Project 06364-10

Hetronic International
MFSHL-BMTX

Certification
Electromagnetic Compatibility Test Report

Prepared for:

Hetronic International

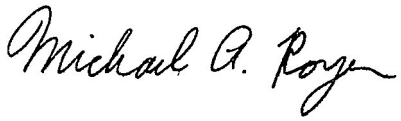
401 East Memorial Road
Suite 300
Oklahoma City, OK 73114

By

Professional Testing (EMI), Inc.
1601 FM 1460, Suite B
Round Rock, Texas 78664

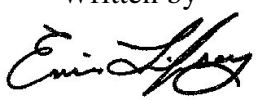
MAY 2006

Reviewed by



Michael Royer
EMC Department Manager

Written by



Eric Lifsey
Test Engineer

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Certificate Of Compliance

Applicant: Hetronic International

Applicant's Address: 401 East Memorial Road, Suite 300
Oklahoma City, OK 73114

Project Number: 06364-10

Test Dates: March 24th - 27th, 2006 and April 7th, 2006

I, Michael A. Royer, for Professional Testing (EMI), Inc., being familiar with the FCC and Industry Canada rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

The **Hetronic International, MFSHL-BMTX** was tested to and found to be in compliance with FCC Part 15 Subpart C for an Intentional Radiator.

The highest emissions generated by the above equipment are listed below:

	Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Fundamental	915	91.7	94	-2.3
Harmonics	1830	67.1	83.5	-16.4
Spurious	933	34.6	46	-11.4

Occupied Bandwidth 176 (kHz)
Transmit Duty Cycle 2.9%

Michael A. Royer, BSEE, NCE
EMC Department Manager

This report has been reviewed and accepted by Hetronic International. The undersigned is responsible for ensuring that **Hetronic International, MFSHL-BMTX** will continue to comply with the FCC and Industry Canada rules.

1.0 EUT Description

The Hetronic International MFSHL-BMTX (EUT) is a portable low-power wireless controller for heavy equipment.

The EUT is a transmitter/coder with an RF section that uses Binary FSK Modulation on a fixed operating frequency 915 MHz, at 76800 Baud rate, and with a transmitter Duty Cycle of 3%.

The transmitter is exclusively battery powered and can not be operated from the AC mains. If rechargeable batteries are used in the battery pack, the pack must be removed from the controller to be charged.

The EUT's coder also works in a direct cable mode. When the coder detects a cable connection the RF section is disabled. Instead, control signals are routed to the CAN cable. A cable for this feature did not exist at the time of this test though will be tested later.

The system tested consisted of the following:

Manufacturer	Description	FCC ID	IC Company Number
Hetronic International	915 MHz	LW9-MFSHL-BMTX	2119B - MFSHL-BMTX

1.1 Modifications to Equipment

No modifications were made to the EUT.

1.2 Applicable Documents

The following guidelines apply to the operation of the EUT:

Guidelines	FCC Rule Parts Part 15	IC Rule Parts
Transmitter Characteristics	15.249	RSS-210 Issue 6 A2.9
Spurious Radiated Power	15.249	RSS-210 Issue 6 A2.6
Occupied Bandwidth	15.249	RSS-210 Issue 6 A2.9
Antenna Requirements	15.203	RSS-Gen 5.5
Averaging Calculations	15.35b	RSS-Gen 4.3

1.3 EUT Operation

The EUT was operated in continuous transmit mode at a fixed and maximum power.

2.0 Electromagnetic Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing.

2.1 Radiated Emissions Measurements

Radiated emission measurements were made of the Fundamental and Spurious Emission levels for the EUT. Measurements of the occupied bandwidth were also made for the EUT.

Measurements of the maximum emission levels for the fundamental and spurious/harmonic emissions of the EUT were made at the Professional Testing "Open Field" Site 3, located in Round Rock, Texas to determine the radio noise radiated from the EUT. A “Description of Measurement Facilities” has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

Tests of the fundamental for the device were performed to determine the worst case polarization of the devices. The fundamental emissions of the device were measured with the antenna of the device in three orthogonal axes.

2.1.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. The radiated emissions were maximized by rotating the EUT.

A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. A drawing showing the test setup is given as Figure 2.

2.1.2 Test Criteria

The table below shows FCC radiated limits for an intentional radiator operating under the provisions of part 15.249. The measurement of the harmonics was performed to 10 GHz. The reference distance for each limit is also shown in this table.

2.1.3 The FCC 15.249 radiated limits

Frequency (MHz)	Test Distance (Meters)	Field Strength (dBµV/m)
30 to 88	3	40.0
88 to 216	3	43.5
216 to 960	3	46.0
960 and above	3	54.0

Note: The lower limit shall apply at the transition frequency. The spurious limits are expressed in Quasi-Peak.

Frequency MHz	Test Distance (Meters)	Field Strength	
		Distance 3 m (µV/m)	At Test Distance (dBµV/m)
Fundamental	3	50000	94.0
Harmonics	1	500	63.5

Note: Fundamental is expressed in Peak field strength and Harmonic Limits are expressed in Average field strengths.

2.1.4 Test Results

The radiated test data for the fundamental is included in Appendix A. Peak detection was used during the test for the fundamental and harmonics. To determine Harmonic field strength an average calculation was applied. Quasi-Peak detection was used for spurious emissions below 1 GHz. The radiated emission test data is included in Appendix A. The radiated emissions generated by the EUT are below the FCC Part 15.249 and Part 15.209 limits.

2.1.5 Radiated Emissions Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
C005	None	None	Underground Coaxial Cable	December 8, 2006
0754	Compliance Design	B100	Biconical Antenna	June 3, 2006
0238	HP	85685A	RF Preselector	April 24, 2006
0950	HP	8566B	Spectrum Analyzer	April 24, 2006
0949	HP	8566B	Spectrum Analyzer Display	April 24, 2006
0275	HP	85650A	Quasi-peak Adapter	April 24, 2006
0483	HP	8447D	RF Preamplifier	January 12, 2007
0755	EMCO	3146	Log Periodic Dipole Array Antenna	June 8, 2006

2.1.6 Microwave Radiated Emissions Test Equipment

Asset #	Manufacturer	Model #	Description	Calibration Due
C031	None	None	1.5 meter Coaxial RF Cable	November 23, 2006
0267	EMCO	3115	Ridge Guide Antenna	July 16, 2006
0950	HP	8566B	Spectrum Analyzer	April 24, 2006
0949	HP	8566B	Spectrum Analyzer Display	April 24, 2006
0897	Miteq	None	Microwave Preamplifier	May 16, 2006

3.0 Occupied Bandwidth Measurements

Measurements of the occupied bandwidth for the fundamental signals were made at Professional Testing Round Rock, Texas site. All measurements were made in a controlled indoor environment in a configuration which did not present measurement distortion or ambient interference.

3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. The table was rotated to an angle which presented the highest signal level. The occupied bandwidth was based on a 20 dB criteria (20 dB down either side of the emission from the peak emission). A drawing showing the test setup is given as Figure 1.

3.2 Test Criteria

According to FCC Part 15.249, the emission must remain in the defined band.

3.3 Test Results

The occupied bandwidth test data is included in Appendix A. The occupied bandwidth satisfies the criteria.

4.0 Burst Length, Pulse Width, Pulse Repetition Rate and Duty Cycle

Measurements of the critical transmitter time domain parameters were made at Professional Testing Round Rock, Texas site. All measurements were made in a controlled indoor environment in a configuration which did not present measurement distortion or ambient interference.

4.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. The relevant transmitter time domain performance parameters were measured.

4.2 Test Criteria

According to FCC Part 15.35, the maximum correction factor that can be used is 20dB.

4.3 Test Results

The transmitter duty cycle data and calculated peak to average derating is included in Appendix A. The calculated peak to average duty cycle derating is applied to measurements of non-spurious transmitter signals.

5.0 Antenna Requirement

An analysis of the EUT was performed to determine compliance with FCC Section 15.203. This section requires specific handling and control of antennas used for devices subject to regulations.

5.1 Evaluation Procedure

The structure and application of the EUT was analyzed with respect to the rules. The antenna is an internal antenna, and is not accessible to the user. An auxiliary antenna port is not present.

5.2 Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

(a) Antenna must be permanently attached to the unit.

(b) Antenna must use a unique type of connector to attach to the EUT.

(c) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

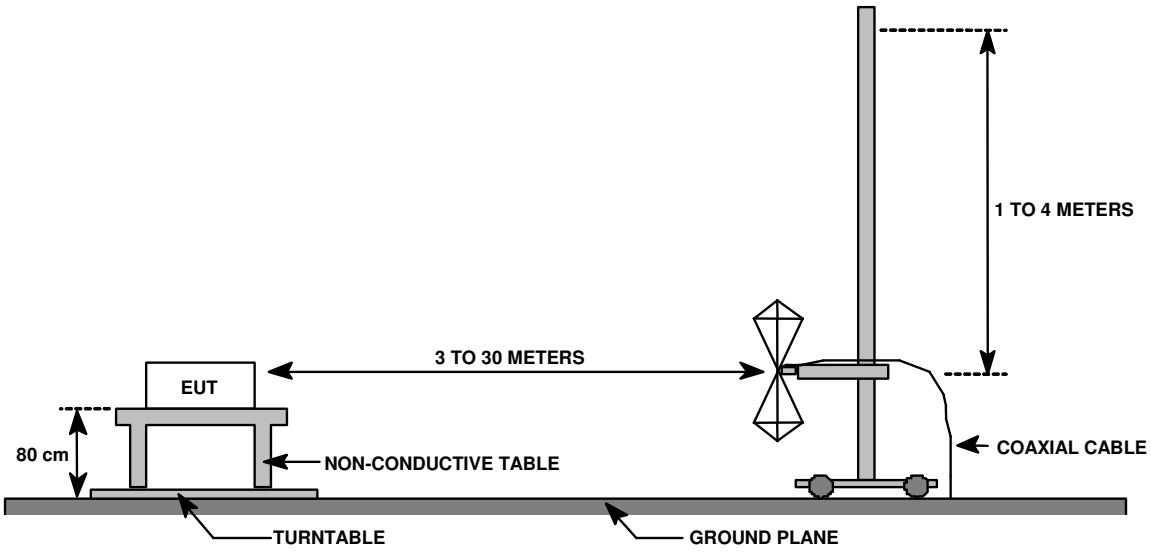
5.3 Evaluation Results

The EUT meets the criteria of this rule by virtue of having an internal antenna inaccessible to the user and installed at the factory. The EUT is therefore compliant.

6.0 Modifications

Fundamental emission exceeded limit by 3 dB, the EUT power output was reduced to satisfy the limit with -2.3 dB of margin.

FIGURE 1: Radiated Emissions Test Setup



APPENDIX A TEST DATA SHEETS

Spurious Radiated Emissions Data Sheet
Hetronic International
MFSHL-BMTX

MEASUREMENT DISTANCE (m): 3 MARCH 24, 2006
ANTENNA POLARIZATION: Horizontal PROJECT #: 06364-10
DETECTOR FUNCTION: Quasi-Peak

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elev. (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
222	noise	floor	34	26.8	11.3	5.2	23.7	46	-22.3
250	noise	floor	29.4	27.1	12.2	5.8	20.4	46	-25.6
457.5	near	floor	30.6	27.4	16.7	7.2	27.1	46	-18.9
636	noise	floor	29.3	26.9	19.6	8.3	30.3	46	-15.7
833	noise	floor	28.9	26.2	21.9	9.5	34.1	46	-11.9
933	noise	floor	28	26.4	22.8	10.1	34.6	46	-11.4

MEASUREMENT DISTANCE (m): 3 MARCH 24, 2006
ANTENNA POLARIZATION: Vertical PROJECT #: 06364-10
DETECTOR FUNCTION: Quasi-Peak

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elev. (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
222	noise	floor	34	26.8	11.3	5.2	23.7	46	-22.3
250	noise	floor	29.4	27.1	12.2	5.8	20.4	46	-25.6
457.5	near	floor	30.6	27.4	16.7	7.2	27.1	46	-18.9
636	noise	floor	29.3	26.9	19.6	8.3	30.3	46	-15.7
833	noise	floor	28.9	26.2	21.9	9.5	34.1	46	-11.9
933	noise	floor	28	26.4	22.8	10.1	34.6	46	-11.4

Test Technician: Jesse Banda

Microwave Radiated Emissions Data Sheet
Hetronic International
MFSHL-BMTX
Harmonics

MEASUREMENT DISTANCE (m): 1 DATE: March 27, 2006
ANTENNA POLARIZATION: Horizontal PROJECT #: 06364-10
DETECTOR FUNCTION: Peak

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Measurement Distance Adjustment	Limit (dBuV/m)	Margin before averaging (dB)	Derating for averaging (dB)	Margin Average (dB)*
1830	90	1	73	33.3	26.8	0.6	67.1	10.5	64.5	2.6	20	-17.4
2745	270	1	61.6	34.9	29.5	0.6	56.9	10.5	64.5	-7.6	20	-27.6
3660	270	1	61	34.0	32.1	0.8	59.9	10.5	64.5	-4.6	20	-24.6
4575	0	1	54.1	31.8	33.5	0.8	56.6	10.5	64.5	-7.9	20	-27.9
5490	90	1	34.8	30.8	35.0	0.6	39.6	10.5	64.5	-24.9	20	-44.9
6405	180	1	37.1	30.7	35.1	1.3	42.8	10.5	64.5	-21.7	20	-41.7
7320	noise	floor	32.3	30.9	36.9	1.4	39.7	10.5	64.5	-24.8	20	-44.8
8237	noise	floor	33.1	31.3	37.5	1.4	40.7	10.5	64.5	-23.8	20	-43.8
9150	noise	floor	33.7	31.1	37.4	1.5	41.5	10.5	64.5	-23.0	20	-43.0

MEASUREMENT DISTANCE (m): 1 DATE: March 27, 2006
ANTENNA POLARIZATION: Vertical PROJECT #: 06364-10
DETECTOR FUNCTION: Peak

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Measurement Distance Adjustment	Limit (dBuV/m)	Margin before averaging (dB)	Derating for averaging (dB)	Margin Average (dB)*
1830	180	1	70.4	33.3	26.8	0.6	64.5	10.5	64.5	0.0	20	-20.0
2745	180	1	62.2	34.9	29.5	0.6	57.5	10.5	64.5	-7.0	20	-27.0
3660	270	1	60.5	34.0	32.1	0.8	59.4	10.5	64.5	-5.1	20	-25.1
4575	90	1	57	31.8	33.5	0.8	59.5	10.5	64.5	-5.0	20	-25.0
5490	270	1	33.9	30.8	35.0	0.6	38.7	10.5	64.5	-25.8	20	-45.8
6405	90	1	36.6	30.7	35.1	1.3	42.3	10.5	64.5	-22.2	20	-42.2
7320	noise	floor	32.4	30.9	36.9	1.4	39.8	10.5	64.5	-24.7	20	-44.7
8237	noise	floor	33	31.3	37.5	1.4	40.6	10.5	64.5	-23.9	20	-43.9
9150	noise	floor	33.6	31.1	37.4	1.5	41.4	10.5	64.5	-23.1	20	-43.1

*Average margin calculated/allowed transmitter duty-cycle derating.

Test Engineer: Eric Lifsey

Fundamental Radiated Emissions Data Sheet
Hetronic International
MFSHL-BMTX

MEASUREMENT DISTANCE (m): 3 DATE: April 7, 2006
ANTENNA POLARIZATION: Horizontal PROJECT #: 06364-10
DETECTOR FUNCTION: Peak

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elev. (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
915	45	2	83.6	26.3	22.7	10.1	90.1	94	-3.9
915	270	2.5	80.7	26.3	22.7	10.1	87.2	94	-6.8
915	90	2	79	26.3	22.7	10.1	85.5	94	-8.5

MEASUREMENT DISTANCE (m): 3 DATE: April 7, 2006
ANTENNA POLARIZATION: Vertical PROJECT #: 06364-10
DETECTOR FUNCTION: Peak

Freq. (MHz)	EUT Dir (Deg.)	Antenna Elev. (Meters)	Recorded Level (dBuV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
915	45	1.25	85.2	26.3	22.7	10.1	91.7	94	-2.3
915	305	1.5	84.3	26.3	22.7	10.1	90.8	94	-3.2
915	90	1.5	84.8	26.3	22.7	10.1	91.3	94	-2.7

Fundamental emissions are measured in all orthogonal orientations.

Test Engineer: Eric Lifsey

Transmit Burst Duration Datasheet
Hetronic International
MFSHL-BMTX

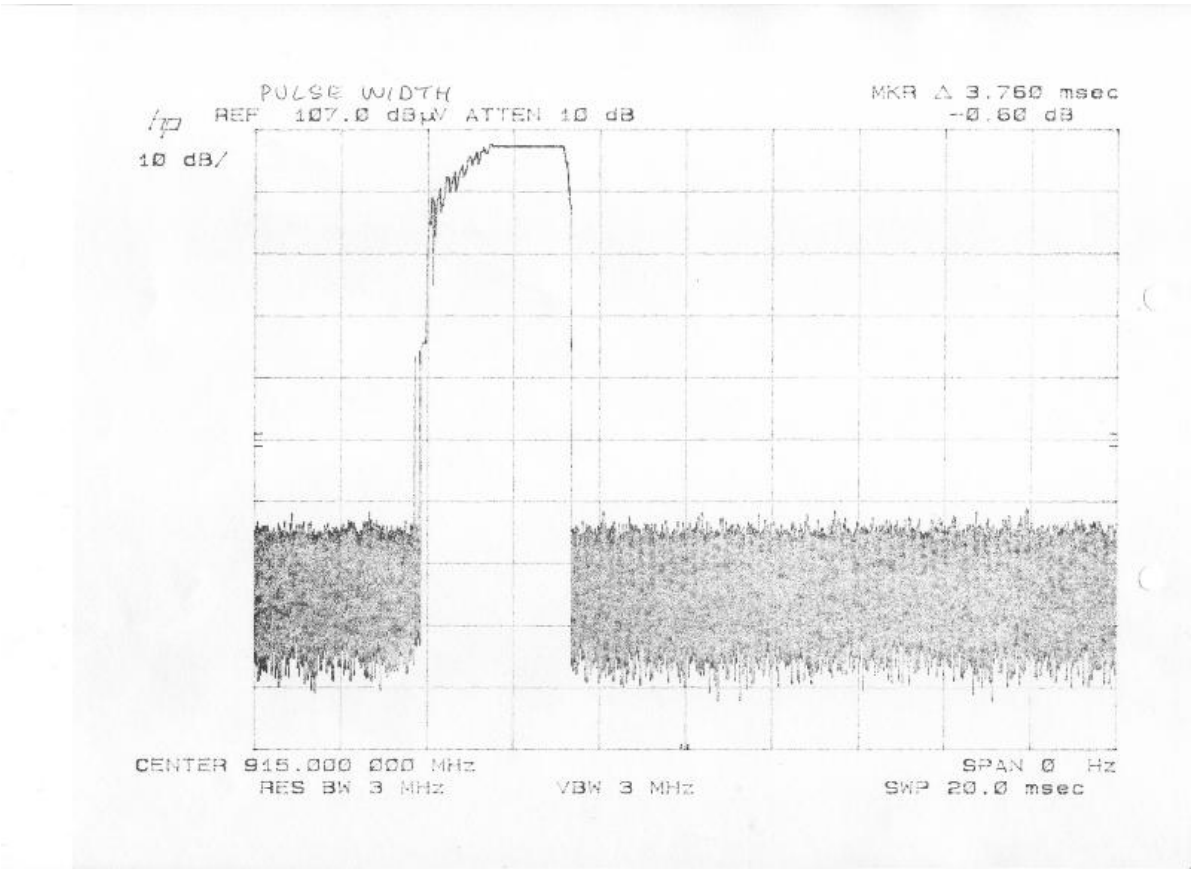
Test Date: March 27, 2006

The EUT was operated in a continuous pulsed transmit mode for this test and the measured interval, presented on the following pages, was measured over a 200 ms sweep to capture more than one pulse. The pulse period was measured as 130.6 ms. Therefore, the measured operation mode was worse-case and a plot of the burst performance was not required.

Test Engineer: Eric Lifsey

Pulse Width Datasheet
Hetronic International
MFSHL-BMTX

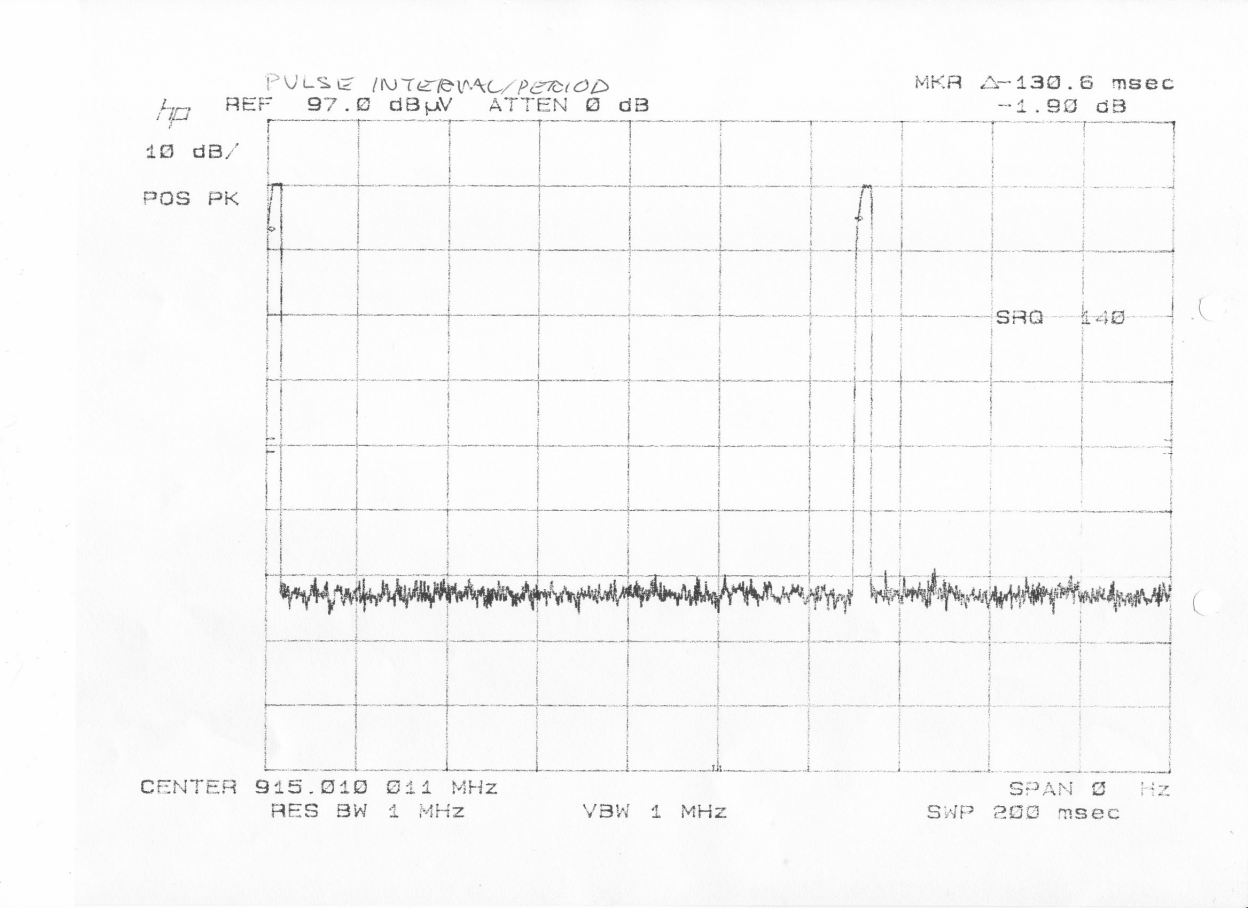
Test Date: March 27, 2006



Test Engineer: Eric Lifsey

Pulse Repetition Datasheet
Hetronic International
MFSHL-BMTX

Test Date: March 27, 2006



Test Engineer: Eric Lifsey

Duty Cycle
Timing Assessment
Calculations

Test Date: March 27, 2006

Duty Cycle

$$DutyCycle = \frac{PulseDuration}{TotalTime}$$

$$DutyCycle = \frac{3.76mS}{130.6mS} = 2.9\%$$

Peak to Average Correction

$$CorrFact = 20 * \log(DutyCycle)$$

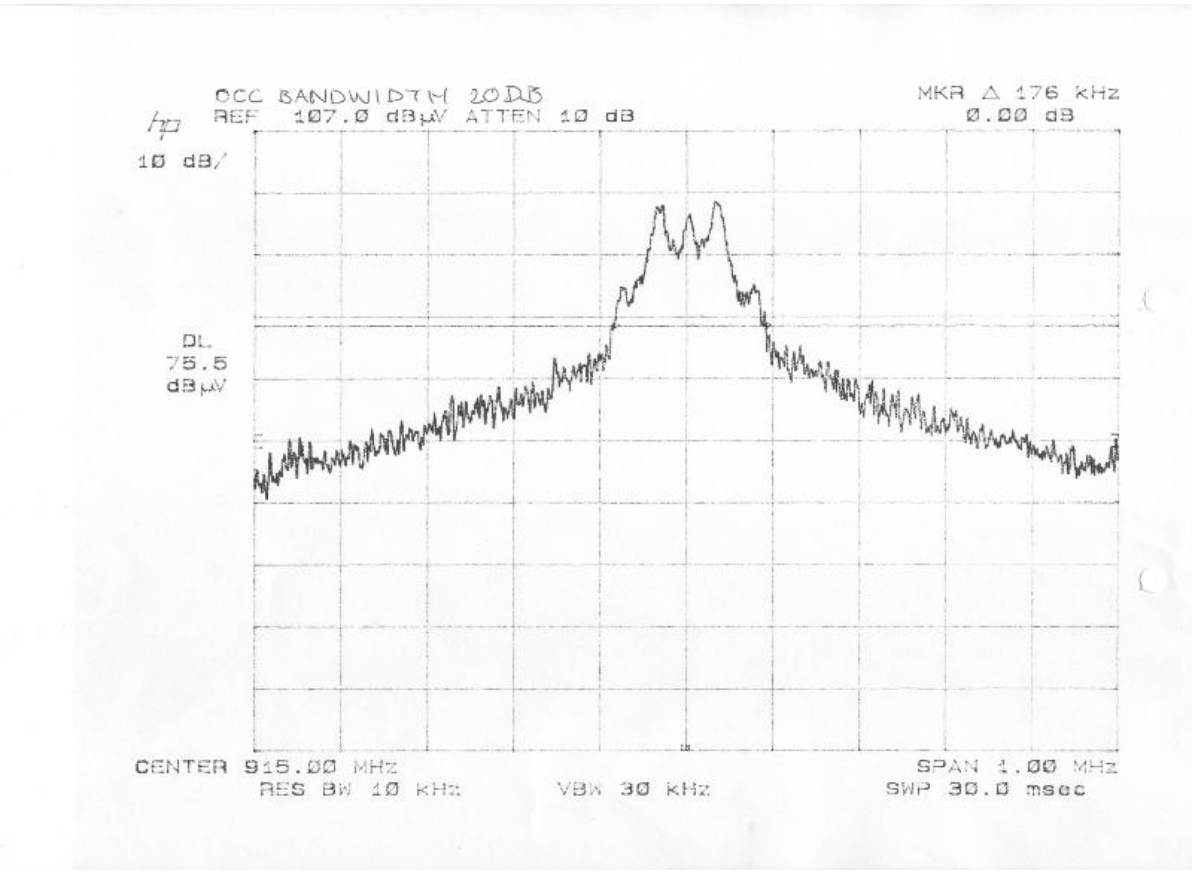
$$CorrFact = 20 * \log(.029) = -35.9dB$$

Applied Correction

Allowed Maximum of 20 dB

Occupied Bandwidth Datasheet
Hetronic International
MFSHL-BMTX

Test Date: February 20, 2006



Test Engineer: Eric Lifsey