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Underwriters Laboratories Inc.®

FCC MEASUREMENT / TECHNICAL TEST REPORT

Samsung Electronics America, Inc.

Microwave Oven Model MR6699GB

With Magnetron OM-75P

FILE: NC2425
PROJECT: 00SC44632
ISSUED: March 29, 2000
FCC ID: A3L24OTR

NAME OF MANUFACTURER: Samsung Electronics America, Inc.

ADDRESS OF MANUFACTURER: 85 West Tasman Drive
San Jose, CA 95134 USA

EQUIPMENT UNDER TEST: Microwave Oven Model MR6699GB
with Magnetron OM-75P

REPORT PREPARED BY: Underwriters Laboratories, Inc.
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Santa Clara, CA 95050-4169 USA
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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this investigation was to perform measurements of electromagnetic interference (EMI) generated by the equipment under test (EUT) for comparison to limits specified in the referenced standards.

1.2 DESCRIPTION OF EQUIPMENT UNDER TEST

The equipment under test (EUT) is a microwave oven. The EUT is provided with an electronic control. The electronic control provides the user with a selection of time duration and power level. The maximum time duration setting 6039 seconds. Maximum power level setting is 9 (100%). The input electrical rating is 120 Vac, 60 Hz, 1.4 kW. The RF Power Output is rated at 900 W.

1.3 REFERENCED STANDARDS AND TEST FACILITIES

The procedures and methods used throughout these tests may be found in the following:

1. Code of Federal Regulations (CFR) Title 47, Part 18, Industrial, Scientific, and Medical Equipment, Subpart - C; and,

2. FCC/OET MP-5 (1986), FCC Methods of Measurements of Radio Noise Emissions from Industrial, Scientific, and Medical Equipment.

Details of the measurement facilities used for these tests have been filed with the Federal Communications Commission's Laboratory in Columbia, Maryland and accepted in a letter dated September 24, 1997 (Ref. No. 31040/SIT 1300F2). The facility is located at:

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1.4 OPERATING CONDITIONS/TEST CONFIGURATION

The EUT was provided for tests as a stand-alone device; it was prepared for testing in accordance with the manufacturer's instructions. The EUT was operated at maximum (continuous) RF output power. The loads consisted of water in a glass beaker in the amounts specified in the test procedure.

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2.0 RADIO NOISE EMISSION MEASUREMENTS PROCEDURES/RESULTS

2.1 RADIATION HAZARD MEASUREMENT

Radiation leakage was measured in the as-received condition with the oven door closed using a microwave leakage meter.

A 700 ml water load was placed in the center of the oven and the oven was operated at maximum output power.

☒ **There was no microwave leakage exceeding a power level of 0.5 mW/cm^2 observed at any point 5 cm or more from the external surface of the oven.**

A maximum of 1.0 mW/cm^2 is allowed in accordance with the applicable Federal Standards. Hence, microwave leakage in the as-received condition with the oven door closed was below the maximum allowed.

2.2 INPUT POWER

Input power and current was measured using a power analyzer. A 275 ml water load was placed in the center of the oven and the oven was operated at maximum output power. A 275 ml water load was chosen for its compatibility with the procedure commonly used by manufacturers to determine their input ratings.

Input Voltage (Vac)	Input Current (amps)	Measured Input power (watts)	Rated Input Power (watts)
120.86	14.8	1648	1400

☒ Based on the measured input power, the EUT was found to be operating within the intended specifications.

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2.3 LOAD FOR MICROWAVE OVENS

For all measurements the energy developed by the oven was absorbed by a dummy load consisting of a quantity of tap water in a beaker. If the oven was provided with a shelf or other utensil support, this support was in its initial normal position. For ovens rated at 1000 watts or less power output, the beaker contained quantities of water as listed in the following subparagraphs. For ovens rated at more than 1000 watts output, each quantity was increased by 50% for each 500 watts or fraction thereof in excess of 1000 watts. Additional beakers were used if necessary.

-- Load for power output measurement: 1000 milliliters of water in the beaker located in the center of the oven.

-- Load for frequency measurement: 1000 milliliters of water in the beaker located in the center of the oven.

-- Load for measurement of radiation on second and third harmonic: Two loads, one of 700 and the other of 300 milliliters, of water are used. Each load is tested both with the beaker located in the center of the oven and with it in the right front corner.

-- Load for all other measurements: 700 milliliters of water, with the beaker located in the center of the oven.

The RF output power is rated at 900 watts.

Load used for power output measurement = 1000 milliliters of water

Load used for frequency measurement = 1000 milliliters of water

Load used harmonic measurement = 700 & 300 milliliters of water

Load used other measurements = 700 milliliters of water

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2.4 RF OUTPUT POWER MEASUREMENT

The Caloric Method was used to determine maximum RF output power. The initial temperature of the water load was measured. The water load was placed in the center of the oven. The oven was operated at maximum output power for 120 seconds, the temperature of the water was re-measured.

Quantiy of Water (ml)	Starting Temperature (°C)	Final Temperature (°C)	Elapsed Time (seconds)
1000	30	50	120

$$\text{Power} = \frac{(4.2 \text{ joules/calorie})(\text{volume in milliliters})(\text{temperature rise})}{\text{time in seconds}}$$

Power = 700 watts

☐ The measured output power was found to be less than 500 watts. Therefore, in accord with Section 18.305 of Subpart - C, the measured out-of-band emissions were compared to the limit of 25 μV/meter at a 300 meter measurement distance.

☒ The measured output power was found to exceed 500 watts. Therefore, in accordance with Section 18.305 of Subpart - C, the measured out-of-band emissions were compared with the limit calculated as follows:

L_{FS} = 25*SQRT(Power Output/500)

where: L_{FS} is the maximum allowable field strength for out-of-band emissions in μV/meter at a 300 meter measurement distance. Power Output is the measured output power in watts.

L_{FS} = 29.6 μV/meter
29.4 dB (μV/m)
69.4 dB (μV/m) @ 3m
78.9 dB (μV/m) @ 1m

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2.5 OPERATING FREQUENCY MEASUREMENTS

2.5.1 VARIATION IN OPERATING FREQUENCY WITH TIME

The operating frequency was measured using a spectrum analyzer. Starting with the EUT at room temperature, a 1000 ml water load was placed in the center of the oven and the oven was operated at maximum output power. The fundamental operating frequency was monitored until the water load was reduced to 20 percent of the original load.

The results of this test are as follows:

Initial Load = 1000 ml Final Load = 200 ml

Minimum frequency observed: 2443 MHz
Minimum frequency allowed: 2400 MHz
Maximum frequency observed: 2468 MHz
Maximum frequency allowed: 2500 MHz

Refer to data pages 1 & 2 for details measurement.

2.5.2 VARIATION IN OPERATING FREQUENCY WITH LINE VOLTAGE

The EUT was operated/warmed by at least 10 minutes of use with a 700 ml water load at room temperature at the beginning of the test. Then the operating frequency was monitored as the input voltage was varied between 80 and 125 percent of the nominal rating.

The results of this test are as follows:

Line voltage varied from 96 Vac to 150 Vac.

Minimum frequency observed: 2449 MHz
Minimum frequency allowed: 2400 MHz
Maximum frequency observed: 2463 MHz
Maximum frequency allowed: 2500 MHz

Refer to data pages 3 & 4 for details of measurement.

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2.6 RADIATED EMISSIONS

Radiated emissions were measured over a frequency range of 100 MHz through the highest detectable harmonic emission (fifth harmonic), of the operating frequency, inclusive. For this test, the device under test was supported by a 1 meter high wooden table in a semi-anechoic EMC test chamber. The table was placed on a turn table.

The measurement antenna was placed at 3 meters for measurements from 100-1000 MHz, and at 1 meter for measurements beyond 1 GHz, respectively, from the device under test. The indicated frequency range was swept as the device under test was rotated about its vertical axis in a full 360 degree rotation. Emissions were observed while the device under test was operated at maximum output power. Maximum readings were recorded after variations in antenna polarization, height, device orientation, load position and size.

Preliminary Test Data - see plots on data pages 8 through 10.

ISM Side Measurements - see date page 5.

Harmonic Measurements - see data page 6.

Out of Band Measurements - see data page 7.

☒ **For all emissions the equivalent 300 meter intensity was calculated assuming a linear decrease in the intensity of the RFI field with increased distance. In the operating mode and conditions described, there were no over-limit emissions discovered.**

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3.0 MEASUREMENT EQUIPMENT:

The test equipment used for these measurements includes the following. Cal. Date is the last calibration date:

- **EMI Receiving System:** Hewlett Packard Co., Model 8566B Spectrum Analyzer S/N 3638A08593, Model OPT Spectrum Analyzer Display S/N 3552A22050, Model 85650A Quasi-Peak Adapter S/N 3303A01831, Model 85685A RF Preselector, S/N 3506A01538, and Model 8449B Preamplifier, S/N 3008A00884, Cal Date 1/10/2000.
- **Spectrum Analyzer:** Hewlett Packard Co., Model 8546A, S/N 3807A00457, Cal. Date 6/26/1999.
- **Biconnical Antenna:** Electro-Metrics Inc. Model EM-6912A, S/N 155, Cal. Date 4/15/1999.
- **Log Periodic Antenna:** Electro-Metrics Inc. Model EM-6950, S/N 935, Cal. Date 11/6/1999.
- **Horn Rigid Guide Antenna:** Electro-Metrics Inc. Model EM-6961, S/N 6275, Cal. Date 10/17/1999.
- **Power Analyzer:** Voltech, , Model PM3000A, S/N 1527, Cal. Date 2/10/1999.
- **Digital Multimeter:** Fluke, , Model 87, S/N 6736177, Cal. Date 5/5/1999.
- **Microwave Leakage Meter:** Holaday, Model 1500, S/N 10012, Cal. Date 10/19/1999.
- **Temperature Indicator:** Doric, Model Trendicator 400A, S/N 31484, Cal. Date 8/9/1999.

Tested By:

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Senior Engineering Assistant
International EMC Services

Reviewed By:

Asim Tirmizi
Associate Project Engineer
International EMC Services

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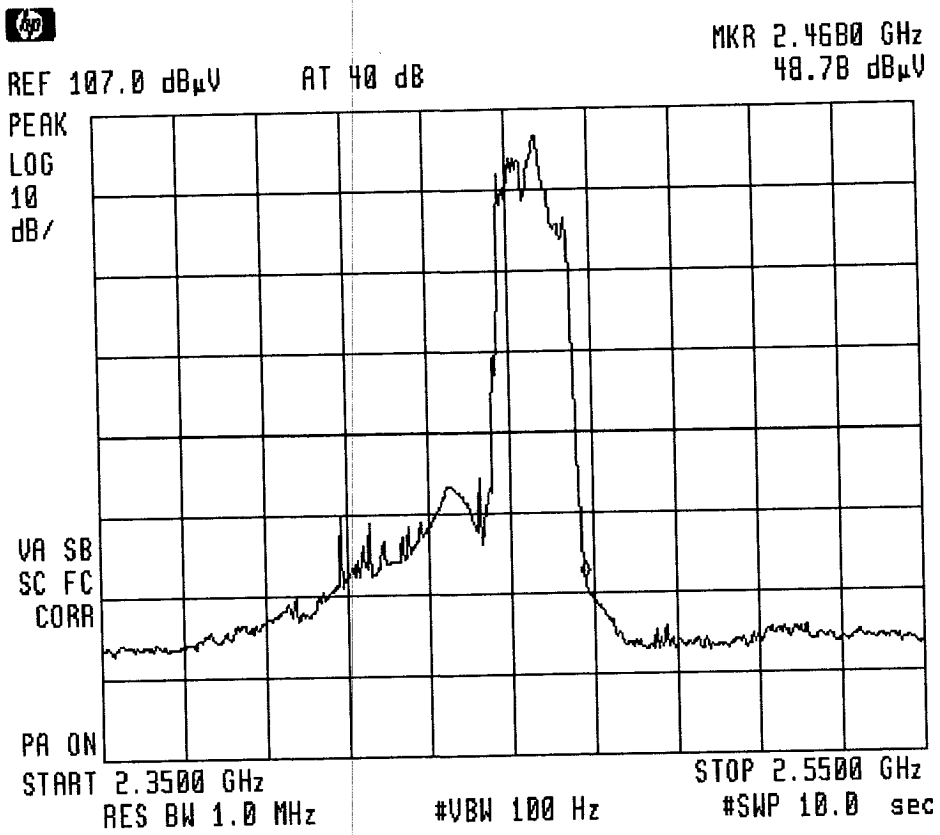
Variation in Operating Frequency with Time



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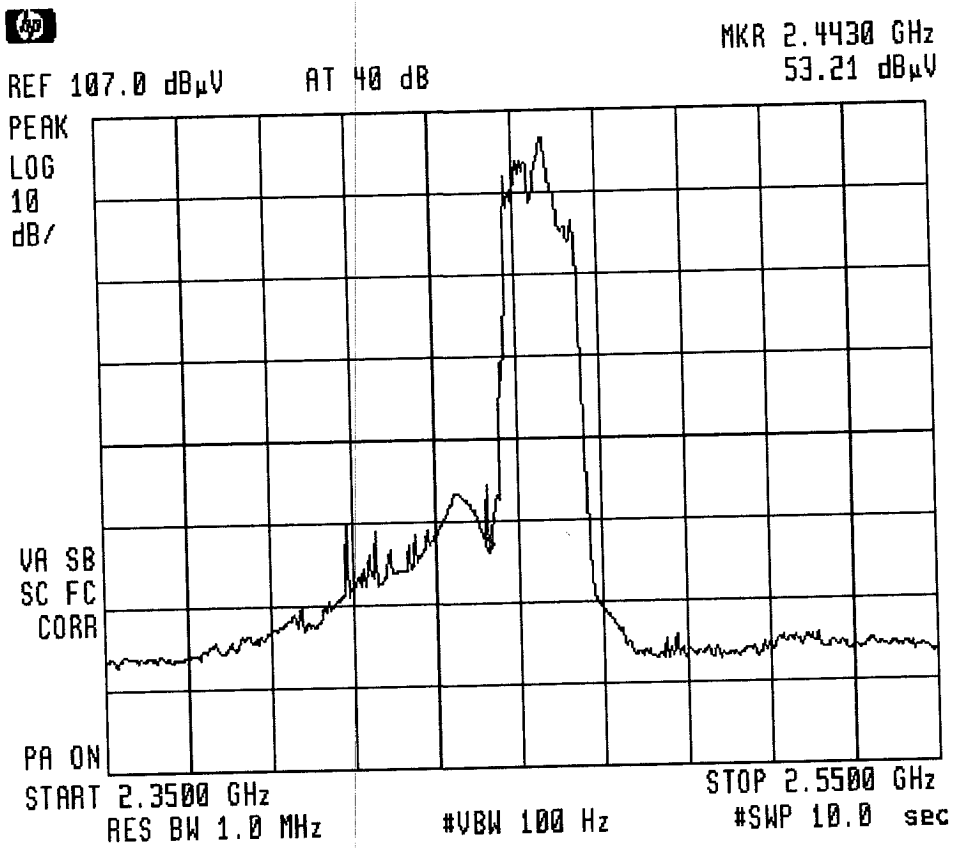
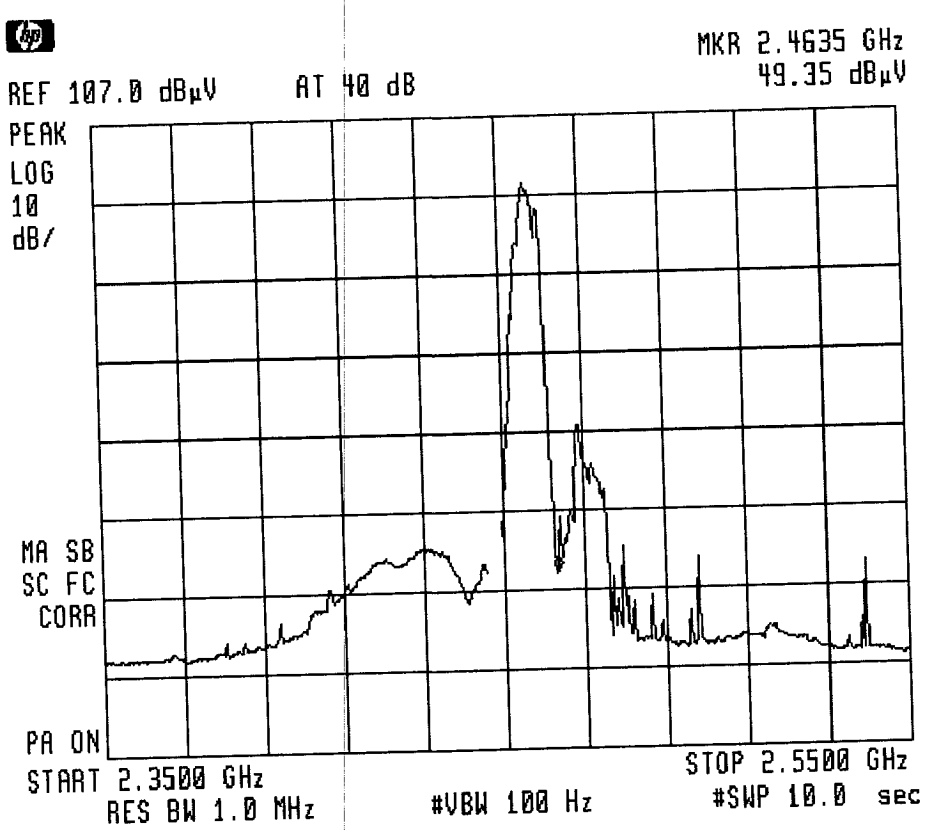
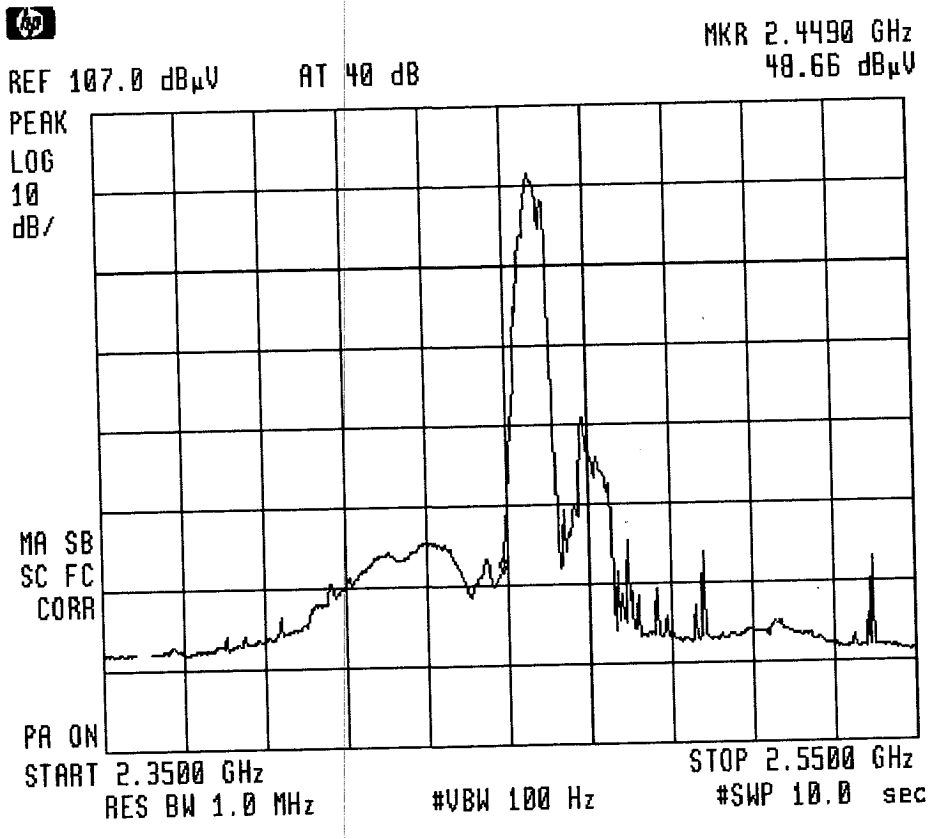


Variation in Operating Frequency with Line Voltage



Variation in Operating Frequency with Line Voltage



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ISM SIDEBAND MEASUREMENTS
Data Page 5

Date Tested: March 17, 2000

Test Requirements:	CFR Title 47, Part 18, Subpart - C
Test Procedure:	FCC/OST MP-5 (1986)
Receiver:	Hewlett-Packard, Spectrum Analyzer, Model HP8566B
Resolution Bandwidth:	1 MHz
Video Bandwidth:	1 Hz (to simulate linear average detection)
Antenna:	Electro-Metrics Inc., Ridged Guide Horn, Model EM-6961
Measurement Distance:	1 meter
Load:	700 ml water in center of oven

Measured Frequency (MHz)	Meter Reading (dB(μV))	Cable Loss (dB)	Antenna Factor (dB)	1 meter Intensity [dB(μV)/m]	300 meter Intensity [μV/m]	300 meter Limit [μV/m]
2399 V	17.63	4.4	28.4	50.43	1.108	29.6
2399 H	18.89	4.4	28.0	51.29	1.222	29.6
2501 V	17.1	4.6	28.5	50.2	1.079	29.6
2501 H	19.28	4.6	28.0	51.88	1.309	29.6

V - indicates vertical antenna polarity H - indicates horizontal antenna polarity

CALCULATIONS - Calculation of the equivalent 300 meter field strength was performed assuming a linear fall-off in the field strength with increased distance from the radiating source.

Field Strength (μV/meter at 300 meters) = K x 10 ^[(SI+AF+CL)/20]

Where: SI is the intensity of the signal in dB(μV)
AF is the antenna factor in dB; CL is the cable loss in dB.
K is the ratio of:[measurement distance/requirement distance]

UNDERWRITERS LABORATORIES INC.
HARMONIC MEASUREMENTS
Data Page 6

Date Tested: March 17, 2000

Test Requirements:	CFR Title 47, Part 18, Subpart - C
Test Procedure:	FCC/OST MP-5 (1986)
Receiver:	Hewlett-Packard, Spectrum Analyzer, Model HP8566B
Resolution Bandwidth:	1 MHz
Video Bandwidth:	1 Hz (to simulate linear average detection)
Antenna:	Electro-Metrics Inc., Horn Rigid Guide, Model EM-6961
Measurement Distance:	1 meter

Measured Frequency (MHz)	Meter Reading (dB(μV))	Cable Loss (dB)	Antenna Factor (dB)	1 meter Intensity [dB(μV)/m]	300 meter Intensity [μV/m]	300 meter Limit [μV/m]
Load: 700 ml water in center of oven						
4913.502 V	19.18	7.0	33.1	59.28	3.068	29.6
7375.4 V	23.71	8.3	36.4	68.41	8.778	29.6
Load: 700 ml water in right front corner of oven						
4876.44 H	26.63	7.0	33.0	66.63	7.152	29.6
7320.7 V	33.26	8.2	36.4	77.86	26.054	29.6
Load: 300 ml water in center of oven						
4905.55 H	18.94	7.0	33.1	59.04	2.985	29.6
7316.0 V	23.11	8.2	36.4	67.71	8.098	29.6
Load: 300 ml water in right front corner of oven						
4877.07 V	20.44	7.0	33.0	60.44	3.507	29.6
7313.02 H	24.02	8.2	36.4	68.62	8.992	29.6

V - indicates vertical antenna polarity H - indicates horizontal antenna polarity

CALCULATIONS - Calculation of the equivalent 300 meter field strength was performed assuming a linear fall-off in the field strength with increased distance from the radiating source.

Field Strength (μV/meter at 300 meters) = K x 10 ^[(SI+AF+CL)/20]

Where: SI is the intensity of the signal in dB(μV)
AF is the antenna factor in dB; CL is the cable loss in dB
K is the ratio of:[measurement distance/requirement distance]

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OUT-OF-BAND EMISSIONS MEASUREMENTS
Data Page 7

Date Tested: March 17, 2000

Test Requirements:	CFR Title 47, Part 18, Subpart - C
Test Procedure:	FCC/OST MP-5 (1986)
Receiver:	Hewlett-Packard, Spectrum Analyzer, Model HP8566B
Resolution Bandwidth:	100 kHz (< 1 GHz) and 1 MHz (> 1 GHz)
Video Bandwidth:	1 Hz (to simulate linear average detection)
Antenna:	Electro-Metrics Inc., Horn Rigid Guide Model EM-6961, and Log-Periodic Model EM6950
Measurement Distance:	3 meter (< 1GHz) and 1 meter (> 1 GHz)
Load:	700 ml water in center of oven

Measured Frequency (MHz)	Meter Reading (dB(μV))	Cable Loss (dB)	Antenna Factor (dB)	3 meter Intensity [dB(μV)/m]	300 meter Intensity [μV/m]	300 meter Limit [μV/m]
No measurements were necessary based on preliminary data, see data pages 8 and 9.						

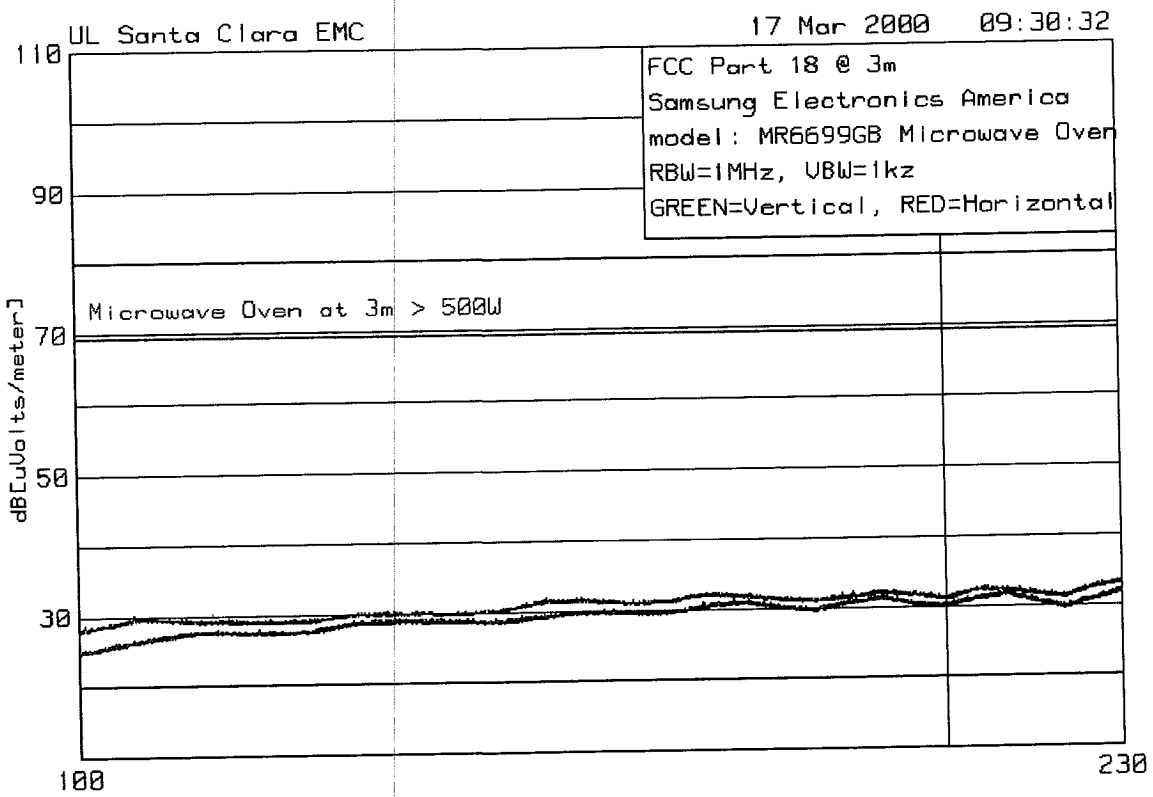
Measured Frequency (MHz)	Meter Reading (dB(μV))	Cable Loss (dB)	Antenna Factor (dB)	1 meter Intensity [dB(μV)/m]	300 meter Intensity [μV/m]	300 meter Limit [μV/m]
1228.34 V	32.25	3.2	24.6	60.05	3.353	29.6
1871.22 V	16.25	4.0	27.5	47.75	0.814	29.6
1871.22 H	34.2	4.0	27.1	65.3	6.136	29.6
12451.9 V	21.51	12.4	39.0	72.91	14.736	29.6

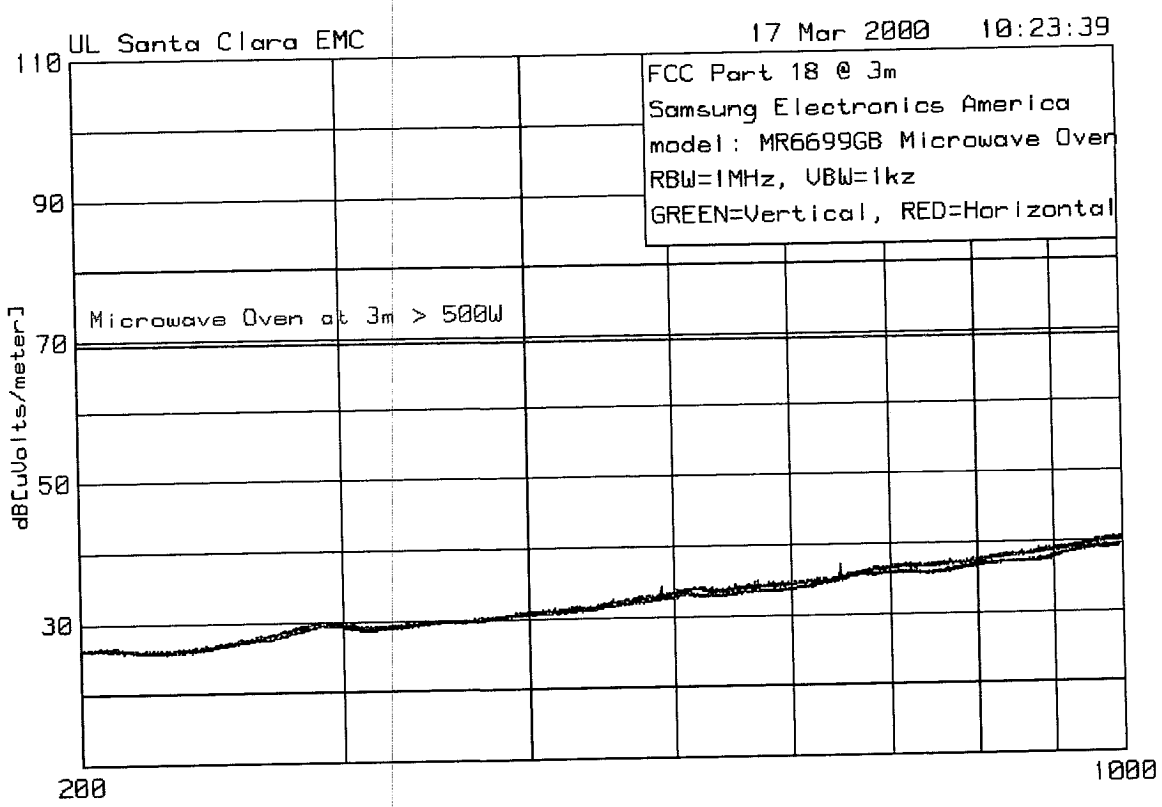
V - indicates vertical antenna polarity H - indicates horizontal antenna polarity.

CALCULATIONS - Calculation of the equivalent 300 meter field strength was performed assuming a linear fall-off in the field strength with increased distance from the radiating source.

Field Strength (μV/meter at 300 meters) = K x 10 ^[(SI+AF+CL/20)]

Where: SI is the intensity of the signal in dB(μV)
AF is the antenna factor in dB; CL is the cable loss in dB.
K is the ratio of:[measurement distance/requirement distance]


UL Santa Clara EMC
17 Mar 2000 09:30:32
FCC Part 18 @ 3m
Samsung Electronics America
model: MR6699GB Microwave Oven
RBW=1MHz, VBW=1kz
GREEN=Vertical, RED=Horizontal
Microwave Oven at 3m > 500W
dBuVolts/meter
110
90
70
50
30
100
230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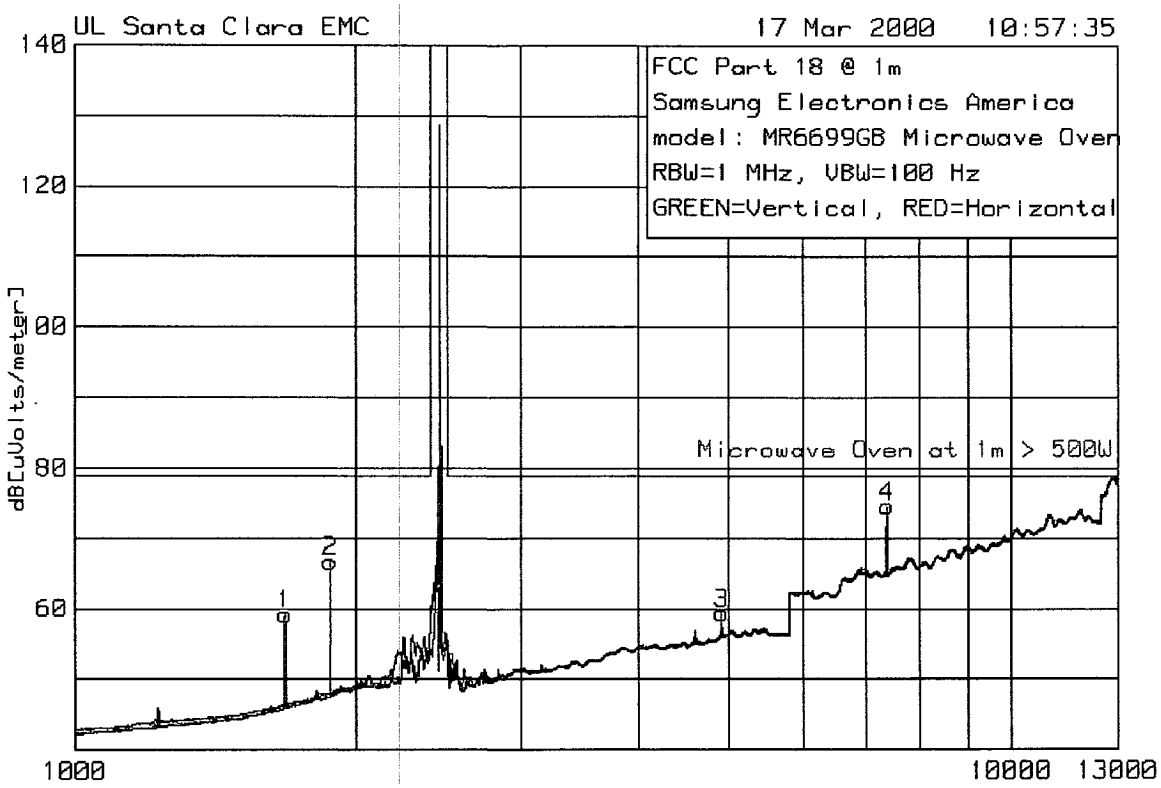
17 Mar 2000 10:23:39
FCC Part 18 @ 3m
Samsung Electronics America
model: MR6699GB Microwave Oven
RBW=1MHz, VBW=1kz
GREEN=Vertical, RED=Horizontal
Microwave Oven at 3m > 500W
dBCuVolts/meter]
110
90
70
50
30
200
1000


UL Santa Clara EMC
17 Mar 2000 10:57:35
FCC Part 18 @ 1m
Samsung Electronics America
model: MR6699GB Microwave Oven
RBW=1 MHz, VBW=100 Hz
GREEN=Vertical, RED=Horizontal
Microwave Oven at 1m > 500W
dBCuVolts/meter
140
120
100
80
60
1000
10000
13000
1
2
3
4