ENGINEERING TEST REPORT

Elite 770 Hand Held
Model No.: Elite 770 Hand Held

FCC ID: O34-Elite770HH

Applicant: **IVI CHECKMATE INC.**
79 Torbarrie Road
Toronto, Ontario
Canada, M3L 1G5

In Accordance With

FCC PART 15, SUBPART C, PARA. 15.249
LOW POWER TRANSMITTERS
OPERATING IN THE FREQUENCY BAND 911.4 - 918.6 MHz

UltraTech's File No.: IVI70-FTX

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

Date: ……

Report Prepared by: Dan Huynh Issued Date: June 20, 2000	Tested by: Hung Trinh, EMI/RFI Technician Test Dates: June 5, 2000

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

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Telephone (905) 829-1570 Facsimile (905) 829-8050
Website: www.ultrat4ech-labs.com Email: vhk.ultratech@sympatico.ca

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9	Test Report - Plots of Measurement Data	-26 dB Bandwidth (plots # 1 to 2) -Transmitter Radiated Emissions (Plots # 3 - 10)	OK
10	Test Setup Photos	Radiated emissions test setup photos	OK
11	External Photos of EUT	Elite 770 Hand Held external photos	OK
12	Internal Photos of EUT	Elite 770 Hand Held internal photos	OK
13	Cover Letters	-Letter from Ultratech for Certification Request -Letter from the Applicant to appoint Ultratech to act as an agent -Letter from the Applicant to request for Confidentiality Filing	OK
14	Attestation Statements	--	--
15	Application Forms	-Form 731 -Form 159	OK
16	ID Label/Location Info	-ID Label -Location of ID Label	OK
17	Block Diagrams	Elite 770 Hand Held Block Diagram	OK
18	Schematic Diagrams	-Schematic MER202 ASIC/CPU/MEMORY/MEM EXT -MER202 EQUIPMENT F1 -MER202 USINAGE -MER202 MONTAGE PLAQUE -Schematic REC109 Multifrequency Radio 915/434 MHz -Plan D'Equipement Carte REC109-01 (915, 433 MHz) -Plan D'Usinage CARTE REC109 -Plan De Montage en Plaque 4x3 -INT217 MINIMUM SECURITY BOARD -INT217 Plan D'Equipement Carte VUE Cote Compsants -Plan D'Usinage Carte INT217 -Montage EN Plaque 3x3 INT200/INT217	OK
19	Parts List/Tune Up Info	-Nomemclature Carte MER202 -Nomemclature Carte REC109-01, 02 -Nomemclature Carte INT217	OK
20	Operational Description	-Elite 770 Short Range RF system (consist of Elite 770 - Intelligent Base and Elite 770 Hand Held)	OK
21	RF Exposure Info	--	--
22	User's Manual	-Elite 770* User's Manual -Elite 770 User's Manual Addendum	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.249:1998
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for transmitters operated within the frequency band of 911.4 - 918.6 MHz .
Test Procedures	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	• Light-industry, Commercial • 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

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name	IVI CHECKMATE INC.
Address	79 Torbarrie Road Toronto, Ontario Canada, M3L 1G5
Contact Person	Mr. Ayman Sydhom
Tel	(416) 245-6700
Fax	(416) 245-6701
Email Address	Email Address: asydhom@ivicm.com

MANUFACTURER	
Name	GROUPE INGENICO
Address	9 Quai De Dion Bouton 92816 Puteaux Cedes, France
Tel	+33 (0) 1 46 25 82 00
Fax	+33 (0) 1 47 72 56 95

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	IVI CHECKMATE INC.
Product Name	Elite 770 Hand Held
Model Name or Number	Elite 770 Hand Held
Serial Number	Preproduction
Type of Equipment	Low Power Transmitters
Input Power Supply Type	Internal Battery
Associated Device(s)	IVI Checkmate Inc. Elite 770 Intelligent Base Model: Elite 770 Intelligent Base
Primary User Functions of EUT:	Provide data communication link through air

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Portable
Intended Operating Environment:	Commercial, light industry & heavy industry
Power Supply Requirement:	12 VDC / 500 mA
RF Output Power Rating:	44 mW EIRP
Operating Frequency Range:	911.4 – 918.6 MHz
RF Output Impedance:	50 Ohms
Duty Cycle:	Continuous
26 dB Bandwidth:	108.9 kHz (refer to Exhibit 9 test plots # 1 and # 2 for details)
Modulation Type:	FM
Emission Designation:	M109F1D
Oscillator Frequencies:	10.7 MHz
Antenna Connector Type:	Integral (the antenna component is soldered onto the radio printed circuit board and located inside the enclosure)
Antenna Description:	Manufacturer: NeoFlex Technology Type: Loop Antenna on flexible printed circuit Frequency Range: 911.4 – 918.6 MHz In/Out Impedance: 50 Ohms Gain: -4.3 $\pm$ 0.5dBi

3.4. GENERAL TEST SETUP

STAND-ALONE UNIT

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:	12VDC / 500mA

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	Each of lowest and highest channel frequencies transmits continuously for emissions measurements.
Special Test Software:	Special software is provided by the Applicant to select and operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of lowest and highest frequencies individually continuously during testing.
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:	
Frequencies: ▪ Band III: 911.4 – 914.2 MHz ▪ Band IV: 915.8 - 918.6 MHz	Lowest and highest channel frequencies tested: 911.4 MHz, 914.2 MHz 915.8 MHz, 918.6 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ .0.44 mW ▪ Each channel is FM modulated ▪ Internal

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)
15.107(a)	AC Power Conducted Emissions	Test not applicable for battery operated devices
15.249(a), 15.209, 15.205 & 1.1310	Transmitter Radiated Emissions, Harmonic Emissions and RF Exposure Limit	Yes

Note: The digital circuits portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and Radio Receivers. 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

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 15.247 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. RF EXPOSURE LIMIT FCC 1.1310

6.5.1. Limits

- **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)

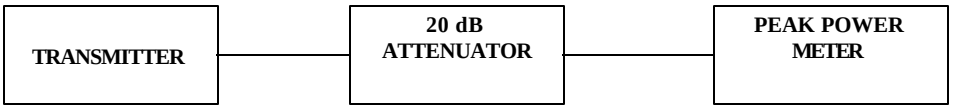
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
300-1500	...	...	F/300	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1500	...	...	F/1500	30

F = Frequency in MHz

6.5.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.3 of this test report, ANSI C63-4:1992, FCC @ 1.1310 & OST Bulletin No. 65-October 1985

6.5.3. Test Arrangement



6.5.4. 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
Peak Power Meter & Peak Power Sensor	Hewlett Packard	8900 8481A	2131A00124 2551A01965	0.1-18 GHz 50 Ohms Input
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz

6.5.5. Test Data

EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) CALCULATED FROM FUNDAMENTAL FIELD STRENGTH MEASURED AT 3 METERS DISTANCE (Substitution Method)					
Tx Channel Output	**Fundamental Frequency (MHz)**	**Tx Antenna Gain (Numeric)**	**Max.Field Strength Level @ 100 KHz BW a 3 m (dBµV/m)**	**Max. EIRP Power In a 100 KHz BW (mW)**	**Power Limit (mW)**
BAND 3					
1	911.4	0.37	90.50	0.34	N/A
15	914.2	0.37	90.98	0.38	N/A
BAND 4					
1	915.8	0.37	90.80	0.36	N/A
15	918.6	0.37	91.64	0.44	N/A

RF EXPOSURE DISTANCE LIMITS				
Transmitter Channel Output	**Fundamental Frequency (MHz)**	**Calculated EIRP Full Power (mW)**	**Power Density (mW/cm^2)**	***Minimum Allowable Distance (r) From Skin (cm)**
BAND 3				
1	911.4	0.34	0.608	0.21
15	914.2	0.38	0.609	0.22
BAND 4				
1	915.8	0.36	0.610	0.22
15	918.6	0.44	0.612	0.24

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

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

$r = (PG/4\Pi S)^{1/2} = ((EIRP/4\Pi S)^{1/2}$

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

Since the power density of 0.61 mW/cm^2 is at a very short distance from the radiating antenna which is integrated on the printed circuit board, and the antenna is completely enclosed inside the case, the RF exposure limit warning or SAR tests are not necessary.

6.6. TRANSMITTER FUNDAMENTAL & HARMONIC RADIATED EMISSIONS @ FCC CFR 47, PARA 15.249 (a)

6.6.1. Limits

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental @ 3m (dBµ/m)	Field Strength of Harmonics @ 3m (dBµ/m)
902 - 928 MHz	94.0	54.0
2400 - 2483.5 MHz	94.0	54.0
5725 - 5875 MHz	94.0	54.0
24.0 - 24.25 GHz	108.0	68.0

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- **@ FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) – Restricted band of operation

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1]Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2]Above 38.6

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
Radiated emission limits, general requirements

Frequency (MHz)	Field Strength (microvolts/m)	Measurement 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 = 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).

6.6.3. Test Arrangement

Please refer to Test Arrangement in Sec. 3.4 for details of test setup for emission measurements.

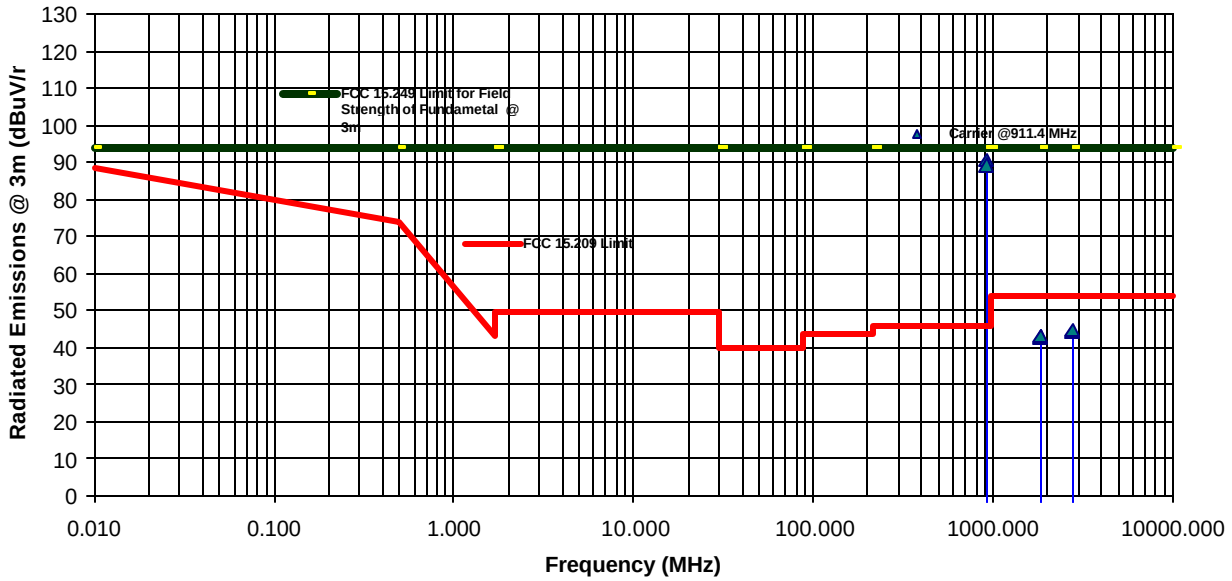
6.6.4. Test Equipment List

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. Test Data

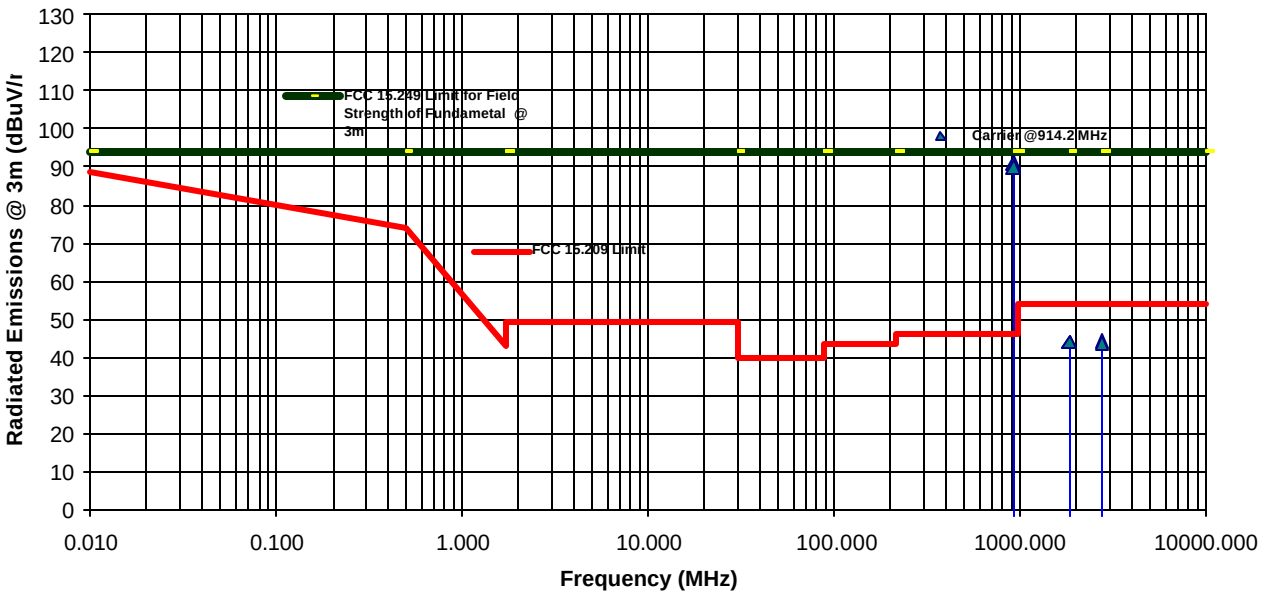
BAND 3 – Lowest Frequency (911.4 MHz)							
FREQUENCY (MHz)	RF PEAK LEVEL (dBµV/m)	RF AVG LEVEL (dBµV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBµV/m)	LIMIT 15.249 (dBµV/m)	MARGIN (dB)	PASS/ FAIL
911.4	90.50	--	V	--	94.0	-3.5	PASS
911.4	89.40	--	H	--	94.0	-4.6	PASS
1822.8	42.88	42.88	V	54.0	--	-11.1	PASS
1822.8	43.06	43.06	H	54.0	--	-10.9	PASS
2734.2	44.19	44.19	V	54.0	--	-9.8	PASS
2734.2	44.78	44.78	H	54.0	--	-9.2	PASS
The emissions were scanned from 10 MHz to 10 GHz and all emissions less 20 dB below the limits were recorded. Refer to Exhibit 9 test plots # 3 and # 4 for details.							

Transmitter Radiated Emissions Measurements at 3 Meters OFTS
TRANSMIT Freq.: 911.4 MHz
IVI Checkmate Inc.
Elite 770 Hand Held, Model Elite 770 Hand Held



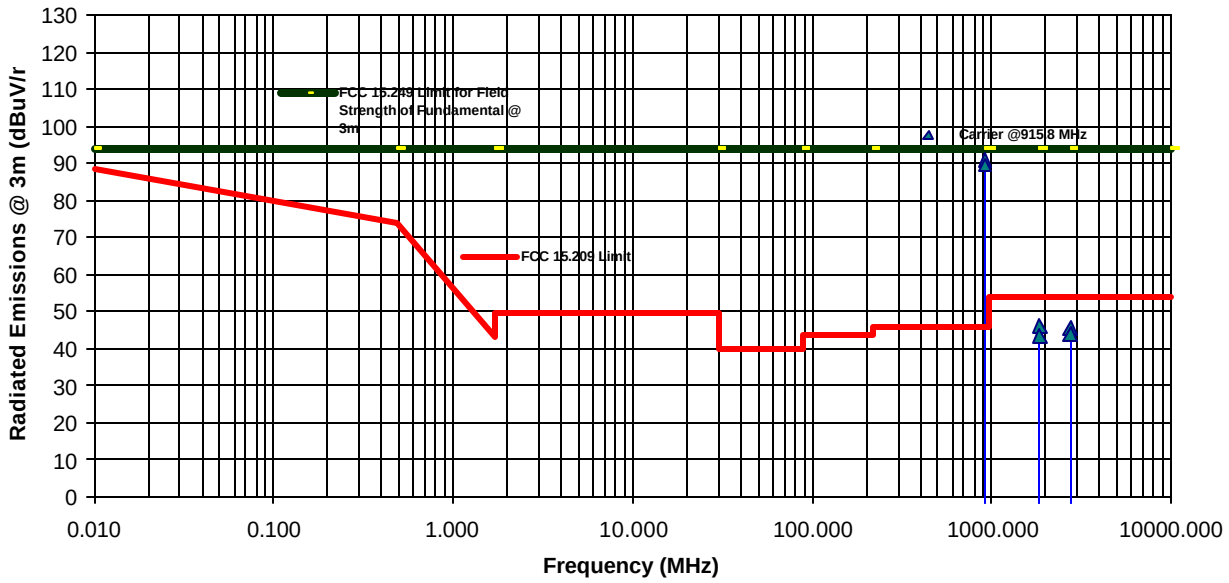
BAND 3 – Highest Frequency (914.2 MHz)							
FREQUENCY (MHz)	RF PEAK LEVEL (dBµV/m)	RF AVG LEVEL (dBµV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBµV/m)	LIMIT 15.249 (dBµV/m)	MARGIN (dB)	PASS/ FAIL
914.2	90.98	--	V	--	94.0	-3.0	PASS
914.2	90.07	--	H	--	94.0	-3.9	PASS
1828.4	44.03	44.03	V	54.0	--	-10.0	PASS
1828.4	44.00	44.00	H	54.0	--	-10.0	PASS
2742.6	44.22	44.22	V	54.0	--	-9.8	PASS
2742.6	43.78	43.78	H	54.0	--	-10.2	PASS
The emissions were scanned from 10 MHz to 10 GHz and all emissions less 20 dB below the limits were recorded. Refer to Exhibit 9 test plots # 5 and # 6 for details.							

Transmitter Radiated Emissions Measurements at 3 Meters OFTS
TRANSMIT Freq.: 914.2 MHz
IVI Checkmate Inc.
Elite 770 Hand Held, Model Elite 770 Hand Held



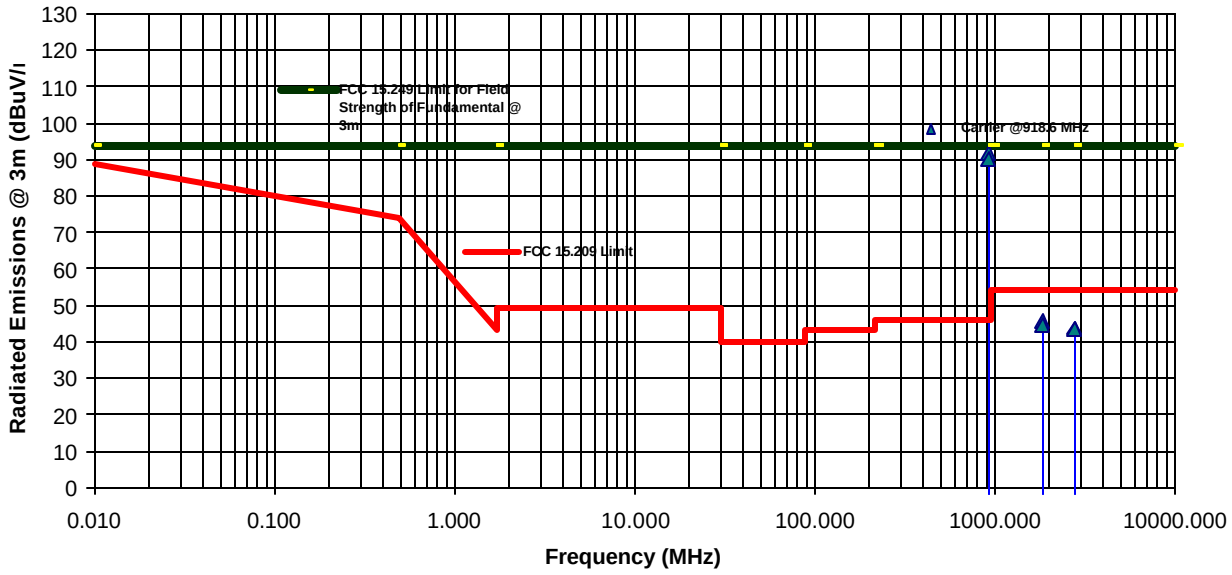
BAND 4 – Lowest Frequency (915.8 MHz)							
FREQUENCY (MHz)	RF PEAK LEVEL (dBµV/m)	RF AVG LEVEL (dBµV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBµV/m)	LIMIT 15.249 (dBµV/m)	MARGIN (dB)	PASS/ FAIL
915.80	90.80	--	V	--	94.0	-3.2	PASS
915.80	89.48	--	H	--	94.0	-4.5	PASS
1831.60	46.06	46.06	V	54.0	--	-7.9	PASS
1831.60	43.44	43.44	H	54.0	--	-10.6	PASS
2747.40	45.69	45.69	V	54.0	--	-8.3	PASS
2747.40	43.97	43.97	H	54.0	--	-10.0	PASS
The emissions were scanned from 10 MHz to 10 GHz and all emissions less 20 dB below the limits were recorded. Refer to Exhibit 9 test plots # 7 and # 8 for details.							

Transmitter Radiated Emissions Measurements at 3 Meters OFTS
TRANSMIT Freq.: 915.8MHz
IVI Checkmate Inc.
Elite 770 Hand Held, Model Elite 770 Hand Held



BAND 4 – Lowest Frequency (918.6 MHz)							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.249 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
918.60	91.64	--	V	--	94.0	-2.4	PASS
918.60	90.12	--	H	--	94.0	-3.9	PASS
1837.20	45.63	45.63	V	54.0	--	-8.4	PASS
1837.20	44.63	44.63	H	54.0	--	-9.4	PASS
2755.80	43.84	43.84	V	54.0	--	-10.2	PASS
2755.80	43.50	43.50	H	54.0	--	-10.5	PASS
The emissions were scanned from 10 MHz to 10 GHz and all emissions less 20 dB below the limits were recorded. Refer to Exhibit 9 test plots # 9 and # 10 for details.							

Transmitter Radiated Emissions Measurements at 3 Meters OFTS
TRANSMIT Freq.: 918.6MHz
IVI Checkmate Inc.
Elite 770 Hand Held, Model Elite 770 Hand Held



6.6.6. Photographs of Test Setup

Refer to the Photographs in Exhibit 10 for setup and arrangement of equipment under tests.

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	PROBABILITY	UNCERTAINTY (dB)	
(Line Conducted)	DISTRIBUTION	9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8$(9 kHz) 0.2 (30 MHz) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

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

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

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 $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

EXHIBIT 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.

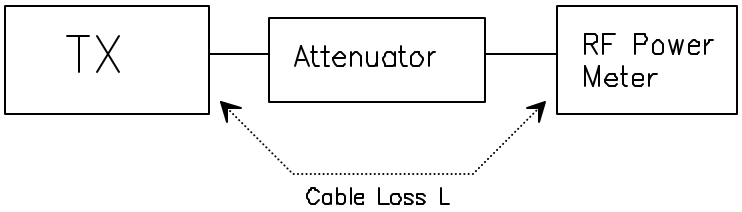
Test procedure shall be as follows:

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 dipole 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 dipole antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution dipole antenna was placed in vertical polarization. The test dipole 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

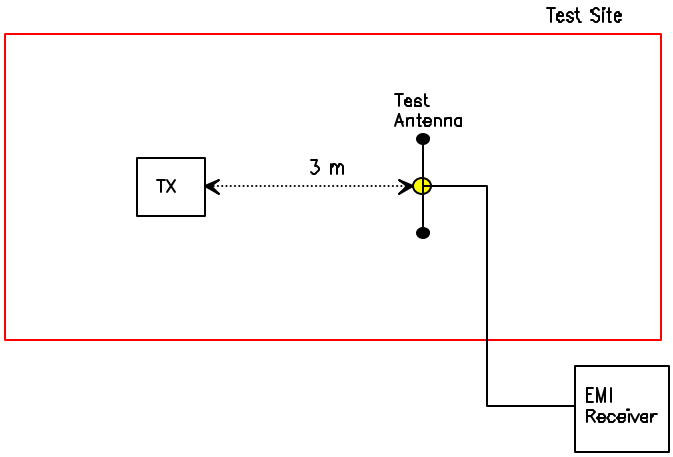
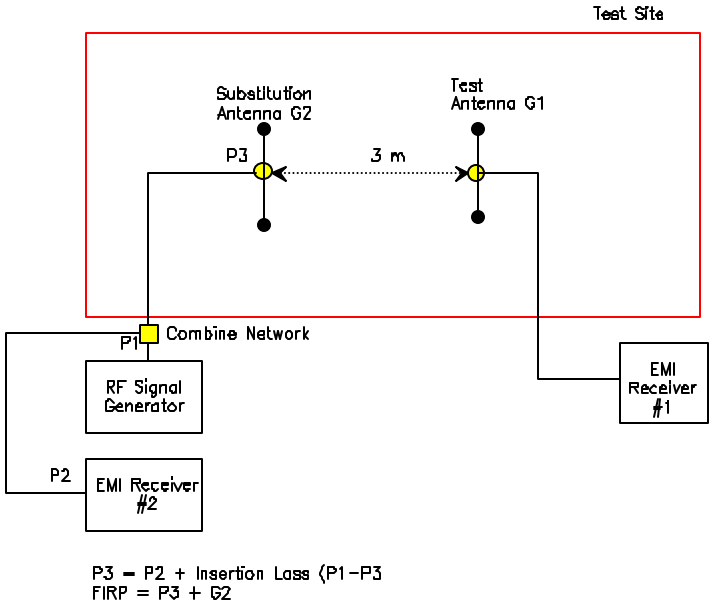


Figure 3



8.4. SPURIOUS EMISSIONS (RADIATED)

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. 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. Calibrated Advantest spectrum analyzer and pre-selector were used. The spectrum analyzer would be used as follows:

For frequencies below 1 GHz:

- Resolution BW: 100 kHz
- Video BW: same or greater
- Detector Mode: Positive Peak
- Averaging: Off
- Span: 100 MHz
- Amplitude: Adjust for middle of the instrument's range
- Sweep Time: Auto

For frequencies above 1 GHz:

- Resolution BW: 1 MHz
- Video BW: same or greater
- Detector Mode: Positive Peak
- Averaging: Off
- Span: 500 MHz
- Amplitude: Adjust for middle of the instrument's range
- Sweep Time: Auto

- The frequencies of emissions were 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.

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 = 60 + 7.0 + 1.0 - 30 = 38.0 dBµV/m.
Field Level = $10^{(38/20)}$ = 79.43 µV/m.

EXHIBIT 9. PLOTS OF MEASUREMENT DATA

EXHIBIT 10. TEST SETUP PHOTOS OF EUT

EXHIBIT 11. EXTERNAL PHOTOS OF EUT

EXHIBIT 12. INTERNAL PHOTOS OF EUT

EXHIBIT 13. COVER LETTERS

EXHIBIT 14. ATTESTATION STATEMENTS

None.

EXHIBIT 15. APPLICATION FORMS

EXHIBIT 16. FCC LABEL/LOCATION INFORMATION

EXHIBIT 17. BLOCK DIAGRAMS

EXHIBIT 18. SCHEMATIC DIAGRAMS

EXHIBIT 19. PARTS LIST / TUNE UP INFORMATION

EXHIBIT 20. OPERATIONAL DESCRIPTION

EXHIBIT 21. RF EXPOSURE INFORMATION

None.

EXHIBIT 22. USER'S MANUAL