ENGINEERING TEST REPORT

5.8GHz FHSS Cordless Telephone

MODEL(S): KX-TG5438(xx) [Base Unit], KX-TGA549(xx) [Handset]

FCC ID: ACJ96NKX-TG5438

Applicant:

Matsushita Electric Industrial Co., Ltd.
1006 Oaza Kadoma
Kadoma Osaka 571
Japan

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Frequency Hopping Spread Spectrum Transmitters
Operating in the 5759 – 5838 MHz Band

UltraTech's File No.: PAN-053F15C247

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: September 29, 2004	
Report Prepared by: Dan Huynh Issued Date: September 29, 2004	Tested by: Mr. Hung Trinh, EMC/RFI Technician Test Dates: September 15-18, 2004

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

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

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247:2003; FCC Public Notice DA 00-705
Title:	Telecommunication – 47 Code of Federal Regulations (CFR), Part 15
Purpose of Test:	To gain FCC Certification Authorization for Frequency Hopping Spread Spectrum Transmitters Operating in the 5759 – 5838 MHz Band .
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	[x] Commercial, industrial or business environment [x] Residential environment

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

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2003	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 & EN 55022	2003 2003	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	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 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Matsushita Electric Industrial Co., Ltd.
Address:	1006 Oaza Kadoma Kadoma Osaka 571 Japan
Contact Person:	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:	Mr. Kunihiko Nawata Phone #: +81-92-477-1405 Fax #: +81-92-477-1487 Email Address: nawata.kunihiko@jp.panasonic.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:	Panasonic
Product Name:	5.8GHz FHSS Cordless Telephone
Model Name or Number:	Base Unit: KX-TG5438(xx) Handset: KX-TGA549(xx)
Serial Number:	Pre- Production
Type of Equipment:	Frequency Hopping Spread Spectrum Transmitters
Input Power Supply Type:	Handset: Ni-MH Battery DC 3.6V , Base Unit: AC Adaptor, DC IN 9V (from AC 120V 60Hz)
Primary User Functions of EUT:	Cordless Telephone

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER		
Equipment Type:	[x] Portable [x] Mobile [ ] Base station (fixed use)	
Intended Operating Environment:	[x] Commercial, industrial or business environment [x] Residential environment	
Power Supply Requirement:	Handset: DC 3.6V , Base Unit: AC 120V 60Hz	
RF Output Power Rating:	Handset: 0.070 W Peak Conducted Power Base Unit: 0.115 W Peak Conducted Power	
Operating Frequency Range:	5759.70240 - 5838.18697 MHz	
RF Output Impedance:	50 Ohm	
Channel Spacing:	892 kHz	
20 dB Bandwidth:	Base Unit: 625.27 kHz Handset: 661.32 kHz	
Modulation Type:	FM (2-FSK)	
Channel Occupancy:	Base Unit: 11.22 ms within a 30 second period Handset: 33.91 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:	Manufacturer:	SANSEI ELECTRIC CO.,LTD. , Miyazaki Matsushita Electric Co.,Ltd.
	Type:	Handset: Pattern Antenna Base Unit: Colliner Antenna
	Model:	Handset : 5/8 λ Pattern Antenna (on P.C. Board) Base Unit : PQSA10158ZA (Left-ANT, SANSEI) PQSA10157ZA (Right-ANT, SANSEI)
	Frequency Range:	5.759 – 5.838 GHz
	Gain:	Handset: 4dBi (nominal) Base Unit: 3dBi (nominal)

2.4. 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 (9V)	1.8m /Non-Shielded
2	Telephone Jack	1	RJ11 (USA) CA11 (Canada)	1.8m /Non-Shielded

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:	Headset
Brand:	Panasonic
Model Name or Number:	KX-TCA92
Serial Number:	N/A
Connected to EUT's Port:	Headset Jack (on Handset)

Ancillary Equipment # 2	
Description:	Telephone Line Simulator
Brand:	Teltone
Model Name or Number:	TLS-5A-02
Serial Number:	250-00193-04
Connected to EUT's Port:	Telephone Line

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

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 Frequency Hopping mode for occupancy duration and frequency separation.
Special Test Software:	None.
Special Hardware Used:	None.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals	
Frequency Band(s):	5759.70240 – 5838.18697 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	▪ 5759.70240 MHz ▪ 5798.05084 MHz ▪ 5838.18697 MHz
RF Power Output (measured maximum output power):	Handset: 0.070 W Peak Conducted Power Base Unit: 0.115 W Peak Conducted Power
Normal Test Modulation:	FM (2-FSK) with 576 kbps data rate
Modulating Signal Source:	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, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: February 17, 2004.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

Reference	Test Requirements	Compliance (Yes/No)
Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval	Not Applicable
15.107(a)	AC Power Line Conducted Emissions Measurements	Yes
15.247(a)(1) & 15.247(a)(1)(ii)	Frequency Hopping Systems Characteristics	Yes
15.247(b)(1)	Peak Output Power	Yes
15.247(b)(5), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report can be provided upon requests.		

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

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 6 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 C63.4, FCC 15.247 and CISPR 16-1.

5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

Cordless Telephone.

5.5. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	
15.31	The hoping function must be disabled for tests, which should be performed with the EUT transmitting on the number of frequencies specified in this Section. The measurements made at the upper and lower ends of the band of operation should be made with the EUT tuned to the highest and lowest available channels.	Hopping function was disabled during testing
15.203	Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed: (a) The application (or intended use) of the EUT (b) The installation requirements of the EUT (c) The method by which the EUT will be marketed	The antenna is permanently attached.
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	Refer to Section 2.3 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 FHSS Description
15.247(a)	Pseudo Frequency Hopping Sequence: Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirements specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1	Refer to FHSS Description
15.247(a)	Equal Hopping Frequency Use: Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g. that each new transmission event begins on the next channel in the hopping sequence after final channel used in the previous transmission events).	Refer to FHSS Description

FCC Section	FCC Rules	Laboratory's Comments
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 FHSS Description
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 FHSS Description
Public Notice DA 00-705	System Receiver Input Bandwidth: Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.	Refer to FHSS Description
Public Notice DA 00-705	System Receiver Hopping Capability: Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals	Refer to FHSS Description

5.6. AC POWER LINE CONDUCTED EMISSIONS [47 CFR §15.107(a)]

5.6.1. Limits

The equipment shall meet the limits of the following table:

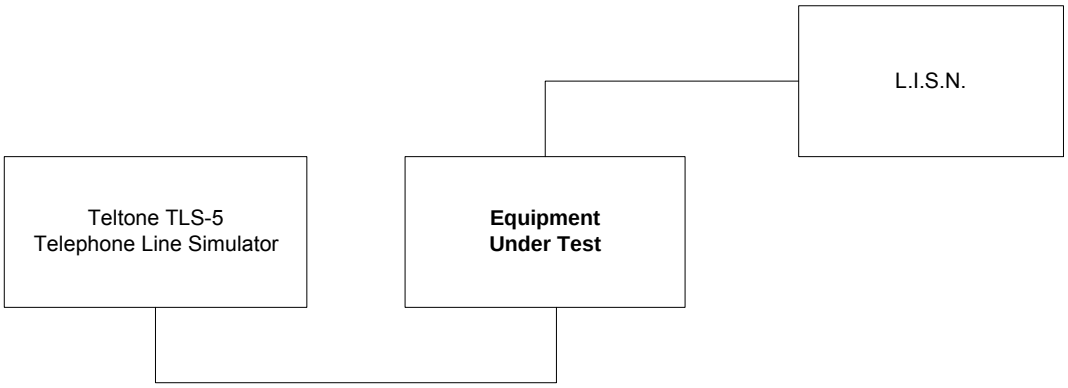
Frequency of emission (MHz)	Class B Conducted Limits (dBμV)		Measuring Bandwidth
	Quasi-peak	Average	
0.15–0.5 .....……..	66 to 56*	56 to 46*	RBW = 9 kHz
0.5–5 .....……..	56	46	VBW ≥ 9 kHz for QP
5-30 ……..	60 ...……..	50	VBW = 1 Hz for Average

* Decreases linearly with logarithm of the frequency

5.6.2. Method of Measurements

Refer to Section 7.2 of this test report & ANSI C63-4

5.6.3. Test Arrangement



5.6.4. 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
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 μH
24'(L) x 16'(W) x 8'(H) RF Shielded Chamber	Braden Shielding	…	…	…

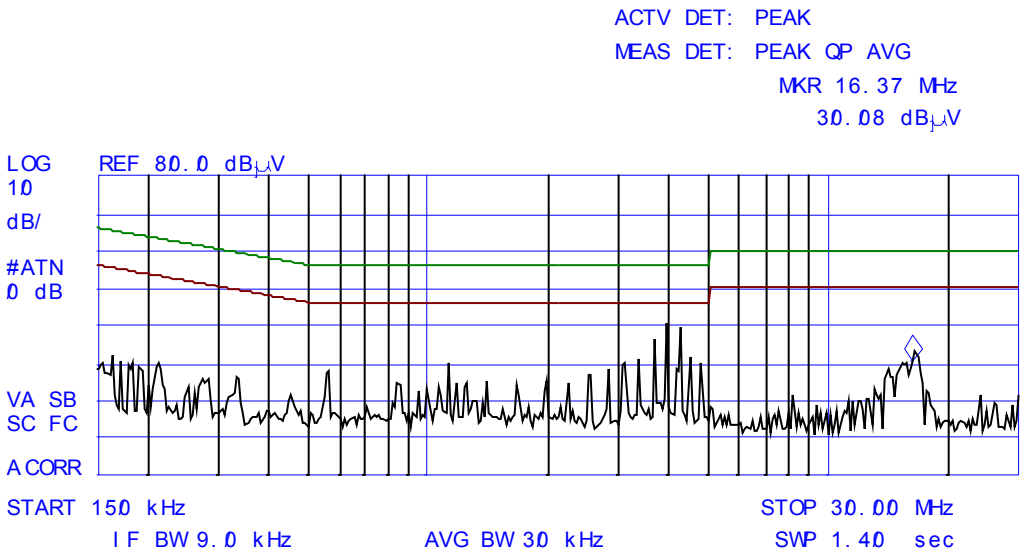
5.6.5. Test Data

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 with Handset on docking bay							
0.164570	26.0	QP	65.2	55.2	-39.2	Pass	L1
0.164570	21.4	AVG	65.2	55.2	-33.8	Pass	L1
0.568750	27.1	QP	56.0	46.0	-28.9	Pass	L1
0.568750	25.7	AVG	56.0	46.0	-20.3	Pass	L1
3.973950	41.9	QP	56.0	46.0	-14.1	Pass	L1
3.973950	38.8	AVG	56.0	46.0	-7.2	Pass	L1
16.465575	29.7	QP	60.0	50.0	-30.3	Pass	L1
16.465575	22.5	AVG	60.0	50.0	-27.5	Pass	L1
0.164565	24.6	QP	65.2	55.2	-40.6	Pass	L2
0.164565	20.8	AVG	65.2	55.2	-34.4	Pass	L2
0.568754	26.3	QP	56.0	46.0	-29.7	Pass	L2
0.568754	24.7	AVG	56.0	46.0	-21.3	Pass	L2
3.973947	40.3	QP	56.0	46.0	-15.7	Pass	L2
3.973947	37.3	AVG	56.0	46.0	-8.7	Pass	L2
16.465574	32.0	QP	60.0	50.0	-28.0	Pass	L2
16.465574	25.7	AVG	60.0	50.0	-24.3	Pass	L2
Test Configuration #2: Base Unit without Handset							
0.164555	22.2	QP	65.2	55.2	-43.0	Pass	L1
0.164555	19.9	AVG	65.2	55.2	-35.3	Pass	L1
0.568762	29.0	QP	56.0	46.0	-27.0	Pass	L1
0.568762	25.8	AVG	56.0	46.0	-20.2	Pass	L1
3.973941	41.5	QP	56.0	46.0	-14.5	Pass	L1
3.973941	38.9	AVG	56.0	46.0	-7.1	Pass	L1
16.465572	30.9	QP	60.0	50.0	-29.1	Pass	L1
16.465572	25.7	AVG	60.0	50.0	-24.3	Pass	L1
0.164560	22.9	QP	65.2	55.2	-42.3	Pass	L2
0.164560	19.8	AVG	65.2	55.2	-35.4	Pass	L2
0.568758	28.5	QP	56.0	46.0	-27.5	Pass	L2
0.568758	25.3	AVG	56.0	46.0	-20.7	Pass	L2
3.973944	39.8	QP	56.0	46.0	-16.2	Pass	L2
3.973944	37.2	AVG	56.0	46.0	-8.8	Pass	L2
16.465573	33.8	QP	60.0	50.0	-26.2	Pass	L2
16.465573	25.8	AVG	60.0	50.0	-24.2	Pass	L2

Note: See the following test data plots (1 – 4) for detailed measurements

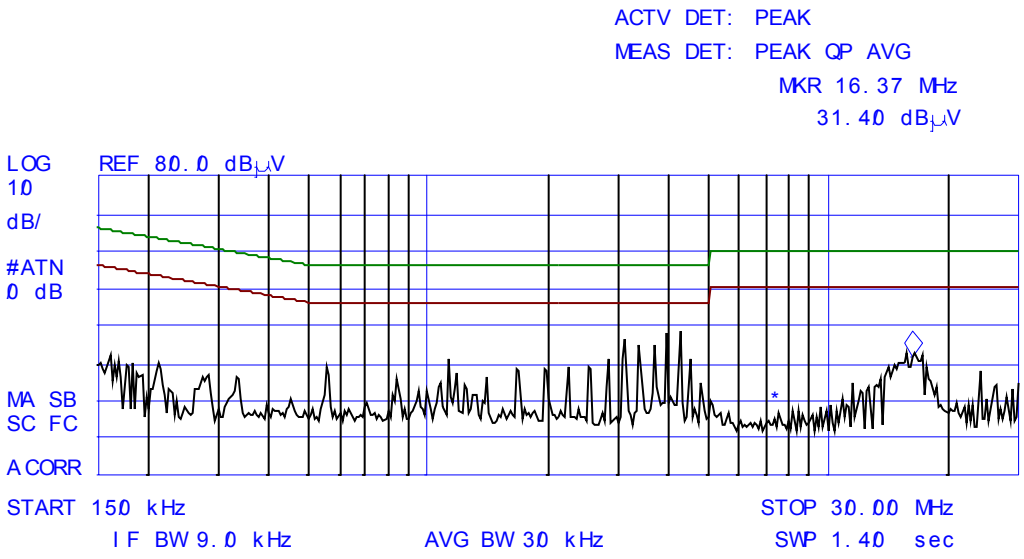
Plot 1:
AC Power Line Conducted Emissions (Base Unit with Handset on docking bay)
Line Voltage: 120 Vac 60 Hz
Line Tested: L1

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.164570	32.8	26.0	21.4	-33.9
2	0.568750	30.1	27.1	25.7	-20.3
3	3.973950	45.8	41.9	38.8	-7.2
4	16.465575	35.3	29.7	22.5	-27.5



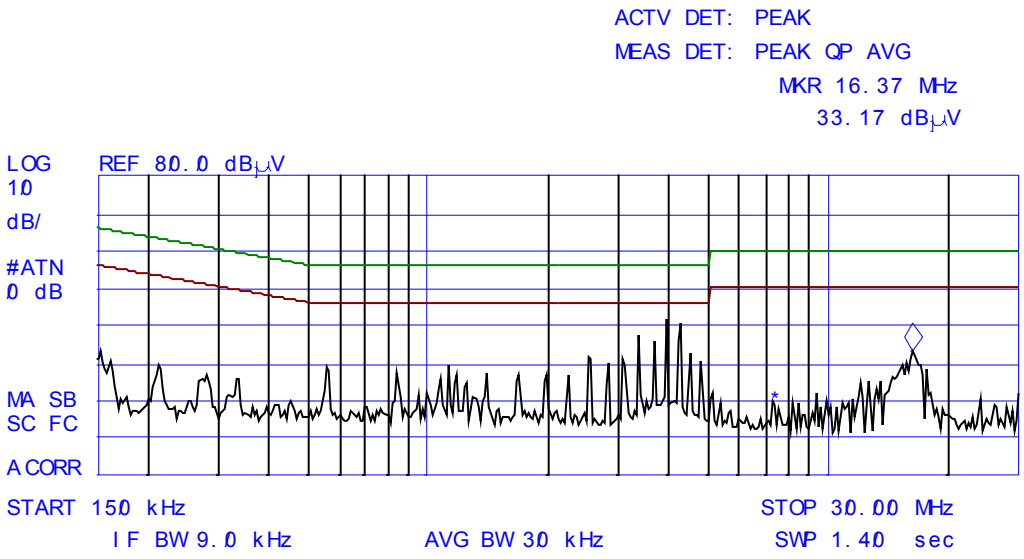
Plot 2:
AC Power Line Conducted Emissions (Base Unit with Handset on docking bay)
Line Voltage: 120 Vac 60 Hz
Line Tested: L2

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.164565	31.7	24.6	20.8	-34.5
2	0.568754	29.2	26.3	24.7	-21.3
3	3.973947	44.4	40.3	37.3	-8.7
4	16.465574	34.5	32.0	25.7	-24.3



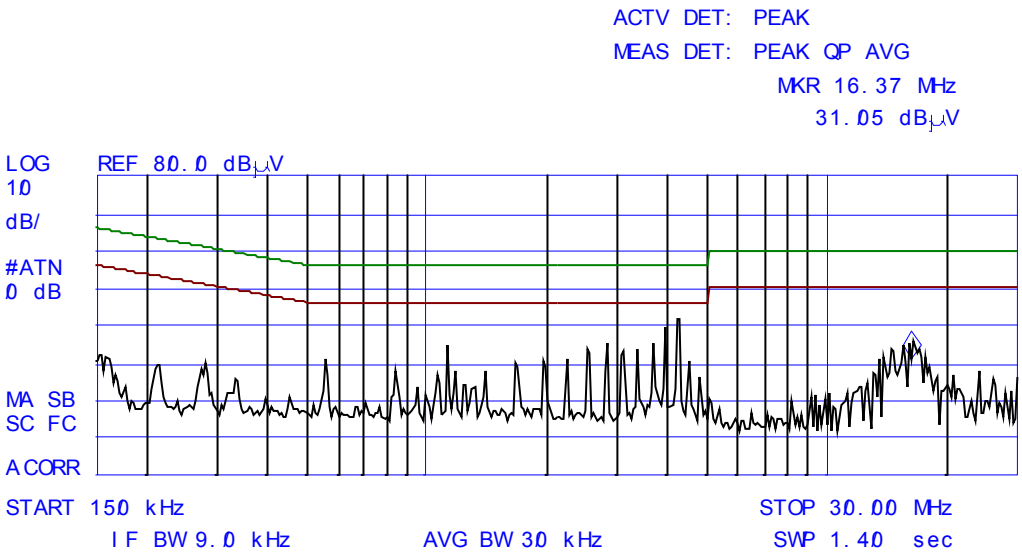
Plot 3:
AC Power Line Conducted Emissions (Base Unit without Handset)
Line Voltage: 120 Vac 60 Hz
Line Tested: L1

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.164555	28.7	22.2	19.9	-35.4
2	0.568762	30.8	29.0	25.8	-20.2
3	3.973941	42.8	41.5	38.9	-7.1
4	16.465572	33.0	30.9	25.7	-24.3



Plot 4:
AC Power Line Conducted Emissions (Base Unit without Handset)
Line Voltage: 120 Vac 60 Hz
Line Tested: L2

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.164560	30.2	22.9	19.8	-35.5
2	0.568758	30.7	28.5	25.3	-20.7
3	3.973944	40.5	39.8	37.2	-8.8
4	16.465573	36.3	33.8	25.8	-24.2



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

5.7.1. 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. The system shall hop to channel frequencies that are selected at the system-hopping rate from a pseudo randomly 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)(ii)**: Frequency hopping systems in the 5725–5850 MHz band shall use at least 75 hopping frequencies. The maximum 20dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

5.7.2. Method of Measurements

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 ≥ RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Number of hopping frequency:

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

Time of Occupancy (Dwell Time):

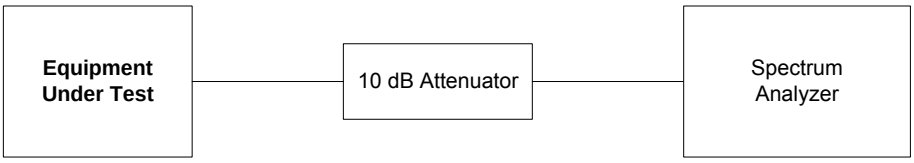
The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:
- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW ≥ RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

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

20 dB Bandwidth:

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

5.7.3. Test Arrangement



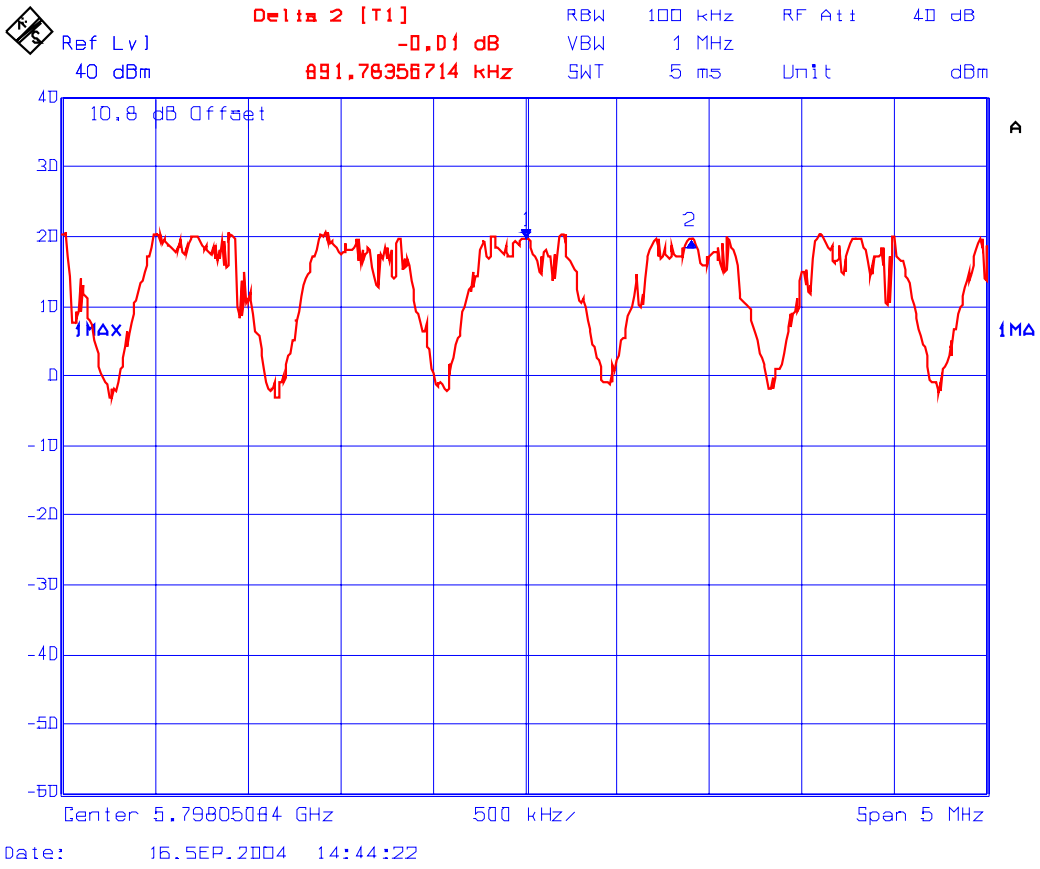
5.7.4. Test Equipment List

Test Instruments	Manufacturer	Model or P/N	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
Attenuator	Weinschel	41-10-12	46231	DC-18 GHz

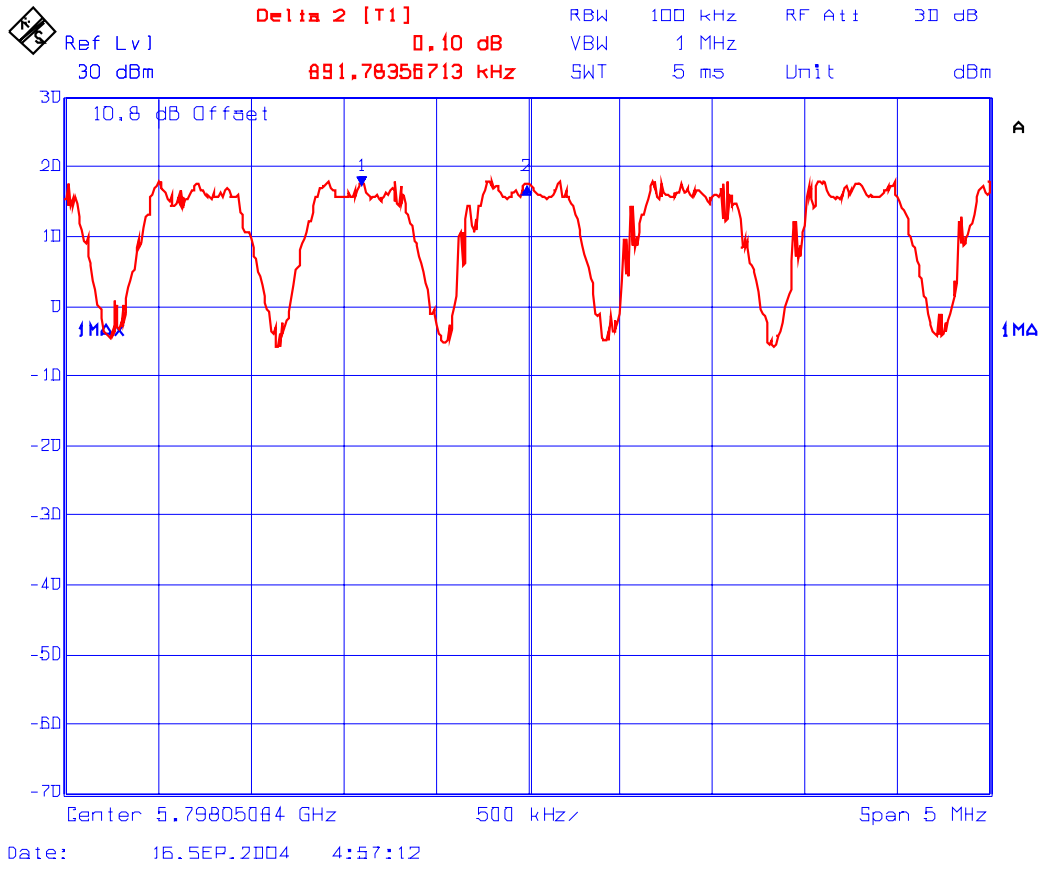
5.7.5. Test data

Test Description	FCC Specifications	Measured Values	Comments
Carrier Frequency Separation	Minimum of 25 kHz or 20dB BW whichever is greater.	891.78 kHz	Complies, see plots 5 to 6 for detailed measurements.
Number of Hopping Frequencies	At least 75 hopping frequencies.	Base Unit: 75 hopping frequencies Handset: 75 hopping frequencies	Complies, see plots 7 to 14 for detailed measurements.
20 dB Bandwidth	The maximum 20dB bandwidth of the hopping channel is 1 MHz	Base Unit: 633.27 kHz Handset: 661.32 kHz	Complies, see plots 15 to 20 for detailed measurements.
Time of Occupancy (Dwell Time)	The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.	Base Unit: 11.22 ms within a 30 second period Handset: 33.91 ms within a 30 second period	Complies, see plots 21 to 32 for detailed measurements.

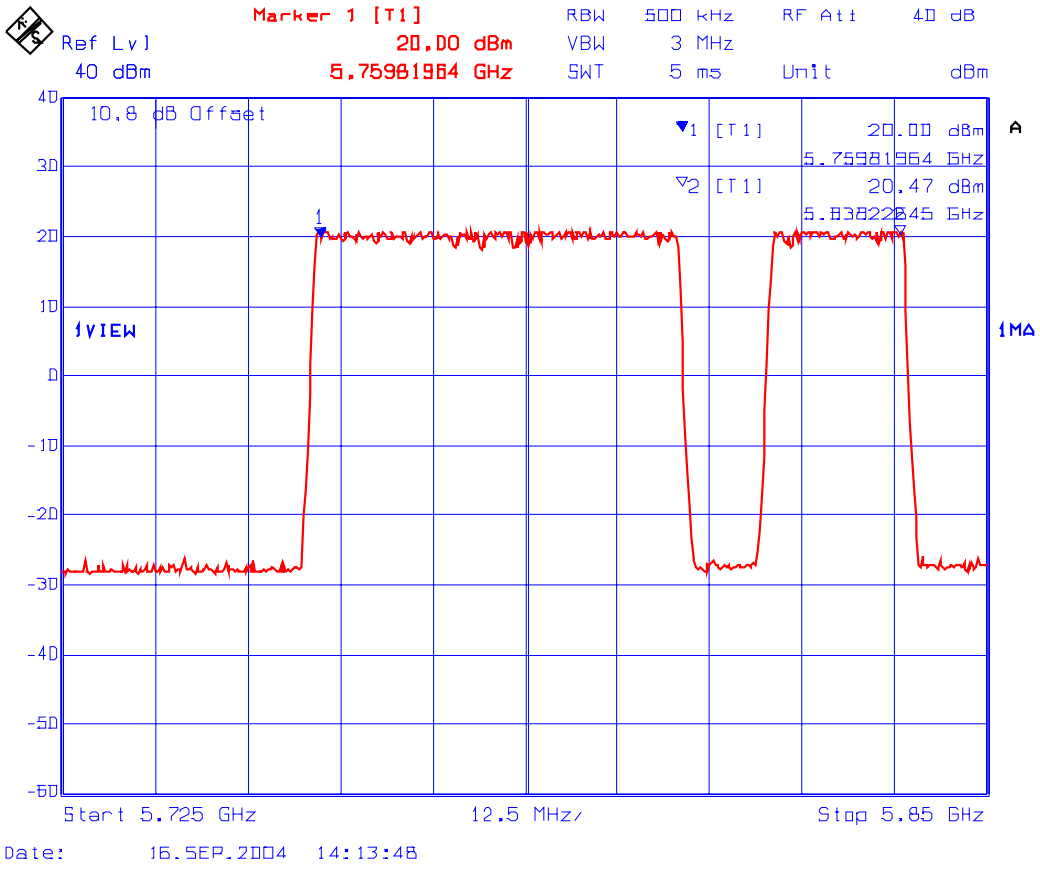
Plot 5:
Carrier Frequency Separation (Base Unit)



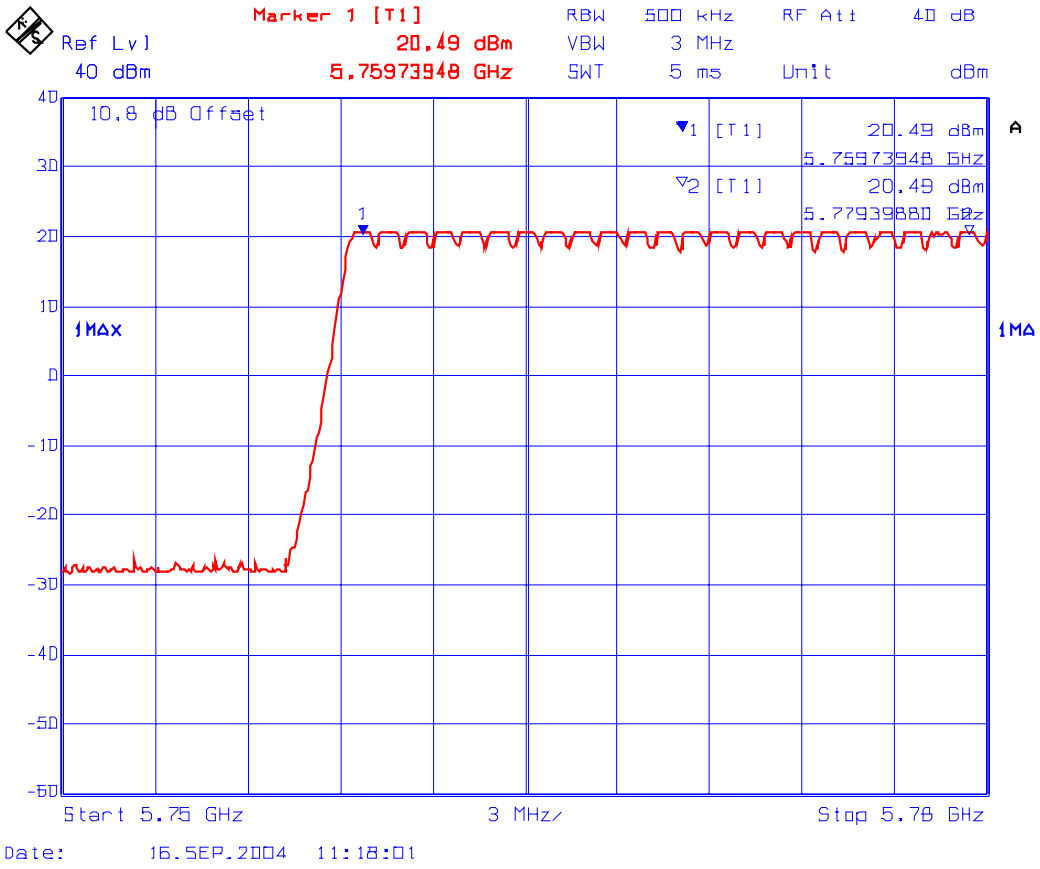
Plot 6:
Carrier Frequency Separation (Handset)



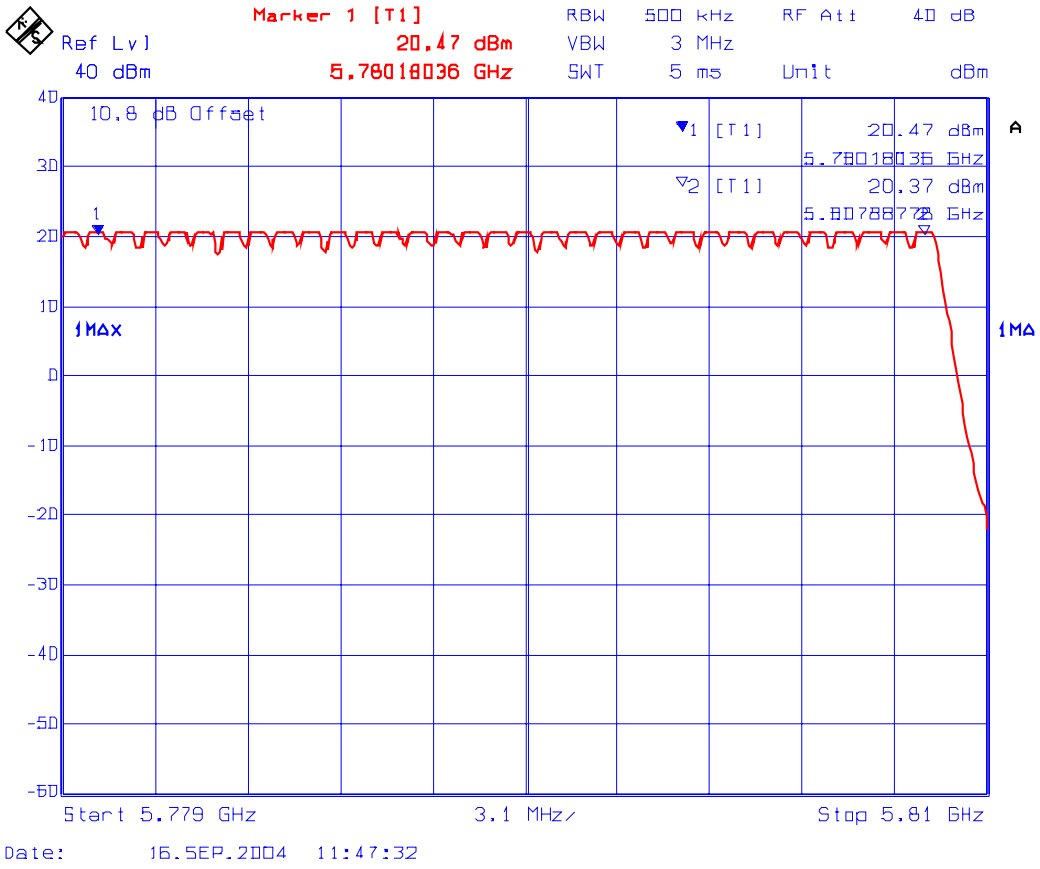
Plot 7:
Number of Hopping Frequencies (Base Unit)
75 Hopping Frequencies (from 5.725 – 5.85 GHz)



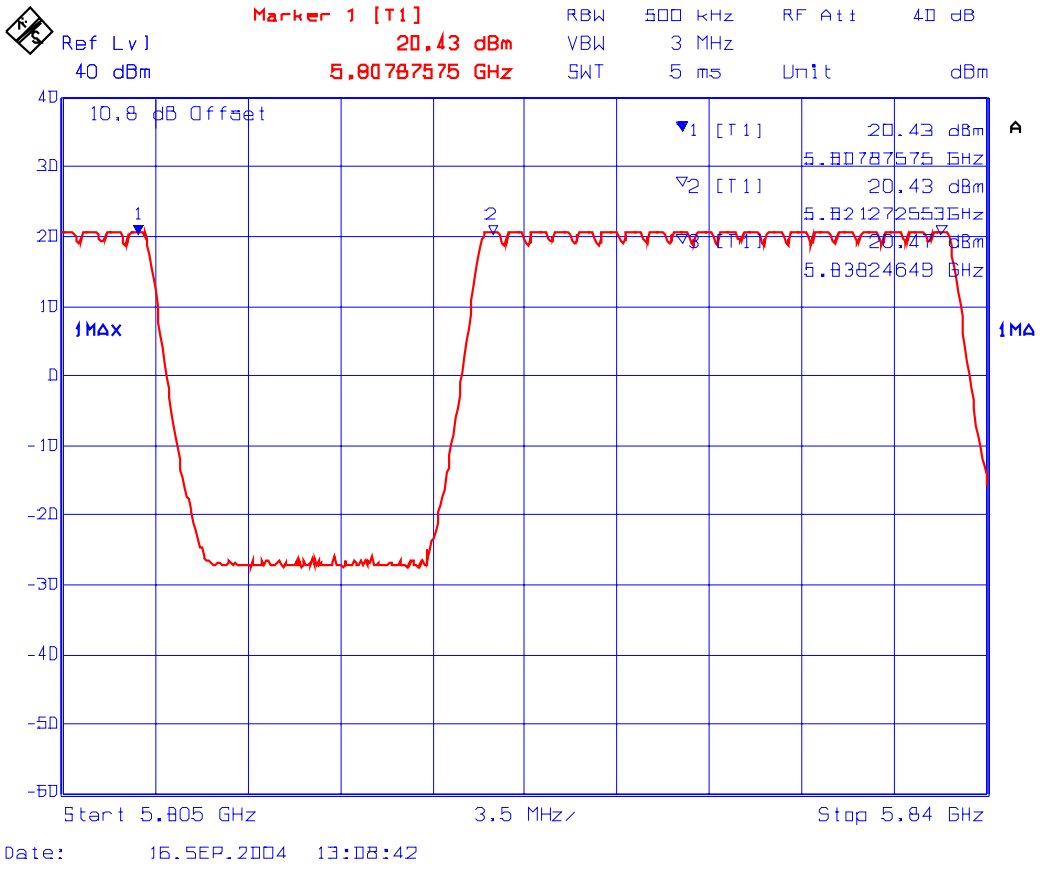
Plot 8:
Number of Hopping Frequencies (Base Unit)
23 hopping frequencies (from 5759.7024 – 5780 MHz band)



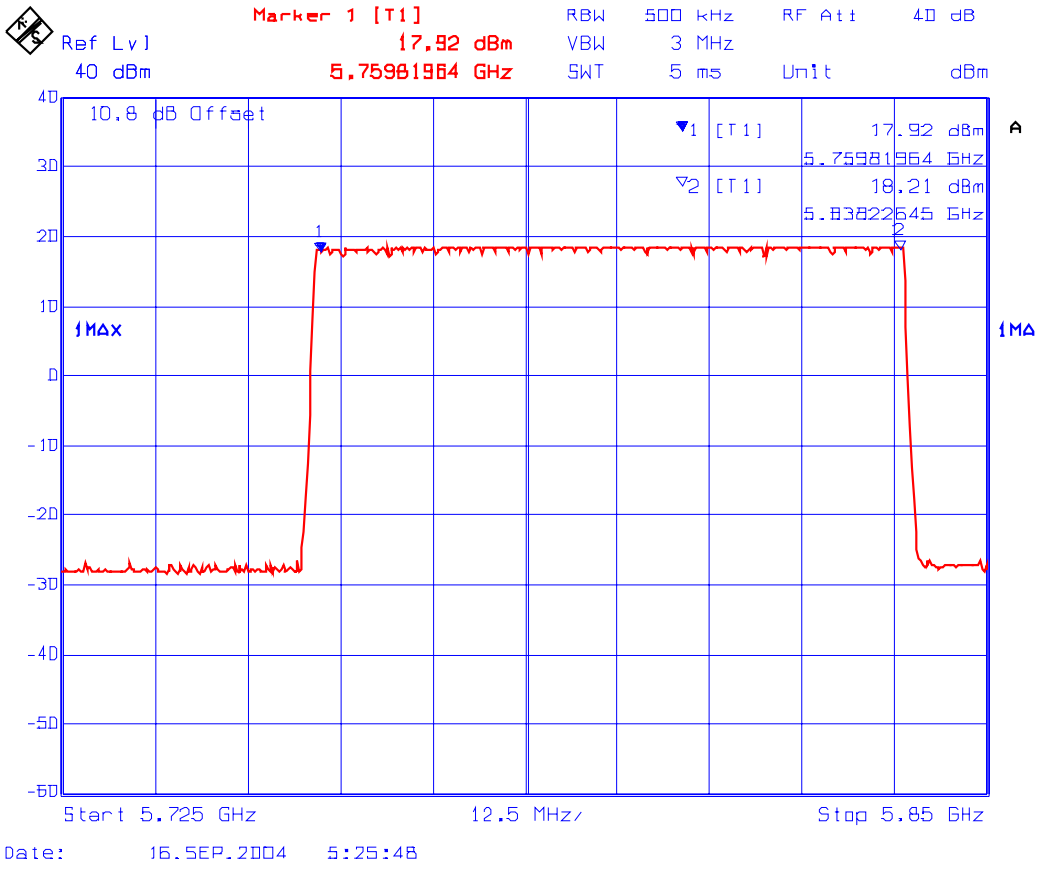
Plot 9:
Number of Hopping Frequencies (Base Unit)
32 hopping frequencies (from 5779 – 5810 MHz)



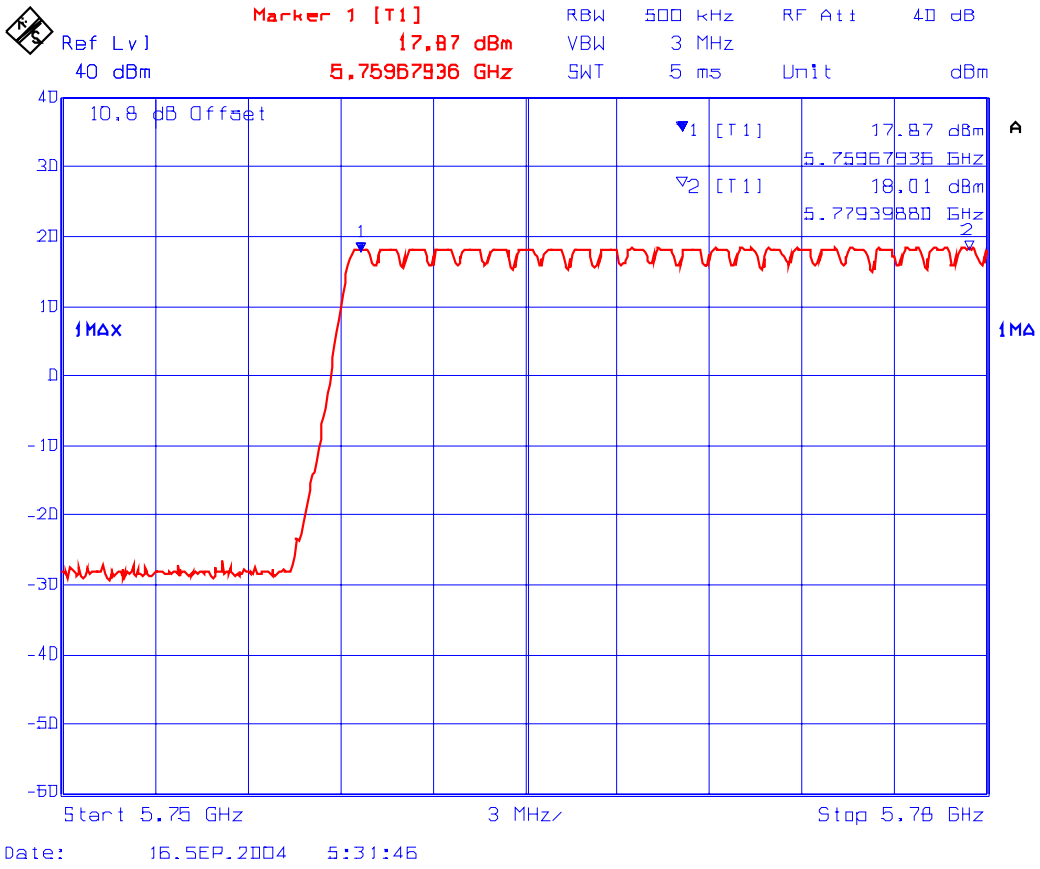
Plot 10:
Number of Hopping Frequencies (Base Unit)
20 hopping frequencies (from 5800 – 5840 MHz)



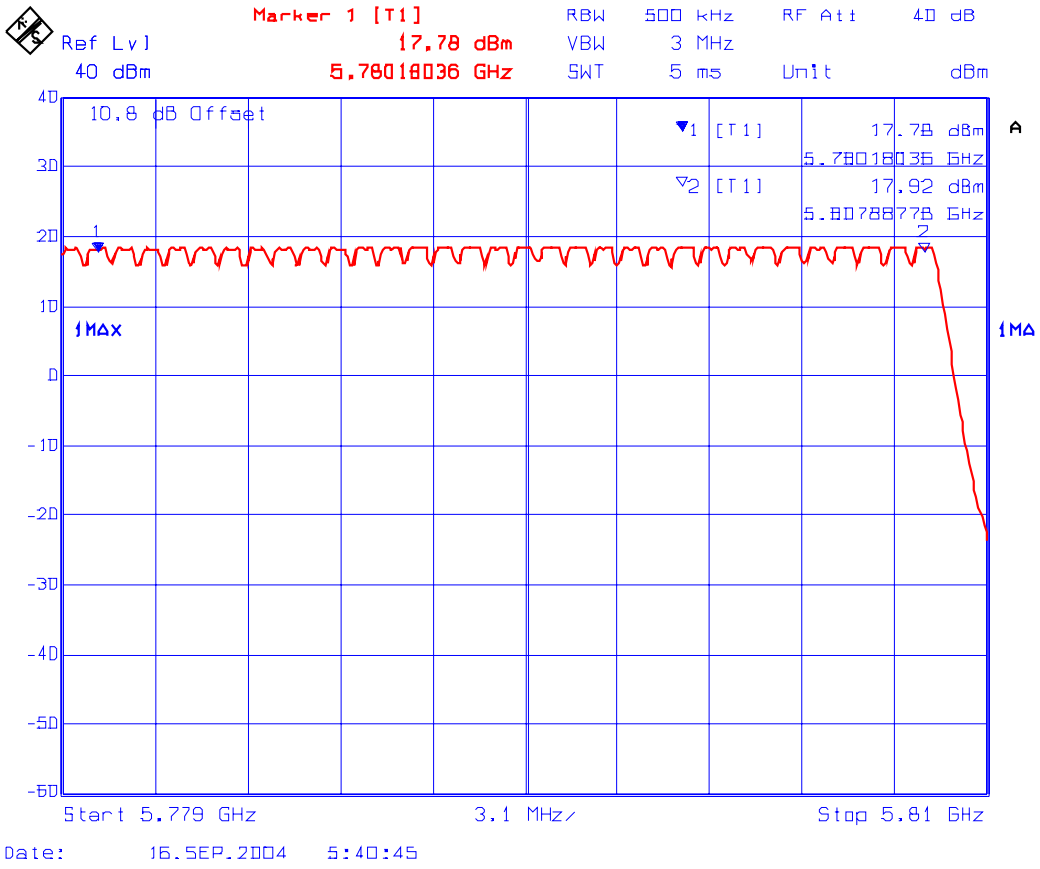
Plot 11:
Number of Hopping Frequencies (Handset)
75 Hopping Frequencies (from 5.725 – 5.85 GHz)



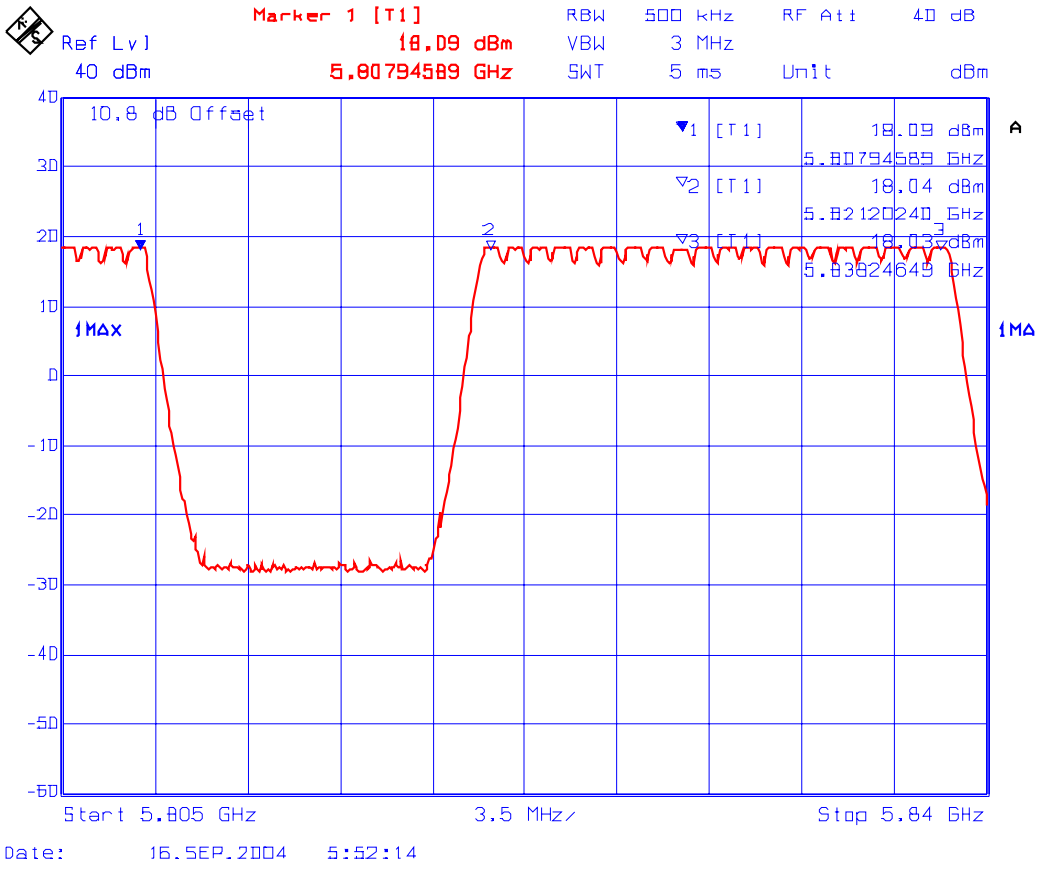
Plot 12:
Number of Hopping Frequencies (Handset)
23 hopping frequencies (from 5759.7024 – 5780 MHz band)



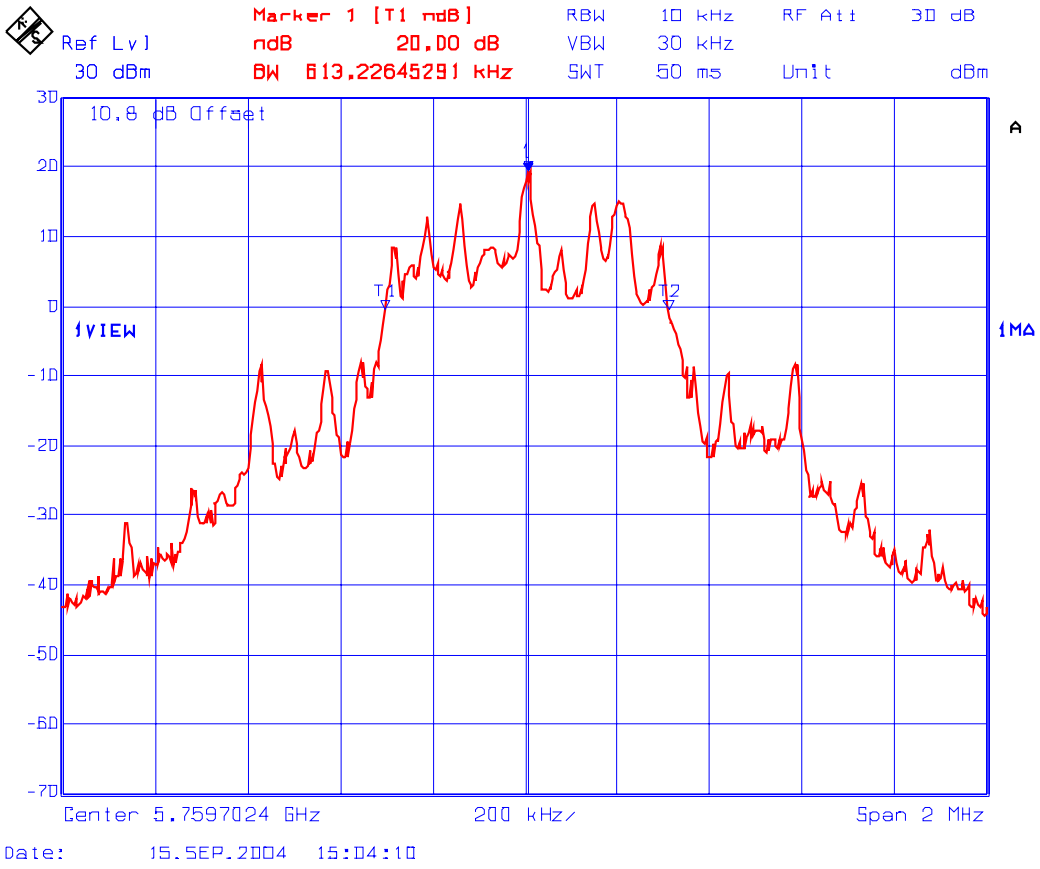
Plot 13:
Number of Hopping Frequencies (Handset)
32 hopping frequencies (from 5779 – 5810 MHz)



Plot 14:
Number of Hopping Frequencies (Handset)
20 hopping frequencies (from 5800 – 5840 MHz)

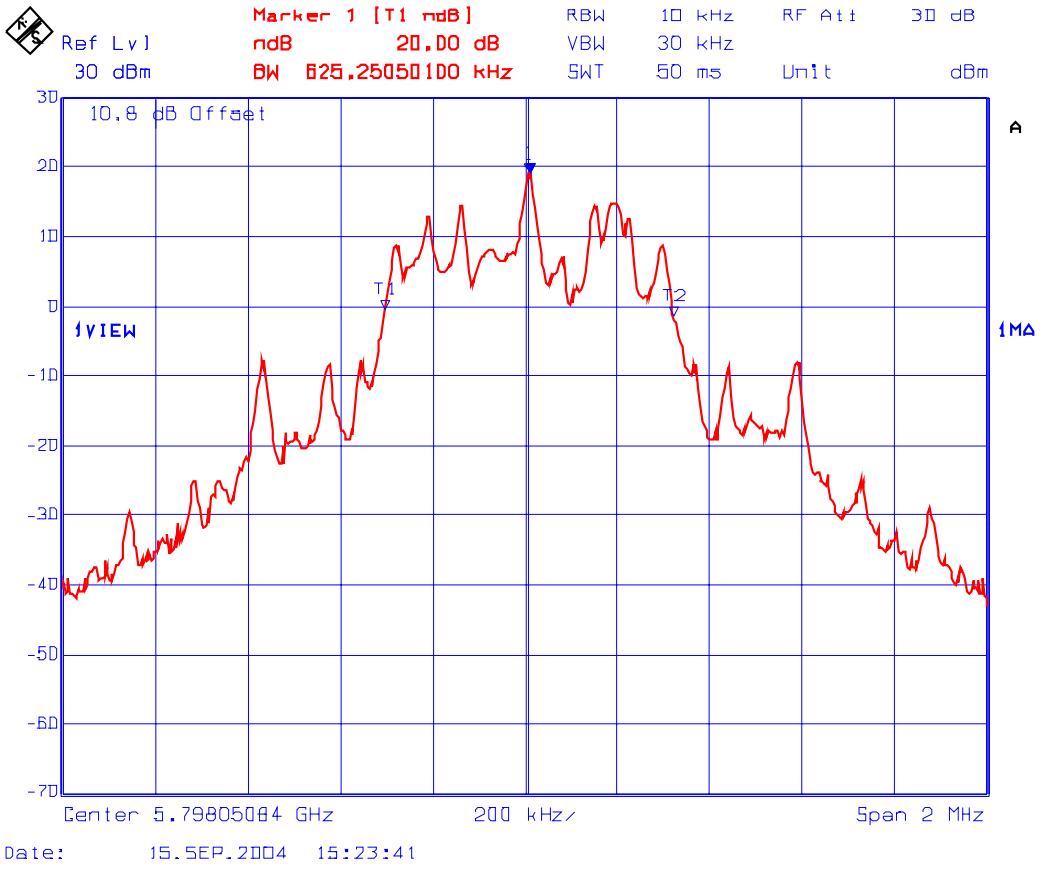


Plot 15:
20 dB Bandwidth (Base Unit)
Test Frequency: 5759.70240 MHz (CH 00)

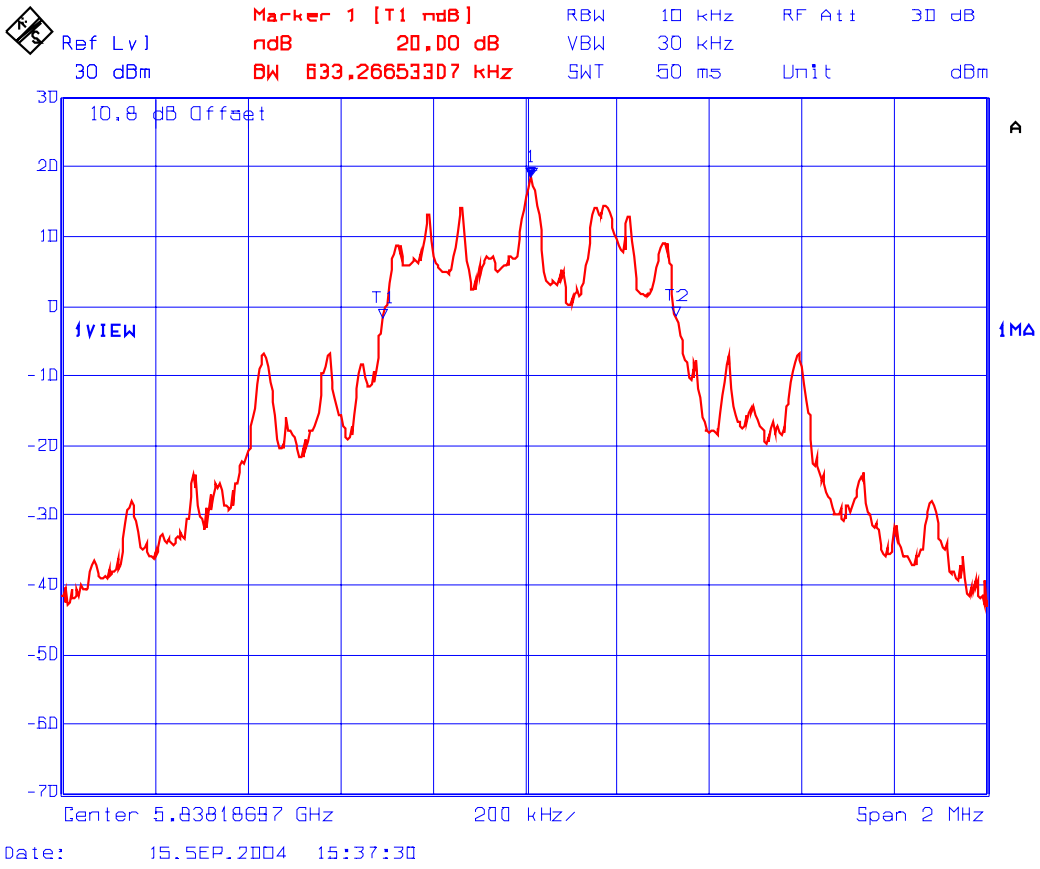


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

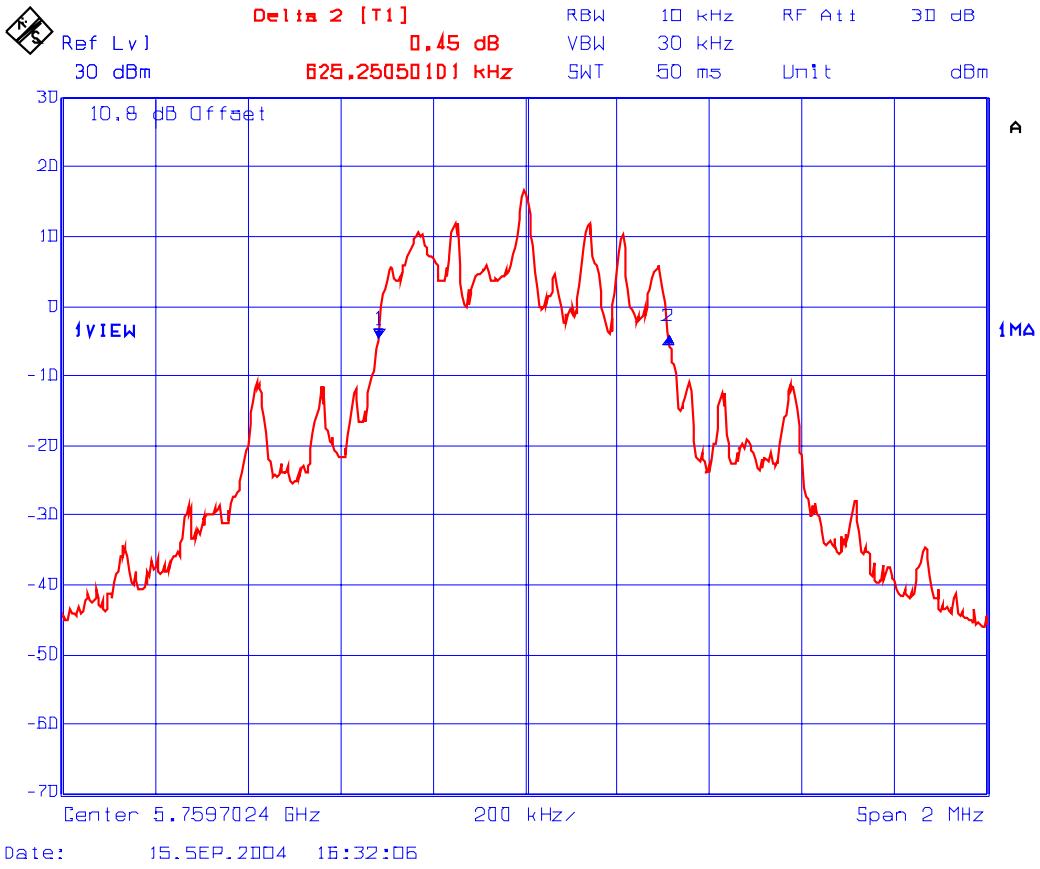
Plot 16:
20 dB Bandwidth (Base Unit)
Test Frequency: 5798.05084 MHz (CH 43)



Plot 17:
20 dB Bandwidth (Base Unit)
Test Frequency: 5838.18697 MHz (CH 88)

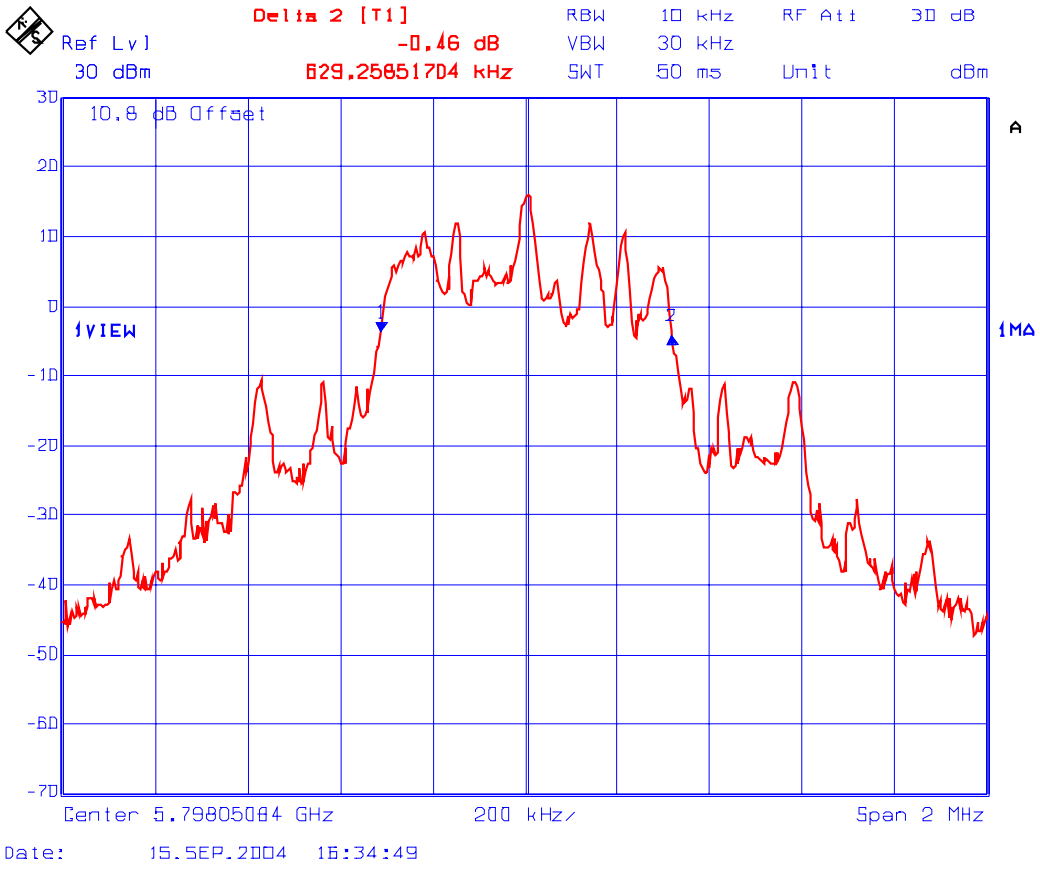


Plot 18:
20 dB Bandwidth (Handset)
Test Frequency: 5759.70240 MHz (CH 00)

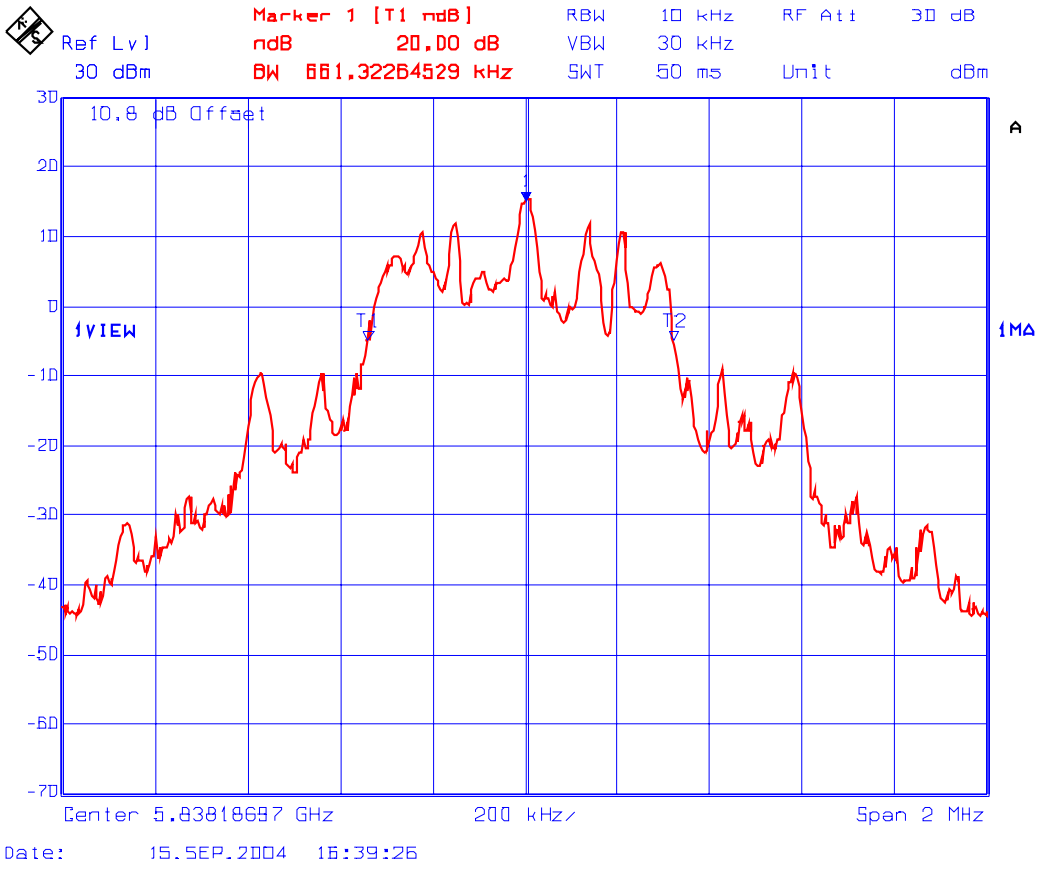


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

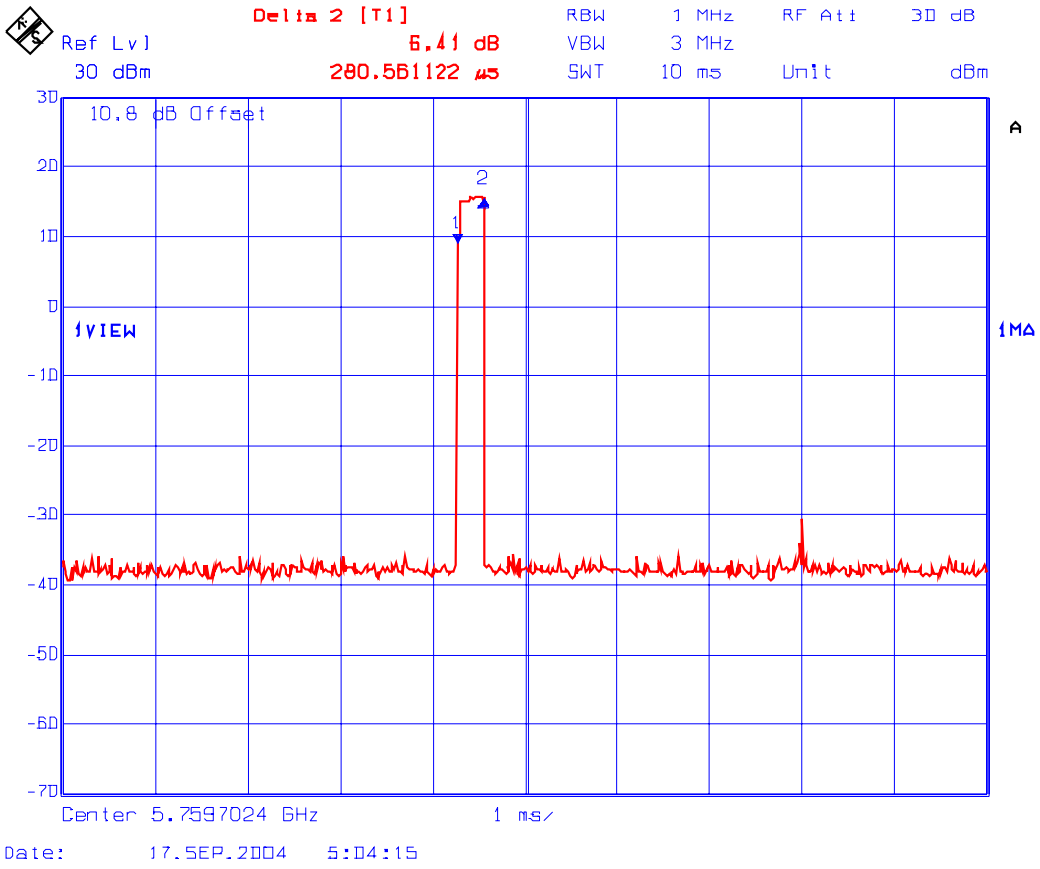
Plot 19:
20 dB Bandwidth (Handset)
Test Frequency: 5798.05084 MHz (CH 43)



Plot 20:
20 dB Bandwidth (Handset)
Test Frequency: 5838.18697 MHz (CH 88)

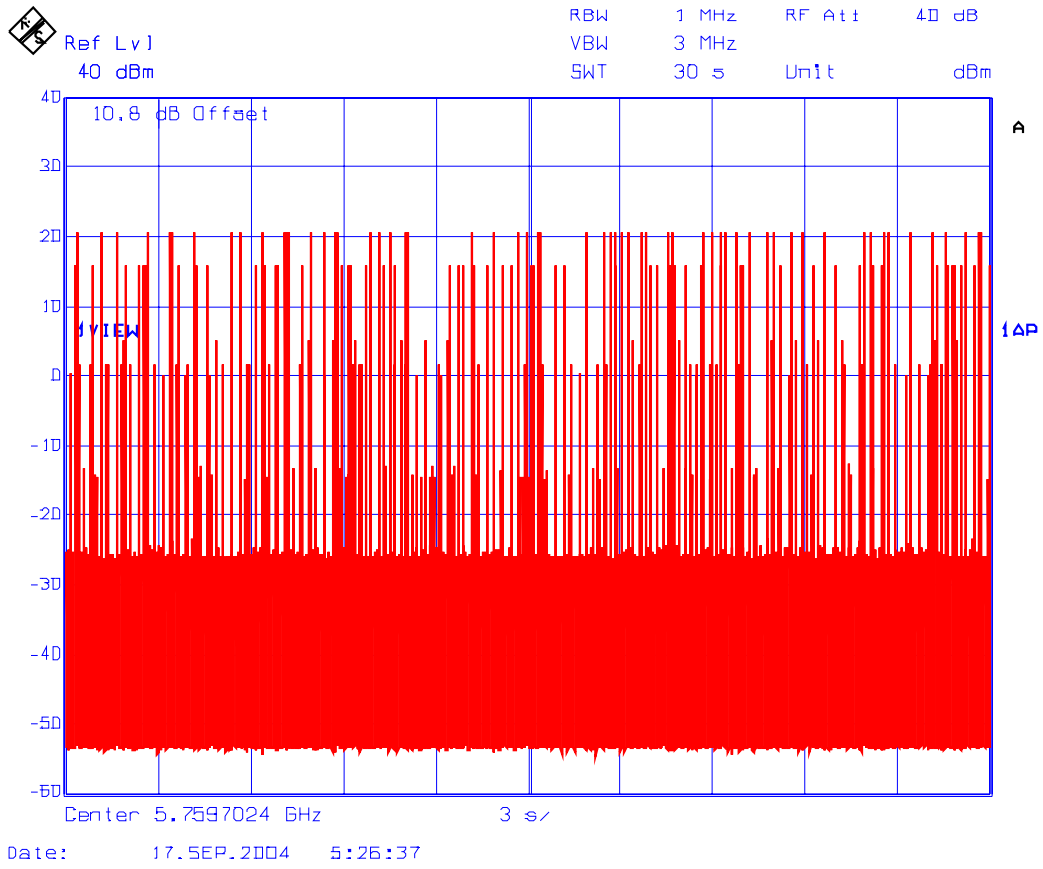


Plot 21:
Time of Occupancy (Base Unit)
Test Frequency: 5759.7024 MHz (CH 00)



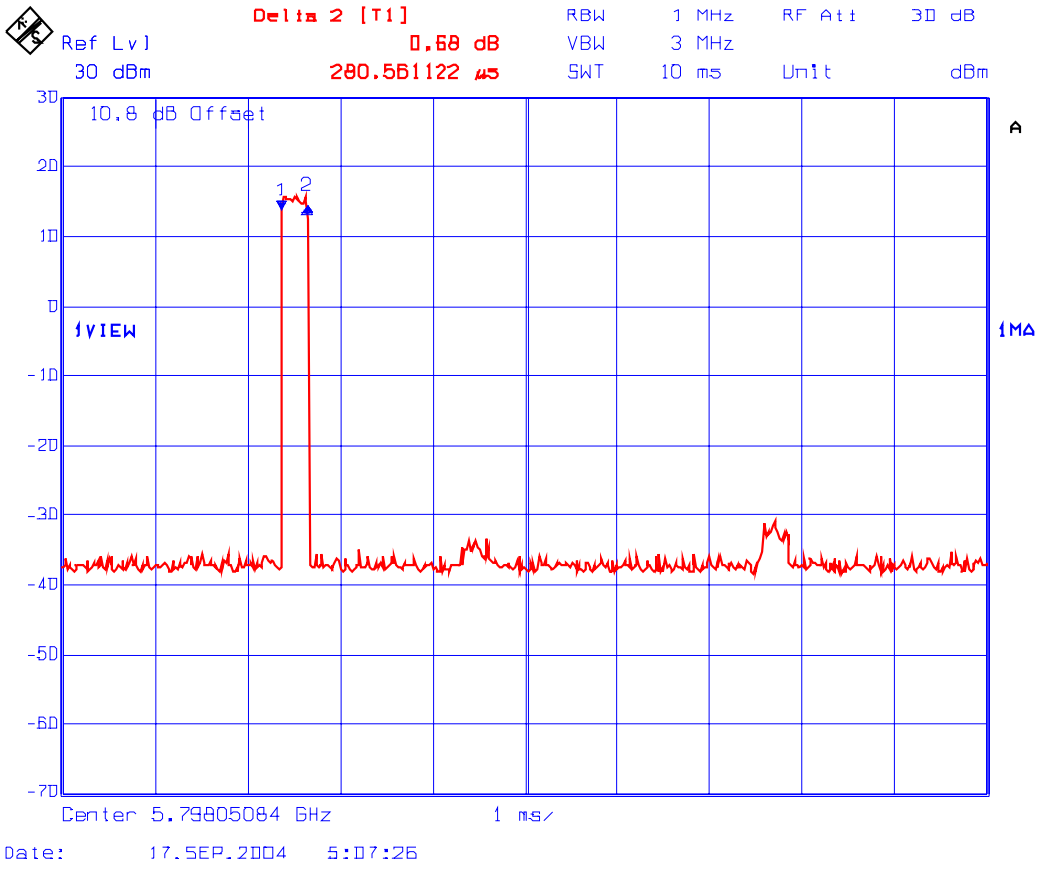
Dwell Time @ 5759.7024 MHz = 280.56 µs

Plot 22:
Time of Occupancy (Base Unit)
Test Frequency: 5759.7024 MHz (CH 00)



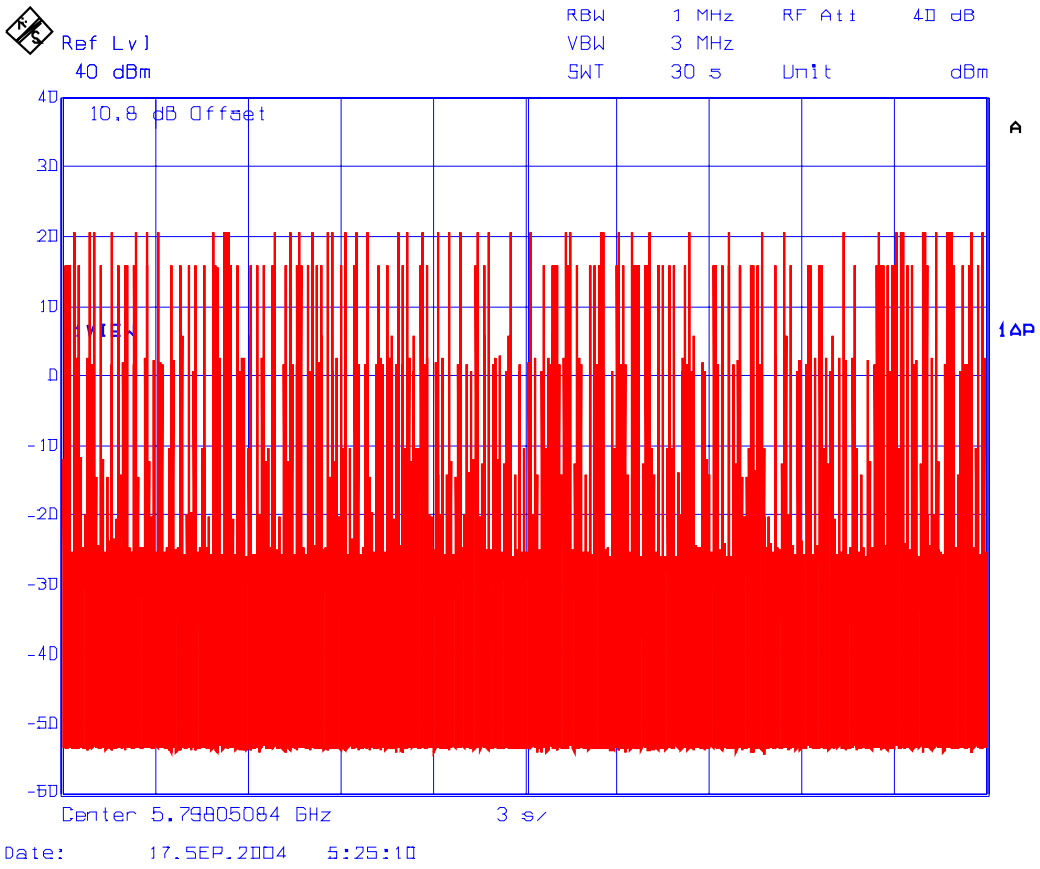
Average time of occupancy in 30 s = (Dwell Time @ 5759.7024 MHz) x (number of hops in 30 s)
= 280.56 μs x 40
= 11.22 ms

Plot 23:
Time of Occupancy (Base Unit)
Test Frequency: 5798.05084 MHz (CH 43)



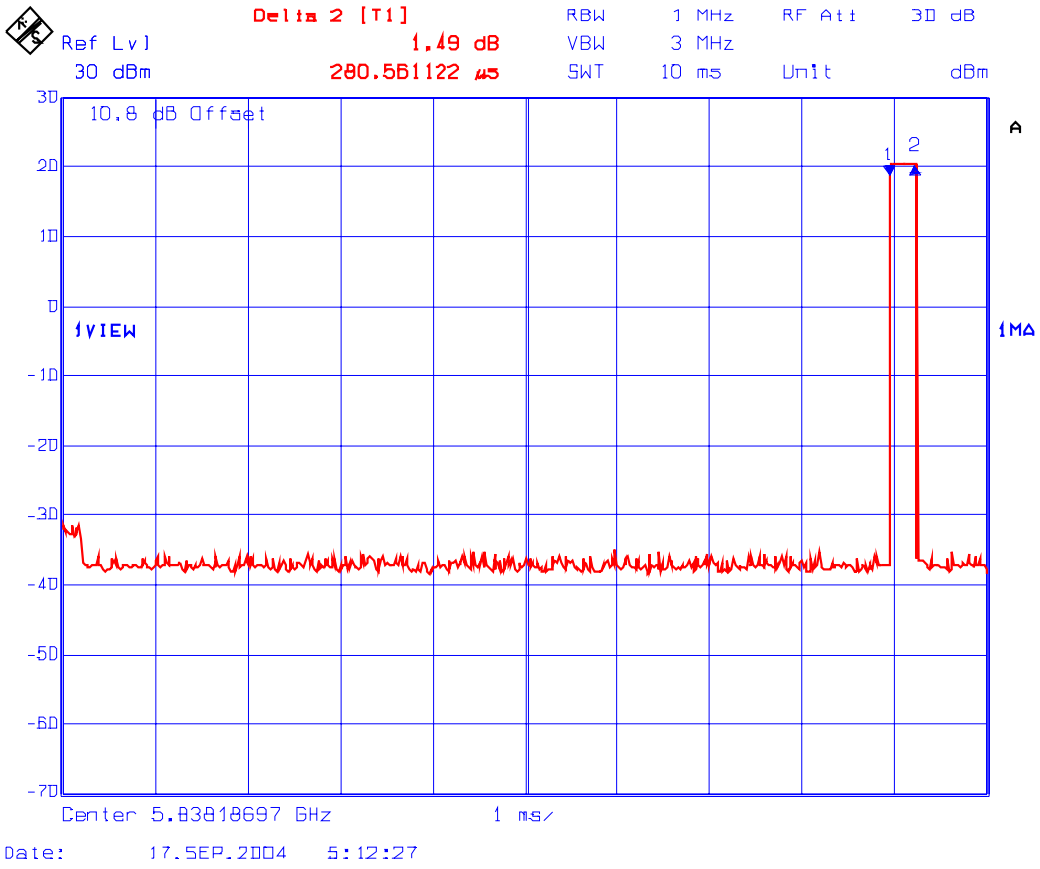
Dwell Time @ 5798.05084 MHz = 280.56 µs

Plot 24:
Time of Occupancy (Base Unit)
Test Frequency: 5798.05084 MHz (CH 43)



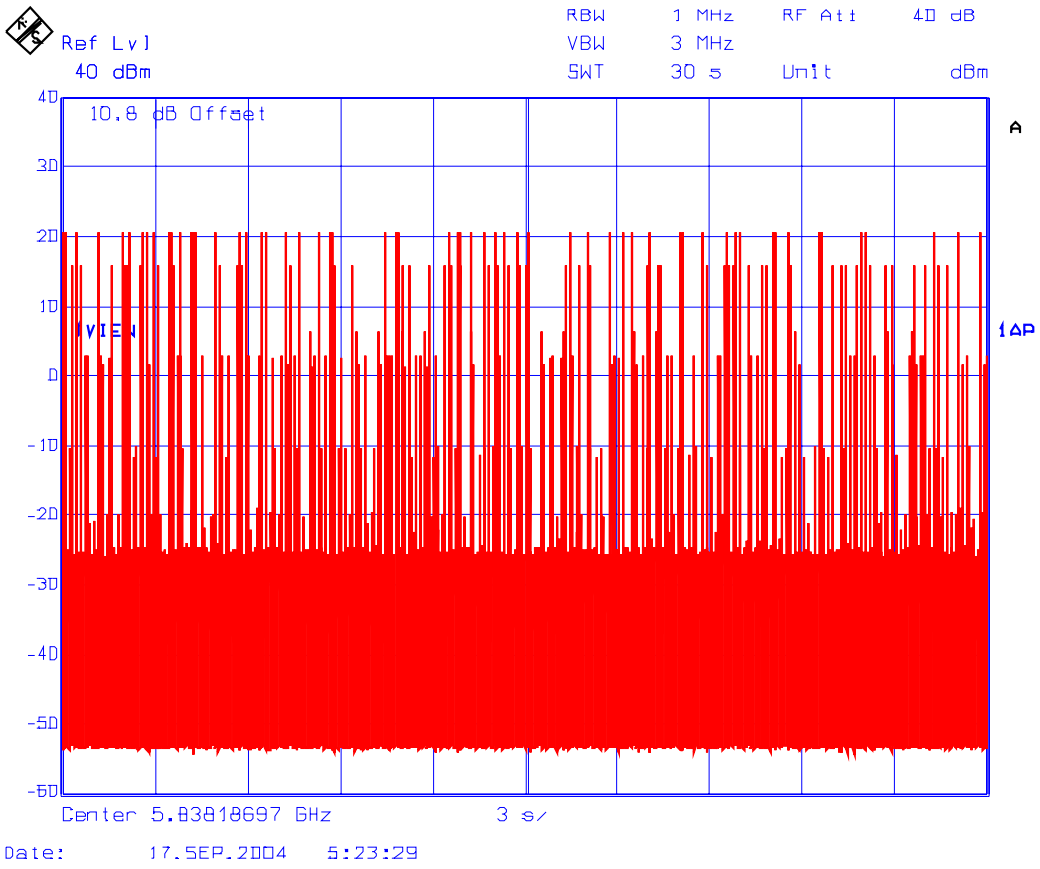
Average time of occupancy in 30 s = (Dwell Time @ 5798.05084 MHz) x (number of hops in 30 s)
= 280.56 μs x 40
= 11.22 ms

Plot 25:
Time of Occupancy (Base Unit)
Test Frequency: 5838.18697 MHz (CH 88)



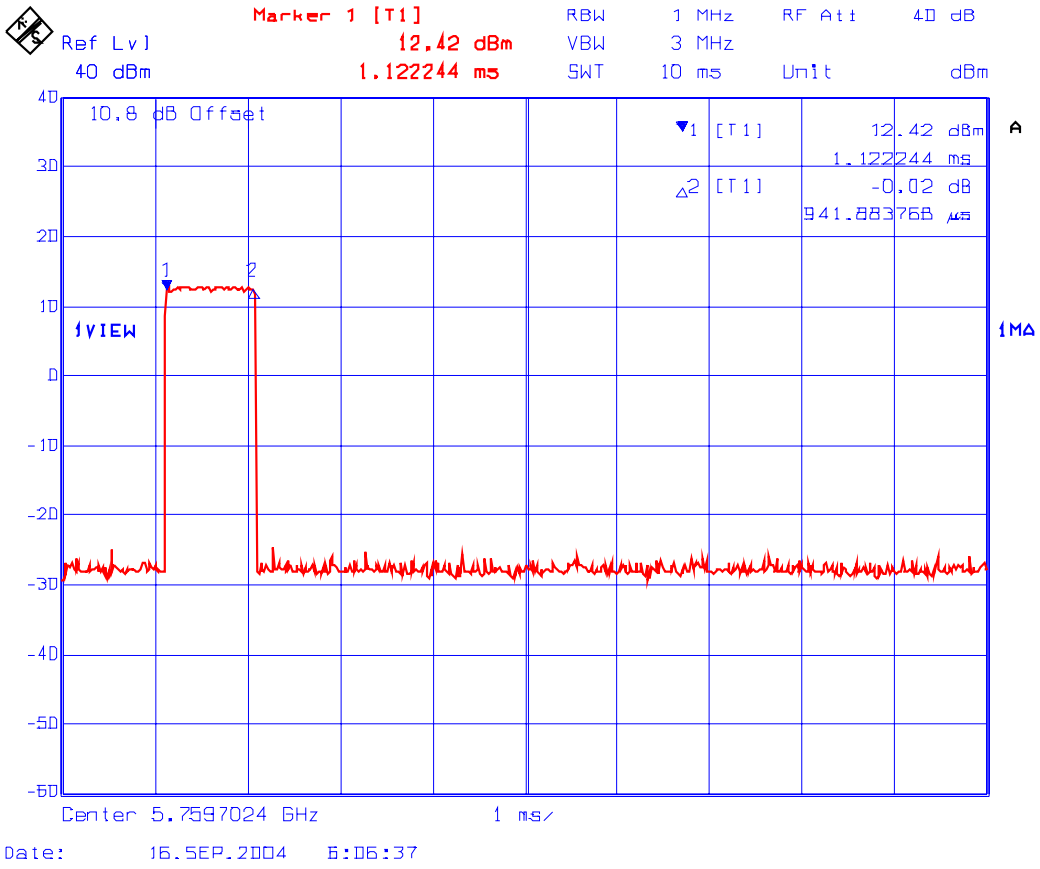
Dwell Time @ 5838.18697 MHz = 280.56 µs

Plot 26:
Time of Occupancy (Base Unit)
Test Frequency: 5838.18697 MHz (CH 88)



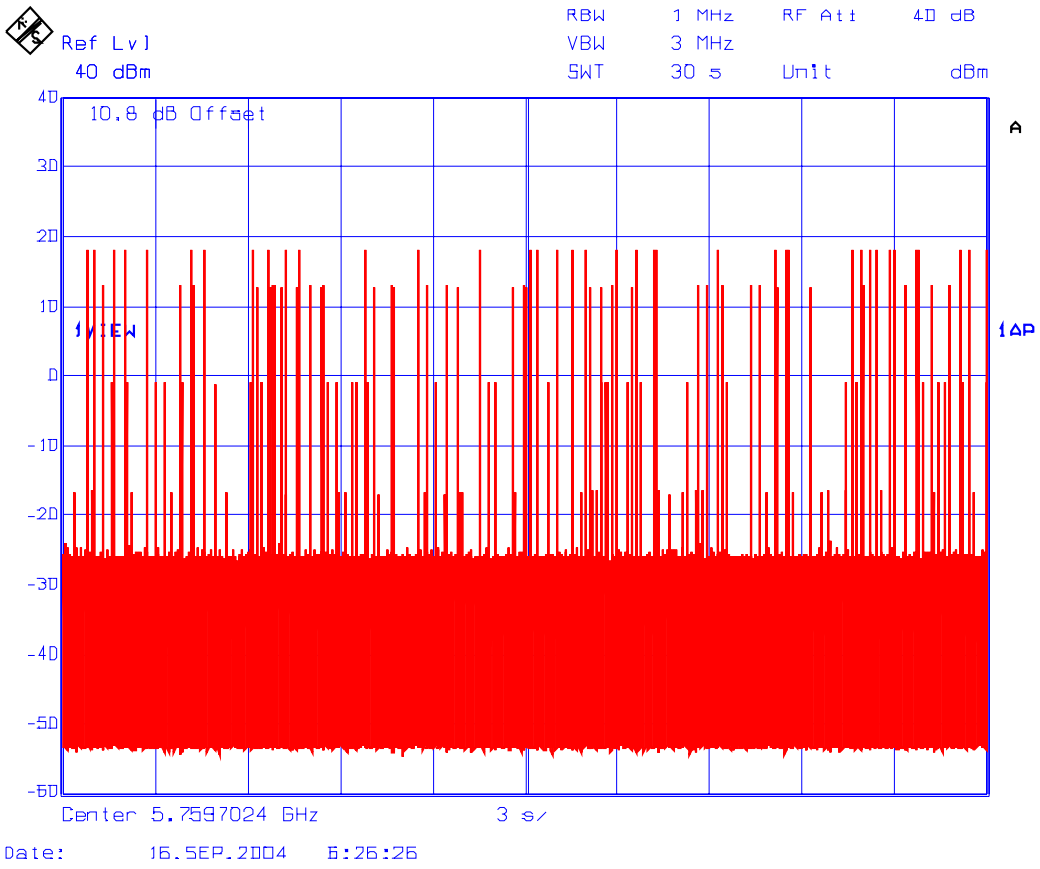
Average time of occupancy in 30 s = (Dwell Time @ 5838.18697 MHz) x (number of hops in 30 s)
= 280.56 μs x 40
= 11.22 ms

Plot 27:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5759.7024 MHz (CH 00)



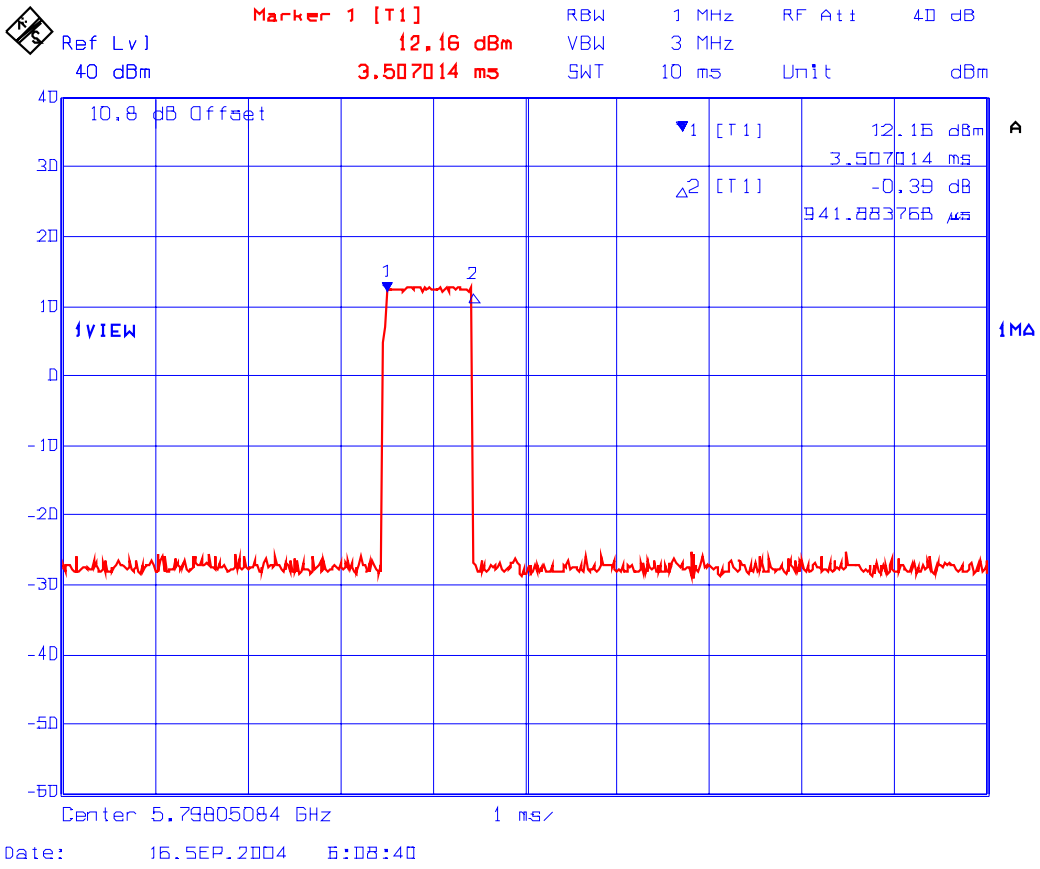
Dwell Time @ 5759.7024 MHz = 941.88 µs

Plot 28:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5759.7024 MHz (CH 00)



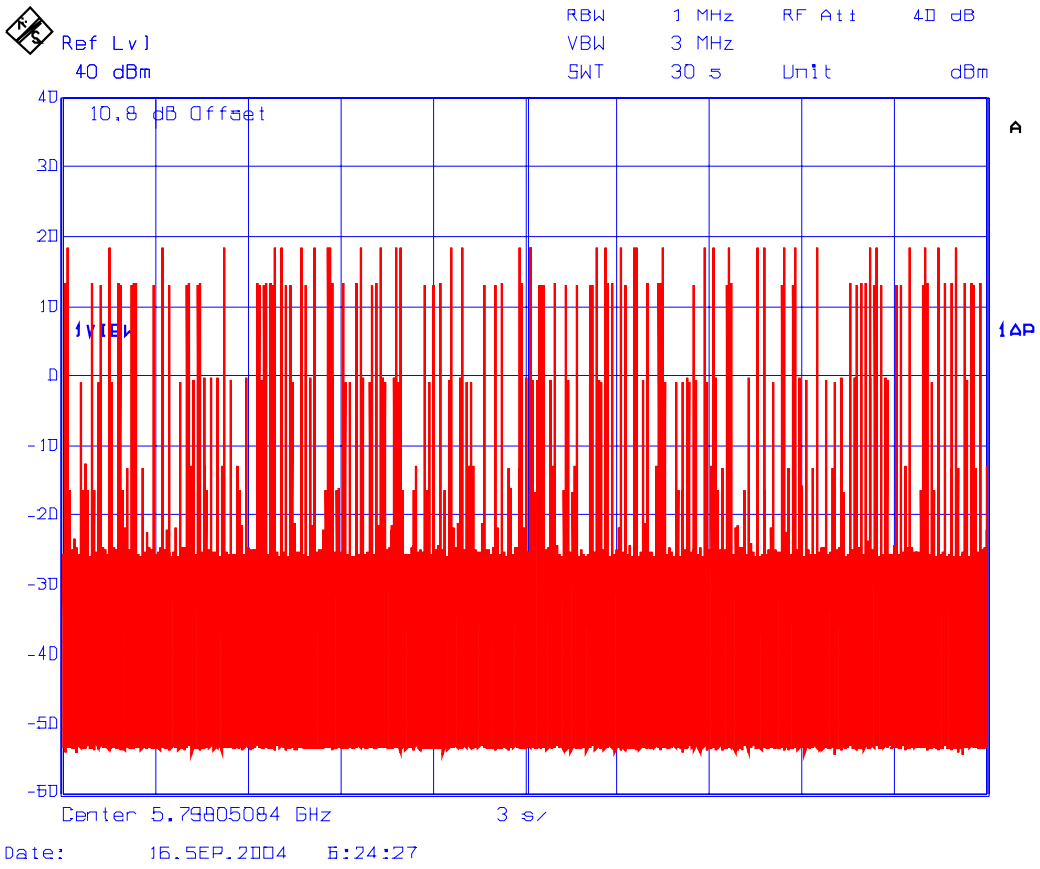
Average time of occupancy in 30 s = (Dwell Time @ 5759.7024 MHz) x (number of hops in 30 s)
= 941.88 μs x 36
= 33.91 ms

Plot 29:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5798.05084 MHz (CH 43)



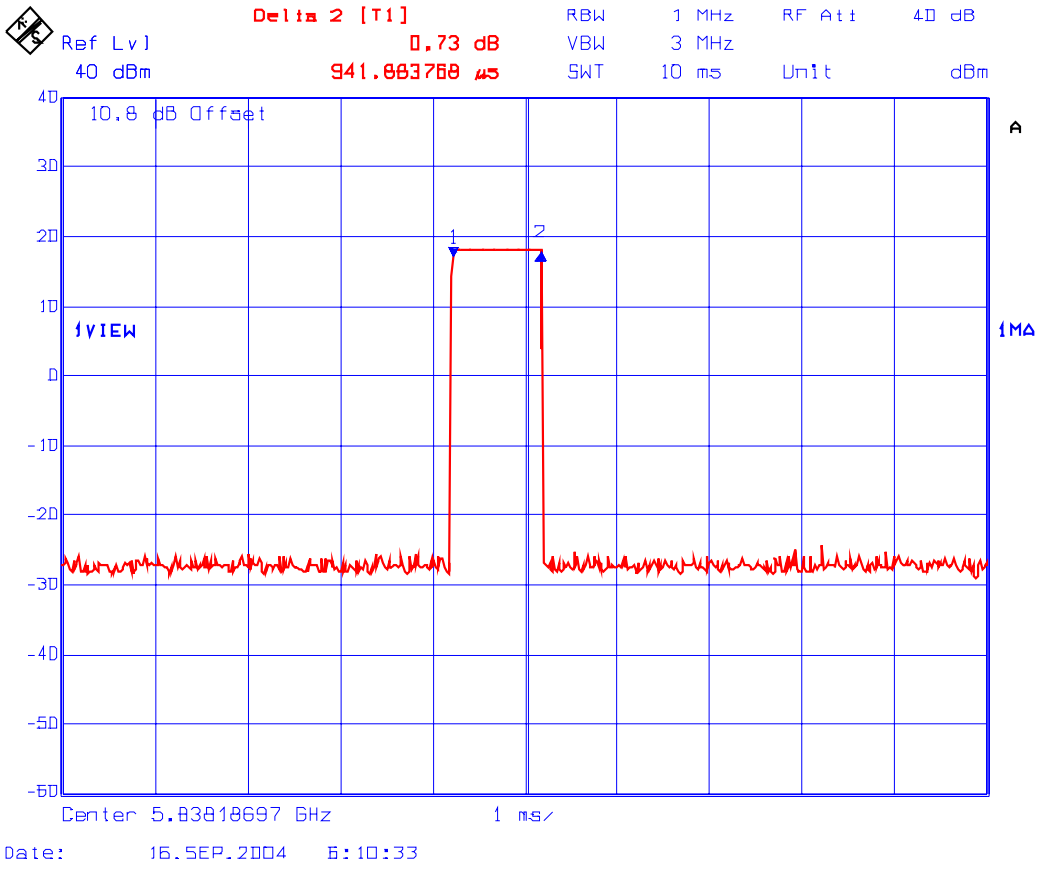
Dwell Time @ 5798.05084 MHz = 941.88 µs

Plot 30:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5798.05084 MHz (CH 43)



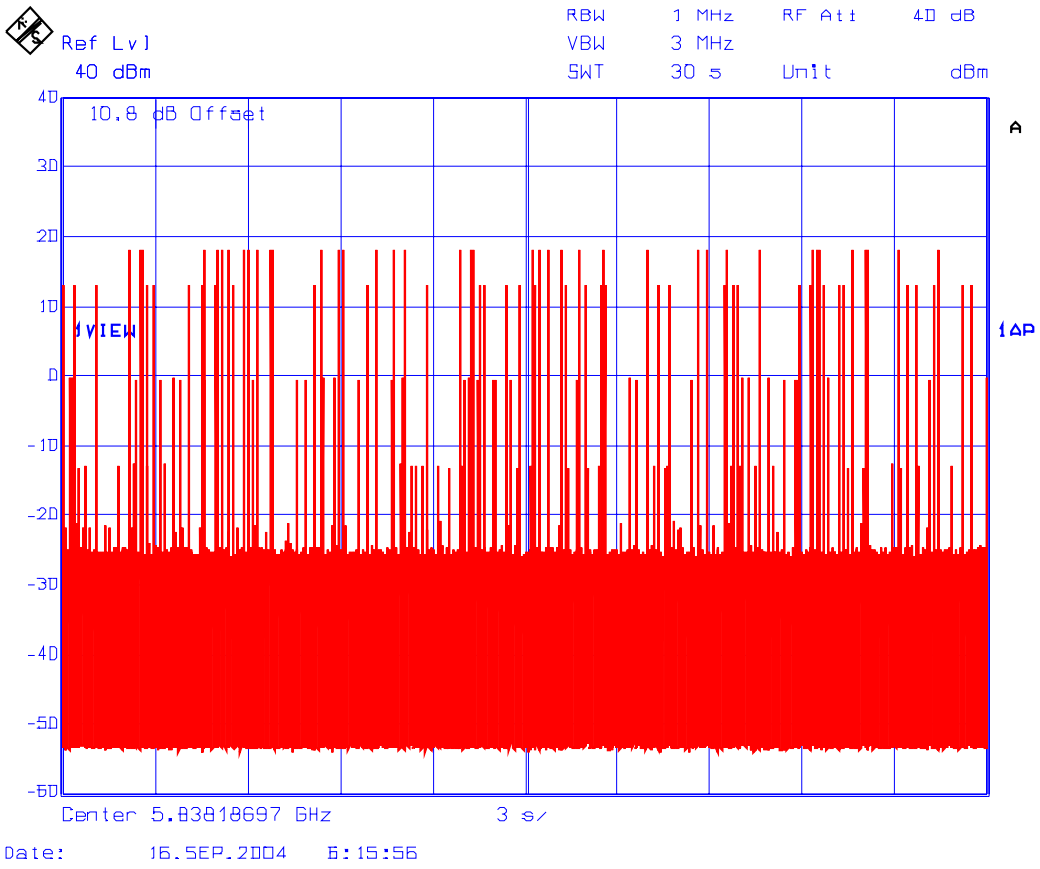
Average time of occupancy in 30 s = (Dwell Time @ 5798.05084 MHz) x (number of hops in 30 s)
= 941.88 μs x 36
= 33.91 ms

Plot 31:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5838.18697 MHz (CH 88)



Dwell Time @ 5838.18697 MHz = 941.88 µs

Plot 32:
Time of Occupancy (Handset -Talk Mode)
Test Frequency: 5838.18697 MHz (CH 88)



Average time of occupancy in 30 s = (Dwell Time @ 5838.18697 MHz) x (number of hops in 30 s)
= 941.88 μs x 36
= 33.91 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 pseudo randomly 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	Refer to FHSS Descriptions
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	Refer to FHSS Descriptions
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	Refer to FHSS Descriptions

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

5.8.1. Limits

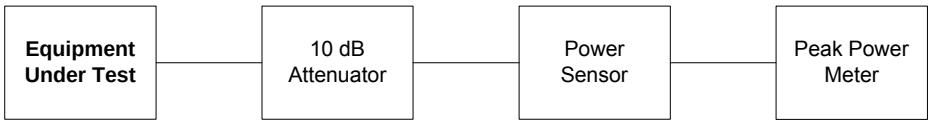
The maximum peak output power of the intentional radiator shall not exceed the following:

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

5.8.2. Method of Measurements

Refer to Section 7.3 of this test report and ANSI C63-4

5.8.3. Test Arrangement



5.8.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Peak Power Meter	Hewlett Packard	HP 8900D	3412A00103	9 kHz – 26.5 GHz
Power Sensor	Hewlett Packard	84811A	2551A02902	9 kHz – 26.5 GHz
Attenuator	Weinschel	41-10-12	46231	DC-18 GHz

5.8.5. 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	5759.70240	20.58	23.58	30.0	36.0
43	5798.05084	20.58	23.58	30.0	36.0
88	5838.18697	20.62	23.62	30.0	36.0
Handset					
00	5759.70240	18.28	22.28	30.0	36.0
43	5798.05084	18.36	22.36	30.0	36.0
88	5838.18697	18.43	22.43	30.0	36.0

* EIRP = Peak power at antenna terminal in dBm + EUT Antenna gain in dBi (Base Unit: 3dBi, Handset: 4dBi).

5.9. RF EXPOSURE REQUIRMENTS [47 CFR §§ 15.247(b)(5) & 1.1310]

5.9.1. Limits

FCC 15.247(b)(5): 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).

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	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/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.

1.1.1. 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

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

- 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)

5.9.2. 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: ***4.3 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:

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

$S = 1.0\ mW/cm^2$
EIRP = 23.62 dBm = 230.14 mW (Max. EIRP)

$r = (EIRP/4\Pi S)^{1/2} = (230.14/4\Pi(1.0))^{1/2} = 4.3$ cm

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

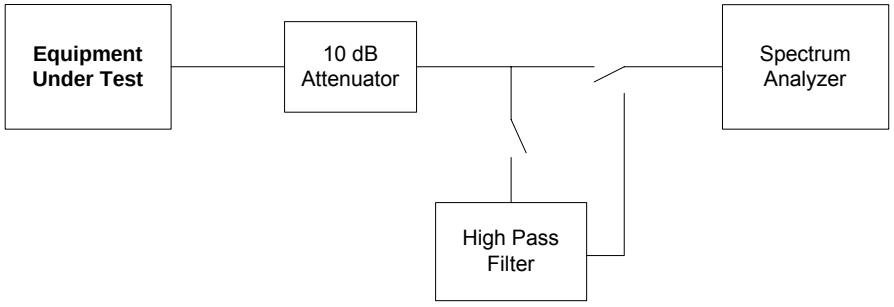
5.10.1. Limits

In any 100 KHz bandwidth outside the operating 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.

5.10.2. Method of Measurements

Refer to Section 7.4 of this test report and ANSI C63-4

5.10.3. Test Arrangement



5.10.4. Test Equipment List

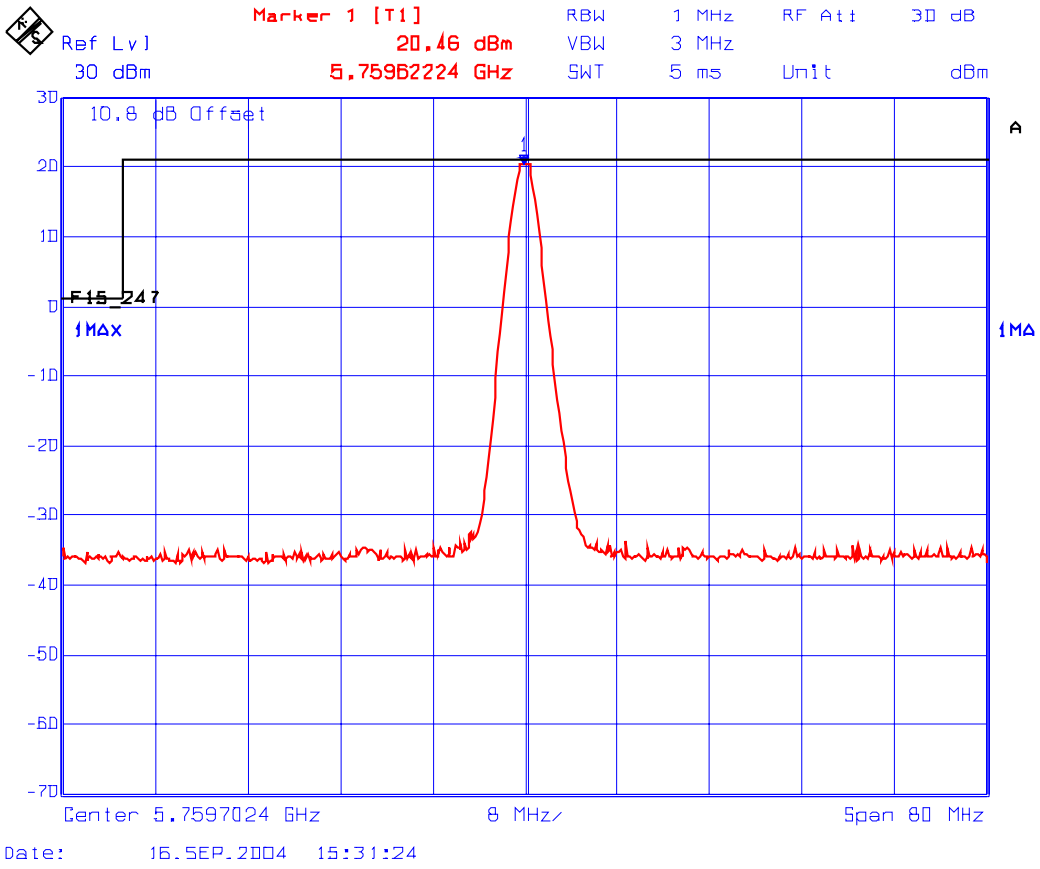
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
Attenuator	Weinschel	41-10-12	46231	DC-18 GHz
High Pass Filter	K & L	11SH10-8000/T18000-0/0	3	Cut-off Frequency at 8 GHz

5.10.5. Test Data

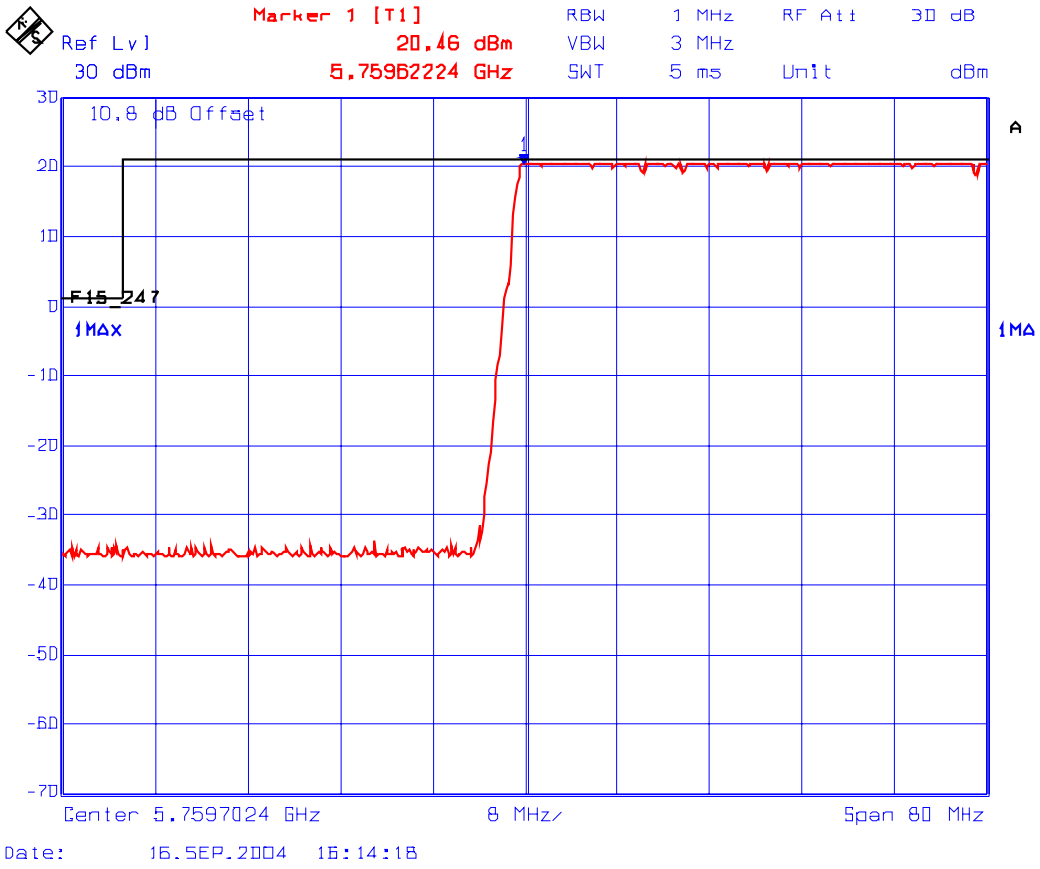
5.10.5.1. Band-Edge RF Conducted Emissions

Refer to the following test data plots (33 to 40) for measurement results:

Plot 33:
Band-Edge RF Conducted Emissions (Base Unit)
Low End of Frequency Band
Single Frequency Mode

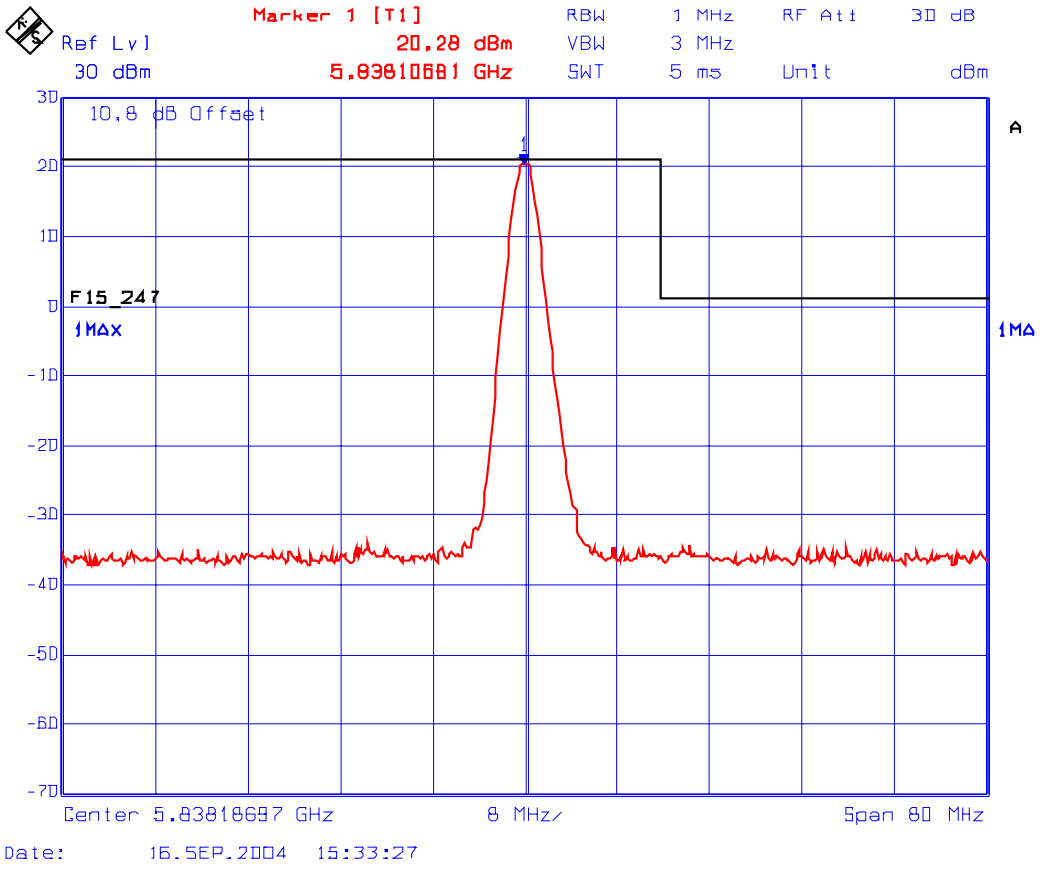


Plot 34:
Band-Edge RF Conducted Emissions (Base Unit)
Low End of Frequency Band
Pseudorandom Channel Hopping Mode



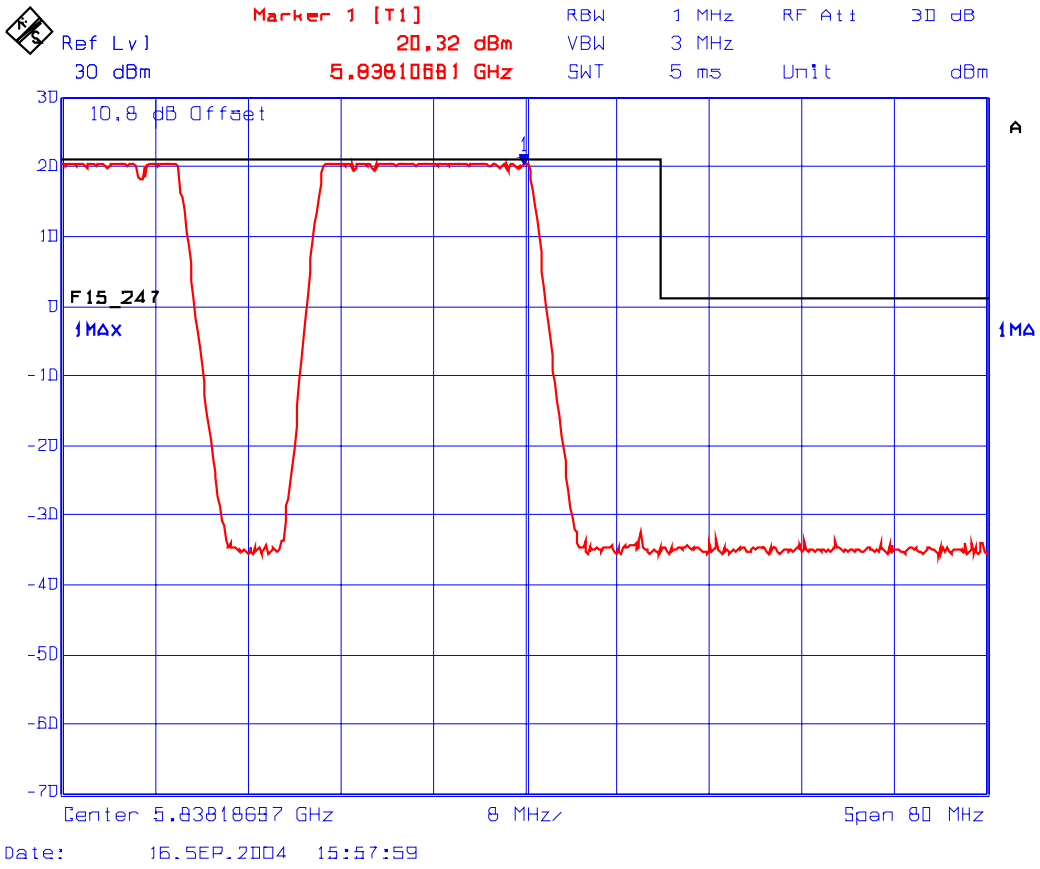
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 35:
Band-Edge RF Conducted Emissions (Base Unit)
High End of Frequency Band
Single Frequency Mode



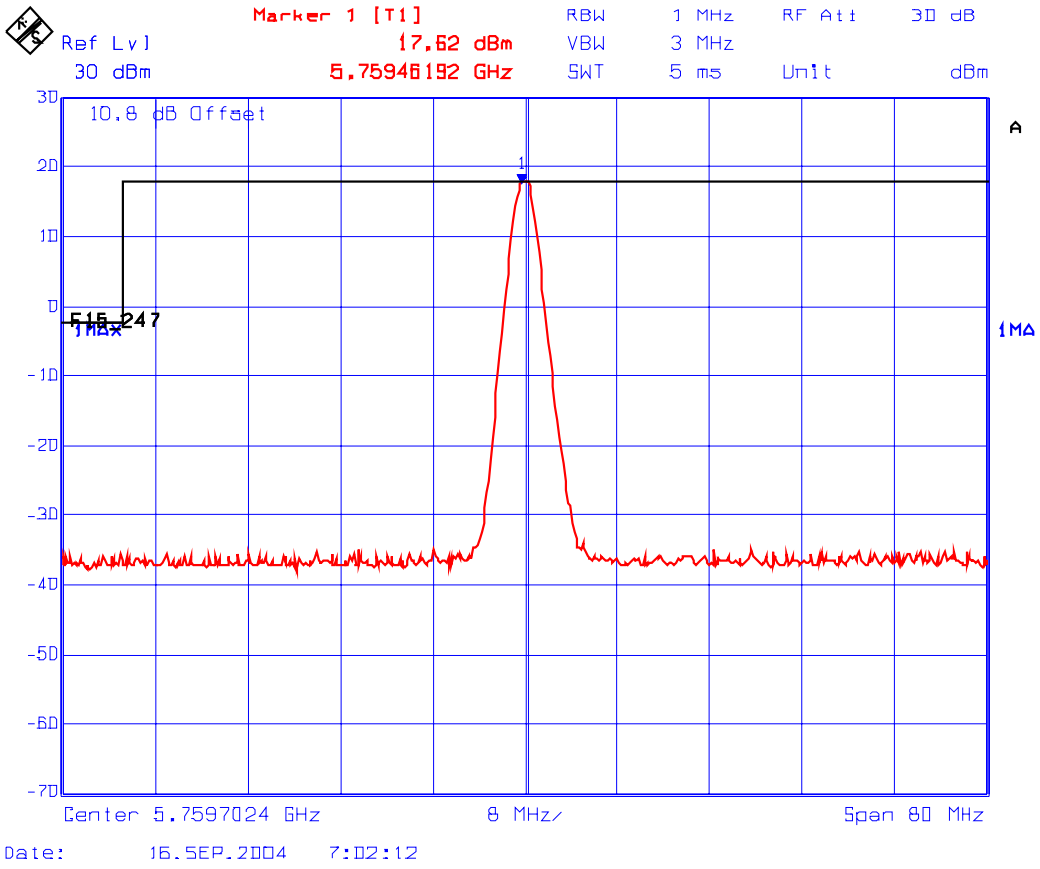
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

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

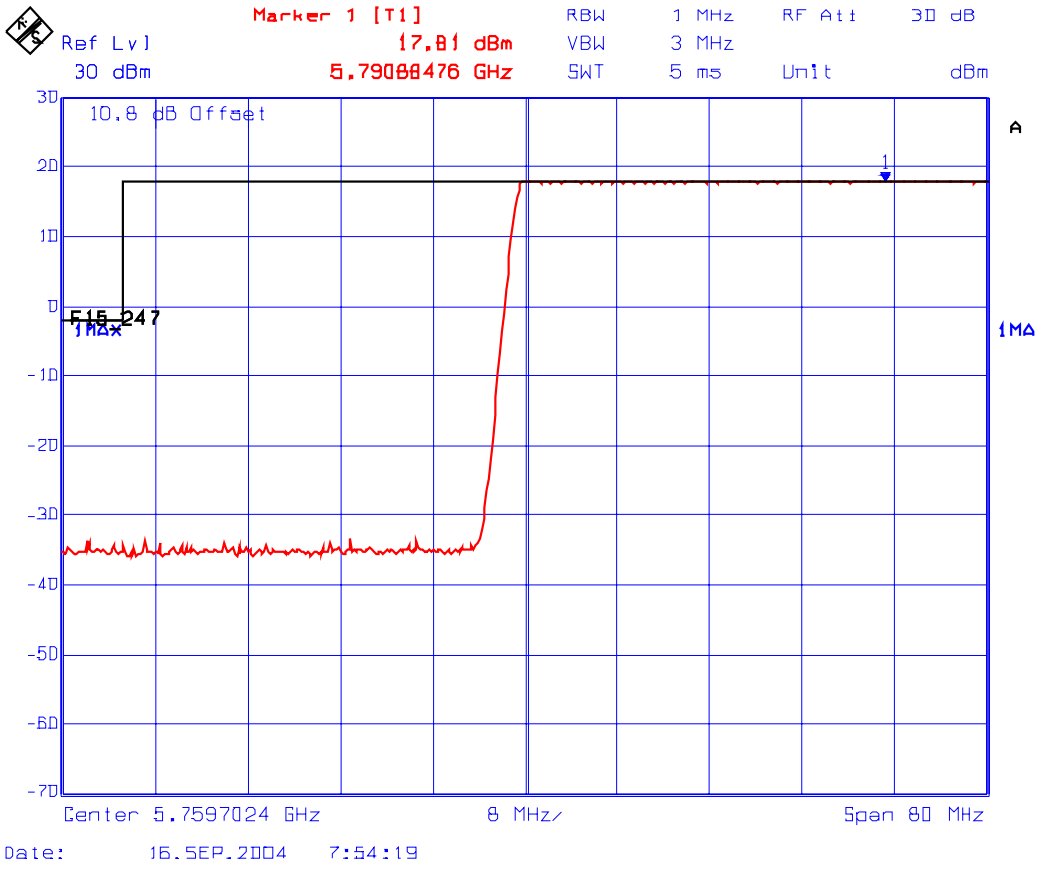


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

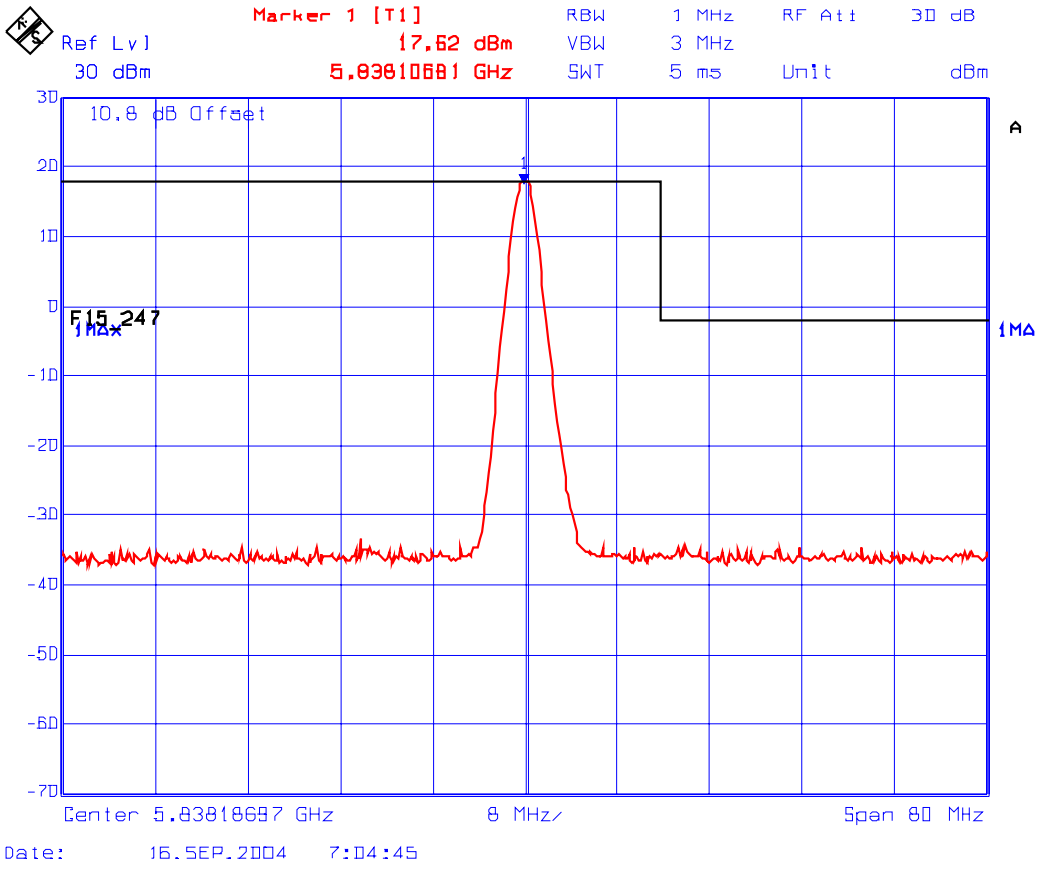
Plot 37:
Band-Edge RF Conducted Emissions (Handset)
Low End of Frequency Band
Single Frequency Mode



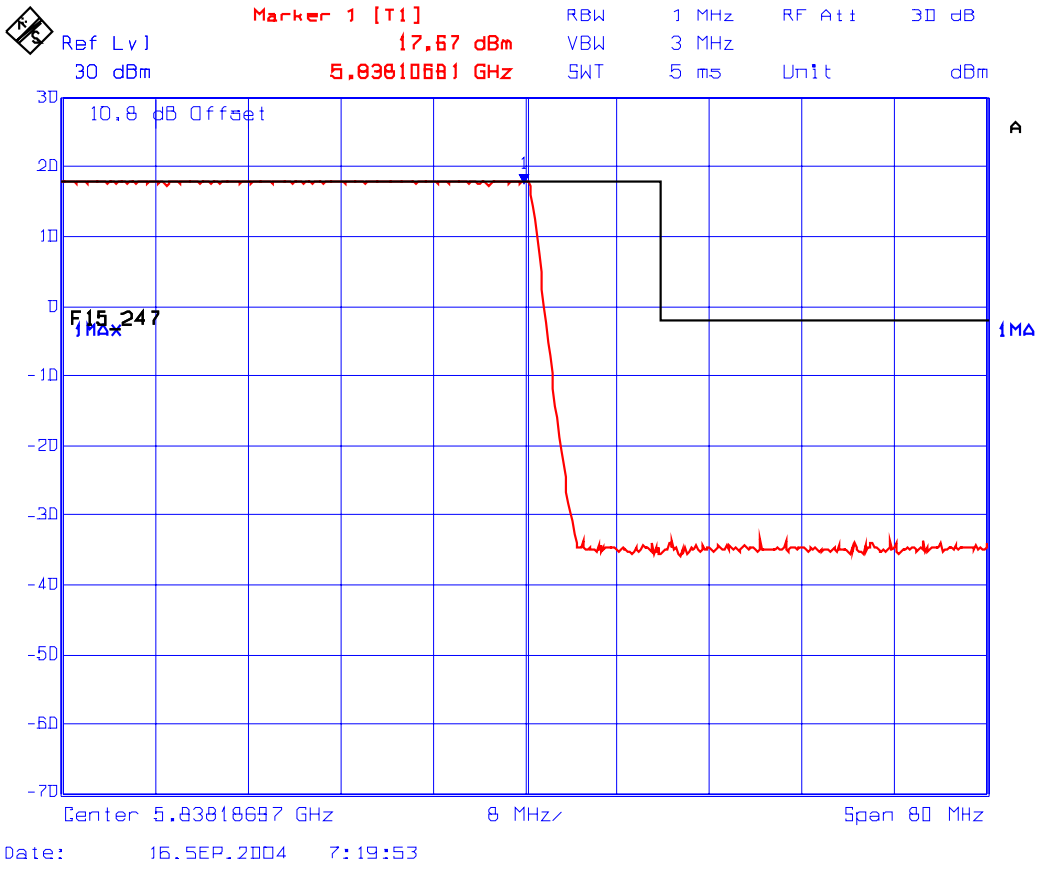
Plot 38:
Band-Edge RF Conducted Emissions (Handset)
Low End of Frequency Band
Pseudorandom Channel Hopping Mode



Plot 39:
Band-Edge RF Conducted Emissions (Handset)
High End of Frequency Band
Single Frequency Mode



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

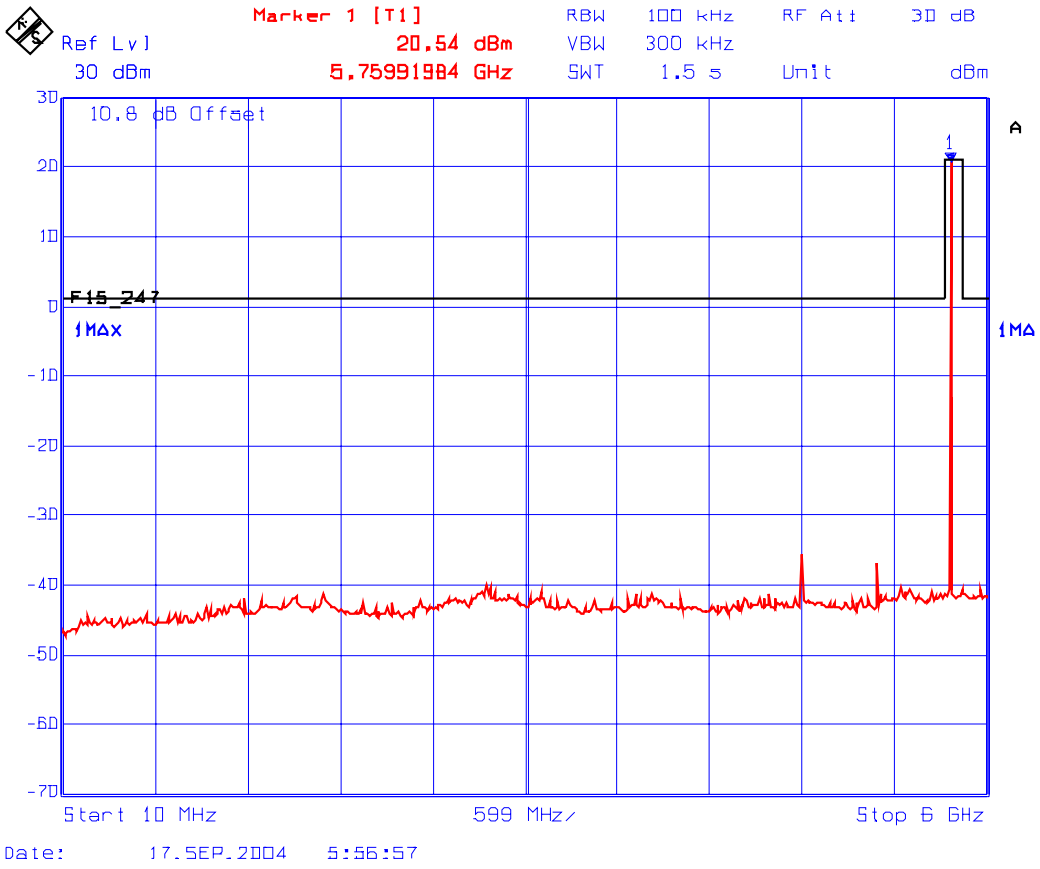


5.10.5.2. Transmitter Spurious RF Conducted Emissions

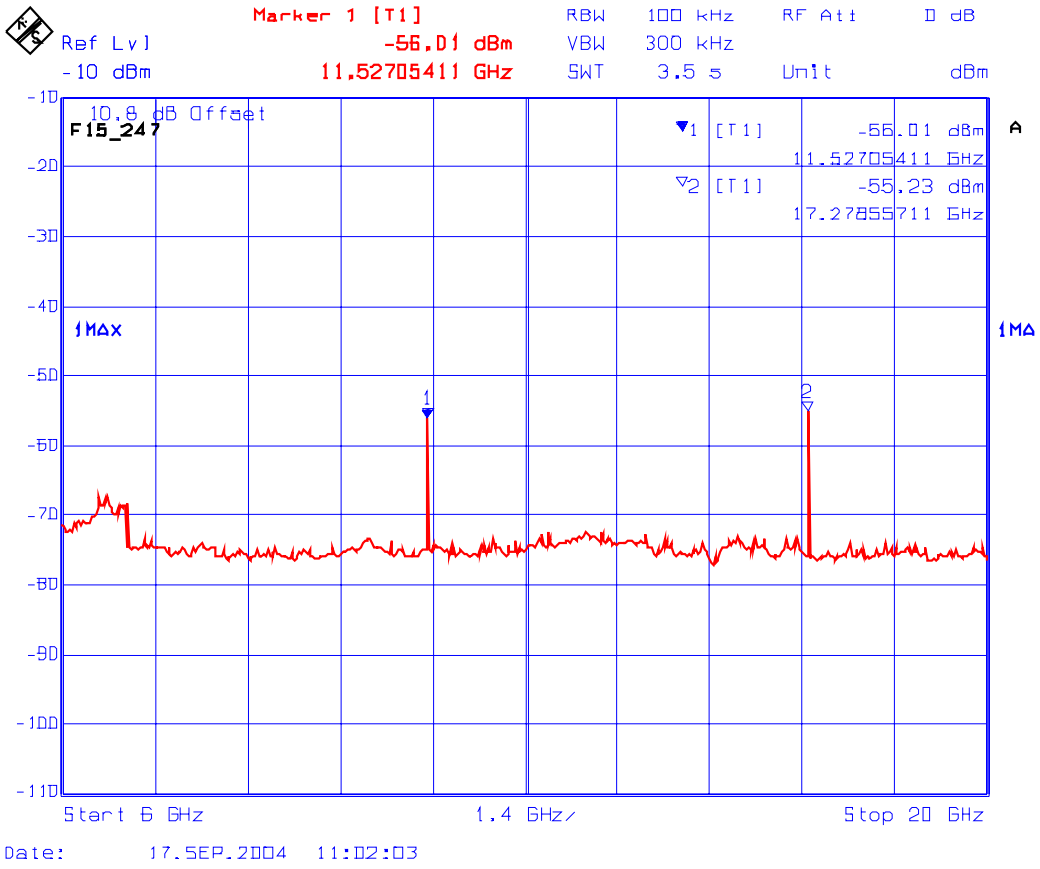
5.10.5.2.1. Lowest Frequency (5759.70240 MHz)

The emissions were scanned from 10 MHz to 40 GHz; refer to the following test data plots (41 to 46) for measurement results.

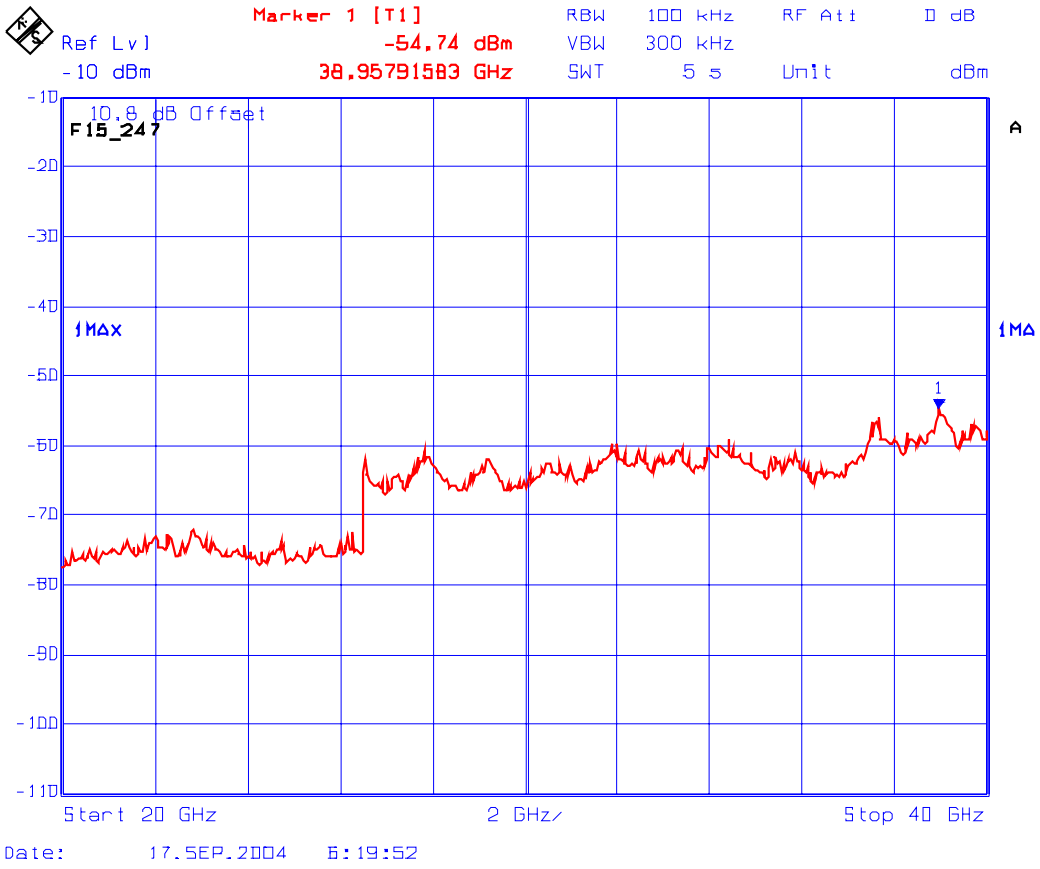
Plot 41:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5759.70240 MHz (CH 00)



Plot 42:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5759.70240 MHz (CH 00)

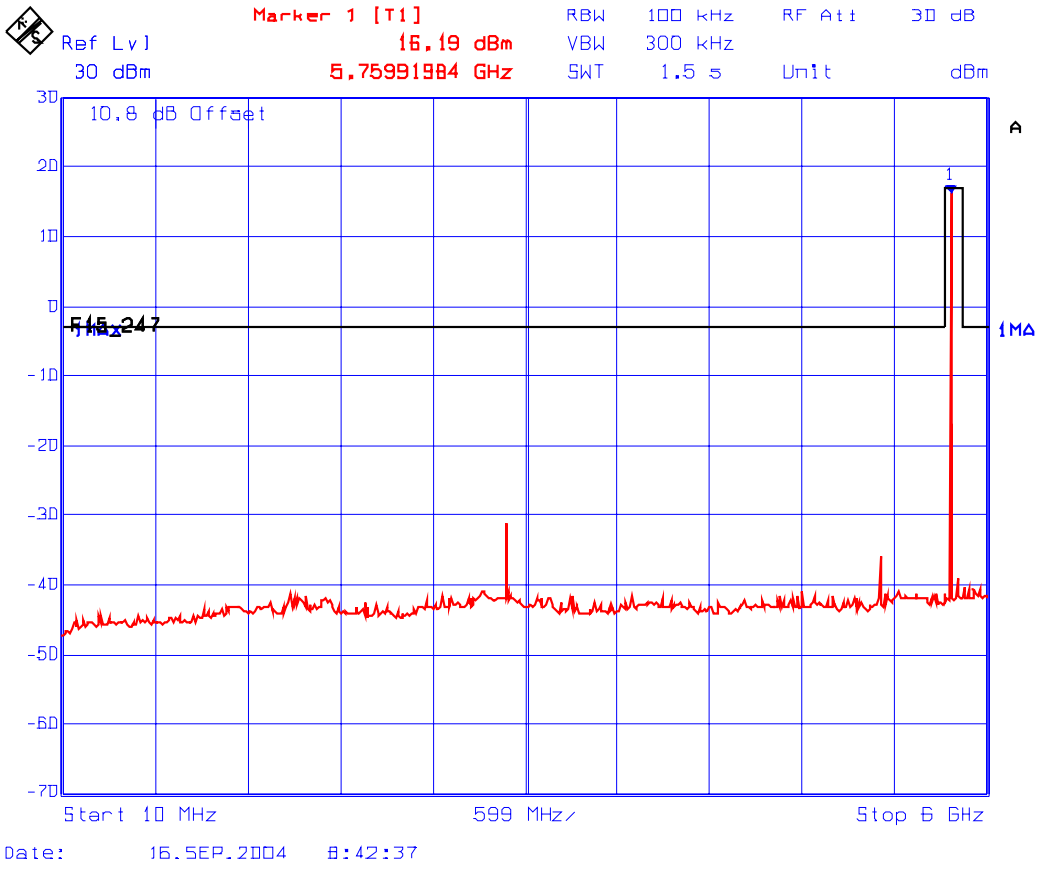


Plot 43:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5759.70240 MHz (CH 00)

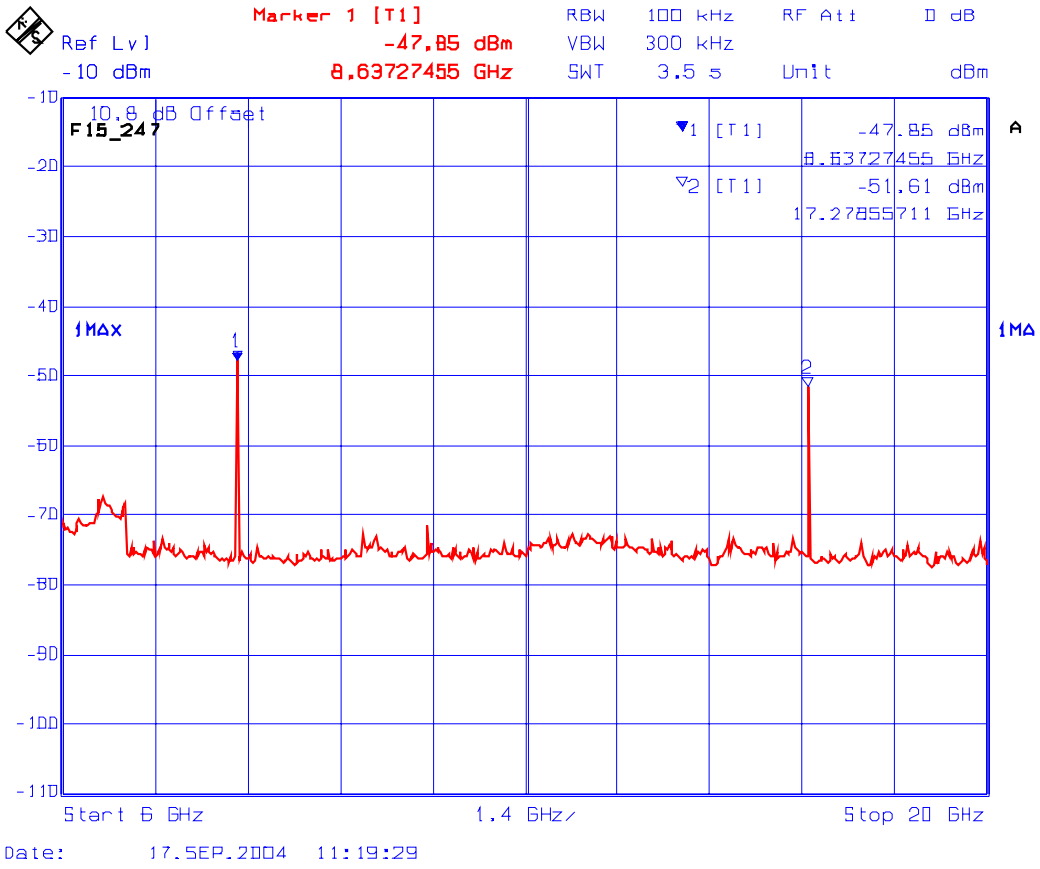


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 44:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5759.70240 MHz (CH 00)

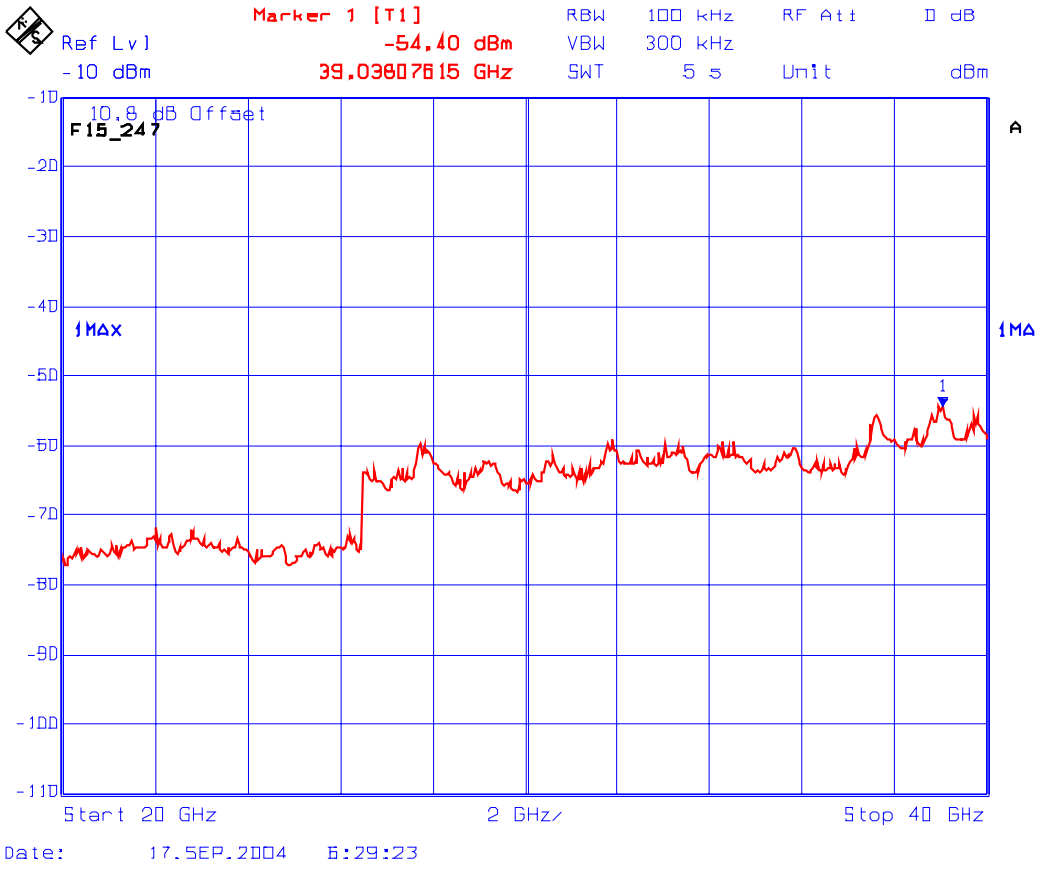


Plot 45:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5759.70240 MHz (CH 00)



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

Plot 46:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5759.70240 MHz (CH 00)

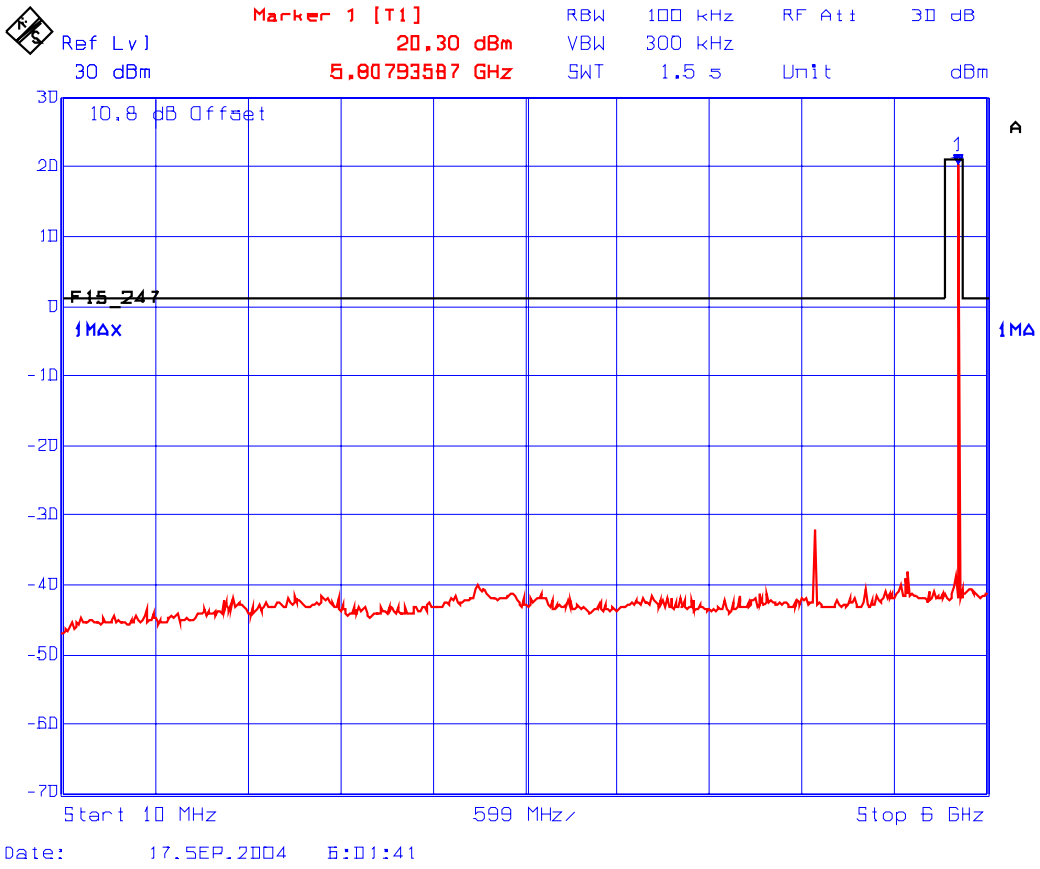


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

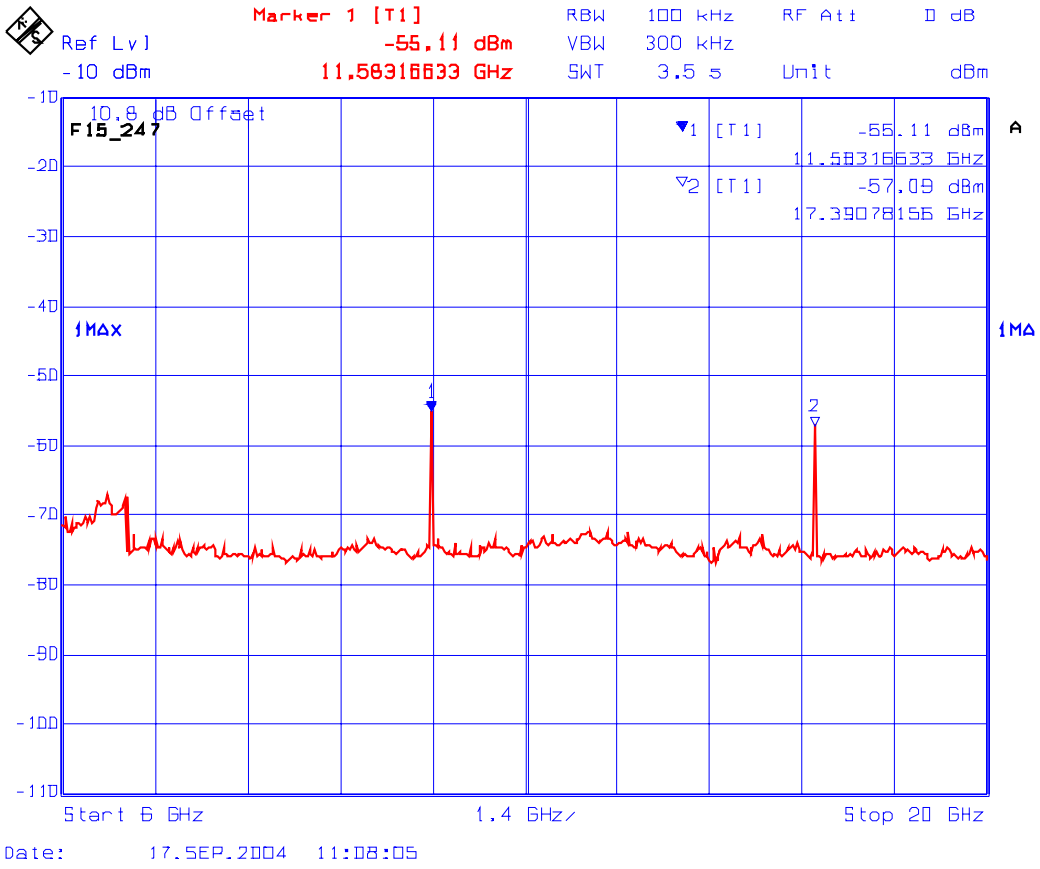
5.10.5.2.2. Middle Frequency (5798.05084 MHz)

The emissions were scanned from 10 MHz to 40 GHz; refer to the following test data plots (47 to 52) for measurement results.

Plot 47:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5798.05084 MHz (CH 43)

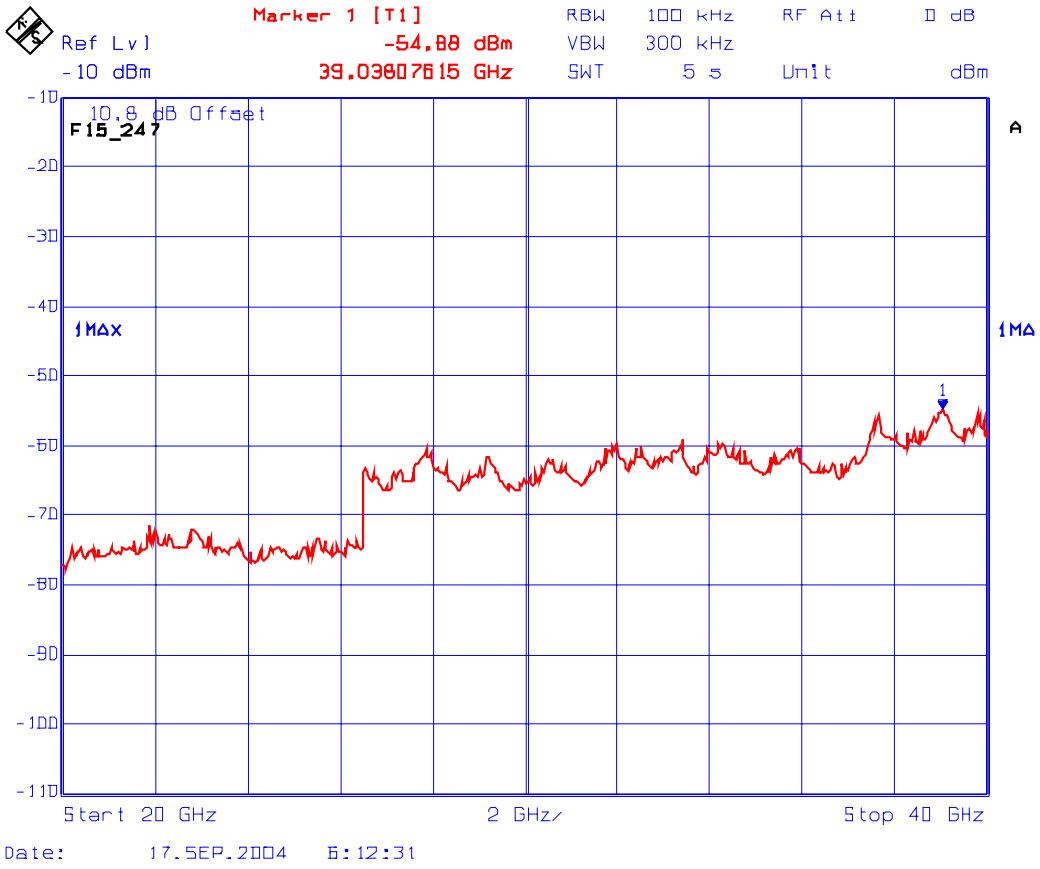


Plot 48:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5798.05084 MHz (CH 43)



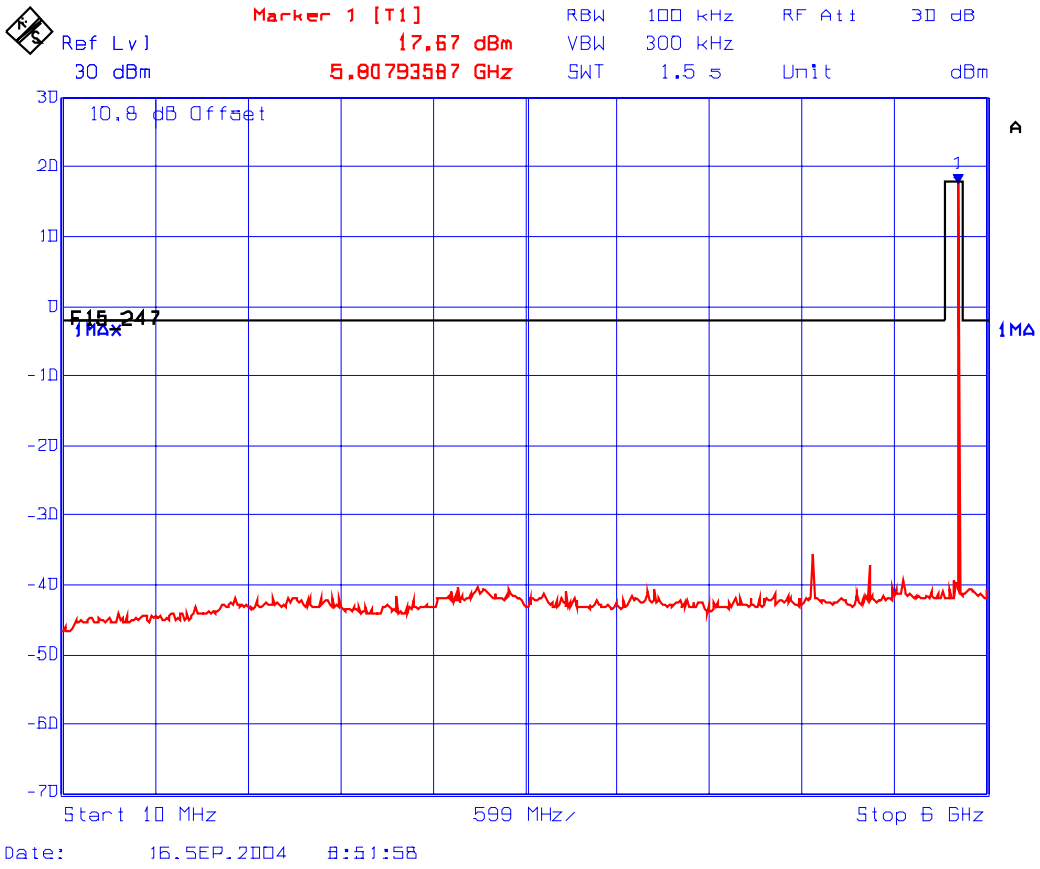
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 49:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5798.05084 MHz (CH 43)

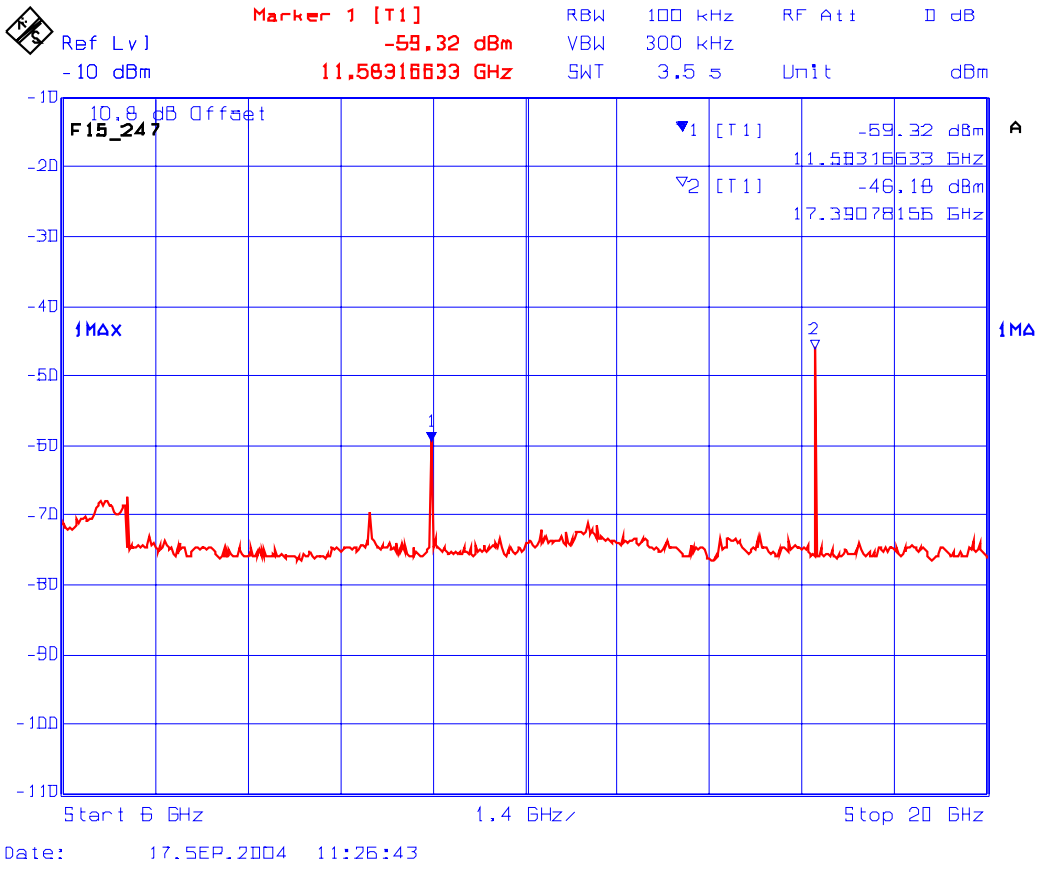


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

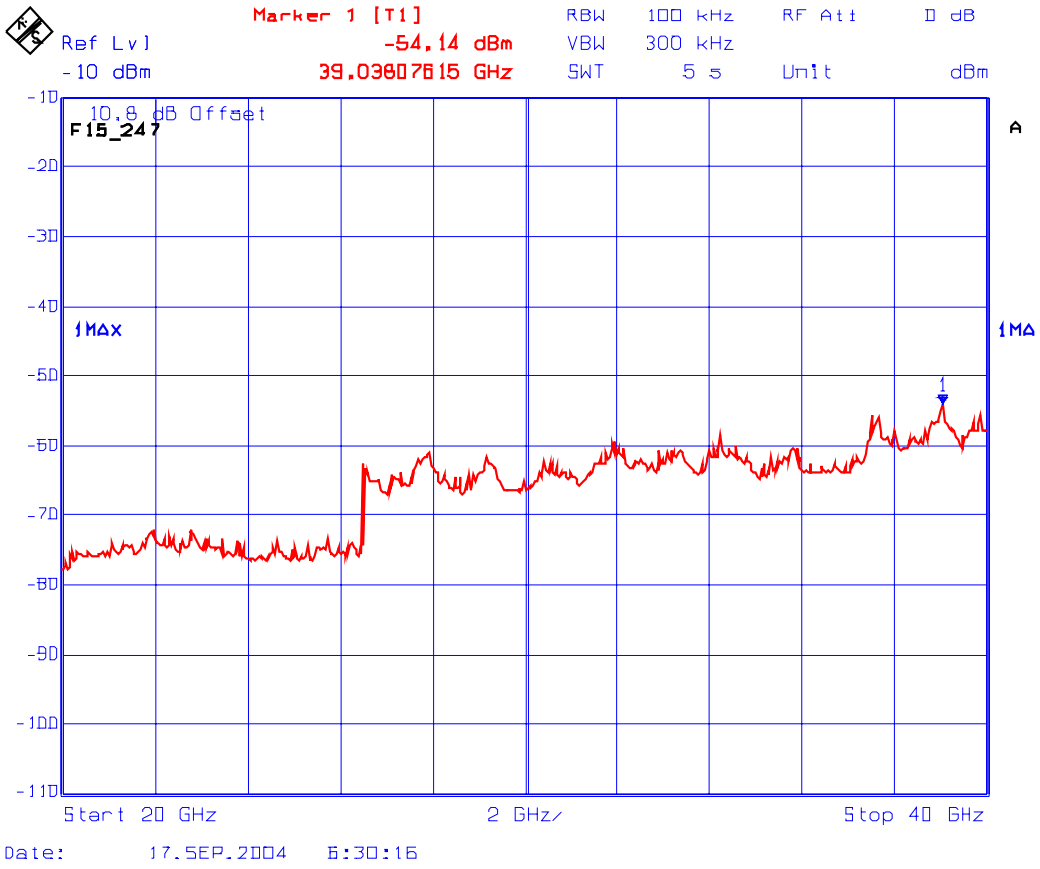
Plot 50:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5798.05084 MHz (CH 43)



Plot 51:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5798.05084 MHz (CH 43)



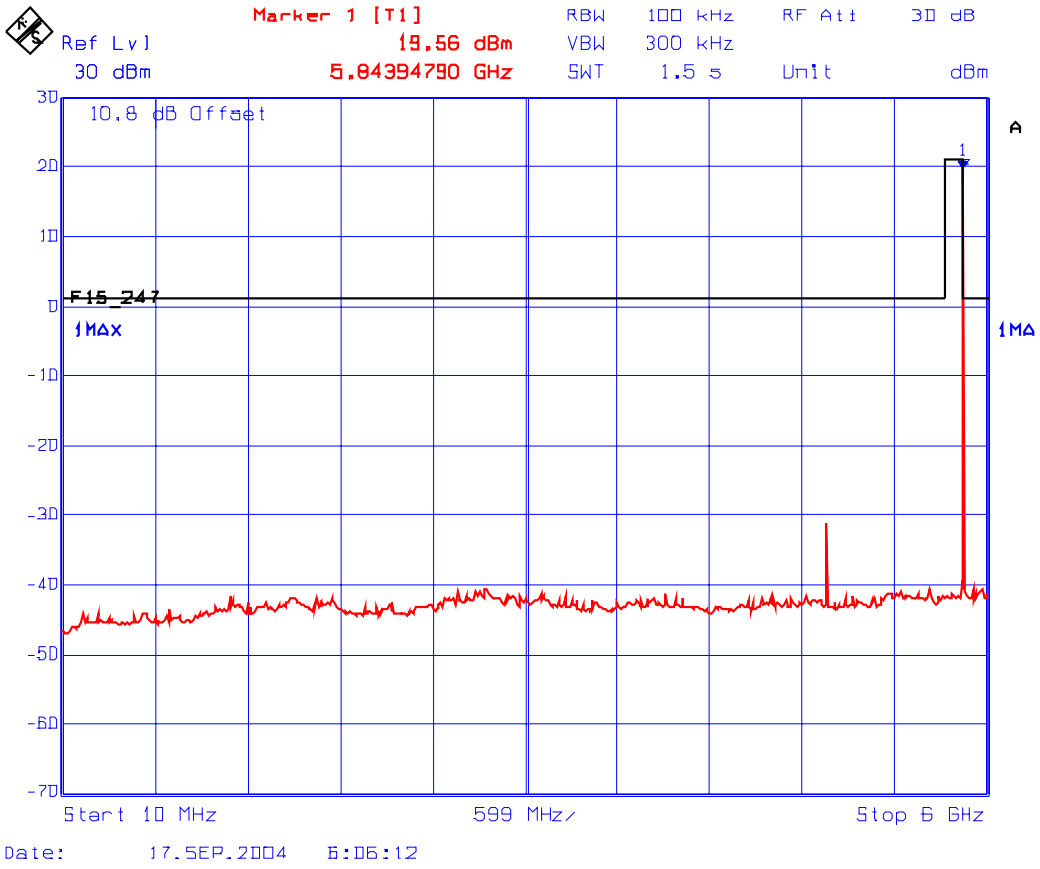
Plot 52:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5798.05084 MHz (CH 43)



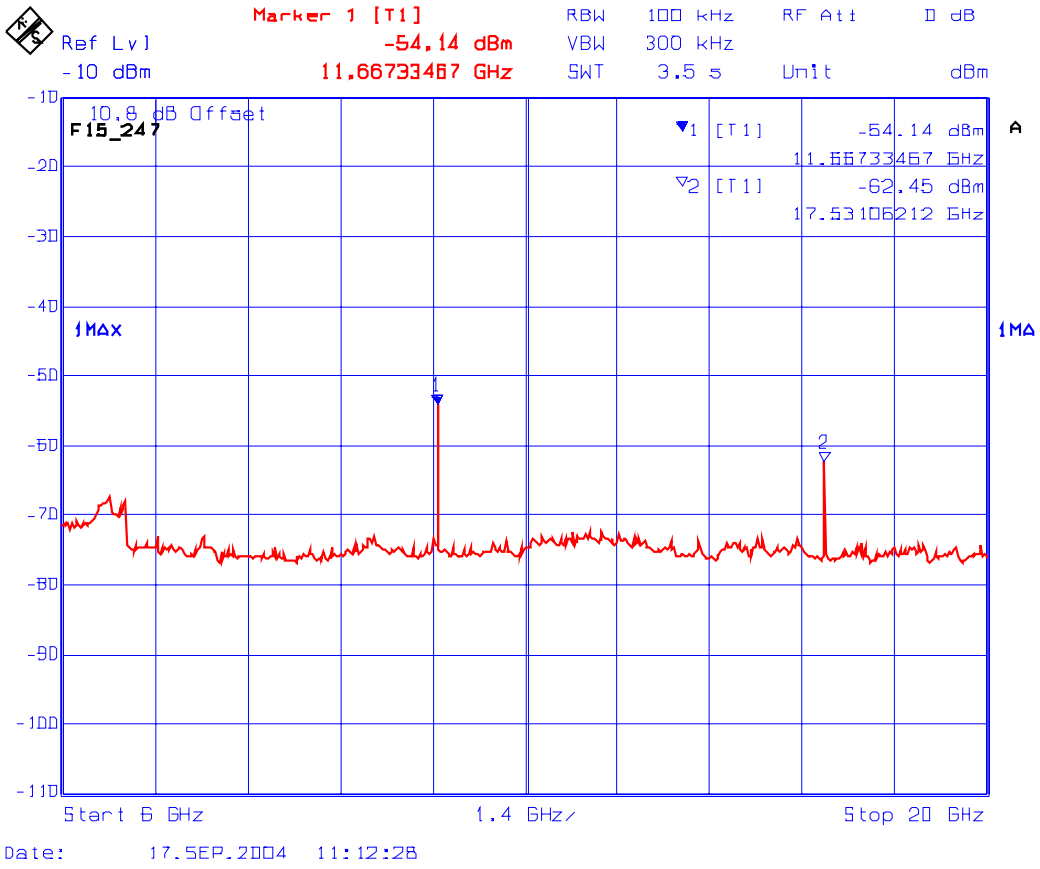
5.10.5.2.3. Highest Frequency (5838.18697 MHz)

The emissions were scanned from 10 MHz to 40 GHz; refer to the following test data plots (53 to 58) for measurement results.

Plot 53:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5838.18697 MHz (CH 88)

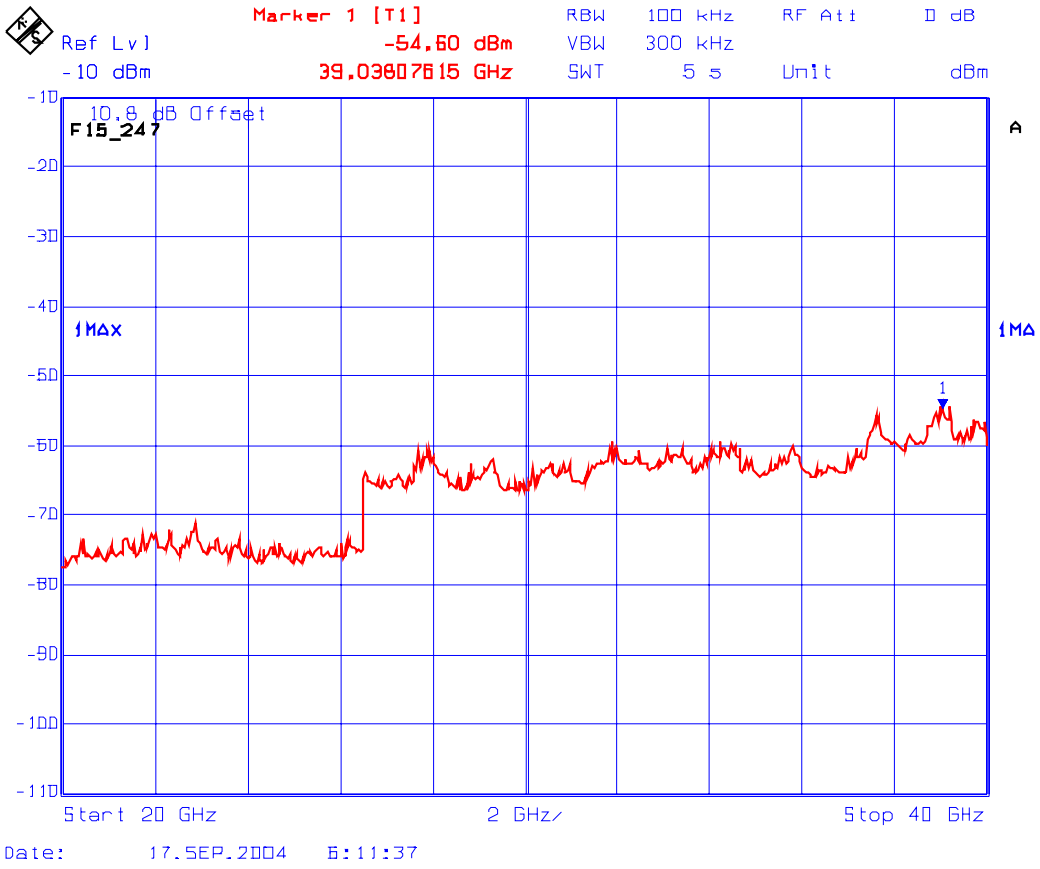


Plot 54:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5838.18697 MHz (CH 88)



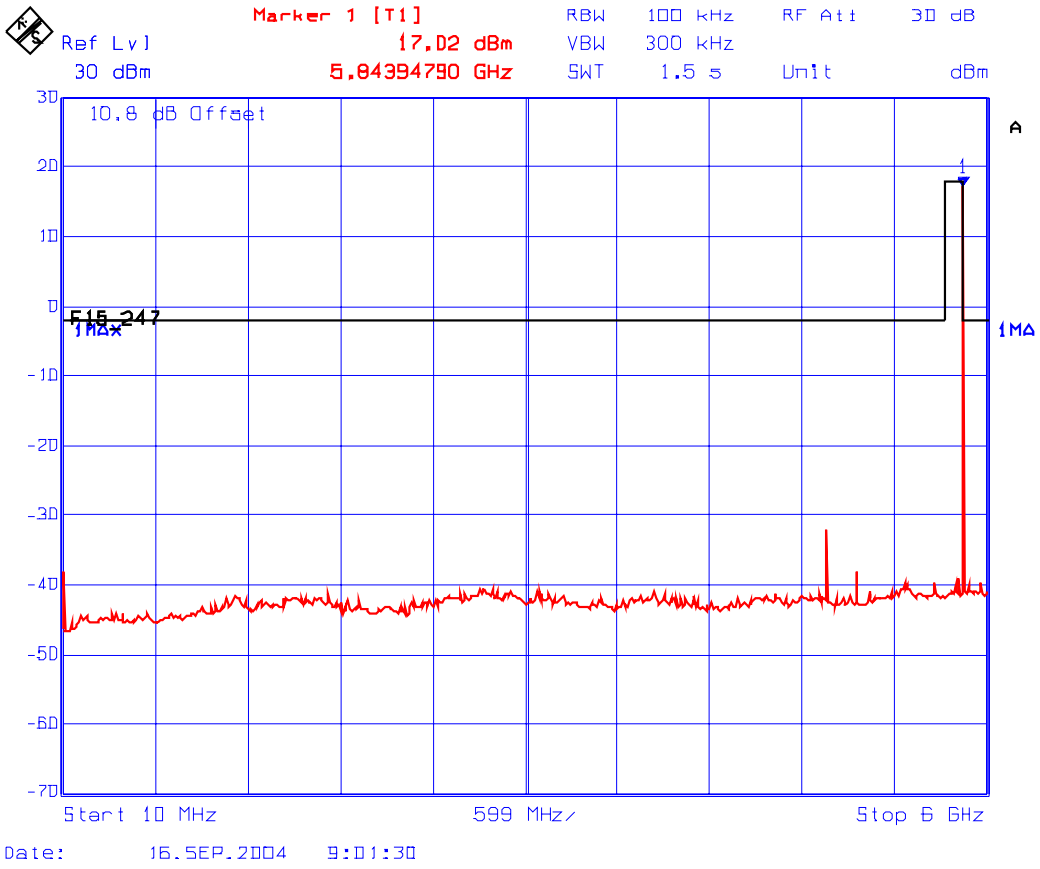
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 55:
Spurious RF Conducted Emissions (Base Unit)
Transmitter Frequency: 5838.18697 MHz (CH 88)

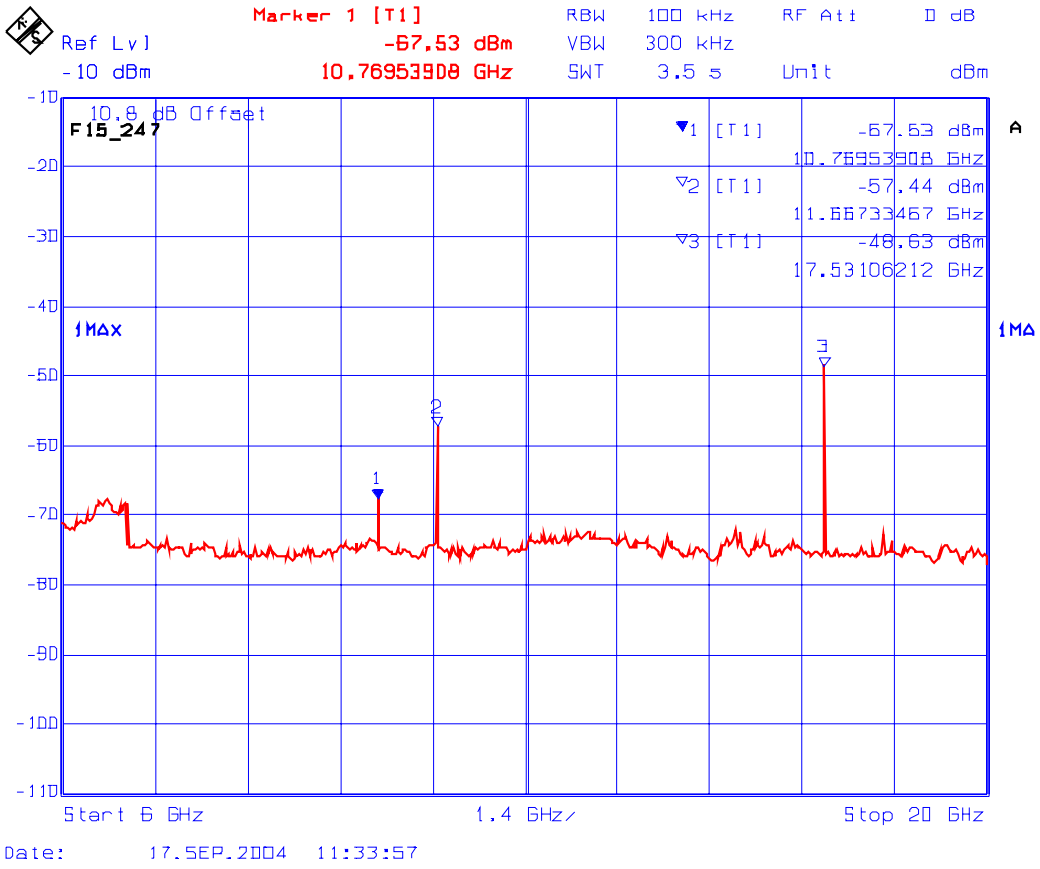


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 56:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5838.18697 MHz (CH 88)

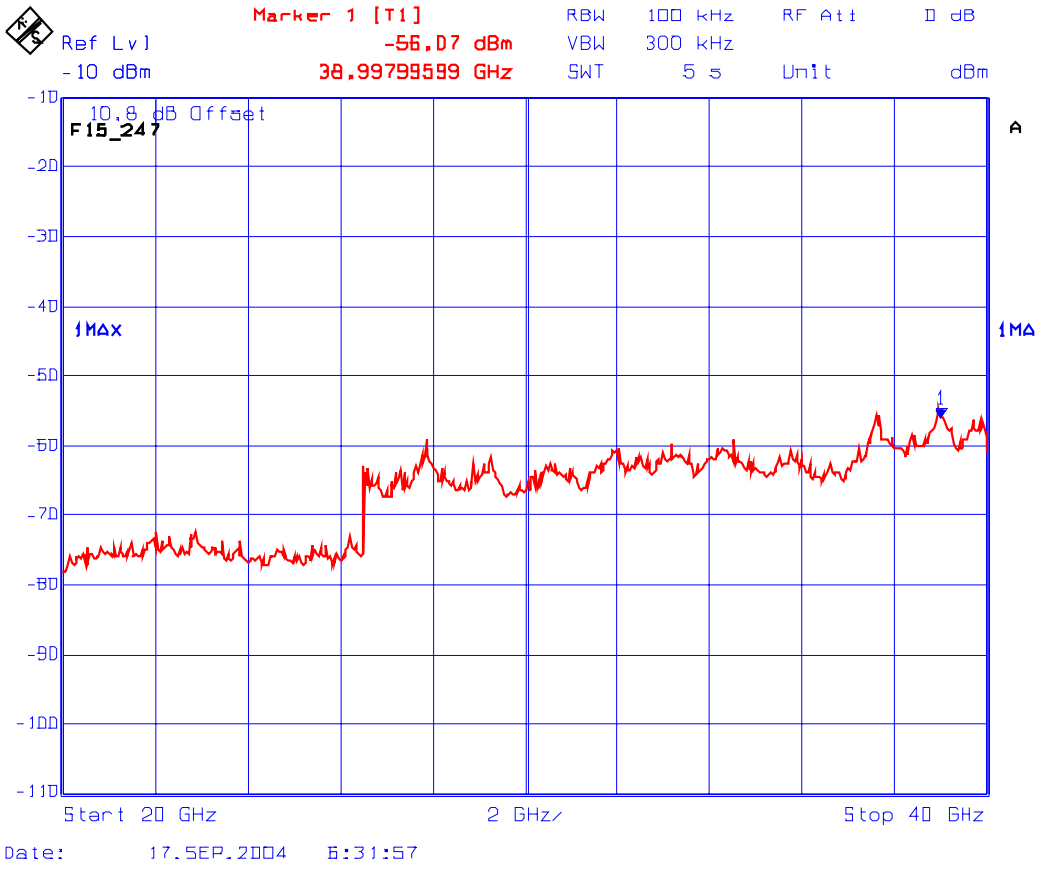


Plot 57:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5838.18697 MHz (CH 88)



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

Plot 58:
Spurious RF Conducted Emissions (Handset)
Transmitter Frequency: 5838.18697 MHz (CH 88)



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

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

5.11.1. Limits

In any 100 KHz bandwidth outside the operating 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. Attenuation below the general limits specified in Section 15.209(a) is not required.

In addition, radiated emissions, which fall in the restricted bands, 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.

47 CFR 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	([2])
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

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

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

5.11.2. Method of Measurements

Refer to Section 7.4 of this test report and ANSI C63.4 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 Sections 15.35(b) and (c).

5.11.3. Test Arrangement

5.11.4. 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

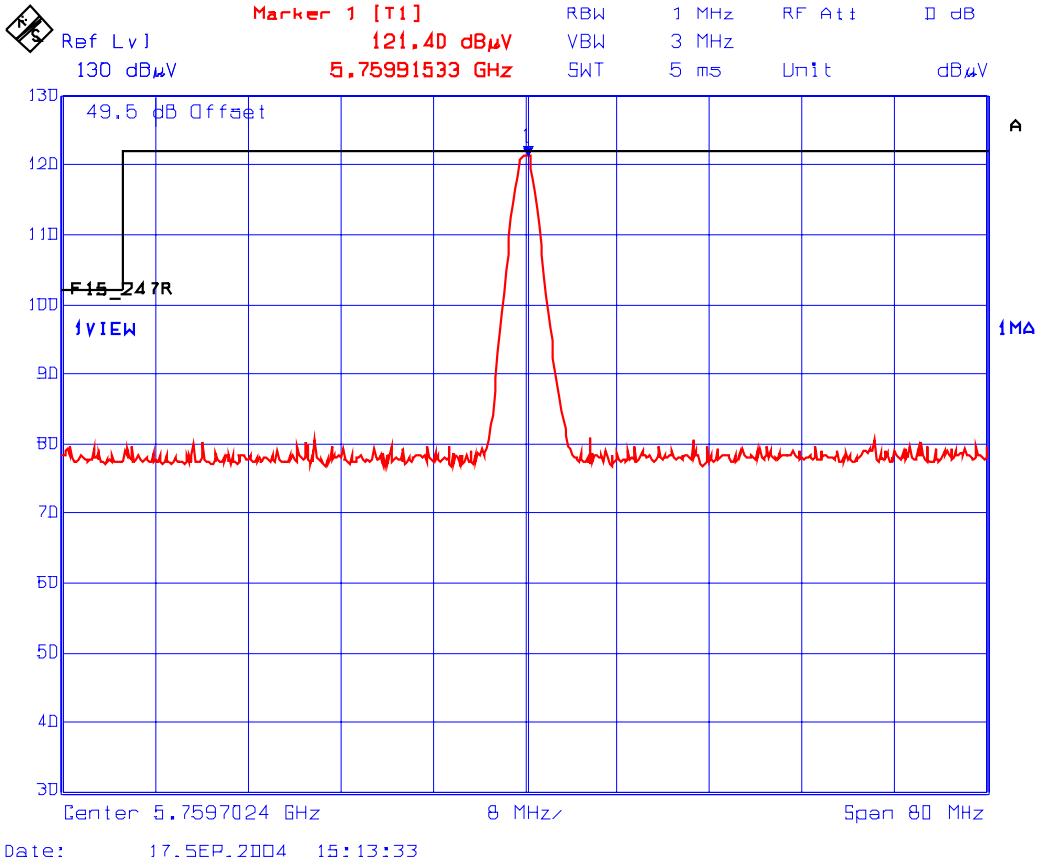
5.11.5. Test Data

The following test results are the worst-case measurements:

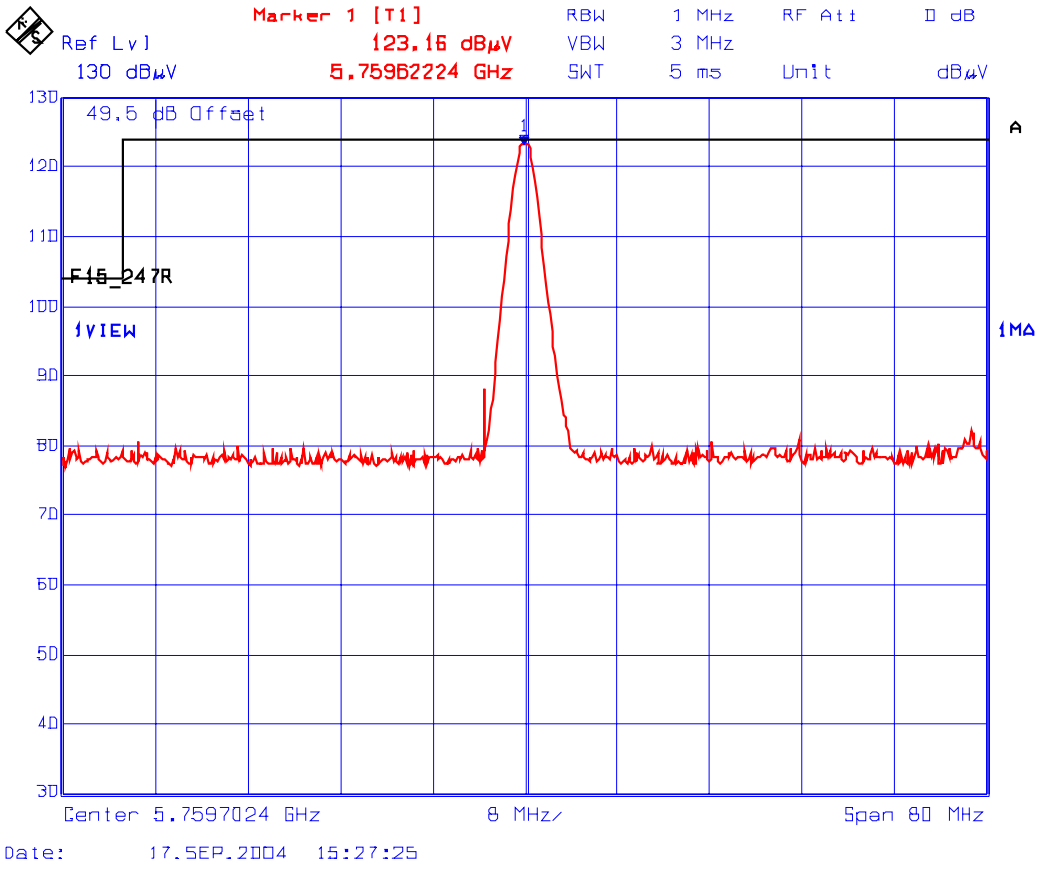
5.11.5.1. Band-Edge RF Radiated Emissions @ 3 Meters

Refer to the following test data plots (59 to 66) for measurement results:

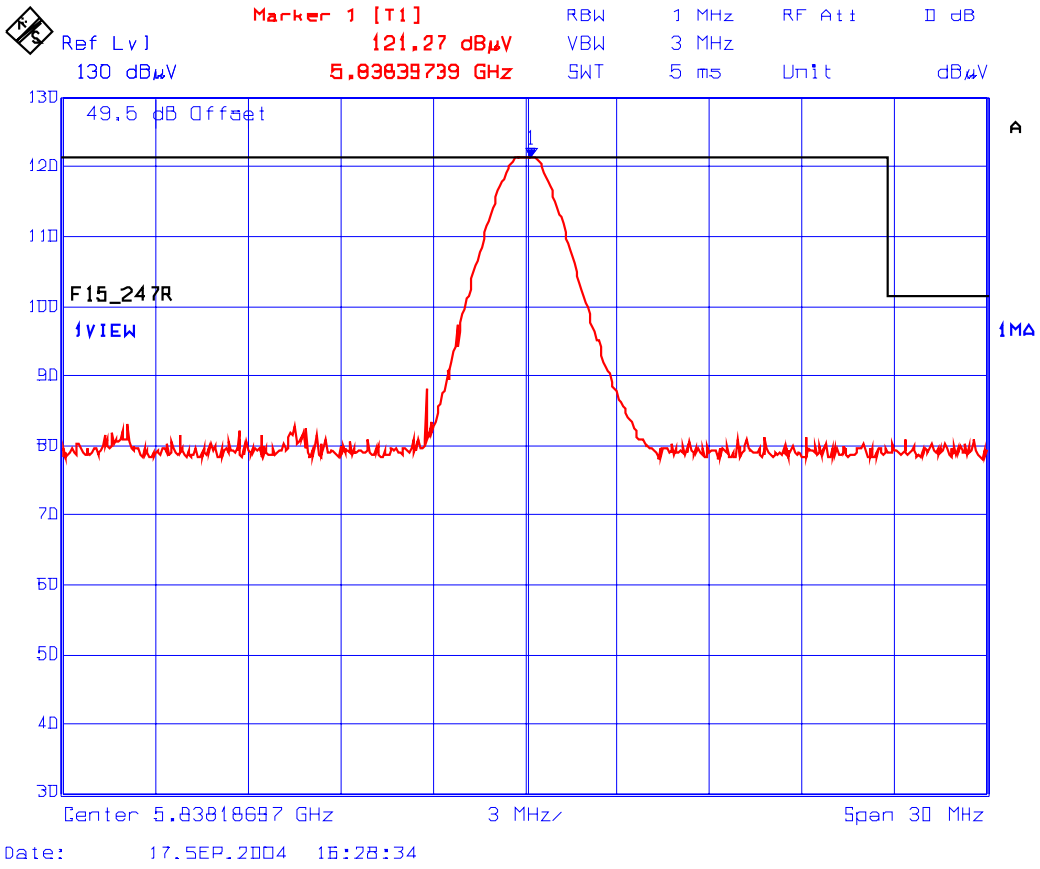
Plot 59:
Band-Edge RF Radiated Emissions @ 3 meters (Base Unit)
Low End of Frequency Band
Vertical Polarization



Plot 60:
Band-Edge RF Radiated Emissions @ 3 meters (Base Unit)
Low End of Frequency Band
Horizontal Polarization

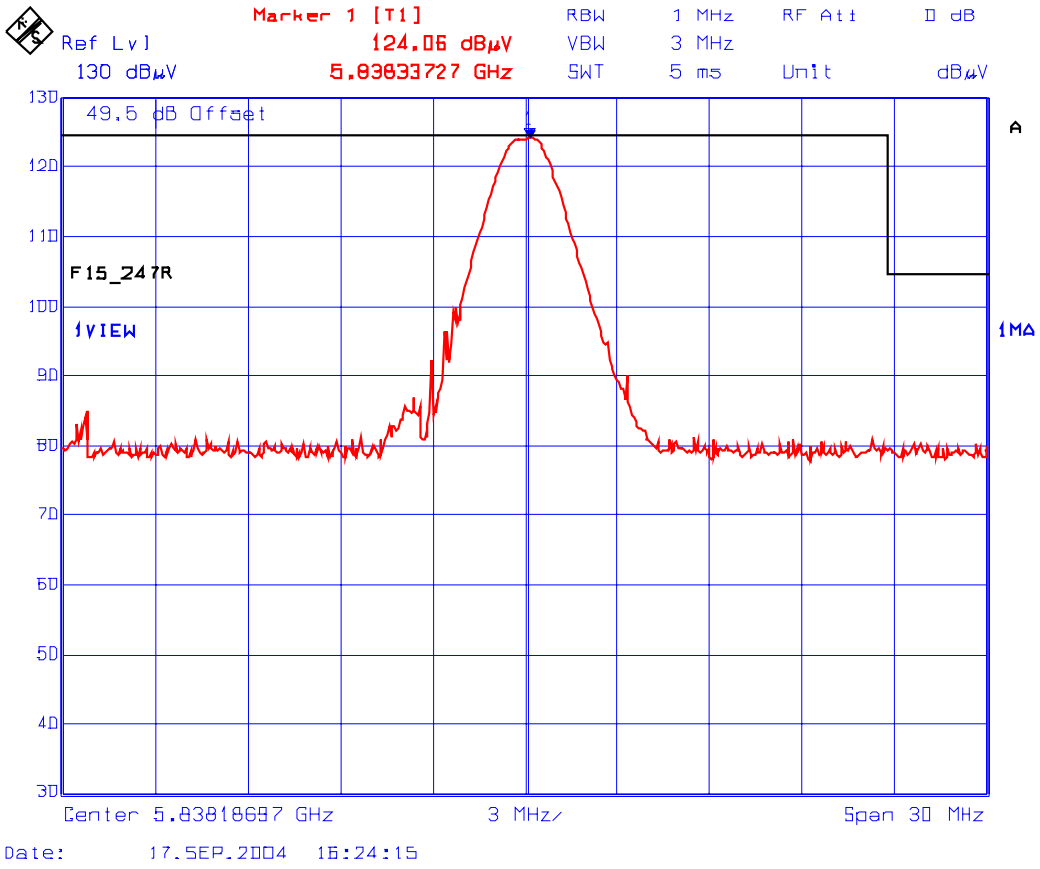


Plot 61:
Band-Edge RF Radiated Emissions @ 3 meters (Base Unit)
Upper End of Frequency Band
Vertical Polarization

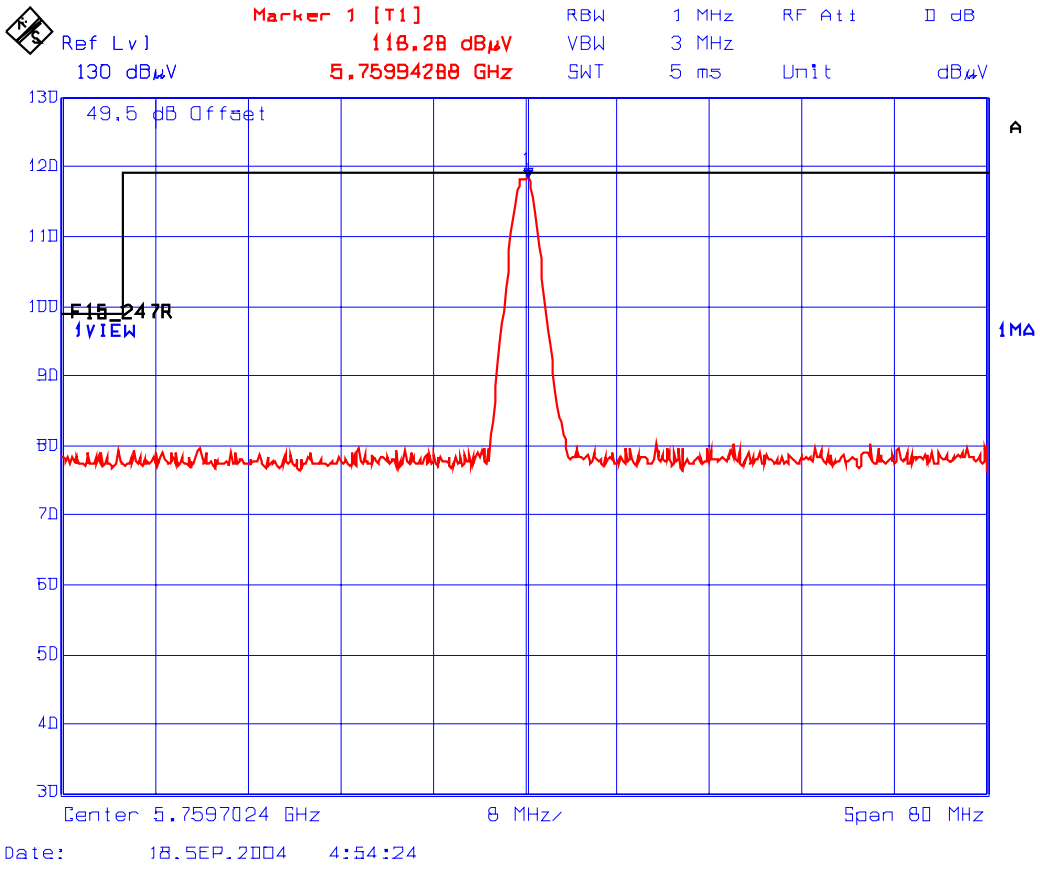


All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 62:
Band-Edge RF Radiated Emissions @ 3 meters (Base Unit)
Upper End of Frequency Band
Horizontal Polarization

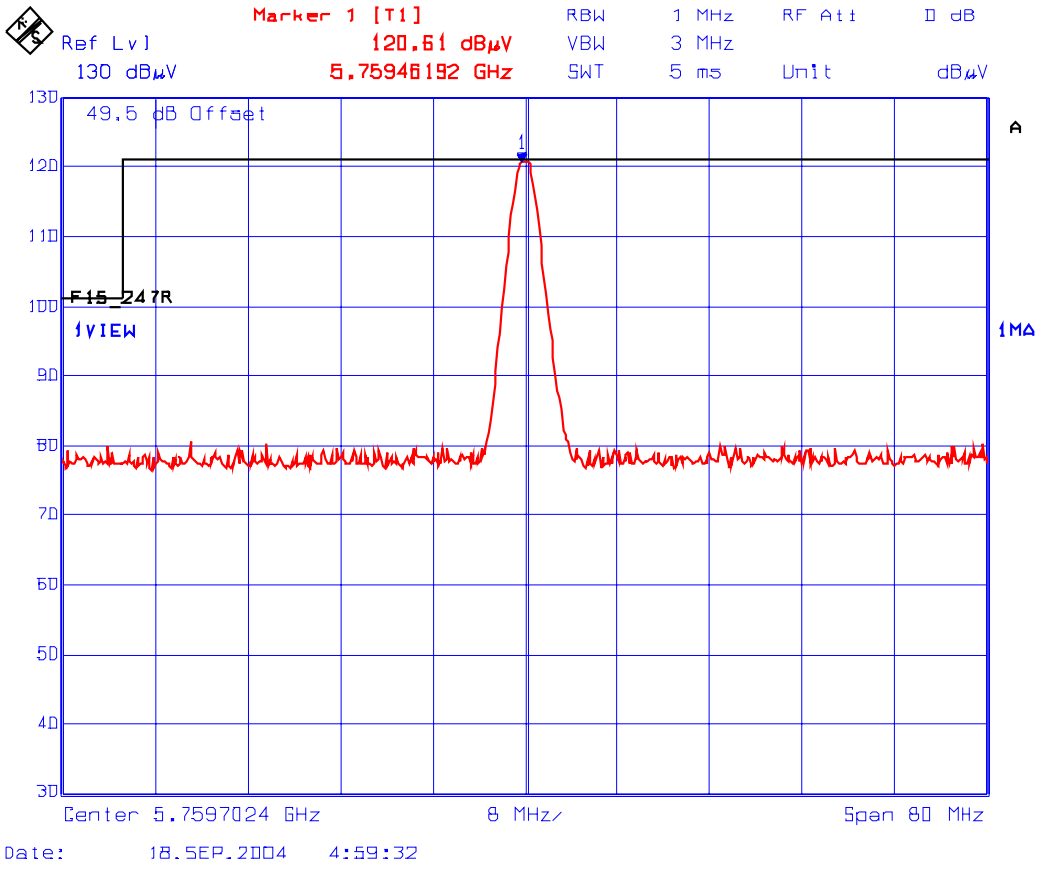


Plot 63:
Band-Edge RF Radiated Emissions @ 3 meters (Handset)
Low End of Frequency Band
Vertical Polarization



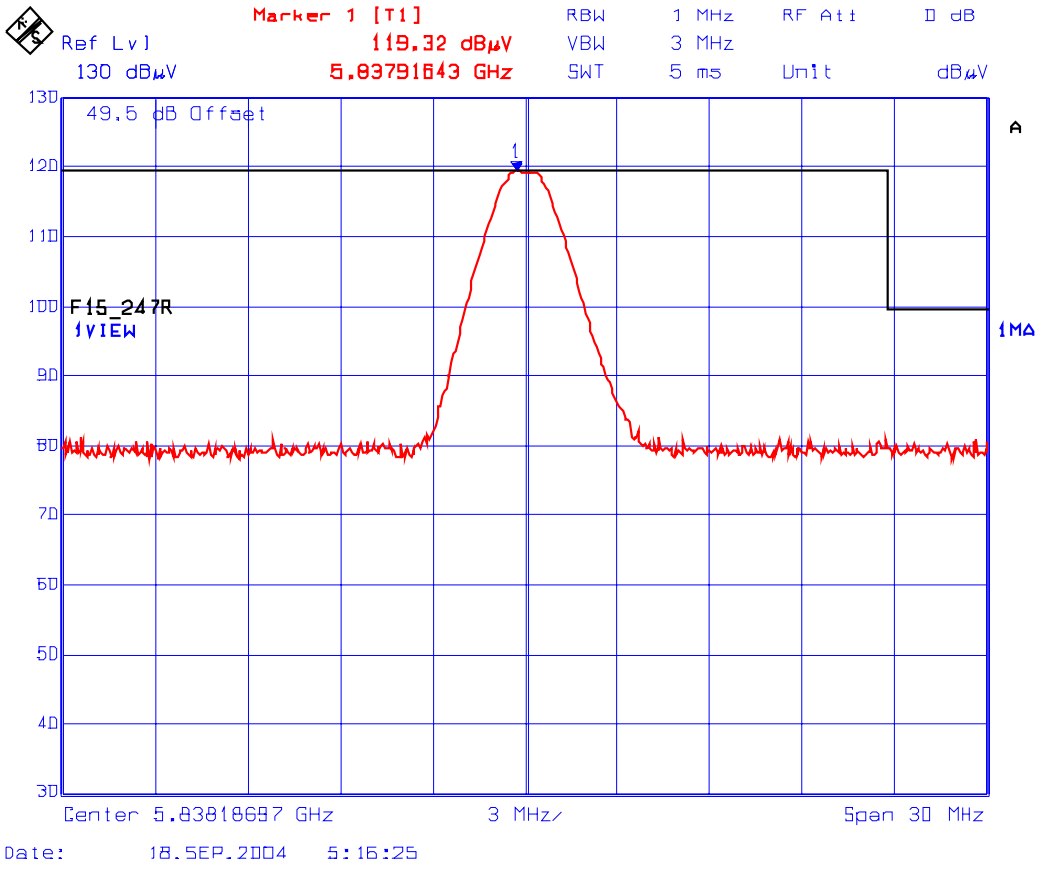
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 64:
Band-Edge RF Radiated Emissions @ 3 meters (Handset)
Low End of Frequency Band
Horizontal Polarization



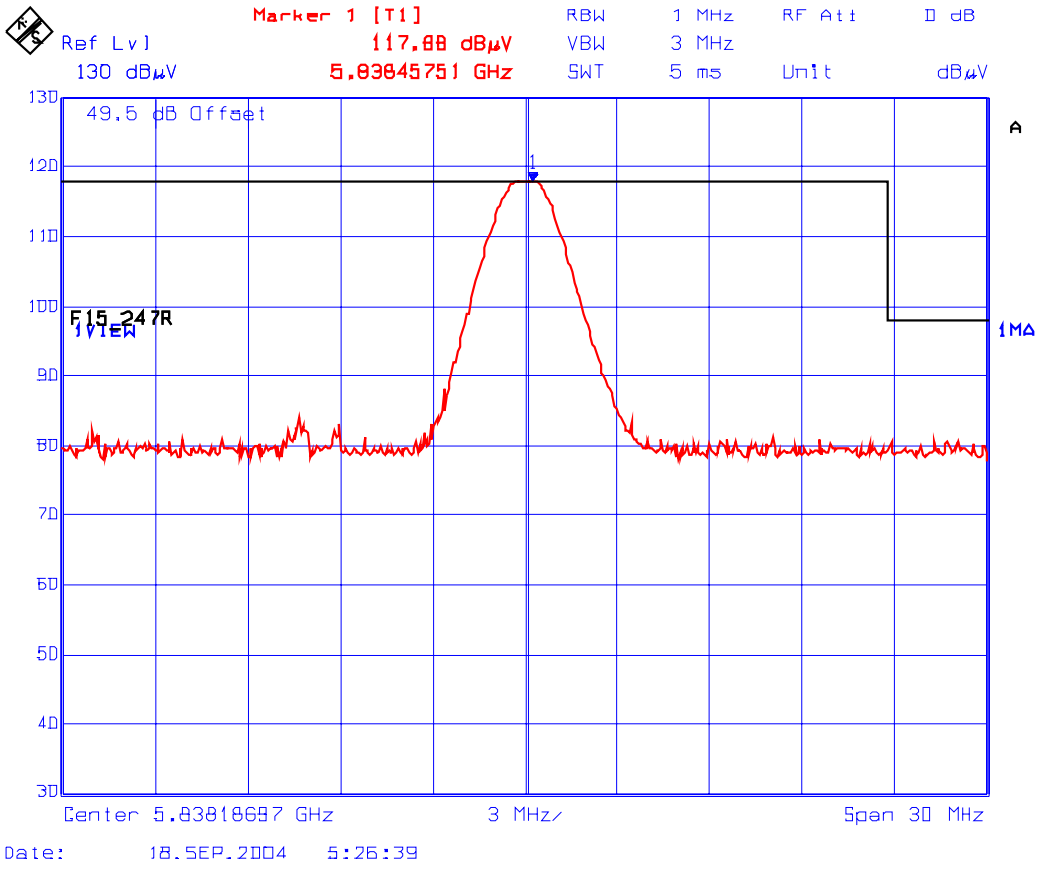
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Plot 65:
Band-Edge RF Radiated Emissions @ 3 meters (Handset)
Upper End of Frequency Band
Vertical Polarization



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

Plot 66:
Band-Edge RF Radiated Emissions @ 3 meters (Handset)
Upper End of Frequency Band
Horizontal Polarization



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

5.11.5.2. Spurious Radiated Emissions @ 3 Meters

Remarks:

1. Test frequency range is from 30 MHz to 40 GHz
2. All spurious emissions and harmonics attenuated less than 20 dB from the limit are recorded.

5.11.5.2.1. 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: 5759.70240 MHz (CH 00)							
5759.70240	121.40	--	V	--	--	--	--
5759.70240	123.16	--	H	--	--	--	--
11519.40480	59.72	44.20	V	54.0	103.2	-9.8	Pass*
11519.40480	59.54	44.38	H	54.0	103.2	-9.6	Pass*
Fundamental Frequency: 5798.05804 MHz (CH 43)							
5798.05084	120.99	--	V	--	--	--	--
5798.05084	124.72	--	H	--	--	--	--
11596.10168	60.46	44.75	V	54.0	104.7	-9.3	Pass*
11596.10168	59.01	44.25	H	54.0	104.7	-9.8	Pass*
Fundamental Frequency: 5838.18697 MHz (CH 88)							
5838.18697	121.27	--	V	--	--	--	--
5838.18697	124.06	--	H	--	--	--	--
11676.37394	58.74	44.48	V	54.0	104.1	-9.5	Pass*
11676.37394	59.05	44.12	H	54.0	104.1	-9.9	Pass*

* Emission inside restricted bands.

5.11.5.2.2. 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: 5759.70240 MHz (CH 00)							
5759.70240	118.28	--	V	--	--	--	--
5759.70240	120.61	--	H	--	--	--	--
11519.40480	58.54	44.01	V	54.0	100.6	-10.0	Pass*
11519.40480	61.00	44.49	H	54.0	100.6	-9.5	Pass*
Fundamental Frequency: 5798.05804 MHz (CH 43)							
5798.05084	118.74	--	V	--	--	--	--
5798.05084	120.10	--	H	--	--	--	--
11596.10168	58.33	43.98	V	54.0	100.1	-10.0	Pass*
11596.10168	61.76	45.08	H	54.0	100.1	-8.9	Pass*
Fundamental Frequency: 5838.18697 MHz (CH 88)							
5838.18697	119.32	--	V	--	--	--	--
5838.18697	117.89	--	H	--	--	--	--
11676.37394	59.77	44.59	V	54.0	99.3	-9.4	Pass*
11676.37394	60.81	44.97	H	54.0	99.3	-9.0	Pass*

* Emission inside restricted bands.

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 Γ_1 = 0.03 LISN VRC Γ_R = 0.8(9 kHz) 0.2 (30 MHz) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

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

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

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

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 shall be performed with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

- 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, 24'(L) x 16'(W) x 8'(H).
- The test was performed were made over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, AC Mains conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlet. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 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 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.

7.3. EQUIVALENT ISOTROPIC RADIATED POWER (EIRP)

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

Test procedure shall be as follows:

Step 1: Duty Cycle measurements

- Using a spectrum analyzer with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;

- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

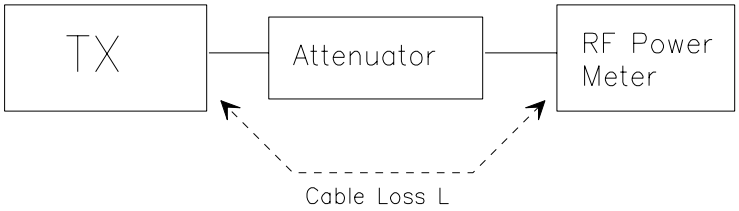
Step 2: Calculation of Peak and Average EIRP

- The peak output power of the transmitter shall be determined using a wideband, calibrated RF Peak Power Meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as “P” (in dBm);

- The Average EIRP shall be calculated from the above measured power output “A”, the observed duty cycle x, and the applicable antenna assembly gain “G” in dBi, according to the formula:

  Peak EIRP = P + G
  Average EIRP = Peak EIRP + 10log(1/x)

Figure 1



Step 3: Substitution Method. See Figure 2

(a) The measurements was performed in the absence of modulation (un-modulated)

(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).

(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)

(d) The dipole test antenna was used and tuned to the transmitter carrier frequency.

(e) The spectrum analyzer was tuned to transmitter carrier frequency. The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.

(f) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.

(g) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.

(h) The substitution dipole antenna and the signal generator replaced the transmitter and antenna under test in the same position, and the substitution dipole antenna was placed in vertical polarization. The test dipole antenna was lowered or raised as necessary to ensure that the maximum signal is stilled received.

(i) The input signal to the substitution antenna was adjusted in level until an equal or a known related level to that detected from the transmitter was obtained in the test receiver. The maximum carrier radiated power is equal to the power supply by the generator.

(j) The substitution antenna gain and cable loss were added to the signal generator level for the corrected ERP level.

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

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

Figure 2

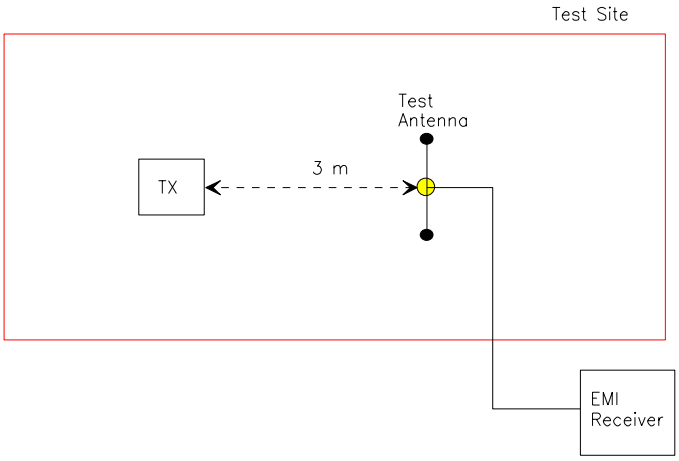
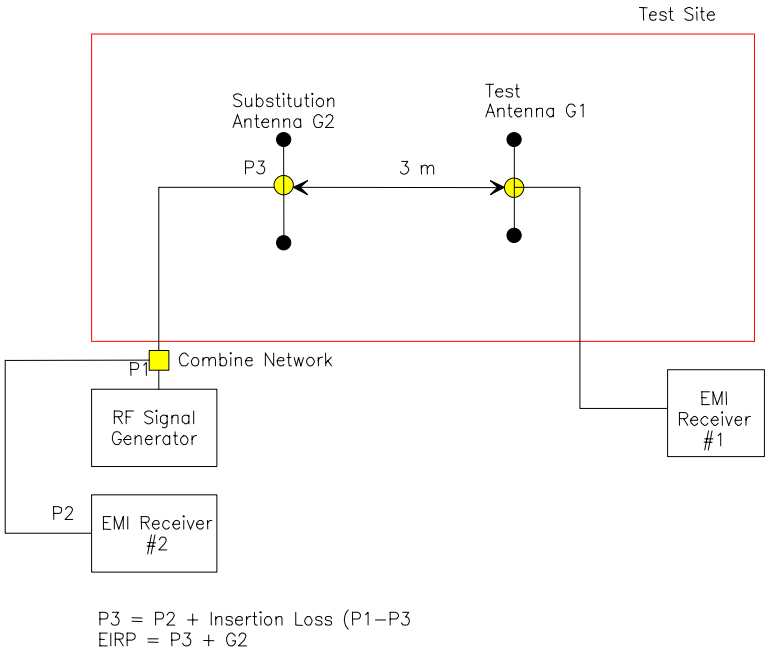


Figure 3



Use the following spectrum analyzer settings:

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

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
- 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

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

Calculation of Field Strength:

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

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

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

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

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

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

Maximizing The Radiated Emissions:

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

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

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

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

  Step 3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

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

  Step 5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

  Step 6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

  Step 7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

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 15.2479(c), use the following spectrum analyzer settings:

- Span = wide enough to fully capture the emission being measured
- RBW = 100 kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Measure the field strength of both the fundamental and all spurious emissions with these settings.
- Follow the procedures C63-4-1992 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