



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 REMOTE SCOREBOARD

Prepared for:
TRANS-LUX MIDWEST CORPORATION

Test Report Number: 90173

Date(s) of Testing:
JULY 14,21,22, 1999

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

Section	Description	Page #
	Cover Page	
	Index	
	Description of Measurement Facilities	1
	Signature Page	2
2.3	Summary of Test Report	3
2.4	Introduction	3
2.5	Purpose	4
2.6	Conducted Emissions	4
2.7	Radiated Emission Test Setup	5
2.8	Radiated Emission Test Procedure	5
2.9	Test Equipment Utilized	6
2.10	Restricted Bands Affected	7
2.11	Photos taken of testing	8
2.12	Conclusions	10
2.13	Test Equipment List	11
	Appendices	
	A Sample Calculations:	12
	i. Calculation of Radiated Emissions Limits	13
	B Data Charts	14
	C Graphs	18

FCC ID: OMF-FP-MP-70

DESCRIPTION OF MEASUREMENT FACILITIES

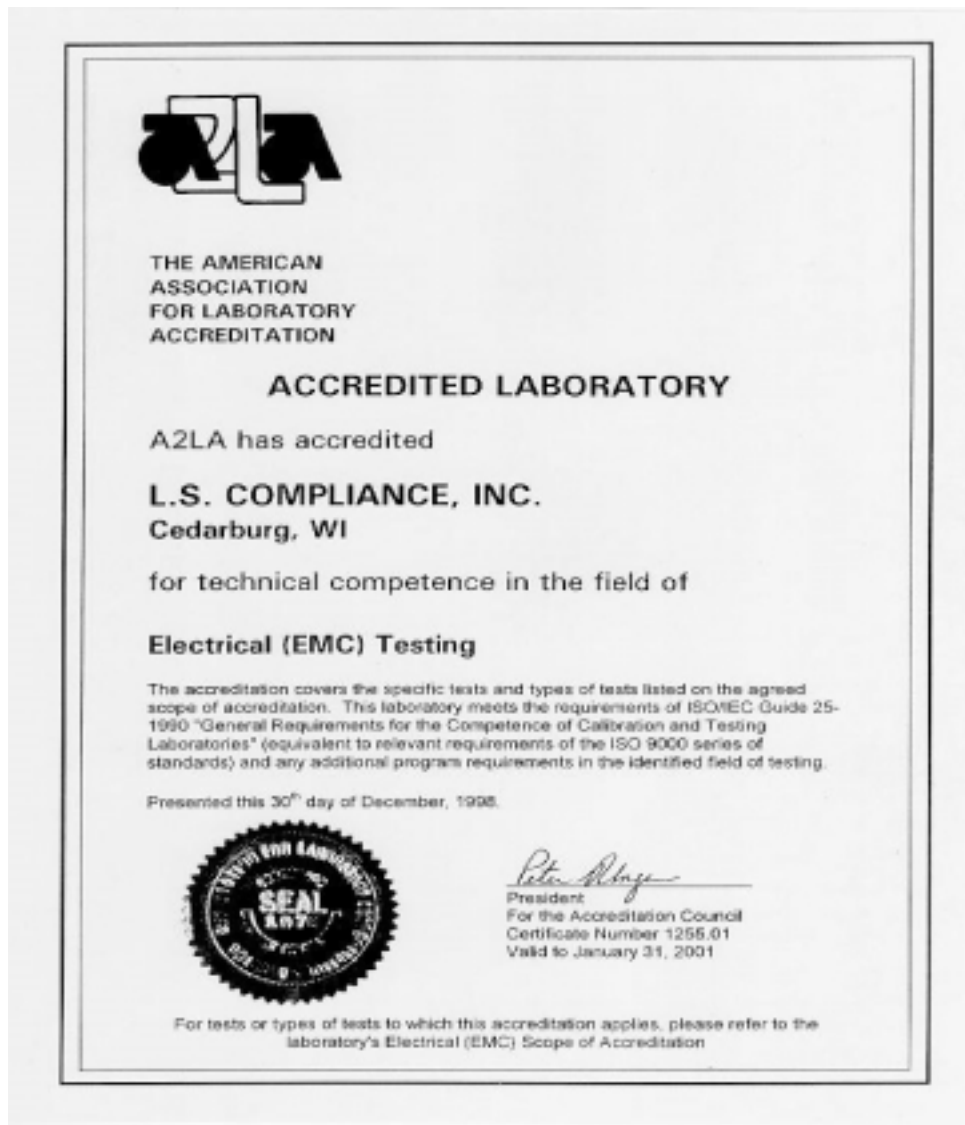
Site on File with the FCC

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.”*

FCC ID: OMF-FP-MP-70



FCC ID: OMF-FP-MP-70

SIGNATURE PAGE

Testing By:



29 july,
1999

Paul McCoy PE, NCE

Date

Testing By:



29 july,
1999

Thomas T. Lee

Testing By:



29 july,
1999

Kenneth L. Boston PE

Prepared by:
Approved by



29 july,
1999

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

Date



FCC ID: OMF-FP-MP-70

2.3 SUMMARY OF TEST REPORT

MANUFACTURER: Trans-Lux Midwest Corporation

MODEL: MP-70-0211

SERIAL: prototype

DESCRIPTION: Remote Scoreboard wireless controller

FREQUENCY RANGE: 902-928 MHz

The Fairplay MP-70 was found to **“meet”** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

The Fairplay MP-70 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.

2.4 INTRODUCTION

On July 14, 21, and 22 of 1999, a series of Radiated Emissions tests were performed on a sample model of the Fairplay MP-70, a spread spectrum transmitter module, designed for wireless data transfer, as a remote data controller 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 periodic 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 Thomas T. Lee, Paul McCoy, and Kenneth L. Boston, PE, of L. S. Compliance, Inc.



FCC ID: OMF-FP-MP-70

2.5 PURPOSE

The above mentioned tests were performed in order to determine the compliance of the Fairplay MP-70 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. 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).

2.6 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.

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 receiver. 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 8546A EMI receiver, 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.



FCC ID: OMF-FP-MP-70

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 2.11.



FCC ID: OMF-FP-MP-70

2.7 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 8 (medium) or channel 15 (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 2.15 for pictures of the test setup.

2.8 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 2.10. 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



FCC ID: OMF-FP-MP-70

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.



FCC ID: OMF-FP-MP-70

2.9 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 2.17, 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.

2.10- Restricted Bands affecting this product

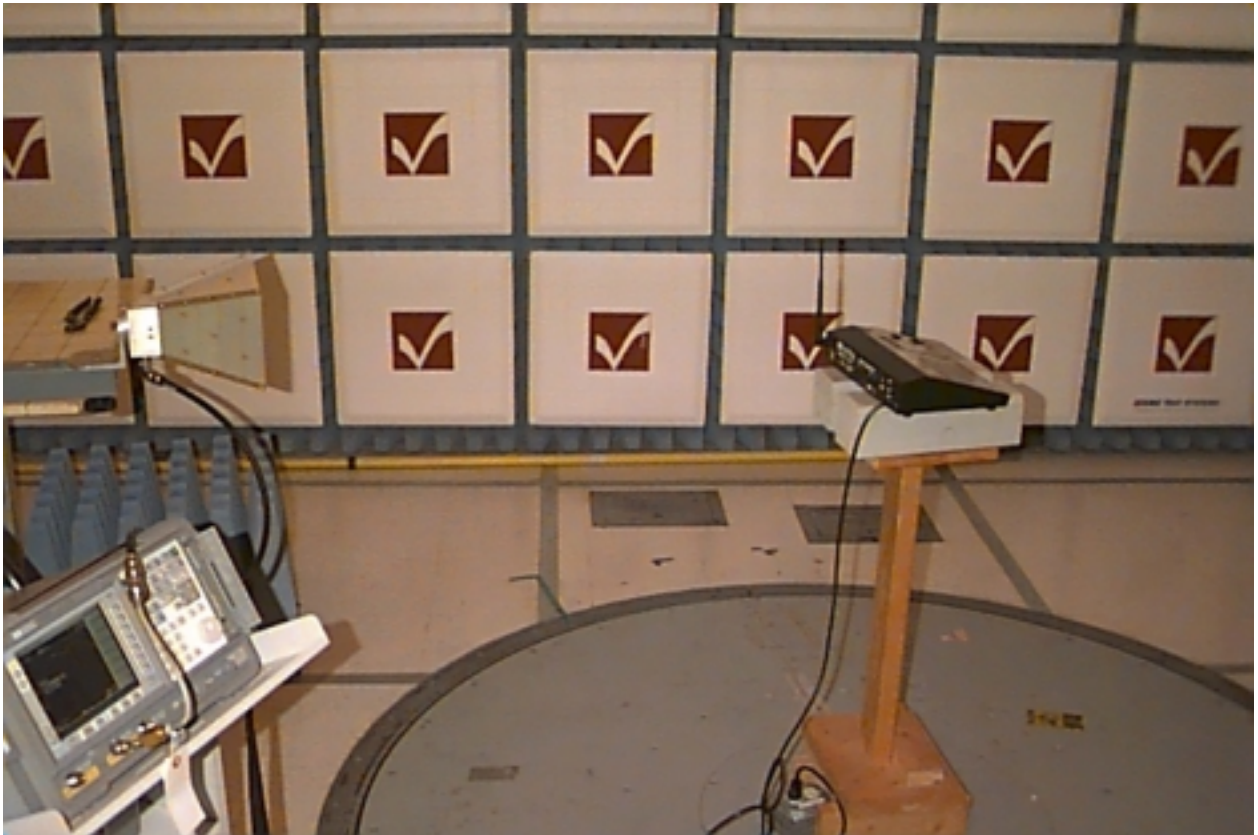
3 Meter limits

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.

FCC ID: OMF-FP-MP-70

2.11 – Photos taken during testing



View of the Fairplay MP-70 during the Radiated Emissions tests.

FCC ID: OMF-FP-MP-70



View of the Fairplay MP-70 during conducted emission testing.



2.12 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 MP-70 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.



FCC ID: OMF-FP-MP-70

2.13 - Test Equipment

Asset #	Manufacturer	Model #	Serial #	Description	Due Date
AA960003	EMCO	3121C	786	Dipole Set Antenna	9/12/99
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	9/12/99
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	9/12/99
AA960007	EMCO	3115	99111-4198	Double Ridged Guide/Horn Antenna	7/22/99
EE960004	EMCO	2090	9607-1164	Mast/Ttable Controller	I.O
EE960013	HP	8546A	3617A00320	Receiver RF Section W/Display and RF filter section	8/12/99
EE960014	HP	85460A	3448A00296	Receiver RF Section Preselector	8/12/99
EE9900xx	HP	E4407b	39060256	26.5 GHz Spectrum Analyzer	6/16/00



APPENDIX A:

SAMPLE CALCULATIONS

FCC ID: OMF-FP-MP-70
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 μV/m)	1m limit (dB μV/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):

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

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

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

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



FCC ID: OMF-FP-MP-70

$|E|$ (in dBuV) = +10 dBm + 95.23 = 105.23 dBuV/m , at 3 meters

At 1 meter; limit = 105.23+ 9.54= 114.77 dBuV/m or rounded to 114.8 dBuV/m



APPENDIX B:

DATA CHARTS



FCC ID: OMF-FP-MP-70

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 1000 MHz

Date of Test:	14, 21, 22, July 1999	Manufacturer:	Trans-Lux Midwest
Location:	L. S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	MP-70-0211
Specifications:	47CFR FCC Part 15.10	Serial No.:	prototype
Distance:	3 meters	Configuration:	TX; Channels 1,8, 15
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 in 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)
73.73	V	1.0	0	28.9	40	11.1
960.0	V	1.0	0	44.5	46	1.5
960.0	H	1.0	0	39.7	46	6.3



FCC ID: OMF-FP-MP-70

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 1 to 26 GHz

Date of Test:	14, 21, 22, July 1999	Manufacturer:	Trans-Lux Midwest
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	MP-70-0211
Specifications:	47CFR, FCC Part 15.247(c), 15.205	Serial No.:	prototype
Distance:	1 meter	Configuration:	TX; Channels 1,8, 15
Equipment:	HP 8546A EMI Receiver HP 84125C microwave EMI system EMCO 3115 Double Ridged Waveguide	Detector(s) Used:	Average

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

Frequency (GHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Channel	EMI Meter Reading (dB μ V/m)	15.205 Limit (dB μ V/m)	Margin (dB)
1.817	V	1.0	10	1	74.6	114.8 **	40.2
2.725	V	1.05	10	1	60.4	63.5	3.1
3.634	V	1.0	230	1	56.8	63.5	6.7
4.543	V	1.1	330	1	60.1	63.5	3.4
7.270	V	1.0	145	1	58.9	63.5	4.6
8.177	V	1.1	200	1	60.2	63.5	3.3
1.830	V	1.15	0	8	76.7	114.8 **	38.1
2.745	V	1.05	10	8	60.7	63.5	2.8
3.660	V	1.0	210	8	57.6	63.5	5.9
4.575	V	1.1	330	8	58.7	63.5	4.8
7.315	V	1.0	140	8	59.1	63.5	4.4
8.230	V	1.1	195	8	59.9	63.5	3.6
1.853	V	1.15	7	15	72.4	114.8 **	42.4
2.779	V	1.05	10	15	59.5	63.5	4.0
3.705	V	1.0	210	15	61.3	63.5	2.2
4.631	V	1.05	210	15	58.6	63.5	4.9



FCC ID: OMF-FP-MP-70

7.410	V	1.05	150	15	59.3	63.5	4.2
8.336	V	1.0	190	15	59.6	63.5	3.9



FCC ID: OMF-FP-MP-70

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

Date of Test:	14, 21, 22, July 1999	Manufacturer:	Trans-Lux Midwest
Location:	L. S. Compliance, Inc.	Model No.:	MP-70-0211
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	Title 47CFR, FCC Part 15 Subpart C	Serial No.:	prototype
Distance:	40 cm to vert. G.P.	Configuration:	TX: Channels 1,8, 15
Equipment:	HP 85460A, 85462A EMI Receiver	Detector(s) Used:	Quasi-Peak
	EMCO 3810/2NM LISN		
	HP 11947A Limiter		
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)
0.45	L1	31.8	48	16.2
1.16	L1	27.4	48	20.6
14.75	L1	25.2	48	22.8
25.8	L1	18.2	48	29.8
0.45	L2	31.6	48	16.4
1.16	L2	27.7	48	20.3
14.75	L2	33.8	48	14.2
25.8	L2	37.0	48	11.0
29.5	L2	38.0	48	10.0



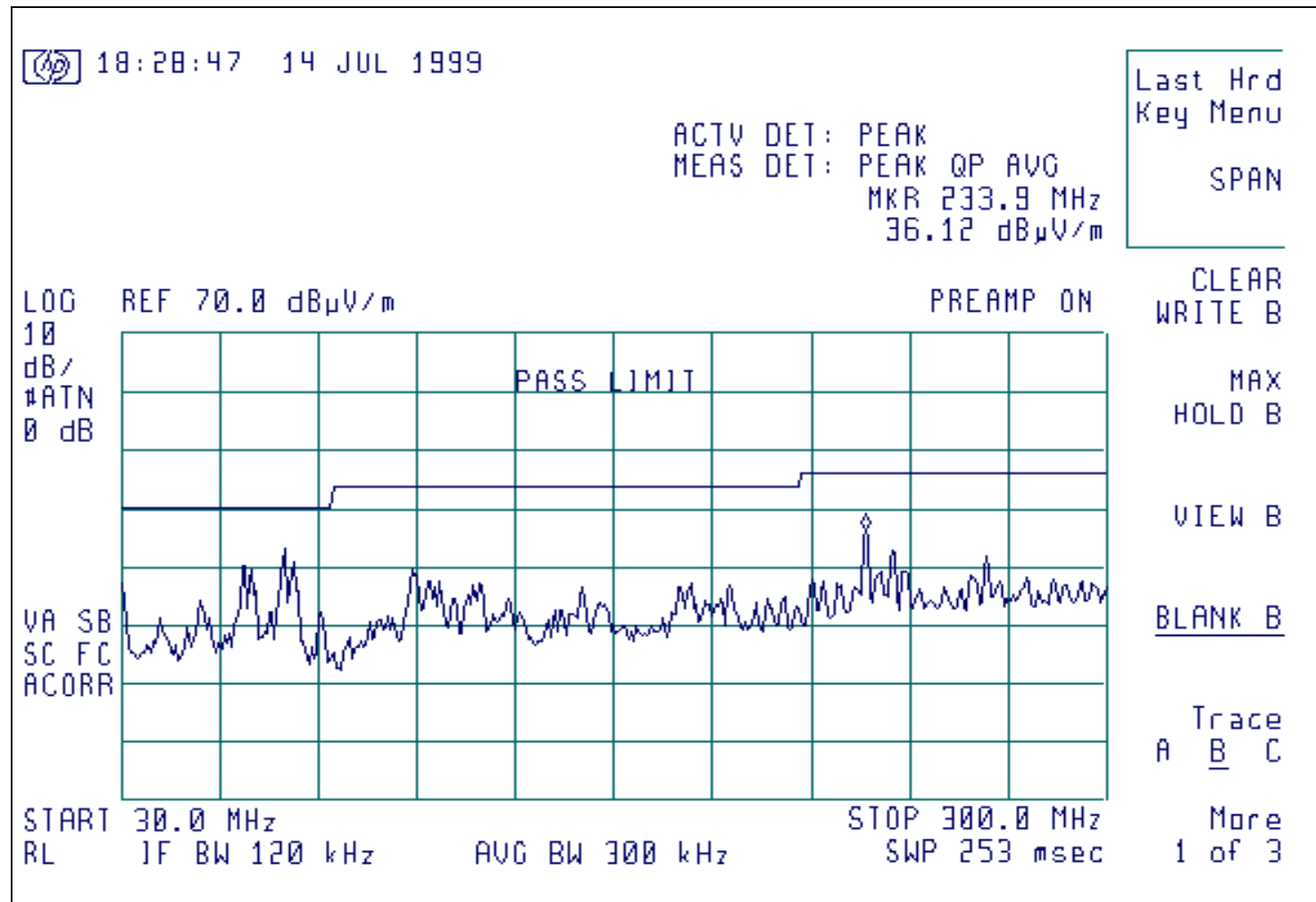
APPENDIX C:

GRAPHS



FCC ID : OMF-FP-MP-70

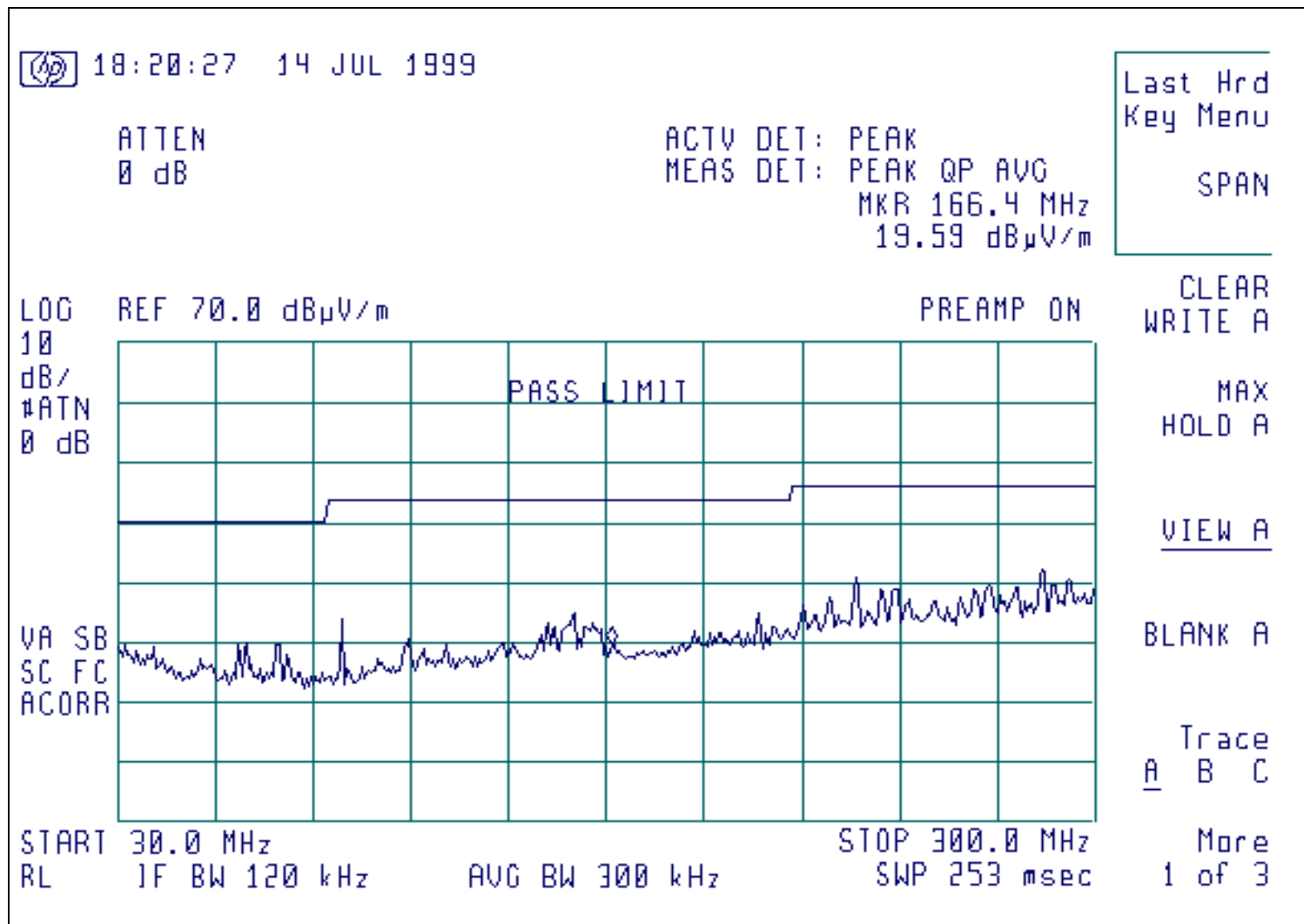
Radiated Emissions 30-300 MHz, vertical polarity





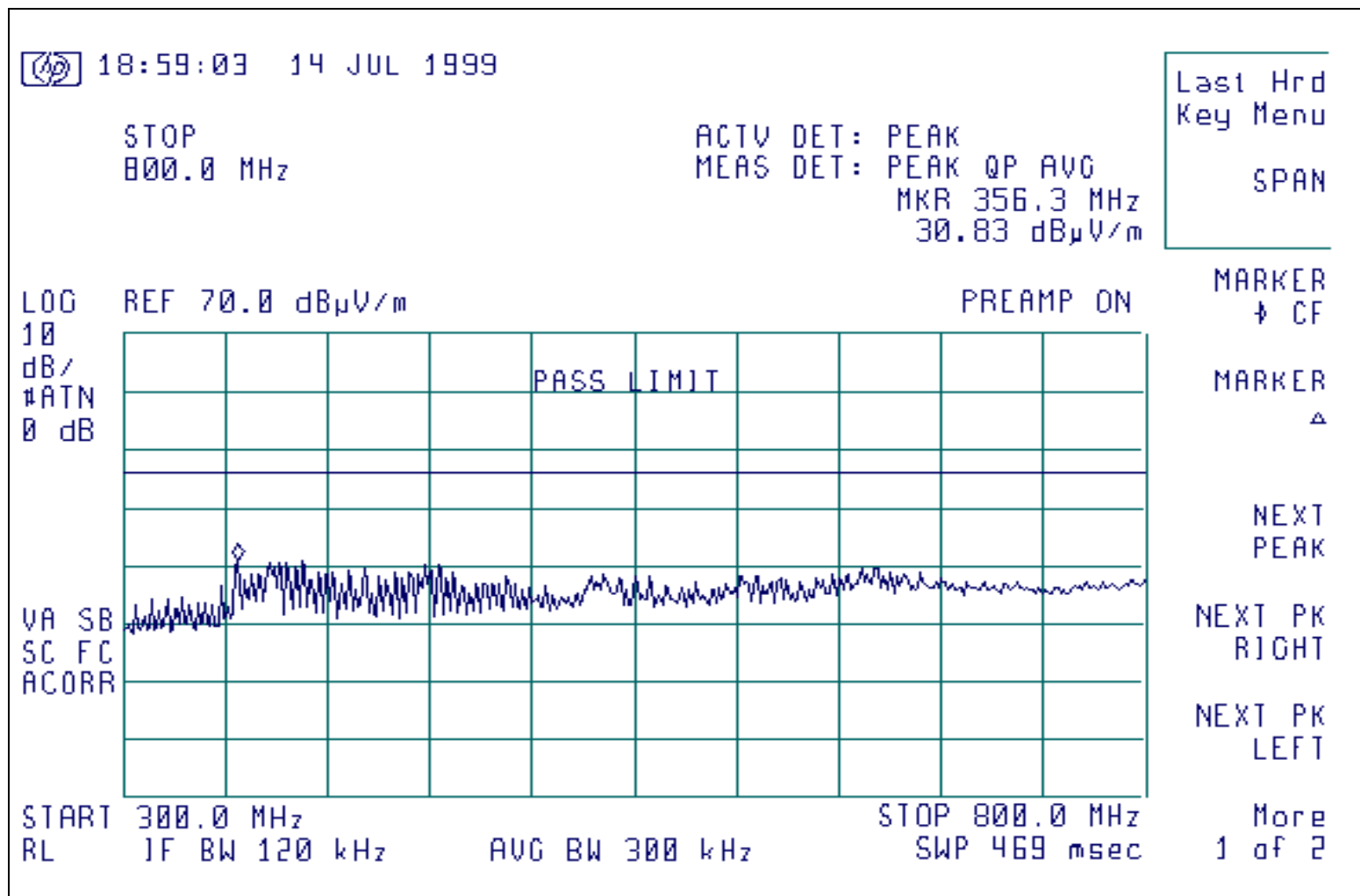
FCC ID : OMF-FP-MP-70

Radiated Emissions 30-300 MHz, horizontal polarity



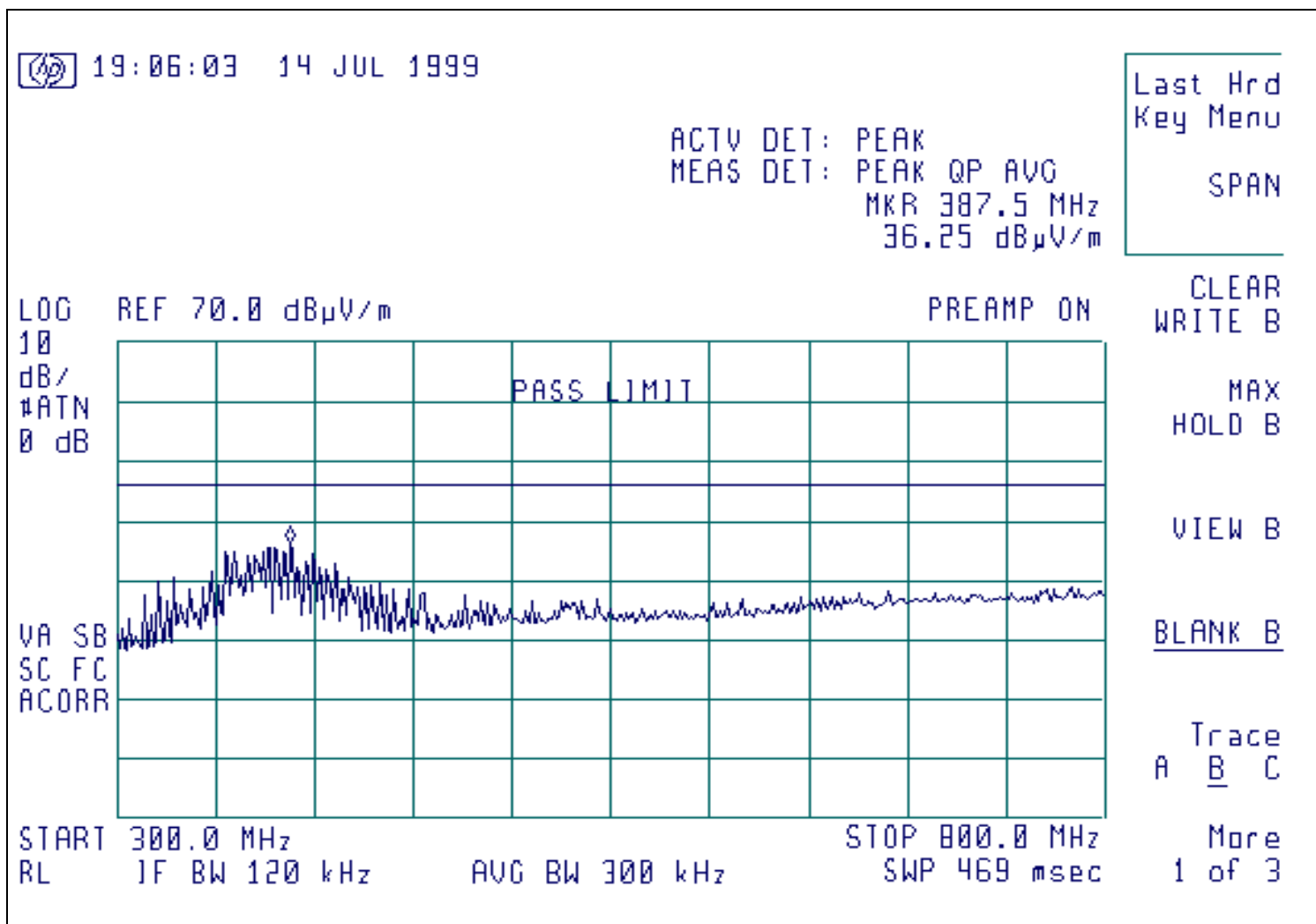
FCC ID : OMF-FP-MP-70

Radiated emissions below 1 GHz, vertical polarity



FCC ID : OMF-FP-MP-70

Radiated Emissions below 1 GHz, horizontal polarity

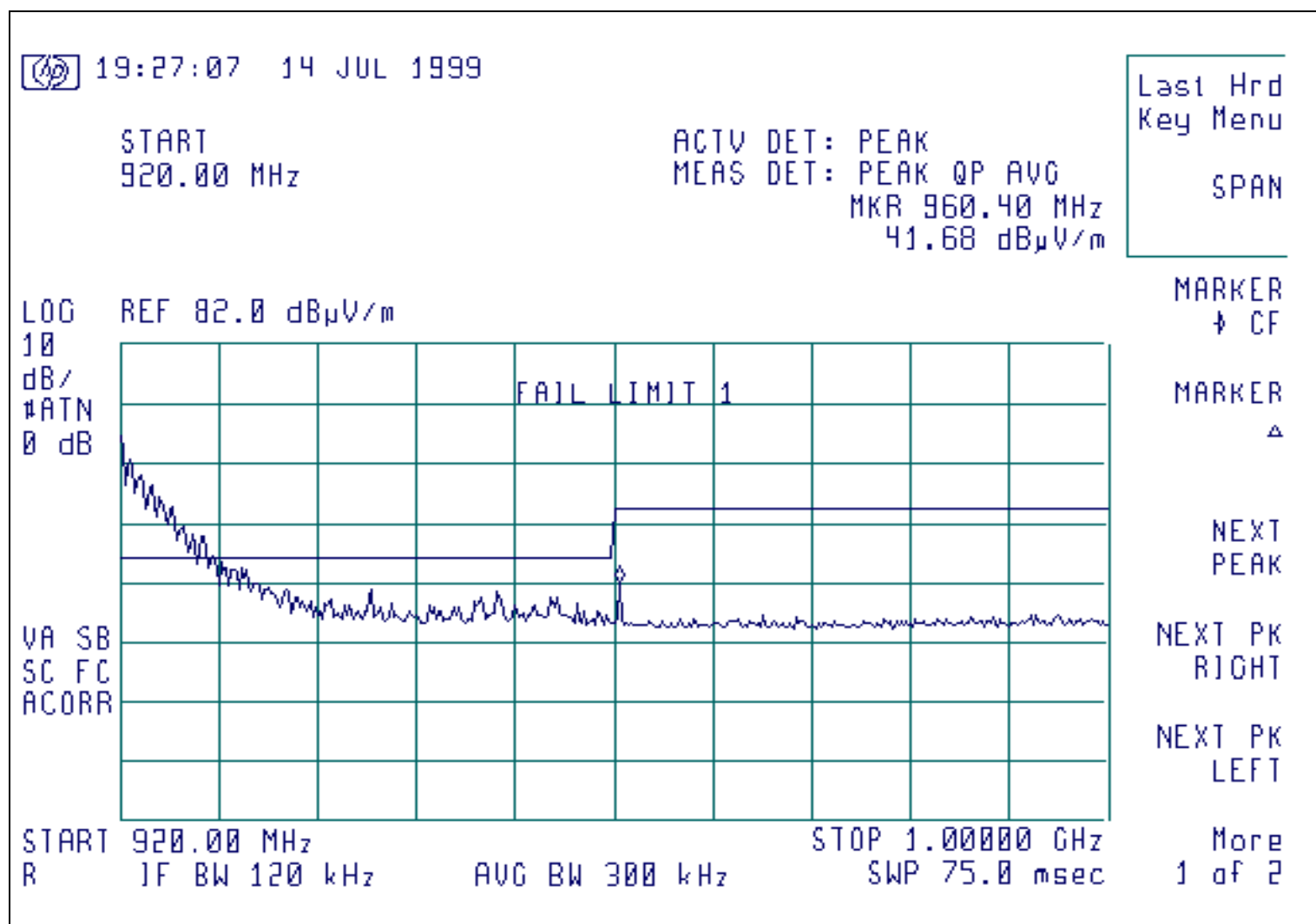




FCC ID : OMF-FP-MP-70

FCC ID : OMF-FP-MP-70

Radiated Emissions below 1 GHz, horizontal polarity

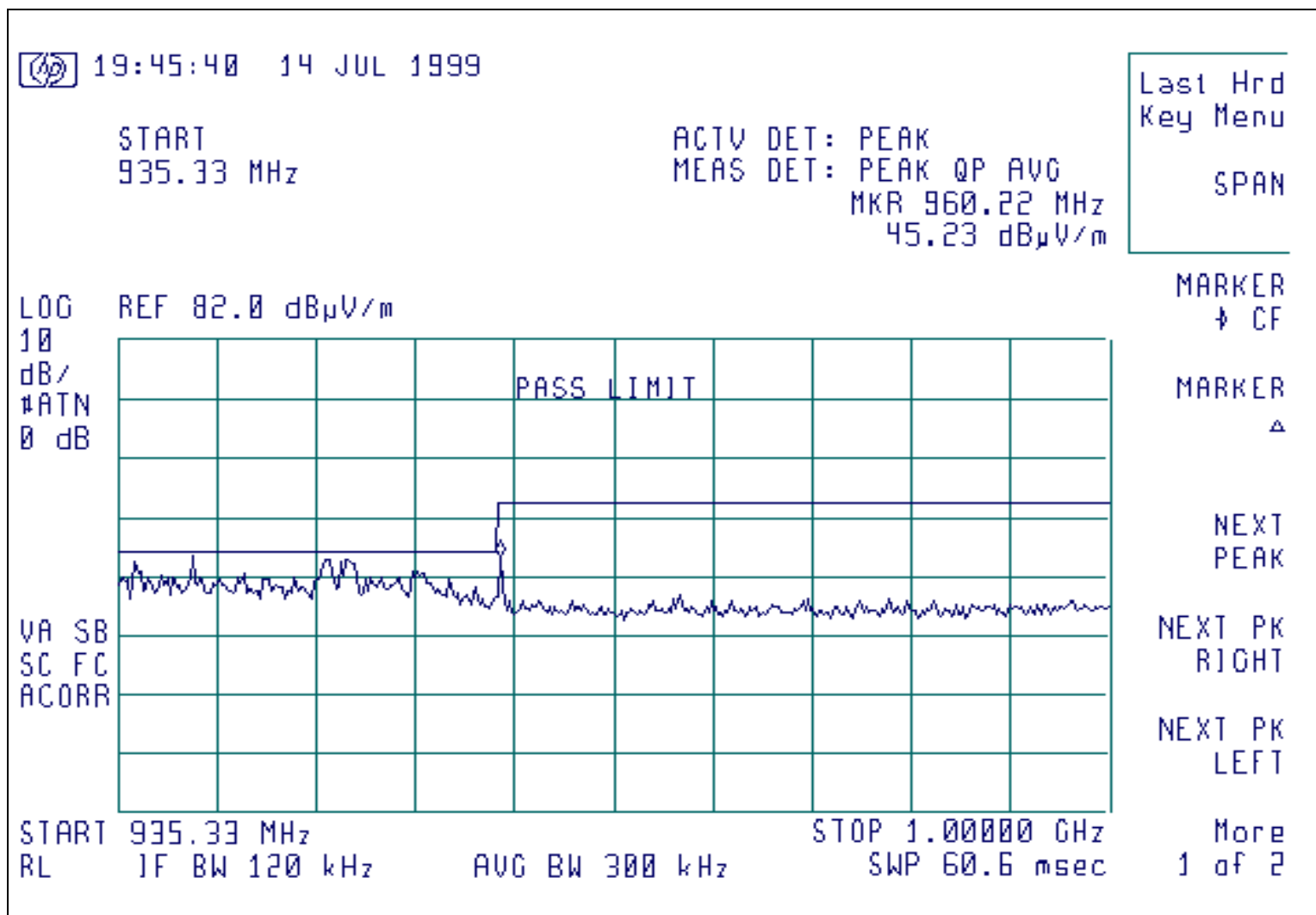




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FCC ID : OMF-FP-MP-70

Radiated Emissions below 1 GHz, vertical polarity





FCC ID : OMF-FP-MP-70

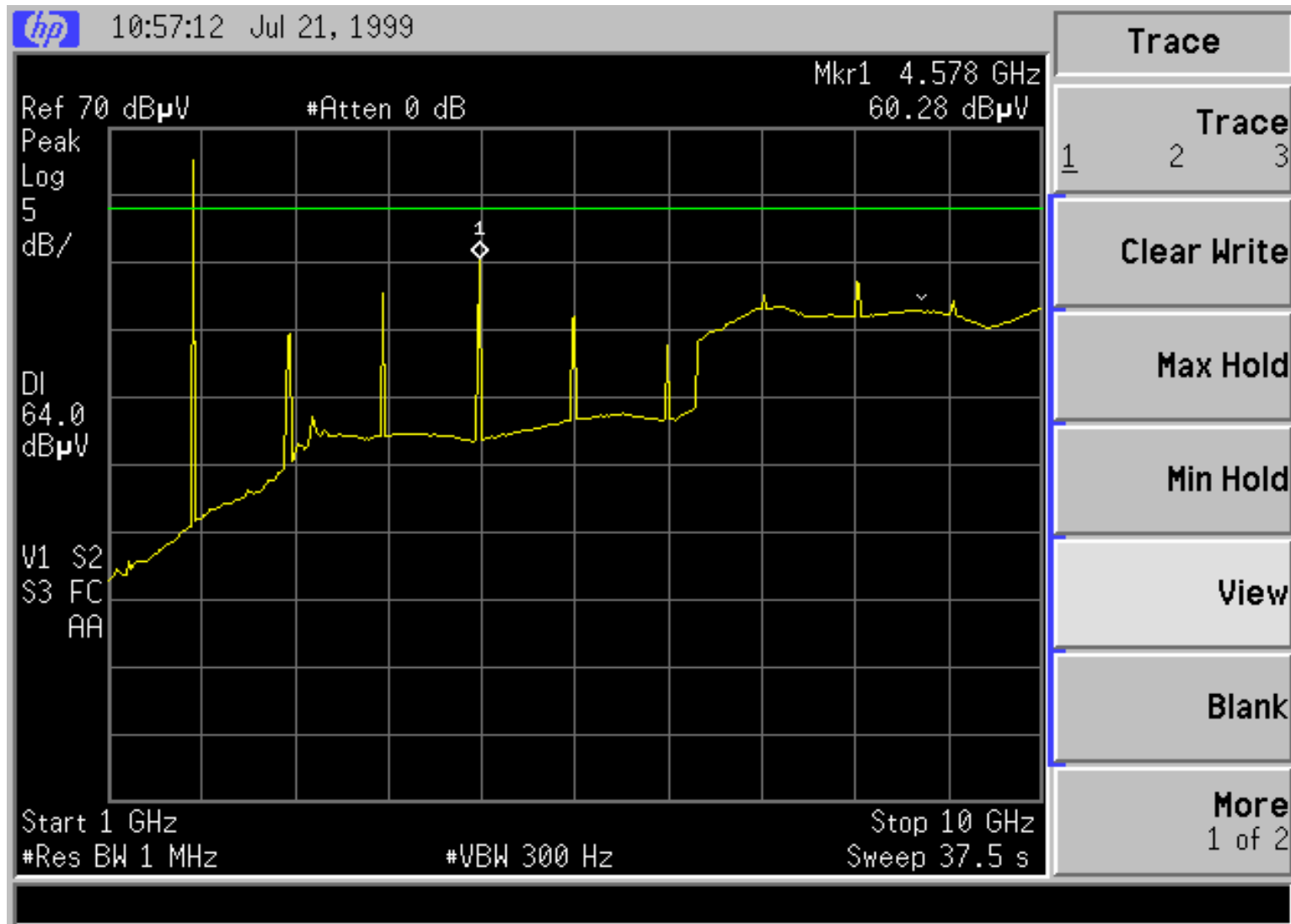


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Radiated Emissions 1 to 10 GHz, horizontal Polarity



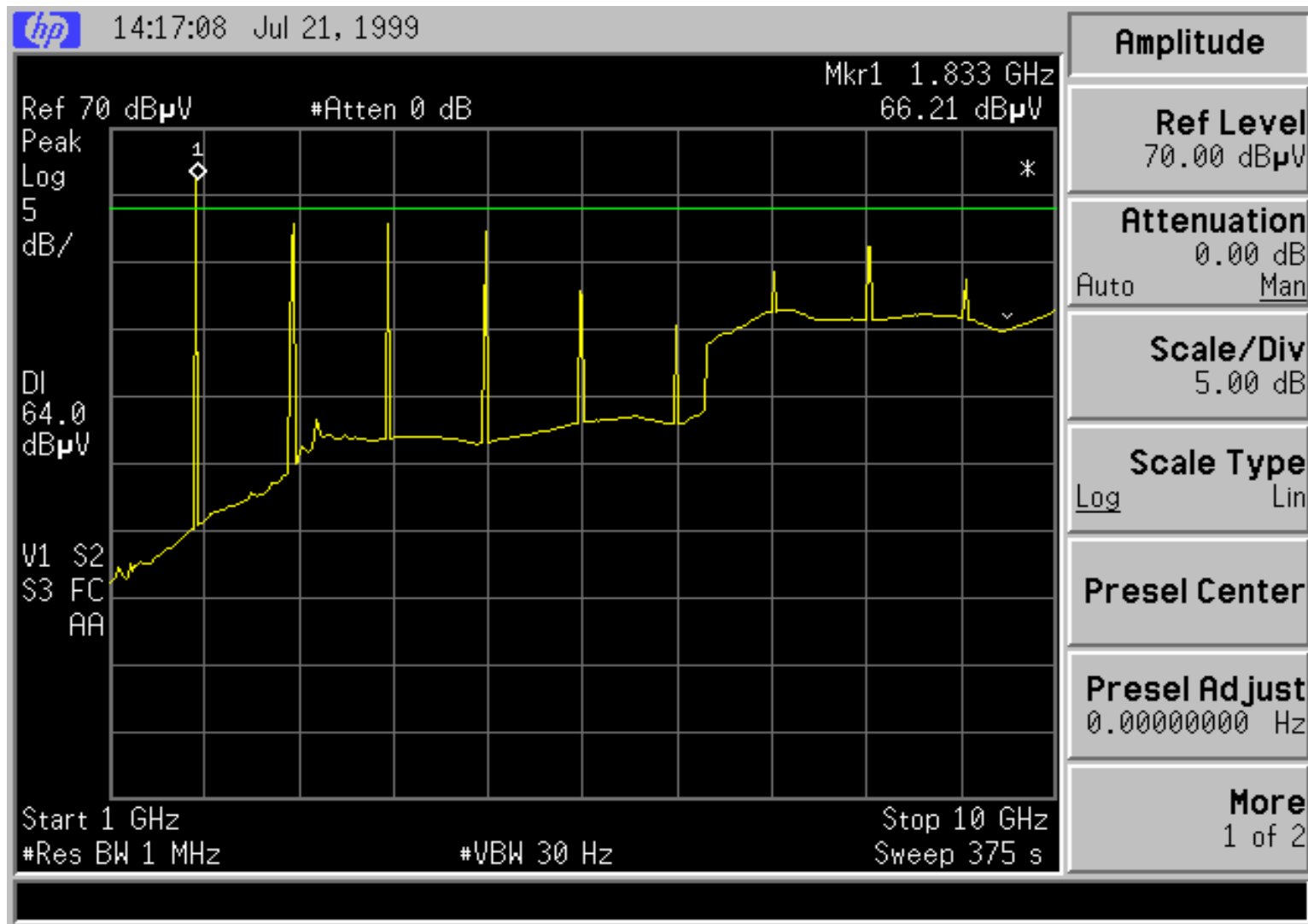
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FCC ID : OMF-FP-MP-70

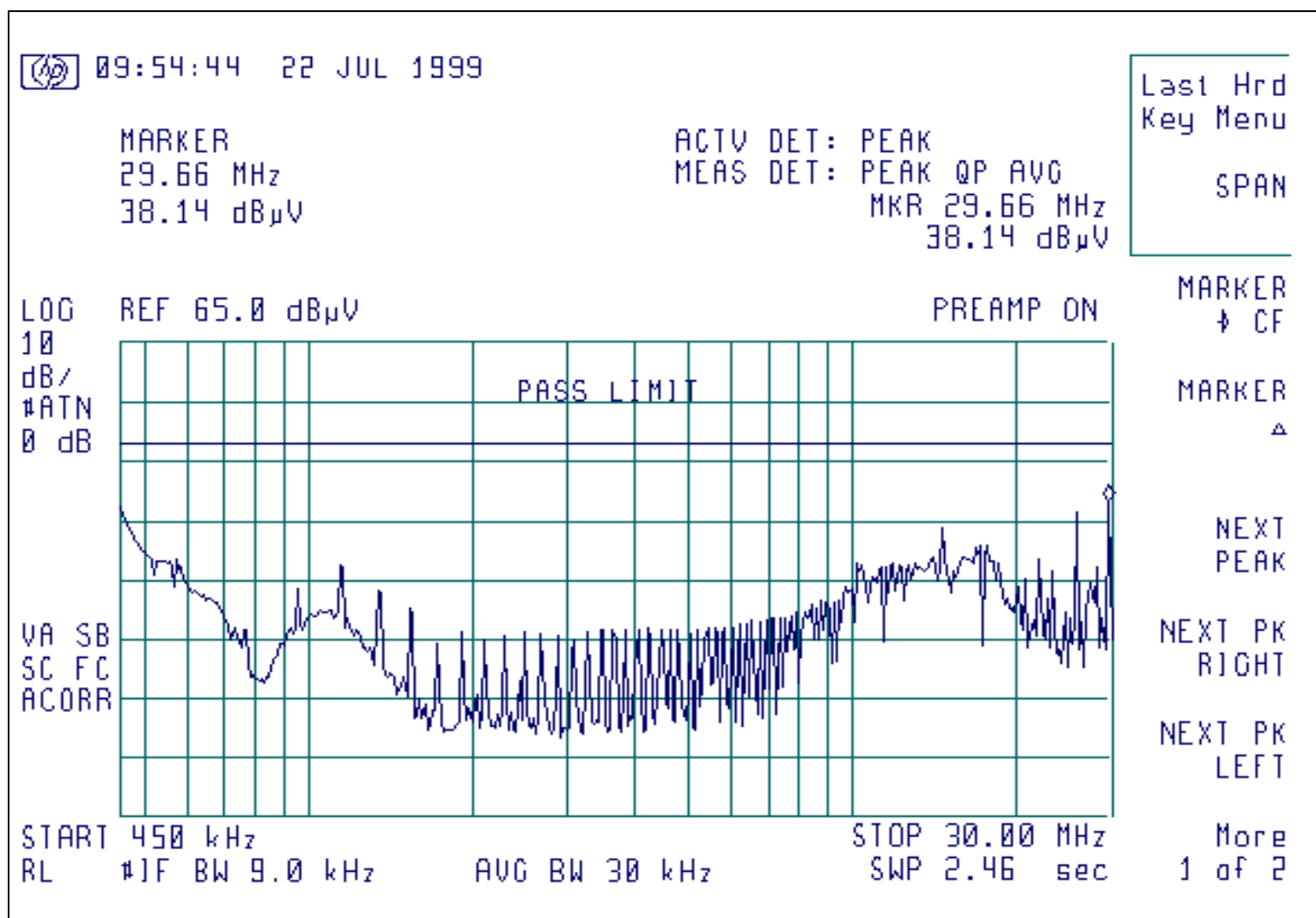
Radiated Emissions 1 to 10 GHz, vertical Polarity





FCC ID : OMF-FP-MP-70

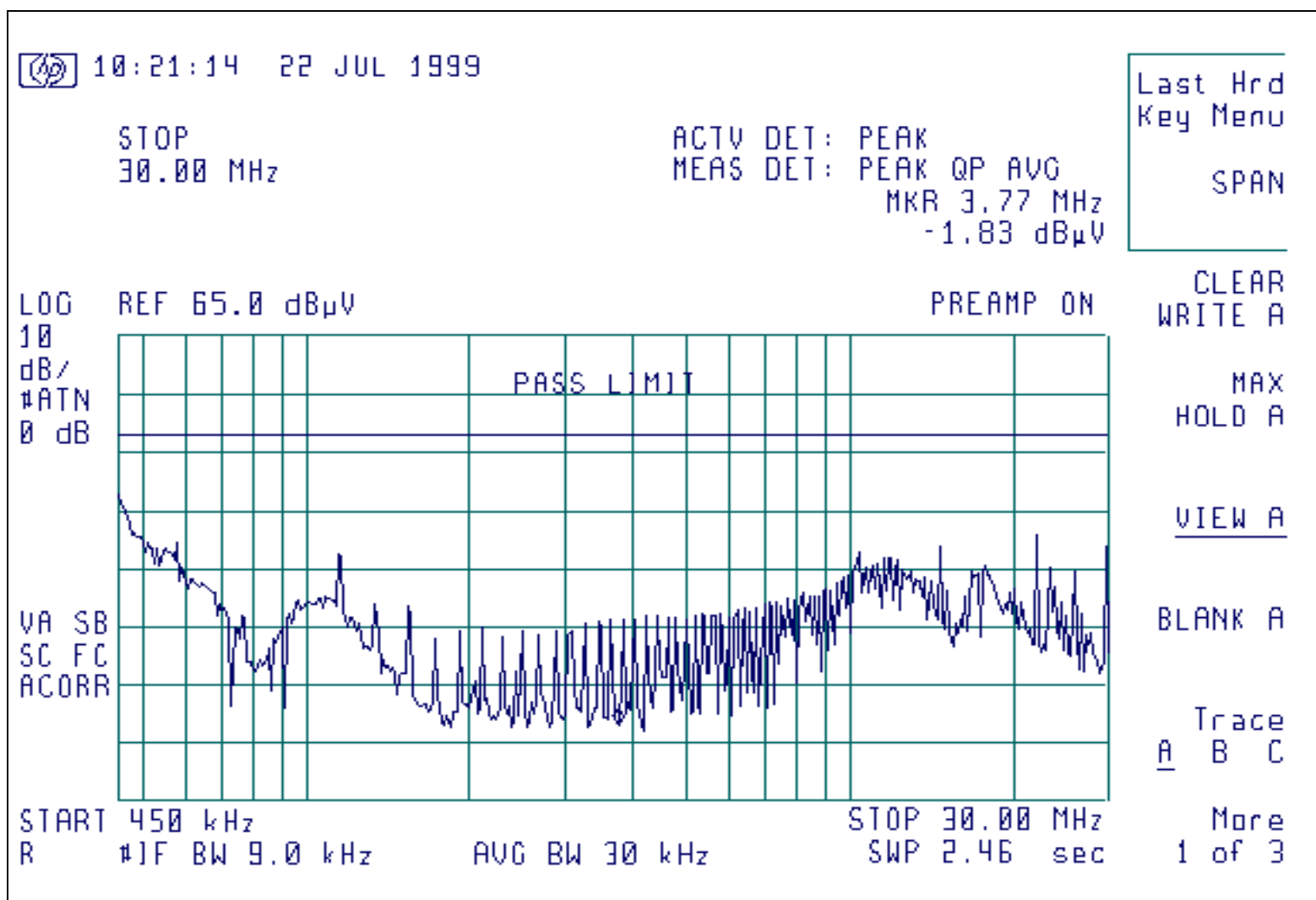
Conducted Emissions, Line 1





FCC ID : OMF-FP-MP-70

Conducted Emissions, Line 2





FCC ID : OMF-FP-MP-70
