ENGINEERING TEST REPORT

900 MHz Frequency Hopping OEM Module
Model No.: 9XSTREAM

FCC ID: OUR9XSTREAM

Applicant:

MaxStream Inc.
PO Box 1508 / 1215 South 1680 West
Orem, UT
USA, 84058

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SECTION 15.247
Frequency Hopping Spread Spectrum Transmitters
Operating in the Frequency Band 902 - 928 MHz

UltraTech's File No.: MXS015-FTX

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: June 6, 2002	
Report Prepared by: Dan Huynh Issued Date: June 6, 2002	Tested by: Mr. Hung Trinh, EMI/RFI Technician Test Dates: December 6 - 12, 2001

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

TABLE OF CONTENTS

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Report – Test Data Plots	• 20 dB Bandwidth (Plots # 1 to 3) • Channel Hopping Frequency Separation (Plots # 4 to 6) • Average Time of Occupancy (Plots # 7 to 12) • Band-Edge Spurious Emissions at Antenna Terminals (Plots #13 to 16) • Spurious Emissions at Antenna Terminals (Plots # 17 to 25) • Radiated Emissions (Plots # 26 to 55)	OK
2	Test Setup Photos	Radiated Emissions Test Setup Photos	OK
3	External Photos of EUT	External EUT and Antennas Photos	OK
4	Internal Photos of EUT	Internal EUT Photos	OK
5	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
6	Attestation Statements	--	--
7	ID Label/Location Info	FCC ID Label and Location Information	OK
8	Block Diagrams	9XSTREAM Block Diagram	OK
9	Schematic Diagrams	9XSTREAM Schematics	OK
10	Parts List/Tune Up Info	9XSTREAM Parts List	OK
11	Operational Description	Theory of Operation for the 9XTREAM Frequency Hopping Radio	OK
12	RF Exposure Info	See section 6.9 in this test report for details	OK
13	Users Manual	9XStream Wireless OEM Module Operation Manual v 2.8	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247:2001
Title:	Telecommunication – 47 Code of Federal Regulations (CFR), Part 15
Purpose of Test:	To gain FCC Certification Authorization for Frequency Hopping Spread Spectrum Transmitters Operating in the Frequency Band 902 - 928 MHz .
Type of Certification:	• Modular Approval: This application is subject to the FCC certification for a modular transceiver, please kindly refers to Section 6.5 of the submitted test report for clarification of compliance for this modular transceiver with FCC Public Notice DA 00-1407. • Limitation of the FCC Modular Certification for Model 9XSTREAM: The radio module is approved for used only with antennas filed with FCC and in compliance with FCC RF Exposure Requirements per FCC Rules at section 2.1091 with the minimum RF safety distance of 20 cm (see section 6.9 of the Test Report for MPE evaluation and User's Manual for RF Exposure Information to Installers or End Users). The approved antennas list is specified in the Operation Manual (page 5).
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:	[x] Residential [x] Light-industry, Commercial [x] Industry

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	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	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	MaxStream Inc.
Address:	PO Box 1508 / 1215 South 1680 West Orem, UT USA, 84058
Contact Person:	Mr. David Steed Vice President - Engineering Phone #: 801-765-9885 Fax #: 801-765-9895 Email Address: david@maxstream.net

MANUFACTURER	
Name:	MaxStream Inc.
Address:	PO Box 1508 / 1215 South 1680 West Orem, UT USA, 84058
Contact Person:	Mr. David Steed Vice President - Engineering Phone #: 801-765-9885 Fax #: 801-765-9895 Email Address: david@maxstream.net

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:	MaxStream Inc.
Product Name:	900 MHz Frequency Hopping OEM Module
Model Name or Number:	9XSTREAM
Serial Number:	Test Sample
Type of Equipment:	Frequency Hopping Spread Spectrum Transmitters
Input Power Supply Type:	External Regulated DC Sources
Primary User Functions of EUT:	Provide data communication link through air

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	[ ] Portable [x] Mobile [x] Base Station (fixed use)
Intended Operating Environment:	[x] Residential [x] Commercial, light industry & heavy industry
Power Supply Requirement:	5 Vdc
RF Output Power Rating:	0.148 Watts
Operating Frequency Range:	902 - 928 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	300 kHz
Duty Cycle:	Continuous frequency-hopping
20 dB Bandwidth:	247 kHz
Modulation Type:	FSK
Channel Occupancy:	302.1 ms within 20 second period
Emission Designation:	Frequency Hopping Spread Spectrum
Antenna Connector Type:	The 9XSTREAM Module is provided with MMCX or reversed SMA connector with exception when the antenna is integral (A09-QI).

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	RF IN/OUT Port	1	Reversed SMA for external antenna	Shielded
2	DC Supply & I/O Port	1	Pin header	No cable, direct connection

3.5. ASSOCIATED ANTENNA DESCRIPTIONS

The 9XSTREAM Module is equipped a reversed SMA or MMCX connector with any removable antenna as follows:

3.5.1. Yagi Antenna Family, Manufacturer: MaxStream, Inc

*Antenna Part Number	Operating Frequency Band (MHz)	Antenna Gain (dBi)	Connector Type
A09-Y6	896 - 980	6.2	Reversed SMA
A09-Y7	902 - 928	7.2	Reversed SMA
A09-Y8	902 - 928	8.2	Reversed SMA
A09-Y9	902 - 928	9.2	Reversed SMA
A09-Y10	902 - 928	10.2	Reversed SMA
A09-Y11	902 - 928	11.2	Reversed SMA
A09-Y12	902 - 928	12.2	Reversed SMA
A09-Y13	902 - 928	13.2	Reversed SMA
A09-Y14	902 - 928	14.2	Reversed SMA
A09-Y15	902 - 928	15.2	Reversed SMA

* The structure of each antenna element is exactly identical; elements are internally connected in series to provide higher gain. The antenna with the highest gain (P/N: A09-Y15, Gain =15.2 dBi) will be used for testing to represent the worst case.

3.5.2. Base Station Antenna Family, Manufacturer: MaxStream, Inc

*Antenna Part Number	Operating Frequency Band (MHz)	Antenna Gain (dBi)	Connector Type
A09-W7	902 - 928	7.2	Reversed SMA
A09-M7	902 - 928	7.2	Reversed SMA
A09-F2	902 - 928	2.2	Reversed SMA
A09-F5	902 - 928	5.2	Reversed SMA
A09-F8	902 - 928	8.2	Reversed SMA
A09-F9	902 - 928	9.2	Reversed SMA

* The structure of each antenna element is exactly identical; elements are internally connected in series to provide higher gain. The antenna with the highest gain (P/N: A09-F9, Gain =9.2 dBi) will be used for testing to represent the worst case.

3.5.3. Half-wave Whip Antenna Family, Manufacturer: MaxStream, Inc

*Antenna Part Number	Operating Frequency Band (MHz)	Antenna Gain (dBi)	Connector Type
A09-HASM-675	902 - 928	2.1	Reversed SMA
A09-HBMM-7-P6I	902 - 928	2.1	Bulkhead mount MMCX with pig tail

* The structures of the above antennas are exactly identical; the only difference is connector type. The antenna P/N: A09-HBMM-7-P6I, Gain =2.1 dBi with no pigtail cable will be used for testing to represent the worst case since there is no loss on the pigtail cable.

3.5.4. Quarter-Wave Whip Antenna Family, Manufacturer: MaxStream, Inc

Antenna Part Number	Operating Frequency Band (MHz)	Antenna Gain (dBi)	Connector Type
A09-QBMM-P6I	902 - 928	1.9	Bulkhead mount MMCX with pigtail
A09-QI	902 - 928	1.9	Integrated Wire Antenna

3.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Interface Test Board
Brand:	Maxstream
Model Name or Number:	N/A
FCC Certification/FCC ID:	N/A
Serial Number:	N/A
Connected to EUT's Port:	PCMCIA type II

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:	5 Vdc

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in normal Frequency Hopping mode for occupancy duration, and frequency separation.
Special Test Software & Hardware:	Special firmware and hardware provided by the Applicant are installed to allow the EUT to operates in hopping mode or at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as non-integral antenna equipment.

Transmitter Test Signals	
Frequency Band(s):	902 - 928 MHz
Frequency (ies) Tested:	Lowest: 902.6 MHz Middle: 914.9 MHz Highest: 927.2 MHz
RF Power Output (measured maximum output power):	0.148 Watts
Normal Test Modulation:	FSK
Modulating Signal Source:	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: August 8, 2001.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (Yes/No)
Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval	Yes
15.107(a)	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	N/A
15.247(a)(1) & 15.247(a)(1)(i)	Frequency Hopping Systems Characteristics	Yes
15.247(b)(2)	Peak Output Power	Yes
15.247(b)(4), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The 900 MHz Frequency Hopping OEM Module, **Model No.: 9XSTREAM,** manufacture by **MaxStream, Inc.** has been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers**. The engineering test report has been documented and kept in file and it is available upon FCC request.		

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, ANSI C63-4:1992 and FCC Public Notice @ DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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 MANUFACTURER

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

6.5. UNLICENSED MODULAR TRANSMITTER APPROVAL REQUIREMENTS @ FCC PUBLIC NOTICE DA 00-1407 (JUNE 26, 2000)

In order to satisfy FCC requirements for equipment authorization for modular transmitters, the transmitters shall meet the following parameters:

Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
(a) In order to be considered a transmitter module, the device must be complete RF transmitter, i.e., it must have its own reference oscillator (e.g., VCO), antenna, etc…. The only connectors to the module, if any, may be power supply and modulation/data inputs	✓ The transmitter is completed with its own reference oscillator, antenna. ✓ Only connectors provide are dc supply, data and rf ports are provided with the modular transmitter	Conform Conform
(b) Compliance with FCC RF Exposure requirements may, in some instances, limit the output power of a module and/or the final applications in which the approved module may be employed	✓ The radio complies with MPE per 2.1091 for use with mobile or fixed base stations.	Conform
(c) While the applicant for a device into which an authorized module is installed is not required to obtain a new authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for the device (e.g., a WLAN into which the authorized module is installed still be authorized as PC peripheral, subject to the appropriate equipment authorization)	✓ The equipment under complies with FCC Part15, Subpart B, Class B – Unintentional radiators	Conform
(d) In the case of a modular transceiver, the modular approval policy only applies to the transmitter portion of such devices. Pursuant to section 15.101(b), the receiver portion will either be subject to Verification, or it will not be subject to any authorization requirements (unless if is a Scanning Receiver, in which case it is also subject to Certification, pursuant to Section 15.101(a)	✓ The receiver operating in 902 - 928 MHz and complies with FCC Part 15, Subpart B – Radio Receivers.	Conform
(e) The holder of the grant of equipment authorization (Grantee) of the module is responsible for the compliance of the module in its final configuration, provided that the OEM, integrator, and /or end user has complied with all of the instructions provided by the Grantee which indicate installation and/or operating conditions necessary for compliance.	End-users must comply with the following instruction stated in the users' manual: ✓ Labeling requirement for equipment using this modular transmitter. ✓ RF Exposure information for compliance with FCC Rules 2.1091 specified in the user manual for OEM, integrator and/or end user.	 Conform. Conform.

In order to obtain a modular transmitter approval, a cover letter requesting modular approval must be submitted and the numbered requirements identified below must be addressed in the application for equipment authorization:

Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
1. The modulator transmitter must have its own RF shielding. This is intended to ensure that the module does not have to reply upon the shielding provided by the device into which it is installed in order for all modular transmitter emissions to comply with Part 15 limits. It is also intended to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Such coupling may result in non-complaint operation.	✓ Metal enclosure and ground plane to finish the complete shielding on the radio portion of the module.	Conform
2. The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation.	✓ The modular transmitter has buffered modulation/data inputs	Conform
3. The modular transmitter must have its own power supply regulation. This is intended to ensure that the module will comply with Part 15 requirements regardless of the design of the power supplying circuitry in the device into which the module is installed.	✓ The modular transmitter has its own power supply regulation.	Conform
4. The modular transmitter must comply with the antenna requirements of section 15.203 and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules.	✓ The radio complies with Rules 15.203 and 15.204(c) with permanently attached antenna (for the A09-QI integrated wire antenna only, see section 3.5.4 in this test report for details) ✓ The radio and its associated antennas are provided with the special coupling antenna connectors (MMCX, reversed SMA)	Conform Conform

Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
5. The modular transmitter must be tested in a stand-alone configuration, i.e., the module must not be inside another device during testing. This is intended to demonstrate that the module is capable of complying with Part 15 emission limits regardless of the device into which it is eventually installed. Unless the transmitter module will be battery powered, it must comply with the AC conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will marketed with the module (see Section 15.27(a)). The length of these lines shall be length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (See Section 15.31(I)).	✓ The modular transmitter was tested in a stand-alone configuration	Conform

6.6. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
15.31	The hoping function must be disabled for tests, which should be performed with the EUT transmitting on the number of frequencies specified in this Section. The measurements made at the upper and lower ends of the band of operation should be made with the EUT tuned to the highest and lowest available channels.	Hopping function was disabled during testing
15.203	Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed: • The application (or intended use) of the EUT • The installation requirements of the EUT • The method by which the EUT will be marketed	The radio and its associated antennas are provided with the special coupling antenna connectors (MMCX and reversed SMA)
15.204	Provided the information for every antenna proposed for use with the EUT: (a) type (e.g. Yagi, patch, grid, dish, etc…), (b) manufacturer and model number (c) gain with reference to an isotropic radiator	Please refer to Section 3.5 of this test report for details of antenna information
15.247(a)	Description of how the EUT meets the definition of a frequency hopping spread spectrum, based on the technical description.	The carrier is modulated in a conventional way while carrier changes frequency approximately every 400ms or on each transmission event. Receivers have input bandwidths that match the hopping channel bandwidths and shift frequencies in synchronization with the transmitter.
15.247(a)	Pseudo Frequency Hopping Sequence: Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirements specified in the definition of a frequency hopping spread spectrum system.	A random decimal number was generated and associated with each channel. The random numbers were then sorted along with the corresponding channels. Thus, near term distribution of the signal would appear random. Each channel is used 1/n of the time where n is the number of channels. Since each channel is used at least once before the next channel the long term distribution is even. An example of the random sequence with 25 channels is 7, 3, 17, 18, 4, 12, 14, 22, 21, 13, 20, 25, 1, 8, 10, 19, 6, 15, 9, 2, 5, 24, 11, 23, 16

FCC Section	FCC Rules	Laboratory's Comments
15.247(a)	Equal Hopping Frequency Use: Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g. that each new transmission event begins on the next channel in the hopping sequence after final channel used in the previous transmission events).	When presented with a continuous stream of data the transmitter transmits as much data as possible. Just before 400ms elapses, the transmitter hops to a new channel. Each channel is used before the reuse of any channel in the sequence. For short transmissions, each new transmission event begins on the next channel in the hopping sequence.
15.247(g)	Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system	Transmitter operation: When presented with a continuous stream of data, the transmitter transmits a preamble for syncing, and then as much data as possible until the channel duration time nears 400 milliseconds. Just before the 400 ms timer elapses, the transmitter hops then to a new channel that is pseudo randomly ordered, and transmits first a preamble for syncing and then data. This occurs over and over again until all of the data has been transmitted. If the transmitter sits idle most of the time and transmits only for short bursts, each transmission occurs on a separate channel. Receiver operation: The receiver continuously scans all channels for valid data. Once valid data is detected, it is demodulated. If the data transmission extends longer than 400ms, the receiver hops in synchroniztion with the transmitter in order to receive all the data. The receiver has the same pseudo randomly sequenced hopping channels as does the transmitter.
15.247(h)	Describe how the EUT complies with the requirement that it not have the ability to coordinated with other FHSS is an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters	The EUT has no hardware or software to coordinate the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
Public Notice DA 00-705	System Receiver Input Bandwidth: Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.	The approximate occupied bandwidth of the input receiver is 250kHz. The receiver, as per the system block diagram, has 10.7MHz IF filters with a bandwidth of 330kHz. The channel spacing for the FHSS system is 400kHz. Therefore, unless both the transmitter and receiver are on the same channel, no successful data transfer takes place.

FCC Section	FCC Rules	Laboratory's Comments
Public Notice DA 00-705	System Receiver Hopping Capability: Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals	Receiver operation: The receiver continuously scans all its' channels for valid data. Once valid data is detected, it is demodulated. If the data transmission extends longer than 400ms, the receiver hops in synchronization with the transmitter in order to receive all the data. The receiver has the same pseudo randomly sequenced hopping channels as does the transmitter.

6.7. HOPPING CHANNEL CARRIER FREQUENCY CHARACTERISTICS [47 CFR §§ 15.247(a)(1) & (a)(1)(i)]

6.7.1. Limits

- **FCC 47 CFR, Para 15.247(a)(1)**: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

- **FCC 47 CFR, Para 15.247(a)(1)(i)**: For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

6.7.2. Method of Measurements

Refer to FCC 15.247(a)(1) & ANSI C63-4:1992 and Public Notice DA 00-705

Carrier Frequency Separation:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:
- Span = wide enough to capture the peaks of two adjacent channels
- RBW = 1% of the span
- VBW = RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Number of hopping frequency:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:
- Span = the frequency band of operation
- RBW = 1% of the span
- VBW = RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Time of Occupancy (Dwell Time):

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW = RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

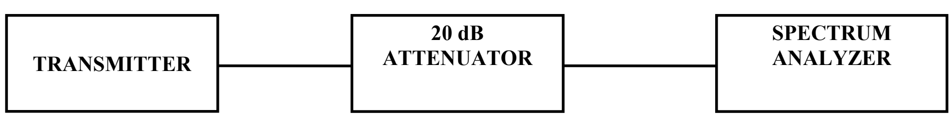
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. date rate modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

20 dB Bandwidth:

Use the spectrum analyzer setting as follows:

- Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20 dB bandwidth
- VBW = RBW
- Sweep = auto
- Detector = peak
- Trace = max hold
- The transmitter shall be transmitting at its maximum data rate.
- Allow the trace to stabilize.
- Use the marker-to-peak function to set the marker to the peak of the emission.
- Use the marker-delta function to measure 20 dB down on both sides of the emission.
- The 20 dB BW is the delta reading in frequency between two markers.

6.7.3. Test Arrangement



6.7.4. 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	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz

6.7.5. Test data

- 20 dB Bandwidth Measurements

Channel Frequency (MHz)	20 dB Bandwidth (kHz)	Limit (kHz)	Pass/Fail
902.6	247	500	Pass
914.9	246	500	Pass
927.2	246	500	Pass

* Refer to test data plots # 1 to 3 in Annex 1 for detailed information of measurements

Test Description	FCC Specification	Measured Values	Comments
Channel Hopping Frequency Separation	Minimum of 25 kHz or 20dB BW whichever is greater.	300 kHz	Pass, refer to test data plots # 4 to 6 in Annex 1 for measurement data
Number hopping frequencies	At least 50 hopping frequencies	83 channels starting from 902.6 MHz to 927.2 MHz	Pass
20 dB BW of the hopping channel	500 kHz maximum	247 kHz	Pass
Average Time of Occupancy	Not greater than 0.4 seconds within 20 second period	302.1 msec within 20 second period	Pass, refer to test data plots # 7 to 12 in Annex 1 for measurement data

FCC Specification	Manufacturer's Explanation
FCC Requirement @ Section 15.247(a)(1): The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals	Conform. Refer to section 6.6 of this report
FCC Requirement @ Section 15.247(g): Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system	Conform. Refer to section 6.6 of this report
FCC Requirement @ Section 15.247(h): Describe how the EUT complies with the requirement that it does not have the ability to coordinated with other FHSS is an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters	Conform. Refer to section 6.6 of this report

6.8. PEAK OUTPUT POWER & EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) [47 CFR § 15.247(b)]

6.8.1. Limits

- **47 CFR 15.247(b)(2):** 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels

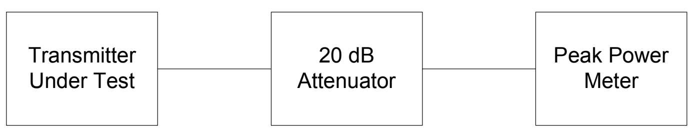
- **47 CFR 15.247(b)(3):** If the antennas of directional gain greater than 6 dBi are used, the peak power from the intentional radiator shall be reduced below, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.8.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this test report, 47 CFR 15.247(b)(2)&(3), and ANSI C63-4:1992

6.8.3. Test Arrangement

- Conducted Output Power at Antenna Terminals



- For EIRP test arrangement, refer to section 8.3 of this test report for details

6.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Peak Power Meter	Hewlett Packard	8900D	2131A01044	100 MHz – 18 GHz, sensor dependent
Peak Power Sensor	Hewlett Packard	84811A	2551A02902	0.1 – 18 GHz
Attenuator	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 MHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Synthesized Sweeper	Hewlett Packard	83752B	3610A00457	0.01 – 20 GHz

6.8.5. Test Data

6.8.5.1. Peak Power Measurements at Antenna Terminals

For systems employing at least 50 hopping channels:

Transmitter Channel	Frequency (MHz)	Peak Power at Antenna Terminal (Watt)	Limit (Watt)
Lowest	902.6	0.148	1
Middle	914.9	0.132	1
Highest	927.2	0.118	1

6.8.5.2. EIRP Measurements – Substitution Method

The highest gain antenna from each antenna family was selected for testing to represents the worst-case (EUT with highest gain antenna) in each antenna family with exception to quarter-wave whip antenna family. The A09-QBMM-P61 (Bulkhead mount MMCX with pigtail) and A09-QI (Integrated wire antenna) will be subject to all applicable tests.

Test Configurations:

1) EUT with A09-HBMM-P6I Half-wave antenna (2.1 dBi gain)
2) EUT with A09-QBMM-P6I Quarter-wave antenna (1.9 dBi gain)
3) EUT with A09-QI Quarter-wave Integrated Wire antenna (1.9 dBi gain)
4) EUT with A09-Y15 Yagi antenna (15.2 dBi gain)
5) EUT with A09-F9 Base Station antenna (9.2 dBi gain)

Maximum EIRP: 34.1 dBm or 2.6 Watts (Test Configuration #4: EUT with A09-Y15 Yagi antenna, 15.2 dBi gain). Refer to the following test data for details:

- **Test Configuration #1: EUT with A09-HBMM-P6I Half-wave antenna (2.1 dBi gain)**

Frequency (MHz)	Peak E-Field @ 3m (dBμV/m)	Antenna Polarization (V/H)	Peak Power From Signal Generator (dBm)	Substitution Dipole Antenna Gain (dBi)	Measured EIRP (dBm)	EIRP Limit (dBm)
902.6	123.4	V	26.1	1.8	27.9	36.0
	124.2	H	23.0	1.8	24.8	36.0
914.9	120.3	V	19.1	2.4	21.5	36.0
	120.3	H	20.7	2.4	23.1	36.0
927.2	120.9	V	21.3	2.8	24.1	36.0
	119.3	H	16.5	2.8	19.3	36.0

- **Test Configuration #2: EUT with A09-QBMM-P6I Quarter-wave antenna (1.9 dBi gain)**

Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Antenna Polarization (V/H)	Peak Power From Signal Generator (dBm)	Substitution Dipole Antenna Gain (dBi)	Measured EIRP (dBm)	EIRP Limit (dBm)
902.6	123.3	V	26.0	1.8	27.8	36.0
	122.3	H	21.1	1.8	22.9	36.0
914.9	119.2	V	18.1	2.4	20.5	36.0
	120.6	H	21.0	2.4	23.4	36.0
927.2	120.5	V	20.9	2.8	23.7	36.0
	119.7	H	16.9	2.8	19.7	36.0

- **Test Configuration #3: EUT with A09-QI Quarter-wave Integrated Wire antenna (1.9 dBi gain)**

Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Antenna Polarization (V/H)	Peak Power From Signal Generator (dBm)	Substitution Dipole Antenna Gain (dBi)	Measured EIRP (dBm)	EIRP Limit (dBm)
902.6	122.0	V	24.7	1.8	26.5	36.0
	116.5	H	15.3	1.8	17.1	36.0
914.9	117.7	V	16.6	2.4	19.0	36.0
	113.5	H	13.9	2.4	16.3	36.0
927.2	117.0	V	17.4	2.8	20.2	36.0
	114.8	H	12.0	2.8	14.8	36.0

- **Test Configuration #4: EUT with A09-Y15 Yagi antenna (15.2 dBi gain)**

Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Antenna Polarization (V/H)	Peak Power From Signal Generator (dBm)	Substitution Dipole Antenna Gain (dBi)	Measured EIRP (dBm)	EIRP Limit (dBm)
902.6	129.6	V	32.3	1.8	34.1	36.0
	126.0	H	24.8	1.8	26.6	36.0
914.9	126.1	V	25.0	2.4	27.4	36.0
	122.0	H	22.4	2.4	24.8	36.0
927.2	127.0	V	27.4	2.8	30.2	36.0
	123.8	H	21.0	2.8	23.8	36.0

- **Test Configuration #5: EUT with A09-F9 Base Station antenna (9.2 dBi gain)**

Frequency (MHz)	Peak E-Field @ 3m (dBµV/m)	Antenna Polarization (V/H)	Peak Power From Signal Generator (dBm)	Substitution Dipole Antenna Gain (dBi)	Measured EIRP (dBm)	EIRP Limit (dBm)
902.6	126.7	V	29.4	1.8	31.2	36.0
	113.5	H	12.3	1.8	14.1	36.0
914.9	128.2	V	27.1	2.4	29.5	36.0
	113.8	H	14.2	2.4	16.6	36.0
927.2	124.8	V	25.3	2.8	28.1	36.0
	114.9	H	12.1	2.8	14.9	36.0

6.9. RF EXPOSURE REQUIREMENTS [47 CFR §§ 15.247(b)(4), 1.1310 & 2.1091]

6.9.1. Limits

FCC 15.247(b)(4): Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See @ 1.1307(b)(1).

6.9.2. MPE Evaluation

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/cm²)	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/f²)	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/f²)	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.

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/cm^2
- G: numeric gain of antenna relative to isotropic radiator
- r: distance to centre of radiation in cm

$$r = \sqrt{PG/4\Pi S} = \sqrt{EIRP/4\Pi S}$$

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: *18.4 cm	Manufacturer' instruction for separation distance between antenna and persons required: 20 cm. Please refer to user's manual for RF Exposure information.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Please refer to user's manual for RF Exposure information
Any other RF exposure related issues that may affect MPE compliance	None.

* The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

RF Exposure Distance Limits: $r = (EIRP/4\Pi S)^{1/2}$

$S = f/1500$ mW/cm^2
EIRP (in mW) = The maximum peak EIRP measured for mobile/fixed application antenna is 34.1 dBm = 2570 mW

$r = (EIRP / 4\Pi S)^{1/2} = [2570 / 4\Pi(902/1500)]^{1/2} = 18.4$ cm

Per FCC Rules for mobile devices, the minimum separation distance shall be 20 cm, which will be specified in the user's manual to inform end users of RF Exposure requirements.

6.10. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [47 CFR § 15.247(c)]

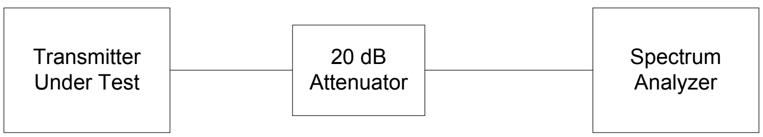
6.10.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power.

6.10.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this test report, 47 CFR § 15.247(c) and ANSI C63-4:1992

6.10.3. Test Arrangement



6.10.4. 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	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz

6.10.5. Test Data

6.10.5.1. Band-Edge Spurious Emissions During Hopping

Please refer to test data plots # 13 to 16 in Annex 1 for measurement results.

6.10.5.2. Lowest Frequency (902.6 MHz)

The emissions were scanned from 10 MHz to 10 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 17 to 19 in Annex 1 for measurement results.

6.10.5.3. Middle Frequency (914.9 MHz)

The emissions were scanned from 10 MHz to 10 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 20 to 22 in Annex 1 for measurement results.

6.10.5.4. Highest Frequency (927.2 MHz)

The emissions were scanned from 10 MHz to 10 GHz and no emission was found within 20 dB below the limits. Refer to test data plots # 23 to 25 in Annex 1 for measurement results.

6.11. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [47 CFR §§ 15.247(c), 15.209 & 15.205]

6.11.1. Limits

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in section 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in section 15.205(a) shall not exceed the general radiated emission limits specified in section 15.209(a)

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.
- **47 CFR § 15.237(c)**: The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in section 15.35 for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands

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

47 CFR § 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength (microvolts/meter)	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

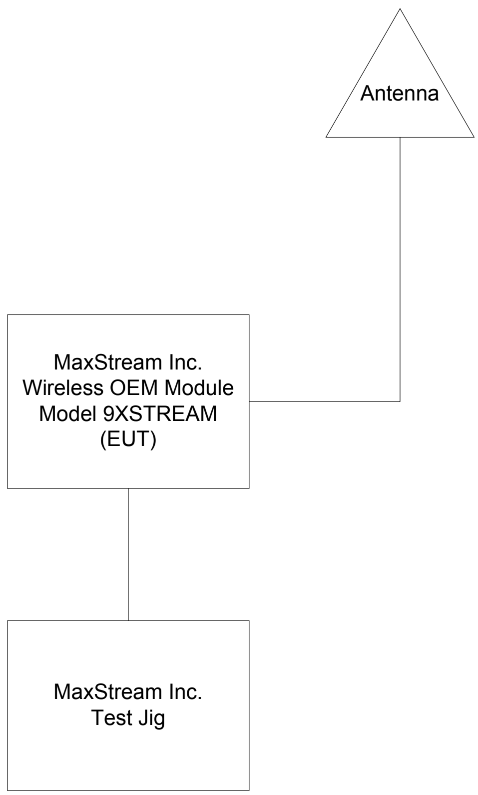
6.11.2. Method of Measurements

Refer to Exhibit 8, Section 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 ≥ 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).

6.11.3. Test Arrangement



6.11.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Microwave Amplifier	Hewlett Packard	8449B	3008A00769	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

6.11.5. Test Data

The highest gain antenna from each antenna family was selected for testing to represents the worst case (EUT with highest gain antenna) in each antenna family with exception to quarter-wave whip antenna family. The A09-QBMM-P61 (Bulkhead mount MMCX with pigtail) and A09-QI (Integrated wire antenna) will be subject to all applicable tests.

Test Configurations:

1) EUT with A09-HBMM-P6I Half-wave antenna (2.1 dBi gain)
2) EUT with A09-QBMM-P6I Quarter-wave antenna (1.9 dBi gain)
3) EUT with A09-QI Quarter-wave Integrated Wire antenna (1.9 dBi gain)
4) EUT with A09-Y15 Yagi antenna (15.2 dBi gain)
5) EUT with A09-F9 Base Station antenna (9.2 dBi gain)

6.11.5.1. Test Configuration #1: EUT with A09-HBMM-P6I Half-wave antenna

Lowest Frequency (902.6 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.6	123.4	--	V	--	--	--	--
902.6	124.2	--	H	--	--	--	--
4513.0	50.3	35.0	V	54.0	104.2	-19.0	*Pass
5415.6	52.6	37.1	V	54.0	104.2	-17.0	*Pass
5415.6	51.3	36.2	H	54.0	104.2	-17.8	*Pass
8123.4	57.6	41.8	V	54.0	104.2	-12.2	*Pass
8123.4	55.2	40.0	H	54.0	104.2	-14.0	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands, therefore FCC 15.209 limit applied.
Refer to test data plots # 26 & 27 in Annex 1 for band-edge emissions.

Middle Frequency (914.9 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
914.9	120.3	--	V	--	--	--	--
914.9	120.3	--	H	--	--	--	--
2744.7	51.6	35.5	V	54.0	100.3	-18.5	*Pass
2744.7	50.6	35.5	H	54.0	100.3	-18.5	*Pass
3659.6	47.2	34.5	V	54.0	100.3	-19.5	*Pass
3659.6	49.0	34.8	H	54.0	100.3	-19.2	*Pass
4574.5	47.1	34.0	V	54.0	100.3	-20.0	*Pass
4574.5	47.1	34.2	H	54.0	100.3	-19.8	*Pass
7319.2	62.5	45.3	V	54.0	100.3	-8.7	*Pass
7319.2	56.9	41.1	H	54.0	100.3	-12.9	*Pass
8234.1	57.8	43.5	V	54.0	100.3	-10.5	*Pass
8234.1	56.6	42.4	H	54.0	100.3	-11.7	*Pass
The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded * Frequency in restricted bands therefore FCC 15.209 is applied. Refer to test data plots # 28 & 29 in Annex 1 for band-edge emissions.							

Highest Frequency (927.2 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
927.2	120.9	--	V	--	--	--	--
927.2	119.3	--	H	--	--	--	--
2781.6	48.8	34.0	V	54.0	100.9	-20.0	*Pass
2781.6	50.1	35.4	H	54.0	100.9	-18.6	*Pass
3708.8	49.3	35.3	H	54.0	100.9	-18.7	*Pass
7417.6	58.3	40.7	V	54.0	100.9	-13.3	*Pass
7417.6	58.4	42.3	H	54.0	100.9	-11.7	*Pass
8344.8	56.9	42.3	V	54.0	100.9	-11.7	*Pass
8344.8	57.1	42.9	H	54.0	100.9	-11.2	*Pass
The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded * Frequency in restricted bands therefore FCC 15.209 is applied. Refer to test data plots # 30 & 31 in Annex 1 for band-edge emissions.							

6.11.5.2. Test Configuration #2: EUT with A09-QBMM-P6I Quarter-wave antenna

Lowest Frequency (902.6 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.6	123.3	--	V	--	--	--	--
902.6	122.3	--	H	--	--	--	--
3610.4	51.9	36.5	H	54.0	103.3	-17.6	*Pass
4513.0	48.4	34.7	V	54.0	103.3	-19.3	*Pass
4513.0	49.0	35.1	H	54.0	103.3	-19.0	*Pass
5415.6	48.6	34.9	V	54.0	103.3	-19.1	*Pass
8123.4	58.9	43.2	V	54.0	103.3	-10.8	*Pass
8123.4	55.1	41.6	H	54.0	103.3	-12.4	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 32 & 33 in Annex 1 for band-edge emissions.

Middle Frequency (914.9 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
914.9	119.2	--	V	--	--	--	--
914.9	120.6	--	H	--	--	--	--
2744.7	48.0	34.1	H	54.0	100.6	-20.0	*Pass
3659.6	47.6	34.2	V	54.0	100.6	-19.8	*Pass
3659.6	48.9	35.4	H	54.0	100.6	-18.6	*Pass
7319.2	64.6	46.3	V	54.0	100.6	-7.7	*Pass
7319.2	55.5	40.2	H	54.0	100.6	-13.8	*Pass
8234.1	60.0	44.5	V	54.0	100.6	-9.6	*Pass
8234.1	54.8	40.6	H	54.0	100.6	-13.4	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 34 & 35 in Annex 1 for band-edge emissions.

Highest Frequency (927.2 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
927.2	120.5	--	V	--	--	--	--
927.2	119.7	--	H	--	--	--	--
3708.8	48.4	34.8	H	54.0	100.5	-19.2	*Pass
7417.6	58.5	41.6	V	54.0	100.5	-12.4	*Pass
7417.6	59.6	43.8	H	54.0	100.5	-10.2	*Pass
8344.8	59.1	43.9	V	54.0	100.5	-10.1	*Pass
8344.8	55.5	42.7	H	54.0	100.5	-11.3	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 36 & 37 in Annex 1 for band-edge emissions.

6.11.5.3. Test Configuration #3: EUT with A09-QI Quarter-wave Integrated Wire antenna

Lowest Frequency (902.6 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.6	122.0	--	V	--	--	--	--
902.6	116.5	--	H	--	--	--	--
8123.4	51.6	37.3	V	54.0	102.0	-16.7	*Pass
8123.4	49.2	36.0	H	54.0	102.0	-18.0	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 38 & 39 in Annex 1 for band-edge emissions.

Middle Frequency (914.9 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
914.9	117.7	--	V	--	--	--	--
914.9	113.5	--	H	--	--	--	--
2744.7	49.4	34.9	V	54.0	97.7	-19.1	*Pass
3659.6	47.9	34.3	V	54.0	97.7	-19.7	*Pass
7319.2	60.1	43.3	V	54.0	97.7	-10.7	*Pass
7319.2	54.5	38.6	H	54.0	97.7	-15.4	*Pass
8234.1	55.5	41.6	V	54.0	97.7	-12.4	*Pass
8234.1	53.9	40.3	H	54.0	97.7	-13.7	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 40 & 41 in Annex 1 for band-edge emissions.

Highest Frequency (927.2 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
927.2	117.0	--	V	--	--	--	--
927.2	114.8	--	H	--	--	--	--
3708.8	48.3	34.2	V	54.0	97.0	-19.8	*Pass
7417.6	52.7	36.8	V	54.0	97.0	-17.2	*Pass
7417.6	57.0	41.7	H	54.0	97.0	-12.3	*Pass
8344.8	54.0	40.6	V	54.0	97.0	-13.4	*Pass
8344.8	53.7	40.3	H	54.0	97.0	-13.7	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 42 & 43 in Annex 1 for band-edge emissions.

6.11.5.4. Test Configuration #4: EUT with A09-Y15NF Yagi antenna

Lowest Frequency (902.6 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.6	129.6	--	V	--	--	--	--
902.6	126.0	--	H	--	--	--	--
3610.4	48.9	35.4	H	54.0	109.6	-18.6	*Pass
4513.0	48.6	35.2	H	54.0	109.6	-18.8	*Pass
5415.6	50.2	37.0	H	54.0	109.6	-17.0	*Pass
8123.4	52.2	38.4	V	54.0	109.6	-15.6	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 44 & 45 in Annex 1 for band-edge emissions.

Middle Frequency (914.9 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
914.9	126.1	--	V	--	--	--	--
914.9	122.0	--	H	--	--	--	--
3659.6	47.6	34.2	V	54.0	106.1	-19.8	*Pass
7319.2	59.2	42.8	V	54.0	106.1	-11.2	*Pass
7319.2	57.7	41.4	H	54.0	106.1	-12.7	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 46 & 47 in Annex 1 for band-edge emissions.

Highest Frequency (927.2 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
927.2	127.0	--	V	--	--	--	--
927.2	123.8	--	H	--	--	--	--
7417.6	55.7	40.0	V	54.0	107.0	-14.0	*Pass
7417.6	55.0	41.8	H	54.0	107.0	-12.2	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 48 & 49 in Annex 1 for band-edge emissions.

6.11.5.5. Test Configuration #5: EUT with A09-F7NF Base Station antenna

Lowest Frequency (902.6 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.6	126.7	--	V	--	--	--	--
902.6	113.5	--	H	--	--	--	--
2707.8	51.4	44.9	V	54.0	106.7	-9.1	*Pass
2707.8	52.5	47.9	H	54.0	106.7	-6.2	*Pass
3610.4	51.9	43.2	V	54.0	106.7	-10.8	*Pass
3610.4	50.4	43.5	H	54.0	106.7	-10.5	*Pass
4513.0	55.4	46.4	V	54.0	106.7	-7.6	*Pass
4513.0	52.0	44.1	H	54.0	106.7	-9.9	*Pass
8123.4	53.5	39.8	V	54.0	106.7	-14.2	*Pass
8123.4	54.7	40.7	H	54.0	106.7	-13.3	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 50 & 51 in Annex 1 for band-edge emissions.

Middle Frequency (914.9 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
914.9	128.2	--	V	--	--	--	--
914.9	113.8	--	H	--	--	--	--
2744.7	48.5	40.6	V	54.0	108.2	-13.4	*Pass
2744.7	50.5	45.2	H	54.0	108.2	-8.8	*Pass
3659.6	49.8	40.8	V	54.0	108.2	-13.3	*Pass
3659.6	51.7	44.0	H	54.0	108.2	-10.0	*Pass
4574.5	50.7	41.1	V	54.0	108.2	-12.9	*Pass
4574.5	50.7	40.4	H	54.0	108.2	-13.6	*Pass
7319.2	55.0	44.4	V	54.0	108.2	-9.6	*Pass
7319.2	59.4	49.7	H	54.0	108.2	-4.3	*Pass
8234.1	50.8	38.7	V	54.0	108.2	-15.3	*Pass
8234.1	51.5	39.3	H	54.0	108.2	-14.7	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 52 & 53 in Annex 1 for band-edge emissions.

Highest Frequency (927.2 MHz)

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
927.2	124.8	--	V	--	--	--	--
927.2	114.9	--	H	--	--	--	--
2781.6	48.4	41.5	V	54.0	104.8	-12.5	*Pass
2781.6	50.7	45.5	H	54.0	104.8	-8.5	*Pass
3708.8	49.9	41.8	V	54.0	104.8	-12.2	*Pass
3708.8	50.1	41.2	H	54.0	104.8	-12.8	*Pass
4636.0	48.8	38.1	V	54.0	104.8	-15.9	*Pass
4636.0	49.6	38.4	H	54.0	104.8	-15.6	*Pass
7417.6	55.1	43.6	V	54.0	104.8	-10.5	*Pass
7417.6	59.9	49.4	H	54.0	104.8	-4.6	*Pass
8344.8	51.6	38.8	V	54.0	104.8	-15.2	*Pass
8344.8	50.6	37.6	H	54.0	104.8	-16.4	*Pass

The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded
* Frequency in restricted bands therefore FCC 15.209 is applied.
Refer to test data plots # 54 & 55 in Annex 1 for band-edge emissions.

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 (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	**0.15-30 MHz**
EMI Receiver specification	Rectangular	$\pm$1.5	$\pm$1.5
LISN coupling specification	Rectangular	$\pm$1.5	$\pm$1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	$\pm$0.3	$\pm$0.5
Mismatch: Receiver VRC Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	$\pm$0.2	$\pm$0.3
System repeatability	Std. deviation	$\pm$0.2	$\pm$0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	$\pm$1.25	$\pm$1.30
Expanded uncertainty U	Normal (k=2)	$\pm$2.50	$\pm$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 $20\text{Log}(1 \pm \Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

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^{o}C to +35^{o}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. EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

- 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.

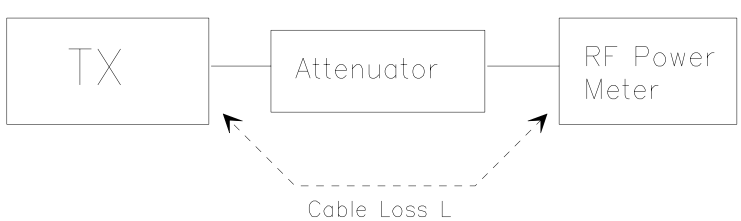
Step 2: Calculation of Peak and Average EIRP

- 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^{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 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

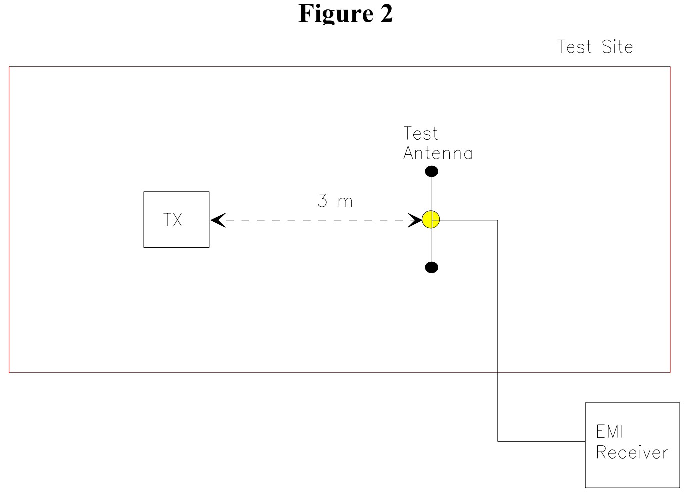
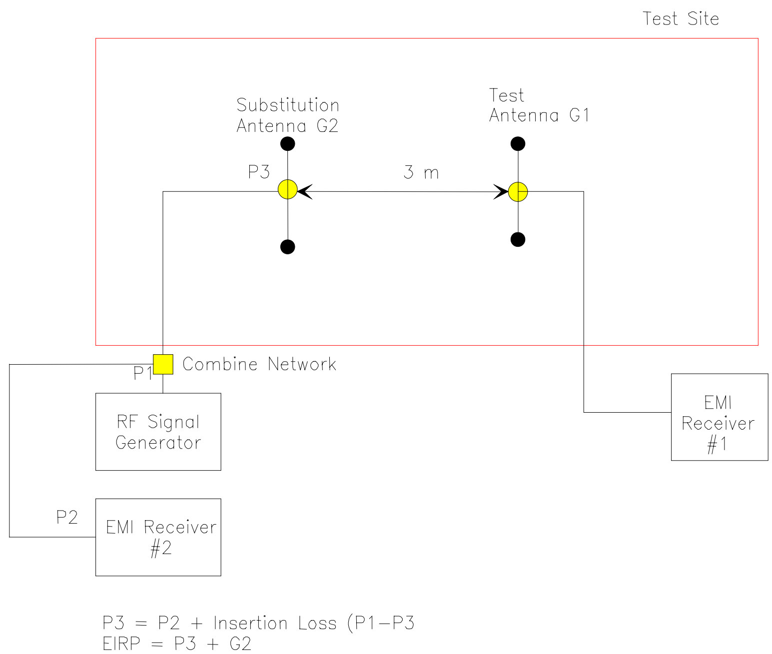


Figure 3



Use the following spectrum analyzer settings:

- Span = approximately 5 times the 20 dB BW, centered on a hopping channel
- RBW > 20 dB BW of the emission measured
- VBW = RBW
- Trace = max hold
- Allow the trace to stabilize
- Use the marker-to-marker function to set the marker to the peak of the emission.
- The indicated level is the peak output power (with the addition of the external attenuation and cable loss).
- The limit is specified in one of the subparagraph of this Section.
- Submit this plot.
- A peak responding power meter may be used instead of a spectrum analyzer.

8.4. SPURIOUS EMISSIONS (CONDUCTED & RADIATED)

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

8.4.1. Band-Edge and Spurious Emissions (Conducted)

Band-Edge Compliance of RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
- RBW = 1 % of the span
- VBW = RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge
- Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission.
- The marker-delta value now displayed must comply with the limit specified
- Now, using the same instrument settings, enable the hopping function of the EUT
- Allow the trace to stabilize
- Follow the same procedure listed above to determine if any spurious emissions cause by the hopping function also comply with the specify limits.
- Submit this plot

Spurious RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the in-band-emission and all spurious emissions (e.g. harmonics) from the lowest frequency generated in the EUT up through the 10^{th} harmonic. Typically, sevral plots are required to cover this entire span.
- RBW = 100 kHz
- VBW = RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize
- Set the marker on the any spurious emission recorded. The level displayed must comply with the limit specified in this Section.
- Submit this plot

8.4.2. 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. The test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

➢ RBW = 100 kHz for f < 1GHz and RBW = 1 MHz for f $\geq$ 1 GHz
➢ VBW = RBW
➢ Sweep = auto
➢ Detector function = peak
➢ Trace = max hold
➢ Follows the guidelines in ANSI C63.4-1992 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc.. A pre-amp and highpass filter are required for this test, in order to provide the measuring system with sufficient sensitivity.
➢ Allow the trace to stabilize.
➢ The peak reading of the emission, after being corrected by the antenna correction factor, cable loss, pre-amp gain, etc…. is the peak field strength which comply with the limit specified in Section 15.35(b)

Calculation of Field Strength:

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

$$\boxed{FS = RA + AF + CF - AG}$$

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

Example: If a receiver reading of 60.0 dBuV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:

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

- Submit this test data
- Now set the VBW to 10Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100ms, then the reading obtained may be further adjusted by a "duty cycle correction factor", derived from 10log(dwell time/100mS) in an effort to demonstrate compliance with the 15.209.
- Submit test data

Maximizing The Radiated Emissions:

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.
- During this process, cables and peripheral devices were manipulated within the range of likely configuration.
- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement were explored to produce the highest amplitude signal relative to the limit.

The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

Step4: Move the antenna over its full allowable range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

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

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

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

8.5. ALTERNATIVE TEST PROCEDURES

If the antenna conducted tests cannot be performed on this device, radiated tests show compliance with the peak output power limit specified in Section 15.247(b) and the spurious RF conducted emission limit specified in Section 15.247(c) are acceptable. As stated previously, a pre-amp, and, in the later case, a high pass filter, are required for the following measurements:

8.5.1. Peak Power Measurements

Calculate the transmitter's peak power using the following equation:

$E = 30PG/d$
$P = (Ed)^2/30G$

Where:

- E: measured maximum fundamental field strength in V/m. Utilizing a RBW, the 20 dB bandwidth of the emission VBW >RBW, peak detector function. Follow the procedures in C63.4-1992 with respect to maximizing the emission
- G is numeric gain of the transmitting antenna with reference to an isotropic radiator
- D is the distance in meters from which the field strength was measured
- P is the distance in meters from which the field strength was measured

8.5.2. Spurious RF conducted emissions

The demonstrate compliance with the spurious RF conducted emission requirement of Section 15.2479(c), use the following spectrum analyzer settings:

- Span = wide enough to fully capture the emission being measured
- RBW = 100 kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Measure the field strength of both the fundamental and all spurious emissions with these settings.
- Follow the procedures C62-4:1994 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247(c). Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions listed above must be followed