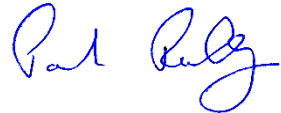


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|                                   |   |
|-----------------------------------|---|
| <b>Project Num</b>                | 20E8928-3b  |
| <b>Quotation</b>                  | Q20-1410-1  |
| <b>Prepared For</b>               | Sensata Technologies Ltd  |
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| <b>Tested By</b>                  | Joy Dalayap Michael Kirby   |
| <b>Test Report By</b>             | Michael Kirby   |
| <b>FCC Test Firm Registration</b> | 409640  |
| <b>IC Site Registration</b>       | IE0001  |
| <b>Date</b>                       | 15 <sup>th</sup> Mar 2021   |
| <b>EUT Description</b>            | HUBA  |
| <b>FCC ID</b>                     | 2ATIMHUBA   |
| <b>IC ID</b>                      | 25094-HUBA  |
| <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 15.247 Section | RSS-247 Section | TEST PARAMETERS             | Test Result |
|--------------------|-----------------|-----------------------------|-------------|
| 15.205             | RSS Gen 8.9     | Radiated Spurious Emissions | Pass        |
| 15.209             | RSS Gen 8.10    |                             |             |

RSS 247-2 (Feb 2017)

RSS Gen Issue5 Amd 2 (Feb 2021)

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

**Exhibit A – Technical Report**

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**1.0 EUT Description**

|                                      |  |
|--------------------------------------|--|
| <b>Model:</b>                        | HUBA   |
| <b>Type:</b>                         | Wireless Gateway   |
| <b>Type of radio:</b>                | Stand-alone  |
| <b>Transmitter Type:</b>             | 802.15.4 (Thread), 802.11G 802.11N Wifi  |
| <b>Operating Frequency Range(s):</b> | 2.405 GHz - 2.480GHz Thread<br>2.412-2.462GHz Wifi   |
| <b>Number of Channels:</b>           | 16 Thread<br>11 Wifi   |
| <b>Antenna:</b>                      | Integral   |
| <b>Power configuration:</b>          | 12 v Battery.  |
| <b>Ports:</b>                        | None   |
| <b>Classification:</b>               | DTS, CYY   |
| <b>HVIN:</b>                         | HUBA   |
| <b>PMN:</b>                          | HUBA   |
| <b>Test Standards:</b>               | 15.247 RSS-247   |
| <b>Test Methodology:</b>             | Measurements performed according to the procedures in<br>ANSI C63.10-2013<br>KDB 558074 V5 R02 |

The EUT was a Gateway for use in the vehicles. Its purpose was to relay packets received on the 433MHz band using a transmitter in the 2.4GHz band.

The EUT contained transmitters using Wifi and Thread technology and also a 433MHz receiver.

For Wifi it was possible to switch between 2 internal antennas, one an internal module antenna and the other one a printed pcb antenna.

The Thread radio had its own dedicated pcb antenna.

This report details test carried out with the Wifi and Thread transmitters transmitting simultaneously.

## 1.1 EUT Operation

### Operating Conditions during Test:

The EUT was operated in test mode where the channel and modulation was set via USB connection from the EUT to a laptop.

The EUT was powered from a bench PSU set to 12Vdc. for all tests

Radiated measurements were performed on a sample with standard internal antennas with Wifi and Thread transmitting simultaneously.

### Environmental conditions

|                          | Temperature | Relative Humidity |
|--------------------------|-------------|-------------------|
| <b>Test</b>              | °C          | %                 |
| Radiated Emissions <1GHz | 17          | 41                |
| Radiated Emissions >1GHz | 21          | 44                |

## 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 17<sup>th</sup> -19<sup>th</sup> Feb 2021.

## 1.4 Special Software

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

## **2 Emissions Measurements**

### **2.1 Conducted Emissions Measurements**

Radio Conducted measurements were carried out on the EUT as per section 1.1 above.

All results were measured as conducted on the antenna except radiated spurious emissions.

### **2.2 Radiated Emissions Measurements**

Emissions below 1GHz were measured using a test antenna positioned at a distance of 3 metres from the EUT (as measured from the closest point of the EUT) which was placed on a turntable allowing 360 degree rotation, in a semi anechoic chamber. 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. In this case the resolution bandwidth was 100kHz.

Emissions in the above 1GHz were measured using a horn antenna located at 3 metres distance from the EUT in a fully anechoic chamber.

The radiated emissions were maximised by configuring the EUT and by rotating the EUT, and by raising and lowering the test antenna from 1 to 4 metres.

Emissions above 18GHz were measured using a horn antenna located at 1 metre distance from the EUT in a fully anechoic chamber. The radiated emissions were maximised by configuring the EUT and by rotating the EUT and raising the test and antenna from 1 to 4 metres.

The resolution bandwidth was 1MHz and video bandwidth was 3 MHz for peak measurements for radiated emissions above 1GHz.

A pre-scan was performed to determine the worst case EUT orientation for the radiated measurements.

All radiated tests were performed with the EUT in orientation O1 for Horizontal polarization measurements and with the EUT in orientation O2 for Vertical polarisation measurements.

Ref Appendix C for orientations.

### 3. Spurious Emissions Measurements

#### 3.1 Test setup

A number of co-location tests were performed, and the worst case are reported here.

For the restricted band at 2.4835GHz it was found that the worst case results were achieved with Wifi at 2.462GHz and Thread at 2.475GHz

For the restricted band below 2.39GHz it was found that the worst case results were achieved with Wifi at 2.422 GHz and Thread at 2.405 GHz

A full scan was performed with Wifi operating at 2.462GHz and Thread operating at 2.475GHz

#### 3.2 Radiated Spurious Emissions in Restricted bands

##### 3.2.1 Test Method

As per Ansi63.10 Section 11.12.1 and 6.10.5

##### Ansi63.10 Section 11.12.1 Radiated emission measurements

Because the typical emission requirements are specified in terms of radiated field strength levels, measurements performed to determine compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for determining compliance to the specified requirements; however antenna-port conducted measurements are also now acceptable to determine compliance (see 11.12.2 for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in 6.3, 6.5, and 6.6 shall be followed

##### 6.10.5 Restricted-band band-edge measurements

These procedures are applicable for determining compliance at band edges of restricted bands.

##### 6.10.5.1 Test setup

Restricted-band band-edge tests shall be performed as radiated measurements, on a test site meeting the specifications in 5.2 at the measurement distances specified in 5.3.57

The instrumentation shall meet the requirements in 4.1.1 using the bandwidths and detectors specified in 4.1.4.2. Considering the requirements of 5.8, the antenna(s) shall be connected to the antenna ports. When performing radiated measurements, the measurement antenna(s) shall meet the specifications in 4.3. The EUT shall be connected to an antenna and operated at the highest power settings following procedures in 6.3, and the relevant procedure in 6.4, 6.5, or 6.6

Results

Ref scans in Appendix B

### 3.3 Radiated Spurious Emissions

| 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 |
|---------------|-------------------------|------------------|-------------------|---------------|--|-------------------------|-----------|
| 154.3         | 22.1                    | Vertical         | 11.9              | 1.2           | 35.2                                   | 43.5                    | 8.3       |
| 240           | 8.1                     | Vertical         | 15.7              | 1.4           | 25.2                                   | 46.0                    | 20.8      |
| 272           | -0.2                    | Horizontal       | 17.2              | 1.4           | 18.4                                   | 46.0                    | 27.6      |
| 400           | 5.8                     | Vertical         | 16.3              | 1.6           | 23.7                                   | 46.0                    | 22.3      |
| 336           | 19.2                    | Horizontal       | 15.5              | 1.5           | 36.2                                   | 46.0                    | 9.8       |
| 384           | 22.1                    | Horizontal       | 15.7              | 1.7           | 39.5                                   | 46.02                   | 6.52      |
| 400           | 12.2                    | Horizontal       | 16.3              | 1.6           | 30.1                                   | 46.0                    | 15.9      |

| 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     |
| 4.951     | 46.3                | 33.5           | 37.4        | 5.4        | Horizontal       | 0.00                  | 47.8             | 74                  | 26.2   |
| 9.848     | 41.3                | 38.2           | 36.3        | 8.3        | Horizontal       | 0.00                  | 51.5             | 74                  | 22.5   |
| 9.848     | 42.2                | 38.2           | 36.3        | 8.3        | Vertical         | 0.00                  | 52.4             | 74                  | 21.6   |

Average measurements were not performed, where recorded peak levels were less than the average limit of 54dBuV/m

Test Result: - Pass



**4 List of Test Equipment**

| <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> |
|---------------------------------------|---------------------|---------------|-----------------------|----------------|---------------------|----------------------------|
| Spectrum Analyser 30Hz-40GHz          | Rohde & Schwarz     | FSP40         | 100053                | 850            | 11-Dec-21           | 36                         |
| Test Receiver 3.6GHz                  | Rohde & Schwarz     | ESR           | 1316.3003k03-101625-s | 869            | 28-May-23           | 36                         |
| Antenna Biconical                     | Schwarzbeck         | VHBB 9124     | 9124 667              | 871            | 03-Sep-21           | 36                         |
| Antenna Horn                          | EMCO                | 3115          | 9905-5809             | 655            | 14-Mar-21           | 24                         |
| Anechoic Chamber                      | CEI                 | SAR 10M       | 845                   | 845            | 16-May-22           | 36                         |
| Antenna Log Periodic                  | Chase               | UPA6108       | 1072                  | 609            | 03-Sep-21           | 36                         |
| Fully Anechoic Chamber                | CEI                 | FAR 3M        | 906                   | 906            | 22-Mar-21           | 36                         |
| Microwave Preamplifier                | Hewlett Packard     | 83017A        | 3123A00175            | 805            | 30-Sep-21           | 12                         |
| Antenna Horn Standard Gain 18-26.5GHz | A-Info              | LB-42-25-C-KF | J2021091103028        | 877            | 05-Oct-21           | 12                         |

## 5 Measurement Uncertainties

| Measurement                     | Uncertainty            |
|---------------------------------|------------------------|
| Radio Frequency                 | +/- $5 \times 10^{-7}$ |
| Maximum Frequency Deviation     | +/- 1.7 %              |
| Conducted Emissions             | +/- 1 dB               |
| 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             |
| Modulation bandwidth            | +/- $5 \times 10^{-7}$ |
| Duty Cycle                      | +/- 5 %                |
| Power supply                    | $\pm 0.1$ VDC          |
| Temperature                     | $\pm 0.2$ °C           |
| Frequency                       | $\pm 0.01$ ppm         |

The measurement uncertainties stated were calculated with a k=2 for a confidence level of over 95% as per ETS TR100 028.

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**

**Radiated Spurious Emissions Co-location**

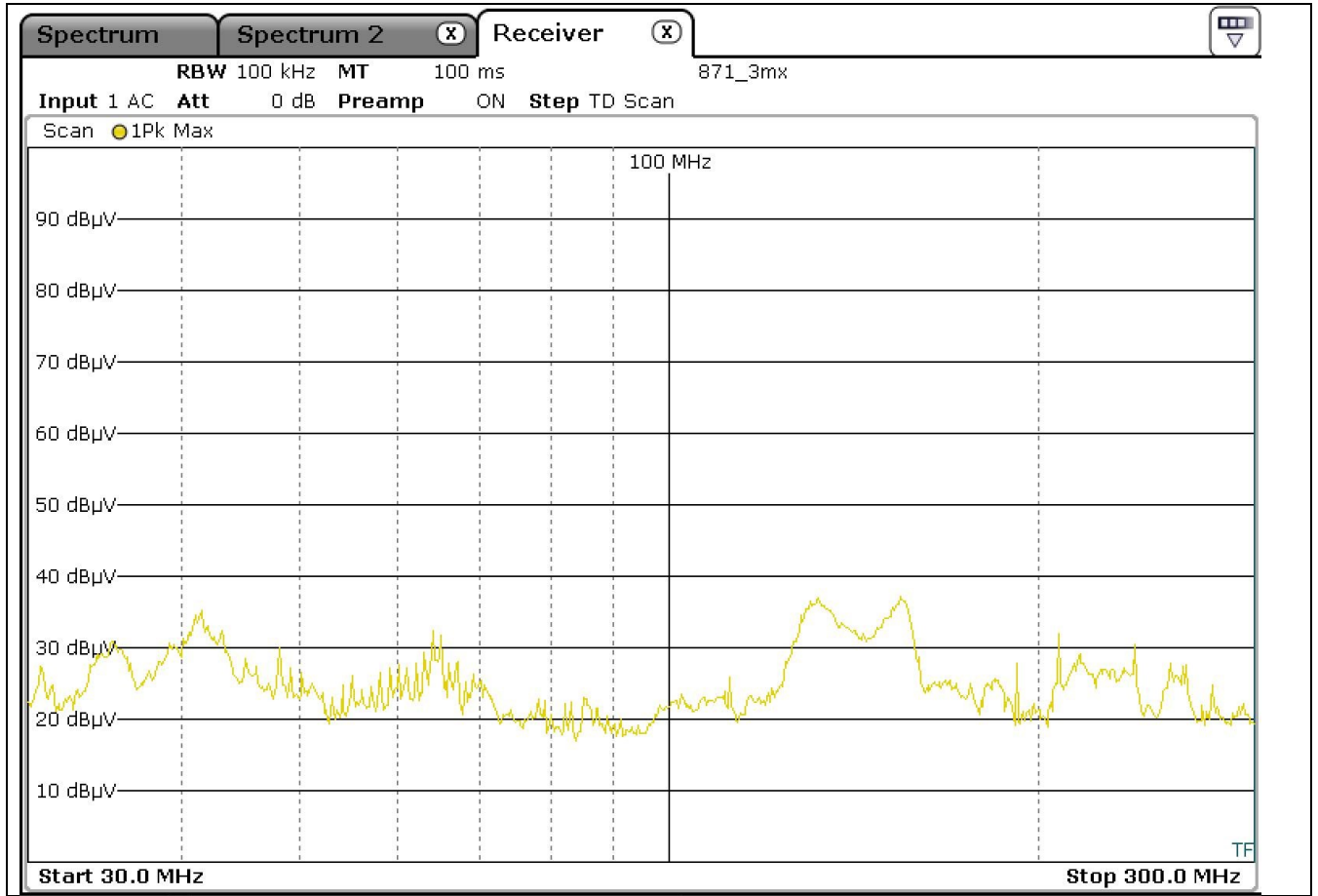


Fig C1 High Channel Radiated Emissions 30MHz -300MHz Vertical 3metres

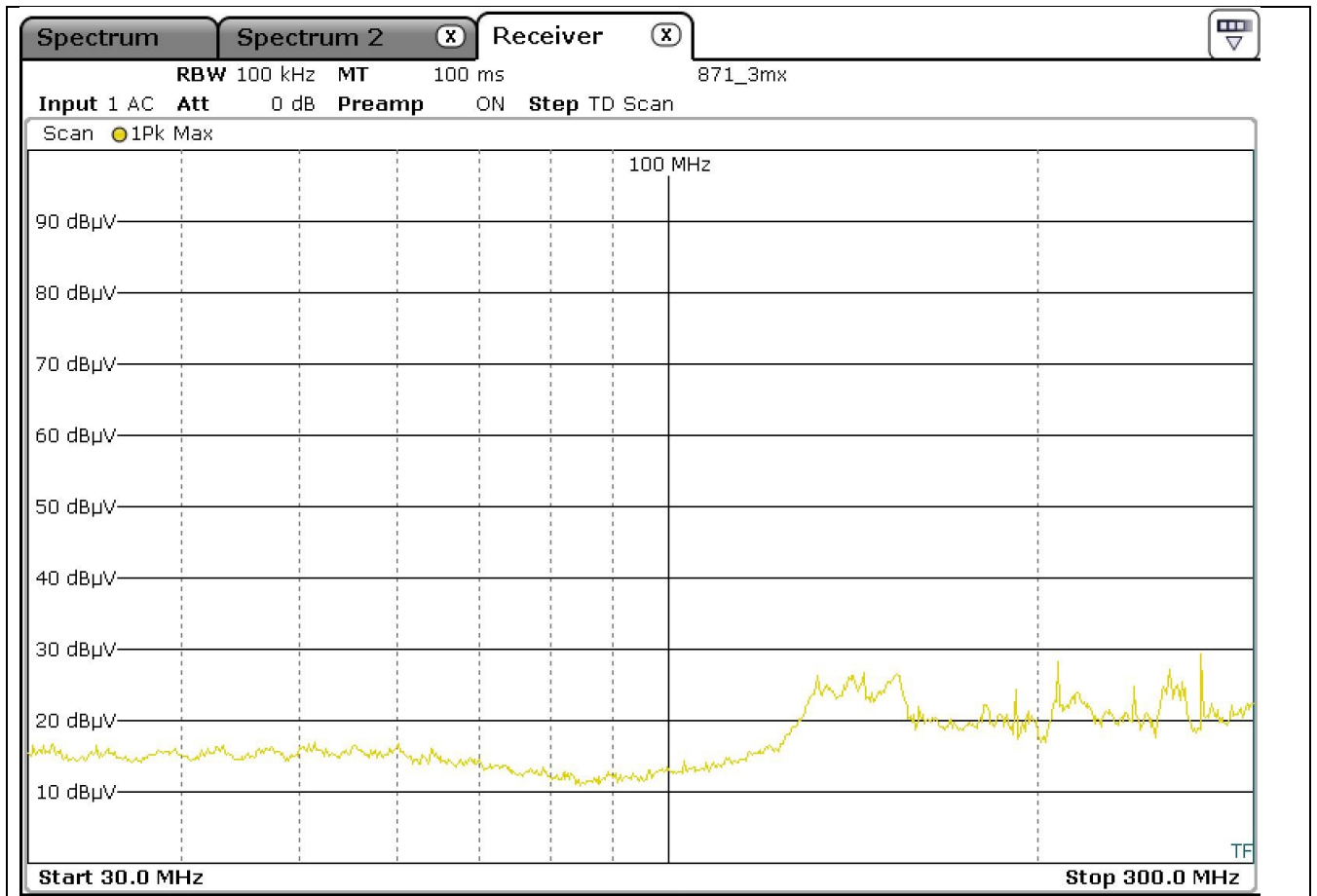


Fig C2 High Channel Radiated Emissions 30MHz -300MHz Horizontal 3metres

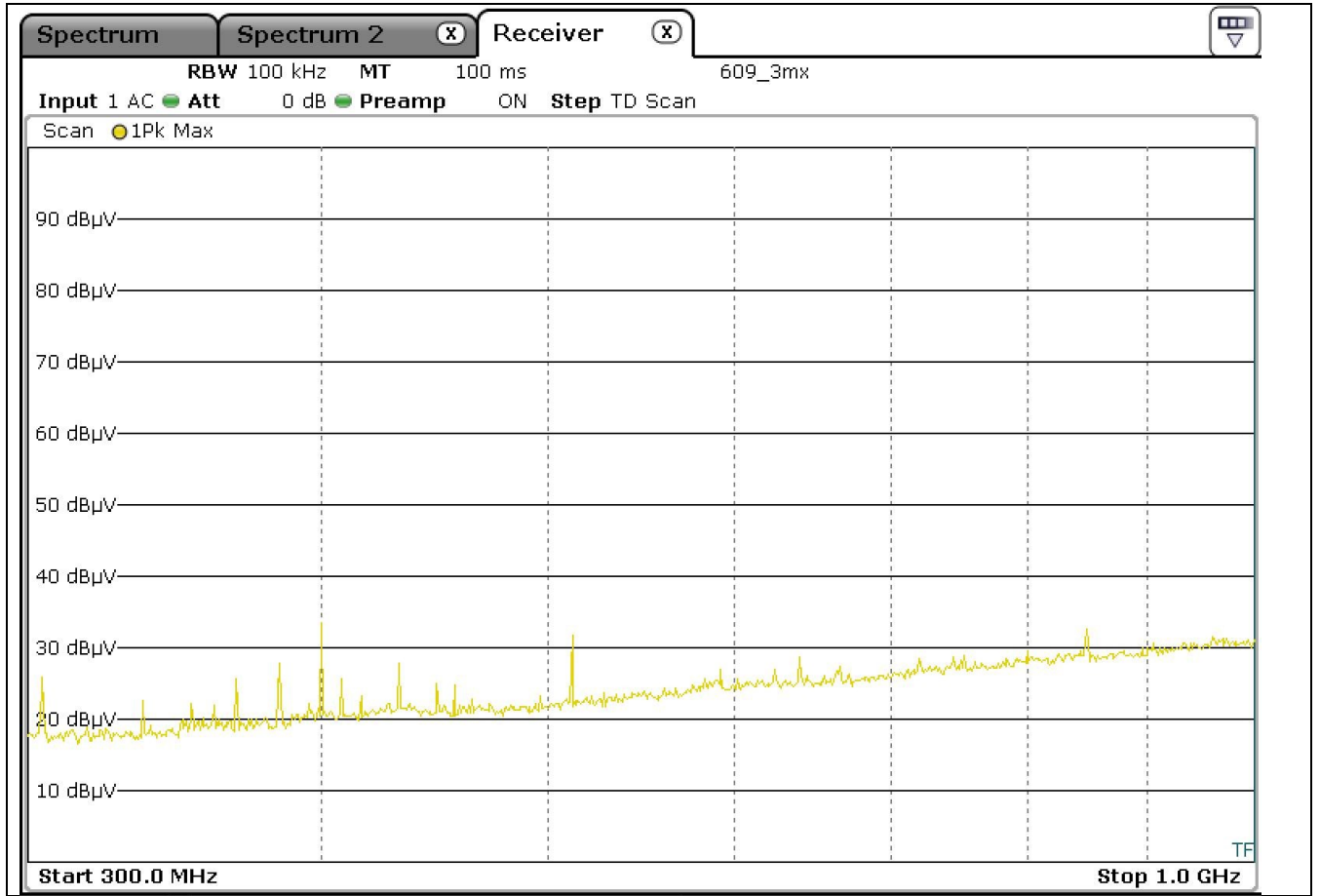


Fig C3 High Channel Radiated Emissions 300MHz -1GHz Vertical 3metres

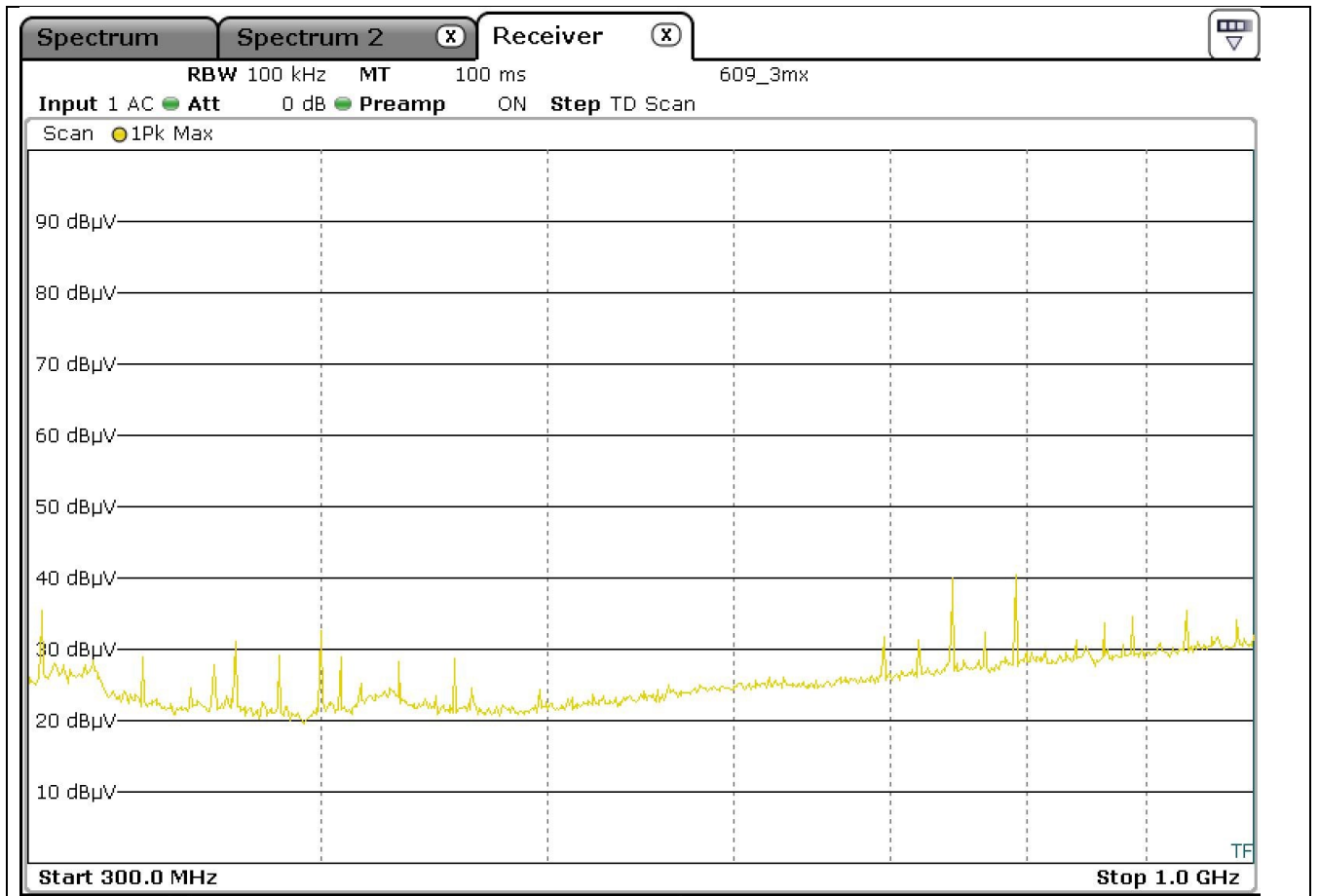


Fig C4 High Channel Radiated Emissions 300MHz -1GHz Horizontal 3metres

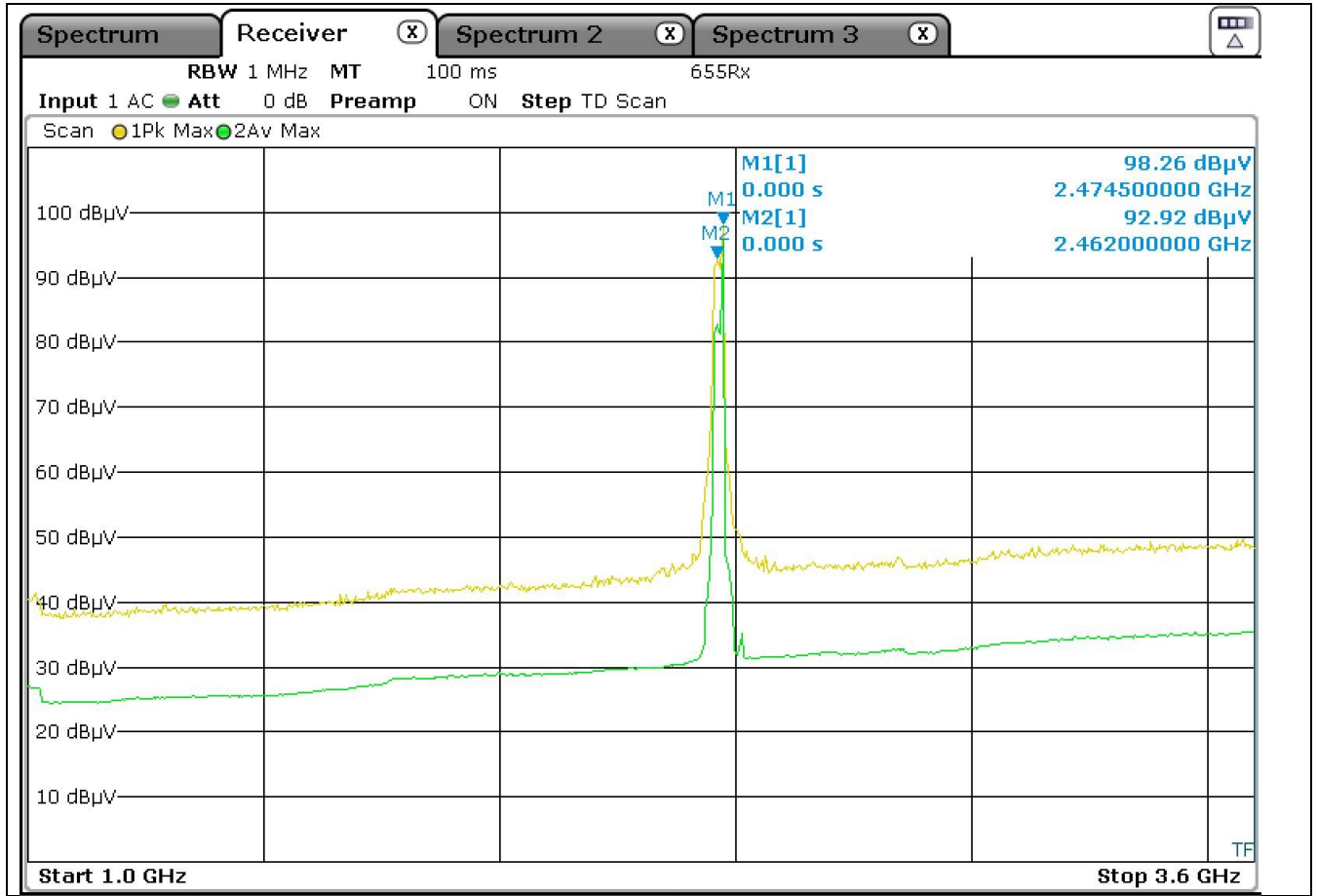


Fig C5 High Channel Radiated Emissions 1GHz -3.6GHz Vertical 3metres

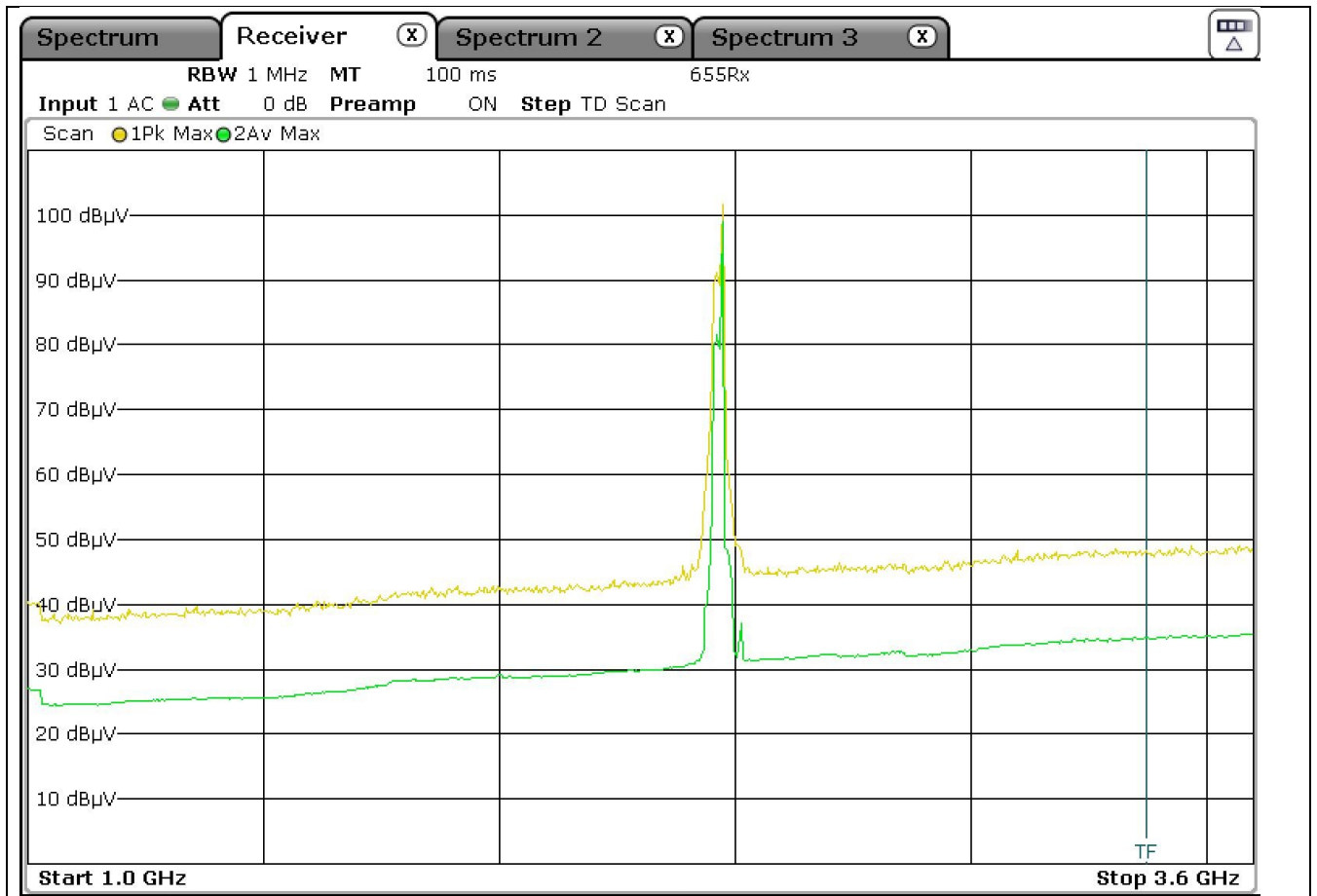
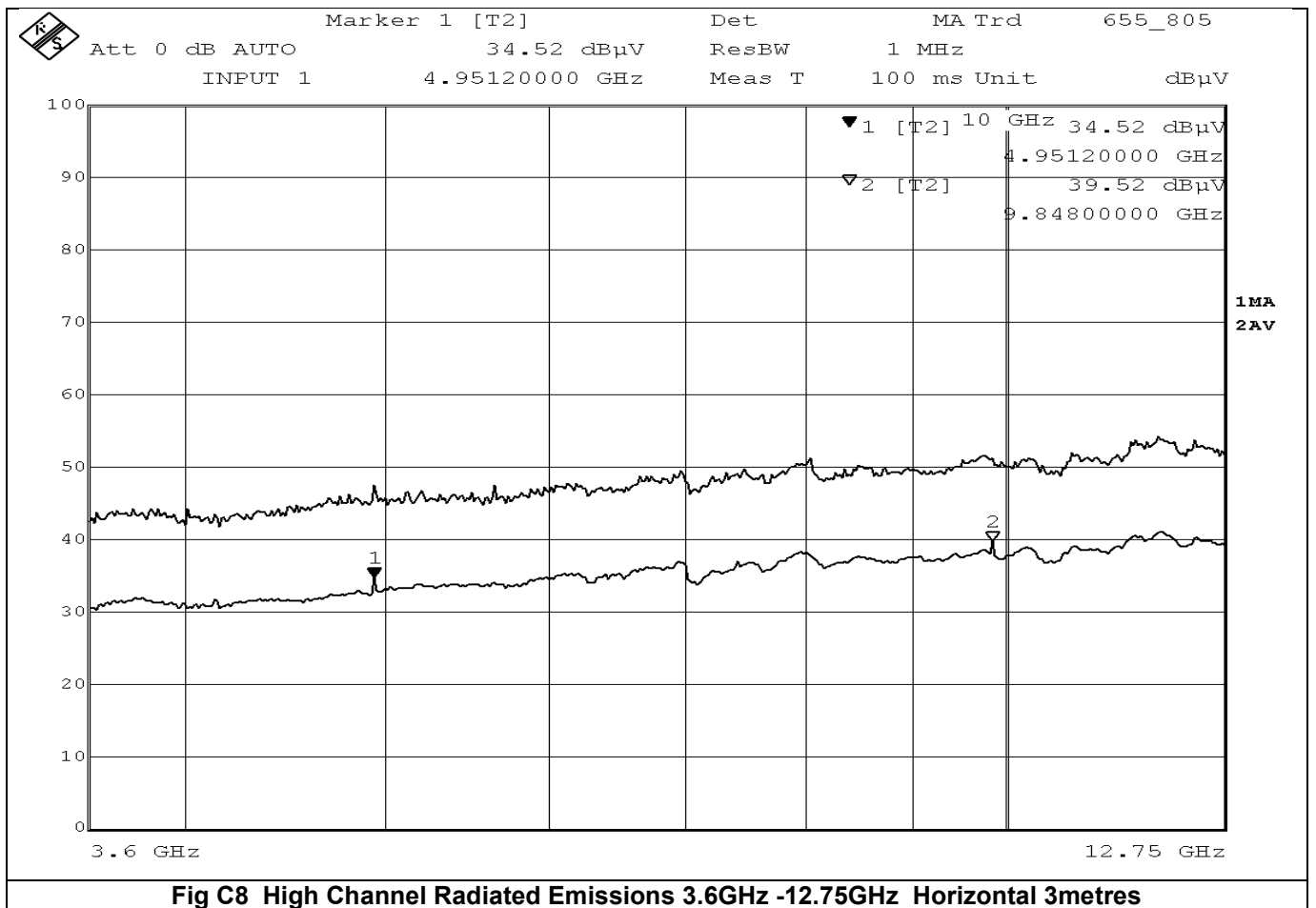
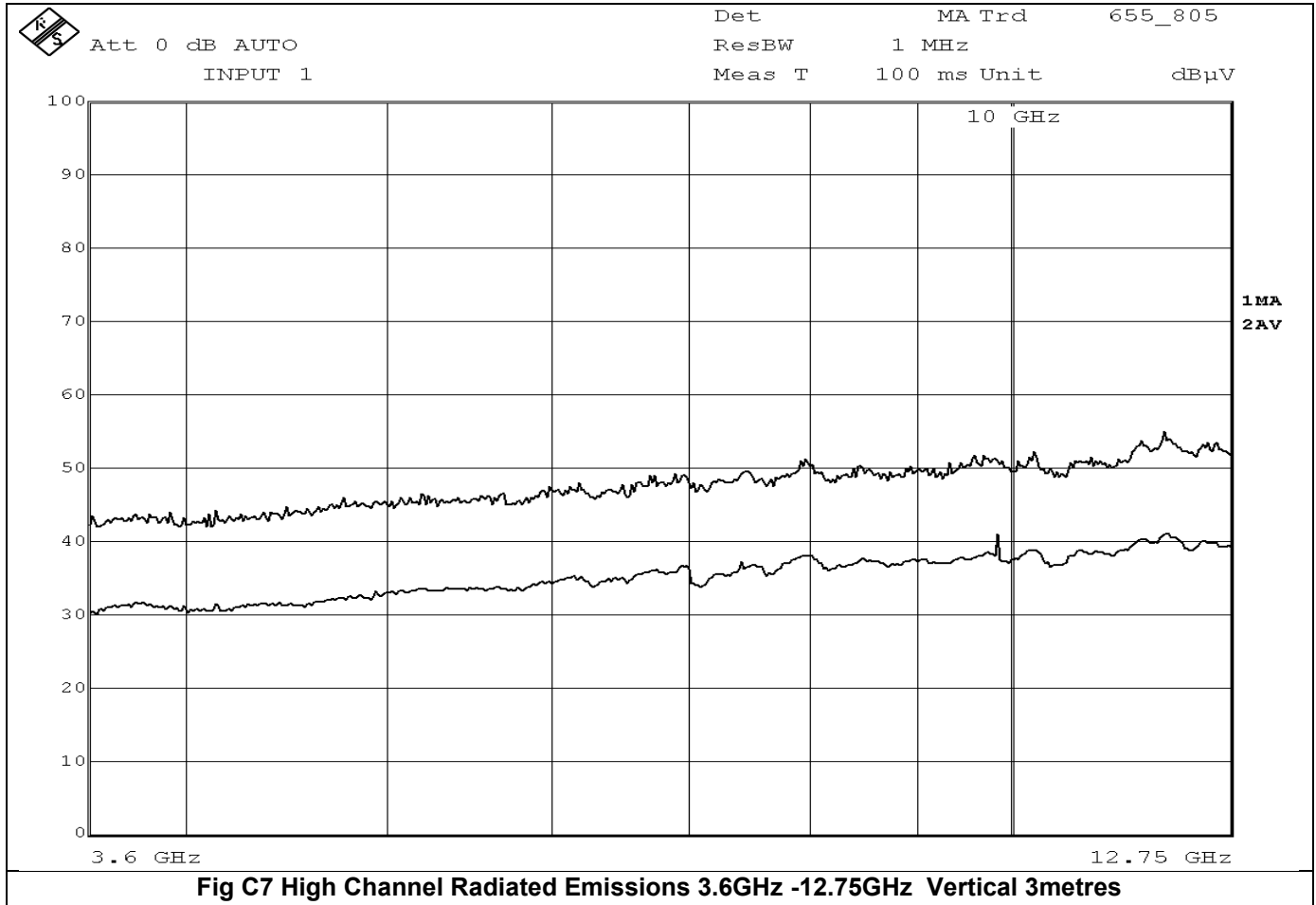
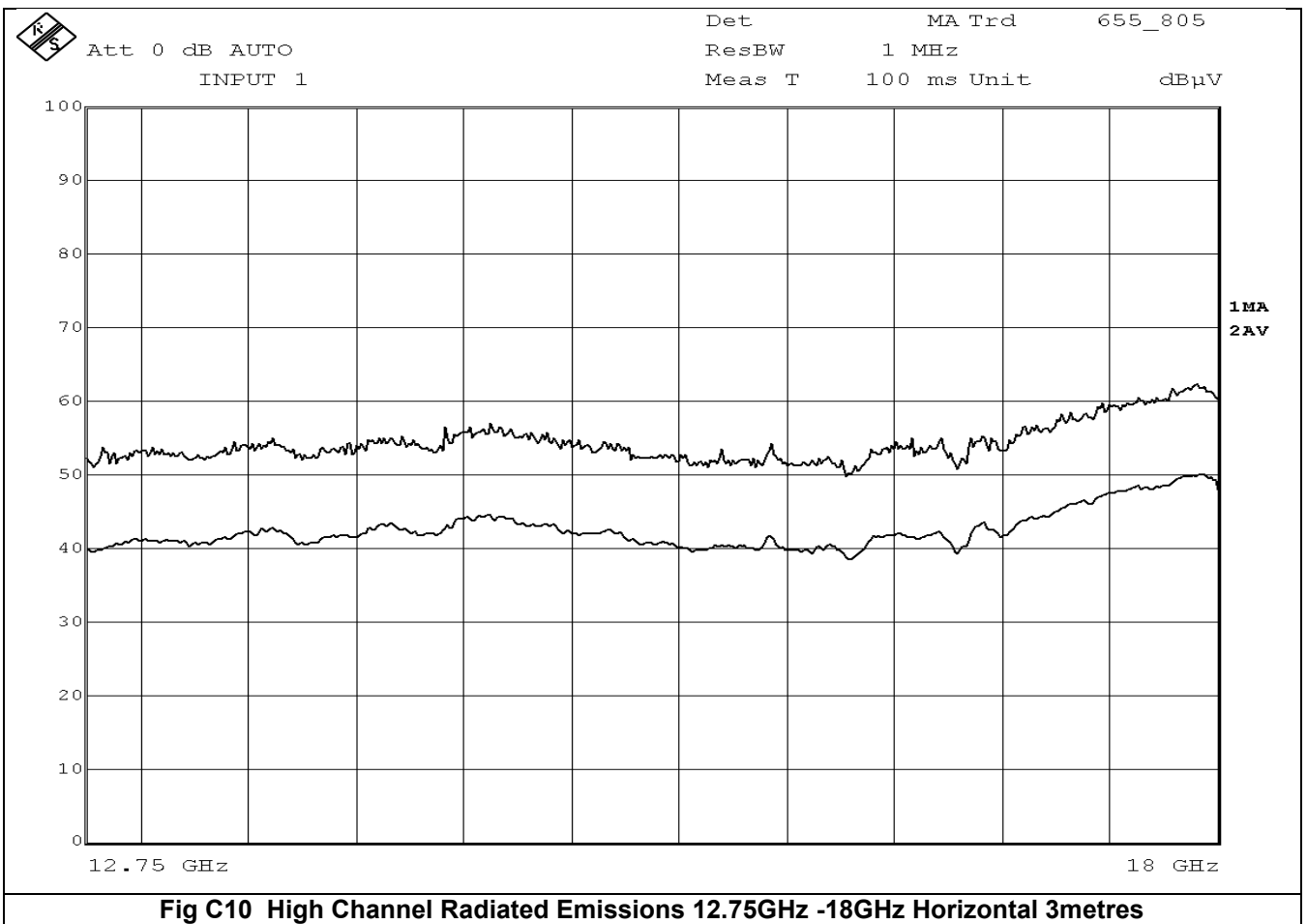
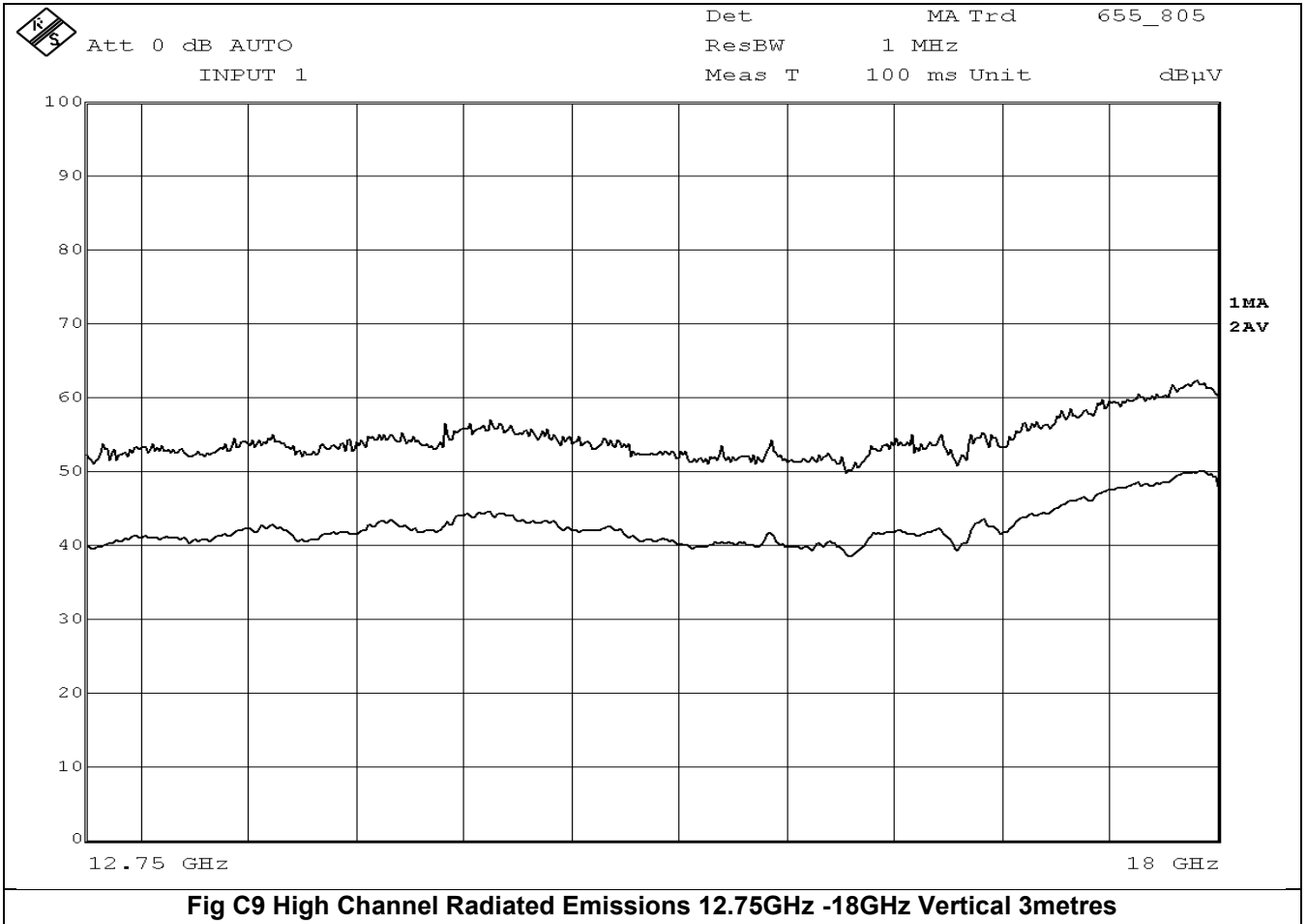
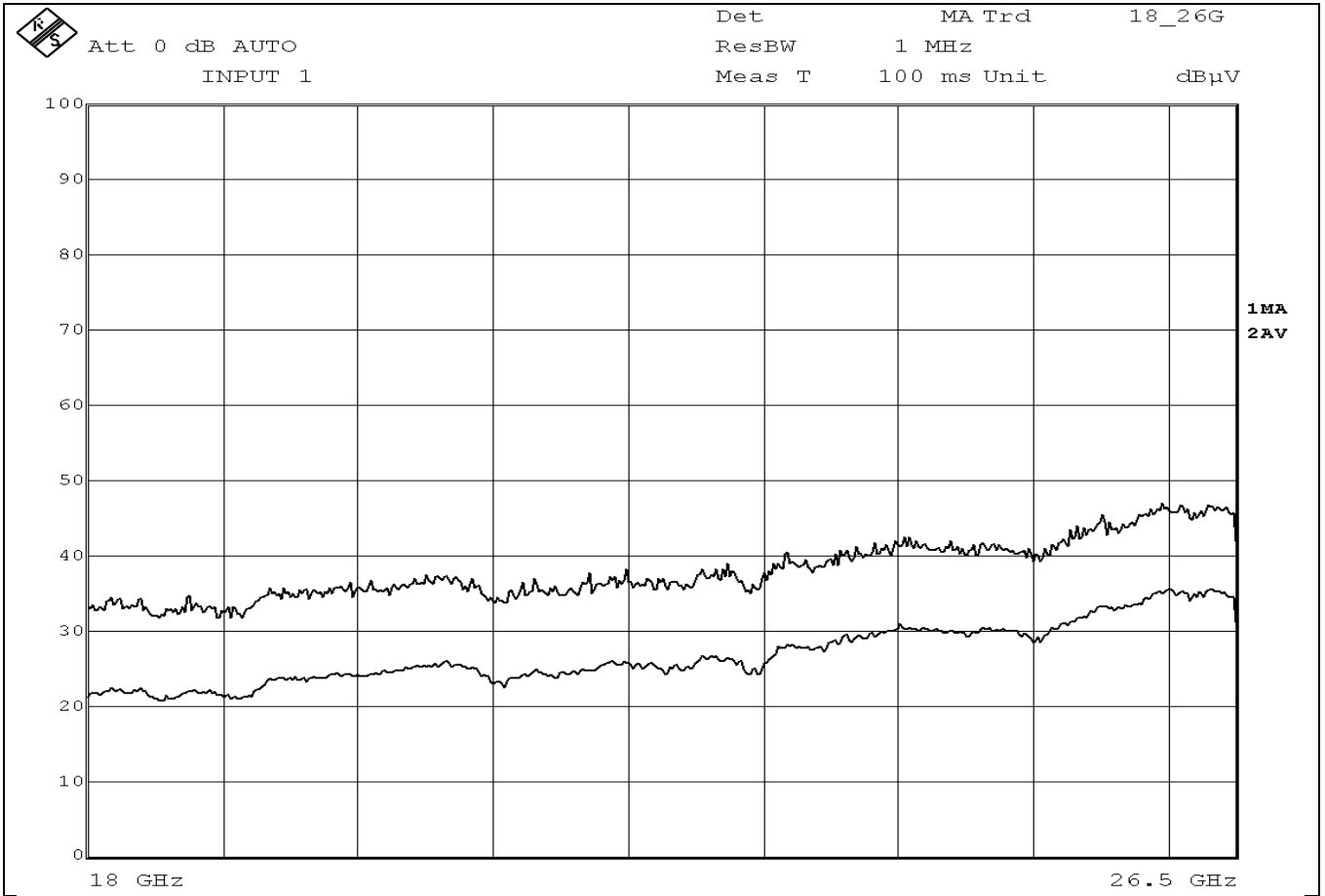


Fig C6 High Channel Radiated Emissions 1GHz -3.6GHz Horizontal 3metres

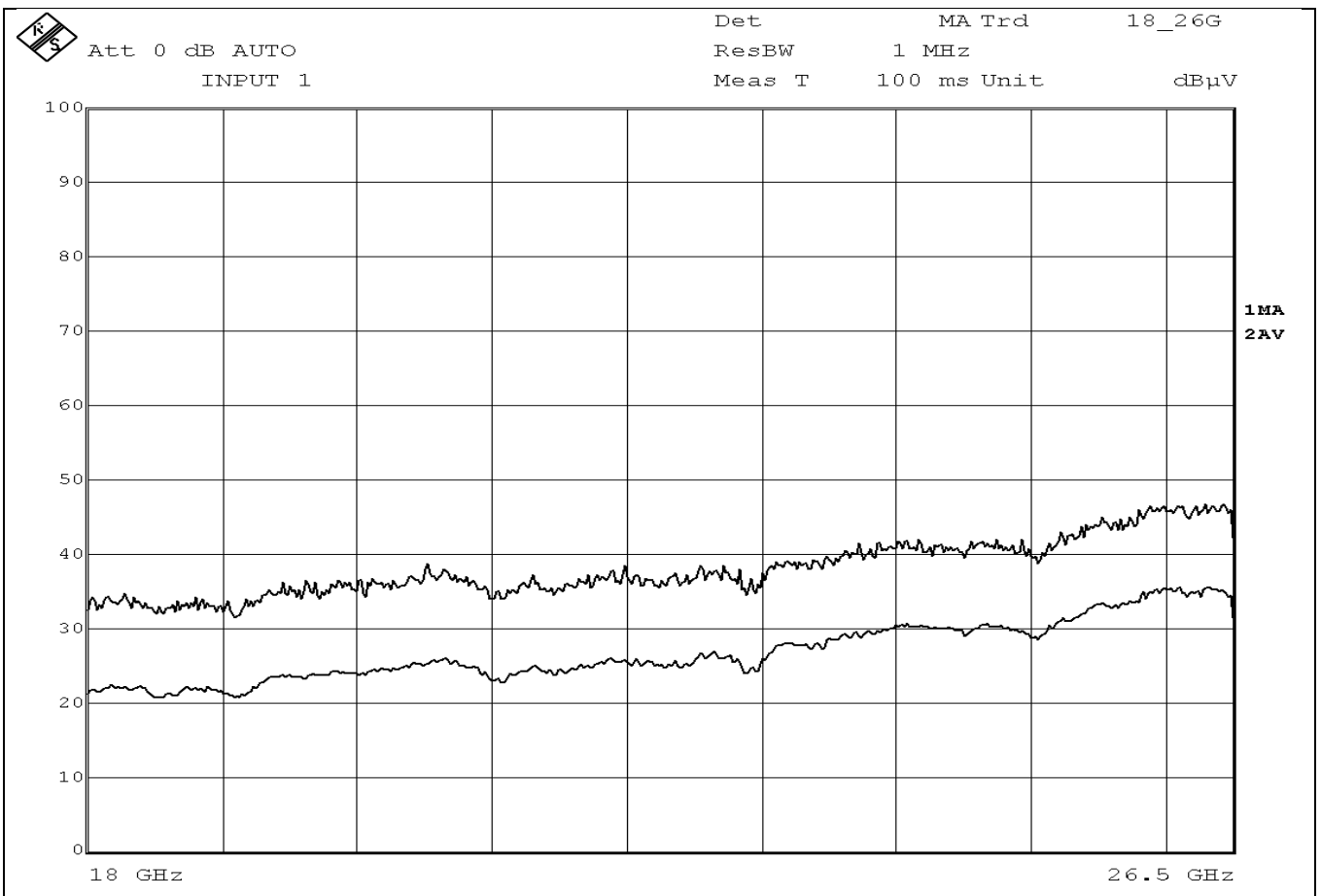








**Fig C11 High Channel Radiated Emissions 18GHz -26.5GHz Vertical 1metre**



**Fig C12 High Channel Radiated Emissions 18GHz -26.5GHz Horizontal 1metre**

**Appendix B**

**Radiated tests for Band Edges /Restricted band Co-Location**

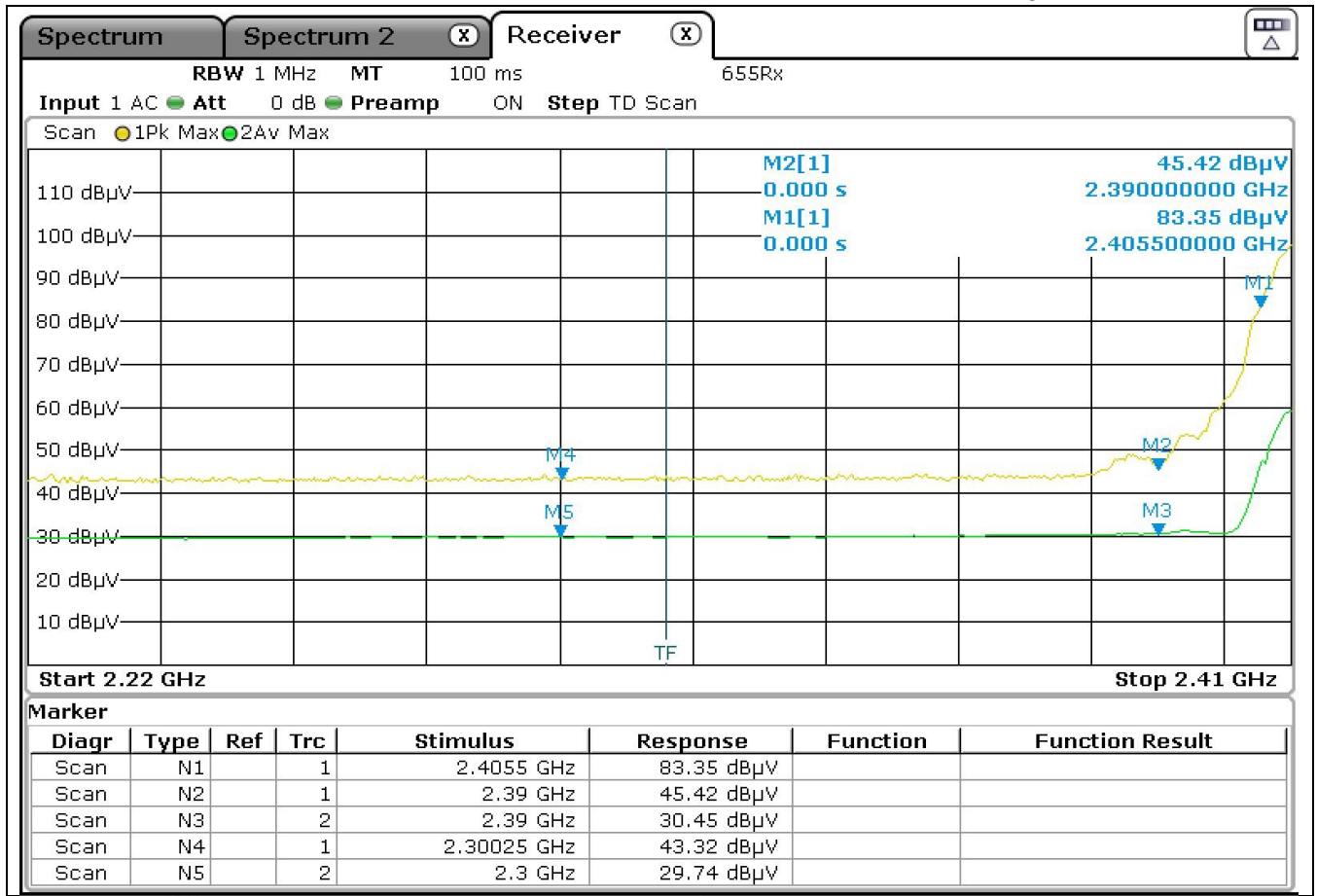


Fig B1 Co-location Restricted band Vertical peak and average at 3 metres

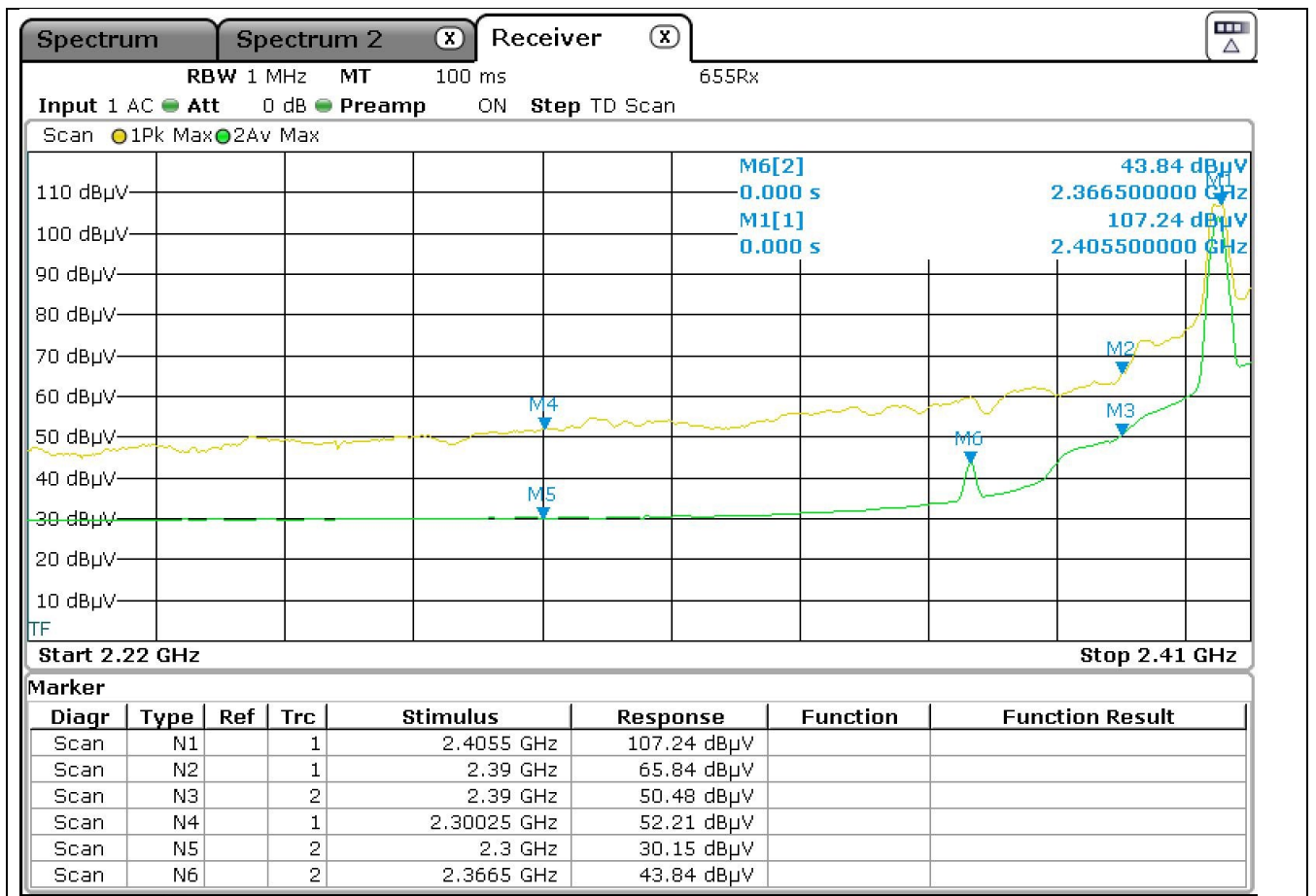


Fig B2 Co-location Restricted band Horizontal peak and average at 3 metres

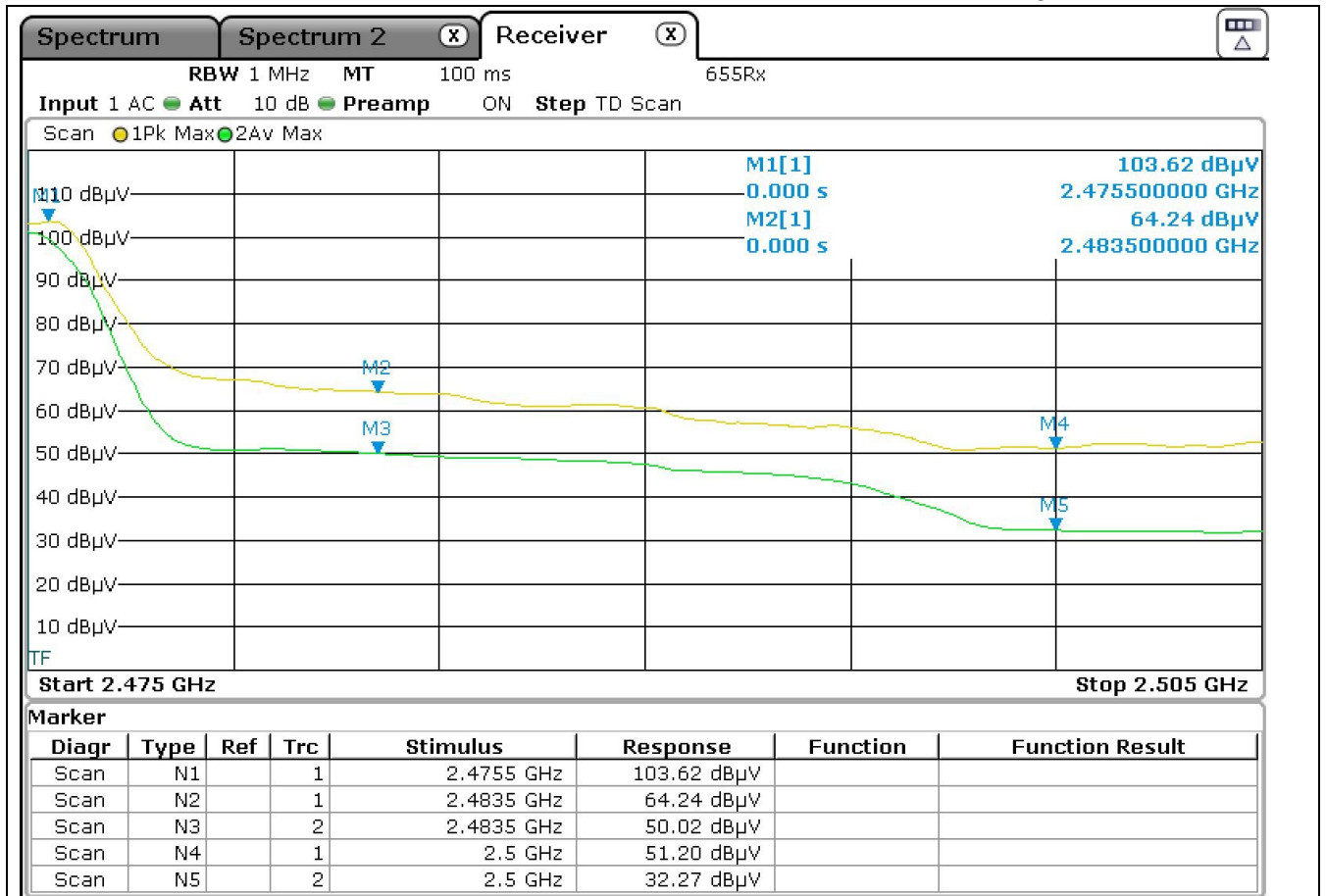


Fig B3 Co-location Restricted band Vertical peak and average at 3 metres

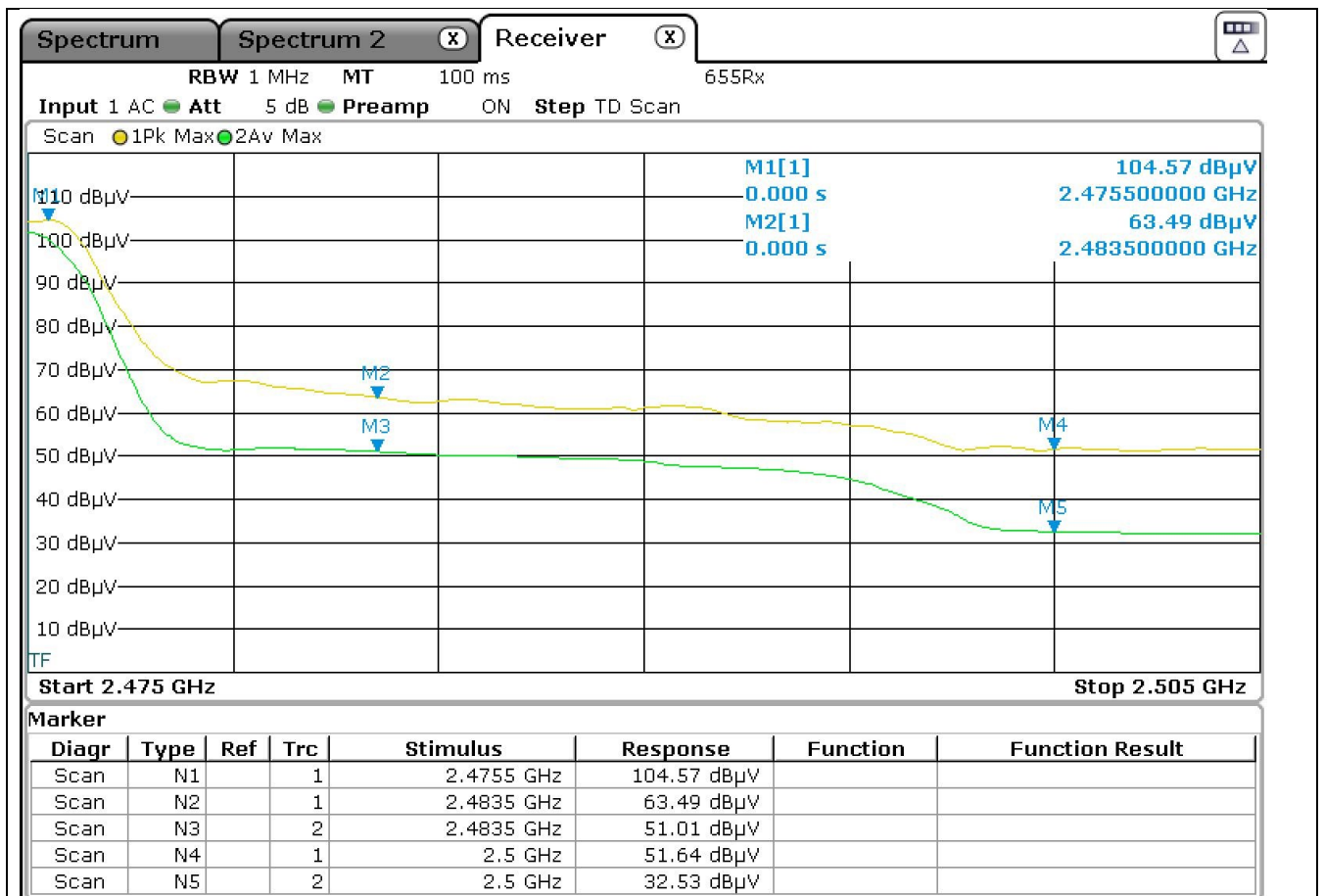
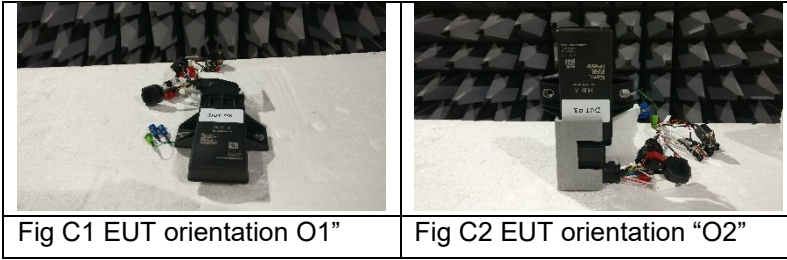


Fig B4 Co-location Restricted band Horizontal peak and average at 3 metres

## Appendix C



Orientations for Radiated Emissions

End of Report