

ENGINEERING TEST REPORT



**Wireless Proprietary Telephone
Model No.: KX-TD7896**

FCC ID: ACJ96NKX-TD7896

Applicant:

Panasonic Corporation of North America
*One Panasonic Way, 4B-8
Secaucus, New Jersey
USA, 07094*

In Accordance With

**Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Frequency Hopping Spread Spectrum (FHSS) Operating
in the Frequency Band 2400 – 2483.5 MHz**

UltraTech's File No.: PAN-061F15C247

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



Date: April 19, 2005

Report Prepared by: Anca Dobre

Tested by: Hung Trinh, RFI Technician

Issued Date: April 19, 2005

Test Dates: March 21-22, 2005; April 11-15, 2005

- *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

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April 19, 2005

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

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	Test Report	OK
1	Test Setup Photos	Radiated Emissions Setup Photos	OK
2	External Photos of EUT	External EUT Photos	OK
3	Internal Photos of EUT	Internal EUT Photos	OK
4	Cover Letters	Letter from Ultratech for Certification Request	OK
5	Attestation Statements	<ul style="list-style-type: none">Letter from the Applicant to appoint Ultratech to act as an agentLetter from the Applicant to request for Confidentiality Filing	OK OK
6	ID Label/Location Info	<ul style="list-style-type: none">ID LabelLocation of ID Label	OK
7	Block Diagrams	Block Diagram	OK
8	Schematic Diagrams	Schematic Diagram	OK
9	Parts List/Tune Up Info	Parts List	OK
10	Operational Description	Operational Description	OK
11	RF Exposure Info	See SAR Test Report for details and Section 6.9 of the test report	OK
12	Users Manual	Operating Instructions	OK

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EXHIBIT 2. INTRODUCTION

2.1. 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 Frequency Hopping Spread Spectrum 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:	<ul style="list-style-type: none">• Commercial, industrial or business• Residential

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

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19	2005	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 & EN 55022	2003 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	2003	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

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Panasonic Corporation of North America
Address:	One Panasonic Way, 4B-8 Secaucus, New Jersey, USA, 07094
Contact Person:	Name: Richard Mullen Phone #: 201-348-7758 Fax #: 201-392-4564 Email Address: mullenr@us.panasonic.com

MANUFACTURER	
Name:	Panasonic Communications Co., Ltd.
Address:	1-62, 4-chome, Minoshima, Hakata-ku Fukuoka, Fukuoka-ken 812-8531 Japan
Contact Person:	Name: M. Miyazaki Phone #: 81-92-477-1101 Fax #: 81-92-477-1450 Email Address: miyazaki.michihito@jp.panasonic.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:	Panasonic
Product Name:	Wireless Proprietary Telephone
Model Name or Number:	KX-TD7896
Serial Number:	Pre-production
Type of Equipment:	Frequency Hopping Spread Spectrum Transmitter
Input Power Supply Type:	Handset: Ni-MH Battery DC 3.6V Base Unit: AC Adaptor, DC 6V (from 120V / 60Hz)
Primary User Functions of EUT:	Cordless Telephone

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3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER											
Equipment Type:	<ul style="list-style-type: none"> • Portable • Mobile 										
Intended Operating Environment:	<ul style="list-style-type: none"> • Commercial, industrial or business • Residential 										
Power Supply Requirement:	Handset: DC 3.6V Base Unit: AC 120V / 60Hz										
RF Output Power Rating:	0.315 W (25 dBm) Peak conducted power										
Operating Frequency Range:	2401.056 – 2479.680 MHz (Channel 00 to 91)										
RF Output Impedance:	50 Ohms										
Channel Spacing:	864 kHz										
20 dB Bandwidth:	Base Unit: 636 kHz Handset: 621 kHz										
Modulation Type:	GFSK										
Oscillator Frequencies:	Tx/Rx VCO: 2300-2600 MHz(typ.2450 MHz) Digital: 10.368 MHz										
Channel Occupancy:	Base Unit: 30.5 ms within a 30 second period Handset: 30.5 ms within a 30 second period										
Emission Designation:	Frequency Hopping Spread Spectrum										
Antenna Connector Type:	Permanently attached, antenna cable is soldered and fixed at EUT										
Antenna Description:	<table style="width: 100%; border: none;"> <tr> <td style="width: 40%; vertical-align: top;">Manufacturer:</td> <td>Handset: Staff Corporation</td> </tr> <tr> <td style="vertical-align: top;">Frequency:</td> <td>Base Unit: Sansei Electric Co., Ltd. Handset: 2400 – 2500 MHz</td> </tr> <tr> <td style="vertical-align: top;">Type of Antenna:</td> <td>Base Unit: 2400 – 2500 MHz Handset: Helical antenna (1/4 wave length)</td> </tr> <tr> <td style="vertical-align: top;">Gain:</td> <td>Base Unit: Dipole Antenna (1/2 wave length) Handset: max. 2.14 dBi</td> </tr> <tr> <td></td> <td>Base Unit: max. 2.14 dBi</td> </tr> </table>	Manufacturer:	Handset: Staff Corporation	Frequency:	Base Unit: Sansei Electric Co., Ltd. Handset: 2400 – 2500 MHz	Type of Antenna:	Base Unit: 2400 – 2500 MHz Handset: Helical antenna (1/4 wave length)	Gain:	Base Unit: Dipole Antenna (1/2 wave length) Handset: max. 2.14 dBi		Base Unit: max. 2.14 dBi
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Gain:	Base Unit: Dipole Antenna (1/2 wave length) Handset: max. 2.14 dBi										
	Base Unit: max. 2.14 dBi										

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
Handset				
1	Headset Jack	1	2.5mm Jack	Non-Shielded
Base Unit				
1	AC Adaptor Jack	1	DC in Jack (6V)	1.8m /Non-Shielded
2	Telephone Jack	1	RJ11 (USA) CA11 (Canada)	1.8m /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:	Headset
Brand name:	Panasonic
Model Name or Number:	KX-TCA86
Serial Number:	N/A
Connected to EUT's Port:	Headset Jack (on Handset)

Ancillary Equipment # 2	
Description:	AC adaptor
Brand name:	Panasonic
Model Name or Number:	PQLV19
Serial Number:	N/A
Connected to EUT's Port:	AC adaptor jack (on Base Unit))

Ancillary Equipment # 3	
Description:	Battery Charger
Brand name:	Panasonic
Serial Number:	N/A
Connected to EUT's Port:	Charge contact (on Handset)

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:	Handset: DC 3.6V, Base Unit: AC 120V/60 Hz

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	<ul style="list-style-type: none"> Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. The EUT operates in normal Frequency Hopping mode for occupancy duration and frequency separation.
Special Test Software:	Special software was provided by the Applicant to operate the EUT in hopping mode or at each channel frequency continuously. For example, the transmitter will be operated at each of the lowest, middle and highest frequencies individually continuously during testing.
Special Hardware Used:	None.
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):	2401.056 – 2479.680 MHz
Test Frequency(ies): (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	<ul style="list-style-type: none"> 2401.056 MHz (channel 00) 2440.800 MHz (channel 46) 2479.680 MHz (channel 91)
Transmitter Wanted Output Test Signals:	
Transmitter Power (measured maximum output power):	Handset: 0.280 Watts Peak Conducted Power Base: 0.250 Watts Peak Conducted Power
Normal Test Modulation:	GFSK
Modulating signal source:	Internal

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: January 10, 2005.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (Yes/No)
15.107 (a)	AC Power Line Conducted Emissions Measurements	Yes
15.247 (a)(1)	Provisions for Frequency Hopping Systems	Yes
15.247(b)	Peak Output Power	Yes
15.247 (h)(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes. See section 6.9 of this report and SAR Test Report for further details.
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The engineering test report is available upon request.		

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

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EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report, ANSI C63.4 and FCC Public Notice @ DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

6.2. MEASUREMENT UNCERTAINTIES

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

6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4, FCC Section 15.247 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

Cordless Telephone.

6.5. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	Manufacturer's Clarification
15.31	The hopping 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	<p>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.</p> <p>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:</p> <ul style="list-style-type: none"> ➤ 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.
15.204	<p>Provided the information for every antenna proposed for use with the EUT:</p> <ul style="list-style-type: none"> ➤ type (e.g. Yagi, patch, grid, dish, etc...), ➤ manufacturer and model number ➤ gain with reference to an isotropic radiator 	Refer to Section 3.3 of this Test Report for details of antenna information.
15.247(a)	Description of how the EUT meets the definition of a frequency hopping spread spectrum, found in Section 2.1. Based on the technical description.	Refer to Conformance to FCC Requirements document

FCC Section	FCC Rules	Manufacturer's Clarification
15.247(a)	<u>Pseudo Frequency Hopping Sequence:</u> 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	Refer to Conformance to FCC requirements document
15.247(a)	<u>Equal Hopping Frequency Use:</u> 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).	Refer to Conformance to FCC requirements document
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	Refer to Conformance to FCC requirements documents
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	Refer to Conformance to FCC requirements documents
Public Notice DA 00-705	<u>System Receiver Input Bandwidth:</u> 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.	Refer to Conformance to FCC requirements documents
Public Notice DA 00-705	<u>System Receiver Hopping Capability:</u> Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals	Refer to Conformance to FCC requirements documents

6.6. AC POWER LINE CONDUCTED EMISSIONS [§ 15.107 (a)]

6.6.1. Limits

The equipment shall meet the limits of the following table:

Frequency of emission (MHz)	Class B Conducted Limits (dB μ V)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW \geq 9 kHz for QP VBW = 1 Hz for Average
0.5–5	56	46	
5–30	60	50	

* Decreases linearly with logarithm of the frequency

6.6.2. Method of Measurements

Refer to Section 8.2 of this test report & ANSI C63.4.

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 μ H
24'(L) x 16'(W) x 8'(H) RF Shielded Chamber	Braden Shielding	...	...	...

6.6.4. Test Data

Frequency (MHz)	RF Level (dBµV)	Receiver Detector (P/QP/AVG)	QP Limit (dBuV)	AVG Limit (dBuV)	Margin (dB)	Pass/ Fail	Line Tested (L1/L2)
Test Configuration #1: Base Unit							
0.15	33.6	QP	65.7	55.7	-32.1	Pass	L1
0.15	29.2	AVG	65.7	55.7	-26.5	Pass	L1
1.76	28.5	QP	56.0	46.0	-27.5	Pass	L1
1.76	24.7	AVG	56.0	46.0	-21.3	Pass	L1
Test Configuration #2: Handset on Battery Charger							
0.15	33.9	QP	65.8	55.8	-31.9	Pass	L2
0.15	29.3	AVG	65.8	55.8	-26.5	Pass	L2
1.88	27.7	QP	56.0	46.0	-28.3	Pass	L2
1.88	24.3	AVG	56.0	46.0	-21.7	Pass	L2
Test Configuration #2: Handset on Battery Charger							
0.16	32.8	QP	65.7	55.7	-32.9	Pass	L1
0.16	27.8	AVG	65.7	55.7	-27.9	Pass	L1
1.88	27.9	QP	56.0	46.0	-28.1	Pass	L1
1.88	24.4	AVG	56.0	46.0	-21.6	Pass	L1
Test Configuration #2: Handset on Battery Charger							
0.15	33.3	QP	65.8	55.8	-32.5	Pass	L2
0.15	29.7	AVG	65.8	55.8	-26.1	Pass	L2
1.88	28.2	QP	56.0	46.0	-27.8	Pass	L2
1.88	24.3	AVG	56.0	46.0	-21.7	Pass	L2

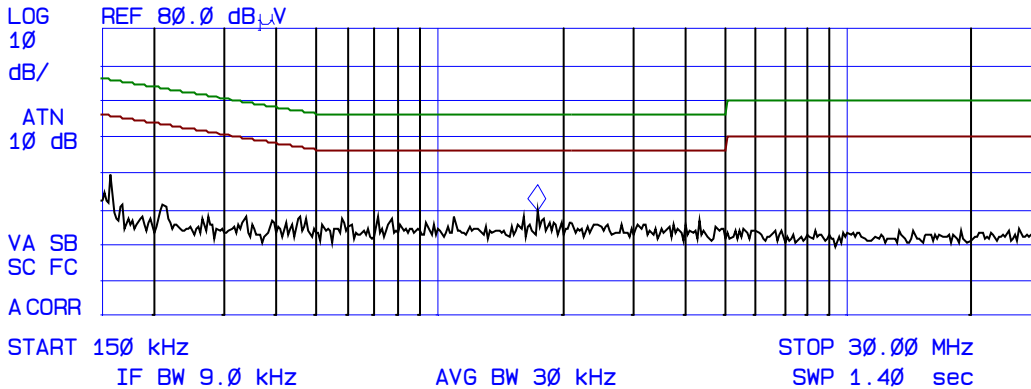
Note: See the following test data plots (#1 to 4) for detailed measurements.

Plot 1:
 AC Power Line Conducted Emissions (Base Unit)
 Line Voltage: 120Vac/60 Hz
 Line Tested: L1

1/17

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.154875	41.8	33.6	29.2	-26.5
2	1.755625	31.4	28.5	24.7	-21.3

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 1.76 MHz
 29.08 dB μ V

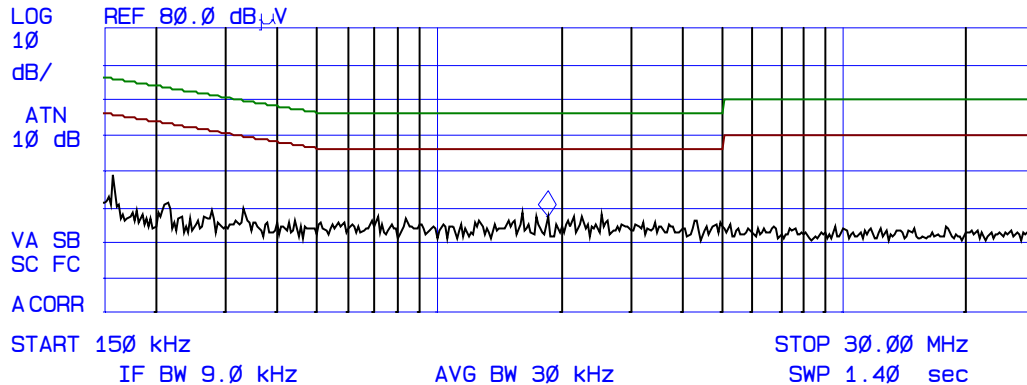


Plot 2:
 AC Power Line Conducted Emissions (Base Unit)
 Line Voltage: 120Vac/60 Hz
 Line Tested: L2

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Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.154050	42.1	33.9	29.3	-26.5
2	1.876625	31.4	27.7	24.3	-21.7

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 1.87 MHz
 26.94 dB μ V

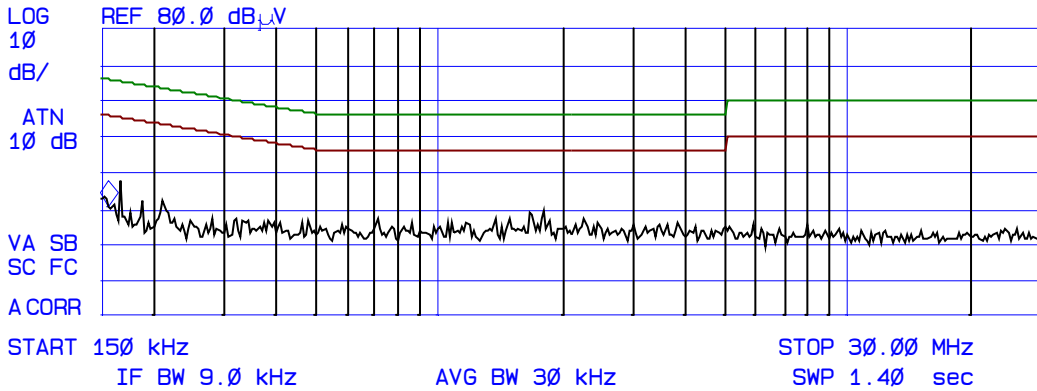


Plot 3:
 AC Power Line Conducted Emissions (Handset on Battery Charger)
 Line Voltage: 120Vac/60 Hz
 Line Tested: L1

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Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.156125	42.1	32.8	27.8	-27.9
2	1.876750	31.8	27.9	24.4	-21.6

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 160 kHz
 30.52 dB μ V

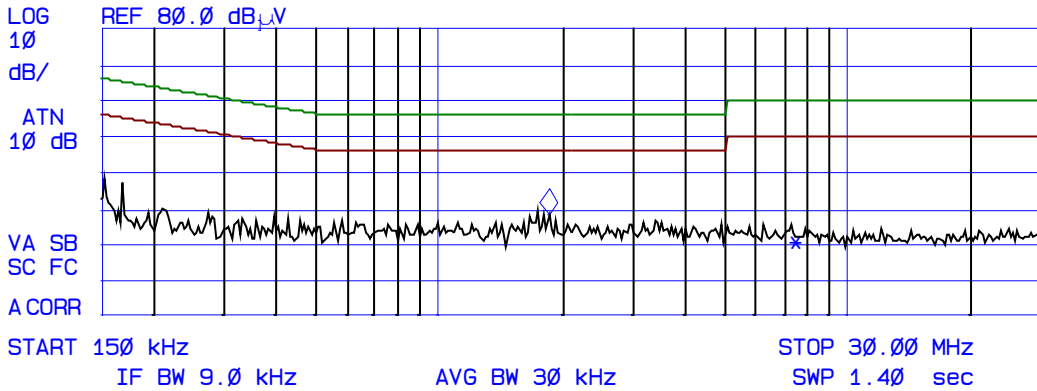


Plot 4:
 AC Power Line Conducted Emissions (Handset on Battery Charger)
 Line Voltage: 120Vac/60 Hz
 Line Tested: L2

17

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.153762	41.5	33.3	29.7	-26.1
2	1.876875	30.5	28.2	24.3	-21.7

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 1.87 MHz
 27.89 dB μ V



6.7. PROVISIONS FOR FREQUENCY HOPPING SYSTEMS [§ 15.247 (a) (1)]

6.7.1. Limits

- § 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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. 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.
- § 15.247 (a)(1)(iii): Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 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 may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

6.7.2. Method of Measurements

Refer to ANSI C63.4 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 \geq 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 \geq 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 \geq RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

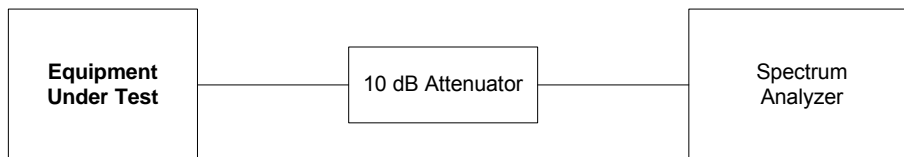
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. data rate modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope 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 \geq RBW
- Sweep = auto
- Detector = peak
- Trace = max hold
- The transmitter shall be transmitting at its maximum data rate.
- Allow the trace to stabilize.
- Use the marker-to-peak function to set the marker to the peak of the emission.
- Use the marker-delta function to measure 20 dB down on both sides of the emission.
- The 20 dB BW is the delta reading in frequency between two markers.

6.7.3. Test Arrangement



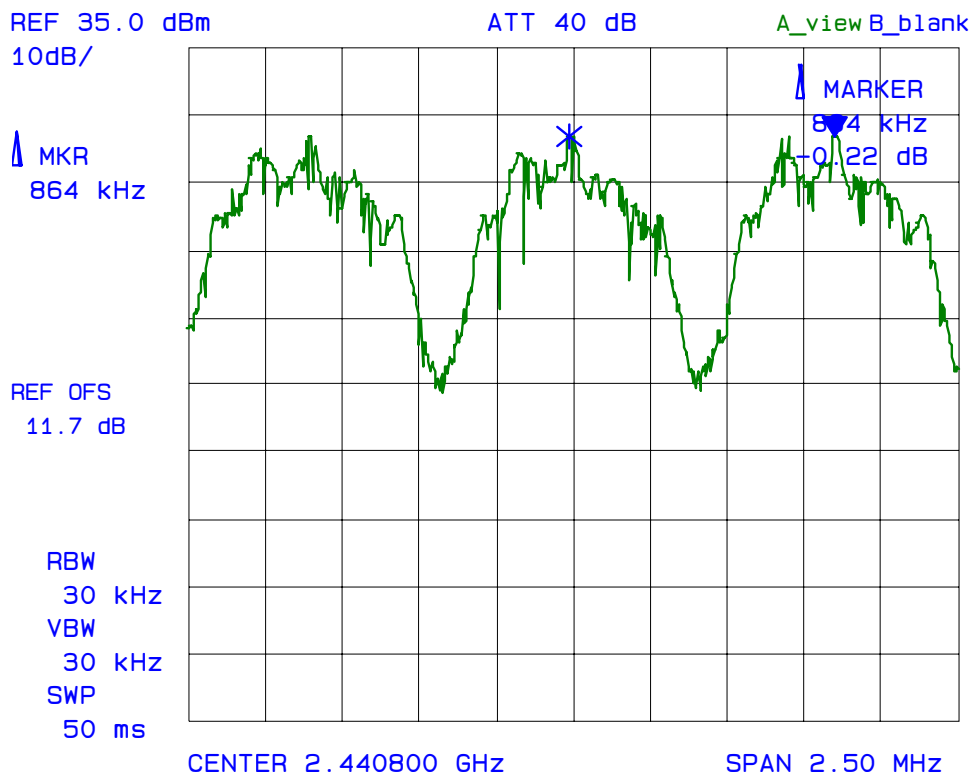
6.7.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Attenuation	Weinshel	24-10-34	BK8612	DC – 8.5 GHz

6.7.5. Test Data

Test Description	FCC Specification	Measured Values	Comments
Carrier Frequency Separation	25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.	Base Unit: 864 kHz Handset: 864 kHz	Pass; see plots 5 to 6 for measurement details.
Number of Hopping Frequencies	At least 15 non-overlapping channels	Base Unit: 75 hopping frequency Handset: 75 hopping frequency	Pass; see plots 7 to 10 for measurement details. Pass: see plots 11 to 14 for measurement details.
20 dB bandwidth	No specified limit	Base Unit: 636 kHz Handset: 621 kHz	Pass; see plots 15 to 17 for measurement details. Pass; see plots 18 to 20 for measurement details.
Average Time of Occupancy (Dwell Time)	Not greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.	Base Unit: 30.5 ms within a 30 seconds period Handset: 30.5 ms within a 30 seconds period	Pass; see plots 21 to 26 for measurement details. Pass; see plots 27 to 32 for measurement details.

Plot 5:
Carrier Frequency Separation (Base Unit)
Test Frequency: 2440.800 MHz (channel 46)



ULTRATECH GROUP OF LABS

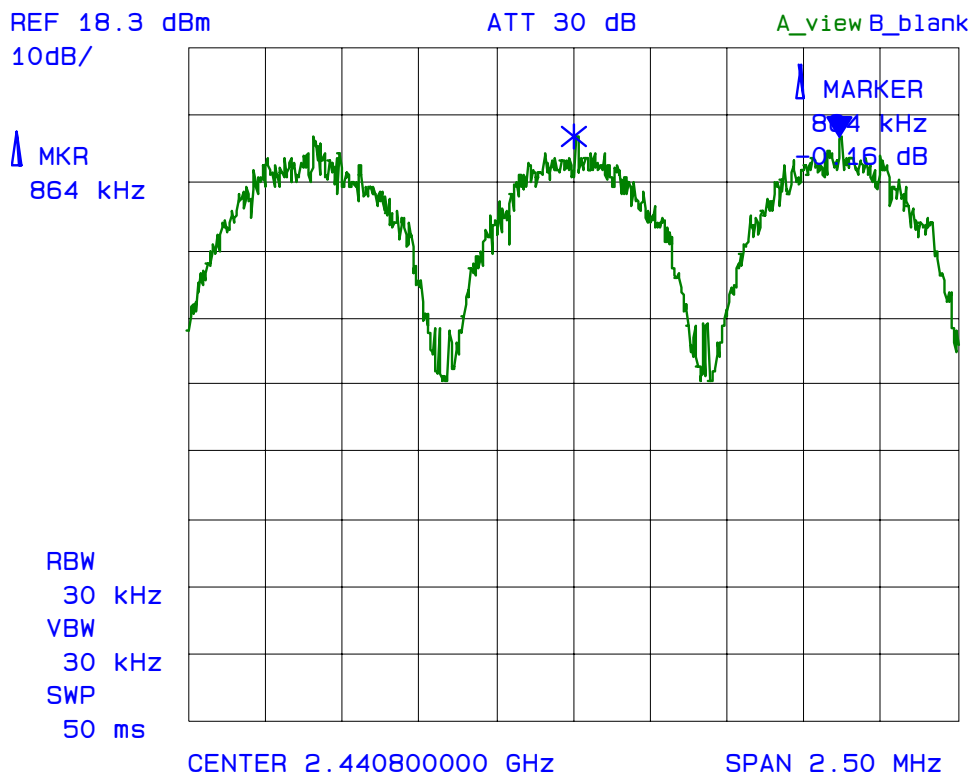
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: yic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: PAN-061F15C247

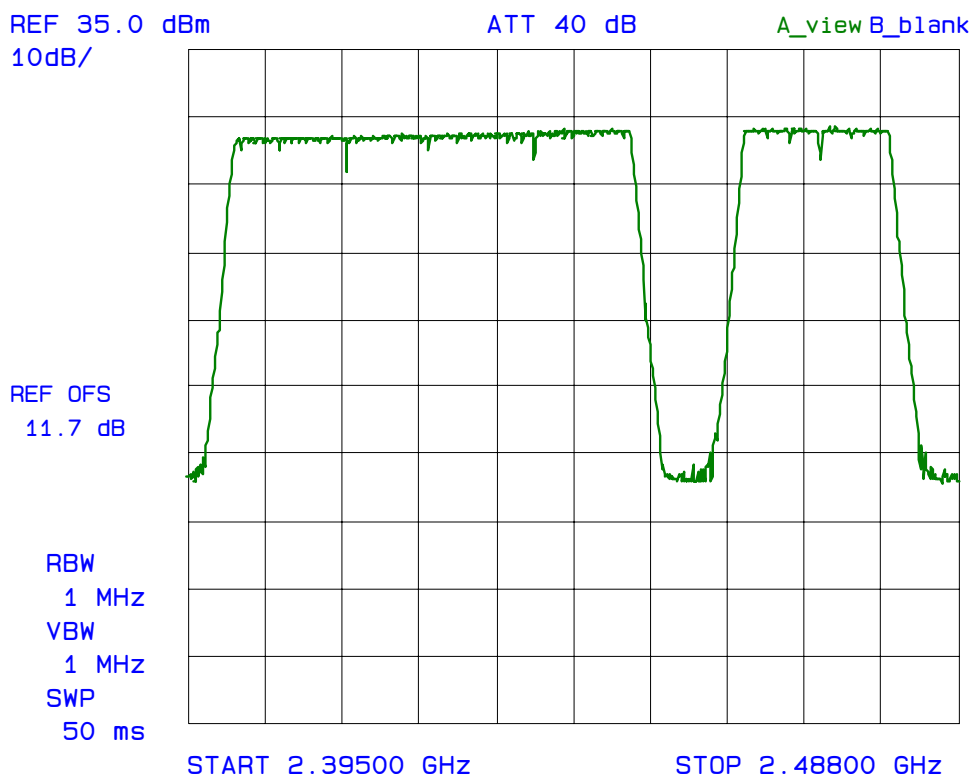
April 19, 2005

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

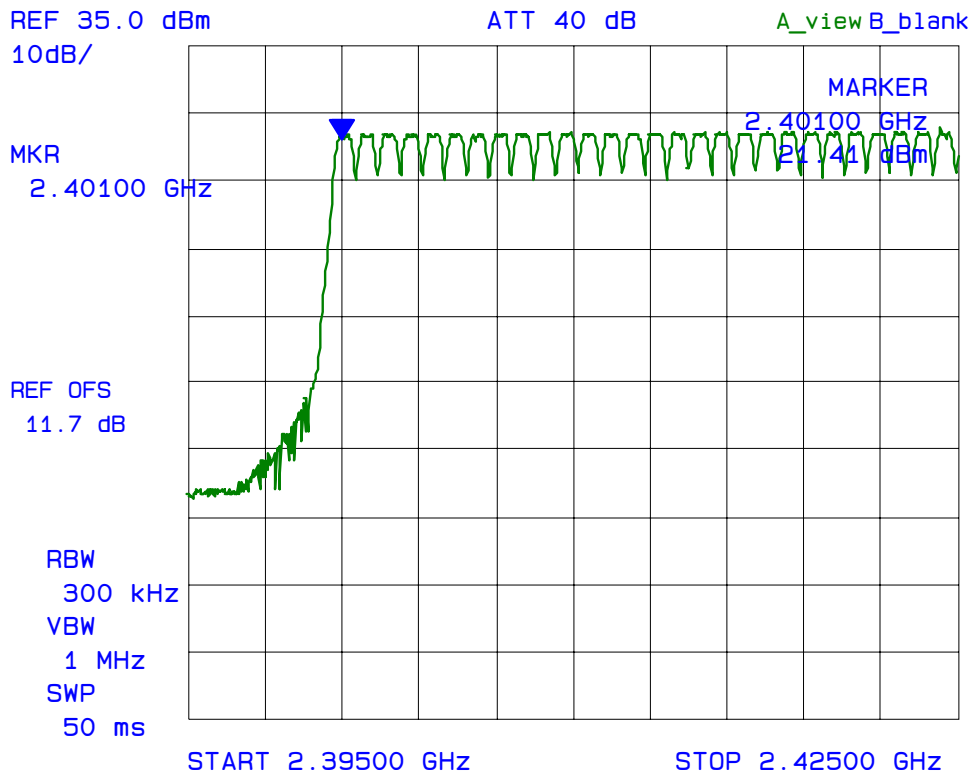
Plot 6:
Carrier Frequency Separation (Handset)
Test Frequency: 2440.800 MHz (channel 46)



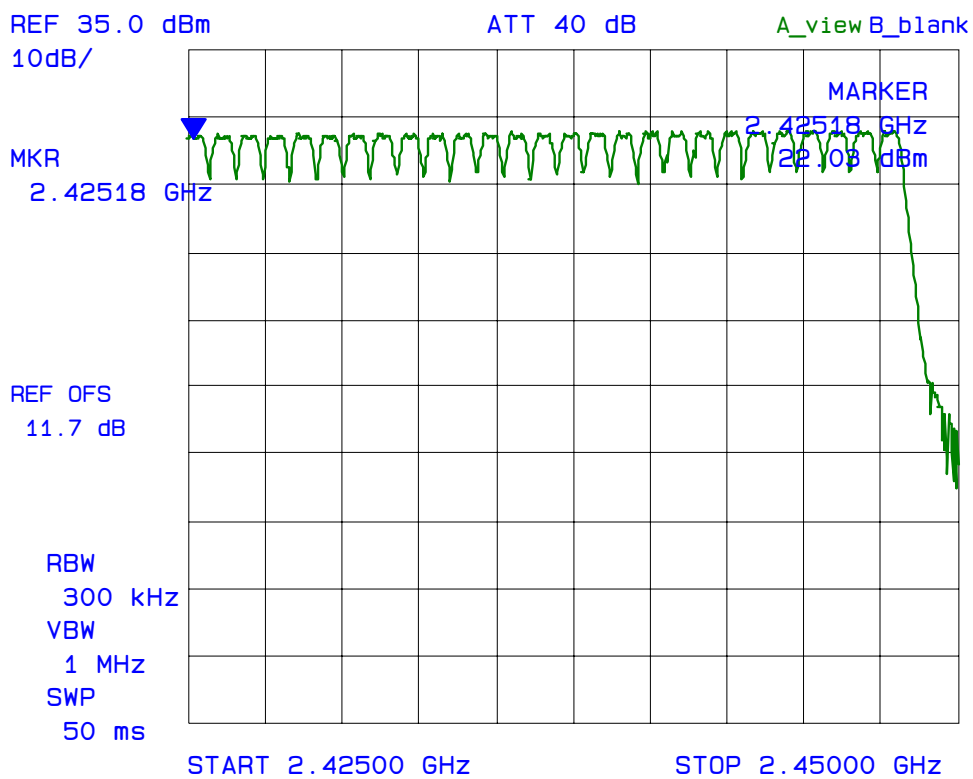
Plot 7:
Number of Hopping Frequencies (Base Unit)
75 Hopping Frequencies (from 2395.0 MHz to 2488.0 MHz)



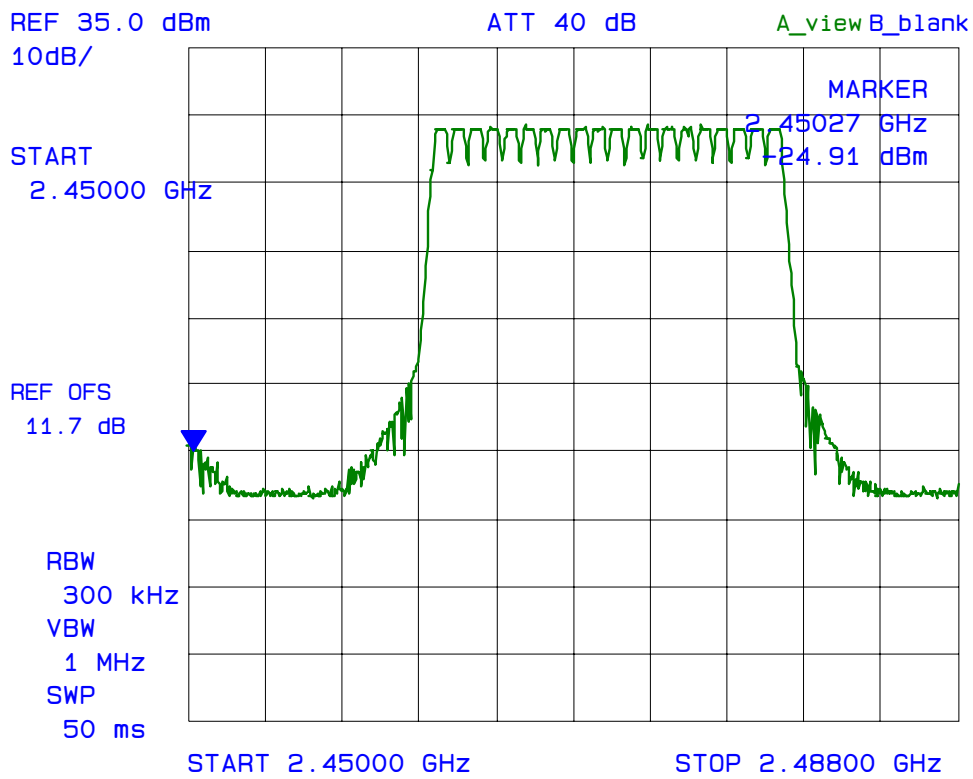
Plot 8:
Number of Hopping Frequencies (Base Unit)
28 hopping frequencies (from 2395.0 MHz to 2425.0 MHz)



Plot 9:
Number of Hopping Frequencies (Base Unit)
27 hopping frequencies (from 2425.0 MHz to 2450.0 MHz)



Plot 10:
Number of Hopping Frequencies (Base Unit)
20 hopping frequencies (from 2450.0 MHz to 2488.0 MHz)



ULTRATECH GROUP OF LABS

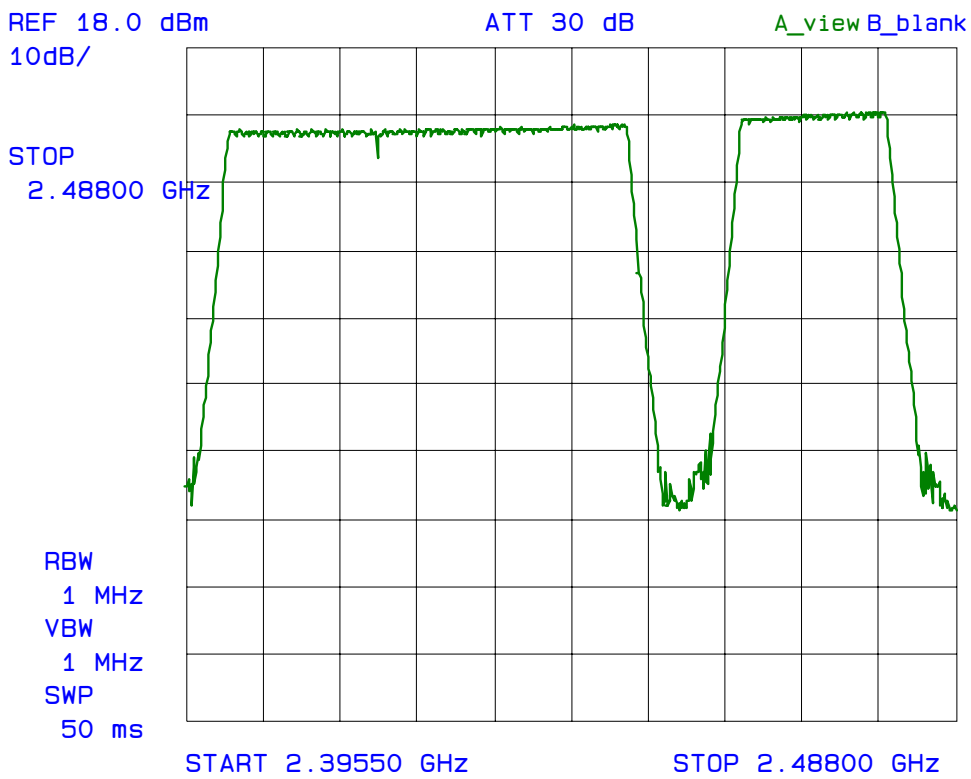
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: PAN-061F15C247

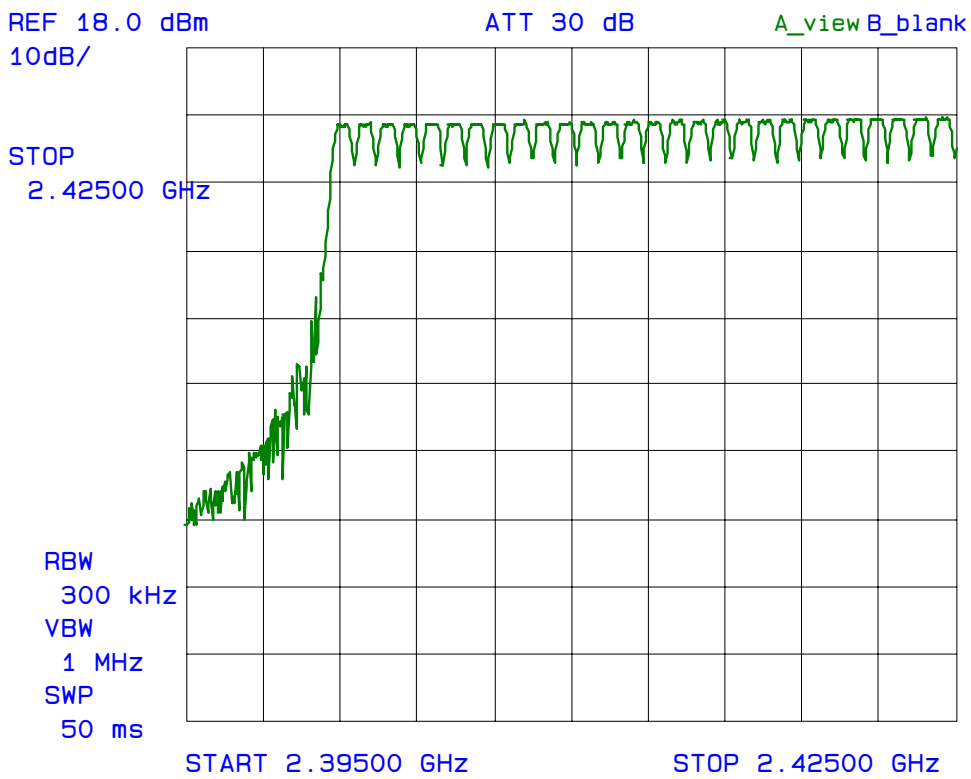
April 19, 2005

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

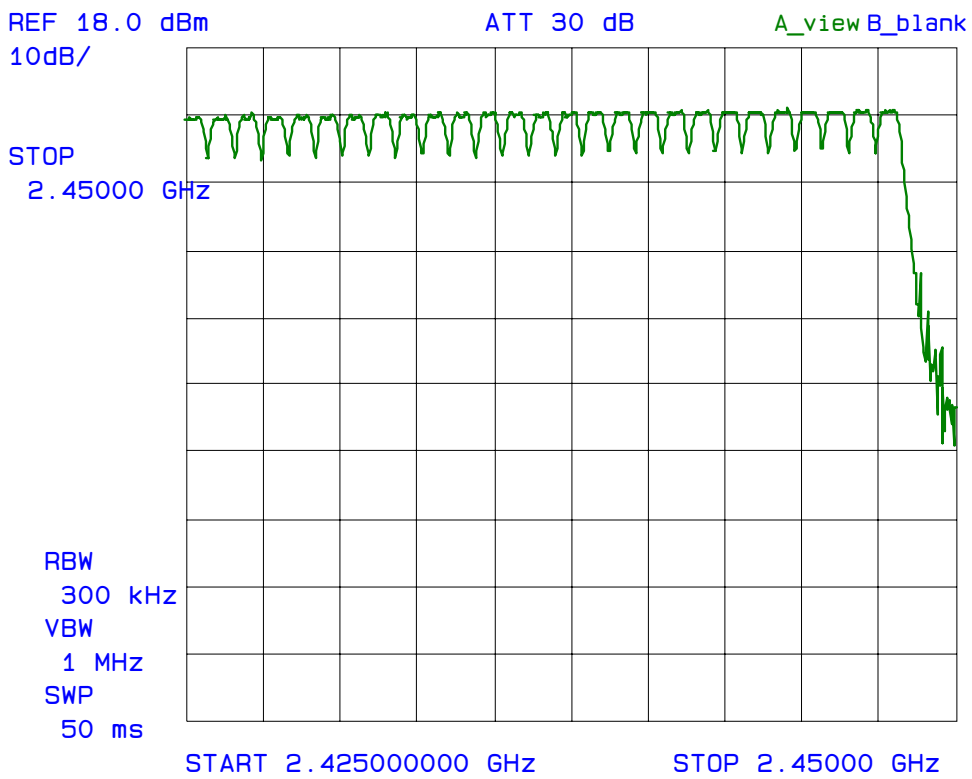
Plot 11:
Number of Hopping Frequencies (Handset)
75 hopping frequencies (from 2395.5 MHz to 2488.0 MHz)



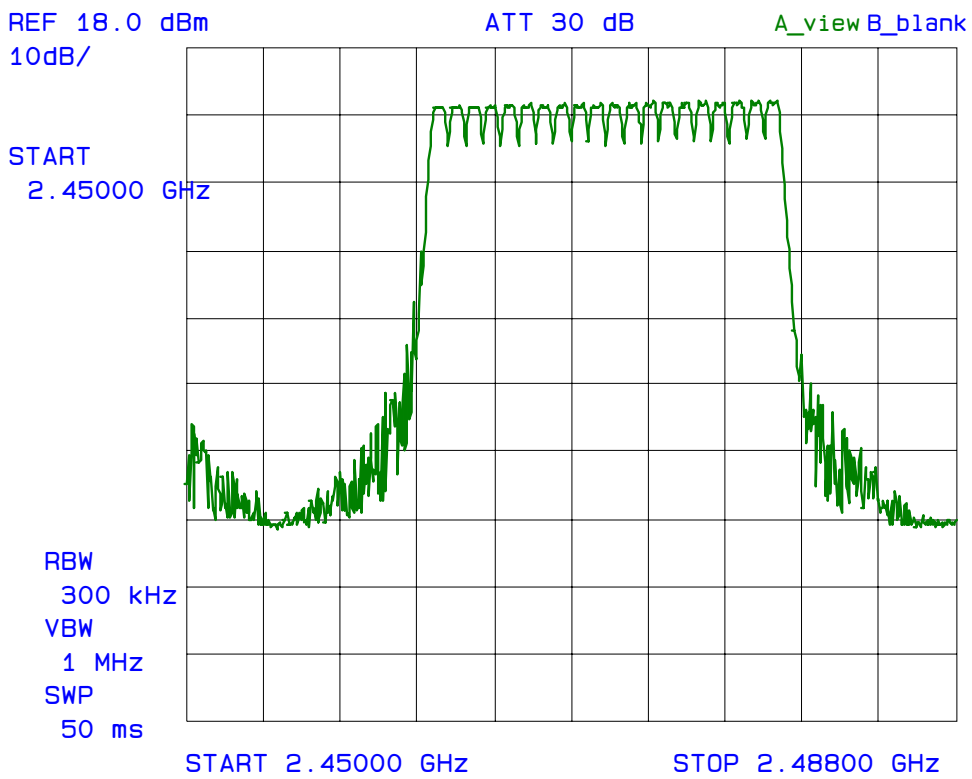
Plot 12:
Number of Hopping Frequencies (Handset)
28 hopping frequencies (from 2395.0 MHz to 2425.0 MHz)



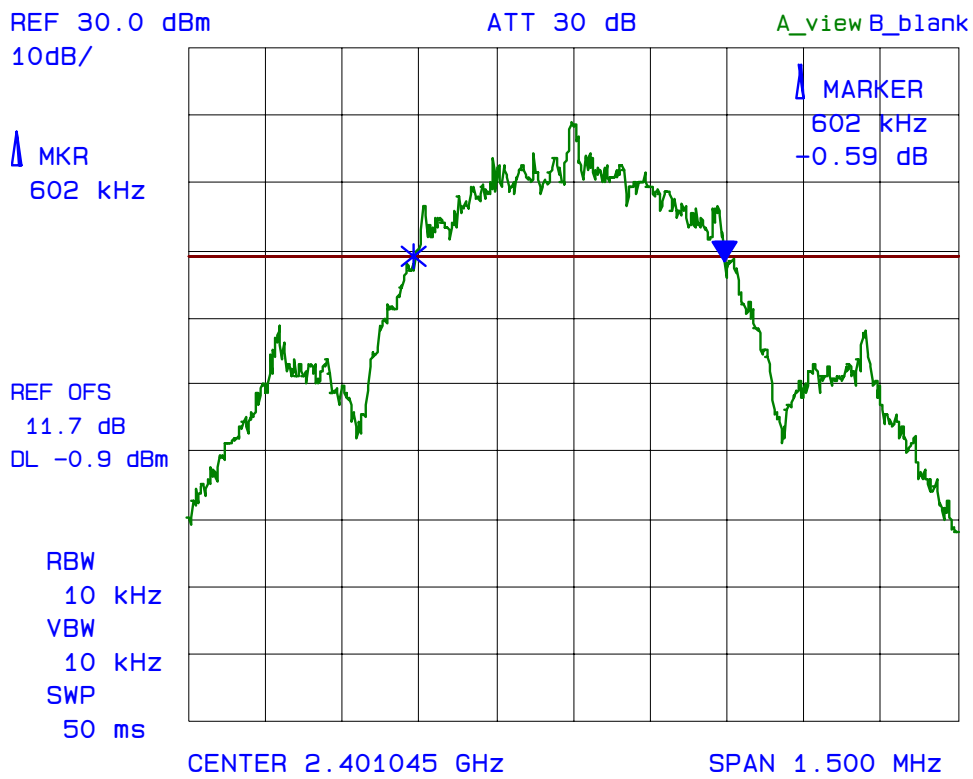
Plot 13:
Number of Hopping Frequencies (Handset)
27 hopping frequencies (from 2425.0 MHz to 2450.0 MHz)



Plot 14:
Number of Hopping Frequencies (Handset)
20 hopping frequencies (from 2450.0 MHz to 2488.0 MHz)



Plot 15:
20 dB Bandwidth (Base Unit)
Test Frequency: 2401.056 MHz (channel 00)



ULTRATECH GROUP OF LABS

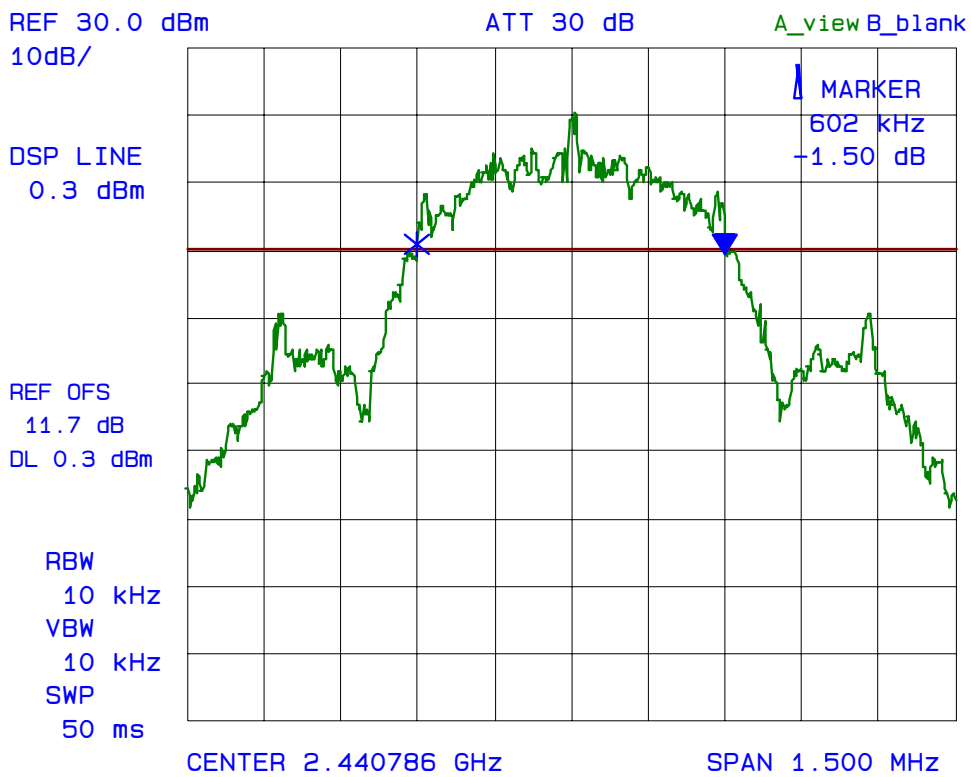
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: PAN-061F15C247

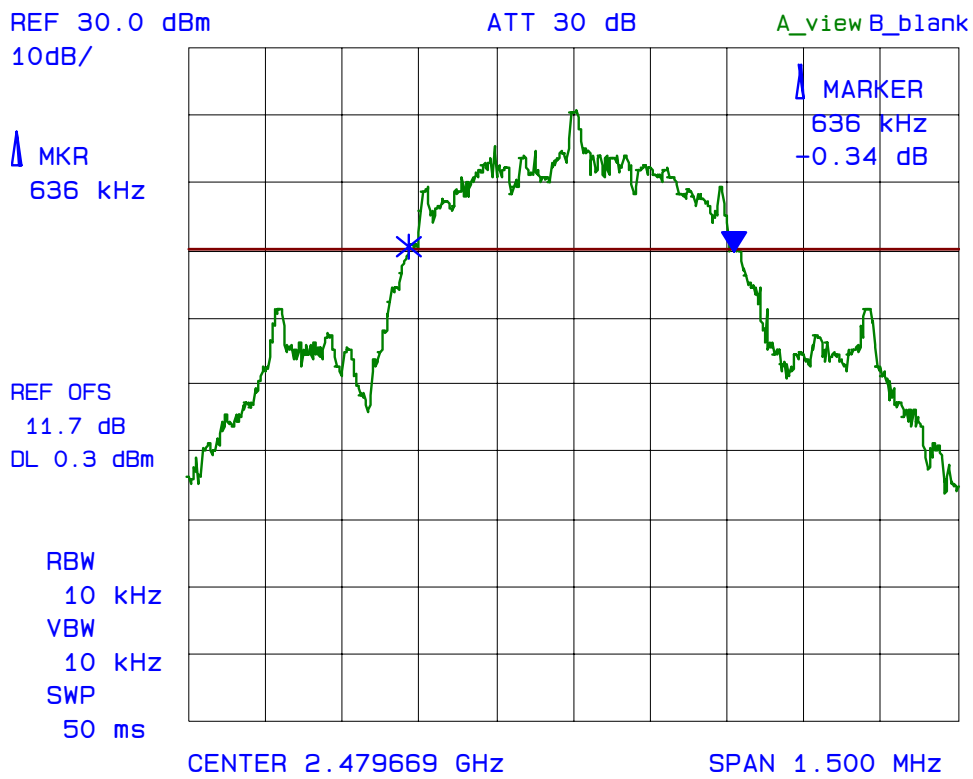
April 19, 2005

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

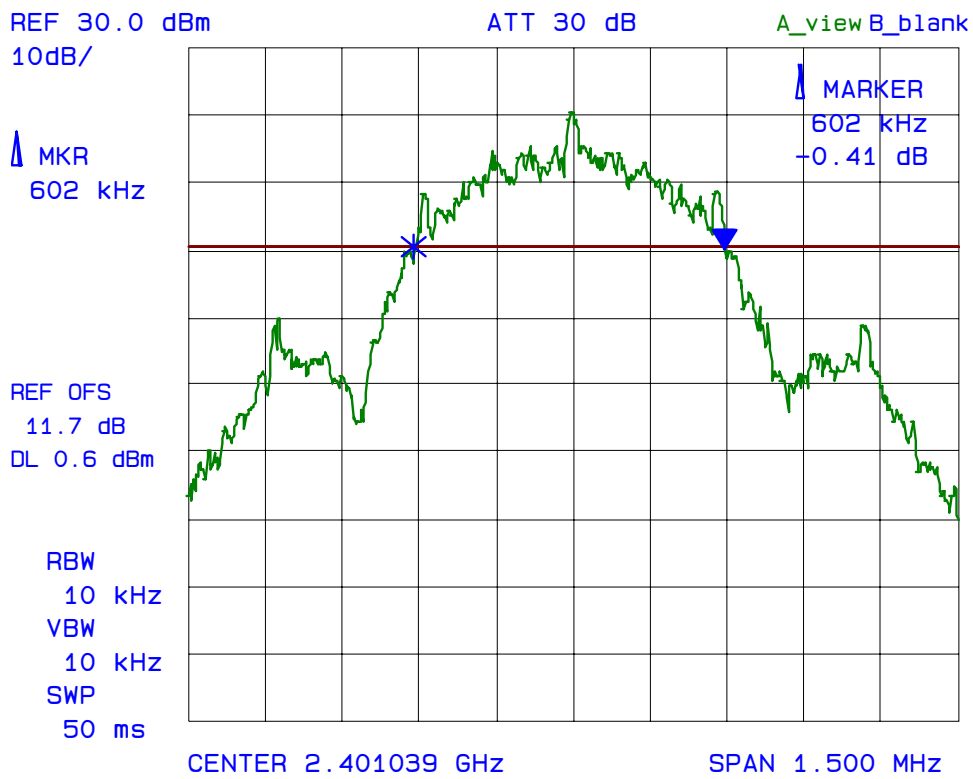
Plot 16:
20 dB Bandwidth (Base Unit)
Test Frequency: 2440.8 MHz (channel 46)



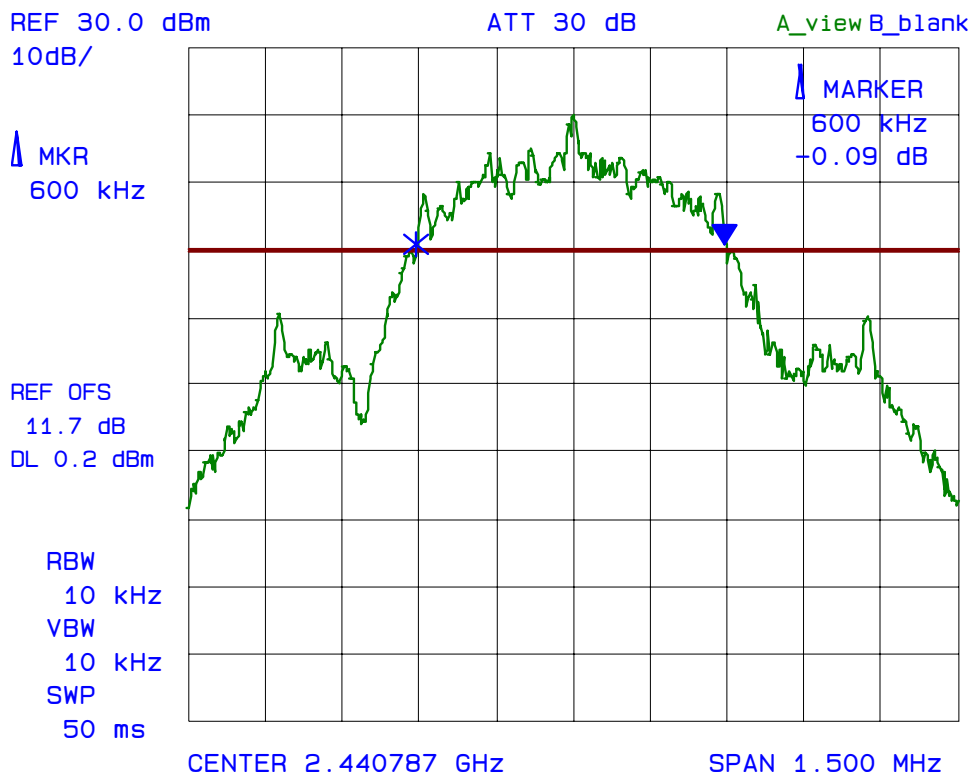
Plot 17:
20 dB Bandwidth (Base Unit)
Test Frequency: 2479.680 MHz (channel 91)



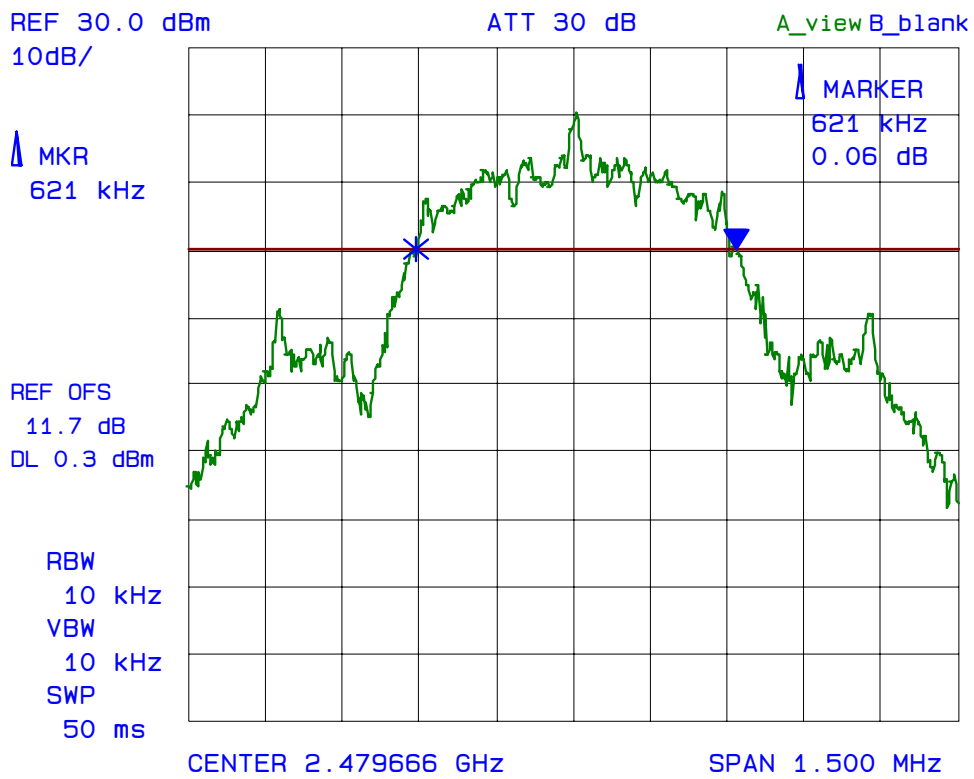
Plot 18:
20 dB Bandwidth (Handset)
Test Frequency: 2401.056 MHz (channel 00)



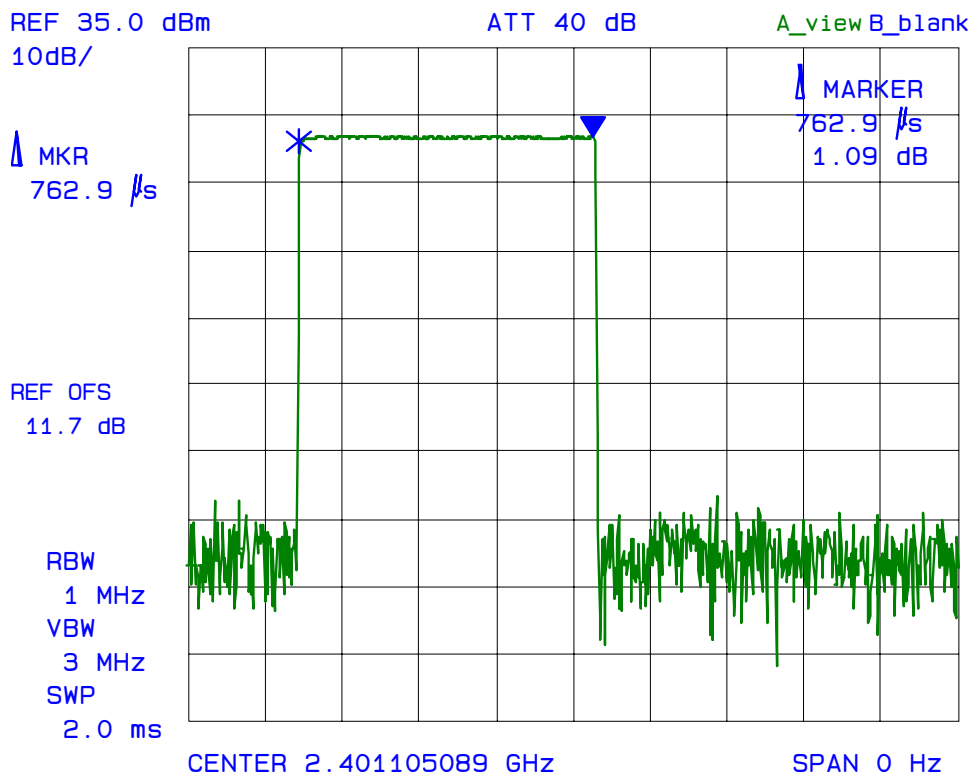
Plot 19:
20 dB Bandwidth (Handset)
Test Frequency: 2440.800 MHz (channel 46)



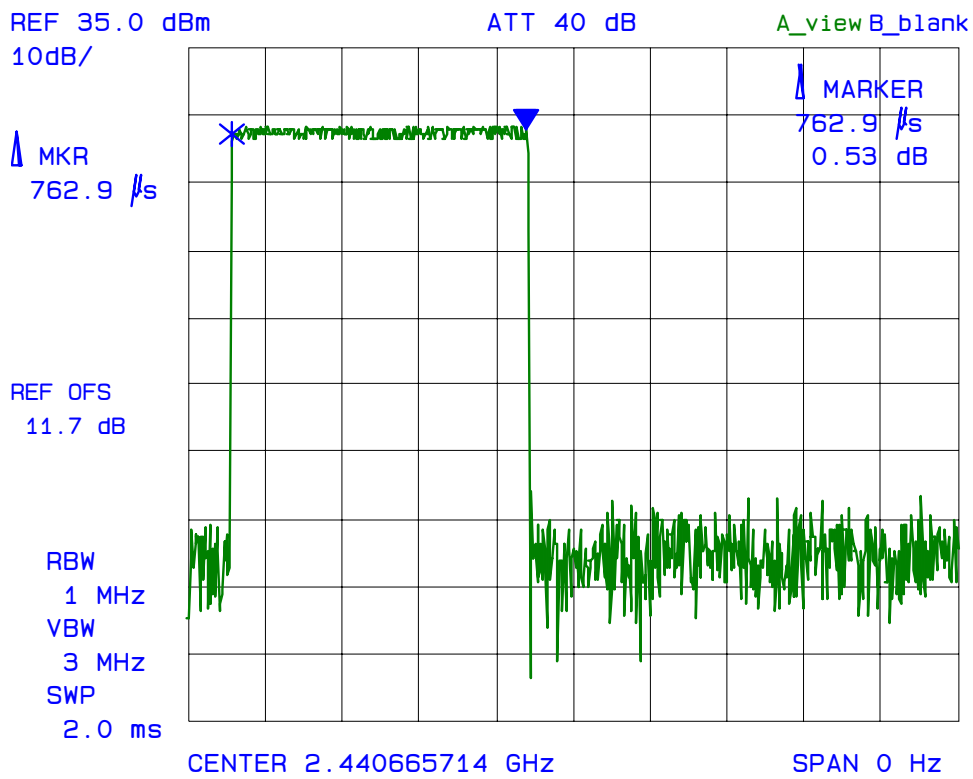
Plot 20:
20 dB Bandwidth (Handset)
Test Frequency: 2479.680 MHz (channel 91)



Plot 21:
Time of occupancy (Base Unit)
Test Frequency: 2401.056 MHz (channel 00)
Dwell Time @ 2401.056 MHz = 762.9 μ s

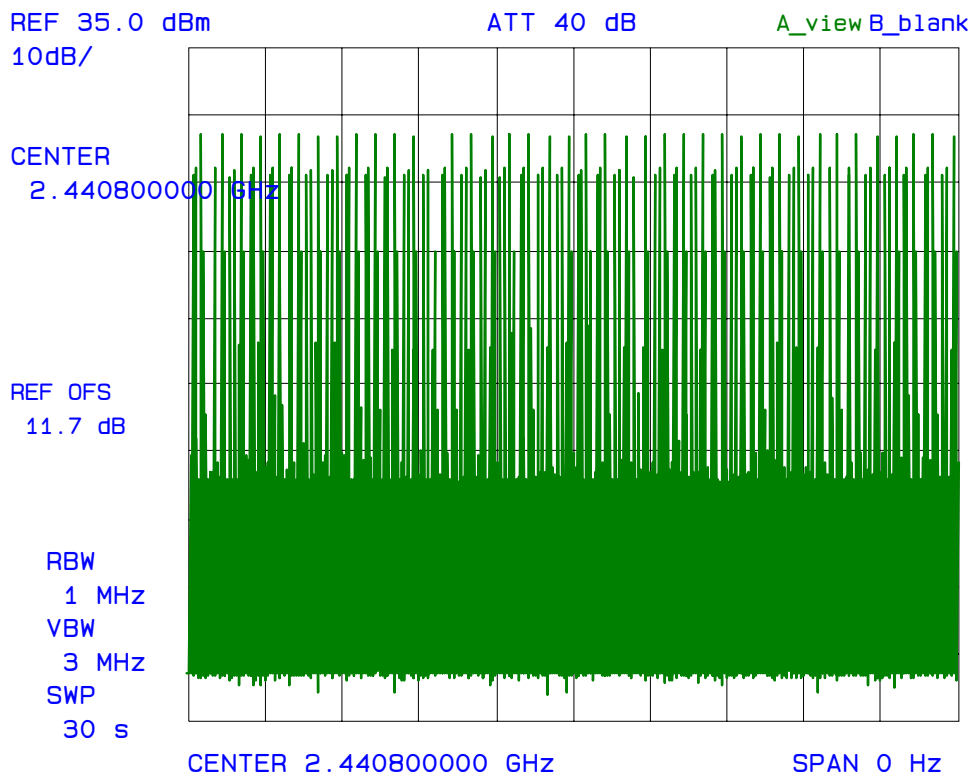


Plot 23:
Time of occupancy (Base Unit)
Test Frequency: 2440.8 MHz (channel 46)
Dwell time @ 2440.8 MHz = 762.9 μ s

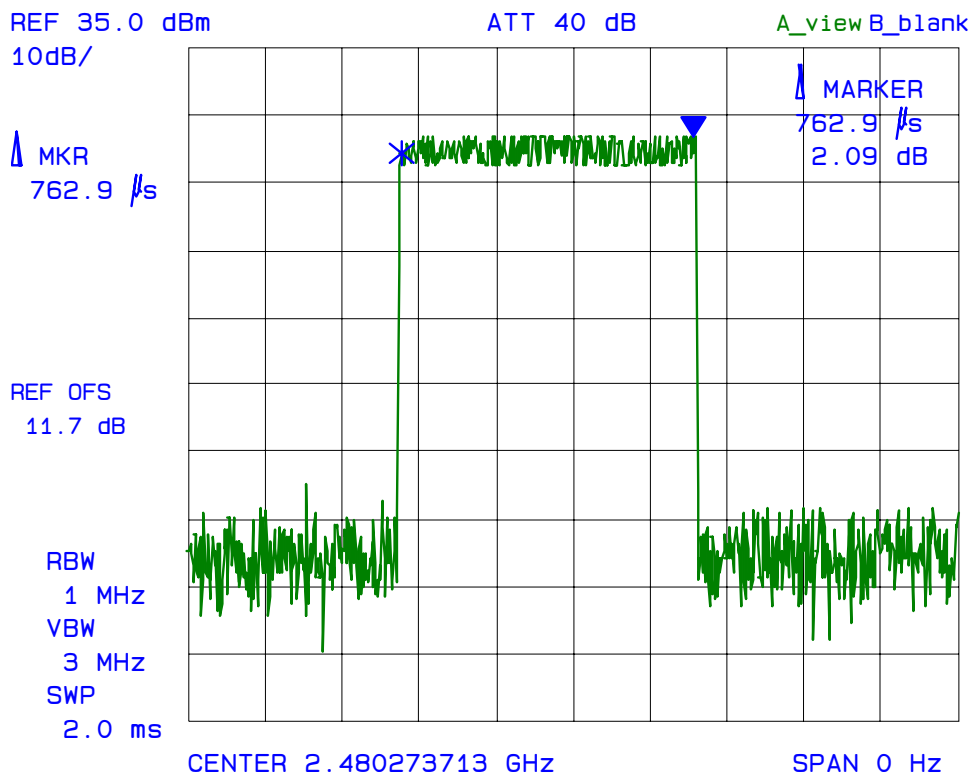


Plot 24:
Time of occupancy (Base Unit)
Test Frequency: 2440.8 MHz (channel 46)

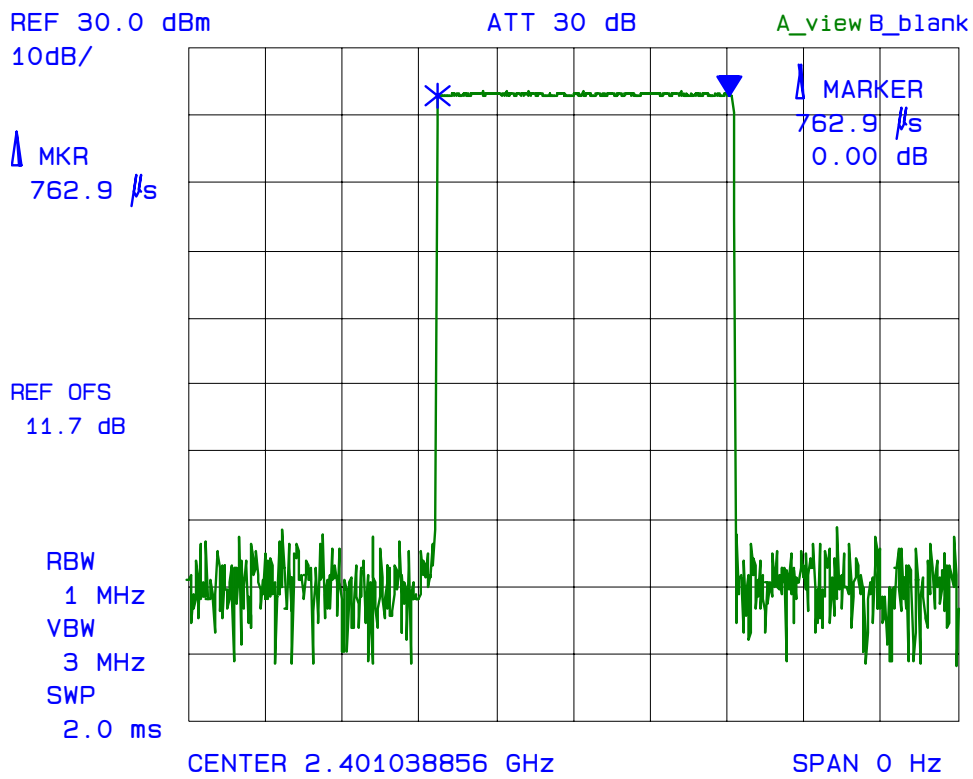
$$\begin{aligned} \text{Average time of occupancy in 30s} &= (\text{Dwell time @ 2440.8 MHz}) \times (\text{number of hops in 30s}) \\ &= 762.9 \mu\text{s} \times 40 = 30.5 \text{ ms} \end{aligned}$$



Plot 25:
Time of occupancy (Base Unit)
Test Frequency: 2479.68 MHz (channel 91)
Dwell time @ 2479.68 MHz = 762.9 μ s

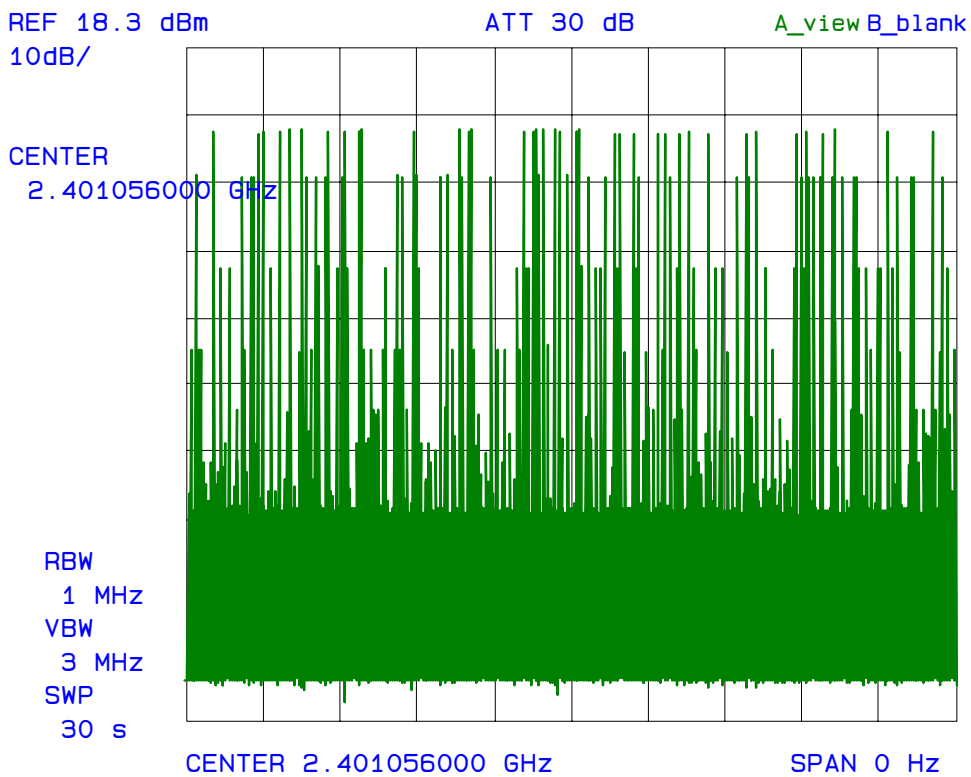


Plot 27:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2401,056 MHz (channel 00)
Dwell time @ 2401.056 MHz = 762.9 MHz



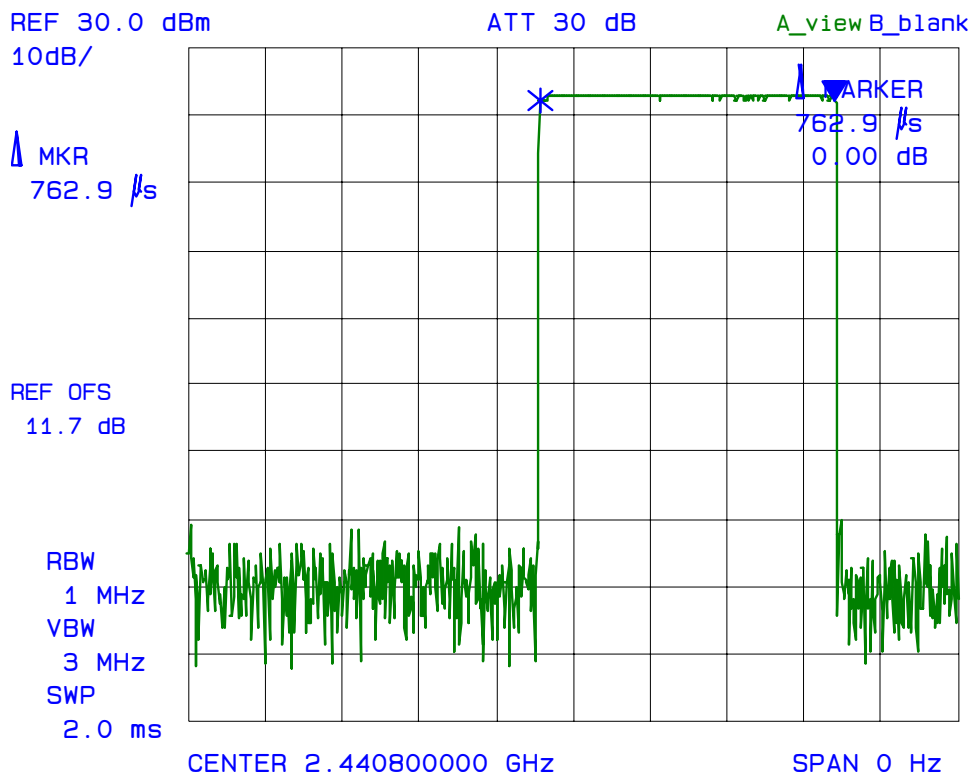
Plot 28:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2401,056 MHz (channel 00)

Average time of occupancy in 30s = (Dwell time @ 2401.056 MHz) x (number of hops in 30s)
= 762.9 μ s x 40 = 30.5 ms



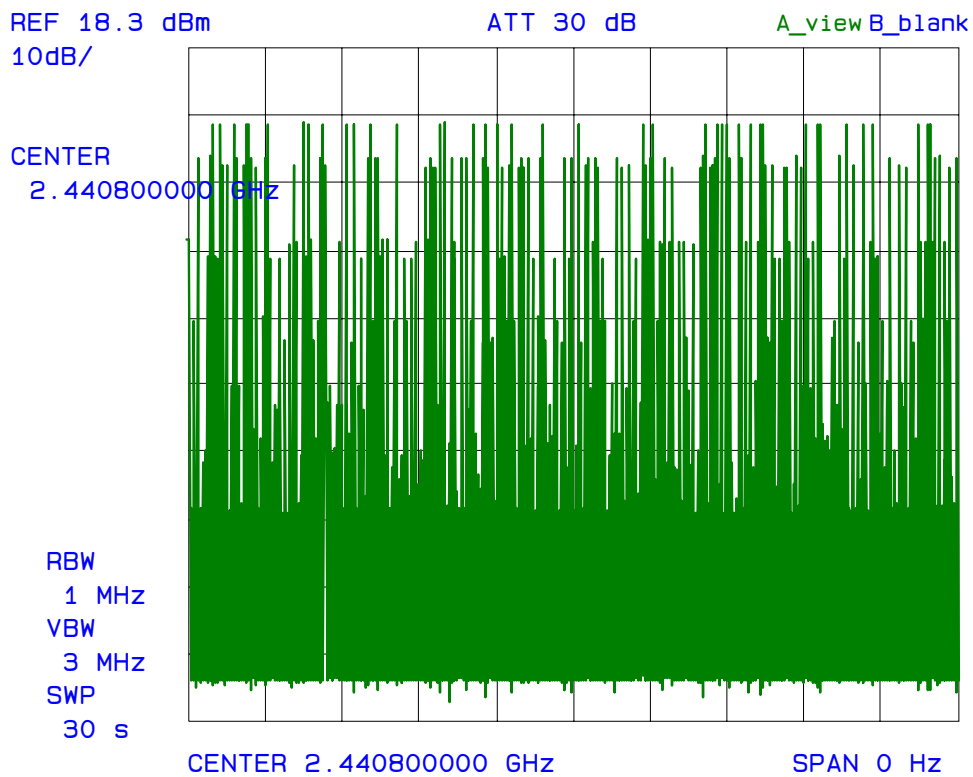
Plot 29:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2440.8 MHz (channel 46)

Dwell time @ 2440.8 MHz = 762.9 μ s



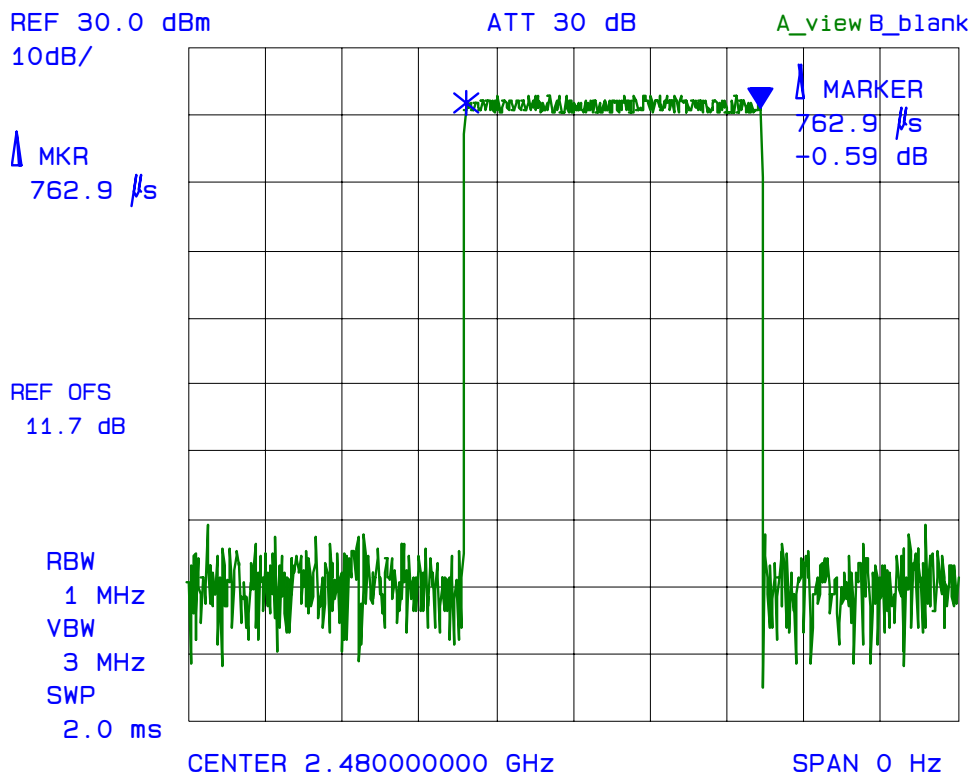
Plot 30:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2440.8 MHz (channel 46)

$$\begin{aligned} \text{Average time of occupancy in 30s} &= (\text{Dwell Time @ 2440.8 MHz}) \times (\text{number of hops in 30s}) \\ &= 762.9 \mu\text{s} \times 40 = 30.5 \text{ ms} \end{aligned}$$



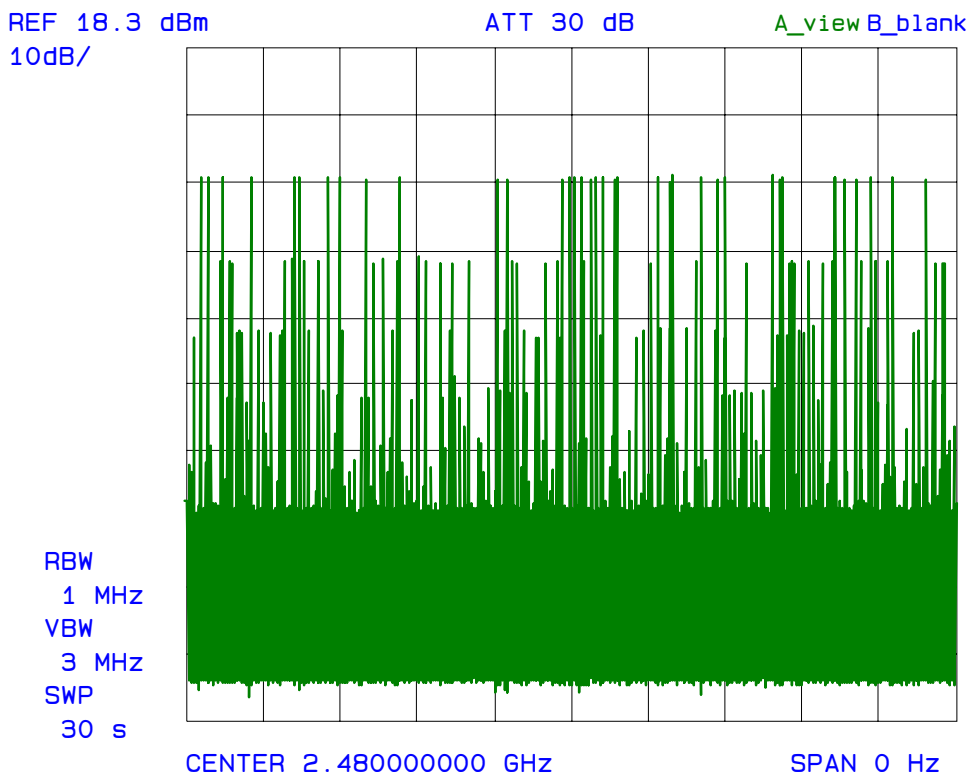
Plot 31:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2479.68 MHz (channel 91)

Dwell time @ 2479.68 MHz = 762.9 μ s



Plot 32:
Time of Occupancy (Handset – Talk Mode)
Test Frequency: 2479.68 MHz (channel 91)

Average time of occupancy in 30s = (Dwell Time @ 2479.68 MHz) x (number of hops in 30 s)
= 762.9 μ s x 40 = 30.5 ms



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

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

6.8.1. Limits

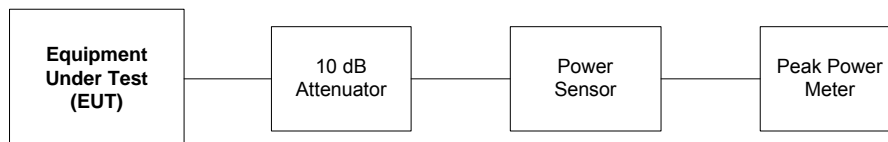
§15.247(b)(1): For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

§15.247(b)(4): If the antennas of directional gain greater than 6 dBi are used, the peak power from the intentional radiator shall be reduced below, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.8.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 and ANSI C63.4.

6.8.3. Test Arrangement



6.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Power Meter	Hewlett Packard	HP 8900D	3412A00103	9 kHz – 26.5 GHz
Attenuator	Weinschel Corp	24-10-34	BT8386	DC – 18 GHz
Power Sensor	Hewlett Packard	84811A	2551A02902	9 kHz – 26.5 GHz

6.8.5. Test Data

Transmitter Channel	Frequency (MHz)	Peak Power at Antenna Terminal (dBm)	*Calculated EIRP (dBm)	Conducted Power Limit (dBm)	EIRP Limit (dBm)
Base Unit					
00	2401.056	22.61	24.75	30.0	36.0
46	2440.800	23.74	25.88	30.0	36.0
91	2479.680	23.97	26.11	30.0	36.0
Handset					
00	2401.056	24.47	26.61	30.0	36.0
46	2440.800	24.13	26.27	30.0	36.0
91	2479.680	23.96	26.10	30.0	36.0

*EIRP = Peak power at antenna terminal in dBm + EUT Antenna gain in dBi (Base Unit: 2.14dBi, Handset: 2.14dBi).

6.9. RF EXPOSURE REQUIREMENTS [§ 15.247 (h) (i)]

6.9.1. Limits

§ 15.247 (h) (i): Systems operating under the 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).

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

f = frequency in MHz

* = Plane-wave equivalent power density

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

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

6.9.2. 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 excluded from routine environmental evaluation for 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 the public (users and nearby persons) does not exceed the Commission’s RF exposure guidelines (see Sections 1.1307, 2.1091 and 2.1093). Unless a device operates at substantially low output 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/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

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

- 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 an SAR evaluation be performed, as provided for in Section 1.1307(d).

6.9.3. MPE Evaluation

Evaluation of RF Exposure Compliance Requirements for Base Unit	
RF Exposure Requirements	Compliance with FCC Rules
Minimum calculated separation distance between antenna and persons required: *1.8 cm	Manufacturer's instruction for separation distance between antenna and persons required: 20 cm.
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	None, antenna is permanently attached.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Please refer to User's Manual for RF Exposure Information.
Any other RF exposure related issues that may affect MPE compliance	None.

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

$$\text{RF EXPOSURE DISTANCE LIMITS: } r = (PG/4\pi S)^{1/2} = (EIRP/4\pi S)^{1/2}$$

$$S = 1.0 \text{ mW/cm}^2$$

$$EIRP = 16.10 \text{ dBm} = 40.74 \text{ mW (Max. EIRP)}$$

$$r = (EIRP/4\pi S)^{1/2} = (40.74/4\pi(1.0))^{1/2} = 1.8 \text{ cm}$$

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

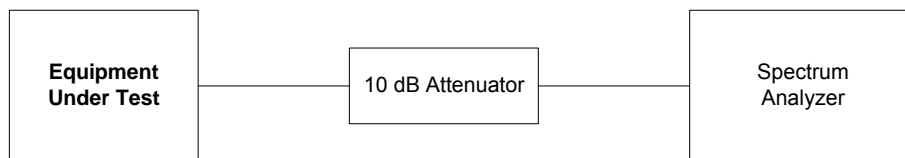
6.10.1. Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement.

6.10.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this test report.

6.10.3. Test Arrangement



6.10.4. Test Equipment List

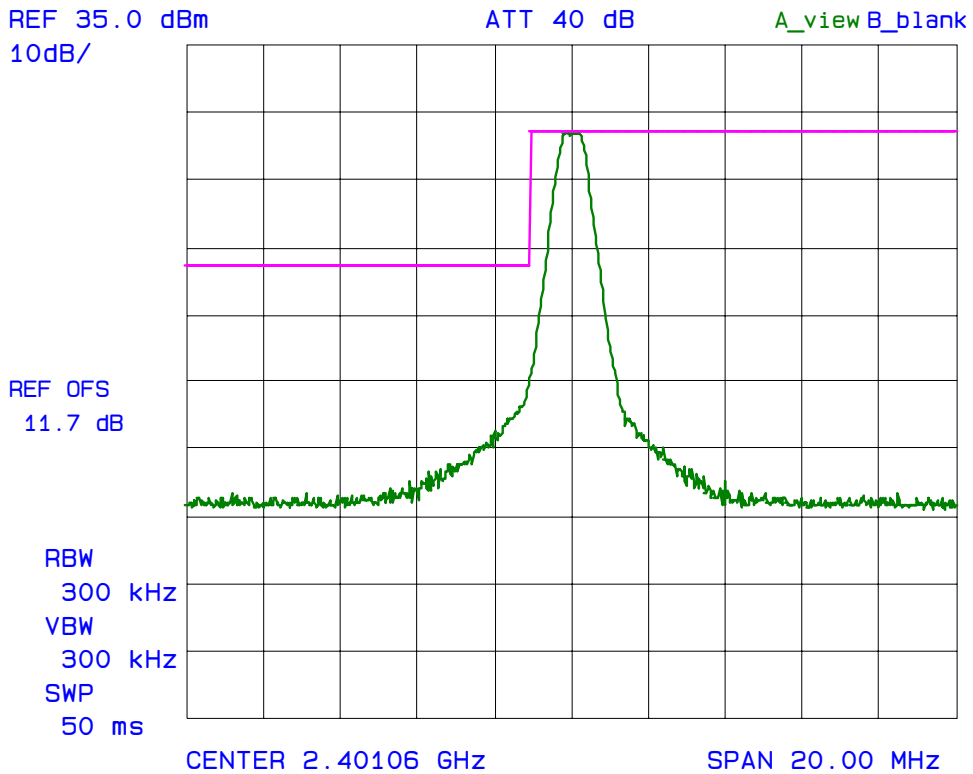
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Attenuator	Weinshel	24-10-34	BK8612	DC – 8.5 GHz

6.10.5. Test Data

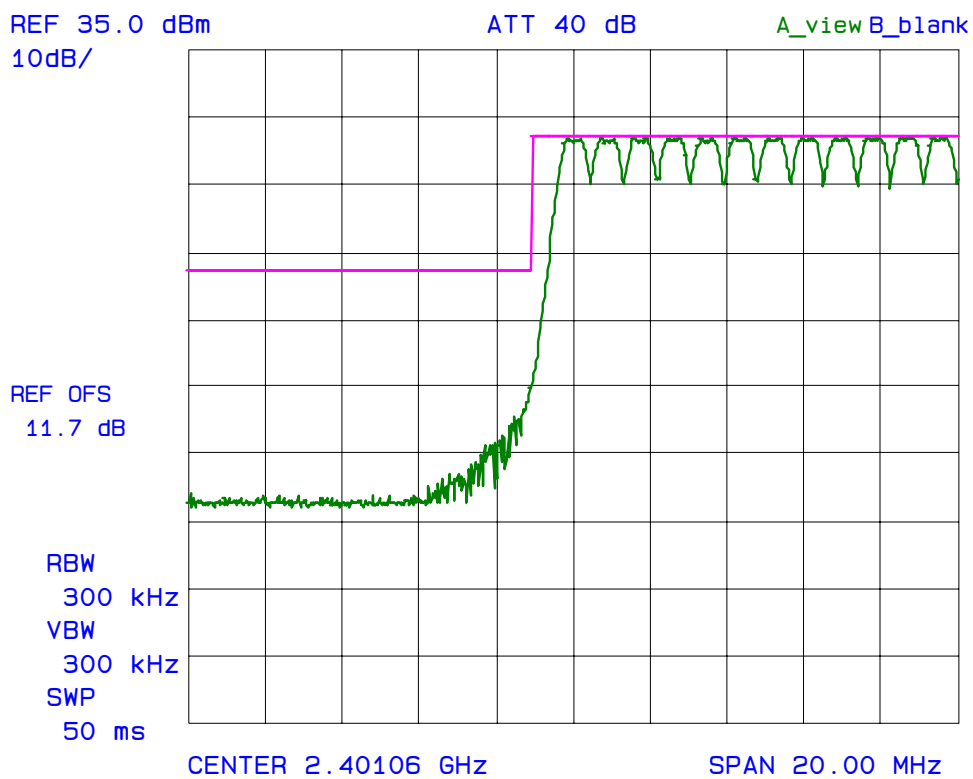
6.10.5.1. Band-Edge RF Conducted Emissions

Refer to the following test data plots (33 to 40) for measurements results.

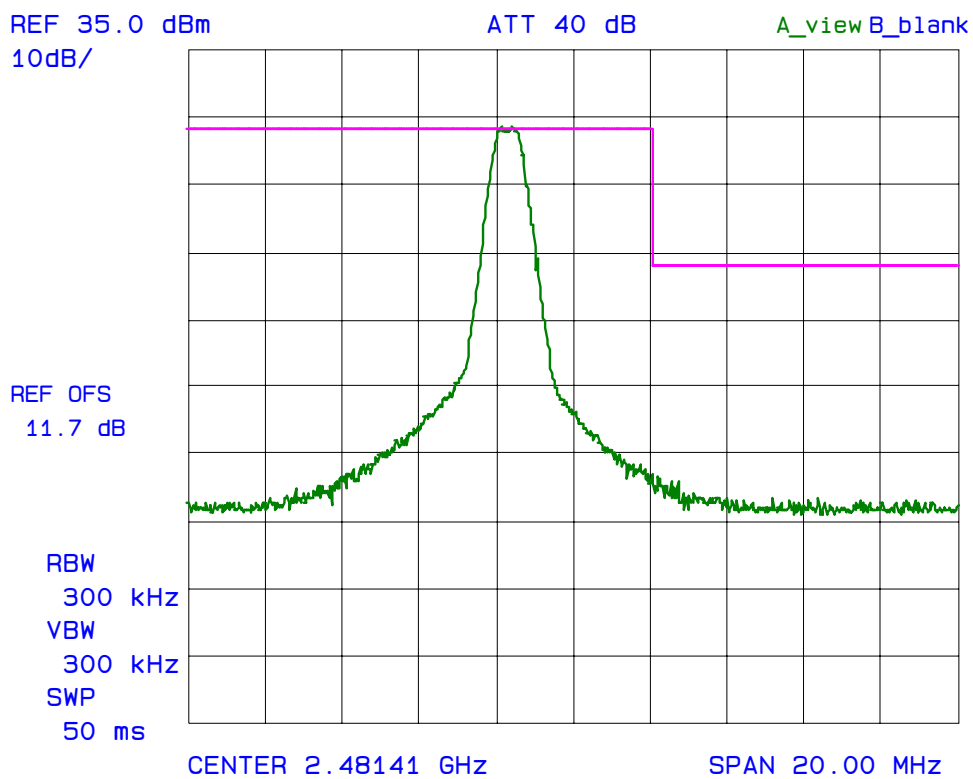
Plot 33:
Band-Edge RF Conducted Emissions (Base Unit)
Low End of Frequency Band
Single Frequency Mode
Test Frequency: 2401, 056 MHz (channel 00)



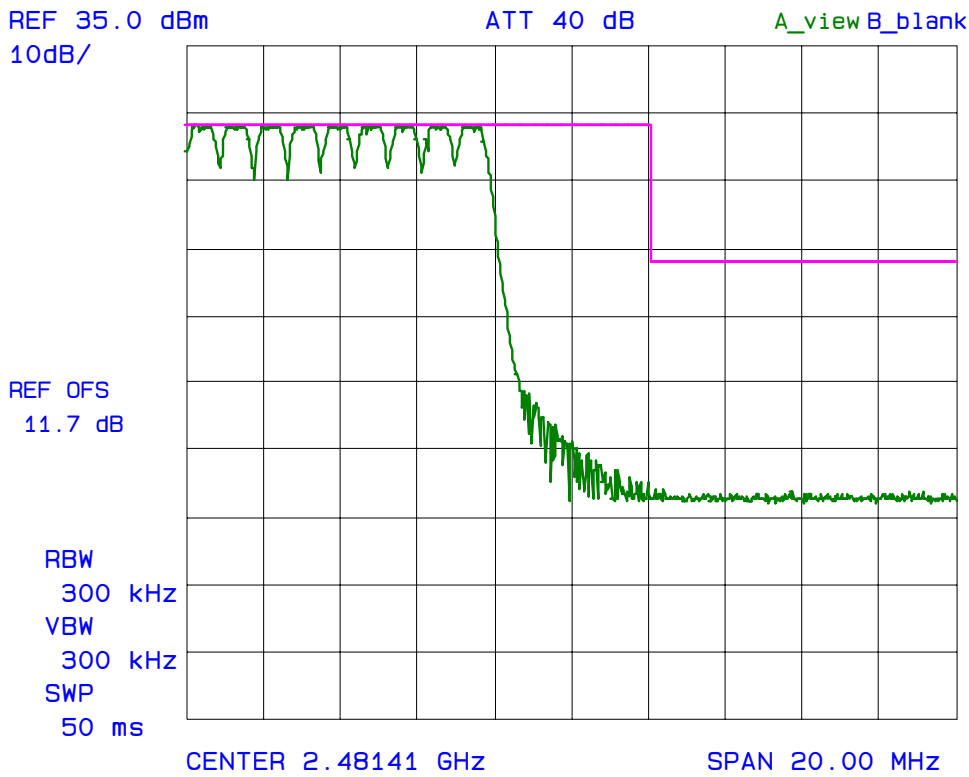
Plot 34:
Band-Edge RF Conducted Emissions (Base Unit)
Low End of Frequency Band
Pseudorandom Channel Hopping Mode
Test Frequency: 2401, 056 MHz (channel 00)



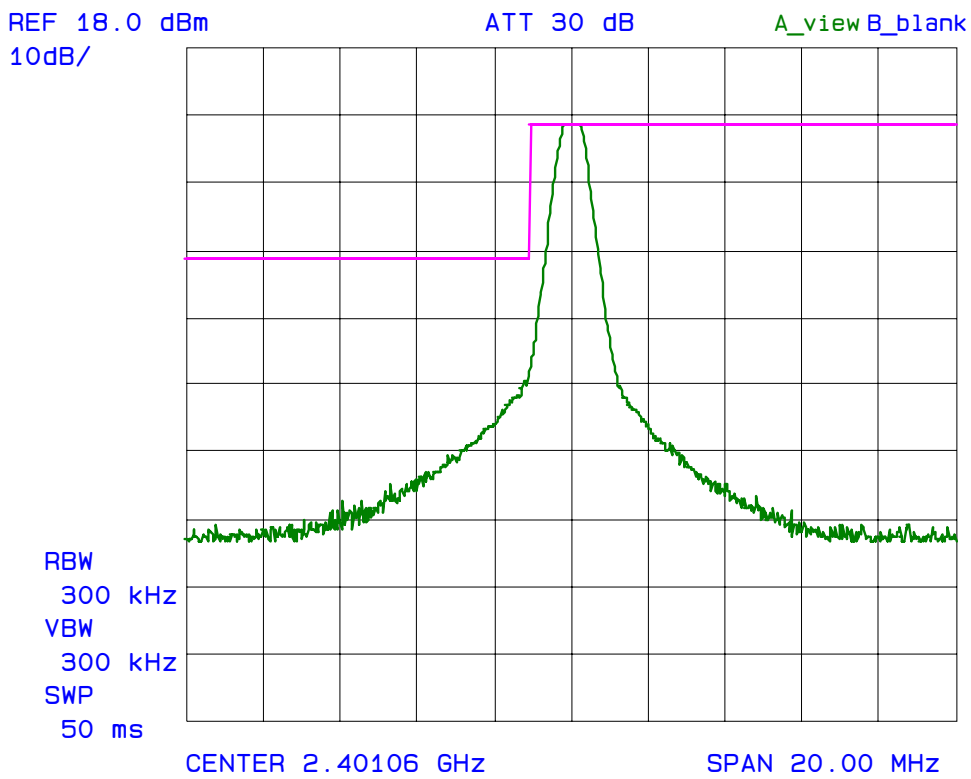
Plot 35:
Band-Edge RF Conducted Emissions (Base Unit)
High End of Frequency Band
Single Frequency Mode
Test Frequency: 2479.680 MHz (channel 91)



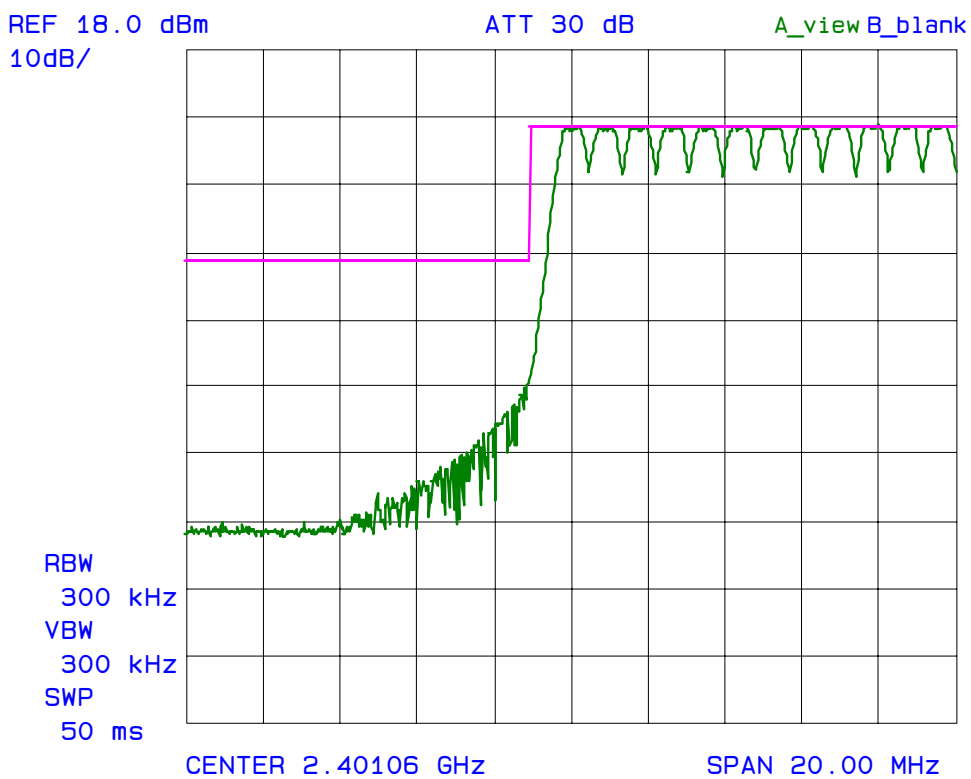
Plot 36:
Band-Edge RF Conducted Emissions (Base Unit)
High End of Frequency Band
Pseudorandom Channel Hopping Mode
Test Frequency: 2479.680 MHz (channel 91)



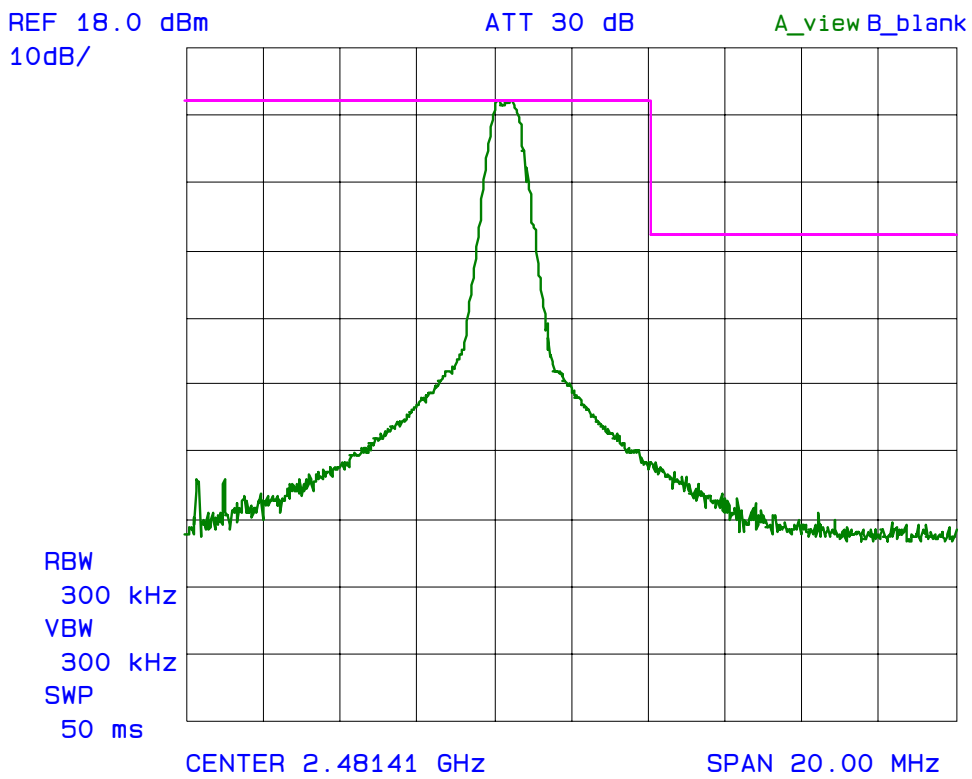
Plot 37:
Band-Edge RF Conducted Emissions (Handset)
Low End of Frequency Band
Single Frequency Mode
Test Frequency: 2401.056 MHz (channel 00)



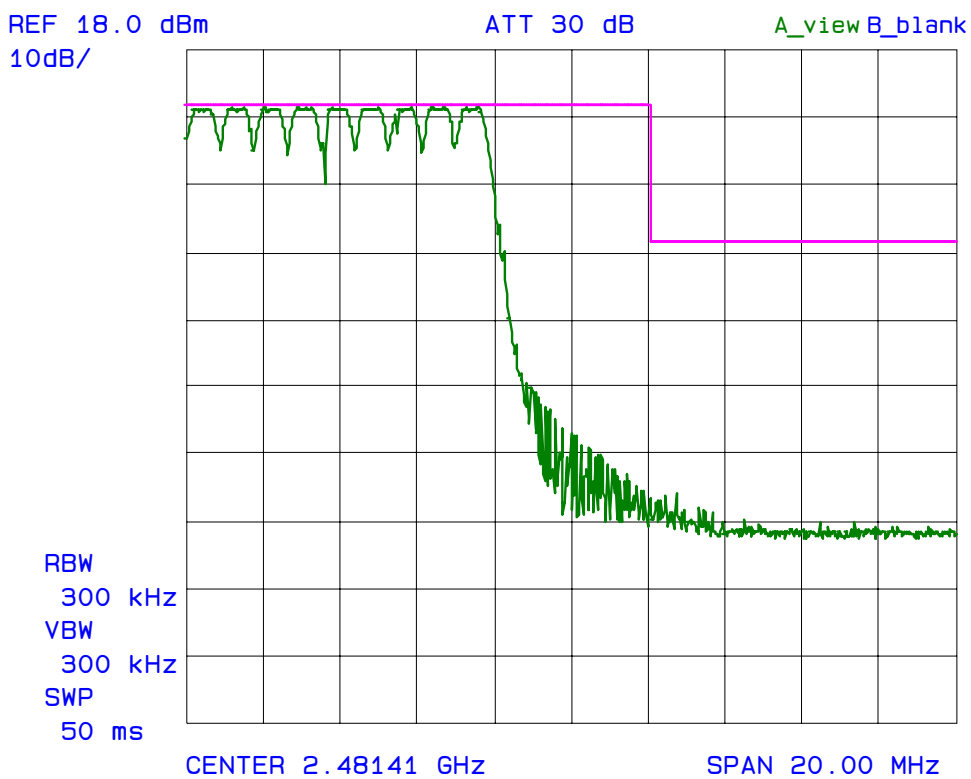
Plot 38:
Band-Edge RF Conducted Emissions (Handset)
Low End of Frequency Band
Pseudorandom Channel Hopping Mode
Test Frequency: 2401.056 MHz (channel 00)



Plot 39:
Band-Edge RF Conducted Emissions (Handset)
High End of Frequency Band
Single Frequency Mode
Test Frequency: 2479.680 MHz (channel 91)



Plot 40:
Band-Edge RF Conducted Emissions (Handset)
High End of Frequency Band
Pseudorandom Channel Hopping Mode
Test Frequency: 2479.680 MHz (channel 91)

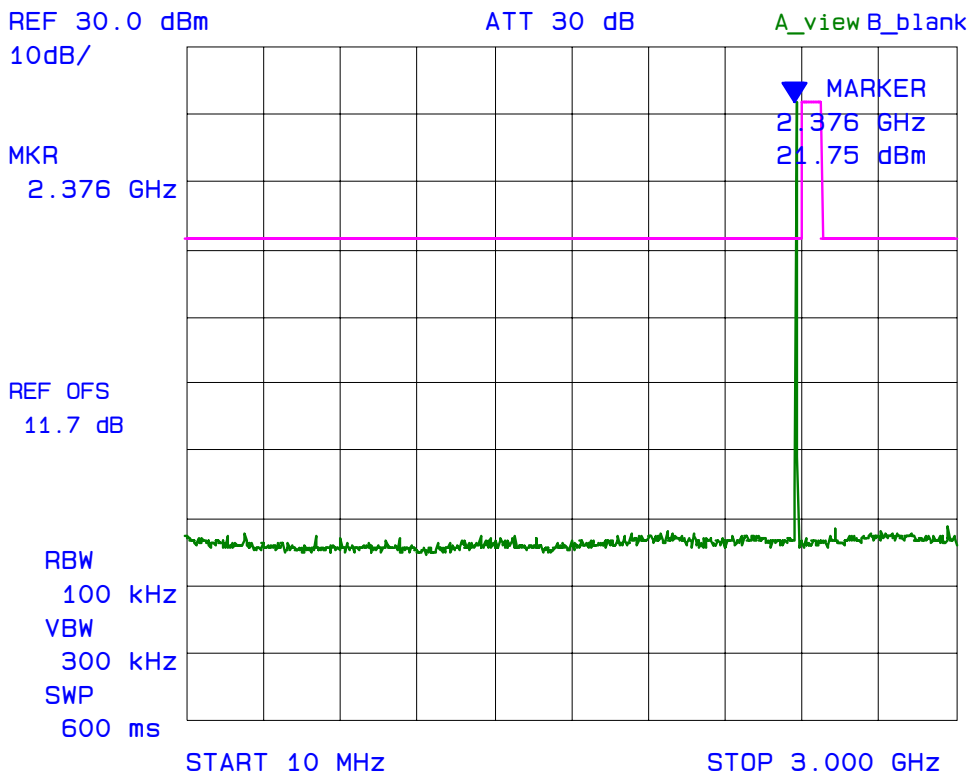


6.10.5.2. Spurious RF Conducted Emissions

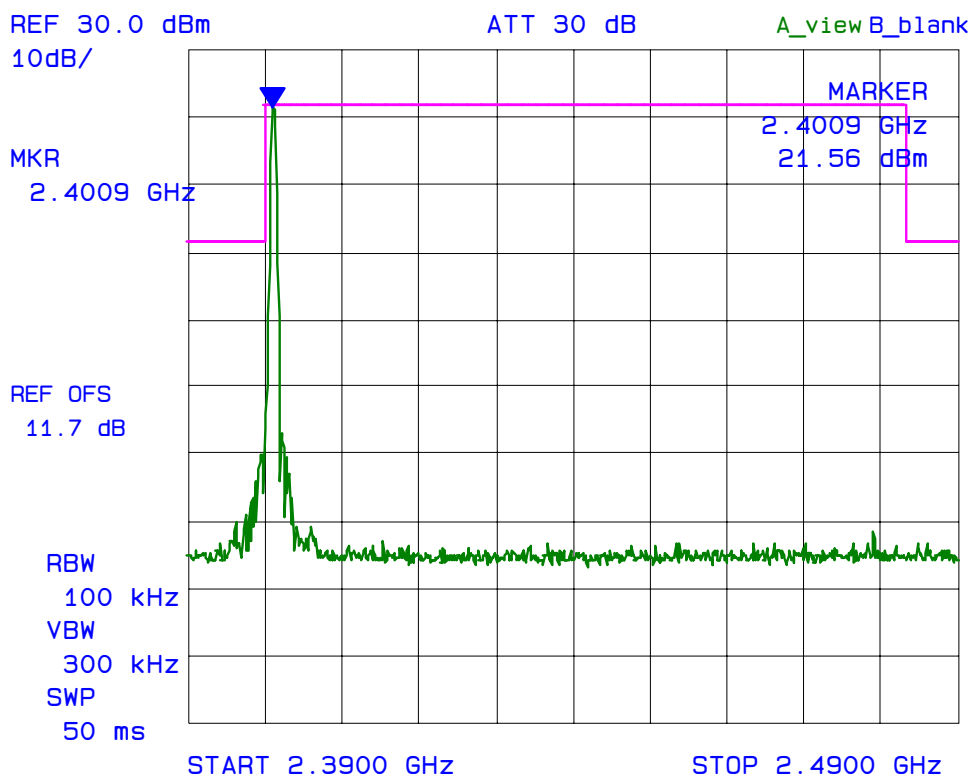
6.10.5.2.1. Lowest Frequency (2401.056 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data (plots 41 to 48) for measurement results.

Plot 41:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)



Plot 42:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)



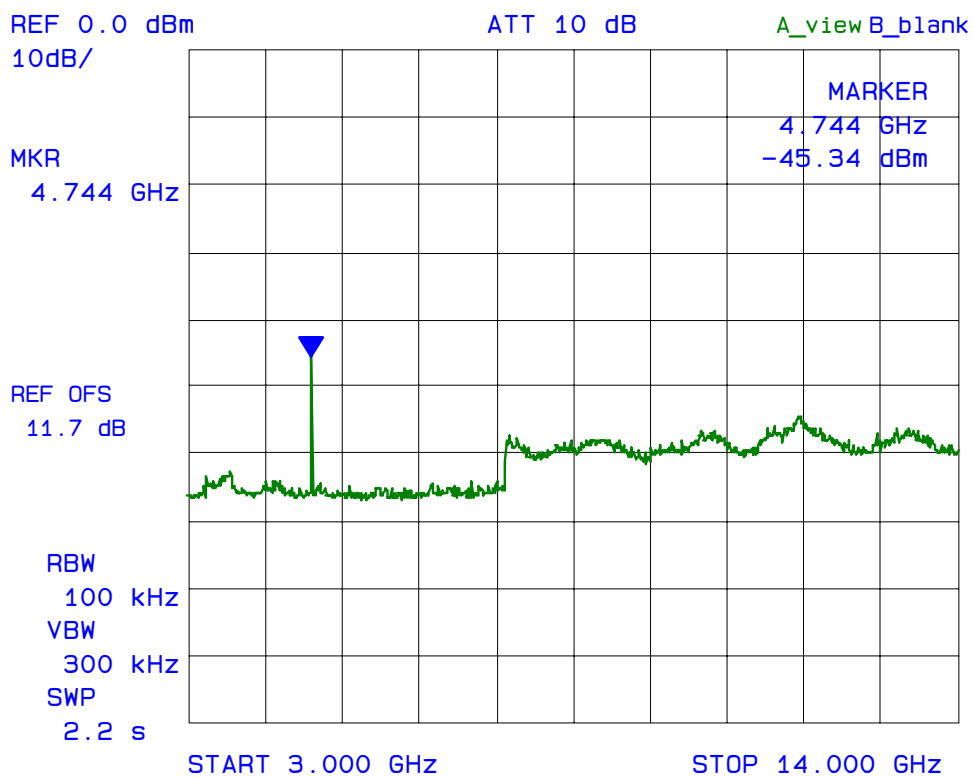
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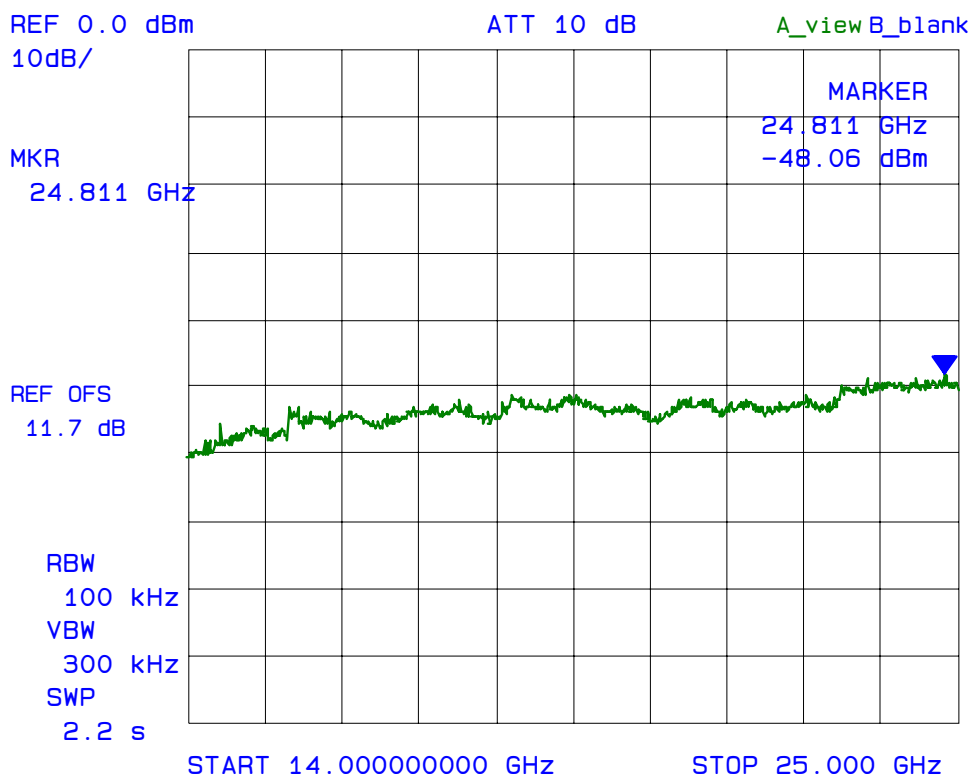
File #: PAN-061F15C247
April 19, 2005

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Plot 43:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)



Plot 44:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)



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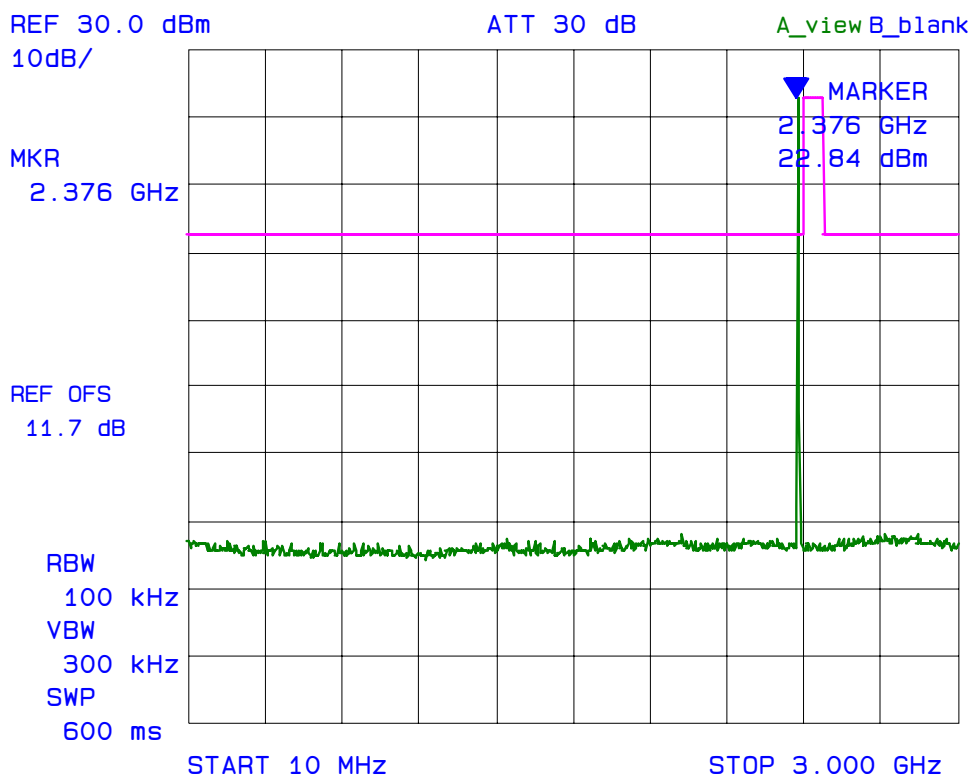
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: yic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: PAN-061F15C247

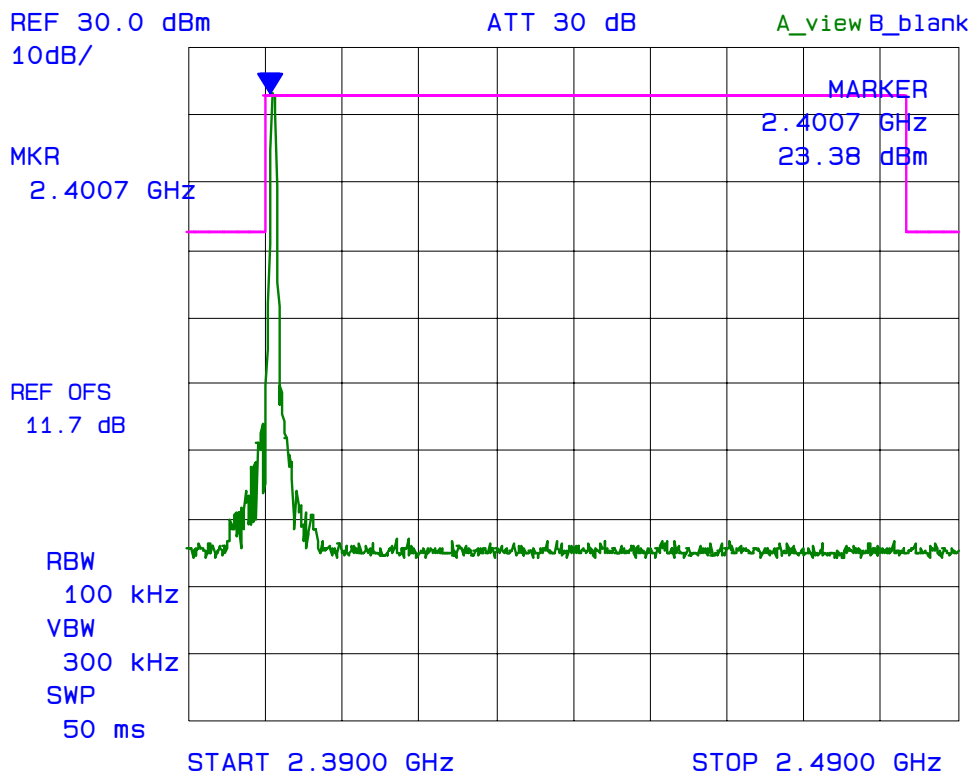
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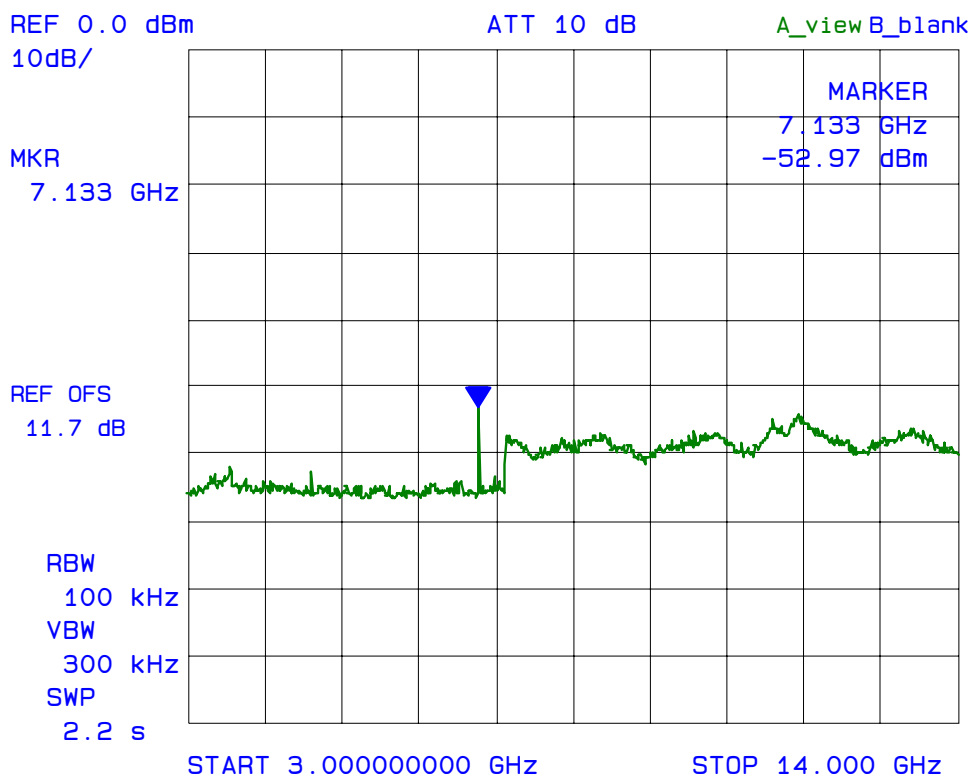
Plot 45:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)



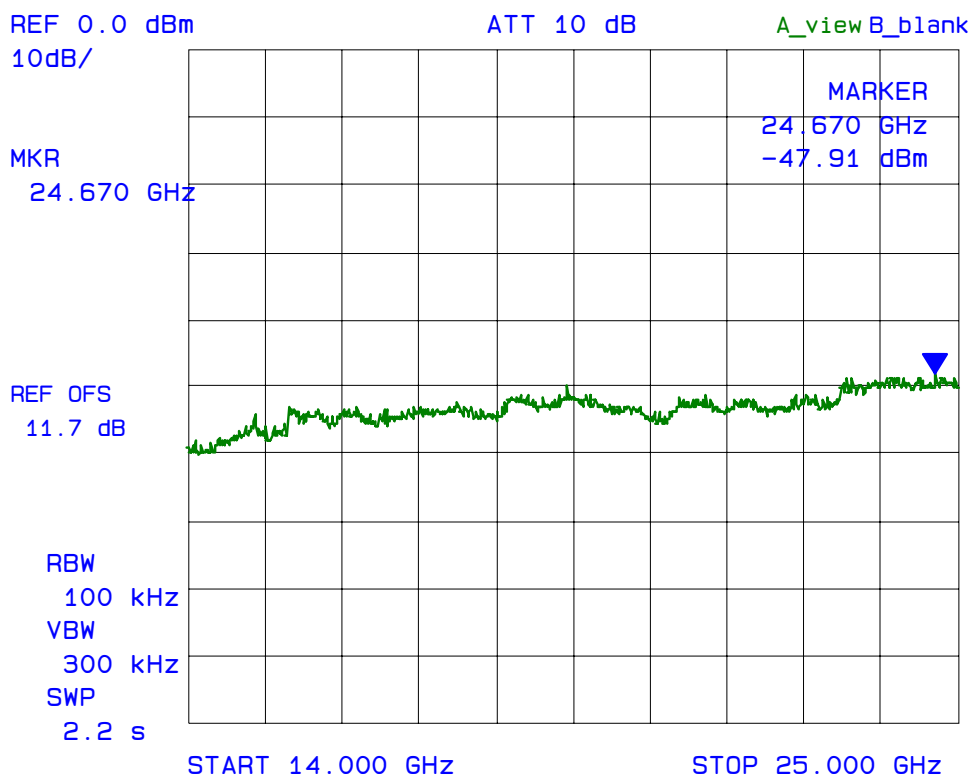
Plot 46:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)



Plot 47:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)



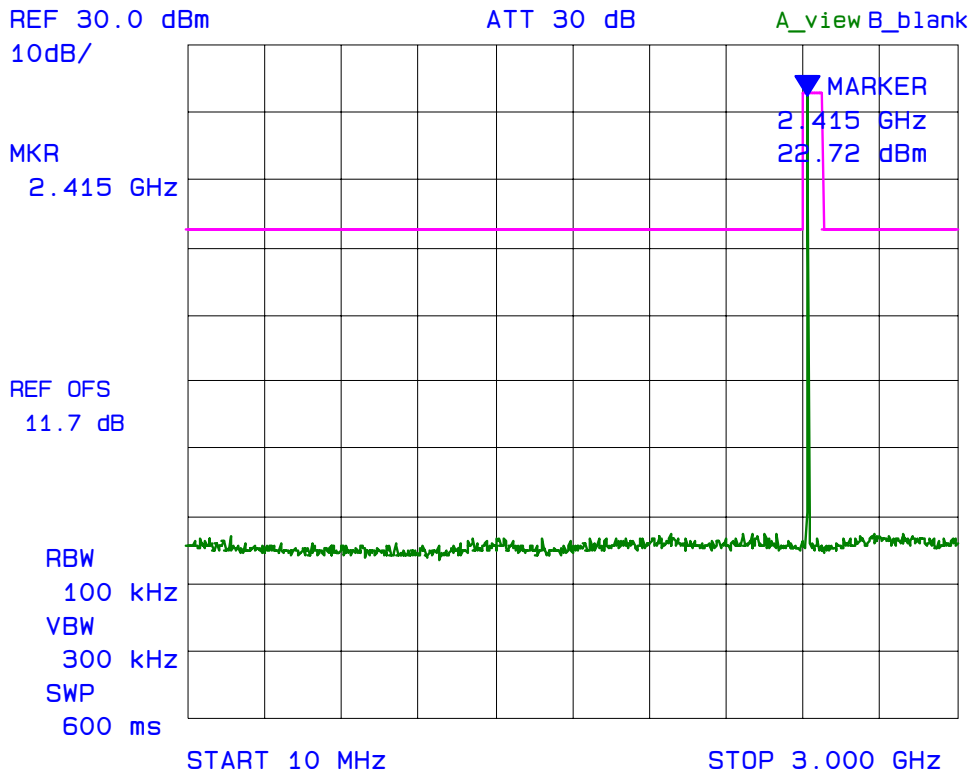
Plot 48:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)



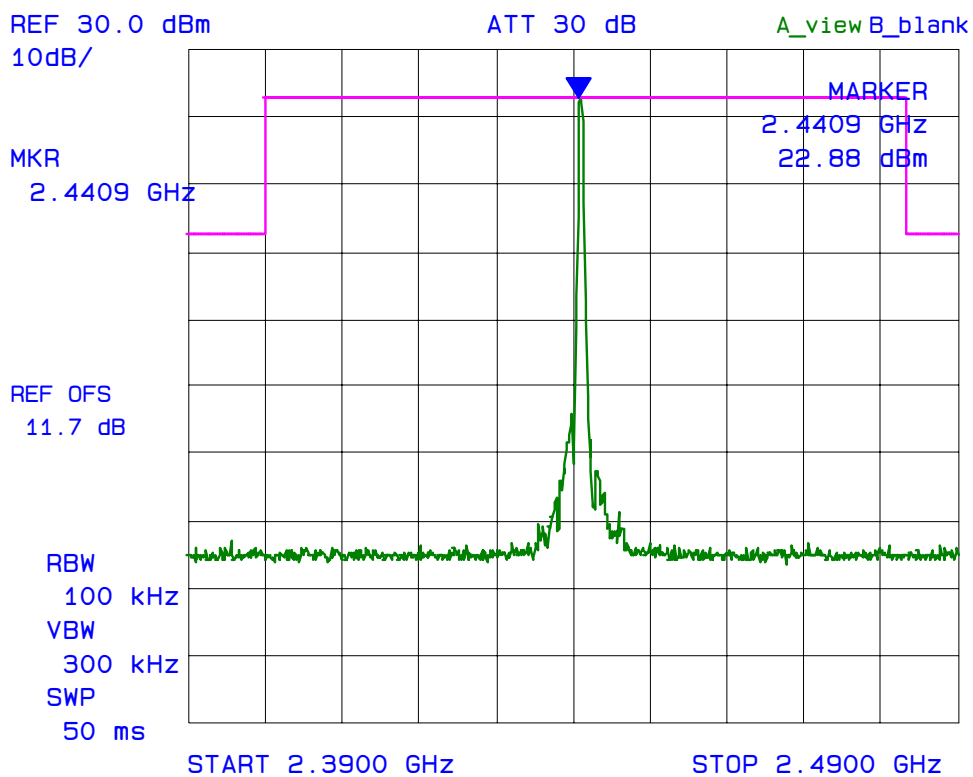
6.10.5.2.2. Middle Frequency (2440.800 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data (plots 49 to 56) for measurements results.

Plot 49:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2440.800 MHz (channel 46)



Plot 50:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2440.800 MHz (channel 46)



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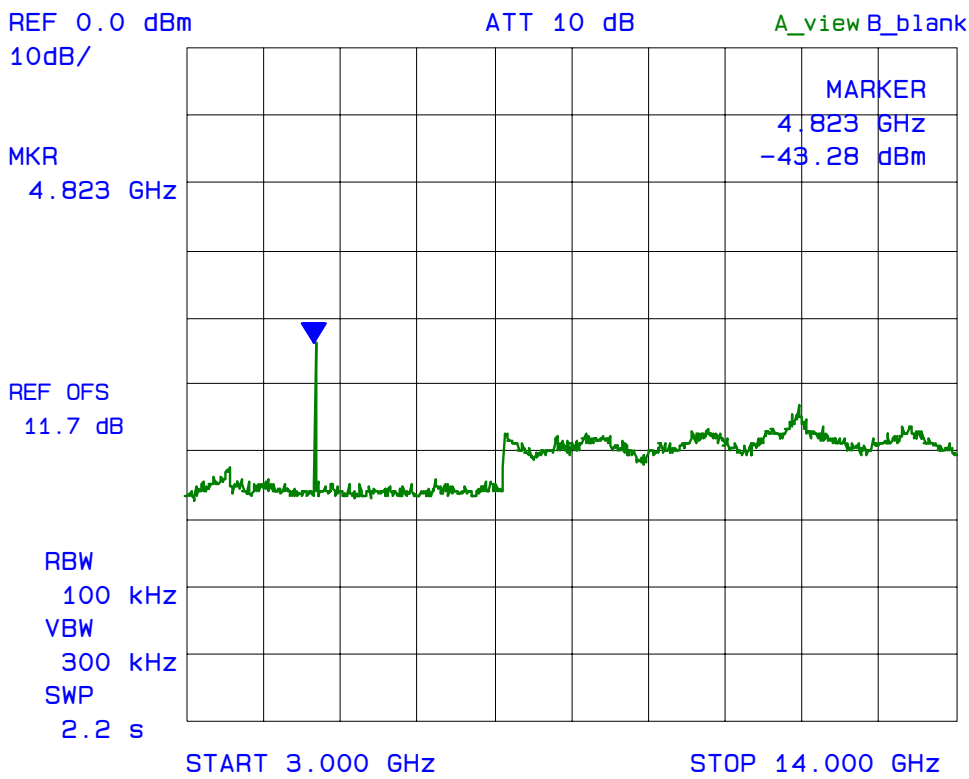
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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File #: PAN-061F15C247

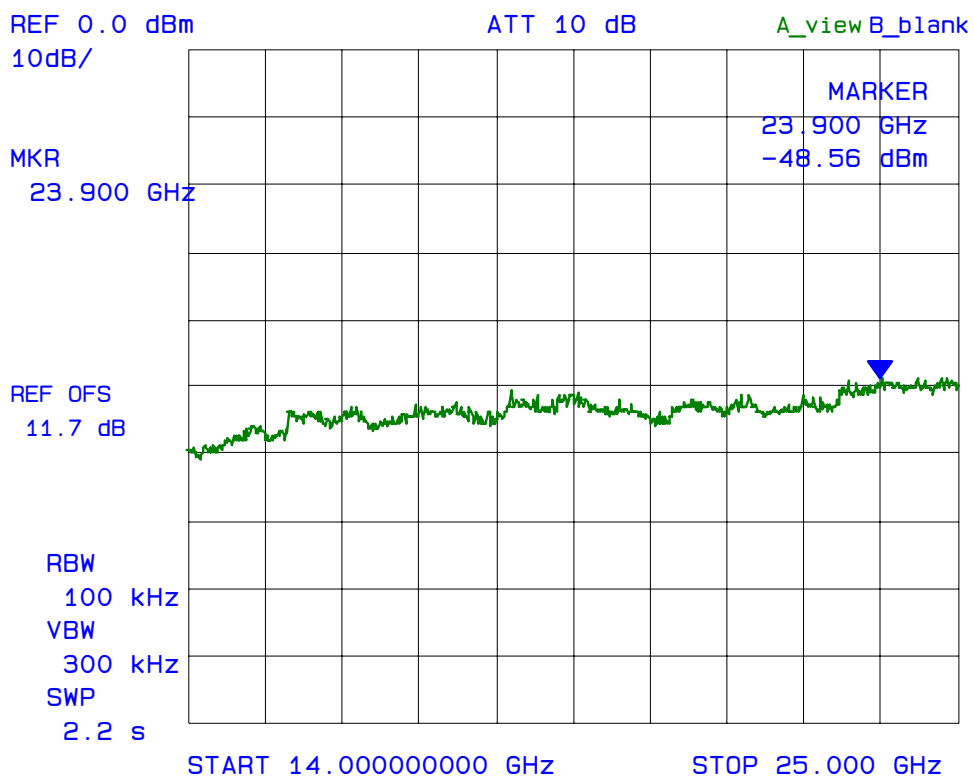
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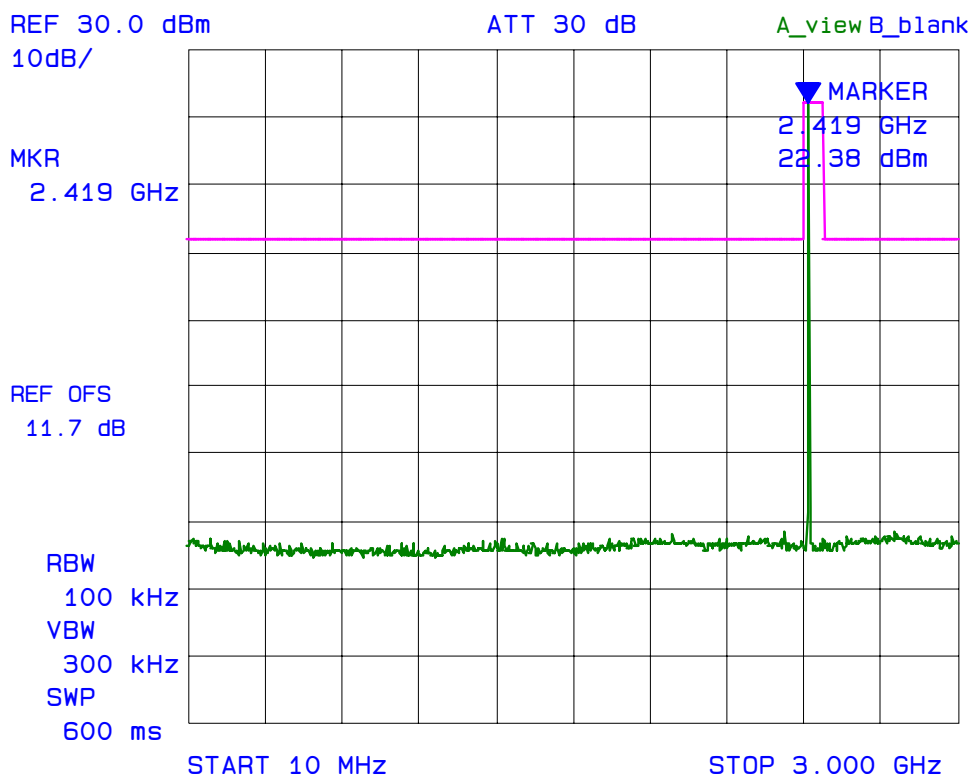
Plot 51:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2440.800 MHz (channel 46)



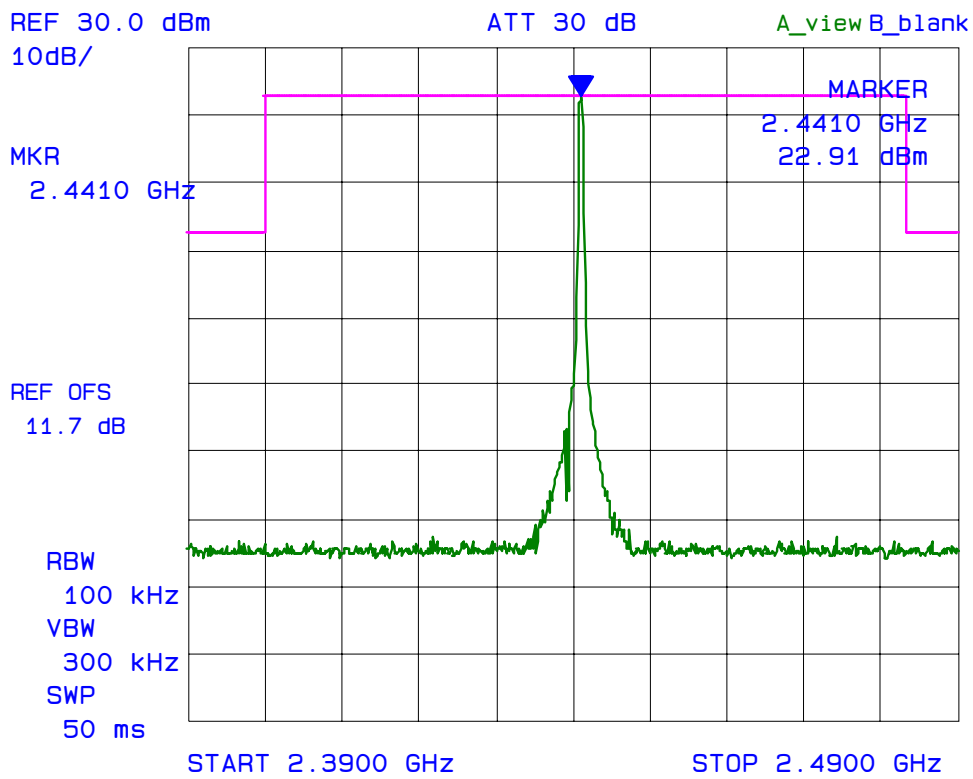
Plot 52:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2440.800 MHz (channel 46)



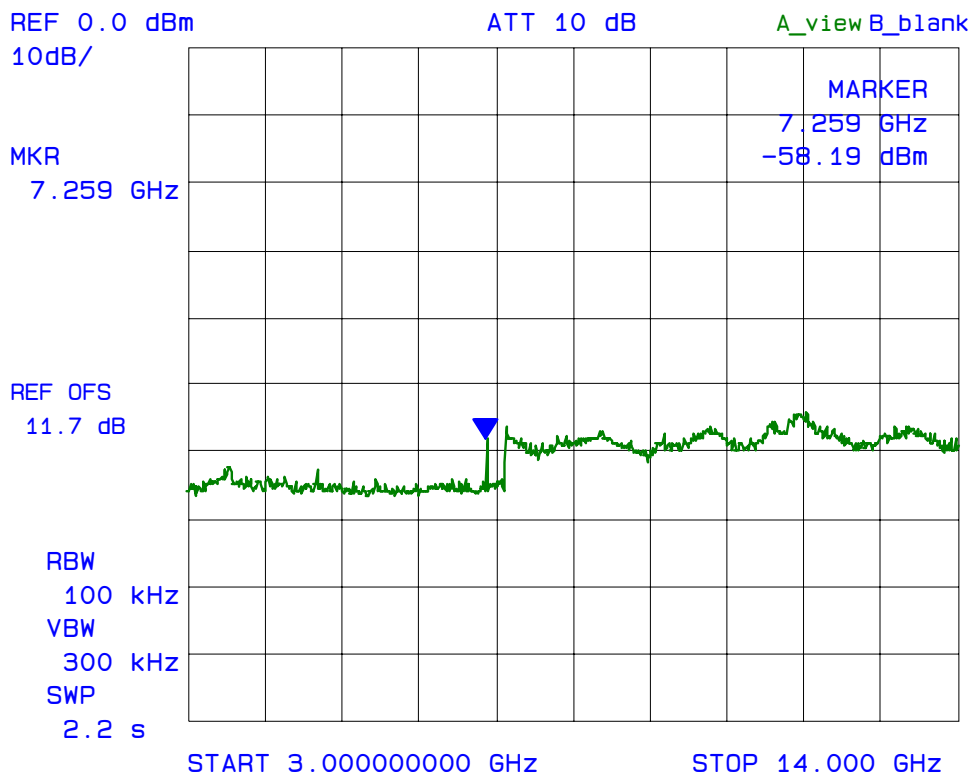
Plot 53:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2440.800 MHz (channel 46)



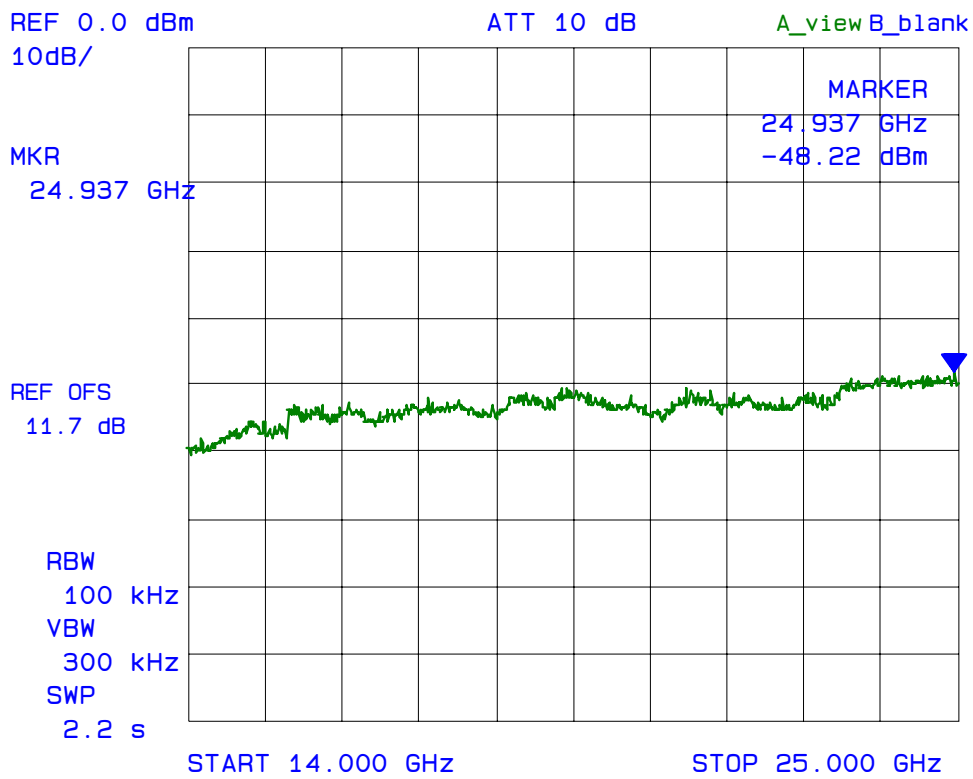
Plot 54:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2440.800 MHz (channel 46)



Plot 55:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2440.800 MHz (channel 46)



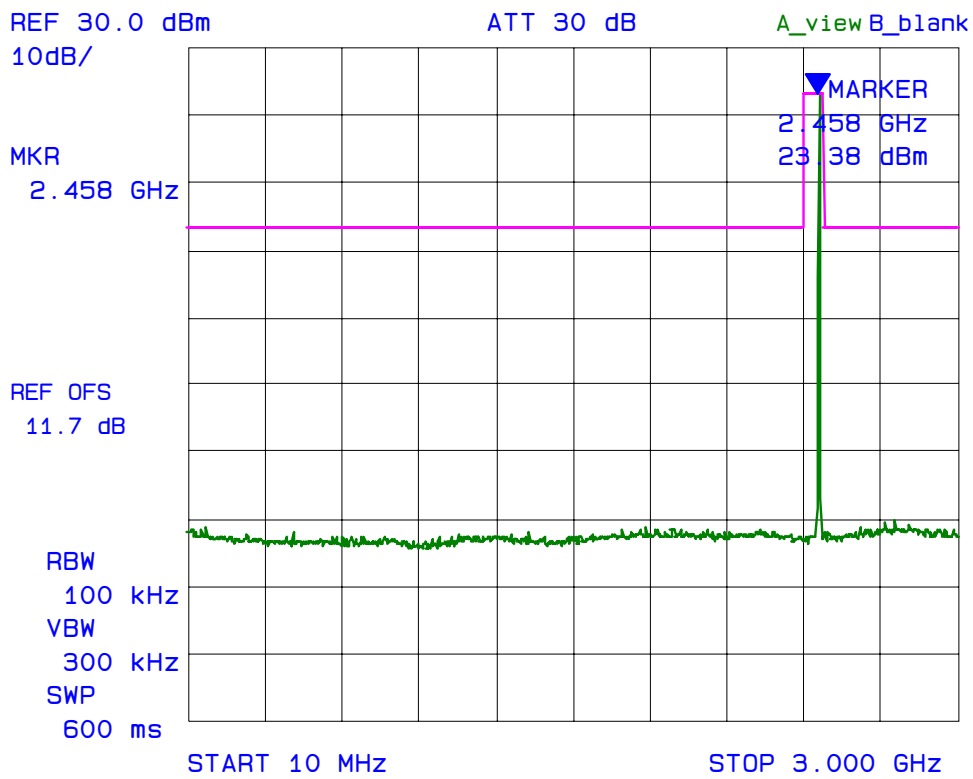
Plot 56:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2440.800 MHz (channel 46)



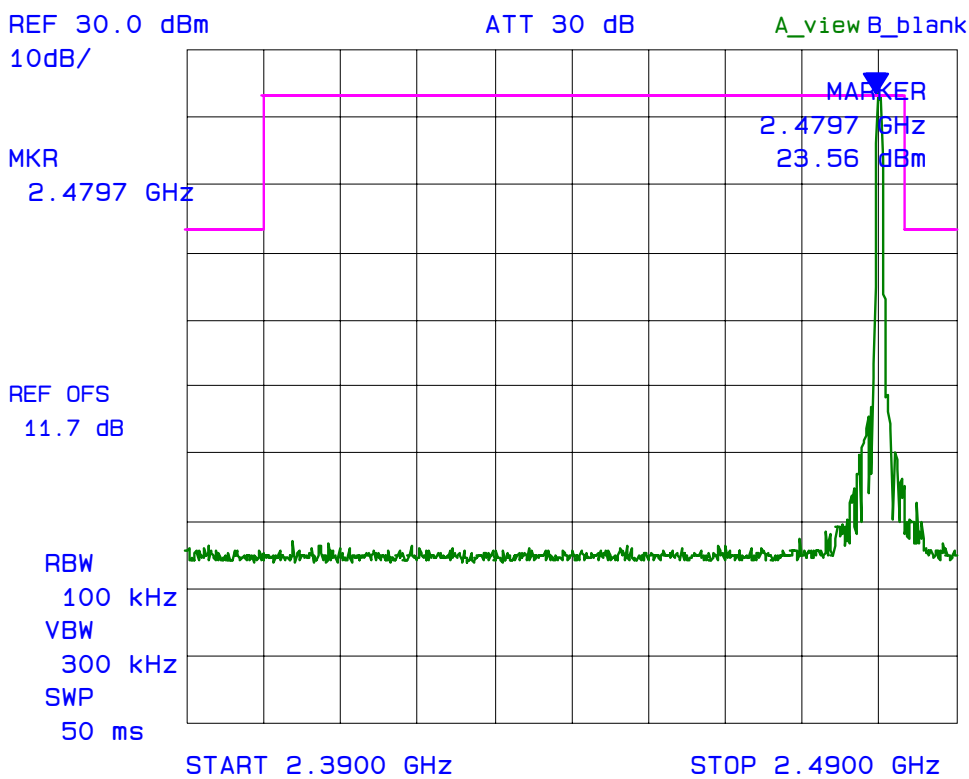
6.10.5.2.3. Highest Frequency (2479.680 MHz)

The emissions were scanned from 10 MHz to 25 GHz; refer to the following test data (plots 57 to 64) for measurements results.

Plot 57:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2479.680 MHz (channel 91)



Plot 58:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2479.680 MHz (channel 91)



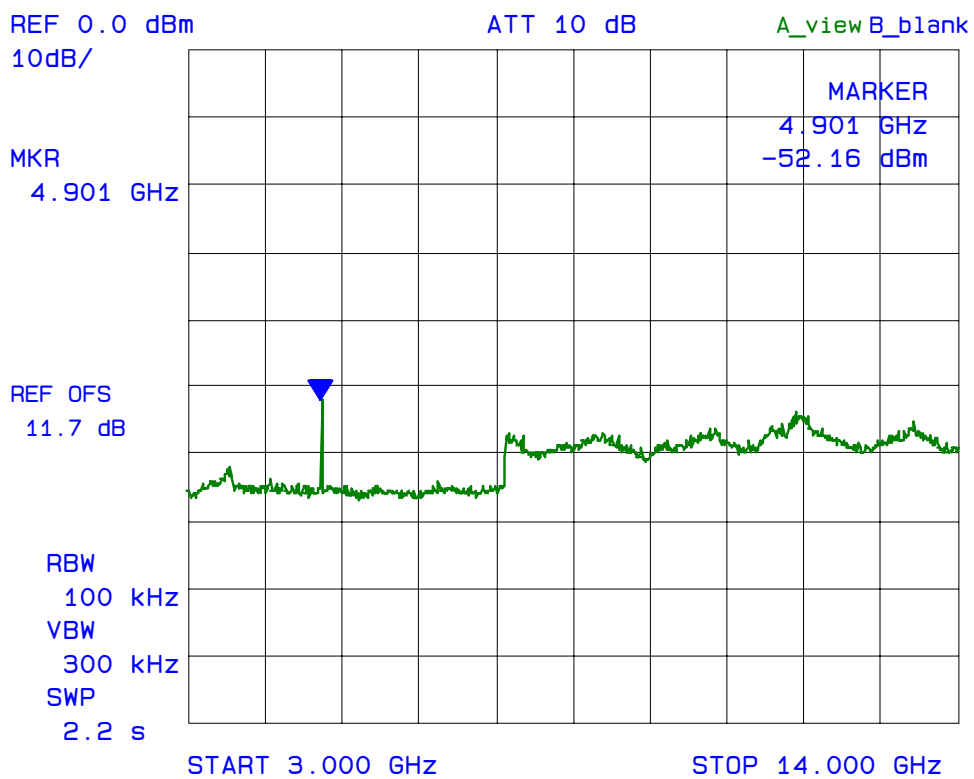
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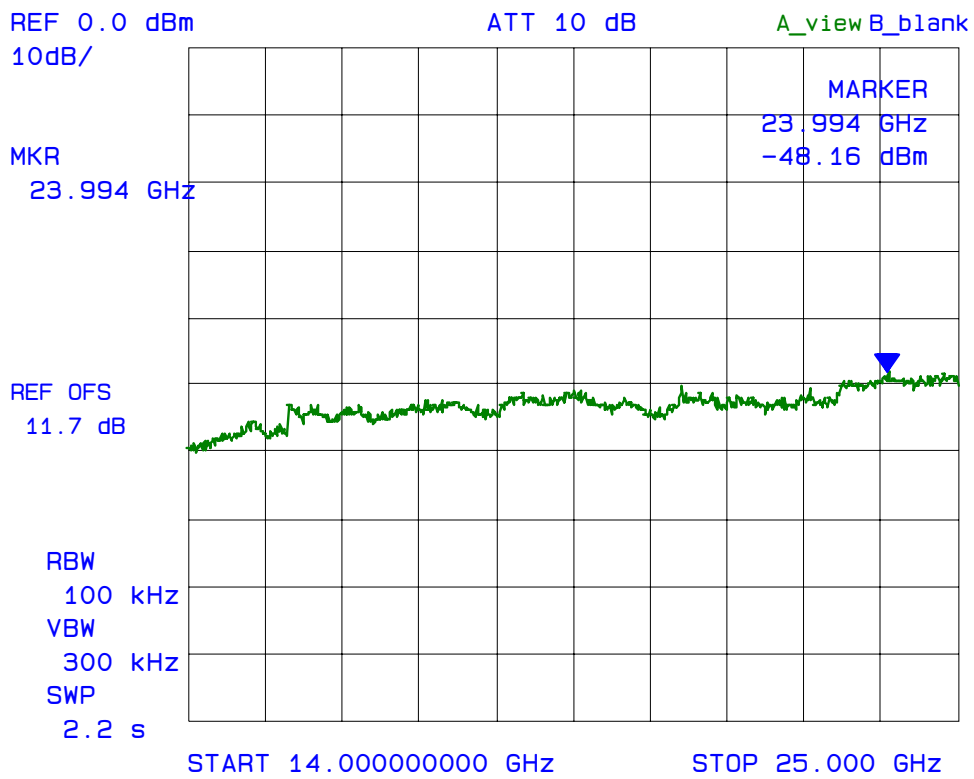
File #: PAN-061F15C247
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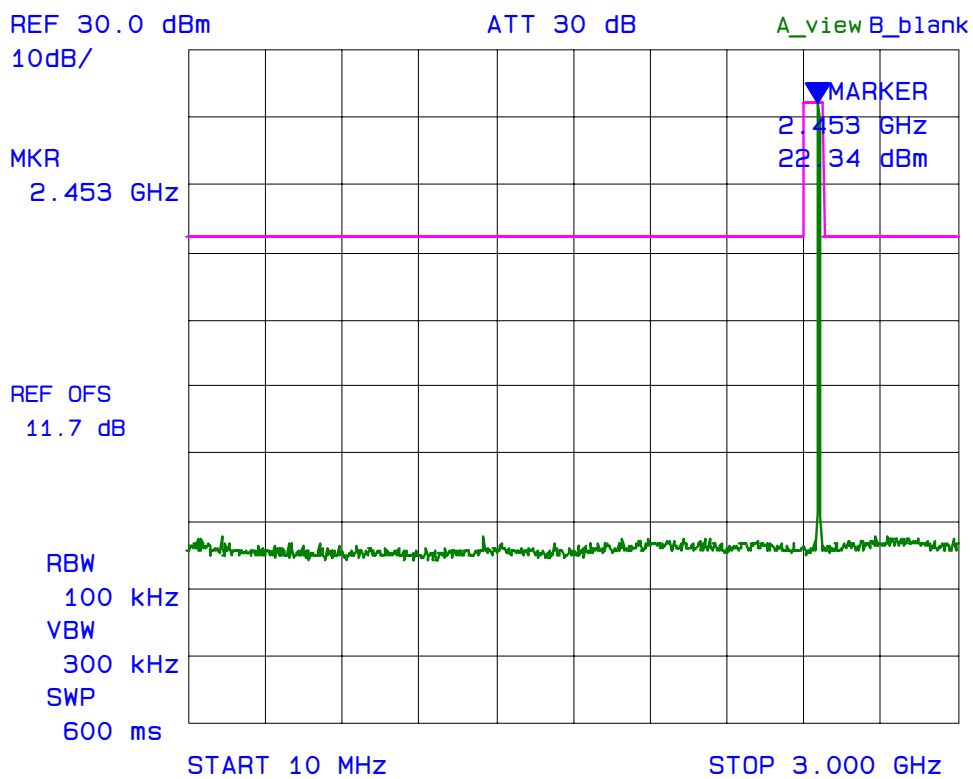
Plot 59:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2479.680 MHz (channel 91)



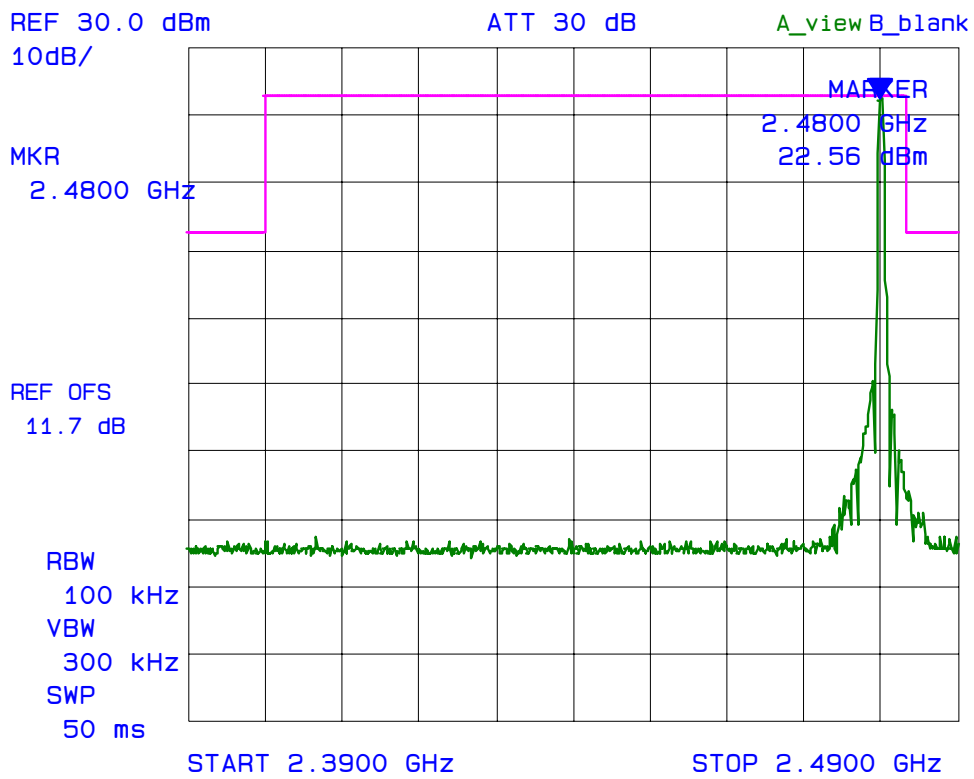
Plot 60:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 2479.680 MHz (channel 91)



Plot 61:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91)



Plot 62:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91)



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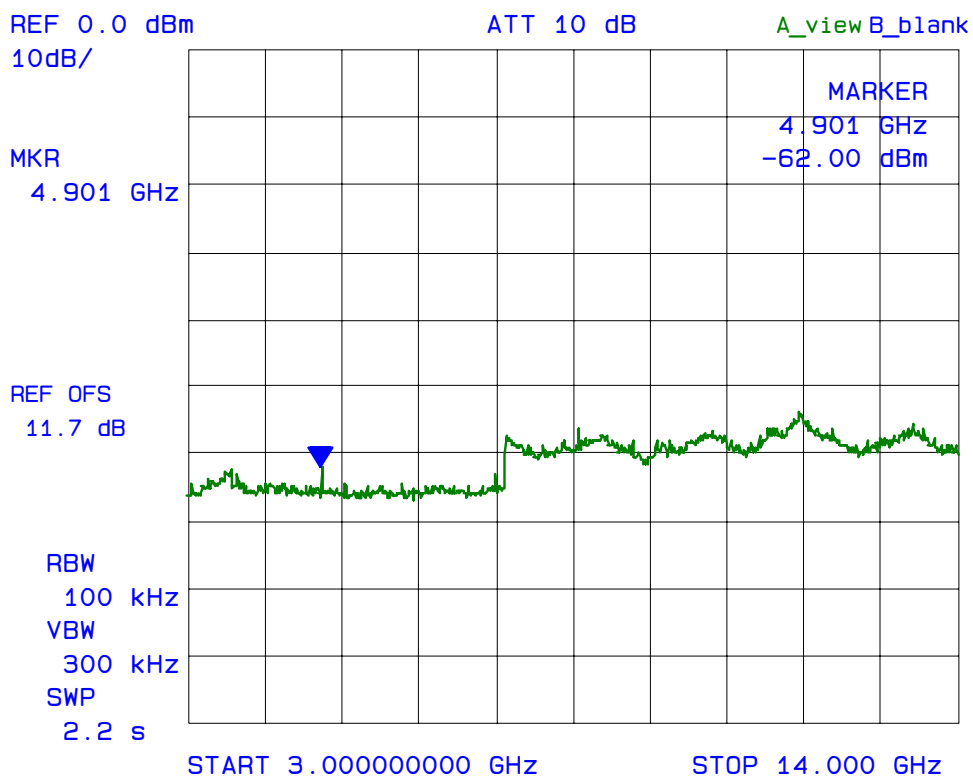
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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File #: PAN-061F15C247

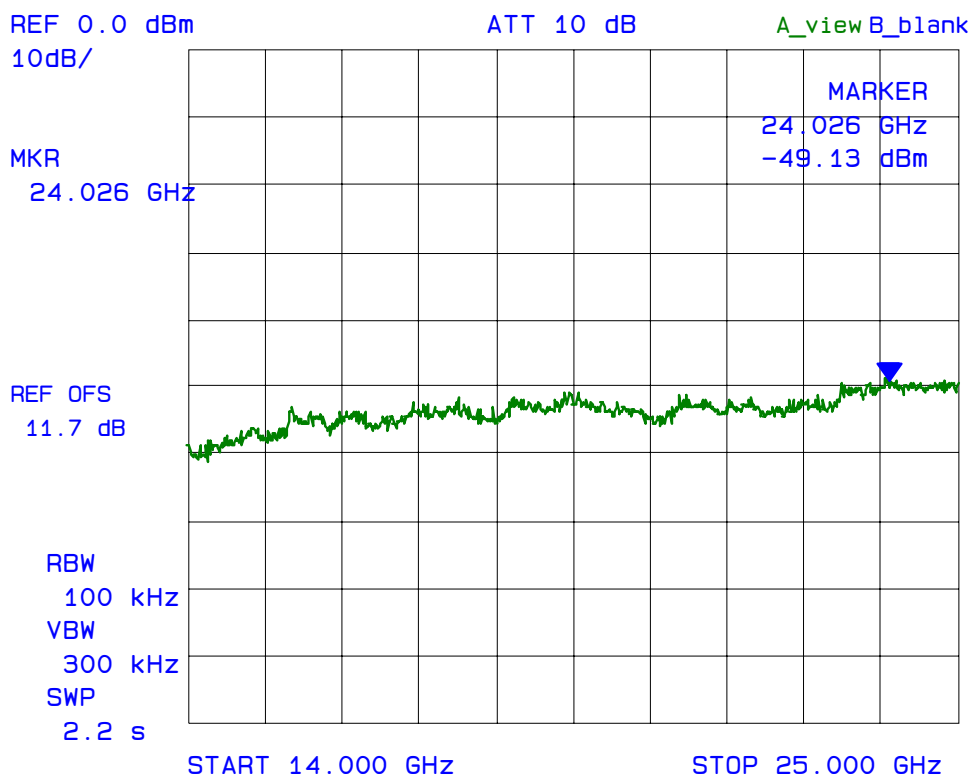
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Plot 63:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91)



Plot 64:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91)



6.11. TRANSMITTER BAND-EDGE & SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§15.247 (d), 15.209 & 15.205]

6.11.1. Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see Section 15.205 (c)).

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.
- The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

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

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

6.11.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this test report and ANSI 63.4 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 Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
Microwave Amplifier	Hewlett Packard	83051A	3611A01947	40 MHz to 50 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	18 GHz – 26.5 GHz
Horn Antenna	EMCO	3160-10	..	26.5 GHz – 40 GHz
Mixer	Tektronix	118-0098-00	..	18 GHz – 26.5 GHz
Mixer	Tektronix	119-0098-00	..	26.5 GHz – 40 GHz

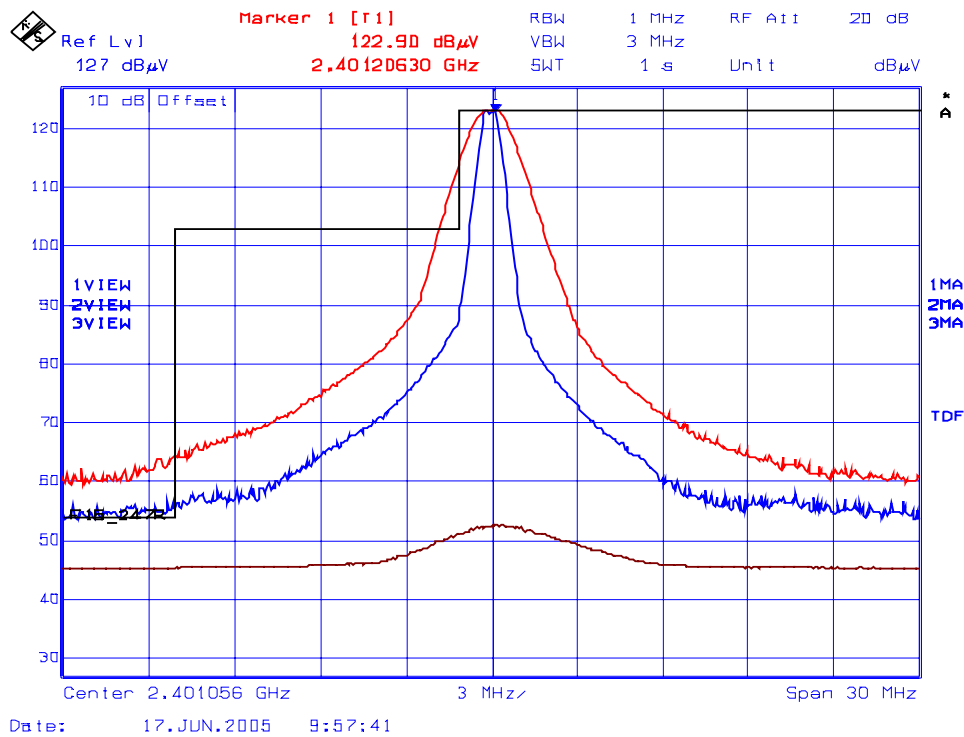
6.11.4. Test Data

6.11.4.1. Band Edge RF Radiated Emissions @ 3 Meters

Plot 65: Low End of Frequency Band (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)
Vertical Polarization

Note:

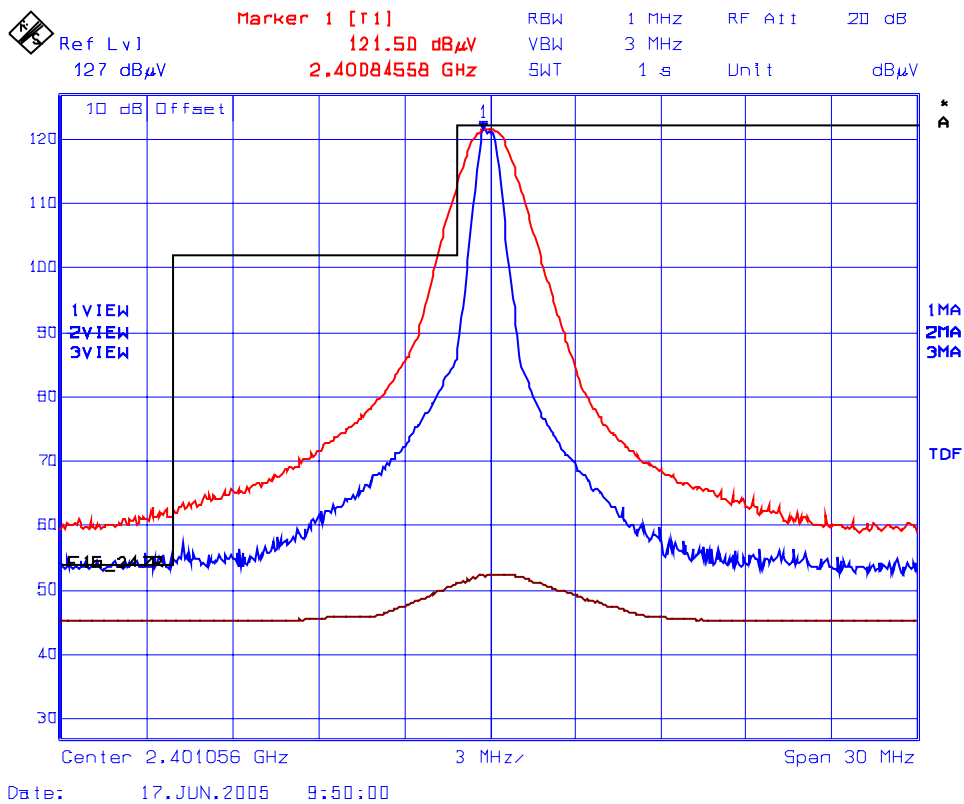
- Trace 1: RBW=1MHz, RBW=3 MHz
- Trace 2: RBW=300 kHz, RBW=1 MHz
- Trace 3: RBW=1 MHz, VBW=10 Hz



Plot 66: Low End of Frequency Band (Base Unit)
Transmitter Frequency: 2401.056 MHz (channel 00)
Horizontal Polarization

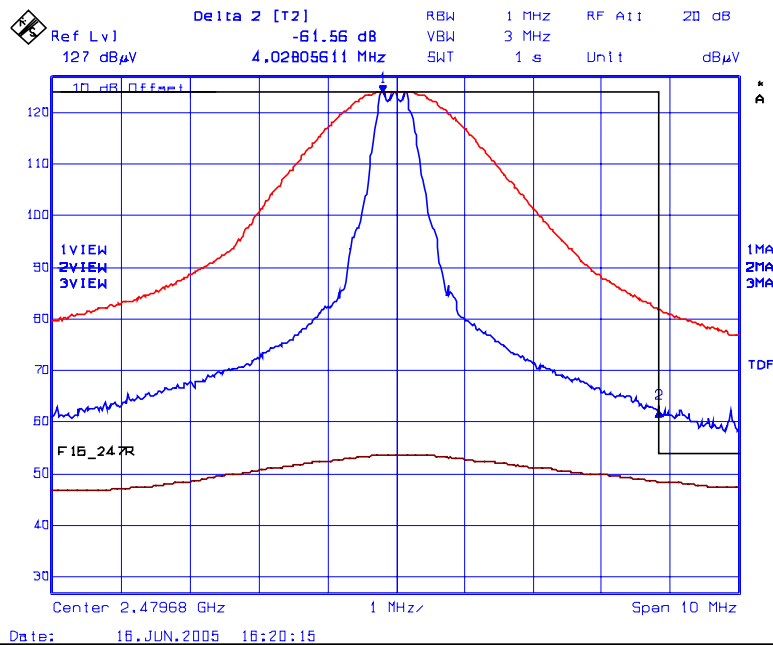
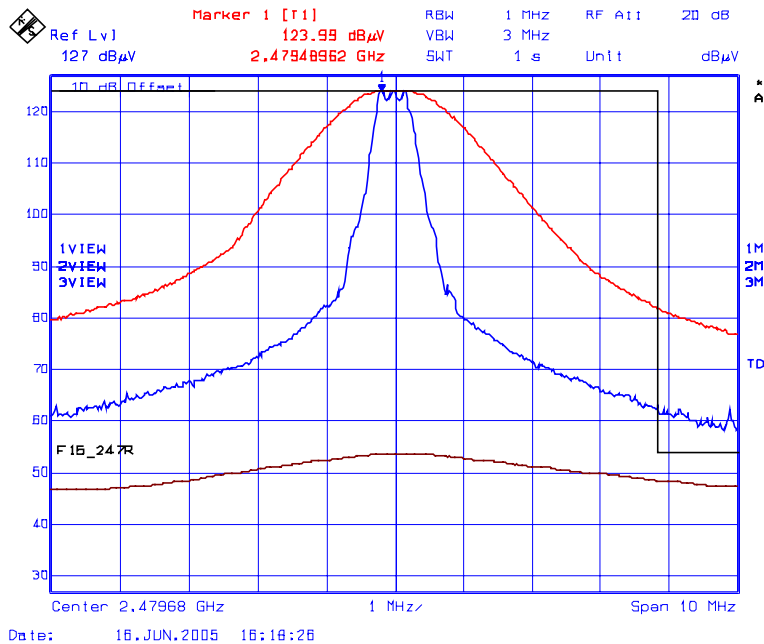
Note:

- Trace 1: RBW=1MHz, RBW=3 MHz
- Trace 2: RBW=300 kHz, RBW=1 MHz
- Trace 3: RBW=1 MHz, VBW=10 Hz



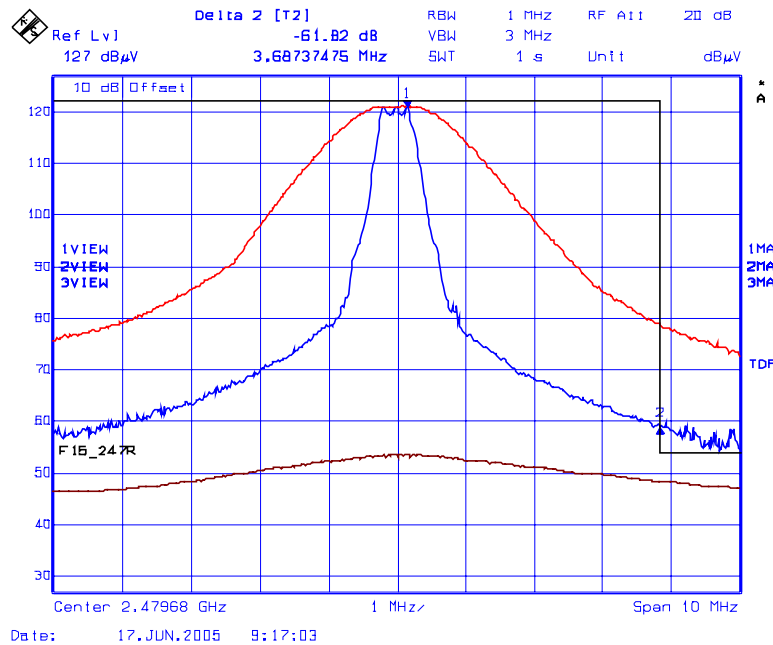
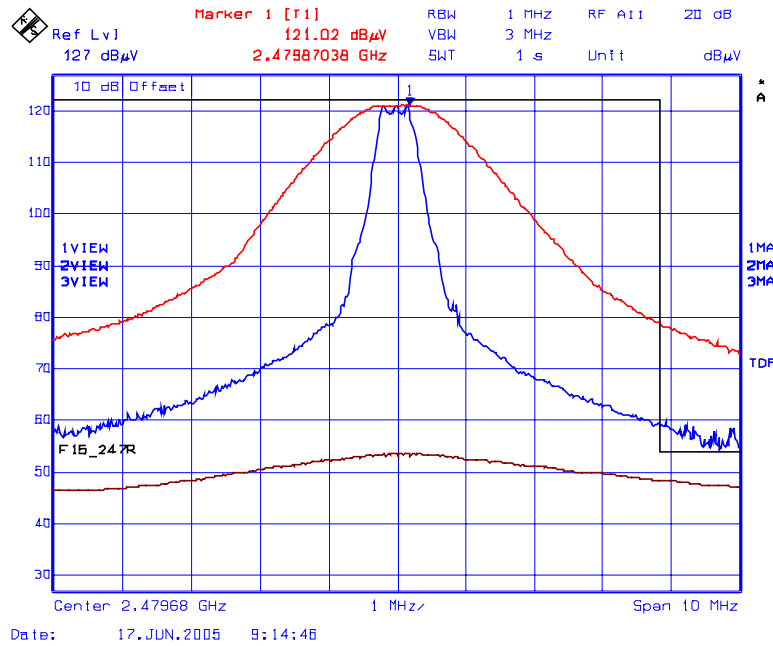
Plot 67: Upper End of Frequency Band (Base Unit)
Transmitter Frequency: 2479.680 MHz (channel 91) / Vertical Polarization

- Trace 1: RBW = 1 MHz, RBW=3 MHz
- Trace 2: RBW = 100 kHz, RBW = 300 kHz, Delta (Peak to Band-Edge): 61.56 dB
- Trace 3: RBW = 1 MHz, VBW = 10 Hz
- Band-Edge Level at 2483.5 MHz: 123.99 dBμV/m – 61.56 dB = 62.43 dBμV/m



Plot 68: Upper End of Frequency Band (Base Unit)
 Transmitter Frequency: 2479.680 MHz (channel 91) / Horizontal Polarization

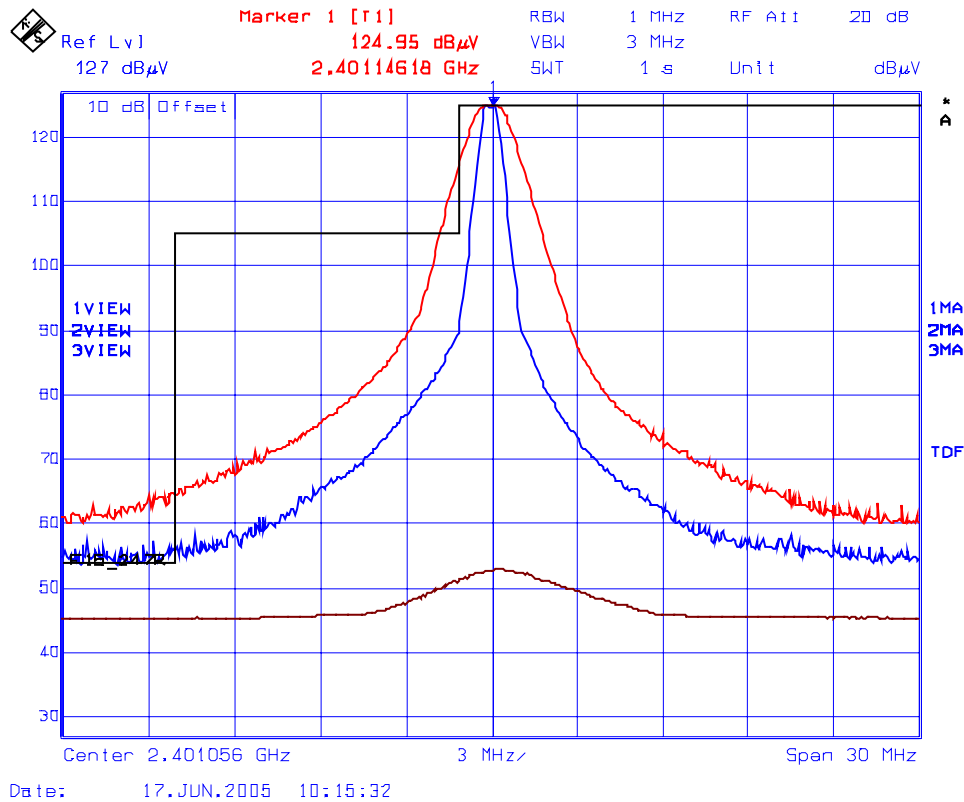
- Trace 1: RBW = 1 MHz, RBW=3 MHz
- Trace 2: RBW = 100 kHz, RBW = 300 kHz, Delta (Peak to Band-Edge): 61.82 dB
- Trace 3: RBW = 1 MHz, VBW = 10 Hz
- Band-Edge Level at 2483.5 MHz: 121.02 dBμV/m – 61.82 dB = 59.20 dBμV/m



Plot 69: Low End of Frequency Band (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)
Vertical Polarization

Note:

- Trace 1: RBW=1MHz, RBW=3 MHz
- Trace 2: RBW=300 kHz, RBW=1 MHz
- Trace 3: RBW=1 MHz, VBW=10 Hz



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File #: PAN-061F15C247

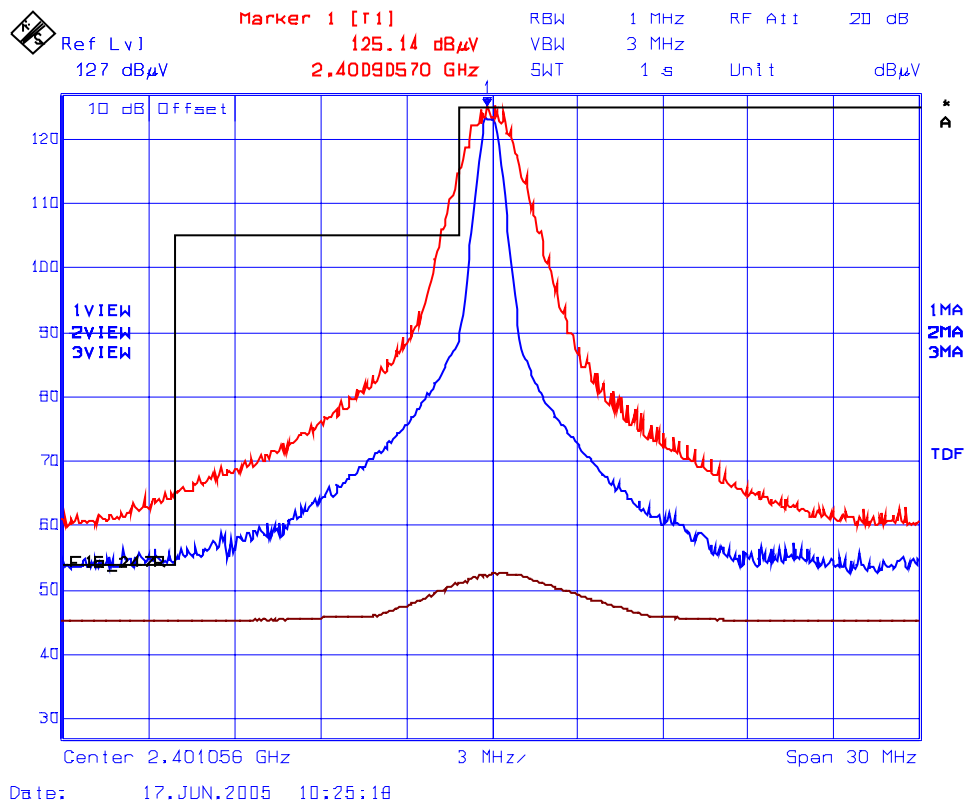
April 19, 2005

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Plot 70: Low End of Frequency Band (Handset)
Transmitter Frequency: 2401.056 MHz (channel 00)
Horizontal Polarization

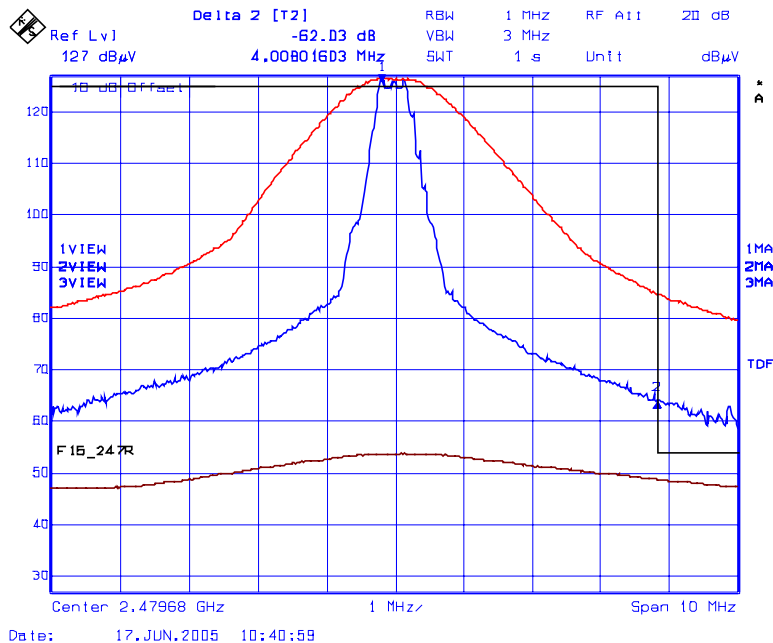
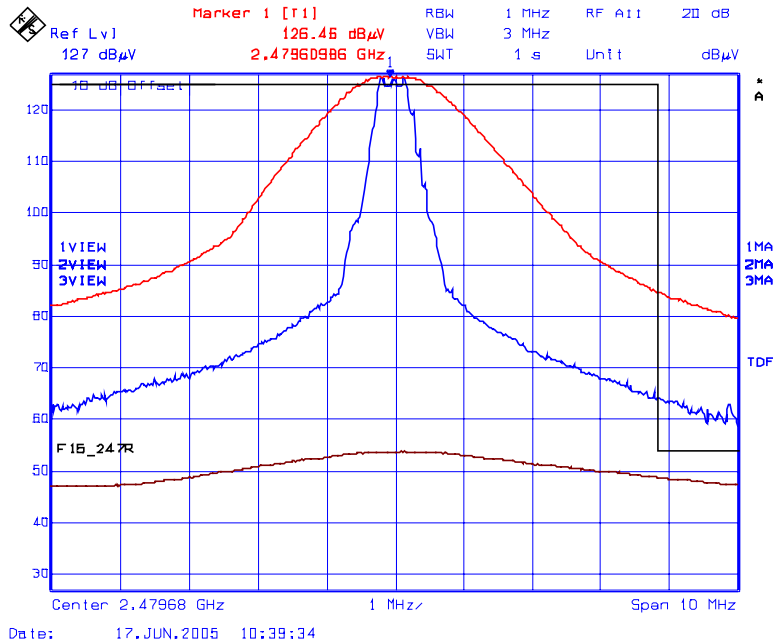
Note:

- Trace 1: RBW=1MHz, RBW=3 MHz
- Trace 2: RBW=300 kHz, RBW=1 MHz
- Trace 3: RBW=1 MHz, VBW=10 Hz



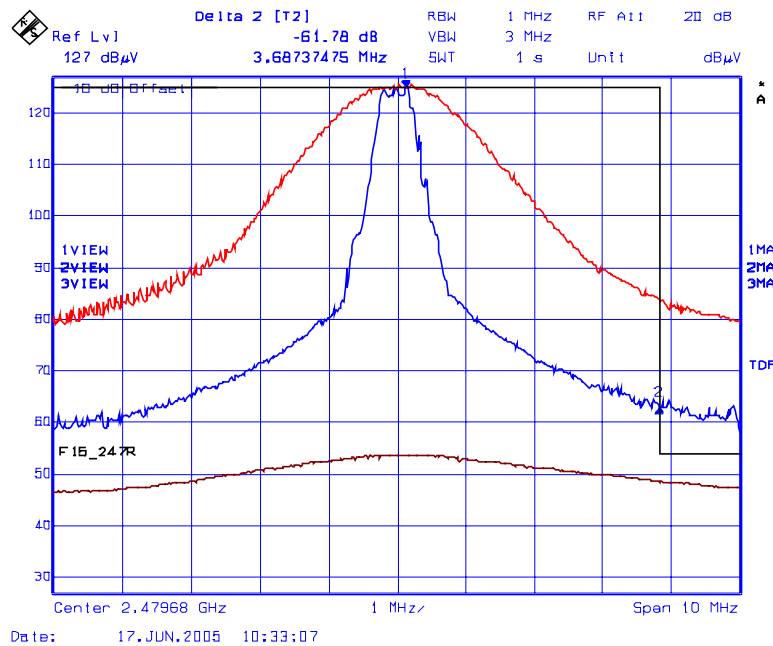
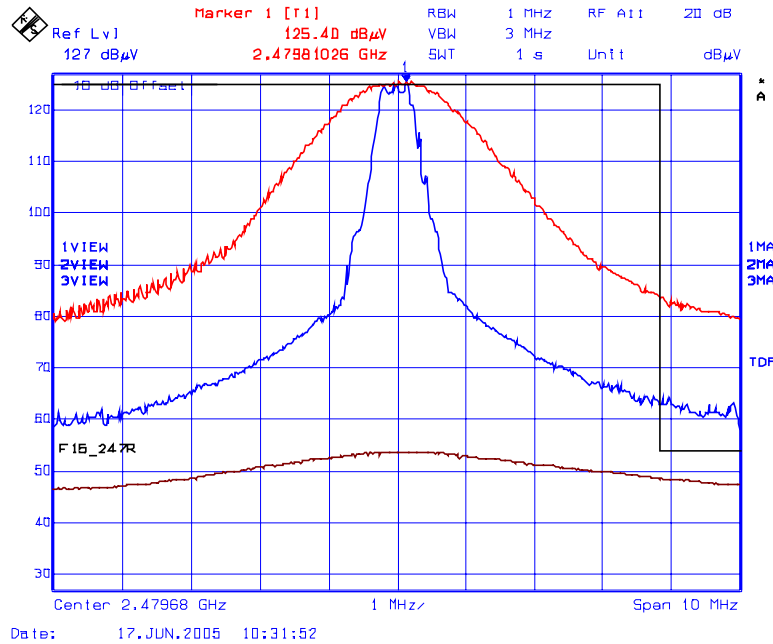
Plot 71: End of Frequency Band (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91) / Vertical Polarization

- Trace 1: RBW = 1 MHz, RBW=3 MHz
- Trace 2: RBW = 100 kHz, RBW = 300 kHz, Delta (Peak to Band-Edge): 62.03 dB
- Trace 3: RBW = 1 MHz, VBW = 10 Hz
- Band-Edge Level at 2483.5 MHz: 126.46 dBμV/m – 62.03 dB = 64.43 dBμV/m



Plot 72: End of Frequency Band (Handset)
Transmitter Frequency: 2479.680 MHz (channel 91) / Horizontal Polarization

- Trace 1: RBW = 1 MHz, RBW=3 MHz
- Trace 2: RBW = 100 kHz, RBW = 300 kHz, Delta (Peak to Band-Edge): 61.78 dB
- Trace 3: RBW = 1 MHz, VBW = 10 Hz
- Band-Edge Level at 2483.5 MHz: 125.40 dBμV/m – 61.78 dB = 63.62 dBμV/m



6.11.4.2. Spurious Radiated Emissions @ 3 Meters

Remarks:

1. Test frequency range is from 30 MHz to 25 GHz.
2. All spurious emissions and harmonics attenuated less than 20 dB from the limit are recorded.

6.11.4.3. Base Unit

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
Fundamental Frequency: 2401.056 MHz (channel 00)							
2401.056	124.14	--	V	--	--	--	--
2401.056	121.47	--	H	--	--	--	--
4802.112	55.46	35.39	V	54.0	104.1	-18.6	Pass*
4802.112	60.03	36.57	H	54.0	104.1	-17.4	Pass*
Fundamental Frequency: 2440.800 MHz (channel 46)							
2440.800	126.09	--	V	--	--	--	--
2440.800	123.22	--	H	--	--	--	--
4881.600	61.07	35.95	V	54.0	106.1	-18.1	Pass*
4881.600	60.62	35.62	H	54.0	106.1	-18.4	Pass*
7322.400	57.62	38.93	V	54.0	106.1	-15.1	Pass*
7322.400	54.44	37.85	H	54.0	106.1	-16.2	Pass*
12204.00	60.25	42.05	V	54.0	106.1	-12.0	Pass*
12204.00	56.54	40.82	H	54.0	106.1	-13.2	Pass*
Fundamental Frequency: 2479.680 MHz (channel 91)							
2479.680	126.13	--	V	--	--	--	--
2479.680	123.38	--	H	--	--	--	--
4959.360	61.75	35.35	V	54.0	106.1	-18.7	Pass*
4959.360	60.3	35.12	H	54.0	106.1	-18.9	Pass*
7439.040	56.72	38.72	V	54.0	106.1	-15.3	Pass*
7439.040	54.35	37.52	H	54.0	106.1	-16.5	Pass*
12398.40	60.84	42.34	V	54.0	106.1	-11.7	Pass*
12398.40	58.06	42.34	H	54.0	106.1	-11.7	Pass*

* Frequency in restricted bands, therefore FCC 15.209 limit applied.

6.11.4.4. Handset

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
Fundamental Frequency: 2401.056 (channel 00)							
2401.056	124.44	--	V	--	--	--	--
2401.056	123.12	--	H	--	--	--	--
4802.112	51.14	35.48	V	54.0	104.4	-18.5	Pass*
4802.112	50.77	35.07	H	54.0	104.4	-18.9	Pass*
12005.28	60.88	42.49	V	54.0	104.4	-11.5	Pass*
12005.28	63.51	42.70	H	54.0	104.4	-11.3	Pass*
Fundamental Frequency: 2440.800 MHz (channel 46)							
2440.800	126.53	--	V	--	--	--	--
2440.800	123.68	--	H	--	--	--	--
4881.600	51.27	34.57	V	54.0	106.5	-19.4	Pass*
4881.600	53.94	35.60	H	54.0	106.5	-18.4	Pass*
7322.400	63.96	40.21	V	54.0	106.5	-13.8	Pass*
7322.400	64.74	40.61	H	54.0	106.5	-13.4	Pass*
12204.00	60.68	42.39	V	54.0	106.5	-11.6	Pass*
12204.00	61.27	43.10	H	54.0	106.5	-10.9	Pass*
Fundamental Frequency: 2479.680 MHz (channel 91)							
2479.680	126.29	--	V	--	--	--	--
2479.680	122.64	--	H	--	--	--	--
4959.360	55.56	35.19	V	54.0	106.3	-18.8	Pass*
4959.360	58.51	36.19	H	54.0	106.3	-17.8	Pass*
7439.040	62.45	39.73	V	54.0	106.3	-14.3	Pass*
7439.040	63.69	40.29	H	54.0	106.3	-13.7	Pass*
12398.40	64.13	43.68	V	54.0	106.3	-10.3	Pass*
12398.40	63.92	43.76	H	54.0	106.3	-10.2	Pass*

* Frequency in restricted bands, therefore FCC 15.209 limit applied.

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 MESUREMENT 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 $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ 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:

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

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (+ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	± 1.0	± 1.0
Cable Loss Calibration	Normal (k=2)	± 0.3	± 0.5
EMI Receiver specification	Rectangular	± 1.5	± 1.5
Antenna Directivity	Rectangular	$+0.5$	$+0.5$
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase center variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	± 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67(Bi) 0.3 (Lp)$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	+1.1 -1.25	± 0.5
System repeatability	Std. Deviation	± 0.5	± 0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

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) x 16'(W) x 8'(H).
- The test was performed 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 this 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 150 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 effect 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 recorded.

8.3. EQUIVALENT ISOTROPIC RADIATED POWER (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).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

Step 1: Duty Cycle Measurements

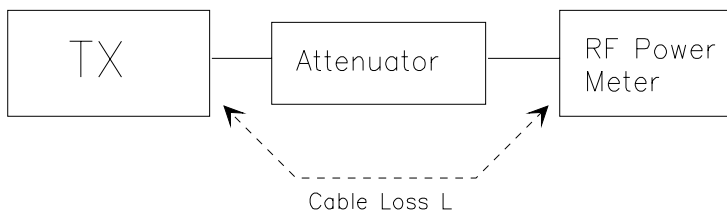
- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$ with $0 < x < 1$, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

Step 2: Calculation of Peak and Average EIRP

- The peak output power of the transmitter shall be determined using a wideband, calibrated RF Peak Power Meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as “P” (in dBm);
- The Average EIRP shall be calculated from the above measured power output “A”, the observed duty cycle x, and the applicable antenna assembly gain “G” in dBi, according to the formula:

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

Figure 1



Step 3: Substitution Method. See Figure 2

- (a) The measurements was performed in the absence of modulation (un-modulated)
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The dipole test antenna was used and tuned to the transmitter carrier frequency.
- (e) The spectrum analyzer was tuned to transmitter carrier frequency. The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (f) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (g) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (h) The substitution dipole antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution dipole antenna was placed in vertical polarization. The test dipole antenna was lowered or raised as necessary to ensure that the maximum signal is still received.
- (i) The input signal to the substitution antenna was adjusted in level until an equal or a known related level to that detected from the transmitter was obtained in the test receiver. The maximum carrier radiated power is equal to the power supply by the generator.
- (j) The substitution antenna gain and cable loss were added to the signal generator level for the corrected ERP level.
- (k) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
- (l) Actual gain of the EUT's antenna is the difference of the measured ERP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

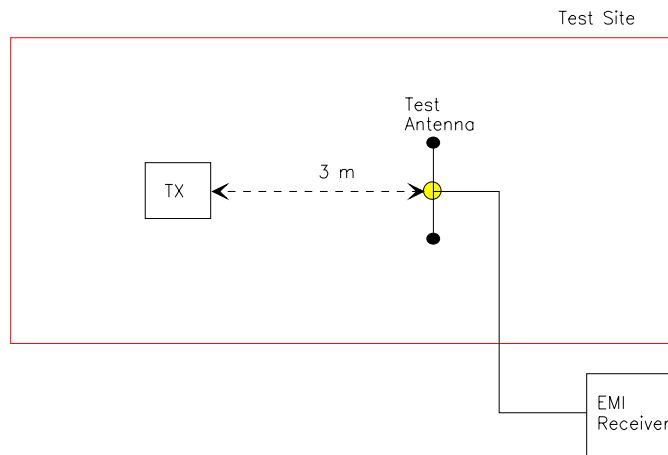
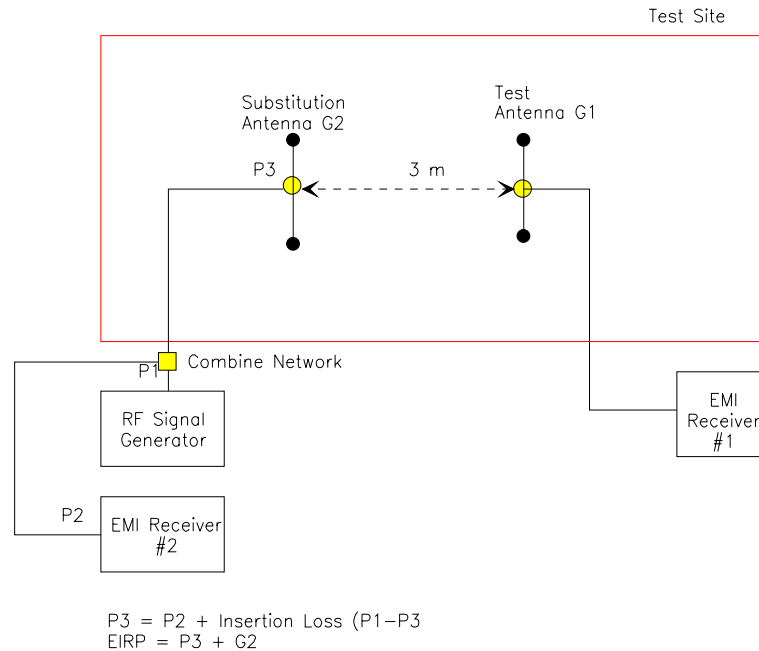


Figure 3



Use the following spectrum analyzer settings:

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

8.4. SPURIOUS EMISSIONS (CONDUCTED & RADIATED)

For both conducted and radiated measurements, the spurious emissions were scanned from the lowest frequency generated by the EUT or 10 MHz whichever is lower to 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
- Now, using the same instrument settings, enable the hopping function of the EUT
- Allow the trace to stabilize
- Follow the same procedure listed above to determine if any spurious emissions cause by the hopping function also comply with the specify limits.
- Submit this plot

Spurious RF Conducted Emissions:

Use the following spectrum analyzer settings:

- The radio was connected to the measuring equipment via a suitable attenuator.
- Span = wide enough to capture the peak level of the in-band-emission and all spurious emissions (e.g. harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several 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 $f < 1\text{GHz}$ and $\text{RBW} = 1\text{ MHz}$ for $f \geq 1\text{ GHz}$
 - VBW = RBW
 - Sweep = auto
 - Detector function = peak
 - Trace = max hold
 - Follows the guidelines in ANSI C63.4-2003 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:

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

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:

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

- Submit this test data
- Now set the VBW to 10Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel

of the hopping signal is less than 100ms, then the reading obtained may be further adjusted by a “duty cycle correction factor”, derived from $10\log(\text{dwell time}/100\text{mS})$ 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:

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 are 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 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 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 (d). 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.