



## **Electromagnetic Compatibility Test Report**

**Test Report No: MBX 210813 Rev.3**

**Issued on: November 28, 2013**

**Product Name**

**Mini Hub**

**Tested According to**

**FCC 47 CFR, Part 15 Subpart B & C**

**Tests Performed for**

**Mobix Wireless Solutions Ltd.**

25 Bazel St. POB 3849 Petach-Tikva, 49510 Israel

Tel: +972 (3) 9213484

***QualiTech EMC Laboratory***

30 Hasivim Street, P.O. Box 7500

Petah-Tikva, 4951169, Israel

Tel: +972-3-926 8443

Fax: +972-3-928 7490



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## Test Personnel

A handwritten signature in blue ink, appearing to be 'M. Shtier'.

**Tests Performed By:** -----

**Michael Shtier**

A handwritten signature in black ink, appearing to be 'R. Nataf'.

**Report Reviewed By:** -----

**Rami Nataf**  
**Compliance Engineer & Operation Manager**  
**QualiTech EMC Laboratory**

A handwritten signature in blue ink, appearing to be 'M. Dadoun'.

**Report Approved By:** -----

**Maurice Dadoun**  
**EMC Lab. Manager**  
**QualiTech EMC Laboratory**

## Test Report Details:

Test commencement date: 17.03.2013  
Test completion date: 13.05.2013  
Customer's Representative: Ofir Appelbaum  
Issued on: 28.11.2013

## Revision details:

Version	Date	Details/Reasons
Rev. 1	21.08.2013	-
Rev. 2	28.11.2013	1.Test results table in clause 3.1:Radiated Emissions (on page 8) updated to meet the test standard requirements. 2.The field strength of fundamental measurement was retested and the duty cycle took into account.(on page 16)
Rev .3	11.02.2014	on sections 3.1 & 4.1 the measurements noise level was documented

## Assessment Information:

This report contains an assessment of the EUT against Electromagnetic Compatibility based upon tests carried out on the samples submitted. The results contained in this report relate only to the items tested. Manufactured products will not necessarily give identical results due to production and measurement tolerances. QualiTech, EMC Lab does not assume responsibility for any conclusion and generalization drawn from the test results with regards to other specimens or samples of type of the equipment represented by test item.

The EUT was setup and exercised using the configuration, modes of operation and arrangements defined in this report only.

## Modifications:

### Modifications made to the EUT

None

### Modifications made to the Test Standard

None

## Summary of Compliance Status:

### FCC Part 15, Subpart C Part 15.249 – Intentional Radiators

Test Spec. Clause	Test Case	Remarks
FCC Part 15, Subpart B – Unintentional Radiators		
§15.107	Conducted Limits	Pass
§15.109	Radiated Emission Limits	Pass
FCC Part 15, Subpart C – Intentional Radiators		
§15.203	Antenna Connector requirement	Pass
§15.205	Radiated Emissions, Restricted Bands	Pass
§15.207	Conducted Limits	Pass
§15.209	Radiated Emission Limits, General Requirements Complies	Pass
§15.249	Operation within the Bands 902-928MHz, 2400-2483.5MHz, 5725-5875MHz, and 24.0-24.25GHz	Pass



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## **1. General Description**

### **1.1. Description of the EUT /test Item:**

**Product name: Mini Hub**

**FCC ID: Z2K400**

**FRN: 0021159595**

#### **EUT Description:**

The n-DNet Mini Hub H100/400 main functions is serving as an n-DNet node and an interface between a single meter (electricity, gas or water meter) and the n-DNet network. The Mini Hub connects to the meter either by serial interface or by pulse output, collects the data, and transmits it to the concentrator periodically.

The communication to the concentrator is done using Mobix n-DNet technology utilizing the advantages of simultaneous data transfer over both the power lines and the air. The transmission over power lines (PLC) complies fully with the CENELEC (European committee for electromechanically standardization) specifications for usage of unlicensed bands over public electricity grid, and with the FCC definitions for the US markets. The Mini Hub unit interfaces seamlessly with non n-DNet devices either PLC or RF based. In this way it can serve as an n-DNet backbone for such devices. A group of Mini Hubs forms a mesh network which is served by an n-DNet concentrator device. The concentrator is then connected to Mobix MDM using any TCP interface (LAN, GPRS etc).

The MiniHub monitoring the meters, and is being polled by a data concentrator several times per day, over RF and PLC modems. When it has data to send back, it will reply on these polls with the accumulated data it is collecting. It has an internal power supply, and two modems to support the communication.

## **2. Method of Measurements**

### **2.1. Radiated Emissions Measurements in the restricted bands:**

For radiated emissions, which fall in the restricted bands the spectrum from 30MHz to 12.7 GHz was investigated following the guidelines in ANSI C63.4-2003

Measurements were performed with peak detector and repeated averaged with VBW=10Hz for frequencies above 1GHz, and quasi-peak detector below 1GHz.

### **2.2. Radiated Field Strength Measurements:**

During the testing process, the EUT was controlled via dedicated software. The EUT was operated at maximum power, continuous transmission and FSK data modulation.

The EUT was placed in an anechoic chamber, on a non-metallic table/support, 0.8m above the turntable, at 3 meter from the receive antenna, and its position where the maximum antenna gain occurs was identified. The peak and average readings of emissions were measured and recorded.

### **2.3. Conducted Measurement:**

The transmitter output was connected to the Spectrum Analyzer via an RF attenuator, and peak output power was measured.

### **2.4. Radiated Emission measurements:**

During the testing process, the EUT was controlled via dedicated software. The EUT was operated at in receive mode.

Measurements were performed at a 3-meter measurement distance in the semi-anechoic chamber in order to evaluate the radiated electromagnetic interference characteristics of the EUT. The EUT was placed on a non-metallic table/support, 0.8m above the turntable, was configured, arranged and operated in a manner consistent with typical application and load conditions.

An appropriate antenna depending upon the frequency range, per ANSI C63.4-2003 clause 4.1.5 was used. While the turntable was being rotated, the height of the antenna was varied from 1 to 4m for the frequency range of 30 MHz to 12.7 GHz. The highest radiated emission was detected by manipulating the system cables to the worst-case position. This process was repeated for both antenna polarizations. The amplitudes of worst-case emission were measured with the detector modes and resolution bandwidths over various frequency ranges according to the requirements of ANSI C63.4-2003 clause 4.2.

### 3. Report of Measurements and Examinations

#### 3.1. Radiated Emission

Reference document:	<b>47 CFR §15.109/209</b>		
Test Requirements:	Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Sec.15.209. Emission Level shall not exceed the limits of §15.109.		
Test setup:	See sec 2.1	<b>Pass</b>	
Method of testing:	Radiated		
Operating conditions:	Under normal test conditions		
S.A. Settings:	f < 1GHz: RBW: 120kHz, VBW: 300kHz f > 1GHz: RBW: 1MHz, VBW: 3MHz		
Mode of operation:	worse case result of intentional & unintentional transmission (max hold trace)		
Environment conditions:	Ambient Temperature: 22°C	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.1.1 – Plot 3.1.6	

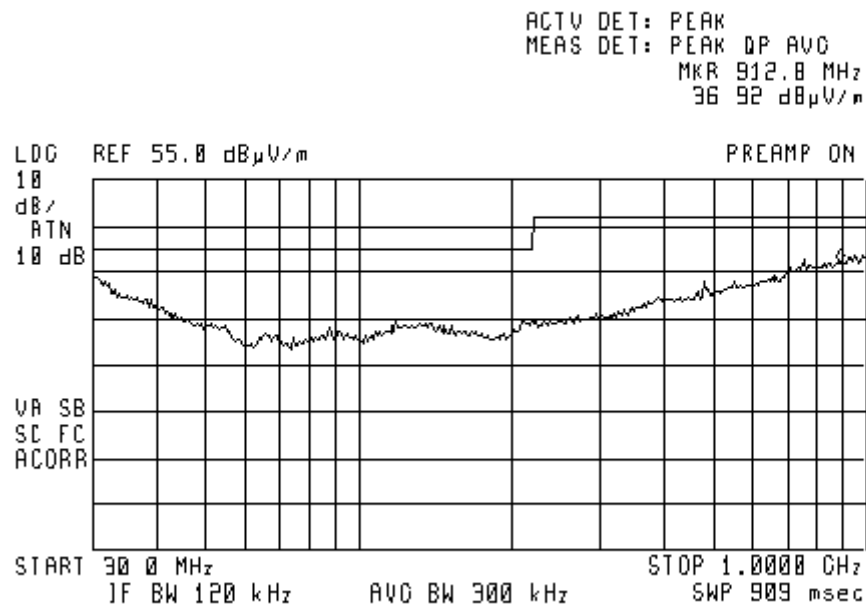
#### Test results: worse case result of intentional & unintentional transmission

Frequency [MHz]	Ant. Type	Ant. Pol.	Ant. Pos. [cm]	Turn-table Azimuth [°]	*Radiated Emission dB(μV/m)	Class B Limit at 3m dB(μV/m)	Margin [dB]	Pass/Fail	comment
30-1,000	Bilog	V&H	100-400	0-360	36.92	46.5	9.58	Pass	Noise Level
1,000-2,900	Horn	V&H	100-400	0-360	33.61	54	20.39	Pass	
2,900-18,000	Horn	V&H	100-400	0-360	18.25	54	35.75	Pass	

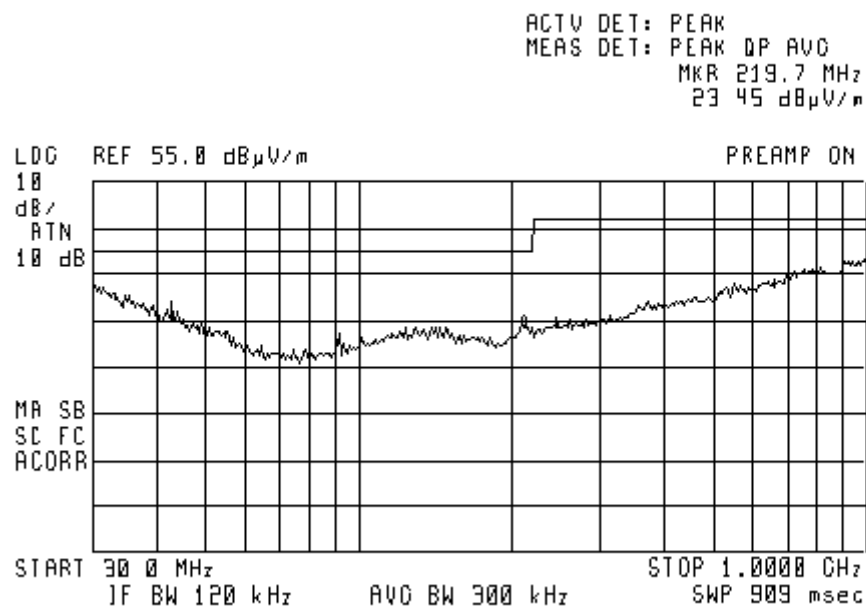
**Note:** Radiated Emission [dBμV/m] = measured [dBμV] + Correction-factor [dB(1/m)]  
Correction Factor = Antenna factor + Cable Loss



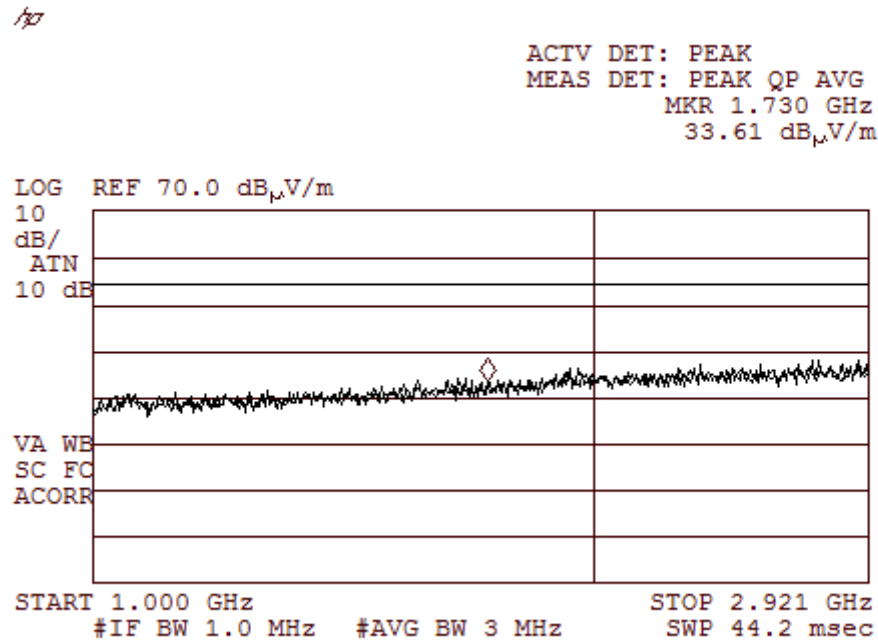
**Horizontal Polarization**  
**30MHz-1GHz**  
**Plot 3.1.1**



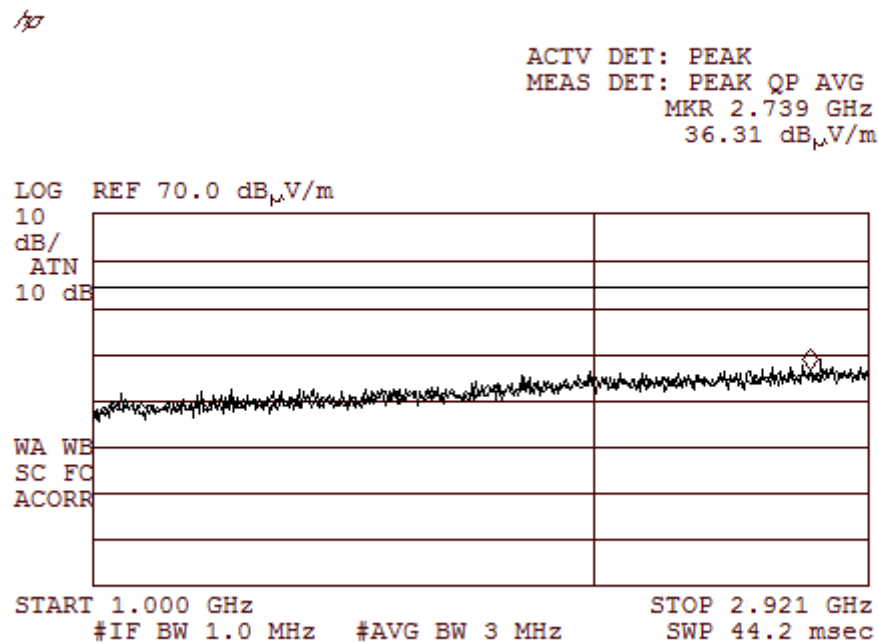
**Vertical Polarization**  
**30MHz-1GHz**  
**Plot 3.1.2**



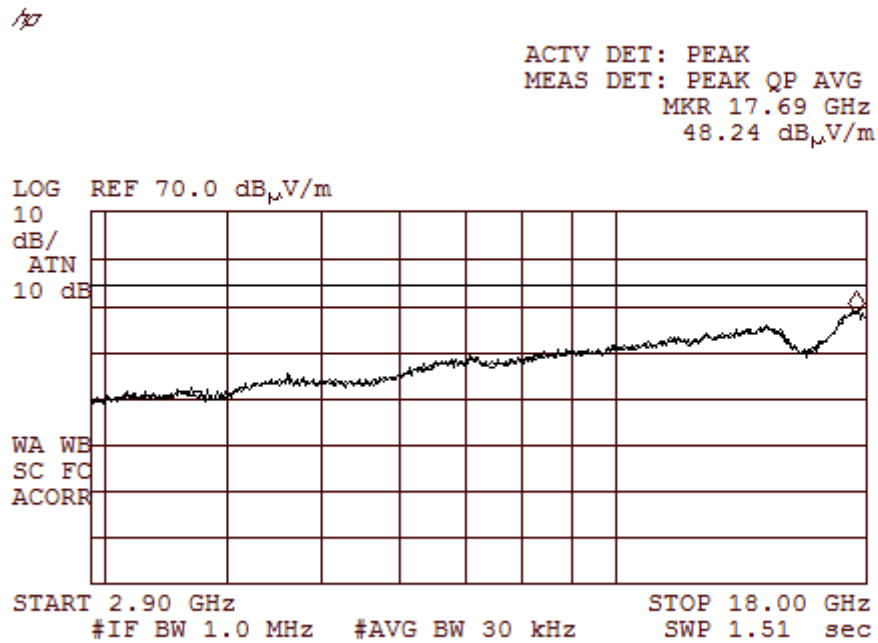
**Horizontal Polarization**  
**1GHz-2.9GHz**  
**Plot 3.1.3**



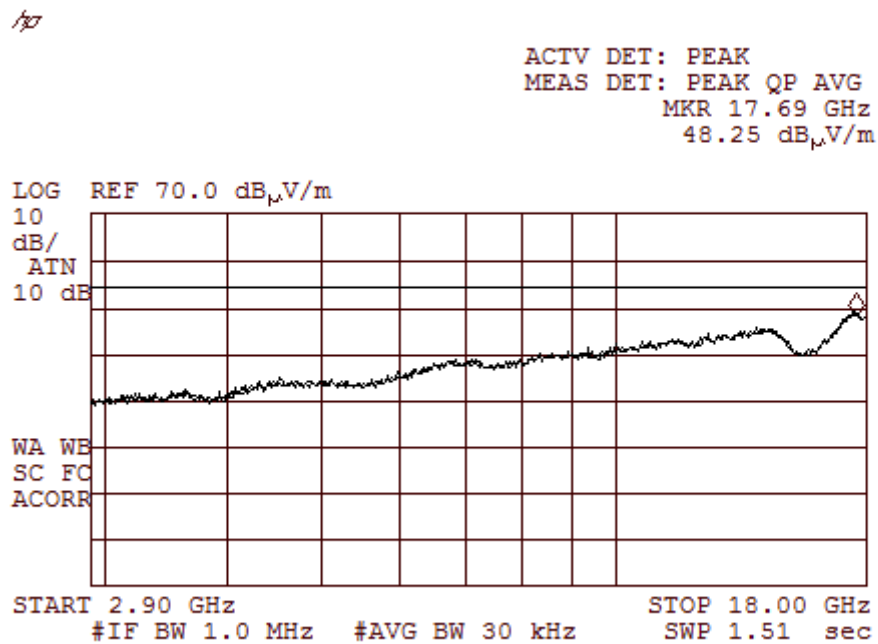
**Vertical Polarization**  
**1GHz-2.9GHz**  
**Plot 3.1.4**



**Horizontal Polarization**  
**2.9GHz-18GHz**  
**Plot 3.1.5**



**Vertical Polarization**  
**2.9GHz-18GHz**  
**Plot 3.1.6**



### 3.2. Power Line Emissions measurements

Reference document:	<b>47 CFR §15.107/207</b>		
Test Requirements:	Any devices using an AC power line are required to comply also with the conducted limits set forth in Sec.15.107/207		
Test setup:	See Sec. 2.2	<b>Pass</b>	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted Emissions		
S.A. Settings:	f <30MHz: RBW: 9kHz, VBW:30kHz		
Mode of operation:	worse case result of intentional & unintentional transmission (max hold trace)		
Environment conditions:	Ambient Temperature: 21°C	Relative Humidity: 54%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.2.1 - Plot 3.2.2	

Test Results: **Test results: worse case result of intentional & unintentional transmission**

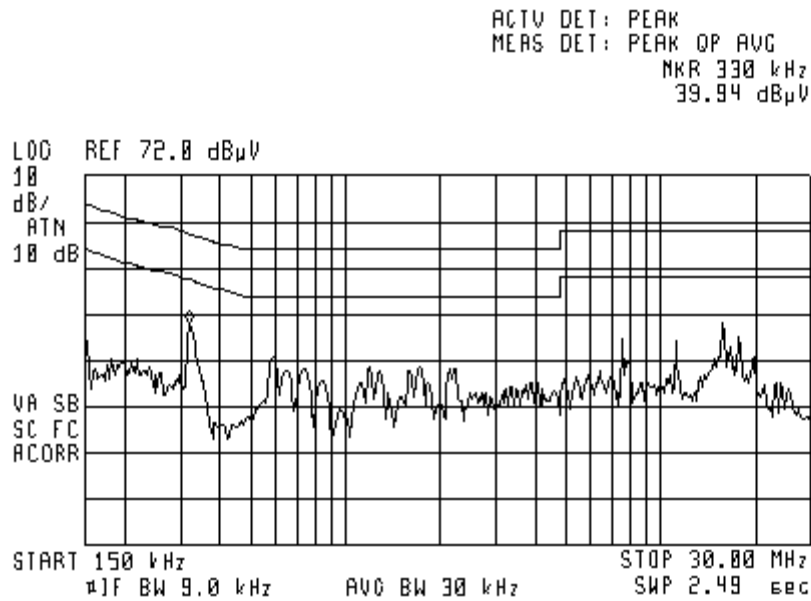
#### “Phase” Lead

Frequency [MHz]	Measured Result [dBμV]		Limit [dBμV]		Margin [dB]		Pass/Fail
	QP	AVR	QP	AVR	QP	AVR	
0.332046	38.6	37.4	59.40	49.40	-20.80	-12.00	Pass
0.673063	28.4	26.6	56.00	46.00	-27.60	-19.40	Pass
1.245927	29	27	56.00	46.00	-27.00	-19.00	Pass
2.245903	27.9	25.2	56.00	46.00	-28.10	-20.80	Pass
5.627219	26.2	22.6	60.00	50.00	-33.80	-27.40	Pass
18.727554	25.4	21.6	60.00	50.00	-34.60	-28.40	Pass

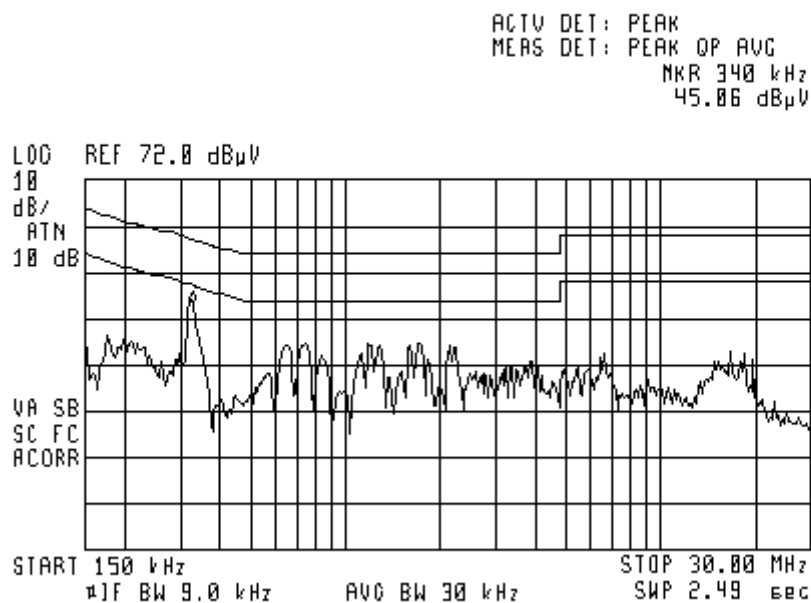
#### “Neutral” Lead

Frequency [MHz]	Measured Result [dBμV]		Limit [dBμV]		Margin [dB]		Pass/Fail
	QP	AVR	QP	AVR	QP	AVR	
0.332982	46	44.5	59.38	49.38	-13.38	-4.88	Pass
0.683398	35.8	33.8	56.00	46.00	-20.20	-12.20	Pass
1.237617	36.2	33.4	56.00	46.00	-19.80	-12.60	Pass
2.248838	35	32	56.00	46.00	-21.00	-14.00	Pass
3.938144	31.7	28.2	56.00	46.00	-24.30	-17.80	Pass
18.436531	34.5	28.8	60.00	50.00	-25.50	-21.20	Pass

**Power Supply Ports**  
**150kHz – 30MHz**  
**“Phase” Lead**  
**Plot 3.2.1**



**Power Supply Ports**  
**150kHz – 30MHz**  
**“Neutral” Lead**  
**Plot 3.2.2**



### 3.3. Antenna Connector Requirements

Reference document:	<b>47 CFR §15.203</b>	
Test Requirements:	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with provisions of this section.	
Test Result:	The EUT had integral antenna.	<b>Pass</b>

### 3.4. Radiated Emissions, Restricted Bands

Reference document:	<b>47 CFR §15.205</b>		
Test Requirements:	Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c).		
Test setup:	See Sec. 2.1	<b>Pass</b>	
Operating conditions:	Under normal test conditions		
Method of testing:	Radiated		
S.A. Settings:	RBW: 1MHz, VBW: 3MHz, 10Hz		
Environment conditions:	Ambient Temperature: 22°C	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	In restricted bands: no peaks found. See below	-	

#### Test results:

The EUT complies with the requirements of this Section since it does not operate close the Restricted Bands of Operation. The EUT operates at 915 MHz.

## 4. Report of Measurements and examinations

### 4.1. Field Strength of Fundamental & Harmonics

Reference document:	<b>47 CFR §15.249 (a)</b>		
Test Requirements:	the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:		
	<b>Fundamental frequency</b>	<b>Field strength of fundamental (millivolts/meter)</b>	<b>Field strength of harmonics (microvolts/meter)</b>
	902-928 MHz	50	500
	2400-2483.5 MHz	50	500
	5725-5875 MHz	50	500
	24.0-24.25 GHz	250	2500
Test setup:	See Sec. 2.2		
Operating conditions:	<b>Fail</b>		
Method of testing:			
S.A. Settings:			
Environment conditions:	Ambient Temperature: 23°C	Relative Humidity: 45%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below		
	Plot 4.1.1 & 4.1.2		

### Test Results:

Frequency [MHz]	Measured field Strength, at 3m [dBμV/m] Peak Value	*Duty Cycle factor For AVG	Polarization	Calculated field Strength limit at 3m [dBμV/m] Average	Calculated field Strength limit at 3m [dBμV/m] Peak	Margin [dB] Average	Margin [dB] Peak	Result	Comments
915	101.1	-7.96	Vertical & Horizontal (worst case)	94	114	-0.86	-12.9	Pass	-
1,000-10,000	46.17	-	Vertical & Horizontal (worst case)	54	74	-7.83	-27.83	Pass	Noise level

\*Duty Cycle factor =  $20 \log (40\text{msec}/100\text{msec}) = -7.95 \text{ db}$

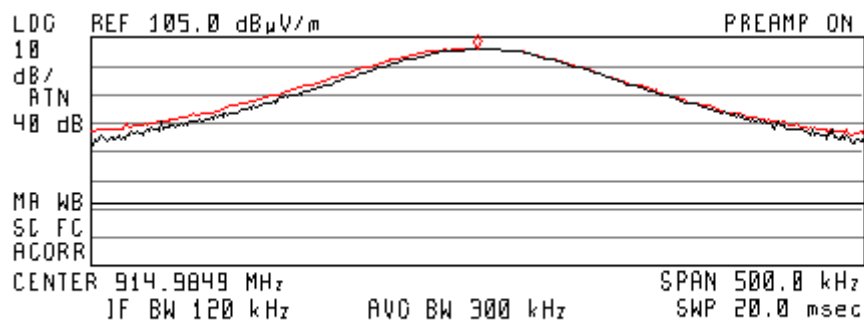


**RE Plot**  
**Plot 4.1.2**

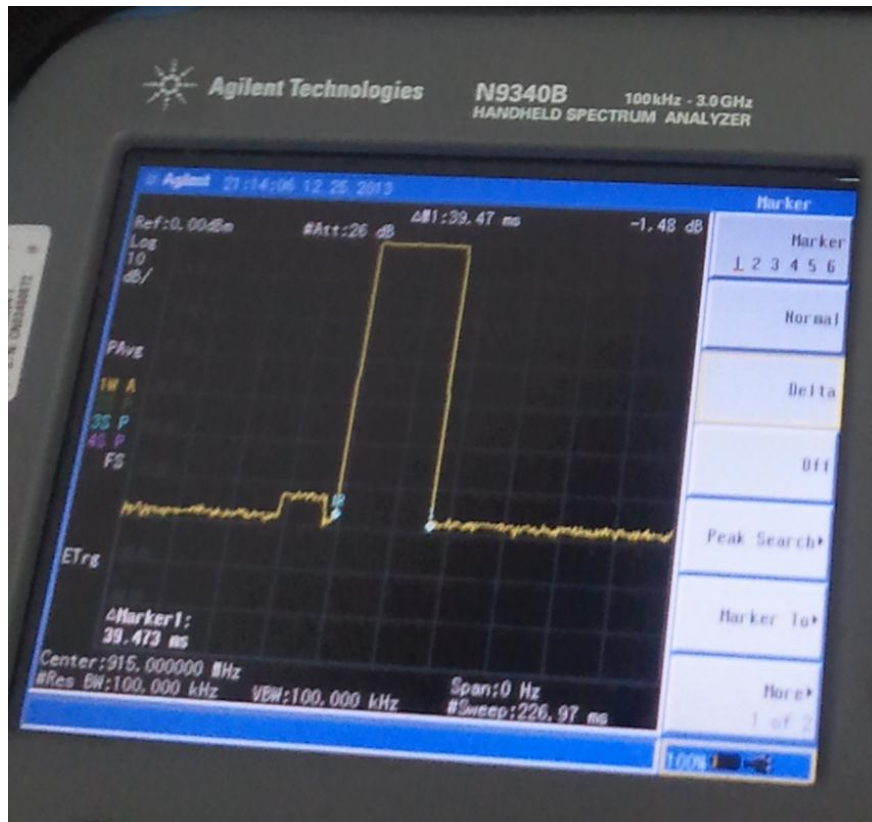


Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QPΔL2
1	914.984873	101.1	100.8	100.9	53.8

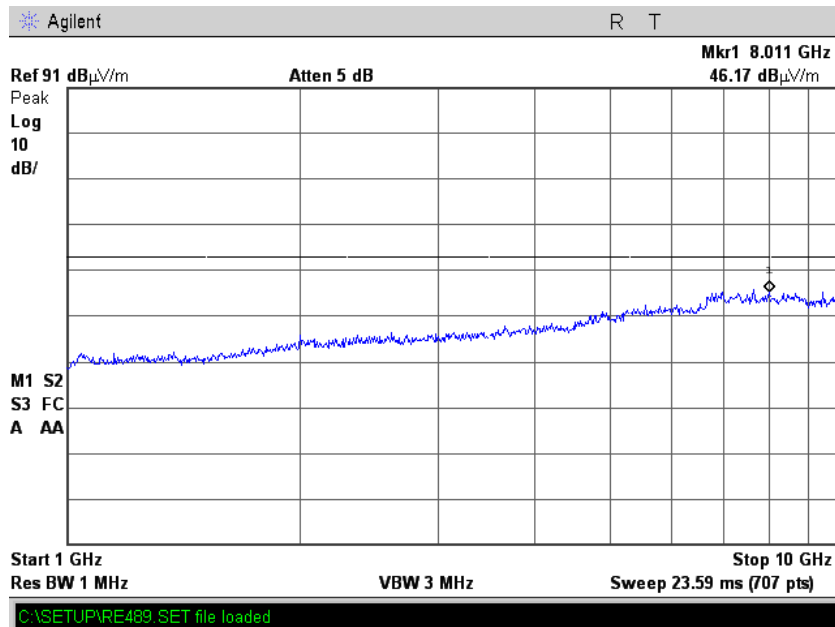
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 914.9849 MHz  
101.15 dBμV/m



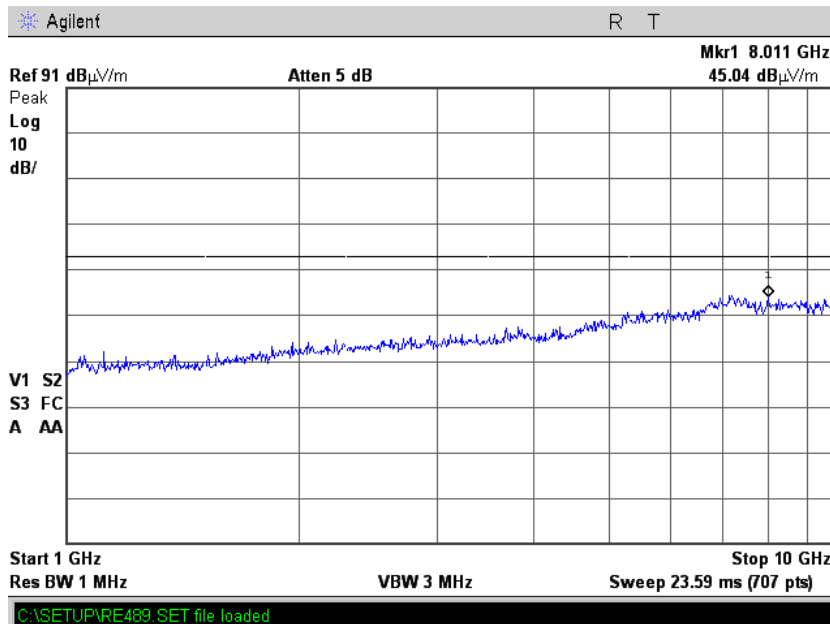
Duty Cycle factor =  $20 \log (40\text{msec}/100\text{msec}) = -7.95 \text{ db}$



### RE Horizontal Polarization Plot 4.1.3



### RE Vertical Polarization Plot 4.1.4



#### 4.2. Emissions radiated outside the band

Reference document:	<b>47 CFR §15.249 (d)</b>		
Test Requirements:	Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.		
Test setup:	See Sec. 2.2	<b>Pass</b>	
Operating conditions:	Under normal test conditions		
Method of testing:	Radiated		
S.A. Settings:	RBW: 120kHz, VBW: 300kHz RBW: 120kHz, VBW: 300kHz		
Environment conditions:	Ambient Temperature: 23°C	Relative Humidity: 45%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	-	

#### Test results:

Frequency [MHz]	Measured field Strength, Peak Value at 3m [dBμV/m]	Polarization	Calculated field Strength limit at 3m [dBμV/m]	Result
All emission were below the limit (see the plots in section 3 )			-50 dbc	Pass

## 5. Appendix

### Appendix A: List of Measuring Equipment used:

Equipment	Manufacturer	Model No.	Serial No.	Calibration Due Date
CISPR16 EMI Receiver	HP	8546A	3710A00392	14.09.2013
EMC Analyzer	HP	8593EM	3536A00131	10.12.2013
Billog Antenna	Teseq	CBL 6141B	34119	03.07.2015
Double Ridge Guide Horn antenna	A.R.A	DRG-118/A	17188	22.01.2015
LISN	Fischer	50/250-25-2	9705	26.10.2013
V-LISN	Schwarzbeck	NNBL 8226-2	120	14.04.2014
Transient Limiter	Agilent	11947A	3107A04121	14.04.2014
Current Probe	Fischer	F35A	44	25.10.2013
CDN	Fischer	T2	9953	31.01.2014
CDN	Fischer	T4	9817	31.01.2014
Universal Telecom	Fischer	ISN F-071115-1057-1	20616	31.01.2014
Discharge Simulator	Noiseken	ESS-2000	8000c03235	10.10.2013
RF Signal Generator	Marconi (IFR)	2025	202301/940	12.11.2013
Power Meter	Boonton	4230	26203	04.12.2013
Power Sensor	Boonton	51015	31821	04.12.2013
EFT Generator	EMtest	EFT 500 N8	V114911192	27.10.2013
Coupling/Decoupling network for burst and surge	EMTest	CNI 503 A18/ 32A	V0947105536	04.10.2013
Surge Generator combination wave,	EMTest	VCS 500 N10	V0824103874	04.10.2013
RF Signal Generator	Marconi	2024	1122681029	08.11.2013
Power Meter	Boonton	4235	26203	10.12.2013
Power Sensor	Boonton	51015	31821	10.12.2013
EM Injection Clamp	Fischer	F2031	348	31.01.2014
CDN	Fischer	C1	9815	31.01.2014
CDN	Fischer	M2	9824	31.01.2014
CDN	Fischer	M3	9840	31.01.2014
CDN	Fischer	T4	9817	02.01.2014
ESD Generator	Noiseken	ESS-2000	8000C03235	10.10.2013
ELF Magnetic Field Meter,	Holaday	HI-3624A	00034615	20.01.2014
Power Source & Analyzer	Pacific Power	140TMX	0233	10.11.2013
Harmonics & Flickers Analyzer,	EM Test	DPA 500	V0627101584	01.10.2013

**Appendix B: Accreditation Certificate**



***End of the Test Report***