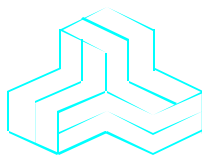


# ENGINEERING TEST REPORT



## Wireless Data Transfer Option Model No.: PX3

**FCC ID: HC8-901-1700-000**

*Applicant:*     **Digital Recorders, Inc.**  
4018 Patriot Dr.  
One Park Center, Suite 100  
P.O. Box 14068  
Research Triangle Park, NC 27709-4068  
USA

*In Accordance With*

**FEDERAL COMMUNICATIONS COMMISSION (FCC)  
PART 15, SUBPART C, SECTION 15.247  
Frequency Hopping Spread Spectrum Transmitters Operating in  
the Frequency Band 2402 - 2478 MHz**

**UltraTech's File No.: DIR1-FTX**

This Test report is Issued under the  
Authority of  
Tri M. Luu, Professional Engineer,  
Vice President of Engineering  
UltraTech Group of Labs



Date: September 4, 2001

Report Prepared by: Dan Huynh

Tested by: Hung Trinh, RFI/EMI Technician

Issued Date: September 4, 2001

Test Dates: August 1 & 31, 2001

*The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*

## UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4  
Telephone (905) 829-1570     Facsimile (905) 829-8050  
Website: [www.ultrat4ech-labs.com](http://www.ultrat4ech-labs.com)     Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca)

## TABLE OF CONTENTS

<b>EXHIBIT 1.</b>	<b>SUBMITTAL CHECK LIST.....</b>	<b>1</b>
<b>EXHIBIT 2.</b>	<b>INTRODUCTION .....</b>	<b>2</b>
2.1.	SCOPE.....	2
2.2.	RELATED SUBMITTAL(S)/GRANT(S) .....	2
2.3.	NORMATIVE REFERENCES.....	2
<b>EXHIBIT 3.</b>	<b>PERFORMANCE ASSESSMENT .....</b>	<b>3</b>
3.1.	CLIENT INFORMATION .....	3
3.2.	EQUIPMENT UNDER TEST (EUT) INFORMATION .....	3
3.3.	EUT'S TECHNICAL SPECIFICATIONS.....	4
3.4.	LIST OF EUT'S PORTS.....	5
3.5.	ANCILLARY EQUIPMENT .....	5
<b>EXHIBIT 4.</b>	<b>EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS .....</b>	<b>6</b>
4.1.	CLIMATE TEST CONDITIONS.....	6
4.2.	OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST S.....	6
<b>EXHIBIT 5.</b>	<b>SUMMARY OF TEST RESULTS.....</b>	<b>7</b>
5.1.	LOCATION OF TESTS.....	7
5.2.	APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS.....	7
5.3.	MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES.....	7
<b>EXHIBIT 6.</b>	<b>MEASUREMENTS, EXAMINATIONS &amp; TEST DATA FOR EMC EMISSIONS .....</b>	<b>8</b>
6.1.	TEST PROCEDURES.....	8
6.2.	MEASUREMENT UNCERTAINTIES.....	8
6.3.	MEASUREMENT EQUIPMENT USED:.....	8
6.4.	ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER.....	8
6.5.	AC POWERLINE CONDUCT ED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.207(A).....	9
6.5.1.	<i>Limits</i> .....	9
6.5.2.	<i>Method of Measurements</i> .....	9
6.5.3.	<i>Test Arrangement</i> .....	9
6.5.4.	<i>Test Equipment List</i> .....	10
6.5.5.	<i>Test Data</i> .....	10
6.6.	PEAK OUTPUT POWER & EFFECTIVE RADIATED POWER (ERP) @ FCC 15.247(B).....	13
6.6.1.	<i>Limits</i> .....	13
6.6.2.	<i>Method of Measurements</i> .....	13
6.6.3.	<i>Test Arrangement</i> .....	13
6.6.4.	<i>Test Equipment List</i> .....	14
6.6.5.	<i>Test Data</i> .....	14
6.7.	RF EXPOSURE REQUIREMENTS @ FCC 15.247(B)(4), 1.1310 & 2.1091 .....	15
6.7.1.	<i>Limits</i> .....	15
6.7.2.	<i>Method of Measurements</i> .....	15
6.7.3.	<i>Test Data</i> .....	16
6.8.	TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205 .....	17

### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

6.8.1.	<i>Limits</i> .....	17
6.8.2.	<i>Method of Measurements</i> .....	18
6.8.3.	<i>Test Arrangement</i> .....	18
6.8.4.	<i>Test Equipment List</i> .....	19
6.8.5.	<i>Test Data</i> .....	19
<b>EXHIBIT 7.</b>	<b>MEASUREMENT UNCERTAINTY</b> .....	<b>20</b>
7.1.	LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY.....	20
7.2.	RADIATED EMISSION MEASUREMENT UNCERTAINTY .....	21
<b>EXHIBIT 8.</b>	<b>MEASUREMENT METHODS</b> .....	<b>22</b>
8.1.	GENERAL TEST CONDITIONS.....	22
8.1.1.	<i>Normal temperature and humidity</i> .....	22
8.1.2.	<i>Normal power source</i> .....	22
8.1.3.	<i>Operating Condition of Equipment under Test</i> .....	22
8.2.	AC MAINS CONDUCTED EMISSIONS.....	23
8.3.	EFFECTIVE RADIATED POWER.....	24
8.4.	SPURIOUS EMISSIONS (CONDUCTED & RADIATED).....	27
8.4.1.	<i>Band-Edge and Spurious Emissions (Conducted)</i> .....	27
8.4.2.	<i>Spurious Emissions (Radiated)</i> .....	28
8.5.	ALTERNATIVE TEST PROCEDURES.....	30
8.5.1.	<i>Peak Power Measurements</i> .....	30
8.5.2.	<i>Spurious RF conducted emissions</i> .....	30

**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vhk.ultratech@sympatico.ca](mailto:vhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX

September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	<ul style="list-style-type: none"> <li>Exhibit 1: Submittal check lists</li> <li>Exhibit 2: Introduction</li> <li>Exhibit 3: Performance Assessment</li> <li>Exhibit 4: EUT Operation and Configuration during Tests</li> <li>Exhibit 5: Summary of test Results</li> <li>Exhibit 6: Measurement Data</li> <li>Exhibit 7: Measurement Uncertainty</li> <li>Exhibit 8: Measurement Methods</li> </ul>	OK
1	Test Data Plots (AeroComm Test Report)	<ul style="list-style-type: none"> <li>Exhibit 9A: 20 dB Occupied Bandwidth/Time Occupancy (plots # 1 to 4)</li> <li>Exhibit 9B: Transmitter Antenna Power Conducted Emissions (plots # 5 to 13)</li> </ul>	OK
2	Test Setup Photos	<ul style="list-style-type: none"> <li>AC Powerline Conducted Emissions</li> <li>Radiated Emissions Test Setup Photos</li> </ul>	OK
3	External EUT Photos	PX3 External Photos	OK
4	Internal EUT Photos	PX3 Internal Photos	OK
5	Cover Letters	<ul style="list-style-type: none"> <li>Letter from Ultratech for Certification Request</li> <li>Letter from the Applicant to appoint Ultratech to act as an agent</li> <li>Letter from the Applicant to request for Confidentiality Filing</li> <li>Letter from AeroComm to request for Confidentiality Filing</li> </ul>	OK
6	Attestation Statements	--	--
7	ID Label/Location Info	<ul style="list-style-type: none"> <li>ID Label</li> <li>Location of ID Label</li> </ul>	OK
8	Block Diagram	AeroComm Radio Module Block Diagram	OK
9	Schematic Diagrams	<ul style="list-style-type: none"> <li>AeroComm Radio Module Schematics</li> <li>PX3 Schematics</li> </ul>	OK
10	Parts List/Tune Up Info	PKLR2400-200 Bill of Material	OK
11	Operational Description	Aerocomm PKLR2400-200 Transmitter Operation	OK
12	RF Exposure Info	Refer to user's manual	OK
13	Users Manual	Digital Recorders Wireless data Transfer Operations and Maintenance Manual	OK

### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

<b>Reference:</b>	FCC Part 15, Subpart C, Section 15.247:2000
<b>Title:</b>	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
<b>Purpose of Test:</b>	To gain FCC Certification Authorization for Frequency Hopping Spread Spectrum Transmitters operating in the Frequency Band 2402 - 2478 MHz .
<b>Test Procedures</b>	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
<b>Environmental Classification:</b>	<ul style="list-style-type: none"><li>• Light-industry, Commercial</li><li>• Industry</li></ul>

### 2.2. RELATED SUBMITTAL(S)/GRANT(S)

None

### 2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19	2000	Code of Federal Regulations – Telecommunication
ANSI C63.4	1992	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 & EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1		Specification for Radio Disturbance and Immunity measuring apparatus and methods
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

APPLICANT	
<b>Name:</b>	Digital Recorders, Inc.
<b>Address:</b>	4018 Patriot Drive One Park Center, Suite 100 P.O. Box 14068 Research Triangle Park, NC 27709-4068 USA
<b>Contact Person:</b>	Mr. Steven Halberstadt Phone #: (+1) 919-361-2155 Fax #: (+1) 919-361-2947 Email Address: <a href="mailto:steveh@digrec.com">steveh@digrec.com</a>

MANUFACTURER	
<b>Name:</b>	Digital Recorders, Inc.
<b>Address:</b>	4018 Patriot Drive One Park Center, Suite 100 P.O. Box 14068 Research Triangle Park, NC 27709-4068 USA
<b>Contact Person:</b>	Mr. Steven Halberstadt Phone #: (+1) 919-361-2155 Fax #: (+1) 919-361-2947 Email Address: <a href="mailto:steveh@digrec.com">steveh@digrec.com</a>

### 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

<b>Brand Name</b>	Digital Recorders, Inc.
<b>Product Name</b>	Wireless Data Transfer Option
<b>Model Name or Number</b>	PX3
<b>Serial Number</b>	Test Sample
<b>Type of Equipment</b>	Frequency Hopping Spread Spectrum Transmitters
<b>Input Power Supply Type</b>	9 - 32 VDC using external power supply
<b>Primary User Functions of EUT:</b>	Provide data communication link through air

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

### 3.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter Specifications	
Equipment Type:	Mobile or Base
Intended Operating Environment:	Commercial, light industry & heavy industry
RF Output Power Rating:	200 mW
Operating Frequency Range:	2402 - 2478 MHz
RF Output Impedance:	50 Ohms
Duty Cycle:	Continuous
20 dB Bandwidth:	1 MHz
Modulation Type:	FSK
Channel Occupancy:	386 ms
Channel Spacing:	1 MHz
Emission Designation:	Frequency Hopping Spread Spectrum
Spectral Density:	200 mWatts/MHz (Power output at the antenna / bandwidth of the RF output spectrum)
Antenna Connector Type:	Standard SMA connector (Professional Installation). Please refer to the User's manual for detailed instruction of antenna installation.
Antenna Description:	Manufacturer: Maxrad Type: Low profile - Vertical Model: MLPV1700 Frequency Range: 1700 – 2500 MHz In/Out Impedance: 50 Ohms Gain: 4dBi (Ground plane and frequency dependent)

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

### 3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Antenna	1	SMA	Shielded
2	P1	1	RS232	Shielded
3	P2-VLU	1	DB-15	Shielded
4	P3	1	DB-25	Shielded
5	J3-POWER	1	9 Pin Circular Connector	Non-shielded

**NOTE:**

*Ports of the EUT which in normal operation were connected to ancillary equipment through interconnecting cables via a representative interconnecting cable to simulate the input/output characteristics. RF input/output was correctly terminated to the associated antenna.*

### 3.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment #1	
Description:	DC Power Supply
Brand name:	Instek
Model Name or Number:	PS-3030
Serial Number:	9472958
Connected to EUT's Port:	J3-POWER

Ancillary Equipment #2	
Description:	Laptop
Brand name:	Hewlett Packard
Model Name or Number:	5500CS
Serial Number:	TW63403246
Connected to EUT's Port:	P2-VLU

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



## EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

### 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	120 Vac 60 Hz using AC-DC adapter (12 Vdc output)

### 4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

<b>Operating Modes:</b>	<ul style="list-style-type: none"><li>Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements.</li><li>The EUT operates in normal Frequency Hopping mode for occupancy duration, and frequency separation.</li></ul>
<b>Special Test Software:</b>	Special software is provided by the Applicant to disable the hopping function, to select and to operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
<b>Special Hardware Used:</b>	None
<b>Transmitter Test Antenna:</b>	The EUT is tested with the antenna fitted in a manner typical of normal intended use as a non-integral antenna equipment.

Transmitter Test Signals	
<b>Frequency band(s):</b> <ul style="list-style-type: none"><li>2400 - 2478 MHz</li></ul>	Lowest, middle and highest channel frequencies tested: 2402, 2440 & 2478 MHz
<b>Transmitter Wanted Output Test Signals:</b> <ul style="list-style-type: none"><li>RF Power Output (measured maximum output power):</li><li>Normal Test Modulation</li><li>Modulating signal source:</li></ul>	<ul style="list-style-type: none"><li>200 mW</li><li>FHSS</li><li>Internal</li></ul>

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## EXHIBIT 5. SUMMARY OF TEST RESULTS

### 5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Section 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: May 2, 2001.

### 5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.107(b)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	Yes
15.247(a)(1) & 15.247(a)(1)(ii)	Hopping Channel Frequency Characteristics	Yes (Note 1)
15.247(b)(2)	Peak Output Power	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes (Note 2)
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices, the associated Radio Receiver operating in 2402 - 2478 MHz is exempted from FCC authorization. The engineering test report can be provided upon FCC requests.		

Note 1: Refer to AeroComm Test Report section 6.6 and 6.7 for details.

Note 2: Refer to AeroComm Test Report section 6.10 for details.

### 5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

---

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## **EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS**

### **6.1. TEST PROCEDURES**

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report, ANSI C63-4:1992 and FCC Public Notice @ DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

### **6.2. MEASUREMENT UNCERTAINTIES**

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

### **6.3. MEASUREMENT EQUIPMENT USED:**

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C64-3:1992, FCC 15.247 and CISPR 16-1.

### **6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER**

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

---

#### **ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 6.5. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.207(a)

### 6.5.1. Limits

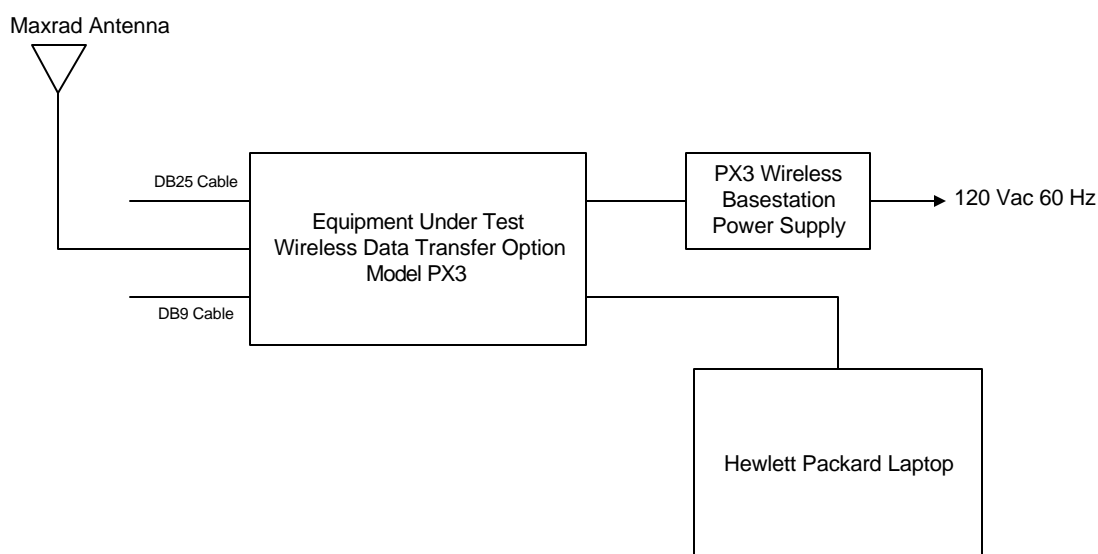
The equipment shall meet the limits of the following table:

Test Frequency Range	Test Limits	EMI Detector Used	Measuring Bandwidth
0.45 to 30 MHz	48 dB $\mu$ V	Quasi-Peak (Narrow band)	B = 10 kHz
	61 dB $\mu$ V	Quasi-Peak (Broad band)	B = 10 kHz

### 6.5.2. Method of Measurements

Refer to Exhibit 8, Section 8.2 of this test report & ANSI C63-4:1992

### 6.5.3. Test Arrangement



#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

#### 6.5.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Advantest	R3261B	91720070	9 kHz – 3.6 GHz
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 $\mu$ H
12'x16'x12' RF Shielded Chamber	RF Shielding	...	..	...

#### 6.5.5. Test Data

FREQUENCY (MHz)	RF LEVEL (dB $\mu$ V)	RECEIVER DETECTOR (P/QP/AVG)	QP/NB LIMIT (dB $\mu$ V)	QP/BB LIMIT (dB $\mu$ V)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
2.390	47.15	Peak	48.0	61.0	-0.9	PASS	L1
3.110	41.50	Peak	48.0	61.0	-6.5	PASS	L1
6.570	37.27	Peak	48.0	61.0	-10.7	PASS	L1
19.280	36.17	Peak	48.0	61.0	-11.8	PASS	L1
28.440	52.47	Peak	48.0	61.0	+4.5	PASS (see Note)	L1
2.430	46.72	Peak	48.0	61.0	-1.3	PASS	L2
3.150	42.77	Peak	48.0	61.0	-5.2	PASS	L2
5.900	38.75	Peak	48.0	61.0	-9.3	PASS	L2
19.280	35.05	Peak	48.0	61.0	-13.0	PASS	L2
28.440	53.35	Peak	48.0	61.0	+5.4	PASS (see Note)	L2
The emissions from 450 kHz to 30 MHz were scanned and all emissions within 20 dB below the limits were recorded. Refer to the following test data plots for details.							

Note: Emissions from Unintentional Radiators, it complies with FCC Class A Unintentional Radiators Limit (69.5 dB $\mu$ V). Therefore, the FCC Limit of 48 dB $\mu$ V for the intentional radiators does not apply to this emission at 28.440 MHz.

#### ULTRATECH GROUP OF LABS


3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

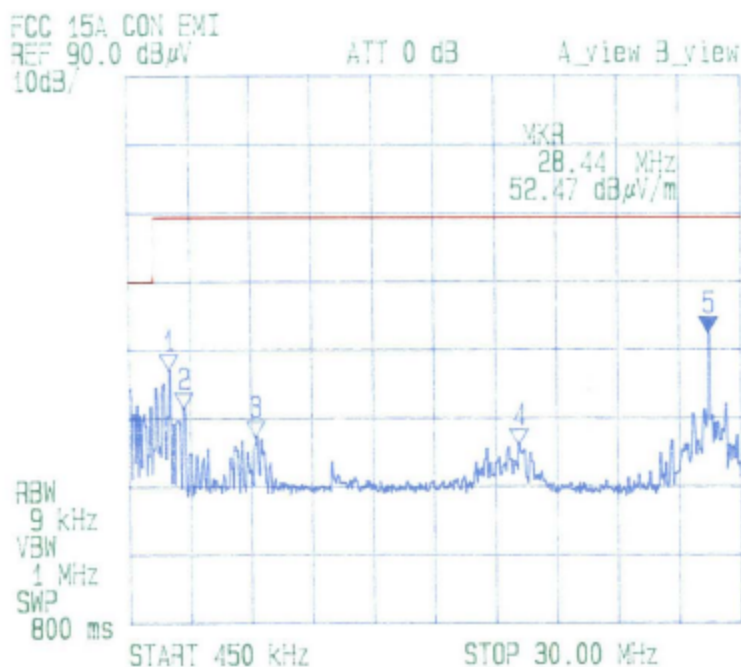
File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

**AC Powerline Conducted Emissions Test Data Plot (Line 1)**

	UltraTech Group of Labs			
	Applicant: Digital Recorder			
	Product:			
	Model:			

CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector: <input type="checkbox"/> PEAK <input type="checkbox"/> QUASI-PEAK <input type="checkbox"/> AVERAGE	Temp: 23°C	Humidity: 63%	
LINE: 1	Line Voltage: 120 VAc	Test Tech: Hung	Test Date: 31-Aug-01
Standard: FCC 15 A	Comments:		



\*\*\* MULTI MARKER LIST \*\*\*

No.	G	M	k Hz	dBμV/m	A/B
1:		2	390 000	47.15	A
2:		3	110 000	41.50	A
3:		6	570 000	37.27	A
4:		19	280 000	36.17	A
5:		28	440 000	52.47	A
6:					
7:					
8:					

**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

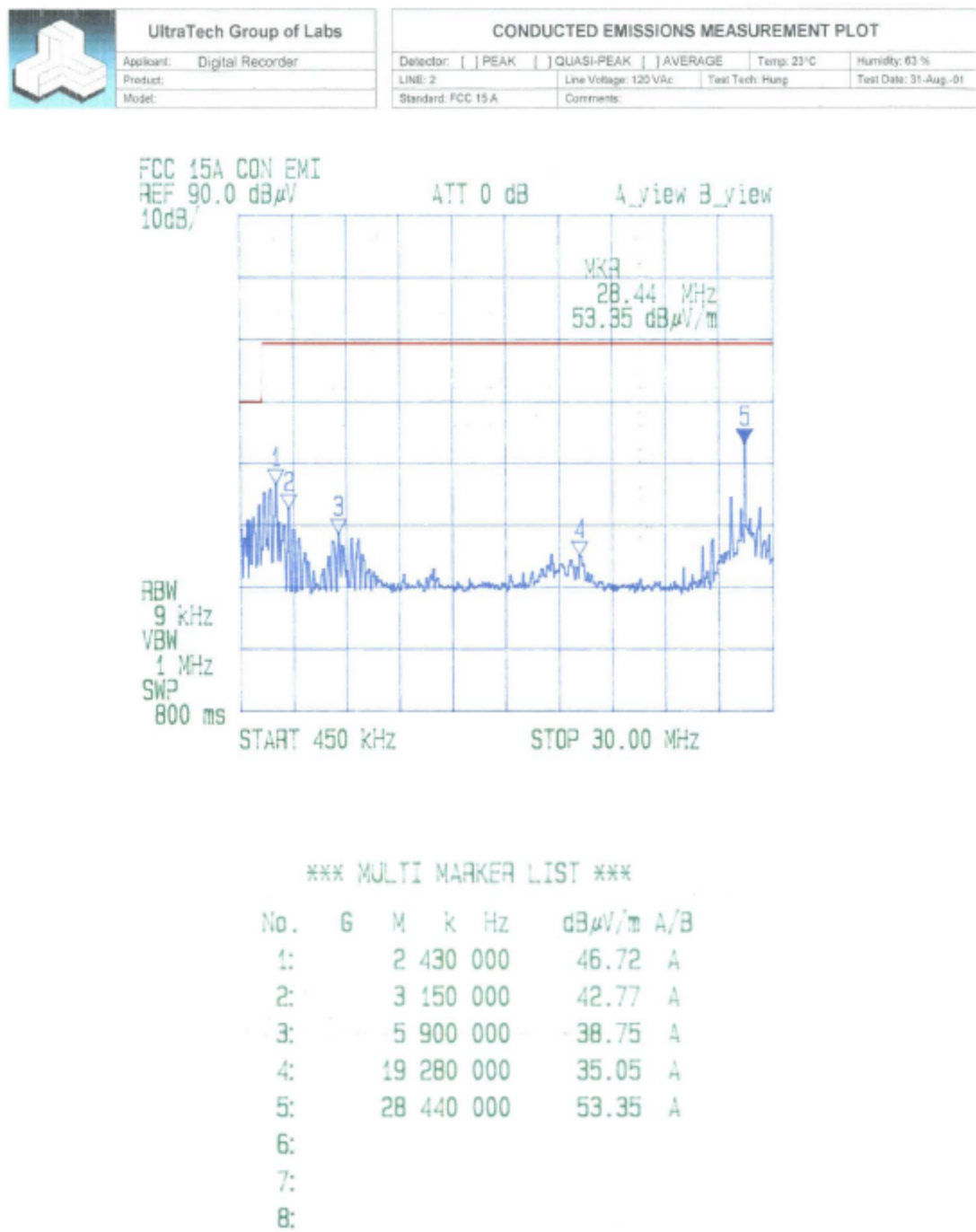
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX

September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

AC Powerline Conducted Emissions Test Data Plot (Line 2)



## 6.6. PEAK OUTPUT POWER & EFFECTIVE RADIATED POWER (ERP) @ FCC 15.247(B)

### 6.6.1. Limits

- **FCC 15.247(b)(1):** Maximum peak output power of the transmitter shall not exceed 1 Watt.
- **FCC 15.247(b)(3):** If the antenna of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
- **FCC 15.247(b)(3)(i):** Systems operating in the 2402 - 2478 MHz band that are used exclusively for fixed, **point-to-point operations** may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduce by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

#### De Facto EIRP Limit

Describe how the EUT complies with the de facto EIRP limit for every antenna proposes for use with the EUT. This includes those devices that will be used in point-to-point applications. If the peak power, as measured above, must be reduced so that the de facto EIRP limit may be met for a particular antenna, described exactly how much it will be reduced for that antenna. If the minimum length of cable which will always be used, the type of cable, and its loss, in dB per unit length, for the frequency of the emission. The limit is specified in one of the subparagraphs of this section. Also, specify who will be responsible for ensuring that compliant operation is maintained for every antenna that will be used with EUT.

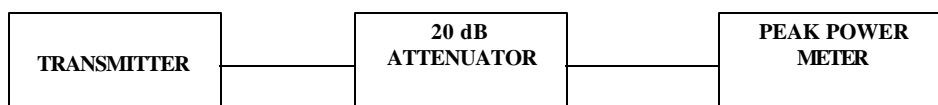
#### Point-to-Point Operation:

- If the EIRP relaxation for point-to-point operation is proposed for any particular antenna, describe who will be responsible for ensuring that the EUT is only used in such an application.
- Fixed, point-to-point operation, as used in 2400-2483.5 MHz and 5725-5850 MHz bands, excludes the use of the following:
  - Point-to-multipoint systems
  - Omnidirectional applications
  - Multiple co-located intentional radiators transmitting the same information.
- The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that *the system is used exclusively for fixed, point-to-point operations*. The instruction manual furnished with the intentional radiators shall contain language in the installation instructions informing the operator and the installer of this responsibility.

### 6.6.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this test report, FCC 15.247(b)(1)&(3), ANSI C63-4:1992

### 6.6.3. Test Arrangement



#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



#### 6.6.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Peak Power Meter & Peak Power Sensor	Hewlett Packard	8900 8481A	2131A00124 2551A01965	0.1-18 GHz 50 Ohms Input
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz

#### 6.6.5. Test Data

##### Conducted Power

Transmitter Channel Output	Fundamental Frequency (MHz)	Measured Power (mW)	Power Rating (mW)
Lowest	2402	182.0	200 mW
Middle	2440	182.0	200 mW
Highest	2478	199.5	200 mW

##### ERP Using Substitution Method

Frequency (MHz)	Peak E-Field @ 3m (dBμV/m)	Antenna Polarization (V/H)	Peak Power From Signal GEN. Ps (dBm)	Substitution Antenna Gain Gd (dBi)	Measured Peak ERP = Ps+Gd -2.15 (dBm)	Measured Peak EIRP = ERP+2.15 (dBm)
2402	118.2	V	11.5	9.9	19.3	21.4
	118.5	H	11.8	9.9	19.6	21.7
2440	115.7	V	9.4	10.0	17.3	19.4
	118.2	H	11.3	10.0	19.2	21.3
2478	115.6	V	9.6	10.1	17.5	19.7
	118.7	H	11.9	10.1	19.9	22.0

Note: The measured EIRP is less than the calculated value because of the cable loss from the transmitter's RF port to the antenna with a minimum length of 20 feet and a loss of 2.9 dB.

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 6.7. RF EXPOSURE REQUIREMENTS @ FCC 15.247(B)(4), 1.1310 & 2.1091

### 6.7.1. Limits

- **FCC 15.247(b)(4):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See @ 1.1307(b)(1).
- **FCC 1.1310:-** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

**LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Average Time (minutes)
<b>(A) Limits for Occupational/Control Exposures</b>				
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
300-1500	...	...	F/1500	6
1500-100,000	...	...	1.0	30

F = Frequency in MHz

### 6.7.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091 and Public Notice DA 00-705 (March 30, 2000)

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

- (1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
- (2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
- (3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
- (4) Any other RF exposure related issues that may affect MPE compliance

#### Calculation Method of RF Safety Distance:

$$S = PG/4\pi r^2 = EIRP/4\pi r^2$$

Where:

- P: power input to the antenna in mW
- EIRP: Equivalent (effective) isotropic radiated power.
- S: power density mW/cm<sup>2</sup>
- G: numeric gain of antenna relative to isotropic radiator
- r: distance to center of radiation in cm

$$r = \sqrt{EIRP/4\pi S}$$

#### **ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

### 6.7.3. Test Data

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	Compliance with FCC Rules
Minimum calculated separation distance between antenna and persons required: 20 cm ( <b>Note</b> )	Manufacturer' instruction for separation distance between antenna and persons required: 32 cm. Please refer to User's Manual and FCC RF Exposure folder
Antenna installation and device operating instructions for installers (certified installation technicians), and the parties responsible for ensuring compliance with the RF exposure requirement	Antenna is required to be professionally installed as specified in section 3-1 of the Manual.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	FCC RF Exposure Caution is provided in the User's Manual
Any other RF exposure related issues that may affect MPE compliance	None

Note: The minimum separation distance between the antenna and body of the user or nearby persons are calculated using the following formula:

$$\text{RF EXPOSURE DISTANCE LIMITS: } r = \sqrt{\text{EIRP}/4\pi S}$$

Where:  $S = 1.0 \text{ mW/cm}^2$  (Limits for General Population/Uncontrolled Exposure)

$\text{EIRP} = 22.0 \text{ dBm} = 158.5 \text{ mW}$  (maximum measured power)

$$\text{Minimum separation distance: } r = \sqrt{\text{EIRP}/4\pi S} = \sqrt{158.5 \text{ mW} / 4\pi (1.0 \text{ mW/cm}^2)} = 3.6 \text{ cm}$$

Per §2.1091(b) definition of mobile equipment, the minimum separation distance shall be 20 cm.

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
 September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 6.8. TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(c), 15.209 & 15.205

### 6.8.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

#### Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- @ **FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in @ **15.35** for limiting peak emissions apply.

**FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) – Restricted band of operation**

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	Above 38.6
13.36 - 13.41			

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

**FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)**  
**Radiated emission limits, general requirements**

Frequency (MHz)	Field Strength (microvolts/m)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

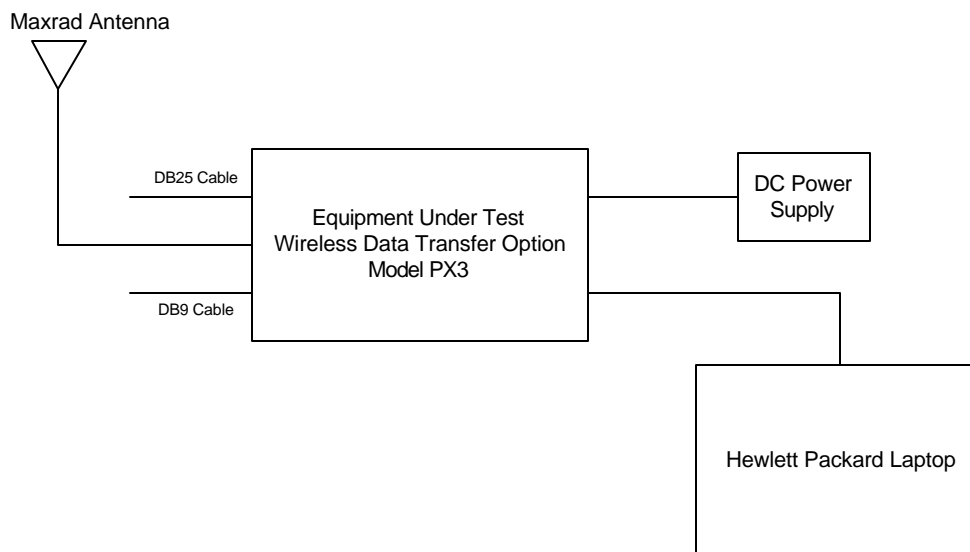
## 6.8.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this test report and ANSI 63.4-1992, Para. 8 for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For measurement below 1 GHz, set RBW = 100 KHz, VBW  $\geq$  100 KHz, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

## 6.8.3. Test Arrangement



## ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

#### 6.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	18 GHz – 26.5 GHz
Horn Antenna	EMCO	3160-10	..	26.5 GHz – 40 GHz
Mixer	Tektronix	118-0098-00	..	18 GHz – 26.5 GHz
Mixer	Tektronix	119-0098-00	..	26.5 GHz – 40 GHz

#### 6.8.5. Test Data

- Near **Lowest Frequency (2402 MHz)**

The emissions were scanned from 10 MHz to 25 GHz and no emission was found within 20 dB of the permissible limits

- Near **Middle Frequency (2442 MHz)**

The emissions were scanned from 10 MHz to 25 GHz and no emission was found within 20 dB of the permissible limits

- Near **Highest Frequency (2478 MHz)**

The emissions were scanned from 10 MHz to 25 GHz and no emission was found within 20 dB of the permissible limits

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

### 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	$\pm 1.5$	$\pm 1.5$
LISN coupling specification	Rectangular	$\pm 1.5$	$\pm 1.5$
Cable and Input Transient Limiter calibration	Normal (k=2)	$\pm 0.3$	$\pm 0.5$
Mismatch: Receiver VRC $\Gamma_I = 0.03$ LISN VRC $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_I \Gamma_R)$	U-Shaped	$\pm 0.2$	$\pm 0.3$
System repeatability	Std. deviation	$\pm 0.2$	$\pm 0.05$
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	$\pm 1.25$	$\pm 1.30$
Expanded uncertainty U	Normal (k=2)	$\pm 2.50$	$\pm 2.60$

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY ( $\pm$ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	$\pm 1.0$	$\pm 1.0$
Cable Loss Calibration	Normal (k=2)	$\pm 0.3$	$\pm 0.5$
EMI Receiver specification	Rectangular	$\pm 1.5$	$\pm 1.5$
Antenna Directivity	Rectangular	$\pm 0.5$	$\pm 0.5$
Antenna factor variation with height	Rectangular	$\pm 2.0$	$\pm 0.5$
Antenna phase center variation	Rectangular	0.0	$\pm 0.2$
Antenna factor frequency interpolation	Rectangular	$\pm 0.25$	$\pm 0.25$
Measurement distance variation	Rectangular	$\pm 0.6$	$\pm 0.4$
Site imperfections	Rectangular	$\pm 2.0$	$\pm 2.0$
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(\text{Bi}) 0.3 (\text{Lp})$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	+1.1 -1.25	$\pm 0.5$
System repeatability	Std. Deviation	$\pm 0.5$	$\pm 0.5$
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k=2 is used:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



## EXHIBIT 8. MEASUREMENT METHODS

### 8.1. GENERAL TEST CONDITIONS

The following test conditions shall be applied throughout the tests covered in this report.

#### 8.1.1. Normal temperature and humidity

- Normal temperature: +15°C to +35°C
- Relative Humidity: +20% to 75%

The actual values during tests shall be recorded in the test report.

#### 8.1.2. Normal power source

##### 8.1.2.1. Mains Voltage

The nominal test voltage of the equipment to be connected to mains shall be the nominal mains voltage which is the declared voltage or any of the declared voltages for which the equipment was designed.

The frequency of test power source corresponding to the AC mains shall be between 59 Hz and 61 Hz.

##### 8.1.2.2. Battery Power Source.

For operation from battery power sources, the nominal test voltage shall be as declared by the equipment manufacturer. This shall be recorded in the test report.

#### 8.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at the following frequencies:
  - The lowest operating frequency,
  - The middle operating frequency and
  - The highest operating frequency
- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers

---

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 8.2. AC MAINS CONDUCTED EMISSIONS

- AC Mains conducted emissions measurements were performed in accordance with the standard against appropriate limits for each detector function.
- The test was performed in the shielded room, 16'(L) by 16'(W) by 12'(H).
- The test was performed over the frequency range from 450 kHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, AC Mains conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlet. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (9 KHz RBW, VBW > RBW), frequency span 450 kHz to 30 MHz.
- The maximum conducted emission for a given mode of operation was found by using the following step-by-step procedure:
  - Step1. Monitor the frequency range of interest at a fixed EUT azimuth.
  - Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
  - Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.
  - Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.
- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW > RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and AVERAGE detector mode (10 kHz RBW, 1 Hz VBW). The final highest RF signal levels and frequencies were record.

---

### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

- **Broad-band ac Powerline conducted emissions:-** If the EUT exhibits ac Powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

### 8.3. EFFECTIVE RADIATED POWER

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

#### Step 1: Duty Cycle measurements

- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter,  $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$  with  $0 < x < 1$ , is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

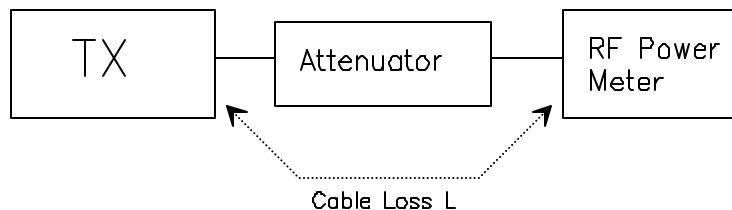
#### Step 2: Calculation of Peak and Average EIRP

- The peak output power of the transmitter shall be determined using a wideband, calibrated RF Peak Power Meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as “P” (in dBm);
- The Average EIRP. shall be calculated from the above measured power output “A”, the observed duty cycle x, and the applicable antenna assembly gain “G” in dBi, according to the formula:

$$\text{Peak EIRP} = P + G$$

$$\text{Average EIRP} = \text{Peak EIRP} + 10\log(1/x)$$

Figure 1.



#### Step 3: Substitution Method. See Figure 2

- (a) The measurements was performed in the absence of modulation (un-modulated)
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The dipole test antenna was used and tuned to the transmitter carrier frequency.

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

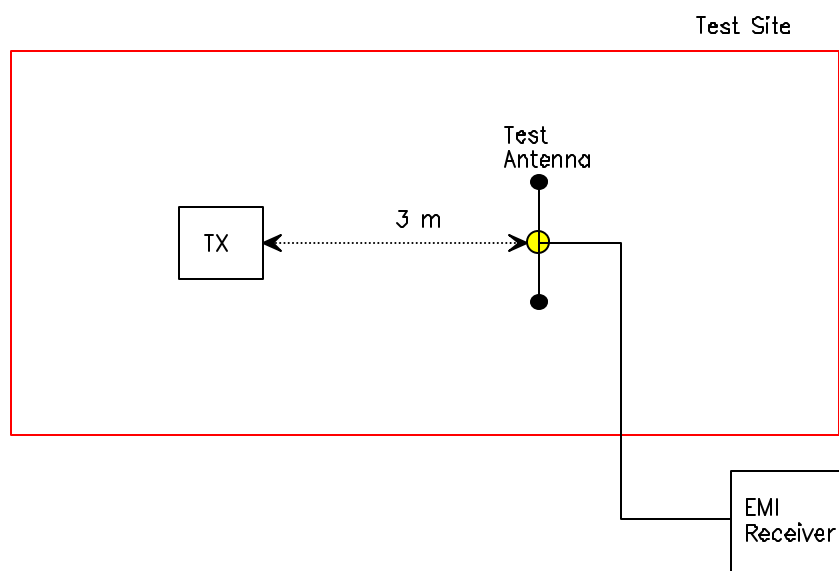
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

- (e) The spectrum analyzer was tuned to transmitter carrier frequency. The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (f) The transmitter was rotated through  $360^\circ$  about a vertical axis until a higher maximum signal was received.
- (g) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (h) The substitution dipole antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution dipole antenna was placed in vertical polarization. The test dipole antenna was lowered or raised as necessary to ensure that the maximum signal is still received.
- (i) The input signal to the substitution antenna was adjusted in level until an equal or a known related level to that detected from the transmitter was obtained in the test receiver. The maximum carrier radiated power is equal to the power supply by the generator.
- (j) The substitution antenna gain and cable loss were added to the signal generator level for the corrected ERP level.
- (k) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
- (l) Actual gain of the EUT's antenna is the difference of the measured ERP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2



**ULTRATECH GROUP OF LABS**

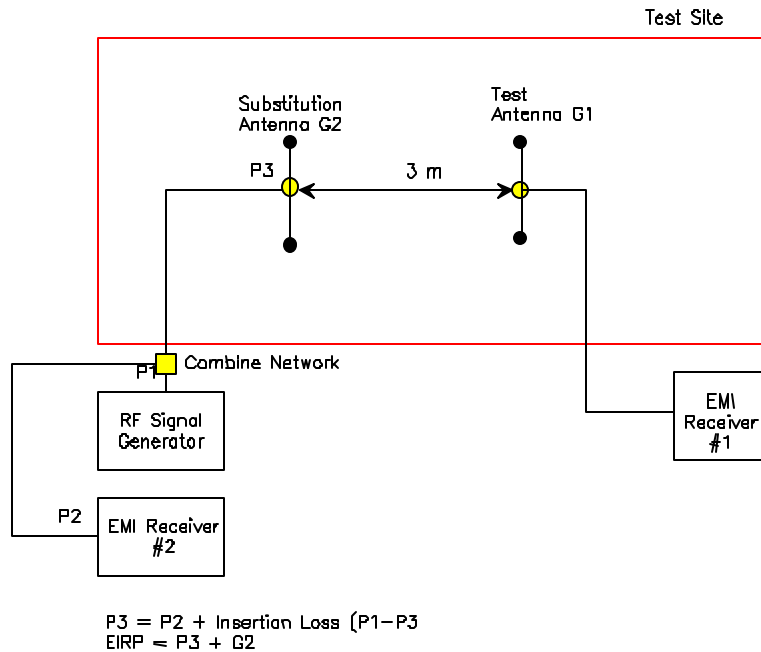
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Figure 3



Use the following spectrum analyzer settings:

- Span = approximately 5 times the 20 dB BW, centered on a hopping channel
- RBW > 20 dB BW of the emission measured
- VBW = RBW
- Trace = max hold
- Allow the trace to stabilize
- Use the marker-to-marker function to set the marker to the peak of the emission.
- The indicated level is the peak output power (with the addition of the external attenuation and cable loss).
- The limit is specified in one of the subparagraph of this Section.
- Submit this plot.
- A peak responding power meter may be used instead of a spectrum analyzer.

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

## 8.4. SPURIOUS EMISSIONS (CONDUCTED & RADIATED)

For both conducted and radiated measurements, the spurious emissions were scanned from the lowest frequency generated by the EUT or 10 MHz whichever is lower to 10<sup>th</sup> harmonic of the highest frequency generated by the EUT.

### 8.4.1. Band-Edge and Spurious Emissions (Conducted)

#### Band-Edge Compliance of RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
- RBW = 1 % of the span
- VBW = RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge
- Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission.
- The marker-delta value now displayed must comply with the limit specified
- Now, using the same instrument settings, enable the hopping function of the EUT
- Allow the trace to stabilize
- Follow the same procedure listed above to determine if any spurious emissions cause by the hopping function also comply with the specify limits.
- Submit this plot

#### Spurious RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the in-band-emission and all spurious emissions (e.g. harmonics) from the lowest frequency generated in the EUT up through the 10<sup>th</sup> harmonic. Typically, several plots are required to cover this entire span.
- RBW = 100 kHz
- VBW = RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the any spurious emission recorded. The level displayed must comply with the limit specified in this Section.
- Submit this plot

---

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

#### 8.4.2. Spurious Emissions (Radiated)

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC, Industry Canada, ACA/Austel, NVLap and ITI.
- Radiated emissions measurements were made using the following test instruments:
  1. Calibrated EMCO BiconiLog antenna in the frequency range from 30 MHz to 2000 MHz.
  2. Calibrated EMCO Horn antennas in the frequency range above 1000 MHz (1GHz - 40 GHz).
  3. The test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:
    - RBW = 100 kHz for  $f < 1\text{GHz}$  and RBW = 1 MHz for  $f \geq 1\text{GHz}$
    - VBW = RBW
    - Sweep = auto
    - Detector function = peak
    - Trace = max hold
    - Follows the guidelines in ANSI C63.4-1992 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc.. A pre-amp and highpass filter are required for this test, in order to provide the measuring system with sufficient sensitivity.
    - Allow the trace to stabilize.
    - The peak reading of the emission, after being corrected by the antenna correction factor, cable loss, pre-amp gain, etc.... is the peak field strength which comply with the limit specified in Section 15.35(b)

##### Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

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

Where	FS	=	Field Strength
	RA	=	Receiver/Analyzer Reading
	AF	=	Antenna Factor
	CF	=	Cable Attenuation Factor
	AG	=	Amplifier Gain

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Example: If a receiver reading of 60.0 dBuV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:

Field Level =  $60 + 7.0 + 1.0 - 30 = 38.0$  dBuV/m.

Field Level =  $10^{(38/20)} = 79.43$  uV/m.

- Submit this test data
- Now set the VBW to 10Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100ms, then the reading obtained may be further adjusted by a “duty cycle correction factor”, derived from  $10\log(\text{dwell time}/100\text{mS})$  in an effort to demonstrate compliance with the 15.209.
- Submit test data

### **Maximizing The Radiated Emissions :**

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.
- During this process, cables and peripheral devices were manipulated within the range of likely configuration.
- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement were explored to produce the highest amplitude signal relative to the limit.

The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

- Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.
- Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
- Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.
- Step4: Move the antenna over its full allowable range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.
- Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.
- Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

---

#### **ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

## 8.5. ALTERNATIVE TEST PROCEDURES

If the antenna conducted tests cannot be performed on this device, radiated tests show compliance with the peak output power limit specified in Section 15.247(b) and the spurious RF conducted emission limit specified in Section 15.247(c) are acceptable. As stated previously, a pre-amp, and in the later case, a high pass filter, are required for the following measurements:

### 8.5.1. Peak Power Measurements

Calculate the transmitter's peak power using the following equation:

$$E = 30PG/d$$

$$P = (Ed)^2/30G$$

Where:

- E: measured maximum fundamental field strength in V/m. Utilizing a RBW, the 20 dB bandwidth of the emission VBW > RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission
- G is numeric gain of the transmitting antenna with reference to an isotropic radiator
- D is the distance in meters from which the field strength was measured
- P is the distance in meters from which the field strength was measured

### 8.5.2. Spurious RF conducted emissions

The demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247©, use the following spectrum analyzer settings:

- Span = wide enough to fully capture the emission being measured
- RBW = 100 kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Measure the field strength of both the fundamental and all spurious emissions with these settings.
- Follow the procedures C62-4:1994 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247©. Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions listed above must be followed

---

#### ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [yhk.ultratech@sympatico.ca](mailto:yhk.ultratech@sympatico.ca), Website: <http://www.ultratech-labs.com>

File #: DIR1-FTX  
September 4, 2001

- Assessed by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australia), VCCI (Japan)
- Accredited by Industry Canada (Canada) under ACC-LAB (Europe/Canada MRA and APEC/Canada MRA)
- Recognized/Listed by FCC (USA)
- All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)