UltraTech
Group of Labs

Dec. 27, 2000

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

**Subject:** **FCC Certification Authorization Application under FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitters operate at 6.3 GHz.**

**Product:** **SIEMENS MILLTRONICS RADAR LEVEL GAUGE (6.3 GHZ)**
**Model No.:** **IQ RADAR 300**
**FCC ID:** **NJA-IQ300**

Dear Sir/Madam

As appointed agent for SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC., 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.

- Operational/Applicable Characteristics of Operation:

  The transmitter is only designed to radiate a 6.3 GHz RF signal inside a tank/ vessel, which may be made of any of material such as plastic, metal, concrete and etc….. The 6.3 GHz RF signal radiates downward to the bottom of the tank/vessel. With the support of proper enclosure shielding, no rf signal shall be radiated to the free space outside the tank with the distance more than 1 meter from the antenna.

- Test Setup for Radiated Emissions:

  In all application, the IQ RADAR 300 is required to be mounted on top the tank/vessel with the antenna fitted inside the tank and faced downward to the bottom of the tank (ground). Therefore, the transmitter will be tested in the open area with the antenna points downward to the ground. This will represent the worst case among its application in any tanks/vessels. No RF emissions shall be observed at a 1 meter distance from the transmitting antenna.

- Compliance with RF Exposure Requirements:

  In all application, the IQ RADAR 300 is required to be mounted on top the tank/vessel with the antenna fitted inside the tank. No users can possibly reach close to the antenna under its operation. Therefore, no RF Exposure Warning is necessary per FCC 2.1091 since the radius of tanks/vessels are always greater than the RF Safety Distance required.

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

Telephone (905) 829-1570
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UltraTech
Group of Labs

Dec. 27, 2000

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

**Attn.:** **Mr. Craig Merchant**

**Subject:** **FCC Certification Application Testing under FCC PART 15, Subpart C, Sec. 15.209 – Low Power Transmitters operate at 6.3 GHz.**

**Product:** **SIEMENS MILLTRONICS RADAR LEVEL GAUGE (6.3 GHZ)**
**Model No.:** **IQ RADAR 300**
**FCC ID:** **NJA-IQ300**

Dear Mr. Merchant,

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 operate at 6.3 GHz.**

- Operational/Applicable Characteristics of Operation:

  The transmitter is only designed to radiate a 6.3 GHz RF signal inside a tank/ vessel, which may be made of any of material such as plastic, metal, concrete and etc….. The 6.3 GHz RF signal radiates downward to the bottom of the tank/vessel. With the support of proper enclosure shielding, no rf signal shall be radiated to the free space outside the tank with the distance more than 1 meter from the antenna.

- Test Setup for Radiated Emissions:

  In all application, the IQ RADAR 300 is required to be mounted on top the tank/vessel with the antenna fitted inside the tank and faced downward to the bottom of the tank (ground). Therefore, the transmitter will be tested in the open area with the antenna points downward to the ground. This will represent the worst case among its application in any tanks/vessels. No RF emissions shall be observed at a 1 meter distance from the transmitting antenna.

- Compliance with RF Exposure Requirements:

  In all application, the IQ RADAR 300 is required to be mounted on top the tank/vessel with the antenna fitted inside the tank. No users can possibly reach close to the antenna under its operation. Therefore, no RF Exposure Warning is necessary per FCC 2.1091 since the radius of tanks/vessels are always greater than the RF Safety Distance required.

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

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# ENGINEERING TEST REPORT

## SIEMENS MILLTRONICS RADAR LEVEL GAUGE (6.3 GHZ)
## Model No.: IQ RADAR 300

**FCC ID: NJA-IQ300**

*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 Transmitters**
**operates at 6.3 GHz**

**UltraTech's File No.: MIL-206FCC**

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

Date: Dec. 01, 2000

| | |
|---|---|
| Report Prepared by: Tri M. Luu<br><br>.<br><br>Issued Date: Dec. 01, 2000 | Tested by: Hung Trinh<br><br><br><br>Test Dates: Nov. 10-23, 2000 |

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


**UltraTech**

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# EXHIBIT 1. SUBMITTAL CHECK LIST

| Exhibit No. | Exhibit Type | Description of Contents | Quality Check (OK) |
|---|---|---|---|
| 1 through 8 | Test Report | • Exhibit 1: Submittal check lists<br>• Exhibit 2: Introduction<br>• Exhibit 3: Performance Assessment<br>• Exhibit 4: EUT Operation and Configuration during Tests<br>• Exhibit 5: Summary of test Results<br>• Exhibit 6: Measurement Data<br>• Exhibit 7: Measurement Uncertainty<br>• Exhibit 8: Measurement Methods | OK |
| 9 | Test Report - Plots of Measurement Data | Plots # 1 to 12 | OK |
| 10 | Test Setup Photos | Photos # 1 to 14 | OK |
| 11 | External Photos of EUT | Photos # 1 to 12 | OK |
| 12 | Internal Photos of EUT | Photos of 1 to 16 | OK |
| 13 | Cover Letters | • Letter from Ultratech for Certification Request<br>• Letter from the Applicant to appoint Ultratech to act as an agent<br>• Letter from the Applicant to request for Confidentiality Filing | OK<br>OK<br>OK |
| 14 | Attestation Statements | • Manufacturer's Declaration for Equipment Specifications, Installation (if it is professionally installed) and Production Quality Production Assurance.<br>• Manufacturer's Declaration of Conformity (FCC DoC) for compliance with FCC Part 15, Sub. B, Class B - Computing Devices - if required | None<br>None |
| 15 | Application Forms | • Form 731<br>• Form 159<br>• Confirmation of Exhibits sent to FCC<br>• Status of Exhibits sent to FCC | OK<br>OK<br>OK<br>OK |
| 16 | ID Label/Location Info | • ID Label<br>• Location of ID Label | OK<br>OK |
| 17 | Block Diagrams | • Block diagrams | OK |
| 18 | Schematic Diagrams | • Schematic diagrams | OK |
| 19 | Parts List/Tune Up Info | • Drawings of antennas | OK |
| 20 | Operational Description | Technical Description | OK |
| 21 | RF Exposure Info | Not required | OK |
| 22 | Users Manual | | OK |

# EXHIBIT 2. INTRODUCTION

## 2.1. 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 operate at 6.3 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:** | • Light-industry, Commercial<br>• Industry |

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

None

## 2.3. NORMATIVE REFERENCES

| Publication | YEAR | Title |
|---|---|---|
| FCC CFR Parts 0-19 | 1999 | Code of Federal Regulations – Telecommunication |
| ANSI C63.4 | 1992 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| CISPR 22 & EN 55022 | 1997 1998 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment |
| CISPR 16-1 | | Specification for Radio Disturbance and Immunity measuring apparatus and methods |
| 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 3. PERFORMANCE ASSESSMENT

## 3.1. CLIENT INFORMATION

| **APPLICANT**: | |
|---|---|
| **Name:** | SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC. |
| **Address:** | P.O. Box 4225, 1954 Technology Drive<br>Peterborough, Ontario<br>Canada, K9J 7B1 |
| **Contact Person:** | Mr. Craig Merchant<br>Phone #: 705-745-2431<br>Fax #: 705-741-0466<br>Email Address: craigme@milltronics.com |

| **MANUFACTURER:** | |
|---|---|
| **Name:** | SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC. |
| **Address:** | P.O. Box 4225, 1954 Technology Drive<br>Peterborough, Ontario<br>Canada, K9J 7B1 |
| **Contact Person:** | Mr. Craig Merchant<br>Phone #: 705-745-2431<br>Fax #: 705-741-0466<br>Email Address: craigme@milltronics.com |

## 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

| | |
|---|---|
| **Brand Name** | SIEMENS MILLTRONICS PROCESS INSTRUMENTS INC. |
| **Product Name** | SIEMENS MILLTRONICS RADAR LEVEL GAUGE (6.3 GHZ) |
| **Model Name or Number** | IQ RADAR 300 |
| **Serial Number** | Pre-production sample |
| **Type of Equipment** | Low Power Transmitters |
| **Input Power Supply Type** | AC/DC 18 to 240 Volts (universal) |
| **Operational Description** | Siemens Milltronics IQ Radar 300 is intended for use in process industries for the determination of material level in the tanks and other process vessels. The tanks/vessels can be vented or non-vented and with or without internal stilling wells. The principle used is pulse radar. The device is mounted at the top of the tank or vessel. A short pulse of microwave energy is transmitted downwards to the surface of the material to be measured. This pulse is reflected from the material surface, and re-transmitted back towards the antenna. The time of flight of the pulse is measured, and hence the distance of the material surface from the antenna is determined (Radar principle). This is then used to calculate the level and/or volume of material in the tank or vessel. |

## 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | ▪ Base station (fixed use) |
| **Intended Operating Environment:** | ▪ Commercial, light industry & heavy industry |
| **Power Supply Requirement:** | AC/DC: 18 to 240 Volts |
| **RF Output Power Rating:** | 0.0 Watts |
| **Operating Frequency Range:** | 6.3 GHz |
| **RF Output Impedance:** | 50 Ohms |
| **Channel Spacing:** | 0 |
| **Duty Cycle:** | 0.075%<br>(Duty Cylce = $T_{on}/T_{on+off}$ = $1.5x10^{-9}/2x10^{-6}$ = 0.00075) |
| **Bandwidth:** | 2.7 GHz<br>($BW_n$ = 4/T = 4/1.5nS = 2.7 GHz) |
| **Modulation Type:** | Pulse desensitization<br><br>Refer to the attached Exhibits for schematic diagram and Technical description of the Microwave Transmitter operation. This information is submitted with the application under confidentiality filing<br><br>Please note that the transmitter circuit is designed with a notch filter at a microstrip transmission line to block any transmission below 5.45 GHz from the rf output to the antenna (which is a restricted band). |
| **Channel Spacing** | N/A |
| **Emission Designation:** | N/A |
| **Oscillator Frequencies:** | 6.3 GHz |
| **Antenna Connector Type:** | Integral, permanently attached (the antenna is attached to the enclosure using hex screws |
| **Antenna Description:** | Manufacturer: Siemens Milltronics, please refer to the following list of optional antennas |

The following antennas will be optionally provided with the Siemens Milltronics IQ RADAR 300:

| Accessory Options | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Antenna Option Number** | **Antenna/Wave Guide Options** | **Integral Seal Antenna Base** | **1.5" Pipe Thread Antenna Base** | **2" Pipe Thread Antenna Base** | **3" Sanitary Antenna Base** | **2" Sanitary Antenna Base** | **Antenna Emitter** |
| 1 | Rod Antenna | Yes | Yes | Yes | Yes | Yes | No |
| 2 | 4" Horn Antenna with option of metallic waveguide extension (4" long minimum) | No | No | No | No | No | Yes |
| 3 | 4" Sanitary Horn Antenna with option of metallic waveguide extension (4" long minimum) | No | No | No | No | No | Yes |
| 4 | 6" Horn Antenna with option of metallic waveguide extension (4" long minimum) | No | No | No | No | No | Yes |
| 5 | 8" Horn Antenna with option of metallic waveguide extension (4" long minimum) | No | No | No | No | No | Yes |
| 6 | Long metallic wave guide without Horn antenna | No | No | No | No | No | Yes |
| 7 | Rod antenna extension | Yes | Yes | Yes | No | No | No |

Please refer to Exhibit 19 for drawings of antenna options.

**Notes**: All options of rod antennas, antenna extensions, antenna bases and antenna emitters are available with the different types non-conducting polymer antenna materials (For example: High density polyethylene HDPE, Polypropylene PP and etc….) and Teflon PTFE. These non-conducting antenna materials are used for protection of the EUTs when they are used in measuring different types of chemical liquid. They have no effect on the equipment signals.

## 3.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | 3 Prong AC Mains or 2 Conductor-DC Mains | 1 | | Non-shielded |
| 2 | RS-232 Port | 1 | | Shielded |

## 3.5. ANCILLARY EQUIPMENT

None

# EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | AC/DC 18 to 240 Volts (universal) |

## 4.2. 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. |

## 4.3. GENERAL TEST SETUP

### 1.1.1. Test Configuration #1: Signal Characteristics & ERP

The EUT was tested with the transmitting antenna pointed to the receiving antenna to measure the rf signal characteristics (RF signal characteristics and ERP). This test did not represent for a real application since the equipment would always be operated with its antenna pointed downward to the ground (bottom of a tank/vessel).

The ERP will be measured with all 5 different optional antennas at the distance of 3 meters.

### 1.1.2. Test Configuration #2: Fundamental and Spurious Harmonic Emissions in Real Applications

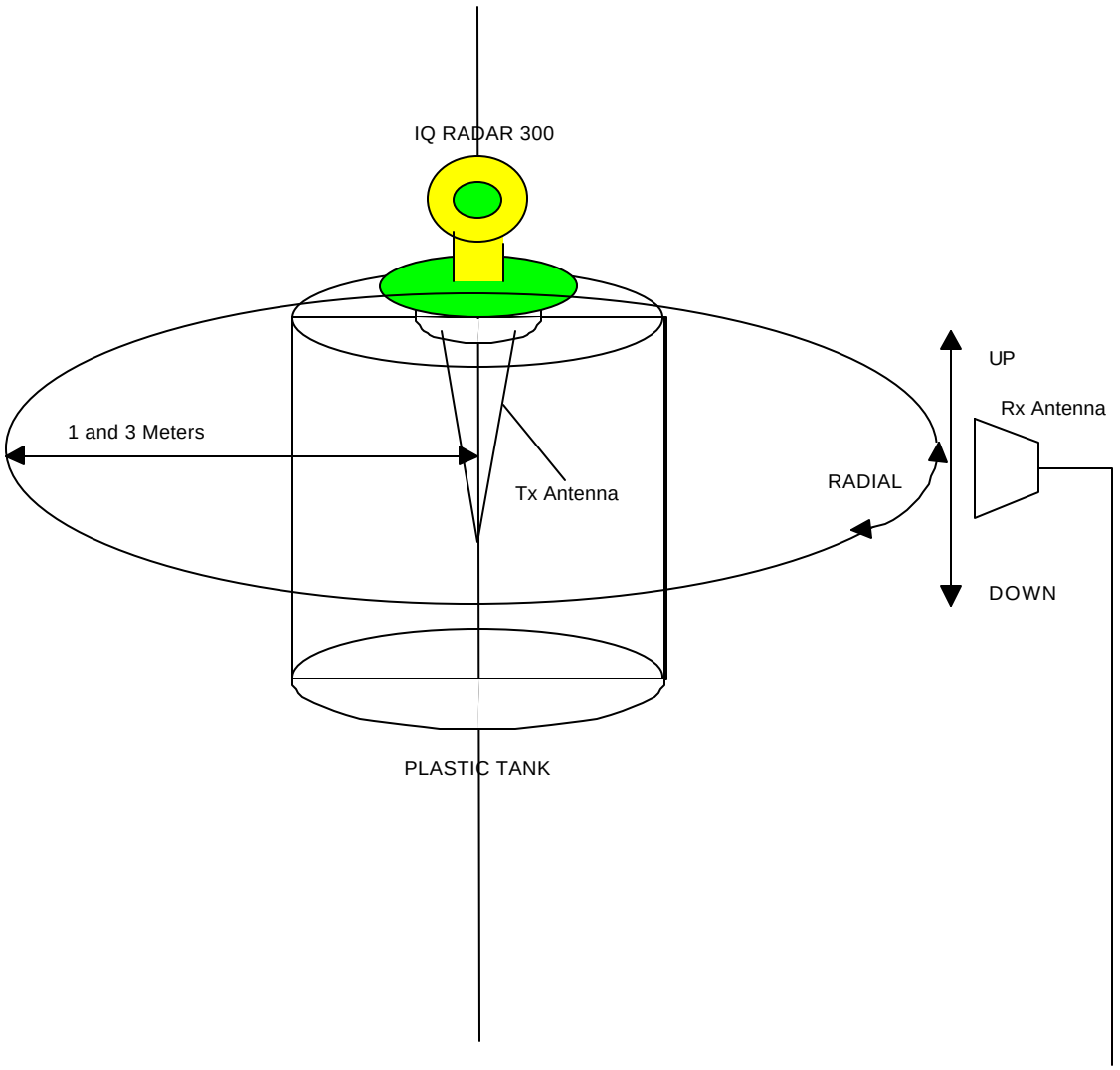
In all application, the IQ RADAR 300 is required to be mounted on top the tank/vessel with the antenna fitted inside the tank and faced downward to the bottom of the tank (ground). Therefore, the transmitter will be tested in the open area with the antenna points downward to the ground. This will represent the worst case among its application in any tanks/vessels. No RF emissions shall be observed at a 1 meter distance from the transmitting antenna.

The fundamental, spurious/harmonic will be scanned with all 5 different optional antennas at the distance of 1 and 3 meters.

### 4.3.1. Test Configuration #3: On-site Radiated Emission Measurements

The IQ RADAR 300 is mounted on top of the plastic tank, which contains chemical liquid, in a chemical factory. The fundamental and spurious/harmonic emissions were scanned.

The fundamental, spurious/harmonic will be scanned with all a Rod antennas and an 8" horn antenna at the distance of 1 meter and 3 meters.



# EXHIBIT 5. SUMMARY OF TEST RESULTS

## 5.1. LOCATION OF TESTS

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

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

  The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Sep.20, 1999.

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

| FCC PARAGRAPH. | TEST REQUIREMENTS | COMPLIANCE (YES/NO) |
|---|---|---|
| Public Notice DA 00-1407 | Part 15 Unlicensed Modular Transmitter Approval | N/A |
| 15.107(a) | AC Power Line Conducted Emissions Measurements (Transmit & Receive) | Yes |
| 1.1307, 1.1310, 2.1091 & 2.1093 | RF Exposure Limit | 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 A Digital Devices, the associated Radio Receiver operating in 6.3 GHz is exempted from FCC authorization . The engineering test report can be provided upon FCC requests. | | |

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

None

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

## 6.1. TEST PROCEDURES

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

## 6.2. MEASUREMENT UNCERTAINTIES

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

## 6.3. MEASUREMENT EQUIPMENT USED:

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

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

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

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

## 6.5.1. Limits

The equipment shall meet the limits of the following table:

| Test Frequency Range | Test Limits | EMI Detector Used | Measuring Bandwidth |
|---|---|---|---|
| 0.45 to 30 MHz | 48 dBµV<br>61 dBµV | Quasi-Peak (Narrow band)<br>Quasi-Peak (Broad band) | B = 10 kHz<br>B = 10 kHz |

## 6.5.2. Method of Measurements

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

## 6.5.3. 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<br>10 dB attenuation |
| L.I.S.N. | EMCO | 3825/2 | 89071531 | 9 kHz – 200 MHz<br>50 Ohms / 50 µH |
| 12'x16'x12' RF Shielded Chamber | RF Shielding | … | .. | … |

## 6.5.4. Plots

The following plots graphically represent the test results recorded in the above Test Data Table.

Refer to Plots # 11 & 12 in Exhibit 9 for actual measurement plots

## 6.5.5. Photographs of Test Setup

Refer to the Photographs #1 & #2 in Exhibit 10 for setup and arrangement of equipment under tests and its ancillary equipment.

### 6.5.6. Test Data

The ac power line conducted emissions were scanned from 450 kHz to 30 MHz, and all rf emissions less than 20 dB below the FCC Limits were recorded as follows:

| FREQUENCY (MHz) | RF LEVEL (dBuV) | RECEIVER DETECTOR (P/QP/AVG) | QP/NB LIMIT (dBuV) | QP/BB LIMIT (dBuV) | MARGIN (dB) | PASS/ FAIL | LINE TESTED (L1/L2) |
|---|---|---|---|---|---|---|---|
| 3.806 | 38.3 | QP | 48 | 61 | -9.7 | PASS | L1 |
| 7.819 | 45.7 | QP | 48 | 61 | -2.3 | PASS | L1 |
| 10.515 | 34.4 | QP | 48 | 61 | -12.6 | PASS | L1 |
| | | | | | | | |
| 0.644 | 40.4 | QP | 48 | 61 | -7.6 | PASS | L2 |
| 0.534 | 43.5 | QP | 48 | 61 | -4.5 | PASS | L2 |
| 8.466 | 42.5 | QP | 48 | 61 | -5.5 | PASS | L2 |
| 10.500 | 40.1 | QP | 48 | 61 | -7.9 | PASS | L2 |

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

## 6.6.1. 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 |

### 6.6.2. Method of Measurements

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

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For measurement below 1 GHz, set RBW = 100 KHz, VBW $\geq$ 100 KHz, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 3 MHz, VBW = 3 MHz (Peak), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

### 6.6.3. Test Arrangement

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

### 6.6.4. Test Equipment List

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

### 6.6.5. Plots

Refer to Plots # 1 & 10 in Exhibit 9 for actual measurement plots

### 6.6.6. Photographs of Test Setup

Refer to the Photographs #3 to #14 in Exhibit 10 for setup and arrangement of equipment under tests and its ancillary equipment.

## 6.6.7. Test Data

### *6.6.7.1. Duty Cycle*

The average rf level is calculated by the peak reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

DUTY CYCLE: 0.075% (Duty Cylce = $T_{on}/T_{on+off}$ = $1.5x10^{-9}/2x10^{-6}$ = 0.00075)
Peak-to-Average Factor = 20*log (0.00075) = -62.5 dB

### *6.6.7.2. Pulse Desensitization Factor*

Base on the following chart of the Pulse Desensitization Factor ($\alpha p$) versus pulse width ($\tau_{off}$), the Pulse Desensitization Factor $\alpha p$ = 43 dB for 1.5 nS pulse width pulse desensitization signal, measurement BW = 3 MHz RBW

### *6.6.7.3. Total Correction Factor*

The total correction factor: TCF = duty cycle factor + pulse desensitization factor = -62.5 dB + 43 dB = -19.5 dB

### *6.6.7.4. Fundamental and Spurious/Harmonic Emissions*

**Remarks**: The transmitter with each antenna will be tested in the following configurations:

1. For worst case of measurements, Tests were performed with the EUT located outside the tank/vessel
2. The transmitting antenna pointed toward the receiving horn antenna at the distance of 3 meters. This test is only for observation of the RF signal characteristics, not for compliance purposes. In all real application the antenna is pointed downward to the ground (bottom of the tank/vessel).
3. For real application, the transmitting antenna was mounted with the antenna pointed downward to the ground. The test results shall comply with FCC 15.209 and FCC 15.205.

There are several conditions which must be satisfied if Eq. (10) is to be valid:

1. The IF bandwidth-pulse width product must be less than two-tenths:

$$B \cdot \tau_{eff} < 0.2 \text{ or } B < \frac{0.2}{\tau_{eff}}$$

2. The normalized scan rate (NSR) of the analyzer must be less than one:

$$\text{NSR} = \frac{\text{Scan Width [Hz/Div]}}{\text{Scan Time [s/Div]} \cdot (B[Hz])^2} < 1$$

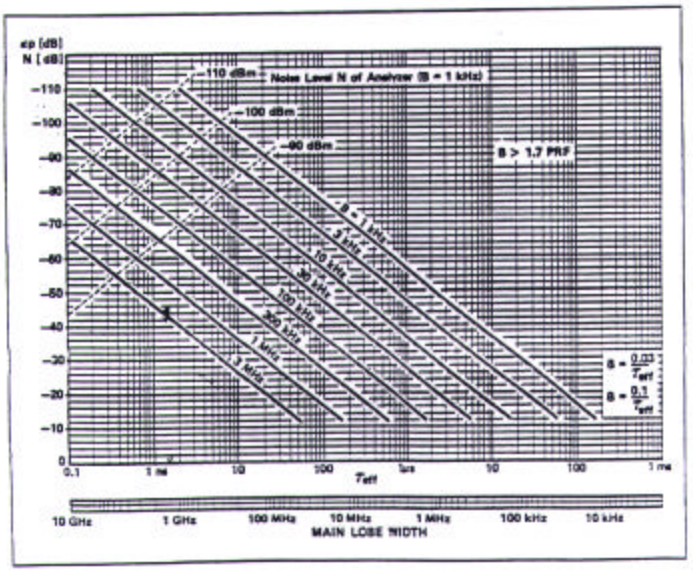
3. The IF bandwidth must be greater than the PRF: $B > \text{PRF}$

The conditions in 1 to 3 are automatically accomplished if the equations (5), (8), and (7) are satisfied.

4. The peak pulse amplitude at the broadband input mixer of the analyzer must stay below the saturation point (1 dB compression). The typical saturation point for HP spectrum analyzers is between −10 dBm and −5 dBm:

$$P_{peak} \leq -10\ dBm \qquad (11)$$

Figure 28 is a diagram showing the pulse desensitization $\alpha_p$ in relation to IF bandwidth $B$ and pulse width $\tau_{eff}$. We see that the PRF does not appear, since it is of no significance for the display amplitude as long as $B >$ PRF. The shaded area between the $B = \frac{0.03}{\tau_{eff}}$ and $B = \frac{0.1}{\tau_{eff}}$ represents the optimum bandwidth range for an analysis of a pulsed signal. There are also three dotted lines which show different noise levels of an analyzer for a fast determination of the dynamic range.

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αp = 43 dB for 1.5 nS pulse width pulse desensitization signal, measurement BW = 3 MHz RBW

### *6.6.7.4.1. Test Configuration #1: Fundamental and Spurious Emissions from the IQ RADAR 300 with a Rod Antenna*

1. **Transmitting Antenna pointed toward the receiving horn antenna (non-intended operation)**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | 62.4 | 105.4 | 42.9 | H | 54.0 | -11.1 | Pass |
| 6.3 | 62.8 | 105.8 | 43.3 | V | 54.0 | -10.7 | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at 3 meters distance (Pre-scans at 1 meter distance was also performed for consistency of measurements. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

2. **Transmitting Antenna pointed downward to the ground as its intended operation**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | << | << | << | H | 54.0 | << | Pass |
| 6.3 | << | << | << | V | 54.0 | << | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

### *6.6.7.4.2. Test Configuration #2: Fundamental and Spurious Emissions from the IQ RADAR 300 with a 8" Horn Antenna*

1. **Transmitting Antenna pointed toward the receiving horn antenna (non-intended operation)**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | 62.4 | 124.9 | 45.1 | H | -8.9 | -11.1 | Pass |
| 6.3 | 62.8 | 125.3 | 47.1 | V | -6.9 | -10.7 | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at 3 meters distance (Pre-scans at 1 meter distance was also performed for consistency of measurements. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

2. **Transmitting Antenna pointed downward to the ground as its intended operation**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | << | << | << | H | 54.0 | << | Pass |
| 6.3 | << | << | << | V | 54.0 | << | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

### *6.6.7.4.3. Test Configuration #3: Fundamental and Spurious Emissions from the IQ RADAR 300 with a 6" Horn Antenna*

1. **Transmitting Antenna pointed toward the receiving horn antenna (non-intended operation)**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+a p) (dBuV/m) | RF AVG LEVEL (E+a p+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | 62.4 | 131.3 | 49.3 | H | 54.0 | -4.7 | Pass |
| 6.3 | 62.8 | 132.5 | 50.5 | V | 54.0 | -3.5 | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at 3 meters distance (Pre-scans at 1 meter distance was also performed for consistency of measurements. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

2. **Transmitting Antenna pointed downward to the ground as its intended operation**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+a p) (dBuV/m) | RF AVG LEVEL (E+a p+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | << | << | << | H | 54.0 | << | Pass |
| 6.3 | << | << | << | V | 54.0 | << | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

### *6.6.7.4.4. Test Configuration #4: Fundamental and Spurious Emissions from the IQ RADAR 300 with a 4" Horn Antenna*

1. **Transmitting Antenna pointed toward the receiving horn antenna (non-intended operation)**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | 66.8 | 129.3 | 47.3 | H | 54.0 | -6.7 | Pass |
| 6.3 | 67.3 | 129.8 | 47.8 | V | 54.0 | -6.2 | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at 3 meters distance (Pre-scans at 1 meter distance was also performed for consistency of measurements. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

2. **Transmitting Antenna pointed downward to the ground as its intended operation**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+ap) (dBuV/m) | RF AVG LEVEL (E+ap+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | << | << | << | H | 54.0 | << | Pass |
| 6.3 | << | << | << | V | 54.0 | << | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

### *6.6.7.4.5. Test Configuration #5: Fundamental and Spurious Emissions from the IQ RADAR 300 with a 4" Sanitary Horn Antenna*

1. **Transmitting Antenna pointed toward the receiving horn antenna (non-intended operation)**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+a p) (dBuV/m) | RF AVG LEVEL (E+a p+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | 66.6 | 129.1 | 47.1 | H | 54.0 | -6.9 | Pass |
| 6.3 | 67.6 | 130.1 | 48.1 | V | 54.0 | -5.9 | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at 3 meters distance (Pre-scans at 1 meter distance was also performed for consistency of measurements. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

2. **Transmitting Antenna pointed downward to the ground as its intended operation**:

| FREQUENCY (GHz) | RF LEVEL READING (E) @3m (dBuV/m) | RF PEAK LEVEL (E+a p) (dBuV/m) | RF AVG LEVEL (E+a p+duty cycle) (dBuV/m) | ANTENNA PLANE (H/V) | LIMIT @3m 15.209 (dBuV/m) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|
| 6.3 | << | << | << | H | 54.0 | << | Pass |
| 6.3 | << | << | << | V | 54.0 | << | Pass |
| 0.030 – 40 | << | << | << | V & H | @ 15.209 | << | Pass |
| No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance. | | | | | | | |
| Note 1: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB) of -19.5 dB was used for Correction of the final measurements. | | | | | | | |

### *6.6.7.4.6. Test Configuration #5: Fundamental and Spurious Emissions from the IQ RADAR 300 mounted on top of a plastic tank in a Chemical Manufacturer located in Ontario, Canada*

No significant fundamental and spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz when the unit was scanned at both 3 meters distance and 1 meter distance with the following antennas

1. Rod Antenna
2. 6" Horn Antenna

3. 4" Horn Antenna
4. 4" Sanitary Antenna

## 6.7. RF EXPOSURE REQUIRMENTS @ FCC 15.209(B)(4), 1.1310 & 2.1091

### 6.7.1. Limits

- **FCC 15.209(b)(4):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See @ 1.1307(b)(1).
- **FCC 1.1310:**- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

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

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

F = Frequency in MHz

### 6.7.2. Method of Measurements

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

- Spread spectrum transmitters operating under section 15.209 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.209(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

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

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

**Calculation Method of RF Safety Distance**:

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

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

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

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

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

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones., an SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d)

### 6.7.3. Test Data

The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

**RF EXPOSURE DISTANCE LIMITS:** $r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$
Where: $S = 1.0\ mW/cm^2$
EIRP (in mW) = maximum EIRP measured in Section 5.8 of this test report

| Frequency (GHz) | Maximum Measured peak EIRP (dBm) | Laboratory's Recommended Minimum RF Safety Distance r (cm) | Manufacturer's specification in User's Manual |
|---|---|---|---|
| 6.3 GHz | 0.0 | None | None |

| Evaluation of RF Exposure Compliance Requirements | |
|---|---|
| **RF Exposure Requirements** | **Compliance with FCC Rules** |
| Minimum calculated separation distance between antenna and persons required: 0.0 cm | Comments: The antenna is always contained inside the tank when it is in use. Therefore, there is no concern of risk of RF Exposure. |
| Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement | Comments: The antenna is always contained inside the tank when it is in use. Therefore, there is no concern of risk of RF Exposure. |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits | None |
| Any other RF exposure related issues that may affect MPE compliance | None |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

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

## 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Line Conducted) | PROBABILITY DISTRIBUTION | UNCERTAINTY (dB) | |
|---|---|---|---|
| | | 9-150 kHz | 0.15-30 MHz |
| EMI Receiver specification | Rectangular | ±1.5 | ±1.5 |
| LISN coupling specification | Rectangular | ±1.5 | ±1.5 |
| Cable and Input Transient Limiter calibration | Normal (k=2) | ±0.3 | ±0.5 |
| Mismatch: Receiver VRC $\Gamma_1 = 0.03$<br>LISN VRC $\Gamma_R = 0.8$(9 kHz) 0.2 (30 MHz)<br>Uncertainty limits 20Log(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:

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

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

## 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

# EXHIBIT 8. MEASUREMENT METHODS

## 8.1. GENERAL TEST CONDITIONS

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

### 8.1.1. Normal temperature and humidity

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

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

### 8.1.2. Normal power source

#### *8.1.2.1. Mains Voltage*

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

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

#### *8.1.2.2. Battery Power Source.*

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

### 8.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at the following frequencies:
  - The lowest operating frequency,
  - The middle operating frequency and
  - The highest operating frequency

- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers

## 8.2. METHOD OF MEASUREMENTS - AC MAINS CONDUCTED EMISSIONS

- AC Mains conducted emissions measurements were performed in accordance with the standard against appropriate limits for each detector function.
- The test was performed in the shielded room, 16'(L) by 16'(W) by 12'(H).
- The test was performed were made over the frequency range from 450 kHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, AC Mains conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlet. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (9 KHz RBW, VBW > RBW), frequency span 450 kHz to 30 MHz.

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

  Step1. Monitor the frequency range of interest at a fixed EUT azimuth.

  Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.

  Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.

- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW > RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and AVERAGE detector mode (10 kHz RBW, 1 Hz VBW). The final highest RF signal levels and frequencies were record.

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

## 8.3. EFFECTIVE RADIATED POWER

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

Test procedure shall be as follows:

**Step 1**: Duty Cycle measurements

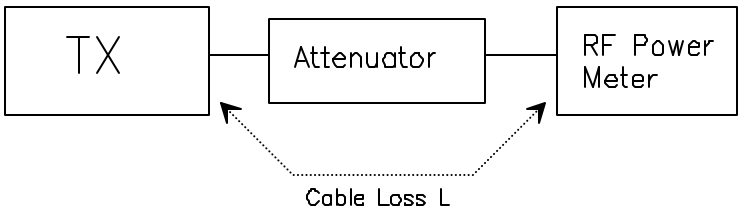
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with $0<x<1$, is measure and recorded in the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

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

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

**Peak EIRP = P + G**
**Average EIRP = Peak EIRP + 10log(1/x)**

**Figure 1.**




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

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

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

**Figure 2**

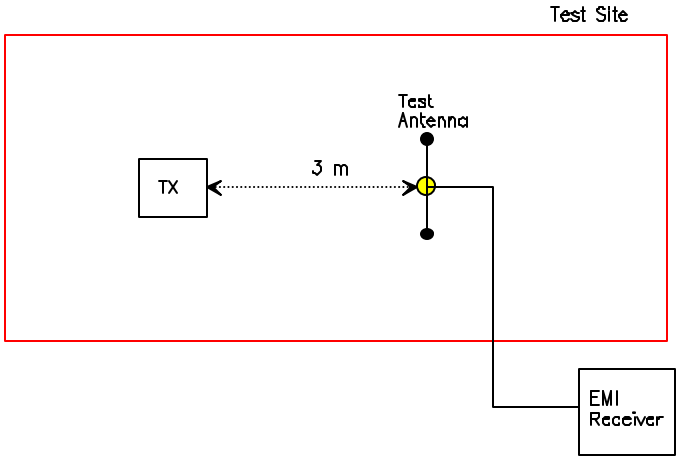
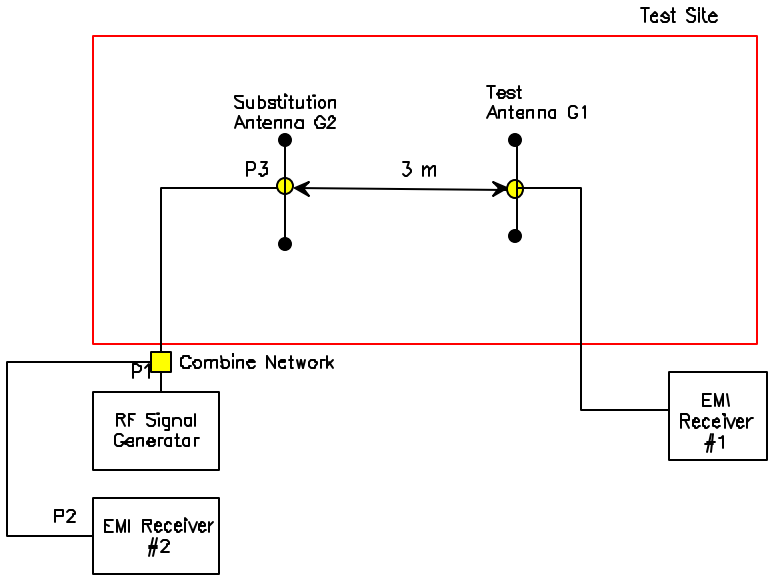



**Figure 3**




P3 = P2 + Insertion Loss (P1–P3
ERP = P3 + G2

Use the following spectrum analyzer settings:

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

## 8.4. SPURIOUS EMISSIONS (CONDUCTED & RADIATED)

For both conducted and radiated measurements, the spurious emissions were scanned from the lowest frequency generated by the EUT or 10 MHz whichever is lower to $10^{th}$ harmonic of the highest frequency generated by the EUT.

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

**Band-edge Compliance of RF Conducted Emissions**:
Use the following spectrum analyzer settings:

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

**Spurious RF Conducted Emissions**:
Use the following spectrum analyzer settings:

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

### 8.4.2. Spurious Emissions (Radiated)

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC, Industry Canada, ACA/Austel, NVLap and ITI.
- Radiated emissions measurements were made using the following test instruments:

1. Calibrated EMCO BiconiLog antenna in the frequency range from 30 MHz to 2000 MHz.
2. Calibrated Emco Horn antennas in the frequency range above 1000 MHz (1GHz - 40 GHz).
3. The test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

   - RBW = 100 kHz for f < 1GHz and RBW = 1 MHz for f $\geq$ 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.

## 8.5. ALTERNATIVE TEST PROCEDURES

If the antenna conducted tests cannot be performed on this device, radiated tests show compliance with the peak output power limit specified in Section 15.209(b) and the spurious RF conducted emission limit specified in Section are acceptable. As stated previously, a pre-amp, and, in the later case, a high pass filter, are required for the following measurements:

### 8.5.1. Peak Power Measurements

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

$E = 30PG/d$
$P = (Ed)^2/30G$

Where:

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

### 8.5.2. Spurious RF conducted emissions

The demonstrate compliance with the spurious RF conducted emission requirement of Section 15.209©, use the following spectrum analyzer settings:

- Span = wide enough to fully capture the emission being measured
- RBW = 100 kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Measure the field strength of both the fundamental and all spurious emissions with these settings.
- Follow the procedures C62-4:1994 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.209©. Note that if the emission falls in a Restricted

Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions listed above must be followed.