Compliance Engineering Ireland Ltd

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Project Number: 11E3767-2

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

5th November 2011

FCC EQUIPMENT AUTHORISATION

Test Report

EUT Description

Repeater 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 repeater using a short range 915 MHz band transceiver intended to be used in temperature sensing and similar applications.

Model:	Repeater
Type:	915 MHz Repeater
FCC ID:	Z4GK102
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:	52
Antenna:	Internal
Transmitter power configuration:	Mains
Power	10 dBm
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 unit was tested using a 120Vac supply.

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 October 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 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 centered on a motorized 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 maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

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.

Emissions above 1 GHz were made at a 3 meter distance using peak detection.

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	6.8	24.5	1.8	0	33.1	0	1	V	43.52	10.42	QP	V
1000	50.5	25.4	1.9	39.3	38.5	0	1	V	54	15.5	Pk	V
6700	48.4	35.4	2.3	38.9	47.2	0	1	V	54	6.8	Pk	V

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

Result: Pass

RADIATED EMISSIONS

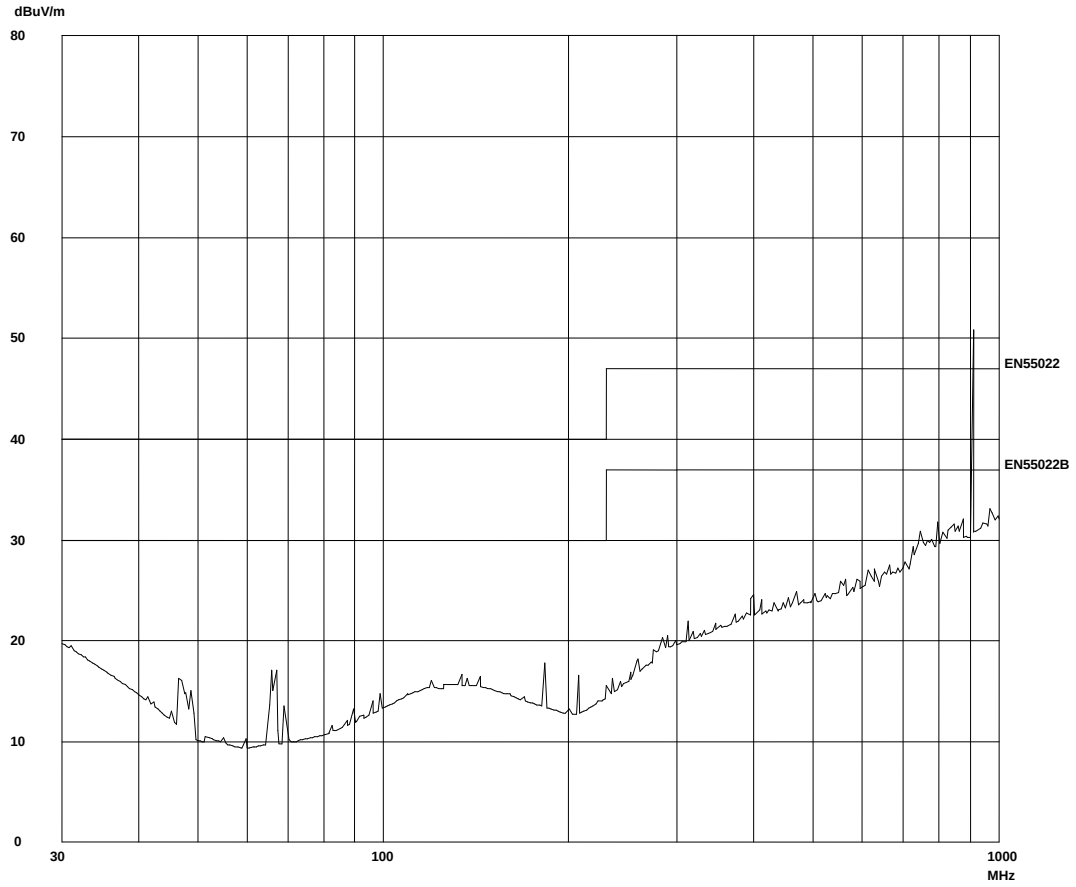
Op Cond: Normal

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	LN OFF	60dB

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

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



Graph 1 Radiated Emissions below 1 GHz

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

4.0 Maximum peak output power

Test result: Pass

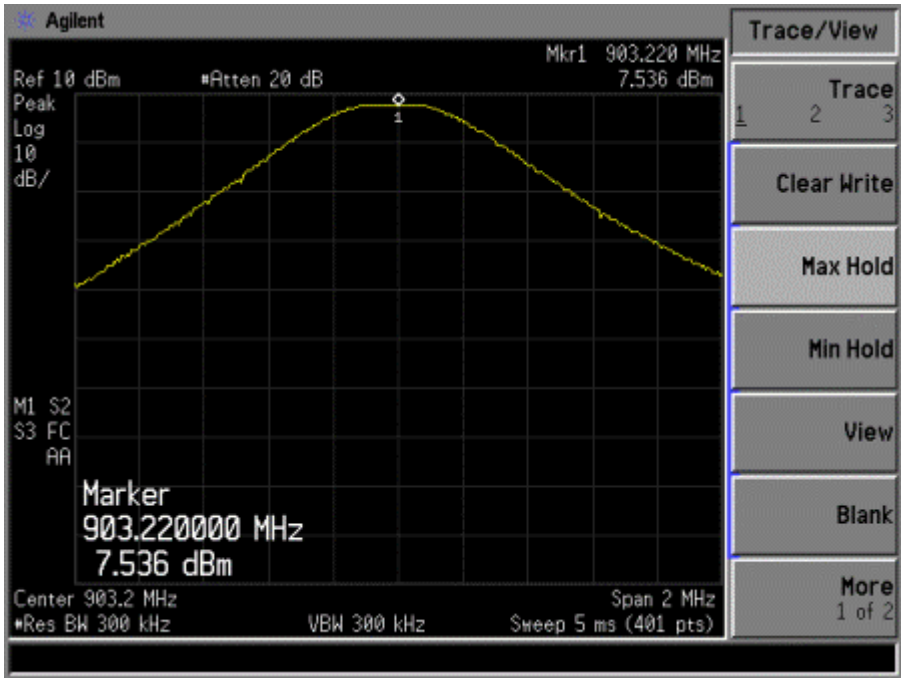
Max. Margin: .15.91dB below the limits

Frequency Range:	☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz						
Low Frequency Channel (MHz)	**Measured power dBm**	**Measured power W**	**Att. dB**	**Power at Antenna W**	**Limit W**	**Limit Reduction dB**	**Margin W**
903.195	**9.04**	**0.008**	**0**	**.008**	**1**	**0**	**0.992**
Middle Frequency MHz							
915.195	**8.24**	**0.0067**	**0**	**0.0067**	**1**	**0**	**0.993**
Upper Frequency MHz							
923.95	**7.2**	**0.0052**	**0**	**0.0052**	**1**	**0**	**0.995**
Antenna Gain:	☒ < 6dBi ☐ > 6 dBi and = dBi, output power reduction = dB						

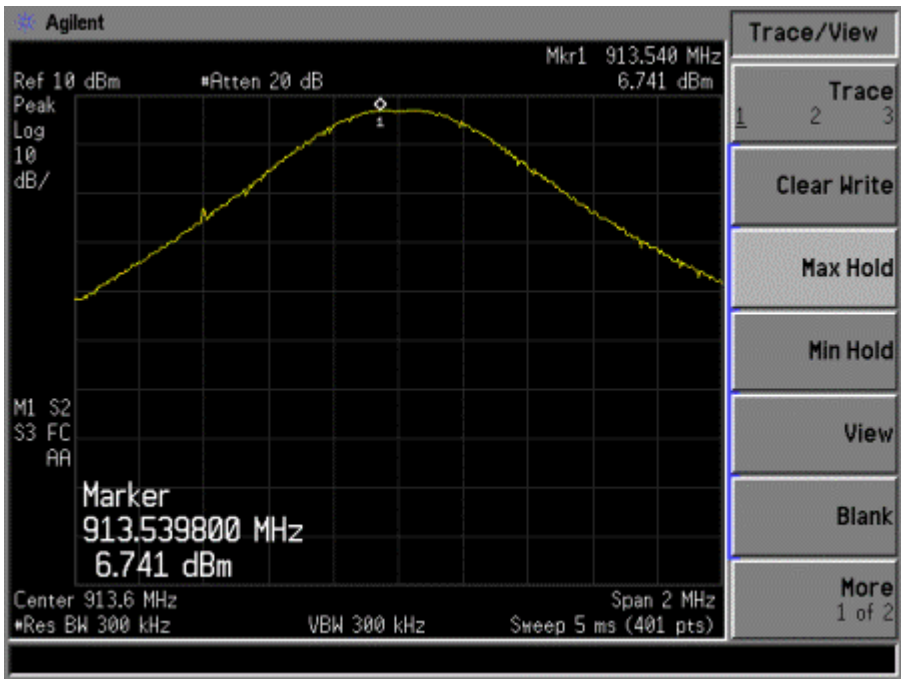
Note: Measured power output values include 1.5 dB for cable losses.

RBW: 300 kHz

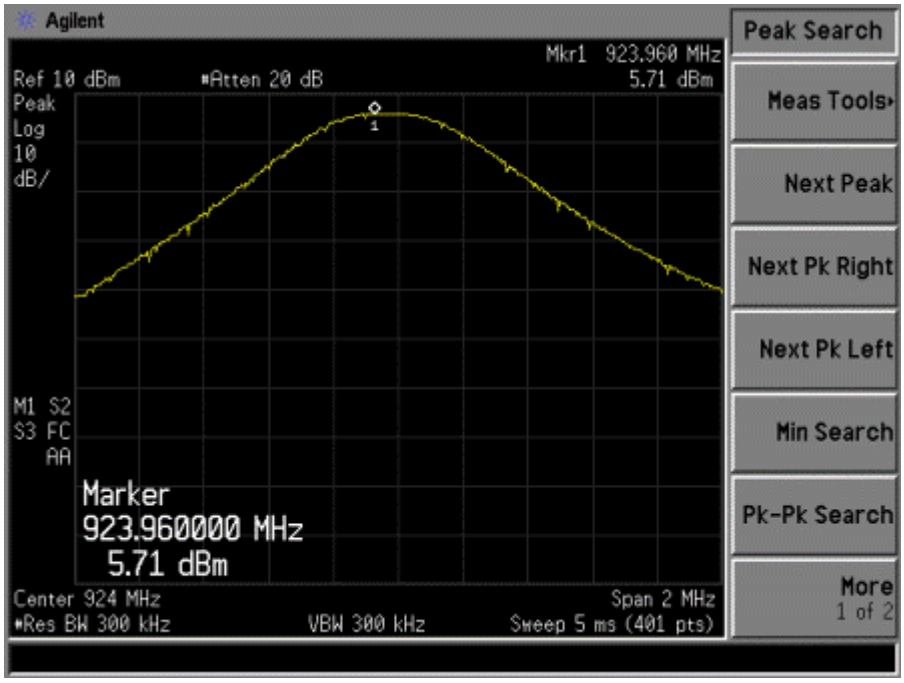
VBW: 300 kHz



Graph 2 Channel 1 (Low)



Graph 3 Channel 26 (Mid)



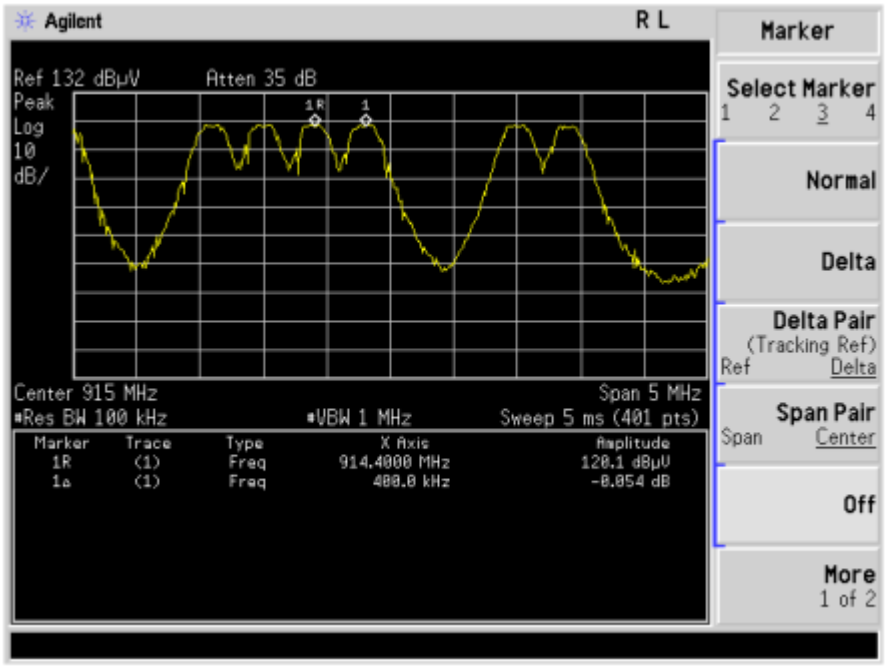
Graph 4

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: **RBW:** **VBW:**	5 MHz 100 kHz 100 kHz	

Notes:



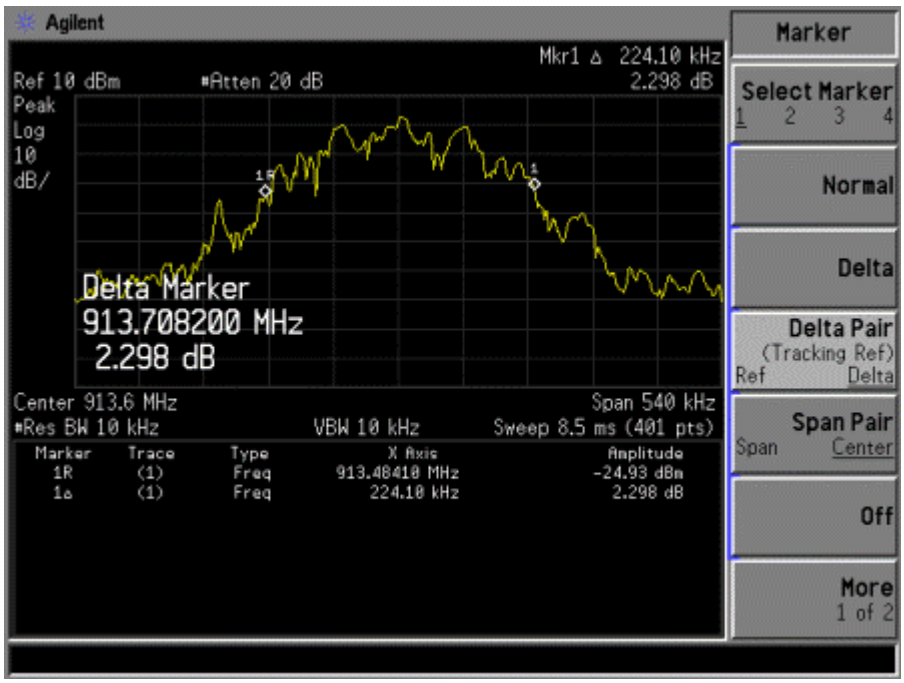
Graph 5 Hopping Channel Carrier Frequency Separation

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**
229.50	**224.10**	**222.75**	**250**	**Pass**
Span: **RBW:** **VBW:**	**540 kHz** **10 kHz** **10 kHz**			

Notes:

Graph 6 20dB bandwidth (low frequency channel)

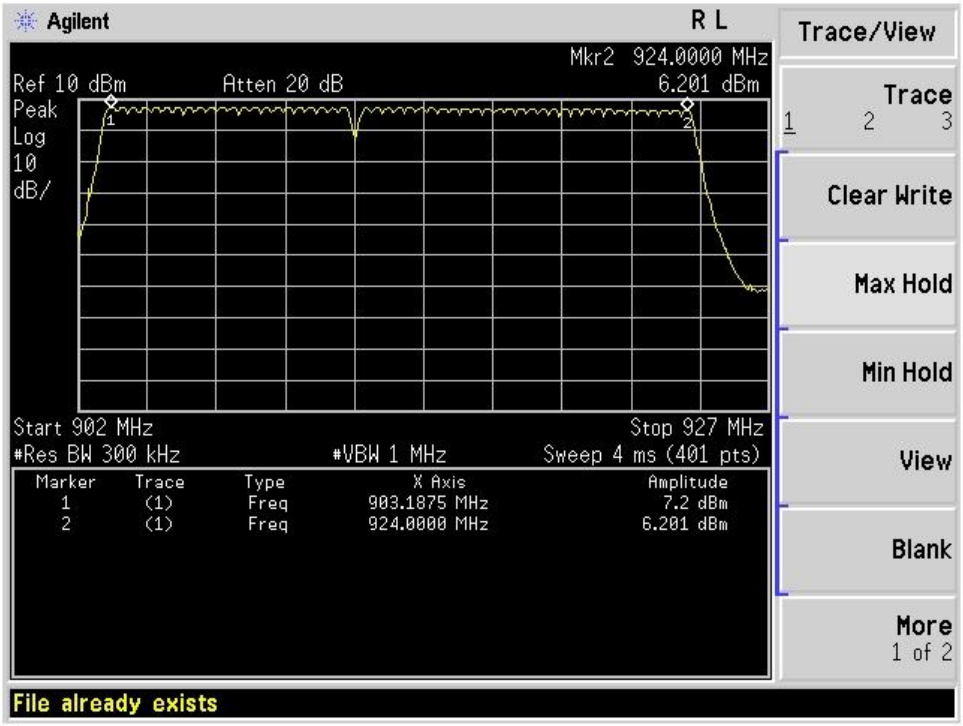


Graph 7 20dB bandwidth (mid frequency channel)

Graph 8 20dB bandwidth (upper frequency channel)

7.0 Number of hopping frequencies

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



Graph 9 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	**0.118**	**0.4**	**Pass**
Period:	☐ 10s ☐ 20s ☐ 30s ☐ 0.4s multiplied by the channel number		
Channel 20dB Bandwidth:	☒ <250kHz ☐ ≥250kHz		

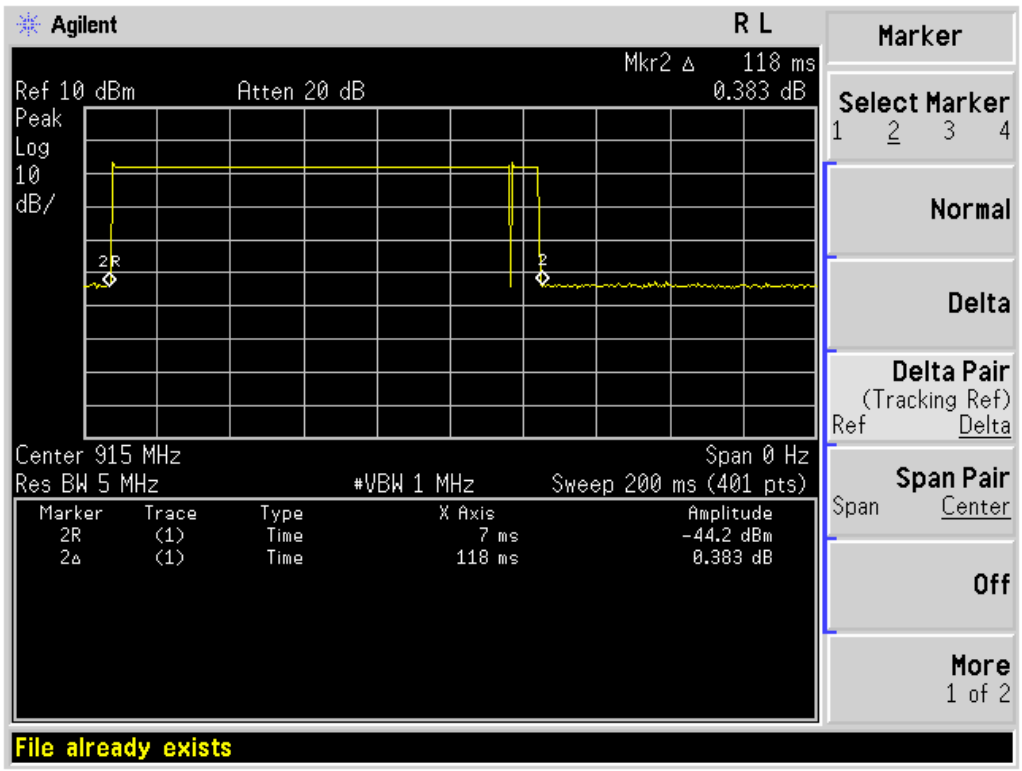
Time of occupancy calculation:

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

Single occupancy duration (single duration) = 0.118 sec

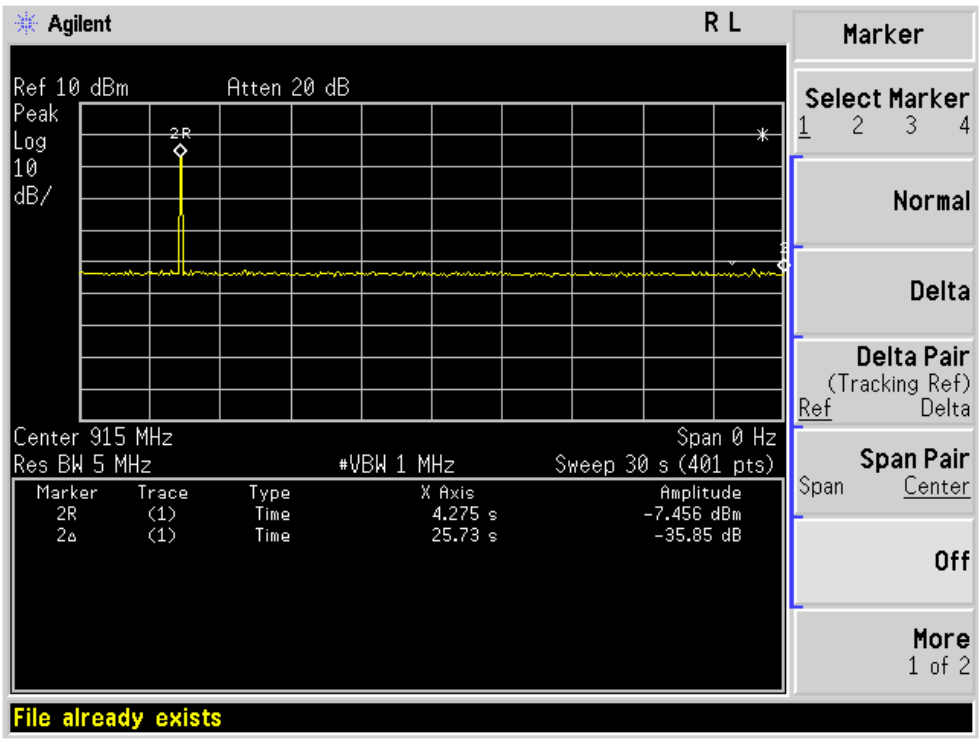
Time of occupancy = (single duration) x (repetition) = 0.118 x 1 = 0.118 sec

Notes: The occupancy was measured using a spectrum analyzer, observation time was sufficient for 50 channels to exercise.



Graph 10

Average Time of occupancy of hopping frequency



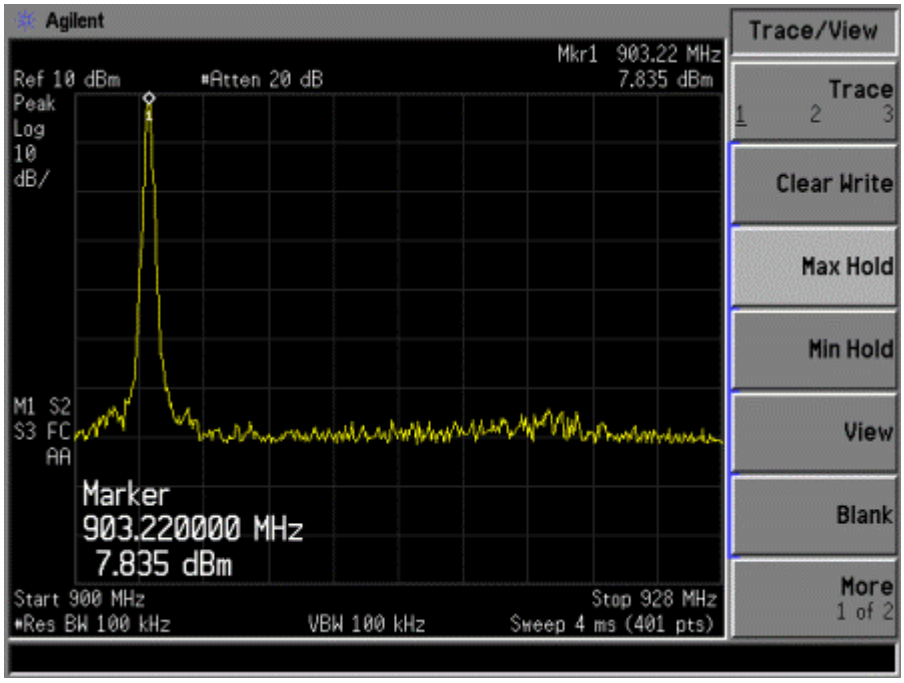
Graph 11

Number of repetitions

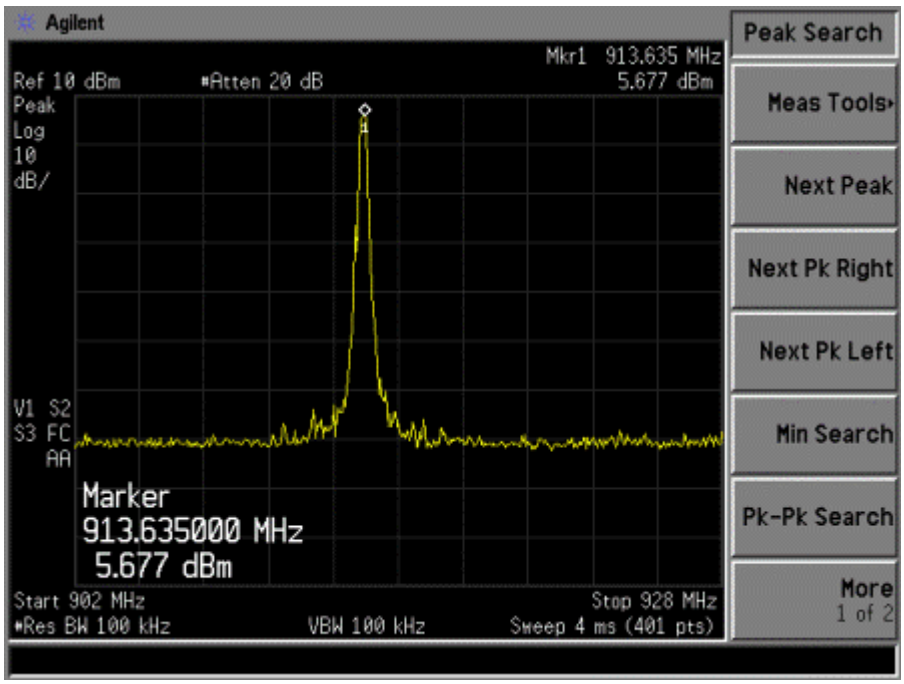
9.0 Antenna conducted spurious emissions

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 ☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval)		

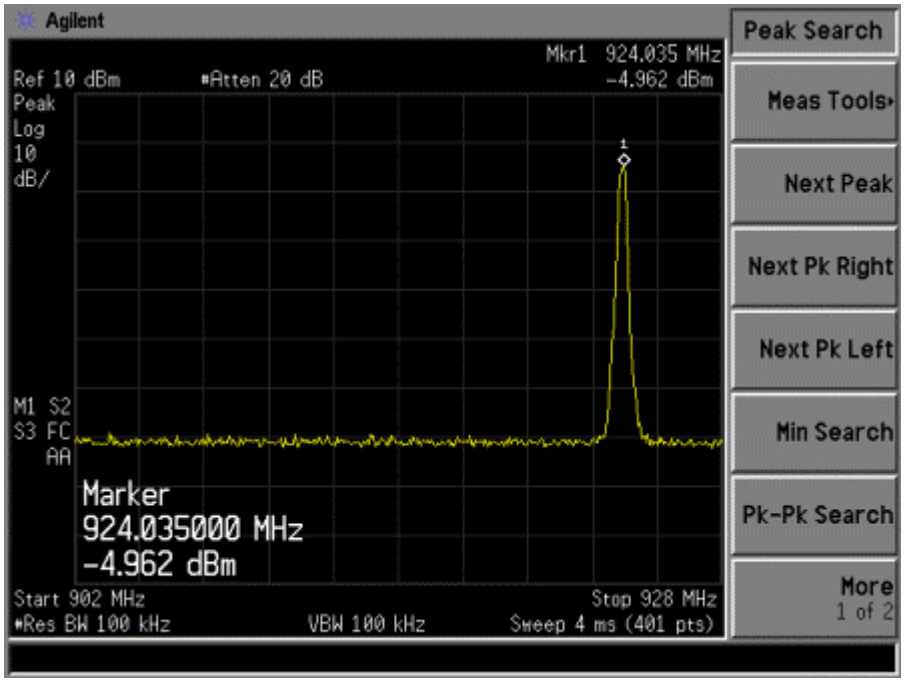
Notes:



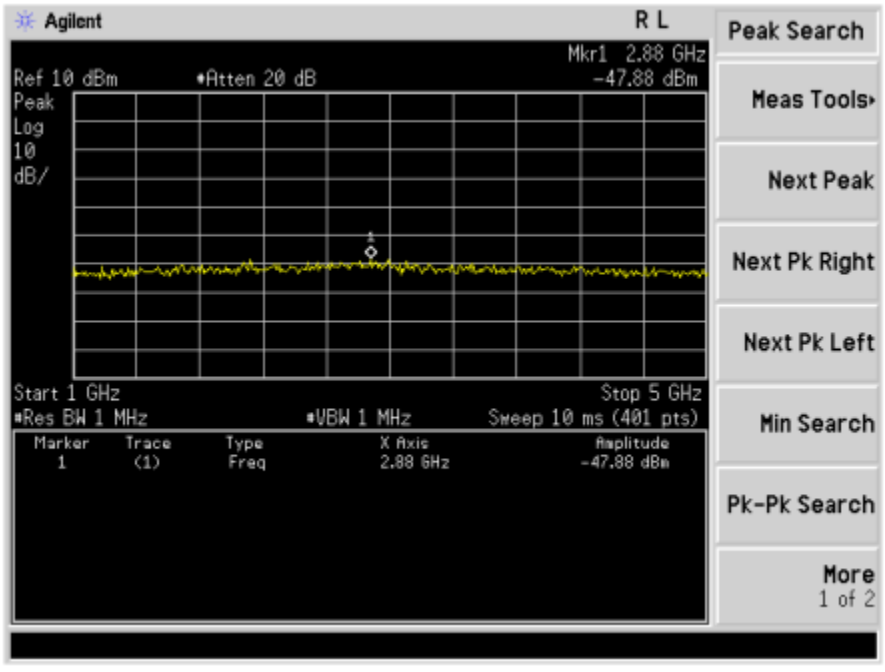
Graph 12 (lower frequency channel)



Graph 13 (mid frequency channel)

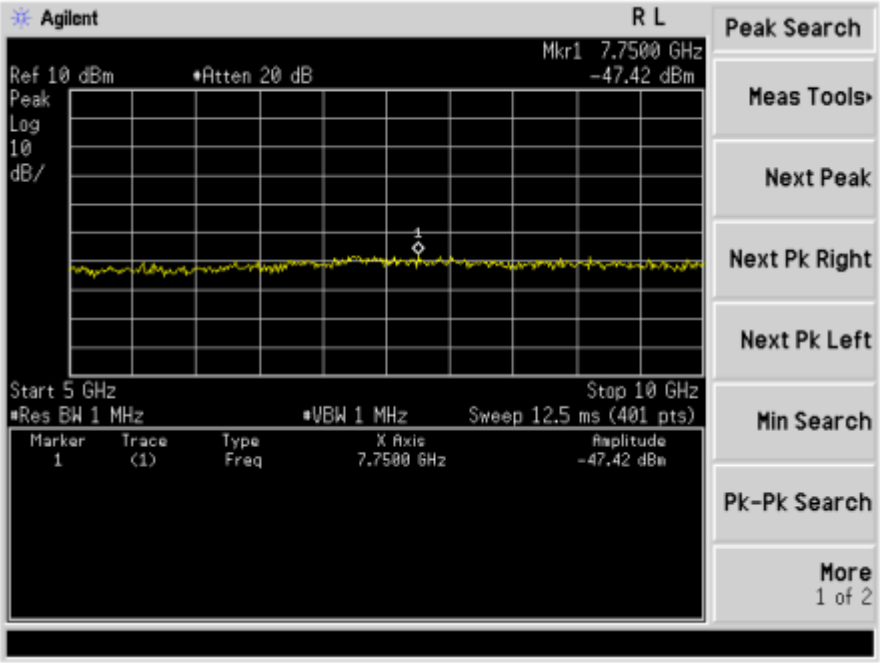


Graph 14 (upper frequency channel)



fg

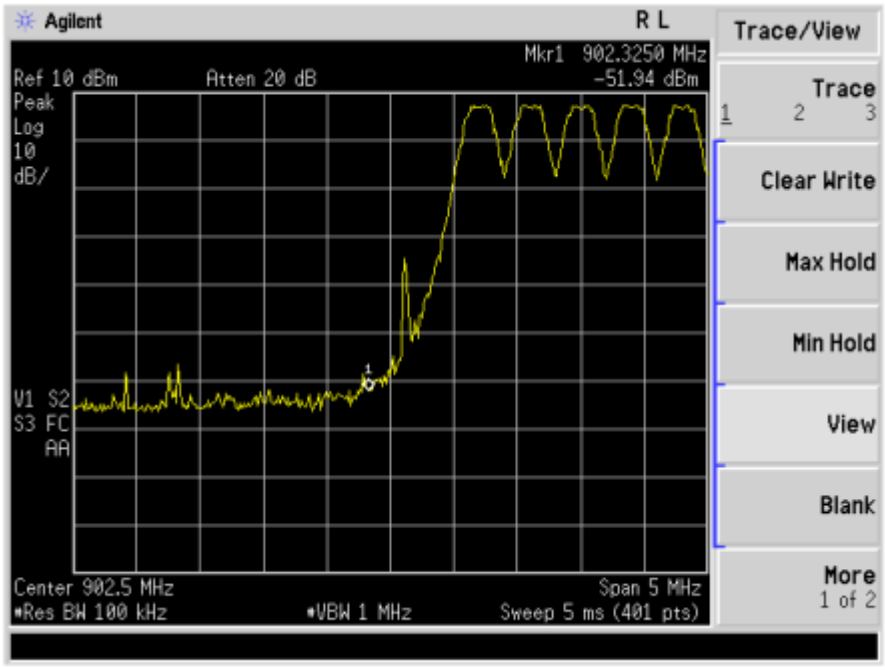
Graph 15 Conducted Spurious Emissions 1 - 5 GHz



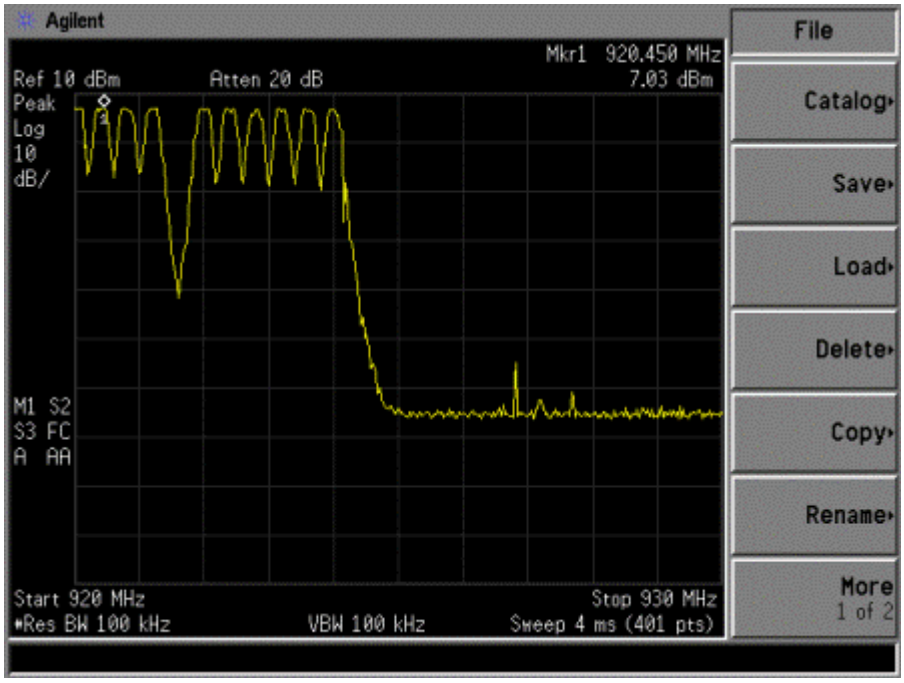
Graph 16 Conducted Spurious Emissions 5 -10 GHz

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 ☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval)		


Agilent
R L
Mkr1 902.3250 MHz
-51.94 dBm
Ref 10 dBm
Atten 20 dB
Peak
Log
10
dB/
V1 S2
S3 FC
AA
Center 902.5 MHz
#Res BW 100 kHz
#VBW 1 MHz
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 17


Agilent
Mkr1 920.450 MHz
7.03 dBm
Ref 10 dBm
Atten 20 dB
Peak
Log
10
dB/
M1 S2
S3 FC
A AA
Start 920 MHz
#Res BW 100 kHz
VBW 100 kHz
Stop 930 MHz
Sweep 4 ms (401 pts)
File
Catalog
Save
Load
Delete
Copy
Rename
More
1 of 2

Graph 18

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) = 9.04 dBm

Antenna Gain (dBi) = 2.15 dBi

EIRP = 11.19 dBm = 13.2 mW

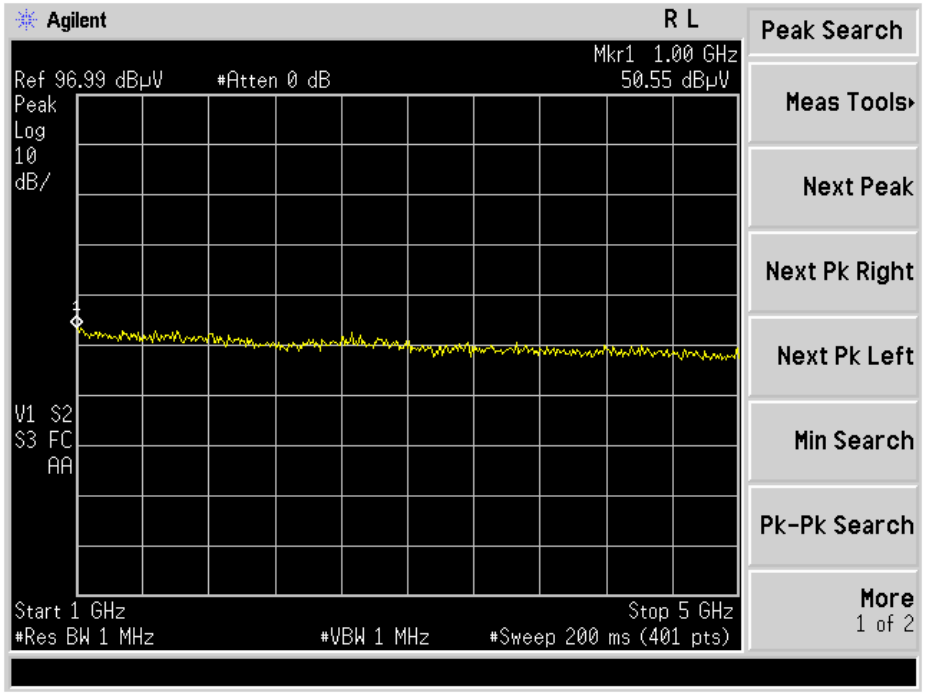
Since both Conducted Output Power and EIRP are below the low threshold, device complies with FCC RF radiation exposure limits for general population/uncontrolled exposure as a portable device without SAR evaluation.

12.0 List of Test Equipment

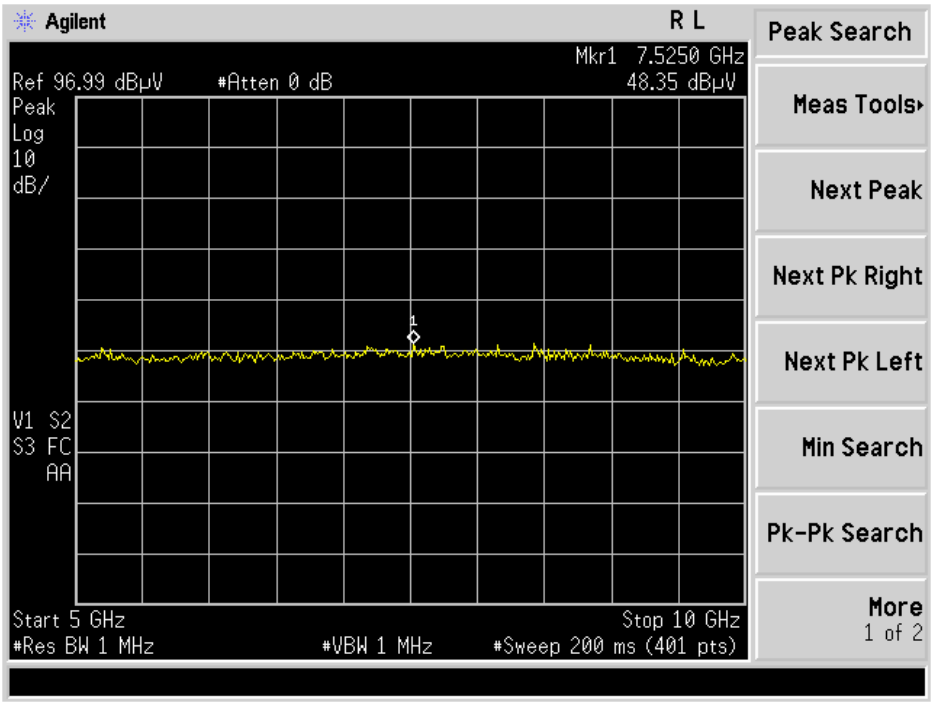
Instrument	Mftr.	Model	Calibration Due
Measuring Receiver	Rohde and Schwarz	ESVS30	18/04/12
Bilog Antenna	Chase	CBL6111	02/09/12
Spectrum Analyser	Agilent	E4408B	11/08/12
Measuring Receiver	Rohde and Schwarz	ESHS30	27/10/12
LISN	Rohde and Schwarz	ESH3-Z5	13/08/12
Horn Antenna	EMCO	3115	12/04/12
Preamplifier	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 19 Radiated Spurious Emissions 1 GHz – 5 GHz Vertical and Horizontal



Graph 20 Radiated Spurious Emissions 5 GHz – 10 GHz Vertical and Horizontal

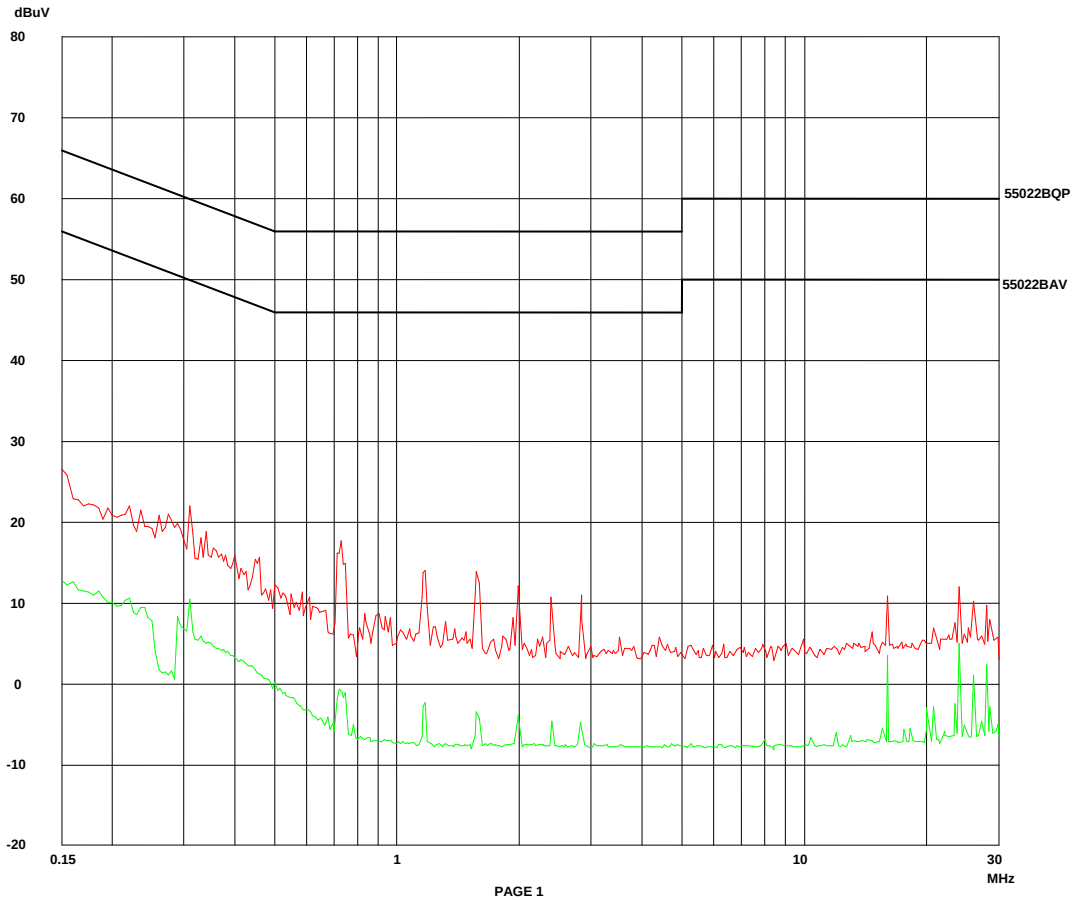
Compliance Engineering Ireland ltd 26. Oct 11 12:47
Conducted Emissions

Op Cond: Normal
Operator: D DUNNE

Scan Settings (1 Range)
|--------- Frequencies ----------||---------- Receiver Settings ----------|

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150k	30M	5k	10k	PK+AV	20ms	AUTO	LN OFF	60dB

Final Measurement: x QP / + AV
Meas Time: 1 s
Subranges: 25
Acc Margin: 6dB



Graph 21 Conducted Emissions Live

Compliance Engineering Ireland ltd
Conducted Emissions

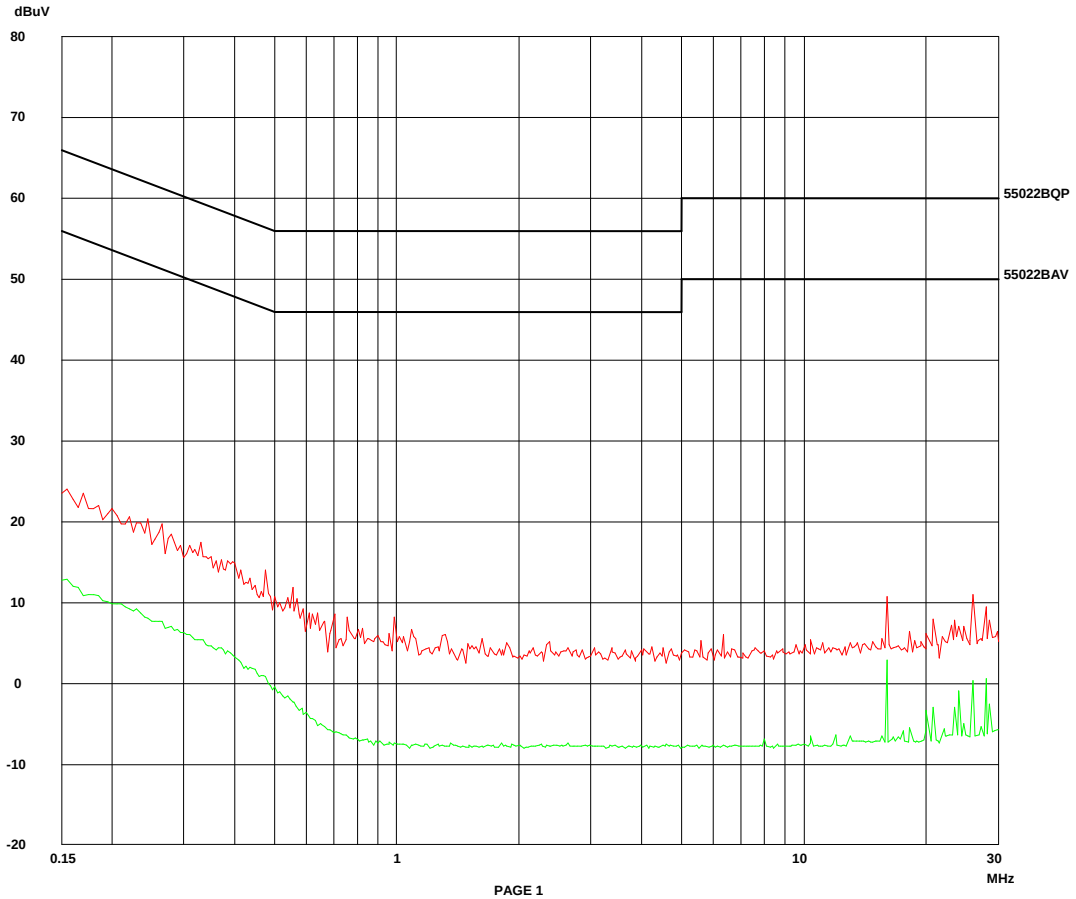
26. Oct 11 13:19

Op Cond: Normal
Operator: D DUNNE

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150k	30M	5k	10k	PK+AV	20ms	AUTO	LN OFF	60dB

Final Measurement: x QP / + AV
Meas Time: 1 s
Subranges: 25
Acc Margin: 6dB



Graph 22 Conducted Emissions Neutral

Appendix B

Test Setups

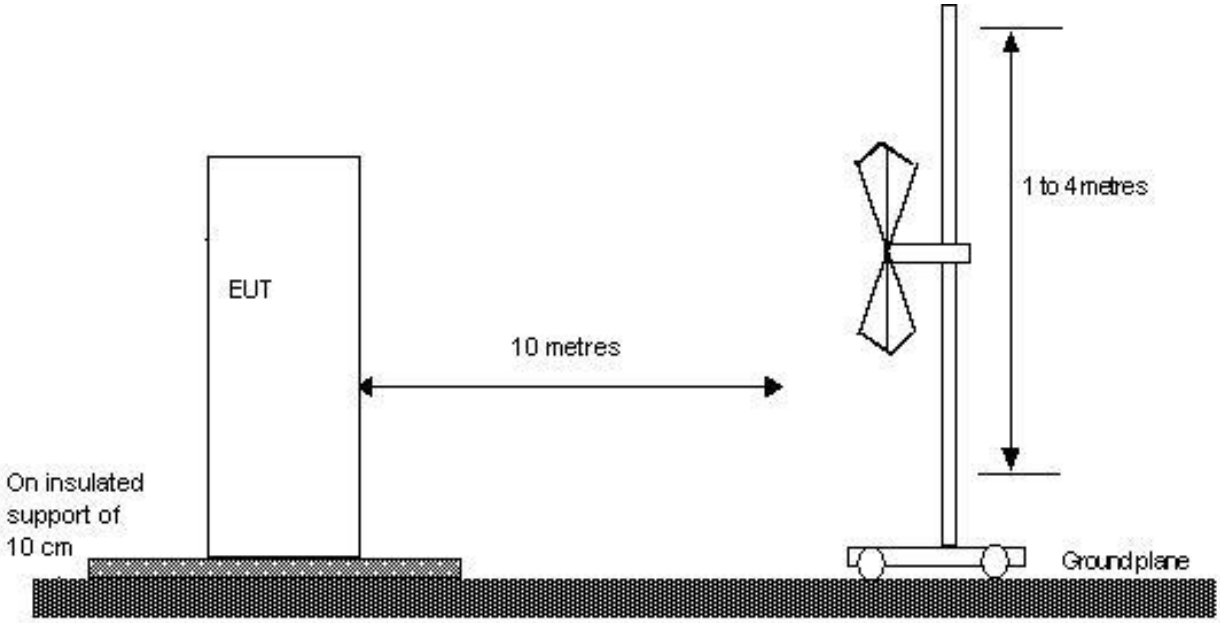


FIGURE 1: Radiated Emissions Test Setup – Test Distance 10m