



# REPORT

issued by an FCC listed Laboratory Reg. no. 93866.  
The test site complies with RSS-Gen, Issue 2, file no: IC 3482A-2.

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2009-06-05

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## Equipment Authorization measurements on 903-913 MHz

### Transceiver Unit with FHSS

FCC ID: W7UMSTRANS

(13 appendices)

### Test object

Product name: NEAT Transceiver D-TECT (D-TECT or REPO+ depending on software)

Part. number: NE2006004-02.

Two different test objects were used during the tests:

Serial number: 0701501000190 (unmodified).

Serial number: 0701501000084 (modified, see appendix 1)

See appendix 1 for which test object sample that been used for each partial test.

The EUT was powered by an AC-DC-adapter Mascot type 9725, primary: 120 V AC/60 Hz, secondary: 12 V DC/7 W.

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FCC ID: W7UMSTRANS

**Summary**

See appendix 1 for general information and appendix 13 for photos.  
 Emission measurements as specified below have been performed.

Standard	Compliant	Appendix	Remarks
<b>FCC 47 CFR Part 15 C (07-10-08)</b>			
§15.247 Operation within the band 902-928 MHz	Yes		
§15.247 (a) (1) Carrier frequency separation and 20 dB BW	Yes	2	
§15.247 (a) (1) (i) Number of hopping frequencies and dwell time	Yes	3	
§15.247 (b) (2) Maximum peak conducted power	Yes	4	
§15.247 (d) 20 dBc below fundamental	Yes	5	
§15.247 (d) Restricted bands of operation	Yes	6	Note 1
§15.247 (i) RF safety	Yes	7	
§15.207 Conducted emission limits	Yes	8	Note 2
§15.215 (c) 20 dB bandwidth	Yes	9	
§15.111 (a) Antenna power conduction limits for receivers	Yes	10	
§2.1049 Occupied bandwidth	Yes	11	
§2.1049 Band Edge	Yes	12	

Note 1: To reduce the emission level below limit, the EUT was modified, see appendix 6.

Note 2: To reduce the emission level below limit, the EUT was modified, see appendix 8.

**SP Technical Research Institute of Sweden**  
**Electronics - EMC**



Christer Karlsson  
 Technical Manager



Fredrik Isaksson  
 Technical Officer

## Performance test and requirements

The tests were performed to verify that the electromagnetic compatibility of NEAT Transceiver meets the requirements of FCC 47 CFR part 15 C.

### Test facility

The used test site (SP 504 114) is compliant with the requirements of section 2.948 of the FCC rules and listed, registration number 96866, as a facility accepted for certification under parts 15 and 18. The site complies with RSS-Gen, Issue 2 and is accepted by Industry Canada for the performance of radiated measurements, file number: IC 3482A-2.

### Test object

Transceiver:	NEAT Transceiver, D-TECT
Antenna	Dedicated (SMA) Yangzhou Jingcheng TQX-800-1.5E, modified for 906 MHz center frequency
Antenna gain:	1.5 dBi
Frequency:	903-913 MHz
Frequency used during test:	903 MHz 913 MHz and FHSS function enabled
Modulation:	FHSS, GFSK
Number of hopping frequencies:	50
Channel hopping separation:	100 kHz
Data rate (radio):	2400 baud
Data rate (RS485):	9600 baud
Supply voltage:	120 V AC/60Hz

The EUT was powered by an AC-DC-adapter Mascot type 9725, primary: 120 V AC/60 Hz, secondary: 12 V DC/7 W.

### Used test object sample for each partial test

	s/n: 0701501000190 (unmodified)	s/n: 0701501000084 (modified)
Carrier frequency separation and 20 dB BW	X	
Number of hopping frequencies and dwell time	X	
6dB bandwidth	X	
Maximum peak conducted power		X
20 dBc below fundamental		X
Restricted bands of operation		X
RF safety		X
Conducted emission limits		X
20 dB bandwidth	X	
Antenna power conduction limits for receivers	X	
Occupied bandwidth		X

**Operational test mode**

Two cables, DC power and RS485 were connected to the EUT.  
The EUT was transmitted continuously (100% duty cycle) with normal modulation.

Cabling during emission test:

EUT port	Cable type	Termination / use
12 V DC	2-wire, unshielded, 3.0 m length., bundled to 1.2 m.	Mascot AC-DC-adapter.
RS485	Unshielded twisted pair 0.9 m length.	Unterminated during the radiated measurement and terminated in the minimum system PC via the USB-RS485 converter serial adaptor during the conducted emission test of the 120 V AC port. The power of the minimum system PC was turned off during the test.

**Connected equipment during the conducted emission test of the AC port ("minimum system") (power turned off during the test, only as a termination)**

Computer Fujitsu Siemens Scenic XS 1171-CSCE Identnr. YBLT059100. Powered with 120 V AC.	SP 503 479
Monitor Samsung SyncMaster 700b, s/n: H2HH900906T FCC ID: A3LCGM760. Powered with 120 V AC.	No SP number
Keyboard Keytronic M/N: E03623ELSV P2K-C FCC ID: CIGE03600W	No SP number
Mouse Logitech M/N: M-S48a, S/N: LZH03016891, FCC ID: JNZ201213	No SP-number
VSCOM USB-RS485 converter USB-COM-I SI	Client equipment

**Uncertainties**

Measurement and test instrument uncertainties are described in the quality assurance documentation "EL-QD 8.2". The measurement uncertainties can be found in the table below. The uncertainties are calculated with a coverage factor k=2 (95% level of confidence).

**Reservation**

The test results in this report apply only to the particular test object as declared in the report.

The following modifications were made during the test.

During the restricted bands of operation test, the following modifications were made:

- Rerouted signal path between the radio amplifier and the antenna contact and changing of the output filter.
- Shielding cover mounted over the radio amplifier.
- Improved matching between the radio chip and the radio amplifier.
- Rerouted power supply path to the radio amplifier.
- Improved matching of the center frequency of the transmitter antenna.

During the conducted emission limits test the USB-RS485 converter was changed from Moxa USB-to-serial adaptor, model: UPort 1130 to VSCOM USB-RS485 converter USB-COM-I SI.

See the table on page 1 which unit (unmodified/modified) has been used for the different partial tests.

**Delivery of test object**

The test object was delivered: 2009-02-13 and 2009-05-07 (modified unit).

**Test participant**

Jörgen Jönsson, ARJO HUNTLEIGH (present 2009-05-07)

**Test engineer**

Fredrik Isaksson

**Carrier frequency separation measurements according to FCC 47 CFR part 15.247 (a) (1)**

Date	Temperature	Humidity
2009-02-24	23 °C ± 3 °C	17 % ± 5 %
2009-03-05	22 °C ± 3 °C	23 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003 and according to Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, DA 00-705, released March 30, 2000.

Conducted measurements were performed at the antenna connector and with the FHSS function enabled.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Inmet 2100-20dB attenuator	2010-06	503 871
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

**Measurement uncertainty: 2.6 %****Results**

The diagrams can be found in the appendix 2.1.

Diagram 1 FHSS enabled Hopping channel carrier frequencies separation = 100 kHz  
Diagram 2 FHSS enabled 20 dB BW of the hopping channel = 11.42 kHz

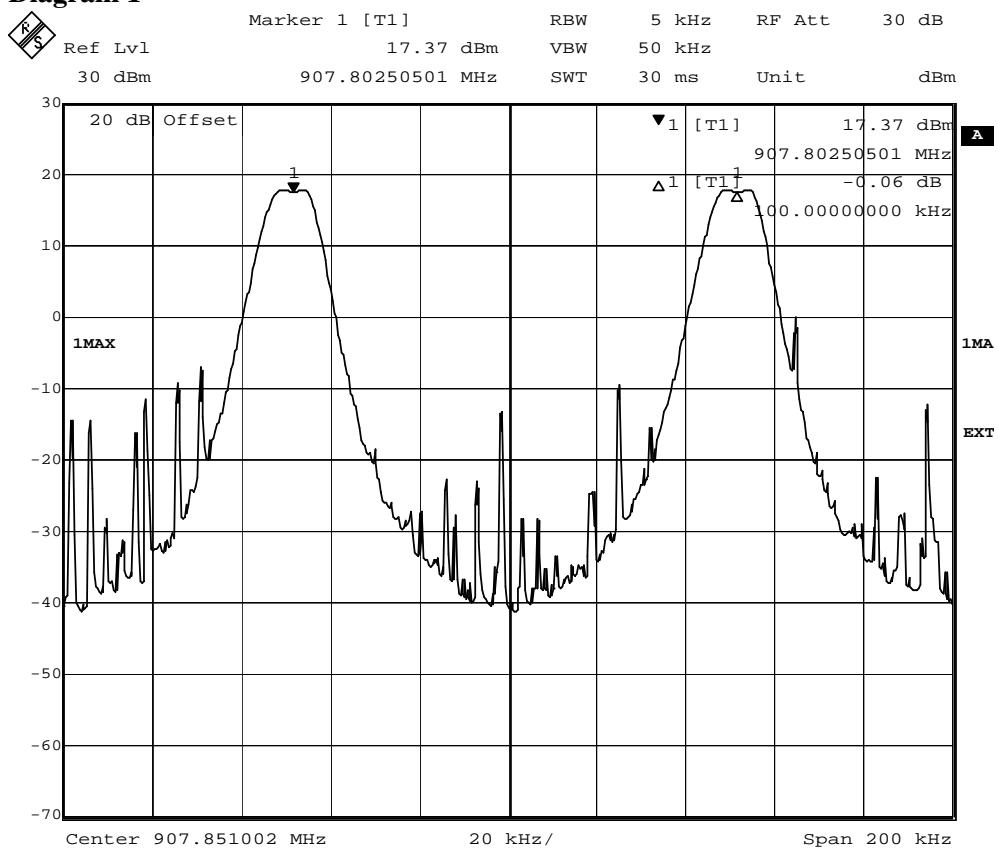
**Limits**

According to 47CFR 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is the greater.

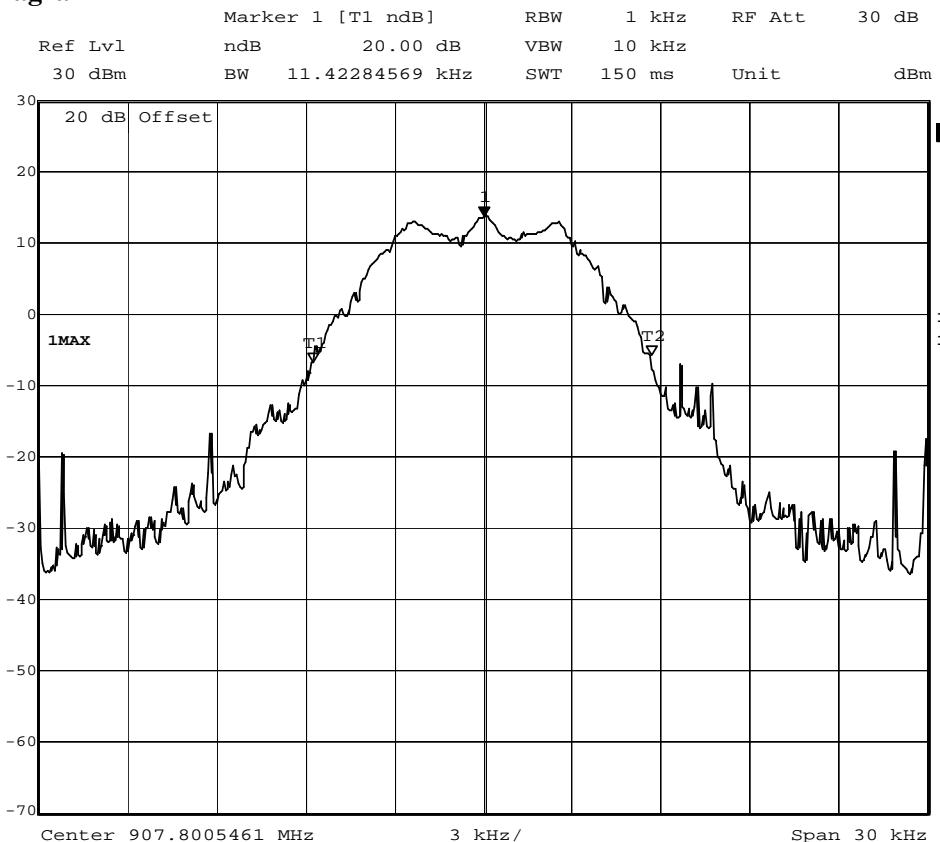
Complies?	Yes
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FCC ID: W7UMSTRANS

Appendix 2.1

**Diagram 1**

Date: 24.FEB.2009 11:15:03

**Diagram 2**

Date: 5.MAR.2009 15:19:29

**Number of hopping frequencies and dwell time measurements according to FCC 47 CFR part 15.247 (a) (1) (i)**

Date 2009-02-24	Temperature 23 °C ± 3 °C	Humidity 17 % ± 5 %
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**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003 and according to Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, DA 00-705, released March 30, 2000.

Conducted measurements were performed at the antenna connector and with the FHSS function enabled.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Inmet 2100-20dB attenuator	2010-06	503 871
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

**Measurement uncertainty:** 1.3 %

**Results**

The diagrams can be found in the appendix 3.1.

Diagram 1	FHSS enabled	Number of hopping frequencies, hopping channel 1-10
Diagram 2	FHSS enabled	Number of hopping frequencies, hopping channel 11-20
Diagram 3	FHSS enabled	Number of hopping frequencies, hopping channel 21-30
Diagram 4	FHSS enabled	Number of hopping frequencies, hopping channel 31-40
Diagram 5	FHSS enabled	Number of hopping frequencies, hopping channel 41-50
Diagram 6	FHSS enabled	Tx on time during one pulse= 129.9 ms
Diagram 7	FHSS enabled	Tx on time during 20 sec = 3 x 129.9 ms = 389.7 ms

**Remark**

During the dwell time measurements according to Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, DA 00-705, released March 30, 2000, the RBW shall be 1 MHz. As the channel separation is 100 kHz the RBW was chosen to 50 kHz to avoid to detect the adjacent hopping channels.

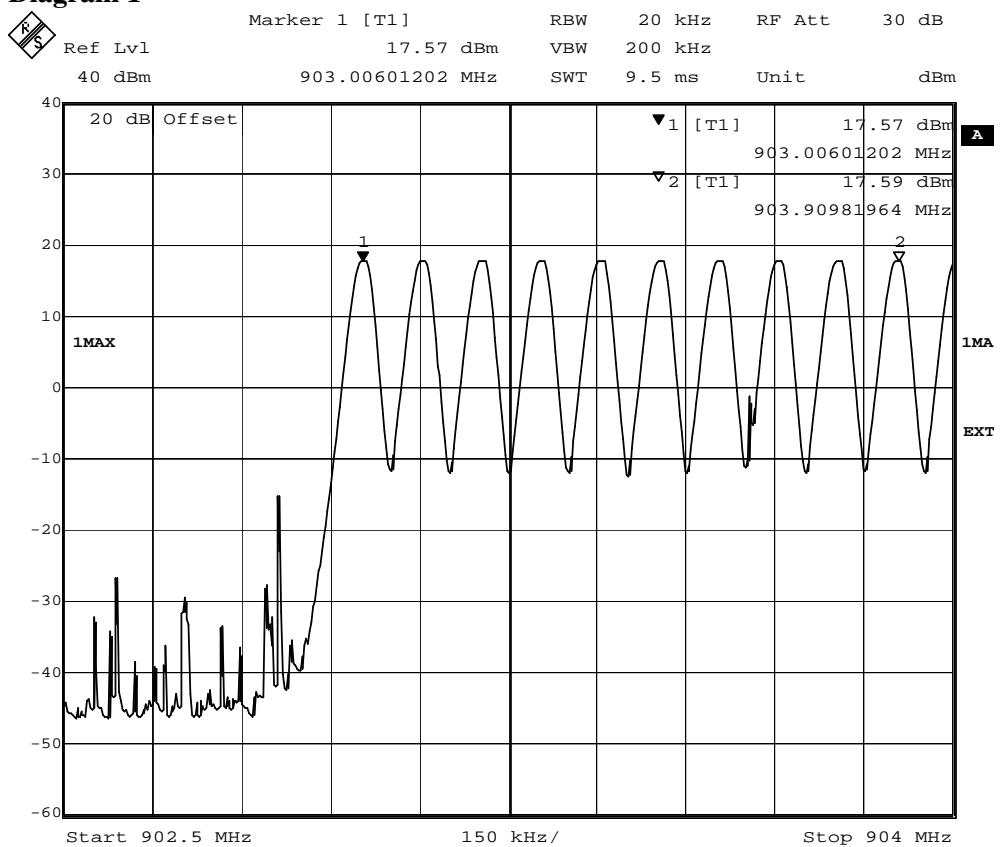
**Limits**

According to 47CFR 15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 20 second period.

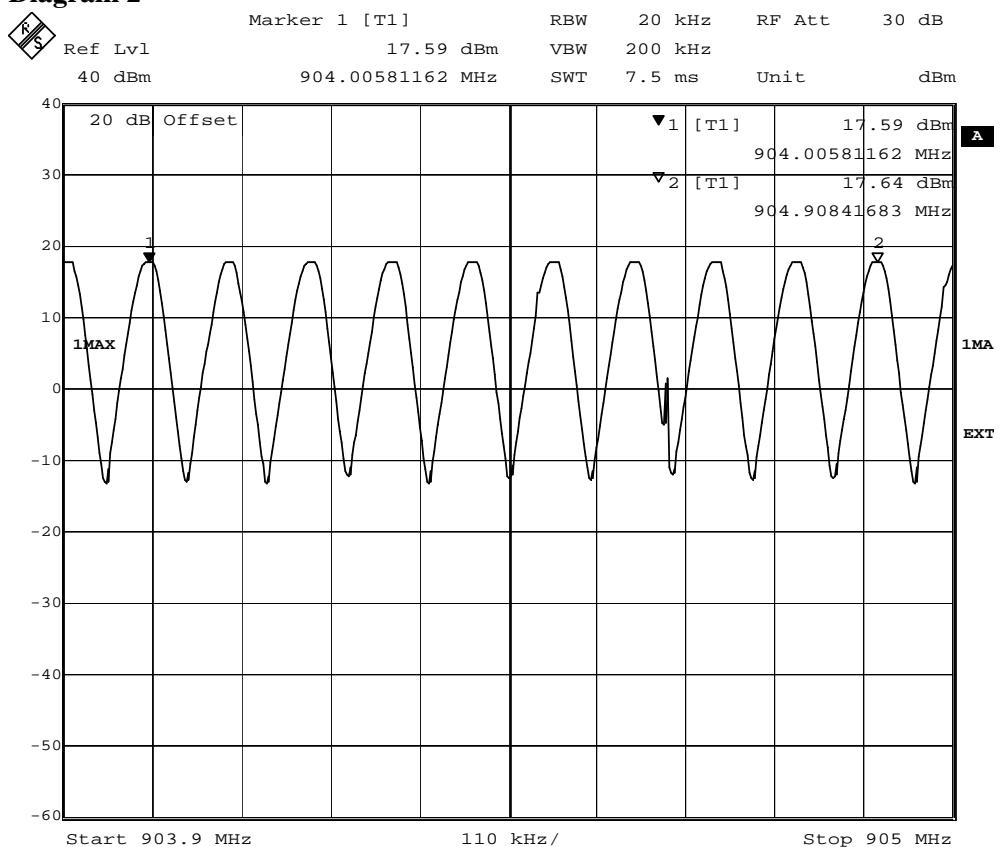
Complies?	Yes
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Appendix 3.1

**Diagram 1**

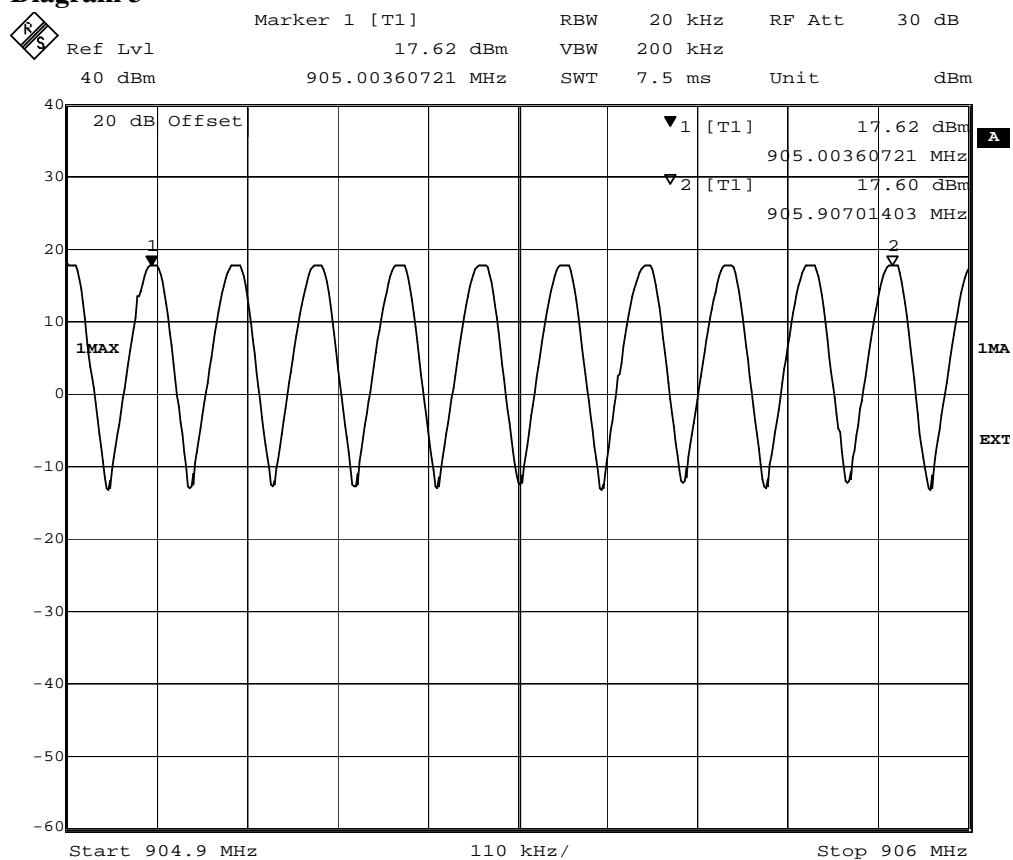
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**Diagram 2**

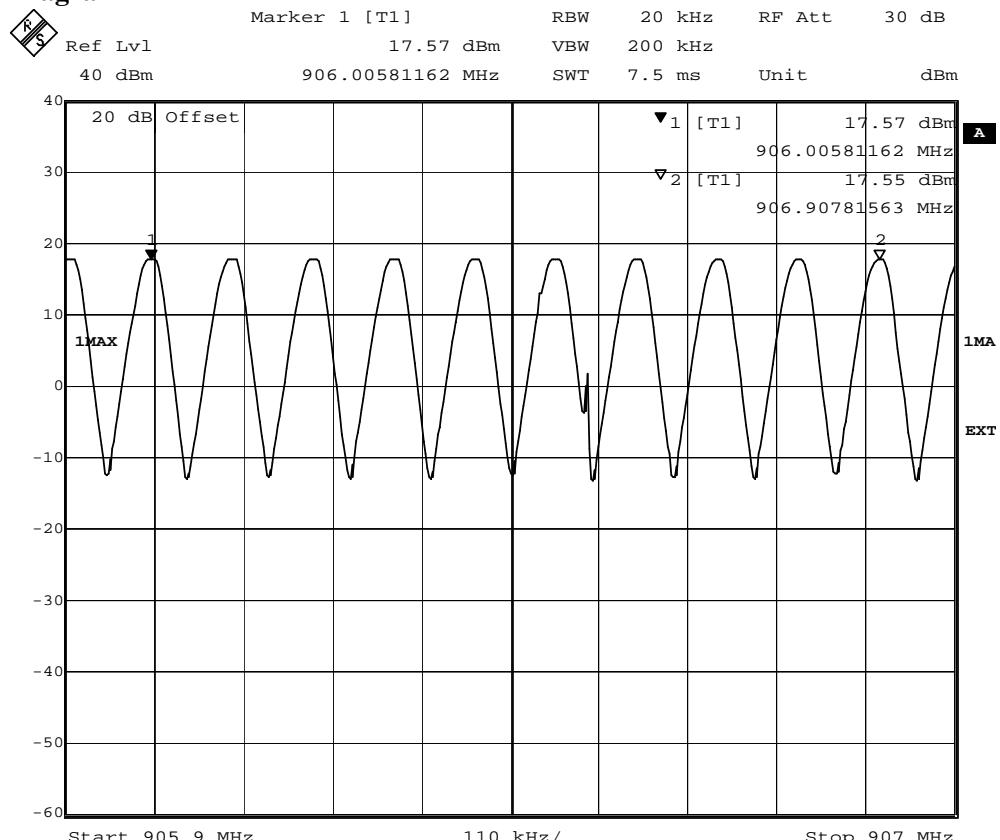
Date: 24.FEB.2009 11:24:40

FCC ID: W7UMSTRANS

Appendix 3.1

**Diagram 3**

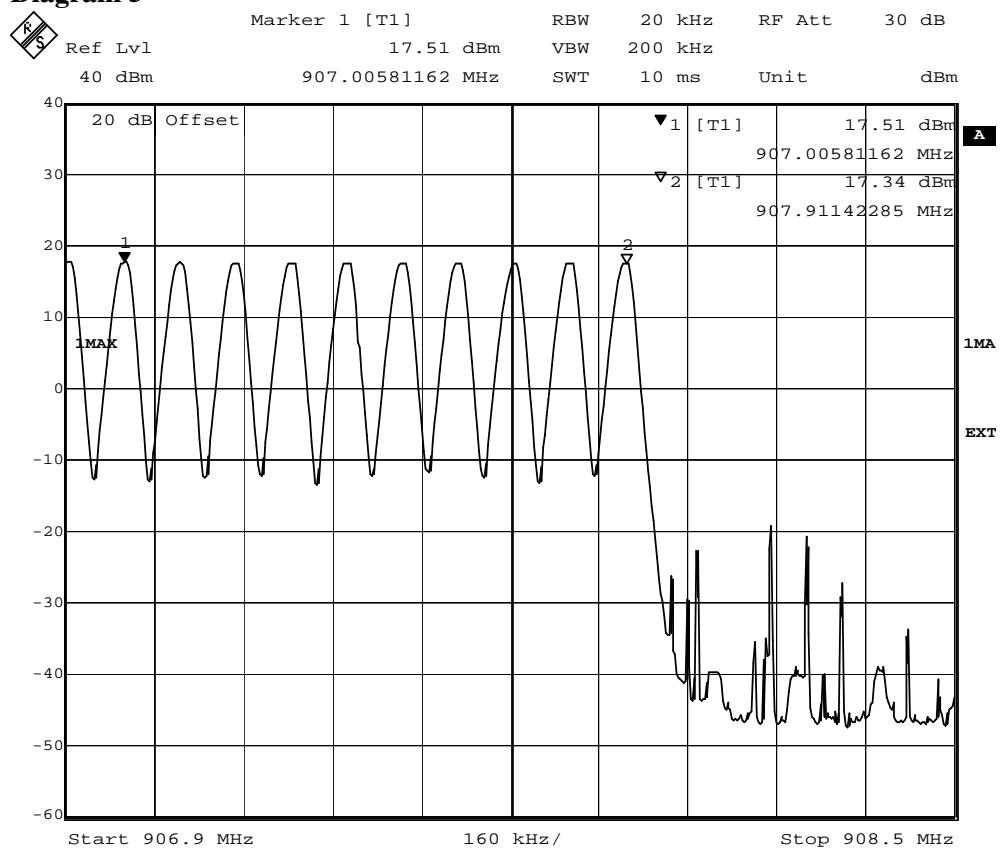
Date: 24.FEB.2009 11:26:02

**Diagram 4**

Date: 24.FEB.2009 11:27:01

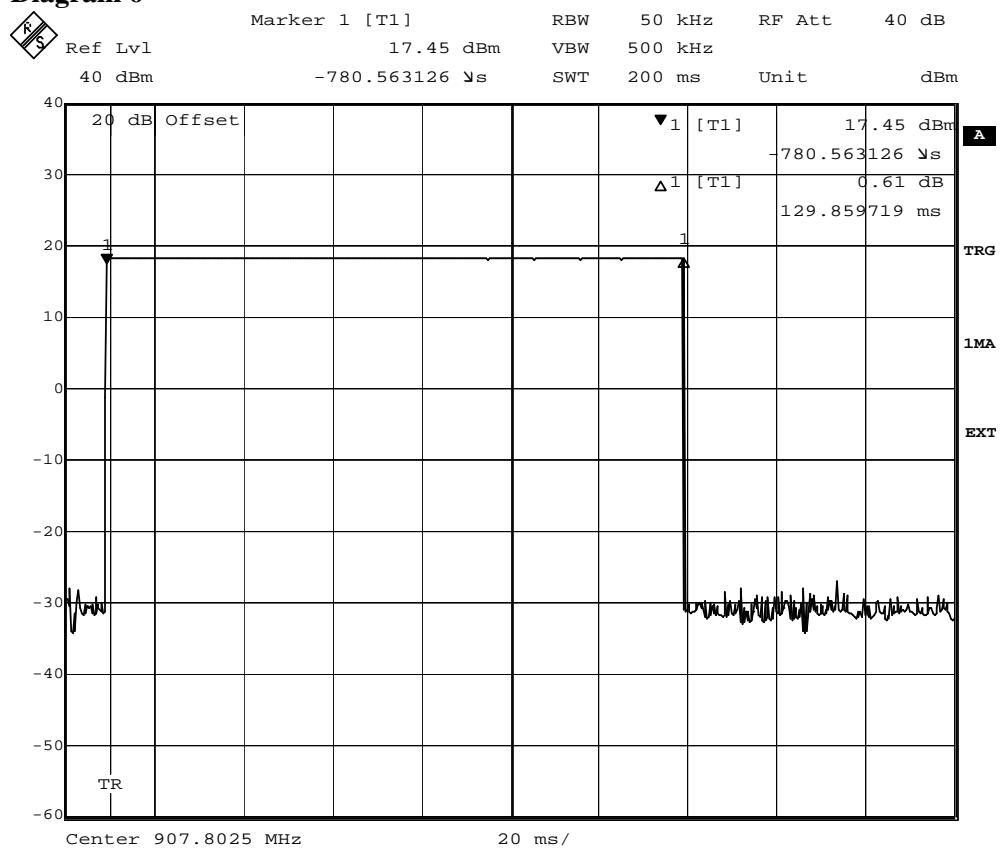
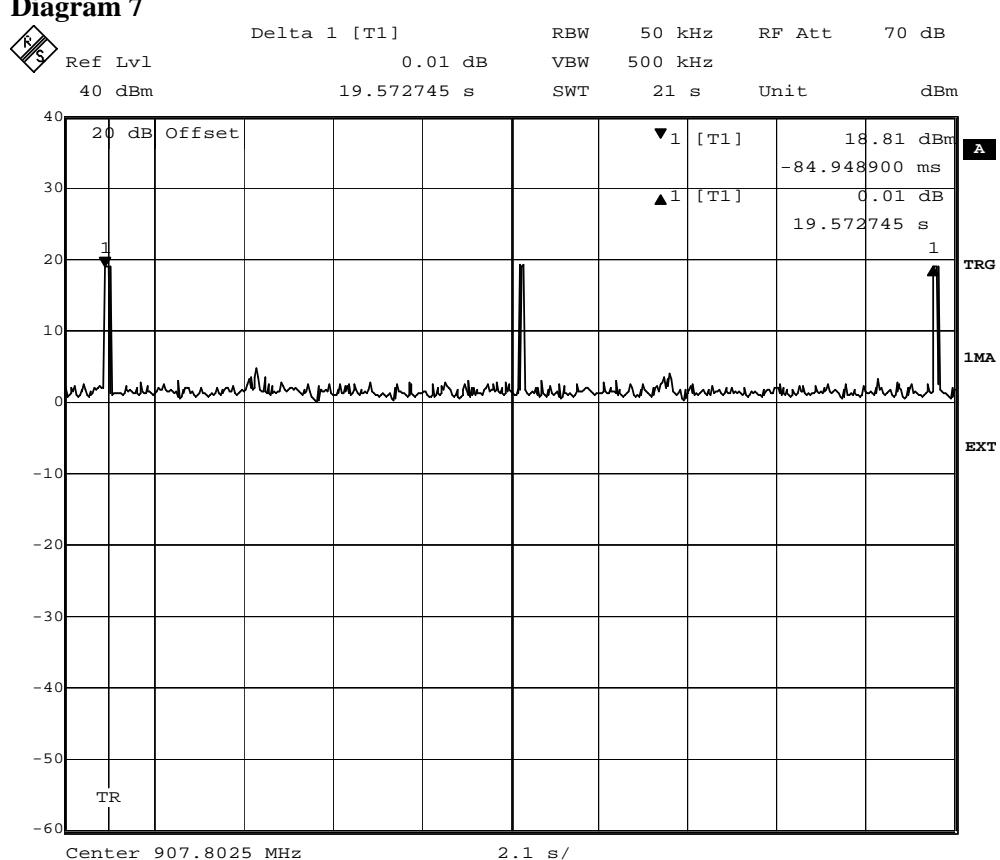
FCC ID: W7UMSTRANS

Appendix 3.1

**Diagram 5**

FCC ID: W7UMSTRANS

Appendix 3.1

**Diagram 6****Diagram 7**



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Appendix 4

**Maximum peak conducted output power measurements according to  
FCC 47 CFR part 15.247 (b) (2)**

Date 2009-05-07	Temperature 23 °C ± 3 °C	Humidity 32 % ± 5 %
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**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

Conducted measurements were performed at the antenna connector and with continuous transmission (100% duty cycle) and with modulation.

Measurement equipment	Calibration Due	SP number
Test site Edison	-	15:121
Boonton RF Peak power meter 4500A	2009-09	503 144
Boonton Peak power sensor 56518-S/4	2009-09	503 146
Inmet 2100-20dB attenuator	2010-06	503 871
HP 6813B AC power source	2010-07	503 091
Fluke 83 multimeter	2010-01	501 522
Temperature and humidity meter Testo 625	2011-03	504 117

**Measurement uncertainty:** 0.7 dB

**Results**

		Max peak output power Peak/Average (dBm)	
		903.0 MHz	913.0 MHz
T <sub>nom</sub> 23°C	V <sub>nom</sub> 120 V AC	10.5/10.2	9.8/9.5
T <sub>nom</sub> 23°C	V <sub>min</sub> 102 V AC Note 1	10.5/10.2	9.8/9.5
T <sub>nom</sub> 23°C	V <sub>max</sub> 138 V AC Note 1	10.5/10.2	9.8/9.5

Note 1: According 47CFR 15.31(e), For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

**Limits**

According to 47CFR 15.247(b)(2), For frequency hopping systems operating in the 902-928 MHz band: 1 Watt (30 dBm) for systems employing at least 50 hopping channels.

Complies?	Yes
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**20 dBc below fundamental measurements according to FCC 47 CFR part 15.247 (d)**

Date	Temperature	Humidity
2009-06-04	22 °C ± 3 °C	19 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

Conducted measurements were performed at the antenna connector and with continuous transmission (100% duty cycle) and with modulation.

The test was performed with peak detector and with RBW=100 kHz.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Inmet 2100-20dB attenuator	2010-06	503 871
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

**Measurement uncertainty:** 2.6 dB

**Results**

The diagrams can be found in the appendix 5.1.

Diagram 1:	903 MHz	Fundamental
Diagram 2:	903 MHz	9 kHz–30 MHz
Diagram 3:	903 MHz	30-1000 MHz
Diagram 4:	903 MHz	1-10 GHz
Diagram 5:	913 MHz	Fundamental
Diagram 6:	913 MHz	9 kHz–30 MHz
Diagram 7:	913 MHz	30-1000 MHz
Diagram 8:	913 MHz	1-10 GHz

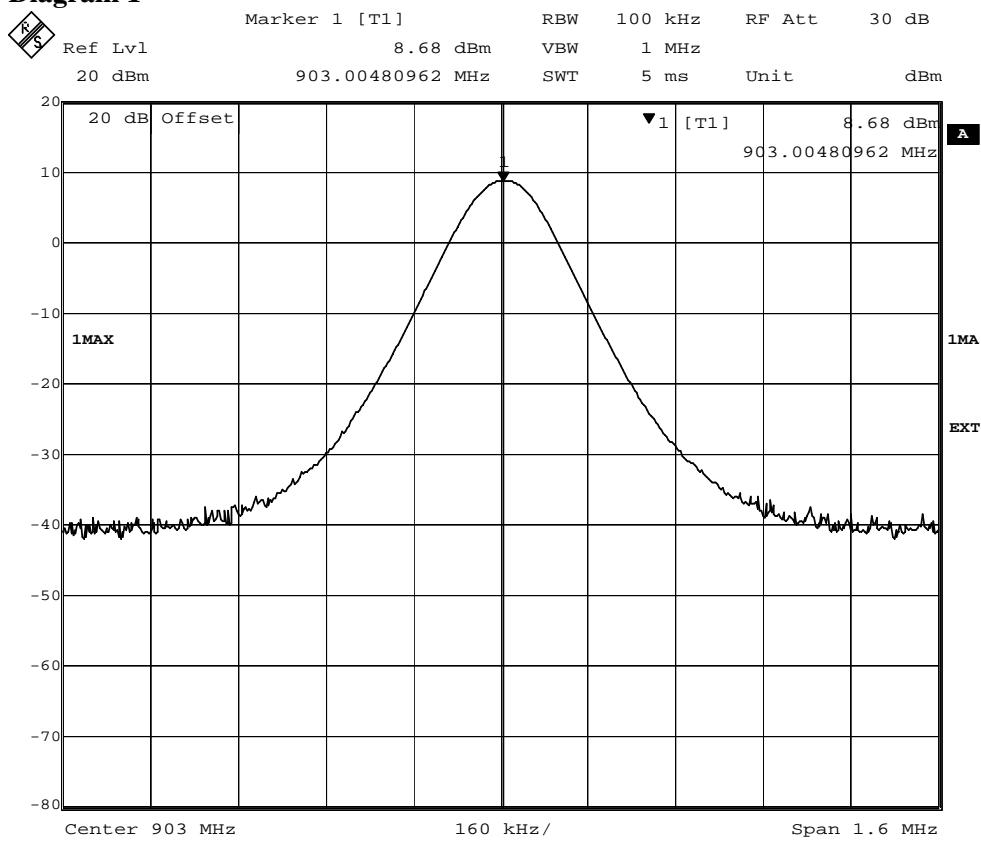
**Limits**

According to 47CFR 15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

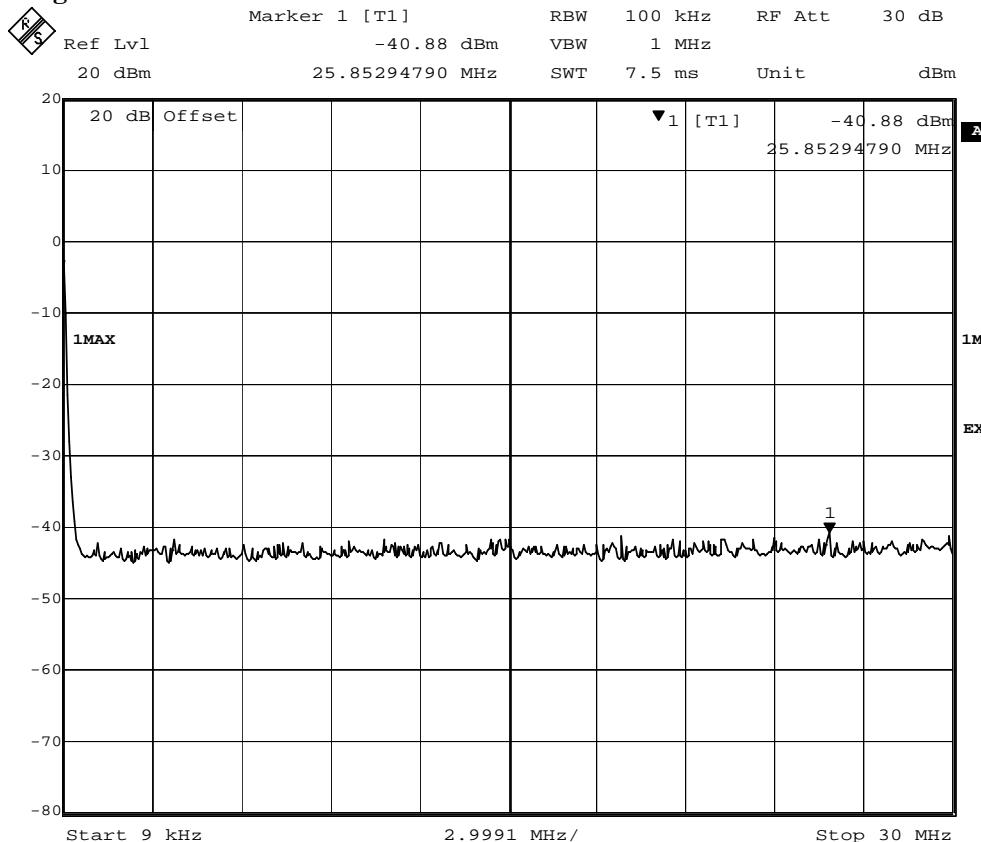
Complies?	Yes
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Appendix 5.1

**Diagram 1**

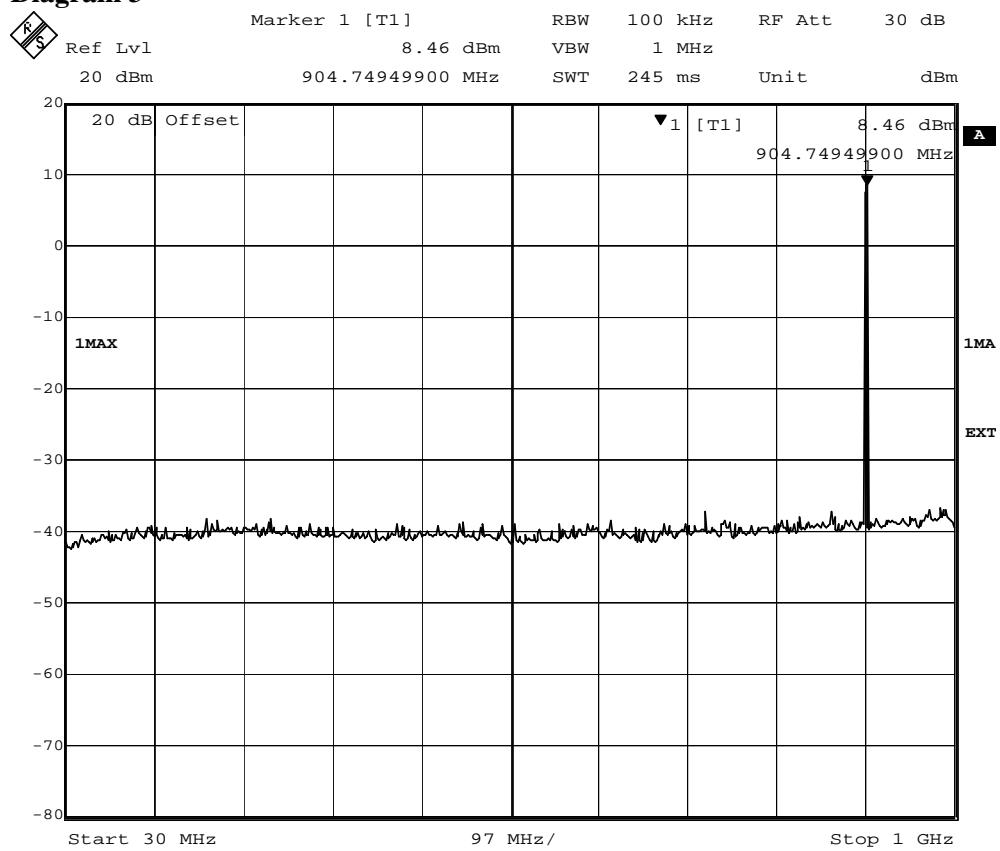
Date: 4.JUN.2009 14:54:54

**Diagram 2**

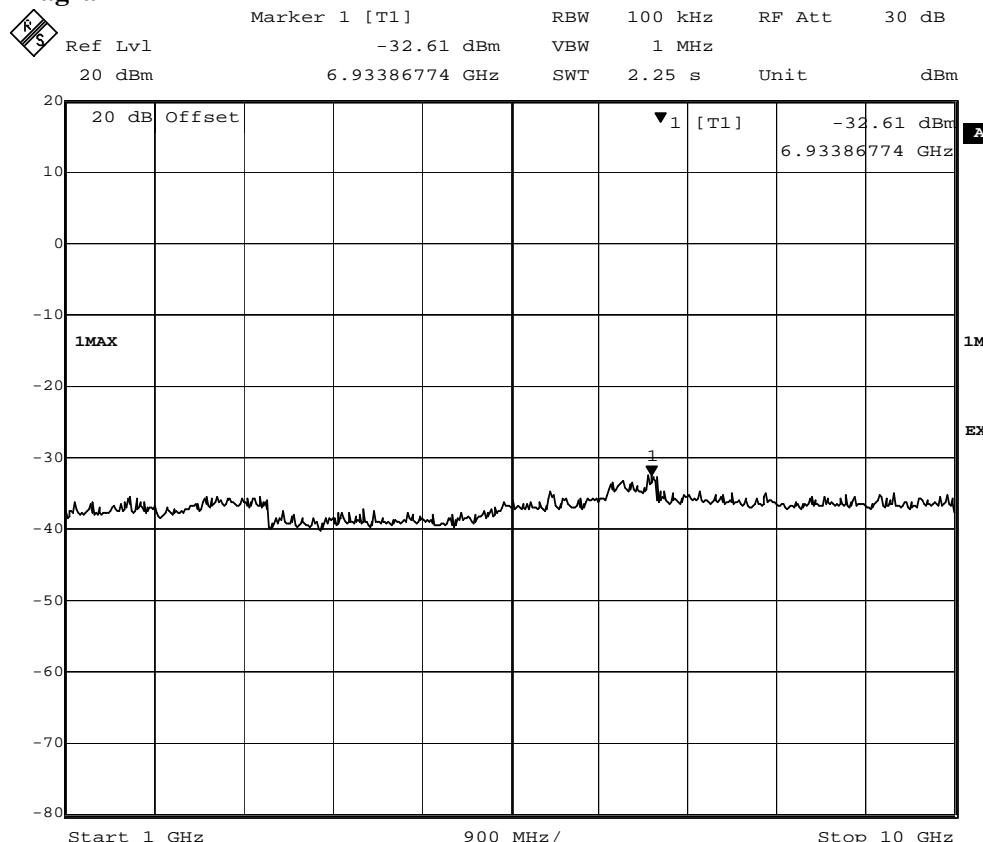
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FCC ID: W7UMSTRANS

Appendix 5.1

**Diagram 3**

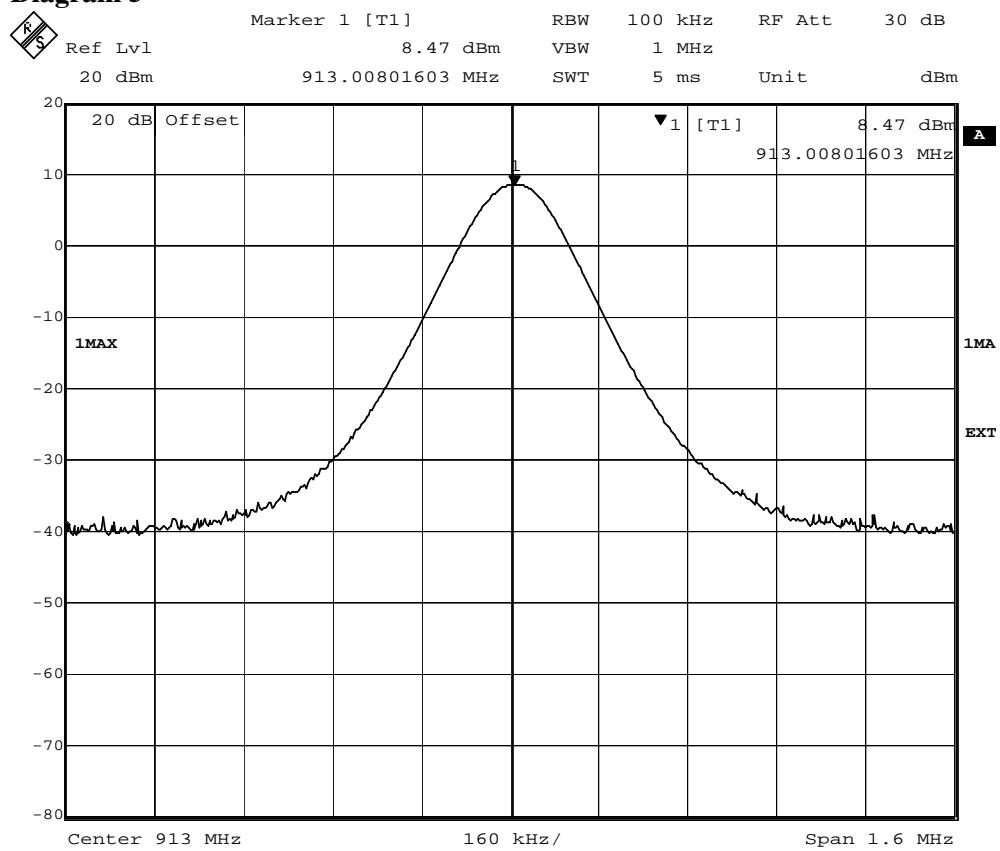
Date: 4.JUN.2009 14:56:09

**Diagram 4**

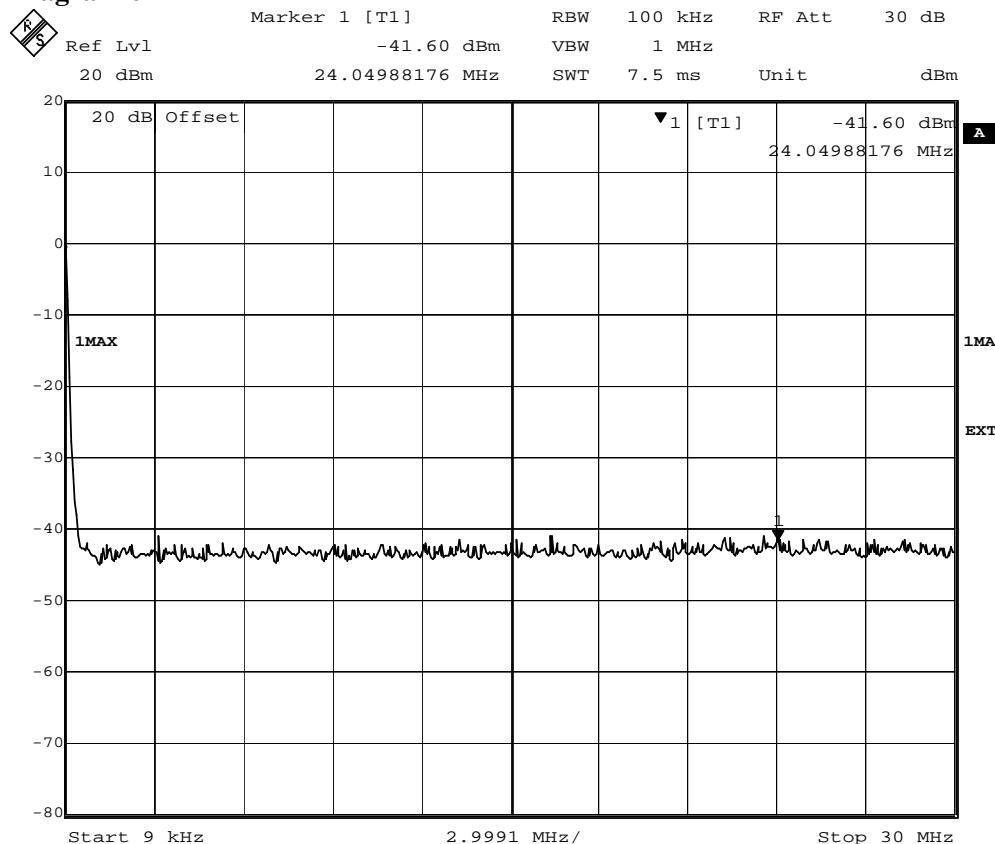
Date: 4.JUN.2009 14:54:27

FCC ID: W7UMSTRANS

Appendix 5.1

**Diagram 5**

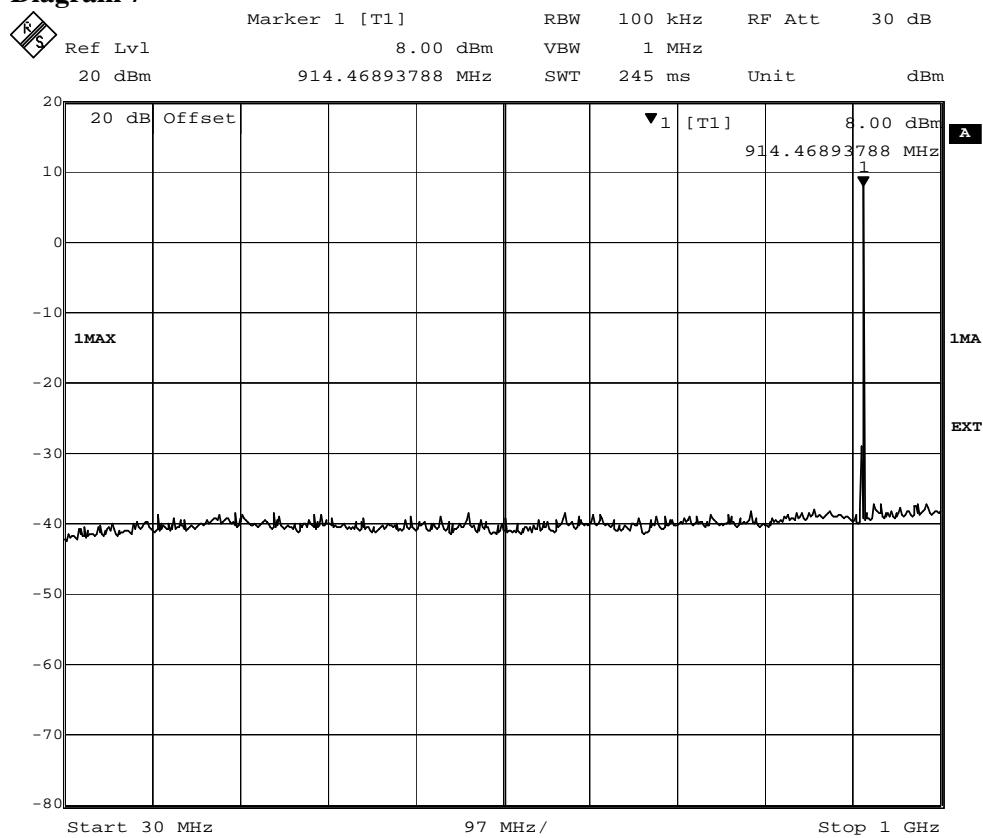
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**Diagram 6**

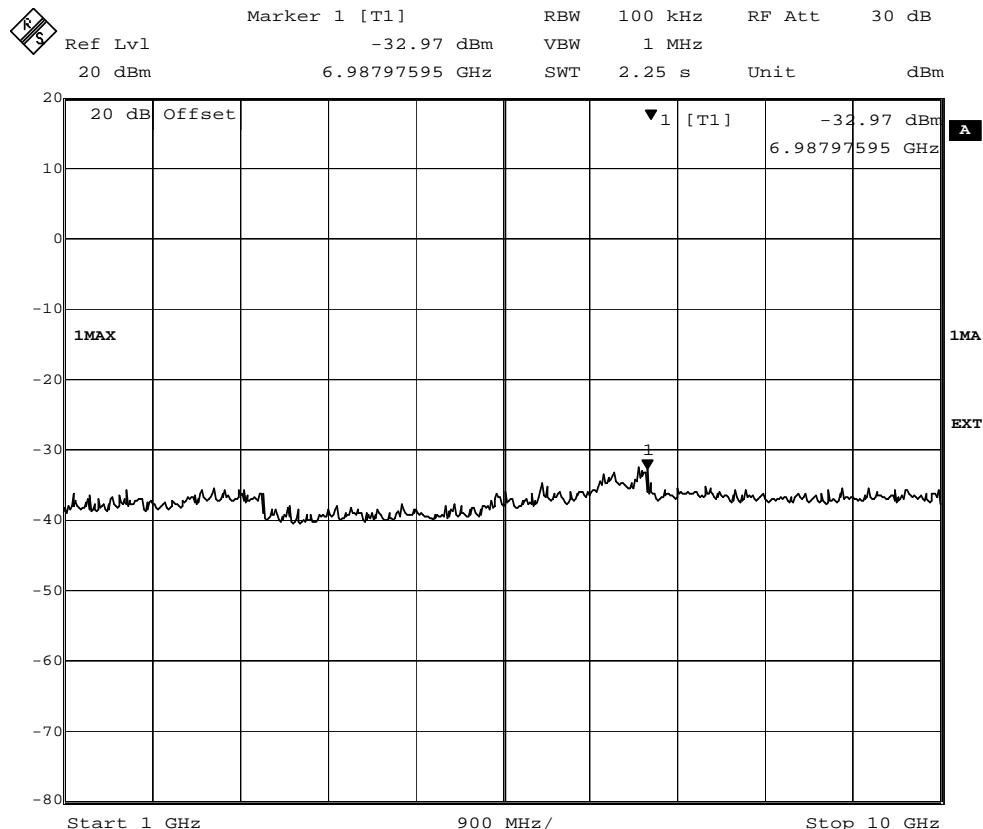
Date: 4.JUN.2009 14:52:21

FCC ID: W7UMSTRANS

Appendix 5.1

**Diagram 7**

Date: 4.JUN.2009 14:52:59

**Diagram 8**

Date: 4.JUN.2009 14:53:40

**Restricted bands of operation measurements according to FCC 47 CFR part 15.247  
(d) and Band edge measurements according to 47CFR 2.1049**

Date	Temperature	Humidity
2009-05-07	23 °C ± 3 °C	32 % ± 5 %
2009-05-08	22 °C ± 3 °C	34 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

The test was performed with continuous transmission (100% duty cycle) and with modulation.

The radiated restricted band measurements were performed in the semi-anechoic chamber. A pre-scan with an antenna height of 1, 1.5, and 2 m was performed with both horizontal and vertical polarization, the turntable was varied between 0-360 degrees. Spurious emission detected with PEAK-detector was scanned with antenna height 1-4 m for maximum response. The antenna distance during the measurements was 3.0 m in the frequency range 30 MHz-10 GHz

The measurement was first performed with peak detector. The following RBW were used:  
30 MHz-1 GHz: RBW=100 kHz

1-10 GHz: RBW=1 MHz

Emission on frequencies close to or above the limit was re-measured with quasi-peak or average detector.

Test set-up photos during the tests can be found in appendix 13.

Measurement equipment	Calibration Due	SP number
Semi anechoic chamber, Edison	-	504 114
Spectrum analyzer R&S ESI 26	2009-07	503 885
EMI measurement computer	-	-
Software: R&S EMC32, ver. 6.30.10	-	503 745
Antenna Schaffner Bilog CBL6143	2010-03	504 079
Horn antenna EMCO 3115	2011-10	501 548
Preamplifier Miteq, 1-18 GHz	2009-08	504 160
High pass filter Wainwright WHKY	2011-01	504 199
Temperature and humidity meter Testo 625	2011-03	504 117

**Measurement uncertainty:** 30-1000 MHz: 4.8/5.6 dB (V/H-pol)  
1-10 GHz: 2.6 dB



## Results

The emission spectra can be found appendix 6.1:

The highest detected levels in the frequency range 30 MHz-10 GHz are listed in the tables in each diagram.

### Low channel, 903 MHz

Diagram 1: Radiated emission 30-1000 MHz, Low channel 903 MHz vertical and horizontal polarizations.

Diagram 2: Radiated emission 1-10 GHz, Low channel, 903 MHz, vertical and horizontal polarizations.

### High channel, 913 MHz

Diagram 3: Radiated emission 30-1000 MHz, High channel 913 MHz, vertical and horizontal polarizations.

Diagram 4: Radiated emission 1-10 GHz, High channel, 913 MHz, vertical and horizontal polarizations.

## Remark

To reduce the emission below limit some modifications of the EUT were made:

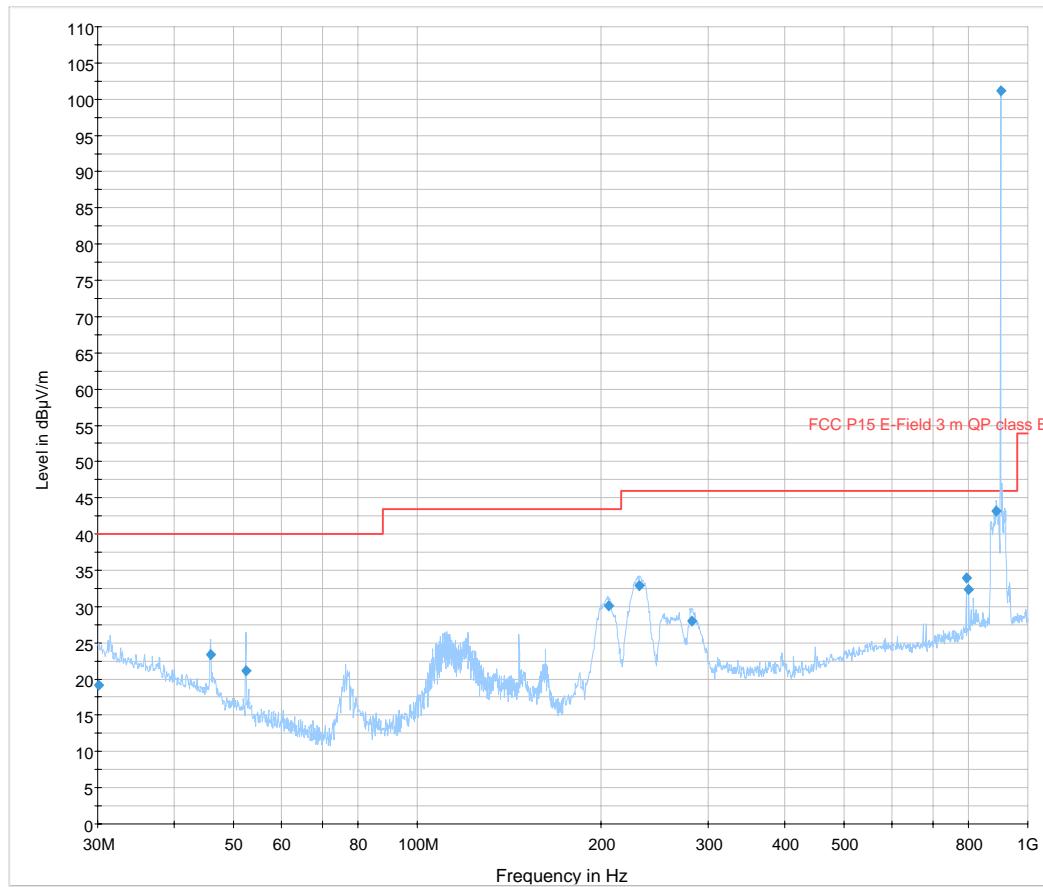
- Rerouted signal path between the radio amplifier and the antenna contact and changing of the output filter.
- Shielding cover mounted over the radio amplifier.
- Improved matching between the radio chip and the radio amplifier.
- Rerouted power supply path to the radio amplifier.
- Improved matching of the center frequency of the transmitter antenna.

## Limits

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).

Complies?	<input checked="" type="checkbox"/> Yes
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## Diagram 1



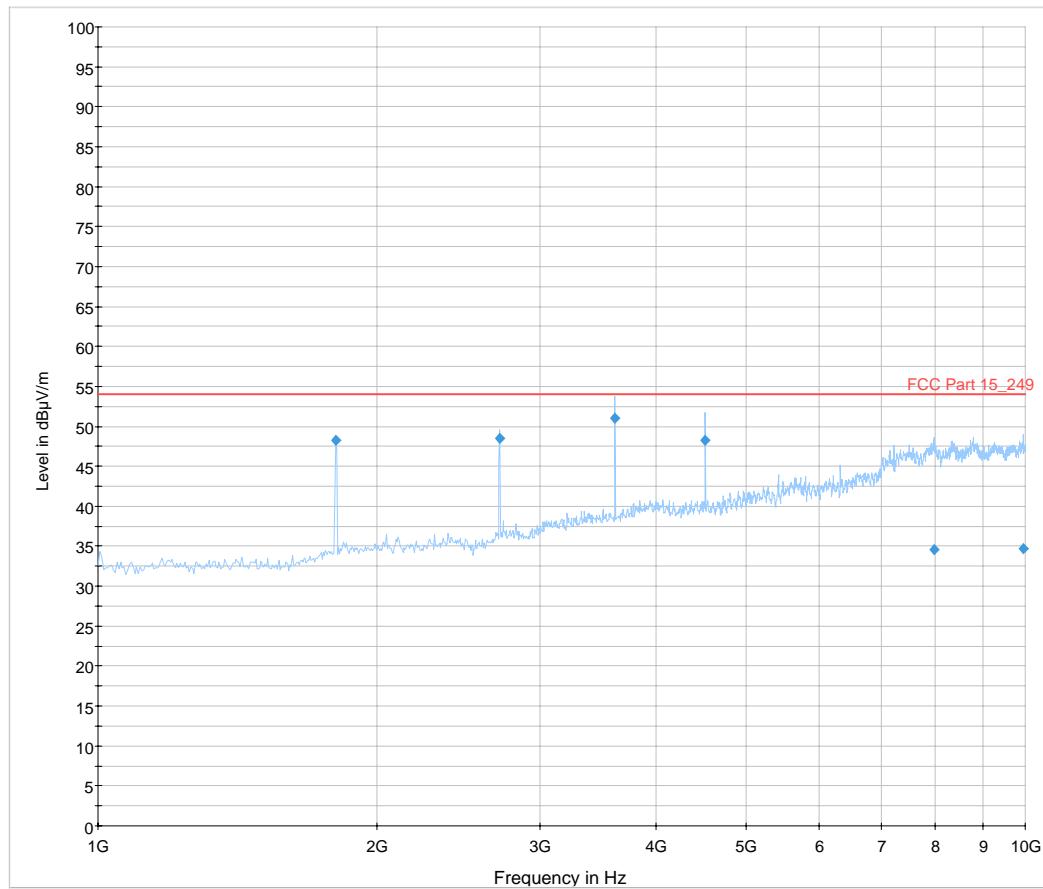
## Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
30.117469	19.2	126.0	V	325.0	22.4	61.9	20 dBc	NRB
45.982966	23.4	115.0	V	180.0	15.2	57.7	20 dBc	NRB
52.554108	21.1	254.0	V	0.0	12.3	60.0	20 dBc	NRB
205.666333	30.1	100.0	V	2.0	11.5	51.0	20 dBc	NRB
231.151303	32.9	100.0	V	42.0	12.6	48.2	20 dBc	NRB
282.127254	28.0	144.0	H	192.0	13.5	18.0	46.0	RB
792.413827	33.9	120.0	H	156.0	21.5	47.2	20 dBc	NRB
799.772546	32.3	150.0	V	81.0	21.5	48.8	20 dBc	NRB
888.255511	43.2	137.0	V	66.0	22.6	37.9	20 dBc	NRB
902.942885	101.1	138.0	V	56.0	22.7	N/A	N/A	carrier

Comments: RB = Frequency in restricted bands

NRB = Frequency Not in restricted bands

## Diagram 2



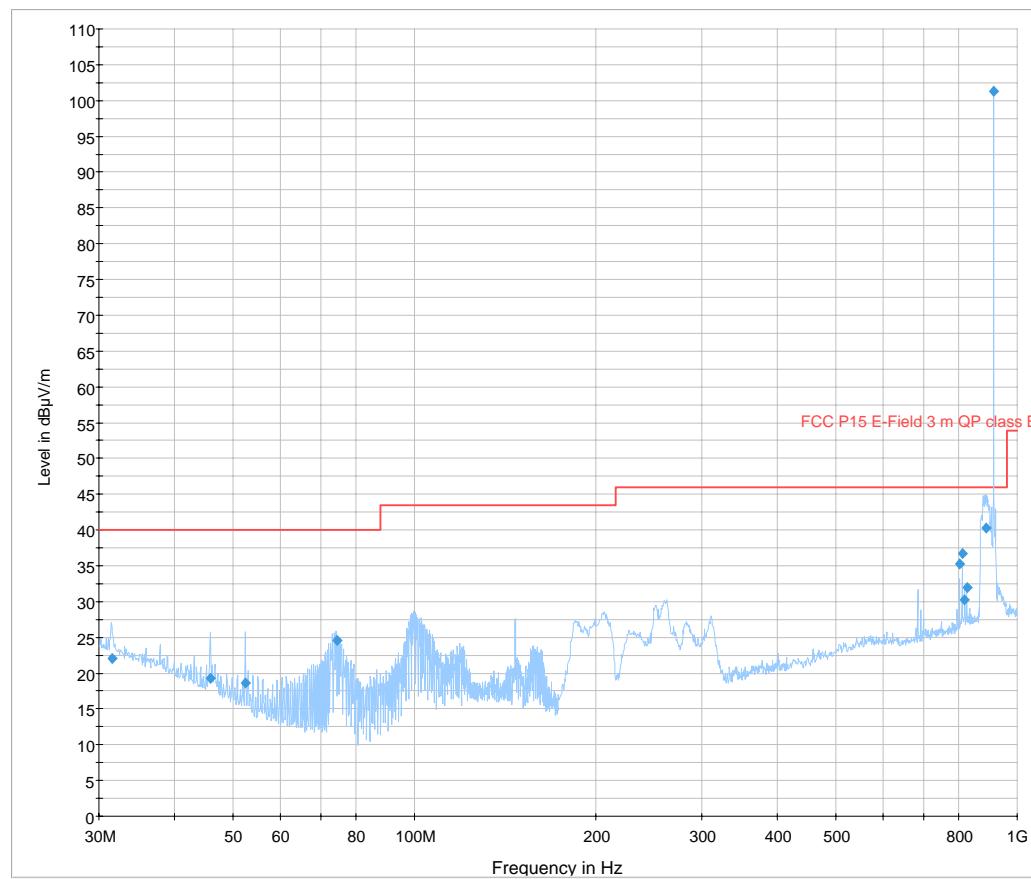
## Final Result

Frequency (MHz)	Average (dB $\mu$ V/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V/m)	Comment
1805.98196	48.8	100.0	H	206.0	-18.6	32.3	20dBc	NRB
2709.02805	49.0	114.0	H	41.0	-15.7	5.0	54.0	RB
3612.01402	51.3	100.0	H	39.0	-12.8	2.7	54.0	RB
4515.08016	48.6	131.0	V	45.0	-11.2	5.4	54.0	RB
7967.26453	34.6	257.0	V	7.0	-2.3	46.5	20 dBc	NRB
9949.26853	34.7	179.0	H	257.0	-1.8	46.4	20 dBc	NRB

Comments: RB = Frequency in restricted bands

NRB = Frequency Not in restricted bands

## Diagram 3



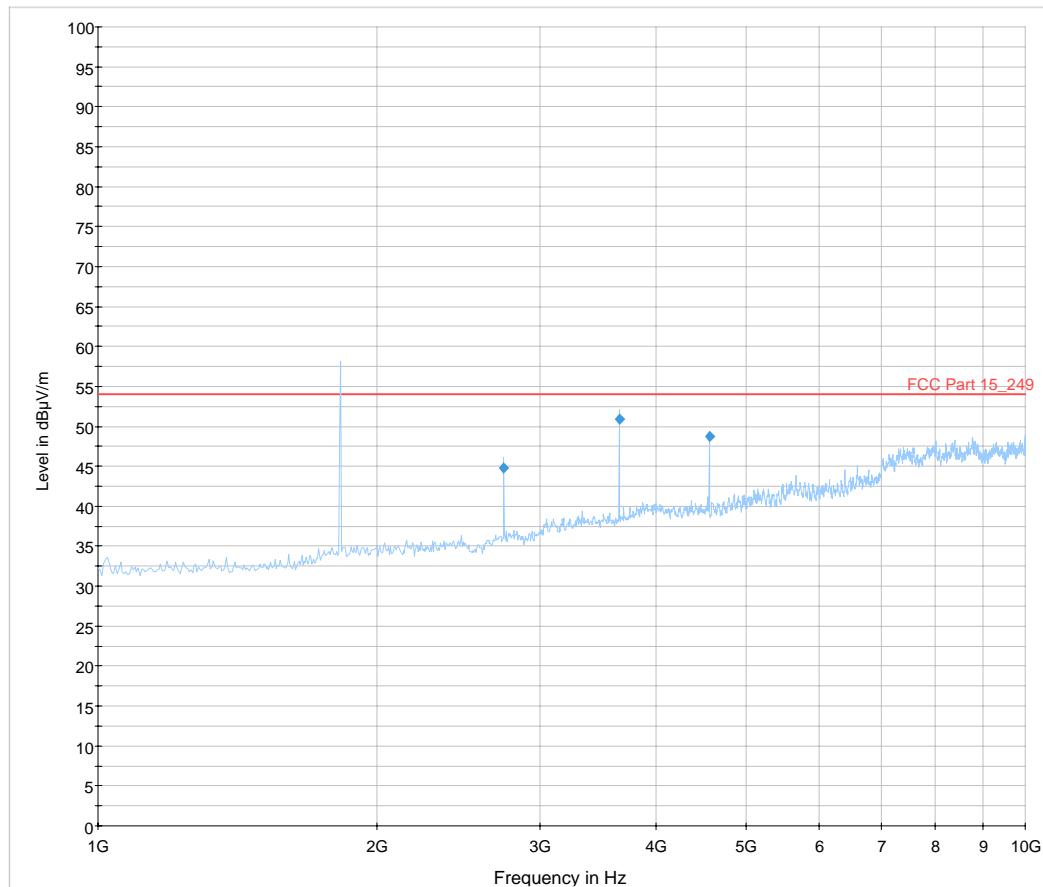
## Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)	Comment
31.544723	22.1	261.0	V	315.0	21.6	59.2	20 dBc	NRB
45.982966	19.3	267.0	V	0.0	15.2	62.0	20 dBc	NRB
52.542084	18.6	345.0	V	80.0	12.3	62.7	20 dBc	NRB
74.367736	24.6	127.0	V	188.0	7.7	56.7	20 dBc	NRB
802.419840	35.3	115.0	H	157.0	21.6	46.0	20 dBc	NRB
809.782566	36.7	115.0	H	156.0	22.0	44.6	20 dBc	NRB
817.129259	30.3	100.0	H	152.0	22.1	51.0	20 dBc	NRB
824.518036	31.9	109.0	H	150.0	22.2	49.4	20 dBc	NRB
887.435872	40.2	100.0	H	345.0	22.6	41.1	20 dBc	NRB
912.958918	101.3	132.0	V	178.0	22.8	N/A	N/A	carrier

Comments: RB = Frequency in restricted bands

NRB = Frequency Not in restricted bands

## Diagram 4



## Final Result

Frequency (MHz)	Average (dB $\mu$ V/m)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V/m)	Comment
2738.96793	45.3	120.0	V	180.0	-15.8	8.7	54.0	RB
3652.07414	51.2	100.0	H	43.0	-12.5	2.8	54.0	RB
4564.95992	49.1	114.0	H	344.0	-11.1	4.9	54.0	RB

Comments: RB = Frequency in restricted bands  
 NRB = Frequency Not in restricted bands

Note: The peak at 1826 MHz is not in any restricted band, thus no final measurement was performed.

**RF exposure evaluation: Mobile equipment, measurements according to  
FCC 47 CFR part 15.247 (i)**

Date 2009-02-23	Temperature 23 °C ± 3 °C	Humidity 18 % ± 5 %
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**Procedure**

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 0.2 m normally can be maintained between the user and the device.

**Results**

The following formula was used to calculate the RF exposure,  
 $Pd = Pout \times G / (4 \times \pi \times r^2_{cm})$

where,

$Pd$  = power density in  $\text{mW/cm}^2$

$Pout$  = output power to antenna in  $\text{mW}$

$G$  = gain of antenna in linear scale

$\pi = 3.1416$

$r$  = distance between observation and center of the radiator in  $\text{cm}$

From the peak EUT RF output power, the minimum mobile separation distance,  $r=0.2\text{m}$ , as well as the gain of the used antenna, the RF power density can be obtained.

The maximum peak output power from appendix 4 was used for calculation of MPE.

Antenna Gain (dBi)	Antenna Gain (numeric)	Peak output power (dBm)	Peak output power (mW)	Power density, $Pd$ [S] ( $\text{mW/cm}^2$ )	Limit of power density ( $\text{mW/cm}^2$ )
1.5	1.4125	10.5	11.22	0.003	0.602

**Limits****(A) Limits for Occupational/Controlled Exposure**

Frequency range (MHz)	Electric field strength [E] (V/m)	Magnetic field strength [H] (A/m)	Power density [S] (mW/cm <sup>2</sup> )	Averaging time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

**(B) Limits for General Population/Uncontrolled Exposure**

Frequency range (MHz)	Electric field strength [E] (V/m)	Magnetic field strength [H] (A/m)	Power density [S] (mW/cm <sup>2</sup> )	Averaging time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
<b>300-1500</b>			<b>F/1500 (=0.602 at 903 MHz)</b>	<b>30</b>
1500-100,000			1.0	30

Note: f=frequency in MHz, \*Plane-wave equivalent power density

Complies?	Yes
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**Conducted emission measurements according to FCC 47 CFR part 15.207**

Date	Temperature	Humidity
2009-05-07	23 °C ± 3 °C	32 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

The test was performed with continuous transmission (100% duty cycle) and with modulation.

Measurements were performed on the 120 V AC/60 Hz, phase and neutral conductors.

Test set-up photos during the tests can be found on page 2 and 3.

Measurement equipment	Calibration Due	SP number
Semi anechoic chamber, Edison	-	504 114
Spectrum analyzer R&S ESI 26	2009-07	503 885
EMI measurement computer	-	-
Software: R&S EMC32, ver. 6.30.10	-	503 745
LISN Schwartzbeck NNLA8120	2010-02	500 574
LISN Schwarzbeck NSLK 8126	2010-02	503 114
Temperature and humidity meter Testo 625	2011-03	504 117

**Measurement uncertainty:** 3.5 dB

**Result**

The conducted emission spectra can be found in appendix 8.1:

- Diagram 1: 903 MHz 120 V AC, neutral conductor
- Diagram 2: 913 MHz 120 V AC, phase conductor
- Diagram 3: 903 MHz 120 V AC, neutral conductor
- Diagram 4: 913 MHz 120 V AC, phase conductor

**Remark**

During the conducted emission limits test the USB-RS485 converter was changed to reduce the emission level below limit from Moxa USB-to-serial adaptor, model: UPort 1130 to VS COM USB-RS485 converter USB-COM-I SI.

The limit lines indicated as EN 55022 in the diagrams are the same limit lines of FCC part 15.

Complies?	Yes
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FCC ID: W7UMSTRANS

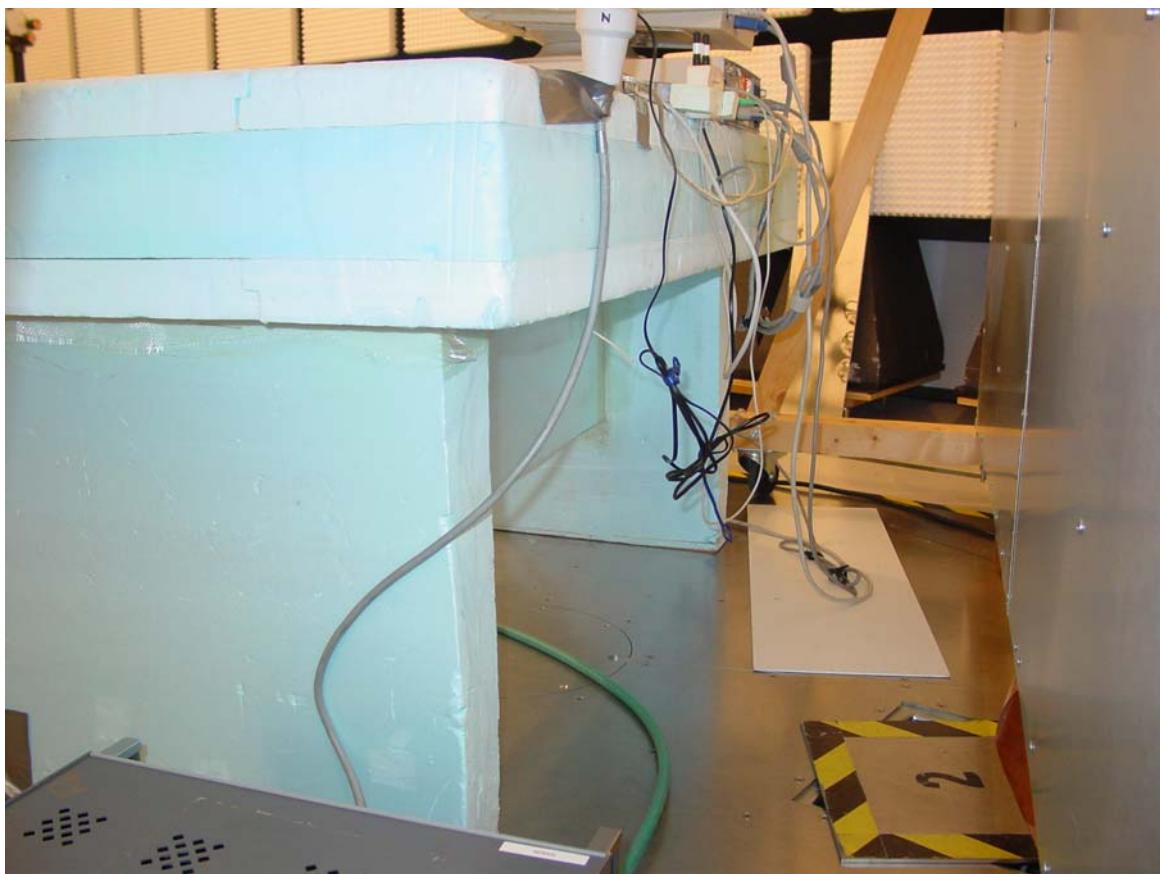
Appendix 8

Test set-up, Conducted emission



FCC ID: W7UMSTRANS

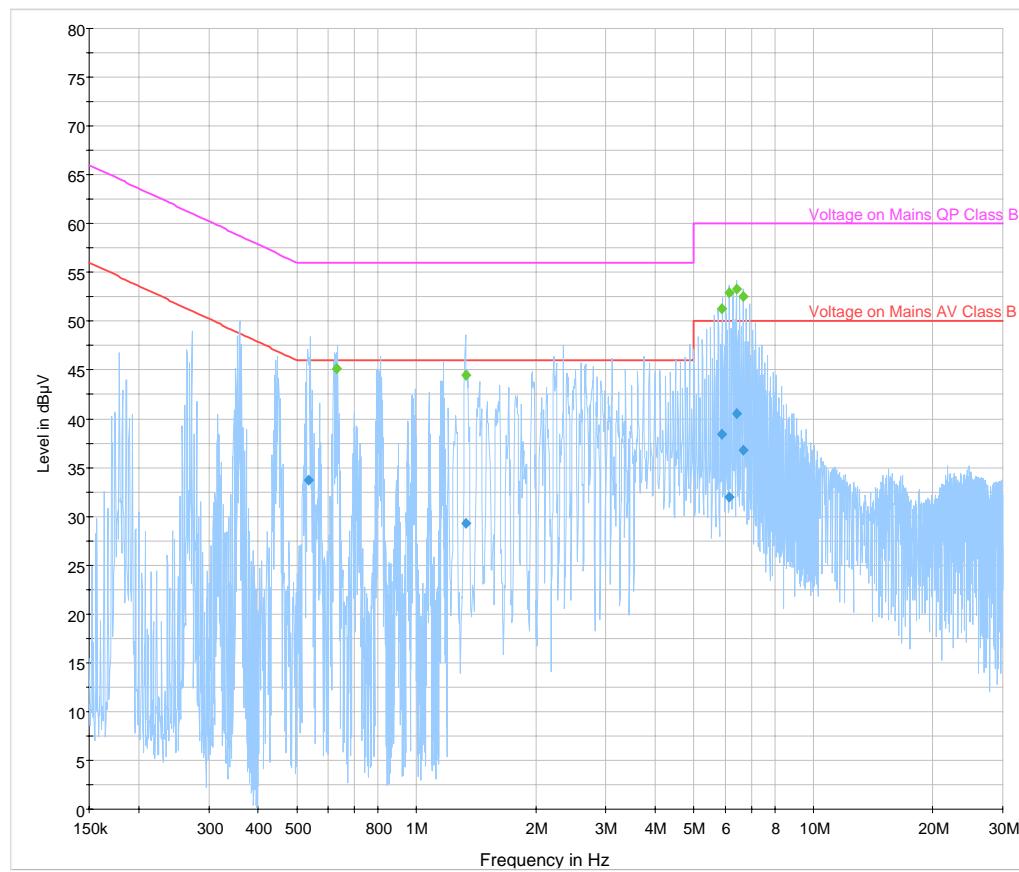
Appendix 8



FCC ID: W7UMSTRANS

Appendix 8.1

## Diagram 1



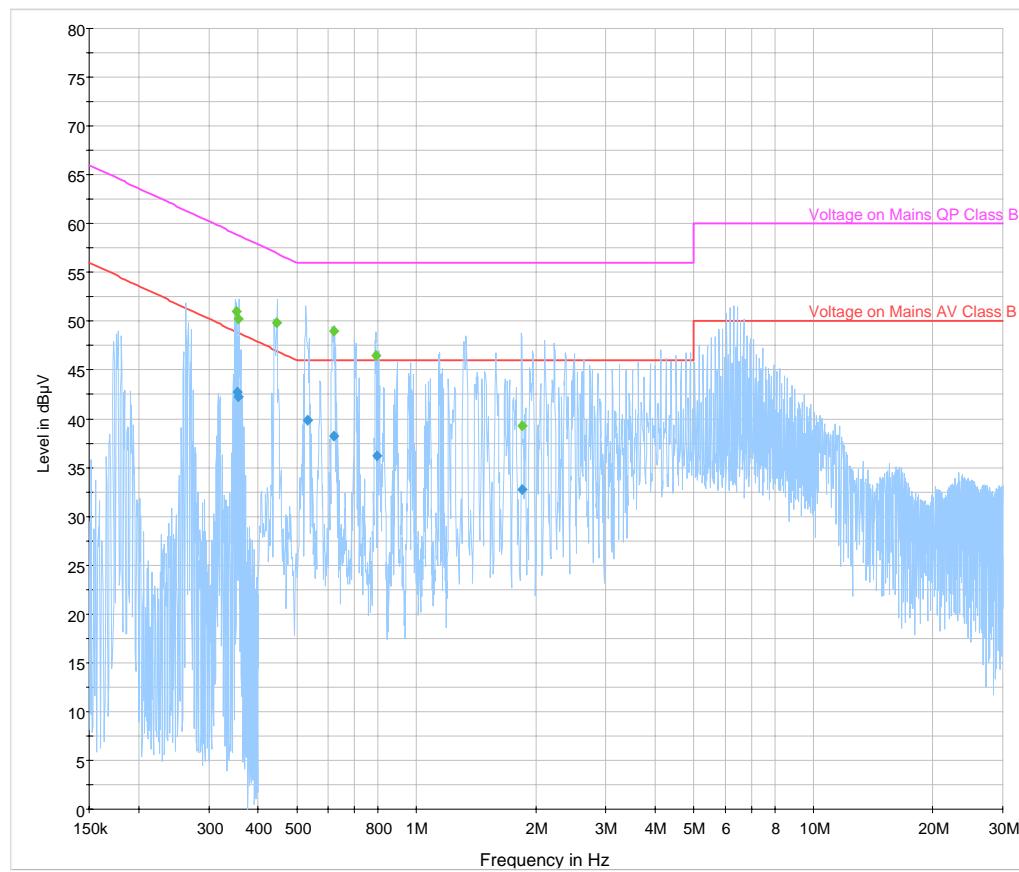
## Final Result Average

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.535082	33.8	1000.000	9.000	0.1	12.2	46.0
1.333860	29.3	1000.000	9.000	0.2	16.7	46.0
5.891992	38.4	1000.000	9.000	0.4	11.6	50.0
6.149102	31.9	1000.000	9.000	0.4	18.1	50.0
6.396212	40.5	1000.000	9.000	0.4	9.5	50.0
6.653323	36.7	1000.000	9.000	0.4	13.3	50.0

## Final Result QuasiPeak

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.631082	45.1	1000.000	9.000	0.1	10.9	56.0
1.333860	44.4	1000.000	9.000	0.2	11.6	56.0
5.891992	51.3	1000.000	9.000	0.4	8.7	60.0
6.145102	52.9	1000.000	9.000	0.4	7.1	60.0
6.398212	53.3	1000.000	9.000	0.4	6.7	60.0
6.651323	52.5	1000.000	9.000	0.4	7.5	60.0

## Diagram 2



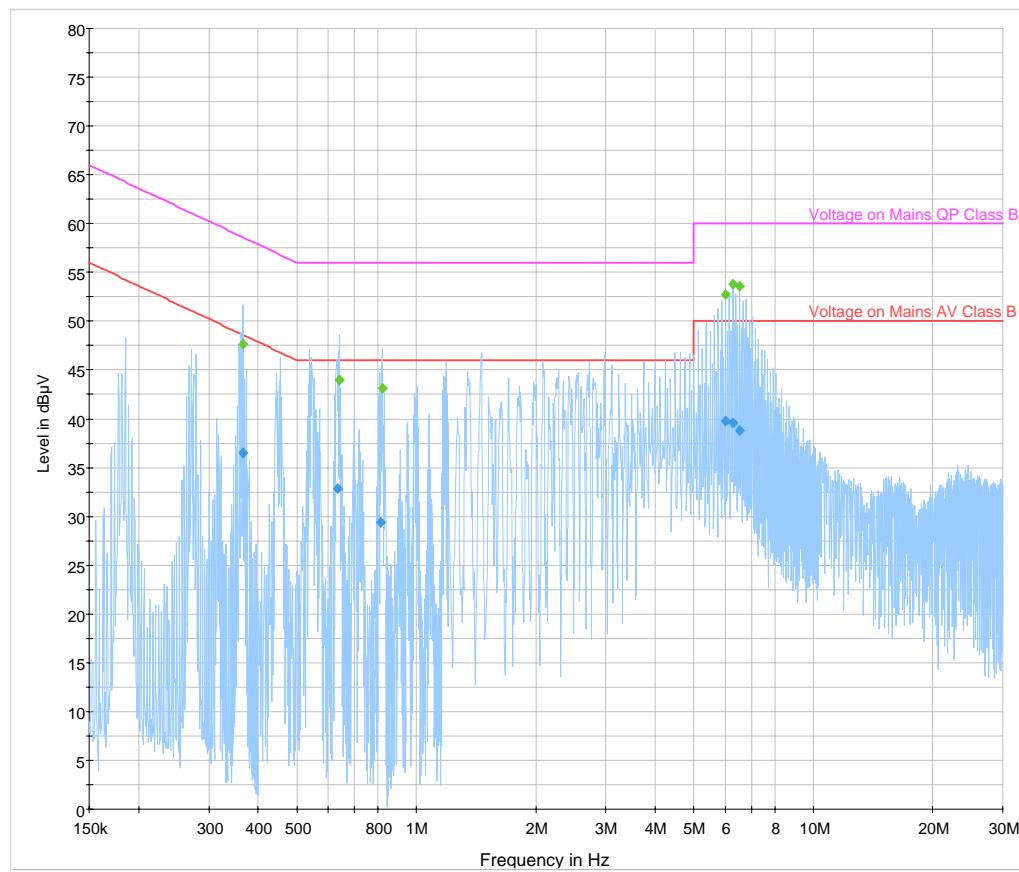
## Final Result Average

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.353415	42.7	1000.000	9.000	0.1	6.2	48.9
0.356493	42.2	1000.000	9.000	0.1	6.6	48.8
0.530653	39.8	1000.000	9.000	0.1	6.2	46.0
0.618449	38.2	1000.000	9.000	0.1	7.8	46.0
0.795182	36.2	1000.000	9.000	0.1	9.8	46.0
1.843679	32.7	1000.000	9.000	0.2	13.3	46.0

## Final Result QuasiPeak

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.351415	51.0	1000.000	9.000	0.1	7.9	58.9
0.356493	50.2	1000.000	9.000	0.1	8.6	58.8
0.444653	49.8	1000.000	9.000	0.1	7.2	57.0
0.618449	49.0	1000.000	9.000	0.1	7.0	56.0
0.793182	46.5	1000.000	9.000	0.1	9.5	56.0
1.851679	39.3	1000.000	9.000	0.2	16.7	56.0

## Diagram 3



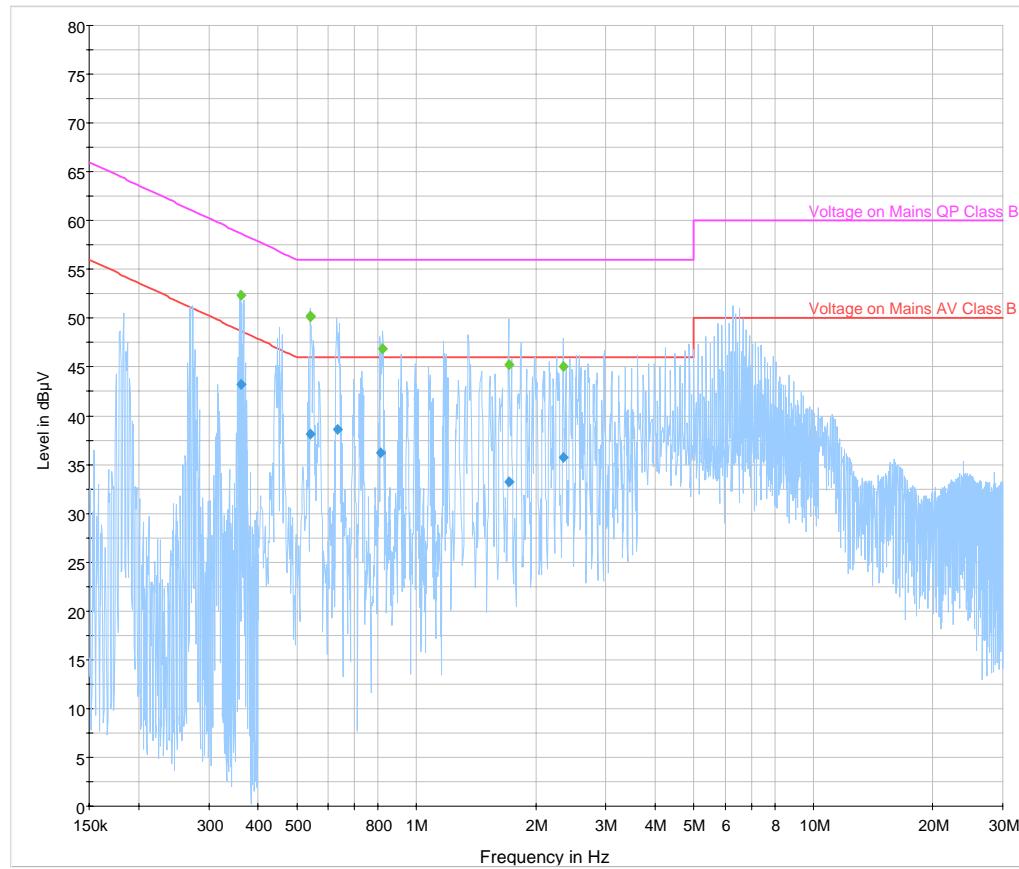
## Final Result Average

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.365431	36.5	1000.000	9.000	0.1	12.1	48.6
0.632878	32.8	1000.000	9.000	0.1	13.2	46.0
0.812040	29.4	1000.000	9.000	0.1	16.6	46.0
6.012834	39.7	1000.000	9.000	0.4	10.3	50.0
6.263944	39.6	1000.000	9.000	0.4	10.4	50.0
6.521054	38.8	1000.000	9.000	0.4	11.2	50.0

## Final Result QuasiPeak

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.365431	47.6	1000.000	9.000	0.1	11.0	58.6
0.640878	44.0	1000.000	9.000	0.1	12.0	56.0
0.824040	43.1	1000.000	9.000	0.1	12.9	56.0
6.012834	52.7	1000.000	9.000	0.4	7.3	60.0
6.265944	53.8	1000.000	9.000	0.4	6.2	60.0
6.519054	53.6	1000.000	9.000	0.4	6.4	60.0

## Diagram 4



## Final Result Average

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.361419	43.2	1000.000	9.000	0.1	5.5	48.7
0.539479	38.2	1000.000	9.000	0.1	7.8	46.0
0.632862	38.6	1000.000	9.000	0.1	7.4	46.0
0.813247	36.2	1000.000	9.000	0.1	9.8	46.0
1.711820	33.3	1000.000	9.000	0.2	12.7	46.0
2.341880	35.7	1000.000	9.000	0.2	10.3	46.0

## Final Result QuasiPeak

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.361419	52.4	1000.000	9.000	0.1	6.3	58.7
0.540862	50.2	1000.000	9.000	0.1	5.8	56.0
0.541479	50.2	1000.000	9.000	0.1	5.8	56.0
0.823247	46.8	1000.000	9.000	0.1	9.2	56.0
1.709820	45.3	1000.000	9.000	0.2	10.7	56.0
2.341880	45.1	1000.000	9.000	0.2	10.9	56.0

**20 dB bandwidth measurements according to FCC 47 CFR part 15.215 (c)**

Date	Temperature	Humidity
2009-02-24	23 °C ± 3 °C	17 % ± 5 %
2009-03-05	22 °C ± 3 °C	23 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003 and according to Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, DA 00-705, released March 30, 2000.

Conducted measurements were performed at the antenna connector and with continuous transmission (100% duty cycle) and with modulation and also with the FHSS function enabled.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Inmet 2100-20dB attenuator	2010-06	503 871
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

**Measurement uncertainty:** 2.6 %

**Results**

The diagrams can be found in the appendix 9.1.

Diagram 1 903 MHz 20 dB BW = 11.24 kHz  
Diagram 2 913 MHz 20 dB BW = 11.30 kHz  
Diagram 3 FHSS enabled 20 dB BW = 11.42 kHz

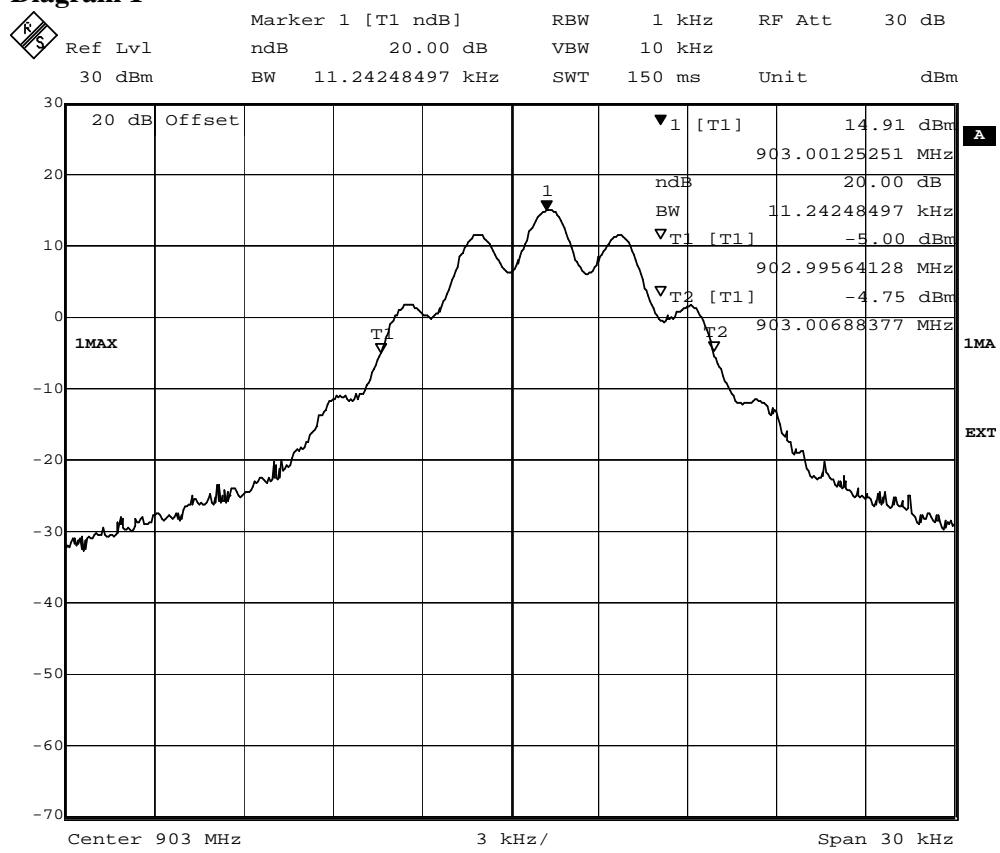
**Limits**

According to 47CFR 15.215(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

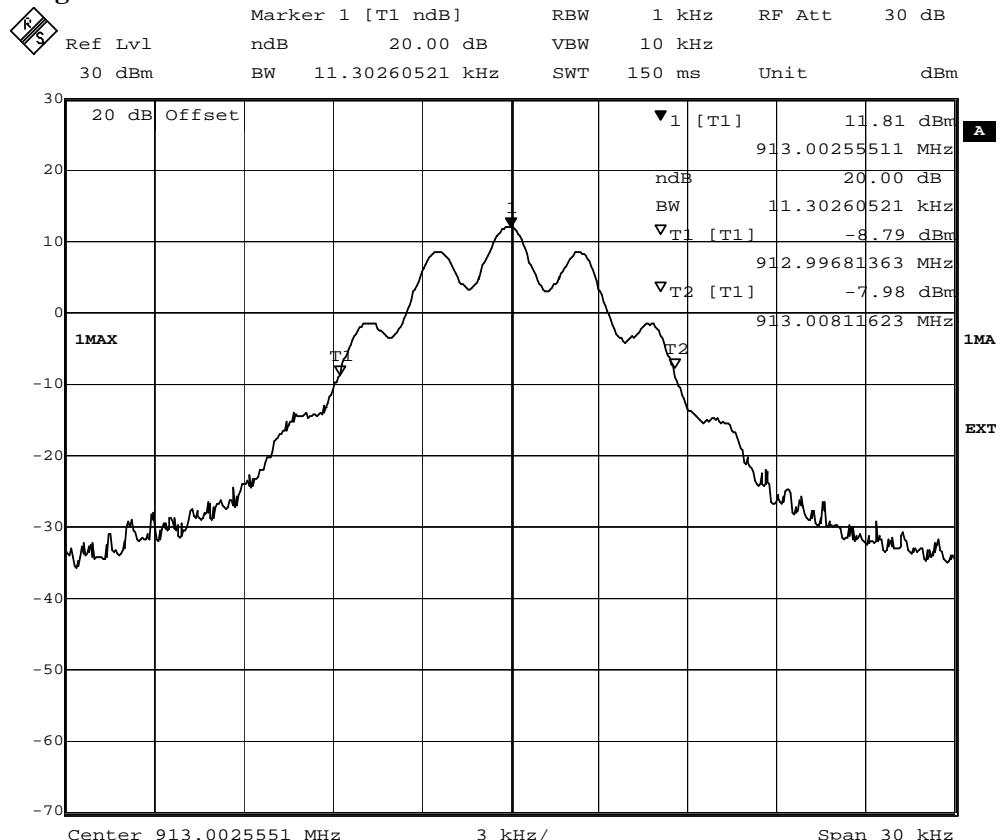
Complies?	Yes
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FCC ID: W7UMSTRANS

Appendix 9.1

**Diagram 1**

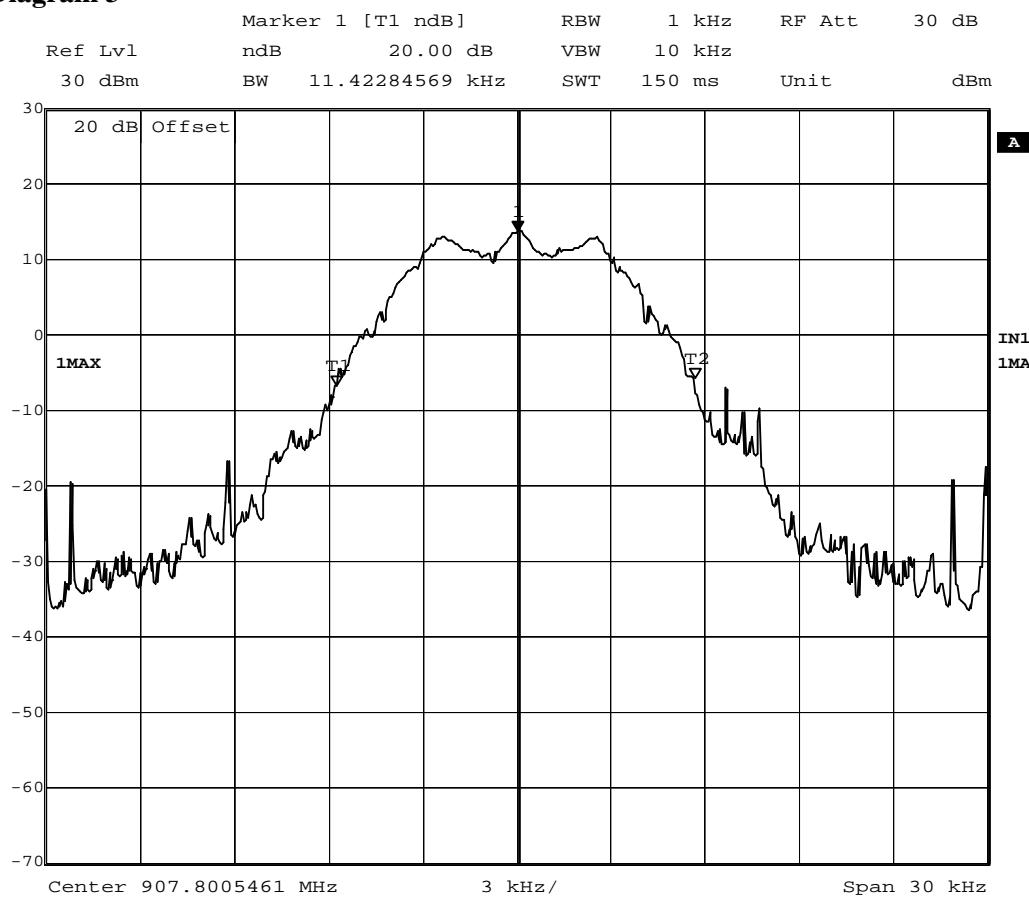
Date: 24.FEB.2009 09:10:33

**Diagram 2**

Date: 24.FEB.2009 09:13:14

FCC ID: W7UMSTRANS

Appendix 9.1

**Diagram 3**

Date: 5.MAR.2009 15:19:29

**Antenna power conduction limits for receivers according to FCC 47 CFR part 15.111 (a)**

Date 2009-02-23	Temperature 23 °C ± 3 °C	Humidity 18 % ± 5 %
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**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

Conducted measurements were performed at the antenna connector.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

**Measurement uncertainty:** 2.6 dB

**Result**

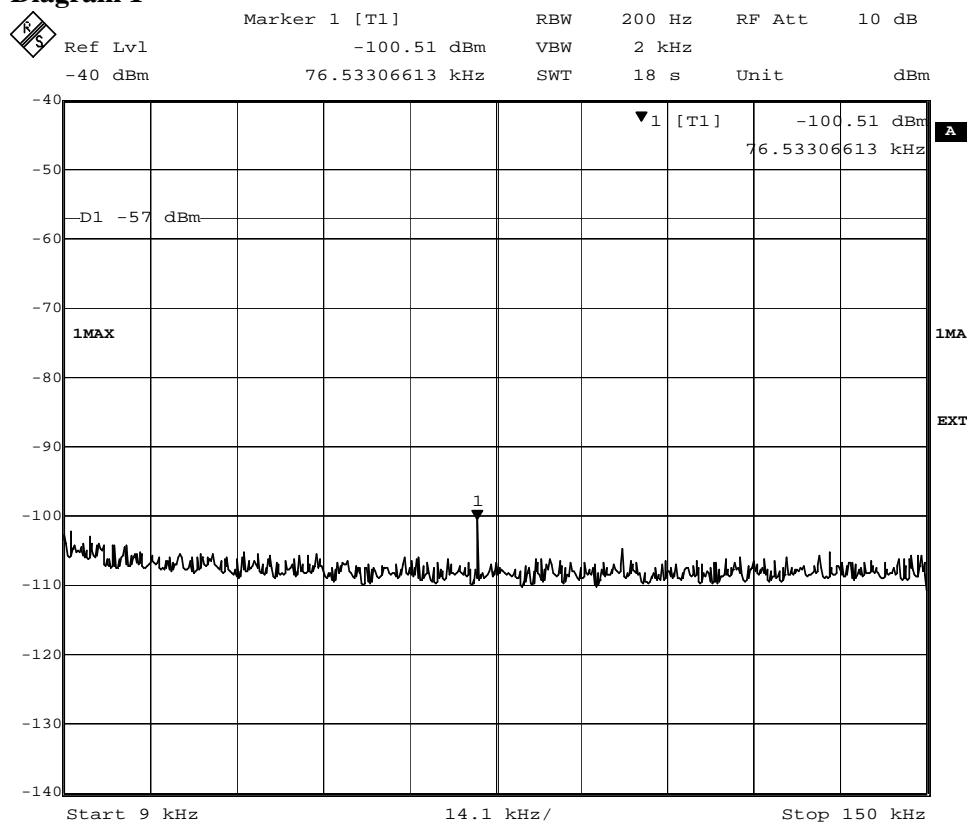
The antenna power conduction emission spectra can be found in appendix 10.1:

Diagram 1: 903 MHz 9-150 kHz  
Diagram 2: 903 MHz 150 kHz-30 MHz  
Diagram 3: 903 MHz 30-1000 MHz  
Diagram 4: 903 MHz 1-5 GHz  
Diagram 5: 913 MHz 9-150 kHz  
Diagram 6: 913 MHz 150 kHz-30 MHz  
Diagram 7: 913 MHz 30-1000 MHz  
Diagram 8: 913 MHz 1-5 GHz

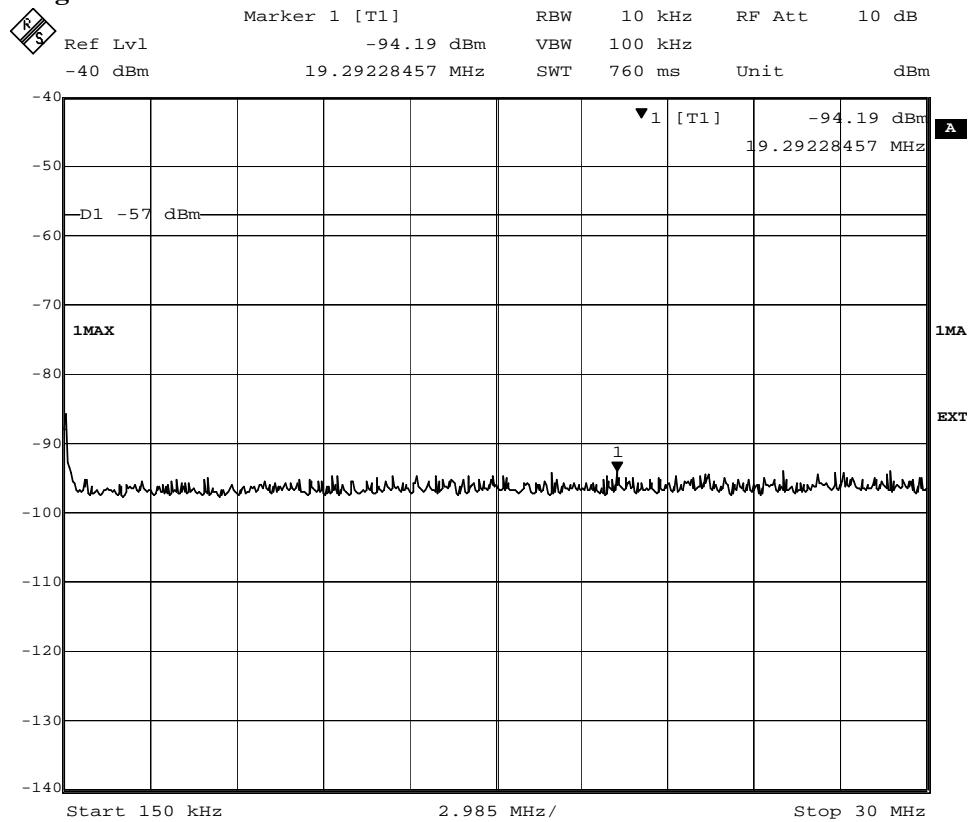
Complies?	Yes
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FCC ID: W7UMSTRANS

Appendix 10.1

**Diagram 1**

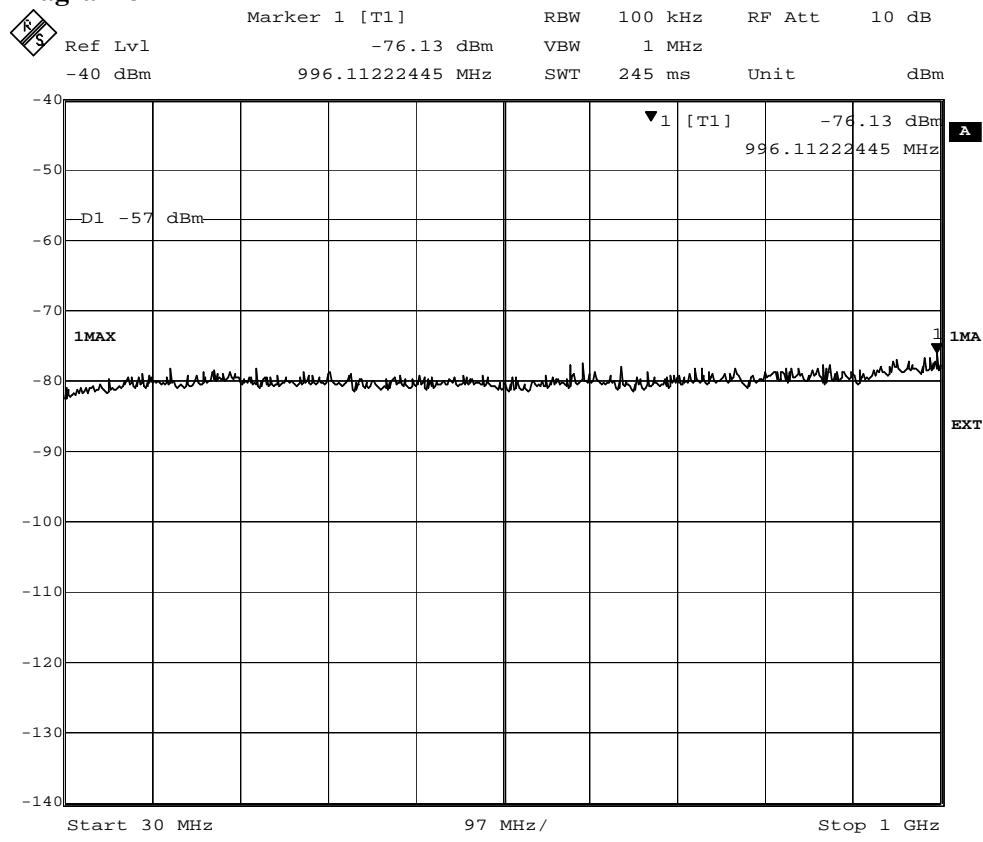
Date: 23.FEB.2009 17:30:01

**Diagram 2**

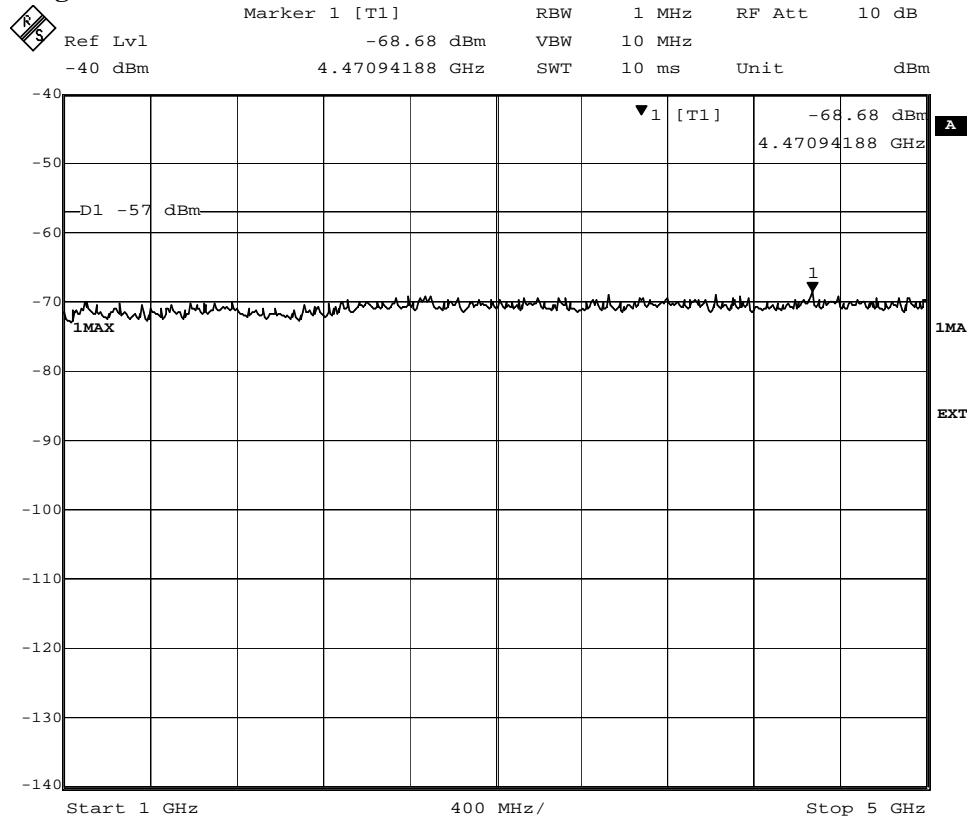
Date: 23.FEB.2009 17:30:42

FCC ID: W7UMSTRANS

Appendix 10.1

**Diagram 3**

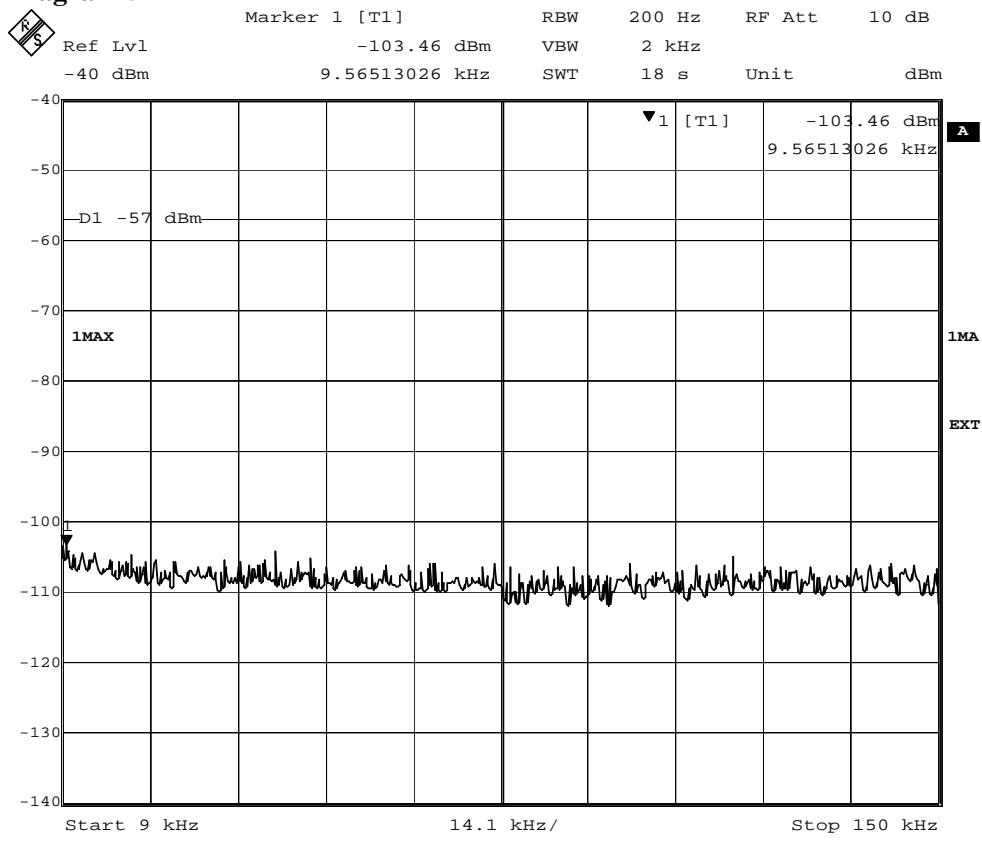
Date: 23.FEB.2009 17:31:25

**Diagram 4**

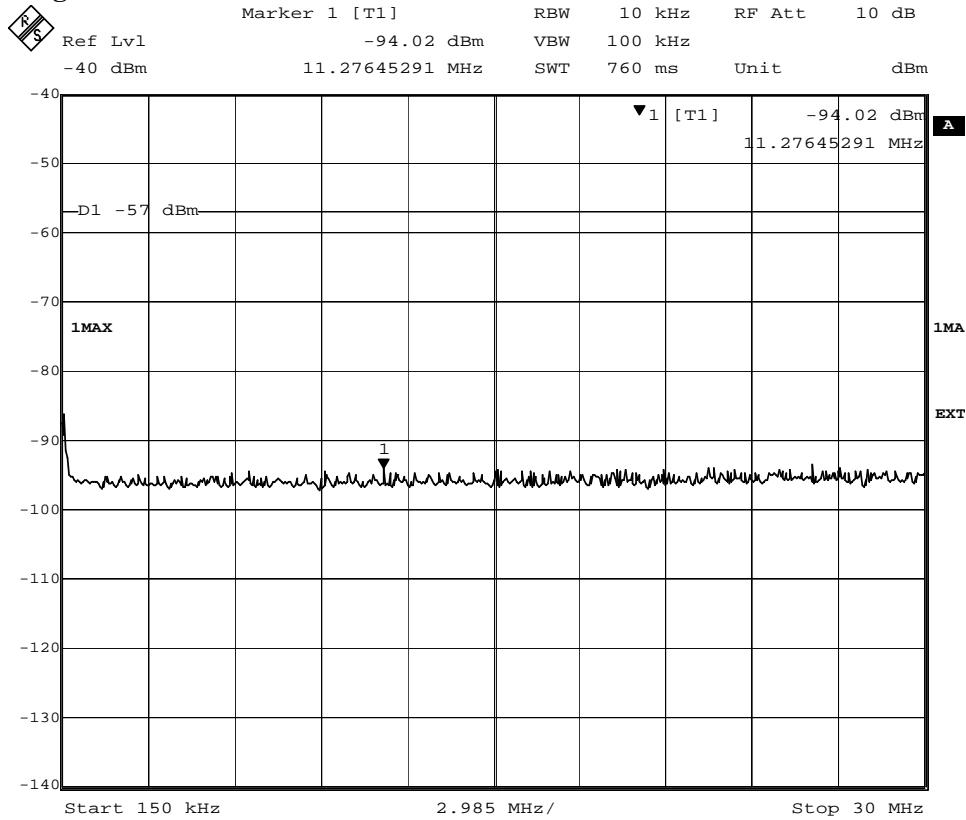
Date: 23.FEB.2009 17:32:00

FCC ID: W7UMSTRANS

Appendix 10.1

**Diagram 5**

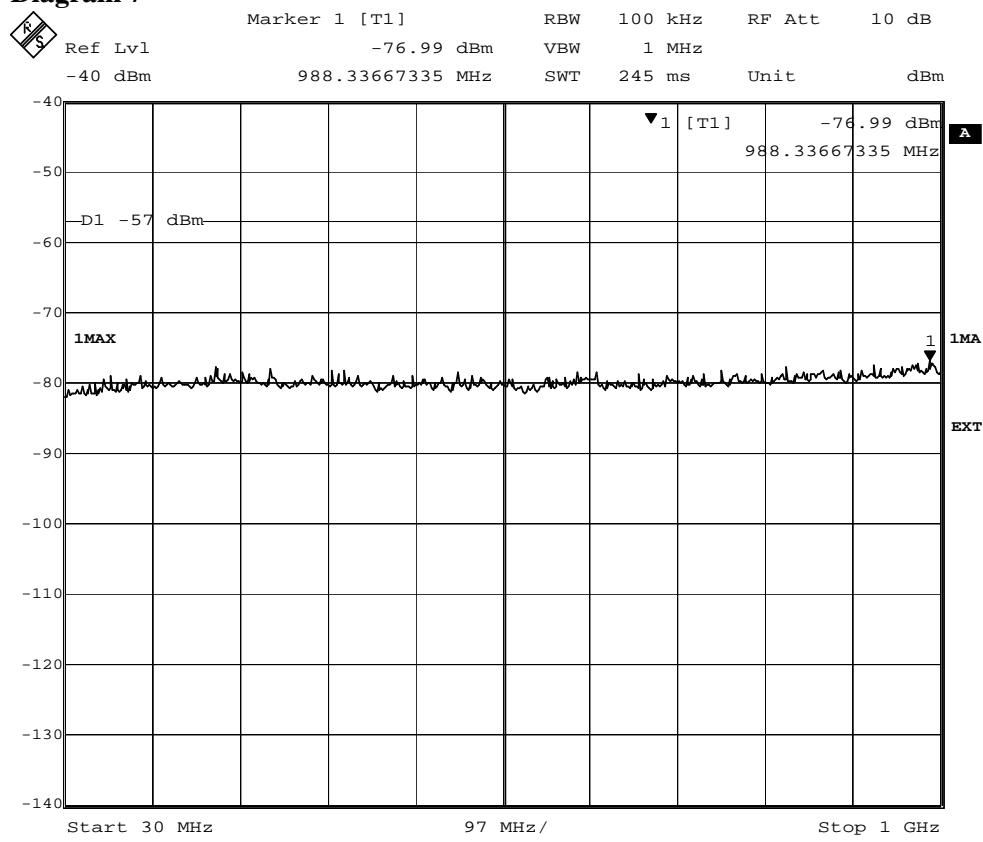
Date: 23.FEB.2009 17:36:31

**Diagram 6**

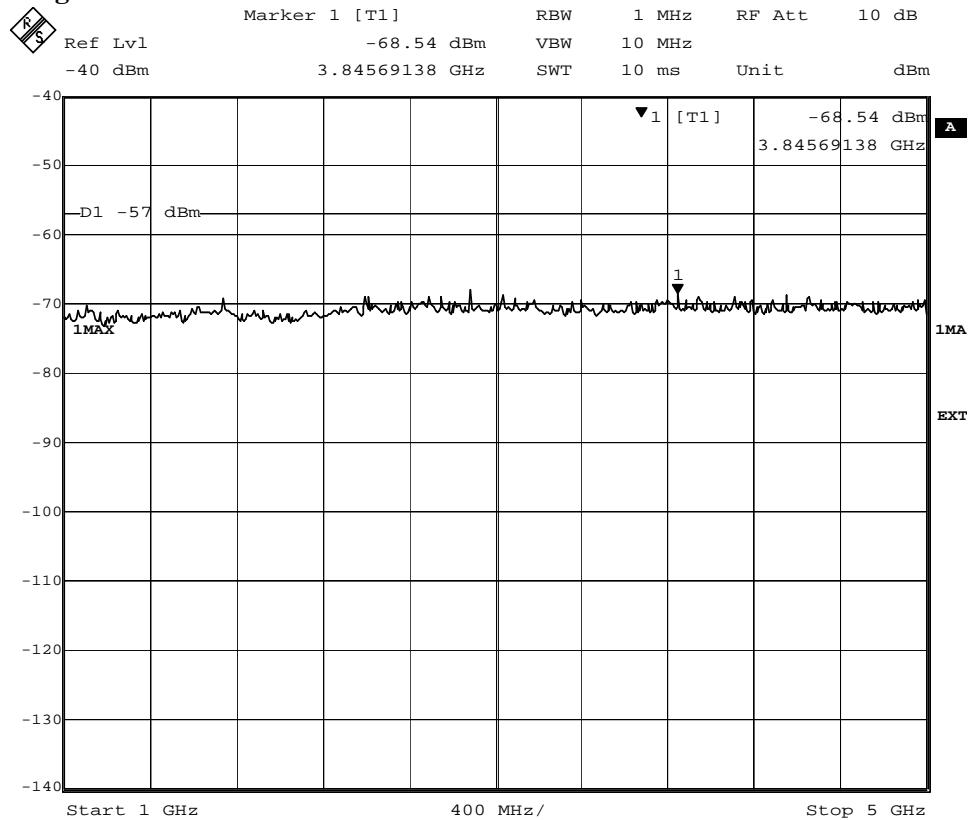
Date: 23.FEB.2009 17:35:12

FCC ID: W7UMSTRANS

Appendix 10.1

**Diagram 7**

Date: 23.FEB.2009 17:33:56

**Diagram 8**

Date: 23.FEB.2009 17:33:04

**Occupied bandwidth measurements according to 47CFR 2.1049**

Date	Temperature	Humidity
2009-06-04	22 °C ± 3 °C	19 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

Conducted measurements were performed at the antenna connector and with continuous transmission (100% duty cycle) and with modulation.

The used test equipment was connected to an external 10 MHz reference standard during measurements.

Measurement equipment	Calibration Due	SP number
Test site Marconi	-	15:121
R&S FSIQ 40 Signal analyser	2009-08	503 738
HP 6813B AC power source	2010-07	503 091
Inmet 2100-20dB attenuator	2010-06	503 871
Fluke 87 True RMS voltmeter	2010-01	502 190
Temperature and humidity meter Testo 615	2010-02	503 498

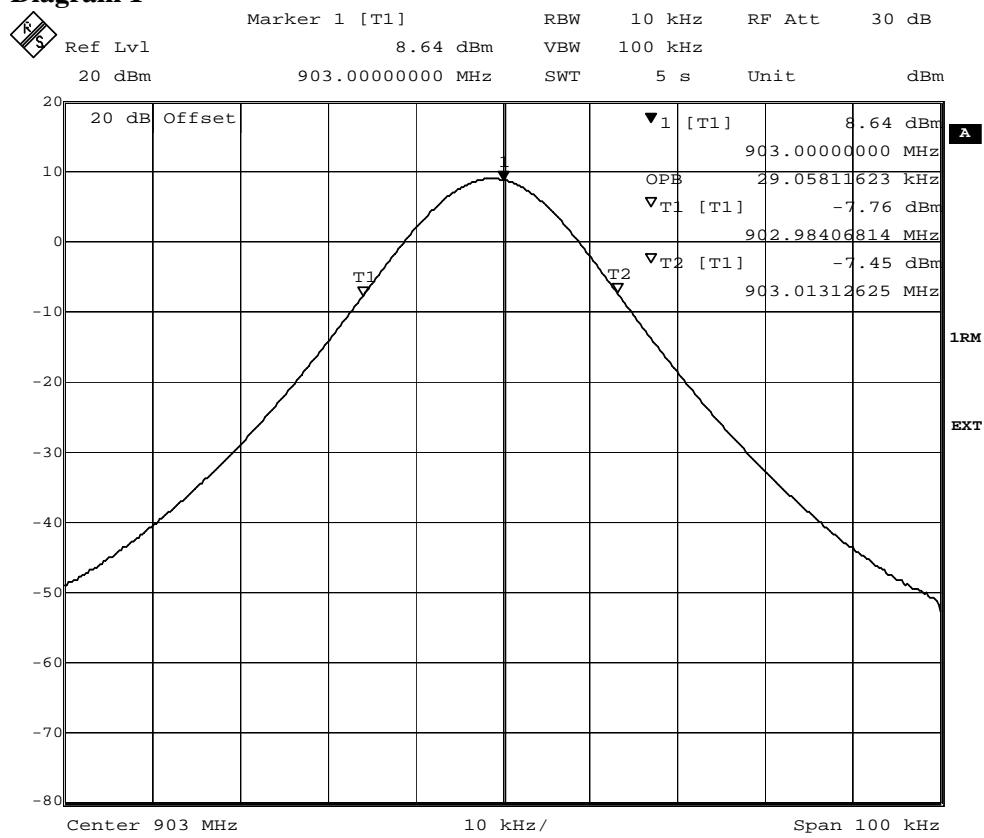
**Measurement uncertainty: 2.6 %****Results**

The diagrams can be found in the appendix 11.1.

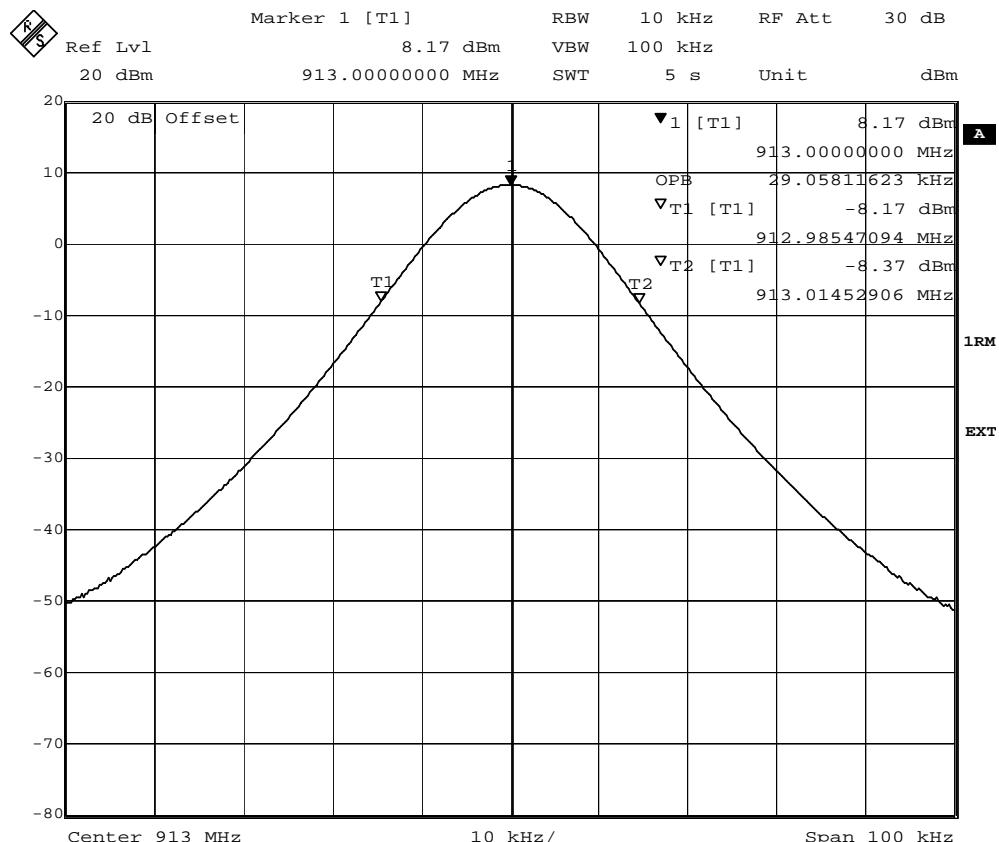
Diagram 1 903 MHz OBW = 29.06 kHz (99%)  
Diagram 2 913 MHz OBW = 29.06 kHz (99%)

FCC ID: W7UMSTRANS

Appendix 11.1

**Diagram 1**

Date: 4.JUN.2009 14:31:24

**Diagram 2**

Date: 4.JUN.2009 14:32:50

**Band edge measurements according to 47CFR 2.1049**

Date	Temperature	Humidity
2009-06-04	23 °C ± 3 °C	21 % ± 5 %

**Test set-up and procedure**

The measurements were performed according to ANSI C63.4-2003.

The test was performed with continuous transmission (100% duty cycle) and with modulation and also with the FHSS function enabled.

The test of the band edge was performed in a semi anechoic chamber. The fundamental was scanned with PEAK-detector with the antenna height 1-4 m and the turntable was varied between 0-360 degrees for maximum response. The antenna distance during the measurements was 3.0 m.

Test set-up photos during the tests can be found in appendix 13.

Measurement equipment	Calibration Due	SP number
Semi anechoic chamber, Edison	-	504 114
Spectrum analyzer R&S ESI 26	2009-07	503 885
EMI measurement computer	-	-
Software: R&S EMC32, ver. 6.30.10	-	503 745
Antenna Schaffner Bilog CBL6143	2010-03	504 079
Temperature and humidity meter Testo 625	2010-04	504 117

**Measurement uncertainty: 5.6 dB****Results**

Operation band 902-928 MHz

The diagrams can be found in the appendix 12.1

Diagram 1	903 MHz	Band edge at 960 MHz
Diagram 2	913 MHz	Band edge at 960 MHz
Diagram 3	FHSS enabled	Band edge at 960 MHz
Diagram 4	FHSS enabled	Band edge at 608-614 MHz

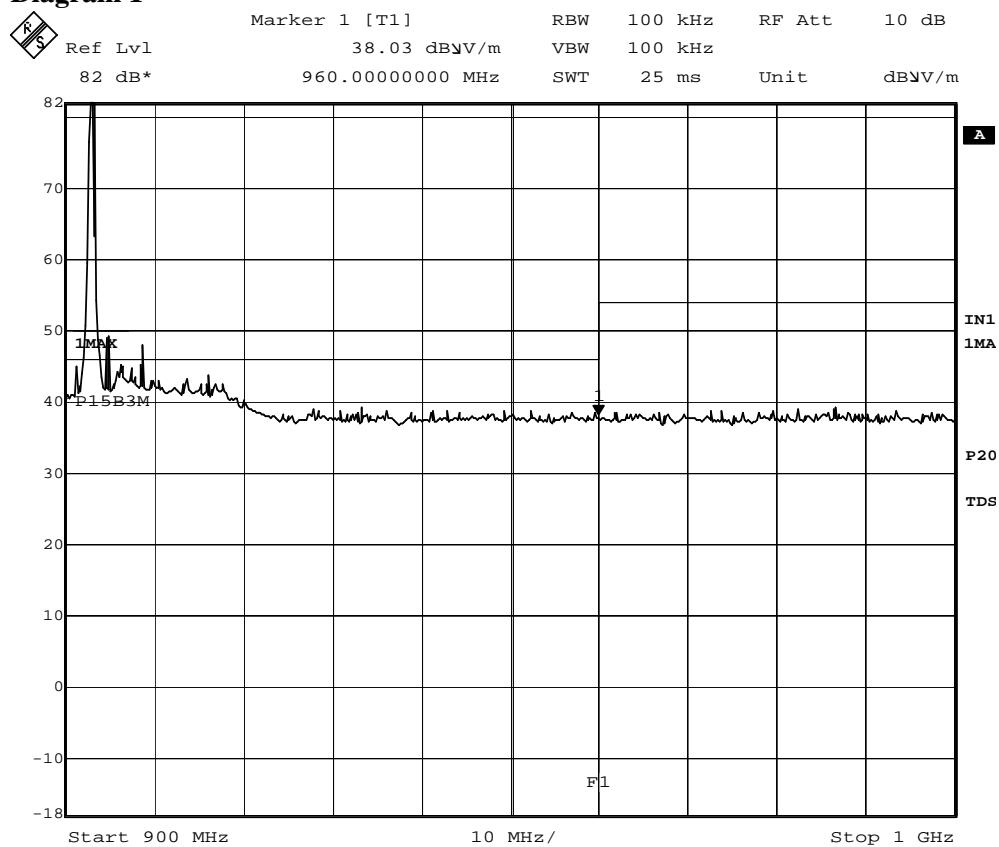
**Limits**

According to 47CFR 15.247(d), 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).

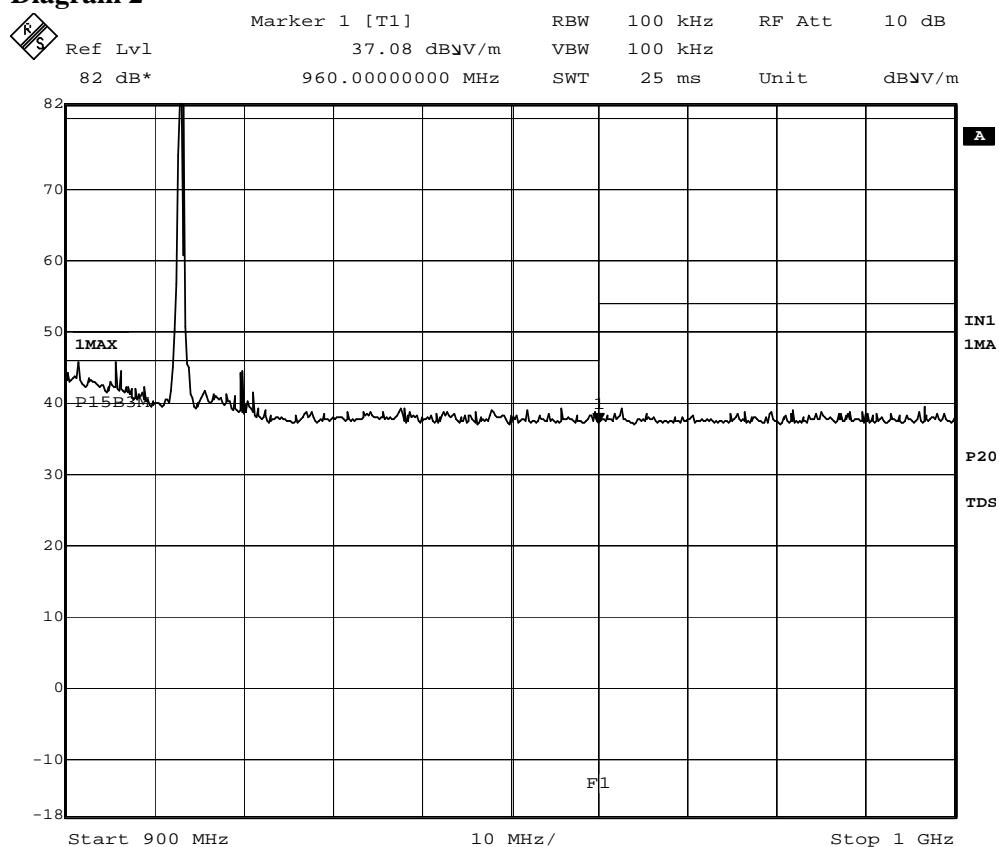
Complies?	Yes
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FCC ID: W7UMSTRANS

Appendix 12.1

**Diagram 1**

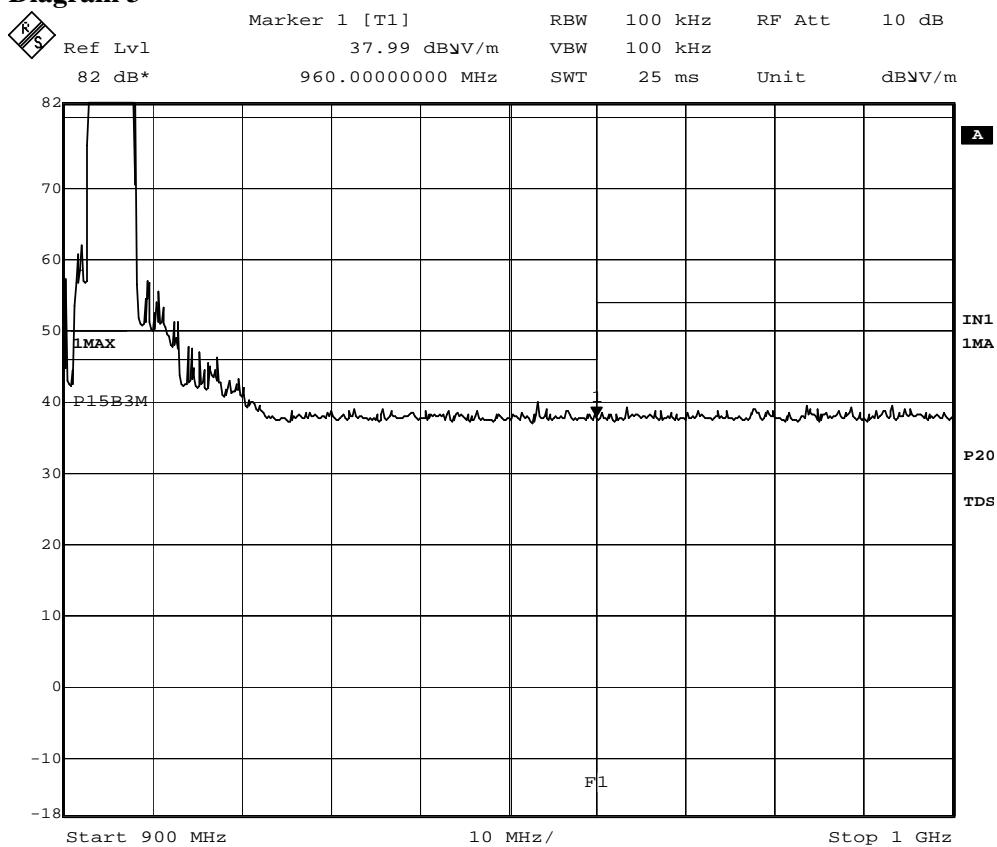
Date: 4.JUN.2009 14:14:22

**Diagram 2**

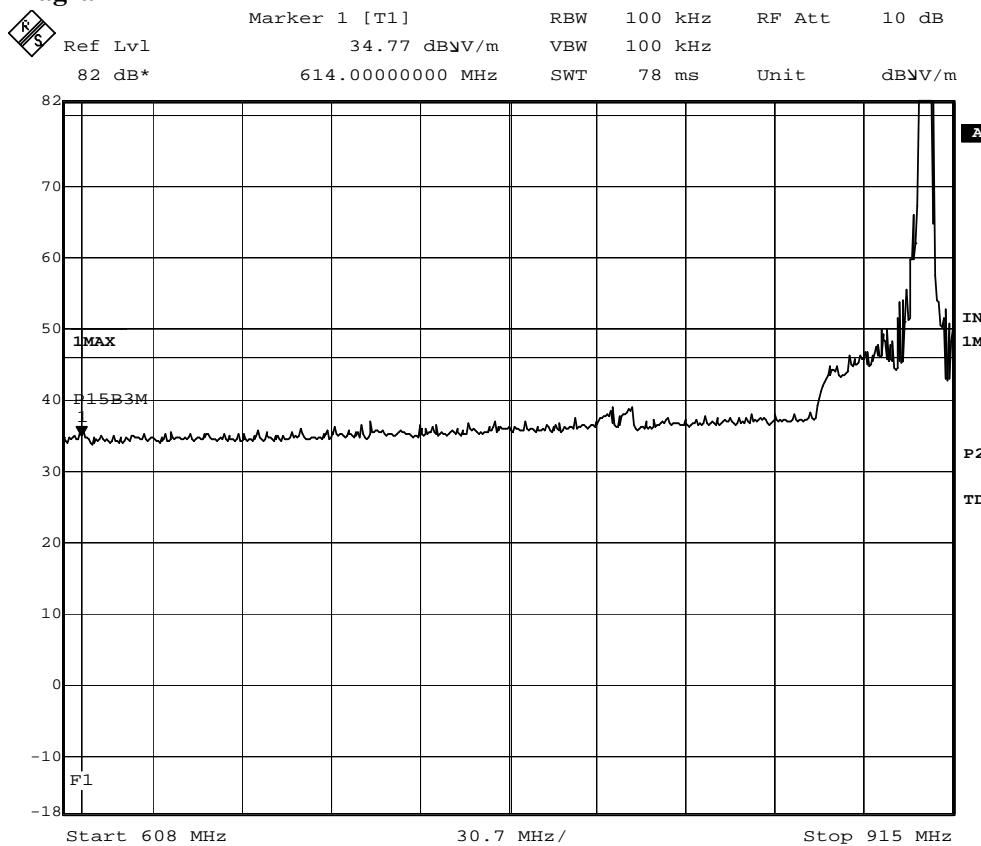
Date: 4.JUN.2009 14:06:25

FCC ID: W7UMSTRANS

Appendix 12.1

**Diagram 3**

Date: 4.JUN.2009 13:45:18

**Diagram 4**

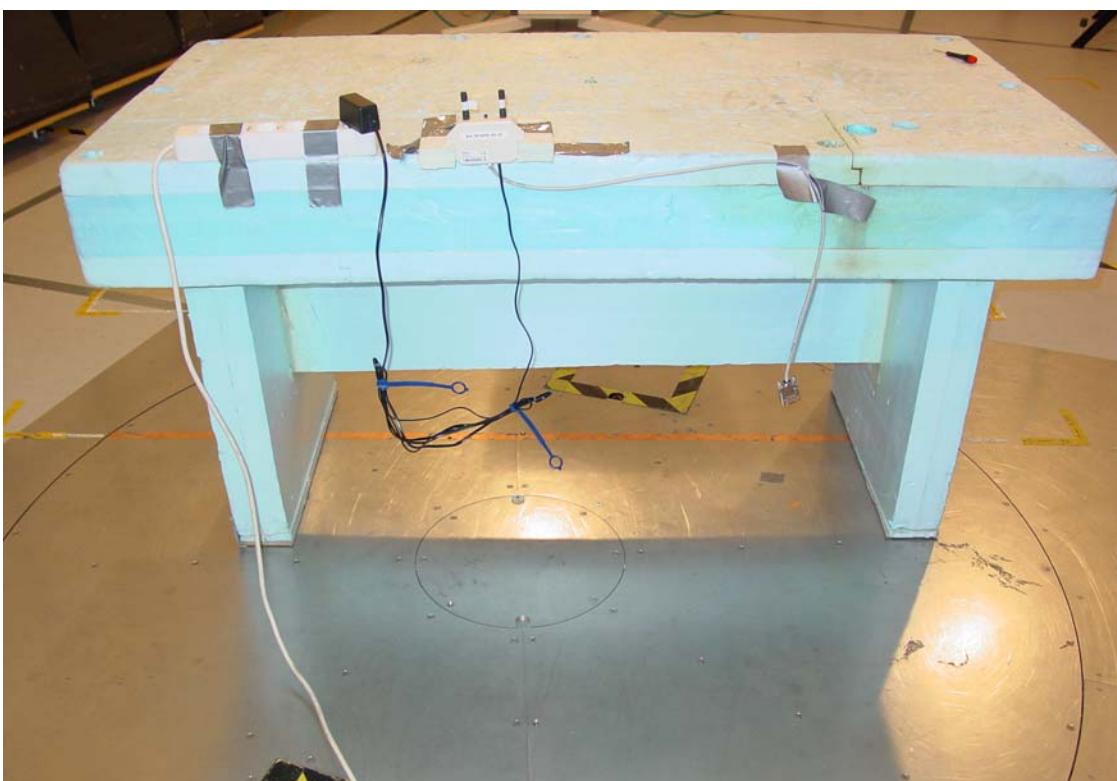
Date: 4.JUN.2009 13:54:38

FCC ID: W7UMSTRANS

Appendix 13

## Photos

The test set-up during the radiated tests, 2009-05-07--08, can be seen in the pictures below

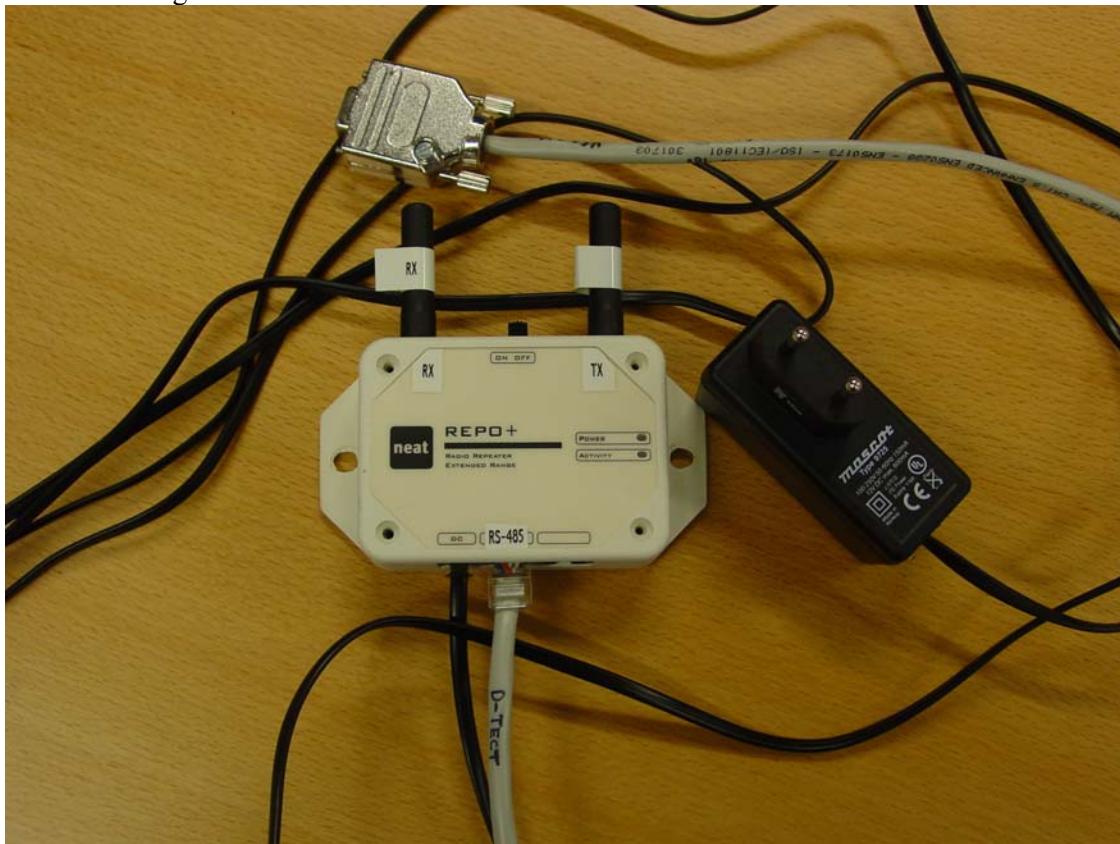


FCC ID: W7UMSTRANS

Appendix 13

Serial number: 0701501000084 (modified)

Front including cables



Front



FCC ID: W7UMSTRANS

Appendix 13

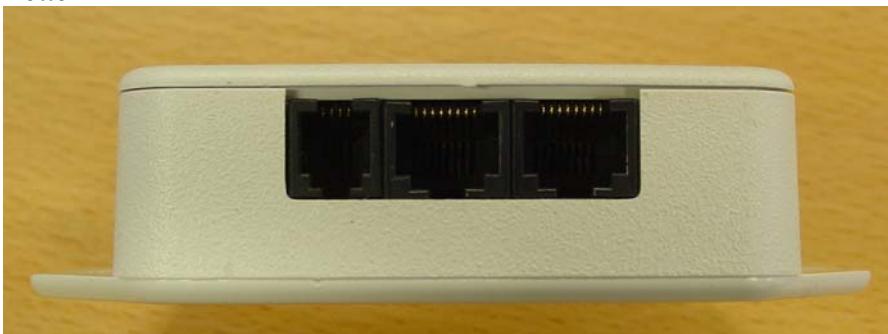
Rear



Top



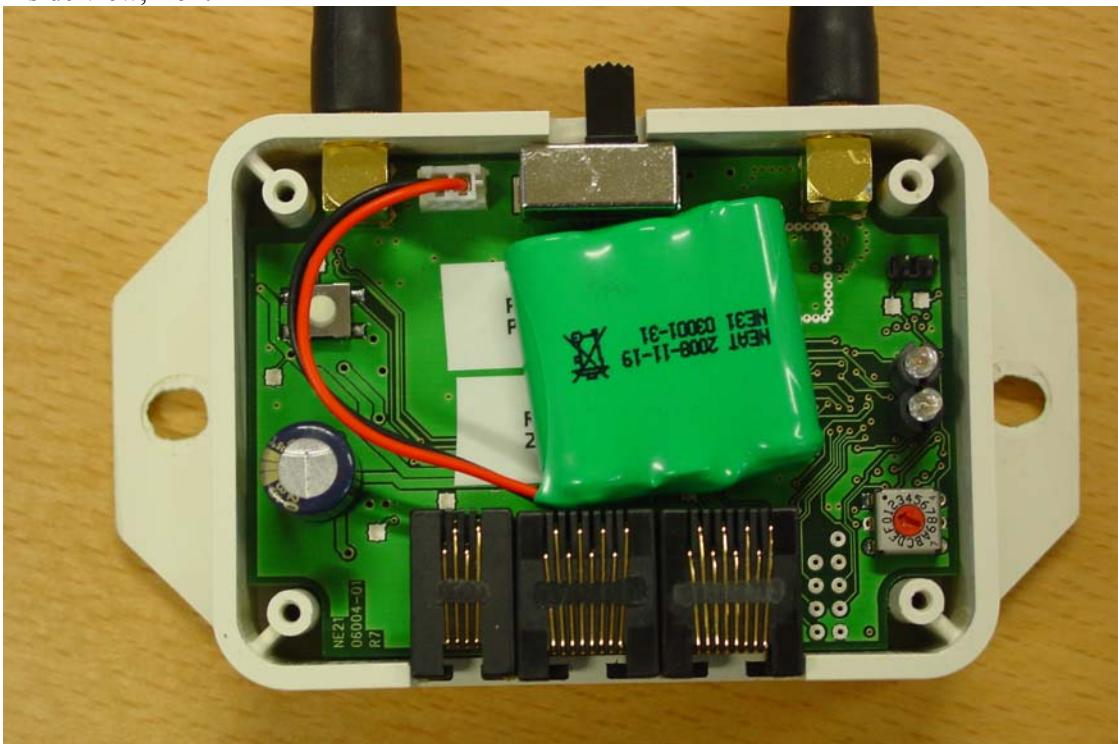
Bottom



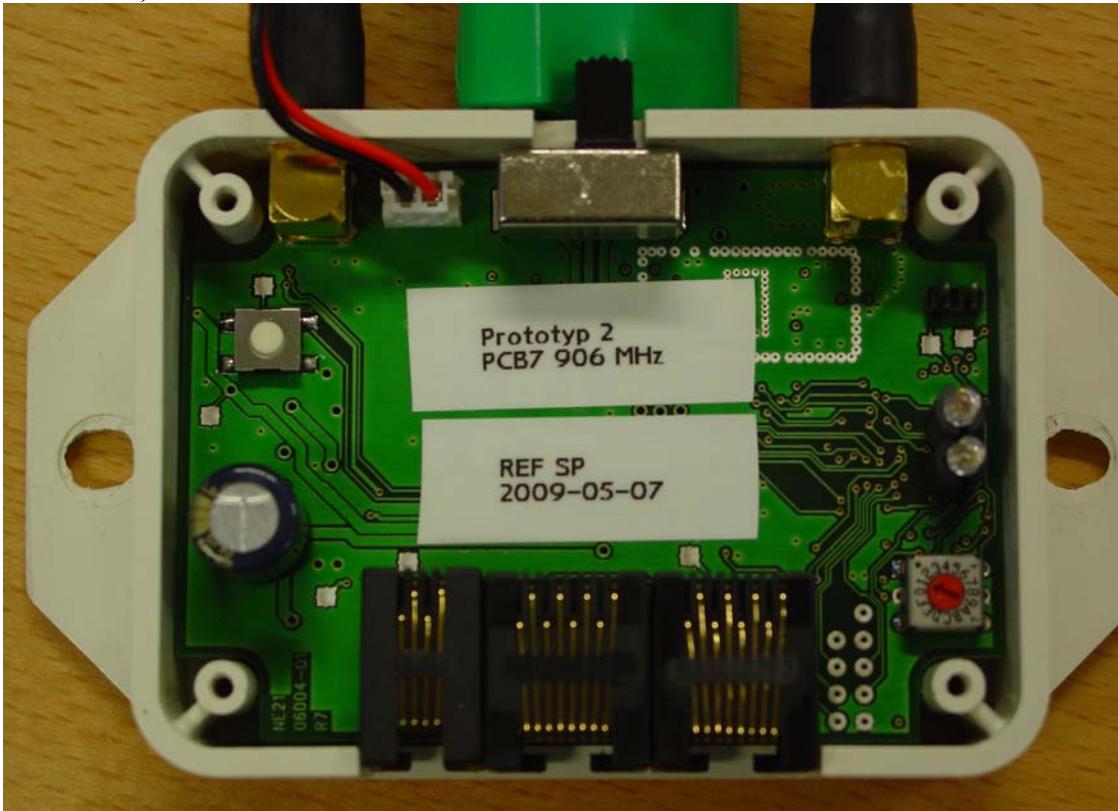
FCC ID: W7UMSTRANS

Appendix 13

Inside view, front 1



Inside view, front 2



FCC ID: W7UMSTRANS

Appendix 13

Inside view, rear

