Test Report Serial Number:	**45461700 R2.0**
Test Report Date:	**20 January 2022**
Project Number:	**1551**

EMC Test Report - New Application

Applicant:

tekmar Control Systems Ltd.
5100 Silver Star Road
Vernon, British Columbia, V1B 3K4
Canada

FCC ID:	IC Registration Number
2AHQR-11500A	**21247-11500A**
Product Model Number / HVIN	Host Marketing Name / HMN
1150-01	**Smart Boiler Control 294**

In Accordance With:

CFR Title 47, Part 15 Subpart B
Unintentional Radiators

RSS-Gen, ICES-003
Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement

Approved By:

Ben Hewson, President
Celltech Labs Inc.
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Canada

Test Lab Certificate: 2470.01

IC Registration 3874A

FCC Registration: CA3874

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1.0 DOCUMENT CONTROL

Revision History				
Samples Tested By:	Art Voss, P.Eng.	**Date(s) of Evaluation:**		22 - 23 September 2021
Report Prepared By:	Art Voss, P.Eng.	**Report Reviewed By:**		Ben Hewson
Report Revision	**Description of Revision**	**Revised Section**	**Revised By**	**Revision Date**
0.1	Draft	n/a	Art Voss	9 December 2021
1.0	Initial Release	n/a	Art Voss	20 December 2021
2.0	Revised PLCE Data	9.0	Art Voss	20 January 2022

2.0 CLIENT AND DUT INFORMATION

Client Information	
Applicant Name (FCC)	**tekmar Control Systems Ltd.**
Applicant Address (FCC)	5100 Silver Star Road
	Vernon, British Columbia, V1B 3K4
	Canada
DUT Information	
Device Identifier(s):	**FCC ID:** **2AHQR-11500A**
	ISED ID: **21247-11500A**
Device Type:	Boiler Controller
Host Device Model(s) / HVIN:	1150-01
Host Marketing Name / HMN:	Smart Boiler Control 294
Host Firmware Version ID Number / FVIN:	-
Test Sample Serial No.:	Engineering Sample 5
Equipment Class (FCC):	JAD - Part 15 Class A Digital Device
Equipment Class (ISED):	-
Transmit Frequency Range:	-
Number of Channels:	-
Manuf. Max. Rated Output Power:	-
Antenna Make and Model:	-
Antenna Type and Gain:	-
Modulation:	-
Mode:	-
DUT Power Source:	120VAC
DUT Dimensions [LxWxH] (mm)	L x W x H: 215mm x 200mm x 60mm
Deviation(s) from standard/procedure:	None
Modification of DUT:	None
Integrated Module Information	
Module Manufacturer:	ESPRESSIF SYSTEMS (SHANGHAI) Co., LTD.
Device Identifier(s):	**FCC ID:** **2AC7Z-ESP32WROOM32E**
	ISED ID: **21098-ESPWROOM32E**
Device Type:	WiFi and BlueTooth IoT Module
Module Device Model(s) / HVIN:	ESP32-WROOM-32E
Module Product Marketing Name / PMN:	ESP32-WROOM-32E
Host Firmware Version ID Number / FVIN:	V1.0
Equipment Class (FCC):	Digital Transmission System (DTS)
Equipment Class (FCC):	Part 15 Spread Spectrum Transmitter (DSS)
Equipment Class (ISED):	Wireless Local Area Network Device (Indoor Only)
Transmit Frequency Range:	WiFi : 2412-2462MHz, BlueTooth / BLE: 2402-2480MHz
Test Channels:	n/a
Manuf. Max. Rated Output Power:	WiFi: 398mW (26dBm), BlueTooth 10mW (10dBm), BLE: 6mW (7.8dBm)

Integrated Module Information	
Module Manufacturer:	Silicon Laboratories Finland Oy
Device Identifier(s):	**FCC ID:** QOQMGM12P0
	ISED ID: 5123A-MGM12P0
Device Type:	802.15.4 Transceiver
Module Device Model(s) / HVIN:	MGM12P02GA
Module Product Marketing Name / PMN:	MGM12P
Host Firmware Version ID Number / FVIN:	2.6x
Equipment Class (FCC):	Digital Transmission System (DTS)
Equipment Class (ISED):	Spread Spectrum or Digital Device (2400-2483.5 MHz)
Transmit Frequency Range:	2402-2480MHz
Test Channels:	n/a
Manuf. Max. Rated Output Power:	9.14mW (9.6dBm)

3.0 SCOPE

Preface:

This Certification Report was prepared on behalf of:

tekmar Control Systems Ltd.

,(the '*Applicant*"), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 and Innovation, Scientific and Economic Development (ISED) Canada rules parts and regulations (the '*Rules*'). The scope of this investigation was limited to only the equipment, devices and accessories (the '*Equipment*') supplied by the *Applicant*. The tests and measurements performed on this *Equipment* were only those set forth in the applicable *Rules* and/or the Test and Measurement Standards they reference. The *Rules* applied and the Test and Measurement Standards used during this evaluation appear in the Normative References section of this report. The limits set forth in the technical requirements of the applicable *Rules* were applied to the measurement results obtained during this evaluation and ,unless otherwise noted, these limits were used as the Pass/Fail criteria. The Pass/Fail statements made in this report apply to only the tests and measurements performed on only the *Equipment* tested during this evaluation. Where applicable and permissible, information including test and measurement data and/or results from previous evaluations of same or similar equipment, devices and/or accessories may be cited in this report.

Device Description:

The HVIN: 1150-01,HMN: Smart Boiler Controller 294 is a Class A industrial boiler controll device containing a pre-certified WiFi module and a pre-certified 802.15.4 module. It contains no other transmitter. Both transmitters are cable of simultaneous transmission.

Application:

This is an application for a New Certification, Single.

Regulatory Requirement:

As per FCC 47 CFR 2 Subpart I and the Radiocommunication Regulations of Canada, Equipment Authorization is require for this *Equipment* by means of Certification in accordance with FCC 47 CFR §15.249 and ISED RSS-210.

Scope of Work:

The scope of this investigation is limited only to the evaluation of the 1150-01 to determine compliance to the *Rules* identified herein, including simultaneous transmission evaluation.

RF Exposure:

As per FCC 47 CFR §2.1091 and Canada Health Safety Code 6, an RF Exposure (MPE) evaluation is required for this *Equipment* and the results of the RF Exposure (MPE) evaluation appear in a separate report.

4.0 TEST SUMMARY

TEST SUMMARY						
Section	**Description of Test**	**Procedure Reference**	**Applicable Rule Part(s) FCC**	**Applicable Rule Part(s) ISED**	**Test Date**	**Result**
7.0	Radiated Tx Emissions	ANSI C63.4-2014	§15.209	RSS-Gen 8.10	22 Sep 2021	Pass
8.0	Radiated Rx Emissions	ANSI C63.4-2014	§15.109	ICES-003(6.1)	22 Sep 2021	Pass
9.0	Power Line Conducted Emissions	ANSI C63.4-2014	§15.107	ICES-003(6.1)	23 Sep 2021	Pass

Test Station Day Log					
Date	**Ambient Temp (°C)**	**Relative Humidity (%)**	**Barometric Pressure (kPa)**	**Test Station**	**Tests Performed Section(s)**
22 Sep 2021	16.0	63	101.8	**OATS**	**7.0, 8.0**
23 Sep 2012	23.0	18	102.6	**LISN**	**9.0**

EMC - EMC Test Bench
OATS - Open Area Test Site
LISN - LISN Test Area
IMM - Immunity Test Area
SAC - Semi-Anechoic Chamber
TC - Temperature Chamber
ESD - ESD Test Bench
RI - Radiated Immunity Chamber

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.

Art Voss, P.Eng.
Technical Manager
Celltech Labs Inc.

14 December 2021
Date

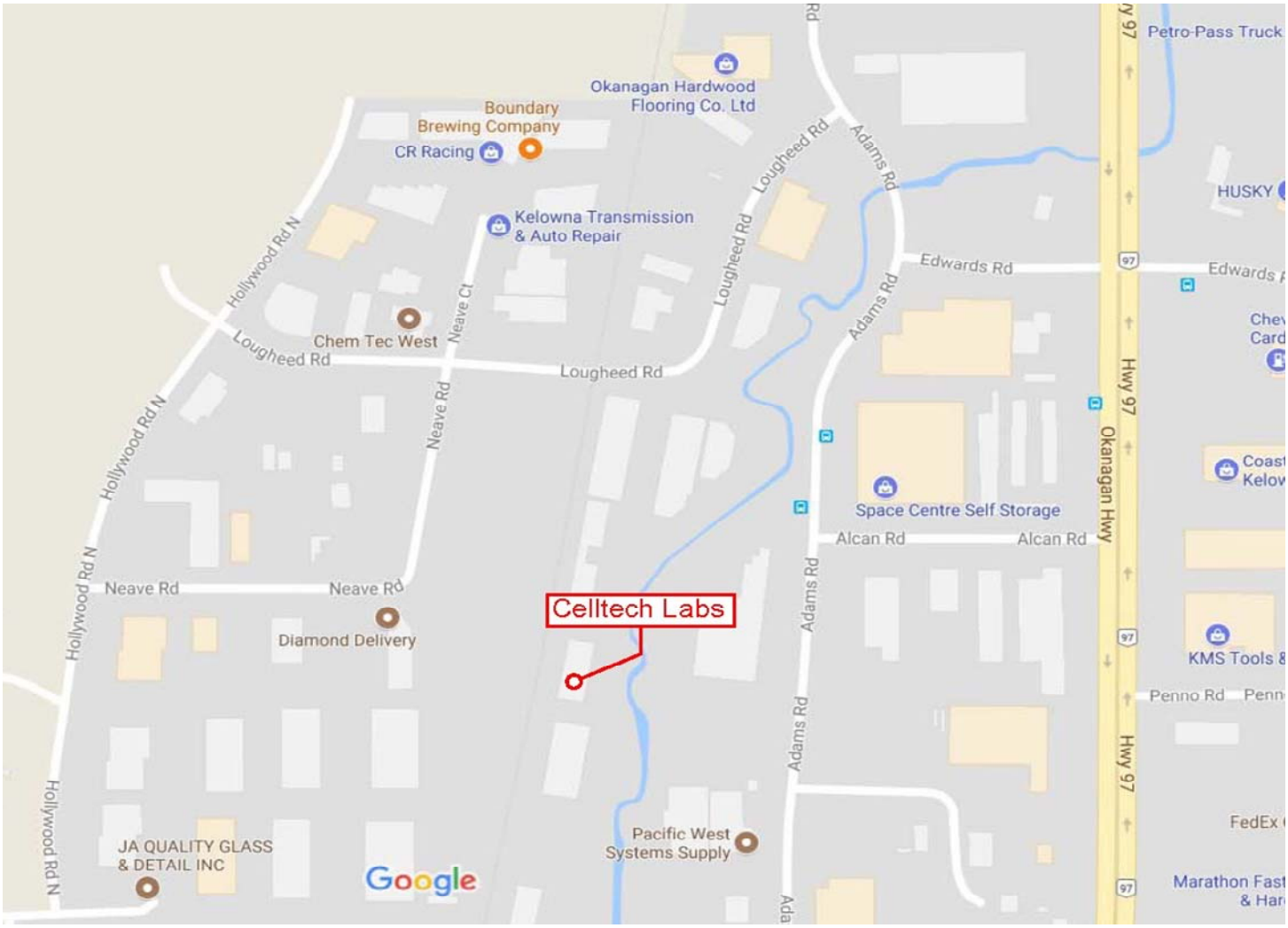
5.0 NORMATIVE REFERENCES

Normative References	
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
ANSI C63.4-2014	American National Standard of Procedures for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electric and Electronic Equipment in the Range of 9kHz to 40GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CFR Title 47: Part 2:	Code of Federal Regulations Telecommunication Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
CFR Title 47: Part 15: Subpart B:	Code of Federal Regulations Telecommunication Radio Frequency Devices Unintentional Radiators
ISED RSS-Gen Issue 5A1: March 2019	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification General Requirements and Information for the Certification of Radiocommunication Equipment
ISED ICES-003 Issue 6: Jan 2016	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement
FCC KDB 996369 D04v02	OET Major Guidance Publications, Knowledge Data Base Modular Transmitter Integration Guide Guidance for Host Product Manufacturers

6.0 FACILITIES AND ACCREDITATIONS

Facility and Accreditation:

The facilities used to evaluate this device outlined in this report are located at 21-364 Lougheed Road, Kelowna, British Columbia, Canada V1X 7R8. The radiated emissions site (OATS) conforms to the requirements set forth in ANSI C63.4 and is filed and listed with the FCC under Test Firm Registration Number CA3874 and Innovation, Science and Economic Development Canada under Test Site File Number ISED 3874A. Celltech is accredited to ISO 17025, through accrediting body A2LA and with certificate 2470.01.



7.0 RADIATED TX SIMULTANEOUS EMISSIONS (RESTRICTED BAND)

Test Procedure	
Normative Reference	FCC 47 CFR §2.1051, §15.209(a), RSS-GEN (8.10)
	KDB 558074 (8.6), ANSI C63.10 (11.12)

Limits

47 CFR §15.249(d)	(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
47 CFR §15.209(a)	**§15.209 Radiated emission limits; general requirements.** (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)
0.009 - 0.490	2400/F (kHz) @300m
0.490 - 1.705	24000/F (kHz) @30m
1.705 - 30	30 @ 30m
30 - 88	100 @3m
88 - 216	150 @3m
216 - 960	200 @3m
Above 960	500 @3m

See Appendix D for Measurement Plots

Table 7.1 – Summary of Radiated Tx, Simultaneous Emissions (Restricted Band)

Summary of Radiated Tx Emissions (Restricted Band)										
Measured Frequency Range (MHz)	Channel Frequency (MHz)	Antenna Polarization	Emission Frequency	Measured Emission [E_{Meas}] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L_C] (dB)	Amplifier Gain [G_A] (dB)	Corrected Emission [E_{Corr}] (dBuV/m)	Limit (dBuV)	Margin (dB)
30-1000MHz	2412 & 2475	Horizontal	452.60	36.0	0.00	0.00	0.00 (3)	36.0 (2)	45.0	**9.0**
30-1000MHz		Horizontal	500.20	36.7	0.00	0.00		36.7 (2)	45.0	**8.3**
30-1000MHz		Horizontal	856.52	42.7	0.00	0.00		42.7 (2)	45.0	**2.3**
30-1000MHz		Horizontal	878.90	42.6	0.00	0.00		42.6 (2)	45.0	**2.4**
30-1000MHz		Vertical	729.10	39.3	0.00	0.00		39.3 (2)	45.0	**5.7**
30-1000MHz		Vertical	856.50	41.2	0.00	0.00		41.2 (2)	45.0	**3.8**
1 - 3GHz		Horizontal	ND	ND (1)	30.09	5.88		ND	60.0	**n/a**
1 - 3GHz		Vertical			30.09	5.88		ND	60.0	**n/a**
3-10GHz		Horizontal			37.97	11.21		ND	60.0	**n/a**
3-10GHz		Vertical			37.97	11.21		ND	60.0	**n/a**
10 - 13.6GHz		Horizontal			40.79	14.00		ND	60.0	**n/a**
10 - 13.6GHz		Vertical			40.79	14.00		ND	60.0	**n/a**
13.6 - 18GHz		Horizontal			47.45	17.60		ND	60.0	**n/a**
13.6 - 18GHz		Vertical			47.45	17.60		ND	60.0	**n/a**
18 - 22GHz		Horizontal			42.55	21.00		ND	60.0	**n/a**
18 - 22GHz		Vertical			42.55	21.00		ND	60.0	**n/a**
22 - 25GHz		Horizontal			42.96	23.40		ND	60.0	**n/a**
22 - 25GHz		Vertical			42.96	23.40		ND	60.0	**n/a**
								Results:	**Complies**	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
(3) External Amplier not used

$E_{Corr} = E_{Meas} + ACF + L_C - G_A$

8.0 RADIATED RX EMISSIONS

Test Procedure	
Normative Reference	FCC 47 CFR §15.109, ICES-003(6.2) ANSI C63.4-2014

Limits		
47 CFR §15.109	(b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:	
	30-88MHz: 39.1dBuV/m	30-88MHz: 49.6dBuV/m @ 3m
	88-216MHz: 43.5dBuV/m	88-216MHz: 54.0dBuV/m @ 3m
	216-960MHz: 46.4dBuV/m	216-960MHz: 56.9dBuV/m @ 3m
	> 960MHz: 49.5dBuV/m	> 960MHz: 60.0dBuV/m @ 3m
ICES-003(6.2.1)	6.2.1 - Radiated Emissions Limits Below 1 GHz Class A: ITE that meets the conditions for Class A operation defined in Section 2.2 shall comply with the Class A radiated limits set out in Table 4 determined at a distance of 10 metres.	
	30-88MHz: 39.1dBuV/m	30-88MHz: 49.6dBuV/m @ 3m
	88-216MHz: 43.5dBuV/m	88-216MHz: 54.0dBuV/m @ 3m
	216-960MHz: 46.4dBuV/m	216-960MHz: 56.9dBuV/m @ 3m
	> 960MHz: 49.5dBuV/m	> 960MHz: 60.0dBuV/m @ 3m

Test Setup	Appendix A	Figure A.1

Measurement Procedure
The DUT was set up as per ANSI C63.4:2014. Emissions were scanned between 30MHz and 1000MHz. The turntable was rotated 360 degrees and the antenna was elevated to 4m to optimize the measured emissions.

See Appendix E for Measurement Plots

Table 8.1 – Summary of Radiated Rx Emissions

Summary of Radiated Rx Emissions									
Measured Frequency Range (MHz)	**Antenna Polarization**	**Emission Frequency**	**Measured Emission [E_{Meas}] (dBuV)**	**Antenna ACF [ACF] (dB)**	**Cable Loss [L_C] (dB)**	**Amplifier Gain [G_A] (dB)**	**Corrected Emission [E_{Corr}] (dBuV/m)**	**Limit (dBuV)**	**Margin (dB)**
30-1000MHz	Horizontal	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	56.9	**n/a**
30-1000MHz	Vertical			0.00	0.00		ND (2)	56.9	**n/a**
1 - 3GHz	Horizontal			30.09	5.88		ND	60.0	**n/a**
1 - 3GHz	Vertical			30.09	5.88		ND	60.0	**n/a**
3-10GHz	Horizontal			37.97	11.21		ND	60.0	**n/a**
3-10GHz	Vertical			37.97	11.21		ND	60.0	**n/a**
10 - 13.6GHz	Horizontal			40.79	14.00		ND	60.0	**n/a**
10 - 13.6GHz	Vertical			40.79	14.00		ND	60.0	**n/a**
13.6 - 18GHz	Horizontal			47.45	17.60		ND	60.0	**n/a**
13.6 - 18GHz	Vertical			47.45	17.60		ND	60.0	**n/a**
18 - 22GHz	Horizontal			42.55	21.00		ND	60.0	**n/a**
18 - 22GHz	Vertical			42.55	21.00		ND	60.0	**n/a**
22 - 25GHz	Horizontal			42.96	23.40		ND	60.0	**n/a**
22 - 25GHz	Vertical			42.96	23.40		ND	60.0	**n/a**
							Results:	**Complies**	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
(3) External Amplier not used

$E_{Corr} = E_{Meas} + ACF + L_C - G_A$

9.0 LINE CONDUCTED EMISSIONS

Test Procedure	
Normative Reference	**FCC 47 CFR §15.107, ICES-003(6.1)** **ANSI C63.4-2014**

Limits	
47 CFR §15.107	(b) For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms LISN. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges. 0.15 - 0.5 MHz: 79 dBuV Quasi Peak, 66 dBuV Average 0.5 - 30.0 MHz: 73 dBuV Quasi Peak, 60 dBuV Average
ICES-003(6.1)	6.1 - AC Power Line Conducted Emissions Limits Class A: ITE that meets the conditions for Class A operation defined in Section 2.2 shall comply with the Class A conducted limits set out below in Table 1. 0.15 - 0.5 MHz: 79 dBuV Quasi Peak, 66 dBuV Average 0.5 - 30.0 MHz: 73 dBuV Quasi Peak, 60 dBuV Average

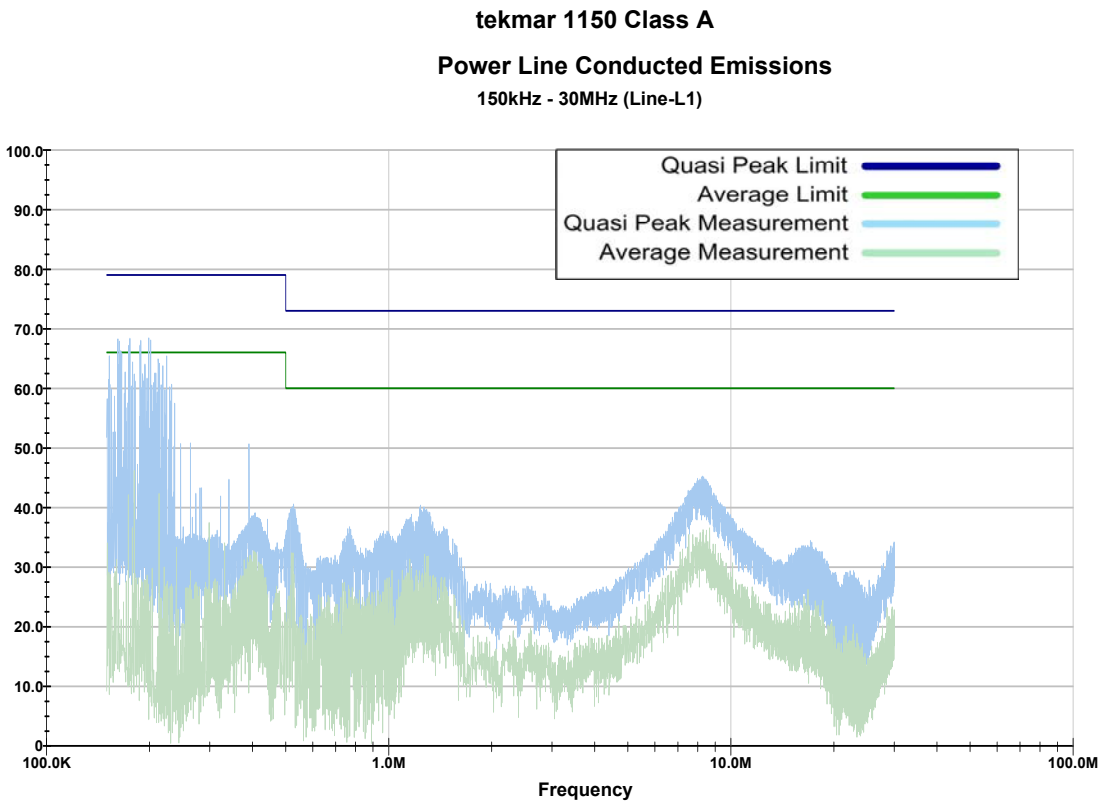
Test Setup	**Appendix A** **Figure A.1**

Measurement Procedure

The device was connected to the LISN as shown in Appendix A. The input power supply was connected to a 120VAC, 1PH power source. The AC Line Conducted emissions were measured from 150kHz to 30MHz on both Lines L1 and L2 while the DUT was set to maximum output power.

Plot 9.1 – Line Conducted Emissions, Simultaneous Transmission, L1

Power Line Conducted Emissions



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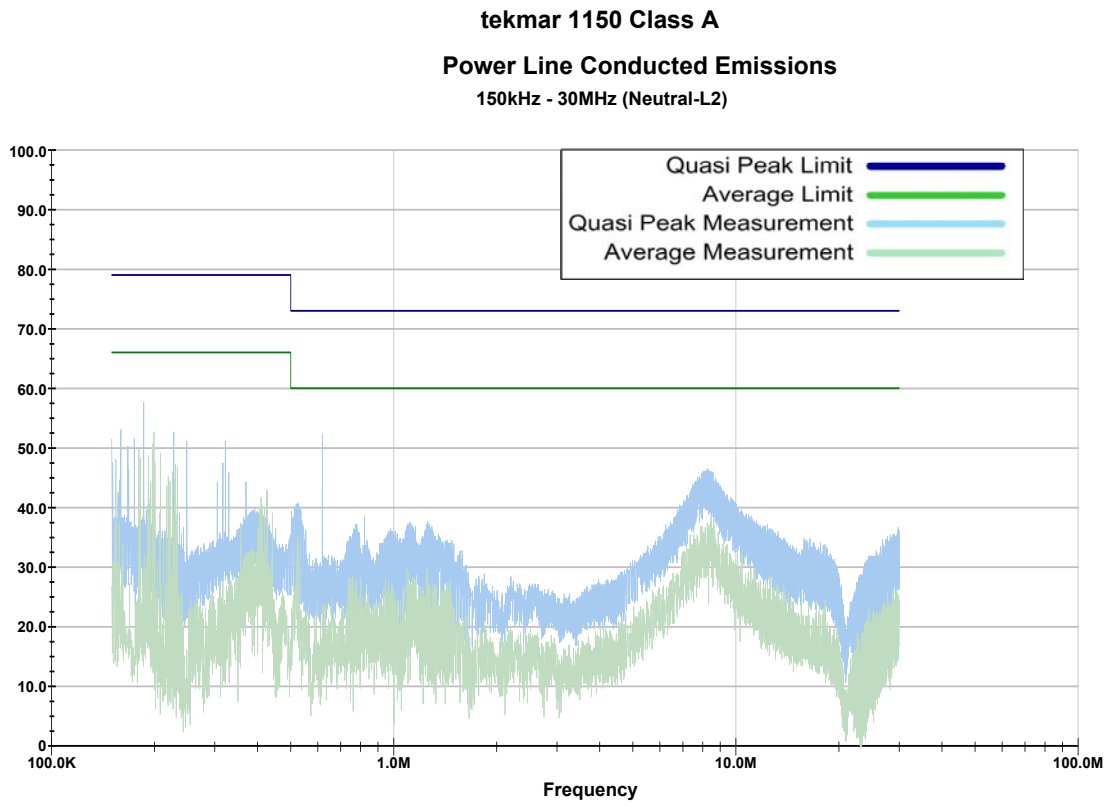
Profile Build: 2020.10.01

Channel Frequeny *(MHz)*	Modulation	LISN Port	Emission Frequency *(MHz)*	Measured Emission *(dBuV)*
912	FSK	L1	-	-

Plot 9.2 – Line Conducted Emissions, Simultaneous Transmission, L2

Power Line Conducted Emissions



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Profile Build: 2020.10.01

Channel Frequeny *(MHz)*	Modulation	LISN Port	Emission Frequency *(MHz)*	Measured Emission *(dBuV)*
912	FSK	L2	-	-

Table 9.1 – Summary of Line Conducted Emissions, L1

Summary of Power Line Conducted Tx Emissions

Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f_{Emm}]	Measured Emission [E_{Meas}] (dBuV)	Detector*	Insertion Loss [L_{LISN}] (dB)	Cable Loss [L_C] (dB)	Amplifier Gain [G_A] (dB)	Corrected Emission [E_{Corr}] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2412 & 2475	L1	161.70 kHz	67.62	Peak	0.40	0.25	0.00 (3)	68.27 (2)	79.0	**10.7**
			175.30 kHz	67.73		0.30	0.26		68.29 (2)	79.0	**10.7**
			188.60 kHz	67.44		0.30	0.26		68.00 (2)	79.0	**11.0**
			201.60 kHz	67.53		0.30	0.27		68.10 (2)	79.0	**10.9**
			390.70 kHz	50.00		0.40	0.25		50.65 (2)	79.0	**28.4**
			8.32 MHz	44.58		0.30	0.26		45.14 (2)	73.0	**27.9**
			173.40 kHz	41.57	Average	0.30	0.26		42.13 (2)	66.0	**23.9**
			180.50 kHz	40.08		0.30	0.27		40.65 (2)	66.0	**25.4**
			213.30 kHz	41.80		0.30	0.27		42.37 (2)	66.0	**23.6**
			298.50 kHz	36.79		0.40	0.26		37.45 (2)	66.0	**28.6**
			8.66 MHz	35.98		0.30	0.27		36.55 (2)	60.0	**23.5**
									Results:	**Complies**	

* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.
(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
(3) External Amplier not used
$E_{Corr} = E_{Meas} + L_{LISN} + L_C - G_A$
Class B QP Limit = 56 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz
Class B Avg Limit = 46 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz
Class A QP Limit = 79dBuV for f_{Emm} = 150kHz to 500kHz
Class A Avg Limit = 66dBuV for f_{Emm} = 150kHz to 500kHz
Margin = Limit - E_{corr}

Table 9.2 – Summary of Line Conducted Emissions, L2

Summary of Power Line Conducted Tx Emissions

Measured Frequency Range (MHz)	Channel Frequency (MHz)	LISN Port	Emission Frequency [f_{Emm}]	Measured Emission [E_{Meas}] (dBuV)	Detector*	Insertion Loss [L_{LISN}] (dB)	Cable Loss [L_C] (dB)	Amplifier Gain [G_A] (dB)	Corrected Emission [E_{Corr}] (dBuV)	Limit (dBuV)	Margin (dB)
150kHz - 30MHz	2412 & 2475	L2	159.40 kHz	52.35	Peak	0.40	0.25	0.00 (3)	53.0 (2)	79.0	**26.0**
			186.60 kHz	57.03		0.30	0.26		57.6 (2)	79.0	**21.4**
			227.50 kHz	52.04		0.30	0.26		52.6 (2)	79.0	**26.4**
			322.20 kHz	50.50		0.30	0.27		51.1 (2)	79.0	**27.9**
			618.90 kHz	51.73		0.30	0.28		52.3 (2)	79.0	**26.7**
			8.25 MHz	45.86		0.30	0.28		46.4 (2)	73.0	**26.6**
			154.20 kHz	35.99	Average	0.40	0.25		36.6 (2)	66.0	**29.4**
			180.20 kHz	35.70		0.30	0.26		36.3 (2)	66.0	**29.7**
			199.30 kHz	50.09		0.30	0.26		50.7 (2)	66.0	**15.4**
			233.00 kHz	46.64		0.30	0.27		47.2 (2)	66.0	**18.8**
			8.46 MHz	38.26		0.30	0.28		38.8 (2)	60.0	**21.2**
									Results:	**Complies**	

* In accordance with FCC §15.35 and ANSI C63.4, a Peak detector may be used to demonstrate compliance to Quasi-Peak limits provided the Resolution Bandwidth (RBW) is equal to or greater than Quasi-Peak bandwidth. The Detector RBW employed was ≥ 9kHz.
(2) LISN Insertion Loss, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
(3) External Amplier not used
$E_{Corr} = E_{Meas} + L_{LISN} + L_C - G_A$
Class B QP Limit = 56 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz
Class B Avg Limit = 46 - 20Log (f_{Emm}/500) for f_{Emm} = 150kHz to 500kHz
Class A QP Limit = 79dBuV for f_{Emm} = 150kHz to 500kHz
Class A Avg Limit = 66dBuV for f_{Emm} = 150kHz to 500kHz
Margin = Limit - E_{corr}

APPENDIX A – TEST SETUP DRAWINGS

Table A.1 – Conducted Measurement Setup

Equipment List				
Asset Number	**Manufacturer**	**Model Number**	**Serial Number**	**Description**
00241	R&S	FSU40	100500	Spectrum Analyzer
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable

Figure A.1 – Test Setup – Conducted Measurements

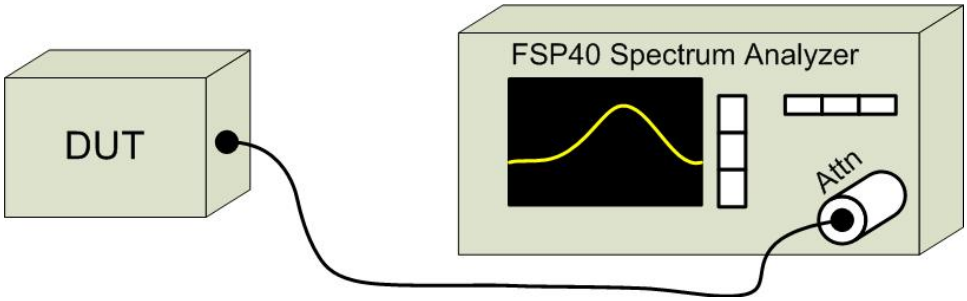

Table A.2 – Radiated Emissions Measurement Equipment

Equipment List				
Asset Number	**Manufacturer**	**Model Number**	**Serial Number**	**Description**
00050	Chase	CBL-6111A	1607	Bilog Antenna
00034	ETS	3115	6267	Double Ridged Guide Horn
00035	ETS	3115	6276	Double Ridged Guide Horn
00085	EMCO	6502	9203-2724	Loop Antenna
00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00162	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00166	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00241	R&S	FSU40	100500	Spectrum Analyzer
00265	Miteq	JS32-00104000-58-5P	1939850	Microwave L/N Amplifier
00071	EMCO	2090	9912-1484	Multi-Device Controller
00072	EMCO	2075	0001-2277	Mini-mast
00073	EMCO	2080	0002-1002	Turn Table
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable
00275	TMS	LMR400	n/a	25m Cable
00278	TILE	34G3	n/a	TILE Test Software

Figure A.2 – Test Setup Radiated Measurements 9kHzMHz – 30MHz

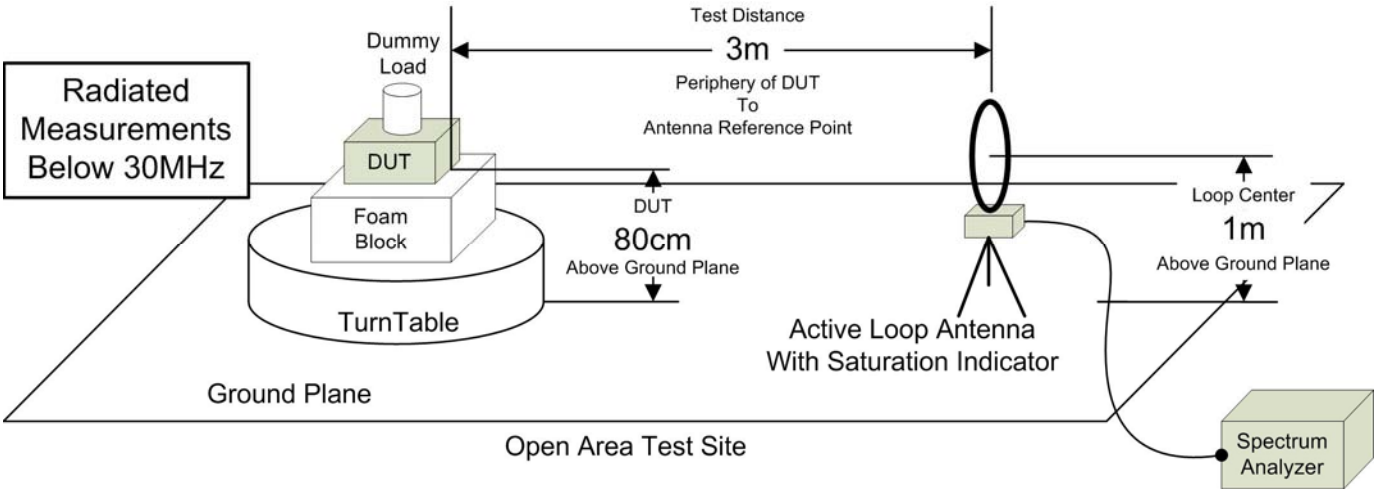

Figure A.3 – Test Setup Radiated Measurements 30MHz – 1GHz

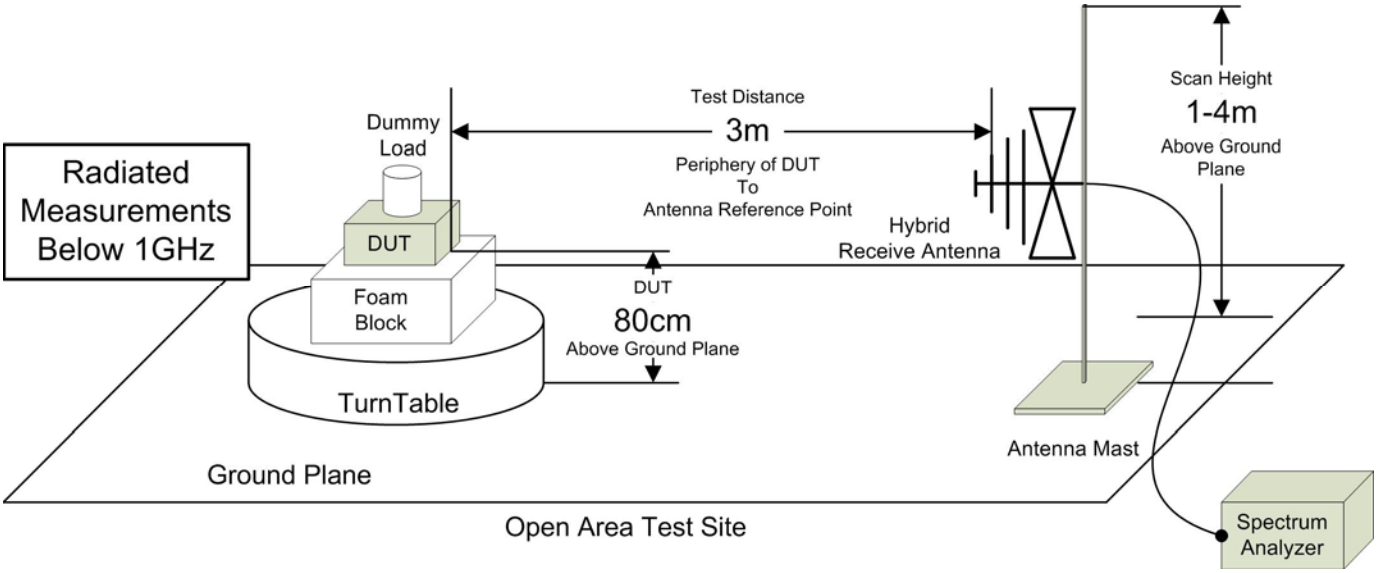

Figure A.4 – Test Setup Radiated Measurements 30MHz – 1GHz, Signal Substitution

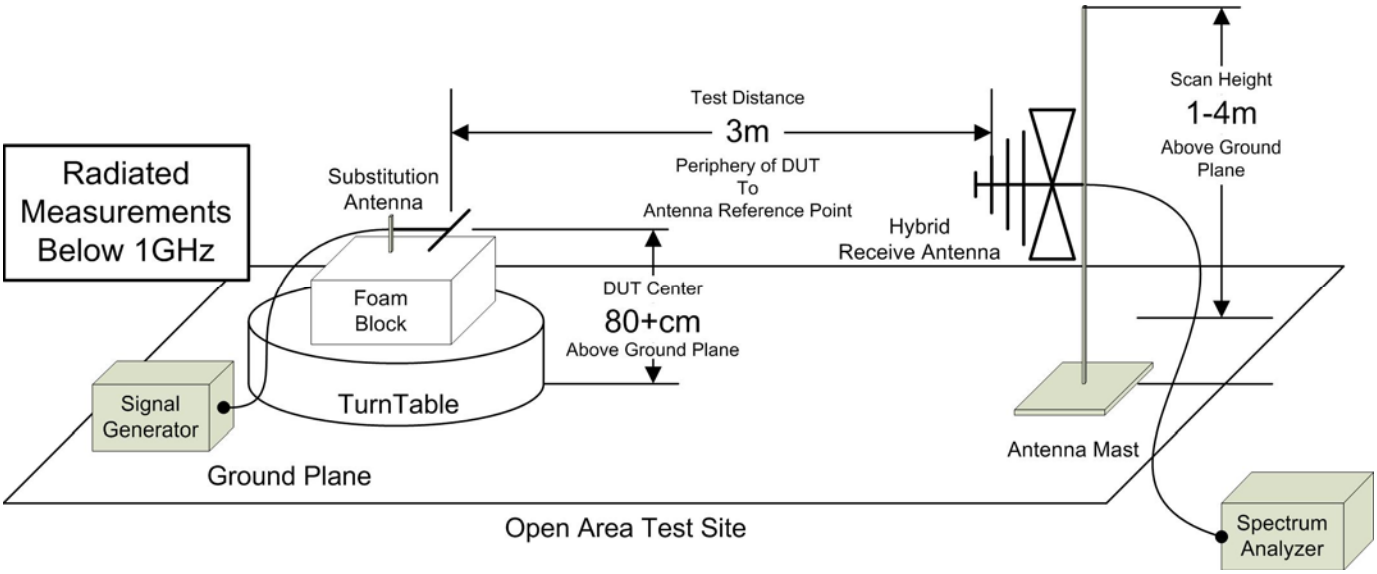

Figure A.5 – Test Setup Radiated Measurements 1 – 18GHz,

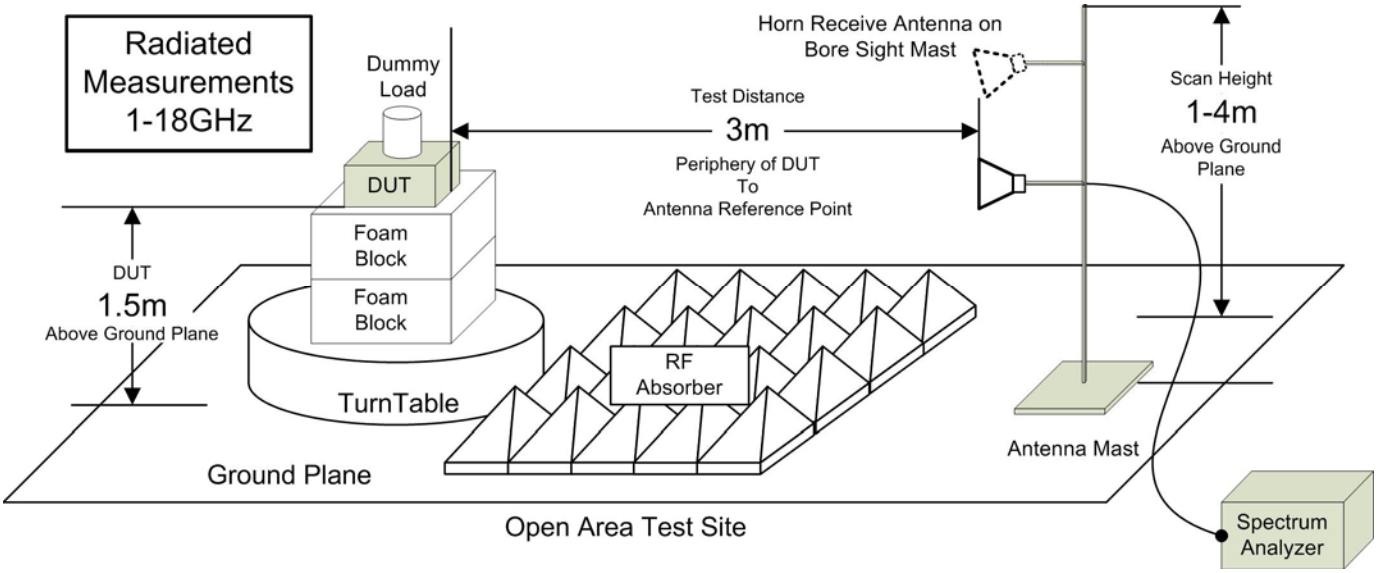

Figure A.6 – Test Setup Radiated Measurements 18 – 26.5GHz,

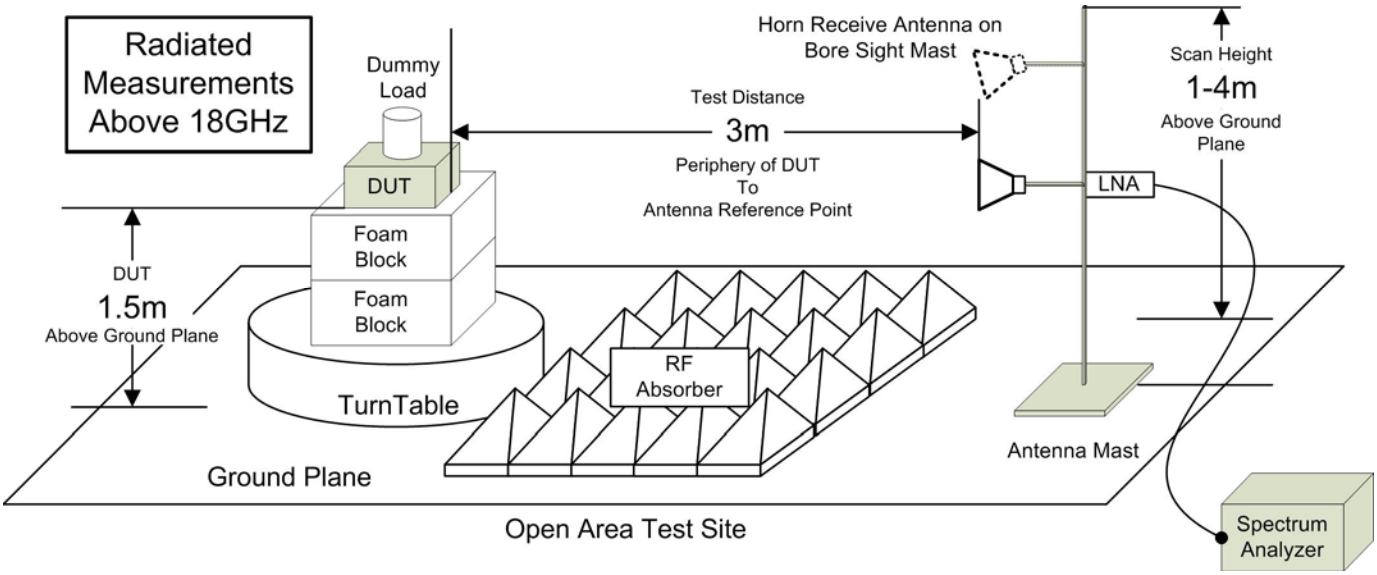

Table A.3 – Setup – Conducted Emissions Equipment List

Equipment List				
Asset Number	**Manufacturer**	**Model Number**	**Serial Number**	**Description**
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00223	HP	8901A	3749A07154	Modulation Analyzer
00257	Com-Power	LI-215A	191934	LISN
00276	TMS	LMR400	n/a	4m Cable

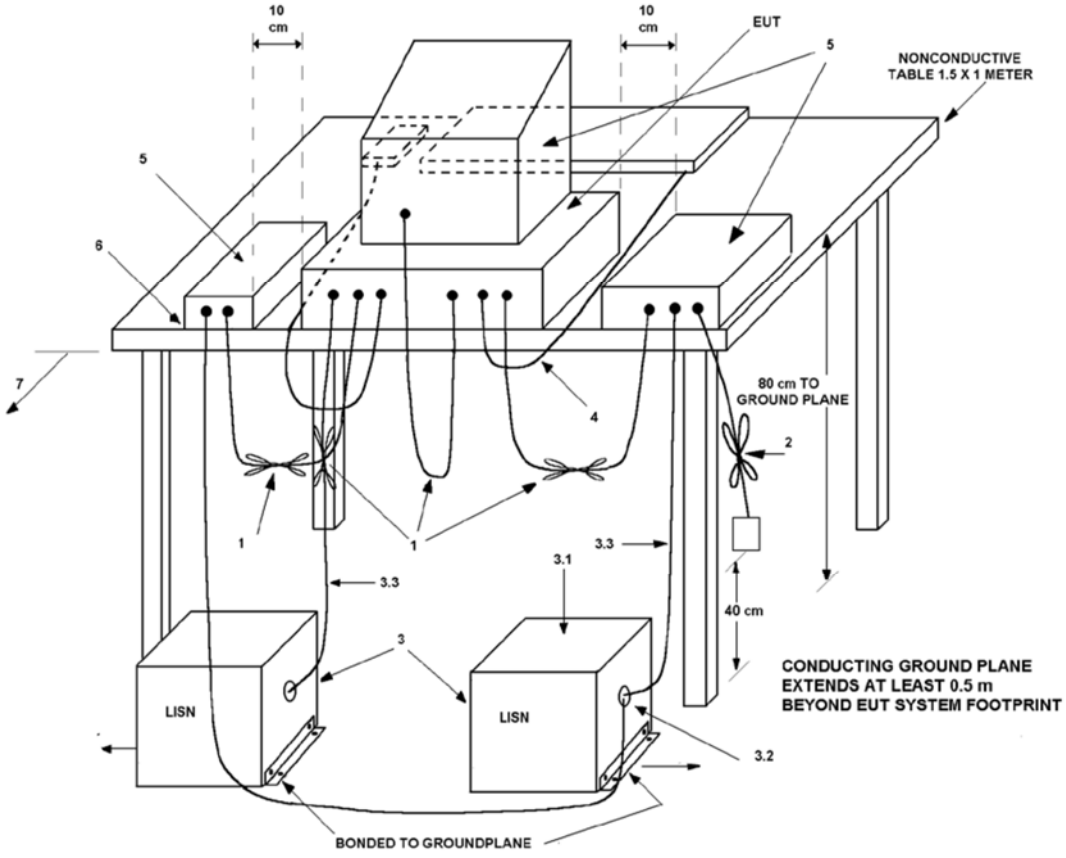

Figure A.7 – Test Setup Conducted Emissions Measurements

APPENDIX B – EQUIPMENT LIST AND CALIBRATION

Equipment List							
Asset Number	Manufacturer	Model Number	Serial Number	Description	Last Calibrated	Calibration Interval	Calibration Due
00050	Chase	CBL-6111A	1607	Bilog Antenna	3 Jan 2019	Triennial	3 Jan 2022
00034	ETS	3115	6267	Double Ridged Guide Horn	26 Nov 2018	Triennial	26 Nov 2021
00035	ETS	3115	6276	Double Ridged Guide Horn	22 Mar 2019	Triennial	21 Mar 2022
00085	EMCO	6502	9203-2724	Loop Antenna	11 Jun 2019	Triennial	11 Jun 2022
00333	HP	85685A	3010A01095	RF Preselector	23 Jun 2020	Triennial	30 Jun 2023
00049	HP	85650A	2043A00162	Quasi-peak Adapter	23 Jun 2020	Triennial	23 Jun 2023
00051	HP	8566B	2747A05510	Spectrum Analyzer	23 Jun 2020	Triennial	23 Jun 2023
00241	R&S	FSU40	100500	Spectrum Analyzer	10 Aug 2021	Triennial	10 Aug 2024
00071	EMCO	2090	9912-1484	Multi-Device Controller	n/a	n/a	n/a
00072	EMCO	2075	0001-2277	Mini-mast	n/a	n/a	n/a
00073	EMCO	2080	0002-1002	Turn Table	n/a	n/a	n/a
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable	COU	n/a	COU
00275	TMS	LMR400	n/a	25m Cable	COU	n/a	COU
00276	TMS	LMR400	n/a	4m Cable	COU	n/a	COU
00278	TILE	34G3	n/a	TILE Test Software	NCR	n/a	NCR

NCR: No Calibration Required
COU: Calibrate On Use

APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY

CISPR 16-4 Measurement Uncertainty (U_{LAB})	
This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence interval using a coverage factor of k=2	
Radiated Emissions 30MHz - 200MHz	
U_{LAB} = 5.14dB U_{CISPR} = 6.3dB	
Radiated Emissions 200MHz - 1000MHz	
U_{LAB} = 5.90dB U_{CISPR} = 6.3dB	
Radiated Emissions 1GHz - 6GHz	
U_{LAB} = 4.80dB U_{CISPR} = 5.2dB	
Radiated Emissions 6GHz - 18GHz	
U_{LAB} = 5.1dB U_{CISPR} = 5.5dB	
Power Line Conducted Emissions 9kHz to 150kHz	
U_{LAB} = 2.96dB U_{CISPR} = 3.8dB	
Power Line Conducted Emissions 150kHz to 30MHz	
U_{LAB} = 3.12dB U_{CISPR} = 3.4dB	
If the calculated uncertainty U_{lab} is **less** than U_{CISPR} then:	
1	Compliance is deemed to occur if **NO** measured disturbance exceeds the disturbance limit
2	Non-Compliance is deemed to occur if **ANY** measured disturbance **EXCEEDS** the disturbance limit
If the calculated uncertainty U_{lab} is **greater** than U_{CISPR} then:	
3	Compliance is deemed to occur if **NO** measured disturbance, increased by (U_{lab} - U_{CISPR}), exceeds the disturbance limit
4	Non-Compliance is deemed to occur if **ANY** measured disturbance, increased by (U_{lab} - U_{CISPR}), **EXCEEDS** the disturbance limit

Other Measurement Uncertainties (U_{LAB})
RF Conducted Emissions 9kHz - 40GHz
U_{LAB} = 1.0dB U_{CISPR} = n/a
Frequency/Bandwidth 9kHz - 40GHz
U_{LAB} = 0.1ppm U_{CISPR} = n/a
Temperature
U_{LAB} = 1^{O}C U_{CISPR} = n/a

END OF REPORT

