UltraTech
Group of Labs

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Jan 29, 2003

ABM Sensor Technology
730 The Kingsway
Peterborough, Ontario
Canada, K9J 6W6

Attn.: **Mr. Bogdan Cherek**

Subject: **FCC Certification Application Testing under FCC PART 15, Subpart C, Sec. 15.209 – Low Power Transmitters operating in the frequency band 6.3 GHz.**

Product: **ABM300/400-XXXR Pulse Radar**
Model No.: **ABM300/400-XXXR**
FCC ID: **QVK-ABMX00**

Dear Mr. Cherek,

The product sample, as provided by you, has been tested and found to comply with **FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitters operating in the frequency band 6.3 GHz.**

Enclosed you will find copies of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,

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

Encl

ENGINEERING TEST REPORT

ABM300/400-XXXR Pulse Radar
Model No.: ABM300/400-XXXR

FCC ID: QVK-ABMX00

Applicant: **ABM Sensor Technology**
730 The Kingsway
Peterborough, Ontario
Canada, K9J 6W6

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.209
Low Power Transmitters
operating in the frequency band 6.3 GHz

UltraTech's File No.: ABM-005FCC15C

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Jan 29, 2003	
Report Prepared by: Tri Luu, P.Eng. Issued Date: Jan 29, 2003	Tested by: Hung Trinh, RFI Technician Test Dates: Jan. 27-28, 2003

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

UltraTech

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

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Photos # 1 to 4	OK
2	External Photos of EUT	Photos # 1 to 2	OK
3	Internal Photos of EUT	Photos of 1 to 4	OK
4	Cover Letters	• Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK OK
5	ID Label/Location Info	• ID Label • Location of ID Label	OK OK
6	Block Diagrams	• Block diagrams # 1 of 1	OK
7	Schematic Diagrams	• Schematic diagrams # 1 of 1	OK
8	Parts List/Tune Up Info	•	None
9	Operational Description		N/A
10	RF Exposure Info		
11	Users Manual	Information/instructions that will be intended in the installation/operation pertains to:	OK

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

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.209
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low Power Transmitters operating in the Frequency Band 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 • Industry
Grant Note:	• This radio transmitter is certified for use with metal tank only.

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

None

1.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR Parts 0-19	2002	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 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

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

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT:	
Name:	ABM Sensor Technology
Address:	730 The Kingsway Peterborough, Ontario Canada, K9J 6W6
Contact Person:	Mr. Bogdan Cherek Phone #: 705-740-2010 Fax #: 705-740-2563 Email Address: general@abmsensor.com

MANUFACTURER:	
Name:	ABM Sensor Technology
Address:	730 The Kingsway Peterborough, Ontario Canada, K9J 6W6
Contact Person:	Mr. Bogdan Cherek Phone #: 705-740-2010 Fax #: 705-740-2563 Email Address: general@abmsensor.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name	ABM Sensor Technology
Product Name	ABM300/400-XXXR Pulse Radar
Model Name or Number	ABM300/400-XXXR
Serial Number	Preproduction
Type of Equipment	Low Power Transmitters
Input Power Supply Type	• AC Mains 115 V 60 Hz or • External DC Sources, 24 Vdc
Primary User Functions of EUT:	For measuring substance level contained in a metal tank.

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

2.3. TECHNICAL/OPERATION DESCRIPTION OF ABM300/400-XXXR

The equipment under test consists of 2 different Models, ABM300-XXXR and ABM400-XXXR. These 2 models are exactly identical except for the power supply mains; the Model ABM300-XXXR employs 24 Vdc input supply and the Model ABM400-XXXR employs 115 Vac 60 Hz input supply.

Pulse radar transmits pulses of about of 6.3GHz with duration of **1.5ns. These pulses stimulate dominant mode TE10 of rectangular resonator. The resonator is coupled to rod antenna. Reflecting pulses from an object are received by rod antenna that is coupled with the rectangular resonator and receiver circuit. The receiver circuit is connected to mixer and at the output of the mixer a slow motion echoes are obtained. Repetition rate is decided by PLL circuit and is equal to 280ns.** Reflected pulses from objects return to the receiver and being stretched and slowed down using down sampling process controlled by PLL circuit. Two oscillators in the PLL circuit run 54Hz frequency difference. This low frequency is a new span for stretched and slowed down pulses. Echo envelope is converted to a digital marker that is monitored by a microprocessor. Microprocessor calculates distance and converts its timer to 4mA to 20mA current output.

Type of modulation used in the pulse radar: it is a pulse modulation with carrier frequency equal to 6.3GHz. The duration of the burst (pulse) is 1.5ns.

Repetition rate: The repetition rate is 280ns

Duty cycle is calculated as ratio of the pulse width to repetition rate 1.5ns/280ns=5.36e-03,

Theoretically **signal bandwidth** is 2/T , where T is the pulse duration equal to 1.5ns, so the bandwidth is equal to 1.33GHz with the center frequency 6.3GHz, so it is 6.3GHz +/-665MHz

2.4. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	▪ Portable ▪ Mobile ▪ Base station (fixed use)
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	24Vdc or 115 Vac 60 Hz
RF Output Power Rating:	40.8 dBuV/m at 3 meters
Operating Frequency Range:	6.3 GHz
RF Output Impedance:	50 Ohms
Channel Spacing:	N/A
Duty Cycle:	1.5ns/280ns=5.36e-03 or 0.536%
26 dB Bandwidth:	1374 MHz
Modulation Type:	Pulse modulated in Width/Duration (pulse desensitization)
Emission Designation:	1G37L0N
Oscillator Frequencies:	3.58 MHz ang 6.3 GHz
Antenna Connector Type:	• Integral, permanently attached
Antenna Description:	Manufacturer: ABM Sensor Technology Type: Rod antenna

2.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RS232/RS485, AC/DC IN & Loop Current Ports	1	8C Pin header	Nonshielded wirelead harness

2.6. ANCILLARY EQUIPMENT

None

2.7. GENERAL TEST SETUP

The equipment under test consists of 2 different Models, ABM300-XXXR and ABM400-XXXR. These 2 models are exactly identical except for the power supply mains; the Model ABM300-XXXR employs 24 Vdc input supply and the Model ABM400-XXXR employs 115 Vac 60 Hz input supply.

The Model ABM400XXXR with the AC 120V 60Hz supply was used for testing and it shall also represent for the Model ABM300-XXXR.

- Tests were conducted with the EUT mounted on top of a metal tank and with the antenna pointed downward to the bottom of the tank as its intended use. This test configuration concerns the effect of reflection of the rf signal which may cause interference to free space when the metal tank is used. Please refer to Photos # 1 and 2 in the Annex 1 for test setup.

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

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	24Vdc or 115 Vac 60 Hz

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	Transmit as intended
Special Test Software:	N/A
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna equipment.

Transmitter Test Signals:	
Test Frequency:	6.3 GHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 40.8 dBuV/m at 3 meters ▪ Pulse modulated in width/duration ▪ Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

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

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

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

  The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Aug. 10, 2002.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.203	Antenna Requirement	Yes. Permanently attached Rod antenna.
15.209 & 15.205	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
	26 dB Bandwidth	Yes
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	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.		

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

(1) Gap between the antenna and chassis was properly closed up to reduce emission leakage and 6.3 GHz
(2) 100 pF capacitors were connected between AC hot and neutral line to ground to reduce conducted and radiated from the AC power cord.

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

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

5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report, ANSI C63-4:1992..

5.2. MEASUREMENT UNCERTAINTIES

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

5.3. MEASUREMENT EQUIPMENT USED:

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

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

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

5.5. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.207

5.5.1. Limits

The equipment shall meet the limits of the following table:

	CLASS B LIMITS		
Test Frequency Range (MHz)	**Quasi-Peak (dBmV)**	**Average* (dBmV)**	**Measuring Bandwidth**
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency

5.5.2. Method of Measurements

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

5.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 µH
12'x16'x12' RF Shielded Chamber	RF Shielding	…	..	…

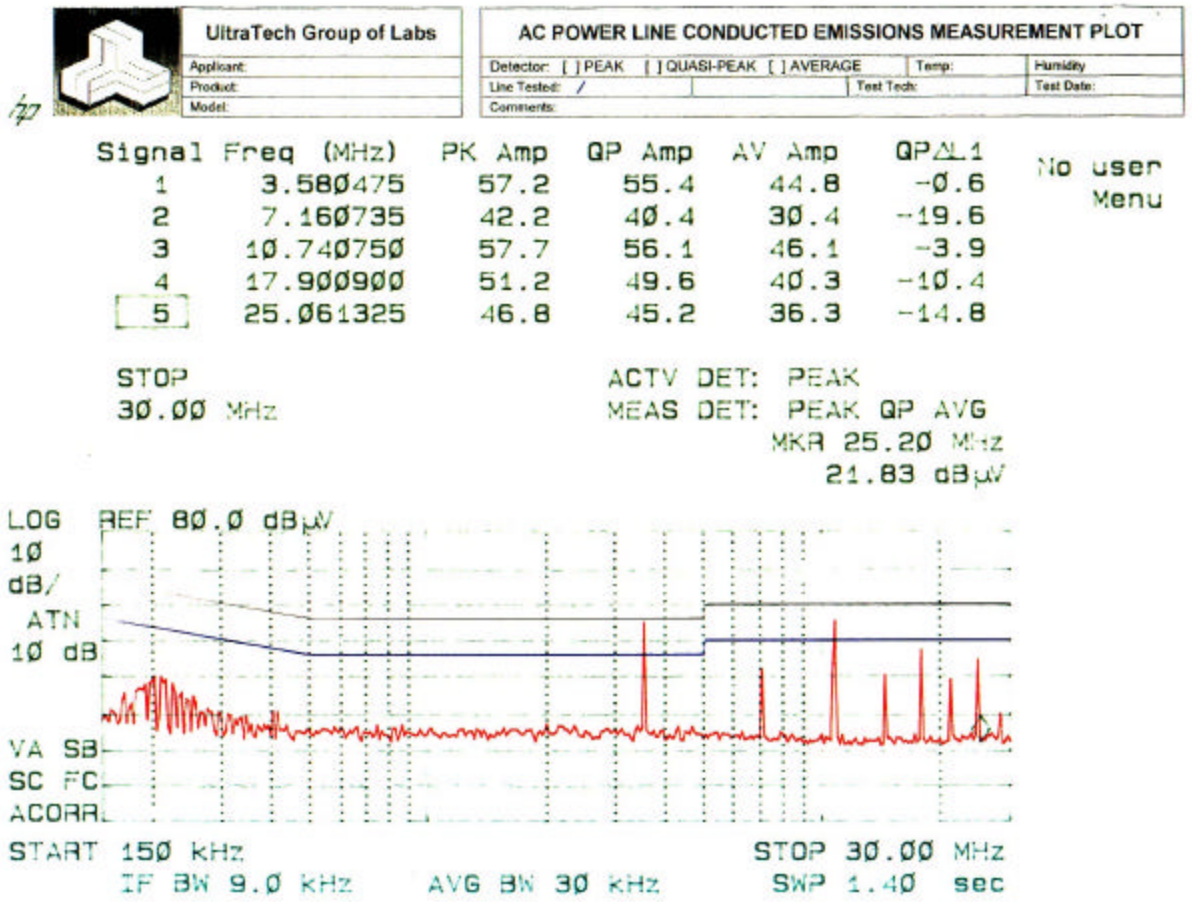
5.5.4. Photographs of Test Setup

Refer to the Photographs #3 & #4 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

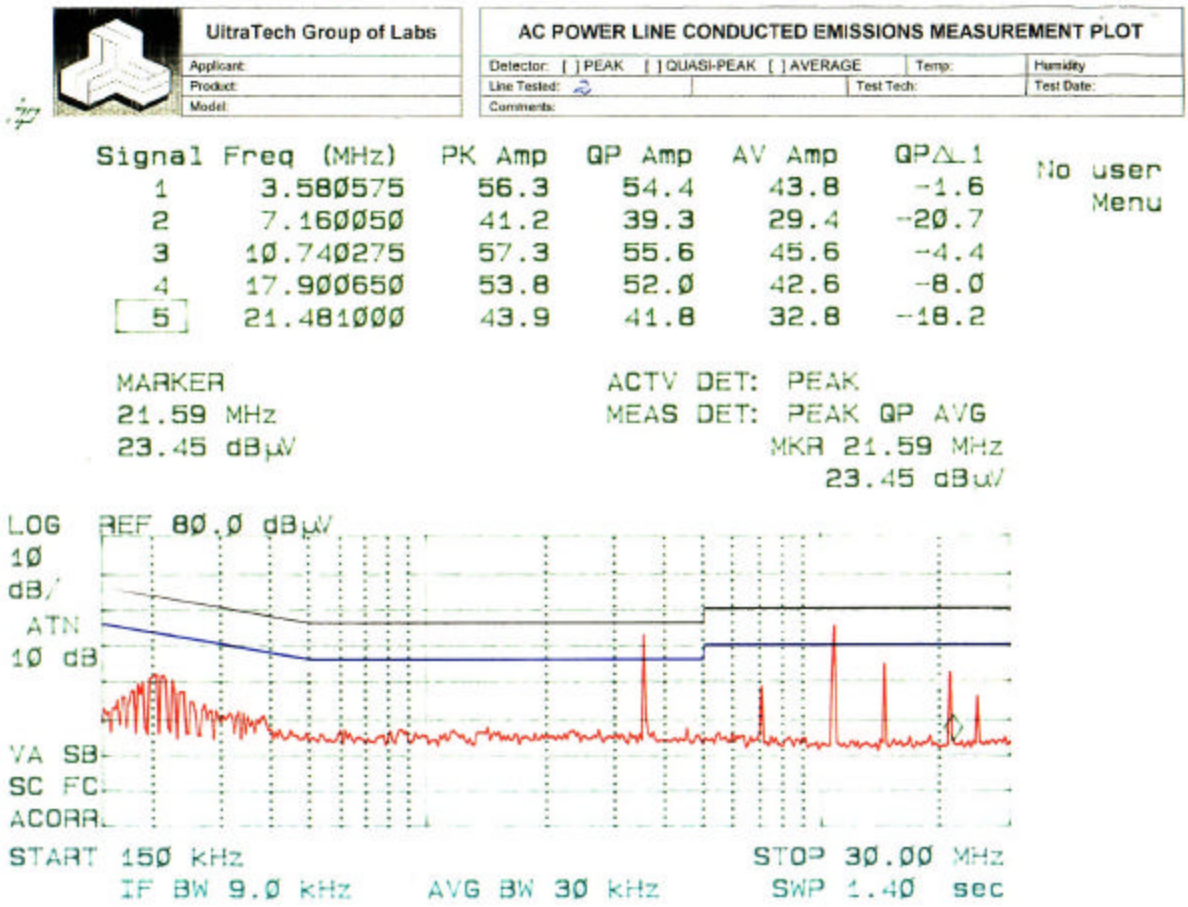
5.5.5. Test Data

FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVERAGE LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
3.58	55.4	QP	56.0	46.0	-0.6	PASS	L1
3.58	44.8	AVG	56.0	46.0	-1.2	PASS	L1
7.16	40.4	QP	60.0	50.0	-19.6	PASS	L1
7.16	30.4	AVG	60.0	50.0	-19.6	PASS	L1
10.74	56.1	QP	60.0	50.0	-3.9	PASS	L1
10.74	46.1	AVG	60.0	50.0	-3.9	PASS	L1
17.90	49.6	QP	60.0	50.0	-10.4	PASS	L1
17.90	40.3	AVG	60.0	50.0	-9.7	PASS	L1
25.06	45.2	QP	60.0	50.0	-14.8	PASS	L1
25.06	36.3	AVG	60.0	50.0	-13.7	PASS	L1
3.58	54.4	QP	56.0	46.0	-1.6	PASS	L2
3.58	43.8	AVG	56.0	46.0	-2.2	PASS	L2
10.74	55.2	QP	60.0	50.0	-4.8	PASS	L2
10.74	46.3	AVG	60.0	50.0	-3.7	PASS	L2
14.32	45.8	QP	60.0	50.0	-14.2	PASS	L2
14.32	35.8	AVG	60.0	50.0	-14.2	PASS	L2
17.90	53.0	QP	60.0	50.0	-7.0	PASS	L2
17.90	43.2	AVG	60.0	50.0	-6.8	PASS	L2
25.06	42.4	QP	60.0	50.0	-17.6	PASS	L2
25.06	42.4	AVG	60.0	50.0	-7.6	PASS	L2

- The RF emissions were scanned from 150 kHz to 30 MHz an all rf voltage levels less 20 dB below the limits were recorded.



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



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

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

5.6.1. 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

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

5.6.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.3 of this test report and **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For 9 kHz $\leq$ frequencies $\leq$ 150 kHz: RBW = 1 KHz, VBW $\geq$ 1 KHz, SWEEP=AUTO.
- For 150 MHz $\leq$ frequencies $\leq$ 30 MHz: RBW = 10 KHz, VBW $\geq$ 10 KHz, SWEEP=AUTO.
- For 30 MHz $\leq$ frequencies $\leq$ 1 GHz: RBW = 100 KHz, VBW $\geq$ 100 KHz, SWEEP=AUTO.
- For frequencies $\geq$ 1 GHz: RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

Desensitization for Pulse Emissions: Since the ABM300/400-XXXR 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 1 MHz, the corresponding pulse desensitization factor (αp) of 52 dB at pulse width τeff = 1.5 nS can be derived from Figure 28 of HP 150-2.

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: 1.5ns/280ns=5.36e-03 or 0.536%
Peak-to-Average Factor = 20*log (0.0054) = -45.4 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:

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

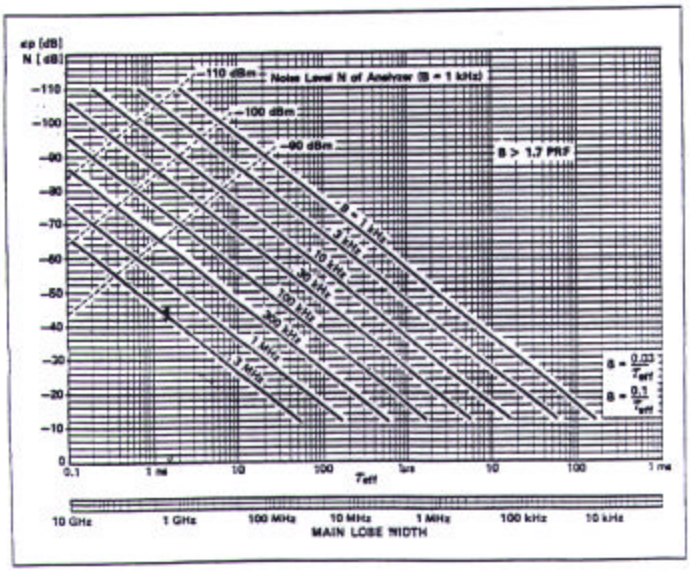
3. The IF bandwidth must be greater than the PRF: $B > \text{PRF}$

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 $B > \text{PRF}$. 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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- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

5.6.3. 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
Active Loop antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	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

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

5.6.4. Test Data

Remarks: The equipment under test consists of 2 different Models, ABM300-XXXR and ABM400-XXXR. These 2 models are exactly identical except for the power supply mains; the Model ABM300-XXXR employs 24 Vdc input supply and the Model ABM400-XXXR employs 115 Vac 60 Hz input supply.

The Model ABM400XXXR with the AC 120V 60Hz supply was used for testing and it shall also represent for the Model ABM300-XXXR.

5.6.4.1. Test with Metal Tank

- Tests were conducted with the EUT mounted on top of a metal tank and with the antenna pointed downward to the bottom of the tank as its intended use. This test configuration concerns the effect of reflection of the rf signal which may cause interference to free space when the metal tank is used..

FREQUENCY (MHz)	RF PEAK LEVEL in 1 MHz (dBuV/m)	RF ** AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT MARGIN (dB)	PASS/ FAIL	Distance (m)
6.3	Note 1	Note 1	V	54.0	--	PASS	3
6.3	Note 1	Note 1	H	54.0	--	PASS	3
10 kHz to 40GHz	Note 1	Note 1	V & H	--	--	PASS	3

- The spurious/harmonic emissions were scanned from 10 kHz to 40 GHz and there is no significant emissions were found from the transmitter. Other rf emissions from digital devices, such as harmonic of 3.58 MHz, were found to comply with FCC Class A Limits.
- Refer to Photos # 1 to 2 in Annex 1.

Remarks:

1) DUTY CYCLE: 1.5ns/280ns=5.36e-03 or 0.536%.
Peak-to-Average Factor = 20*log (0.0054) = -45.4 dB.

(2) With the measuring resolution bandwidth (RBW) of 1 MHz, the corresponding pulse desensitization factor (αp) of 52 dB at pulse width τeff = 1.5 nS can be derived from Figure 28 of HP 150-2.

(3) Peak measurement = peak reading from EMI receiver + desensitization factor (52 dB)

(4) Average Measurement = Peak Readings in MHz (including antenna factor & cable loss) + duty cycle factor

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

5.7. 26 DB OCCUPIED BANDWIDTH

5.7.1. Limits

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

5.7.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 & ANSI C63-4:1992

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna and the bandwidth of bandwidth of the fundamental frequency was measured with the spectrum analyzer with the resolution bandwidth of the spectrum analyzer set per ANSI 63-4:1992, Sec. 13.1.6.2

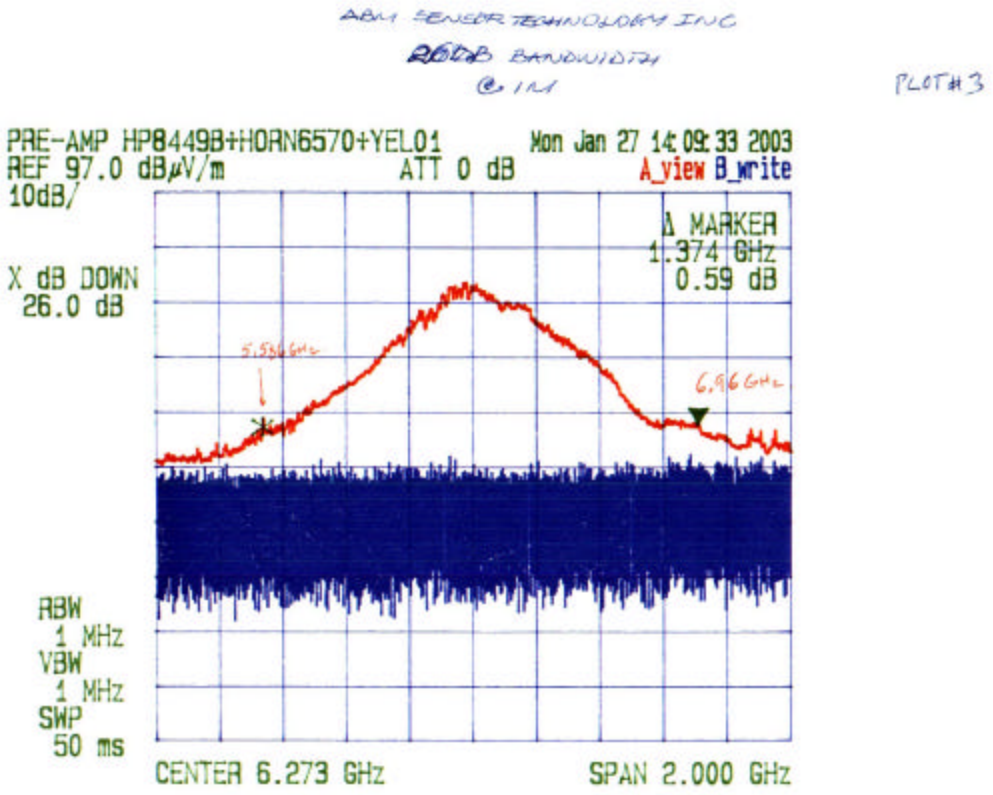
5.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz

5.7.4. Test Data

CHANNEL FREQUENCY (MHz)	26 dB BANDWIDTH (MHz)	MAXIMUM LIMIT (kHz)	PASS/FAIL
6.3	1374	Note 1	PASS

Note 1: The 26 dB BW was 1374 MHz with its 26 dB points at 5586 MHz and 6960 MHz. These 26 dB points were found to be outside of the adjacent restricted bands of 5350 - 5460 MHz and 7250 - 7750 MHz specified in FCC 15.205. Please refer to the plot below for detailed information.



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

EXHIBIT 6. MEASUREMENT UNCERTAINTY

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

6.1. 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 Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) 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:

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

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

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6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

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EXHIBIT 7. MEASUREMENT METHODS

7.1. GENERAL TEST CONDITIONS

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

7.1.1. Normal temperature and humidity

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

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

7.1.2. Normal power source

7.1.2.1. Mains Voltage

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

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

7.1.2.2. Battery Power Source.

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

7.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at :
  - the lowest, middle and highest channel frequencies if the operating frequency band is greater than 10 MHz
  - the lowest and highest channel frequencies if the operating frequency band is from 1 to 10 MHz.
  - the middle channel frequency if the operating frequency band is less than 1 MHz.
- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers.

7.2. 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.

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- ***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.

7.3. SPURIOUS EMISSIONS

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

- 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:

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

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.

7.4. 26 DB BANDWIDTH MEASUREMENTS

- Couple the RF output signal to the spectrum analyzer by means of direct connection or by a receiving antenna.
- The spectrum analyzer shall be se as follows:
  - Span: Minimum span to fully display the entire emission, approximately 3 x emission BW.
  - Resolution RBW: 1% to 3% of the approximate emission BW
  - Video VBW: 3 x RBW
  - EMI Detector: Peak
  - Sweep Time: Coupled or set to a slow rate
  - Trace: Max-hold
- Place the marker at both sides of the emission slope and at -26 dB down from the peak value.
- The difference of frequencies of 2 markers will be the 26 dB bandwidth
- Record and plot the test results.

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