TEST DATA for H25DSS950TX

I. INTRODUCTION

These tests were conducted on a sample of the H25DSS950TX spread spectrum audio transmitter, for the purpose of demonstrating compliance with the requirements of Part 15 Certification and tested to Part 2 of Title 47 of the CFR. The H25DSS950TX transmitter is a Binary Phase Shift Keyed (BPSK) direct sequence spread spectrum intentional radiator with a rated output power of 500 mW. This device operates on three channels in the 902-928 MHz band. This transmitter is marketed only to the police radio service and government agencies for short-term surveillance and personal protection applications in concert with receiver FCC ID: 18WWRM91-50, also marketed by DTC Communications, Inc.

All testing was conducted at DTC Communications, Inc.; 75 Northeastern Blvd., Nashua, NH 03062 with the exception of the radiated spurious testing, which was, performed at the OAT site at Retlif Laboratories Goffstown, NH facility. Retlif Testing Laboratories is listed by the FCC as a facility available to do measurement work for others on a contract basis.

II. INFORMATION REQUIRED FOR CERTIFICATION

Para.

2.10033(a) This Application for Certification is filed on form 731 with all questions answered. Confidentiality is being requested for the schematic. An application fee of $940 and a request for confidentiality of $135 is attached.

2.10033(b)(1) The full name and address of the applicant and manufacturer for certification is:

DTC Communications Inc.
75 Northeastern Blvd.
Nashua, NH 03062

(2) The FCC Identifier of the device is H25DSS950TX

(3) A copy of the operating instructions is included in the EXHIBITS.

(4) Circuit Functions and Operation

The H25DSS950TX is designed to operate as a portable direct sequence spread spectrum radiator in the 902-928 MHz band. The antenna is an integral patch, attached to the enclosure. This unit is battery powered. A description of the circuit functions follows:

The H25DSS950TX is a low power, spread spectrum audio surveillance transmitter used for law enforcement applications. The transmitter employs digital modulation with direct sequence spread spectrum on one of three factory-selected channels. It has a peak power output of 500mW to an integral patch antenna and meets the requirements of Part 15.203.

Two microphone modes are supported, internal and external. The microphone audio is processed by an amplifier equipped with an automatic gain control (AGC) which may be turned ON or OFF with an external switch. Audio is processed with a continuously variable slope delta-modulation (CVSD) speech coder at a rate of 32 Kbps. Radiated testing was performed with the external microphone connected.

The H25DSS950TX is powered by three AA batteries, which supply a nominal 4.5 VDC. All critical circuits are regulated.

Necessary Bandwidth

This is a digitally modulated device. The modulation method is binary phase shift keying (BPSK) with direct sequence spreading based on a pseudorandom code. The occupied bandwidth is related to the coded voice data rate along with the number of spreading chips per bit and system filtering. The chips per bit times the data rate known as the chip rate or *code rate* is the dominant factor since it does the actual "spreading".

The audio data converter rate is 32 Kbps. The *effective* number of chips per bit is 11.

The code rate is the data rate times the chips per bit or 357.1 K chips per second (cps).

The necessary bandwidth calculation for the H25DSS950TX transmitter follows the general formula for direct sequence transmitters:

BW = 2 X code rate

Because of the use of a proprietary technique called recombinant spread spectrum (RSS), which improves fade resistance, the chip clock rate appears to be higher than 357.1 Kcps, actually 704 Kcps, so far as occupied BW is concerned. So the necessary bandwidth is:

BW = 2 (704 Kcps) = 1.4 MHz

Emissions Designator
Part 15 does not require an emissions designator.

A representative emissions designator is: 1M4G1D

This indicates that this is a binary phase shift keyed, single channel, digital transmission, with an occupied bandwidth of 1.4 MHz.

The actual bandwidth including major sidelobes, measured at the 6dB points, is just over 1 MHz. This bandwidth meets the requirements of §15.247(a)(2).

RF Radiation Exposure Evaluation

§15.247(4) states that systems shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commissions guidelines.

The H25DSS950 was tested to ANSI/IEEE C95.1-1992 at PC Test Labs.and was found to be within the SAR limits for uncontrolled exposure when the transmitter is properly used. **The SAR test report is a located in a separate EXHIBIT from the test data.**

This transmitter employs a patch antenna, which radiates more than 80% of the RF energy away from the body. This fact coupled with the low average power, and limited mission time, insures that exposure levels are well below the SAR limits of §2.1093(1) and ANSI/IEEE C95.1-1992.

The instruction manual includes safety warnings and a description of how to properly mount the transmitter on the body, so as to minimize exposure and maximize outward radiation. In addition, the transmitter is equipped with a "This Side on Body" warning label as shown in the photo EXHIBITS.

(5) A block diagram of the device is included in the EXHIBITS.

(6) This Test Report includes tabular data and plots.

(7) Internal and external photographs of this device are included in the EXHIBITS.

(8) No peripherals, other than the external microphone, were involved in this evaluation.

(9) Certification under the transition provisions of Paragraph 15.37 is not being requested for this device.

(10) The Processing Gain of the H25DSS950TX exceeds 10 dB.

Processing Gain

Processing gain in a direct sequence spread spectrum transmitter is 10log (chips per bit).

$$10\log(11) = 10.4\text{dB}$$

This processing gain is more than 10dB and thus meets the requirements of Part 15.247(e).

The transmitter and receiver system components provided by Digital Wireless Corporation, have been previously certified under Part 15 and have been found to provide an acceptable processing gain when used as a system. Data from FCC ID: 18WWRM91-50 for jamming measurements follows:

GAMBATTE INC. TRADE SECRET INFORMATION

Processing Gain in the WRM91 Receiver

This document contains Trade Secret and/or Company Confidential information. We request that the contents of this correspondence and all related correspondence be withheld from public inspection as provided under Section 0.457, as requested in the application for Part 15 intentional spread spectrum radiator certification for FCC ID: I8WWRM91-50.

FCC Part 15.247, amended June 14, 1990, requires that direct sequence spread spectrum (DS/SS) receivers exhibit at least 10 dB processing gain. Processing gain in DS/SS systems is defined as the difference between receiver input signal to noise ratio and post-correlation signal to noise ratio. The Rules state that processing gain shall be determined from the ratio of the signal to noise ratio with the system spreading code turned off and the signal to noise ratio with the system spreading code turned on, as measured at the demodulated output of the receiver." In many systems, including the subject WRM91 receiver, the signal to noise ratio cannot be measured with the spreading code "turned off" because the code is permanently programmed into a digital FIR filter.

If the FIR filter clock is disabled to "turn off" the spreading code, the FIR filter will be disabled, making any measurement of signal to noise ratio impossible.

As an alternative, measurement a related quantity -- jamming margin -- provides a convenient substitute measurement. Jamming margin is generally considered a valid substitute measurement of realized processing gain. Jamming margin is often a function of the nature of the jamming signal. The use of a CW jammer for jamming margin measurements is simple and straightforward and is meaningful and repeatable. Using a Jammer and measuring system bit error rate (BER) as a function of the signal interference (S/I) ratio or its converse, the jam to signal (J/S) ratio, provides an indication of a receiver's ability to resist jamming.

Digital communications systems exhibit a BER threshold effect: They perform well in the presence of noise or jamming up to a certain point, then BER precipitously deteriorates. The theoretical 10-5 BER threshold for BPSK systems is about 9.6 dB. Most commercial systems, for reasons relating to practical and economic aspects of commercial-quality circuit realization, exhibit a 10-5 BER at approximately 12 to 14 dB S/I. Using this as a standard, a spread spectrum system that exhibits a 10-5 BER at an input S/I ratio in the range of 2 to 4 dB has probably achieved 10 dB jamming margin and, by inference, 10 dB of processing gain.

Measurements of WRM91 receiver jamming margin were made using a Hewlett Packard 8656B UHF synthesizer as a jammer The results are shown in the tables and graphs on the following pages. The RMS powers of the jammer and the signal were measured precisely for the tests using a, Hewlett Packard Model 438A RF power meter which is has 0.01 dB resolution, It can be seen that the minimum 10 dB margin requirement is met or exceeded at all frequencies, Out-of-band rejection is very exceptionally high, requiring a jamming (blocking) signal of -2 dBm or so to Jam the desired signal (-20 dBrn blocking is considered excellent for most commercial or industrial receivers),

We have submitted data on the CW Jamming margin of the WRM91 receiver in-band and out-of-band in order to demonstrate that its a very robust receiver. We submit the following data and information as evidence that the WRM91 receiver does indeed possess at least 10 dB processing gain:

1) The spreading ratio of the WRM91 transmitter is 14 (18.6 dB), thus 10 dB is theoretically achievable.

GAMBATTE INC. TRADE SECRET INFORMATION

2) The system exhibits less than 10-5 BER at 2.1 dB S/I typical, 3.8 dB worst case with a CW jammer, This is indicative of a 11.9 dB typical and 10.2 dB worst case assuming that 14 dB S/N is necessary at the demodulator for 10-5 BER.

3) The receiver is a well-designed, industrial-quality single conversion superheterodyne design. It uses a high-intercept-point RF preamp and mixer, a high rejection SAW IF filter, insuring that it has no significant response (as is demonstrated by the out-of-band CW interference measurements) to out-of-band signals.

4) The receiver employs a differential demodulator with a 2:1 input/output symbol ratio followed by a 37-tap FIR filter correlator for a net 74:1 input output symbol ratio. It also features a post-correlation integrate-and-dump bit decision circuit (as opposed to simple threshold detection) to insure that as much as possible of the post-processed energy is recovered and utilized in making the bit decision,

5) The system's 74-elernent spreading code was designed by computer and was chosen for its random spectral distribution properties, 1/0 code balance, and excellent even and odd correlation characteristics.

We submit that our CW jamming margin measurements are a valid demonstration of the WRM91 receiver's having met the 10 dB processing gain requirement of FCC Part 15.247, as amended June 14, 1990.

Respectfully submitted,

P. Stuckey McIntosh
Chairman
Gambatte Digital Wireless

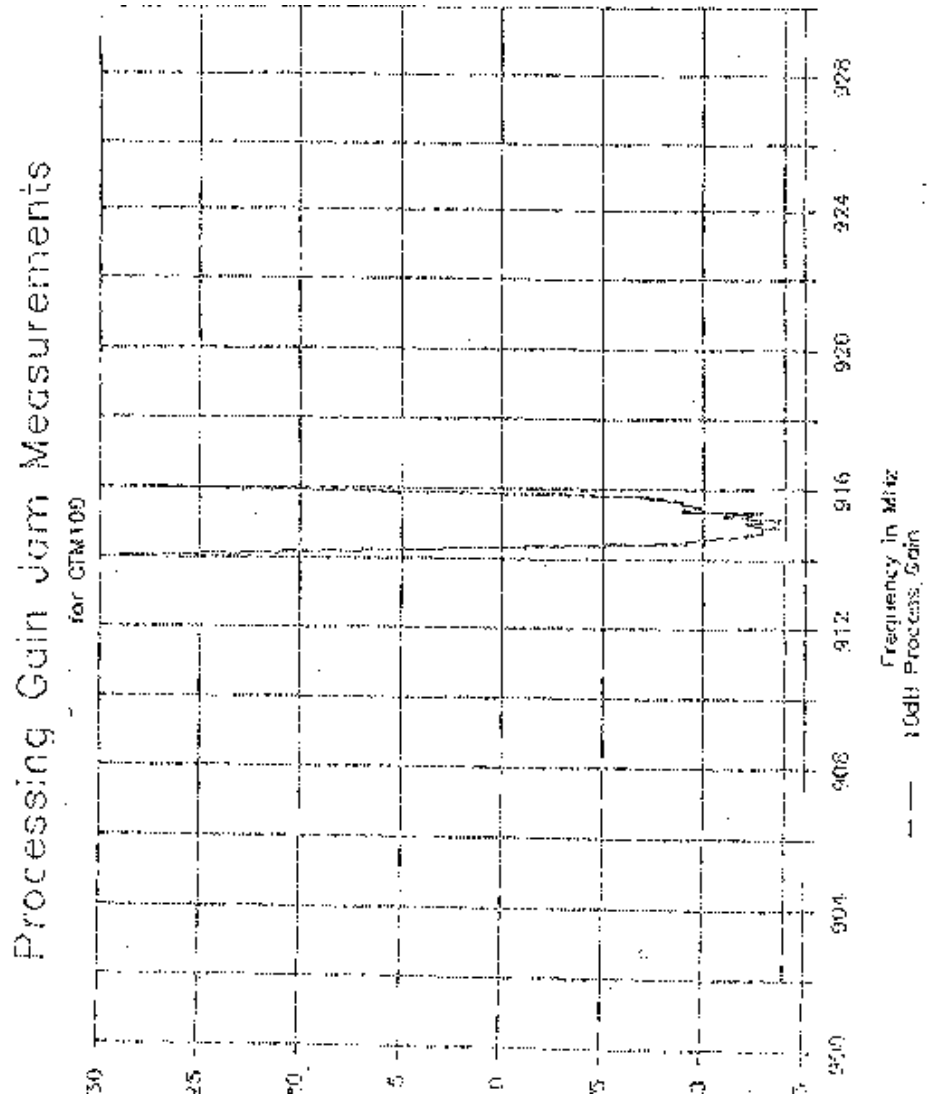
This document contains Trade Secret and/or Company Confidential Information. We request that the contents of this correspondence and all related correspondence be: withheld from public inspection as provided under Section 0 457, as requested in the application for Part 15 intentional spread spectrum radiator certification for FCC ID: I8WWRM91-50.

GAMBATTE INC TRADE SECRET INFORMATION

JAMMING MEASUREMENTS OF THE WRM91 SYSTEM

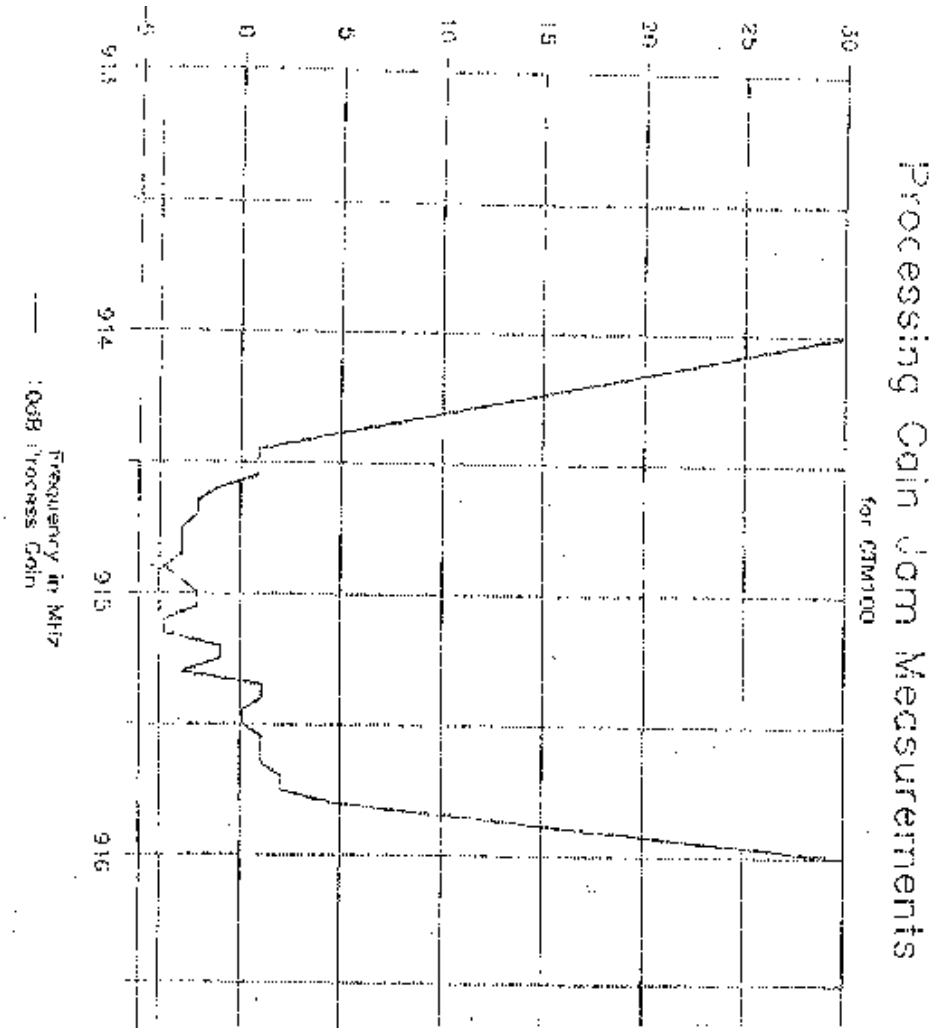
Frequency(MHz)	CW Jammer Level (Dbm Relative to Signal)
900	30
902	30
903	30
904	30
905	30
906	30
907	30
908	30
909	30
910	30
911	30
912	30
913	30
914	30
914.4	3.9
914.45	0.9
914.5	0.9
914.55	0.9
914.5	-1.1
914.65	-2.1
914.7	-2.1
914.75	-2.9
914.3	-2.9
914.85	-2.9
914.9	-3.8
914.95	-2.9
9113	-2.1
915-05	-2.1
915.1	-3.8
915.15	-3.8
915.2	-1
915.25	-1
915.3	-2.9
915.35	1.1
915.4	1.1
915.45	0.1
915.5	0.1
915.55	1.1
915.6	1.1
915.65	1.1
915.7	2.1
915.75	2.1
915.8	4.7
916	30
917	30
918	30
919	30
920	30
921	30
922	30
923	30
924	30
925	30

926	30
927	30
918	30
930	30
931	



This document contains Trade Secret and or Company Confidential information. We request that the contents of this correspondence and A related correspondence be withheld from public inspection as provided under Section 0.457, as requested in the application for Part 15 intentional spread spectrum radiator certification for FCC ID I18WWRM91-50.

GAMBATTE INC TRADE SECRET INFORMATION



This document contains Trade Secret and or Company Confidential information. We request that the contents of this correspondence and A related correspondence be withheld from public inspection as provided under Section 0.457, as requested in the application for Part 15 intentional spread spectrum radiator certification for FCC ID I18WWRM91-50.

GAMBATTE INC TRADE SECRET INFORMATION

(11) N/A

III. TEST RESULTS

a) The minimum 6dB bandwidth per §15.247(a)(2) is given in Plot 1. This 1MHz-plus occupied bandwidth meets the minimum 500 kHz requirement for DSSS transmitters.

b) Peak power within the band 902 – 928 MHz has been measured with a spectrum analyzer. The results are shown in Plot 2. All measurements are with an external attenuation of 30 dB so the top of the graph is +30 dBm. The average power of the transmitter, as measured on a power meter was 0.467 W. This output power is below the 1 Watt limit of §15.247(b)(1).

c) Spurious emissions were measured over the frequency range of 30 – 9280 MHz per §15.247(c) as shown in Plots 5-8. Conducted spurious emissions are all greater than 55 dBc.

d) Per §15.247(d), the transmitter power spectral density averaged over a one -second interval in a 3 kHz band is given in Plot 9. The + 4 dBm peak level is below the + 8 dBm limit.

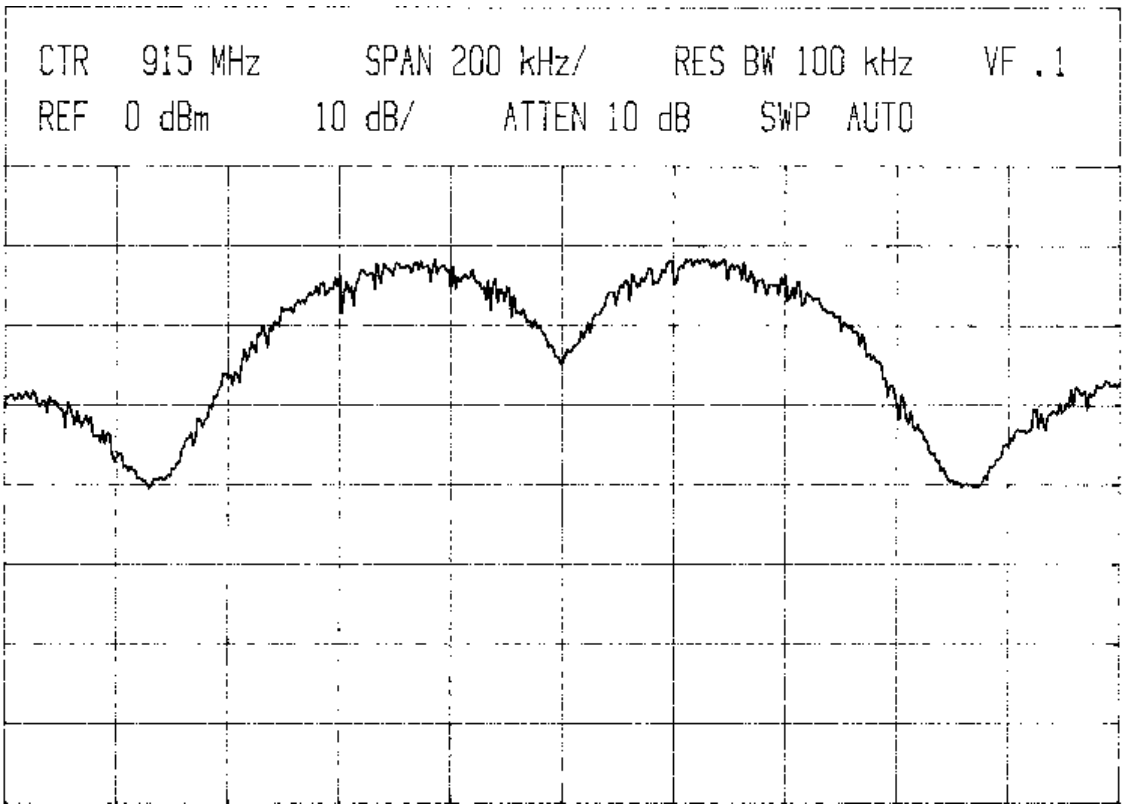
e) Conducted voltage measurements per §15.207(a), N/A – this is a portable, battery operated device.

f) Radiated field strength measurements were taken in the range 30 MHz – 1000 MHz per §15.109(a). This testing was performed by Retlif Labs. at their Goffstown, NH site. A complete test report is attached which includes test photographs and a test equipment list. All correction factors are included in the measurement results. All detected spurious emissions were within Part 15 limits including restricted band limits.

a. Minimum 6 dB Bandwidth

This measurement was done with 30 dB of external attenuation between the test sample and the spectrum analyzer. The integral antenna connection was removed from the transmitter output and a test cable pigtail was substituted. This bandwidth (1 MHz), is greater than the minimum 6dB bandwidth of 500 kHz required by §15.247(a)(2).

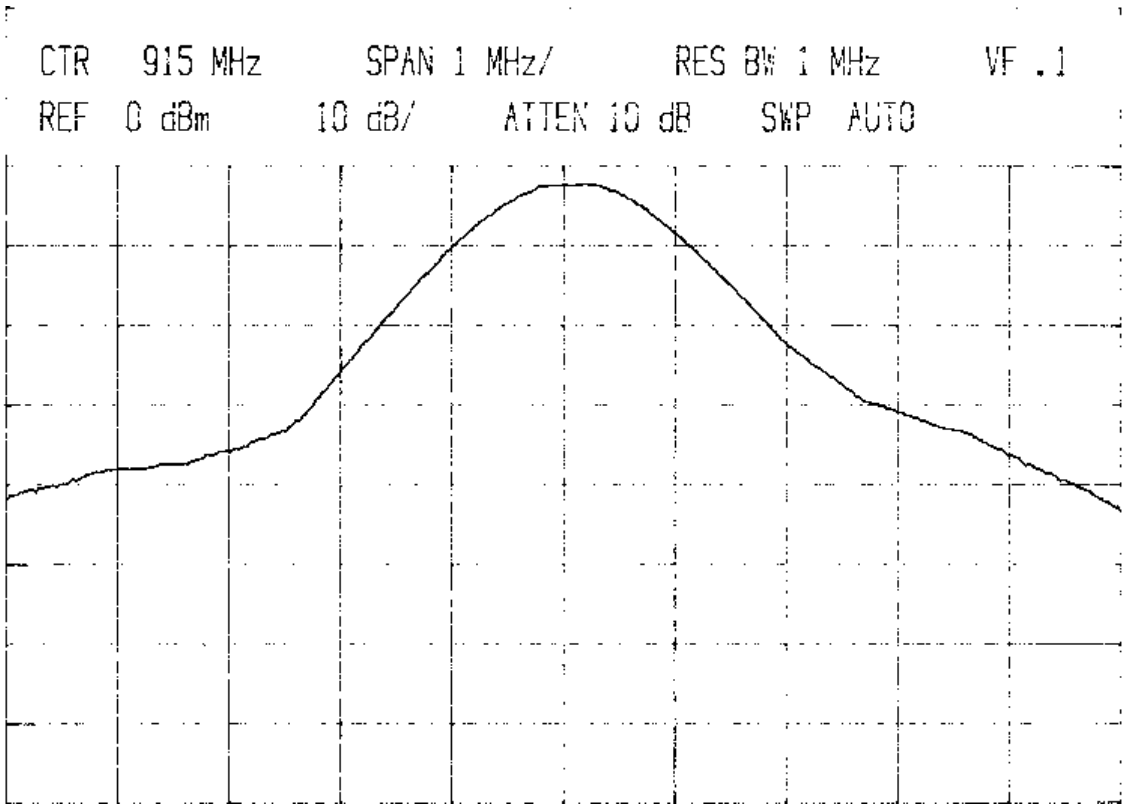
Plot 1 Minimum 6dB BW



Peak Power Measurement

The peak power measurement was made with 30 dB of attenuation between the test sample and the spectrum analyzer. Thus the peak output power is –3 dBm + 30 dB = 27dBm or 0.500 W.

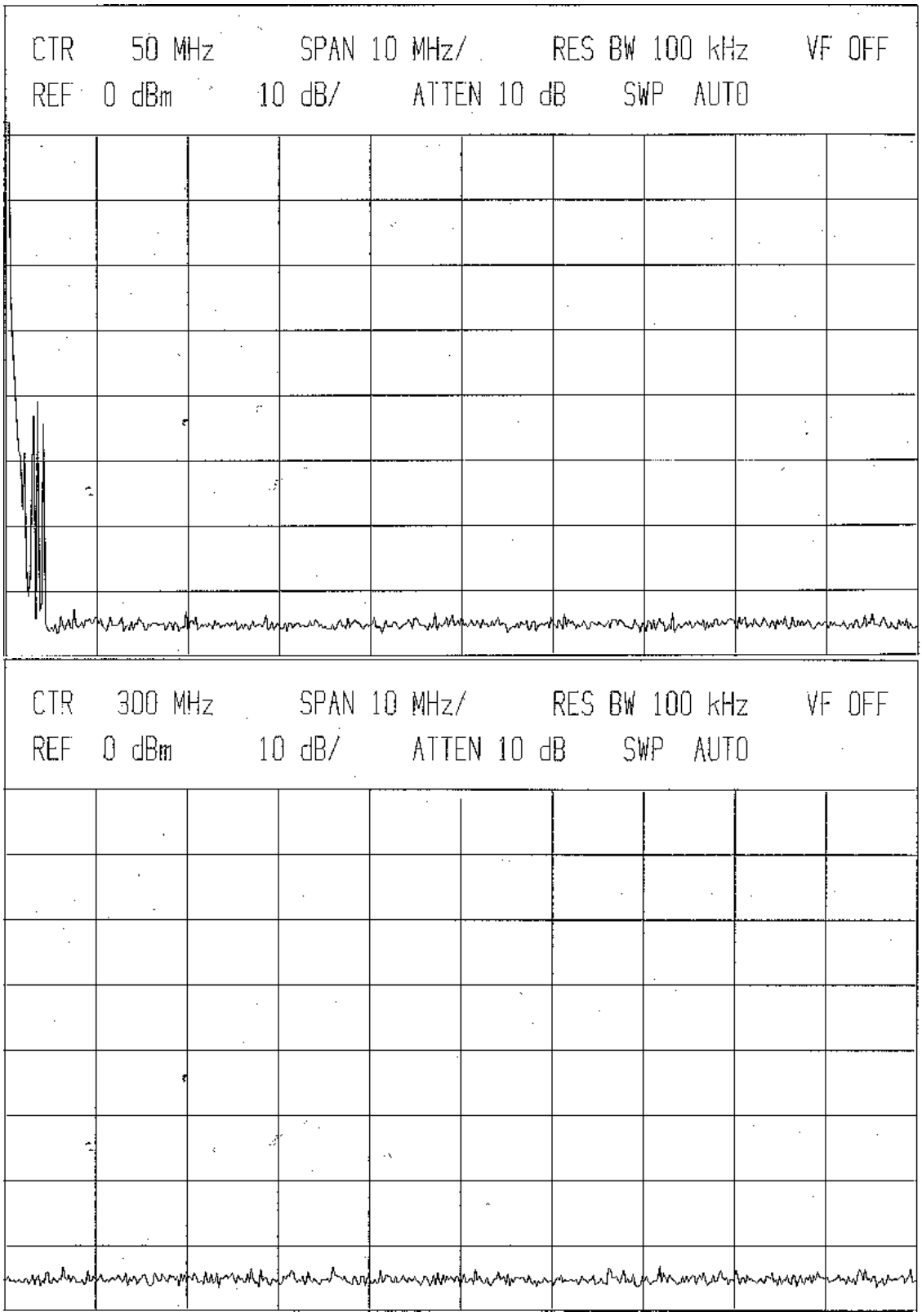
Plot 2 Peak Power



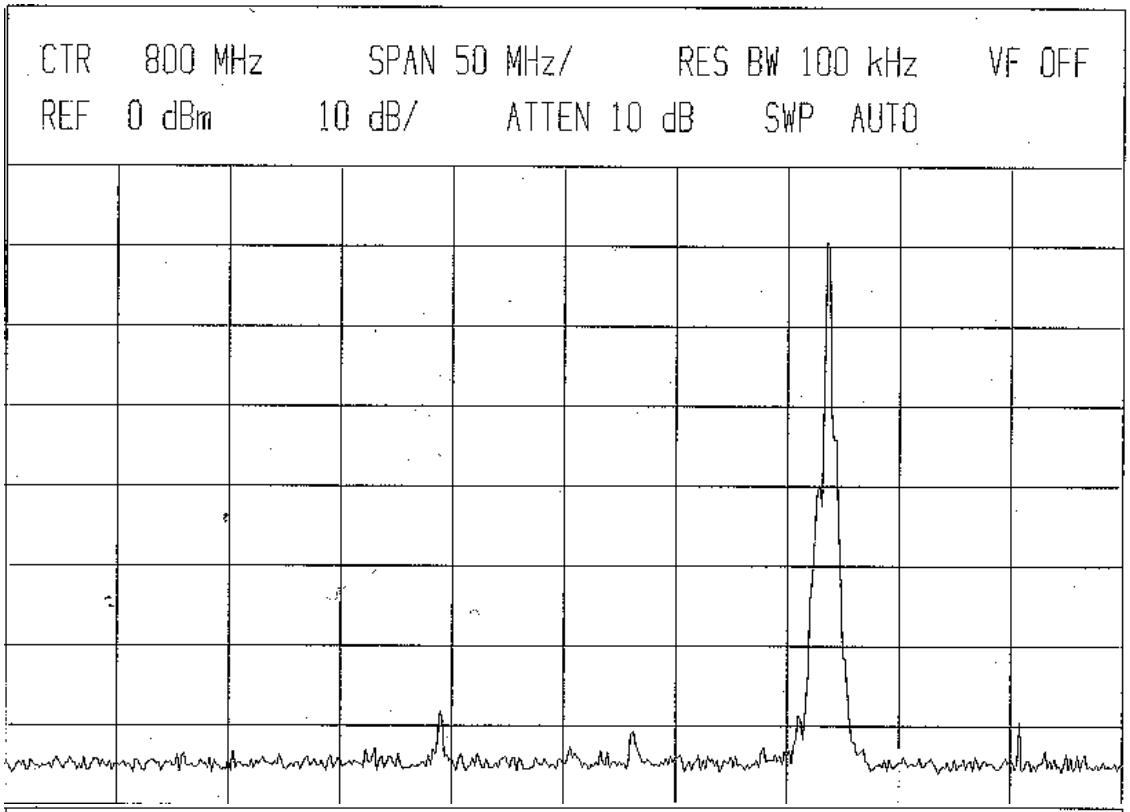
Conducted Spurious Emissions

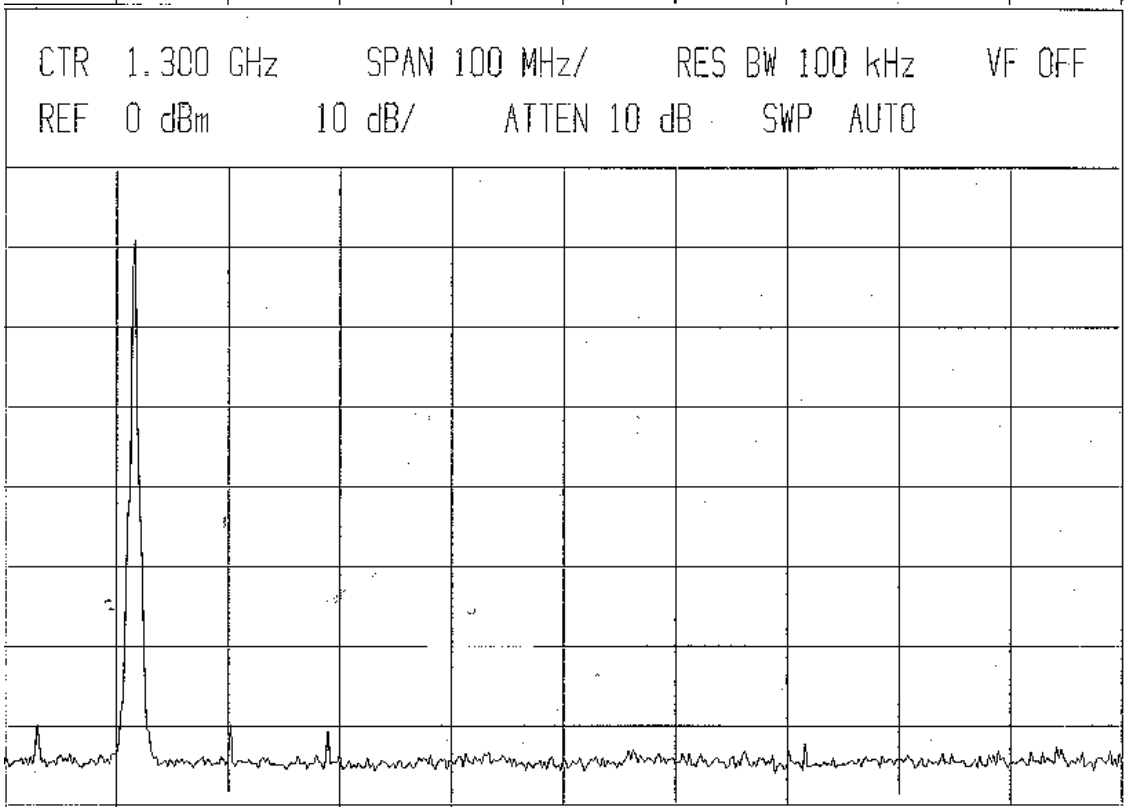
Measurements were done with 30 dB external attenuation in a frequency range of less than 10 MHz to greater than 9280 MHz.

Plots 3 + 4 Spurious Emissions

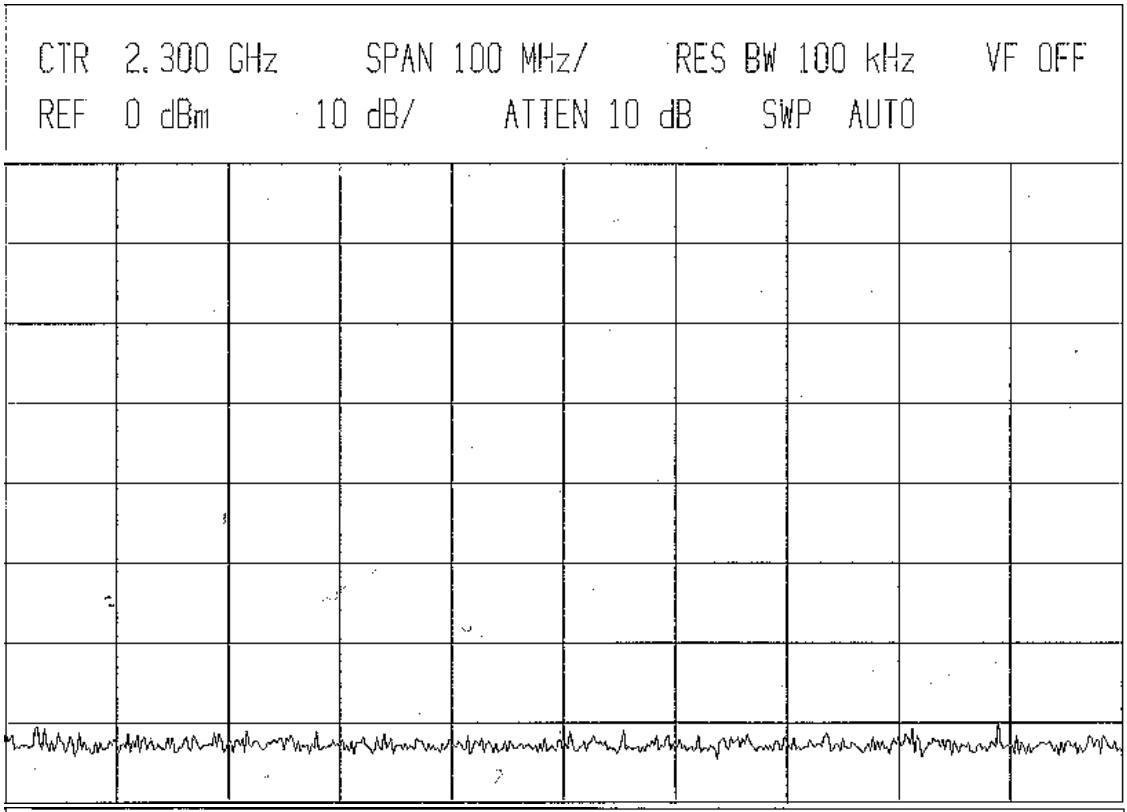


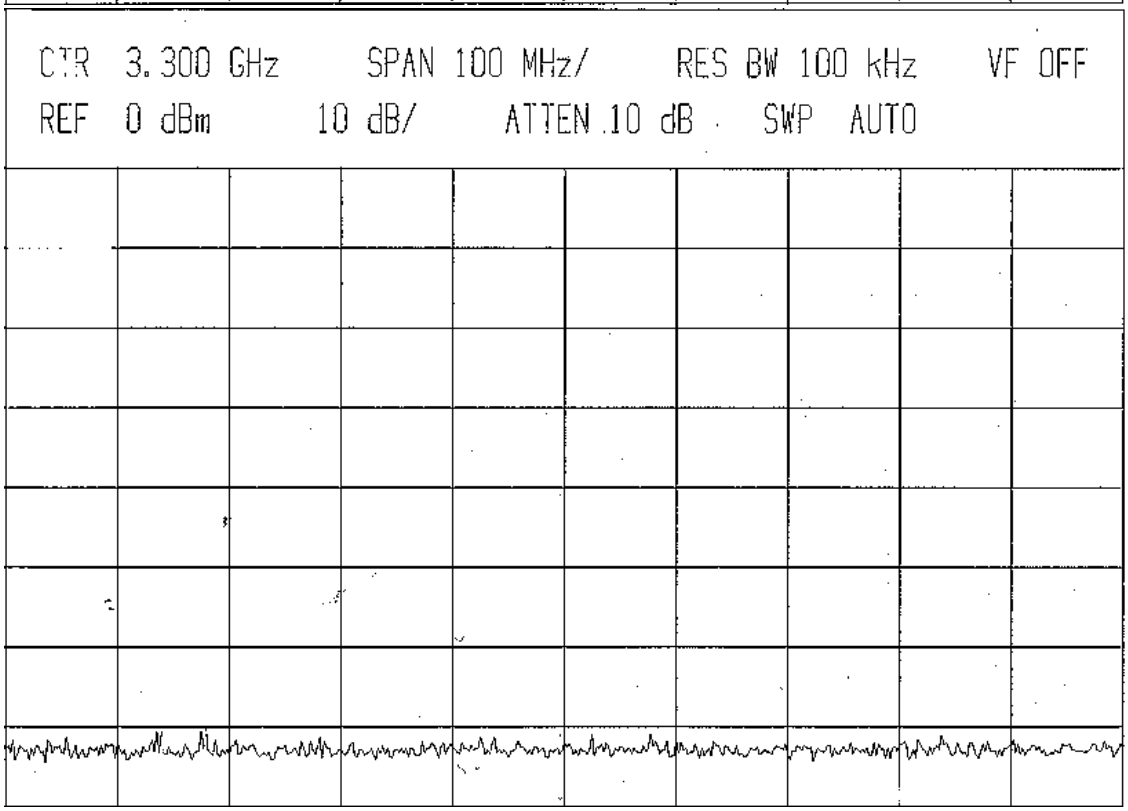
Plot 5 + 6 Spurious Emissions



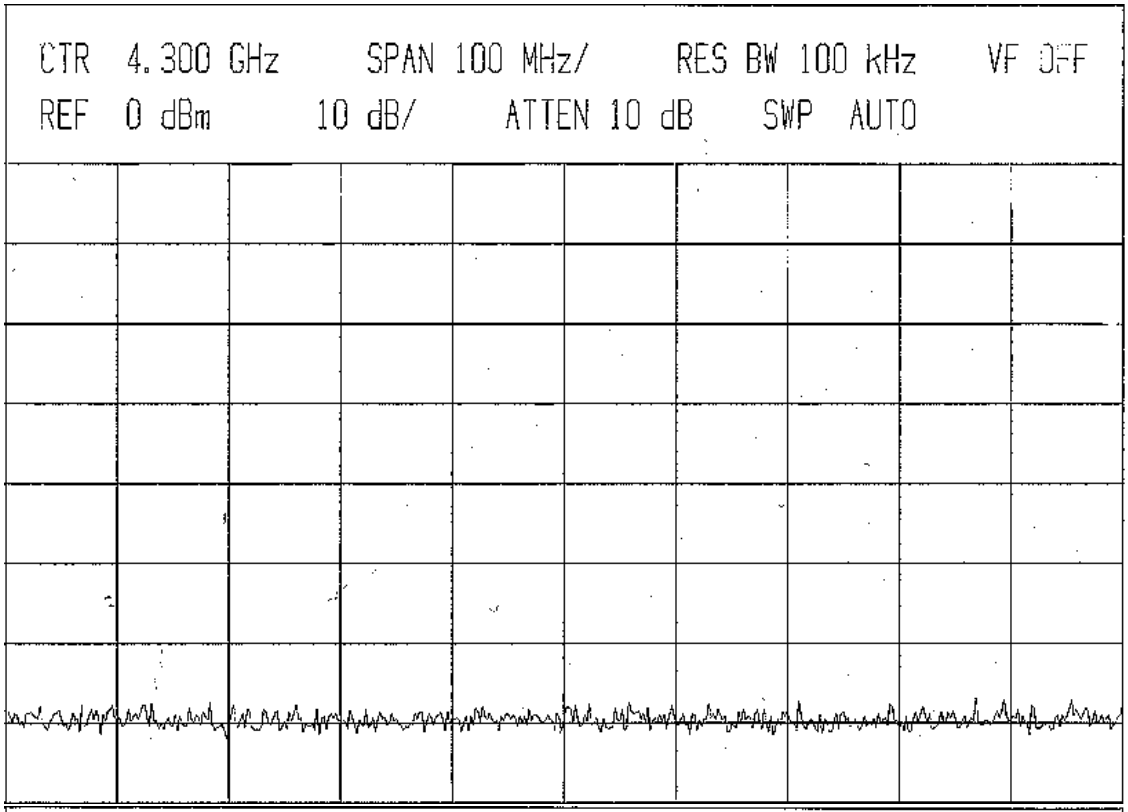


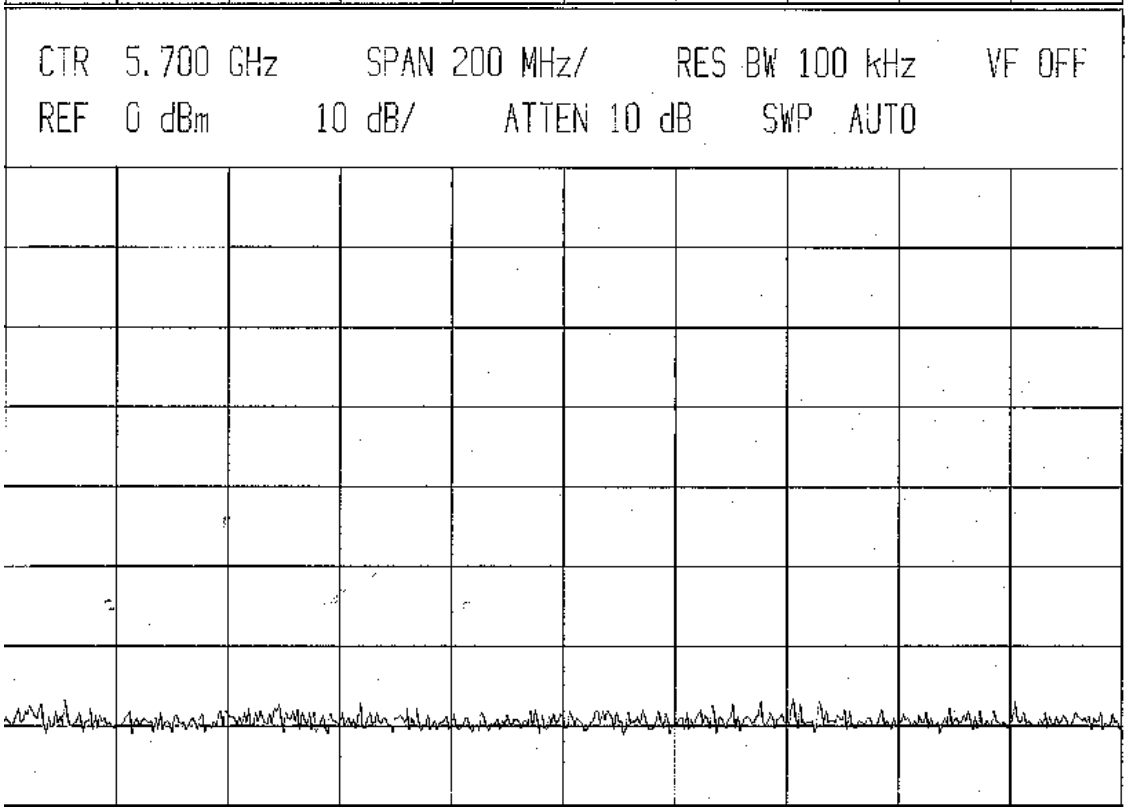
Plots 7 + 8 Spurious Emissions



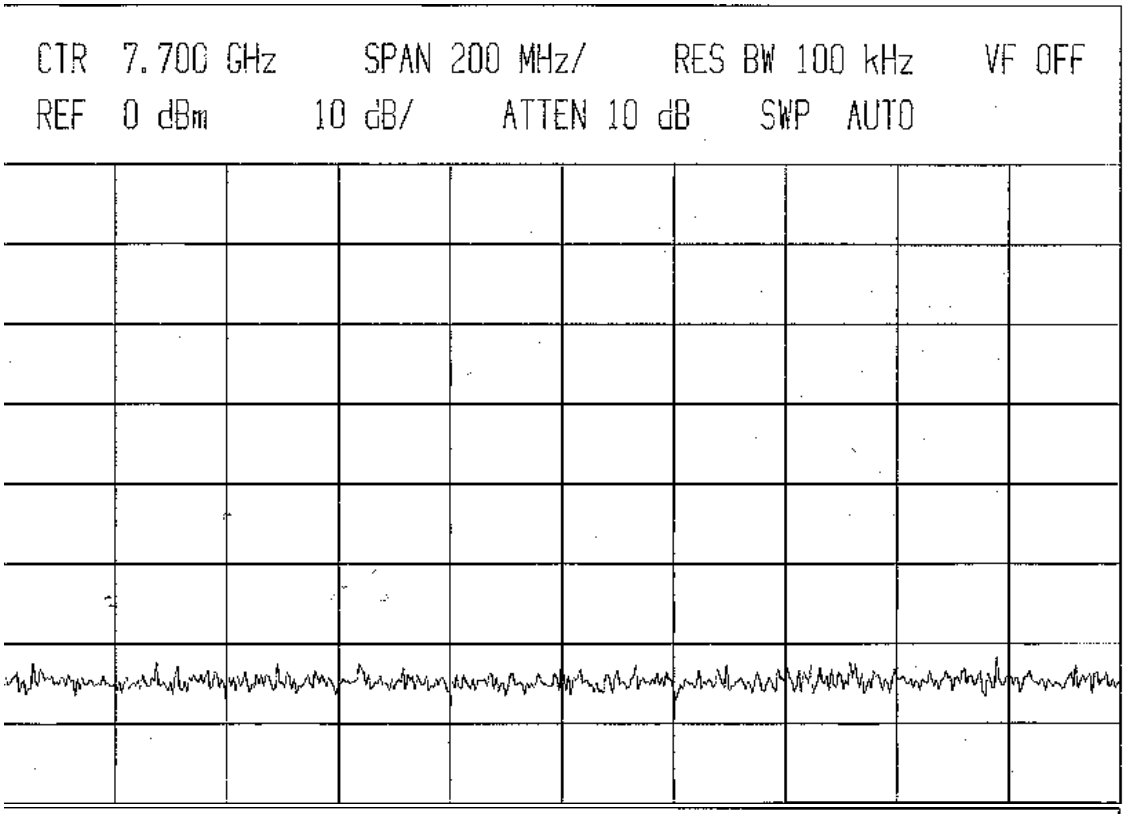


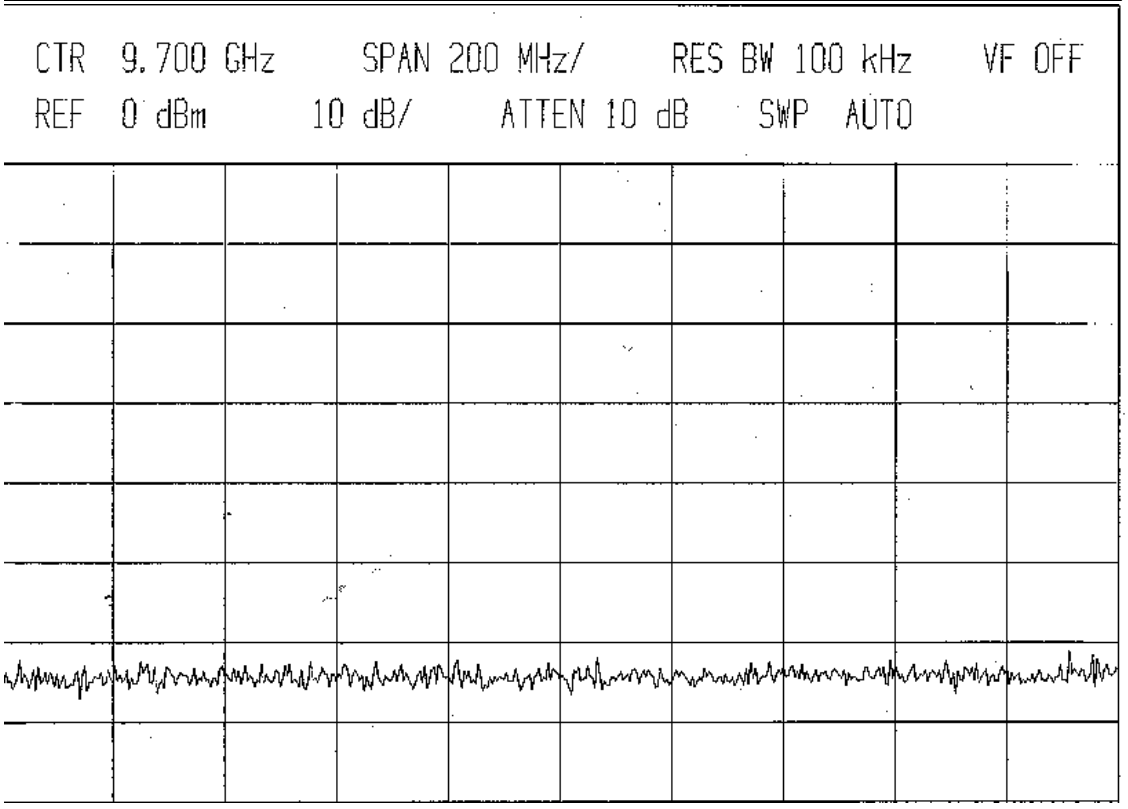
Plots 9 + 10 Spurious Emissions





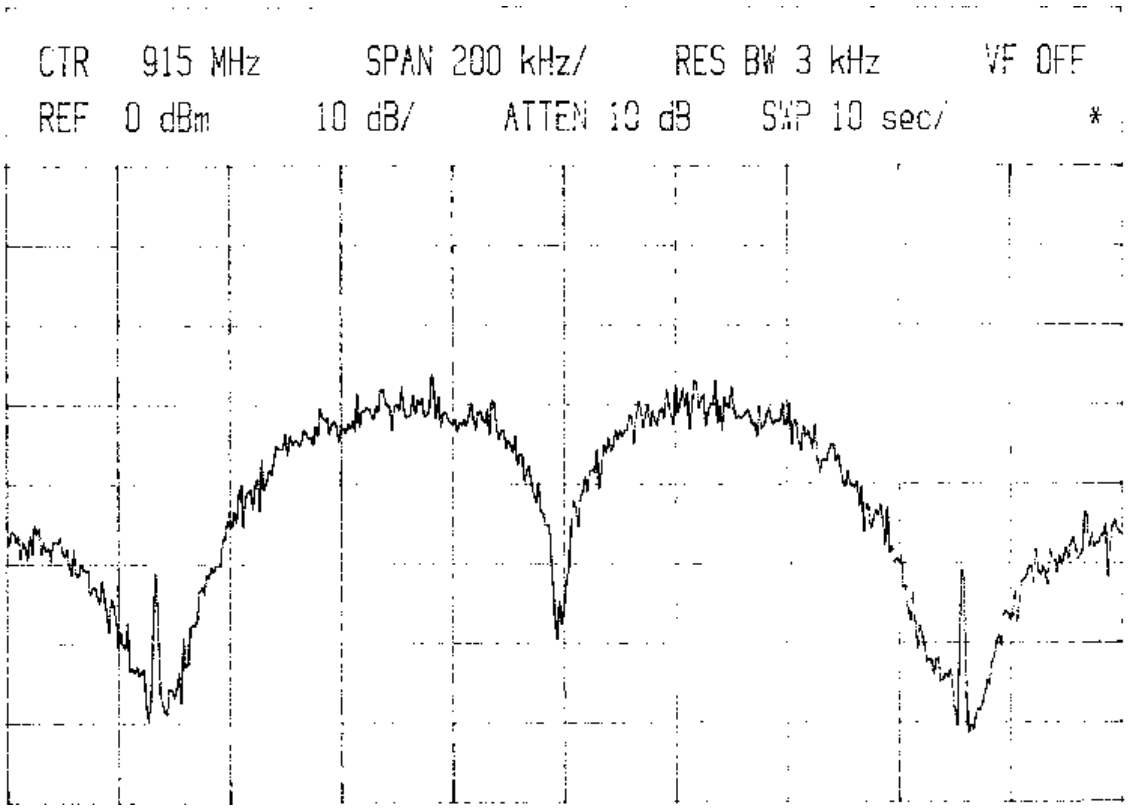
Plots 11 + 12 Spurious Emissions





b. Power Spectral Density was done with 30 dB of attenuation between the test sample and the spectrum analyzer. Peak spectral power is no greater than +4 dBm, thus meeting the + 8 dBm limit.

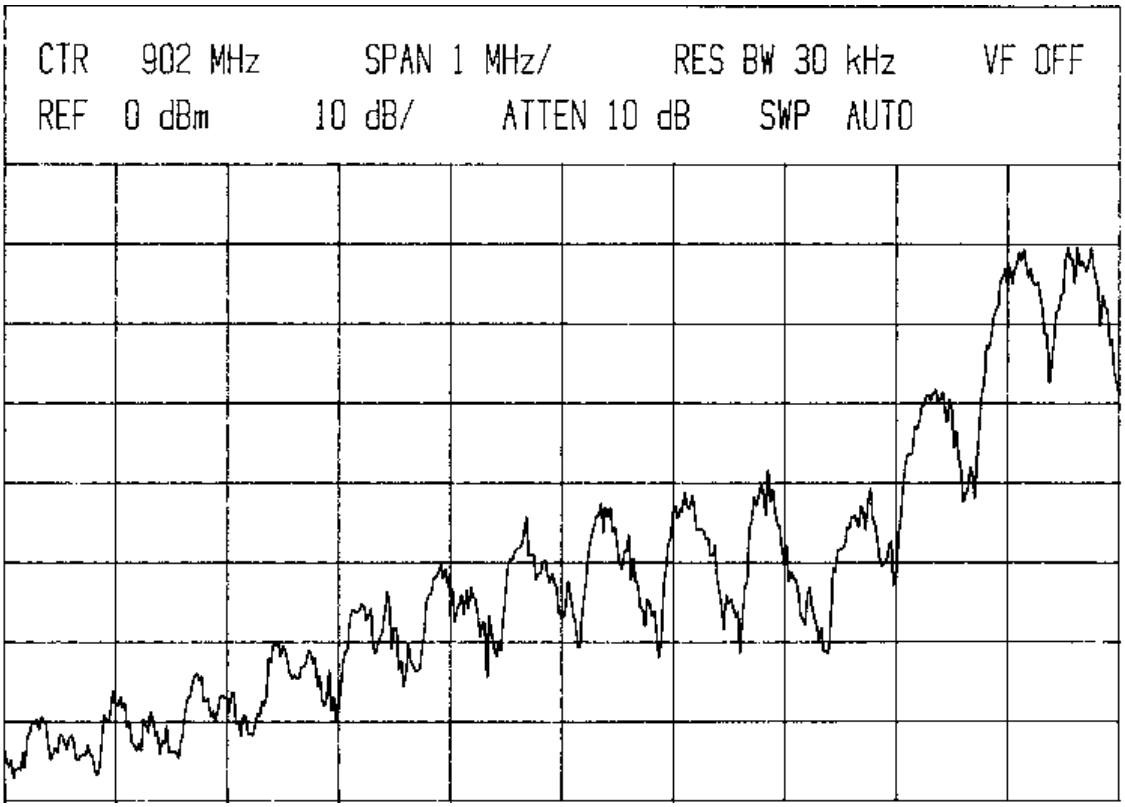
Plot 13 Power Spectral Density

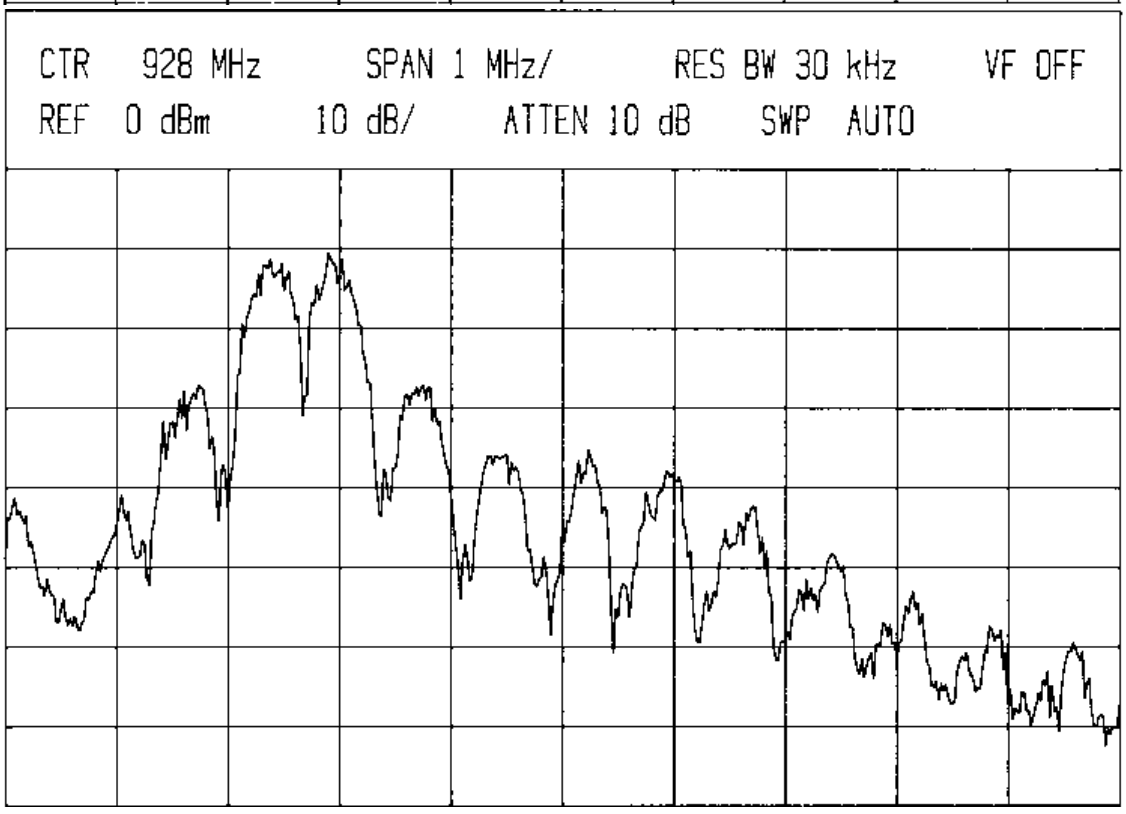


Band Edge Spectral Data

Conducted band edge data were taken with the transmitter set for Channel 1 (905.5Hz) and Channel 3 (924.5 MHz). This test was done with 30 dB of attenuation between the test sample and the spectrum analyzer. The peak power at the band edges is greater than –30 dBc on the lower edge and -25 dBc on the upper edge, thus meeting the – 20 dBc minimum of 15.247c.

Plots 14, 15 Band Edges, Low-High Channels





Conducted Voltage - N/A

c. Radiated Spurious Emissions (Retlif Labs)

Retlif Testing Laboratories
101 New Boston Road, Goffstown, NH 03045
603-497-4600 - Fax: 603-497-5281

CORPORATE OFFICE
795 Marconi Avenue
Ronkonkoma, NY 11779
516-737-1600 Fax 516-737-1497
(A NY Corporation)

BRANCH LABORATORY
11 Harts Lane, Suite H
East Brunswick, NJ 08816
732-257-0800 Fax 732-257-6663
(A NJ L.L.C.)

ENGINEERING OFFICE
27777 Franklin Road
Southfield, MI 48034
248-213-0295 Fax 248-213-0257

March 1, 2000

DTC Communications, Inc.
75 Northeastern Blvd.
Nashua, NH 03062

Attention: Mike Murphy

Dear Sir:

Enclosed you will find Data Package R-3562N covering testing of the Digital Spread Spectrum Audio Surveillance Transmitter, Model No. DSS950TX, to the requirements of FCC Part 15, Subpart B, Radiated Emissions. This testing was performed against Purchase Order Number 46701.

Test setup photographs, equipment lists, and test data are included for each test method performed on the above test sample.

Thank you for this opportunity to be of service to you. Should you have any questions concerning this data or the actual testing of your unit, please do not hesitate to contact us.

Sincerely,

RETLIF TESTING LABORATORIES

Terra G. Tarango

Terra G. Tarango
Publications

Enc. (as stated)

Retlif Testing Laboratories
101 New Boston Road, Goffstown, NH 03045
603-497-4600 - Fax: 603-497-5281

CORPORATE OFFICE
795 Marconi Avenue
Ronkonkoma, NY 11779
516-737-1500 Fax 516-737-1497
(A NY Corporation)

BRANCH LABORATORY
11 Harts Lane, Suite H
East Brunswick, NJ 08816
732-257-0800 Fax 732-257-0663
(A NJ L.L.C.)

ENGINEERING OFFICE
27777 Franklin Road
Southfield, MI 48034
248-213-0366 Fax 248-213-0257

DATA PACKAGE
FOR

Digital Spread Spectrum
Audio Surveillance Transmitter
Model No. DSS950TX

Customer Name: DTC Communications, Inc.

Customer P.O.: 46701

Data Package No.: R-3562N

Package Date: March 1, 2000

Test Start Date: February 24, 2000

Test Finish Date: February 24, 2000

Test Technician(s): Tim Firkowski

Test Engineer: John Monahan

Data Prepared By: Terra G. Tarango

Supervisor: Scott Wentworth

MODIFICATION TO THE EUT

MADE DURING THE TEST PROGRAM

Job Number: R-3562N **Test Sample Name:** H25DSS950TX

Test Method: RE **Technician:** TF **Date:** 02/24/00

Reason for Modification: HIGH SPURIOUS RADIATED EMISSIONS IN SEVERAL RESTRICTED BANDS (HARMONICS OF FUND.)

Description of Modification: POWER AMPLIFIER IC CHANGED FROM RF MICRODEVICES 2103P TO RF MICRODEVICES 2131P. CIRCUIT BOARD UPDATE TO ACCEPT NEW FOOTPRINT AND MATCHING COMPONENTS.

* HARMONIC FILTER UNCHANGED, EXCITER CIRCUIT UNCHANGED; POWER SUPPLY UNCHANGED; ANTENNA UNCHANGED; HOUSING UNCHANGED

Circle One:

Temporary	(Installed temporarily during test evaluation; manufacturer to install permanently)
(Permanent)	(Installed permanently by manufacturer during test evaluation)

Result of Modification: CHANGING THE AMPLIFIER TO A MORE LINEAR DEVICE REDUCED ALL SPURS WELL INTO COMPLIANCE.

THE VALIDITY OF THE EUT COMPLIANCE AND OF THIS REPORT IS BASED, IN PART, ON THE PRESENCE OF THE ABOVE MODIFICATION.

At the time of the modification installation, and at the conclusion of the test program, the EUT manufacturer was made aware of the need to have the above modification incorporated in all future productions of the EUT.

Customer Initials

MIKE MURPHY DTC COMMUNICATIONS

☐ Customer Copy ☒ Lab Copy

Retlif Testing Laboratories

MODIFICATION REVIEW SHEET

EQUIPMENT LIST

Radiated Emissions

EN	Type	Manufacturer	Frequency Range	Model No.	Cal Date	Due Date
3118	Broadband Pre-Amplifier	Electro-Metrics	10 KHz - 1 GHz	BPA-1000	07/16/1999	07/16/2000
3258	Double Ridge Guide	EMCO	1 - 18 GHz	3115	04/07/1999	04/07/2000
4202	Biconilog	EMCO	26 MHz - 2 GHz	3142	06/16/1999	06/16/2000
4895	Spectrum Analyzer	Hewlett Packard	9kHz - 22GHz	8593EM	02/17/2000	02/17/2001
4921	Graphics Plotter	Hewlett Packard	N/A	7550A	04/19/1999	04/19/2000
4986	Interference Analyzer	Electro-Metrics	9 KHz to 1 GHz	EMC-30C	02/14/2000	02/14/2001

RETLIF TESTING LABORATORIES

TABULAR DATA SHEET

TEST METHOD:	Radiated Emissions 30MHz to 10GHz
CUSTOMER:	DTC Communicatons, Inc. JOB No.: R-3562N
TEST SAMPLE:	Digital Spread Spectrum Audio Surveillance Transmitter
MODEL No.:	DSS950TX SERIAL No.: n/a
TEST SPECIFICATION:	FCC Part 15, Subpart C PARAGRAPH: 15.247
OPERATING MODE:	Continuously Transmitting
TECHNICIAN:	T. Firkowski DATE: 2/24/00
NOTES:	Detector Function: Quasi-Peak (30MHz-1GHz) Test Distance(30MHz-1GHz): 3 Meters Average (1GHz-10GHz) Test Distance(1GHz-10GHz): 1 Meter See Modification Sheet

TEST FREQUENCY	ANTENNA POSITION	TURNTABLE POSITION	METER READING	CORRECTION FACTOR	CORRECTED READING		CONVERTED TO 3 METERS	LIMIT @ 3 METERS
MHz	(H/V)-HEIGHT	DEGREES	dBuV	dB	dBuV/m		dBuV/m	dBuV/m
30.0	-	-	-	-	-		-	40.0
|	-	-	-	-	-		-	|
88.0	-	-	-	-	-		-	40.0
88.0	-	-	-	-	-		-	43.5
|	-	-	-	-	-		-	|
216.0	-	-	-	-	-		-	43.5
216.0	-	-	-	-	-		-	46.0
|	-	-	-	-	-		-	|
960.0	-	-	-	-	-		-	46.0
960.0	-	-	-	-	-		-	54.0
|	-	-	-	-	-		-	|
915.6	H-1.5m	90	79.1	12.6	91.7		-	*
915.6	V-1.5m	0	79.7	12.6	92.3		-	*
|							-	|
|			@1m				-	|
1829.0	H-1.5m	180	19.8	27.0	46.8		36.8	71.7
2745.0	H-1.5m	180	20.4	28.0	48.4		38.4	54.0
3659.0	H-1.5m	180	15.4	33.0	48.4		38.4	|
2745.0	V-1.5m	270	23.6	28.0	51.6		41.6	|
3659.0	V-1.5m	270	18.9	33.0	51.9		41.9	|
4574.8	V-1.5m	270	26.2	33.5	59.7		49.7	54.0
5488.0	V-1.5m	270	20.0	33.5	53.5		43.5	72.3
|	-	-	-	-	-		-	-
10000.0	-	-	-	-	-		-	54.0

EUT emissions observed throughout the given frequency spectrum were recorded and evaluated.
Emission levels closest to the limit are listed on this data sheet.

EQUIPMENT LIST – Retliff Testing Laboratories

Spurious Radiated Emissions

Type	Manufacturer	Model Number
Pre-Amplifier	Miteq	AFS42-35
Broadband Pre-Amplifier	Electro-Metrics	BPA-1000
Double Ridge Guide	EMCO	3115
Open Area Test Site	Retlif	3/10 Meters
Biconilog	EMCO	26MHz – 2 GHz
Graphics Plotter	Hewlett Packard	7550A
EMC Analyzer	Hewlett Packard	8593EM

III. MODIFICATIONS

No modifications were made by DTC Communications Inc. or Retlif Testing Laboratories, to bring the unit into compliance other than those shown on the Retlif Modification to EUT Sheet shown in the Retlif data package. This modification involved the redesign of the RF power amplifier by DTC to accept a similar, but more linear, power amplifier MMIC. Approximately one month of time elapsed between the initial testing and the final testing sessions. All final conducted and spurious radiation data were taken with the final configuration. A short coaxial jumper made of 7 Inches of RG-188 with a male SMA connector was substituted for the patch antenna during the conducted spurious radiation testing.

IV. DTC TEST EQUIPMENT

Type	Manufacturer	Model No.
Power Meter	Hewlett Packard	HP 437B
Spectrum Analyzer	Hewlett Packard	HP 8570A
Multimeter	Hewlett Packard	34401A
DC Power Supply	Hewlett Packard	E3610A
Audio Generator	Leader	LAG-12S
Temperature Chamber	Associated Systems	BK-1101
Frequency Counter	Systron Donner	6420
Attenuator Pad 30 dB	JFW	50FH-030