FCC Certification Test Report

FCC Certification Test Report
for
YDI Wireless
Marquee Bridge Radio
Model Number MB-EXT 49
FCC ID: NM5-MB-49

Prepared for:

YDI Wireless
11717 Exploration Drive
Germantown, MD 20876

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

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for the
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Marquee Bridge Radio
NM5-MB-49

WLL JOB# 8206

Prepared by: _____
Michael Violette
President

Reviewed by: _____
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Chief EMC Engineer

Abstract

This report has been prepared on behalf of YDI Wireless to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Non-Broadcast Station Transmitter under Part 90 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a YDI Wireless Marquee Radio operating at 4.9GHz.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The YDI Wireless complies with the limits for a licensed transmitter under Part 90 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The YDI Wireless Marquee Bridge Radio complies with the limits of Part 90 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2001 version of ANSI C63.4 and EIA/TIA 603. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	YDI Wireless 11717 Exploration Drive Germantown, MD 20876
Quotation Number:	61645

1.4 Test Dates

Testing was performed from 6/17/2004 to 6/18/2004.

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Greg Snyder

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	Centimeter
CW	Continuous Wave
dB	Decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Marquee 4.9 Bridge is a single channel wireless network bridge transmitting at 4.965 GHz. Power is supplied via an Ethernet DC injector.

The Marquee 4.9 Bridge uses an OFDM radio card with a digital interface. The system does nothing to change the modulation, duty cycle, or timing of the signal. The system has one input port for DC and Ethernet data, and one output port for an OFDM 4.9 GHz signal to an antenna.

The radio is configured using the Ethernet port of the radio. This configuration uses a single channel at 4.965GHz, and offers data rates between 6Mbs and 54Mbs.

The 4.9 GHz OFDM radio operates as follows. The radio card consists of a chipset that handles the MAC, the decoding/encoding, and baseband filtering. The companion chip takes the encoded digital data and modulates it using OFDM to 4.9GHz signal. Internal to this chip is also amplification. The same chipset also does the receiving LNA and demodulation.

The radio card is controlled by a digital interface card that allows for Ethernet connectivity for both configuration and monitoring of the link. This device can be configured as a point-to-point or point-to-multipoint system to bridge two Ethernet LAN's. The product is professionally installed and is used for outdoor installations only.

The EUT uses the YDI-Fi software which supports VLAN bridging (802.1q protocol).

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	YDI Wireless
FCC ID Number	NM5-MB-49
EUT Name:	Marquee Bridge Radio
Model:	Marquee Bridge
FCC Rule Parts:	§90
Frequency Range:	4.965 GHz
Modulation:	OFDM
Authorized Bandwidth:	50MHz
Keying:	Continuous
Type of Information:	Data
Number of Channels:	1
Power Output Level	10.5 dBm
Antenna Type	Connector
Frequency Tolerance:	<0.01%
Emission Type(s):	OFDM
Interface Cables:	Ethernet/DC input port
Power Source & Voltage:	24VDC from Ethernet Injector
Emissions Designator	20M3X1D

2.2 Test Configuration

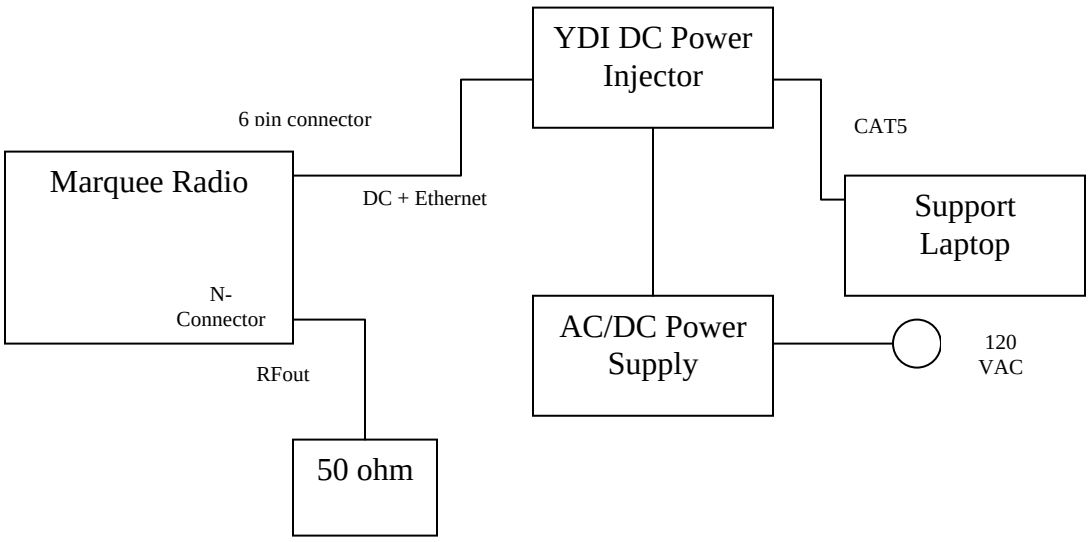

Figure 1. EUT Testing Configuration

3 Support Equipment

Item	Model
Computer	Hewlett Packard Onmibook 900 S/N: TW94090069
Ethernet Card	D-Link Model DFE-690TXD Ethenet Card S/N: 004005335BA8
Power Supply	Phihong Model PSA31U-480 AC Adapter
DC Power Injector	YDI "DC Power Injector" (No other identifiers)

3.1 Testing Algorithm

The EUT was configured with YDI-Fi software connected via an Ethernet cable which commanded the EUT to modulate at a maximum data rate.

Worst-case emission levels are provided in the test results data.

3.2 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

3.3 Measurements

3.3.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

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

3.4 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

4 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Equipment	Serial/Asset Number	Calibration Due
HP 8564E Spectrum Analyzer (Radiated and conducted emissions)	67	1/31/2005
HP8593A Spectrum Analyzer (temperature stability)	74	6/25/2004
DRG-118 Double Ridge Waveguide Antenna	425	4/17/2005
Narda 638 Standard Gain Horn Antenna 18-26.5 GHz	210	10/1/2005
Narda 638 Standard Gain Horn Antenna 26.5-40 GHz	209	10/1/2005
Hewlett-Packard Microwave Preamp: 8449B 1-18 GHz	3008A00729	2/11/2005
A.H. Systems Preamplifier PAM-1840 18GHz-40 GHz	453	1/6/2005
Hewlett-Packard Synth. Signal Generator: 8672A	2311A03131	3/23/2005
Hewlett-Packard Power Meter: 438A	3048U02786	3/10/2005
Hewlett-Packard 30dB Attenuator: 8481B	331BA04749	3/10/2005
Hewlett-Packard Power Head: 8481B	331BA04749	3/10/2005
Solar Electronics LISN 8012-50-R-24-BNC	8379493	6/30/2004
HP 11970U Harmonic Mixer w/SGH-19 Horn 40-60GHz	83	10/1/2005
HP 11970V Harmonic Mixer w/SGH-15 Horn 60-75 GHz	54	10/1/2005
HP 11970W Harmonic Mixer w/SGH-10 Horn 75-110 GHz	53	10/1/2005

5 Test Results

5.1 RF Power Output: (FCC Part §2.1046)

The RF output power was measured using the diode detector method. The output of the EUT was connected to the input of an RF diode detector. The output of the diode detector was connected to the input of an oscilloscope. The DC deflection on the oscilloscope was measured and recorded. A signal generator was then used to substitute for the EUT and the RF output power of the signal generator increased until the same deflection was measured on the oscilloscope as was made by the EUT.

This power was then measured by an RF power meter and the result recorded. The results are shown in **Table 3**.

Table 3. RF Output Power Results

Channel and/or Frequency GHz	Measured Level (dBm)	Measured Level (Watts)
4.965	10.5	11.2m

5.2 Occupied Bandwidth (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the radio to the input of a spectrum analyzer via an attenuator.

Table 4 provides a summary of the Occupied Bandwidth Results. Maximum authorized bandwidth is 50 MHz.

Table 4. Occupied Bandwidth Results

Frequency GHz	Bandwidth MHz
4.965	20.32

At full modulation, the occupied bandwidth was measured as shown in Figure 2.

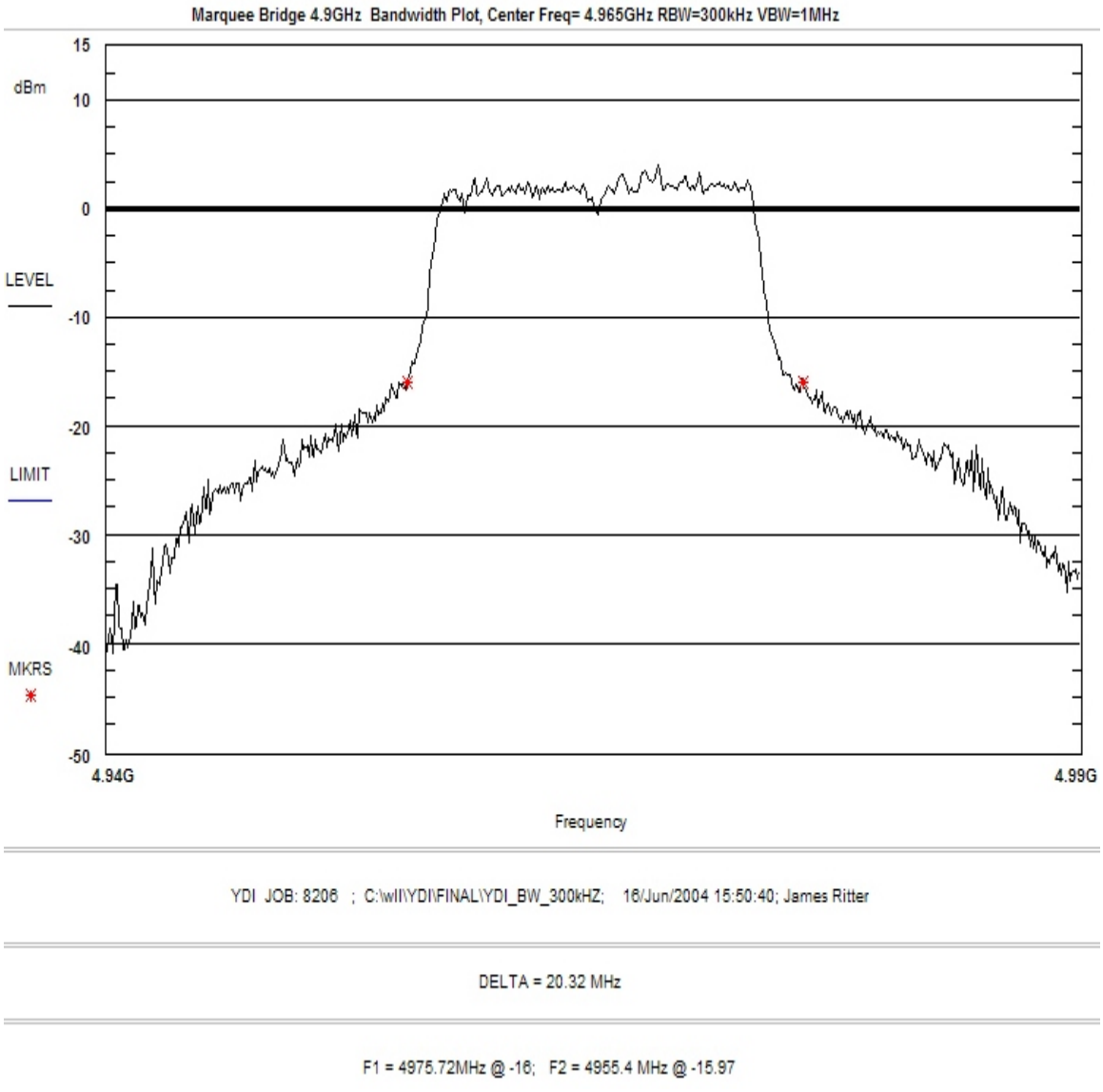

Figure 2. Occupied Bandwidth

5.3 Emissions and emission limitations to §90.210

Emissions limitations are specified in §90.210. The output of the transmitter was connected to the input of the spectrum analyzer and the transmitter modulated with data. Conducted emissions from the antenna port were measured from 30 MHz to 40GHz were measured.

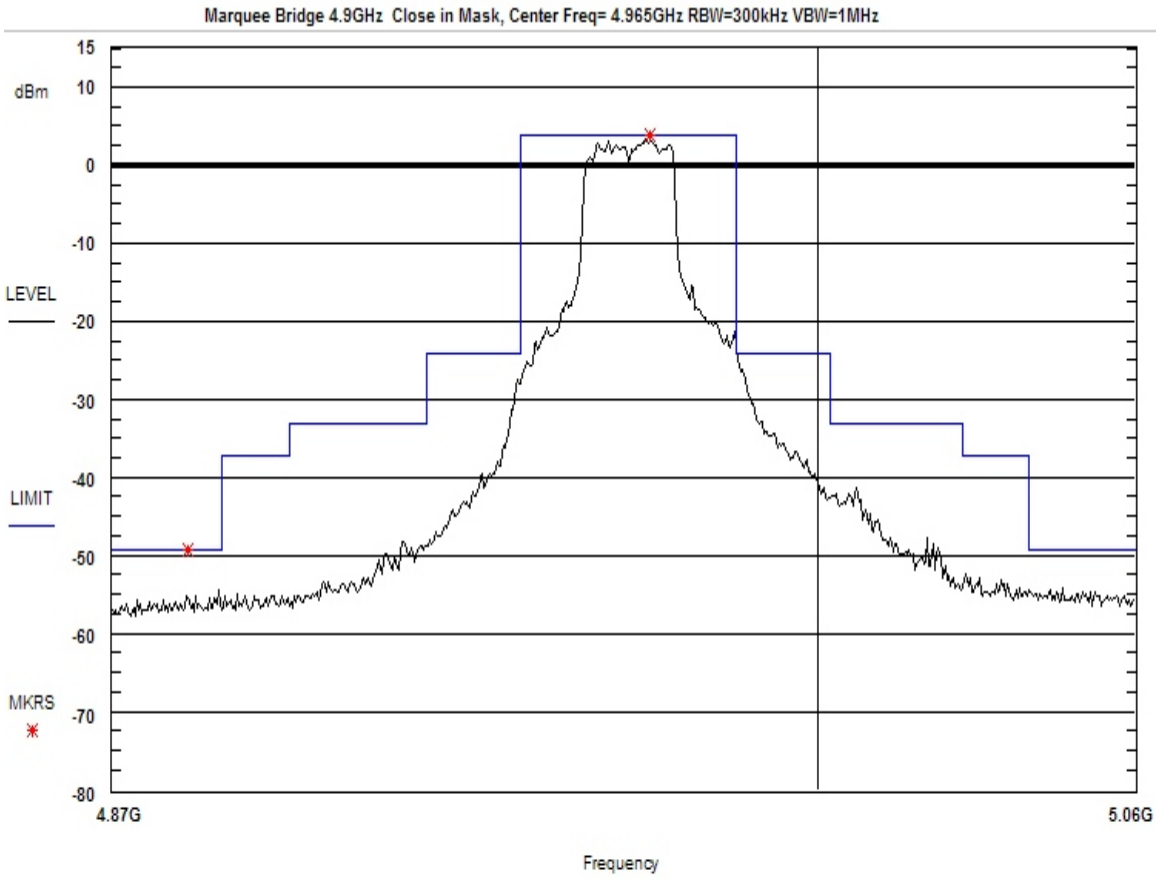

Figure 3. Emissions Mask, 90.210(l)

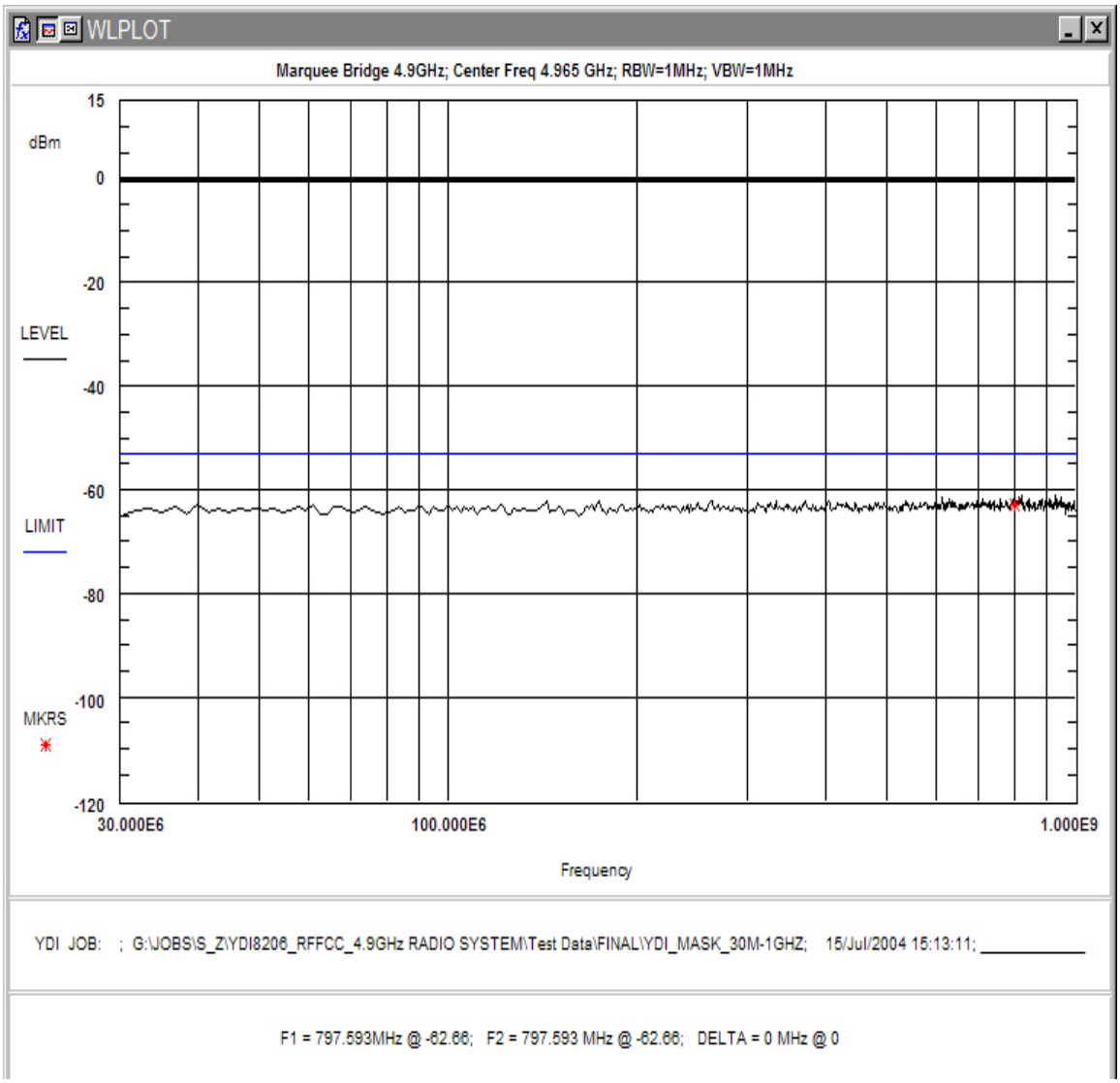

Figure 4. Spurious Emissions, 30M – 1GHz

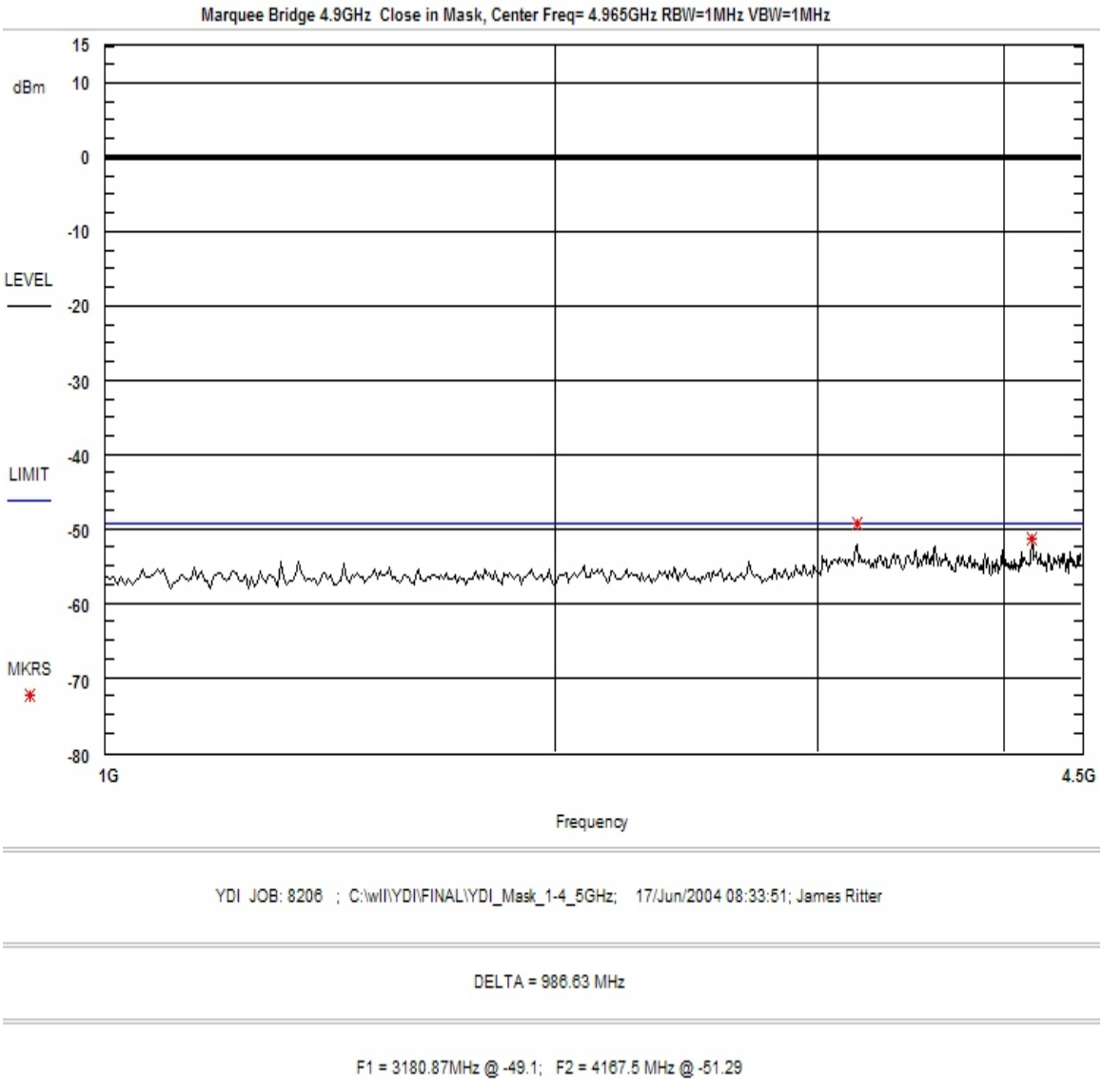

Figure 5. Spurious Emissions, 1G – 4.5GHz

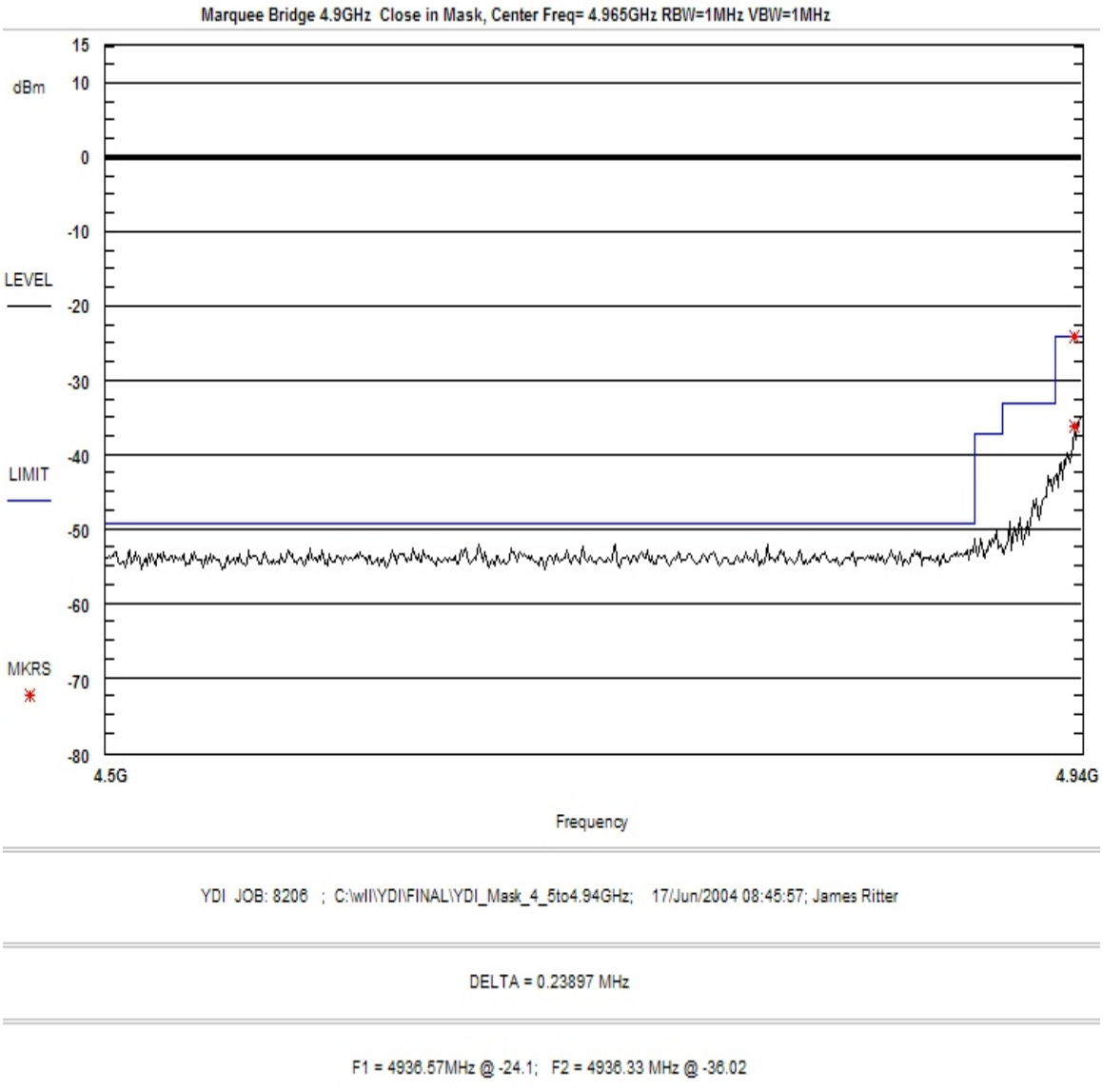

Figure 6. Spurious Emissions, 4.5G – 4.94GHz

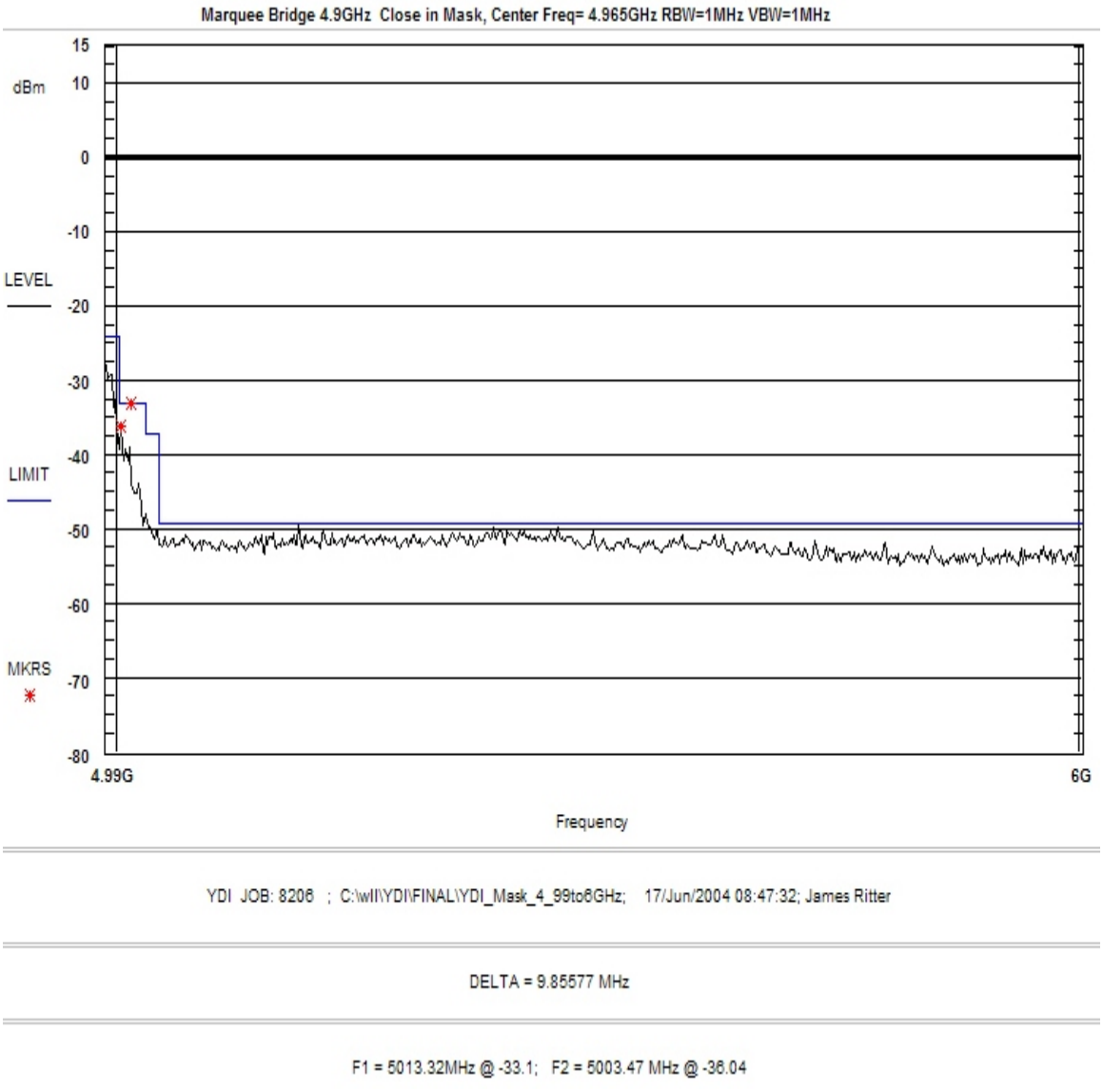

Figure 7. Spurious Emissions, 4.99G – 6GHz

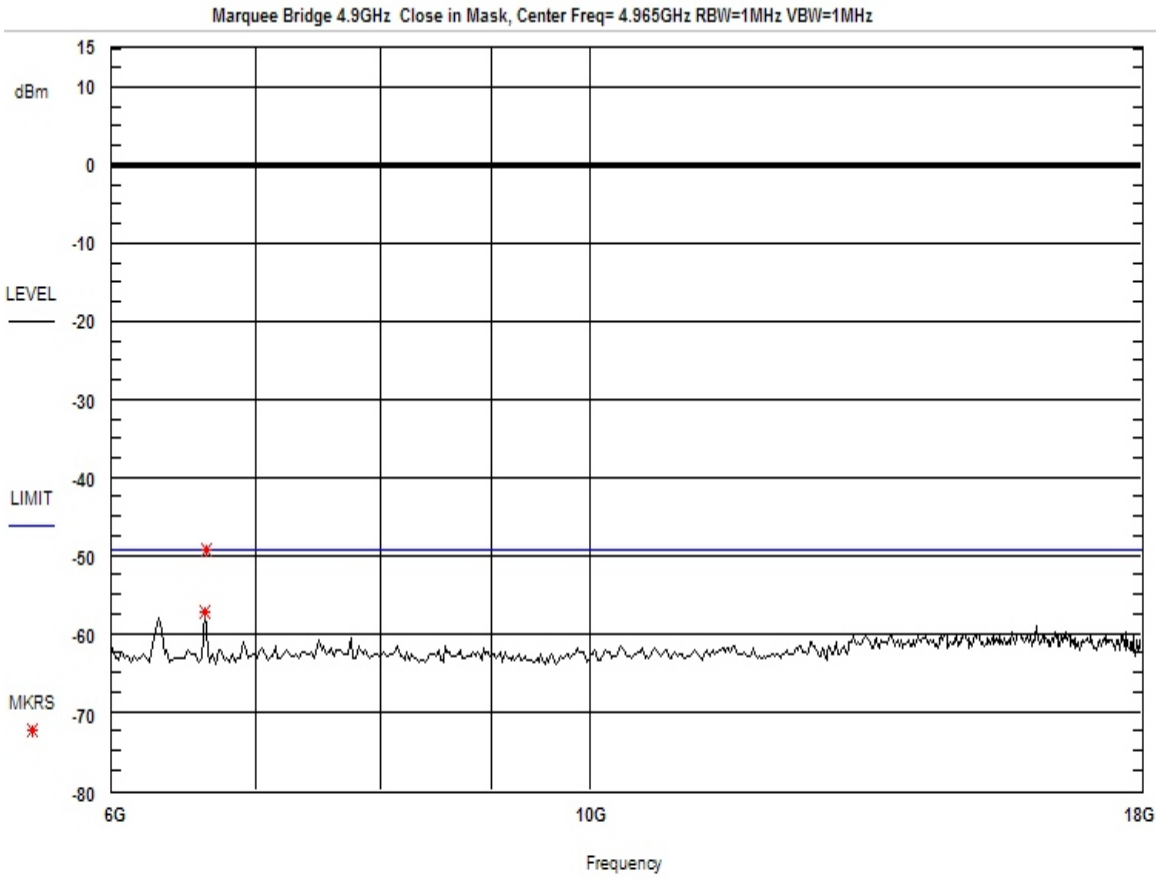

Figure 8. Spurious Emissions, 6G – 18GHz

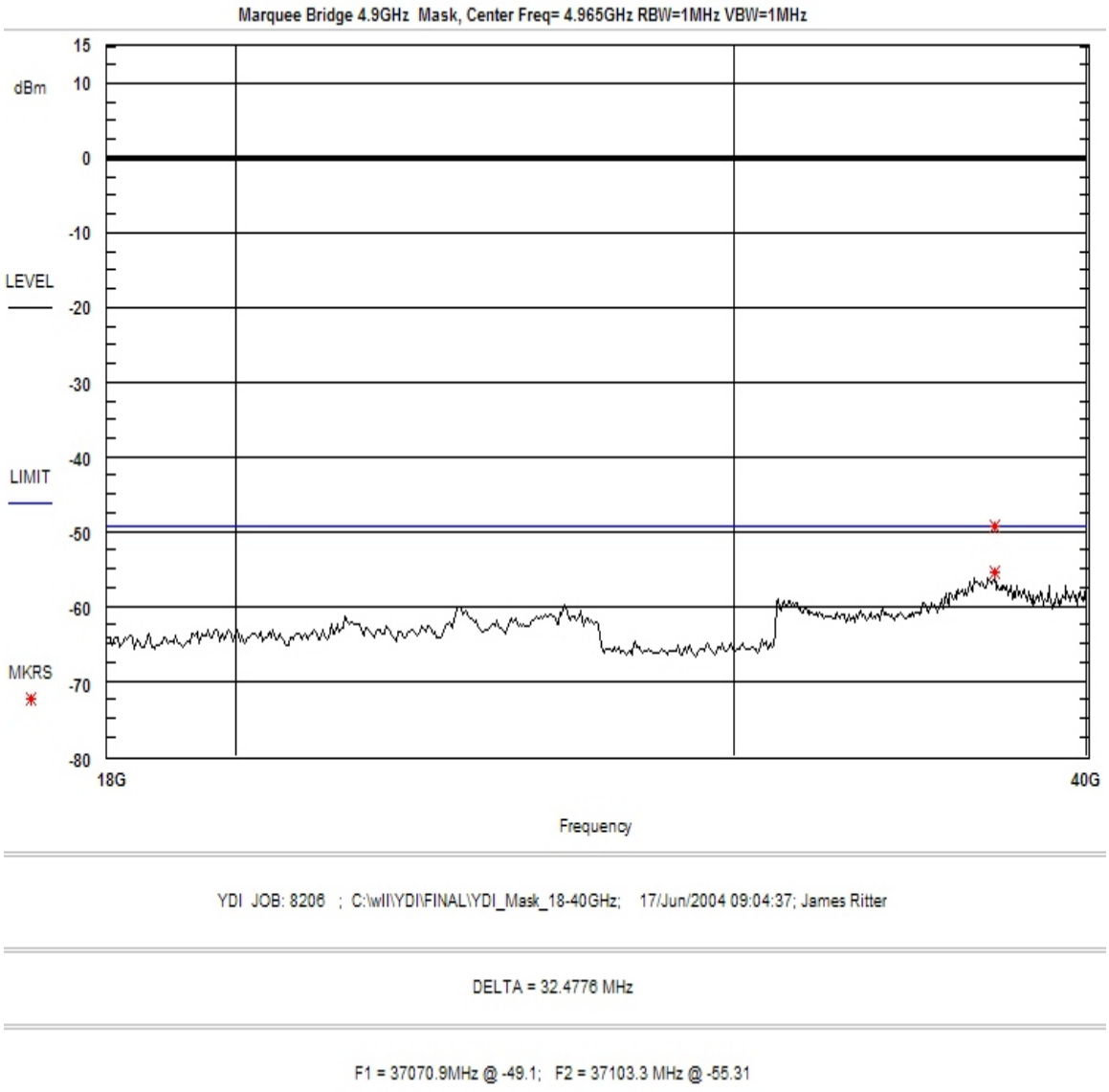

Figure 9. Spurious Emissions, 18G – 40GHz

5.4 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with requirements for radiated spurious emissions. The limits are based on the emissions mask of §90.210(l) and are as shown in the following table.

5.4.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Where emissions were detected, the EIRP levels were determined using the method of signal substitution.

The frequency range of 30 MHz to 40 GHz was measured. All emissions detected are recorded in Table 5.

Table 5: Spurious Radiated Emissions, EIRP Levels

CLIENT:	YDI	DATE:	6/17/2004
TESTER:	James Ritter	JOB #:	8206
EUT Information:		**Test Requirements:**	
EUT:	Marquee Bridge 4.9 GHz	TEST STANDARD:	FCC 90
CONFIGURATION:	In full speed mode	DISTANCE:	3m
S/N: 4240001			

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Gain dBi	Sig Gen Level dBm	EIRP Level dBm	Limit (dBm)	Margin dB
1100.050	V	315.0	1.0	54.2	5.3	-69.6	-64.3	-49.1	-15.2
1160.000	V	290.0	1.0	51.7	5.3	-74.1	-68.8	-49.1	-19.7
1199.920	V	180.0	1.0	53.8	5.5	-70.1	-64.6	-49.1	-15.5
3600.000	V	0.0	1.0	48.8	10.9	-71.7	-62.8	-49.1	-13.7
4965.000	V	90.0	1.0	70.7	10.5	-43.2	-32.7	3.9	-36.6
9930.000	V	180.0	1.0	44.3	10.2	-74.6	-64.4	-49.1	-15.3
1100.050	H	90.0	1.0	50.7	5.3	-73.2	-67.9	-49.1	-18.8
1160.000	H	0.0	1.0	51.0	5.3	-75.0	-69.7	-49.1	-20.6
1199.920	H	90.0	1.0	53.7	5.5	-71.4	-65.9	-49.1	-16.8
3600.000	H	0.0	1.0	50.3	10.9	-68.8	-60.9	-49.1	-11.8
4965.000	H	45.0	1.0	67.8	10.5	-46.1	-35.6	3.9	-39.5
9930.000	H	0.0	1.0	46.4	10.2	-72.1	-61.9	-49.1	-12.8

5.5 Emission Designator

The emission designator is determined from the necessary bandwidth, the type of modulation and the information conveyed in the signal.

For the subject unit, the following Emission Designator has been determined according to Section 2.201 of the FCC Rules.

- First Symbol, type of modulation of the main carrier: X-Other Modulation
- Second Symbol, nature of signal(s) modulating the main carrier: 1
- Third Symbol, type of information to be transmitted: D-Digital

The necessary bandwidth, Bn, is taken to be the occupied bandwidth of the signal: 20.3MHz.

Hence, the emission designator is: **20M3X1D**

5.6 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The EUT is powered by 24DC voltage supplied externally via an Ethernet injector.

Table 6. Frequency Deviation

CLIENT: YDI
MODEL NO: MB-EXT 49
DATE: 6/11/2004
JOB #: 8206
BY: Ken Gemmell/James Ritter
Limit: Specified by station authorization

Center Of Channel

Temperature Degrees C	Frequency MHz	Difference Hz	Deviation (%)
Ambient	4965.000000	0.0	0
-30	4965.250000	250000.0	0.005035
-20	4965.150000	150000.0	0.003021
-10	4965.100000	100000.0	0.002014
0	4965.050000	50000.0	0.001007
10	4965.050000	50000.0	0.001007
20	4965.100000	100000.0	0.002014
30	4965.100000	100000.0	0.002014
40	4965.200000	200000.0	0.004028
50	4965.200000	200000.0	0.004028

Upper Edge

Temperature Degrees C	Frequency MHz	Difference Hz	Deviation (%)
Ambient	4973.350000	0.0	0
-30	4973.300000	-50000.0	0.001005
-20	4973.350000	0.0	0.000000
-10	4973.350000	0.0	0.000000
0	4973.300000	-50000.0	0.001005
10	4973.300000	-50000.0	0.001005
20	4973.400000	50000.0	0.001005
30	4973.350000	0.0	0.000000
40	4973.300000	-50000.0	0.001005
50	4973.350000	0.0	0.000000

Lower edge

Temperature Degrees C	Frequency MHz	Difference Hz	Deviation (%)
Ambient	4956.850000	0.0	0
-30	4956.900000	50000.0	0.001009
-20	4956.800000	-50000.0	0.001009
-10	4956.850000	0.0	0.000000
0	4956.950000	100000.0	0.002017
10	4957.000000	150000.0	0.003026
20	4956.950000	100000.0	0.002017
30	4957.000000	150000.0	0.003026
40	4956.950000	100000.0	0.002017
50	4956.950000	100000.0	0.002017

Voltage Volts	Frequency MHz	Difference Hz	Deviation (%)
At rated	4965.000000	0	0.0
At 85%	4965.010000	-10000	0.000201
At 115%	4965.000000	0	0.000000

Notes: Measured in Peak mode