



FCC MEASUREMENT / TECHNICAL TEST REPORT

Samsung Electronics America, Inc.

Microwave Oven Model MC5694R

With Magnetron Samsung, Model OM-75P

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San Jose, CA 95134 USA

EQUIPMENT UNDER TEST: Microwave Oven Model MC5694R
with Magnetron Samsung, Model OM-75P

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This report contains 9 pages + 10 data pages. Page 1 of 9

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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 99:99 (minutes: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 850 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:

Underwriters Laboratories Inc., 1655 Scott Boulevard, Santa Clara, CA

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.

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/cm² observed at any point 5 cm or more from the external surface of the oven.**

A maximum of 1.0 mW/cm² 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.

(maximum observed values)

Input Voltage (Vac)	Input Current (amps)	Measured Input power (watts)	Rated Input Power (watts)
118	13.8	1420	1400

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

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 1000 watts.

Load used for output power measurement = 1000 milliliters of water

Load used frequency measurement = 1000 milliliters of water

Load used for harmonic measurement = 700 & 300 milliliters of water

Load used other measurements = 700 milliliters of water

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.

Quantity of Water (ml)	Starting Temperature (°C)	Final Temperature (°C)	Elapsed Time (seconds)
1000	22	42°C	120

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

$$\text{Power} = 700 \text{ watts}$$

- ☐ 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 $\mu\text{V}/\text{meter}$ 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:

$$\text{LFS} = 25 * \text{SQRT}(\text{Power Output}/500)$$

where: LFS is the maximum allowable field strength for out-of-band emissions in $\mu\text{V}/\text{meter}$ at a 300 meter measurement distance. Power Output is the measured output power in watts.

$$\begin{aligned}\text{LFS} &= 29.58 \mu\text{V meter} \\ &= 29.42 \text{ dB } (\mu\text{V}/\text{meter}) \\ &= 69.42 \text{ dB } (\mu\text{V}/\text{meter}) @ 3\text{m} \\ &= 78.96 \text{ dB } (\mu\text{V}/\text{meter}) @ 1\text{m}\end{aligned}$$

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:

Minimum frequency observed: 2442 MHz
Minimum frequency allowed: 2400 MHz

Maximum frequency observed: 2470 MHz
Maximum frequency allowed: 2500 MHz

Refer to data pages 1 & 2 for details of the variation in operating frequency with time measurements.

2.5.2 VARIATION IN OPERATING FREQUENCY WITH LINE VOLTAGE

The EUT was operated/warmed by at least 10 minutes of use with a 1000 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: 2425 MHz
Minimum frequency allowed: 2400 MHz

Maximum frequency observed: 2466 MHz
Maximum frequency allowed: 2500 MHz

Refer to data pages 3 & 4 for details of the variation in operating frequency with line voltage measurements.

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 data page 5.

Harmonic Measurements - see data page 6.

Out of Band Measurements - see data page 7.

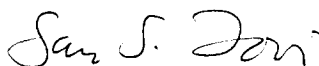
- ☒ **For all emissions the equivalent 300 meter intensity was calculated assuming a linear decrease in the intensity of the RFI field with increased distance. In the operating mode and conditions described, there were no over-limit emissions discovered.**

3.0 MEASUREMENT EQUIPMENT:

The test equipment used for these measurements includes:

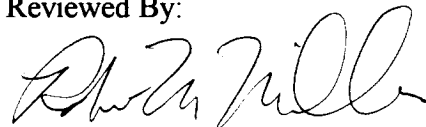
- **EMI Receiving System:** Hewlett Packard Co., Model 8566B Spectrum Analyzer S/N 3638A08593, Model OPT Spectrum Analyzer Display S/N 3552A22050, Model 85650A Quasi-Peak Adapter S/N 3303A01831, Model 85685A RF Preselector, S/N 3506A01538, and Model 8449B Preamplifier, S/N 3008A00884, Last Cal Date 11-24-97.
- **Biconnical Antenna:** Electro-Metrics Inc. Model EM-6912A, S/N 155, Cal. Date new from manufacturer 10/98.
- **Log Periodic Antenna:** Electro-Metrics Inc. Model EM-6950, S/N 1025, Cal. Date new from manufacturer 10/98.
- **Horn Rigid Guide Antenna:** Electro-Metrics Inc. Model EM-6961, S/N 6275, Cal. Date 10-08-98.
- **Power Analyzer:** Voltech, , Model PM3000A, S/N 1527, Cal. Date 01-21-98.
- **Digital Multimeter:** Fluke, , Model 87, S/N 67361177, Cal. Date 04-06-98.
- **Microwave Leakage Meter:** Holaday Industries, Model 1500, S/N 10012, Cal. Date 09-09-98.
- **Temperature Indicator:** Omega, Model 650, S/N 0321-4, Cal. Date 07/98.

Tested By:



San S. Toor
Senior Project Engineer
International EMC Services

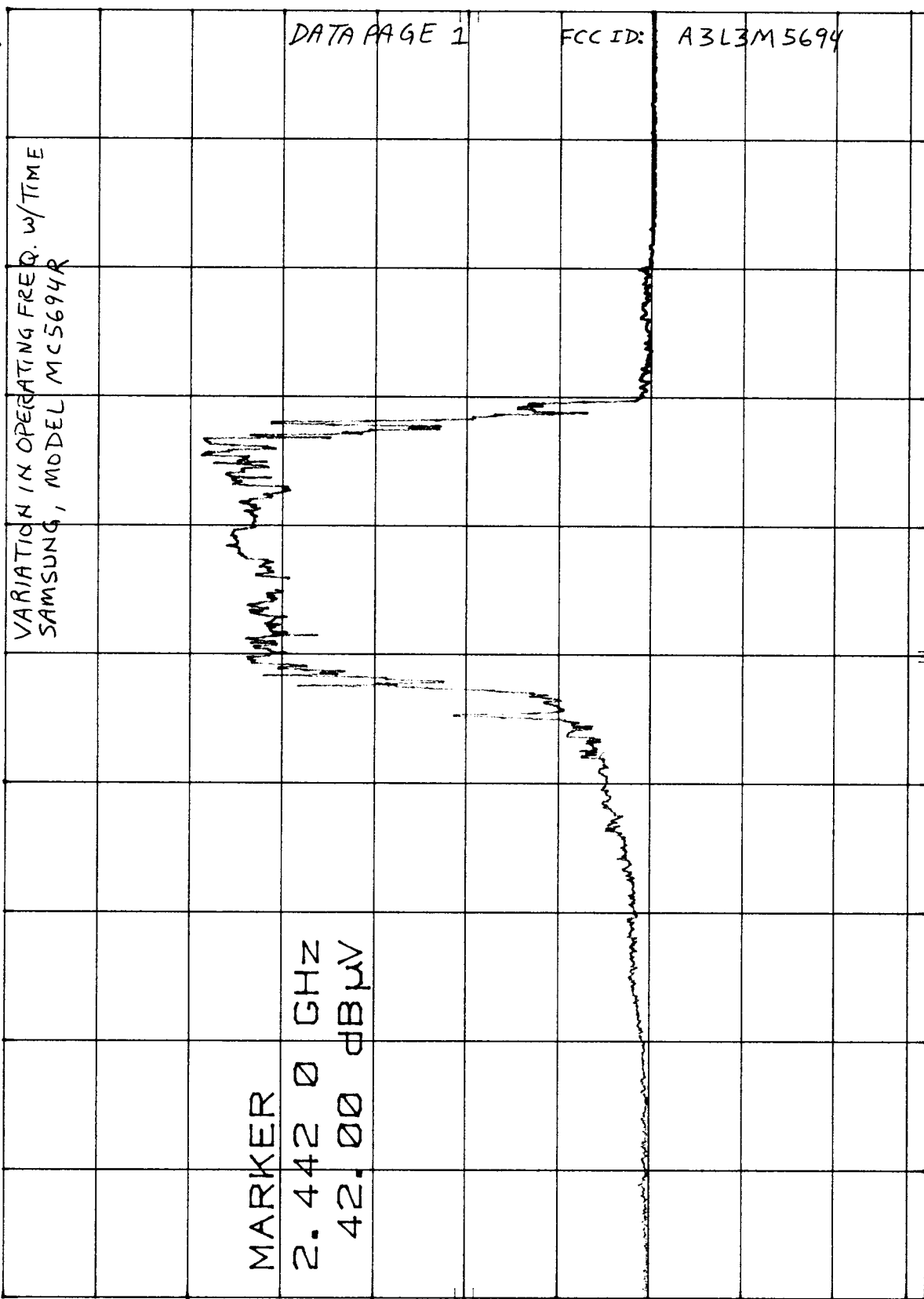
Reviewed By:



Robert M. Miller
Associate Managing Engineer
International EMC Services

HP MKR 2.442 0 GHZ
10 dB/ 42.00 dBμV

REF 107.0 dBμV ATTEN 20 dB +0 dB



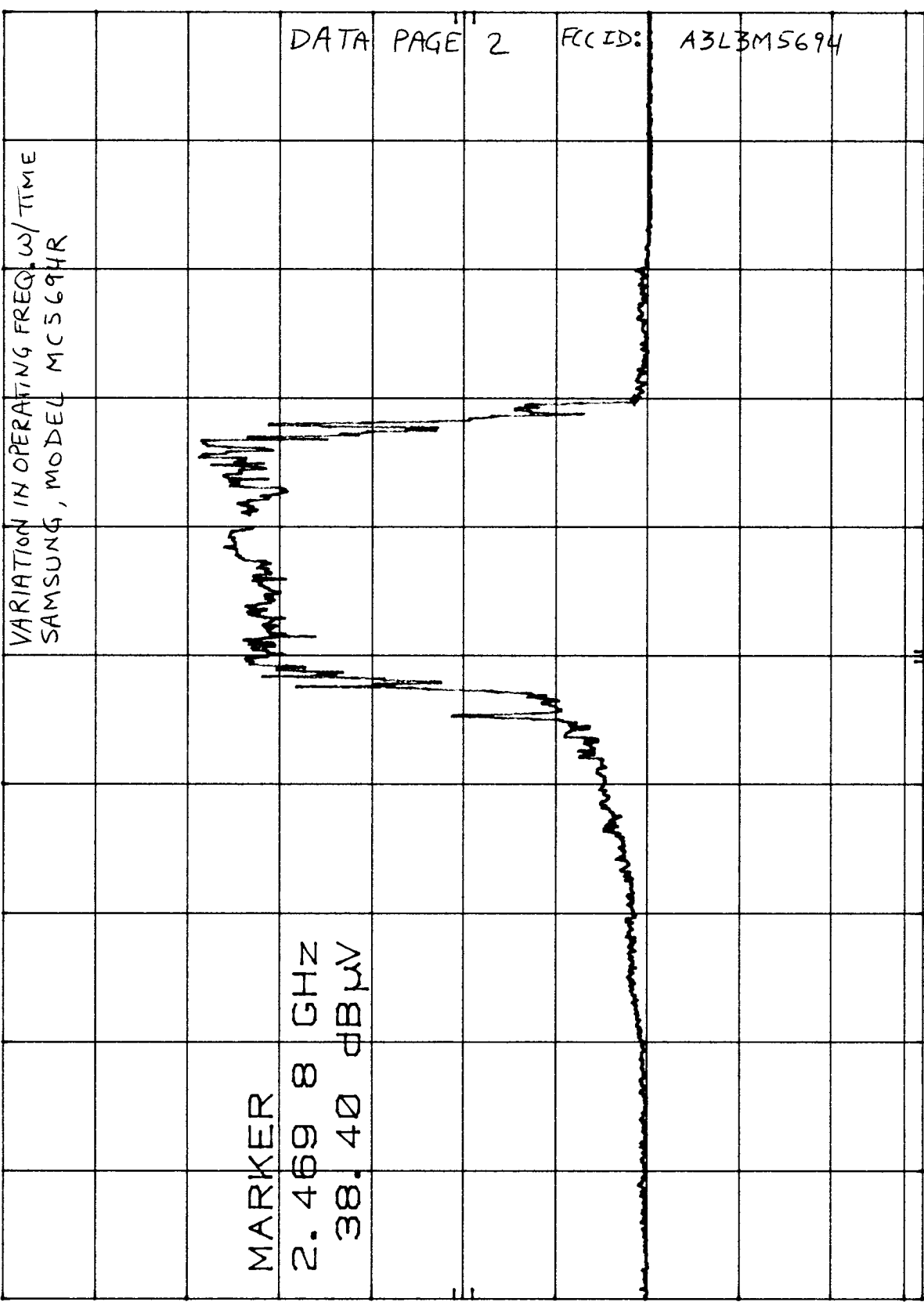
CORR'D

START 2.400 GHZ STOP 2.500 GHZ
RES BW 1 MHz(1) SWP 10.0 sec
S. S. TOOR

HP 10 dB/

REF 107.0 dBμV ATTEN 20 dB +0 dB

MKR 2.469 8 GHz
38.40 dBμV



MARKER

2.469 8 GHz
38.40 dBμV

DATA PAGE 2

FCC ID: A3L3M5694

CORR'D

START 2.400 GHz
RES BW 1 MHz (1)
STOP 2.500 GHz
SWP 10.0 sec

S. S. 2001
S. S. 100R

VBW 100 Hz

10 dB /
hp R

COR'D

2.425 1 GHz
38.20 dBμV

A3L3M5694

S. S. 2000.
S. S. 1000.

400 GHZ
RES BW 1 MHZ (1)

STOP 2.500 GHZ
SWP 10.0 sec

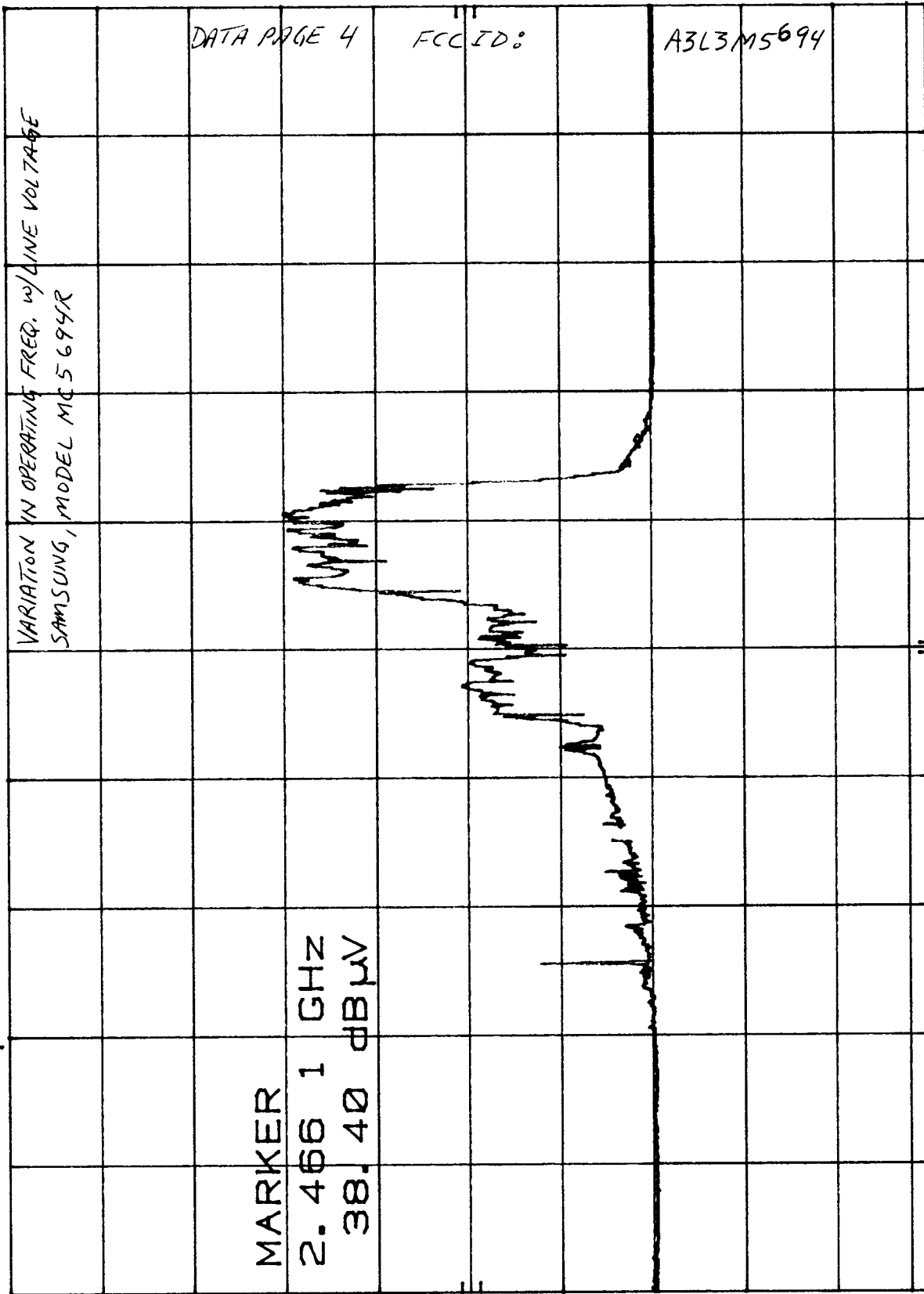
START 2.400 GHZ

HP MKR 2.466 1 GHz
10 dB/ 38.40 dBμV

REF 107.0 dBμV ATTN 20 dB +0 dB

HP

10 dB/



START 2.400 GHz
RES BW 1 MHz (1)

STOP 2.500 GHz
SWP 10.0 sec

S.S. TOOR

VBW 100 Hz

UNDERWRITERS LABORATORIES INC.
ISM SIDEBAND MEASUREMENTS
Data Page 5

Date Tested: November 06, 1998

Test Requirements: CFR Title 47, Part 18, Subpart - C
Test Procedure: FCC/OST MP-5 (1986)
Receiver: Hewlett-Packard, Spectrum Analyzer, Model
HP8566B, S/N 3638A08593
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	22.6	4.2	30.4	57.2	2.4	29.58
2399 H	22.5	4.2	30.4	57.1	2.4	29.58
2501 V	19.2	4.6	30.9	54.7	1.8	29.58
2501 H	21.3	4.6	30.9	56.8	2.3	29.58

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.

$$\text{Field Strength } (\mu\text{V/meter at 300 meters}) = K \times 10^{[(SI+AF+CL)/20]}$$

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: November 6, 1998

Test Requirements: CFR Title 47, Part 18, Subpart - C
Test Procedure: FCC/OST MP-5 (1986)
Receiver: Hewlett-Packard, Spectrum Analyzer, Model
HP8566B, S/N 3638A08593
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						
4923 V	19.3	6.8	34.7	60.8	3.7	29.58
7383 V	22.8	8.9	37.4	69.1	9.5	29.58
Load: 700 ml water in right front corner of oven						
4923 H	18.7	6.8	34.7	60.1	3.4	29.58
7382 V	22.0	8.9	37.4	68.3	8.7	29.58
Load: 300 ml water in center of oven						
4923 H	17.4	6.8	34.7	58.9	2.9	29.58
7390 V	21.9	9.0	37.4	68.3	8.7	29.58
Load: 300 ml water in right front corner of oven						
4917 H	18.9	6.8	34.7	60.4	3.5	29.58
7389 V	22.0	9.0	37.4	68.4	8.8	29.58

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.

$$\text{Field Strength } (\mu\text{V}/\text{meter at 300 meters}) = K \times 10^{[(SI+AF+CL)/20]}$$

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.
OUT-OF-BAND EMISSIONS MEASUREMENTS
Data Page 7

Date Tested: November 6, 1998

Test Requirements: CFR Title 47, Part 18, Subpart - C
Test Procedure: FCC/OST MP-5 (1986)
Receiver: Hewlett-Packard, Spectrum Analyzer, Model HP8566B,
S/N 3638A08593
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]
255 H	1.1	1.7	13.2	16.0	0.06	29.58
255 V	-6.0	1.7	13.2	8.9	0.03	29.58
492 H	-0.5	2.4	18.0	19.9	0.1	29.58

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]
2212 H	21.7	4.4	29.4	55.5	2.0	29.58

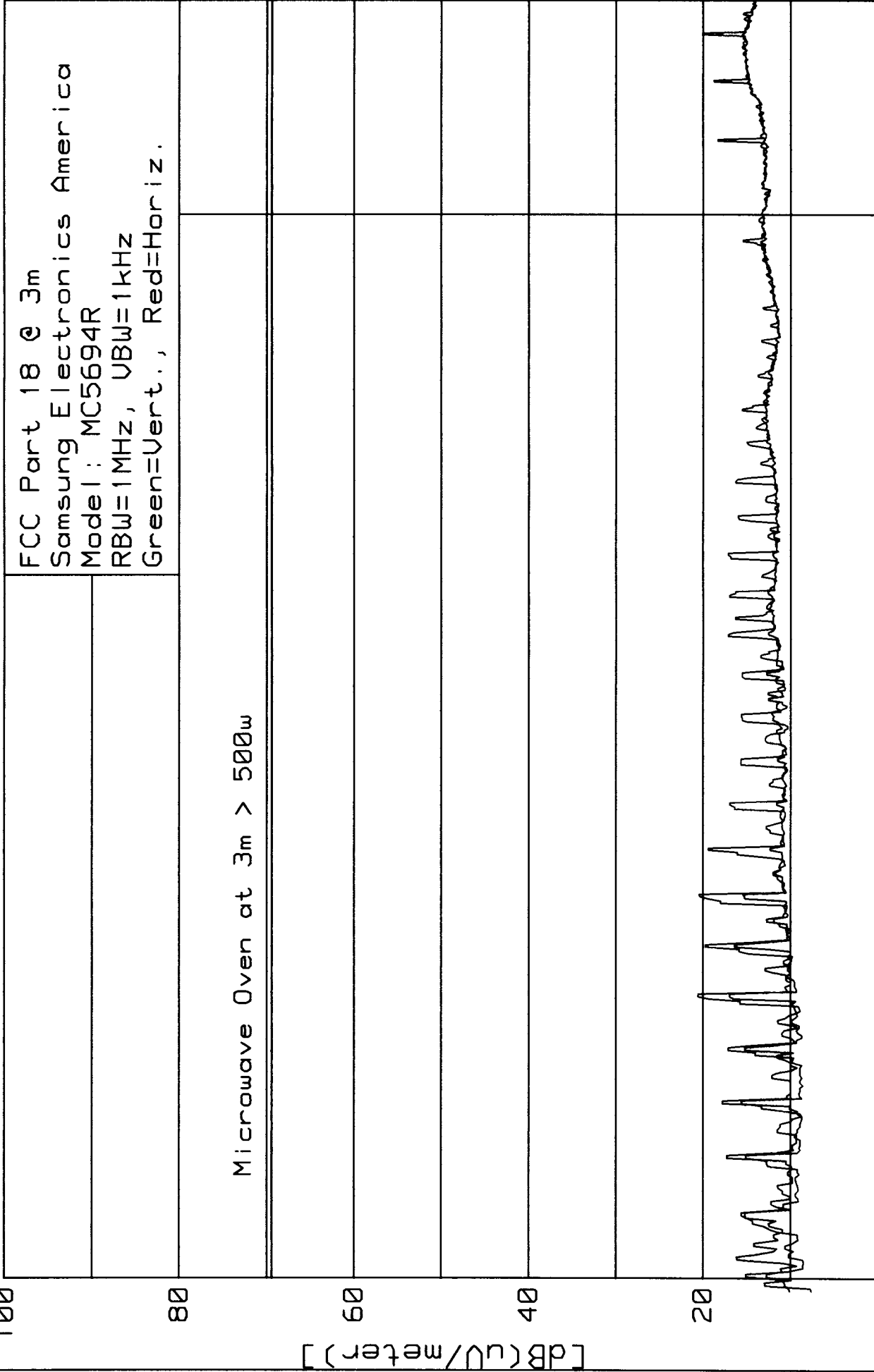
V - indicates vertical antenna polarity H - indicates horizontal antenna polarity.

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) = $K \times 10^{[(SI+AF+CL)/20]}$

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]

Frequency [MHz]



FCC Part 18 @ 3m
Samsung Electronics America
Model: MC5694R
RBW=1MHz, VBW=1kHz
Green=Vert., Red=Horiz.

FCC Part 18 @ 3m
 Samsung Electronics America
 Model: MC5694R
 RBW=1MHz, VBW=1kHz
 Green=Vert., Red=Horiz.

Microwave Oven at 3m > 500w

[dB(uV/meter)]

Frequency [MHz]

200

S. S. TOOR

1000

100

80

60

40

20

FCC 18 @ 1m
Samsung Electronics America
Model: MC5694R
RBW=1MHz, VBW=100Hz
Green=Vert., Red=Horiz.

Microwave Oven at 1m > 500W

[dB(uV/meter)]

Frequency [MHz]

1000

S. S. 200
S. S. TOOR

10000 13000

140

120

100

80

60