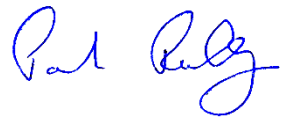


**Confidential Report**

<b>Project No.</b>	<b>22E9792-1</b>
<b>Quotation</b>	<b>Q21-1609-1</b>
<b>Prepared For</b>	<b>Sensata Schrader Electronics Ltd</b>
<b>Address</b>	<b>Unit 10 Antrim Technology Park Belfast Road Antrim Northern Ireland BT41 1QS</b>
<b>Contact</b>	<b>Zoe Gourley</b>
<b>Contact (Phone)</b>	<b>+44 2894 482536</b>
<b>Contact (Email)</b>	<b>Gourley, Zoe [zgourley@sensata.com]</b>
<b>Prepared By</b>	<b>Compliance Engineering Ireland</b>
<b>Test Lab Address</b>	<b>Clonross Lane Derrockstown Dunshaughlin Co. Meath Ireland A85XN59</b>
<b>Tested By</b>	<b>Daniel Ikeh/Joy Israel Dalayap</b>
<b>Test Report By</b>	<b>Daniel Ikeh/Michael Kirby</b>
<b>FCC Test Firm Registration</b>	<b>409640</b>
<b>ISED CAB identifier</b>	<b>8517A</b>
<b>Date Received</b>	<b>11<sup>th</sup> January 2022</b>
<b>Issue Date</b>	<b>22<sup>nd</sup> Mar 2022</b>
<b>EUT Description</b>	<b>Sensor 433MHz, Tyre Pressure Monitor</b>
<b>FCC ID</b>	<b>MRXAG2FP4</b>
<b>IC ID</b>	<b>2546A-AG2FP4</b>
<b>Authorised by</b>	<b>Paul Reilly</b>
<b>Authorised Signature:</b>	

## 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)

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**Exhibit A – Technical Report**

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## 1. EUT Description

The EUT was monitor using a short range 433.914 MHz band transmitter for reporting of tyre pressure and temperature in cars/trucks.

<b>Model:</b>	AG2FP4
<b>Type:</b>	Tyre Pressure Monitor
<b>Type of radio:</b>	Stand-alone
<b>Transmitter Type:</b>	FSK
<b>Operating Frequency Range(s):</b>	433.92 MHz
<b>Number of Channels:</b>	One
<b>Antenna:</b>	Integral peak gain -23.88dBi
<b>Transmitter power configuration:</b>	3 VDC Internal Battery.
<b>Operating. Temp Range:</b>	-40° C to +85° C
<b>Classification:</b>	DSC
<b>HVIN:</b>	AG2PF4
<b>FVIN:</b>	0x4900
<b>Test Methodology:</b>	Measurements performed according to the procedures in ANSI C63.10-2013

*Table 1: Detailed Description of EUT*

## 1.1. EUT Operation

### Operating Conditions during Test:

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

A sample of EUT which was programmed to operate in test mode (CW mode) was used for all tests except duty cycle and bandwidth.

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

### Environmental conditions:

	<b>Temperature</b>	<b>Relative Humidity</b>
<b>Test</b>	<b>°C</b>	<b>%</b>
Radiated Emissions SAR	23	38
Radiated Emissions FAR	20	46
Duty Cycle	23	39

*Table 2: Environmental Conditions During the Tests*

## 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 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup> & 17<sup>th</sup> of January 2022.

## 1.4. 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.

## 1.5. 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 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 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 (orientation1 O1)

The EUT in a horizontal 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 E.U.T is permanently attached.

\*The E.U.T Complies with the requirement of 15.203

### 3 Occupied Bandwidth and Duty Cycle

#### 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:

#### RESULTS

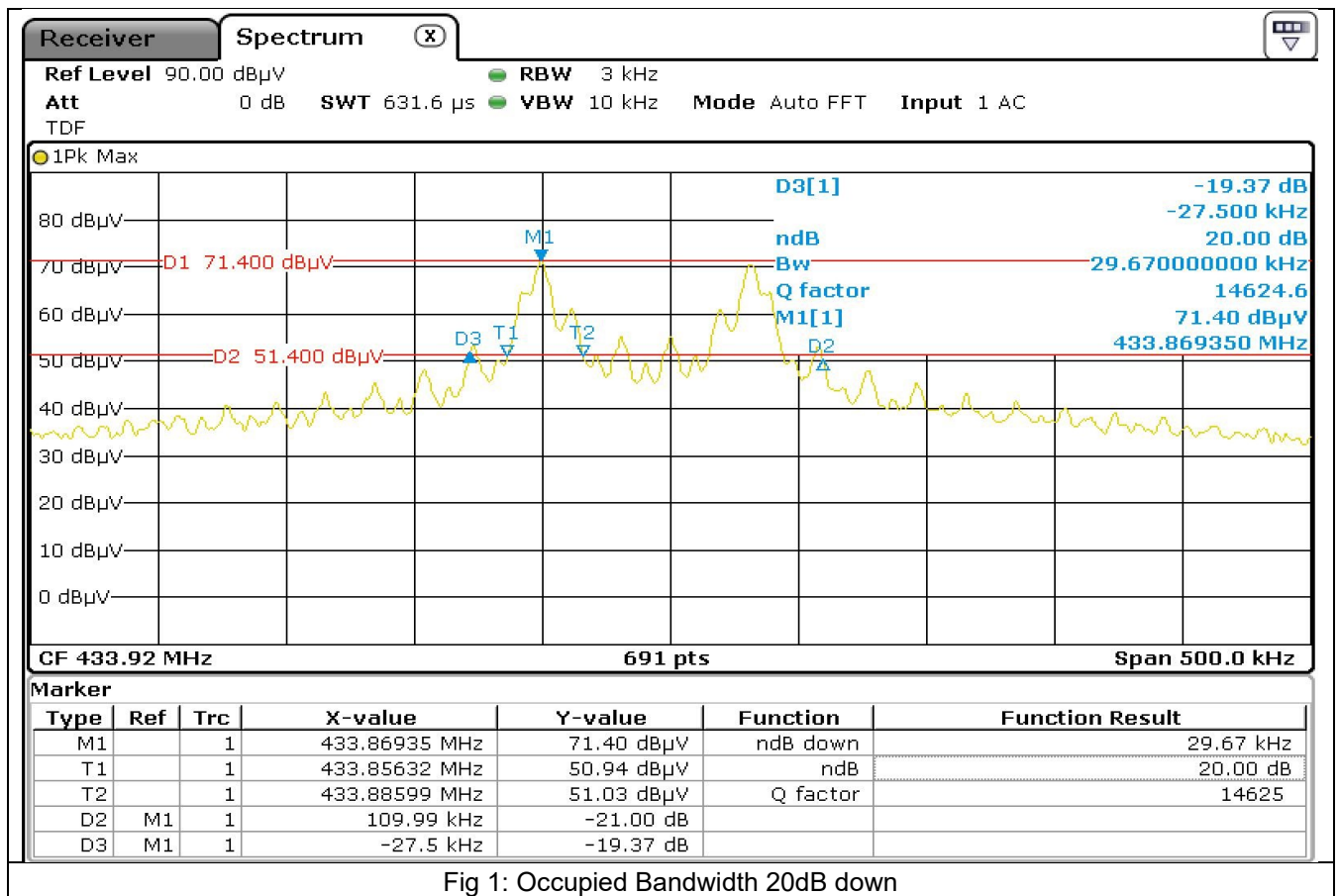


Fig 1: Occupied Bandwidth 20dB down

Operating Frequency	20dB Bandwidth	Limit	Margin	Result
MHz	KHz	KHz	KHz	
433.92	137.5	1084.8	1047.46	Pass

Table 3: Occupied Bandwidth 20dB Down Results



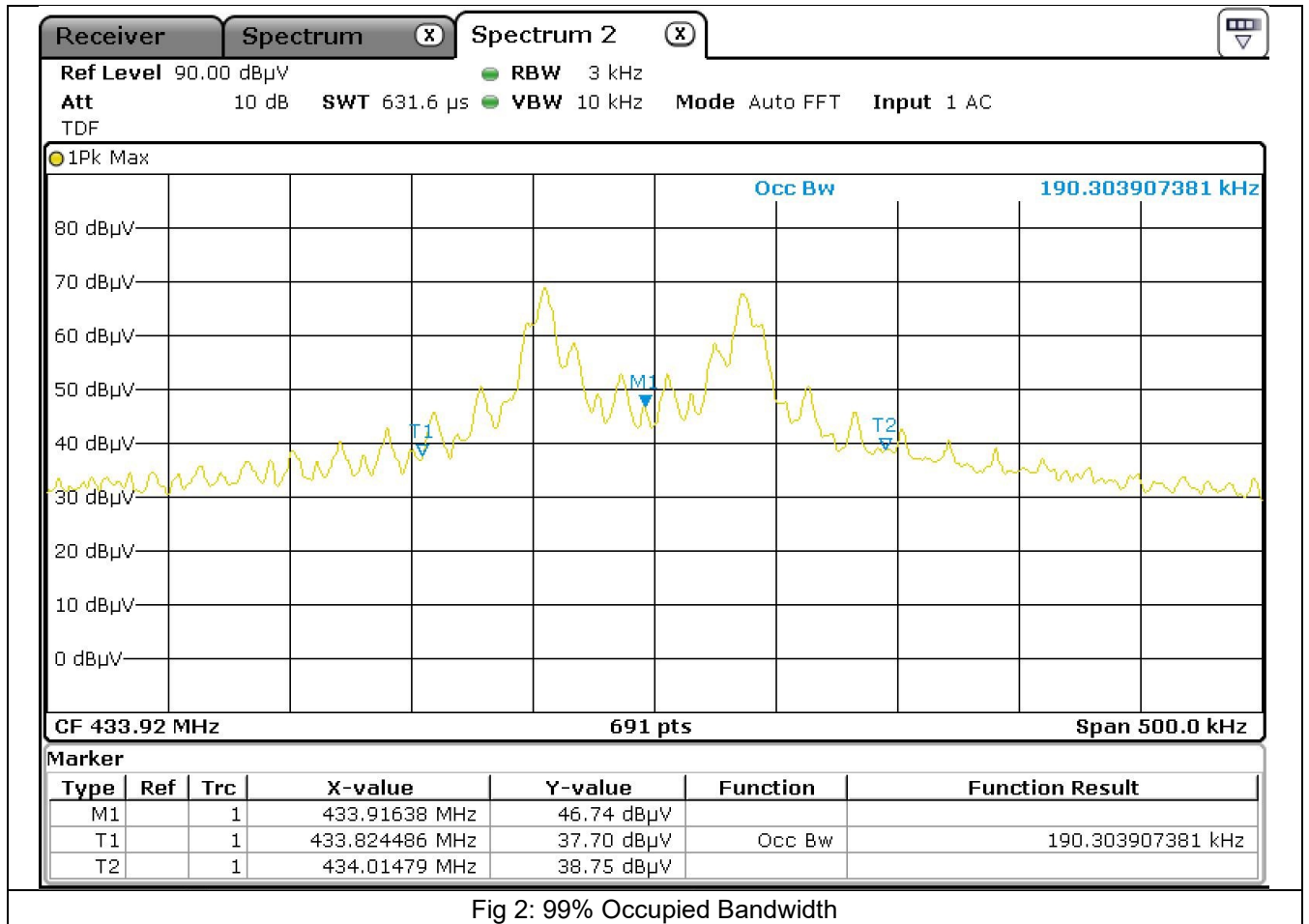


Fig 2: 99% Occupied Bandwidth

Operating Frequency	99% Bandwidth
MHz	KHz
<b>433.916</b>	<b>190.304</b>

Table 4: 99% Occupied Bandwidth Results

### 3.2 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	28.99	1	0.29	-10.76

Table 5: Maximum Modulation Percentage/Duty Cycle Result

#### CALCULATION:

Average Reading = Peak Reading dB( $\mu$ V/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)
-10.76

#### 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 = 753.6ms	Limit 1sec	Comply
Silent period between transmissions >32Secs	Limit 22.6secs	Comply

#### Test Result Pass

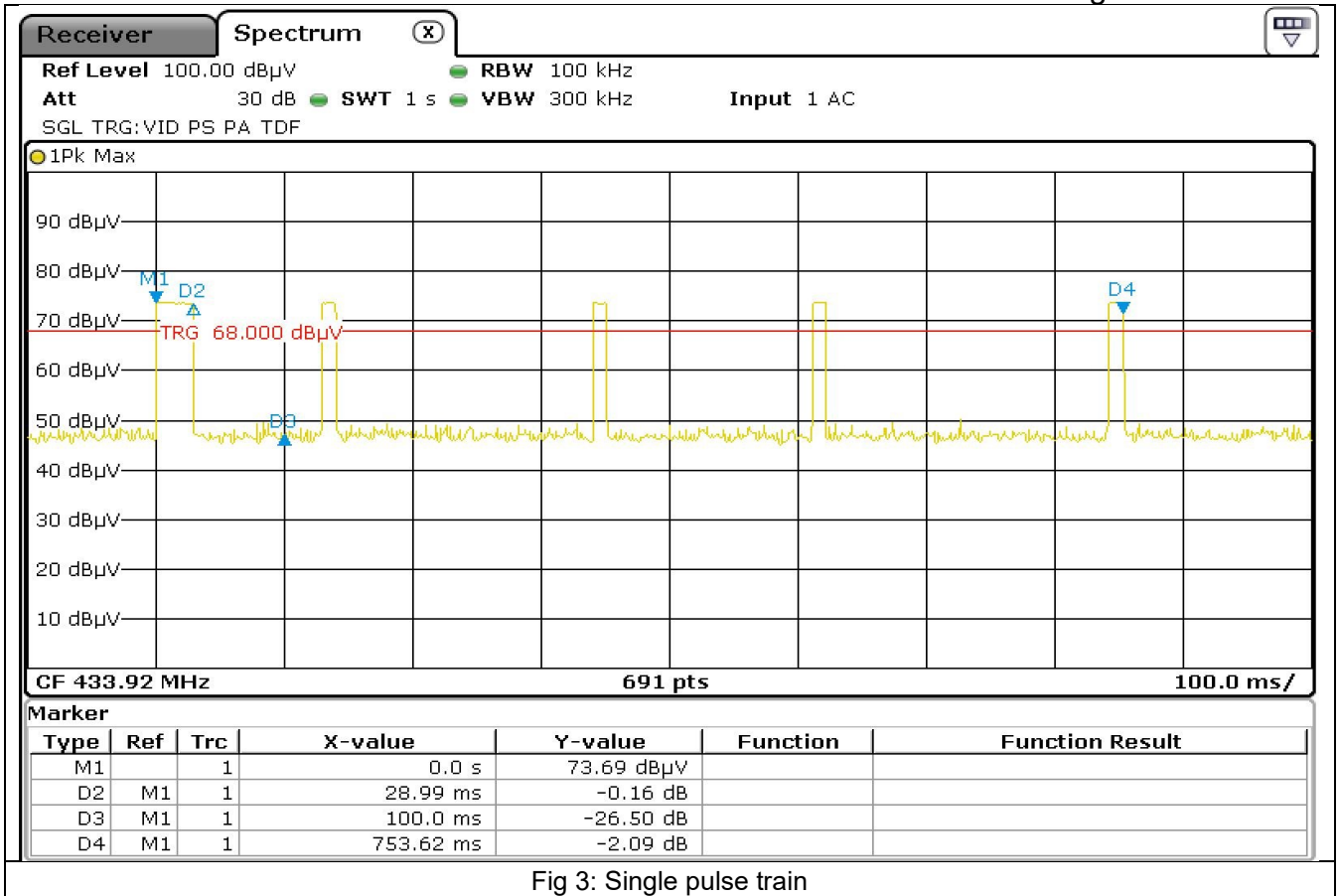


Fig 3: Single pulse train

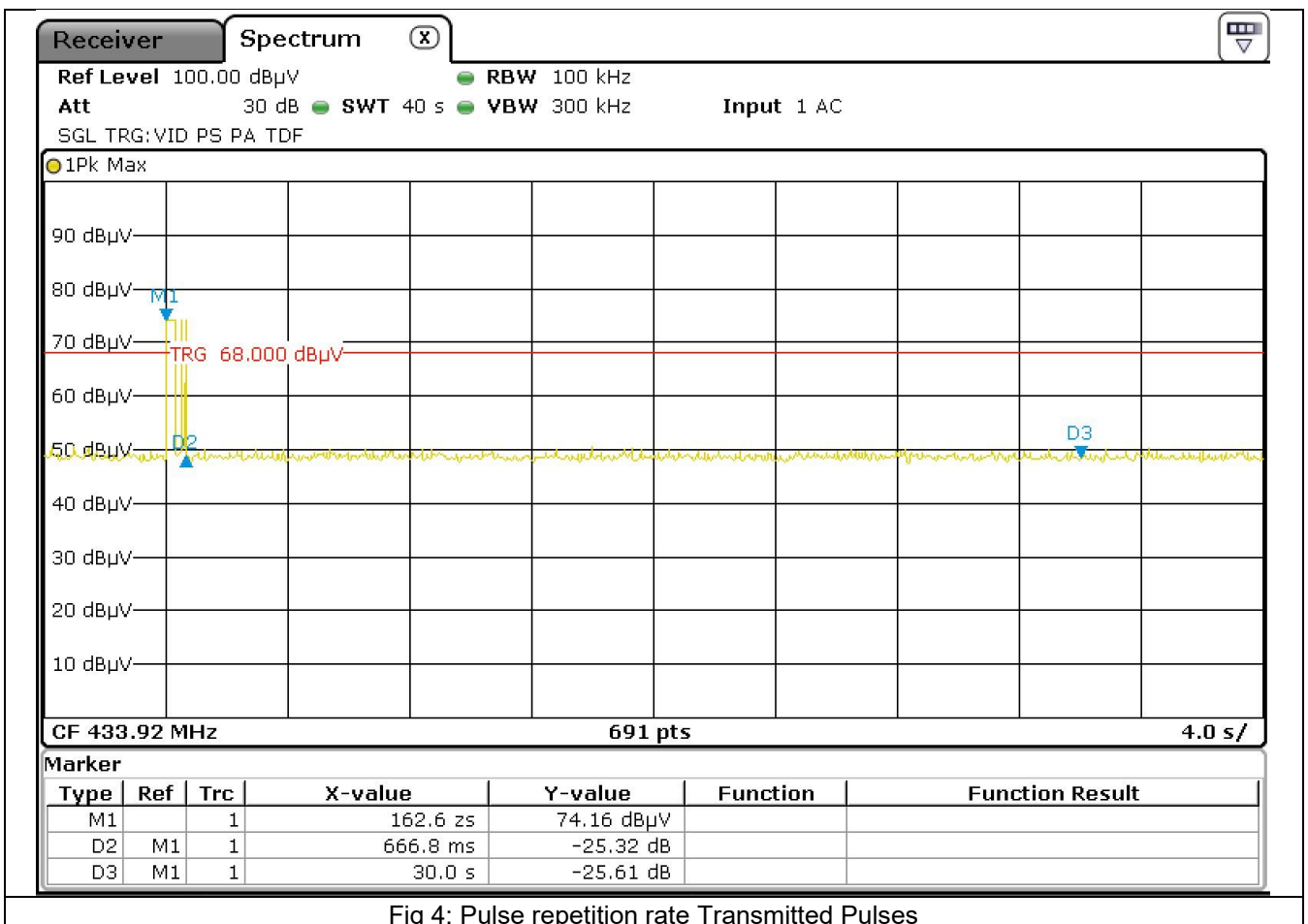


Fig 4: Pulse repetition rate Transmitted Pulses

#### 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 ( $\mu\text{V/m}$ )	Strength of Spurious Emissions ( $\mu\text{V/m}$ ).
40.66 ~ 40.70	22.50	225
70 ~ 130	1250	125
130 ~ 174	1250 to 3750 **	125 to 375 **
174 ~ 260	3750	375
260 ~ 470	3750 to 12500 **	375 to 1250 **
Above 470	12500	1250

**Table 6: Reference Frequencies with their Corresponding Levels**

##### \*\* Linear interpolations

**Interpolation Formula =  $16.67 \times \text{Freq MHz} - 2833.33$**

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	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$
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 ( $\mu\text{V/m}$ )	Field Strength ( $\text{dB}\mu\text{V/m}$ )
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 =  $20\text{Log}(\text{duty cycle}) \text{ dB}$

**Duty Cycle correction for Average measurement of pulsed signal = Peak – 10.76dB**  
as per ANSI C63.10-2013 Section 7.5

## 4.2 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

#### 4.2.1 Fundamental

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamplifier 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	54.3	O1	Vertical	16.8	0	1.7	72.8	72.9	20.1
433.950	56.5	O2	Horizontal	16.8	0	1.7	75.0	72.9	17.9

**Table 9: Fundamental Result of 433MHz**

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -10.8dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
433.950	72.8	O1	Vertical	62.0	72.9	10.9
433.950	75.0	O2	Horizontal	64.3	72.9	8.6

**Table 10: Average Level and Limit of the Fundamental**

**Result: Pass**

#### 4.2.2 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	5.1	O1	Vertical	23.3	0	2.2	30.6	52.9	42.3
867.900	10.9	O2	Horizontal	23.3	0	2.2	36.4	52.9	36.5

**Table 11: Result of Harmonics Below 1GHz**

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -10.8dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
867.900	30.6	O1	Vertical	19.8	52.9	33.1
867.900	36.4	O2	Horizontal	25.6	52.9	27.3

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

**Result: Pass**

## 4.2.3 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	61.2	O1	Vertical	24.2	39.8	3.8	49.4	52.9	23.5
1.736	62.7	O1	Vertical	25.4	39.3	2.8	51.6	52.9	21.3
2.217	62.2	O1	Vertical	27.4	39.5	3.4	53.5	52.9	19.4
2.604	62.3	O1	Vertical	28.7	38.9	3.6	55.7	52.9	17.2
3.038	62.0	O1	Vertical	30.4	38.9	3.8	57.3	52.9	15.6
3.472	60.8	O1	Vertical	31.3	37.8	4.5	58.8	52.9	14.1
3.906	50.1	O1	Vertical	31.3	37.7	4.8	48.5	52.9	24.4
4.340	47.1	O1	Vertical	32.6	37.3	5	47.4	52.9	25.5
1.302	51.9	O2	Horizontal	24.2	39.8	3.8	40.1	52.9	32.8
1.736	52.9	O2	Horizontal	25.4	39.3	2.8	41.8	52.9	31.1
2.217	52.1	O2	Horizontal	27.4	39.5	3.4	43.4	52.9	29.5
2.604	52.8	O3	Horizontal	28.7	38.9	3.6	46.2	52.9	26.7
3.038	51.9	O2	Horizontal	30.4	38.9	3.8	47.2	52.9	25.7
3.472	50.8	O2	Horizontal	31.3	37.8	4.5	48.8	52.9	24.1
3.906	49.7	O2	Horizontal	31.3	37.7	4.8	48.1	52.9	24.8
4.340	48.4	O2	Horizontal	32.6	37.3	5	48.7	52.9	24.2

Table 13: Result of Harmonics Above 1GHz

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -10.8dB Duty Cycle factor)	Average Limit	Margin
GHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
1.302	49.4	O1	Vertical	38.6	52.9	14.3
1.736	51.6	O1	Vertical	40.8	52.9	12.1
2.217	53.5	O1	Vertical	42.7	52.9	10.2
2.604	55.7	O1	Vertical	44.9	52.9	8
3.038	57.3	O1	Vertical	46.5	52.9	6.4
3.472	58.8	O1	Vertical	48.0	52.9	4.9
3.906	48.5	O1	Vertical	37.7	52.9	15.2
4.340	47.4	O1	Vertical	36.7	52.9	16.2
1.302	40.1	O2	Horizontal	29.3	52.9	23.6
1.736	41.8	O2	Horizontal	31.0	52.9	21.9
2.217	43.4	O2	Horizontal	32.6	52.9	20.3
2.604	46.2	O3	Horizontal	35.4	52.9	17.5
3.038	47.2	O2	Horizontal	36.4	52.9	16.5
3.472	48.8	O2	Horizontal	38.0	52.9	14.9
3.906	48.1	O2	Horizontal	37.4	52.9	15.5
4.340	48.7	O2	Horizontal	38.0	52.9	14.9

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

Duty cycle correction =  $20\text{Log}(\text{duty cycle}) \text{ dB} = -10.76\text{dB}$

**Duty Cycle correction for Average measurement of pulsed signal = Peak – 10.76dB**  
as per ANSI C63.10-2013 Section 7.5

**Result: Pass**



#### 4.2.4 Non-Harmonics Spurious Emissions Measurements

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

Frequency MHz	Quasi Peak Level dBuV/m	Antenna Polarity	Antenna Factor dB	Cable loss dB	Final Field Strength Quasi Peak dBuV/m	Quasi Peak Limit dBuV/m	Margin dB
33.54	6.5	Vertical	12.3	0.9	19.7	40.0	20.3
43.2	5.7	Vertical	10.8	0.9	17.4	40.0	22.6
113.22	4.5	Vertical	10.2	1.1	15.8	43.5	27.7
151.83	4.7	Vertical	11.8	1.2	17.7	43.5	25.8
457.95	3.4	Vertical	17.3	1.7	22.4	46.0	23.6
731.52	3.1	Vertical	21.4	2.1	26.6	46.0	19.4
98.73	3.7	Horizontal	9.4	1.1	14.2	43.5	29.3
143.22	3.6	Horizontal	11.5	1.2	16.3	43.5	27.2
421.95	5.8	Horizontal	16.7	1.7	24.2	46.0	21.8
731.4	3.8	Horizontal	21.4	2.1	27.3	46.0	18.7

*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	+/- $5 \times 10^{-7}$
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**

<b>Instrument</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial Num</b>	<b>CEI Ref</b>	<b>Cal Due Date</b>	<b>Cal Interval Months</b>
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-22	12
Spectrum Analyser 30Hz-40GHz	Rohde& Schwarz	FSP40	100053	850	09-Dec-22	36
Test Receiver 3.6GHz	Rohde& Schwarz	ESR	1316.3003k03-101625-s	869	28-May-23	36
Antenna Horn	AH Systems	SAS-200/571	373	839	08-Apr-24	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	23-Jul-22	36
Anechoic Chamber	CEI	SAR 10M	845	845	16-May-22	36
Antenna Trilog	Schwarzbeck	VULB 9160	9160-3361	889	09-Sep-24	36
Antenna Log Periodic	Chase	UPA6108	1072	609	09-Sep-24	36

**Table 17: Equipment Used During Testing**

**Appendix A: Scans for Spurious Emissions Test Configurations**

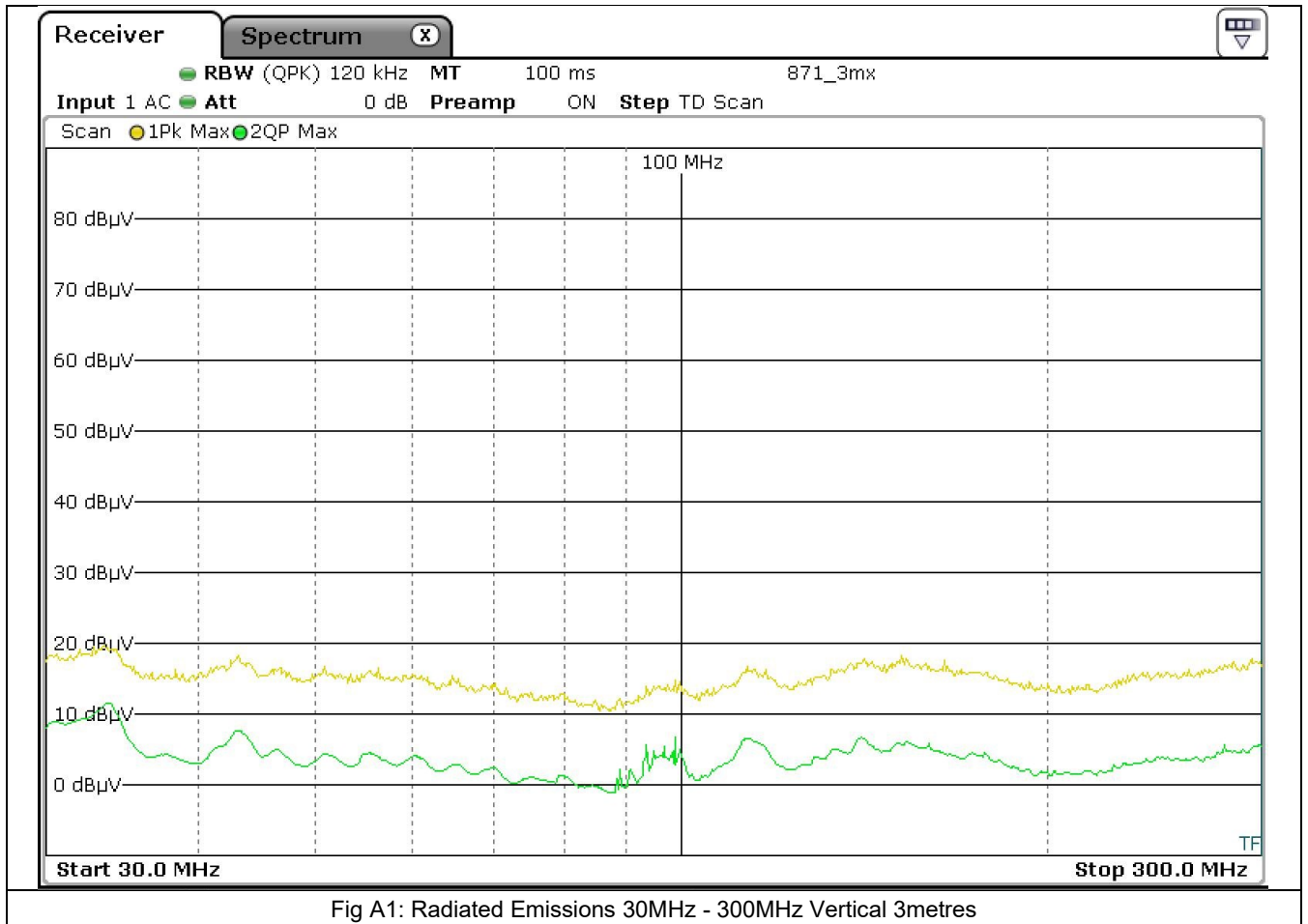


Fig A1: Radiated Emissions 30MHz - 300MHz Vertical 3metres

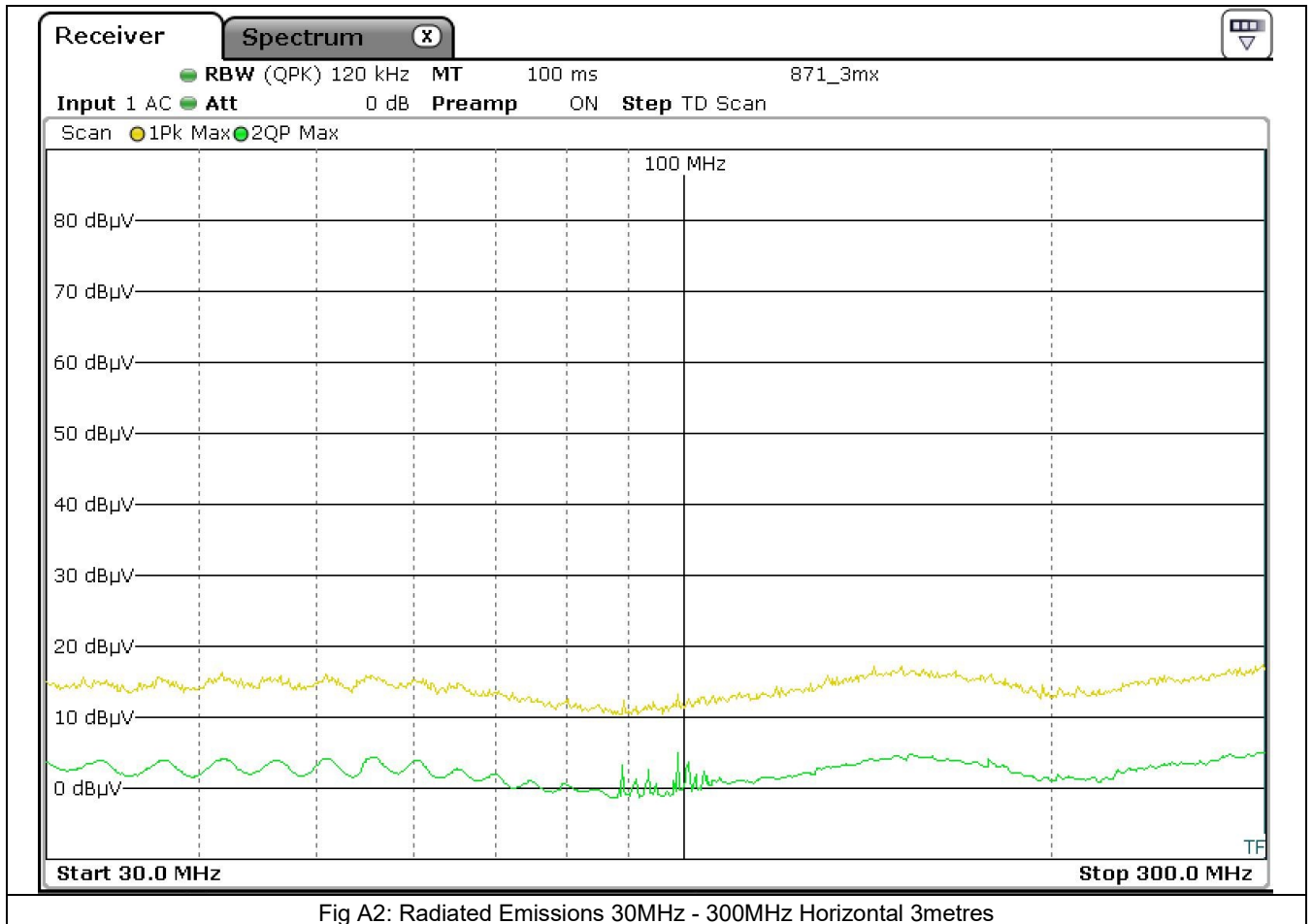
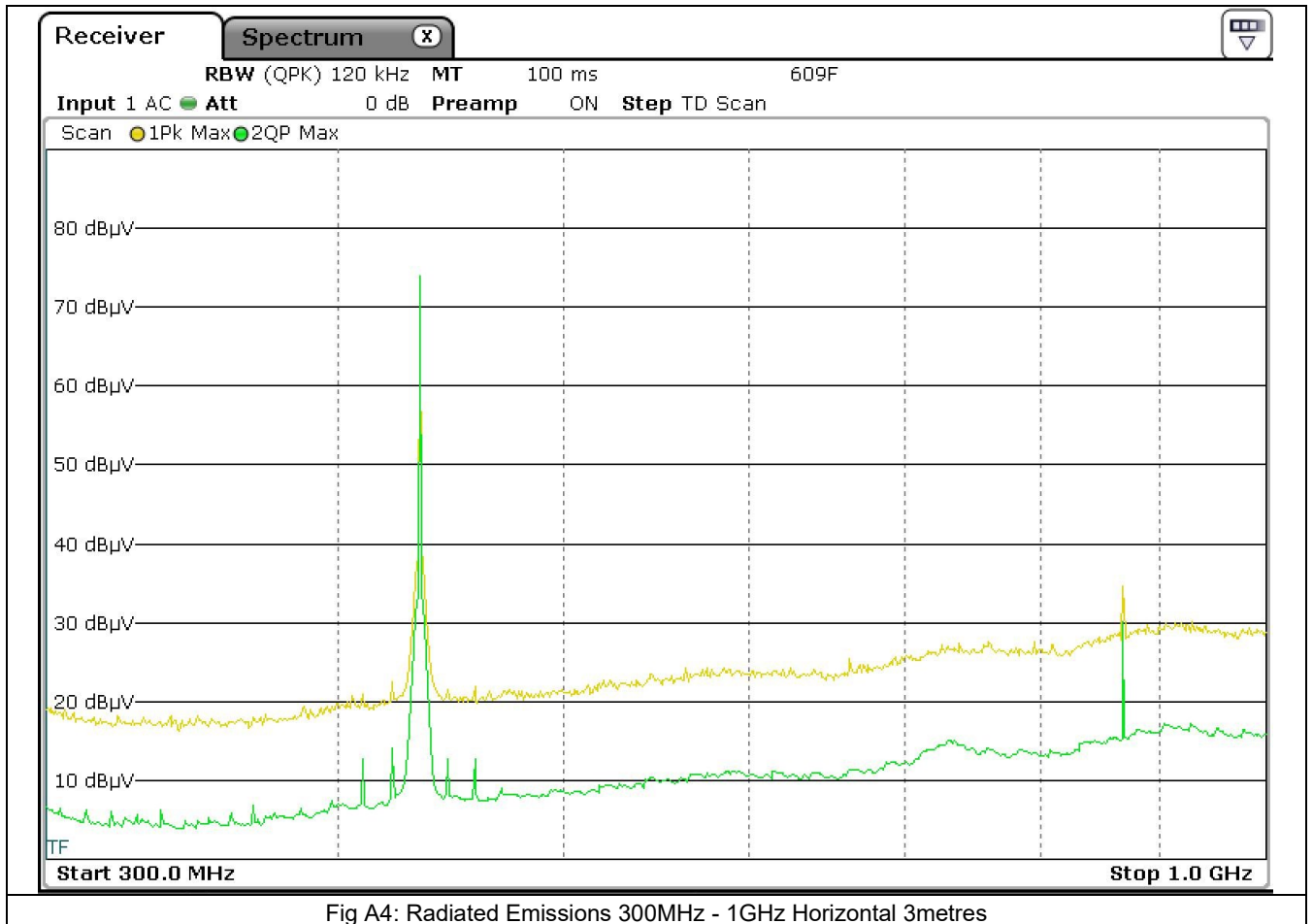
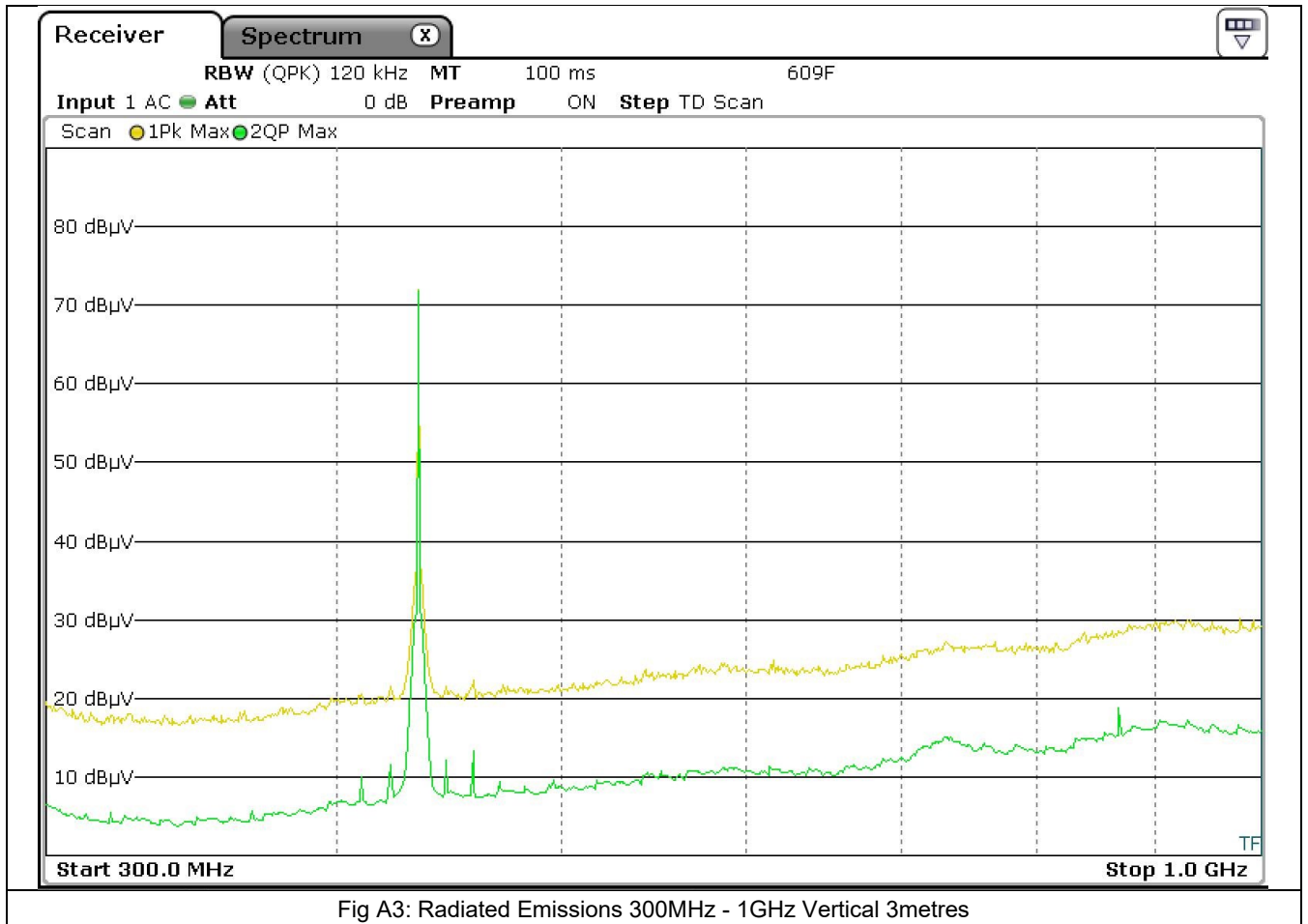
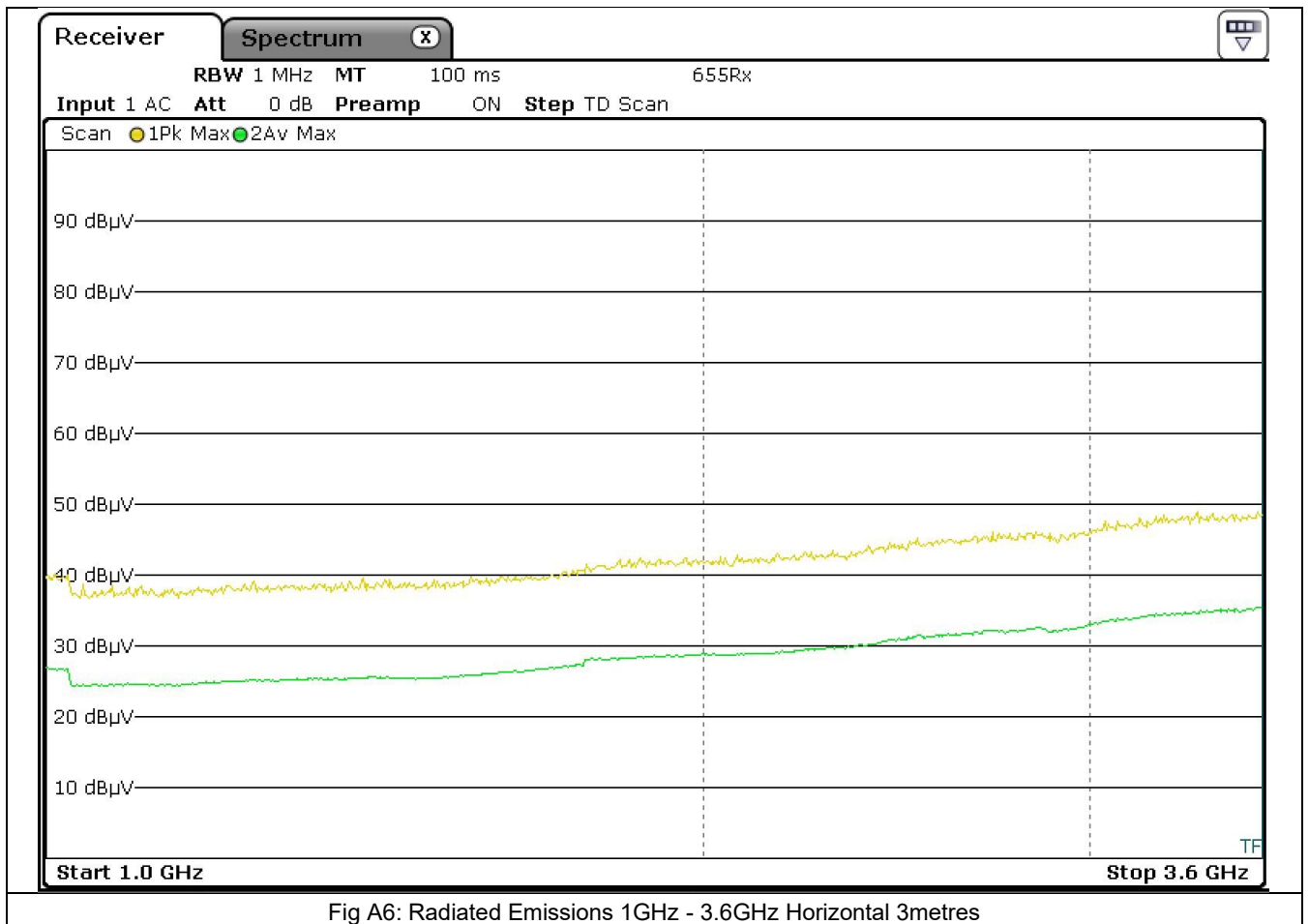
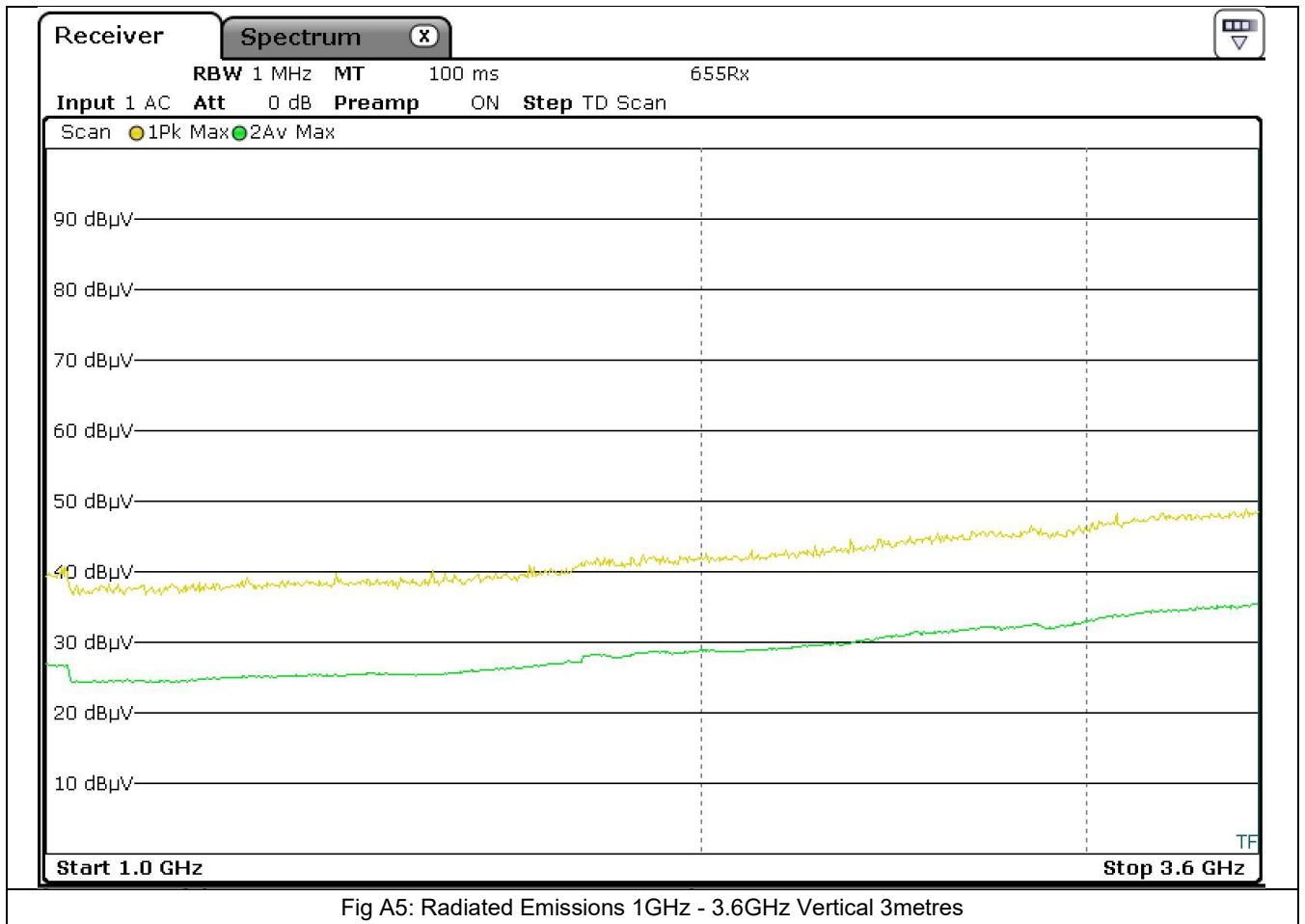


Fig A2: Radiated Emissions 30MHz - 300MHz Horizontal 3metres





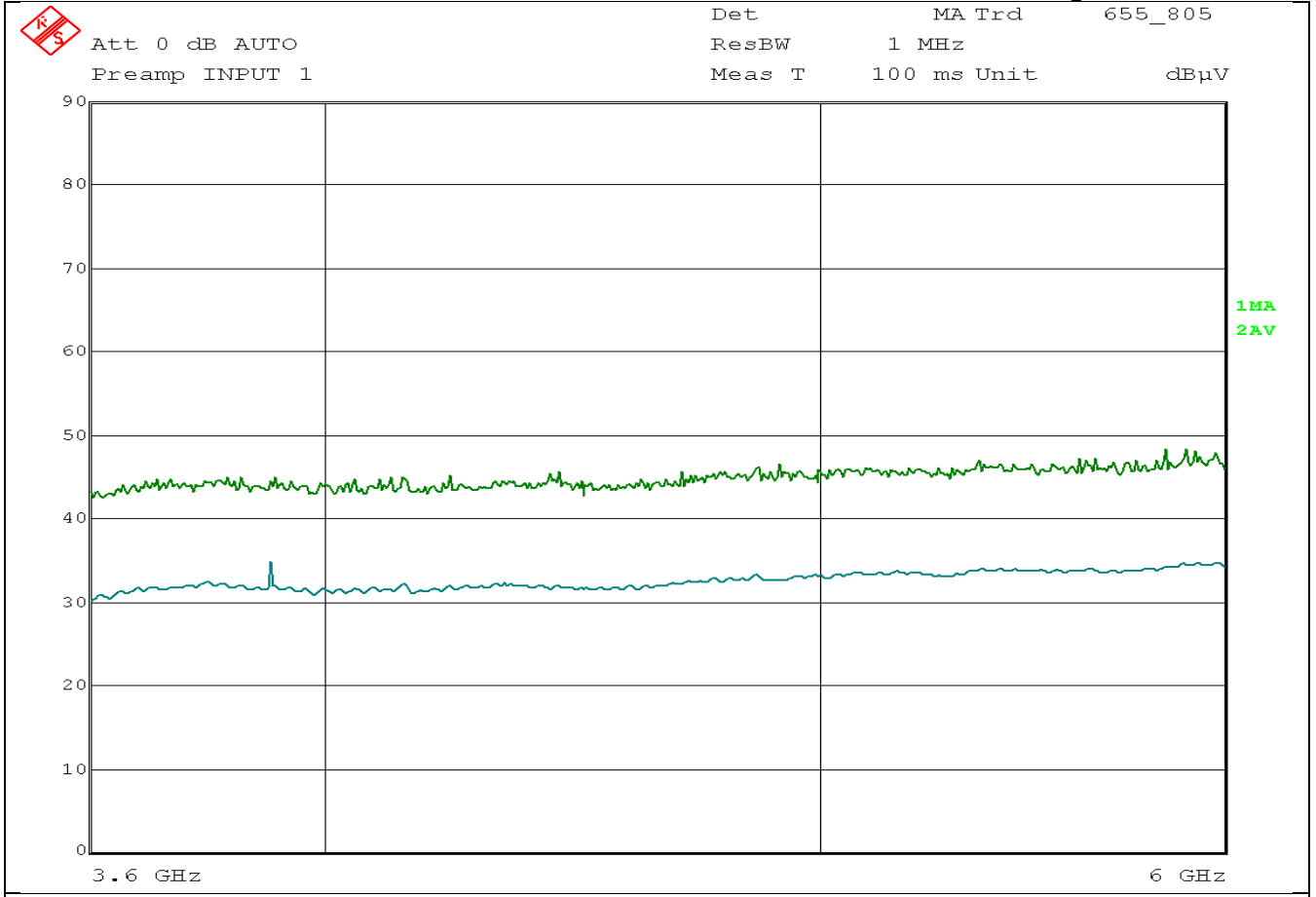


Fig A7: Radiated Emissions 3.6GHz - 6GHz Vertical 3metres

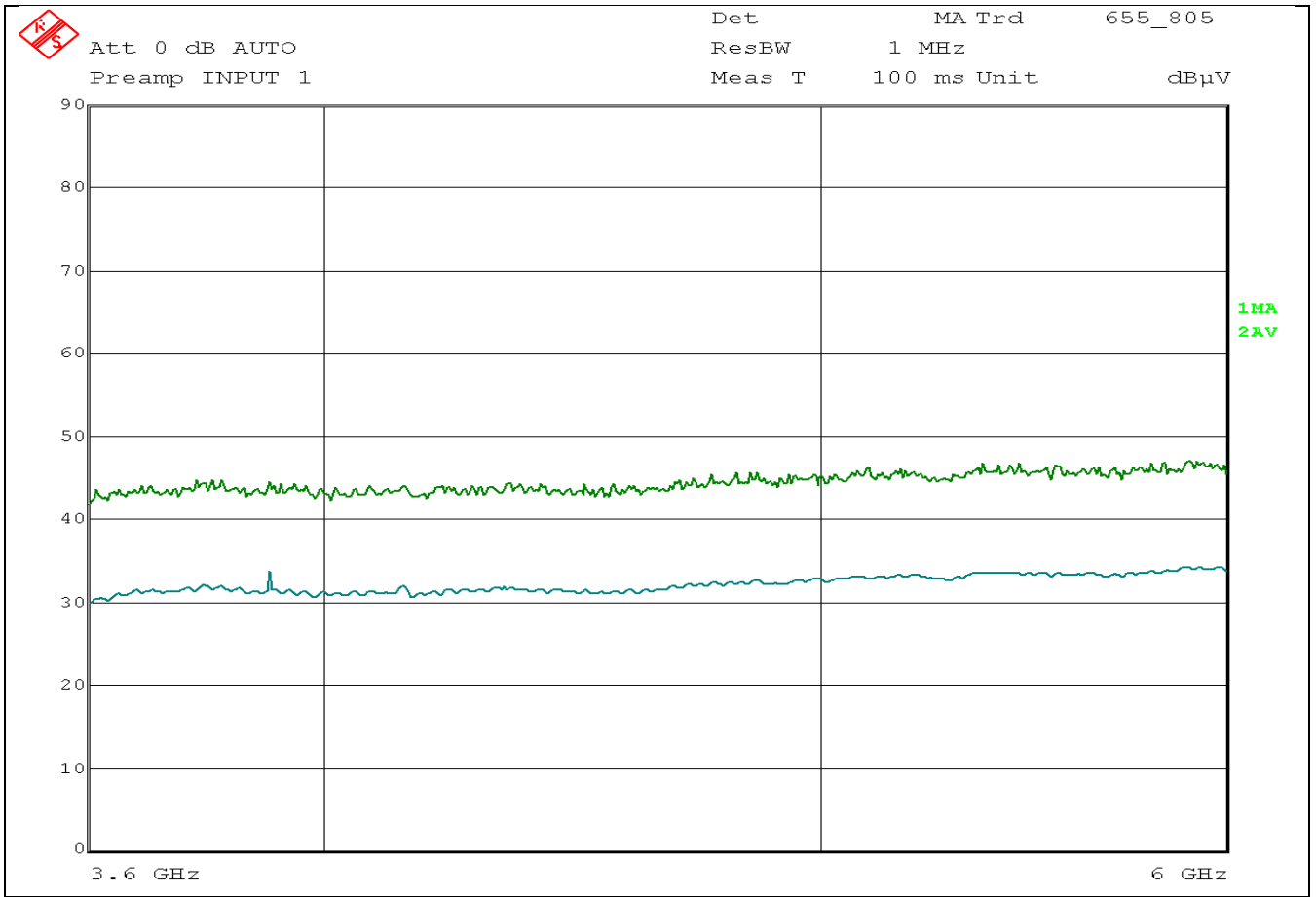
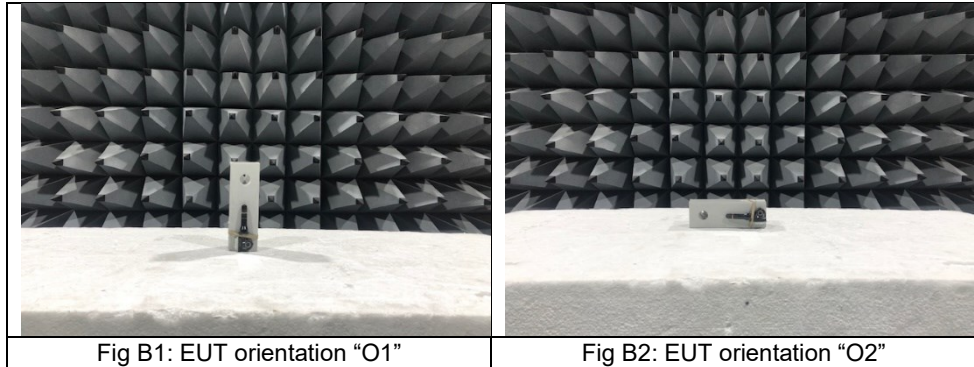


Fig A8: Radiated Emissions 3.6GHz - 6GHz Horizontal 3metres



### Appendix B: Test Configurations:

#### Orientations for Radiated Emissions



### Appendix C: Block Diagrams of Test Setup

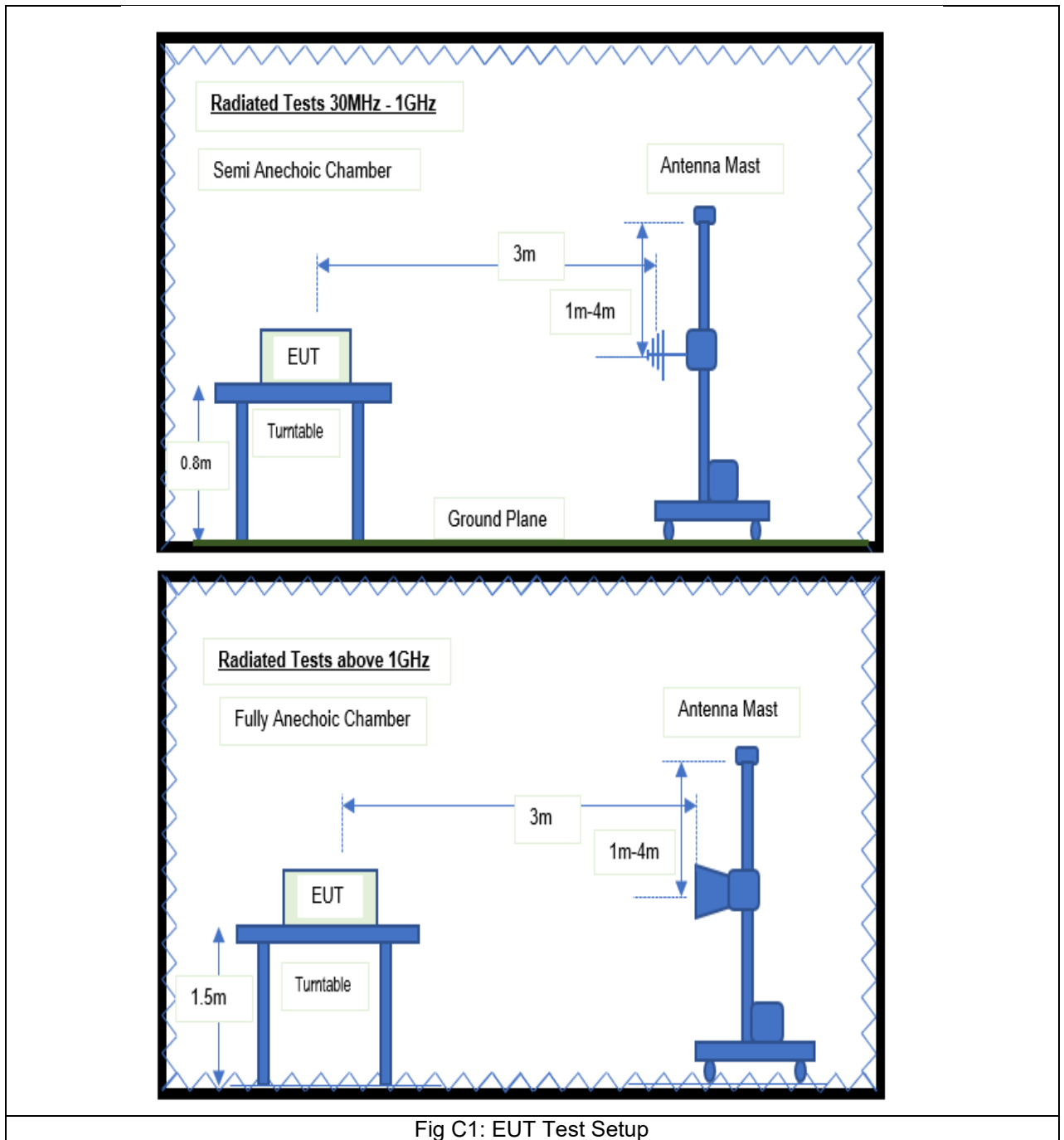


Fig C1: EUT Test Setup

End of Report