ENGINEERING TEST REPORT

BTcam Camera System
Model No.: BT-001

FCC ID: RHJBT001

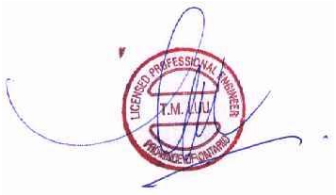
Applicant:

1417188 Ontario Limited
18 Basaltic Road
Vaughan, Ontario
Canada, L4K 1G6

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Frequency Hopping and Digitally Modulated Device
Operating in the Frequency Band 2402-2480 MHz

UltraTech's File No.: PAT-005F15C247

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: September 22, 2003	
Report Prepared by: Dan Huynh Issued Date: September 22, 2003	Tested by: Hung Trinh, EMI/RFI Technician Test Dates: June 19 - 27, 2003

- *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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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	• AC Power Line Conducted Emissions • Radiated Emissions Setup Photos	OK
2	External EUT Photos	External EUT Photos	OK
3	Internal EUT Photos	Internal EUT Photos	OK
4	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
5	Attestation Statements	--	--
6	ID Label/Location Info	• ID Label • Location of ID Label	OK
7	Block Diagrams	Block Diagram	OK
8	Schematic Diagrams	Schematics	OK
9	Parts List/Tune Up Info	Parts List	OK
10	Operational Description	Circuit Description	OK
11	RF Exposure Info	See SAR Test Report	OK
12	Users Manual	Owners Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	Part 15, Subpart C, Section 15.247
Title:	Telecommunication -, 47 Code of Federal Regulations (CFR), Part 15
Purpose of Test:	To gain FCC Certification Authorization for Bluetooth Device 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 SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC 47 CFR Parts 0-19	2002	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
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:	1417188 Ontario Ltd.
Address:	18 Basaltic Road Vaughan, Ontario Canada, L4K 1G6
Contact Person:	Mr. James Chan Phone #: 905-660-9066 (230) Fax #: 905-660-9261 Email Address: james@ppi-stech.com

MANUFACTURER	
Name:	1417188 Ontario Ltd.
Address:	18 Basaltic Road Vaughan, Ontario Canada, L4K 1G6
Contact Person:	Mr. James Chan Phone #: 905-660-9066 (230) Fax #: 905-660-9261 Email Address: james@ppi-stech.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:	1417188 Ontario Ltd.
Product Name:	BTcam Camera System
Model Name or Number:	BT-001
Serial Number:	Preproduction
Type of Equipment:	Bluetooth
Input Power Supply Type:	External DC Sources from PC's USB port for Base Unit 3 x 1.5 V Batteries or external 4.5 Vdc
Primary User Functions of EUT:	Provide data communication link through air

Note: The BTcam Camera System uses a Wireless Bluetooth Radio Module, manufactured by Infineon Technologies, which was certified by an FCC TCB under FCC ID: Q23104001 on June 18, 2003. With the power increased to 44.7 mWatts. The increased power of this device requires a new FCC Grant and re-tests need to be performed.

3.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	▪ Portable/Wall-mount base unit ▪ Base station unit
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	3 x 1.5 V Alkaline batteris or 4.5 Vdc
RF Output Power Rating:	44.7 mWatts
Operating Frequency Range:	2402-2480 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	1 MHz
Occupied Bandwidth:	20 dB BW : 800 kHz 6 dB BW : 535 kHz
Modulation Type:	Bluetooth
Emission Designation:	Bluetooth
Antenna Connector Type:	Integral, permanently attached
Antenna Description:	Manufacturer: Murata MFG Co. Ltd. Type: Chip Multilayer Antenna Model: LDA 92 2G78 20D -204 Frequency Range: 2.45 GHz Band In/Out Impedance: 50 Ohms Gain: 0dbi

3.4. LIST OF EUT'S PORTS

Potable/Wall-mount Unit

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	4.5 Vdc input port	1	Jack	Non-shielded

PC Peripheral (Base) Unit

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	USB	1	USB	Non-shielded

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:	Laptop Computer
Brand name:	Toshiba
Model Name or Number:	1605CDS/413
FCC ID:	FCC Class B Compliance
Serial Number:	1027387CN
Connected to EUT's Port:	USB

3.6. GENERAL TEST SETUP

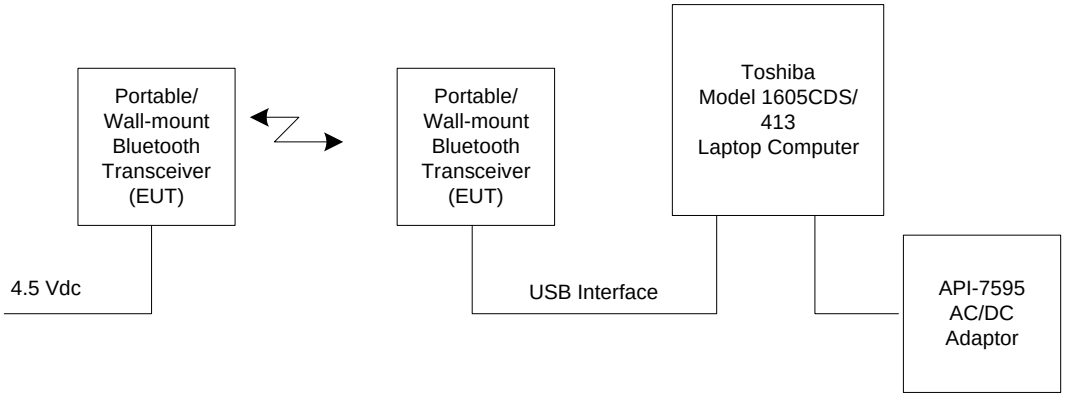


EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

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:	3 x 1.5 V Alkaline batteris or 4.5 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 Frequency Hopping Mode and Direct Sequence mode.
Special Test Software:	Special software is provided by the Applicant to operate the EUT.
Special Hardware Used:	Special test samples are provided by the Applicant to operate the EUT at lowest, middle and highest frequencies, DSSS, FHSS and normal Bluetooth mode.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna equipment.

Transmitter Test Signals:	
Frequency Band(s):	2402-2480 MHz
Test Frequency(ies):	2402, 2441 and 2480 MHz
Transmitter Wanted Output Test Signals: RF Power Output (measured maximum output power): Normal Test Modulation: Modulating Signal Source:	 44.7 mWatts Bluetooth 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, 24'(L) by 16'(W) by 8'(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 Section(s)	Test Requirements	Compliance (Yes/No)
15.107(a) & 207	AC Power Line Conducted Emissions	Yes
15.247(a)(1) & 15.247(a)(1)(iii)	Frequency Hopping Systems	Yes
15.247(b)(1) & (3)	Peak Output Power	Yes
15.247(b)(5), 1.1307, 1.1310, 2.1091/2.1093	RF Exposure Requirements	Yes
15.247(c)	Band-Edge and Spurious RF Conducted Emissions	Yes
15.247(c), 15.209 & 15.205	Band-Edge and Spurious Radiated Emissions	Yes
15.247(d)(f)	Peak Power Spectral Density of a Hybrid System (Bluetooth) in acquisition mode	Yes

Note: The Equipment Under Test complies with FCC Part 15, Subpart B - Class B Unintentional Radiators. The engineering test report is available upon 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 and ANSI C63-4:1992

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. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	Comments
15.31(m)	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 antenna is permanently attached and mounted inside the EUT's enclosure
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	N/A
15.247(a)(1)	Description of how the EUT meets the definition of a frequency hopping spread spectrum, found in Section 2.1. Based on the technical description.	Equipment Under Test is Bluetooth Device
15.247(a)(1)	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, found in Section 2.1	Equipment Under Test is Bluetooth Device
15.247(a)(1)	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).	Equipment Under Test is Bluetooth Device
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	Equipment Under Test is Bluetooth Device

FCC Section	FCC Rules	Comments
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	Equipment Under Test is Bluetooth Device
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.	Equipment Under Test is Bluetooth Device
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	Equipment Under Test is Bluetooth Device

6.6. AC POWER LINE CONDUCTED EMISSIONS [§§ 15.107 & 15.207]

6.6.1. Limits

The equipment shall meet the limits of the following table:

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

* Decreasing linearly with logarithm of frequency

6.6.2. Method of Measurements

Refer to Exhibit 8, Sec. 8.2 of this test report & ANSI C63-4:1992

6.6.3. 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
24'x16'x8' RF Shielded Chamber	RF Shielding	…	..	…

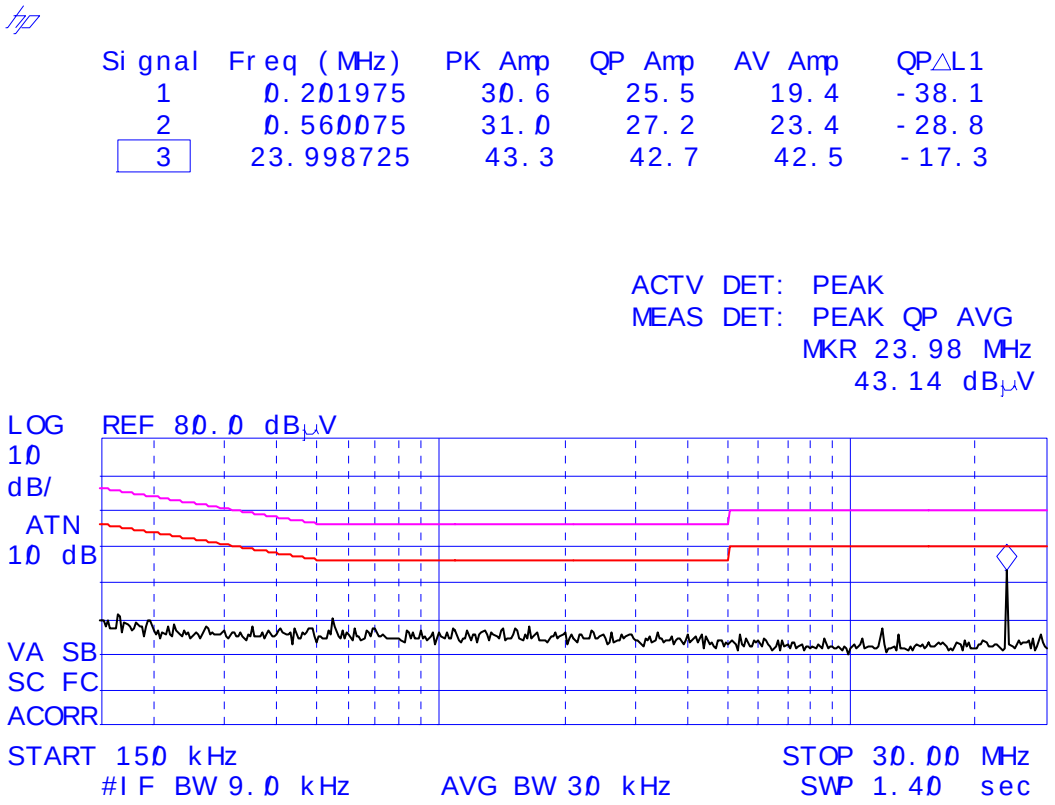
6.6.4. Test Data

6.6.4.1. AC Power Line Conducted Emissions on a Portable/Wall-mount Unit

Frequency (MHz)	RF Level (dBuV)	Receiver Detector (P/QP/AVG)	QP Limit (dBµV)	AVG Limit (dBµV)	Margin (dB)	Pass/ Fail	Line Tested (L1/L2)
24.00	42.7	QP	60.0	50.0	-17.3	Pass	L1
24.00	42.5	AVG	60.0	50.0	-7.5	Pass	L1
24.00	42.0	QP	60.0	50.0	-18.0	Pass	L2
24.00	41.9	AVG	60.0	50.0	-8.1	Pass	L2

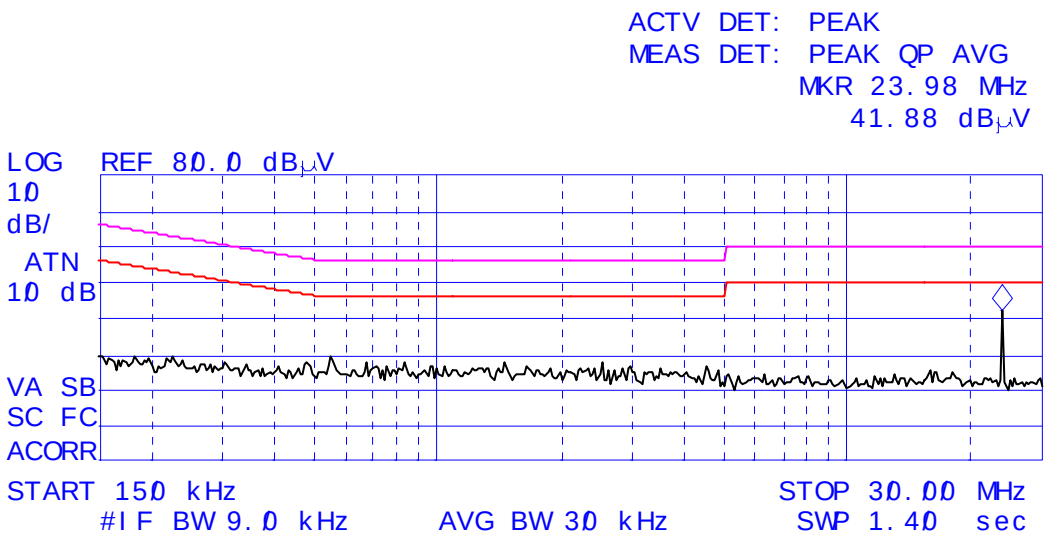
* Refer to Plots # 1 and 2 for detailed measurements

Plot #1: AC Power Line Conducted Emissions
Line Tested: L1



Plot #2: AC Power Line Conducted Emissions
Line Tested: L2

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.216500	31.4	25.7	19.5	-37.3
2	0.558250	31.8	27.9	24.5	-28.1
3	23.999025	42.7	42.0	41.9	-18.0

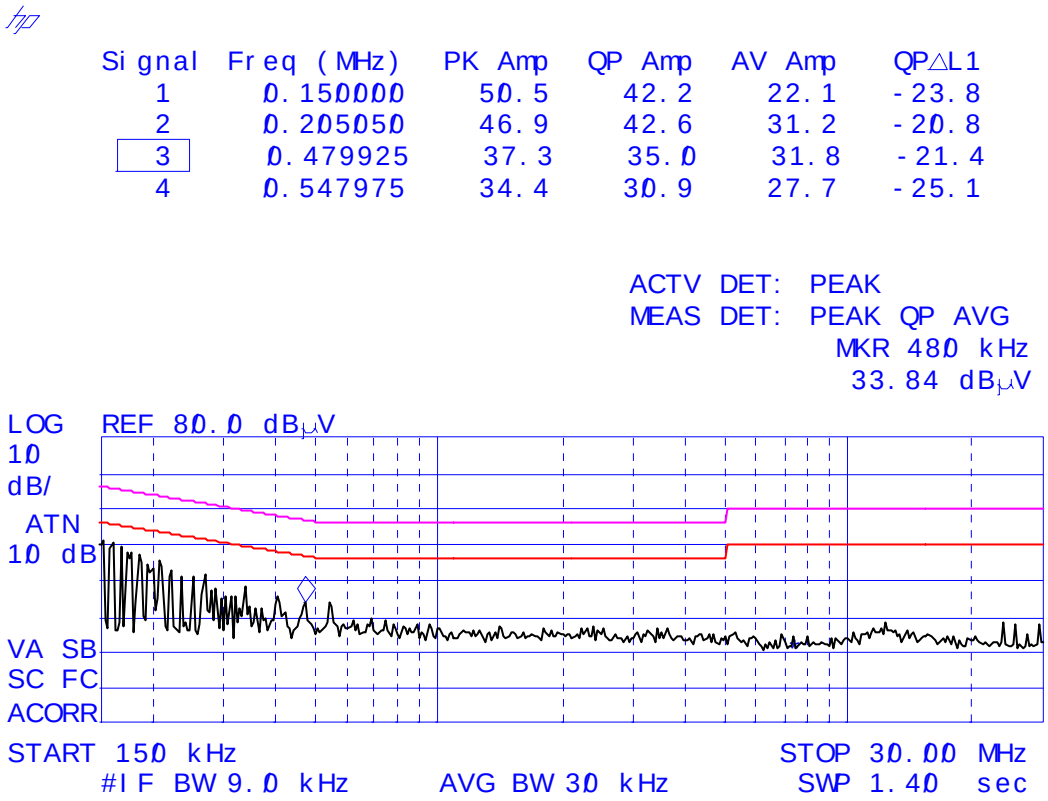


6.6.4.2. AC Power Line Conducted Emissions on a PC Peripheral (Base) Unit

Frequency (MHz)	RF Level (dBuV)	Receiver Detector (P/QP/AVG)	QP Limit (dBµV)	AVG Limit (dBµV)	Margin (dB)	Pass/ Fail	Line Tested (L1/L2)
0.21	42.6	QP	63.2	53.2	-20.6	PASS	L1
0.21	31.2	AVG	63.2	53.2	-22.0	PASS	L1
0.20	42.6	QP	63.6	53.6	-21.0	PASS	L2
0.20	29.4	AVG	63.6	53.6	-24.2	PASS	L2

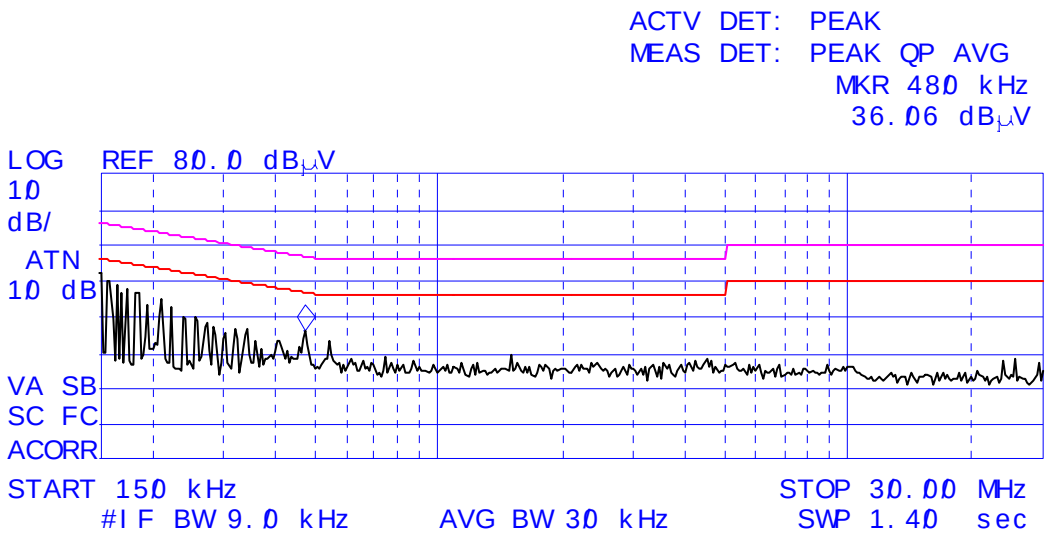
* Refer to Plots # 3 and 4 for detailed measurements

Plot #3: AC Power Line Conducted Emissions
Line Tested: L1



Plot #4: AC Power Line Conducted Emissions
Line Tested: L2

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP△L1
1	0.150750	52.0	44.5	20.7	-21.5
2	0.204675	48.6	42.6	29.4	-20.9
3	0.478500	37.7	34.7	31.4	-21.7
4	0.555975	32.8	28.6	24.7	-27.4



6.7. FREQUENCY HOPPING SYSTEMS [§§ 15.247(a)(1), (a)(1)(iii) & (a)(2)]

6.7.1. Limits

47 CFR 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.

47 CFR 15.247(a)(1)(iii): Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

47 CFR 15.247(a)(2): Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

6.7.2. Method of Measurements

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):

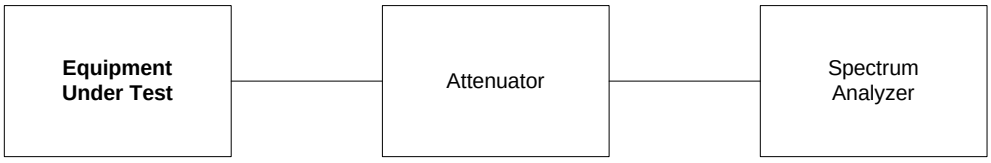
The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:
- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW = RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

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



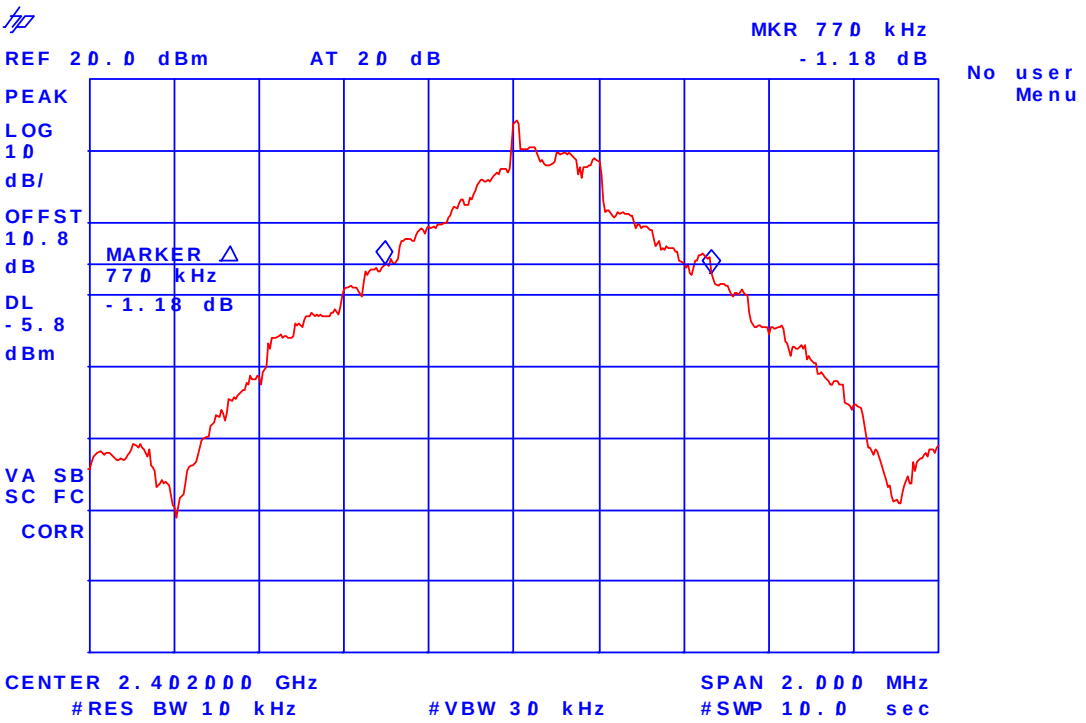
6.7.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No	Frequency Rang
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator	Weinschel Corp	46-10-34	BL2618	DC – 8.5 GHz

6.7.5. Test data

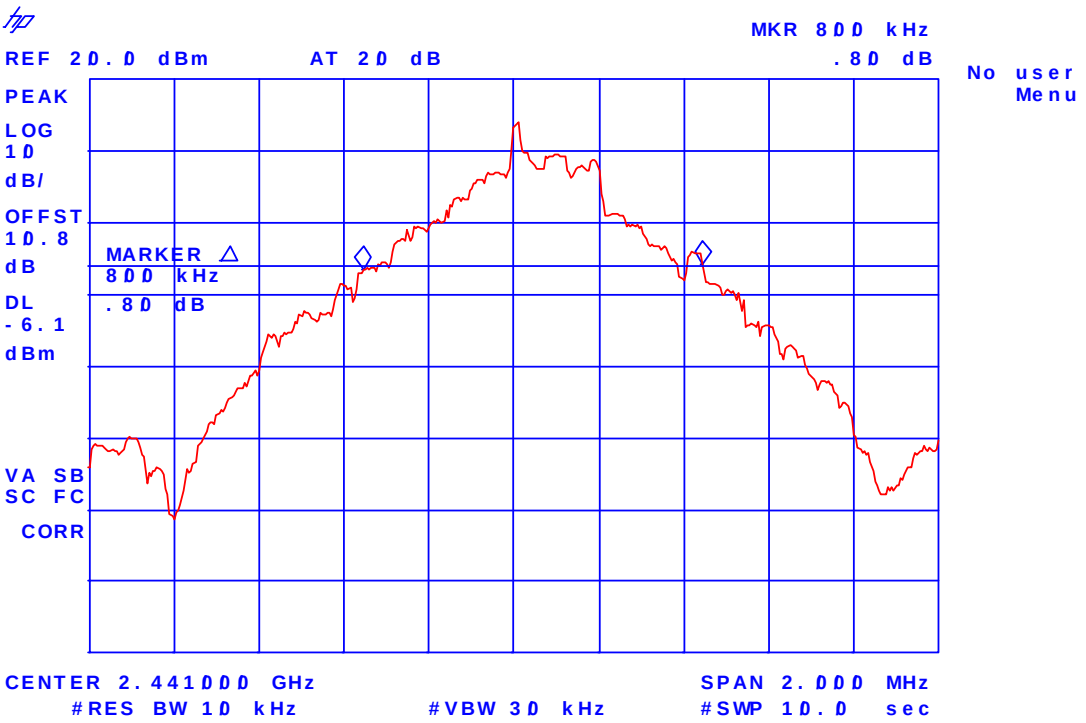
Test Description	FCC Specification	Measured Values	Comments
20 dB BW of the hopping channel	None.	800 kHz	See plots 5 to 7 for measurement details.
6 dB BW	Shall be at least 500 kHz	535 kHz	See plots 8 to 10 for measurement details.
Carrier Frequency Separation	Minimum of 25 kHz or 20dB BW whichever is greater.	1 MHz	See plot 11 for measurement details.
Number of Hopping Frequencies	Shall use at least 15 non-overlapping channels	79 channels starting from 2402 to 2480 MHz separated by 1 MHz channel spacing	Pass, see plot 12 to 15 for measurement details
Time of Occupancy (Dwell Time)	Shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.	48 ms maximum within 30s interval	Pass. Tests were performed by Layers on the Infineon Technologies Bluetooth Radio Module.

Plot #5: 20 dB Bandwidth
Test Frequency: 2042 MHz



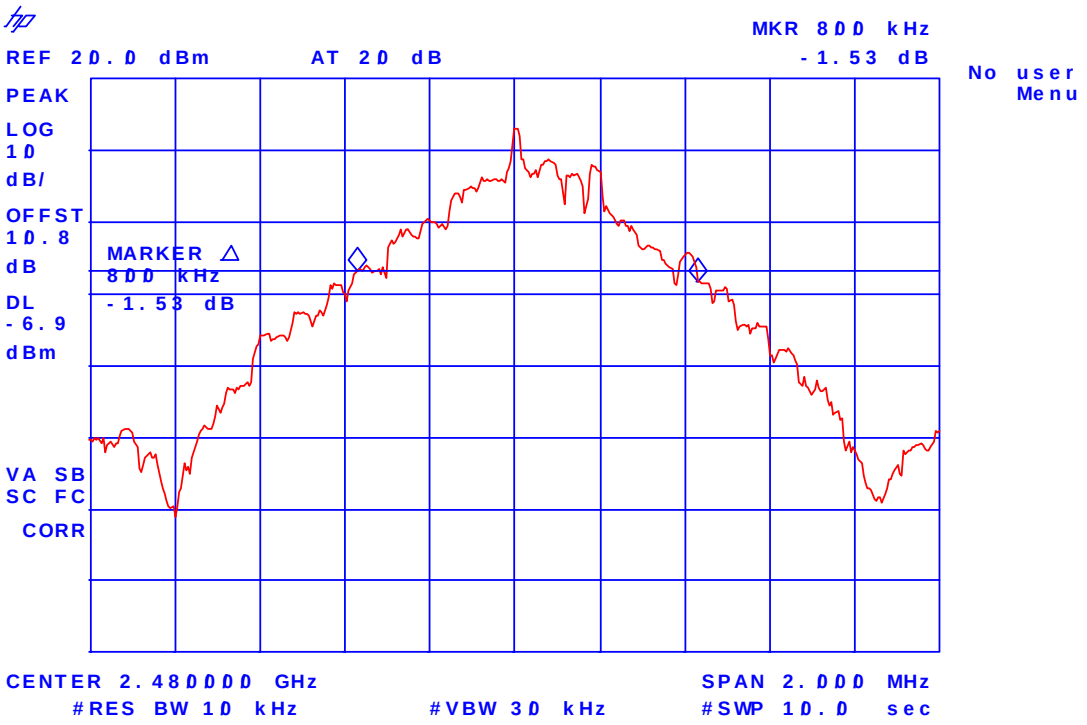
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #6: 20 dB Bandwidth
Test Frequency: 2441 MHz



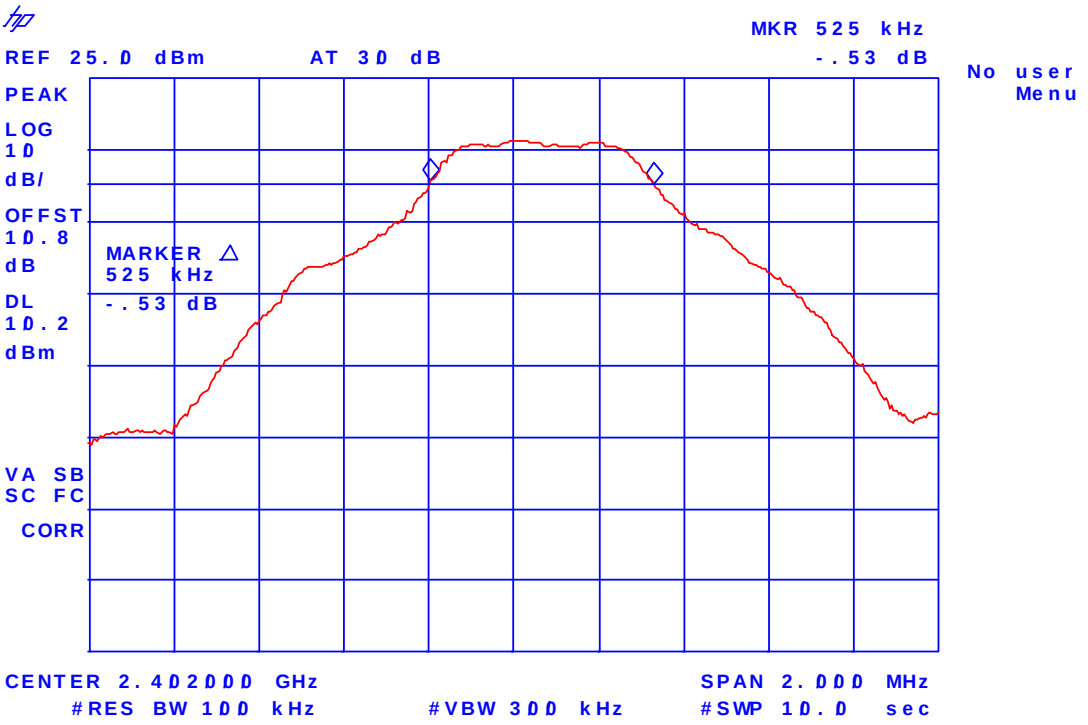
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #7: 20 dB Bandwidth
Test Frequency: 2480 MHz



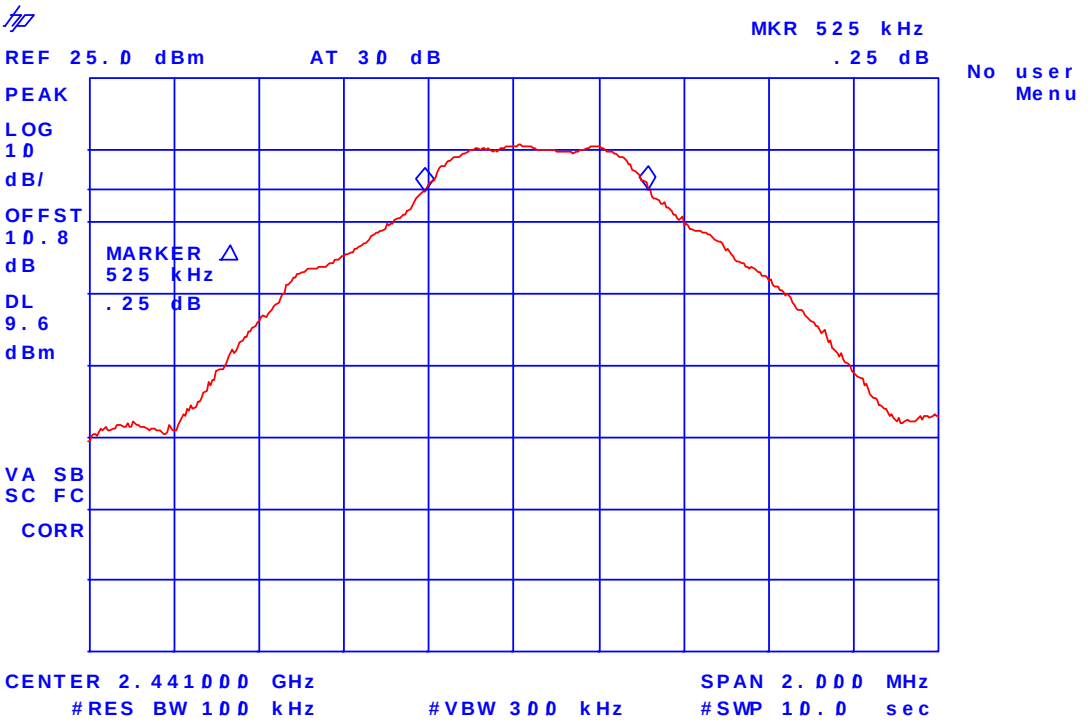
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #8: 6 dB Bandwidth
Test Frequency: 2042 MHz



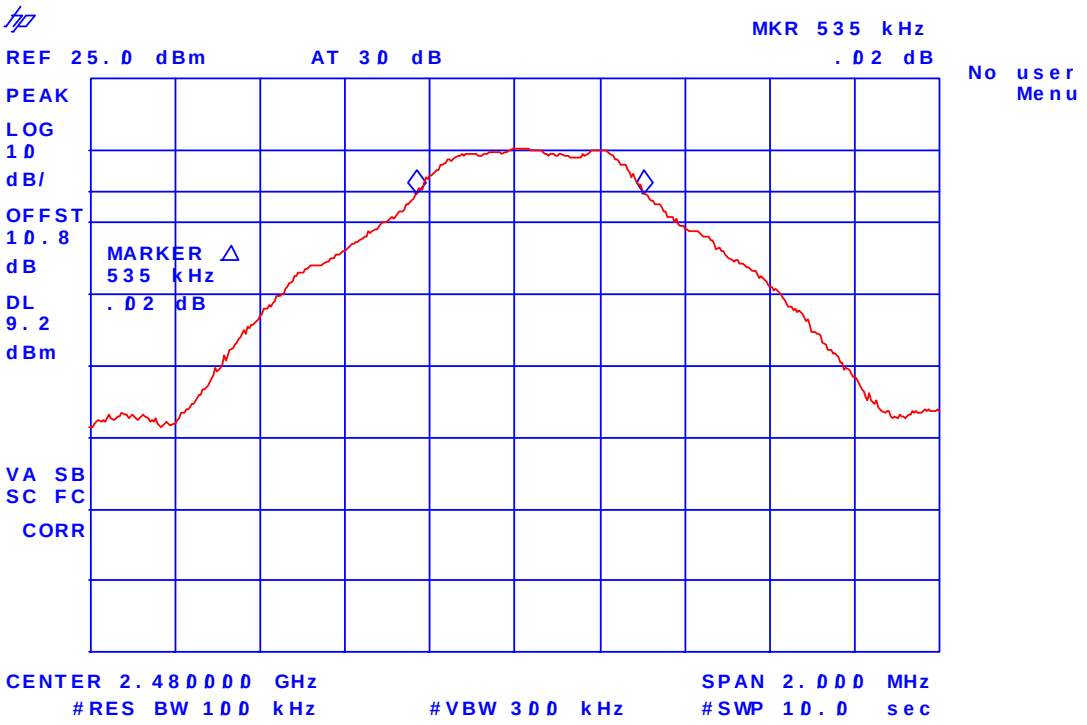
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #9: 6 dB Bandwidth
Test Frequency: 2042 MHz



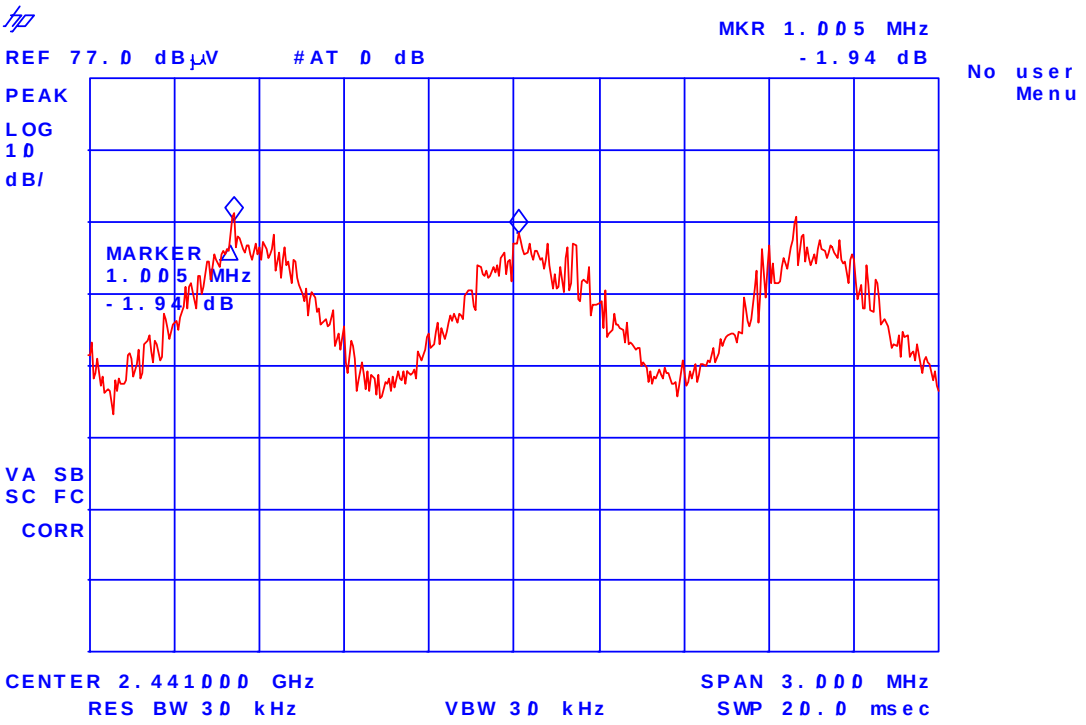
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #10: 6 dB Bandwidth
Test Frequency: 2042 MHz



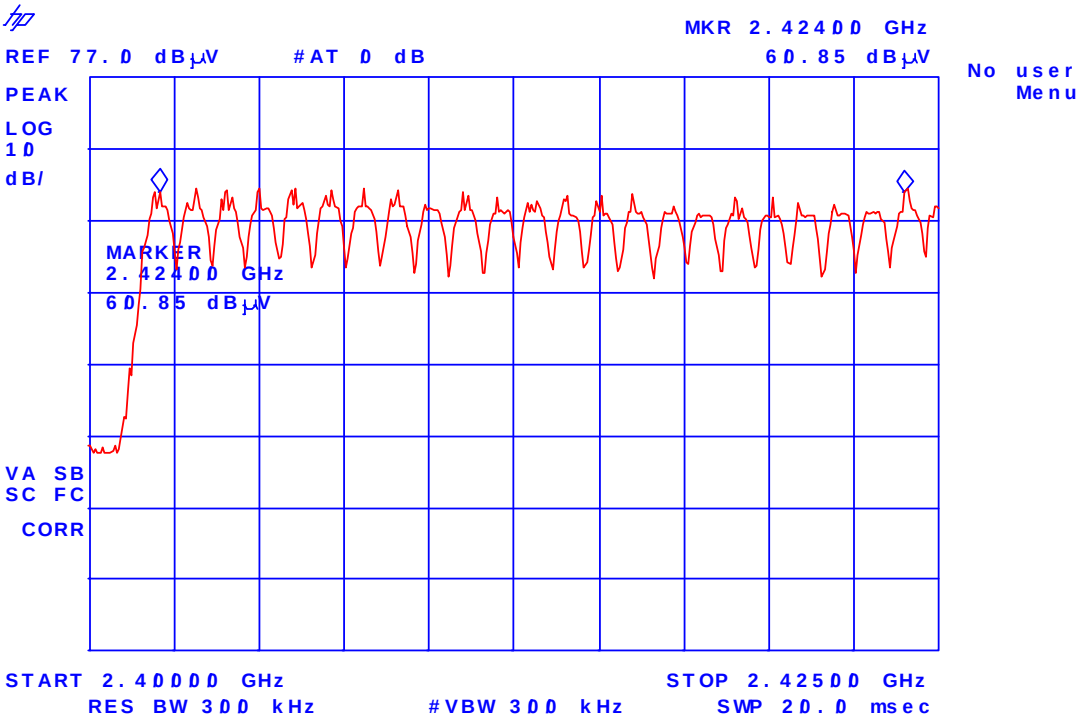
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot # 11: Channel Hopping Frequency Separation



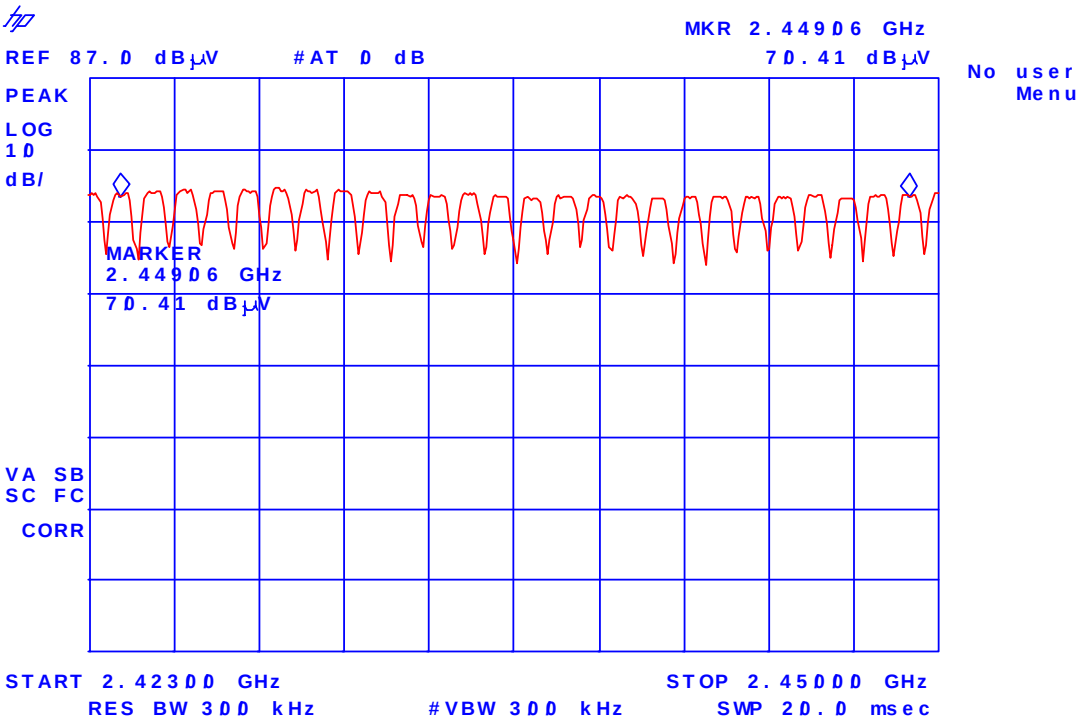
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot # 12: Number of Hopping Frequencies

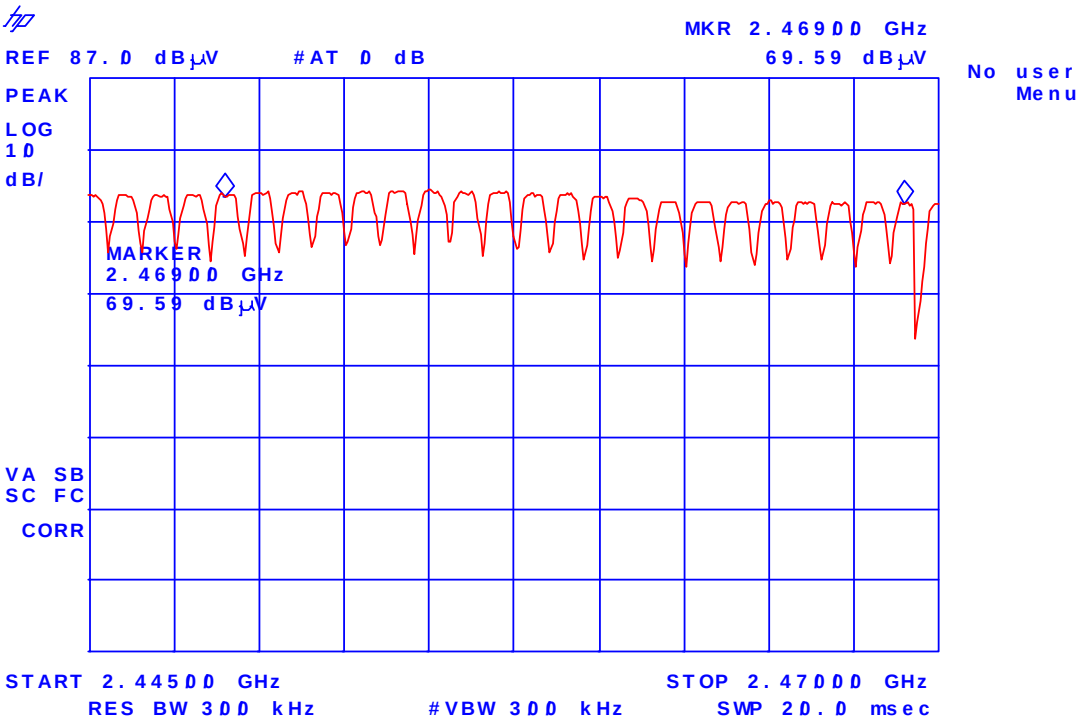


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot # 13: Number of Hopping Frequencies

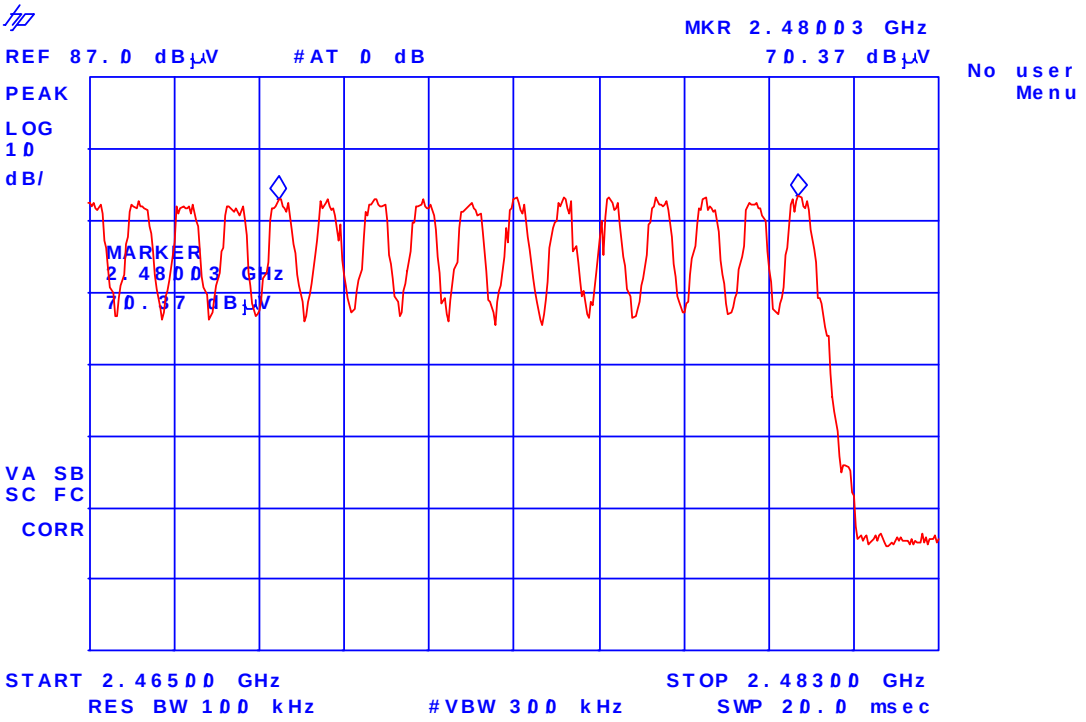


Plot # 14: Number of Hopping Frequencies



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

Plot # 15: Number of Hopping Frequencies



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

4. 5 Dwell Time

Standard FCC Part 15, Subpart C 10-1-98

The test was performed according to: FCC §15.31 10-1-1998

4.5.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the output power measurements.

The reference level of the spectrum analyser was set equal to the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

To determine the dwell time, 3 single measurments are necessary.
The first plot shows the activity for an complete inquiry/paging on one channel.
The second plot shows the repetition rate on one channel, and the third plot showsthe duration of the burst used in inquiry/paging.

With this 3 single values the dwell time of the channel can be calculated.

4.5.2 Test Limits

FCC Part 15, Subpart C, §15.247 (f)

The dwell time of the channel shall be less than 400 ms in a 30 s period

4.5.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1024 hPa
Humidity: 27 %

Op. Mode	Setup	Port	Test Parameter
op-mode 4	21s60b01	temporary antenna connector	

Dwell time ms	Remarks
48	((1,71s+2,55s) / 10ms) * 181,5us

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1024 hPa
Humidity: 27 %

Op. Mode	Setup	Port	Test Parameter
op-mode 5	21s60b01	temporary antenna connector	

Dwell time ms	Remarks
45,36	((1,26s+1,26s) / 10ms) * 180us

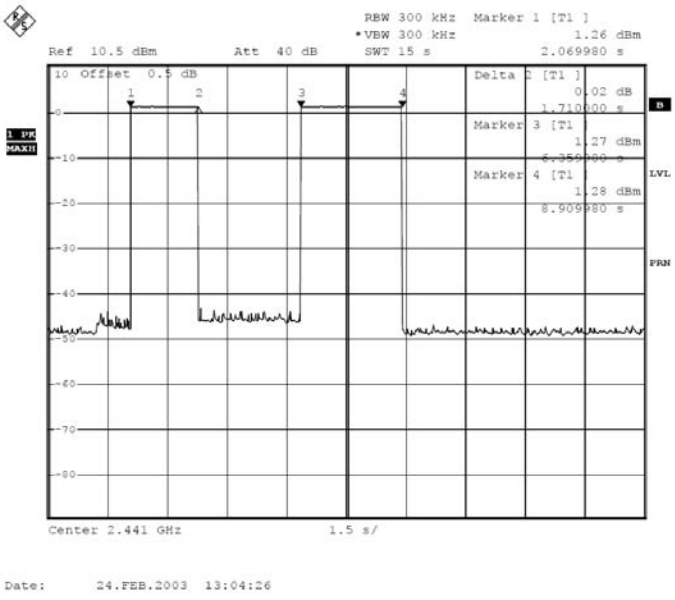
Remark: none

4.5.3 Test result: Dwell Time

FCC Part 15, Subpart C	Op. Mode	Setup	Port	Result
	op-mode 4	21s60b 01	temporary antenna connector	passed
	op-mode 5	21s60b 01	temporary antenna connector	passed

Dwell Time

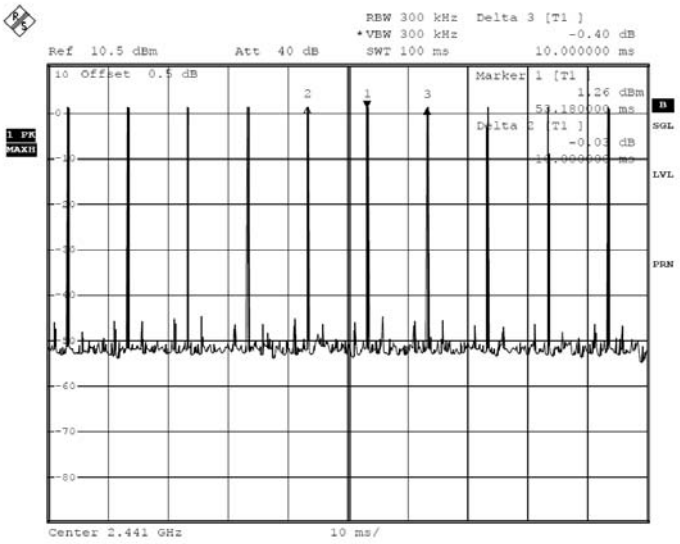
Op. Mode	Setup	Port
op-mode 4 inquiry	21s60b01	temporary antenna connector



15 seconds sweep for a complete inquiry

Dwell Time

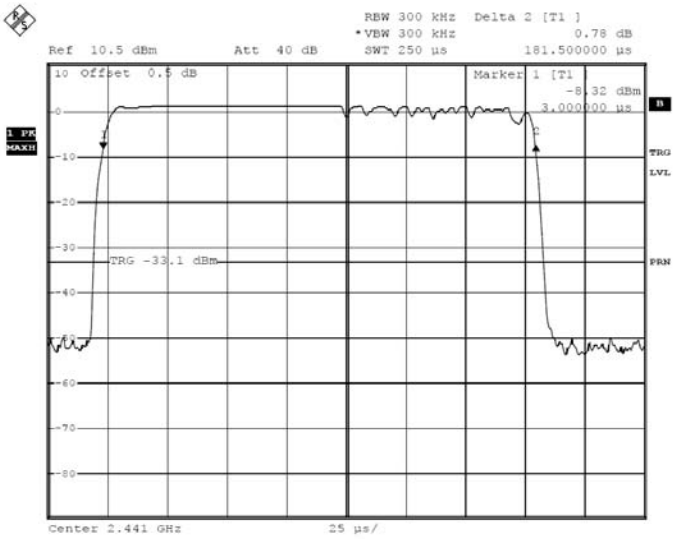
Op. Mode	Setup	Port
op-mode 4 inquiry	21s60b01	temporary antenna connector



100 ms sweep of a channel to determine the repetition frequency

Dwell Time

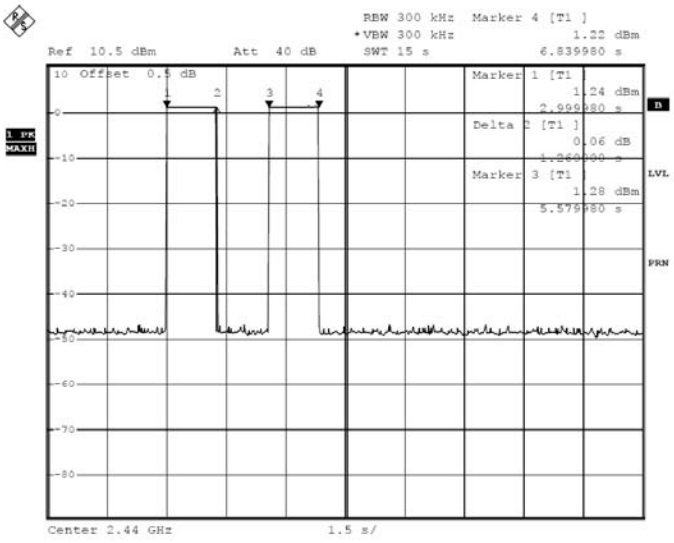
Op. Mode	Setup	Port
op-mode 4 inquiry	21s60b01	temporary antenna connector



250 µs sweep for a complete burst

Dwell Time

Op. Mode	Setup	Port
op-mode 5 paging	21s60b01	temporary antenna connector

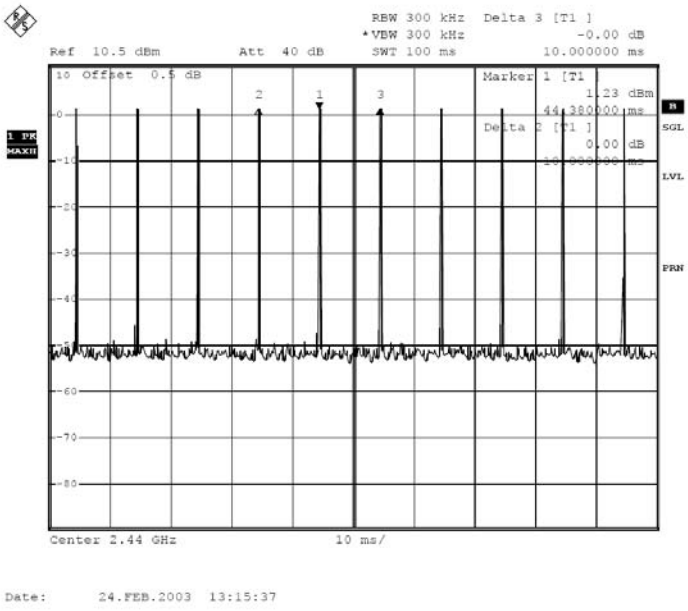


Date: 24.FEB.2003 13:13:41

15 seconds sweep for a complete inquiry

Dwell Time

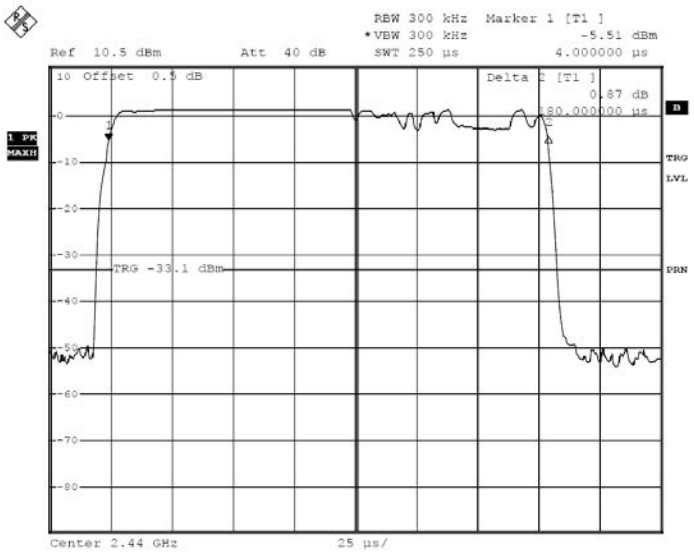
Op. Mode	Setup	Port
op-mode 5 paging	21s60b01	temporary antenna connector



100 ms sweep of a channel to determine the repetition frequency

Dwell Time

Op. Mode	Setup	Port
op-mode 5 paging	21s60b01	temporary antenna connector



250 µs sweep for a complete burst

6.8. PEAK OUTPUT POWER [§ 15.247(b)(1)&(3)]

6.8.1. Limits

The maximum peak output power of the intentional radiator shall not exceed the following:

47 CFR 15.247(b)(1): For frequency hopping systems in the 2400–2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400–2483.5 band: 0.125 Watt.

47 CFR 15.247(b)(3): For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

6.8.2. Method of Measurements & Test Arrangement

Refer to Exhibit 8, Section 8.3 of this test report, ANSI C63-4:1992 & 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.

6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
RF Detector (Diode Detector)	Narda	503A-03	--	0.01 – 18 GH
Storage Oscilloscope	Philips	PM3320A	--	250 Ms/s, DC – 100 MH
Attenuator	Weinschel Corp	46-10-34	BL2618	DC – 8.5 GHz

6.8.4. Test Data

Transmitter Channel	Frequency (MHz)	(Full bandwidth) Peak Power at Antenna Terminals (dBm)	Limit (dBm)
Lowest	2402	16.5	30.0
Middle	2441	15.8	30.0
Highest	2480	15.4	30.0

Note: The above test results are applied for both Portable/Wallmount and Base Units.

6.9. RF EXPOSURE REQUIRMENTS [§§ 15.247(b)(5), 1.1310 & 2.1093]

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
SAR Tests for Portable	Complies with SAR limits, please refer to SAR test report for details.

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

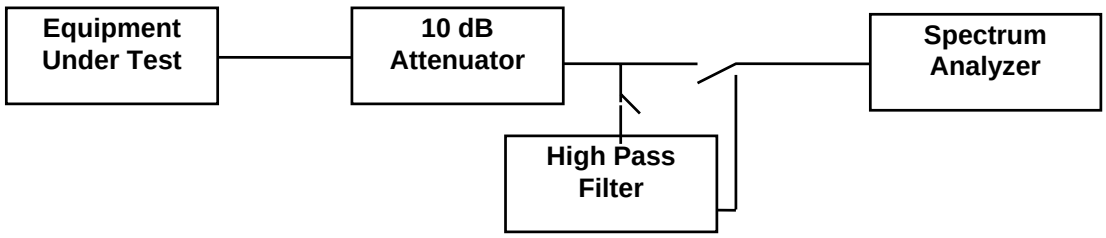
6.10.1. Limits

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, FCC Public Notice DA 00-705 & ANSI C63-4:1992

6.10.3. Test Arrangement



6.10.4. Test Equipment List

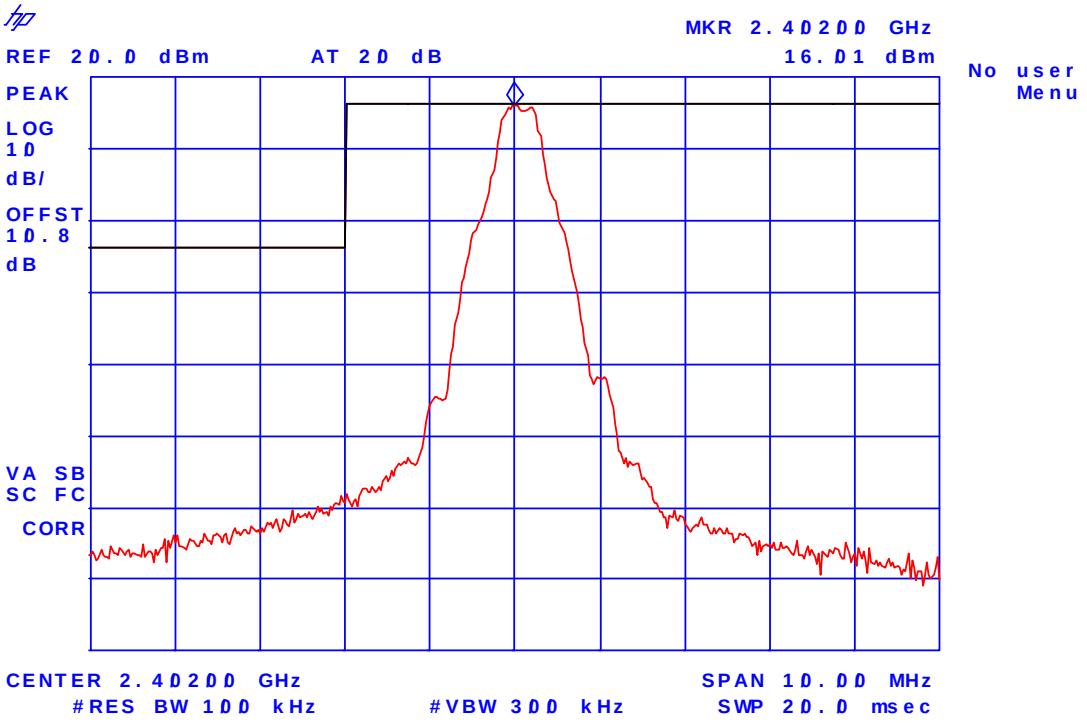
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut-off at 4 GHz
Attenuator	Weinschel Corp	46-10-34	BL2618	DC – 8.5 GHz

6.10.5. Test Data

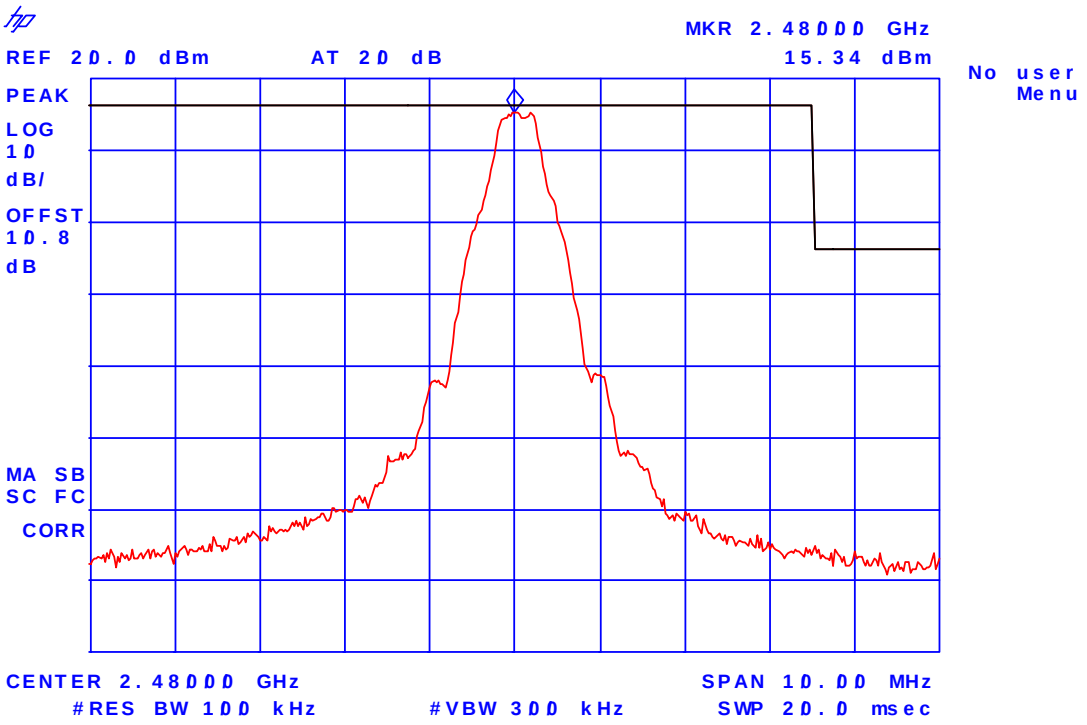
6.10.5.1. Band-Edge RF Conducted Emissions

Please refer to Plot # 16 and 17 for band-edge emissions of low and high end of frequency band.

Plot # 16: Low End of Frequency Band



Plot #17: High End of Frequency Band

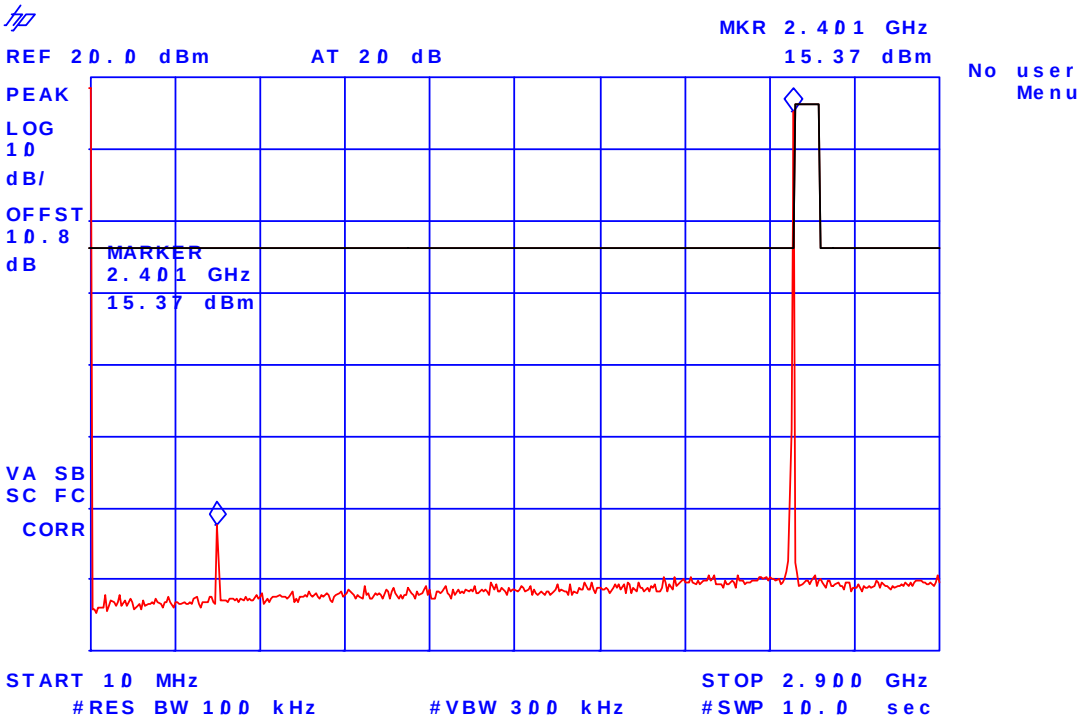


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

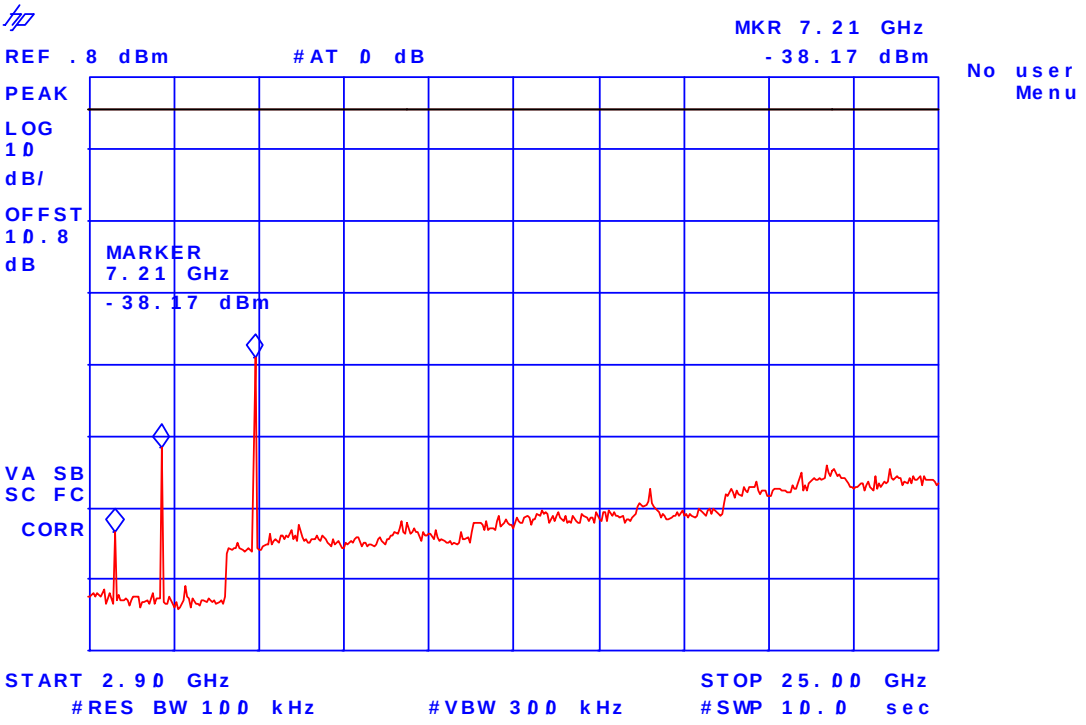
6.10.5.2. Spurious RF Conducted Emissions at Lowest Frequency (2042 MHz)

Frequency (MHz)	RF Level (dBm)	Detector Used (Peak/QP)	Limit (dBm)	Margin (dB)	Pass/ Fail
2402.00	15.4	Peak	--	--	--
444.00	-42.4	Peak	-4.6	-37.8	Pass
3560.00	-62.5	Peak	-4.6	-57.9	Pass
4804.00	-50.8	Peak	-4.6	-46.2	Pass
7206.00	-38.2	Peak	-4.6	-33.6	Pass
The emissions were scanned from 10 MHz to 25 GHz; refer to Plot 18 and 19 for measurement details.					

Plot # 18: Spurious RF Conducted Emissions @ 2402 MHz RF Output
(1) 444 MHz, -42.39 dBm
(2) 2402 MHz, 15.00 dBm



Plot # 19: Spurious RF Conducted Emissions @ 2402 MHz RF Output
(3) 3560 MHz, -62.51 dBm
(4) 4780 MHz, -50.78 dBm
(5) 7210 MHz, -38.17 dBm

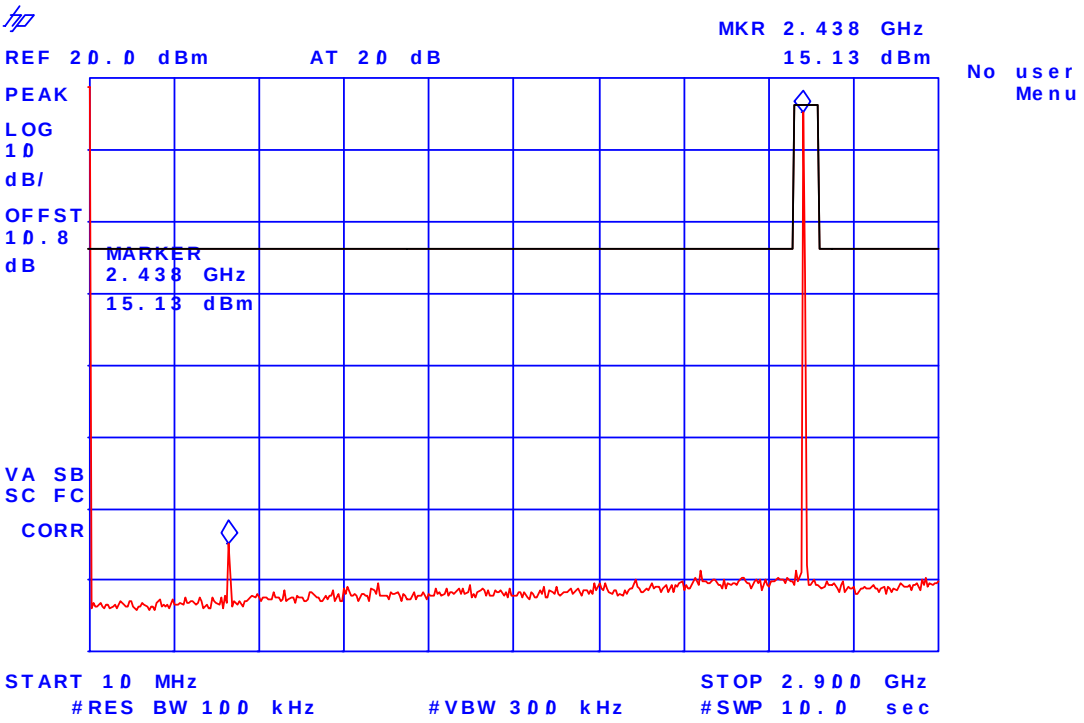


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

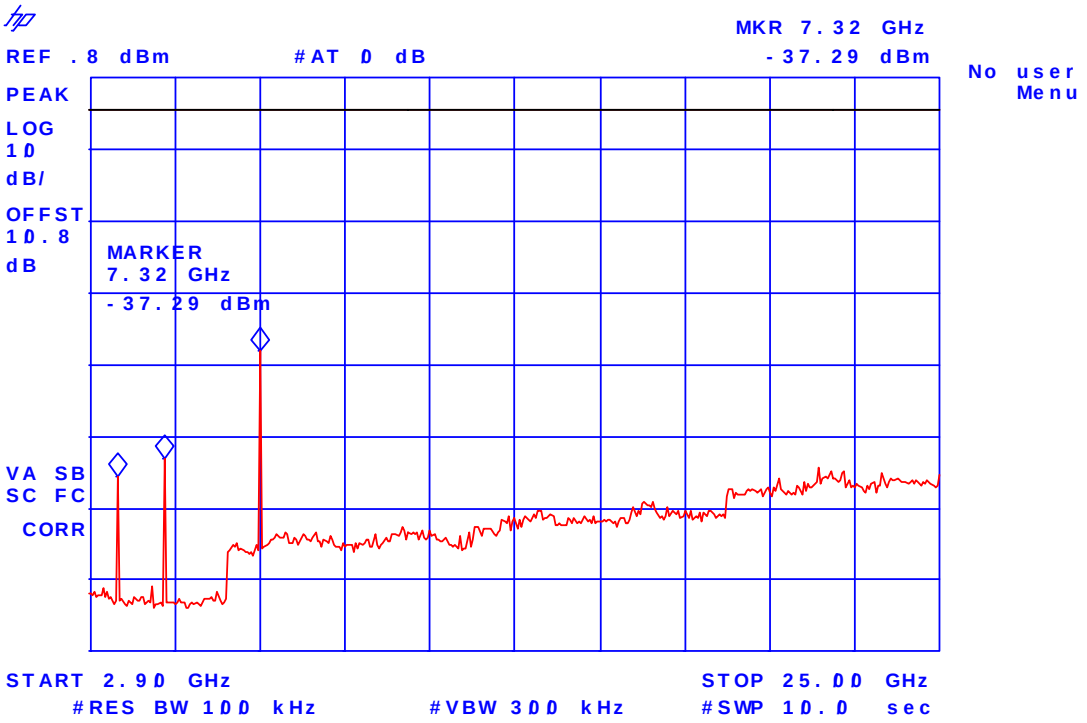
6.10.5.3. Spurious RF Conducted Emissions at Middle Frequency (2441 MHz)

Frequency (MHz)	RF Level (dBm)	Detector Used (Peak/QP)	Limit (dBm)	Margin (dB)	Pass/ Fail
2441.00	15.1	Peak	--	--	--
487.00	-44.9	Peak	-4.9	-40.0	Pass
3620.00	-54.7	Peak	-4.9	-49.8	Pass
4882.00	-52.5	Peak	-4.9	-47.6	Pass
7320.00	-37.3	Peak	-4.9	-32.4	Pass
The emissions were scanned from 10 MHz to 25 GHz; refer to Plot 20 and 21 for measurement details..					

Plot # 20: Spurious RF Conducted Emissions @ 2441 MHz RF Output
(1) 487 MHz, -44.87 dBm
(2) 2438 MHz, 15.13 dBm



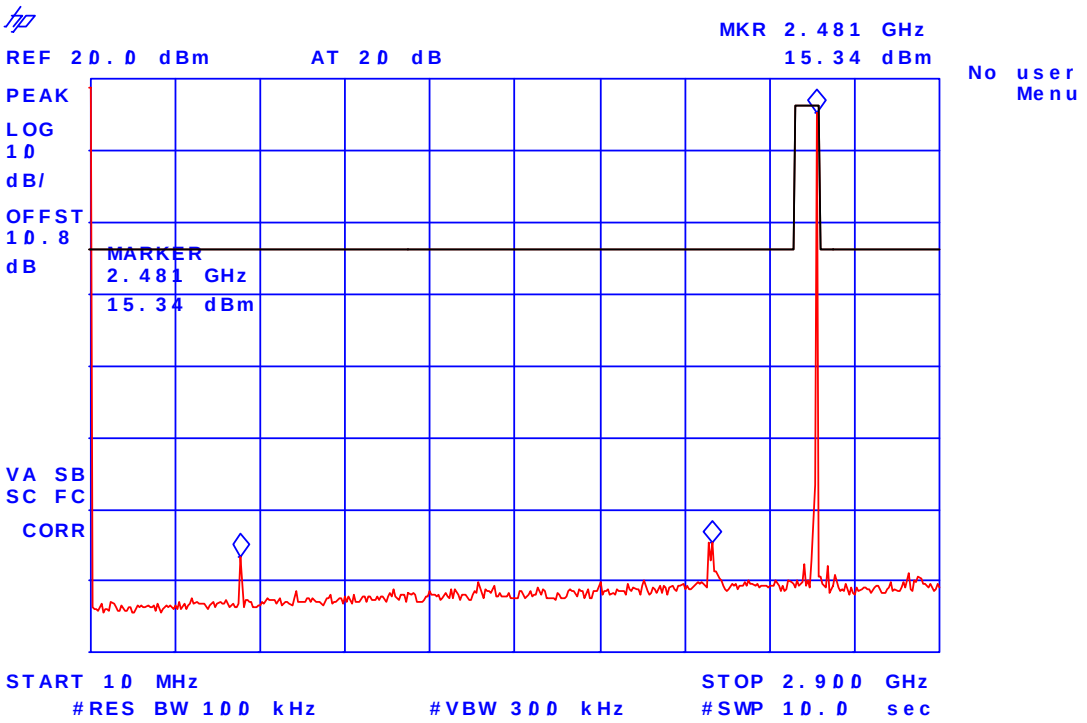
Plot # 21: **Spurious RF Conducted Emissions @ 2441 MHz RF Output**
(3) 3620 MHz, -54.72 dBm
(4) 4830 MHz, -52.49 dBm
(5) 7320 MHz, -37.29 dBm



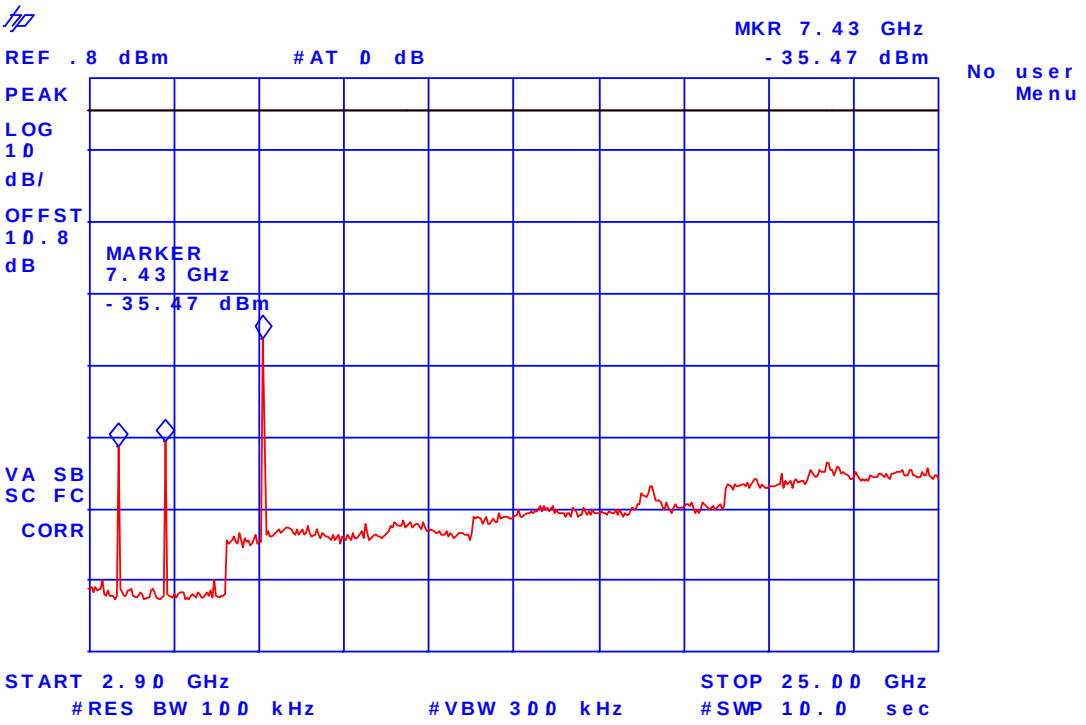
6.10.5.4. Spurious RF Conducted Emissions at Highest Frequency (2480 MHz)

Frequency (MHz)	RF Level (dBm)	Detector Used (Peak/QP)	Limit (dBm)	Margin (dB)	Pass/ Fail
2480.00	15.3	Peak	--	--	--
523.00	-46.5	Peak	-4.7	-41.8	Pass
2127.00	-44.7	Peak	-4.7	-40.0	Pass
3670.00	-50.5	Peak	-4.7	-45.8	Pass
4960.00	-49.9	Peak	-4.7	-45.2	Pass
7440.00	-35.5	Peak	-4.7	-30.8	Pass
The emissions were scanned from 10 MHz to 25 GHz; refer to Plot 22 and 23 for measurement details.					

Plot # 22: Spurious RF Conducted Emissions @ 2480 MHz RF Output
(1) 523 MHz, -46.53 dBm
(2) 2127 MHz, -44.70 dBm
(3) 2480 MHz, 15.34 dBm



Plot # 23: Spurious RF Conducted Emissions @ 2480 MHz RF Output
(4) 3670 MHz, -50.47 dBm
(5) 4890 MHz, -49.90 dBm
(6) 7430 MHz, -35.47 dBm



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

6.11. BAND-EDGE & SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 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. Radiated emissions which fall in the restricted bands, as defined
in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

§ 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
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	Above 38.6
13.36–13.41			

§ 15.209(a) – General Radiated Emission Limits

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/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 $\geq$ 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).

6.11.3. Test Arrangement

6.11.4. Test Equipment List

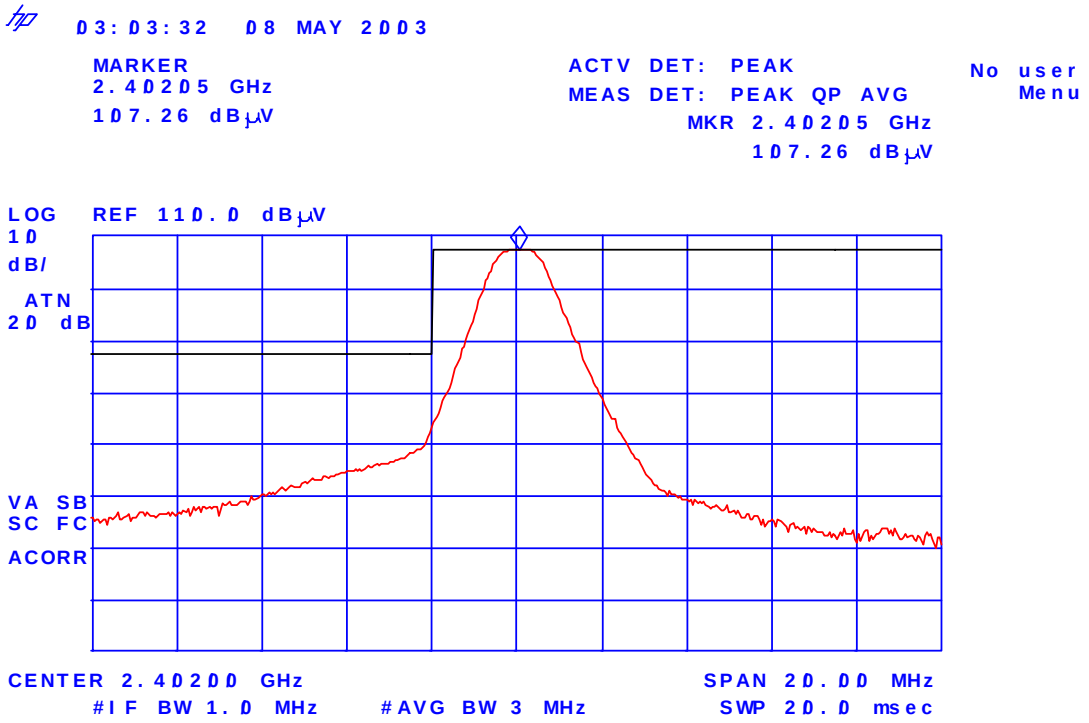
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A	--	1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz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

6.11.5. Test Data

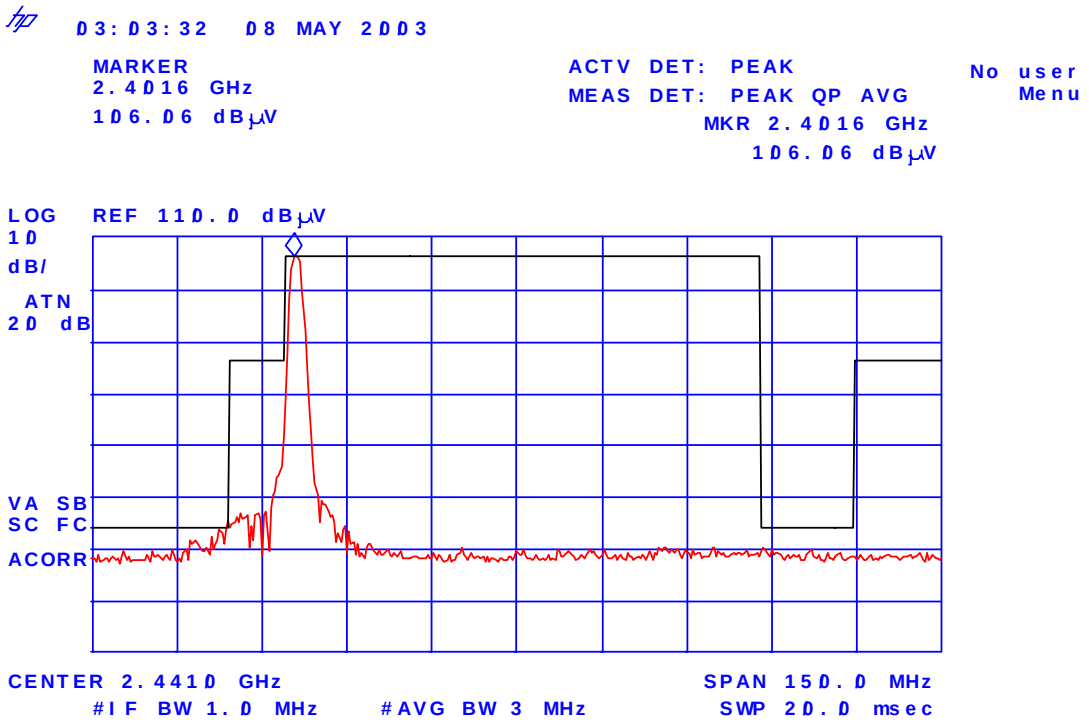
6.11.5.1. Band-Edges Radiated Emissions

Please refer to Plots # 24 and 31 for Details of Band-edge Emissions at lowest and highest channel frequencies.

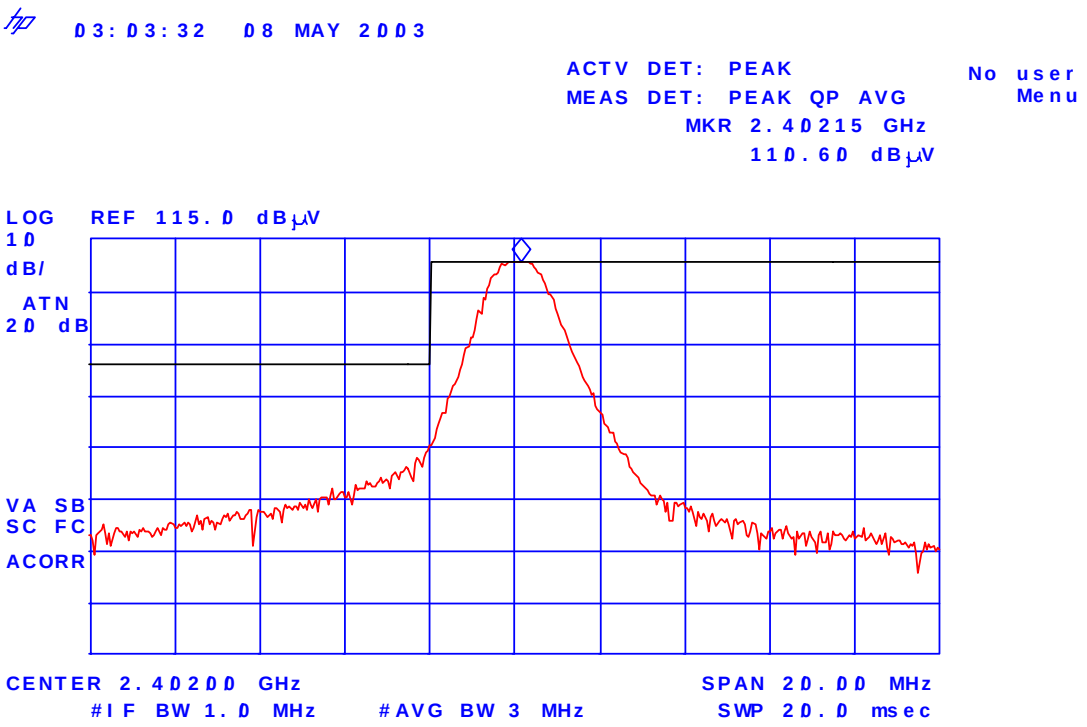
Plot # 24: Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization (Zoom in)



Plot # 25: Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization (Zoom Out)

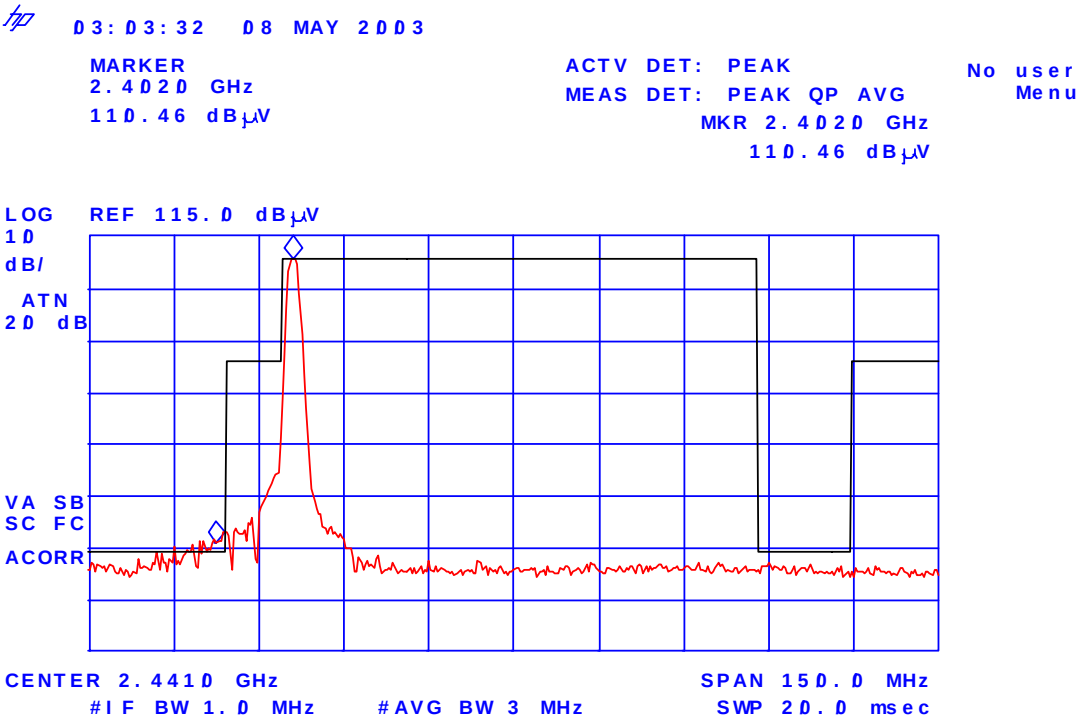


Plot # 26: Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization (Zoom in)



Plot # 27: Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization (Zoom in)

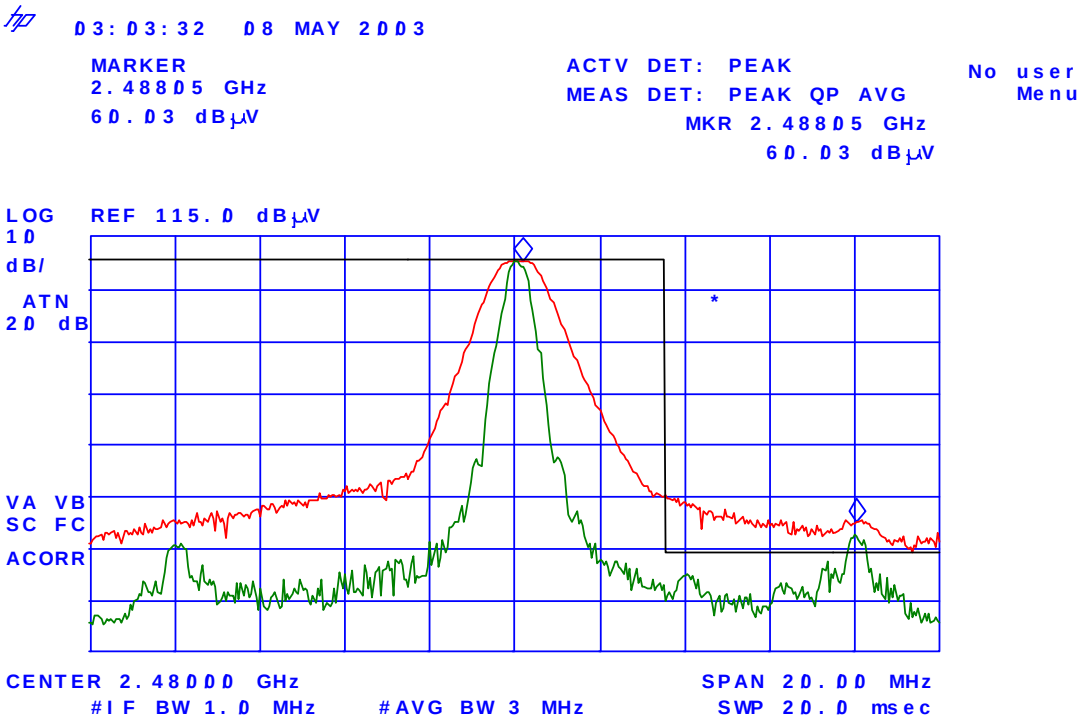
(1) 2385 MHz, Peak: 57.37 dBμV/m, Average: 49.91 dBμV/m



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

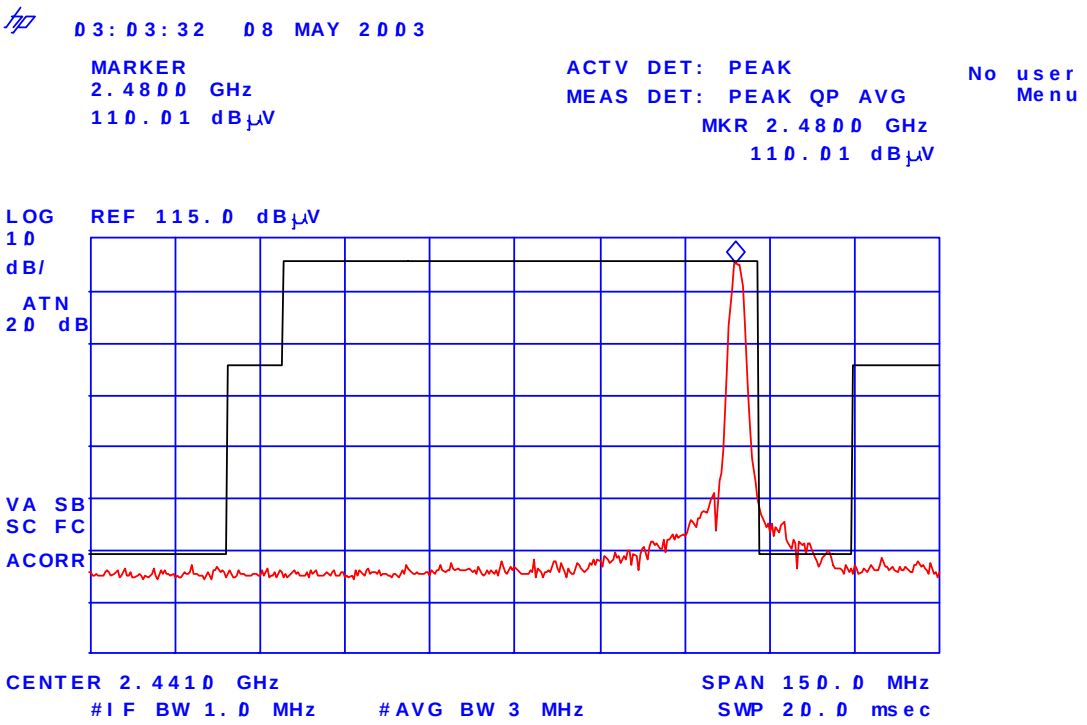
Plot # 28: Upper Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization (Zoom in)

(2) 2488 MHz, Peak: 60.03 dBuV/m, Average: 51.15 dBuV/m



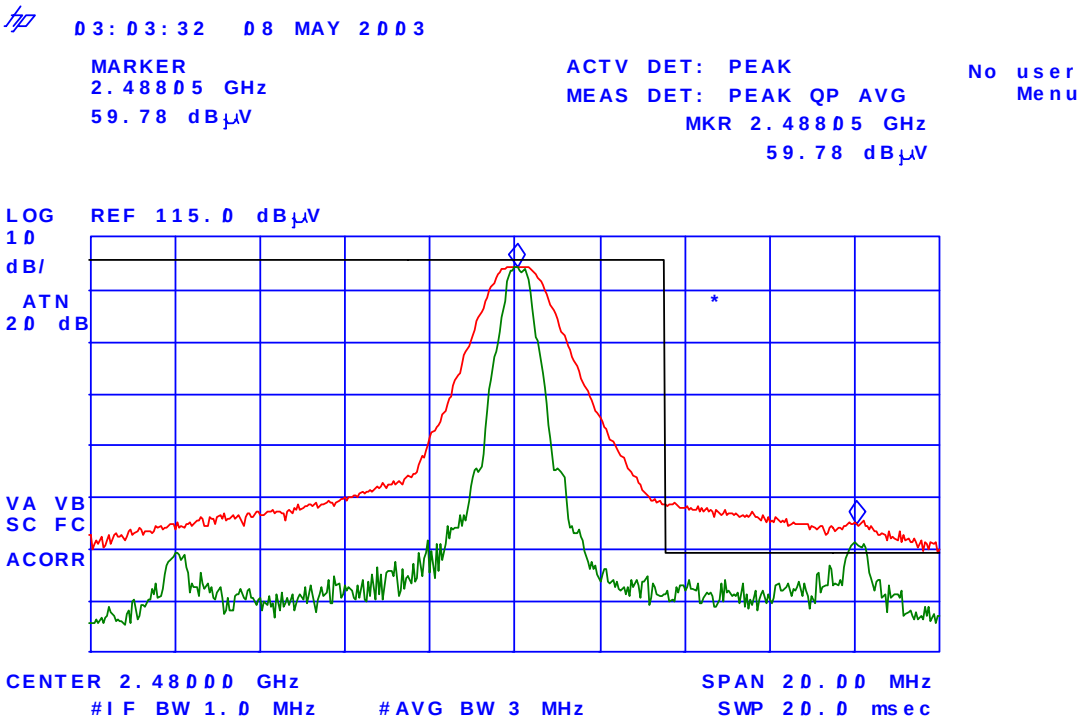
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot # 29: Upper Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization (Zoom Out)



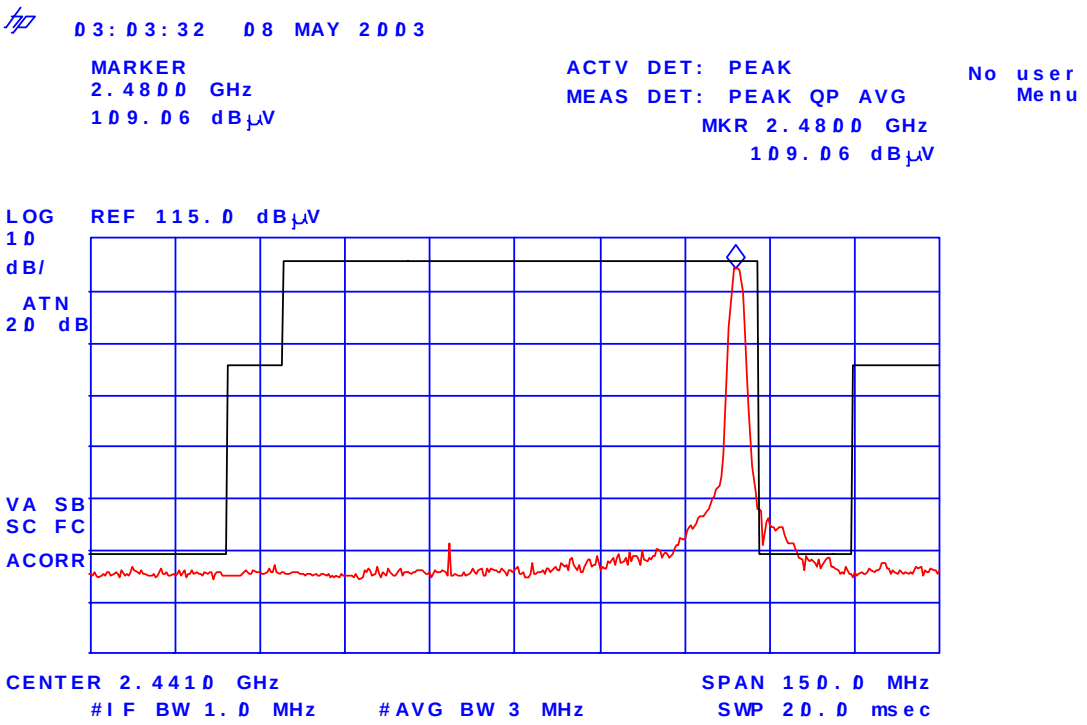
Plot # 30: **Upper Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization (Zoom in)**

Trace A: RBW=1 MHz, VBW=3 MHz
Trace B: RBW=100 kHz, VBW=300 kHz
(2) 2488 MHz, Peak: 59.78 dBuV/m, Average: 50.05 dBuV/m



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

Plot # 31: Upper Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization (Zoom Out)



6.11.5.2. Radiated Emissions at 3 Meters Distance

Lowest Frequency (2042 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
2402.00	107.3	--	V	--	--	--	--
2402.00	110.6	--	H	--	--	--	--
4804.00	72.8	47.2	H	54.0	90.6	-6.8	*Pass
4804.00	71.4	46.6	H	54.0	90.6	-7.4	*Pass
7206.00	72.6	49.6	H	54.0	90.6	-4.4	*Pass
7206.00	68.1	47.3	H	54.0	90.6	-6.7	*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

Middle Frequency (2441 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
2441.00	111.6	--	V	--	--	--	--
2441.00	111.5	--	H	--	--	--	--
4882.00	69.6	46.1	H	54.0	91.6	-7.9	*Pass
4882.00	73.1	47.6	H	54.0	91.6	-6.4	*Pass
7323.00	72.8	50.3	H	54.0	91.6	-3.7	*Pass
7323.00	72.2	49.4	H	54.0	91.6	-4.6	*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

Highest Frequency (2480 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
2480.00	110.2	--	V	--	--	--	--
2480.00	109.6	--	H	--	--	--	--
4960.00	70.3	46.3	H	54.0	90.2	-7.7	*Pass
4960.00	66.6	44.8	H	54.0	90.2	-9.2	*Pass
7440.00	73.1	49.0	H	54.0	90.2	-5.0	*Pass
7440.00	69.1	47.7	H	54.0	90.2	-6.3	*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

6.12. PEAK POWER SPECTRAL DENSITY [§ 15.247(d) & (f)]

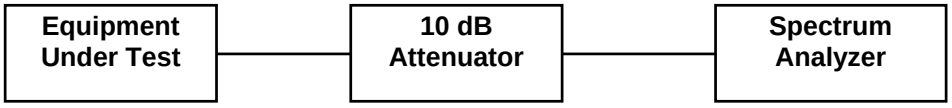
6.12.1. Limits

For a direct sequence system operation of the Hybrid (Bluetooth) System, with the frequency hopping turned off, shall comply with the power density of FCC 15.247(d) - the transmitted power density average over any 1 second interval shall not be greater than 8 dBm in any 3 KHz bandwidth within this band.

6.12.2. Method of Measurements

Refer to Exhibit 8, Section 8.6 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
Attenuator	Weinschel Corp	46-10-34	BL2618	DC – 8.5 GHz

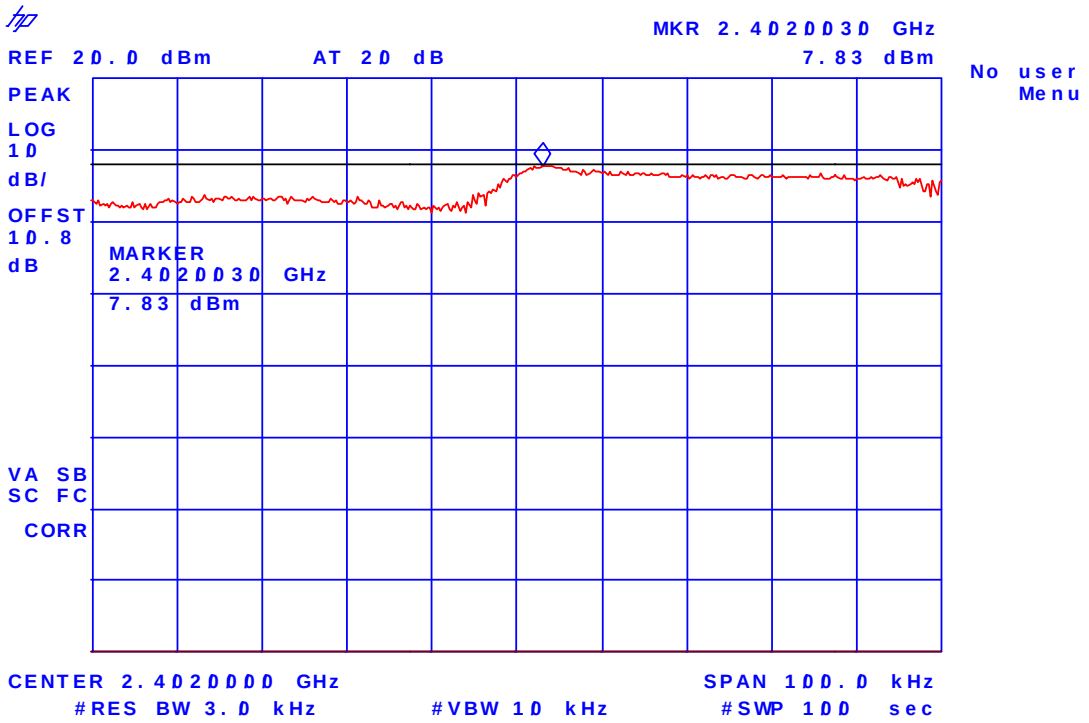
6.12.5. Test Data

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	7.83	8.0	-0.17	Pass
2441	7.45	8.0	-0.55	Pass
2480	7.02	8.0	-1.98	Pass

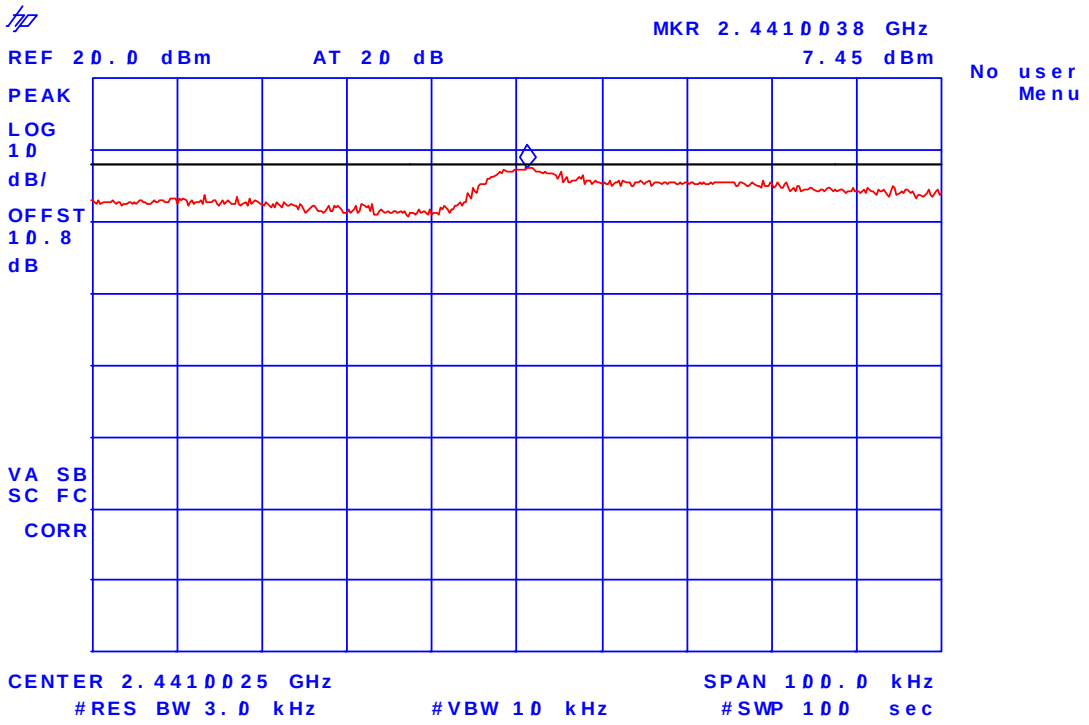
* Please refer to Plots # 32 to 34 for details of measurements.

Plot #32: Peak Power Spectral Density @ 2402 MHz



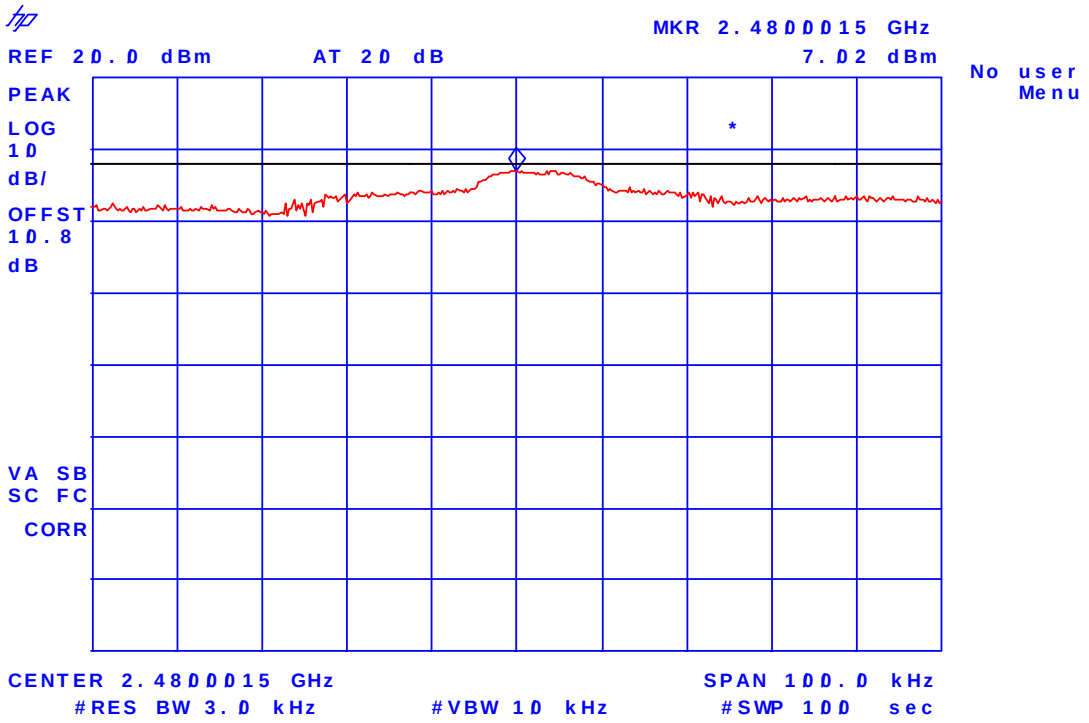
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot #33: Peak 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 #34: Peak Power Spectral Density @ 2480 MHz



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

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	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

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

$u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30$ 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±$\Gamma_1\Gamma_R$)	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, 24'(L) by 16'(W) by 8'(H).
- The test was performed were made over the frequency range from 150 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:

  Step 1. Monitor the frequency range of interest at a fixed EUT azimuth.

  Step 2. 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.

  Step 3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.

  Step 4. 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

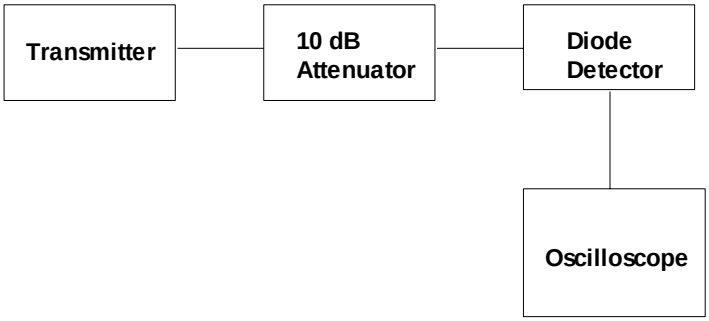
8.3.1. Measurements of Transmitter Parameters (Duty Cycle & Peak Power)

- 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:

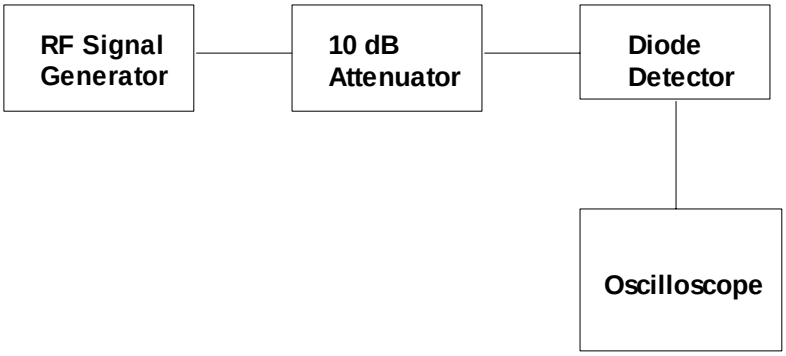
Step 1: Duty Cycle (x) and Peak Power (y) parameters measurements

- 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

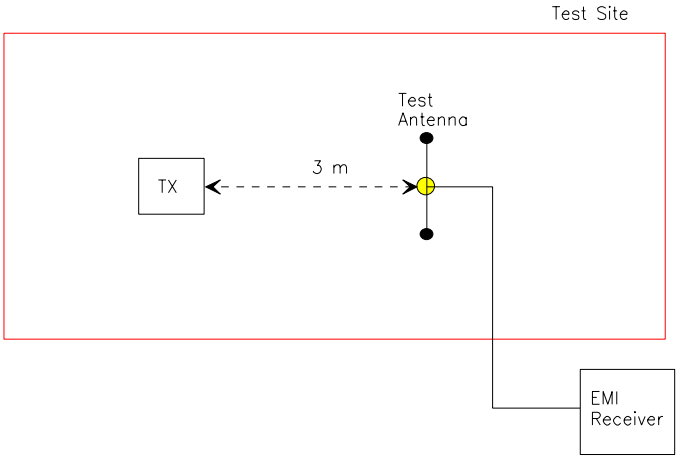
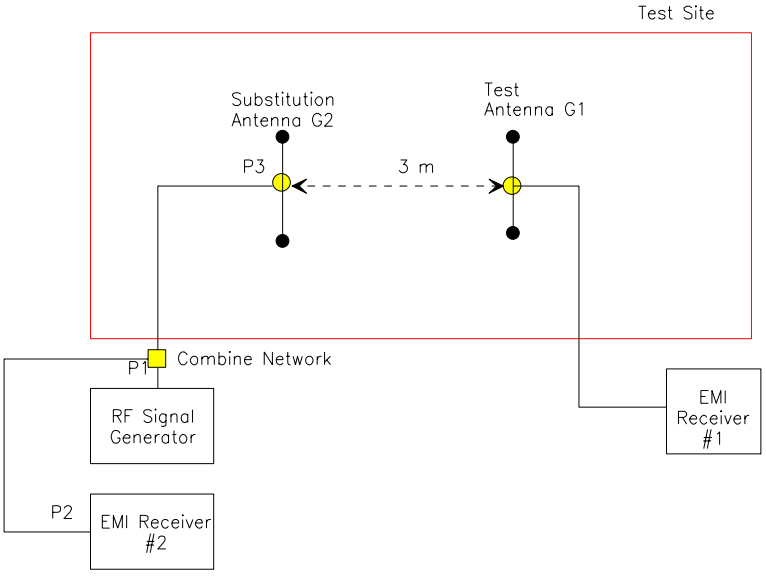


Figure 3



P3 = P2 + Insertion Loss (P1–P3
EIRP = P3 + G2

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 10th 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 10th 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:

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

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

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

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

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

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

  Step 1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

  Step 2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step 3: 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.

  Step 4: 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.

  Step 5: 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.

  Step 6: 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.

  Step 7: 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 15.247©, 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.