Oklahoma City, Oklahoma

CELESTICA

OATS EMC Testing Facility

Hetronic International

MFS-A-1

Radiated Emissions Testing

for

Periodic Intentional Radiator under Part 15.249 of FCC Rules and Regulations

FCC ID: LW9-MFS-A-1

Submitted on this date

February 4, 2002

Tester Signature: _____Date: _____
Typed Name: Ramon Jordan – Test Engineer for Celestica

Acknowledgements

I wish to thank Mike Malherbe of Hetronic International for his engineering support during the testing period of January 7, 2002.

Table of Contents

List of Tables

List of Illustrations

Oklahoma City, Oklahoma OATS EMC Testing Facility **Date: February 4, 2002**

Subject: FCC Testing of the Hetronic MFS-A-1

From: OATS EMC Testing Facility
Organization OK4420
(405) 491-4061
Report No.: 2002February4-MFS-A-1

FINAL REPORT

General Statement

1.0 Statement of Test Results for Hetronic International MFS-A-1

The Hetronic MFS-A-1 tested at the OATS EMC Testing Facility was found to be in compliance with FCC Part 15.249 Periodic Intentional Radiator.

Tester Signature: _____Date: _____
Typed Name: Ramon J. Jordan – Test Engineer for Celestica

General Information

2.0 Product Description

The Hetronic MFS-A-1 is a transmitter used for sending remote control signals for several industrial application. The module is battery powered and incorporated into a small case containing multiple buttons. The unit transmits for 1.5ms within 75ms period once a button is depressed. Once the button is released the transmitter ceases transmission automatically after 2s.

The Hetronic MFS-A-1 contains a 3.686MHz oscillator.

2.1 Related Submittal(s)/Grant(s)

This is the only submittal known for this product and is being submitted to the FCC at this time for Certification of this product line under FCC part 15.249.

FCC ID: LW9-MFS-A-1

2.2 Tested System Details

See section *4.3 Configuration of Tested System*

2.3 Test Methodology

All tests were performed in accordance with the procedures set forth in ANSI C63.4. All equipment was set up for measuring under Part15.249 of FCC intentional radiator testing as shown in *Figure 4-1, Figure 4-2, Figure 4-3* and *Figure 4-4* below.

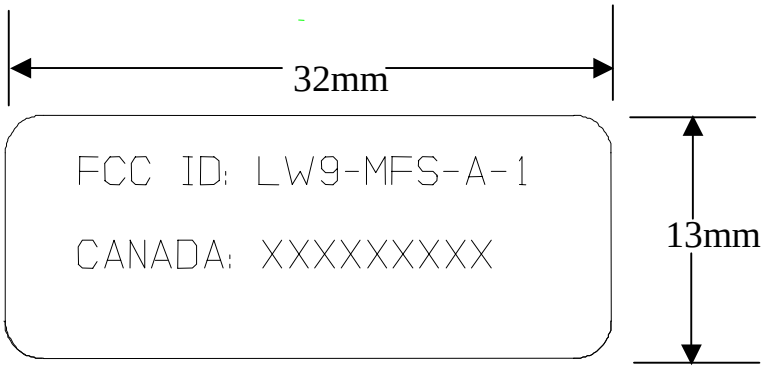
2.4 Testing Facility

Radiated emissions measurements was preformed on a Hetronic MFS-A-1 at the Oklahoma City, Oklahoma OATS EMC Testing Facility, for the purpose of determining compliance with Periodic Intentional Radiation under Part 15.249 of the FCC Rules and Regulations. The FCC file number for the OATS is 90771, dated 1, 1999 in compliance with ANSI C63.4. In addition, the OATS has a Competent Test Body Association with Technology International Inc. (UK), Certificate Number 99-041. The equipment under test (EUT) MFS-A-1 was factory assembled and tested. Testing was conducted January 7, 2002.

Labeling

3.0 Product Labeling

Labeling of the EUT applies to this product line and is shown below and will be applied to the back of the MFS-A-1 upon certification by the FCC.



System Test Configuration

4.0 Justification

Performance verification was accomplished reviewing the Hetronic MFS-RX-T8 radio remote receiver

4.1 Special Accessories

No special accessories were used with the Hetronic MFS-A-1 during the EMC tests. The Hetronic MFS-A-1 was placed on continuous transmission mode by grounding pin 13 of IC 2.

4.2 Equipment Modifications

No modifications were made to the EUT during FCC compliance testing.

Signature: _____Date: _____
Typed Name: Erich Kantsperger – V.P. Research and Development for Hetronic International

4.3 Configuration of Tested System

The Hetronic MFS-A-1 was configured for continuous transmission.

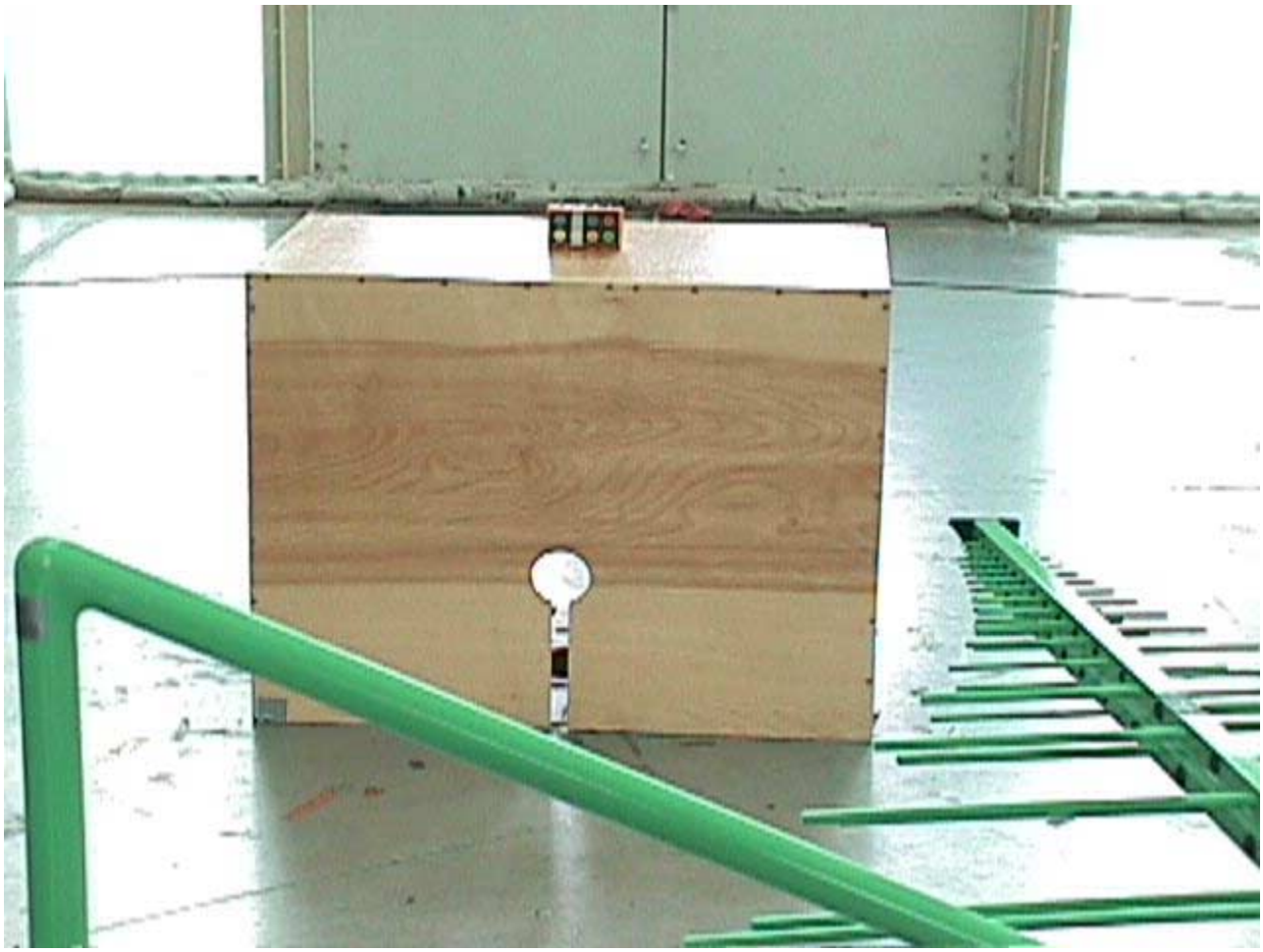


Figure 4-1: Horizontal position of the Hetronic MFS-A-1

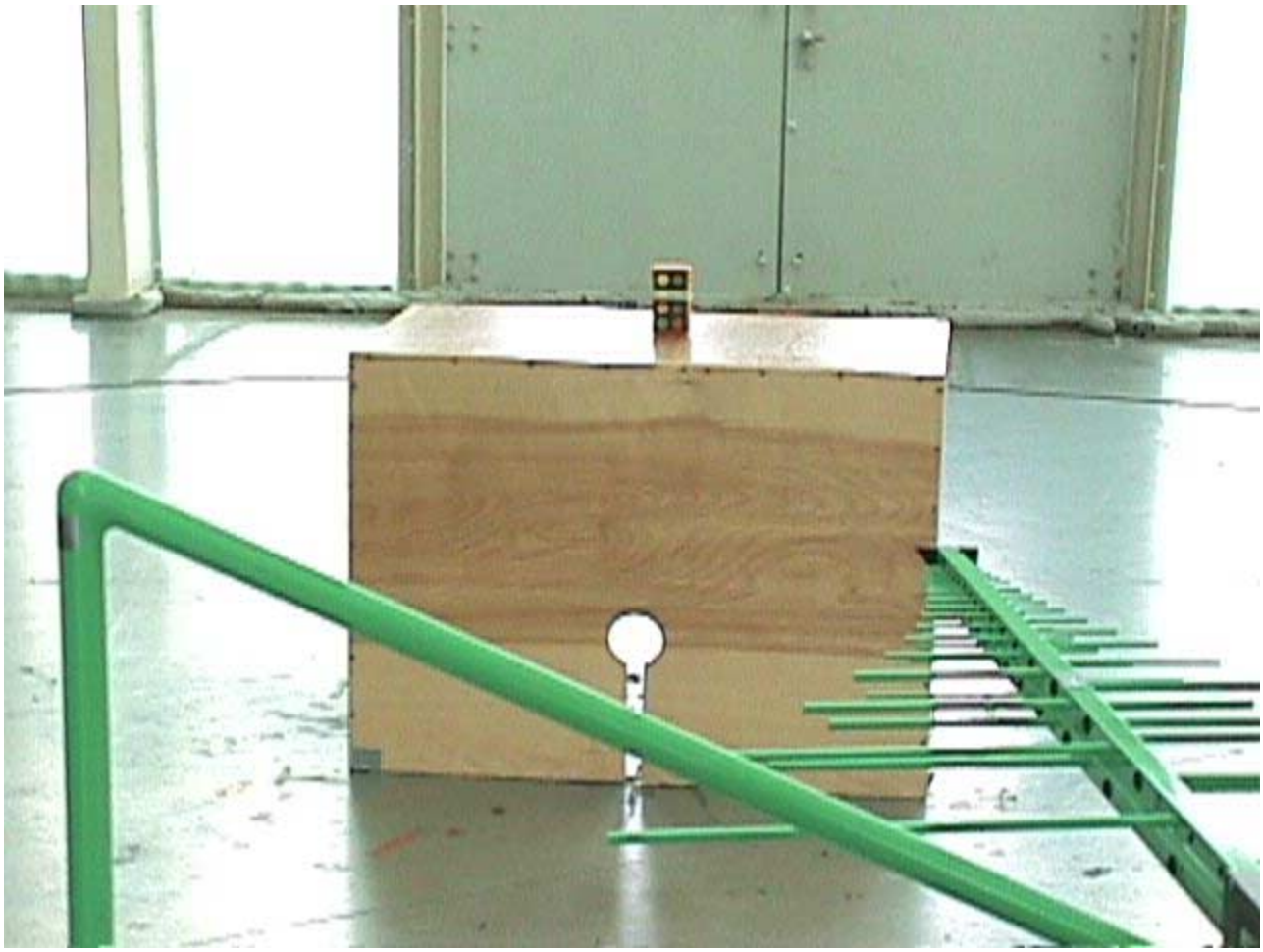


Figure 4-2: Vertical position of the Hetronic MFS-A-1

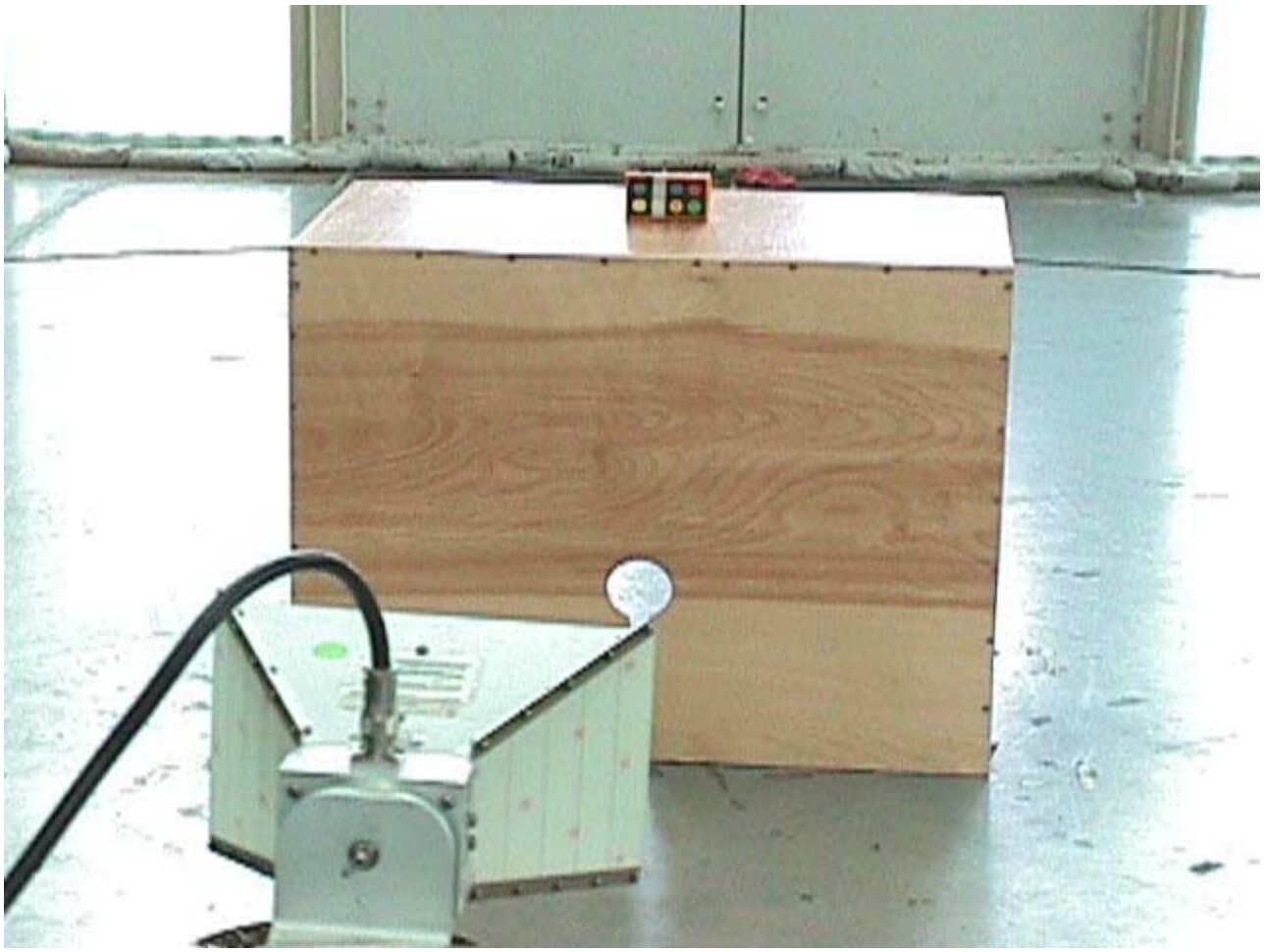


Figure 4-3: Test Setup for the Hetronic MFS-A-1 (From the antenna)

Figure 4-4: Test Setup for the Hetronic MFS-A-1 (From back of EUT)

Radiated Emissions Testing

5.0 Radiated emission data

The following data table lists the significant emissions frequencies, antenna polarity, measured levels and the limits. The limits are listed for FCC Part 15.249.

Judgment: Passed FCC Part 15.249.

Frequency	Polarity	Azimuth	Antenna	Measured	E-Filed	Limit	Margin
MHZ	H/V	Degree	Height M	QP/AVG dBuV	uV/m	uV/m	dB
916.613	H	162	1	92.40	41686.9383	50000	-1.5794
916.613	V	135	1	77.20	7244.3596	50000	-16.7794
1833.226	H	45	1	50.26	325.8367	500	-3.7194
1833.226	V	180	1	42.07	126.9112	500	-11.9094
2749.839	H	270	1	45.92	197.6970	500	-8.0594
2749.839	V	0	1	41.30	116.1449	500	-12.6794
3666.452	H	135	1	41.12	113.7627	500	-12.8594
3666.452	V	0	1	40.73	108.7677	500	-13.2494
4583.065	H	325	1	41.89	124.3083	500	-12.0894
4583.065	V	45	1	40.68	108.1434	500	-13.2994
5499.678	H	270	1	41.87	124.0224	500	-12.1094
5499.678	V	90	1	41.45	118.1680	500	-12.5294
6416.291	H	90	1	42.85	138.8353	500	-11.1294
6416.291	V	45	1	42.56	134.2765	500	-11.4194
7332.906	H	270	1	48.32	260.6154	500	-5.6594
7332.906	V	45	1	48.26	258.8213	500	-5.7194
8249.517	H	270	1	48.09	253.8049	500	-5.8894
8249.517	V	0	1	48.09	253.8049	500	-5.8894
9166.13	H	90	1	47.66	241.5461	500	-6.3194
9166.13	V	0	1	47.84	246.6039	500	-6.1394

Note: Measurements above 1 GHz are average levels.

Table 5-1: Radiated Emissions Data for Hetronic MFS-A-1 horizontal position.

Frequency	Polarity	Azimuth	Antenna	Measured	E-Filed	Limit	Margin
MHZ	H/V	Degree	Height M	QP/AVG dBuV	uV/m	uV/m	dB
916.613	H	280	1	79.80	9772.3722	50000	-14.1794
916.613	V	100	1	91.20	36307.8055	50000	-2.7794
1833.226	H	325	1	48.25	258.5235	500	-5.7294
1833.226	V	325	1	47.04	224.9055	500	-6.9394
2749.839	H	180	1	43.34	146.8926	500	-10.6394
2749.839	V	180	1	41.60	120.2264	500	-12.3794
3666.452	H	180	1	41.39	117.3546	500	-12.5894
3666.452	V	225	1	40.76	109.1440	500	-13.2194
4583.065	H	180	1	41.02	112.4605	500	-12.9594
4583.065	V	135	1	40.62	107.3989	500	-13.3594
5499.678	H	325	1	41.39	117.3546	500	-12.5894
5499.678	V	0	1	41.89	124.3083	500	-12.0894
6416.291	H	45	1	42.57	134.4312	500	-11.4094
6416.291	V	135	1	42.13	127.7909	500	-11.8494
7332.906	H	325	1	48.23	257.9289	500	-5.7494
7332.906	V	135	1	48.32	260.6154	500	-5.6594
8249.517	H	270	1	48.35	261.5170	500	-5.6294
8249.517	V	270	1	48.04	252.3481	500	-5.9394
9166.13	H	45	1	48.02	251.7677	500	-5.9594
9166.13	V	270	1	47.94	249.4595	500	-6.0394

Note: Measurements above 1 GHz are average levels.

Table 5-2: Radiated Emissions Data for Hetronic MFS-A-1 vertical position.

5.1 Radiated Emissions Testing Procedures

The adopted test procedure is intended to provide emission levels at the lowest level radio frequency signal generated in the device up to at least the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower. An in-depth investigation was conducted to identify and accurately measure the worst case system related emission levels.

The levels of emission was measured up to 1GHz using a biconical antenna connected to the input of a receiver. For emissions greater than 1 GHz, a horn antenna connected to the input of a spectrum analyzer was used. The receivers were set to quasi-peak or peak, as appropriate. The measurement bandwidth was set to 120kHz. Quasi-peak measurements were taken for frequencies below 1 GHz. For all other measurements above 1 GHz measurements are average levels.

The EUT was tested with the antenna laying flat on the test table (horizontal) and in vertical orientation. The EUT was placed on an 3 meter table on a non-conductive motorized turntable. The antenna was placed 3 meters from the EUT. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Biconical antenna was mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. Both the horizontal and vertical field components were measured.

The voltage measured by the receiver/spectrum analyzer is corrected to account for the amplification of the pre-amplifier used to amplify the signal from the antenna and for the cable attenuation of the cable between the antenna and the pre-amplifier. The corrected voltage level is converted to the electric field intensity at the measuring antenna by using the appropriate antenna factors. The antenna factors are obtained from antenna calibration measurements using the three-antenna method and also by comparing to a National Bureau of Standards calibrated tuned dipole antenna set. The basic equation for these corrections, along with a sample calculation, as shown below:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength (dB V/m), RA = Voltage at the input to the pre-amplifier (dBV), AF = Antenna Factor (dB/m), CF = Cable Attenuation Factor (dB) and AG = Pre-Amplifier Gain (dB).

5.2 Radiated emissions photographs

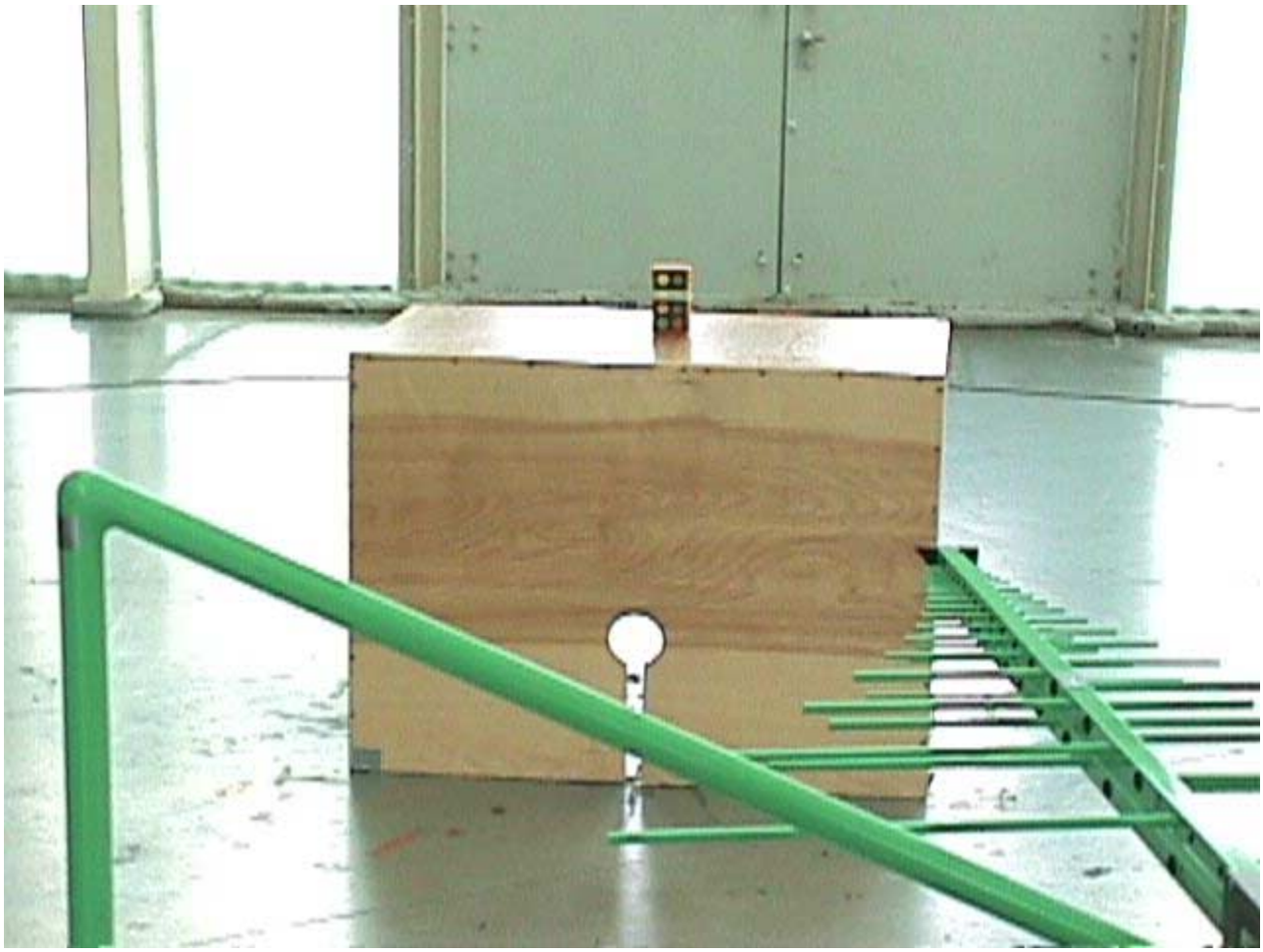


Figure 5-1: Current Test Setup for Hetronic MFS-A-1 vertical position Antenna in the horizontal position. (Front - From Antenna)

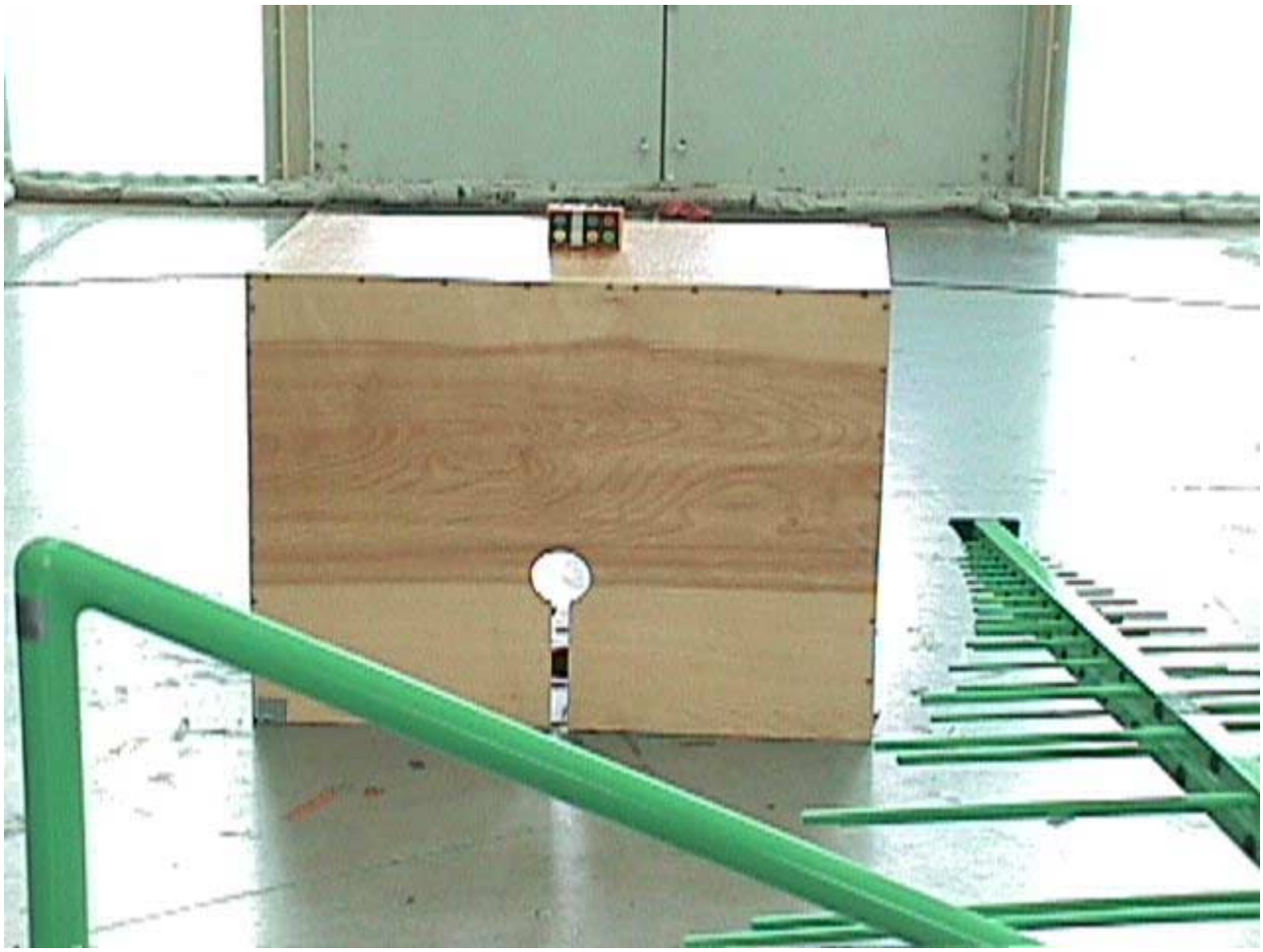


Figure 5-2: Current Test Setup for Hetronic MFS-A-1 horizontal position. Antenna in the horizontal position.(Front - From Antenna)

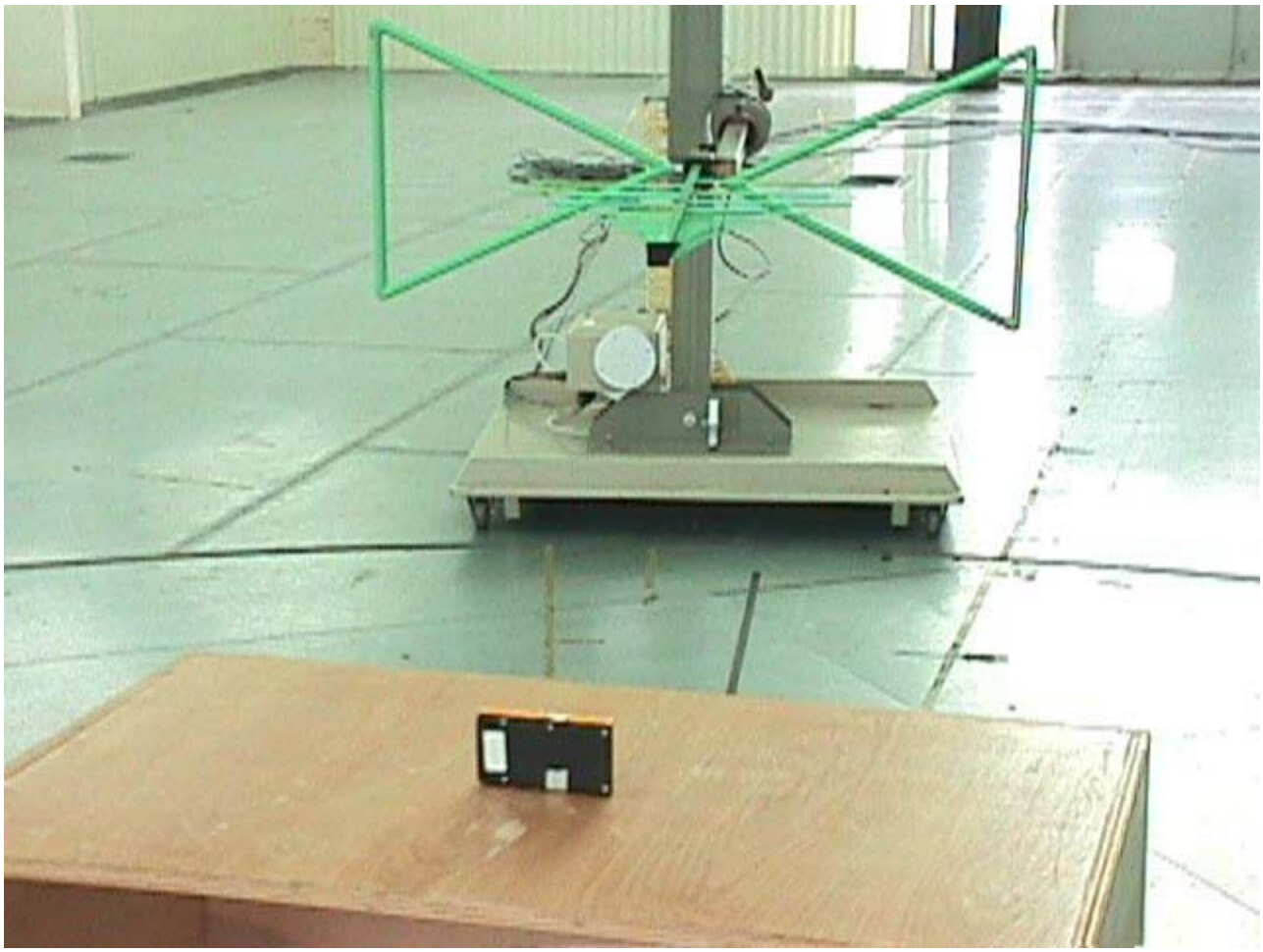


Figure 5-3: Current Test Setup for Hetronic MFS-A-1 horizontal position. Antenna in the horizontal position. (From back of EUT)

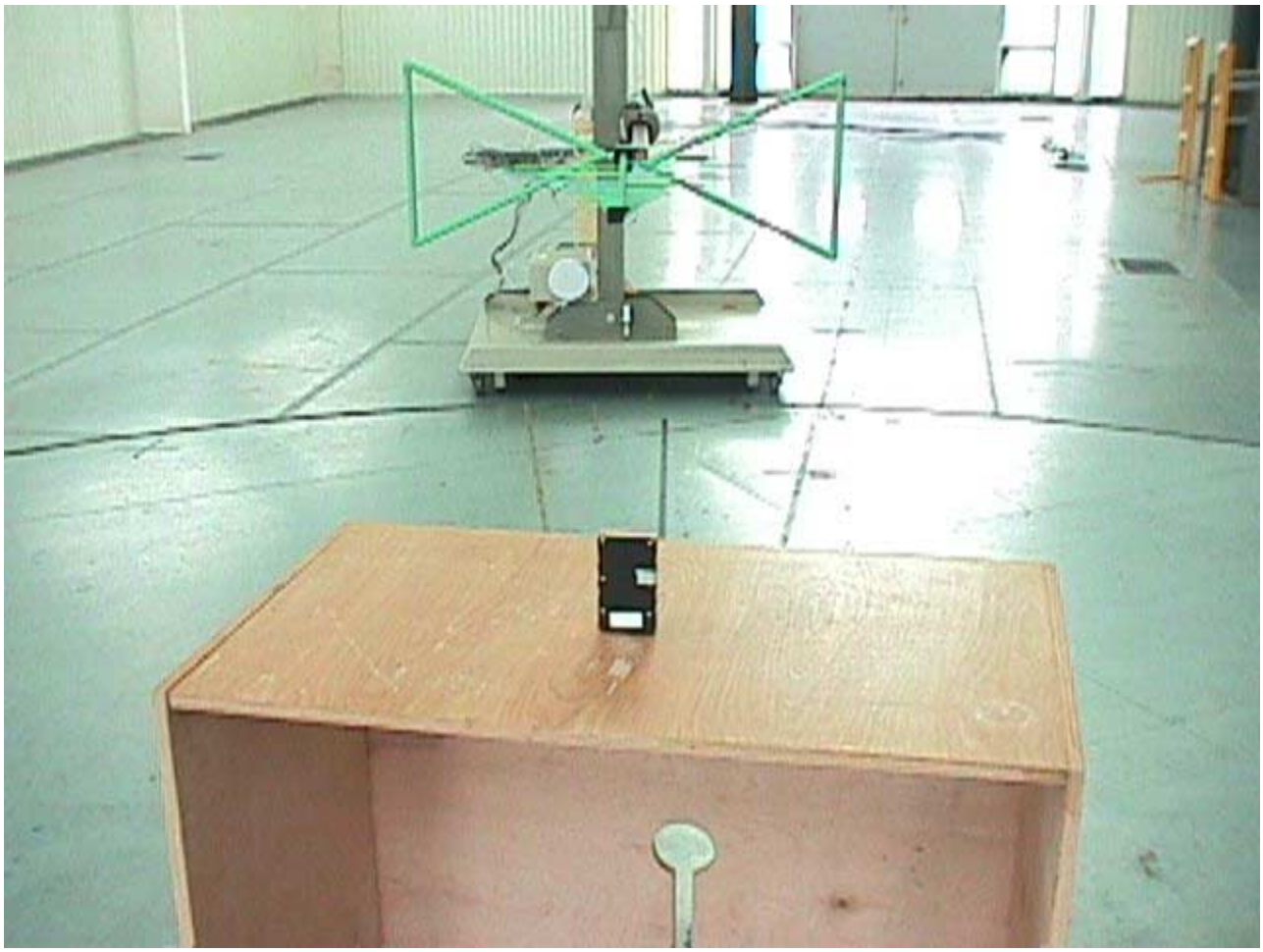


Figure 5-4: Current Test Setup for Hetronic MFS-A-1 vertical position.Antenna in the horizontal position. (From back of EUT)

Figure 5-5: Current Test Setup for Hetronic MFS-A-1 horizontal position. Antenna in the horizontal position. (From back of EUT)

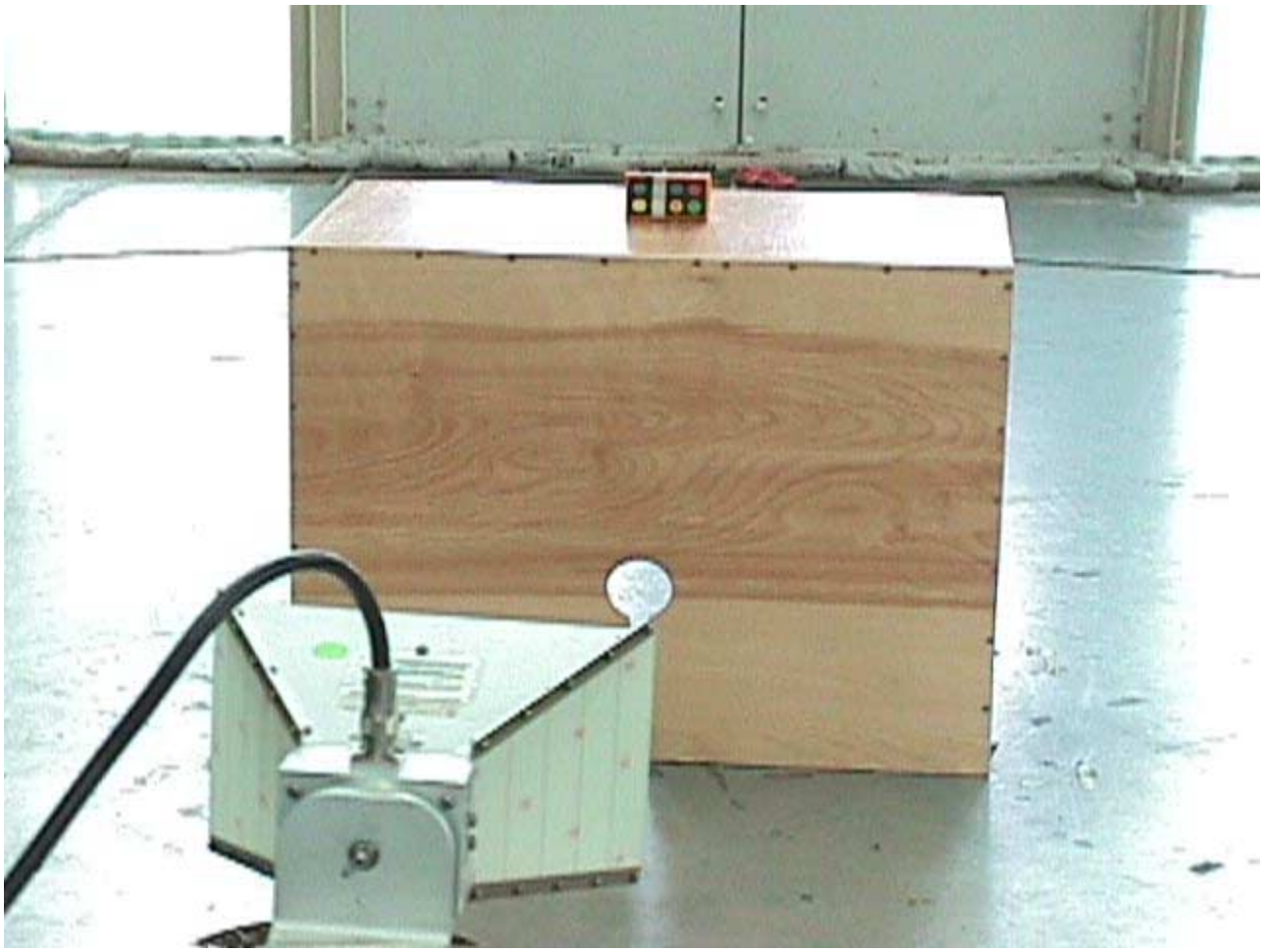


Figure 5-6: Current Test Setup for Hetronic MFS-A-1 horizontal position. Antenna in the horizontal position. (Front - From Antenna)

Figure 5-7: Current Test Setup for Hetronic MFS-A-1 vertical position. Antenna in the horizontal position. (From back of EUT)

Appendix A

A.1 EMC Testing Standards and Specifications

A list of applicable standards and specifications used in the EMC testing of the Hetronic MFS-A-1.

- Federal Communications Commission Part 15.249

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A.2 Limit Data

The following are the limits used for testing the Hetronic MFS-A-1.
as shown below.

FCC Part 15.249		
Radiated Emissions Test Limits		
3m distance		
Fundamental Frequency	Field Strength	Field Strength
	of fundamental	of harmonics
	(millivolts/meter)	(microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 Mhz	50	500
24.0-24.25 GHz	250	2500

Appendix A-2: FCC Limits Used for Testing the Hetronic MFS-A-1.

A.3 Calibration Data

The following is a list of test equipment used in the EMC testing of the Hetronic MFS-A-1 containing the calibration dates as shown below.

Serial Number	Description	Calibration Interval	Last Calibration Date	Next Calibration date	Used
US39010156	HP-E4407B Spectrum Analyzer	Annually	10/26/2001	10/26/2002	Yes
883580/009	Rohde & Schwarz - EZM Monitor	Annually	12/14/2001	12/14/2002	Yes
892661/025	Rohde & Schwarz - ESVP Receiver	Annually	12/14/2001	12/14/2002	Yes
893517/020	Rohde & Schwarz - ESH3 Receiver	Annually	12/14/2001	12/14/2002	No
96OC8514-1-001	Chase - BILOG Antenna	Two Years	08/12/2000	08/12/2002	Yes
4215	EMCO- 3115 Horn Antenna	Two Years	12/17/2001	12/17/2003	Yes

Appendix A-3: Equipment List and Calibration Data

A.4 Abstract

The issue of electromagnetic compatibility (EMC) is concerned with the generation, transmission and reception of electromagnetic energy. These three aspects of the EMC problem form the basis framework of any EMC design. A system is electromagnetically compatible if it satisfies three criteria. The first of these criteria states that the system under test does not cause interference with other systems. The second is that it is not susceptible to emissions from other systems. The third criterion is that it does not cause interference with itself

EMC has become a problem that almost all designers of electronic or electrical circuits and systems have to face because of its extreme industrial importance. Designing for EMC is not only important for the desired functional performance, but the devices must also meet legal requirements in virtually all countries before they can be sold. In today's digital design environment, EMC engineering plays an important role in bringing digital electronic products to the market. Often functional performance of a product is not the primary problem in meeting product introduction schedules. Passing the required EMC testing as required by the various regulatory agencies of different countries is often the limiting factor.

The Oklahoma City, Oklahoma OATS EMC Facility is a certified test site (FCC Test Firm Registration Number 90771), whose testing and EMC mitigation expertise allows companies to test their products, meet legal requirements and bring their products to the market. *The OATS EMC Facility is pleased to provide this report validating Hetronic MFS-A-1 to be in compliance with Part 15.249 of FCC rules and regulations.*

A.5 List of Abbreviations

AC – Alternating Current

ASCII – American Standard Code for Information Interchange

AM – Amplitude Modulation

ANSI – American National Standards Institute

BJT – Bipolar-Junction Transistors

CDN – Coupler/Decoupler Networks

CISPR – International Special Committee on Radio Interference

CMOS – Complementary Metal-Oxide Semiconductor

dB - Decibels

DC – Direct Current

DSP – Digital Signal Processing

ECL – Emitter-Coupled Logic

EFT - Electrical Fast Transient

EMC – Electromagnetic Compatibility

EMF – Electromagnetic Force

EMI – Electromagnetic Interference

EN – Norme Européenne (European Standard)

ESD – Electrostatic Discharge

ESL – Equivalent Series Inductance

ESR – Equivalent Series Resistance

EU – European Union

EUT – Equipment Under Test

FCC – Federal Communications Commission

FET – Field-Effect Transistors

GHz – Giga-Hertz

GPIB - General Purpose Instrument Bus

IC – Integrated Circuits

IEEE – Institute of Electrical and Electronic Engineers

LISN - Line impedance stabilization network

MHz – Mega-Hertz

MOSFET – Metal-Oxide Semiconductor Field-Effect Transistors

MSI – Medium-Scale Integration

nH – Nano-Henry

OATS – Open Area Test Site

ODBC – Open database connectivity

OLE 2.0 - Object Linking and Embedding

PC – Personal Computer

PCB – Printed Circuit Board

pF – Pico-Farads

RF – Radio Frequency

SSI – Small-Scale Integration

TDM - Time Division Multiplexing

TILE - Total Integrated Laboratory Environment

TTL – Transistor-transistor logic

UK – United Kingdom

USA – United States of America