ENGINEERING TEST REPORT

Bluetooth Module

Model No.: DW-SBTM1

FCC ID: R37-DWSBTM1

Applicant: **Datawind Net Access Corp.**
555 Rene Levesque West, Suite 1130
Montreal, Quebec
Canada, H2Z 1B1

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.247

Spread Spectrum (Bluetooth) Transmitter operating in the frequency band 2402-2480 MHz

UltraTech's File No.: DOC005_FCC15.247

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

Date: May 05, 2004

Report Prepared by: Dharmajit Solanki, RFI Engineer	Tested by: Mr. Hung Trinh, RFI Technician
Issued Date: May 05, 2004	Test Dates: May 05, 2004

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

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31040/SIT C-1376 46390-2049 200093-0 SL2-IN-E-1119R 00-034

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 Setup Photos	Photos # 1 to 7	OK
2	External Photos of EUT	Photos # 1 to 2	OK
3	Internal Photos of EUT	Photos # 1 to 3	OK
4	Cover Letters	• Letter from Ultratech for Certification Request	OK
5	Attestation Statements	• Manufacturer's letter for Modular approval request confirming requirements as per FCC Notice DA 00-1407. • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK
6	ID Label/Location Info	• ID Label • Location of ID Label	OK
7	Block Diagrams	• Block diagram	OK
8	Schematic Diagrams	• Schematic diagram	OK
9	Parts List/Tune Up Info	• Parts list	OK
10	Operational Description	• Functional Description	OK
11	RF Exposure Info	• RF Exposure Information	OK
12	Users Manual	• User Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Docket No.: 99-231:2002 (Amendment to FCC Part 15 of the Commission's Rules Regarding to Spread Spectrum Devices), Part 15, Subpart C, Section 15.247
Title	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Spread Spectrum (Bluetooth) Transmitters operating in the Frequency Band 2402-2480 MHz .
Test Procedures	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	• Residential • Light-industry, Commercial • Industry

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

None

2.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC CFR 47 Parts 0-19	2003	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	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	2003 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1		Specification for Radio Disturbance and Immunity measuring apparatus and methods
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding to Spread Spectrum Devices

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT:	
Name:	DATAWIND NET ACCESS CORP.
Address:	555, Rene Levesque West, Suite 1130 Montreal, Quebec, H2Z 1B1 Canada
Contact Person:	Mr. Sunnet Tuli Phone #: 514-871-0984 Fax #: 514-871-3864 Email Address: sunnet@datawind.com

MANUFACTURER:	
Name:	DATAWIND NET ACCESS CORP.
Address:	555, Rene Levesque West, Suite 1130 Montreal, Quebec, H2Z 1B1 Canada
Contact Person:	Mr. Sunnet Tuli Phone #: 514-871-0984 Fax #: 514-871-3864 Email Address: sunnet@datawind.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	DATAWIND
Product Name	Bluetooth Module
Model Name or Number	DW-SBTM1
Serial Number	Pre-production
Type of Equipment	Bluetooth Transmitter
Input Power Supply Type	External 3.3V DC stabilized and Filtered (range 2.2 V–3.6 V)
Primary User Functions of EUT:	Provide data communication link through air

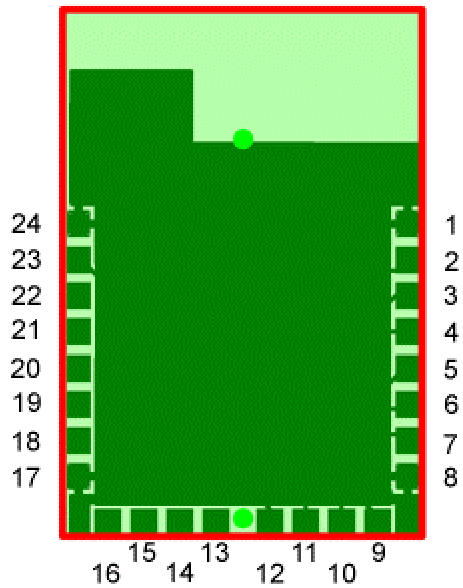
3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	▪ Portable ▪ Mobile
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	External 3.3Vdc stabilized and filtered (range 2.2 V–3.6 V)
RF Output Power Rating:	1.85 mW
Operating Frequency Range:	2402-2480 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	1 MHz
20 dB Bandwidth:	721 kHz
Modulation Type:	Bluetooth FSK (FHSS)
Emission Designation:	Bluetooth
Oscillator Frequencies:	16 MHz
Spectral Density	0.073 mW/3MHz (Power output at the antenna / bandwidth of the RF output spectrum)
Antenna Connector Type:	• Integral, Permanently attached on the PCB
Antenna Description:	Manufacturer: YOKOWA make Type: Ceramic Chip (Wire-Coupled) Model: YCE-5241 Frequency Range: 2.400 – 2.484 GHz In/Out Impedance: 50 Ohms Peak Gain: +0.5dbi Average Gain: -5.5 dbi

3.4. LIST OF EUT'S PORTS

Pin details and Electrical settings:

Pin	Pin Name	Nominal level	MAX level
1.	GND	Ref. Level (GND)	
2.	VDD1	1.8V	2.2V
3.	SPI_MISO	3.3V	VDD2+0.4V
4.	SPI_CSB	3.3V	VDD2+0.4V
5.	SPI_CLK	3.3V	VDD2+0.4V
6.	SPI_MOSI	3.3V	VDD2+0.4V
7.	VDD2	3.3V	3.6V
8.	GND	Ref. Level (GND)	
9.	UART_CTS	3.3V	VDD2+0.4V
10.	UART_RTS	3.3V	VDD2+0.4V
11.	UART_TX	3.3V	VDD2+0.4V
12.	UART_RX	3.3V	VDD2+0.4V
13.	Reserved	N/A	N/A
14.	Reserved	N/A	N/A
15.	Reserved	N/A	N/A
16.	Reserved	N/A	N/A
17.	GND	Ref. Level (GND)	
18.	Reserved	N/A	N/A
19.	Reserved	N/A	N/A
20.	Reserved	N/A	N/A
21.	Reserved	N/A	N/A
22.	Reserved	N/A	N/A
23.	RESET	3.3V	VDD2+0.4V
24.	GND	Ref. Level (GND)	



View from the bottom

Note: VDD2 is internally regulated from VDD1 coming through VDD_ANA pin. It can be supplied externally, but then tight regulation and filtering is required (less than 10mVpp). Check original manufacturer IC data book for more details (Check BOM for part number)

RESET pin is active high and has to stay on for at least 5ms for a proper reset of the module.

Pin name	**Pin state during reset**
UART_TX	Output tri-stated with weak pull-up
UART_RX	Input with weak pull-down
UART_RTS	Output tri-stated with weak pull-up
UART_CTS	Input with weak pull-down
SPI_CSB	Input with weak pull-up
SPI_CLK	Input with weak pull-down
SPI_MISO	Output tri-stated with weak pull-down
SPI_MOSI	Input with weak pull-down

3.5. 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:	Test Jig
Brand name:	Datawind Net Access Corp
Serial Number:	None
Connected to EUT's Port:	Pin Nos. 1, 7, 9,10,11,12 & 23.

3.6. GENERAL TEST SETUP

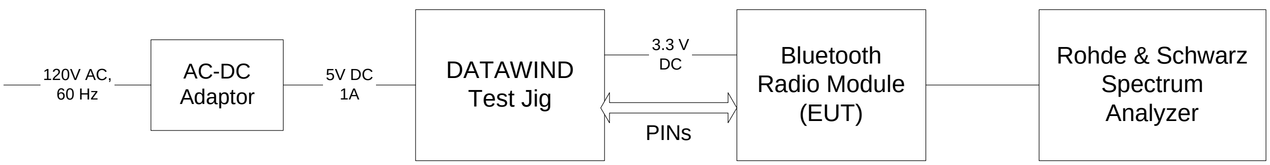


EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

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:	120V AC, 60 Hz

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 Frequency Hopping Mode and Direct Sequence mode.
Special Test Software:	▪ Special software is provided by the Applicant to select and operate the EUT at each channel frequency continuously and mode of operation such as frequency hopping or direct sequence for testing purpose.
Special Hardware Used:	Datawind provided Test Jig
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals:	
Test Frequencies: ▪ 2402-2480 MHz band:	Lowest, middle and highest channel frequencies tested: ▪ 2402, 2441 & 2480 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured max conducted o/p power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 1.85 mW or 2.67 dBm ▪ Bluetooth – FSK (Low Power FHSS) ▪ 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: Aug. 10, 2002.

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) & 207	AC Power Conducted Emissions	Yes
15.247(a)(1) & (2)	20dB Bandwidth of a FHSS (Bluetooth) System	Yes
15.247(b)(1) & (3)	Maximum Peak Power Conducted Power & EIRP	Yes
15.247 (b) (5)	RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d) & (f)	Transmitted Power Spectral Density of a Hybrid System (Bluetooth) in acquisition mode	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
FCC Part 15, Sub. B, Sec. 15.109	Class B Radiated Emissions	Yes. Note 1

Note 1: A separate engineering test report for compliance with FCC Part 15, Subpart B - Class B Unintentional Radiators will be provided upon request.

5.3. BLUETOOTH APPROVAL REQUIREMENTS

The following indicates the FCC Spread Spectrum requirements in Section 15.247 for devices meeting the Bluetooth Specifications in the 2.4 GHz band as of February 2001 operating in the USA. The purpose of this exhibit is to help expedite the approval process for Bluetooth devices. This exhibit provides items that vary for each device and also provides a list of items that are common to Bluetooth devices that explains the remaining requirements. The list of common items can be submitted for each application for equipment authorization. This exhibit only specifies requirements in Section 15.247, requirements in other rule Sections for intentional radiators such as in Section 15.203 or 15.207 must be also be addressed. A Bluetooth device is a FHSS transmitter in the data mode and applies as a Hybrid spread spectrum device in the acquisition mode.

For each individual device, the following items, 1-7 will vary from one device to another and must be submitted.
1) The occupied bandwidth in Section 15.247(a)(1)(ii).
2) Conducted output power specified in Section 15.247(b)(1).
3) EIRP limit in Section 15.247(b)(3).
4) RF safety requirement in Section 15.247(b)(4)
5) Spurious emission limits in Section 15.247(c).
6) Processing gain and requirements for Hybrids in Section 15.247(f) in the acquisition mode.
7) Power spectral density requirement in Section 15.247(f) in the acquisition mode.

For all devices, the following items, 1-12, are common to all Bluetooth devices and will not vary from one device to another. This list can be copied into the filing.

1 Output power and channel separation of a Bluetooth device in the different operating modes:

The different operating modes (data-mode, acquisition-mode) of a Bluetooth device don't influence the output power and the channel spacing. There is only one transmitter, which is driven by identical input parameters concerning these two parameters. Only a different hopping sequence will be used. For this reason, the RF parameters in one op-mode is sufficient.

2 Frequency range of a Bluetooth device:

The maximum frequency of the device is: **2402 – 2480 M**Hz.
This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for devices, which will be operated in the USA. Other frequency ranges (e.g. for Spain, France, Japan) which are allowed according the Core Specification must **not be** supported by the device.

3 Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consist of max. 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from it's BD address which is unique for every Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

4 Example of a hopping sequence in data mode:

Example of a 79 hopping sequence in data mode:
40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67,
56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59,
72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75,
09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06,
01, 51, 03, 55, 05, 04

5 Equally average use of frequencies in data mode and short transmissions:

The generation of the hopping sequence in connection mode depends essentially on two input values:
1. LAP/UAP of the master of the connection
2. Internal master clock

The LAP (lower address part) are the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS. The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronization with other units, only the offsets are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5 µs. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures (permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions, the Bluetooth system has the following behavior: The first connection between the two devices is established, a hopping sequence is generated. For transmitting the wanted data, the complete hopping sequence is not used and the connection ends. The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5 µs). The hopping sequence will always differ from the first one.

6 Receiver input bandwidth, synchronization and repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz.
In every connection, one Bluetooth device is the master and the other one is the slave.
The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master. Additionally the type of connection (e.g. single or multi-slot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing is according to the packet type of the connection. Also, the slave of the connection uses these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

7 Dwell time in data mode:

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length).
The calculation for a 30 second period is a follows:
Dwell time = time slot length * hop rate / number of hopping channels *30s
Example for a DH1 packet (with a maximum length of one time slot)
Dwell time = 625 µs * 1600 1/s / 79 * 30s = 0.3797s (in a 30s period)
For multi-slot packet the hopping is reduced according to the length of the packet.
Example for a DH5 packet (with a maximum length of five time slots)
Dwell time = 5 * 625 µs * 1600 * 1/5 *1/s / 79 * 30s = 0.3797s (in a 30s period)
This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. Therefore, all Bluetooth devices **comply** with the FCC dwell time requirement in the data mode. This was checked during the Bluetooth Qualification tests.
The Dwell time in hybrid mode is approximately 2.6 mS (in a 12.8s period)

8 Channel Separation in hybrid mode:

The nominal channel spacing of the Bluetooth system is 1Mhz independent of the operating mode.
The maximum "initial carrier frequency tolerance" which is allowed for Bluetooth is fcenter = 75 kHz.
This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/07-E) for three frequencies (2402, 2441, 2480 MHz).

9 Derivation and examples for a hopping sequence in hybrid mode:

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see item 5), but this time with different input vectors:
**For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.
**For the page hop sequence, the device address of the paged unit is used as the input vector. This results in the use of a subset of 32 frequencies, which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.
So it is ensured that also in hybrid mode, the frequency is used equally on average.
Example of a hopping sequence in inquiry mode:
48, 50, 09, 13, 52, 54,41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06,
17, 21, 08, 10, 66, 70, 12, 14, 19, 23
Example of a hopping sequence in paging mode:
08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18,
58, 56, 20, 53, 60, 62, 55, 06, 66, 64

10 Receiver input bandwidth and synchronization in hybrid mode:

The receiver input bandwidth is the same as in the data mode (1 MHz). When two Bluetooth devices establish contact for the first time, one device sends an inquiry access code and the other device is scanning for this inquiry access code. If two devices have been connected previously and want to start a new transmission, a similar procedure takes place. The only difference is, instead of the inquiry access code, a special access code, derived from the BD_ADDRESS of the paged device will be, will be sent by the master of this connection. Due to the fact that both units have been connected before (in the inquiry procedure) the paging unit has timing and frequency information about the page scan of the paged unit. For this reason the time to establish the connection is reduced.

11 Spread rate / data rate of the direct sequence signal:

The Spread rate / Data rate in inquiry and paging mode can be defined via the access code. The access code is the only criterion for the system to check if there is a valid transmission or not. If you regard the presence of a valid access code as one bit of information, and compare it with the length of the access code of 68 bits, the Spread rate / Data rate will be 68/1.

12 Spurious emission in hybrid mode:

The Dwell in hybrid mode is shorter than in data mode. For this reason the spurious emissions average level in data mode is worst case. The spurious emissions peak level is the same for both modes.

5.4. 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 and ANSI C63.4

6.2. MEASUREMENT UNCERTAINTIES

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

6.3. MEASUREMENT EQUIPMENT USED:

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C64-3:1992, FCC 15.247 and CISPR 16-1.

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

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

6.5. UNLICENSED MODULAR TRANSMITETR 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 complete with its own reference oscillator, antenna. ✓ Only connectors provide are dc supply, data and rf ports are provided with the modular transmitter	Satisfactory
(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 is intended for use in all applications (portable, mobile and base). This module has very low power output (2.07mW Peak EIRP). For details refer to RF Exposure folder.	Satisfactory
(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 test complies with FCC Part15, Subpart B, Class B – Unintentional radiators	Satisfactory
(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 equipment under test complies with FCC Part15, Subpart B, Class B – Radio Receivers	Satisfactory

	Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
(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 sated in the users' manual: ✓ Labeling requirement for equipment using this modular transmitter. ✓ RF Exposure Warning for compliance with FCC Rules 2.1091 and 1.1307 when the radio is used in a mobile or base system	Satisfactory

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.	✓ The modular transmitter has its own RF shielding	Satisfactory
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	Satisfactory
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.	Satisfactory

	Requirements for Modular Transmitters	Manufacturer's Clarification	Laboratory's Comments
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 module complies with Rules 15.203 and 15.204(c) with permanently attached antenna.	Satisfactory
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	Satisfactory

6.6. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
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 radio module complies with Rules 15.203 and 15.204(c). It is mounted with permanently fixed antenna.
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	 Ceramic Chip (Wire-Coupled) YOKOWA make model: YCE-5241 Peak Gain: 0.5dbi, Average Gain: -5.5 dbi

6.7. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.107(A) & 15.207

6.7.1. Limits

The equipment shall meet the limits of the following table:

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

* Decreasing linearly with logarithm of frequency

6.7.2. Method of Measurements

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

6.7.3. Test Equipment List

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

6.7.4. Photographs of Test Setup

Refer to the Photographs # 1 & 2 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

6.7.5. Test Data

6.7.5.1. AC Powerline Conducted Emissions on EUT

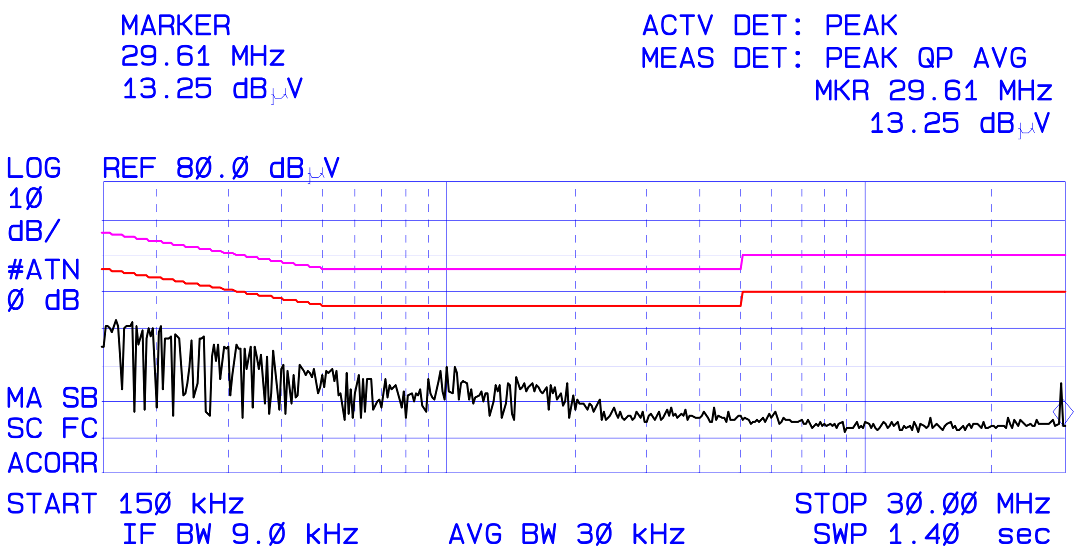
FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVG LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.17	33.5	QP	64.5	54.5	- 31.0	PASS	L1
0.17	25.9	AVG	64.5	54.5	- 28.6	PASS	L1
0.97	26.2	QP	56.0	46.0	- 29.8	PASS	L1
0.97	24.8	AVG	56.0	46.0	- 21.2	PASS	L1
29.5	23.3	QP	60.0	50.0	- 36.7	PASS	L1
29.5	22.2	AVG	60.0	50.0	- 27.8	PASS	L1
0.17	33.5	QP	64.5	54.5	- 31.0	PASS	L2
0.17	25.9	AVG	64.5	54.5	- 28.6	PASS	L2
0.97	26.2	QP	56.0	46.0	- 29.8	PASS	L2
0.97	24.8	AVG	56.0	46.0	- 21.2	PASS	L2
29.5	23.3	QP	60.0	50.0	- 36.7	PASS	L2
29.5	22.2	AVG	60.0	50.0	- 27.8	PASS	L2

* Refer to Plots # 1 and 2 for detailed measurements

Plot # 1: AC Line Conducted Emissions, Line 1

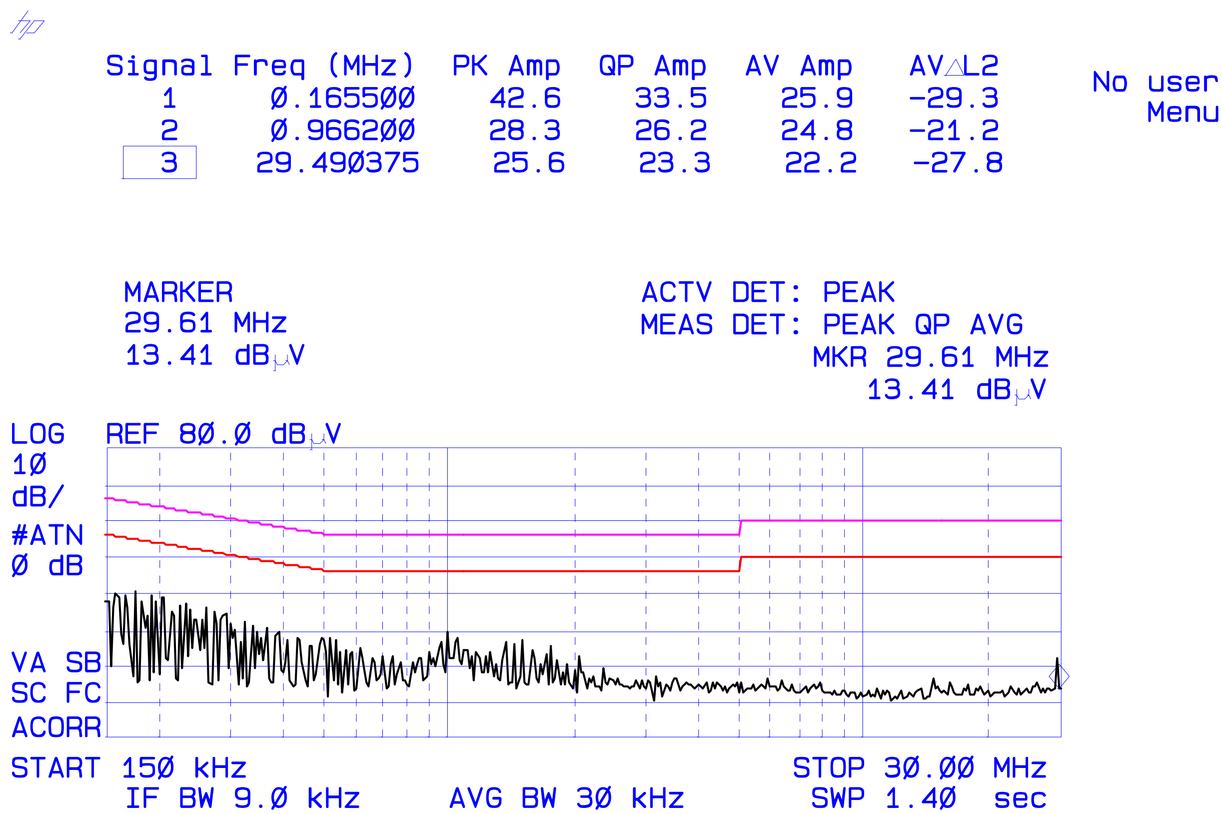
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.165495	42.2	33.6	25.2	-30.0
2	0.966196	29.2	25.0	21.3	-24.7
3	29.490375	25.4	23.0	22.3	-27.7

No user Menu



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

Plot # 2: AC Line Conducted Emissions, Line 2



6.8. 20 DB BANDWIDTH @ FCC 15.247(A)(1)

6.8.1. Limits

- For Frequency Hopping System, The Hopping channel carrier frequencies separated by a minimum of 25 kHz or 20 db bandwidth of the hopping channel, whichever is greater.

6.8.2. Method of Measurements

Refer to ANSI C63.4

The transmitter output was connected to the spectrum analyzer through an attenuator. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using 30 KHz RBW, VBW = 100 KHz,. The 20 dB Bandwidth was measured and recorded.

6.8.3. Test Arrangement

6.8.4. Test Equipment List

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

6.8.5. Test Data

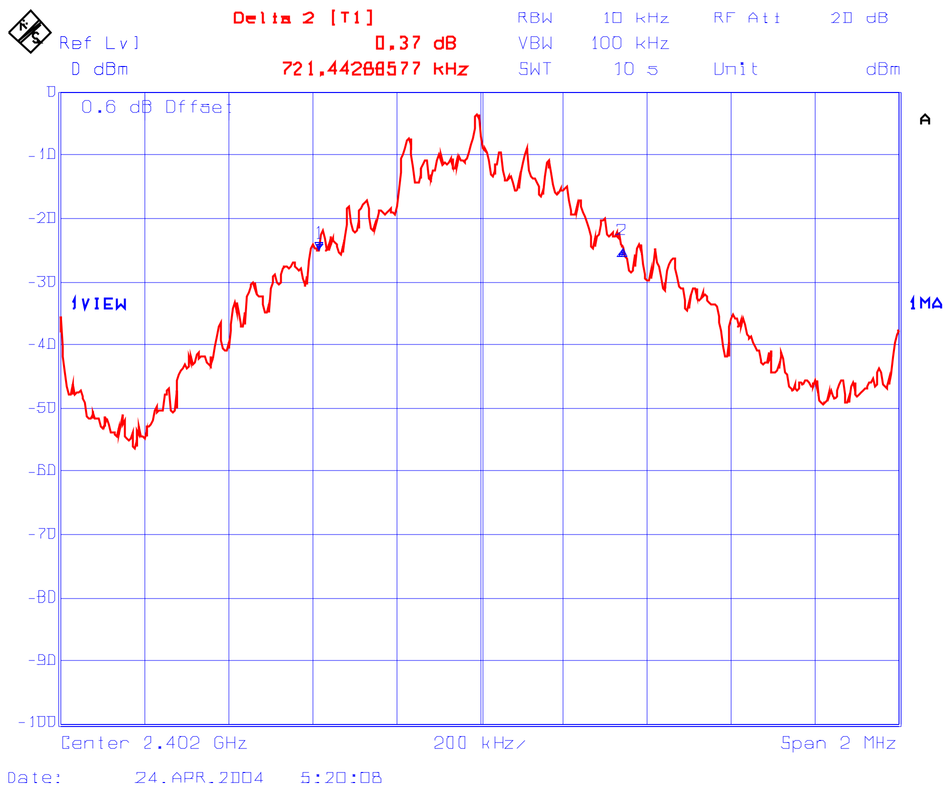
6.8.6. For Frequency Hopping Spread Spectrum Mode

The channel spacing of this Bluetooth module is 1 MHz.

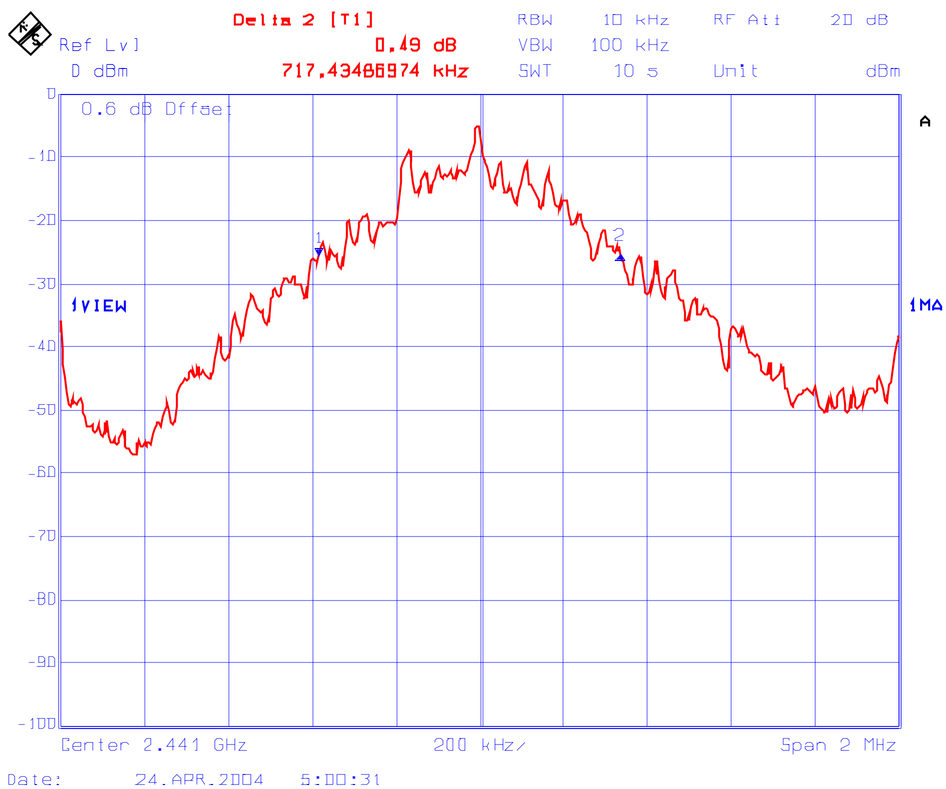
CHANNEL FREQUENCY (MHz)	20 dB Bandwidth (MHz)	MAXIMUM LIMIT (MHz)	PASS/FAIL
2402	0.721	1.000	PASS
2441	0.717	1.000	PASS
2480	0.717	1.000	PASS

* Refer to Plots 3 to 5 for detailed measurements

Plot # 3: 20 dB Bandwidth of 2402 MHz Hopping Channel Frequency

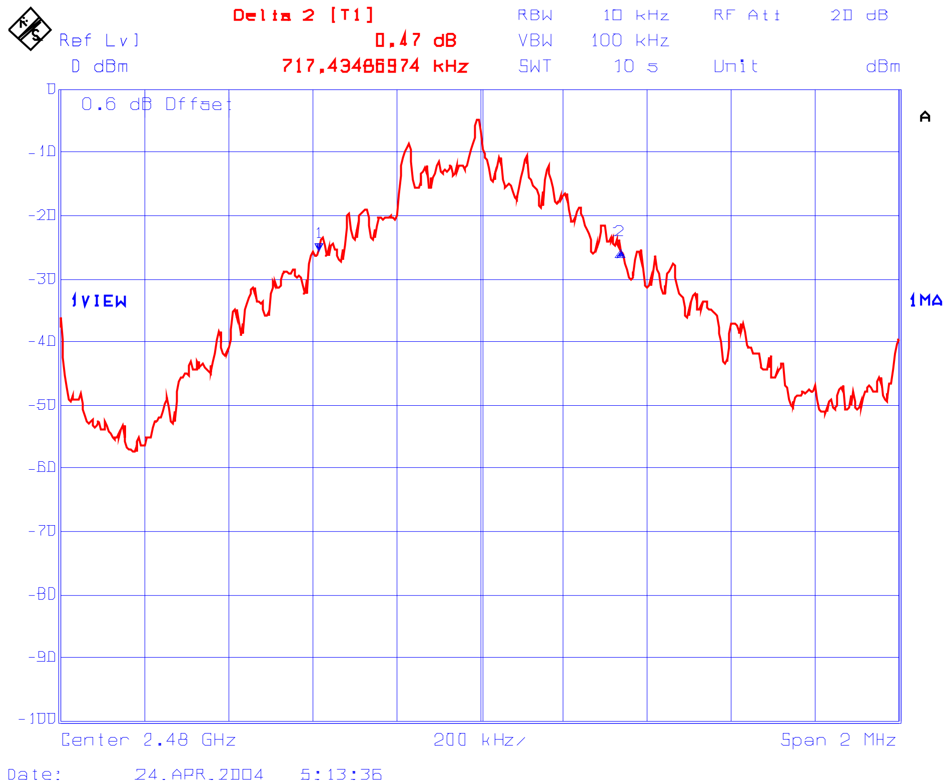


Plot # 4: 20 dB Bandwidth of 2441 MHz Hopping Channel Frequency



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

Plot # 5: 20 dB Bandwidth of 2480 MHz Hopping Channel Frequency



6.9. PEAK CONDUCTED OUTPUT POWER & EIRP @ FCC 15.247(B)(1)&(3)

6.9.1. Limits

- **FCC 15.247(b)(1):** Maximum peak output power of the transmitter employing at least 75 hopping channels shall not exceed 1 Watt.
- **FCC 15.247(b)(3)(i):** If the device is not for fixed point to point radio, the antenna of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.9.2. Method of Measurements & Test Arrangement

Refer to Exhibit 8, Sec. 8.3 of this test report, FCC 15.247(b)(1)&(3), ANSI C63.4 & ETSI 300 328

Note: The conducted peak power measurement method was performed in accordance with ETSI 300 328 since it was proven to be independent with the peak power meter characteristics.

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8546A	…	9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors.
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
67297 RF Detector (Diode Detector)	Herotex	DZ122-553	63400	..
Storage Oscilloscope	Philips	PM3320A	ST9907959	--

6.9.4. Test Data

Transmitter Channel	Frequency (MHz)	Peak Power at Antenna Terminals (full bandwidth) (dBm)	Calculated max EIRP with Antenna Gain (dBm)	Limit (dBm)
Lowest	2402	2.67	3.17	30.0
Middle	2441	1.04	1.54	30.0
Highest	2480	1.04	1.54	30.0

6.10. RF EXPOSURE REQUIRMENTS @ FCC 15.247(B)(5), 1.1310 & 2.1091

This DATAWIND DW-SBTM1 Module has 1.85mW (2.67dbm) of conducted peak output power and 2.08 mW (3.17dbm) of EIRP (Peak Antenna Gain is 0.5dbi). Also the highest measured field strength of fundamental emission is 92.2 dBuV/m only. Hence the peak conducted & radiated EIRP power is very low and below 5mW, this kind of equipment hardly go over SAR value limited of 1.6W/Kg for public residential use which is regulated by "OET Bulletin 65, Supplement C".

DATAWIND Bluetooth module DW-SBTM1 complies with FCC radiation exposure requirement specified as per these sections.

6.11. TRANSMITTER BAND-EDGE & SPURIOUS EMISSIONS (CONDUCTED), FCC CFR 47, PARA. 15.247(C)

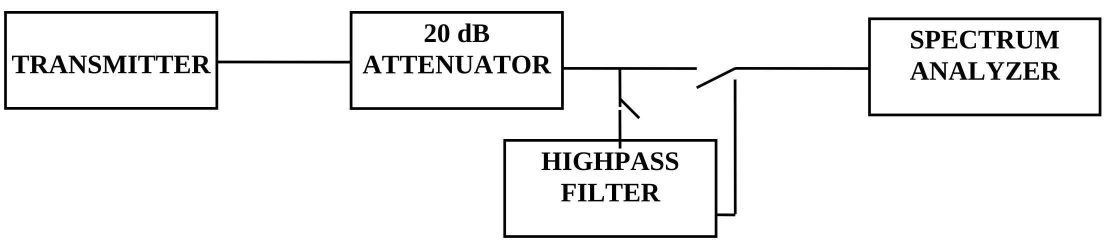
6.11.1. Limits

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 at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power.

6.11.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 of this test report, FCC 15.247(c) & ANSI C63.4

6.11.3. Test Arrangement



6.11.4. Test Equipment List

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

6.11.5. Test Data

6.11.5.1. Emissions at the band-edges of the FCC Permitted Band

Please refer to Plots # 6 and 7 for details of Band-edge emissions at lowest and highest channel frequencies.

6.11.5.2. Tx Conducted Emissions at Lowest Frequency (2402 MHz)

FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2402.0	- 2.0	Peak	----	----	----
4799.6	- 47.1	Peak	-22.0	-25.1	PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.
- Refer Plots 8 and 9 for details of measurements

6.11.5.3. Tx Conducted Emissions at Middle Frequency 2441 MHz)

FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2441.0	- 3.3	Peak	----	----	----
4844.5	- 48.1	Peak	-23.3	-24.8	PASS

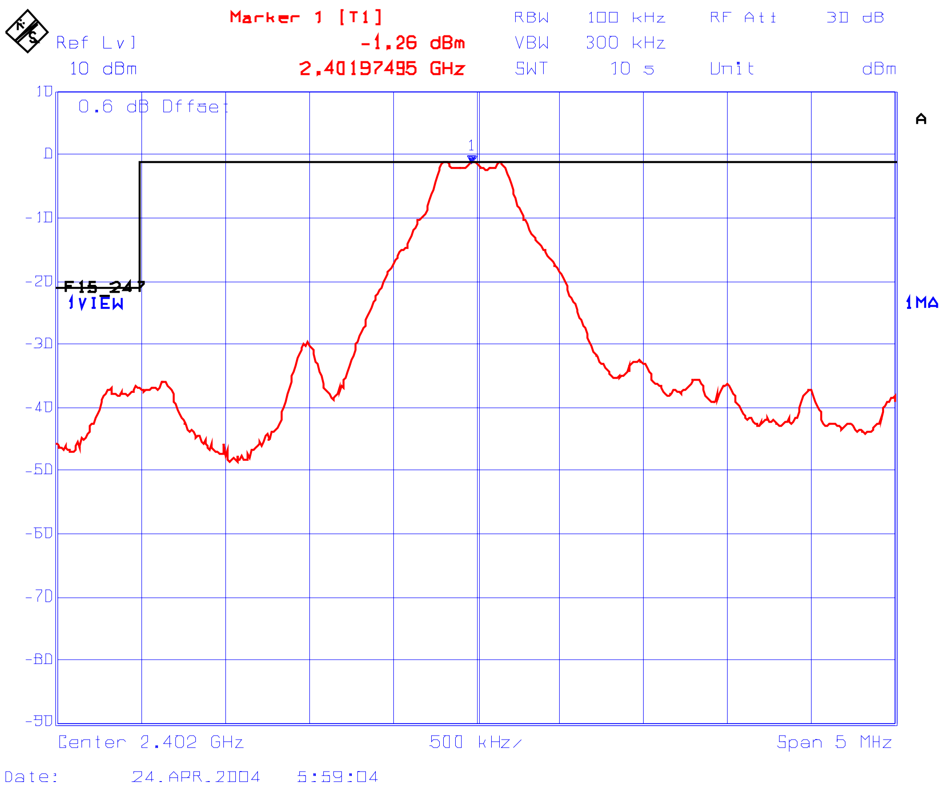
- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.
- Refer Plots 10 and 11 for details of measurements

6.11.5.4. Tx Conducted Emissions at Highest Frequency (2480 MHz)

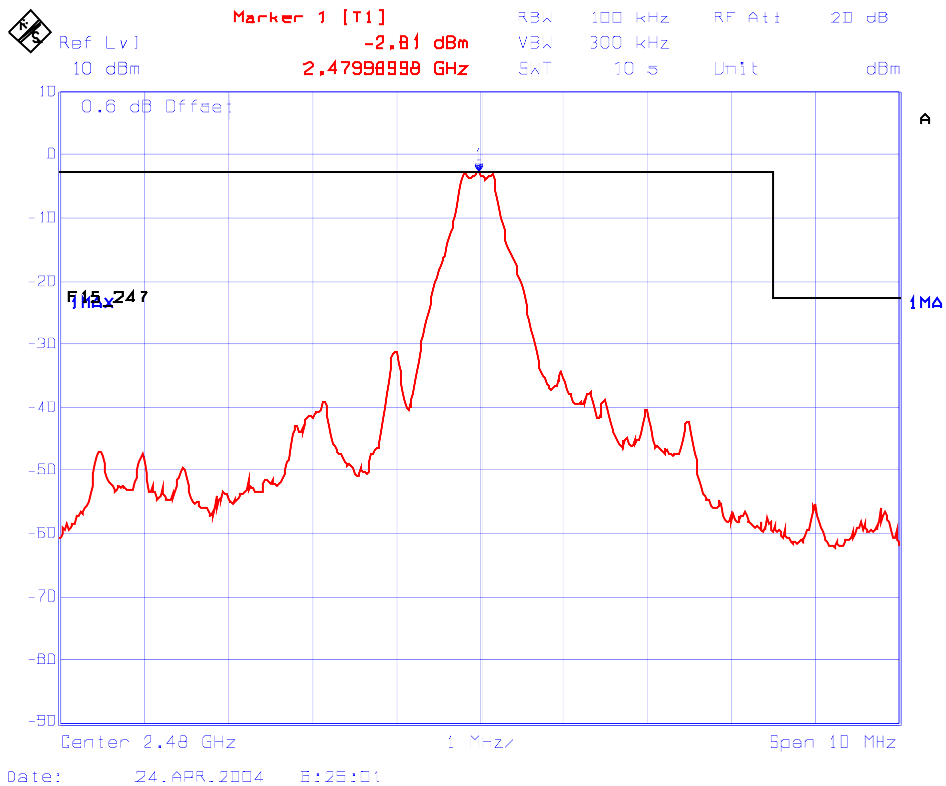
FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2480.0	- 3.5	Peak	----	----	----
4934.3	- 42.5	Peak	-23.5	-19.0	PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.
- Refer Plots 12 and 13 for details of measurements

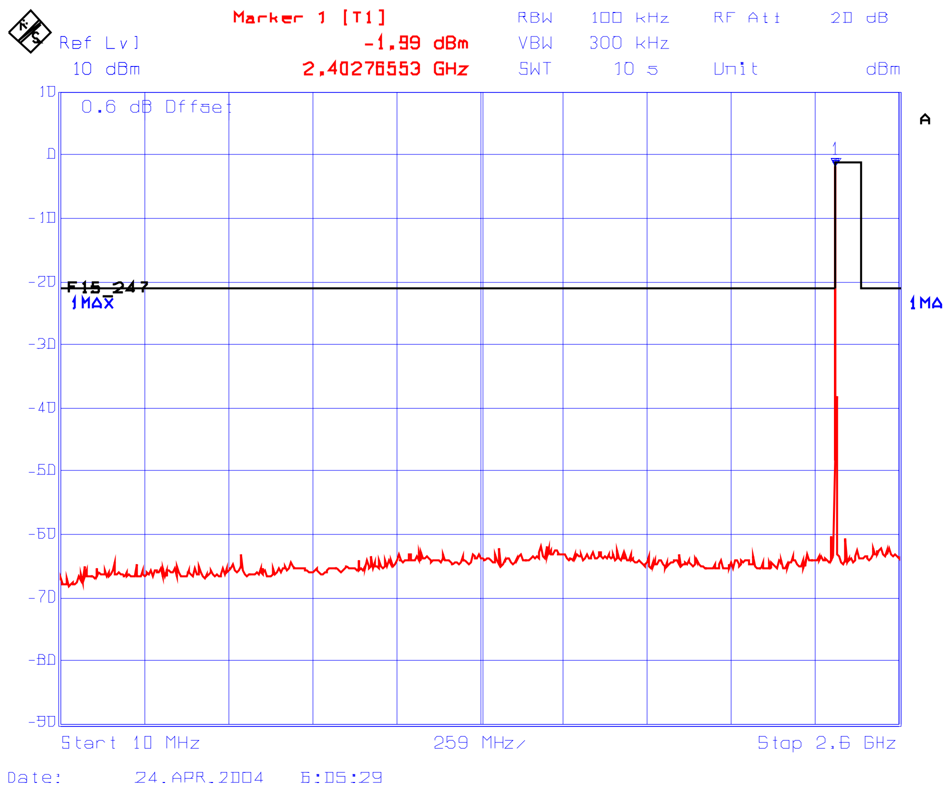
Plot # 6: Lower Band-Edge RF Conducted Emissions, Fc = 2402 MHz



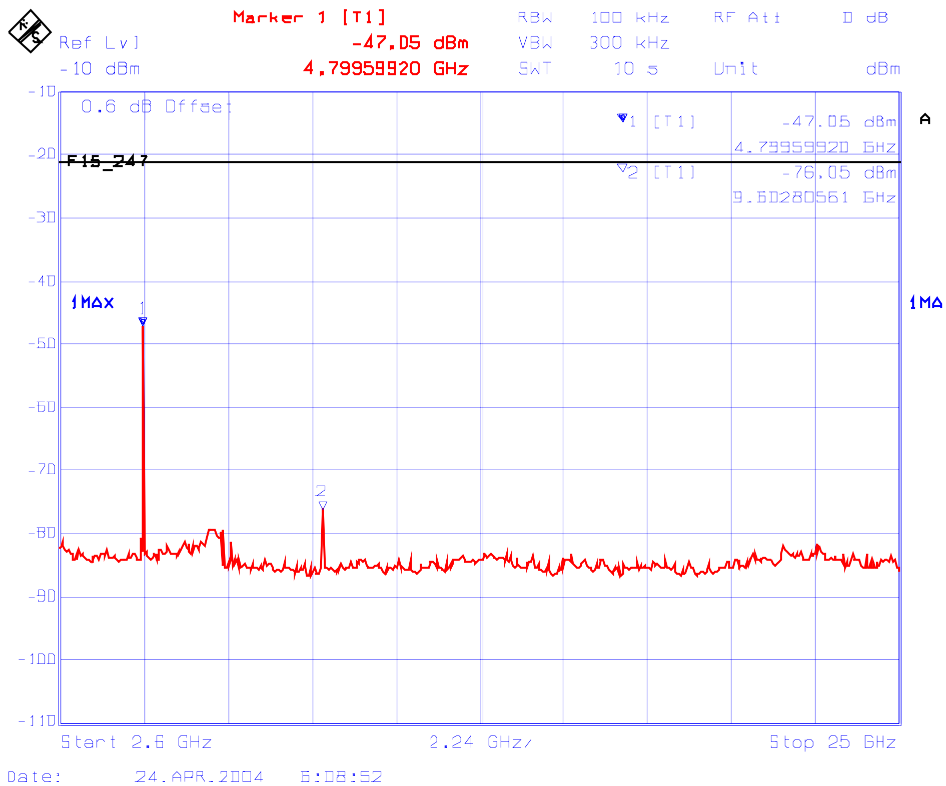
Plot # 7: Upper Band-Edge RF Conducted Emissions, Fc = 2480 MHz



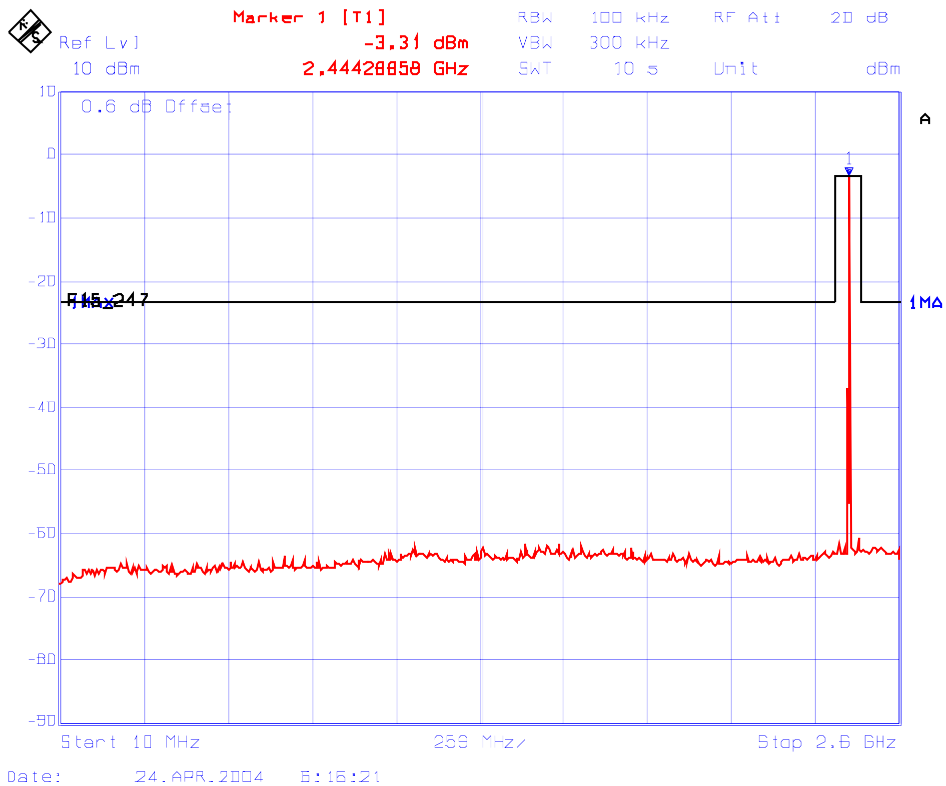
Plot # 8: Spurious RF Conducted Emissions @ Freq. 2402 MHz



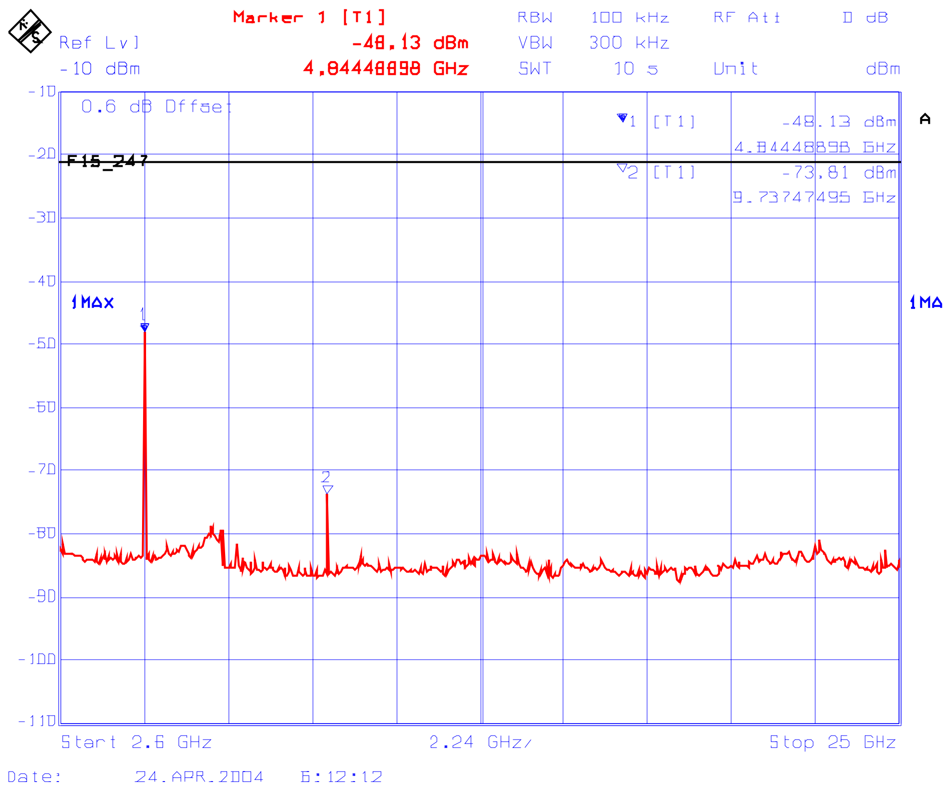
Plot # 9: Spurious RF Conducted Emissions @ Freq. 2402 MHz



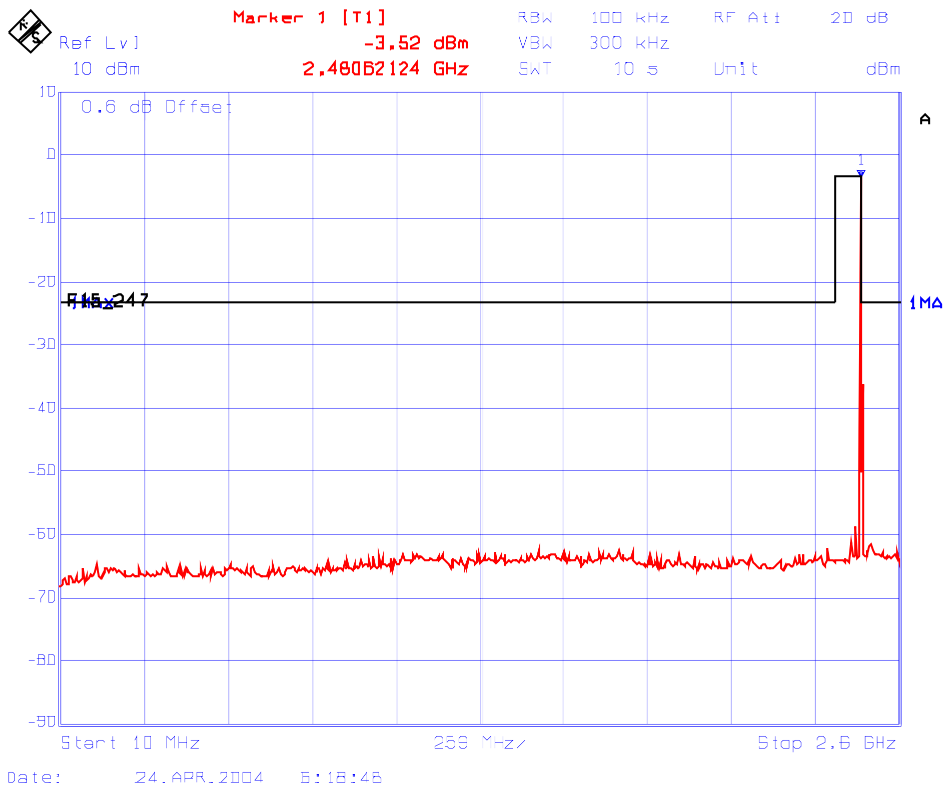
Plot # 10: Spurious RF Conducted Emissions @ Freq. 2441 MHz



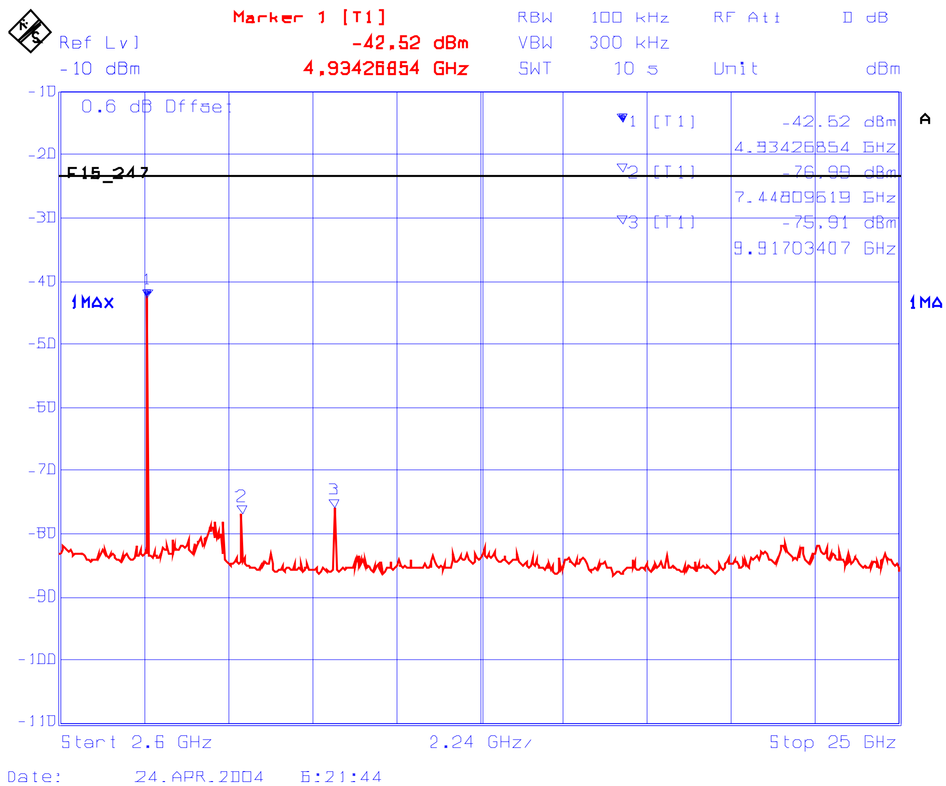
Plot # 11: Spurious RF Conducted Emissions @ Freq. 2441 MHz



Plot # 12: Spurious RF Conducted Emissions @ Freq. 2480 MHz



Plot # 13: Spurious RF Conducted Emissions @ Freq. 2480 MHz



6.12. TRANSMITTED POWER SPECTRAL DENSITY OF A (BLUETOOTH) SYSTEM IN THE ACQUISITION MODE, FCC CFR 47, PARA. 15.247(F) / 15.247(D)

6.12.1. Limits

For a Hybrid spread spectrum (Bluetooth) System in the acquisition mode, with the frequency hopping turned off, shall comply with the power density of FCC 15.247(d) - the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz bandwidth during any time interval of continuous transmission.

6.12.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.5 of this test report for detailed measurement procedures

6.12.3. Test Arrangement

6.12.4. Test Equipment List

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

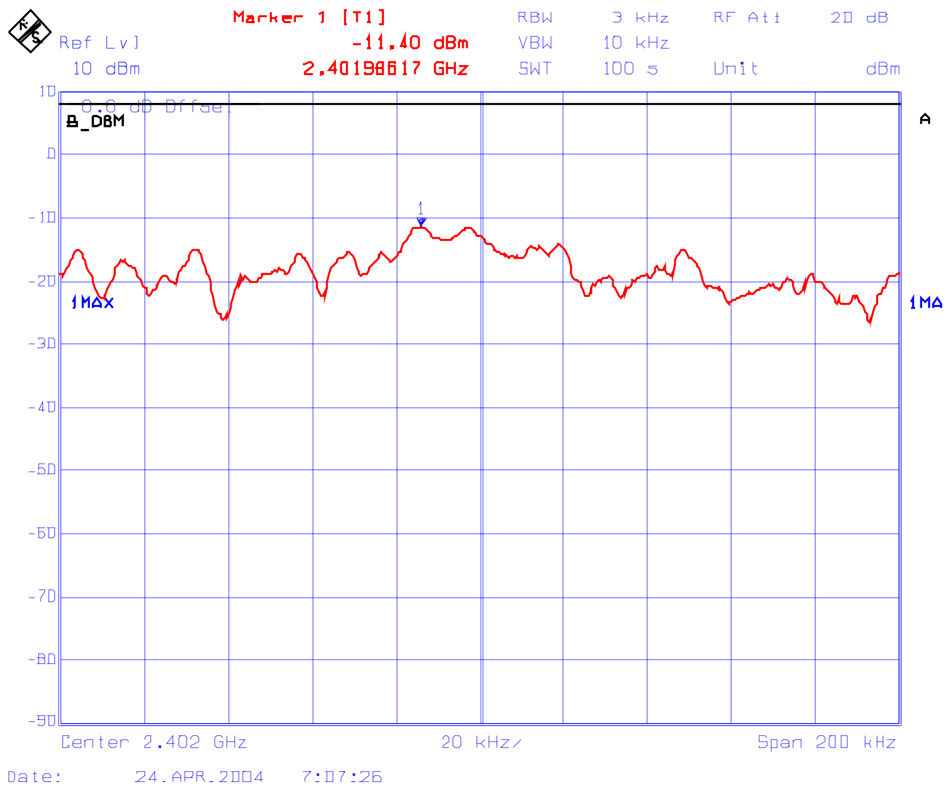
6.12.5. Test Data

Remark: The following power density was performed with the frequency hopping turned off.

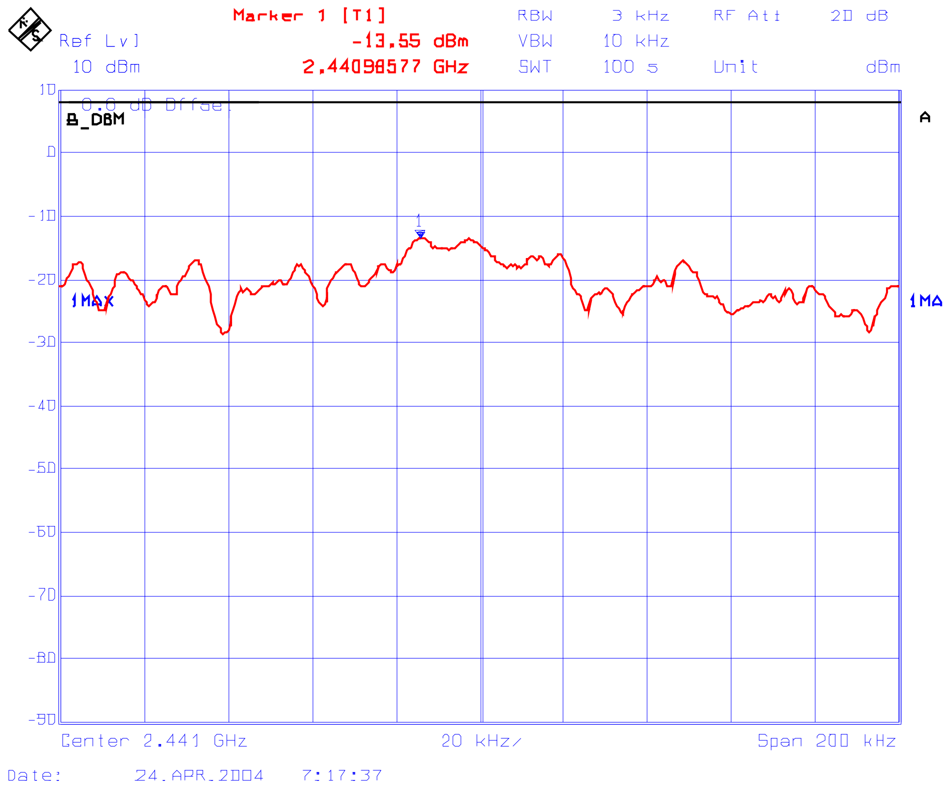
CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN 3 KHz BW (dBm)	LIMIT (dBm)	MARGIN (dB)	COMMENTS (PASS/FAIL)
2402	-11.4	8.0	-19.4	PASS
2441	-13.5	8.0	-21.5	PASS
2480	-13.3	8.0	-21.3	PASS

* Please refer to Plots # 14 to 16 for details of measurements.

Plot # 14: Power Spectral Density @ 2402 MHz

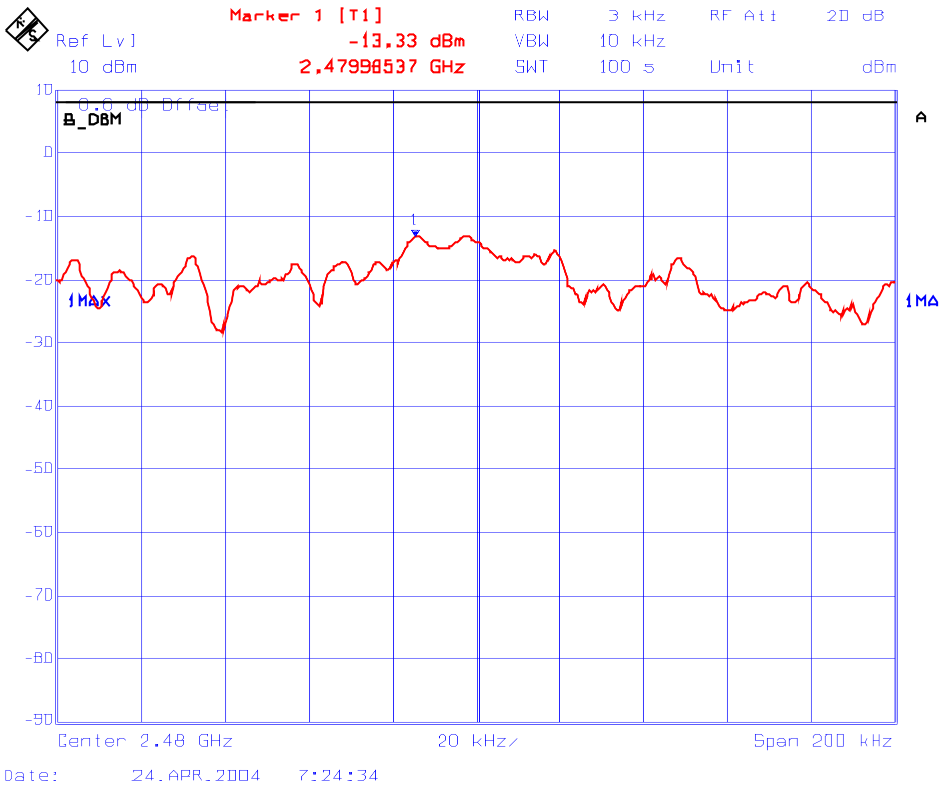


Plot # 15: Power Spectral Density @ 2441 MHz



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

Plot # 16: Power Spectral Density @ 2480 MHz



6.13. BAND-EDGE & SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205

6.13.1. 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 @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 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.
- **@ FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

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

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 – 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 – 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 – 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 – 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 – 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 – 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 – 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	DISTANCE (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

6.13.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.4 of this test report and **ANSI 63.4, Para. 8** for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

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

6.13.3. Test Arrangement

Please refer to Test Arrangement in Sec. 5.5.3 for details of test setup for emission measurements.

6.13.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Highpass Filter	Michael Lab	XD40N	--	Cut-off at 4 GHz used for 2.4-2.4835 GHz

6.13.5. Photographs of Test Setup

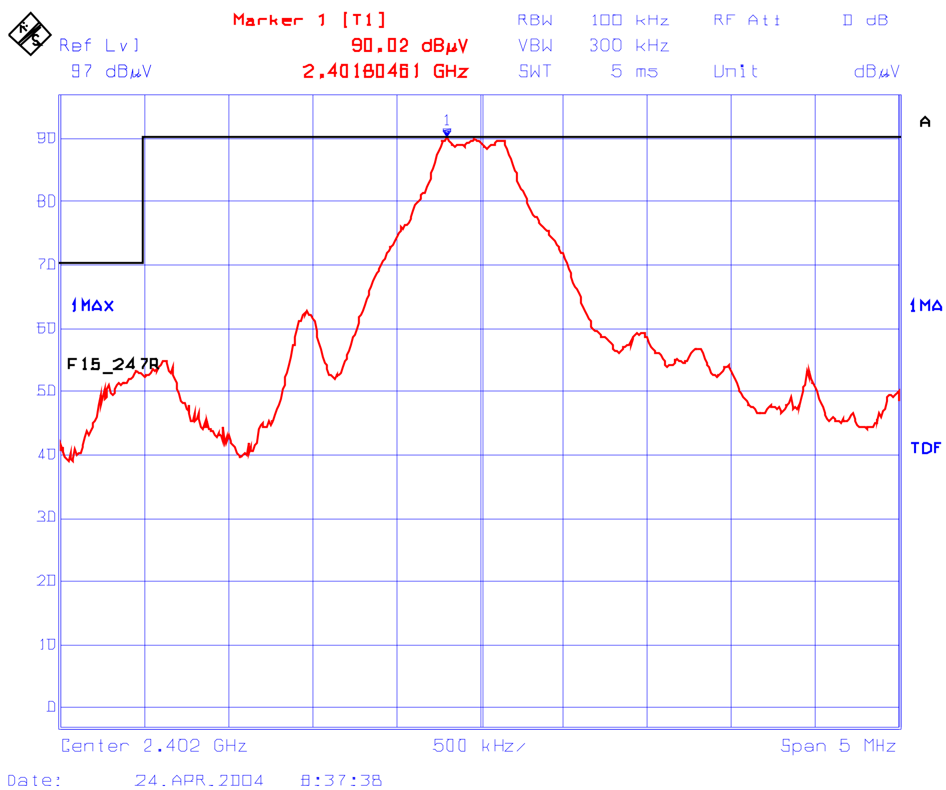
Refer to the Photographs # 3 to 7 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

6.13.6. Test Data

6.13.6.1. Radiated Emissions at the band-edges of the FCC Permitted Band

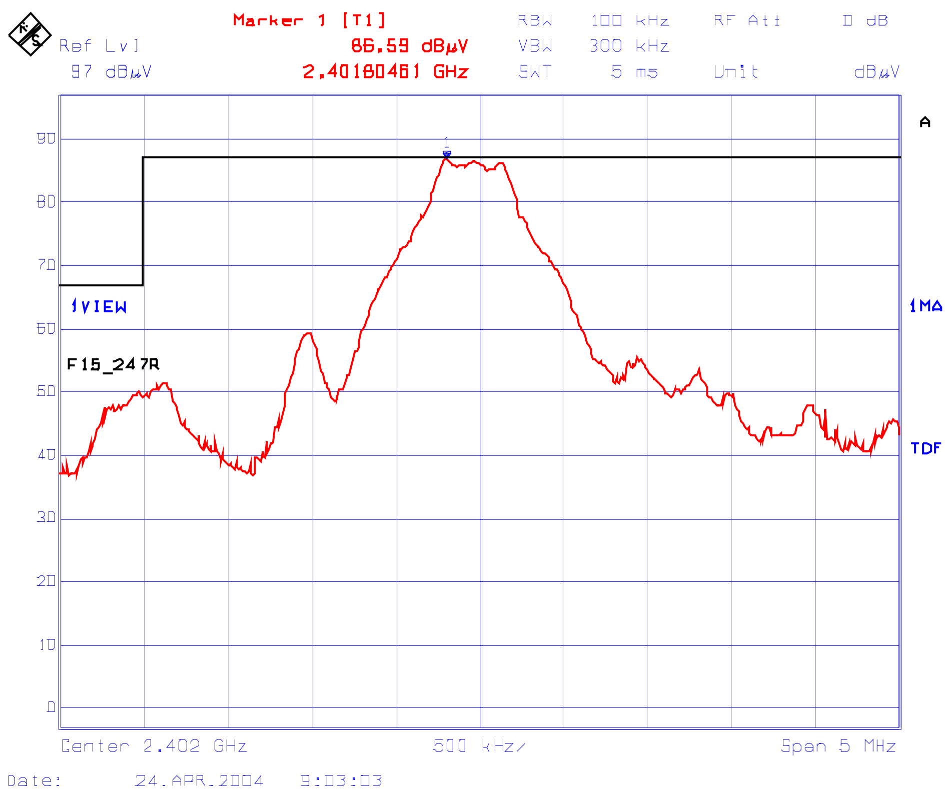
Please refer to Plots # 17 and 20 for Details of Band-edge Emissions at lowest and highest channel frequencies.

Plot # 17: Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization

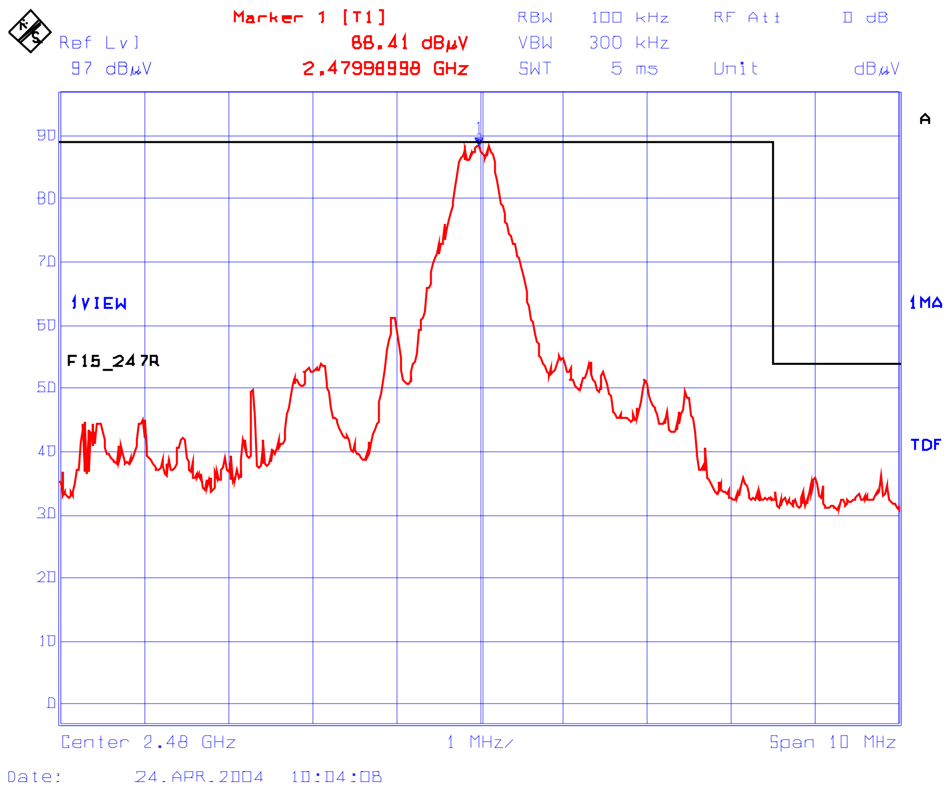


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 18: Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization

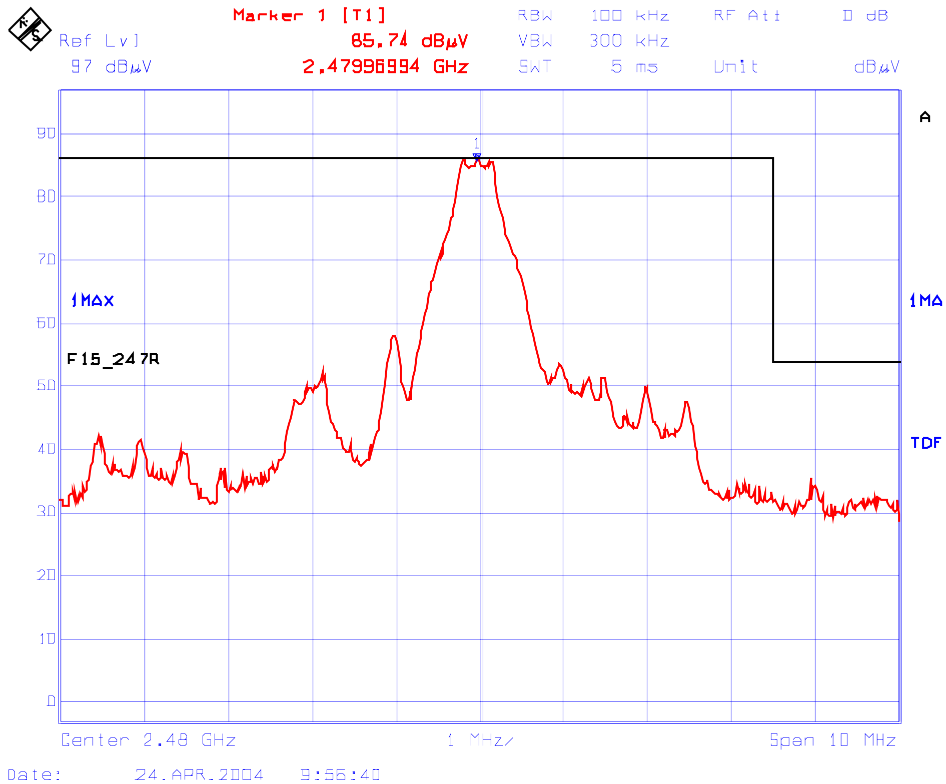


Plot # 19: Upper Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization



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

Plot # 20: Upper Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization



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

6.13.6.2. Transmitter Radiated Emissions @ Lowest Frequency (2042 MHz)

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2402.0	87.0	---	V	54.0	--	--	PASS
2402.0	89.6	---	H	54.0	--	--	PASS
4804.4	61.5	42.2	V	54.0	67.0	- 11.8	*PASS
4804.0	58.7	40.7	H	54.0	69.6	- 13.3	*PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded.
- * Frequency that falls in the FCC Restricted Band @ FCC 15.205

6.13.6.3. Transmitter Radiated Emissions @ Middle Frequency (2441 MHz)

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2441.0	86.5	---	V	54.0	--	--	PASS
2441.0	92.2	---	H	54.0	--	--	PASS
4882.0	64.6	43.5	V	54.0	67.0	- 10.5	*PASS
4882.0	57.0	40.5	H	54.0	69.6	- 13.5	*PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded.
- * Frequency that falls in the FCC Restricted Band @ FCC 15.205

6.13.6.4. Transmitter Radiated Emissions @ Highest Frequency (2480 MHz)

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2480.0	86.0	---	V	54.0	--	--	PASS
2480.0	89.2	---	H	54.0	--	--	PASS
4960.4	64.9	44.1	V	54.0	67.0	- 9.9	*PASS
4960.0	58.3	41.3	H	54.0	69.6	- 12.7	*PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded.
- * Frequency that falls in the FCC Restricted Band @ FCC 15.205

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 $20Log(1\pm\Gamma_1\Gamma_R)$	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:

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

$U = 2u_c(y) = \pm 2.6$ 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 Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits $20Log(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

EXHIBIT 8. MEASUREMENT METHODS

8.1. GENERAL TEST CONDITIONS

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

8.1.1. Normal temperature and humidity

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

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

8.1.2. Normal power source

8.1.2.1. Mains Voltage

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

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

8.1.2.2. Battery Power Source.

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

8.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at the following frequencies:
  - The lowest operating frequency,
  - The middle operating frequency and
  - The highest operating frequency

- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers

8.2. METHOD OF MEASUREMENTS - AC MAINS CONDUCTED EMISSIONS

- AC Mains conducted emissions measurements were performed in accordance with the standard against appropriate limits for each detector function.
- The test was performed in the shielded room, 16'(L) by 16'(W) by 12'(H).
- The test was performed were made over the frequency range from 450 kHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, AC Mains conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlet. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (9 KHz RBW, VBW > RBW), frequency span 450 kHz to 30 MHz.

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

  Step1. Monitor the frequency range of interest at a fixed EUT azimuth.

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

  Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.

  Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.

- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW > RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and AVERAGE detector mode (10 kHz RBW, 1 Hz VBW). The final highest RF signal levels and frequencies were record.

- ***Broad-band ac Powerline conducted emissions***:- If the EUT exhibits ac Powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

8.3. PEAK CONDUCTED POWER & PEAK EIRP

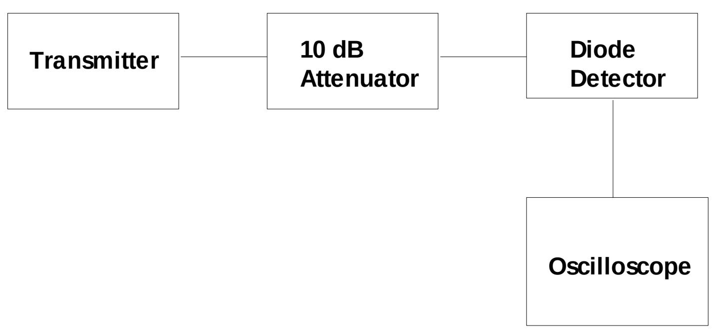
8.3.1. Measurements of Transmitter Parameters (Duty Cycle & Peak Power)

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- I f the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

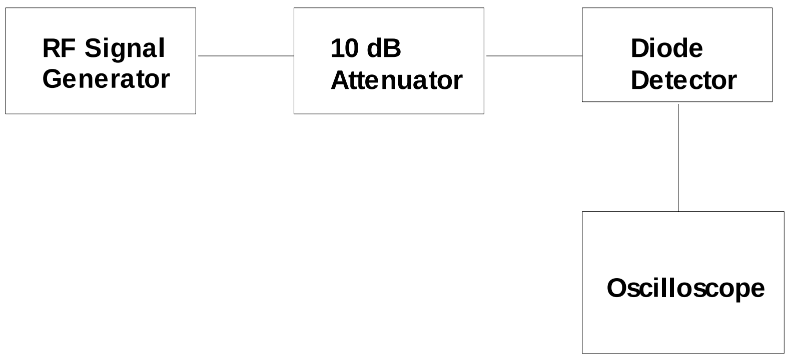
Step 1: Duty Cycle (x) and Peak Power (y) parameters measurements

- Connect the transmitter output to a diode detector through an attenuator
- Connect the diode detector to the vertical channel of an oscilloscope.
- The observed 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.
- Observe and record the y parameter of the DC level on the oscilloscope.



Step 2: Peak Power Measurements

- Replace the transmitter by a RF signal generator
- Set the signal generator frequency be the same as the transmitter frequency
- Adjust the rf output level of the RF signal generator until the DC level on the oscilloscope is same as that (y) recorded in step 1.
- Measure the RF signal generator output level using a power meter
- Calculate the total peak power (Pp) by adding the signal generator level with the attenuator value and the cable loss.



Step 3: Total Peak EIRP Substitution Method. See Figure 2

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

Center Frequency:	equal to the signal source
Resolution BW:	100 kHz for FSS, 1 MHz for DIGITAL MODULATION (BLUETOOTH)
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(b) Connect the transmitter output to the spectrum analyzer and measure the peak power in 1 MHz bandwidth for reference.
(c) Calculate the difference (Kp) between the total peak power and 1 MHz BW peak power. This value will be used to add onto the 1MHz BW peak EIRP to obtain the TOTAL peak EIRP.
(d) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(e) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(f) The horn test antenna was used and tuned to the transmitter carrier frequency.
(g) 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.
(h) The transmitter was rotated through 360^o 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 substitution horn antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution horn antenna was placed in vertical polarization. The test horn antenna was lowered or raised as necessary to ensure that the maximum signal is stilled received.
(k) 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.

(l) The substitution antenna gain and cable loss were added to the signal generator level for the corrected 1MHz BW peak EIRP level. The total peak EIRP can be calculated by adding its value with the Kp

(m) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization. Measured in step (c).

(n) Actual gain of the EUT's antenna is the difference of the measured ERP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

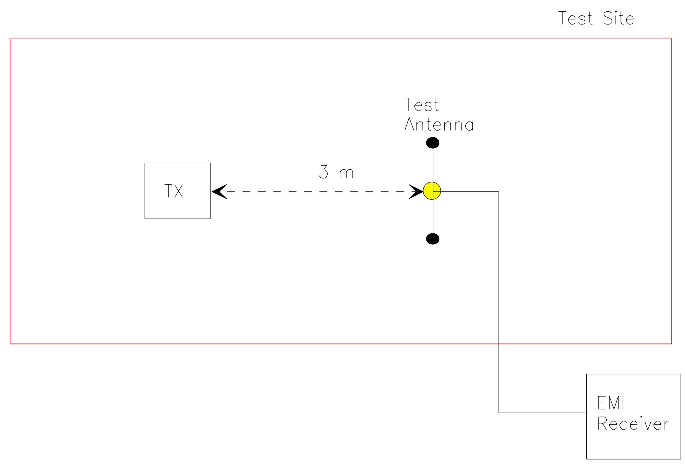
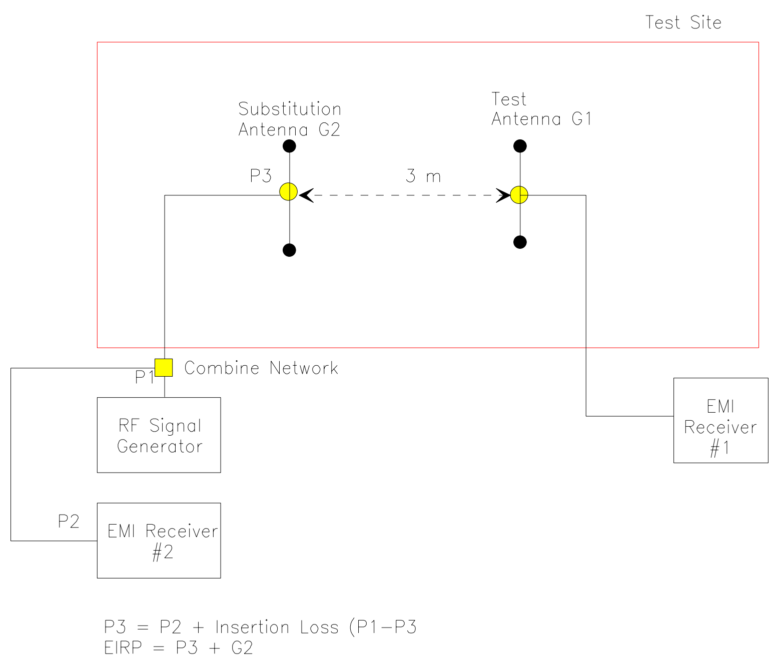


Figure 3



8.4. SPURIOUS EMISSIONS (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
- 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 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc.. A pre-amp and highpass filter are required for this test, in order to provide the measuring system with sufficient sensitivity.
   - Allow the trace to stabilize.
   - The peak reading of the emission, after being corrected by the antenna correction factor, cable loss, pre-amp gain, etc…. is the peak field strength which comply with the limit specified in Section 15.35(b)

Calculation of Field Strength:

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

$$FS = RA + AF + CF - AG$$

Where			
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 of the each channel 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 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

8.5.2. Spurious RF conducted emissions

The demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247©, 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©. 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

8.6. TRANSMITTED POWER DENSITY OF A DIGITAL MODULATION (BLUETOOTH) SYSTEM

- The radio was connected to the measuring equipment via a suitable attenuator.
- Locate and zoom in on emission peak(s) within the passband
- The spectrum analyzer were used and set as follows:

  - Resolution BW: 3 kHz
  - Video BW: same or greater
  - Detector Mode: Normal
  - Averaging: Off
  - Span: 3 MHz
  - Amplitude: Adjust for middle of the instrument's range
  - Sweep Time: 1000 seconds

- Locate and zoom in on emission peak(s) within the passband. Set RBW = 3 KHz, VBW $\geq$ RBW, Sweep = SPAN/3 KHz. For example, a span of 1.5 MHz, the sweep should be $1.6x10^6/3.0x10^3$= 500 seconds. The measured peak level must be no greater than +8 dBm.
- For devices with spectrum line spacing greater than 3 KHz no change is required.
- For devices with spectrum line spacing equal to or less than 3 KHz, the resolution bandwidth must be reduced below 3 KHz until the individual lines in the spectrum are resolved. The measurement data must then be normalized to 3 KHz by summing the power of all the individual spectral lines within 3 KHz band (in linear power units) to determine compliance.
- If the spectrum line spacing cannot be resolved on the available spectrum analyzer, the noise density function on most modern conventional spectrum analyzer will directly measure the noise power density normalized to 1 Hz noise power bandwidth. Add 30 dB for correction to 3 KHz.
- Should all the above fail or any controversy develop regarding accuracy of measurement, the Laboratory will use HP 89440A Vector Signal Analyzer for final measurement unless a clear showing can be made for a further alternate.