TEST REPORT

Applicant	Hayward Industries, Inc.
Address	One Hayward Industrial Drive, Clemmons NC 27012

FCC ID	RNW-BT923
ISED Canada IC	5110A-BT923
Product Description	BT and 900 Wireless Module 2023
PMN Model/HVIN FVIN HMN	BT923 G066000227A N/A N/A
Additional Models	None
Date of tests	Jun 13, 2023 - Jul 25, 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 15.247**
☒ **ISED Canada RSS-247 Issue 3**

CONCLUSION: The submitted sample was found to <u>COMPLY</u> with the test requirement

Prepared by	Approved by
Yunus Faziloglu Sr. Wireless Engineer	Ahmed Ait Ahmed EMC Supervisor
Issue Date: Dec 10, 2024	Issue Number: 4

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RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
1	Original release	Feb 7, 2024
2	Revision to address TCB review comments: Corrected input voltage Revised Block Diagram Support equipment list updates Repeated AC Line Conducted test and updated test equipment used Clarified references to ANSI C63.10-2013 Standard Mentioned Adjusted reading formula	Jul 31, 2024
3	Revision to address TCB review comments: Corrected Antenna model number. Note added in section 4.4.7. for measurement path losses	Aug 22, 2024
4	Revision to address TCB review comments: HVIN corrected Power setting used during testing specified in Section 3.1	Dec 10, 2024

1 SUMMARY OF TEST RESULTS

EUT was tested against the following requirements:

APPLIED STANDARD: FCC PART 15, SUBPART C (SECTION 15.247), RSS-247				
STANDARD SECTION		TEST TYPE AND LIMIT	APPLICABLE	RESULT
47CFR15	RSS			
15.207	Gen 8.8	AC Power Line Conducted Emissions	Y	PASS
15.205 15.209	247 3.3 247 5.5 Gen 8.9 Gen 8.10	Radiated Spurious Emissions	Y	PASS
15.247(d)	247 5.5	Conducted Spurious Emissions	Y	PASS
15.247(a)(2)	247 5.2(a)	6dB Bandwidth	Y	PASS
--	Gen 6.7	99% Occupied Bandwidth	Y	PASS
15.247(b)(3)	247 5.4(d)	Conducted Output Power	Y	PASS
15.247(e)	247 5.2(b)	Power Spectral Density	Y	PASS
15.203	Gen 6.8	Antenna Requirement	Y	PASS

This report addresses 2.4GHz (DTS) operation of the module. 900MHz (DSS) operation of the module is addressed in EX0020-2 Test Report.

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 TECHNOLOGY	DTS
MODULATION TYPES	GFSK
DATA RATES	1Mbps (GFSK)
OPERATING FREQUENCY	2402 – 2480MHz
EUT Power Setting During Testing	5dBm
OUTPUT POWER	1.5mW (Average Conducted) External Antenna 1.3mW (Average Conducted) Internal Antenna

Customer Supplied Antenna Information

Type	Manufacturer	Model	Peak Gain
External Hinged	AVX/Kyocera	X9000984-4GDRMW	4.7dBi
PCB Trace	N/A	N/A	5dBi

EUT Ports:							
Port Label	**Port Type**	**No. of ports**	**No. Populated**	**Cable Type**	**Shielded**	**Ferrites**	**Length**
DC Power	Power	1	1	DC	No	No	1m

Highest clock frequency in the device (used/generated): 2480MHz

NOTES:

1. For a more detailed description of the EUT, please refer to the manufacturer's specifications or the user's manual.
2. Please disregard 5VDC references in the rest of the report data tables and plots.
3. For photos of the EUT, please refer to External and Internal Photos exhibits.

3.2 DESCRIPTION OF TEST MODES

40 channels are provided for BLE (GFSK):

CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)	CHANNEL	FREQ. (MHZ)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Four configurations were provided for testing:

Sample	Description	EUT Antenna	Purpose
1	External Antenna	External Dipole attached	Radiated Sample
2	External Antenna	External Dipole detached	Conducted Sample
3	Internal Antenna	Trace antenna in place	Radiated Sample
4	Internal Antenna	Trace antenna replaced with an SMA connector	Conducted Sample

Notes:

- All samples were powered with an external 3.3VDC power supply.
- Please disregard 5VDC references in the rest of the report data tables and plots.
- The customer provided a laptop to set up test modes with a programming tool from the radio chipset manufacturer.

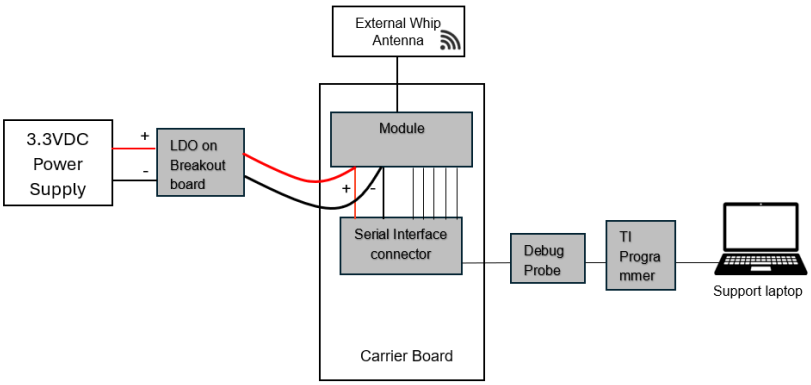
EUT Test Modes:

TEST MODE	DESCRIPTION
A	Continuous Transmit at 1Mbps (Duty-cycle: 100%)

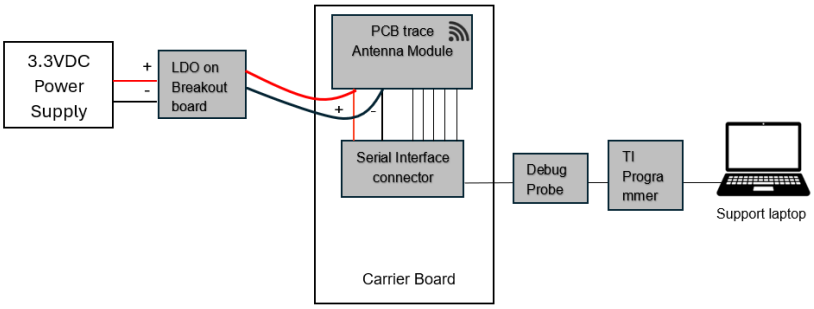
EUT Setup Block Diagram:

Radiated Emissions EUT Setup

With External Antenna



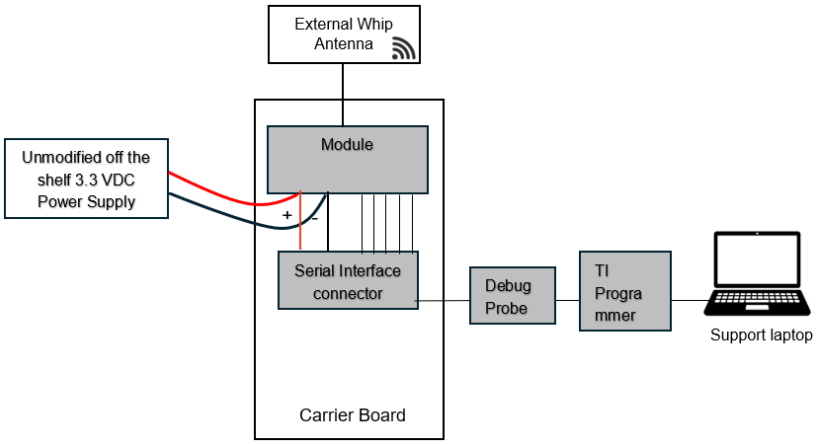
With Internal Antenna



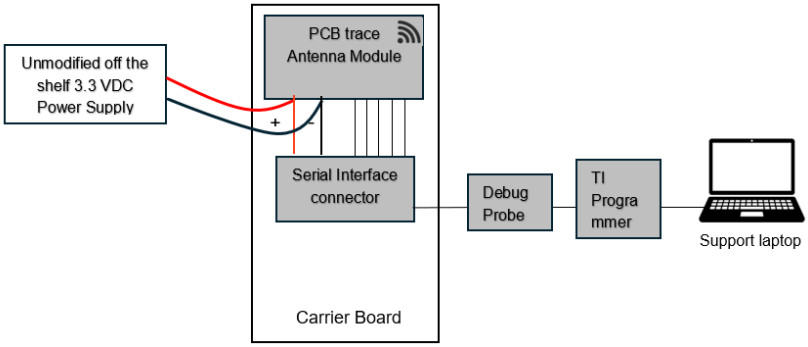
Note: Debug Probe, TI Programmer and support Laptop are disconnected after the test mode is set.

AC line Conducted Emissions EUT Setup

With External Antenna



With Internal Antenna



Note:

- Debug Probe, TI Programmer and support Laptop are disconnected after the test mode is set.
- During AC line conducted emission testing LDO breakout board is removed to supply 3.3VDC power directly to the module for worst-case testing.

For antenna port test setup block diagrams, please see the corresponding sections of this report.

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

TEST	TEST MODE	AVAILABLE CHANNELS	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)	Notes
COP	A	0 to 39	0,19,39	GFSK	1	--
PSD	A	0 to 39	0,19,39	GFSK	1	--
CBE	A	0 to 39	0,39	GFSK	1	--
6DB	A	0 to 39	0,19,39	GFSK	1	--
OBW	A	0 to 39	0,19,39	GFSK	1	--
CSE	A	0 to 39	0,19,39	GFSK	1	--
RSE<1G	A	0 to 39	0,39	GFSK	1	1, 2
RSE≥1G	A	0 to 39	0,19,39	GFSK	1	1
RBE	A	0 to 39	0,39	GFSK	1	1
PLCE	A	0 to 39	19	GFSK	1	3

Note 1: For internal antenna configuration, module was maximized on X, Y and Z. Worst case orientation was Y. For external antenna configuration, module was maximized on X, Y, Z and external antenna was maximized in horizontal and vertical orientations for each. Worst case was when module was in Y axis and external antenna in horizontal orientation as shown in the test setup photos exhibit.
Note 2: Testing was limited to 1 channel only since no significant emissions were detected. Below 30MHz, High channel was tested for both antennas. In 30MHz – 1GHz range, external antenna was tested on Low channel and internal antenna was tested on High channel.
Note 3: Testing was limited to 1 channel only since no significant emissions were detected.
COP: Conducted Output Power
PSD: Power Spectral Density
CBE: Conducted Band-edge
6DB: 6dB Bandwidth
OBW: 99% Occupied Bandwidth
CSE: Conducted Spurious Emissions
RSE<1G: Radiated Spurious Emissions Below 1GHz
RSE≥1G: Radiated Spurious Emissions Above 1GHz
RBE: Radiated Band-edge
PLCE: Power Line Conducted Emissions

TEST CONDITIONS:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TESTED BY
RE<1G	As listed on corresponding data tables	Ryan M. Brown
RE≥1G	As listed on corresponding data tables	Ryan M. Brown Yunus Faziloglu
PLCE	As listed on corresponding data tables	Ryan M. Brown
Antenna Port Measurements	12/04/2023: 18.1°C, 42% RH, 1016 mbar 12/07/2023: 18.7°C, 44% RH, 1013 mbar	Yunus Faziloglu

3.3 MEASUREMENT PROCEDURES USED

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

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

ANSI C63.10-2013

RSS-Gen Issue 5

3.4 DESCRIPTION OF SUPPORT EQUIPMENT

Support Equipment	Model #	Serial #	Comments
Laptop	Acer PEW51	LXTZ9030250353FFEB1601	Customer supplied for test mode set up
Debug Probe	XDS200	TC54683	Customer supplied for test mode set up
Debug Board	HRI-ENG-0003-01	N/A	Customer supplied for test mode set up
AC Adaptor CUI INC	SW16-3.3-N	SW16-3.3-N-P5	Supplied by the customer for testing. Used during REMI and antenna port tests
Lab DC power Supply	HP E3612A	KR61304227	Used during REMI tests
144W Universal Power Adapter	LGY-363000	NA	Off-the-shelf unmodified supply used during AC line conducted testing

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. 7/11/2024

Conducted Test Sites (Mains / Telco)	FCC Code		VCCI Code			Cat	Calibration Due	Calibrated on
CEMI 5	719150		A-0015			III	NA	N/A
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	6/11/2025	6/11/2024
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
CEMI-02	9kHz - 2GHz		C-S			II	1/26/2025	1/26/2024
Attenuators	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
20dB20W Attenuator(A#2499)	9KHz-4GHz	766-20	Narda	8710	2499	II	12/5/2024	12/5/2023
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
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 #2654		1235C97	Control Company	200477432	2654	I	8/18/2025	8/18/2022

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

4.1.3 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.

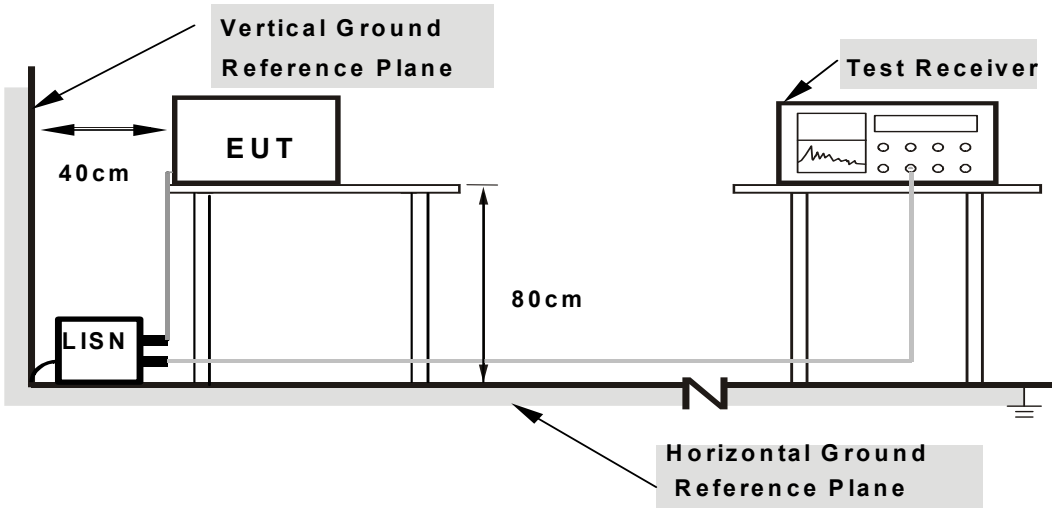
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

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

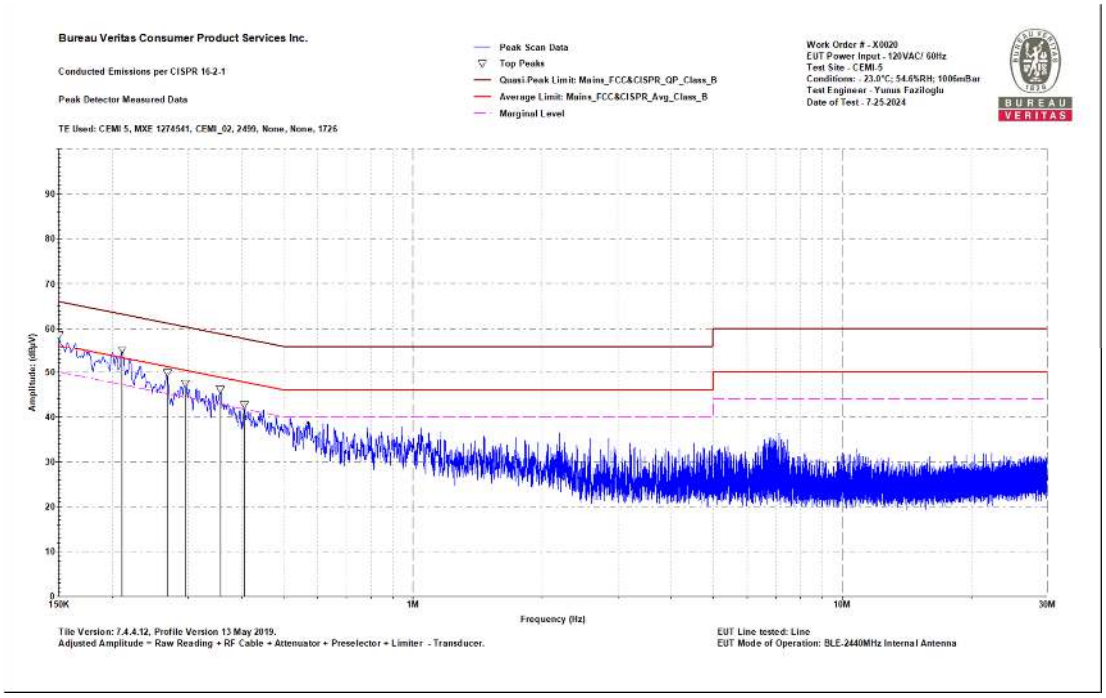
a. EUT was operated according to manufacturer's specifications.

4.1.7 TEST RESULTS

Internal Antenna

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120VAC/ 60Hz
Peak Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Line	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz Internal Antenna	Date of Test - 7-25-2024

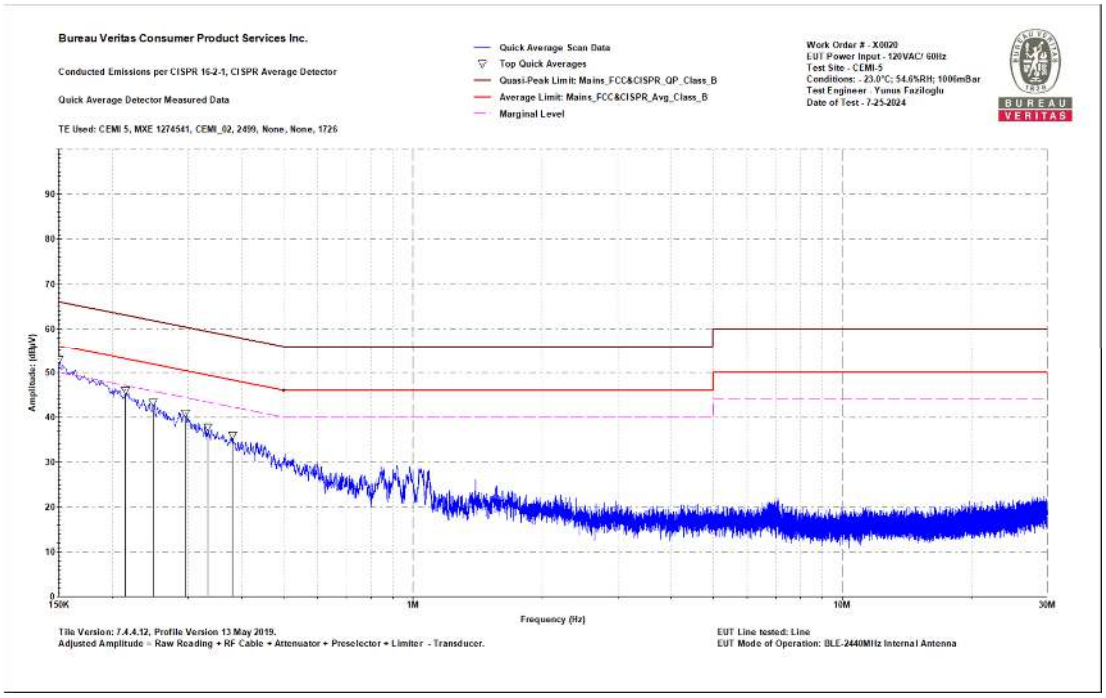
Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.15	38.6	20	58.6	66	-7.4	PASS	-7.4
0.21	35.1	19.9	55	63.2	-8.2	PASS	
0.268	30	19.9	49.8	61.2	-11.4	PASS	
0.296	27.7	19.9	47.6	60.4	-12.8	PASS	
0.357	26.3	19.8	46.1	58.8	-12.7	PASS	
0.405	22.9	19.9	42.7	57.7	-15	PASS	



0.15-30MHz Line Peak Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120VAC/ 60Hz
Quick Average Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Line	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz Internal Antenna	Date of Test - 7-25-2024

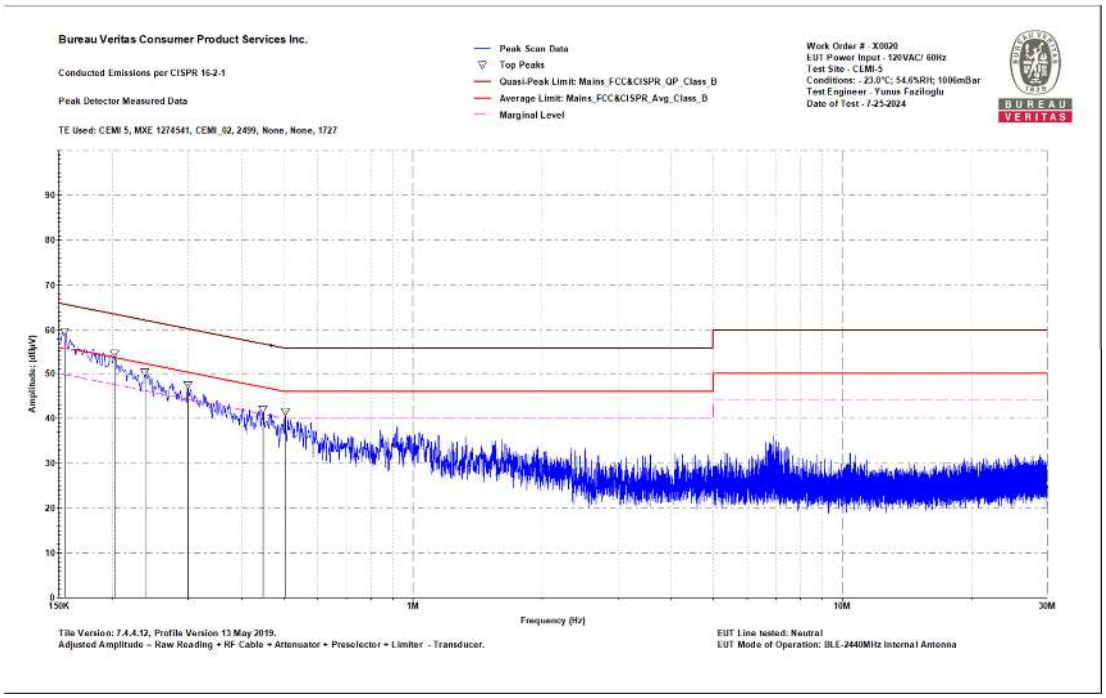
Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.15	32.9	20	52.9	56	-3.1	PASS	-3.1
0.214	26.1	19.9	46	53	-7	PASS	
0.249	23.5	19.9	43.4	51.8	-8.4	PASS	
0.295	21.1	19.9	40.9	50.4	-9.4	PASS	
0.334	17.9	19.9	37.8	49.4	-11.6	PASS	
0.381	16.2	19.9	36	48.3	-12.2	PASS	



0.15-30MHz Line Quick Average Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120VAC/ 60Hz
Peak Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Neutral	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz Internal Antenna	Date of Test - 7-25-2024

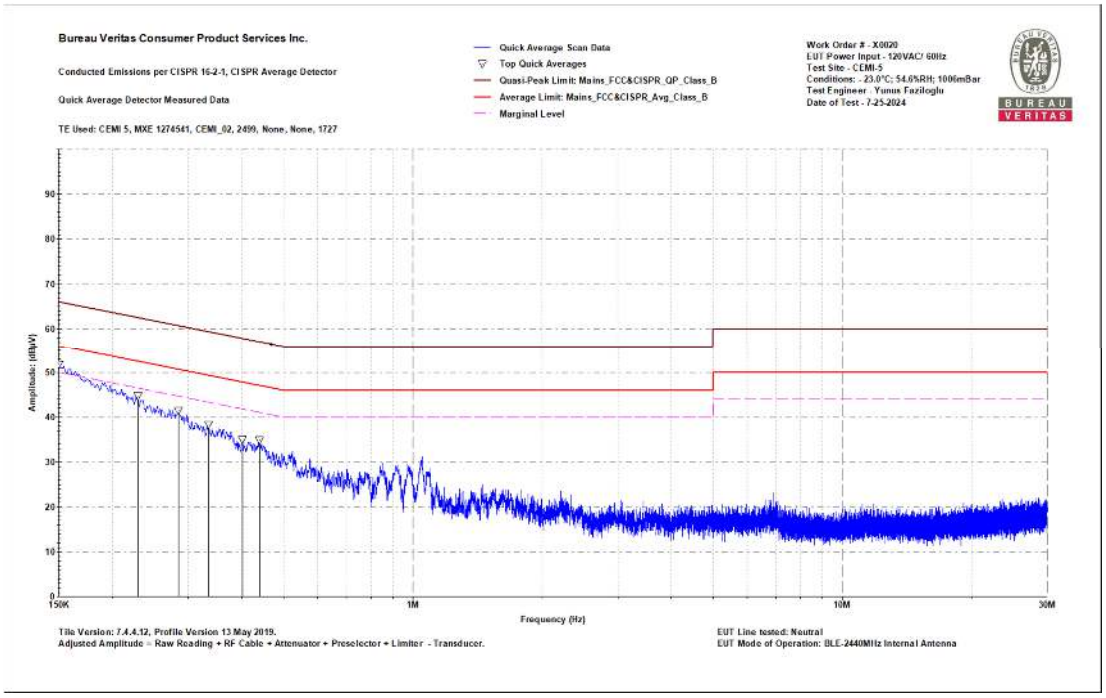
Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.154	39.8	19.9	59.7	65.8	-6.1	PASS	-6.1
0.202	34.6	19.9	54.4	63.5	-9.1	PASS	
0.238	30.5	19.9	50.3	62.2	-11.8	PASS	
0.299	27.7	19.8	47.5	60.3	-12.7	PASS	
0.448	22.1	19.8	41.9	56.9	-15	PASS	
0.504	21.8	19.8	41.6	56	-14.4	PASS	



0.15-30MHz Neutral Peak Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120VAC/ 60Hz
Quick Average Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Neutral	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz Internal Antenna	Date of Test - 7-25-2024

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	19.9	51.9	56	-4.1	PASS	-4.1
0.229	24.9	19.9	44.8	52.5	-7.7	PASS	
0.284	21.6	19.8	41.5	50.7	-9.2	PASS	
0.335	18.5	19.8	38.4	49.3	-10.9	PASS	
0.401	15.2	19.8	35.1	47.8	-12.8	PASS	
0.44	15	19.8	34.8	47.1	-12.2	PASS	

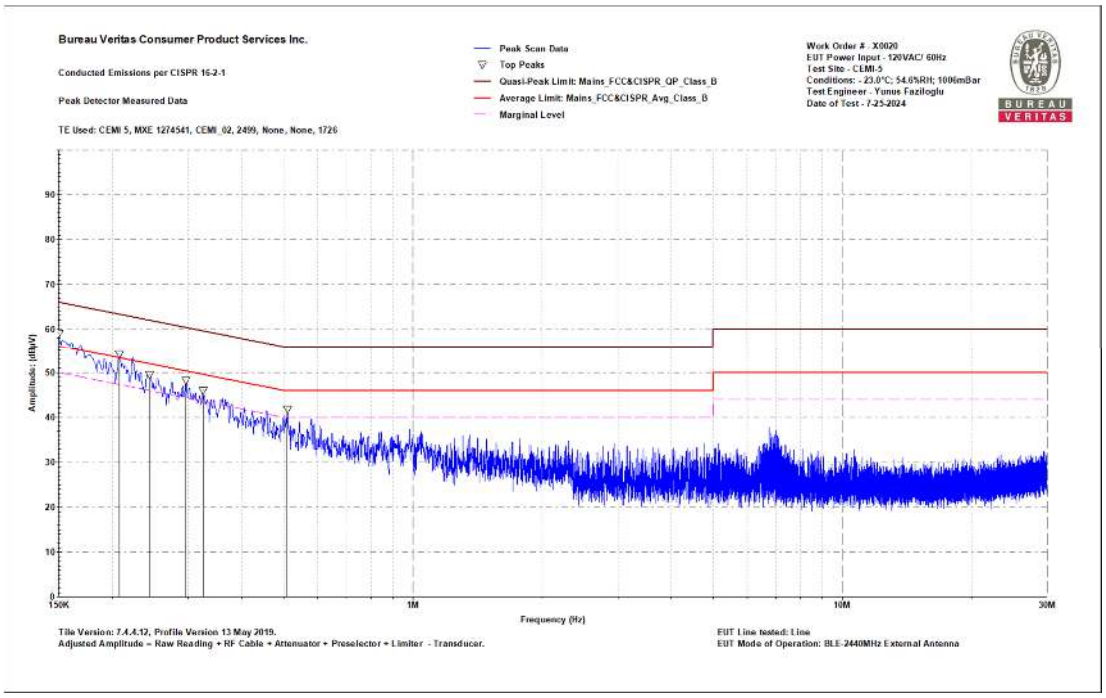


0.15-30MHz Neutral Quick Average Data table and Plot

External Antenna

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120VAC/ 60Hz
Peak Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Line	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz External Antenna	Date of Test - 7-25-2024

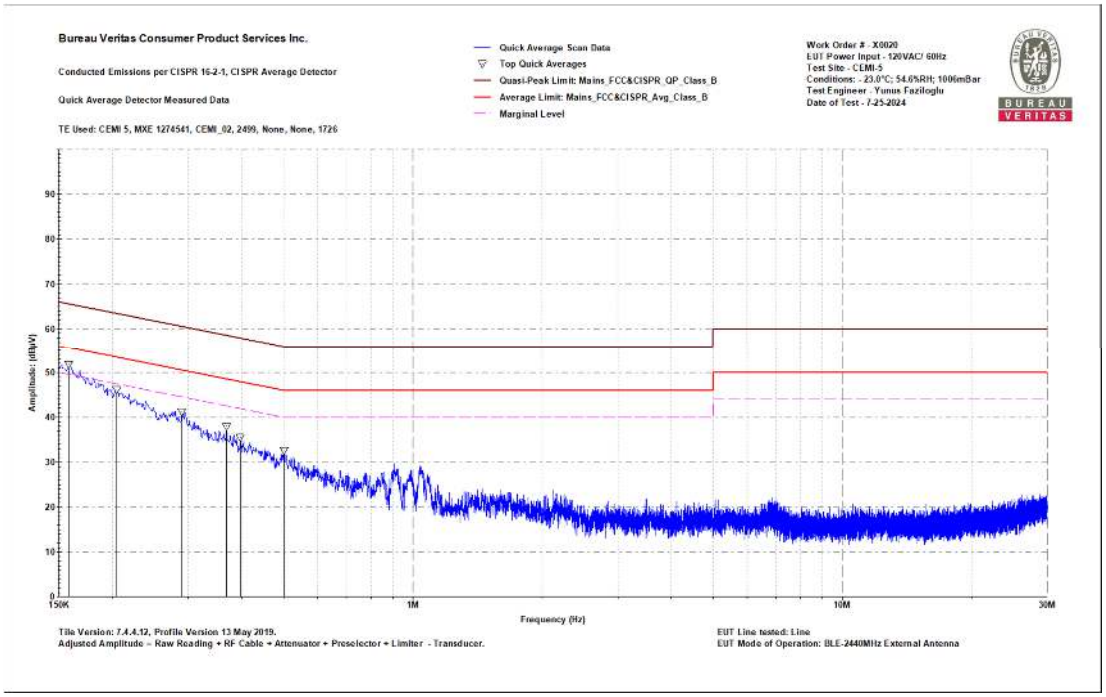
Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.15	39	20	59	66	-7	PASS	-7
0.207	34.2	19.9	54.1	63.3	-9.2	PASS	
0.244	29.7	19.9	49.6	62	-12.4	PASS	
0.296	28.4	19.9	48.2	60.3	-12.1	PASS	
0.325	26.2	19.9	46.1	59.6	-13.5	PASS	
0.51	22	19.8	41.8	56	-14.2	PASS	



0.15-30MHz Line Peak Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120VAC/ 60Hz
Quick Average Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Line	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz External Antenna	Date of Test - 7-25-2024

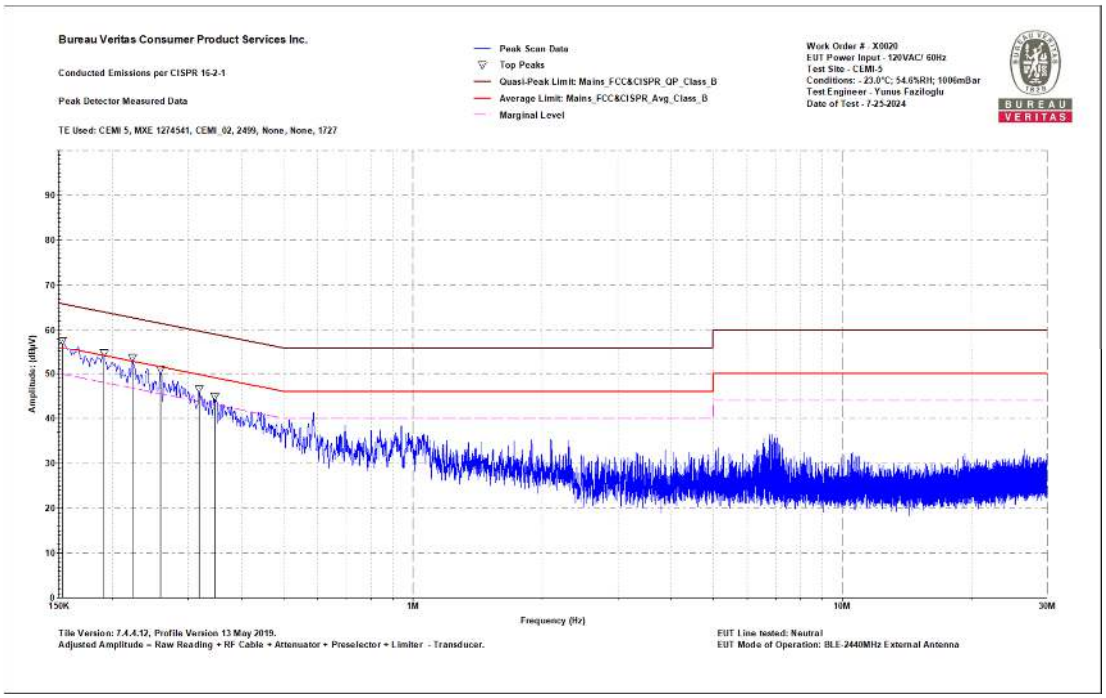
Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.158	31.9	19.9	51.9	55.6	-3.7	PASS	-3.7
0.204	26.3	19.9	46.2	53.4	-7.2	PASS	
0.29	21.4	19.9	41.2	50.5	-9.3	PASS	
0.368	18.2	19.9	38	48.5	-10.5	PASS	
0.397	15.6	19.9	35.5	47.9	-12.4	PASS	
0.502	12.7	19.8	32.5	46	-13.5	PASS	



0.15-30MHz Line Quick Average Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1	EUT Power Input - 120VAC/ 60Hz
Peak Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Neutral	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz External Antenna	Date of Test - 7-25-2024

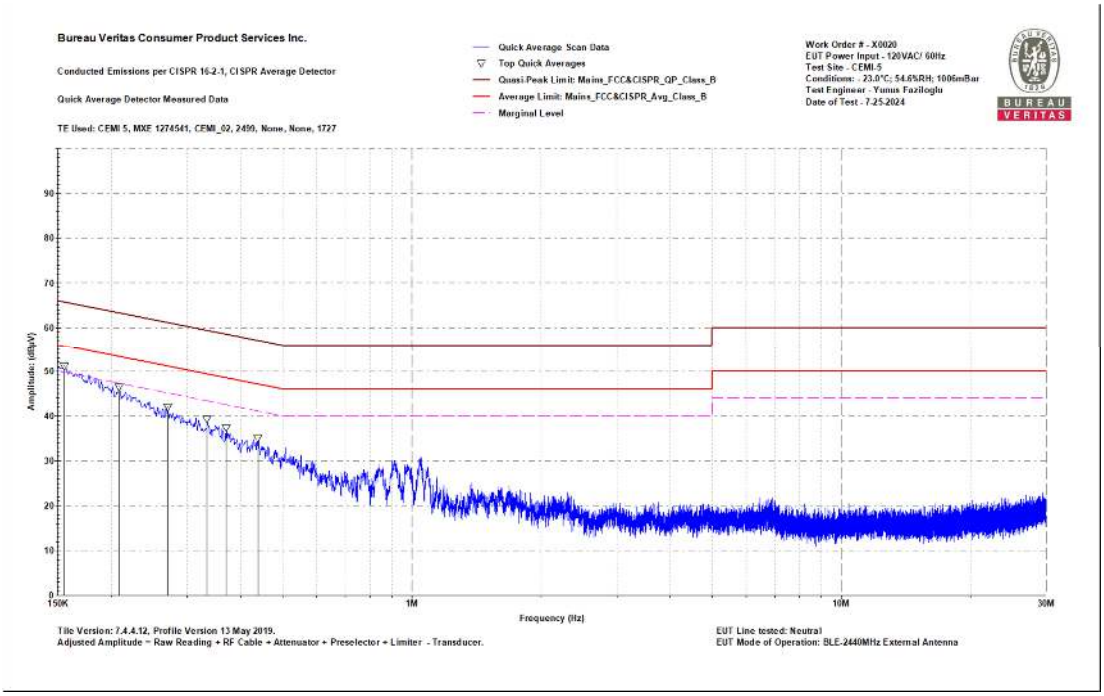
Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.153	37.8	19.9	57.7	65.8	-8.1	PASS	-8.1
0.191	34.7	19.9	54.6	64	-9.4	PASS	
0.222	33.6	19.9	53.5	62.7	-9.2	PASS	
0.259	31.1	19.9	50.9	61.5	-10.5	PASS	
0.318	26.8	19.8	46.6	59.8	-13.1	PASS	
0.346	25.1	19.8	45	59.1	-14.1	PASS	



0.15-30MHz Neutral Peak Data table and Plot

Bureau Veritas Consumer Product Services Inc.	Work Order # - X0020
Conducted Emissions per CISPR 16-2-1, CISPR Average Detector	EUT Power Input - 120VAC/ 60Hz
Quick Average Detector Data	Test Site - CEMI-5
Notes:	Conditions: - 23.0°C; 54.6%RH; 1006mBar
EUT Line tested: Neutral	Test Engineer - Yunus Faziloglu
EUT Mode of Operation: BLE-2440MHz External Antenna	Date of Test - 7-25-2024

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	31.2	19.9	51.1	55.7	-4.6	PASS	-4.6
0.208	26.6	19.9	46.5	53.3	-6.8	PASS	
0.27	22.2	19.8	42.1	51.1	-9.1	PASS	
0.334	19.6	19.8	39.4	49.4	-9.9	PASS	
0.37	17.5	19.8	37.4	48.5	-11.1	PASS	
0.438	15.2	19.8	35.1	47.1	-12	PASS	



0.15-30MHz Neutral Quick Average Data table and Plot

4.2 RADIATED SPURIOUS EMISSIONS

4.2.1 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. 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.
3. Measurements above 6GHz or 18GHz can be performed at distances less than 3m from the EUT due to increased noise floor of the measurement system. Since such measurements produce higher amplitudes than what they would be if they were measured at 3 meters, this would be considered worst-case and no compensation back to 3 meters is needed. Limit conversion above 30MHz is done by using inverse linear distance extrapolation factor (20dB/decade) as allowed in FCC 15.31(f)(1).

   Limit(1m) = Limit(3m) + 20*log(3/1) = Limit(3m) + 9.5

   Limit(0.1m) = Limit(3m) + 20*log(3/0.1) = Limit(3m) + 29.5
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. Adjusted Reading (dBuV/m) = Raw Reading (dBuV) + Transducer(Correction) Factor (dB/m)

   Transducer Factor (dB/m) = Antenna Factor (dB/m) – PreAmp Gain (dB) + Cable Loss (dB) + Filter Loss (dB)

   Note: Filter loss only applies if a notch filter is used during testing.
6. 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 H-field limit or an H-field reading is compared to an H-field limit.

4.2.2 TEST EQUIPMENT USED

TEU Below 1GHz 6/21/2023-6/26/2023

Rev. 4/28/2023

Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Rental MXE EMI Receiver(1170725)	20Hz-26.5GHz	N9038A	Agilent	MY51210151	1170725	I	2/21/2024	2/21/2023
Radiated Emissions Sites	**FCC Code**	**IC Code**	**VCCI Code**	**Range**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
EMI Chamber 1	719150	2762A-6	A-0015	30-1000MHz	1685	I	11/29/2024	11/29/2022
Preamps /Couplers Attenuators / Filters	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
8447F Rental PA	9KHz-1.3GHz	84477F	HP	3113A05395		II	10/17/2023	10/17/2022
Antennas	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Red-Black Bilog	30-2000MHz	JB1	Sunol	A091604-2	1106	I	9/14/2023	6/14/2021
Small Loop	10kHz-30MHz	PLA-130/A	ARA	1024	755	I	9/12/2024	9/12/2022
Large Loop	20Hz-5MHz	6511	EMCO	9704-1154	67	I	8/22/2024	8/22/2022
Meteorological Meters/Chambers		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Asset 2707		SD700	EXTECH	A.115171	2707	I	1/13/2025	1/13/2023
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2474	9KHz-18GHz		MegaPhase			II	11/1/2023	11/1/2022
Asset #2610	9KHz-18GHz		Pasternack			II	3/3/2024	3/3/2023
Asset #2681	9KHz-18GHz		Pasternack			II	12/13/2023	12/13/2022

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

TEU above 1GHz 6/15/2023-6/17/2023

Rev. 4/28/2023

Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Rental MXE EMI Receiver(1170725)	20Hz-26.5GHz	N9038A	Agilent	MY51210151	1170725	I	2/21/2024	2/21/2023
Radiated Emissions Sites	**FCC Code**	**IC Code**	**VCCI Code**	**Range**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
EMI Chamber 1	719150	2762A-6	A-0015	1-18GHz	1685	I	12/29/2024	12/29/2022
Antennas	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
3117 Horn / PA	1-18GHZ	3117	ETS	259199	2710	I	3/15/2024	3/15/2023
Meteorological Meters/Chambers		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Asset 2707		SD700	EXTECH	A.115171	2707	I	1/13/2025	1/13/2023
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2610	9KHz-18GHz		Pasternack			II	3/3/2024	3/3/2023
Asset #2681	9KHz-18GHz		Pasternack			II	12/13/2023	12/13/2022

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

TEU 18-25GHz 7/12/2023

Rev. 6/19/2023

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
Radiated Emissions Sites	**FCC Code**	**IC Code**	**VCCI Code**	**Range**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
EMI Chamber 1	719150	2762A-6	A-0015	1-18GHz	1685	I	12/29/2024	12/29/2022
Antennas	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
3116C Horn / PA	18-40GHz	3116C	ETS	258845	2709	I	3/7/2024	3/7/2023
Meteorological Meters/Chambers		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Asset 2707		SD700	EXTECH	A.115171	2707	I	1/13/2025	1/13/2023
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
Asset #2596	9KHz-40GHz		Carlisle			II	4/20/2024	4/20/2023

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

4.2.3 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-18GHz 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. In 18-25GHz a smaller horn antenna was used to make measurements at 1m away from the EUT.

f. For battery operated equipment, tests were performed using fresh batteries.

g. 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)

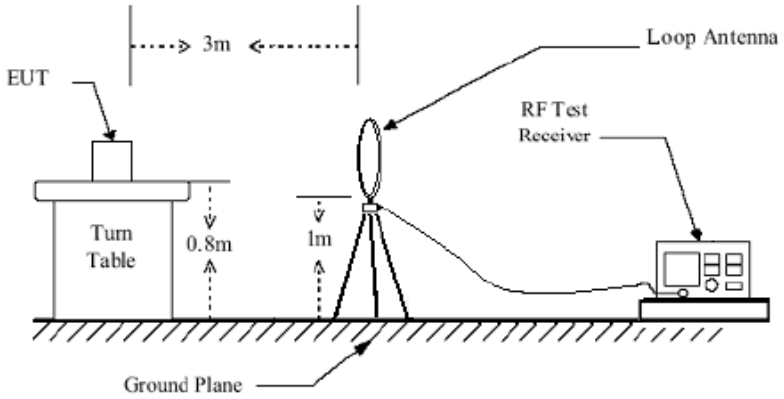
Per FCC §15.209(d), limits §15.209(a) are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. If peak measurements in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

4.2.4 DEVIATIONS

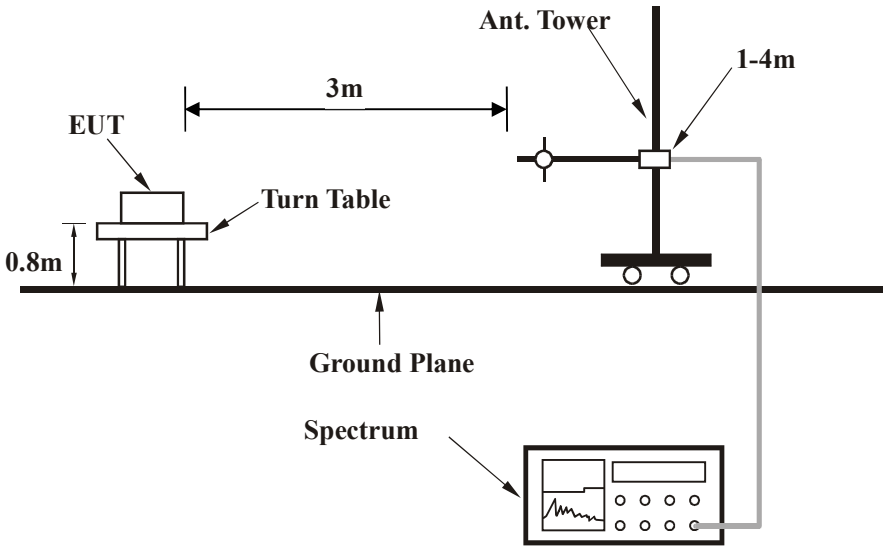
No deviations from the standard.

4.2.5 TEST SETUP

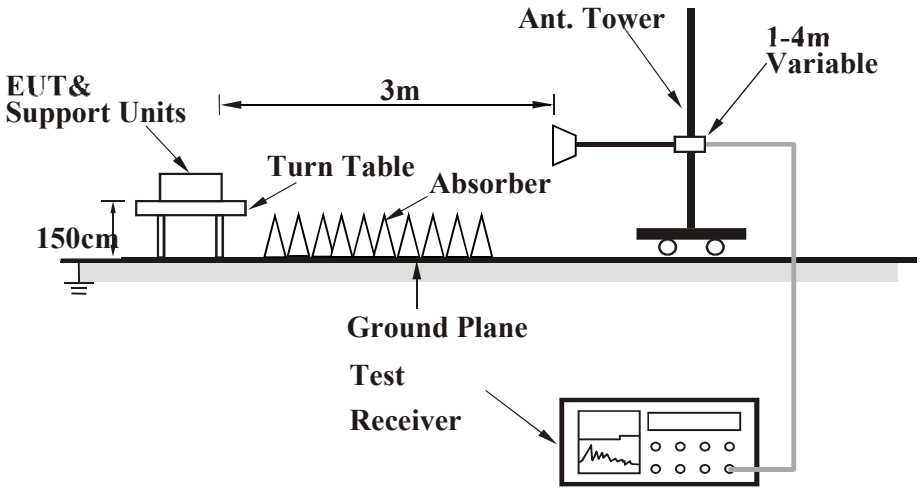
Below 30MHz Test Setup



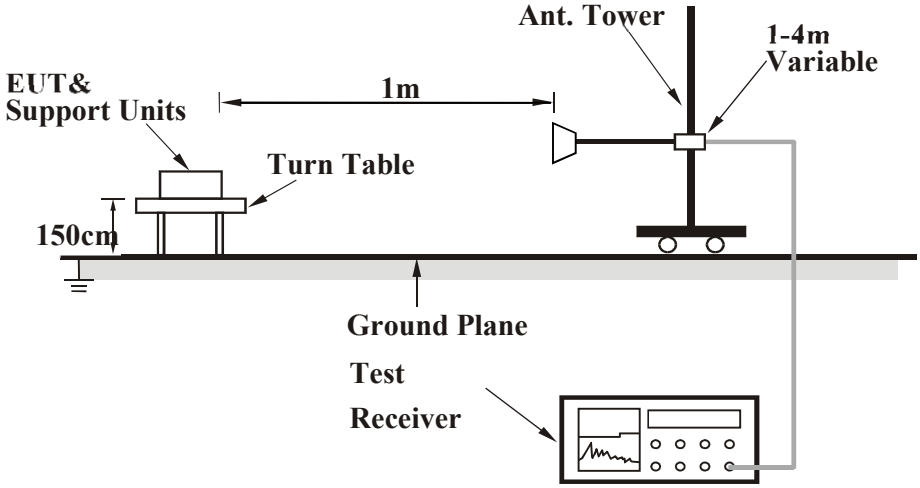
30MHz - 1GHz Test Setup



1GHz – 18GHz Test Setup



18GHz – 25GHz Test Setup



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

4.2.6 EUT OPERATING CONDITIONS

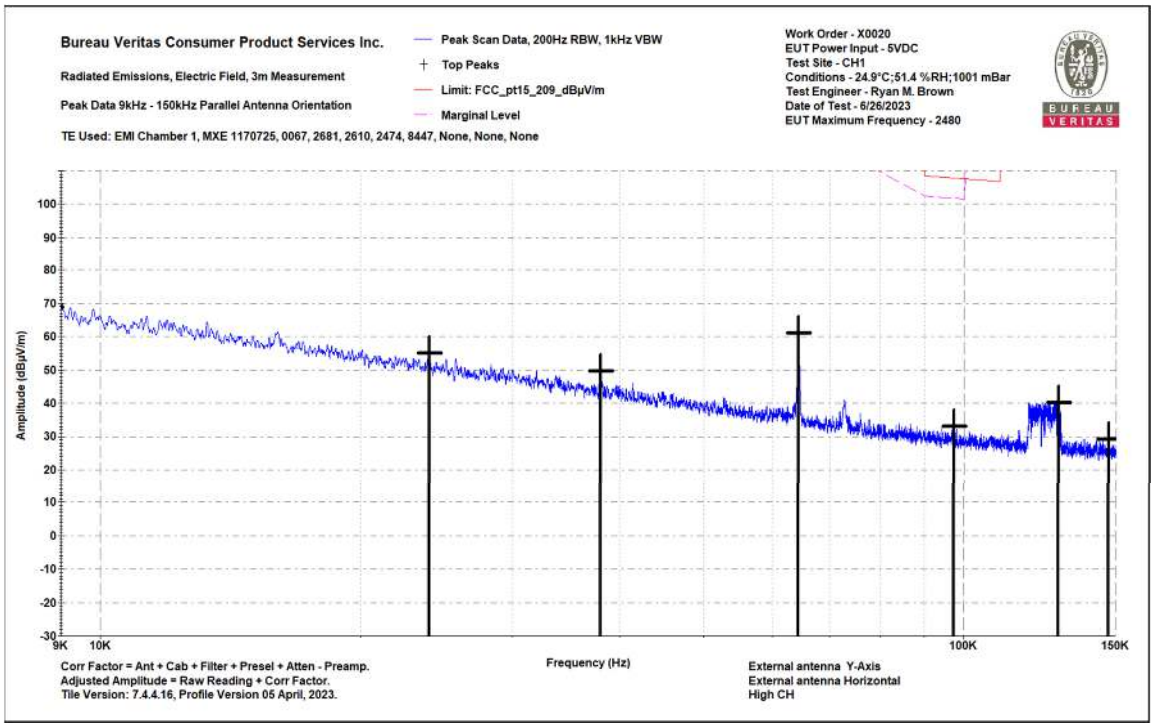
EUT was operated according to the manufacturer's specifications.

4.2.7 TEST RESULTS

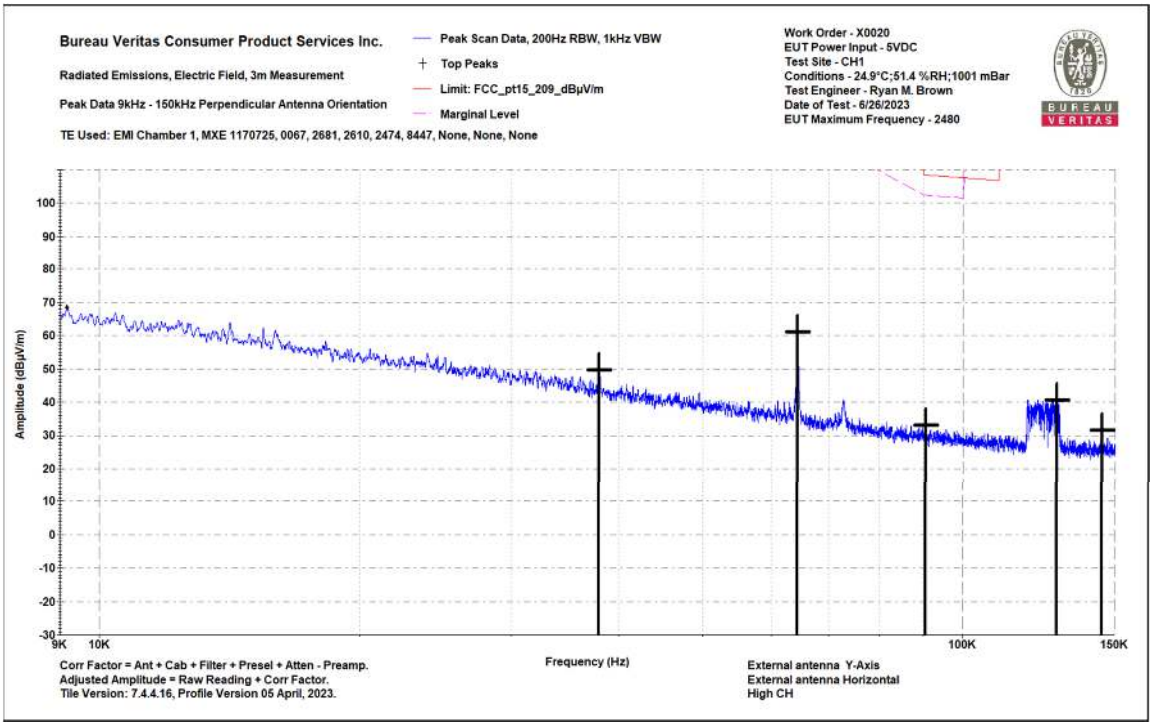
Emissions below 1GHz

External Antenna

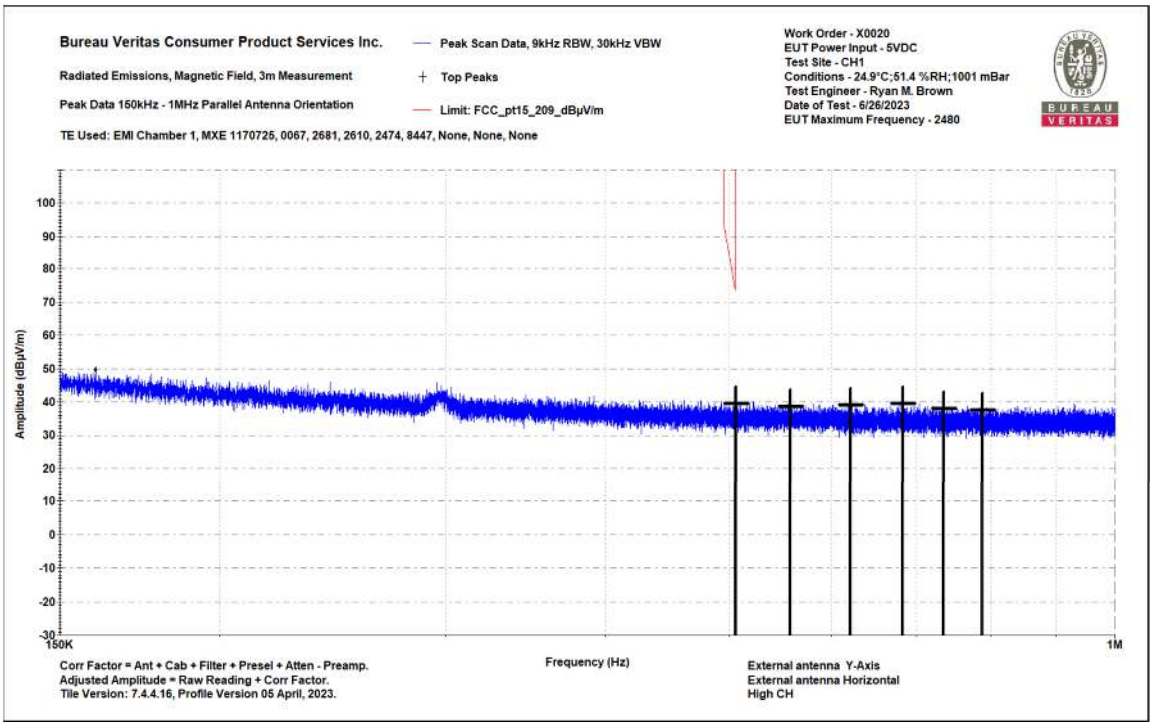
No emissions within 10dB of the limit were identified in the restricted bands of 9kHz-30MHz range. Only plots shown below.



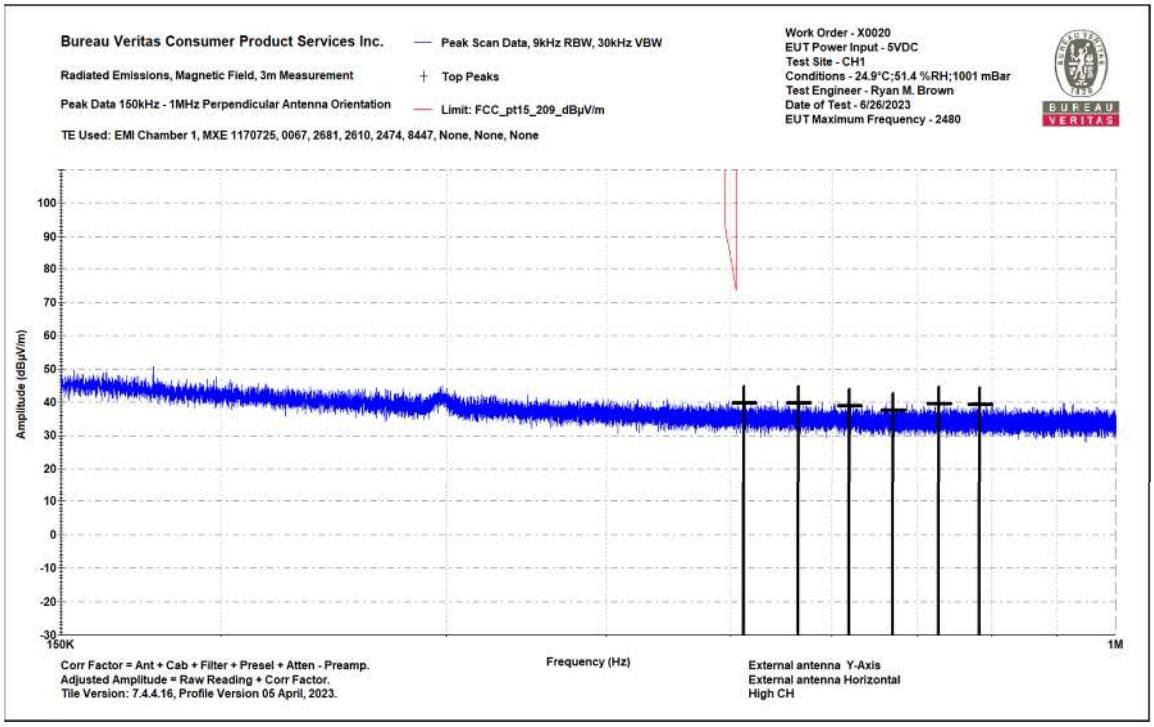
0.009-0.15MHz Parallel



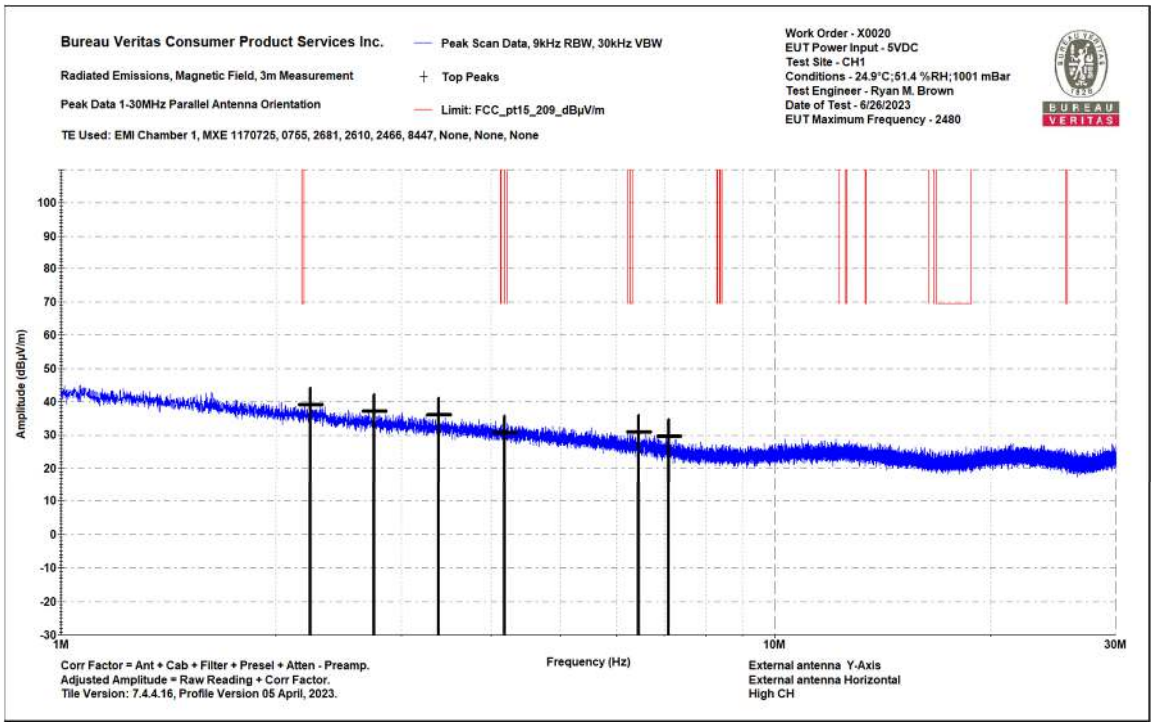
0.009-0.15MHz Perpendicular



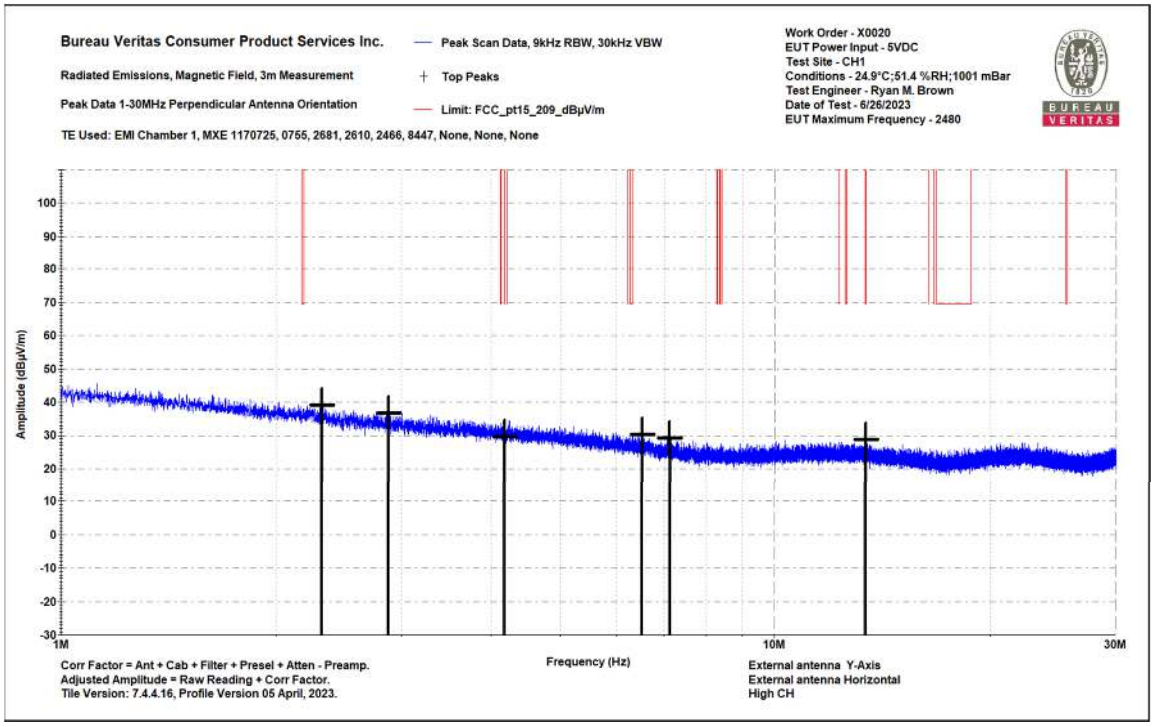
0.15-1MHz Parallel



0.15-1MHz Perpendicular



1-30MHz Parallel



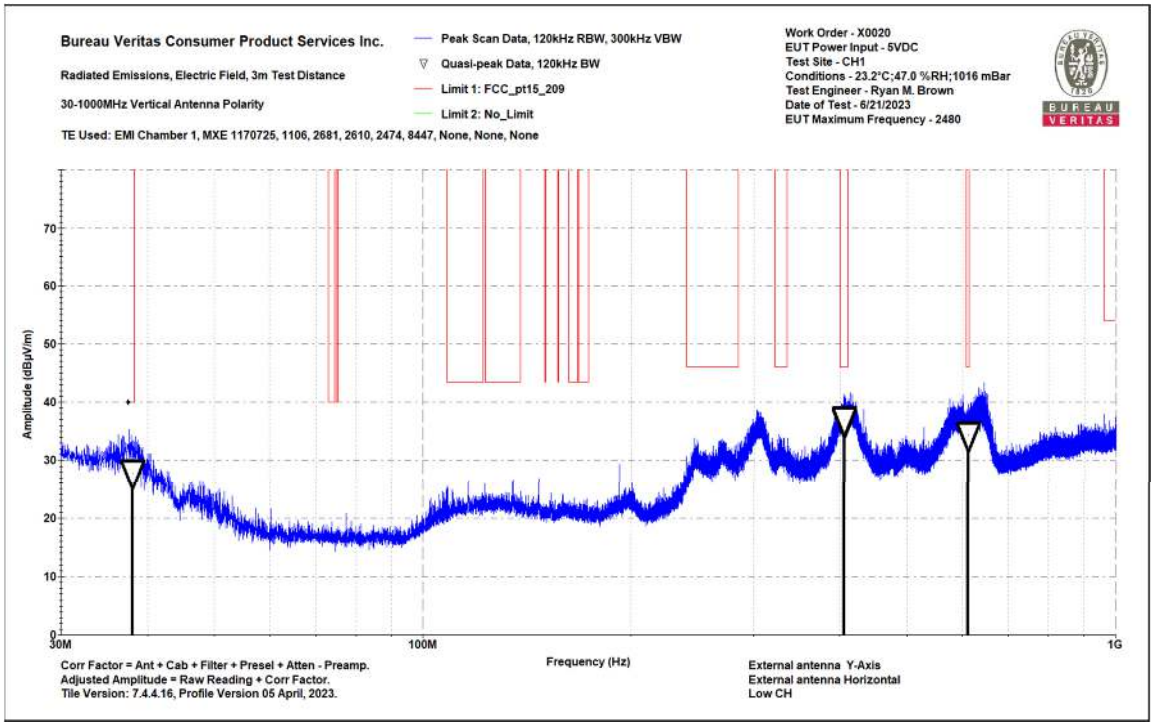
1-30MHz Perpendicular

Bureau Veritas Consumer Product Services Inc.
Radiated Emissions Electric Field 3m Distance
30-1000MHz Vertical Data
Notes:
External antenna Y-Axis
External antenna Horizontal
Low CH

Work Order - X0020
EUT Power Input - 5VDC
Test Site - CH1
Conditions - 23.2°C;47.0 %RH;1016 mBar
Test Engineer - Ryan M. Brown
Date of Test - 6/21/2023

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)	Antenna Height (cm)	EUT Azimuth (degrees)
38.1	31.8	-4	27.8	40	-12.2	PASS		125	114
405.188	39.4	-2.8	36.6	46	-9.4	PASS		130	73
405.903	39.7	-2.8	36.9	46	-9.1	PASS	-9.1	130	306
612.698	33.9	0.4	34.4	46	-11.6	PASS		130	25

30-1000MHz Vertical Data Table



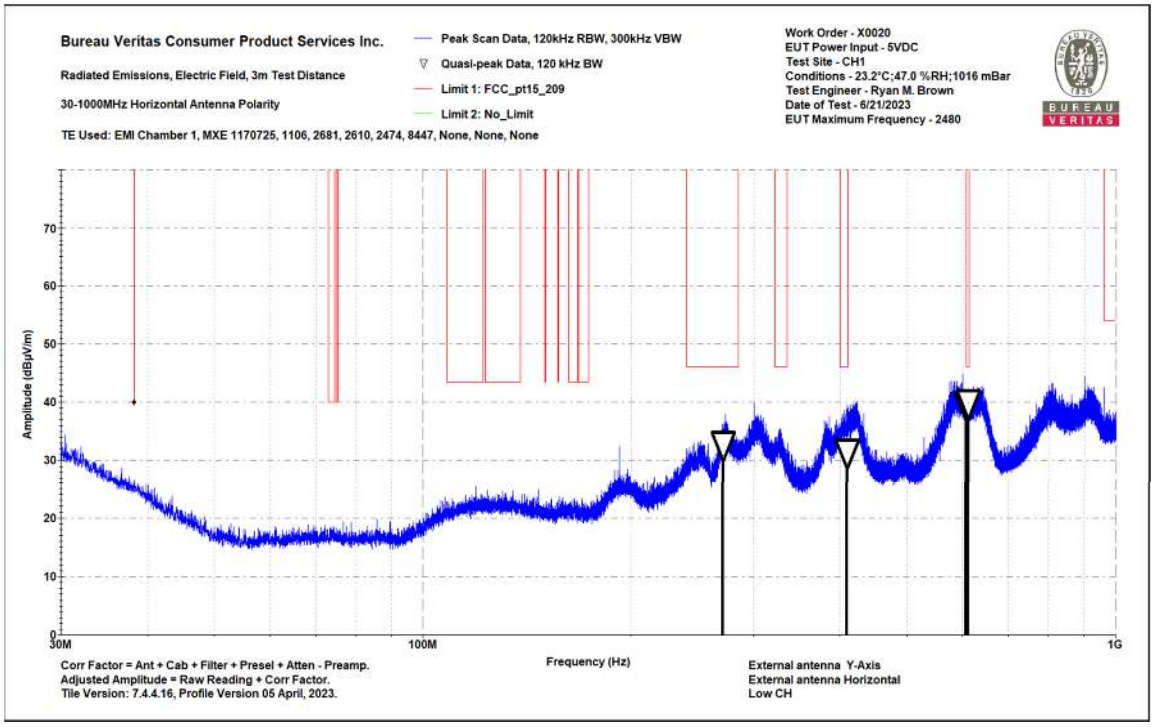
30-1000MHz Vertical Plot

Bureau Veritas Consumer Product Services Inc.
Radiated Emissions Electric Field 3m Distance
30-1000MHz Horizontal Data
Notes:
External antenna Y-Axis
External antenna Horizontal
Low CH

Work Order - X0020
EUT Power Input - 5VDC
Test Site - CH1
Conditions - 23.2°C;47.0 %RH;1016 mBar
Test Engineer - Ryan M. Brown
Date of Test - 6/21/2023

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)	Antenna Height (cm)	EUT Azimuth (degrees)
271.155	37.7	-4.9	32.8	46	-13.2	PASS		125	25
409.299	34.1	-2.7	31.4	46	-14.6	PASS		125	43
608.558	39.3	0.4	39.6	46	-6.4	PASS		125	295
612.895	39.4	0.4	39.9	46	-6.1	PASS	-6.1	125	286

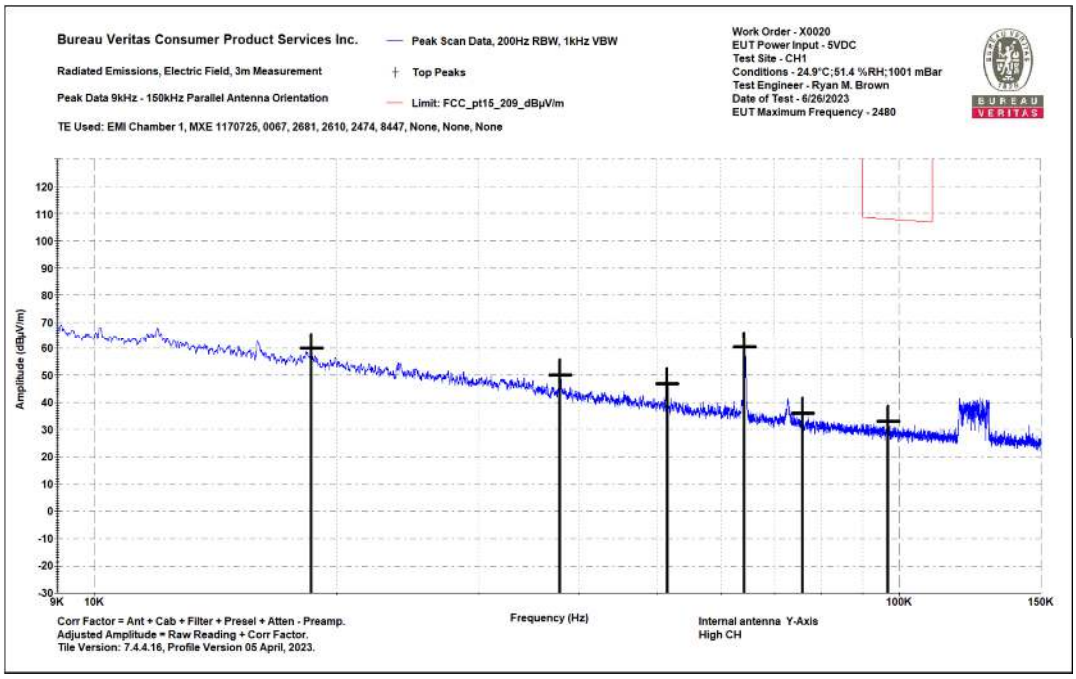
30-1000MHz Horizontal Data Table



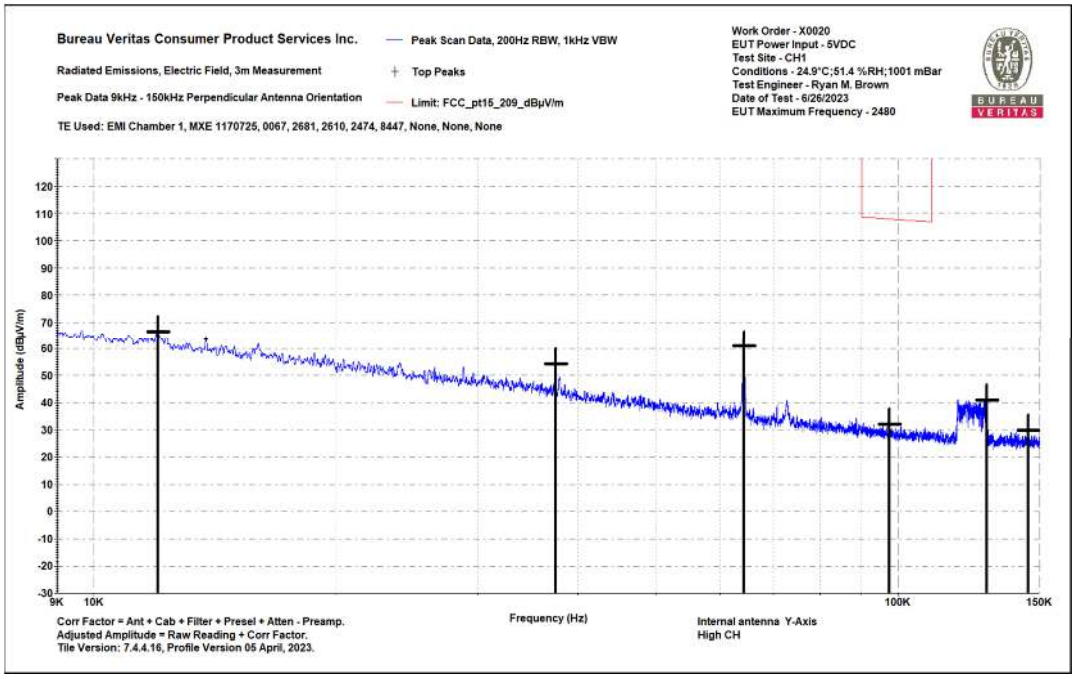
30-1000MHz Horizontal Plot

Internal Antenna

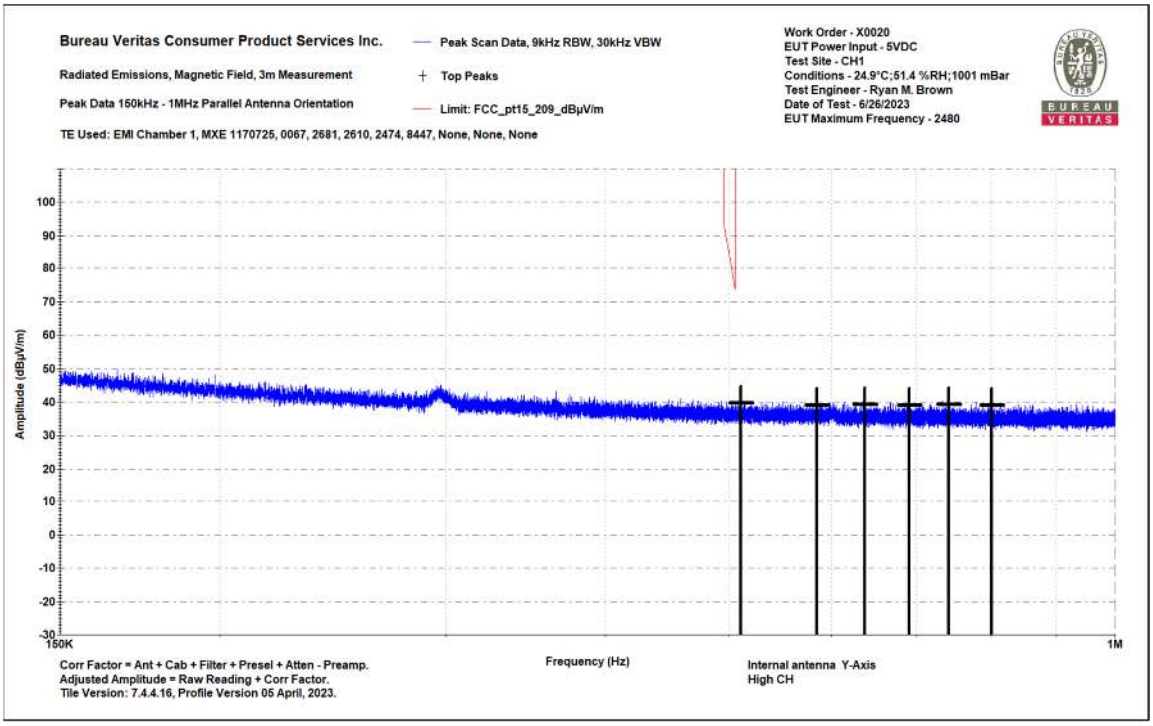
No emissions within 10dB of the limit were identified in the restricted bands of 9kHz-30MHz range. Only plots shown below.



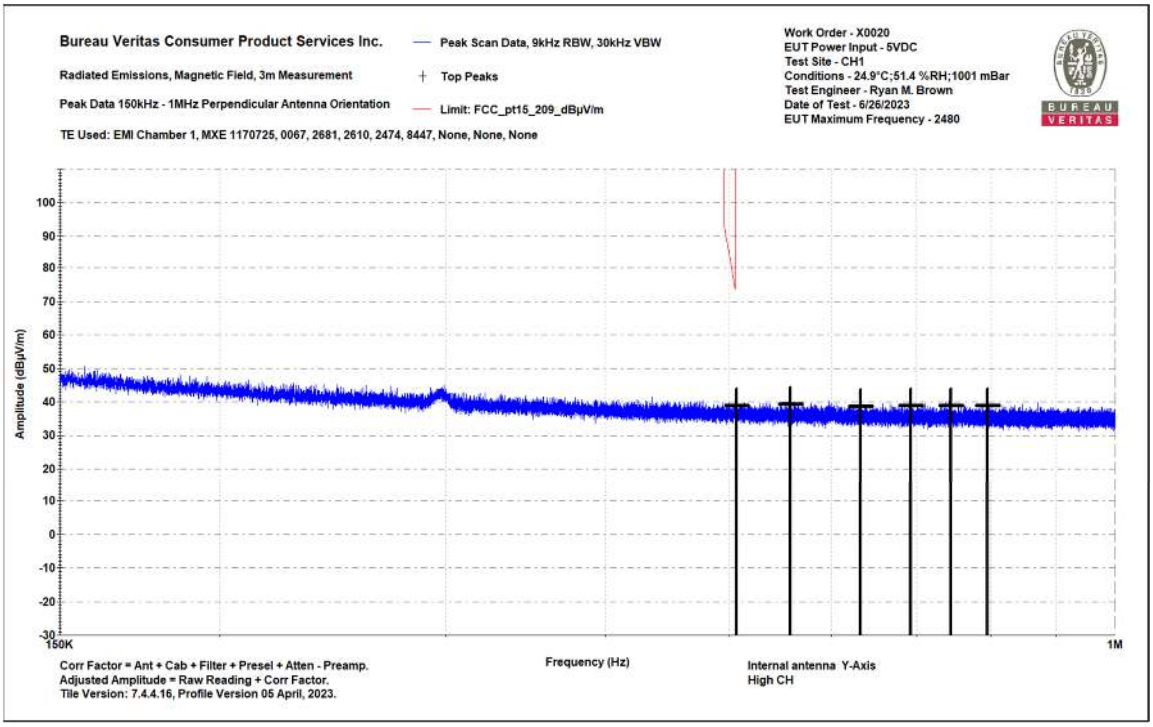
0.009-0.15MHz Parallel



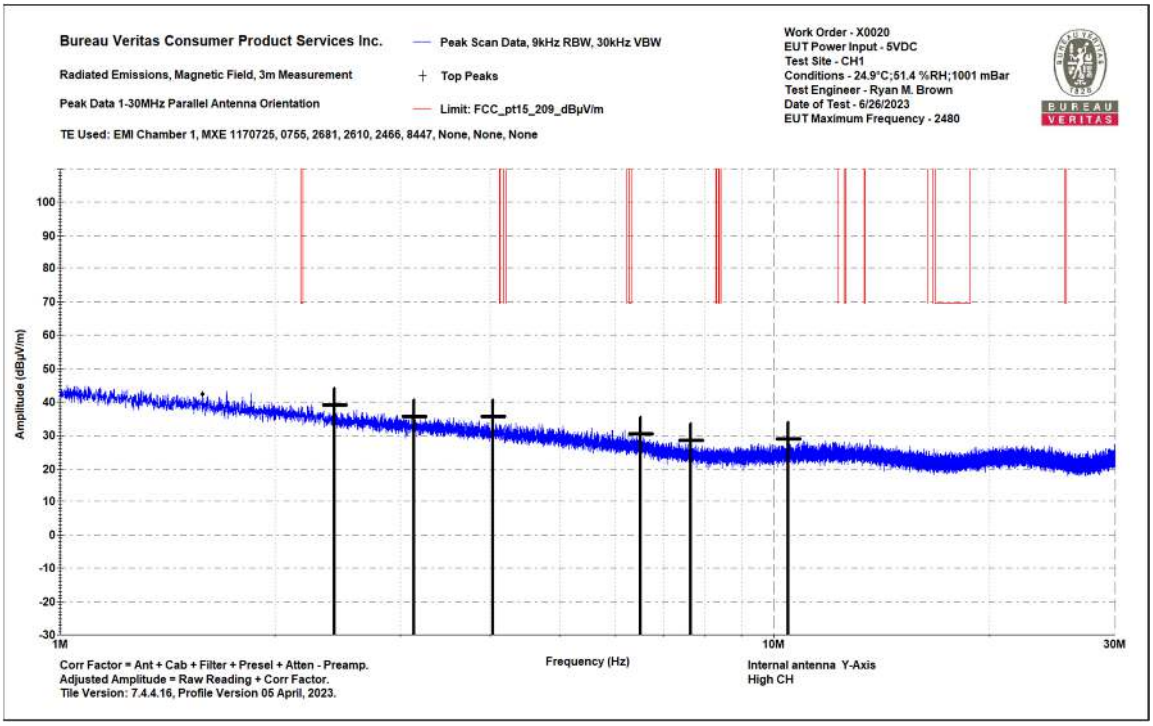
0.009-0.15MHz Perpendicular



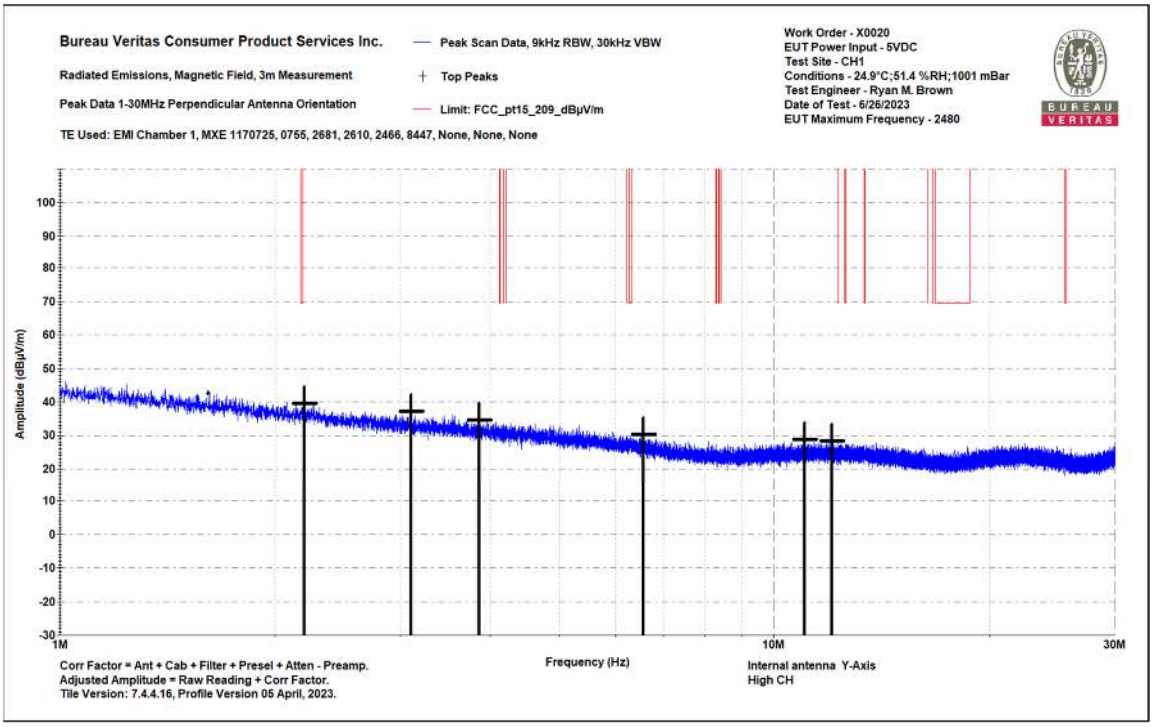
0.15-1MHz Parallel



0.15-1MHz Perpendicular



1-30MHz Parallel

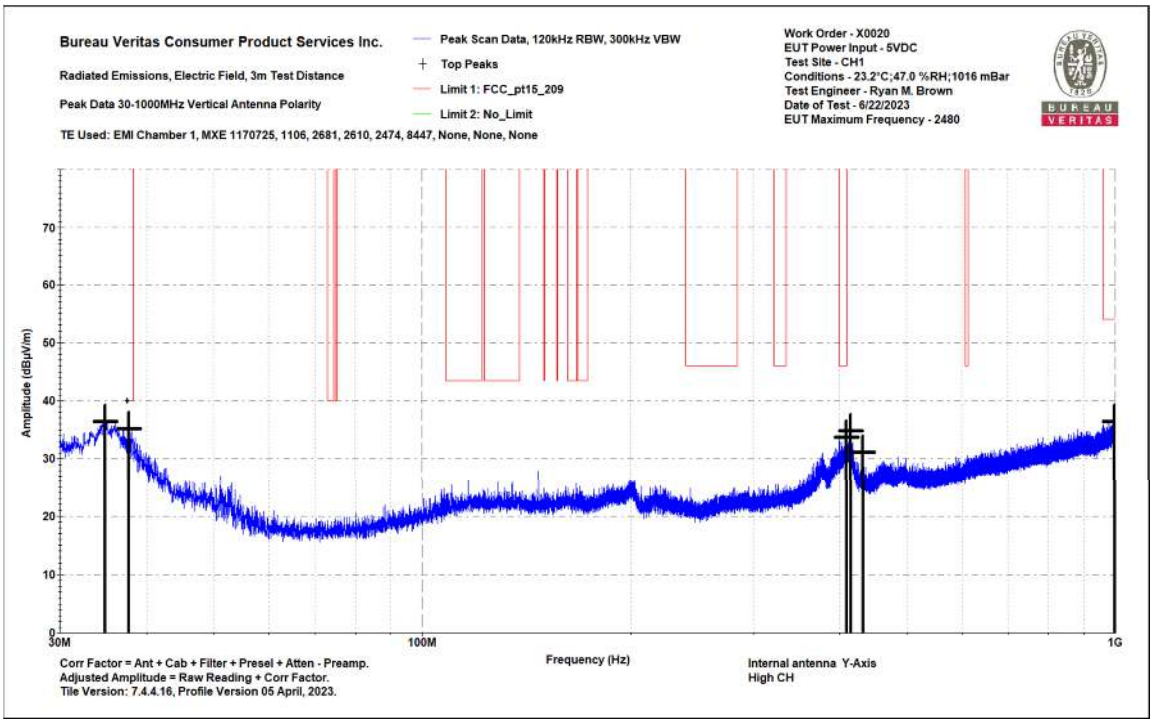


1-30MHz Perpendicular

Bureau Veritas Consumer Product Services Inc.	Work Order - X0020
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 5VDC
Top Peaks Vertical 30-1000MHz	Test Site - CH1
Notes:	Conditions - 23.2°C;47.0 %RH;1016 mBar
Internal antenna Y-Axis	Test Engineer - Ryan M. Brown
High CH	Date of Test - 6/22/2023
0	

Frequency (MHz)	Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim1: FCC_pt15_209 (dBµV/m)	Lim1 Margin (dB)	Lim1 Test Results (Pass/Fail)	Worst Margin Lim1 (dB)	Antenna Height (cm)	Turntable Azimuth (degrees)
37.687	38.9	-3.7	35.2	40	-4.8	PASS	-4.8	100	225
409.294	36.5	-2.7	33.8	46	-12.2	PASS		150	45
998.545	29.5	6.9	36.4	54	-17.6	PASS		100	270

30-1000MHz Vertical Data Table

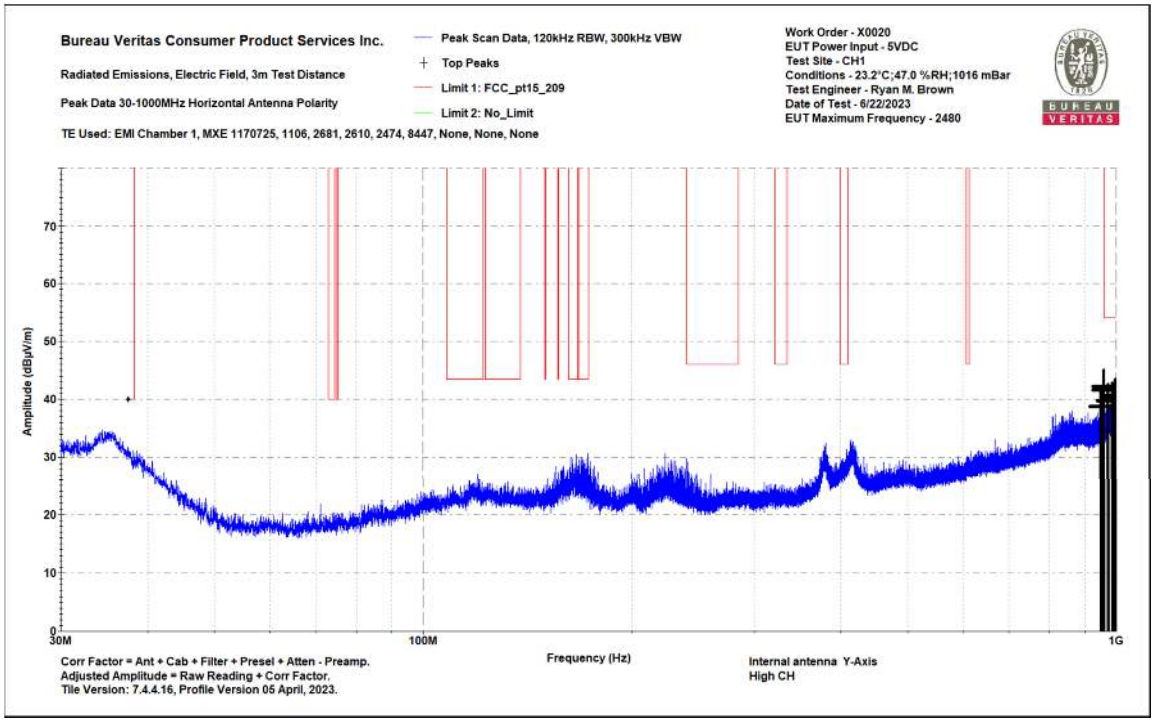


30-1000MHz Vertical Plot

Bureau Veritas Consumer Product Services Inc.	Work Order - X0020
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 5VDC
Top Peaks Horizontal 30-1000MHz	Test Site - CH1
Notes:	Conditions - 23.2°C;47.0 %RH;1016 mBar
Internal antenna Y-Axis	Test Engineer - Ryan M. Brown
High CH	Date of Test - 6/22/2023
0	

Frequency (MHz)	Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim1: FCC_pt15_209 (dBµV/m)	Lim1 Margin (dB)	Lim1 Test Results (Pass/Fail)	Worst Margin Lim1 (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
960.012	35.2	6.4	41.6	54	-12.4	PASS	-12.4	150	45
975.265	33.2	6.6	39.7	54	-14.3	PASS		150	45
987.705	33.3	6.7	40	54	-14	PASS		150	45
996.532	33.7	6.9	40.6	54	-13.4	PASS		150	45

30-1000MHz Horizontal Data Table



30-1000MHz Horizontal Plot

Emissions above 1GHz

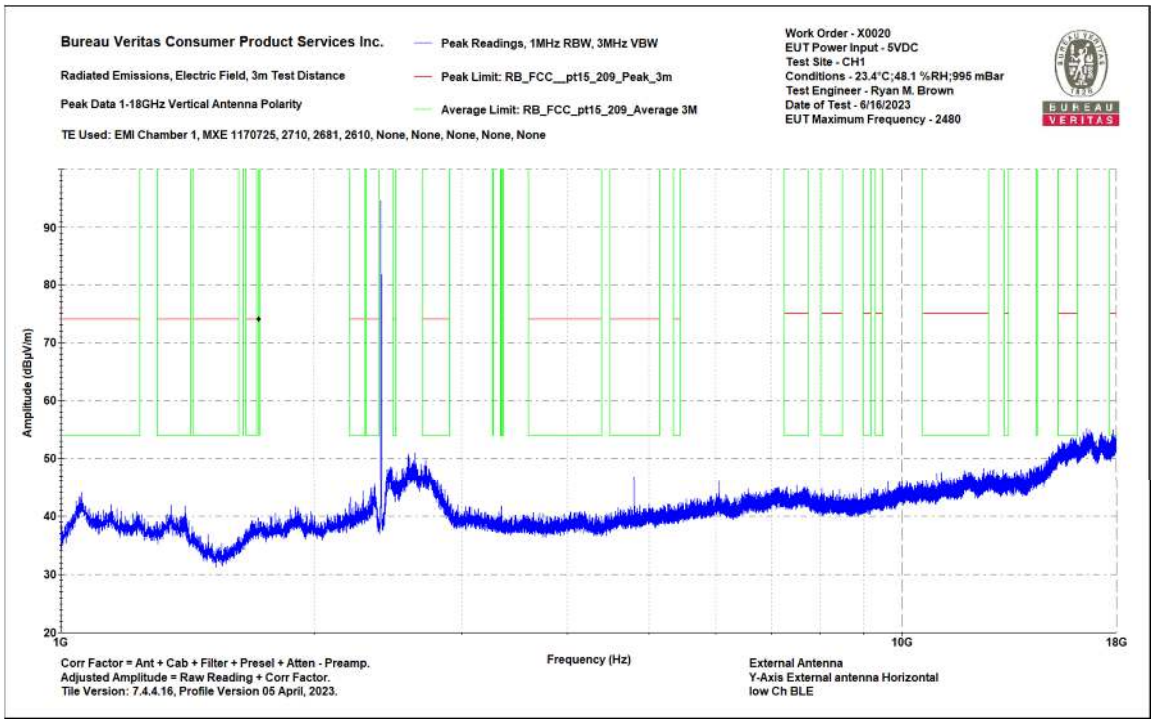
External Antenna

Results for BLE 1Mbps GFSK Channel 0

Bureau Veritas Consumer Product Services Inc.	Work Order - X0020
Radiated Emissions Electric Field 3m Distance	EUT Power Input - 5VDC
1-18GHz Vertical Data	Test Site - CH1
Notes:	Conditions - 23.4°C;48.1 %RH;995 mBar
External Antenna	Test Engineer - Ryan M. Brown
Y-Axis External antenna Horizontal	Date of Test - 6/16/2023
low Ch BLE	

Frequency (MHz)	Raw Peak (dBµV)	Raw RMS Average (dBµV)	Correction Factor (dB/m)	Adjusted Peak (dBµV/m)	Adjusted RMS Average (dBµV/m)	Peak Limit FCC 15.209 (dBµV/m)	Peak Margin (dB)	Peak Result (Pass/Fail)	Peak Worst Margin (dB)	Average Limit FCC 15.209 (dBµV/m)	Average Margin (dB)	Average Result (Pass/Fail)	Average Worst Margin (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
2286.6	34.35	34.35	6.6	40.95	40.95	74	-33.05	PASS	--	54	-13.05	PASS	--	100	25
4803.7	35.82	35.82	9.9	45.72	45.72	74	-28.28	PASS	--	54	-8.28	PASS	--	200	272
17808.6	29.16	29.16	22.5	51.66	51.66	74	-22.34	PASS	--	54	-2.34	PASS	-2.34	100	119
17826	28.81	19.6	22.5	51.31	42.1	74	-22.69	PASS	--	54	-11.9	PASS	--	200	151
17874	29.06	20.18	22.5	51.56	42.68	74	-22.44	PASS	--	54	-11.32	PASS	--	100	10
17986.9	30.75	20.09	22.6	53.35	42.69	74	-20.65	PASS	-20.65	54	-11.31	PASS	--	100	97

1-18GHz Vertical Data Table



1-18GHz Vertical Plot