



L. S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, Wisconsin 53012

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

L. S. Compliance, Inc.

Compliance Testing of:

TRANSLUX FAIRPLAY QUICK PITCH

Model: QP-100-RF

Prepared for:

TRANS-LUX MIDWEST CORPORATION

Test Report Number: 90354

Date(s) of Testing:

February 9, 10, March 21, April 25, 2000



FCC ID: OMF-QP-100-RF

All results of this report relate only to the items that were tested.

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ATTACHMENT

**Report of Conducted Emission and Jamming
Margin Test Results on the Fair-Play RF Module
used within the Trans-Lux Fair-Play Quick
Pitch.**

FCC ID Number: OMF-QP-100-RF

**Please see File Name:
“Response – Attachment Report for 15.247 Tests”**



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DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

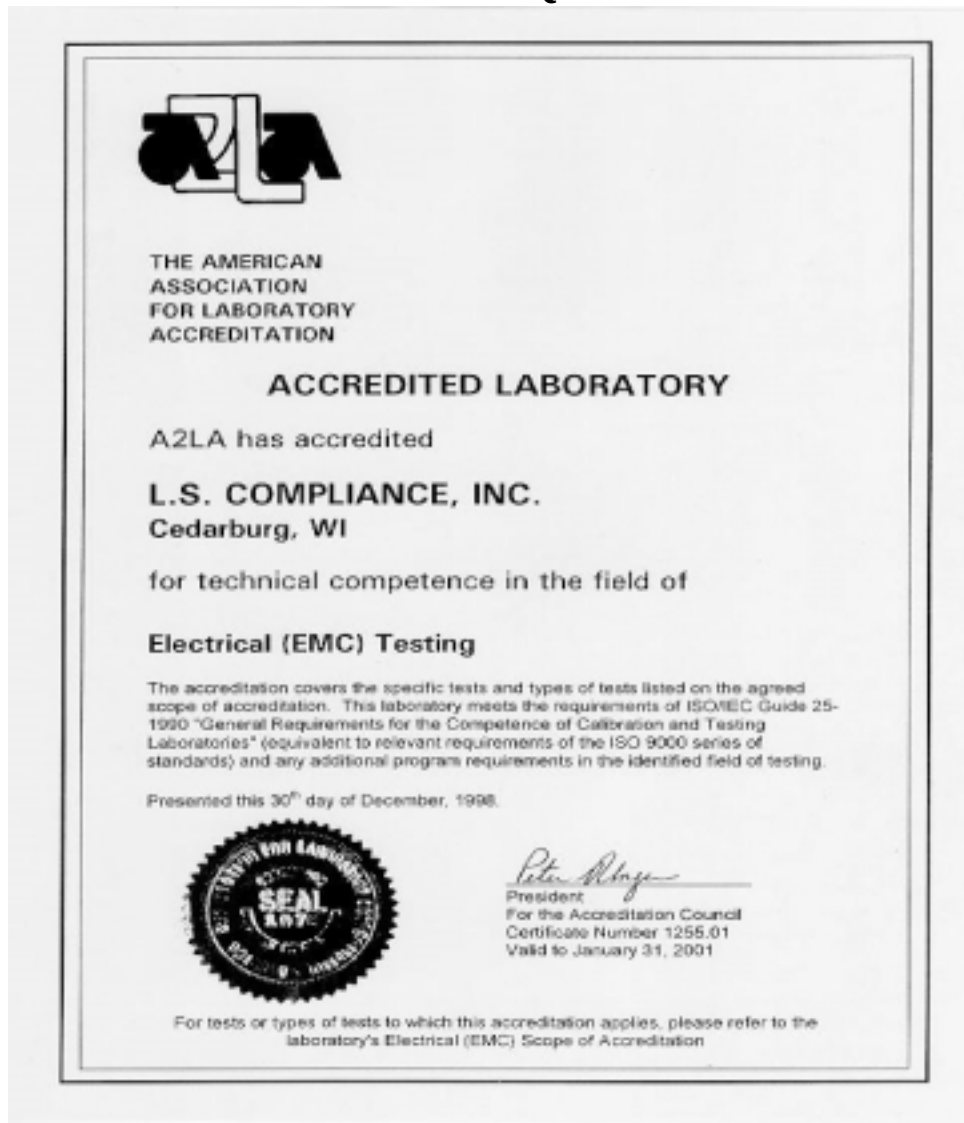
ID Number: 31040/SIT

1300F2

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



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SIGNATURE PAGE

Testing By:

April 27,
2000

Kenneth L. Boston PE

Prepared by:
Approved by

April 27,
2000

Kenneth L. Boston, EMC Lab Manager

Date

PE #31926

Registered Professional Engineer

(State of Wisconsin)



FCC ID: OMF-QP-100-RF

1.3 SUMMARY OF TEST REPORT

MANUFACTURER: Trans-Lux Midwest Corporation

MODEL: Quick Pitch, QP-100-RF

SERIAL: prototype

DESCRIPTION: Quick Pitch speed display interface unit

FREQUENCY RANGE: 902-928 MHz

The Fairplay Quick Pitch was found to **“meet”** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

The Fairplay Quick Pitch was also found to **“meet”** the radiated emission specification of Title 47 CFR, FCC Part 15, subpart B for emissions with regards to the receiver and digital sections of the product.

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

1.4 INTRODUCTION

On February 9, 10, March 21, and April 25 of 2000, a series of Radiated and Conducted Emissions tests were performed on a sample model of the Fairplay QP-100-RF, a spread spectrum transmitter module, designed for wireless data transfer, as a remote data interface unit for a scoreboard. These tests were performed using the test procedures outlined in ANSI C63.4-1992 for intentional radiators, and in accordance with the requirements set forth in FCC Part 15.247 for a spread spectrum transmitter. Tests were also performed as outlined in ANSI C63.4-1992 for non-intentional radiators, in order to verify compliance with the limits set forth in part 15.109 for and to allow verification of emissions for the digital section of the product. These tests were performed by Kenneth L. Boston, PE, of L. S. Compliance, Inc.

**FCC ID: OMF-QP-100-RF****1.5 PURPOSE**

The above mentioned tests were performed in order to determine the compliance of the Fairplay QP-100-RF product with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.207	15.247b	15.247e
15.205	15.247c	15.109
15.247a2	15.247d	

Various of these tests, including the conducted RF out the antenna port and the jamming margin test are contained in an additional test report that is attached to this report. These measurements were earlier performed on the Fairplay MP-70 product, which has the same RF module, and differs only in the case, and outer hardware. 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 Conducted (AC LINE) Test Setup and measurements

The Conducted Emission tests were performed within an 8 by 10 foot shielded room located at L. S. Compliance, Inc. in Cedarburg, WI. The test item was placed on a non-conductive rubber cart, with a height of 80 cm above the reference ground plane. The test object was spaced 40 cm from the rear wall of the shielded room and further than 80 cm from adjacent walls, and the test object power supply was plugged into a 50 Ω (ohm) 50/250 μ H Line Impedance Stabilization Network (LISN). The test area and set-up are in accordance with ANSI C63.4-1992, sections 5, 6, and 7. The AC power supply to the LISN was fed into the shielded room via an appropriate broadband EMI filter. The test sample was set to operate on the middle channel in continuous transmit during the measurements, and operation was also checked on the low and high channels.

After the equipment under test was set-up in the shielded room and connected to the LISN, the RF sampling port of the LISN was cabled to a 10dB attenuator-limiter, and then to the EMI analyzer. The EMCO LISN used has the facility to terminate the unused port with a 50 Ω (ohm) load when switched to either L1 (line) or L2 (neutral). The appropriate frequency range and bandwidths were entered into the HP 8591EM EMI analyzer, and measurements were made. The test object cables and position were varied to find the maximum signal levels. Final readings were then taken and recorded. The test procedure guidelines used are found in ANSI C63.4-1992: Sections 7 and 11 including Annex E1 and E2.



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The limits for conducted emissions for this test object are found in Title 47CFR, FCC Part 15.207 (b) for an intentional radiator. The levels of these limits are 250 μ V (48dB μ V) from 450 kHz to 30 MHz. Test results are located in Appendix II and pictures of the test setup are in section 1.11.



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1.7 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. The sample was positioned on a small wood pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on its internal power supply. The test sample was configured to run in a continuous transmit mode during the 15.247 and 15.205 measurements. The sample was also set to run in a continuous transmit loop. One test sample was set to operate on either channel 1 (low), channel 6 (medium) or channel D (high) while being tested as an intentional radiator, in order to determine compliance within a frequency range of 902-928 MHz, as dictated by FCC part 15.31m

The system was also mounted on the 80 CM high wooden table, centered on the turntable for measurement of spurious signals emanating from the system while in the transmit mode.

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

1.8 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 15.247c limits for Direct Sequence Spread Spectrum systems, and the 15.205 general limits, within the restricted bands. For the calculations used to determine the 1 meter limits, see Appendix A. The test sample was tested from the lowest frequency generated by the transmitter to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed where 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 sample was mounted on the supplied metal tripod and placed in the 3 Meter chamber and the antenna mast was placed such that the antenna was either 1 meter or 3 meters from the test object. 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, 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. Emissions above 1 GHz were also measured at a 1 meter separation, using the HP Microwave spectrum analyzer.

No significant emissions were found aside from the transmitter fundamental and some spurious signals. The unit was scanned for emissions in both transmit and receive modes, over the range 30 to 10000 MHz to establish compliance with Part 15.247c and 15.205 for the system. Also, the scans were performed to evaluate the digital controller section of the product, which is subject to verification as a Class B digital device. The same procedures as detailed for the transmitter tests



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described above were used to perform these measurements. The results of the system measurements are found in Appendix B, with graphs of the signature scans found in Appendix C.



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1.9 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment 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 peak and Quasi-peak detector functions were used.

For measurements in the upper microwave region, an HP E4407B 26.5 GHz spectrum analyzer was used. Antenna factors for the horn antenna, a short jumper cable and a high pass filter were entered into the analyzer as correction factors. This allowed for direct readings to be made of the field strength. During emissions testing, signals where significant levels were noted were measured using the 1 MHz IF bandwidth, and a 10 or 100 Hz video bandwidth, resulting in an average measurement mode of the analyzer.

**1.10- Restricted Bands affecting this product**

3 Meter limits

Frequency (MHz)	Limit (μ V)	Limit (dB/ μ V/m)
73.74.6	100	40.0
608-614	200	46.0
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
4500-5150	500	54.0
5350-5460	500	54.0
7250-7750	500	54.0
8025-8500	500	54.0
9000-9200	500	54.0
9300-9500	500	54.0

Plus others in the frequency range below 960 MHz, not listed were spurious signals were not present.

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1.11 - Photo taken during testing View of the QP-100 during the Radiated Emissions tests.



View of the QP-100 during the Conducted Emissions tests.

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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 Fairplay QP-100-RF does **“meet”** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. Emission levels at the 3rd and 4th harmonics of the product were seen to be close to the limit (0.4 to 0.9 dB). As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

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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1.13 - Test Equipment

Asset #	Manufacturer	Model	Serial#	Description	Due Date
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	3aug2000
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	3aug2000
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	1aug2000
EE960004	EMCO	2090	9607-1164	Mast/Ttable controller	I.O.
EE960003	HP	85460	3617A00320	EMI receiver Display section	23aug2000
EE960003	HP	85462	3205A00103	EMI receiver Preselector section	23aug2000
CC000221	HP	E4407b	Us39160256	26.5 GHz Spectrum Analyzer	16june2000
FF666020	HP	8591EM	3710A01194	EMI Spectrum Analyzer	29nov2000
AA960008	EMCO	3816/2	9701-1057	16 amp LISN	29july2000
AA960031	HP	11947A	3107A01708	Limiter	10june2000
--	LSC	Cable	0011	3 meter Helix	23feb2000
--	LSC	Cable	0038	1 meter RG214	30dec1999
--	LSC	Cable	0050	10 meter RG214	30dec1999



APPENDIX A:

SAMPLE CALCULATIONS

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**Calculation of Radiated Emissions limits for
FCC Part 15.209 (above 1 GHz)**

The following table depicts the Class B limits for an unintentional radiator. Limits are established at a measurement distance of 3 meters and limits corrected for a 1 meter measurement distance which are extrapolated from the 3 meter limit.

Frequency (MHz)	3m limit (dB μ V/m)	1m limit (dB μ V/m)
960 MHz up	54	63.54

- The 1 meter limits were calculated by adding a factor of 9.54 dB, derived from:

$$20\log_{10}(3/1) = 9.54 \text{ dB } \mu\text{V/m}$$

$$1\text{m limit} = 3\text{m limit} + \text{factor}$$

$$= 54 \text{ dB } \mu\text{V/m} + 9.54 \text{ dB } \mu\text{V/m} = 63.54 \text{ dB } \mu\text{V/m}$$

$$\text{rounded off} = 63.5 \text{ dB } \mu\text{V/m}$$

**Calculation of Radiated Emission Limits for 15.247(b)(1); 20db below 1
Watt**

FROM THE STANDARD REFERENCE FORMULA FOR POWER TRANSMITTED VERSUS ELECTRIC FIELD:

$$P_t = (R^{**}) \times |E|^{**} / 30$$

$$P_t = 20\log|E| + 20\log(R) - 10\log(30)$$

Insert additional terms to convert watts to milli-watts (in dB) and volts to micro-volts (in dBuV):

$$P_t = 20\log|E_{uv}| - 20\log(1,000,000) + 10\log(1000) + 20\log(3) - 10\log(30)$$

$$P_t = 20\log|E_{uv}| - 120 + 30 + 9.54 - 14.77$$

$$P_t = 20\log|E_{uv}| - 95.23$$

$$\text{OR; } 20\log|E_{uv}| = P_t (\text{in dBm}) + 95.23$$



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$$|E| \text{ (in dBuV)} = +10 \text{ dBm} + 95.23 = \underline{105.23 \text{ dBuV/m}}, \text{ at 3 meters}$$

At 1 meter; limit = $105.23 + 9.54 = 114.77 \text{ dBuV/m}$ or rounded to 114.8 dBuV/m



APPENDIX B:

DATA CHARTS

**FCC ID : OMF-QP-100-RF**

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed
Chamber

Frequency Range inspected: 30 to 1000 MHz

Date of Test:	February 9,10, 2000	Manufacturer:	Trans-Lux Midwest
Location:	L. S. Compliance, Inc.	Model No.:	QP-100-RF
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	47CFR FCC Part 15.10	Serial No.:	prototype
Distance:	3 meters	Configuration:	TX; Channels 1,6, D
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Quasi-peak
	EMCO 3146A Log Periodic		
	EMCO 3110B Biconical		

The following table depicts the level of significant spurious emissions found at lower frequencies, including restricted bands. (*)

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB μ V/m)	15.205 Limit (dB μ V/m)	Margin (dB)
73.71(*)	V	1.0	235	20.1	40.0	19.9
81.07	V	1.0	140	16.7	40.0	23.3
158.48	V	1.0	180	24.2	43.5	19.3
158.6	H	1.2	270	22.3	43.5	21.2

**FCC ID : OMF-QP-100-RF**

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed
Chamber

Frequency Range inspected: 1 to 9 GHz

Date of Test:	March 21, 2000	Manufacturer:	Trans-Lux Midwest
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	QP-100-RF
Specifications:	47CFR, FCC Part 15.247(c), 15.205	Serial No.:	prototype
Distance:	1 meter	Configuration:	TX; Channels 1,8, D
Equipment:	HP 8546A EMI Receiver HP 84125C microwave EMI system EMCO 3115 Double Ridged Horn	Detector(s) Used:	Average

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

(On all channels, the second harmonic was seen to be the strongest harmonic, but for this
frequency range, this harmonic does not fall within a restricted band, as defined by 15.205,
and the highest levels seen were greater than 20 dB below the limit)

Frequency (GHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Channel	EMI Meter Reading (dB μV/m)	15.205 Limit (dB μV/m)	Margin (dB)
2733	V	1.0	225	1	61.1	63.5	2.4
3644	V	1.0	330	1	63.1	63.5	0.4
4555	V	1.0	140	1	62.6	63.5	0.9
9111	V	1.0	160	1	62.7	63.5	0.8
2752	V	1.0	180	8	57.7	63.5	5.8
3667	V	1.0	325	8	62.9	63.5	0.6
4586	V	1.0	145	8	56.2	63.5	7.3
7336	V	1.0	355	8	57.3	63.5	6.2
9174	V	1.0	210	8	58.3	63.5	5.2
2779	V	1.0	180	D	62.7	63.5	0.8



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3705	V	1.0	10	D	63.0	63.5	0.5
7410	V	1.0	10	D	59.8	63.5	3.7

**FCC ID : OMF-QP-100-RF**

Measurement of Conducted Emissions within 8' X 10' FCC Listed Shielded Room.

Date of Test:	April 26, 2000	Manufacturer:	Trans-Lux Midwest
Location:	L. S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	QP-100-RF
Specifications:	Title 47CFR, FCC Part 15 Subpart C	Serial No.:	prototype
Distance:	40 cm to vert. G.P.	Configuration:	TX: Channels
Equipment:	HP 85460A, 85462A EMI Receiver EMCO 3810/2NM LISN HP 11947A Limiter	Detector(s) Used:	Quasi-Peak
Lab Conditions:	Temp.: 72° F	Humidity:50%	

The following table depicts the level of significant spurious emissions found:

Frequency (MHz)	Line	EMI Meter Reading (dB μ V)	FCC 15.207 Limit (dB μ V)	Margin (dB)
0.768	L1	33.8	48	14.2
0.784	L1	33.6	48	14.4
25.80	L1	33.0	48	15.0
29.49	L1	35.6	48	12.4
25.80	L2	31.8	48	16.2
29.49	L2	35.1	48	12.9



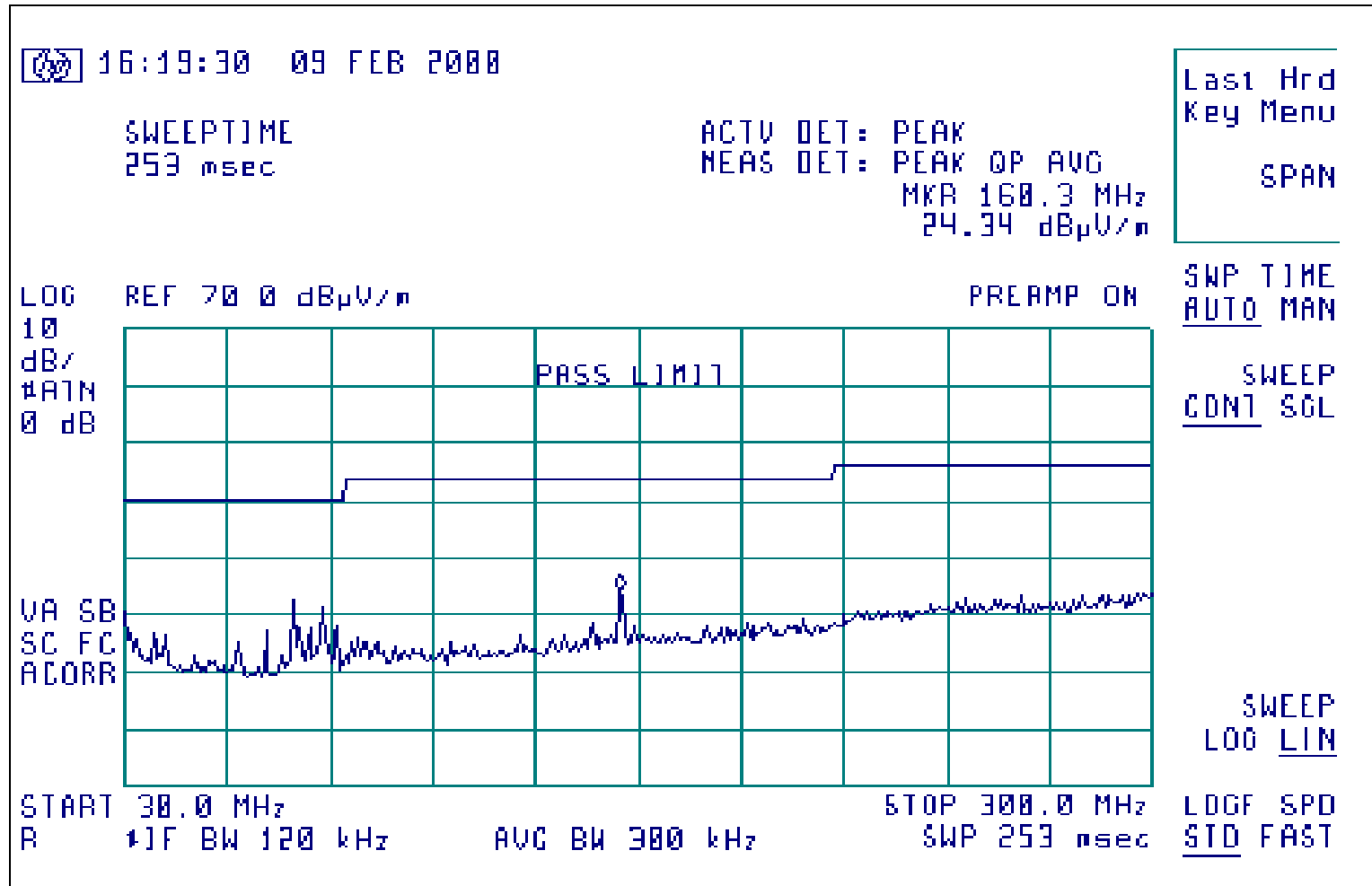
APPENDIX C:

GRAPHS



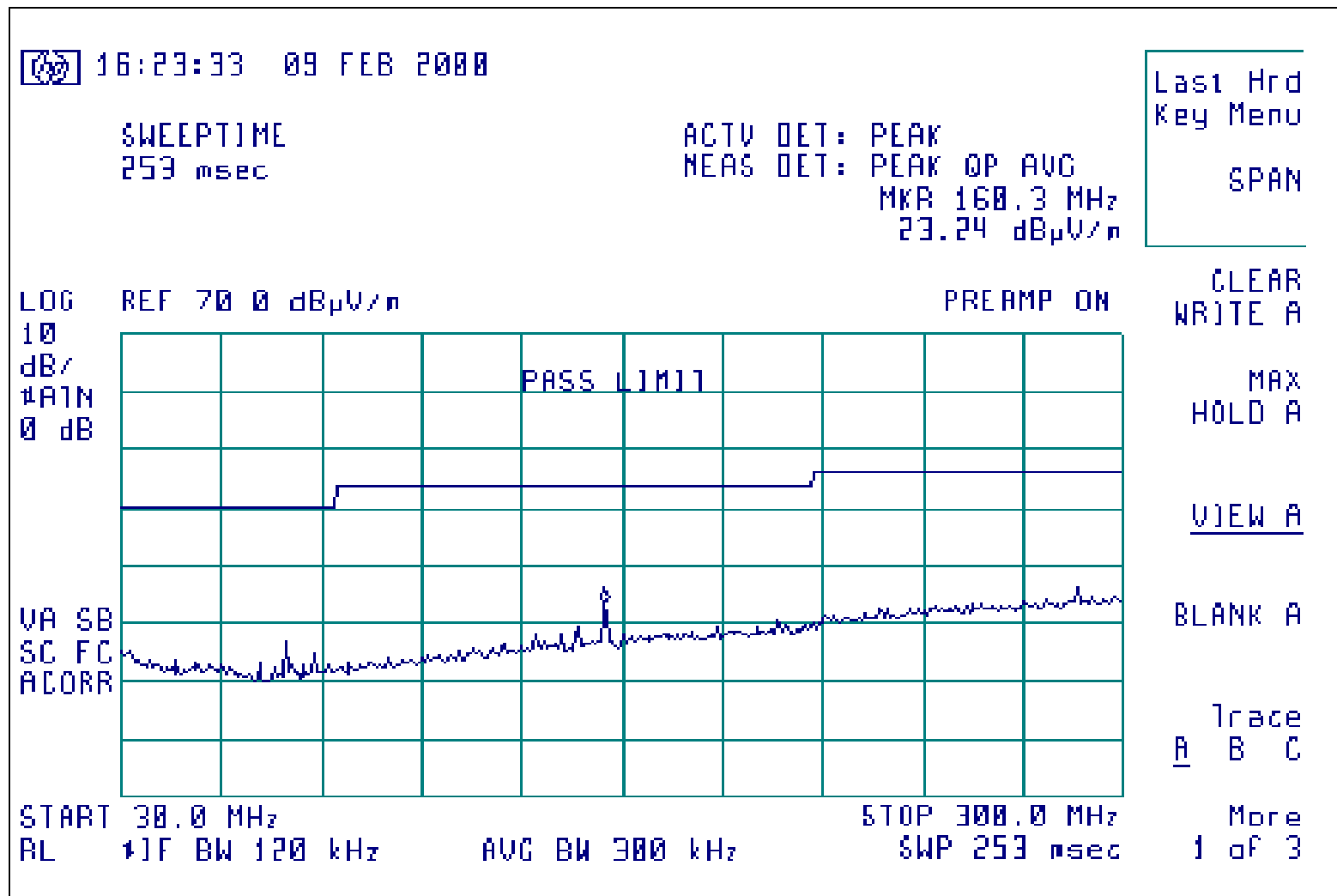
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Radiated Emissions 30-300 MHz, vertical polarity

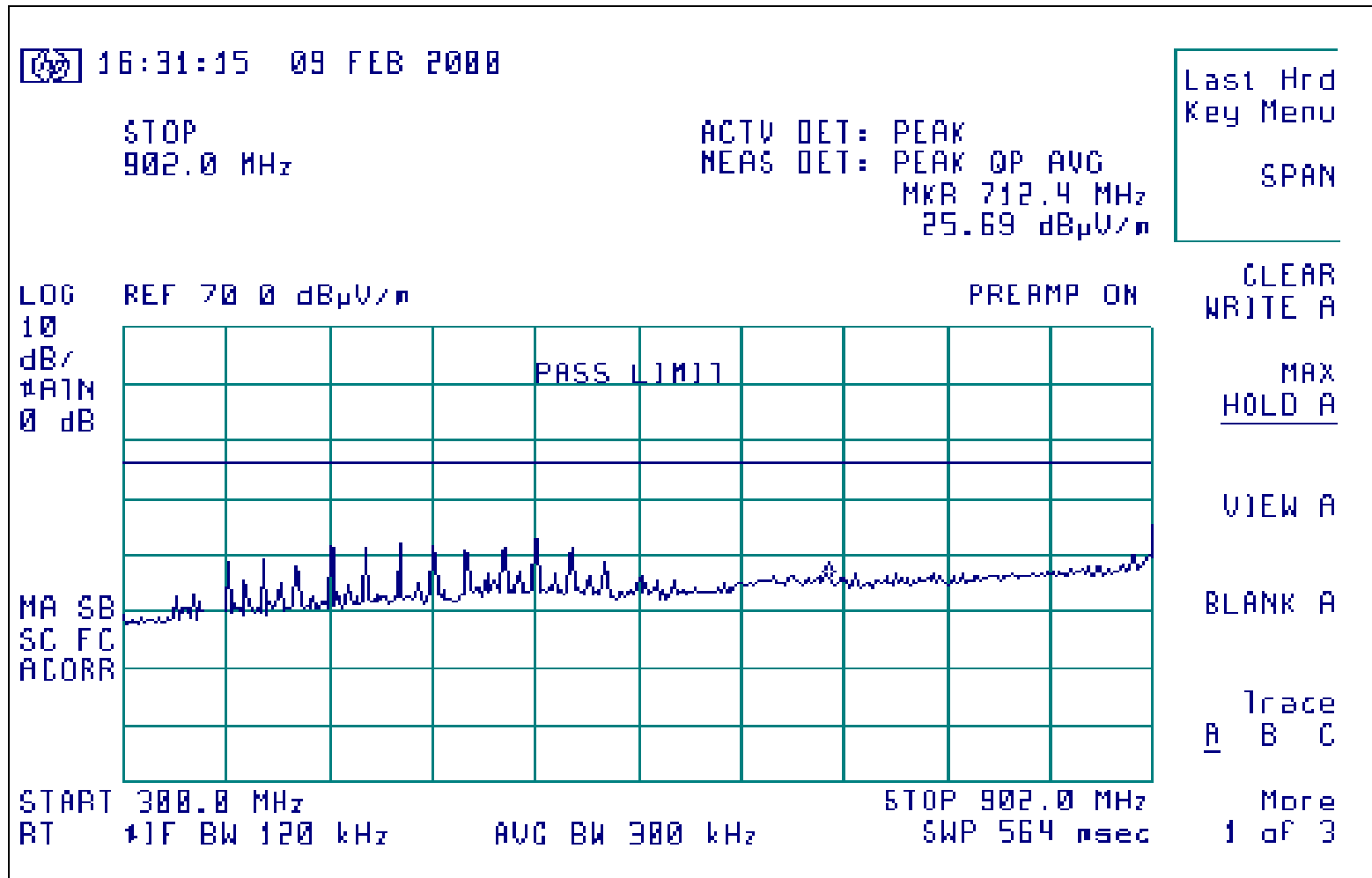


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Radiated Emissions 30-300 MHz, horizontal polarity

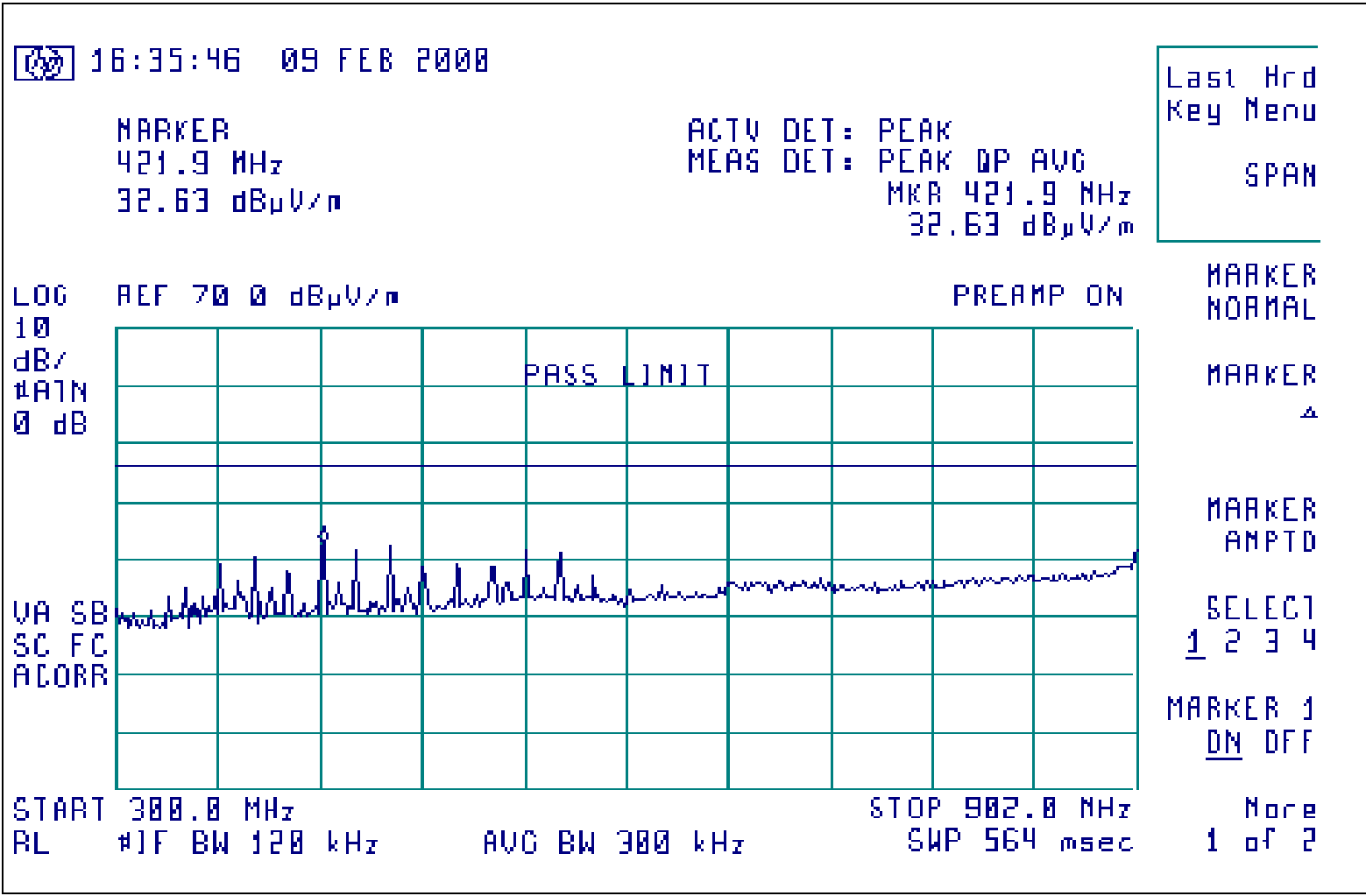


Radiated emissions below 1 GHz, vertical polarity



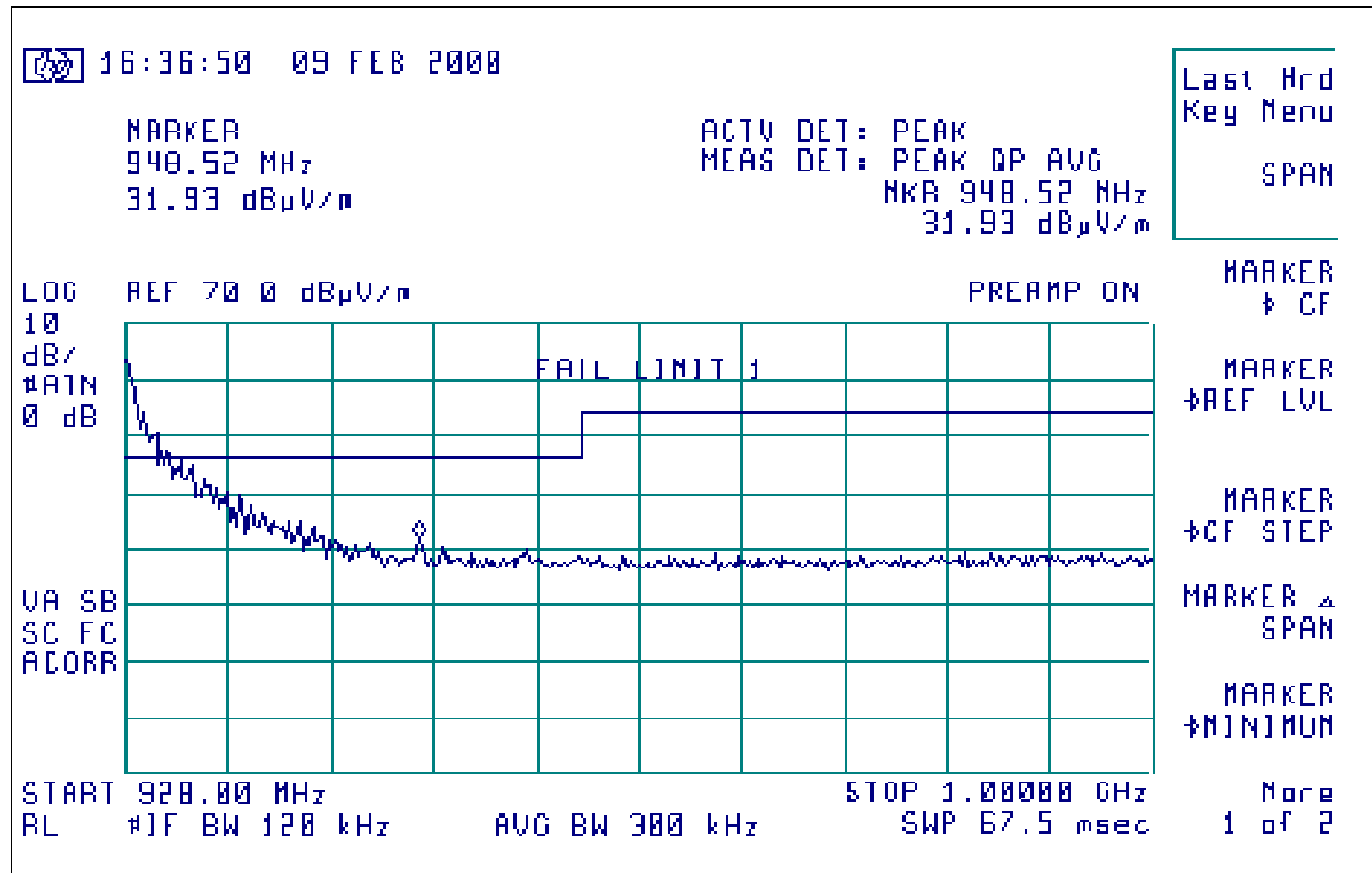
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Radiated Emissions below 1 GHz, horizontal polarity



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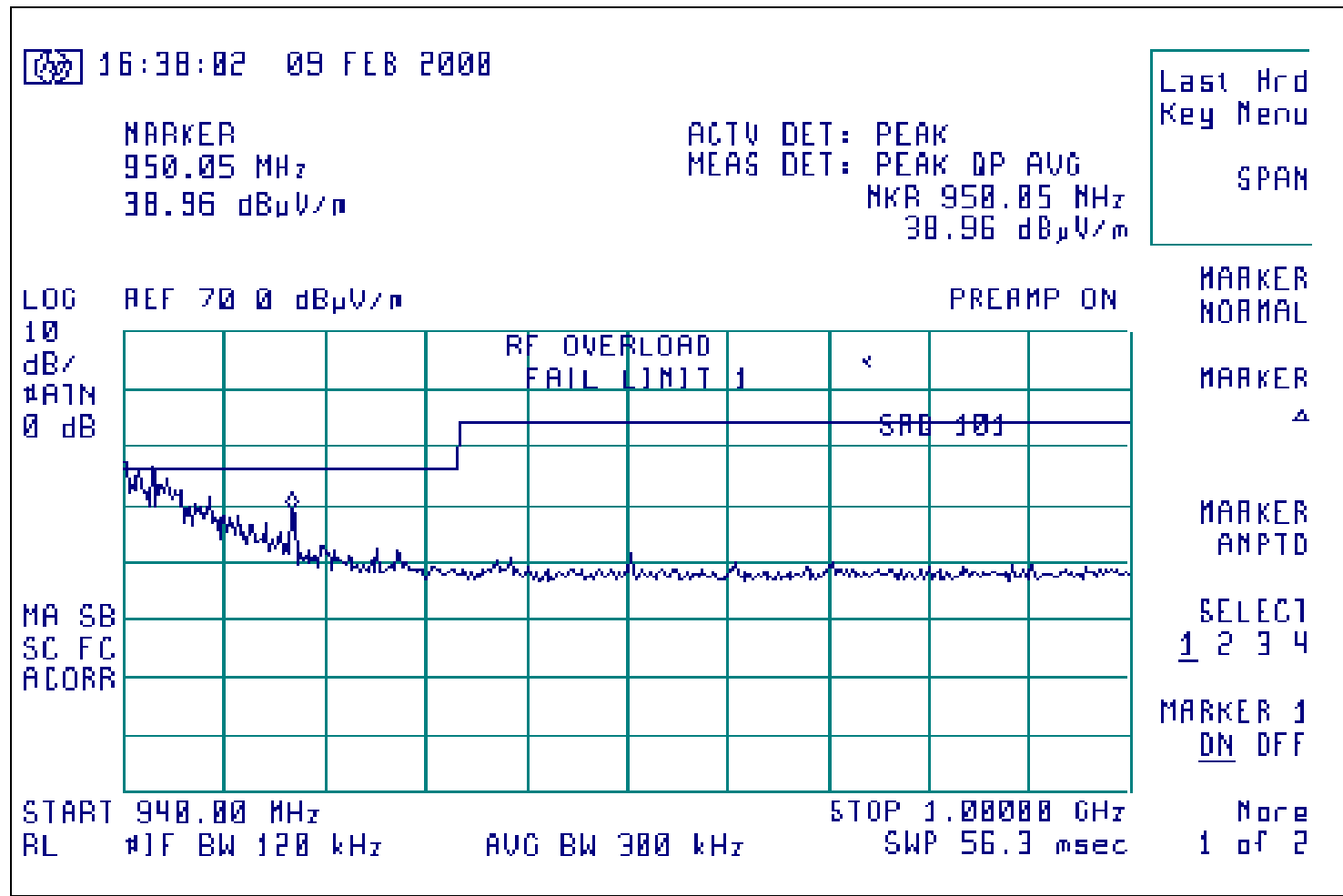
Radiated Emissions below 1 GHz, horizontal polarity





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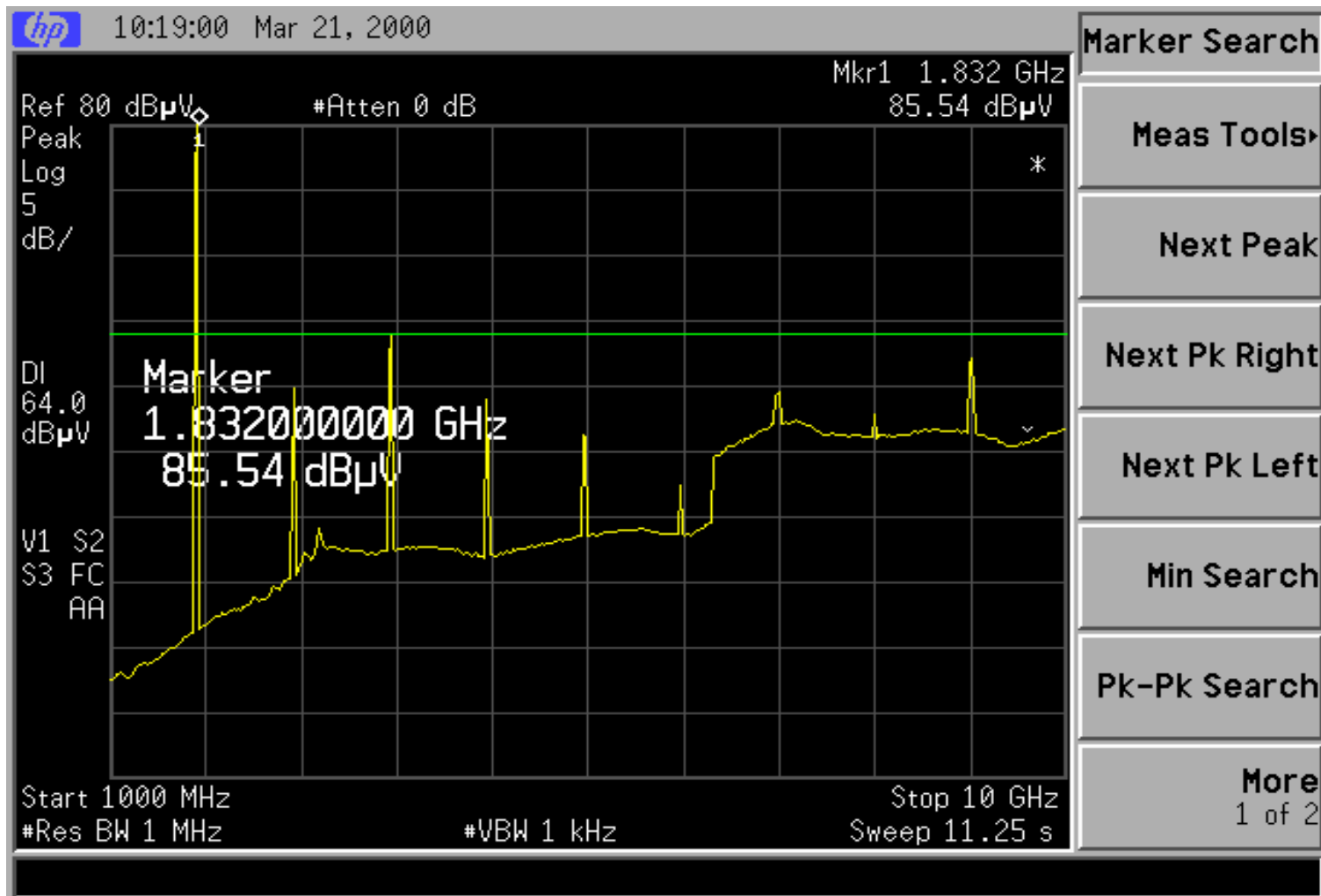
Radiated Emissions below 1 GHz, vertical polarity





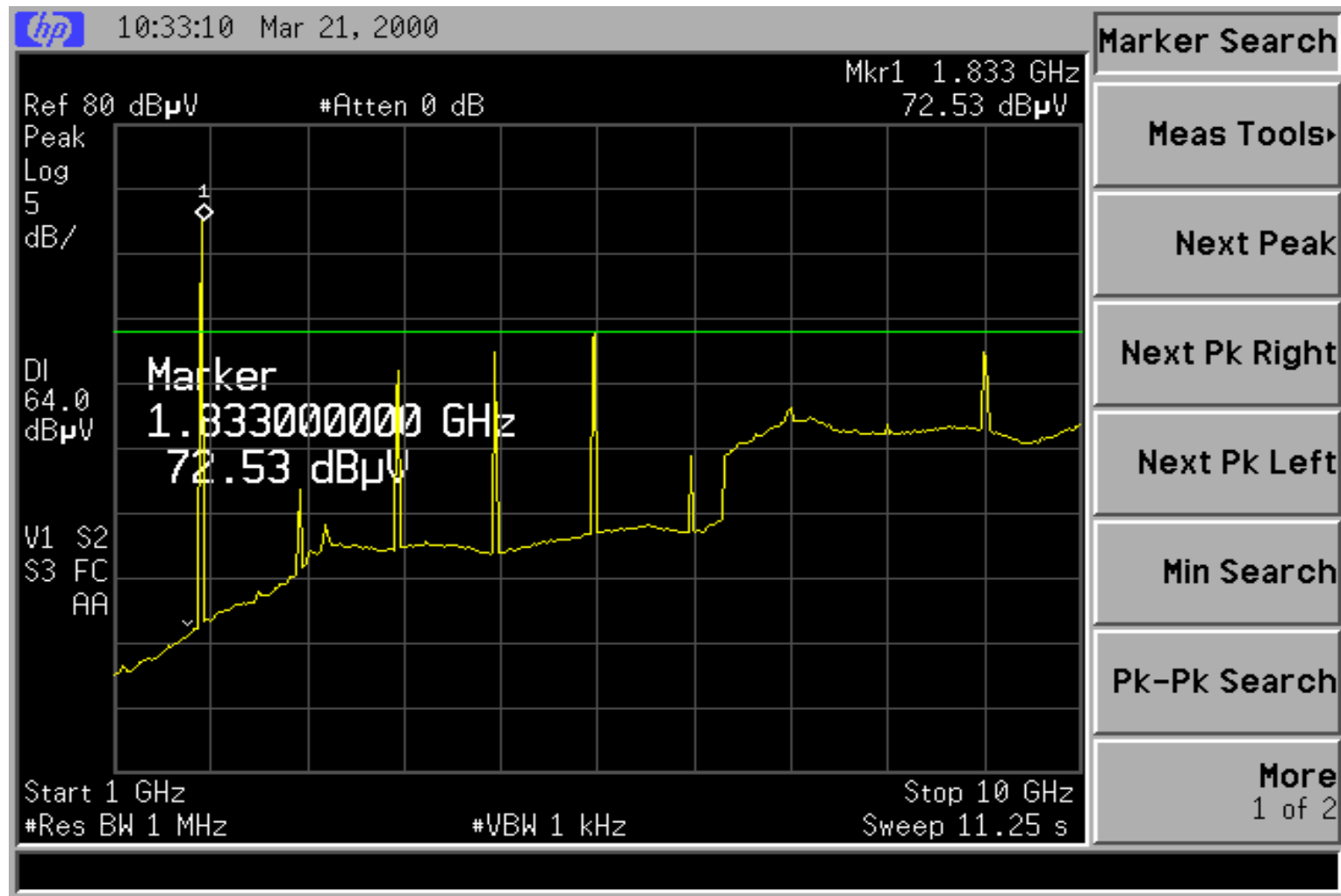
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Radiated Emissions 1 to 10 GHz, vertical Polarity, channel 1





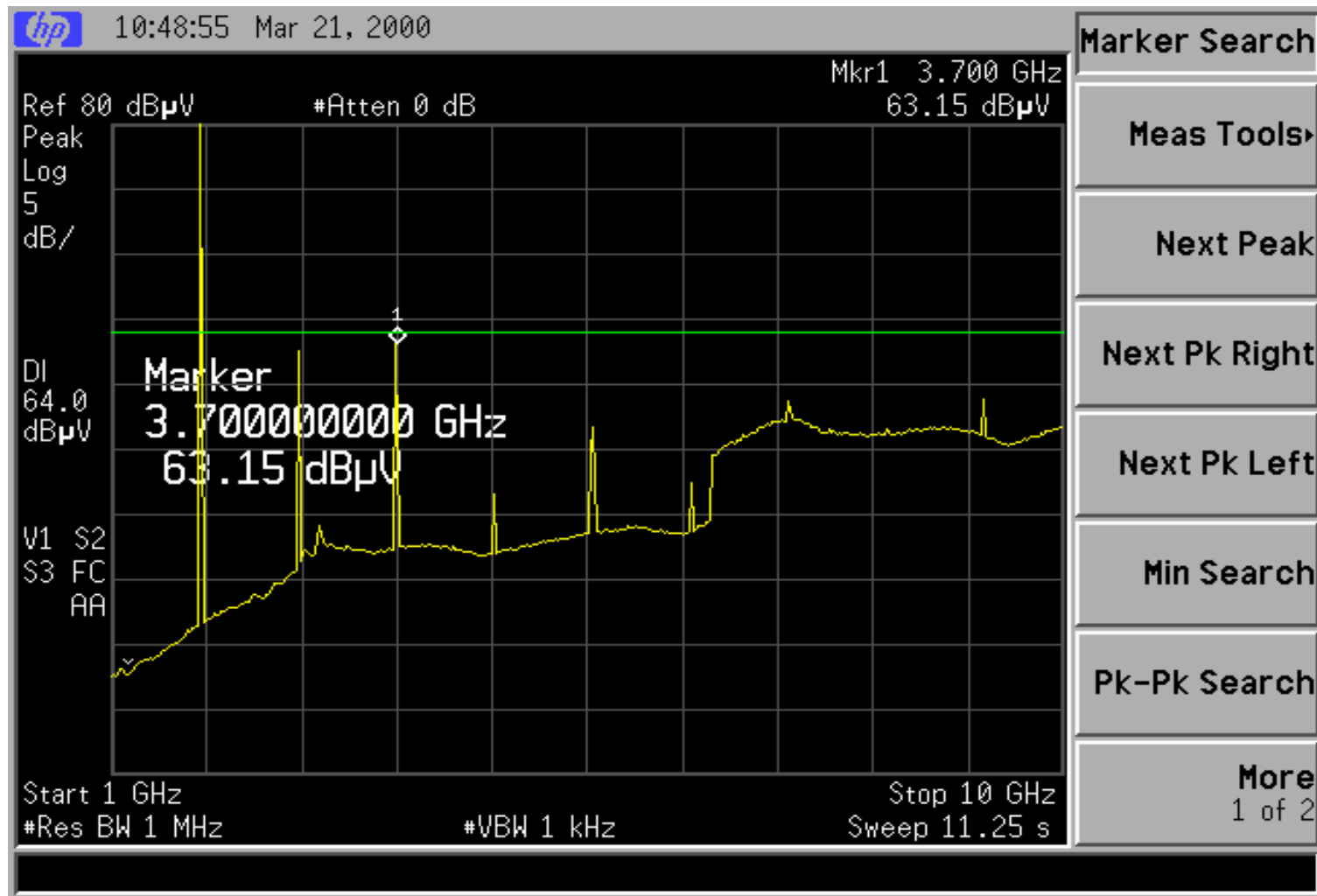
FCC ID : OMF-QP-100-RF

Radiated Emissions 1 to 10 GHz, horizontal Polarity, channel 1



FCC ID : OMF-QP-100-RF

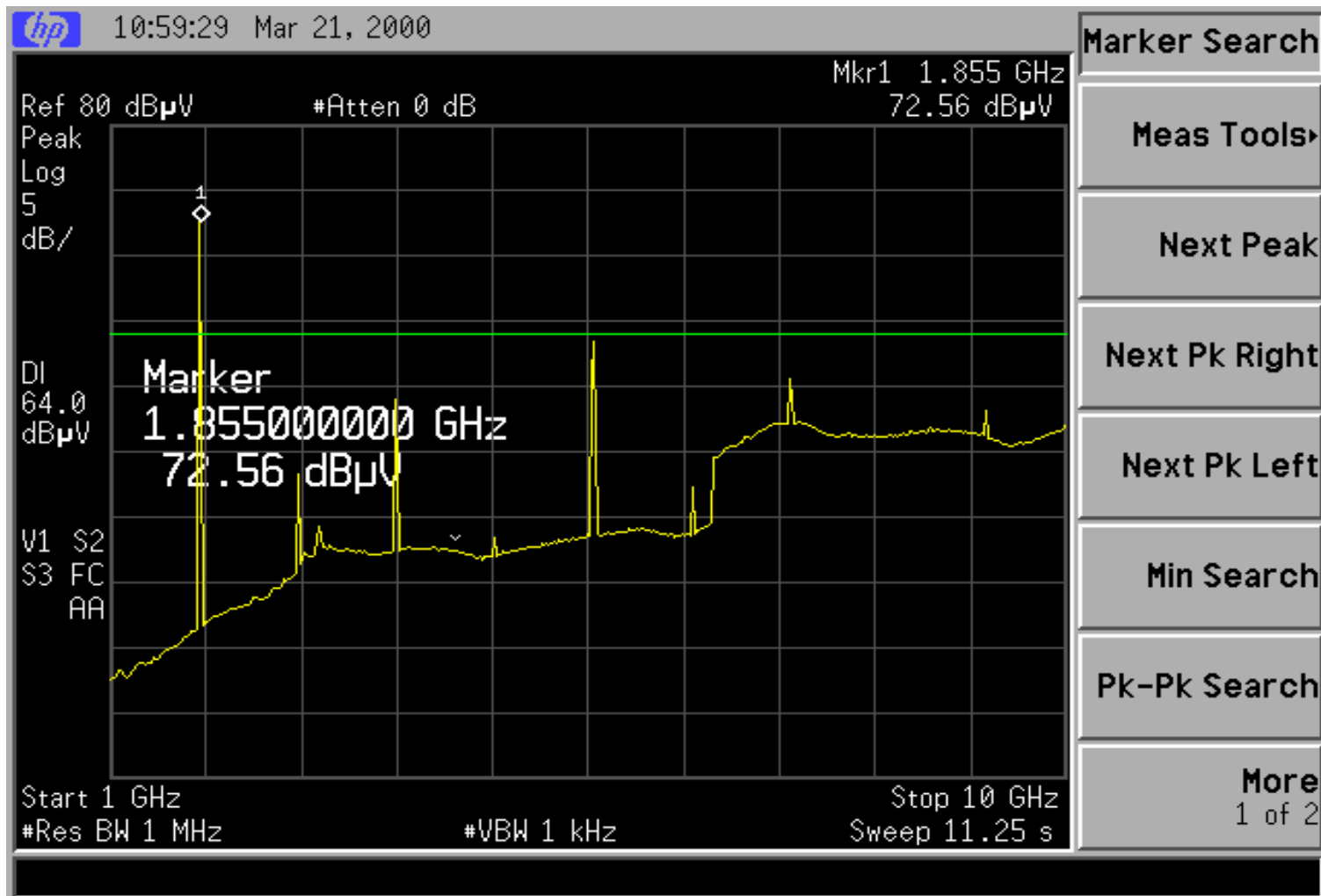
Radiated Emissions 1 to 10 GHz, vertical Polarity, channel D





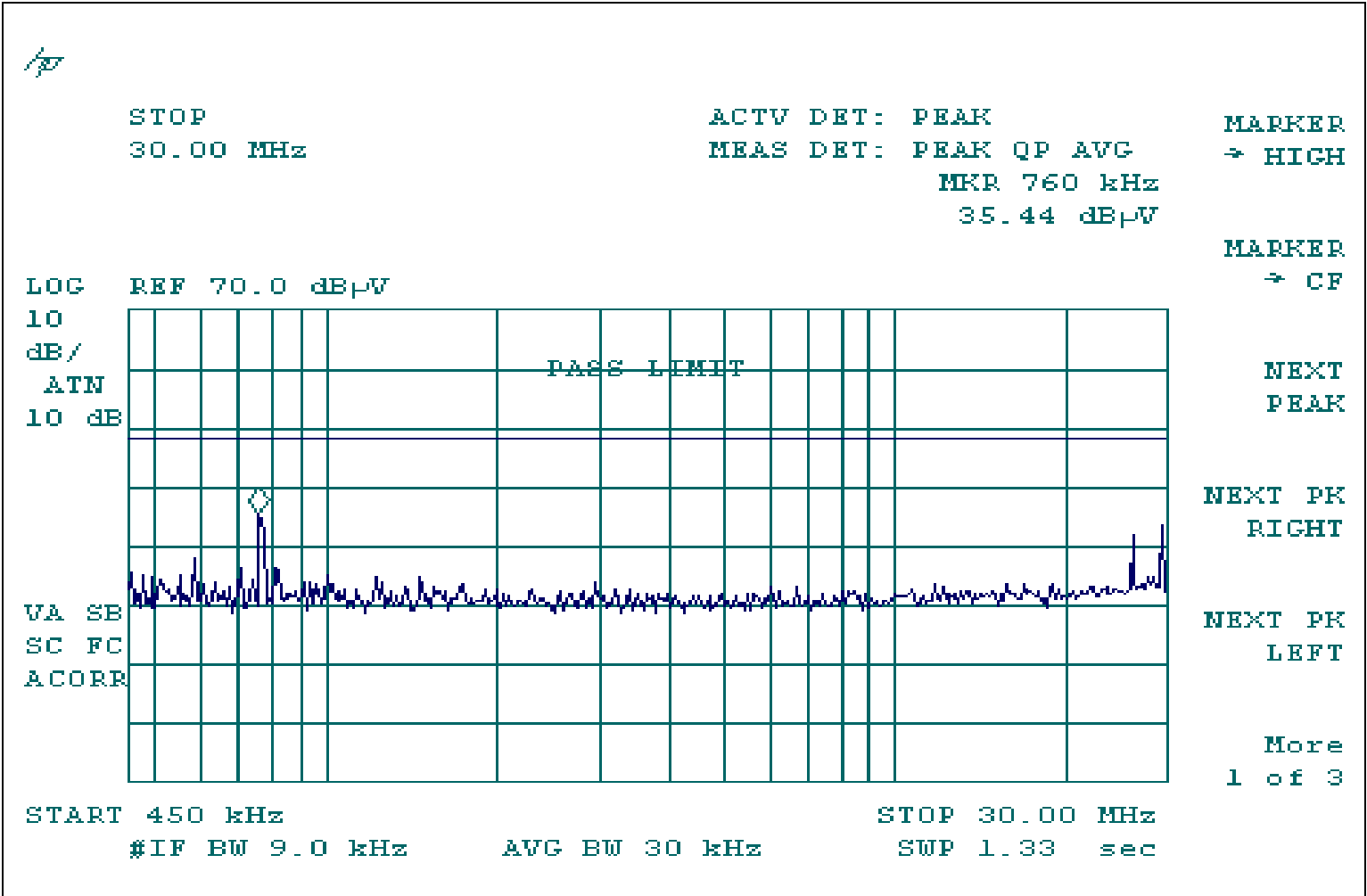
FCC ID : OMF-QP-100-RF

Radiated Emissions 1 to 10 GHz, horizontal Polarity, channel D



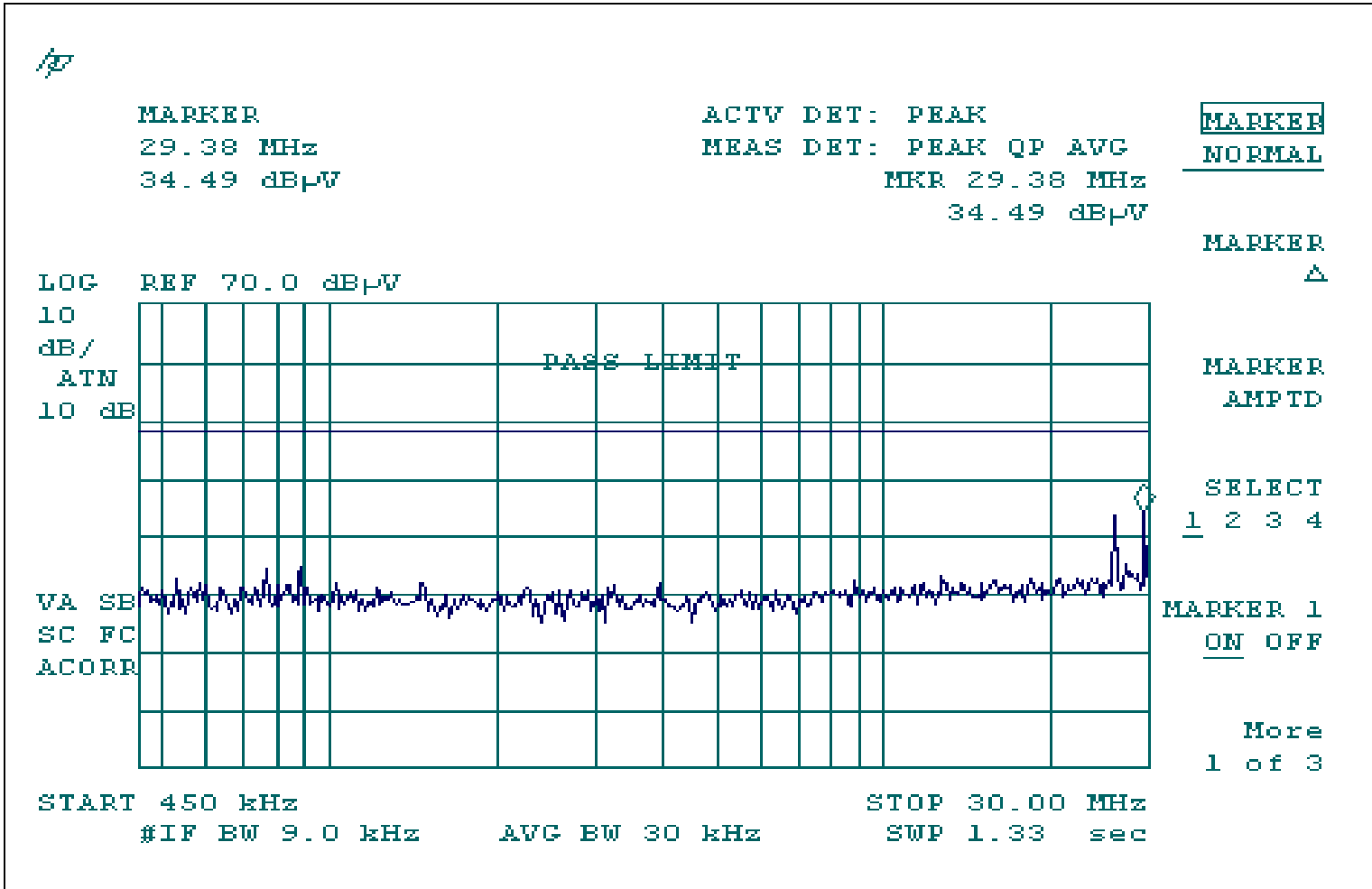
FCC ID : OMF-QP-100-RF

Conducted Emissions, Line 1



FCC ID : OMF-QP-100-RF

Conducted Emissions, Line 2





FCC ID : OMF-QP-100-RF

L.S. Research, Inc.