July 02, 1998

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

Subject: **Certification Application under FCC Part 15, Subpart C, Para. 15.209, Low Power Communication Device Transmitters Operating at 6.3 GHz.**

Applicant:	**MILLTRONICS**
Product:	**Milltronics Radar Level Gauge (6.3 GHz)**
Model:	**IQ RADAR 160 (AC)**
FCC ID:	**NJA-IQ160**

Dear Sir/Madam,

As appointed agent for **MILLTRONICS**, please find enclosed copies of the engineering report, authorization form, application form and a cheque of US $1025.00.

Grant Limitation: The FCC Certification of the Milltronics IQ RADAR 160 (AC) is applied for being used in a vented or non-vented metal tanks with or without internal stilling wells (typical metal: stainless steel)

If you have any queries, please do not hesitate to contact us by our TOLL FREE numbers:

OUR TELEPHONE NO.: 1-800-263-7670

Yours truly,

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

TML/AK

Encl.

July 02, 1998

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

Attn.: **Mr. Tony Kormos**

Subject: **Certification Application under FCC Part 15, Subpart C, Para. 15.209, Low Power Communication Device Transmitters Operating at 6.3 GHz.**

Product:	**Milltronics Radar Level Gauge (6.3 GHz)**
Model:	**IQ RADAR 160 (AC)**
FCC ID:	**NJA-IQ160**

Dear Mr. Kormos,

The product sample, as provided by you, has been tested and found to comply with **FCC Part 15, Subpart C, Para. 15.209, Low Power Communication Device Transmitters operating at 6.3 GHz.**

Grant Limitation: The FCC Certification of the Milltronics IQ RADAR 160 (AC) is applied for being used in a vented or non-vented metal tanks with or without internal stilling wells (typical metal: stainless steel)

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

Milltronics Radar Level Gauge (6.3 GHz)
MODEL NO.: IQ RADAR 160 (AC)

FCC ID: NJA-IQ160

In Accordance With

FCC PART 15, SUBPART C, PARA. 15.209
LOW POWER COMMUNICATION DEVICE TRANSMITTER
OPERATING AT 6.3 GHz

UltraTech FILE NO.: MIL-162FTX

Tested for:

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

Tested by:

ULTRATECH GROUP OF LABS
4181 Sladeview Crescent, Unit 33
Mississauga, Ontario
Canada L5L 5R2

REPORT PREPARED BY: Mr. Tri M. Luu, P.Eng.

DATE: July 02, 1998

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1. EXHIBIT 1 - SUMMARY OF TEST RESULTS & GENERAL STATEMENT OF CERTIFICATION

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.209	Transmitter Radiated Emissions	Yes
15.109	AC Power Conducted Emissions	Yes

Note 1: The digital portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices. The engineering test report can be provided upon FCC requests.

TESTIMONIAL AND STATEMENT OF CERTIFICATION

THIS IS TO CERTIFY:

1) *THAT the application was prepared either by, or under the direct supervision of the undersigned.*

2) *THAT the measurement data supplied with the application was taken under my direction and supervision.*

3) *THAT the data was obtained on representative production units.*

4) *THAT, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.*

Certified by:

____

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

DATE: July 02, 1998

- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australian
- Recognized/Listed by FCC (USA), Industry Canada (Canada)
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

2. EXHIBIT 2 - GENERAL INFORMATION

2.1. APPLICANT

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

Applicant's Representative: Mr. Tony Kormos

2.2. MANUFACTURER

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

2.3. DESCRIPTION OF EQUIPMENT UNDER TEST

OPERATIONAL DESCRIPTIONS:

Milltronics IQ-Radar 160 is intended for use in process industries for the determination of material level in the metal tanks and other process metallic vessels. The metal 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 towards 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. Please refer to the attached Exhibit for details of technical description and system block diagram. This information is submitted with the application under confidentiality filing

PULSE DESENSITIZATION:

Refer to the attached Exhibit for schematic diagram and Technical description of the Microwave Transmitter operation. This information is submitted with the application under confidentiality filing

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).

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PRODUCT NAME:	Milltronics Radar Level Gauge (6.3 GHz)
SERIAL NUMBER:	Pre-production
TYPE OF EQUIPMENT:	LOW POWER COMMUNICATION DEVICE TRANSMITTER
OPERATING FREQ.:	6.3 GHz
BANDWIDTH:	2.7 GHz $BW_n = 4/T = 4/1.5nS = 2.7$ GHz
POWER RATING:	N/A
EMISSION DESIGNATION:	N/A
DUTY CYCLE:	0.075% (Duty Cylce = $T_{on}/T_{on+off} = 1.5x10^{-9}/2x10^{-6} = 0.00075$)
OSC. FREQUENCY(IES):	500 kHz, 8 MHz and 6.3 GHz
CPU SPEED:	2 MHz
INPUT SUPPLY:	120V 60Hz
ASSOCIATED DEVICES:	N/A
ANTENNA TYPE:	Milltronics Rod Antenna, permanently attached to the system
INTERFACE PORTS:	(1) RSS-485 Port (2) DC Loop Current

2.4. RELATED SUBMITTAL(S)/GRANT

Not applicable

2.5. TEST METHODOLOGY

These tests were conducted on a sample of the equipment for the purpose of certification compliance with Code of Federal Regulations (CFR47-1991), Part 15, Subpart C, Para. 15.209, Low Power Communication Device Transmitters operating at 6.3 GHz.

Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute 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.

2.6. TEST FACILITY

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 3-10 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: July 16, 1997.

The above test site is also filed with Interference Technology International Ltd (ITI - An EC Directive on EMC).

2.7. UNITS OF MEASUREMENTS

Measurements of conducted emissions are reported in units of dB referenced to one microvolt [dB(μV)].

Measurements of radiated emissions are reported in units of dB referenced to one microvolt per meter [dB(μV)/m] at the distance specified in the report, wherever it is applicable.

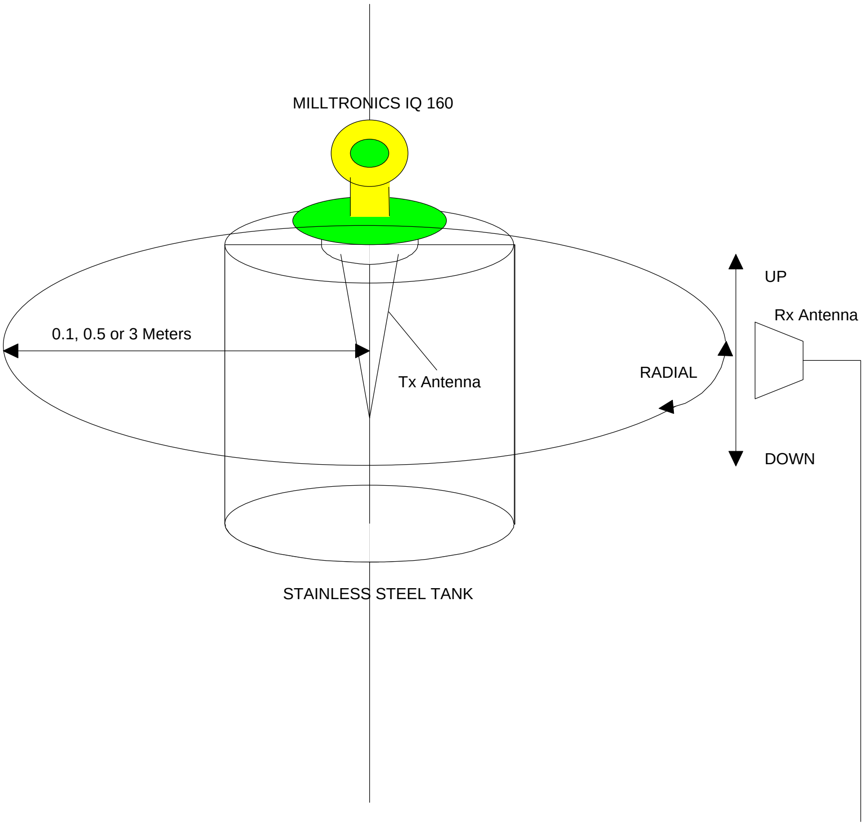
3. EXHIBIT 3 - SYSTEM TEST CONFIGURATION

3.1. TEST SYSTEM DETAILS

The following peripherals, FCC identifiers and types interconnecting cables were used with the EUT for testing:

(1) **EUT**: MILLTRONICS, Milltronics Radar Level Gauge (6.3 GHz), Model : IQ RADAR 160 (AC),, S/N: Pre-production, OSC. FREQ: 500 kHz, 8 MHz and 6.3 GHz.
I/O Cable: All I/O cables were shielded
Power Supply Cable: Non-shielded

(2) **PERIPHERAL**:
I/O Cable: All I/O Cables were shielded
Power Supply Cable: Non-shielded



- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australian
- Recognized/Listed by FCC (USA), Industry Canada (Canada)
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

3.2. BLOCK DIAGRAMS FOR CONDUCTED & RADIATED EMISSION MEASUREMENTS

3.2.1. TEST SETUP FOR THE TRANSMITTER MOUNTED ON TOP OF A METAL TANK – FINAL MEASUREMENTS

- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australian
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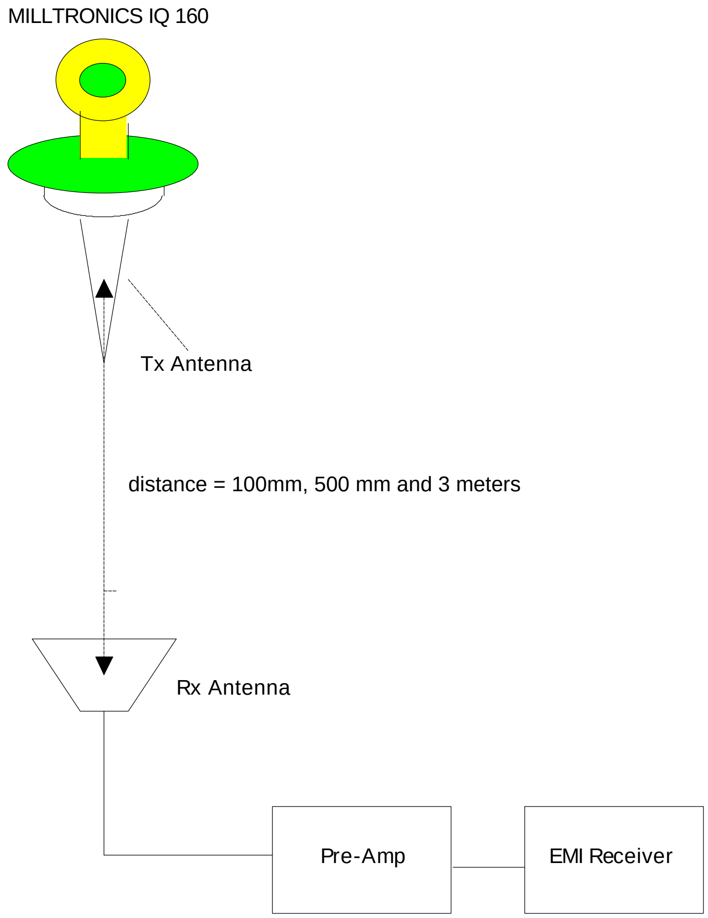
3.2.2. TEST SETUP FOR THE TRANSMITTER ALONE (NOT MOUNTED ON A METAL TANK) - PRESCANS



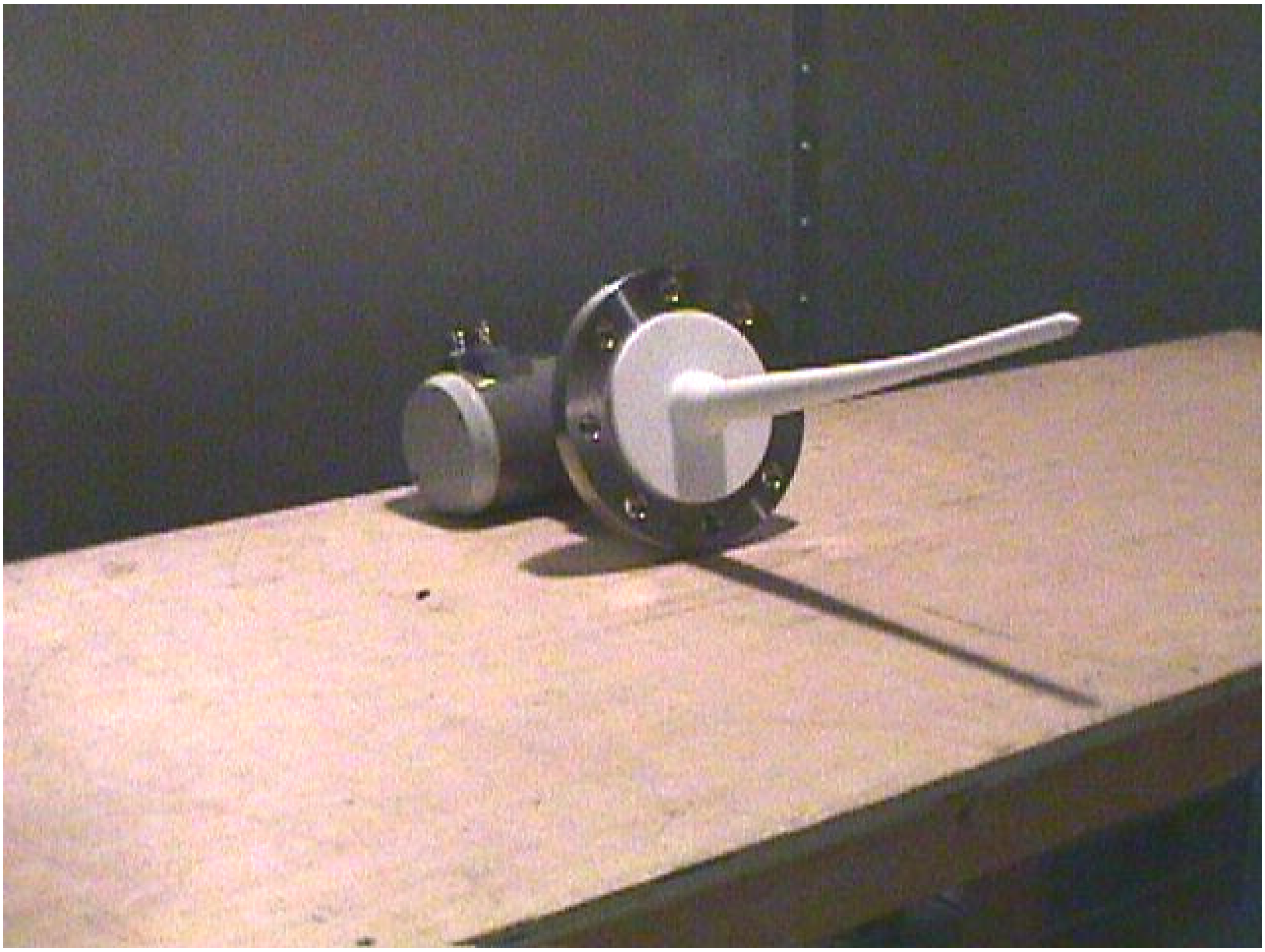
- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australian
- Recognized/Listed by FCC (USA), Industry Canada (Canada)
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

3.3. PHOTOGRAPH FOR RF EMISSION MEASUREMENTS

Please refer to the attached photos.

3.3.1. TEST SETUP FOR AC POWER LINE CONDUCTED EMISSIONS MEASUREMENTS

Tests were performed in the screen room.

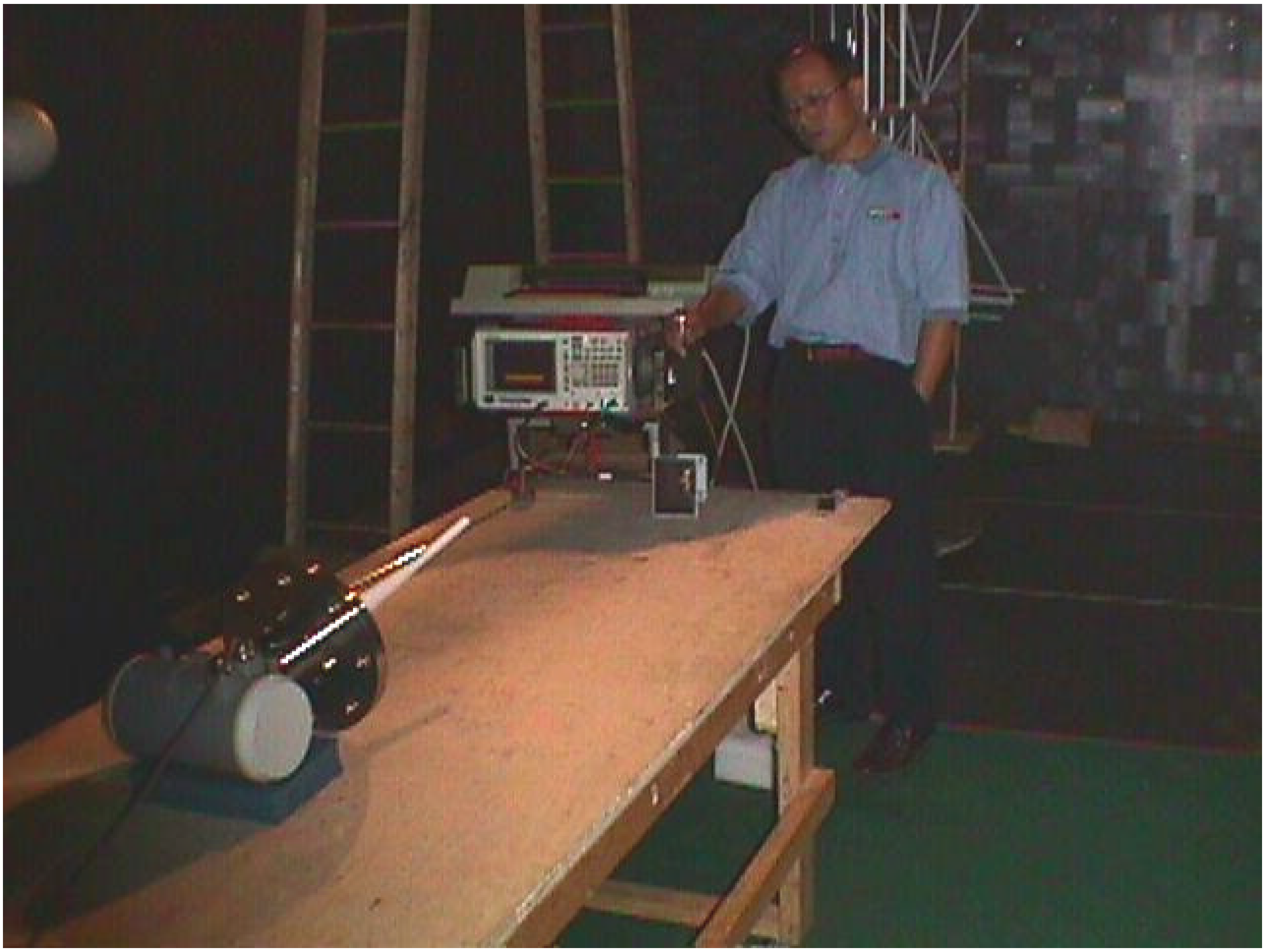


3.3.2. TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS

3.3.3. TEST SETUP FOR PRE-SCANS IN THE ANECHOIC ENCLOSURE

3.3.3.1. PRESCAN @ 3m for measuring frequencies from 30 MHz to 8 GHz

3.3.3.2. PRESCAN @ 1m for measuring frequencies from 8 GHz to 40 GHz



3.3.4. TEST SETUP FOR THE TRANSMITTER MOUNTED ON TOP OF A METAL TANK

Tested were performed at Milltronics' Facilities.

3.4. JUSTIFICATION

No deviation, in both configuration and operation manners, different from normal operation were required.

3.5. EUT OPERATING CONDITION

The Milltronics IQ Radar 160 (AC) was powered on and transmit the 6.3 GHz microwave signal in a pulse spectrum mode The measuring resolution bandwidth (RBW) of 3 MHz is used for testing and the corresponding pulse desensitization factor of 43 dB at 1.5 nS pulse width from Figure 28 of HP 150-2 is used for calculation of the peak rf levels.

3.6. SPECIAL ACCESSORIES

No special accessories were required.

3.7. EQUIPMENT MODIFICATIONS

Not required.

4. EXHIBIT 4 - TEST DATA

4.1. TRANSMITTER RADIATED EMISSIONS @ 3 METERS, FCC CFR 47, PARA. 15.209

PRODUCT NAME: **Milltronics Radar Level Gauge (6.3 GHz), Model No.: IQ RADAR 160 (AC)**

FCC REQUIREMENTS:

- The rf spectrum carrier shall not fall inside the restricted bands specified in the following table.

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	

- Fundamental and Spurious/harmonic emissions shall not exceed the limits specified in the following table:

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

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 ^{o}C
- Relative humidity: 43 %

POWER INPUT: 120V 60 Hz.

TEST EQUIPMENT:

- **Spectrum Analyzer**, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- **Microwave Amplifier**, HP, Model 83017A, Frequency Range 1 to 26.5 GHz, 34-38 dBdB gain nominal.
- **Active Loop Antenna**, Emco, Model 6507, SN 8906-1167, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms
- **Log Periodic/Bow-Tie Antenna**, Emco, Model 3143, SN 1029, 20 - 1000 MHz, @ 50 ohms.
- **Horn Antenna,** Emco, Model 3115, SN 9701-5061, Frequency Range: 1 - 18 GHz, @ 50 Ohms.
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-10, 26.5-40GHz
- **Mixer**, Tektronix, P/N 118-0098-00, 18-26.5GHz
- **Mixer**, Tektronix, P/N 119-0098-00, 26.5-40GHz

METHOD OF MEASUREMENTS:

Prescans: The EUT will be pre-scanned in the following order to determine its characteristics at different distances before final measurements since its un-corrected emissions are too low to observe at 3 meters distance when it is mounted on top of the metal tank:

1. **Pre-scans** at 3 m distance in the frequency range from 30 MHz to 8 GHz and pre-scans at 1 m distance in the frequency range from 8 GHz to 40 GHz when the IQ-Radar 160 was not mounted on top of the tank. These tests were carried in the Anechoic Room.
2. **Final Measurements** at 3 m distance in the frequency range from 30 MHz to 8 GHz and at 1 m distance in the frequency range from 8 GHz to 40 GHz when the IQ-Radar 160 was mounted on top of the tank. These tests were carried at Milltronics' facility where the metal tank was installed.

Desensitization for Pulse Emissions: Since the Milltronics IQ Radar 160 (AC) transmits pulse RF energy with Ton = 1.5 nS, the desensitization factor (αp) shall be included in the calculation for the final peak value.

With the measuring resolution bandwidth (RBW) of 3 MHz, the corresponding pulse desensitization factor (αp) of 43 dB at pulse width τeff = 1.5 nS can be derived from Figure 28 of HP 150-2.

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)

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

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:

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

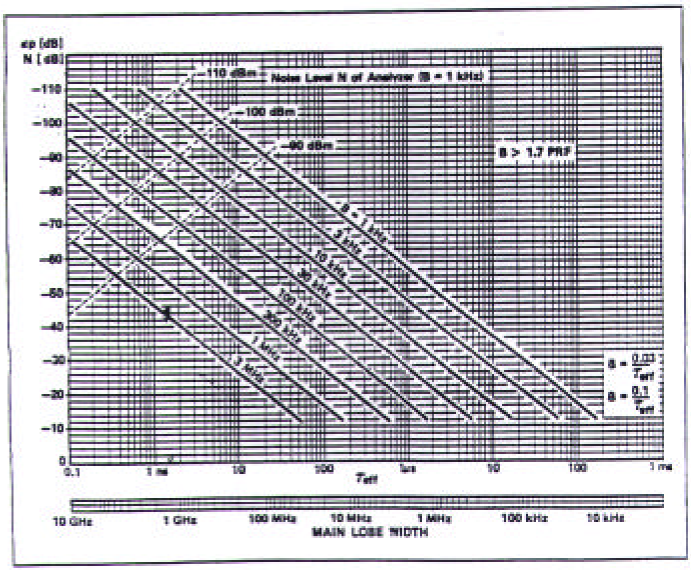
3. The IF bandwidth must be greater than the PRF: $B > \text{PRF}$

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 α_p in relation to IF bandwidth B and pulse width τ_{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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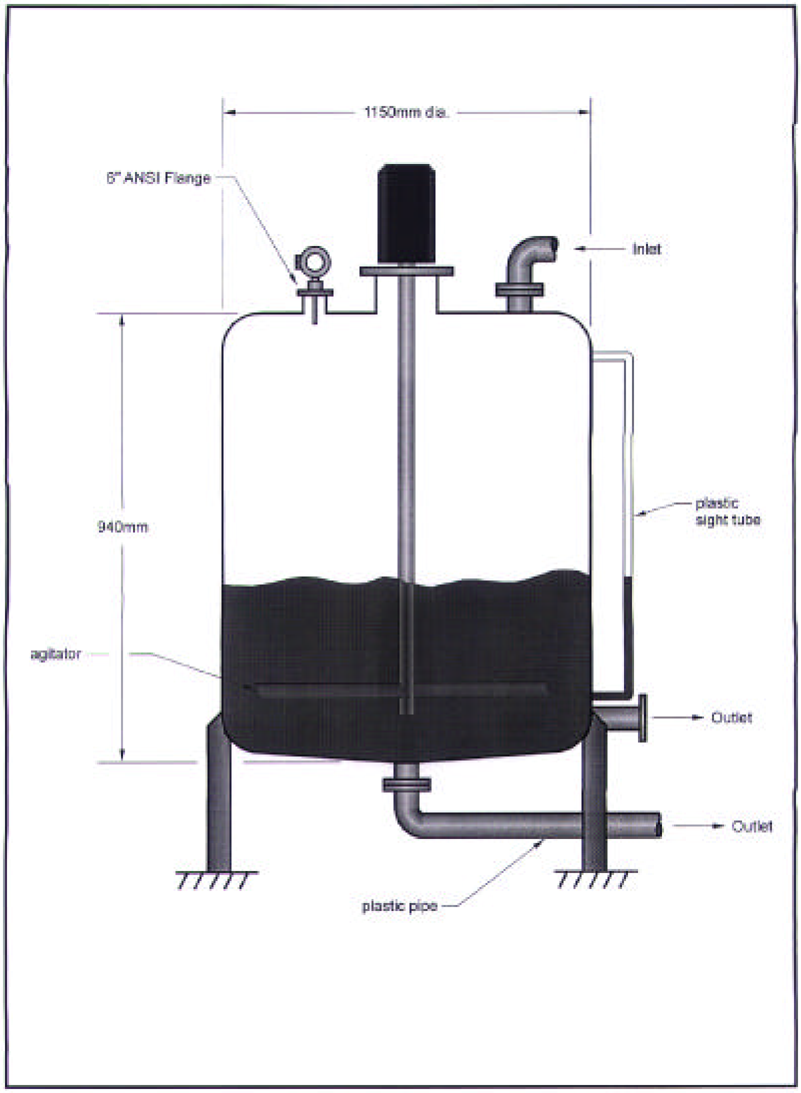
αp = 43 dB for 1.5 nS pulse width pulse desensitization signal, measurement BW = 3 MHz RBW

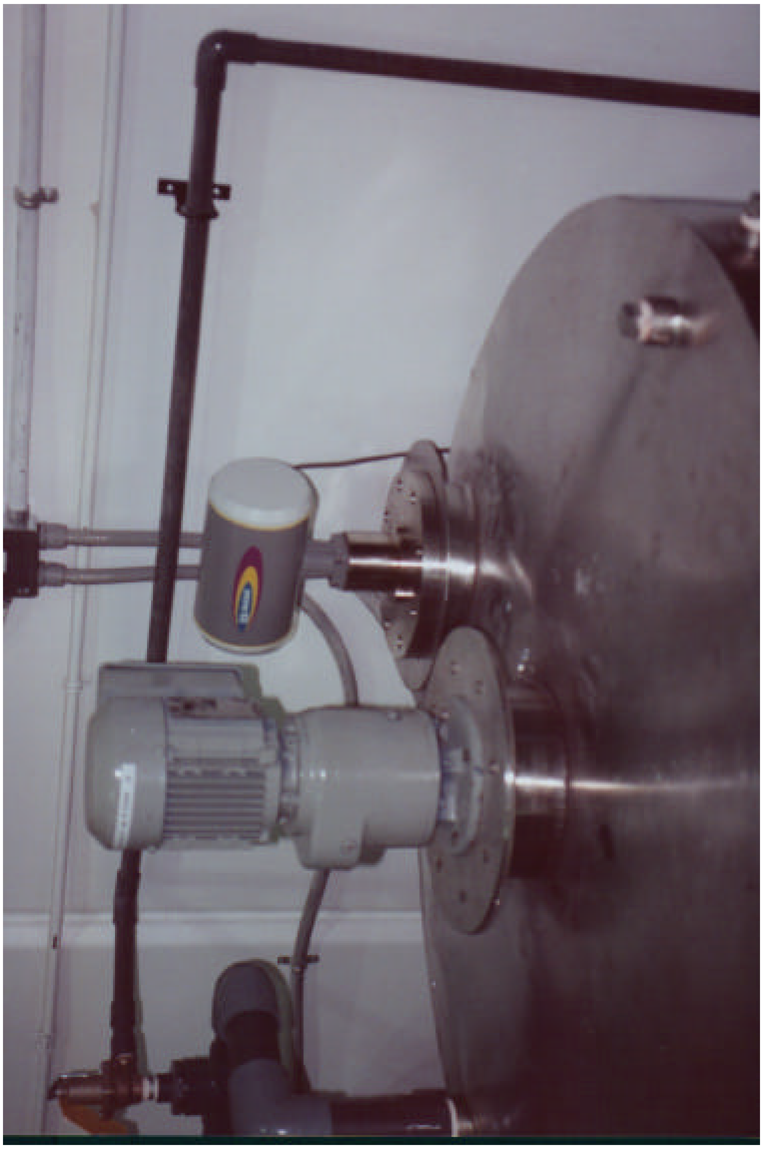
Description of Metal Tank Used for Testing

The tests were carried out in a typical metal chemical reactor tank. The tank included an agitator and several access flanges.

The IQ Radar 160 was mounted on one of the flanges, with no special gasketing and with the holding screws not tightened. All piping on the inlet and outlet of the tank comprised plastic pipe. A transparent plastic sight tube is located on the side of the tank.

We believe this type of tank represents a typical installation in tanks made mostly of metal but including vents, sight glasses and openings.





TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri Luu, P.Eng.

DATE: Jan. 29 and 30, 1998

MEASUREMENT DATA

RADIATED EMISSIONS MEASUREMENTS @ 3 METERS

TEST CONFIGURATION

- *For measuring radiated emissions at frequencies below 1 GHz, the Spectrum Analyzer was set as 100 KHz RBW, VBW ≥ RBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *For measuring radiated emissions at frequencies above 1 GHz, the Spectrum Analyzer was set as 3 MHz RBW, VBW ≥ RBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *The receiving antenna is used to probed around, up and down the EUT and the metal tank to search for maximum rf emissions levels.*
- ***RF Peak Level**: Maximum level readings are added by 43 dB*
- ***RF Average Level**: the average rf levels were calculated by subtracting the Peak readings added by the duty cycle correction factor.* ***DUTY CYCLE FACTOR = 20LOG$_{10}$(0.00075) = -62.5dB***

TEST CONFIG. #1: IQ-RADAR 160 BY ITSELF (NOT MOUNTED ON TOP OF THE METAL TANK)

Pre-scans at 3 meters for frequency from 30 MHz – 8 GHz and 1 meter for frequency from 8 GHz – 40 GHz in the Anechoic Enclosure with ferrite tiled walls, floor and ceiling.

FREQUENCY (MHz)	RF LEVEL READING (dBuV/m)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
6300	66.8	109.8	47.3	H & V	54.0	-6.7	Pass
No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz. All emissions from plots except that at 6.3 GHz are harmonics of 500 kHz oscillator from the CPU board.							
Note 1: Refer to plots #1 to #7 and plots #16, #17 of the Appendix A for detailed of measurement. Note 2: Prescan Plots # 1 to #7 of the Appendix A showed harmonic emissions of the 500 kHz oscillator which were generated from the CPU board alone. Therefore, they are excluded in this table. Note 3: Antenna factor, cable loss and Pre-Amp gain were corrected using the Spectrum Analyzer data file. Note 4: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB0 of -19.5 dB was corrected using Ref. Offset. Therefore, plots of the transmitter's emissions showed the corrected average levels.							

TEST CONFIG. #2: IQ-RADAR 160 MOUNTED ON TOP OF A METAL TANK

Final Measurements at 3 meters for frequency from 30 MHz – 8 GHz and 1 meter for frequency from 8 GHz – 40 GHz at Milltronics Facilities.

FREQUENCY (MHz)	RF LEVEL READING (dBuV/m)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
6300	**	**	**	H & V	54.0	**	Pass
No significant spurious/harmonic emissions from the transmitters were found in the frequency from 30 MHz to 40 GHz. All emissions from plots except that at 6.3 GHz are harmonics of 500 kHz oscillator from the CPU board.							

** No significant emissions were found at 3 meter distance.
Note 1: Refer to plots #8 through #15 of the Appendix A for detailed of measurement.
Note 2: Based on the prescan test results, no rf emissions from the transmitter were found in the frequencies from 30 MHz to 5 GHz. Therefore, they are excluded in this table. Plots # 8 to #9 of the Appendix A showed harmonic emissions of the 500 kHz oscillator which were generated from the CPU board alone. The RF emissions from the digital circuit portions were tested at 10m OFTS and found to comply with FCC Part 15, Sub. B, Class A Digital Devices, the engineering report can be provided upon FCC request.
Note 3: Antenna factor, cable loss and Pre-Amp gain were corrected using the Spectrum Analyzer data file.
Note 4: The Pulse Desensitization Factor (+43 dB) and Duty Cycle Factor (-62.5 dB0 of -19.5 dB was corrected using Ref. Offset. Therefore, plots of the transmitter's emissions showed the corrected average levels.

- Accredited by ITI (UK) Competent Body, NVLAP (USA) Accreditation Body & ACA/AUSTEL (Australian
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4.2. AC POWERLINE CONDUCTED EMISSIONS, FCC CFR 47, PARA. 15.107(A)

PRODUCT NAME: **Milltronics Radar Level Gauge (6.3 GHz), Model No.: IQ RADAR 160 (AC)**

NAME OF TEST: **AC Powerline Conducted Emissions.**

FCC LIMIT:

The RF voltage conducted back onto the public utility lines shall not exceed 250 µV or 48.0 dBµV measured from 450 KHz to 30 MHz.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

120V 60 Hz.

TEST EQUIPMENT:

- Advantest R3271 Spectrum Analyzer, Frequency Range: 100Hz-26.5GHz, with built-in Peak, Quasi-Peak and Average Detectors.
- HP 11947A Transient Limiter, HP, Model 11947A, Frequency Range: 9KHz-200MHz, Attenuation: 10dB HP.
- HP 7475 Plotter
- EMCO 3825/2 LISN, Frequency Range: 9KHz-200MHz
- RF Shielded Enclosure (12x16x12 feet)

METHOD OF MEASUREMENTS:

Refer to ANSI C63.4-1992.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri Luu, P.Eng.

DATE: Jan. 30, 1998

MEASUREMENT DATA

AC POWER-LINE CONDUCTED EMISSIONS

REMARKS

- *All rf emissions from 450 KHz to 30 MHz were scanned, and eight highest emission levels were recorded. See attached plots.*
- *P: Peak Detector, 10 KHz RBW, VBW ≥ RBW*
- *Q: CISPR QUASI-PEAK, 9 KHz RBW, VBW ≥ RBW*
- *QP/BB: for broadband emission (QP level - AVG level > 6 dB); the recorded level was QP level less 13 dB.*

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)
0.68	37.0	QP	48.0	61.0	-11.0	PASS	L1
24.00	33.7	QP	48.0	61.0	-14.3	PASS	L1
25.00	36.3	QP	48.0	61.0	-11.7	PASS	L1
26.00	37.9	QP	48.0	61.0	-10.1	PASS	L1
27.00	36.2	QP	48.0	61.0	-11.8	PASS	L1
0.68	35.8	QP	48.0	61.0	-12.2	PASS	L2
24.50	35.4	QP	48.0	61.0	-12.6	PASS	L2
25.50	38.0	QP	48.0	61.0	-10.0	PASS	L2
26.00	39.0	QP	48.0	61.0	-9.0	PASS	L2
27.50	35.3	QP	48.0	61.0	-12.7	PASS	L2

Please refer to Plots 18 and 19 of the Appendix A for detailed measurement data.

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5. EXHIBIT 5 - GENERAL TEST PROCEDURES

5.1. AC POWERLINE CONDUCTED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- AC Powerline Conducted Emissions were performed in the shielded room, 16'(L) by 12'(W) by 12'(H).
- Conducted power-line measurements 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 was operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, ac power-line 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 outlets. 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 (10 KHz RBW, VBW $\geq$ RBW), frequency span 450KHz-30MHz.
- 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.

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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 the final highest RF signal level and frequency was 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.

5.2. ELECTRICAL FIELD RADIATED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- 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.

- Radiated emissions measurements were made using the following test instruments:

  1) Calibrated EMCO active loop antenna in the frequency range from 10 KHz to 1 MHz
  2) Calibrated EMCO biconilog antenna in the frequency range from 30 MHz to 2000 MHz.
  3) Horn Antennas:
     a) Horn Antenna, Emco, Model 3115, 1 – 18 GHz
     b) Horn Antenna, Emco, Model 3160-09, 18-26.5GHz
     c) Horn Antenna, Emco, Model 3160-10, 26.5-40GHz
     d) Mixer, Tektronix, P/N 118-0098-00, 18-26.5GHz
     e) Mixer, Tektronix, P/N 119-0098-00, 26.5-40GHz
  4) Calibrated Advantest spectrum analyzer and pre-selector/pre-amplifier. In general, the spectrum analyzer would be used as follows:

     – The rf electric field levels were measured with the spectrum analyzer set to PEAK detector (1 KHz RBW and 1 KHz VBW for frequency below 30 MHz, 100 KHz RBW and VBW ≥ RBW for Frequency below 1 GHz and 1 MHz RBW and 1 MHz VBW for frequency greater than 1 GHz).

     – If any rf emission was observed to be a broadband noise, the spectrum analyzer's CISPR QUASI-PEAK detector (120 KHz RBW and 1MHz VBW) was then set to measure the signal level.

     – If the signal being measured was narrowband and the ambient field was broadband, the bandwidth of the spectrum analyzer was reduced.

- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.

- 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 (each variable within bounds specified elsewhere) 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 allowed range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

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

Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where	FS	=	Field Strength
	RA	=	Receiver/Analyzer Reading
	AF	=	Antenna Factor
	CF	=	Cable Attenuation Factor
	AG	=	Amplifier Gain

Example: If a receiver reading of 60.0 dBµV 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 in dBµV/m = 60 + 7.0 + 1.0 - 30 = 38.0 dBµV/m.

Field Level in µV/m = $10^{(38/20)}$ = 79.43 µV/m.

Notes: The frequency and amplitude of at least six highest conducted emissions relative to the limit are recorded unless such emissions are more than 20 dB below the limit. If less than six emissions are within 20dB of the limit, the background or receiver noise level shall be reported at representative frequencies.

6. EXHIBIT 6 - INFORMATION RELATED TO EQUIPMENT UNDER TESTS

6.1. FCC ID LABELING AND SKETCH OF FCC LABEL LOCATION

Refer to the attached sheets

6.2. PHOTOGRAPHS OF EQUIPMENT UNDER TEST

Refer to the attached photographs

6.3. SYSTEM BLOCK DIAGRAM(S)

Refer to the attached sheets

6.4. SCHEMATIC DIAGRAMS

Refer to the attached sheets

6.5. USER'S MANUAL WITH "FCC INFORMATION TO USER STATEMENTS"

Refer to the attached Users' manual

7. EXHIBIT 7: Appendix A – Plots of Measurement Data

Please refer to the attached Exhibit for Appendix A

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