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Electromagnetic Emissions Test Report
In Accordance With
FCC Part 90
on the
Microwave Data Systems
Transmitter
Model: MDS Series 4 point to point microwave link

FCC ID NUMBER:	E5MDS- Series4
GRANTEE:	Microwave Data Systems 175 Science Parkway Rochester, NY 14620
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	March 27, 2006
FINAL TEST DATE:	March 22, 2006
AUTHORIZED SIGNATORY:	Juan Martinez Senior EMC Engineer

ACCREDITED
2016-01

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FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2, Subpart J, Section 2.1033(C) & to Industry Canada RSP-100.

2.1033(c)(1) Applicant:

Microwave Data Systems
175 Science Parkway
Rochester, NY 14620

2.1033(c)(2) & RSP-100 (4) FCC ID: E5MDS- Series4

2.1033(c)(3) & RSP-100 (7.2(a)) Instructions/Installation Manual

Please refer to Exhibit 7: User Manual, Theory of Operation, and Tune-up Procedure

2.1033(c)(4) & RSP-100 (7.2(b)(iii)) Type of emissions

FCC 90: 12M5X1D , 13M7X1D

2.1033(c)(5) & RSP-100 (7.2(a)) Frequency Range

FCC 90: **4940 – 4990 MHz**

2.1033(c)(6) & RSP-100 (7.2(a)) Range of Operation Power

FCC 90 & RSS-119**: 17.4 – 24.4 dBm**

2.1033(c)(7) & RSP-100 (7.2(a)) Maximum FCC & IC Allowed Power Level

FCC 90.210**:** Maximum power is 24.7 dBm (500mW)

2.1033(c)(8) & RSP-100 (7.2(a)) Applied voltage and currents into the final transistor elements

10Vdc, 2 Watts

2.1033(c)(9) & RSP-100 (7.2(a)) Tune-up Procedure

Please refer to Exhibit 7: User Manual, Theory of Operation, and Tune-up Procedure

2.1033(c)(10) & RSP 100 (7.2(a)) Schematic Diagram of the Transmitter

Refer to Exhibit 6: Schematic diagram

2.1033(c)(10) & RSP-100 (7.2(a)) Means for Frequency Stabilization

16 MHz TXCO (Y501)

2.1033(c)(10) & RSP-100 (7.2(a)) Means for Suppression of Spurious radiation

Please refer to Exhibit 6: Schematic diagram.

2.1033(c)(10) & RSP-100 (7.2(a)) Means for Limiting Modulation

Control by DSP (U504)

2.1033(c)(10) & RSP-100 (7.2(a)) Means for Limiting Power

Control by DSP (U504)

2.1033(c)(11) & RSP-100 (7.2(g)) Photographs or Drawing of the Equipment Identification Plate or Label

Refer to Exhibit 4

2.1033(c)(12) & RSP-100 (7.2(c)) Photographs of equipment

Refer to Exhibit 5

2.1033(c)(13) & RSP-100 (7.2(a)) Equipment Employing Digital Modulation & 90.203 (Certification Requirements)

N/A

2.1033(c)(14) & RSP-100 (7.2(b)(ii)) Data taken per Section 2.1046 to 2.1057 and RSS-133 issue 2, Rev. 1.

Refer to Exhibit 2

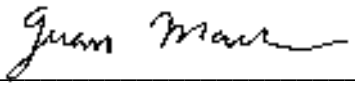
DECLARATIONS OF COMPLIANCE

Equipment Name and Model:
MDS Series 4 point to point microwave link

Manufacturer:
Microwave Data Systems
175 Science Parkway
Rochester, NY 14620

Tested to applicable standards:
FCC Part 90 (Private Land Mobile Radio Service)

I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above mentioned departmental standards (through the use of TIA/EIA-603 and the specific RSS standards applicable to this device); and that the equipment performed in accordance with the data submitted in this report.

Signature	
Name	Juan Martinez
Title	Senior EMC Engineer
	Elliott Laboratories Inc.
Address	684 W. Maude Ave
	Sunnyvale, CA 94086
	USA
Date:	March 27, 2006

Maintenance of compliance with the above standards is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

SCOPE

FCC Part 90 testing was performed for the equipment mentioned in this report. The equipment was tested in accordance with the procedures specified in Sections 2.1046 to 2.1057 of the FCC Rules. TIA-603 was also used as a test procedure guideline to perform some of the required tests.

The intentional radiator above was tested in a simulated typical installation to demonstrate compliance with the relevant FCC & RSS performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the FCC Part 90. Certification of these devices is required as a prerequisite to marketing as defined in Section 2.1033.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to FCC & Industry Canada. FCC & Industry Canada issues a grant of equipment authorization and a certification number upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product that may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

SUMMARY OF TEST RESULTS

Part 90 Test Summary

Measurement Required	FCC Part 2 & 90 Sections	Test Performed	Measured Value	Test Procedure Used	Result
Modulation Tested	16QAM 64QAM	-	-	-	-
Modulation characteristics	2.1047	Modulated with appropriated signal	-	H	-
Radiated RF power output (ERP/EIRP)	2.1046 / 90.279 & 90.205(g)	Radiated Output Power Test	-	-	-
Conducted RF power output	2.1046 / 90.279 & 90.205(g)	Conducted Output Power Test	24.4dBm (.2754 Watts)	B	Complies
Spurious emissions at antenna Port	2.1051/ 90.210(d)	Emission Limits and/or Unwanted Emission 30MHz – 40GHz (**Antenna Conducted**)	All spurious emissions < -25dBm	J	Complies
Occupied Bandwidth	2.1049/ 90.210(c) & (d)	Emission Mask and 99% Bandwidth	Refer to Plots	C & D	Complies
Field strength of spurious radiation	2.1053 / 90.210(d)	Radiated Spurious Emissions 30MHz – 40GHz	41.8dBµV/m @ 1125.0MHz (-28.5dB)	N	Complies
Frequency stability	2.1055 / 90.213	Frequency Vs. Temperature	.4 ppm	K	Complies
Frequency stability	2.1055 / 90.213	Frequency Vs. Voltage	0 ppm	L & M	Complies
Exposure to Mobile devices	2.1091	Exposure of Humans to RF Fields	MPE Calculation	-	Complies
Receiver	15.109	Receiver Spurious Emissions	-	-	-

MEASUREMENT UNCERTAINTIES

ISO Guide 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Microwave Data Systems model MDS Series 4 point to point microwave link is a "tower mounted 4.9GHz transceiver" for Public Safety organizations for applications that require high throughput and citywide coverage in the United States in the 4.94 - 4.99 GHz band. Normally, the EUT would be placed on a tabletop during operation. The EUT was, therefore, treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is -48vdc @ 1amp max.

The sample was received on March 22, 2006 and tested on March 22, 2006. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave Data Systems	MDS Series Four	Tower mounted Microwave Transceiver	TBP	E5MDS-Series4

ENCLOSURE

The EUT does not have an enclosure as it is designed to be installed within the enclosure of a host. The EUT is self enclosed for direct outdoor antenna mounting

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with the emission specifications.

SUPPORT EQUIPMENT

No local equipment was used during emissions testing.

The following equipment was used as remote support equipment for emissions testing:

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave	Series 4	IDU	-	-

EUT INTERFACE PORTS

The I/O cabling configuration during emissions testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Antenna power	50 ohm termination	-	-	-
DC Input	IDU	coaxial	Shielded	1

EUT OPERATION DURING TESTING

Device transmitting continuously at the data rate and power stated in each run description. For frequency stability the device was placed into a CW mode (ART software showed "Single Carrier" mode).

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TEST SITE

GENERAL INFORMATION

Final test measurements were taken on March 22, 2006 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. Pursuant to Section 2.948 of the FCC Rules, construction, calibration, and equipment data has been filed with the Commission.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing are performed in conformance with Section 2 of FCC Rules. Measurements are made with the EUT connected to a spectrum analyzer through an attenuator to prevent overloading the analyzer.

RADIATED EMISSIONS CONSIDERATIONS

Radiated measurements are performed in an open field environment or Anechoic Chamber. The test site is maintained free of conductive objects within the CISPR 16-1 defined elliptical area.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers are capable of measuring over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the particular detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. If average measurements above 1000MHz are performed, the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz is used.

INSTRUMENT CONTROL COMPUTER

A personal computer is utilized to record the receiver measurements of the field strength at the antenna, which is then compared directly with the appropriate specification limit. The receiver is programmed with appropriate factors to convert the received voltage into filed strength at the antenna. Results are printed in a graphic and/or tabular format, as appropriate.

The test receiver also provides a visual display of the signal being measured.

PEAK POWER METER

A peak power meter and thermister mount may be used for output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or EUT and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transmitters and transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

The requirements of ANSI C63.4:2003 were used for configuration of the equipment turntable. It specifies that the test height above ground for table-mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An appendix of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

General: For Transmitters with detachable antenna, direct measurements for output power, modulation characterization, occupied bandwidth, and frequency stability are performed with the antenna port of the EUT connected to either the power meter, modulation analyzer, or spectrum analyzer via a suitable attenuator and/or filter. The attenuators and/or filters are used to ensure that the transmitter fundamental will not overload the front end of the measurement instrument.

Procedure B – Power Measurement (Conducted Method): The following procedure was used for transmitters that do use external antennas.

1) Set the EUT to maximum power and to the lowest channel.
2) Either a power meter or a spectrum analyzer was used to measure the power output.
3) If a spectrum analyzer was used a resolution and video bandwidth 10kHz was used to measure the power output. Corrected for any external attenuation used for the protection of the input of analyzer. In addition, For CDMA or TDMA modulations set spectrum analyzer resolution to 1MHz and video to 30 kHz. Use video averaging with a 100-sample rate.
4) If a power meter was used, corrected for any external attenuation used for the protection of the input of the sensor head. Also set the power sensor correction by setting up the frequency range that will be measured.
5) Repeat this for the high channel and all modulations that will be used and all output ports used for transmission

Procedure C - Occupied Bandwidth (Conducted Method): Either for analog, digital, or data modulations, occupied bandwidth was performed. The EUT was set to transmit the appropriate modulation at maximum power. The bandwidth was measured using following methods:

1) The built-in 99% function of the spectrum analyzer was used.
2) If the built-in 99% is not available then the following method is used:

   26-dB or 20-dB was subtracted to the maximum peak of the emission. Then the display line function was used, in conjunction with the marker delta function, to measure the emissions bandwidth.

3) For the above two methods a resolution and video bandwidth of 100 or 300 Hz was used to measure the emission's bandwidth.

Procedure D - Occupied Bandwidth (Conducted Emission Mask): Either for analog, digital, or data modulations, emission mask was performed. The EUT was set to transmit the appropriate modulation at maximum power. The following method was used:

Taken from Part 90.210 Emission Mask M

The following Resolution and Video bandwidth was used to show compliance for the above requirement: 1% of the occupied bandwidth.

Procedure H - Other Types of Equipment: Either digital or data modulated signals were simulated, by software or external sources, to performed the required tests. The EUT was set to transmit the appropriate digital modulation.

Procedure J – Antenna Conducted Emissions: For spurious emission measurements at the antenna terminal the following procedure was performed:

1) Set the transmitting signal at the middle of the operating range of the transmitter, as specified in the standard. Power is set to maximum and then to minimum.
2) Set the spectrum analyzer display line function to –25-dBm.
3) Set the spectrum analyzer bandwidth to 10kHz <1GHz and 1 MHz >1GHz.
4) For the spectrum analyzer, the start frequency was set to 30 MHz and the stop frequency set to the 10^{th} harmonic of the fundamental. All spurious or intermodulation emission must not exceed the –25dBm limit.
5) Steps 1 to 4 were repeated for all modulations and output ports that will be used for transmission.

Procedure K - Frequency Stability: The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The spectrum analyzer is configured to give a 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature. The Temperature chamber was varied from –30 to +50° C (or +60° C for some IC RSS standards, if applicable) in 10 degrees increment. The EUT was allowed enough time to stabilize for each temperature variation.

Procedure L - Frequency Stability: For AC or DC operated devices the nominal voltage is varied to 85% and to 115% at either room temperature or at a controlled +20°C temperature.

Procedure M - Frequency Stability: For battery-powered devices the voltage battery end-point is determined by reducing the dc voltage until the unit ceases to function. This is performed at either room temperature or at a controlled +20°C temperature.

Procedure N - Field Strength Measurement: The EUT was set on the turntable and the search antenna position 3 meters away. The output antenna terminal was terminated with a 50-ohm terminator. The EUT was set at the middle of the frequency band and set at maximum output power.

For the first scan, a pre-liminary measurement is performed. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. One or more of these is with the antenna polarized vertically while the one or more of these are with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

For the final measurement, Substitution method is performed on spurious emissions not being 20-dB below the calculated radiated limit. Substitution method is performed by replacing the EUT with a horn antenna and signal generator. The horn antenna factors can be reference to a half-wave dipole in dBi. The signal generator power level was adjusted until a similar level, which was measured on the first scan, is achieved on the spectrum analyzer. The level on the signal generator is than added to the antenna factor, in dBi, which will give the corrected value.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

RADIATED EMISSIONS SPECIFICATION LIMITS

The limits for radiated emissions are based on the power of the transmitter at the operating frequency. Data is measured in the logarithmic form of decibels relative to one milliwatt (dBm) or one microvolt/meter (dBuV/m,). The field strength of the emissions from the EUT is measured on a test site with a receiver.

Below is a formula example used to calculate the attenuation requirement, relative to the transmitters power output, in dBuV/m. For this example an operating power range of 3 watts is used. The radiated emissions limit for spurious signals outside of the assigned frequency block is $43+10\text{Log}_{10}$(mean output power in watts) dB below the measured amplitude at the operating power.

CALCULATIONS – EFFECTIVE RADIATED POWER

$$E(V/m) = \frac{\sqrt{30 * P * G}}{d}$$

E= Field Strength in V/m
P= Power in Watts (for this example we use 3 watts)
G= Gain of antenna in numeric gain (Assume 1.64 for ERP)
d= distance in meters

$$E(V/m) = \frac{\sqrt{30 * 3 \text{ watts} * 1.64 \text{ dB}}}{3 \text{ meters}}$$

20 * log (4.049 V/m * 1,000,000) = 132.14 dBuV/m @ 3 meters

FCC Rules request an attenuation of 43 + 10 log (3) or 47.8 dB for all emissions outside the assigned block, the limit for spurious and harmonic emissions is:

132.1 dBuV/m – 47.8 dB = 84.3 dBuV/m @ 3 meter.

Note: Substitution Method is performed for spurious emission not being 20-dB below the calculated field strength.

EXHIBIT 1: Test Equipment Calibration Data

1 Page

1000 - 40,000 MHz, Transmitter Radiated Emissions, 06-Apr-06
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	26-Apr-06
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	28-Nov-06
Hewlett Packard	EMC Spectrum Analyzer 30Hz - 40GHz, Sunnyvale (SA40) Red	8564E (84125C)	1148	09-Sep-06

Antenna Conducted Measurements, 06-Apr-06
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer 30Hz - 40GHz, Sunnyvale (SA40) Red	8564E (84125C)	1148	09-Sep-06
Rohde & Schwarz	Power Sensor 100uW - 10 Watts	NRV-Z53	1236	01-Mar-06
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1290	09-May-06

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T63391 24 Pages

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Emissions Spec:	FCC part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Microwave Data Systems

Model

MDS Series 4 point to point microwave link

Date of Last Test: 8/2/2006

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Emissions Spec:	FCC part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is a "tower mounted 4.9GHz transceiver" for Public Safety organizations for applications that require high throughput and citywide coverage in the United States in the 4.94 - 4.99 GHz band. Normally, the EUT would be placed on a tabletop during operation. The EUT was, therefore, treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is -48vdc @ 1amp max.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave Data Systems	MDS Series Four	Tower mounted Microwave Transceiver	TBP	E5MDS-Series4

EUT Enclosure

The EUT does not have an enclosure as it is designed to be installed within the enclosure of a host. The EUT is self enclosed for direct outdoor antenna mounting

Modification History

Mod. #	Test	Date	Modification
1	-	-	None

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Emissions Spec:	FCC part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave	Series 4	IDU	-	-

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Antenna power	50 ohm termination	-	-	-
DC Input	IDU	coaxial	Shielded	1

EUT Operation During Emissions Tests

Device transmitting continuously at the data rate and power stated in each run description. For frequency stability the device was placed into a CW mode.

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	N/A

Radiated Spurious Emissions, FCC Part 90

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 3/22/2005
Test Engineer: Mark Briggs, Juan Martinez
Test Location: SV #1
Config. Used: 1
Config Change: None
EUT Voltage: 48Vdc to IDU

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

The measurement antenna was located 3 meters from the EUT.

Ambient Conditions:

Temperature: 18 °C
Rel. Humidity: 65 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	RE, 1000 - 40,000 MHz - Spurious Emissions Transmit Mode	FCC 90	Pass	41.8dBµV/m @ 1125.0MHz (-28.5dB)

Modifications Made During Testing:

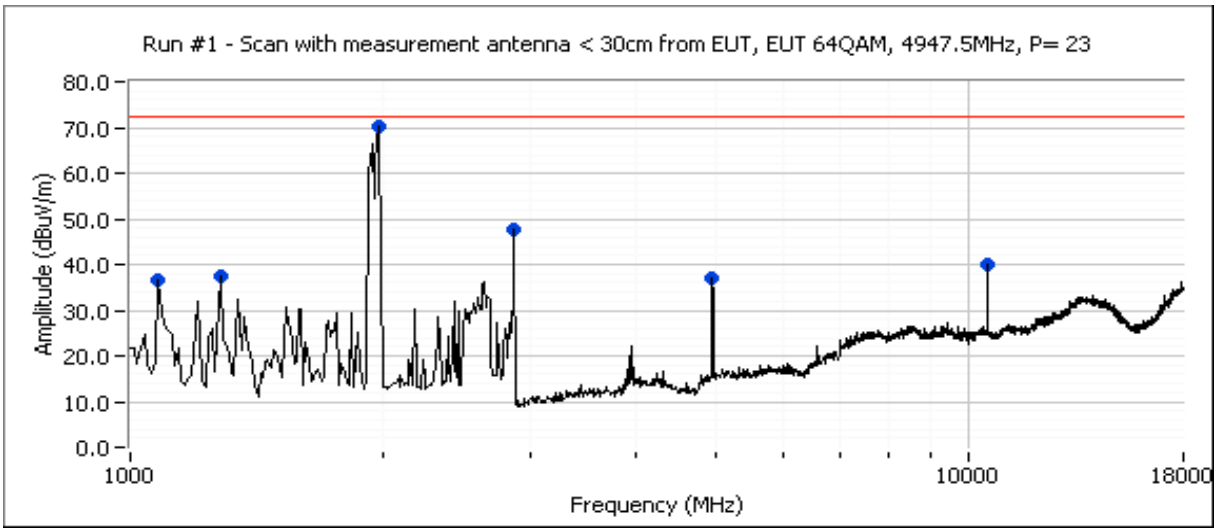
No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	N/A

Run #1: Radiated Spurious Emissions, Transmit Mode: Final Field Strength and Substitution Measurements
Spurious measurements made on the power setting and modulation that gave the highest PSD (64 QAM, highest power setting). Spurious limits based on the lowest output power (17.1 dBm, 0.05W) and the limit is 55+10Log(P) dB below the fundamental signal = 42dB. The field strength limit was based on the -42dB attenuation and the lowest power (17.1dBm), which would be a reference power of -25dBm, field strength of ~ 70.3dBuV/m.
Frequency = 4947.5 MHz, Power setting = 23 (24.2dBm), Modulation = 64 QAM



Preliminary measurements made with measurement antenna < 30cm from the EUT and results extrapolated to 3m using 20log(0.3/3).

Frequency	Level	Pol	FCC 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1078.355	36.5	V	-	-	Peak	-	-	Ambient
1285.066	37.7	V	-	-	Peak	-	-	Ambient
1974.585	70.3	V	-	-	Peak	-	-	GSM/CDMA Cellular ambient
1988.472	70.3	V	-	-	Peak	-	-	GSM/CDMA Cellular ambient
1989.003	70.3	V	-	-	Peak	-	-	GSM/CDMA Cellular ambient
1970.598	70.3	V	-	-	Peak	-	-	GSM/CDMA Cellular ambient
2875.407	47.6	V	-	-	Peak	-	-	Ambient, pulsed signal
4947.500	36.9	V	-	-	Peak	-	-	Fundamental, leakage
10523.70	40.1	V	-	-	Peak	-	-	Ambient, pulsed signal

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	N/A

Final measurements made at a 3m test distance

Frequency	Level	Pol	FCC 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1124.989	41.8	V	70.3	-28.5	AVG	71	1.0	Leakage from IF interface cable
9893.655	31.9	V	70.3	-38.4	AVG	242	1.0	Harmonic Noise floor
9895.400	32.2	H	70.3	-38.1	AVG	82	1.0	Harmonic Noise floor
14841.41	40.5	H	70.3	-29.8	AVG	69	1.0	Harmonic Noise floor
1125.104	37.7	H	70.3	-32.6	AVG	337	1.0	Leakage from IF interface cable
14841.97	40.4	V	70.3	-30.0	AVG	32	1.0	Harmonic Noise floor

Note 1:	The field strength limit in the tables above was calculated from the -25dBm eirp limit detailed in the standard using the free space propagation equation: $E=\sqrt{(30PG)}/d$. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Above 18GHz, no emissions were observed above the noise floor

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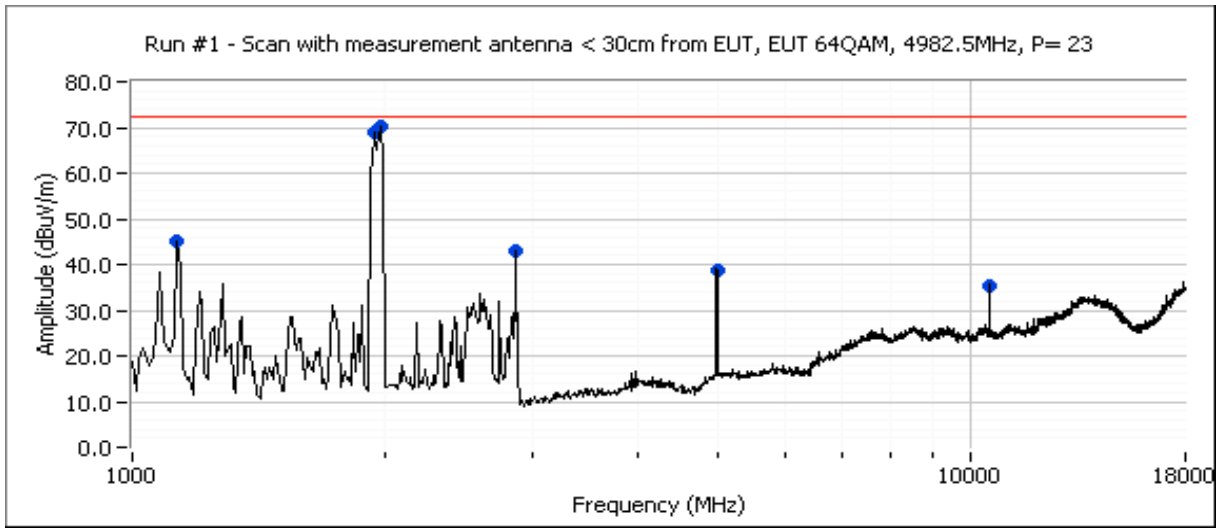
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	N/A

Frequency = 4982.5 MHz, Power setting = 23 (24.4dBm), Modulation = 64 QAM



Preliminary measurements made with measurement antenna < 30cm from the EUT and results extrapolated to 3m using 20log(0.3/3).

Frequency	Level	Pol	FCC 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4982.500	38.9	V	-	-	Peak	-	-	Fundamental leakage
1948.779	70.1	V	-	-	Peak	-	-	Cellular ambient
1974.593	70.1	V	-	-	Peak	-	-	Cellular ambient
1988.198	70.1	V	-	-	Peak	-	-	Cellular ambient
2875.756	43.0	V	-	-	Peak	-	-	Ambient, pulsed
1125.174	45.3	V	70.3	-25.0	Peak	-	-	Leakage from IF interface cable
10516.33	35.4	V	-	-	Peak	-	-	Ambient, pulsed

Final measurements made at a 3m test distance

Frequency	Level	Pol	FCC 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
9966.330	30.5	V	70.3	-39.8	AVG	190	1.0	Harmonic Noise floor
14947.22	39.0	V	70.3	-31.3	AVG	360	1.0	Harmonic Noise floor
9964.380	31.2	H	70.3	-39.1	AVG	106	1.0	Harmonic Noise floor
14946.24	41.4	H	70.3	-28.9	AVG	121	1.0	Harmonic Noise floor
1125.034	48.4	V	70.3	-21.9	AVG	58	1.0	Leakage from IF interface cable
1125.029	40.2	H	70.3	-30.1	AVG	23	1.0	Leakage from IF interface cable

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	N/A

Note 1:	The field strength limit in the tables above was calculated from the -25dBm eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Above 18GHz, no emissions were observed above the noise floor

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Antenna Conducted Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 3/22/2005
Test Engineer: Mark Briggs
Test Location: SV #1

Config. Used: 1
Config Change: None
EUT Voltage: 48Vdc to IDU

General Test Configuration

Connected the radios antenna port directly to the spetrum analyzer. Used external attenuation to protect the analyzer input. Any losses were included into the measurements.

For the out of band measurements the limit is based on the following: 20.1dBm (Average Power) and Per 90.210 (m)(6) 50 dB attenuation. Per this emissions must be below 19 dBm - 50 dB = **-31 dBm. (Note: 19 dBm was selected as this gives the worse case attenuation for both Spurious conducted and radiated).**

Ambient Conditions:

Temperature: 19 °C
Rel. Humidity: 48 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Power Output & PSD	Part 90	Pass	Refer to run
1	Occupied Bandwith	FCC 90.210 (Mask M)	Pass	Refer to plots
2	Out of Band	Part 90 - high power	Pass	-40.8dBm (noise floor), limit = -25dBm

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Run #1: Power Output and Power Spectral Density

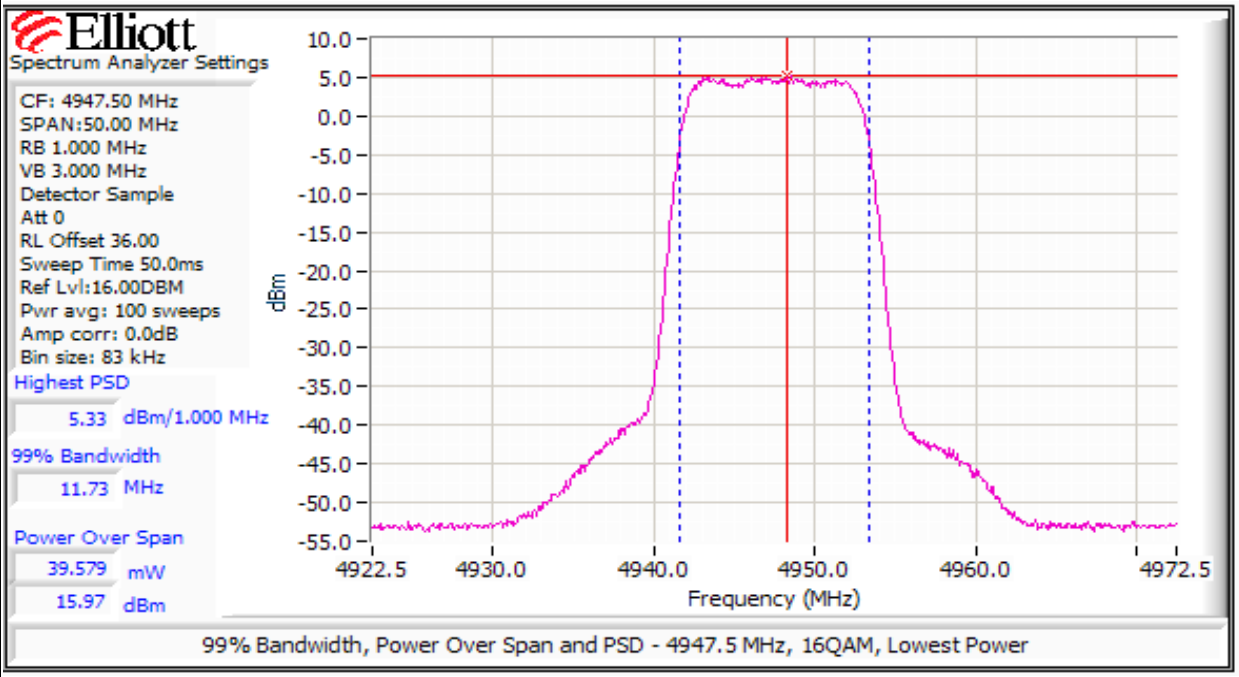
Measurements made at three different power settings to demonstrate that the system is capable of meeting the maximum permitted eirp with antennas of gains between 39.5dBi, 36.1dBi and 33.1dBi. The highest power setting (23.1dBm) is limited by the spectral mask.

BW	Freq. (MHz)	Gmax dBi	Output Power Avg[1]	Output Power Avg[2]	Limit (dBm)	PSD[2] (dBm)	PSD limit (MHz)	Modulation	Setting	Mask
13.700	4947.5	39.5	17.4	16.0	18.3	5.3	7.5	16QAM	16.0	-
12.500	4947.5	39.5	17.4	16.0	18.3	5.1	7.5	64QAM	16.0	-
	4982.5	39.5	17.1	15.9	18.3	5.5	7.5	16QAM	16.0	-
	4982.5	39.5	17.2	16.0	18.3	5.4	7.5	64QAM	16.0	-
	4947.5	36.1	21.7	19.9	21.7	9.1	10.9	16QAM	20.0	-
	4947.5	36.1	21.1	20.1	21.7	9.3	10.9	64QAM	20.0	-
	4982.5	36.1	21.4	20.2	21.7	9.5	10.9	16QAM	20.0	-
	4982.5	36.1	21.0	20.3	21.7	9.5	10.9	64QAM	20.0	-
	4947.5	*33.1*	*24.6*	*22.9*	*24.7*	*12.1*	*13.9*	*16QAM*	*23.0*	***FAIL***
	4947.5	*33.1*	*24.6*	*23.1*	*24.7*	*12.3*	*13.9*	*64QAM*	*23.0*	***FAIL***
	4947.5	33.1	24.0	22.2	24.7	11.7	13.9	16QAM	23.0	Pass, note 7
	4947.5	33.1	24.0	22.5	24.7	11.6	13.9	64QAM	23.0	Pass, note 7
	4982.5	33.1	24.4	22.9	24.7	12.2	13.9	16QAM	23.0	Pass
	4982.5	33.1	24.4	23.1	24.7	12.4	13.9	64QAM	23.0	Pass

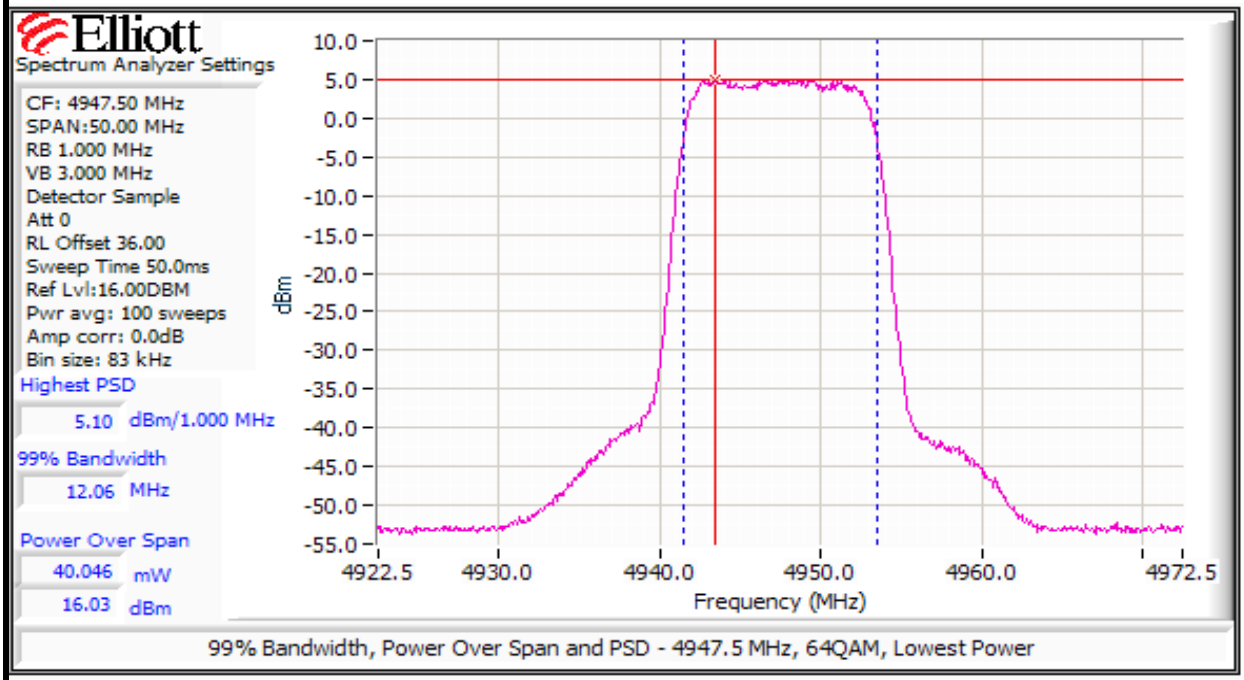
Note 1	Average power measured using a power meter with average power sensor
Note 2	Average power measured from integration over emission bandwidth with a spectrum analyzer, RB=1MHz, VB=3MHz, Sample detector and power averaging. Power spectral density taken from the same plot.
Note 3	Setting is the power setting used in the control software and is included for reference only
Note 4	Limits are based on the device's use limited to point-to-point applications only, therefore power allowed is limited to a 57.8dBm eirp. Device uses the following antennas: 8' dish, G=39.5dBi; 6' dish, G=36.1dBi; 4' dish, G=33.1dBi; 3' dish, G=30.5; 2'dish, G=27.1. Power and PSD measurements were evaluated at three power settings (one power setting for the 8' dish, one for the 6' dish and one for the remaining antennas.
Note 5	Mask plots follow the power/power spectral density plots and use the Mask 'M' detailed in Part 90.210. Mask measured using RB=VB=300kHz (BW > 1% of 15 MHz channel), video averaging enabled. The **channel power** detailed in the mask plot is obtrained from the mask plot which uses video averaging and not power averaging. It is included for reference only.
Note 6	Mask measurements made at the highest power setting only. Spurious measurements made on the power setting and modulation that gave the highest PSD (64 QAM, highest power setting). Spurious limits based on the lowest eirp system (51dBm eirp).
Note 7	Power and mask measurements repeated at a lower power setting to comply with Mask M, note that spurious measurements were made on the modulation that gave the highest PSD (64 QAM, highest power setting) and at the higher power setting that failed mask M - these would represent worst case as the spurious limits were based on the lowest eirp system (51dBm eirp).

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, Lowest Power Setting, Low Channel



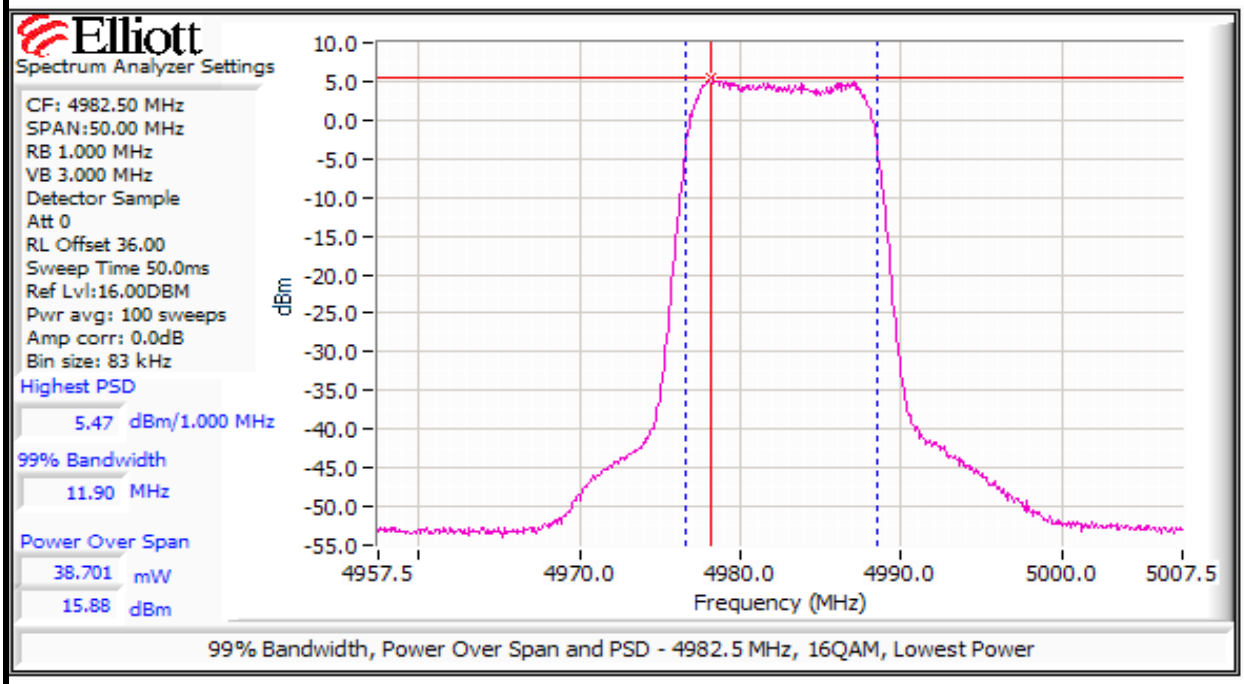
99% Bandwidth, Power Over Span and PSD - 4947.5 MHz, 16QAM, Lowest Power



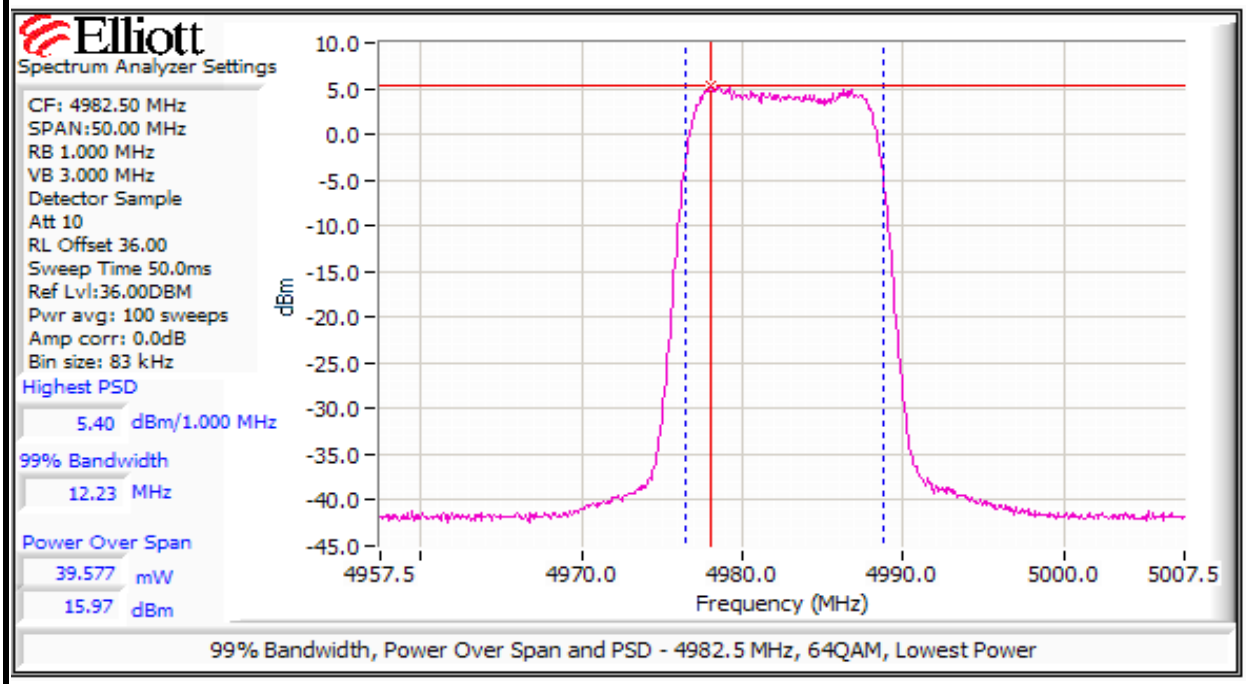
99% Bandwidth, Power Over Span and PSD - 4947.5 MHz, 64QAM, Lowest Power

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, Lowest Power Setting, High Channel



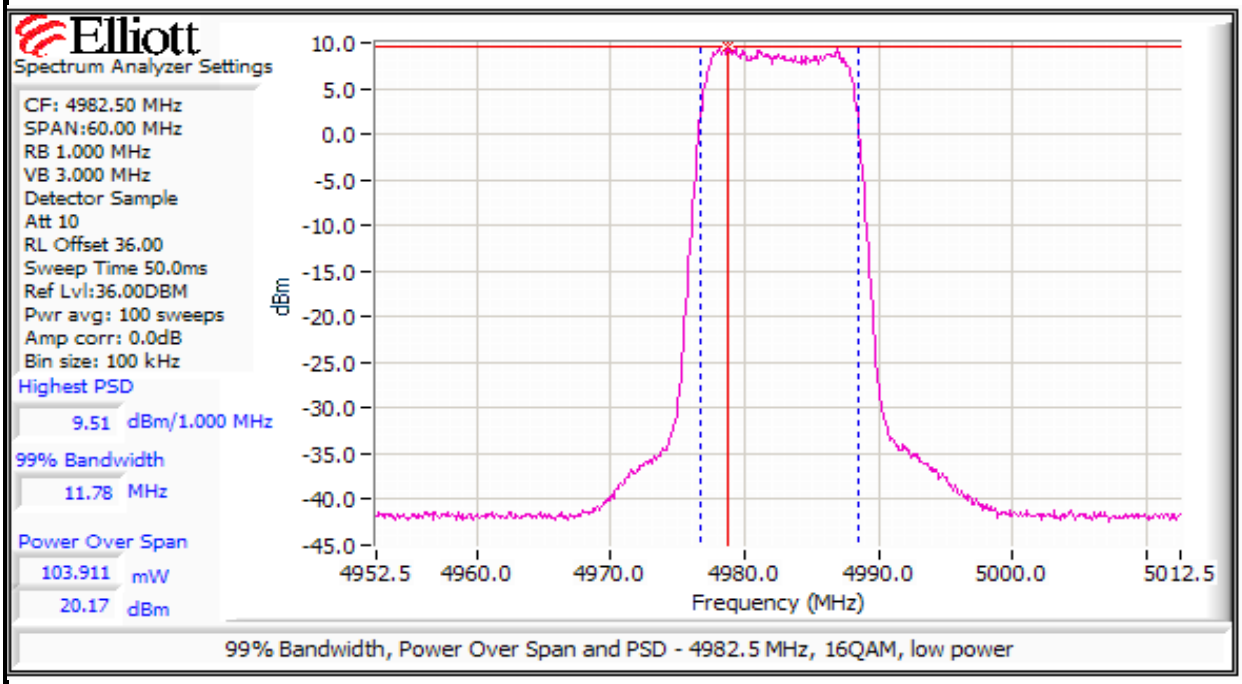
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 16QAM, Lowest Power



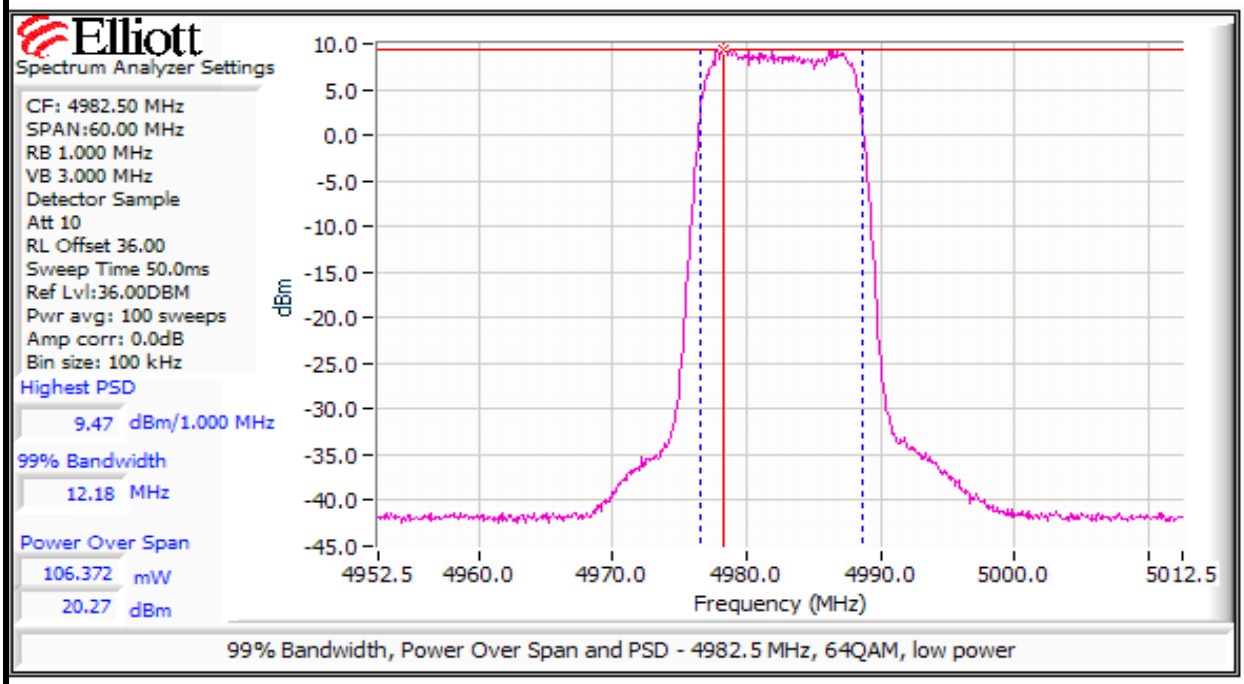
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 64QAM, Lowest Power

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, Middle Power Setting, Low Channel



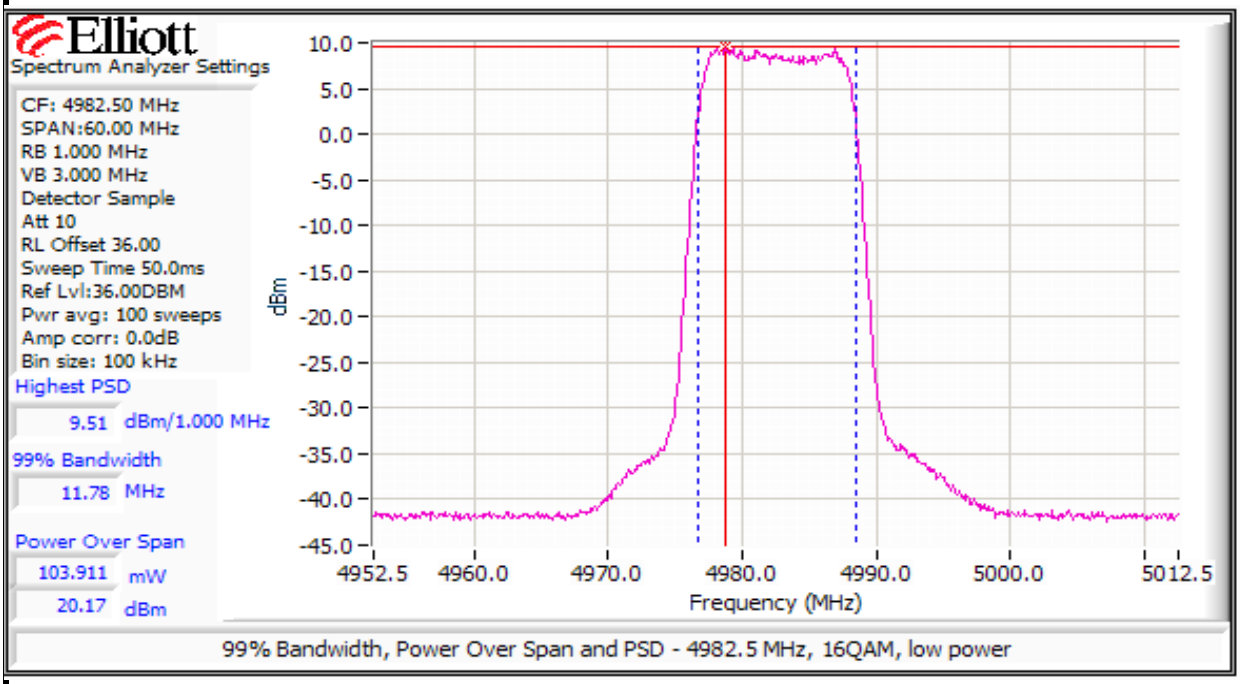
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 16QAM, low power



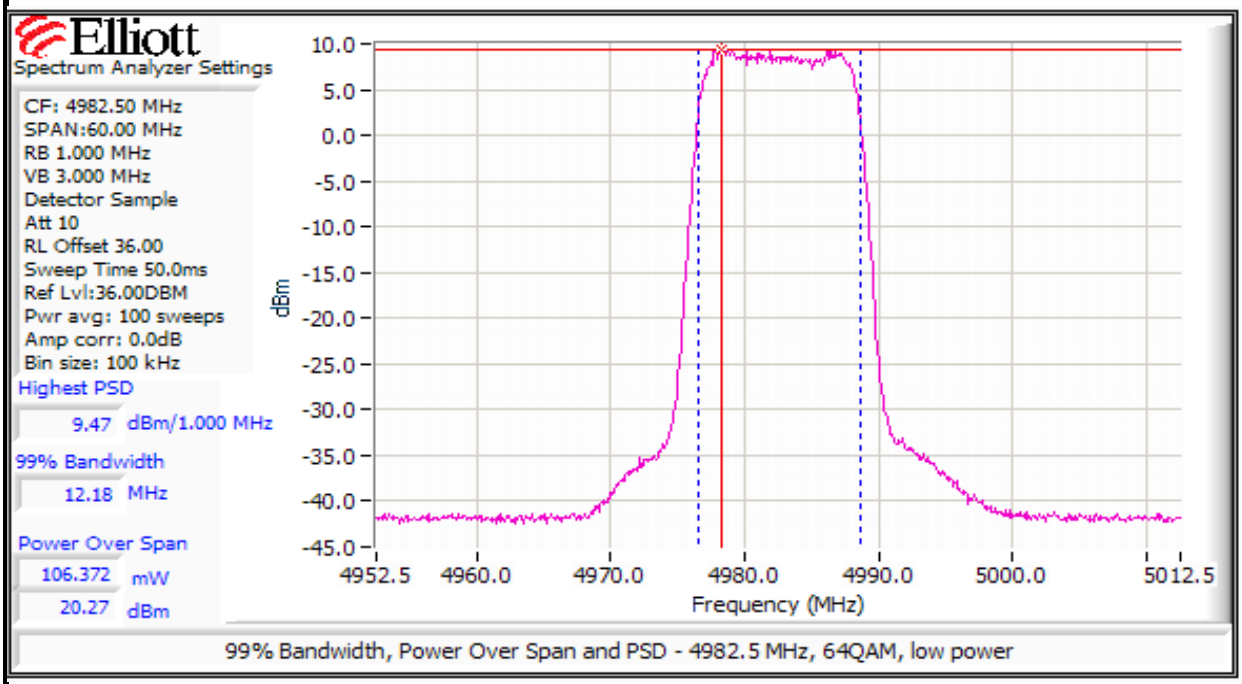
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 64QAM, low power

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, Middle Power Setting, High Channel



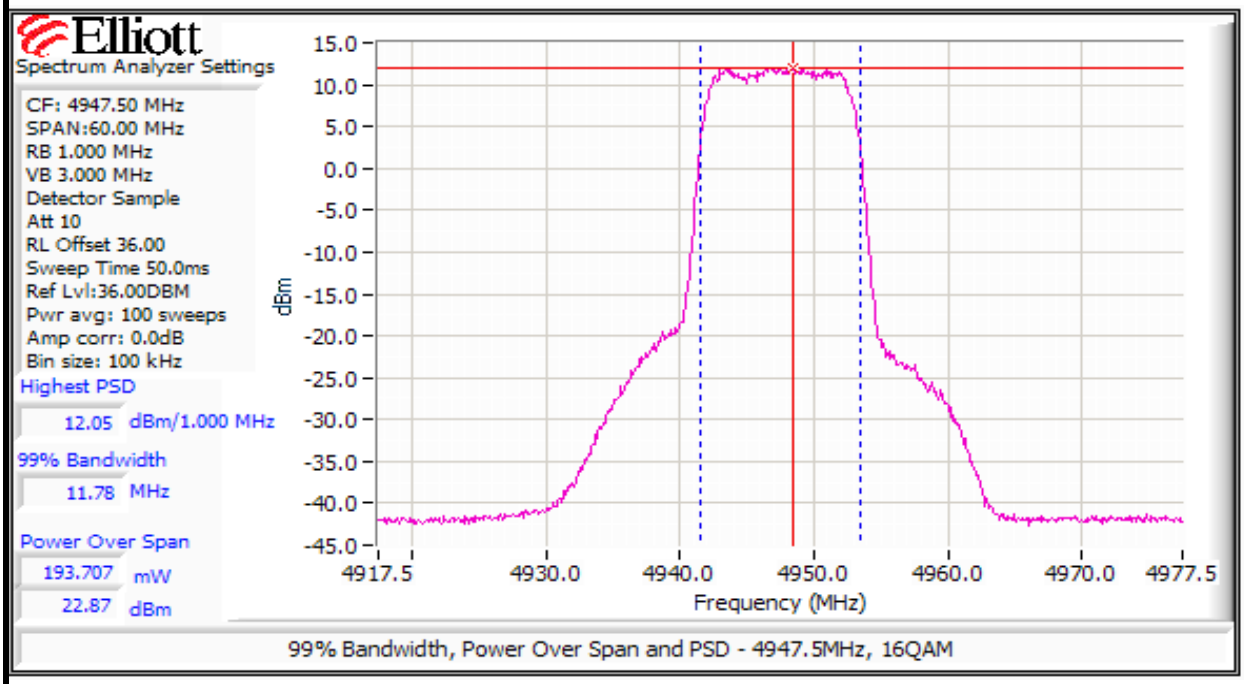
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 16QAM, low power



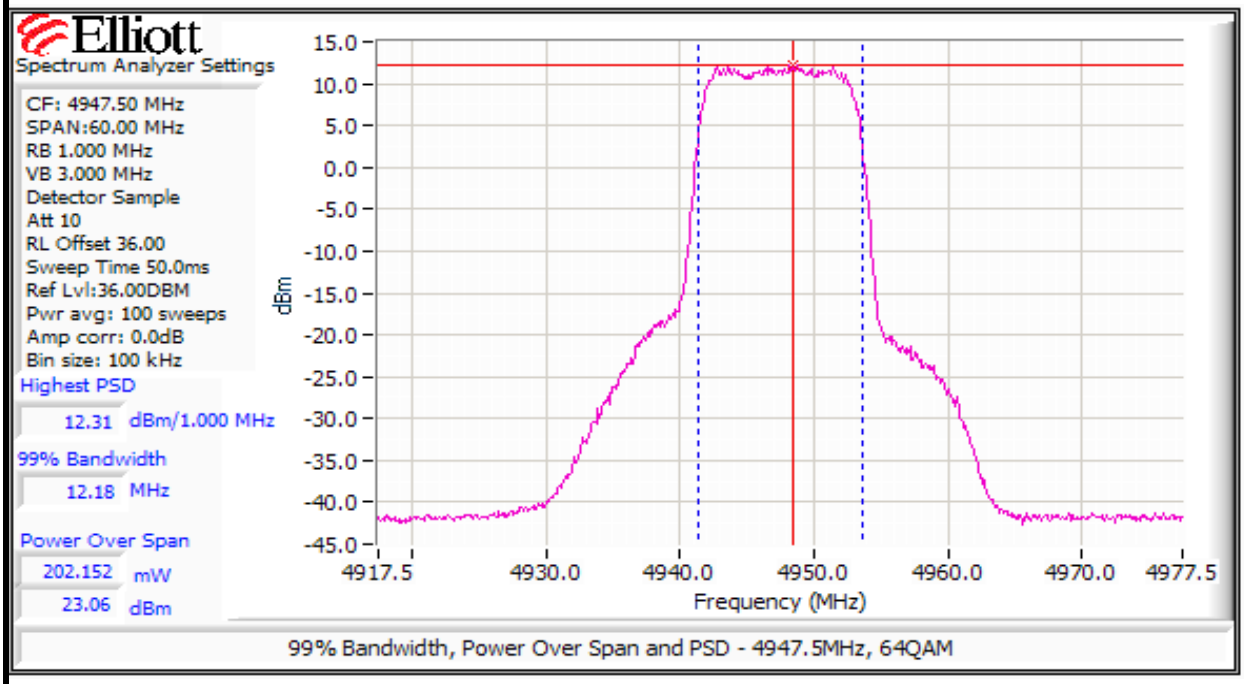
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 64QAM, low power

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, High Power Setting, Low Channel



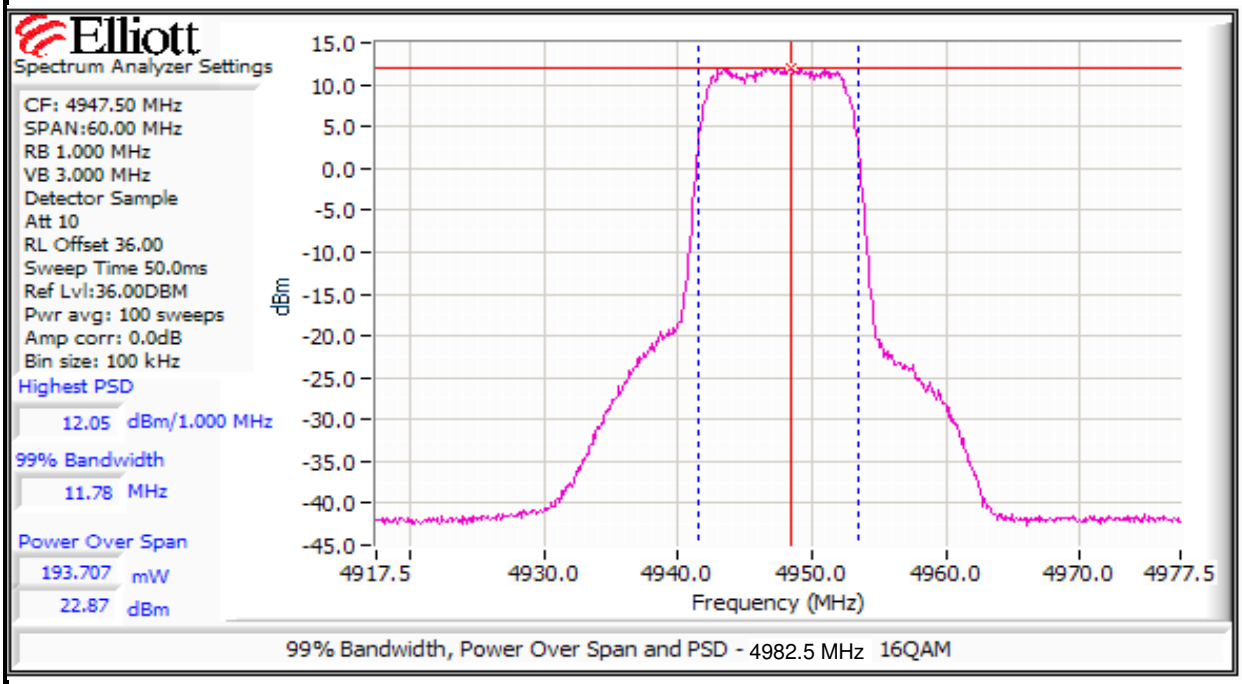
99% Bandwidth, Power Over Span and PSD - 4947.5MHz, 16QAM



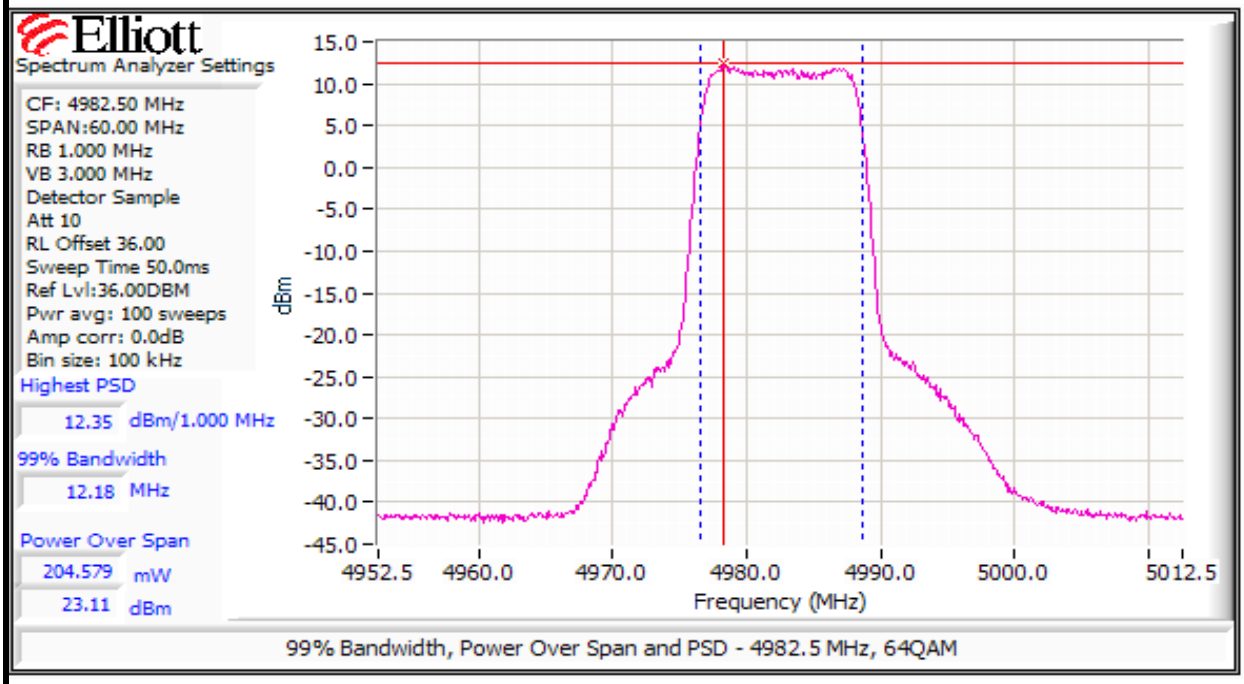
99% Bandwidth, Power Over Span and PSD - 4947.5MHz, 64QAM

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Power and PSD Plots, 16QAM and 64QAM, High Power Setting, High Channel



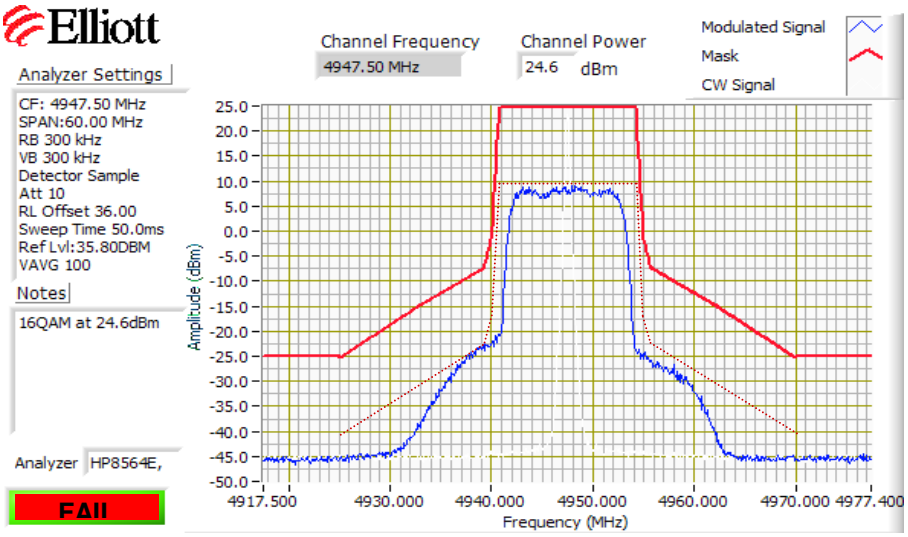
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz 16QAM



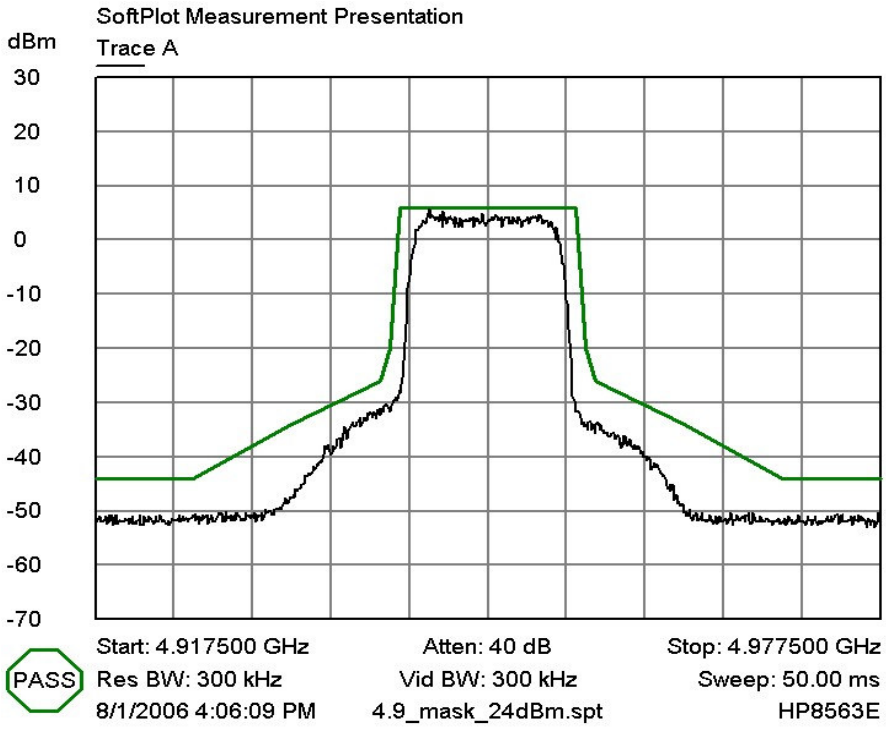
99% Bandwidth, Power Over Span and PSD - 4982.5 MHz, 64QAM

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Mask Plot - 16QAM Low Channel



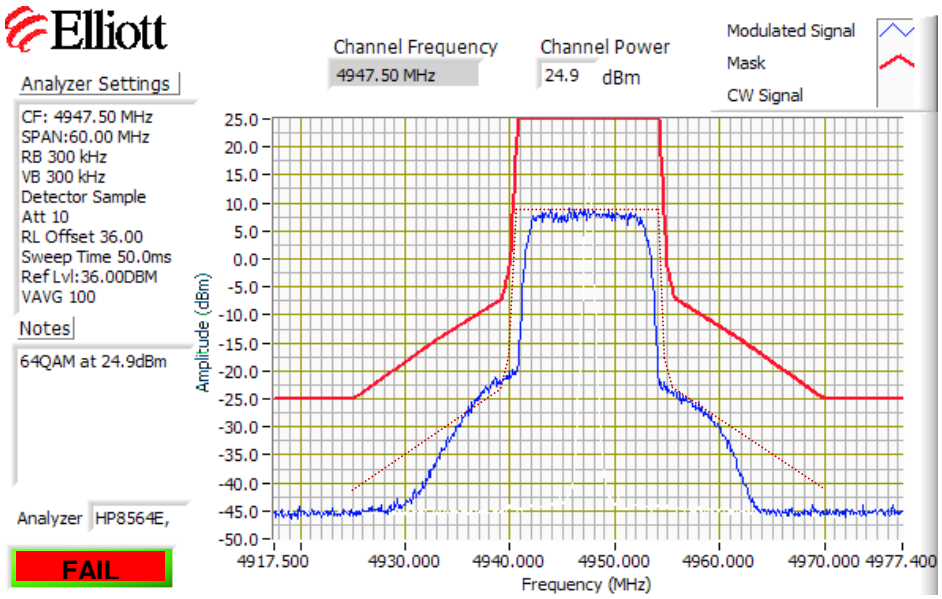
Above: Initial mask measurement with power set to 24.6dBm - device fails new mask interpretation (dotted red line).



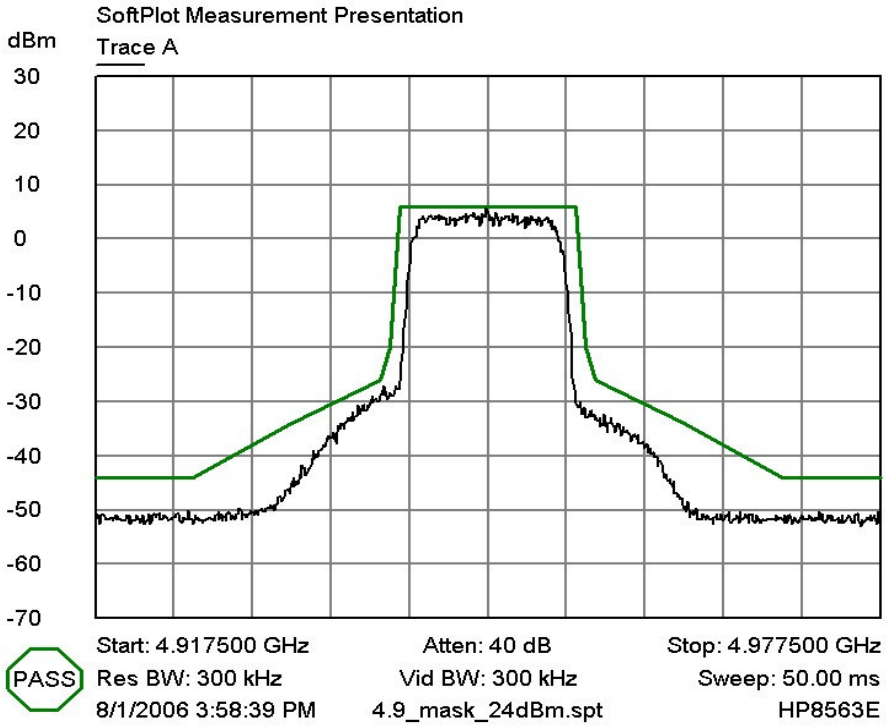
4947.5 MHz 25Mbps (16QAM) with power setting of 24dBm (Average power measured with avreage power sensor).

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Mask Plot - 64QAM Low Channel



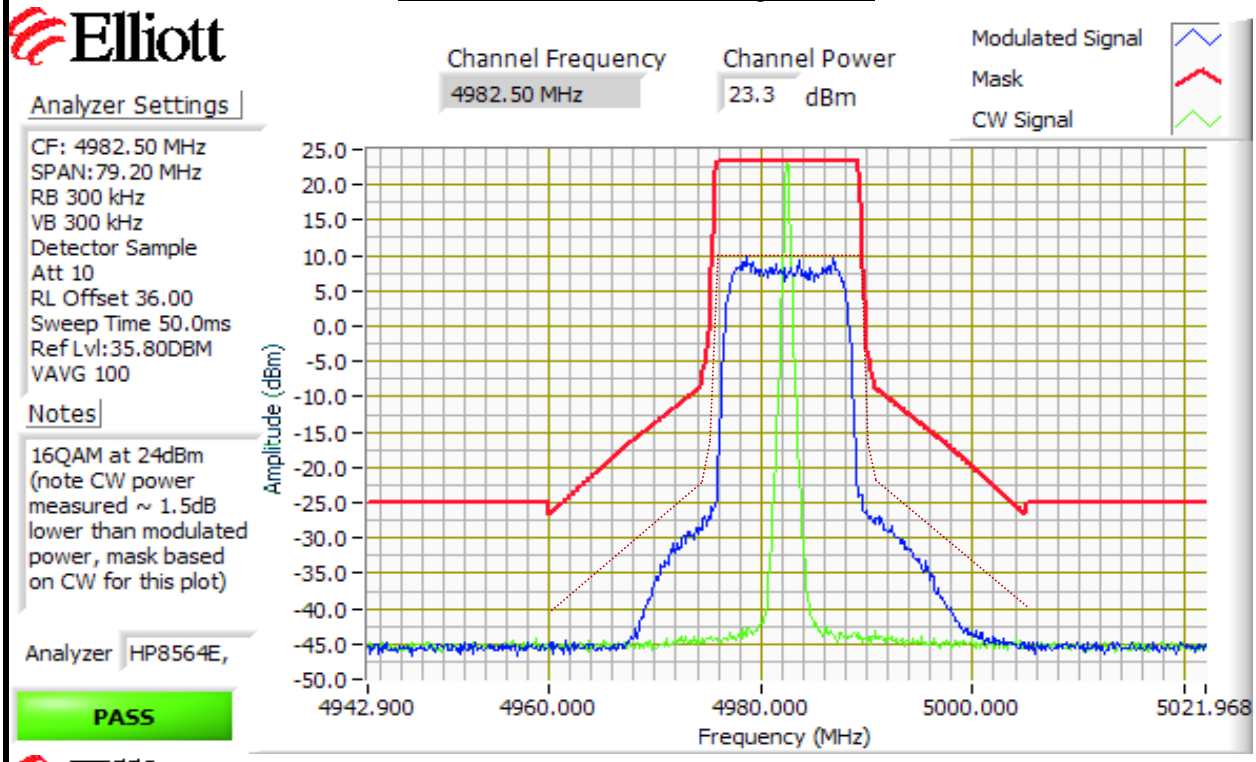
Above: Initial measurement with power set to 24.6dBm - device fails new mask interpretation (dotted red line).

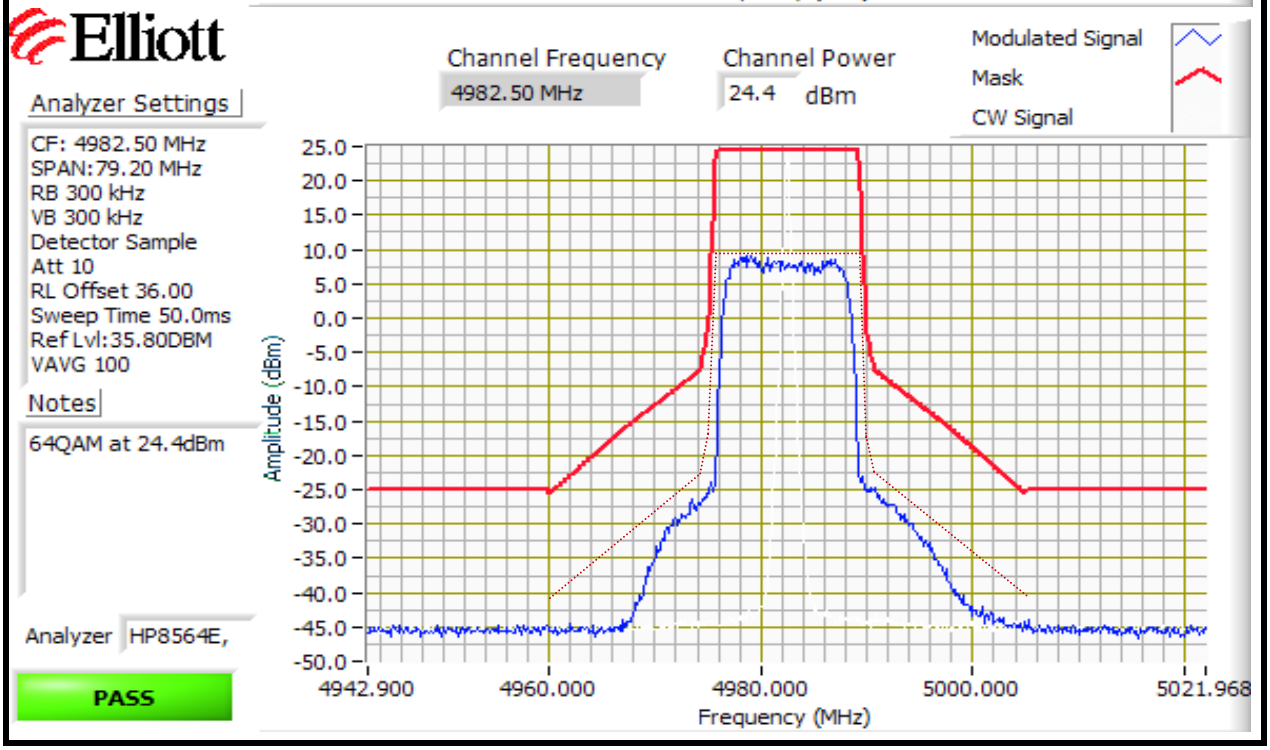


4947.5 MHz 50Mbps (64QAM) with power setting of 24dBm (Average power measured with average power sensor).

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Mask Plot - 16QAM and 64 QAM High Channel

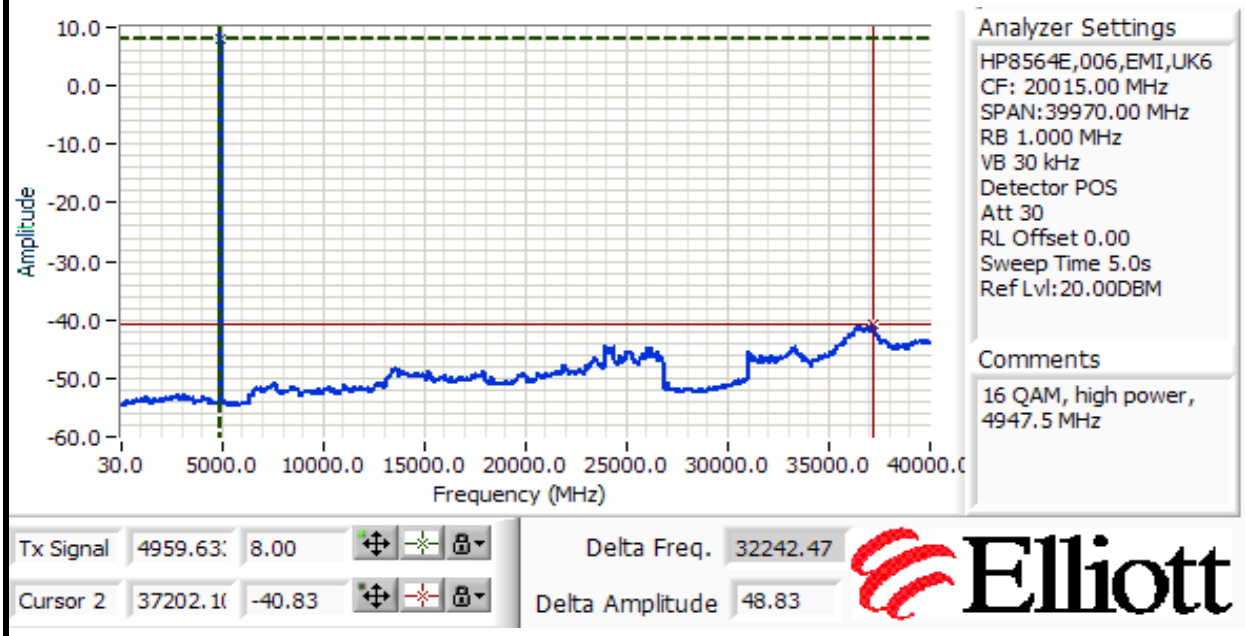




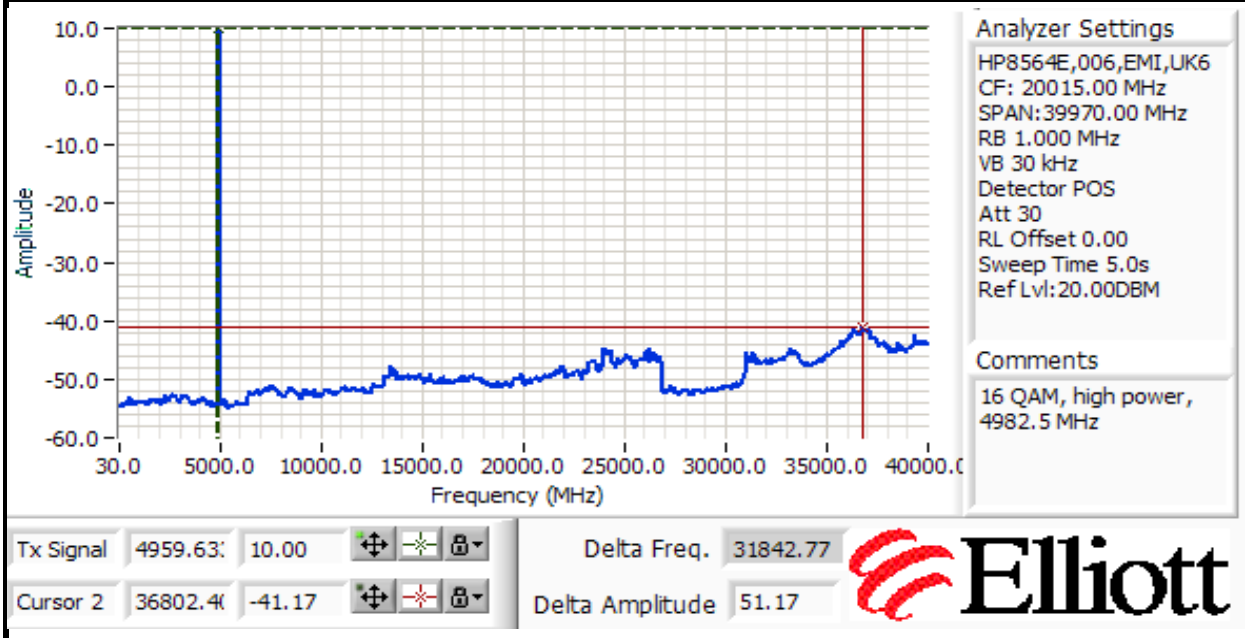
Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

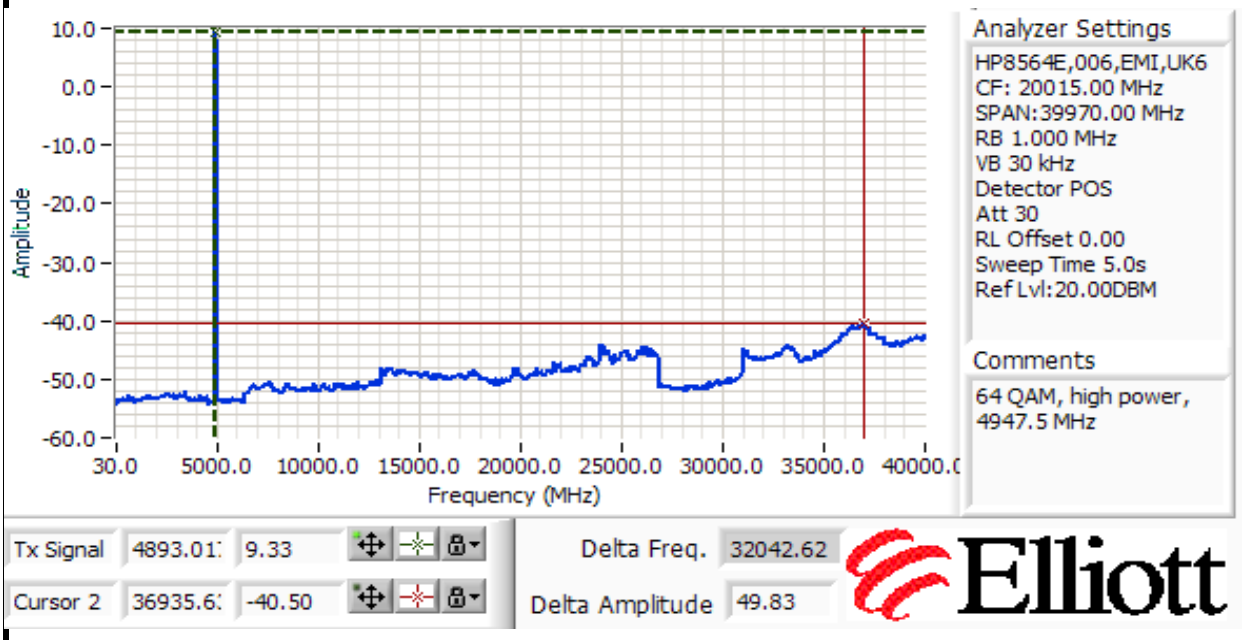
Run #2: Out of Band Spurious Emissions (Antenna Port), 30MHz - 40 GHz

The spurious limits were based on the lowest output power (17.1 dBm, 0.05W). This gave a limit of 42 dBc below the fundamental signal. The limit would, therefore, be [17.1 - 42] = **-25dBm**. The measurements were made with the output power set at nominal 25dBm average. As the device met the limit for the lowest power setting at the highest power setting, measurements were not made at other power settings.
Measurements were made using RB=1MHz and VB=30kHz. The RB was greater than 1% of the signal bandwidth.

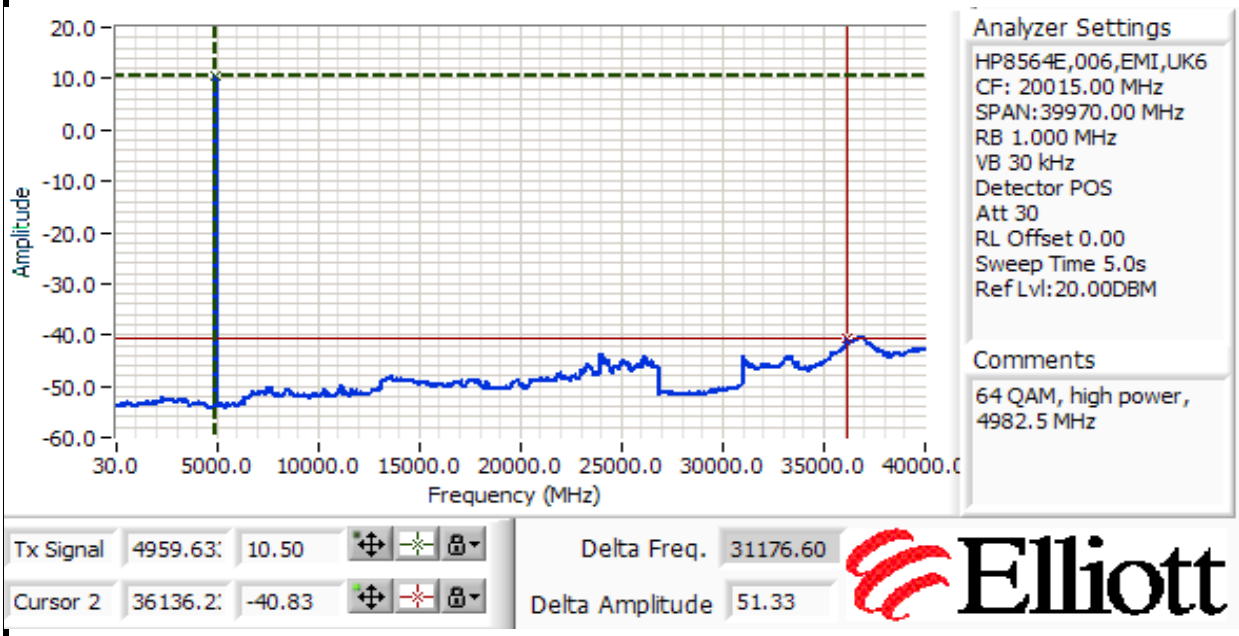


Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio





Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio



Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Radio Performance Test - Part 90
Frequency Stability

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 2/23/2006
Test Engineer: Jmartinez/Mark Briggs
Test Location: Environmental Chamber
Config. Used: 1
Config Change: None
EUT Voltage: 48Vdc to IDU

General Test Configuration

The EUT's rf port was connected to the measurement instrument's rf port, via an attenuator or dc-block if necessary. EUT was place inside an environmental chamber.

Summary of Results

Run #	Test Performed	Limit	Result	Value / Margin
1,2	Frequency Stability Over Temperature and Voltage	Part 90	Pass	+0.4/-0.1ppm

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J62991
Model:	MDS Series 4 point to point microwave link	T-Log Number:	T63325
		Account Manager:	Esther Zhu
Contact:	Greg Mills		
Spec:	FCC part 90	Class:	Radio

Run #1: Temperature Vs. Frequency

T (°C)	Ref Frequency[1] (MHz)	Frequency at T (MHz)	Drift (Hz)	Drift (ppm)
-30	4947.501017	4947.500592	-425	-0.1
-20	4947.501017	4947.500552	-465	-0.1
-10	4947.501017	4947.501634	617	0.1
0	4947.501017	4947.501334	317	0.1
10	4947.501017	4947.501059	42	0.0
20	4947.501017	4947.501017	0	0.0
30	4947.501017	4947.501100	83	0.0
40	4947.501017	4947.501559	542	0.1
50	4947.501017	4947.503025	2008	0.4
		Frequency drift:	+2008/-465Hz	+0.4/-0.1ppm

Note 1:	Ref. Frequency: Frequency measured at 20°C and nominal input voltage(s). EUT transmitting CW signal. Measurements made with RB=300Hz, VB=3MHz, Span = 5kHz.

Run #2: Voltage Vs. Frequency

Nominal Voltage is: 48 Vdc

Voltage (Dc)	Ref Frequency[1] (MHz)	Frequency Drift (MHz)	Drift (Hz)	Drift (ppm)	Comment
85%	4947.501017	4947.501184	167	0.0	40.8 v
115%	4947.501017	4947.501184	167	0.0	55.2 v
		Frequency drift:	+167/-0Hz	+0.0/-0ppm	

Note 1:	Ref. Frequency: Frequency measured at 20°C and nominal input voltage(s). EUT transmitting CW signal. Measurements made with RB=300Hz, VB=3MHz, Span = 5kHz.

EXHIBIT 3: Test Configuration Photographs

Uploaded as A Separate Attachment

EXHIBIT 4: Theory of Operation
Microwave Data Systems Model MDS Series 4 point to point microwave link

Uploaded as A Separate Attachment

EXHIBIT 5: Proposed FCC ID Label & Label Location

Uploaded as A Separate Attachment

EXHIBIT 6: Detailed Photographs
Microwave Data Systems Model MDS Series 4 point to point microwave link

Uploaded as A Separate Attachment

EXHIBIT 7: Installation Guide
Microwave Data Systems Model MDS Series 4 point to point microwave link

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EXHIBIT 8: Block Diagram
Microwave Data Systems Model MDS Series 4 point to point microwave link

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EXHIBIT 9: Schematic Diagrams
Microwave Data Systems Model MDS Series 4 point to point microwave link

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