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Test Report

Company:	MetroTel Corp 26 First Ave SE New London, MN 56273
Product:	Model MT-9100CBU Cellular Tank Transmitter
FCC ID: IC :	RWBMT9103CTM 115A-MT9103CTM
Test Report No:	R20130910-21
APPROVED BY:	Nic S. Johnson Technical Manager iNARTE Certification EMC-003337-NE
DATE:	29 July 2014
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ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

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1.0 Summary of 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	Unique Antenna Requirement	Pass	External Antenna
15.207	Conducted Emissions	Pass	Meets the requirement of the limit.
15.209	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(2)	Minimum Bandwidth, Limit: Min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b)	Maximum Peak Output Power, Limit: Max. 30dBm	Pass	Meets the requirement of the limit.
15.247(c)	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.
15.247(d)	Power Spectral Density, Limit: Max. 8dBm	Pass	Meets the requirement of the limit.
15.247(c)	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a WESROC RMS 3G Cellular Base Unit.

The EUT contains a pre-approved modular transmitter (FCC ID:R17HE910NA, IC: 5131A-HE910NA). It is a GSM Quad-band cellular module with modular approval.

EUT Received Date: 19 March 2014
EUT Tested Date: 19 March 2014 - 20 March 2014

PRODUCT	WESROC RMS 3G Cellular Tank Monitor
MODEL	MT9103CTMGUG10
POWER INPUT	3.6 VDC
MODULATION TYPE	FSK
RADIO TECHNOLOGY	Frequency-Shift Keying (FSK)
FREQUENCY	916.74 MHz
POWER SUPPLY	3.6 VDC internal Battery
ANTENNA TYPE	Dipole
SERIAL NUMBER OF TEST UNIT	00003405 (Radio measurements), 00003406 (Radiate Emissions measurements)

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 37 ± 5%
Temperature of 23 ± 3° Celsius

2.3 Description of test modes

Channel	Frequency
1	916.74 MHz

2.4 Applied standards

The EUT is a digital transmission device operating in the 902 MHz to 928 MHz amateur band. 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: 2009
Industry Canada, RSS 210, Issue 8, Category I Equipment
KDB Publication No. 558074: 2012

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 3.6 VDC internal Battery for all the tests and had no auxiliary devices. It was tested by itself. The EUT was programmed by the manufacturer to transmit continually for testing purposes only.
The EUT was modified by the manufacturer to test with the device continuously transmitting a series of 1's and 0's, or to set the EUT to continuous receive mode for testing purposes.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ESIB26	100037	21 Jan 2014
EMCO Biconilog Antenna	3142B	1647	07 Aug 2013
EMCO Horn Antenna	3115	6416	14 Jan 2014
Rohde & Schwarz Preamplifier	TS-PR18	NCEEPAHF2	13 Mar 2013*

*Internal characterization

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 internal to the device and the user would need a security keyed tool to open the enclosure and remove the antenna.

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.

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 according to 15.209 do not apply within the 902MHz to 928MHz band for transmitters.
6.**For frequencies not in a restricted band as specified in 15.205, spurious emissions shall be at least 20dB less than the field strength at the fundamental frequency.

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

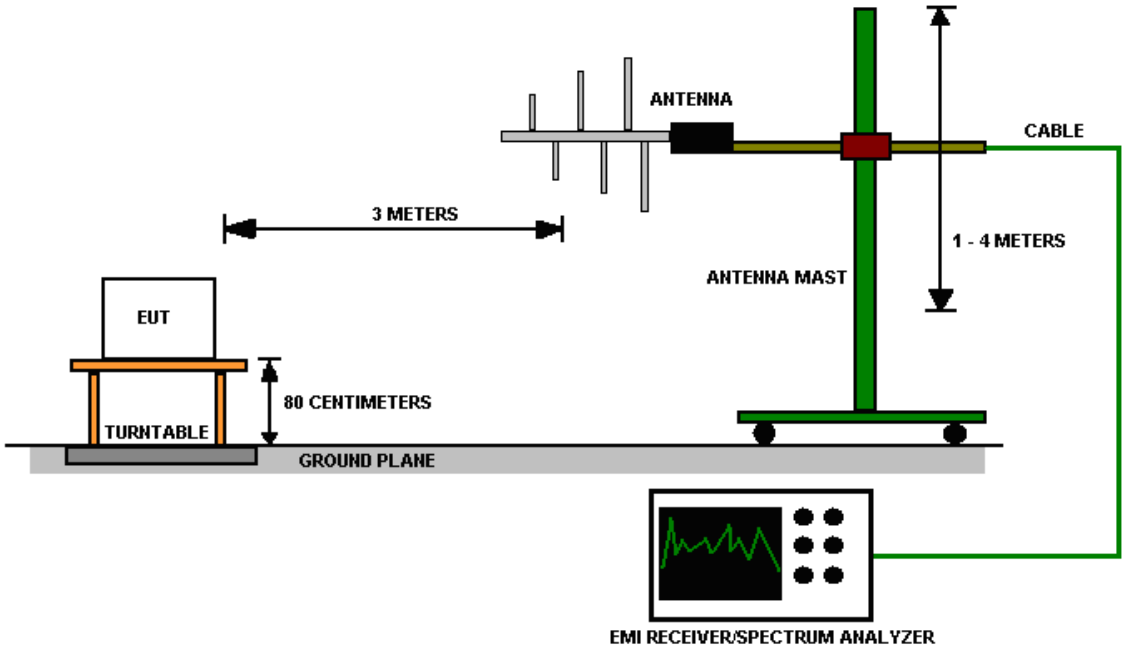


Figure 1 - Radiated Emissions Test Setup

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

4.2.5 EUT operating conditions

See section 2.6.

4.2.6 Test results

EUT	Cellular Tank Monitor	Model	MT-9100CBU
MODE	Transmit, Ch. 1	FREQUENCY RANGE	30MHz – 10GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

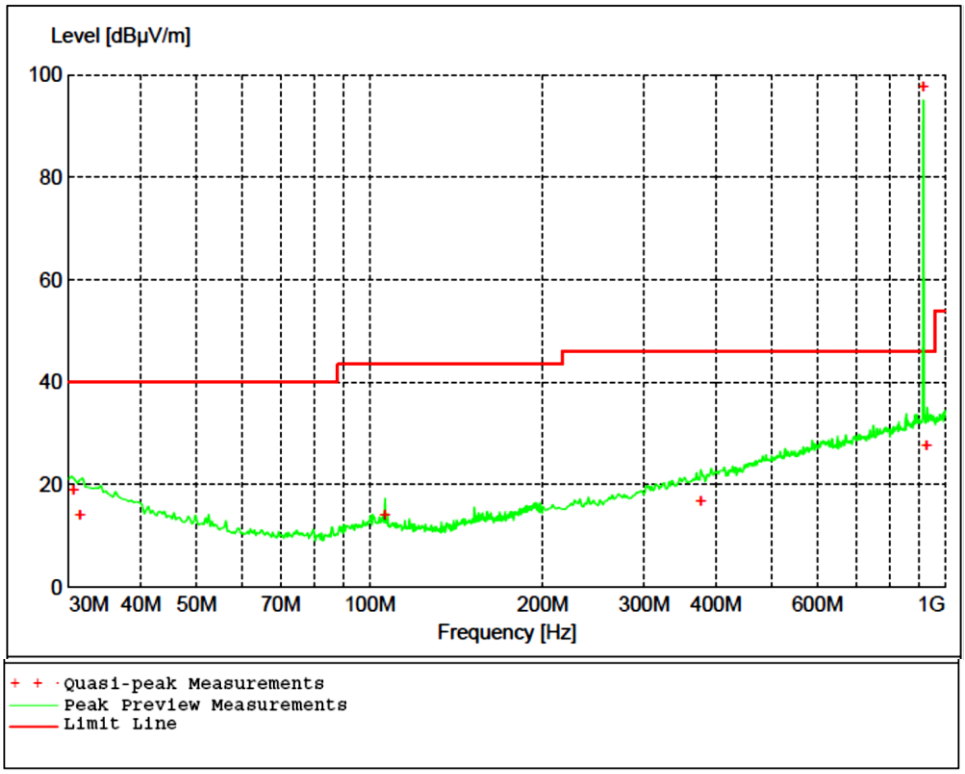


Figure 2 - Radiated Emissions Plot, Ch. 1

Quasi-peak Measurements, Ch. 1

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
30.540000	18.93	40.00	21.10	359	360	HORI
31.380000	14.03	40.00	26.00	329	70	HORI
106.260000	13.95	43.50	29.60	179	329	HORI
376.920000	16.72	46.00	29.30	132	39	HORI
916.740000	97.78	NA	NA	123	307	VERT
929.760000	27.54	46.00	18.50	99	346	HORI

Average Measurements – Transmit Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1833.000000	33.62	54.00	20.40	148	5	VERT
2747.000000	28.76	54.00	25.20	99	130	VERT
3675.600000	32.26	54.00	21.70	398	195	VERT
4583.000000	34.39	54.00	19.60	100	41	VERT
5499.200000	37.71	54.00	16.30	389	276	VERT
6398.800000	39.71	54.00	14.30	184	327	VERT
7349.800000	35.98	54.00	18.00	237	193	VERT
8239.600000	37.26	54.00	16.70	102	66	HORI
9138.200000	39.70	54.00	14.30	214	360	HORI

.

Peak Measurements – Transmit Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1833.000000	43.56	74.00	30.44	148	5	VERT
2747.000000	42.08	74.00	31.92	99	130	VERT
3675.600000	45.76	74.00	28.24	398	195	VERT
4583.000000	47.93	74.00	26.07	100	41	VERT
5499.200000	51.52	74.00	22.48	389	276	VERT
6398.800000	52.91	74.00	21.09	184	327	VERT
7349.800000	49.14	74.00	24.86	237	193	VERT
8239.600000	50.73	74.00	23.27	102	66	HORI
9138.200000	53.89	74.00	20.11	214	360	HORI

EUT	Cellular Tank Monitor	Model	MT-9100CBU
MODE	Receive	FREQUENCY RANGE	30MHz – 10GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

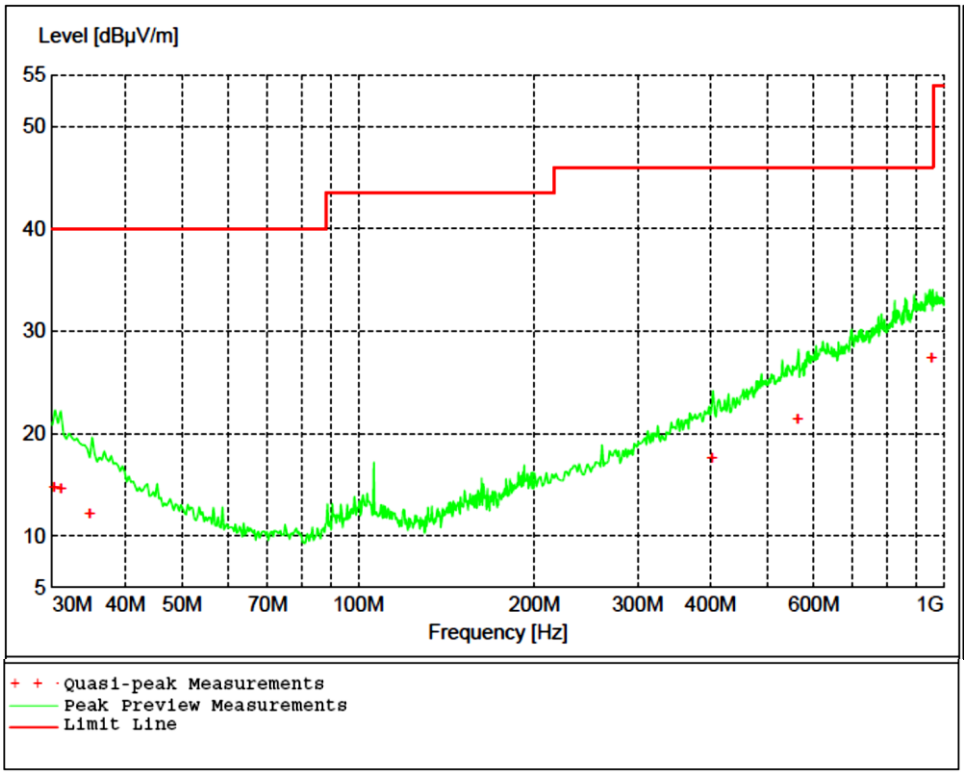


Figure 3 - Radiated Emissions Plot– Receive Mode

Quasi-peak Measurements– Receive Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
30.240000	14.73	40.00	25.30	373	53	VERT
31.080000	14.53	40.00	25.50	186	0	VERT
34.800000	12.12	40.00	27.90	115	84	HORI
402.360000	17.58	46.00	28.40	211	47	HORI
563.160000	21.43	46.00	24.60	329	139	VERT
954.960000	27.30	46.00	18.70	317	185	VERT
30.240000	14.73	40.00	25.30	373	53	VERT

Average Measurements – Receive Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1853.600000	27.05	54.00	26.90	163	358	HORI
2756.400000	28.73	54.00	25.30	398	265	HORI
3673.600000	32.25	54.00	21.80	324	106	VERT
4579.800000	34.14	54.00	19.90	382	11	VERT
5493.200000	37.63	54.00	16.40	361	224	HORI

.

Peak Measurements – Receive Mode

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1853.600000	40.34	74.00	33.66	163	358	HORI
2756.400000	42.79	74.00	31.21	398	265	HORI
3673.600000	45.32	74.00	28.68	324	106	VERT
4579.800000	47.36	74.00	26.64	382	11	VERT
5493.200000	51.79	74.00	22.21	361	224	HORI

4.4 Bandwidth

4.4.1 Limits of bandwidth measurements

The 6dB bandwidth of the signal must be greater than 500 kHz

4.4.2 Test procedures

The transmitter output was connected to the spectrum analyzer directly. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 500 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. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then 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.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. This was not taken into account on the plot below because it is a relative measurement.

4.4.5 EUT operating conditions

See section 2.6.

4.4.6 Test results

EUT	Cellular Tank Monitor	Model	MT-9100CBU
MODE	Continuous Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB MINIMUM LIMIT (kHz)	99% Occupied BW (kHz)	RESULT
1	916.76	1024.18	500.00	1280.70	PASS

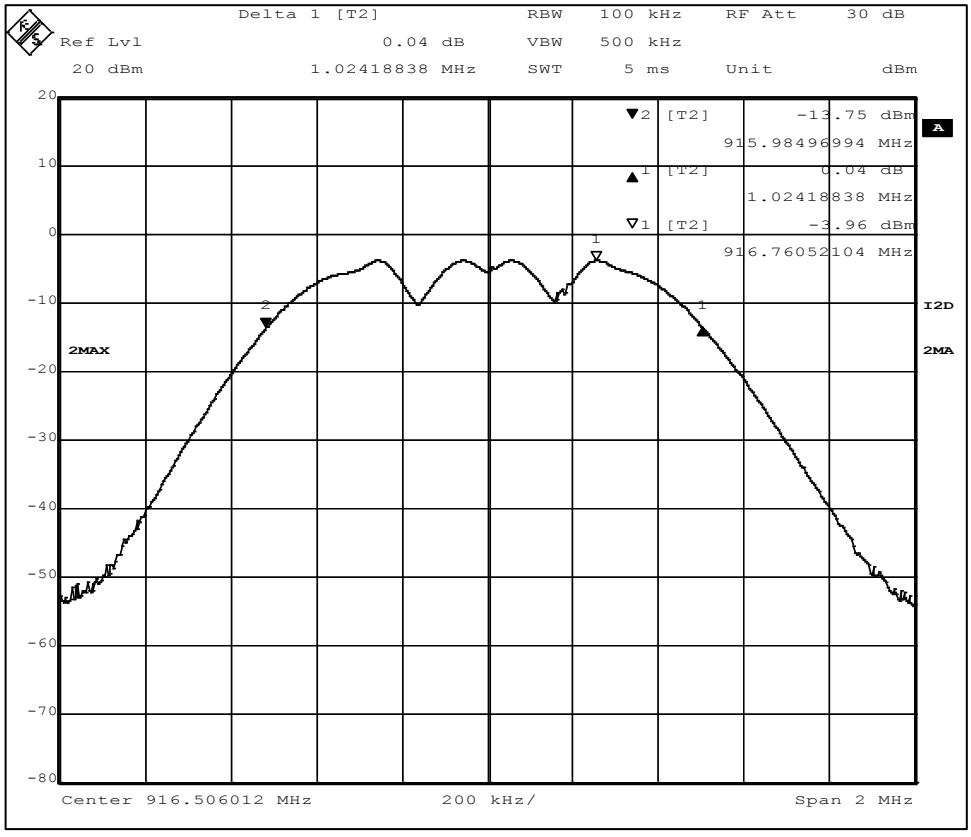


Figure 4 - 6dB Bandwidth

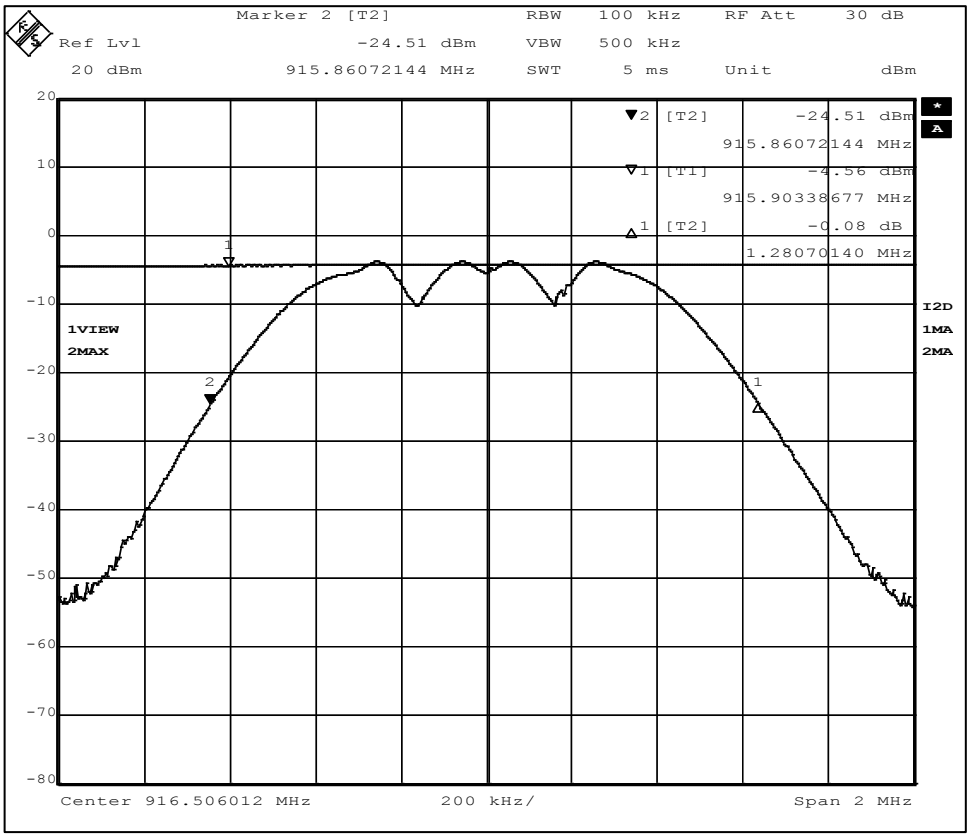


Figure 5 - 99% Occupied Bandwidth

4.5 Maximum peak output power

4.5.1 Limits of power measurements

The maximum peak output power allowed is 30dBm

4.5.2 Test procedures

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

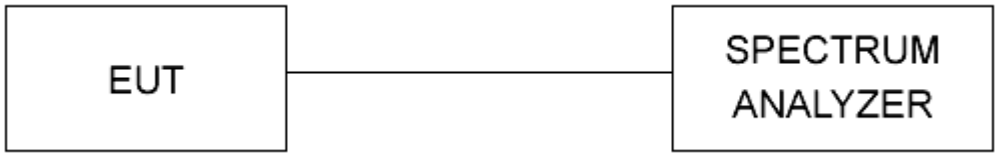
2. The channel power function of the spectrum analyzer was used to calculate the cumulative power output per MHz over the range of the set channel bandwidth. The channel bandwidth was set to 30MHz.

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.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup



The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. The plot shows the uncorrected value. The corrected value was recorded from this plot with 0.25dB added.

4.5.5 EUT operating conditions

See Section 2.6

4.5.6 Test results

Maximum peak output power

EUT	Cellular Tank Monitor	Model	MT9103CTMGUG10
MODE	Continuous Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	916.74	-4.31	30	PASS

*Corrected (0.25dB of attenuation added to account for RF cable)

Note: Screen captures of the measurements can be found in Section 4.4. The maximum power measurement with a 10MHz resolution bandwidth can be seen in the 99% occupied bandwidth plots.

4.6 Power spectral density (PSD)

4.6.1 Limits of PSD measurements

The maximum power spectral density allowed is 8dBm.

4.6.2 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 30 kHz VBW, the sweep time was set to auto. 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.

4.6.3 Deviations from test standard

No deviation.

4.6.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. The plot shows the uncorrected value. The corrected value was recorded from this plot with 0.25dB added.

4.6.5 EUT operating conditions

See Section 2.6.

4.6.6 Test results

Power Spectral Density

EUT	Cellular Tank Monitor	Model	MT9103CTMGUG10
MODE	Continuous Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	916.74	-4.41	8.0	PASS

*Corrected (0.25dB of attenuation added to account for RF cable)

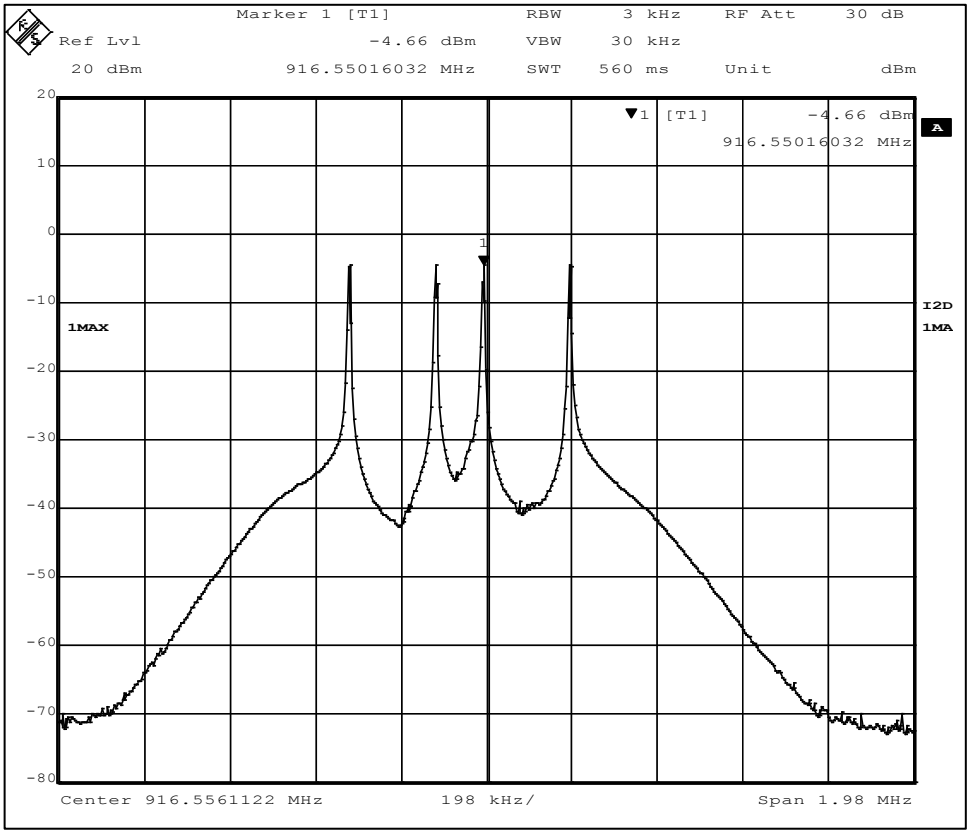


Figure 6 - Power Spectral Density Measurement, Ch. 1

4.7 Bandedges

4.7.1 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.

4.7.2 Test procedures

The transmitter output was connected directly to the spectrum analyzer. The resolution bandwidth was set to 100kHz and the spectrum analyzer was used at bandedges to the fundamental frequency with a 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.

4.7.3 Deviations from test standard

No deviation.

4.7.4 Test setup

The cable used to go from the spectrum analyzer to the EUT had a loss of 0.25dB. This was not taken into account on the plot below because it is a relative measurement.

4.7.5 EUT operating conditions

See Section 2.6.

4.7.6 Test results

EUT	Cellular Tank Monitor	Model	MT9103CTMGUG10
MODE	Continuous Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	3.6 VDC	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	37% ± 5% RH 23 ± 3ºC	TECHNICIAN	Kvepuri

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Level (dBm)	Fund. Level (dBm)	Delta
1	902 MHz	-55.43	-4.03	51.40
3	928 MHz	-54.98	-4.02	50.96

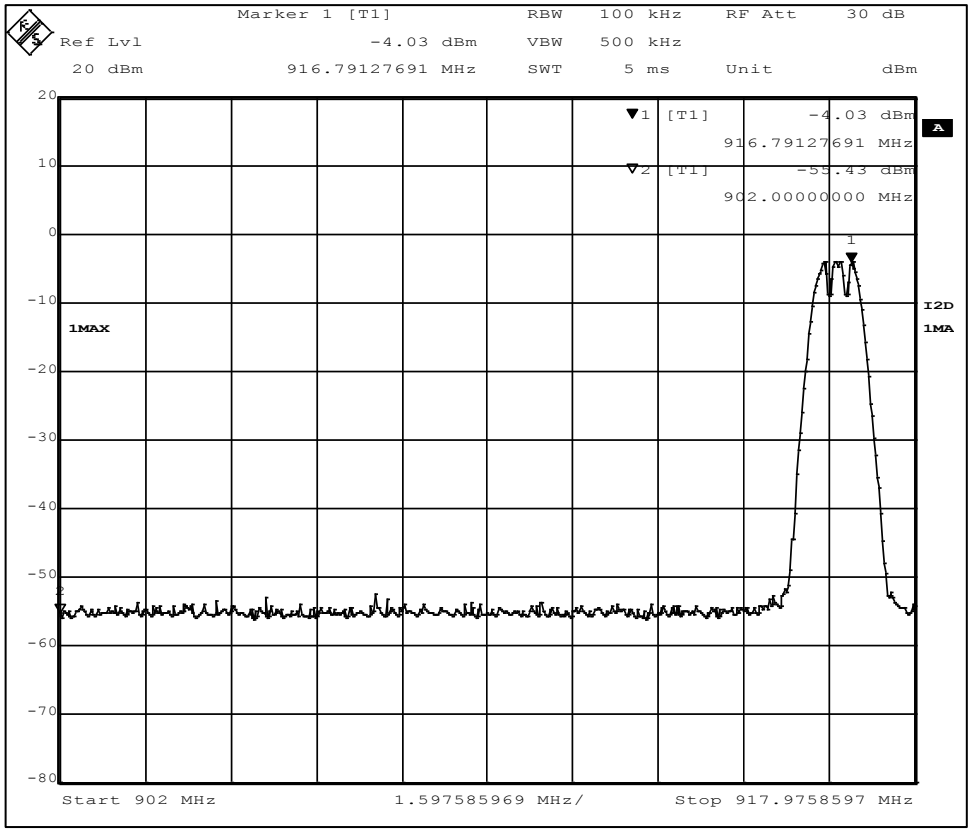


Figure 7 - Lower Band-edge Measurements

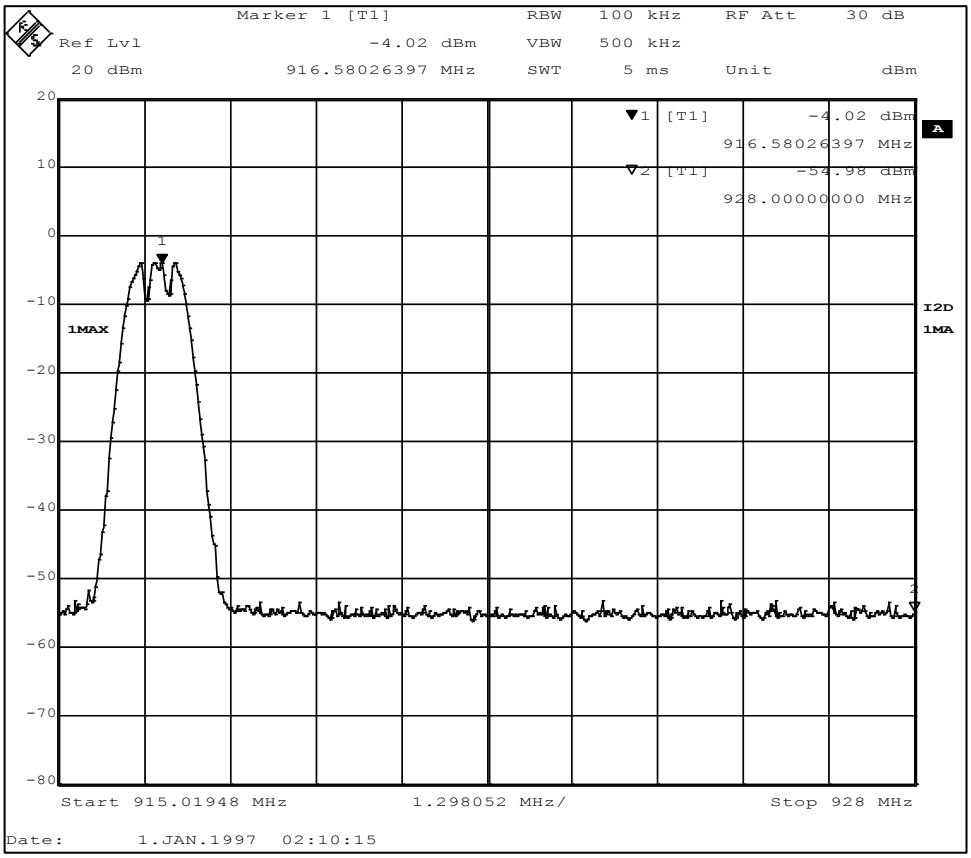


Figure 8 - Higher Band-edge Measurements

Appendix A: Test Photos

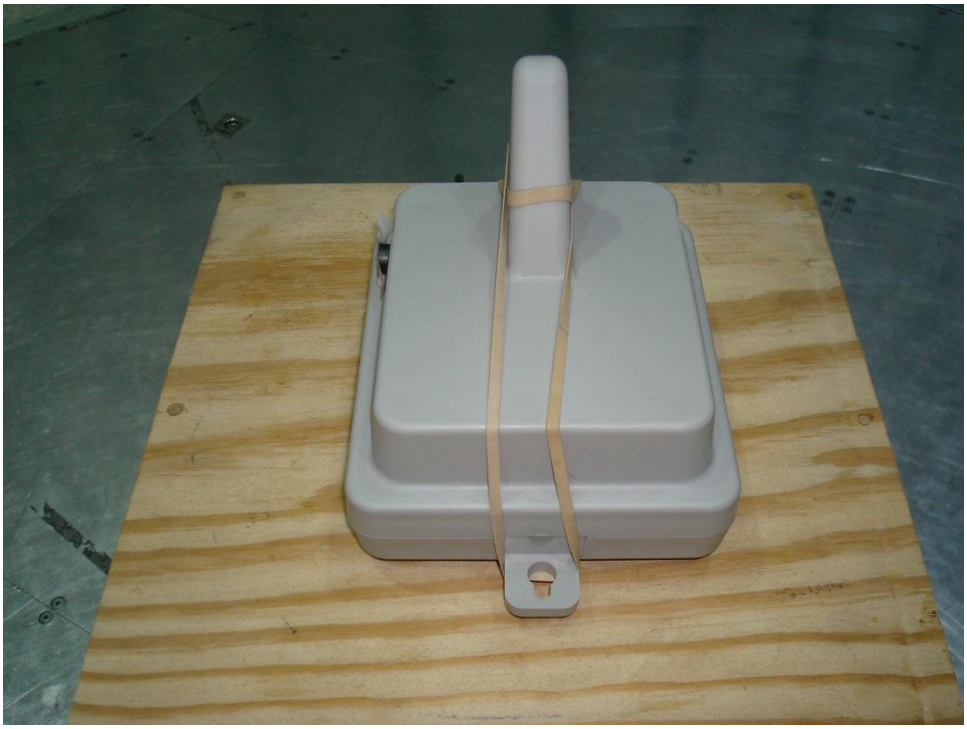


Figure 9 - Radiated Emissions Test Setup

Figure 10 - 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
.