EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement:	Federal Communications Commissions Industry Canada
Test Requirements:	15.205, 15.207, 15.209, 15.247 RSS-210
Applicant:	Invensys Metering Systems
FCC ID:	KCH-XEMICS-BAT

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Invensys FCC ID: KCH-XEMICS-BAT is a limited modular hybrid FHSS/DTS transceiver operating at 902-928 MHz, used with Invensys power meters and other energy management products.

Transmitter Specification

Supply Voltage	2.4v – 3.6v
Current	69mA
TX Power	13dBm (nom.)
Frequency Deviation (FSK)	+/- 40 kHz (narrow band) +/- 250 kHz (wide band)
Centre Frequency Error	+15 / -25 kHz
Frequency of operation	905.2 – 924.8 MHz
Data Rate	19.2 kbps
Data Format	NRZ
Number of channels (see hop tables)	50 (narrow band) 4 (wide band)
Channel Separation	400 kHz (narrow band) 5 MHz (wide band)
20dB occupied bandwidth	130 kHz (narrow band) 620 kHz (wide band)
6dB occupied bandwidth	550 kHz (wide band)
Temperature Range	-40°C to +85°C

III . TEST PROCEDURE REFERENCE

Testing was performed in accordance to the requirements of the following published test procedures /standards, unless otherwise indicated:

ANSI C63.4	Radiated emissions, 30 – 40,000 MHz AC line conducted emissions, 0.150 – 30 MHz
FCC Public Notice 97-114	Guidance on Measurements for Direct Sequence Spread Spectrum Systems
FCC Public Notice DA00-705	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

IV. TEST LOCATION

All tests except channel occupancy tests were performed at

Compliance Certification Services
561F Monterey Road
Morgan Hill, CA 95037

Channel occupancy tests were performed by Invensys Metering Systems.

T.N. Cokenias 8 October 2003
EMC Consultant/Agent for Invensys

15.203 Antenna connector requirement

The antenna is permanently attached to the product. Antenna gain figures are found in Operational Description (separate attachment). Maximum peak antenna gain is 5.6 dBi.

15.204 Antenna description

The transceiver module uses a printed circuit board antenna.
Measured antenna data and radiation patterns are presented in Operational Description (separate attachment). Maximum peak antenna gain is 5.6 dBi

15.247(a) Frequency hopping spread spectrum definition

Pseudorandom frequency hopping sequence:

The transmitter cannot coordinate its hopping sequence with the hopping sequence of other transmitters, or vice versa, for the purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters

Each access unit has an individual ID number and there is no link or association between two access units so there is no simultaneous occupancy of individual hopping frequency transmission of two or more access units.

Equal hopping frequency use:

The EUT utilizes 50 hopping channels. Hopset is 50 channels long, then repeats. On average all channels are used equally.

System receiver input bandwidth and receiver hopping capability:

Receiver 26 dB bandwidth is 200 kHz, approximately equal to 26 dB bandwidth of TX. Receiver channel hops are synchronized to transmitter operating frequency.

15.247(f) Hybrid Systems

Wideband Mode

In addition to frequency hopping operation, the EUT has a wideband DTS mode. Each channel is approximately 550 kHz wide. The wideband channels hop in such a way that maximum channel occupancy is approximately 200 msec in any 20 second period. Power spectral density is less than 8 dBm/3kHz.

TEST DATA and TEST PROCEDURES - CCS Laboratory

Radiated Emissions
Test Requirement: 15.205, 15.247

Out of Band Measurements
Test Requirement: 15.247

Measurement Equipment Used:

Agilent E4446A Spectrum analyzer
Miteq NSP2600-44 Microwave pre-amplifier, 1-26.5 GHz
EMCO 3115 Double Ridged Horn antenna, 1 - 18 GHz

Radiated emissions generated by the transmitter portion of the EUT were measured.

1. The EUT was placed on a wooden table resting on a turntable in the anechoic chamber. The EUT was configured in the "X" orientation as shown in attached test setup photographs. The search antenna was placed 3m from the EUT.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Radiated emissions were investigated for a LOW channel, a MID channel, and HIGH channel. Emissions were investigated to the 10^{th} harmonic.

4. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations.

5. Steps (2) through (4) above were repeated with the EUT in the "Y" and "Z" orientations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst case results are presented. Refer to data sheets in separate attachments. Restricted band emissions meet 54 dBuV/m. Other undesired emissions from the transmitter meet the -20 dBc requirement in 15.247(c).

Radiated Emissions
Test Requirement: 15.109

Measurement Equipment Used:

HP 8542E EMI Receiver, 9kHz-2.9 GHz
Schaffner/Chase CBL6112B Bilog Antenna, 30 - 2000 MHz

Radiated emissions below 1 GHz and those generated by the digital portion of the EUT were measured.

1. The EUT was placed on a wooden table resting on a turntable in the anechoic chamber. The search antenna was placed 3m from the EUT. The EUT antenna was mounted vertically as per normal installation. The EUT was set to transmit continuously .

2. Measurement software was activated and results plotted.

Test Results: Worst case results are presented. Refer to data sheets in separate attachment.

NOTE: Data sheets show two frequencies over FCC class B limit:

934.040 MHz – This is fundamental frequency of 924.8 MHz
(data capture software frequency accuracy not sufficient)

895.240 MHz – Transmitter L.O. of 885.8 MHz (924.8MHz – 39 MHz).
(data capture software frequency accuracy not sufficient)

The L.O. emission from the transmitter portion is more than –20dB below highest in-band emission, per 15.247c. Fundamental field strength = 115.2 dBuV/m (off scale), consistent with predicted field strength for 13.9dBm into 5.6 dBi antenna.

AC Line Conducted Emissions
Test Requirement: 15.107, 15.207

Measurement Equipment Used:

Rohde & Schwarz EMI Receiver ESHS-20
Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

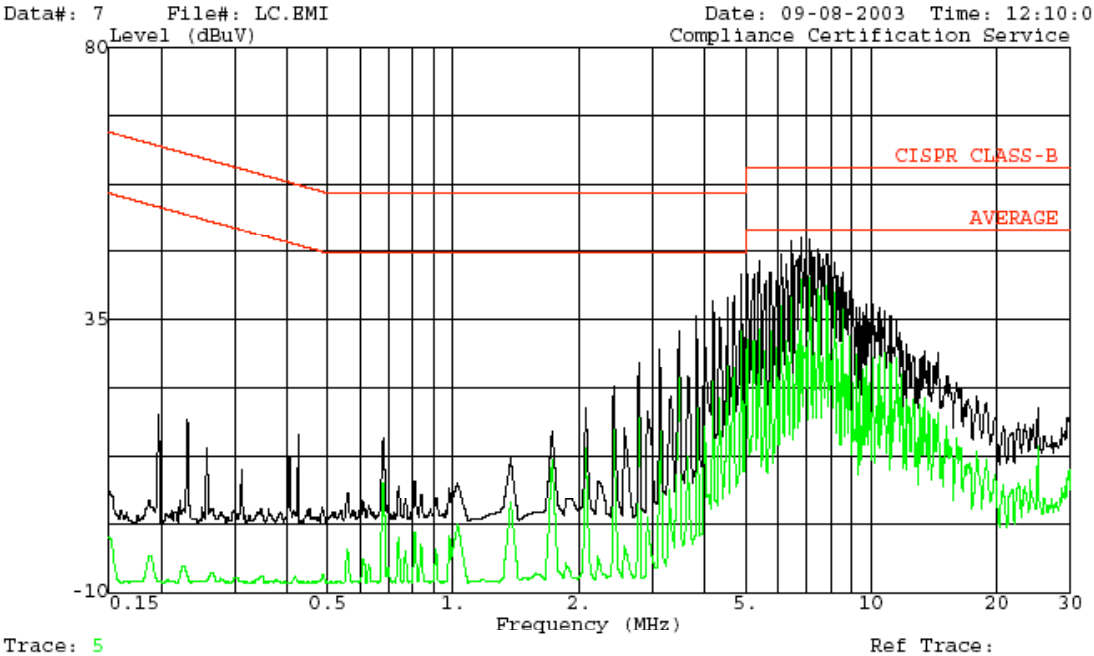
Test Procedure

1. The EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The EUT was set to transmit in normally.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

Test Results

PASS. Refer to data sheet below.

COMPLIANCE Engineering Service, Inc.
561F Monterey Road,
San Jose, CA 95037 USA
Tel: (408) 463-0885
Fax: (408) 463-0888



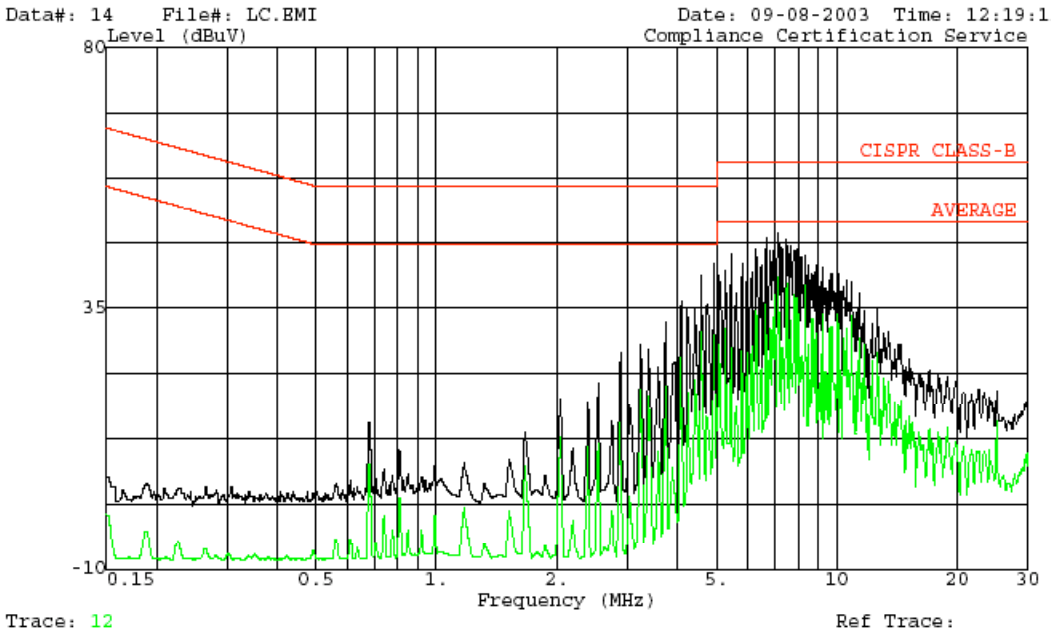
Trace: 5 Ref Trace:

Project #	:	03U2216-1
Test Engineer	:	William Zhuang
Company	:	Invensys
EUT	:	902-928 MHz DTS Device
Model	:	Energy Management System
S/N	:	N/A
Configuration	:	EUT/ support Equipment
Mode of Operation	:	TX
Target of Test	:	FCC-B
Voltage	:	115VAC/60Hz

[1]. Peak (Black) AVG (Green)

COMPLIANCE Engineering Service, Inc.
FCC,VCCI,IC,NEMKO,TUV
UL,CSA,TUV

561F Monterey Road,
San Jose, CA 95037 USA
Tel: (408) 463-0885
Fax: (408) 463-0888



Trace: 12 Ref Trace:

Project #	:	03U2216-1
Test Engineer	:	William Zhuang
Company	:	Invensys
EUT	:	902-928 MHz DTS Device
Model	:	Energy Management System
S/N	:	N/A
Configuration	:	EUT/ support Equipment
Mode of Operation	:	TX
Target of Test	:	FCC-B
Voltage	:	115VAC/60Hz
	:	L2: Peak (Black), AVG (Green)

Maximum 20 dB Bandwidth for FHSS
Test Requirement: 15.247(a)(1)

The EUT is capable of operation as a narrowband FHSS transceiver. In narrowband, 50 hopping channels of approximately 140 kHz bandwidth are used in a pseudorandom hopping sequence. Channels are separated by 400 kHz.

Measurement Equipment Used:

Agilent E4446A Spectrum Analyzer
3' length cable attached to antenna connector

Test Procedures

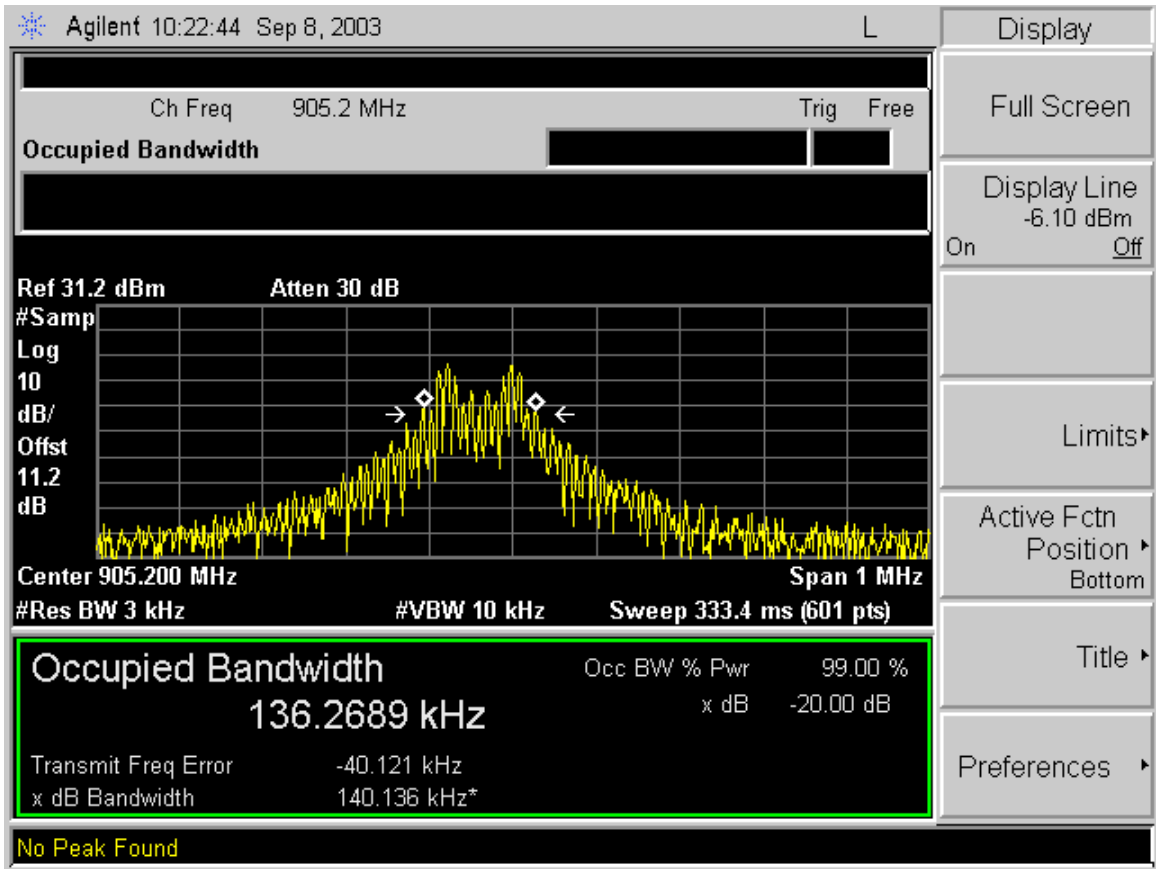
A board was specially modified with a coaxial antenna connector for direct connection to the spectrum analyzer.

The EUT was configured on a test bench. The EUT's hopping function was stopped, transmission was continuous at 915 MHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer OCCUPIED BANDWIDTH function was used to capture the envelope of the transmission occupied bandwidth.

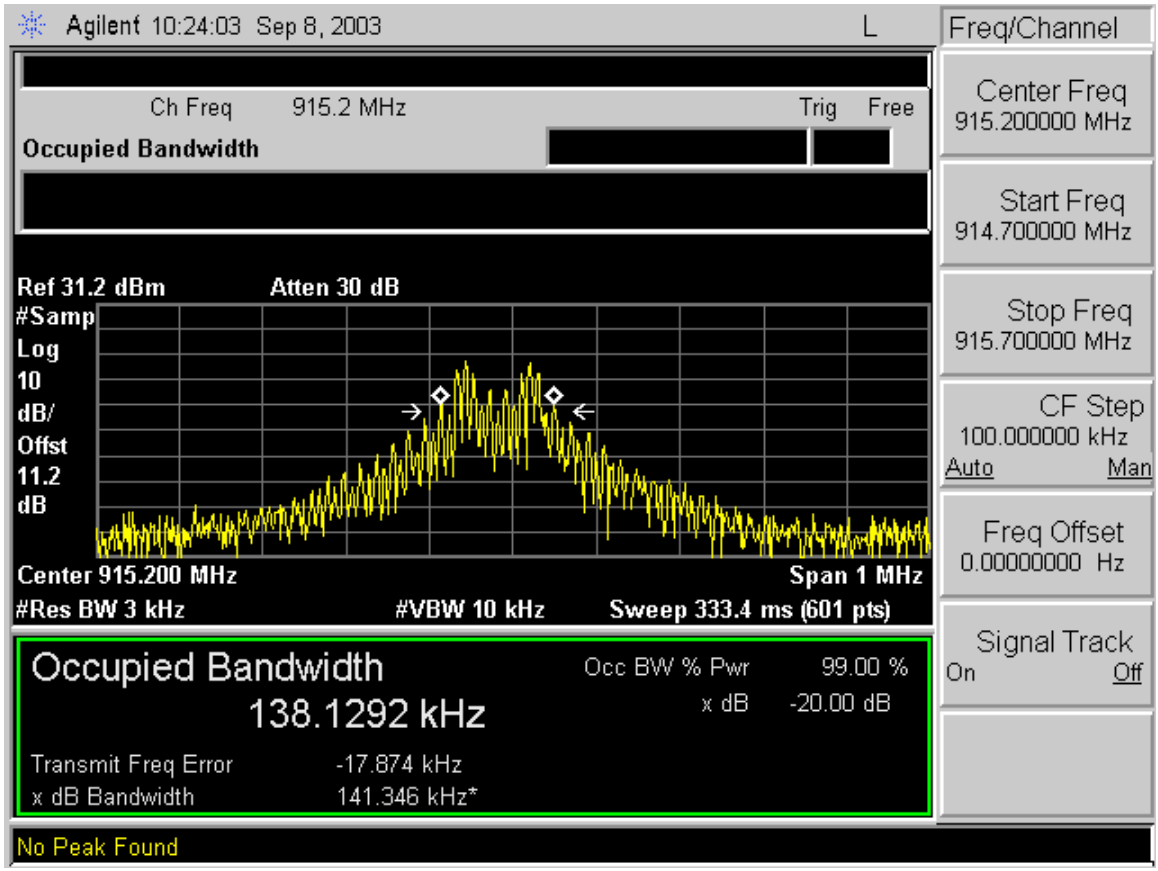
Test was repeated for MID and HIGH channels.

Test Results: Approximately 136 kHz, design goal 140 kHz. Refer to data plots below.

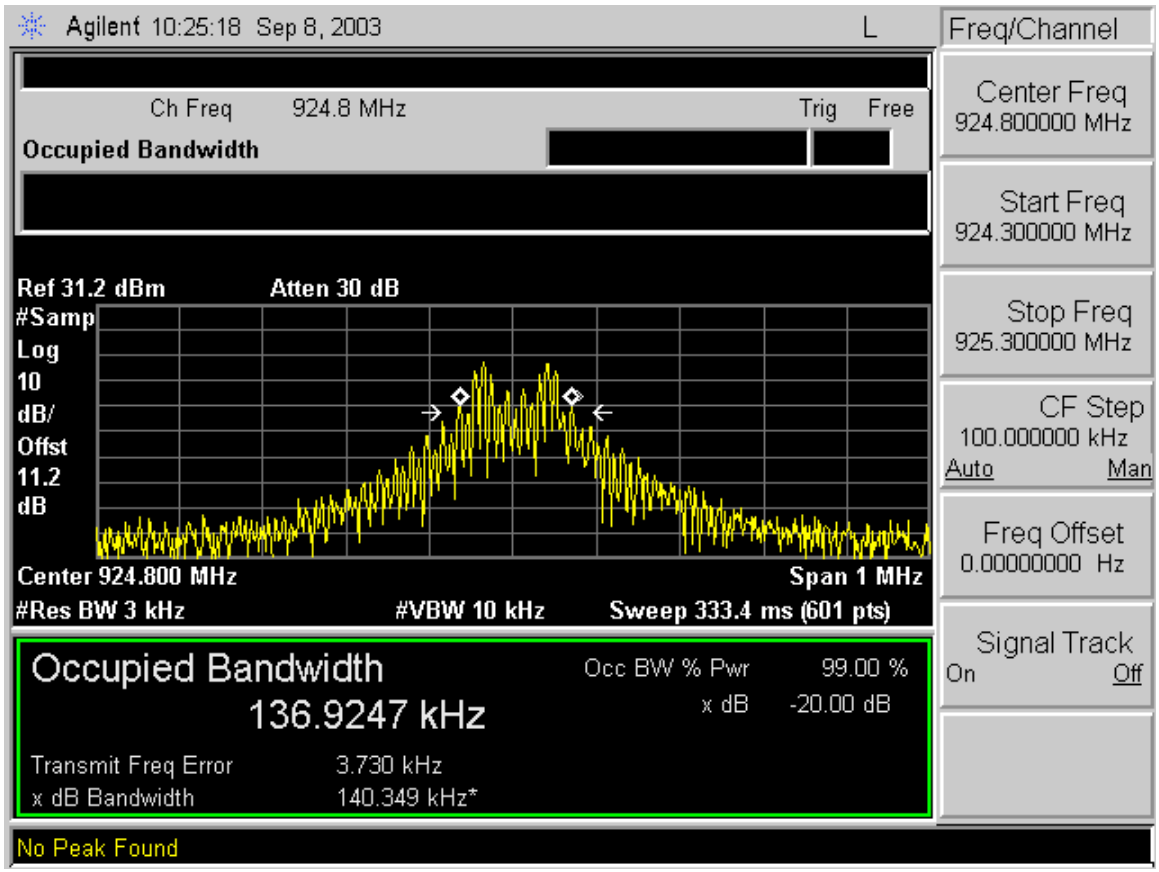
15.247(a)(1) Maximum 20 dB Narrowband Channel Bandwidth LOW channel



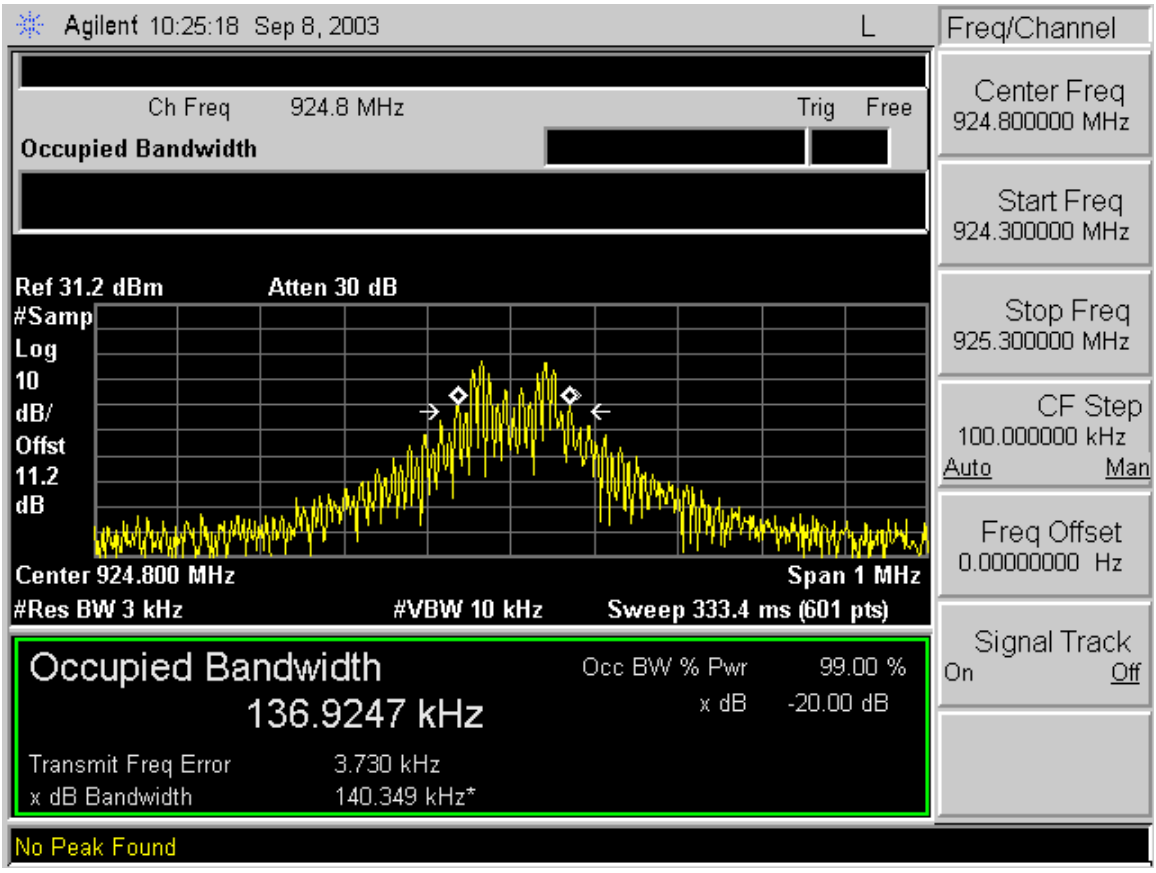
15.247(a)(1) Maximum 20 dB Narrowband Channel Bandwidth MID channel



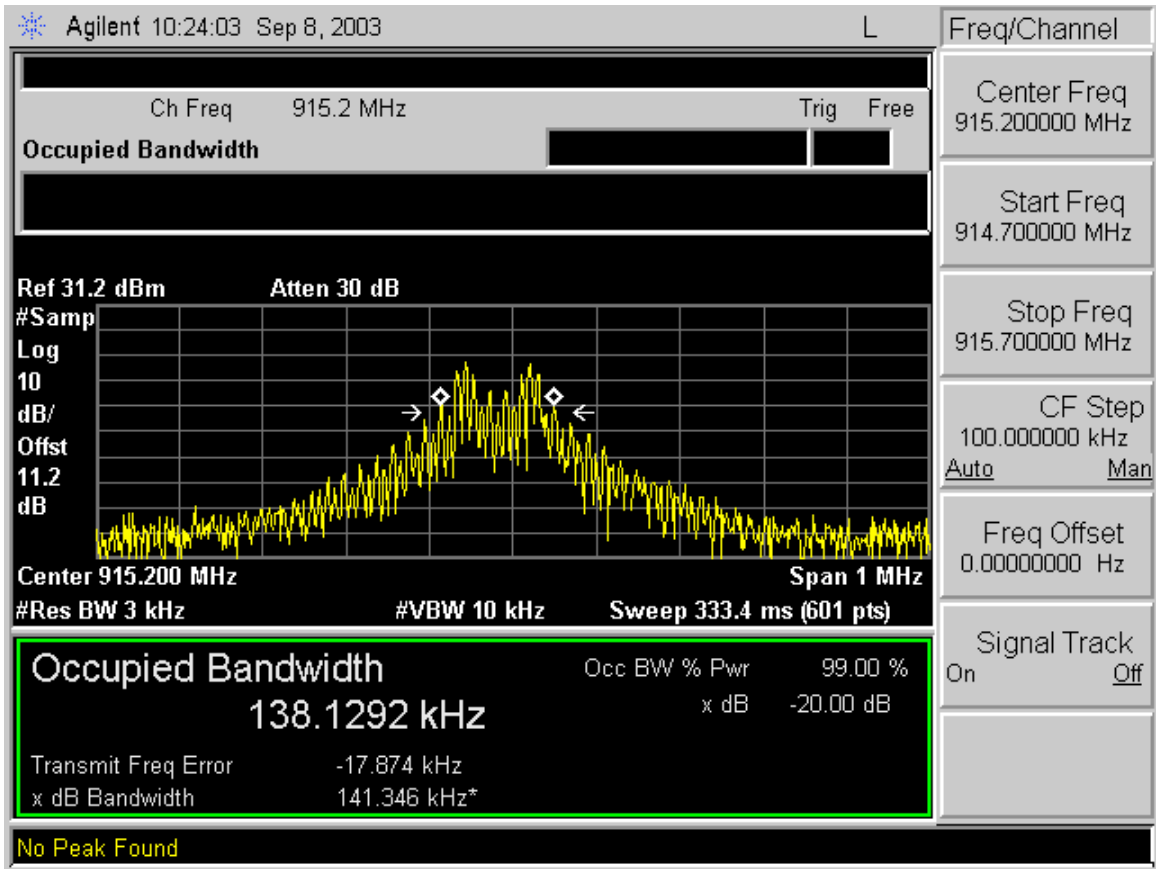
15.247(a)(1) Maximum 20 dB Narrowband Channel Bandwidth HIGH channel



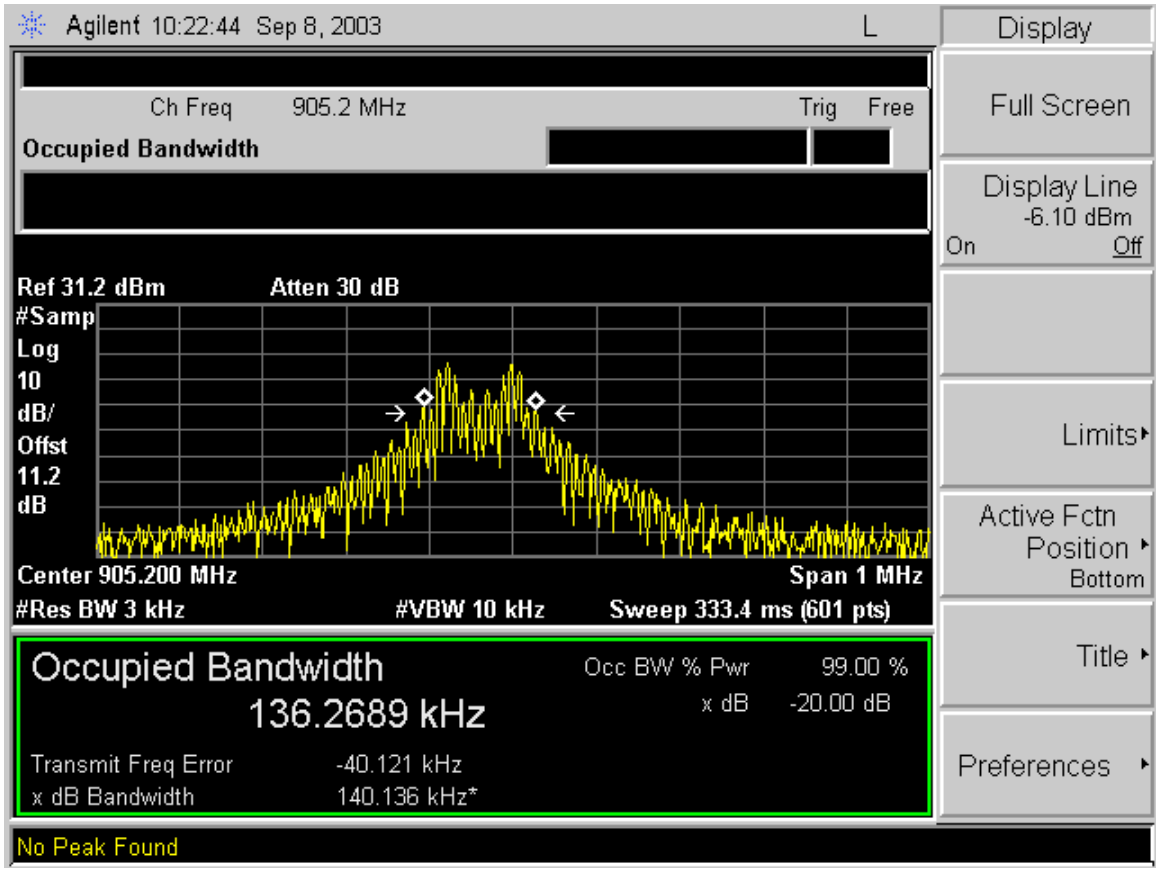
Industry Canada RSS 210:
99% Occupied Bandwidth Narrowband HIGH channel



Industry Canada RSS 210:
99% Occupied Bandwidth Narrowband MID channel



Industry Canada RSS 210:
99% Occupied Bandwidth Narrowband LOW channel



Minimum 6 dB Bandwidth for DTS
Test Requirement: 15.247(a)(2)

In wideband mode, the EUT uses 4 channels with a 6 dB bandwidth of approximately 550 kHz. The EUT can also be programmed to hop among channels.

NOTE: Test data was originally taken for 20 dB and 99% BW. The 6 dB bandwidth information was added to the original plots using graphical techniques.

Measurement Equipment Used:

Agilent E4446A Spectrum Analyzer
3' length cable attached to antenna connector

Test Procedures
A board was specially modified with a coaxial antenna connector for direct connection to the spectrum analyzer.

The EUT was configured on a test bench. The, transmission was continuous at 915 MHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer captured the envelope of the transmission occupied bandwidth.

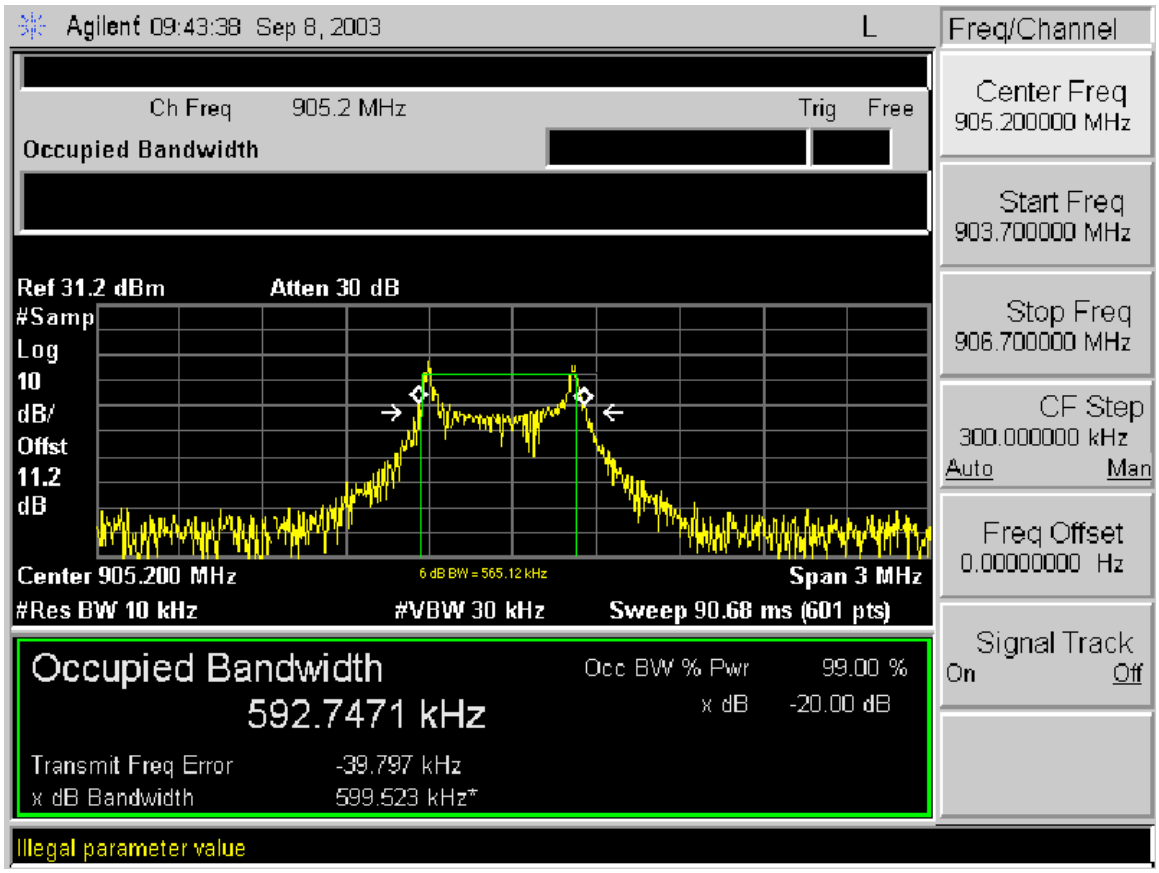
Test was repeated for MID and HIGH channels.

Test Results:

Minimum 6 dB BW:

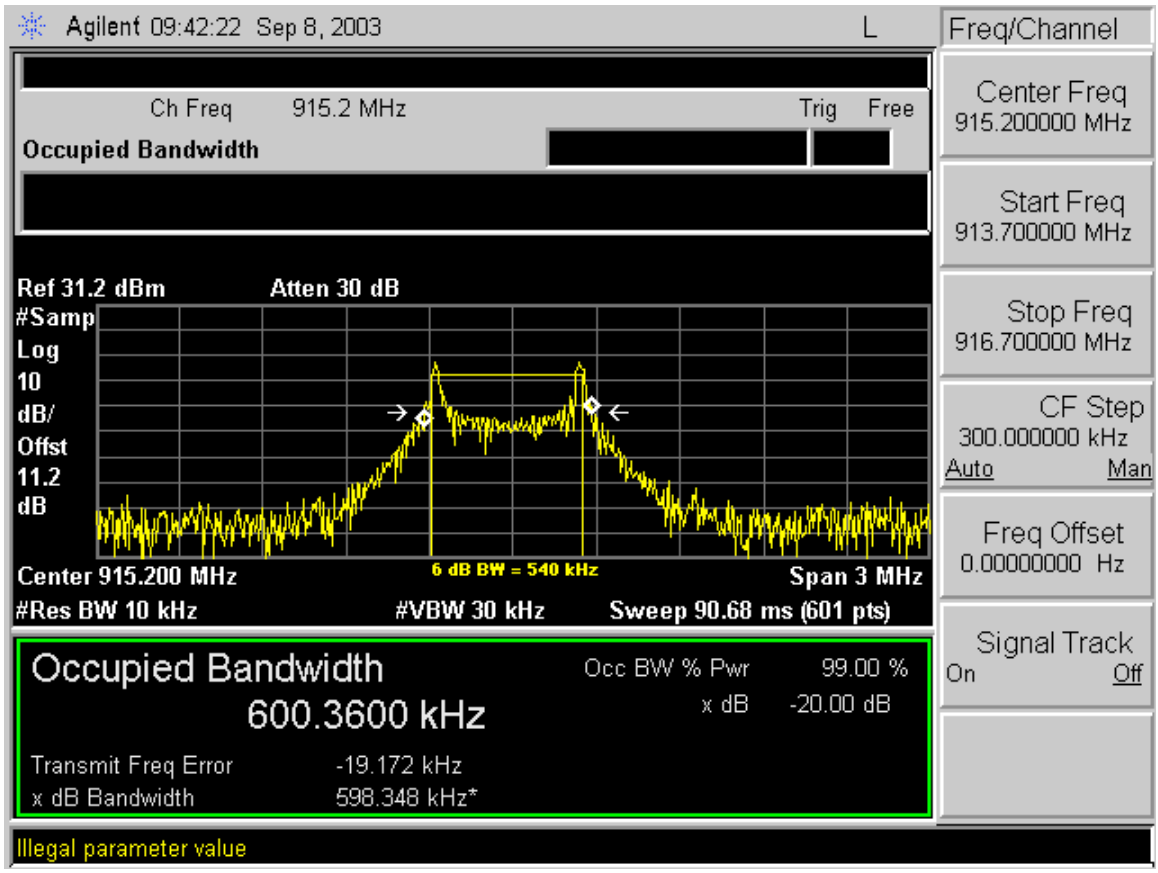
Approximately 545kHz, design goal 550 kHz. Refer to data plots below.

15.247(a)(2) Minimum 6 dB DTS Bandwidth, LOW channel



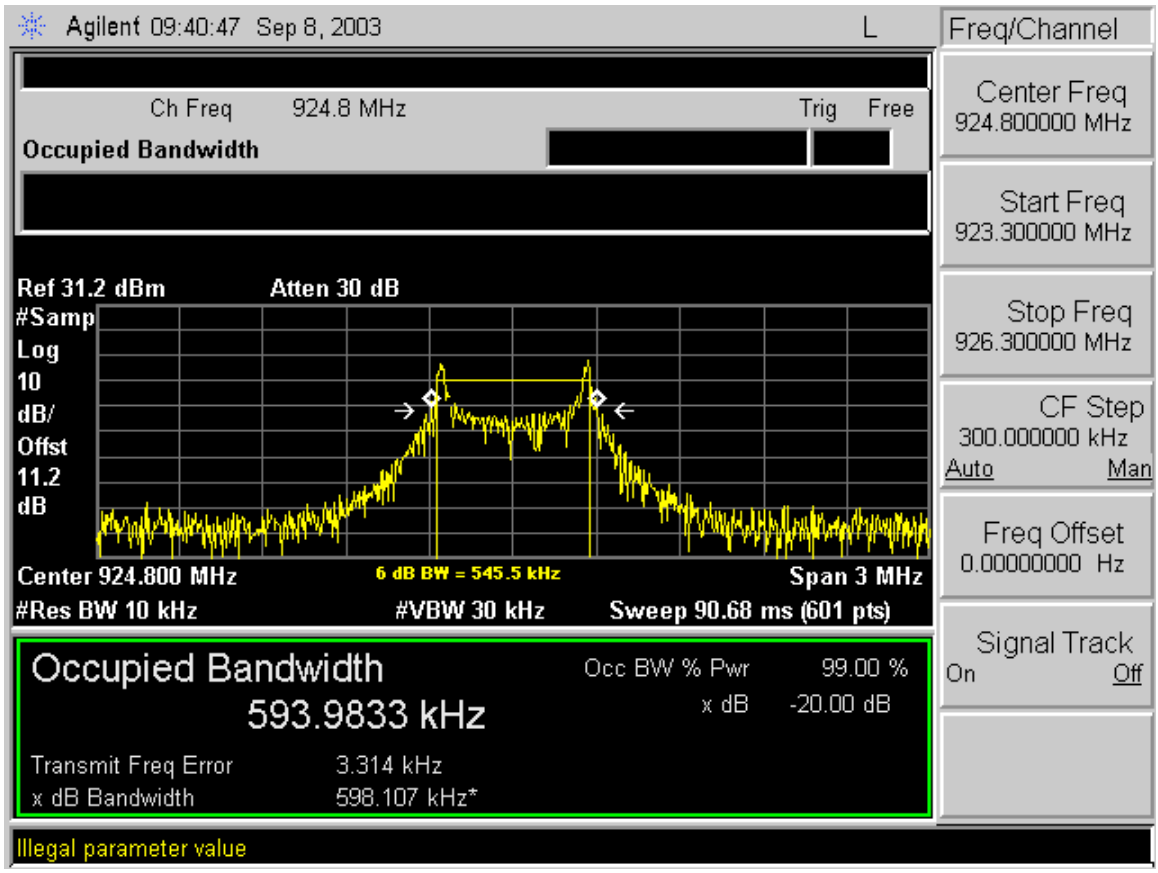
6 dB BW = 565.12 kHz

15.247(a)(2) Minimum 6 dB DTS Bandwidth, MID channel



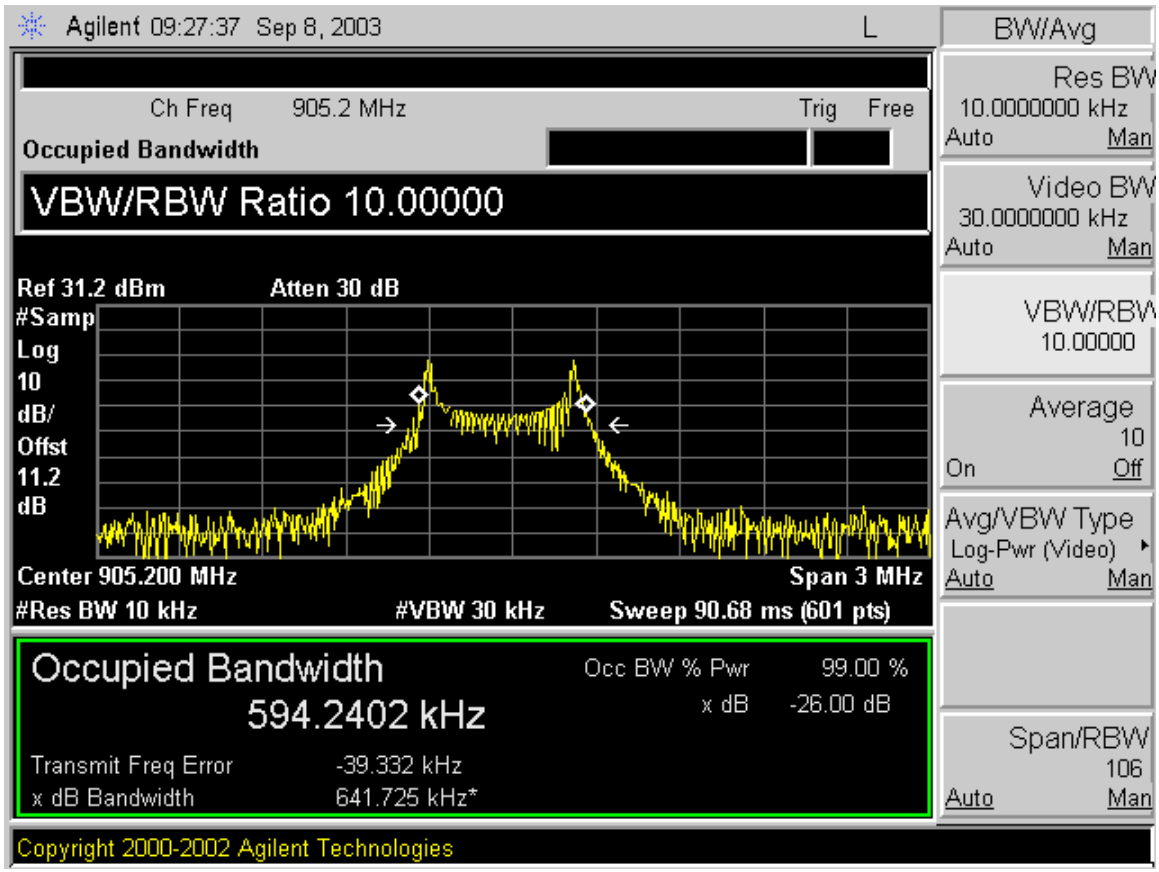
6 dB BW = 540 kHz

15.247(a)(2) Minimum 6 dB DTS Bandwidth, HIGH channel

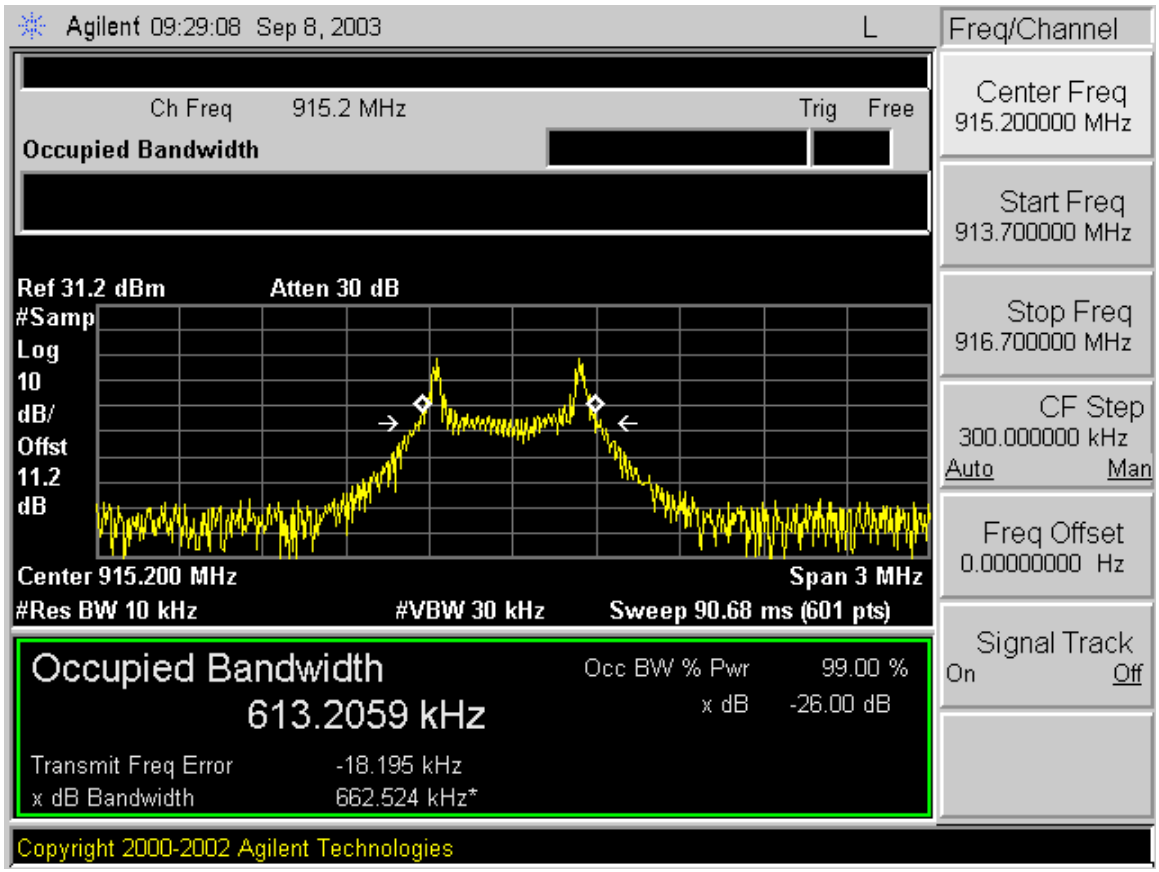


6 dB BW = 545.5 kHz

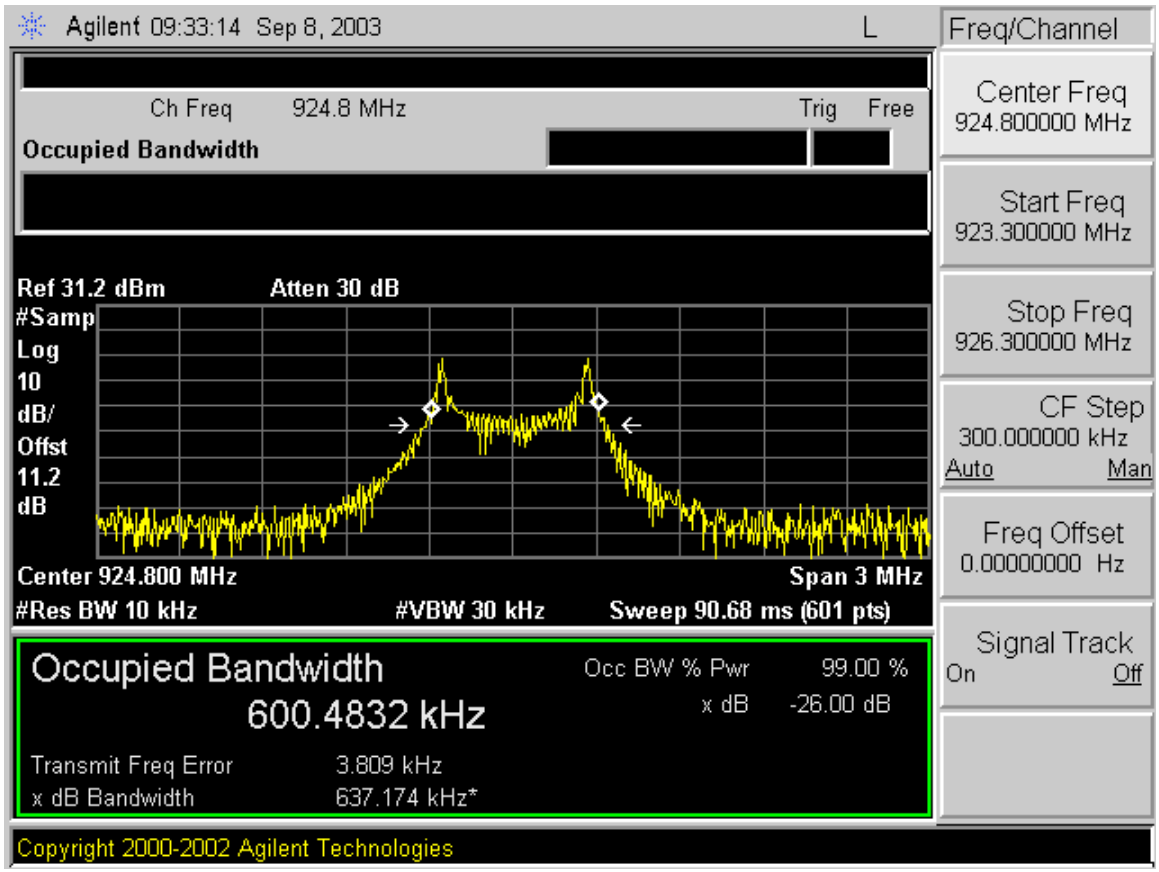
Industry Canada RSS 210:
99% Occupied Bandwidth Wideband LOW channel



Industry Canada RSS 210:
99% Occupied Bandwidth Narrowband MID channel



Industry Canada RSS 210:
99% Occupied Bandwidth Narrowband HIGH channel



RF Power Output
Test Requirement: 15.247(b)(2),(3)

Measurement Equipment Used:

Agilent E4416A power meter
Agilent E9327A peak power sensor

Test Procedures

A board was specially modified with a coaxial antenna connector for direct connection to the power meter head via an SMA adapter. Peak power was measured directly . Peak power measurements were performed for both narrowband and wide band modulation.

Test Results

Channel No.	Frequency	P dBm, NB	P dBm, WB
1	905.2	13.5	13.9
26	915.2	13.7	13.7
50	924.8	13.9	13.9

Minimum Number of Hopping Channels
Test Requirement: 15.247(a)(1)(ii)

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
3' low loss cable

Test Procedures

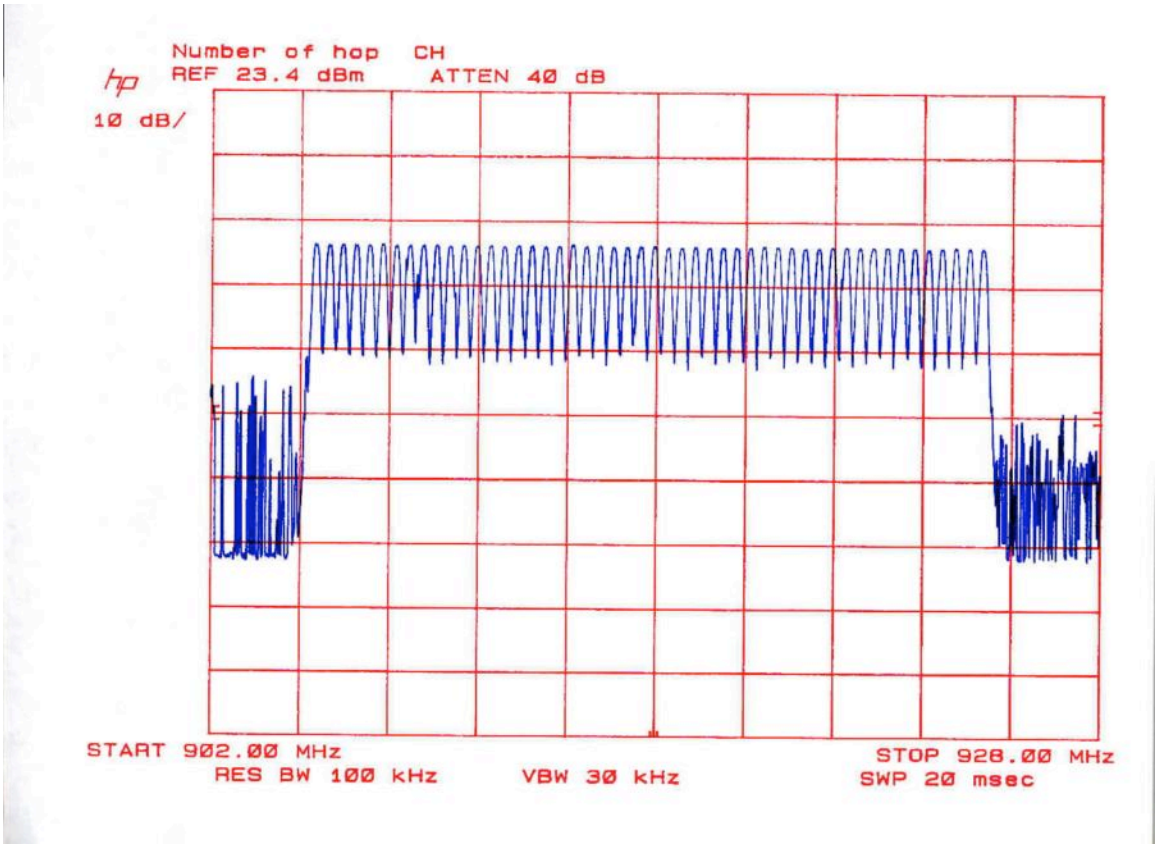
A board was specially modified with a coaxial antenna connector for direct connection to the spectrum analyzer.

1. The EUT was configured on a test bench. The EUT's hopping function was activated.
2. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the emissions over a 3 minute period.

Test Results

A total of 50 hopping channels were counted. This corresponds to design. Refer to attached data sheet.

15.247(a)(1)(ii) Minimum number of hopping channels



Channel separation: 400 kHz (minimum separation = 25 kHz or 20 dB BW)

Maximum channel occupancy
Test Requirement: 15.247(a)(2)

In wideband DTS mode, the EUT uses 4 channels with a 6 dB bandwidth of approximately 540 kHz. The EUT can also be programmed to hop among channels.

NOTE: Test data was originally taken for 20 dB and 99% BW. The 6 dB bandwidth information was added to the original plots using graphical techniques.

Measurement Equipment Used:

HP 8563 Spectrum Analyzer (Invensys)
3' length cable attached to antenna connector

Test Procedures

A board was specially modified with a coaxial antenna connector for direct connection to the spectrum analyzer.

The EUT was configured on a test bench. The, transmission was continuous at 915.2 MHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer captured the envelope of the transmission occupied bandwidth.

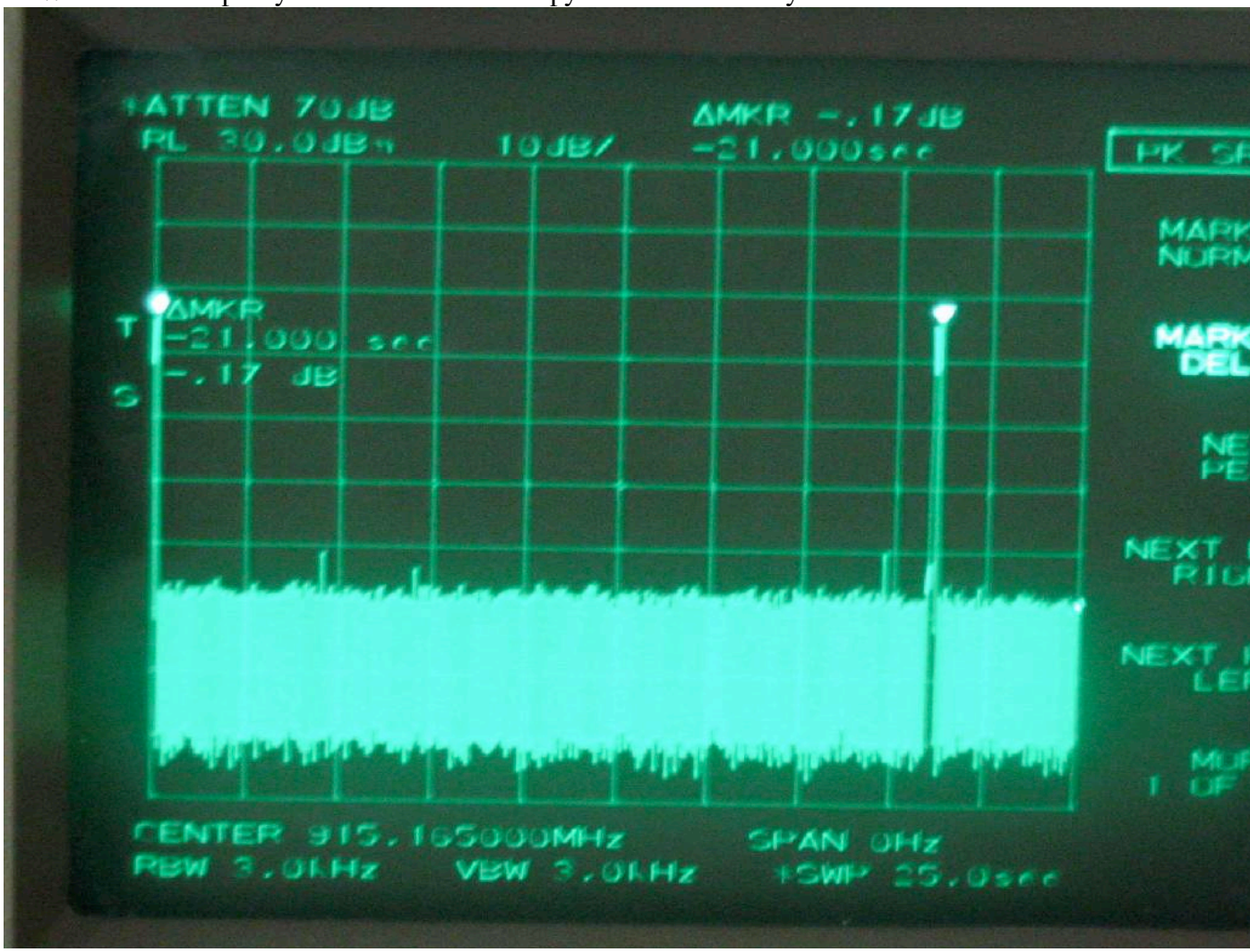
Test was repeated for MID and HIGH channels.

Test Results:

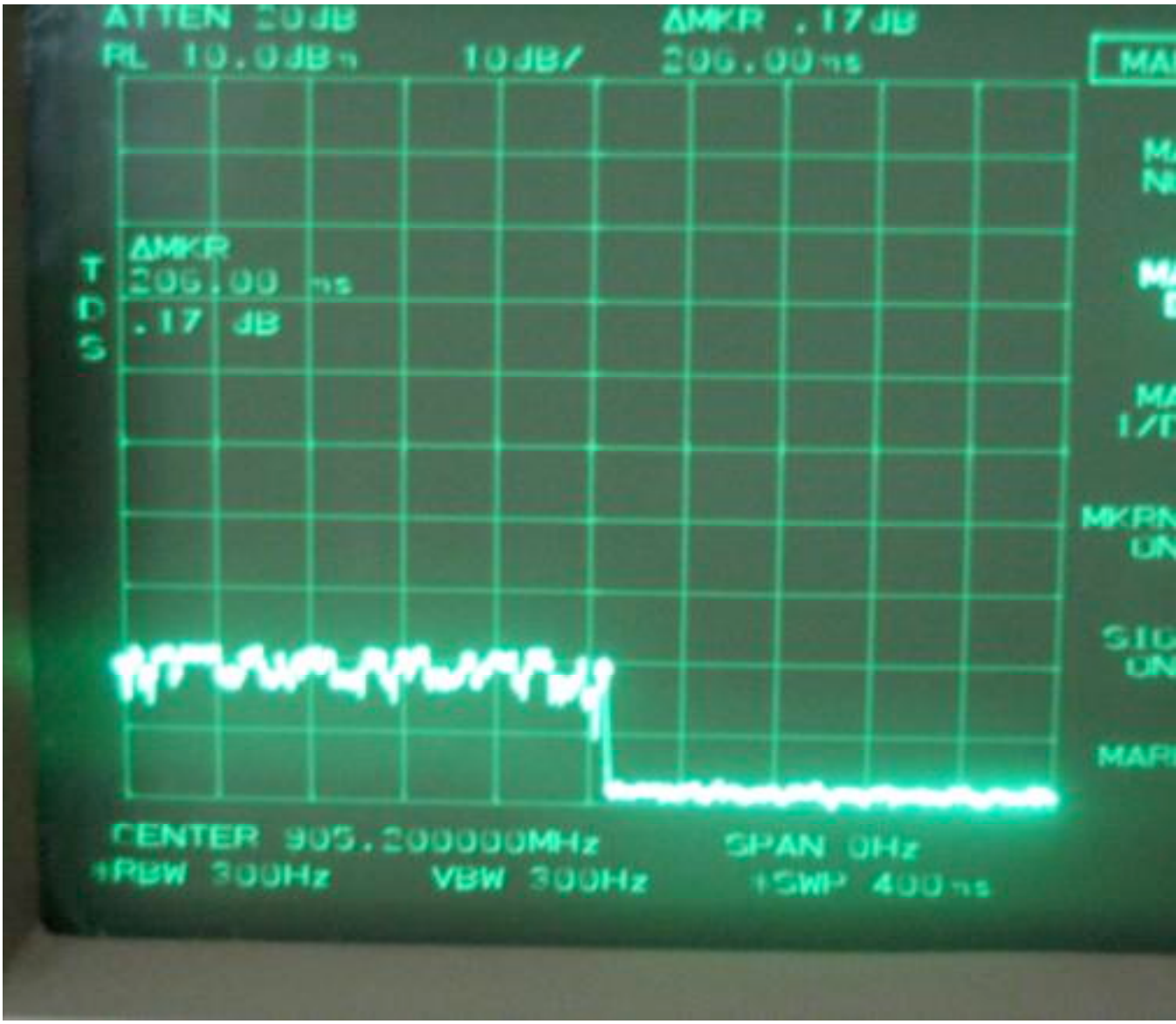
Worst case occupany: 206 msec in 20 seconds
Limit: 400 msec max occupancy in 20 seconds.

Refer to attached data plots.

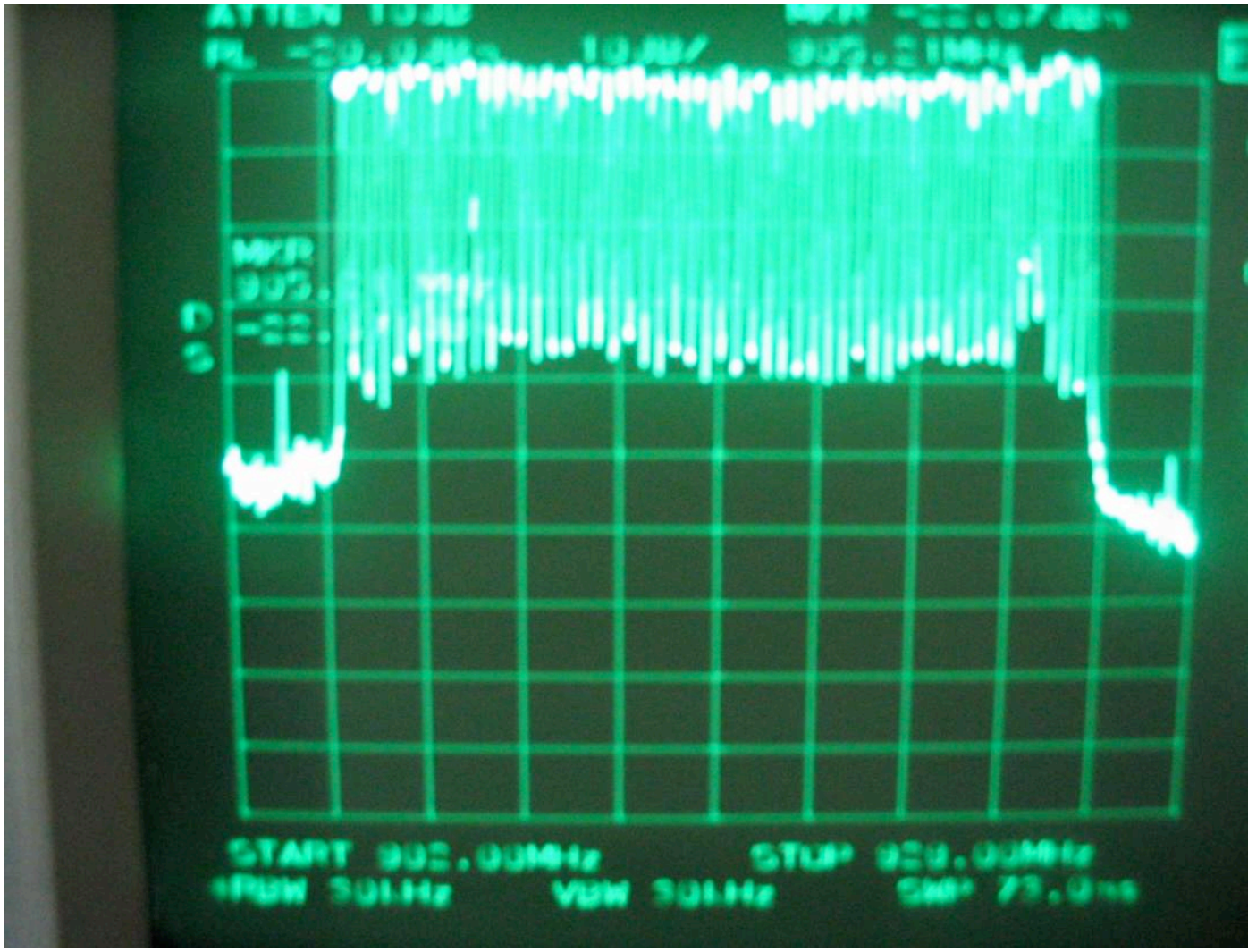
1. Worst case occupancy. Transmitter will occupy each channel every 21 seconds.



2. Maximum occupancy of any individual channel is 206 mS.



3. 50 Channels are used starting at 905.2 MHz, spaced by 400kHz.



15.247(d) Power Spectral Density (Wideband DTS)

In wideband DTS mode, the EUT uses 4 channels with a 6 dB bandwidth of approximately 540 kHz.

Measurement Equipment Used:

Agilent E4446A Spectrum Analyzer
3' length cable attached to antenna connector

Test Procedures

A board was specially modified with a coaxial antenna connector for direct connection to the spectrum analyzer.

The EUT was configured on a test bench. The, transmission was continuous at 915.2 MHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer captured the maximum PSD in 3 kHz BW.

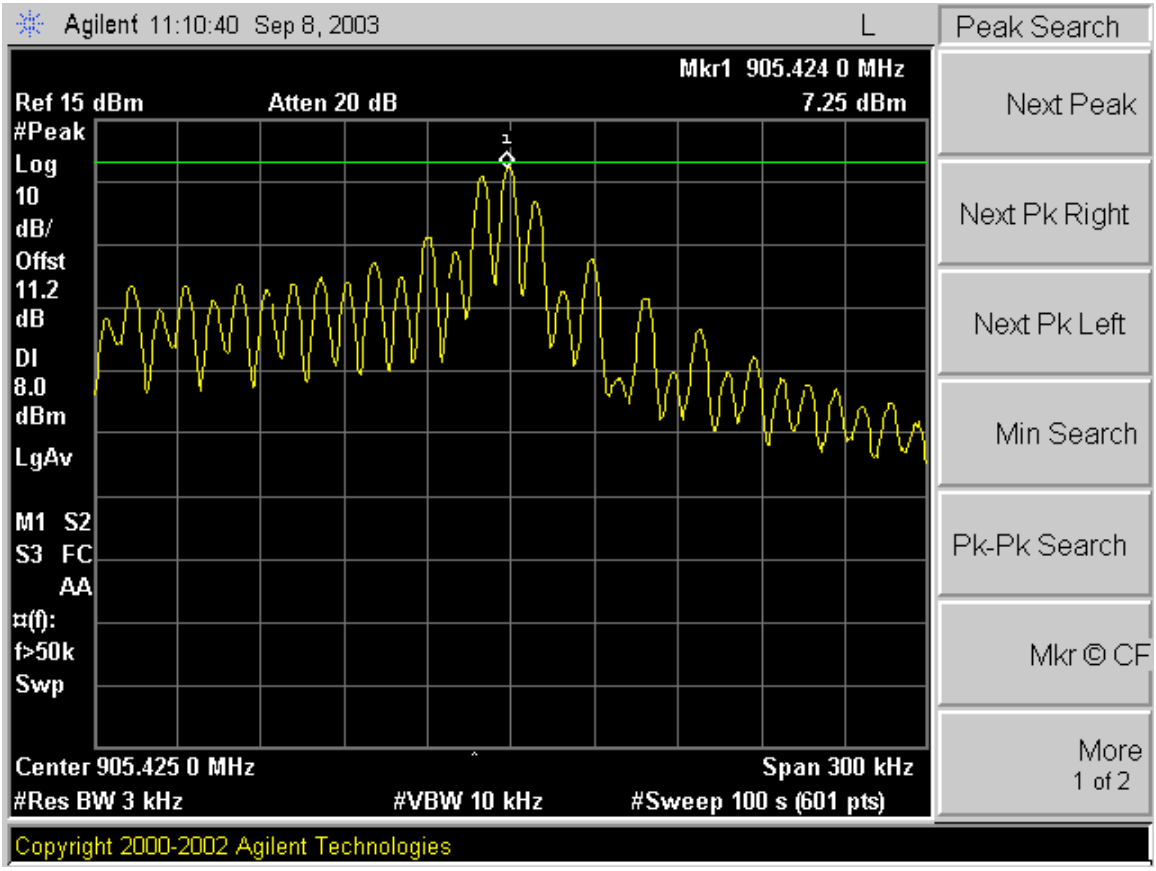
Test was repeated for MID and HIGH channels.

Test Results:

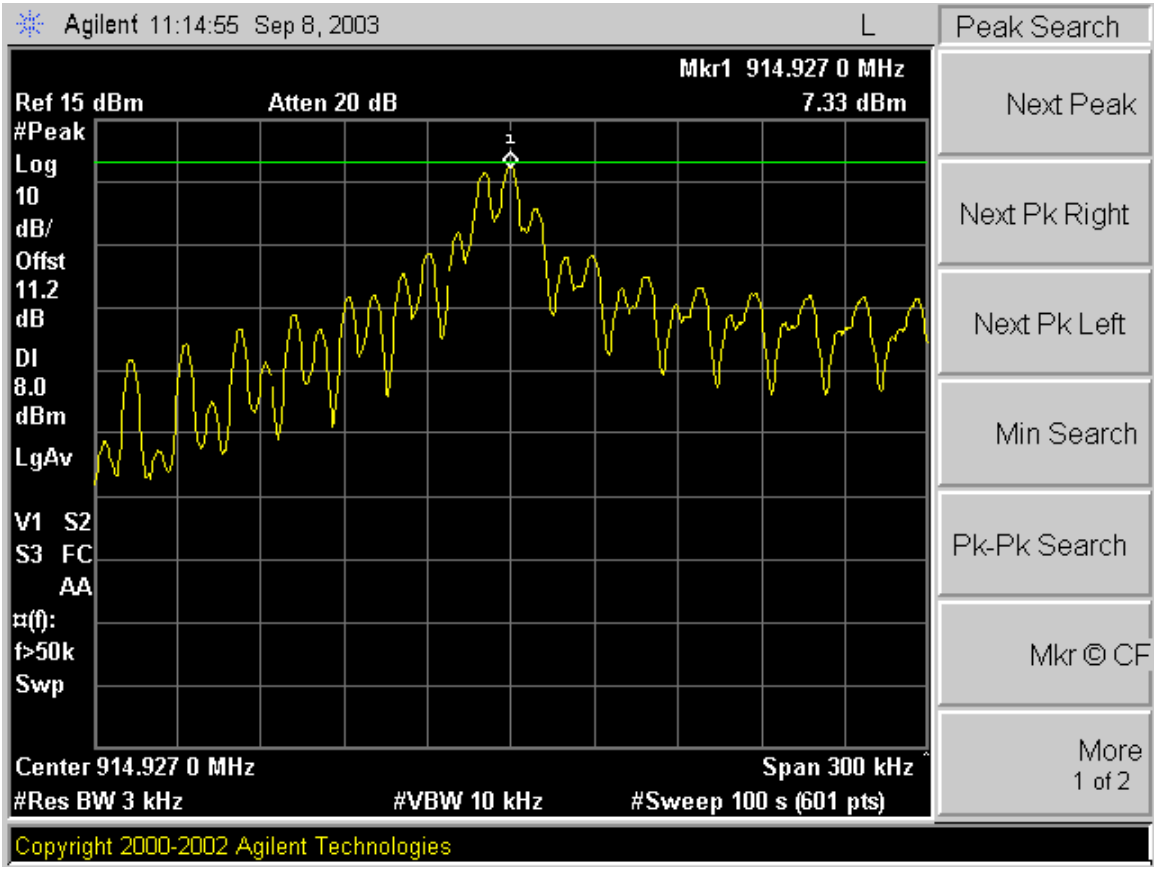
Worst case 7.33 dBm
Limit: 8 dBm max

Refer to attached data plots.

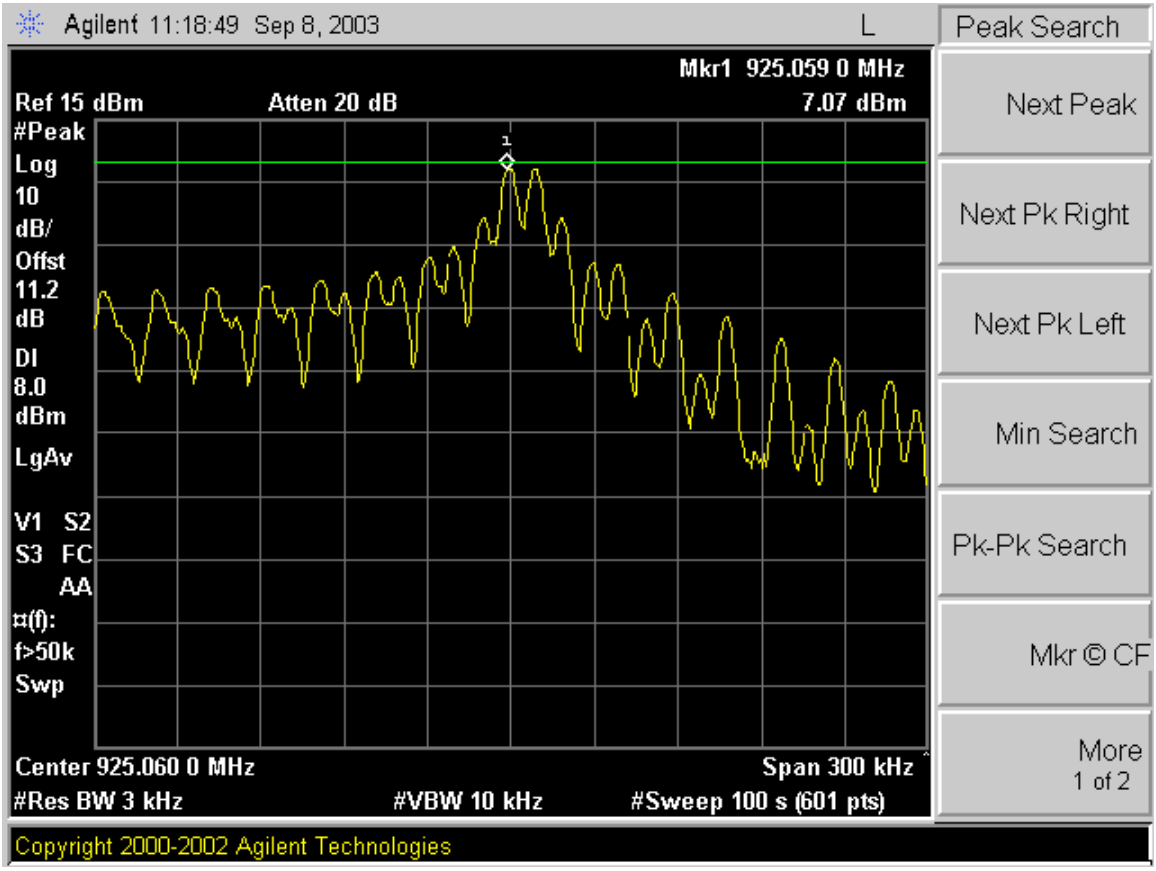
15.247(d) Power Spectral Density LOW Wideband channel



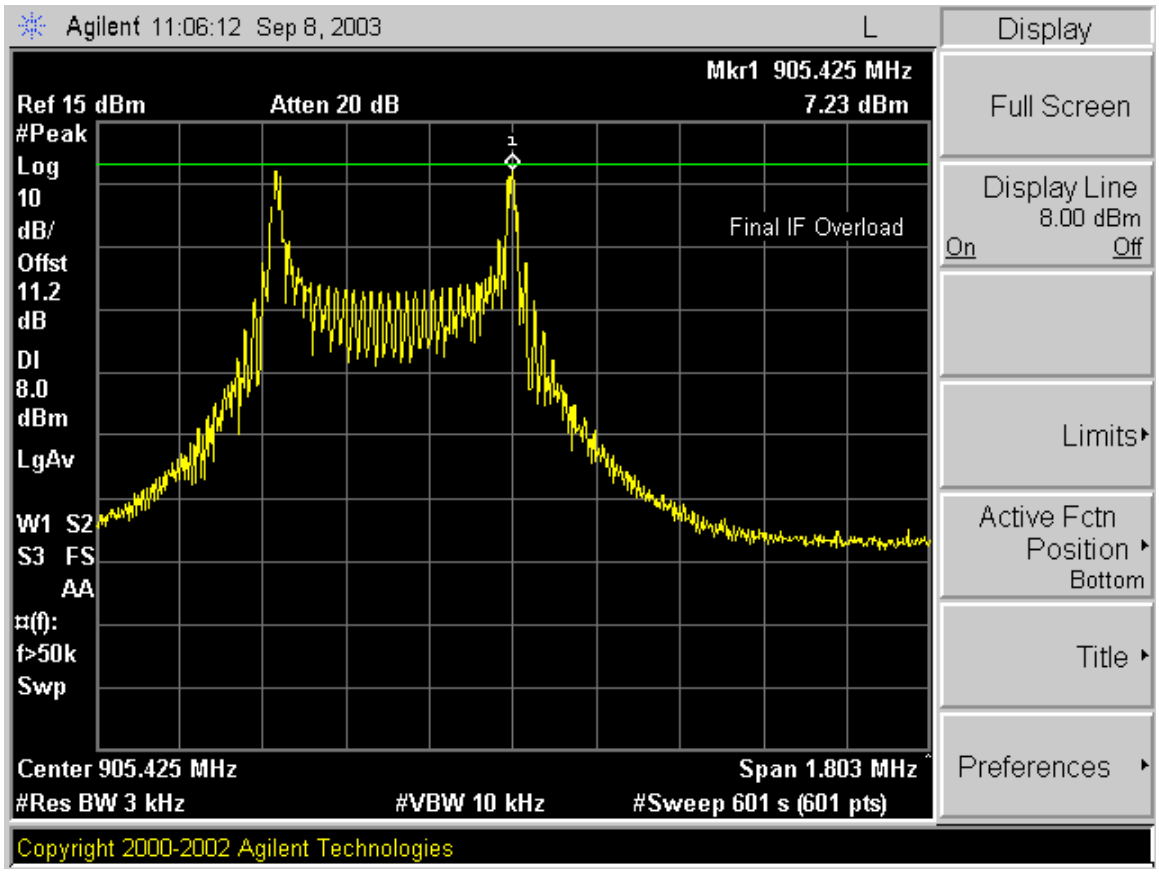
15.247(d) Power Spectral Density MID Wideband channel



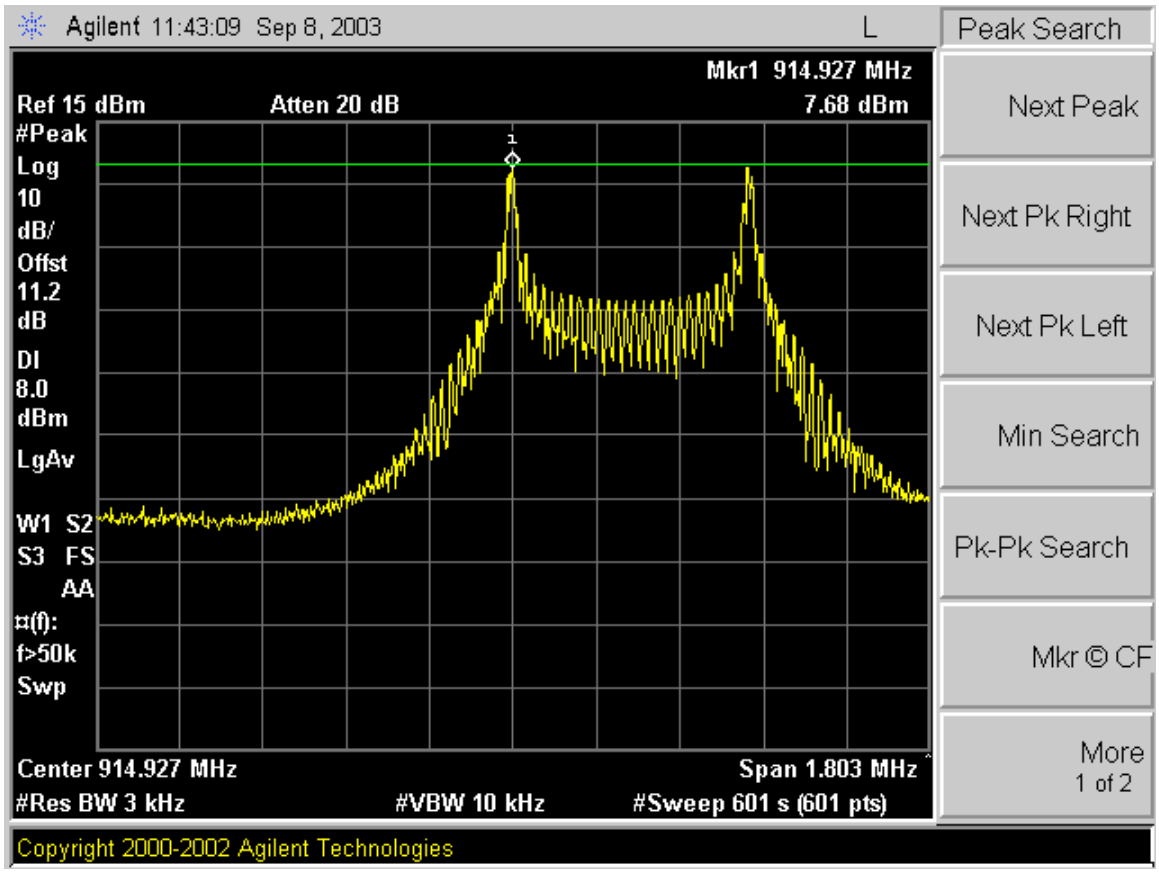
15.247(d) Power Spectral Density HIGH Wideband channel



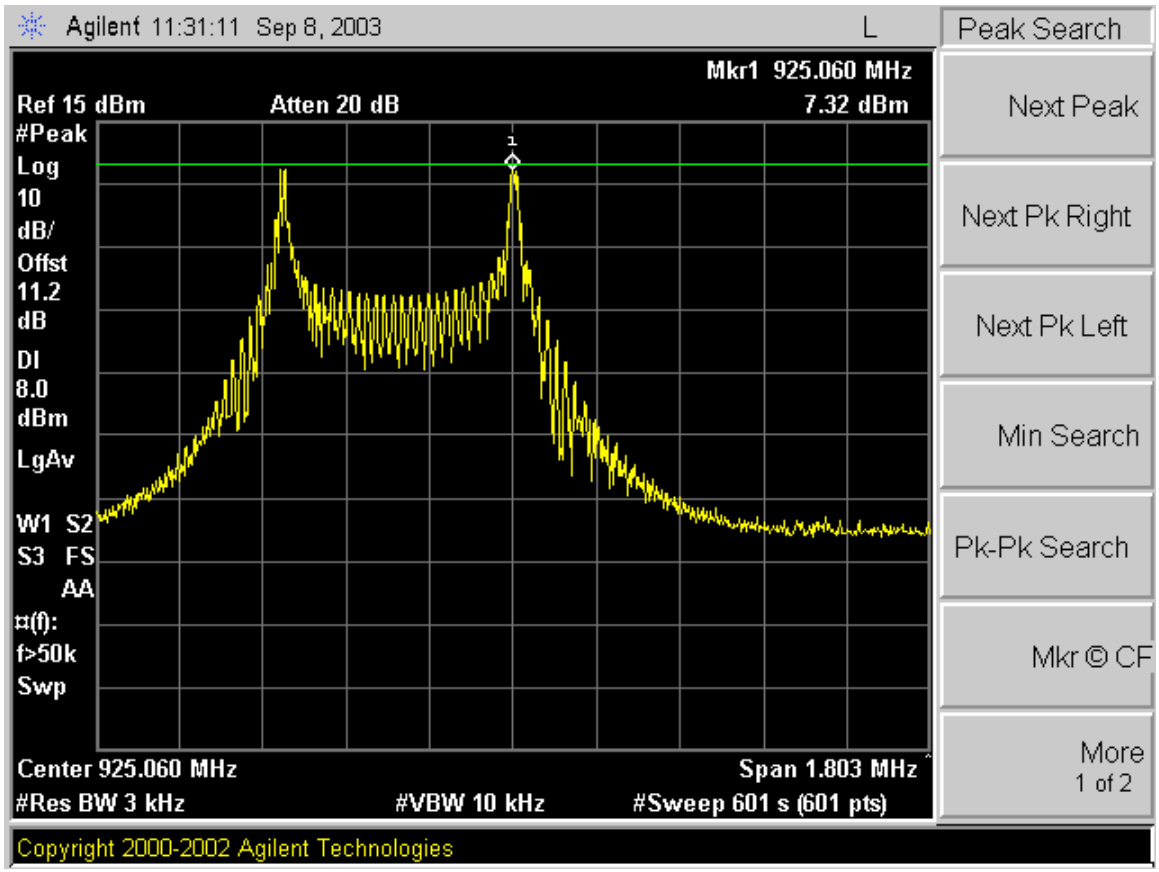
Industry Canada RSS-210:
Power Spectral Density LOW Wideband channel



Industry Canada RSS-210:
Power Spectral Density MID Wideband channel



Industry Canada RSS-210:
Power Spectral Density HIGH Wideband channel



RF Exposure Information
MPE Calculations

RF Hazard Distance Calculation

mW/cm2 from Table1: 0.60

Max RF Power P, dBm	TX Antenna G, dBi	MPE Safe Distance, cm
13.9	5.6	3.5

Basis of Calculations:

E^2/3770 = S, mW/cm2
E, V/m = (Pwatts*Ggain*30)^.5/d, meters
d = ((Pwatts*G*30)/3770*S))^0.5 Pwatts*Ggain = 10^(PdBm-30+GdBi)/10)

NOTE: For mobile or fixed location transmitters, minimum separation distance is 20 cm, even if calculations indicate MPE distance is less