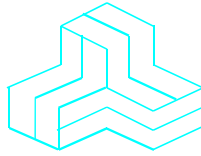


ENGINEERING TEST REPORT



Exciter
Model No.: EX23G

FCC ID: PQG-EX23G

Applicant:

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

In Accordance With
Federal Communications Commission (FCC)
Part 15, Subpart C, Sections 15.209 & 15.231
Low Power Transmitter & Momentarily Operation (125 kHz & 433.92 MHz)

UltraTech's File No.: LYI-025F15C231

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



Date: July 20, 2006

Report Prepared by: Dan Huynh

Tested by: Hung Trinh

Issued Date: July 20, 2006

Test Dates: May 17 - June 18, 2006

- *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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TABLE OF CONTENTS

EXHIBIT 1:	INTRODUCTION.....	1
1.1.	SCOPE	1
1.2.	RELATED SUBMITTAL(S)/GRANT(S)	1
1.3.	NORMATIVE REFERENCES	1
EXHIBIT 2:	PERFORMANCE ASSESSMENT.....	2
2.1.	CLIENT INFORMATION	2
2.2.	EQUIPMENT UNDER TEST (EUT) INFORMATION	2
2.3.	EUT'S TECHNICAL SPECIFICATIONS.....	3
2.4.	LIST OF EUT'S PORTS.....	3
2.5.	ANCILLARY EQUIPMENT	3
2.6.	TEST SETUP BLOCK DIAGRAM	4
EXHIBIT 3:	EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS.....	5
3.1.	CLIMATE TEST CONDITIONS.....	5
3.2.	OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS.....	5
EXHIBIT 4:	SUMMARY OF TEST RESULTS.....	6
4.1.	LOCATION OF TESTS	6
4.2.	APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS	6
4.3.	MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES.....	6
EXHIBIT 5:	MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS.....	7
5.1.	TEST PROCEDURES.....	7
5.2.	MEASUREMENT UNCERTAINTIES	7
5.3.	MEASUREMENT EQUIPMENT USED	7
5.4.	ANTENNA REQUIREMENTS [47 CFR § 15.203]	7
5.5.	AC POWERLINE CONDUCTED EMISSION [47 CFR 15.207(a)]	8
5.6.	PROVISIONS FOR PERIODIC TRANSMITTERS [47 CFR 15.231(a)]	11
5.7.	TRANSMITTER RADIATED EMISSIONS [47 CFR §§ 15.231(b), 15.209 & 15.205]	12
5.8.	20 dB BANDWIDTH [47 CFR 15.231(c)].....	18
EXHIBIT 6:	MEASUREMENT UNCERTAINTY.....	21
6.1.	LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY	21
6.2.	RADIATED EMISSION MEASUREMENT UNCERTAINTY	22

EXHIBIT 1: INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Sections 15.209 and 15.231
Title:	Code of Federal Regulations (CFR), Title 47, Telecommunication - Part 15
Purpose of Test:	To gain FCC Equipment Authorization for a Low Power Transmitter operating at 125 kHz and Section 15.231 - 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:	Commercial, industrial or business environment

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

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19	2005	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	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 +A1 EN 55022	2003-04-10 2004-10-14 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement
CISPR 16-2-3	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Radiated disturbance measurement

EXHIBIT 2: PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Lyngsoe Systems Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada L4Z 2A9
Contact Person:	Donald Ferguson Phone #: 905-501-1533 ext 221 Fax #: 905-501-1538 Email Address: dfe@lyngsoesystems.com

MANUFACTURER	
Name:	Lyngsoe Systems Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada L4Z 2A9
Contact Person:	Donald Ferguson Phone #: 905-501-1533 ext 221 Fax #: 905-501-1538 Email Address: dfe@lyngsoesystems.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 Systems Ltd.
Product Name:	Exciter
Model Name or Number:	EX23G
Serial Number:	Test sample
Type of Equipment:	Low power transmitter & momentarily operated device
Input Power Supply Type:	22 Vac
Primary User Functions of EUT:	The main function of the Exciter EX23G is to generate the LF field, which will wake up tags used in postal quality monitoring systems.

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July 20, 2006

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Base station
Intended Operating Environment:	Commercial, light industry & heavy industry
Power Supply Requirement:	22 Vac $\pm$ 10%, 0.5 A
RF Output Power Rating:	111.63 dB μ V/m peak at 10m distance
Operating Frequency Range:	125 kHz & 433.92 MHz
Duty Cycle:	50 %
20 dB Bandwidth:	42.7 kHz
Modulation Type:	OOK (LF) & FSK (UHF)
Oscillator Frequencies:	20.000 MHz, 13.560 MHz
Antenna Connector Type:	Integral
Antenna Description:	Manufacturer: Lyngsoe Systems Type: Two loops 40 x 40cm, 15 turns each for 125 kHz; PCB loop Antenna for 433.92 MHz Model: N/A Frequency Range: 125 kHz; 433.92 MHz Gain: Not applicable for near field operation @ 125 kHz; -17.2 dBi @ 433.92 MHz

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Power Supply	2	Header,3Pins,4.2mm, RA Molex 39-30-3035	Provo 92234-30 18/16 2/c tin Shld 105C CSA or equivalent
2	RS485 communication	2	Mod Jack,8-8,SE,LP,Shld,RJ45 - Tyco 555153-1	Any CAT5 Ethernet cable
3	Lamps	1	Header,3Pins,3.0mm, RA Molex 43650-0304	Non-shielded

2.5. ANCILLARY EQUIPMENT

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

No ancillary equipment.

2.6. TEST SETUP BLOCK DIAGRAM

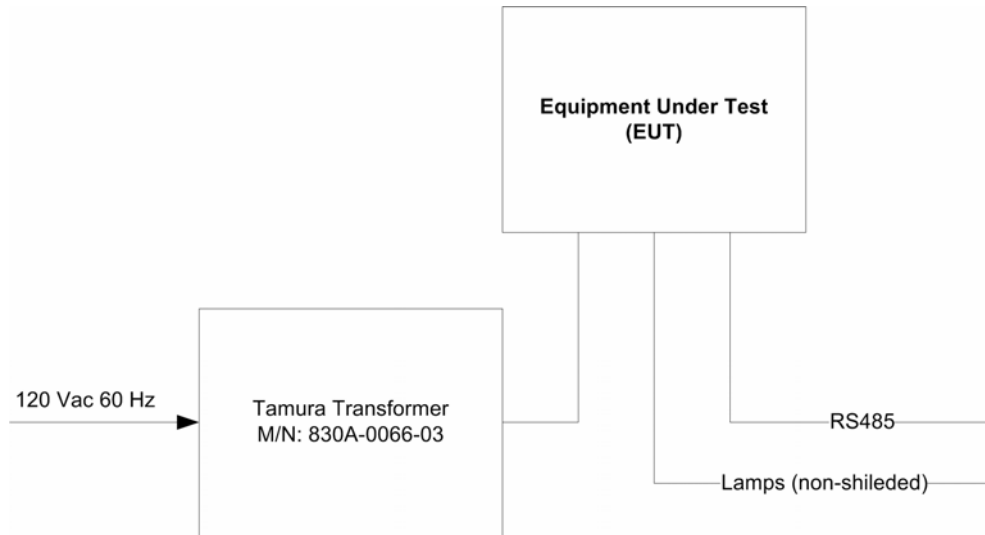


EXHIBIT 3: EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

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:	22 Vac

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The EUT was configured for continuous transmission for the duration of testing.
Special Test Software:	N/A
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT was tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals	
Frequency Band(s):	125 kHz and 433.92 MHz
Test Frequency(ies):	125 kHz and 433.92 MHz
RF Power Output: (measured maximum output power at antenna terminals)	111.63 dBμV/m peak at 10m distance
Normal Test Modulation:	OOK and FSK
Modulating Signal Source:	Internal

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 Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated emissions were performed at the Ultratech's 3-10 TDK semi-anechoic chamber situated in the Town of Oakville, province of Ontario. This test site 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 3-10 TDK semi-anechoic chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last date of site calibration: June 20, 2005.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna Requirement	Yes
15.207(a)	AC Powerline Conducted Emissions	Yes
15.231(a)	Provisions for Periodic Operation	Yes
15.231(b) 15.109 15.209	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious Emissions	Yes
15.231(c)	20 dB Bandwidth	Yes
15.231(d)	Frequency Tolerance for Devices Operating within the Frequency Band 40.66-40.70 MHz	Not applicable

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 ANSI C63.4 and Ultratech's test procedures ULTR-P001-2004.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 with a confidence level of 95%. Please refer to Exhibit 6 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 C63.4 and CISPR 16-1.

5.4. ANTENNA REQUIREMENTS [47 CFR § 15.203]

5.4.1. Requirements

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.

Notes: 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.

5.4.2. Engineering Analysis

The antenna is an integral part of the EUT; it is soldered onto the radio printed circuit board and located inside the enclosure.

5.5. AC POWERLINE CONDUCTED EMISSION [47 CFR 15.207(a)]

5.5.1. Limit

The equipment shall meet the limits of the following table:

Frequency of emission (MHz)	Conducted Limits (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases linearly with the logarithm of the frequency

5.5.2. Method of Measurements

Refer to ANSI C63.4.

5.5.3. 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
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 μ H
RF Shielded Chamber	Braden Shielding	...	...	...

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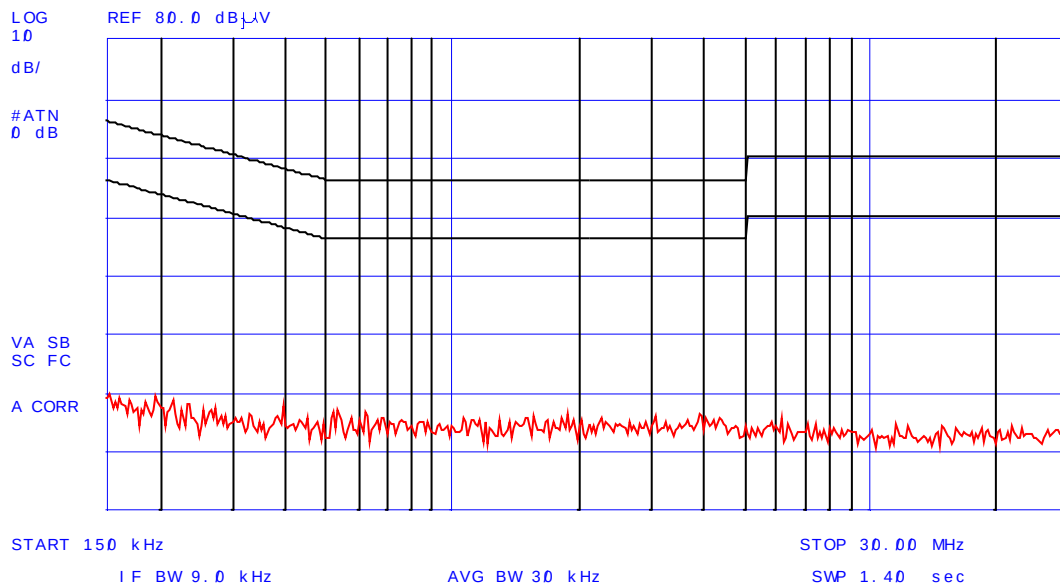
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.5.4. Test Data

Plot 5.5.4.1
AC Powerline Conducted Emission
Line Voltage: 120VAC 60Hz
Line Tested: L1

HP

ACTV DET: PEAK
MEAS DET: PEAK QP AVG



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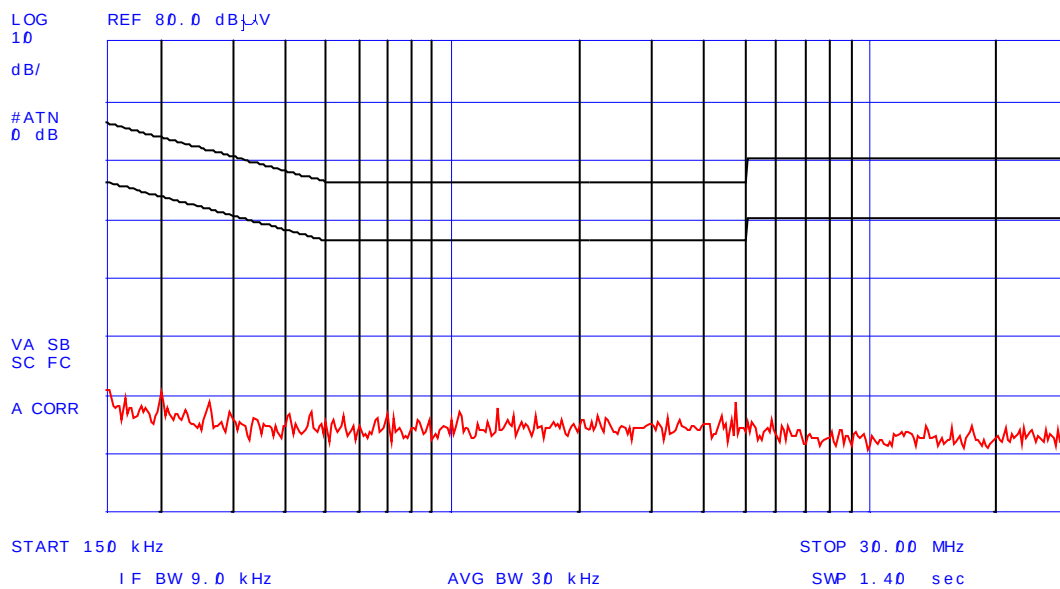
File #: LYI-025F15C231
July 20, 2006

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 5.5.4.2
AC Powerline Conducted Emission
Line Voltage: 120VAC 60Hz
Line Tested: L2

HP

ACTV DET: PEAK
MEAS DET: PEAK QP AVG



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5.6. PROVISIONS FOR PERIODIC TRANSMITTERS [47 CFR 15.231(a)]

5.6.1. Engineering Analysis

FCC Rules	FCC Provisions	Analysis on Compliance
15.231(a)	The intentional radiator restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal.	The EUT transmission contains a fixed recognition code only, it does not transmit data.
15.231(a)(1)	A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.	N/A
15.231(a)(2)	A transmitter activated automatically shall cease transmission within 5 seconds after activation.	The transmitter is automatically deactivated within 1 second.
15.231(a)(3)	Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.	N/A
15.231(a)(4)	Intentional radiators which are 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
15.231(a)(5)	Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.	N/A

5.7. TRANSMITTER RADIATED EMISSIONS [47 CFR §§ 15.231(b), 15.209 & 15.205]

5.7.1. Limits

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70.	2,250	225
70-130	1,250	125
130-174	¹ 1,250 to 3,750	¹ 125 to 375
174-260	3,750	375
260-470	¹ 3,750 to 12,500	¹ 375 to 1,250
Above 470	12,500	1,250

¹ Linear interpolations with frequency F in MHz:

For 130-174 MHz: FS (microvolts/m) = (56.82 x F) - 6136

For 260-470 MHz: FS (microvolts/m) = (41.67 x F) - 7083.

- (1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
- (2) Intentional radiators operating under the provisions of this Section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Section 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Section 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

47 CFR 15.205(a) Restricted bands of operation

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 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	2690-2900	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	(²)
13.36-13.41.			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

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July 20, 2006

- (3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

47 CFR 15.209(a) General Field Strength Limits

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/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
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76– 88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.		

5.7.2. Method of Measurements

Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods.

5.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
EMI Receiver System / Spectrum Analyzer	Hewlett Packard	HP 8546A	3520A00248	9KHz-5.6GHz, 50 Ohms
Microwave Amplifier	Hewlett Packard	HP 83017A	311600661	1 GHz to 26.5 GHz
Loop Antenna	EMCO	6502	2611	10 kHz - 30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz - 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz - 18 GHz

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5.7.4. Test Data

5.7.4.1. For Fundamental Frequency at 125 kHz

Frequency (MHz)	RF Peak Level @10m (dBμV/m)	⁽¹⁾ RF Avg Level (dBμV/m)	Antenna Plane	⁽²⁾ Limit @10m 15.209 (dBμV/m)	Margin (dB)
0.125	109.93	103.91	0 degree	114.3	-10.39
0.125	111.63	105.61	90 degree	114.3	-8.69
The emissions were scanned from 10 kHz to 1 GHz and all spurious emissions were more than 20 dB below the permissible limits.					

Remarks:

- (1) Duty Cycle = 0.50 (Tx on = Tx off)

$$\text{Peak-to-Average factor} = 20 \cdot \log(0.50) = -6.02 \text{ dB}$$

- (2) The 300m limit was converted to 10 m using cube factor (x) as it was found by measurements as follows:

- Maximum E-field at 10 meters distance: 111.63 dBμV/m (vertical)
- Maximum E-field at 20 meters distance: 93.79 dBμV/m (vertical)

$$\begin{aligned} \text{Difference of measurement between 10 m \& 20 m: } \Delta E &= 111.63 - 93.79 = 17.84 \text{ dB} \\ \Delta E &= 20 \cdot \log(20/10)^x = 17.84 \text{ dB} \text{ or } x = 17.84 / (20 \cdot \log(20/10)) = 2.96 \end{aligned}$$

Therefore the limit for 125 kHz at 10 meters were calculated as:

$$\text{Limit}_{10\text{m}} = \text{Limit}_{300\text{m}} + 20 \cdot \log(300/10)^3 = 20 \cdot \log(2400/125) + 60 \cdot \log(300/10) = 114.3 \text{ dB}\mu\text{V/m}$$

5.7.4.2. For Fundamental Frequency at 433.92 MHz

The emissions were scanned from 30 MHz to 5000 MHz and all significant emissions were recorded.						
Note:						
- For portable transmitter, EUT was placed in three different orthogonal positions for searching maximum field strength level. - In the restricted band per FCC 15.205: § 15.209 (a) limits applied - Outside the restricted band per FCC 15.205: § 15.231 (b) limits or § 15.209 (a) applied, whichever allows higher field strength emission.						
Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Average E-Field @ 3m (dBµV/m)	Antenna Plane (H/V)	§ 15.231 (b) Limits @ 3m (dBµV/m)	§ 15.209 (a) Limits @ 3m (dBµV/m)	Margin (dB)
433.92	80.39	60.68	V	80.8	--	-20.1
433.92	81.45	61.74	H	80.8	--	-19.1
2169.60	61.46	41.75	V	60.8	54.0	-19.1
2169.60	62.90	43.19	H	60.8	54.0	-17.6
2603.52	65.65	45.94	V	60.8	54.0	-14.9
2603.52	67.80	48.09	H	60.8	54.0	-12.7
3037.44	60.51	40.80	V	60.8	54.0	-20.0
3471.36	73.63	53.92	V	60.8	54.0	-6.9
3471.36	72.83	53.12	H	60.8	54.0	-7.7
*3905.28	61.07	41.36	V	60.8	54.0	-12.6
*3905.28	57.68	37.97	H	60.8	54.0	-16.0
*4339.20	63.04	43.33	V	60.8	54.0	-10.7
*4339.20	64.60	44.89	H	60.8	54.0	-9.1

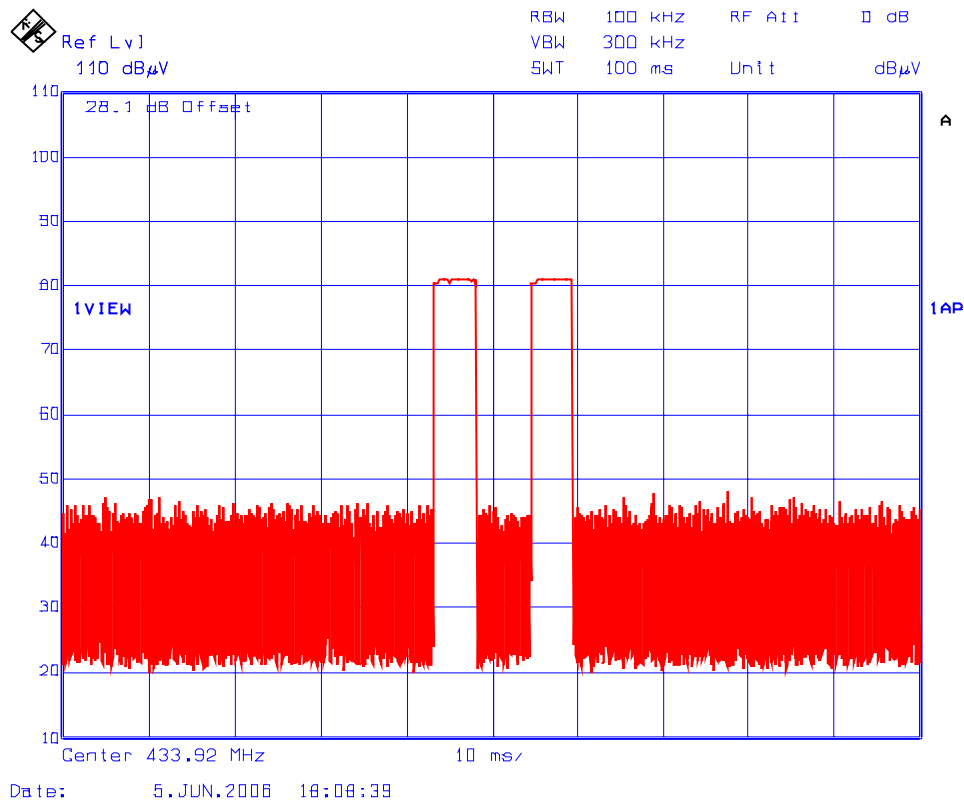
* Emissions within the restricted bands.

Remarks:

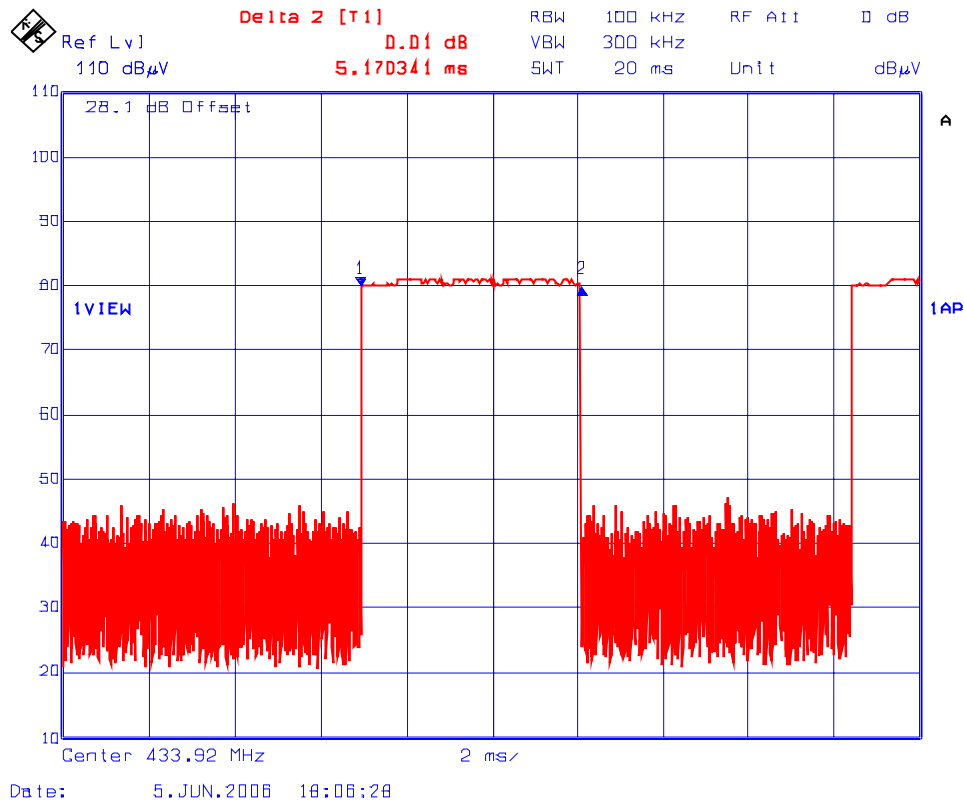
- Field strength limit of the fundamental at 433.92 MHz = $20 \log [(41.67 \times 433.92) - 7083] = 80.8 \text{ dB}\mu\text{V/m}$
- Spurious emissions limit is 20 dB below fundamental limit.
- Duty Cycle Measurements: $2 * 5.170341 \text{ msec} / 100 \text{ msec} * 100 = 10.34 \%$
- Peak-Average Conversion factor = $20 * \log(2 * 5.170341/100) = -19.71 \text{ dB}$

See the following plots for detailed duty cycle measurements.

Plot 5.7.4.2.1: Duty Cycle in 100 ms
Tx Frequency: 433.92 MHz



Plot 5.7.4.2.2: Duty Cycle
Pulse Length Measurement
Tx Frequency: 433.92 MHz



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File #: LYI-025F15C231
July 20, 2006

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5.8. 20 dB BANDWIDTH [47 CFR 15.231(c)]

5.8.1. Limits

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

5.8.2. Method of Measurements

The measurements were performed in accordance with Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4:2003.

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna. The bandwidth of the fundamental frequency was measured with the spectrum analyzer, with the resolution bandwidth of the spectrum analyzer set per ANSI 63.4, Section 13.1.7

5.8.3. Test Equipment List

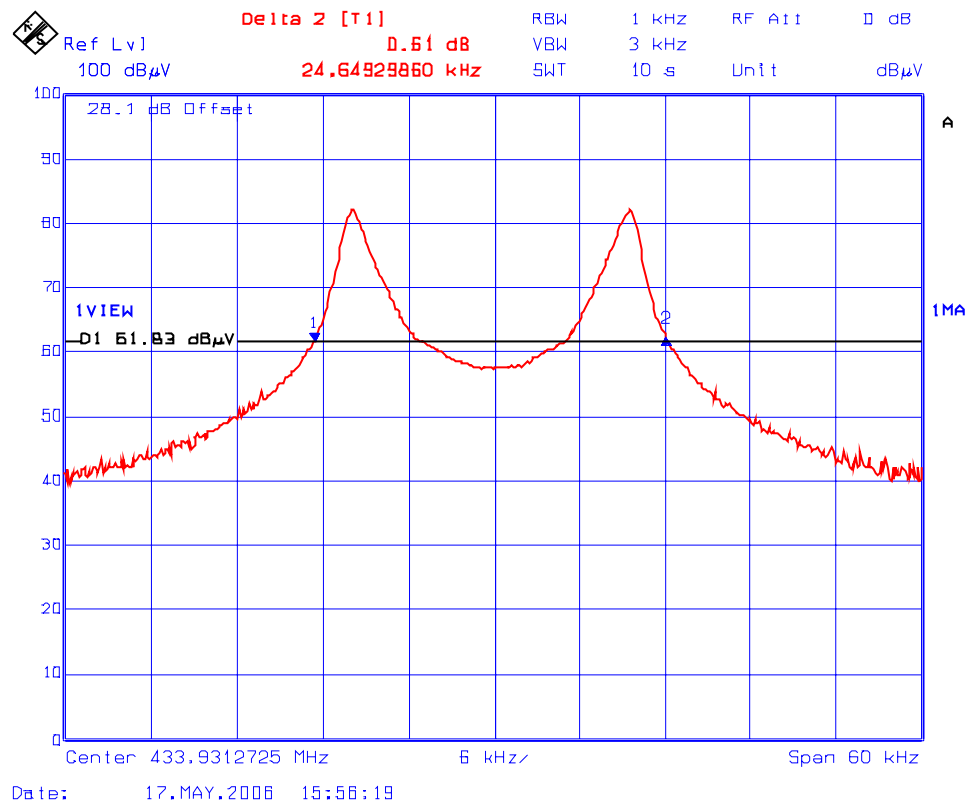
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
EMI Receiver System / Spectrum Analyzer	Hewlett Packard	HP 8546A	3520A00248	9KHz-5.6GHz, 50 Ohms
Microwave Amplifier	Hewlett Packard	HP 83017A	311600661	1 GHz to 26.5 GHz
Loop Antenna	EMCO	6502	2611	10 kHz - 30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz

5.8.4. Test Data

Channel Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Bandwidth Limit (kHz)
433.92	42.7	1084.8

See the following plot for details.

Plot 5.8.4.1: 20 dB Bandwidth
Fc: 433.92 MHz (FSK modulation with a rectangular signal at 1bps)



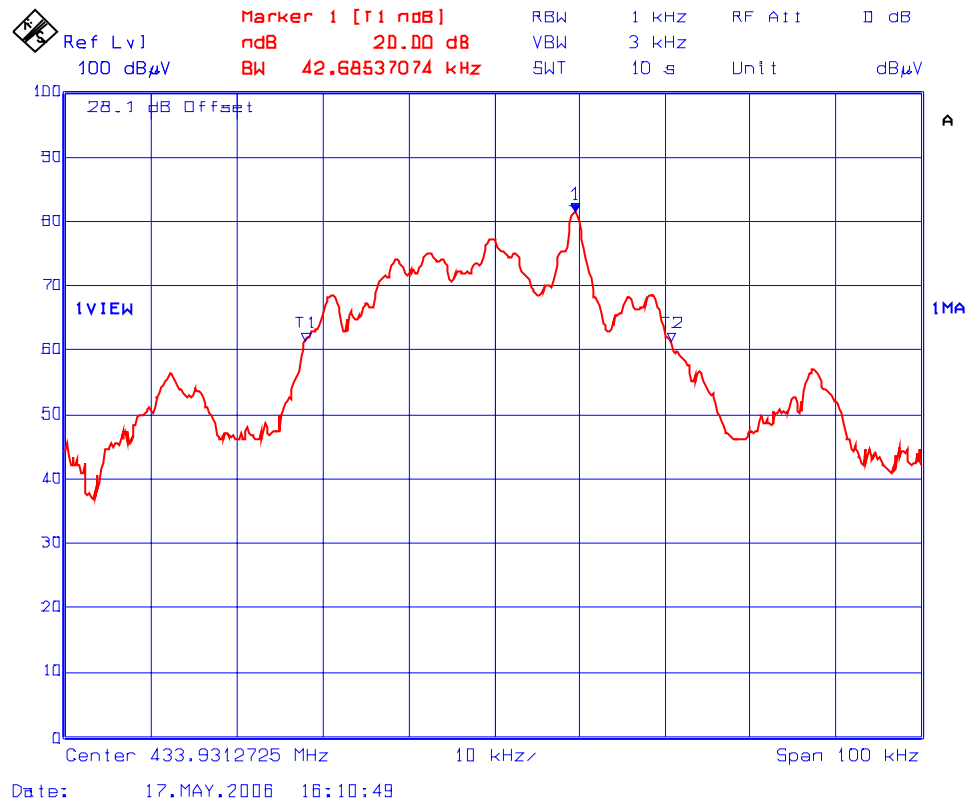
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File #: LYI-025F15C231
July 20, 2006

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Plot 5.8.4.2: 20 dB Bandwidth
Fc: 433.92 MHz (FSK modulation with programmed message)



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File #: LYI-025F15C231
July 20, 2006

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EXHIBIT 6: MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and LAB 34

6.1. 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 $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ Uncertainty limits $20\text{Log}(1+\Gamma_1\Gamma_R)$	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:

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

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

6.2. 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 Directivity	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 $\Gamma_R = 0.67(\text{Bi}) 0.3 (\text{Lp})$ 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:

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

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