

Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE


FCC Part 15 Certification Measurement


PRODUCT : LCD MONITOR
MODEL/TYPE NO : L21C0FAL0 / NONE
FCC ID : PJIL21C0FAL0
MULTIPLE MODEL : P227D, P227DS, P227DL, P227DT, P227DU, P227DV
BRAND NAME : **HYUNDAI**
APPLICANT : HYUNDAI IBT CORP.
106, Apogongdan-gil, Gimcheon-si,
Gyeongsangbuk-do, 740-862, Korea
Attn.: Yoon Suk Lee / Manager
MANUFACTURER : HYUNDAI IBT CORP.
106, Apogongdan-gil, Gimcheon-si,
Gyeongsangbuk-do, 740-862, Korea
FCC CLASSIFICATION : Class B Personal computers and peripherals
RULE PART(S) : FCC Part 15 Subpart B & ICES-003 Issue 4
TEST PROCEDURE : ANSI C63.4-2003
TEST REPORT No. : ETLE121210.1430
DATES OF TEST : December 10, 2012 to December 11, 2012
REPORT ISSUE DATE : January 09, 2013
TEST LABORATORY : ETL Inc. (FCC Designation Number: KR0022, IC OATS Number: 6473B-1)

This LCD MONITOR, Model L21C0FAL0 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2003 at the ETL/EMC Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart B & ICES-003 Issue 4:

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is 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.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by: 
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January 09, 2013

Reviewed by: 
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January 09, 2013

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*The test report merely corresponds to the test sample(s).
This report shall not be reproduced, in whole or in part without the written approval of ETL Inc.*

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FCC MEASUREMENT REPORT

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

General Information

Applicant Name : HYUNDAI IBT CORP.

Address : 106, Apogongdan-gil, Gimcheon-si,
Gyeongsangbuk-do, 740-862, Korea

Attention : Yoon Suk Lee / Manager

- **EUT Type :** LCD MONITOR
- **Model Number :** L21C0FAL0
- **S/N :** -
- **Frequency Range :** X-tal → 14.318 MHz; F/MEMORY clock → 85 kHz;
LVDS clock → 74.250 MHz
- **Rule Part(s) :** FCC Part 15 Subpart B & ICES-003 Issue 4
- **Test Procedure :** ANSI C63.4-2003
- **FCC Classification :** Class B Personal computers and peripherals
- **Dates of Tests :** December 10, 2012 to December 11, 2012
- **Place of Tests :** ETL Inc. Testing Lab. (FCC Designation Number : KR0022)

Radiated Emission test;
#499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,
Gyeonggi-do, 445-882, Korea

Conducted Emission test;
ETL Inc. Testing Lab. (FCC Designation Number : KR0022)
371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
- **Test Report No. :** ETLE121210.1430

1. INTRODUCTION

The measurement tests for radiated and conducted emission test were conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2003 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with the requirements of Section 2.948 FCC Rules according to the ANSI C63.4-2003 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) was used in determining radiated and conducted emissions from the HYUNDAI IBT CORP., Model: L21C0FAL0.

2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the LCD MONITOR (model: L21C0FAL0).

The model L21C0FAL0 is basic model that was tested.

The model differences are same with below table;

| Model name | DVI | VGA | Speaker | USB | Lift stand | Tilt stand |
|------------|-----|-----|---------|-----|------------|------------|
| L21C0FAL0 | O | O | O | O | O | O |
| P227D | O | O | X | X | X | O |
| P227DS | O | O | O | X | X | O |
| P227DL | O | O | X | X | O | X |
| P227DT | O | O | O | X | O | X |
| P227DU | O | O | O | O | O | X |
| P227DV | O | O | X | O | O | X |

* O: Existence, X: Non-existence

2.2 General Specification

| Item | | Specification |
|-----------------------|------------------------|---|
| LCD | Visible Screen Area | 476.64 mm (H) x 268.11 mm (V) (21.5 Inch) |
| | Pixel Pitch | 0.248 mm (H) x 0.248 mm (V) |
| | Recommended Resolution | 1 920 x 1 080 @ 60 Hz |
| | Maximum Visible Angle | 170°/170° (H/V) |
| | Displayed Color | 16.7 M |
| | Brightness | 250 cd/m ² |
| | Contrast Ratio | 1 000:1 |
| | Response Time | 5 msec |
| Input Signal | Horizontal Frequency | 30 kHz – 80 kHz |
| | Vertical Frequency | 60 kHz – 75 kHz |
| | Video Signal | Analog RGB, DVI |
| | Connector | DVI-I, AUDIO, USB |
| Power | Power Consumption | < 25 W (Typ.) |
| | Stand by Power | < 0.5 W |
| | Input Power | AC 100 V – 240 V; 50 Hz/60 Hz; 2.0 A |
| Multimedia Speakers | | 1 W x 2 |
| Operating Environment | Operation | Temperature: (25 ± 15) °C |
| | | Humidity: (50 ± 30) % (non-condensing) |
| | Storage | Temperature: (20 ± 30) °C |
| | | Humidity: (50 ± 40) % (non-condensing) |

3. DESCRIPTION OF TESTS

3.1 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section 11, "Measurement of Information Technology Equipment" of ANSI C63.4-2003. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 40 cm away from the vertical wall and 1.5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. 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 EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in photographs of conducted emission test setup in Appendix B.

3.2 Radiated Emission Measurement

Radiated emission measurements were made in accordance with section 11, "Measurement of Information Technology Equipment" of ANSI C63.4-2003. The measurements were performed over the frequency range of 30 MHz to 40 GHz (or 5th harmonic of the highest frequency) in using antenna as the input transducer to a spectrum analyzer or a field intensity meter. The measurements below 1 GHz were made with the detector set for "Quasi-peak" within a bandwidth of 120 kHz. The measurements above 1 GHz were made with the detector set for "Peak and Average" within a bandwidth of 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determined the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site at 3 m. The test equipment was placed on a wooden turn-table. 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 re-examined by manual. The detector function was set to CISPR Quasi-peak mode and the bandwidth of the receiver was set to 120 kHz or 1 MHz depending on the frequency of 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 m high nonmetallic 1 m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission. Each emission was maximized by: varying the mode of operation to the EUT and/or support equipment and changing the polarity of the antenna, whichever determined the worst-case emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

4. TEST CONDITION

4.1 Test Configuration

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the EUT and the supported equipments were installed to meet FCC requirement and operated in a manner and which tends to maximize its emission level in a typical application.

4.2 EUT operation

The equipment under test was operated during the measurement under following conditions:

| | Conditions | Remark |
|---|--|-----------------------|
| ■ | Stand by | |
| ■ | The EUT was connected as user's guide. And during the executed test program for EMI program with "H" pattern display on monitor. | RGB mode & USB mode |
| ■ | The EUT was connected as user's guide. And during the executed test program for EMI program with "H" pattern display on monitor. | DVI mode & USB mode * |

* The worst case was investigated for emission test.

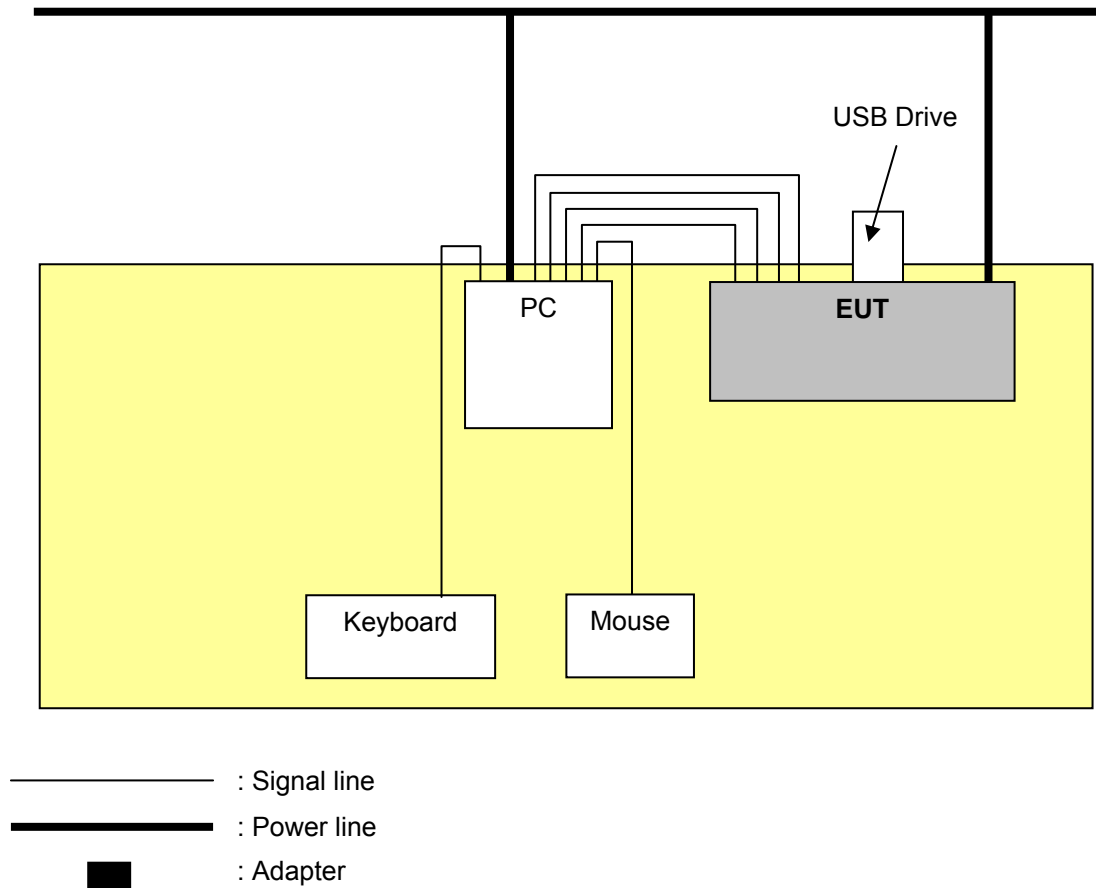
4.3 Support Equipment Used

| Description | Model Name | Serial No. | Manufacturer | FCC |
|------------------|------------|------------|---------------------------------|-----|
| PC | D07M001 | 66KMQBX | Dell Inc. | DoC |
| Keyboard | SK-8115 | NONE | Yet Foundate Ltd | DoC |
| Mouse | MOC5UO | NONE | Dongguan Primax Electronics Ltd | DoC |
| USB Drive (2 GB) | NONE | NONE | NONE | DoC |

4.4 Type of Cables Used

| Device from | Device to | Type of I/O port | Length[m] | Type of shield | Used ferrite core |
|-------------|--------------|------------------|-----------|----------------|-------------------|
| EUT | PC | RGB | 1.5 | Shielded | O |
| EUT | PC | DVI | 1.5 | Shielded | O |
| EUT | PC | PC Audio In | 1.5 | Shielded | X |
| EUT | PC | USB | 1.2 | Shielded | X |
| EUT | USB Drive | USB | - | - | - |
| EUT | Power socket | AC Input | 1.2 | Unshielded | X |
| PC | Keyboard | USB | 1.5 | Shielded | X |
| PC | Mouse | USB | 1.5 | Shielded | X |
| PC | Power socket | AC Input | 1.2 | Unshielded | X |

4.5 The setup drawing(s)



5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

| FCC Rule | Measurement Required | Result |
|-----------|--------------------------------|----------------------------|
| 15.107(a) | Conducted Emission Measurement | Passed by 7.70 dB |
| 15.109(a) | Radiated Emission Measurement | Passed by 3.20 dB * |

** The highest frequency of the internal sources of the EUT is less than 108 MHz. This test was measurement made up to 1 GHz according to the section 15.33 of FCC Part 15.*

The data collected shows that the **HYUNDAI IBT CORP. / LCD MONITOR / L21C0FAL0** complied with technical requirements of above rules part 15.107(a) and 15.109(a) Class B Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

5.2 Conducted Emissions Measurement

5.2.1 Conducted Emissions Data

| | |
|---------------------|---|
| EUT | LCD MONITOR / L21C0FAL0 (S/N: N/A) |
| Limit apply to | FCC Part 15.107(a) Class B |
| Test Date | December 11, 2012 |
| Operating Condition | The EUT was connected as user's guide. And during the executed test program for EMI program with "H" pattern display on monitor. (Worst case: DVI mode & USB mode) |
| Result | Passed by 7.70 dB |

Conducted Emission Test Data

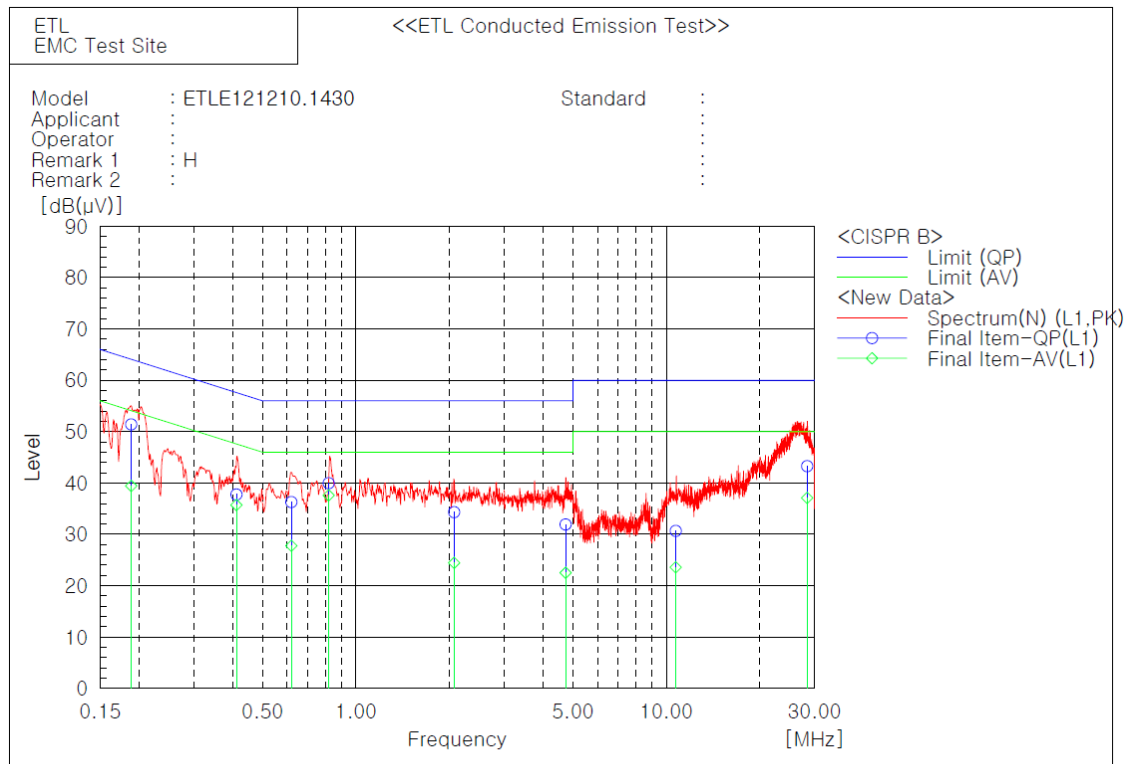
The following data and graph shows the highest levels of conducted emissions on both polarizations of hot and neutral line.

Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

NOTES:

1. Please see the measured data and graph in next page.
2. The c.f value was included the antenna factor and cable loss.
3. Result value = Reading + c.f
4. Margin = Limit - Result
5. Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15.107(a) Class B.
6. If the average limit is met when using a Quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

Line: HOT

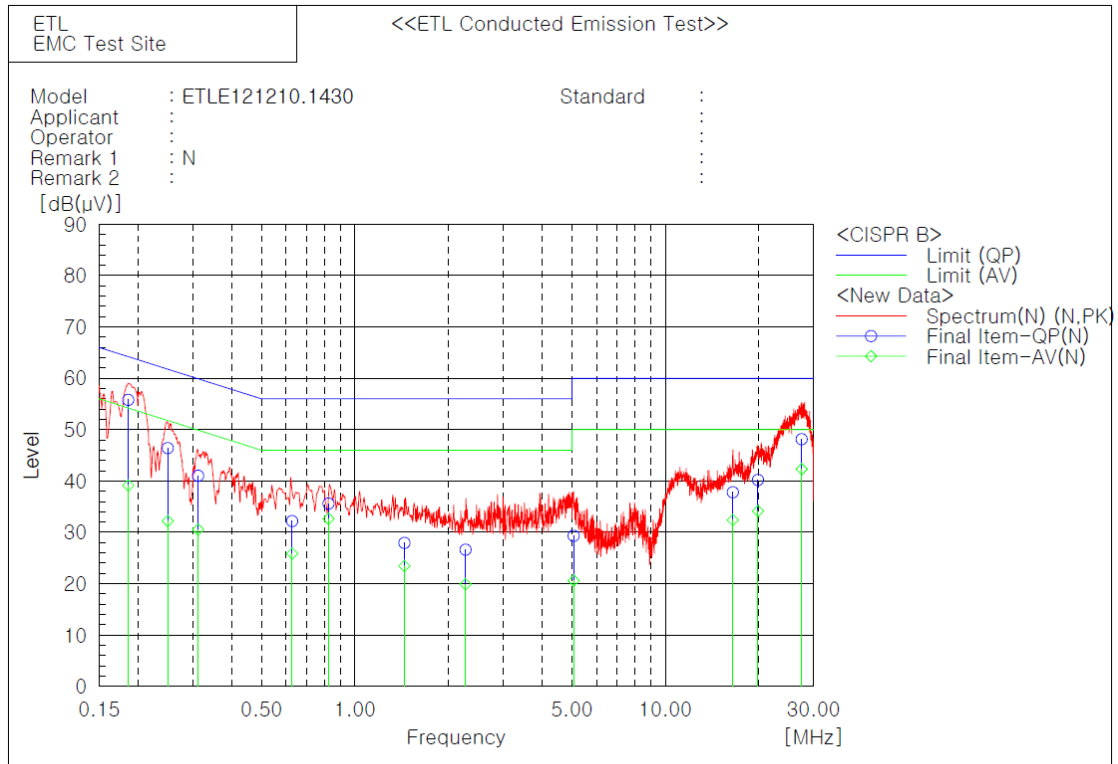


Final Result

--- L1 Phase ---

| No. | Frequency | Reading QP | Reading AV | c. f | Result QP | Result AV | Limit QP | Limit AV | Margin QP | Margin AV |
|-----|-----------|---------------|---------------|------|--------------|--------------|-------------|-------------|--------------|--------------|
| | [MHz] | [dB(μV)] | [dB(μV)] | [dB] | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB(μV)] | [dB] | [dB] |
| 1 | 0.18869 | 41.7 | 29.7 | 9.7 | 51.4 | 39.4 | 64.1 | 54.1 | 12.7 | 14.7 |
| 2 | 0.41225 | 28.0 | 26.0 | 9.7 | 37.7 | 35.7 | 57.6 | 47.6 | 19.9 | 11.9 |
| 3 | 0.61945 | 26.6 | 18.1 | 9.7 | 36.3 | 27.8 | 56.0 | 46.0 | 19.7 | 18.2 |
| 4 | 0.81685 | 30.3 | 27.9 | 9.7 | 40.0 | 37.6 | 56.0 | 46.0 | 16.0 | 8.4 |
| 5 | 2.07135 | 24.5 | 14.6 | 9.8 | 34.3 | 24.4 | 56.0 | 46.0 | 21.7 | 21.6 |
| 6 | 4.73382 | 22.1 | 12.7 | 9.8 | 31.9 | 22.5 | 56.0 | 46.0 | 24.1 | 23.5 |
| 7 | 10.7218 | 20.8 | 13.7 | 9.9 | 30.7 | 23.6 | 60.0 | 50.0 | 29.3 | 26.4 |
| 8 | 28.4074 | 33.0 | 26.8 | 10.3 | 43.3 | 37.1 | 60.0 | 50.0 | 16.7 | 12.9 |

Line: Neutral



Final Result

--- N Phase ---

| No. | Frequency | Reading QP [dB(μV)] | Reading AV [dB(μV)] | c. f | Result QP [dB(μV)] | Result AV [dB(μV)] | Limit QP [dB(μV)] | Limit AV [dB(μV)] | Margin QP [dB] | Margin AV [dB] |
|-----|-----------|---------------------------|---------------------------|------|--------------------------|--------------------------|-------------------------|-------------------------|----------------------|----------------------|
| 1 | 0.18604 | 46.1 | 29.4 | 9.7 | 55.8 | 39.1 | 64.2 | 54.2 | 8.4 | 15.1 |
| 2 | 0.24952 | 36.7 | 22.5 | 9.7 | 46.4 | 32.2 | 61.8 | 51.8 | 15.4 | 19.6 |
| 3 | 0.31257 | 31.3 | 20.8 | 9.7 | 41.0 | 30.5 | 59.9 | 49.9 | 18.9 | 19.4 |
| 4 | 0.62805 | 22.5 | 16.1 | 9.7 | 32.2 | 25.8 | 56.0 | 46.0 | 23.8 | 20.2 |
| 5 | 0.82205 | 25.9 | 22.9 | 9.7 | 35.6 | 32.6 | 56.0 | 46.0 | 20.4 | 13.4 |
| 6 | 1.44285 | 18.3 | 13.7 | 9.7 | 28.0 | 23.4 | 56.0 | 46.0 | 28.0 | 22.6 |
| 7 | 2.272 | 16.8 | 10.1 | 9.8 | 26.6 | 19.9 | 56.0 | 46.0 | 29.4 | 26.1 |
| 8 | 5.06376 | 19.5 | 10.8 | 9.8 | 29.3 | 20.6 | 60.0 | 50.0 | 30.7 | 29.4 |
| 9 | 16.5016 | 27.8 | 22.4 | 10.0 | 37.8 | 32.4 | 60.0 | 50.0 | 22.2 | 17.6 |
| 10 | 19.8732 | 30.1 | 24.0 | 10.1 | 40.2 | 34.1 | 60.0 | 50.0 | 19.8 | 15.9 |
| 11 | 27.4684 | 38.0 | 32.1 | 10.2 | 48.2 | 42.3 | 60.0 | 50.0 | 11.8 | 7.7 |

5.3 Radiated Emissions Measurement

5.3.1 Radiated Emissions Data

- Below 1 GHz

| | |
|---------------------|---|
| EUT | LCD MONITOR / L21C0FAL0 (S/N: N/A) |
| Limit apply to | FCC Part 15.109(a) Class B |
| Test Date | December 10, 2012 |
| Operating Condition | The EUT was connected as user's guide. And during the executed test program for EMI program with "H" pattern display on monitor. (Worst case: DVI mode & USB mode) |
| Result | Passed by 3.20 dB |

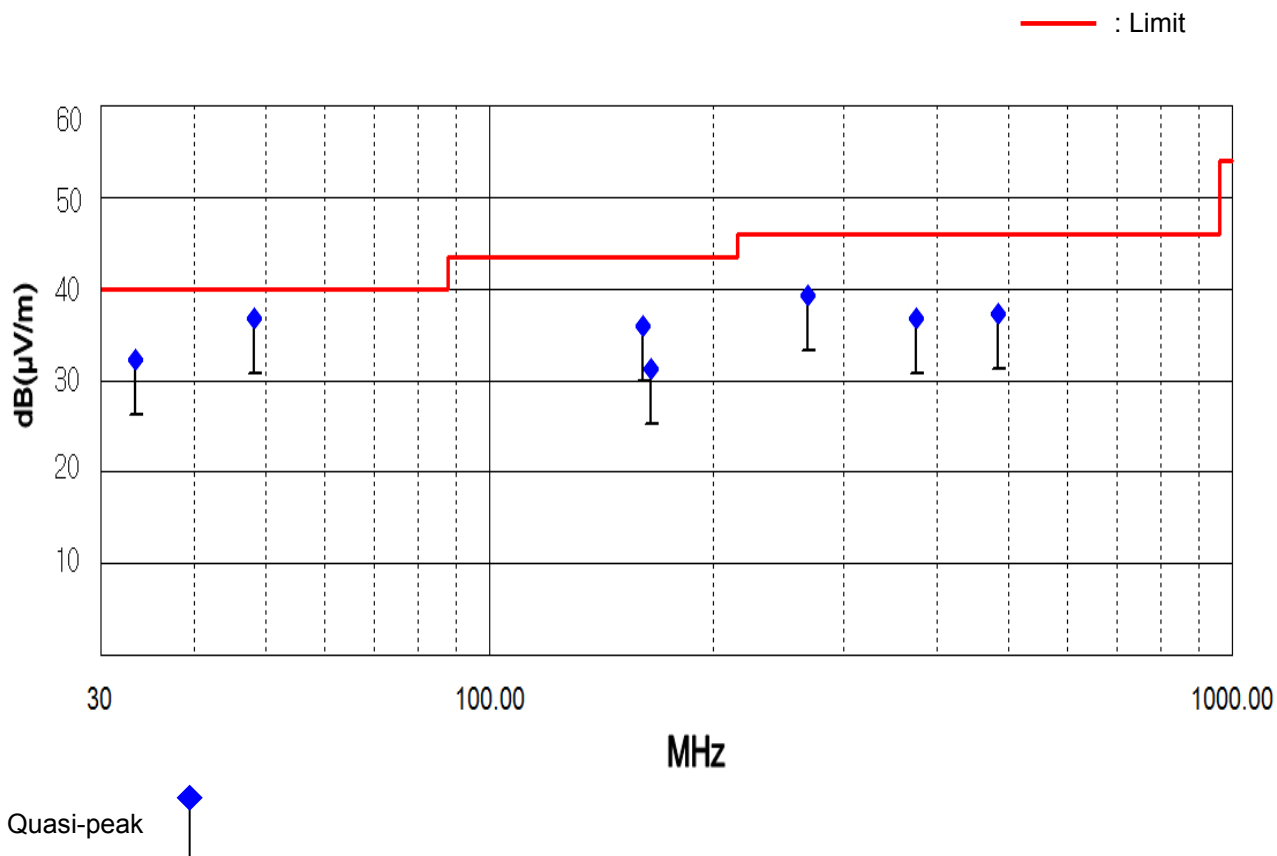
Radiated Emission Test Data

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 120 kHz)

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Ant. Factor [dB/m] | Cable Loss [dB(μV)] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|--------------------|---------------------|-------------------|------------------|-------------|
| 33.40 | 19.43 | V | 11.36 | 1.41 | 32.20 | 40.00 | 7.80 |
| 48.15 | 23.11 | V | 12.31 | 1.38 | 36.80 | 40.00 | 3.20 |
| 160.98 | 20.80 | V | 13.13 | 2.07 | 36.00 | 43.50 | 7.50 |
| 165.23 | 16.43 | V | 12.77 | 2.10 | 31.30 | 43.50 | 12.20 |
| 268.61 | 24.37 | H | 12.29 | 2.54 | 39.20 | 46.00 | 6.80 |
| 376.00 | 18.67 | H | 15.11 | 2.92 | 36.70 | 46.00 | 9.30 |
| 483.82 | 16.65 | H | 17.31 | 3.34 | 37.30 | 46.00 | 8.70 |

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- The measurement was performed for the frequency range 30 MHz ~ 1 000 MHz according to the FCC Part 15.109(a) Class B.
- The highest frequency of the internal sources of the EUT is less than 108 MHz. This test was measurement made up to 1 GHz according to the section 15.33 of FCC Part 15.



6. SAMPLE CALCULATION

Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.
The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - PA$$

Where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

PA* = Preamplifier Factor

* PA is only be used for the measuring frequency above 1 GHz.

$$dB(\mu V) = 20 \log_{10} (\mu V) : \text{Equation}$$

$$dB(\mu V) = dBm + 107$$

Example : @ 48.15 MHz

$$\text{Class B Limit} = 40.00 \text{ dB}(\mu V/m)$$

$$\text{Reading} = 23.11 \text{ dB}(\mu V)$$

$$\text{Antenna Factor + Cable Loss} = 12.31 + 1.38 = 13.69 \text{ dB}(\mu V/m)$$

$$\text{Total} = 36.80 \text{ dB}(\mu V/m)$$

$$\text{Margin} = 40.00 - 36.80 = 3.20 \text{ dB}$$

$$= 3.20 \text{ dB below Limit}$$

7. List of test equipments used for measurements

| | Test Equipment | Model | Mfg. | Serial No. | Cal. Date | Cal. Due Date |
|-------------------------------------|--------------------|----------|-----------------------|------------|-----------|---------------|
| <input checked="" type="checkbox"/> | EMI Test Receiver | ESVS 10 | R&S | 835165/001 | 12.03.20 | 13.03.20 |
| <input checked="" type="checkbox"/> | EMI Test Receiver | ESPI3 | R&S | 100478 | 12.09.05 | 13.09.05 |
| <input checked="" type="checkbox"/> | Two-Line V-Network | ENV216 | R&S | 958599/106 | 12.03.19 | 13.03.19 |
| <input checked="" type="checkbox"/> | LISN | 3816-2 | EMCO | 1002 | 12.09.05 | 13.09.05 |
| <input checked="" type="checkbox"/> | LogBicon Antenna | VULB9160 | Schwarzbeck | 3128 | 12.02.22 | 14.02.22 |
| <input checked="" type="checkbox"/> | Turn-Table | MFT-120S | Max-Full Antenna Corp | - | N/A | N/A |
| <input checked="" type="checkbox"/> | Antenna Master | MFA-440E | Max-Full Antenna Corp | - | N/A | N/A |