Actall Corporation

ALERTx AX7910
Transceiver Module

CONDUCTED EMISSION TESTING

TITLE: ALERTx AX7910 MODULE CONDUCTED TESTS			W66 N220 COMMERCE COURT CEDARBURG, WI 53012, USA (262)-375-4400 FAX: (262)-375-6731 email: eng@lsr.com, http://www.lsr.com	
PROJECT: ALERTx 7910 RADIO MODULE DEVELOPMENT				
DRAWN BY: John Lofgren	DATE: November 3, 2003	SIZE: A	DRAWING NUMBER: XE1203-915-PCT-0.1	REVISION: 0.3
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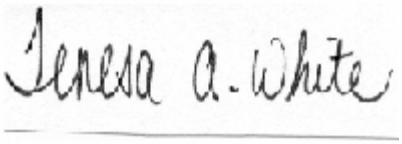
TABLE OF CONTENTS

1.0 SIGNATURES....3
2.0 SCOPE....4
3.0 REVISION CONTROL....4
4.0 APPLICABLE DOCUMENTS....5
5.0 EQUIPMENT UNDER TEST CONDITIONS (CONDUCTED EMISSIONS)7
5.1 Output Power and Occupied Bandwidths15.247(a) (b) (c) :....8
5.1.1 Minimum Channel Separation (Part 15.247(a)(1))....9
5.1.2 Equal Channel Usage (Part 15.247(a)(1))....11
5.1.3 Pseudorandom Hopping Pattern (Part 15.247(a)(1))....11
5.1.4 Receiver Synchronization (Part 15.247(a)(1))....11
5.1.5 Receiver Input Bandwidth (Part 15.247(a)(1))....11
5.1.6 Number of Hopping Frequencies (Part 15.247(a)(1)(i))....12
5.1.7 Dwell Time (Part 15.247(a)(1)(i))....18
5.1.8 20dB Bandwidth (Part 15.247(a)(1)(i))....19
5.1.9 Peak Output Power (Part 15.247(b)(2)....20
5.1.10 EIRP Limit (Part15.247(b)(3))....22
5.1.11 Maximum Permissible Exposure (Part 15.247(b)(4)))....22
5.1.12 Spurious Emission at Band Edges (Part 15.247(c))....23
5.1.13 Spurious Emission, Wideband (Part 15.247(c))....25

1.0 SIGNATURES

Manufacturer:	**Actall / Abenex**
Date(s) of Test:	**November 6, 2003 to November 13, 2003**
Test Engineer:	**John Lofgren**
Model #:	**AX7910**
Serial #:	**105**
Operating Mode:	**Hopping / CW, as required per individual test**



Prepared By: December 16, 2003

Teresa A. White, Document Coordinator Date

Tested By: signed by John A. Lofgren December 16, 2003

John A. Lofgren, Senior Design Engineer Date

Approved By: signed by Brian E. Petted December 16, 2003

Brian E. Petted, VP Engineering Date

Approved By: December 16, 2003

Kenneth L. Boston, EMC Lab Manager Date

PE # 31926 Licensed Professional Engineer

Registered in the State of Wisconsin, United States

2.0 SCOPE

This report presents the results associated with the conducted emission tests of the Actall ALERTx AX7910 RF Transceiver Module. This particular module is configured for 902-928 MHz operation. This report presents conducted test results required for pre-compliance for authorization under FCC Part 15.247 as a potential frequency hopping device.

3.0 REVISION CONTROL

DATE	CHANGES	REVISION
11/03/03	ORIGINAL RELEASE	0.0
11/13/03	UPDATE PLOTS AND DATA FOR NEW CHANNEL SPACING	0.1
11/17/03	REPAIR GRAMMAR, SPELLING, AND EQUATION ERRORS	0.2
11/18/03	UPDATE PRODUCT NAME AND DESCRIPTION, ADD SIGNATURE PAGE	0.3

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4.0 APPLICABLE DOCUMENTS

[1] "Code of Federal Regulations Title 47, Volume 1, Sec. 1.1310 Radiofrequency radiation exposure limits" ***47CFR1.1310,*** Revised as of October 1, 2001, Page 297-298.

[2] "Code of Federal Regulations Title 47, Volume 1, Sec. 2.1091 Radiofrequency radiation exposure evaluation: mobile devices." ***47CFR2.1091,*** Revised as of October 1, 2001, Page 588-589.

[3] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.31 "Measurement standards." ***47CFR15.31,*** Revised as of October 1, 2001, Page 677-681.

[4] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.33 "Frequency range of radiated measurements." ***47CFR15.33,*** Revised as of October 1, 2001, Page 682-683.

[5] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.35 "Measurement detector functions and bandwidths." ***47CFR15.35,*** Revised as of October 1, 2001, Page 683-684.

[6] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.203 "Antenna requirement." ***47CFR15.203,*** Revised as of October 1, 2001, Page 720-721.

[7] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.205 "Restricted Bands of Operation." ***47CFR15.205,*** Revised as of October 1, 2001, Page 721-722.

[8] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.209 "Radiated emission limits; general requirements." ***47CFR15.209,*** Revised as of October 1, 2001, Page 723.

[9] "Code of Federal Regulations Title 47, Volume 1, Sec. 15.247 "Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz." ***47CFR15.247,*** Revised as of October 1, 2001, Page 733-735.

[10] American National Standards Institute (ANSI) C63.4-1992, ``Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz," ***Electrical and Electronic Engineers, Inc***. July 17, 1992 , Document Number: SH15180.

[11] Federal Communications Commission Public Notice, ``PART 15 UNLICENSED MODULAR TRANSMITTER APPROVAL", June 26, 2000 , Document Number: DA 00-1407.

5.0 EQUIPMENT UNDER TEST CONDITIONS (CONDUCTED EMISSIONS)

The Equipment Under Test (EUT) is the configured using the L.S. Research test tool and RS-232 interface cable. Unless otherwise indicated the settings for radiated measurements are as follows:

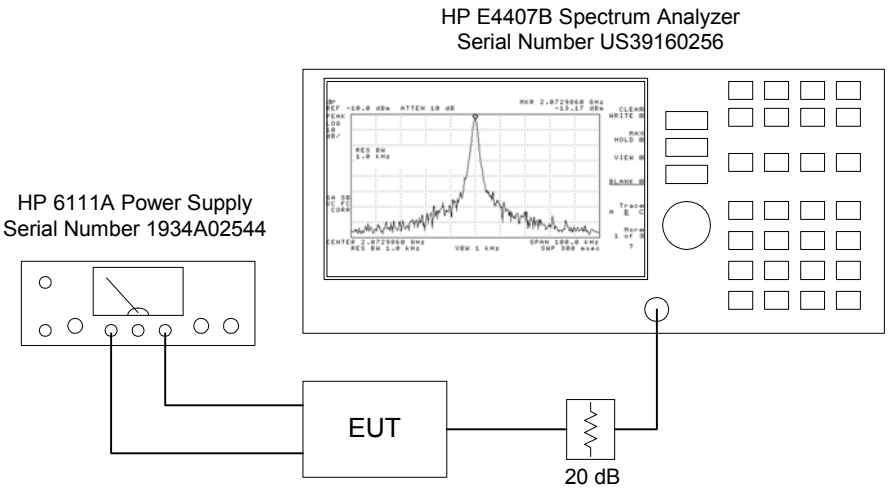
1. Nominal Transmit and Receive Frequencies: 902 MHz to 928 MHz
2. Nominal Bit Rate: 76.8 kbps
3. Transmitter Peak Frequency Deviation: 114 kHz CW Mode
4. Receiver Bandwidth: 600 kHz
5. Output Power Setting: +20 dBm and +27 dBm
6. Antenna: Nearson P/N C321 AM-925
7. Power Supply: +3.0 VDC Nominal, +3.6 VDC Maximum.

5.1 Output Power and Occupied Bandwidths15.247(a) (b) (c) :

Presented below is the measurement configuration for conducted output power and occupied bandwidths. The test configuration for this device is simply direct spectrum analysis using an Agilent E4407B spectrum analyzer, LSR Asset number CC000283, calibrated October 28,2002 .

An input attenuator of 20 dB was added to protect the spectrum analyzer and an input gain offset was entered to produce correct readings direct from the instrument with no further correction. No cable loss is associated with the measurement because the EUT was connected directly to the input attenuator.

The channel power measurement feature of the E4402B is utilized where appropriate.



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5.1.1 Minimum Channel Separation (Part 15.247(a)(1))

Part 15.247(a)(1) requires a frequency spacing of at least 25 kHz or the 20dB emission bandwidth, which ever is greater.

The radio uses a channel plan with spacing of 525 kHz between 902 MHz and 907.5 MHz. It switches to a spacing of 430 kHz between 907.5 MHz and 922.5 MHz, then back to 525 kHz between 922.5 MHz and 928 MHz. This is necessary to accommodate some performance characteristics of the receiver circuit.

The widest 20 dB bandwidth of transmission (Section 4.1.8) is 415 kHz.

Minimum Channel Spacing of 430 kHz > 415 kHz. **PASS**

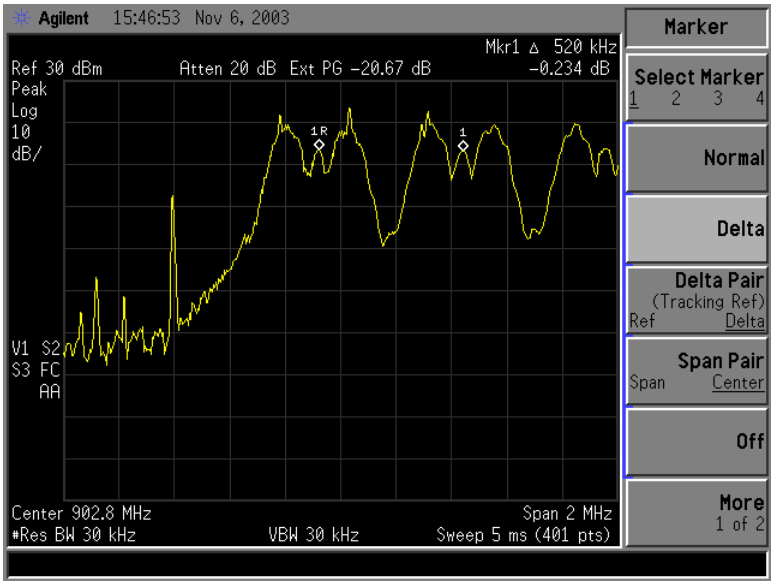

Figure 1. Channel separation at low band is 520 kHz

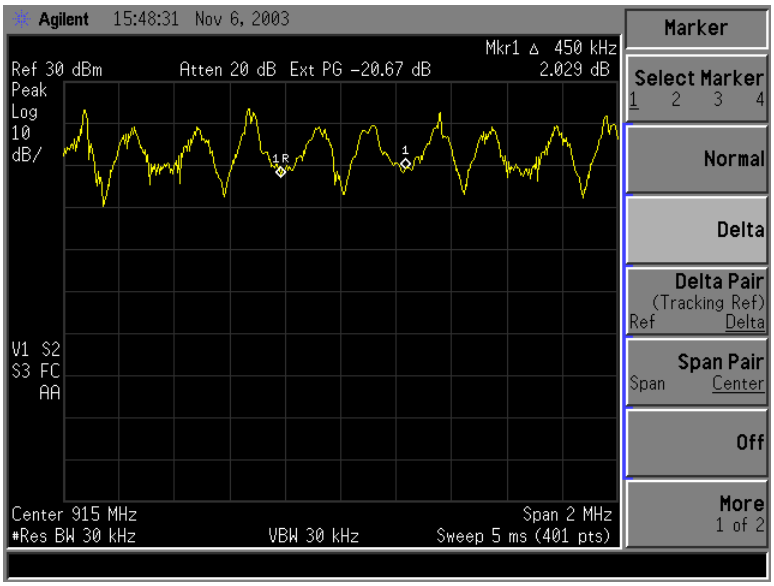

Figure 2. Channel separation at mid band is 450 kHz

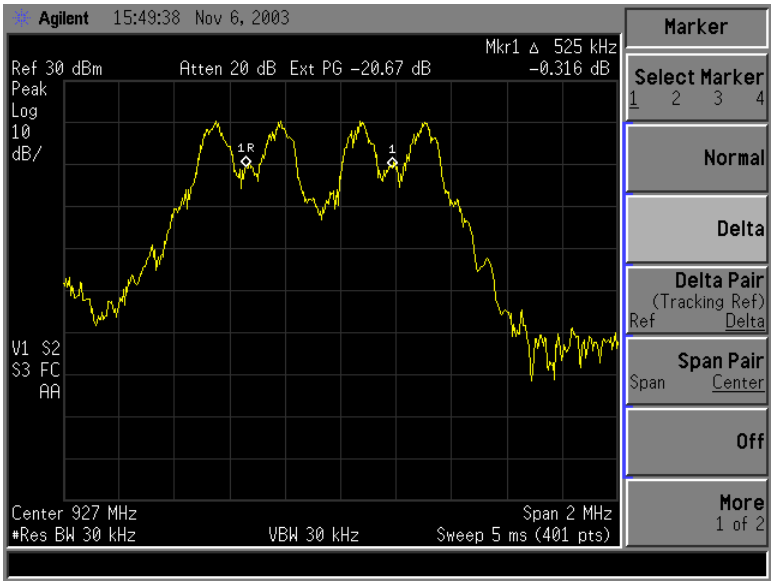

Figure 3. Channel separation at high band is 525 kHz

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5.1.2 Equal Channel Usage (Part 15.247(a)(1))

50 channels are chosen from a pool of 53 available frequencies. These channels are arrayed in a table which the system uses to determine the next hopping channel. Each time a transmission is made the system uses the next frequency in the table. The table is started over once the end has been reached. Thus, any given frequency will not be reused until all other frequencies have been accessed.

5.1.3 Pseudorandom Hopping Pattern (Part 15.247(a)(1))

The hopping table is built using an 8 bit seed into an $X^{15}+1$ pseudorandom number generator giving the possibility of 256 unique pseudorandom hopping tables.. Output from the generator is used to pick frequencies from a pool of 53 available channels.

5.1.4 Receiver Synchronization (Part 15.247(a)(1))

Each receiver requires the same seed for the pseudorandom sequence generator as the transmitter it is operating with. The same seed will produce the same hop sequence in each device. Once the receiver scans and finds the transmitter on any given channel it will automatically be synchronized to go to the next correct channel by virtue of using the same hopping table.

5.1.5 Receiver Input Bandwidth (Part 15.247(a)(1))

The radio receiver is a direct conversion type with a baseband filter whose cutoff frequency is matched to the transmission spectrum. The bandwidth is 600 kHz for use at the 76.8 kbps rate. Two level frequency shift keying is used for modulation. The simple Carson bandwidth for this type of signal is given as the bit rate plus 2 times the deviation. This system uses 114 kHz deviation for the 76.8 kbps rate, giving a bandwidth of 304.8 kHz. The excess filter bandwidth allows for frequency tolerance errors between the transmitter and receiver.

5.1.6 Number of Hopping Frequencies (Part 15.247(a)(1)(i))

Transmitted 20dB bandwidth is a maximum of 415 kHz. This gives a requirement of at least 25 hopping channels. Sine the unit transmits at a power level over 250 mW the requirement increases to 50 channels.

Figures 4 through 14 show band usage captured in 3 MHz parts to make all channels visible. Channels have been counted and are presented below:

5+5+3.5+4.5+4+4+5+4.5+4.5+5+5=**50** **PASS**

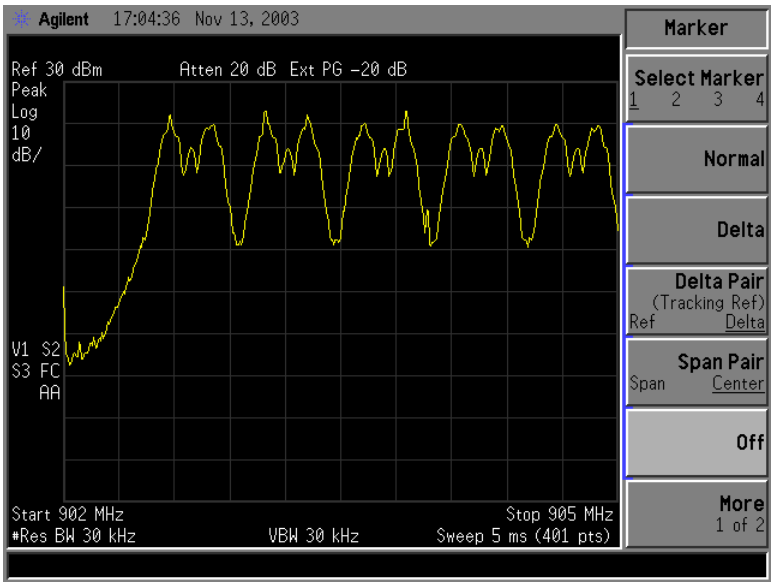

Figure 4. 5 channels from 902 MHz to 905 MHz

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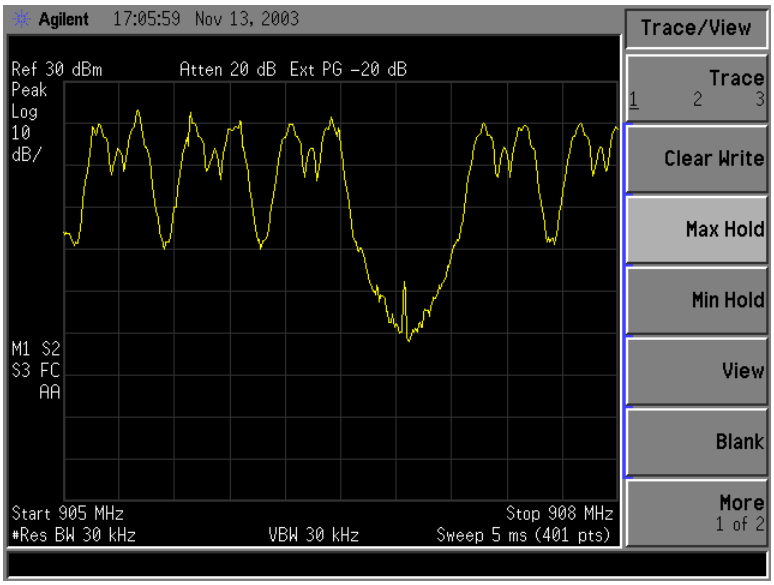

Figure 5. 5 channels from 905 MHz to 908 MHz

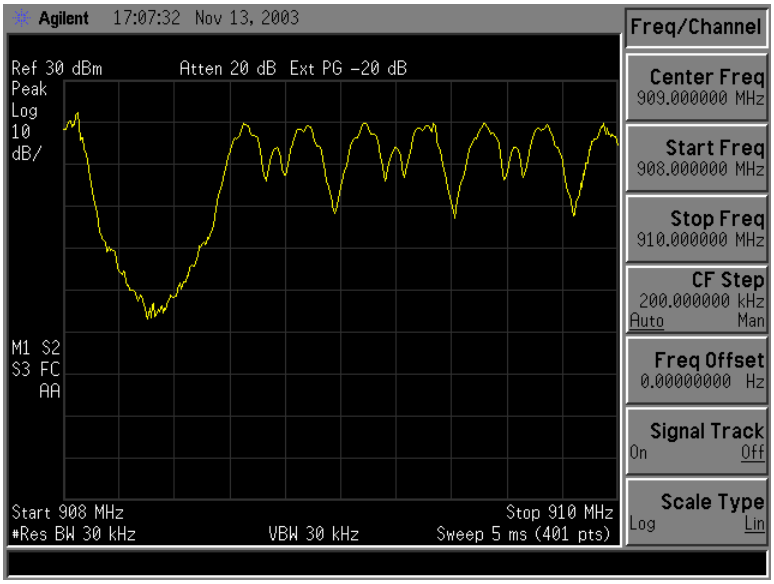

Figure 6. 3.5 channels from 908 MHz to 910 MHz

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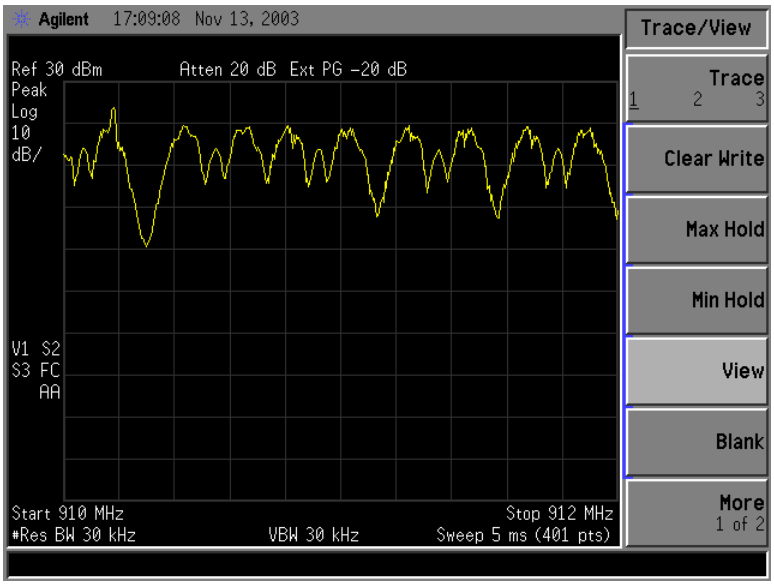

Figure 7. 4.5 channels from 910 MHz to 912 MHz

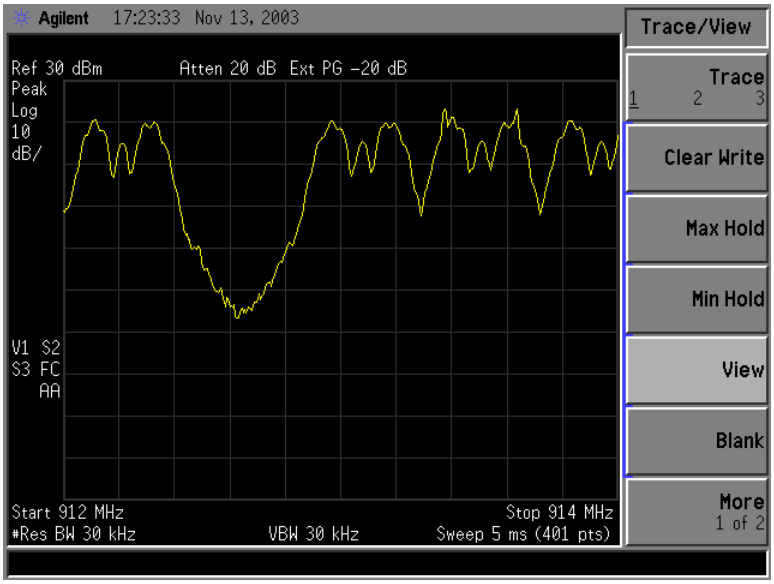

Figure 8. 4 channels from 912 MHz to 914 MHz

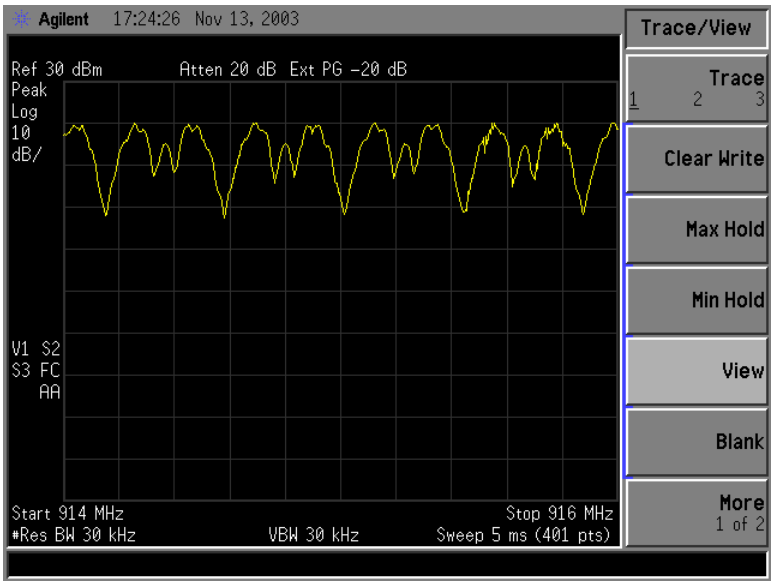

Figure 9. 4 channels from 914 MHz to 916 MHz

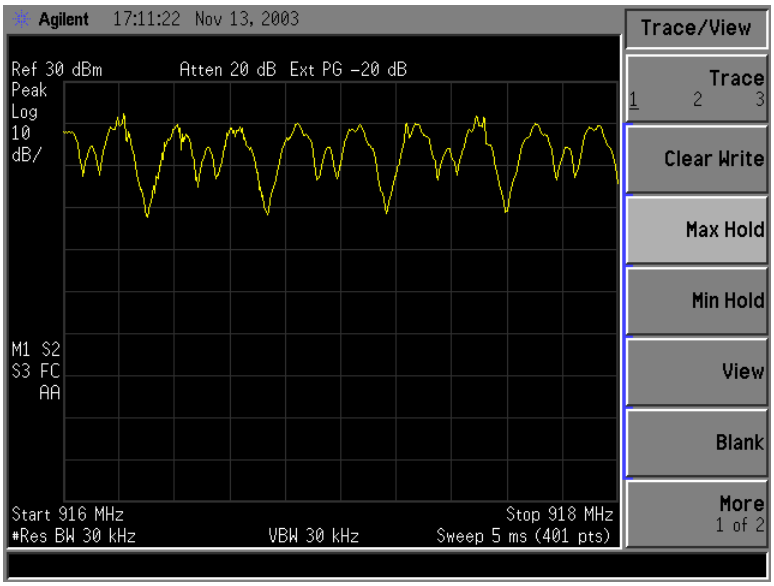

Figure 10. 5 channels from 916 MHz to 918 MHz

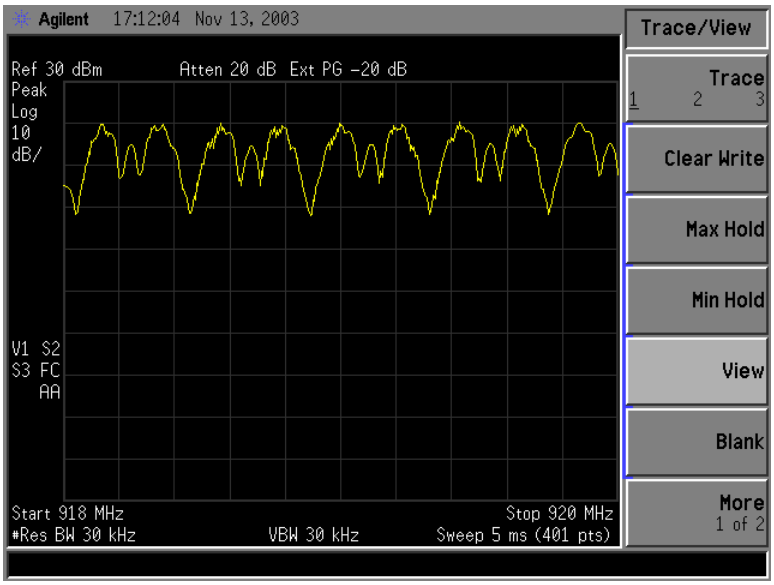

Figure 11. 4.5 channels from 918 MHz to 920 MHz

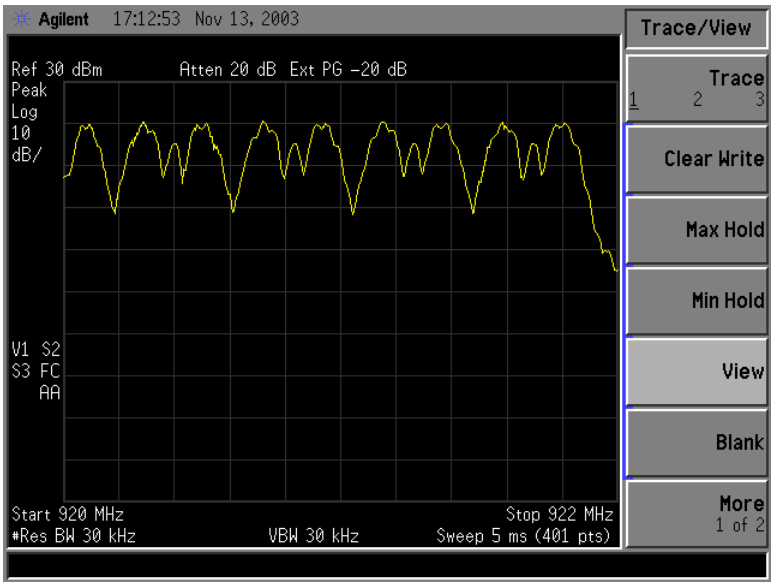

Figure 12. 4.5 channels from 920 MHz to 922 MHz

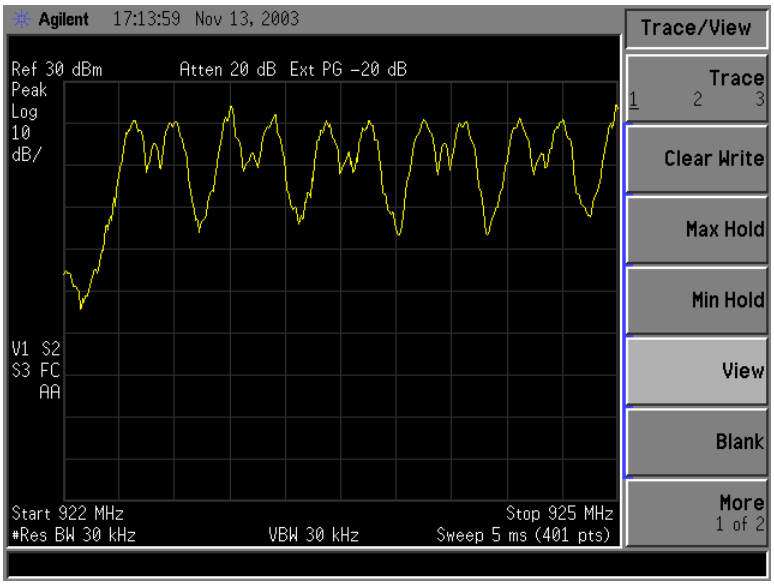

Figure 13. 5 channels from 922 MHz to 925 MHz

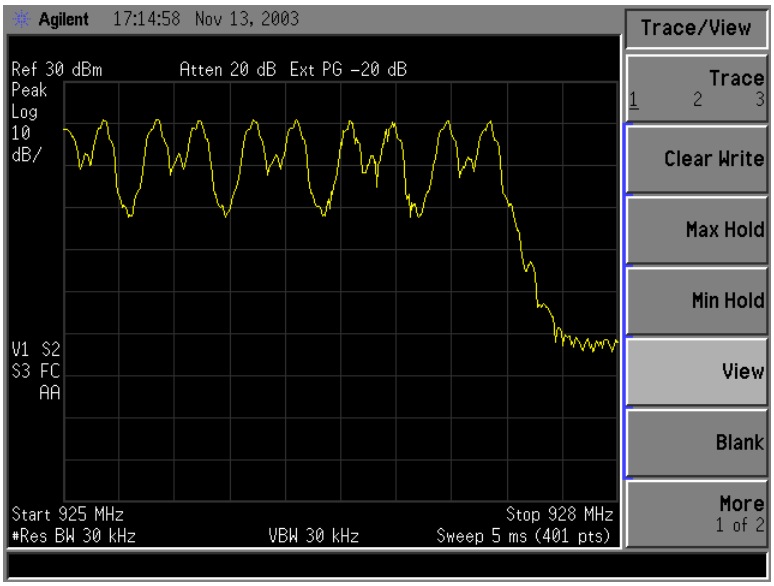

Figure 14. 5 channels from 925 MHz to 928 MHz

5.1.7 Dwell Time (Part 15.247(a)(1)(i))

A system with a 20dB bandwidth greater than 250 kHz must not occupy a given channel for more than 400 mS in a 10 second window.

The longest time any transmission will occur on a single channel is 52 mS (Figure 15)

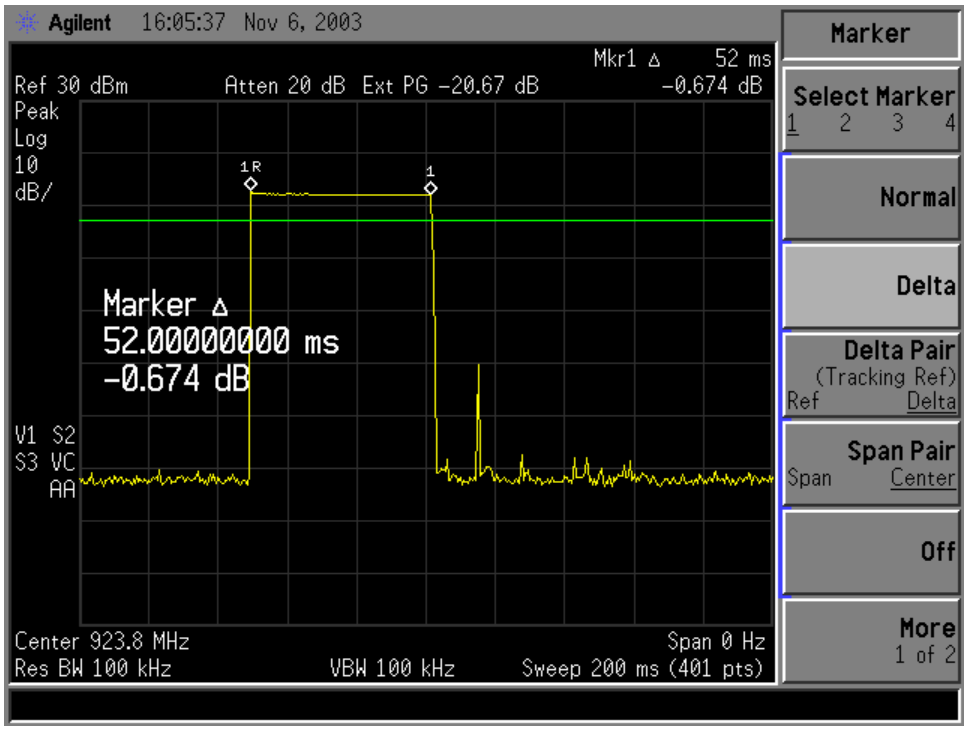

Figure 15. Longest channel dwell time is 52 mS.

A total of 50 channels are used. With each channel occupying 50 mS it will take 2.6 seconds for the sequence to repeat. 3.85 repetitions will fit into a 10 second window giving a maximum channel occupancy of 200.2 mS in a 10 second window.

200.2 mS < 400 mS **PASS**

5.1.8 20dB Bandwidth (Part 15.247(a)(1)(i))

Test Conditions	
EUT Mode	Hopping
Data Rate	76.8 kbps
EUT Power Setting	27 dBm
Span	1 MHz
RBW	30 kHz
VBW	30 kHz
Detector	Peak
Display Mode	Max Hold

Test Results			
Frequency (MHz)	**Measured Bandwidth (kHz)**	**Bandwidth Limit (kHz)**	**Test Indication**
902.77	415	500	**PASS**
914.85	408	500	**PASS**
927.21	415	500	**PASS**

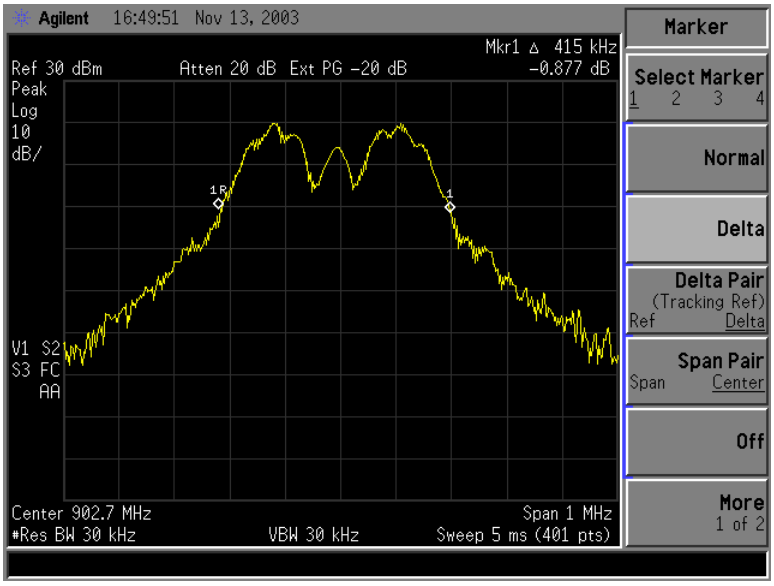

Figure 16. Widest 20 dB channel bandwidth is 415 kHz

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5.1.9 Peak Output Power (Part 15.247(b)(2)

A peak output power of 1 Watt is allowed by virtue of having 50 hopping channels.

Test Conditions	
EUT Mode	Single channel transmit
Data Rate	76.8 kbps
EUT Power Setting	+20 dBm, +27 dBm
EUT Supply Voltage	+2.7, +3.0, +3.6 VDC
Span	2.25 MHz
RBW	10 kHz
VBW	100 kHz
Detector	Peak
Display Mode	Channel Power

High Power Test Results				
Set Frequency (MHz)	**Supply Voltage (Volts)**	**Measured Power (dBm)**	**Power Limit (dBm)**	**Test Indication**
902.70	2.7	25.50	30.0	**PASS**
	3.0	27.13 (Hi Pwr)	30.0	**PASS**
		17.79 (Lo Pwr)	30.0	**PASS**
	3.6	27.24	30.0	**PASS**
914.85	2.7	25.50	30.0	**PASS**
	3.0	27.15 (Hi Pwr)	30.0	**PASS**
		19.16 (lo Pwr)	30.0	**PASS**
	3.6	27.42	30.0	**PASS**
927.21	2.7	25.78	30.0	**PASS**
	3.0	27.15 (Hi Pwr)	30.0	**PASS**
		23.46 (Lo Pwr)	30.0	**PASS**
	3.6	27.66	30.0	**PASS**

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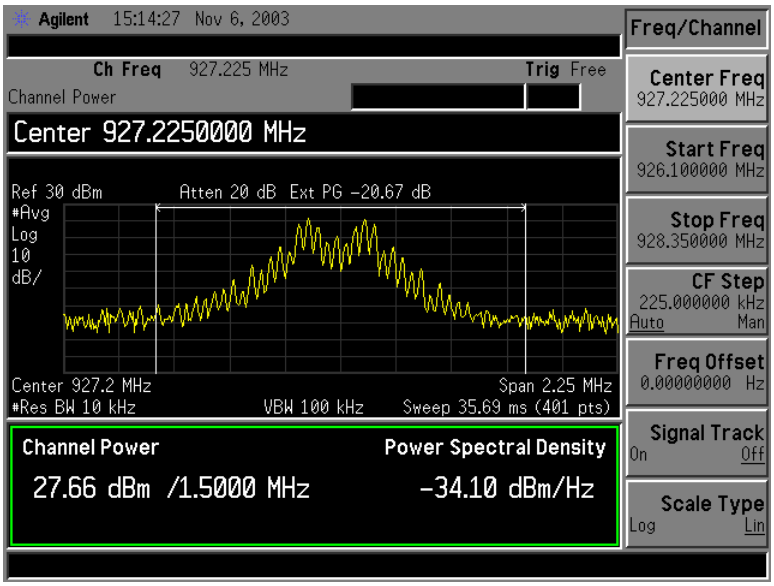

Figure 17. Highest channel power is +27.66 dBm on highest channel at 3.6 volt supply input.

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5.1.10 EIRP Limit (Part15.247(b)(3))

Parts 15.247(b)(2) and 15.247(b)(3) set maximum power limit of 1 watt (+30 dBm) conducted into an antenna with 6.0 dBi of gain, or less. This gives a maximum ERP of +36.0 dBm.

The XETI 915 MHz module has a maximum conducted output power of +27.7 dBm. The specified Nearson model S321AM-915 antenna has a gain of 0 dBi yielding an ERP of +27.7 dBm which is less than the limit of +36.0 dBm.

5.1.11 Maximum Permissible Exposure (Part 15.247(b)(4)))

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	27.7	(dBm)
Maximum peak output power at antenna input terminal:	588.84	(mW)
Antenna gain(typical):	0.0	(dBi)
Maximum antenna gain:	1.00	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.61	(mW/cm^2)
Power density at prediction frequency:	0.11715	(mW/cm^2)
Maximum allowable antenna gain:	7.17	(dBi)

Margin of Compliance at 20 cm = 7.17 dB

5.1.12 Spurious Emission at Band Edges (Part 15.247(c))

Test Conditions	
EUT Mode	Hopping
Data Rate	76.8 kbps
EUT Power Setting	27 dBm
EUT Supply Voltage	+3.0 VDC
Span	10 MHz
RBW	100 kHz
VBW	100 kHz
Detector	Peak
Display Mode	Max Hold

Test Results			
Band Edge	**Spur Level (dBc)**	**Spur Limit (dBc)**	**Test Indication**
Lower	-48.29	-20	**PASS**
Upper	-34.88	-20	**PASS**

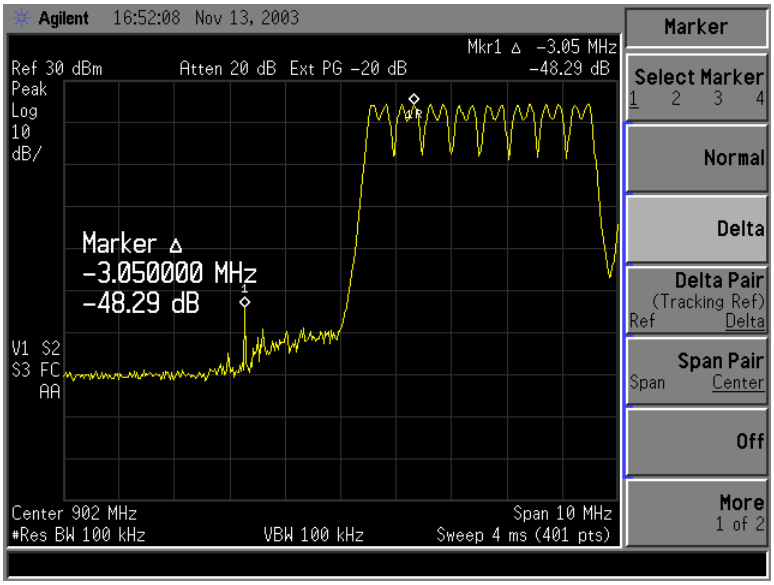

Figure 18. Spurious emission at lower band edge is -48.29 dBc.

TITLE: ALERTx AX7910 MODULE CONDUCTED TESTS		L.S. RESEARCH, Inc. WIRELESS PRODUCT DEVELOPMENT	W66 N220 COMMERCE COURT CEDARBURG, WI 53012, USA (262)-375-4400 FAX: (262)-375-6731 email: eng@lsr.com, http://www.lsr.com	
PROJECT: ALERTx 7910 RADIO MODULE DEVELOPMENT				
DRAWN BY: John Lofgren	DATE: November 3, 2003	SIZE: A	DRAWING NUMBER: XE1203-915-PCT-0.1	REVISION: 0.3
CHECKED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
APPROVED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
FILENAME, FILES AFFECTED: ALERTx Conducted Emissions Report v0.3		SCALE: NOT TO SCALE	SHEET: 23 OF 27	

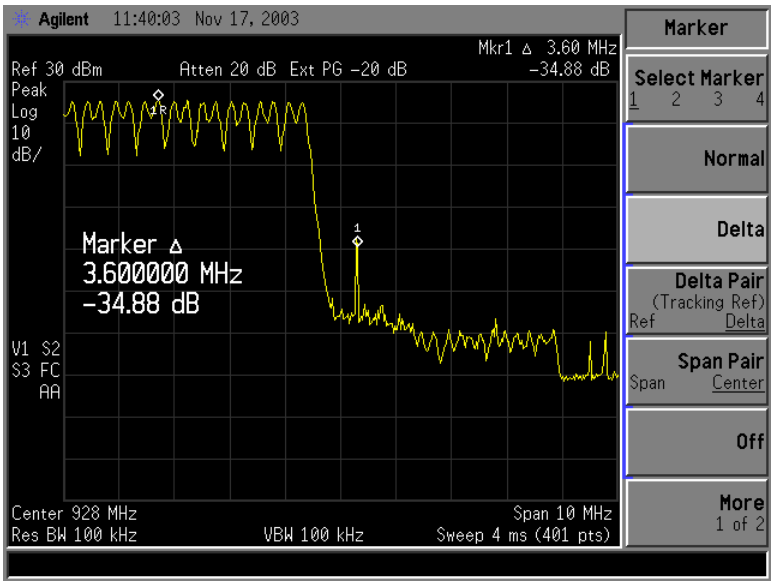

Figure 19. Spurious emission at upper band edge is -49.06 dBc.

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PROJECT: ALERTx 7910 RADIO MODULE DEVELOPMENT				
DRAWN BY: John Lofgren	DATE: November 3, 2003	SIZE: A	DRAWING NUMBER: XE1203-915-PCT-0.1	REVISION: 0.3
CHECKED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
APPROVED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
FILENAME, FILES AFFECTED: ALERTx Conducted Emissions Report v0.3		SCALE: NOT TO SCALE	SHEET: 24 OF 27	

5.1.13 Spurious Emission, Wideband (Part 15.247(c))

Test Conditions	
EUT Mode	Hopping
Data Rate	76.8 kbps
EUT Power Setting	27 dBm
EUT Supply Voltage	+3.0 VDC
Span	As Required
RBW	100 kHz
VBW	100 kHz
Detector	Peak
Display Mode	Max Hold

Test Results			
Frequency Span	**Spur Level (dBc)**	**Spur Limit (dBc)**	**Test Indication**
9 kHz to 902 MHz	-53.93	-20	**PASS**
928 MHz to 10 GHz	-46.80	-20	**PASS**

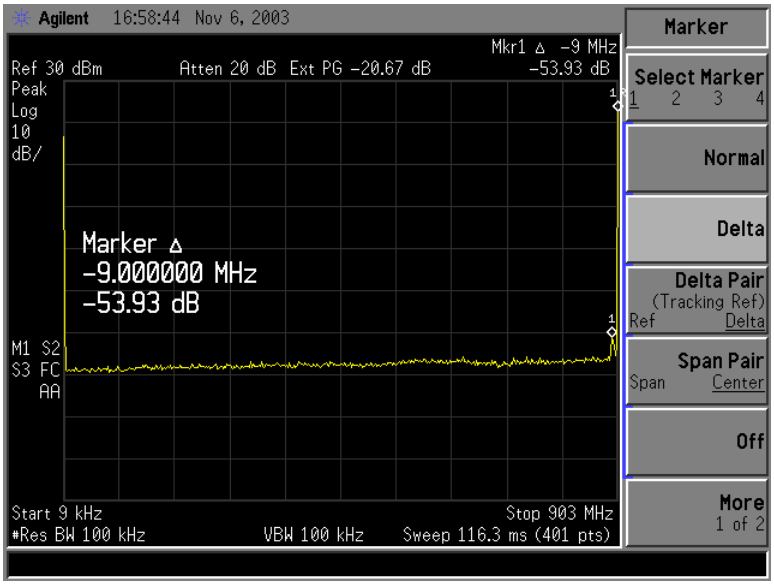

Figure 20. Spurious emission between 9 kHz and 902 MHz is -53.93 dBc.

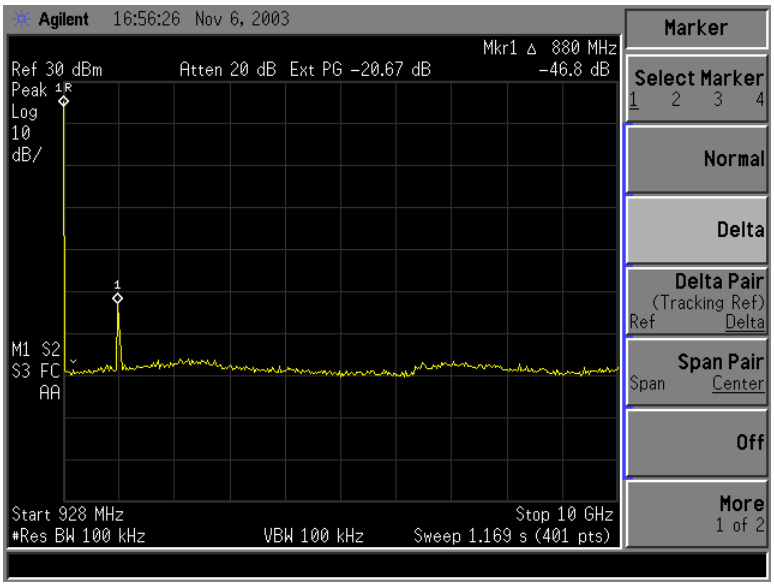

Figure 21. Spurious emission between 902 MHz and 10 GHz is -46.80 dBc.

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PROJECT: ALERTx 7910 RADIO MODULE DEVELOPMENT				
DRAWN BY: John Lofgren	DATE: November 3, 2003	SIZE: A	DRAWING NUMBER: XE1203-915-PCT-0.1	REVISION: 0.3
CHECKED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
APPROVED BY: BRIAN PETTED, VP ENG	DATE: November 18, 2003			
FILENAME, FILES AFFECTED: ALERTx Conducted Emissions Report v0.3		SCALE: NOT TO SCALE	SHEET: 26 OF 27	

TITLE: XE1202 RADIO MODULE PRE-COMPLIANCE TESTS PROJECT: XE1202 RADIO MODULE DEVELOPMENT		L.S. RESEARCH, Inc. WIRELESS PRODUCT DEVELOPMENT	W66 N220 COMMERCE COURT CEDARBURG, WI 53012, USA (262)-375-4400 FAX: (262)-375-6731 email: eng@lsr.com, http://www.lsr.com	
DRAWN BY: BRIAN PETTED , VP ENG	DATE: February 7, 2003	SIZE: A	DRAWING NUMBER: XE1202-915-PCT-0.0	REVISION: 0.0
CHECKED BY: BRIAN PETTED , VP ENG	DATE: February 7, 2003			
APPROVED BY: BRIAN PETTED , VP ENG	DATE: February 7, 2003			
FILENAME, FILES AFFECTED: ALERTx Conducted Emissions Report v0.3		SCALE: NOT TO SCALE		SHEET: 27 OF 27