COMPLIANCE ENGINEERING IRELAND LTD

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Project Number: 11E3697-4

Prepared for:

**Kelsius Ltd**

By

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Raystown

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Co. Meath

**FCC Site Registration: 92592**

**Industry Canada Assigned Code: 8517A**

**Date**

September 2011

FCC EQUIPMENT AUTHORISATION

Test Report

**EUT Description**

Sensor Module for use by applicant only.

Authorised: 

## TEST SUMMARY

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

| TEST SPECIFICATION | TEST PARAMETERS | RESULT |
|---|---|---|
| 15.247(b), (c) / RSS-210 A8.4 | Maximum peak output power | Pass |
| 15.247/(e) / RSS-210 A8.1 | Hopping channel carrier frequencies separation | Pass |
| 15.247(a) / RSS-210 A8.1 | 20dB bandwidth of the hopping channel | Pass |
| 15.247/(e) / RSS-210 A8.1 | Number of hopping frequencies | Pass |
| 15.247/(e) / RSS-210 A8.1 | Average time of occupancy of hopping frequency | Pass |
| 15.247(d) / RSS-210 A8.5 | Antenna conducted spurious and band edge emissions | Pass |
| 15.247(d) / RSS-210 A8.5 | Radiated spurious emissions | Pass |
| 15.109 / ICES-003 | Receiver/digital device radiated emissions | Pass |

# Exhibit A – Technical Report

Table of Contents

## 1.0 EUT Description

The EUT was a module using a short range 915 MHz band transceiver intended to be used by Kelsius only as the basis for detector modules used in temperature sensing and similar applications.

| | |
|---|---|
| **Model:** | Network Controller |
| **Type:** | 915 MHz Sensor Module |
| **FCC ID:** | Z4GK101 |
| **Company:** | Kelsius |
| **Contact** | Dr David Gray |
| **Address:** | Unit 6, Ballyconnell<br>Industrial Estate, Falcarragh,<br>Co Donegal, Ireland |
| **Phone:** | +353 7491 62982 extn 223 |
| **e-mail:** | david.gray@kelsius.com |
| **Test Standards:** | 47 CFR, Part 15.247 |
| **Type of radio:** | Stand-alone |
| **Transmitter Type:** | FHSS |
| **Operating Frequency Range(s):** | 902 to 927 MHz |
| **Number of Channels:** | 53 |
| **Antenna:** | Internal |
| **Transmitter power configuration:** | Internal battery |
| **Test Methodology:** | Measurements performed according to the procedures in ANSI C63.4-2003 |

## 1.1 EUT Operation

**Operating Conditions during Test:**

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

☐ Standby
☒ Continuous transmissions with hopping function enabled
☐ Continuous transmissions with hopping function disabled (modulated signal)
☐ Continuous transmissions with hopping function disabled (un-modulated signal)
☐ Continuous receiving
☐ Test program (customer specific)

| No. | Description |
|---|---|
| 1. | Test was performed at low channel, middle channel, and upper channel |

New batteries were fitted prior to testing.

The module transmits once every 60 seconds under internal control.

**Environmental conditions**

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

☒ Normal

Temperature: +15 to +35 ° C

Humidity: 20-75 %

## 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 during the month of September 2011.

## 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 C63.4-2009.

### 1.4.1 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).

## 2.0 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.

## 2.1 Test Procedure

The EUT was centred on a motorised turntable, which allows 360 degree rotation. From frequencies between 30 MHz and 1000 MHz, a measurement antenna was positioned at a distance of 10 meters 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 above 1 GHz were made at a 3 metre distance.

A measuring receiver with peak detection was used to find the maximums of the radiated emissions during the variability testing below 1 GHz. All final measurements were taken using the quasi peak detector with a measurement bandwidth of 120 kHz. A drawing showing the test setup is given as Figure 2.

## 2.2 Test Criteria

The FCC Part 15.209 radiated limits are given below for a measurement distance of 10 meters.

| Frequency (MHz) | Field Strength μV/m | Field Strength (dBμV/m) |
|---|---|---|
| 30-88 | 100 | 40.0 |
| 88-216 | 150 | 43.52 |
| 216-960 | 200 | 46.0 |
| above 960 | 500 | 54.0 |

## 3.0 Field Strength of Spurious Radiated Emissions

**Test Specification:** FCC PART 15, SECTION 47 CFR 15.209

For the spurious and harmonics measurements, below 1GHz, the EUT was set up at a 3 meter distance from the receiving antenna, in an Anechoic Chamber, with the EUT running in a continuous mode. The EUT was rotated 360 degrees azimuth and the search antenna height varied 1 to 4m in order to maximize the emissions. Significant peaks from the EUT were then recorded to determine margin to the limits.

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

No emissions were evident in the frequency range 30 MHz to 1000 MHz.

**Table 1 – Final Radiated Emissions, OATS**

| Indicated | | Correction | | | Corr | Turntable/Antenna | | | Limit | | Det | EUT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Freq | Ampl | Ant | Cabl | Amp | Ampl | Ang | Ht | Pol | | Marg | | Orien |
| GHz | dBµV | dB | dB | dB | dB µV/m | deg | m | V/H | | dB | | |
| 1000 | 2.8 | 24.5 | 1.8 | 0 | 29.1 | 0 | 1 | V | 43.52 | 14.42 | QP | V |
| 1460.0 | 52.3 | 25.4 | 1.9 | 39.3 | 40.3 | 0 | 1 | V | 54.0 | 13.7 | Pk | V |
| 6700.0 | 47.8 | 35.4 | 2.3 | 38.9 | 46.6 | 0 | 1 | V | 54.0 | 7.4 | Pk | V |

No harmonics of the fundamental were observed during final radiated spurious measurements.

**Result: Pass**

## RADIATED EMISSIONS

07. Oct 11 08:15

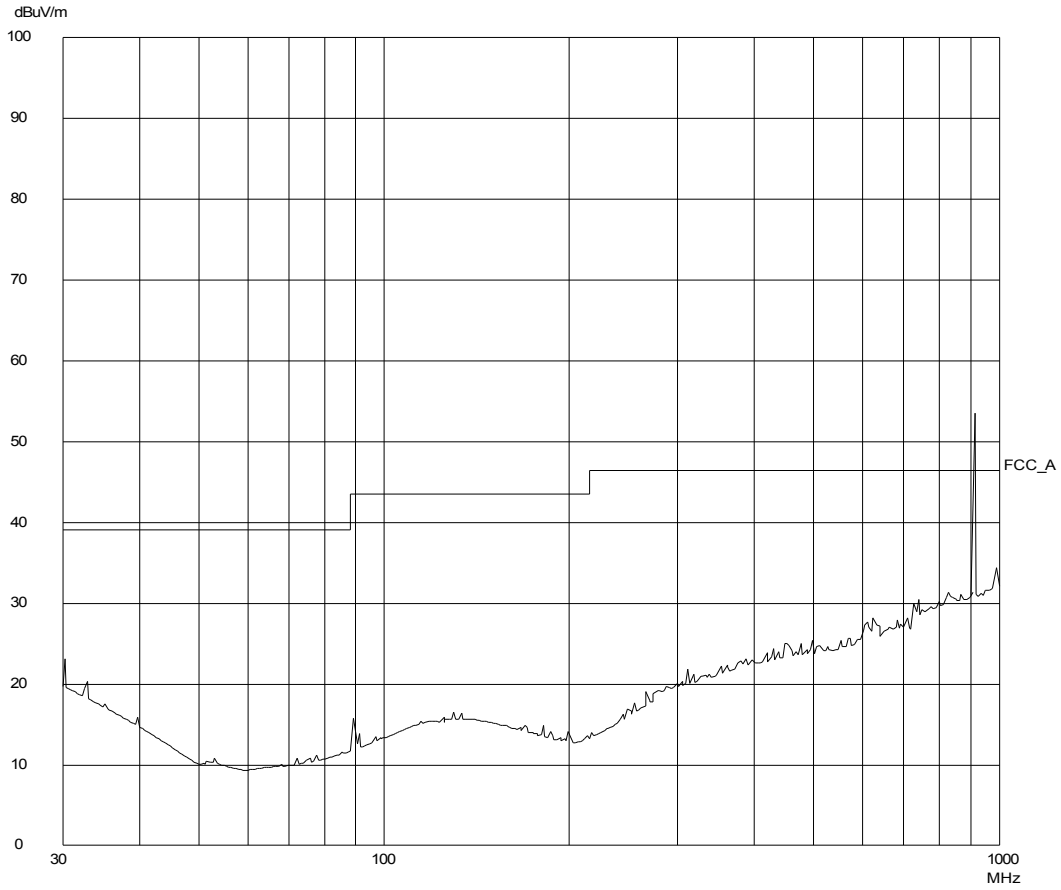
Op Cond: Normal
Operator: J McAuley

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 30M | 1000M | 120k | 120k | PK | 20ms | 0dBLN | OFF | 60dB |

Final Measurement: x Hor-Max / + Vert-Max
Meas Time: 1 s
Subranges: 8
Acc Margin: 0dB

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 3 | 9 | 20M | 1000M | CEIL615 |
| | 19 | 30M | 1000M | BILOG |




Note: Radiated Spurious Emissions above 1 GHz are shown in Appendix A.

## 4.0 Maximum peak output power

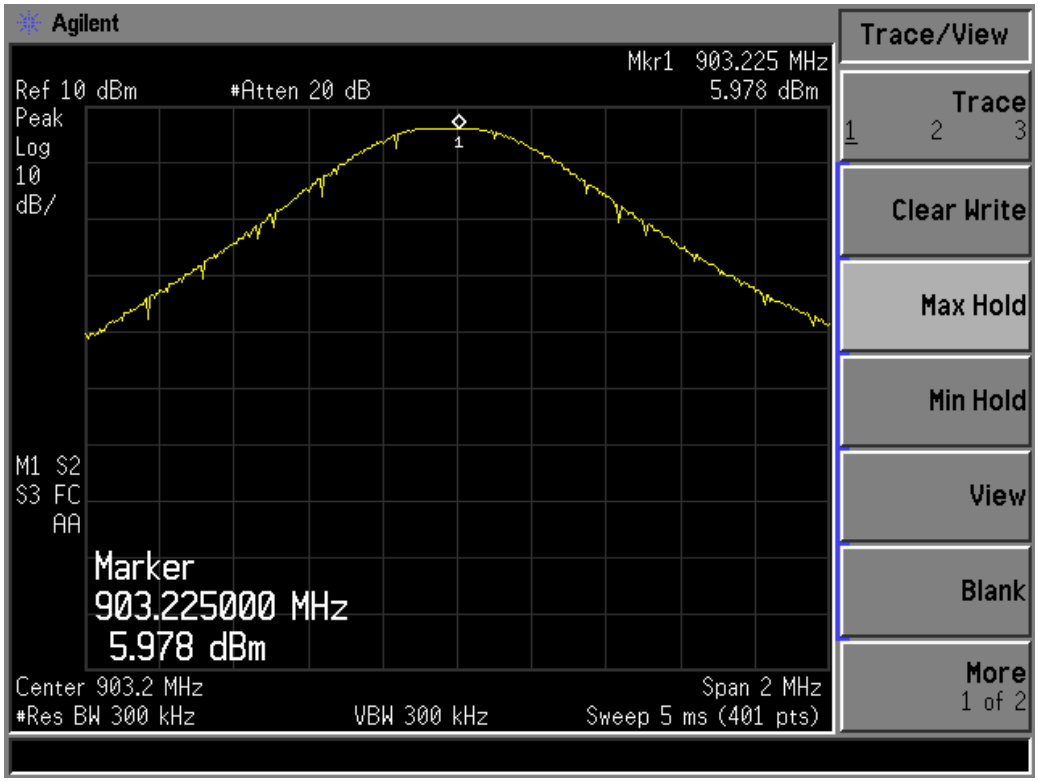
**Test result: Pass**

**Max. Margin:** .15.91dB below the limits

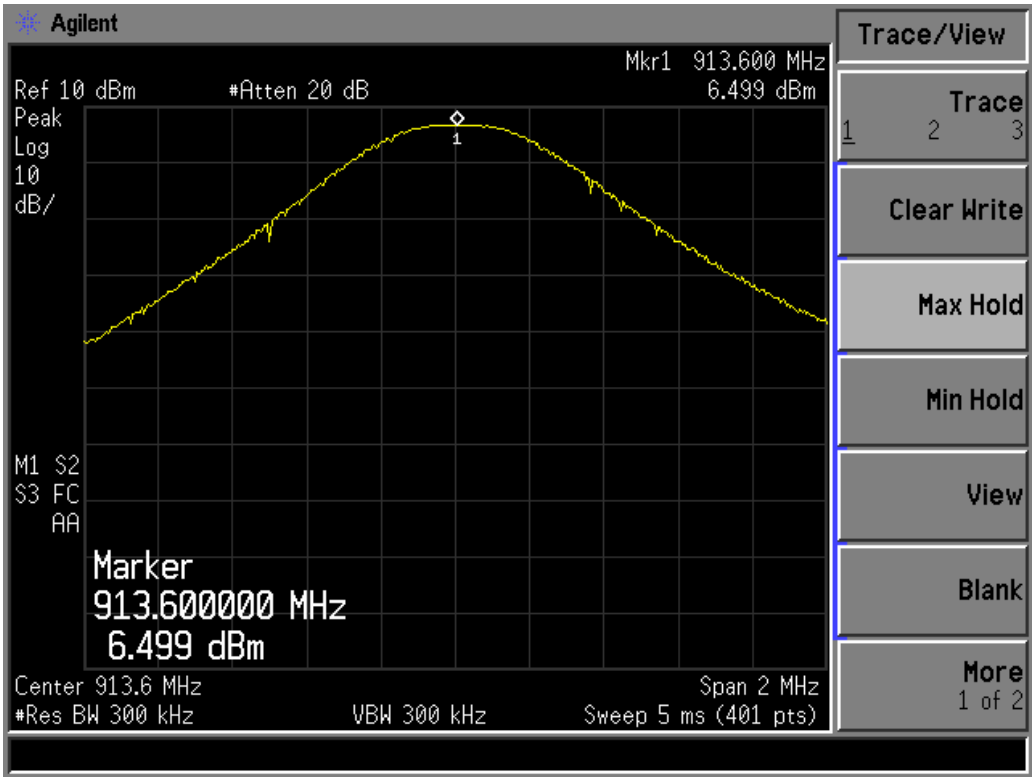
| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | | | | |
|---|---|---|---|---|---|---|
| **Low Frequency Channel (MHz)** | **Measured power W** | **Attenuation dB** | **Power at Antenna W** | **Limit W** | **Limit Reduction dB** | **Margin W** |
| **903.195** | **0.0040** | **0** | **.0040** | **1** | **0** | **0.996** |
| **Middle Frequency MHz** | | | | | | |
| **915.195** | **0.0045** | **0** | **0.0045** | **1** | **0** | **0.996** |
| **Upper Frequency MHz** | | | | | | |
| **923.95** | **0.0037** | **0** | **0.0037** | **1** | **0** | **0.996** |
| **Antenna Gain:** | ☒ < 6dBi ☐ > 6 dBi and = dBi, output power reduction = dB | | | | | |

RBW: 300 kHz

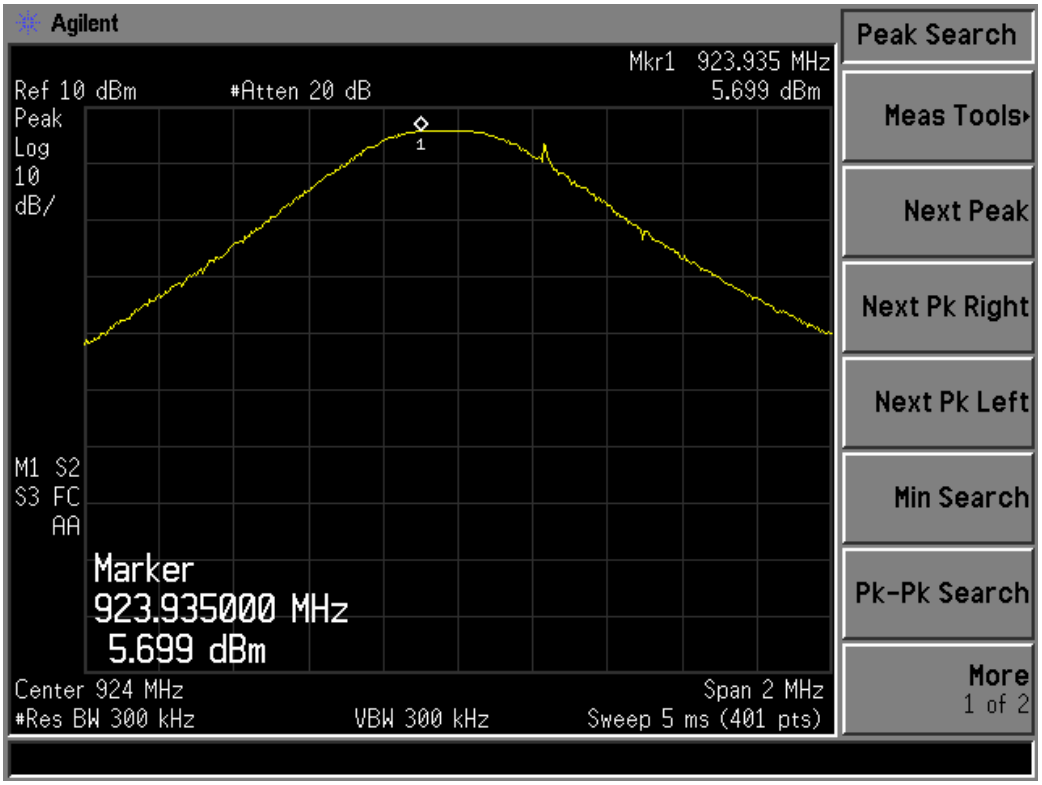
VBW: 300 kHz




**Graph 1 Channel 1 (Low)**




**Graph 2 Channel 26 (Mid)**



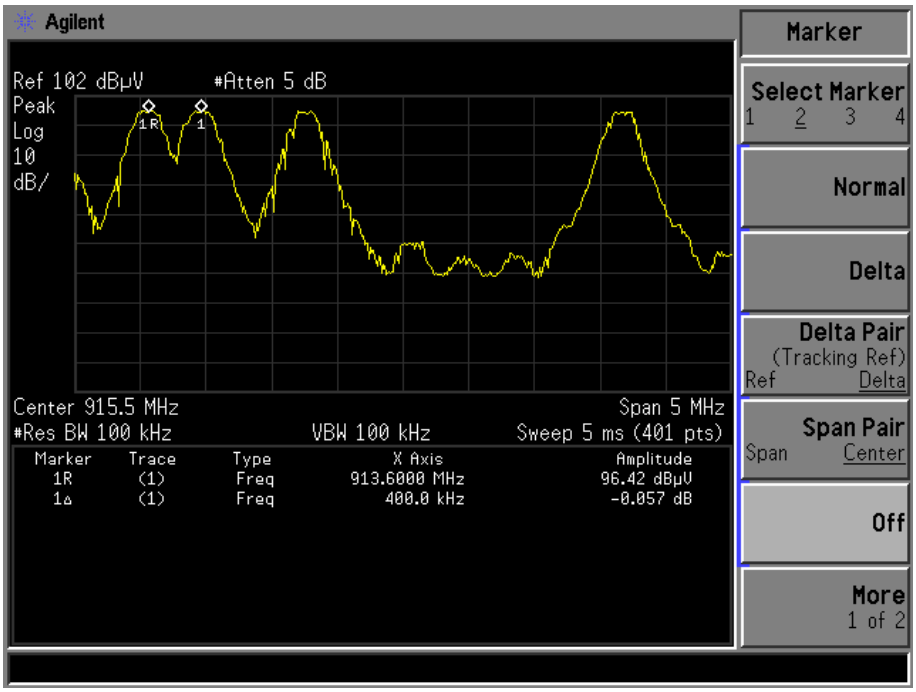

**Graph 3**

**Channel 50 (High)**

## 5.0 Hopping channel carrier frequencies separation

| **Frequency Range** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | |
|---|---|---|
| **Measured Separation (kHz)** | **Limit (kHz)** | **Result** |
| 400 | >234 | **Pass** |
| **Limit:** | 20dB channel bandwidth | |
| **Span:**<br>**RBW:**<br>**VBW:** | 5 MHz<br>100 kHz<br>100 kHz | |

**Notes:**




**Graph 4**

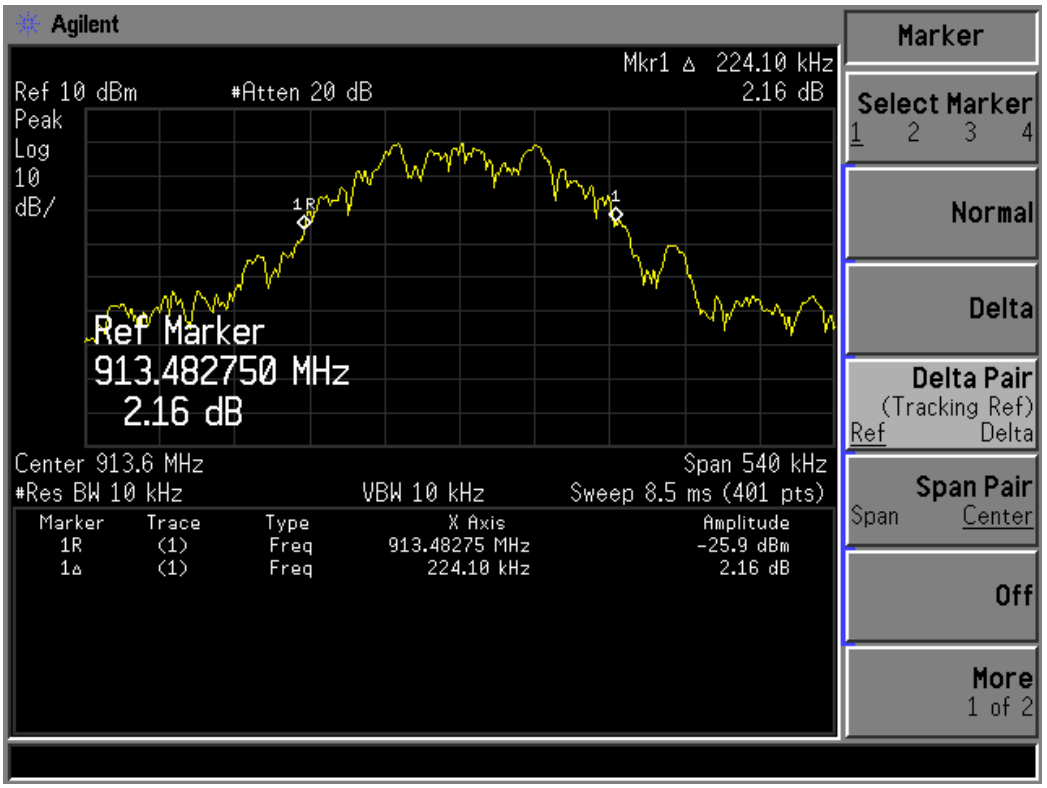
**Hopping Channel Carrier Frequency Separation**

## 6.0 20dB bandwidth of the hopping channel

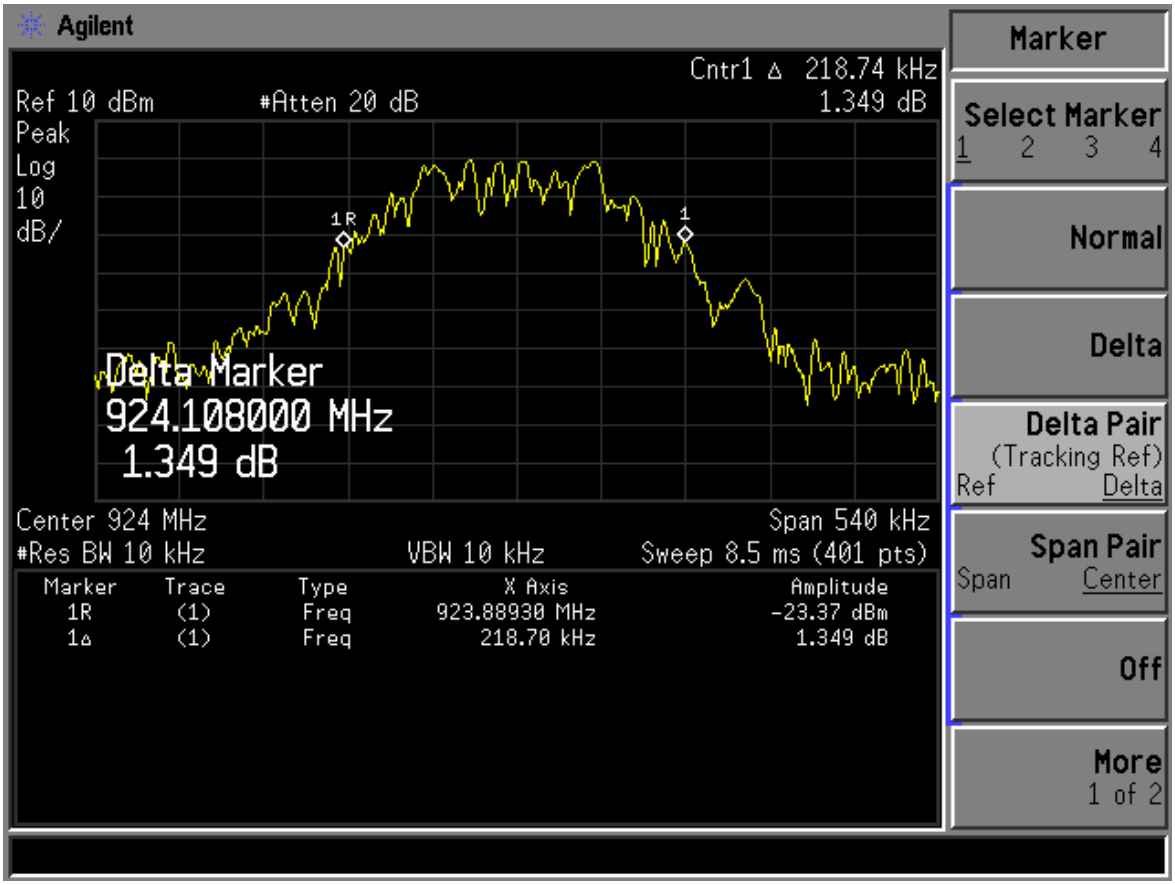
| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | | |
|---|---|---|---|---|
| **Low Frequency Channel (kHz)** | **Middle Frequency Channel (kHz)** | **Upper Frequency Channel (kHz)** | **Limit (kHz)** | **Result** |
| **225.45** | **225.45** | **224.10** | **218.70** | **Pass** |
| **Span:**<br>**RBW:**<br>**VBW:** | **540 kHz**<br>**10 kHz**<br>**10 kHz** | | | |

**Notes:**


**Graph 5 20dB bandwidth (low frequency channel)**



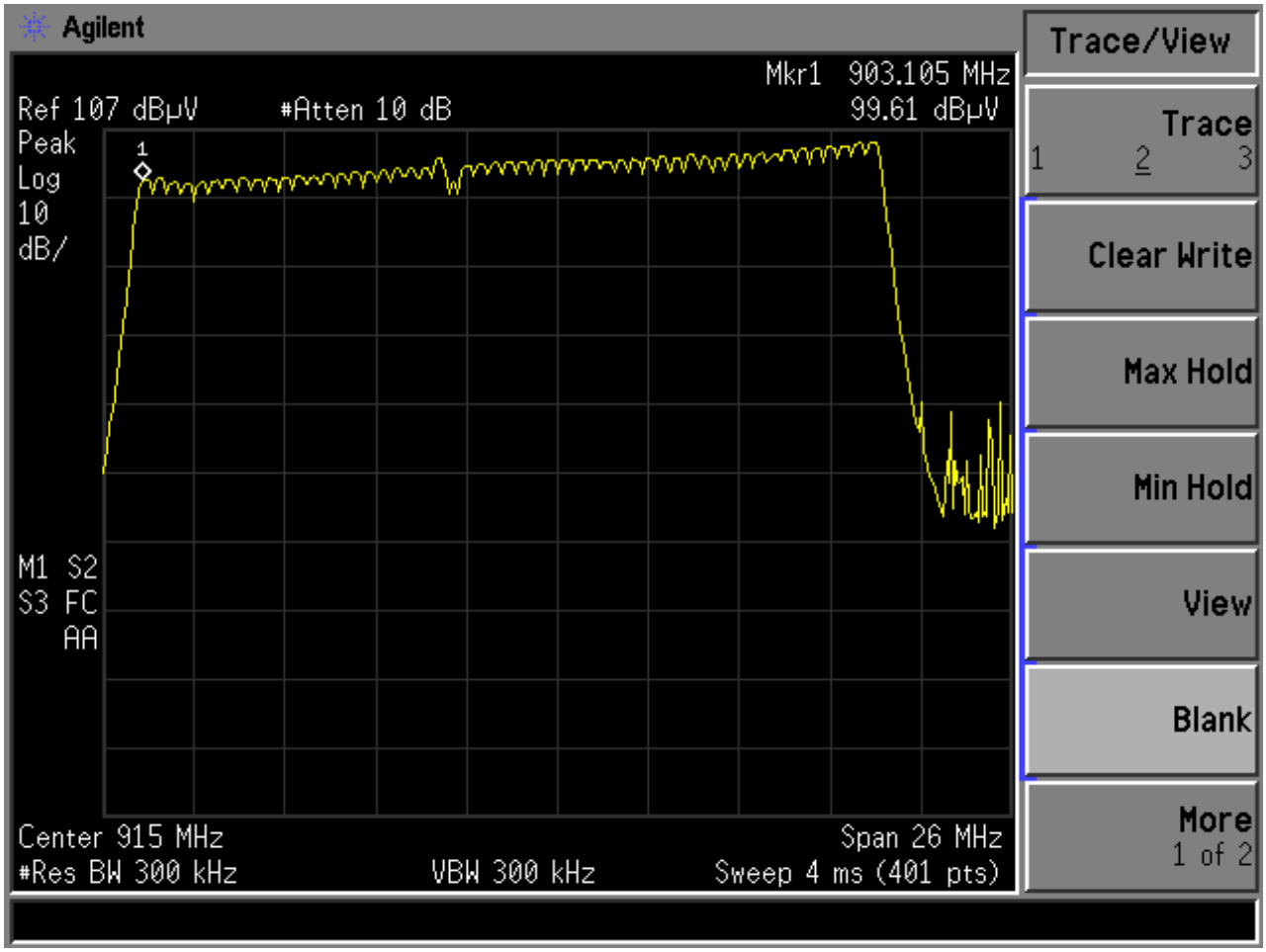

**Graph 6 20dB bandwidth (mid frequency channel)**




**Graph 7 20dB bandwidth (upper frequency channel)**

## 7.0 Number of hopping frequencies

| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | |
|---|---|---|
| **Measured Number** | **Requirements** | **Result** |
| 53 | At least 50 | **Pass** |
| **Channel 20dB Bandwidth:** | <250kHz ≥250kHz | |




**Graph 8**

**Number of hopping frequencies**

## 8.0 Average time of occupancy of hopping frequency

| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | |
|---|---|---|---|
| **Measured Single Duration sec** | **Time of Occupancy Sec** | **Limit Sec** | **Result** |
| **10 random channels** | **0.116** | **0.4** | **Pass** |
| **Period:** | ☐ 10s ☐ 20s ☐ 30s ☐ 0.4s multiplied by the channel number | | |
| **Channel 20dB Bandwidth:** | ☒ <250kHz ☐ ≥250kHz | | |

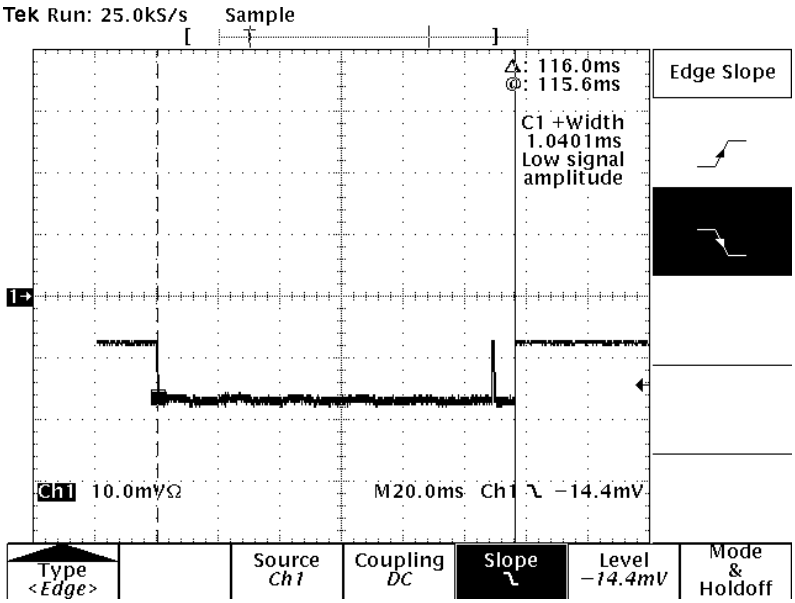
Time of occupancy calculation:

The minimum measured repetition of the channel occupancy (repetition) = 1

Single occupancy duration (single duration) = 0.116 sec

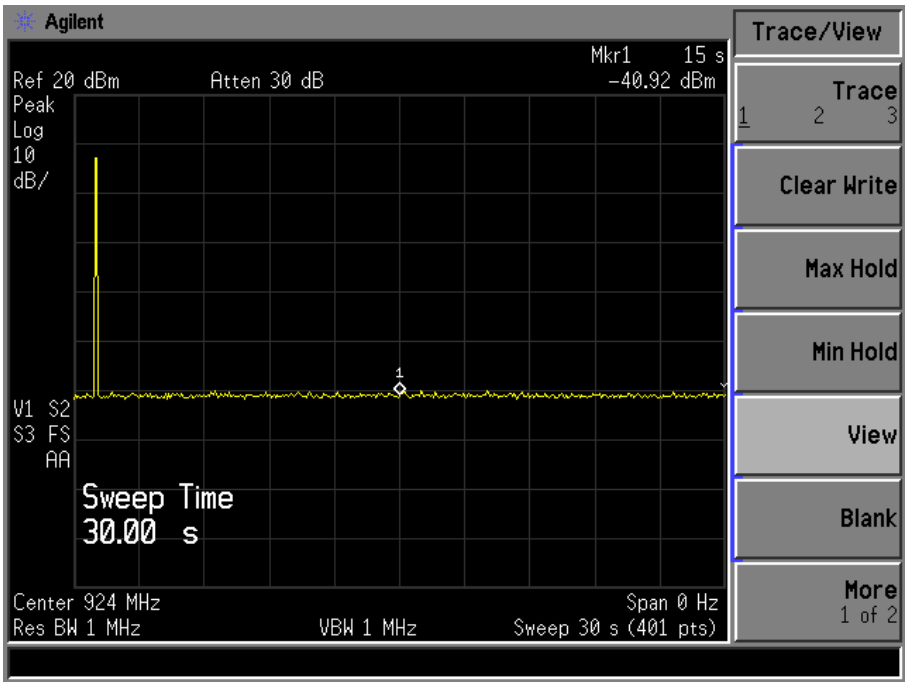
Time of occupancy = (single duration) x (repetition) = 0.116 x 1 = 0.116 sec

Notes: The occupancy was measured using a crystal detector and oscilloscope, observation time was sufficient for 50 channels to exercise.




**Graph 9**

**Average Time of occupancy of hopping frequency**



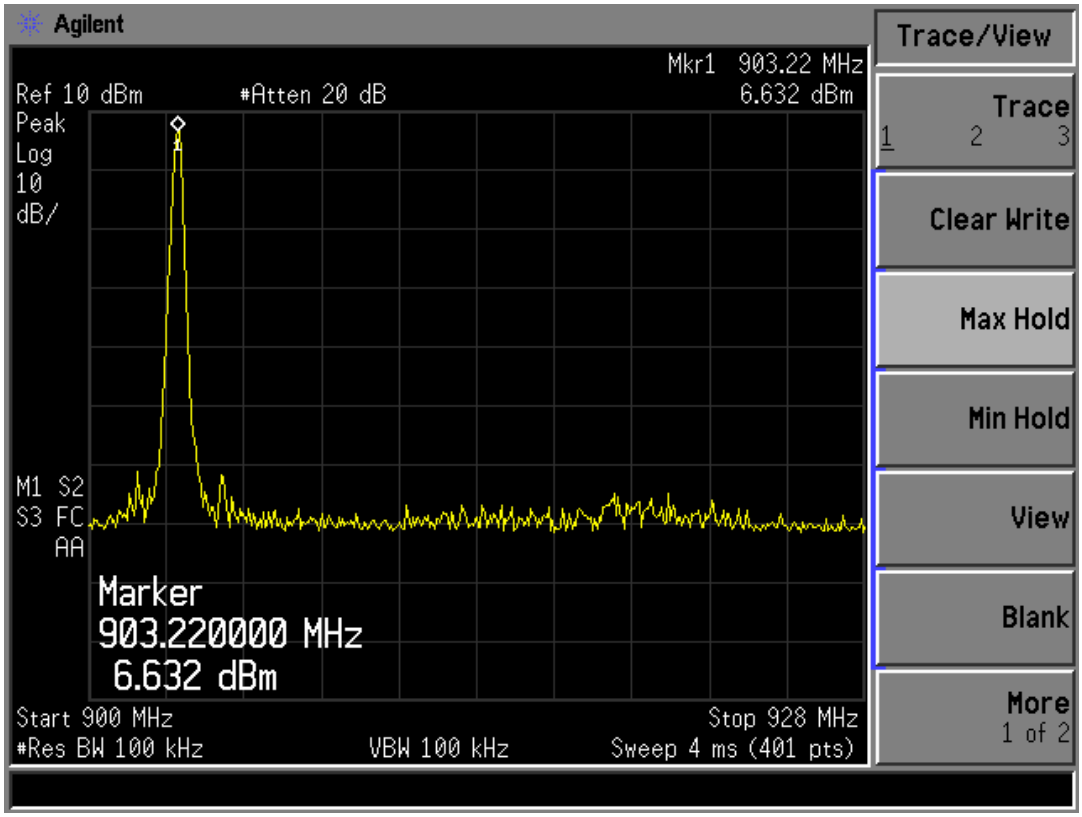

**Graph 10**

**Number of repetitions**

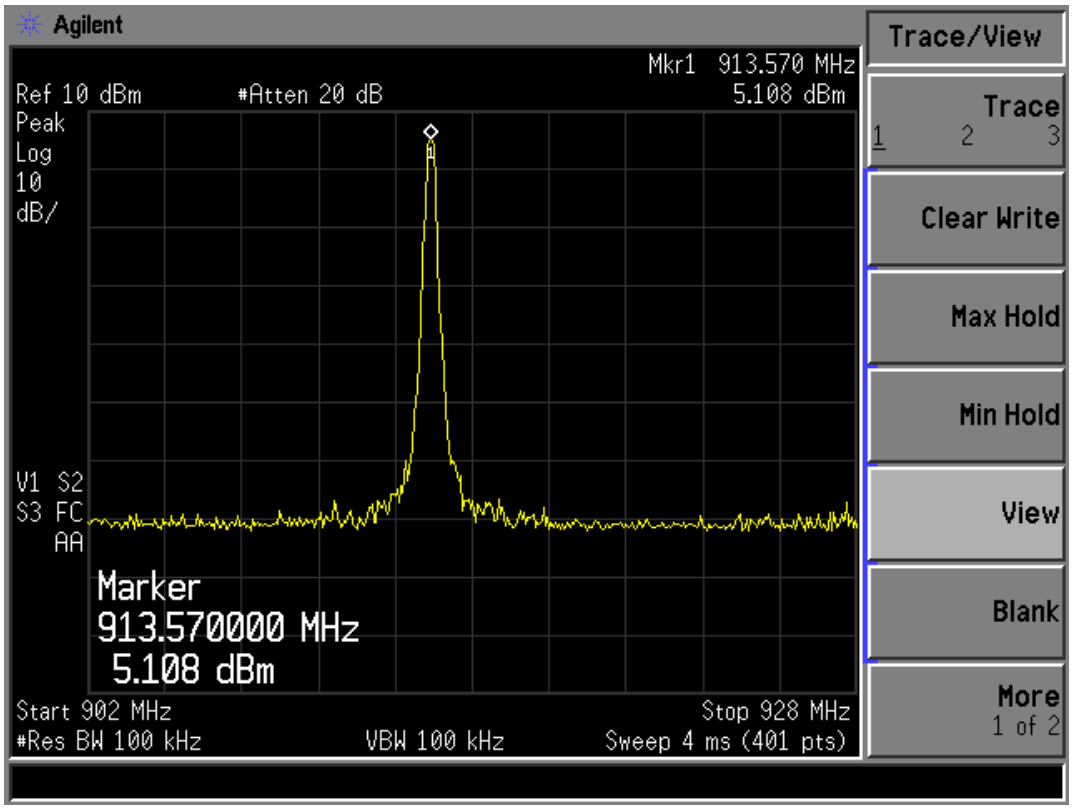
## 9.0 Antenna conducted spurious emissions

| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | |
|---|---|---|---|
| | **Minimum Measured Attenuation dB** | **Minimum Allowed Attenuation dB** | **Margin dB** |
| **Low Frequency Channel** | **>60** | **20** | **>40** |
| **Middle Frequency Channel** | **>60** | **20** | **>40** |
| **Upper Frequency Channel** | **>60** | **20** | **>40** |
| **Analyzer Settings:** | ☒ RBW=100KHz | | |
| **Minimum Allowed Attenuation:** | ☒ 20dB<br>☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval) | | |

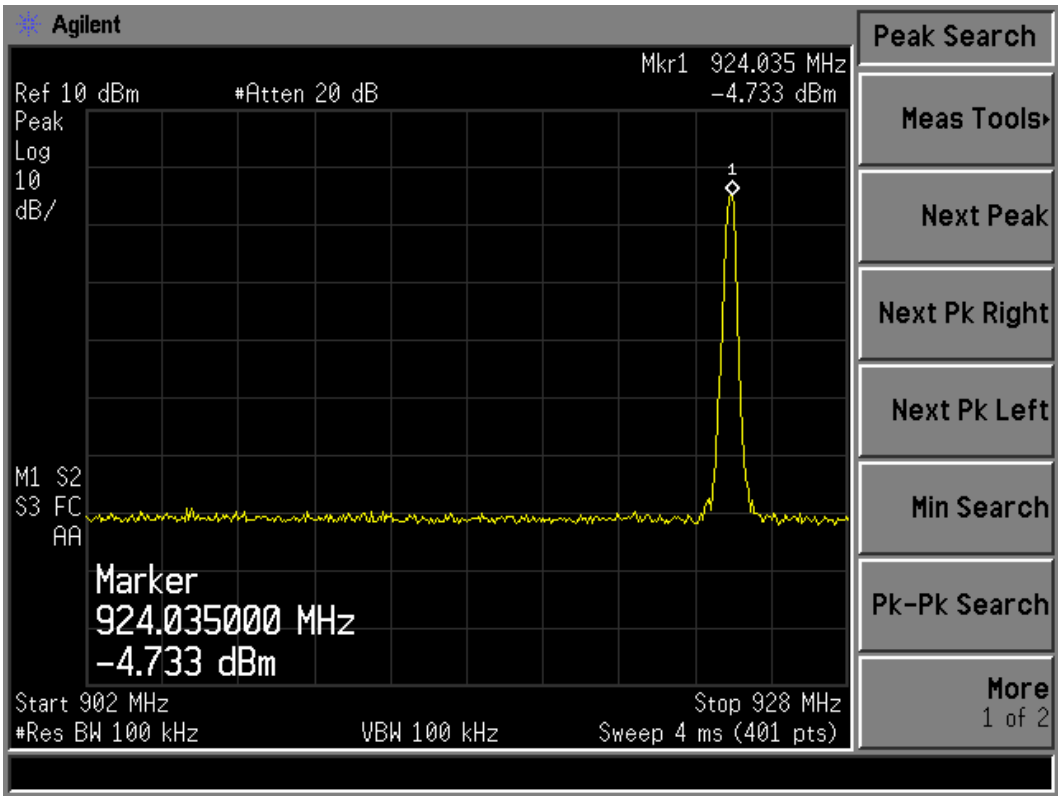
**Notes:**



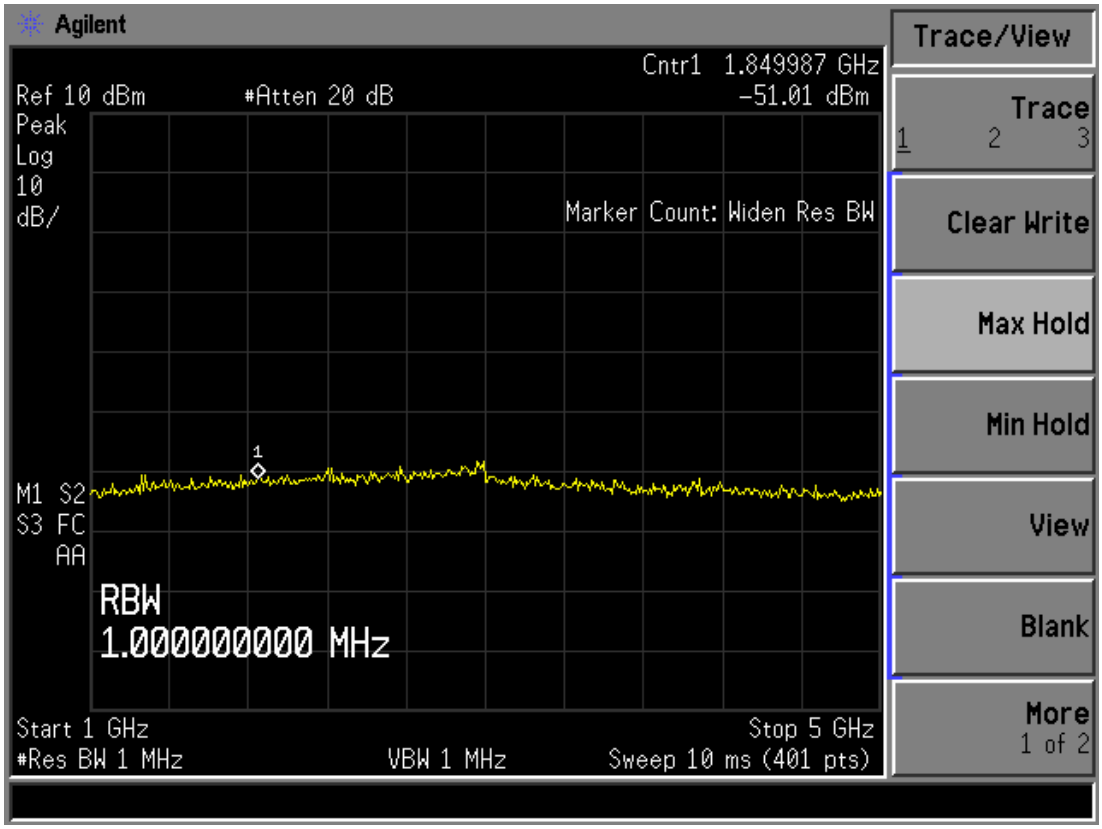

**Graph 11 (lower frequency channel)**



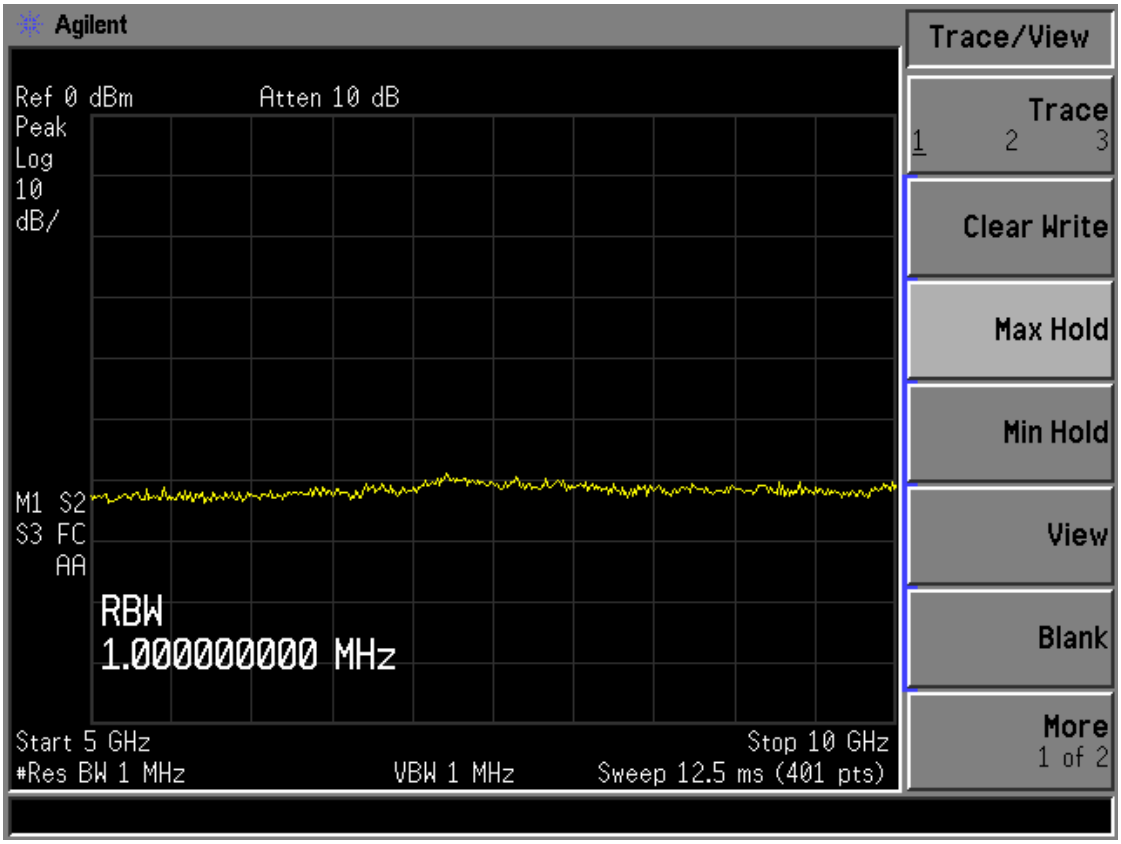

**Graph 12 (mid frequency channel)**




**Graph 13 (upper frequency channel)**



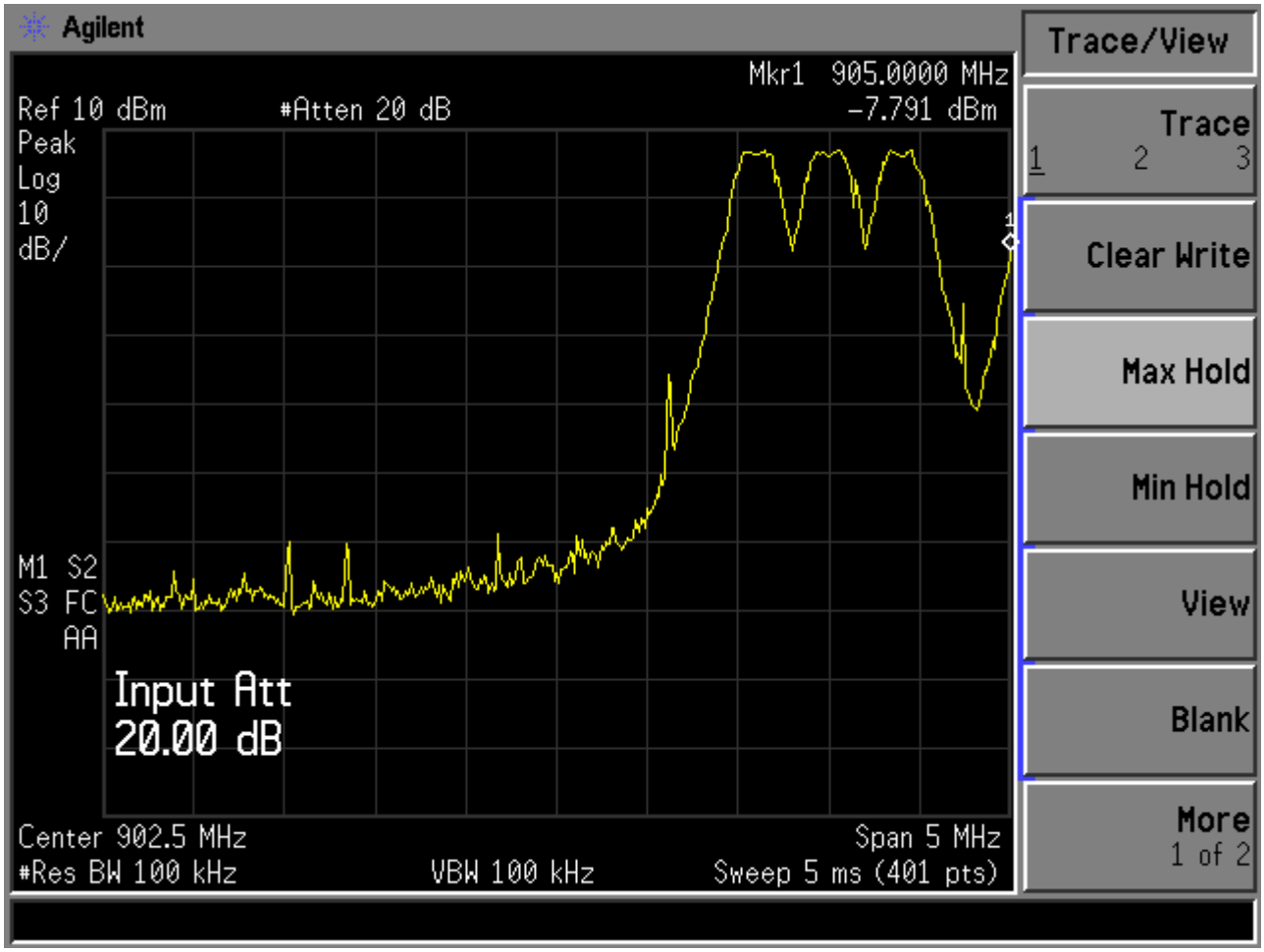

**Graph 14 Conducted Spurious Emissions 1 -5 GHz**



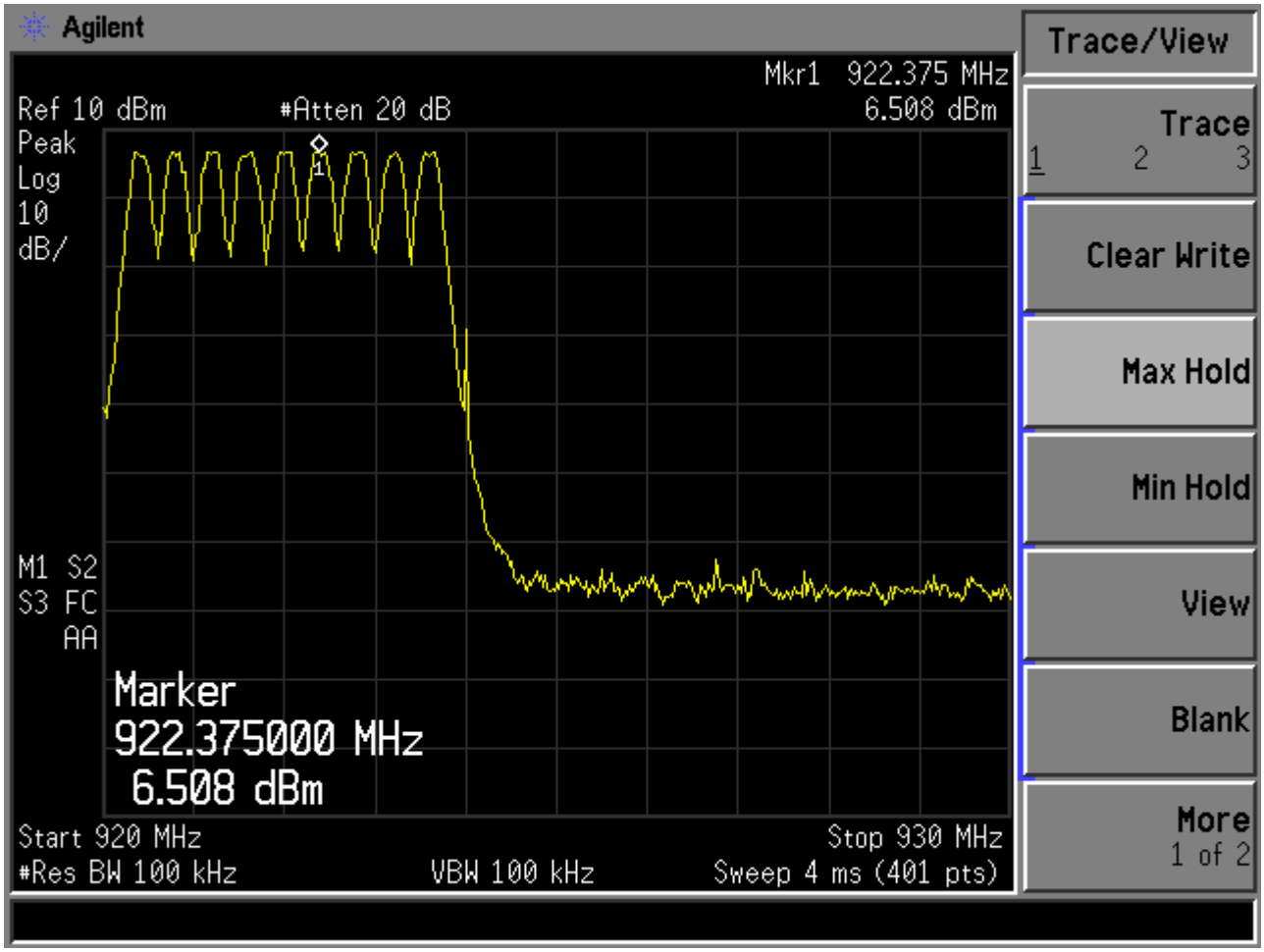

**Graph 15 Conducted Spurious Emissions 5 -10 GHz**

## 10.0 Antenna conducted band edge compliance

| **Frequency Range:** | ☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz | | |
|---|---|---|---|
| | **Minimum Measured Attenuation dB** | **Minimum Allowed Attenuation dB** | **Margin dB** |
| **Low Frequency Channel** | **>50** | **20** | **>30** |
| **Upper Frequency Channel** | **>50** | **20** | **>30** |
| **Analyzer Settings:** | ☒ RBW=100KHz | | |
| **Minimum Allowed Attenuation:** | ☒ 20dB<br>☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval) | | |


Agilent
Mkr1 905.0000 MHz
-7.791 dBm
Ref 10 dBm
#Atten 20 dB
Peak
Log
10
dB/
M1 S2
S3 FC
AA
Input Att
20.00 dB
Center 902.5 MHz
#Res BW 100 kHz
VBW 100 kHz
Span 5 MHz
Sweep 5 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2

**Graph 16**


Agilent
Mkr1 922.375 MHz
6.508 dBm
Ref 10 dBm
#Atten 20 dB
Peak
Log
10
dB/
M1 S2
S3 FC
AA
Marker
922.375000 MHz
6.508 dBm
Start 920 MHz
#Res BW 100 kHz
VBW 100 kHz
Stop 930 MHz
Sweep 4 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2

**Graph 17**

## 11.0 Maximum Permissible Exposure

Frequency Range: 902 -928 MHz

Low threshold = 60/f(GHz) mW = 60 / 0.928 = 64.6 mW

Conducted Output Power Measured (dBm) = 6.5 dBm

Antenna Gain (dBi) = 2.15 dBi

EIRP = 8.65 dBm = 7.3 mW

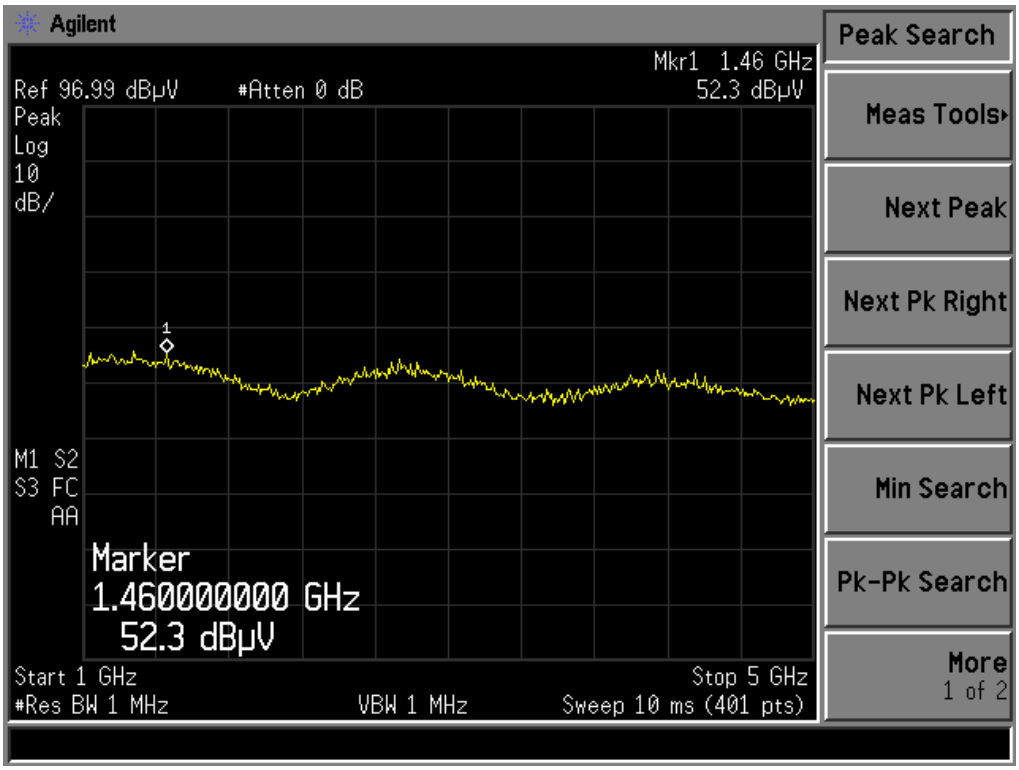
Since both Conducted Output Power and EIRP are below the low threshold, device complies with FCC RF radiation exposure limits for general population/uncontrolled exposure as a portable device without SAR evaluation.

## 12.0 List of Test Equipment

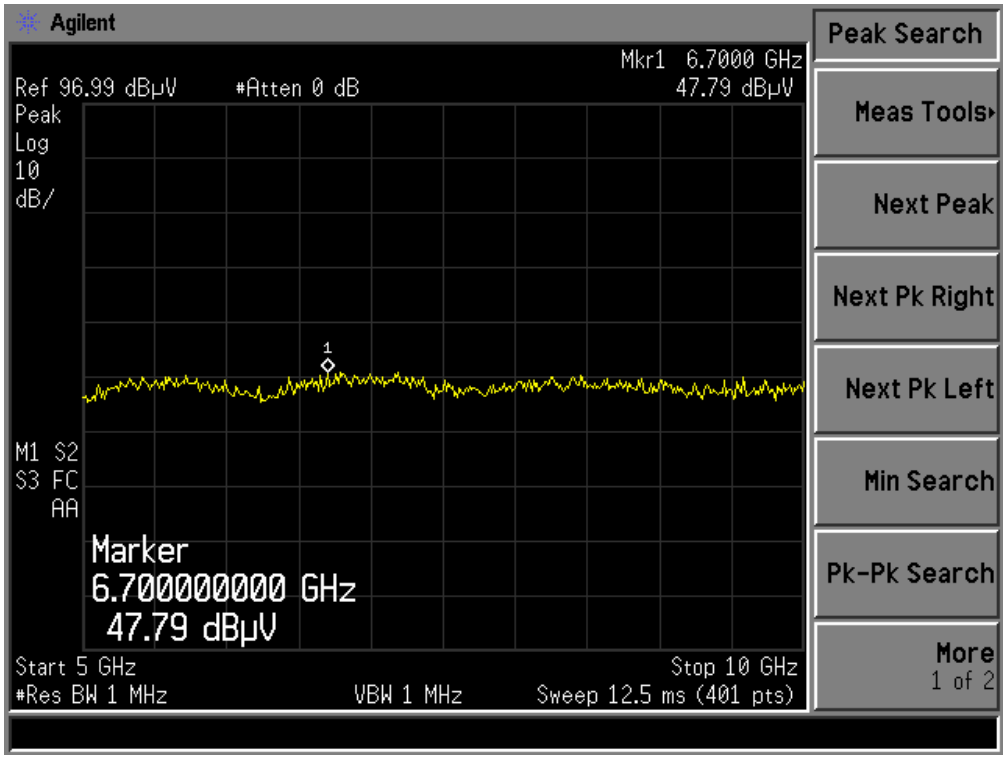
| Instrument | Mftr. | Model | Calibration Due |
|---|---|---|---|
| Measuring Receiver | Rohde and Schwarz | ESVS30 | 18/04/12 |
| Bilog Antenna | Chase | CBL6111 | 02/09/12 |
| Spectrum Analyser | Agilent | E4408B | 11/08/12 |
| Measuring Receiver | Rohde and Schwarz | ESHS30 | 27/10/12 |
| LISN | Rohde and Schwarz | ESH3-Z5 | 13/08/12 |
| Horn Antenna | EMCO | 3115 | 12/04/12 |
| Preamplifier | Hewlett Packard | 83017A | 16/10/12 |
| Horn Antenna | AH Systems | SAS 200/571 | 25/05/13 |
| Signal Generator | Rohde and Schwarz | SME03 | 12/07/12 |
| Crystal Detector | Hewlett Packard | 8470B | 15/05/12 |
| Oscilloscope | Tektronix | 794D | 06/05/12 |

## Appendix A

## Additional Test Results




**Graph 16 Radiated Spurious Emissions 1 GHz – 5 GHz Vertical and Horizontal**




**Graph 17 Radiated Spurious Emissions 5 GHz – 10 GHz Vertical and Horizontal**

## Appendix B

## Test Setups

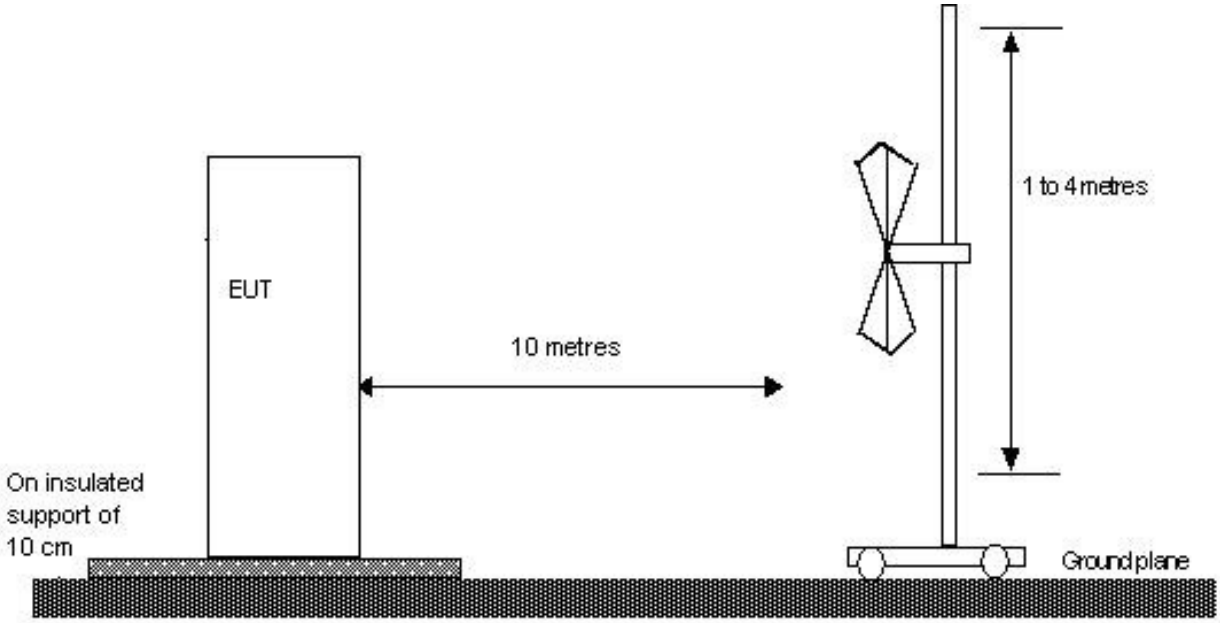



**FIGURE 1: Radiated Emissions Test Setup – Test Distance 10m**