



Compliance Engineering Ireland Ltd

Raystown, Ratoath Road, Ashbourne, Co. Meath

Tel: +353 1 8256722 Fax: +353 1 8256733

Project Number: 11E3272-2

Prepared for:

**Kelsius Ltd**

By

Compliance Engineering Ireland Ltd

Raystown

Ratoath Road

Ashbourne

Co. Meath

**FCC Site Registration: 92592**

**Industry Canada Assigned Code: 8517A**

**Date**

13 January 2012

FCC EQUIPMENT AUTHORISATION

Test Report

**EUT Description**

Sensor Module for use by applicant only.

Authorised:

A handwritten signature in blue ink that reads 'John McAnby'. The signature is fluid and cursive, with 'John' and 'McAnby' being the most distinct parts.

**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

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

---

**Exhibit A – Technical Report****Table of Contents**

---

<b>1.0</b>	<b>EUT DESCRIPTION .....</b>	<b>4</b>
<b>1.1</b>	<b>EUT OPERATION.....</b>	<b>5</b>
<b>1.2</b>	<b>MODIFICATIONS .....</b>	<b>5</b>
<b>1.3</b>	<b>DATE OF TEST .....</b>	<b>6</b>
<b>1.4.1</b>	<b>MEASUREMENT UNCERTAINTY .....</b>	<b>6</b>
<b>2.0</b>	<b>EMISSIONS MEASUREMENTS .....</b>	<b>7</b>
<b>2.1</b>	<b>CONDUCTED EMISSIONS MEASUREMENTS .....</b>	<b>7</b>
<b>2.2</b>	<b>RADIATED EMISSIONS MEASUREMENTS.....</b>	<b>7</b>
<b>2.3</b>	<b>TEST CRITERIA .....</b>	<b>8</b>
<b>3.0</b>	<b>FIELD STRENGTH OF SPURIOUS RADIATED EMISSIONS .....</b>	<b>9</b>
<b>4.0</b>	<b>MAXIMUM PEAK OUTPUT POWER.....</b>	<b>11</b>
<b>5.0</b>	<b>HOPPING CHANNEL CARRIER FREQUENCIES SEPARATION .....</b>	<b>14</b>
<b>6.0</b>	<b>20DB BANDWIDTH OF THE HOPPING CHANNEL.....</b>	<b>16</b>
<b>7.0</b>	<b>NUMBER OF HOPPING FREQUENCIES .....</b>	<b>19</b>
<b>8.0</b>	<b>AVERAGE TIME OF OCCUPANCY OF HOPPING FREQUENCY .....</b>	<b>21</b>
<b>9.0</b>	<b>ANTENNA CONDUCTED SPURIOUS EMISSIONS .....</b>	<b>23</b>
<b>10.0</b>	<b>ANTENNA CONDUCTED BAND EDGE COMPLIANCE.....</b>	<b>28</b>
<b>11.0</b>	<b>LIST OF TEST EQUIPMENT.....</b>	<b>31</b>

## 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.

<b>Model:</b>	Wireless Sensor Module K115
<b>Type:</b>	915 MHz Sensor Module
<b>FCC ID:</b>	Z4GK115
<b>Company:</b>	Kelsius
<b>Contact</b>	Dr David Gray
<b>Address:</b>	Unit 6, Ballyconnell Industrial Estate, Falcarragh, Co Donegal, Ireland
<b>Phone:</b>	+353 7491 62982 extn 223
<b>e-mail:</b>	david.gray@kelsius.com
<b>Test Standards:</b>	47 CFR, Part 15.247
<b>Type of radio:</b>	Stand-alone
<b>Transmitter Type:</b>	FHSS
<b>Operating Frequency Range(s):</b>	902 to 927 MHz
<b>Number of Channels:</b>	53
<b>Antenna:</b>	Internal
<b>Transmitter power configuration:</b>	12VDC supply from mains power adaptor
<b>Test Methodology:</b>	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

The module transmits once every 5 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 December 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  $\pm 3.5$  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).

## 2.0 Emissions Measurements

### 2.1 Conducted Emissions Measurements

The measurements were taken using a Line Impedance Stabilisation Network (LISN). A Rohde and Schwarz ESHS30 Receiver with a bandwidth of 9 kHz was used to measure the conducted emissions. The measurements were carried out using the receiver analysis feature, which uses three detectors; peak, quasi peak and average. Using this mode the voltage emission spectrum was scanned in peak detection mode and the emissions which exceeded a sub range margin relevant to the respective limits were further measured using the quasi peak and average detectors. The live and neutral conductors were examined individually to determine the maximum. The receiver bandwidth was set to 10 kHz. Appendix A shows the plots from the test.

The excess interface cables were bundled in a non-inductive arrangement at the approximate centre of the cable with the bundle 30 to 40 centimetres in length. The conducted emissions were maximised by varying the operating states and configuration of the EUT.

The results of conducted emissions are shown in Appendix A, Figures 21 and 22.

### 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.

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 1.

### 2.3 Test Criteria

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

Frequency (MHz)	Field Strength μV/m	Field Strength (dBμV/m)
30-88	100	30.0
88-216	150	33.52
216-960	200	36.0
above 960	500	44.0

### 3.0 Field Strength of Spurious Radiated Emissions

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

For the spurious and harmonics measurements, the EUT was set up in an Anechoic Chamber, with the EUT running in a continuous low channel 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. Distance of EUT to the measurement antenna specified in **section 2.2**.

Testing was repeated with EUT in continuous mid channel and high channel modes.

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
MHz	dB $\mu$ V	dB	dB	dB	dB $\mu$ V/m	deg	m	V/H		dB		
1845	78.5	26.6	2.5	39.8	67.8	0	1	V	96*	28.2	Pk	V
2774	51.7	28.7	4.5	38.3	46.6	0	1	V	54.0	7.4	Pk	V
7208	46.3	35.8	6.2	38.9	49.4	0	1	V	54.0	4.6	Pk	V

\*The fundamental signal was 116 dB( $\mu$ V/m). The limit at 1845 MHz was -20dBc or 96 dB( $\mu$ V/m).

**Result:**

**Pass**

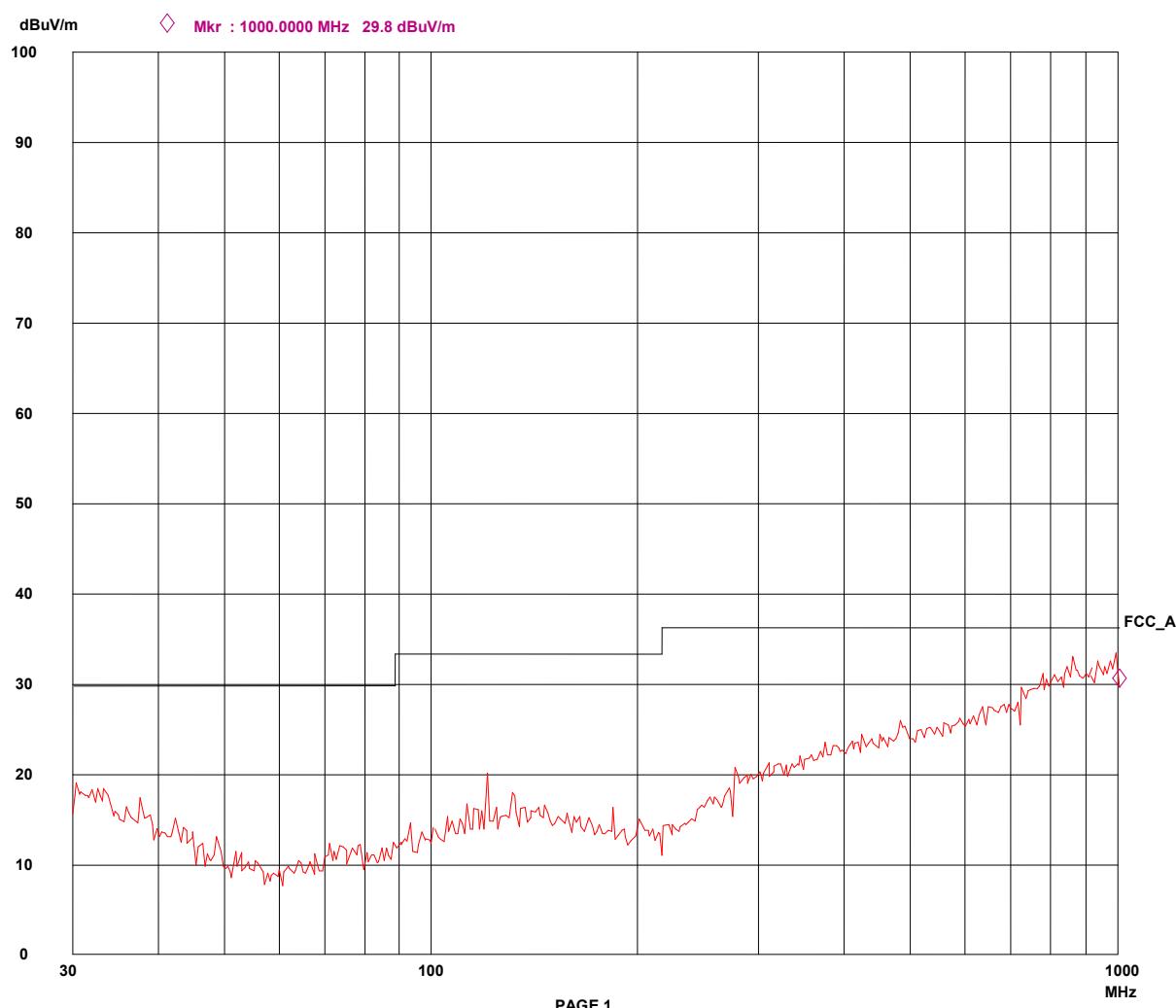
## RADIATED EMISSIONS

28. Dec 11 15:49

## Scan Settings (1 Range)

Frequencies				Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	1000M	120k	120k	PK	5ms	0dB	LBD OFF	60dB

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

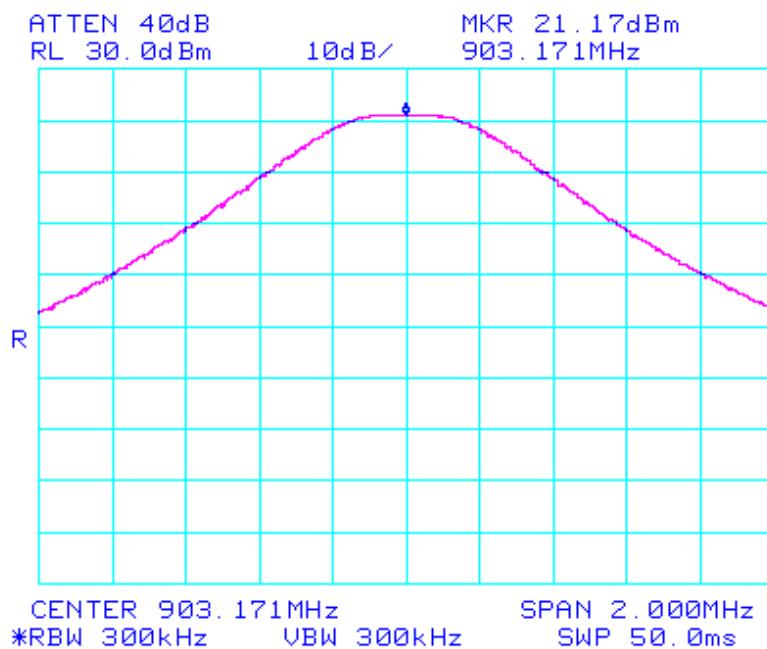
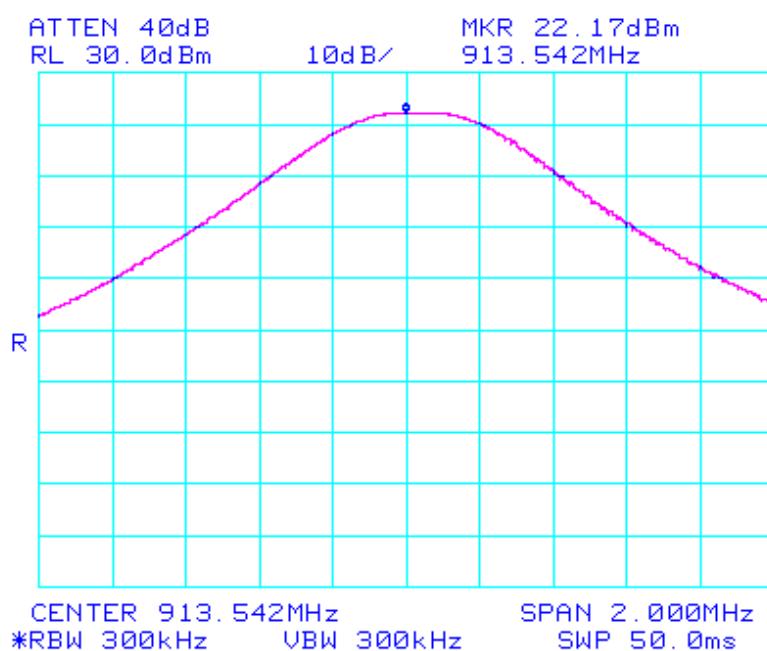
**Test result: Pass**

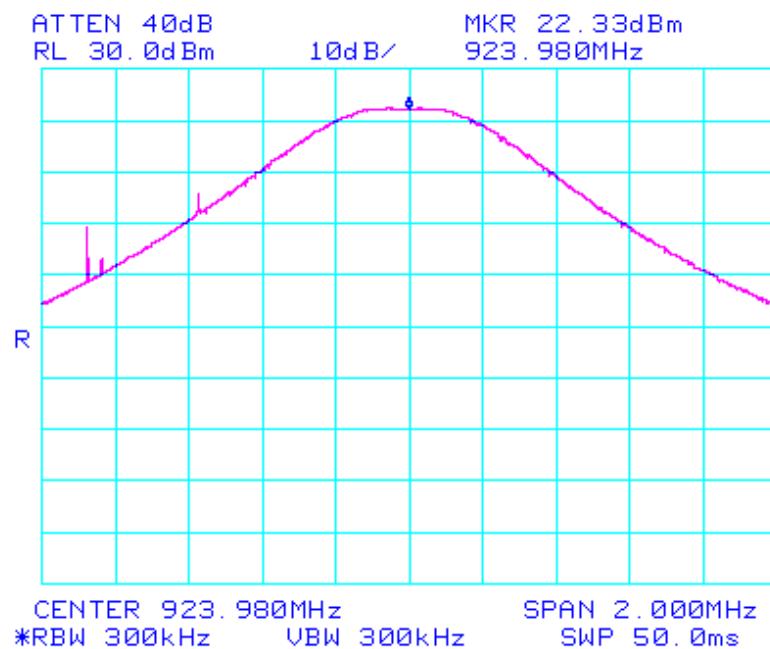
**Max. Margin:** . 7.2 dB below the limits

Frequency Range:	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz					
Low Frequency Channel (MHz)	Measured power W	Attenuation dB	Power at Antenna W	Limit W	Limit Reduction dB	Margin W
903.171	0.131	0	.131	1	0	0.869
Middle Frequency MHz						
913.542	0.169	0	0.169	1	0	0.831
Upper Frequency MHz						
923.98	0.173	0	0.173	1	0	0.827
Antenna Gain:	<input checked="" type="checkbox"/> < 6dBi <input type="checkbox"/> > 6 dBi and = dB, output power reduction = dB					

RBW: 300 kHz

VBW: 300 kHz

**Graph 1 Channel 1 (Low)****Graph 2 Channel 26 (Mid)**



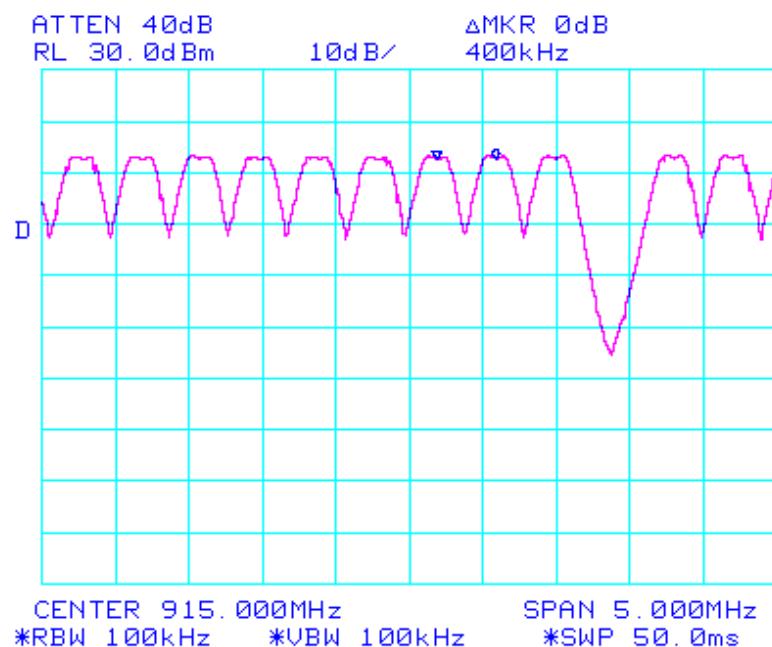
**Graph 3**

**Channel 50 (High)**

## 5.0 Hopping channel carrier frequencies separation

Frequency Range	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz				
Measured Separation (kHz)	Limit (kHz)	Result			
400	>234	<b>Pass</b>			
Limit:	20dB channel bandwidth				
Span:	5 MHz				
RBW:	100 kHz				
VBW:	100 kHz				

**Notes:**



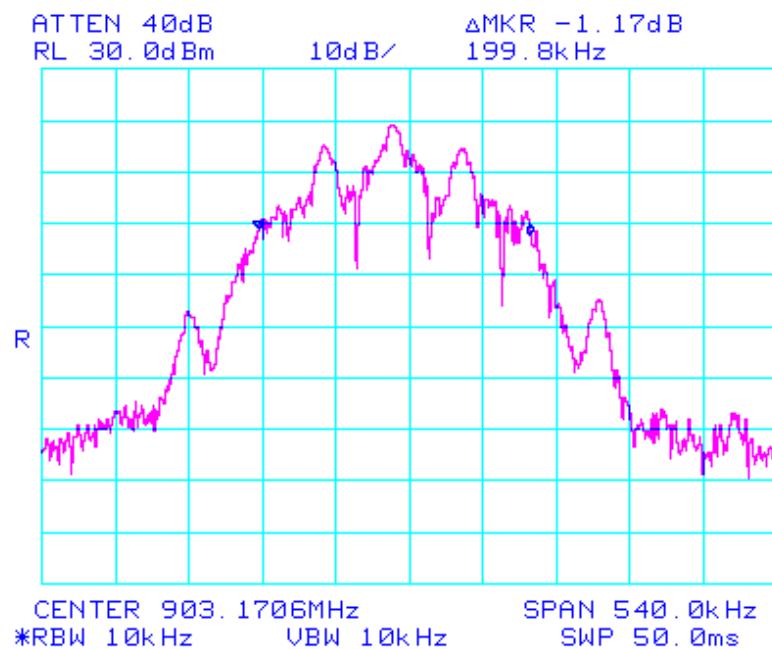
**Graph 4**

**Hopping Channel Carrier Frequency Separation**

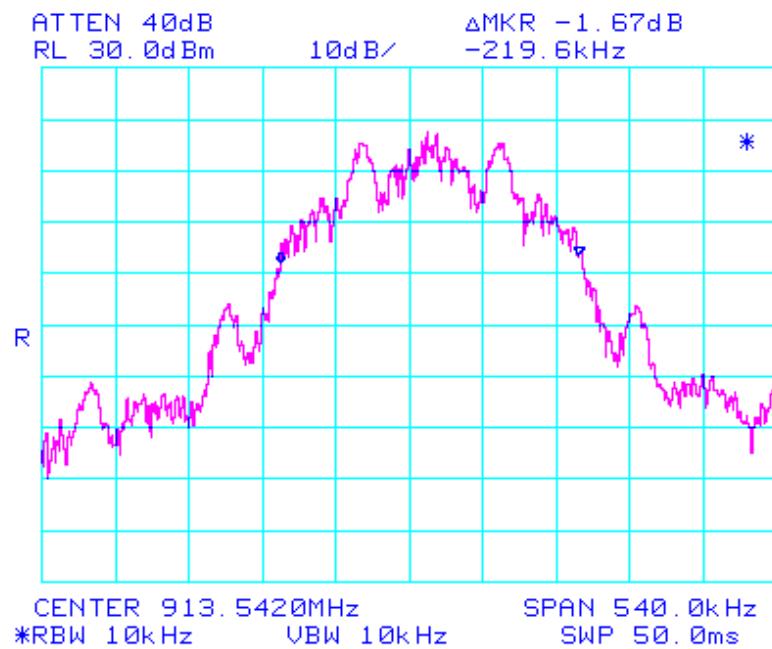
**6.0 20dB bandwidth of the hopping channel**

<b>Frequency Range:</b>	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz			
Low Frequency Channel (kHz)	Middle Frequency Channel (kHz)	Upper Frequency Channel (kHz)	Limit (kHz)	Result
<b>199.8</b>	<b>219.6</b>	<b>221.4</b>		<b>Pass</b>
<b>Span:</b>	<b>540 kHz</b>			
<b>RBW:</b>	<b>10 kHz</b>			
<b>VBW:</b>	<b>10 kHz</b>			

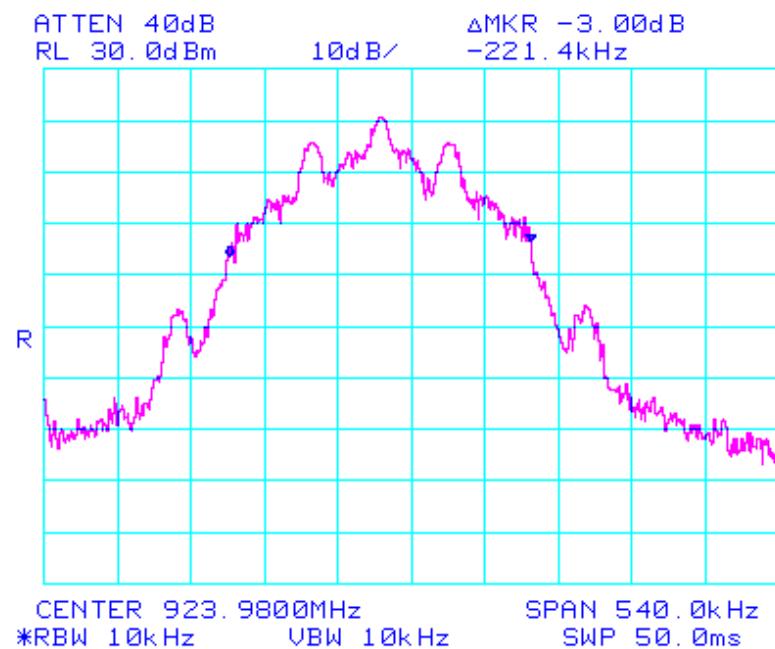
**Notes:**



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



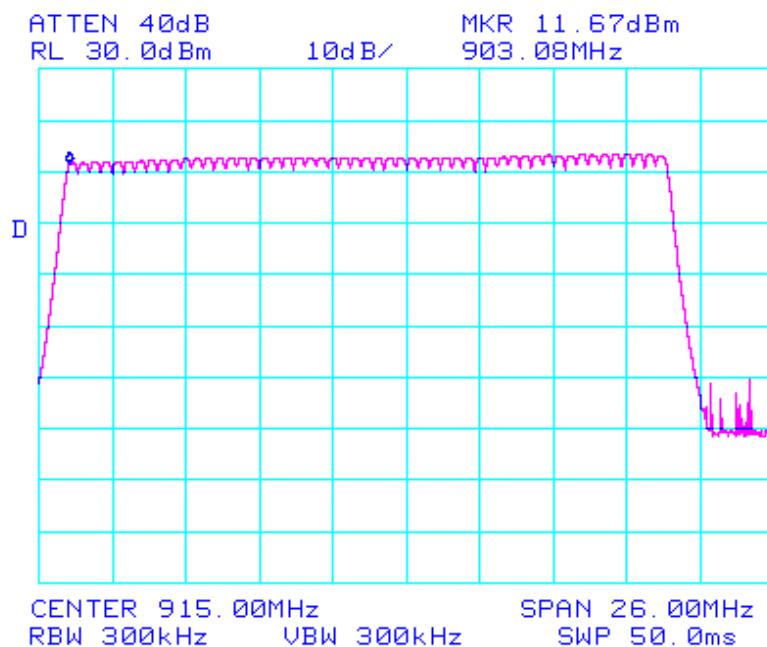
**Graph 6 20dB bandwidth (mid frequency channel)**



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

## 7.0 Number of hopping frequencies

Frequency Range:	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz		
Measured Number	Requirements	Result	
53	At least 50	<b>Pass</b>	
<b>Channel 20dB Bandwidth:</b>	<250kHz ≥250kHz		



**Graph 8**  
**Number of hopping frequencies**

## 8.0 Average time of occupancy of hopping frequency

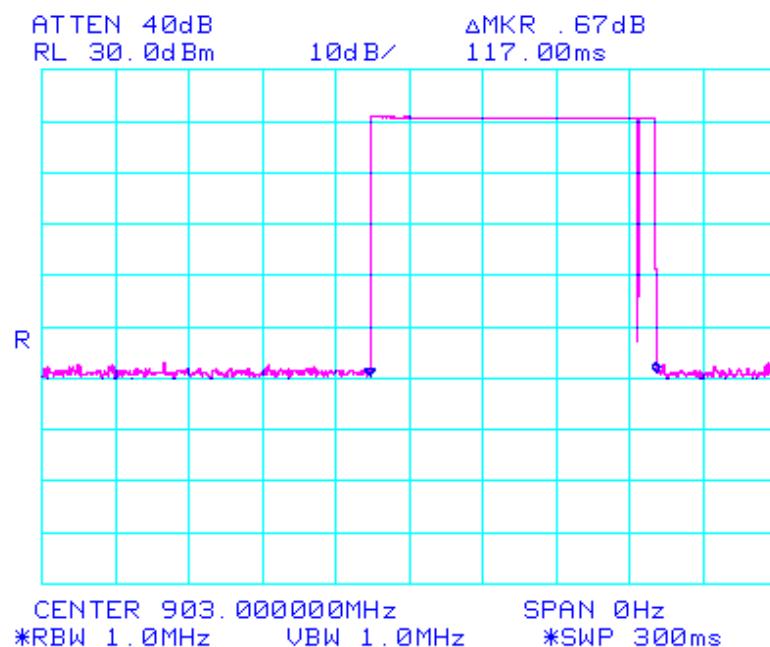
Frequency Range:	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz		
Measured Single Duration sec	Time of Occupancy Sec	Limit Sec	Result
10 random channels	0.117	0.4	Pass
Period:	<input type="checkbox"/> 10s <input type="checkbox"/> 20s <input type="checkbox"/> 30s <input type="checkbox"/> 0.4s multiplied by the channel number		
Channel 20dB Bandwidth:	<input checked="" type="checkbox"/> <250kHz <input type="checkbox"/> ≥250kHz		

Time of occupancy calculation:

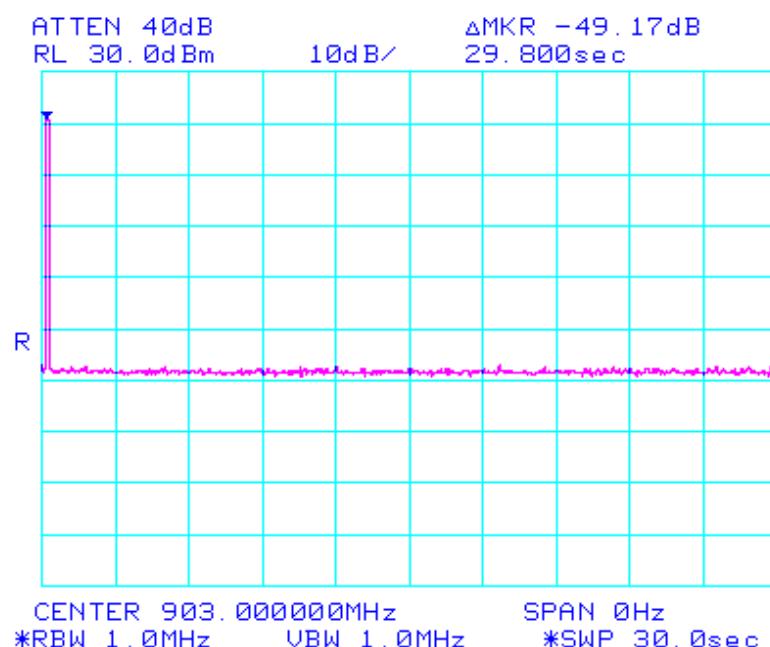
The minimum measured repetition of the channel occupancy (repetition) = 1

Single occupancy duration (single duration) = 0.117 sec

Time of occupancy = (single duration) x (repetition) =  $0.117 \times 1 = 0.117$  sec



**Graph 9**  
**Average Time of occupancy of hopping frequency**

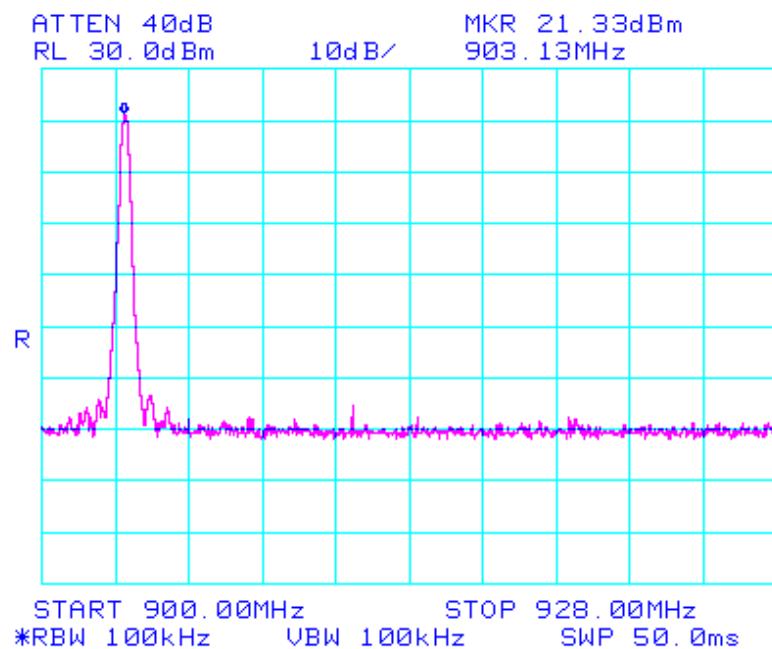


**Graph 10**  
**Number of repetitions**

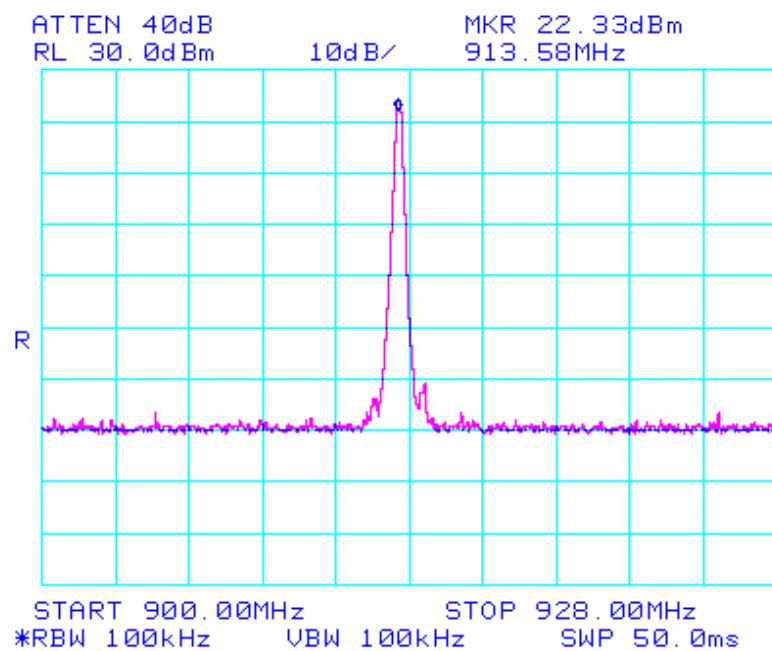
## 9.0 Antenna conducted spurious emissions

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

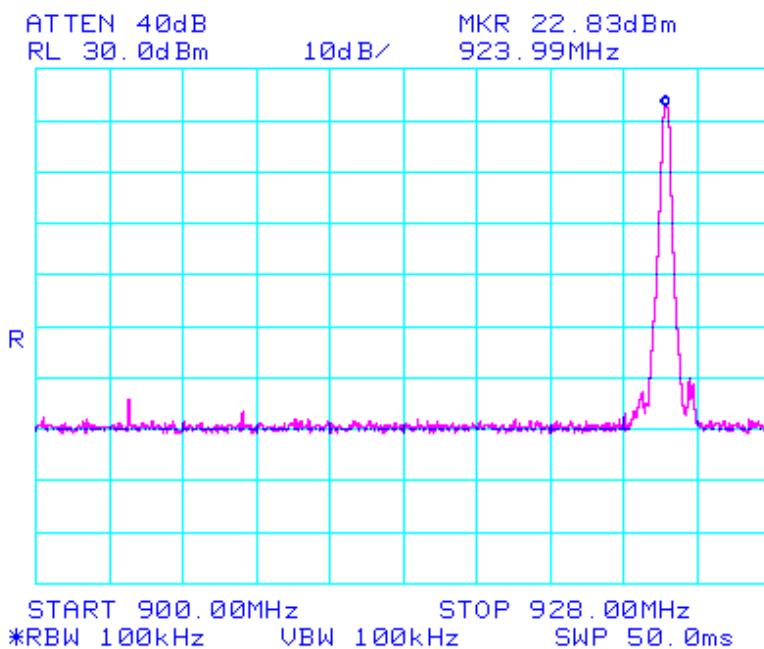
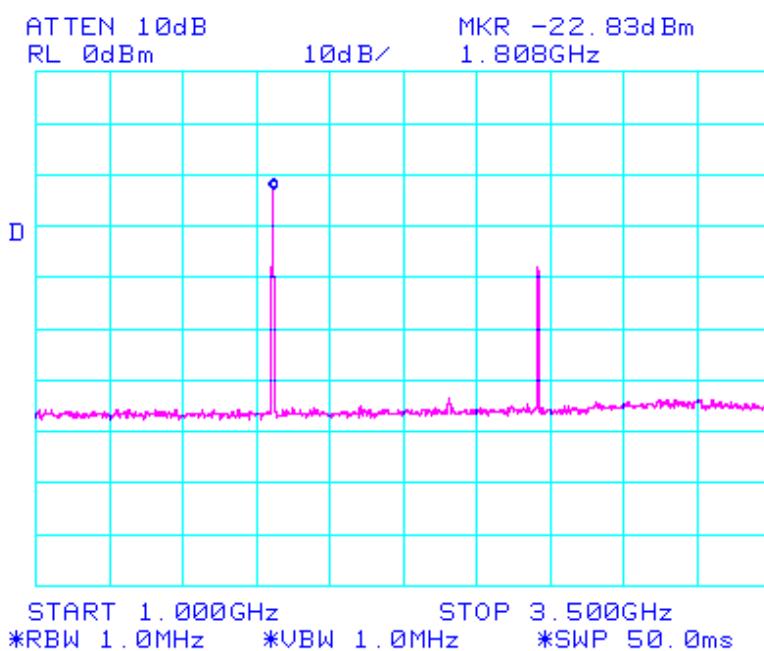
**Notes:**

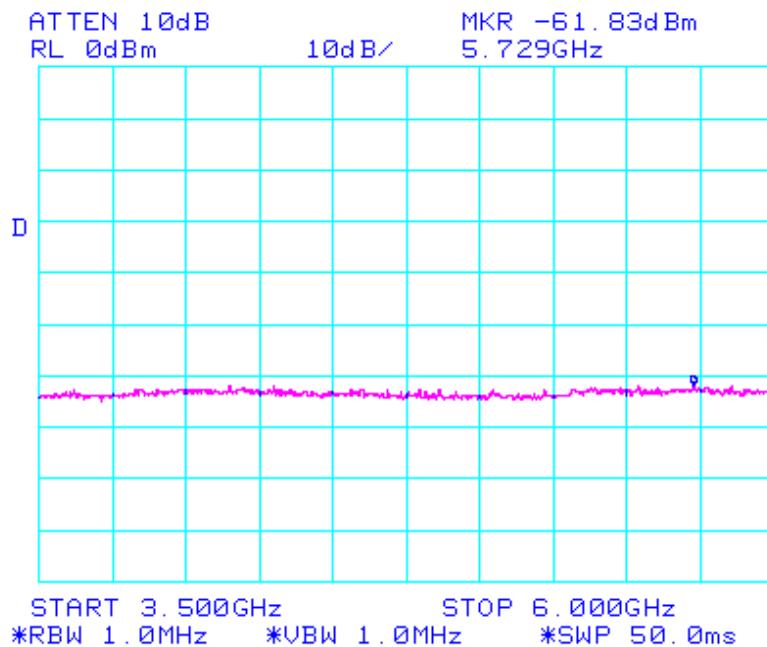


**Graph 11 (lower frequency channel)**

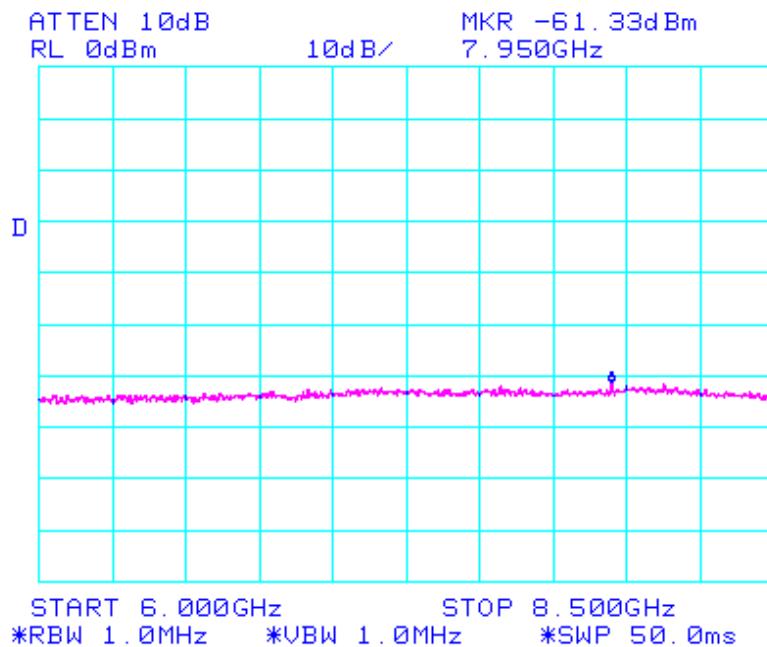


**Graph 12 (mid frequency channel)**

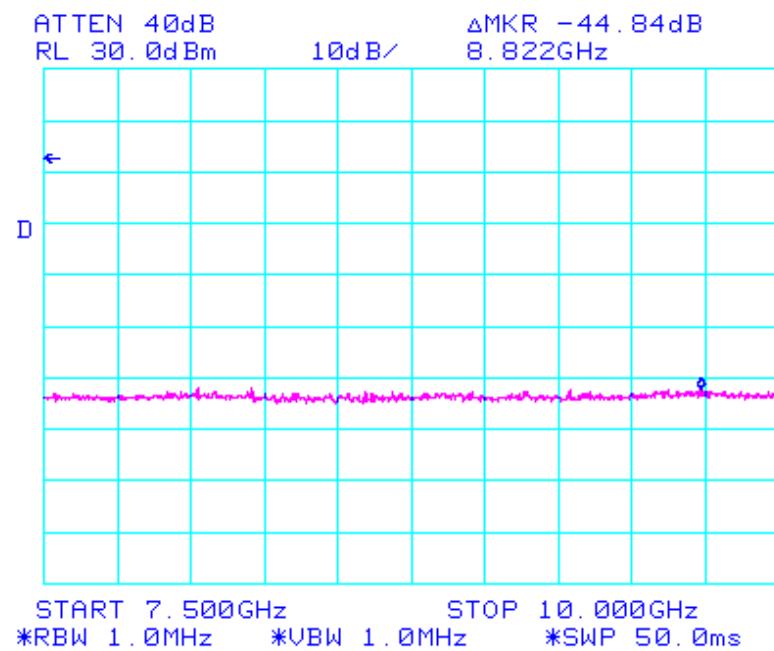
**Graph 13 (upper frequency channel)****Graph 14 Conducted Spurious Emissions 1 -3.5 GHz**



**Graph 15 Conducted Spurious Emissions 3.5-6 GHz**



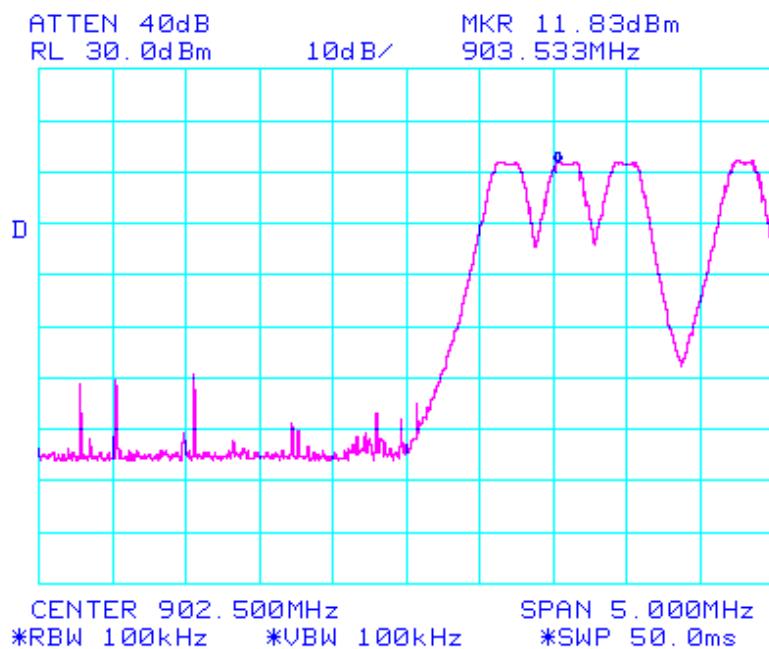
**Graph 16 Conducted Spurious Emissions 6-8.5 GHz**

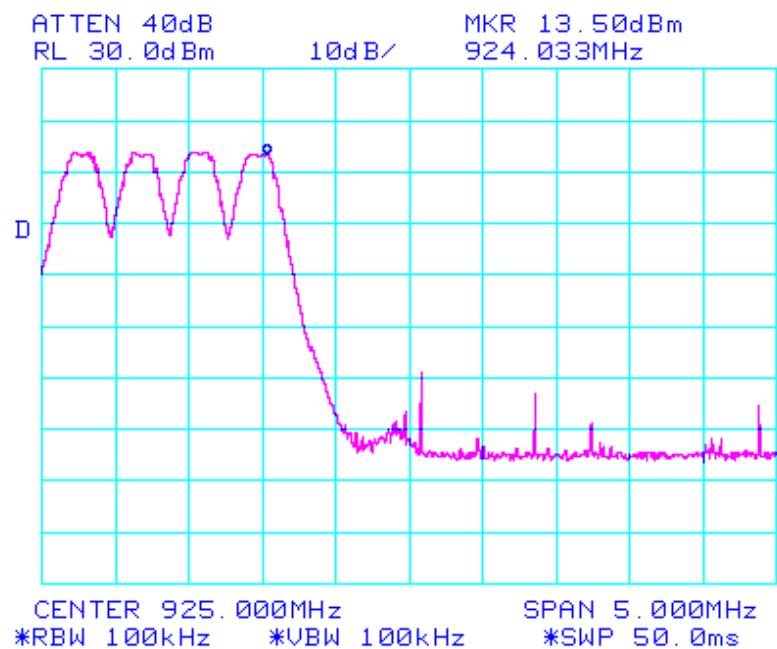


**Graph 17 Conducted Spurious Emissions 7.5-10 GHz**

## 10.0 Antenna conducted band edge compliance

Frequency Range:	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz		
	Minimum Measured Attenuation dB	Minimum Allowed Attenuation dB	Margin dB
Low Frequency Channel	>30	20	>30
Upper Frequency Channel	>30	20	>30
Analyzer Settings:	<input checked="" type="checkbox"/> RBW=100KHz		
Minimum Allowed Attenuation:	<input checked="" type="checkbox"/> 20dB <input type="checkbox"/> 30dB (for digital systems with conducted power measured using RMS averaging over a time interval)		

**Graph 16**

**Graph 17**

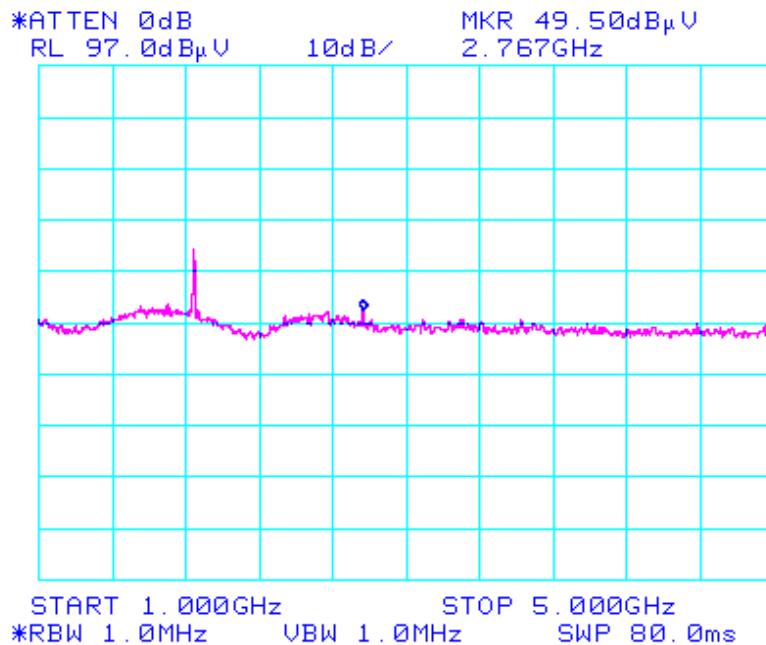
## 11.0 List of Test Equipment

Instrument	Mftr.	Model	Calibration Due
Measuring Receiver	Rohde and Schwarz	ESVS30	18/04/12
Bilog Antenna	Chase	CBL6111	02/09/12
Spectrum Analyser	Agilent	8565EC	13/04/13
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

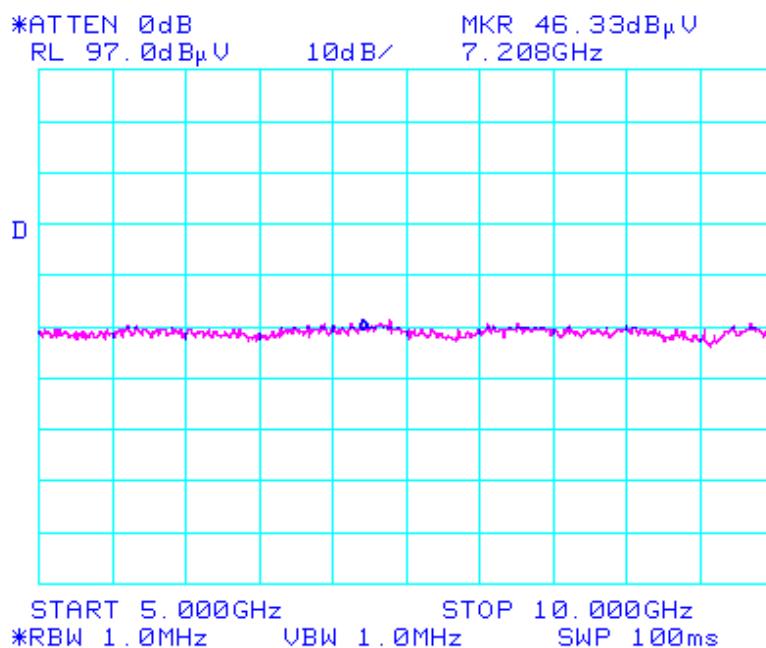
## Appendix A

### Additional Test Results

**Graph 18: Radiated Spurious Emissions 1 GHz – 5 GHz Vertical and Horizontal (see section 3.0 for actual results)**



**Graph 19: Radiated Spurious Emissions 5 GHz – 10 GHz Vertical and Horizontal**

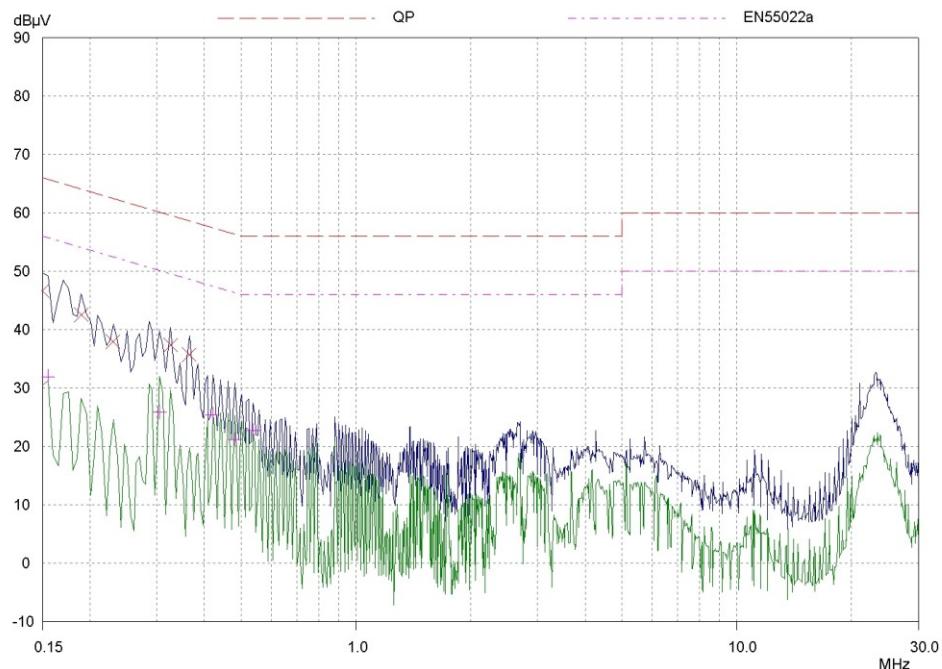


Compliance Engineering Ireland Ltd  
Conducted Emissions

03 Jan 2012 11:17

EUT: Low Power Amplified Module  
Manuf: Kelsius  
Op Cond: Normal Operation  
Operator: L Brien  
Test Spec: EN 55022 Class B  
Comment: Live

Scan Settings		(1 Range)			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge	
150kHz	30MHz	5kHz	10kHz	PK+AV	20msec	Auto	OFF	60dB	
<hr/>									
Final Measurement:	Detectors:	X QP / + AV							
	Meas Time:	1sec							
	Subranges:	25							
	Acc Margin:	20 dB							



PAGE 1

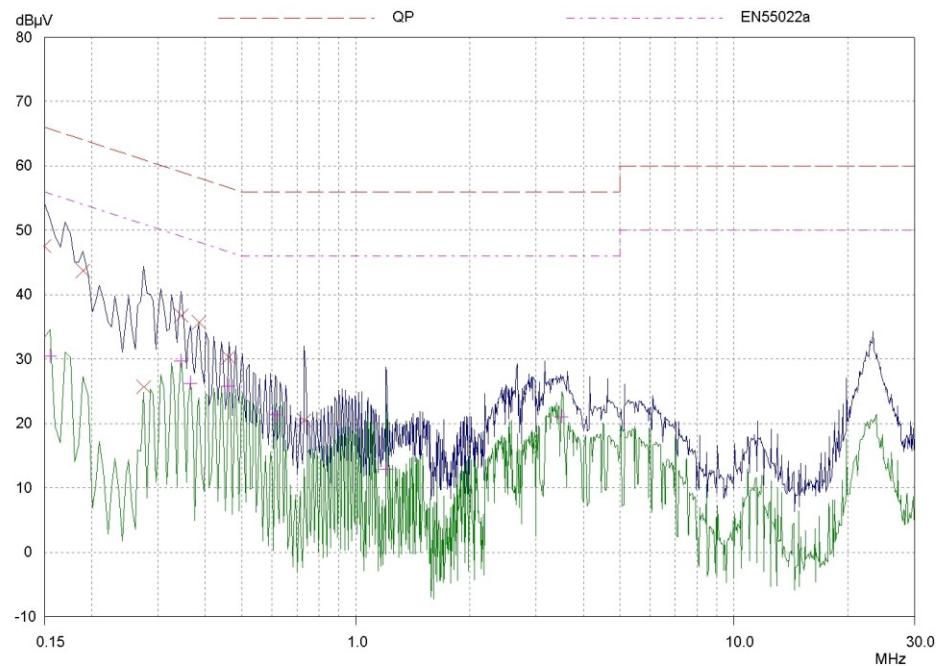
**Graph 20 Conducted Emissions Live**

Compliance Engineering Ireland Ltd  
Conducted Emissions

03 Jan 2012 11:46

EUT: Low Power Amplified Module  
Manuf: Kelsius  
Op Cond: Normal Operation  
Operator: Lewis Brien  
Test Spec: EN 55022 Class B  
Comment: Neutral

Scan Settings		(1 Range)			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge	
150kHz	30MHz	5kHz	10kHz	PK+AV	20msec	Auto	OFF	60dB	
Final Measurement:				Detectors: X QP / + AV					
				Meas Time: 1sec					
				Subranges: 25					
				Acc Margin: 20 dB					

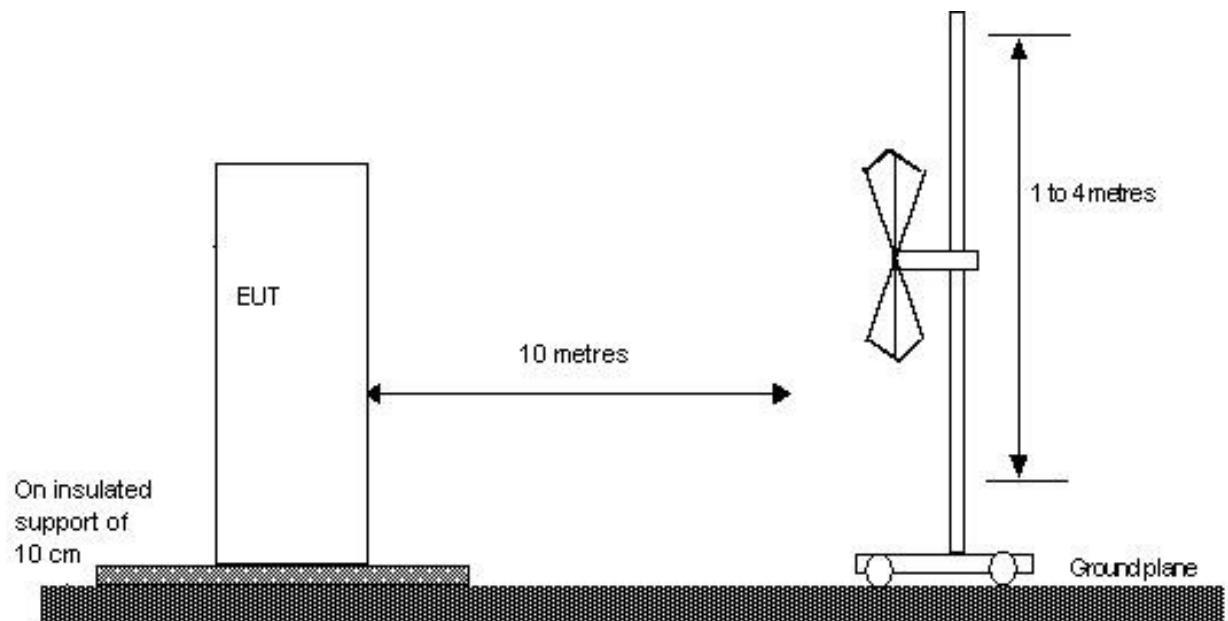


PAGE 1

**Graph 21 Conducted Emissions Neutral**

## Appendix B

### Test Setups



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