

RF TEST REPORT

FCC / ISED

APPLICANT

Safetrust Inc

MODEL NAME

SA520

FCC ID

2ANI5SA520

ISED ID

23133-SA520

REPORT NUMBER

HA220420-SFT-002-R22

TEST REPORT

Date of Issue
August 17, 2022

Test Site
Hyundai C-Tech, Inc. dba HCT America, Inc.
1726 Ringwood Ave, San Jose, CA 95131, USA

| | |
|---------------------------|--|
| Applicant | Safetrust Inc |
| Applicant Address | 8116 Mill Creek Rd, Fremont, CA 94539, U.S.A. |
| FCC ID | 2ANI5SA520 |
| ISED ID | 23133-SA520 |
| Model Name | SA520 |
| EUT Type | IoT Sensor |
| Modulation Type | 13.56 MHz (ASK) / 125 kHz (ASK/FSK/PSK) |
| FCC Classification | Low Power Transmitter Below 1705 kHz (DCD) Low Power Communication Device Transmitter (DXX) |
| FCC Rule Part(s) | Part 15.225, Part 15.209, Part 15.207 |
| ISED Rule Part(s) | RSS-210 Issue 10 (April 2020) |

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

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.

Hyundai C-Tech, Inc. dba HCT America, Inc. certifies that no party to application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C 862

Tested By

Yongsoo Park

Test Engineer

Reviewed By

Sunwoo Kim

Technical Manager

REVISION HISTORY

The revision history for this document is shown in table.

| TEST REPORT NO. | DATE | DESCRIPTION |
|----------------------|-----------------|---------------|
| HA220420-SFT-002-R22 | August 17, 2022 | Initial Issue |
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1. GENERAL INFORMATION

EUT DESCRIPTION

| | |
|------------------------------|---|
| Model | SA520 |
| EUT Type | IoT Sensor |
| Serial Number | Radiated : SN1 |
| Power Supply | 12 V d.c. |
| RF Specification | WIFI 5 GHz (U-NII 3) : 802.11a/n(HT20/40)/ ac(VHT20/40/80) Bluetooth LE MCU (1Mbps) Bluetooth LE MESH (1Mbps) RFID (LF/HF) |
| Transmitter Chain | 5 GHz : SISO Bluetooth LE : SISO |
| Operating Environment | Indoor and outdoor |
| Operating Temperature | -20 °C ~ 50 °C |

RF SPECIFICATION SUBJECT TO THE REPORT

| | |
|---------------------------------------|---|
| RF Specification | RFID (LF/HF) |
| Frequency Range | LF : 125 kHz HF : 13.56 MHz |
| Max. RF Output Power | LF : 78 dBuV/m @3m HF : 62.3 dBuV/m @3m |
| Modulation Type | LF : ASK, FSK, PSK HF : ASK |
| Number of Channels | LF : 1channel HF : 1 channel |
| Antenna Specification | Loop antenna |
| Firmware Version ¹⁾ | BLE MCU/RFID (LF/HF) : 1.52.1009 BLE MESH : 1.52.167 WIFI : 1.0.344 |
| Hardware Version ¹⁾ | V4 |
| Date(s) of Tests | June 6, 2022 ~ July 19, 2022 |

Note :

1. Firmware and Hardware Version are as received by the client.

2. METHODOLOGY

The measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.225 under the FCC Rules Part 15 Subpart C and RSS-GEN issue 5, RSS-210 issue 10.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. Also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. To find out the maximum emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

DESCRIPTION OF TEST MODES

The EUT has been tested per test setup instruction provided by the manufacturer under continuous Tx operating condition. Testing was performed at the Tx mode using the key card provided by the manufacturer.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC (Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at 1726 Ringwood Avenue, San Jose, California 95131, USA.

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.



EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

- (1) The antenna of this E.U.T is permanently attached and there is no provision for connection to an external antenna.
- (2) The E.U.T Complies with the requirement of §15.203

According to RSS-Gen Issue 5 (Section 6.8) :

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

| Parameter | Expanded Uncertainty (\pm dB) |
|----------------------------------|----------------------------------|
| Occupied Bandwidth | ± 12.4 kHz |
| Radiated Emissions (below 1 GHz) | ± 6.09 dB |

7. DESCRIPTION OF TESTS

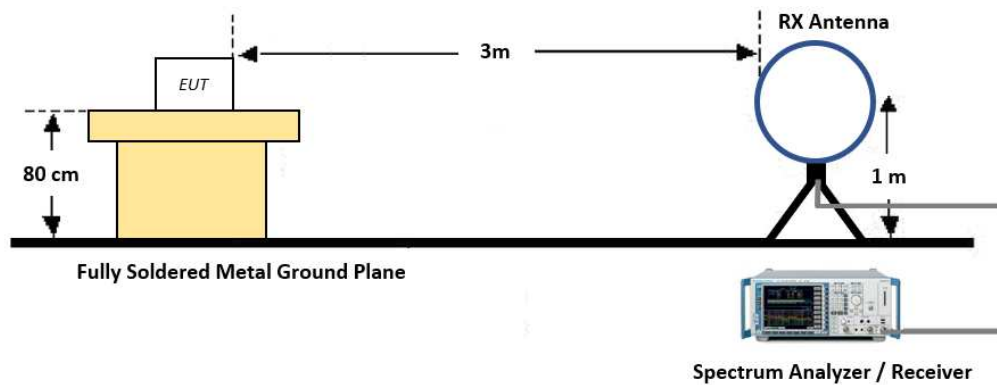
7.1. 20 dB BANDWIDTH / 99 % BANDWIDTH

Limit

20 dB bandwidth : According to §15.215(c), the bandwidth at 20 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

99% Bandwidth : Section 6.7, RSS-Gen Issue 5

Test Configuration



Test Procedure (20 dB Bandwidth)

The Spectrum Analyzer setting :

- RBW = 1 kHz
- VBW $\geq 3 \times$ RBW
- Detector = Peak
- Trace mode = max hold
- Sweep = auto couple
- Allow the trace to stabilize

Test Procedure (99 % Bandwidth)

The transmitter output is connected to the spectrum analyzer.

- RBW = 1 kHz
- VBW $\cong 3 \times$ RBW
- Detector = Peak
- Trace mode = max hold
- Sweep = auto couple
- Allow the trace to stabilize

Note :

Bandwidth measurement feature in the spectrum analyzer was used to measure 20 dB bandwidth (X dB bandwidth function) and 99 % bandwidth.

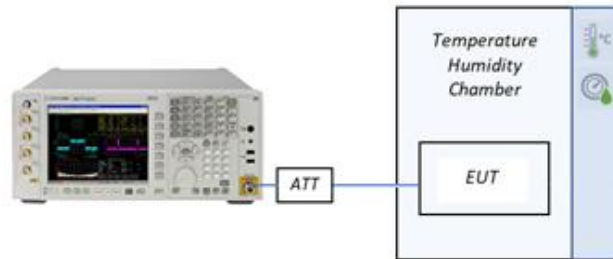
7.2. FREQUENCY STABILITY

Limit

§15.225 (e), RSS-210 Issue 10

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency.

Test Configuration



Test Procedure

For battery operated equipment, the equipment tests shall be performed using a new battery.

- 1) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.
- 2) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.
- 3) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.
- 4) Frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency.

Note:

- Temperature humidity chamber is used to adjust the temperature between -20°C and $+50^{\circ}\text{C}$
- The primary supply voltage was adjusted between 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

7.3. RADIATED EMISSION

RADIATION EMISSION LIMIT

| FCC : 47 CFR § 15.209 | | |
|-----------------------|-----------------------|--------------------------|
| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
| 0.009 – 0.490 | 2400/F(kHz) | 300 |
| 0.490 – 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

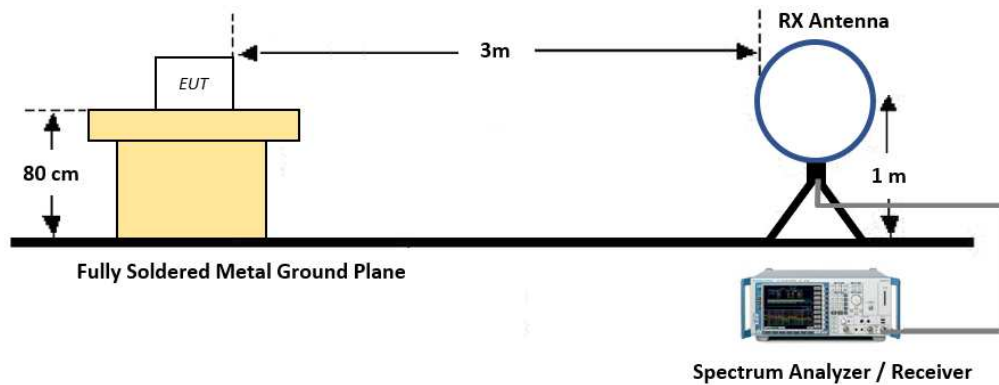
| ISED : RSS-GEN Section 8.9 | | |
|----------------------------|-----------------------|--------------------------|
| Frequency (MHz) | Field Strength (uA/m) | Measurement Distance (m) |
| 0.009 – 0.490 | 6.37/F(kHz) | 300 |
| 0.490 – 1.705 | 63.7/F(kHz) | 30 |
| 1.705 – 30 | 0.08 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

Operation within the band 13.110 MHz – 14.010 MHz

| FCC : 47 CFR § 15.225 (a), (b), (c), (d) / ISED : RSS-210 ANNEX B.6 | | |
|---|-----------------------|--------------------------|
| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
| 13.553 – 13.567 | 15,848 | 30 |
| 13.410 ≤ f ≤ 13.553 13.567 ≤ f ≤ 13.710 | 334 | 30 |
| 13.110 ≤ f ≤ 13.410 13.710 ≤ f ≤ 14.010 | 106 | 30 |

Test Configuration

Below 30 MHz



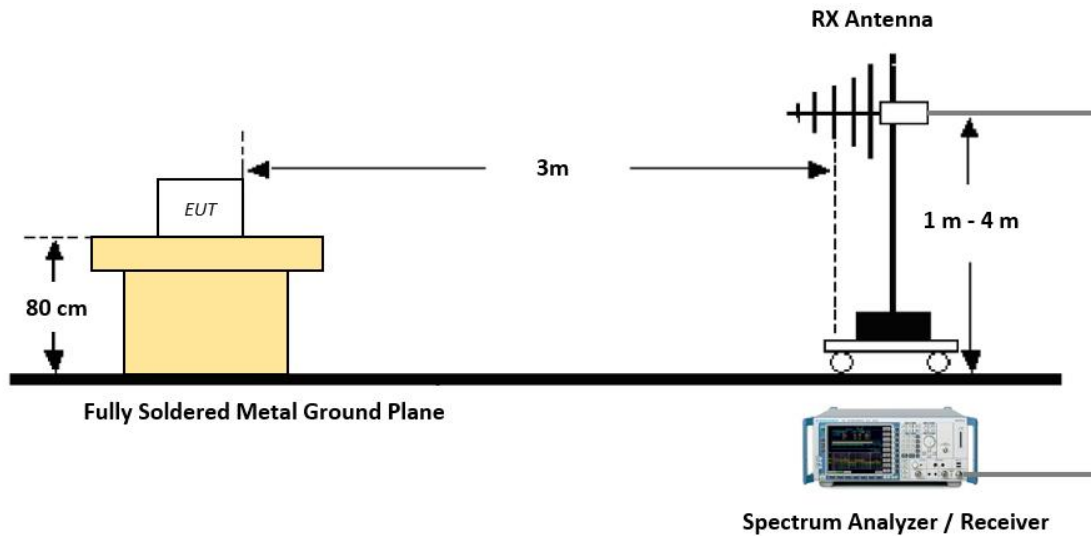
Test Procedure of Radiated spurious emissions (Below 30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor (0.009 MHz – 0.490 MHz) = $40 \cdot \log(3 \text{ m}/300 \text{ m}) = - 80 \text{ dB}$
Measurement Distance: 3 m
7. Distance Correction Factor (0.490 MHz – 30 MHz) = $40 \cdot \log(3 \text{ m}/30 \text{ m}) = - 40 \text{ dB}$
Measurement Distance: 3 m
8. Spectrum Setting
 - Frequency Range = 9 kHz ~ 30 MHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 9 kHz
 - VBW $\geq 3 \cdot \text{RBW}$

9. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L) + Distance Factor (D.F)

Adequate comparison measurements were confirmed against an open field site since the test was performed at alternative site (3m SAC) other than the open area test site. Sufficient test was made to demonstrate that the alternative site produces result that correlate with the one of test made at the open field site based on KDB 414788.

30 MHz - 1 GHz



Test Procedure of Radiated spurious emissions (Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting

(1) Measurement Type (Peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 100 kHz
- VBW $\geq 3 \cdot$ RBW

(2) Measurement Type(Quasi-peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Quasi-Peak
- RBW = 120 kHz

In general, the method (1) is mainly used

6. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)

7.4. AC LINE CONDUCTED EMISSIONS

LIMIT

47 CFR § 15.207, RSS-GEN Section 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

| Frequency Range (MHz) | Limits (dB μ V) | |
|-----------------------|---------------------|-----------|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56* | 56 to 46* |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

*Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.

According to FCC KDB 174176 D01 Line Conducted FAQ v01r01 :

Devices Operating Above 30 MHz

For a device with a permanent or detachable antenna operating above 30 MHz, measurements must be performed with the antenna connected as specified in clause 6.2 of ANSI C63.10-2013.

Devices Operating Below 30 MHz

For a device with a permanent or detachable antenna operating at or below 30 MHz, the FCC will accept measurements performed with a suitable dummy load in lieu of the antenna under the following conditions:

- (1) Perform the AC power-line conducted tests with the antenna connected to determine compliance with Section 15.207 limits outside the transmitter's fundamental emission band;
- (2) Retest with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network which simulates the antenna in the fundamental frequency band. All measurements must be performed as specified in clause 6.2 of ANSI C63.10-2013.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

8. SUMMARY OF TEST RESULTS

| Test Description | FCC Part Section(s) | IC Part Section(s) | Test Limit | Test Condition | Test Result |
|--|---------------------|----------------------------------|-----------------|----------------|-------------------|
| 20 dB Bandwidth | §15.215 (c) | - | N/A | Radiated | PASS |
| Occupied Bandwidth | - | Section 6.7 RSS-GEN | N/A | | PASS |
| Radiated E-Field Emissions 13.553 MHz - 13.567 MHz | §15.225 (a) | Annex B.6 (a)(i) RSS-210 | cf. Section 7.3 | | N/A ¹⁾ |
| Radiated E-Field Emissions 13.410 MHz ≤ f ≤ 13.553 MHz 13.567 MHz ≤ f ≤ 13.710 MHz | §15.225 (b) | Annex B.6 (a)(ii) RSS-210 | cf. Section 7.3 | | N/A ¹⁾ |
| Radiated E-Field Emissions 13.110 MHz ≤ f ≤ 13.410 MHz 13.710 MHz ≤ f ≤ 14.010 MHz | §15.225 (c) | Annex B.6 (a)(iii) RSS-210 | cf. Section 7.3 | | N/A ¹⁾ |
| Radiated Spurious Emissions | 15.209 | Section 8.9 RSS-GEN | cf. Section 7.3 | | PASS |
| Frequency Stability | §15.225 (e) | RSS-210, B.6 | cf. Section 7.2 | | PASS |
| AC Power line Conducted Emissions | §15.207 | RSS-GEN, 8.8 | cf. Section 7.4 | Conducted | PASS |

Notes:

1. No tests were applied because the fundamental level did not exceed the spurious limit per part 15.209.
2. According to the comparative measurement data in the Evaluation Report, all measurement data from the reference FCC ID below were reused for this report.

FCC ID : 2ANI5SA530

WORST CASE CONFIGURATION

RADIATED TEST

All X, Y, and Z positions for horizontal / vertical antenna polarization were investigated to find the worst-case position. Y position was selected for the final evaluation.

All the modulations below were investigated

HF : ASK

LF : ASK, FSK, PSK

All radiated tests were performed without turning off the HF and LF signals.

Conducted test

AC Line conducted emission test was performed with PSK modulation.

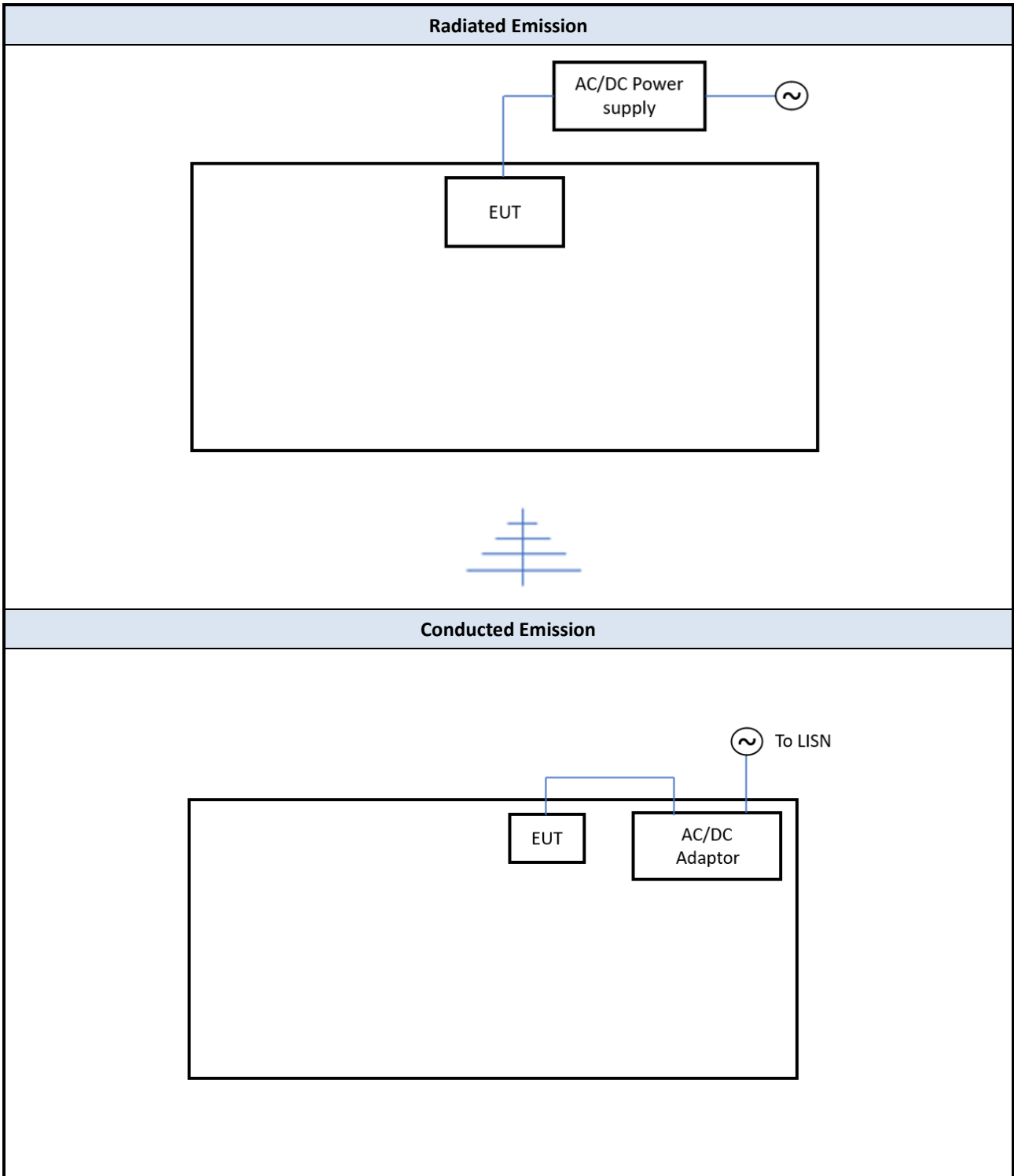
.

AC Line conducted emission test was performed in two modes because the EUT operates below 30 MHz

(1) Ante Device with antenna connected

(2) Device with antenna terminated with dummy load

TEST CONFIGURATION



LIST OF SUPPORT EQUIPMENT

| Equipment Type | Model No. | Serial Number | Manufacturer | Qty | Note |
|---|-----------------|---------------|-----------------------|-----|---|
| AC/DC Adaptor (For AC line conducted Emission) | MU18-D120150-A1 | DP8C231701641 | LEADER ELECTRONICS | 1 | Input: 100-240 V~, 0.6 A, 50/60 Hz Output: 12 V d.c., 1.5 A |

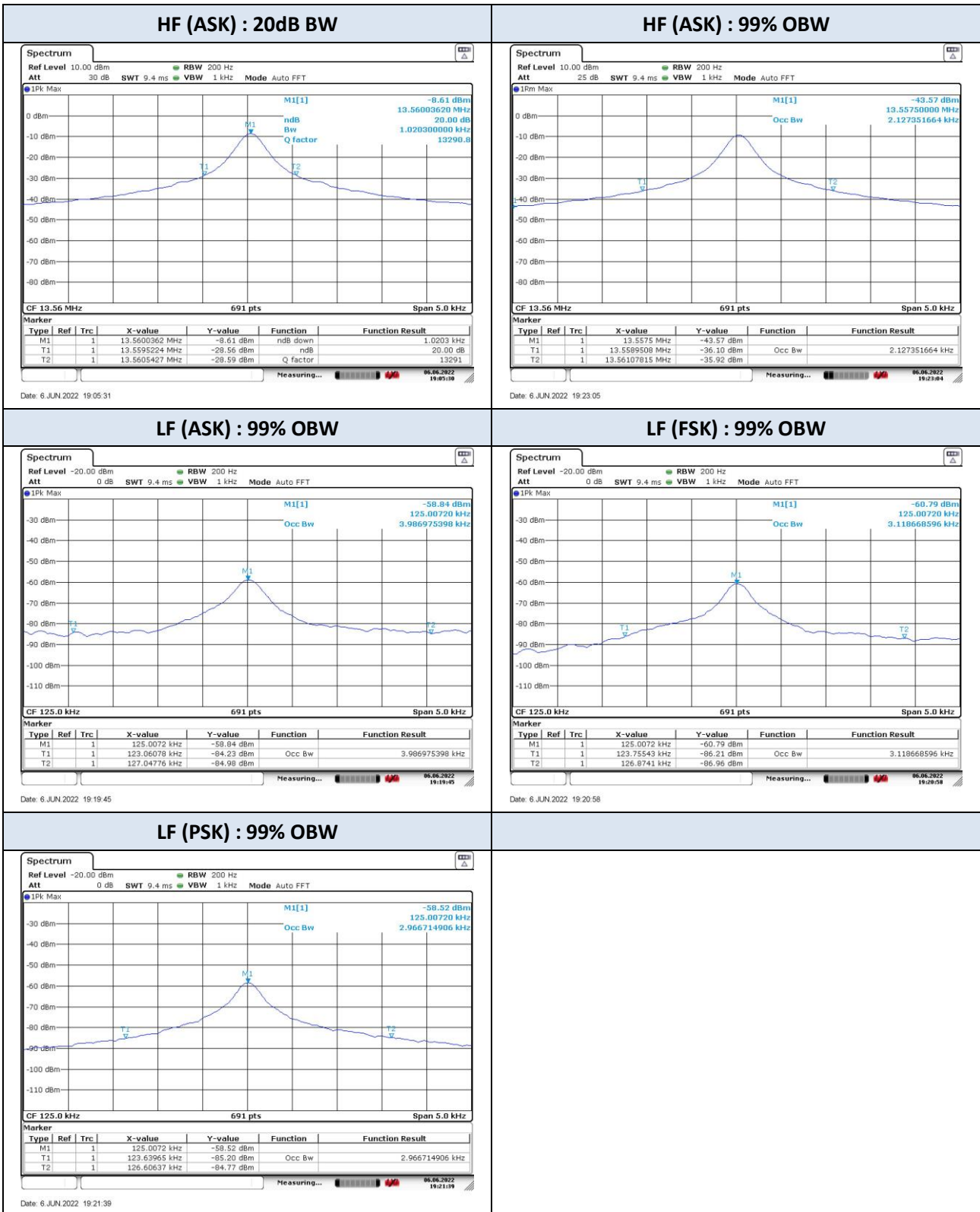
9. TEST RESULT

9.1 20 dB BANDWIDTH / 99% BANDWIDTH

| HF | | 20 dB Bandwidth (kHz) | 99% Bandwidth (kHz) | Limit |
|-----------------|------------|-----------------------|---------------------|-------|
| Frequency (MHz) | Modulation | Result | Result | |
| 13.56 | ASK | 1.020 | 2.127 | N/A |

| LF | | 99% Bandwidth (kHz) | | Limit |
|-----------------|------------|---------------------|--|-------|
| Frequency (MHz) | Modulation | Result | | |
| 0.125 | ASK | 3.987 | | N/A |
| | FSK | 3.119 | | |
| | PSK | 2.967 | | |

TEST PLOTS



9.2 FREQUENCY STABILITY

Operating Frequency 13.56 MHz
 Reference Voltage 12 VDC
 Limit 100 PPM = 1356 Hz

| Voltage (%) | Power (VDC) | Temp. (°C) | Frequency [MHz] | Frequency Dev. (Hz) | Frequency (ppm) |
|-------------|-------------|------------|-----------------|---------------------|-----------------|
| 100% | 12.0 | -20 | 13.560125 | 125 | 9.22 |
| 100% | | -10 | 13.559821 | 179 | 13.20 |
| 100% | | 0 | 13.559666 | 334 | 24.63 |
| 100% | | +10 | 13.559071 | 929 | 68.51 |
| 100% | | +20 (Ref.) | 13.560641 | 641 | 47.27 |
| 100% | | +30 | 13.560158 | 158 | 11.65 |
| 100% | | +40 | 13.560750 | 750 | 55.31 |
| 100% | | +50 | 13.560213 | 213 | 15.71 |
| 115% | | 13.8 | +20 | 13.560079 | 79 |
| 85% | 10.2 | +20 | 13.560812 | 812 | 59.88 |

9.3 RADIATED SPURIOUS EMISSIONS

Radiated Spurious Emission

Test Mode HF (ASK)
 Operating Frequency 13.56 MHz

Frequency Range : 9 kHz – 30MHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) ²⁾ | Margin (dB) | Measurement Type |
|----------------------|--------------|----------------|--------------------------|----------------|------------------------------|-------------|------------------|
| 0.125 ³⁾ | H | 58.5 | 19.4 | 77.9 | 105.7 | 27.8 | QP |
| 0.125 ³⁾ | V | 54.8 | 19.4 | 74.2 | 105.7 | 31.5 | QP |
| 0.627 | H | 16.9 | 19.3 | 36.2 | 71.7 | 35.5 | QP |
| 0.627 | V | 14.0 | 19.3 | 33.3 | 71.7 | 38.4 | QP |
| 13.560 ³⁾ | H | 38.6 | 19.6 | 58.2 | 69.5 | 11.3 | QP |
| 13.560 ³⁾ | V | 35.3 | 19.6 | 54.9 | 69.5 | 14.6 | QP |

Notes:

- Correction Factor: Antenna Factor + Cable loss
- Limit = specific Limits (dBuV) + Distance extrapolation factor
 - The measurement distance is 3 meters.
 - Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
- Fundamental frequency for 125 kHz and 13.56 MHz band

Frequency Range : Below 1 GHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Measurement Type |
|-----------------|--------------|----------------|--------------------------|----------------|----------------|-------------|------------------|
| 40.689 | V | 51.7 | -16.3 | 35.4 | 40 | 4.6 | QP |
| 54.255 | V | 57.2 | -22.3 | 34.9 | 40 | 5.1 | QP |
| 67.797 | V | 55.0 | -21.6 | 33.4 | 40 | 6.6 | QP |
| 189.841 | H | 58.7 | -18.1 | 40.6 | 43.5 | 2.9 | QP |
| 189.846 | V | 59.3 | -18.1 | 41.2 | 43.5 | 2.3 | QP |
| 216.961 | V | 61.7 | -18.8 | 42.9 | 46 | 3.1 | QP |
| 216.963 | H | 56.6 | -18.8 | 37.8 | 46 | 8.2 | QP |
| 244.088 | H | 47.3 | -17.7 | 29.6 | 46 | 16.4 | QP |
| 244.090 | V | 55.5 | -17.7 | 37.8 | 46 | 8.2 | QP |
| 424.409 | H | 43.0 | -12.4 | 30.6 | 46 | 15.4 | QP |
| 822.830 | H | 39.5 | -5.0 | 34.5 | 46 | 11.5 | QP |

Notes:

- Correction Factor: Antenna Factor + Cable loss

Test Mode LF (ASK)
 Operating Frequency 125 kHz

Frequency Range : 9 kHz – 30MHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) ²⁾ | Margin (dB) | Measurement Type |
|----------------------|--------------|----------------|--------------------------|----------------|------------------------------|-------------|------------------|
| 0.125 ³⁾ | H | 58.6 | 19.4 | 78.0 | 105.7 | 27.7 | QP |
| 0.125 ³⁾ | V | 54.7 | 19.4 | 74.1 | 105.7 | 31.6 | QP |
| 0.624 | V | 14.7 | 19.3 | 34.0 | 71.7 | 37.7 | QP |
| 0.625 | H | 17.8 | 19.3 | 37.1 | 71.7 | 34.6 | QP |
| 13.560 ³⁾ | H | 38.7 | 19.6 | 58.3 | 69.5 | 11.2 | QP |
| 13.560 ³⁾ | V | 35.4 | 19.6 | 55.0 | 69.5 | 14.5 | QP |

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. Limit = specific Limits (dBuV) + Distance extrapolation factor
 - The measurement distance is 3 meters.
 - Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Fundamental frequency for 125 kHz and 13.56 MHz band

Frequency Range : Below 1 GHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Measurement Type |
|-----------------|--------------|----------------|--------------------------|----------------|----------------|-------------|------------------|
| 40.684 | V | 46.4 | -16.5 | 29.9 | 40 | 10.1 | QP |
| 54.253 | V | 52.2 | -22.4 | 29.8 | 40 | 10.2 | QP |
| 67.811 | V | 55.2 | -21.5 | 33.7 | 40 | 6.3 | QP |
| 189.839 | H | 58.5 | -18.1 | 40.4 | 43.5 | 3.1 | QP |
| 189.840 | V | 59.2 | -18.0 | 41.2 | 43.5 | 2.3 | QP |
| 216.956 | H | 56.3 | -18.9 | 37.4 | 46 | 8.6 | QP |
| 216.960 | V | 62.1 | -18.8 | 43.3 | 46 | 2.7 | QP |
| 244.075 | H | 48.1 | -18.0 | 30.1 | 46 | 15.9 | QP |
| 244.088 | V | 54.0 | -17.7 | 36.3 | 46 | 9.7 | QP |
| 423.497 | H | 42.3 | -12.7 | 29.6 | 46 | 16.4 | QP |

Notes:

1. Correction Factor: Antenna Factor + Cable loss

Test Mode LF (FSK)
 Operating Frequency 125 kHz

Frequency Range : 9 kHz – 30MHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) ²⁾ | Margin (dB) | Measurement Type |
|----------------------|--------------|----------------|--------------------------|----------------|------------------------------|-------------|------------------|
| 0.125 ³⁾ | H | 58.5 | 19.4 | 77.9 | 105.7 | 27.8 | QP |
| 0.125 ³⁾ | V | 54.8 | 19.4 | 74.2 | 105.7 | 31.5 | QP |
| 0.624 | H | 17.7 | 19.3 | 37.0 | 71.7 | 34.7 | QP |
| 0.625 | V | 14.9 | 19.3 | 34.2 | 71.7 | 37.5 | QP |
| 13.560 ³⁾ | H | 42.7 | 19.6 | 62.3 | 69.5 | 7.2 | QP |
| 13.560 ³⁾ | V | 35.5 | 19.6 | 55.1 | 69.5 | 14.4 | QP |

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. Limit = specific Limits (dBuV) + Distance extrapolation factor
 - The measurement distance is 3 meters.
 - Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Fundamental frequency for 125 kHz and 13.56 MHz band

Frequency Range : Below 1 GHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Measurement Type |
|-----------------|--------------|----------------|--------------------------|----------------|----------------|-------------|------------------|
| 40.667 | V | 47.4 | -16.5 | 30.9 | 40 | 9.1 | QP |
| 54.268 | V | 54.9 | -22.4 | 32.5 | 40 | 7.5 | QP |
| 67.786 | V | 56.9 | -21.5 | 35.4 | 40 | 4.6 | QP |
| 189.835 | V | 57.5 | -18.0 | 39.5 | 43.5 | 4.0 | QP |
| 189.837 | H | 56.0 | -18.0 | 38.0 | 43.5 | 5.5 | QP |
| 216.961 | V | 62.3 | -18.9 | 43.4 | 46 | 2.6 | QP |
| 216.969 | H | 55.0 | -18.9 | 36.1 | 46 | 9.9 | QP |
| 244.069 | V | 55.4 | -18.0 | 37.4 | 46 | 8.6 | QP |
| 244.080 | H | 52.7 | -18.0 | 34.7 | 46 | 11.3 | QP |
| 325.429 | H | 49.1 | -15.3 | 33.8 | 46 | 12.2 | QP |
| 439.850 | V | 48.6 | -12.4 | 36.2 | 46 | 9.8 | QP |

Notes:

1. Correction Factor: Antenna Factor + Cable loss

Test Mode LF (PSK)
 Operating Frequency 125 kHz

Frequency Range : 9 kHz – 30MHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) ²⁾ | Margin (dB) | Measurement Type |
|----------------------|--------------|----------------|--------------------------|----------------|------------------------------|-------------|------------------|
| 0.125 ³⁾ | H | 51.2 | 19.4 | 70.6 | 105.7 | 35.1 | QP |
| 0.125 ³⁾ | V | 54.9 | 19.4 | 74.3 | 105.7 | 31.4 | QP |
| 0.625 | H | 13.3 | 19.3 | 32.6 | 71.7 | 39.1 | QP |
| 0.625 | V | 15.1 | 19.3 | 34.4 | 71.7 | 37.3 | QP |
| 13.560 ³⁾ | H | 40.0 | 19.6 | 59.6 | 69.5 | 9.9 | QP |
| 13.560 ³⁾ | V | 35.4 | 19.6 | 55.0 | 69.5 | 14.5 | QP |

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. Limit = specific Limits (dBuV) + Distance extrapolation factor
 - The measurement distance is 3 meters.
 - Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Fundamental frequency for 125 kHz and 13.56 MHz band

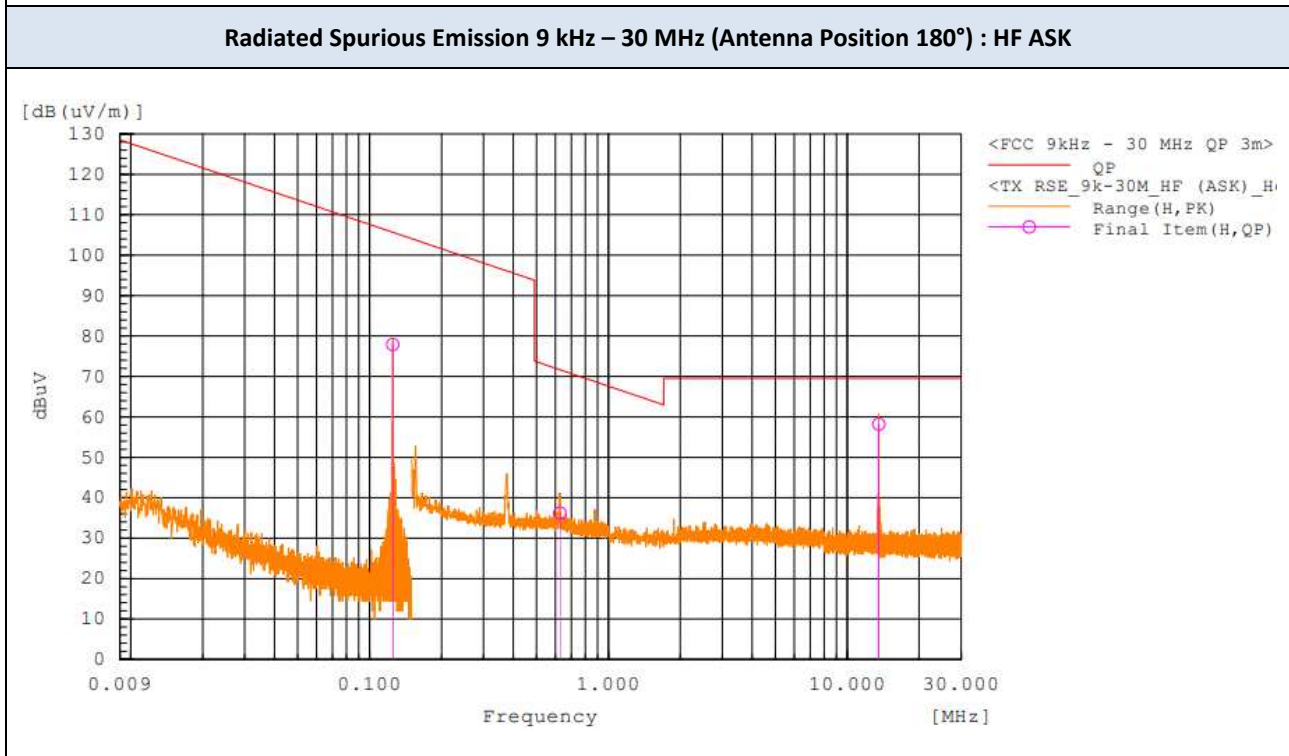
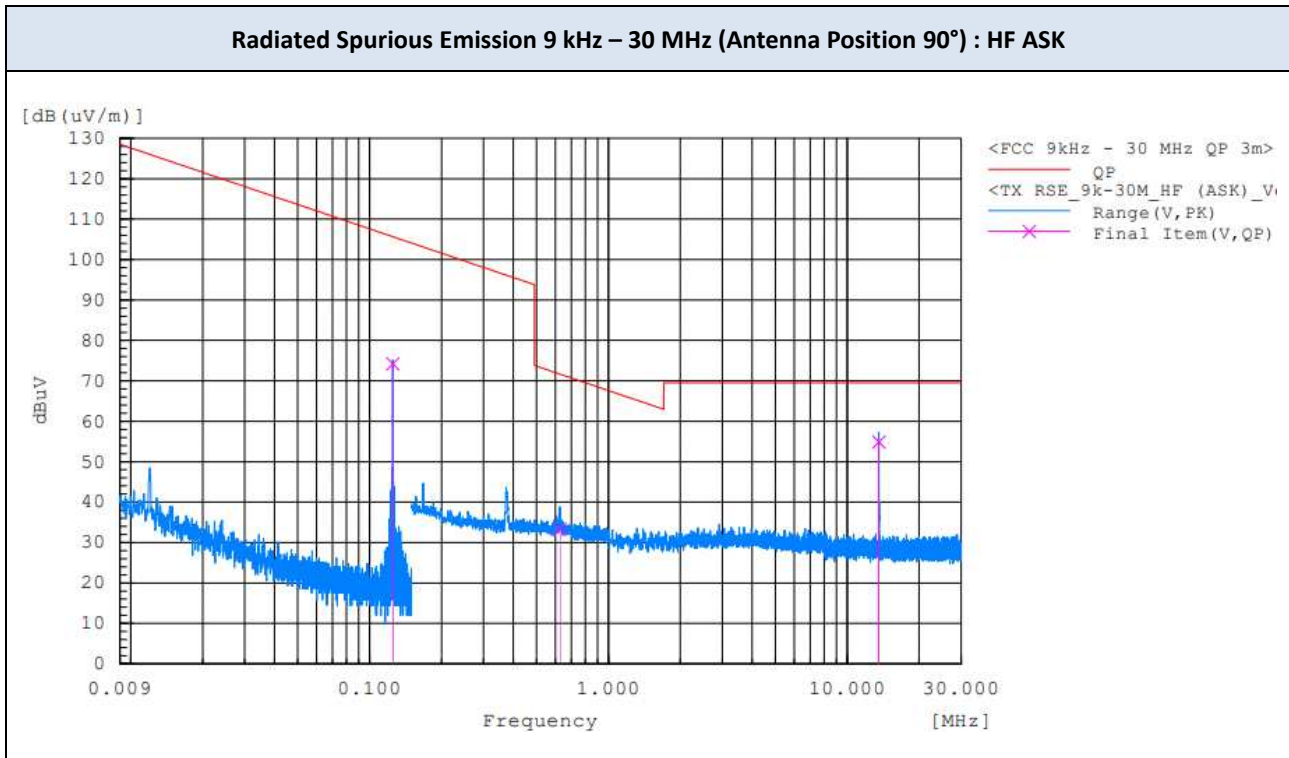
Frequency Range : Below 1 GHz

| Frequency (MHz) | Polarization | Reading (dBuV) | Corr. ¹⁾ (dB) | Total (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Measurement Type |
|-----------------|--------------|----------------|--------------------------|----------------|----------------|-------------|------------------|
| 40.688 | V | 47.2 | -16.5 | 30.7 | 40 | 9.3 | QP |
| 54.268 | V | 51.0 | -22.4 | 28.6 | 40 | 11.4 | QP |
| 67.802 | V | 55.7 | -21.5 | 34.2 | 40 | 5.8 | QP |
| 189.827 | V | 56.9 | -18.0 | 38.9 | 43.5 | 4.6 | QP |
| 189.845 | H | 56.7 | -18.0 | 38.7 | 43.5 | 4.8 | QP |
| 216.961 | H | 55.2 | -18.9 | 36.3 | 46 | 9.7 | QP |
| 216.961 | V | 62.3 | -18.9 | 43.4 | 46 | 2.6 | QP |
| 244.076 | H | 58.4 | -18.0 | 40.4 | 46 | 5.6 | QP |
| 244.090 | V | 63.4 | -18.0 | 45.4 | 46 | 0.6 | QP |
| 439.344 | H | 42.7 | -12.4 | 30.3 | 46 | 15.7 | QP |
| 440.708 | V | 49.1 | -12.4 | 36.7 | 46 | 9.3 | QP |

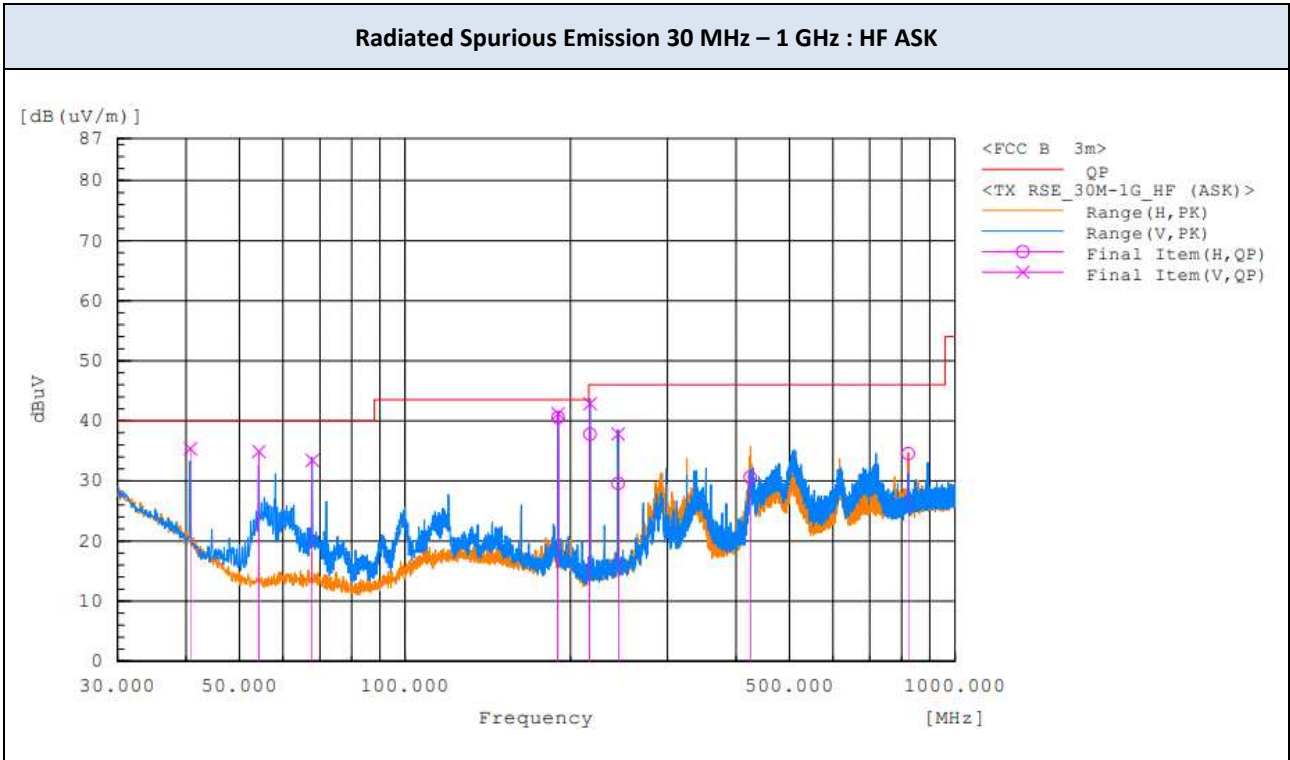
Notes:

1. Correction Factor: Antenna Factor + Cable loss

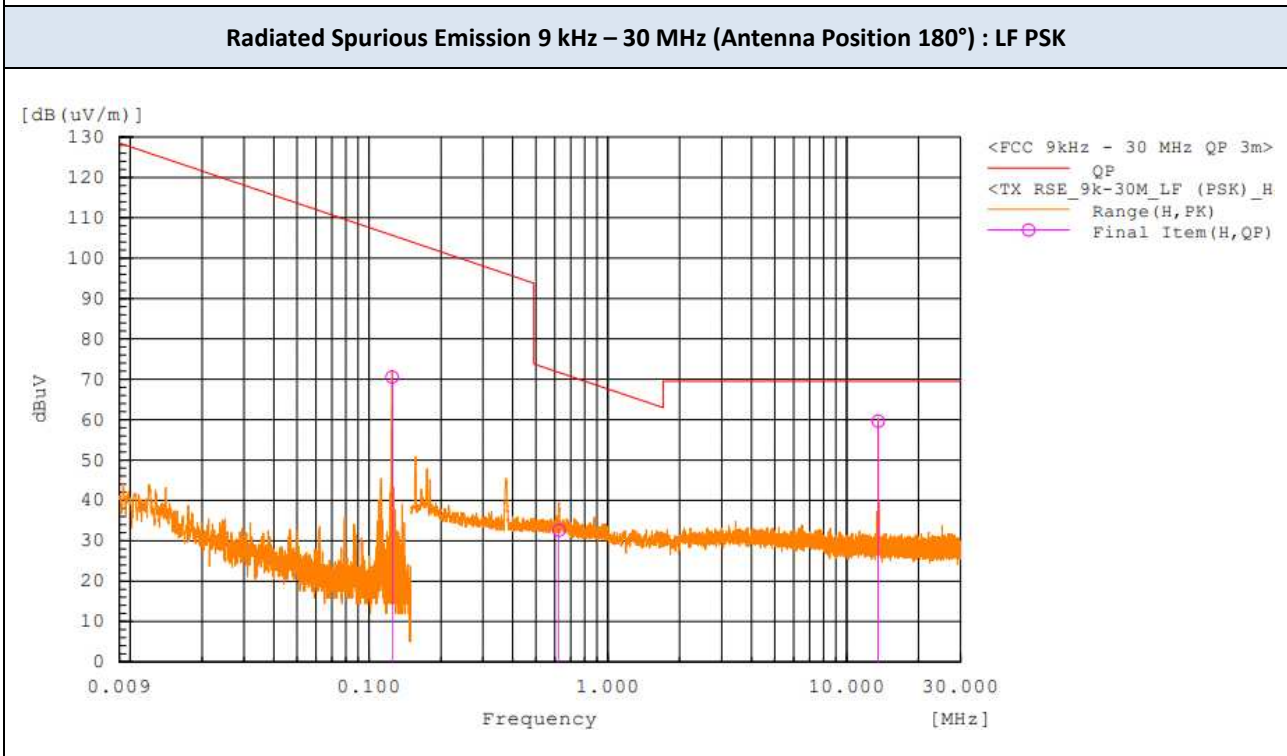
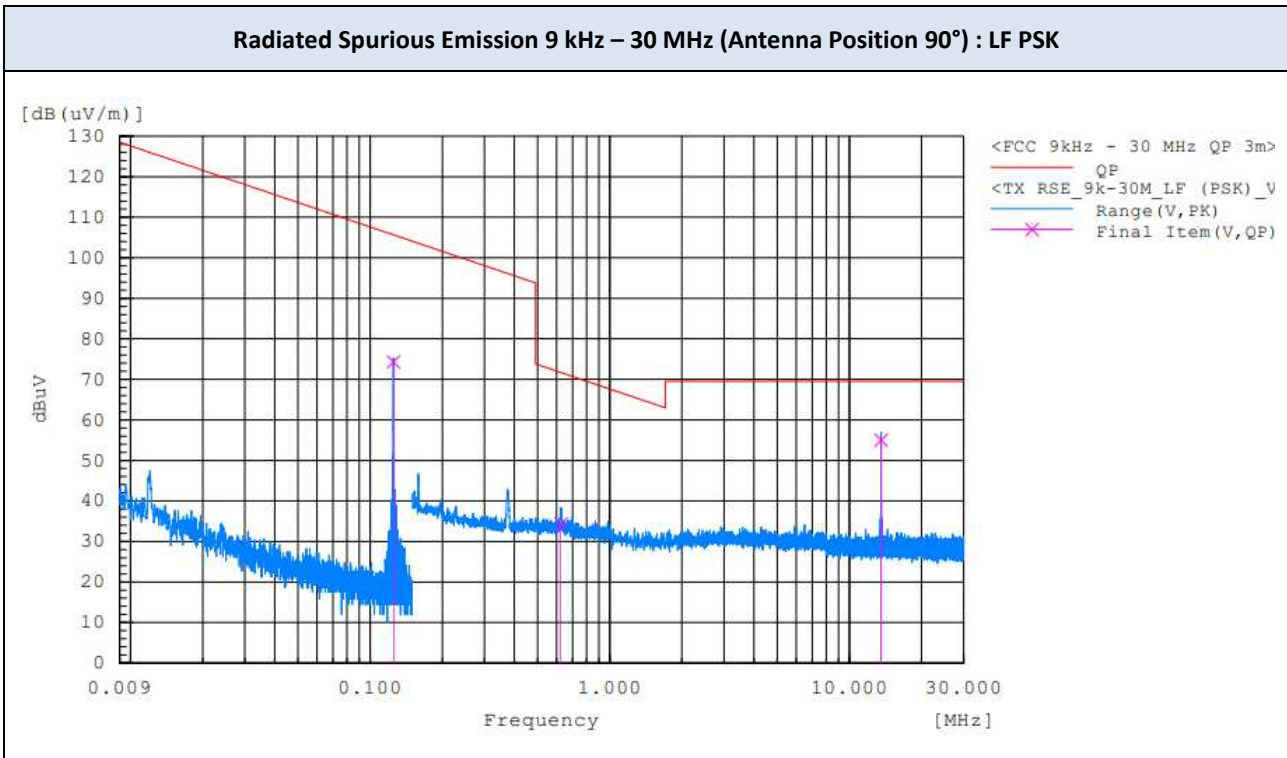
▣ TEST PLOTS



▣ TEST PLOTS



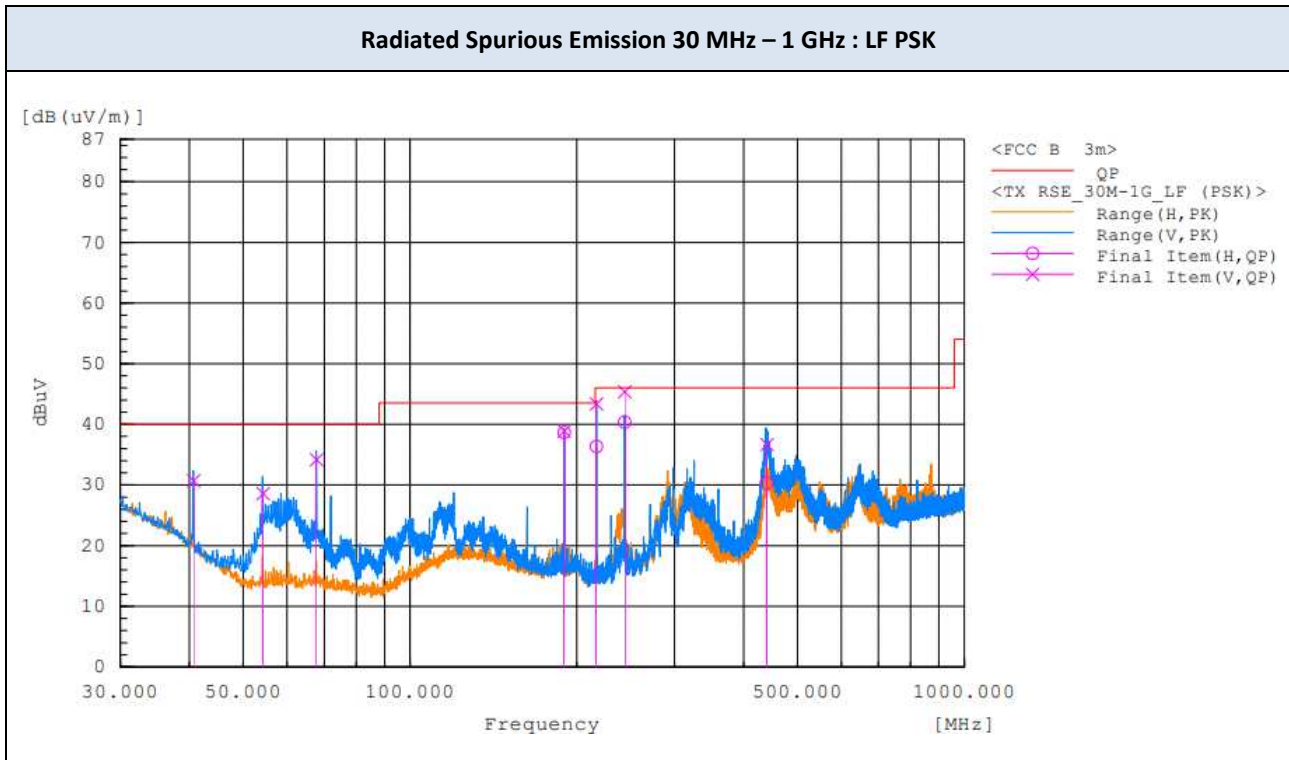
▣ TEST PLOTS



Notes:

The worst-case plots are included in this report.

▣ TEST PLOTS



Notes:

The worst-case plots are included in this report.

9.4. POWERLINE CONDUCTED EMISSIONS

AC Main : Device with antenna connected

| Frequency (MHz) | Line | Reading (dB μ V) | | Corr. ¹⁾ (dB) | Level (dB μ V) | | Limit (dB μ V) | | Margin (dB) | |
|-----------------|------|----------------------|------|--------------------------|--------------------|------|--------------------|------|-------------|------|
| | | QP | CAV | | QP | CAV | QP | CAV | QP | CAV |
| 0.173 | L1 | 35.0 | 21.7 | 9.7 | 44.7 | 31.4 | 64.8 | 54.8 | 20.1 | 23.4 |
| 0.151 | L1 | 38.0 | 21.6 | 9.7 | 47.7 | 31.3 | 66 | 56 | 18.3 | 24.7 |
| 2.976 | L1 | 6.6 | -0.2 | 9.8 | 16.4 | 9.6 | 56 | 46 | 39.6 | 36.4 |
| 0.569 | L1 | 18.1 | 9.3 | 9.6 | 27.7 | 18.9 | 56 | 46 | 28.3 | 27.1 |
| 13.187 | L1 | 14.8 | 3.8 | 10.1 | 24.9 | 13.9 | 60 | 50 | 35.1 | 36.1 |
| 15.729 | L1 | 14.4 | 9.7 | 10.2 | 24.6 | 19.9 | 60 | 50 | 35.4 | 30.1 |

| Frequency (MHz) | Line | Reading (dB μ V) | | Corr. ¹⁾ (dB) | Level (dB μ V) | | Limit (dB μ V) | | Margin (dB) | |
|-----------------|------|----------------------|------|--------------------------|--------------------|------|--------------------|------|-------------|------|
| | | QP | CAV | | QP | CAV | QP | CAV | QP | CAV |
| 0.174 | N | 35.3 | 22.7 | 9.7 | 45.0 | 32.4 | 64.8 | 54.8 | 19.8 | 22.4 |
| 0.151 | N | 37.1 | 22.0 | 9.7 | 46.8 | 31.7 | 65.9 | 55.9 | 19.1 | 24.2 |
| 0.748 | N | 8.1 | 3.1 | 9.7 | 17.8 | 12.8 | 56 | 46 | 38.2 | 33.2 |
| 0.568 | N | 25.1 | 20.0 | 9.6 | 34.7 | 29.6 | 56 | 46 | 21.3 | 16.4 |
| 15.510 | N | 14.7 | 10.1 | 10.1 | 24.8 | 20.2 | 60 | 50 | 35.2 | 29.8 |
| 27.120 | N | 17.3 | 13.7 | 10.4 | 27.7 | 24.1 | 60 | 50 | 32.3 | 25.9 |

Note :

1. Quasi-peak(Final Result) = Reading Value + Correction Factor

AC Main : Device with antenna terminated with dummy load

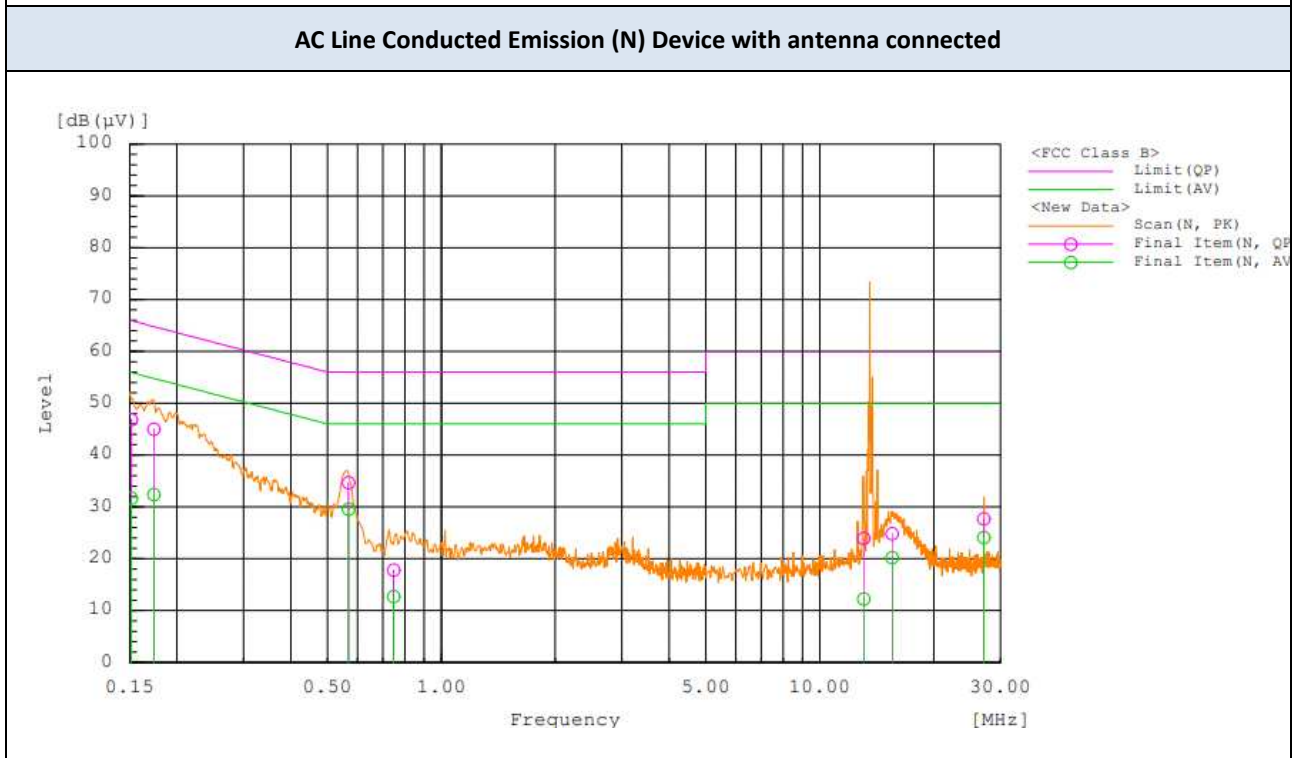
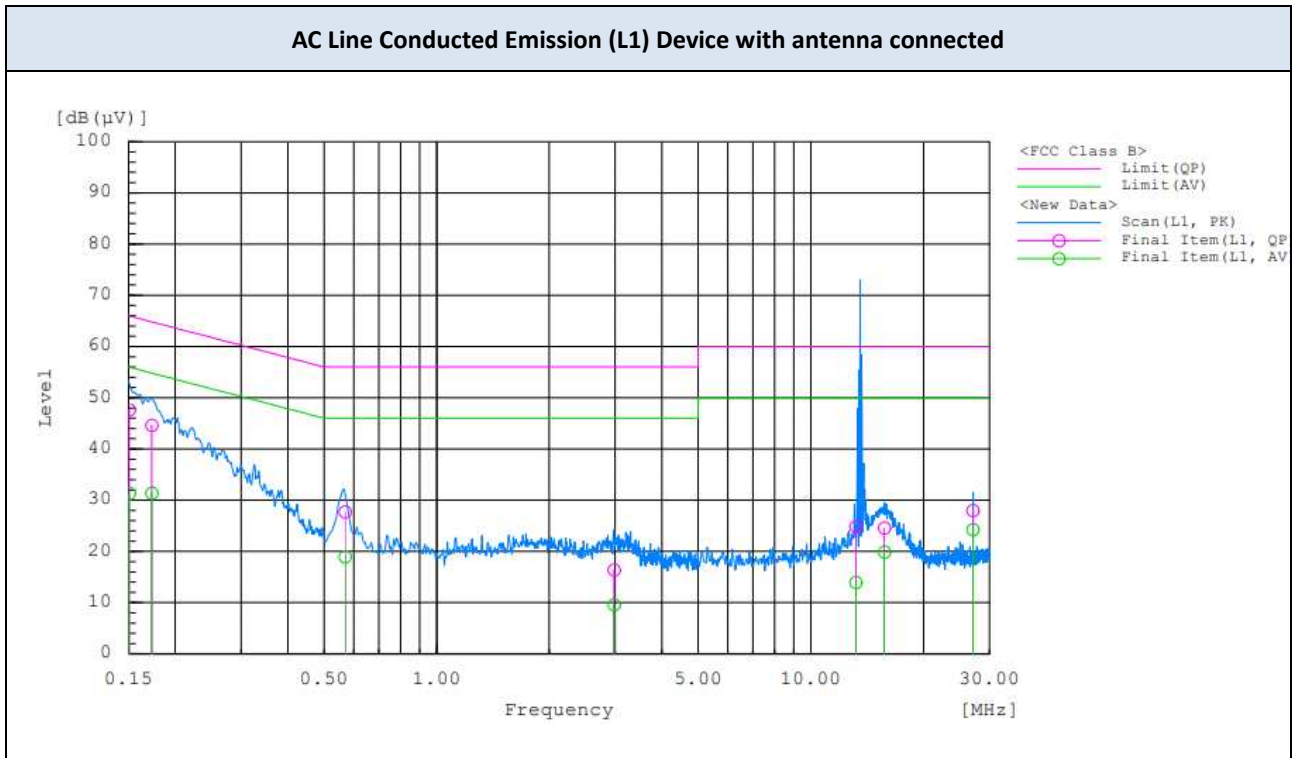
| Frequency (MHz) | Line | Reading (dB μ V) | | Corr. ¹⁾ (dB) | Level (dB μ V) | | Limit (dB μ V) | | Margin (dB) | |
|-----------------|------|----------------------|------|--------------------------|--------------------|------|--------------------|------|-------------|------|
| | | QP | CAV | | QP | CAV | QP | CAV | QP | CAV |
| 0.153 | L1 | 40.2 | 24.0 | 9.7 | 49.9 | 33.7 | 65.9 | 55.9 | 16.0 | 22.2 |
| 0.329 | L1 | 19.6 | 3.7 | 9.7 | 29.3 | 13.4 | 59.5 | 49.5 | 30.2 | 36.1 |
| 0.577 | L1 | 16.1 | 7.7 | 9.6 | 25.7 | 17.3 | 56 | 46 | 30.3 | 28.7 |
| 2.990 | L1 | 7.0 | 0.7 | 9.8 | 16.8 | 10.5 | 56 | 46 | 39.2 | 35.5 |
| 13.560 | L1 | 25.4 | 21.6 | 10.1 | 35.5 | 31.7 | 60 | 50 | 24.5 | 18.3 |
| 15.811 | L1 | 15.0 | 10.3 | 10.2 | 25.2 | 20.5 | 60 | 50 | 34.8 | 29.5 |

| Frequency (MHz) | Line | Reading (dB μ V) | | Corr. ¹⁾ (dB) | Level (dB μ V) | | Limit (dB μ V) | | Margin (dB) | |
|-----------------|------|----------------------|------|--------------------------|--------------------|------|--------------------|------|-------------|------|
| | | QP | CAV | | QP | CAV | QP | CAV | QP | CAV |
| 0.154 | N | 38.4 | 24.0 | 9.7 | 48.1 | 33.7 | 65.8 | 55.8 | 17.7 | 22.1 |
| 0.246 | N | 29.0 | 16.7 | 9.7 | 38.7 | 26.4 | 61.9 | 51.9 | 23.2 | 25.5 |
| 0.564 | N | 24.9 | 20.3 | 9.6 | 34.5 | 29.9 | 56 | 46 | 21.5 | 16.1 |
| 2.911 | N | 6.4 | -0.5 | 9.8 | 16.2 | 9.3 | 56 | 46 | 39.8 | 36.7 |
| 13.560 | N | 33.6 | 22.0 | 10.1 | 43.7 | 32.1 | 60 | 50 | 16.3 | 17.9 |
| 15.901 | N | 15.5 | 10.8 | 10.1 | 25.6 | 20.9 | 60 | 50 | 34.4 | 29.1 |

Note :

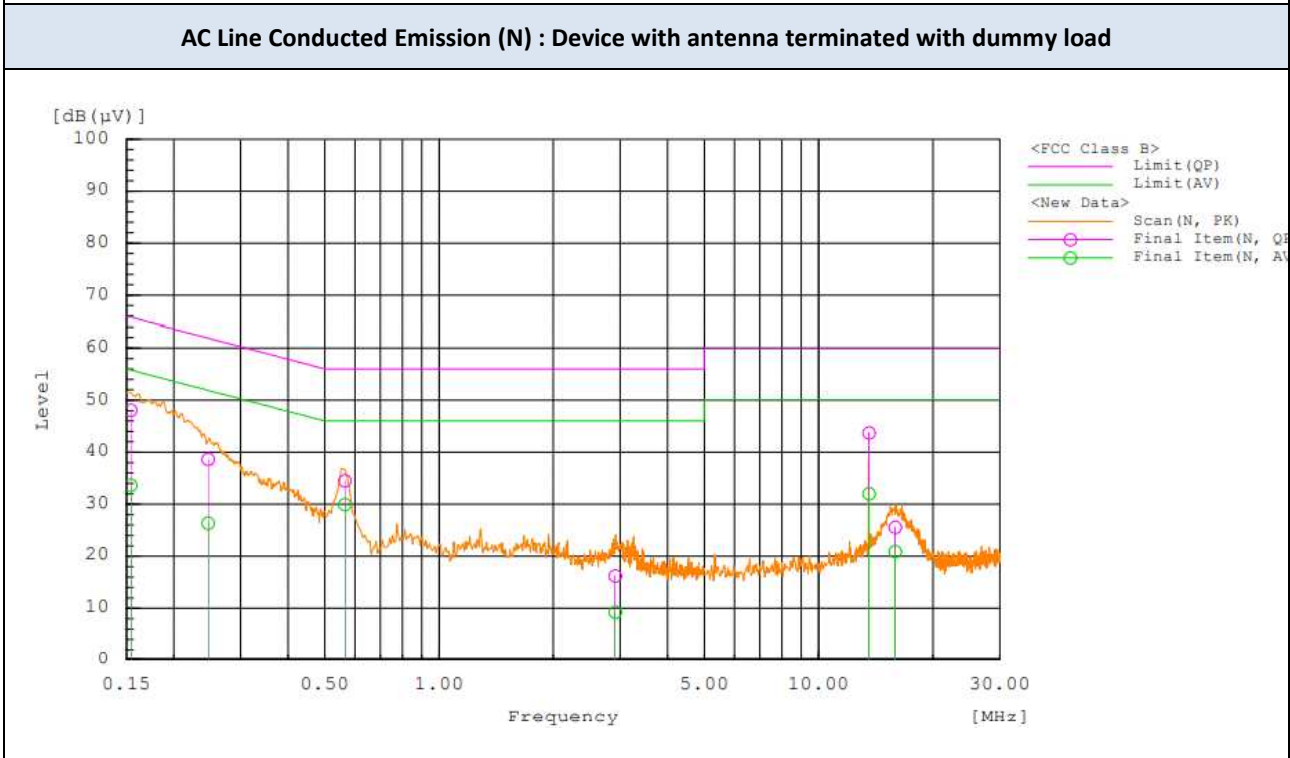
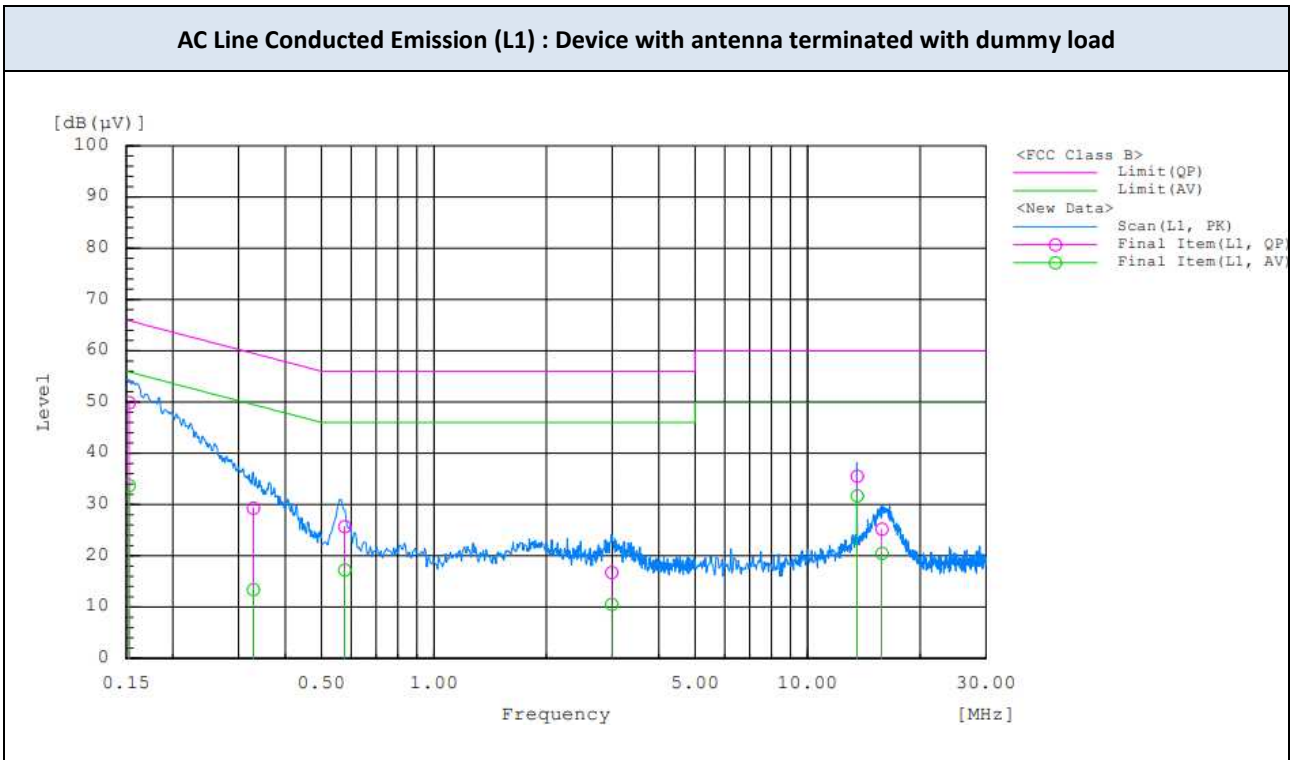
1. Quasi-peak(Final Result) = Reading Value + Correction Factor

▣ TEST PLOTS



Note :
Peak at 13.56 MHz is a fundamental frequency of HF.

▣ TEST PLOTS



10. LIST OF TEST EQUIPMENT

| No. | Instrument | Model No. | Calibration Due (mm/dd/yy) | Manufacture | Serial No. |
|-------------------------------------|---------------------------------------|-------------|----------------------------|-----------------|------------|
| <input checked="" type="checkbox"/> | Signal Analyzer (20 Hz ~ 40.0 GHz) | ESU40 | 12/03/2022 | Rohde & Schwarz | 100529 |
| <input checked="" type="checkbox"/> | Signal Analyzer (10 Hz - 40 GHz) | FSV | 02/16/2023 | Rohde & Schwarz | 101424 |
| <input checked="" type="checkbox"/> | Signal Analyzer (10 Hz ~ 26.5 GHz) | N9020A | 11/04/2022 | Keysight | MY52091291 |
| <input type="checkbox"/> | Attenuator (20 dB, DC ~ 26.5 GHz) | CFADC262002 | 01/13/2023 | CERNEX | - |
| <input type="checkbox"/> | Attenuator (10 dB, DC ~ 26.5 GHz) | CFADC261002 | 01/13/2023 | CERNEX | - |
| <input checked="" type="checkbox"/> | Loop Antenna (0.009 ~ 30 MHz) | HLA 6121 | 09/15/2023 | TESEQ | 43964 |
| <input checked="" type="checkbox"/> | BI-LOG Antenna (30 MHz ~ 1 GHz) | JB6 | 10/26/2022 | Sunol | A071116 |
| <input checked="" type="checkbox"/> | LNA (30 MHz ~ 1GHz) | PAM-103 | 04/14/2023 | Com-Power | 18020254 |
| <input checked="" type="checkbox"/> | EMI Test Receiver | ESR3 | 12/03/2022 | Rohde & Schwarz | 102363 |
| <input checked="" type="checkbox"/> | LISN | ENV216 | 01/19/2023 | Rohde & Schwarz | 101349 |
| <input checked="" type="checkbox"/> | Temp & Humidity Chamber | SH-641 | 06/14/2023 | ESPEC | 92002929 |

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date

APPENDIX A. TEST SETUP PHOTOS

The setup photos are provided as a separate document

APPENDIX B. PHOTOGRAPHS OF EUT

B.1. EXTERNAL PHOTOS

The external photos are provided as a separate document

B.2. INTERNAL PHOTOS

The internal photos are provided as a separate document

END OF TEST REPORT