



TEST SPECIFICATION:

FCC "Rules and Regulations", Part 74,
Experimental Radio, Auxiliary, Special Broadcast and Other Program
Distribution Services for Operation in the

692.125-715.875 MHz Band

Subpart H, Low Power Auxiliary Stations
Sections 74.801 to 74.882

THE FOLLOWING **MEETS** THE ABOVE TEST SPECIFICATION

Formal Name: U2B Wireless UHF-FM Transmitter

Kind of Equipment: UHF-FM Transmitter

Test Configuration: NA

Emission Designator: 120KF3B

Transmitter FCC ID: DD4U2B

Model Number: U2B

Serial Number: 0106980819

Dates of Test: November 16, 1998 & January 28, 1999

Test Conducted For: Shure Brothers, Inc.

222 Hartrey Avenue

Evanston, Illinois 60202

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SIGNATURE PAGE

Report Written By:

A handwritten signature in black ink that reads "Arnom C. Rowe". The signature is written in a cursive style with a large initial "A".

Arnom C. Rowe
Test Engineer
EMC-001375-NE

Report Reviewed by:

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Jack Prawica
Lab Manager

Report Approved by:

A handwritten signature in black ink that reads "Brian J. Mattson". The signature is written in a cursive style with a large initial "B".

Brian J. Mattson
General Manager

Company Official:

Shure Brothers, Inc.

United States Department of Commerce
National Institute of Standards and Technology



Certificate of Accreditation

D.L.S. ELECTRONIC SYSTEMS, INC.
WHEELING, IL

Under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with
ed in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements
le 25 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of
st results. Accreditation is awarded for specific services, listed on the Scope of Accreditation for:

**FROM MAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS
FCC**

September 30, 1999

Effective through

A handwritten signature is present, followed by a horizontal line. Below the line, the text "For the National Institute of Standards and Technology" is printed.

NVLAP Lab Code: 100276-0

National Institute
of Standards and Technology



National Voluntary
Laboratory Accreditation Program

ISO/IEC GUIDE 25:1990
ISO 9002:1987

Scope of Accreditation



Page: 1 of 1

**ELECTROMAGNETIC COMPATIBILITY
AND TELECOMMUNICATIONS**

NVLAP LAB CODE 100276-0

D.L.S. ELECTRONIC SYSTEMS, INC.

1250 Peterson Drive

Wheeling, IL 60090-6454

Mr. Brian J. Mattson

Phone: 847-537-6400 Fax: 847-537-6488

NVLAP Code Designation / Description

International Special Committee on Radio Interference (CISPR) Methods

12/CIS22 IEC/CISPR 22:1993: Limits and methods of measurement of radio disturbance characteristics of information technology equipment

Federal Communications Commission (FCC) Methods

12/F01 FCC Method - 47 CFR Part 15 - Digital Devices

12/F01a Conducted Emissions, Power Lines, 450 KHz to 30 MHz

12/F01b Radiated Emissions

Australian Standards referred to by clauses in AUSTEL Technical Standards

12/T51 AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment



1.	Cover Page	i
2.	Signature Page	ii
3.	NBS Certificate of Accreditation	iii
5.	Table of Contents	iv
7.	Summary of Test Report	1.0
7.	Introduction	2.0
7.	Object	3.0
7.	Test Set-up	4.0
8.	Test Equipment (Bandwidths and Detector Function)	5.0
8.	RF Power Output	6.0
9.	Graphs taken of the RF Power Output Measurements	6.0
10.	Modulation Characteristics	7.0
11.	Graphs taken of the Modulation Characteristics	7.0
12.	Occupied Bandwidth	8.0
13.	Graphs taken of the Occupied Bandwidth	8.0
20.	Frequency Deviation	9.0
21.	Graphs taken of the Frequency Deviation	9.0
23.	Spurious Emission Measurements at Antenna Terminals	10.0
24.	Conducted Emission Data taken	10.0
25.	Conducted Emission Graphs Taken	10.0



26.	Field Strength of Spurious Emission Measurements	11.0
28.	Radiated Data taken for Field Strength Measurements	11.0
29.	Radiated Graphs taken for Field Strength Measurements	11.0
30.	Frequency Stability (Temperature)	12.0
31.	Graphs taken of Frequency Stability (Temperature)	12.0
32.	Frequency Stability (Voltage Variation)	13.0
33.	Graphs taken of Frequency Stability	13.0
34.	Photo Information and Test Set-Up	14.0
35.	Photos Taken During Testing	15.0
37.	Change Information	16.0
39.	Results of Tests	17.0
39.	Conclusion	18.0
40.	Equipment List	TABLE 1



1.0 SUMMARY OF TEST REPORT

It was found that the U2B Wireless UHF-FM Transmitter S/N 0106980819 **meets** the radio interference emission requirements of the FCC "Rules and Regulations", Part 74, Subpart H, Sections 74.801 to 74.882 for Low Power Auxiliary Stations operating in the 692-716 MHz Frequency Band.

2.0 INTRODUCTION

On November 16, 1998 & January 28, 1999, a series of radio frequency interference measurements were performed on UHF-FM Transmitter, S/N 0106980819. The tests were performed according to the procedures of FCC as stated in Part 2 Subpart J, Equipment Authorization Procedures of the Code of Federal Regulations 47, by personnel of D.L.S. Electronic Systems, Inc. who are responsible to Donald L. Sweeney, Senior EMC Engineer.

3.0 OBJECT

The purpose of this series of tests was to determine if the test sample could meet the radio frequency emission requirements of the FCC "Rules and Regulations", Part 74, Subpart H, Sections 74.801 to 74.882 for Low Power Auxiliary Stations operating in the 692-716 MHz Frequency Band.

4.0 TEST SET-UP

All radiated emission tests were performed at D.L.S. Electronic Systems, Inc. The radiated tests were made with the test item placed on a wooden turntable located in the Test Room with the receive antenna placed one meter from the device under test.



5.0 TEST EQUIPMENT (Bandwidths and Detector Function)

All data was automatically plotted using peak detector function. This information was then used to determine the frequencies of maximum emissions. Manual measurements were performed on these frequencies using a peak detector function of the Analyzer with the bandwidths specified by the FCC. From 200 MHz to 1000 MHz a bandwidth of 100 kHz was used (except for Occupied Bandwidth), and above 1000 MHz, wide enough bandwidths were used, depending upon the test being made, to ensure proper measurement of the narrowband signal. A list of the equipment used can be found in Table 1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

6.0 RF POWER OUTPUT - PART 2.985

As stated in PART 74.861 (e-1), the output power should not exceed 250 milliwatts (24 dBm). The U2B Wireless UHF-FM Transmitter was tuned according to the tune-up procedures specified in Part 2.983 (d-5), and adjusted for its maximum output power. The RF output power was measured in the open field, using the following test method:

The radiated signal from the EUT was measured. The EUT was then substituted with a signal generator and a tuned dipole antenna. The output of the signal generator was increased until the level received by the tuned dipole equaled that of the previous measured from the EUT.

Actual Measurements Taken:

11.2	dBuV	Measured output of the transmitter
+0	dBuV	<u>Total system losses (Antenna, Pads & Cable)</u>
11.20	dBuV	which equals 0.01 watts

LIMIT:

Manufacturer's rated output power = 0.01 watts
Tolerance = 100 ppm

MARGIN:

0.25 watts - 0.01 watts = 0.24 watts

NOTE:

See the following pages for the graphs of the actual measurements made:



GRAPHS TAKEN OF THE RF POWER

OUTPUT MEASUREMENTS

PART 2.985

NOTE:

The RF Power Output graphs taken during testing can be found under the exhibits label "RF Power Output".



7.0 Modulation Characteristics - Part 2.987

a. Voice modulated communication equipment

A curve showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz is submitted with this report.

b. Equipment which employs modulation limiting

A family of curves showing the percentage of modulation versus the modulation input voltage with sufficient information showing the modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

NOTE:

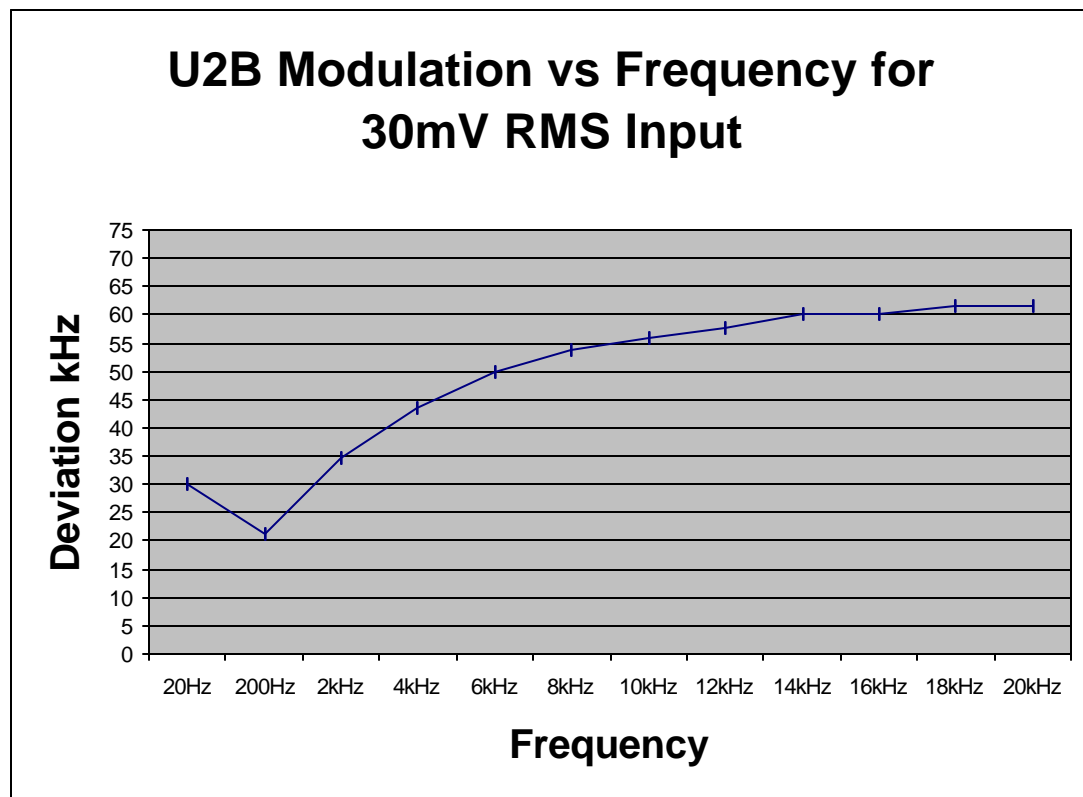
See the following pages for the graphs of the actual measurements made:

GRAPHS TAKEN SHOWING THE FREQUENCY

RESPONSE OF THE

AUDIO MODULATING CIRCUIT

PART 2.987





8.0 OCCUPIED BANDWIDTH – PART 2.989

The frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to .5% of the total mean power radiated by a given emission.

As stated in Part 2.989 c-1 the U2B Wireless UHF-FM Transmitter was modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. This input level was established at the frequency of maximum response of the audio modulating circuit.

The U2B Wireless UHF-FM Transmitter uses the same frequency range as television broadcast monaural transmitters so the test was also run using a 15 kHz input signal modulated by 85% as stated in Part 2.989 e-6.

Paragraph e-5 states that the maximum authorized bandwidth shall be **200 kHz** for all emissions inside these frequency bands.

Carson's Rule:

Section 2.202 (g)

$B_n = 2M_{2DK}, K=1$ $B_n =$ Bandwidth

$M = 15 \text{ kHz},$ $M =$ Maximum Modulating Frequency

$D = 45 \text{ kHz},$ $D =$ Peak Deviation

$B_n = 2(15) + 2(45)(1) = 120 \text{ kHz}$

NOTE: See the following pages for the graphs of the actual measurements made:

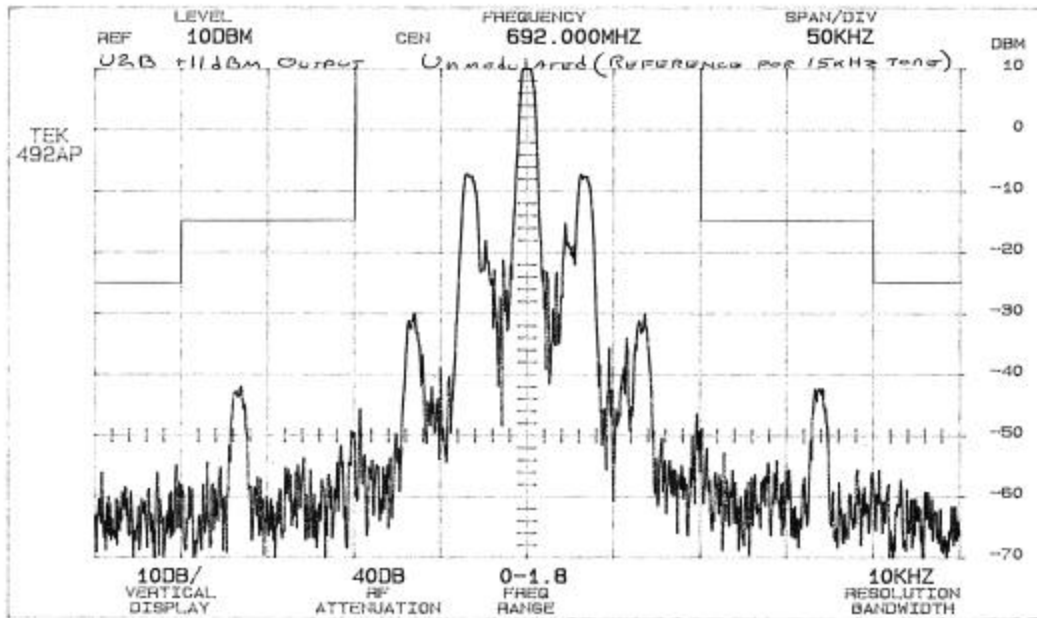


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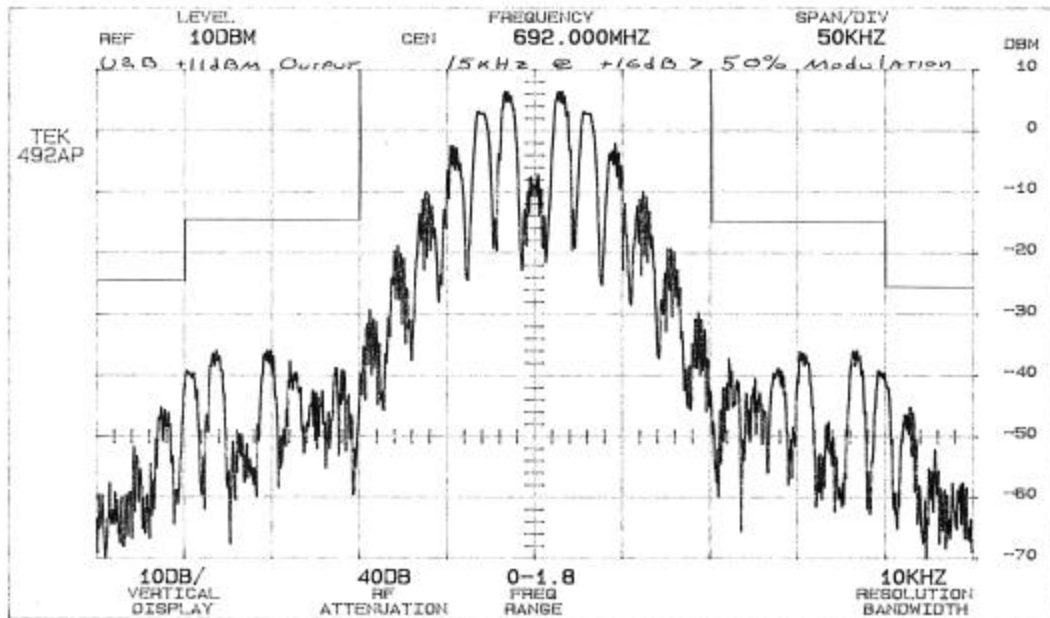
Report No. 6995
07/03/01

GRAPHS TAKEN OF THE OCCUPIED BANDWIDTH

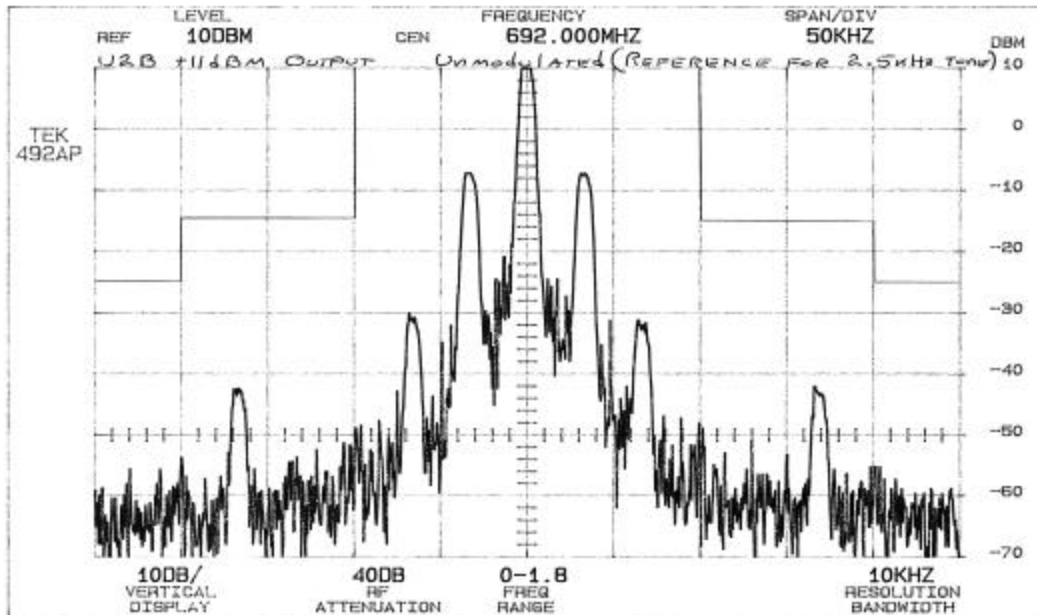
PART 2.989



U2B 692 15kHz Reference

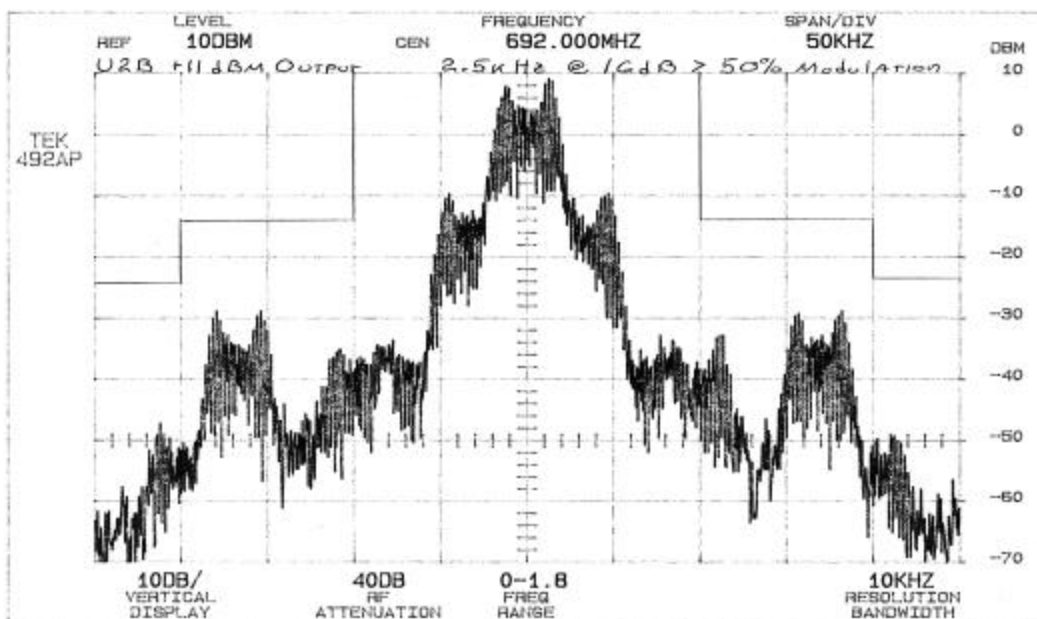


U2B 692 15kHz @ +16dB >50% Modulation

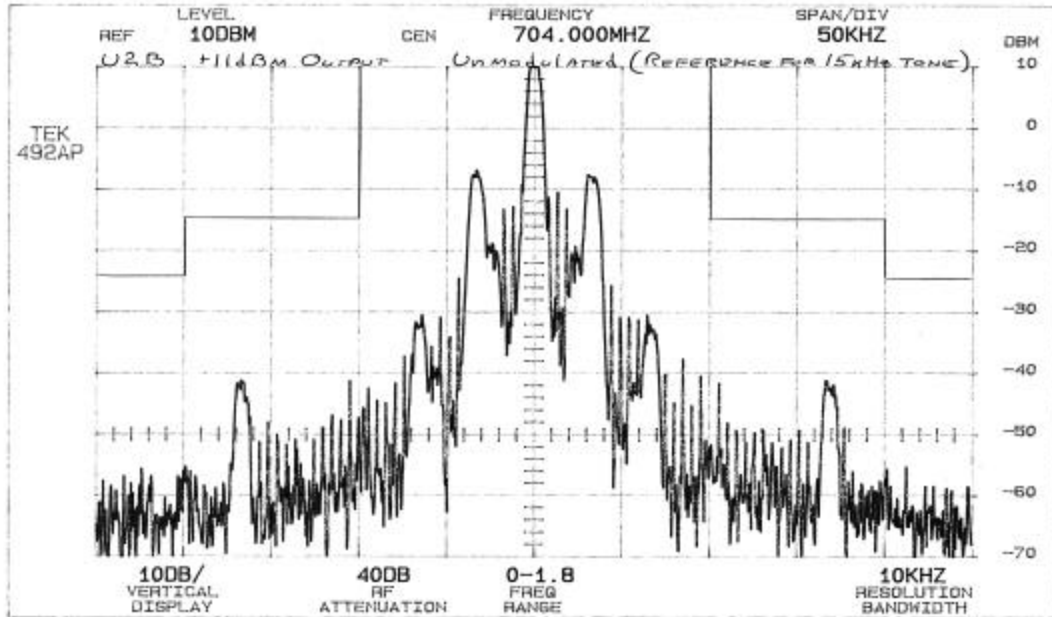


U2B 692 2.5kHz Reference

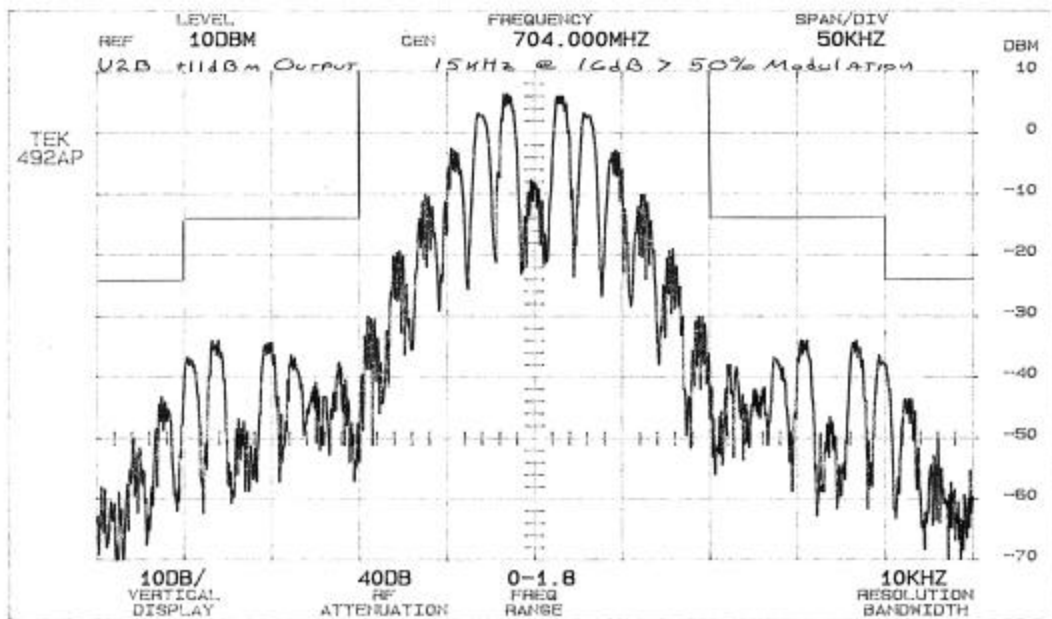
Note: The input level for +16dB >50% Modulation was -38.5dBV for all U2B Occupied Bandwidth Tests.



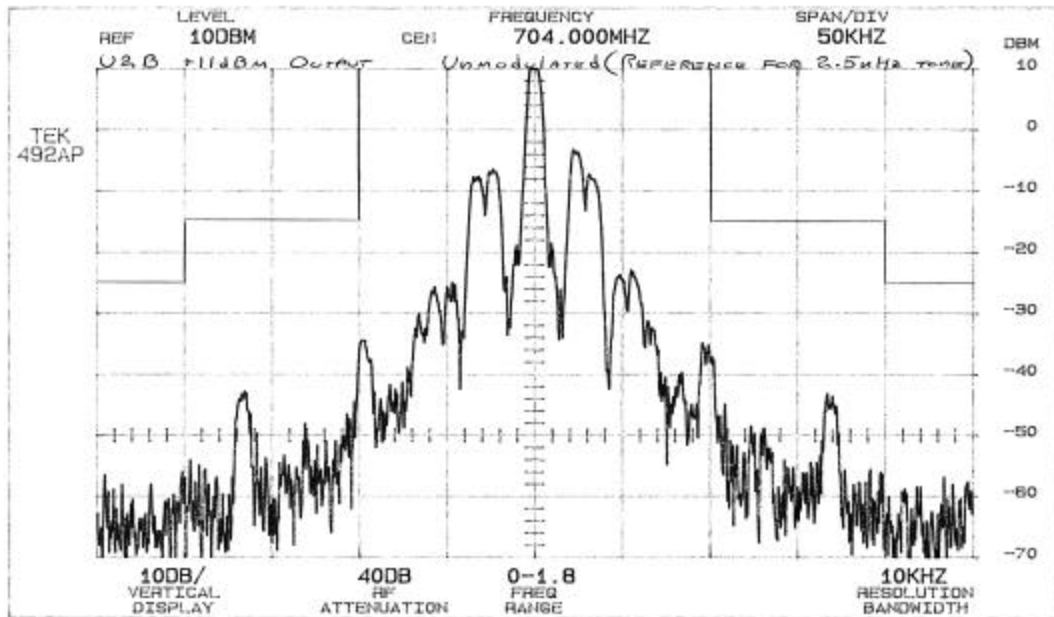
U2B 692 2.5kHz @ +16dB >50% Modulation



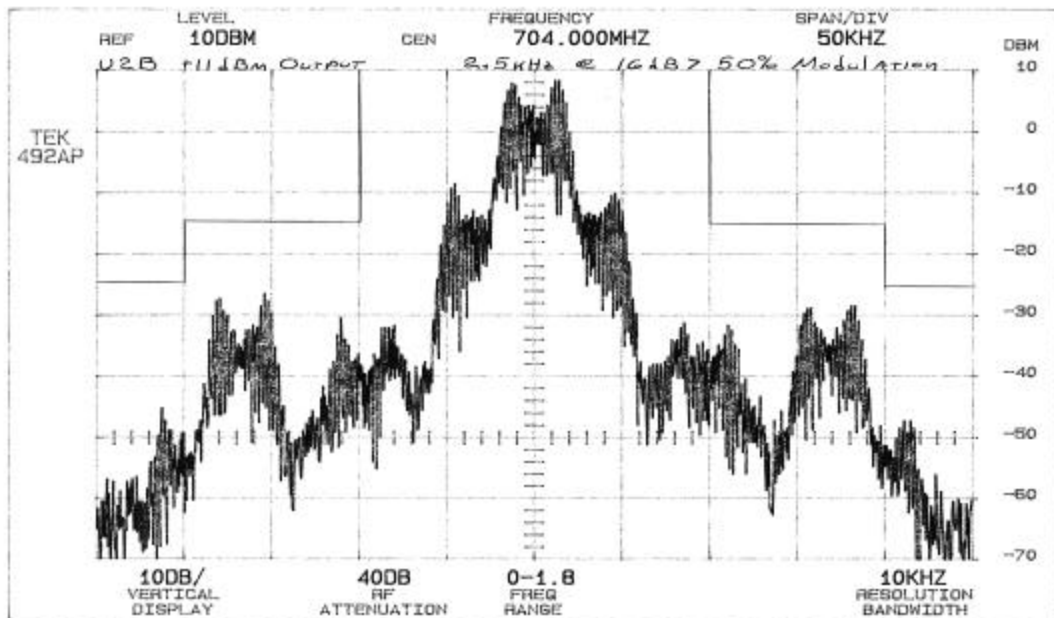
U2B 704 15kHz Ref.



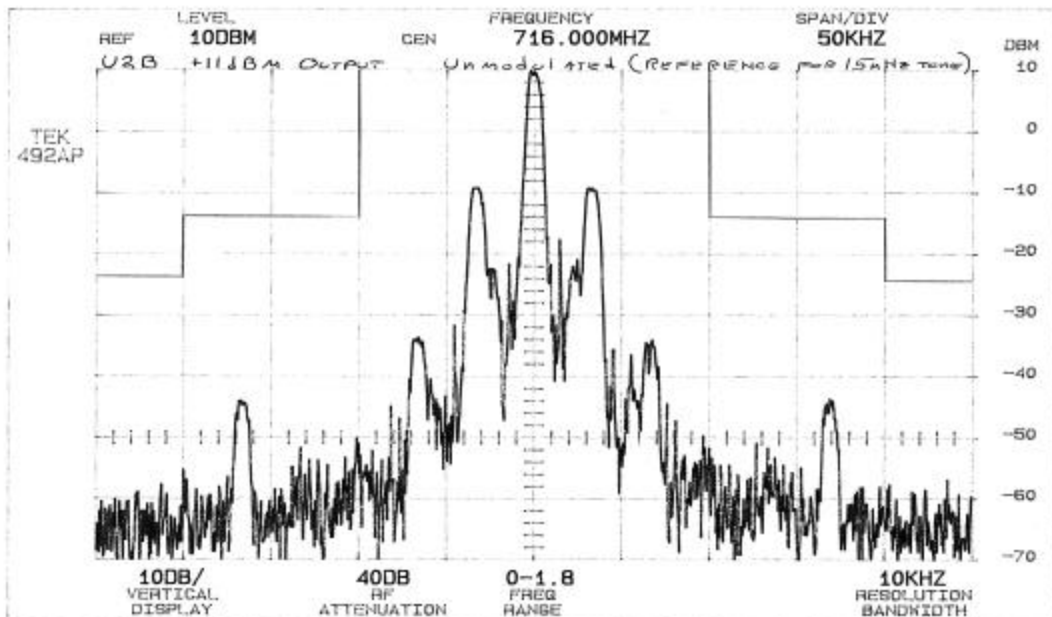
U2B 704 15kHz @ +16dB > 50% Modulation



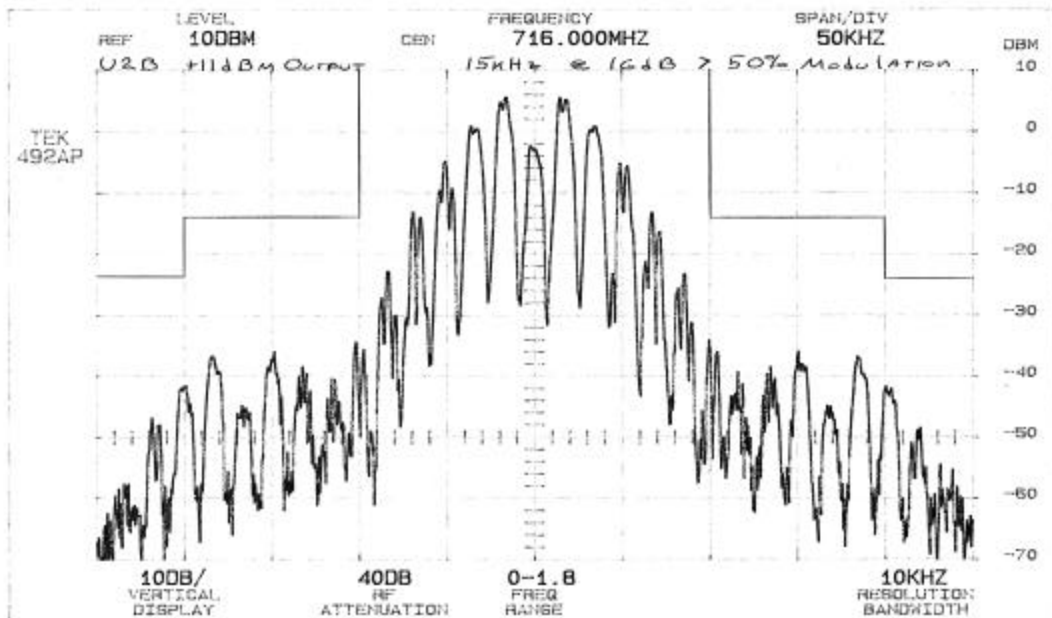
U2B 704 2.5kHz Reference



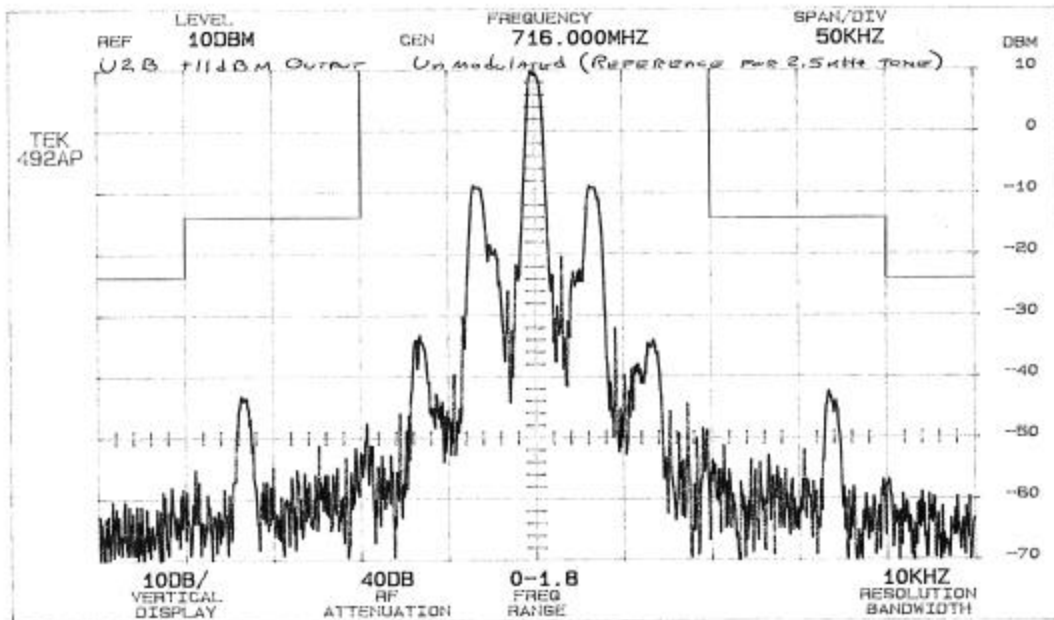
U2B 704 2.5kHz @ +16dB >50% Modulation



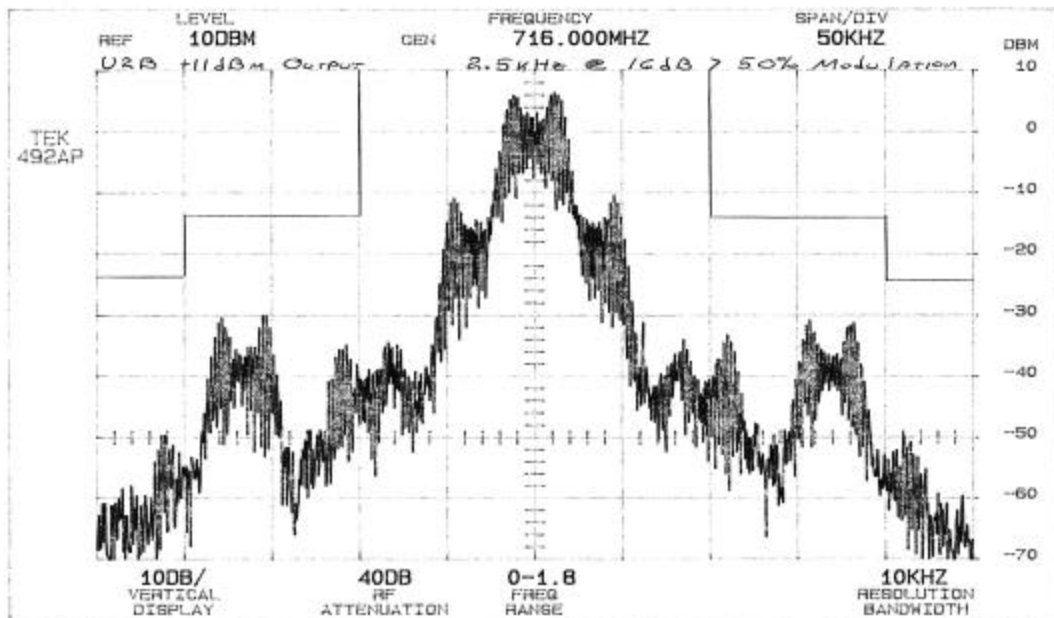
U2B 716 15kHz Reference



U2B 716 15kHz @ +16dB >50% Modulation



U2B 716 2.5kHz Reference



U2B 716 2.5kHz @ +16dB >50% Modulation



9.0 Frequency Deviation and Tolerance - PART 74.861

Paragraph e-3 states that the maximum authorized deviation shall be 75 kHz for all frequency modulation emissions in the frequency bands 692-716 MHz.

Frequency Deviation used: **15 kHz, 164.44% modulation**

Paragraph e-4 states that the frequency tolerance of the transmitter shall be .005 percent.

NOTE:

See the following pages for the graphs of the actual measurements made:



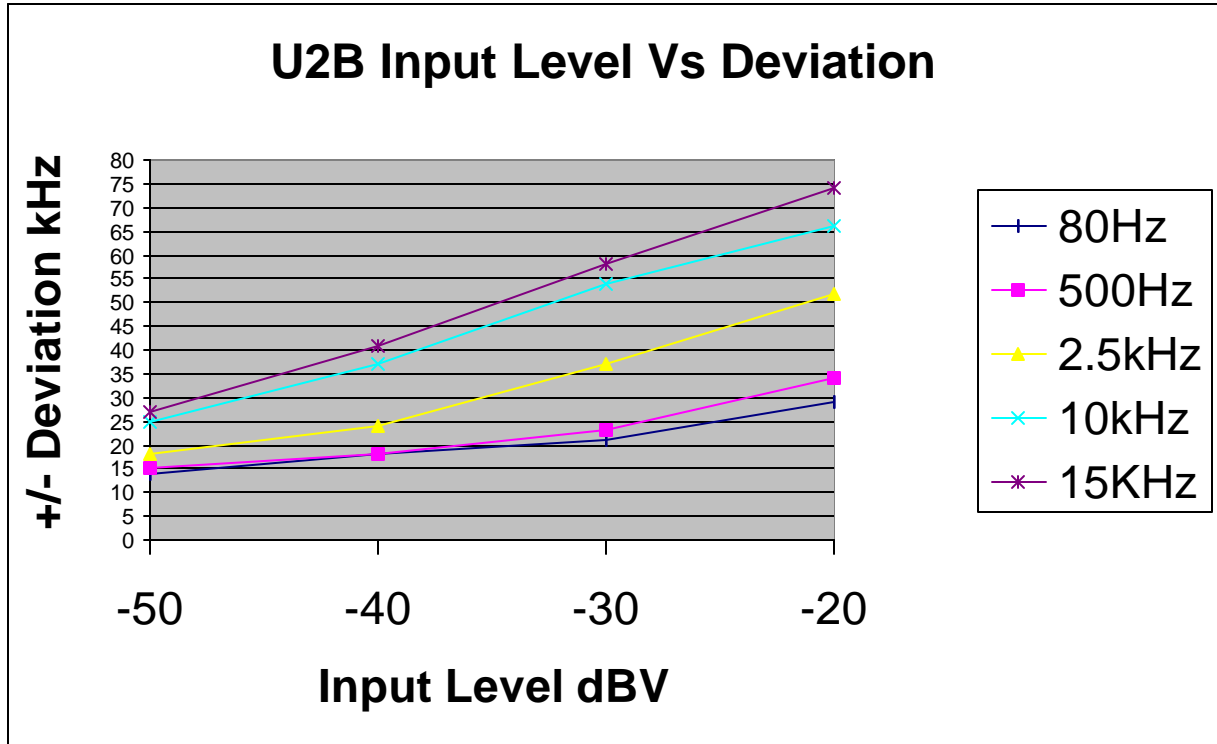
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GRAPHS TAKEN OF THE FREQUENCY DEVIATION

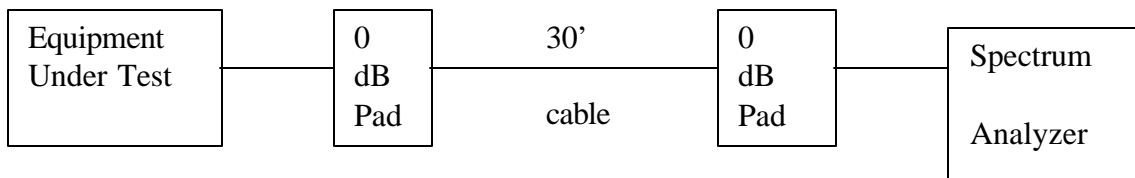
WITH MODULATION

PART 2.989



10.0 SPURIOUS CONDUCTED EMISSION MEASUREMENTS AT ANTENNA TERMINALS PART 2.991

Spurious conducted emissions were measured at the antenna terminals using an artificial load. Plots were made showing the amplitude of each harmonic emissions with the equipment operated as specified in 2.989. As shown by the radiated charts there was no reason to believe that there were any spurious emissions other than the harmonics which were than individually investigated when doing the conducted test at the antenna terminals. Measurements were made up to the 10th Harmonic of the fundamental. The following setup was used showing placement of the attenuators:



The allowed emissions for transmitters operating in the 692-716 MHz bands for U2B Wireless UHF-FM Transmitter equipment are found under Part 74, Section 74.861, Paragraph e-6 for Low Power Auxiliary Stations. This paragraph states the mean power of the emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

- (1) On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB.
- (2) On any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB.
- (3) On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least $43+10\text{Log}_{10}$ (mean output power in watts) dB.

NOTE: See the following pages for the data and graphs of the actual measurements made:

NOTE: This test was not run because there is no antenna port.



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Report No. 6995
07/03/01

**CONDUCTED EMISSION DATA TAKEN FOR
SPURIOUS EMISSION MEASUREMENTS MADE
AT THE ANTENNA TERMINALS**

PART 2.991

NOTE: This test was not run because there is no antenna port.



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Report No. 6995
07/03/01

**CONDUCTED EMISSION GRAPHS TAKEN FOR
SPURIOUS EMISSION MEASUREMENTS MADE
AT THE ANTENNA TERMINALS**

PART 2.991

NOTE: This test was not run because there is no antenna port.



11.0 FIELD STRENGTH OF SPURIOUS EMISSION MEASUREMENTS PART 2.993

Radiated measurements were performed at a 1 or 3 meter test distance automatically scanning the frequency range from 200 MHz to 10000 MHz, depending upon the fundamental frequency.

For the U2B Wireless UHF-FM Transmitter, the highest fundamental frequency is 716 MHz so the scans were made up to 10000 MHz, to cover the tenth harmonic.

All signals in the frequency range of 30 MHz to 200 MHz were measured with a Biconical Antenna and from 200 MHz to 1000 MHz a Log Periodic Antenna was used as the pickup devices. From 1000 MHz to 10000 MHz, a Double Ridge Horn Antenna was used. The cables and equipment were placed and moved within the range of positions likely to find their maximum emissions. Tests were made in both the horizontal and vertical planes of polarization.

The allowed emissions for transmitters operating in the 692-716 MHz bands for U2B Wireless UHF-FM Transmitter equipment are found under Part 74, Section 74.861, Paragraph e-6 for Low Power Auxiliary Stations. This paragraph states the mean power of the emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

- (1) On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB.
- (2) On any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB.
- (3) On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least $43 + 10 \log_{10}$ (mean output power in watts) dB.



11.0 FIELD STRENGTH OF SPURIOUS EMISSION MEASUREMENTS (CON'T) PART 2.993

To determine the limit for all spurious & harmonic emissions, the following method was used:

LIMIT for Spurious Emissions:

As stated in Part 74, Section 74.861 (e-1 ii) the limit is 250 mW in the frequency range 692.125-715.875 MHz.

$$43 + 10 * \text{LOG}_{10}(0.25 \text{ watts}) = 36.98 \text{ dB}$$

23.03dBm extrapolated level for 0.01 watts

-36.98 dB required reduction below the unmodulated fundamental

-13.95 dBm or 93.05 dBuV/m at 1 meter maximum spurious emissions allowed

Extrapolating the level to 3 meters:

$$93.05 \text{ dBuV/m} - 9.54 \text{ dB} = \mathbf{83.51 \text{ dBuV/m at 3 meters}}$$

NOTE:

The data and graphs taken during testing can be found under the exhibits label "Radiated Data and Radiated Graphs".



RADIATED DATA TAKEN FOR FIELD STRENGTH

SPURIOUS EMISSION MEASUREMENTS

PART 2.993

NOTE:

The data taken during testing can be found under the exhibit label “Radiated Data”.



RADIATED GRAPHS TAKEN FOR FIELD STRENGTH

SPURIOUS EMISSION MEASUREMENTS

PART 2.993

NOTE:

The graphs taken during testing can be found under the exhibit label “Radiated Graphs”.



12.0 FREQUENCY STABILITY - PART 2.995a (Temperature)

The frequency stability was measured from -30° to +50° centigrade at intervals of 10° centigrade throughout the range. Prior to each frequency measurement, the equipment was left alone for a sufficient period of time (approximately 30 minutes or more) to allow the components of the U2B Wireless UHF-FM Transmitter oscillator circuitry to stabilize. The following information was taken:

FREQUENCY STABILITY FOR TEMPERATURE VARIATION IN MHZ:

-30°	703.9942
-20°	703.9952
-10°	703.9984
0°	703.9985
+10°	703.9992
+20°	703.9993
+30°	703.9988
+40°	703.9983
+50°	703.9975

Worst Case Variance:

4100 Hz

As stated in Part 74, Section 74.861 e-4 the Frequency Tolerance and Margin for this range are as follows:

Frequency Tolerance: = **0.005%**

703.9975 * 0.005% = **35199.76 Hz**

35199.76 - 4100 = **31099.76 Hz**

This is well in the specified limits.

NOTE:

The Frequency Stability for Temperature Variation Graphs taken during testing can be found under the exhibit label “Temperature Variation Graphs”.



GRAPHS TAKEN FOR FREQUENCY

STABILITY WHEN VARYING THE TEMPERATURE

PART 2.995A

NOTE:

The Frequency Stability for Temperature Variation Graphs taken during testing can be found under the exhibit label “Temperature Variation Graphs”.



13.0 FREQUENCY STABILITY - PART 2.995d (Voltage)

The frequency stability of U2B Wireless UHF-FM Transmitter was measured by varying the primary supply voltage from 85% to 115% of nominal value for all equipment other than hand carried battery equipment.

FREQUENCY STABILITY FOR VOLTAGE VARIATION:

85%	0
100%	0
115%	0

FREQUENCY STABILITY FOR HAND HELD DEVICES:

For hand carried, battery powered equipment, the supply voltage was reduced to the battery operating end point specified by the manufacturer. Readings were taken at the reduced end point and with a fresh battery:

Fresh Battery verses Battery end point:

Frequency #1 **704.37430 Hz**
Frequency #2 **704.37424 Hz**
Frequency #3 **704.37425 Hz**
Frequency #4 **704.37426 Hz**
Frequency #5 **704.37422 Hz**
Frequency #6 **704.37415 Hz**

As stated in Part 74, Section 74.861 e-4 the Frequency Tolerance and Margin for this range are as follows:

Frequency Tolerance: 0.005%

Limit: 35199.76 Hz

This is well in the specified limits.

NOTE:

The Frequency Stability for Voltage Variation Graphs taken during testing can be found under the exhibit label “Voltage Variation Graphs”.



**GRAPHS TAKEN FOR FREQUENCY
STABILITY WHEN VARYING THE
PRIMARY SUPPLY VOLTAGE**

PART 2.995d

NOTE:

The Frequency Stability for Voltage Variation Graphs taken during testing can be found under the exhibit label “Voltage Variation Graphs”



14.0 PHOTO INFORMATION AND TEST SET-UP

The test set-up can be seen on the accompanying photo page.

Item 0 U2B Wireless UHF-FM Transmitter
FCC ID#: DD4U2B SN: 0106980819

Item 1

Item 2

Item 3

Item 4

Item 5

Item 6

Item 7

Item 8

Item 9

Item 10



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Report No. 6995
07/03/01

15.0 RADIATED PHOTOS TAKEN DURING TESTING.

For photos taken during testing see exhibit label “Test Setup Photos”.



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Report No. 6995
07/03/01

15.0 CONDUCTED PHOTOS TAKEN DURING TESTING

For photos taken during testing see exhibit label “Test Setup Photos”.



16.0 CHANGE INFORMATION

The following changes were implemented during the testing and must be incorporated into the production units to ensure compliance.

Change 1. There were no changes made at D.L.S. Electronic Systems, Inc.

Change 2.

Change 3.

Change 4.

Change 5.



16.0 CHANGE INFORMATION (CON'T)

Change 6.

Change 7.

Change 8.

Change 9.

Change 10.

The responsibility of implementing the changes listed in this report is accepted or I certify that no changes were made

by _____
Signature Title

for _____
Company Name Date



17.0 RESULTS OF TESTS

The emission test results can be seen on pages at the end of this report. Data sheets indicating the open field radiated measurements can also be found with this report. Those points on the radiated charts shown with a yellow mark are background frequencies which were verified during the test.

18.0 CONCLUSION

It was found that the UHF-FM Transmitter, S/N 0106980819 the radio interference emission requirements of the FCC "Rules and Regulations", Part 74, Subpart H, Sections 74.801 to 74.882 for Low Power Auxiliary Stations operating in the 692.125-715.875 MHz Frequency Band. This test report relates only to the items tested.

This report contains the following number of pages.

Text:	40 pages
Data Summary:	6 pages
Charts:	27 pages



TABLE 1 – EQUIPMENT LIST

Test Equipment	Manufacturer/Description	Model Number	Serial Number	Frequency Range	Cal Due Date
*Spectrum Analyzer	Hewlett/Packard	8566B	2240A 02041	5 Hz - 22GHz	4/99
Quasi-Peak Adapter	Hewlett/Packard	85650A	2043A 00121	10 kHz - 1GHz	4/99
Spectrum Analyzer	Tektronix	492AP	B010123	50 kHz-21 GHz	5/99
Modulation Analyzer	Boonton	8200	24602BH	100kHz-2000MHz	6/99
Receiver	Electrometrics	EMC-25 Mark-III	772	.01-1000 MHz	10/99
Meter Module	Electrometrics	CRM-25	162	.01-1000 MHz	10/99
Receiver	Electrometrics	EMC-25 Mark-III	804	.01-1000 MHz	10/99
Meter Module	Electrometrics	CRM-25	138	.01-1000 MHz	10/99
Antenna	Electrometrics	BIA-25	2453	20-200 MHz	10/99
Antenna	Electrometrics	LPA-25	1114	200-1000 MHz	10/99
Antenna	Electrometrics	BIA-25	2614	20-200 MHz	10/99
Antenna	Electrometrics	LPA-25	1205	200-1000 MHz	10/99
Antenna	D.L.S.	Dipoles		20-1000 MHz	I/O
Antenna	Electro-Mechanics Co	3115	2479	1 – 18 GHz	I/O

*Firmware Version	29.9.86	Software Version	85864C Rev A
**Firmware Version	14.1.85	Software Version	85864C Rev A
***Firmware Version	5.1.3	Software Version	82301-12029 Rev C

I/O Initial Calibration Only