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Test Report

Company:	MetroTel Corp 26 First Ave SE New London, MN 56273
Contact:	Jim Fangmeier
Product:	WESROC RMS WB Tank Transmitter
FCC ID: IC:	RWBMT9100TNK 115A-MT9100TNK
Test Report No:	R091307-30
APPROVED BY:	Doug Kramer Senior Test Engineer
DATE:	28 September 2007
Total Pages:	31

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: FCC Part 15, Subpart C			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.203 RSS-Gen	Unique Antenna Requirement	Pass	PCB Antenna
15.209 RSS-Gen	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(2) RSS-210 Issue 6	Minimum Bandwidth, Limit: Min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b) RSS-210 Issue 6	Maximum Peak Output Power, Limit: Max. 30dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 6	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.
15.247(d) RSS-210 Issue 6	Power Spectral Density, Limit: Max. 8dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 6	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.

Note: Conducted emissions measurements per 15.207 were not required because the EUT has no AC mains connection.

1.2 Test Methods

1.2.1 Radiated Emissions

Compliance to 47 CFR Parts 15.209 and 15.247 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the receiving antenna was moved vertically from 1m to 4m in both vertical and horizontal positions. The EUT was tested while sitting both vertically and horizontally. The horizontal configuration produced the highest emissions, and that position was used for all radiated testing. All measurements were taken at a distance of 3m from the EUT for Part 15.209 intentional radiator measurements, and 3m for 15.247 measurements of the fundamental frequency in the 902MHz to 928MHz band and subsequent harmonics.

2.0 Description

2.1 Equipment under test

The Transmitter is designed to enhance the efficiency of a bulk liquid distributor's delivery operation. The primary function of the Transmitter is to measure and report the liquid level inside of a tank via a wireless link. In addition, the Transmitter provides a variety of status, version and configuration information. The data gathered by the Transmitter is sent to a WESROC RMS Base Unit. The Base Unit relays the information to a WESROC RMS Host Computer at specified intervals via a standard telephone line. The Transmitter is intended to be installed on the outside of a tank and be connected to the sensor ready dial on a standard magnetic liquid level gauge. The Transmitter senses the position of the gauge and uses this information to calculate the liquid level in the tank. The EUT was the worst case configuration of the three models (MT-9100TNK-Sx, MT-9100TNK-Rx, MT-9100TNK-Ux).

EUT Received Date: 17 September 2007
EUT Tested Date: 17 September 2007

PRODUCT	WESROC RMS WB Tank Transmitter
MODEL	MT-9100TNK-UT
POWER SUPPLY	Internal 3.6VDC battery
MODULATION TYPE	FSK
TRANSFER RATE	2400 bit per second, transmit only
FREQUENCY RANGE	916.48 MHz
NUMBER OF CHANNELS	1
MAXIMUM OUTPUT POWER	9.18dBm, 8.28mW
ANTENNA TYPE	Internal, PCB mounted
DATA CABLE	Hall sensor with 10ft cable
I/O PORTS	N/A
ASSOCIATED DEVICES	N/A

NOTE:
1. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC and IC registered lab. This site has been fully described in previously submitted reports. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 45 ± 4%
Temperature of 20 ± 3° Celsius

2.3 Description of test modes

Channel	Frequency
1	916.48 MHz

The EUT is only capable of transmitting at 916.48MHz. In this report, the frequency will be referred to as Channel 1.

2.4 Applied standards

The EUT is a digital transmission device operating between 902 MHz and 928 MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247) using ANSI/IEEE C63.4: 2003
Industry Canada, RSS 210, Issue 6, Category I Equipment

All test items have been performed and recorded as per the above standards.

2.5 Description of support units

None

2.6 Configuration of system under test

The EUT was powered by an internal 3.6VDC battery unless noted otherwise. The EUT tested was model number MT-91000TNK-UT. This model was chosen because it has the longest possible sensor cable. It is assumed by the manufacturer that all other models will have nearly identical performance on the tests performed in this test or better in the case of the spurious emissions tests.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ESIB26	100037	8/14/2007
Rohde & Schwarz Test Receiver	ESIB7	100007	5/16/2007
EMCO Biconilog Antenna	3142B	1647	1/29/2007
EMCO Horn Antenna	3115	6415	1/31/2007

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 15.203, 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.

4.1.2 Antenna description

The antenna supplied with the EUT is an internal PCB mounted antenna and not interchangeable.

4.2 Radiated emissions

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for peak and average detectors at frequencies above 1GHz.

4.2.3 Deviations from test standard
No deviation.

4.2.4 Test setup

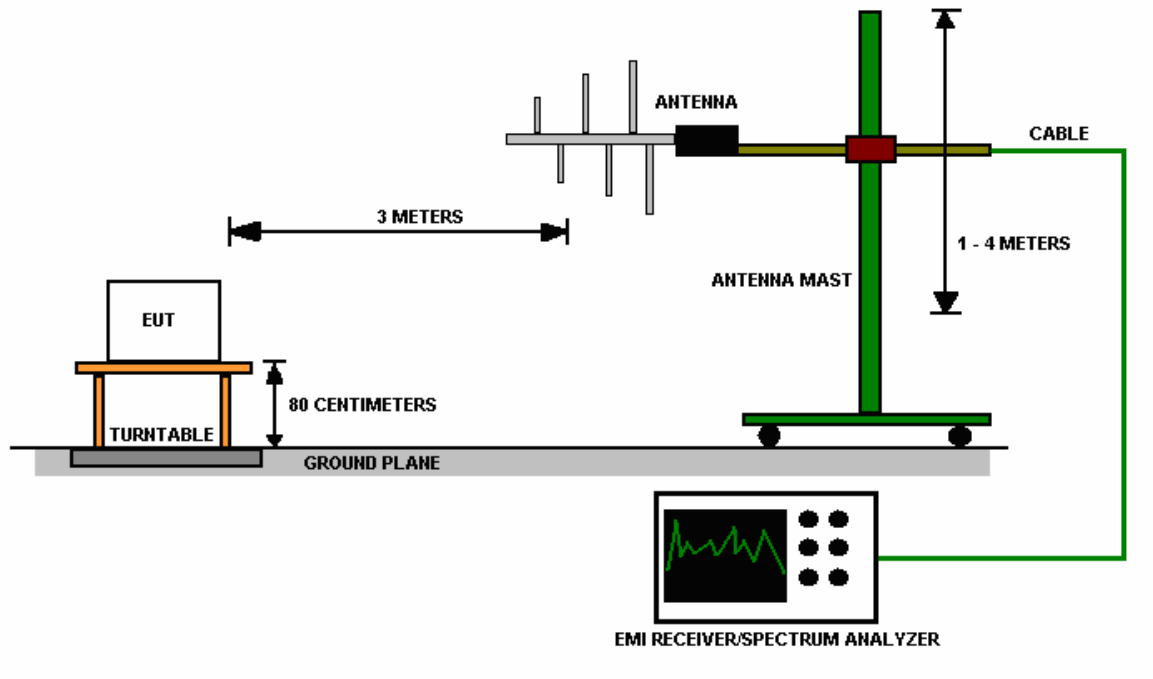

Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions
The EUT was powered by a new, internal 3.6VDC battery. The EUT tested was model number MT-91000TNK-UT.

4.2.6 Test results

EUT	RMS WB Tank Transmitter	Model	MT-9100TNK-XX
MODE	Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	3.6VDC	Date	17 September 2007
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
92.580000	32.38	44.0	11.6	100.0	60	VERT
144.600000	31.29	44.0	12.7	99.0	64	VERT
147.840000	31.12	44.0	12.9	101.0	161	VERT
209.580000	24.72	44.0	19.3	100.0	22	VERT
212.880000	32.69	44.0	11.3	101.0	358	VERT
216.120000	33.14	46.0	12.9	98.0	34	VERT
310.380000	36.43	46.0	9.6	126.0	199	HORI
656.520000	35.92	46.0	10.1	99.0	273	HORI
695.520000	36.81	46.0	9.2	99.0	15	VERT
760.500000	40.43	46.0	5.6	144.0	19	VERT
812.400000	42.53	46.0	3.5	122.0	162	VERT
864.420000	40.24	46.0	5.8	118.0	175	VERT
901.860000	33.65	46.0	12.4	106.0	263	VERT
916.500000	107.48	N/A*	N/A	109.0	258	VERT
916.740000	99.06	N/A*	N/A	106.0	258	VERT
928.200000	33.70	46.0	12.3	100.0	250	VERT

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits do not apply within the 902MHz to 928MHz band.

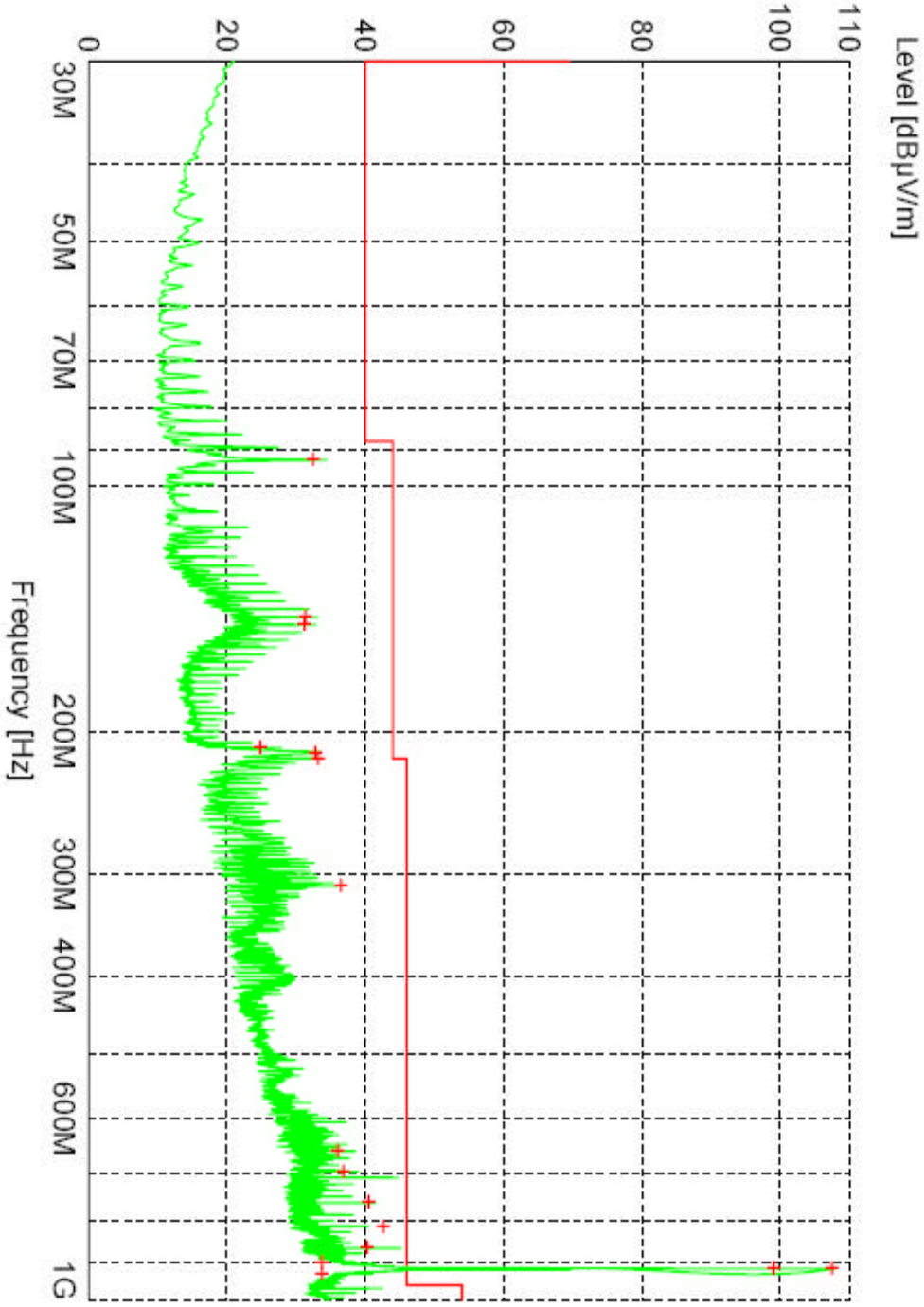

Figure 2 - Radiated Emissions Plot, 30MHz-1GHz

EUT	RMS WB Tank Transmitter	Model	MT-9100TNK-XX
MODE	Transmit	FREQUENCY RANGE	1MHz – 10GHz
INPUT POWER (SYSTEM)	3.6VDC	Date	17 September 2007
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1833.0	52.97	87.49*	34.52	118	181	VERTICAL
2755	38.54	53.9	15.4	294	87	VERTICAL
3667.0	30.82	53.9	23.08	191	214	VERTICAL
4581.0	35.86	53.9	18.04	227	214	VERTICAL
5498.5	44.86	53.9	9.04	201	88	VERTICAL
6415.0	41.51	53.9	12.39	191	169	VERTICAL

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1833.0	59.13	73.9	14.77	118	181	VERTICAL
2755	49.71	73.9	24.19	294	87	VERTICAL
3667.0	53.94	73.9	19.96	191	214	VERTICAL
4581.0	55.55	73.9	18.35	227	214	VERTICAL
5498.5	59.79	73.9	14.11	201	88	VERTICAL
6415.0	62.31	73.9	11.59	191	169	VERTICAL

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. "*" 1833.0MHz falls in an unrestricted band. Spurious emissions are then required to be 20dB below the value of the peak emission at the fundamental frequency. In this case, the peak emissions is 107.49dBµV/m, so the limit is 87.49 dBµV/m. All measurements made in restricted bands that were below the limits in 15.209 were referenced to those limits.

4.3 Bandwidth

4.3.1 Limits of bandwidth measurements

The 6dB bandwidth of the signal must be greater than 0.50MHz

4.3.2 Test procedures

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 100 kHz VBW. The 6 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 6dB.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level, which was 9.18dBm. The signal was captured with a 100kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

4.3.5 EUT operating conditions

The EUT was modified to be powered by a 3.6VDC power supply. The EUT tested was model number MT-91000TNK-UT.

4.3.6 Test results

EUT	RMS WB Tank Transmitter	MODEL	MT-9100TNK-XX
DATE	17 September 2007	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC
TECHNICIAN	NJohnson	MODE	Continuous Transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB MINIMUM LIMIT (MHz)	99% Occupied BW (kHz)	RESULT
1	916.48	907.14	0.500	1170	Pass

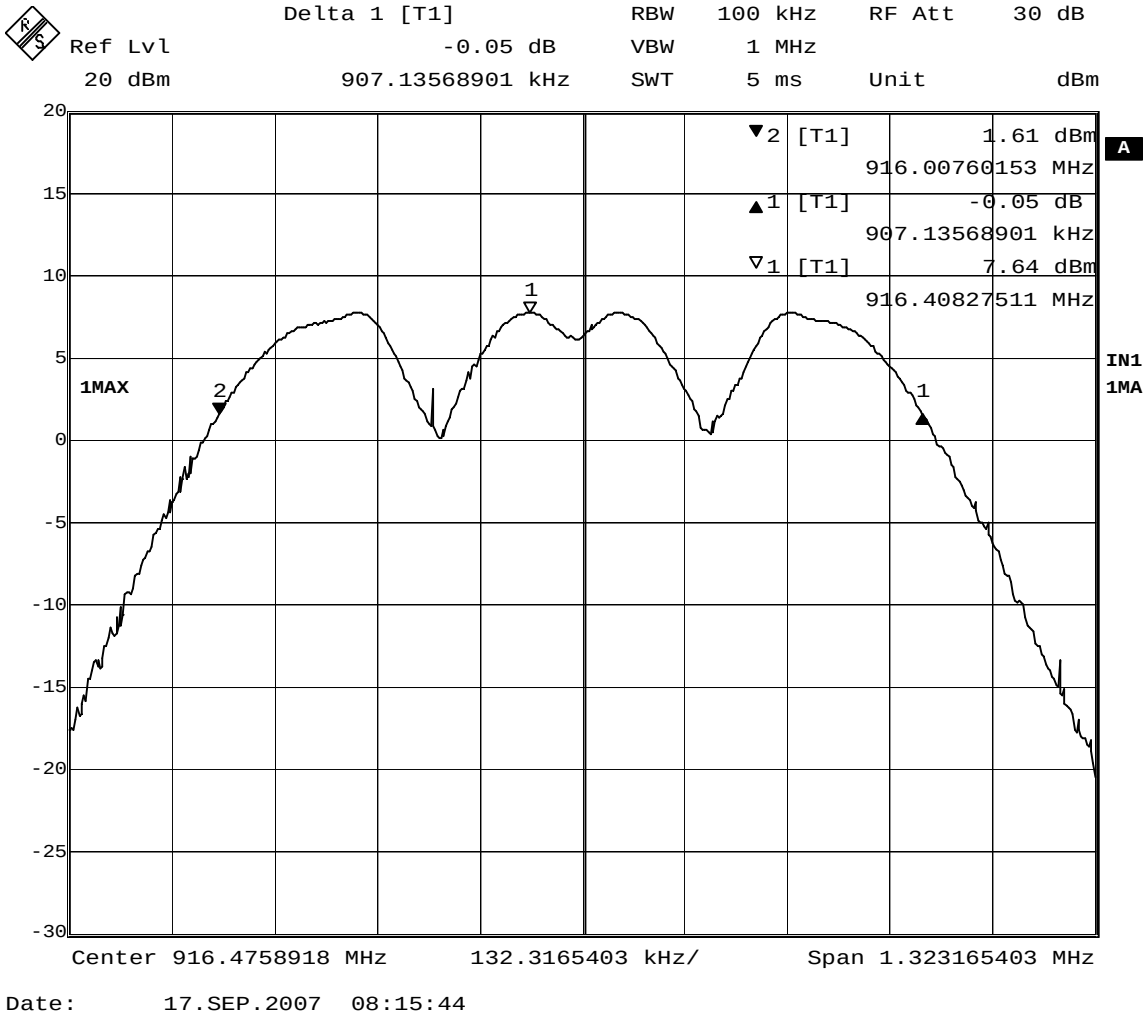

Figure 3 - 6dB Bandwidth, 907.14kHz

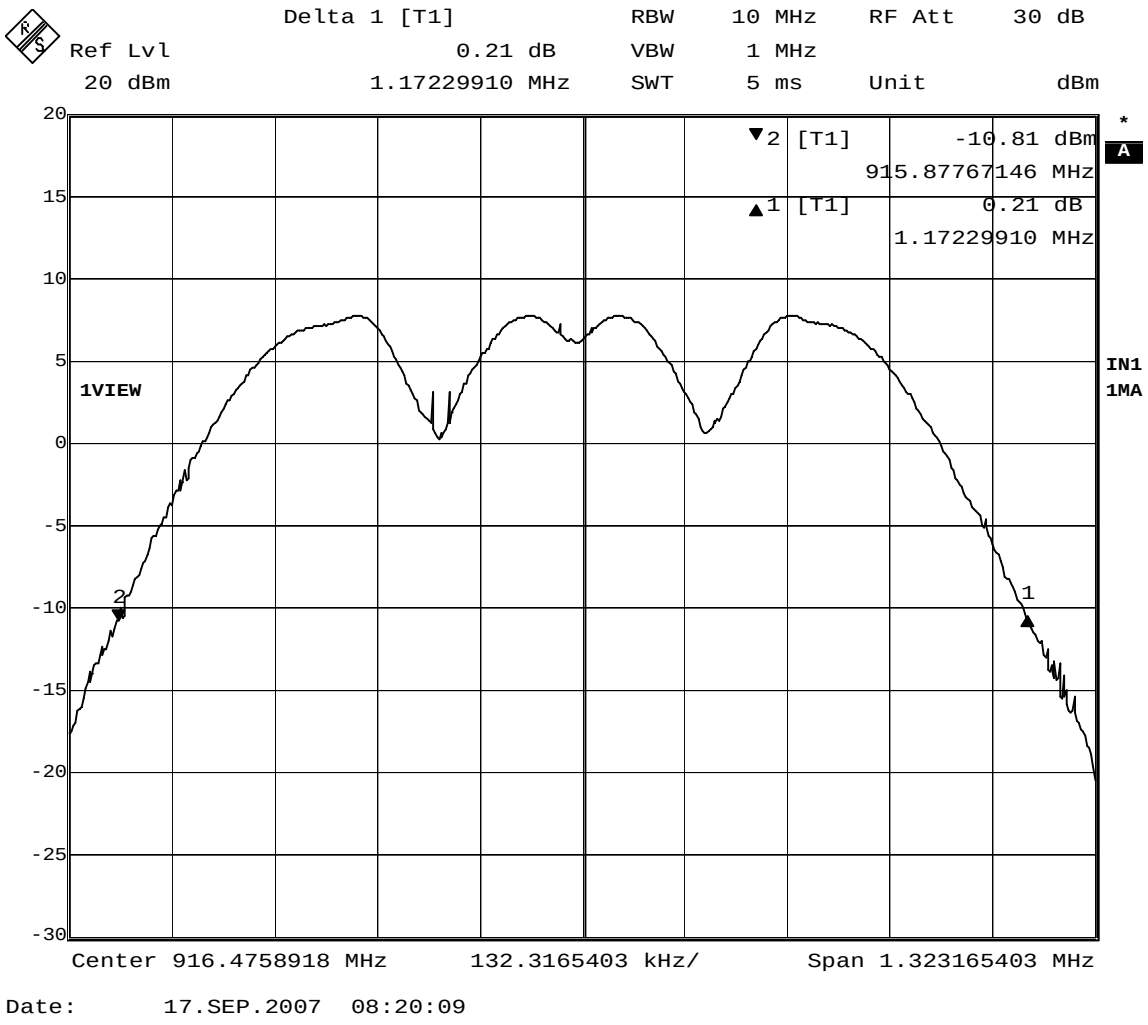

Figure 4 - 99% Occupied Bandwidth, 1.17MHz

4.4 Maximum peak output power

4.4.1 Limits of power measurements

The maximum peak output power allowed is 30dBm.

4.4.2 Test procedures

1. The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable.

2. The channel power function of the spectrum analyzer was used to calculate the cumulative power output per MHz over the range of the set channel bandwidth. The channel bandwidth was set to 30MHz.

3. The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

4.4.5 EUT operating conditions

The EUT was modified to be powered by a 3.6VDC power supply. The EUT tested was model number MT-91000TNK-UT.

4.4.6 Test results

Maximum peak output power

EUT	RMS WB Tank Transmitter	MODEL	MT-9100TNK-XX
Date	17 September 2007	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC
TECHNICIAN	NJohnson	MODE	Continuous transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	916.48	9.18	30	Pass

4.5 Power spectral density (PSD)

4.5.1 Limits of PSD measurements

The maximum power spectral density allowed is 8dBm.

4.5.2 Test procedures

The transmitter output was connected directly to the spectrum analyzer. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using 3 kHz RBW and 1 MHz VBW, the sweep time was 500s. The power spectral density was measured and recorded at the frequency with the highest emission. The sweep time is allowed to be longer than span/3KHz for a full response of the mixer in the spectrum analyzer.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

4.5.5 EUT operating conditions

The EUT was modified to be powered by a 3.6VDC power supply. The EUT tested was model number MT-91000TNK-UT.

4.5.6 Test results

Power Spectral Density

EUT	RMS WB Tank Transmitter	MODEL	MT-9100TNK-XX
Date	17 September 2007	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC
TECHNICIAN	NJohnson	MODE	Continuous transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN # KHz BW (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	916.48	7.70	8	Pass

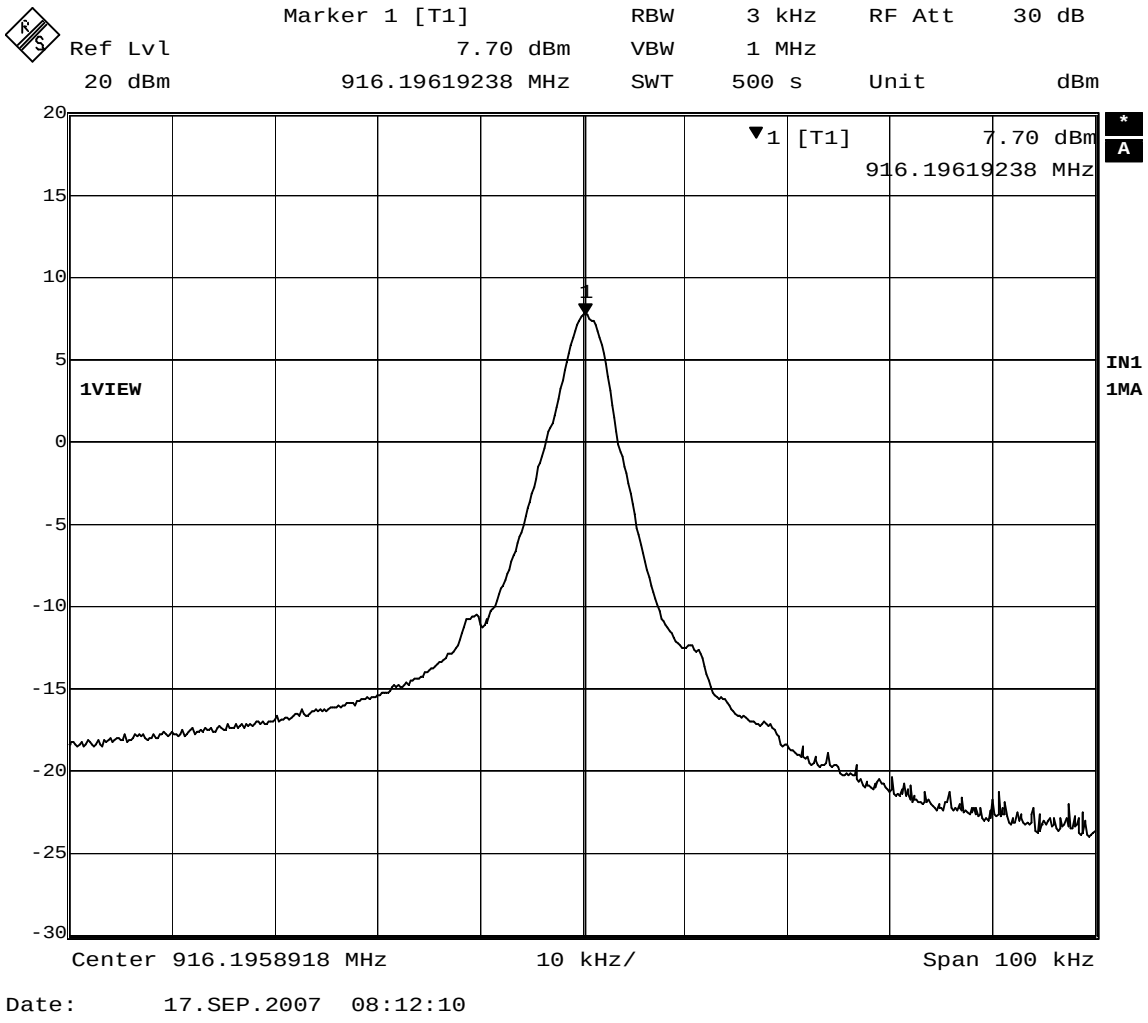

Figure 5 - PSD Measurement, 7.70dBm

4.6 Bandedges

4.6.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (902MHz – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.6.2 Test procedures

The EUT was tested in the same method as described in section *4.2 - Radiated emissions*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 120kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. If the out of band emissions do not fall within a restricted band from 15.205, then it is required that the out of band emission be 20dB below that of the fundamental emission level. If the out of band emission falls with a restricted band from 15.205, then it is required that the emission be below the limits from 15.209.

4.6.3 Deviations from test standard

No deviation.

4.6.4 Test setup

See 4.2.2

4.6.5 EUT operating conditions

The EUT was powered by an internal 3.6VDC battery. The EUT tested was model number MT-91000TNK-UT.

4.6.6 Test results

EUT	RMS WB Tank Transmitter	MODEL	MT-9100TNK-XX
Date	17 September 2007	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC
TECHNICIAN	NJohnson	MODE	Continuous transmit

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Peak Level (dBµV/m)	Fund. QP Level	Delta
1	902 MHz	42.25	107.48	-65.23
1	928 MHz	42.3	107.48	-65.18

NOTE:
The plots show corrected measurements. All values listed include all transducer and cable loss factors and reflect actual field strength levels.

Appendix A: Test Photos

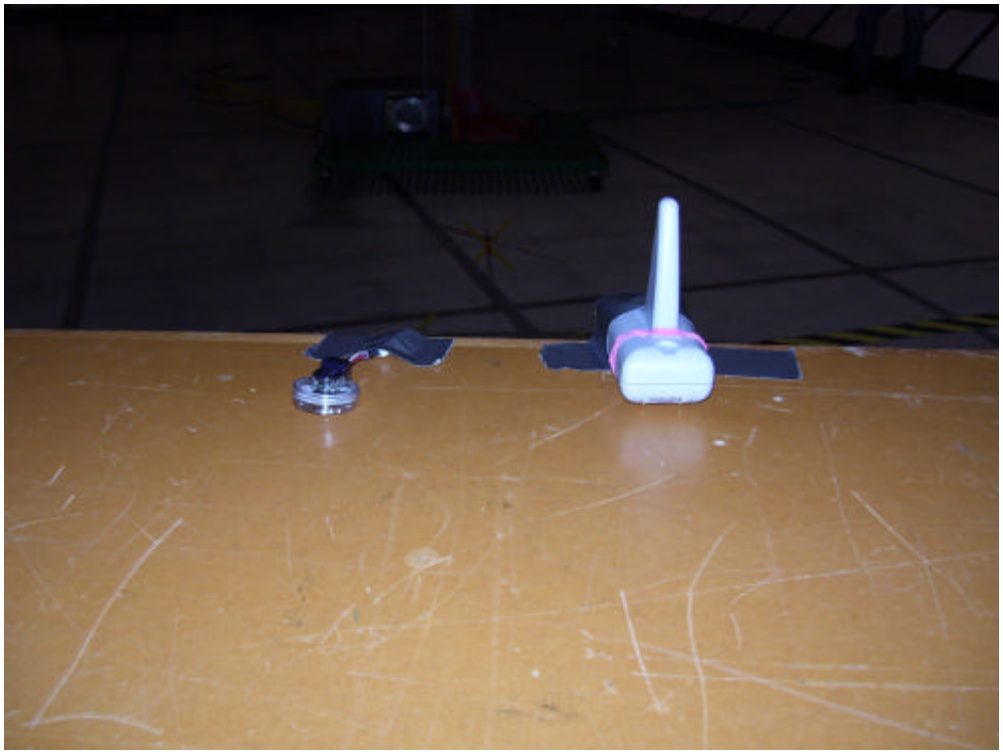

Figure 6 - Radiated Emissions Test Setup

Figure 7 - Radiated Emissions Test Setup

Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBµV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBµV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBµV/m

The 48.1 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm [(48.1 dBµV/m)/20]= 254.1 µV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

Appendix C: RF Exposure Evaluation

FCC ID: RWBMT9100TNK
RF Exposure Statement for MT9100TNK

Notice in Installation Manual:
FCC Radiation Exposure Statement
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 0.983cm (0.39 inches) between the radiator and your body.

RF Exposure Calculations:
The following information provides the minimum separation distances for the two major antenna types used in this system.

Directional Antenna:
The 1dBi antenna is the maximum gain antenna certified for use with the product. The minimum separation distance is calculated from **FCC OET 65 Appendix B, Table 1B** Guidelines for General Population/Uncontrolled Exposure. This calculation is based on the highest EIRP possible from the system, considering maximum power and antenna gain. The exposure limit for a transmitter operating at 916.5MHz is found in mW/cm^2 using the equations f/1200. Since the operating frequency in channel DA produced the lowest limit, that limit will be used in calculation. (916.5/1200 = 0.763mW/cm^2)

S = (Po * G) / (4 * Pi * r^2) or r = SQRT [(Po * G) / (4 * Pi * S)]

Where S = 0.763 mW/cm^2 for 916.5 MHz
Where Po = 8.28 mW (Peak RF, 9.18dBm)
Where G = 1.12 (numeric equivalent to 1dBi antenna gain with 0.0 dB cable loss)
Where r = Minimum Safe Distance from antenna (cm)

For Po = 8.28mW, r = 0.983cm (0.39 inches)

For a distance [r] of 20cm from this antenna, the field density S = 0.0019 mW/cm^2

Notes:
1. The minimum safe distance is based on a conservative "worst case" prediction, i.e. using the formula shown above and no duty factor. In practice the minimum distance will be much shorter. (Ref. 2)
2. The minimum safe distance has been calculated for the maximum allowed Power Density (S) limit of 0.75 mW/cm^2 for the frequency 915 MHz for uncontrolled environments (Ref. 2).

References:
1. FCC Part 15, sub-clause 15.247 (b) (4) (i)
2. FCC OET Bulletin 65, Edition 97-01
3. FCC Supplement C to OET Bulletin 65, edition 01-01

Appendix D: Table of Figures

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