UltraTech
Group of Labs

Oct. 23, 2000

FEDERAL COMMUNICATIONS COMMISSION
7435 Oakland Mills Road
Columbia, MD 21046
USA

Subject:	**Certification Application under FCC Part 15, Subpart C, Para. 15.231, Momentarily Operation in 433.95 MHz.**
Applicant:	**LEEDS ELECTRONIC ENGINEERING LTD.**
Product:	**WIRELESS MAGNETIC SWITCH FOR DOORS/WINDOWS**
Model No.:	**LS1001**
FCC ID:	**PDB-LS1001**

Dear Sir/Madam,

As appointed agent for LEEDS ELECTRONIC ENGINEERING LTD., we would like to submit the application to the Federal Communications Commission for certification of the above product. Please review all necessary files uploaded to FCC OET site for detailed information.

Since the rf exposure safety distance is approximately 0.08 cm where the power density reach 0.29 mW/cm^2 and the antenna is enclosed within the case, the RF exposure risk is in-considerable. Therefore, the applicant wishes to apply for the exemption of meeting both the SAR test requirements per FCC OET Bulletin 65 and FCC RF Exposure Distance per 2.1093

I you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

3000 Bristol Circle
Oakville, Ontario, Canada
L6H 6G4

Telephone (905) 829-1570
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UltraTech
Group of Labs

Oct. 23, 2000

LEEDS ELECTRONIC ENGINEERING LTD.
Flat B, 21/F, Yally Ind. Bldg., 6 Yip Fat St.
Wong Chuk Hang, Hong Kong

Attn.: **Mr. Lui, Yun Tak Michael**

Subject: **Certification Application under FCC Part 15, Subpart C, Para. 15.231, Momentarily Operation in 433.95 MHz.**

Product: **WIRELESS MAGNETIC SWITCH FOR DOORS/WINDOWS**
Model No.: **LS1001**
FCC ID: **PDB-LS1001**

Dear Mr. Lui,

The product sample, as provided by you, has been tested and found to comply with **FCC PART 15, Subpart C, FCC Part 15, Subpart C, Para. 15.231, Momentarily Operation in 433.95 MHz.**

Since the rf exposure safety distance is approximately 0.08 cm where the power density reach 0.29 mW/cm^2 and the antenna is enclosed within the case, the RF exposure risk is in-considerable. Therefore, the applicant wishes to apply for the exemption of meeting both the SAR test requirements per FCC OET Bulletin 65 and FCC RF Exposure Distance per 2.1093.

Enclosed you will find copies of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P. Eng.,
V.P., Engineering

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ENGINEERING TEST REPORT

WIRELESS MAGNETIC SWITCH FOR DOORS/WINDOWS
Model No.: LS1001

FCC ID: PDB-LS1001
731 Confirmation No.: EA99343

Applicant: **LEEDS ELECTRONIC ENGINEERING LTD.**
Flat B, 21/F, Yally Ind. Bldg., 6 Yip Fat St.
Wong Chuk Hang, Hong Kong

In Accordance With
FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.231
Momentarily Operated Transmitters in 433.95 MHz

UltraTech's File No.: KCE-011A-FCCTX

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

Date: Oct. 23, 2000

Report Prepared by: Tri M. Luu . Issued Date: Oct. 23, 2000	Tested by: Hung Trinh Test Dates: Oct. 23, 2000

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

UltraTech

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EXHIBIT 1: SUBMITTAL CHECK LIST

Exhibit No.	Exhibit Type	Description of Contents	Quality Check (OK)
1 through 8	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
9	Test Report - Plots of Measurement Data	Plots # 1 to 3	OK
10	Test Setup Photos	Photos # 1 to 3	OK
11	External Photos of EUT	Photos # 1 to 2	OK
12	Internal Photos of EUT	Photos of 1 to 2	OK
13	Cover Letters	• Letter from Ultratech for Certification Request • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK
14	Attestation Statements	• Manufacturer's Declaration of Conformity (FCC DoC) for compliance with FCC Part 15, Sub. B, Raduio Receiver	OK
15	Application Forms	• Form 731 • Form 159 • Confirmation of Exhibits sent to FCC • Status of Exhibits sent to FCC	OK
16	ID Label/Location Info	• ID Label • Location of ID Label	OK
17	Block Diagrams	• Block diagram # 1 of 1	OK
18	Schematic Diagrams	• Schematic diagram 1 of 1	OK
19	Parts List/Tune Up Info	• Part lists	OK
20	Operational Description	Refer to Technical Manual	OK
21	RF Exposure Info	N/A	N/A
22	Users Manual		OK

EXHIBIT 2: INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.231
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for a Low Power Transmitter operating in the frequency band 433.95 MHz.
Test Procedures	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.
Environmental Classification:	• Residential • Light-industry, Commercial • Industry

2.2. RELATED SUBMITAL(S)/GRANT(S)

None

2.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR Parts 0-19	1999	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

EXHIBIT 3: PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT:	
Name:	LEEDS ELECTRONIC ENGINEERING LTD.
Address:	Flat B, 21/F, Yally Ind. Bldg., 6 Yip Fat St. Wong Chuk Hang, Hong Kong
Contact Person:	Mr. Lui, Yun Tak Michael Phone #: (852) 2550-5284 Fax #: (852) 2873 1255 Email Address: leeds@netvigator.co

MANUFACTURER:	
Name:	LEEDS ELECTRONIC ENGINEERING LTD.
Address:	Flat B, 21/F, Yally Ind. Bldg., 6 Yip Fat St. Wong Chuk Hang, Hong Kong
Contact Person:	Mr. Lui, Yun Tak Michael Phone #: (852) 2550-5284 Fax #: (852) 2873 1255 Email Address: leeds@netvigator.co

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name	LEEDS ELECTRONIC ENGINEERING LTD.
Product Name	WIRELESS MAGNETIC SWITCH FOR DOORS/WINDOWS
Model Name or Number	LS1001
Serial Number	Pre-production
Type of Equipment	Momentarily operated Transmitter for Alarm Security System
Input Power Supply Type	9 V battery
Primary User Functions of EUT:	This transmitter is for used as a wireless magnetic switch for doors / windows. When the door/window is opened, a signal is sent to the main console to trigger the alarms.

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	▪ Fixed use
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	9 V battery
RF Output Power Rating:	0.024 mWatts
Operating Frequency Range:	433.95 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	1 Channel only
Duty Cycle:	22%
20 dB Bandwidth:	22 KHz
Modulation Type:	AM modulation with the pulse signal
Emission Designation:	22K0P0N
Oscillator Frequencies:	433.95 MHz
Antenna Connector Type:	• Integral (the antenna is a piece of wire lead soldered onto the radio printed circuit board and located inside the enclosure)

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	Terminal block with 2 conductors is optionally provided for non-wireless uses. Note 1	1	Terminal block	Non-shielded

NOTE 1*: Not connected for testing since it is only provided for non-wireless uses.*

3.5. ANCILLARY EQUIPMENT

None

3.6. GENERAL TEST SETUP

LEEDS ELECTRONICS
WIRELESS MAGNETIC SWITCH FOR DOORS/WINDOWS
MODEL LS1001

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:	

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Transmit continuously
Special Test Software:	▪ A jumper was used to short the internal circuit to allow the transmitter to transmit continuously at the duty cycle of 22% for convenience of testing.
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna equipment.

Transmitter Test Signals:	
Frequencies: ▪ 433.95 MHz band:	433.95 MHz

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 Sec. 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: Sep.20, 1999.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.203	Antenna Requirement	Yes
15.231(a)	Provisions of FCC 15.231	Yes
15.231(a) & (b)	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
1.1310	RF Exposure Limits	Yes
15.231(c)	20 dB Bandwidth	Yes
15.107, 15.109	AC Power Conducted Emissions & Radiated Emissions for Receiver and Digital Circuit Portions	Not applicable for battery operated device.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

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

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 15.231 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER:

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

6.5. ANTENNA REQUIREMENTS @ FCC CFR 47, PARA 15.203

6.5.1. Limits

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

N**otes**: This requirement does not apply to carrier current devices operated under the provisions of @ 15.211, 15.213, 15.217, 17.219 or 15.221.

6.5.2. Method of Measurements

Refer to Exhibit 7, Sec. 7.2 of this test report & ANSI C63-4:1992

6.5.3. Engineering Analysis

Internal integral antenna component mounted on the printed circuit board.

6.6. PROVISIONS OF FCC 15.231(A) FOR PERIODIC TRANSMITTERS

6.6.1. Engineering Analysis

FCC PROVISSIONS	ANALYSIS ON COMPLIANCE
Permitted Type of Devices (alarm systems, door opener, remote switches etc ...)	Door sensor for alarm systems
Prohibited Type of Devices (radio control of toys)	Not radio control toys
Prohibited Transmission Type (voice, video or data continuous transmission)	Recognition codes to identify other particular component as part of the system
A Manually Operated Transmitter (shall employ with the switch that automatically deactivate the transmitter within 5 seconds of being released)	The transmitter is automatically deactivated within less than 1 seconds of being releases.
Periodic Transmissions: at regular predetermined intervals are not permitted. However, polling or supervision transmissions to determine system integrity of transmitter used in security or safety applications are allowed if the periodic rate of transmission does not exceed one transmission of not more than one second duration per hour for the transmitter Internal Radiators which are not employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.	N/A

6.7. TRANSMITTER RADIATED EMISSIONS @ 3 METERS, FCC CFR 47, PARA. 15.231(B)(C), 15.209 & 15.205

6.7.1. Limits

The RF radiated emissions measured at 3 Meter distance shall not exceed the field strength below:

Fundamental Frequency (MHz)	Average Field Strength Limits (mV)	
	Fundamental	Harmonic/Spurious
260 - 470 MHz	3750 - 12,500	375 - 1250

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 Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 - 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 - 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 - 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 - 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 - 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 - 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 - 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	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

6.7.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 of this test report & ANSI C63-4:1992

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 measurements from 9 KHz to 150 KHz, set RBW = 200 Hz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 150 KHz to 30 MHz, set RBW = 10 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 30 MHz to 1 GHz, set RBW = 100 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz, 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).

6.7.3. 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
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Log Periodic/Bow-Tie Antenna	EMCO	3143	1029	20 - 1000 MHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

6.7.4. Photograph of Test Setup

Please refer to Photographs # 1 through #2 in Exhibit 10 for Measurements data

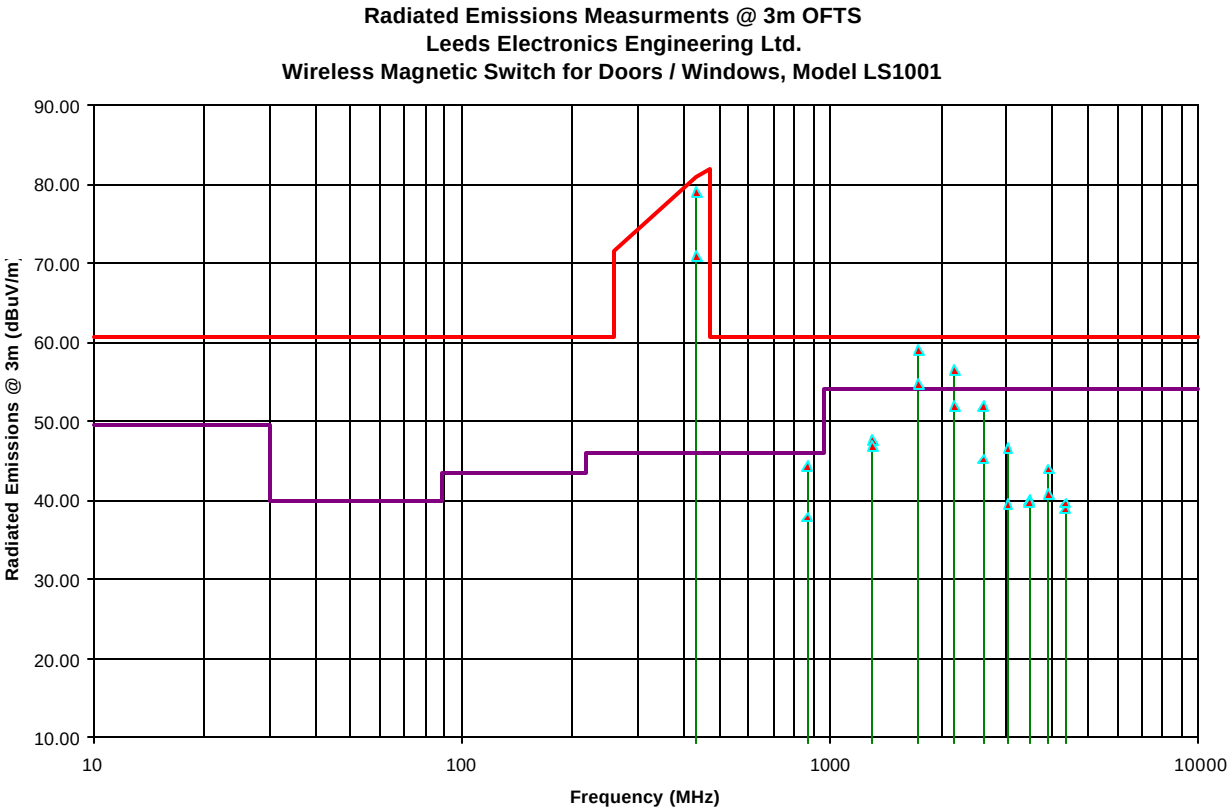
6.7.5. Test Data

Duty Cycle Measurements: 22% or Peak-Average Conversion factor = -13.1 dB
Please refer o the Plot # 1 in Exhibit 9 for Plots of duty cycle measurements

The emissions were scanned from 10 MHz to 10th harmonic of the highest oscillator frequency (433.95 MHz) and all emissions less 20 dB below the limits were recorded.

Note:
- In the restricted band per FCC 15.205: Limit (2) per 15.209 is applied
- Outside the restricted band per FCC 15.205: Limit (1) per FCC 15.231 or Limit (2) per 15.209 whichever allows higher field strength emission, is applied.

Frequency (MHz)	Peak E-Field @3m (dBuV/m)	Avergae E-Field @3m (dBuV/m)	Antenna Plane (H/V)	Average (1) Limit @3m (dBuV/m)	Restricted (2) Band Limits @3m (dB)	Margin (dB)	Results (Pass/Fail)
433.95	**92.1**	**79.00**	**V**	**80.8**	**46.0**	**-1.8**	**PASS**
433.95	**84.13**	**71.03**	**H**	**80.8**	**46.0**	**-9.8**	**PASS**
867.90	57.45	44.35	V	60.8	46.0	-16.5	PASS
867.90	51.06	37.96	H	60.8	46.0	-22.8	PASS
1301.85	60.76	47.66	V	60.8	54.0	-6.3	*PASS
1301.85	59.98	46.88	H	60.8	54.0	-7.1	*PASS
1735.80	72.13	59.03	V	60.8	54.0	-1.8	PASS
1735.80	67.78	54.68	H	60.8	54.0	-6.1	PASS
2169.75	69.57	56.47	V	60.8	54.0	-4.3	PASS
2169.75	65.10	52.00	H	60.8	54.0	-8.8	PASS
2603.70	65.05	51.95	V	60.8	54.0	-8.9	PASS
2603.70	58.36	45.26	H	60.8	54.0	-15.5	PASS
3037.65	59.81	46.71	V	60.8	54.0	-14.1	PASS
3037.65	52.68	39.58	H	60.8	54.0	-21.2	PASS
3471.60	53.27	40.17	V	60.8	54.0	-20.6	PASS
3471.60	52.98	39.88	H	60.8	54.0	-20.9	PASS
3905.55	53.89	40.79	V	60.8	54.0	-13.2	*PASS
3905.55	57.06	43.96	H	60.8	54.0	-10.0	*PASS
4339.50	52.07	38.97	V	60.8	54.0	-15.0	*PASS
4339.50	52.82	39.72	H	60.8	54.0	-14.3	*PASS


Radiated Emissions Measurments @ 3m OFTS
Leeds Electronics Engineering Ltd.
Wireless Magnetic Switch for Doors / Windows, Model LS1001
Radiated Emissions @ 3m (dBuV/m)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10
100
1000
10000
Frequency (MHz)

6.8. 20 DB BANDWIDTH @ FCC CFR 47, PARA. 15.209(C)

6.8.1. Limits

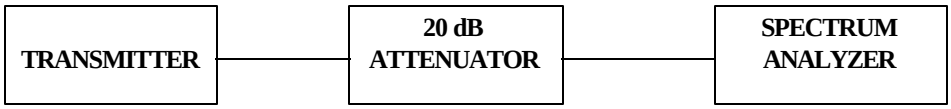
The 20dB bandwidth of the emission shall be no more than 0.25% of the centre frequency for devices operating above 70MHz.

6.8.2. Method of Measurements

Refer to FCC 15.231(c) & ANSI C63-4:1992

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna and the bandwidth of bandwidth of the fundamental frequency was measured with the spectrum analyzer with the resolution bandwidth of the spectrum analyzer set per ANSI 63-4:1992, Sec. 13.1.6.2

6.8.3. Test Arrangement



6.8.4. 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

6.8.5. Plots

Please refer to Plot # 2 in Exhibit 9 for Measurements data

6.8.6. Test Data

CHANNEL FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)	MAXIMUM LIMIT (kHz)	PASS/FAIL
433.95	22.0	1084.88	PASS

6.9. EFFECTIVE RADIATED POWER (EIRP), RF EXPOSURE LIMIT FCC 1.1310 &B 2.1091

6.9.1. Limits

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

F = Frequency in MHz

6.9.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.3 of this test report, FCC 15.231(b)(1)&(3), ANSI C63-4:1992, FCC @ 1.1310 & OST Bulletin No. 65-August 1997

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

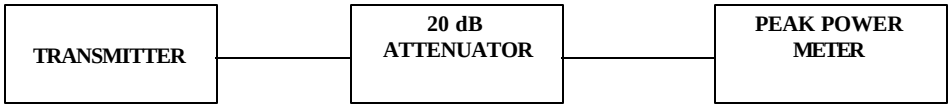
Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$$r = \sqrt{PG/4\Pi S}$$

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

6.9.3. Test Arrangement



6.9.4. 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
RF Amplifier	HF Measurements	HFA-2900	1310790-04	1 to 2000 MHz 50Ohms Input/Output
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz 50Ohms Input/Output
Dipole Antenna Set	EMCO	3121C	8907-434	20-1000 MHz
Dipole Antenna Set	EMCO	3121C	8907-440	20-1000 MHz

6.9.5. Test Data

Duty Cycle Measurements: 22% or Peak-Average Conversion factor = -13.1 dB
Please refer o the Plot # 1 in Exhibit 9 for Plots of duty cycle measurements

Frequency (MHz)	Max. Average E-Field E1 in 100 kHz BW @ 3m (dBuV/m)	Antenna Polarization (V/H)	Calculated EIRP (dBm)	(2) Laboratory's Recommended Minimum RF Safety Distance (cm)
433.95 MHz	79.0	V	-16.2 dBm	0.08

Note 1: RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$
$S = 433.95/1500 = 0.2893\ mW/cm^2$

Note2: The minimum RF Safety Distance calculation shown in the above table is laboratory's recommendation, compliance to this value may not be applicable if the radio complies with SAR test requirements or the EIRP level is too low.

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	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8$(9 kHz) 0.2 (30 MHz) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

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

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

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

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

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

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

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

8.2. METHOD OF MEASUREMENTS - 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 were made 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.

- ***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).
- I f 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

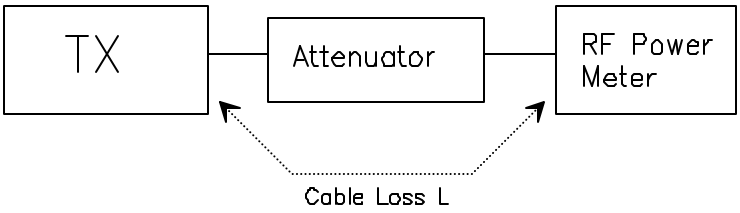
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with $0<x<1$, is measure and recorded in the 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 dBi, according to the formula:

Peak EIRP = P + G
Average EIRP = Peak EIRP + 10log(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.
(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^{o} 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 stilled 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

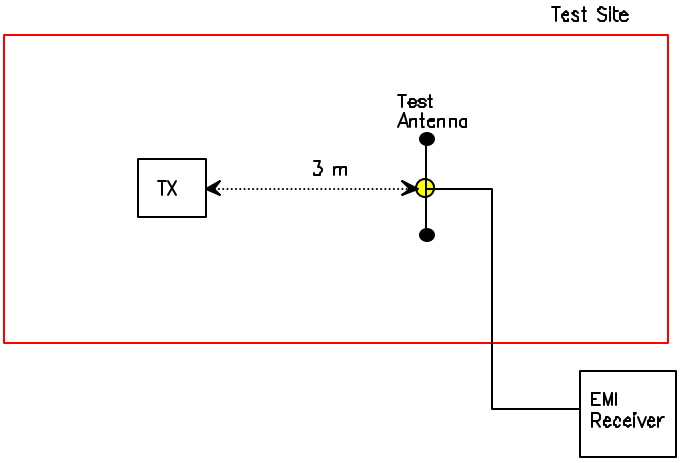
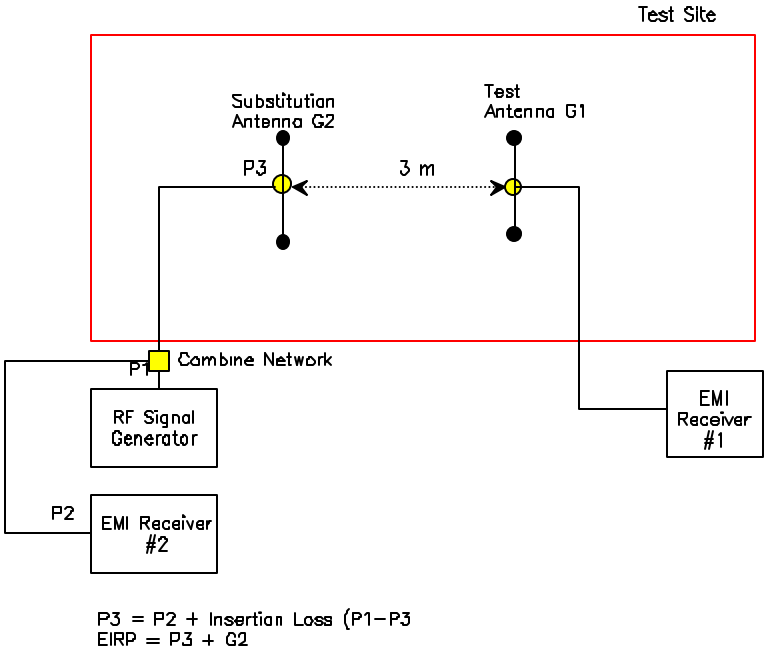


Figure 3



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 10th harmonic of the highest frequency generated by the EUT.

8.4.1. Spurious Emissions (Conducted)

- The radio was connected to the measuring equipment via a suitable attenuator.
- The spectrum analyzer were used and set as follows:

  - Resolution BW: 100 kHz
  - Video BW: same or greater
  - Detector Mode: Positive Peak
  - Averaging: Off
  - Span: 100 MHz
  - Amplitude: Adjust for middle of the instrument's range
  - Sweep Time: Auto

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. Calibrated Advantest spectrum analyzer and pre-selector were used. The spectrum analyzer would be used as follows:

   For frequencies below 1 GHz:

   - Resolution BW: 100 kHz
   - Video BW: same or greater
   - Detector Mode: Positive Peak
   - Averaging: Off
   - Span: 100 MHz
   - Amplitude: Adjust for middle of the instrument's range
   - Sweep Time: Auto

For frequencies above 1 GHz:
- Resolution BW: 1 MHz
- Video BW: same or greater
- Detector Mode: Positive Peak
- Averaging: Off
- Span: 500 MHz
- Amplitude: Adjust for middle of the instrument's range
- Sweep Time: Auto

- 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.

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

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

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.