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Electromagnetic Emissions Test Report and Request for Class II Permissive Change pursuant to FCC Part 15, Subpart C (15.247) DTS Specifications and Industry Canada RSS 210 Issue 5 for an Intentional Radiator on the Microwave Data Systems Model: CW500 SONET Version

FCC ID:	E5MDS-CW500
GRANTEE:	Microwave Data Systems 175 Science Parkway Rochester, NY 14620
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	August 21, 2003
FINAL TEST DATE:	August 12, August 13 and August 14, 2003

Mark Briggs

AUTHORIZED SIGNATORY: _____

Mark Briggs
Director of Engineering

ACCREDITED

DECLARATIONS OF COMPLIANCE

Equipment Name and Model:
CW500 SONET Version

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

Tested to applicable standards:
RSS-210, Issue 5, November 2001 (Low Power License-Exempt Radiocommunication Devices)
FCC Part 15.247 (DTS)

Measurement Facility Description Filed With Department of Industry:

Departmental Acknowledgement Number: IC2845 **SV2** Dated August 12, 2001
Departmental Acknowledgement Number: IC2845 **SV4** Dated July 19, 2001

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 ANSI C63.4 as detailed in section 5.3 of RSS-210, Issue 5); and that the equipment performed in accordance with the data submitted in this report.

Signature	_____
Name	Mark Briggs
Title	Director of Engineering
Company	Elliott Laboratories Inc.
Address	684 W. Maude Ave Sunnyvale, CA 94086 USA
Date:	August 21, 2003

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.).

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SCOPE

An electromagnetic emissions test has been performed on the Microwave Data Systems model CW500 SONET Version pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and RSS-210 Issue 5 for licence-exempt low power devices. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC 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.

The test results recorded herein are based on a single type test of the Microwave Data Systems model CW500 SONET Version and therefore apply only to the tested sample. The sample was selected and prepared by Dennis McCarthy of Microwave Data Systems

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules and RSS-210 Issue 5 for license-exempt low power devices for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization 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 which are subsequently manufactured.

SUMMARY OF RESULTS

FCC Part 15 Section	RSS 210 Section	Description	Measured Value	Comments	Result
15.247(a)	6.2.2(o)(b)	Digital Modulation	Systems uses OFDM techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	6.2.2(o)(b)	6dB Bandwidth	36.8 MHz for SONET data rate	Minimum allowed is 500kHz	Complies
	RSP 100	99% Bandwidth	42 MHz	For information only	Complies
15.247 (b) (3) 15.247 (b) (4) (ii)	6.2.2(o)(b)	Output Power, 5725 - 5850 MHz	24.8 dBm (0.3029 Watts) EIRP = 2188W	Point-to-point applications: Maximum permitted is 1Watt, with unlimited EIRP.	Complies
15.247(d)	6.2.2(o)(b)	Power Spectral Density	-6.7 dBm / 3kHz for SONET data rate	Maximum permitted is 8dBm/3kHz	Complies
15.247(c)	6.2.2(o)(e1)	Antenna Port Spurious Emissions – 30MHz – 40GHz	All spurious emissions < -20dBc	All spurious emissions < -20dBc.	Complies
15.247(c) / 15.209		Radiated Spurious Emissions – 30MHz – 40GHz	42.2dBuV/m @ 23,300MHz (-11.8 dB)	Emissions in restricted bands must meet the radiated emissions limits detailed in 15.207. All others must be < -20dBc	Complies
15.207		AC Conducted Emissions	Not performed – the device is DC powered		Complies
	6.6	AC Conducted Emissions			Complies
15.247 (b) (5)		RF Exposure Requirements	Fixed installation will require separation distances of up to 4.2m depending on antenna gain	Refer to RF Exposure exhibit for MPE calculations. Installation manual updated with table to show separation distance.	
15.203		RF Connector	Standard N connector	Standard rf connectors permitted for professionally installed systems	Complies

EIRP calculated using antenna gain of 38.3 dBi (6760) for the highest EIRP point-to-point system and the output power stated on the original grant.

Output power measured during the tests contained in this application is slightly lower than that of the previously certified system (25.1dBm). This is due to product variance.

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 NAMAS document NIS 81.

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 CW500 an ISM Band Radio which is designed to FCC part 15 license free applications. The device can use multiple channels at data rates of up to 100 Mb/s and two 40 MHz channels at a SONET data rate (155Mb/s).

Normally, the IDU (indoor unit) would be placed on a table top during operation. The IDU was, therefore, treated as tabletop equipment during testing to simulate the end user environment. The electrical rating of the IDU is -33 to -72 V DC @ 1.5 Amps.

The ODU (outdoor unit) is tower mounted during normal operation. The ODU was, therefore, treated as a tabletop during operation during testing to simulate the end user environment. The ODU gets it DC voltages from the IDU.

The sample was received on August 12, 2003 and tested on August 12, August 13 and August 14, 2003. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	Proposed FCC ID #
MDS Carrier Wave 500 ISM Band Radio	-	E5MDS-CW500

ENCLOSURE

The IDU enclosure is primarily constructed of fabricated sheet steel. It measures approximately 17" wide by 18" deep by 4" high

The ODU enclosure is primarily constructed of die-cast aluminum. It measures approximately 15" wide by 15" deep by 4" high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

No equipment was used as local support equipment for emissions testing

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

Manufacturer/Model/Description	Serial Number	FCC ID Number
Kepco 4822M DC power supply	P185238	-

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)
T1 (A)	Not connected	Multiwire	Shielded	2
T1 (B)	Not connected	Multiwire	Shielded	2
Ch1	Not connected	RJ45	Ushielded	2
Ch2	Not connected	RJ45	Ushielded	2
Ch3	Not connected	RJ45	Ushielded	2
Ch4	Not connected	RJ45	Ushielded	2
RF Out	External Antenna	Coaxial	Shielded	15
DC Input	DC power source	2 wire	Ushielded	30

EUT OPERATION DURING TESTING

The EUT was transmitted continuously at full power on either Channel A (5.75 GHz) or Channel B (5.825 GHz) when operating at the new SONET data rate and at full power on the top, bottom and center channels at the ethernet data rate (100Mb/s).

ANTENNA REQUIREMENTS

The antenna port is a standard, N-type connector, which is permitted as the system is intended to be professionally installed.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Microwave Data Systems model CW500 SONET Version being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

Modulation

The device was originally certified with data rates using modulation that included 16-QAM with a coding rate of ¾. The proposed changes include enabling a higher data rate (SONET) that uses 32-QAM modulation with a coding rate of 9/10. This modification requires no circuit changes as the existing design can handle both modulation schemes. The higher data rate has a wider bandwidth than the previous, lower data rate signal and so the system is reduced to having only two channels at the SONET data rate.

As per the FCC "*If the output power and frequency remain the same and there is no degradation in spurious emission(spurs, harmonics, band-edge) and power density, then you do not have to file a Class II permissive change*."

The change is being included in this application for a Class II Permissive change only for completeness as the tests performed indicated that there was no degradation in either spurious emissions or power density from the original application.

A complete set of antenna conducted measurements and radiated spurious emissions measurements were made with the device configured with the original internal antenna and original high pass filter from the configuration originally approved by the FCC.

Output Filter

Microwave Data Systems would like to be able to use a duplexer filter in pace of the band pass filter that is located between the rf output and the antenna.

A complete set of antenna conducted measurements and radiated spurious emissions measurements were made with the device operating at the new data rate (see above) with the duplexer installed and connected to the internal antenna. The duplexer results had slightly lower output power and power spectral density. The antenna port conducted and radiated spurious emissions were not significantly affected by the change.

Antenna

Microwave Data Systems would like to approve the following antennas for use with the subject device:

Manufacturer	Model	Antenna Type	Antenna Gain (Max, dBi)
Radio Waves	SP1-5.2 5.250	1' Dish	22
Radio Waves	SP1.5-5.2 5.250	1.5' Dish	25.3
Radio Waves	SP2-5.2 5.250	2' Dish	28
Radio Waves	SP3-5.2 5.250	3' Dish	31.2
Radio Waves	SP4-5.2 5.250	4' Dish	34.6
Radio Waves	***SP6-5.2 5.250***	***6' Dish***	***37.6***
Radio Waves	SPD1-5.2 5.250	1' Dish (Dual Polarized)	22
Radio Waves	SPD1.5-5.2 5.250	1.5' Dish (Dual Polarized)	25.3
Radio Waves	SPD2-5.2 5.250	2' Dish (Dual Polarized)	28
Radio Waves	SPD3-5.2 5.250	3' Dish (Dual Polarized)	31.2
Radio Waves	SPD4-5.2 5.250	4' Dish (Dual Polarized)	34.6
Radio Waves	SPD6-5.2 5.250	6' Dish (Dual Polarized)	37.6
Gabriel	QF2-52-N	2' Dish (Dual Polarized)	29.0
Gabriel	QF2-52-N-RK	2' Dish (Dual Polarized)	29.0
Gabriel	QF4-52-N	4' Dish (Dual Polarized)	35.3
Gabriel	QF4-52-N-RK	4' Dish (Dual Polarized)	35.3
Gabriel	*QF6-52-N*	*6' Dish (Dual Polarized)*	***38.3***
Gabriel	QFD2-52-N	2' Dish (Dual Polarized)	28.9
Gabriel	QFD2-52-N-RK	2' Dish (Dual Polarized)	28.9
Gabriel	QFD4-52-N	4' Dish (Dual Polarized)	35.2
Gabriel	QFD4-52-N-RK	4' Dish (Dual Polarized)	35.2
Gabriel	QFD6-52-N	6' Dish (Dual Polarized)	38.2
Gabriel	HQFD2-52-N	2' Dish (Dual Polarized)	28.1
Gabriel	HQFD4-52-N	4' Dish (Dual Polarized)	34.8
Gabriel	HQFD6-52-N	6' Dish (Dual Polarized)	37.8
Gabriel	HQF2-52-N	2' Dish	28.7
Gabriel	HQF4-52-N	4' Dish	34.9
Gabriel	HQF6-52-N	6' Dish	37.9

The following tests were performed to demonstrate that the proposed changes to the antennas comply with the requirements of FCC Part 15 and RSS210 for Digital transmission Systems:

1. Radiated spurious emissions with the product connected to a Radio Wave 6' dish antenna. This test was performed with the device transmitting at the highest available data rate on each of the two available channels.
2. Radiated spurious emissions with the product connected to a 6' Gabriel antenna (model *QF6-52-N*). This test was performed with the device transmitting at the highest available data rate on each of the two available channels.
3. Radiated spurious emissions were repeated using the antenna with the least margin (the Gabriel Antenna) and with the device transmitting at the lowest available data rate on the top, bottom and center channels.

In accordance with the FCC's guidelines, the highest gain antenna was tested to cover the lower gain antenna configurations. In all cases the radiated spurious emissions were more than 10dB below the limit.

The results for the single polarized antenna should also apply to the dual polarized antenna since the dual polarized antennas allow one polarization to be used for transmit and the other for receive and have the same gain as their single polarization counterparts.

Antenna specification sheets and revised rf exposure calculations are included with this application. Note that the dual polarized Radio Wave antenna specifications are the same as those of the single polarization antennas

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on August 12, August 13 and August 14, 2003at the Elliott Laboratories Open Area Test Site #2&4 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Federal Communications Commission. In accordance with Industry Canada rules detailed in RSS 210 Issue 5 and RSS-212, construction, calibration, and equipment data for the test sites have been filed with the Federal Communications Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure 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 CISPR 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. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde and Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and peak power sensor are used for all direct 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 LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude 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 entire 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.

ANSI C63.4 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 exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is 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.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

Measurement bandwidths (video and resolution) are set in accordance with FCC procedures for the type of radio being tested.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions from the AC power port are given in units of microvolts, the limits for radiated electric field emissions are given in units of microvolts per meter at a specified test distance and the output power limits are given in temrs of Watts, milliwatts or dBm. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp) the following formula is used to determine the field strength limit in terms of microvolts per meter at a distance of 3m from the equipment under test:

$$E = \frac{1000000 \text{ v } 30 \text{ P}}{3} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For reference, converting the voltage and electric field strength specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. Conversion of power specification limits from linear units (in milliwatts) to decibel form (in dBm) is accomplished by taking the base ten logarithm, then multiplying by 10.

FCC 15.407 (a)and RSS 210 (o) OUTPUT POWER LIMITS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watts (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watts (30 dBm)	8 dBm/3kHz
5725 – 5850	1 Watts (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

RSS 210 (o) AND FCC 15.247 SPURIOUS RADIATED EMISSIONS LIMITS

T limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands detailed in Part 15.205 and for all spurious emissions from the receiver are:

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level.

FCC 15.205 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in FCC Part 15.205.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RSS-210 SECTION 6.6 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in Industry Canada RSS-210 section 6.6.

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 30 - 6500 MHz, 12-Aug-03
Engineer: mfaustino

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	773	12	3/18/2003	3/18/2004
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	12	10/9/2002	10/9/2003
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	12	3/31/2003	3/31/2004
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	12	3/11/2003	3/11/2004
Hewlett Packard	EMC Spectrum Analyzer, Opt. 026 9 KHz -26.5GHz	8593EM	1141	12	3/19/2003	3/19/2004
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	1/24/2003	1/24/2004
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	12	7/24/2003	7/24/2004

Conducted Emissions on Antenna Ports and Radiated Spurious Emissions, 13-Aug-03, 12-Aug-03
Engineer: mfaustino

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Hewlett Packard	Microwave EMI test system (SA40, 9kHz - 40GHz)	84125C	1149	12	3/12/2003	3/12/2004

Radiated Emissions, 1000 - 40000 MHz, 14-Aug-03
Engineer: Chris

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Hewlett Packard	Microwave EMI test system (SA40, 9kHz - 40GHz)	84125C	1149	12	3/12/2003	3/12/2004

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T52265 31 Pages

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Emissions Spec:	FCC part 15/EN55022	Class:	A
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Microwave Data Systems

Model

CW500 SONET version

Date of Last Test: 8/14/2003

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Emissions Spec:	FCC part 15/EN55022	Class:	A
Immunity Spec:	-	Environment:	-

EUT INFORMATION

The EUT is a ISM Band Radio which is designed to FCC part 15 license free applications. Normally, the IDU (indoor unit) would be placed on a table top during operation. The IDU was, therefore, treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the IDU is -33 to -72 V DC @ 1.5 Amps.

The ODU (outdoor unit) is tower mounted during normal operation. The ODU was, therefore, treated as a table top during operation during testing to simulate the end user environment. The ODU gets it DC voltages from the IDU.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
MDS	Carrier Wave 500	ISM Band Radio	N/A	E5MDS-CW500

Other EUT Details

Thepurpose of the tests contained in this document is to demonstrtae contionued compliance of the system with a new digital interface (155Mb/s), a new transmit data rate (155Mb/s), a new output stage filter (duplexer) and new, high gain, external antennas.

EUT Enclosure

The IDU enclosure is primarily constructed of fabricated sheet steel. It measures approximately 17" wide by 18" deep by 4" high

The ODU enclosure is primarily constructed of diecast aluminum. It measures approximately 15" wide by 15" deep by 4" high.

Modification History

Mod. #	Test	Date	Modification
1	-	-	None

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Emissions Spec:	FCC part 15/EN55022	Class:	A
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
Kepco	4822M	DC power supply	P185238	N/A
		Dish Antenna		

Interface Cabling and Ports

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length(m)
T1 (A)	Terminated	Multiwire	Shielded	2
T1 (B)	Terminated	Multiwire	Shielded	2
Ch1	Terminated	RJ45	Ushielded	2
Ch2	Terminated	RJ45	Ushielded	2
Ch3	Terminated	RJ45	Ushielded	2
Ch4	Terminated	RJ45	Ushielded	2
RF Out	External Antenna	Coaxial	Shielded	1.5
DC Input	DC power source	2 wire	Ushielded	30

EUT Operation During Emissions(Digital Device)

The EUT was powered on with the radio in recieve. Internal software was used to exercise the RJ45 ports

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Emissions Spec:	FCC part 15/EN55022	Class:	A
Immunity Spec:	-	Environment:	-

Test Configuration #2

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Kepco	4822M	DC power supply	P185238	N/A

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
T1 (A)	Not connected	Multiwire	Shielded	2
T1 (B)	Not connected	Multiwire	Shielded	2
Ch1	Not connected	RJ45	Ushielded	2
Ch2	Not connected	RJ45	Ushielded	2
Ch3	Not connected	RJ45	Ushielded	2
Ch4	Not connected	RJ45	Ushielded	2
RF Out	External Antenna	Coaxial	Shielded	15
DC Input	DC power source	2 wire	Ushielded	30

Note: The Consolde port was not connected as the manufacturer stated that this is for configuration purpose and therefore would not normally be connected.

EUT Operation During Emissions(DTS)

The EUT was transmitted continuously at full power on either Channel A(5.75 GHz) for Channel B (5.825 GHz)

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Radiated Emissions (Digital Device and Receiver)

Test Specifics

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

Date of Test: 8/12/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #2

Config. Used: 1
Config Change: none
EUT Voltage: -48Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing. Remote support equipment was located 15 meters from the test area with all I/O connections routed overhead.

On the OATS, the measurement antenna was located 10 meters from the EUT for the measurement range 30 - 1000 MHz and 3m from the EUT for the frequency range 1 - 10 GHz.

Ambient Conditions:

Temperature: 24 °C
Rel. Humidity: 51 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 -1000 MHz, Preliminary Scan	EN 55022 A	Eval	-10.5dB @ 39.993MHz
2	RE, 30 - 1000MHz, Maximized Emissions	EN 55022 A	Pass	-7.5dB @ 39.993MHz
3	RE, 1000 - 5000 MHz, Maximized Emissions	FCC A	Pass	-7.9dB @ 4775.3MHz

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.

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Run #1: Preliminary Radiated Emissions, 30-1000MHz

Frequency	Level	Pol	EN 55022 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
39.993	29.5	V	40.0	-10.5	QP	230	1.0	
599.989	33.5	V	47.0	-13.5	QP	155	1.0	
399.996	31.3	H	47.0	-15.7	QP	333	1.0	
599.989	31.1	H	47.0	-15.9	QP	81	2.0	
349.998	31.0	H	47.0	-16.0	QP	63	2.5	
499.984	30.8	H	47.0	-16.2	QP	248	1.8	
949.985	29.7	V	47.0	-17.3	QP	265	4.0	
899.986	29.5	H	47.0	-17.5	QP	275	1.0	
899.986	29.0	V	47.0	-18.0	QP	213	1.6	
158.181	21.6	H	40.0	-18.4	QP	263	4.0	
239.994	28.5	H	47.0	-18.5	QP	0	4.0	
835.893	27.7	V	47.0	-19.3	QP	244	1.0	
374.993	26.7	H	47.0	-20.3	QP	0	2.4	
650.004	25.9	H	47.0	-21.1	QP	224	1.0	
399.996	25.7	V	47.0	-21.3	QP	328	1.0	
499.984	24.7	V	47.0	-22.3	QP	265	1.0	
65.538	17.0	V	40.0	-23.0	QP	202	1.0	
35.993	16.5	V	40.0	-23.5	QP	202	1.0	
32.760	16.3	V	40.0	-23.7	QP	237	1.0	
650.004	23.2	V	47.0	-23.8	QP	153	1.0	
349.998	22.5	V	47.0	-24.5	QP	3	1.0	
249.994	22.3	H	47.0	-24.7	QP	150	4.0	
374.993	21.5	V	47.0	-25.5	QP	90	1.0	
388.793	19.3	V	47.0	-27.7	QP	0	1.0	

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Run #2: Maximized Readings From Run #1

Frequency	Level	Pol	EN 55022 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
39.993	32.5	V	40.0	-7.5	QP	230	1.0	
599.989	33.7	V	47.0	-13.3	QP	155	1.0	
399.996	33.0	H	47.0	-14.0	QP	333	1.0	
599.989	31.1	H	47.0	-15.9	QP	81	2.0	
349.998	31.0	H	47.0	-16.0	QP	63	2.5	
499.984	30.8	H	47.0	-16.2	QP	248	1.8	

Run #3: Maximized readings, 1000 - 5000 MHz

Measurements made at 3m test distance and extrapolated to 10m using -10.5 correction factor.

Frequency	Level	Pol	FCC Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4775.280	41.6	V	49.5	-7.9	Avg	232	1.0	
2373.823	39.7	V	49.5	-9.8	Avg	164	1.0	
2075.000	36.7	H	49.5	-12.8	Avg	228	1.0	
2373.823	47.4	V	69.5	-22.1	Pk	164	1.0	
4775.280	46.8	V	69.5	-22.7	Pk	232	1.0	
1325.015	21.3	H	49.5	-28.2	Avg	0	1.0	
2075.000	39.4	H	69.5	-30.2	Pk	228	1.0	
1325.015	34.2	H	69.5	-35.3	Pk	0	1.0	

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Antenna Port Conducted Emissions-original band pass filter and internal antenna, new data rate

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: 8/12/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #2

Config. Used: 2 (Sonet data rate / BP filters)
Config Change:
EUT Voltage: -48Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT.
When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 24 °C
Rel. Humidity: 51 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	6dB Bandwidth	15.247(a)	Pass	36.4 MHz
2	Output Power	15.247(b)	Pass	24.8 dBm
3	Power Spectral Density (PSD)	15.247(d)	Pass	-7dBm/MHz
4	Out of Band	15.247(c)	Pass	Refer to Plots

Modifications Made During Testing:

No modifications were made to the EUT during testing

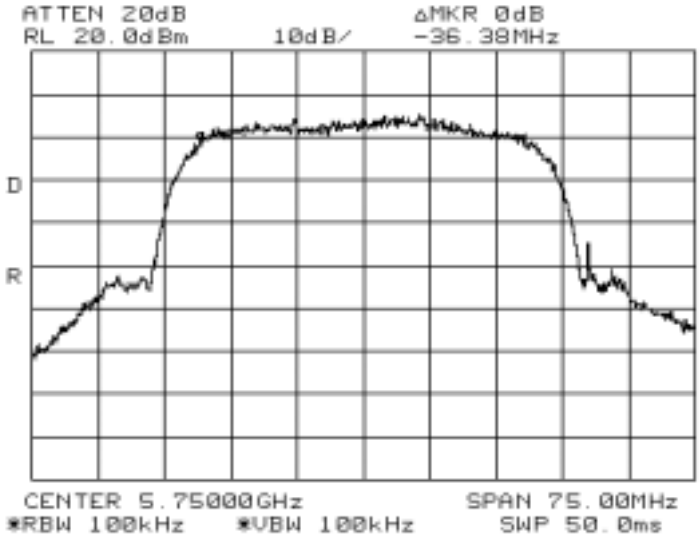
Deviations From The Standard

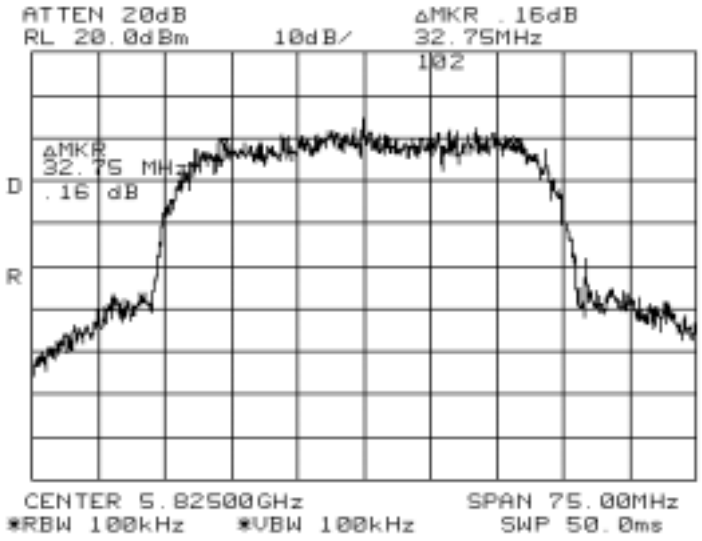
No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Run #1: Signal Bandwidth

Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #		
A	5750	100kHz	36.4		101	
B	5825	100kHz	32.7		102	





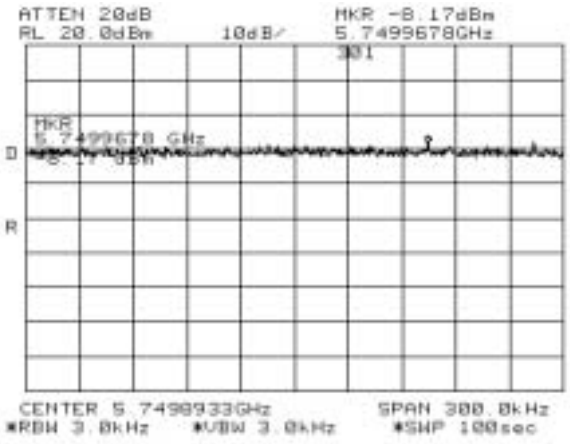
Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

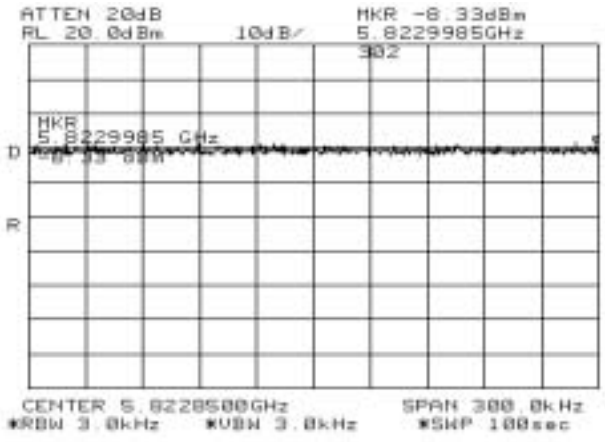
Run #2: Output Power

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)
A	5750	1MHz	24.8	0.302
B	5825	1MHz	24.1	0.257

Run #3: Power Spectral Density

Channel	Frequency (MHz)	Res BW	P.S.D. (dBm per 3kHz)	Graph reference #		
A	5750	3kHz	-7.42		301	
B	5825	3kHz	-7		302	

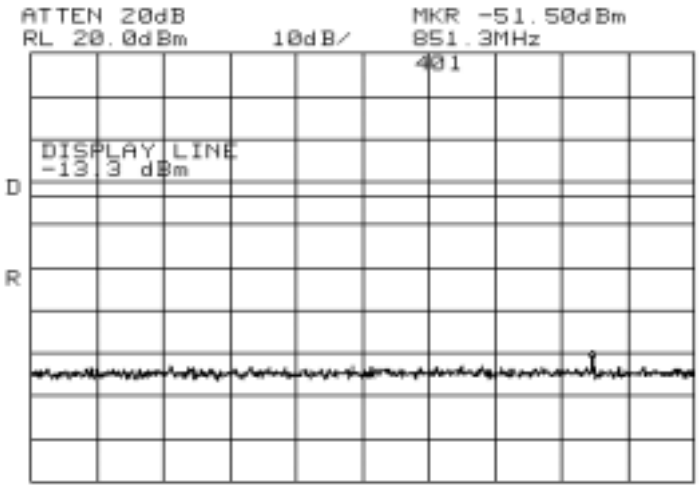


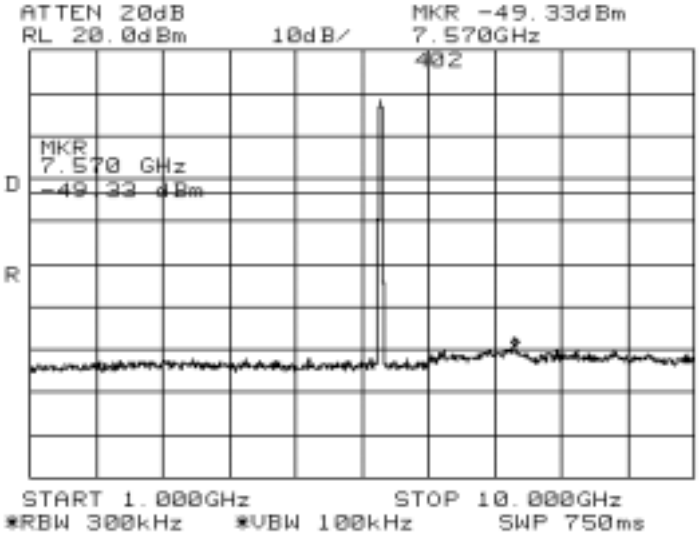


Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

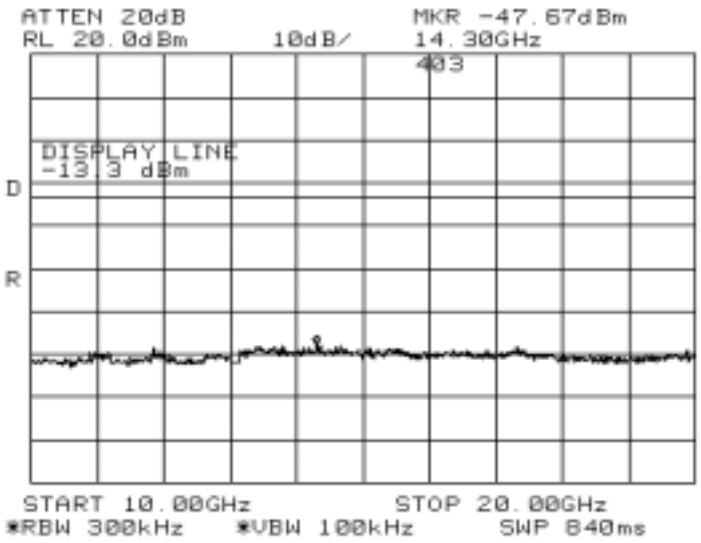
Run #4: Out-of-band Conducted Spurious Emissions

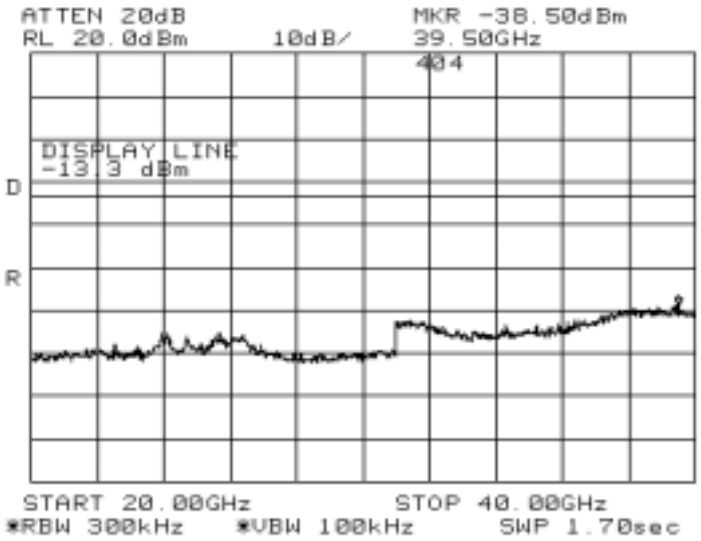
Channel	Frequency (MHz)	Notes	Graph reference #s
A	5750	All out of band signals in any 100kHz bandwidth were more	401, 402, 403, 404,
B	5825	than 20dB below the fundamental signal level.	405, 406, 407, 408, 409



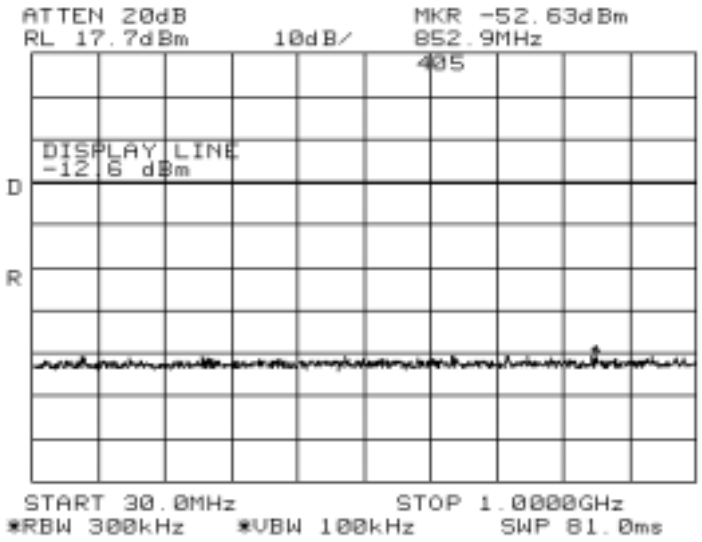


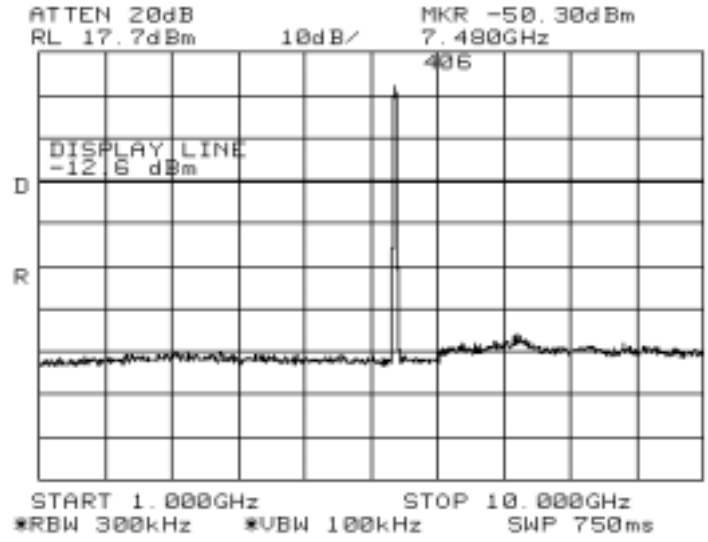
Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A



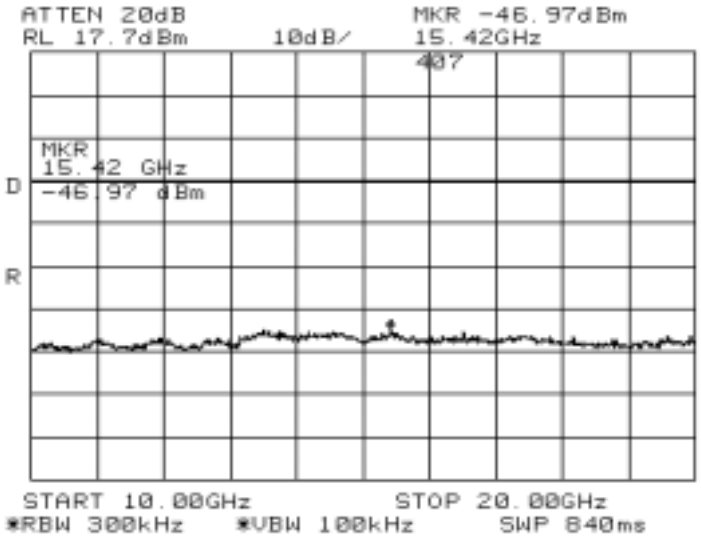


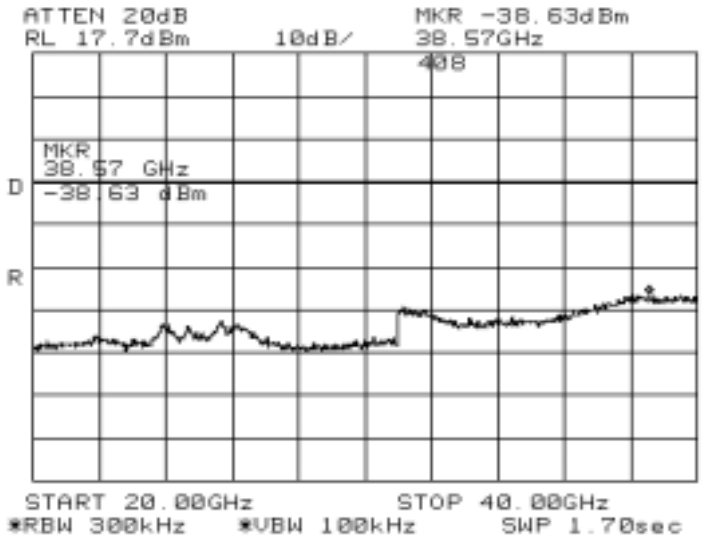
Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A





Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A





Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Radiated Emissions-original band Pass Filter and Integral Antenna at new data rate

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: 8/13/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #4
Config. Used: 2 (Sonet Data rate / BP Filters)
Config Change:
EUT Voltage: -48Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing. All remote support equipment was located approximately 30 meters from the EUT with all I/O connections running on top of the groundplane or routed in overhead in the GR-1089 test configuration.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 41 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 40000 MHz - Spurious Emissions In	FCC Part 15.209 / 15.247(c)	Pass	-13.1dB @ 23300.0MHz

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:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Run #1a: Radiated Spurious Emissions, 10000 - 40000 MHz. Low Channel @ 5750 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23000.00	39.5	V	54.0	-14.5	AVG	0	1.0	
23000.00	39.4	H	54.0	-14.6	AVG	0	1.0	
11500.00	37.6	H	54.0	-16.4	AVG	0	1.0	
11500.00	37.6	V	54.0	-16.4	AVG	0	1.0	
23000.00	53.1	V	74.0	-20.9	PK	0	1.0	
23000.00	52.6	H	74.0	-21.4	PK	0	1.0	
11500.00	50.7	H	74.0	-23.3	PK	0	1.0	
11500.00	50.7	V	74.0	-23.3	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions,10000 - 40000 MHz. High Channel @ 5825 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23300.00	40.9	V	54.0	-13.1	AVG	0	1.0	
23300.00	40.9	H	54.0	-13.1	AVG	0	1.0	
11650.00	37.8	V	54.0	-16.2	AVG	0	1.0	
11650.00	37.8	H	54.0	-16.2	AVG	0	1.0	
23300.00	53.8	V	74.0	-20.2	PK	0	1.0	
23300.00	53.8	H	74.0	-20.2	PK	0	1.0	
11650.00	50.9	V	74.0	-23.1	PK	0	1.0	
11650.00	50.9	H	74.0	-23.1	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Antenna Port Conducted Emissions - Duplexer at SONET Data Rate

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: 8/13/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #2

Config. Used: 2 (Sonet data rate / Duplexer)
Config Change:
EUT Voltage: -48Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT.
When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 24 °C
Rel. Humidity: 51 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	6dB Bandwidth	15.247(a)	Pass	36.8 MHz
2	Output Power	15.247(b)	Pass	24.1 dBm
3	Power Spectral Density (PSD)	15.247(d)	Pass	-6.7 dBm/MHz
4	Out of Band	15.247(c)	Pass	Refer to Plots

Modifications Made During Testing:

No modifications were made to the EUT during testing

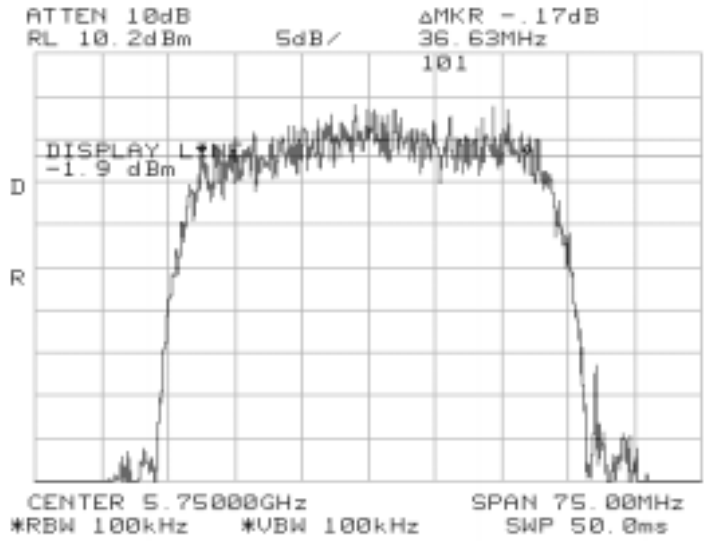
Deviations From The Standard

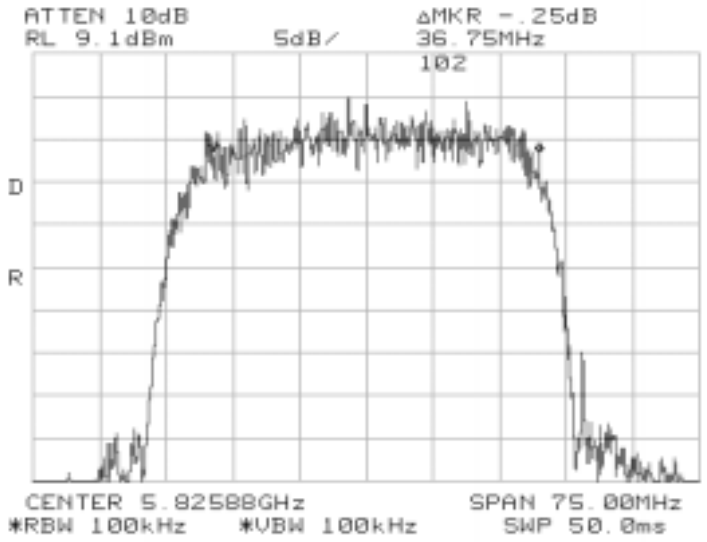
No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

Run #1: Signal Bandwidth

Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #		
A	5750	100kHz	36.6		101	
B	5825	100kHz	36.8		102	





Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

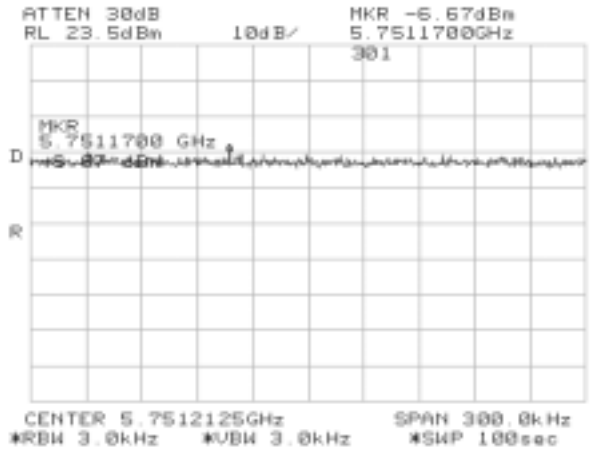
Run #2: Output Power

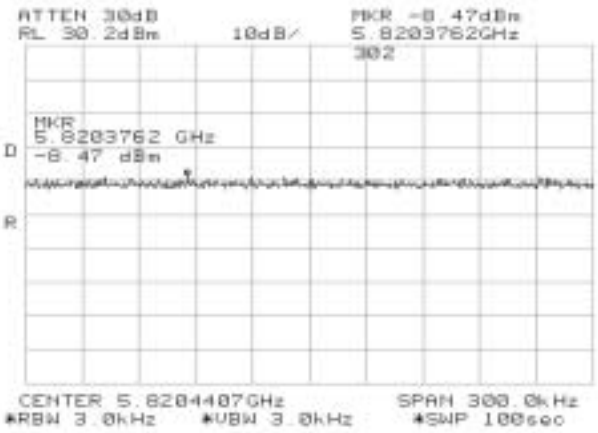
Measured with a peak power meter

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)
A	5750	1MHz	24.1	0.257
B	5825	1MHz	23.6	0.229

Run #3: Power Spectral Density

Channel	Frequency (MHz)	Res BW	P.S.D. (dBm per 3kHz)	Graph reference #		
A	5750	3kHz	-6.7		301	
B	5825	3kHz	-8.5		302	

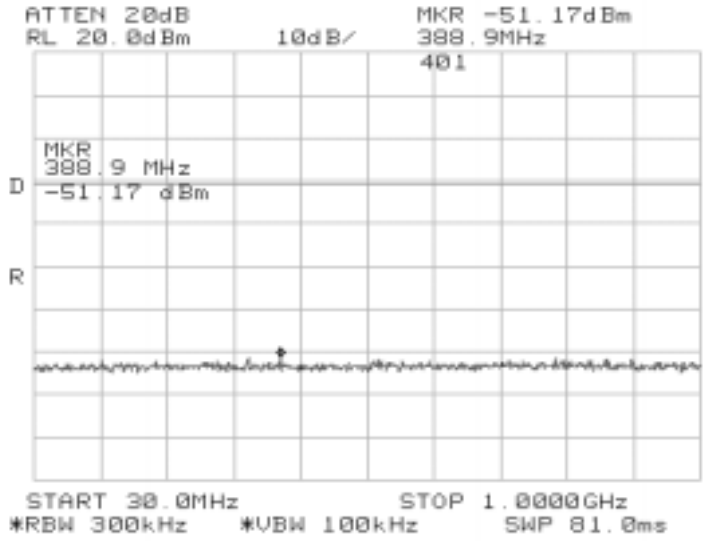


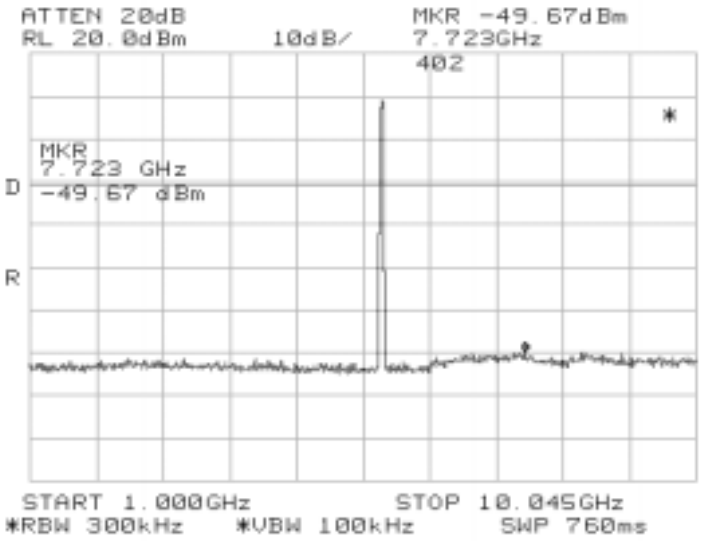


Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A

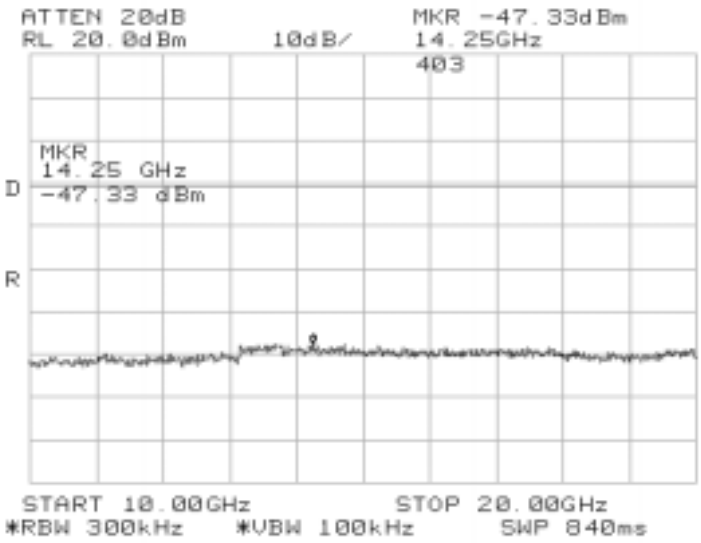
Run #4: Out-of-band Conducted Spurious Emissions

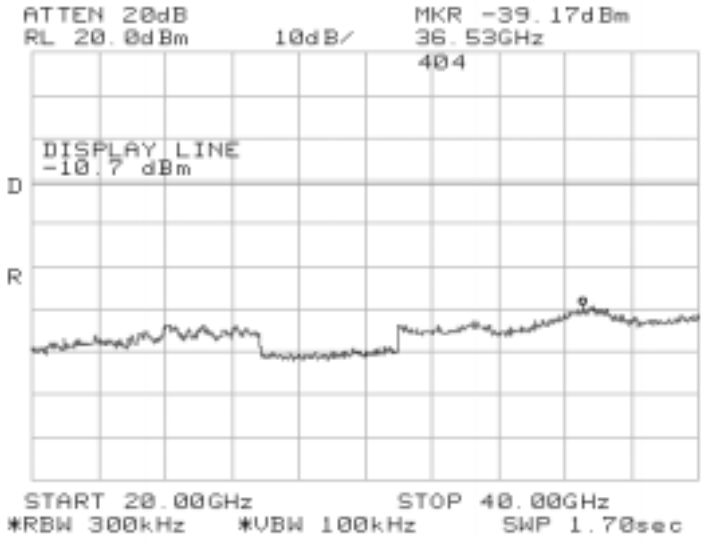
Channel	Frequency (MHz)	Notes	Graph reference #s
A	5750	All out of band signals in any 100kHz bandwidth were more	401, 402, 403, 404,
B	5825	than 20dB below the fundamental signal level.	406, 407, 408,409



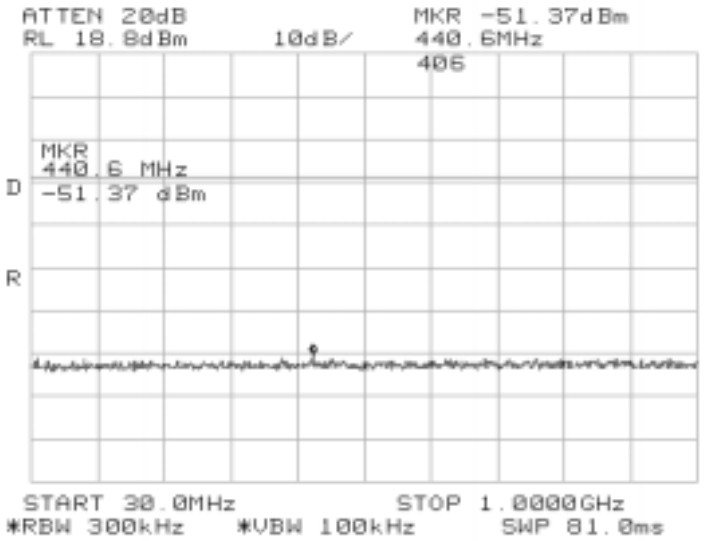


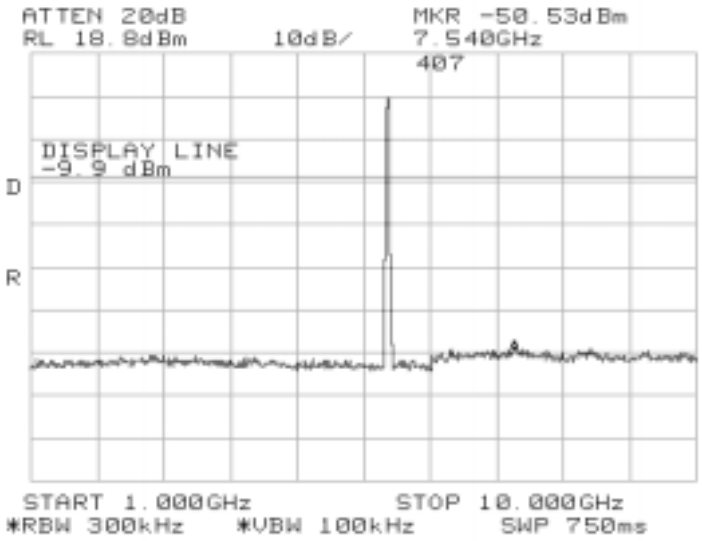
Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A



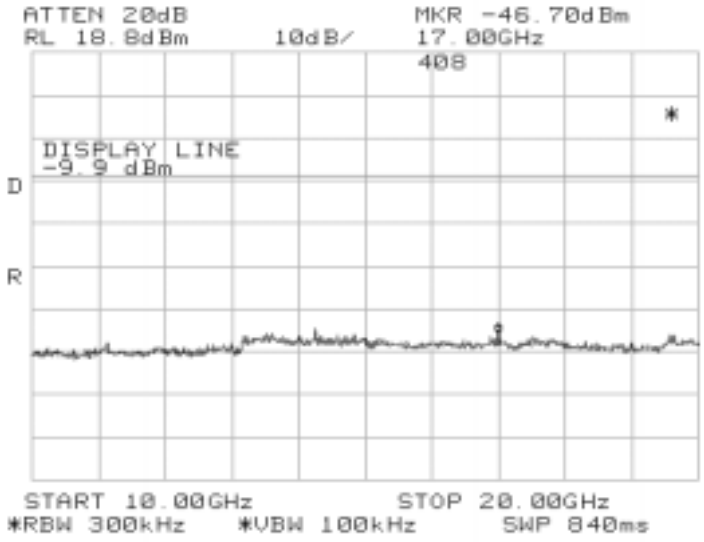


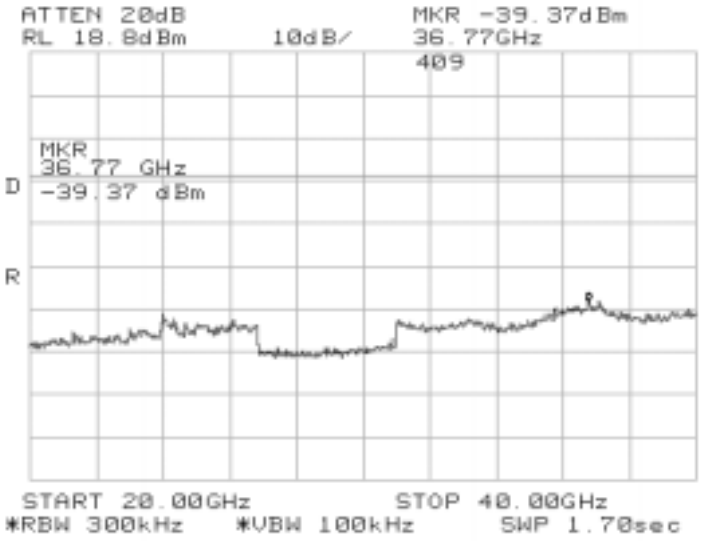
Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A





Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	A





Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Radiated Emissions - Duplexer and Integral Antenna at SONET Data Rate

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: 8/13/2003
Test Engineer: Marissa Faustino
Test Location: SVOATS #4
Config. Used: 2 (Sonet data rate / Duplexer)
Config Change:
EUT Voltage: -48Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing. All remote support equipment was located approximately 30 meters from the EUT with all I/O connections running on top of the groundplane or routed in overhead in the GR-1089 test configuration.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 24 °C
Rel. Humidity: 51 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 10000 - 40000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	-13.0dB @ 23300.0MHz

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:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Run #1a: Radiated Spurious Emissions, 10000 - 40000 MHz. Low Channel @ 5750 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23000.00	39.8	H	54.0	-14.2	AVG	0	1.0	
23000.00	39.7	V	54.0	-14.3	AVG	0	1.0	
11500.00	37.3	H	54.0	-16.7	AVG	0	1.0	
11500.00	37.2	V	54.0	-16.8	AVG	0	1.0	
23000.00	53.8	H	74.0	-20.2	PK	0	1.0	
23000.00	52.9	V	74.0	-21.1	PK	0	1.0	
11500.00	50.6	H	74.0	-23.4	PK	0	1.0	
11500.00	50.1	V	74.0	-23.9	PK	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions,10000 - 40000 MHz. High Channel @ 5825 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23300.00	41.1	H	54.0	-13.0	AVG	0	1.0	
23300.00	40.8	V	54.0	-13.2	AVG	0	1.0	
11650.00	38.1	V	54.0	-15.9	AVG	0	1.0	
11650.00	38.1	H	54.0	-15.9	AVG	0	1.0	
23300.00	54.1	H	74.0	-20.0	PK	0	1.0	
23300.00	53.0	V	74.0	-21.0	PK	0	1.0	
11650.00	51.4	H	74.0	-22.6	PK	0	1.0	
11650.00	50.9	V	74.0	-23.1	PK	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Radiated Emissions - Sonet Data Rate, Duplexer and Radio Wave Antenna (6ft)

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: 8/13/2003
Test Engineer: Rafael
Test Location: SVOATS #2

Config. Used: 2 (Sonet data rate / Duplexer)
Config Change: None
EUT Voltage: -48Vdc

General Test Configuration

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

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 19 °C
Rel. Humidity: 64 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
	RE, 10000-40000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	-12.2dB @ 23300.0MHz

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:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Run #1a: Radiated Spurious Emissions, 10000 - 40000 MHz. Low Channel @ 5750 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23000.00	40.8	V	54.0	-13.2	AVG	360	1.0	
23000.00	40.1	H	54.0	-13.9	AVG	360	1.0	
11500.00	39.3	H	54.0	-14.7	AVG	0	1.0	
11500.00	38.7	V	54.0	-15.3	AVG	0	1.0	
23000.00	53.4	V	74.0	-20.6	PK	360	1.0	
23000.00	53.1	H	74.0	-20.9	PK	360	1.0	
11500.00	52.3	H	74.0	-21.7	PK	0	1.0	
11500.00	51.1	V	74.0	-22.9	PK	0	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions,10000 - 40000 MHz. High Channel @ 5825 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23300.00	41.8	V	54.0	-12.2	AVG	0	1.0	
23300.00	41.6	H	54.0	-12.4	AVG	0	1.0	
11650.00	39.3	V	54.0	-14.7	AVG	360	1.0	
11650.00	39.1	H	54.0	-14.9	AVG	360	1.0	
23300.00	54.8	V	74.0	-19.2	PK	0	1.0	
23300.00	54.6	H	74.0	-19.4	PK	0	1.0	
11650.00	51.9	V	74.0	-22.1	PK	360	1.0	
11650.00	50.7	H	74.0	-23.3	PK	360	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Radiated Emissions - Sonet Data Rate, Duplexer and Gabriel Antenna (6ft)

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: 8/13/2003
Test Engineer: Rafael
Test Location: SVOATS #2
Config. Used: 2 (Sonet Data rate / Duplexer)
Config Change: None
EUT Voltage: -48Vdc

General Test Configuration

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

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 19 °C
Rel. Humidity: 64 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 10000-40000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	-11.8dB @ 23300.0MHz

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.

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Run #1a: Radiated Spurious Emissions, 10000 - 40000 MHz. Low Channel @ 5750 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23000.00	40.9	V	54.0	-13.1	AVG	360	1.0	
23000.00	40.8	H	54.0	-13.2	AVG	360	1.0	
11500.00	39.1	H	54.0	-14.9	AVG	0	1.0	
11500.00	38.3	V	54.0	-15.7	AVG	0	1.0	
23000.00	53.7	H	74.0	-20.3	PK	360	1.0	
23000.00	53.5	V	74.0	-20.5	PK	360	1.0	
11500.00	51.6	H	74.0	-22.4	PK	0	1.0	
11500.00	51.3	V	74.0	-22.7	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions,10000 - 40000 MHz. High Channel @ 5825 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23300.00	42.2	V	54.0	-11.8	AVG	0	1.0	
23300.00	42.1	H	54.0	-11.9	AVG	0	1.0	
11650.00	39.5	H	54.0	-14.5	AVG	360	1.0	
11650.00	39.4	V	54.0	-14.6	AVG	360	1.0	
23300.00	54.5	V	74.0	-19.5	PK	0	1.0	
23300.00	54.1	H	74.0	-19.9	PK	0	1.0	
11650.00	52.1	H	74.0	-21.9	PK	360	1.0	
11650.00	51.6	V	74.0	-22.4	PK	360	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Radiated Emissions - Ethernet Data Rate, Duplexer and Gabriel Antenna (6ft)

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: 8/14/2003
Test Engineer: Chris Byleckie
Test Location: SVOATS #2

Config. Used: 2 (Enet data rate / Duplexer)
Config Change: None
EUT Voltage: -48Vdc

General Test Configuration

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

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 18 °C
Rel. Humidity: 68 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 10000-40000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	-13.6dB @ 23074.8MHz

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.

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J52094
Model:	CW500 SONET version	T-Log Number:	T52265
		Account Manager:	Mike Conrad
Contact:	Dennis McCarthy		
Spec:	FCC part 15/EN55022	Class:	N/A

Run #1a: Radiated Spurious Emissions, 10000 - 40000 MHz. Low Channel @ 5731 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
22924.00	39.9	H	54.0	-14.1	AVG	0	1.0	
22924.00	39.8	V	54.0	-14.2	AVG	0	1.0	
11462.00	38.6	V	54.0	-15.4	AVG	0	1.0	
11462.00	38.5	H	54.0	-15.5	AVG	0	1.0	
22924.00	52.1	V	74.0	-21.9	PK	0	1.0	
22924.00	52.0	H	74.0	-22.0	PK	0	1.0	
11462.00	50.8	H	74.0	-23.2	PK	0	1.0	
11462.00	50.5	V	74.0	-23.5	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions,10000 - 40000 MHz. Middle Channel @ 5768.7 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
23074.80	40.4	V	54.0	-13.6	AVG	0	1.0	
23074.80	40.2	H	54.0	-13.8	AVG	0	1.0	
11537.40	39.1	V	54.0	-14.9	AVG	0	1.0	
11537.40	39.1	H	54.0	-14.9	AVG	0	1.0	
23074.80	52.3	V	74.0	-21.7	PK	0	1.0	
23074.80	52.1	H	74.0	-21.9	PK	0	1.0	
11537.40	51.4	V	74.0	-22.6	PK	0	1.0	
11537.40	50.7	H	74.0	-23.3	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #1c: Radiated Spurious Emissions,10000 - 40000 MHz. High Channel @ 5843.7 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
11687.40	38.9	H	54.0	-15.1	AVG	0	1.0	
11687.40	38.8	V	54.0	-15.2	AVG	0	1.0	
11687.40	51.3	V	74.0	-22.7	PK	0	1.0	
11687.40	50.8	H	74.0	-23.2	PK	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

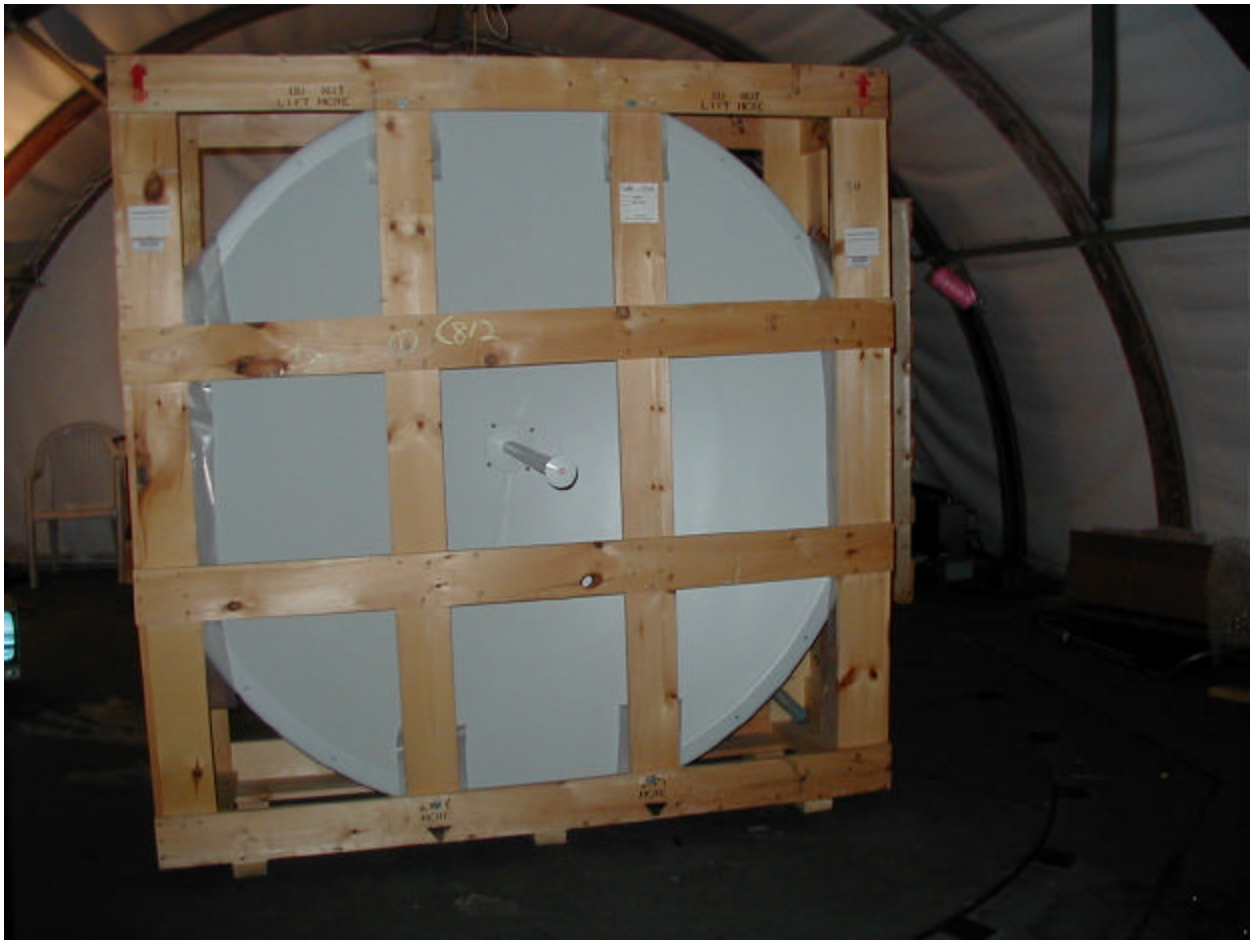
EXHIBIT 3: Test Configuration Photographs

Pages

Radiated Emissions Test Configuration Photographs

Radiated Emissions Test Configuration Photographs

Radiated Emissions Test Configuration Photographs



Radiated Emissions Test Configuration Photographs

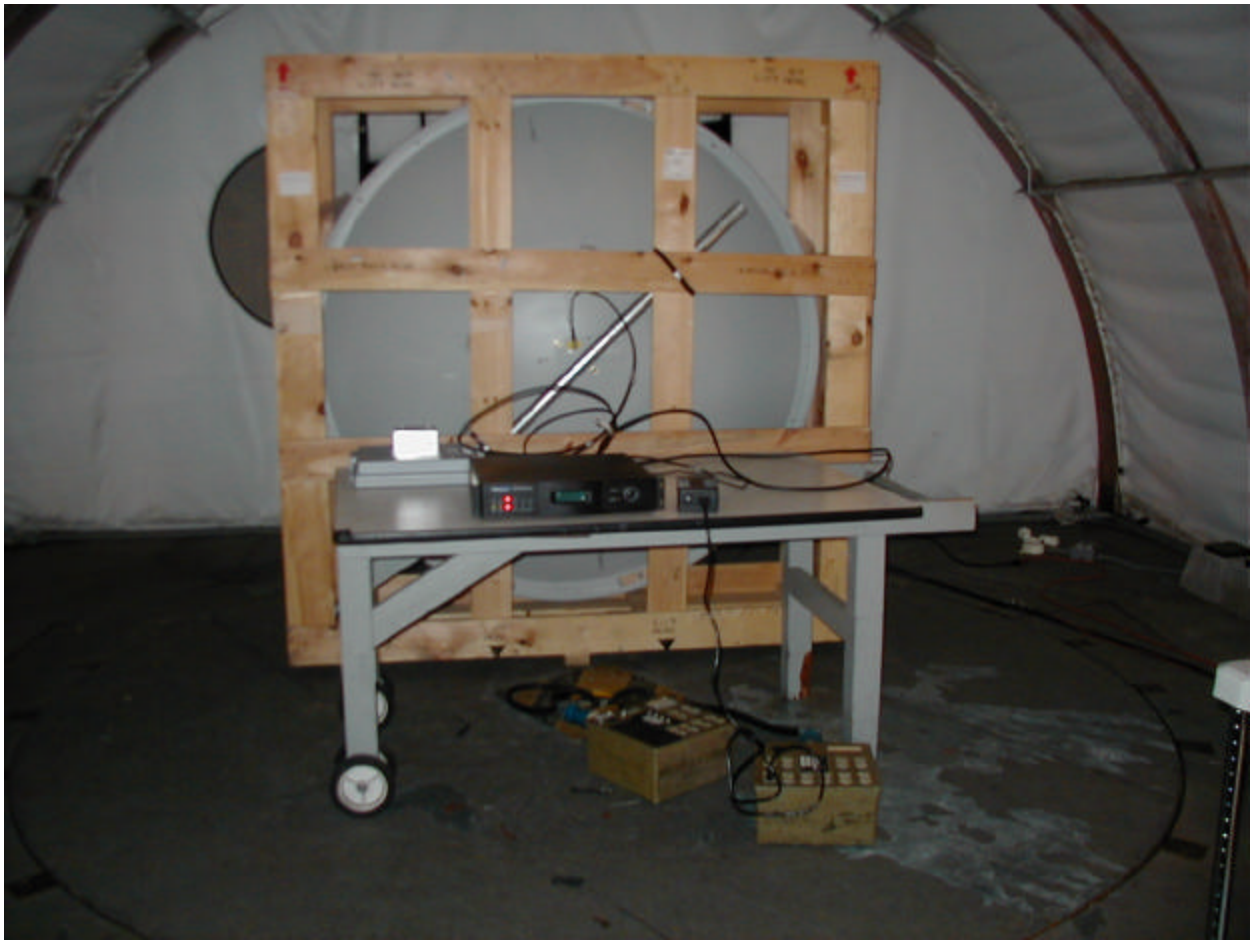


EXHIBIT 4: Proposed FCC ID Label & Label Location

EXHIBIT 5: Detailed Photographs of Microwave Data Systems Model CW500 SONET VersionConstruction

Pages

EXHIBIT 6: Operator's Manual for Microwave Data Systems Model CW500 SONET Version

Pages

EXHIBIT 7: Block Diagram of Microwave Data Systems Model CW500 SONET Version

Pages

EXHIBIT 8: Schematic Diagrams for Microwave Data Systems Model CW500 SONET Version

Pages

EXHIBIT 9: Theory of Operation for Microwave Data Systems Model CW500 SONET Version

Pages

EXHIBIT 10: Advertising Literature

TBP

EXHIBIT 11: RF Exposure Information

Pages