TEST REPORT

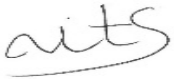
Applicant	JADAK, a business unit of Novanta Corporation
Address	7279 William Barry Blvd. N. Syracuse, New York, 13212, USA

FCC ID	2AAVI-M1MINI
ISED Canada IC	11355A-M1MINI
Product Description	13.56MHz RFID Module
PMN Model/HVIN	M1-MINI-EX M1-MINI-EX
Additional Models	None
Date of tests	Mar 11 – Mar 21, 2024
FCC Test Firm DN Canada CABID	US1028 US0106

The tests have been carried out according to the requirements of the following standard:

☒ **FCC Part 15, Subpart C, Section 15.225**
☒ **ISED Canada RSS-210 Issue 10 Annex B.6**

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Prepared by	Approved by
Yunus Faziloglu Sr. Wireless Engineer	Ahmed Ait Ahmed EMC Supervisor
	
Report Issue Date: May 8, 2024	Issue Number: 2

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RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
1	Original release	Apr 17, 2024
2	To address TCB review comments: - Modified Section 3.2 of the report to clarify the test setups - Removed incorrect references to REMI testing above 1GHz on Pg 9	May 8, 2024

1 SUMMARY OF TEST RESULTS

EUT was tested against the following requirements:

APPLIED STANDARD: FCC PART 15, SUBPART C (SECTION 15.225), RSS-210				
STANDARD SECTION		TEST TYPE AND LIMIT	APPLICABLE	RESULT
47 CFR	RSS			
15.207	Gen 8.8	AC Power Line Conducted Emissions	Y	PASS
15.205 15.209	Gen 8.9 Gen 8.10	Radiated Spurious Emissions	Y	PASS
15.225(a)	210 Annex B.6 (a)(i)	Fundamental Field Strength	Y	PASS
15.225(b)-(d)	210 Annex B.6 (a)(ii)-(iv)	Emission mask	Y	PASS
15.225(e)	210 Annex B.6 (b)	Frequency Tolerance	Y	PASS
--	Gen 6.7	99% Occupied Bandwidth	Y	PASS
15.203	Gen 6.8	Antenna Requirement	Y	PASS

2 MEASUREMENT UNCERTAINTY

The listed uncertainties are the worst-case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results. Values for measurement uncertainty are calculated per ETSI TR 100 028 (2001).

Measurement	Expanded Uncertainty k=2	Maximum allowable uncertainty
Radio frequency (@ 2.4GHz)	3.23×10^{-8}	1×10^{-7}
RF power, conducted	0.40dB	0.75dB
Maximum frequency deviation: Within 300Hz and 6kHz of audio frequency / Within 6kHz and 25kHz of audio frequency	3.4% 0.3dB	5% 3dB
Adjacent channel power	1.9dB	3dB
Conducted spurious emission of transmitter, valid up to 12.75GHz	2.39dB	3dB
Conducted emission of receivers	1.3dB	3dB
Radiated emission of transmitter, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of transmitter, valid up to 80GHz	3.3dB	6dB
Radiated emission of receiver, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of receiver, valid up to 80GHz	3.3dB	6dB
Humidity	2.37%	5%
Temperature	0.7°C	1.0°C
Time	4.1%	10%
RF Power Density, Conducted	0.4dB	3dB
DC and low frequency voltages	1.3%	3%
Voltage (AC, <10kHz)	1.3%	2%
Voltage (DC)	0.62%	1%
The above reflects a 95% confidence level		

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k = 2.

3 GENERAL INFORMATION

3.1 GENERAL DESCRIPTION OF EUT

NOMINAL VOLTAGE	3.3VDC
MODULATION TYPES	ASK
DATA RATES	26.48kbps
OPERATING FREQUENCY	13.56MHz
EUT Power Setting	Maximum (default)
FUNDAMENTAL FIELD STRENGTH	58.2dBuV/m at 3m
ANTENNA TYPE	External PCB trace loop antenna

EUT Ports:

Port Label	Port Type	No. of ports	No. Populated	Cable Type	Shielded	Ferrites	Length
Power and I/O on Carrier Board	Power and I/O	1	1	Copper Wire	No	No	2.7m

Lowest clock frequency in the device (used/generated): 13.56MHz

Highest clock frequency in the device (used/generated): 13.56MHz

NOTES:

1. For a more detailed description of the EUT, please refer to the manufacturer's specifications or the user's manual.
2. For photos of the EUT, please refer to External and Internal Photos exhibits.

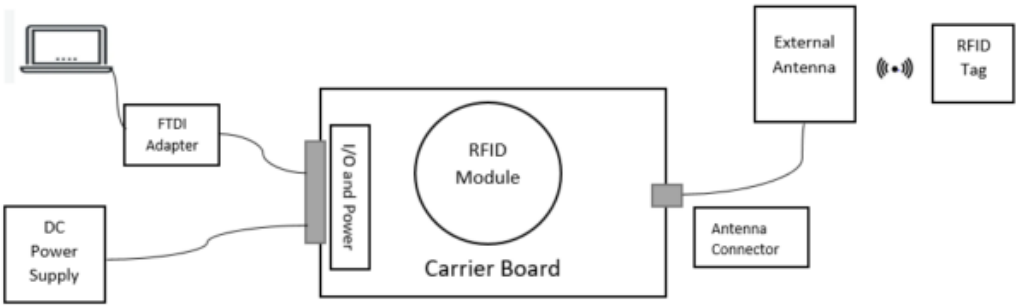
3.2 DESCRIPTION OF TEST MODES

EUT operates at a single channel at 13.56MHz. EUT was powered by a lab supplied AC to DC power supply. Customer supplied a support laptop and an FTDI adapter to activate and control the RFID.

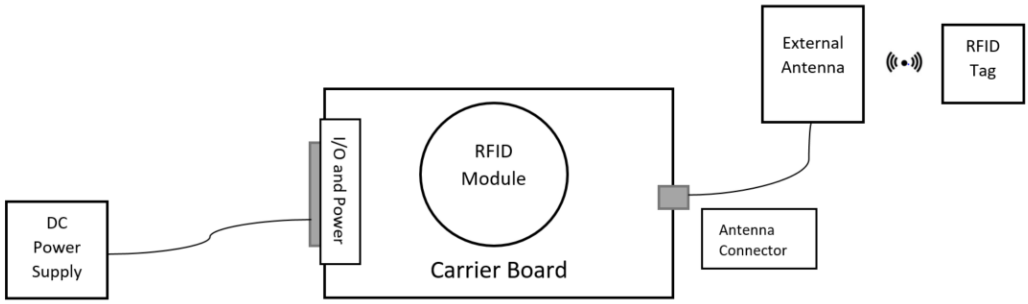
EUT configuration modes:

TEST MODE	DESCRIPTION
A	Continuous Transmit at 26.48kbps (Duty-cycle: 100%)

EUT SETUP BLOCK DIAGRAMS



Fundamental and 9kHz-30MHz Radiated Emissions Setup



30MHz-1GHz Radiated Emissions and AC Line Conducted Emissions Setup

Note: For radiated emissions testing, support laptop and FTDI adapter was removed from the EMI chamber after setting up the test mode in order to eliminate emissions from the support equipment. Same setup was used for AC Line Conducted Emissions testing as well.

Following channels/modes were selected for the applicable tests below.

TEST	TEST MODE	AVAILABLE CHANNELS	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)	Notes
FFS	A	1	1	ASK	26.48kbps	1
FT	A	1	1	ASK	26.48kbps	1
OBW	A	1	1	ASK	26.48kbps	1
RSE<1G	A	1	1	ASK	26.48kbps	1
PLCE	A	1	1	ASK	26.48kbps	1, 2

Note 1: RFID module and external antenna were maximized individually on 3 orthogonal axis (X, Y, Z). Worst case was found to be when the module was flat on the table and the external antenna was in upright position as seen in the test setup photos exhibit.
Note 2: Tested with both production antenna and termination.
FFS: Fundamental Field Strength
FT: Frequency Tolerance
OBW: 99% Occupied Bandwidth
RSE<1G: Radiated Spurious Emissions Below 1GHz
PLCE: Power Line Conducted Emissions

TEST CONDITIONS:

Environmental conditions during all testing can be seen in the corresponding data tables.

3.3 MEASUREMENT PROCEDURES USED

All tests were performed in accordance with the following measurement procedures:

ANSI C63.10-2013

RSS-Gen Issue 5

3.4 DESCRIPTION OF SUPPORT EQUIPMENT

Support Equipment	Model #	Serial #
Laptop	DELL Precision 5510	None
Lab DC Power Supply	HP E3612A	KR61304227

4 TEST RESULTS

4.1 AC LINE CONDUCTED EMISSIONS

4.1.1 LIMITS

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15 ~ 0.5	66 to 56	56 to 46
0.5 ~ 5	56	46
5 ~ 30	60	50

NOTE: 1. Lower limit applies at the transition frequencies.

2. Limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.1.2 TEST EQUIPMENT USED

Rev. 3/22/2024

Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Rental MXE EMI Receiver(1168255)	20Hz-8.4GHz	N9038A	Agilent	MY53290009	1168255	I	8/23/2024	8/23/2023
LISNs/Measurement Probes	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
LISN Asset 1726	150kHz-30MHz	LI-150A	Com-Power	201092	1726	I	1/17/2025	1/17/2024
LISN Asset 1727	150kHz-30MHz	LI-150A	Com-Power	201093	1727	I	1/17/2025	1/17/2024
Conducted Test Sites (Mains / Telco)	**FCC Code**		**VCCI Code**			**Cat**	**Calibration Due**	**Calibrated on**
CEMI 1	719150		A-0015			III	NA	N/A
Meteorological Meters/Chambers		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	12/15/2025	12/15/2022
Asset #2657		1235C97	Control Company	200435369	2657	I	8/18/2025	8/18/2022
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
CEMI-04	9kHz - 2GHz		C-S			II	2/14/2025	2/14/2024
Attenuators	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
20dB ATT(A#2507)	9kHz-2GHz	PE7014-20	Pasternack	2030	2507	II	10/18/2024	10/18/2023

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

4.1.3 TEST PROCEDURES

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

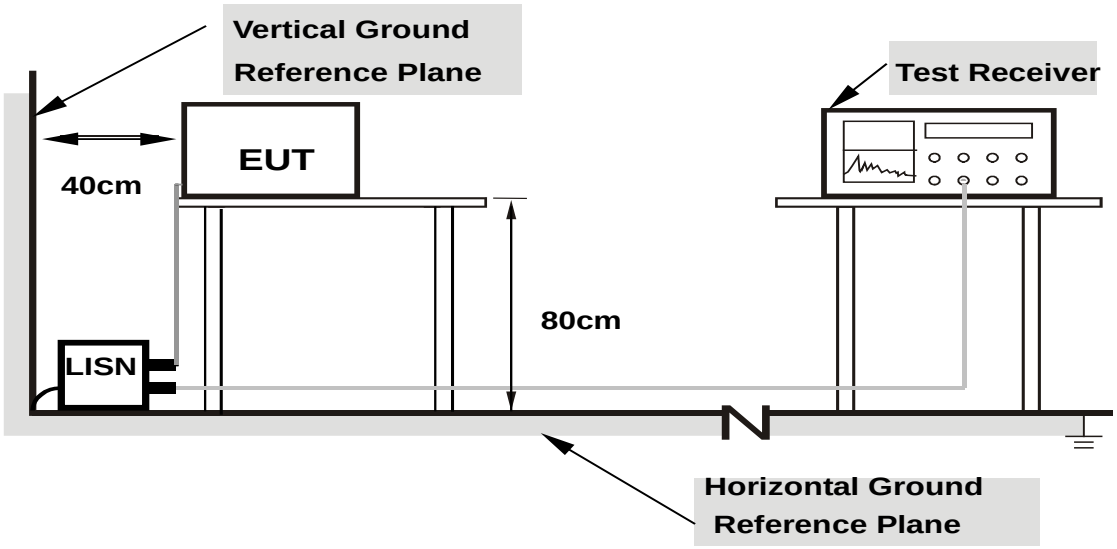
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) were not recorded. RBW of 9kHz and VBW of 30kHz were used during measurement.

4.1.4 DEVIATIONS

No deviations from the standard.

4.1.5 TEST SETUP



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

For the actual test configuration, please refer to Test Setup Photos exhibit.

4.1.6 EUT OPERATING CONDITIONS

EUT was operated according to manufacturer's specifications.

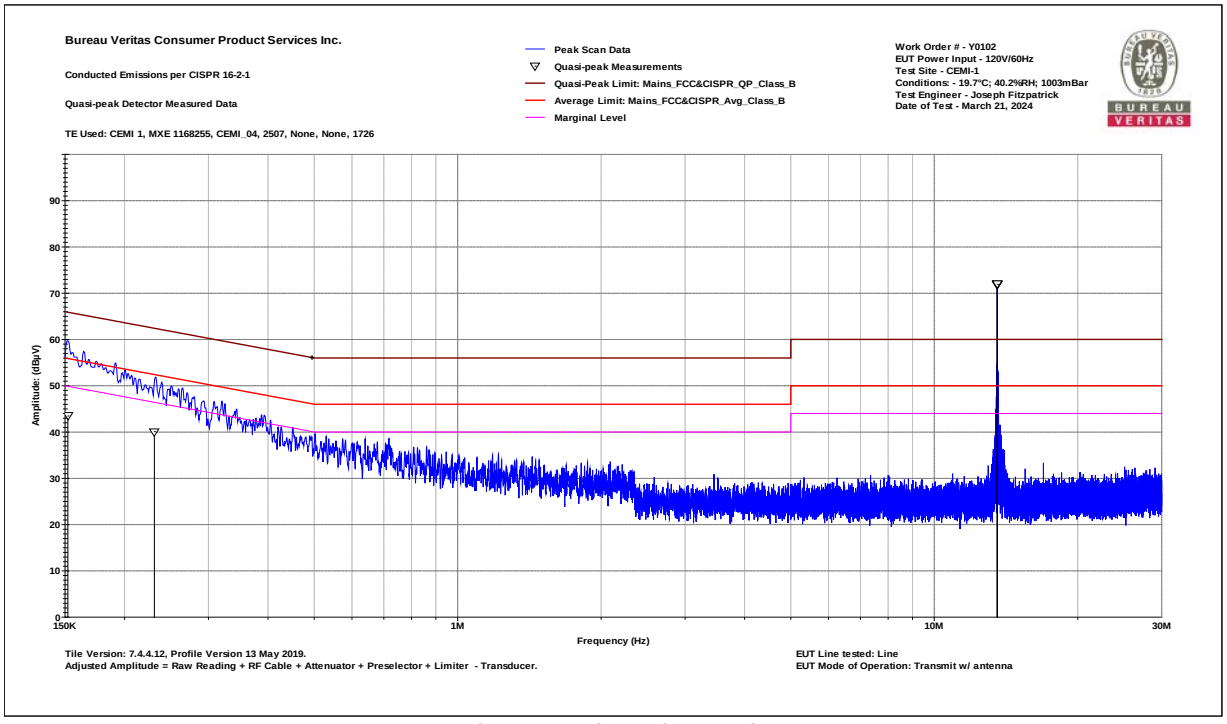
4.1.7 TEST RESULTS

EUT antenna in place

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120V/60Hz
Quasi-peak Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Line	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/ antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB)	Adjusted QP Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to QP Limit (dB)	QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.152	23.255	20.2	43.5	65.9	-22.4	PASS	
0.231	19.901	20.2	40.1	62.4	-22.3	PASS	-22.3
13.56	Fundamental						

Line Quasi Peak Table

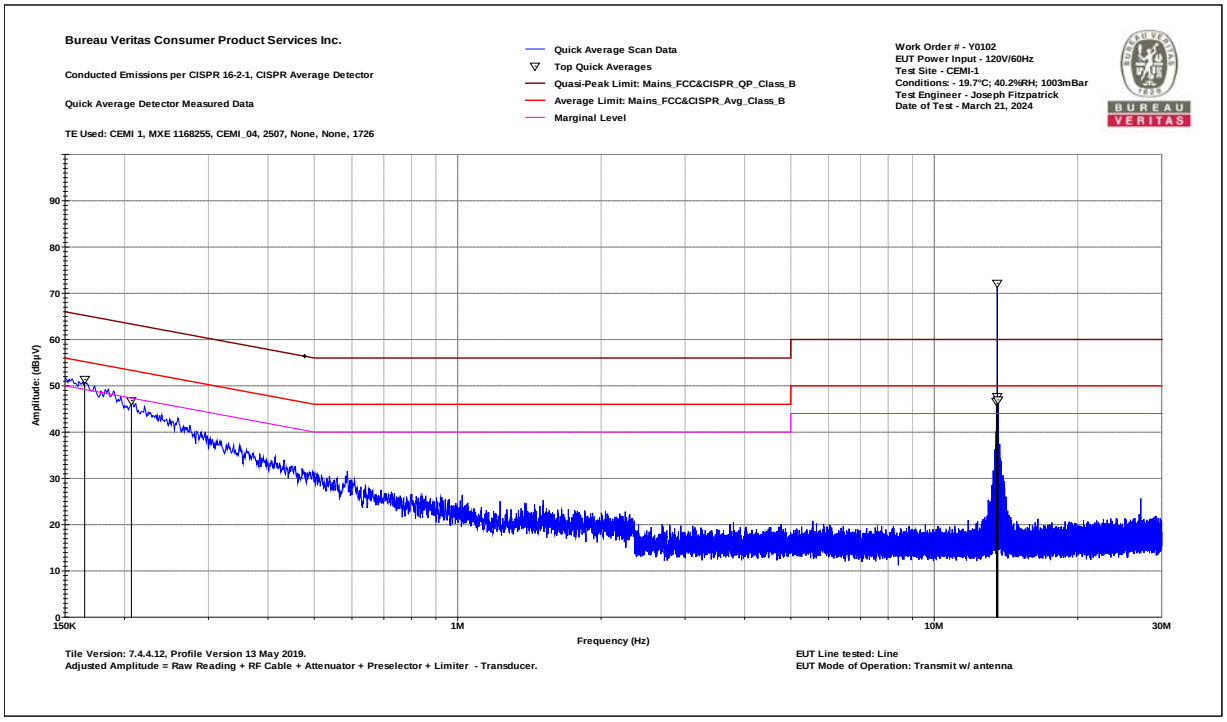


Line Quasi Peak Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120V/60Hz
Quick Average Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Line	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/ antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.165	31.1	20.2	51.3	55.2	-3.9	PASS	
0.207	26.6	20.2	46.8	53.3	-6.5	PASS	
13.507	26.2	20.4	46.6	50	-3.4	PASS	
13.533	27.3	20.4	47.7	50	-2.3	PASS	-2.3
13.56	Fundamental						
13.596	26.6	20.4	46.9	50	-3.1	PASS	

Line Average Table

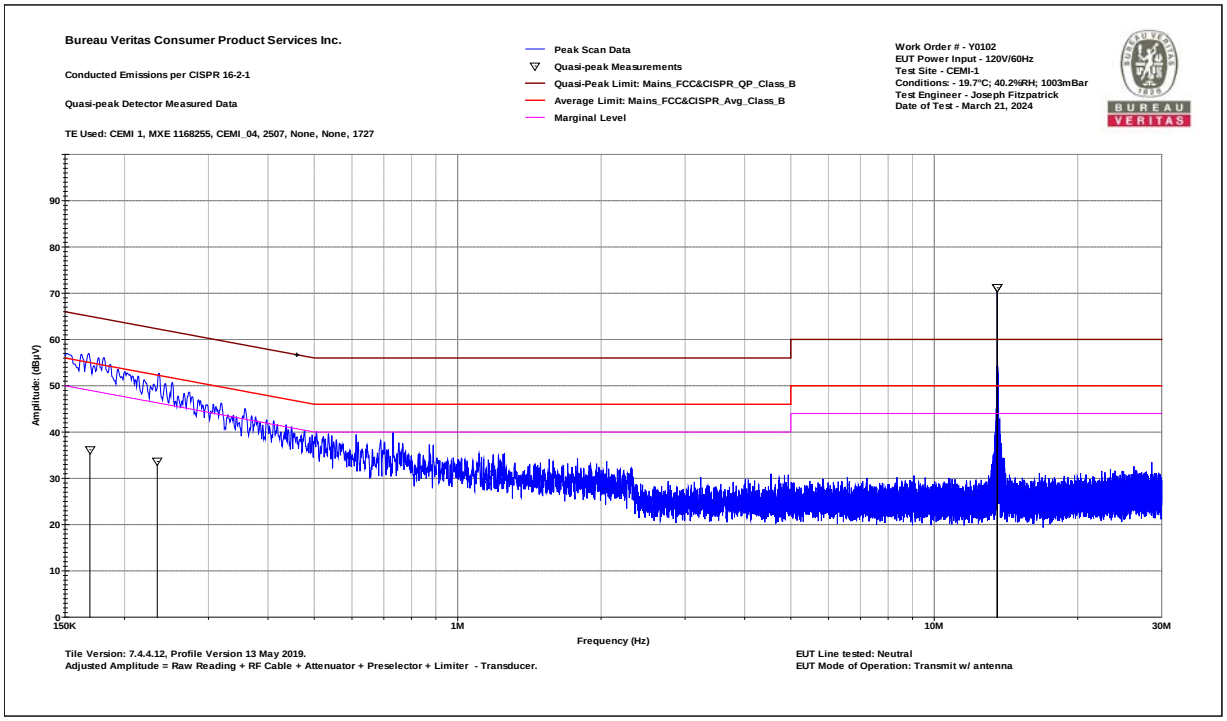


Line Average Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120V/60Hz
Quasi-peak Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Neutral	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/ antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB)	Adjusted QP Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to QP Limit (dB)	QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.169	16.008	20.2	36.2	65	-28.8	PASS	
0.234	13.465	20.1	33.6	62.3	-28.7	PASS	-28.7
13.56	Fundamental						

Neutral Quasi Peak Table

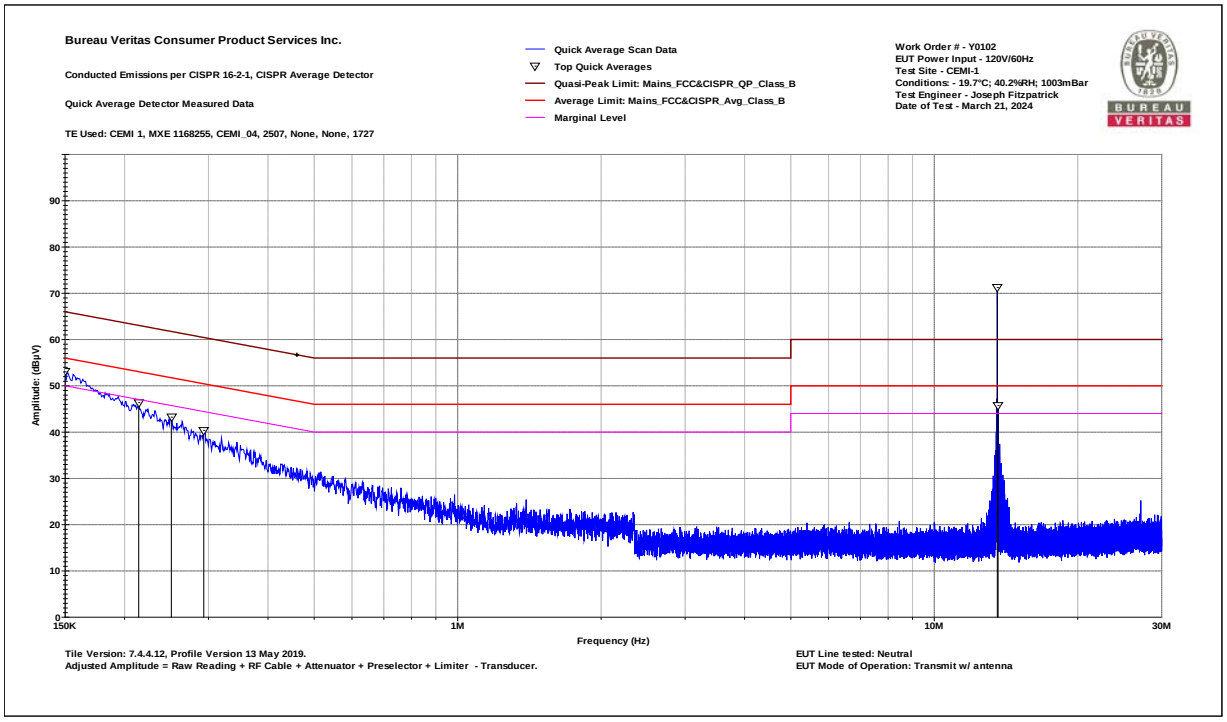


Neutral Quasi Peak Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120V/60Hz
Quick Average Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Neutral	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/ antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.15	32.9	20.2	53	56	-3	PASS	-3
0.214	26.2	20.2	46.4	53	-6.7	PASS	
0.251	23.1	20.1	43.2	51.7	-8.5	PASS	
0.293	20.2	20.1	40.4	50.4	-10.1	PASS	
13.559	Fundamental						
13.611	25.3	20.4	45.7	50	-4.3	PASS	

Neutral Average Table



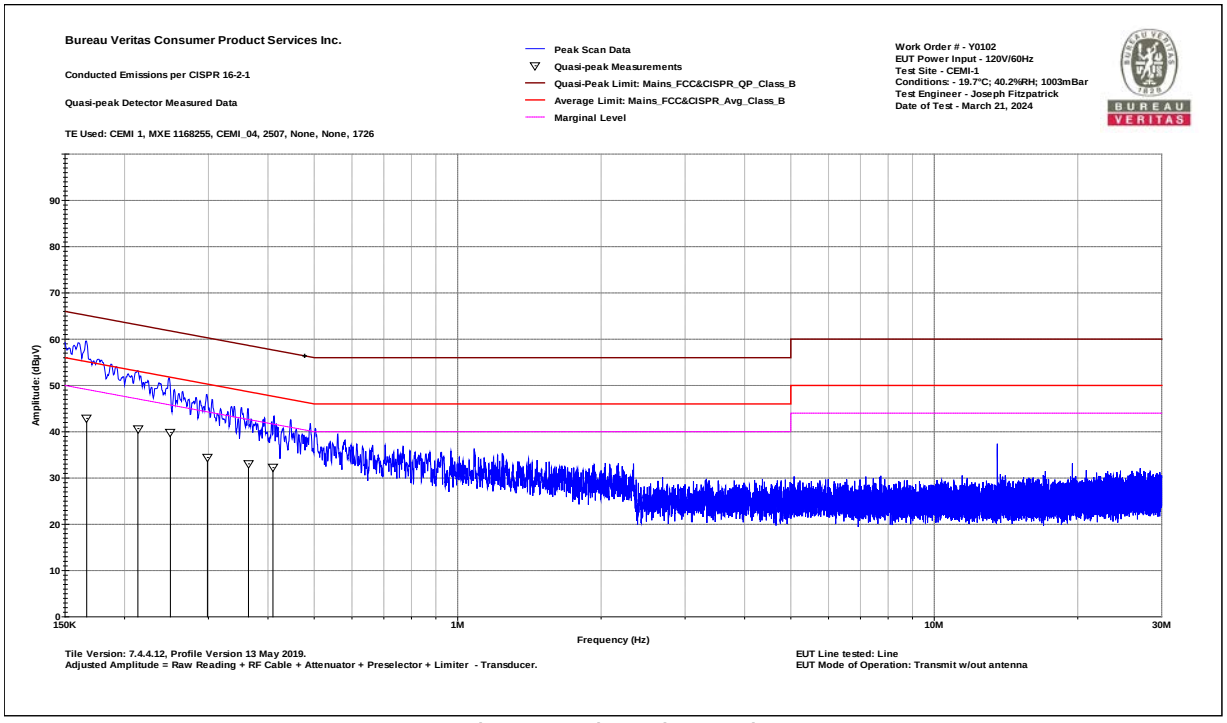
Neutral Average Graph

EUT antenna replaced with termination

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120V/60Hz
Quasi-peak Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Line	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/out antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB)	Adjusted QP Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to QP Limit (dB)	QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.167	22.662	20.2	42.9	65.1	-22.2	PASS	
0.213	20.482	20.2	40.7	63.1	-22.4	PASS	
0.25	19.699	20.2	39.9	61.8	-21.9	PASS	-21.9
0.299	14.242	20.2	34.4	60.3	-25.9	PASS	
0.364	12.898	20.2	33.1	58.6	-25.6	PASS	
0.41	12.074	20.2	32.2	57.7	-25.4	PASS	

Line Quasi Peak Table

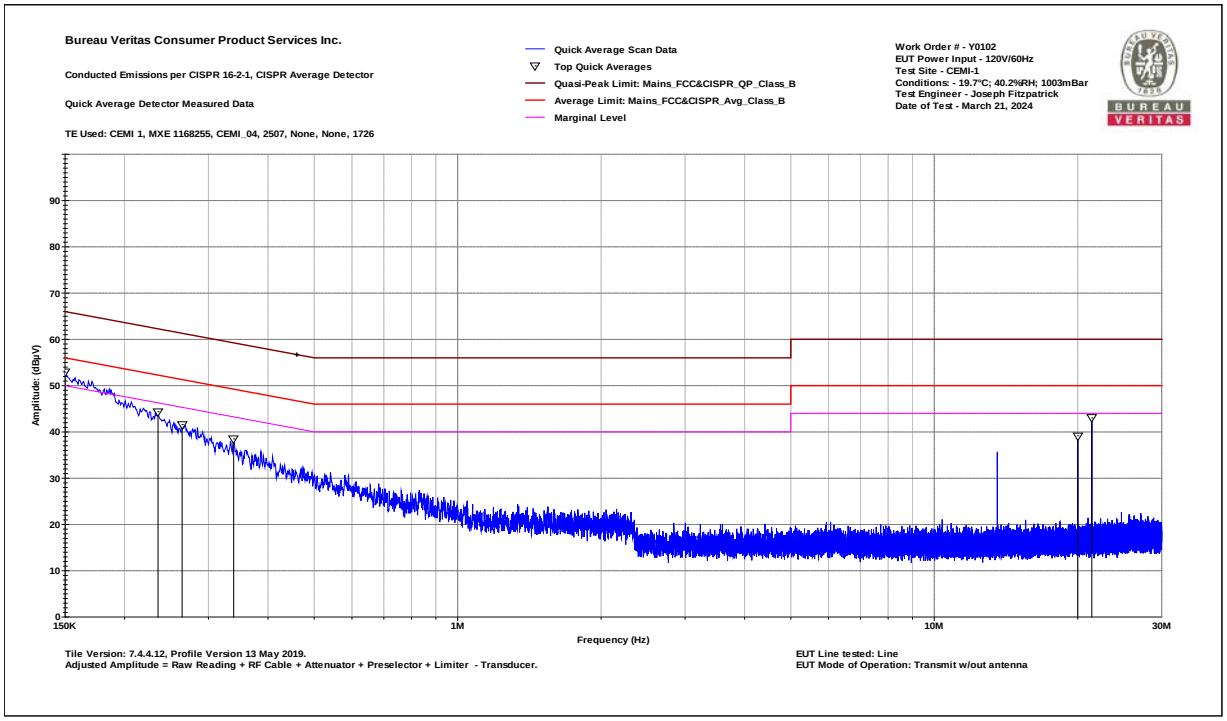


Line Quasi Peak Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120V/60Hz
Quick Average Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Line	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/out antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.15	32.7	20.2	52.9	56	-3.1	PASS	-3.1
0.235	24.2	20.2	44.3	52.3	-7.9	PASS	
0.264	21.4	20.2	41.6	51.3	-9.7	PASS	
0.339	18.3	20.1	38.5	49.2	-10.8	PASS	
19.996	18.7	20.4	39.1	50	-10.9	PASS	
21.401	22.6	20.4	43	50	-7	PASS	

Line Average Table

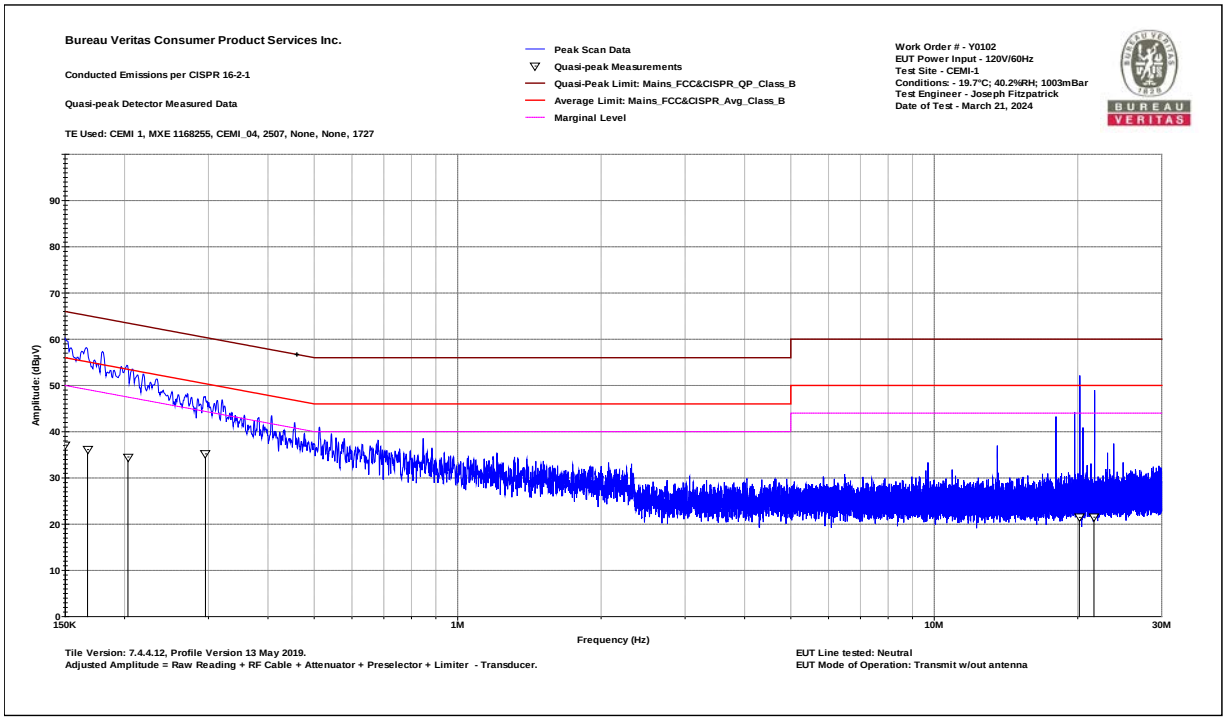


Line Average Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120V/60Hz
Quasi-peak Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Neutral	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/out antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB)	Adjusted QP Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to QP Limit (dB)	QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.15	16.906	20.2	37.1	66	-28.9	PASS	
0.167	15.935	20.2	36.1	65.1	-29	PASS	
0.203	14.354	20.2	34.5	63.5	-29	PASS	
0.296	15.035	20.1	35.2	60.4	-25.2	PASS	-25.2
20.151	1.013	20.4	21.5	60	-38.5	PASS	
21.63	1.074	20.4	21.5	60	-38.5	PASS	

Neutral Quasi Peak Table

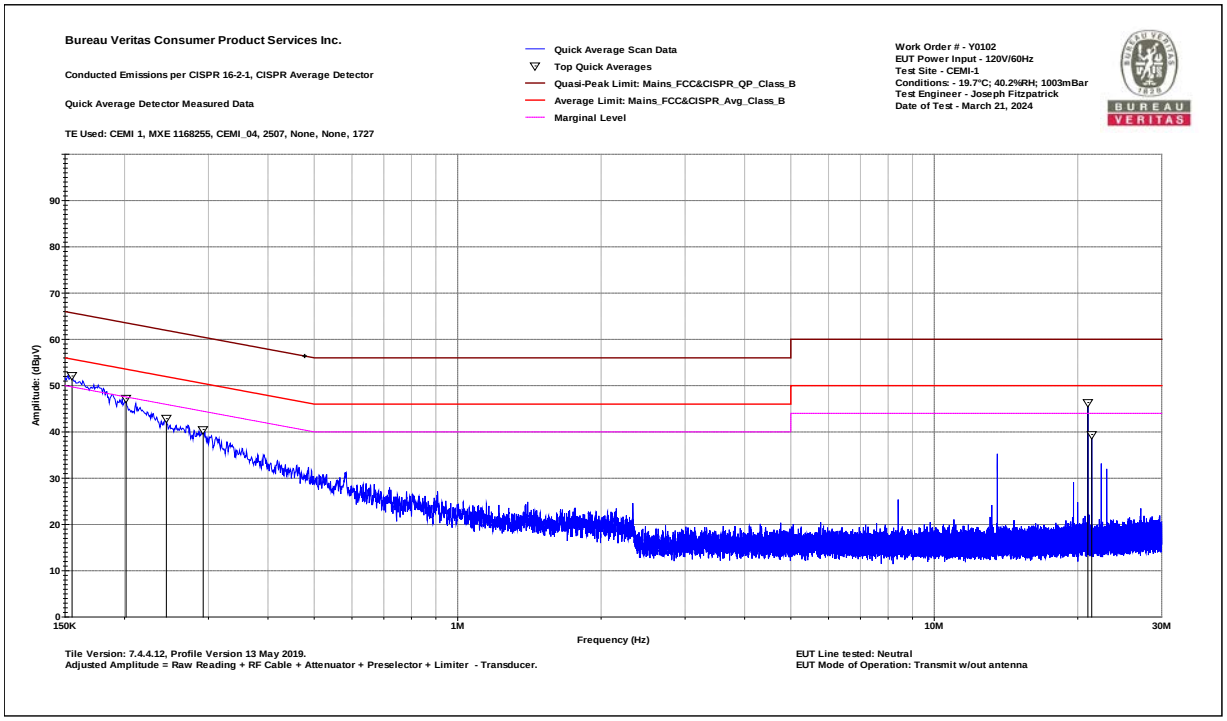


Neutral Quasi Peak Graph

Bureau Veritas Consumer Product Services Inc.	Work Order # - Y0102
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120V/60Hz
Quick Average Detector Data	Test Site - CEMI-1
Notes:	Conditions: - 19.7°C; 40.2%RH; 1003mBar
EUT Line tested: Neutral	Test Engineer - Joseph Fitzpatrick
EUT Mode of Operation: Transmit w/out antenna	Date of Test - March 21, 2024

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.155	31.9	20.2	52.1	55.7	-3.7	PASS	-3.7
0.201	27	20.2	47.2	53.5	-6.4	PASS	
0.245	22.7	20.1	42.8	51.9	-9.1	PASS	
0.293	20.4	20.1	40.5	50.5	-9.9	PASS	
20.997	25.9	20.4	46.3	50	-3.7	PASS	
21.394	19	20.4	39.4	50	-10.6	PASS	

Neutral Average Table



Neutral Average Graph

4.2 FUNDAMENTAL FIELD STRENGTH AND EMISSION MASK

4.2.1 LIMITS

Fundamental Field Strength:
The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

Emission Mask:
Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in FCC 15.209 and RSS-Gen.

Limit conversion below 30MHz is done by using the square of an inverse linear distance extrapolation factor (40 dB/decade) as allowed in FCC 15.31(f)(2).
Limit (3m) = Limit (30m) + 40*log(30/3) = Limit (30m) + 40
Limit (3m) = Limit (300m) + 40*log(300/3) = Limit (300m) + 80

4.2.2 TEST SETUP

Same as radiated spurious emissions setup below 30MHz (Section 4.3.5).

4.2.3 TEST EQUIPMENT USED

Same as Section 4.3.2.

4.2.4 TEST PROCEDURES

Same as Section 4.3.3.

4.2.5 DEVIATIONS

No deviations from the standard.

4.2.6 EUT OPERATING CONDITIONS

EUT was operated according to manufacturer’s specifications.

4.2.7 TEST RESULTS

Fundamental Data Table

Date: 11-Mar-24 **Company:** Jadak (a business unit of Novanta Corp.) **Work Order:** Y0102
Engineer: Ahmed Ahmed **EUT Desc:** M1-MINI-EX **EUT Operating Voltage/Frequency:** 3.3VDC
Temp: 23°C **Humidity:** 40% **Pressure:** 1010mBar

Frequency Range: 13.56MHz **Measurement Distance:** 3 m

Notes: Fundamental Peak Reading
Worst case orienation(Antenna & Module)

Antenna Polarization (0° - 90°)	Frequency (MHz)	Peak Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)		Adjusted Peak Reading (dBµV/m)	--- Limit (dBµV/m)	--- Margin (dB)	--- Result (Pass/Fail)	--- Limit (dBµV/m)	--- Margin (dB)	--- Result (Pass/Fail)
X (Module), X (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*34.5*	*29.0*	*38.6*	*0.2*	*---*	*44.3*	*124.0*	*-79.7*	*Pass*	---	---	---
Perpendicular	*13.56*	*44.8*	*29.0*	*38.6*	*0.2*	*---*	*54.6*	*124.0*	*-69.4*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*32.6*	*29.0*	*38.6*	*0.2*	*---*	*42.4*	*124.0*	*-81.6*	*Pass*	---	---	---
X (Module), Y (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*41.6*	*29.0*	*38.6*	*0.2*	*---*	*51.4*	*124.0*	*-72.6*	*Pass*	---	---	---
Perpendicular	*13.56*	*48.4*	*29.0*	*38.6*	*0.2*	*---*	*58.2*	*124.0*	*-65.8*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*34.6*	*29.0*	*38.6*	*0.2*	*---*	*44.4*	*124.0*	*-79.6*	*Pass*	---	---	---
X (Module), Z (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*41.1*	*29.0*	*38.6*	*0.2*	*---*	*50.9*	*124.0*	*-73.1*	*Pass*	---	---	---
Perpendicular	*13.56*	*46.3*	*29.0*	*38.6*	*0.2*	*---*	*56.1*	*124.0*	*-67.9*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*36.1*	*29.0*	*38.6*	*0.2*	*---*	*45.9*	*124.0*	*-78.1*	*Pass*	---	---	---
Y (Module), X (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*32.0*	*29.0*	*38.6*	*0.2*	*---*	*41.8*	*124.0*	*-82.2*	*Pass*	---	---	---
Perpendicular	*13.56*	*41.7*	*29.0*	*38.6*	*0.2*	*---*	*51.5*	*124.0*	*-72.5*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*32.6*	*29.0*	*38.6*	*0.2*	*---*	*42.4*	*124.0*	*-81.6*	*Pass*	---	---	---
Y (Module), Y (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*39.8*	*29.0*	*38.6*	*0.2*	*---*	*49.6*	*124.0*	*-74.4*	*Pass*	---	---	---
Perpendicular	*13.56*	*46.6*	*29.0*	*38.6*	*0.2*	*---*	*56.4*	*124.0*	*-67.6*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*33.6*	*29.0*	*38.6*	*0.2*	*---*	*43.4*	*124.0*	*-80.6*	*Pass*	---	---	---
Y (Module), Z (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*40.4*	*29.0*	*38.6*	*0.2*	*---*	*50.2*	*124.0*	*-73.8*	*Pass*	---	---	---
Perpendicular	*13.56*	*46.1*	*29.0*	*38.6*	*0.2*	*---*	*55.9*	*124.0*	*-68.1*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*35.5*	*29.0*	*38.6*	*0.2*	*---*	*45.3*	*124.0*	*-78.7*	*Pass*	---	---	---
Z (Module), X (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*34.4*	*29.0*	*38.6*	*0.2*	*---*	*44.2*	*124.0*	*-79.8*	*Pass*	---	---	---
Perpendicular	*13.56*	*42.9*	*29.0*	*38.6*	*0.2*	*---*	*52.7*	*124.0*	*-71.3*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*32.9*	*29.0*	*38.6*	*0.2*	*---*	*42.7*	*124.0*	*-81.3*	*Pass*	---	---	---
Z (Module), Y (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*40.2*	*29.0*	*38.6*	*0.2*	*---*	*50.0*	*124.0*	*-74.0*	*Pass*	---	---	---
Perpendicular	*13.56*	*46.8*	*29.0*	*38.6*	*0.2*	*---*	*56.6*	*124.0*	*-67.4*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*34.1*	*29.0*	*38.6*	*0.2*	*---*	*43.9*	*124.0*	*-80.1*	*Pass*	---	---	---
Z (Module), Z (ANT)			---	---	---	---	---	---	---	---	---	---	---
Parallel	*13.56*	*41.4*	*29.0*	*38.6*	*0.2*	*---*	*51.2*	*124.0*	*-72.8*	*Pass*	---	---	---
Perpendicular	*13.56*	*46.5*	*29.0*	*38.6*	*0.2*	*---*	*56.3*	*124.0*	*-67.7*	*Pass*	---	---	---
Parallel to Ground	*13.56*	*34.9*	*29.0*	*38.6*	*0.2*	*---*	*44.7*	*124.0*	*-79.3*	*Pass*	---	---	---

Table Result: Pass by -65.8 dB ***Worst Freq:*** 13.56 MHz

Test Site: EMI Chamber 2 **Cable 1:** Asset #2054 **Cable 2:** Asset #2682 **Cable 3:** Asset #2474
Analyzer: MXE #1274541 **Preamp:** #8447F **Antenna:** Sm Loop (high) ---
CSsoft Radiated Emissions Calculator v 1.017.226
Adjusted Reading = Reading - Preamp Factor + Antenna Factor + Cable Factor

Emission mask defined in 15.225 (a)-(d) was not necessary since the maximum 13.56MHz fundamental of 58.2dBuV/m at 3m is below the 15.209 limit of 69.5dBuV/m at 3m. In addition, all radiated spurious emissions were below the 15.209 limits.

4.3 RADIATED SPURIOUS EMISSIONS

4.3.1 LIMITS

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emissions limits specified in Section 15.209(a).

FREQUENCIES (MHz)	FIELD STRENGTH (microvolts/meter)	MEASUREMENT DISTANCE (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. Lower limit applies at the transition frequencies.
2. dBµV/m = 20*log(µV/m).
3. As specified in 15.35(b), for frequencies above 1000MHz, field strength limits are based on the use of measurement instrumentation employing an average detector function. However, there is also a limit on the peak level of the emissions that is 20 dB above the maximum permitted average emission limit.
4. Limit conversion below 30MHz is done by using the square of an inverse linear distance extrapolation factor (40 dB/decade) as allowed in FCC 15.31(f)(2).

   Limit (3m) = Limit (30m) + 40*log(30/3) = Limit (30m) + 40

   Limit (3m) = Limit (300m) + 40*log(300/3) = Limit (300m) + 80
5. RSS-GEN Table 6 H-field limits are 51.5dB lower than FCC 15.209(a) E-field limits. Measurements are performed in terms of magnetic field and converted to electric field using the free space impedance of 377Ω (E-field = H-field +51.5). Therefore resulting pass/fail margin would be the same if an E-field reading is compared to an E-field limit or an H-field reading is compared to an H-field limit.

4.3.2 TEST EQUIPMENT USED

Rev. 3/29/2024

Chambers and Stripline	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
EMI Chamber 2	30-1000MHz	DRS2014X8LH	ETS	J1173 - 0002B	1686	II	12/28/2024	12/28/2022
Spectrum Analyzers / Receivers /Preselectors	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Rental MXE EMI Receiver (1274541)	20Hz-26.5GHz	N9038A	Keysight	MY53220101	1274541	1	6/19/2024	6/19/2023
Antennas	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Red-Black Bilog	30-2000MHz	JB1	Sunol	A091604-2	1106	I	10/2/2025	10/2/2023
Small Loop	10kHz-30MHz	PLA-130/A	ARA	1024	755	I	9/12/2024	9/12/2022
Preamps /Couplers Attenuators / Filters	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
8447F Rental PA	9KHz-1.3GHz	84477F	HP	3113A05395		II	10/18/2024	10/18/2023
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2054	9kHz - 18GHz		Florida RF			II	11/2/2024	11/2/2023
Asset #2466	9KHz-18GHz		MegaPhase			II	11/2/2024	11/2/2023
Asset #2474	9KHz-18GHz		MegaPhase			II	11/2/2024	11/2/2023
Asset #2682	9KHz-18GHz		Pasternack			II	10/9/2024	10/9/2023
Meteorological Meters/Chambers		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	regon Scientif	C3166-1	831	I	12/15/2025	12/15/2022
Asset #2654		1235C97	ontrol Compar	200477432	2654	I	8/18/2025	8/18/2022

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

4.3.3 TEST PROCEDURES

a. The EUT was placed on the top of a rotating table 1.5 meters (above 1GHz) and 0.8 meters (below 1GHz) above the ground at a 3 meters semi-anechoic chamber.

b. For below 30MHz, a loop antenna with its lowest point 1m above the ground was placed 3m away from the EUT and it was rotated 0 and 90 degrees around its vertical axis.

c. In 30MHz-1GHz range, a BiConiLog antenna was mounted on a variable-height antenna tower and placed 3m away from the EUT. Antenna height was varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna were investigated. The table was rotated 360 degrees to determine the position of the highest radiation.

d. In 1GHz-6GHz range, a horn antenna was mounted on a variable-height antenna tower and placed 3m away from the EUT. Antenna height was varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna were investigated. The table was rotated 360 degrees to determine the position of the highest radiation.

e. Following bandwidths were used during emissions testing:

Freq. (MHz)	RBW	VBW	Pre-scan	Final
0.009-0.15	200Hz	1kHz	Peak	Quasi Peak and RMS Power Avg (Trace Avg)
0.15-30	9kHz	30kHz	Peak	Quasi Peak and RMS Power Avg (Trace Avg)
30-1000	120kHz	300kHz	Peak	Quasi Peak
>1000	1MHz	3MHz	Peak	Peak Max Hold and RMS Power Avg (Trace Avg)

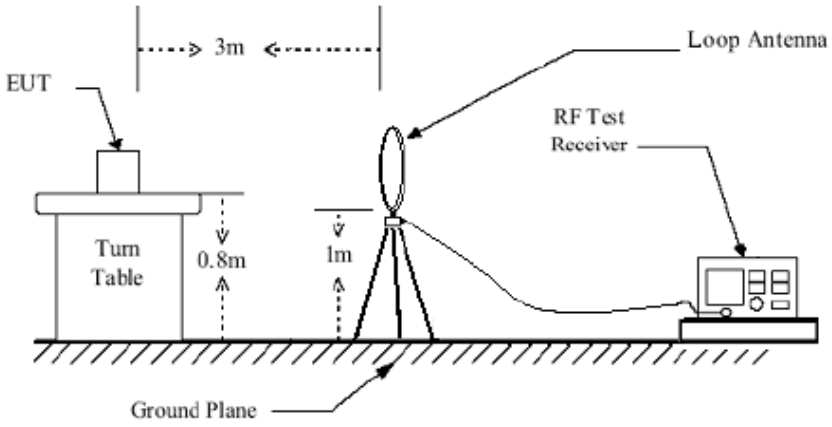
Per FCC §15.209(d), limits §15.209(a) are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. If peak measurements in these frequency bands were below the applicable limits, QPk and RMS measurements were not performed.

4.3.4 DEVIATIONS

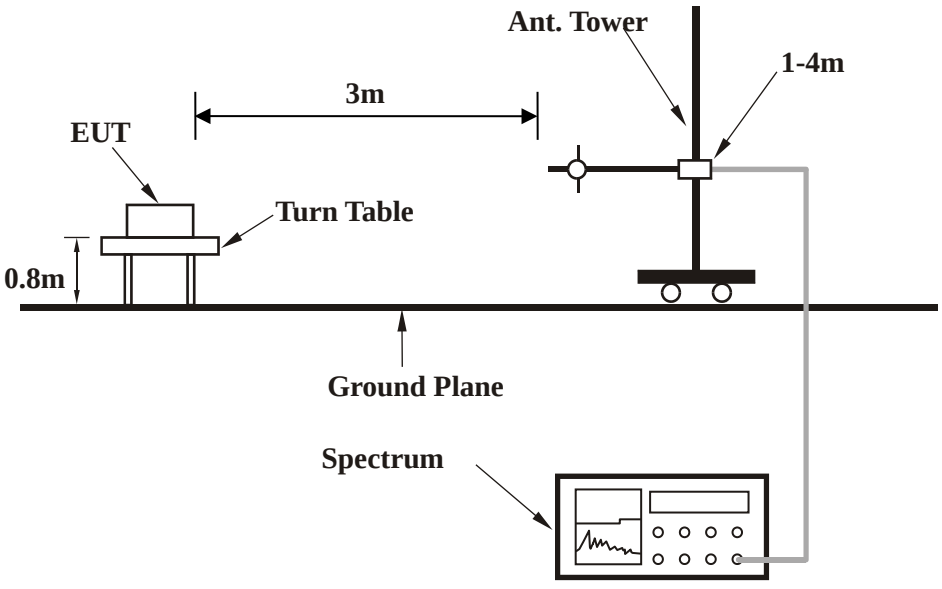
No deviations from the standard.

4.3.5 TEST SETUP

Below 30MHz Test Setup



30MHz - 1GHz Test Setup



Note: For the actual test configuration, please refer to the Test Setup Photos exhibit.

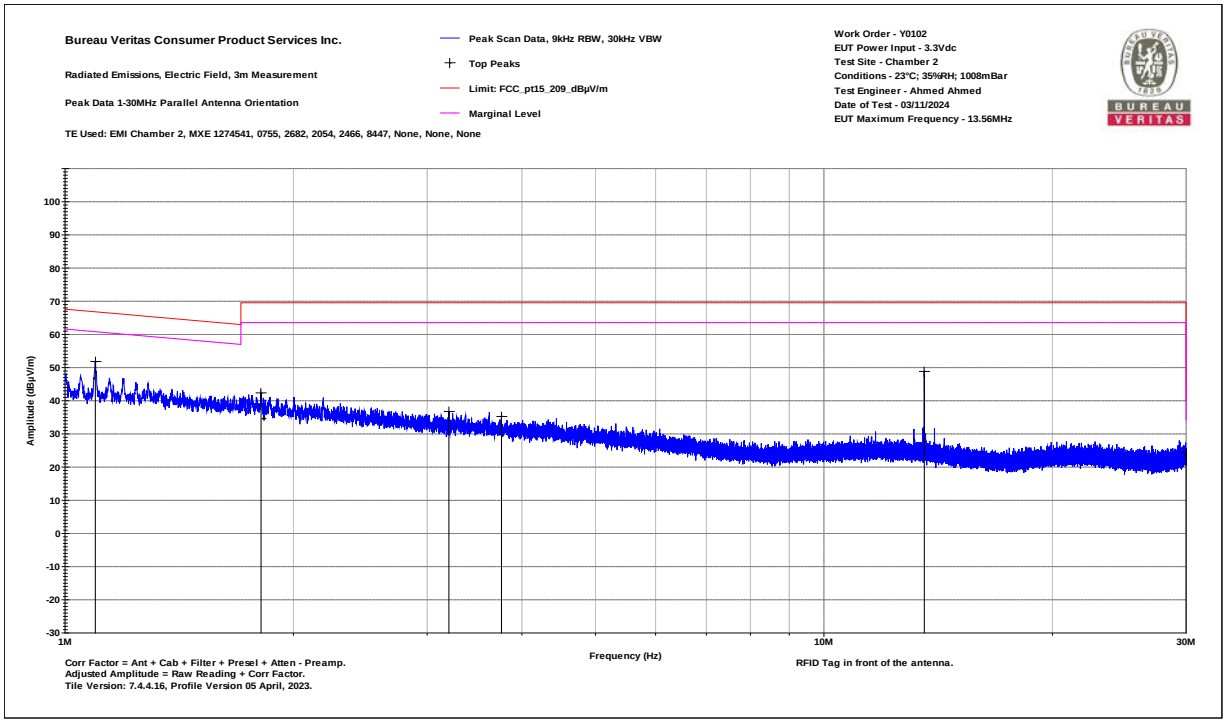
4.3.6 EUT OPERATING CONDITIONS

EUT was operated according to the manufacturer's specifications.

4.3.7 TEST RESULTS

Bureau Veritas Consumer Product Services Inc.	Work Order - Y0102
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 3.3Vdc
Top Peaks Parallel 1-30MHz	Test Site - Chamber 2
Notes:	Conditions - 23°C; 35%RH; 1008mBar
RFID Tag in front of the antenna.	Test Engineer - Ahmed Ahmed
	Date of Test - 03/11/2024

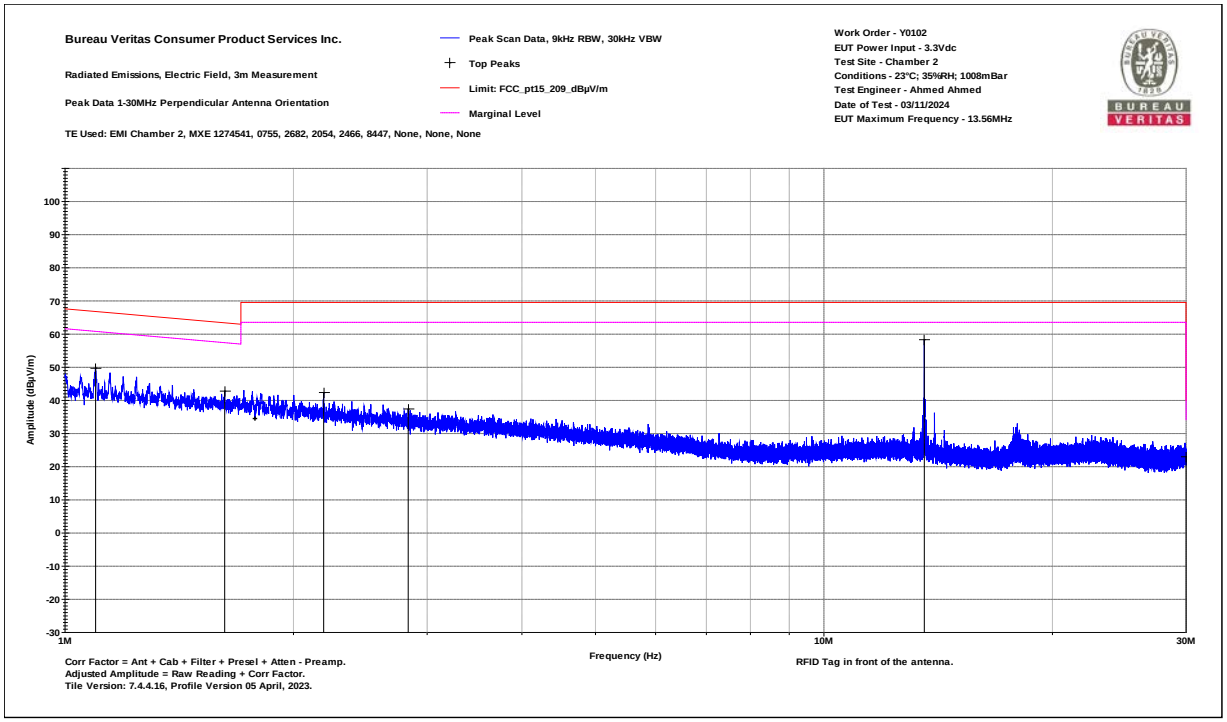
Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim: FCC_pt15_209_dBµV/m (dBµV/m)	Peak Margin (dB)	Peak Test Results (Pass/Fail)	Worst Margin (dB)	EUT Azimuth (degrees)
1.096	24.6	27.1	51.7	66.8	-15.1	PASS	-15.1	15
1.813	19.1	23.1	42.3	69.5	-27.3	PASS		240
3.205	18.4	18.3	36.7	69.5	-32.8	PASS		240
3.759	18.2	17.1	35.3	69.5	-34.2	PASS		150
13.56	38.9	9.9	48.9	69.5	-20.7	PASS		345
30	15.7	8.7	24.3	40	-15.7	PASS		90



1-30MHz Parallel

Bureau Veritas Consumer Product Services Inc.	Work Order - Y0102
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 3.3Vdc
Top Peaks Perpendicular 1-30MHz	Test Site - Chamber 2
Notes:	Conditions - 23°C; 35%RH; 1008mBar
RFID Tag in front of the antenna.	Test Engineer - Ahmed Ahmed
	Date of Test - 03/11/2024

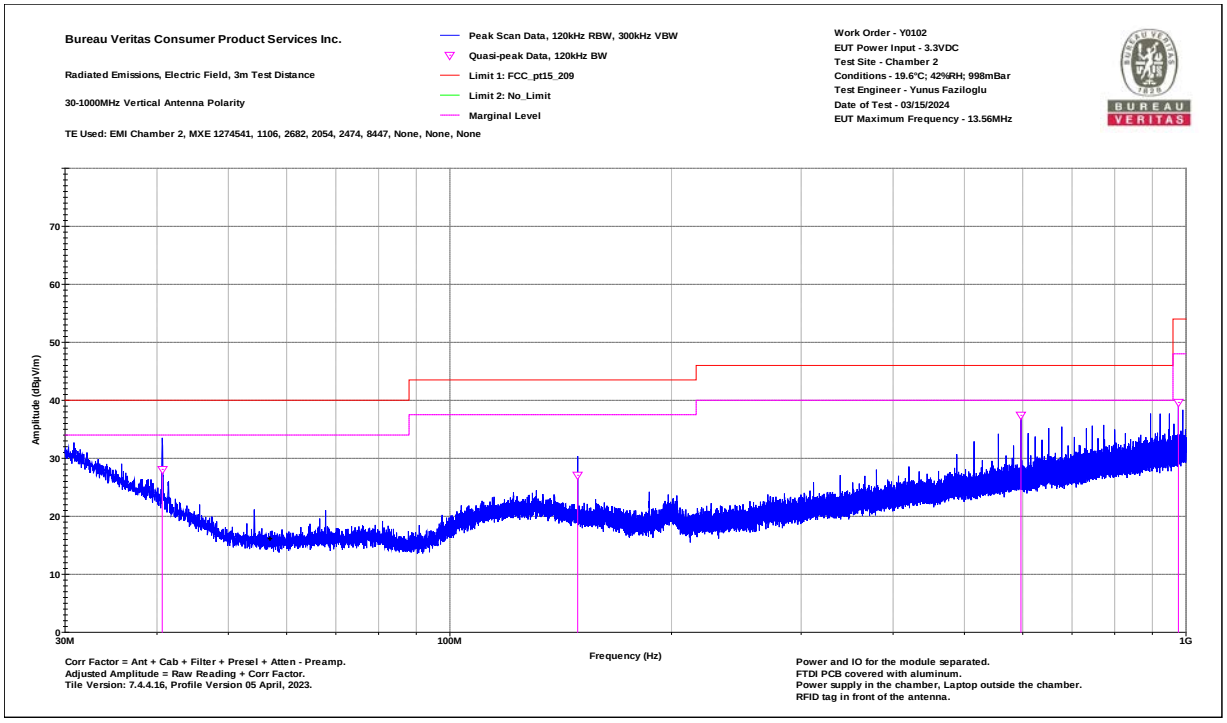
Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim: FCC_pt15_209_dBµV/m (dBµV/m)	Peak Margin (dB)	Peak Test Results (Pass/Fail)	Worst Margin (dB)	EUT Azimuth (degrees)
1.097	22.6	27.1	49.7	66.8	-17.1	PASS		240
1.623	18.6	24.2	42.8	63.4	-20.6	PASS		255
2.192	20.8	21.4	42.3	69.5	-27.3	PASS		75
2.833	18	19.4	37.4	69.5	-32.2	PASS		90
13.559	48.3	9.9	58.3	69.5	-11.3	PASS	-11.3	60
30	14.4	8.7	23	40	-17	PASS		315



1-30MHz Perpendicular

Bureau Veritas Consumer Product Services Inc.	Work Order - Y0102
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 3.3VDC
30-1000MHz Vertical Data	Test Site - Chamber 2
Notes:	Conditions - 19.6°C; 42%RH; 998mBar
Power and IO for the module separated.	Test Engineer - Yunus Faziloglu
FTDI PCB covered with aluminum.	Date of Test - 03/15/2024
Power supply in the chamber, Laptop outside the chamber.	

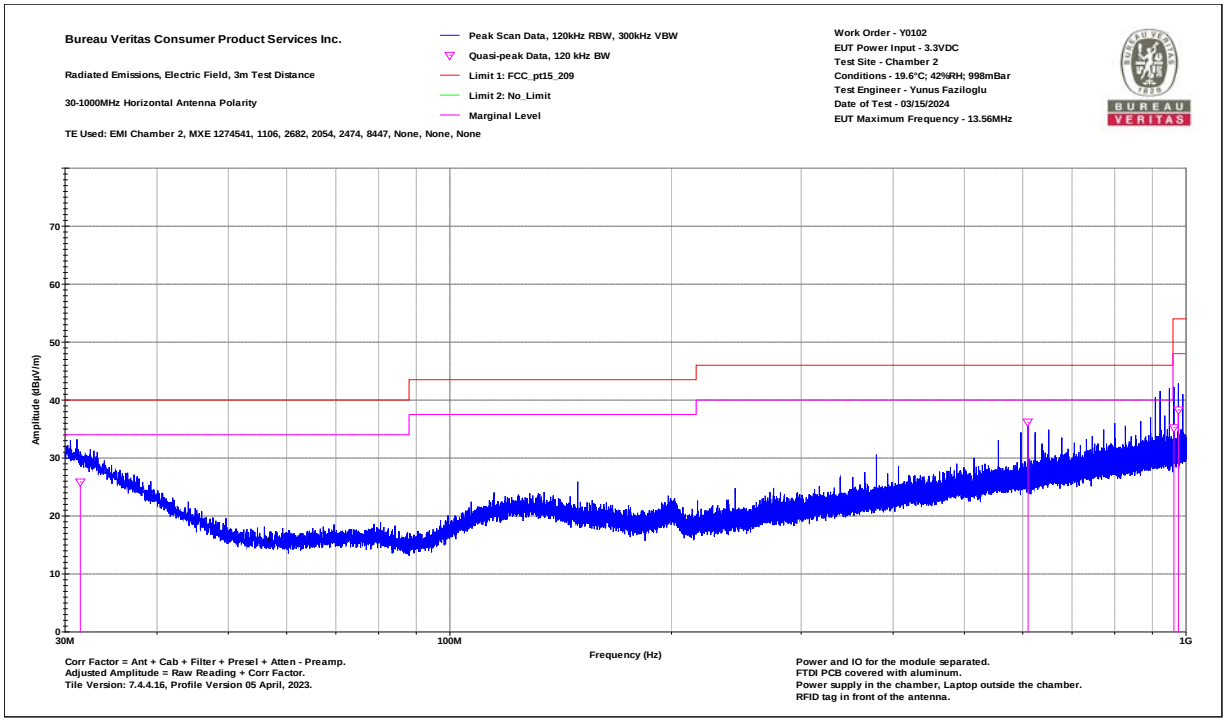
Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB/m)	Adjusted QP Amplitude (dBµV/m)	Lim1: FCC_pt15_209 (dBµV/m)	Margin to Lim1 (dB)	Test Results Lim1 (Pass/Fail)	Worst Margin Lim1 (dB)
40.665	33.8	-5.7	28.1	40	-11.9	PASS	
149.129	33.2	-6.1	27.1	43.5	-16.4	PASS	
596.613	36.8	0.6	37.4	46	-8.6	PASS	-8.6
976.298	32.6	7	39.6	54	-14.4	PASS	



30-1000MHz Vertical

Bureau Veritas Consumer Product Services Inc.	Work Order - Y0102
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 3.3VDC
30-1000MHz Horizontal Data	Test Site - Chamber 2
Notes:	Conditions - 19.6°C; 42%RH; 998mBar
Power and IO for the module separated.	Test Engineer - Yunus Faziloglu
FTDI PCB covered with aluminum.	Date of Test - 03/15/2024
Power supply in the chamber, Laptop outside the chamber.	

Frequency (MHz)	Raw QP Reading (dBµV)	Correction Factor (dB/m)	Adjusted QP Amplitude (dBµV/m)	Lim1: FCC_pt15_209 (dbµV/m)	Margin to Lim1 (dB)	Test Results Lim1 (Pass/Fail)	Worst Margin Lim1 (dB)
31.476	24.9	1	25.9	40	-14.1	PASS	
610.168	35.5	0.7	36.1	46	-9.9	PASS	-9.9
962.727	28.3	6.9	35.2	54	-18.8	PASS	
976.286	31.3	7	38.3	54	-15.7	PASS	



30-1000MHz Horizontal

4.4 99% OCCUPIED BANDWIDTH

4.4.1 LIMITS

When an occupied bandwidth is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is its 99% emission bandwidth, as calculated or measured. [RSS-Gen Issue 5 Section 6.7].

4.4.2 TEST SETUP

Same as radiated spurious emissions setup below 30MHz (Section 4.3.5).

4.4.3 TEST EQUIPMENT USED

Meteorological Meters/Chambers		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Temp/Humidity Chamber #18		EPX-2H	Espec	137664	1645	I	1/2/2025	1/2/2024
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2595	9KHz-40GHz		Carlisle			II	2/17/2025	2/17/2024
Spectrum Analyzers / Receivers /Preselectors	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
FSV40 Spectrum Analyzer	10Hz-40GHz	FSV40	ROHDE & SCHWARZ	101551	2200	I	10/9/2024	10/9/2023
Antenna	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Loop Probe	0.1-300MHz	100C	Beehive Electronics	3038	2347	I	5/23/2024	2/23/2022

4.4.4 TEST PROCEDURES

Per RSS-Gen Issue 5 Section 6.7.

4.4.5 DEVIATIONS

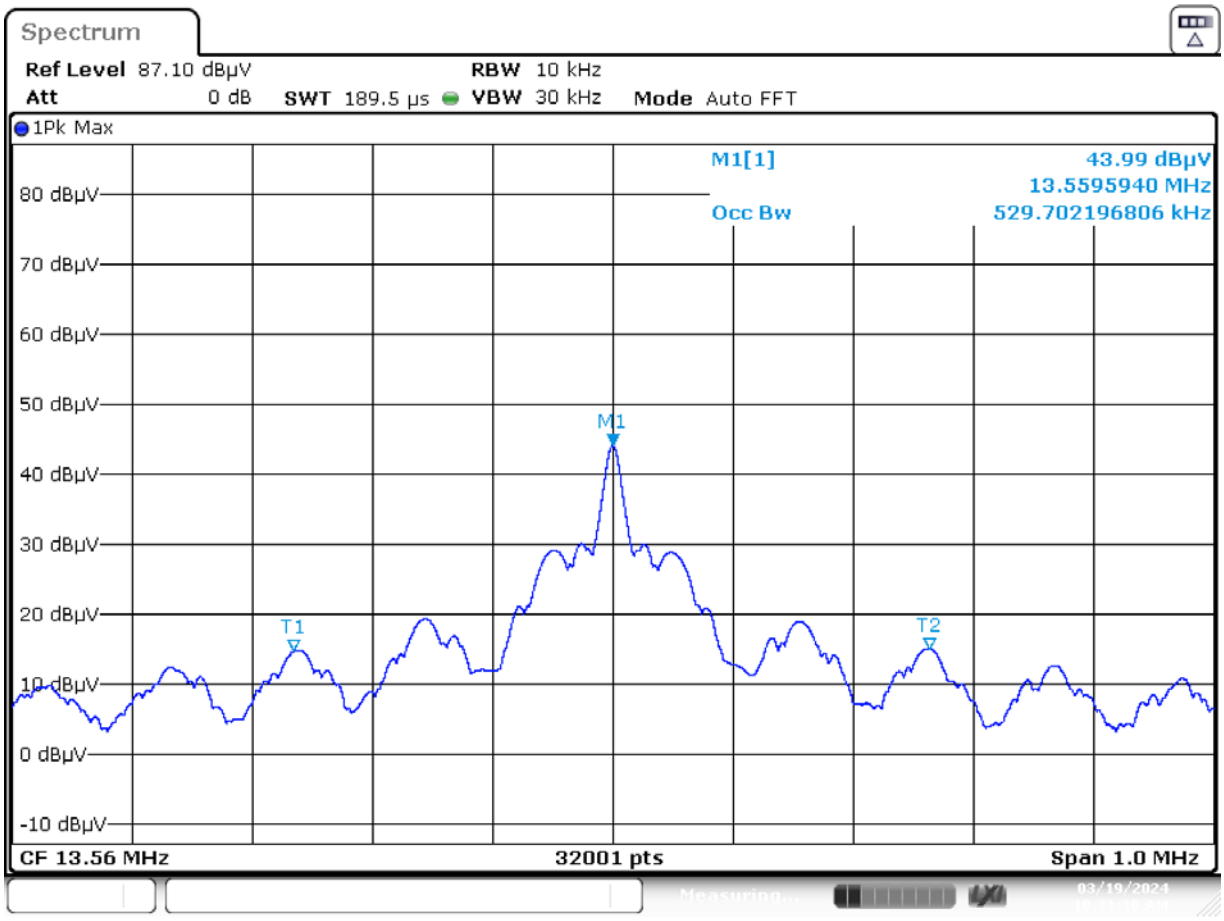
No deviations from the standard.

4.4.6 EUT OPERATING CONDITIONS

EUT was operated according to manufacturer's specifications.

4.4.7 TEST RESULTS

Measured 99% OBW: 529.7kHz



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4.5 FREQUENCY TOLERANCE

4.5.1 LIMITS

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 °C to + 50 °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 °C. For battery operated equipment, the equipment tests shall be performed using a new battery.

4.5.2 TEST SETUP

EUT placed in the climatic chamber. Measurement loop placed inside the chamber close to the EUT and connected to the spectrum analyzer outside the chamber.

4.5.3 TEST EQUIPMENT USED

Meteorological Meters/Chambers		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Temp/Humidity Chamber #18		EPX-2H	Espec	137664	1645	I	1/2/2025	1/2/2024
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2595	9KHz-40GHz		Carlisle			II	2/17/2025	2/17/2024
Spectrum Analyzers / Receivers /Preselectors	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
FSV40 Spectrum Analyzer	10Hz-40GHz	FSV40	ROHDE & SCHWARZ	101551	2200	I	10/9/2024	10/9/2023
Antenna	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Loop Probe	0.1-300MHz	100C	Beehive Electronics	3038	2347	I	5/23/2024	2/23/2022

4.5.4 TEST PROCEDURES

Per ANSI C63.10 - 2013 Section 6.8.

4.5.5 DEVIATIONS

No deviations from the standard.

4.5.6 EUT OPERATING CONDITIONS

EUT was operated according to manufacturer’s specifications

4.5.7 TEST RESULTS

Measurements were recorded at startup, 2 minutes, 5 minutes, and 10 minutes after the EUT was energized. Worst-case measurements are shown in the data table below.

Frequency Stability Under Extreme Conditions								
Date:	3/19/2024				**Work Order:**	Y0102		
Engineer:	Yunus Faziloglu							
Nominal Voltage:	3.3VDC	**Min Voltage:**	2.8VDC	**Max Voltage:**	3.8VDC			
Temperature		**Voltage**	**Amplitude**	**Amplitude Delta**	**Frequency**	**Frequency Delta**	**Limit**	**Result**
°C		**V**	**(dBuA)**	**(dB)**	**(MHz)**	**(MHz)**	**(MHz)**	
-20C		Nominal	12.23	0.08	13.559719	0.000056	0.001356	Pass
-10C		Nominal	12.24	0.09	13.559775	0.000112	0.001356	Pass
0C		Nominal	12.14	-0.01	13.559719	0.000056	0.001356	Pass
10C		Nominal	12.06	-0.09	13.559719	0.000056	0.001356	Pass
Nominal (20C)		Minimum	11.42	-0.73	13.559606	-0.000057	0.001356	Pass
		Nominal	12.15	Reference	13.559663	Reference	--	--
		Maximum	12.14	-0.01	13.559606	-0.000057	0.001356	Pass
30C		Nominal	11.89	-0.26	13.559555	-0.000108	0.001356	Pass
40C		Nominal	12.00	-0.15	13.559494	-0.000169	0.001356	Pass
50C		Nominal	11.89	-0.26	13.559438	-0.000225	0.001356	Pass
Test Site:	1645 (Chamber 18)		**Antenna:**	2347				
Cable 1:	2595		**Analyzer:**	FSV40				

Maximum Frequency Deviation: ±0.000225MHz
Limit: ±0.001356MHz

Result: PASS

5 PHOTOGRAPHS OF THE TEST CONFIGURATION

Please refer to the Test Setup Photos exhibit.

6 APPENDIX A – MODIFICATIONS

None.

---END OF REPORT---