



Compliance Engineering Ireland Ltd

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Project Number: 11E3273-1

Prepared for:

Kelsius Ltd

By

Compliance Engineering Ireland Ltd

Raystown

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FCC Site Registration: 92592

Industry Canada Assigned Code: 8517A

Date

17th January 2012

FCC EQUIPMENT AUTHORISATION

Test Report

EUT Description

Sensor Module for use by applicant only.

Authorised:

A handwritten signature in blue ink, appearing to read 'John Mc Anley', written over the word '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

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

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:	Wireless Transceiver Unit K116
Type:	915 MHz Wireless Transceiver
FCC ID:	Z4GK116
Company:	Kelsius
Contact	Dr David Gray
Address:	Unit 6, Ballyconnell Industrial Estate, Falcarragh, 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:	12VDC supply from mains power adaptor
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

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 period of December 2011 to January 2012.

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 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 20 and 21.

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 $\mu\text{V/m}$	Field Strength (dB $\mu\text{V/m}$)
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	dBμV	dB	dB	dB	dB μV/m	deg	m	V/H	dB μV/m	dB		
1830.0	68.32	26.7	2.0	35.5	61.52	0	1	V	108*	46.48	Pk	V
2740.0	55.3	29.6	2.5	38.3	49.1	0	1	V	54.0	4.9	Pk	V
4567.0	49.33	32.5	4.4	37.9	48.33	0	1	V	54.0	5.67	Pk	V
8083.0	48.5	37.0	6.1	38	53.6	0	1	V	54.0	.4	Pk	V

*The fundamental signal was 128 dB(μV/m). The limit at 1830 MHz was -20dBc or 108 dB(μV/m).

Result:

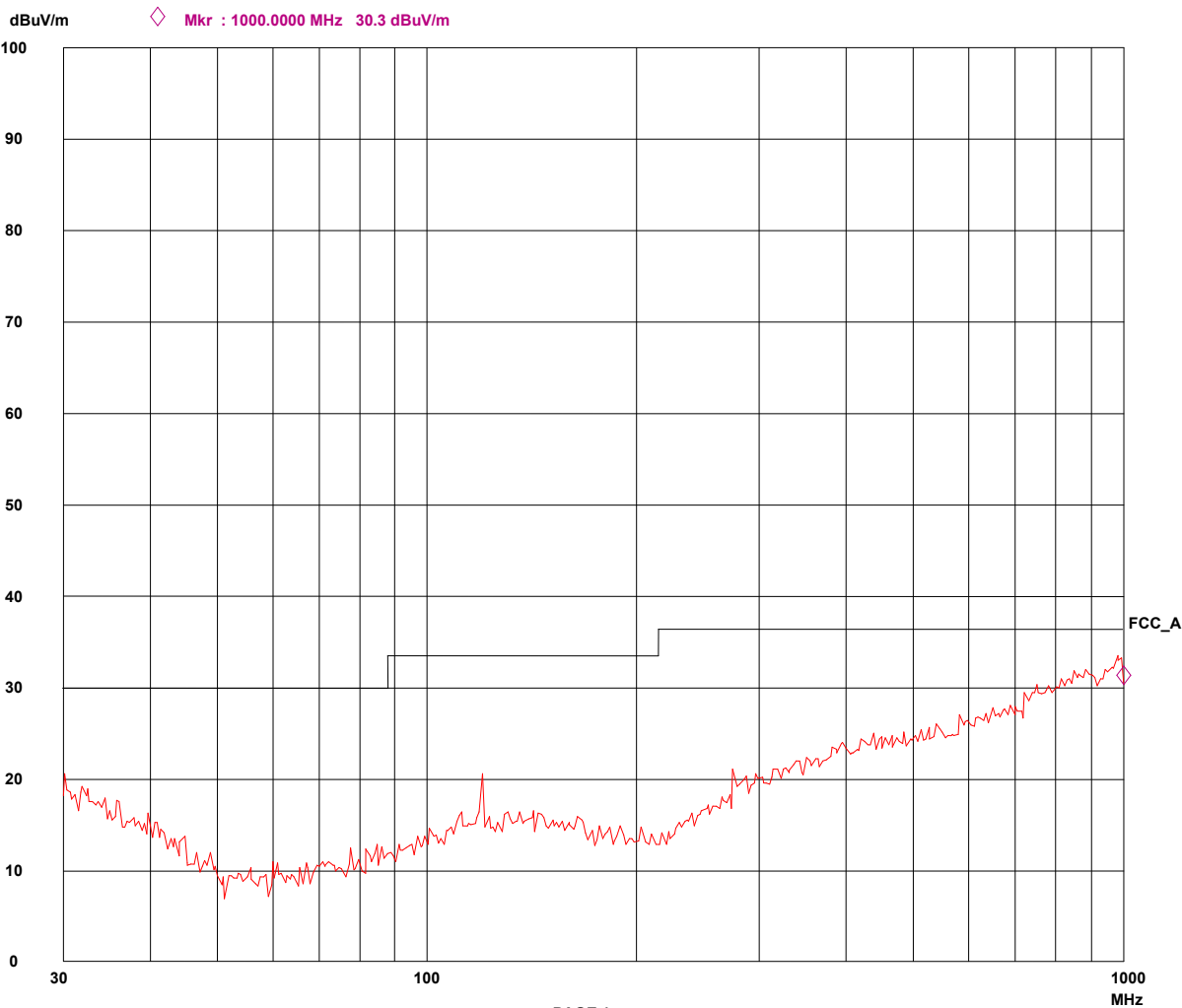
Pass

RADIATED EMISSIONS

28. Dec 11 15:53

Scan Settings (1 Range)
----- Frequencies -----||----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
30M 1000M 120k 120k PK 5ms 0dBLD OFF 60dB

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



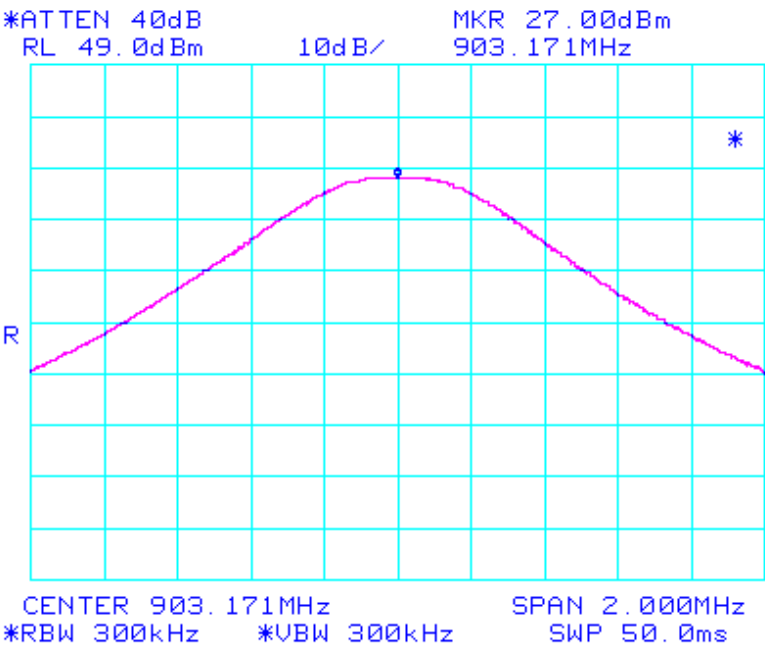
Note: Radiated Spurious Emissions above 1 GHz are shown in Appendix A.

4.0 Maximum peak output power**Test result: Pass****Max. Margin:** 2.67 dB below the limits

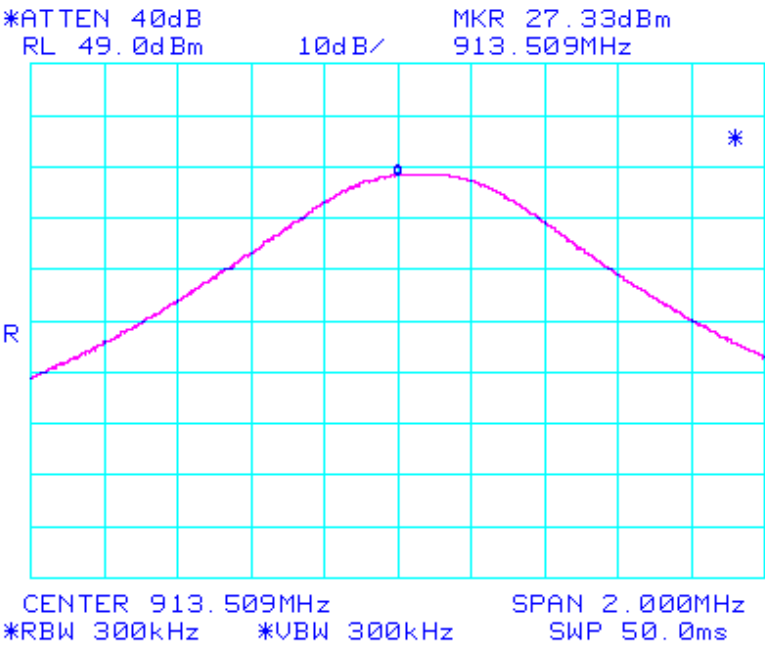
Frequency Range:	<input checked="" type="checkbox"/> 902-928MHz <input type="checkbox"/> 2400-2483.5MHz <input type="checkbox"/> 5725-5850MHz					
Low Frequency Channel (MHz)	Measured power W	Attenuation dB	Power at Antenna W	Limit W	Limit Reduction dB	Margin W
903.171	0.5	0	.5	1	0	0.5
Middle Frequency MHz						
913.509	0.543	0	0.543	1	0	0.457
Upper Frequency MHz						
923.98	0.522	0	0.522	1	0	0.478
Antenna Gain:	<input checked="" type="checkbox"/> < 6dBi <input type="checkbox"/> > 6 dBi and = dBi, output power reduction = dB					

RBW: 300 kHz

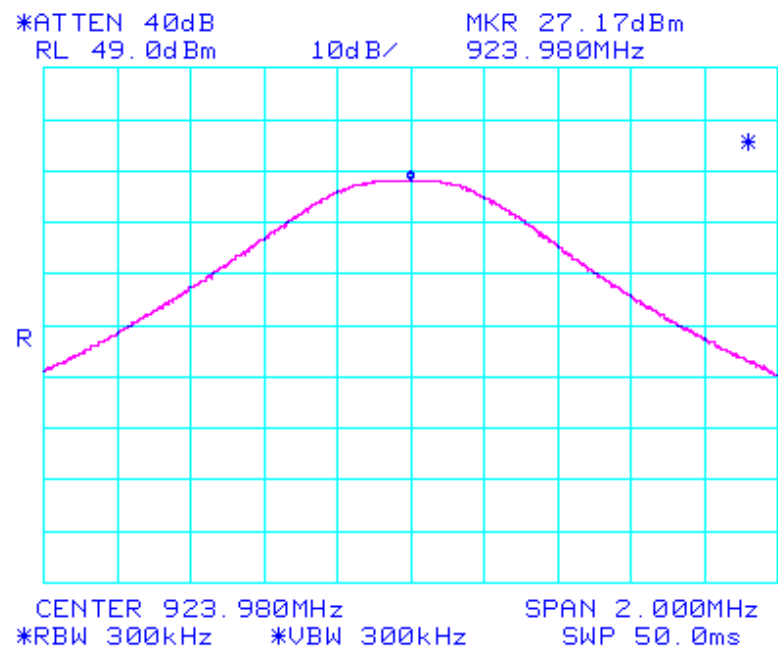
VBW: 300 kHz



Graph 1 Channel 1 (Low)



Graph 2 Channel 26 (Mid)

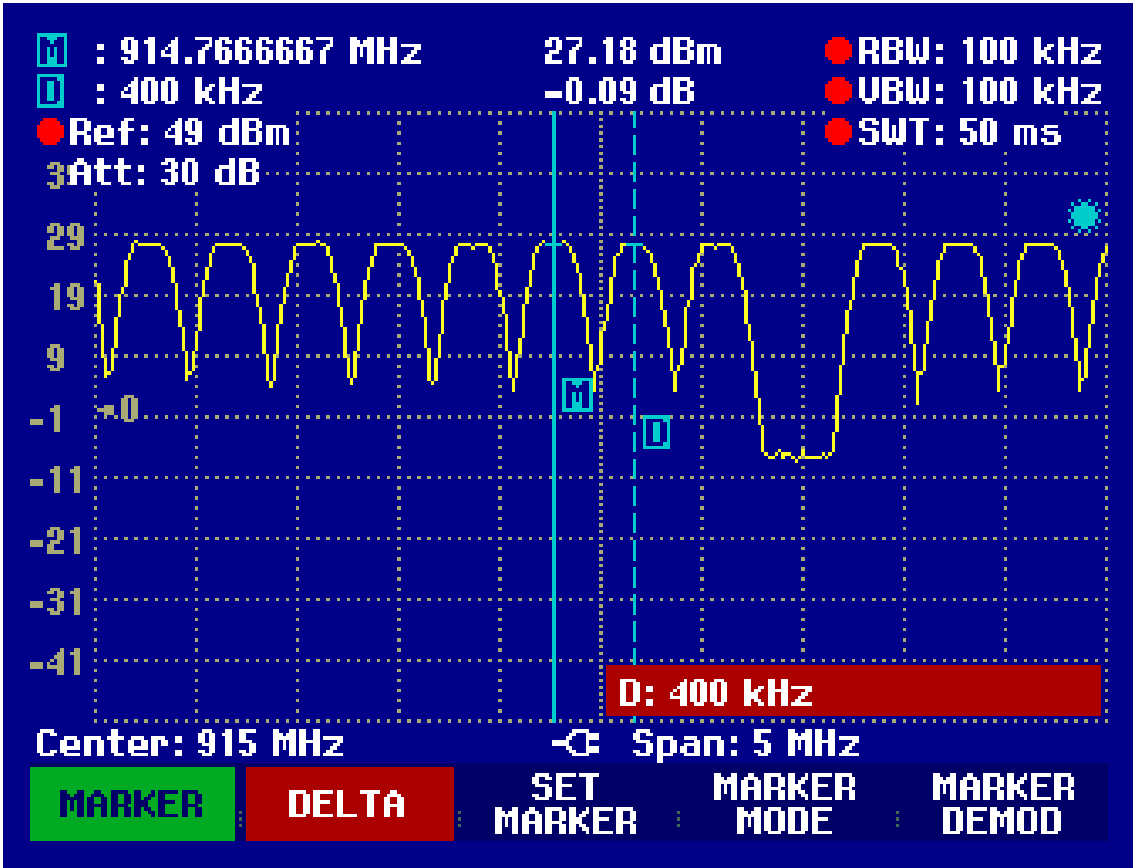


Graph 3
Channel 50 (High)

5.0 Hopping channel carrier frequencies separation

Frequency Range <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	Pass
Limit:	20dB channel bandwidth	
Span:	5 MHz	
RBW:	100 kHz	
VBW:	100 kHz	

Notes:



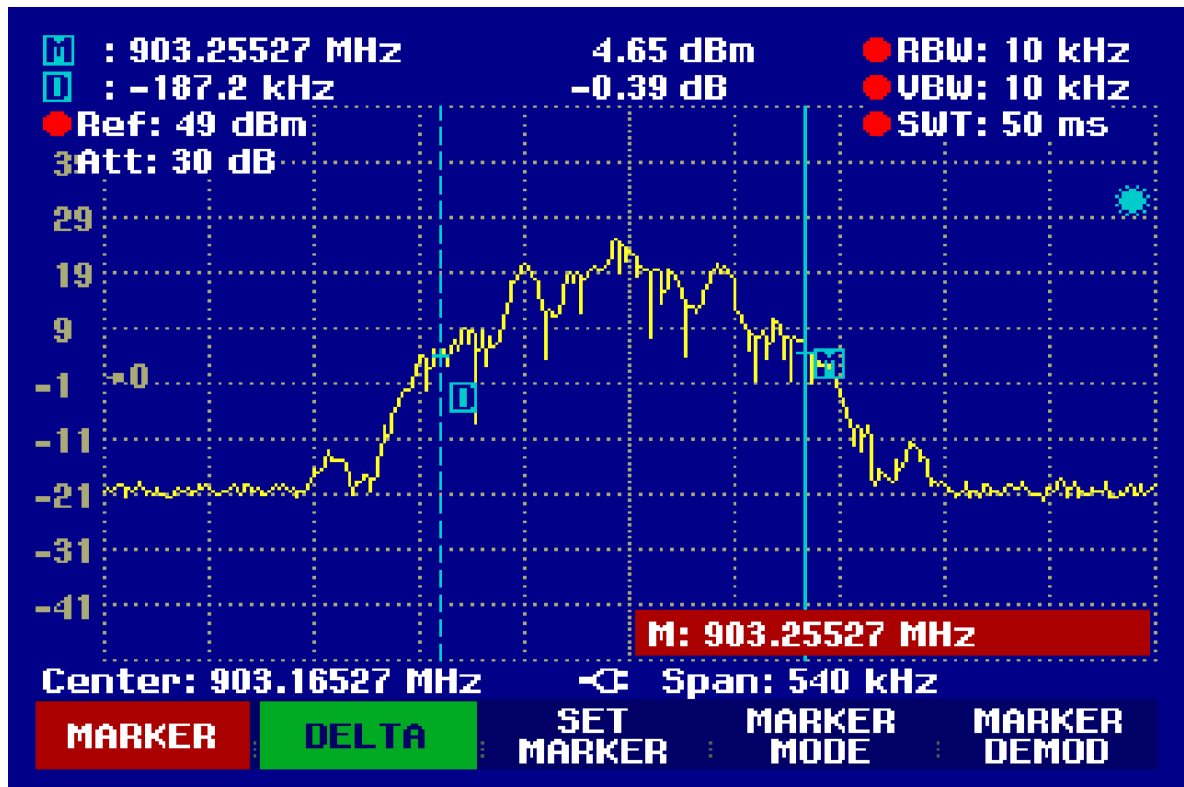
Graph 4

Hopping Channel Carrier Frequency Separation

6.0 20dB bandwidth of the hopping channel

Frequency Range:	<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
187.2	212.4	199.8		Pass
Span:	540 kHz			
RBW:	10 kHz			
VBW:	10 kHz			

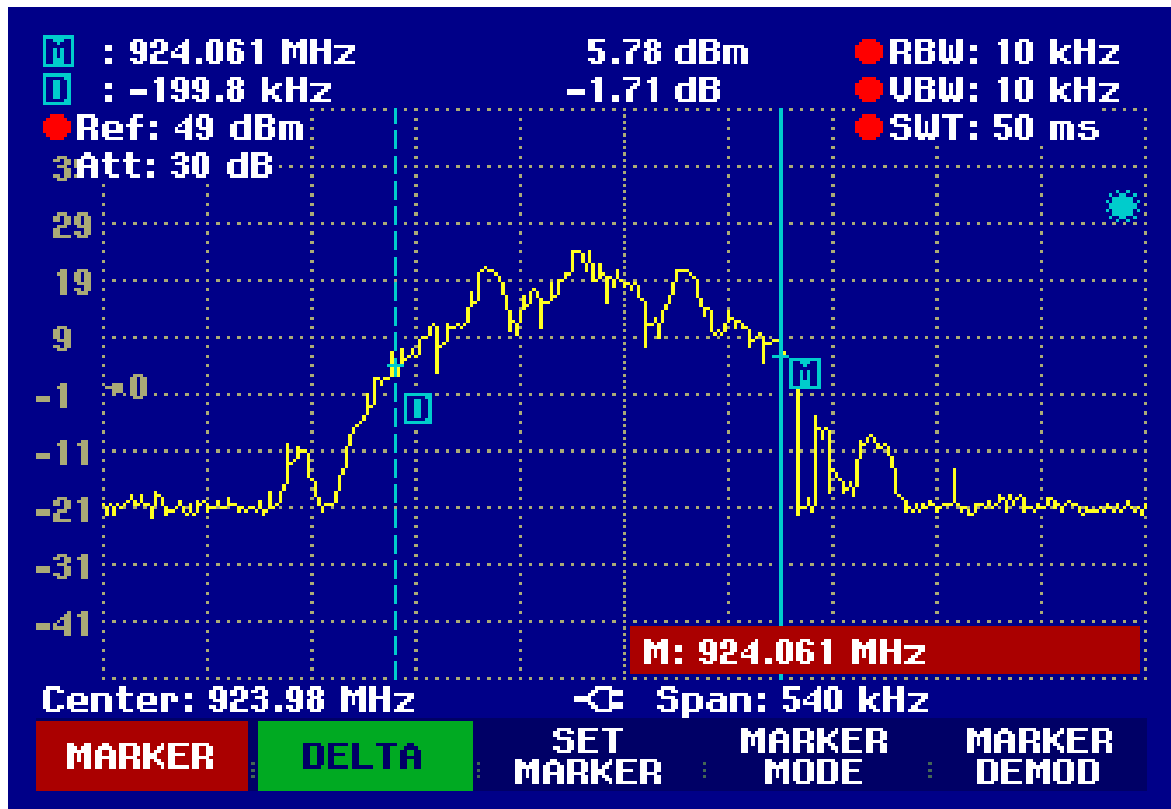
Notes:



Graph 5 20dB bandwidth (low frequency channel)



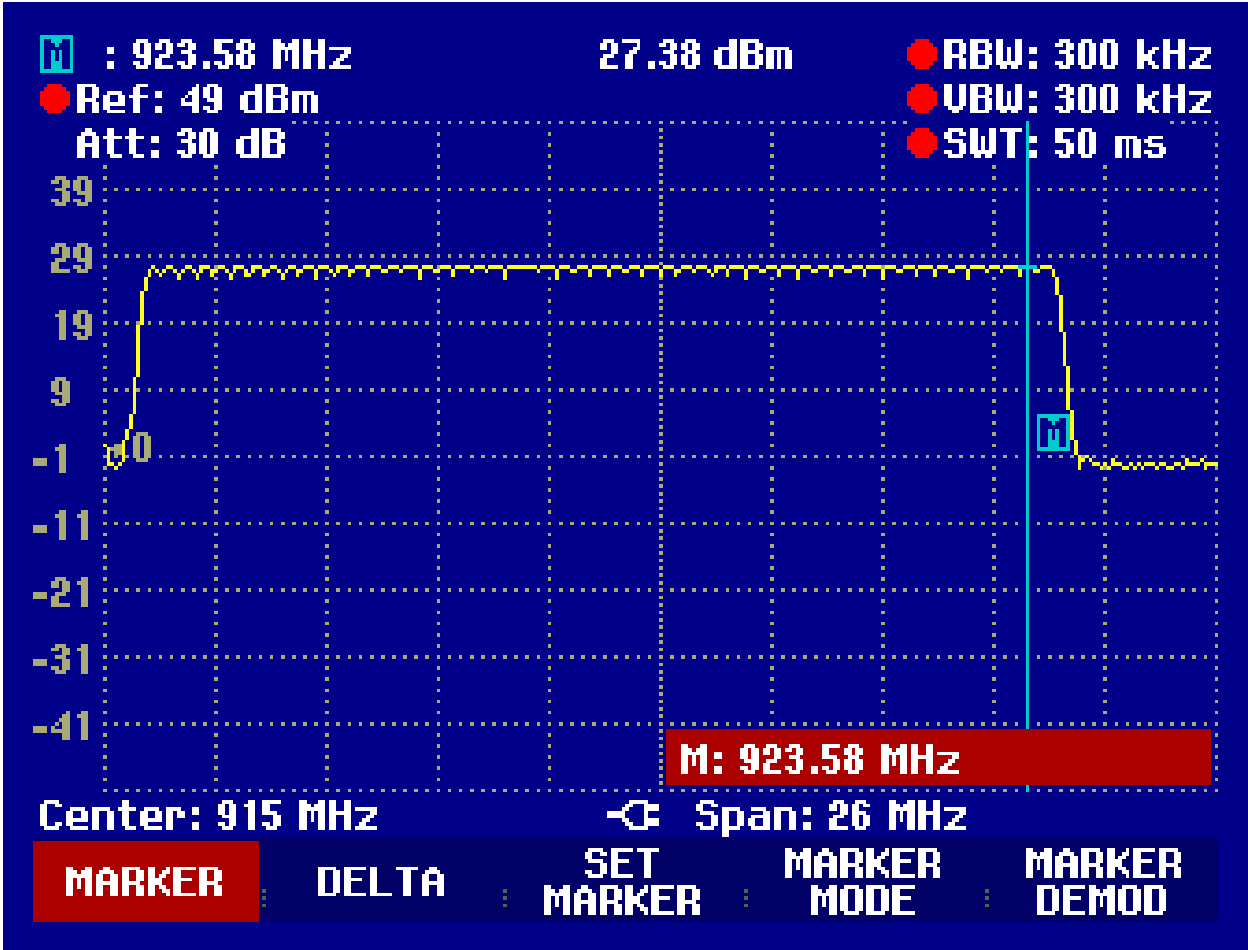
Graph 6 20dB bandwidth (mid frequency channel)



Graph 7 20dB bandwidth (upper frequency channel)

7.0 Number of hopping frequencies

Frequency Range:	<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	Pass
Channel 20dB Bandwidth:	<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	0.118	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		

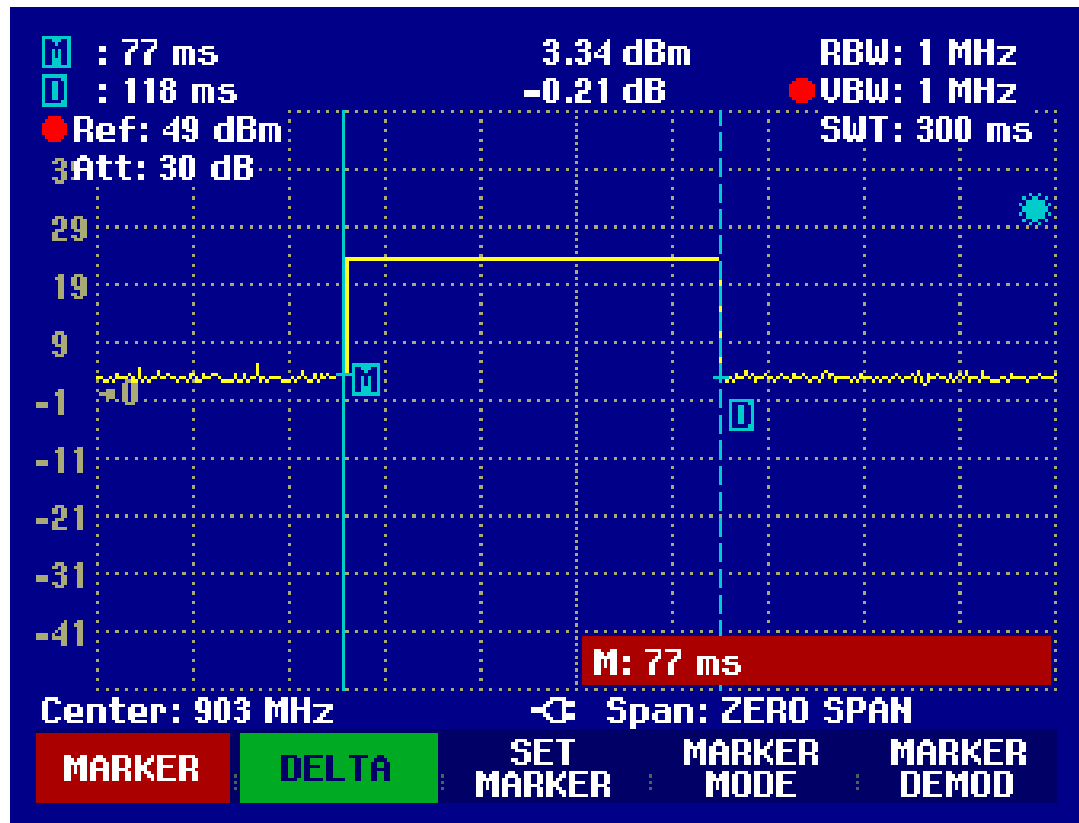
Time of occupancy calculation:

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

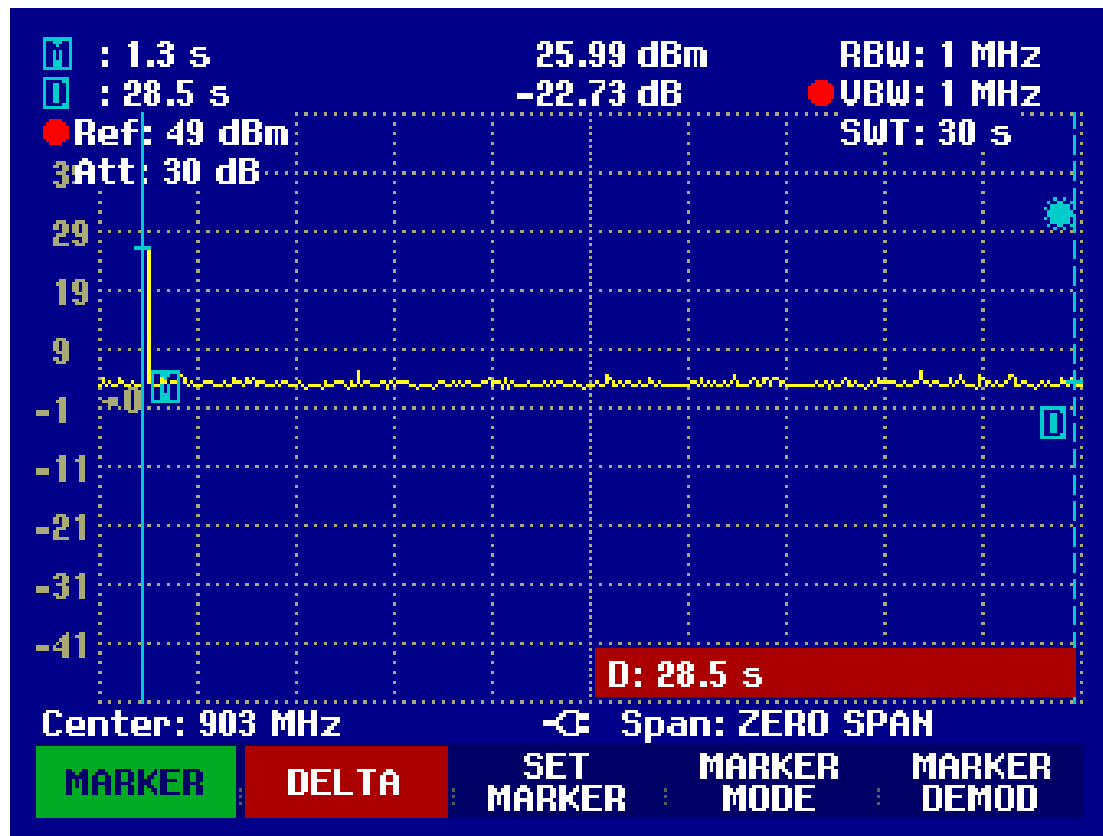
Single occupancy duration (single duration) = 0.118 sec

Time of occupancy = (single duration) x (repetition) = 0.118 x 1 = 0.118 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

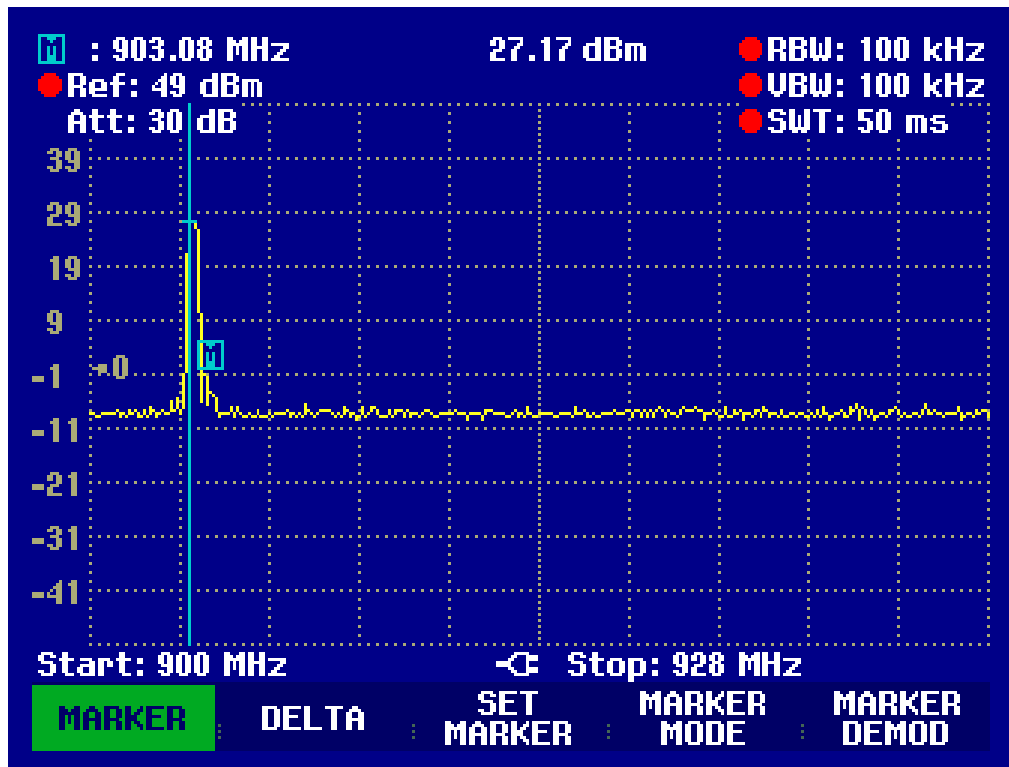


Graph 10 Number of repetitions

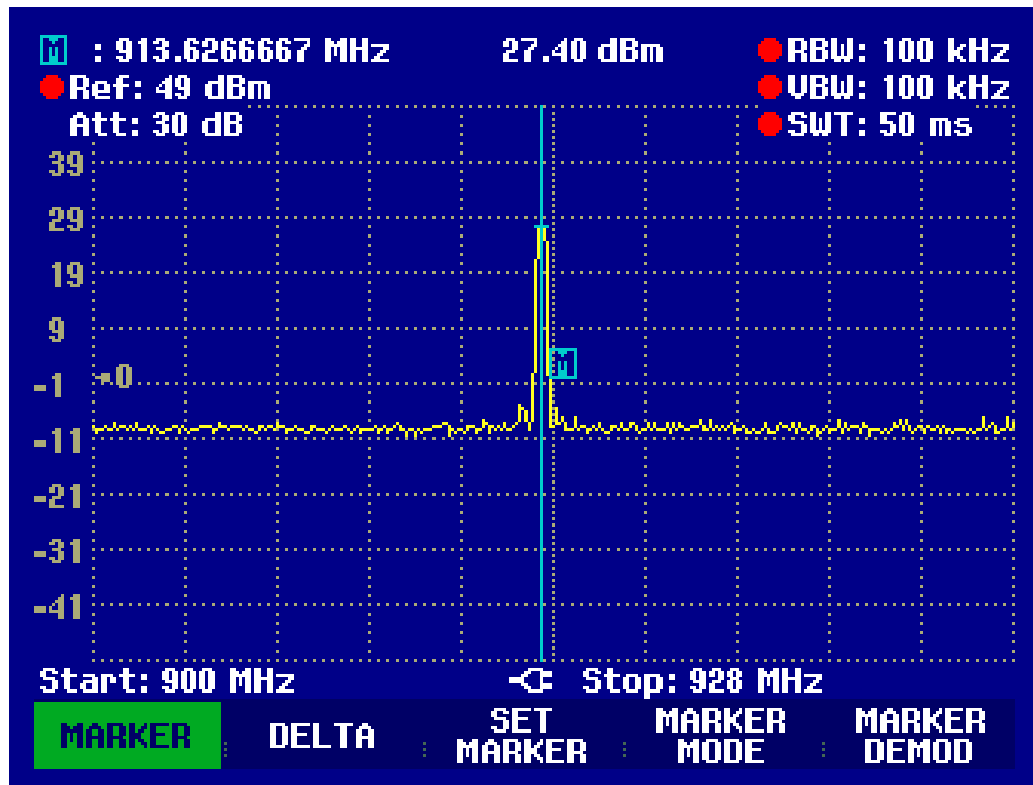
9.0 Antenna conducted spurious emissions

Frequency Range:	<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	>35	20	>15
Middle Frequency Channel	>35	20	>15
Upper Frequency Channel	>35	20	>15
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)		

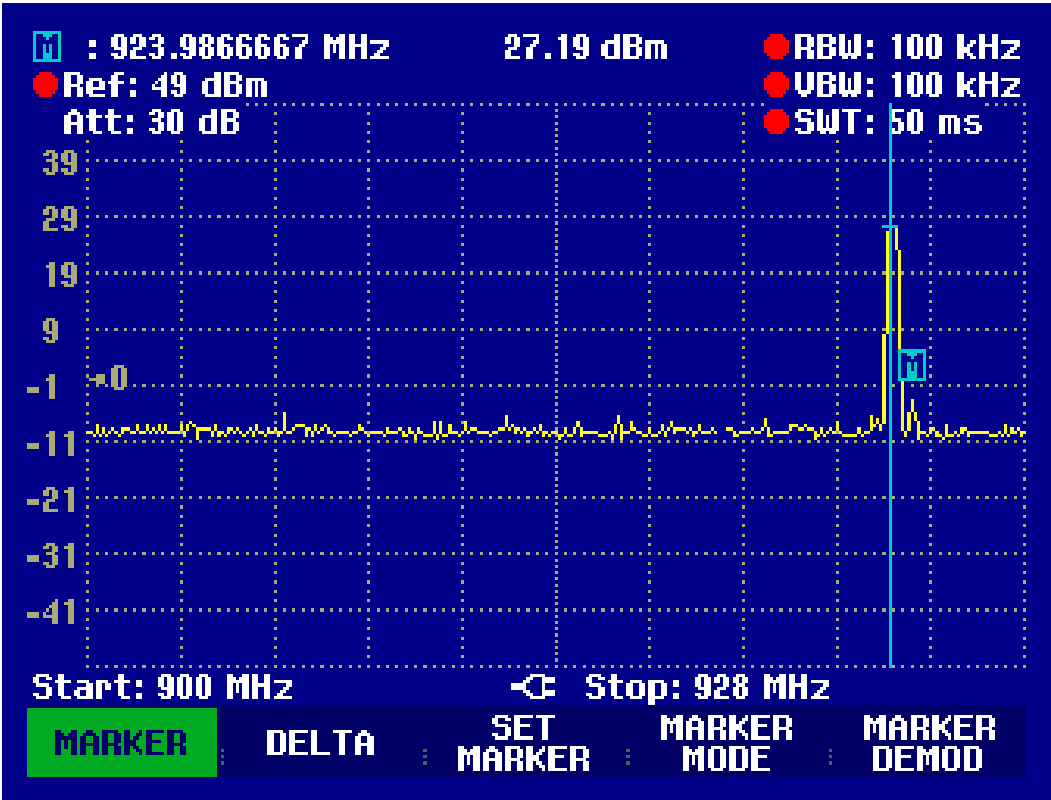
Notes:



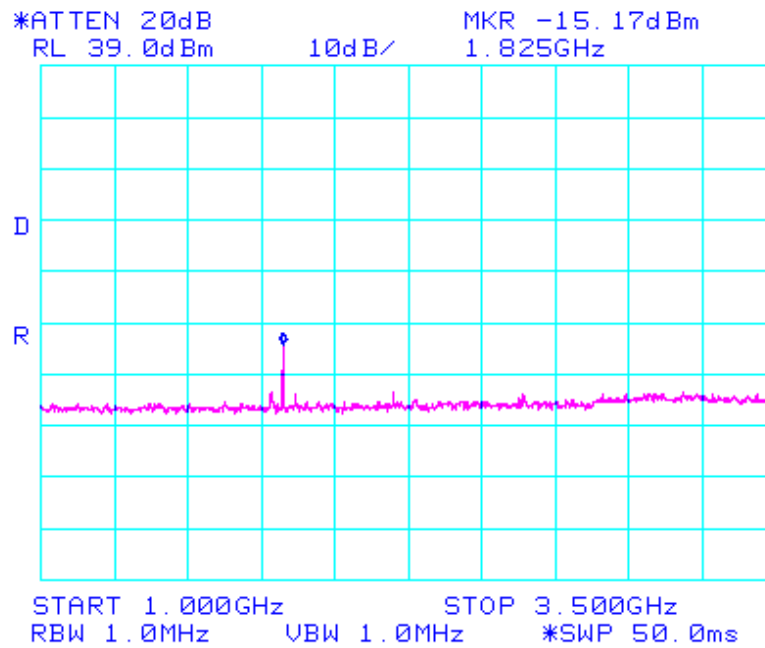
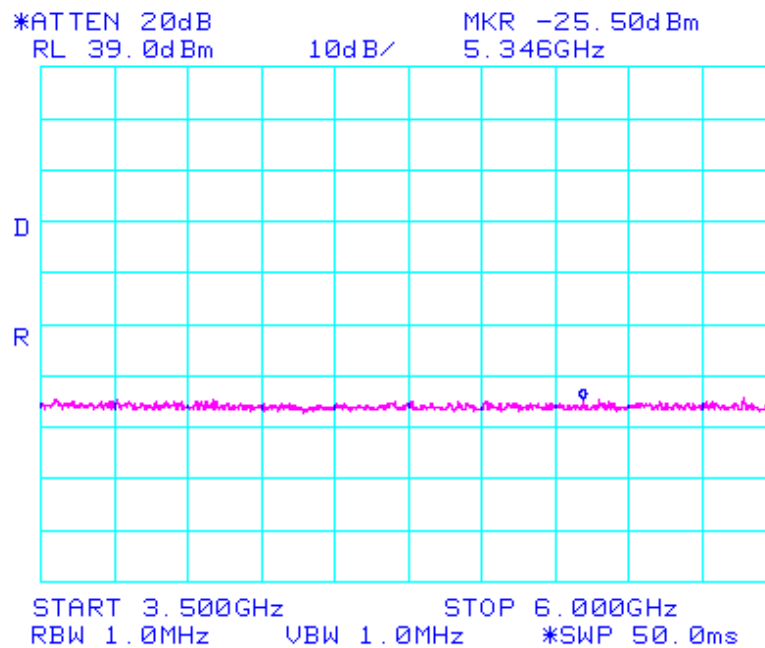
Graph 11 (lower frequency channel)

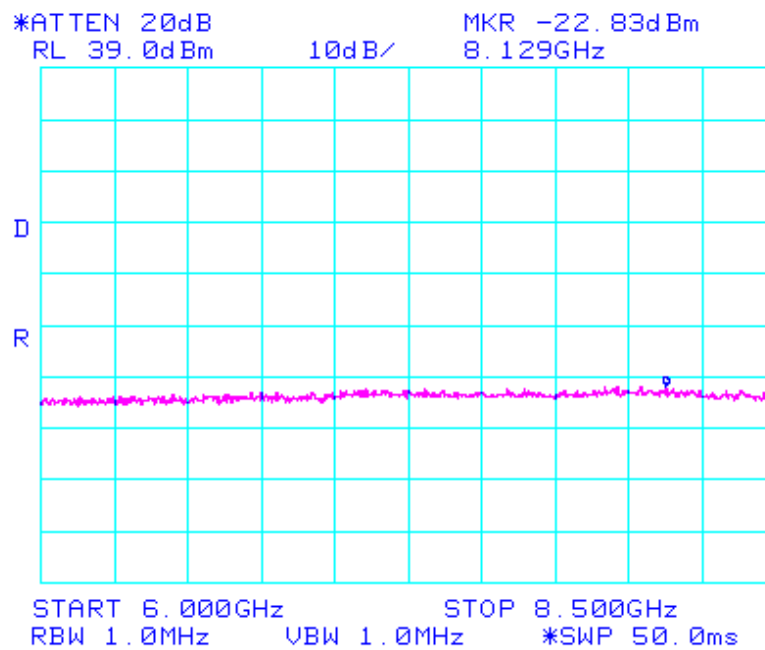
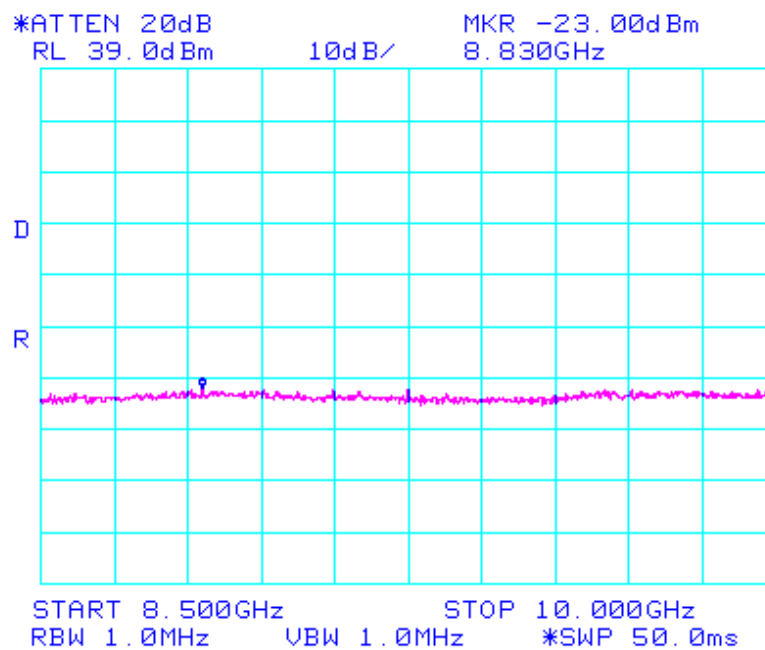


Graph 12 (mid frequency channel)



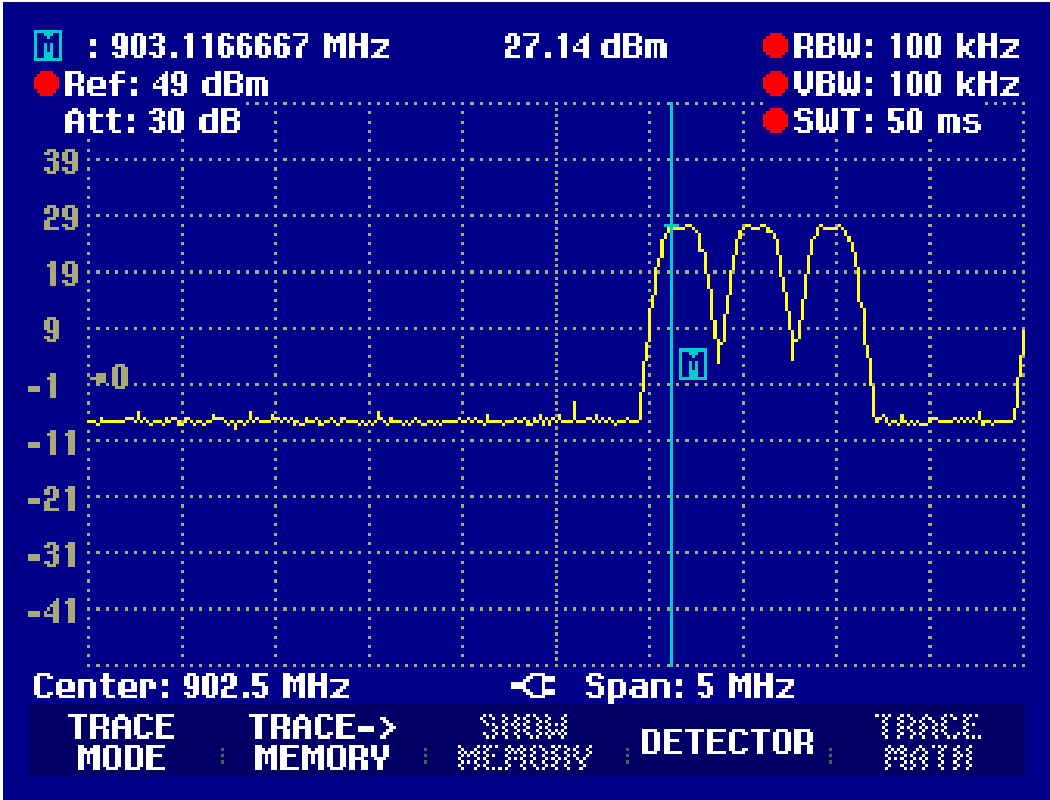
Graph 13 (upper frequency channel)

**Graph 14 Conducted Spurious Emissions 1 -3.5 GHz****Graph 15 Conducted Spurious Emissions 3.5-6 GHz**

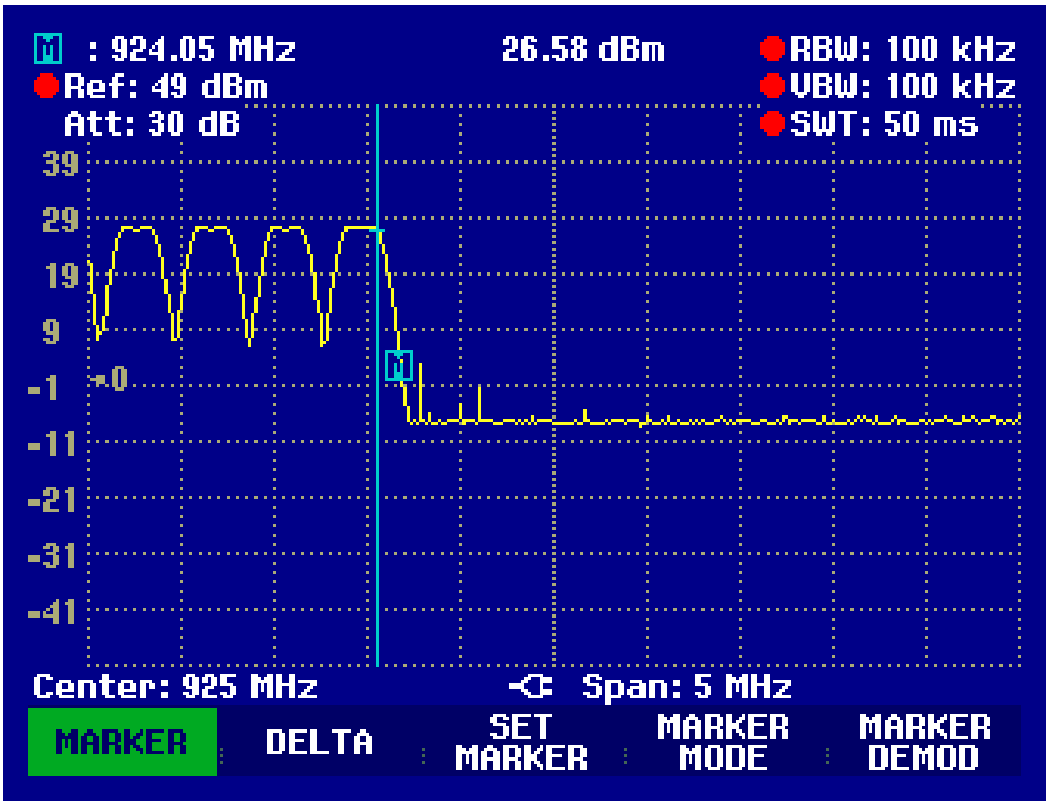
**Graph 16 Conducted Spurious Emissions 6-8.5 GHz****Graph 17 Conducted Spurious Emissions 8.5-10 GHz**

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	>10
Upper Frequency Channel	>30	20	>10
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



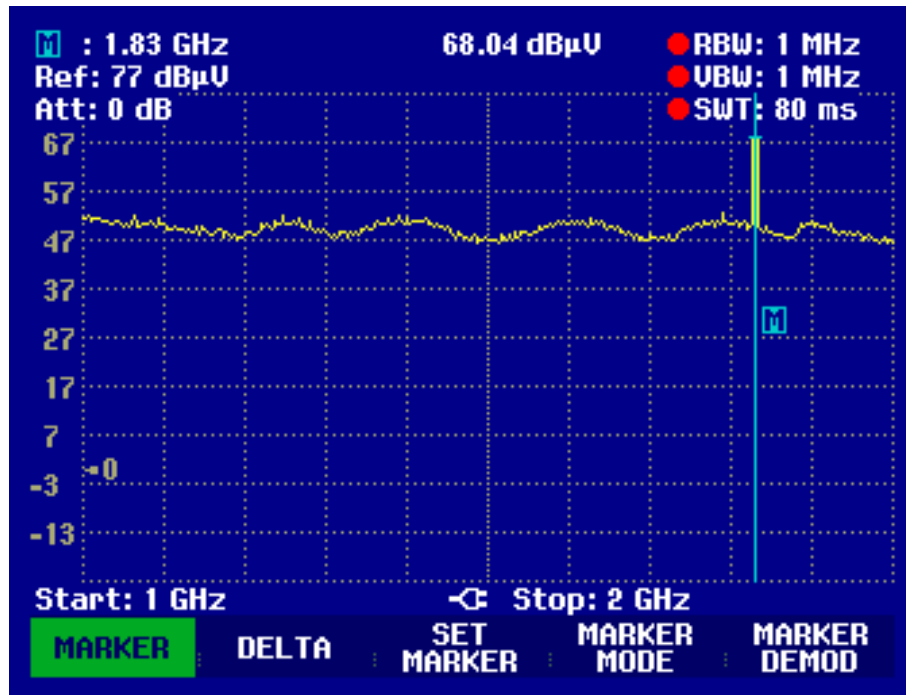
Graph 17

11.0 List of Test Equipment

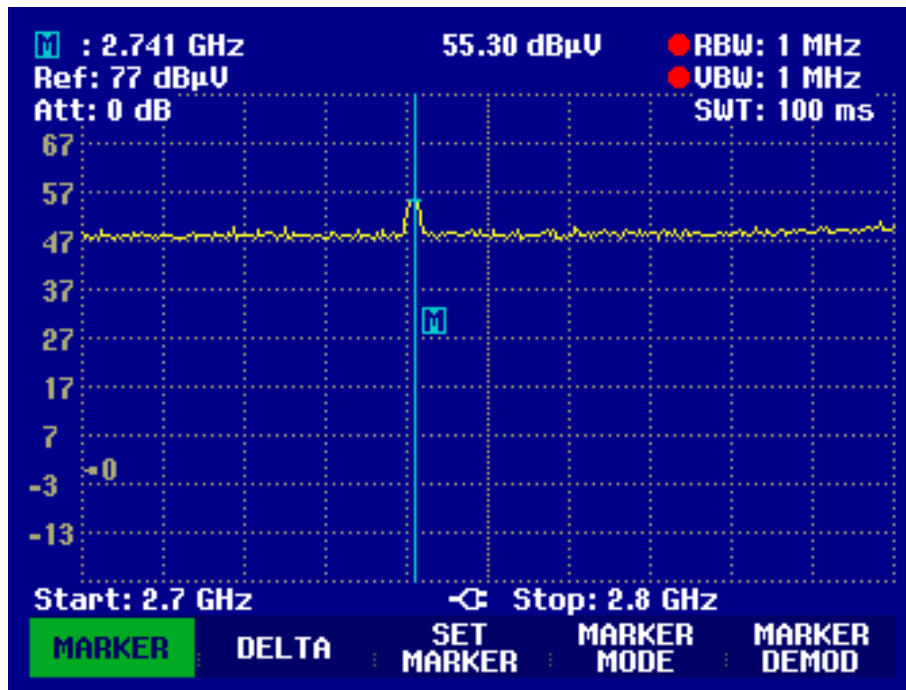
Instrument	Mftr.	Model	Calibration Due
Measuring Receiver	Rohde and Schwarz	ESVS30	18/04/12
Bilog Antenna	Chase	CBL6111	02/09/12
Spectrum Analyser	Agilent	8565EC	13/04/13
	Rohde and Schwarz	FSH3	28/02/12
Measuring Receiver	Rohde and Schwarz	ESHS30	27/10/12
LISN	Rohde and Schwarz	ESH3-Z5	13/08/12
Horn 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

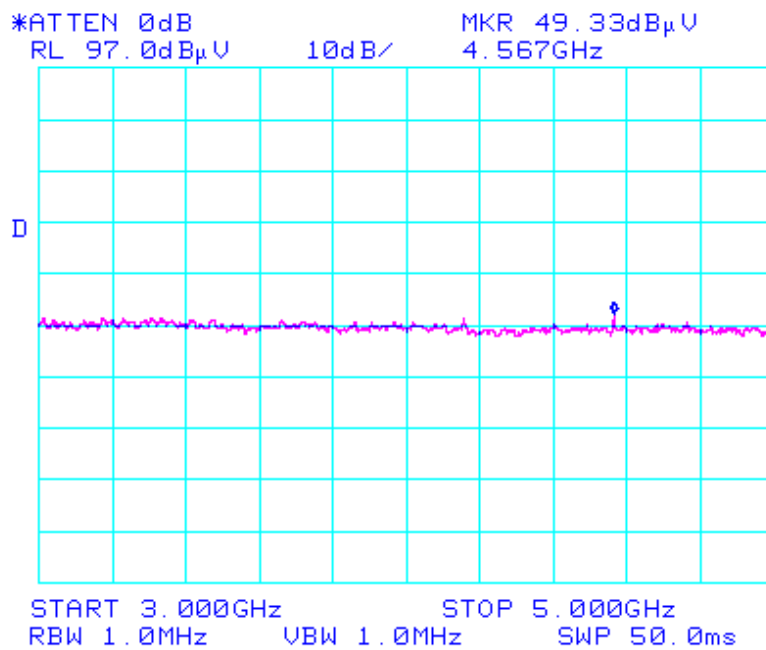
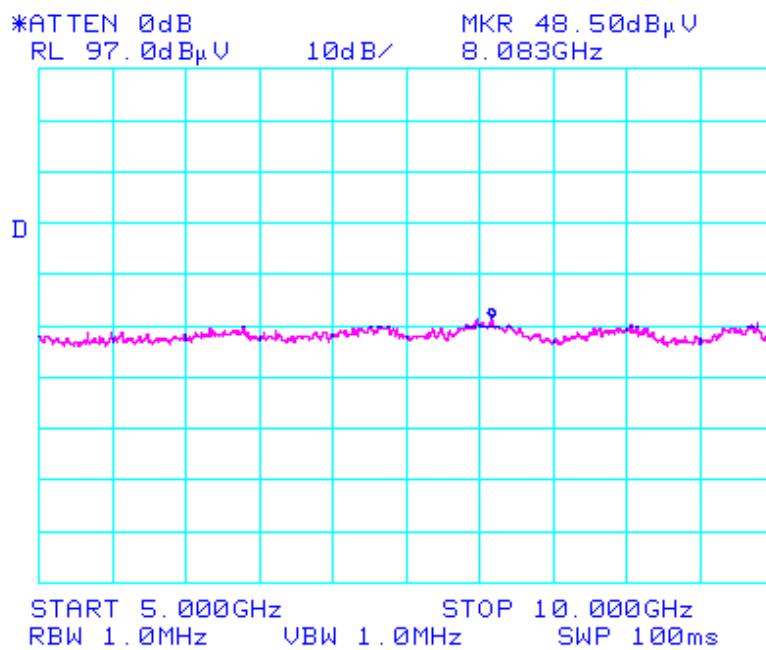
Additional Test Results



Graph 18 Radiated Spurious Emissions 1 GHz – 2 GHz Vertical and Horizontal



Graph 18 Radiated Spurious Emissions 2.7 GHz – 2.8 GHz Vertical and Horizontal

**Graph 18 Radiated Spurious Emissions 3 GHz – 5 GHz Vertical and Horizontal****Graph 19 Radiated Spurious Emissions 5 GHz – 10 GHz Vertical and Horizontal**

Compliance Engineering Ireland Ltd
Conducted Emissions

03 Jan 2012 12:36

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

Scan Settings			(1 Range)			Receiver Settings			
Frequencies									
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					

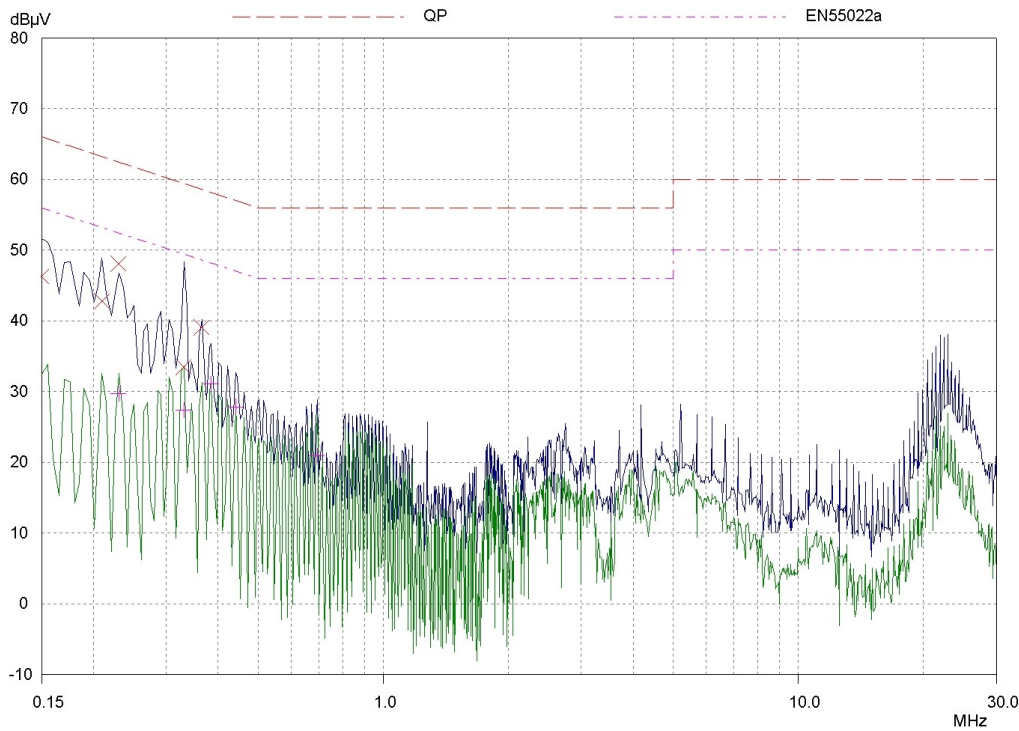


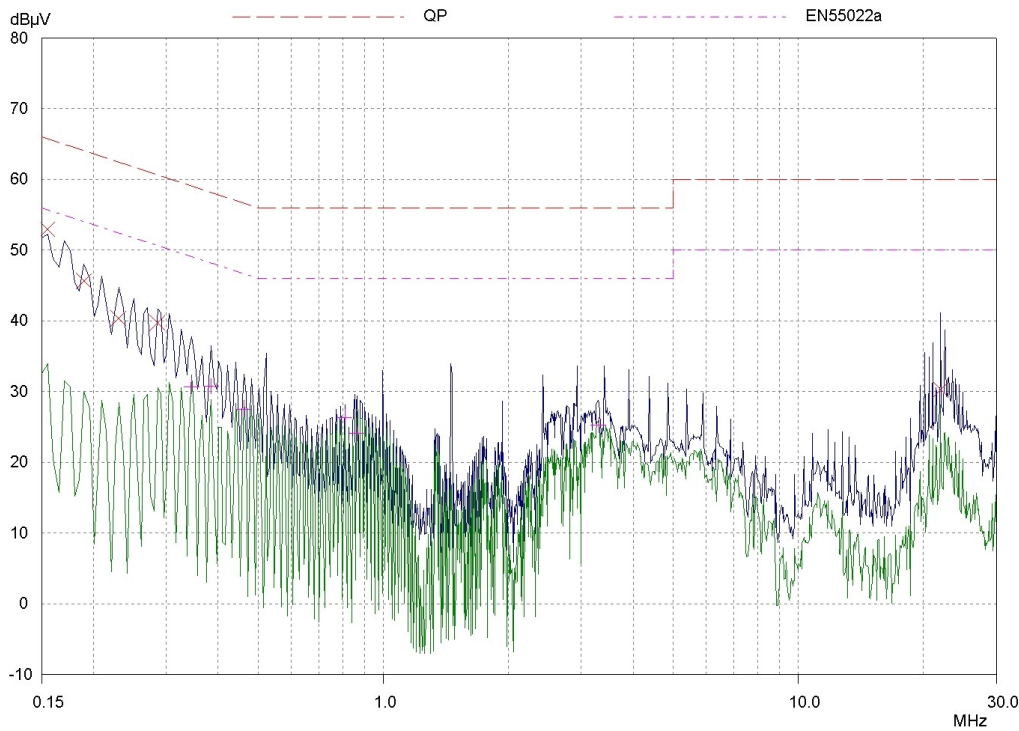
Figure 20 Conducted Emissions Live

Compliance Engineering Ireland Ltd
Conducted Emissions

03 Jan 2012 14:51

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

Scan Settings		(1 Range)		Receiver Settings				
Frequencies								
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					



Graph 21 Conducted Emissions Neutral

Appendix B

Test Setups

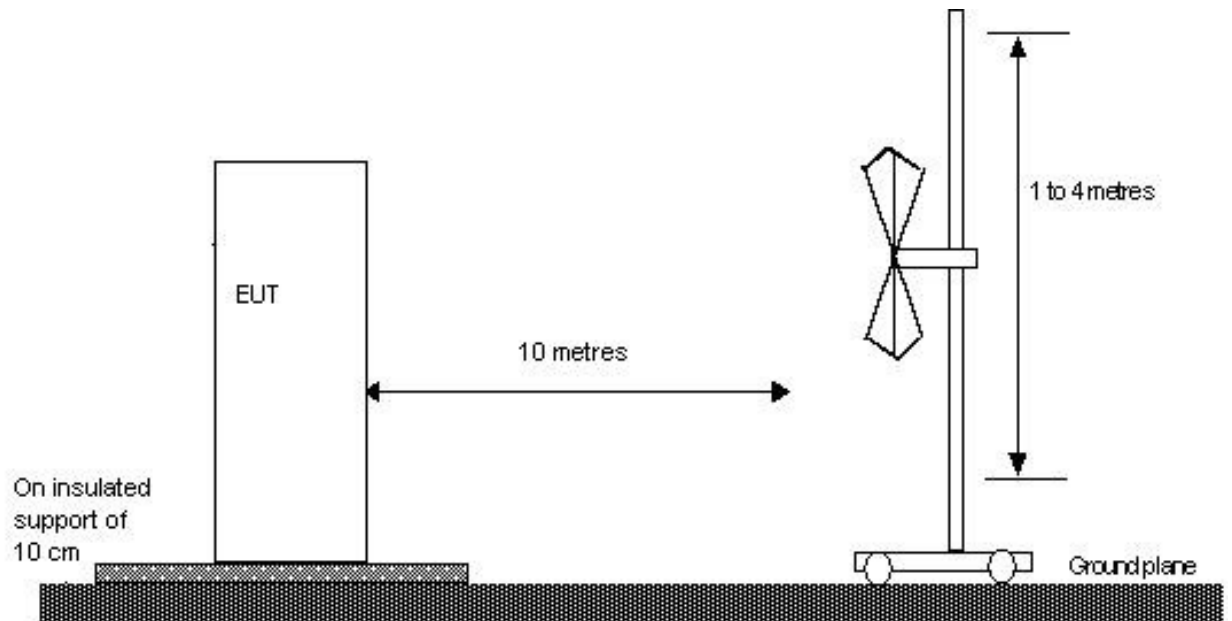


FIGURE 1: Radiated Emissions Test Setup – Test Distance 10m