

SGS KES Co., Ltd. EMC Laboratory

705, Dongchun-Ri Sooji-Eub, Yongin-Shi Kyungki-Do, KOREA
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FCC Part 15 Report

Manufacture :

Cardinal

2F. Ace techno Tower, 197-17 Kuro-Dong,
Kuro-Gu, Seoul, 152-050, Korea

Attn : Jong - Hyub, Kim

Dates of Tests : Sep. 27 to Nov. 26 2002

Test Report No. : 2002KESEMC-II-0380.FCC

Test Site : SGS KES Co., Ltd., EMC Site,
Korea

TYPE of EUT
MODEL No.

**TFT-LCD Monitor
CS-104**

APPLICANT

Cardinal

2F. Ace techno Tower, 197-17, Kuro-Gu, Seoul
152-050, Korea

CONTACT PERSON

Jong-Hyub, Kim

Tel. / Fax. : 82-2-868-6660/82-2-867-0131

FCC Rule Part(s) :
Classification :

Part 2 & Part 15
FCC Class B Device

The device bearing the trade name and model specified above has been shown to comply 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.

I attest to the accuracy of data and 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.



Kew - Seung, Lim

EMC Lab. Manager

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FCC Part 15

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SCOPE

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 under FCC part 15.

Responsible Party* :	Cardinal
Contact Person :	Jong-Hyub, Kim
	Tel /Fax. : 82-2-868-6660 / 82-2-867-0131
Manufacturer :	Cardinal
	2F. Ace techno Tower, 197-17, Kuro-Dong, Kuro-Gu, Seoul, 152-050, Korea

- Trade / Model : CS-104
- Brand Name : -
- EUT Type : TFT-LCD Monitor
- Classification : FCC Class B
- Rule Part(s) : FCC Part 2 & Part 15 Subpart B
- Test Procedure(s): ANSI C63.4 (1992)
- Dates of Test: Sep. 27 to Nov. 26 2002
- Place of Tests: SGS KES Co., Ltd. EMC Site
- Test Report No.: 2002KESEMC-II-0380.FCC
- Order No. : SKI-02-0190/E

Note : Tuner Test Data is for reference only and not for certification

PRODUCT INFORMATION

Equipment Description:

The Equipment Under Test (EUT) is the **Cardinal**

Model : **CS-104**

Clock :	24MHz, 20.25MHz	
Chipset :	Gm5020, VPC3230D B3, PSD934F2-90, TS80C51RA2-MCB	
Port(s) :	Power, S-VHS, Video1, Audio R, Audio L, Speaker Out, RGB, Antenna	
Power Consumption :	AC 110V, 60Hz	
Power Supply :	Model : API0AD42 (ACBEL POLYTECH INC.)	S/N : 019583
Main Board :	Model : N/A (N/A)	S/N : N/A
I/O Board :	Model : CS-104 (Cardinal)	S/N : N/A
Tuner Card :	Model : DI104S (N/A)	S/N : N/A
LCD Panel :	Model : PD104SL5 (N/A)	S/N : PD104SL6W1C20 0000589A
Inverter :	Model : GH025A (GREEN C&C TECH)	S/N : 02250191
OSD Board :	Model : N/A (N/A)	S/N : N/A

EUT operating mode :

- Display " H " Pattern.

EMI suppression device(s) added and/or modified during testing:

- none

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 emissions emanating from *Cardinal*

Model : *CS-104*

These measurement tests were conducted at *SGS KES Co., Ltd. EMC Laboratory*.

The site address is 705, Dongchun-Ri, Sooji-Eub, Yongin-Shi, Kyungki-Do, Korea.

The area of SGS KES Co., Ltd. EMC Test Site is located in a mountain area at 45 kilometers (28 miles) southeast from Seoul National Airport (Kimpoo Airport), 23 kilometers (14miles) southeast from central Seoul.

It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures.

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.

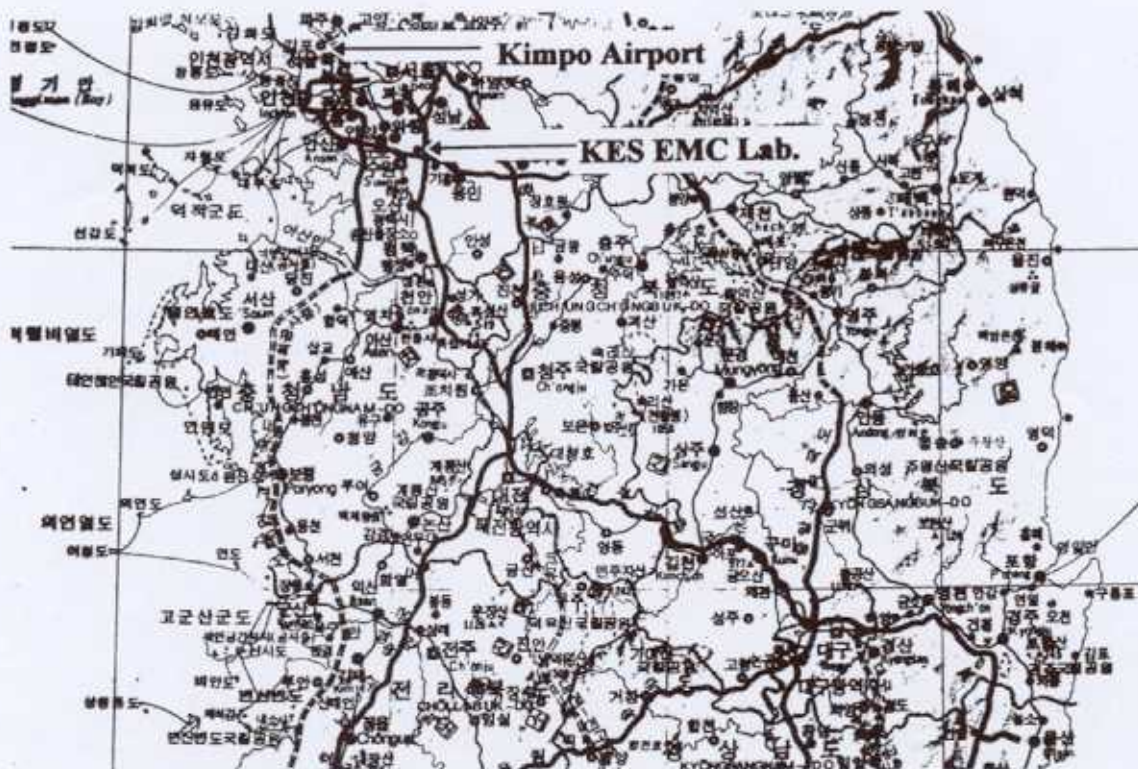


Fig. 1. The map above shows the Seoul in Korea vicinity area.
The map also shows SGS KES Co., Ltd. EMC Lab and Kimpoo Airport.

DESCRIPTION OF TESTS

Conducted Emissions

The line-conducted facility is located inside a 3.0x6.0x2.5 shielded enclosure. It is manufactured by Daeil EMC Engineering. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1mx1.5m. wooden table 0.8m. height is placed 0.4m. away from the vertical wall and 1.5m away from the side wall of the shielded room. PMM L3-25, L1-150 and EMCO Model 3825-2 (10kHz-30MHz) 50 Ω /50 μ H Line Impedance Stabilization Networks (LISNs) are bonded to the shielded room. The EUT is powered from the PMM LISN and the support equipment is powered from the EMCO LISN. Power to the LISNs are filtered by a high-current high-insertion loss Sangshin power line filters (100dB 14kHz-10GHz). The purpose of the filter is to attenuate ambient signal interference and this filter is also bonded to the shielded enclosure. All electrical cables are shielded by braided tinned copper zipper tubing with inner diameter of 1/2". If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the PMM LISN. LISN schematic diagram is shown in Figure 2. All interconnecting cables more than 1 meter were shortened by non-inductive bundling (serpentine fashion) to a 1-meter length. Sufficient time for the EUT, support equipment, and test equipment was 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 from the EUT. The spectrum was scanned from 450 kHz to 30 MHz with 20 msec sweep time. The frequency producing the maximum level was reexamined using EMI/Field Intensity Meter and Quasi-Peak adapter. The detector function was set to CISPR quasi-peak mode. The bandwidth of the receiver was set to 10 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by: switching power lines; 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 from the floor mounted outlet box and the computer aux AC outlet, if applicable; which ever determined the worst-case emission. Photographs of the worst-case emission can be seen in Appendix C. Each EME reported was calibrated using the R/S SMG signal generator.

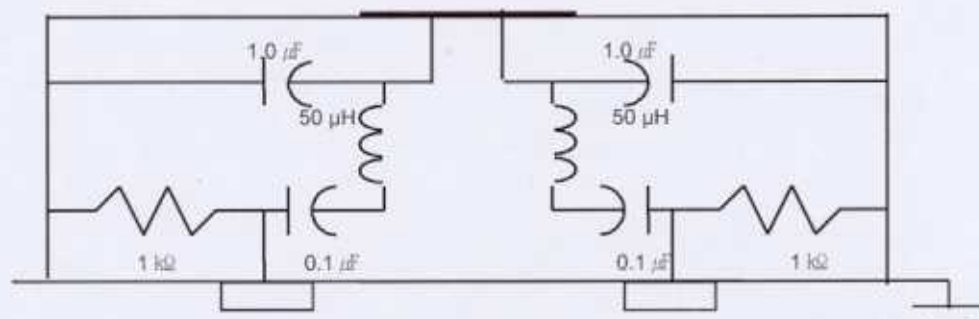


Fig. 2. LISN Schematic Diagram

Radiated Emissions

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 system configuration, clock speed, mode of operation or video resolution, turntable azimuth with respect to the antenna were note for each frequency found. The spectrum was scanned from 30 to 300 MHz using biconical antenna and 300 to 1000 MHz using log-periodic antenna.

Final measurements were made outdoors at 3 meter test range. The test equipment was placed on a wooden and plastic bench situated on a 1.5x2 meter area adjacent to measurement area. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was reexamined and investigated using EMI/Field Intensity Meter. The detector function was set to average mode and the bandwidth of the receiver was set to 100 kHz or 1 MHz depending on the frequency or type of signal.

The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8-meter high non-metallic 1x1.5 meter table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each EME emission. The turntable containing the system was rotated; the antenna height was varied 1 to 4 meter and stopped at the azimuth or height producing the maximum emission. 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 from the floor mounted outlet box and 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 C. Each EME reported was calibrated using the R/S SMG signal generator.

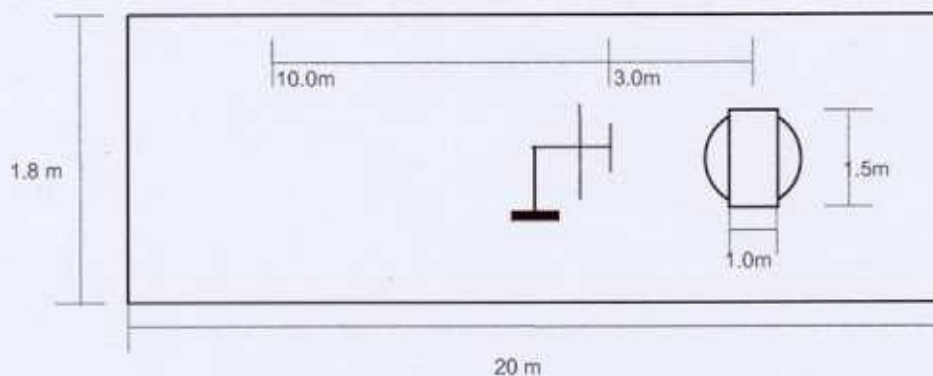
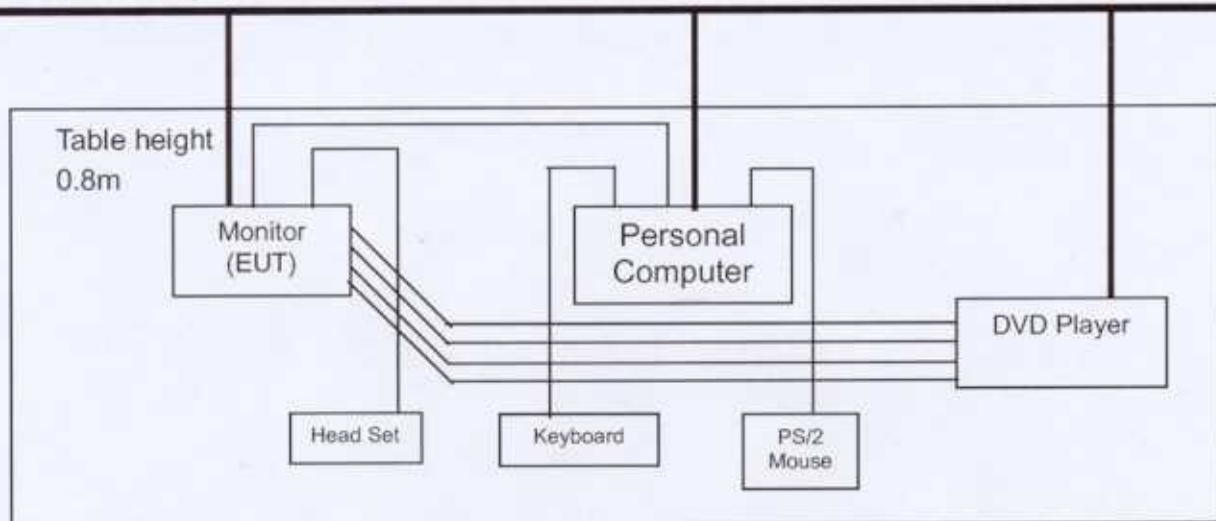


Fig. 3. Dimensions of Outdoor Test Site

● Test set-up for test



TEST DATA

Conducted Emissions

Company : Cardinal

Model No. : CS-104

Date of Test : 27 September 2002

Measure Bandwidth : 9kHz

Mode : RGB

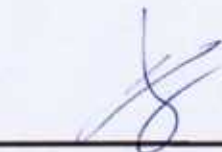
FREQ (MHz)	LEVEL(dB μ V)	LINE	LIMIT(μ V)	(μ V)	MARGIN*(dB)
0.45	36.2	N	250	64.57	11.8
0.52	34.7	H	250	54.45	13.3
0.58	35.8	N	250	61.38	12.2
0.77	31.3	N	250	36.73	16.7
1.60	30.8	N	250	34.75	17.2
12.97	30.3	N	250	32.73	17.7

Table 1. Line Conducted Emissions Tabulated Data

NOTES:

1. All modes of operation were investigated and the worst -case emission are reported. See attached Plots.
2. The limit for Class B digital device is 250 μ V from 450 kHz to 30MHz.
3. Line H = Hot Line N = Neutral

* Measurements using CISPR quasi-peak mode



Tested by See - Ho, Lee

TEST DATA

Conducted Emissions

Company : Cardinal

Model No. : CS-104

Date of Test : 27 September 2002

Measure Bandwidth : 9kHz

Mode : S-Video

FREQ (MHz)	LEVEL(dB μ V)	LINE	LIMIT(μ V)	(μ V)	MARGIN*(dB)
0.45	28.7	N	250	27.23	19.3
0.52	38.7	N	250	86.30	9.3
0.58	33.3	N	250	46.03	14.7
0.72	30.2	N	250	32.43	17.8
1.17	29.3	N	250	29.17	18.7
3.58	33.5	N	250	47.32	14.5

Table 2. Line Conducted Emissions Tabulated Data

NOTES:

1. All modes of operation were investigated and the worst -case emission are reported. See attached Plots.
2. The limit for Class B digital device is 250 μ V from 450 kHz to 30MHz.
3. Line H = Hot Line N = Neutral

* Measurements using CISPR quasi-peak mode


 Tested by See - Ho, Lee

TEST DATA

Radiated Emissions

Company : Cardinal

Model No. : CS-104

Date of Test : 01 October 2002

Measure Bandwidth : 120kHz

Mode : RGB

Resolution : 1024X768 V_f : 75Hz

Freq. (MHz)	Level (dB μ V)	AF* (dB)	CL** (dB)	POL (H/V)	Limit (μ V/m)	F/S (μ V/m)	Margin*** (dB)
110.86	26.30	10.73	2.10	H	150	90.47	4.37
219.42	28.30	9.33	3.63	V	200	115.62	4.74
371.62	21.90	14.66	5.14	V	200	121.62	4.30
539.99	15.30	19.29	6.51	V	200	46.00	4.90
1345.65	21.20	25.33	3.47	H	500	316.23	4.03
1357.20	20.70	25.33	3.47	H	500	298.54	4.51
1358.33	20.30	25.33	3.47	H	500	285.10	4.87
3098.52	15.90	28.16	6.00	H	500	318.42	3.94
4902.61	10.80	31.59	8.21	H	500	338.84	3.40

Table 3. Radiated Measurements at 3meters.

* AF = Antenna Factor.

** CL = Cable Loss.

*** Margin=Each Frequency Limit Level(dBuV) - (Level+AF+CL)


 Tested by See - Ho, Lee

TEST DATA

Radiated Emissions

Company : Cardinal

Model No. : CS-104

Date of Test : 01 October 2002

Measure Bandwidth : 120kHz

Mode : S-Video

Resolution : 1024X768 V_f : 75Hz

Freq. (MHz)	Level (dB μ V)	AF* (dB)	CL** (dB)	POL (H/V)	Limit (μ V/m)	F/S (μ V/m)	Margin*** (dB)
110.65	25.90	10.73	2.10	H	150	86.40	4.77
214.26	26.30	9.13	3.57	H	150	89.07	4.51
1085.26	21.30	23.84	3.10	H	500	258.23	5.76
1345.62	22.30	25.33	3.47	H	500	46.00	2.90
1357.85	22.10	25.33	3.47	H	500	350.75	3.10
1358.33	20.30	25.33	3.47	H	500	285.10	4.90
2111.86	20.30	26.08	4.51	H	500	350.35	3.11
3098.63	15.20	28.16	6.00	H	500	293.76	4.64
4902.61	9.60	31.59	8.21	H	500	295.12	4.60

Table 4. Radiated Measurements at 3meters.

* AF = Antenna Factor.

** CL = Cable Loss.

*** Margin=Each Frequency Limit Level(dBuV) - (Level+AF+CL)



 Tested by **See - Ho, Lee**

TEST DATA**Conducted Emission (Antenna Terminal)**

Company : Cardinal

Model No. : CS-104

Date of Test : 25 November 2002

Measurement Bandwidth : 120kHz

Channel	Freq. (MHz)	Level (dB μ V)	Correction Factor* (dB)	Result (dB μ V/m)	Limit (dB μ V)	Margin** (dB)
CH8	227.00	12.6	14.60	27.20	50	22.80
(181.25)						
CH9	233.00	12.2	13.62	25.80	50	24.18
(187.25)						
CH10	239.00	11.8	14.60	26.40	50	23.60
(193.25)						
CH11	245.00	11.8	14.60	26.40	50	23.60
(199.25)						
CH12	248.00	15.0	14.60	29.60	50	20.40
(205.25)						
CH21	209.00	6.8	14.47	21.30	50	28.73
(163.25)	418.00	6.9	19.04	25.90	50	24.06
CH26	278.00	5.3	15.16	20.50	50	29.54
(235.25)	556.00	4.3	22.08	26.40	50	23.62
CH36	341.00	11.2	16.43	27.60	50	22.37
(295.25)	682.00	5.8	30.11	35.90	50	14.09
CH46	401.00	12.3	18.53	30.80	50	19.17
(355.25)	802.00	6.2	38.61	44.80	50	5.19
CH51	431.00	11.2	19.43	30.60	50	19.37
(385.25)	862.00	10.5	31.10	41.60	50	8.40
CH81	611.00	11.2	23.51	34.70	50	15.29
(565.25)						
CH96	143.00	15.3	13.66	29.00	50	21.04
(97.25)						
CH101	701.00	12.5	32.47	45.00	50	5.03
(655.25)						
CH120	815.00	9.2	36.77	46.00	50	4.03
(769.25)						
CH125	845.00	6.3	32.51	38.80	50	11.19
(799.25)						

Table 5. Antenna Terminal Conducted Emission Data

* Correction Factor : Matching Pad Loss + 3 Way Splitter

**Margin : Limit Level(dB μ V)-(Level +MPL)


 Tested by **See - Ho, Lee**

TEST DATA**Radiated Emissions (CATV Mode)**

Company : Cardinal

Model No. : CS-104

Date of Test : 26 November 2002

	Freq. (MHz)	Level (dB μ V)	AF* (dB)	CL** (dB)	Result (dB μ V/m)	Limit (μ V/m)	Margin*** (dB)
CH21	209.00	16.9	8.92	3.51	29.33	43.5	14.17
(163.25)	418.00	12.3	16.29	5.54	34.13	46.0	11.87
CH26	278.00	10.9	12.59	4.28	27.77	46.0	18.23
(235.25)	556.00	3.6	20.11	6.65	30.36	46.0	15.64
CH31	311.00	15.6	13.27	4.60	33.46	46.0	12.54
(265.25)	622.00	10.2	20.51	7.18	37.88	46.0	8.12
CH36	341.00	11.1	14.03	4.87	30.00	46.0	16.00
(295.25)	682.00	6.3	20.43	7.66	34.39	46.0	11.61
CH46	401.00	12.5	15.67	5.41	33.57	46.0	12.43
(355.25)	802.00	5.2	22.04	8.62	35.86	46.0	10.14
CH61	491.00	15.4	17.49	6.13	39.02	46.0	6.98
(445.25)	982.00	3.2	24.64	10.06	37.90	54.0	16.10
CH86	641.00	3.2	20.49	7.33	34.12	46.0	11.88
(595.25)							
CH91	671.00	11.2	20.35	7.57	39.12	46.0	6.88
(625.25)							
CH101	701.00	5.4	20.71	7.81	33.92	46.0	12.08
(655.25)							
CH120	815.00	10.2	22.50	8.72	41.42	46.0	4.58
(769.25)							

Table 6. Radiated Measurements at 3meters

* AF = Antenna Factor.

** CL = Cable Loss.

*** Margin=Each Frequency Limit Level(dBuV) - (Level+AF+CL)


 Tested by See - Ho, Lee

PLOTS OF EMISSIONS

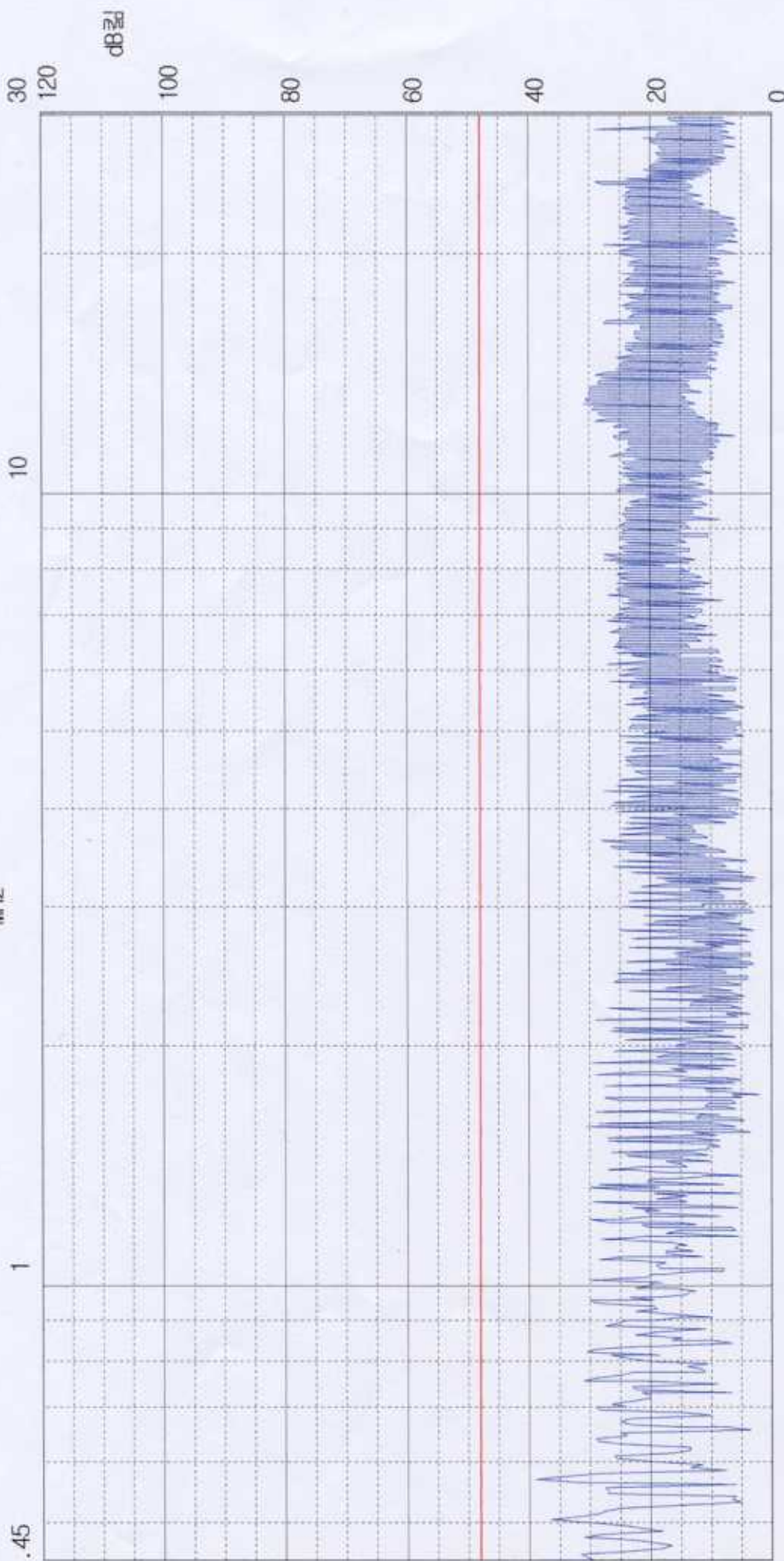
P M M 8 0 1 0 for Windows

Name:

Date: 02-09-27

Time: 17:57

MHz



Input None

Detector: Peak

Limit : Fcc_15_b

MODEL: CS-104

MODE: RGB

LINE: NEUTRAL

OPERATOR: S.H. LEE

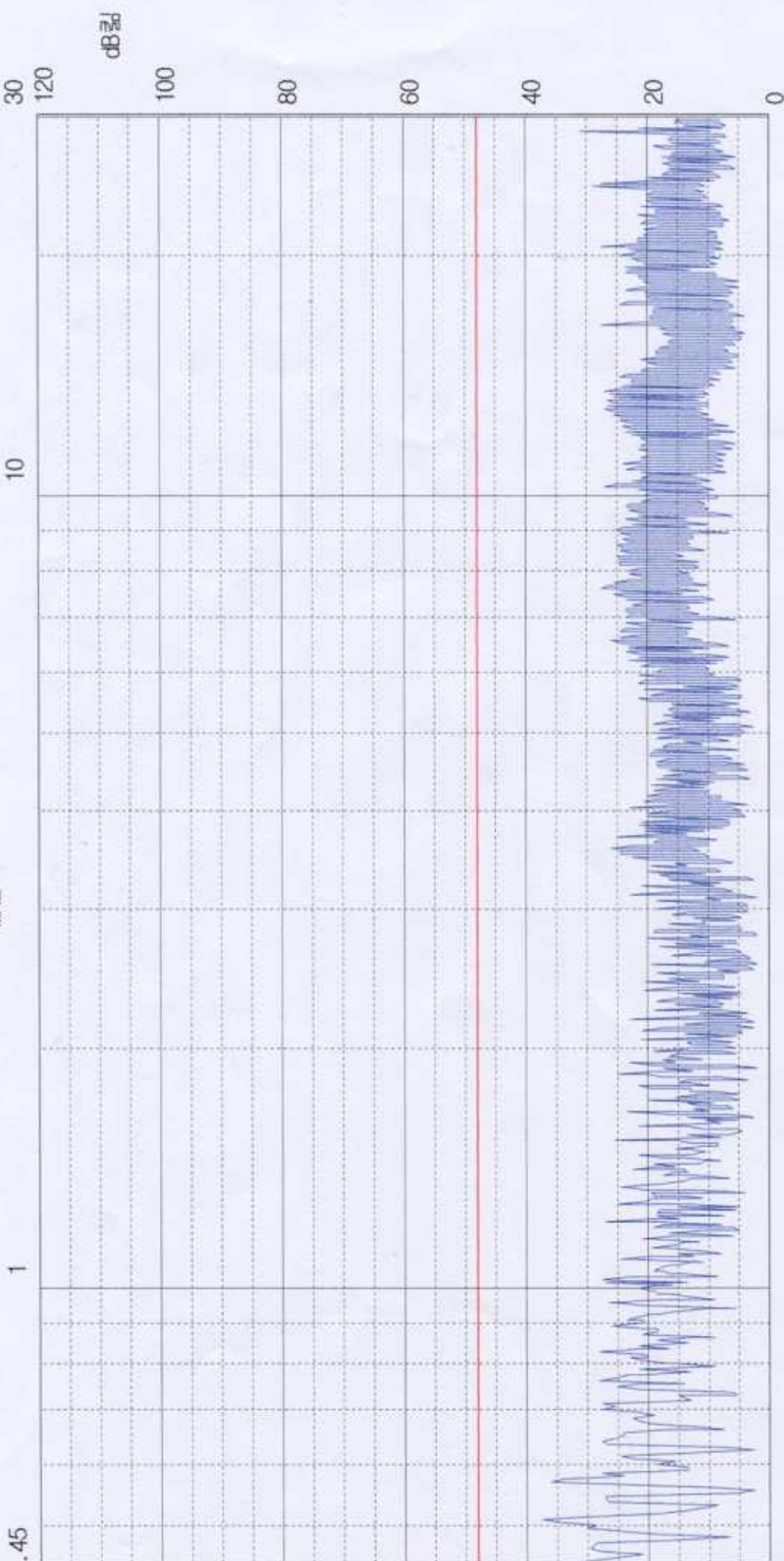
P M M 3 0 1 0 for Windows

Name:

Date: 02-09-27

Time: 18:08

MHz



Input None

Detector: Peak

Limit : Fcc_15_b

MODEL: CS-104

MODE: RGB

LINE: HOT

OPERATOR: S.H.LEE

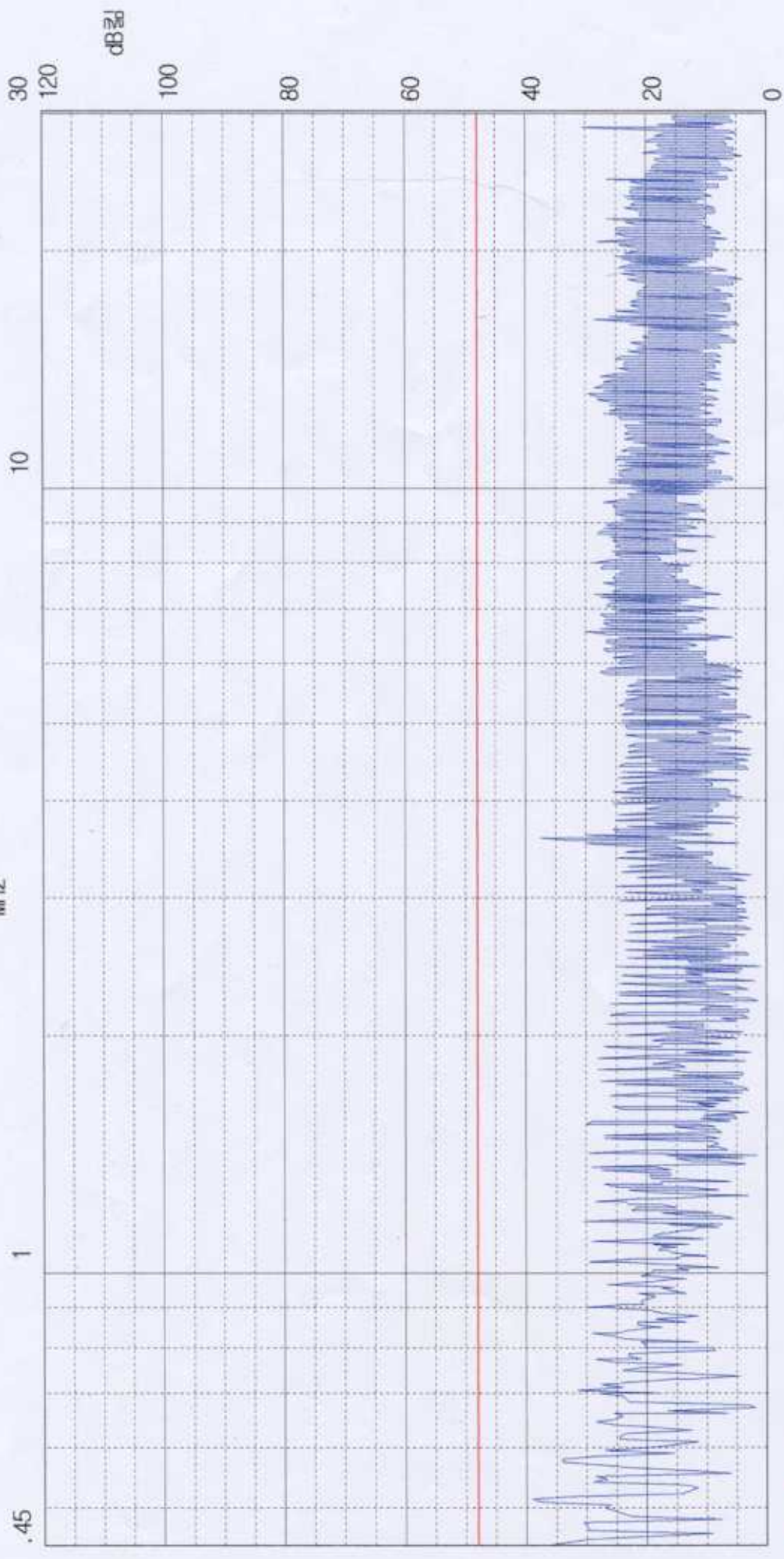
P M M 8 0 1 0 for Windows

Name:

Date: 02-09-27

Time: 18:45

MHz



Input None

Detector: Peak

Limit : Fcc_15_b

MODEL: CS-104

MODE: S-VIDEO

LINE: NEUTRAL

OPERATOR: S.H.LEE

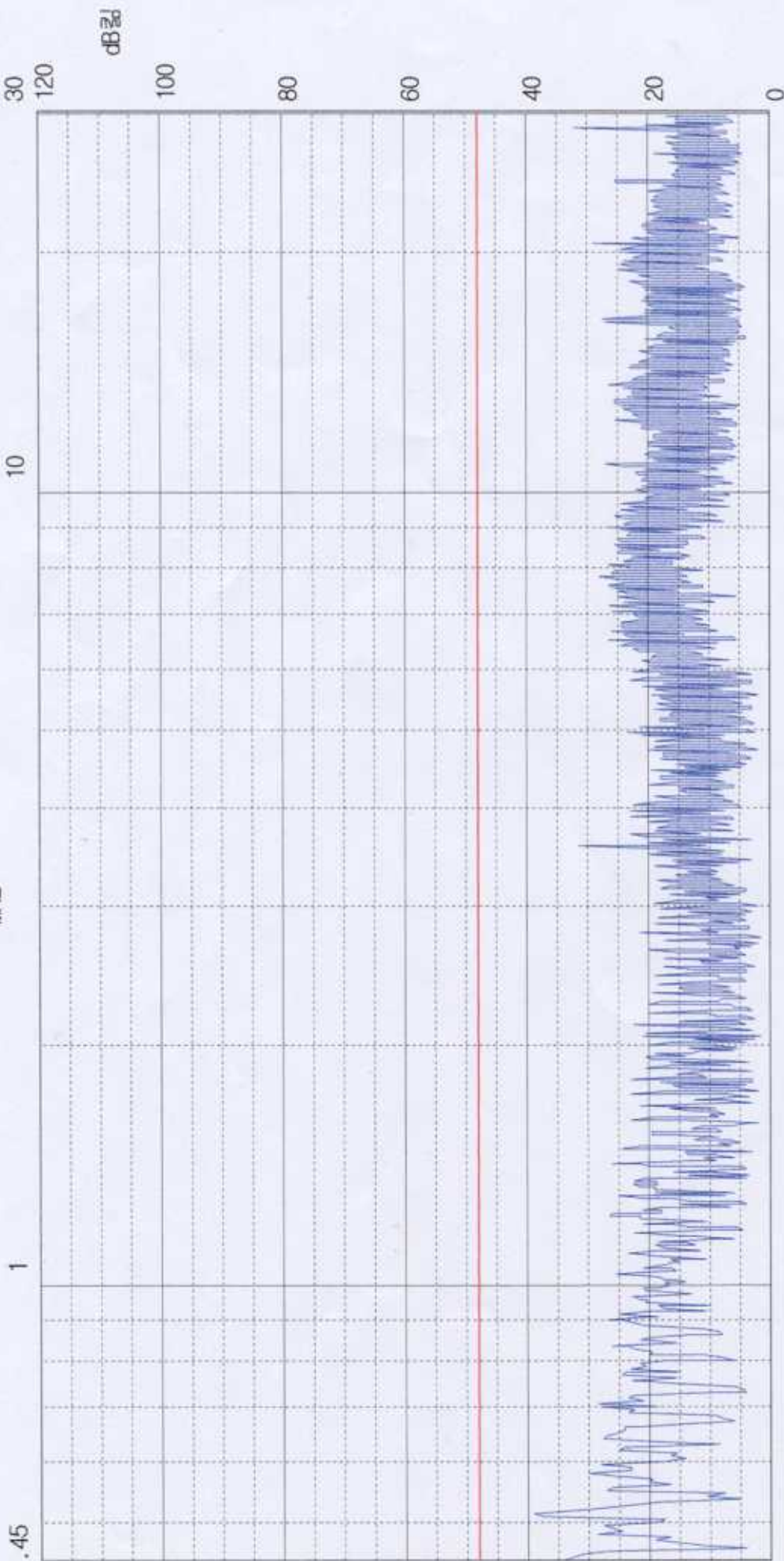
P M M 8 0 1 0 for Windows

Name:

Date: 02-09-27

Time: 18:39

MHz



Input None

Detector: Peak

Limit : Fcc_15_b

MODEL: CS-104

MODE: S-VIDEO

LINE: HOT

OPERATOR: S.H.LEE

SAMPLE CALCULATIONS

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

$$\mu\text{V} = 10^{(\text{dB } \mu\text{V}/20)}$$

EX. 1.

@20.3 MHz

Class B limit = 250 μV = 48.0 dB μV

Reading = 40.8 dB μV (calibrated level)

$$10^{(40.8/20)} = 109.64 \mu\text{V}$$

$$\text{Margin} = 48.0 - 40.8 = 7.2$$

7.2 dB below limit

EX. 2.

@57.7 MHz

Class B limit = 100 $\mu\text{V}/\text{m}$ = 40.0 dB $\mu\text{V}/\text{m}$

Reading = 19.1 dB μV (calibrated level)

Antenna factor + Cable Loss = 10.12 dB

Total = 29.22 dB $\mu\text{V}/\text{m}$

$$\text{Margin} = 40.0 - 29.22 = 10.78$$

10.78 dB below the limit

ACCURACY OF MEASUREMENT

The Measurement Uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 with the confidence level of 95%

Contribution	Distribution	Uncertainties	
		3 m	10 m
Field Strength Monitor	Gaussian (2s)	+/- 0.5	+/- 0.5
Field Strength Variation	Rectangular	+/- 1.2	+/- 1.5
Random	Gaussian (1s)	+/- 0.7	+/- 0.7
Total Uncertainty@95% min. confidence probability		+/- 1.91	+/- 2.11

Measurement Uncertainty Calculations:

$$U = 2 \sqrt{S^2_{s1} + S^2_{s2} + \dots + S^2_{sr}}$$

TEST EQUIPMENT

Conducted Emission

Equipment	Manufactory	Model	Cal. Date
Signal Analyzer	PMM	8010	Sep. 2002
LISN	PMM	3825/2	Apr. 2002
LISN	PMM	3825/2	Apr. 2002
Pulse Limiter	PMM	PL-01	Jul. 2002
Shielded Room	Daeil	N/A	-

Radiated Emission

Equipment	Manufactory	Model	Cal. Date
Test Receiver	R & S	ESVS30	Nov. 2002
Spectrum Analyzer	H.P	E4411A	Dec. 2002
RF Amplifier	H.P	8447F	May. 2002
Bilog Antenna	SCHAFFNER	CBL6111C	Apr. 2002
RF Select s/w	DAIWA	CS201	Apr. 2002

CONCLUSION

The test results collected show that the EUT

Company : Cardinal

Model : CS-104

complies with § 15.107 and 15.109 and 15.111 of the FCC Rules.

Mode : RGB

The highest emission observed was at 0.58MHz for conducted emissions with a margin of 12.2dB and at 4902.61MHz for radiated emissions with a margin of 3.4dB.

Mode : Video

The highest emission observed was at 0.52MHz for conducted emissions with a margin of 9.3dB and at 1345.62MHz for radiated emissions with a margin of 2.9dB.

APPENDIX A – SAMPLE LABEL

Labelling Requirements

The sample label shown shall be *permanently affixed* at a conspicuous location on the unit and be readily visible to the user at the time of purchase.

TFT LCD Monitor Model : CS-104 Cardinal FCC ID : QSNCS-104
THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1)THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE AND (2)THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.