Test Report – Products
Prüfbericht – Produkte

Test Report No.: *Prüfbericht-Nr.:*	**JP24PHIU 001**	**Order No.:** *Auftrags-Nr.:*	**150296509**	**Page 1 of 40** *Seite 1 von 40*
Client Reference No.: *Kunden-Referenz-Nr.:*	N/A	**Order Date:** *Auftragsdatum:*	2024-06-19	
Client: *Auftraggeber:*	Kyocera Document Solutions Inc. 2-28, 1-Chome, Tamatsukuri, Chuo-ku, Osaka 540-5858 Japan			
Test Item: *Prüfgegenstand:*	RFID Module			
Identification / Type No.: *Bezeichnung / Typ-Nr.:*	C2GA1485	**Serien-Nr.:** *Serial No.:*	0-4506	
Order Content: *Auftrags-Inhalt:*	Radio Testing			
Test Specification: *Prüfgrundlage:*	**Federal Communications Commission (FCC):** FCC 47 CFR Part 15, Subpart C, Section 15.225 ANSI C63.10-2013 **Innovation, Science and Economic Development Canada (ISED):** RSS-Gen:2018 (Issue 5): General Requirements for Compliance of Radio Apparatus RSS-210 (Issue 10): 2019+Amendment 1:2020: License-Exempt Radio Apparatus: Category I Equipment			
Date of Sample Receipt: *Wareneingangsdatum:*	2024-06-21			
Test Sample No.: *Prüfmuster-Nr.:*	A003750574			
Testing Period: *Prüfzeitraum:*	2024-06-25 to 2024-07-16			
Place of Testing: *Ort der Prüfung:*	Yokohama EMC Laboratory			
Testing Laboratory: *Prüflaboratorium:*	TÜV Rheinland Japan Ltd.			
Test Result*: *Prüfergebnis*:*	Pass			

compiled by: *zusammengestellt von:*		**authorized by:** *genehmigt von:*	
Date: 2024-08-06 *Datum:*	D. Watanuki	**Issue Date:** 2024-08-06 *Ausstellungsdatum:*	Pin Zhang
Position / *Stellung:*	Project Engineer	**Position** / *Stellung:*	Authorizer

Other / *Sonstiges:*

Condition of the test item at delivery: *Zustand des Prüfgegenstandes bei Anlieferung:*	Test item complete and undamaged *Prüfmuster vollständig und unbeschädigt*

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
** Legende:*	*P(ass) = entspricht o.g. Prüfgrundlage(n)*	*F(ail) = entspricht nicht o.g. Prüfgrundlage(n)*	*N/A = nicht anwendbar*	*N/T = nicht getestet*

REVISIONS

Report No.	Issue date	Changes / Remarks
JP24PHIU 001	2024-08-06	Original document

Remarks

1	The equipment used during the specified testing period was calibrated according to the test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of the laboratory's management system.
2	Unless otherwise specified by the applied standard(s), the decision rule used in this test report for statements of conformity based on numerical measurement results is the "Zero Guard Band"/"Simple Acceptance" rule in accordance with ILAC G8:2019 and IEC Guide 115:2021. When the "Zero Guard Band" rule is applied, measurement uncertainty is not taken in account. For additional information on the risk resulting from the application of the "Zero Guard Band" decision rule, refer to ILAC G8:2019.

Contents

1. General Remarks

1.1 Test Specifications

Table 1: Test Summary

Test	Specifications	Result
Radio: FCC 47 CFR Part 15, Subpart C, Section 15.225 RSS-Gen, RSS-210 (Issue 10): 2019+Amendment 1:2020 ANSI C63.10-2013		
Supply Voltage Requirements	FCC 15.31(e)	Pass
Antenna Requirements	FCC 15.203	Pass
Restricted Bands of Operation	FCC 15.205, RSS-Gen §8.10	Pass
20dB Bandwidth	FCC 15.215(c) and 15.225	Pass
99% Bandwidth	RSS-Gen §6.6	PERFORMED
Frequency Stability	FCC 15.225(e), RSS-Gen §6.11& 8.11, RSS-Gen §B.6	Pass
Field Strength of Fundamental	FCC 15.225(a)(b)(c), RSS-Gen §B.6(a)(b)(c)	Pass
Radiated Spurious Emissions of Transmitter	FCC 15.209, FCC 15.225(d), RSS-Gen §8.9 & 8.10, RSS-Gen §B.6(d)	Pass
AC Power Line Conducted Emission of Transmitter	FCC 15.207, RSS-Gen §8.8	Pass

1.2 Test Report Purpose

The purpose of this test report is to show compliance of the EUT (Equipment Under Test) with the requirements of the FCC & ISED rules listed in section 1.1 for original grant application. Also, the EUT is seeking Modular Approval in each regulations.

However, the EUT does not have own shield structure and DC regulator. Therefore, Limited Modular Approval (LMA) is applied under the condition that this is installed into a certain Multifunction Printer (MFP) series called "**TASKalfa**" as the specified host equipment.

The followings are the considerations to each items regarding LMA in KDB 996369 D01.

1. **§15.212(a) (1)(i): No RF shielding. A Class 2 or Class 3 Permissive Change (C2/3 PC) test plan for each specific host.**

   The EUT does not have own shield. The EUT is tested in stand-alone condition. Additionally, to demonstrate the EUT still complies with each specific host, the EUT is tested with being integrated into a representative MFP of TASKalfa series.

2. **§ 15.212 (a) (1& 2) (ii): No buffered modulation/data inputs. The Grantee must provide a test plan for the host integrator.**

   The EUT has own data buffer.

3. **§ 15.212(a) (1&2) (iii): No voltage regulation. The Grantee must provide a test plan for the host integrator.**

   See Item No.1.

4. **§ 15.212(a) (1 & 2) (iv): Host professional Antenna installation. When the host requires professional antenna installation, provide clear instructions for installation by an experienced professional installer.**

   There is no antenna which needs professional installation. All antennas are printed on PCB.

5. **§ 15.212(a)(1)(v): The module cannot be tested in a stand-alone configuration. Clear instructions that the module only applies to specific conditions the host provides, i.e., module host authentication and C2/3 PC are required for different hosts, etc. Details will vary case-by-case.**

   The EUT can be tested stand-alone basis. See Setup 2 of Figure 1: Block Diagram.

1.3 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The test facility is accredited according to ISO/IEC 17025:2005 by VLAC (member of ILAC) under number VLAC-017.

The test facility is recognized by the Federal Communications Commission (FCC) as a Conformity Assessment Body under designation number JP0017 and test firm registration number 386498.

The test site is registered by Innovation, Science and Economic Development Canada (ISED) under OATS filing number 3466B-1.The test facility is recognized by the Federal Communications Commission (FCC) as Accredited Testing Laboratory under designation number JP0017.

2.2 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
For Power Port Conducted Emission (CE)							
Path Loss Correction Factors for CE	-	-	-	RF-0597	1 year	2024-01-30	2025-01-30
Conducted Emission Measurement Software	Toyo Corporation	EP9/CE	Ver. 4.2.010	RF-0810	N/A	N/A	N/A
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2024-03-22	2025-03-22
LISN	Rohde & Schwarz	ENV216	100276	RF-0016	1 year	2024-05-21	2025-05-21
LISN	Rohde & Schwarz	ENV216	101958	RF-0708	1 year	2024-05-21	2025-05-21
For Radiated Emission (RE)							
Radiated Emission Measurement Software (below 30MHz)	Toyo Corporation	EP5/ME	Ver. 5.2.10	RF-0172	N/A	N/A	N/A
Radiated Emission Measurement Software (above 30MHz)	Toyo Corporation	EP7/RE	VER. 8.0.90	RF-0026	N/A	N/A	N/A
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2024-03-22	2025-03-22
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	N/A	N/A	N/A
Loop Antenna with Amplifier, 9kHz-30MHz	Rohde & Schwarz	HFH2-Z2	100139	RF-0048	1 year	2023-07-25	2024-07-25
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB 9168	9168-475	RF-0462	1 year	2024-05-09	2025-05-09
5dB Attenuator	Pasternack	PE7047-5	-	RF-0731	1 year	2024-05-22	2025-05-22
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	1 year	2023-12-27	2024-12-27
Low Pass Filter, DC-1GHz	R&K	LP1000CH3	12104001	RF-0515	1 year	2023-12-27	2024-12-27
For Frequency Stability							
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2024-03-22	2025-03-22
EMI Receiver	Rohde & Schwarz	ESW 44	103396	RF-1250	1 year	2024-05-22	2025-05-22
Temperature Chamber	Voetsch	VT 4018	58566025 090010	BT-8012	1 year	2024-06-29	2025-06-29
Loop Antenna, 9kHz-30MHz	Rohde & Schwarz	HFH2-Z2	100139	RF-0048	1 year	2023-07-25	2024-07-25

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
Constant Voltage Constant Frequency Stabilizers and Power Accessories							
CVCF (Shielded Room)	NF Corporation	ES2000S	9075612	RF-0210	1 year	2024-03-19	2025-03-19
CVCF Booster (Shielded Room)	NF Corporation	ES2000B	9074403	RF-0211	1 year	2024-03-19	2025-03-19
CVCF (10m Chamber)	NF Corporation	ES2000U	9067307	RF-0212	1 year	2024-03-19	2025-03-19
CVCF Booster (10m Chamber)	NF Corporation	ES2000B	9074408	RF-0213	1 year	2024-03-19	2025-03-19
True RMS Multimeter	Fluke	87V	97680445	RF-0281	1 year	2023-12-06	2024-12-06

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 3: Measurement Uncertainty

Measurement Type	Frequency Range	Uncertainty (k=2)
Conducted Emission on Power Ports	9 - 150kHz	±3.79dB
	150kHz - 30MHz	±3.31dB
Conducted Emission on Telecommunication Ports	150kHz - 30MHz (using ISN)	±3.87dB
	150kHz - 30MHz (using Current Probe)	±2.42dB
Radiated Emission up to 1GHz	30MHz - 1GHz (3m Distance)	±6.01dB (Vertical) ±4.91dB (Horizontal)
	30MHz - 1GHz (10m Distance)	±4.95dB (Vertical) ±4.94dB (Horizontal)
Radiated Emission above 1GHz	1 - 6GHz	±5.15dB
	6 - 18GHz	±5.09dB
	18 - 40GHz	±5.18dB

Note:

The measurement instrumentation uncertainty (MIU) was determined according to CISPR 16-4-2. All MIU values mentioned in the above table are smaller than the uncertainty budgets specified by CISPR 16-4-2, therefore compliance for all emission measurements is deemed to occur if no measured disturbance level exceeds the disturbance limit.

3. General Product Information

3.1 Product Function and Intended Use

The EUT (Equipment Under Test) is RFID reader-writer module intended to be integrated into printers for monitoring status of toner cartridges. The EUT has multi diversity antennas which don‘t work simultaneously.

3.2 Ratings and System Details

Radio standard:	ISO 15693
Frequency range:	13.56MHz
Antenna gain:	-53dBi
Antenna type:	Loop Antenna
Antenna mounting type:	Printed on PCB
Modulation type:	ASK
Number of channels:	1
Rated temperature:	-20 to +50°C
Rated voltage:	DC 3.3V
Rated input Power:	Not specified
Protection class:	III
Test voltage, frequency:	DC 3.3V(EUT), AC 120V, 60Hz(Host MFP)

3.3 Noise Generating and Noise Suppressing Parts

The highest frequency generated or used by the EUT is 13.56MHz, fundamental frequency of the transmitter.

3.4 Submitted Documents and Information

Following information provided in this test report has been submitted by the client:

- client name and address;
- EUT identification, ratings, system details, and description of product function and intended use;
- information related to noise generating and noise suppressing parts (if any).

4. Test Setup and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.225.

The test methods, which have been used, are based on ANSI C63.10 and RSS-Gen.

For details, see under each test item.

4.2 Operation Modes

Testing was performed at operating frequency 13.56MHz.

The basic operation mode used for testing is:

A. Continuously Reading data from tags at 13.56MHz
B. Un-modulated continuous carrier at 13.56MHz

Since this assessment shall consider two different configurations that are Stand-Alone and With a Specific Host, the following three setup configurations shall be taken for suitable test arrangements.

Configurations (Also see Figure 1: Block Diagram):

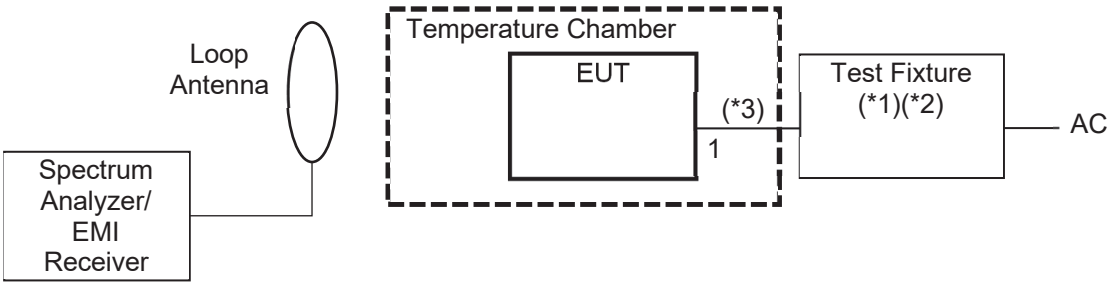
Conf1: Stand-alone with Setup 1
Conf2: Stand-alone with Setup 2
Conf3: Integrated in a specific host with Setup 3

4.3 Physical Configuration for Testing

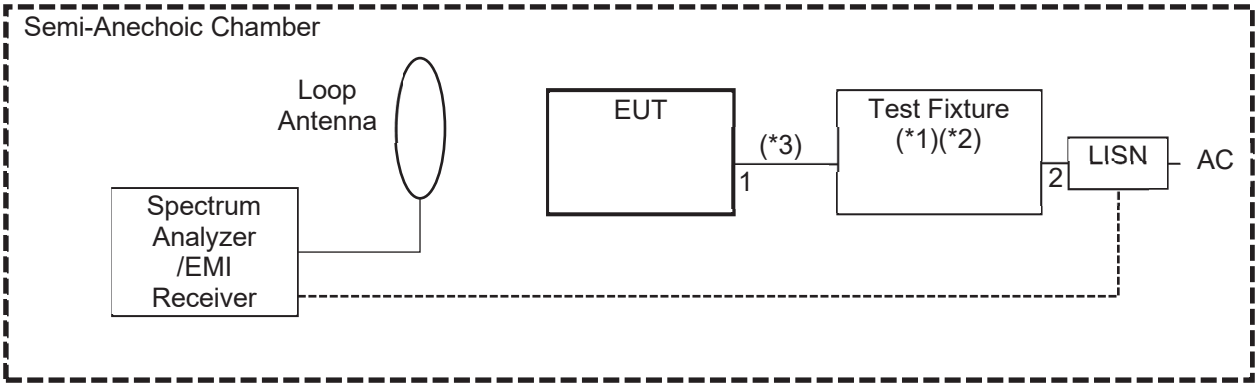
The test system was configured in a typical fashion (as a customer would normally use it). The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10.

Figure 1: Block Diagram

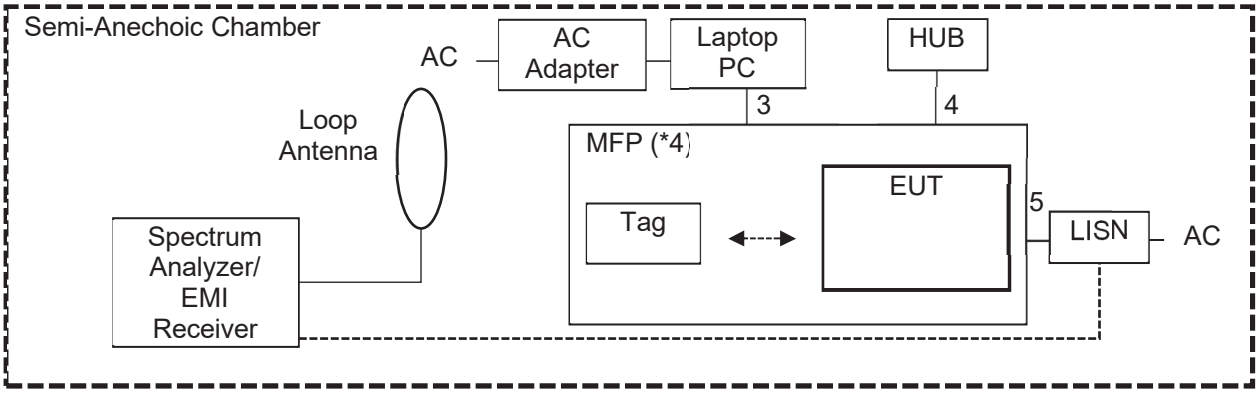
[Setup 1 for Frequency Stability Measurement]



[Setup 2 for Radiated Measurement and AC Power Line Conducted Emission] (Stand-Alone)



[Setup 3 for Radiated Measurement with a Specific Host]



Note: (*1) Test Fixture enables EUT to make continuous transmission mode, switching antenna.
(*2) Test Fixture feeds DC power to and control EUT for making test mode.
(*3) This cable is 4-wire flat cable containing DC and control signal lines
(*4) MFP is a representative model of the product series which integrate the EUT. (See Section 1.2)

Table 4: Interfaces present on the EUT and Test Fixture

No.	Interface(s):	Max. Cable Length, Shielding	Cable Classification
1.	4-wire Flat Cable	0.5 m, Un-shielded	Signal and DC Power Line
2.	AC Mains (Test Fixture)	2.0m, Un-shielded	AC Power Line

Table 5: Interfaces present on the host Multi-Function Printer(MFP)

No.	Interface(s):	Max. Cable Length, Shielding	Cable Classification
3.	USB	1.8m, shielded	Signal Line
4.	Ethernet (Cat. 6)	2.0m, Un-shielded	Telecommunication Line
5.	AC Mains (Host MFP)	2.5m, Un-shielded	AC Power Line

Note: For more details, refer to section: Photographs of the Test Set-Up.

4.4 Test Software

No special test software was used to operate the EUT. All operation was manually done by pushing buttons, turning dial on the test fixture or the host MFP.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. Product: MFP (TASKalfa Series)
   Manufacturer: Kyocera
   Model: TASKalfa MZ7001ci
   Rated Voltage: 120V ~
   Input Current: 16.0A
   Frequency: 60Hz
   Protection Class: I
   Serial Number: Engineering Sample

2. Product: Laptop PC
   Manufacturer: HP
   Model: 2ZA83AV
   Rated Voltage: DC 19.5V
   Input Current: 2.31A
   Protection Class: III
   Serial Number: JPH904DCLT

3. Product: AC adapter
   Manufacturer: HP
   Model: HSTNN-CA41
   Rated Voltage: AC 100-240V
   Input Current: 1.4A
   Frequency: 50-60Hz
   Protection Class: II
   Serial Number: WDVTN0CGC9X1YN

4. Product: USB Memory
   Manufacturer: Buffalo
   Model: RUF3-K32GA-WH/B
   Serial Number: P31005

5. Product: USB Memory
   Manufacturer: Buffalo
   Model: RUF3-K32GA-WH/B
   Serial Number: P31102

6. Product: Test Fixture
   Manufacturer: Kyocera
   Model: ---
   Serial Number: ---

Figure 2: Test Fixture

7. Product: HUB (Emission Testing more than 30MHz)
   Manufacturer: ELECOM
   Model: EHC-G08MN2-HJB
   Rated Voltage: AC 100-240V
   Frequency: 50/60Hz
   Protection Class: II
   Serial Number: 3BL097803974E

8. Product: HUB (Emission Testing less than 30MHz)
   Manufacturer: Allide Telesis
   Model: CenterCOM GS908XL
   Rated Voltage: AC100-240V
   Input Current: 0.2A
   Frequency: 50/60Hz
   Protection Class: I
   Serial Number: 007613G125000804 E1

4.6 Countermeasures to achieve Compliance

No additional measures were employed to achieve compliance.

5. Test Results RADIO

5.1 Technical Requirements

5.2 Supply Voltage Requirements

RESULT: **PASS**

Requirements:

FCC 15.31(e)

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Verdict:

The maximum carrier output field level for the EUT was measured between 85% and 115% of the nominal rated supply voltage. Hence it complies with the power supply requirements. See 5.3.4 Field Strength of Fundamental.

5.2.1 Antenna Requirements

RESULT: **PASS**

Requirements:

FCC 15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Verdict:

The EUT has an internal antenna which is not user accessible. Hence it complies with the antenna requirements.

5.2.2 Restricted Bands of Operation

RESULT: **PASS**

Requirements:

FCC 15.205 and RSS-Gen §8.10

Only spurious emissions are permitted in any of the restricted frequency bands, unless otherwise specified.

Verdict:

The EUT operation frequency range is 13.110-14.010MHz. Therefore only spurious emissions may be found in the restricted bands of operation and the EUT complies with the restricted frequency band requirement.

5.3 Radiated Measurements

5.3.1 20dB Bandwidth

RESULT: **PASS**

Date of testing:	2024-07-12
Ambient temperature:	23°C
Relative humidity:	59%
Atmospheric pressure:	999hPa
Operation Modes:	A, Conf 2
Test Voltage:	DC 3.3V

Requirements:

FCC 15.215(c) and 15.225

The 20dB bandwidth of the emission shall be contained within the frequency band designated in the rule section under which the equipment is operated.

Test procedure:

ANSI C63.10 §7.8.7.

The 20dB bandwidth was measured with a loop antenna connected to a spectrum analyzer using a peak detector with the following settings: RBW = 10Hz, VBW = 30Hz. Markers were placed at the lowest and highest intersections of the trace with a 20dBc line to obtain the value of the emission bandwidth.

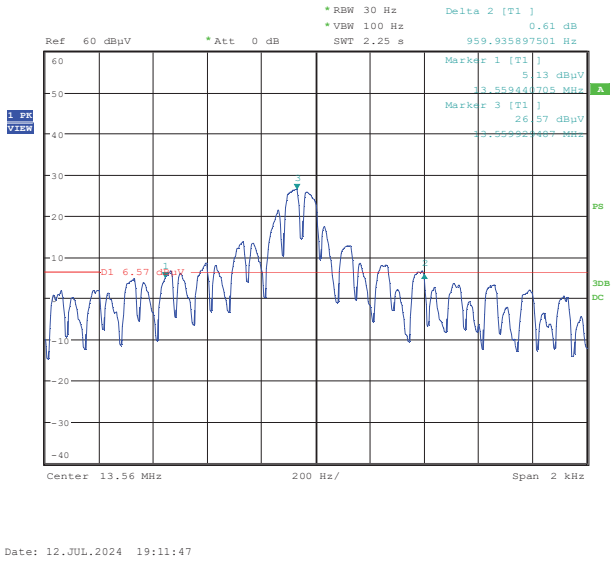
Table 6: 20dB Bandwidth Edge Frequencies, Mode A

20dB Bandwidth Edge Side	Operating Frequency [MHz]	Edge Frequency [MHz]	Limit [MHz]	Margin [MHz]
Lower Frequency	13.560	13.55944	13.11000	0.45
Higher Frequency		13.55993	14.01000	0.45

Table 7: 20dB Bandwidth, Mode A

Operating Frequency [MHz]	20dB Bandwidth [Hz]
13.56	488.8

Figure 3: 20dB Bandwidth, Mode A



5.3.2 99% Bandwidth

RESULT: **PERFORMED**

Date of testing:	2024-07-12
Ambient temperature:	23°C
Relative humidity:	59%
Atmospheric pressure:	999hPa
Operation Modes:	A, Conf1
Test Voltage:	DC 3.3V

Test procedure:

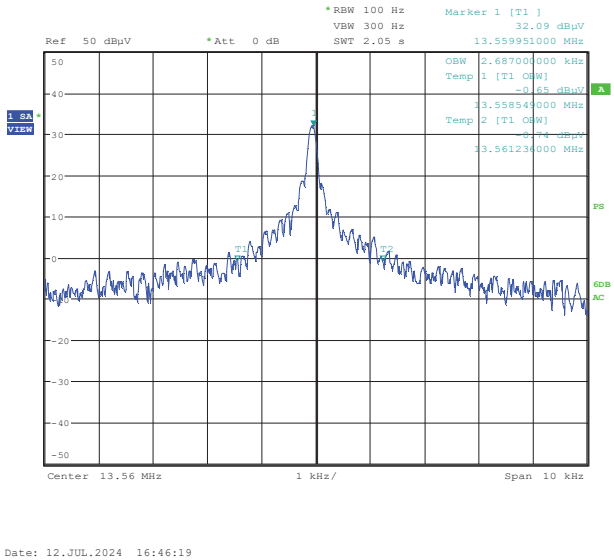
ANSI C63.10 §6.9.3 and RSS-Gen §6.6

The 99% bandwidth was measured with a spectrum analyzer using a peak detector. The value of the emission bandwidth was obtained by using the OBW function of the analyzer with a 99% coverage setting.

Table 8: 99% Bandwidth, Mode A

Operating Frequency [MHz]	99% Bandwidth [kHz]
13.56	2.69

Figure 4: 99% Bandwidth, Mode A



5.3.3 Frequency Stability

RESULT: **PASS**

Date of testing:	2024-06-25, 2024-06-26
Ambient temperature:	26, 26°C
Relative humidity:	53, 52%
Atmospheric pressure:	1002, 1006hPa
Temperature range:	-20 ~ 50°C
Operation Modes:	B, Conf1
Test Voltage:	DC 2.805, 3.300 and 3.795V

Requirements:

FCC 15.225(e)

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test procedure:

ANSI C63.10 §6.8 and RSS-Gen §6.11& 8.11, RSS-Gen §B.6

The EUT was place nide a temperature chamber and was set to produce an unmodulated carrier (Mode B).

The carrier frequency was measured with a loop antenna connected to a spectrum analyzer. Measurements were performed rom 50°C down to -20°C for every 10°C. For each temperature step, the measurements started after the temperature was sufficiently stabilized and were performed at start-up of the EUT, and then after 2, 5 and 10 minutes. The EUT was turned off during temperature changes.

The carrier frequency measurement was then performed at a temperature of 20°C for a variation of +/-15°% of the nominal input voltage.

Table 9: Frequency Stability at 50°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.560450	0.0033	+/-0.01%	Pass
2		13.559970	-0.0002		Pass
5		13.559940	-0.0004		Pass
10		13.560020	0.0001		Pass

Table 10: Frequency Stability at 40°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.560300	0.0022	+/-0.01%	Pass
2		13.560500	0.0037		Pass
5		13.560000	0.0000		Pass
10		13.559820	-0.0013		Pass

Table 11: Frequency Stability at 30°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.559670	-0.0024	+/-0.01%	Pass
2		13.559180	-0.0060		Pass
5		13.559760	-0.0018		Pass
10		13.560710	0.0052		Pass

Table 12: Frequency Stability at 20°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.560350	0.0026	+/-0.01%	Pass
2		13.559580	-0.0031		Pass
5		13.559920	-0.0006		Pass
10		13.559560	-0.0032		Pass

Table 13: Frequency Stability at 10°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.559510	-0.0036	+/-0.01%	Pass
2		13.559790	-0.0015		Pass
5		13.559230	-0.0057		Pass
10		13.560200	0.0015		Pass

Table 14: Frequency Stability at 0°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.559460	-0.0040	+/-0.01%	Pass
2		13.559940	-0.0004		Pass
5		13.559970	-0.0002		Pass
10		13.560680	0.0050		Pass

Table 15: Frequency Stability at -10°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.559460	-0.0040	+/-0.01%	Pass
2		13.559840	-0.0012		Pass
5		13.559710	-0.0021		Pass
10		13.559720	-0.0021		Pass

Table 16: Frequency Stability at -20°C, DC 3.3V

Elapsed Time [min]	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
Start-up	13.56	13.559790	-0.0015	+/-0.01%	Pass
2		13.559670	-0.0024		Pass
5		13.560250	0.0018		Pass
10		13.559430	-0.0042		Pass

Table 17: Frequency Stability with Supply Voltage Variation at 20°C

Supply Voltage	Nominal Frequency [MHz]	Measured Frequency [MHz]	Deviation [%]	Limit [%]	Result
DC 2.805V	13.56	13.559210	-0.0058	+/-0.01%	Pass
DC 3.300V		13.560350	0.0026		Pass
DC 3.795V		13.560320	0.0024		Pass

5.3.4 Field Strength of Fundamental

RESULT: **PASS**

Date of testing:	2024-07-11, 2024-07-12
Ambient temperature:	24, 23°C
Relative humidity:	49, 59%
Atmospheric pressure:	996, 999hPa
Frequency range:	13.110-14.010MHz
Measurement distance:	3m
Kind of test site:	Semi Anechoic Chamber
Operation Modes:	A, Conf2 & Conf3

Requirements:

FCC 15.225(a)(b)(c) and RSS-Gen §B.6(a)(b)(c)

The field strength of fundamental shall not exceed the level specified in FCC 15.225(a)(b)(c) and RSS-Gen §B.6(a)(b)(c).

Test procedure:

ANSI C63.10 §6.3 and 6.4

The EUT was placed on a nonconductive turntable whose height was 0.8m. The EUT was rotated 360° in order to determine the emission's maximum level.

Measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 6dB bandwidth set to 9kHz.

Two prechecks were performed. The one was to determine the worst antenna from 4 antennas (#1 ~ #4). The other was to determine the worst case setup from Conf2 & Conf3. The final measurement was performed for Antenna #1 and Conf2 as the worst condition.

Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the EUT, the associated cabling and the EUT orientation (X, Y, Z) were varied in order to ensure the maximum emission amplitudes were attained. The supplying voltage was additionally varied with +/-15% of the normal voltage (DC 2.805 ~ 3.795V) to achieve worst case conditions.

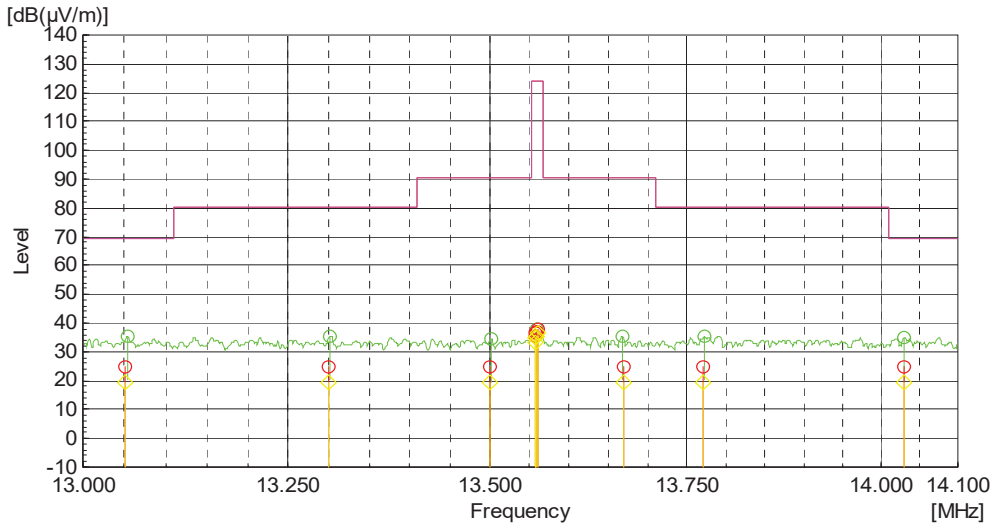
The highest emission amplitudes relative to the appropriate limit were recorded in this report. The field strength values taken at 3m measurement distance were recalculated for a 30m distance using a factor of 40dB/decade according to FCC 15.31(f) and RSS-Gen §6.4.

Table 18: Field Strength of Fundamental, Mode A, Conf2 (Stand-Alone)

Frequency [MHz]	Reading QP at 3m [dB(uV)]	Factor [dB(1/m)]	Level QP at 3m [dBuV/m]	Level QP at 30m [dBuV/m]	Limit QP at 30m [dBuV/m]	Margin QP [dB]	Angle [°]
13.05177	5.5	19.5	25.0	-15.0	69.5	29.5	147
13.29922	5.5	19.5	25.0	-15.0	80.5	40.5	330
13.49959	5.4	19.5	24.9	-15.1	90.5	50.5	256
13.55806	15.7	19.5	35.2	-4.8	124	84.0	142
13.55845	17.3	19.5	36.8	-3.2	124	84.0	142
13.56064	18.6	19.5	38.1	-1.9	124	84.0	142
13.67020	5.5	19.5	25.0	-15.0	90.5	50.5	235
13.77039	5.4	19.5	24.9	-15.1	80.5	40.5	177
14.02954	5.5	19.5	25.0	-15.0	69.5	29.5	136

Notes: Level QP at 3m = Reading QP at 3m + Factor
Level QP at 30m = Level QP at 3m - distance extrapolation factor for one decade
Distance extrapolation factor = 40dB/decade
Margin QP = Limit QP at 30m – Level QP at 30m

Figure 5: Field Strength of Fundamental, Spectral Diagram, Mode A, Conf2 (Stand-Alone)



Note: This spectral diagram is given for reference purpose only.

5.3.5 Radiated Spurious Emissions of Transmitter

RESULT: **PASS**

Date of testing:	2024-07-11, 2024-07-12
Ambient temperature:	24, 23°C
Relative humidity:	49, 59%
Atmospheric pressure:	996, 999hPa
Frequency range:	9kHz - 136MHz
Measurement distance:	3m
Kind of test site:	Semi Anechoic Chamber
Operation Modes:	A, Conf2 & Conf3

Requirements:

FCC 15.209, FCC 15.225(d), RSS-Gen §8.9 & 8.10, RSS-Gen §B.6(d).

Radiated emissions outside the band 13.110-14.010MHz must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen §8.9 & 8.10, RSS-Gen §B.6(d).

Test procedure:

The EUT was placed on a nonconductive turntable. The table height was 0.8m for measurements below 1GHz and 1.5m for measurements above 1GHz. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 9kHz to the 10th harmonic of the highest frequency generated by the EUT (136MHz). Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° in order to determine the emission's maximum level. For frequencies above 30MHz, the antenna was raised and lowered from 1 to 4m and measurements were taken using both horizontal and vertical antenna polarizations.

For emissions below 30MHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 6dB bandwidth set to 9kHz. For emissions between 30MHz and 1GHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 6dB bandwidth set to 120kHz. For emissions above 1GHz, measurements were performed with a spectrum analyzer using Peak and Average detector.

Absorbers have been placed on the floor between the EUT and the measuring antenna for testing above 1GHz.

Precheck was performed to determine the worst antenna from 4 antennas (Antenna #1 ~ #4). The final measurement was performed for Antenna #1 as the worst condition.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Emissions other than those mentioned are small or not detectable.

For measurements below 30MHz, the field strength values taken at 3m measurement distance were recalculated for a 30m distance using a factor of 40dB/decade according to FCC 15.31(f) and RSS-Gen §6.4.

Table 19: Radiated Emissions, Quasi Peak Data, 9kHz - 30MHz, Mode A, Conf2 (Stand-Alone)

Freq. [MHz]	EUT Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP at 3m [dBµV/m]	Level QP at 30m [dBµV/m]	Limit at 30m [dBµV/m]	Margin QP [dB]	Angle [°]
0.983	X	13.8	19.3	33.1	-6.9	27.8	34.7	355

Note: Level QP at 3m = Reading QP + Factor
Level QP at 30m = Level QP at 3m – distance extrapolation factor for one decade
Distance extrapolation factor = 40dB/decade
Margin QP =Limit QP at 30m – Level QP at 30m

Table 20: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A, Conf2 (Stand-Alone)

Freq. [MHz]	EUT/ANT Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
30.044	Y/V	53.5	-22.1	31.4	40.0	8.6	100	147
30.640	Z/V	54.1	-22.1	32.0	40.0	8.0	100	262
30.843	X/V	51.9	-22.0	29.9	40.0	10.1	101	143
41.292	X/V	55.9	-21.3	34.6	40.0	5.4	100	11
41.699	Z/V	53.6	-21.2	32.4	40.0	7.6	105	37
46.517	Y/H	46.5	-21.0	25.5	40.0	14.5	360	285
47.120	Z/V	55.8	-21.0	34.8	40.0	5.2	100	359
47.928	Y/V	54.2	-20.9	33.3	40.0	6.7	105	9
48.123	X/V	54.9	-20.9	34.0	40.0	6.0	100	309
48.725	Z/H	45.7	-20.9	24.8	40.0	15.2	400	272
62.397	Z/V	51.9	-21.6	30.3	40.0	9.7	105	259
62.589	Y/V	49.7	-21.6	28.1	40.0	11.9	101	201
64.597	X/V	50.5	-21.8	28.7	40.0	11.3	105	257
70.227	Y/V	46.8	-22.8	24.0	40.0	16.0	101	165
75.246	X/H	53.2	-24.0	29.2	40.0	10.8	304	135
76.053	Y/H	51.9	-24.3	27.6	40.0	12.4	288	143
76.662	Z/H	51.1	-24.4	26.7	40.0	13.3	284	147
82.683	X/H	52.7	-25.8	26.9	40.0	13.1	382	137
89.717	Z/V	51.0	-26.4	24.6	43.5	18.9	101	302
90.317	X/V	52.4	-26.4	26.0	43.5	17.5	144	303
90.928	Y/V	51.1	-26.4	24.7	43.5	18.8	100	216
103.383	Y/H	50.0	-24.6	25.4	43.5	18.1	194	140
113.223	X/H	45.2	-23.4	21.8	43.5	21.7	321	145
124.483	Z/H	39.3	-22.3	17.0	43.5	26.5	254	270

Note: Level QP = Reading QP + Factor

Table 21: Radiated Emissions, Quasi Peak Data, 9kHz - 30MHz, Mode A, Conf3 (with Host)

Freq. [MHz]	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP at 3m [dBµV/m]	Level QP at 30m [dBµV/m]	Limit at 30m [dBµV/m]	Margin QP [dB]	Angle [°]
0.527	26.2	19.3	45.9	5.9	33.2	27.3	181

Note: Level QP at 3m = Reading QP + Factor
Level QP at 30m = Level QP at 3m – distance extrapolation factor for one decade
Distance extrapolation factor = 40dB/decade
Margin QP =Limit QP at 30m – Level QP at 30m

Table 22: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A, Conf3 (with Host)

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
30.1	V	51.1	-22.1	29.0	40.0	11.0	105	162
34.5	V	48.5	-21.8	26.7	40.0	13.3	116	173
45.4	H	46.3	-21.0	25.3	40.0	14.7	400	259
86.0	V	53.3	-26.2	27.1	40.0	12.9	116	340
97.3	H	49.4	-25.6	23.8	43.5	19.7	251	35
125.0	V	58.8	-22.2	36.6	43.5	6.9	105	107
125.0	H	49.6	-22.2	27.4	43.5	16.1	296	7

Note: Level QP = Reading QP + Factor

5.4 AC Power Line Conducted Measurements

5.4.1 AC Power Line Conducted Emission of Transmitter

RESULT: **PASS**

Date of testing:	2024-07-16
Ambient temperature:	24°C
Relative humidity:	60%
Atmospheric pressure:	1013hPa
Frequency range:	0.15 - 30MHz
Kind of test site:	Shielded Room
Operation Modes:	A, Conf2 & Conf3

Requirements:

FCC 15.207

The AC power line conducted emission on any frequency within the band 150kHz to 30MHz shall not exceed the limits specified in FCC 15.207.

Test procedure:

ANSI C63.10 §6.2 and RSS-Gen §8.8

The EUT was placed on a wooden table raised 80cm above the reference ground plane. A vertical conducting plane of the screened room was located 40cm to the rear of the EUT. The EUT was connected to a Line Impedance Stabilization Network (LISN).

The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude and frequency in order to ensure that maximum emission amplitudes were attained.

The measurements were performed with a test receiver operating in the CISPR quasi-peak and average detection modes. The receiver’s 6dB bandwidth was set to 9kHz.

Precheck was performed to determine the worst antenna from 4 antennas (Antenna #1 ~ #4). The final measurement was performed for Antenna #1 as the worst condition.

Disturbances other than those mentioned are small or not detectable.

Figure 6: Conducted Emission on AC Mains Port, Spectral Diagram, 0.15 - 30MHz, Phase N (N), Mode A, Conf2 (Stand-Alone)

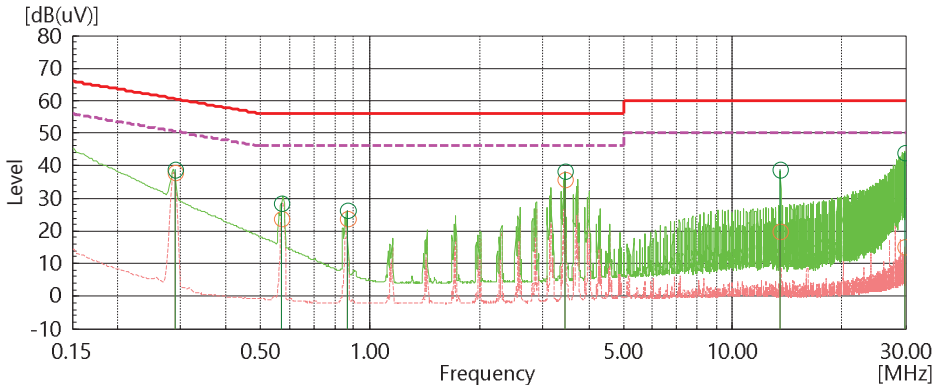


Figure 7: Conducted Emission on AC Mains Port, Spectral Diagram, 0.15 - 30MHz, Phase L1 (L), Mode A, Conf2 (Stand-Alone)

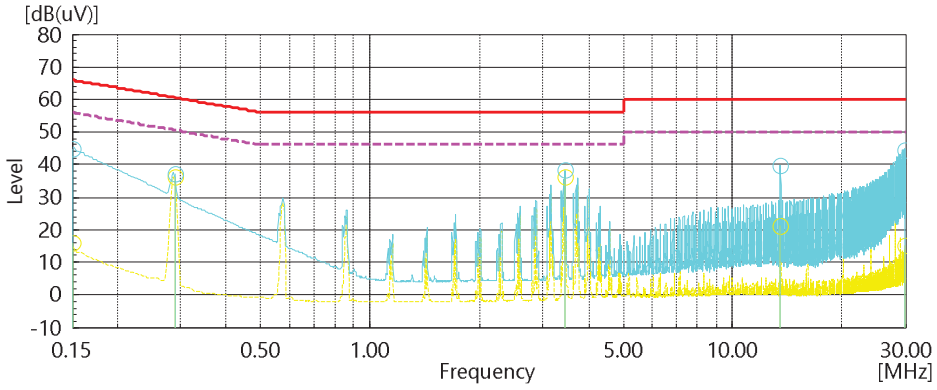


Table 23: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode A, Conf2 (Stand-Alone)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.150	L1	35.1	6.0	9.9	45.0	15.9	66.0	56.0	21.0	40.1
0.288	N	28.7	27.9	10.0	38.7	37.9	60.6	50.6	21.9	12.7
0.288	L1	27.3	26.2	10.0	37.3	36.2	60.6	50.6	23.3	14.4
0.569	N	18.2	13.7	10.2	28.4	23.9	56.0	46.0	27.6	22.1
0.864	N	16.2	13.9	10.1	26.3	24.0	56.0	46.0	29.7	22.0
3.456	L1	28.3	26.1	10.0	38.3	36.1	56.0	46.0	17.7	9.9
3.457	N	28.3	26.1	10.0	38.3	36.1	56.0	46.0	17.7	9.9
13.560	N	28.2	9.5	10.5	38.7	20.0	60.0	50.0	21.3	30.0
13.560	L1	29.3	10.6	10.5	39.8	21.1	60.0	50.0	20.2	28.9
29.829	L1	33.3	4.0	11.3	44.6	15.3	60.0	50.0	15.4	34.7
29.831	N	32.8	3.8	11.2	44.0	15.0	60.0	50.0	16.0	35.0

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

Figure 8: Conducted Emission on AC Mains Port, Spectral Diagram, 0.15 - 30MHz, Phase N (N), Mode A, Conf3 (with Host)

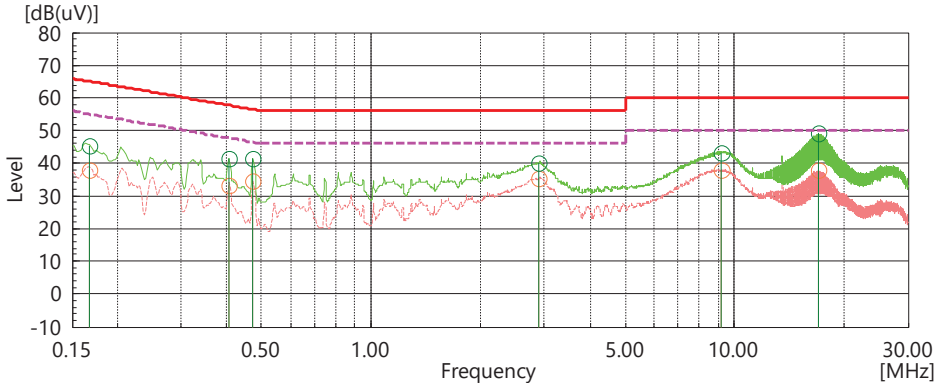


Figure 9: Conducted Emission on AC Mains Port, Spectral Diagram, 0.15 - 30MHz, Phase L1 (L), Mode A, Conf3 (with Host)

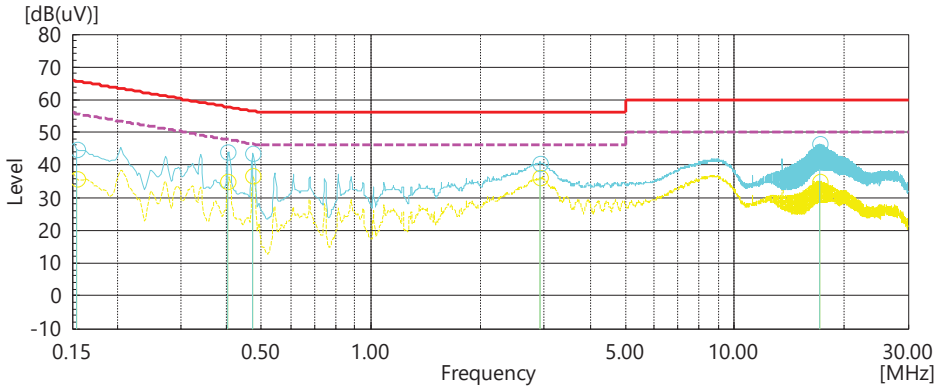


Table 24: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode A, Conf3 (with Host)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.155	L1	35.0	26.2	9.9	44.9	36.1	65.7	55.7	20.8	19.6
0.168	N	35.2	28.2	10.0	45.2	38.2	65.1	55.1	19.9	16.9
0.404	L1	33.8	24.9	10.2	44.0	35.1	57.8	47.8	13.8	12.7
0.405	N	31.4	23.3	10.2	41.6	33.5	57.8	47.8	16.2	14.3
0.473	N	31.1	24.5	10.2	41.3	34.7	56.5	46.5	15.2	11.8
0.474	L1	33.3	26.7	10.2	43.5	36.9	56.4	46.4	12.9	9.5
2.880	N	30.1	25.4	10.0	40.1	35.4	56.0	46.0	15.9	10.6
2.910	L1	30.8	26.1	10.0	40.8	36.1	56.0	46.0	15.2	9.9
9.207	N	33.1	27.6	10.3	43.4	37.9	60.0	50.0	16.6	12.1
17.058	N	38.6	27.2	10.6	49.2	37.8	60.0	50.0	10.8	12.2
17.126	L1	36.1	24.6	10.6	46.7	35.2	60.0	50.0	13.3	14.8

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

7. List of Tables

8. List of Figures

9. List of Photographs

– End of test report –