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Electromagnetic Emissions Test Report and Request for Class II Permissive Change pursuant to FCC Part 90 on the Microwave Data Systems Transmitter Model: MDS2710D

FCC ID NUMBER:	E5MDS2710D
GRANTEE:	Microwave Data Systems 175 Science Parkway Rochester, NY 14620
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
AND:	Elliott Laboratories, Inc. 41039 Boyce Road Fremont, CA. 94538-2435
REPORT DATE:	March 14, 2005
FINAL TEST DATES:	February 25 and February 26, 2005

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).

2.1033(c)(1) Applicant:

Microwave Data Systems
175 Science Parkway
Rochester, NY 14620

2.1033(c)(2) FCC ID: E5MDS2710D

2.1033(c)(3) Instructions/Installation Manual

The user manual has not changed from that provided with the original filing.

2.1033(c)(4) Type of emissions

FCC 90**: 9K6F1D**

Data: 12.5KHz channel aggregated from three 5 kHz channels
maximum frequency deviation = 2.3 kHz

B = 2M + 2D, 2(2.5) = 2(2.3)
B = 9.6 kHz

2.1033(c)(5) Frequency Range

FCC 90**: 220 - 222**

2.1033(c)(6) Range of Operation Power

FCC 90**: 0.1 – 5 Watts**

2.1033(c)(7) Maximum FCC Allowed Power Level

FCC 90.205(e): 5 - 500 Watts ERP depending on antenna height.

2.1033(c)(8) Applied voltage and currents into the final transistor elements

The voltage and current have not changed from those reported in the original filing.

2.1033(c)(9) Tune-up Procedure

The Tune-up Procedure has not changed from that submitted in the original filing.

2.1033(c)(10) Schematic Diagram of the Transmitter

The schematic diagram has not changed from that submitted in the original filing.

2.1033(c)(10) Means for Frequency Stabilization

The means for frequency stabilization have not changed from that submitted in the original filing.

2.1033(c)(10) Means for Suppression of Spurious radiation

The means for suppression of spurious radiation have not changed from that submitted in the original filing.

2.1033(c)(10) Means for Limiting Modulation

The means for means for limiting modulation have not changed from that submitted in the original filing.

2.1033(c)(10) Means for Limiting Power

The command available to the user for setting power does not allow entries that would set the output power above 37 dBm (5 watts).

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

The label has not changed from that submitted in the original filing.

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

The physical appearance of the product has not changed from that submitted in the original filing since this is a software change.

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

CPFSK modulation is used with the following settings:

- BAUD=3.2kbps, BW=12.5KHz

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

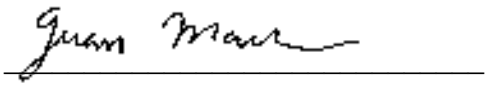
DECLARATIONS OF COMPLIANCE

Equipment Name and Model:
MDS2710D

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 standards (through the use of TIA/EIA-603); 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 14, 2005

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 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. The FCC 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 90Test Summary

Measurement Required	FCC Part 2 & 90 Sections	Test Performed	Measured Value	Test Procedure Used	Result
Modulation Tested	CPFSK	-	-	-	-
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	37dBm (5 Watts)	B	Complies
Spurious emissions at antenna Port	2.1051/ 90.210(d)	Emission Limits and/or Unwanted Emission 30MHz – 2.9GHz (Antenna Conducted)	All spurious emissions < -25 dBm	J	Complies
Occupied Bandwidth	2.1049/ 90.210(c) & (d)	Emission Mask and Frequency deviation	Refer to Plots	C & D	Complies
Field strength of spurious radiation	2.1053 / 90.210(d)	Radiated Spurious Emissions 30MHz – 2.3GHz	-36.3 dBm @ 2202.886 MHz (-11.3 dB)	N	Complies
Frequency stability	2.1055 / 90.213	Frequency Vs. Temperature	300 Hz	K	Complies
Frequency stability	2.1055 / 90.213	Frequency Vs. Voltage	247Hz (Battery End Point is 7.7Vdc)	L & M	Complies
Transient Frequency Behavior	90.214	Transient Behavior	Refer to Plots	I	Complies
Exposure to Mobile devices	2.1091	Exposure of Humans to RF Fields	N/A	-	

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 MDS2710D is a VHF modem that operates in the 220 - 222 Mhz band. The EUT is a data telemetry radio design to operate in a point to multipoint environment, such as electric utility Supervisory Control and Data Acquisition (SCADA) and distribution automation, gas field automation, water and wastewater SCADA, and on-line transaction processing applications The devices can operate in both simplex (tx and rx frequencies the same) and half-duplex mode (tx and rx on different channels).
Normally, the EUT could be mounted to the wall or to the Remote Terminal Unit (RTU) it is used with. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 10.5 - 16 Vdc, 2.5 Amps.
The sample was received on February 25, 2005 and tested on February 25 and February 26, 2005. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave Data Systems	MDS2710D	3200bps VHF Modem		E5MDS2710D

ENCLOSURE

The EUT enclosure is primarily constructed of metal. It measures approximately 14 cm wide by 17 cm deep by 5 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

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

Manufacturer	Model	Description	Serial Number
Microwave Data Systems	TT1EAR2-2	Handheld terminal	HH171101

No remote support equipment was used during emissions testing.

EUT INTERFACE PORTS

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

Port	Connected to	Description	Shielded or Unshielded	Length (m)
EUT Diag	Handheld terminal	RJ-11	Unshielded	2
EUT Data Interface	Resistive termination	Multiwire	Shielded	3

Note: The Diag port is used for configuring the radio and would not be connected during normal operation. It was connected during testing for convenience to be able to set the operating mode.
Note: The Data Interface port would connect to a remote terminal unit or master system, which is typically a complex monitoring system (for the remote terminal) or server system (for the master system). These were not available as support equipment and so a resistive load was used to simulate the electrical connection to the terminal device.

EUT OPERATION DURING TESTING

The device was configured to transmit or receive on the channel specified in the test description. The antenna port was terminated in a 50-ohm load during radiated emissions tests and connected to the analyzer, via a suitable attenuator, for receive mode tests.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Microwave Data Systems model MDS2710D being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

CHANNELIZATION

There were no hardware changes to the transmit path, the only changes were in the DSP software to allow 12.5KHz operation due to the use of three aggregate 5KHz channels.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on February 25 and February 26, 2005 at the Elliott Laboratories Chamber 5 located at 41039 Boyce Road Fremont, California and OATS 2 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 detector 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 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:

1) The EUT was connected directly to the spectrum analyzer and used an attenuator to protect the input of the analyzer. The EUT antenna was removable, so conducted measurements was performed. The EUT was set to transmit continuous packets of data and the Fundamental Frequency set to the middle of the EUT frequency range.

2) Since EUT is designed with a 12.5 kHz channel Section 90.210 (f) was used to show compliance to the emission mask.

The following Resolution and Video bandwidth was used to show compliance for the above requirement: 100 Hz.

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 10th 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.

Procedure I – Transient Frequency Behavior: The TIA/EIA 603 procedure was used to determine compliance to radio being keyed on and off.

1) Connected the Test Receiver DOP or Video Output to Channel 1 of the oscilloscope. The output of the RF crystal detector was connected to Auxiliary channel 1, which served as a trigger input. The output of the combiner was connected to the Test Receiver.

2) Set the EUT to maximum power and connected as illustrated above. Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at 6.25kHz, 12.5 kHz, or 25 kHz deviation and set its output to –100 dBm, then turn on the EUT.

3) The Combiner output side was connected to the Test Receiver, which was used to measure the Power. Used enough external attenuation so that the output at the combiner was set to 40 dB below the maximum input of the Test Receiver, then turn off the EUT.

4) Set the signal generator output to the same level in step 3. This level was maintained for the remainder of the test.

5) Set the horizontal sweep rate on the storage oscilloscope to 10 milliseconds per division and adjusted the display to continuously view the 1 kHz tone from the DOP or Video Output. Adjusted the vertical amplitude control to display the 1 kHz at +/- 4 divisions vertically centered on the display.

6) Set the oscilloscope to trigger at the AUX channel 1 input port.

7) Removed enough external attenuation so that the input to the RF detector and combiner is increased by 30 dB.

8) Turn on the transmitter and plotted the result for **Ton**, **T1**, and **T2**.

9) Set the oscilloscope to trigger in decreasing magnitude from the RF crystal detector.

10) Turn off the transmitter and plotted the result for **T3**.

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

Radiated Emissions, 30 - 2300 MHz, 25-Feb-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	13-May-06
Rohde & Schwarz	EMI Test Receiver, 20Hz-7GHz	ESIB7	1538	26-May-05
Sunol Sciences	Biconilog, 30-3000MHz	JB3	1548	29-Mar-05
Com-Power Corp.	Pre Amplifier , 30-1000MHz	PA-103	1632	28-Jan-06

Frequency Stability, 25-Feb-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-Feb-05

Radio Antenna Port (Power and Spurious Emissions), 26-Feb-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Rohde & Schwarz	Test Receiver, 0.009-2750 MHz	ESN	1332	12-May-05
Hewlett Packard	EMC Spectrum Analyzer, 9KHz-26.5GHz	8593EM	1141	23-Mar-05

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T58811 20 Pages

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Emissions Spec:	FCC Part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Microwave Data Systems

Model

MDS2710D

Date of Last Test: 3/5/2005

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Emissions Spec:	FCC Part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is a VHF modem that operates in the 220 - 222 Mhz band. The EUT is a data telemetry radio design to operate in a point to multipoint enviorment, such as electric utility Supervisory Control and Data Acquisition (SCADA) and distribution automation, gas field automation, water and wastewater SCADA, and on-line transaction processing applications The devices can operate in both simplex (tx and rx frequencies the same) and half-duplex mode (tx and rx on different channels). Normally, the EUT could be mounted to the wall or to the Remote Terminal Unit (RTU) it is used with. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 10.5 - 16 Vdc, 2.5 Amps.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave Data	MDS2710D	3200bps VHF Modem		E5MDS2710D

EUT Enclosure

The EUT enclosure is primarily constructed of metal. It measures approximately 14 cm wide by 17 cm deep by 5 cm high.

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:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Emissions Spec:	FCC Part 90	Class:	Radio
Immunity Spec:	-	Environment:	-

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Microwave Data Systems	TT1EAR2-2	Handheld terminal	HH171101	N/A

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT Diag	Handheld terminal	RJ-11	Unshielded	2
EUT Data Interface	Resistive termination	Multiwire	Shielded	3

Note: The Diag port is used for configuring the radio and would not be connected during normal operation. It was connected during testing for convenience to be able to set the operating mode.
Note: The Data Interface port would connect to a remote terminal unit or master system, which is typically a complex monitoring system (for the remote terminal) or server system (for the master system). These were not available as support equipment and so a resistive load was used to simulate the electrical connection to the terminal device.

EUT Operation During Emissions Tests

The device was configured to transmit or receive on the channel specified in the test description. The antenna port was terminated in a 50-ohm load during radiated emissions tests and connected to the analyzer, via a suitable attenuator, for receive mode tests.

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Radio Performance Test - FCC 90.210

RF

Port Measurements (12.5 kHz Channel)

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: 2/26/2005
Test Engineer: Juan Martinez
Test Location: SVOATS #2

Config. Used: 1
Config Change: None
EUT Voltage: 13Vdc

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.

Ambient Conditions:

Temperature: 18 °C
Rel. Humidity: 52 %

Summary of Results

Run #	Test Performed	Limit	Result	Value / Margin
1	Output Power	FCC 90.210	Pass	5 Watts
2	Emission Mask	FCC 90.210 (f)	Pass	-
3	Conducted spurious emissions, 30MHz - 2300MHz, Transmit mode	FCC 90.210 (f)	Pass	-30.7 dBm / -5.7 dB

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:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

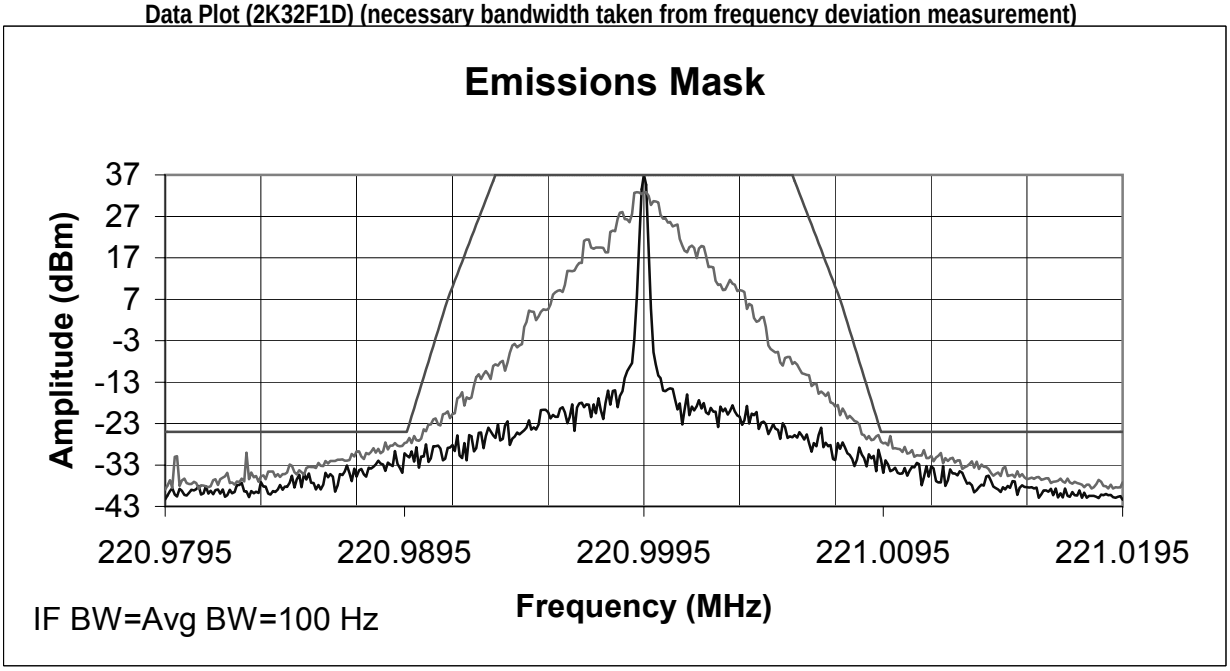
Run #1: Power Measurements

Freq.	Setting	Pmeas	Duty Cycle	Pout
220	37	37.0	100%	37.0
222	37	37.0	100%	37.0

Setting: software power setting of EUT
Pmeas: Measured output power (average)
Duty Cycle: Duty cycle of transmissions

Run #2: Emission Mask

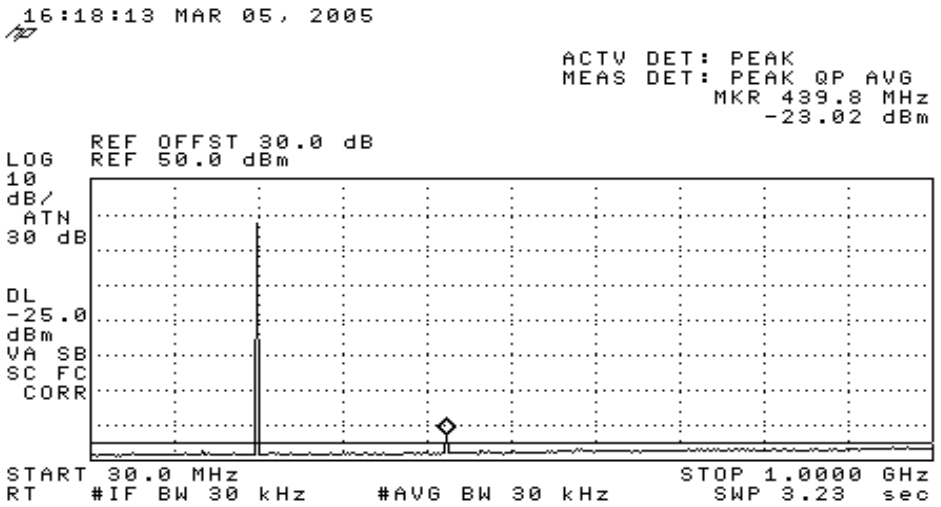
Data Plot (2K32F1D) (necessary bandwidth taken from frequency deviation measurement)

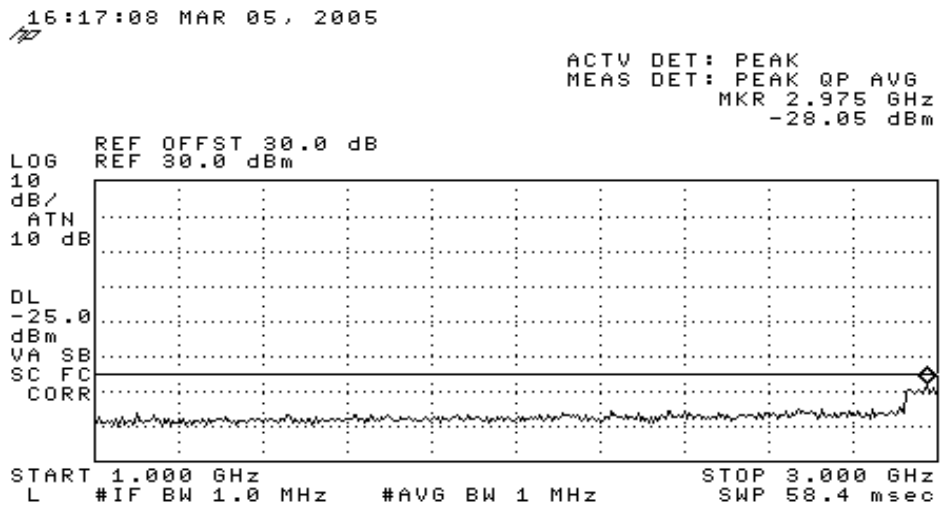


Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Run #3a: Antenna Port Conducted Spurious Emissions, Transmit Mode, 30 - 2300 MHz. EUT on 220 MHz

PWR = 37



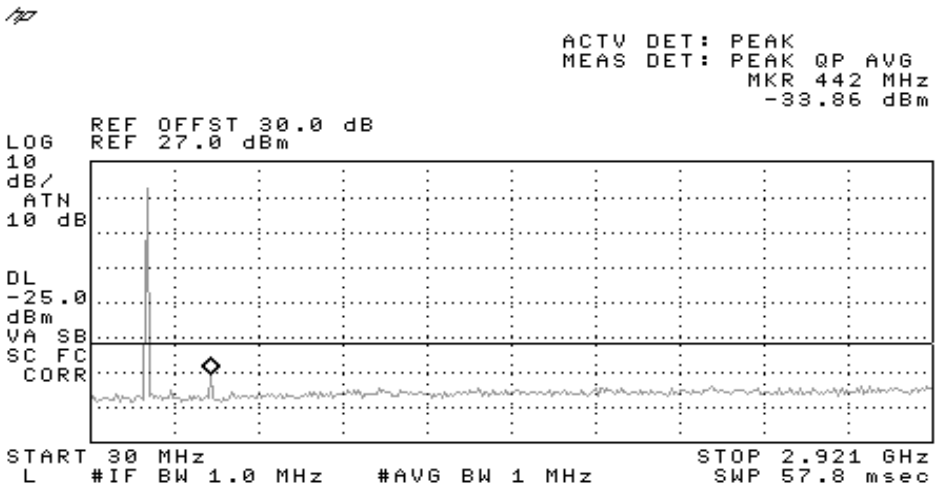


Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Frequency	Level	Port	Part 90 Note 1		Detector	Comments
MHz	dBm		Limit	Margin	Pk/QP/Avg	
440.000	-32.7	RF	-25.0	-7.7	Peak	Note 1

Note 1:	Measured the 2nd harmoinc with a Test Reciever with built in Pre-selector. Attenuation was adjusted to prevent overload at the input of the receiver.

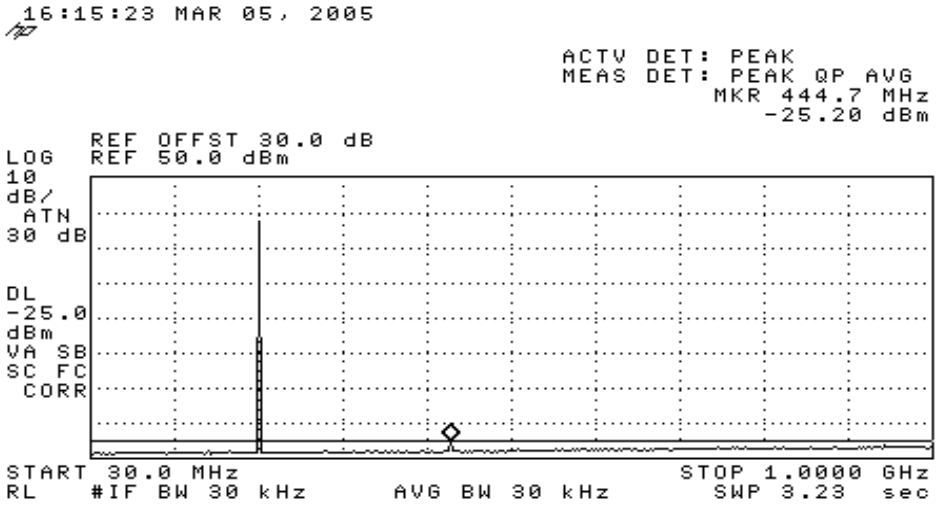
PWR = 20 (lowest possible power setting)

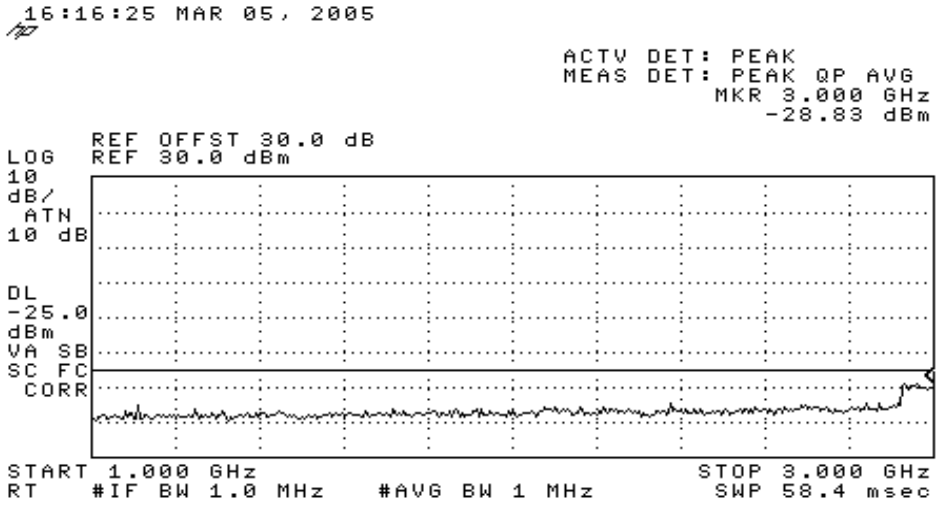


Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Run #3b: Antenna Port Conducted Spurious Emissions, Transmit Mode, 30 - 2300 MHz. EUT on 222 MHz

PWR = 37



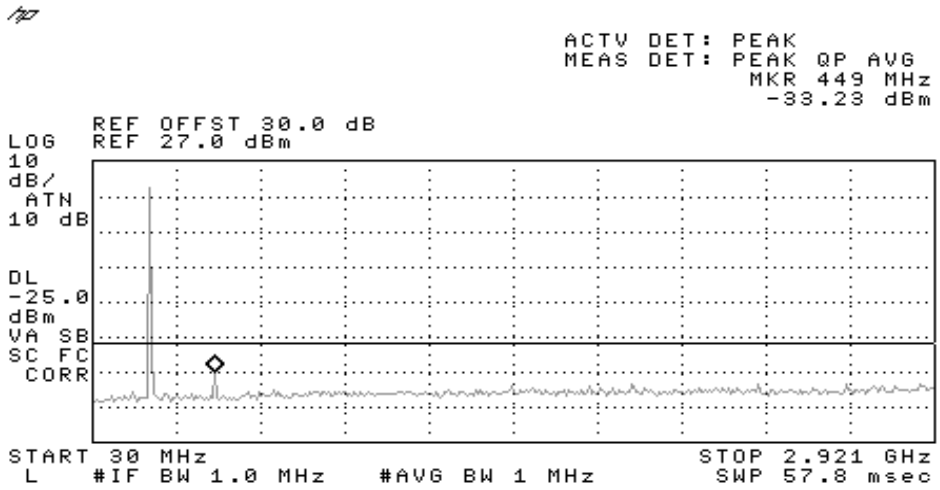


Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Frequency	Level	Port	Part 90 [Note 1]		Detector	Comments
MHz	dBm		Limit	Margin	Pk/QP/Avg	
444.000	-30.7	RF	-25.0	-5.7	Peak	Note 1

Note 1:	Measured the 2nd harmoinc with a Test Reciever with built in Pre-selector. Attenuation was adjusted to prevent overload at the input of the receiver.

PWR = 20 (lowest possible power setting)



Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Radio Performance Test - Transient Frequency Behavior
RF Port Measurements

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: 2/26/2005
Test Engineer: Juan Martinez
Test Location: SVOATS# 2
Config. Used: 1
Config Change: None
EUT Voltage: 13.8 Vdc

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.

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Transient Behavior (12.5 kHz)	FCC 90.214	Pass	Refer to plots

Modifications Made During Testing:

No modifications were made to the EUT during testing

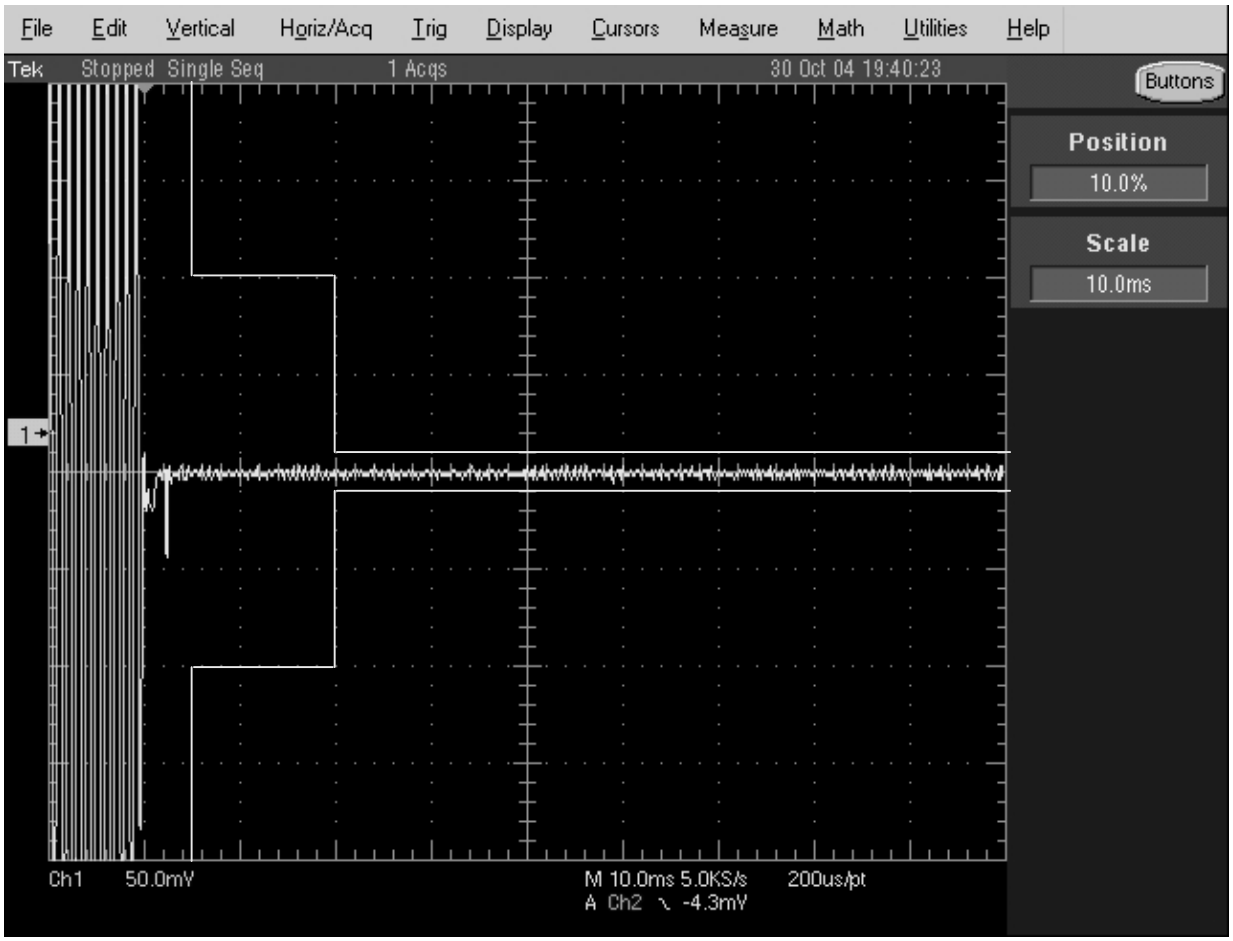
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Run# 1: Transient Frequency Behavior

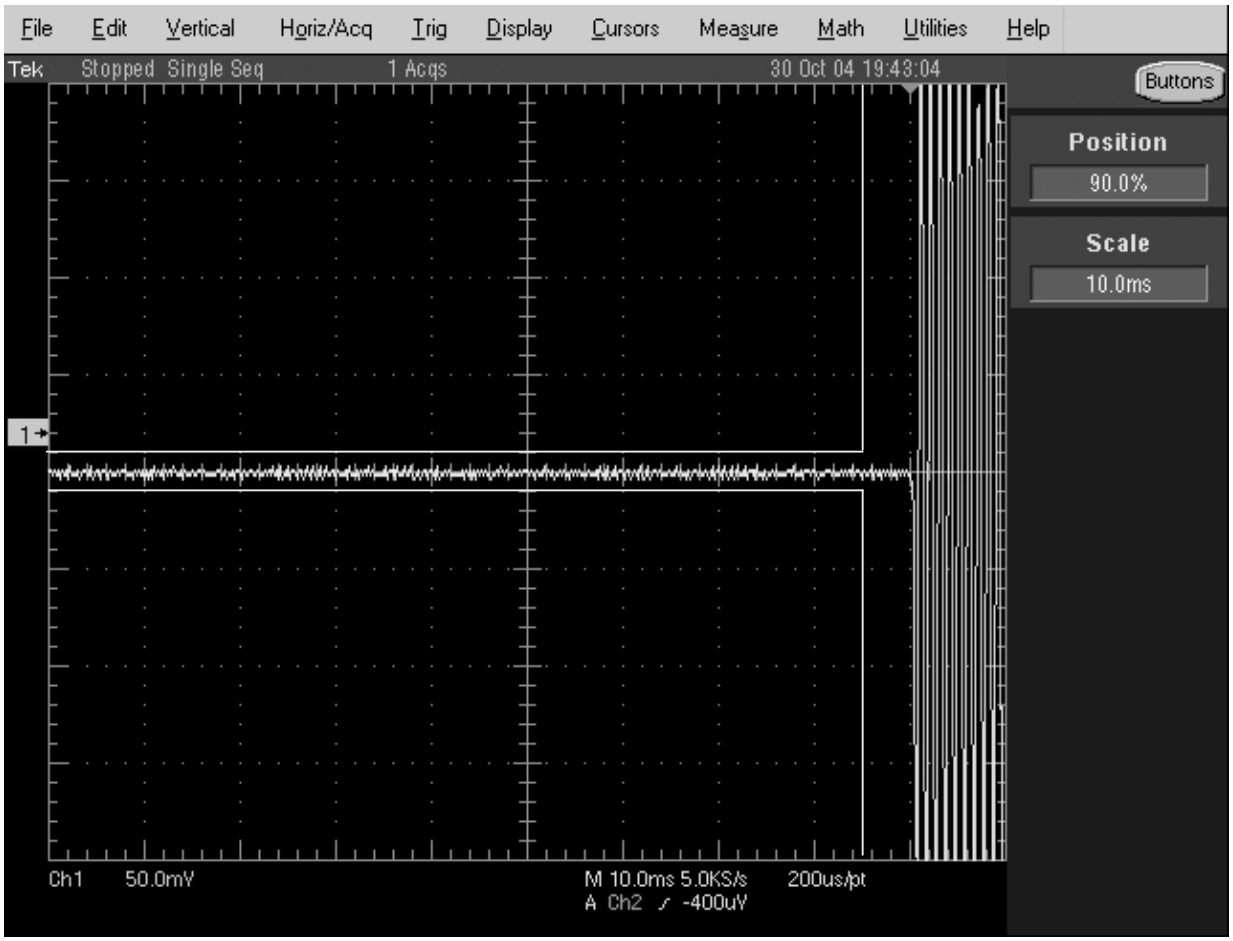
Transient Behavior 221 MHz (12.5kHz On Key)



EMC Test Data

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Transient Behavior 221 MHz (12.5kHz Off Key)



Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

Radiated Spurious Emissions (ERP), 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: 2/26/2005
Test Engineer: Juan Martinez
Test Location: Fremont Chamber #5
Config. Used: 1
Config Change: None
EUT Voltage: 13.8Vdc

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: 17.7 °C
Rel. Humidity: 52 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1a	RE, 30 - 1300 MHz - Spurious Emissions Transmit Mode (220 MHz)	Part 90.210(f)	Pass	Refer to run
1b	RE, 30 - 2300 MHz - Spurious Emissions Transmit Mode (222 MHz)	Part 90.210(f)	Pass	Refer to run
2	Final Substitution Measurements (TIA-603)	Part 90.210(f)	Pass	-36.3 dBm @ 2202.886 MHz (-11.3 dB)

Modifications Made During Testing:

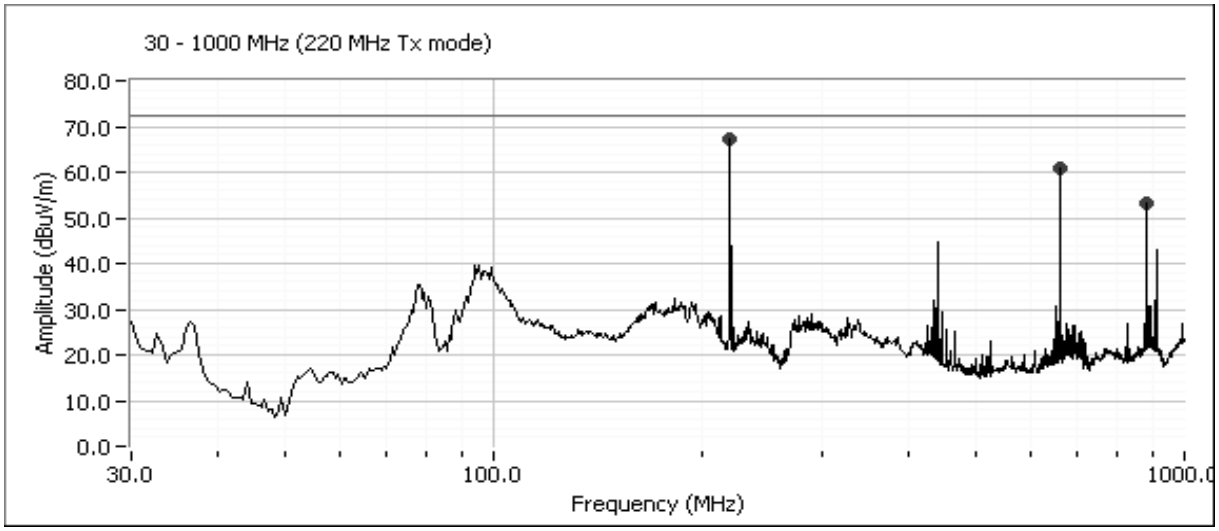
No modifications were made to the EUT during testing

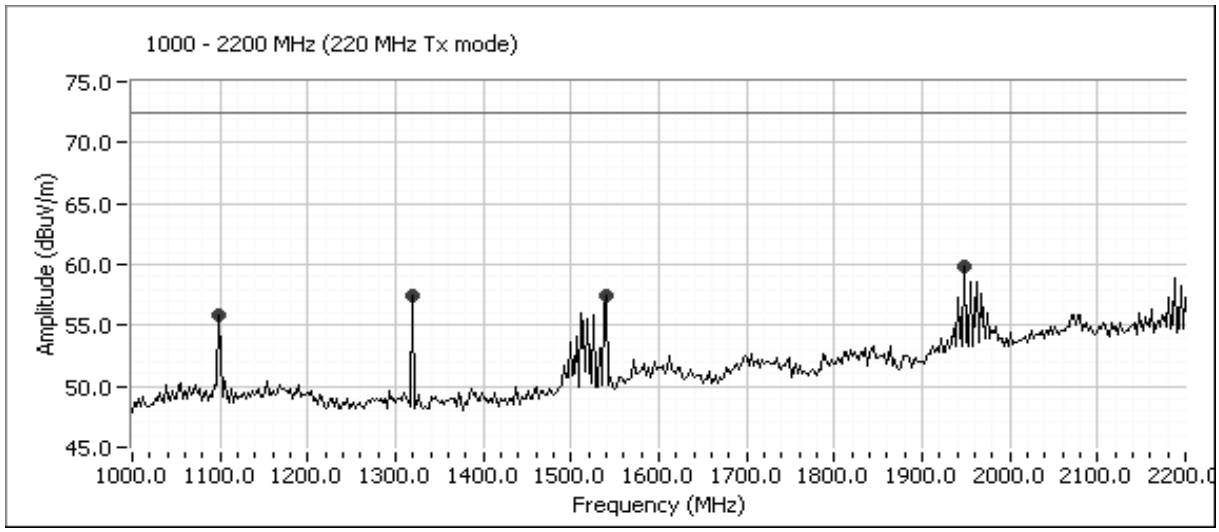
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

Run #1a: Radiated Spurious Emissions, Transmit Mode, 30 - 2300 MHz. EUT @ 220 MHz





Elliott

EMC Test Data

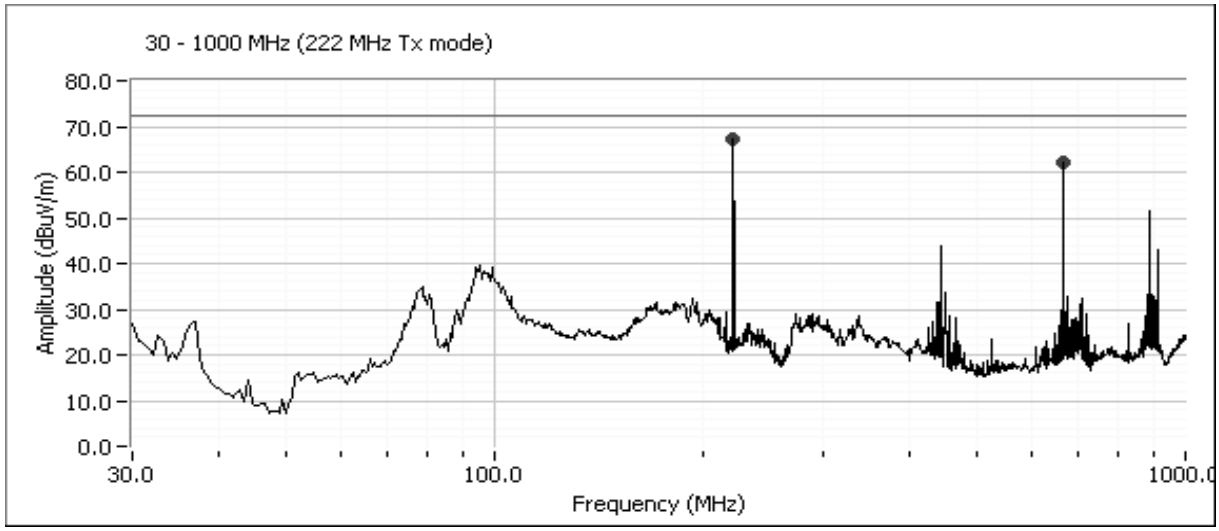
Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

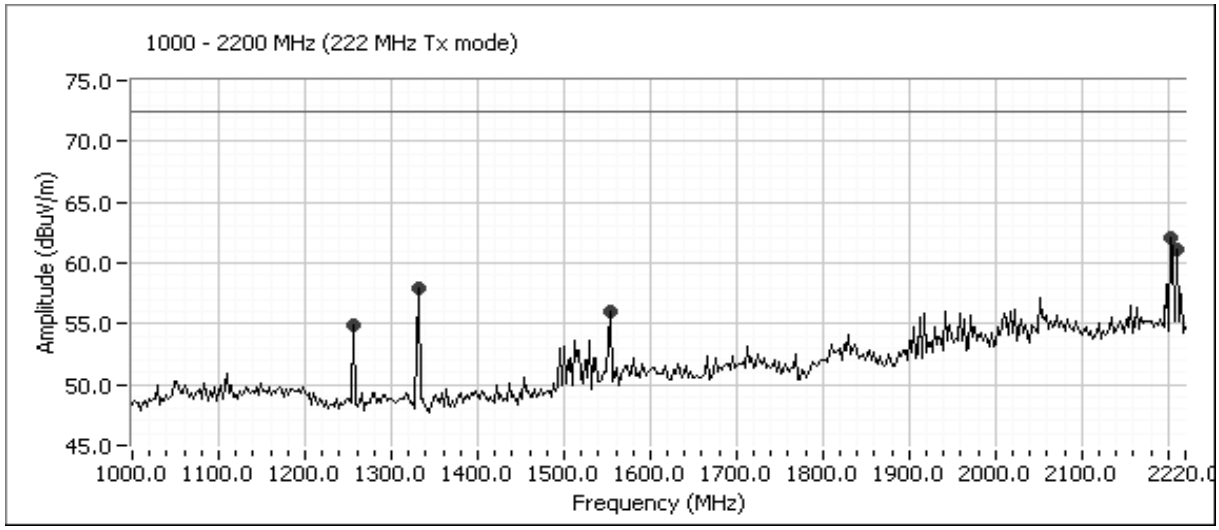
Frequency	Level	Pol	Part 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
660.521	61.0	V	72.4	-11.4	Peak	231	1.0	
880.762	53.2	H	72.4	-19.2	Peak	124	1.0	
1098.597	55.8	V	72.4	-16.6	Peak	178	1.4	
1319.840	57.4	V	72.4	-15.0	Peak	171	1.2	
1541.082	57.5	V	72.4	-14.9	Peak	152	1.0	
1947.495	59.8	V	72.4	-12.6	Peak	177	1.0	

Note 1:	The field strength limit in the tables above was calculated from the erp/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. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

Run #1b: Radiated Spurious Emissions, Transmit Mode, 30 - 2300 MHz. EUT @ 222 MHz





Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

Frequency	Level	Pol	Part 90 Note 1		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
666.132	62.1	V	72.4	-10.3	Peak	233	1.0	
1256.713	54.9	V	72.4	-17.5	Peak	286	1.6	
1332.505	58.0	V	72.4	-14.5	Peak	110	1.0	
1554.990	56.0	V	72.4	-16.4	Peak	188	1.0	
2202.886	62.1	V	72.4	-10.3	Peak	211	1.2	
2210.220	61.1	V	72.4	-11.3	Peak	194	1.4	

Note 1:	The field strength limit in the tables above was calculated from the erp/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. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.

Elliott

EMC Test Data

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	N/A

Run #2: Radiated Spurious Emissions, Transmit Mode: Final Field Strength and Substitution Measurements

Vertical

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
666.132	-10.8	5.8	94.0	99.0	62.1	-36.9	-39.1		-25.0	-14.1
1256.713	-11.0	7.0	92.3	96.3	54.9	-41.4	-43.6		-25.0	-18.6
1332.505	-11.0	7.0	92.7	96.7	58.0	-38.8	-41.0		-25.0	-16.0
1554.990	-11.0	8.2	94.2	97.0	56.0	-41.0	-43.2		-25.0	-18.2
2202.886	-10.8	8.5	93.9	96.2	62.1	-34.1	-36.3		-25.0	-11.3
2210.220	-10.8	8.5	93.5	95.8	61.1	-34.7	-36.9		-25.0	-11.9
660.521	-10.9	5.8	93.6	98.7	61.0	-37.7	-39.9		-25.0	-14.9
1098.597	-10.9	6.0	91.6	96.5	55.8	-40.7	-42.9		-25.0	-17.9
1319.840	-11.2	7.0	93.0	97.2	57.4	-39.8	-42.0		-25.0	-17.0
1541.082	-11.2	8.2	94.0	97.0	57.5	-39.5	-41.7		-25.0	-16.7
1947.495	-11.2	8.5	93.3	96.0	59.8	-36.1	-38.3		-25.0	-13.3

Horizontal

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
880.762	-10.9	5.3	95.6	101.2	53.2	-48.0	-50.2		-25.0	-25.2

Note 1:	Pin is the input power (dBm) to the substitution antenna
Note 2:	Gain is the gain (dBi) for the substitution antenna. A dipole has a gain of 2.2dBi.
Note 3:	FS is the field strength (dBuV/m) measured from the substitution antenna.
Note 4:	Site Factor - this is the site factor to convert from a field strength in dBuV/m to an eirp in dBm.
Note 5:	EUT field strength as measured during initial run.

Client:	Microwave Data Systems	Job Number:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
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: 2/25/2004
Test Engineer: Juan Martinez
Test Location: Environmental Chamber
Config. Used: 1
Config Change: None
EUT Voltage: 13Vdc

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 and Voltage Stability	Part 90	Pass	Refer to individual runs

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:	J58733
Model:	MDS2710D	T-Log Number:	T58811
		Account Manager:	Rod Wong
Contact:	Dennis McCarthy		
Spec:	FCC Part 90	Class:	Radio

Run #1: Temperature Vs. Frequency

Drift	Freq.	Limit
(ppm)	(MHz)	(Hz)
1.5	217.00	325.5

Temperature	Reference Frequency	Frequency Drift	Drift	Limit
(Celsius)	(MHz)	(MHz)	(Hz)	(Hz)
-30	221.000075	221.000375	300	325.5
-20	221.000075	221.000325	250	325.5
-10	221.000075	221.000350	275	325.5
0	221.000075	221.000300	225	325.5
10	221.000075	221.000213	138	325.5
20	221.000075	221.000075	0	325.5
30	221.000075	221.000075	0	325.5
40	221.000075	221.000038	-37	325.5
50	221.000075	221.000050	-25	325.5

Run #2: Voltage Vs. Frequency

Nominal Voltage is 13Vdc.

Voltage	Reference Frequency	Frequency Drift	Drift	Limit	Comment
(Dc)	(MHz)	(MHz)	(Hz)	(Hz)	
85%	221.000075	221.000138	63	325.5	11.1
115%	221.000075	221.000138	63	325.5	15.0

Battery endpoint is 7.7 Vdc

Voltage	Reference Frequency	Frequency Drift	Drift	Limit	Comment
(Dc)	(MHz)	(MHz)	(Hz)	(Hz)	
7.7	221.000075	220.999828	-247	325.5	Note 1

Note 1:	Maximum drift of fundamental frequency before it shut down at 7.7 Vdc.

EXHIBIT 3: Test Configuration Photographs

Uploaded as A Separate Attachment

EXHIBIT 4: Theory of Operation Microwave Data Systems Model MDS2710D

Unchanged from original

EXHIBIT 5: Proposed FCC ID Label & Label Location

Unchanged from original

EXHIBIT 6: Detailed Photographs Microwave Data Systems Model MDS2710D

Unchanged from original

EXHIBIT 7: Installation Guide Microwave Data Systems Model MDS2710D

Unchanged from original

EXHIBIT 8: Block Diagram Microwave Data Systems Model MDS2710D

Unchanged from original

EXHIBIT 9: Schematic Diagrams Microwave Data Systems Model MDS2710D

Unchanged from original

EXHIBIT 10: Advertising Literature

Unchanged from original