ENGINEERING TEST REPORT

FOR

LEDR Microwave Radio
Model: LEDR 400S
FCC ID: E5M-LEDR400S-74

IN ACCORDANCE WITH

FEDERAL COMMUNICATIONS COMMISSION (FCC)
REMOTE BROADCAST PICKUP STATIONS
47 CFR, PARTS 2 and 74, Subpart D

TESTED FOR

Applicant: Microwave Data Systems Inc.
175 Science Parkway
Rochester, NY
USA, 14620-4261

ULTRATECH FILE NO. MIC44_F74

This Test Report is hereby issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Inc.

Date: _____

Report Prepared By: Mike Tom	Tested By: Hung Trinh, RFI Technician
_____	_____
Date: July 26, 2001	Date: June 4-5, 2001

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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
A	Test Report - Plots of Measurement Data	• Plots # 1-40	Ok
B	Test Setup Photos	• Photos # 1-2	Ok
C	External Photos	• Photos # 1-3	Ok
D	Internal Photos	• Photos # 1-8	Ok
E	Cover Letters	• Letter from UltraTech for Certification Request • Letter from the Applicant to appoint UltraTech to act as an agent • Letter from applicant requesting a confidentiality filing	Ok Ok Ok
F	Application Forms	• Form 731 • Form 159 • Confirmation of Exhibits sent to FCC	Ok Ok Ok
G	ID Label and Location	• FCC labeling requirements and location	Ok
H	Block Diagram	• Block Diagrams	Ok
I	Schematics	• Schematics of EUT	Ok
J	Parts List / Tune Up info	• Bill of Materials	Ok
K	Operational Description	• Theory of Operation	Ok
L	Users Manual	• Instructions for operation of device	Ok

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 74, Subpart D: 1998
Title	Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 74
Purpose of Test:	To gain FCC Certification Authorization for Remote Pickup Broadcast Stations
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.

2.2. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 2 & 74	1998	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. APPLICANT INFORMATION

APPLICANT:	
Name:	Microwave Data Systems Inc.
Address:	175 Science Parkway Rochester, NY USA, 14620-4261
Contact Person:	Mr. Dennis McCarthy Phone #: 716-242-8440 Fax #: 716-241-5590 Email Address: dmcarthy@microwavedata.com

MANUFACTURER:	
Name:	Microwave Data Systems Inc.
Address:	175 Science Parkway Rochester, NY USA, 14620-4261
Contact Person:	Mr. Dennis McCarthy Phone #: 716-242-8440 Fax #: 716-241-5590 Email Address: dmcarthy@microwavedata.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name	Microwave Data Systems Inc.
Product Name	LEDR Microwave Radio
Model Name or Number	LEDR 400S
Serial Number	883073
Type of Equipment	Radio Communication Equipment
External Power Supply	Auto Switch AC Power Adaptor Model DT100PW240P Input: 115/230V ~ 2A 50/60Hz DC Output: 15 VDC – 24VDC 100 W Max. Present: 24V / 4.1A Or I.T.E Power Supply Model PW100 Input: 100 – 250V ~, 50-60Hz, 2.5 – 1.3A Output: 48VDC, 1.875A
Transmitting/Receiving Antenna Type	Non-integral
Primary User Functions of EUT:	To correctly communicate data to and from radios over RF link

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Base station (fixed use)
Intended Operating Environment:	Commercial, light industry & heavy industry
Power Supply Requirement:	24/48 Vdc via AC Adaptor
RF Output Power Rating:	1 Watt or 30 dBm
Operating Frequency Range:	450.0875-455.6125 MHz (25 kHz channel spacing) 450.05-455.85 MHz (50 kHz channel spacing)
RF Output Impedance:	50 Ohms
Channel Spacing:	25 kHz and 50 kHz
Max. Occupied Bandwidth (99%):(1)	21.1 kHz (25 kHz Channel Spacing) 41.3 kHz (50 kHz Channel Spacing)
Emission Designation:	20K0D1W (25 kHz Channel Spacing) 50K0D1W (50 kHz Channel Spacing)
Oscillator Frequencies:	Fixed: 4.9152,MHz, 12 MHz, 20 MHz, 64MHz Variable: Tx and Rx Local Oscillators are 70 MHz above the respective Tx and Rx frequencies for high side injection.
Antenna Connector Type:	N-type

(1) Refer to plots #1 to 10 in Annex A for details of 99% OBW measurements.

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Console Port (RS232)	1	DB9	Shielded
2	Phone Jack	1	4 Wires	Non-shielded
3	Antenna Port	1	N Type	--
4	Ethernet NMS Port	1	RJ45	Non-shielded
5	EIA-530-A Port	1	DB25	Shielded
6	Service Channel Port	1	DB9	Shielded
7	Alarm I/O Port	1	DB9	Shielded
8	DC Power Input	1	2 Wires	Non-shielded

NOTES:

(1) ***Ports of the EUT which in normal operation*** *were connected to ancillary equipment through interconnecting cables via a representative interconnecting cable to simulate the input/output characteristics. RF input/output was correctly terminated to the 50 Ohm RF Load.*

3.5. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

The following filters were installed in place of the existing filters to provide the 50 kHz channel spacing. Refer to Page 122 of the user's manual for details of installation procedure.

- Networks International Filter, PN: A-803, 64-1001A14C
- Networks International Filter, PN: A-893, 64-1001A14C
- Networks International Filter, PN: A-889, 64-1001A10C

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:	24/48 Vdc AC Adapter

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	None
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated into a 50 Ohm RF Load.

Transmitter Test Signals	
Frequencies: ▪ 450.0875 – 455.6125 MHz (25 kHz Channel Spacing) ▪ 450.05 – 455.85 MHz (50 kHz Channel Spacing)	Near lowest & near highest frequencies each frequency bands that the transmitter covers: ▪ 450.4875 MHz, 455.4875 MHz • 450.4875 MHz, 455.4875 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 1 Watt ▪ QPSK with 64 kbps random data ▪ 16 QAM with 64 kbps random data ▪ 32 QAM with 64 kbps random data ▪ 16 QAM with 128 kbps random data ▪ 32 QAM with 128 kbps random data ▪ 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.

- 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	Applicability (Yes/No)
74.461 & 2.1046	Transmitter Power	Yes
74.464 & 2.1055	Frequency Tolerance	Yes
74.463 & 2.1047(b)	Modulation Requirements	Note 1
74.462(b) & 2.1049	Authorized Bandwidth and Emissions	Yes
74.462(c) & 2.1051	Emission Limits – Spurious Emissions at Antenna Terminal	Yes
74.462(c) & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes

***Note 1**: In accordance with 47 CFR, Part 74.463(a), modulating requirements only apply to equipment whose RF power output exceeds 3 Watts. Since the LEDR400S has a maximum RF power output of 1 Watt, this requirement is not applicable.*

LEDR Microwave Radio, **Model No.: LEDR400S**, by **Microwave Data Systems Inc.** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices**. The engineering test report has been documented and is kept on file. This report can be made available to the FCC upon request.

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 C63.4:1992 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. TRANSMITTER POWER @ FCC 2.1046 & 74.461

6.5.1. Limits @ FCC 74.461(b)

The authorized transmitter power for a remote pickup broadcast station shall be limited to that necessary for satisfactory service and, in any event, shall not be greater that the following:

Type of Station	Average Transmitter Power Limit
Broadcast Station	100 Watts
When Used aboard Aircraft	15 Watts

6.5.2. Method of Measurements

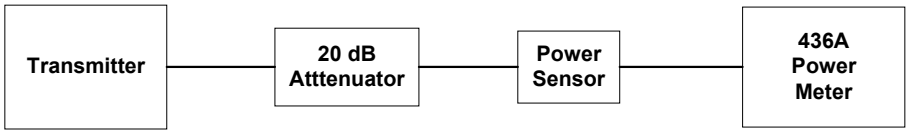
Please refer to Exhibit 8, Sec. 8.1 for test procedures and test setup.

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Attenuator(s)	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz
Average Power Meter	Hewlett Packard	HP 436A	1725A02249	10kHz to 50GHz @ 50 Ohm input
Power Probe sensor	Hewlett Packard	HP 8481A	2702A68983	100 MHz to 18 GHz @ 50 Ohms input
Attenuator(s)	Bird	…	…	DC – 22 GHz

6.5.4. Test Arrangement

- Power at RF Power Output Terminals



6.5.5. Test Data

Frequency (MHz)	Measured Average Power (W)	Station Limit (W)
450.4875	1	100
455.4875	1	100

6.6. FREQUENCY TOLERANCE @ FCC 2.1055 & 74.464

6.6.1. Limits

Please refer to FCC CFR 47, Part 74, Subpart D, Sec. 74.464

Frequency Range (MHz)	Frequency Tolerance (%) or (ppm)	
	Base Station	Mobile Station
300-500 MHz, All Power	0.00025 or 2.5	0.0005 or 5

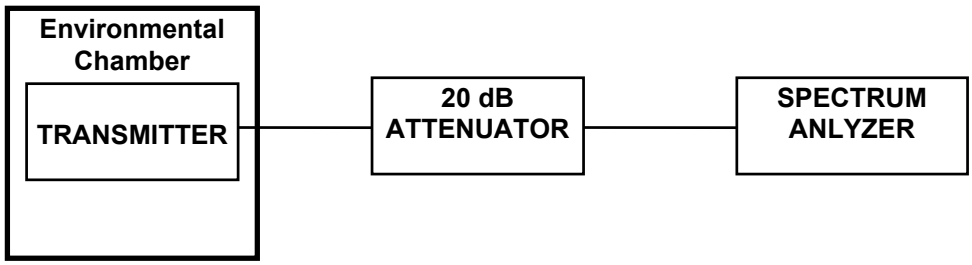
6.6.2. Method of Measurements

Refer to FCC @ 2.1055 and Exhibit 8, Sec. 8.2 of this report for detailed test procedures.

6.6.3. 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
Attenuator(s)	Bird	..	…	DC – 22 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40° to +60° C range

6.6.4. Test Arrangement



6.6.5. Test Data

Test Frequency	450.0875 MHz
Full Power Level	1 Watt Average
Frequency Tolerance Limit	2.5 ppm or 1125 Hz

Input Voltage Rating	24 Vdc	48 Vdc
Max. Frequency Tolerance Measured	390 Hz or 0.90 ppm	430 Hz or 0.95 ppm

Supply Voltage: 24 V

AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	CENTER FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 24 Volts		Supply Voltage (85% of Nominal) 20.4 Volts		Supply Voltage (115% of Nominal) 27.6 Volts	
		Hz	dB	Hz	dB	Hz	dB
-30	0	10	N/A	N/A	N/A	N/A	N/A
-20	0	-60	N/A	N/A	N/A	N/A	N/A
-10	0	70	N/A	N/A	N/A	N/A	N/A
0	0	160	N/A	N/A	N/A	N/A	N/A
+10	0	70	N/A	N/A	N/A	N/A	N/A
+20	0	-30	0.2	10	0.2	30	0.4
+30	0	-60	N/A	N/A	N/A	N/A	N/A
+40	0	-70	N/A	N/A	N/A	N/A	N/A
+50	0	**390**	N/A	N/A	N/A	N/A	N/A

Supply Voltage: 48 V

AMBIENT TEMP. (°C)	KEYED-ON TIME (Minutes)	CENTER FREQUENCY & RF POWER OUTPUT VARIATION					
		Supply Voltage (Nominal) 48 Volts		Supply Voltage (85% of Nominal) 40.8 Volts		Supply Voltage (115% of Nominal) 55.2 Volts	
		Hz	dB	Hz	dB	Hz	dB
-30	0	200	N/A	N/A	N/A	N/A	N/A
-20	0	270	N/A	N/A	N/A	N/A	N/A
-10	0	**430**	N/A	N/A	N/A	N/A	N/A
0	0	410	N/A	N/A	N/A	N/A	N/A
+10	0	290	N/A	N/A	N/A	N/A	N/A
+20	0	10	0	10	0.1	40	2.1
+30	0	-130	N/A	N/A	N/A	N/A	N/A
+40	0	-310	N/A	N/A	N/A	N/A	N/A
+50	0	-130	N/A	N/A	N/A	N/A	N/A

6.7. EMISSION LIMITATION @ FCC 2.1049, 74.462

6.7.1. Limits @ 74.462

Emissions shall be attenuated below the mean output power of the transmitter as follows:

	EMISISON LIMITATIONS	
Frequency Range & Authorized Bandwidth	**Frequency removed from the carrier frequency**	**Attenuation wrt Carrier Level**
450.0875 to 455.6125 MHz (25 kHz Channels) (25 kHz BW)	▪ 12.5 to 25 kHz ▪ 25 kHz to 62.5 kHz ▪ 62.5 kHz to 2*Fc	▪ 25 dBc ▪ 35 dBc ▪ 43+10*log(P) dBc (P in Watts)
450.05 to 455.85 MHz (50 kHz Channels)	▪ 12.5 to 25 kHz ▪ 25 kHz to 62.5 kHz ▪ 62.5 kHz to 2*Fc	▪ 25 dBc ▪ 35 dBc ▪ 43+10*log(P) dBc (P in Watts)

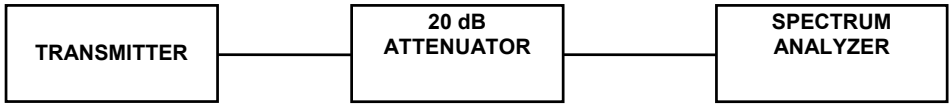
6.7.2. Method of Measurements

Please refer to FCC 2.1049(h) and Exhibit 8, Sec. 8.3 for detailed test procedures.

6.7.3. 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
Attenuator(s)	Bird	..	…	DC – 22 GHz

6.7.4. Test Arrangement



6.7.5. Test Data

Conforms. Please refer to the Plots #11 to 20 in Annex A for detailed measurement.

6.8. TRANSMITTER ANTENNA CONDUCTED SPURIOUS EMISSIONS @ 2.1051 & 74.462

6.8.1. Limits @ 74.462

Refer to the appropriate limits of 47 CFR Part 74.462

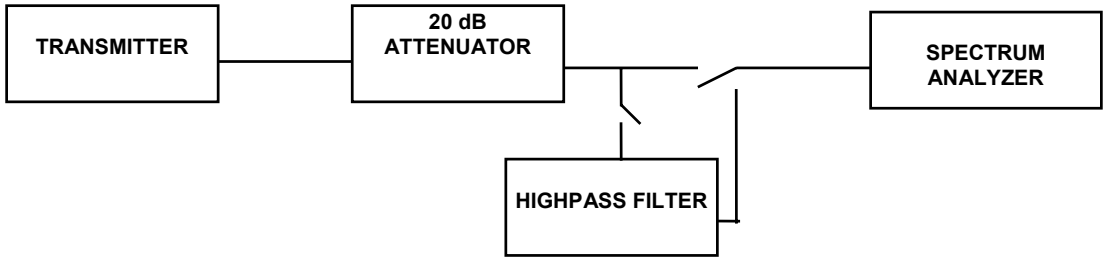
6.8.2. Method of Measurements

Refer to Exhibit 8 § 8.4 of this report for measurement details

6.8.3. 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 above 32 GHz
Attenuator(s)	Bird	..	…	DC – 22 GHz
Highpass Filter	Microphase	CR220HID	IITI11000AC	Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz

6.8.4. Test Arrangement



6.8.5. Test Data

25 kHz CHANNEL SPACING

UNDER EACH OF THE FOLLOWING TEST MODULATION:

16 QAM WITH 64 kbps RANDOM DATA AND AUDIO FILTER,
32 QAM WITH 64 kbps RANDOM DATA AND AUDIO FILTER,

THE EUT WAS OPERATED NEAR THE LOWEST FREQUENCY AND NEAR THE HIGHEST FREQUENCY OF THE OPERATING BAND. AT EACH FREQUENCY, THE EUT WAS SCANNED FROM 10 MHz TO 5 GHz, AND ALL EMISSIONS FOUND WERE MORE THAN 20 dB BELOW THE LIMITS.

50 kHz CHANNEL SPACING

UNDER EACH OF THE FOLLOWING TEST MODULATION:

16 QAM WITH 128 kbps RANDOM DATA AND AUDIO FILTER,
32 QAM WITH 128 kbps RANDOM DATA AND AUDIO FILTER,
QPSK WITH 64 kbps RANDOM DATA AND AUDIO FILTER,

THE EUT WAS OPERATED NEAR THE LOWEST FREQUENCY AND NEAR THE HIGHEST FREQUENCY OF THE OPERATING BAND. AT EACH FREQUENCY, THE EUT WAS SCANNED FROM 10 MHz TO 5 GHz, AND ALL EMISSIONS FOUND WERE MORE THAN 20 dB BELOW THE LIMITS.

PLEASE REFER TO THE PLOTS #21-40 IN ANNEX A FOR MEASUREMENT DETAILS.

6.9. TRANSMITTER ANTENNA RADIATED SPURIOUS EMISSIONS @ 2.1053 @ 74.462

6.9.1. Limits @ FCC 74.462

Refer to the appropriate limits of 47 CFR Part 74.462 for details.

6.9.2. Method of Measurements

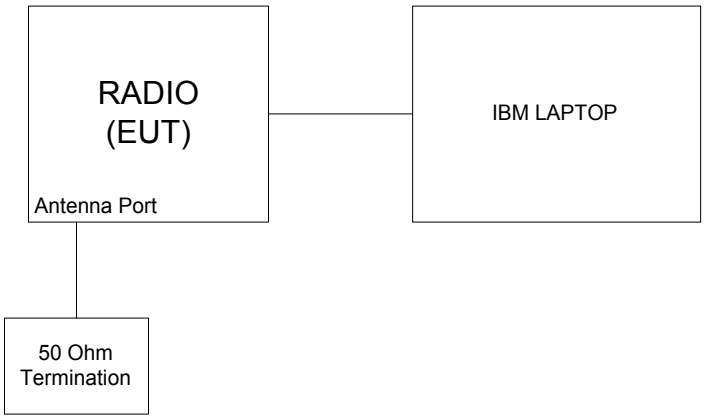
Refer to Exhibit 8, § 8.1 and 8.5 of this report for measurement details. Method of measurements can be referenced to TIA/EIA-603 standard, Section 2.2.12

6.9.3. 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
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A	3116A00661	1 GHz to 26.5 GHz, 30 dB gain nominal
RF Pre-Amplifier	Com-Power	PA -102	1425	30 MHz – 1 GHz, 30 dB gain Nominal
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	20-1000 MHz
Dipole Antenna	EMCO	3121C	8907-440	20-1000 MHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz

6.9.4. Test Arrangement

The following drawings show details of the test setup for radiated emissions measurements



6.9.5. Test Data

Remarks:

- Tests were performed at a 3 meter distance.

THE EUT WAS OPERATED NEAR THE LOWEST FREQUENCY AND NEAR THE HIGHEST FREQUENCY OF THE OPERATING BAND. AT EACH FREQUENCY, THE EUT WAS SCANNED FROM THE FUDAMENTAL UP TO THE 10th HARMONIC, AND ALL EMISSIONS FOUND WERE MORE THAN 20 dB BELOW THE LIMITS.

PLEASE REFER TO THE PLOTS #21-40 IN ANNEX A FOR MEASUREMENT DETAILS.

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. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_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. EFFECTIVE RADIATED POWER (ERP) MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If 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

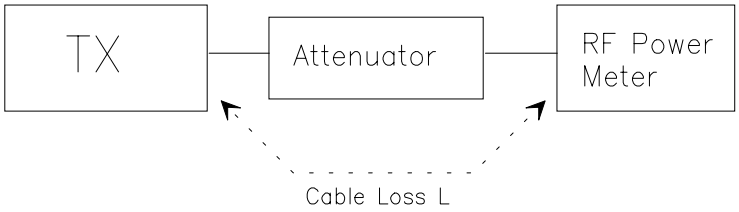
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test 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 Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF 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 “A” (in dBm);
- The 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:

EIRP = A + G + 10log(1/x)

Figure 1.



Step 3: Substitution Method. See Figure 2

(a) The setting of the spectrum analyzer shall be:

Center Frequency:	equal to the signal source
Resolution BW:	100 kHz for narrow band signal and 1 MHz for broadband signal
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(b) Perform tests 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) Tune the dipole test antenna to the transmitter carrier frequency.
(e) Load an appropriate correction factors files in Spectrum Analyzer #1 for correcting the field strength reading level (E = reading + cable loss + Antenna factor)
(f) Load an appropriate correction files in Spectrum Analyzer #2 to correct the EIRP reading which is pre-calibrated.
(g) Tune the spectrum analyzers # 1 & # 2 to transmitter carrier frequency.
(h) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(i) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) Again, lowered or raised the test antenna from 1 to 4 meters to ensure the position where the maximum E-filed was read . Record E-field level.
(l) Substitute the dipole antenna and the signal generator with the EUT at the same location.
(m) Adjust the substitution antenna at 1.5 meter high from the ground plane.
(n) Placed the dipole antenna in vertical polarization.
(o) Lower or raise as necessary to ensure that the maximum signal is stilled received.
(p) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(q) The EIRP power was read in the spectrum analyzer #2 (this reading was already corrected by our pre-calibrated values as follows:

Frequency (MHz)	Cable+Combiner Loss L2 For Port #2 (dB)	Cable+Combiner Loss L1 For Port # 1 (dB)	Total Corr. (L2-L1) for S/G Power (P) (dB)	DIPOLE ANTENNA S/N:8907-440 Gain G1 (dBi)	DIPOLE ELEMENT
100	-7.0	-7.8	0.8	1.0	DB-2
120	-7.0	-8.0	1.0	1.0	DB-2
140	-7.0	-8.1	1.1	1.9	DB-2
160	-7.0	-7.9	0.9	1.4	DB-3
180	-7.2	-7.9	0.7	1.8	DB-3
200	-7.1	-8.0	0.9	1.9	DB-3
250	-7.1	-8.1	1.1	0.9	DB-3
300	-7.1	-8.4	1.4	1.7	DB-3
350	-7.2	-8.5	1.4	2.8	DB-3
400	-7.3	-8.8	1.5	0.3	DB-3
450	-7.3	-8.7	1.4	1.2	DB-4
500	-7.2	-9.0	1.8	0.8	DB-4
550	-7.4	-9.0	1.6	0.9	DB-4
600	-7.3	-8.9	1.5	0.4	DB-4
650	-7.3	-9.3	2.0	1.3	DB-4
700	-7.4	-9.4	2.0	0.8	DB-4
750	-7.5	-9.6	2.1	2.0	DB-4
800	-7.4	-9.5	2.1	2.0	DB-4
850	-7.4	-9.8	2.3	1.0	DB-4
900	-7.5	-9.7	2.2	2.0	DB-4
950	-7.5	-10.0	2.5	2.4	DB-4
1000	-7.6	-10.0	2.4	0.6	DB-4

Frequency (MHz)	Cable+Combiner Loss L2 For Port #2 (dB)	Cable+Combiner Loss L1 For Port # 1 (dB)	Total Corr. (L2-L1) for S/G Power (P) (dB)	E 3115 Horn S/N: 9911-5955 Gain G1 (dBi)
1500	-7.9	-11.0	3.1	8.8
2000	-8.3	-11.7	3.4	9.0
2500	-8.4	-12.0	3.6	9.3
3000	-8.7	-13.0	4.4	9.0
3500	-8.8	-13.4	4.6	8.1
4000	-9.4	-15.5	6.2	9.6
4500	-9.6	-17.4	7.9	11.3
5000	-9.3	-17.5	8.1	10.7
5500	-9.9	-20.1	10.2	10.3
6000	-10.3	-20.2	9.9	10.5
6500	-10.5	-22.5	12.0	11.3
7000	-10.2	-22.9	12.7	11.2
7500	-10.3	-24.0	13.7	10.8
8000	-10.5	-20.4	9.9	11.4
8500	-11.0	-18.8	7.8	11.0
9000	-10.7	-23.0	12.3	10.7
9500	-11.1	-21.5	10.4	11.5
10000	-11.4	-23.2	11.8	12.0
12000	-12.1	-29.4	17.3	12.9
14000	-11.7	-33.5	21.8	11.6
16000	-13.3	-28.1	14.8	16.0
18000	-14.2	-29.4	15.2	8.6

Note: Calculation of EIRP:

P = P1 - L1 = (P2 + L2) – L1 = P2 + (L2-L1)
EIRP = P + G1 = P2 + (L2-L1) + G1
ERP = EIRP – 2.15 dB
Correction factor in Spectrum Analyzer 2 = G1 + L2 – L1

Where: P: Actual RF Power fed into the substitution antenna port after corrected.
P1: Power output from the signal generator
P2: Power measured at spectrum analyzer #2
EIRP: EIRP after correction
ERP: ERP after correction

(r) The substitution antenna gain and cable loss were added to the signal generator level for the corrected EIRP level.
(s) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(t) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

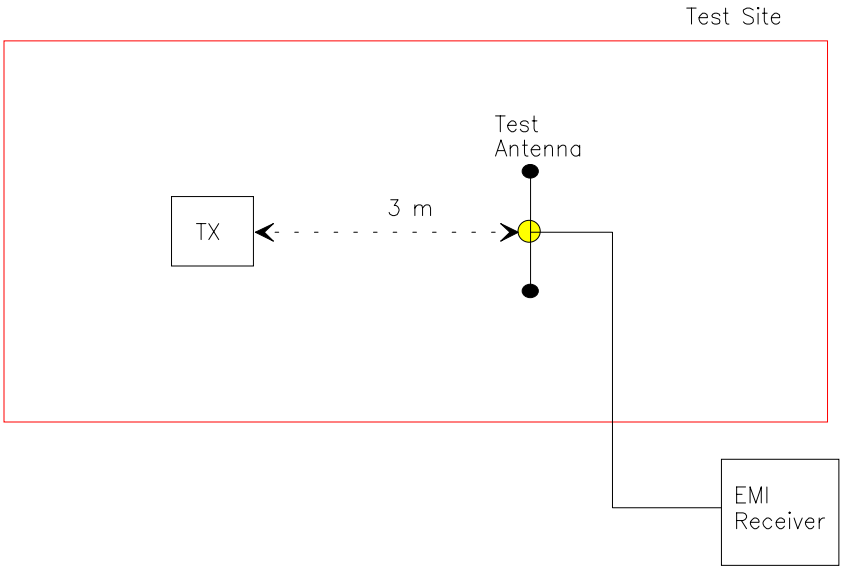
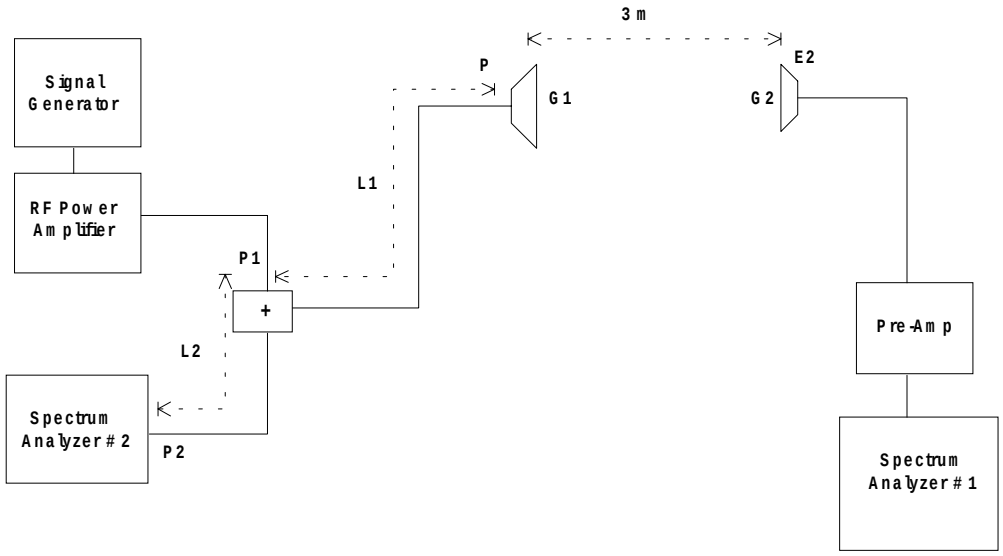


Figure 3



8.2. FREQUENCY TOLERANCE

Refer to FCC @ 2.1055

(a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.

(b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.

(d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

8.3. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(1):- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ±2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

Digital Modulation Through a Data Input Port @ 2.1049(h):- Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following spectrum analyzer bandwidth shall be used for measurement of spurious emissions:

(1) When operating in the radio telephony mode or the supervisory audio Tone mode:
   (i) Any emission not more than 45 kHz removed from the carrier frequency: 300 Hz.
   (ii) Any emission more than 45 kHz removed from the carrier frequency: 30 kHz.

(2) When operating in the wideband data mode or the signaling tone mode:
   (iii) Any emission not more than 60 kHz removed from the carrier frequency: 300 Hz.
   (iv) Any emission more than 60 kHz removed from the carrier frequency: 30 kHz.

In all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

8.4. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 30 kHz minimum , VBW ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.1057 - Frequency spectrum to be investigated:- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and sub-harmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.1051 - Spurious Emissions at Antenna Terminal:- The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

8.5. SPURIOUS EMISSIONS (RADIATED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the Spectrum Analyzer controls set as RBW = 100 kHz minimum , VBW ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output and modulation, tested using the following procedure:

8.5.1. Maximizing RF Emission Level

(a) The measurements was performed with standard modulation
(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 Biconilog Antenna (20 MHz to 1 GHz) or Horn Antenna (1 GHz to 18 GHz) was used for measuring.
(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^{o} 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 recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(i) Repeat the step (d) to (h) for different test frequencies

8.5.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Start from the list of the Field strength level obtain in Sec. 8.5.1
(b) Substitute the EUT by a signal generator with the RF output connected to a dipole/horn antenna {use dipole antenna for frequency from 30-1000 MHz) and use horn antenna for frequency above 1 GHz }.
(c) For frequencies less than or equal 1000 MHz, replace the test receiving antenna by a dipole antenna
(d) Setup the substitution EIRP measurements as follows (only use the RF Power AMP if necessary):
(e) For frequencies less than or equal 1000 MHz, replace the test receiving antenna by a dipole antenna
(f) Apply the test setup and test method in Step 3 of Section 8.1 for EIRP of the spurious/harmonic emissions measurements with the following settings of both spectrum analyzer # 1 and 2

Center Frequency:	equal to the signal source
Resolution BW:	10 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

ANNEX A. PLOTS OF TEST DATA

ANNEX B. PHOTOGRAPHS OF TEST SETUP

ANNEX C. COVER LETTERS

ANNEX D. APPLICATION FORMS

ANNEX E. USER'S MANUAL

ANNEX F. APPLICATION FORMS

ANNEX G. FCC ID LABEL AND LOCATION

ANNEX H. BLOCK DIAGRAM

ANNEX I. SCHEMATICS

ANNEX J. PARTS LIST / TUNE-UP INFO

ANNEX K. OPERATIONAL DESCRIPTION

ANNEX L. USERS MANUAL