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Report Number:	R10CA21254-FCC
Project Number:	10CA21254
File Number:	MC16461
Date:	05/07/2010 (Revised 05/20/2010)
Model:	Rex Water 900 MHz Transmitter Class 2 permissive change (FCC ID: QZC-REXWM900 IC: 4557A-REXWM900)

Electromagnetic Compatibility Test Report

For

ELSTER SOLUTIONS, LLC

Raleigh, NC

Test Report Details

Tests Performed By:	**Underwriters Laboratories Inc. 12 Laboratory Dr. Research Triangle Park, NC 27709**
Tests Performed For:	**Elster Solutions, LLC 208 S. Rogers Ln Raleigh, NC 27610**
Applicant Contact:	**Michael Carter**
Phone:	**(919) 212-4859**
E-mail:	**Michael.carter@us.elster.com**
Test Report Date:	**05/07/2010 (Revised 05/20/2010)**
Product Type:	**Spread-Spectrum Transmitter Class A permissive change**
Product standards	**FCC Part 15, Subpart C, Section 15.247**
Model Number:	**Rex Water 900 MHz**
Sample Serial Number:	**Unserialized sample**
EUT Category:	**Low-Powered Transmitter**
Testing Start Date:	**04/22/2010**
Date Testing Complete:	**05/07/2010**
Overall Results:	**Compliant**

Report Directory

Report Revision History

Revision Date	Description	Revised By	Revision Reviewed By
5-14-2010, 5-20-2010	Changes in descriptive comments	J. Marley	M. Nolting

1.0 G E N E R A L - Product Description

1.1 Equipment Description

The device is a 902-915 MHz low powered transmitter that functions to send water meter data to a receiver. The device operates as a frequency hopping spread spectrum transmitter falling under FCC Part 15.247. This device was previously certified. This Class 2 permissive change incorporates a new antenna, and an alteration in the impedance matching circuit to more accurately match to the new antenna.

1.2 Equipment Marking Plate

The sample tested had no marking plate.

1.3 Device Configuration During Test

1.3.1 Equipment Used During Test:

Use	Product Type	Manufacturer	Model	Comments
EUT	Low-Powered Transmitter	Elster	Rex Water 900 MHz	
ACC	Metal Lid	Industry Standard	-	
Note: **EUT** - Equipment Under Test, **AE** - Auxiliary/Associated Equipment, or **SIM** - Simulator (Not Subjected to Test)				

1.3.2 Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
0	Enclosure	N/E	—	—	None
1	Battery	DC	N	N	A larger battery was attached during test to enable the device to operate for extended periods during the measurements.
2	Antenna	N/E	N/A	N/A	
Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical TP = Telecommunication Ports I/O = Input/Output					

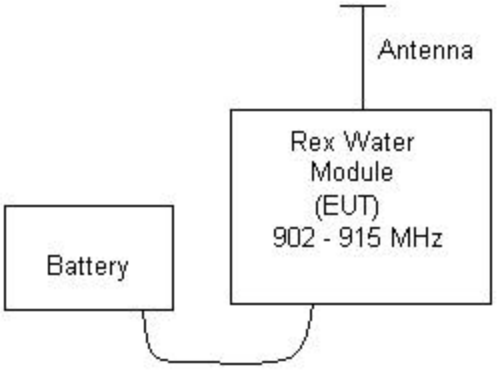
1.3.3 EUT Internal Operating Frequencies:

Frequency (MHz)	Description
902.8-914.8	Transmit Frequency Range

1.3.4 Power Interface:

Mode # /Rated	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Comments
1	3.6 V	-	-	DC	Operating Battery. Battery was replaced with a fresh battery prior to each day's testing

1.4 Block Diagram:



1.5 EUT Configurations

Mode #	Description
1	Low-Powered Transmitter with antenna on non-conductive foam test table measuring 1.5m x 1.0m x 80cm high. Antenna is mounted in an industry-standard metal water meter lid. This arrangement produced the highest radiated power (thus antenna gain) and highest radiated spurious emissions. This data is presented in the report. Additional Radiated Spurious measurements were performed with a non-metal water meter lid. Spurious emissions were lower in this arrangement.
2	Same as above, except EUT antenna is replaced with a 50-ohm load to perform radiated spurious measurement between 30-1000 MHz. This was necessary to remain within the measurement system's dynamic range, due to the strength of the transmit signal.
3	EUT antenna port was connected directly to the receiver's 50-ohm input to measure conducted power.

1.6 EUT Operation Modes

Mode #	Description
1	Transmitter operating on low, middle, high channel, or hopping (as described) with normal modulation and antenna attached.
2	Radiated Spurious (30-1000 MHz): Transmitter is hopping normally. EUT antenna is replaced by matched load because signal strength at transmit frequency with antenna attached exceeded measurement system dynamic range.
3	Unintentional Emissions (30-1000 MHz): Transmitter is transmitting at zero power to view unintentional emissions. All circuits except power amplifier are operating as normal.

2.0 Summary

The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The applicant determined the list of tests performed were applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

2.1 Deviations from standard test methods

None

2.2 Device Modifications Necessary for Compliance

To meet radiated spurious emissions requirement the manufacturer reduced output power to setting "160" on the transmitter. No other modifications were performed.

2.3 Reference Standards

Standard Number	Standard Name	Standard Date
FCC Part 15	Radio Frequency Devices (Sections 15.109, 15.209 and 15.247)	Oct 1, 2009
RSS-210 Issue 7	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment	June 2007

2.4 Justification for Limited Testing

These tests are performed as a Class 2 permissive change. The transmitter electronics and board layout are unchanged from the original submission. Only passive circuitry is modified to better match the impedance of the transmitter output to the antenna. As a result of the testing the transmitter output power was reduced to 40 mW. By engineering judgement the following elements from the original report remain valid:

Test	Justification
(1) Occupied Bandwidth	Transmitter RF circuitry, including modulation, is unchanged
(2) Bandedge	Transmitter RF circuitry, including frequencies, bandwidth are unchanged. Output power is reduced
(3) Number of Channels	Number of Channels unchanged
(4) Channel Occupancy	Frequency hopping timing is unchanged
(5) Pseudo-random pattern	Hopping pattern is unchanged

2.5 Results Summary

This product is considered Class B. Transmitter spurious emissions must comply with 15.209 where frequencies fall in a 15.205 restricted band.

Requirement – Test	Result (Compliant / Non-Compliant)*
Spurious Emissions – Radiated (15.209) and Conducted (15.247(b)(4))	Compliant (15.209 and 15.247(b)(4))*
Radiated Emissions – Unintentional (15.109)	Compliant (Class B)
Antenna Port Conducted Power (15.247(b)(2))	Compliant (<0.25 W)
Antenna Gain	Antenna < 6 dBi gain
Maximum Permissible Exposure	Compliant
Note: Radiated Spurious Limit was met by limiting Peak Output Power to power setting “160” which will be set at the factory and not adjustable. Other required tests are considered to remain valid from the original certification and were not repeated here.	

Test Engineer:

Jim Marley (Ext.919-549-1408)
Staff Engineer
International EMC Services
Conformity Assessment Services-

Reviewer:

Mark Nolting (Ext.919-549-1584)
Staff Engineer
International EMC Services
Conformity Assessment Services

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3.0 Calibration of Equipment Used for Measurement

All test equipment and test accessories are calibrated on a regular basis. The maximum time between calibrations is one year or the manufacturers' recommendation, whichever is less.

All test equipment calibrations are traceable to the National Institute of Standards and Technology (NIST); therefore, all test data recorded in this report is traceable to NIST.

4.0 EMISSIONS TEST RESULTS

The emissions tests were performed according to following regulations:

FCC 47 CFR	47 CFR Part 15.247
Industry Canada	RSS-210

Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be verified at the time the test is conducted.

Ambient Temperature, °C	22.5 ± 2.5	Relative Humidity, %	45 ± 15	Barometric Pressure, mBar	950 ± 150

4.1 Test Conditions and Results – SPURIOUS EMISSIONS (Antenna Conducted and Radiated)

Test Description	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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, 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 Section15.205(c)).

Basic Standard	47 CFR Part 15.247(d) RSS-210, A8.5 RSS-Gen 7.2.1 and 7.2.3

	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30MHz – 1GHz	3 meter distance and / or antenna port
Fully configured sample scanned over the following frequency range	1GHz – 9.15 GHz (10^{th} harmonic)	3 meter distance and / or antenna port

Limits (Antenna Conducted)

All emissions must be 20dB below the level of the fundamental frequency.

Limits (Radiated – Restricted Bands Only)

Frequency (MHz)	Limit (dBµV/m)		
	Quasi-Peak	Average	
	General Emissions	Fundamental	Spurious
30 – 88	40	-	-
88 – 216	43.5	-	-
216-960	46	-	-
960-1000	54	-	-
1,000-10^{th} harmonic	-	-	54

Supplementary information: Both conducted and radiated spurious emissions are performed. Radiated spurious emission emissions below 1 GHz are performed with antenna port terminated in a matched impedance to avoid overloading measurement set. Above 1 GHz radiated spurious is performed with antenna in place. 2^{nd} harmonic, between 1804 MHz and 1830 MHz, does not fall within a restricted band.

Table 1 SPURIOUS EMISSIONS EUT Configuration Settings

Power Interface Mode #	EUT Configurations Mode #	EUT Operation Mode #
1	3 (Conducted Spurious)	1 (low, mid, high channel)
1	1 (Radiated Spurious, 1 – 10 GHz)	1 (low, mid, high channel)
1	2 (Radiated Spurious, 30 – 1000 MHz)	2 (all channels, hopping)
Supplementary information: None		

Table 2 SPURIOUS CONDUCTED EMISSIONS Test Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	All Ranges				
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	1088.7490K40	3/18/10	3/31/11
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA

Table 3 SPURIOUS RADIATED EMISSIONS Test Equipment

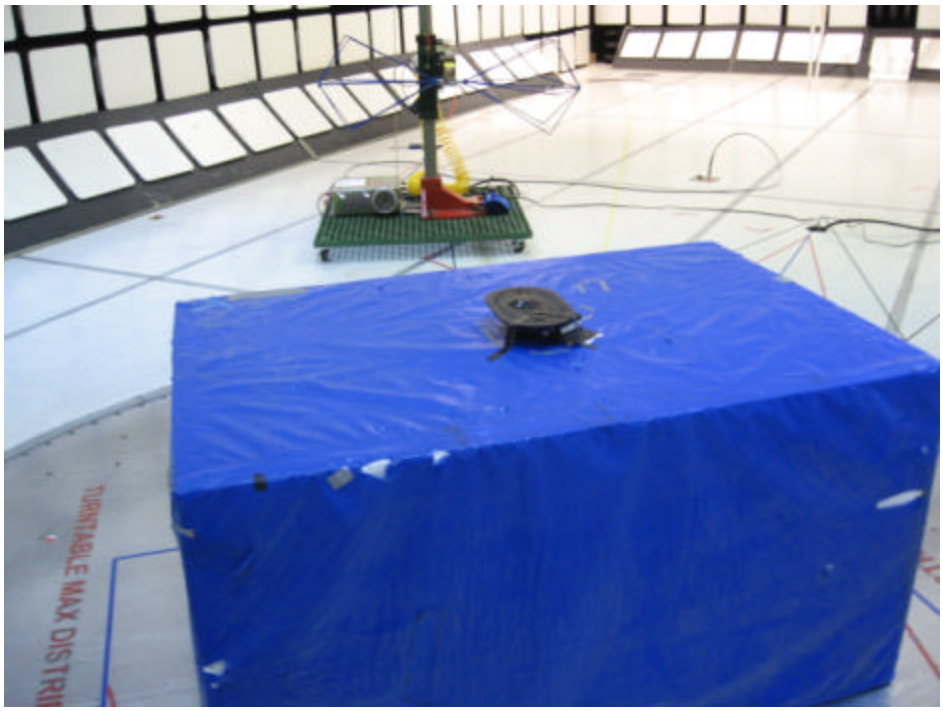
Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz Range				
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner, EMC	VBA6106A	5/12/09	5/31/10
AT0030	Log-periodic Antenna, 200 MHz to 1000 MHz	Schaffner, EMC	3160-07	5/7/09	5/31/10
	1-18 GHz				
AT0032	Horn Antenna 1 to 18 GHz	EMC Test Systems	3115	9/25/09	9/30/10
ATA185	Hi-pass filter (to block 900 MHz transmit frequency)	Mini-Circuits	VHF-1320	4/1/10	4/30/11
ATA186	Hi-pass filter (to block 900 MHz transmit frequency)	Mini-Circuits	VHF-1300	6/23/09	6/30/10
	Tuned Dipole Set				
AT0016	Tuned Dipole Antenna Set, 400 to 1000 MHz	EMCO	3121C-DB-4	1/5/10	1/31/11
	Gain-Loss Chains				

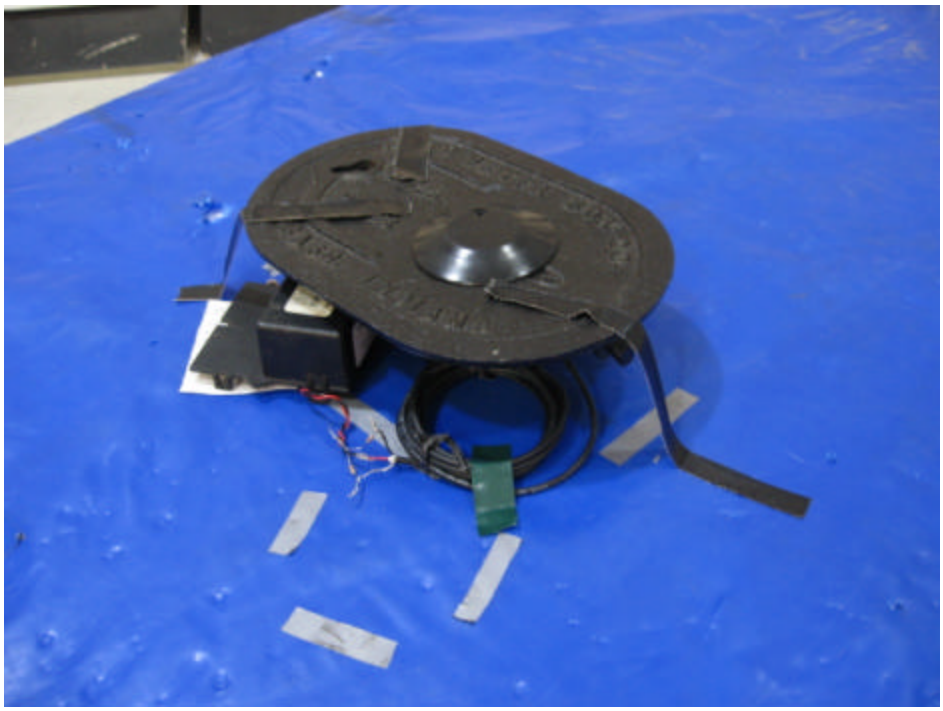
Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SAC_C (Biconical 3m location)	(1) ATA084: Attenuator (2) ATA124: Amplifier (3) ATA224: Cable (4) ATA132: Cable (5) ATA229: DC Bias Tee (6) ATA199: Cable	(1) Pasternack (2) Miteq (3) Eupen (4) UL (5) Miteq (6) Micro-Coax	(1) PE7002-6 (2) AM-3A-000110-N (3) CMS/RG 214 (4) UFA210A-0-6000-50U-50U (5) BT2000-C (6) UFB293C-0-0720-5GU50U)	08/24/09	08/31/10
SAC_D (Log-Periodic 3m location)	(1) ATA085: Attenuator (2) ATA125: Amplifier (3) ATA225: Cable (4) ATA189: Cable (5) ATA115: DC Bias Tee (6) ATA198: Cable	(1) Pasternack (2) Miteq (3) EUPEN (4) EUPE (5) Miteq (6) Micro-Coax	(1) PE7002-6 (2) AM-3A-000110-N (3) CMS/RG 214 (4) CMS/RG 214 (5) AM-1523-7687 (6) UFB293C-0-0720-5GU50U	02/17/10	08/31/10
SAC_E_HORN (Horn 3m location)	(1) ATA144: Amplifier (2) ATA207: Cable (3) ATA096: Cable (4) ATA199: Cable	(1) Miteq (2) Micro-Coax (3) Micro-Coax (4) Micro-Coax	(1) AFS42-00101800-25-N-42MF (2) UFB293C-1-3360-50U50U (3) UTiFLEX (4) UFB293C-0-0720-5GU50U	08/24/09	08/31/10
	Receiver and Software				
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	1088.7490K40	1/18/10	1/31/11
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
HI0034	Environmental meter (T/H/P)	Control Company	99760-00	10/19/09	10/31/10
MG1180	Tape Measure	Lufkin	HI-VIZ	8/8/08	8/31/11

Test setup for SPURIOUS EMISSIONS – Antenna conducted

Photo was not taken. Antenna port of EUT was directly connected to input of receiver.

Test setup for SPURIOUS EMISSIONS – Radiated





Note: Attaching wires are coiled in water meter housing per manufacturer's instructions. Larger battery used for test is placed as closely under perimeter of the lid as possible to best represent and installation arrangement.

Figure 1 30MHz-10 GHz Antenna Port Spurious Emissions Plots TX Mode, Low Channel.

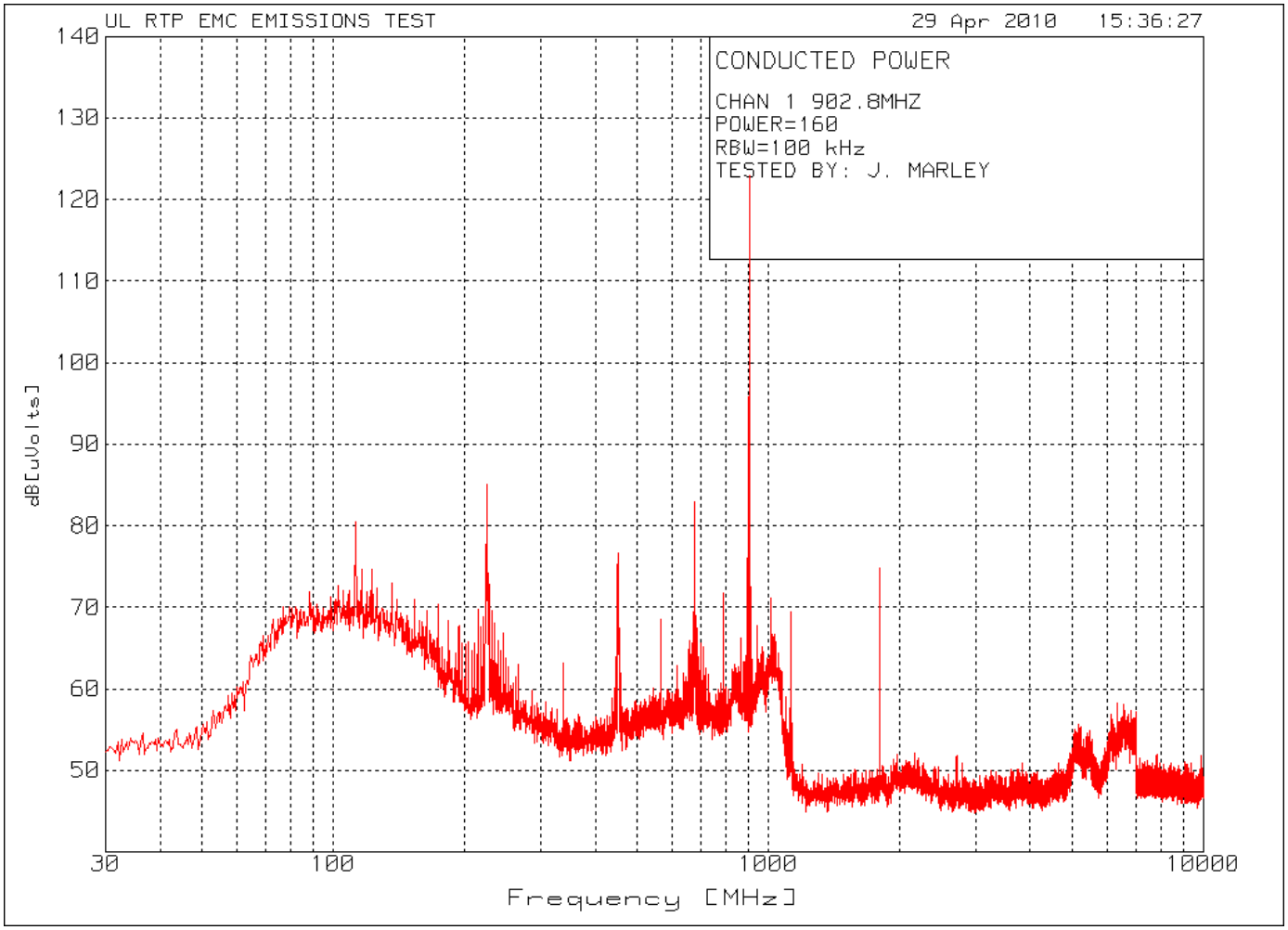


Table 4 30MHz-10 GHz Antenna Port Spurious Emissions Table TX Mode, Low Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV)	Specified Limit** (dBuV)	Spec Margin (dB)	See Comment (#)***
P	902.9677	122.99	0	0	122.99	131.0	-8.01	
P	112.4775	85.49	0	0	85.49	102.99	-17.50	
P	225.035	88.03	0	0	88.03	102.99	-14.96	
P	452.0907	80.49	0	0	80.49	102.99	-40.50	
P	677.5292	86.85	0	0	86.85	102.99	-16.14	
P	1805.581	76.11	0	0	86.85	102.99	-16.14	

*P= Peak, Q = Quasi-Peak, A= Average
** Limit for Spurious is 20 dB below Transmit Frequency Value.

Figure 2 30 MHz-10 GHz Antenna Port Spurious Emissions Plots TX Mode, Middle Channel.

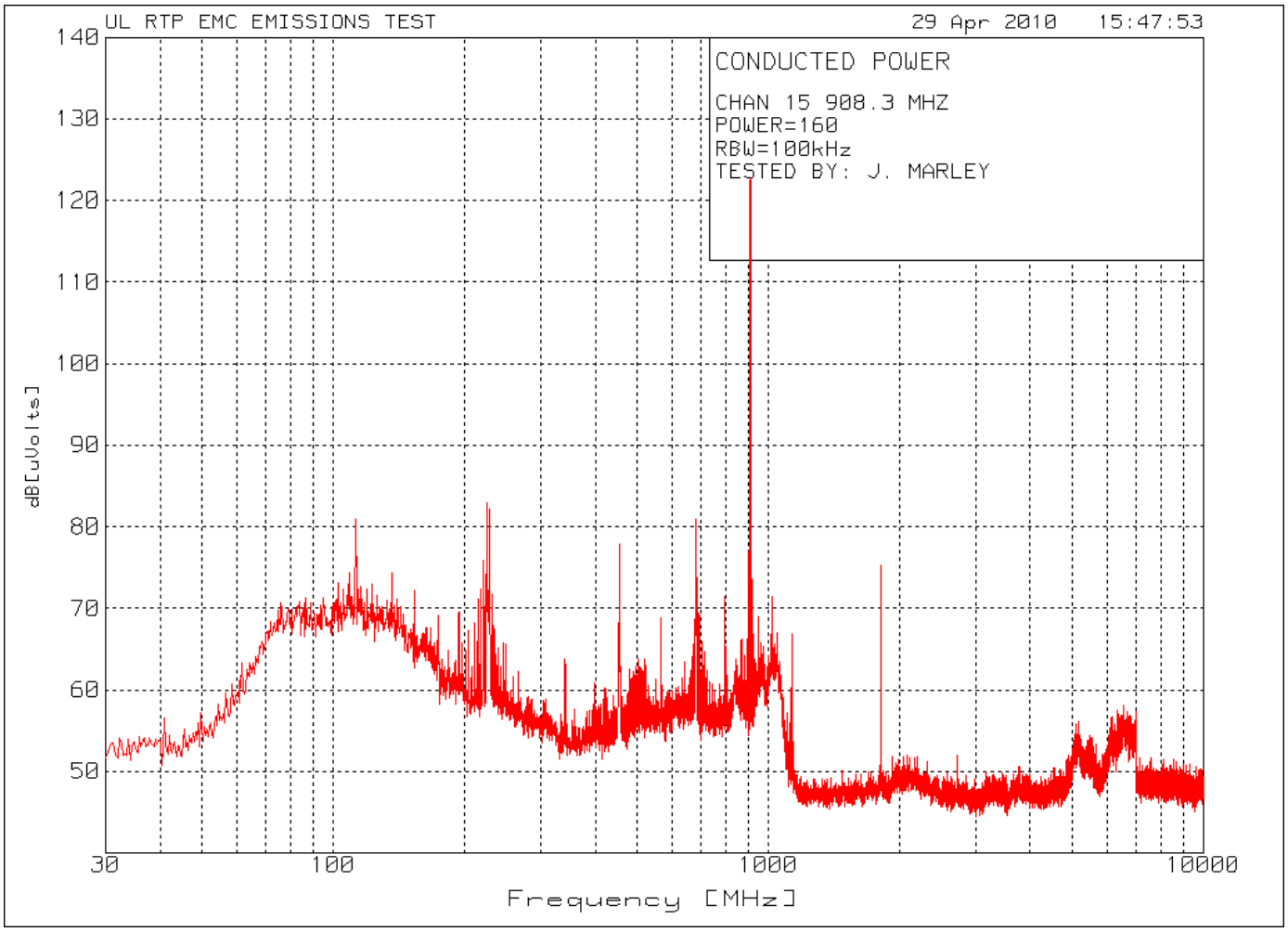


Table 5 30MHz-10 GHz Antenna Port Spurious Emissions Table TX Mode, Middle Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV)	Specified Limit** (dBuV)	Spec Margin (dB)	See Comment (#)***
P	908.7896	122.81	0	0	122.81	131.0	-8.19	
P	112.4775	80.88	0	0	80.88	120.81	-39.93	
P	225.3585	82.92	0	0	82.92	120.81	-37.89	
P	454.3548	77.85	0	0	77.85	120.81	-42.96	
P	679.7933	80.45	0	0	80.45	120.81	-40.36	
P	1816.382	75.33	0	0	75.33	120.81	-45.67	

*P= Peak, Q = Quasi-Peak, A= Average
** Limit for Spurious is 20 dB below Transmit Frequency Value.

Figure 3 30 MHz-10 GHz Antenna Port Spurious Emissions Plots TX Mode, High Channel.

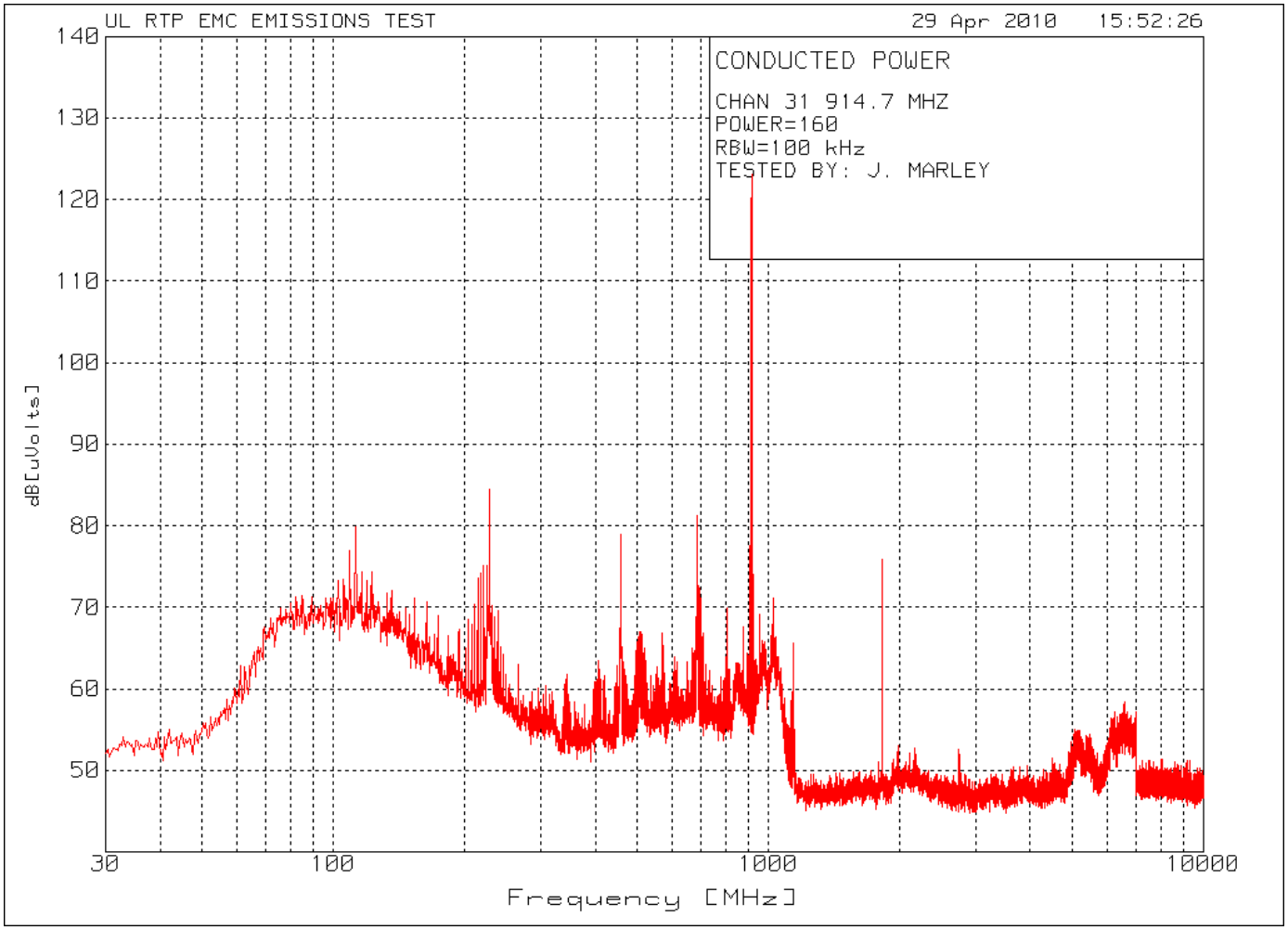
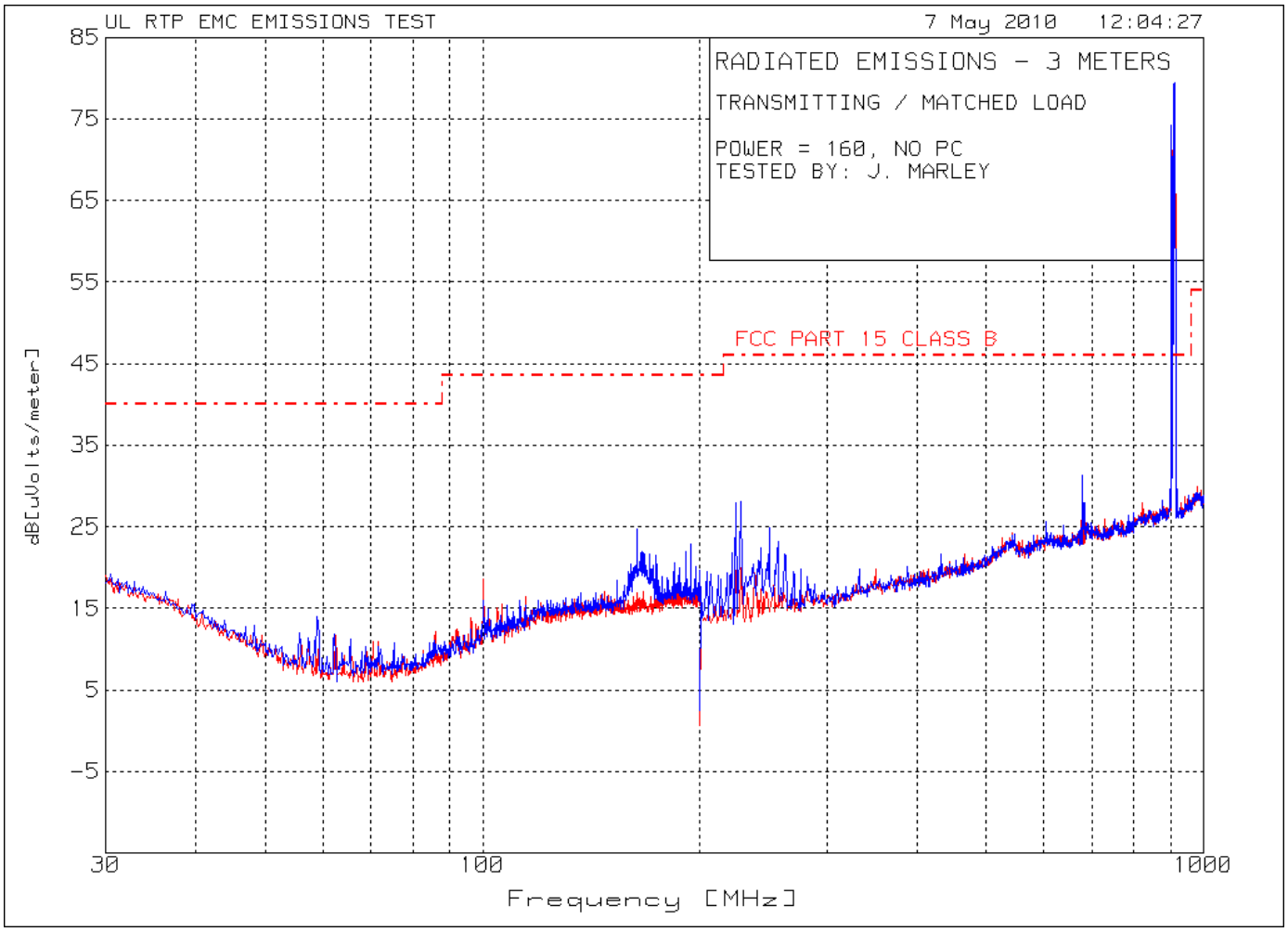


Table 6 30MHz-10 GHz Antenna Port Spurious Emissions Table TX Mode, High Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV)	Specified Limit** (dBuV)	Spec Margin (dB)	See Comment (#)***
P	914.935	123.03	0	0	123.03	131.0	-7.96	
P	112.4775	79.86	0	0	79.86	103.03	-23.17	
P	228.5929	84.54	0	0	84.54	103.03	-18.49	
P	457.2658	79.00	0	0	79.00	103.03	-24.03	
P	686.2621	81.28	0	0	81.28	103.03	-21.75	
P	1828.983	75.91	0	0	75.91	103.03	-27.12	

*P= Peak, Q = Quasi-Peak, A= Average
** Limit for Spurious is 20 dB below Transmit Frequency Value.

Figure 4 Radiated Spurious Emissions 30-1000 MHz, All Channels (hopping)



Note: EUT antenna was replaced by a matched-impedance termination during this test.

Table 7 30MHz-1000 MHz Radiated Spurious Emissions Table - TX Mode, Hopping.

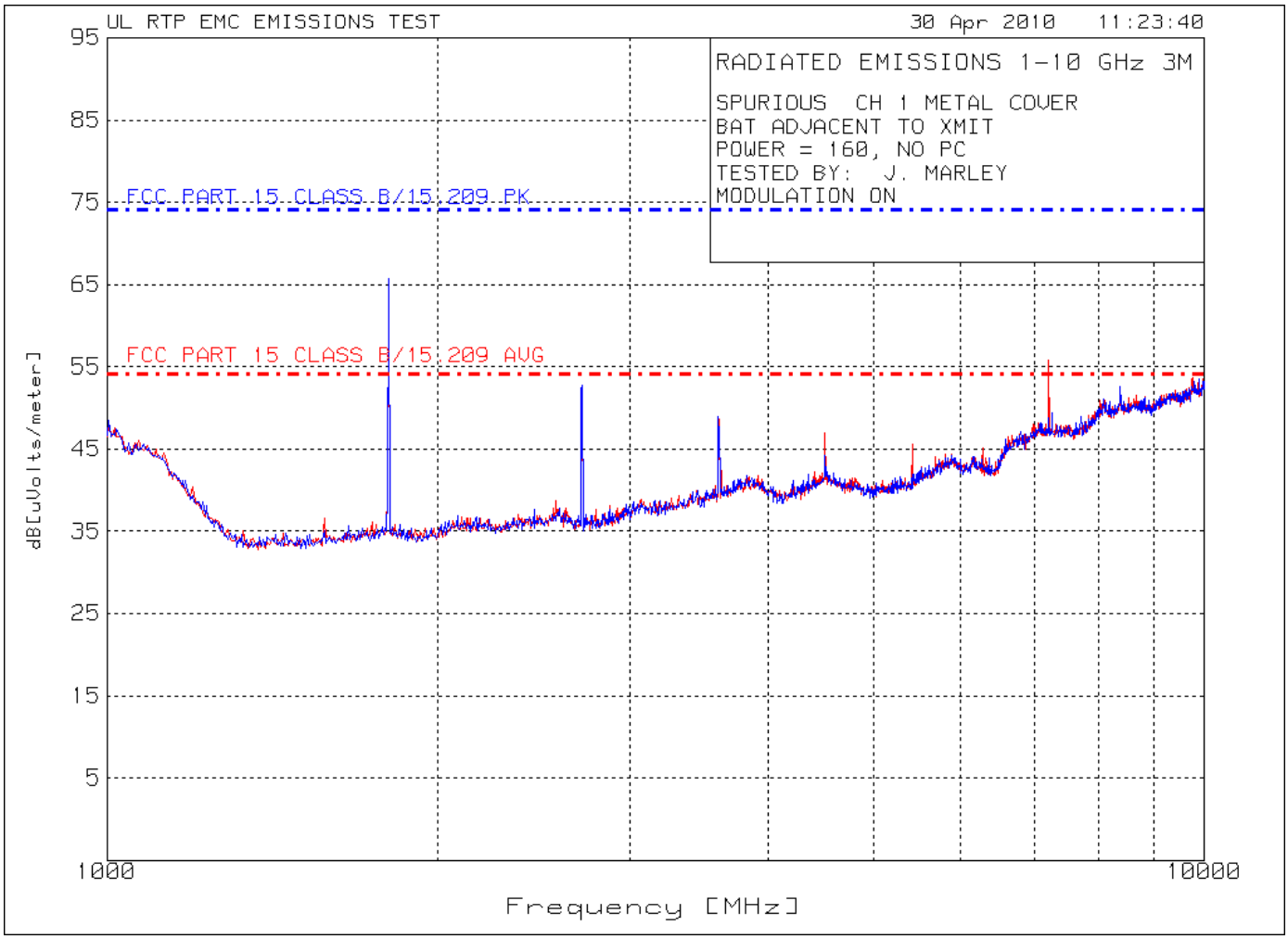
Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV/m)	Quasi-Pk Limit** (dBuV/m)	Quasi-Pk Margin (dB)	Antenna Polarity (V/H)	Antenna Height (cm)	Turntable Angle (degrees)
P	163.9239	36.32	-26.2	14.6	24.72	43.5	-18.78	H	250	Rot
P	224.8248	42.96	-25.9	10.8	27.86	46	-18.14	H	100	Rot
P	228.028	43.34	-26	10.8	28.14	46	-17.86	H	100	Rot
P	249.6497	38.7	-25.9	12.0	24.8	46	-21.2	H	100	Rot
P	678.8789	34.41	-23	19.9	23.18	46	-22.82	H	100	Rot
P	911.1111	78.03	-21.7	23.1	79.43	-	-	H	100	Rot

*****P= Peak, Q= Quasi-Peak, A= Average

**Average Limit and Peak Limit applied to frequencies within 15.209 restricted bands.

Note: All spurious frequencies below 1000 MHz meet 15.209 limits.

Figure 5 Radiated Spurious Emissions above 1GHz, Low Channel



Note: 2nd harmonic emission 1804-1830 MHz does not fall within a restricted band and does not need to comply with 15.209 limits.

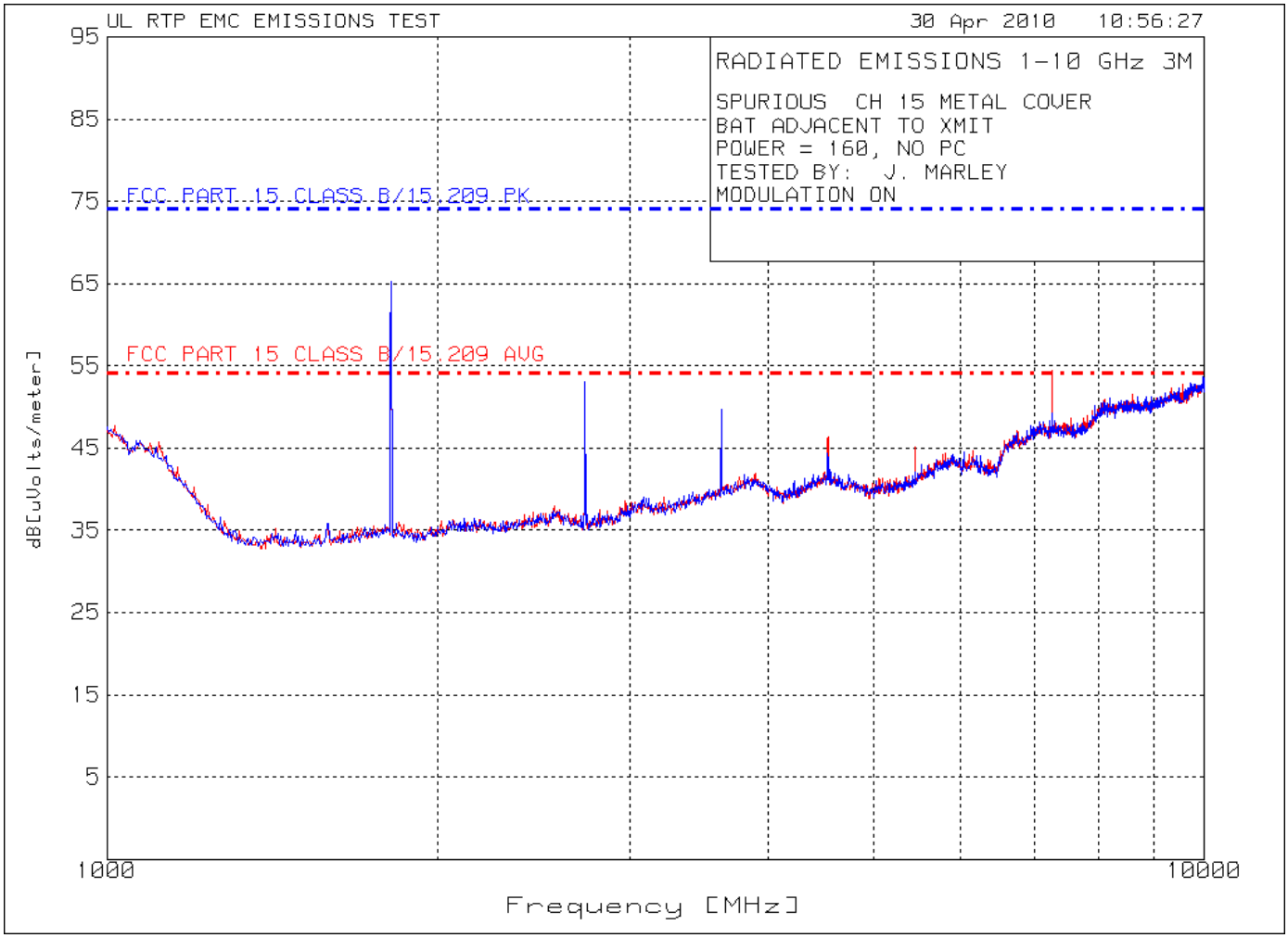
Table 8 1 GHz-10 GHz Radiated Spurious Emissions Table TX Mode, Low Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV/m)	Average Limit** (dBuV/m)	Average Margin (dB)	Peak Limit** (dBuV/m)	Peak Margin (dBuV/m)	Antenna Polarity (V/H)	Antenna Height (cm)	Turntable Angle (degrees)
P	2711.423	49.6	-27.2	28.8	51.2	-	-	74	-22.8	V	101	Rot
P	2711.423	51.19	-27.2	28.8	52.79	-	-	74	-21.21	H	100	Rot
P	3607.214	43.49	-26.2	31.7	48.89	-	-	74	-25.01	V	149	Rot
P	7218.437	38.96	-19.2	36.0	55.76	-	-	74	-18.24	V	150	Rot
P	8380.762	31.65	-16.1	37.0	52.55	-	-	74	-21.45	H	150	Rot
A	2708.524	49.34	-27.2	28.8	50.94	54	-3.06	-	-	V	204	108
A	2708.4698	50.35	-27.2	28.8	51.95	54	-2.05	-	-	H	206	101
A	3611.196	42.44	-26.1	31.8	48.14	54	-5.86	-	-	V	218	132
A	7222.9943	33.2	-19.2	36.1	50.1	54	-3.9	-	-	V	54	150
A	8347.798	18.24	-16.3	37.0	38.94	54	-15.06	-	-	H	118	101

*P= Peak, Q= Quasi-Peak, A= Average

**Average Limit and Peak Limit applied to frequencies within 15.209 restricted bands.

Figure 6 Radiated Spurious Emissions above 1GHz, Middle Channel



Note: 2nd harmonic emission 1804-1830 MHz does not fall within a restricted band and does not need to comply with 15.209 limits.

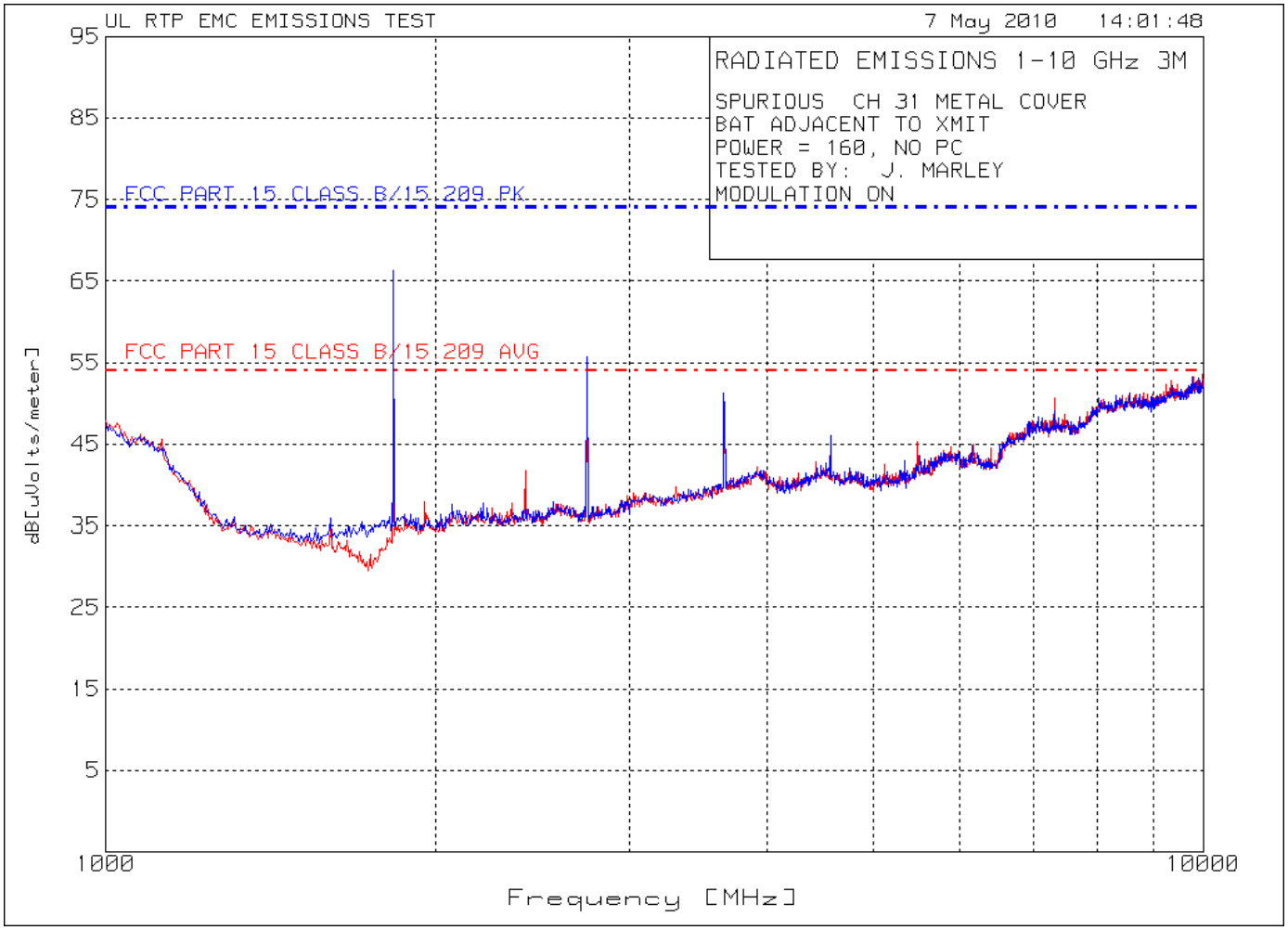
Table 9 1 GHz-10 GHz Radiated Spurious Emissions Table TX Mode, Middle Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV/m)	Average Limit** (dBuV/m)	Average Margin (dB)	Peak Limit (dBuV/m)	Peak Margin (dBuV/m)	Antenna Polarity (V/H)	Antenna Height (cm)	Turntable Angle (degrees)
P	1817.635	64.75	-27.6	26.9	64.05	-	-	-	-	V	100	Rot
P	2727.455	50.06	-27.1	28.0	51.86	-	-	74	-22.14	V	100	Rot
P	2727.455	51.19	-27.1	28.9	52.99	-	-	74	-21.01	H	100	Rot
P	3631.263	42.93	-26.0	31.9	48.83	54	-5.17	74	-25.17	V	149	Rot
P	4545.09	37.57	-23.6	32.3	46.27	54	-7.73	74	-27.73	V	100	Rot
P	5452.906	34.66	-23.6	34.1	45.16	54	-8.84	74	-28.84	V	149	Rot
P	7266.533	37.27	-19.2	36.3	54.37	-	-	74	-19.63	V	150	Rot
A	2725.1274	49.14	-27.1	28.9	50.94	54	-3.06	-	-	V	106	210
A	2725.1587	49.40	-27.1	28.9	51.2	54	-2.8	-	-	H	101	206
A	7267.7294	29.34	-19.2	36.3	46.44	54	-7.56	-	-	V	161	53

*P= Peak, Q= Quasi-Peak, A= Average

**Average Limit and Peak Limit applied to frequencies within 15.209 restricted bands.

Figure 7 Radiated Spurious Emissions above 1GHz, High Channel



Note: 2nd harmonic emission 1804-1830 MHz does not fall within a restricted band and does not need to comply with 15.209 limits.

Table 10 1 GHz-10 GHz Radiated Spurious Emissions Table TX Mode, High Channel.

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV/m)	Average Limit** (dBuV/m)	Average Margin (dB)	Peak Limit (dBuV/m)	Peak Margin (dBuV/m)	Antenna Polarity (V/H)	Antenna Height (cm)	Turntable Angle (degrees)
P	1829.659	65.25	-27.7	27.0	64.55	-	-	-	-	V	100	Rot
P	1829.659	66.96	-27.7	27.0	66.26	-	-	-	-	H	149	Rot
P	2747.495	53.98	-27.2	28.9	55.68	-	-	74	-18.32	H	100	Rot
P	3655.311	45.22	-26.0	32.0	51.22	-	-	74	-22.78	H	150	Rot
P	4575.15	37.83	-24.1	32.3	46.03	54	-7.97	74	-27.97	H	100	Rot
P	7314.629	33.37	-19.2	36.5	50.67	-	-	74	-23.33	V	100	Rot
A	2744.3118	52.04	-27.2	28.9	53.74	54	-0.26	-	-	H	100	31
A	3659.1907	43.82	-26.0	32.1	49.92	54	-4.08	-	-	H	110	13
A	7319.1472	27.62	-19.2	36.5	44.92	54	-9.08	-	-	V	100	342

4.2 Test Conditions and Results – RADIATED EMISSIONS UNINTENTIONAL

Test Description	Measurements were made in a 10-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.4. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 10-meter. The EUT was rotated 360° about its azimuth with the receive antenna located at various heights in both horizontal and vertical polarities. Final measurements (quasi-peak or average as noted) were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4-meters. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.

Basic Standard	FCC Part 15, Subpart B	
UL LPG	80-EM-S0029	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30 MHz – 1GHz	(3 meter measurement distance)

Limits

Frequency (MHz)	Limit (dBµV/m)	
	Quasi-Peak	Average
30 – 88	40	-
88 – 216	43.5	-
216-960	46	-
960-1000	54	-

Supplementary information: Highest operating frequency, not including transmit frequencies, is less than 108 MHz. Therefore, no testing above 1000 MHz is required.

Table 11 Radiated Emissions EUT Configuration Settings

Power Interface Mode # (See Section 1.3.4)	EUT Configurations Mode # (See Section 1.6)	EUT Operation Mode # (See 1.5)
1	1	3 (transmitter at zero power for unintentional emissions)

Supplementary information:

None

Table 12 Radiated Emissions Test Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz Range				
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner, EMC	VBA6106A	5/12/09	5/31/10
AT0030	Log-periodic Antenna, 200 MHz to 1000 MHz	Schaffner, EMC	3160-07	5/7/09	5/31/10
	Tuned Dipole Set				
AT0013-AT0016	Four Dipole Antenna Set, 30 to 1000 MHz	EMCO	3121C-DB-1, -2, -3, -4	1/5/10	1/31/11
	Gain-Loss Chains				
SAC_C (Biconical 3m location)	(7) ATA084: Attenuator (8) ATA124: Amplifier (9) ATA224: Cable (10) ATA132: Cable (11) ATA229: DC Bias Tee (12) ATA199: Cable	(7) Pasternack (8) Miteq (9) Eupen (10) UL (11) Miteq (12) Micro-Coax	(7) PE7002-6 (8) AM-3A-000110-N (9) CMS/RG 214 (10) UFA210A-0-6000-50U-50U (11) BT2000-C (12) UFB293C-0-0720-5GU50U)	08/24/09	08/31/10
SAC_D (Log-Periodic 3m location)	(7) ATA085: Attenuator (8) ATA125: Amplifier (9) ATA225: Cable (10) ATA189: Cable (11) ATA115: DC Bias Tee (12) ATA198: Cable	(7) Pasternack (8) Miteq (9) EUPEN (10) EUPE (11) Miteq (12) Micro-Coax	(7) PE7002-6 (8) AM-3A-000110-N (9) CMS/RG 214 (10) CMS/RG 214 (11) AM-1523-7687 (12) UFB293C-0-0720-5GU50U	02/17/10	08/31/10
	Receiver and Software				
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	1088.7490K40	1/18/10	1/31/11
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
HI0034	Environmental meter (T/H/P)	Control Company	99760-00	10/19/09	10/31/10
MG1180	Tape Measure	Lufkin	HI-VIZ	8/8/08	8/31/11

Figure 8 Test setup for Radiated Emissions

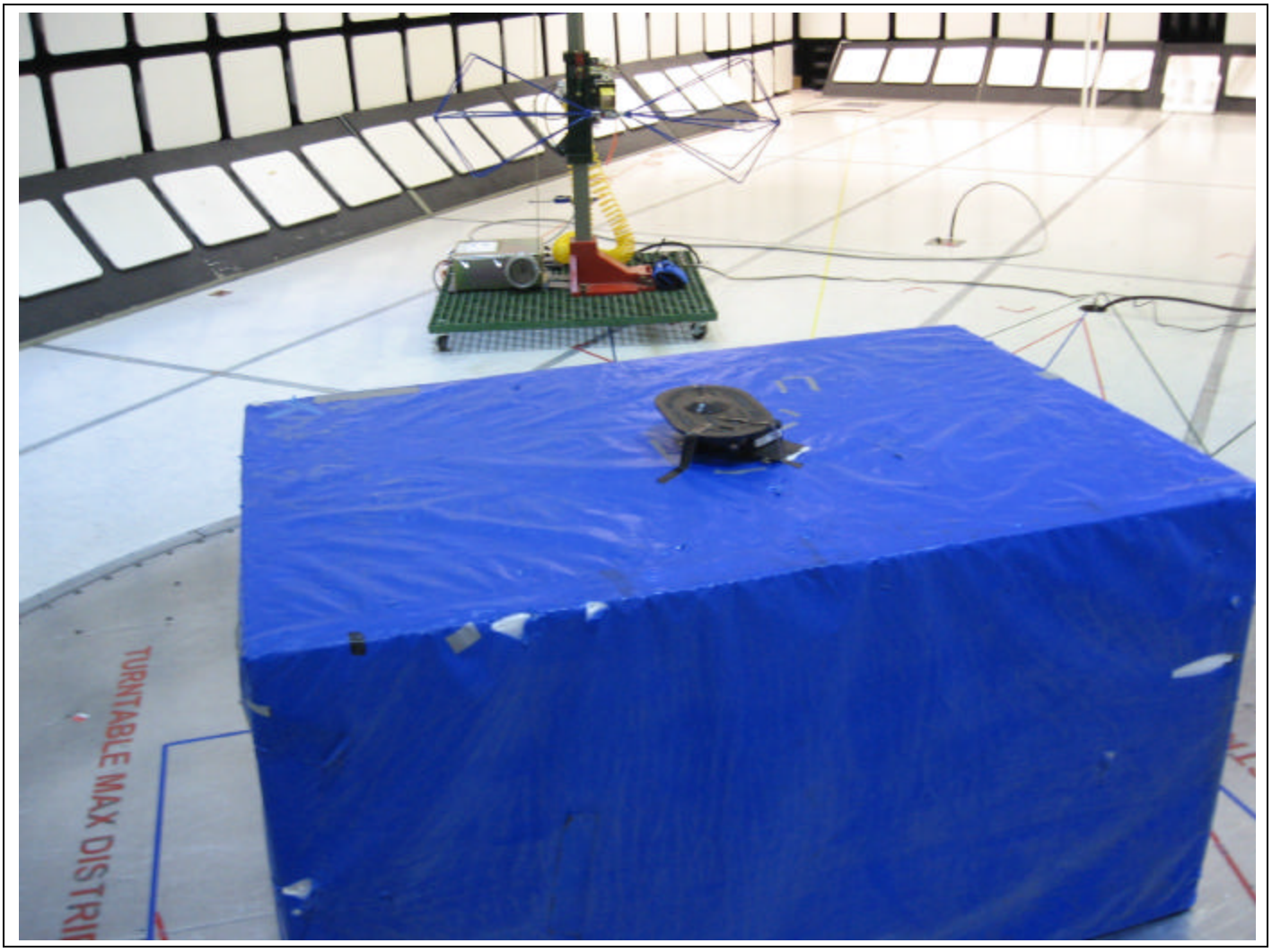


Figure 9 Radiated Spurious Emissions/Unintentional emissions 30-1000 MHz

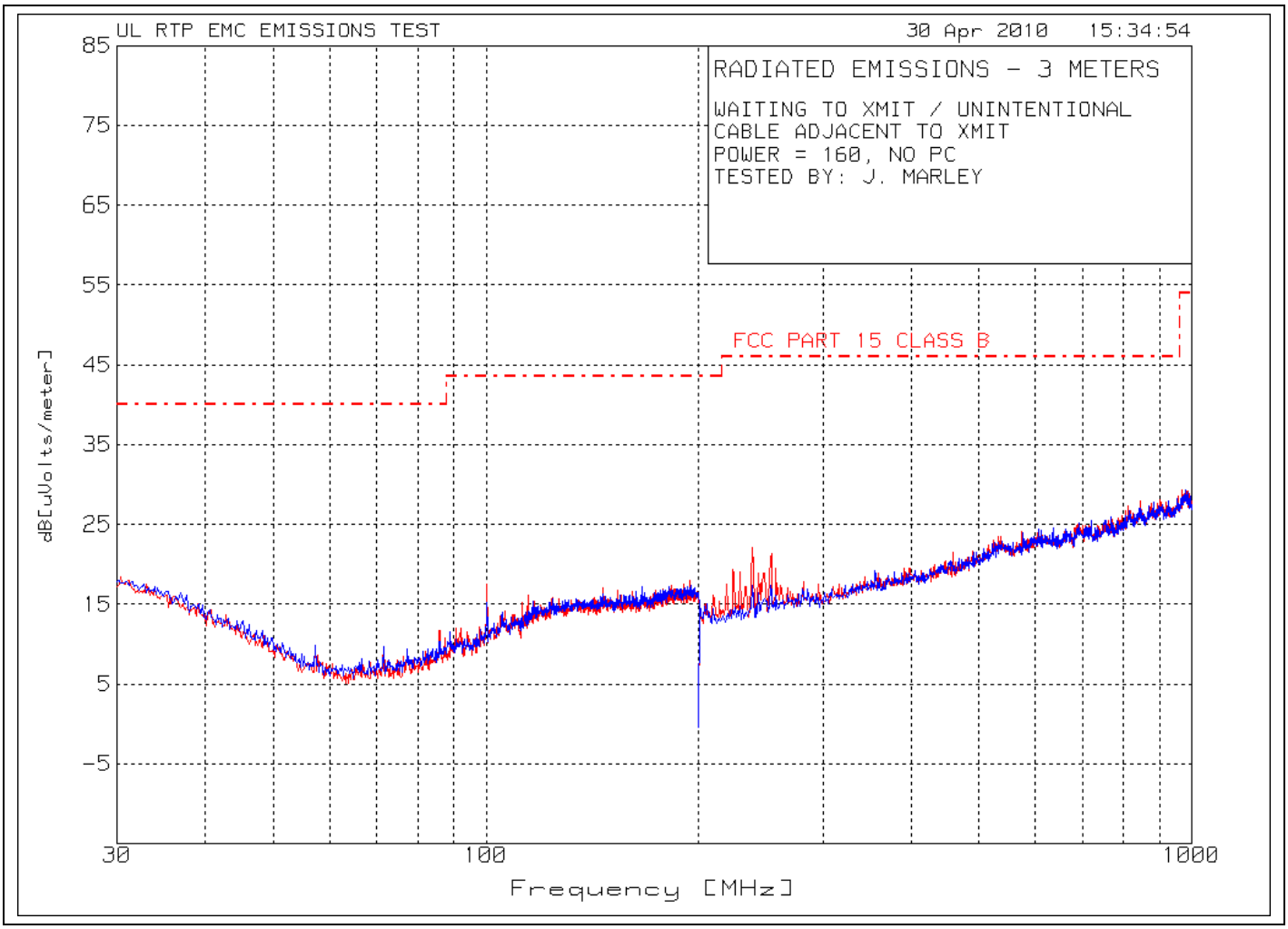


Table 13 Radiated Emissions Data Points

Detector Type* (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Gain/Loss (dB)	Transducer Factor (dB)	Corrected Value (dBuV/m)	Quasi-Pk Limit** (dBuV/m)	Quasi-Pk Margin (dB)	Antenna Polarity (V/H)	Antenna Height (cm)	Turntable Angle (degrees)
P	224.024	34.51	-26	10.8	19.31	46	-26.69	V	100	Rot
P	228.8288	34.41	-26.1	10.8	19.11	46	-26.89	V	100	Rot
P	238.4384	36.87	-26	11.2	22.07	46	-23.93	V	100	Rot
P	243.2432	33.28	-25.9	11.5	18.88	46	-27.12	V	300	Rot
P	248.048	33.02	-25.9	11.8	18.92	46	-27.08	V	100	Rot
P	253.6537	35.09	-26	12.2	21.29	46	-24.71	V	100	Rot
P	257.6577	32.96	-25.9	12.4	19.46	46	-26.54	V	399	Rot

**P= Peak, Q= Quasi-Peak, A= Average

4.3 Test Conditions and Results – CONDUCTED POWER

Test Description	Peak Conducted Power is recorded with the output of the EUT antenna port directly connected to the spectrum analyzer/receiver input. The EUT channel is set to low, middle, and high channels with normal modulation and continuous transmission. Resolution Bandwidth and Video Bandwidth were set to 1 MHz. The results are recorded for each frequency and compared to the maximum permissible limit as provided in 15.247.	
Basic Standard	47 CFR Part 15.247(d) RSS-210, A8.5 RSS-Gen 7.2.1 and 7.2.3	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	Low, Middle, and High Channels	Radiated Power, Conducted Power
Limits (Power)		
This device is limited to ¼ W conducted power, because 25 or greater, but less than 50 hopping channels, are used.		

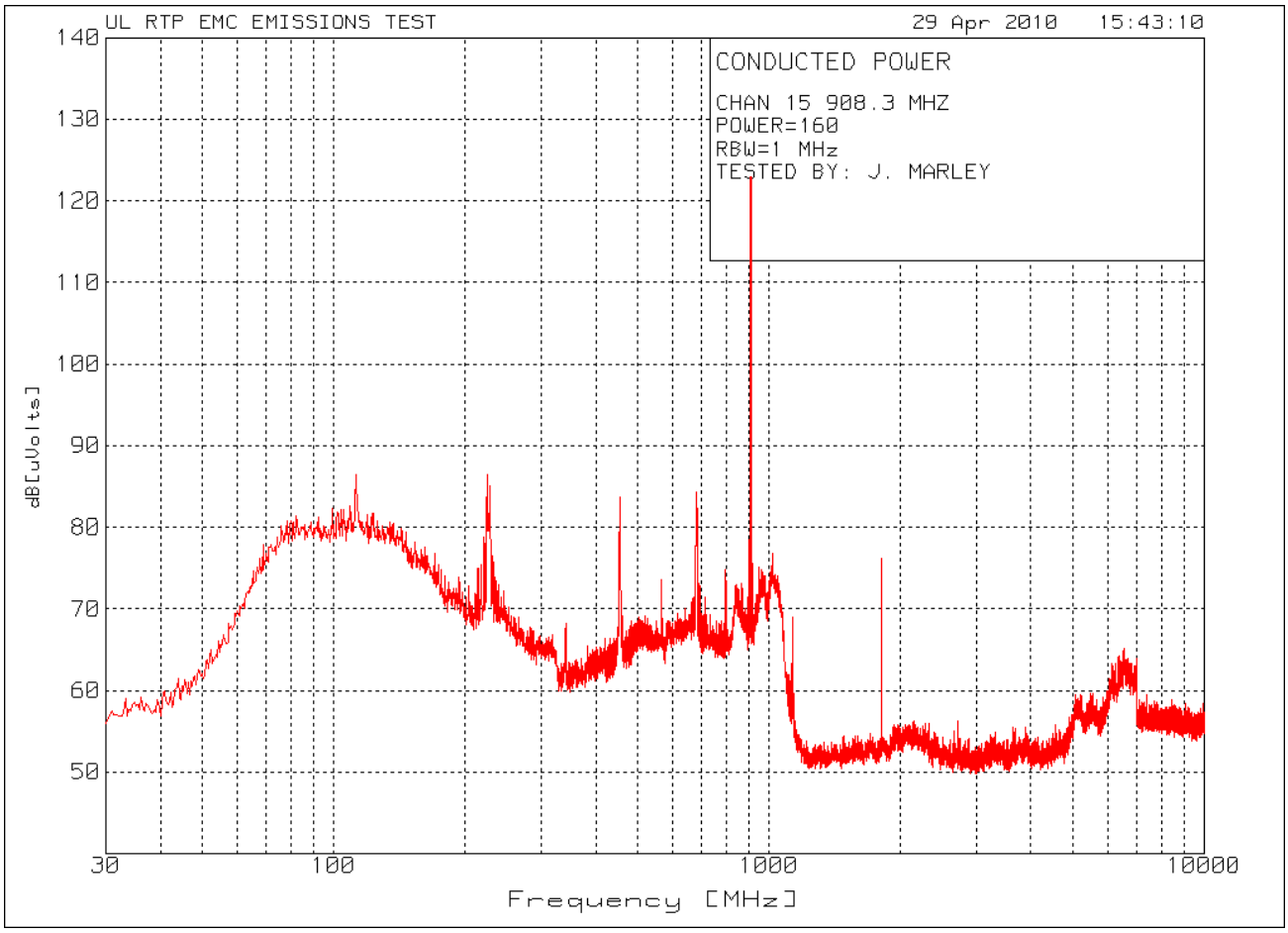
Table 14 Conducted Power EUT Configuration Settings

Power Interface Mode # (See Section 1.3.4)	EUT Configurations Mode # (See Section 1.6)	EUT Operation Mode # (See 1.5)
1	3 (Connected directly to receiver input)	1 (Low, Middle, and High Channels)
Supplementary information: Note: Output power setting was reduced to setting “160” to meet spurious requirements.		

Table 15 Conducted Power Test Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Receiver and Software				
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	1088.7490K40	1/18/10	1/31/11
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA

Table 16 Conducted Power Results



Channel 15 measurement shown. Channel 1 and 31 plots are similar.

Table 17 Conducted Power Results

Channel (#)	Frequency Measured (MHz)	Detector Type** (P/Q/A)	Measured Value (dBuV)	Correction Factor (dB)	Corrected Value (dBuV)	Unit Conversion Factor (dBm/dBuV)	Corrected Value (dBm)	Peak Conducted Power (mW)	Conducted Power Limit (mW)	Pass/Fail (P/F)
1	902.9677	P	122.99	0	122.99	-106.99	16.00	39.8	250	P
15	908.6279	P	123.02	0	123.02	-106.99	16.03	40.0	250	P
31	914.935	P	123.02	0	123.02	-106.99	16.03	40.0	250	P

** RBW=1 MHz, VBW=1 MHz

Sample Calculations:

(1) Conversion from Conducted Power (dBuV) to Conducted Power (dBm) in a 50-ohm impedance:

Conducted Power (dBm) = Conducted Power (dBuV) – 106.99

(2) Conversion from Conducted Power (dBm) to Conducted Power (mW):

$$\text{Conducted Power (mW)} = 10^{(\text{Conducted Power (dBm)} / 10)}$$

4.4 Test Conditions and Results – ANTENNA GAIN

Test Description	Antenna Gain is measured by performing a Radiated Power measurement and a Conducted Power measurement at three transmit frequencies (low, middle, and high channels). The Radiated Power measurement is performed with the EUT in place on a 1.0m x 1.5m x 80cm high non-conductive table with the receive antenna positioned 3 meters away. The maximum turntable angle and antenna height are found and the receiver reading is recorded. The EUT is then substituted with a signal generator and tuned dipole antenna. The signal generator output level is adjusted until the same signal level is observed on the receiver. Finally, the signal generator is connected to a power meter to measure the power input to the dipole. After the dipole factor is applied, then the radiated power of the antenna is known. This power is compared to the conducted power measurement performed in the previous section. The difference between the radiated power and conducted power measurement is defined to be the antenna gain (dBi).	
Basic Standard	47 CFR Part 15.247(d) RSS-210, A8.5	
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	Low, Middle, and High Channels	Radiated Power, Conducted Power
Limits (Antenna Conducted)		
If antenna gain is measured to be greater than 6 dB, then output power limit is reduced by the amount of gain in excess of 6 dB.		

Table 18 Antenna Gain EUT Configuration Settings

Power Interface Mode # (See Section 1.3.4)	EUT Configurations Mode # (See Section 1.6)	EUT Operation Mode # (See 1.5)
1	3 (Conducted power – connected directly to receiver)	1 (Low, Middle, and High channels)
2	1 (Radiated power)	1 (Low, Middle, and High channels)
Supplementary information: None.		

Table 19 Antenna Gain Test Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz Range				
AT0030	Log-periodic Antenna, 200 MHz to 1000 MHz	Schaffner, EMC	3160-07	5/7/09	5/31/10
	Tuned Dipole Set				
AT0013-AT0016	Four Dipole Antenna Set, 30 to 1000 MHz	EMCO	3121C-DB-1, -2, -3, -4	1/5/10	1/31/11
	Gain-Loss Chains				
SAC_D (Log-Periodic 3m location)	(13) ATA085: Attenuator (14) ATA125: Amplifier (15) ATA225: Cable (16) ATA189: Cable (17) ATA115: DC Bias Tee (18) ATA198: Cable	(13) Pasternack (14) Miteq (15) EUPEN (16) EUPE (17) Miteq (18) Micro-Coax	(13) PE7002-6 (14) AM-3A-000110-N (15) CMS/RG 214 (16) CMS/RG 214 (17) AM-1523-7687 (18) UFB293C-0-0720-5GU50U	02/17/10	08/31/10
	Receiver and Software				
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	1088.7490K40	3/18/10	3/31/11
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
HI0034	Environmental meter (T/H/P)	Control Company	99760-00	10/19/09	10/31/10
MG1180	Tape Measure	Lufkin	HI-VIZ	8/8/08	8/31/11

Table 20 Antenna Gain Results

Chan.	Polarity	Frequency (MHz)	Maximum Received Signal (dBuV)	Signal Generator Setting to duplicate signal strength with dipole* (dBm)	Power Meter reading at end of cable (dBm)	Correction Factor* (dB)	Corrected Power Meter Reading (dBm)	Dipole Gain (dBi)	Equivalent Isotropic Radiated Power (dBm EIRP)	Conducted Power Measure-ment - Direct (dBuV)	Conducted Power Measure-ment - Converted to dBm	Antenna Gain (Radiated Power minus Conducted Power) (dBi)
1	H	902.967	77.5	0.8	-0.5	10	9.5	1.8	11.32	122.99	16.00	-4.68
1	V	902.967	82.0	7.7	6.5	10	16.5	1.8	18.27	122.99	16.00	2.27
15	H	908.628	78.2	1.5	0.2	10	10.2	1.8	12.02	123.02	16.03	-4.01
15	V	908.628	82.7	9.5	8.3	10	18.3	1.8	20.06	123.02	16.03	4.03
31	H	914.935	78.7	2.5	1.2	10	11.2	1.8	13.01	123.02	16.03	-3.02
31	V	914.935	82.7	9.2	7.9	10	17.9	1.8	19.67	123.02	16.03	3.64

* Note: limited power with signal generator, so substitution signal was set to 10 dB lower than measured signal. 10 dB correction factor is then applied.

Maximum Antenna Gain observed was **4.03** dBi. This is less than 6 dBi, so no reduction in the maximum output power is required.

Maximum EIRP:

Maximum EIRP observed was **20.06 dBm (EIRP)** or **101.4 mW**.

4.5 Test Conditions and Results – MAXIMUM PERMISSIBLE EXPOSURE CALCULATION

Test Description	Maximum Permissible Exposure calculation is performed to ensure that this device meets RF exposure limits for its intended environment. This device is required to meet the General Population/Uncontrolled exposure limits.
Basic Standard	47 CFR Part 1.1307 Industry Canada IC Safety Code 6

FCC 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^2)	Averaging Time $\|E^2\|$, $\|H^2\|$. or S (MINUTES)
0.3 – 3.0	614	1.63	(100)*	6
3.0 - 30	1824/F	4.89/F	($900/F^2$)*	6
30 - 300	61.4	0.163	1.0	6
300 – 1500	-	-	F/300	6
1500 – 100,000	-	-	5.0	6
FCC 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^2)	Averaging Time $\|E^2\|$, $\|H^2\|$. or S (MINUTES)
0.3 - 1.34	614	1.63	(100)*	30
1.34 - 30	824/F	2.19/F	($180/F^2$)*	30
30 - 300	27.5	0.073	0.2	30
300 – 1500	-	-	F/1500	30
1500 – 100,000	-	-	1.0	30

Table 21 MPE - EUT Configuration Settings

Calculation is performed from conducted power and antenna gain measurements documented within this report.

Background: Per the following guidance from OET Bulletin 65 Supplement C required minimum spacings are provided to the professional installer.

Transmitter or Device Type[18]	Output[19]	Applicable Methods to Ensure Compliance[20]
Transmitters using indoor antennas that operate at 20 cm or more from nearby persons	>2.5 W at 915 MHz	If the MPE distance is greater than that required for normal operation of the device, operating instructions, warning instructions and/or warning labels may be used to ensure compliance by indicating the minimal separation distance to comply with MPE limits. If the antennas are professionally installed to ensure compliance, warning instructions and warning labels are not necessary.
	=< 2.5 W at 915 MHz or =< 4 W at 2450 MHz	Transmitters operating at 2.5 W EIRP (1.5 W ERP) or less at 915 MHz, or at 4 W EIRP (2.4 W ERP) or less at 2450 MHz, generally are not expected to exceed MPE limits when nearby persons are 20 cm or more from most antennas. Therefore, special instructions and warnings are normally not necessary to ensure compliance.

Table 22 MPE - Calculation

MPE Calculation with highest EIRP:

The highest radiated power was observed at the center channel (908.6 MHz) and these measurements are used for the calculation. Duty cycle is programmable and we assume worst case for this calculation (100%).

$S = EIRP / (4 * Pi * R^2)$,

Power Density = EIRP / (4 * Pi * R^2),
where EIRP = Output Power * Antenna Gain

Uncontrolled/General Exposure
0.0401 Watt, 4.03 dBi antenna (2.535 linear), 20 cm spacing

Operating Frequency	908.628 MHz		
Output Power (Peak)	**0.040** Watts		
Antenna Gain	**4.03** dB	or (linear)	2.53 (unitless)
Separation Distance	**0.2** m	-or-	7.874 inches
Peak Power Density	0.202 W/m^2	- or -	0.0202 mW/cm^2
Exposure % (over 6 min timespan for uncontrolled)	100%		
Transmit Duty Cycle (Peak-to-Average Ratio)	100%		
Average Power Density	**0.202** W/m^2	- or -	**0.0202** mW/cm^2
Limit for **Uncontrolled** Exposure at Operating Frequency	**6.057** W/m^2	- or -	**0.6057** mW/cm^2

The product was found to comply with this requirement.

Appendix A

Accreditations and Authorizations

NVLAP Lab code: 200246-0

NVLAP: The National Institute of Standards and Technology (NIST) administers the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP is comprised of laboratory accreditation programs (LAPs) which are established on the basis of requests and demonstrated need. Each LAP includes specific calibration and/or test standards and related methods and protocols assembled to satisfy the unique needs for accreditation in a field of testing or calibration. NVLAP accredits public and private laboratories based on evaluation of their technical qualifications and competence to carry out specific calibrations or tests. Accreditation criteria are established in accordance with the U.S. Code of Federal Regulations (CFR, Title 15, Part 285), NVLAP Procedures and General Requirements, and encompass the requirements of ISO/IEC 17025. For a full scope listing see http://ts.nist.gov/ts/htdocs/210/214/scopes/2002460.htm

FCC: Details of the measurement facilities used for these tests have been filed with the Federal Communications Commission's Laboratory in Columbia, Maryland (Ref. No. 91039).

Industry Canada Industrie Canada

Industry of Canada: Accredited by Industry Canada for performance of radiated measurements. Our test site complies with RSP 100, Issue 7, Section 3.3. File #: IC 2953

VCCI: Accepted as an Associate Member to the VCCI. The measurement facilities detailed in this test report have been registered in accordance with Regulations for Voluntary Control Measures, Article 8. Registration Nos.: Test Station 5 (Test LocationA) C-2427, Test Station 1 (Location D) C-742, Test Station 4 (Location E) C-743, Test Station 6 (Location C) C-744, Test Location A-Test Station 5 R-722, TEST STATION1 (TEST LOCATION D)T-235, TEST STATION4 (TEST LOCATION E) T-236, TEST STATION6 (TEST LOCATION C)T-237.

ICASA: ICASA (Independent Communications Authority of South Africa) has appointed UL as a Designated Test Laboratory to test Telecommunications equipment for type approval in compliance with CISPR 22 to assist in fulfilling its mandate under section 54(1) of the Telecommunications Act, 1996 (Act 103 of 1996).

NIST/CAB: Validated by the European Commission as a U.S. Conformity Assessment Body (CAB) of the U.S.-EU Mutual Recognition Agreement (MRA) for the Electromagnetic Compatibility - Council Directive 89/336/EEC, Article 10 (2). Also validated for the Telecommunication Equipment-Council Directive 99/5/EC, Annex III and IV, Identification Number: 0983.
NIST/CAB: Provisioned to act as a U.S. Conformity Assessment Body (CAB) under Appendix B, Phase I Procedures, of the Asia Pacific Economic Cooperation (APEC) MRA between the American Institute in Taiwan (AIT) and the United States. Our laboratory is considered qualified to test equipment subject to the applicable EMC regulations of the Chinese Taipei Bureau of Standards, Metrology and Inspection (BSMI) which require testing to CNS 13438 (CISPR 22).
NIST/CAB: Recognized by the Infocomm Development Authority of Singapore (IDA) under the Asia Pacific Economic Cooperation Mutual Recognition Agreement (APEC MRA). Our laboratory is provisionally designated to act as a Conformity Assessment Body (CAB) under Appendix B, Phase I Procedures, of the APEC MRA. Our scope of designation includes IDA TS EMC (CISPR 22), IEC 61000-4-2, -4-3, -4-4, -4-5, and -4-6