UltraTech
Group of Labs

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Sept. 08, 2004

SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC.
P.O. Box 4225, 1954 Technology Drive
Peterborough, Ontario
Canada, K9J 7B1

Attn.: **Mr. Enzo De Simone**

Subject: **FCC Certification Authorization Application under FCC PART 15, Subpart C, Sec. 15.209 – Low Power Licence-Exempt RadioCommunication Devices totally enclosed in Metal and Concrete Containers and swept in the frequency band 24.2 - 25.2 GHz.**

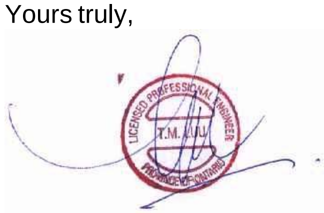
Product: **SITRANS LR 400 (25 GHZ RADAR LEVEL GAUGE)**
Model No.: **7ML5420 & 7ML5421**
FCC ID: **NJA-LR400-1**

Dear Mr. De Simone,

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 Transmitters operating in the frequency band 24.2 - 25.2 GHz.**

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

ENGINEERING TEST REPORT

SITRANS LR 400 (25 GHZ RADAR LEVEL GAUGE)
(for use with Metal and Concrete Tanks/Vessels without ventilation)
Model No.: 7ML5420 & 7ML5421

FCC ID: NJA-LR400-1

Applicant: **SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC.**
P.O. Box 4225, 1954 Technology Drive
Peterborough, Ontario
Canada, K9J 7B1

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.209
Low Power Licence-Exempt RadioCommunication Devices totally enclosed in Metal and Concrete Containers and swept in the frequency band 24.2 - 25.2 GHz.

UltraTech's File No.: MIL-322F15C

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Sept. 08, 2004	LICENSED PROFESSIONAL ENGINEER T.M. LUU PROVINCE OF ONTARIO
Report Prepared by: Tri Luu, P.Eng. Issued Date: Sept. 08, 2004	Tested by: Tri Luu & Hung Trinh Test Dates: Aug. 05 & 24, 2004

- *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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31040/SIT C-1376 46390-2049 200093-0 SL2-IN-E-1119R 00-034

TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.209:1998
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low Power Transmitters operating in the Frequency Band 24.2 - 25.2 GHz .
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:	• Industry

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

None

1.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR Parts 0-19	2004	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	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	2003 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	2003	Specification for Radio Disturbance and Immunity measuring apparatus and methods

1.4. DIFFEENCE BETWEEN MODEL 7ML5420 & 7ML5421

The Model 7ML5420 was certified by FCC under FCC ID: NJA-LR400. The new variant of the Sitrans LR400 radar unit has the following differences from the existing FCC Certified Sitrans LR400 radar unit:

Description	**Existing Sitrans LR400 (7ML5421)**	**New Sitrans LR400, Easy Aimer Version (7ML5420)**
Enclosure and Electronics	Is offered with 24 & 25 GHz technology modules, HART and PROFIBUS communications, 24V DC & 110 to 230V AC power supply. The enclosure is available with both M20 and ½" NPT connections.	Remains the same as that of existing Sitrans LR400
HF Cable and transition	Uses Spinner transition with the cable exiting vertically	Uses new transition designed by SMPI with cable exiting from the side. Refer the sketch below for details.
Waveguide	Has a 8mm waveguide made of SS316	Uses a 8.6mm waveguide made SS304. Refer the sketch below for details. The waveguide also acts a swiveling mechanism to aim the antenna a various angles of repose
Fastening Mechanism	Uses orings and threaded nut to connect the electronics to the process side	Uses M20 threads with face seal done by FKM orings to connect the electronics to the process side. Refer the sheet 10 of drawing 23650263 rev 2 for details.
Flange	Has both pressure and non-pressure rated flanges of 3", 4" & 6" sizes.	Uses 2", 3", 4" & 6" non-pressure rated universal slotted flanges.
Emitter	Uses PTFE emitter with FKM (viton) or PTFE orings to seal.	Uses new PTFE emitter with integral bumps to seal. Refer the sheet 10 of drawing 23650263 rev 2 for details.
Flange to Waveguide (zonal) Seals	Uses FKM (viton) or PTFE orings and pressure seal weld to form the seal	Uses specially designed FKM / PTFE seal.
Horn antenna	Uses 3" and 4" horn antenna of SS316 construction	Uses 2", 3" & 4" horn antenna made of SS304
Options	Use PTFE dust covers with various horn antennae and 100 & 200 mm horn antenna extension of SS316 construction	Use dust covers with various horn antennae and 100 & 200 mm horn antenna extension made of SS304

For convenience of labeling and marketing, the applicant wish to re-certify both old and new Models under one FCC Grant.

Photo #1: PHOTO SHOWING THE DIFFERENCE BETWEEN THE EXISTING AND NEW VERSIONS OF SITRANS LR400

Figure 1: DRAWING SHOWING THE DIFFERENCE BETWEEN THE EXISTING AND NEW VERSIONS OF SITRANS LR400

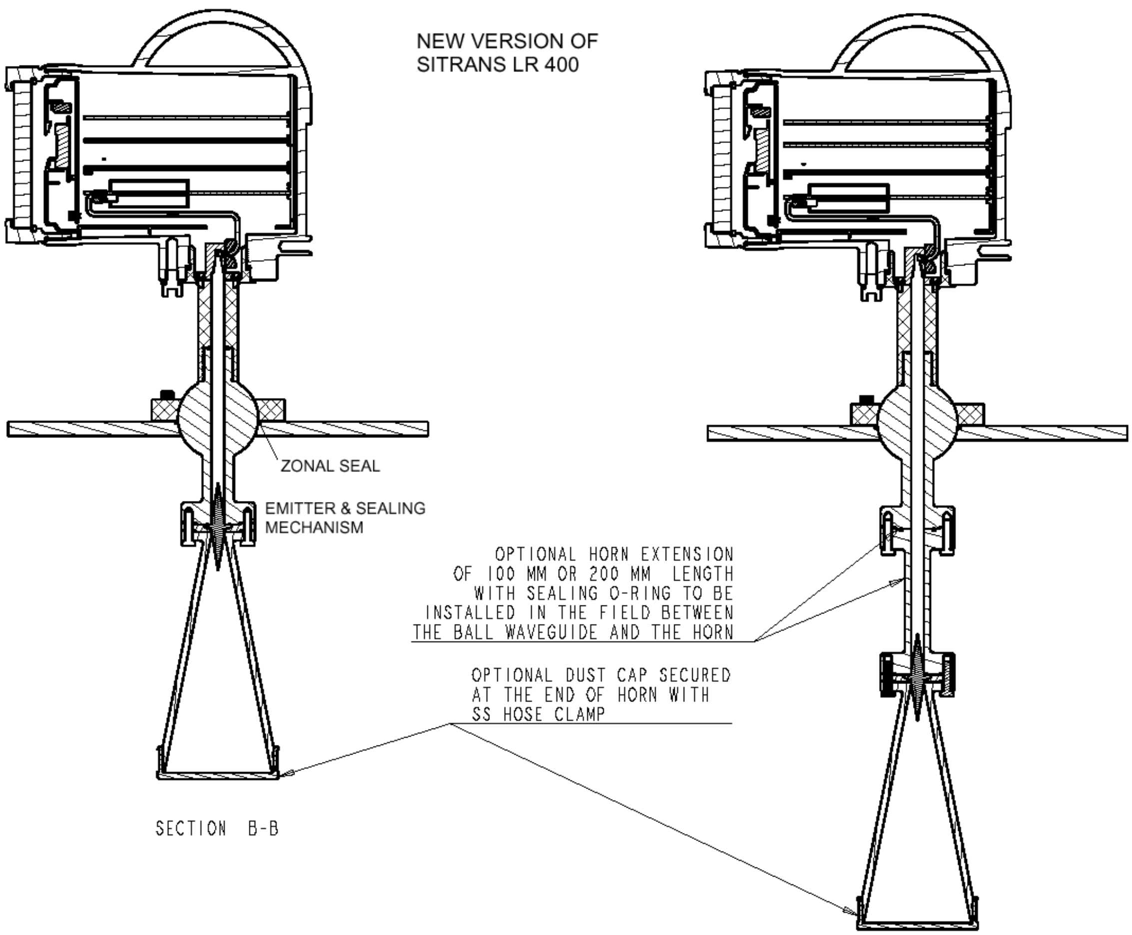


EXHIBIT 1. PERFORMANCE ASSESSMENT

1.1. CLIENT INFORMATION

APPLICANT:	
Name:	SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC.
Address:	1954 Technology Drive P.O. Box 4225 Peterborough, Ontario Canada, K9J 7B1
Contact Person:	Mr. Enzo De Simone Phone #: 705-740-7009 Fax #: 705-741-0466 Email Address: Enzo.desimone@siemens.com

MANUFACTURER:	
Name:	SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC.
Address:	1954 Technology Drive P.O. Box 4225 Peterborough, Ontario Canada, K9J 7B1
Contact Person:	Mr. Enzo De Simone Phone #: 705-740-7009 Fax #: 705-741-0466 Email Address: Enzo.desimone@siemens.com

1.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name	SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC.
Product Name	SITRANS LR 400 (25 GHZ RADAR LEVEL GAUGE)
Model Name or Number	7ML5420 & 7ML5421
Serial Number	Pre-production sample
Type of Equipment	Low Power Licence-Exempt RadioCommunication Devices totally enclosed in Metal and Concrete Containers and swept in the frequency band 24.2 - 25.2 GHz.
Input Power Supply Type	• AC Mains or • External DC Sources
Intended Use/Purpose of the Equipment	• Measure the level of material inside a closed tank

1.3. EUT'S TECHNICAL SPECIFICATIONS

1. Introduction

Siemens Milltronics 7ML5420 & 7ML5421 is intended for use in process industries for the determination of material level in tanks and other process vessels. The principle used is Frequency Modulated Continuous Wave (FMCW). A microwave frequency is generated whose frequency varies with time. This signal is directed towards the target. The signal is reflected by the target and received by the antenna. The time of flight of the pulse, τ is calculated by comparing the transmitted and received frequencies for a given sweep rate.

2. Technical Description

The sweep frequency is obtained by mixing the output of the 2.4 GHz Voltage Controlled Oscillator (VCO) with the 22.4 GHz Local Oscillator (LO). VCO is also applied directly to a saw-wave reference (OFW) to obtain the reference signal REF which can be used to maintain the accuracy of the device over temperature. The sweep (frequency sum of LO and VCO) is applied to the antenna via a splitter. The received signal is then mixed with the transmitted signal to obtain the measured signal MESS (difference frequency). Since in a real measuring system multiple targets exist, the measurement signal will not be a single frequency but will be a combination of many frequencies representing the different targets. Digital Signal Processing techniques are used to extract the frequencies present in the measured signal and to reject false targets to select the correct target and calculate the target distance.

TRANSMITTER	
Equipment Type:	▪ Base station (fixed use)
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	AC 120V 60 Hz / DC 24 V (with regulated DC voltage input to the radio transmitter)
RF Output Power Rating:	0.0 Watts EIRP
Operating Frequency Range:	24.2 - 25.2 GHz
Frequency of Operation:	24.7 GHz
Duty Cycle in 100 mS:	24% Time on = 2 mS+22mS = 24 mS pulse train = Time on +Time off = 135 mS
RF Output Impedance:	50 Ohms
Bandwidth:	1000 MHz
Modulation Type:	Frequency Modulated Continuous Wave (FMCW)
Emission Designation:	1G00F0X
Oscillator Frequencies:	22.4 GHz (lo)
Antenna Connector Type:	• Integral, permanently attached
Antenna Description:	Manufacturer: Siemens Milltronics Type: 2", 3" and 4" Horn Antennas Maximum Gains: 18.5 dBi (2" horn), 22 dBi (3" horn) and 24 dBi (4" horn) In/Out Impedance: 50 Ohms

1.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	3 Prong AC Mains or 2 Conductor-DC Mains	1		Non-shielded
2	Hart / Profibus Communication Port	1		Shielded

1.5. ANCILLARY EQUIPMENT

None

EXHIBIT 2. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

2.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	DC 24 V or AC 120V 60 Hz

2.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	Normal continuous transmission
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.

2.3. GENERAL TEST SETUP

2.3.1. Test Configuration #1: Metal Tank with no ventilation

The 7ML5420 & 7ML5421 is mounted on top of the metal tank with no ventilation, which contains water. The fundamental and spurious/harmonic emissions were scanned at distances of 0.2, 0.5, 1 and 3 meters.

Please refer to Photo # 3 in Annex 1 for detailed of test set up.

2.3.2. Test Configuration #2: Concrete Tank with ventilation

The 7ML5420 & 7ML5421 is mounted on top of the concrete vessel with ventilation, which contains cement in a cement plant. The fundamental and spurious/harmonic emissions were scanned at distances of 0.2, 0.5, 1 and 3 meters.

Please refer to Photos # 4 to 6 in Annex 1 for detailed of test set up.

Remark: Tests were performed for the LR 400 with the 4” horn (maximum gain) and the results shall represent the worst case including 2” and 3 horn antennas.

EXHIBIT 3. SUMMARY OF TEST RESULTS

3.1. LOCATION OF TESTS

All of the measurements described in this report were performed by 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 measurement in the frequency range 10 MHz to 100 GHz, except the fundamental operating band 24.2-25.2 GHz, were performed at the Ultratech's 10 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, Province of Ontario. It was tested with the antenna pointed downward to the ground.

  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: Feb. 17, 2004.

- Radiated Emissions at the fundamental operating frequency band 24.2-25.2 GHz were performed on-site at the Siemens Milltronics' and St Mary's in Ontario, Canada. It was tested with EUT mounted on the concrete and metal tanks and it's antenna pointed downward to the bottom of the tanks.

3.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	Yes
15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices, the associated Radio Receiver operating in 24.2 - 25.2 GHz is exempted from FCC's authorization. The engineering test report can be provided upon FCC requests.		

EXHIBIT 4. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

4.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 6 of this report and ANSI C63.4.

4.2. 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 5 for Measurement Uncertainties.

4.3. MEASUREMENT EQUIPMENT USED:

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

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

The essential function of the EUT is to correctly measure the level of material which is stored in an enclosed tank.

4.5. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.107(A)

4.5.1. Limits

The equipment shall meet the limits of the following table:

	CLASS B LIMITS		
Test Frequency Range (MHz)	**Quasi-Peak (dBµV)**	**Average* (dBµV)**	**Measuring Bandwidth**
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 10 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 10 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 10 Hz for Average

* Decreasing linearly with logarithm of frequency

4.5.2. Method of Measurements

Refer to Exhibit 6, Sec. 6.2 of this test report & ANSI C63.4

4.5.3. 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 µH
12'x16'x12' RF Shielded Chamber	RF Shielding	N/A	N/A	N/A

4.5.4. Photographs of Test Setup

Refer to the Photographs #1 & #2 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

4.5.5.2. Test Configuration #2: Model 7ML5421 - AC Power Supply Option (120V, 60 Hz)

Plot # 3: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT			
Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 22C°	Humidity: 53%
Line Tested: Line 1	Line Voltage 120V AC	Test Tech: Hung	Test Date: July 16, 04
Standard: FCC Class B	Comments:		

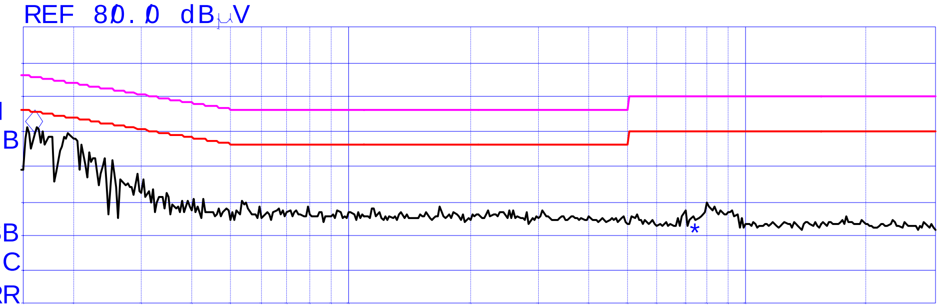
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.161538	51.8	42.4	13.5	-23.0

No user Menu

MARKER
160 kHz
48.93 dBµV

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 160 kHz
48.93 dBµV

LOG REF 80.0 dBµV
10 dB/
#ATN 10 dB
MA SB
SC FC
ACORR



START 150 kHz STOP 30.00 MHz
#IF BW 9.0 kHz AVG BW 30 kHz SWP 1.40 sec

Plot # 4: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT			
Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 22C°	Humidity: 53%
Line Tested: Line 2	Line Voltage 120V AC	Test Tech: Hung	Test Date: July 16, 04
Standard: FCC Class B	Comments:		

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.152425	53.6	45.5	14.0	-20.3

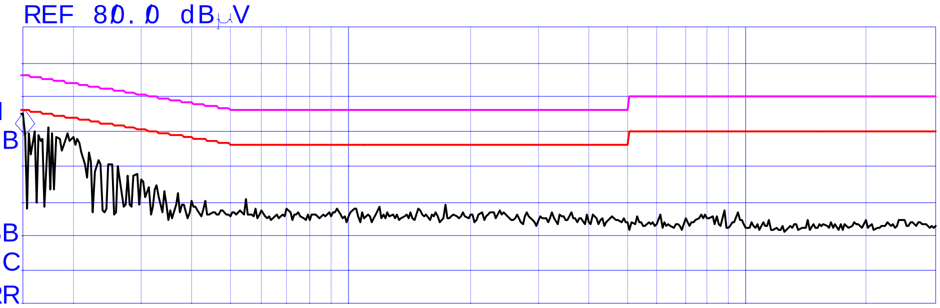
No user Menu

MARKER
150 kHz
48.56 dBμV

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 150 kHz
48.56 dBμV

LOG REF 80.0 dBμV
10
dB/
#ATN
10 dB

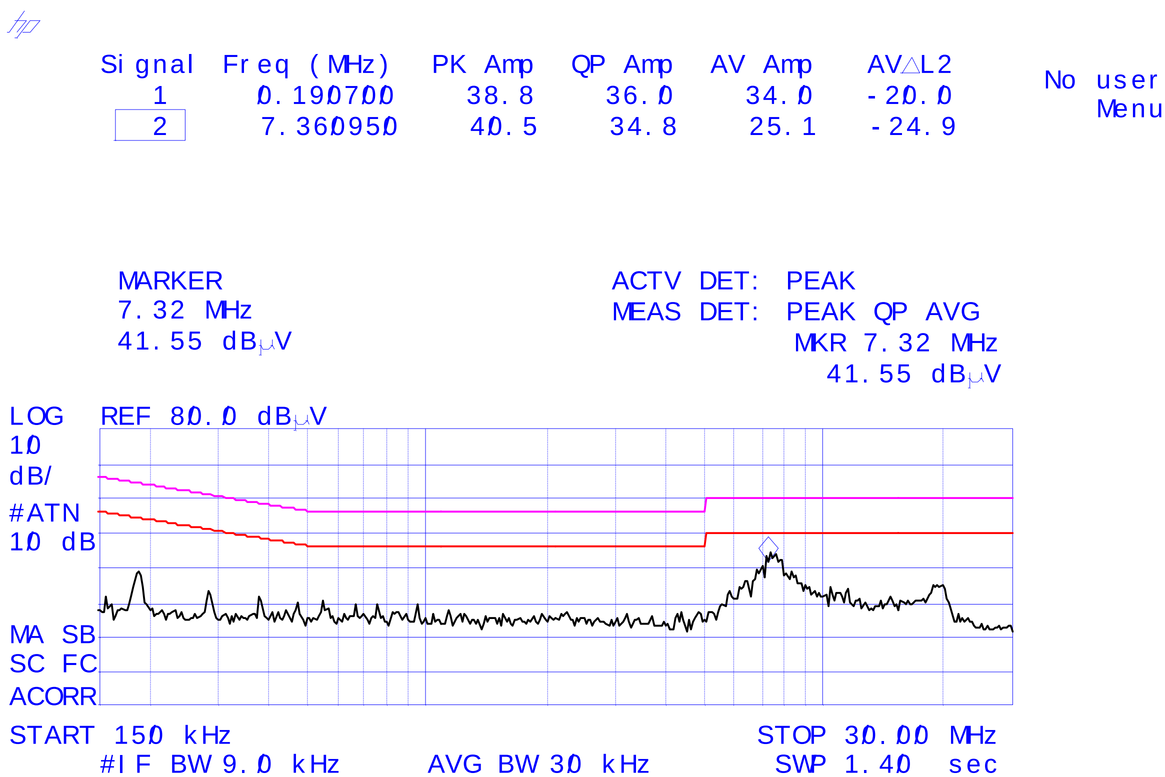
MA SB
SC FC
ACORR



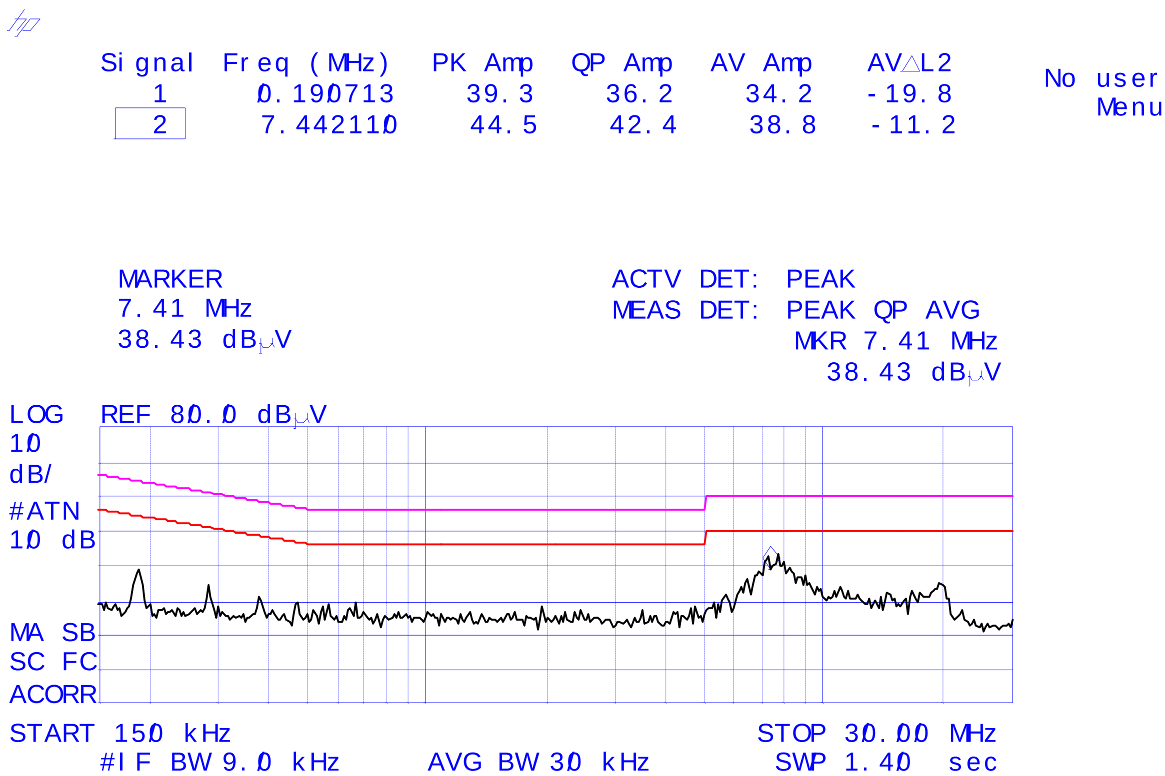
START 150 kHz
#IF BW 9.0 kHz
AVG BW 30 kHz
STOP 30.00 MHz
SWP 1.40 sec

4.5.5.3. Test Configuration #3: Model 7ML5421 - DC Power Supply Option (24 Vdc)

Plot # 5: DC POWER LINE CONDUCTED EMISSIONS MEASUREMENT			
Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 22C°	Humidity: 53%
Line Tested: Line 1	Line Voltage 24 Vdc	Test Tech: Hung	Test Date: July 16, 04
Standard: FCC Class B	Comments:		



Plot # 6: DC POWER LINE CONDUCTED EMISSIONS MEASUREMENT			
Detector: [X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 22C°	Humidity: 53%
Line Tested: Line 2	Line Voltage 24 Vdc	Test Tech: Hung	Test Date: July 16, 04
Standard: FCC Class B	Comments:		



4.6. TRANSMITTER SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.209 & 15.205

4.6.1. 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

4.6.2. Method of Measurements

Refer to Exhibit 6, Sec. 6.3 of this test report and **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

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

4.6.3. Test Arrangement

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

4.6.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Rohde & Schawrz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz with external mixer
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	8593EM	3412A00103	9 kHz – 26.5 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
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	N/A	18 GHz – 26.5 GHz
Horn Antenna	EMCO	3160-10	N/A	26.5 GHz – 40 GHz
Mixer	Tektronix	118-0098-00	N/A	18 GHz – 26.5 GHz
Mixer	Tektronix	119-0098-00	N/A	26.5 GHz – 40 GHz
Horn Antenna & Mixer	OML	WR-19	U30625-1	40 –60 GHz
Horn Antenna & Mixer	OML	E-Band	E30625-1	60 – 90 GHz
Horn Antenna & Mixer	OML	WR-08	F30625-1	90 –140 GHz

4.6.5. Photographs of Test Setup

Refer to the Photographs #3 & #6 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

4.6.6. Test Data

4.6.7. Test Configuration #1: Model 7M5420 - Metal Tank with no ventilation

FREQUENCY (GHz)	RF PEAK LEVEL READING (E) @ 0.2 - 3m (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
24.2 – 25.2	<<	H & V	54.0	>>	Pass
0.01 – 100	<<	H & V	Refer to 15.209	>>	Pass

<< No emissions were found in the frequency range from 10 MHz to 100 GHz at any distance from 0.2 m to 3.0 m, when the 7ML5420 & 7ML5421 was mounted on top of the metal tank, between the found and the tank and secured to the tank by means of screws and nuts, its antenna is pointed downward to the bottom of the tank.

Refer to Photo # 3 in the Annex 1 for details of test setup.

4.6.8. Test Configuration #2: Model 7M5420 Concrete Tank with ventilation

FREQUENCY (GHz)	RF PEAK LEVEL READING (E) @ 0.2 - 3m (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
24.2 – 25.2	<<	H & V	54.0	>>	Pass
0.01 – 100	<<	H & V	Refer to 15.209	>>	Pass

<< No emissions were found in the frequency range from 10 MHz to 100 GHz at any distance from 0.2 m to 3.0 m, when the 7ML5420 & 7ML5421 was mounted on top of the metal tank, between the found and the tank and secured to the tank by means of screws and nuts, its antenna is pointed downward to the bottom of the tank.

Refer to Photos # 4 to 6 in the Annex 1 for details of test setup.

4.6.9. Test Configuration #3: Model 7M5421 - Metal Tank with no ventilation

FREQUENCY (GHz)	RF PEAK LEVEL READING (E) @ 0.2 - 3m (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
24.2 – 25.2	<<	H & V	54.0	>>	Pass
0.01 – 100	<<	H & V	Refer to 15.209	>>	Pass

<< No emissions were found in the frequency range from 10 MHz to 100 GHz at any distance from 0.2 m to 3.0 m, when the 7ML5420 & 7ML5421 was mounted on top of the metal tank, between the found and the tank and secured to the tank by means of screws and nuts, its antenna is pointed downward to the bottom of the tank.

Refer to Photo # 3 in the Annex 1 for details of test setup.

4.6.10. Test Configuration #4: Model 7M5421 Concrete Tank with ventilation

FREQUENCY (GHz)	RF PEAK LEVEL READING (E) @ 0.2 - 3m (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
24.2 – 25.2	<<	H & V	54.0	>>	Pass
0.01 – 100	<<	H & V	Refer to 15.209	>>	Pass

<< No emissions were found in the frequency range from 10 MHz to 100 GHz at any distance from 0.2 m to 3.0 m, when the 7ML5420 & 7ML5421 was mounted on top of the metal tank, between the found and the tank and secured to the tank by means of screws and nuts, its antenna is pointed downward to the bottom of the tank.

Refer to Photos # 4 to 6 in the Annex 1 for details of test setup.

EXHIBIT 5. MEASUREMENT UNCERTAINTY

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

5.1. 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 $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	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:

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

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

5.2. 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 $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits $20Log(1\pm\Gamma_1\Gamma_R)$	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 6. MEASUREMENT METHODS

6.1. GENERAL TEST CONDITIONS

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

6.1.1. Normal temperature and humidity

- Normal temperature: +15^{o}C to +35^{o}C
- Relative Humidity: +20% to 75%

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

6.1.2. Normal power source

6.1.2.1. 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.

6.1.2.2. 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.

6.1.3. 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

6.2. 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 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.
- If 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.

6.3. SPURIOUS 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 10^{th} harmonic of the highest frequency generated by the EUT or 100 GHz whichever is lower.

- 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.