ATTACHMENT C – TEST REPORT

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CERTIFICATE OF COMPLIANCE

LG Electronics Inc. – DID DIVISION
642, Jinpyung-dong, Kumi-city,
Kyoungsangbuk-do, 730-360 KOREA
Attn: Mr. Yeong Hur, EMC Engineer

Dates of Tests: July 11-12, 2001
Test Report S/N: B.210707387.BEJ
Test Site: PCTEST Lab., MD U.S.A.

FCC ID	BEJLI561G
APPLICANT	LG ELECTRONICS INC.

Rule Part(s):	FCC Part 15 Subpart B
Equipment Class:	Class B Peripheral Device (JBP)
Standard(s):	EN55022: 1998 (CISPR 22)
EUT Type:	15-inch LCD Monitor
Max. Resolution(s):	1024 x 768 Non-interlaced @ 75Hz
Trade Name(s):	*IBM*
Model(s):	*6656-HW2*

This equipment has been shown to be in compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.4-1992. (Note Codes: #19, #28)

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Alfred Cirwithian
Vice President Engineering

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NVLAP
Lab Code 100431-0

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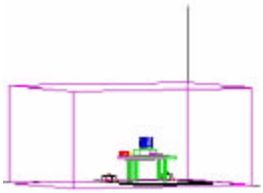
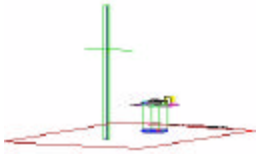
MEASUREMENT REPORT





1.1 Scope

Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission.

Applicant Name:	**LG ELECTRONICS INC.**
Address:	**642, Jinpyung-dong, Kumi-city, Kyoungsangbuk-do, 730-360 KOREA**
Contact Person:	**Yeong Hur, EMC Engineer Product Engineering Dept., Safety & EMC Team**

- FCC ID: **BEJLI561G**
- Equipment Class: B Digital Device / Peripheral (JBP)
- EUT Type: 15-inch LCD Monitor
- Trade Name(s): ***IBM***
- Model(s): ***6656-HW2***
- Max. Resolution: 1024 x 768 Non-interlaced @ 75Hz
- Cable(s): Shielded D-Sub (with ferrite on both ends
- Power Cord: Unshielded
- Rule Part(s): FCC Part 15 Subpart B
- Test Procedure(s): ANSI C63.4 (1992)
- Dates of Tests: July 11-12, 2001
- Place of Tests: PCTEST Lab, Columbia, MD U.S.A.
- Test Report S/N: B.210707387.BEJ

NVLAP Lab Code 100431-0

2.1 INTRODUCTION

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz (ANSI C63.4-1992) was used in determining radiated and conducted emissions emanating from **LG Electronics Inc. 15-inch LCD Monitor FCC ID: BEJLI561G.**

These measurement tests were conducted at ***PCTEST Engineering Laboratory, Inc.*** facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49'38" W longitude. The facility is 1.5 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on October 19, 1992.

2.2 PCTEST Location

The map at right shows the location of the PCTEST Lab, its proximity to the FCC Lab, the Columbia vicinity area, the Baltimore-Washington International (BWI) airport, and the city of Baltimore, and the Washington, D.C. area. (see Figure 1).

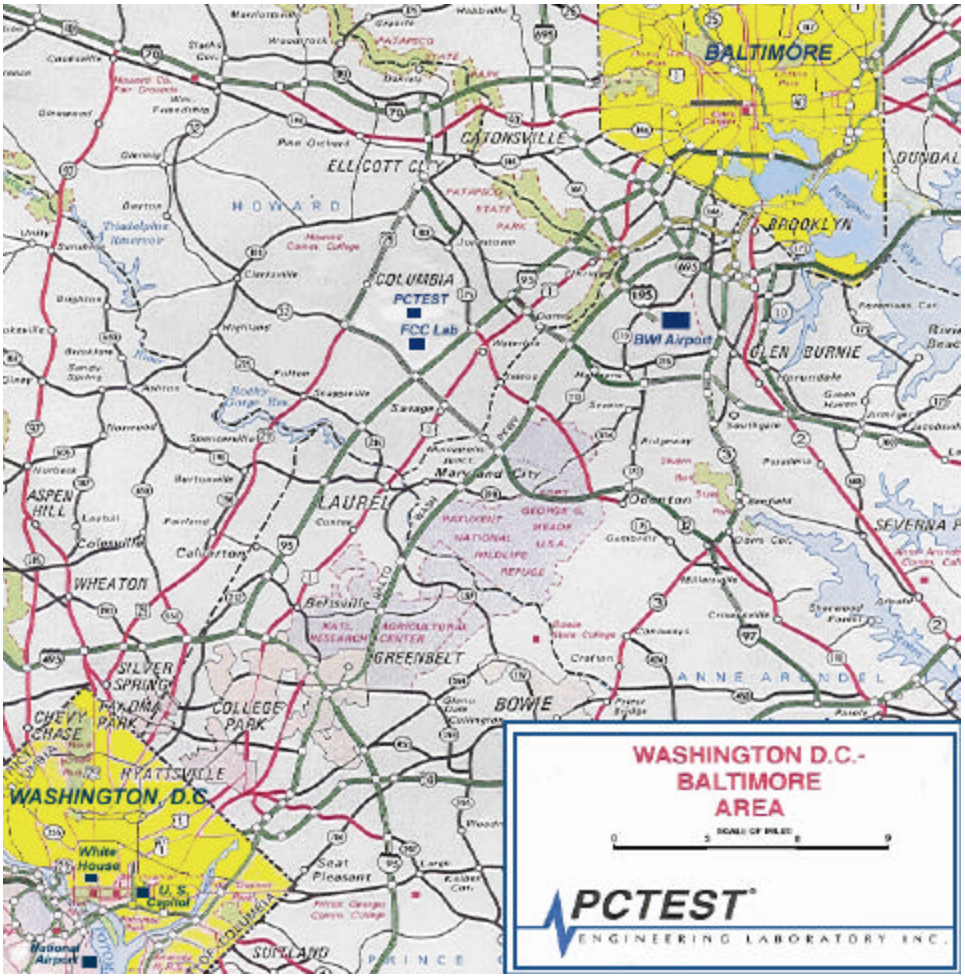


Figure 1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area.

3.1 Product Information

3.2 Equipment Description

The Equipment Under Test (EUT) is the **LG Electronics Inc. (IBM Model: *6656-HW2*) 15-inch LCD Monitor FCC ID: BEJLI561G.**

Maximum Resolution(s):	1024 x 768 Non-interlaced @ 75Hz
Pixel Pitch:	0.297mm (H) x 0.297mm (V)
Power Supply:	90-264VAC, 60/50+\-3Hz
Power Cord:	*Unshielded* AC power cord
Port(s)/Input Connector(s):	15-pin D-Sub type VGA signal connector
Cable(s):	Shielded D-Sub (with ferrite on both ends)
Dimensions (WxHxD):	365.2 x 433 x 235 mm
Weight (Net):	4.5 kg

EMI Suppression Devices:

~ No modifications were made to the device.

4.1 Description of Tests

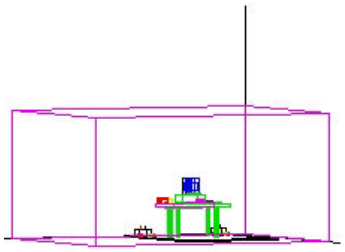


Fig. 2. Shielded Enclosure

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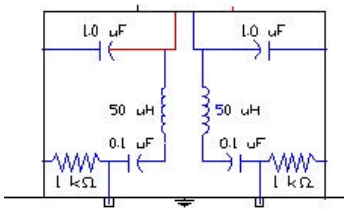

Fig. 3. LISN Schematic Diagram

4.2 Powerline Conducted RFI (150kHz- 30MHz)

The powerline conducted RFI measurements were performed according to CISPR 22. The EUT was placed on a non-conducting 1.0 by 1.5 meter table which is 0.8 meters in height and 0.40 meters away from the vertical wall of the shielded enclosure (see Figure 2). Power to the EUT is provided through a Rohde & Schwarz 50 Ω / 50 uH Line Impedance Stabilization Network (LISN) and the support equipment through a separate Solar 50 Ω / 50 uH Line- Conducted Test Facility LISN. Sufficient time for the EUT, support equipment, and test equipment were allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME. The spectrum was scanned from 150kHz to 30 MHz. Each maximum EME was remeasured using an EMI receiver. The detector function of the receiver was set to CISPR quasi- peak and average mode with the bandwidth set to 9 kHz. Each emission was maximized consistent with the typical applications by varying the configuration of the test sample. Interface cables were connected to the available interface ports of the test unit. The effect of varying the position of cables was investigated to find the configuration that produces maximum Diagram emission. Excess cable lengths were bundled at the centre with 30- 40cm. in length. The worst-case configuration is noted in the test report and the photographs are attached. Each EME reported was calibrated using the Rohde & Schwarz SMX signal generator and are listed on Table 1.

RFI Conducted	FCC Class B Limits dB[uV/m]	CISPR 22 Class B Limits dB[uV/m]	
Freq. Range	FCC Class B Quasi-Peak	CISPR 22 Quasi-Peak	CISPR 22 Average
150 kHz – 0.5 MHz	48*	66 – 56**	56 – 46**
0.5 MHz – 5 MHz	48	56	46
5 MHz – 30 MHz	48	60	50
* FCC Class B limits starts from 450 kHz. ** Limit decreases linearly with the logarithm of frequency.			

Table 1. CISPR 22 Class B RFI Conducted Limits

4.1 Description of Tests (continued)

4.3 Radiated Emissions

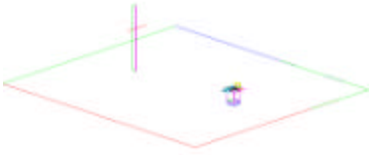

Fig. 4. Radiated Test @ 10-meters

Preliminary measurements were made indoors at 1 meter using broadband antennas, broadband amplifier, and spectrum analyzer to determine the frequency producing the maximum EME. Appropriate precaution was taken to ensure that all EME from the EUT were maximized and investigated. The spectrum was scanned from 30 to 200 MHz using biconical antenna, 200 to 1000 MHz using log- spiral antenna, and above 1 GHz using linearly polarized horn antennas. Final measurements were made outdoors at 10-meter test range using Roberts™ Dipole antennas (see Figure 4) and EMI receiver. For frequencies above 1 GHz, horn antennas were used. Sufficient time for the EUT, support equipment, and test equipment were allowed in order for them to warm up to their normal operating condition. The EMI receiver detector function was set to CISPR quasi-peak mode and the bandwidth of the receiver was set to 120 kHz. The EUT, support equipment, and interconnecting cables were arranged to the configuration that produces the maximum EME emission found during preliminary scan. The turntable containing the system was rotated; the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission (see Figure 4). Horizontal and vertical antenna polarizations were checked. Each emission was maximized by: varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/ or support equipment, and powering the monitor the computer aux AC outlet, if applicable; and changing the polarity of the antenna, whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in Appendix A. Each EME reported was calibrated using the Rohde & Schwarz SMX signal generator.

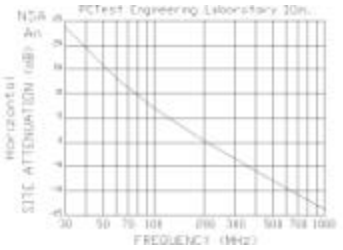

Fig. 5. NSA Theoretical Attenuation Curves (Horiz. Pol.)

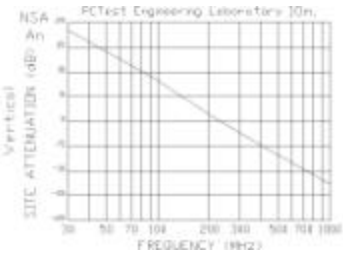

Fig. 6. NSA Theoretical Attenuation Curves (Vert. Pol.)

ITE Radiated Limits			
Frequency (MHz)	FCC Limit @ 3m. Quasi-Peak dB[µV/m]	FCC Limit @ 10m.* Quasi – Peak dB[µV/m]	CISPR Limit @ 10m. Quasi-Peak dB[µV/m]
30-88	40.0	29.5	30.0
88-216	43.5	33.0	30.0
216-230	46.0	35.6	30.0
230-960	46.0	35.6	37.0
960-1000	54.0	43.5	37.0
> 1000	54.0	43.5	No Specified limit
* Limit extrapolated 20 dB/decade			

Table 2. Radiated Class B limits @ 10-meters

5.1 Support Equipment Used

1. **LGE IBM 15" LCD Monitor**	**FCC ID: BEJLI561G (EUT)** 1.8 m. unshielded AC power cord 2.9 m. shielded D-SUB cable with ferrite on both ends 2.9 m. shielded DVI cable with ferrite on both ends	S/N: 66-00001
IBM AC Adapter	Model: PSCV360104A 1.8 m. shielded power cord with ferrite on monitor side	
2. GATEWAY Mid-Tower PC	Model: GP6-450 1.8 m. unshielded AC power cord	S/N: 0011745565
ATI AGP Video Card	Model: RADEON VE/32DDR	
3. H/P Printer	FCC ID: BS46XU2225 1.8 m. unshielded AC power cord 1.5 m. shielded cable	S/N: 2651S40366
4. LOGITECH Mouse	FCC ID: DZL211029 1.6 m. shielded cable	S/N: LZB02058777
5. GATEWAY Keyboard	FCC ID: D7J2196003-XX 1.6 m. shielded cable	S/N: 03400409
6. ZOOM Modem	FCC ID: BDNV34MINI-EXT 1.8 m. unshielded DC power cord 1.2 m. shielded cable	S/N: 3117ZM4X40211

(See "Attachment G - Test Setup Photographs" for actual system test setup.)

6.1 LINE-CONDUCTED TEST DATA

6.2 Conducted Emissions

(See Data under PLOTS – Attachment D)

NOTES:

1. **All modes of operation were investigated and the worst-case emissions are reported.**
2. **The CISPR RFI conducted limits are listed on Table 1 (Page 4).**
3. **Line A = Phase Line B = Neutral**
4. **Deviations to the Specifications: None**

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* *All readings are calibrated by HP8640B signal generator with accuracy traceable to the National Institute of Standards and Technology (formerly NBS).*

** *Measurements using CISPR quasi-peak mode.*

7.1 RADIATED TEST DATA

7.2 Radiated Emissions

FREQ. (MHz)	**Level*** (dBµV/m)	**AFCL**** (dB)	**POL** (H/V)	**Height** (m)	**Azimuth** (° angle)	**F/S** (dBµV/m)	**Margin***** (dB)
86.5	15.19	8.22	V	3.1	160	23.4	- 6.6
148.9	10.00	13.53	H	2.9	95	23.5	- 6.5
194.3	6.58	16.22	V	2.8	125	22.8	- 7.2
273.6	8.25	19.65	H	2.5	240	27.9	- 9.1
373.1	5.65	22.95	H	1.8	265	28.6	- 8.4
384.3	4.24	23.26	V	1.8	190	27.5	- 9.5
486.2	1.03	25.77	H	1.5	85	26.8	- 10.2
552.1	1.53	27.17	H	1.3	130	28.7	- 8.3

Table 3. Radiated Measurements at 10-meters.

1024 x 768 Non-interlaced @ 75Hz

NOTES:
1. All modes of operation were investigated, and the worst-case emissions are reported.
2. The radiated limits are listed on Table 2 (Page 5).

* *All readings are calibrated by HP8640B signal generator with accuracy traceable to the National Institute of Standards and Technology (formerly NBS).*

** *AFCL = Antenna Factor (Roberts dipole) and Cable Loss (30 ft. RG58C/U).*

*** *Measurements using CISPR quasi-peak mode. Above 1GHz, peak detector function mode is used using a resolution bandwidth of 1MHz and a video bandwidth of 1MHz. The peak level complies with the average limit. Peak mode is used with linearly polarized horn antenna and low-loss microwave cable.*

8.1 Sample Calculations

$$dB\mu V = 20 \log_{10} (\mu V/m)$$
$$dB\mu V = dBm + 107$$

8.2 Example 1:

@ 20.3 MHz

Class B limit	= 250 μV = 47.96 dBμV
Reading	= - 67.8 dBm (calibrated level)
Convert to dbμV	= - 67.8 + 107 = 39.2 dBμV
$10^{(39.2/20)}$	= 91.2 μV
Margin	= 39.2 - 47.96 = - 8.76
	= **8.8 dB below limit**

8.3 Example 2:

@ 66.7 MHz

Class B limit	= 100 μV/m = 47.96 dBμV/m
Reading	= - 76.0 dBm (calibrated level)
Convert to dbμV/m	= - 76.0 + 107 = 31.0 dBμV/m
Antenna Factor + Cable Loss	= 5.8 dB
Total	= 36.8 dBμV/m
Margin	= 36.8 - 40.0 = - 3.2
	= **3.2 dB below limit**

9.1 Accuracy of Measurement

9.2 Measurement Uncertainty Calculations:

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994).

Contribution (Line Conducted)	Probability Distribution	Uncertainty (± dB)	
		9kHz-150MHz	150-30MHz
Receiver specification	Rectangular	1.5	1.5
LISN coupling specification	Rectangular	1.5	1.5
Cable and input attenuator calibration	Normal (k=2)	0.3	0.5
Mismatch: Receiver VRC Γ_1 = 0.03 LISN VRC Γ_R = 0.8 (9kHz) 0.2 (30MHz) Uncertainty limits 20Log(1 ± Γ_1 Γ_R)	U-Shaped	0.2	0.35
System repeatability	Std. deviation	0.2	0.05
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	1.26	1.30
Expanded uncertainty	Normal (k=2)	2.5	2.6

Calculations for 150kHz to 30MHz:

$$u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)} = \pm\sqrt{\frac{1.5^2 + 1.5^2}{3} + (\frac{0.5}{2})^2 + 0.35} = \pm 1.298\text{dB}$$

$U = 2U_c(y) = \pm 2.6\text{dB}$

Contribution (Radiated Emissions)	Probability Distribution	Uncertainties (± dB)	
		3 m	10 m
Ambient Signals		-	-
Antenna factor calibration	Normal (k=2)	± 1.0	± 1.0
Cable loss calibration	Normal (k=2)	± 0.5	± 0.5
Receiver specification	Rectangular	± 1.5	±1.5
Antenna directivity	Rectangular	+ 0.5 / - 0	+ 0.5
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase centre variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	±. 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67 (Bi) 0.3 (Lp) Uncertainty limits 20Log(1 ± Γ_1 Γ_R)	U-Shaped	+ 1.1 - 1.25	± 0.5
System repeatability	Std. Deviation	± 0.5	± 0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+ 2.19 / - 2.21	+ 1.74 / - 1.72
Expanded uncertainty U	Normal (k=2)	+ 4.38 / - 4.42	+ 3.48 / - 3.44

Calculations for 3m biconical antenna. Coverage factor of k=2 will ensure that the level of confidence will be approximately 95%, therefore:

$U = 2u_c(y) = 2 \times \pm 2.19 = \pm 4.38\text{dB}$

10.1 Test Equipment

10.2 Type	Model	Cal. Due Date	S/N
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	12/05/01	3638A08713
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	04/17/02	2542A11898
Spectrum Analyzer/Tracking Gen.	HP 8591A (9kHz-1.8GHz)	06/02/02	3144A02458
Spectrum Analyzer	HP 8591A (9kHz-1.8GHz)	10/15/01	3108A02053
Spectrum Analyzer	HP 8594A (9kHz-2.9GHz)	11/02/01	3051A00187
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/02	2232A19558
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/02	1851A09816
Signal Generator*	Rohde & Schwarz (0.1-1000MHz)	09/11/01	894215/012
Ailtech/Eaton Receiver	NM 37/57A-SL (30-1000MHz)	04/12/02	92-03271
Ailtech/Eaton Receiver	NM 37/57A (30-1000MHz)	03/11/02	0805-03334
Ailtech/Eaton Receiver	NM 17/27A (0.1-32MHz)	09/17/01	0608-03241
Quasi-Peak Adapter	HP 85650A	08/09/01	2043A00301
Ailtech/Eaton Adapter	CCA-7 CISPR/ANSI QP Adapter 03/11/02	0194-04082	
RG58 Coax Test Cable	No. 167		n/a
Harmonic/Flicker Test System	HP 6841A (IEC 555-2/3)		3531A00115
Broadband Amplifier (2)	HP 8447D		1145A00470, 1937A03348
Broadband Amplifier	HP 8447F		2443A03784
Transient Limiter	HP 11947A (9kHz-200MHz)		2820A00300
Horn Antenna	EMCO Model 3115 (1-18GHz)		9704-5182
Horn Antenna	EMCO Model 3115 (1-18GHz)		9205-3874
Horn Antenna	EMCO Model 3116 (18-40GHz)		9203-2178
Biconical Antenna (4)	Eaton 94455/Eaton 94455-1/Singer 94455-1/Compliance Design		1295, 1332, 0355
Log-Spiral Antenna (3)	Ailtech/Eaton 93490-1		0608, 1103, 1104
Roberts Dipoles	Compliance Design (1 set) A100		5118
Ailtech Dipoles	DM-105A (1 set)		33448-111
EMCO LISN (2)	3816/2		1077, 1079
EMCO LISN	3725/2		2009
Microwave Preamplifier 40dB Gain	HP 83017A (0.5-26.5GHz)		3123A00181
Microwave Cables	MicroCoax (1.0-26.5GHz)		
Ailtech/Eaton Receiver	NM37/57A-SL		0792-03271
Spectrum Analyzer	HP 8591A		3034A01395
Modulation Analyzer	HP 8901A		2432A03467
NTSC Pattern Generator	Leader 408		0377433
Noise Figure Meter	HP 8970B		3106A02189
Noise Figure Meter	Ailtech 7510		TE31700
Noise Generator	Ailtech 7010		1473
Microwave Survey Meter	Holaday Model 1501 (2.450GHz)		80931
Digital Thermometer	Extech Instruments 421305		426966
Attenuator	HP 8495A (0-70dB) DC-4GHz		
Bi-Directional Coax Coupler	Narda 3020A (50-1000MHz)		
Shielded Screen Room	RF Lindgren Model 26-2/2-0		6710 (PCT270)
Shielded Semi-Anechoic Chamber	Ray Proof Model S81		R2437 (PCT278)
Environmental Chamber	Associated Systems Model 1025 (Temperature/Humidity)		PCT285

* Calibration traceable to the National Institute of Standards and Technology (NIST).

11.1 Test Software Used

```
10    CLS:COLOR 7,0
20    FOR I = 1 TO 80
30    PRINT H;
40    NEXT I
50    FOR K= 1 TO 25
60    LPRINT H;
70    NEXT K
80    OPEN COM1:1200,N,8,1,CS0,DS0" FOR OUTPUT AS #1
90    PRINT#1,ATDT,0123456789"
100   CLOSE:GOTO 20
```

NOTE: This is a sample of the basic program used during the test. However, during testing, a different software program may be used; whichever determines the worst-case condition. In addition, the program used also depends on the number and type of devices being tested.

Actual program used is the "H" pattern in Notepad under Windows environment. All resolution modes (1024x768, 800x600, 640x480 Non-interlaced) were investigated and tested.

12.1 Conclusion

The data collected shows that the **LG Electronics Inc. 15-inch LCD Monitor FCC ID: BEJLI561G** complies with §15.107 and §15.109 of the FCC Rules.