A (RX) 044-04897-A (TX)	DO4UNV55	Shielded DC leads

1.4 Test Methodology

Both conducted and radiated testing were performed according to the procedure in ANSI C63.4-1992 and MP-1 1983. Radiated testing was performed at an antenna distance of 3 meters and 30 meters.

1.5 Test Facility

The Open Area Test Site (OATS) and Conducted Measurement Facility used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning these test sites are found in the report entitled, "Description of Measurement Facility," dated 28 April 1997, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 12, 1997, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

2.0 PRODUCT LABELING

2.1 FCC ID Label

See Attachment D for a drawing of the FCC ID Label.

2.2 Location of Label

See Attachment D for a drawing of the location of the FCC ID Label.

3.0 SYSTEM TEST CONFIGURATION

3.1 Justification

The 5.5 MHz Universal Electronics was configured in a typical configuration with a transmit and receive pedestal fashion for the anti-pilferage system, with the pedestals separated by 48 inches.

Radiated signature scans were made in a 3-meter shielded anechoic chamber over the frequency range of 2.4 MHz to 1000 MHz to determine the frequency of worst case emissions. The scans were made with the transmit signal in a CW mode at 5.5 MHz.

Radiated signature scan measurements were made with the voltage at TP 4 and 5 on the transmitter to 37 Vpp, and the plots are given in the Appendix.

3.2 EUT Exercise

The Universal Electronics was operated in two modes, continuous wave (CW) and sweep. The sweep mode was used to show that the system would detect a tag and give an alarm during testing. Conducted measurements were made with the EUT in the sweep mode, and radiated measurements were made at CW frequency of 5.5 MHz. The system tested was operational when turned on.

3.3 Special Accessories

The DC power supply had a shielded AC power cord with a power line filter in the molded AC plug end. The DC power cables were shielded. To meet the limit for the radiated emission of the fundamental the voltage at TP4 and TP5 on the transmit board was set to 37 Vpp.

3.4 Equipment Modification

No modification were made during testing.

3.5 Configuration of Tested System

Refer to the photographs in Section 5.

4.0 BLOCK DIAGRAM OF UNIVERSAL ELECTRONICS

A block diagram of the transmitter and receiver are provided in Attachment B of this report.

6.0 CONDUCTED EMISSIONS DATA

6.1 Conducted Measurement Data

The initial step in collecting conducted data was to provide a spectrum analyzer peak scan of the measurement range to determine worst case. A computer-controlled spectrum analyzer was used to produce a peak measurement data plot provided on the following page. The peak measurement scan showed that the conducted emissions are under the limit.

6.2 Test Instrumentation

The test instrumentation used to make conducted measurements is given in Table 6.1.

TABLE 6.1
CONDUCTED TEST INSTRUMENTATION

Type	Manufacturer/ Model No.	Serial No.	Cal Due
Spectrum Analyzer	HP 8568B	2403A07074	8 Oct 98
Quasi-Peak Adapter	HP 85650A	2043A00254	4 Nov 98
Computer	HP 9836C	2441A03889	N/A
Limiter	HP 11867A	4598	Verified
PLISN	Rohde & Schwarz ESH2-Z5	8813621017	13 Feb 99

7.0 RADIATED EMISSIONS DATA

The data below are the corrected highest level EME measurements taken from the following radiated data sheets. The data sheets include the emissions frequencies, receiver reading, correction factor (including cable loss, amplifier gain if used, and antenna factor), corrected level, and the limit.

7.1 Radiated Data

Measurements were taken on the fundamental frequency at 30 meters at the OATS. The highest fundamental signal measurement for the antenna configuration at 5.5 MHz is given in Table 7.1:

TABLE 7.1
MEASUREMENTS OF EMISSIONS BELOW 30 MHz

Judgment: EUT Passed By 1.7 dB		
Frequency (MHz)	Corrected Level[1] dB(μV/m)	Limit 30 Meters dB(μV/m)
5.435	38.3	40

[1] All readings are quasi-peak manual measurements made with a receiver, using a loop antenna that was rotated on its vertical axis for maximum signal level.

Signature scans showed that spurious emissions were low. Emission measurements at the OATS were made at 3 meters from the EUT. The highest emission levels are given in Table 7.2. The signature measurement plots are provided in the Appendix.

TABLE 7.2
SPURIOUS EMISSIONS ABOVE 30 MHz

Judgment: EUT Passed By 6.4 dB		
Frequency (MHz)	Corrected Level [2] dB(μV/m)	Limit dB(μV/m)
48.87	32.3	40
43.46	32.4	40
54.38	33.6	40
135.35	33.3	43.5
178.09	19	43.5

[2] All readings are quasi-peak manual measurements made with a receiver.

	BAND 9		BAND 10 (1)	(1)	(1)	(1)				
FREQUENCY (MHz)	5.435	5.435	10.87	16.305	21.74	27.175				
TRANSDUCER	ALR-25 S/N 96	→	→	→	→	→				
TRANSDUCER DIST. from EUT(m)/HEIGHT(m)	30 / 1	30 / 1	30 / 1	30 / 1	30 / 1	30 / 1	/	/	/	/
POLARIZATION (V,H) AMBIENT NOISE (A)	— EUT	1 EUT	A + E	A + E	A + E	A + E				
SIGNAL DIRECTION	90°	180°	0-360°	0-360°	0-360°	0-360°	°	°	°	°
RECEIVER ATTENUATION (dB)	-20	-20	-20	-20	-20	-20				
METER READING (dBμV)	18	14	12.0	13.0	13.5	15				
TRANSDUCER FACTOR (dB)	39.61	39.61	34.01	34.17	31.56	25.55				
EXTERNAL GAIN/ CABLE LOSS (dB)	.7	.7	1.1	1.3	1.6	1.8				
CORRECTED LEVEL (dBμV/m)	38.31	34.31	27.11	28.47	26.66	22.35				
LIMIT (dBμV/m)	40	40	30	30	30	30				

Date: 1 MAY 98

Detection Method: X CISPR __ PEAK __ AVERAGE __ Other

OPR/Asst.: Ron

EUT VPP - 37V

Conf. ____ Run ____ of ____

Page ____ of ____

Notes, (1) antenna was also moved up to 3 meters distances from DUT, but no emissions were detected from the DUT.

Project No.: 10-1853-001

Test Category: ____

Time, Temp., & % r.H.: 0400, 94°F, 22%

Approved: David A Carney

P:\10-1853\qp4000-fcr.wpd

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FCC ID: DO4UNV55

FREQUENCY (MHz)	48.87	43.46	54.38	135.35	178.09					
TRANSDUCER	BDA S/N 535									
TRANSDUCER DIST. from EUT(m)/HEIGHT(m)	3 / 1.3	3 / 1.4	3 / 1.3	3 / 1.5	3 / 1.5	/	/	/	/	/
POLARIZATION (V,H) AMBIENT NOISE (A)	V	V	V	H	V					
SIGNAL DIRECTION	250°	70°	250°	270°	80°	°	°	°	°	°
RECEIVER ATTENUATION (dB)	0	0	10.0	0	10					
METER READING (dBμV)	18	16	10.5	14.0	15.0					
TRANSDUCER FACTOR (dB)	11.8	14.0	10	14.5	16.7					
EXTERNAL GAIN/ CABLE LOSS (dB)	2.5	2.4	2.6	4.8	-22.7					
CORRECTED LEVEL (dBμV/m)	32.3	32.4	33.6	33.3	19.0					
LIMIT (dBμV/m)	40	40	40	43.5	43.5					

Date: 5 MAY 98 Detection Method: X CISPR ___ PEAK ___ AVERAGE ___ Other

OPR/Asst.: Ron EUT QS-4000, 37 VOLTS P-P

Conf. ___ Run ___ of ___ Notes, ___

Page ___ of ___

Project No.: 10-1853-001

POLARAD RECEIVER ESV, S/N 872147/53 CAL DUE 17 NOV 98

Test Category: FCC CLASS B

Time, Temp., & % r.H.: 1600, 82°F, 50% Approved: David A Carmany

7.2 Test Instrumentation for Radiated Measurements

Signature scans were made in a RF semi-anechoic chamber 28' long x 16' wide x 16' high with its interior lined on the ceiling and four walls with pyramidal absorber material up to four feet in length. Signature scan measurements were made with a spectrum analyzer with a quasi-peak adapter. The test instrumentation used in the RF semi-anechoic chamber and at the OATS is given in Table 7.3.

TABLE 7.3
RADIATED TEST INSTRUMENTATION

Type	Manufacturer/ Model No.	Serial No.	Cal Due
Spectrum Analyzer	HP 8568B	2152A03081	27 Jul 98
Quasi-Peak Adapter	HP 85650A	2043A00213	9 Aug 98
RF Amplifier	SwRI VTC10-221-1	9112SN15	Verified
RF Amplifier	HP 8447F	2727A02261	Verified
Receiver	Polarad ESH2	879014/018	14 Nov 98
Receiver	Polarad ESV	872147/53	17 Nov 98
Loop Antenna	Electro-Metrics ALR-25	086	4 Dec 98
Dipole Antenna	Electro-Metrics BDA 255	535	24 Mar 98

7.3 Transmit Sweep Bandwidth

The data plot of the spectrum analyzer display shows that the sweep bandwidth of the EUT was 4.945 MHz to 6.05 MHz. A spectrum analyzer with a loop antenna placed near the EUT was used to take a measurement of the sweep bandwidth of the system. The slope of the measurement shows the antenna factor.

7.4 Field Strength Calculation

For measurements from 200 MHz to 1 GHz, a preamplifier was used.

The field strength was calculated by adding the antenna factor and cable factor, and subtracting the amplifier gain (when used) from the measured reading. The basic equation with a sample calculation is provided below:

FS = RA + AF + CF - AG

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation
AG = Amplifier Gain

For example, reducing the first column of the enclosed radiated data sheet on page 15, 48.87 MHz yields:

0.0 dB
18.0 dB(μV)
11.8 dB(1/m)
2.5 dB (CF/AG FACTOR)
FS = 32.3 dB(μV/m)

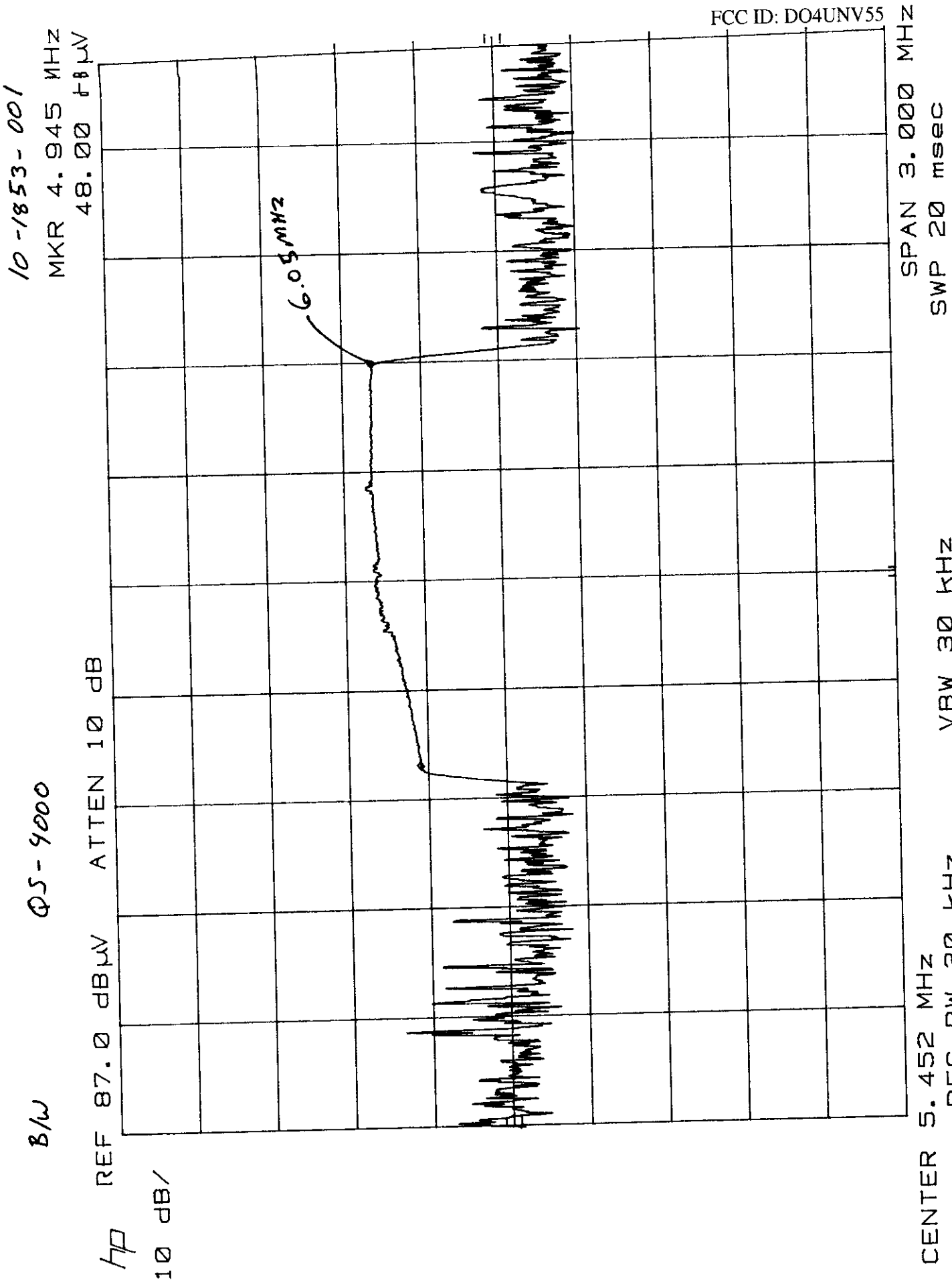
The equation to convert the dB(μV/m) value to its corresponding level in μV/m is as follows:

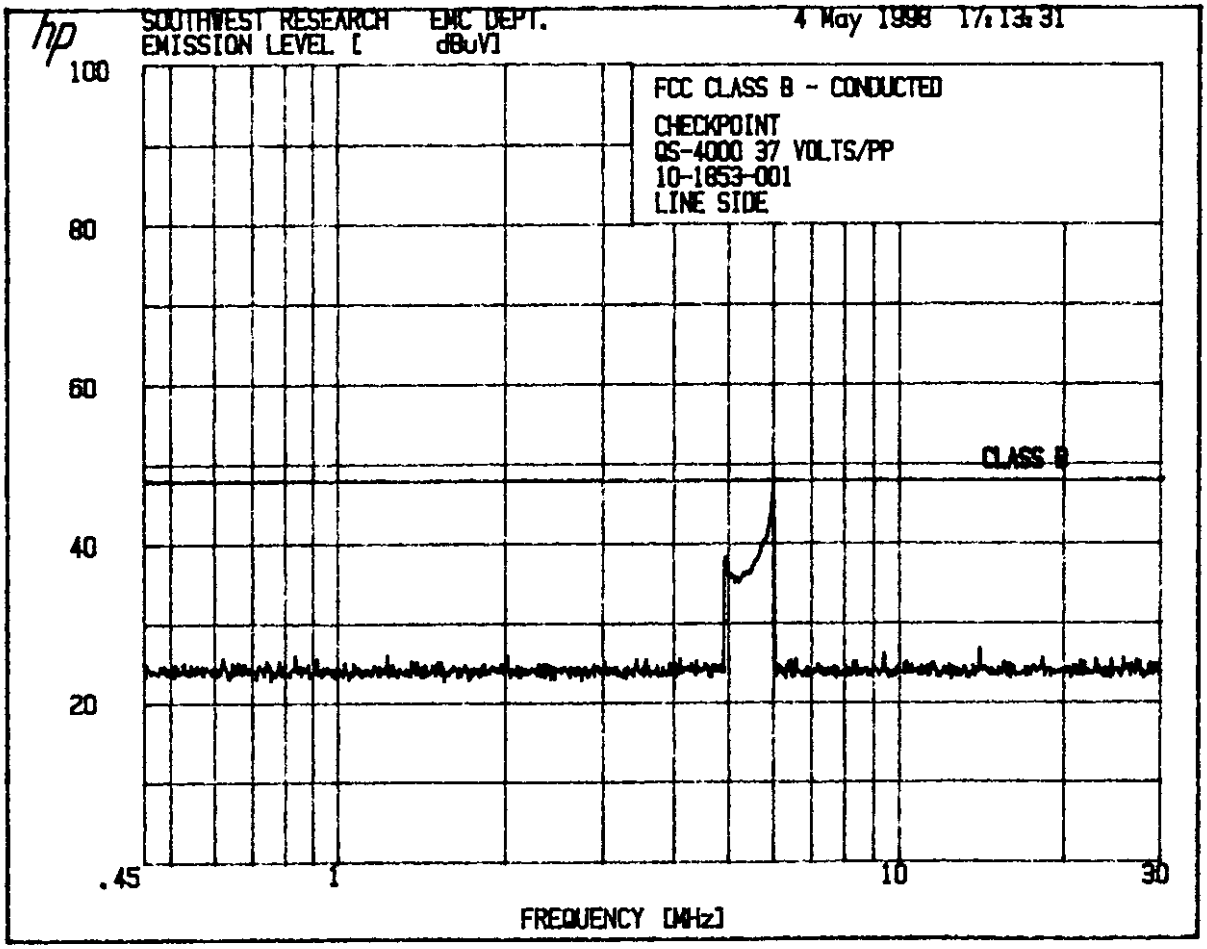
Level in μV/m Common Antilogarithm [(32.3 dBμV/m)/20] = 41.2 μV/m

8.0 PHOTOS OF TESTED EUT

Following are photos of the tested EUT.

APPENDIX


10-1853-001
MKR 4.945 MHz
48.00 dBµV
6.05 MHz
SPAN 3.000 MHz
SWP 20 msec
QS-9000
B/W
REF 87.0 dBµV
ATTEN 10 dB
VBW 30 kHz
10 dB/
CENTER 5.452 MHz
RES BW 30 kHz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CHECKPOINT
QS-4000 37 VOLTS/PP
10-1853-001
LINE SIDE
CLASS B
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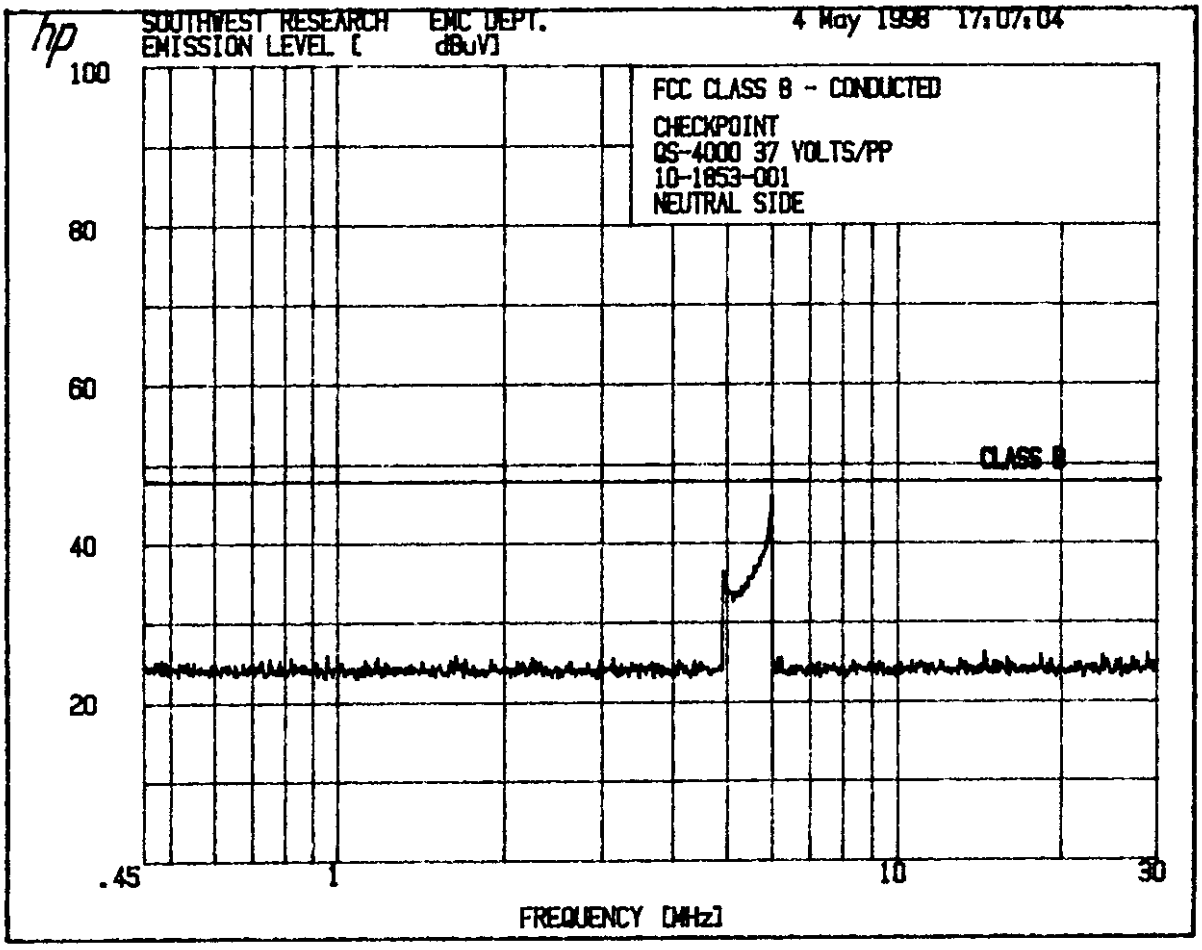
60
40
20
.45
1
10
30
FREQUENCY [MHz]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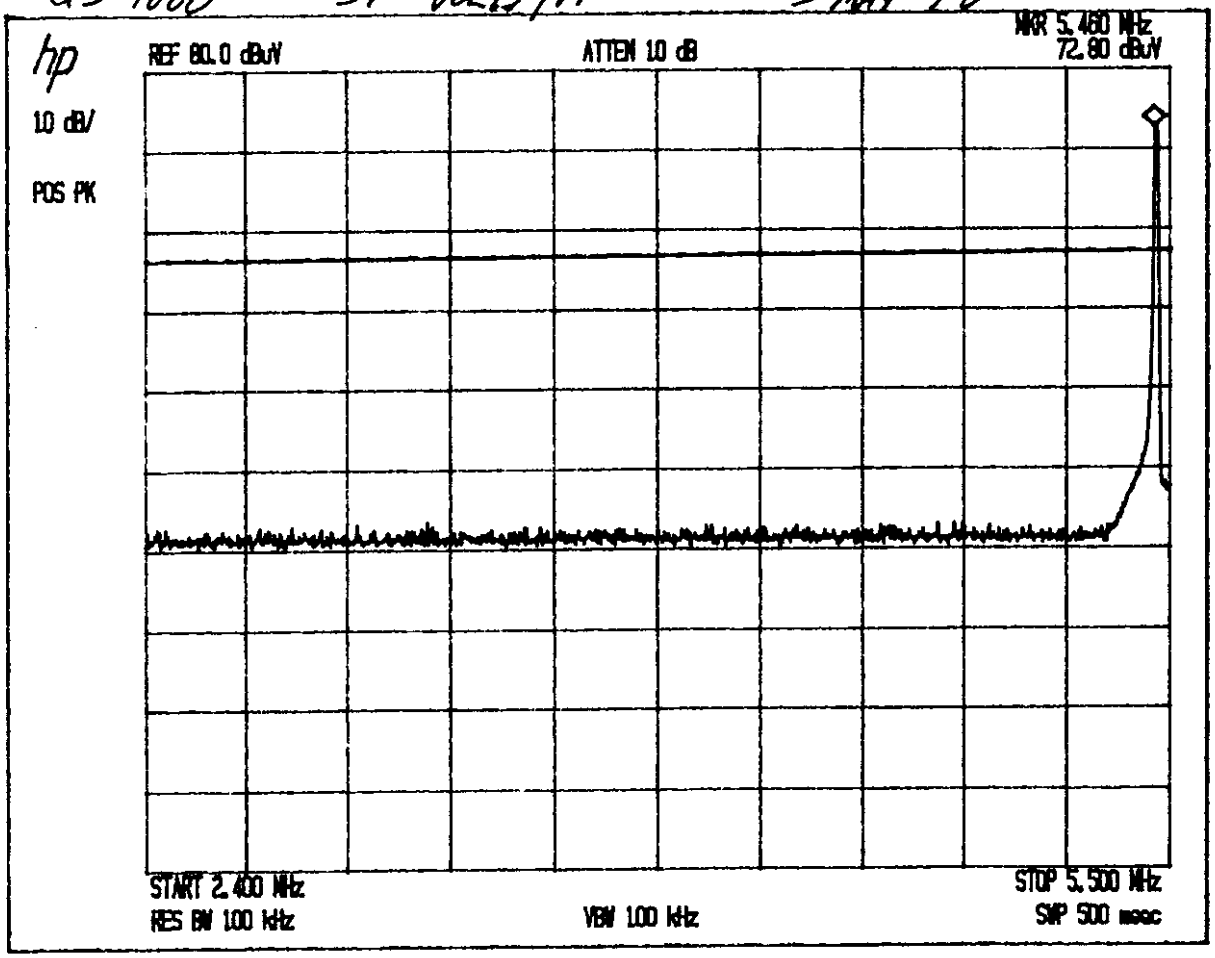
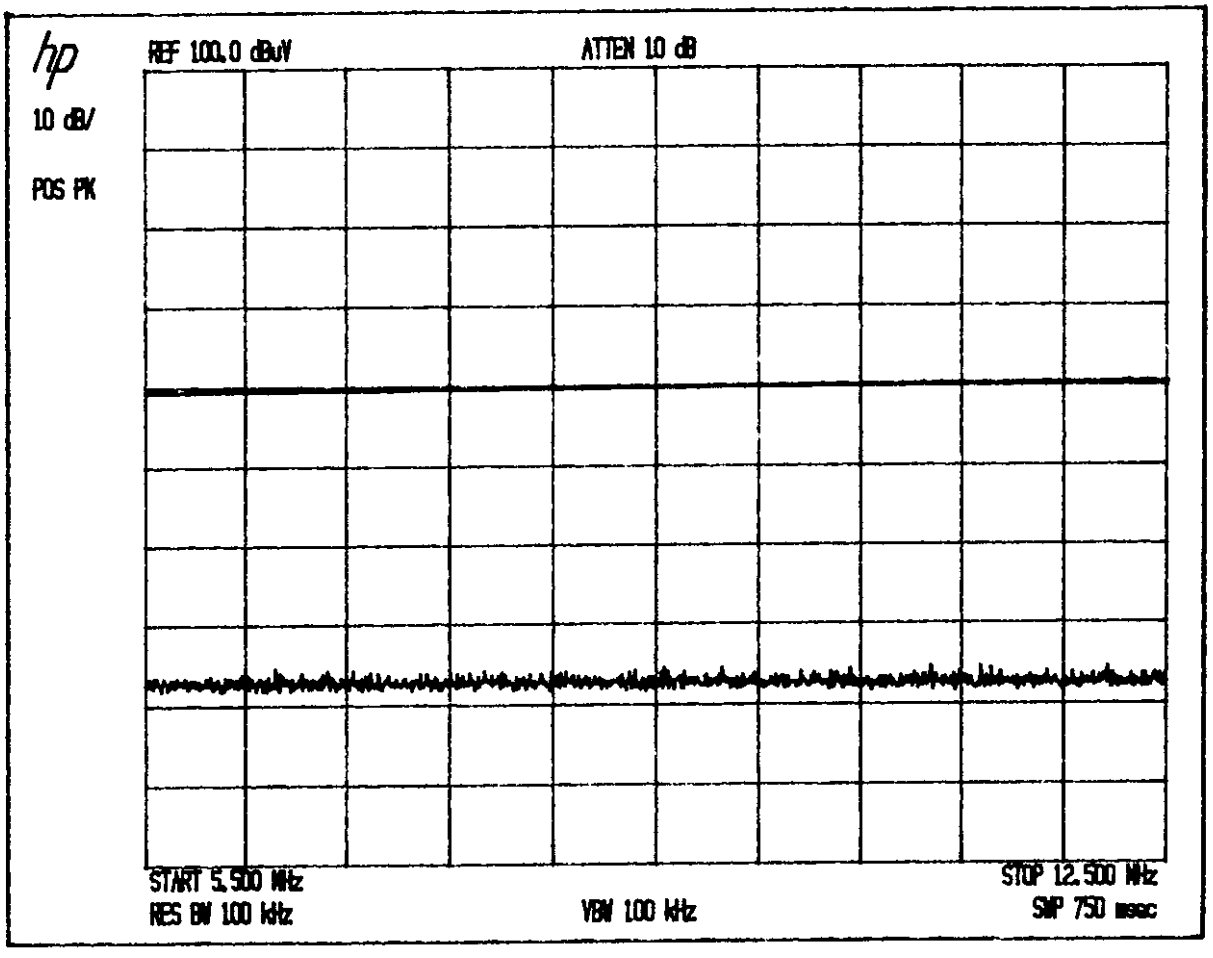
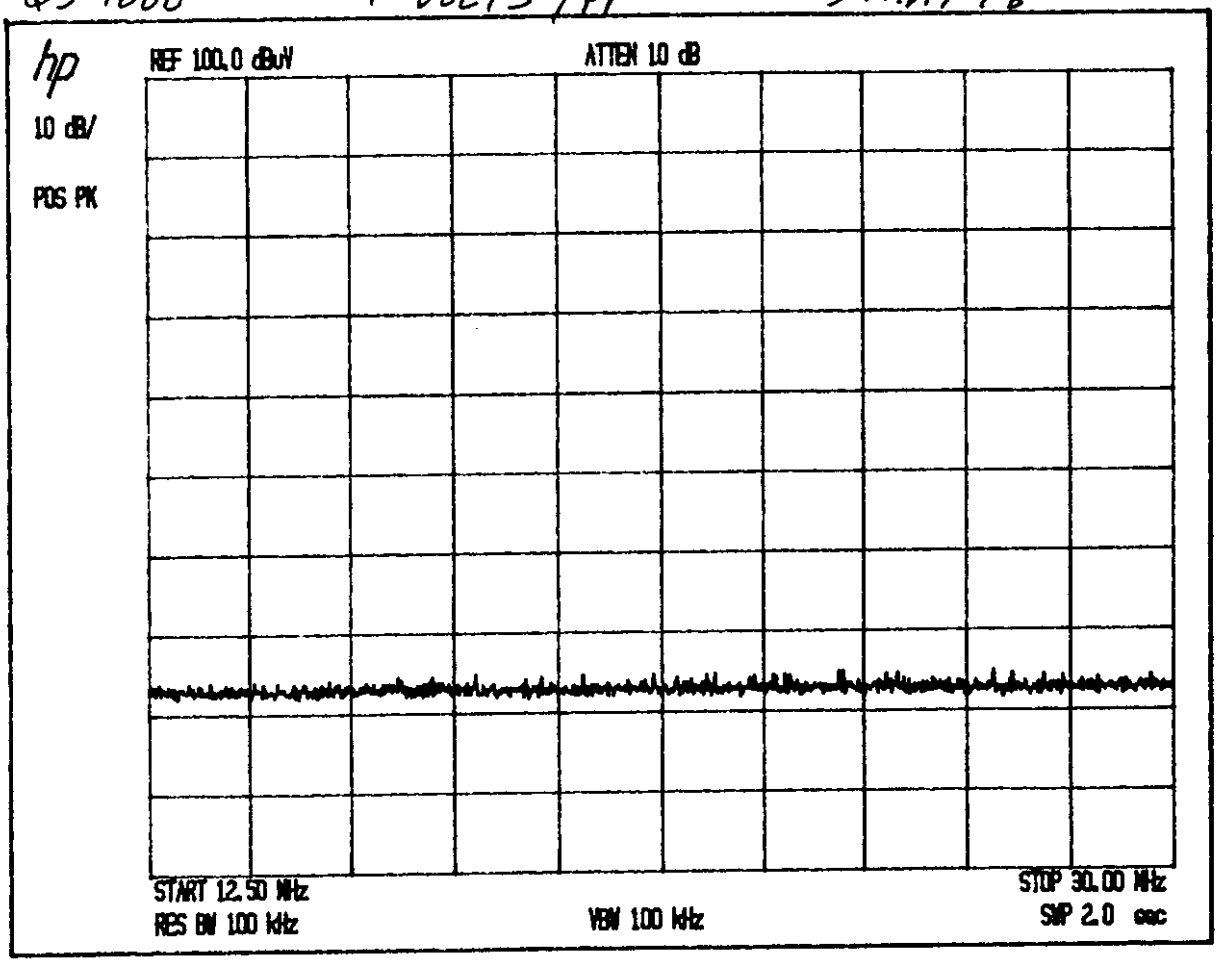
10-1853-001
NEUTRAL SIDE
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

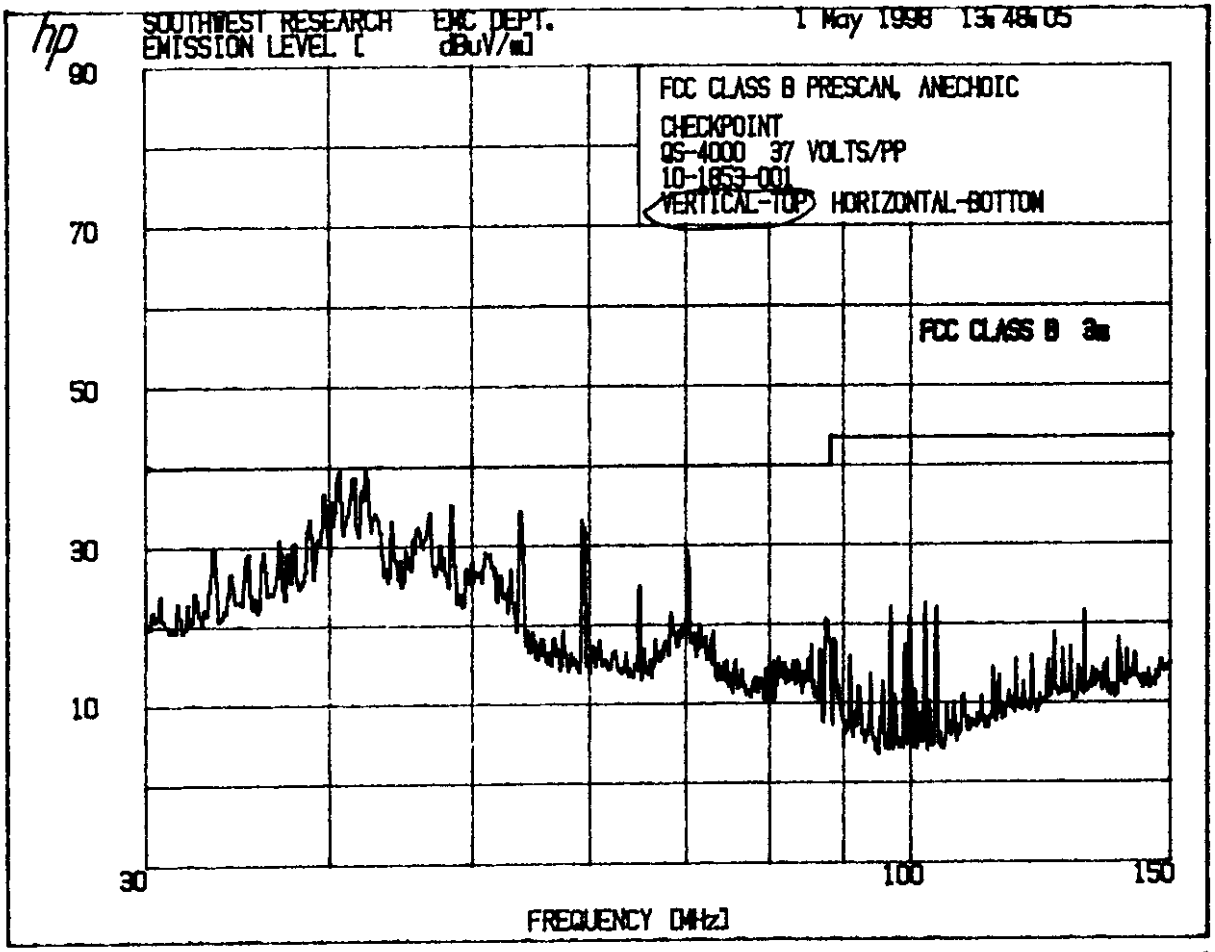
QS 4000 37 VOLTS/PP 5 MAY 98





QS4000 37 VOLTS / PP 5 MAY 98

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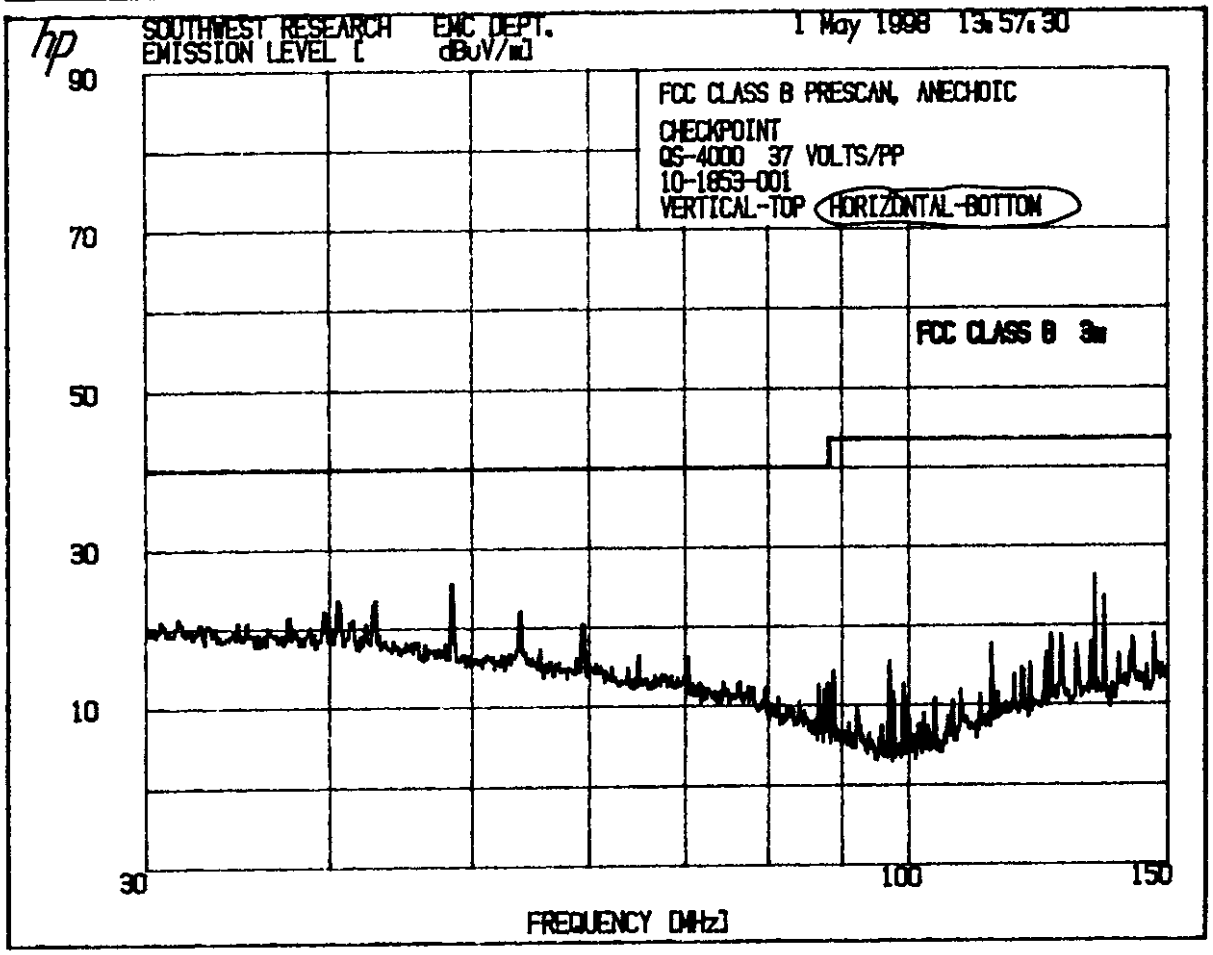
CHECKPOINT
QS-4000 37 VOLTS/PP
10-1853-001
VERTICAL-TOP HORIZONTAL-BOTTOM
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]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10-1853-001
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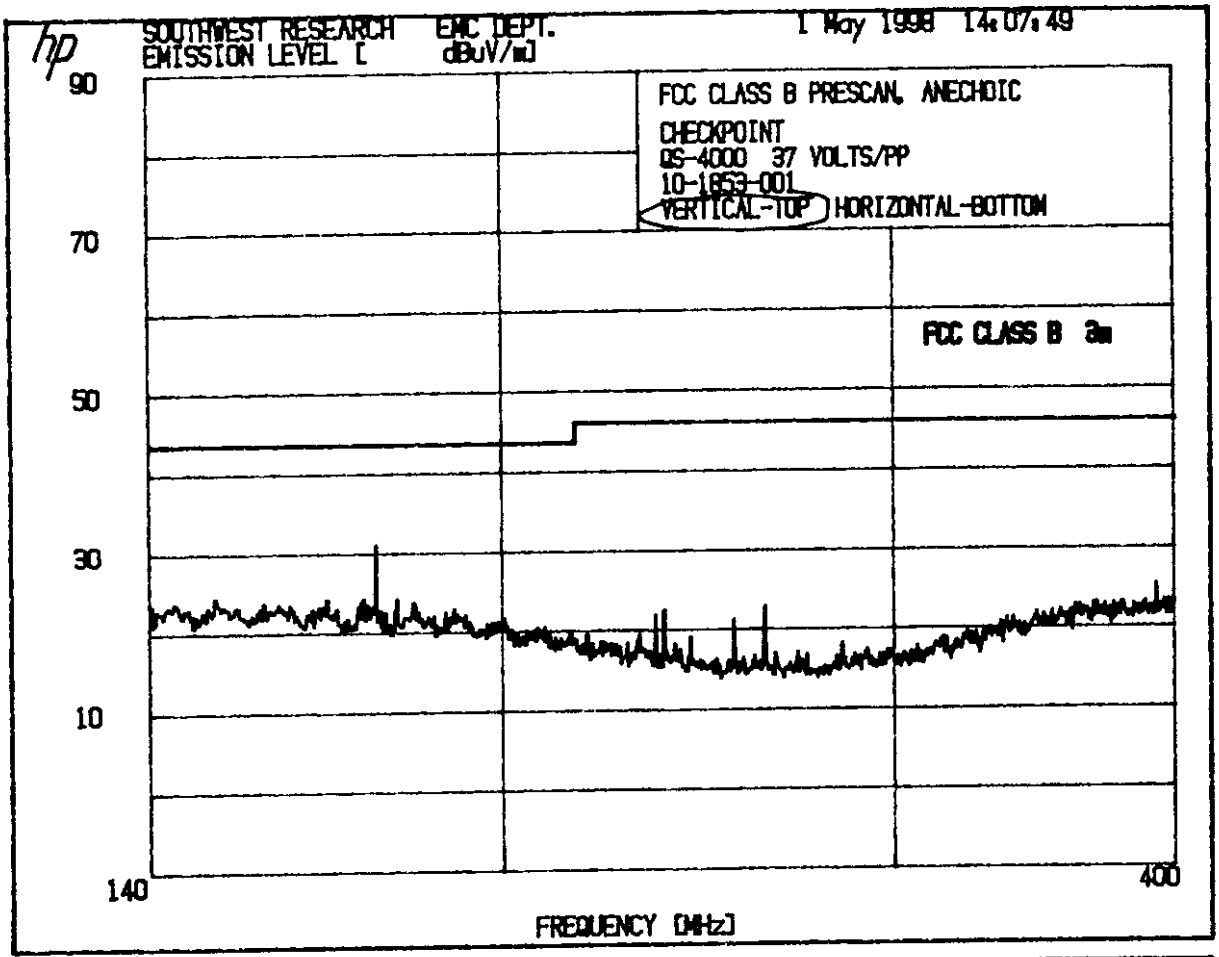
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]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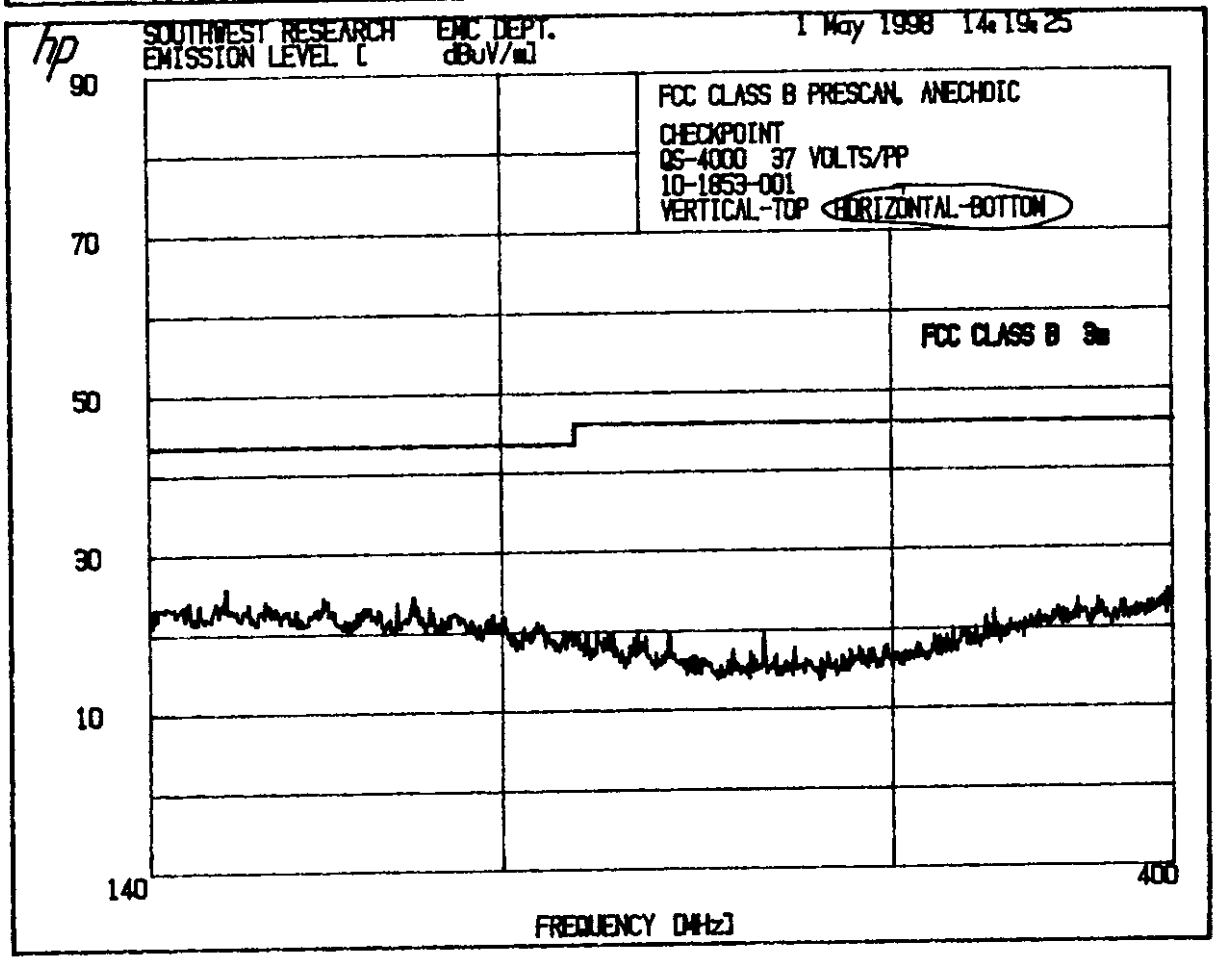
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]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CHECKPOINT
QS-4000 37 VOLTS/PP
10-1853-001
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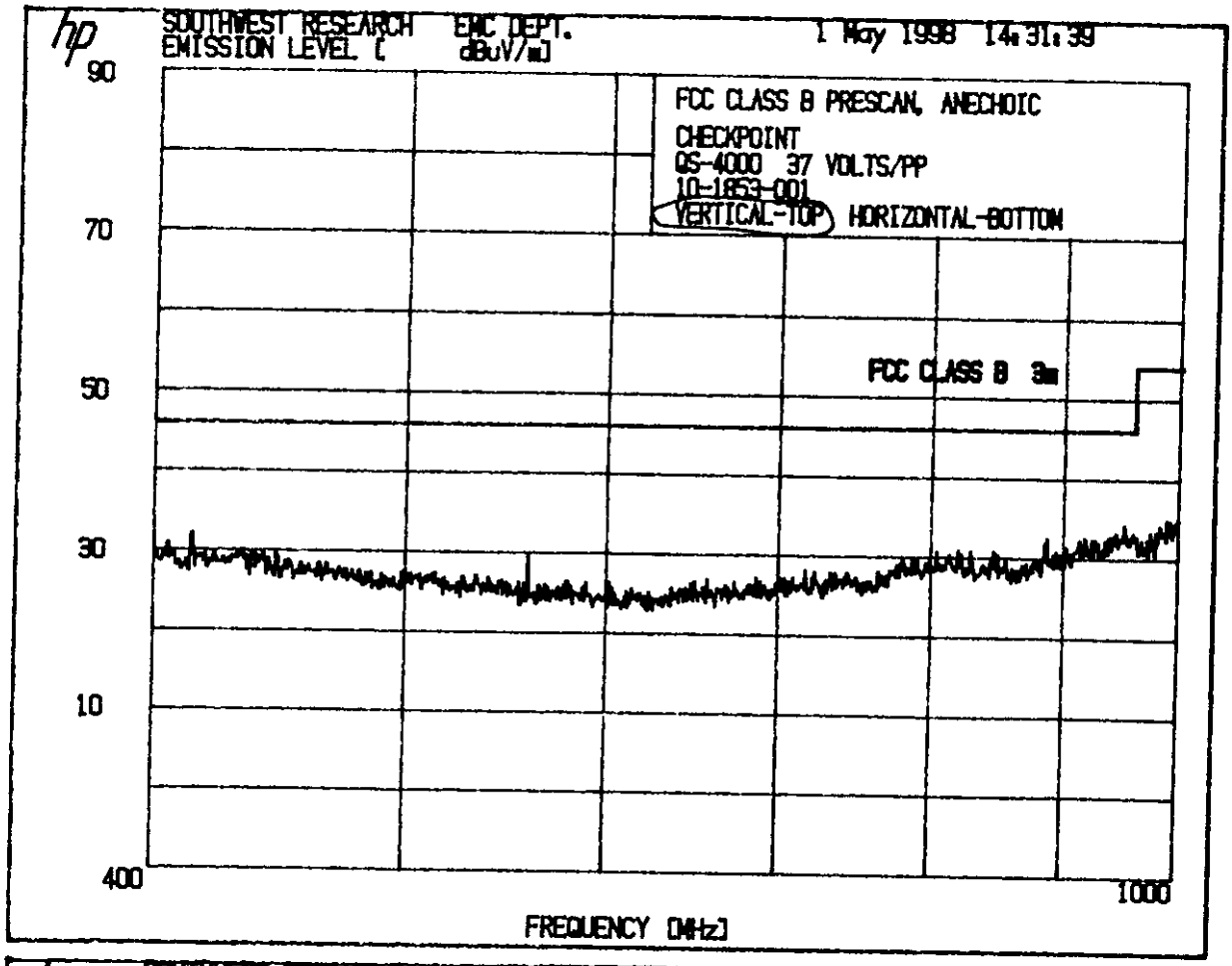
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]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10-1853-001
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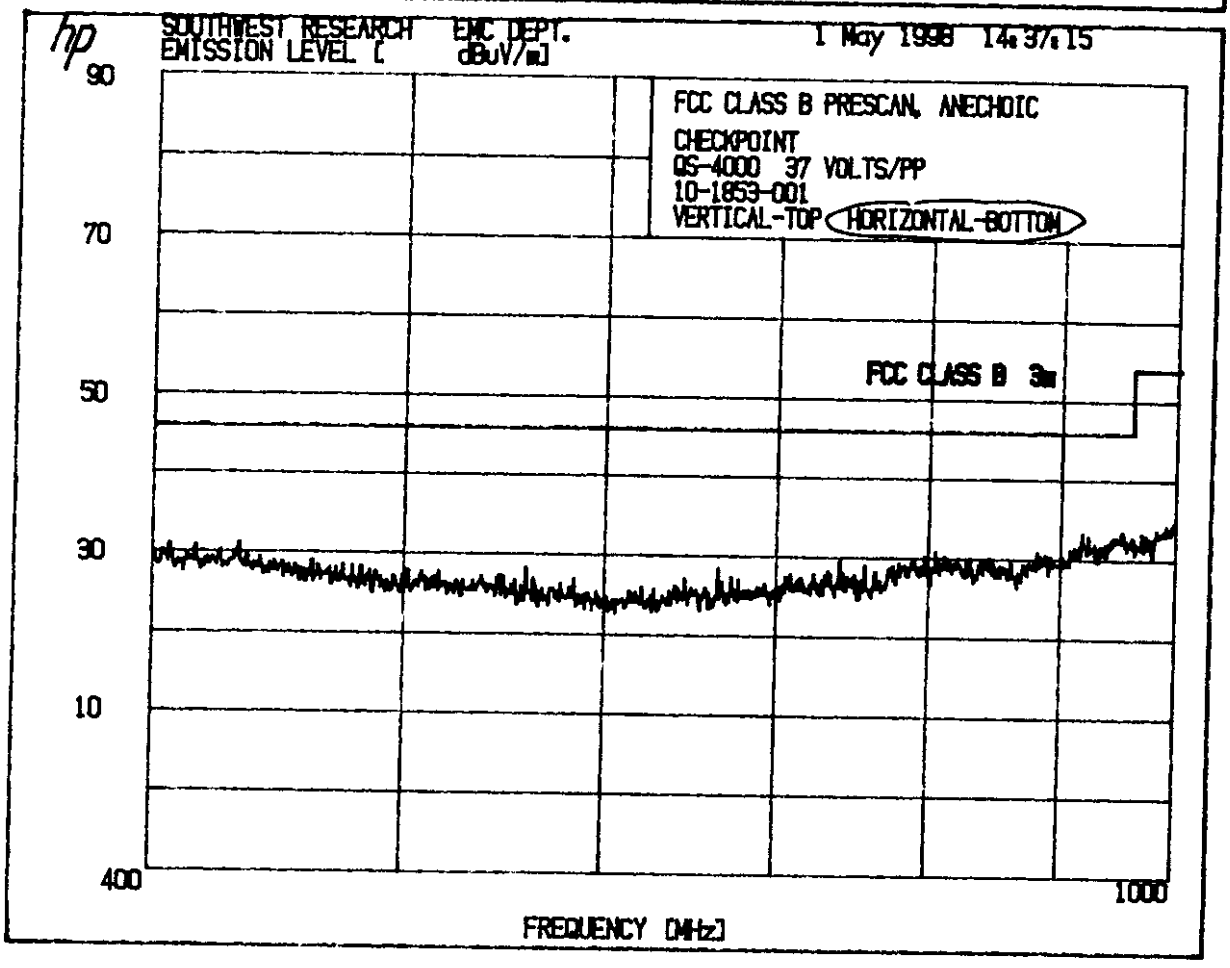
90
70
50
30
10
400
1000
FREQUENCY [MHz]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CHECKPOINT
QS-4000 37 VOLTS/PP
10-1853-001
VERTICAL-TOP HORIZONTAL-BOTTOM
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]