

ENGINEERING TEST REPORT

Alarmpath Echo
Model No.: AP-4700
FCC ID: ITC-AP-4700

Applicant: **CRN Telemetry Devices Inc.**
1515 Middle Country Road
Centerreach, NY
USA, 11720

Tested in Accordance With

Federal Communications Commission (FCC)
CFR 47, PARTS 2 and 90 (Subpart I)

UltraTech's File No.: CRN04_90

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: Mike Tom

Tested by: Hung Trinh, RFI Engineer

Issued Date: March 18, 2002

Test Dates: March 13, 2002

- *The results in this Test Report apply only to the sample(s) tested, which was randomly selected.*
- *Under no circumstances may this report be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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

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ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex	Exhibit Type	Description of Contents	Quality Check (OK)
	Test Report	<ul style="list-style-type: none"> 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 and 2	Ok
2	External Photos of EUT	Photos # 1 to 3	Ok
3	Internal Photos of EUT	Photos # 1 to 7	Ok
4	Cover Letters	<ul style="list-style-type: none"> Letter from UltraTech for Certification Request Letter from the Applicant to appoint UltraTech to act as an agent 	Ok Ok
5	ID Label/Location Info	<ul style="list-style-type: none"> ID Label Location of ID Label 	Ok Ok
6	Operational Description	<ul style="list-style-type: none"> Technical description 	Ok
7	Users Manual	<ul style="list-style-type: none"> Operating Instructions 	Ok
8	RF Exposure Info	<ul style="list-style-type: none"> MPE Evaluation data 	Refer to this test report, section 6.6

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EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 90
Purpose of Test:	To gain FCC Certification Authorization for Radio operating in the frequency bands 806-821 MHz (25 kHz Channel Spacing).
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. RELATED SUBMITAL(S)/GRANT(S)

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2001	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

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EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	CRN Telemetry Devices Inc.
Address:	1515 Middle Country Road Centerreach, NY USA, 11720
Contact Person:	Mr. Herb Krieger Phone #: 631-696-2769 Fax #: 631-698-7943 Email Address: hkrieger@alarmpath.com

MANUFACTURER	
Name:	CRN Telemetry Devices Inc.
Address:	1515 Middle Country Road Centerreach, NY USA, 11720
Contact Person:	Mr. Herb Krieger Phone #: 631-696-2769 Fax #: 631-698-7943 Email Address: hkrieger@alarmpath.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:	CRN Telemetry Devices Inc.
Product Name:	Alarmpath Echo
Model Name or Number:	AP-4700
Serial Number:	Pre-Production
Type of Equipment:	Non-Broadcast Radio Communication Equipment
External Power Supply:	Yes, 12Vdc
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	To provide alarm condition signals through the air using the AlarmPath Network to any Central Station via standard communicator techniques.

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3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Base station (fixed use)
Intended Operating Environment:	<ul style="list-style-type: none"> • Commercial • Residential • Light Industry & Heavy Industry
Power Supply Requirement:	12Vdc
RF Output Power Rating:	13.8 Watts ERP maximum
Operating Frequency Range:	806-821 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 kHz
Emission Designation:	20K0F1D
Antenna Connector Type:	Screw terminal
Antenna Description:	<p>Manufacturer: CRN Telemetry Devices Inc. Type: Colinear Part Number: HG3DB Length: Approx. 13.5 inches Frequency Range: 806-821 MHz Input/Output Impedance: 50 Ω Gain: Variable (2.4 dBi to 11.7 dBi)</p>
	<p>Manufacturer: CRN Telemetry Devices Inc. Type: 1/4 Wave Rigid Whip Part Number: G0DB Length: Approx. 3.8 inches Frequency Range: 806-821 MHz Input/Output Impedance: 50 Ω Gain: Variable (-0.1 to 7.8 dBi)</p>

3.4. LIST OF ANCILLARY EQUIPMENT

The radio device was connected to the following ancillary/peripheral equipment necessary to exercise the functions and features of the EUT.

1. IBM Laptop, Model 2625, SN: 78-WWM48 96/05, FCC ID: AN0KAJIPENCP
2. CRN Telemetry Devices Inc., 3.3V serial to RS232 converter

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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

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:	Software supplied by Research In Motion Ltd. (RIM) was used to operate the radio transceiver module.
Special Hardware Used:	Hardware supplied by CRN Telemetry was used to provide the communications interface with the radio transceiver.
Transmitter Test Antenna:	Supplied by CRN Telemetry Devices Inc.

Transmitter Test Signals	
Frequency Band(s):	Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers:
<ul style="list-style-type: none"> ▪ 806-821 MHz band: 	<ul style="list-style-type: none"> ▪ 806 MHz, 813.5 MHz, 821 MHz
Transmitter Wanted Output Test Signals:	
<ul style="list-style-type: none"> ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source: 	<ul style="list-style-type: none"> ▪ 13.8 Watts ERP maximum with the Colinear Antenna, PN: HG3DB ▪ FM Data ▪ Internal

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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 comply 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: August 2000.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	APPLICABILITY (YES/NO)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
90.213 & 2.1055	Frequency Stability	See Note 1
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	See Note 1
90.210 & 2.1047(b)	Modulation Limiting	See Note 1
90.209 90.210 & 2.1049	Emission Limitation & Emission Mask	See Note 1
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	See Note 1
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes

Note 1: There are no changes to the FCC certified radio modem 801D, manufactured by Research In Motion Ltd. (RIM), therefore this test is not required to be performed. For more details, please refer to FCC ID: L6AR800D-15-O.

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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 MANUFACTURER:

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

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6.5. RF POWER OUTPUT @ §2.1046 & §90.205

6.5.1. Limits

Please refer to FCC CFR 47, Part 90, Subpart I, §90.205 for specification details.

6.5.2. Method of Measurements

Refer to Exhibit 8, § 8.1 of this report for measurement details.

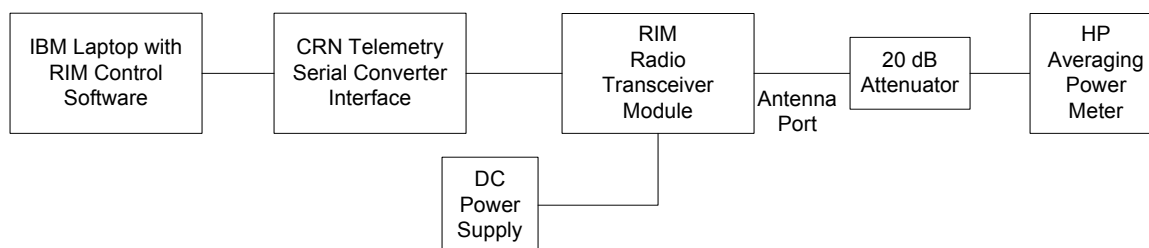
Since the supplied antenna is secured to the radio interface board by a screw, conducted power measurements cannot be performed, therefore ERP measurements were used as the alternative.

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Attenuator(s)	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 MHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Synthesized RF Signal Generator	Gigatronics	6061A	5130408	10kHz – 1050 MHz

6.5.4. Test Arrangement

Details of equipment arrangement to measure average conducted power of the RIM radio transceiver module



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6.5.5. Test Data

Note: The conducted power measurements were performed at the antenna port of the RIM R801D radio module for verification of manufacturer's rated output. The ERP measurements were performed on the AlarmPath Echo (DUT) to determine compliance with Part 90 of the FCC rules.

6.5.5.1. Conducted Power Measurements of Radio Transceiver Module

Transmitter Channel	Frequency (MHz)	Average Measured RF Output (dBm)	Manufacturers Rated Output (dBm)
Lowest	806.0	31.8	31.8
Middle	813.5	31.7	31.8
Highest	821.0	31.7	31.8

6.5.5.2. ERP Measurements of Device Under Test (DUT) – Using Substitution Method

ANTENNA TESTED: Colinear Antenna, PN: HG3DB							
Transmitter Channel Output	Fundamental Frequency (MHz)	E-Field (dB μ V/m)	Antenna Polarization (H/V)	Signal Generator (Ps) (dBm)	Substitution Ant. Gain (Gd) (dBi)	Substitution EIRP = Ps+Gd (dBm)	ERP = EIRP-2.15 (dBm)
Lowest	806.0	130.75	V	33.15	2.30	35.45	33.30
	806.0	138.84	H	41.24	2.30	43.54	41.39
Middle	813.5	130.49	V	33.19	2.00	35.19	33.04
	813.5	133.38	H	36.08	2.00	38.08	35.93
Highest	821.0	129.47	V	32.47	1.70	34.17	32.02
	821.0	130.44	H	33.44	1.70	35.14	32.99

ANTENNA MODEL: Quarter-wave Rigid Whip, PN: G0DB							
Transmitter Channel Output	Fundamental Frequency (MHz)	E-Field (dB μ V/m)	Antenna Polarization (H/V)	Signal Generator (Ps) (dBm)	Substitution Ant. Gain (Gd) (dBi)	Substitution EIRP = Ps+Gd (dBm)	ERP = EIRP-2.15 (dBm)
Lowest	806.0	130.30	V	32.70	2.30	35.00	32.85
	806.0	134.91	H	37.31	2.30	39.61	37.46
Middle	813.5	127.81	V	30.51	2.00	32.51	30.36
	813.5	130.16	H	32.86	2.00	34.86	32.71
Highest	821.0	127.00	V	30.00	1.70	31.70	29.55
	821.0	130.19	H	33.19	1.70	34.89	32.74

Note: (1) The gain of the supplied antennas was found to be non-linear across the frequency band of operation. The following table summarizes the range of the antenna gain.

Antenna Tested	Minimum Gain (dBi)	Maximum Gain (dBi)
Colinear Antenna, PN: HG3DB	2.4	11.7
Quarter-wave Rigid Whip, PN: G0DB	-0.1	7.8

*Gain is determined by taking the difference between rated power (31.8 dBm) and maximum and minimum EIRP measured.

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6.6. RF EXPOSURE REQUIRMENTS @ §1.1310 & §2.1091

6.6.1. 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).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

6.6.2. Method of Measurements

Refer to 47 CFR, § 1.1310, § 2.1091 and Public Notice DA 00-705 (March 30, 2000)

- In order to demonstrate compliance with MPE requirements (see § 2.1091), the following information is typically needed:
 - (1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
 - (2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
 - (3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
 - (4) Any other RF exposure related issues that may affect MPE compliance

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Calculation Method of RF Safety Distance:

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

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

$$r = \sqrt{PG/4\pi S} \text{ or;}$$

$$r = \sqrt{EIRP/4\pi S}$$

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

Calculation Example

For General Population/Uncontrolled Exposure, Power Density (S) = F/1500 mW/cm²

For the operating frequency range of 806-821 MHz for this device,

F = lowest operating frequency of 806 MHz, thus Power Density (S) = 806/1500 = 0.537 mW/cm²

EIRP = 43.54 dBm = 22594.36 mW
S = 0.537 mW/cm²

Since $r = \sqrt{EIRP/4\pi S}$

Then $r = \sqrt{22594.36 \text{ mW} / 4 \times \pi \times 0.537}$
= 58 cm

Therefore, a minimum separation distance of 60 cm when used with the Colinear Antenna, PN: HG3DB is necessary to comply with RF exposure requirements. The following RF exposure warning statement will be placed in the installation manual.

RF Exposure Warning:

To ensure user's safety and to satisfy RF exposure requirements, this unit must be installed so that a minimum separation distance of 40 cm or 60 cm is always maintained between the antenna of the transmitting device and the body of nearby persons. Operation at closer than this distance is not recommended. Use ONLY the following antenna supplied by AlarmPath to comply with this warning: Colinear Antenna, PN: HG3DB – 60cm or 1/4 Wave Rigid Whip Antenna, PN: G0DB – 40cm

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6.6.3. Test Data

GENERAL POPULATION/UNCONTROLLED ENVIRONMENT

Antenna Type	Frequency (MHz)	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Calculated Minimum r (cm) ⁽¹⁾	Manufacturer's Recommended r
Colinear, PN: HG3DB	806.00	43.54	22594.36	57.85	60 cm
Quarter-wave Rigid Whip	806.00	39.61	9141.13	36.79	40 cm

Notes:

(1) RF EXPOSURE DISTANCE LIMITS: $r = \sqrt{EIRP/4\pi S}$, where $S=0.537 \text{ mW/cm}^2$

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6.7. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ §90.210

6.7.1. Limits

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

FCC RULES	ATTENUATION LIMIT (dBc)
FCC 90.210 (b)	43+log (P), where P is power in Watts

6.7.2. Method of Measurements

The spurious/harmonic ERP measurements, using substitution method specified in Exhibit 8, § 8.2 of this report and its value in dBc is calculated as follows:

If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.

If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:

Lowest ERP of the carrier = EIRP – 2.15 dB = $P_c + G - 2.15 \text{ dB} = \text{xxx dBm (conducted)} + 0 \text{ dBi} - 2.15 \text{ dB}$
 Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)

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
Microwave Amplifier	Hewlett Packard	HP 83017A	3116A00661	1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 GHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 GHz – 1 GHz
Horn Antenna	EMCO	3115	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3115	9911-5955	1 GHz – 18 GHz

6.7.4. Test Setup

Please refer to Annex 1 for details of the test setup.

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6.7.5. Test Data

Remarks:

- Two antennas, supplied with the device were tested individually to determine the worst case spurious harmonic emissions. It was found that the Colinear antenna, PN: HG3DB radiated more strongly than the 1/4 Wave Rigid Whip antenna, PN: G0DB. All further tests were performed using the Colinear antenna.
- The Radiated emission measurements were performed at 3 meters distance using a Peak Detector.

The frequency range from 10 MHz to 10 GHz was scanned for emissions and all emissions found were attenuated more than 20 dB below the limit.

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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 (\pm 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 $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(Bi) 0.3 (Lp)$ Uncertainty limits $20\text{Log}(1+\Gamma_1\Gamma_R)$	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:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

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EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER 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

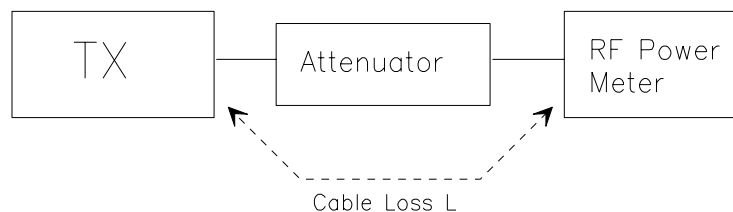
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, $x = \text{Tx on} / (\text{Tx on} + \text{Tx off})$ with $0 < x < 1$, is measure 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 e.i.r.p. 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:

$$\text{EIRP} = \text{A} + \text{G} + 10\log(1/x)$$

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP AND EIRP) USING SUBSTITUTION METHOD

8.2.1. Maximizing RF Emission Level (E-Field)

- (a) The measurements were performed with full rf output power and 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) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level
 - ▶ Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 - ▶ $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$
- (f) Set the EMI Receiver #1 and #2 as follows:

Center Frequency:	test frequency
Resolution BW:	100 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies

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.

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8.2.2. Measuring the EIRP Of Spurious/Harmonic Emissions Using Substitution Method

(a) Set the EMI Receiver #1(for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

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

- (b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level
- ▶ Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 - ▶ $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$
- (c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
- (d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
- ▶ DIPOLE antenna for frequency from 30-1000 MHz or
 - ▶ HORN antenna for frequency above 1 GHz
- (e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
- (f) Use one of the following antenna as a receiving antenna:
- ▶ DIPOLE antenna for frequency from 30-1000 MHz or
 - ▶ HORN antenna for frequency above 1 GHz
- (g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
- (h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
- (i) Tune the EMI Receivers to the test frequency.
- (j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
- (k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
- (m) 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.
- (n) Record the power level read from the Average Power Meter and calculates the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$EIRP = P + G1 = P3 + L2 - L1 + A + G1$$

$$ERP = EIRP - 2.15 \text{ dB}$$

Total Correction factor in EMI Receiver # 2 = $L2 - L1 + G1$

Where: P: Actual RF Power fed into the substitution antenna port after corrected.
P1: Power output from the signal generator
P2: Power measured at attenuator A input
P3: Power reading on the Average Power Meter
EIRP: EIRP after correction
ERP: ERP after correction

- (o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
- (p) Repeat step (d) to (o) for different test frequency
- (q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
- (r) 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.

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Figure 2

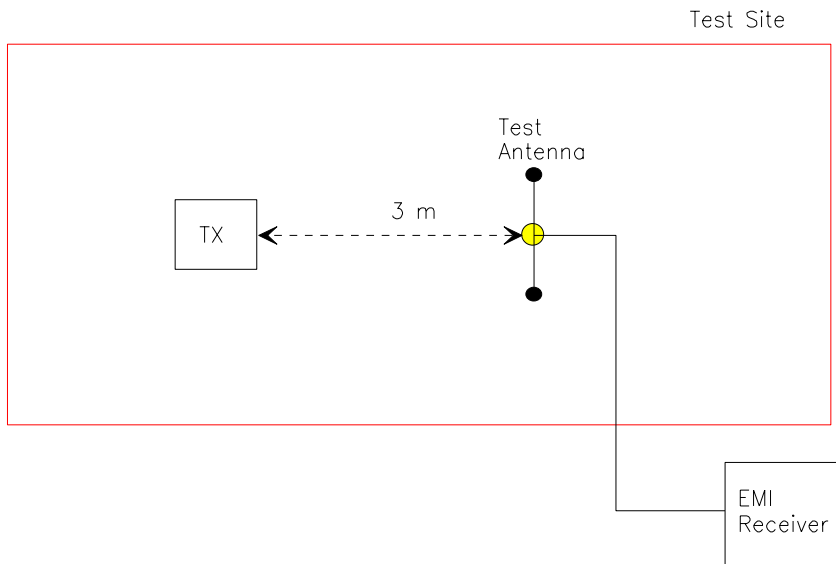
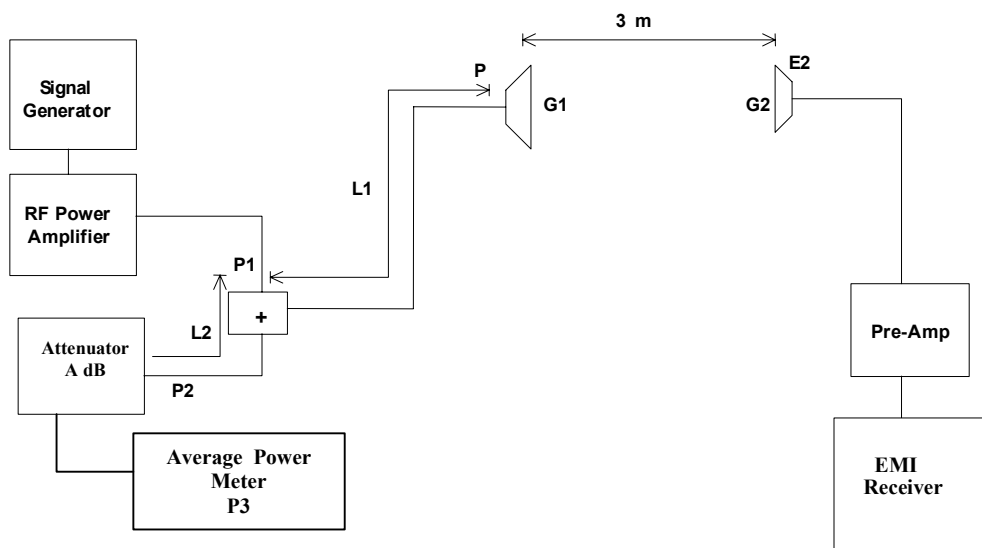


Figure 3



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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 EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

For 25 kHz Channel Spacing: RBW = 300 Hz
For 12.5 kHz or 6.25 kHz Channel Spacing: RBW = 100 Hz

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 \geq 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 10th 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 subharmonics 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.

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