UltraTech
Group of Labs

31040/SIT

C-1376

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SL2-IN-E-1119R

3000 Bristol Circle,
Oakville, Ontario,
Canada L6H 6G4

Tel.: (905) 829-1570
Fax.: (905) 829-8050

Website: www.ultratech-labs.com
Email: vic@ultratech-labs.com

Aug. 11, 2003

TIMCO ENGINEERING INC.
P O BOX 370
849 N.W. STATE ROAD 45
NEWBERRY, FLORIDA
USA 32669

Subject: **FCC Certification Authorization Application under FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

Product: **Beaconpoint**
Model No.: **BP100S (internal antenna) and BP100E (external antenna)**
FCC ID: **REB-BP100**

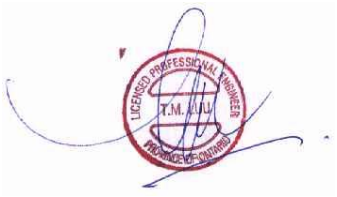
Dear Sir/Madam

As appointed agent for Chantry Networks, we would like to submit the application to FCC for certification of the above product. Please review all necessary files uploaded to TIMCO UPLOAD SITE for detailed information.

- The Models BP100S and BP100E are exactly identical except for there antennas' type and mounting mechanism.
- Compliance with RF Exposure Requirements: The transmitter complies with FCC 2.1091 with the minimum RF safety distance of 20 cm. Please refer to Users Manual for details of RF Exposure Information.

If you have any queries, please do not hesitate to contact us.

Yours truly,



Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

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Email: vic@ultratech-labs.com

Aug. 11, 2003

Chantry Networks
125 - 1900 Minnesota Court
Mississauga, Ontario
Canada, L5N 3C9

Attn.: **Mr. Fai Siew**

Subject: **FCC Certification Application Testing under FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

Product: **Beaconpoint**
Model No.: **BP100S (internal antenna) and BP100E (external antenna)**
FCC ID: **REB-BP100**

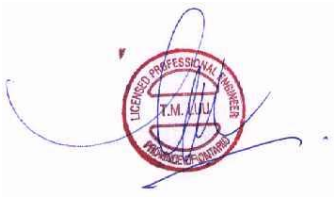
Dear Mr. Siew,

The product sample, as provided by you, has been tested and found to comply with **FCC Part 15, Subpart C, Sec. 15.247 - Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz.**

- The Models BP100S and BP100E are exactly identical except for there antennas' type and mounting mechanism.
- Compliance with RF Exposure Requirements: The transmitter complies with FCC 2.1091 with the minimum RF safety distance of 20 cm. Please refer to Users Manual for details of RF Exposure Information.

Enclosed you will find copies of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,



Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl.

ENGINEERING TEST REPORT

Beaconpoint
Model No.: BP100S (internal antenna)
And
BP100E (external antenna)

FCC ID: REB-BP100

Applicant: **Chantry Networks**
125 - 1900 Minnesota Court
Mississauga, Ontario
Canada, L5N 3C9

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.247
Digital Modulation Transmitters operating in the frequency band 2400 - 2483.5 MHz

UltraTech's File No.: CLS-109FCC15C

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Aug. 11, 2003	
Report Prepared by: Tri Luu, P.Eng. Issued Date: Aug. 11, 2003	Tested by: Hung Trinh, RFI Technician Test Dates: July 28-Aug. 10, 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.*

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com Email: vic@ultratech-labs.com, Email: tri.luu@sympatico.ca

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

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
	Test Report	Test Report	OK
1	Test Setup Photos	Photos # 1 to 6	OK
2	External Photos of EUT	Photos # 1 to 4	OK
3	Internal Photos of EUT	Photos of 1 to 8	OK
4	Cover Letters	• Letter from Ultratech for Certification Request	OK
5	Attestation Statements	• 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 Diagrams	OK
8	Schematic Diagrams	Schematic Diagrams	OK
9	Parts List/Tune Up Info	Parts List/Tune Up Info	OK
10	Operational Description	Operational Description	OK
11	RF Exposure Info	RF Exposure Info	OK
12	Users Manual		OK

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC 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 Digital Modulation Transmitters operating in the Frequency Band 2400 - 2483.5 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

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

None

1.3. NORMATIVE REFERENCES

Publication	YEAR	Title
FCC 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		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 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT:	
Name:	Chantry Networks
Address:	125 - 1900 Minnesota Court Mississauga, Ontario Canada, L5N 3C9
Contact Person:	Mr. Fai Siew Phone #: 905-567-6900 x 243 Email Address: fsiew@chantrynetworks.com

MANUFACTURER:	
Name:	Celestica Inc.
Address:	1150 Eglinton Ave. E. Toronto, Ontario Canada,
Contact Person:	Mr. Tomasz Czernecki Phone #: 416-448-4714 Fax #: 416-448-3205 Email Address: tczernec@celestica.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name:	Chantry Networks
Product Name:	Beaconpoint
Model Name or Number:	BP100S (internal antenna), BP100E (external antenna)
Part Number:	150005 (internal antenna), 150006 (external antenna)
Serial Number:	N/A
Oscillators' Frequencies:	748/374MHz (IF), 2038MHz to 2110MHz in 5 MHz steps, based on channel (Ch.1 = 2038MHz, Ch.14=2110MHz)
CPU's Frequencies:	16MHz, 25MHz, 44MHz
Power input source:	5 Vdc from the DC Input Port or 48 Vdc from The LAN Port

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	▪ Base station (fixed use)
Intended Operating Environment:	▪ Residential ▪ Commercial, light industry & heavy industry
Power Supply Requirement:	5 Vdc from the DC Input Port or 48 Vdc from The LAN Port
RF Output Power Rating:	103 mili-Watts
Operating Frequency Range:	2412 – 2462 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	5 MHz
Duty Cycle:	100%
6 dB Bandwidth:	8.5 MHz
Modulation Type:	Digital Modulation • DBPSK for 1Mb/s Data Rate • DQPSK for 2 Mb/s Data Rate • CCK for 5.5 Mb/s Data Rate • CCK for 11 Mb/s Data Rate
Emission Designation:	Digital Modulation
Oscillator Frequencies:	748/374MHz (IF), 2038MHz to 2110MHz in 5 MHz steps, based on channel (Ch.1 = 2038MHz, Ch.14=2110MHz)
Antenna Description:	**Alternative Internal Antenna:** Manufacturer: Rangestar (Tyco) Type: Omnidirectional SMT-mount Model: 1513151-1 (100930) Frequency Range: 2400-2500MHz In/Out Impedance: 50 Ohms Gain: 4dBi **Alternative External Antenna:** Manufacturer: Nearson, Inc. Type: Omnidirectional RPSMA intreface with swivel knurl Model: S131AH-2450S Frequency Range: 2400-2500MHz In/Out Impedance: 50 Ohms Gain: 2dBi

RECEIVER	
Operating Frequency Range:	2412MHz to 2462MHz
RF Output Impedance:	50 ohms
Channel Spacing:	5MHz
Antenna Connector Type: (If it is different from the transmitter antenna)	Same as transmitter
Antenna Description: (If it is different from the transmitter antenna)	Same as transmitted
Oscillator Frequencies:	748/374MHz (IF), 2038MHz to 2110MHz in 5 MHz steps, based on channel (Ch.1 = 2038MHz, Ch.14=2110MHz)

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Ethernet with 48 Vdc Supply Port	1	RJ45	Shielded
2	DC Input Port	1	RAP712 Jack	Non-shielded
3	RF Antenna Port	2	Reverse polarity SMA	Mates directly to the antennae

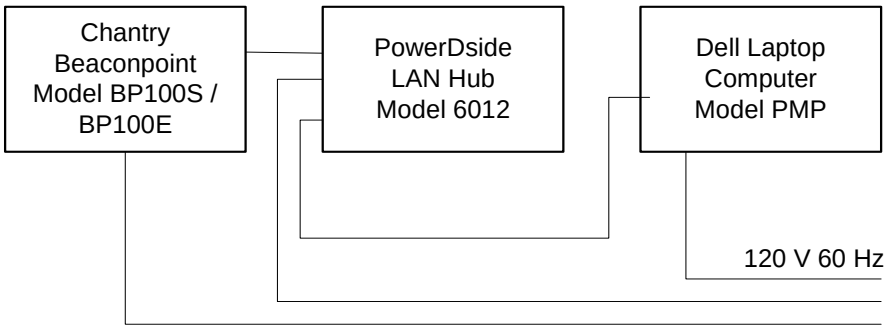
2.5. ANCILLARY EQUIPMENT

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:	Dell
Model Name or Number:	PMP
FCC ID:	FCC Class B DoC
Part Number:	10YRJ
Connected to EUT's Port:	RJ-45 LAN

Ancillary Equipment # 2	
Description:	Hub
Brand name:	Powerside
Model Name or Number:	6012
FCC ID:	FCC Class B DoC
Part Number:	PD-6012/AC/M
Connected to EUT's Port:	RJ-45 LAN

2.6. GENERAL TEST SETUP



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

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	5 Vdc at the DC input & 48 Vdc at Ethernet Ports

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in normal Direct Sequence mode for occupancy duration, and frequency separation.
Special Test Software:	▪ Special software is provided by the Applicant to select and operate the EUT at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
Special Hardware Used:	N/A
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:	
Frequencies: ▪ 2412 - 2462 MHz band:	Lowest, middle and highest channel frequencies tested: 2412, 2437 and 2462 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 103 mili-Watts • DBPSK for 1Mb/s Data Rate, DQPSK for 2 Mb/s Data Rate, CCK for 5.5 Mb/s Data Rate, CCK for 11 Mb/s Data Rate ▪ Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. 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. 08, 2001.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.107(a) & 207	AC Power Conducted Emissions	Yes
15.247(a)(2)	6dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & 1.1310	Maximum Peak Power (Conducted)	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d)	Transmitted Power Density of a Digital Modulation System	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
FCC Part 15, Sub. B, Sec. 15.109	Class A Radiated Emissions	Yes. Note 1

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

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 7 of this report and ANSI C63-4:1992

5.2. 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.

5.3. 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.

5.4. 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.

5.5. 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 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	Integral antenna for internal antennas for Model BP100E and Reverse SMA Antenna for Model BP100S.
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	**Alternative Internal Antenna:** Manufacturer: Rangestar (Tyco) Type: Omnidirectional SMT-mount Model: 1513151-1 (100930) Frequency Range: 2400-2500MHz In/Out Impedance: 50 Ohms Gain: 4dBi **Alternative External Antenna:** Manufacturer: Nearson, Inc. Type: Omnidirectional RPSMA intreface with swivel knurl Model: S131AH-2450S Frequency Range: 2400-2500MHz In/Out Impedance: 50 Ohms Gain: 2dBi

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

5.6.1. 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

5.6.2. Method of Measurements

Refer to Exhibit 7, Sec. 7.2 of this test report & ANSI C63-4:1992

5.6.3. 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
12'x16'x12' RF Shielded Chamber	RF Shielding	…	..	…

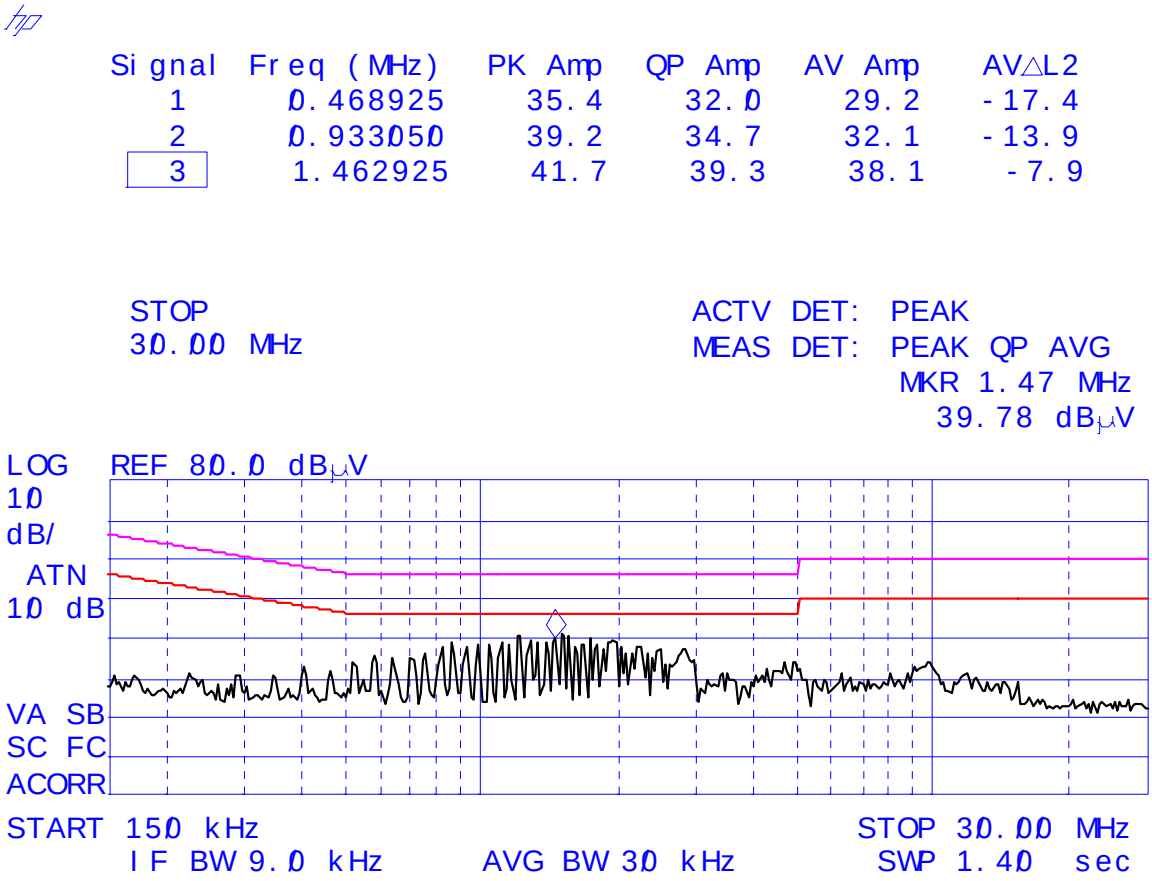
5.6.4. Test Data

5.6.4.1. Test Configuration #1: AC Conducted Emissions at AC Mains of an external AC-DC power supply when the EUT was powered at the 5V DC input Port

FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVG LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.47	32.0	QP	56.5	46.5	-24.5	PASS	L1
0.47	29.2	AVG	56.5	46.5	-17.3	PASS	L1
0.93	34.7	QP	50.9	46.0	-16.2	PASS	L1
0.93	32.1	AVG	50.9	46.0	-13.9	PASS	L1
1.46	39.3	QP	47.1	46.0	-7.8	PASS	L1
1.46	38.1	AVG	47.1	46.0	-7.9	PASS	L1
0.47	32.2	QP	56.5	46.5	-24.3	PASS	L2
0.47	29.2	AVG	56.5	46.5	-17.3	PASS	L2
0.93	35.0	QP	50.9	46.0	-15.9	PASS	L2
0.93	32.5	AVG	50.9	46.0	-13.5	PASS	L2
1.46	39.4	QP	47.1	46.0	-7.7	PASS	L2
1.46	38.2	AVG	47.1	46.0	-7.8	PASS	L2

- The rf emissions were scanned from 150 kHz to 30 MHz and al emissions less than 30 dB below the limits were recorded.
- Please refer to Photos # 1 and 2 in Annex 1 for details of test setup
- Please refer to Plots # 1 and 2 for details of measurements

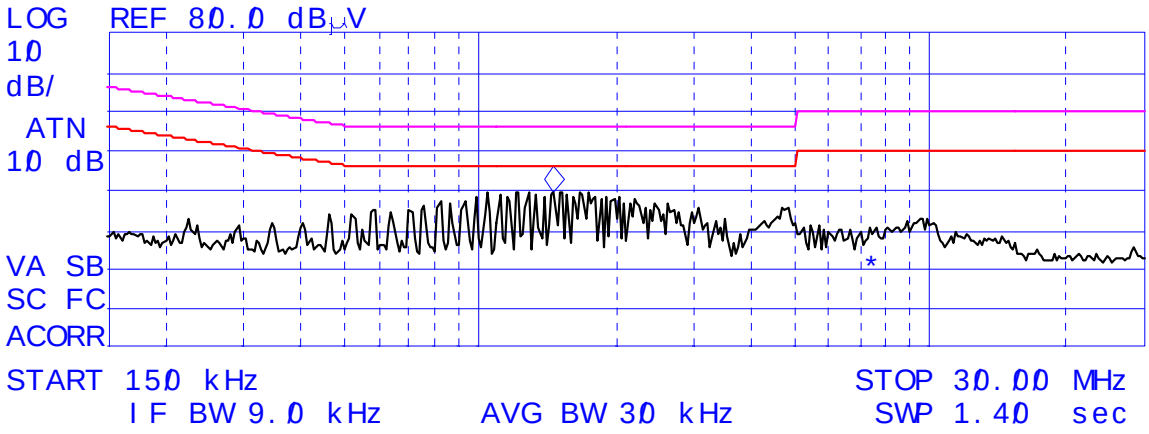
Plot #1: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23°C	Humidity:46%
Line Tested : 1	Line Voltage : 120Vac	Test Tech: Hung	Test Date: 08 Aug. 03
Standard FCC15 CLASS B	EUT's AC-DC External Power Supply Mains		



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

Plot #2: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23°C	Humidity:46%
Line Tested : 1	Line Voltage : 120Vac	Test Tech: Hung	Test Date: 08 Aug. 03
Standard FCC15 CLASS B	EUT's AC-DC External Power Supply Mains		

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.468925	35.4	32.1	29.2	-17.4
2	0.933063	39.7	35.0	32.5	-13.4
3	1.462917	41.8	39.4	38.2	-7.8



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

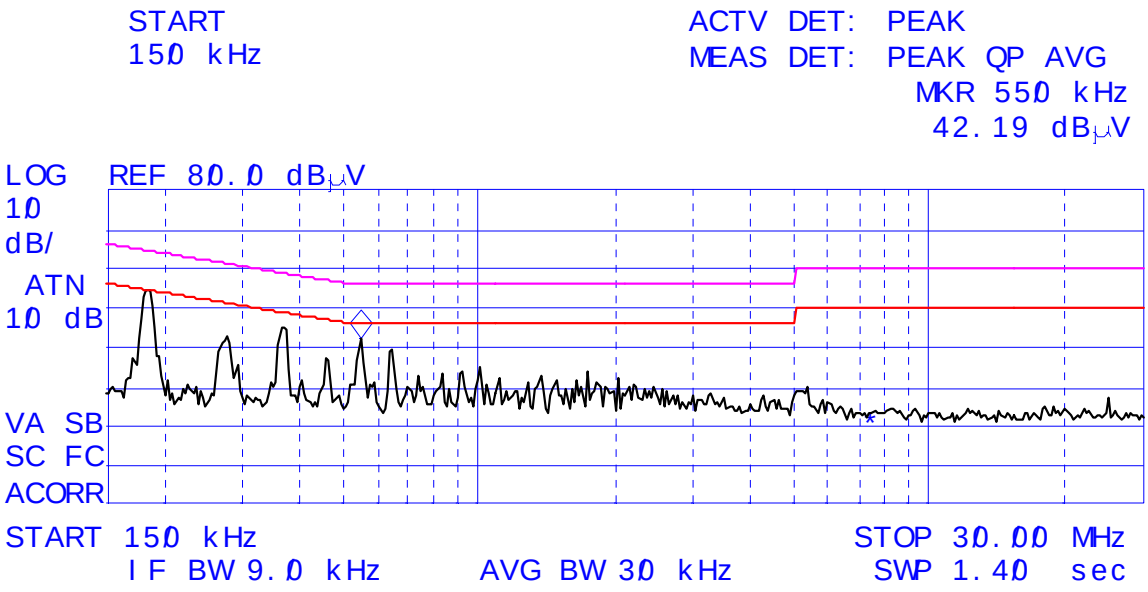
5.6.4.2. Test Configuration #2: AC Conducted Emissions at AC Mains of an LAN Hub (peripheral device) when the EUT was powered at the 48V DC Input LAN Port

FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVG LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.19	53.9	QP	64.0	54.0	-10.1	PASS	L1
0.19	47.3	AVG	64.0	54.0	-6.7	PASS	L1
0.56	41.0	QP	55.1	46.0	-14.1	PASS	L1
0.56	39.6	AVG	55.1	46.0	-6.4	PASS	L1
0.19	51.5	QP	64.0	54.0	-12.5	PASS	L2
0.19	46.6	AVG	64.0	54.0	-7.4	PASS	L2
0.56	42.2	QP	55.1	46.0	-12.9	PASS	L2
0.56	41.0	AVG	55.1	46.0	-5.0	PASS	L2

- The rf emissions were scanned from 150 kHz to 30 MHz and al emissions less than 30 dB below the limits were recorded.
- Please refer to Photos # 1 and 2 in Annex 1 for details of test setup
- Please refer to Plots # 3 and 4 for details of measurements

Plot #3: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23°C	Humidity:46%
Line Tested : 1	Line Voltage : 120Vac	Test Tech: Hung	Test Date: 08 Aug. 03
Standard FCC15 CLASS B	Tested at Peripheral Device (LAN Hub) AC Mains which provides 48 V dc supply to the EUT as an alternative power supply		

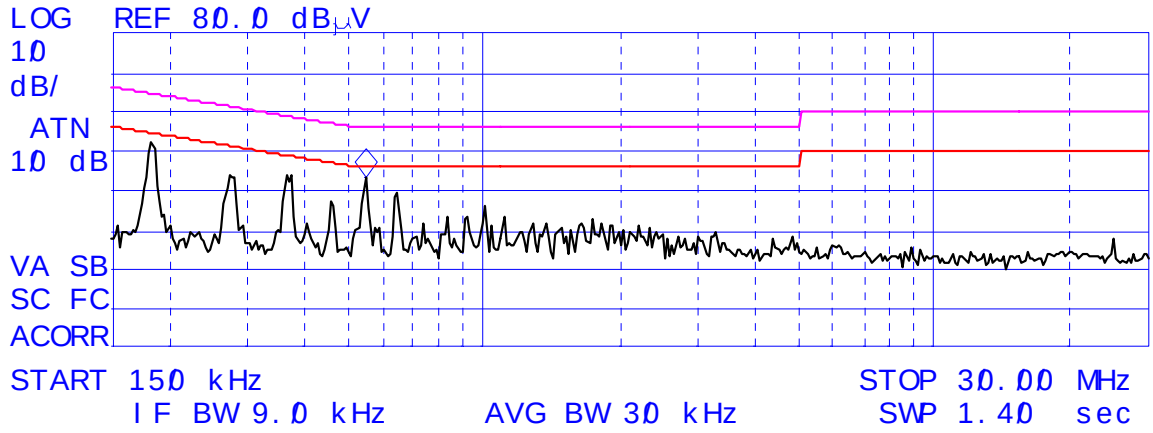
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.185461	54.8	53.9	47.3	-7.0
2	0.556654	43.0	41.0	39.6	-6.4



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

Plot #4: AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp: 23°C	Humidity:46%
Line Tested : 1	Line Voltage : 120Vac	Test Tech: Hung	Test Date: 08 Aug. 03
Standard FCC15 CLASS B	Tested at Peripheral Device (LAN Hub) AC Mains which provides 48 V dc supply to the EUT as an alternative power supply		

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.185450	52.5	51.5	46.6	-7.7
2	0.556650	43.6	42.2	41.0	-5.0



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

5.7. 6 DB BANDWIDTH @ FCC 15.247(A)(2)

5.7.1. Limits

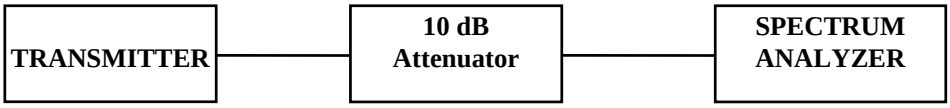
For a Digital Modulation System, the minimum 6 dB bandwidth shall be at least 500 KHz.

5.7.2. Method of Measurements

Refer to ANSI C63-4:1992

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 6 dB bandwidth was measured and recorded.

5.7.3. Test Arrangement



5.7.4. 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

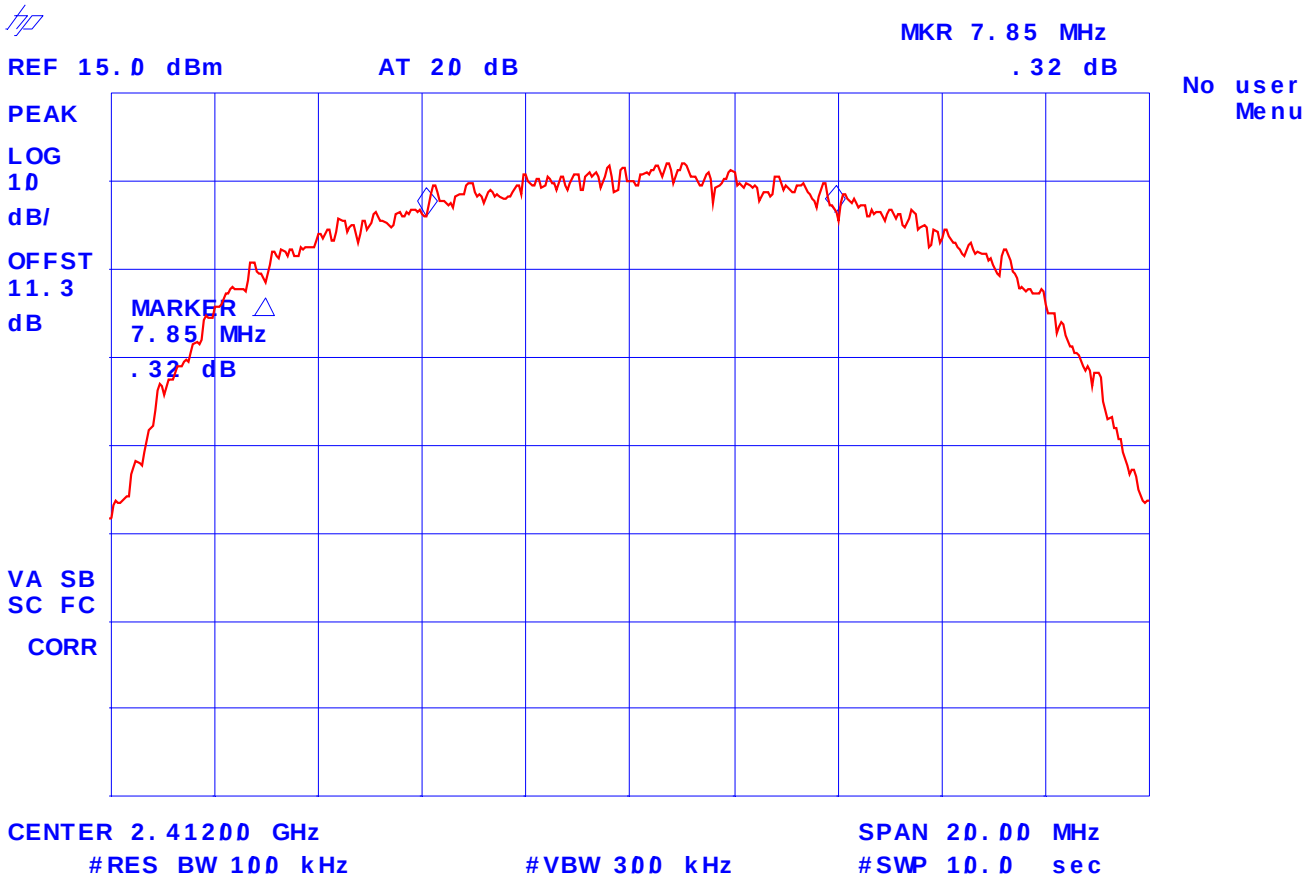
5.7.5. Test Data

CHANNEL FREQUENCY (MHz)	Modulation *	6 dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS/FAIL
2412	DBPSK, DQPSK, CCK 5.5 Mb/s & CCK 11 Mb/s	7.9	0.5	PASS
2437	DBPSK, DQPSK, CCK 5.5 Mb/s & CCK 11 Mb/s	8.5	0.5	PASS
2462	DBPSK, DQPSK, CCK 5.5 Mb/s & CCK 11 Mb/s	7.9	0.5	PASS

* The 6 dB Bandwidths were found to be the same for all different modulations

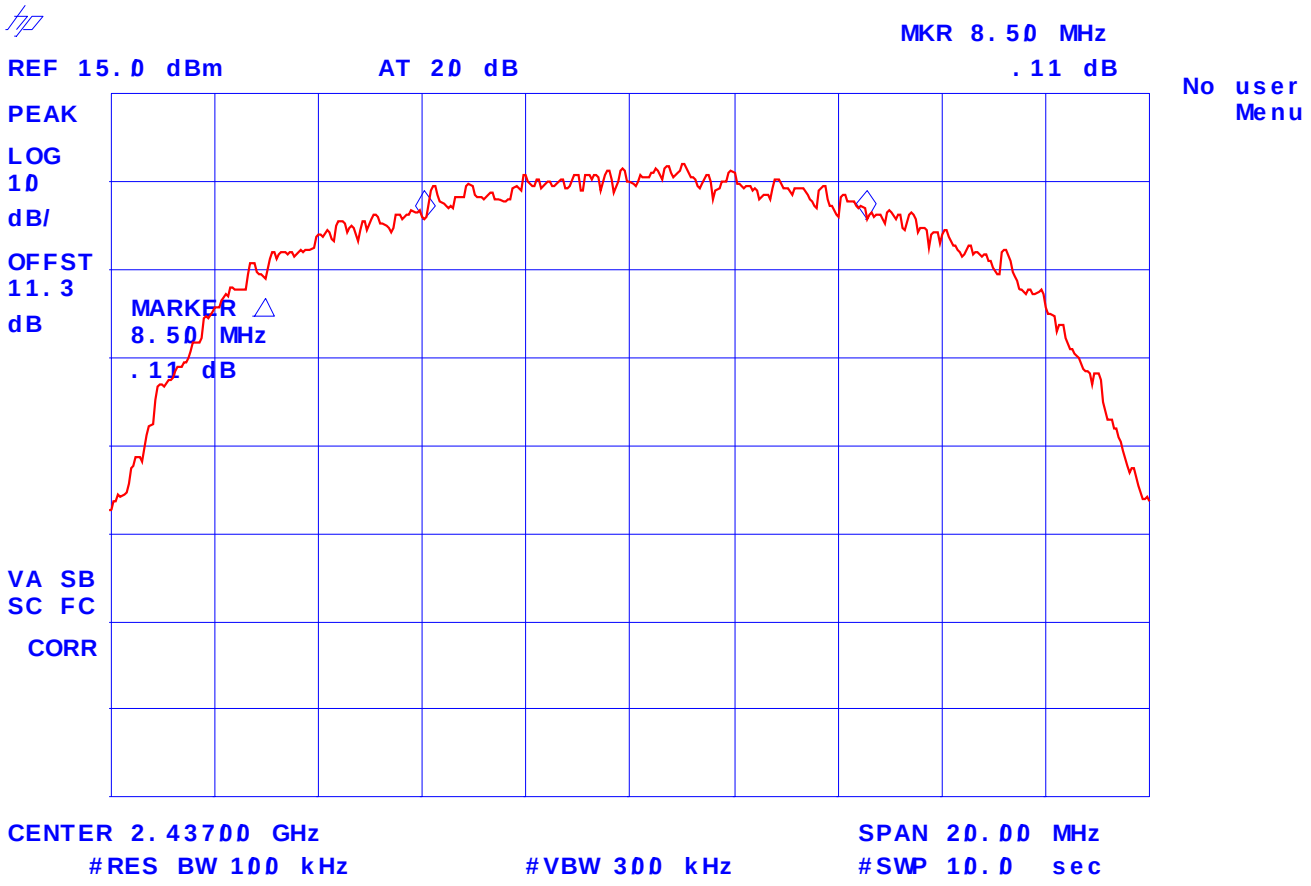
Please refer to Plots # 5 & 7 below for Measurements data

Plot # 5 – 6 dB Bandwidth - Channel 1: 2412 MHz, CCK @ 11 mbps data rata



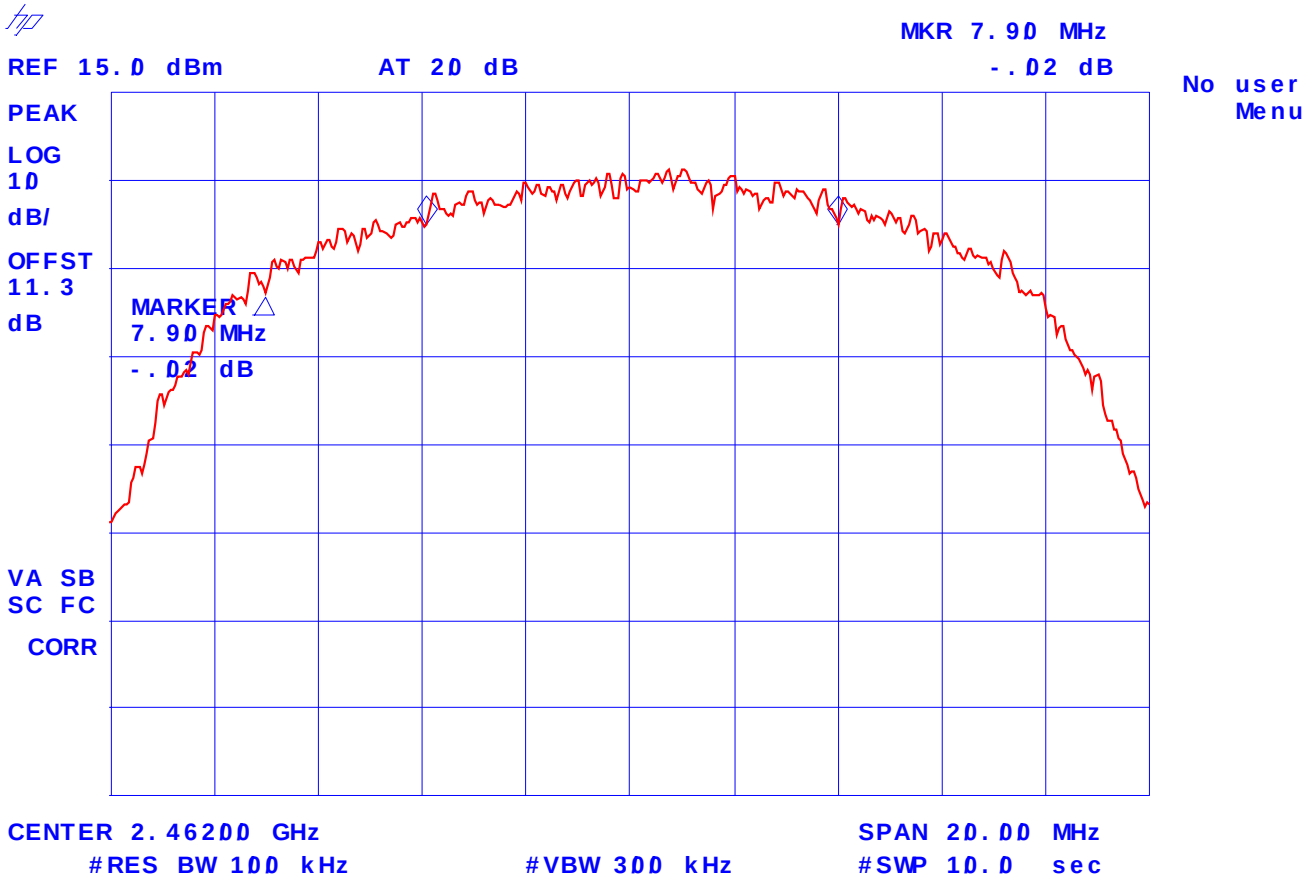
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 6 – 6 dB Bandwidth - Channel 6: 2437 MHz, CCK @ 11 mbps data rata



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

Plot # 7 – 6 dB Bandwidth - Channel 11: 2462 MHz, CCK @ 11 mbps data rata



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

5.8. PEAK OUTPUT POWER (CONDUCTED) @ FCC 15.247(B)

5.8.1. Limits

- **FCC 15.247(b)(3):** Maximum peak output power of the transmitter shall not exceed 1 Watt.
- **FCC 15.247(b)(4)(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.

De Facto EIRP Limit:

Describe how the EUT complies with the de facto EIRP limit for every antenna proposes for use with the EUT. This includes those devices that will be used in point-to-point applications. If the peak power, as measured above, must be reduced so that the de facto EIRP limit may be met for a particular antenna, described exactly how much it will be reduced for that antenna. If the minimum length of cable which will always be used, the type of cable, and its loss, in dB per unit length, for the frequency of the emission. The limit is specified in one of the subparagraphs of this section. Also, specify who will be responsible for ensuring that compliant operation is maintained for every antenna that will be used with EUT.

5.8.2. Method of Measurements & Test Arrangement

Refer to Exhibit 7, Sec. 7.3 of this test report, FCC 15.247(b)(1)&(3), 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.

5.8.3. 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	--

5.8.4. Test Data

Transmitter Channel	Frequency (MHz)	(full bandwidth) Peak Power at Antenna Terminals (dBm)	Maximum Antenna Gain (dBi)	(full bandwidth) Peak EIRP (dBm)	Limit for Power at Antenna Port (dBm)	Limit for EIRP (dBm)
Lowest	2412	20.1	4.0	24.1	30.0	36.0
Middle	2437	20.1	4.0	24.1	30.0	36.0
Highest	2462	20.0	4.0	24.1	30.0	36.0

Remarks: The above measurements were found to be the same for all different modulations such as below:

- DBPSK for 1Mb/s Data Rate
- DQPSK for 2 Mb/s Data Rate
- CCK for 5.5 Mb/s Data Rate
- CCK for 11 Mb/s Data Rate

5.9. RF EXPOSURE REQUIRMENTS @ FCC 15.247(B)(4), 1.1310 & 2.1091

5.9.1. Limits

- **FCC 15.247(b)(4):** Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See @ 1.1307(b)(1).
- **FCC 1.1310:**- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
1500-100,000	...	...	5	6
(B) Limits for General Population/Uncontrolled Exposure				
1500-100,000	...	...	1.0	30

F = Frequency in MHz

5.9.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091 and Public Notice DA 00-705 (March 30, 2000)

- Spread spectrum transmitters operating under section 15.247 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

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

Calculation Method of RF Safety Distance:

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

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

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

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

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones., an SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that a SAR evaluation be performed, as provided for in Section 1.1307(d)

5.9.3. Test Data

Frequency (MHz)	Conducted Peak Power at the Antenna Terminal (dBm)	Maximum Antenna Gain (dBi)	Maximum Measured Total EIRP (dBm)	Laboratory's Recommended Minimum RF Safety Distance r (cm)
2412	20.1	4.0	24.1	4.5

Note 1: **RF EXPOSURE DISTANCE LIMITS:** $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
Limits for General Population/Uncontrolled Exposure: $S = 1.0\ mW/cm^2$

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: 4.5 cm	Manufacturer' instruction for separation distance between antenna and persons required: 20 cm. Please refer to the Users/ Manual and FCC RF Exposure information
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	N/A
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Please refer to the Users/ Manual and FCC RF Exposure information
Any other RF exposure related issues that may affect MPE compliance	N/A

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

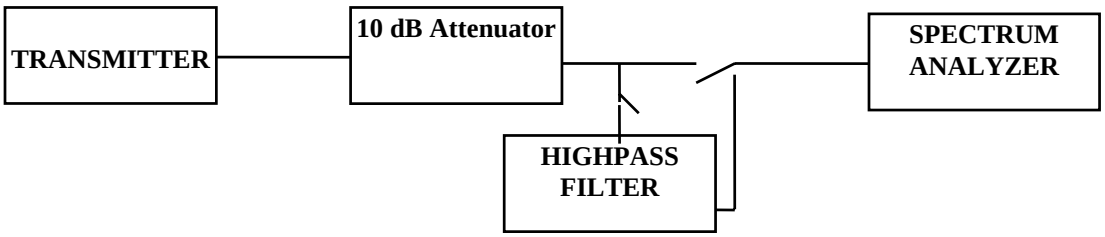
5.10.1. Limits

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.

5.10.2. Method of Measurements

Refer to Exhibit 7, Sec. 7.4 of this test report, FCC 15.247(c) & ANSI C63-4:1992

5.10.3. Test Arrangement



5.10.4. 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

5.10.5. Test Data

Remark: Since the RF signal output are exactly identical with different modulations based on our prescans and IEEE 802.1 standard for DSSS, the CCK with 11 Mb/s data rate was chosen for the final tests.

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

Please refer to Plots # 8 and 9 for detailed measurements of Band-edge emissions at lower and upper permitted band.

5.10.5.2. Tx Conducted Emissions at Lowest Frequency (2412 MHz)

FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2412.00	6.6	PEAK	--	--	--
4076.00	-55.0	PEAK	-13.4	-41.6	PASS
4824.00	-51.3	PEAK	-13.4	-37.9	PASS
7236.00	-57.3	PEAK	-13.4	-43.9	PASS

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

5.10.5.3. Tx Conducted Emissions at Middle Frequency (2437 MHz)

FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2437.00	6.8	PEAK	--	--	--
4126.00	-53.0	PEAK	-13.2	-39.8	PASS
4874.00	-46.6	PEAK	-13.2	-33.4	PASS
7311.00	-57.5	PEAK	-13.2	-44.3	PASS

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

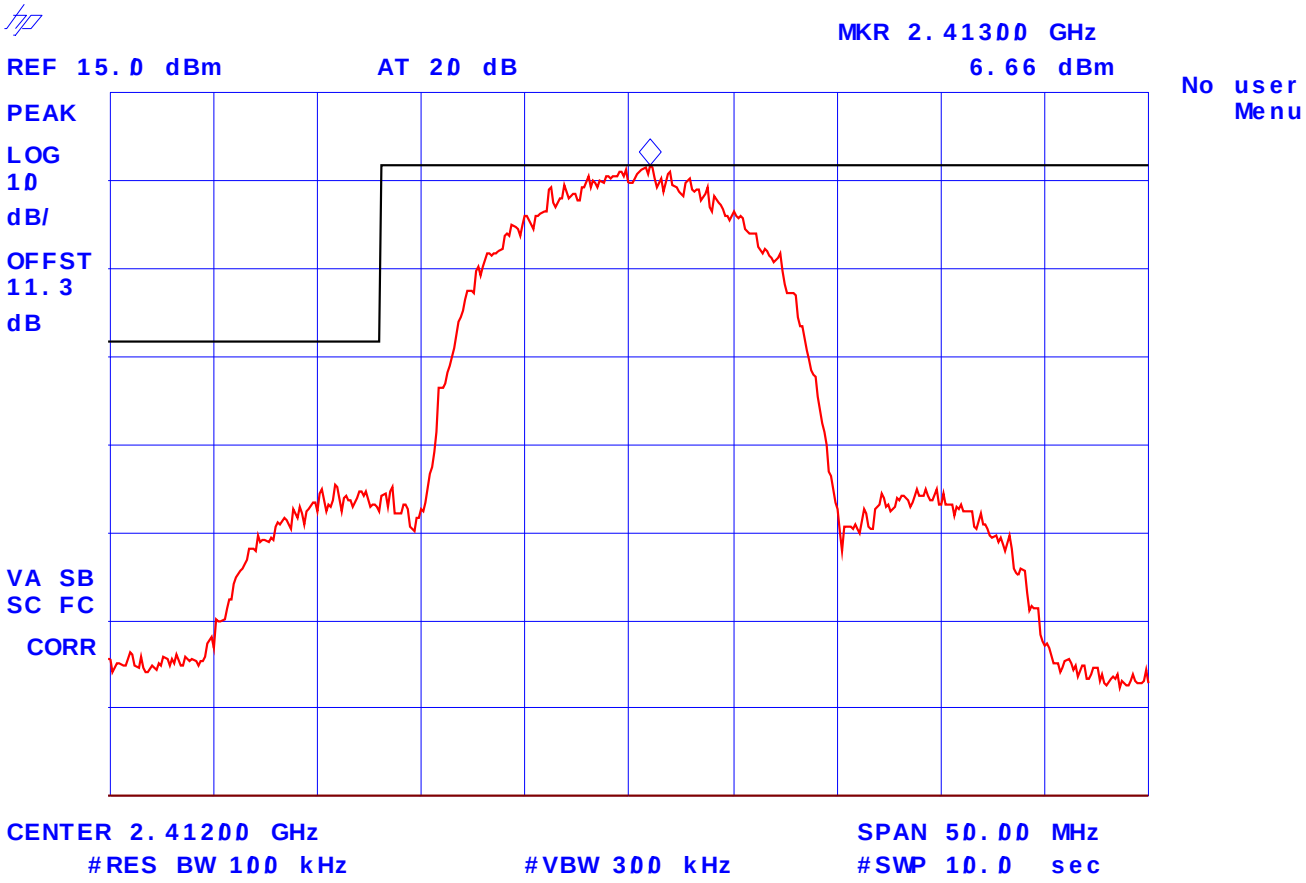
5.10.5.4. Tx Conducted Emissions at Highest Frequency 2462 MHz)

FREQUENCY (MHz)	RF LEVEL (dBm)	DETECTOR USED (PEAK/QP)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2462.00	6.0	PEAK	--	--	--
4176.00	-50.2	PEAK	-14.0	-14.0	PASS
4924.00	-50.7	PEAK	-14.0	-14.0	PASS
7386.00	-53.1	PEAK	-14.0	-14.0	PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 40 dB below the limits were recorded.
- Please to Plots # 14 and 15 for detailed measurements

Plot # 8: Band-edge Conducted Emissions (Lower)

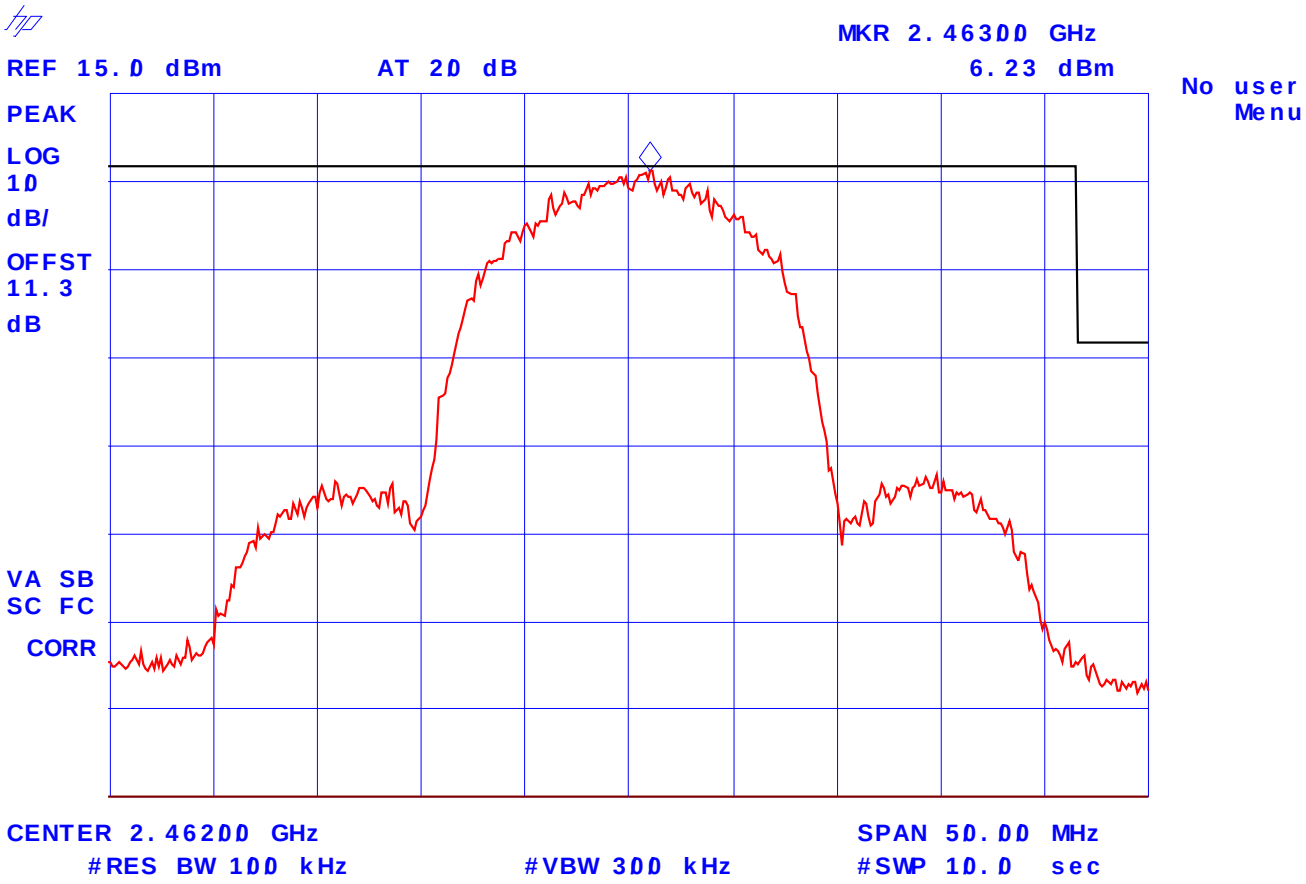
Channel 1: 2412 MHz, CCK @ 11 Mb/s data rate



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

Plot # 9: Band-edge Conducted Emissions (Upper)

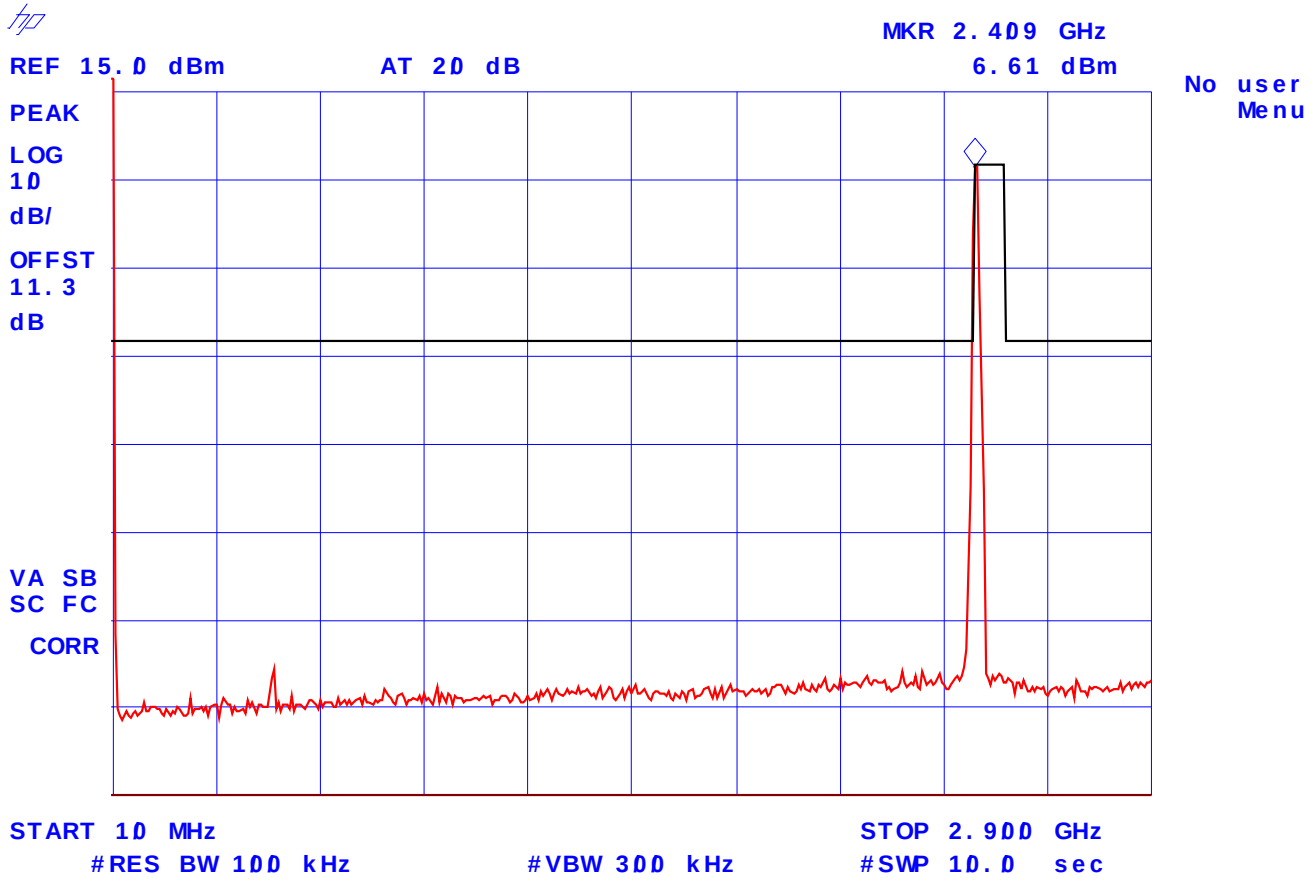
Channel 11: 2462 MHz, CCK @ 11 Mb/s data rate



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

Plot # 10: Transmitter Spurious/Harmonic Conducted Emissions

Channel 1: 2412 MHz, CCK @ 11 Mb/s data rate

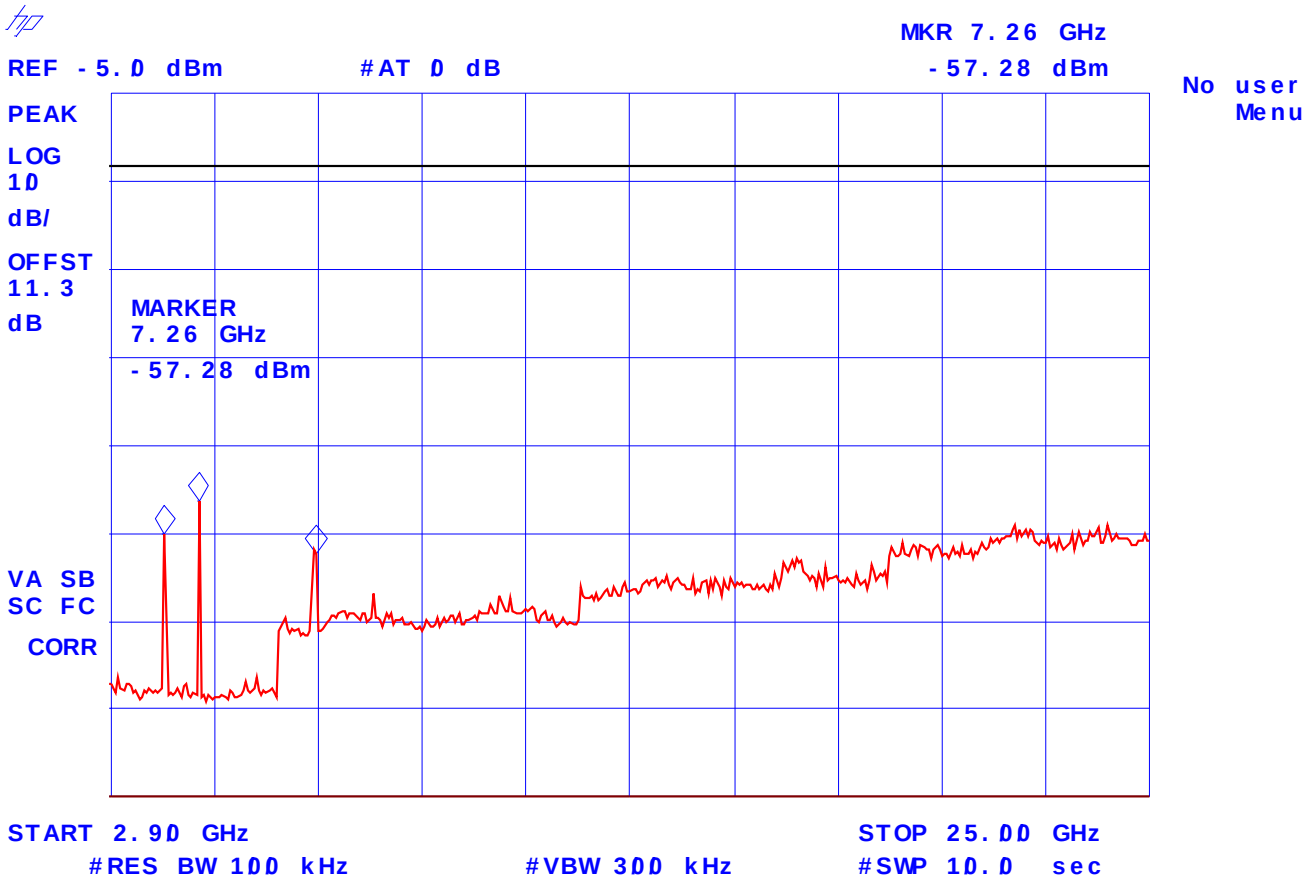


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 11: Transmitter Spurious/Harmonic Conducted Emissions

Channel 1: 2412 MHz, CCK @ 11 Mb/s data rate

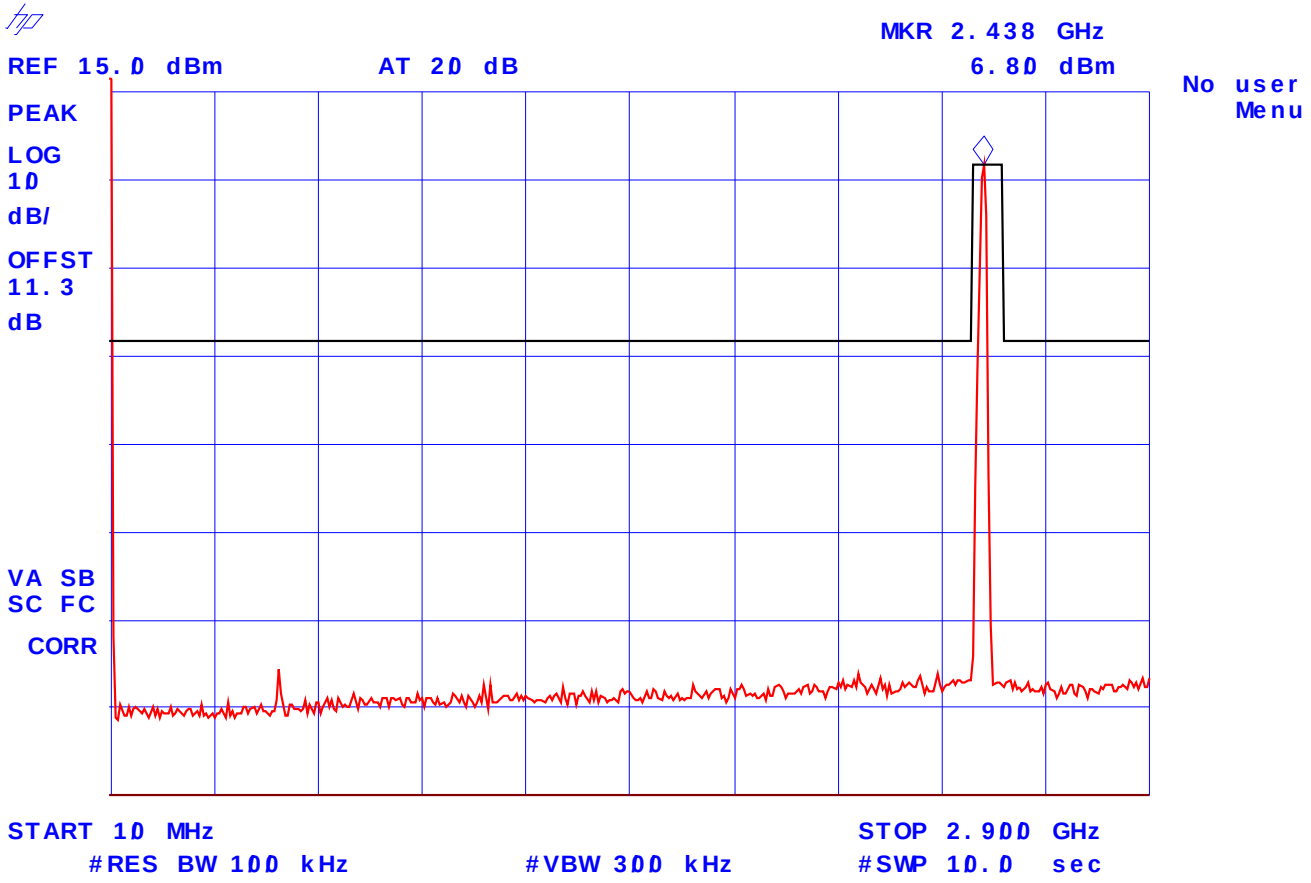
(1) 4.06 GHz, -55.03 dBm
(2) 4.78 GHz, -51.26 dBm
(3) 7.26 GHz, -57.28 dBm



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

Plot # 12: Transmitter Spurious/Harmonic Conducted Emissions

Channel 6: 2437 MHz, CCK @ 11 Mb/s data rate

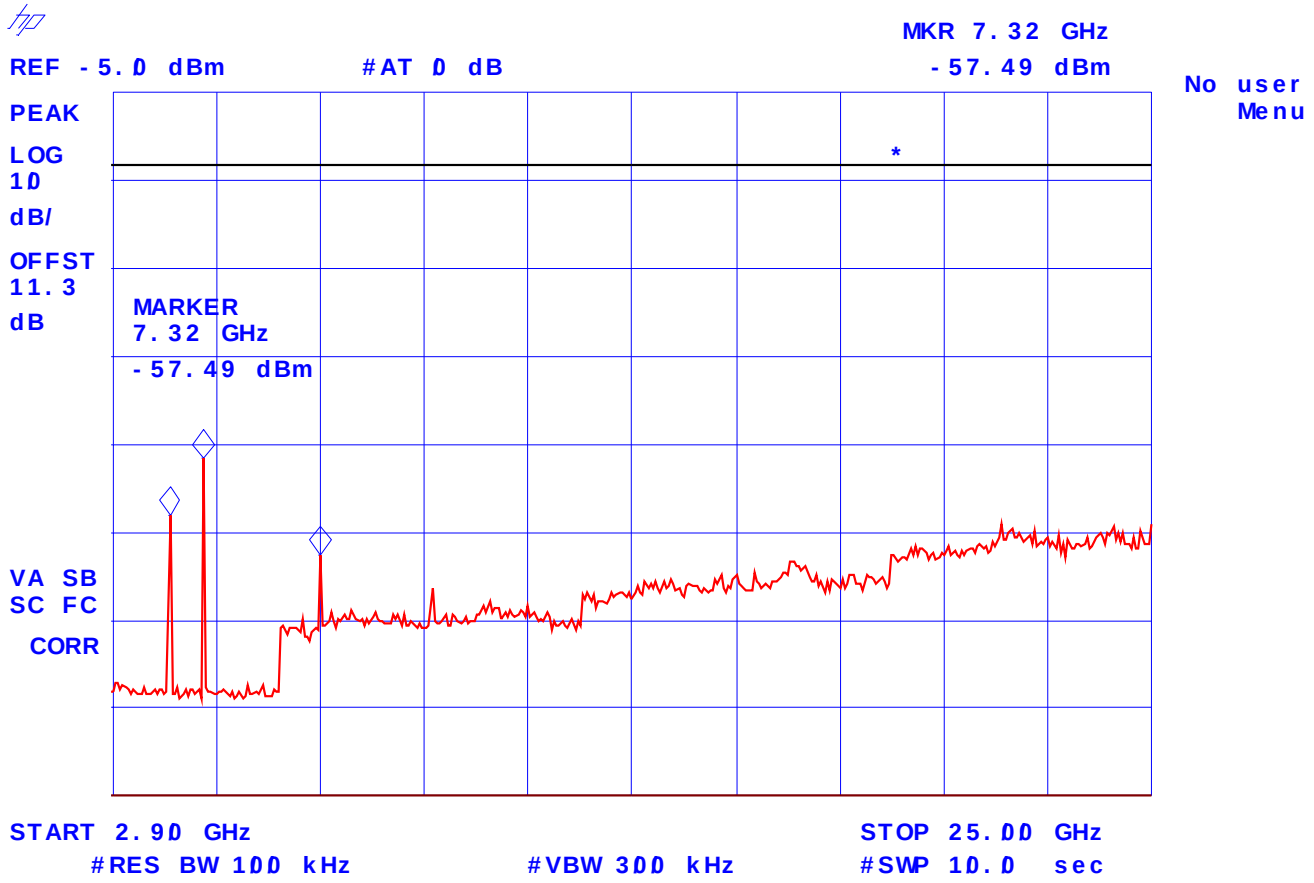


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 13: Transmitter Spurious/Harmonic Conducted Emissions

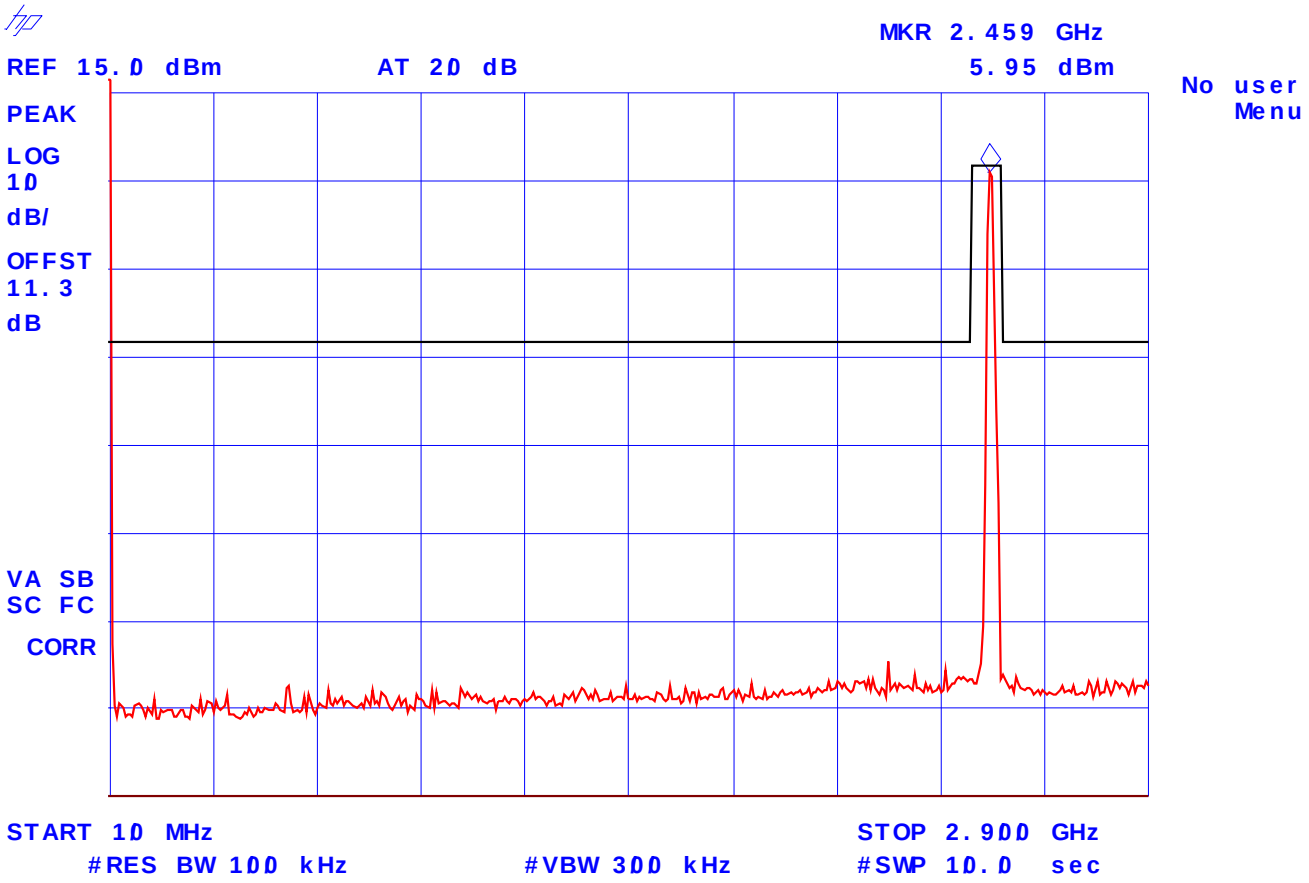
Channel 6: 2437 MHz, CCK @ 11 Mb/s data rate

(1) 4.12 GHz, -53.01 dBm
(2) 4.83 GHz, -46.61 dBm
(3) 7.32 GHz, -57.49 dBm



Plot # 14: Transmitter Spurious/Harmonic Conducted Emissions

Channel 11: 2462 MHz, CCK @ 11 Mb/s data rate

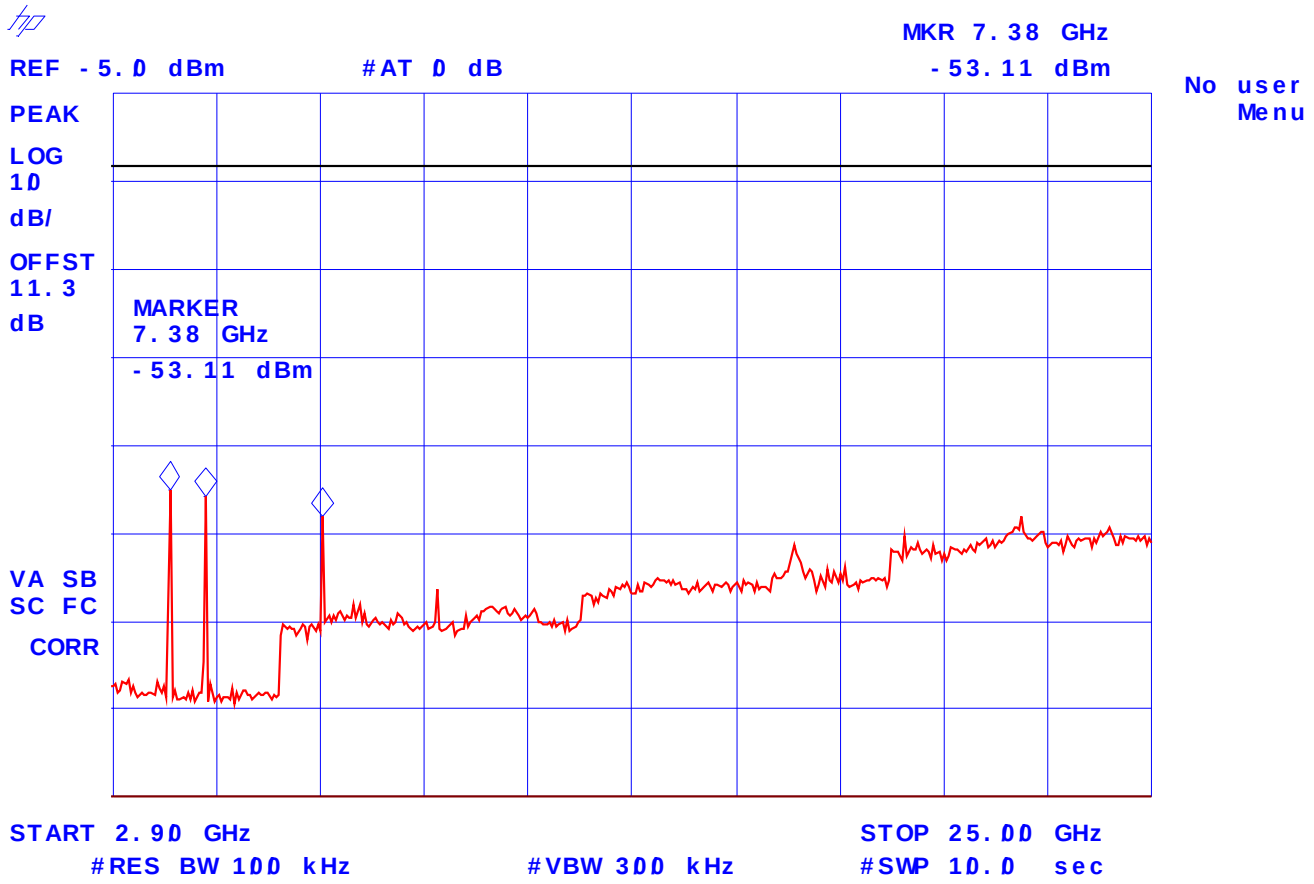


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 15: Transmitter Spurious/Harmonic Conducted Emissions

Channel 11: 2462 MHz, CCK @ 11 Mb/s data rate

(1) 4.12 GHz, -50.15 dBm
(2) 4.89 GHz, -50.73 dBm
(3) 7.38 GHz, -53.11 dBm



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

5.11. TRANSMITTED POWER DENSITY OF A DIGITAL MODULATION SYSTEM, FCC CFR 47, PARA. 15.247(D)

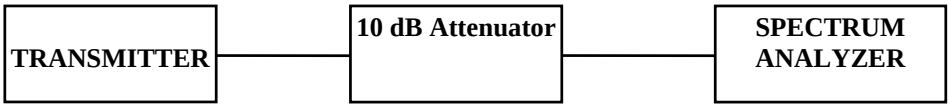
5.11.1. Limits

For a direct sequence system, 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.

5.11.2. Method of Measurements

Refer to Exhibit 7, Sec. 7.6 of this test report for detailed measurement procedures

5.11.3. Test Arrangement



5.11.4. Test Equipment List

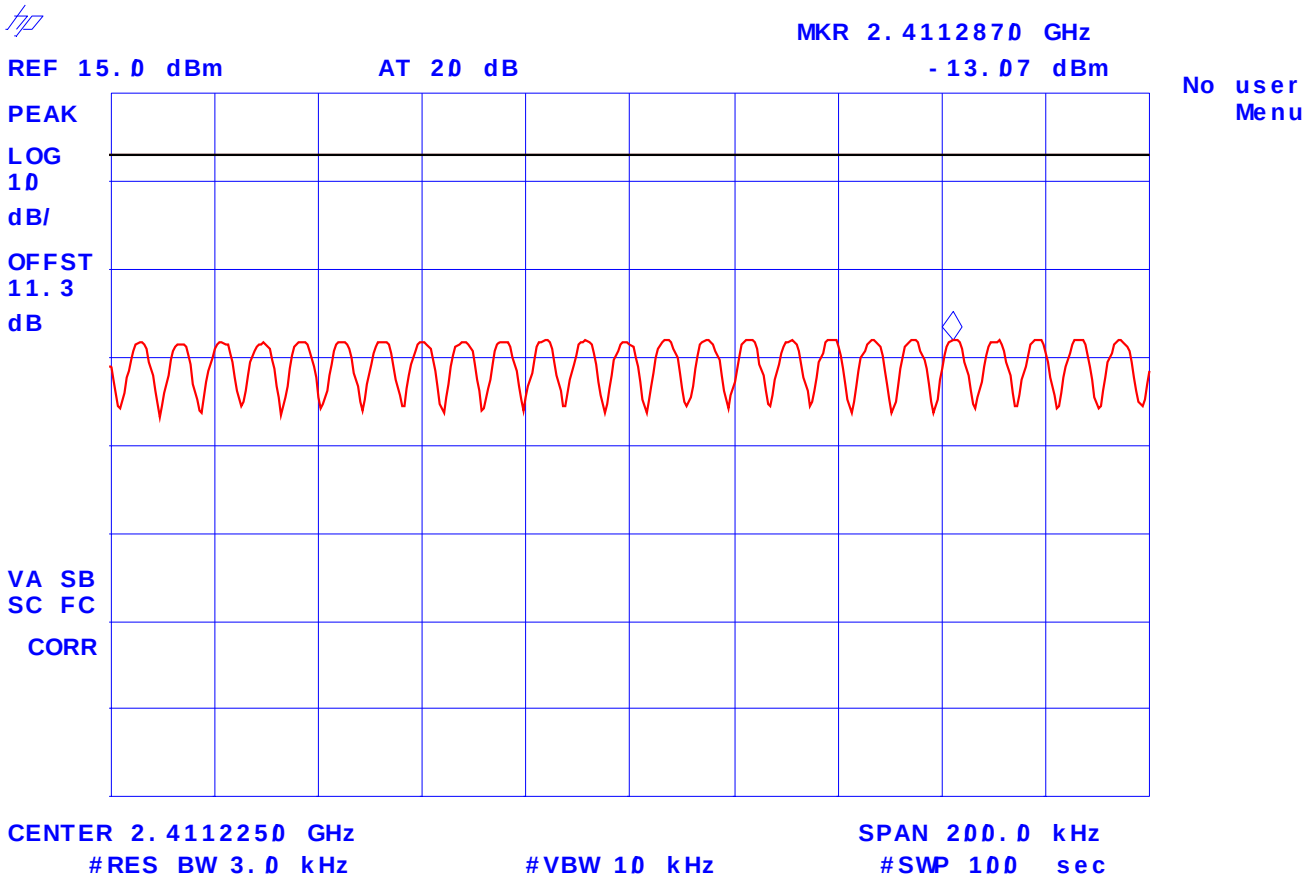
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz

5.11.5. Test Data

CHANNEL FREQUENCY (MHz)	MODULATION DATA RATE	RF POWER LEVEL IN 3 KHz BW (dBm)	LIMIT (dBm)	MARGIN (dB)	COMMENTS (PASS/FAIL)
2412	DBPSK 1 Mbps	-13.1	8.0	-21.1	PASS
2437	DBPSK 1 Mbps	-13.4	8.0	-21.4	PASS
2462	DBPSK 1 Mbps	-13.7	8.0	-21.7	PASS
2412	DQPSK 2 Mbps	-7.6	8.0	-15.6	PASS
2437	DQPSK 2 Mbps	-7.1	8.0	-15.1	PASS
2462	DQPSK 2 Mbps	-7.3	8.0	-15.3	PASS
2412	CCK 5.5 Mbps	-8.0	8.0	-16.0	PASS
2437	DQPSK 1 Mbps	-8.1	8.0	-16.1	PASS
2462	CCK 5.5 Mbps	-8.4	8.0	-16.4	PASS
2412	CCK 11 Mbps	-6.3	8.0	-14.3	PASS
2437	CCK 11 Mbps	-6.3	8.0	-14.3	PASS
2462	CCK 11 Mbps	-6.9	8.0	-14.9	PASS

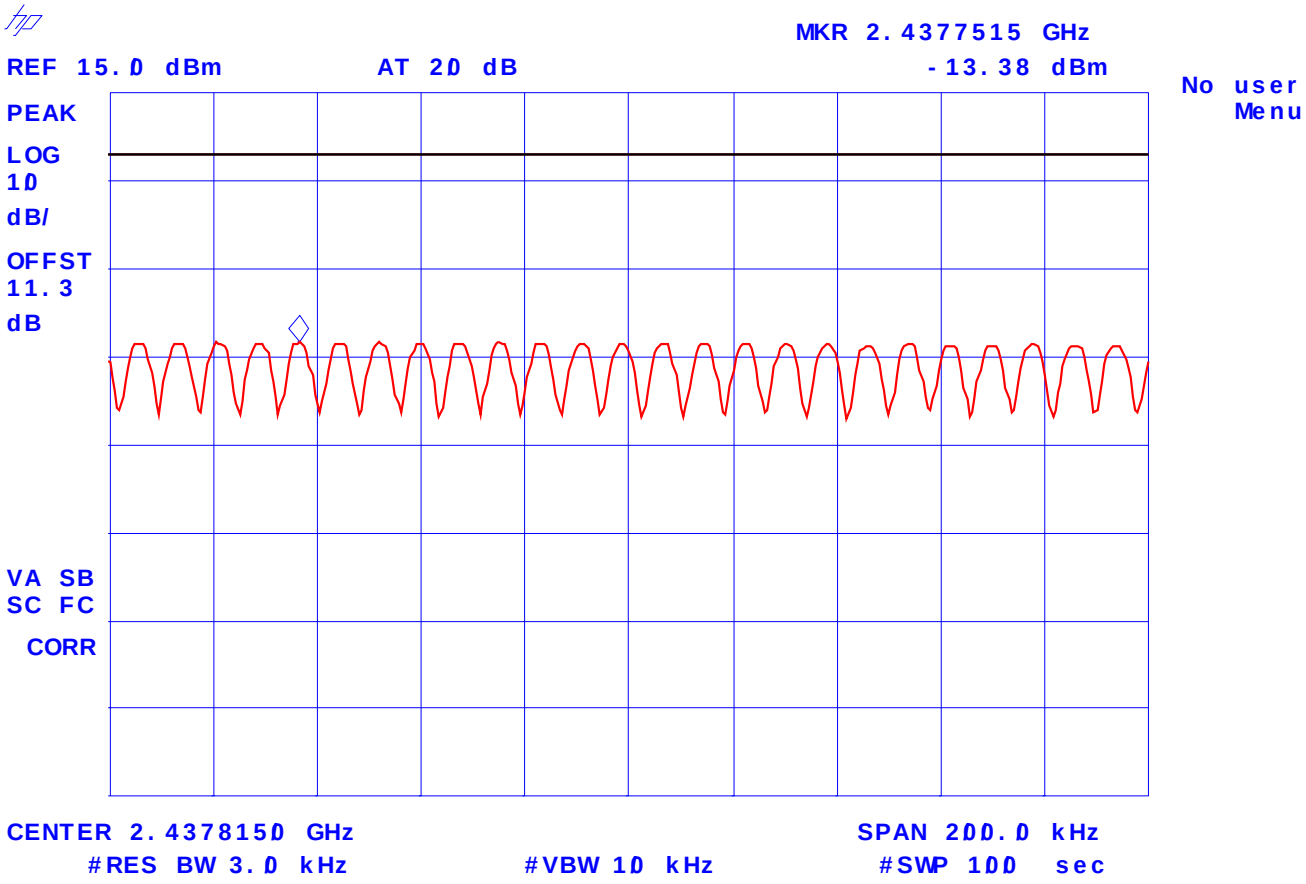
Please refer to Plots 16 to 27 below for detailed measurements

Plot # 16: Power Density in 3 kHz BW – Channel 1: 2412 MHz, DPBSK @ 1 Mb/s



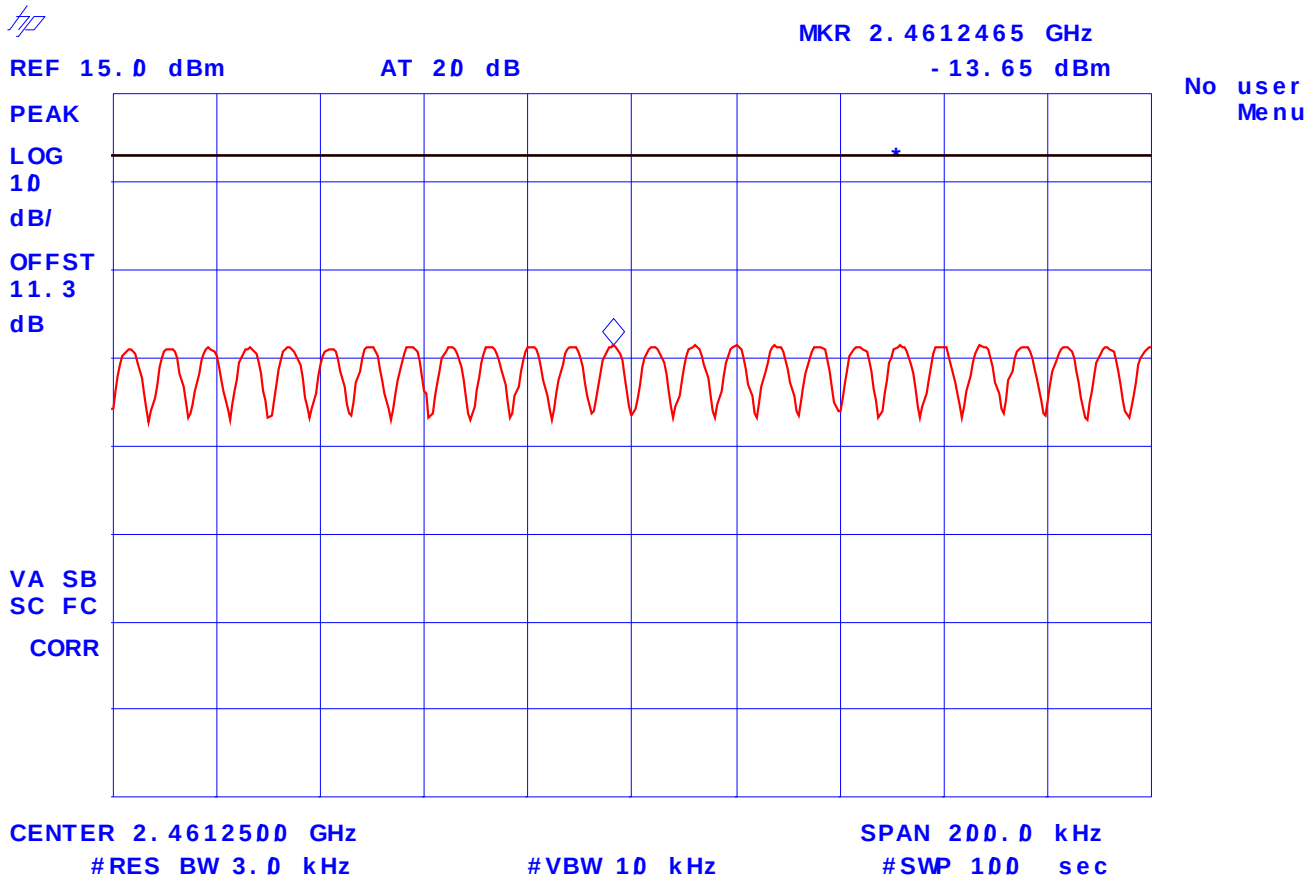
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 17: Power Density in 3 kHz BW – Channel 6: 2437 MHz, DPBSK @ 1 Mb/s



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

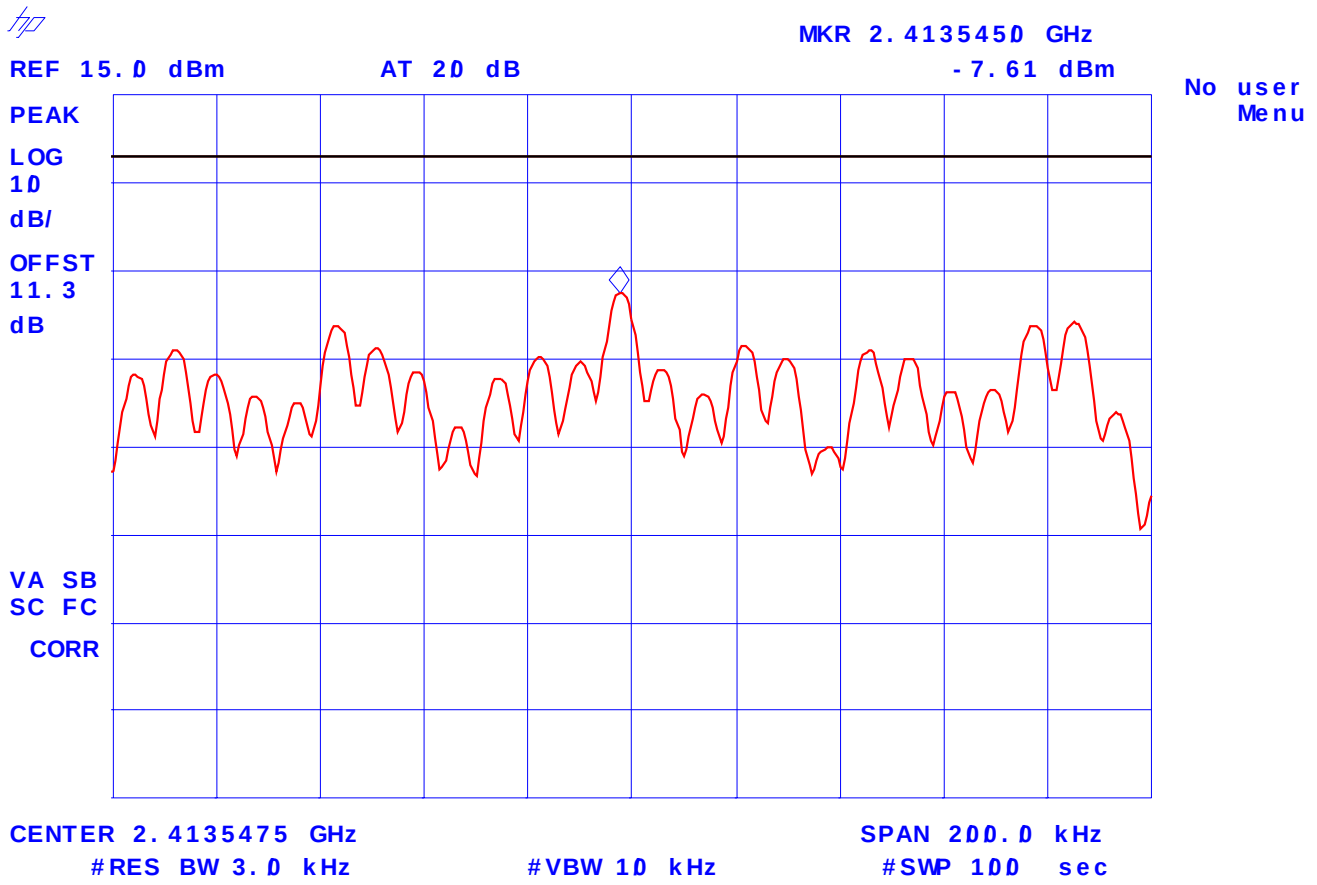
Plot # 18: Power Density in 3 kHz BW – Channel 1: 2462 MHz, DPBSK @ 1 Mb/s



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

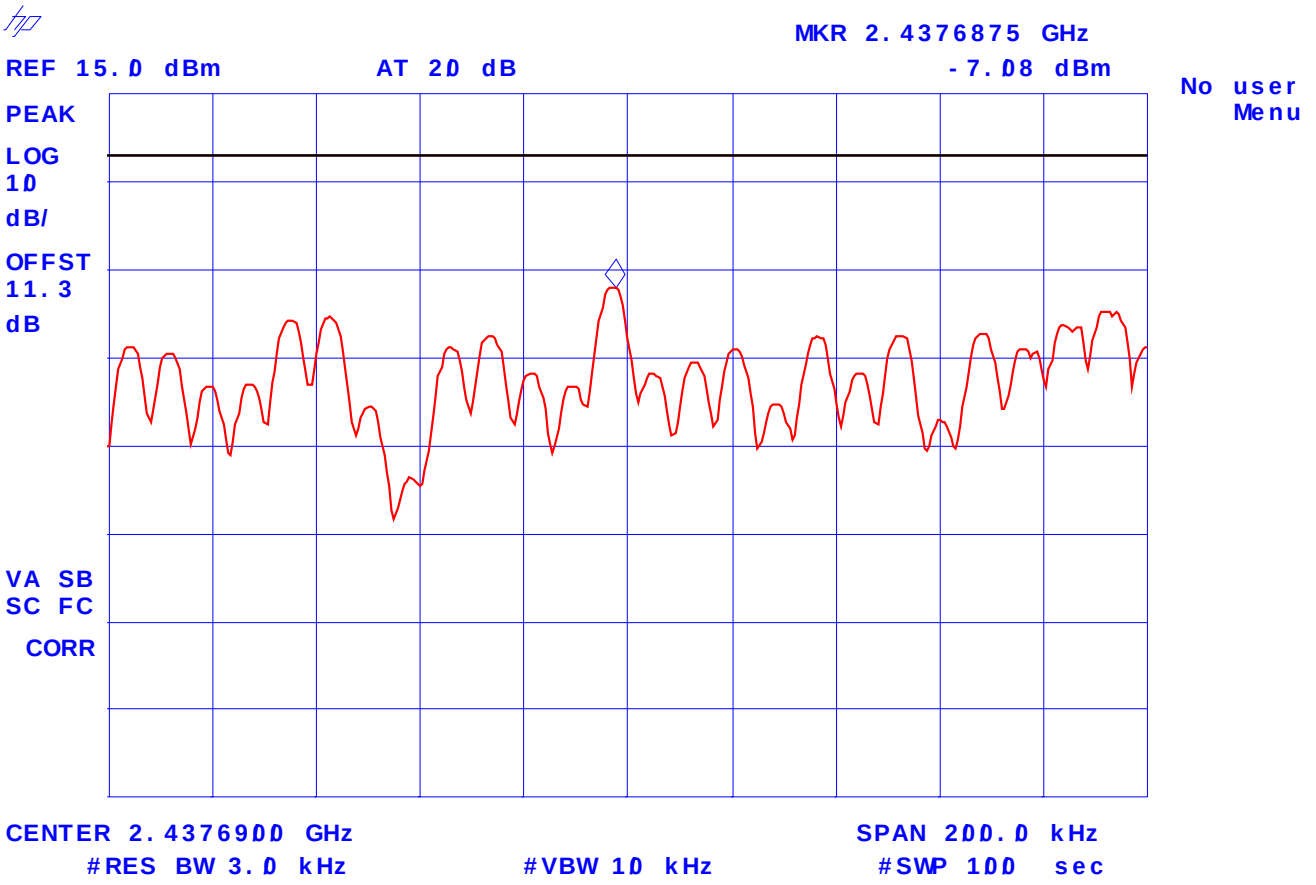
Plot # 19: Power Density in 3 kHz BW – Channel 1: 2412 MHz, DQBSK @ 2 Mb/s

\\



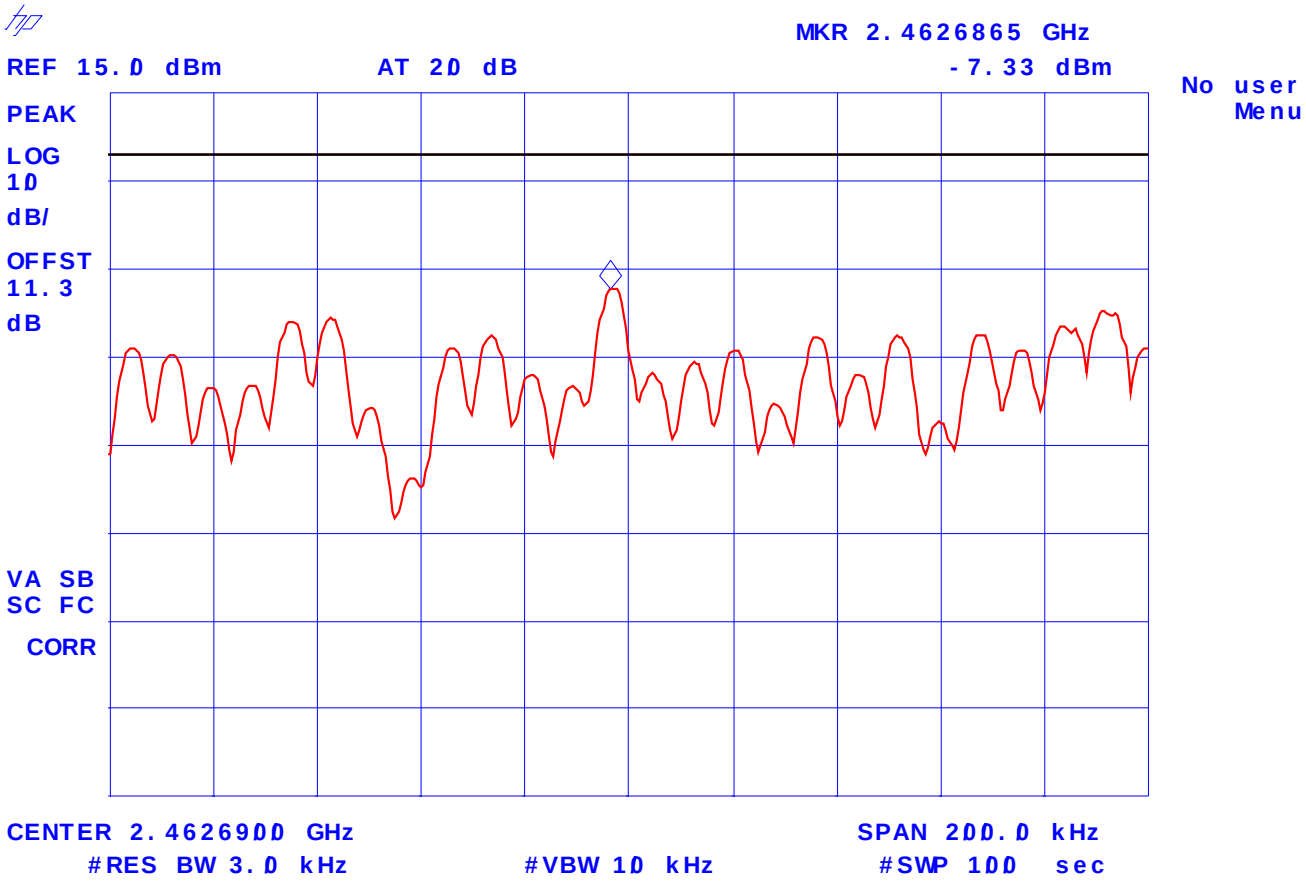
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 20: Power Density in 3 kHz BW – Channel 6: 2437 MHz, DQBSK @ 2 Mb/s



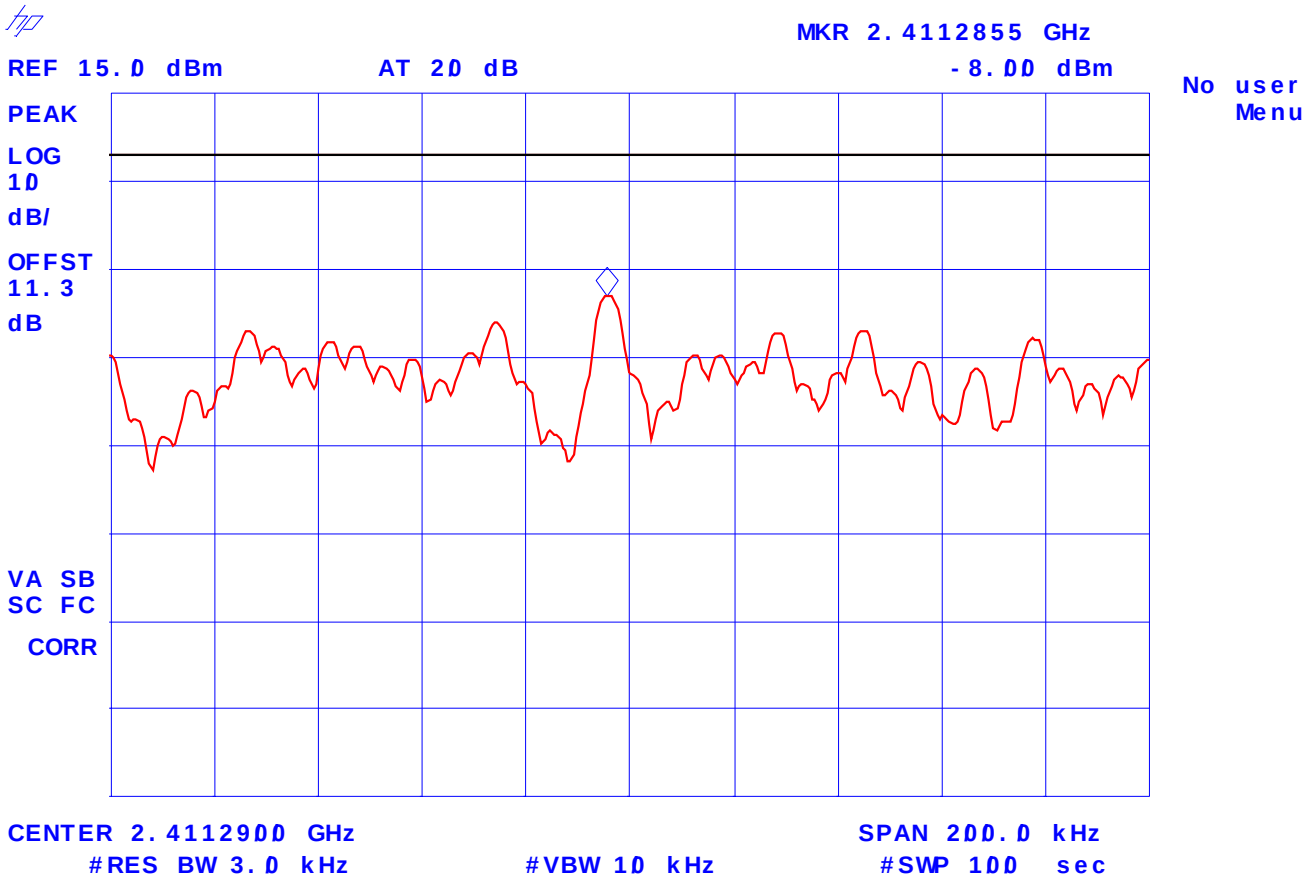
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 21: Power Density in 3 kHz BW – Channel 11: 2462 MHz, DQBSK @ 2 Mb/s



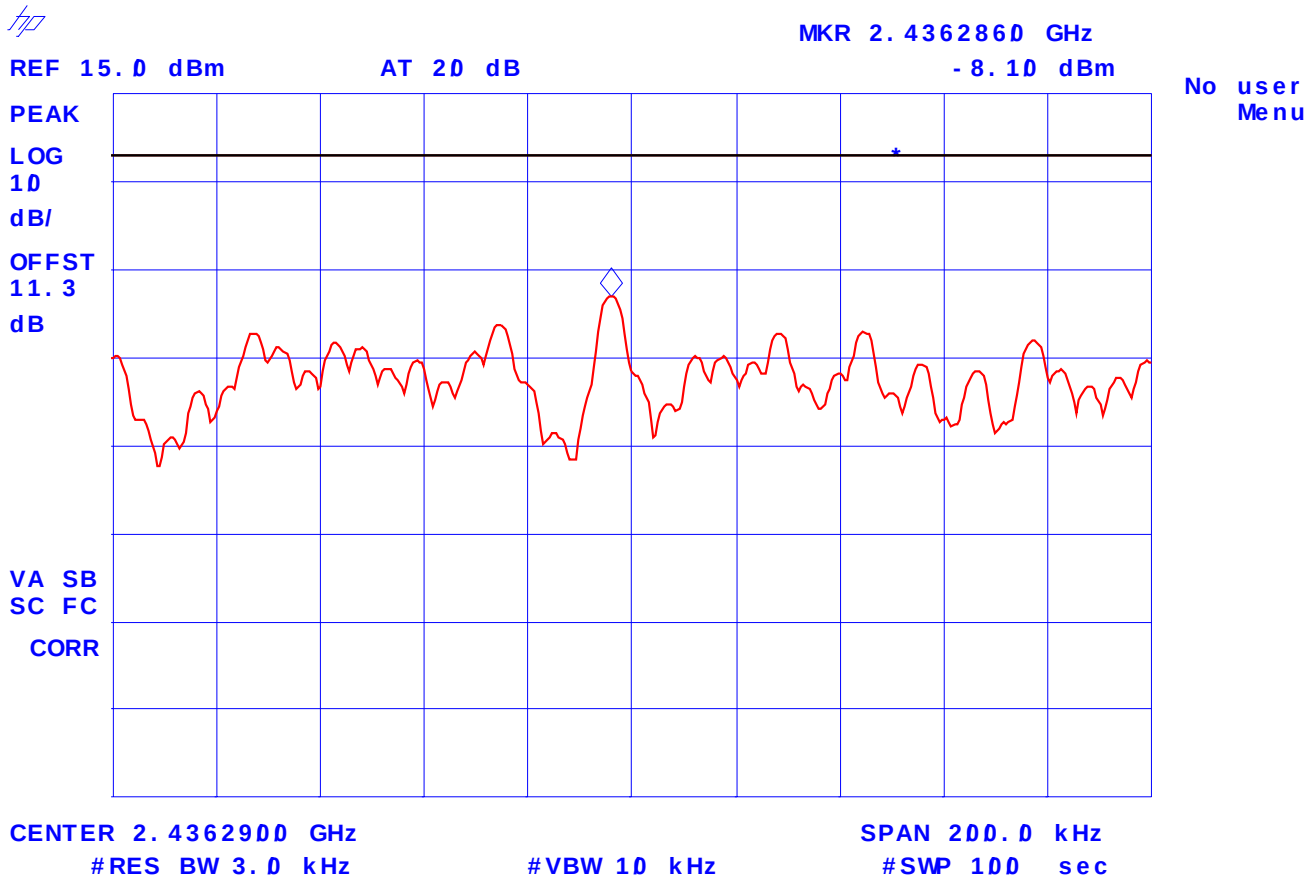
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 22: Power Density in 3 kHz BW – Channel 1: 2412 MHz, CCK @ 5.5 Mb/s



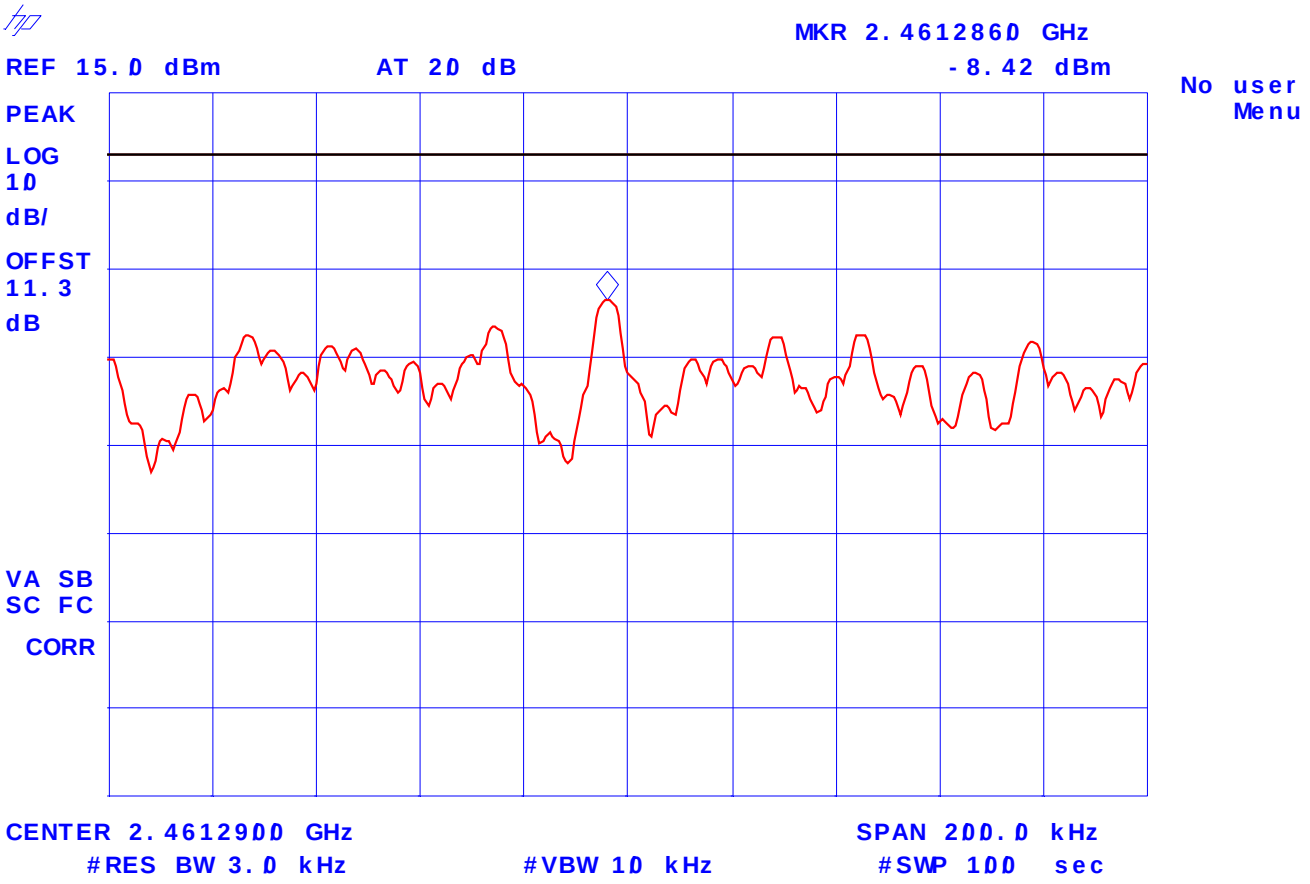
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 23: Power Density in 3 kHz BW – Channel 6: 2437 MHz, CCK @ 5.5 Mb/s



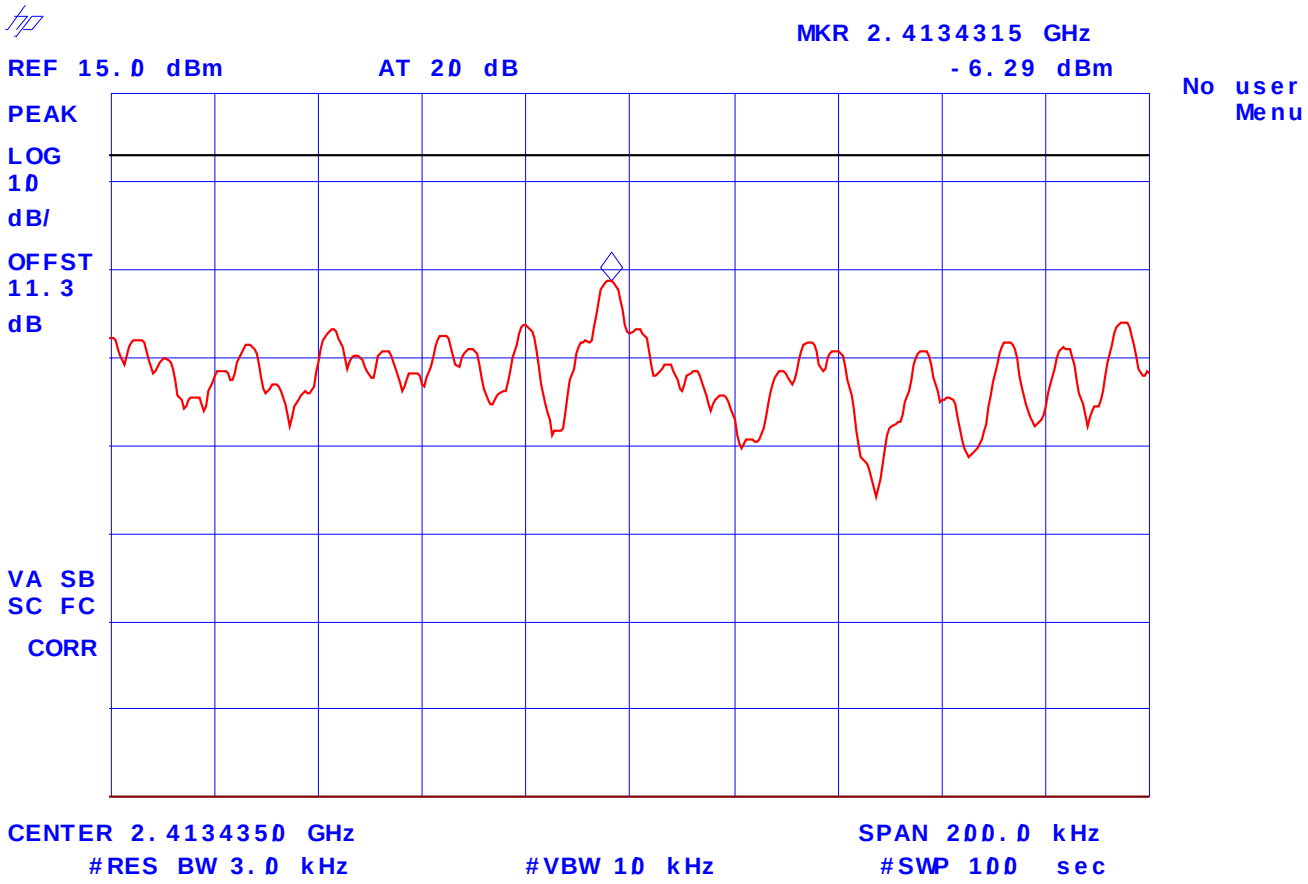
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 24: Power Density in 3 kHz BW – Channel 1: 2462 MHz, CCK @ 5.5 Mb/s



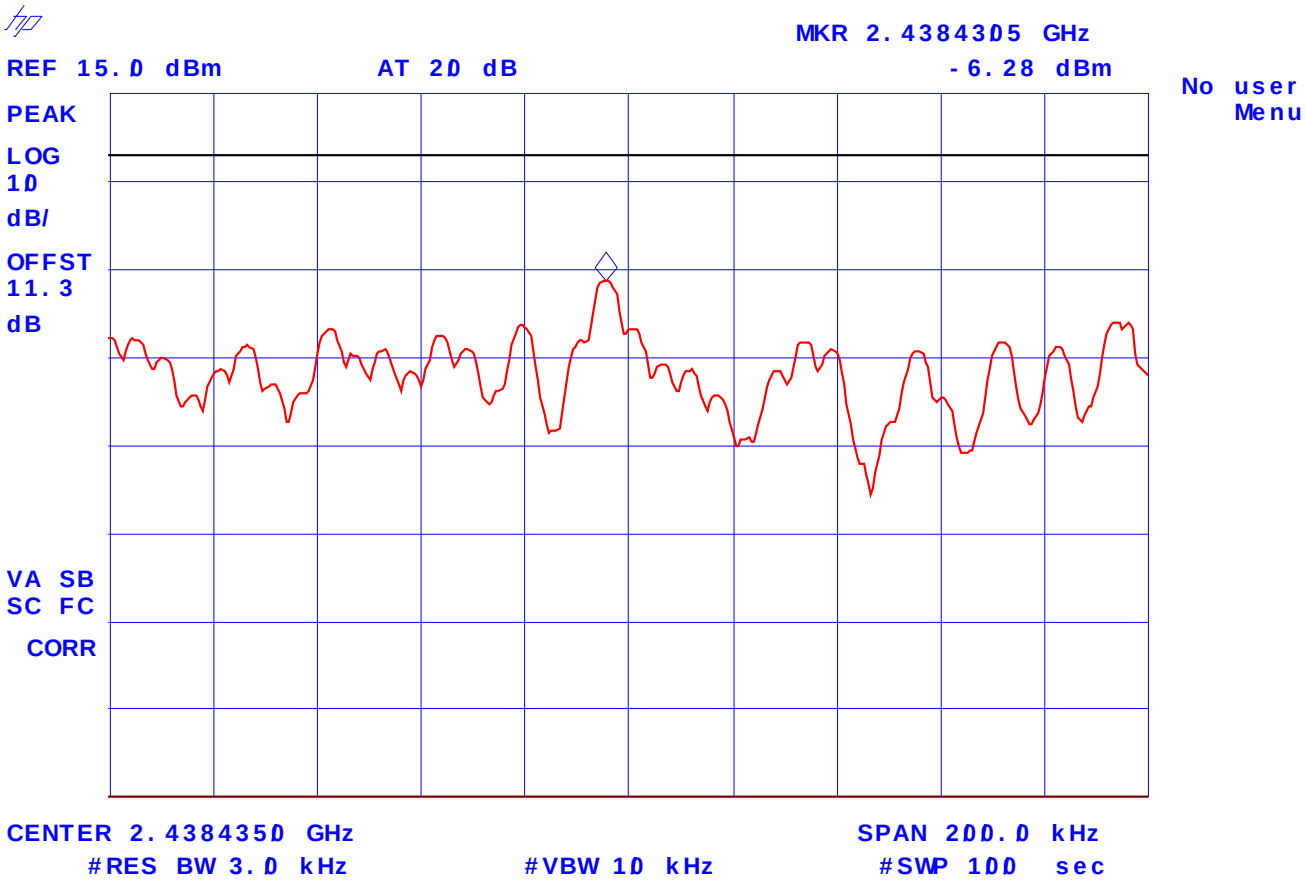
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 25: Power Density in 3 kHz BW – Channel 1: 2412 MHz, CCK @ 11 Mb/s



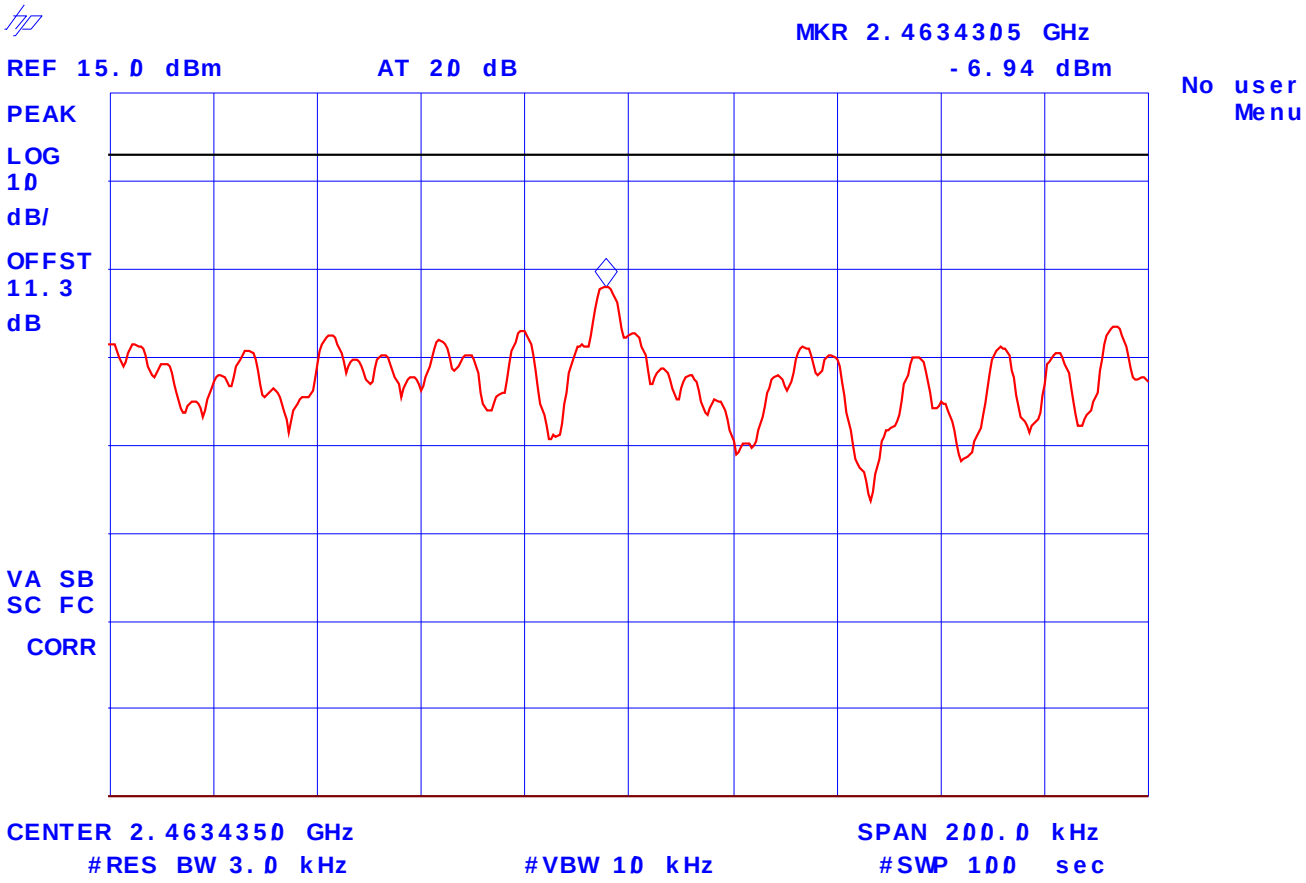
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 26: Power Density in 3 kHz BW – Channel 6: 2437 MHz, CCK @ 11 Mb/s



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

Plot # 27: Power Density in 3 kHz BW – Channel 11: 2462 MHz, CCK @ 11 Mb/s



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

5.12. SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205

5.12.1. 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

5.12.2. Method of Measurements

Refer to Exhibit 7, Sec. 7.4 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).

5.12.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A		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	K&L	11SH10-1500-T8000	--	Cut-off at 1500 MHz used for 902-928 MHz Radio
Highpass Filter	Michael Lab	XD40N	--	Cut-off at 4 GHz used for 2.4-2.4835 GHz

5.12.4. Photographs of Test Setup

Refer to the Photographs #3 & #6 in Annex 1 for setup and arrangement of equipment under tests and its ancillary equipment.

5.12.5. Test Data

5.12.5.1. Test Configuration #1: Transmitter Radiated Emissions for Model BP100E with Nearson RPSMA Ominidirectional Antenna (external), Model S131AH-2450S

5.12.5.1.1. Lowest Frequency (2412 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
2412.00	113.1	113.1	V	--	--	--	--
2412.00	114.4	114.4	H	--	--	--	--
4824.00	53.4	41.2	V	54.0	94.4	-12.8	* PASS
4824.00	53.9	41.3	H	54.0	94.4	-12.7	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded
- Please refer to Plot #28 and 29 for Band-edge Emissions

5.12.5.1.2. Middle Frequency (2437 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
2437.00	114.6	114.6	V	--	--	--	--
2437.00	116.9	116.9	H	--	--	--	--
4874.00	54.8	41.8	V	54.0	96.9	-12.2	* PASS
4874.00	56.3	44.4	H	54.0	96.9	-9.6	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded

5.12.5.1.3. Highest Frequency (2462 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
2462.00	113.7	113.7	V	--	--	--	--
2462.00	115.0	115.0	H	--	--	--	--
4924.00	54.3	41.2	V	54.0	95.0	-12.8	* PASS
4924.00	54.7	41.1	H	54.0	95.0	-12.9	* PASS
7386.00	55.8	43.2	V	54.0	95.0	-10.8	* PASS
7386.00	59.9	47.9	H	54.0	95.0	-6.1	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded
- Please refer to Plot #30 and 31 for Band-edge Emissions

5.12.5.2. Test Configuration #2: Transmitter Radiated Emissions for Model BP100S with RangeStar Omnidirectional SMT-mount antenna (internal), Model 1513151-1 (100930)

5.12.5.2.1. Lowest Frequency (2412 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
2412.00	111.5	111.5	V	--	--	--	--
2412.00	112.1	112.1	H	--	--	--	--
4824.00	57.5	43.6	V	54.0	92.1	-10.4	* PASS
4824.00	60.4	47.8	H	54.0	92.1	-6.2	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded
- Please refer to Plot #32 and 33 for Band-edge Emissions

5.12.5.2.2. Middle Frequency (2437 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
2437.00	110.0	110.0	V	--	--	--	--
2437.00	113.4	113.4	H	--	--	--	--
4874.00	54.3	40.7	V	54.0	93.4	-13.3	* PASS
4874.00	60.4	46.9	H	54.0	93.4	-7.1	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded

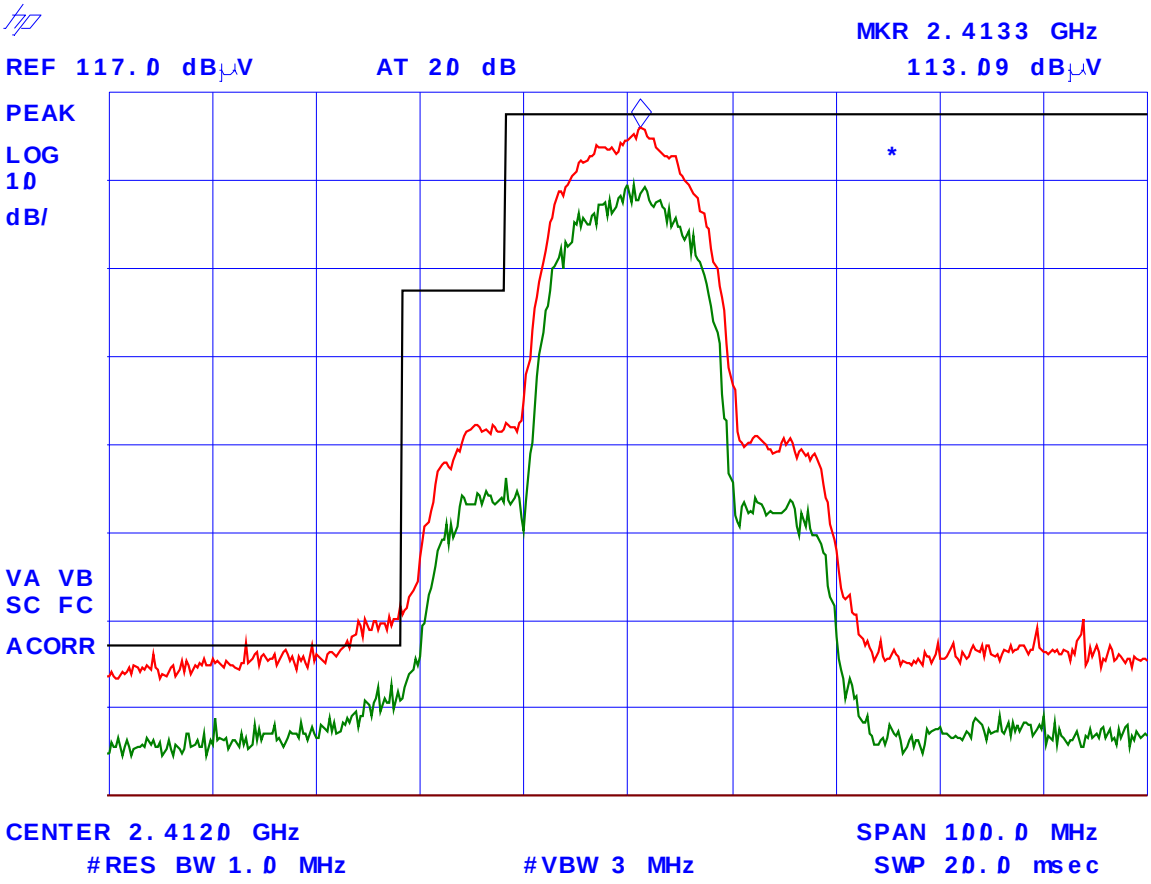
5.12.5.2.3. Highest Frequency (2462 MHz)

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
2462.00	111.8	111.8	V	--	--	--	--
2462.00	113.5	113.5	H	--	--	--	--
4924.00	51.1	37.2	V	54.0	93.5	-16.8	* PASS
4924.00	54.6	40.8	H	54.0	93.5	-13.2	* PASS

- The emissions were scanned from 10 MHz to 25 GHz and all emissions less 20 dB below the limits were recorded
- Please refer to Plot #34 and 35 for Band-edge Emissions

Plot # 28: Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization

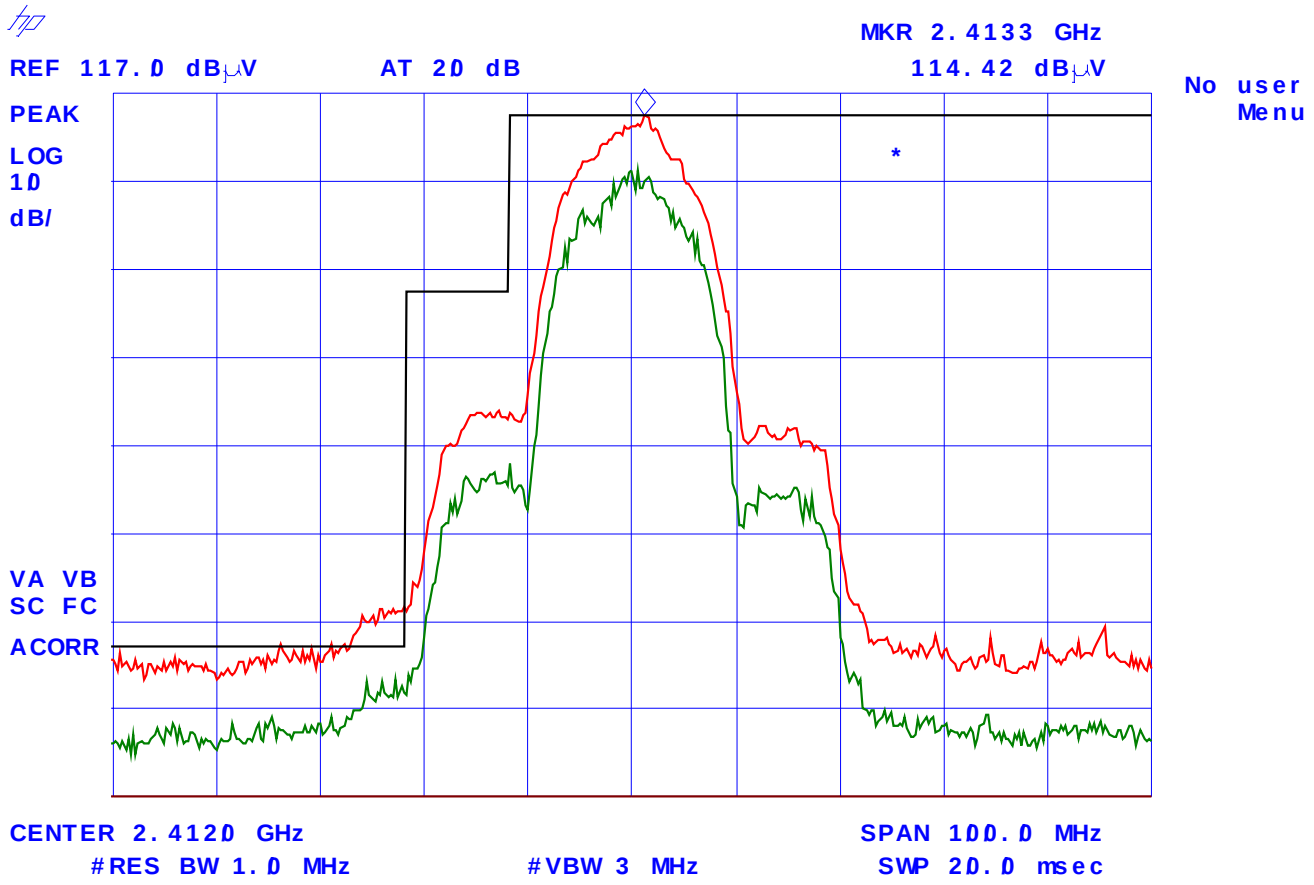
Channel 1: 2412 MHz with Nearson Antenna
Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.56 dB



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

Plot # 29: Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization

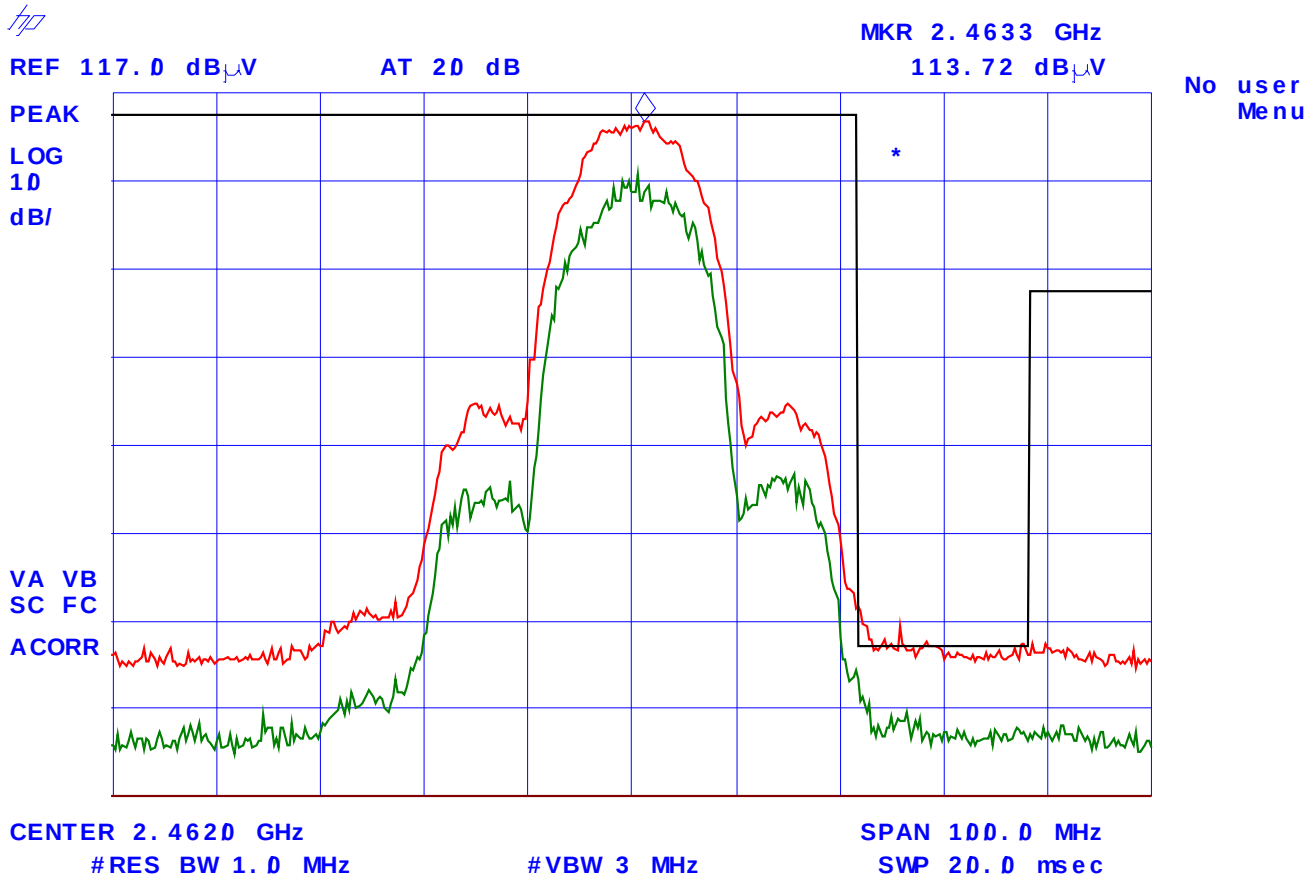
Channel 1: 2412 MHz with Nearson Antenna
Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.17 dB



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

Plot # 30: Upper Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization

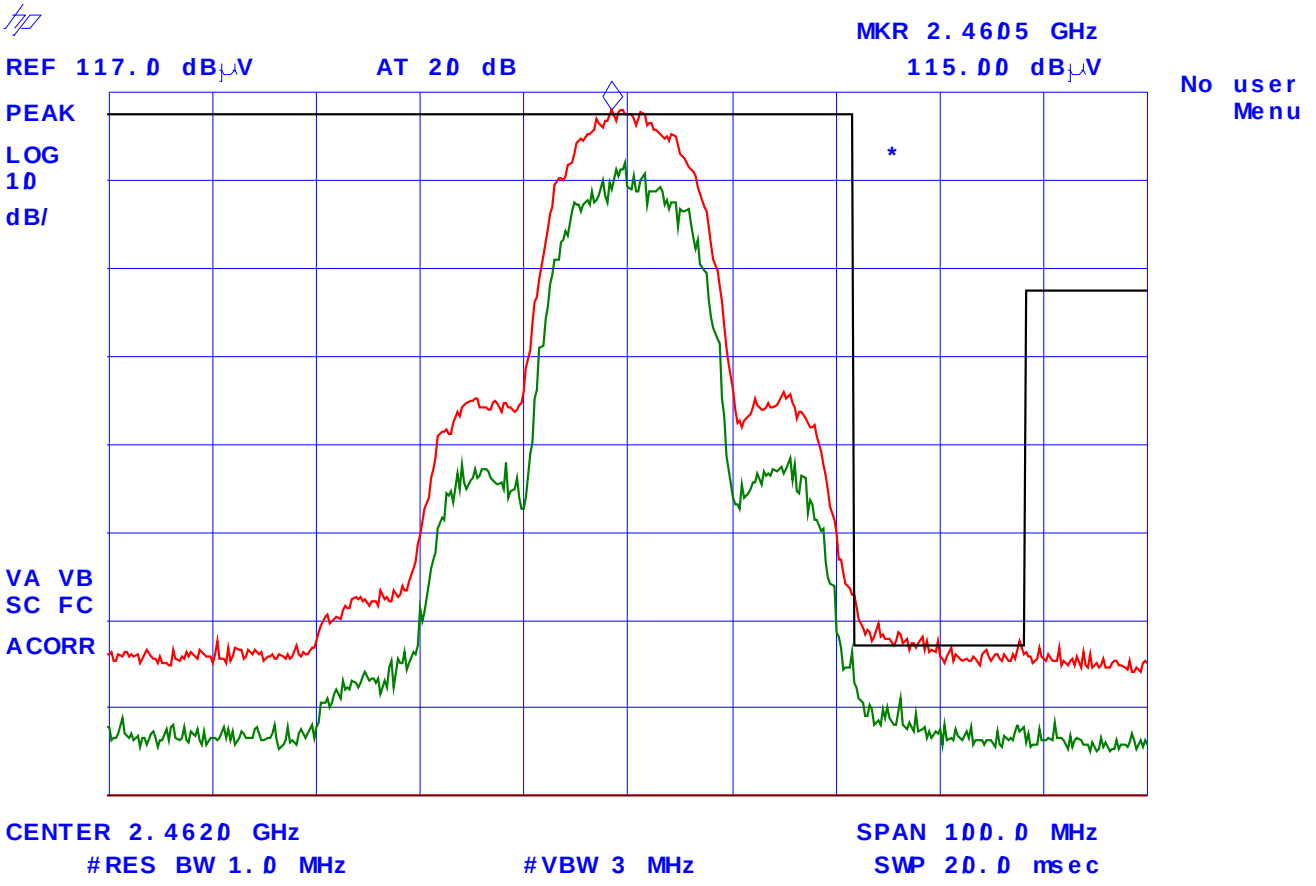
Channel 11: 2462 MHz with Nearson Antenna
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.07 dB



- *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

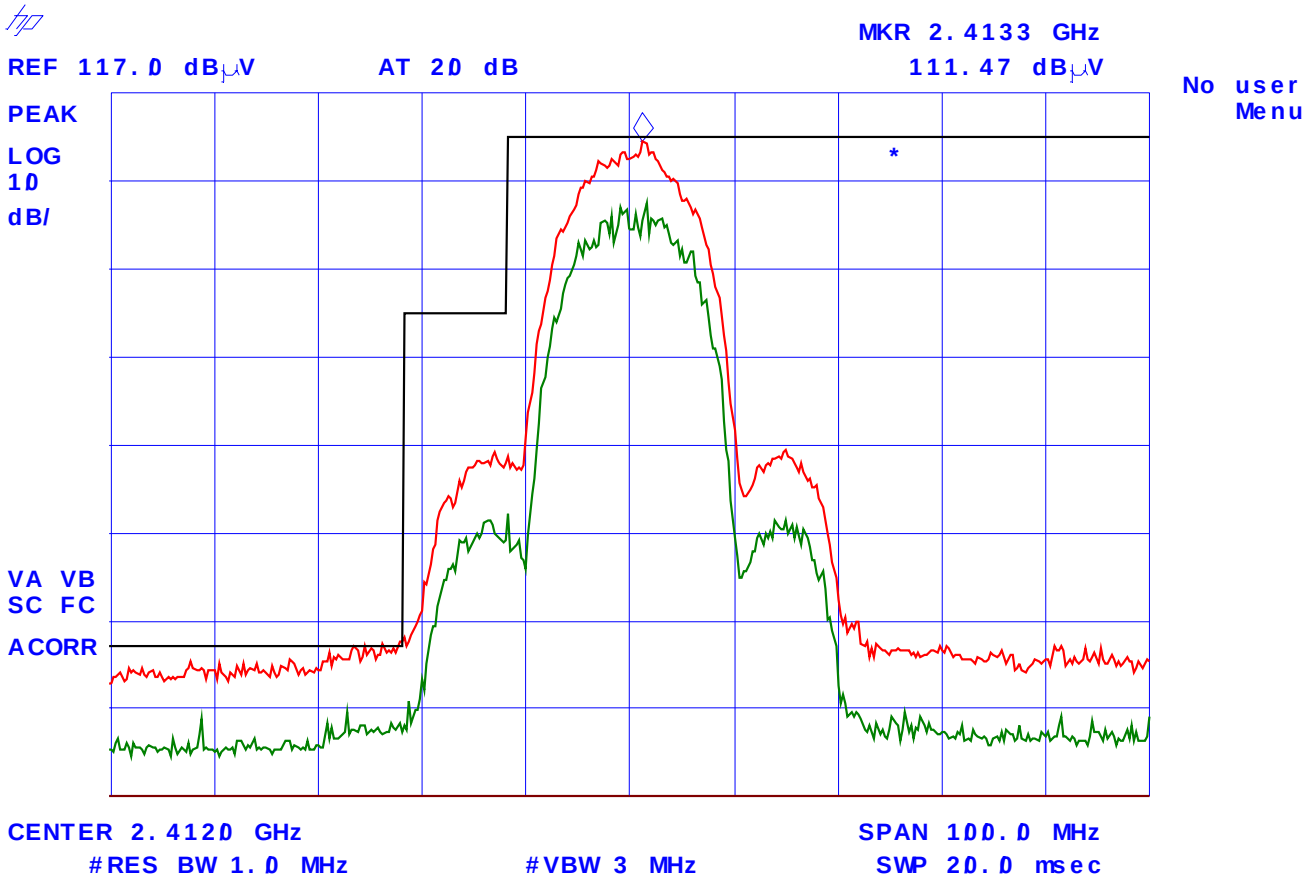
Channel 11: 2462 MHz with Nearson Antenna
Upper Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.12 dB



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

Plot # 32: Lower Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization

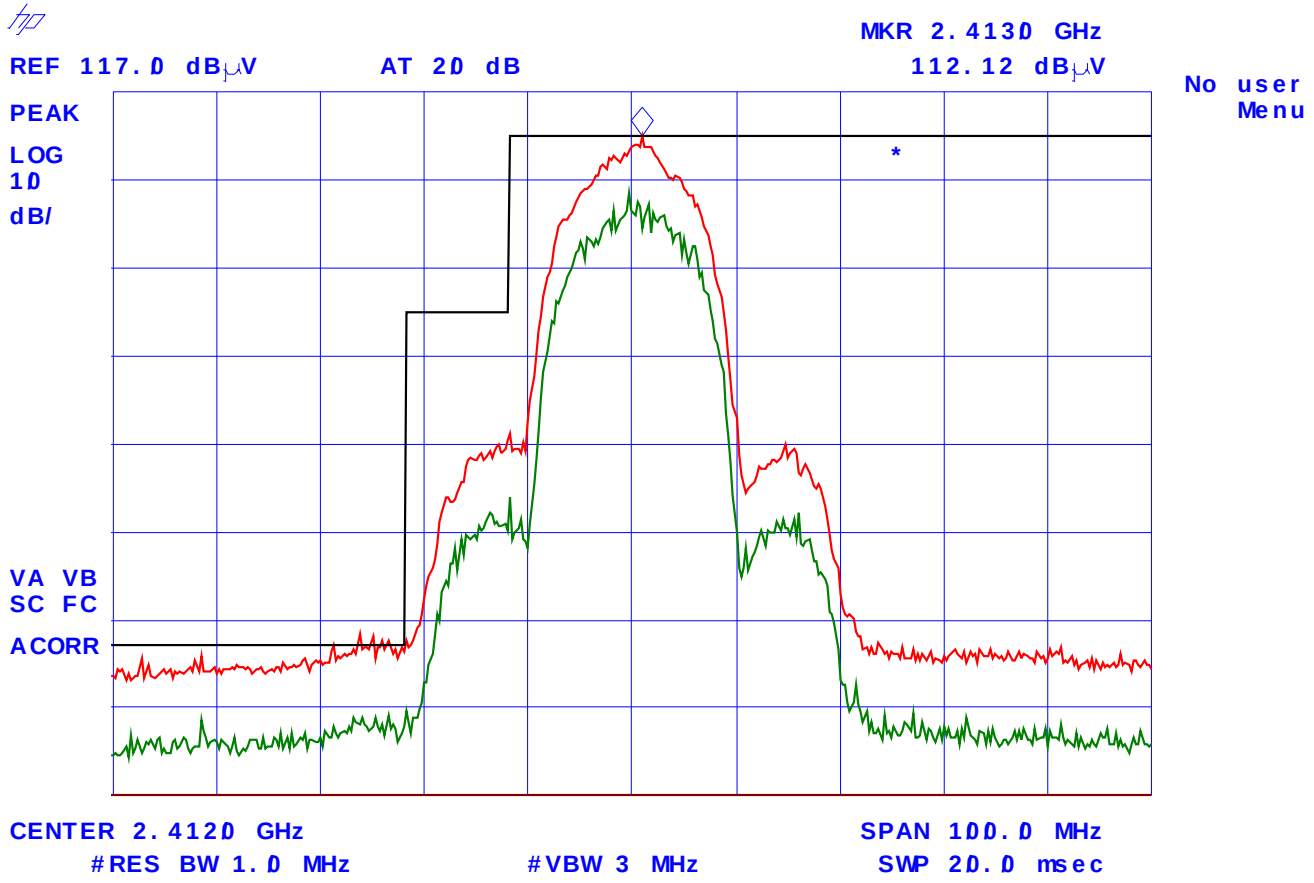
Channel 1: 2412 MHz with Rangerstar Antenna
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.93 dB



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

Plot # 33: Lower Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization

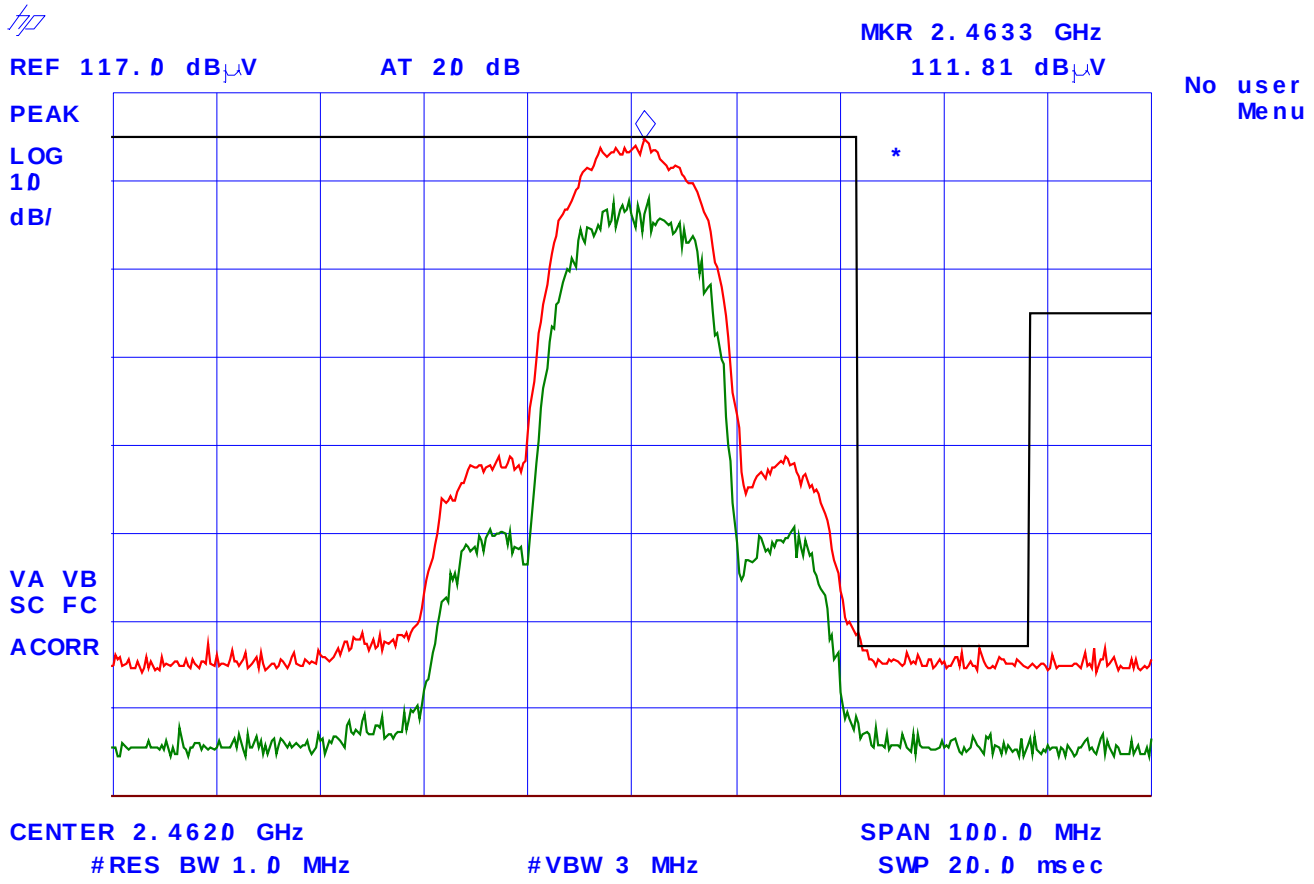
Channel 1: 2412 MHz with Rangerstar Antenna
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 5.33 dB



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

Plot # 34: Upper Band-Edge Radiated Emissions @ 3 meters, Vertical Polarization

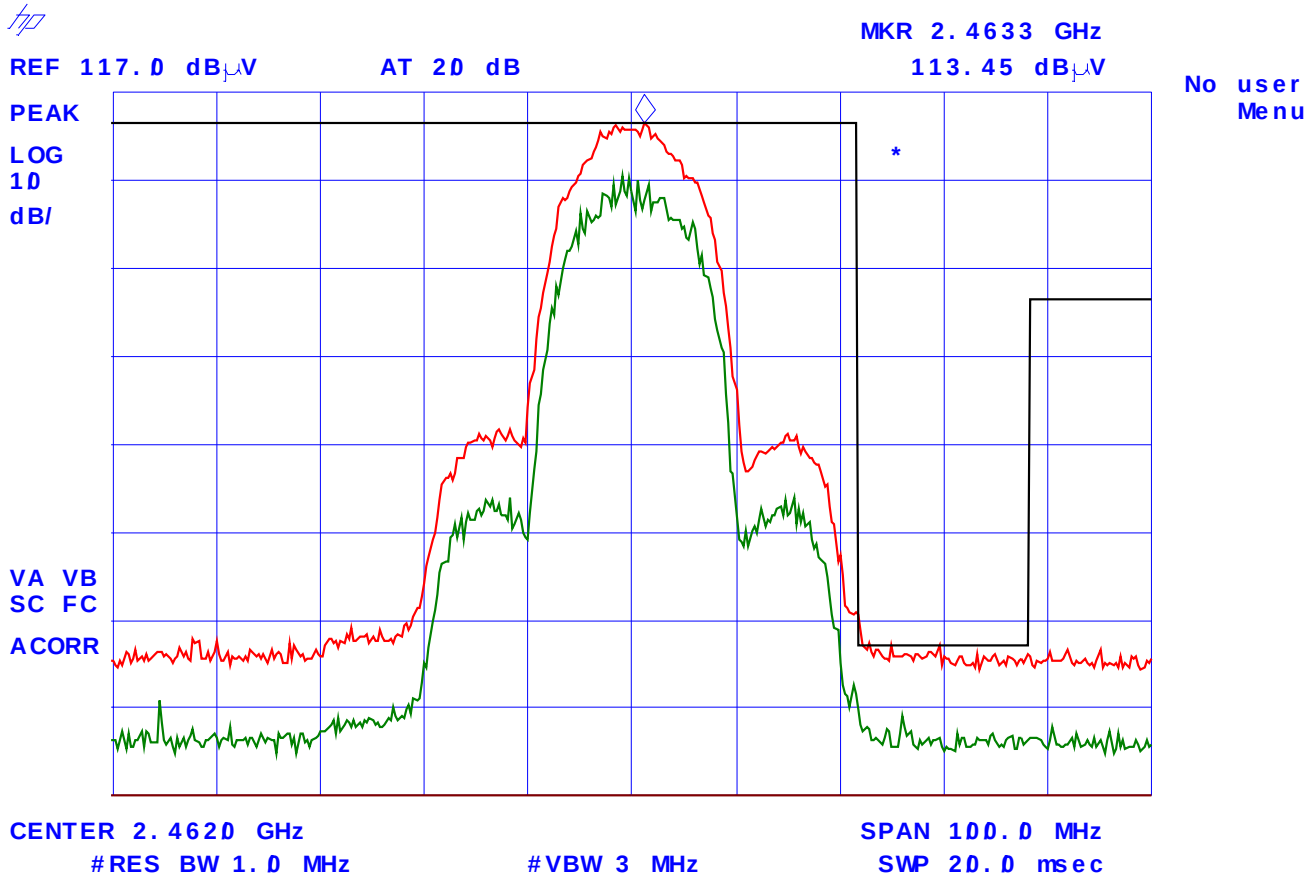
Channel 11: 2462 MHz with Rangerstar Antenna
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 6.93 dB



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

Plot # 35: Upper Band-Edge Radiated Emissions @ 3 meters, Horizontal Polarization

Channel 11: 2462 MHz with Rangerstar Antenna
Trace A: RBW= 1MHz
Trace B: RBW= 100 kHz
Δ= 5.95 dB



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

EXHIBIT 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

6.1. 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 $\Gamma_1 = 0.03$ LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	±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

6.2. 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 7. MEASUREMENT METHODS

7.1. GENERAL TEST CONDITIONS

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

7.1.1. 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.

7.1.2. Normal power source

7.1.2.1. 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.

7.1.2.2. 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.

7.1.3. 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

7.2. 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.

7.3. PEAK CONDUCTED POWER & PEAK EIRP

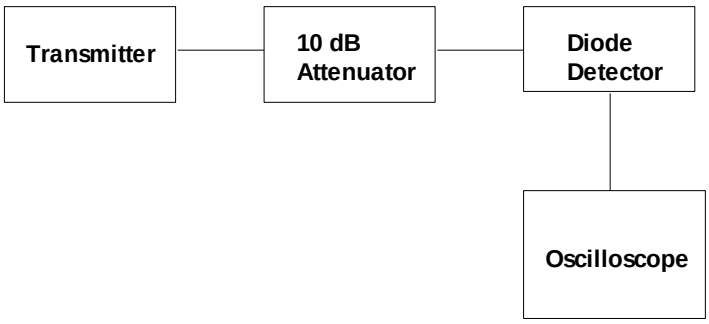
7.3.1. Measurements of Transmitter Parameters (Duty Cycle & Peak Power)

- 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:

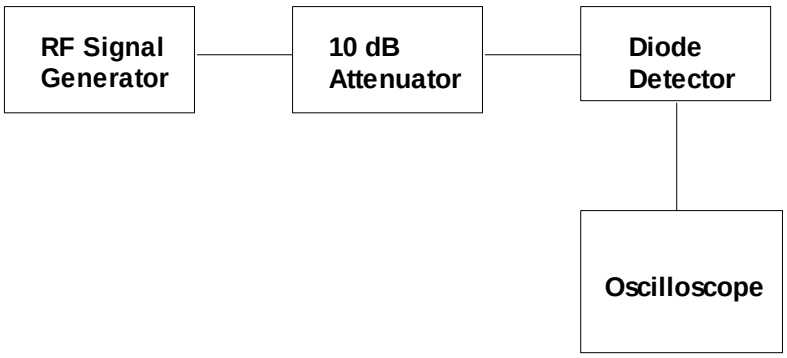
Step 1: Duty Cycle (x) and Peak Power (y) parameters measurements

- 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
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

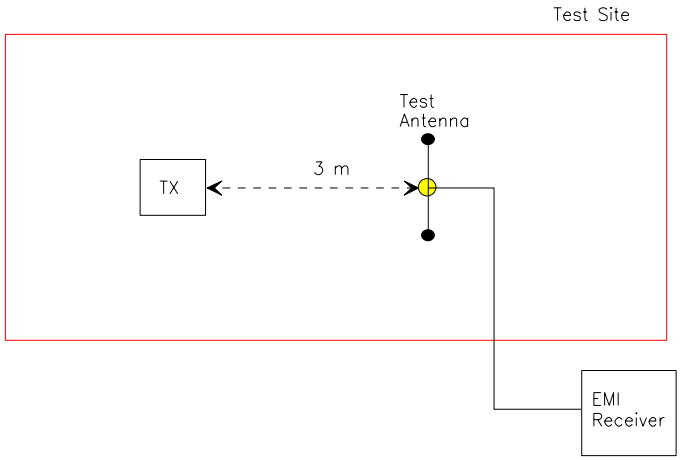
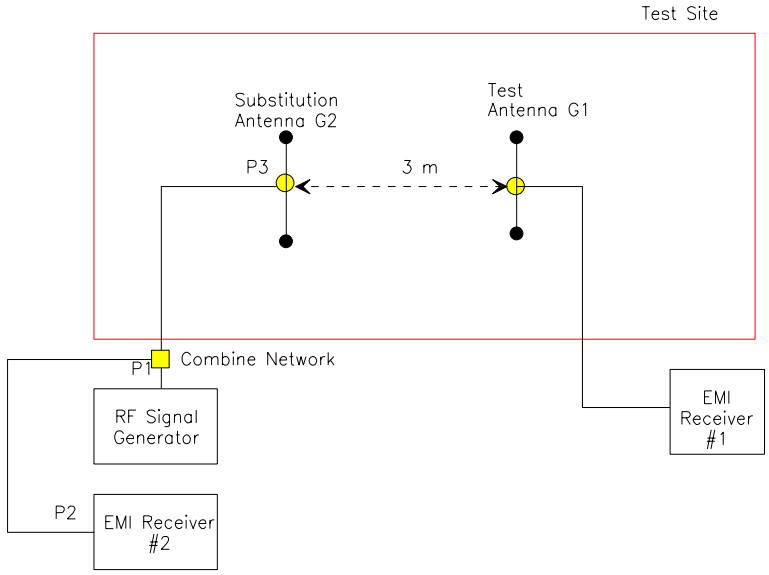


Figure 3



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

7.4. 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.

7.4.1. 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

7.4.2. 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 ≥ 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 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.

7.5. 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:

7.5.1. 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

7.5.2. 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

7.6. TRANSMITTED POWER DENSITY OF A DIGITAL MODULATION 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.