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Confidential Report

Project No.	**22E10095-1b**
Quotation	**Q22-2201-1**
Prepared For	**Sensata** **Schrader Electronics Ltd**
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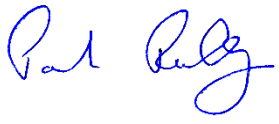
Test Lab Address	**Clonross Lane** **Derrockstown** **Dunshaughlin** **Co. Meath** **Ireland** **A85XN59**
Tested By	**Joy Israel Dalayap**
Test Report By	**Michael Kirby**
FCC Test Firm Registration	**409640**
ISED CAB identifier	**8517A**
Date Received	**24th Aug 2022**
Issue Date	**21st Oct 2022**
EUT Description	**Sensor 433MHz, Tyre Pressure Monitor**
FCC ID	**2ATIMETPMS01**
IC ID	**25094-ETPMS01**
Authorised by	**Paul Reilly**
Authorised Signature:	

TEST SUMMARY

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

FCC Part Section(s)	Industry Canada	TEST PARAMETERS	Test Result
15.231(e) 15.35	RSS-210 A1.4 RSS-Gen 6.10	Duty Cycle	PASS
15.231(e) 15.209	RSS-210 A1.4 RSS-210 8.9	RADIATED EMISSIONS	PASS
15.231(c)	RSS-210 A1.3	20dB BANDWIDTH 99% Bandwidth	PASS

RSS 210 Issue 10 Dec 2019 (Amd Apr 2020)
RSS-Gen Issue 5 Apr 2018 (Amd 1 Mar 2019) (Amd 2 Feb 2021)

Exhibit A – Technical Report

Table of Contents

1 EUT Description

The EUT was monitor using a short range 433.92 MHz transmitter for reporting of tyre pressure and temperature in cars/trucks.

Model:	ETPMS01
Type:	Tyre Pressure Monitor
Type of radio:	Stand-alone
Transmitter Type:	FSK
Operating Frequency Range(s):	433.92 MHz
Number of Channels:	One
Antenna:	Integral peak gain -22.2dBi
Antenna Impedance :	50 ohms
Transmitter power configuration:	3 VDC Internal Battery.
Operating. Temp Range:	-40° C to +85° C
Classification:	DSC
HVIN:	ETPMS01
FVIN:	1.0
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013

Table 1: Detailed Description of EUT

2 EUT Operation

Operating Conditions during Test:

The equipment under test was operated during the measurement under the following conditions:
Sample #1 was used for all tests.
The EUT was programmed to operate in modulated mode for bandwidth test and CW mode was used for all remaining tests except duty cycle.

The duty cycle test was performed on the sample of EUT programmed to operate at the highest duty cycle possible for normal operation.

a) *Test mode1 => CW unmodulated -> Radiated Emissions tests (Spurious Emissions and Carrier power)*
b) *Test mode2 ("EMC mode" repeated modulated transmissions)-> Bandwidth tests*
c) *Roll mode/ Normal mode (represents normal operation highest duty cycle) -> Duty cycle*

The 3 points above cover the standard operational mode of the Sensor

An additional manufacturer doc "ETPMS01 433Mhz Modes Table" shows the available modes and compliance to 15.231

Environmental conditions:

	Temperature	Relative Humidity
Test	**°C**	**%**
Radiated Emissions SAR	23	43
Radiated Emissions FAR	25	45
Duty Cycle	24	48

Table 2: Environmental Conditions During the Tests

2.1 Modifications

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

2.2 Date of Test

The tests were carried out on one sample of the EUT on 24th, & 25th of August 2022.

2.3 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: Spurious emissions in accordance with FCC CFR 15.107, 15.109 and 15.209. Tests were carried out to the requirements of CISPR 16-4 and ANSI C63.4-2014 and C63.10-2013.

2.4 Special Test Software

Tests were performed manually, and no special test software was used.

3 Emissions Measurements

3.1 Conducted Emissions Measurements

Test not performed as EUT is powered from battery.

3.2 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.

3.3 General

Emissions below 1GHz were measured using resolution bandwidth 100kHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

Emissions above 1GHz were measured with resolution bandwidth of 1MHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

3.3.1 Measurements in Transmit mode

A Radiated Emission pre-scan was performed which covered the x & y orientations in horizontal and vertical polarizations. In each case the emission was maximised.
The result of this pre-scan showed that the highest emission for vertical polarization was with the EUT vertical (orientation2 O2)
The EUT in a horizontal orientation (orientation1 O1) gave the highest emissions for horizontal polarization.
A full scan for radiated emission was performed in orientation O2 for vertical polarization and in orientation O1 for horizontal polarization.

The radiated emissions were maximised by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 metres.
Significant peaks from the EUT were then recorded to determine margin to the limits.

Tests were carried out as per Ansi C63.10 -2013.

3.3.2 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 antenna of this E.U.T is permanently attached.
*The E.U.T Complies with the requirement of 15.203

3.3.3 Occupied Bandwidth and Duty Cycle

3.3.3.1 Occupied Bandwidth

Requirement -15.231 (c) & IC RSS-210 A1.3

The bandwidth of the emission shall be no wider than 0.25% of the centre frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz. the emission shall be no wider than 0.5% of the centre frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

TEST PROCEDURE:

3.3.3.1.1 Results for Occupied Bandwidth 20dB Down

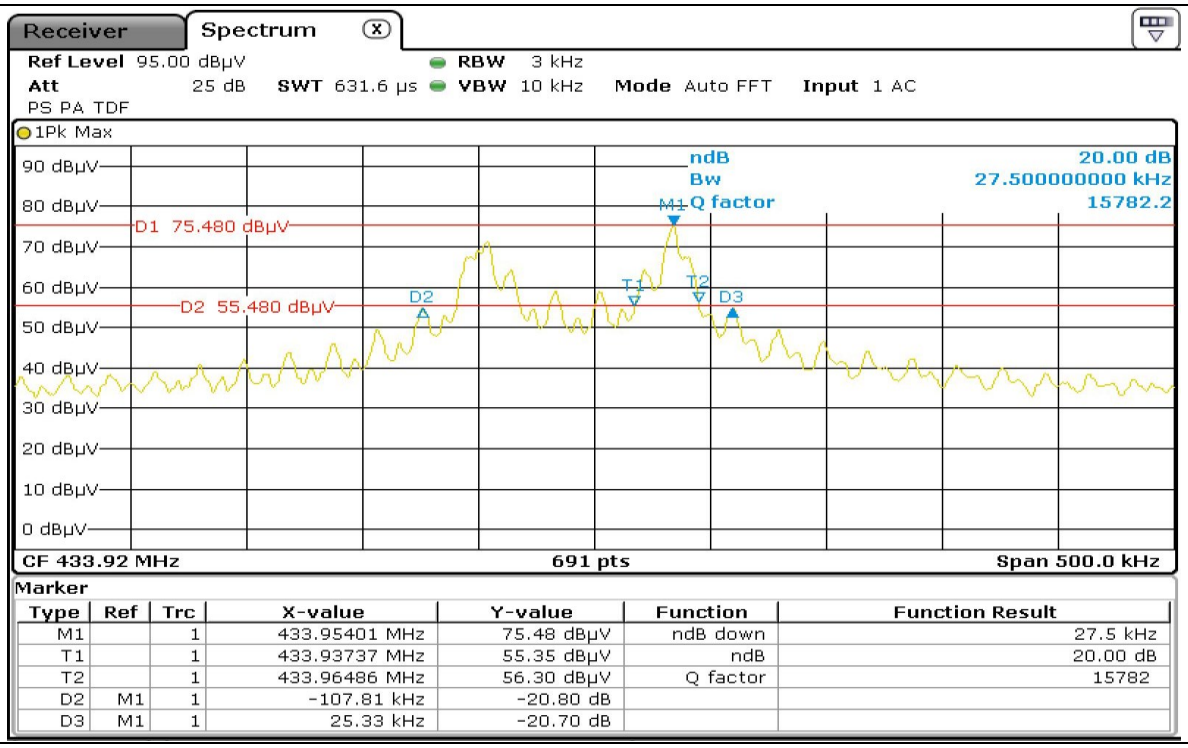


Fig 1. Occupied Bandwidth 20dB down

Operating Frequency	20dB Bandwidth	Limit	Margin	Result
MHz	kHz	kHz	kHz	
433.92	133.14	1084.8	1047.46	Pass

Table 3: Occupied Bandwidth 20dB Down Results

3.3.3.1.2 Results for 99% Occupied Bandwidth

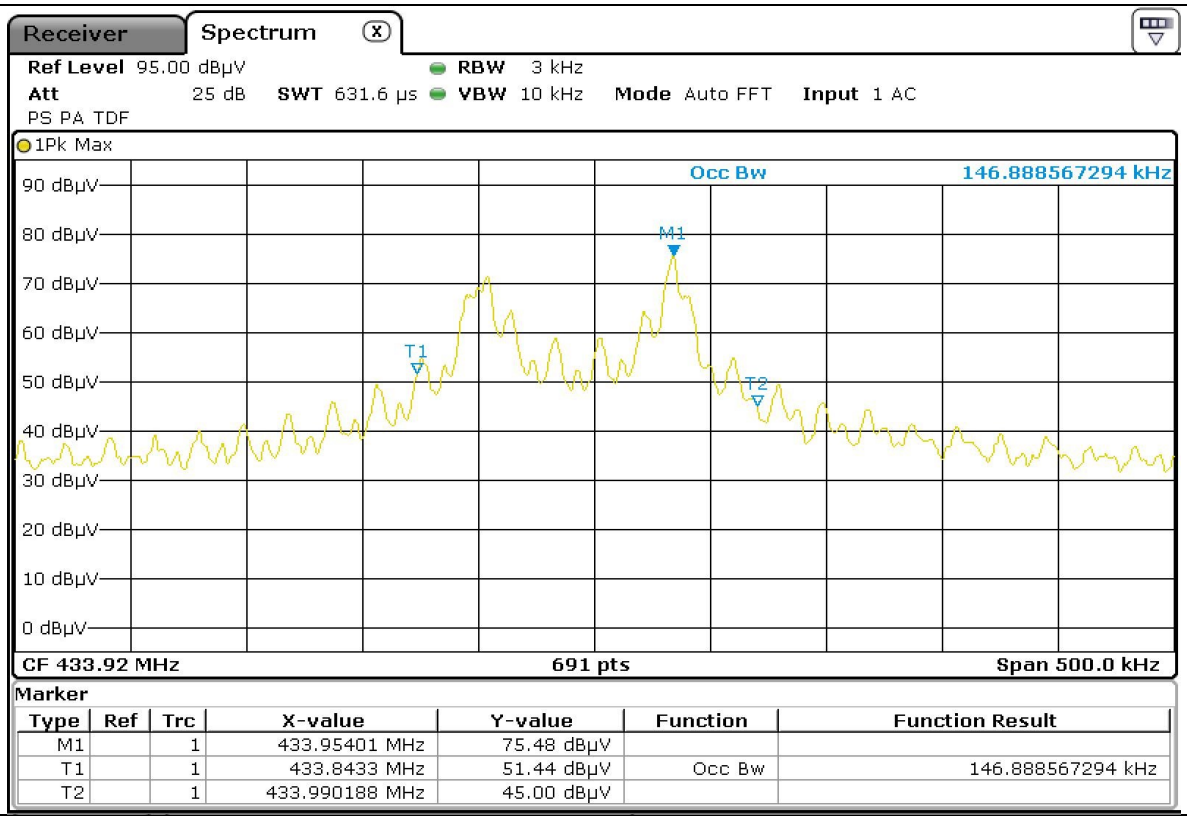


Fig 2. 99% Occupied Bandwidth

Operating Frequency	99% Bandwidth
MHz	**KHz**
433.92	**146.888**

Table 4: 99% Occupied Bandwidth Results

3.3.4 Maximum Modulation Percentage (M %) / Duty cycle

LIMIT

Requirement 15.35 (c), 15.231(e), IC RSS210 A1.4 & IC RSS-Gen 6.10

The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative(provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 seconds interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE:

The transmitter output was connected to a spectrum analyser or radiated field strength. The RBW was set to 100 kHz and the VBW is set to 300KHz. The sweep time was coupled, and the span was set to 0 Hz. The number of pulses was measured and calculated in a 100ms scan.

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	20 log duty cycle (dB)
100	11.304	1	0.113	-18.9

Table 5: Maximum Modulation Percentage/Duty Cycle Result

CALCULATION:

Average Reading = Peak Reading dB(µV/m) +20log (Duty Cycle),
*where Duty Cycle is (No of pulses*pulse width)/100 or T*

Note correction for pulse mode operation is:

20 log duty cycle (dB)
-18.9

15.231(e) duty cycle limits

The duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

Result

Duration of each transmission = 222.754ms	Limit 1sec	Comply
Silent period between transmissions >32Secs	Limit 22.6secs	Comply

Test Result Pass

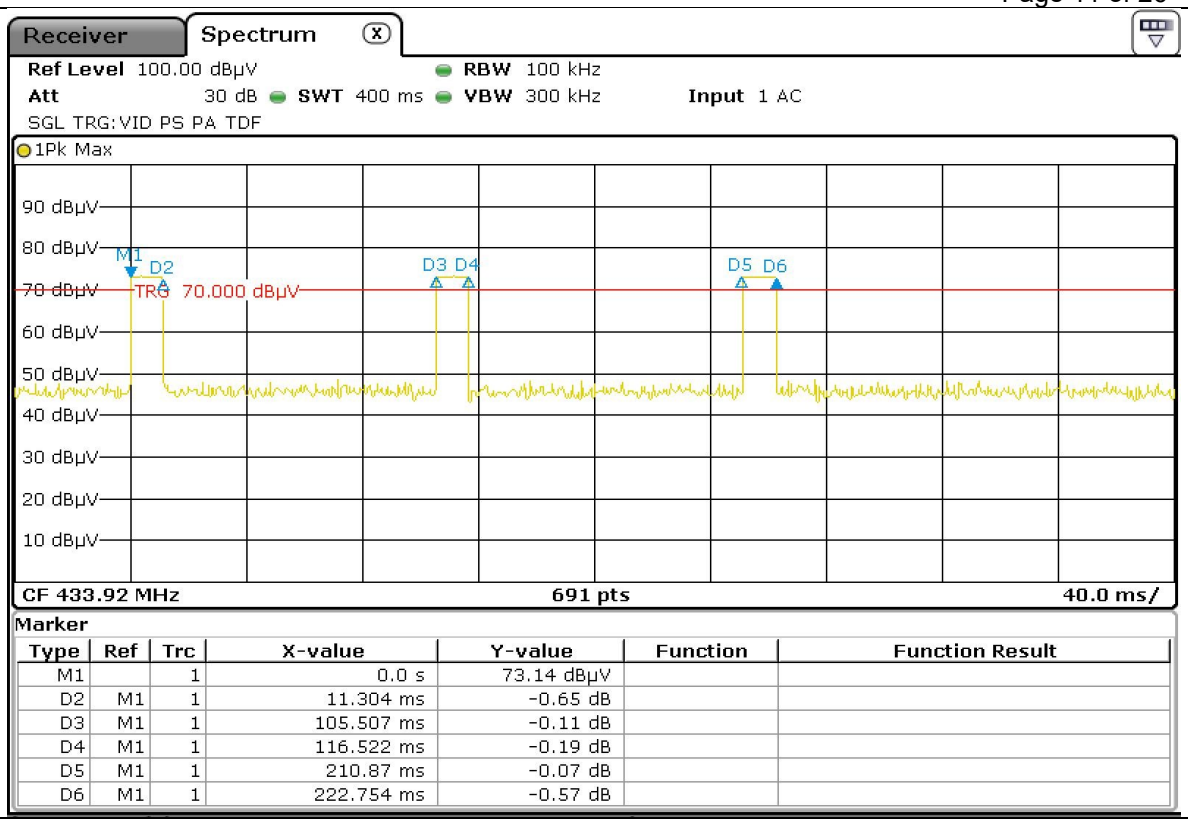


Fig 3. Single pulse train

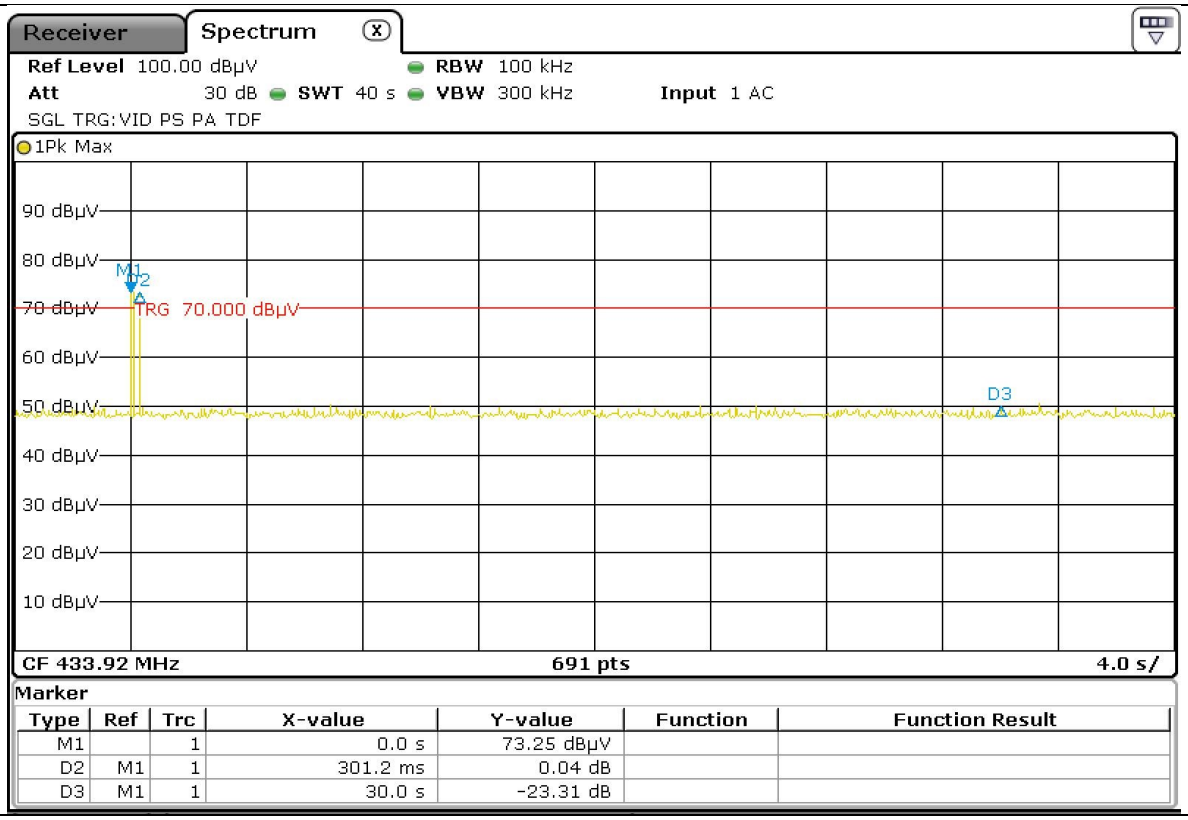


Fig 4. Pulse repetition rate Transmitted Pulses

4 Field Strength of Radiated Emissions

4.1 Test Specification: FCC 15.231(e) and RSS-210 A1.4

Fundamental Frequency (MHz)	Field Strength of fundamental (µV/m)	Strength of Spurious Emissions (µV/m).
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500[1]	50 to 150[1]
174-260	1,500	150
260-470	1,500 to 5,000[1]	150 to 500[1]
Above 470	5,000	500

Table 6: Reference Frequencies with their Corresponding Levels

**** Linear interpolations**
Interpolation Formula = 16.67 x Freq MHz - 2833.33

For operating frequency of 433.95 MHz the following limits apply (using interpolation formula above)

Fundamental Frequency	Field Strength of fundamental	Field Strength of fundamental	Field Strength of Spurious Emissions	Field Strength of Spurious Emissions
MHz	µV/m	dBµV/m	µV/m	dBµV/m
433.920	4400.446	72.870	440.045	52.870

Table 7: Resulting Field Strength when using Interpolation Formula

Test Specification: FCC PART 15, SECTION 47 CFR 15.209, RSS Gen 8.9

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
Above 960	500	54.0

Table 8: Reference Frequencies with their Field Strength in Accordance with the Test Specification

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Sections 15.231 and 15.241

Duty cycle correction = 20Log (duty cycle) dB
Duty Cycle correction for Average measurement of pulsed signal = Peak –18.9dB as per ANSI C63.10-2013 Section 7.5

Results for Radiated Emissions

Test Specification: FCC 15.231(e) and RSS-210 A1.4

Appendix A shows the results of the scans in the anechoic chamber.
Ref Appendix B for EUT orientation

4.1.1 Fundamental

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
433.950	57.1	O2	Vertical	16.8	0	1.7	75.6	72.9	17.3
433.950	57.3	O1	Horizontal	16.8	0	1.7	75.8	72.9	17.1

Table 9: Fundamental Result of 433MHz

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -18.9dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
433.950	75.6	O2	Vertical	56.7	72.9	16.2
433.950	75.8	O1	Horizontal	56.9	72.9	16.0

Table 10: Average Level and Limit of the Fundamental

Result: Pass

4.1.2 Harmonics Spurious Emissions Measurements below 1GHz (30MHz - 1GHz)

Test Specification: FCC 15.231(e) and RSS-210 A1.1.5

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
867.900	13.9	O2	Vertical	23.3	0	2.2	39.4	52.9	33.5
867.900	14.7	O1	Horizontal	23.3	0	2.2	40.2	52.9	32.7

Table 11: Result of Harmonics Below 1GHz

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -18.9dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
867.900	39.4	O2	Vertical	20.5	52.9	32.4
867.900	40.2	O1	Horizontal	21.3	52.9	31.6

Table 12: Average Level and Limit of the Harmonics below 1GHz

Result: Pass

4.1.3 Harmonics Spurious Emissions Measurements above 1GHz (1GHz - 6 GHz)

Test Specification: FCC 15.231(e) and RSS-210 A1.4

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
1.302	52.1	O2	Vertical	24.2	39.8	3.8	40.3	52.9	32.6
1.736	55.3	O2	Vertical	25.4	39.3	2.8	44.2	52.9	28.7
2.170	60.0	O2	Vertical	27.4	39.5	3.4	51.3	52.9	21.6
2.604	58.2	O2	Vertical	28.7	38.9	3.6	51.6	52.9	21.3
3.037	51.8	O2	Vertical	30.4	38.9	3.8	47.1	52.9	25.8
3.471	51.8	O2	Vertical	31.3	37.8	4.5	49.8	52.9	23.1
3.906	47.5	O2	Vertical	31.3	37.7	4.8	45.9	52.9	27.0
4.340	44.8	O2	Vertical	32.6	37.3	5	45.1	52.9	27.8
4.773	46.2	O2	Vertical	32.4	37.1	5.2	46.7	52.9	26.2
5.207	46.0	O2	Vertical	33.5	37	5.3	47.8	52.9	25.1
5.641	43.7	O2	Vertical	34.3	37.6	6.4	46.8	52.9	26.1
1.302	52.4	O1	Horizontal	24.2	39.8	3.8	40.6	52.9	32.3
1.736	59.3	O1	Horizontal	25.4	39.3	2.8	48.2	52.9	24.7
2.170	57.1	O1	Horizontal	27.4	39.5	3.4	48.4	52.9	24.5
2.604	52.9	O1	Horizontal	28.7	38.9	3.6	46.3	52.9	26.6
3.038	52.8	O1	Horizontal	30.4	38.9	3.8	48.1	52.9	24.8
3.472	51.3	O1	Horizontal	31.3	37.8	4.5	49.3	52.9	23.6
3.906	47.3	O1	Horizontal	31.3	37.7	4.8	45.7	52.9	27.2
4.340	44.0	O1	Horizontal	32.6	37.3	5	44.3	52.9	28.6
4.773	45.8	O1	Horizontal	32.4	37.1	5.2	46.3	52.9	26.6
5.207	45.9	O1	Horizontal	33.5	37	5.3	47.7	52.9	25.2
5.641	43.3	O1	Horizontal	34.3	37.6	6.4	46.4	52.9	26.5

Table 13: Result of Harmonics Above 1GHz

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -18.9dB Duty Cycle factor)	Average Limit	Margin
GHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
1.302	40.3	O2	Vertical	21.4	52.9	31.5
1.736	44.2	O2	Vertical	25.3	52.9	27.6
2.170	51.3	O2	Vertical	32.4	52.9	20.5
2.604	51.6	O2	Vertical	32.7	52.9	20.2
3.037	47.1	O2	Vertical	28.2	52.9	24.7
3.471	49.8	O2	Vertical	30.9	52.9	22
3.906	45.9	O2	Vertical	27.0	52.9	25.9
4.340	45.1	O2	Vertical	26.1	52.9	26.8
4.773	46.7	O2	Vertical	27.8	52.9	25.1
5.207	47.8	O2	Vertical	28.9	52.9	24
5.641	46.8	O2	Vertical	27.8	52.9	25.1
1.302	40.6	O1	Horizontal	21.7	52.9	31.2
1.736	48.2	O1	Horizontal	29.3	52.9	23.6
2.170	48.4	O1	Horizontal	29.5	52.9	23.4
2.604	46.3	O1	Horizontal	27.4	52.9	25.5
3.038	48.1	O1	Horizontal	29.2	52.9	23.7
3.472	49.3	O1	Horizontal	30.4	52.9	22.5
3.906	45.7	O1	Horizontal	26.7	52.9	26.2
4.340	44.3	O1	Horizontal	25.3	52.9	27.6
4.773	46.3	O1	Horizontal	27.4	52.9	25.5
5.207	47.7	O1	Horizontal	28.8	52.9	24.1
5.641	46.4	O1	Horizontal	27.4	52.9	25.5

Table 14: Average Level and Limit of the Harmonics Above 1GHz

Duty cycle correction = 20Log (duty cycle) dB =-18.9dB
Duty Cycle correction for Average measurement of pulsed signal = Peak – 18.9dB as per ANSI C63.10-2013 Section 7.5

Result: Pass

Non-HaFig 0-1rmonics Spurious Emissions Measurements

Test Specification: FCC Part 15.209, RSS Gen

Frequency	Quasi peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	EUT Orientation	Final Field Strength Quasi Peak	Average Limit	Margin
MHz	dBuV/m	dB	dB	dB	V/H		dBuV/m	dBuV/m	dB
147.18	-4.0	11.6	0	0.2	Vertical	O2	7.8	43.5	35.7
98.70	4.0	10.3	0	0.2	Horizontal	O1	14.5	43.5	29.0
298.62	-7.9	12.8	0	1.2	Horizontal	O1	6.1	46.0	39.9
409.95	0.0	16	0	1.2	Horizontal	O1	17.2	46.0	28.8
457.98	-0.5	16.5	0	1.2	Horizontal	O1	17.2	46.0	28.8

Table 15: Results for Non-Harmonics Radiated Spurious Emissions

as per ANSI C63.10-2013 Section 7.5

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 16: 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.

6 List of Test Equipment Used

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Due Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-22	12
Spectrum Analyser 30Hz-40GHz	Rohde& Schwarz	FSP40	100053	850	10-Dec-24	36
Test Receiver 3.6GHz	Rohde& Schwarz	ESR	1316.3003k03-101625-s	869	28-May-23	36
LISN	Rohde & Schwarz	ESH3-Z5	825460/003	604	16-Feb-23	36
Antenna Horn	EMCO	3115	9905-5809	655	21-Jan-24	24
Fully Anechoic Chamber	CEI	FAR 3M	906	906	23-Jul-25	36
Anechoic Chamber	CEI	SAR 10M	845	845	17-May-25	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	06-Oct-24	36
Antenna Log Periodic	Chase	UPA6108	1072	609	09-Sep-24	36
Cable Ntype 10m				963	29-Jul-23	12
Cable Ntype 2m				828	29-Jul-23	12
Cable purple Ktype 1.8m				917	29-Jul-23	12
Cable Ntype 10m				914	29-Jul-23	12
Cable HF Ktype 1.5m				705	29-Jul-23	12

Table 17: Equipment Used During Testing

Appendix - A Scans for Spurious Emissions Test Configurations

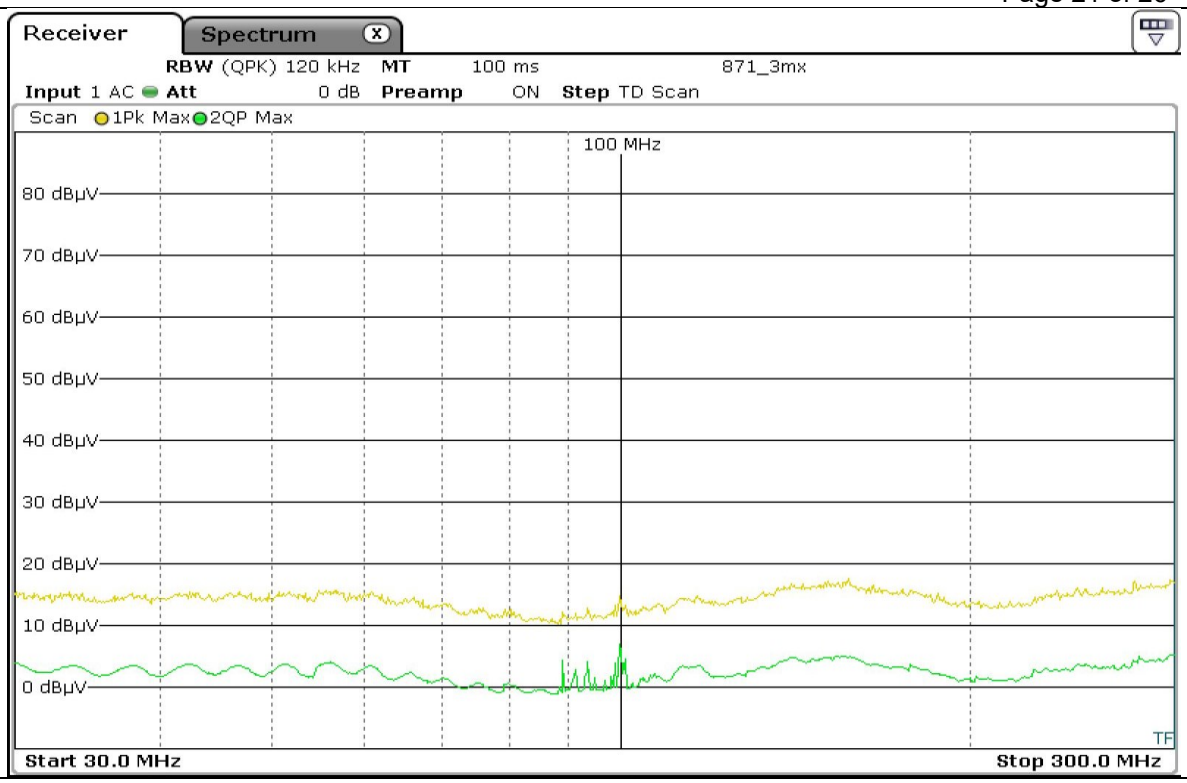


Fig A-1. Radiated Emissions 30MHz-300MHz Vertical 3metres

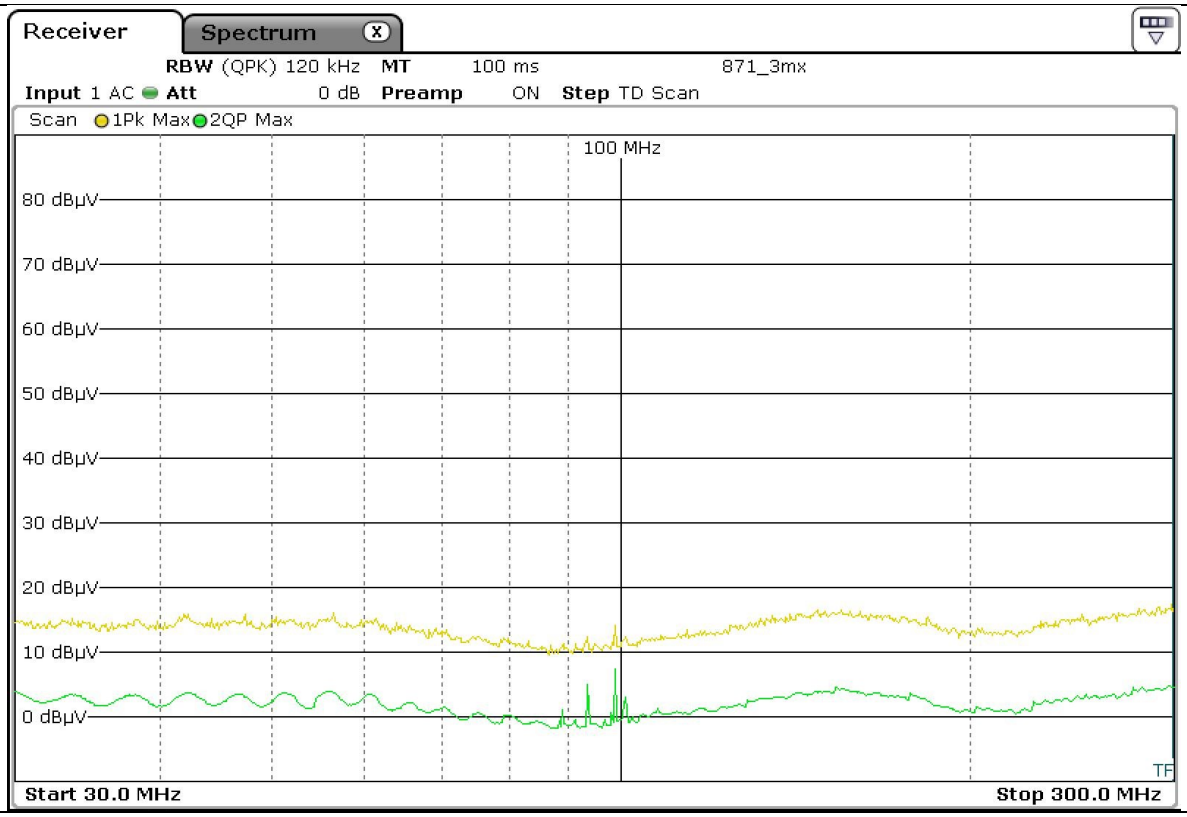


Fig A-2. Radiated Emissions 30MHz-300MHz Horizontal 3metres

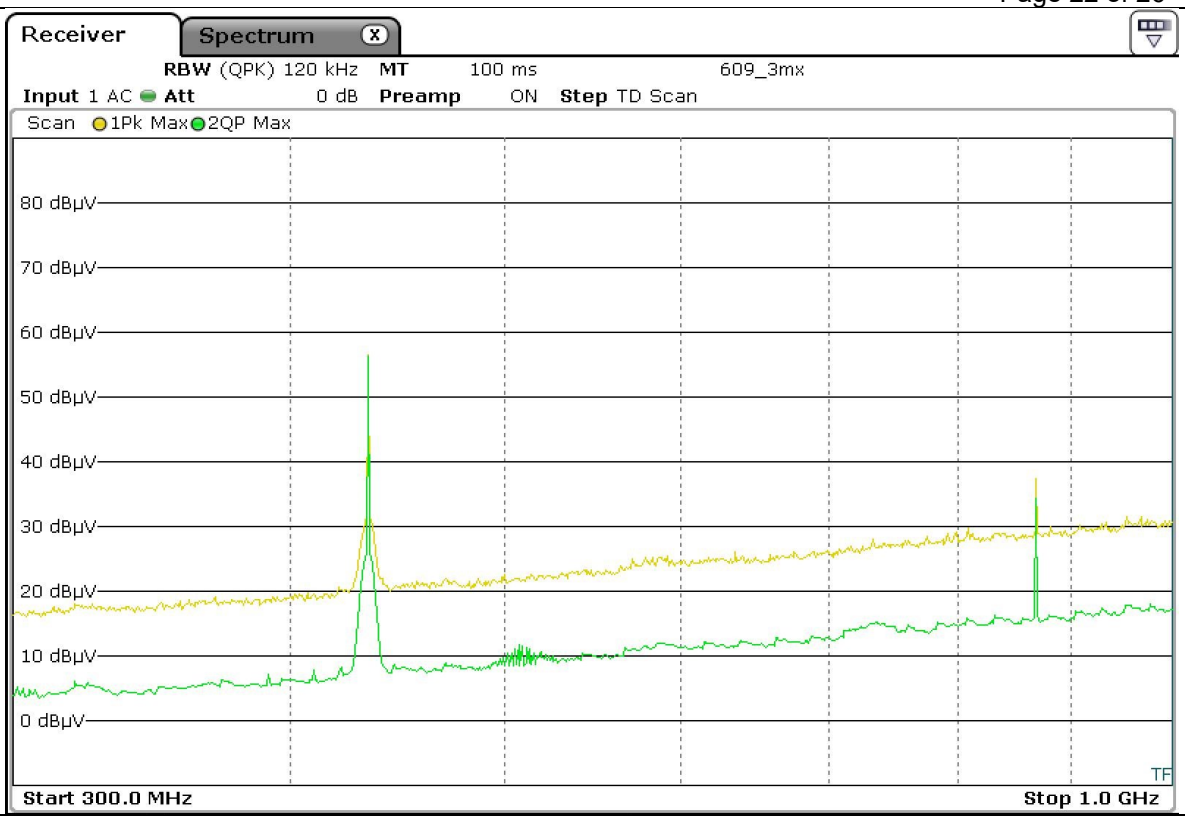


Fig A-3. Radiated Emissions 300MHz – 1GHz Vertical 3metres

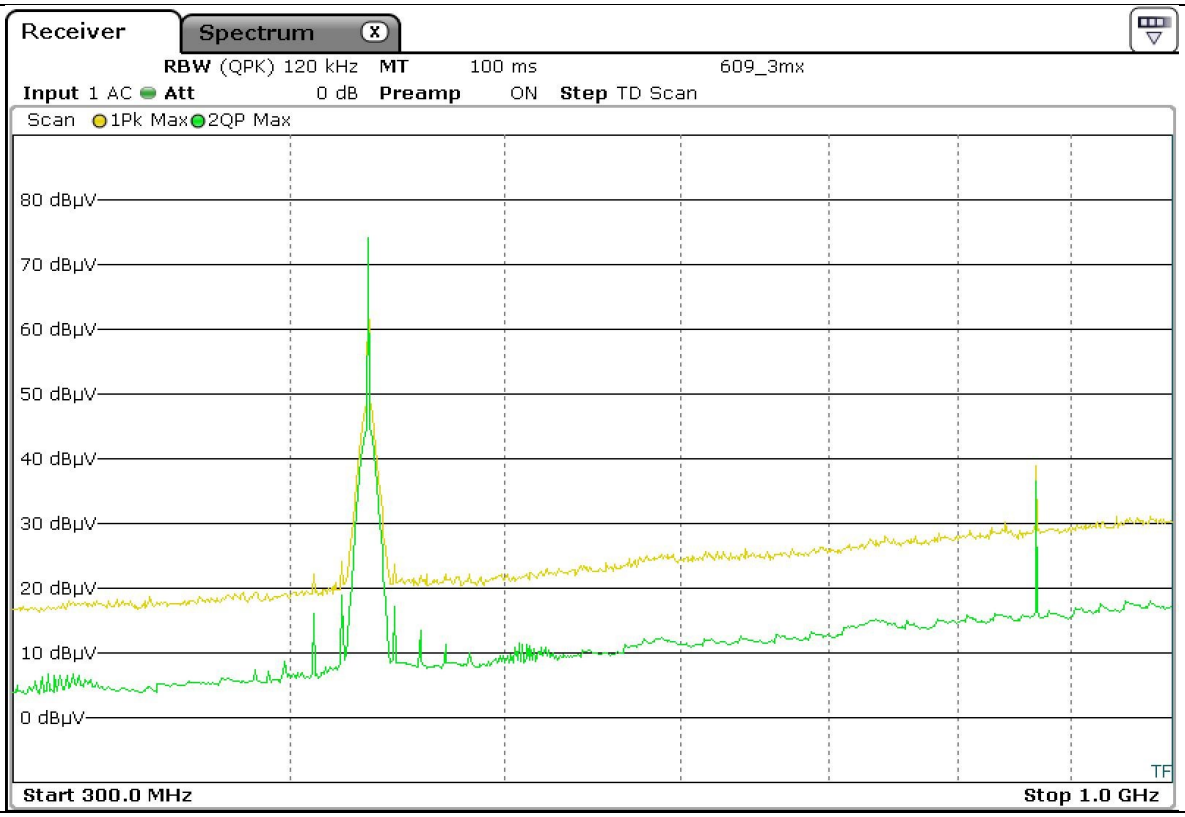


Fig A-4. Radiated Emissions 300MHz – 1GHz Horizontal 3metres

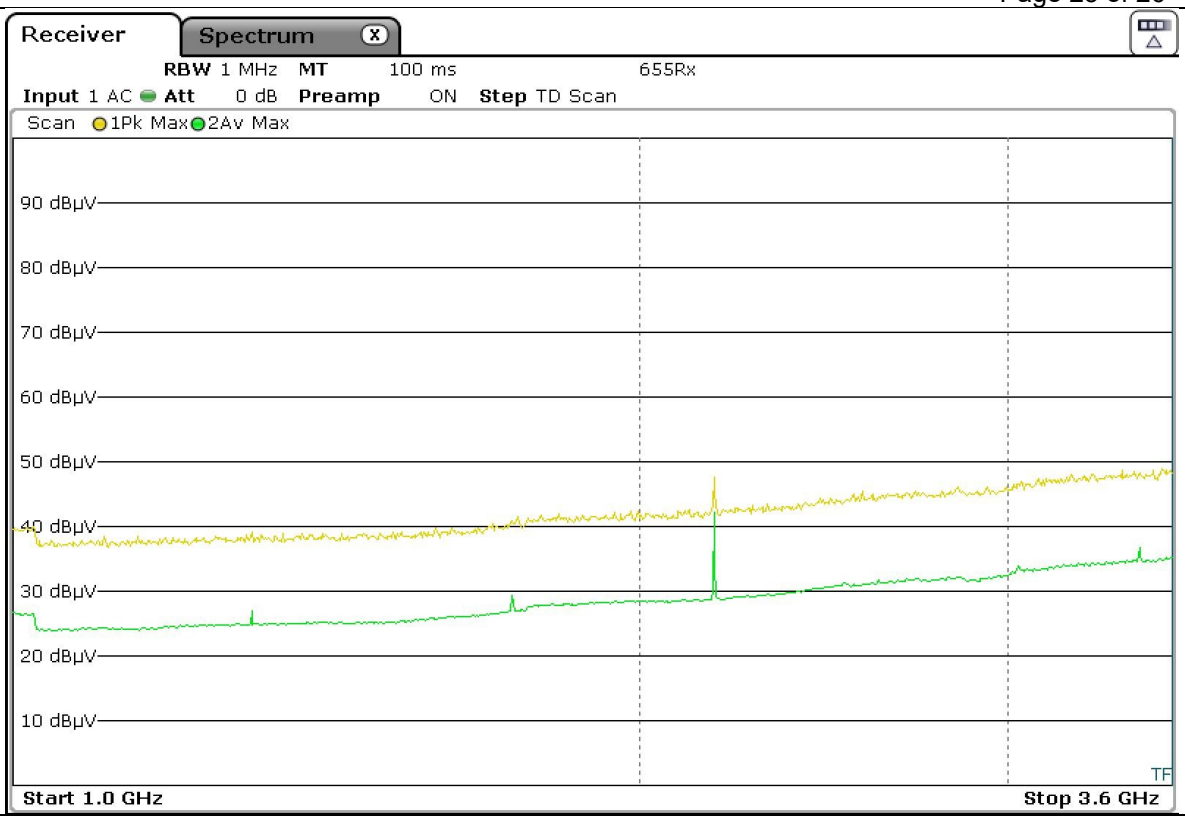


Fig A-5. Radiated Emissions 1GHz – 3.6GHz Vertical 3metres

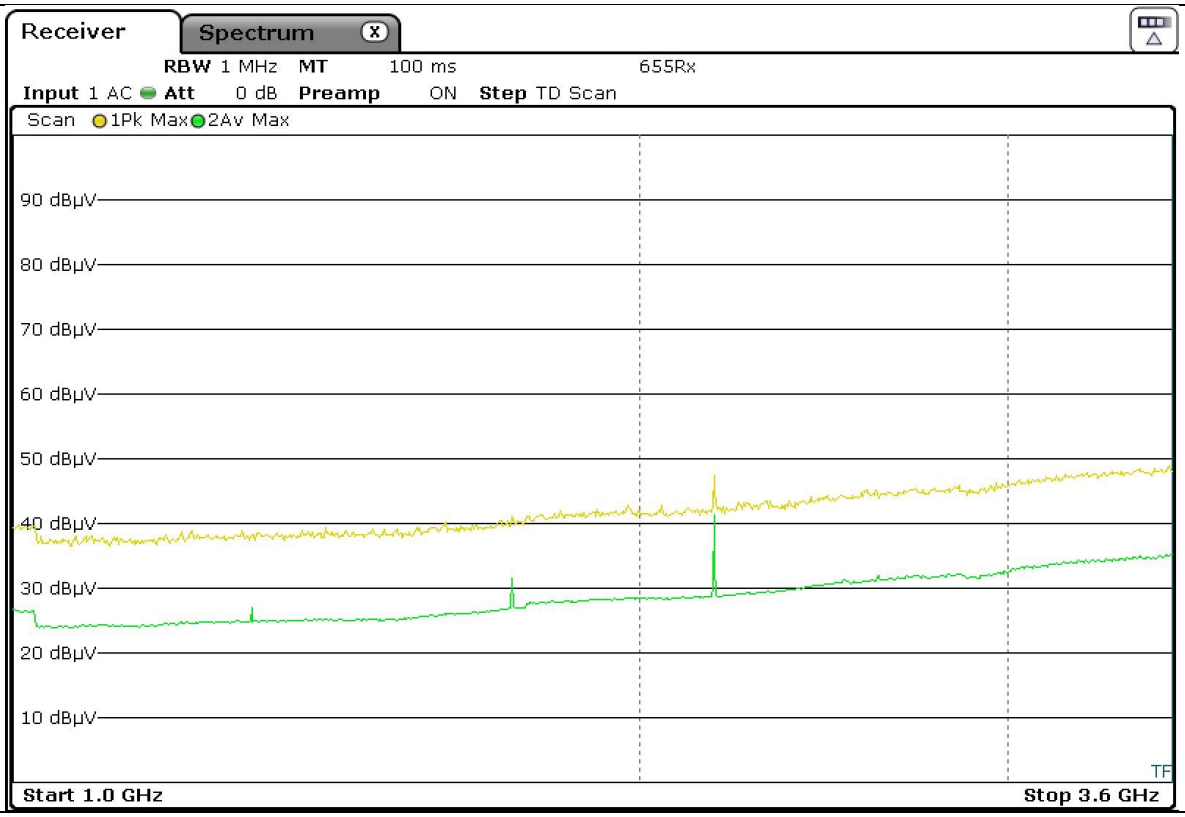


Fig A-6. Radiated Emissions 1GHz – 3.6GHz Horizontal 3metres

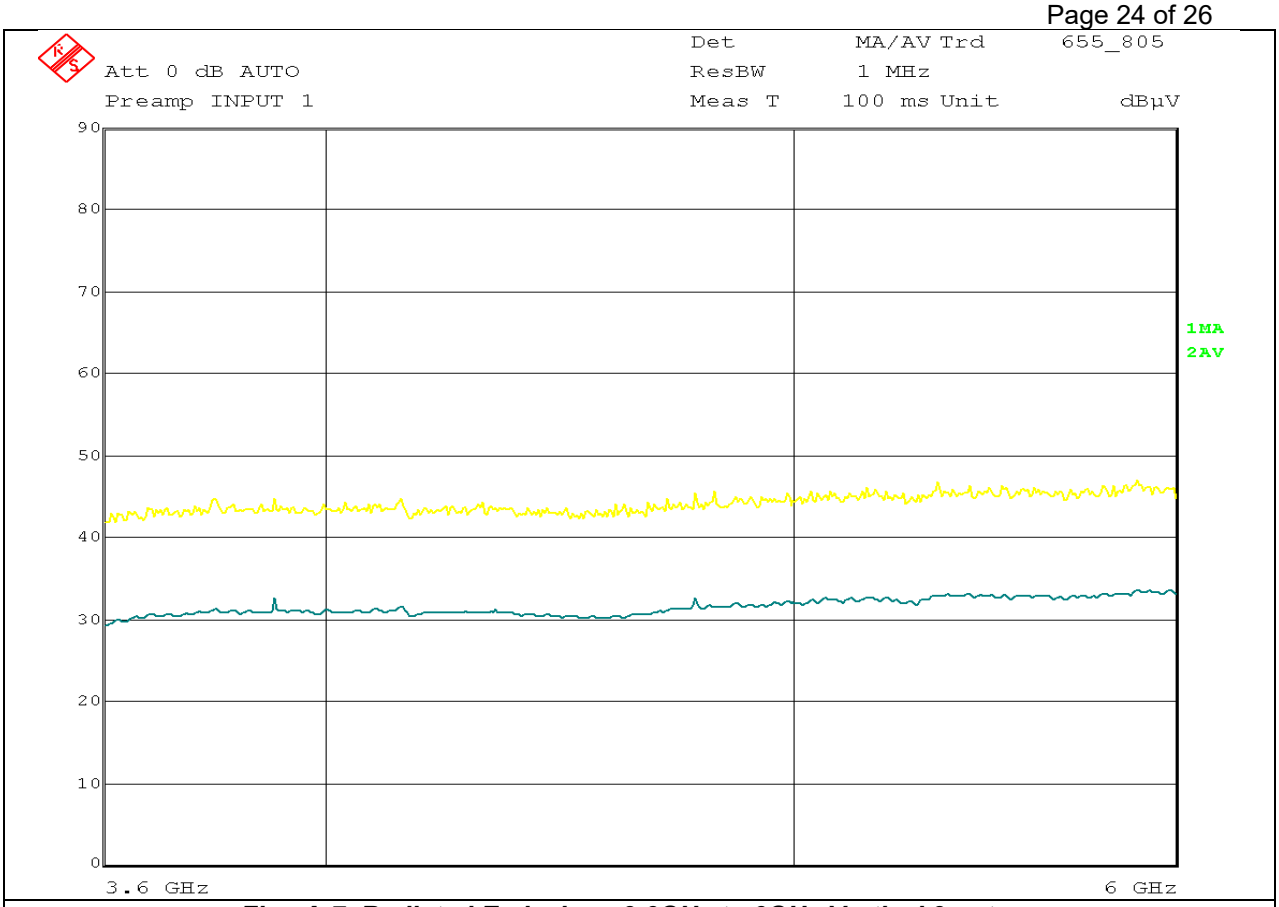


Fig A-7. Radiated Emissions 3.6GHz to 6GHz Vertical 3metres

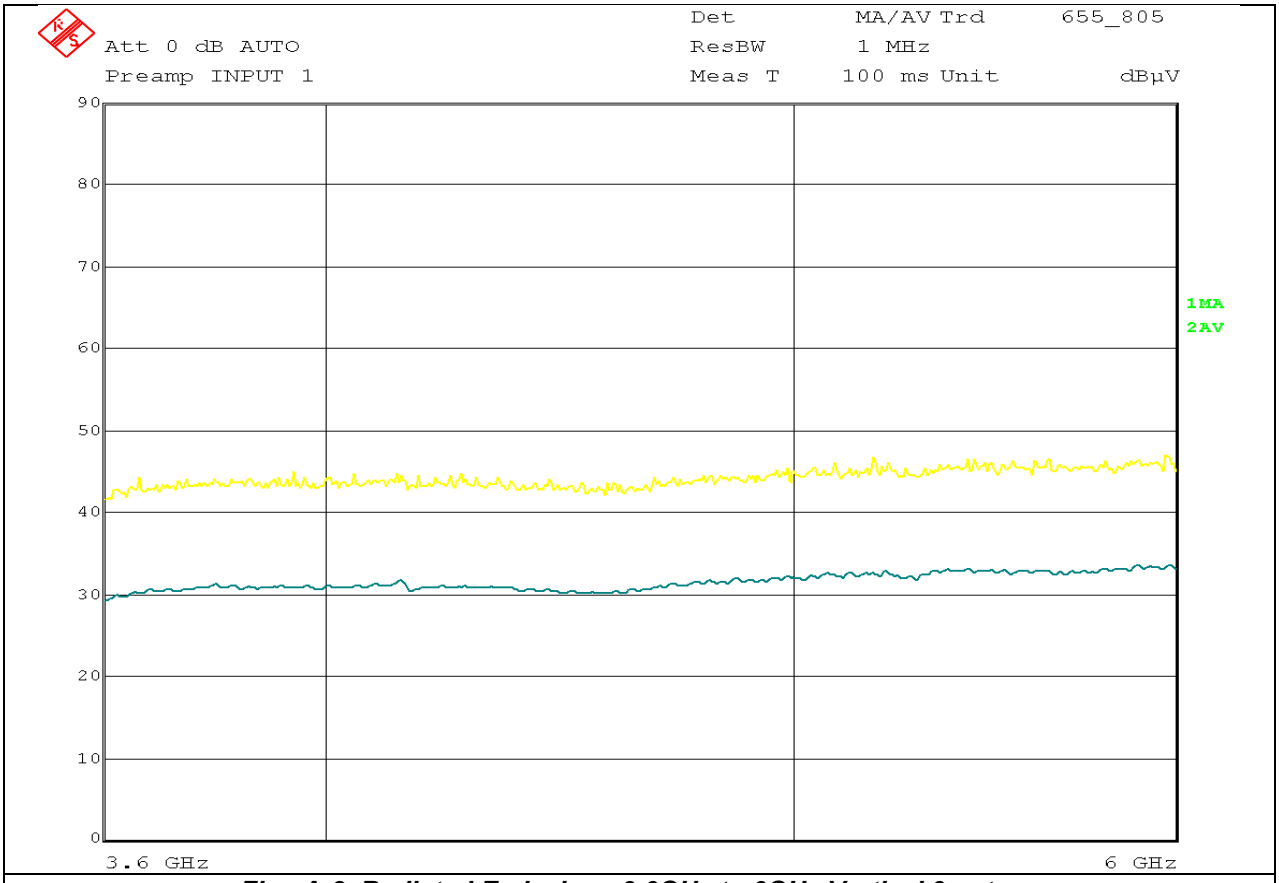


Fig A-8. Radiated Emissions 3.6GHz to 6GHz Vertical 3metres

Appendix - B Test Configurations:

Orientations for Radiated Emissions

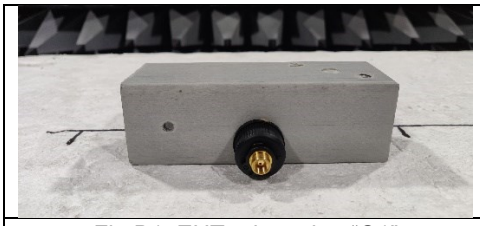


Fig B1: EUT orientation “O1”

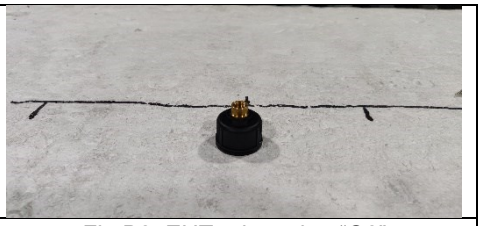


Fig B2: EUT orientation “O2”

Appendix - C Block Diagrams of Test Setup

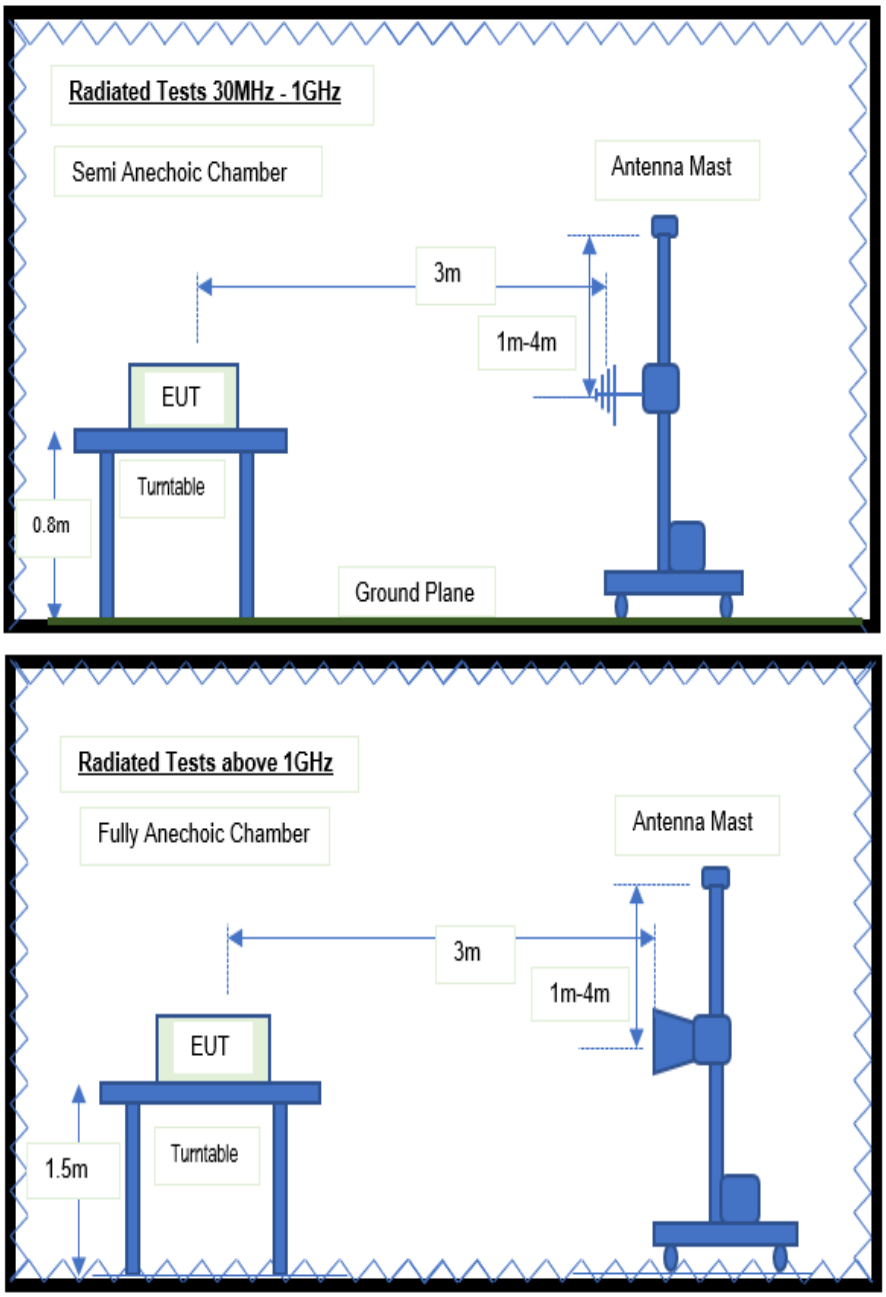


Fig C1: EUT Test Setup

End of Report