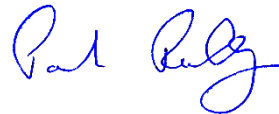


**Confidential Report**

<b>Project No.</b>	<b>22E9851-2a</b>
<b>Quotation</b>	<b>Q22-1501-1</b>
<b>Prepared For</b>	<b>Sensoteq Ltd</b>
<b>Company Address</b>	<b>Unit 23, Ormeau Business Park, Cromac Ave, BT7 2JA Belfast</b>
<b>Contact</b>	<b>Martin McNeill</b>
<b>Contact Email</b>	<b>amccall@sensoteq.co.uk</b>
<b>Contact Phone</b>	<b>+44 2896 208 453</b>
<b>Prepared By</b>	<b>Compliance Engineering Ireland</b>
<b>Test Lab Address</b>	<b>Clonross Lane, Derrockstown, Dunshaughlin, Co. Meath, Ireland</b>
<b>Tested By</b>	<b>Joy Dalayap</b>
<b>Test Report By</b>	<b>Michael Kirby</b>
<b>FCC Test Firm Registration</b>	<b>409640</b>
<b>ISED CAB identifier:</b>	<b>IE0001</b>
<b>Date</b>	<b>24<sup>th</sup> Nov 2022</b>
<b>EUT Description</b>	<b>Wireless Sensor</b>
<b>FCC ID</b>	<b>2ANL3SPR433CA</b>
<b>IC ID</b>	<b>23633-SPR433CA</b>
<b>Authorised by</b>	<b>Paul Reilly</b>
<b>Authorised Signature:</b>	

## TEST SUMMARY

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 Amd 2 Feb 2021

RSS-210 Issue 10 Dec 2019 Amd Apr 2020

RSS-247 Issue 2 Feb 2017

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 all antennas internal	Pass
15.209,15.247,15.231	RSS-Gen 8.9, RSS 247	Spurious Emissions	Pass

Measurements performed according to the procedures in ANSI C63.10-2013

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF COMPLIANCE ENGINEERING IRELAND LTD

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## 1. EUT Description

The KappaX range are non-rechargeable battery powered sensors with Bluetooth and 433.4MHz radios.

The Bluetooth is a pre-certified module FCCID: 2AAQSISP1807 IC:11306A-ISP1807

### 1.1. EUT Operation

#### Operating Conditions during Test:

The equipment under test was operated during the measurement under the following conditions:

Bluetooth and 433.4MHz radios were active during test. Note the 433.4MHz transmitter is always on.

The test was performed on model KPX1001 (Sample #1).

A new internal 3.6V battery was used for the test.

#### Environmental conditions:

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

Temperature:	+20 to +24 ° C
Humidity:	+38 to +43 %

### 1.2. 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 of the EUT on 17<sup>th</sup> , 18<sup>th</sup> , 21<sup>st</sup> , 22<sup>nd</sup> Nov 2022.

#### 1.3.1. Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for the conducted emissions test was  $\pm 3.5$  dB.

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

### 1.4. Special Test Software

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

## **2. Emissions Measurements**

### **2.1. Conducted Emissions Measurements**

Test not performed as EUT is powered from a 3.6V battery.

### **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.

#### **2.2.1. 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.

#### **2.2.2. Measurements in Transmit mode**

A Radiated Emission pre-scan was performed which covered the x, y, and z 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 (orientation O1).

The EUT in a vertical orientation (orientation2 O2) gave the highest emissions for horizontal polarization.

A full scan for radiated emission was performed in orientation O1 for vertical polarization and in orientation O2 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

### 2.3. 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 EUT is permanently attached.

\*The EUT Complies with the requirement of 15.203.

### 3 Results for Radiated Emissions

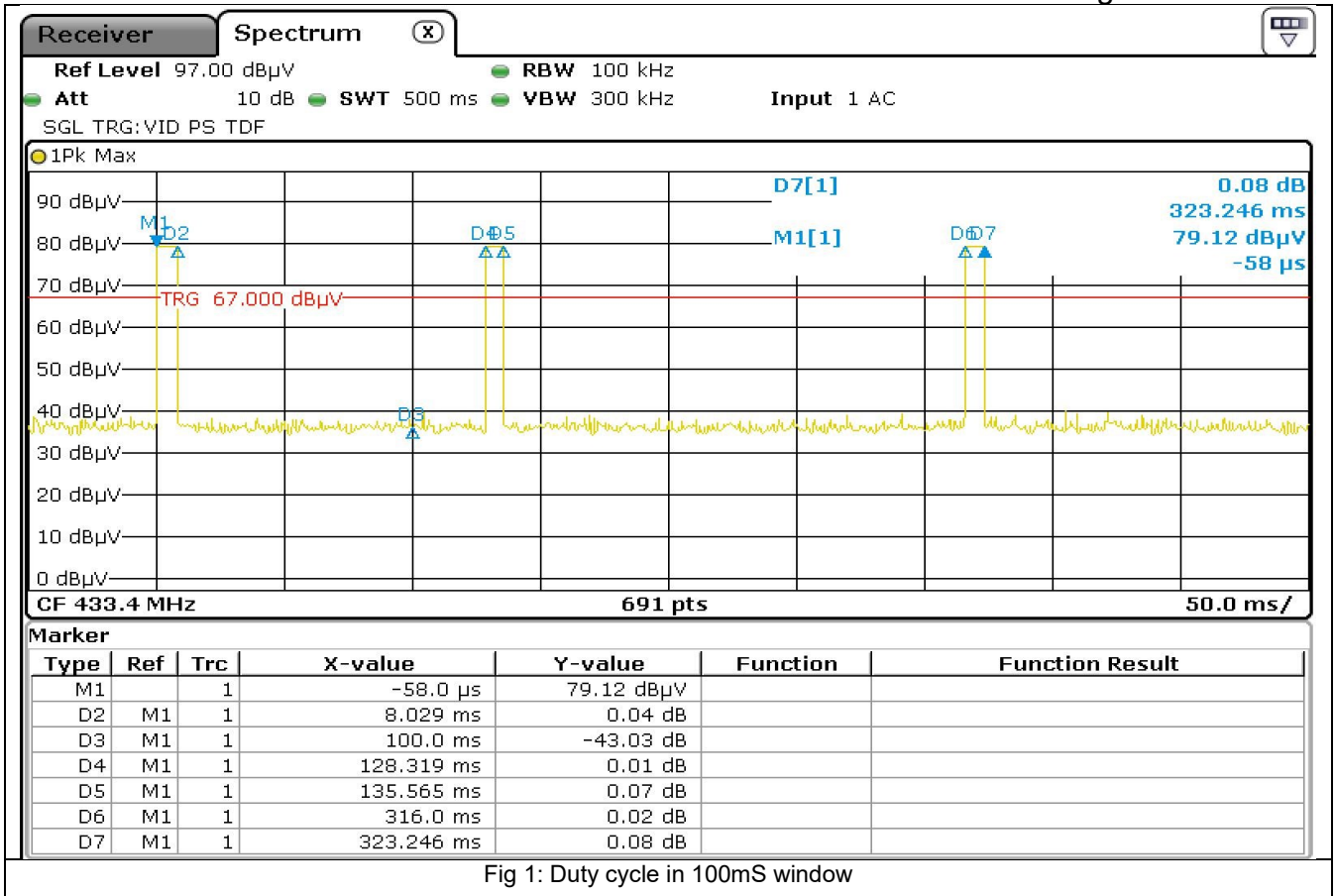
#### 3.1 Fundamental Measurements 433.4MHz transmitter

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	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
433.400	69.5	O1	Vertical	16.1	0	1.2	86.8	72.9	6.1	Pass
433.400	70.6	O2	Horizontal	16.1	0	1.2	87.9	72.9	5.0	Pass

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 22.03dB Duty Cycle factor)	Average Limit	Margin	Result
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB	P/F
433.400	86.8	O1	Vertical	64.8	72.9	8.1	Pass
433.400	87.9	O2	Horizontal	65.9	72.9	7	Pass

**Duty Cycle correction for Average measurement of pulsed signal = Peak -22.03dB**  
as per ANSI C63.10-2013 Section 7.5



MAXIMUM MODULATION PERCENTAGE/Duty Cycle

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	20 log duty cycle (dB)	Duty Cycle %	Test Result
100	8.029	1	0.0803	-21.91	8.0	Pass

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)
-21.91



### 3.2 BLE Radiated Carrier power

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Final Peak Level	Transmitted power	Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dBuV/m	dBm	dBm	dB
2.402	96.6	27.4	38.5	3.5	Vertical	88.99	-6.2	36.0	42.2
2.402	95.6	27.4	38.5	3.5	Horizontal	87.97	-7.2	36.0	43.2
2.426	96.5	27.4	38.5	3.5	Vertical	88.93	-6.3	36.0	42.3
2.426	95.0	27.4	38.5	3.5	Horizontal	87.44	-7.8	36.0	43.8
2.480	93.1	28.7	38.3	3.4	Vertical	86.85	-8.4	36.0	44.4
2.480	90.3	28.7	38.3	3.4	Horizontal	84.13	-11.1	36.0	47.1

Note the Radiated field strength was measured at 3 metres and the conversion formula below was used to determine the EIRP in dBm

$$EIRP (dBm) = E_{3m} (dBuV/m) - 95.2$$

Test Result Pass

### 3.2 Spurious Emissions Measurements BLE and 433.4 MHz transmitters

#### Test Specification: FCC Part 15.205,15.209, RSS Gen 15.247

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
1.300	61.5	24.2	39.8	3.8	Vertical	0.00	49.70	74	24.3
3.901	49.3	31.3	37.7	4.8	Vertical	0.00	47.68	74	26.3
4.334	51.8	32.6	37.3	5.0	Vertical	0.00	52.09	74	21.9
4.852	46.7	32.4	37.3	5.2	Vertical	0.00	47.03	74	27.0
7.278	44.7	37.7	38	6.7	Vertical	0.00	51.08	74	22.9
12.130	41.0	40.3	37.1	7.4	Vertical	0.00	51.56	74	22.4
1.300	60.6	24.2	39.8	3.8	Horizontal	0.00	48.80	74	25.2
3.901	51.7	31.3	37.7	4.8	Horizontal	0.00	50.14	74	23.9
4.334	56.2	32.6	37.3	5.0	Horizontal	0.00	56.48	74	17.5
4.852	46.4	32.4	37.3	5.2	Horizontal	0.00	46.70	74	27.3
7.278	44.3	37.7	38	6.7	Horizontal	0.00	50.74	74	23.3
12.130	40.6	40.3	37.1	7.4	Horizontal	0.00	51.22	74	22.8

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Average Level	Average Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.334	56.2	32.6	37.3	5.0	Horizontal	-21.91	34.57	54	19.4

Test Result Pass

Where peak readings are less than the average limit (54dbuV/m), average tests are not performed.

As per ANSI C63.10-2013 Section 7.5

**Result: Pass**

#### 4 List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Due Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-23	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	19-Nov-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

**Appendix A: Scans for Radiated Spurious Emissions 433MHz Band and BLE Co-locating**

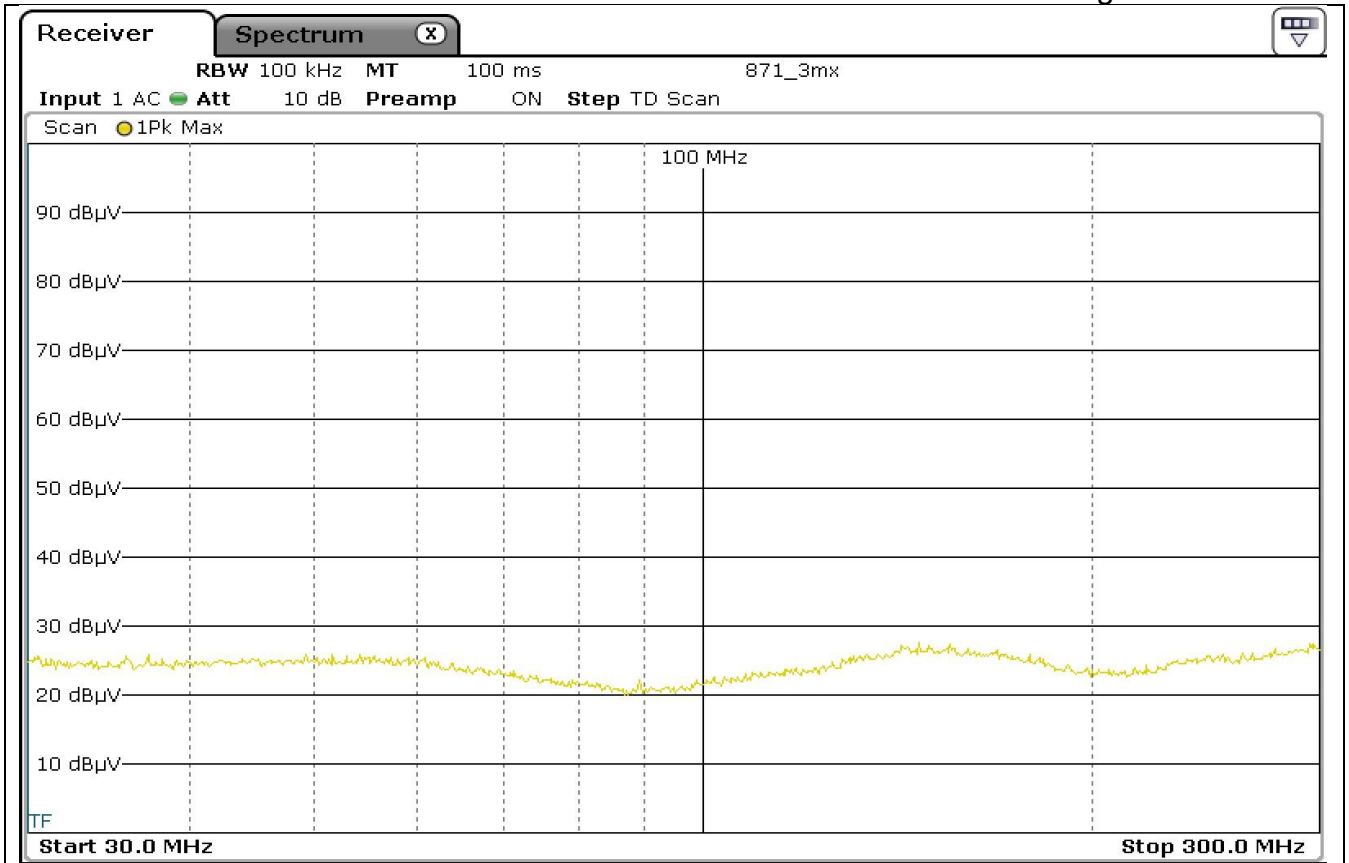


Fig A1: Radiated Emissions 30MHz - 300MHz, Vertical, 3metres

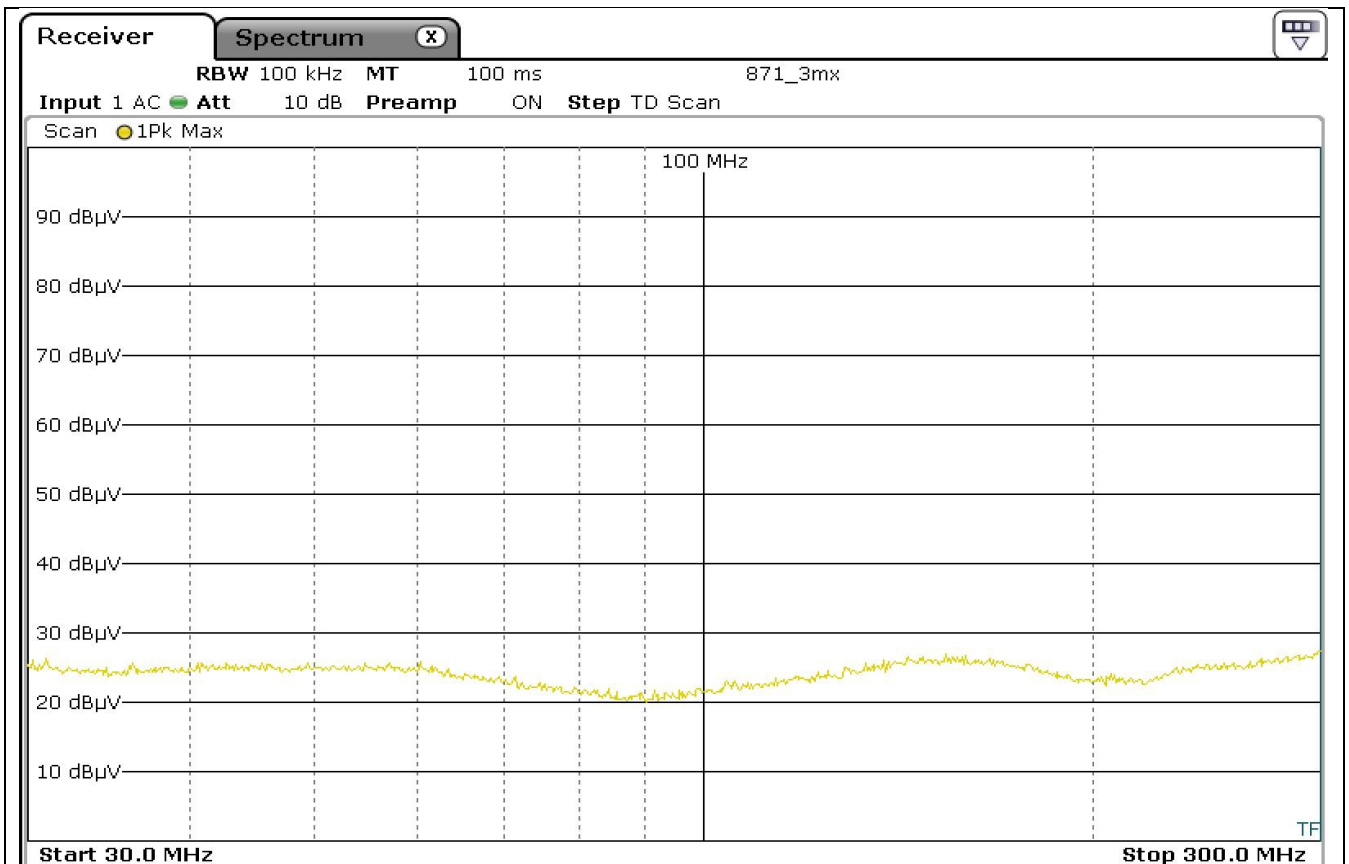
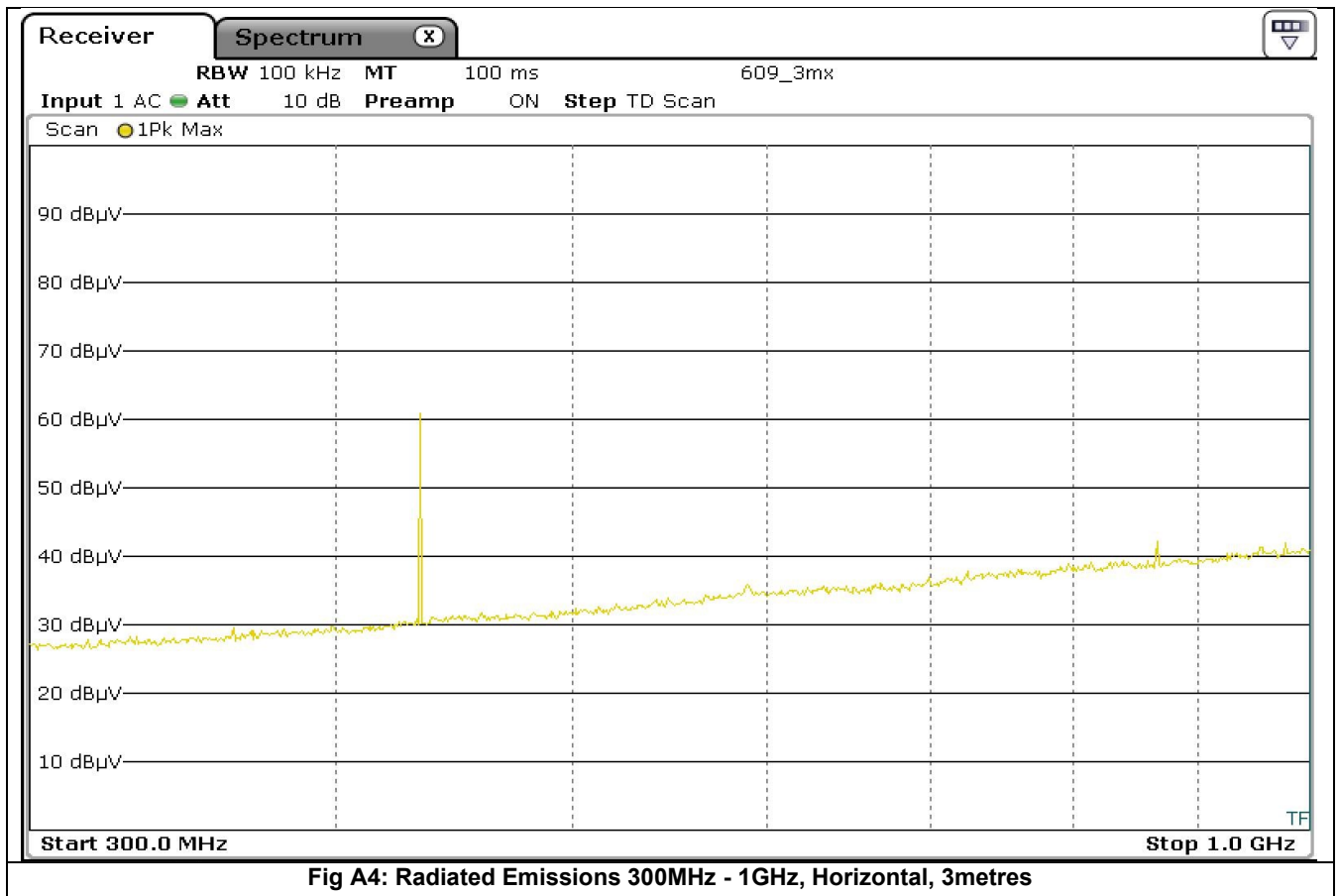
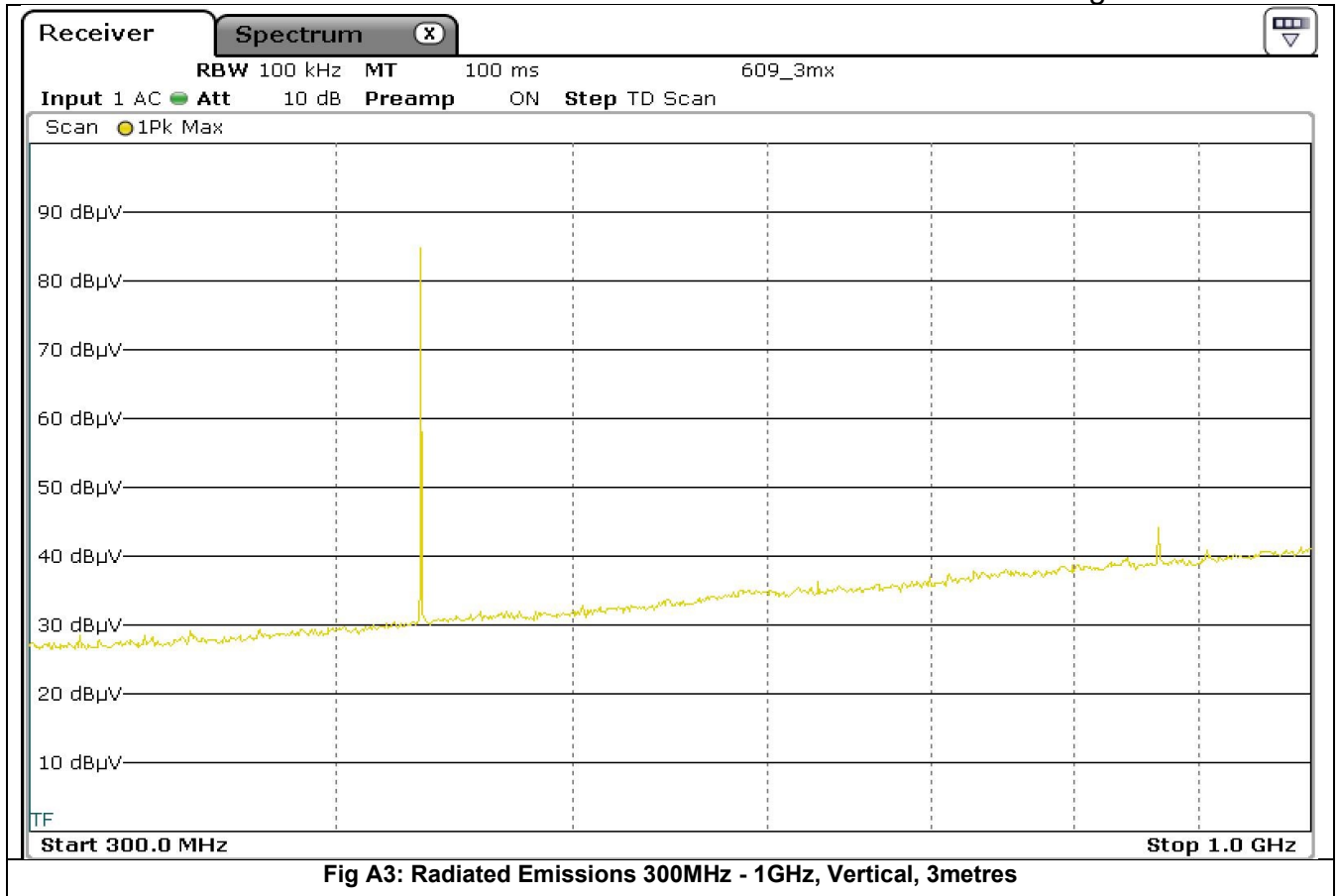
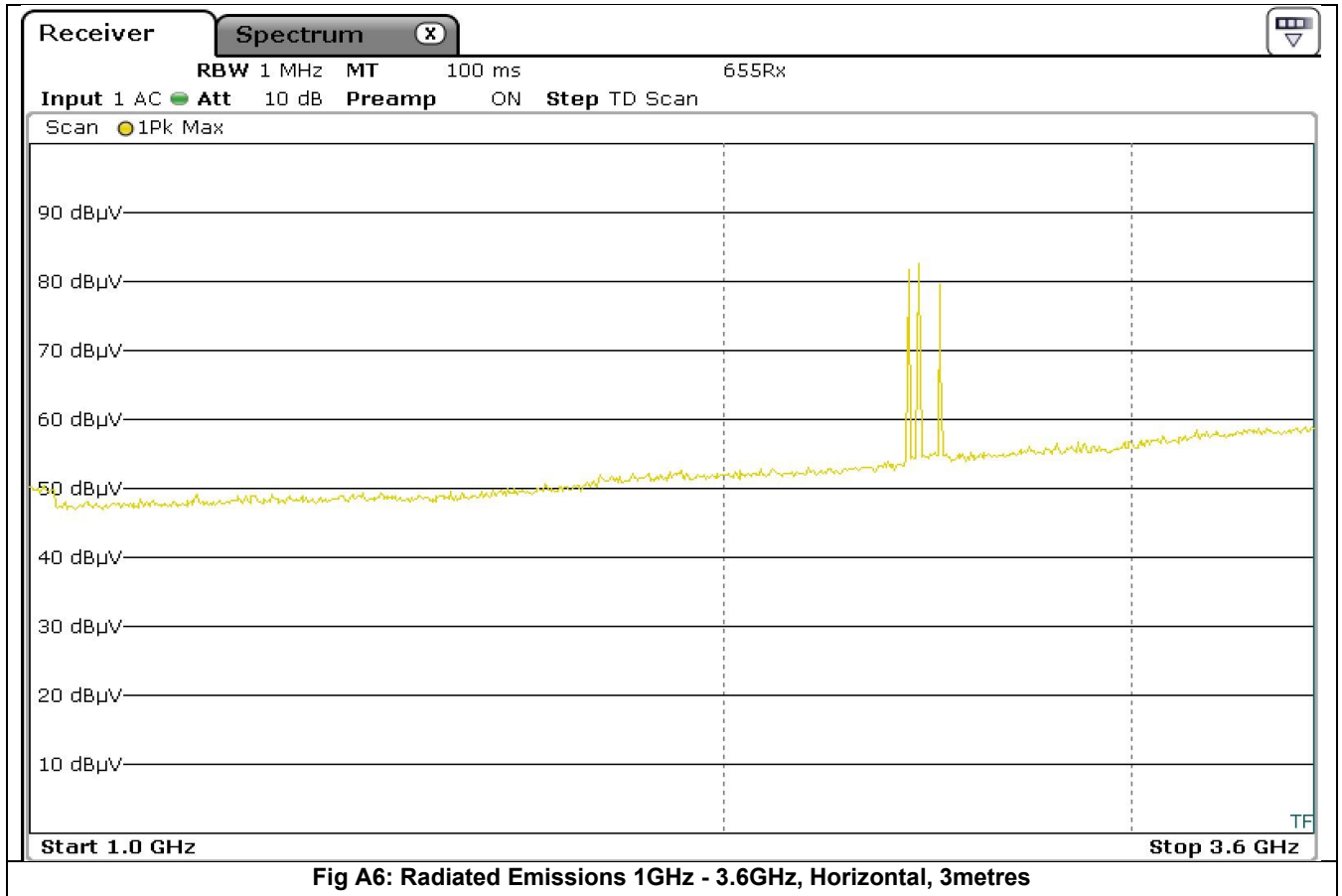
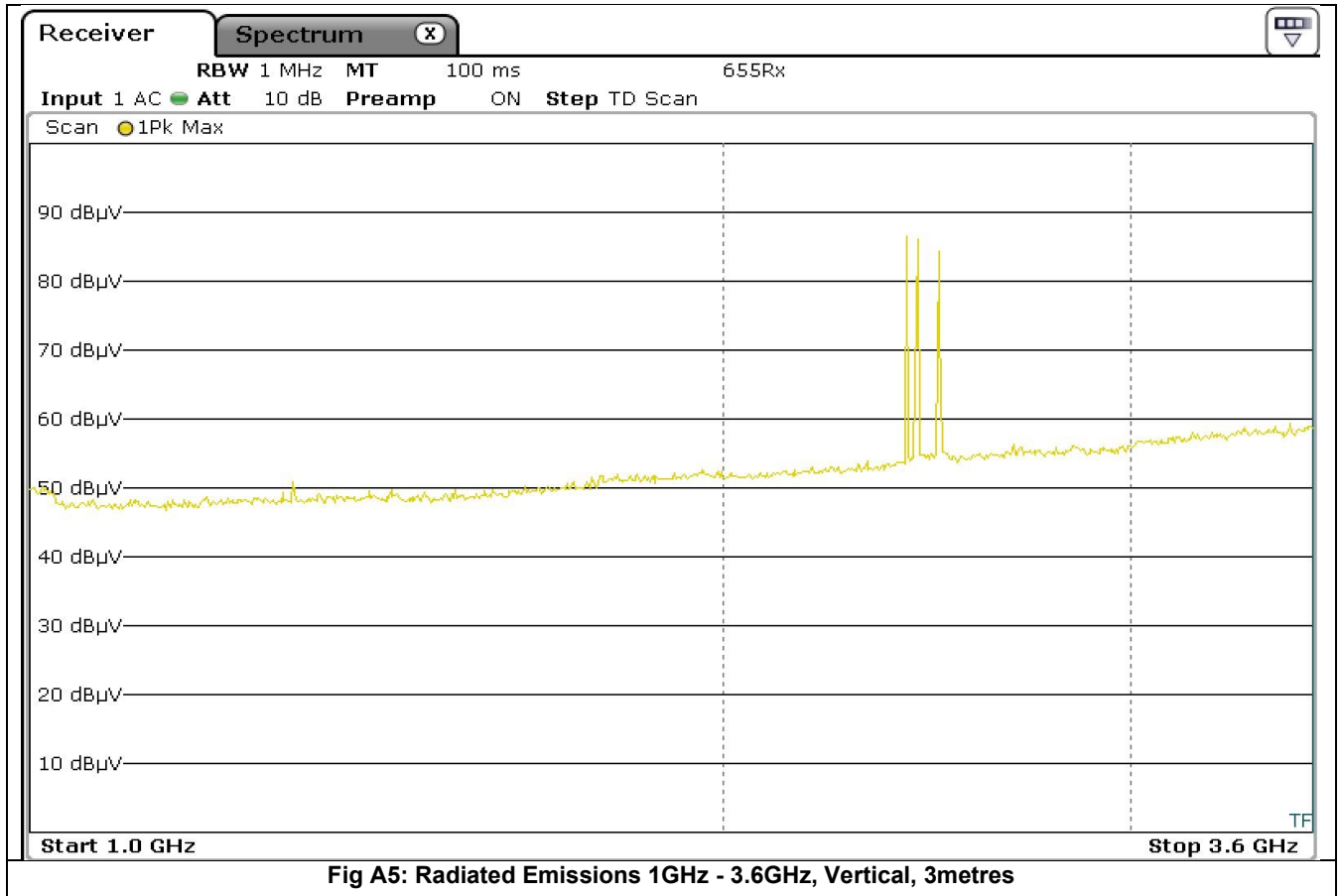


Fig A2: Radiated Emissions 30MHz - 300MHz, Horizontal, 3metres





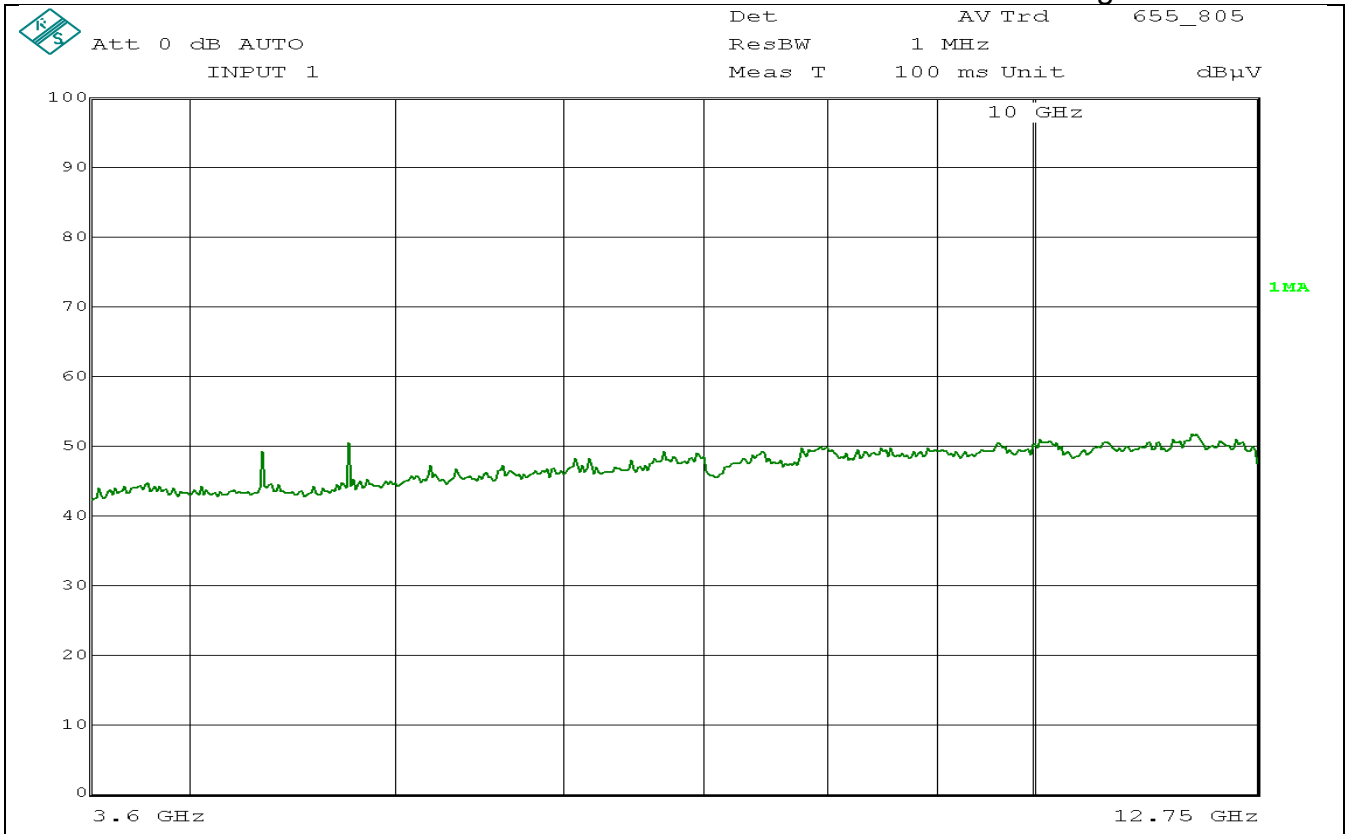


Fig A7: Radiated Emissions 3.6GHz – 12.75GHz, Vertical, 3metres

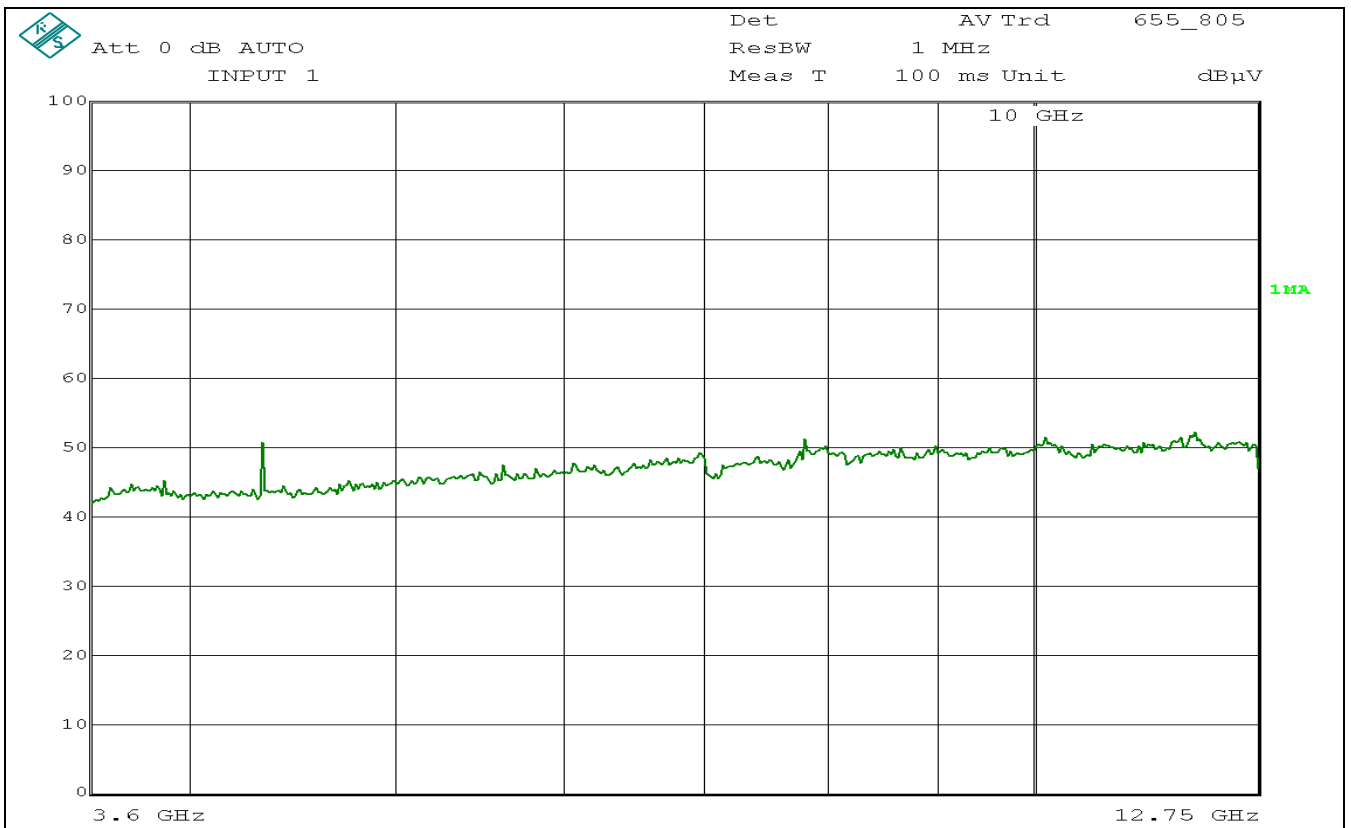


Fig A8: Radiated Emissions 3.6GHz – 12.75GHz, Horizontal, 3metres



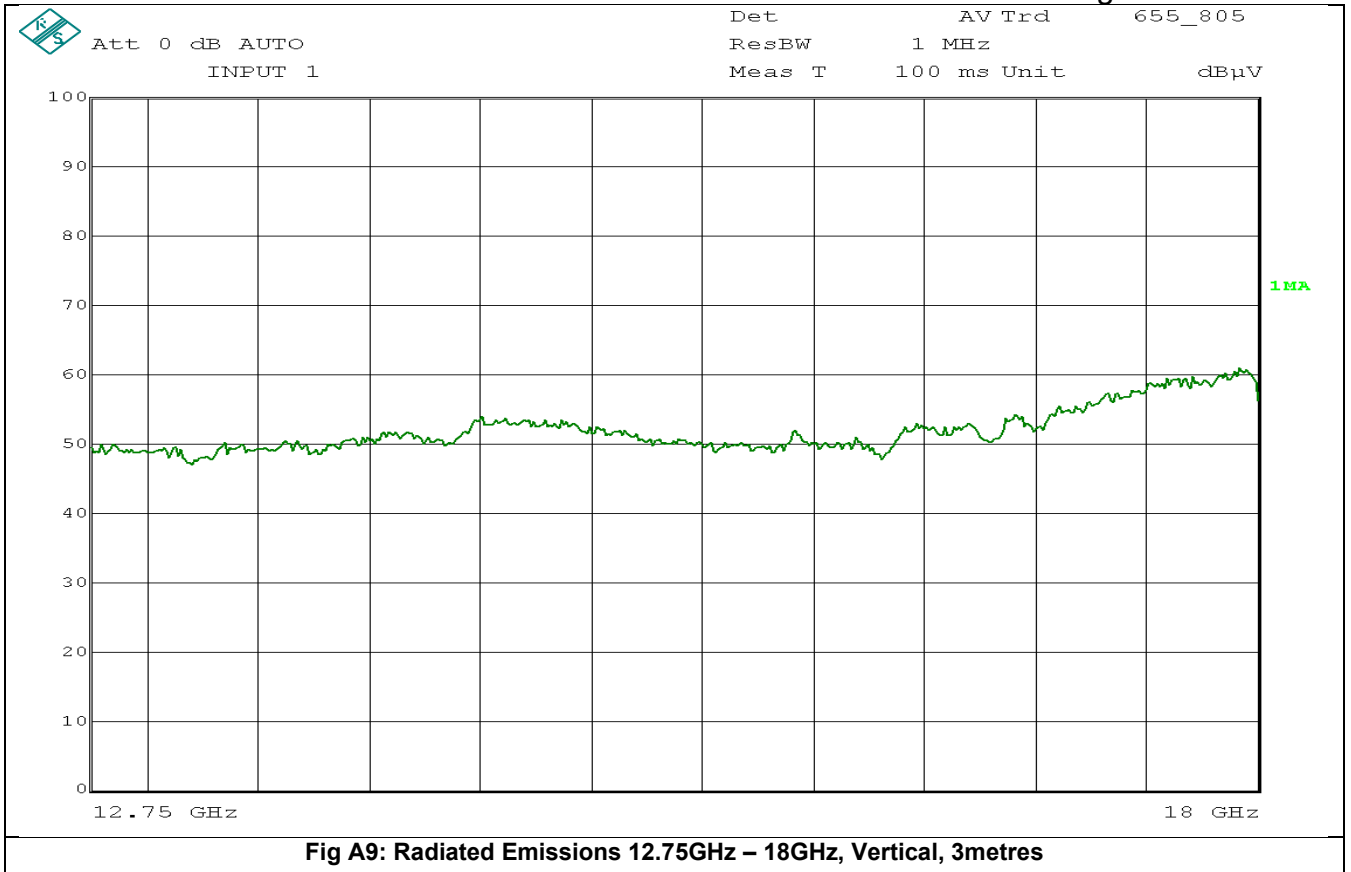


Fig A9: Radiated Emissions 12.75GHz – 18GHz, Vertical, 3metres

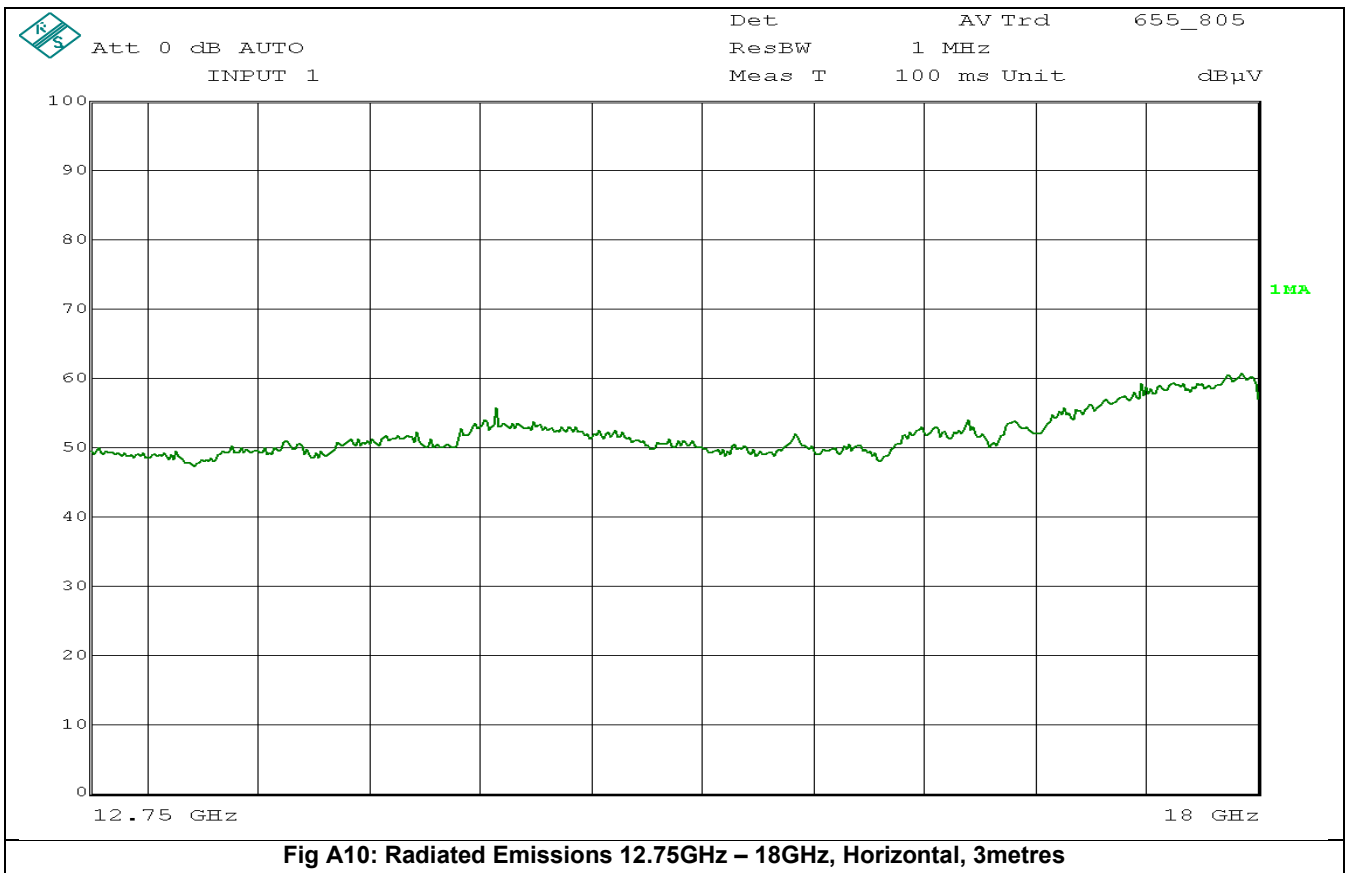
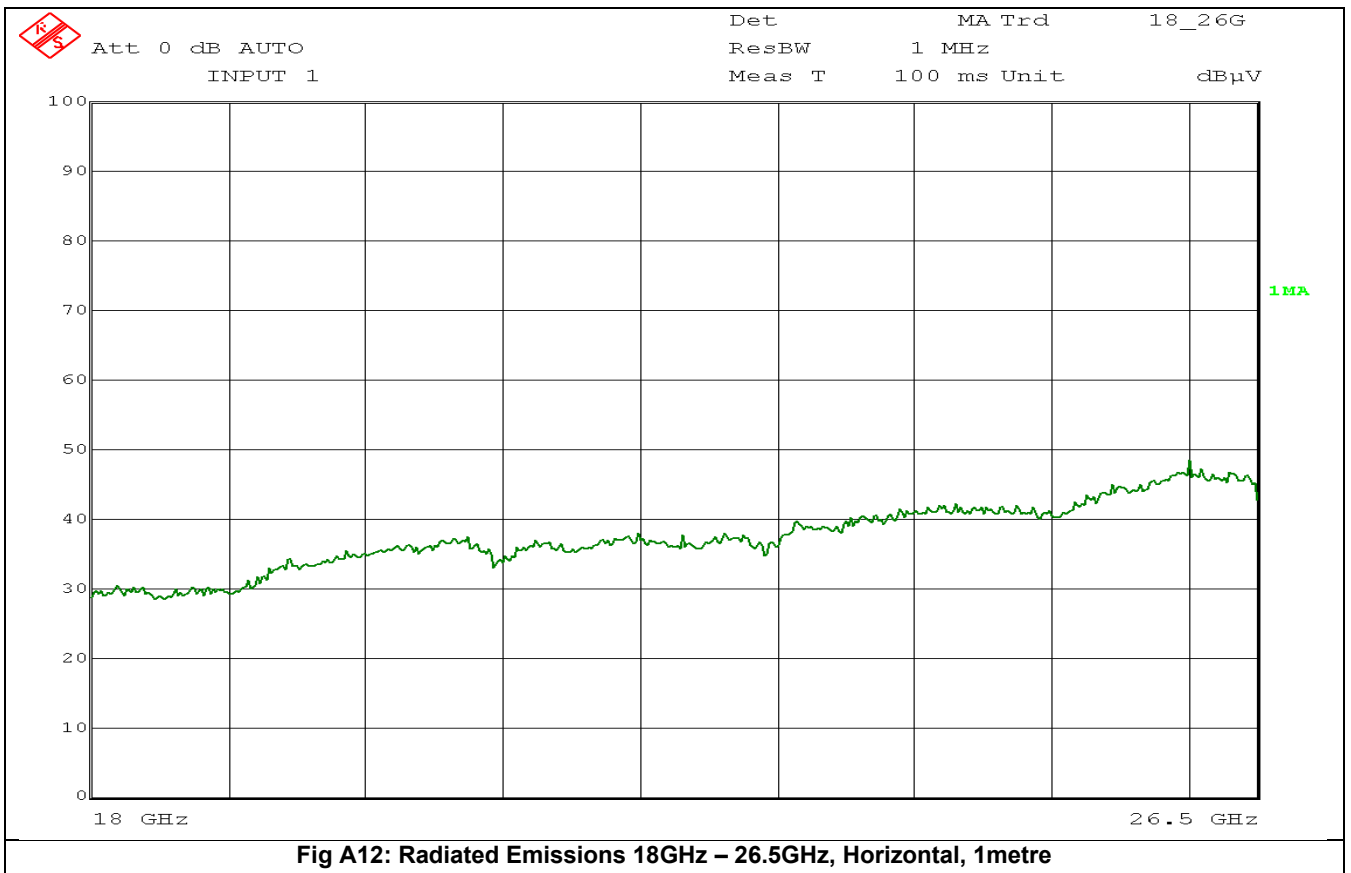
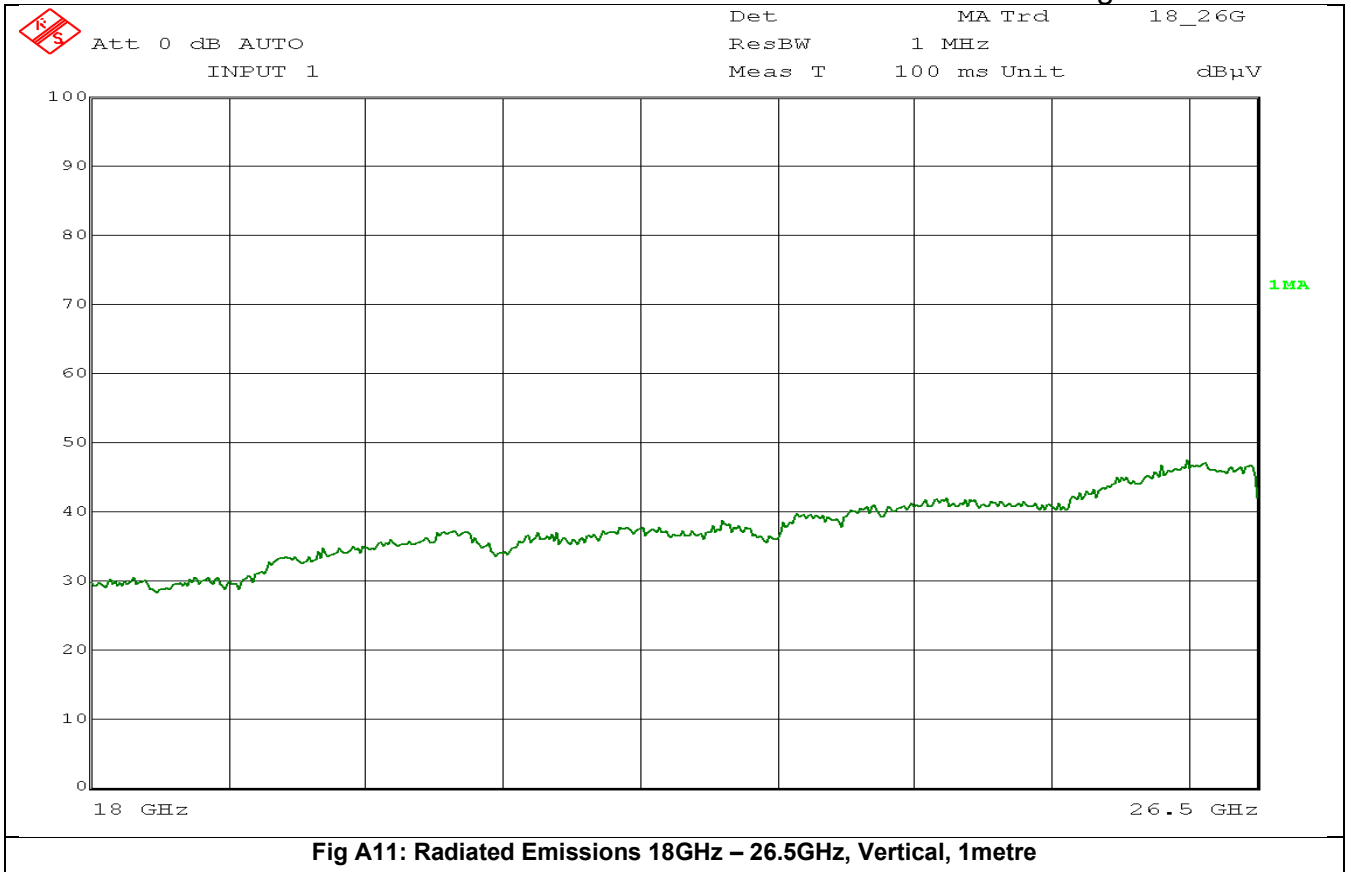
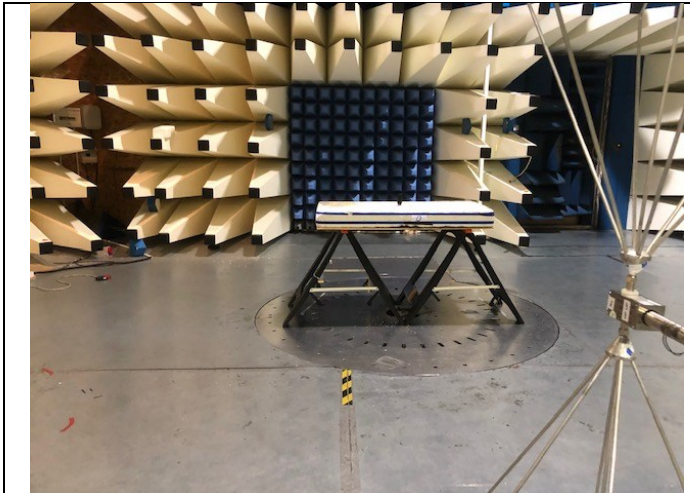


Fig A10: Radiated Emissions 12.75GHz – 18GHz, Horizontal, 3metres



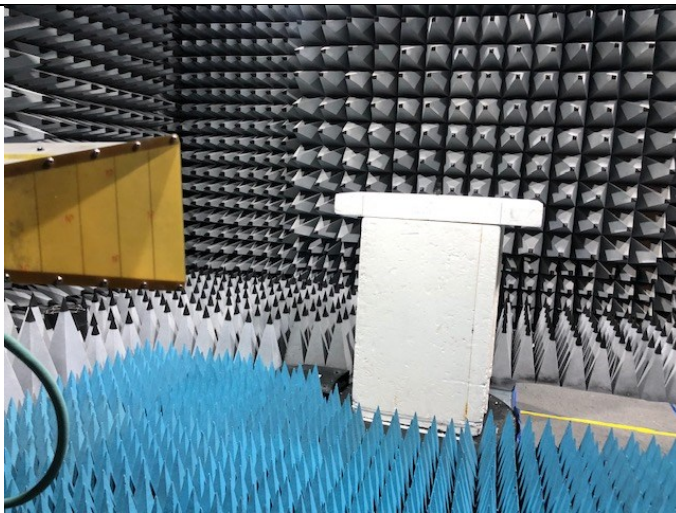
**Appendix B: Test Configurations:**



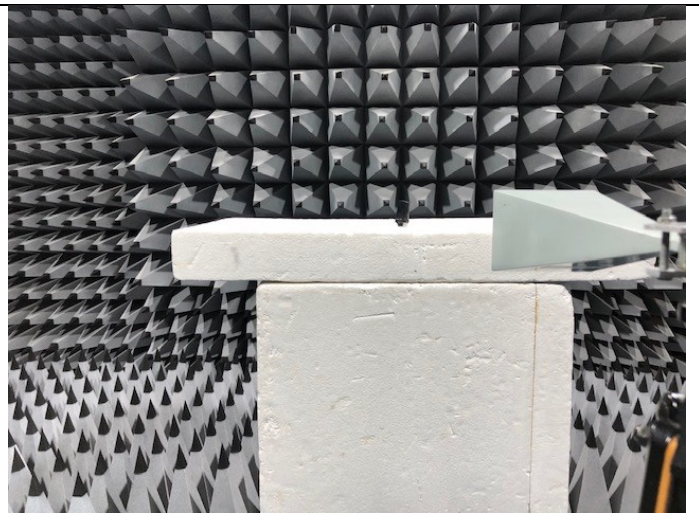
**Fig B1 Radiated Emissions 30MHz-300MHz 3 metres**



**Fig B2 Radiated Emissions 300M-1GHz 3metres**



**Fig B3 Radiated Emissions above 1GHz-18GHz 3metres**

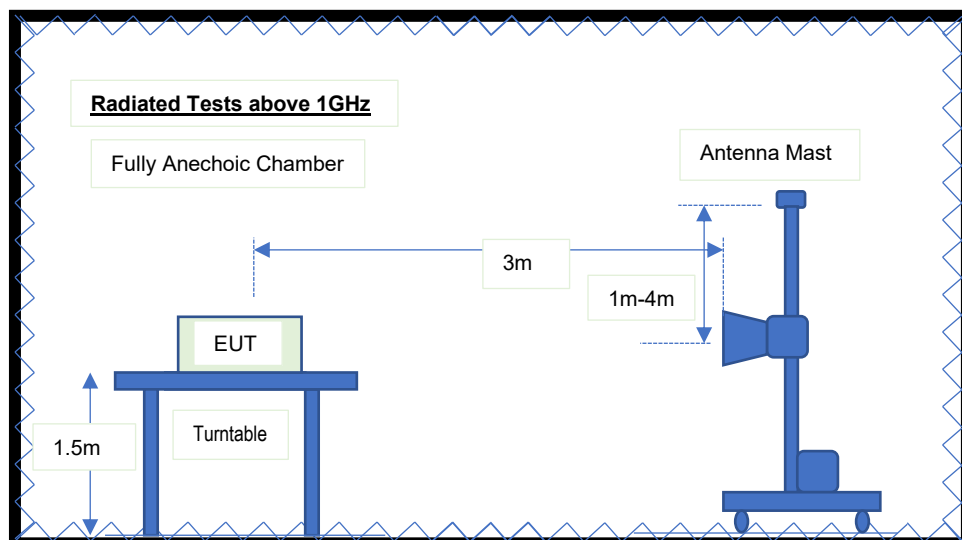
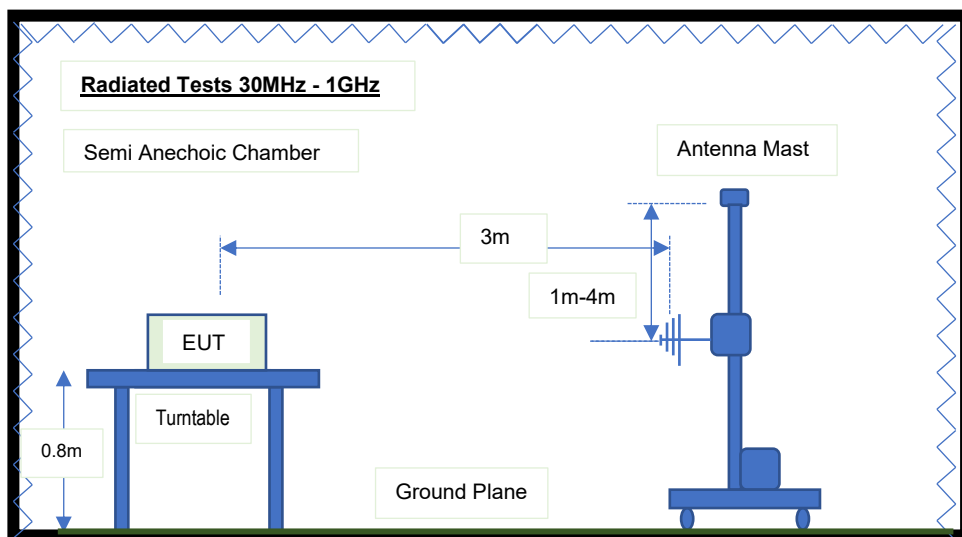
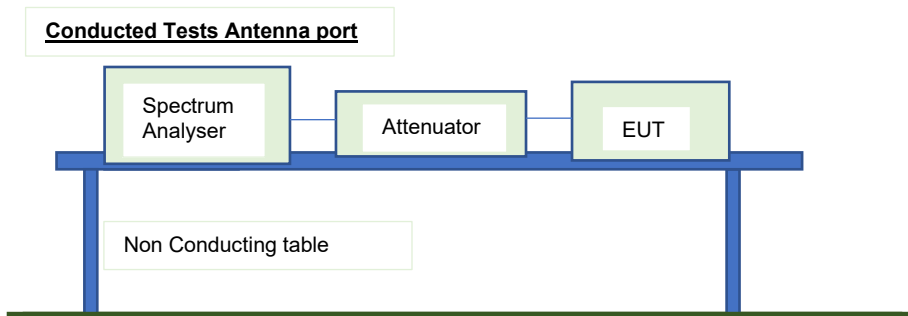


**Fig B4 Radiated Emissions above 18GHz-26.5GHz 1metre**



**Orientations for Radiated Emissions**

### Appendix C: Block Diagrams of Test Setup



End of Report