UltraTech
Group of Labs

31040/SIT

A96/TH/0093

Canada
46390-2049

NVLAP
200093-0

entela

00-034

April 01, 2002

TIMCO ENGINEERING INC.
P O BOX 370
849 N.W. STATE ROAD 45
NEWBERRY, FLORIDA
USA 32669

Subject: **FCC Certification Authorization Application under FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz.**

Product: **Exciter**
Model No.: **E95**
FCC ID: **PQGE95**

Dear Sir/Madam

As appointed agent for Lyngsoe Industries 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.

If 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

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00-034

April 01, 2002

Lyngsoe Industries Ltd.
5570 Kennedy Road, Unit B
Mississauga, Ontario
Canada, L4Z 2A9

Attn.: **Don Ferguson**

Subject: **FCC Certification Application Testing under FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz.**

Product: **Exciter**
Model No.: **E95**
FCC ID: **PQGE95**

Dear Mr. Ferguson,

The product sample, as provided by you, has been tested and found to comply with **FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz.**

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

Encl

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

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ENGINEERING TEST REPORT

Exciter
Model No.: E95

FCC ID: PQGE95

Applicant: **Lyngsoe Industries Ltd.**
5570 Kennedy Road, Unit B
Mississauga, Ontario
Canada, L4Z 2A9

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C
Sec. 15.231(e) - Momentarily Operation at 433.92 MHz

UltraTech's File No.: LYT-003FTX

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

Date: April 01, 2002

Report Prepared by: Tri M. Luu, P.Eng.	Tested by: Hung Trinh, RFI Technician
Issued Date: April 01, 2002	Test Dates: Mar. 22-25, 2002

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
	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
1	Test Report - Plots of Measurement Data	Plots # 1 to 6	OK
2	Test Setup Photos	Photos # 1 to 3	OK
3	External Photos of EUT	Photos # 1 to 3	OK
4	Internal Photos of EUT	Photos of 1 to 3	OK
5	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 OK OK
6	ID Label/Location Info	• ID Label • Location of ID Label	OK OK
7	Block Diagrams	• Block diagrams	OK
8	Schematic Diagrams	• Schematic diagrams	OK
9	Parts List/Tune Up Info		OK
10	Operational Description		OK
11	RF Exposure Info		N/A
12	Users Manual		OK

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Sections 15.209 and 15.231(e)
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 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:	• Light-industry, Commercial • Industry

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

None

1.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR Parts 0-19	2001	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
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT:	
Name:	Lyngsoe Industries Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada, L4Z 2A9
Contact Person:	Don Ferguson Phone #: 905 501 1533 Fax #: 905 501 1538 Email Address: mhu@lyngsoe-industries.com

MANUFACTURER:	
Name:	Lyngsoe Industries Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada, L4Z 2A9
Contact Person:	Don Ferguson Phone #: 905 501 1533 Fax #: 905 501 1538 Email Address: mhu@lyngsoe-industries.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name	Lyngsoe Industries Ltd.
Product Name	Exciter
Model Name or Number	E95
Serial Number	Pre-production sample
Type of Equipment	Low Power Transmitter
Input Power Supply Type	25 Vdc
Primary User Functions of EUT:	This equipment is a part of the RFID System S95 and together with Reader R95 creates a reading point. The main function of the Exciter E95 is to generate the LF Field which "excite" transponder T95. Exciter E95 incorporates also electronic blocks for self-testing and for testing the UHF receiving capability of Reader R95 (an UHF transmitter which stimulates a transponder T95).

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER @ 125 kHz	
Equipment Type:	▪ Base station (fixed use)
Intended Operating Environment:	▪ Commercial, light industry & heavy industry
RF Output Power Rating:	0.0
Operating Frequency Range:	125 kHz
Duty Cycle:	45.2%
25 dB Bandwidth:	8.7 KHz
Modulation Type:	Pulse modulation with recognition coding
Emission Designation:	9K3NON
Antenna Connector Type:	• Integral, permanently attached loop antenna

TRANSMITTER @ 433.92 MHz	
Equipment Type:	▪ Base station (fixed use)
Intended Operating Environment:	▪ Commercial, light industry & heavy industry
RF Output Power Rating:	0.0
Operating Frequency Range:	433.92 MHz
Duty Cycle:	10.8%
20 dB Bandwidth:	40 kHz
Modulation Type:	Pulse modulation with recognition coding
Emission Designation:	40K0L1D
Antenna Connector Type:	• Integral antenna (part of on the printed circuit board) housed inside the enclosure.

2.4. LIST OF EUT'S PORTS

None

2.5. ANCILLARY EQUIPMENT

None

2.6. GENERAL TEST SETUP

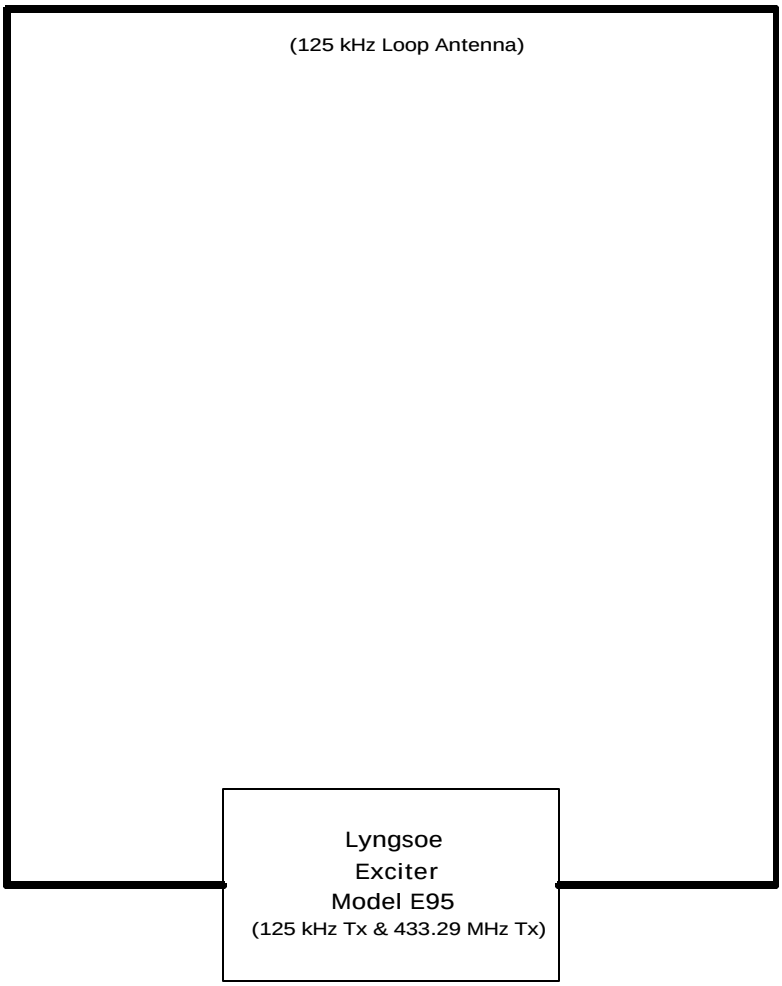


EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	25 Vdc

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The EUT was set to transmit continuously by means of special setting of jumpers on the printed circuit board for testing purpose only.
Special Test Software:	None
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:	125 kHz & 433. 92 MHz

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. 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: Aug. 08, 2001.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC 15.209 - LOW POWER TRANSMITTER @ 125 kHz		
FCC PARAGRAPH.	**TEST REQUIREMENTS**	**COMPLIANCE (YES/NO)**
15.203	Antenna Requirement	Yes. Permanently attached loop antenna.
15.209 & 15.205	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
	25 dB Bandwidth	Yes
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	N/A for DC supplied device

FCC 15.231(e) - MOMENTARILY TRANSMITTER @ 433.92 MHz		
FCC PARAGRAPH.	**TEST REQUIREMENTS**	**COMPLIANCE (YES/NO)**
15.203	Antenna Requirement	Yes. Integral antenna (part of the printed circuit board) housed inside the enclosure.
15.231(e)(a)	Provisions of FCC 15.231(e)	Yes
15.231(e)(a) & (b)	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
15.231(e)(c)	20 dB Bandwidth	Yes
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	N/A for DC supplied device

Unintentional Radiators
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 engineering test report can be provided upon FCC requests.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. 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.

5.2. 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.

5.3. MEASUREMENT EQUIPMENT USED:

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C64-3:1992, FCC 15.209 and CISPR 16-1.

5.4. 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.

5.5. 125 KHZ TRANSMITTER - FUNDAMENTAL & SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.209 & 15.205

5.5.1. Limits

- The fundamental frequency shall not fall within any restricted frequency band specified in 15.205
- All rf other emissions shall not exceed the general radiated emission limits specified in @ 15.209(a).

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

5.5.2. Method of Measurements

Refer to Exhibit 8, Sec. 7.2 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 9 kHz ≤ frequencies ≤ 150 kHz: RBW = 1 KHz, VBW ≥ 1 KHz, SWEEP=AUTO.
- For 150 MHz ≤ frequencies ≤ 30 MHz: RBW = 10 KHz, VBW ≥ 10 KHz, SWEEP=AUTO.
- For 30 MHz ≤ frequencies ≤ 1 GHz: RBW = 100 KHz, VBW ≥ 100 KHz, SWEEP=AUTO.
- For frequencies ≥ 1 GHz: 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).

5.5.3. Test Arrangement

Please refer to Test Arrangement in Sec. 5.5.3 for details of test setup for emission measurements.

5.5.4. 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

5.5.5. Photographs of Test Setup

Refer to the Photos #1 & #2 in Annex 2 (tested at 10 meters and 30 meters distances) for setup and arrangement of equipment under tests and its ancillary equipment.

5.5.6. Test Data

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT MARGIN (dB)	PASS/ FAIL	Distance (m)
0.125	85.5	78.6	V	85.7	-7.1	PASS	30
0.125	75.2	68.3	H	85.7	-17.4	PASS	30
57.30	22.9	22.9	V	40.0	-17.1	PASS	3
57.30	23.2	23.2	H	40.0	-16.8	PASS	3
86.70	20.6	20.6	V	40.0	-19.4	PASS	3
86.70	17.7	17.7	H	40.0	-22.3	PASS	3

- The emissions were scanned from 10 kHz to 1 GHz and all emissions within 20 dB below the limits were recorded.
- Highest measurements were recorded when the transmitter was tested with 3 different orthogonal positions as shown in photos # 1 to 3 in Annex 2.

Remarks:

(1) Duty Cycle = 0.7 mS/1.55 mS = 0.452
Peak-to-Average factor = 20*log (0.452) = -6.9 dB
Please refer to Plot #1 in Annex 1 for detailed measurements.

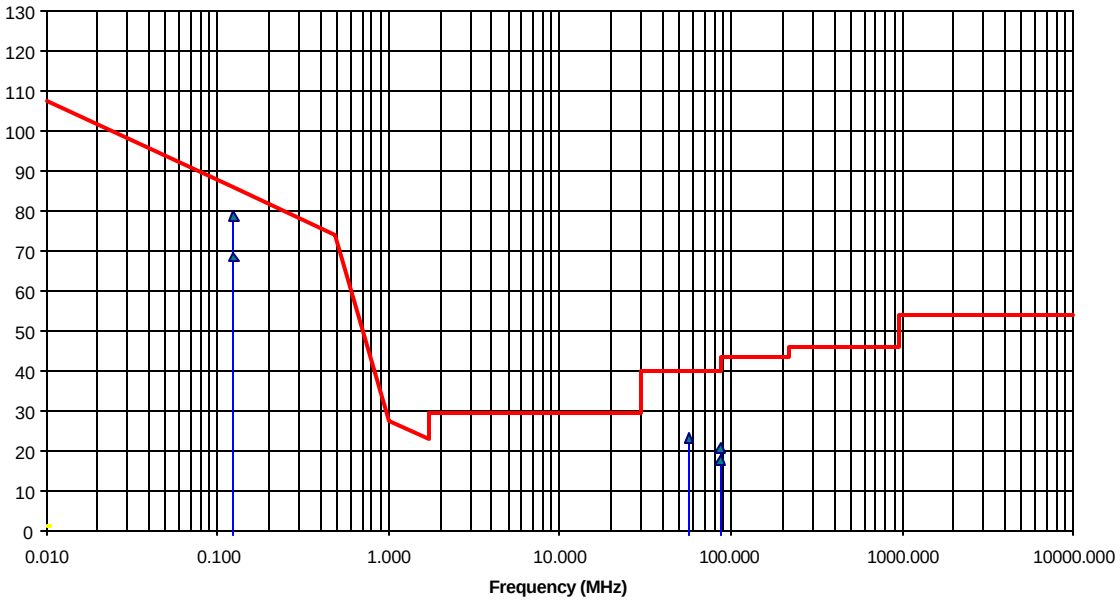
(2) The 300m limit was converted to 30 m using cube factor (x) as it was found by measurements as follows:
- Maximum E-field at 10 meters distance: 114.82 dBuV/m (vertical)
- Maximum E-field at 30 meters distance: 85.45 dBuV/m (vertical)

Difference eof measurement between 10 m & 30 m: $\Delta E = 114.82 - 85.45 = 29$ dB
$\Delta E = 20* \log(30/10)^x = 29$ dB or $x = 29/(20*\log 3) = 3.0$

Therefore the limit for 125 kHz at 30 meters were calculated as:
$\text{Limit}_{30m} = \text{Limit}_{300m} + 20*\log(300/30)^3 = 20*\log[2400/125] + 60 = 85.67$ dBuV/m

Transmitter Radiated Emissions Measurements at OFTS
9 kHz to 30 MHz measured at 30 meters & 30 MHz to 1000 MHz measured at 3 meters
(Conversion Factor from 30 to 300 meters distance = 60 dB)

Lyngsoe Model E95, Tx: 125 kHz



5.6. 125 KHZ TRANSMITTER - 25 DB BANDWIDTH

5.6.1. Limits

The rf spectrum shall not stay in the restricted band specified in FCC 15.205

5.6.2. Method of Measurements

Refer to 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

5.6.3. 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

5.6.4. Test Data

CHANNEL FREQUENCY (kHz)	25 dB BANDWIDTH (kHz)	MAXIMUM LIMIT (kHz)	PASS/FAIL
125	9.3	N/A	N/A

Please refer to Plot #2 in Annex 1 for detailed measurments.

5.7. 433.92 MHZ TRANSMITTER - PROVISIONS OF FCC 15.231(E)(A) FOR PERIODIC OPERATION

5.7.1. Engineering Analysis

FCC PROVISSIONS	ANALYSIS ON COMPLIANCE
Permitted Type of Devices (alarm systems, door opener, remote switches etc ...)	Alarm systems
Prohibited Type of Devices (radio control of toys)	N/A
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. The transmitter sent 40 pulses for maximum 975 mS (39x25mS) and than automatically deactivate.
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

5.8. 433.92 MHZ TRANSMITTER - RADIATED EMISSIONS @ 3 METERS, FCC CFR 47, PARA. 15.231(E), 15.209 & 15.205

5.8.1. Limits

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

Fundamental Frequency (MHz)	Average Field Strength Limits (μV/m)	
	Fundamental	Harmonic/Spurious
260 - 470 MHz	1,500 to 5,000	150 to 500

LIMIT @ 433.92 MHz = 72.9 dBuV/m at 3 meters
HARMONIC/SPURIOUS LIMIT (outside restricted bands) = 52.9 dBuV/m

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

5.8.2. Method of Measurements

Refer to Exhibit 8, Sec. 7.2 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 ≥ RBW, SWEEP=AUTO.
- For measurements from 150 KHz to 30 MHz, set RBW = 10 KHz, VBW ≥ RBW, SWEEP=AUTO.
- For measurements from 30 MHz to 1 GHz, set RBW = 100 KHz, VBW ≥ 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).

5.8.3. 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

5.8.4. Photograph of Test Setup

Please refer to Photos # 3 through #4 (tested at 3 meter distance) for Measurements data

5.8.5. Test Data

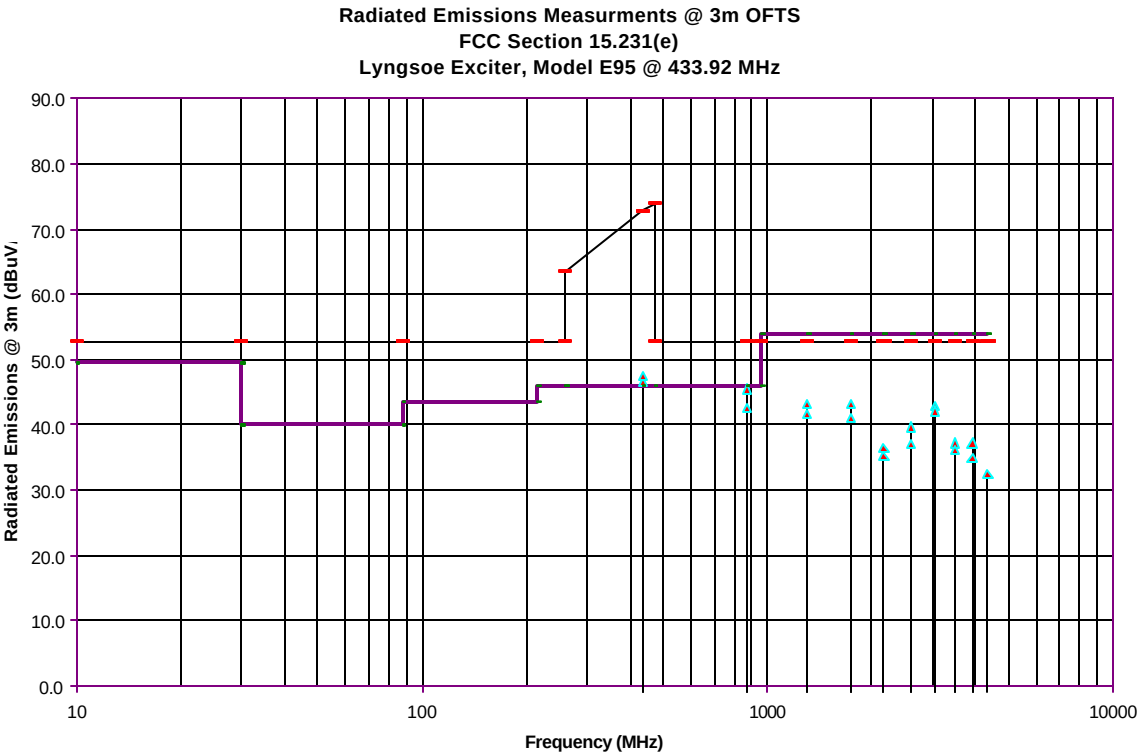
The emissions were scanned from 10 MHz to 5 GHz and all emissions less 20 dB below the limits were recorded.

Notes:

- Transmitter was placed in three different orthogonal position for searching maximum field strength level.
- 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(e) or Limit (2) per 15.209 whichever allows higher field strength emission, is applied.
- Duty Cycle = 4*2.7mS/100 mS = 0.108
  Peak-to-Average factor = 20*log (0.108) = -19.3 dB
  Please refer to Plot #4 in Annex 1 for detailed measurements.

* Emissions fall in FCC restricted bands @ 15.205.

FREQUENCY (MHz)	Peak E-FIELD @3m (dBuV/m)	Avergae E-FIELD @3m (dBuV/m)	ANTENNA PLANE (V/H)	Average (1) LIMIT @3m (dBuV/m)	Restricted (2) Band Limits @3m (dBuV/m)	MARGIN (Pass/Fail)	MARGIN (Pass/Fail)
433.92	65.8	46.5	V	72.9	--	-26.4	PASS
433.92	66.8	47.5	H	72.9	--	-25.4	PASS
867.84	64.8	45.5	V	52.9	46.0	-7.4	PASS
867.84	62.0	42.7	H	52.9	46.0	-10.2	PASS
1301.76	62.6	43.3	V	52.9	54.0	-9.6	*PASS
1301.76	60.9	41.6	H	52.9	54.0	-11.3	*PASS
1735.68	60.4	41.1	V	52.9	54.0	-11.8	PASS
1735.68	62.6	43.3	H	52.9	54.0	-9.6	PASS
2169.60	54.5	35.2	V	52.9	54.0	-17.7	PASS
2169.60	55.7	36.4	H	52.9	54.0	-16.5	PASS
2603.52	56.3	37.0	V	52.9	54.0	-15.9	PASS
2603.52	59.0	39.7	H	52.9	54.0	-13.2	PASS
3037.44	62.3	43.0	V	52.9	54.0	-9.9	PASS
3037.44	61.4	42.1	H	52.9	54.0	-10.8	PASS
3471.36	56.5	37.2	V	52.9	54.0	-15.7	PASS
3471.36	55.5	36.2	H	52.9	54.0	-16.7	PASS
3905.28	54.2	34.9	V	52.9	54.0	-18.0	* PASS
3905.28	56.5	37.2	H	52.9	54.0	-15.7	* PASS
4339.20	51.8	32.5	V	52.9	54.0	-20.4	* PASS


Radiated Emissions Measurments @ 3m OFTS
FCC Section 15.231(e)
Lyngsoe Exciter, Model E95 @ 433.92 MHz
Radiated Emissions @ 3m (dBuV/
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
10
100
1000
10000
Frequency (MHz)

5.9. 433.92 MHZ TRANSMITTER - 20 DB BANDWIDTH @ FCC CFR 47, PARA. 15.209(C)

5.9.1. Limits

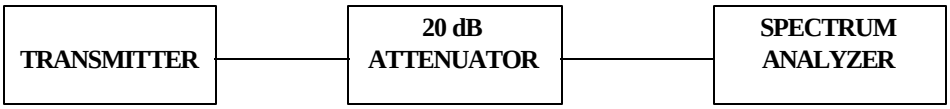
The 20dB bandwidth of the emission shall be no more than 0.25% of the centre frequency for devices operating above 70MHz.

5.9.2. Method of Measurements

Refer to FCC 15.231(e)(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

5.9.3. Test Arrangement



5.9.4. 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

5.9.5. Plots

Please refer to Plot # 5 Annex 1 for Measurements data

5.9.6. Test Data

CHANNEL FREQUENCY (MHz)	20 dB BANDWIDTH (kHz)	MAXIMUM LIMIT (kHz)	PASS/FAIL
433.92	40.0	1085	PASS

EXHIBIT 6. MEASUREMENT UNCERTAINTY

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

6.1. 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 20Log(1±$\Gamma_1\Gamma_R$)	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 7. MEASUREMENT METHODS

7.1. GENERAL TEST CONDITIONS

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

7.1.1. 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.

7.1.2. Normal power source

7.1.2.1. 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.

7.1.2.2. 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.

7.1.3. 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

7.2. RADIATED EMISSIONS

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.

- 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 < 1GHz and RBW = 1 MHz for f ≥ 1 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

   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 10log(dwell time/100mS) 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.

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