# EMC TEST REPORT

| | | | |
|---|---|---|---|
| **Project No.** | LBE20210165 | **Issue No.** | 0 |
| **Applicant** | **Name of organization** | Samsung Electronics Co., Ltd. | |
| | **Address** | (Maetan-dong) 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea | |
| | **Date of receipt** | March 16, 2021 | |
| **EUT** | **Type of device** | ☒ All other Receivers subject to part15<br>☒ Class B Personal Computers and peripherals<br>☐ Other Class B digital devices and peripherals<br>☐ FM Broadcast Receiver | |
| | **Equipment authorization** | ☒ Certification ☐ Supplier's Declaration of Conformity | |
| | **FCC ID** | A3LNP345XLA | |
| | **Kind of product** | Notebook Computer | |
| | **Model No.** | NP345XLA | |
| | **Variant Model No.** | Refer to clause 4.6 | |
| | **Manufacturer** | **Samsung Electronics Vietnam Co., Ltd.**<br>Yenphong 1 - I.P Yentrung Commune, Yenphong Dist., Bac Ninh Province, Vietnam | |
| **Applied Standards** | | 47 CFR Part 15, Subpart B, Class B / ANSI C63.4-2014 | |
| **Test Period** | | March 16, 2020 ~ March 23, 2020 | |
| **Issue date** | | March 25, 2020 | |

**Test result : Complied**

The equipment under test has found to be compliant with the applied standards.
(Refer to the attached test result for more detail.)

| | |
|---|---|
| **Tested by** : Ji-Yeon Lee | **Reviewed by** : Sun-Ho Kim |
| J.Y.Lee | |



Samsung Electronics Co Ltd, Global CS Center
(Maetan dong) 129, Samsung-ro, Yeongtong-Gu, Suwon-Si,Gyeonggi-Do 16677, Korea

# Table of contents

# 1. Report Information

## 1.1 Revision history

| No. | Date of Issue | Revised detailed information |
|---|---|---|
| Issue 0 | 25 March, 2021 | There are no revisions and this version is basic test report. |

※ Remark

Compliance with Part 15B requirements for the receiver part of the licensed transmitter (equipment code CXX) is covered by other test report.

# 2. Summary of test results

## 2.1 Emission

The EUT has been tested according to the following specifications:

| Applied | Test type | Applied standard | Result |
|---|---|---|---|
| ☒ | Conducted Emission (Mains port) | 47 CFR Part 15 Subpart B / ANSI C63.4-2014 (Class B) | Complied |
| ☒ | Radiated Emission | | Complied |

# 3. General Information

## 3.1 Test facility

The Global CS Center is located on Samsung Electronics Co., Ltd. at (Maetan-dong) 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea.
All testing are performed in Semi-anechoic chambers conforming to the site attenuation characteristics defined by ANSI C63.4, CISPR 32, CISPR 16-1-4 and Shielded rooms.
And all antennas are properly calibrated using ANSI C63.5:2017.

The Global CS Center is an ISO/IEC 17025 accredited testing laboratory by the National Radio Research Agency with designation No. KR0004. for EMC testing.

# 4. Test Setup configuration

## 4.1 Test Peripherals

The cables used for these peripherals are either permanently attached by the peripheral manufacturer or coupled with an assigned cable as defined below.
The following is a listing of the EUT and peripherals utilized during the performance of EMC test:

| Mark | Description | Model No. | Serial No. | Manufacturer / Trademark | FCC ID |
|---|---|---|---|---|---|
| A | Notebook Computer | NP345XLA | - | SAMSUNG | A3LNP345XLA |
| B | Battery | AA-PBAN2HE | - | SDI | - |
| C | Headset | EHS64AVFWE | - | CRESYN | - |
| D | Data Cable | EP-DW767 | - | RF Tech | - |
| E | Travel Adapter | EP-TA800 | R37R32A00F8DK3 | DONGYANG | - |
| F | micro SD Card | 64 GB | - | SAMSUNG | DoC |
| G | Mouse | AA-SM7PCPB | CNBA5903634ADV8J 31O3050 | SAMSUNG | DoC |
| | | SNJ-B138 | Z5F8353 | SAMSUNG | DoC |
| H | DP Monitor | 27UD88 | 711NTQD8H004 | LG | DoC |
| I | DP Monitor AC Adapter | LCAP31 | EH8NN629490055062 | LG | DoC |
| J | DP Cable | JCA141 | BW2K1709000770 | J5CREATE | DoC |

## 4.2 EUT operating mode

To achieve compliance applied standard specification including CXX and JBC requirement, the following mode(s) were made during compliance testing:

### 4.2.1 Conducted Emission

| No. | Operating mode |
|---|---|
| 1 | eUFS(Internal storage) & micro SD Card Read/Write + Display Port + Camera preview<br>+ Scrolled H-character on video + Digital white noise sound + Cellular receiver (LTE B26)<br>+ Charging(w/ TA) |

### 4.2.2 Radiated Emission

| No. | Operating mode |
|---|---|
| 1 | eUFS(Internal storage) & micro SD Card Read/Write + Display Port + Camera preview<br>+ Scrolled H-character on video + Digital white noise sound + Charging(w/ TA) |

## 4.3 Details of Sampling

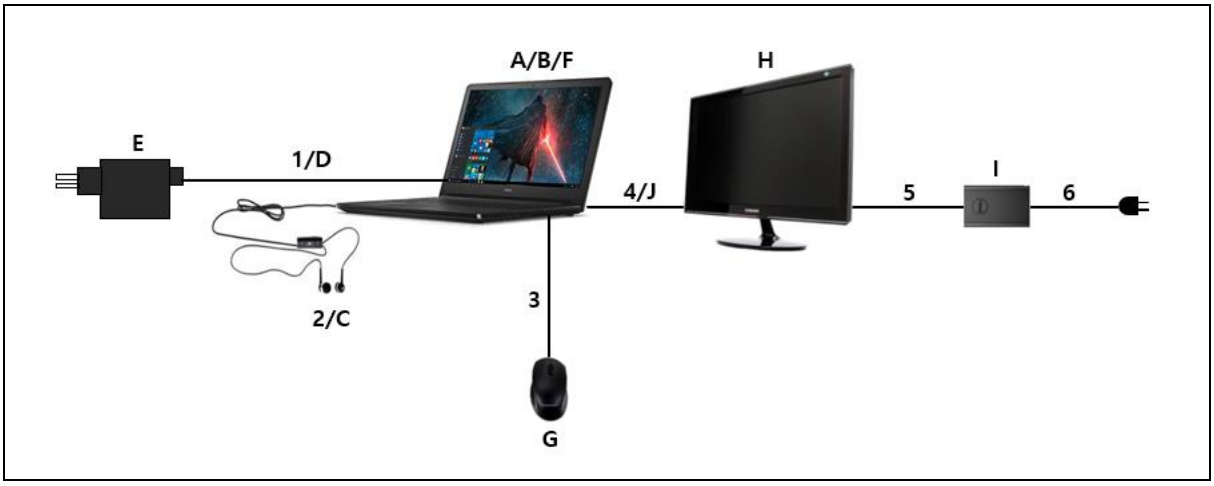
Customer selected, single unit.

## 4.4 Used cable description

The EUT is configured, installed, arranged and operated in a manner consistent with typical applications. Interface cables/loads/devices are connected to at least one of each type of interface port of the EUT, and where practical, each cable shall be terminated in a device typical of actual usage. The type(s) of interconnecting cables to be used and the interface port (of the EUT) to which these were connected:

| No. | Connected cable | Length [m] | Shielded [Y/N] | Note |
|---|---|---|---|---|
| 1 | Data Cable | 1.8 | Y | From EUT to Travel Adapter |
| 2 | Headset | 1.3 | N | For EUT |
| 3 | USB | 1.8 | Y | From EUT to Mouse |
| 4 | DP Cable | 1.1 | Y | From EUT to DP Monitor |
| 5 | Power | 1.2 | N | From DP Monitor to DP Monitor AC Adapter |
| 6 | Power | 1.8 | N | For DP Monitor AC Adapter |

## 4.5 Test arrangement



## 4.6 EUT Description

The EUT is a notebook computer which can operate on WCDMA FDD1/2/4/5/8, LTE FDD1/2/3/4/5/7/8/12/13/17/20/26/28/66, LTE TDD38/40/41 and incorporates a Bluetooth, Wi-Fi(802.11 a/b/g/n/ac), Camera, Audio, Video, DP and micro SD Card.

| Item | Specification | Remarks |
|---|---|---|
| CPU | Qualcomm, SC7180 | - |
| Main Memory | Samsung, LPDDR4X, 4 GB | - |
| Graphic Controller | Qualcomm, Adreno 618 | - |
| Display | AUO, B140HTN02.0, 14 inch, FHD(1 920 x 1 080) | - |
| eUFS | Samsung eUFS, 128GB | - |
| WLAN/Bluetooth | Qualcomm WCN3991 Chipset,<br>802.11a/b/g/n/ac(MIMO), Bluetooth 5.1 | - |
| Battery | SAMSUNG SDI, AA-PBAN2HE, 5 320 mAh | - |
| Camera | Chicony, HD Camera, 1D-MIC | - |
| Input Devices | Keyboard, Touchpad | - |
| Ports | USB Type-C x 2, USB 2.0 x 1, MIC In/HP-Out x 1,<br>micro SD Slot x 1, micro USIM Slot x 1 | - |
| H/W Version | REV. 0.4 | - |
| S/W Version | NP345XLA.001 (Windows 10) | |

### 4.6.1 The variant models

- None

## 4.7 EUT Frequencies

| The highest frequencies<br>(Generated and used) | Frequency [ MHz ] |
|---|---|
| Wi-Fi | 5 825 |
| CPU | 2 550 |
| DDR4 | 2 133 |

## 4.8 Test configuration and condition

The system was configured for testing in a typical fashion that a customer would normally use.

The EUT exercise program was tested using the Burn-In test program for Windows.

Cables were attached to each of the available I/O ports. Where applicable, peripherals were attached to the I/O cables. All the external I/O ports was exercised, as well as internal and external (if available) storage, by writing and reading arbitrary data and charging with TA.

The screen of EUT was open and a scrolled H-character continuously displays on external monitor through display out function using direct DP cable.

RX mode(850MHz) testing was performed with the LTE FDD26 RX test mode at center frequency. All licensed communication (850MHz) RX mode, WCDMA/LTE, test results are not significantly different.

The digital white noise sound was repetitively played with the headset connected.

The camera of the EUT was operated continuously.

Power source for the EUT operating was supplied by CVCF made by the Pacific Corp.

**- Test Voltage : AC 120 V, 60 Hz**

## 4.9 Measurement uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus: (According to CISPR 16-4-2 and UKAS M3003)

| **Test type** | | **Measurement uncertainty (C.L. approximately 95 %, *k* = 2)** |
|---|---|---|
| Conducted Emission | AC Mains | 2.83 dB |
| Radiated Emission (Below 1 GHz) | Horizontal | 4.08 dB |
| | Vertical | 4.58 dB |
| Radiated Emission (Above 1 GHz) | Horizontal | 5.21 dB |
| | Vertical | 5.22 dB |

* Remark

1) The values for uncertainty of conducted and radiated emissions are less than the corresponding values of Ucispr given in CISPR 16-4-2. Therefore no adjustment of measurement results is necessary when comparing them with the relevant limits.

# 5. Results of individual test

## 5.1 Conducted Emission

The EUT is connected to a LISN via travel adapter. If the EUT is connected to the Laptop Computer USB port, the Laptop AC adapter is connected to a LISN.

Both conducted lines are measured in Quasi-Peak and CISPR-Average mode, including the worst-case data points for each tested configuration. The EUT measured in accordance with the methods described in standards.

**Limits for conducted emission at the mains ports of Class B**

| Frequency range Limits [ MHz ] | Resolution Bandwidth [ kHz ] | Limits [ dB(μV) ] | |
|---|---|---|---|
| | | Quasi-peak | Average |
| 0.15 to 0.50 | 9 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 9 | 56 | 46 |
| 5 to 30 | 9 | 60 | 50 |
| NOTE 1 The lower limit shall apply at the transition frequency.<br>NOTE 2 The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz. | | | |

## 5.1.1 Test instrumentation

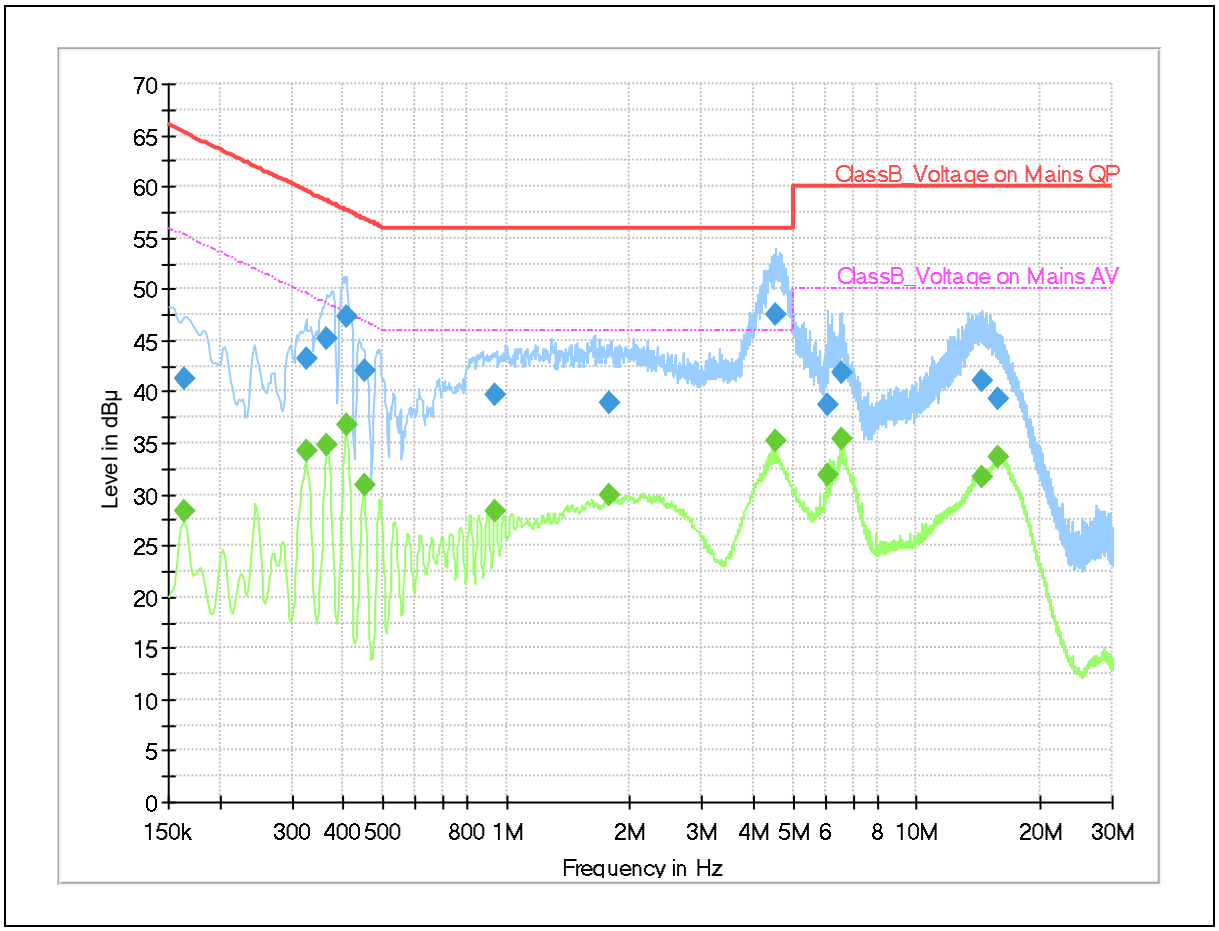
| EMC No. | Test Instrument | Model name | Manufacturer | Serial No. | Next Calibration | |
|---|---|---|---|---|---|---|
| | | | | | Date | Interval (Month) |
| E5I-006 | LTE Communicator | CMW500 | R&S | 132728 | 2021-04-06 | 12 |
| E5I-015 | EMI Test Receiver | ESU8 | R&S | 100481 | 2021-07-01 | 12 |
| E5I-127 | Two-Line V-Network | ENV216 | R&S | 102061 | 2021-07-29 | 12 |
| E5I-043 | Two-Line V-Network | ENV216 | R&S | 101630 | 2021-08-14 | 12 |
| - | Test software | EMC32 | R&S | Ver 9.26.01 | - | - |

## 5.1.2 Temperature and humidity condition

| Test date | 2021-03-23 | Test engineer | Ji-Yeon Lee |
|---|---|---|---|
| Climate condition | Ambient temperature | (23.6 ± 0.5) ℃ | Limit (15.0 to 35.0) ℃ |
| | Relative humidity | (43.7 ± 0.5) % R.H. | Limit (25.0 to 75.0) % R.H. |
| | Atmospheric pressure | (101.4 ± 0.5) kPa | Limit (86.0 to 106.0) kPa |
| Test place | Shield Room (SR8) | | |

## 5.1.3 Test results

### ☐ Operating Mode 1: AC Mains



QP / CAV final measurement results table:

| Frequency (MHz) | QP (dBµV) | CAV (dBµV) | Limit (dBµV) | Margin (dB) | Line | Corr. (dB) |
|---|---|---|---|---|---|---|
| 0.164 | 41.33 | --- | 65.28 | 23.95 | L1 | 10.2 |
| 0.164 | --- | 28.35 | 55.28 | 26.93 | L1 | 10.2 |
| 0.326 | 43.13 | --- | 59.57 | 16.44 | L1 | 10.1 |
| 0.326 | --- | 34.13 | 49.57 | 15.44 | L1 | 10.1 |
| 0.366 | --- | 34.79 | 48.59 | 13.80 | N | 10.2 |
| 0.366 | 45.24 | --- | 58.59 | 13.35 | N | 10.2 |
| 0.407 | 47.36 | --- | 57.72 | 10.36 | N | 10.2 |
| 0.407 | --- | 36.77 | 47.72 | 10.95 | L1 | 10.2 |
| 0.449 | --- | 30.81 | 46.89 | 16.08 | L1 | 10.2 |
| 0.449 | 41.99 | --- | 56.89 | 14.90 | L1 | 10.2 |
| 0.942 | --- | 28.36 | 46.00 | 17.64 | L1 | 10.0 |
| 0.942 | 39.66 | --- | 56.00 | 16.34 | L1 | 10.0 |
| 1.777 | --- | 29.87 | 46.00 | 16.13 | L1 | 9.9 |
| 1.777 | 38.94 | --- | 56.00 | 17.06 | L1 | 9.9 |
| 4.529 | --- | 35.15 | 46.00 | 10.85 | L1 | 10.0 |
| 4.529 | 47.61 | --- | 56.00 | 8.39 | L1 | 10.0 |
| 6.083 | 38.80 | --- | 60.00 | 21.20 | N | 10.0 |
| 6.083 | --- | 31.79 | 50.00 | 18.21 | N | 10.0 |
| 6.540 | --- | 35.45 | 50.00 | 14.55 | N | 10.0 |
| 6.540 | 41.80 | --- | 60.00 | 18.20 | N | 10.0 |
| 14.431 | 41.14 | --- | 60.00 | 18.86 | L1 | 10.3 |
| 14.431 | --- | 31.60 | 50.00 | 18.40 | L1 | 10.3 |
| 15.810 | 39.29 | --- | 60.00 | 20.71 | N | 10.5 |
| 15.810 | --- | 33.60 | 50.00 | 16.40 | N | 10.5 |

Note 1) Two graphs measured for both Live(L1) and Neutral(N) of the LISN are combined into one graph.
Note 2) Level (QP and/or CAV) = Meter Reading (QP and/or CAV) + Corr. (LISN Insertion Loss + Cable Loss)
Margin (QP and/or CAV) = Limit – Level (QP and/or CAV)
QP = Quasi-Peak, CAV = CISPR-Average, Corr. = Correction Factor

## 5.2 Radiated Emission

The following data lists the significant emission frequencies, measured levels, correction factors (for antenna and cables), orientation of table, polarization and height of antenna, the corrected reading, the limit, and the amount of margin.

Peak measurements were made over the changeable frequency range 30 MHz to 1 GHz at a measurement distance of 10 m for the following antenna and turntable arrangements:

| Antenna Height [ cm ] | Antenna Polarisation | Resolution Bandwidth [ kHz ] | Video Bandwidth [ kHz ] | Turntable position [ degrees ] |
|---|---|---|---|---|
| 100 ~ 400 | Horizontal, Vertical | 120 | 300 | Continuous |

Measurements within 6 dB of the limit were then maximized by adjusting turntable position.
Final measurements were made using quasi-peak detector.

Peak/CISPR-Average measurements were made over the changeable frequency range 1 GHz to 40 GHz or 5th harmonics of the highest frequency generated or used in the device or on which the device operates or tunes at a measurement distance of 3 m for the following antenna and turntable arrangements. The measurements above 1 GHz were performed with the bore-sighting antenna aimed at the EUT.

| Antenna Height [ cm ] | Antenna Polarisation | Resolution Bandwidth [ MHz ] | Video Bandwidth [ MHz ] | Turntable position |
|---|---|---|---|---|
| 100 ~ 400 | Horizontal, Vertical | 1 | 3 | Continuous |

Measurements within 6 dB of the limit were then maximized by adjusting turntable position.
Final measurements were made using peak and CISPR-average detectors.

**Limits for radiated emission of Class B at a measuring distance of 3 m and 10 m**

| Frequency range Limits [ MHz ] | Field Strength | | |
|---|---|---|---|
| | 3 m [ μV/m ] | 3 m [ dB(μV/m) ] | 10 m [ dB(μV/m) ] |
| 30 to 88 | 100 | 40.0 | 29.5 |
| 88 to 216 | 150 | 43.5 | 33.0 |
| 216 to 960 | 200 | 46.0 | 35.5 |
| Above 960 | 500 | 54.0 | 43.5 |

Note) Distance correction formula from $D_1$(3m) to $D_2$(10m)
: Limit at $D_2$ = Limit at $D_1$ + 20Log($D_1$ /$D_2$)

Results checked manually; and points close to the limit line were re-measured.

## 5.2.1 Test instrumentation

| EMC No. | Test Instrument | Model name | Manufacturer | Serial No. | Next Calibration | |
|---|---|---|---|---|---|---|
| | | | | | Date | Interval (Month) |
| E5I-020 | EMI Test Receiver | ESU40 | R&S | 100375 | 2021-09-14 | 12 |
| E5I-018 | EMI Test Receiver | ESU8 | R&S | 100484 | 2021-05-22 | 12 |
| E5I-069 | BiLog Antenna | CBL6112D | TESEQ | 35382 | 2021-08-30 | 24 |
| E5I-071 | BiLog Antenna | CBL6112D | TESEQ | 35384 | 2021-08-30 | 24 |
| E5I-075 | Preamplifier | 310N | SONOMA | 332018 | 2021-05-28 | 12 |
| E5I-076 | Preamplifier | 310N | SONOMA | 332019 | 2021-05-28 | 12 |
| E5I-036 | Horn Antenna | HF907 | R&S | 100507 | 2022-04-23 | 24 |
| E5I-039 | Signal Conditioning Unit | SCU-18 | R&S | 10211 | 2022-01-21 | 12 |
| E5I-037 | WideBand Horn Antenna | WBH 18-40K | R&S | 11201 | 2023-02-15 | 24 |
| E5I-042 | Signal Conditioning Unit | SCU-40A | R&S | 10004 | 2021-09-09 | 12 |
| - | Test software | EP7RE | TOYO | Ver 5.8.2 | - | - |
| - | Test software | EMC32 | R&S | Ver 9.25.00 | - | - |

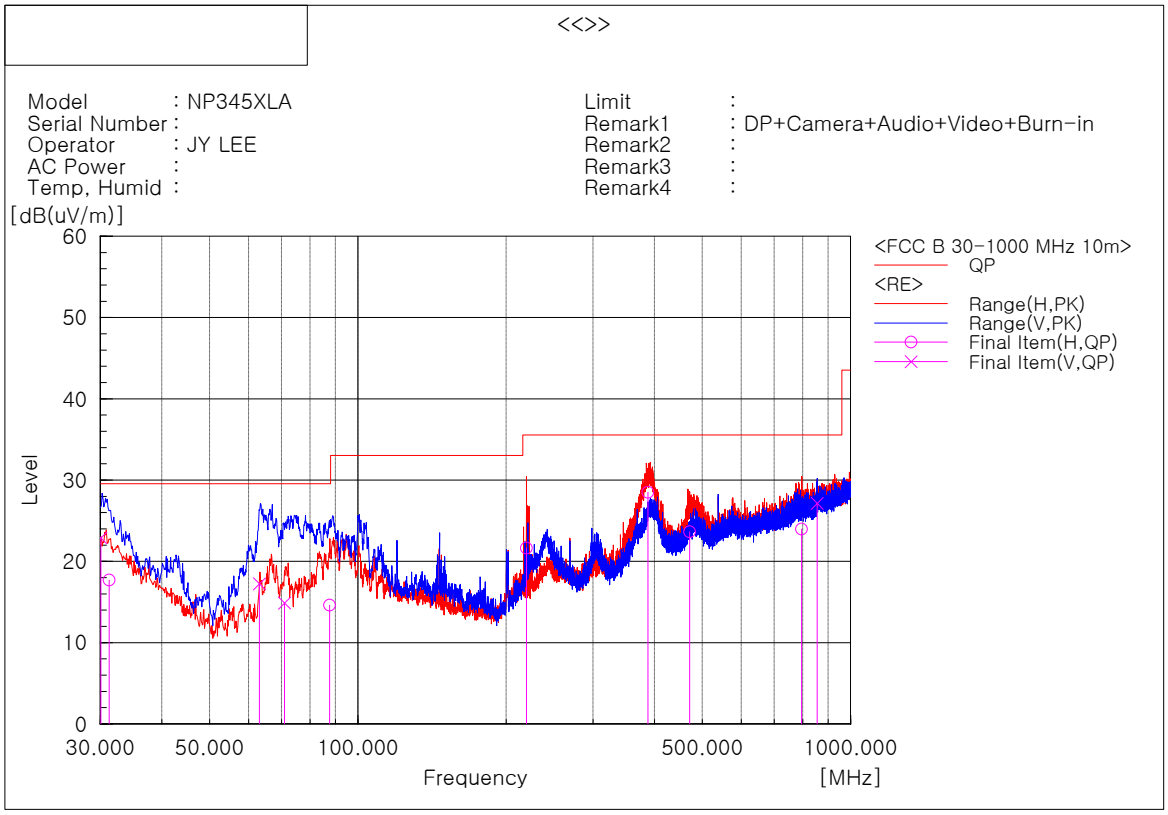
## 5.2.2 Temperature and humidity condition

| | | | |
|---|---|---|---|
| **Test date** | 2021-03-16 ~ 2021-03-17 | **Test engineer** | Ji-Yeon Lee |
| **Climate condition** | Ambient temperature | (24.5 ± 0.5) ℃ | Limit (15.0 to 35.0) ℃ |
| | Relative humidity | (44.8 ± 0.5) % R.H. | Limit (25.0 to 75.0) % R.H. |
| | Atmospheric pressure | (101.6 ± 0.5) kPa | Limit (86.0 to 106.0) kPa |
| **Test place** | Semi-Anechoic Chamber (SAC4) | | |

## 5.2.3 Test results

### ☐ Operating Mode 1

### - Frequencies below 1 GHz

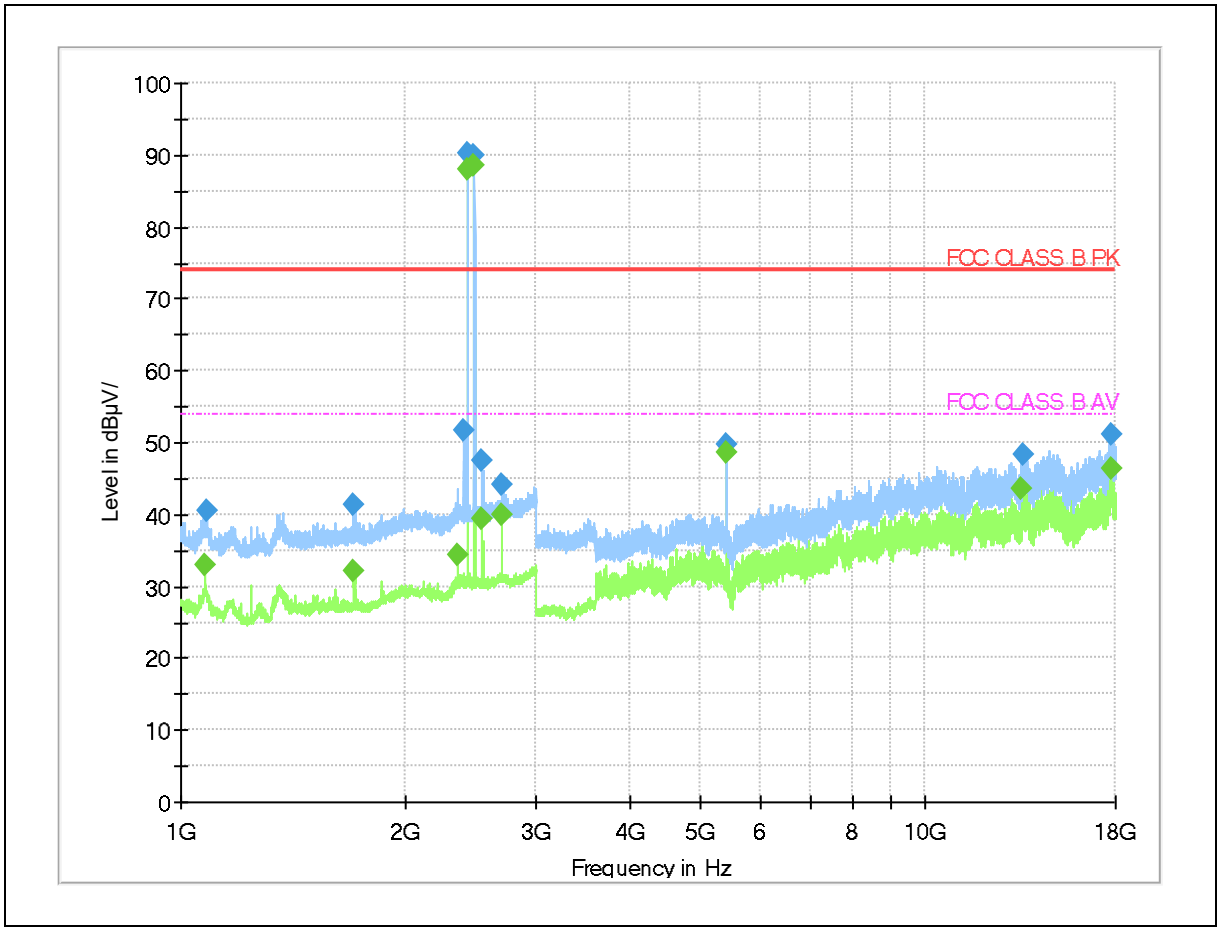



Final Result

| No. | Frequency [MHz] | (P) | Reading QP [dB(uV)] | c.f [dB(1/m)] | Result QP [dB(uV/m)] | Limit QP [dB(uV/m)] | Margin QP [dB] | Height [cm] | Angle [deg] | System |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30.066 | V | 29.9 | -7.0 | 22.9 | 29.5 | 6.6 | 101 | 128 | 2 |
| 2 | 31.259 | H | 24.9 | -7.2 | 17.7 | 29.5 | 11.8 | 397 | 355 | 1 |
| 3 | 63.071 | V | 36.0 | -18.7 | 17.3 | 29.5 | 12.2 | 185 | 262 | 2 |
| 4 | 70.930 | V | 33.5 | -18.6 | 14.9 | 29.5 | 14.6 | 205 | 299 | 2 |
| 5 | 87.640 | H | 31.3 | -16.7 | 14.6 | 29.5 | 14.9 | 400 | 96 | 1 |
| 6 | 219.703 | H | 36.5 | -14.9 | 21.6 | 35.5 | 13.9 | 400 | 320 | 1 |
| 7 | 387.616 | H | 37.0 | -8.5 | 28.5 | 35.5 | 7.0 | 219 | 154 | 1 |
| 8 | 471.251 | H | 29.9 | -6.3 | 23.6 | 35.5 | 11.9 | 202 | 155 | 1 |
| 9 | 795.537 | H | 26.3 | -2.3 | 24.0 | 35.5 | 11.5 | 120 | 214 | 1 |
| 10 | 855.292 | V | 28.0 | -0.9 | 27.1 | 35.5 | 8.4 | 184 | 160 | 2 |

Note1) Receiving antenna polarization : Horizontal, Vertical
Test Distance : 10 m, Antenna Height : 1 to 4 meters
Result (QP) = Reading (QP) + c.f (Antenna Factor + Cable Loss - Amp. Gain)
Margin (QP) = Limit – Level (QP)
QP = Quasi-Peak, c.f = Correction Factor

**- Frequencies above 1 GHz**



| Frequency (MHz) | PK (dBµV/ | CAV (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|
| 1 077.200 | --- | 33.03 | 54.00 | 20.97 | 182.5 | H | 214.0 | 7.1 |
| 1 084.400 | 40.51 | --- | 74.00 | 33.49 | 178.4 | H | 1.0 | 7.1 |
| 1 709.600 | --- | 31.98 | 54.00 | 22.02 | 105.2 | H | 128.0 | 10.9 |
| 1 709.600 | 41.25 | --- | 74.00 | 32.75 | 104.8 | H | 128.0 | 10.9 |
| 2 356.000 | --- | 34.36 | 54.00 | 19.64 | 100.0 | V | 0.0 | 13.4 |
| 2 394.400 | 51.80 | --- | 74.00 | 22.20 | 100.5 | H | 15.0 | 13.7 |
| 2 426.000 | 90.15 | --- | 74.00 | -16.15 | 102.4 | H | 181.0 | 13.9 |
| 2 426.400 | --- | 87.86 | 54.00 | -33.86 | 101.8 | H | 181.0 | 13.9 |
| 2 480.000 | --- | 88.63 | 54.00 | -34.63 | 115.2 | V | 286.0 | 14.2 |
| 2 480.400 | 89.90 | --- | 74.00 | -15.90 | 114.0 | V | 286.0 | 14.2 |
| 2 538.400 | --- | 39.31 | 54.00 | 14.69 | 108.7 | H | 20.0 | 14.4 |
| 2 538.400 | 47.58 | --- | 74.00 | 26.42 | 109.4 | H | 20.0 | 14.4 |
| 2 700.000 | --- | 40.02 | 54.00 | 13.98 | 194.1 | V | 115.0 | 15.4 |
| 2 700.000 | 44.22 | --- | 74.00 | 29.78 | 191.0 | V | 115.0 | 15.4 |
| 5 400.000 | --- | 48.61 | 54.00 | 5.39 | 188.2 | H | 106.0 | 7.3 |
| 5 400.000 | 49.77 | --- | 74.00 | 24.23 | 190.3 | H | 106.0 | 7.3 |
| 13 481.500 | --- | 43.46 | 54.00 | 10.54 | 100.2 | V | 77.0 | 25.9 |
| 13 492.000 | 48.29 | --- | 74.00 | 25.71 | 101.3 | V | 52.0 | 26.1 |
| 17 802.000 | 51.01 | --- | 74.00 | 22.99 | 159.2 | V | 144.0 | 36.2 |
| 17 811.500 | --- | 46.35 | 54.00 | 7.65 | 161.1 | V | 142.0 | 36.0 |

Note 1) We have also tested from 18 GHz to 30 GHz and found no emissions.

Note 2) Receiving antenna polarization : Horizontal, Vertical

Test Distance : 3 m, Antenna Height : 1 to 4 meters

Level (PK and/or CAV) = Reading (PK and/or CAV) + Corr. (Antenna Factor + Cable Loss - Amp. Gain)

Margin (PK and/or CAV) = Limit – Level (PK and/or CAV)

PK = Peak, CAV = CISPR-Average, Corr. = Correction Factor

Note 3) Radiated emissions (Tx / Rx frequency) from the transceiver shall be ignored.

- Data transmission in the 2.4 GHz ISM band (Bluetooth/Wi-Fi 802.11b/g/n)

: Operating frequencies (2 400 ~ 2 483.5) MHz