

PCTC

Product Compliance Test Center

2476 Swedesford Road, Malvern, PA 19355

ELECTROMAGNETIC INTERFERENCE TEST REPORT

Doc. 20050113R / Project No. 1161

TEST STANDARD: USA 47 CFR PART 15

MelodyWave Base Station

FCC ID: RXR0362024000

SCHULMERICH CARILLONS, INC.

SELLERSVILLE, PA

TEST DATE: January 3 – February 4, 2004

ISSUE: February 16, 2005

Prepared by: *Dipak Patel*
Dipak Patel
Technical Staff Engineer

Prepared by: *Itamar Gonen*
Itamar Gonen
Technical Staff Engineer

Approved by: *[Signature]*
John Baumeister
Group Manager, PCTC

The results described in this report relate only to the item(s) tested.
This document shall not be reproduced except in full without written permission of Unisys - PCTC.



AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION

Certificate No: 1028.01

PREFACE

This report documents product testing conducted to verify compliance of the specified EUT with applicable standards and requirements as identified herein. EUT, test instrument configurations, test procedures and recorded data are generally described in this report. The reader is referred to the applicable test standards for detailed procedures. The following table summarizes the test results obtained during this evaluation.

SUMMARY

The Schulmerich Carillons, MelodyWave Base Station (FCC ID: RXR0362024000) was tested to the standards listed below, and found to have the following characteristics:

TEST	STANDARD	REQUIREMENT	RESULT
Radiated Emissions - Intentional Radiation	FCC Part 15C, Section 15.249 (Operating Band: 902 –928 MHz)	902 MHz – 10 GHz	Below Max. Permissible limit
Radiated Emissions - Spurious and Unintentional Radiation	FCC Part 15C, Section 15.209 FCC Part 15B, Class B	30 MHz – 10 GHz	Below Max. Permissible limit
Conducted Emissions - AC Power lines	FCC Part 15C, Section 15.207 FCC Part 15B, Class B	150 KHz - 30 MHz	Below Max. Permissible limit

EUT Modifications

The following modification was made on the MelodyWave Base Station to meet the EMI requirements:

Added three (3) screws at the front bottom edge of MelodyWave Base Station chassis to improve its shielding.

MEASUREMENT UNCERTAINTY				
Measurement Type	Measurement Dist	Frequency Range	Measurement Limit	Expanded Combined Uncertainty
Radio Disturbance	10 meters	30 MHz to 1 GHz	Class A	4.3 dB
Radio Disturbance	10 meters	30 MHz to 1 GHz	Class B	5.0 dB
Radio Disturbance	3 meters	30 MHz to 1 GHz	Class B	4.3 dB
Conducted Disturbance	N/A	150 kHz to 30 MHz	Class A or B	3.6 dB

As all values of uncertainty are less than the CISPR 16-4:2002 recommendations, no adjustments to measured data presented in this report are required.

TABLE OF CONTENTS

1.0	Description of The Equipment Under Test (EUT).....	5
1.1	General Description	5
1.2	Test Configurations.....	9
1.3	Rationale for The Chosen Configuration	12
1.4	EUT Modifications	12
2.0	Operation of The EUT During Testing	13
2.1	General.....	13
2.2	Operating Mode	13
2.3	Rationale for The Chosen Mode of Operation	14
3.0	Applicable Requirements, Methods and Procedures	15
3.1	Applicable Requirements.....	15
3.2	Basic Test Methods and Procedures	15
3.3	Deviations Or Exclusions From The Requirements And Standards.....	15
4.0	Test Results	16
4.1	Radiated Emissions	16
4.1.1	Test Facility	16
4.1.2	Radiated Emissions Test Procedure.....	17
4.1.3	Radiated Emissions Test Results (1/3/2005 -2/4/2005)	19
4.1.3.1	Radiated Emissions - Intentional Radiator	19
4.1.3.2	Radiated Emissions – Spurious and Unintentional Radiation (30 MHz-10 GHz).....	21
4.2	Conducted Emissions	24
4.2.1	Conducted Emission Test Procedure	24
4.2.2	Conducted Emissions Test Results (1/17/2005).....	25
Appendix A – Test Equipment		29

1.0 Description of The Equipment Under Test (EUT)

Equipment Identification	MelodyWave Base Station
Part Number	036-2024-000
ID Number	93
Manufacturer	Schulmerich Carillons, Inc. PO Box 903 1 Carillon Hill Sellersville, PA 18960-0903
Technical Contact	Chris Nadovich (JTA) Mark Hofmeister Gregory L. Schwartz
Condition Received	Acceptable for Test
Date Received	1/3/2005
Sample Type	Production Unit
Equipment Classification	Intentional Radiator, Unlicensed Low power Transmitter
Unisys Test Personnel	Itamar Gonen Dipak Patel

Unless otherwise noted in the individual test results sections, testing was performed on the EUT configured as follows.

1.1 General Description

The MelodyWave Base Station Assembly is comprised of a 915 MHz RF transceiver mounted on a control PCB contained in a 3¼"x 6"x17" steel housing. Combined with the 36-2022 MelodyWave Baton Assembly and some form of tone generation, it forms a musical instrument. In simple terms, when the baton is actuated, it sends a message to the base station; the base station in turn processes this message and causes the tone generator to play a note via MIDI interface.

The instrument uses a TDM scheme to allow unfettered communication between up to 49 batons and the base station. Communication is performed on one pair of frequencies separated by 500 kHz. Base tick transmission occurs on the lower frequency and baton data occurs on the upper. Four possible frequency pairs are listed below:

Base Station Transmit Freq: 908.40 MHz or 909.40 MHz or 910.40 MHz or 911.40 MHz
Base Station Receive Freq: 908.90 MHz or 909.90 MHz or 910.90 MHz or 911.90 MHz

The base station emits a tick message every 53.25 msec from which all batons base their transmission times. In between ticks, the base station sits in receive mode listening for any baton messages. The tick packet contains 48 bits: 32 preamble and 16 synch word. It is modulated with FSK at 76.8 kbits/sec with a deviation of 39.6 kHz around its center frequency. Each packet is 625 μ sec in duration.

The base station is powered via an external desktop power supply (60Hz, 120 VAC, 24 VA). It supplies 12 VDC to the main PCB which powers the LCD backlight. The 12 VDC is regulated down to 3.0 VDC for the RF module and 5.0 VDC for all remaining control circuitry. Power is controlled via a front panel switch.



Photo 1: MelodyWave Base Station – Front View



Photo 2: MelodyWave Base Station – Rear View

1.2 Test Configurations

Testing was carried out on a single EUT configuration. The EUT was placed on a wooden table of 80 cm height.

Detailed EUT Hardware Listing

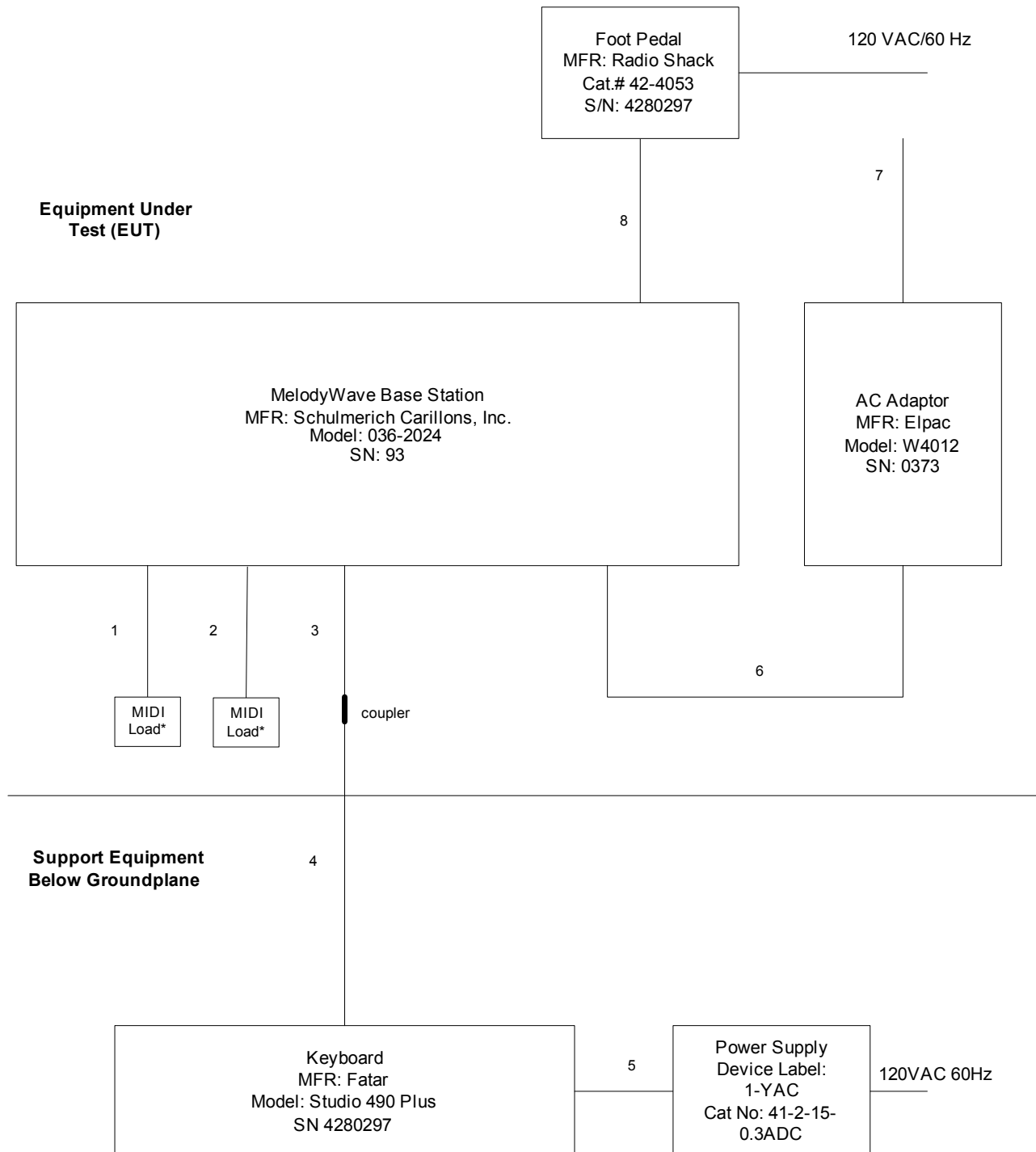
The MelodyWave Base Station has a permanently attached antenna. It incorporates the following RF module:

Description	Manufacturer	Manufacturer's Model Number/Part Number
MelodyWave 915 MHz RF Module	Schulmerich Carillons	036-1736-000

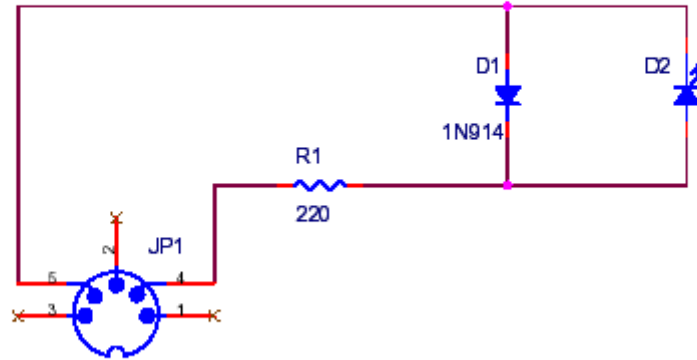
Test Support Items

The following device was used to verify the EUT operation.

Description	Manufacturer	Model Number	Serial Number
MelodyWave Baton	Schulmerich Carillons	036-2022-000	42
Keyboard	Fatar	Studio 490 Plus	4280297



*: MIDI Load used as termination load. Schematic is given on the following page.



MIDI Load Schematic

Cable Identification

Reference	Type	Cable Length
1	MIDI Cable, Shielded	10 feet
2	MIDI Cable, Shielded	10 feet
3	MIDI Cable, Shielded	10 feet
4	MIDI Cable, Shielded	25 feet
5	DC Cable, Unshielded	6 feet
6	DC Cable, Unshielded	6 feet 5 inches
7	AC Cable, Unshielded	6 feet
8	Foot pedal cable, Unshielded	6 feet

1.3 Rationale for The Chosen Configuration

The tested configuration of the EUT represents deliverable hardware.

1.4 EUT Modifications

The following modification was made on the MelodyWave Base Station to meet the EMI requirements:

Added three (3) screws at the front bottom edge of MelodyWave Base Station chassis to improve its shielding. This modification is shown in the photo given below:



2.0 Operation of The EUT During Testing

Unless otherwise noted in the individual test results sections, testing was performed on the EUT as follows.

2.1 General

Climatic Environment

The following were the ambient conditions in the laboratory during testing:

Temperature: $22^{\circ}\text{C} \pm 5^{\circ}\text{C}$

Relative Humidity $50\% \pm 10\% \text{ RH}$

Input Power

The MelodyWave Base Station was powered at 12 VDC which it received from the Elpac Power System model W4012 Power Supply (AC adaptor). The AC adaptor was supplied with input AC power at 120 VAC/60 Hz.

2.2 Operating Mode

During the emissions testing the MelodyWave Base Station was operated for continuous transmit/receive mode of operation. The communication was established with the MelodyWave Baton (used as support item). The base station was transmitting a ticks message approximately every 53.25 msec. During the nontransmit time, the EUT remains in receive mode of operation, receiving data from the MelodyWave Baton. Thus the emissions recorded and presented in this report were taken for both transmit as well as receive operation of the EUT.

Since the MelodyWave Base Station can be operated in four transmitting frequencies (908.4 MHz - 911.4MHz), during intentional radiated emissions testing the MelodyWave Base Station was operated for continuous transmission at the following three selected transmitting frequencies:

908.4 MHz (Low)

909.4 MHz (Medium)

911.4 MHz (High)

2.3 Rationale for The Chosen Mode of Operation

The selected mode of operation simulated the actual transmit/receive application of the EUT, operating at the selected three frequencies as per FCC rules, therefore it was considered as an appropriate operating mode for the EMI evaluation.

3.0 Applicable Requirements, Methods and Procedures

3.1 Applicable Requirements

The results of the measurement of the radio disturbance characteristics of the EUT described herein may be applied and, where appropriate, provide a presumption of compliance to one or more of the following requirements or to other requirement at the discretion of the client, regulatory agencies, or other entities.

USA

47 CFR, Part 15, Radio Frequency Devices,

- Subpart B, "Unintentional Radiators".
- Subpart C, "Intentional Radiators".

Canada

Industry Canada (IC) Spectrum Management and Telecommunication Policy, Radio Standards Specification RSS-210, "Low Power License – Exempt Radiocommunication Devices (All Frequency Bands)". Issue 5, November 2001.

3.2 Basic Test Methods and Procedures

The applicable regulatory product family or generic standards require that radio disturbance/interference tests be performed in accordance with the following:

- C63.4, 2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in The Range of 9 kHz to 40 GHz".

3.3 Deviations Or Exclusions From The Requirements And Standards

There were no deviations or exclusions from the requirements and standards.

4.0 Test Results

4.1 Radiated Emissions

4.1.1 Test Facility

The test site is an all weather, open field measurement facility defined by an elliptical area of 3258 square meters, which is free of reflective metallic objects and extraneous electromagnetic signals. A non-metallic A-Frame enclosure covers 172 square meters of the ellipse. This enclosure contains a ground level 5-meter diameter turntable, capable of rotating equipment through a complete 360 degrees, and a 3-meter and 10-meter test range with a remotely controlled antenna mast. The floor of the A-Frame and surface of the turntable are covered with a flat metal continuous ground plane. The ground plane extends outside the A-Frame to a distance of 35.6 meters from the center of the turntable. The width of the extension is 2.4 meters.

The ground plane, under the A-Frame enclosure, is covered with protective insulating material. A cellar located beneath the ground level of the A-Frame structure houses personnel and instrumentation for remote control of the antenna mast, the turntable, and other equipment above ground level. The test site complies with the Attenuation Measurements specified in ANSI C63.4 - 2001, and is registered with FCC, VCCI, BSMI, NEMKO and EZU.

For electric field radiated emissions, the EUT and support peripherals or devices required to facilitate EUT operation were positioned either directly on the turntable surface (floor standing equipment) or on a wooden table 80 cm. in height (tabletop equipment), depending on the size and status of the sample. Hardware not needed in the test field such as remote terminals or non-standard exercisers were placed in the basement below the turntable.

4.1.2 Radiated Emissions Test Procedure

Radiated Emissions 30 MHz – 1000 MHz

Initial measurements, for the purpose of identifying suspect emissions from the equipment under test, were performed by dividing the test frequency range into the following twenty bands:

Band	Frequency Range	Band	Frequency Range	Band	Frequency Range
1)	30 - 40 MHz	8)	108 - 148 MHz	15)	570 - 670 MHz
2)	40 - 50 MHz	9)	148 - 165 MHz	16)	670 - 770 MHz
3)	50 - 88 MHz	10)	165 - 200 MHz	17)	770 - 855 MHz
4)	88 - 93 MHz	11)	200 - 300 MHz	18)	855 - 875 MHz
5)	93 - 98 MHz	12)	300 - 450 MHz	19)	875 - 892 MHz
6)	98 - 103 MHz	13)	450 - 470 MHz	20)	892 - 1000 MHz
7)	103 - 108 MHz	14)	470 - 570 MHz		

Each of these bands was monitored on a spectrum analyzer display while the turntable was initially positioned at the reference 0 degree point. A mast mounted broadband antenna was located at a distance of 3/10 meters (as applicable) from the periphery of the EUT(s). The antenna was set to a height of 1 meter, for the vertical polarity and a height of 2.5 meters, for horizontal polarity for these suspect emission scans. All emissions with amplitudes 8 dB or less below the appropriate regulatory limit were identified and saved for later source identification and investigation. This initial suspect identification procedure was repeated for turntable positions of 90, 180 and 270 degrees.

The source of questionable emissions was verified by powering off the EUT(s). Those emissions remaining were removed from the suspect list. Valid suspect emissions were then maximized through cable manipulation. The highest six signals or all within 4 dB of the limit, identified during this initial investigation, were then maximized by rotating the turntable through a complete 360 degrees of azimuth and then raising the antenna from 1 to 4 meters of elevation with the turntable positioned at the angle of maximum signal level. When the EUT(s) azimuth, antenna height and polarization that produced the maximum indication were found, the emission amplitude and frequency were remeasured to obtain maximum peak and quasi-peak field strength. The frequencies and amplitudes of RFI emissions are recorded in this report in units derived as follows:

$$\text{Field Strength (dBuV/m)} = \text{meter reading (dBuV)} + \text{antenna factor (dB/m)} + \text{Cable Loss (dB)}$$

Radiated Emissions above 1 GHz

The required test frequency range above 1 GHz, was scanned manually by placing a Double Ridged Guide antenna at a distance of 3 meters from the perimeter of the equipment under test. Emissions were monitored using EMI Test Receiver ESIB 40 set for a 1 MHz bandwidth with rotating the turntable through a complete 360 degrees of azimuth. Both horizontal and vertical antenna polarities were investigated for suspect emissions. The support equipment and test item(s) were powered off in turn to determine the source of the emissions. The test procedure described above for 30 –1000 MHz was observed to maximize the emissions. The measurements were made with both peak and average detectors. The field strengths were recorded as follows:

$$\text{Field Strength (dBuV/m)} = \text{Meter reading (dBuV)} + \text{Correction Factor}^*$$

* Correction Factor includes Antenna Factor (dB/m) + Cable Loss (dB) – Amplifier Gain (dB)

4.1.3 Radiated Emissions Test Results (1/3/2005 -2/4/2005)**4.1.3.1 Radiated Emissions - Intentional Radiator****Fundamental Frequency Emissions**

Fundamental transmission frequency emissions were measured at a test distance of 3 meter. The quasi-peak detector levels measured by the RF measurement receiver were corrected as the PRF of the transmission was found less than 20 Hz. It is understood that because of the emission PRF was less than the 20 Hz, the RF receiver indicated quasi-peak detector levels may have lower amplitude value than the actual amplitude. The required correction to the receiver indicated reading was determined by finding the difference between the amplitudes of EUT emission and the emission that has a same pulse width but a PRF of 20 Hz.

The pulse width and PRF of the emission at the fundamental frequency were measured as below:

Pulse width: 760 us

PRF: 18.97 Hz

Using a Agilent model E8254A (250 KHz - 40 GHz) signal generator, a simulated signals having above measured pulse width and PRF of 18.97 Hz and 20 Hz were generated. The amplitudes of these two simulated signals were measured using quasi-peak detector. The measured amplitudes showed a difference of 0.1 dB. This difference was added to the RF receiver indicated quasi-peak detector level to find accurate amplitude.

The following tables on the next page show the corrected (taking in to account effect of the emission PRF) quasi-peak data compared to the FCC Part 15 Section 15.249 limit for fundamental emissions at 3 meter test distance.

Fundamental Frequency Emissions

Base Station Transmit at Low Transmit Frequency

Freq	Q-Pk	Pol	Angle	Ht	CF	Limit	Delta
[MHz]	[dBuV/m]		[deg]	[cm]	[dB]	[dBuV/m]	[dB]
908.377	92.89	V	345	100	27.84	94	-1.11
908.377	87.05	H	191	68	27.84	94	-6.95

Base Station Transmit at Mid Transmit Frequency

Freq	Q-Pk	Pol	Angle	Ht	CF	Limit	Delta
[MHz]	[dBuV/m]		[deg]	[cm]	[dB]	[dBuV/m]	[dB]
909.376	92.44	V	331	100	27.87	94	-1.56
909.376	87.34	H	65	198	27.87	94	-6.66

Base Station Transmit at High Transmit Frequency

Freq	Q-Pk	Pol	Angle	Ht	CF	Limit	Delta
[MHz]	[dBuV/m]		[deg]	[cm]	[dB]	[dBuV/m]	[dB]
911.380	92.65	V	360	100	27.94	94	-1.35
911.380	87.4	H	57	196	27.94	94	-6.6

No change in fundamental frequency emission amplitude levels was noted when measured with supplying input AC power at 102 VAC, 60 Hz and 138 VAC, 60 Hz as compare to above recorded levels with input AC power at 120 VAC, 60 Hz to the AC adaptor.

Harmonics of Fundamental Frequency Emissions (Upto 10 GHz)

Emission scan for harmonics of the fundamental frequency was performed up to 10 GHz. Harmonics emissions detected with peak detector were significantly below the applicable average limit specified in FCC Part 15, Section 15.249, therefore no peak or average measurements were performed/recorded.

Overall Results: All fundamental radiated emissions and harmonics of the fundamental frequency, at a distance of 3 meters from the MelodyWave Base Station, are below the 3 meter limit specified by FCC Part 15, Section 15.249.

4.1.3.2 Radiated Emissions – Spurious and Unintentional Radiation (30 MHz-10 GHz)

Emission scan for detection of spurious and unintentional radiation was performed. The recorded levels are compared with the applicable limit specified in FCC Part 15, Section 15.209 which is the same limit as FCC Part 15 specified for Class B digital devices for the test measurement frequency spectrum. Measurement scan was performed for the frequency range of 30 MHz to 10 GHz, at the test distance of 3 meters.

30 MHz – 10000 MHz

Freq [MHz]	Q-Pk [dBμV/m]	Pol	Angle [deg]	Ht [cm]	CF [dB]	Limit [dBμV/m]	Delta [dB]
140.005	29.30	V	204	102	10.91	43.5	-14.2
160.007	22.45	V	184	100	10.16	43.5	-21.05
173.038	16.85	V	329	102	11.36	43.5	-26.65
180.007	25.46	V	152	100	11.21	43.5	-18.04
180.007	20.42	H	80	149	11.21	43.5	-23.08
186.989	23.76	V	150	100	11.76	43.5	-19.74
200.009	26.83	V	139	100	11.86	43.5	-16.67
200.009	22.32	H	234	119	11.86	43.5	-21.18
240.007	30.54	H	209	108	14.25	46	-15.46

Overall Results: All the EUT signals, other then fundamental and its harmonics, are under the 3 meter limit specified by FCC Part 15, Class B digital devices and FCC Part 15, Section 15.209.

Test Setup



Photo 3: Radiated Emission Test Setup – Front View



Photo 4: Radiated Emission Test Setup – Rear View

4.2 Conducted Emissions

4.2.1 Conducted Emission Test Procedure

Peak amplitude terminal voltage emissions at the power line input to the Elpac Power System model W4012 Power Supply, were measured with a receiver, using a peak detector and the appropriate CISPR bandwidth, connected to the RF output of a 50 Ohm, 50 microhenry Line Impedance Stabilization Network (LISN) installed in each power line. Peak detector emission data measurements were made over the frequency range from 150 kHz to 30 MHz while the EUT(s) was operating as described in paragraph 2.2.

Note: For speed and convenience, a receiver employing a peak detector was used to sweep through and record the spectrum. As a tool to judge compliance of the emissions, the peak detector sweep is displayed and graphed against the appropriate average limit. This type of measurement is valid given that the peak reading will always be greater than or equal to the average or quasi-peak reading. From the Peak detector emission data plot, the top six (6) emissions or any other peak emissions that exceed the average limit, or are found to be within 1 dB of the average limit, are re-measured using receiver with the detector function first set to quasi-peak and then to average. These measurements are recorded and presented in the table format below the peak emission graph.

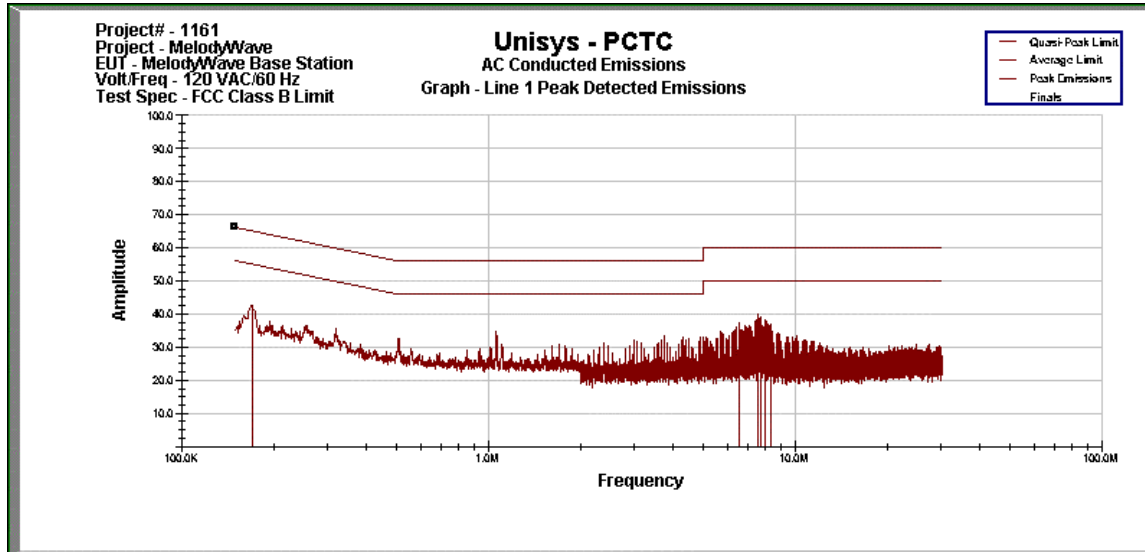
The amplitudes of emissions measured on the AC power lines of the EUT(s) are recorded in this report in units derived as follows:

$$\textbf{Conducted Emission (dBuV) = Meter reading (dBuV) + Correction Factor*}$$

* Correction Factor = Cable Loss (dB) + LISN factor (dB) + Limiter Loss (dB).

4.2.2 Conducted Emissions Test Results (1/17/2005)

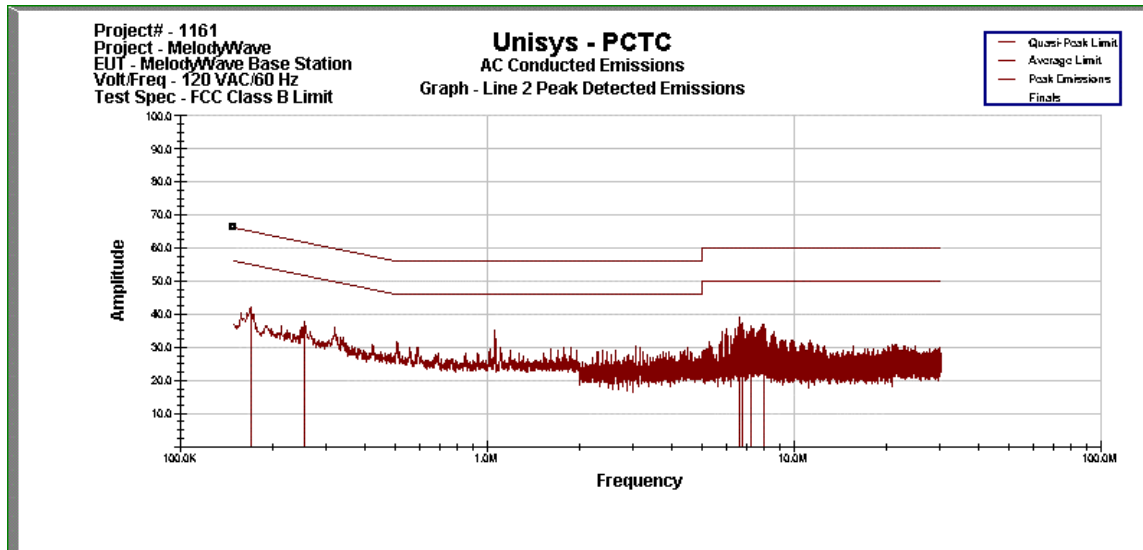
AC Power Line 1



Unisys - PCTC
Line 1 Conducted Emissions
 02:39:52 PM, Monday, January 17, 2005

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
170.000 KHz	32.53	55.43	-22.90	40.05	65.43	-25.38	12.692
6.537 MHz	26.45	50.00	-23.55	34.22	60.00	-25.78	10.141
7.555 MHz	34.38	50.00	-15.62	37.39	60.00	-22.61	10.161
7.724 MHz	33.28	50.00	-16.72	35.96	60.00	-24.04	10.164
7.980 MHz	26.73	50.00	-23.27	34.16	60.00	-25.84	10.170
8.319 MHz	30.27	50.00	-19.73	33.20	60.00	-26.80	10.176
Project# - 1161							
Project - MelodyWave							
EUT - MelodyWave Base Station							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

AC Power Line 2



Unisys - PCTC
Line 2 Conducted Emissions
02:47:23 PM, Monday, January 17, 2005

	1	2	3	4	5	6	7
Frequency	AVG	AVG	AVG	QP	QP	QP	Corr
MHz	dBuV	Limit	Margin	dBuV	Limit	Margin	Factor
170.000 KHz	31.938	55.429	-23.490	39.134	65.429	-26.295	12.692
253.000 KHz	25.278	53.057	-27.779	32.007	63.057	-31.050	10.670
6.617 MHz	31.811	50.000	-18.189	36.721	60.000	-23.279	10.142
6.784 MHz	26.149	50.000	-23.851	33.568	60.000	-26.432	10.146
7.209 MHz	30.253	50.000	-19.747	34.502	60.000	-25.498	10.154
7.978 MHz	27.932	50.000	-22.068	33.785	60.000	-26.215	10.170
Project# - 1161							
Project - MelodyWave							
EUT - MelodyWave Base Station							
Volt/Freq - 120 VAC/60 Hz							
Test Spec - FCC Class B Limit							

Test Setup



Photo 5: Conducted Emission Test Setup – Front View



Photo 6: Conducted Emission Test Setup – Side View

Appendix A – Test Equipment

Description	Freq Range (Hz)	Model Number	Manufacturer	ID / SN	Last Cal Date
EMI Test Receiver	20 Hz – 40 GHz	ESIB 40	Rohde & Schwarz	C-062	12/7/04
Antenna	25M - 2G	LPB-2520/A	ARA	B962	4/7/04
Antenna	1G – 18G	96001	EATON	U926	2/11/04
High Pass Filter	1.5G-18G	6HC1500/18000-3-KK	Trilithic Inc.	A088	11/1/04
Controller, Tower and Turntable	NA	2090	EMCO	B812	NA
Amplifier	1G – 40G	NSP4000-44	Miteq	B827	8/3/04
EMI Test Receiver	20 Hz – 26.5 GHz	ESIB 26	Rohde & Schwarz	C232	2/23/04
Filter, Bandpass	0.15M - 30M	NA	Unisys	NA	NA
Limiter, Pulse	DC - 30M	ESH3-Z2	Polarad	NA	NA
LISN	9k - 30M	MN 2053	Chase	U775	9/21/04