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Test Report

Test Report Num	24E10359-1a
Quotation	Q24-2607-1
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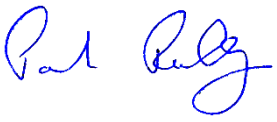
FCC Test Firm Designation	IE0002
ISED Cab Identifier	IE0001
Date	28th Nov 2024
EUT Description	NFC Module
FCC ID	SCC8375A
IC ID	5137A-8375A
Authorised by	**Paul Reilly**
Authorised Signature:	

TEST SUMMARY

The equipment complies with the requirements according to the following standards.

FCC Part Section(s)	RSS Part Section(s)	TEST PARAMETERS	Test Result
15.203		Antenna Requirement	Pass
15.225	RSS-210 B6	Spectrum Mask	Pass
15.225(d), 15.209	RSS-Gen 8.9	Limit outside band 13.11-14.01MHz	Pass
15.225e	RSS-210 B6	Frequency Stability	Pass
15.207	RSS-Gen 8.8	Conducted Emissions	Pass
	RSS-Gen 8.11	Occupied Bandwidth	Pass

Emissions were assessed to the following standards:

FCC CFR 47 Part 15
Federal Communications Commission: Part 15 Radio Frequency Devices

RSS Gen Issue 5 Amendment 1 Mar 2019
RSS-210 Issue 11 Jun 2024

Table of Contents

1 EUT Description

Model:	837-5A
Type:	NFC reader
Type of radio:	Stand-alone
Transmitter Type:	ASK 13.56MHz
Operating Frequency Range(s):	13.56MHz
Number of Channels:	1
Antenna:	Integral
Power configuration:	3.6 Vdc battery
Oper. Temp Range:	5° C to +35° C
Classification:	DXX
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013

The EUT was a custom NFC reader operating at 13.56MHz.
The EUT forms part of a larger host (Nordic HH86-8375A).
This report concerns test on the EUT with the HH86 as support equipment.

1.1 EUT Operation

Operating Conditions during Test:

The equipment under test was operated during the measurement under the following conditions:
The EUT was operated in normal modulated mode for all tests (i.e. transmitter always operational)
The EUT was powered from the internal battery of Nordic ID HH86 (with all other radios off) which operated as support equipment

Note for Conducted Emissions on the mains, the HH86 host (containing the EUT) was placed on a charging cradle (Nordic DTC837-1A) which was connected to the LISN through a mains adapter (EDA power model EA1024K2-240).

All tests were carried out on a single sample (sample #1).

1.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	+15 to +35 ° C
Humidity:	20-75 %

Modifications
No modifications were required in order to pass the test specifications.

1.3 Date of Test

The tests were carried out on one sample (Sample #01) of the EUT on dates 20th ,21st and 22nd Nov 2024 .

1.4 Description of Test Methods

Tests were performed manually, and no special software was used

1.5 Electromagnetic Emissions Testing

The guidelines of CISPR 16-4 were used for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of Compliance Engineering Ireland Ltd.'s policy for EMC Measurement Uncertainty is available on request.
RF Requirements:

1.6 Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for the conducted emissions test was ±3.5 dB.
The measurement uncertainty (with a 95% confidence level) for the radiated emissions test was ±5.3 dB (from 30 to 100 MHz), ±4.7 dB (from 100 to 300 MHz),
±3.9 dB (from 300 to 1000 MHz) and ±3.8 dB (from 1 GHz to 40 GHz).

1.7 Antenna Requirements

According to FCC 47 CFR 15.203:

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

* The antennas of this E.U.T are internal to the unit and are permanently attached.
*The E.U.T Complies with the requirement of 15.203

2 Emissions Measurements

2.1 Conducted Emissions Measurements

Measurements were carried out using a Receiver over the frequency range 150KHz to 30MHz.

2.2 Radiated Emissions Measurements

Radiated Power measurements were made at the Compliance Engineering Ireland Ltd anechoic chamber located in Dunshaughlin, Co. Meath, Ireland to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.
The EUT was centred on a motorized turntable, which allows 360 degree rotation.
A measurement antenna was positioned at a distance of 3 metres as measured from the closest point of the EUT. The radiated emissions were maximised by configuring the EUT, by rotating the EUT and by raising and lowering the antenna from 1 to 4 meters.
Emissions below 30MHz were measured using a loop antenna. In this case the resolution bandwidth was 200Hz for frequencies below 150KHz and RBW was 9KHz for frequencies above 150KHz.

Emissions between 30MHz and 300MHz were measured using a bi-conical antenna.
Emissions between 300MHz and 1GHz were measured using a bi-log antenna. In both cases the resolution bandwidth was 120KHz.

3.0 Results for Conducted emissions

Mains Conducted Emissions results

Detector	Frequency	Reading	Margin	Phase
QP/ Ave	MHz	dBuV	dB	L/N
Quasi-Peak	0.1523	45.77	-20.17	Live
Average	0.1680	35.76	-19.73	Live
Average	0.3975	28.35	-20.58	Live
Average	0.5325	16.52	-29.48	Live
Quasi-Peak	1.442	20.98	-35.02	Live
Average	1.446	16.33	-29.67	Live
Average	1.448	16.45	-29.55	Live
Average	1.840	16.46	-29.54	Live
Average	1.842	16.43	-29.57	Live
Quasi-Peak	1.871	21.05	-34.95	Live
Quasi-Peak	2.243	20.51	-35.49	Live
Quasi-Peak	2.634	20.28	-35.72	Live
Quasi-Peak	3.026	20.39	-35.61	Live
Quasi-Peak	4.310	20.15	-35.85	Live
Quasi-Peak	13.560	30.21	-29.79	Live
Average	13.560	29.91	-20.09	Live

Detector	Frequency	Reading	Margin	Phase
QP/ Ave	MHz	dBuV	dB	L/N
Quasi-Peak	0.1523	45.22	-20.72	Neutral
Average	0.1680	35.08	-20.41	Neutral
Average	0.3975	28.37	-20.56	Neutral
Average	0.5325	18.01	-27.99	Neutral
Quasi-Peak	1.4415	20.60	-35.4	Neutral
Average	1.4460	15.95	-30.05	Neutral
Average	1.4483	15.99	-30.01	Neutral
Average	1.8398	15.04	-30.96	Neutral
Average	1.8420	14.98	-31.02	Neutral
Quasi-Peak	1.8713	19.62	-36.38	Neutral
Quasi-Peak	2.2425	20.04	-35.96	Neutral
Quasi-Peak	2.6340	19.60	-36.4	Neutral
Quasi-Peak	3.0255	18.30	-37.7	Neutral
Quasi-Peak	4.3103	17.66	-38.34	Neutral
Quasi-Peak	13.5600	32.21	-27.79	Neutral
Average	13.5600	31.95	-18.05	Neutral

Ref Appendix B for scans

Result: Pass

4.0 Results for Radiated emissions

4.1 Carrier Power

Limit as per 15.225

Frequency	Peak Level	Antenna Factor	Cable Loss	Final Field Strength Peak	Detector	Emission Limit	Margin	Pass / Fail
MHz	dBuV/m	dB	dB	dBuV/m		dBuV/m	dB	P/F
13.56	37.55	8.25	0.1	45.9	Peak	124	78.1	Pass

Final Field Strength Peak (dBuV/m) = Peak Level (dBuV/m) + Antenna Factor (dB) +Cable Loss (dB)
Calculation Example **45.9 = 37.55+ 8.25 + 0.1**

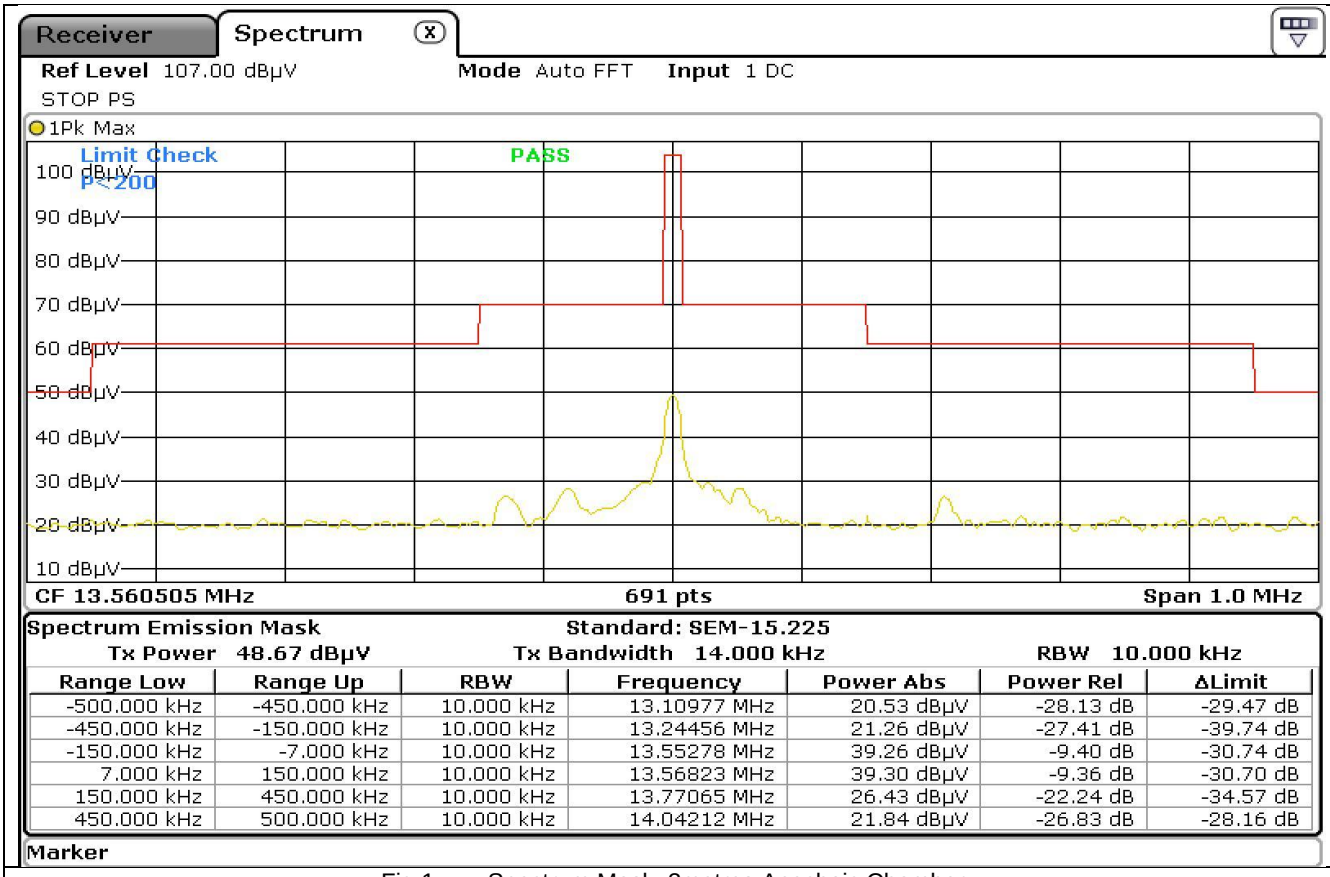
Note1 as the pulse rate (1/period) is less than 20Hz, a peak detector measurement as per 15.35a was used

Note 2
Field strength 45.9dBuV/m @ 3m
Limits are for 30m
Correction for distance 40*log(3/30) = - 40dB as per RSS Gen 6.5

45.9 dBuV/m @3m -40 = 5.9 dBuV/m @ 30m

Result: Pass

4.2 Mask



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-500.000 kHz	-450.000 kHz	10.000 kHz	13.10977 MHz	20.53 dBµV	-28.13 dB	-29.47 dB
-450.000 kHz	-150.000 kHz	10.000 kHz	13.24456 MHz	21.26 dBµV	-27.41 dB	-39.74 dB
-150.000 kHz	-7.000 kHz	10.000 kHz	13.55278 MHz	39.26 dBµV	-9.40 dB	-30.74 dB
7.000 kHz	150.000 kHz	10.000 kHz	13.56823 MHz	39.30 dBµV	-9.36 dB	-30.70 dB
150.000 kHz	450.000 kHz	10.000 kHz	13.77065 MHz	26.43 dBµV	-22.24 dB	-34.57 dB
450.000 kHz	500.000 kHz	10.000 kHz	14.04212 MHz	21.84 dBµV	-26.83 dB	-28.16 dB

Fig 1 Spectrum Mask 3metres Anechoic Chamber

Test result Pass

4.3 Duty Cycle

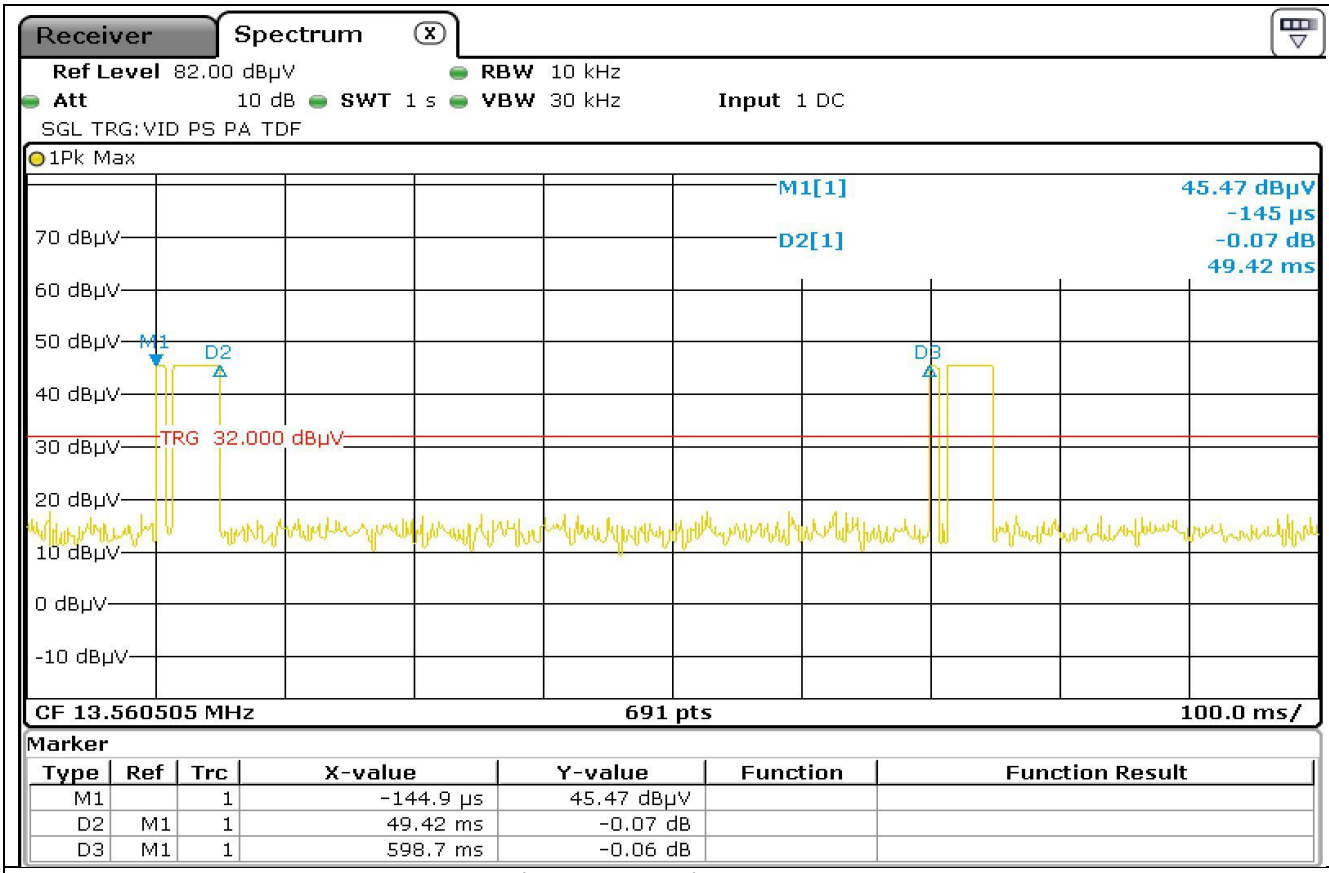


Fig 2 Duty Cycle 13.56 MHz

Pulse repetition rate =1/598mS = 1.67Hz

4.4 Spurious Emissions Measurements 9kHz -30MHz

Frequency	Level	Antenna Factor	Cable Loss	Final Field Strength	Detector	Spurious Emission Limit Average	Margin	Pass / Fail
MHz	dBuV/m	dB	dB	dBuV/m		dBuV/m	dB	P/F
*0.01	78.53	13.6	0.1	92.23	Peak	127.6	35.37	Pass
*0.0158	63.38	11.78	0.1	75.26	Peak	123.63	48.37	Pass
*0.02	60.87	10.86	0.1	71.83	Peak	121.58	49.75	Pass
*0.03215	53.28	10.66	0.1	64.04	Peak	117.46	53.42	Pass

* background

Final Field Strength Peak (dBuV/m) = Peak Level (dBuV/m) + Antenna Factor (dB) +Cable Loss (dB)
Calculation Example **92.23 = 78.53+ 13.6 + 0.1**

Spurious Emissions which are harmonics of the fundamental at 13.56MHz

Frequency	Peak Level	Antenna Factor	Cable Loss	Final Field Strength Peak	Detector	Limit Average	Margin	Pass / Fail
MHz	dBuV/m	dB	dB	dBuV/m		dBuV/m	dB	P/F
27.12	11.08	6.32	0.1	17.5	Peak	69.54	52.04	Pass

Final Field Strength Peak (dBuV/m) = Peak Level (dBuV/m) + Antenna Factor (dB) +Cable Loss (dB)
Calculation Example **17.5 = 11.08+ 6.32 + 0.1**

Note as the pulse rate (1/period) is less than 20Hz, a peak detector measurement as per 15.35a was used Appendix A shows the results of the scan.

Result: Pass

4.5 Measurements 30MHz to 1GHz

4.5.1 Spurious Emissions which are not harmonics of the fundamental

Frequency	Quasi peak Level	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Quasi Peak	Average Limit	Margin	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
393.240	-3.0	O1	Vertical	16.1	0	3.2	16.3	46.0	29.7	Pass
406.830	5.8	O1	Vertical	16.6	0	3.3	25.7	46.0	20.3	Pass
420.360	5.3	O1	Horizontal	16.7	0	3.3	25.3	46.0	20.7	Pass
980.920	4.8	O1	Horizontal	24.6	0	5.6	35.0	54.0	19.0	Pass

Final Field Strength Quasi Peak (dBuV/m) =Quasi peak Level (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **16.3 = -3 + 16.1 - 0 + 3.2**

Appendix A shows the results of the scans in the anechoic chamber.

Result: Pass

4.5.2 Spurious Emissions which are harmonics of the fundamental

Frequency	Peak Level	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
40.680	15.1	O1	Vertical	11.5	0	1.1	27.7	40.0	12.3	Pass
54.240	6.2	O1	Vertical	10.1	0	1.2	17.5	40.0	22.5	Pass
67.800	4.1	O1	Vertical	9.5	0	1.4	15.0	40.0	25.0	Pass
40.680	9.6	O1	Horizontal	11.5	0	1.1	22.2	40.0	17.8	Pass
54.240	6.5	O1	Horizontal	10.1	0	1.2	17.8	40.0	22.2	Pass
67.800	7.2	O1	Horizontal	9.5	0	1.4	18.1	40.0	21.9	Pass

Final Field Strength Peak (dBuV/m) = Peak Level (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **27.7 = 15.1 + 11.5 - 0 + 1.1**

Note as the pulse rate (1/period) is less than 20Hz, a peak detector measurement as per 15.35a is used

Appendix A shows the results of the scan in the anechoic chamber.

Result: Pass

4.6 Frequency Stability Temperature Testing

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

The EUT was supplied from the internal rechargeable battery of the HH83 product which could not be removed. The HH83 battery was fully charged prior to the test.

Temp	Supply	Frequency	Variation	Limit	Result
Deg C	V dc	MHz	%	%	
50	3.6	13.560454	-0.0003	0.01	Pass
40	3.6	13.560464	-0.0003	0.01	Pass
30	3.6	13.56048	-0.0001	0.01	Pass
20	3.6	13.560498	0	0.01	Pass
10	3.6	13.56052	0.0002	0.01	Pass
0	3.6	13.560526	0.0002	0.01	Pass
-10	3.6	13.560514	0.0001	0.01	Pass
-20	3.6	13.560476	-0.0002	0.01	Pass

Result: Pass

4.7 99% Occupied Bandwidth

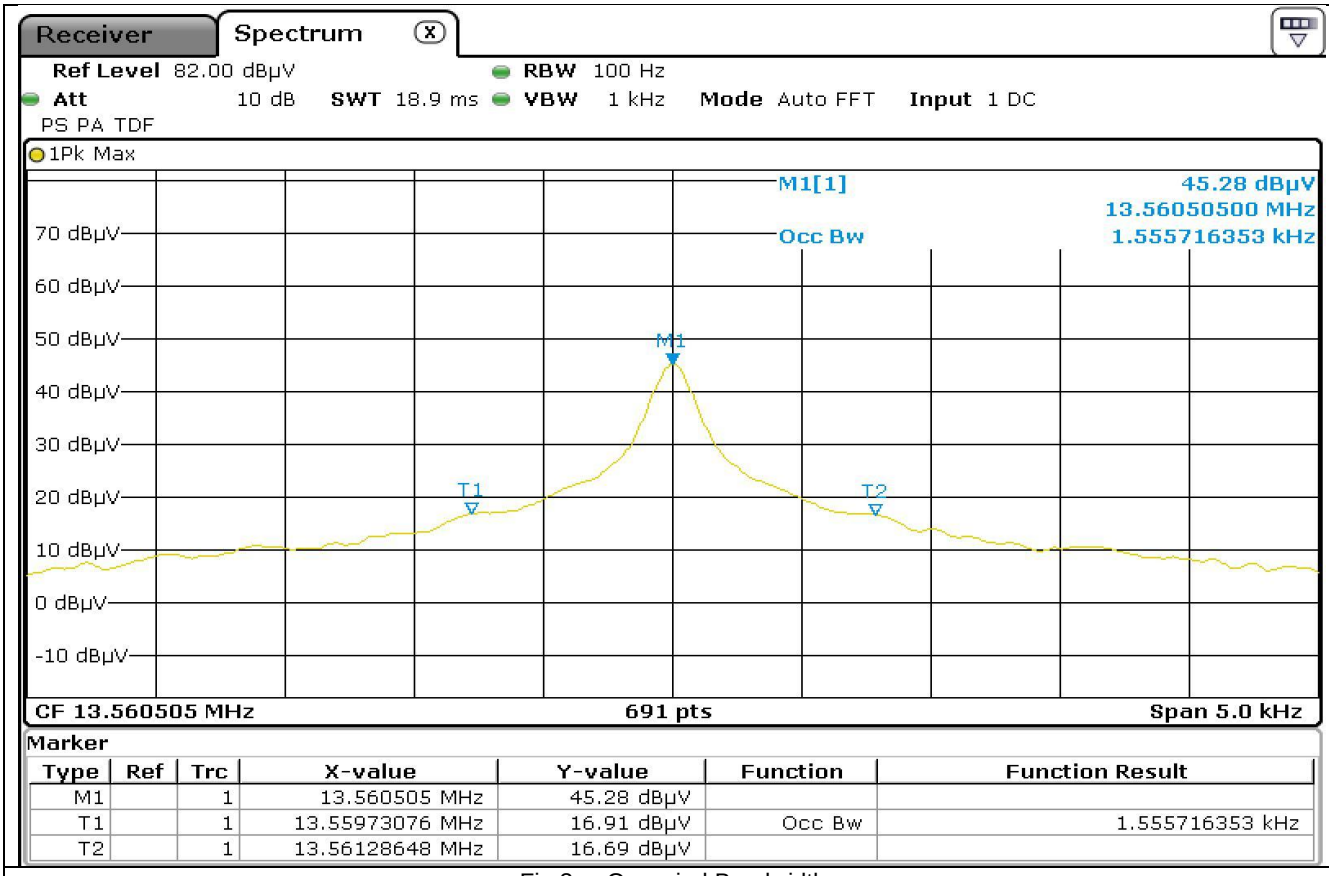


Fig 3 Occupied Bandwidth

13.56MHz Occupied Bandwidth = 1.56KHz

Test Result Pass

5. Measurement Uncertainties

Measurement	Uncertainty
Radio Frequency	+/- $5x10^{-7}$
Maximum Frequency Deviation	+/- 1.7 %
Radiated Emission 30MHz-100MHz	+/- 5.3 dB
Radiated Emission 100MHz-300MHz	+/- 4.7 dB
Radiated Emission 300MHz-1GHz	+/- 3.9 dB
Radiated Emission 1GHz-40GHz	+/- 3.8 dB
Occupied Bandwidth	± 5%
Conducted RF power	± 1.23 dB
Conducted Spurious Emission of transmitter	± 2.14 dB
Conducted Emissions of Receivers	± 2.14 dB
RF level of uncertainty for a given BER	± 1.23 dB
Temperature	± 0.2˚C
Humidity	± 4% RH
Frequency	±0.01 ppm
Duty Cycle	+/- 5 %

Table 1: Measurement Uncertainties

The measurement uncertainties stated were calculated with a k=2 for a confidence level of 95.45%.

The test data can be compared directly to the specification limit to determine compliance, as the calculated measurement uncertainty meets the requirements of the applicable specification.

Appendix A: Spurious Emissions Scans

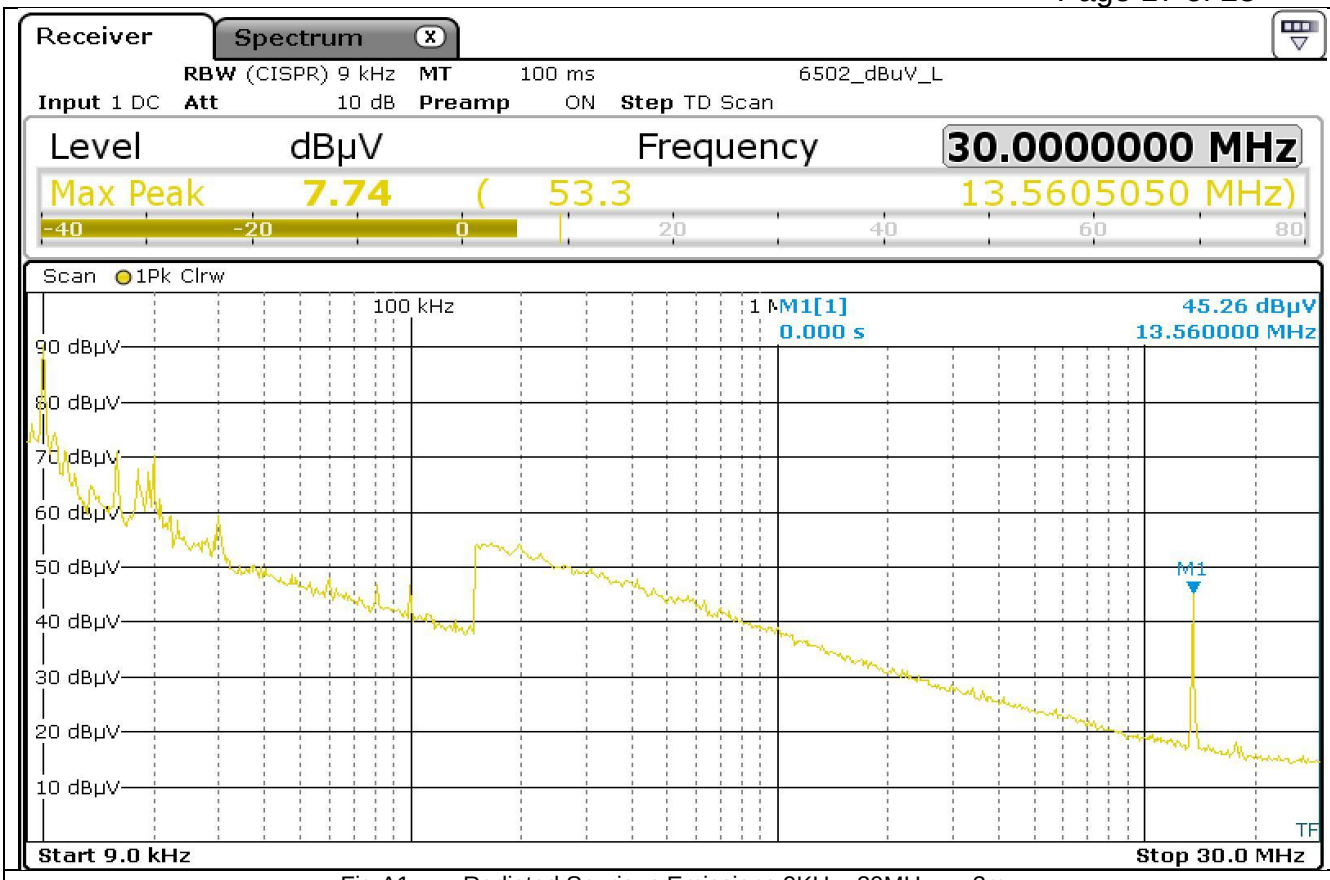


Fig A1 Radiated Spurious Emissions 9KHz -30MHz 3m

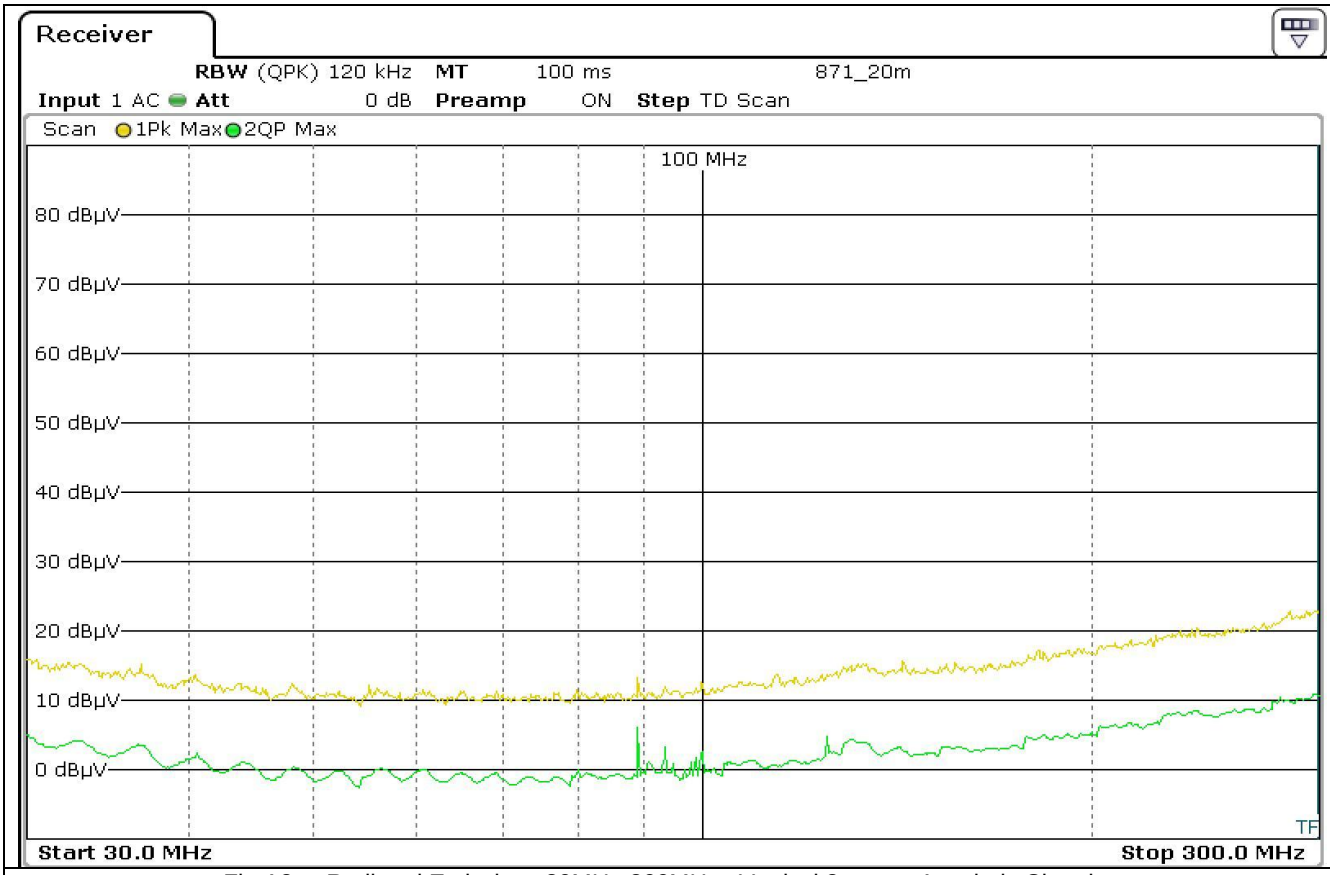


Fig A2 Radiated Emissions 30MHz-300MHz Vertical 3metres Anechoic Chamber

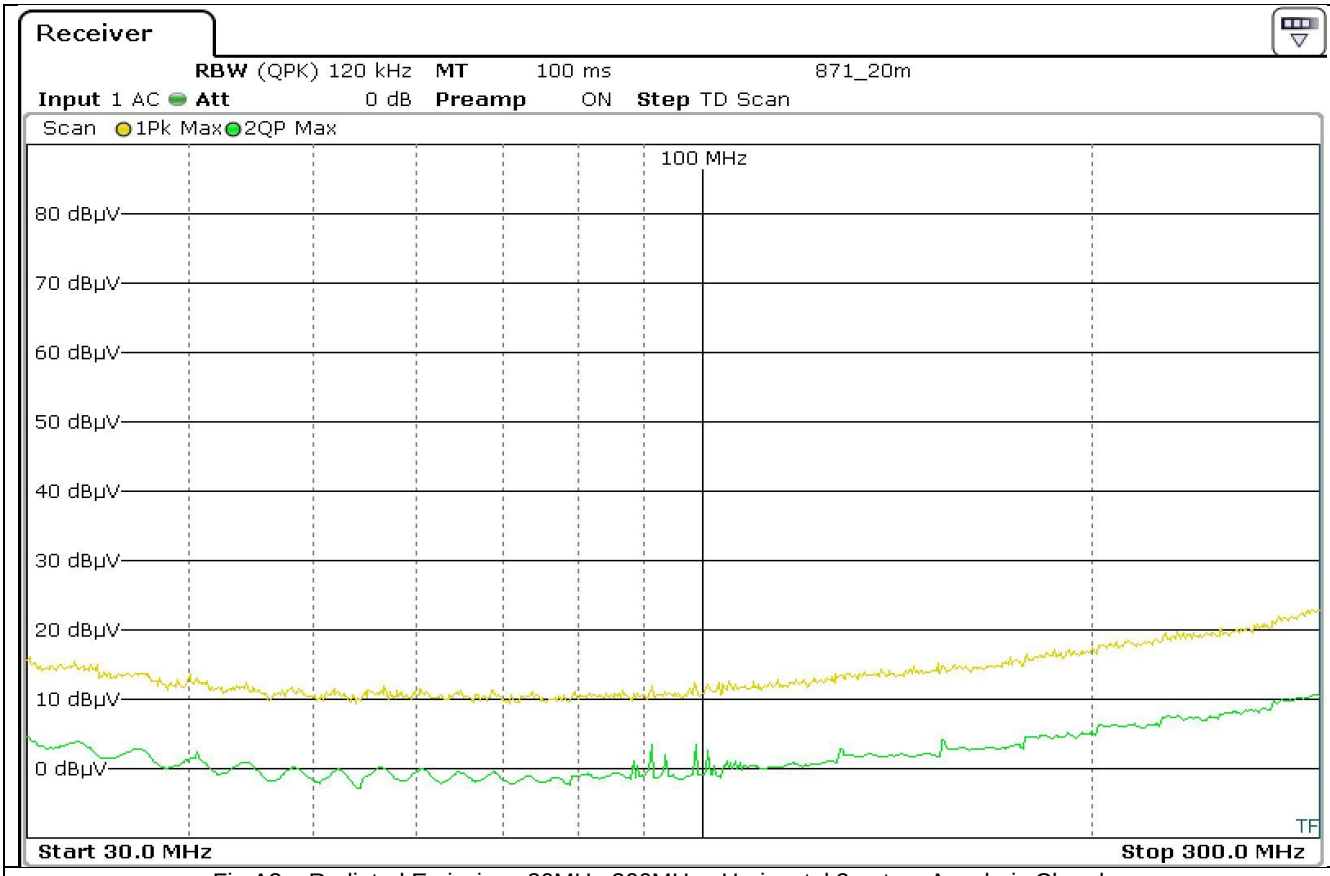


Fig A3 Radiated Emissions 30MHz-300MHz Horizontal 3metres Anechoic Chamber

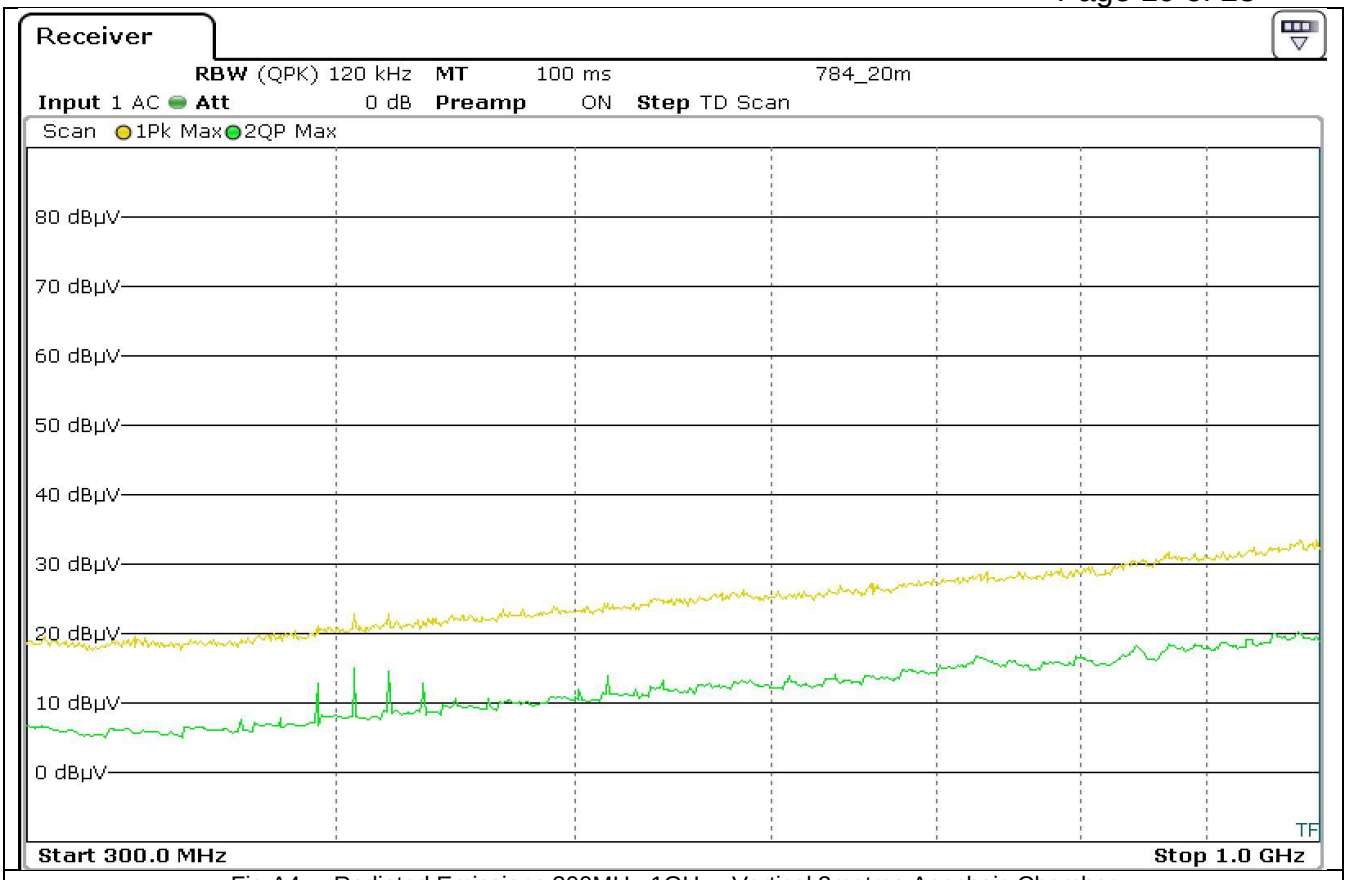


Fig A4 Radiated Emissions 300MHz-1GHz Vertical 3metres Anechoic Chamber

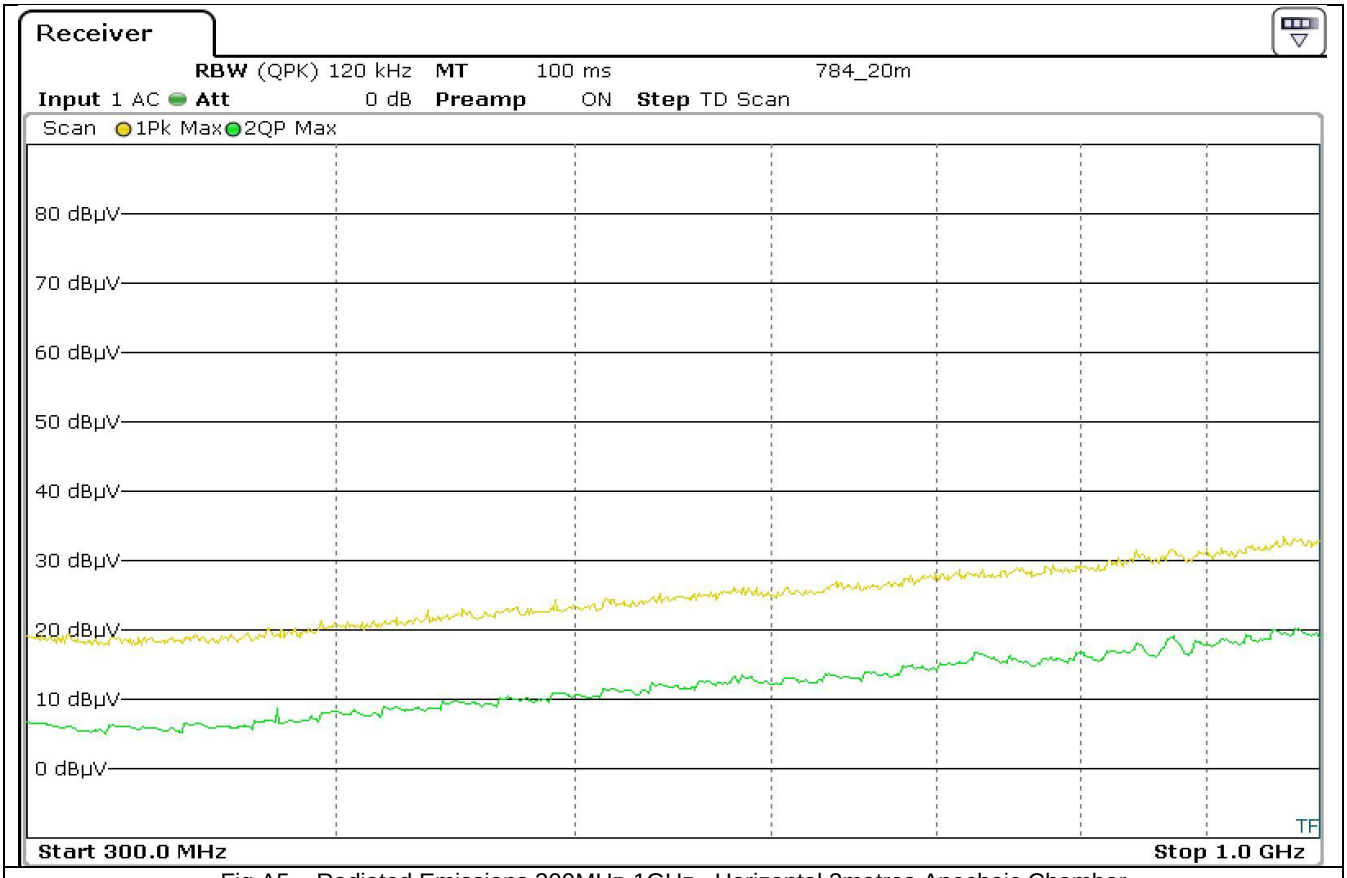


Fig A5 Radiated Emissions 300MHz-1GHz Horizontal 3metres Anechoic Chamber

Appendix B Conducted Emissions on the mains

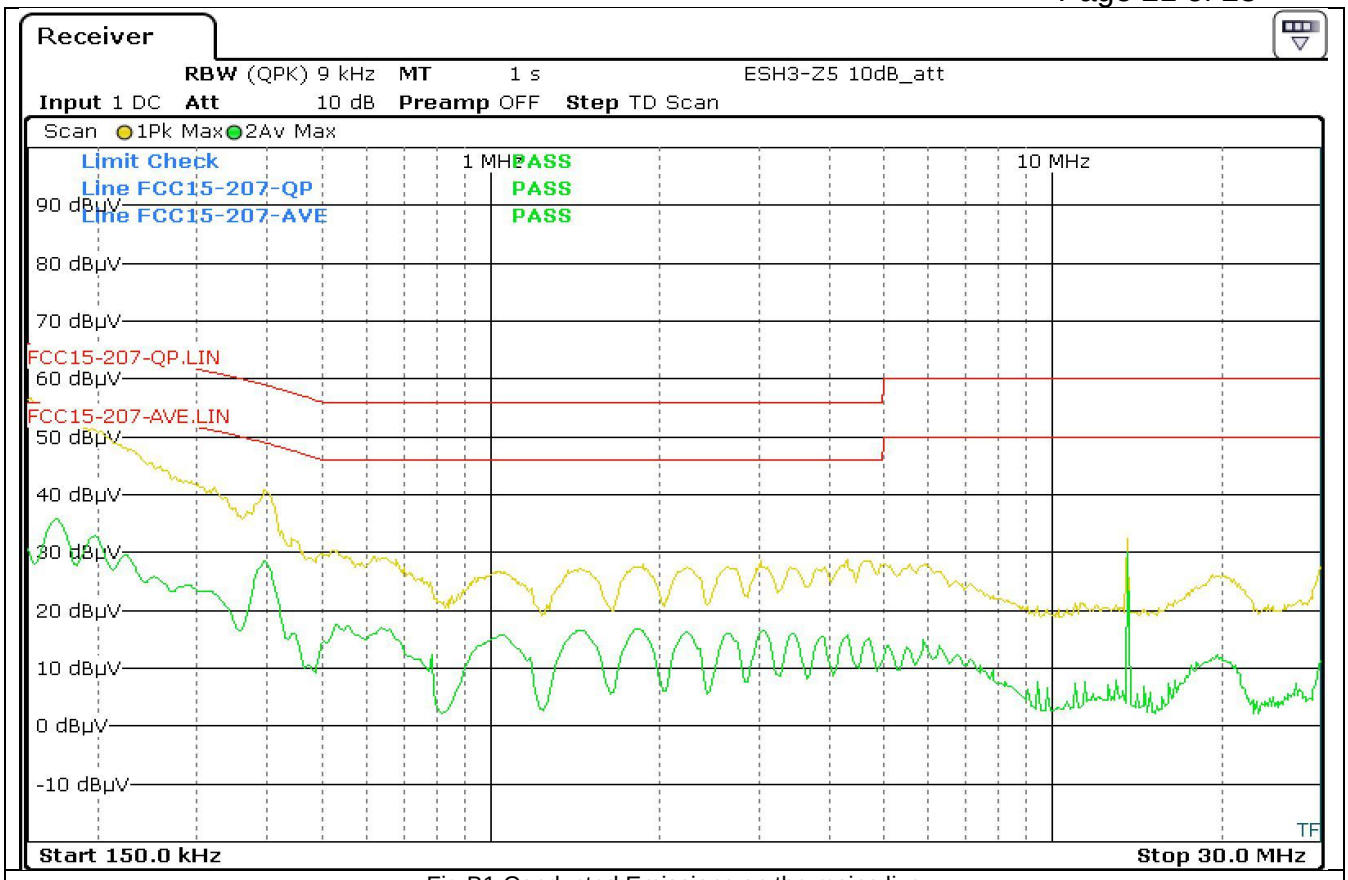


Fig B1 Conducted Emissions on the mains live

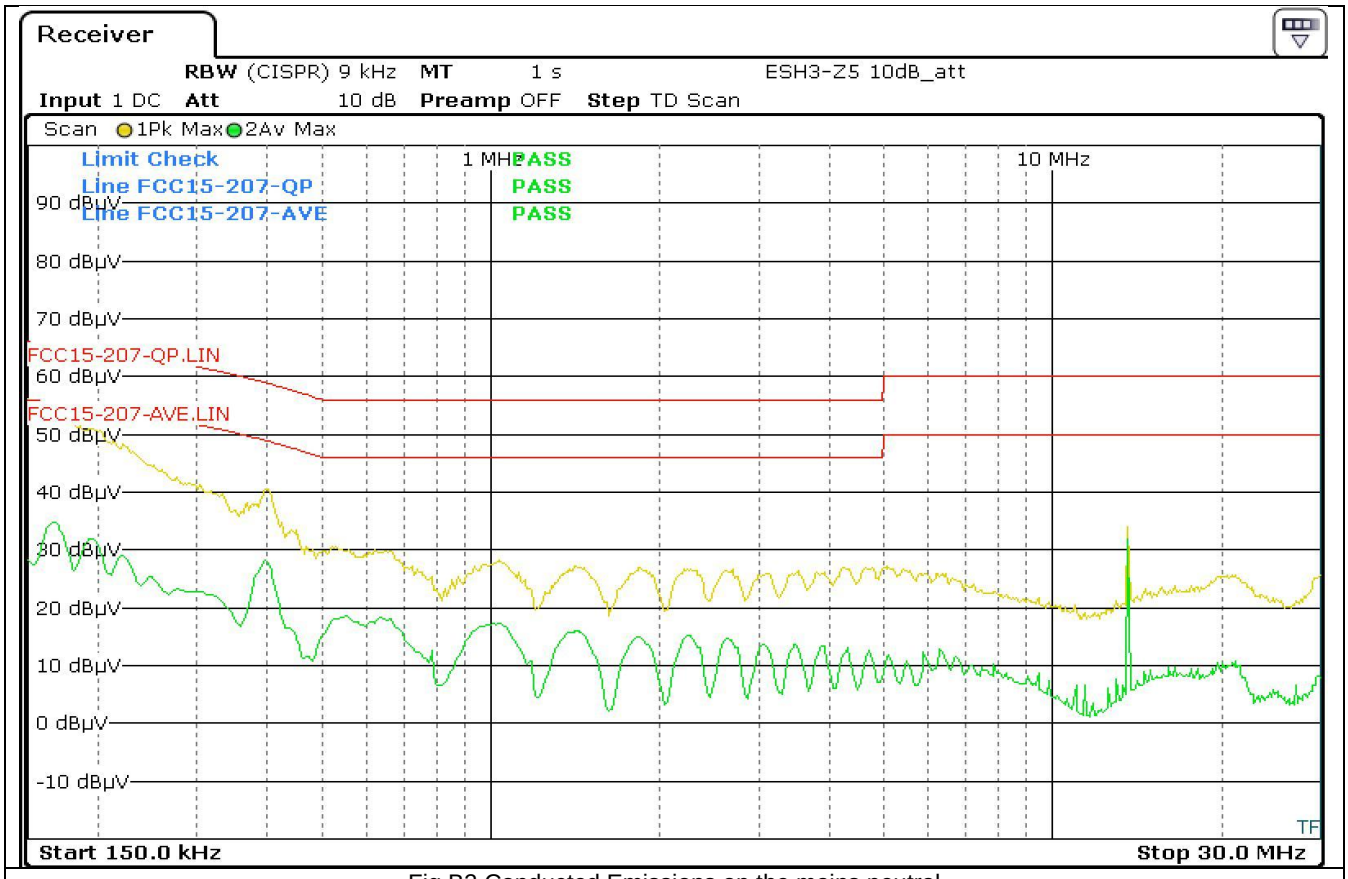
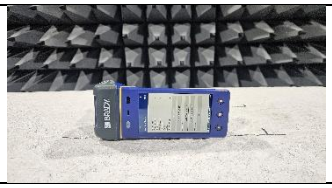


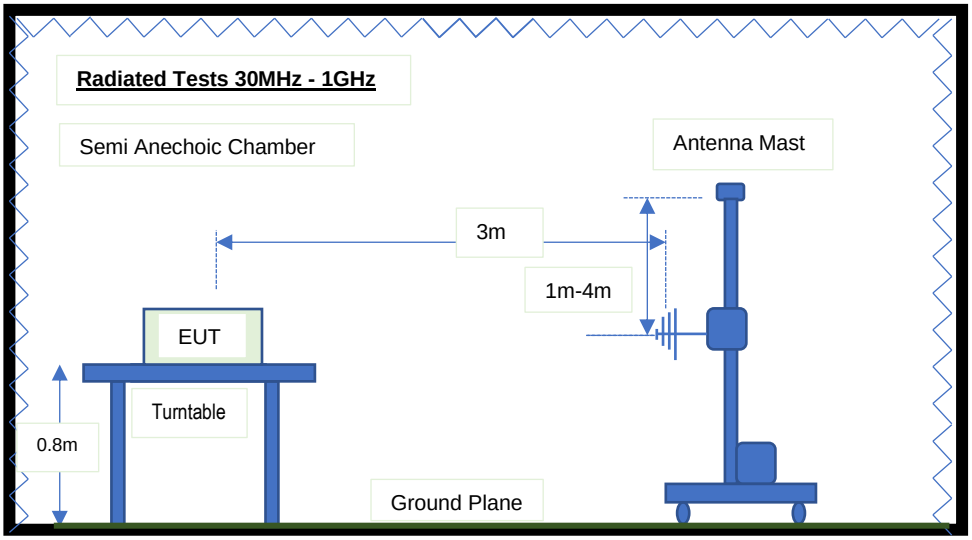
Fig B2 Conducted Emissions on the mains neutral

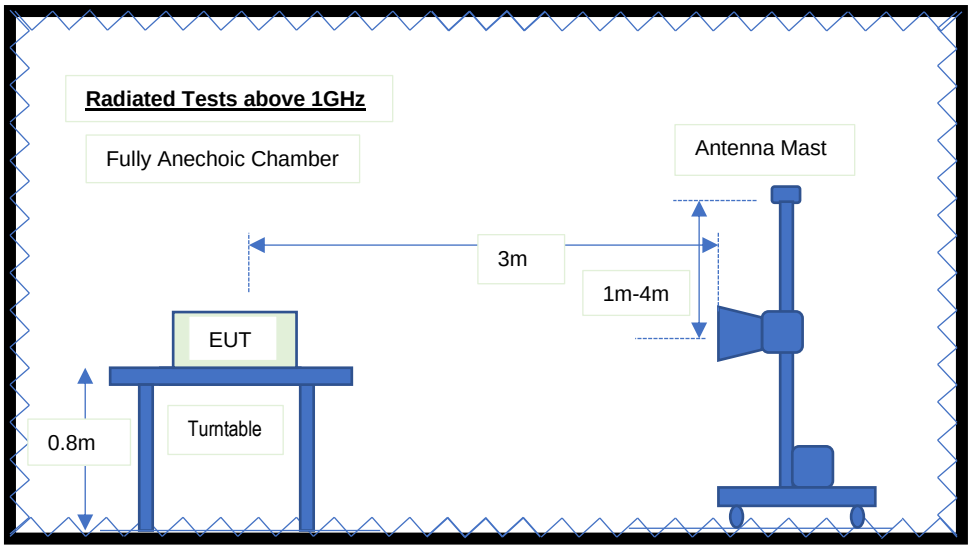
Appendix C List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	29-Jul-24	12
Spectrum Analyser 30Hz-40GHz	Rohde & Schwarz	FSP40	100053	850	10-Dec-21	36
Test Receiver 3.6GHz	Rohde & Schwarz	ESR	1316.3003k03-101625-s	869	23-May-23	36
Antenna Horn	EMCO	3115	2363	1100	19-Feb-23	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	29-Jul-22	36
Anechoic Chamber	CEI	SAR 10M	845	845	12-Sep-22	36
Antenna Biconical	EMCO		3110B	847	31-Oct-24	36
Antenna Log Periodic	AH Systems	SAS200/510	1001	784	16-Nov-22	36
Loop Antenna	EMCO	6502	2233	1065	13-Nov-23	36
Cable 20m				1213	02-Aug-24	12
Cable purple Ktype 1.8m				917	02-Aug-24	12
Cable HF Ktype 1.5m				705	02-Aug-24	12
LISN	Rohde & Schwarz	ESH3-Z5	825460/003	604	09-Mar-22	36

Appendix D Test Setup

		
Fig D1 EUT orientation O1"	Fig D2 EUT orientation "O2"	Fig D3 EUT orientation "O3"





End of Report