Engineering Report

in Support of Type Acceptance FCC Form 731
for MCUC5 radiomodem

Subject:	Compliance of Radio Modem with Respect to FCC Rules & Regulations Parts 2, 90 and 101 for Type Acceptance FCC Form 731
Equipment:	900 MHz Radio Modem
FCC Id:	EOTMCUC5
Applicant:	Dataradio Incorporated 5500 Royal Mount Ave., Suite 200 Town of Mount Royal, H4P 1H7 Quebec, Canada

Johnson Data Telemetry Corporation
Waseca, Minnesota

ENGINEERING STATEMENT OF MARK CHRISTENSEN

The application consisting of the attached engineering exhibit and associated FCC form 731, has been prepared in support of a request for Type Acceptance for the Johnson Data Telemetry (JDT) DL-3492, 928-960 MHz Telemetry Transceiver with the Dataradio MCU 3246 Modem. The Transceiver/Modem will be identified by the FCC number EOTMCUC5. The transceiver operates pursuant to Part(s) 90 of the Rules and Regulations.

EXISTING CONDITIONS

The units utilized for these type acceptance measurements were obtained from the pilot-production. The transceiver is designed to operate on frequencies ranging from 928.000 MHz to 960.000 MHz. The frequency tolerance of the transceiver is .00015% or 1.5 parts per million. A temperature compensated crystal oscillator operating at 17.5 MHz controls the frequency stability of the transceiver.

PROPOSED CONDITIONS

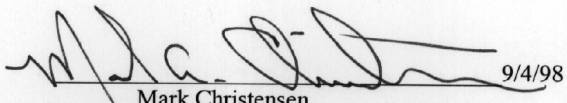
It is proposed to Type Accept the MCUC5, 900 MHz Transceiver/Modem for operation in the band of frequencies previously outlined. The applicant anticipates marketing the device for use in wireless transmission of data.

PERFORMANCE MEASUREMENTS

All Type Acceptance measurements were conducted in accordance with Section 2.983 of 47 CFR 1997 of the Rules and Regulations. Equipment performance measurements were made in the engineering laboratory and on the FCC certified Open Area Test Site at the E.F. Johnson Corporation Operations Center in Waseca, Minnesota. All measurements were made and recorded by myself or under my direction. The performance measurements were made between July 2, 1998 and July 23, 1998.

CONCLUSION

Given the results of the measurements contained herein, the applicant requests that Type Acceptance be granted for the MCUC5, 928-960 MHz Transceiver/Modem as tested for data communications.



9/4/98

Mark Christensen
Director of Engineering, Johnson Data Telemetry

QUALIFICATIONS OF ENGINEERING PERSONNEL

NAME:	Allen Frederick
TITLE:	Certified Technologist
TECHNICAL EDUCATION:	Bachelor of Science Degree in Electronic Engineering Technology (1998) from Mankato State University
TECHNICAL EXPERIENCE:	2 years experience in analog and radio frequency comunications

NAME:	Constantin Pintilei
TITLE:	R&D Test Engineer
TECHNICAL EDUCATION:	Bachelor of Science Degree in Radiotechnique Electronic Engineering (1993) from Technical University of Iasi, Romania
TECHNICAL EXPERIENCE:	5 years experience in radio frequency measurements

Contents

Engineering Summary

This report contains the results of the engineering evaluation performed on a Dataradio Inc. radio modem, having a frequency range of 928-960 MHz , model MCUC5. Johnson Data Telemetry (JDT) Corporation carried out the tests in accordance with FCC Rules and Regulation Part 2, Part 90 and Part 101.

The radio modem was evaluated for output power levels of 1 and 5 watts.

Based on test results, it is certified that the product meets the requirements as set forth in the above specifications for Type Acceptance.

The MCUC5 900 MHz radio modem is comprised of a MCU 3246 loader/modem board and a DL 3492 Telemetry transceiver. Test data and graphs for this configuration are presented in this report.

General Information

FCC submission information

FCC Id:	EOTMCUC5
Equipment:	900 MHz radio modem
Model:	MCUC5
Applicant:	Dataradio Incorporated 5500 Royal Mount Ave., Suite 200 Town of Mount Royal, H4P 1H7 Quebec, Canada
Manufacturer	Dataradio Incorporated 5500 Royal Mount Ave., Suite 200 Town of Mount Royal, H4P 1H7 Quebec, Canada
Test laboratory	Johnson Data Telemetry Corporation (JDT) 299 Johnson Ave. SW Waseca , MN 56093

Manufacturer's data

Equipment:	900 MHz radio modem
Model:	MCUC5
Serial Number:	xxxx (prototype serial)
Reference:	FCC Rules and Regulations Part 2, Part 90 and Part 101
Manufacturer:	Dataradio Incorporated

Product's general specifications

1	Frequency range	928-960 MHz		
2	Ratted transmitted output power	1 - 5W		
3	Data modulation	DGMSK		
4	Channel spacing	25 KHz	25 KHz	12.5 KHz
5	Emission type	16K6 F1D	16K0 F1D	9K80 F1D
6	Frequency deviation	±3.5 KHz	±3.2 KHz	±2.5 KHz
7	Data rate	9600 bps	9600 bps	4800 bps
8	Antenna impedance	50 Ω		
9	Power source	13.3 V		

Information for Type Acceptance

Ref: FCC Part 2 paragraph 2.983

a. Name of Applicant:

Ref: FCC Part 2 paragraph 2.983 (a)

Applicant:	Dataradio Incorporated 5500 Royal Mount Ave., Suite 200 Town of Mount Royal, H4P 1H7 Quebec, Canada
Manufacturer	Same as applicant

b. Identification of equipment:

Ref: FCC Part 2 paragraph 2.983 (b)

Model No.:	MCUC5, comprised of two boards: MCU 3246 (Dataradio 115-03246-0xx)- modem board DL 3492 (JDT 242-3492-5x0)- transceiver board
Serial No.:	xxxx (prototype serial) xxx-3246-0xx-modem board 3492- xxxxxx-5x0-transceiver board
FCC Id:	EOTMCUC5

c. Production Quantity:

Ref: FCC Part 2 paragraph 2.983 (c)

Quantity production planned.

d. Technical description

d1. Type of emission

Ref: FCC Part 2 paragraph 2.983 (d) (1)

16K6 F1D, 16K0 F1D, 9K80 F1D

d2. Frequency range

Ref: FCC Part 2 paragraph 2.983 (d) (2)

928-960 MHz

d3. Range of operating power levels

Ref: FCC Part 2 paragraph 2.983 (d) (3)

The power is adjusted at the manufacturer at a level of 5W.

d4. Maximum Power rating

Ref: FCC Part 2 paragraph 2.983 (d) (4)

5 Watts

d5. DC voltages and currents into final amplifier

Ref: FCC Part 2 paragraph 2.983 (d) (5)

Refer also to RF output and DC input power measurement in section “Test Results”.

d6. Function of semi-conductors and active circuits

Ref: FCC Part 2 paragraph 2.983 (d) (6)

For the main control circuits and the modem circuits, see the section Dataradio MCU modem, in Description of Circuitry, Attachment A part 3.

For the transceiver circuits see the section JDT DL-3492 Telemetry Transceiver, in Description of Circuitry, Attachment A part 4.

d7. Complete circuit diagram

Ref: FCC Part 2 paragraph 2.983 (d) (7)

See schematics in Schematics, Attachment B

d8. Instruction book

Ref: FCC Part 2 paragraph 2.983 (d) (8)

See technical manual in Integra-T Technical Manual, Attachment C,

d9. Tune-up procedure

Ref: FCC Part 2 paragraph 2.983 (d) (9)

1. Connect the transceiver to be aligned to a DC power source. A DC current meter capable of measuring at least 2.5 Amps should be connected in line with the DC source. Connect the output of the transceiver through a watt meter and into a 50 ohm dummy load.

2. Load the synthesizer with the center channel frequency.

3. Key the transmitter and make sure that the supply voltage at the RF board is 13.3 VDC. (Do not transmit for extended periods of time).

4. Adjust PwrSet R525 potentiometer clockwise for 5.0 Watts of output power.

5. Check the power levels on the low and the high frequencies for 5.0 Watts +/- 1 Watt.

d10. Circuitry and devices for determining and stabilizing frequency

Ref: FCC Part 2 paragraph 2.983 (d) (10)

For the main control circuits and the modem circuits see the section Dataradio MCU modem, in Description of Circuitry, Attachment A part 1.

For the transceiver circuits see the section JDT DL-3492 Telemetry Transceiver, in Description of Circuitry, Attachment A part 2.

Circuitry's mainly involved in determining and stabilizing frequency are VCO block and Synthesizer block described in Transceiver's part.

d11. Circuits for suppression of spurious radiation, limiting of modulation and limiting of power

Ref: FCC Part 2 paragraph 2.983 (d) (11)

i) spurious radiation- The main suppression of spurious radiation is performed by the filter described in "Low Pass Filter" paragraph from JDT DL-3492 Telemetry Transceiver, Description of Circuitry part 2, Attachment A

ii) limiting of modulation- Limiting of modulation is given by amplitude limited audio signal provided by modem part as it was explained in "Modem" paragraph from Dataradio MCU modem, Description of Circuitry part 1, Attachment A. Supplementary limiting of modulation is described in " Frequency Modulation" paragraph from Synthesizer section JDT DL-3492 Telemetry Transceiver, Description of Circuitry part 2, Attachment A.

iii) limiting of power- A very tight control of transmission power is maintained by circuitry described in "Power Control" paragraph from JDT DL-3492 Telemetry Transceiver, Description of Circuitry part 2, Attachment A

d12. Digital modulation techniques

Ref: FCC Part 2 paragraph 2.983 (d) (12)

The digital modulation used by the MCU modem is DGMSK (Differential Gaussian Minimum Shift Keying). A modem using such type of modulation is divided in three main units. They are:

1. Scrambler,
2. Differential encoder,
3. Waveshape generator.

We will explain each of those units, starting with the scrambler.

1. Scrambler:

The scrambler converts data stream to a new data stream having better characteristics for a FM radio system. Here are the main advantages:

-It removes the DC component from a DGFSK signal,

-It randomizes the data in such a way we can avoid predictable patterns, by example:

00000000, 111111111, 01010101, 00110011, etc.

-It keeps the power spectrum more compact by avoiding sequences like 01010101…

All these functions are performed with a serial shift register and 2 exclusive OR gates that implement the polynomial form X^7+X^5-1. The receiver side of our radio modems has a similar circuit called descrambler to decode the received scrambled data.

2. Differential encoder:

After data is scrambled, we encode the data with a differential encoder. Here is the process that differential encoder does:

previous input bit	current input bit	output bit
0	0	0
0	1	1
1	0	1
1	1	0

Example:
From a sequence of 010010111101000101010010, differentially encoded data stream is:
11011100011100111111110011.
The differential encoder is used to make the modem insensitive to audio polarity inversion of the FM radio system.

3. Waveshape generator:
The waveshape generator converts the processed data bits (scrambled and differentially encoded for DGMSK) to the audio signal that will modulate a FM transmitter. This gives the DGMSK waveshape having a compact spectrum to fit inside FCC Part 90 and Part 101 masks according to the channel bandwidth intended.

Furthermore, the modem itself generates a RF signal heading the transmission in normal usage and a test pattern for test purposes.

1. Transmission preamble:
Each data transmission begins by sending a 15ms preamble of sinewave (101010…). This is to synchronize the digital phase looked loop of the receiver modem.
2. Test pattern generator:
A 30s test pattern sequence is generated by test software at "test data" click button event. According to the baud rate, the highest resulting modulating frequency is (baud rate)/2 Hz. The sequence is sent with baud rate speed, and its data has the pattern:

###ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789\r\n,

repeated for 30 seconds.

e. Test data

Ref: FCC Part 2 paragraph 2.983 (e)

All applicable test data according to:
-Part 2: 2.985, 2.989, 2.991, 2.993, 2.995 and 2.997
-Part 90, Subpart I: 90.209, 90.210, 90.211 and 90.213
-Part 101, Subpart C: 101.107, 101.109 and101.111
are provided in section Test Results of this Engineering Report

For data according to 2.987, this unit is not designed for voice modulation and therefore falls under the category "Other type of equipment",2.987(d). The description of RF modulation parameters is provided for each emission designator necessary bandwidth calculation in paragraphs named "Modulation source description" and the description for digital modulation parameters is provided in previous paragraph, "Digital modulation techniques"

f. Equipment identification plate/label

Ref: FCC Part 2 paragraph 2.983 (f)

A scanned image of the Equipment identification label is provided in Photographs, Attachment D

g.Photographs of the equipment

Ref: FCC Part 2 paragraph 2.983 (g)

All scanned photographs of the Equipment are provided in Photographs, Attachment D

Tests Results for MCUC5 radio modem

Contents

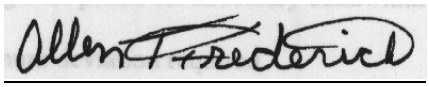
NAME OF TEST: Transmitter Rated Output Power (2.985)

RULE PART NUMBER: 2.983 (d)(5), 2.985 (a)

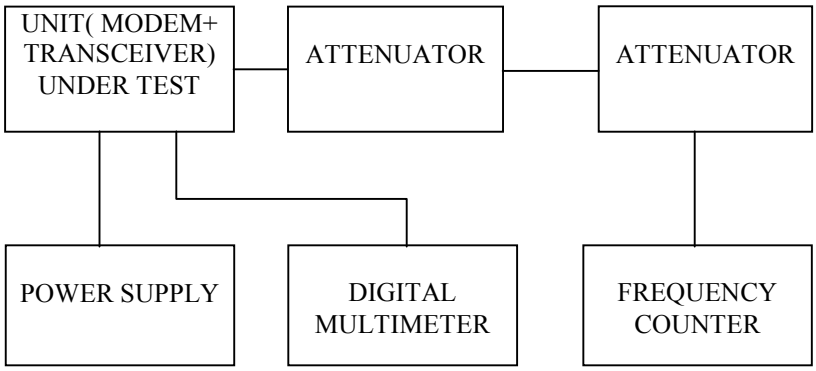
TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Attenuator, Tenuline Model 8340 / 10 dB / 25 Watt
Power Supply, Model HP-6284A
Power Meter, Model HP436A
Digital Voltmeter, Fluke Model 8012A

PERFORMED BY:  DATE: 7/14/98
Allen Frederick

TEST SET-UP:



TEST RESULTS:

Frequency (MHz)	DC Voltage at Final (Vdc)	DC Current into Final (Adc)	DC Power into Final (W)	RF Power Output (W)
944.000	13.3	1.61	21.41	5.0

NAME OF TEST: Transmitter Occupied Bandwidth (2.989)

part 1. In Support of Emission Designator 16K0F1D and 16K6F1D (MCU 3246 Modem at 9600 Baud)

RULE PART NUMBER: 2.989 (h),
2.201, 2.202, 90.209 (b)(5), 101.109(c) for Authorized Bandwidth calculation
90.210 (b), 101.111 (a)(6) for emission limitations

MINIMUM STANDARD: 90.210 (b)-Mask B
Sidebands and Spurious [Rule 90.210 (b), P = 5 Watts]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]
From 10 kHz to 20 kHz, down 25 dB minimum.
From 20 kHz to 50 kHz, down 35 dB minimum.
Greater than 50 kHz, down 50 dB minimum.

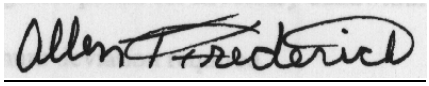
Mask 101.111(a)(6)
Sidebands and Spurious [Rule 101.111(a)(6), P = 5 Watts]
Authorized Bandwidth = 25 kHz [Rule 101.109]
From Fo to 5.0 kHz, down 0 dB.
Greater than 5.0 kHz to 250% auth BW, down 116log(fd/6.1)
or 50+10log)P) or 70 dB.
Greater then 250% auth BW, $43+10\log_{10}(P)$ or 80 dB.
Values:
Attenuation = 0 db at Fo to 5 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 57 dB at 18.91 kHz
Attenuation = 50 dB at > 62.5 kHz

TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST PROCEDURE: TIA/EIA - 603, 2.2.11

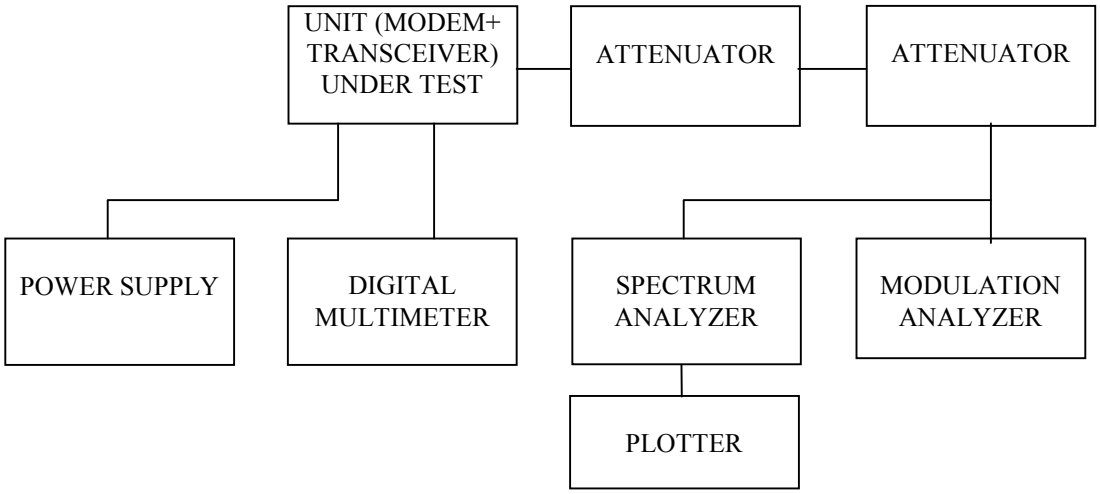
TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Attenuator, Tenuline Model 8340 / 10 dB / 25 Watt
Modulation Analyzer, Model HP8901A
Power Supply, Model HP-6284A
Digital Voltmeter, Fluke Model 8012A
Modulation Source, DL-3276 9600 BAUD Modem
Spectrum Analyzer, Model HP8563E
Plotter, HP7470A

PERFORMED BY:  DATE: 7/3/98
Allen Frederick

NAME OF TEST: Transmitter Occupied Bandwidth (continued)
In Support of Emission Designator 16K0F1D and 16K6F1D (MCU 3246 Modem at 9600 BAUD)

TEST SETUP:



MODULATION SOURCE DESCRIPTION:

The MCU-3246 modem was used as the modulating source for this test configuration.
The deviation was set to +/- 3.2 kHz and to +/- 3.5 kHz. A Pseudo-random test pattern was generated by the modem.
The baud rate was set to 9600 BPS. In this mode, the highest resulting modulating frequency is 4800 Hz.

NECESSARY BANDWIDTH (Bn) CALCULATION

Bn = 2M + 2DK

M= 4800 Hz. This is the highest modulating frequency corresponding to 9600 baud.

D1 = 3200 Hz. This is the maximum deviation required.

K = 1.0

Bn = 2(4800) + 2(3200)(1.0) = 16,000 Hz.
The corresponding emission designator prefix for necessary bandwidth for 3200 Hz deviation = **16K0**.

D2 = 3500 Hz. This is the maximum deviation required.

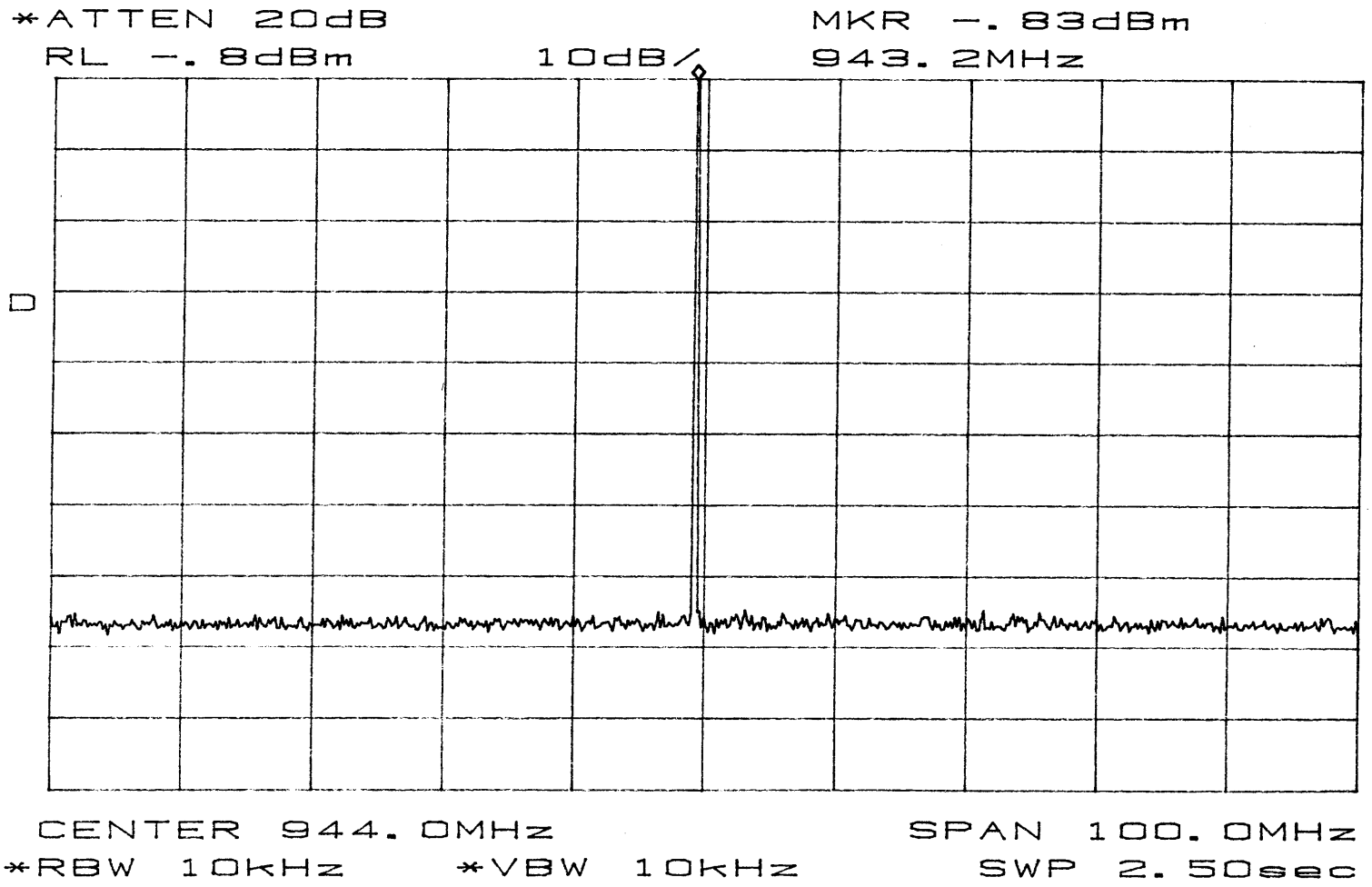
K = 1.0

Bn = 2(4800) + 2(3500)(1.0) = 16,600 Hz.
The corresponding emission designator prefix for necessary bandwidth for 3200 Hz deviation = **16K6**.

TEST DATA: (next 10 graphs for 9600 bps &+/- 3.5 khz dev and +/- 3.2 khz dev)

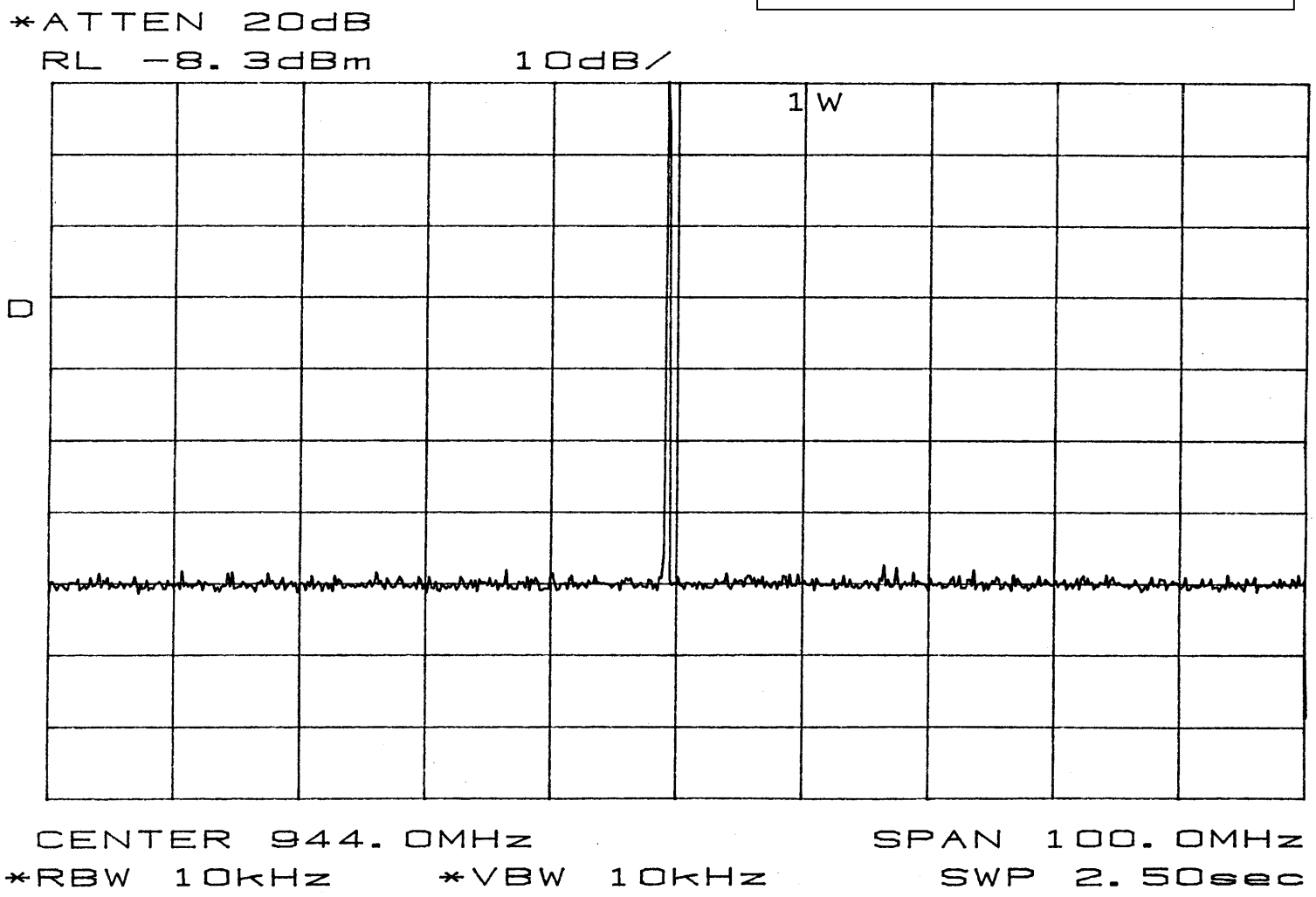
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D, 16K6F1D
5W REFERENCE LEVEL
Unmodulated carrier



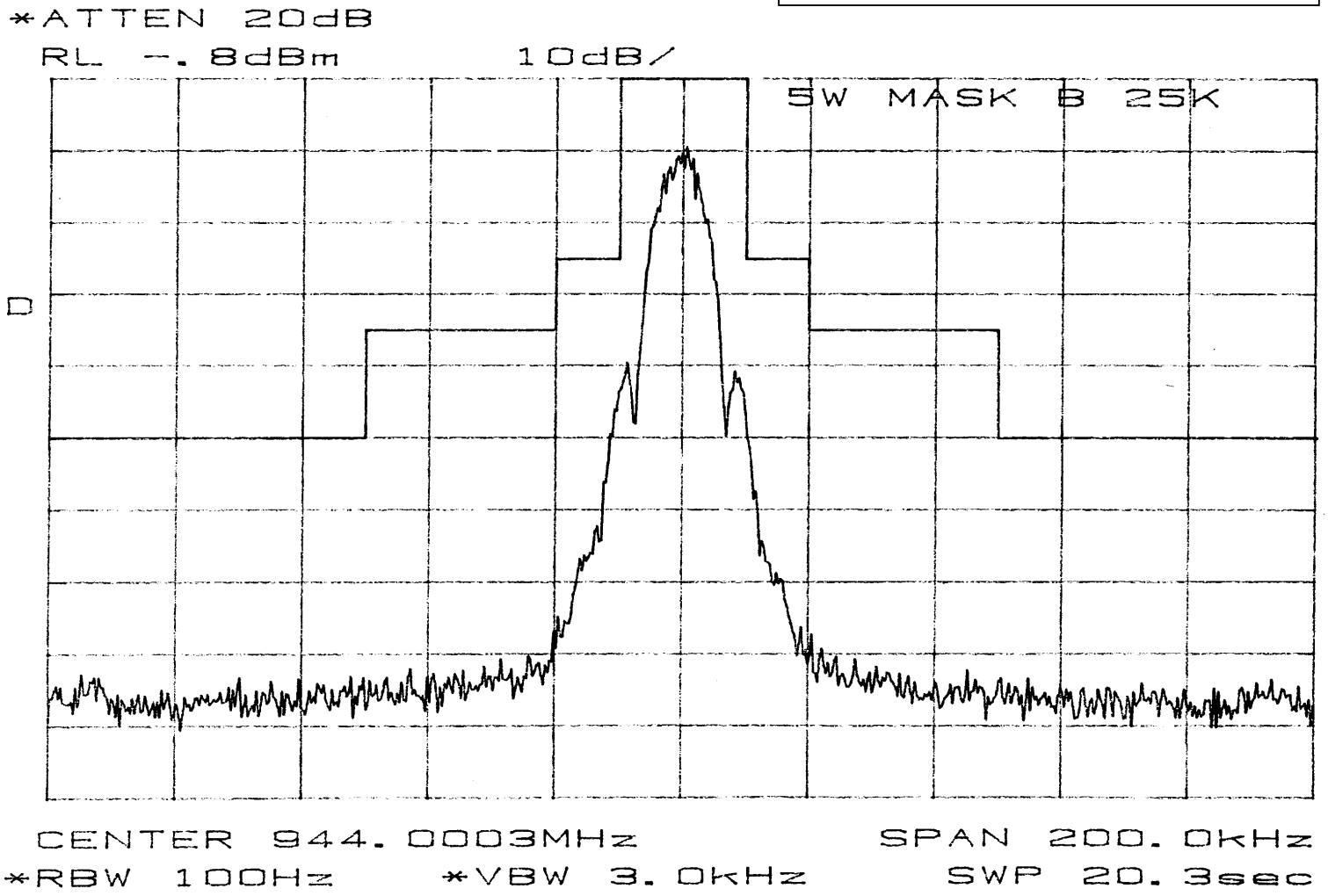
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D , 16K6F1D
1W REFERENCE LEVEL
Unmodulated carrier



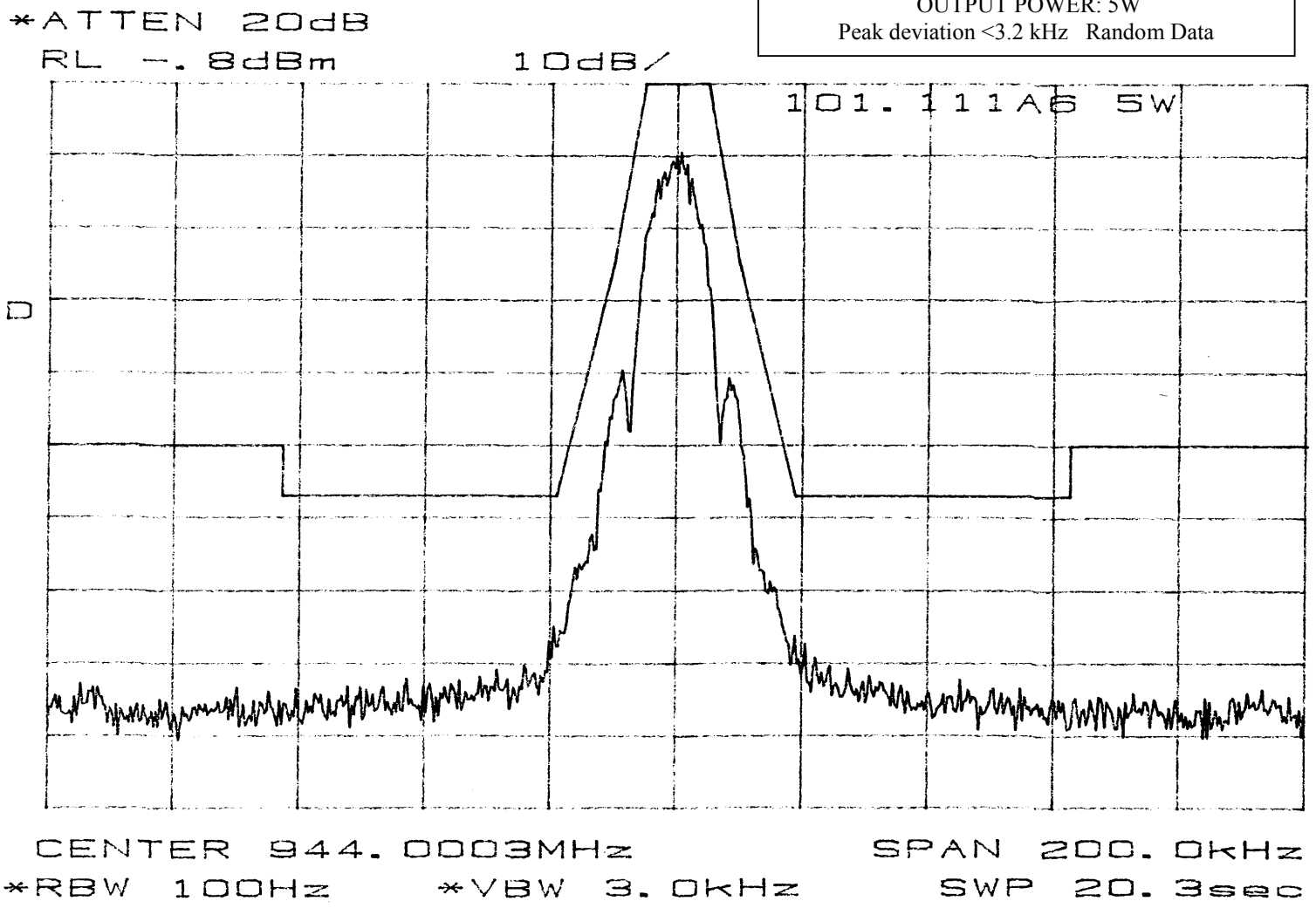
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D MASK B (90.210)(b)
OUTPUT POWER: 5W
Peak deviation <3.2 kHz Random Data



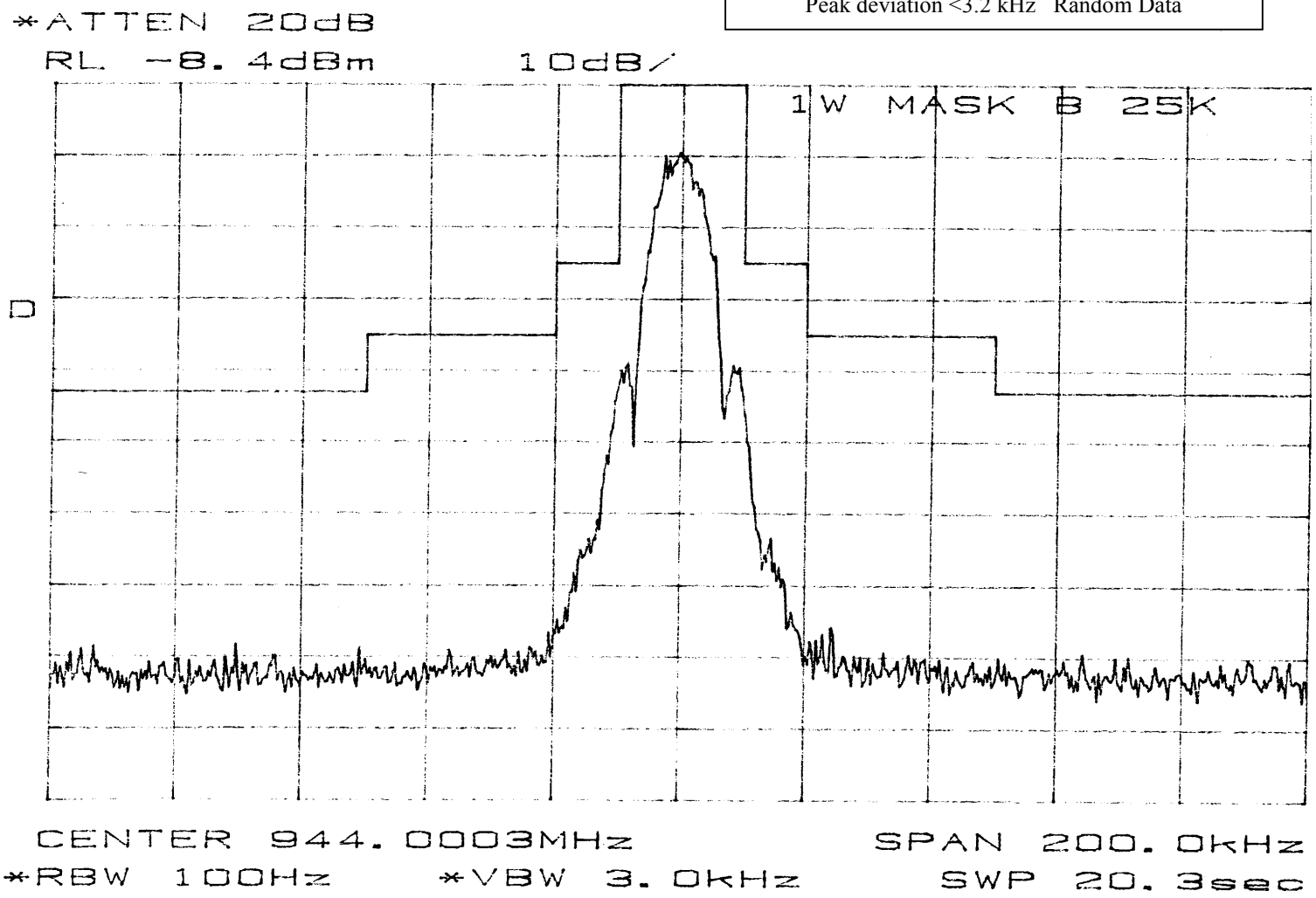
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D MASK (101.111)(a)(6)
OUTPUT POWER: 5W
Peak deviation <3.2 kHz Random Data



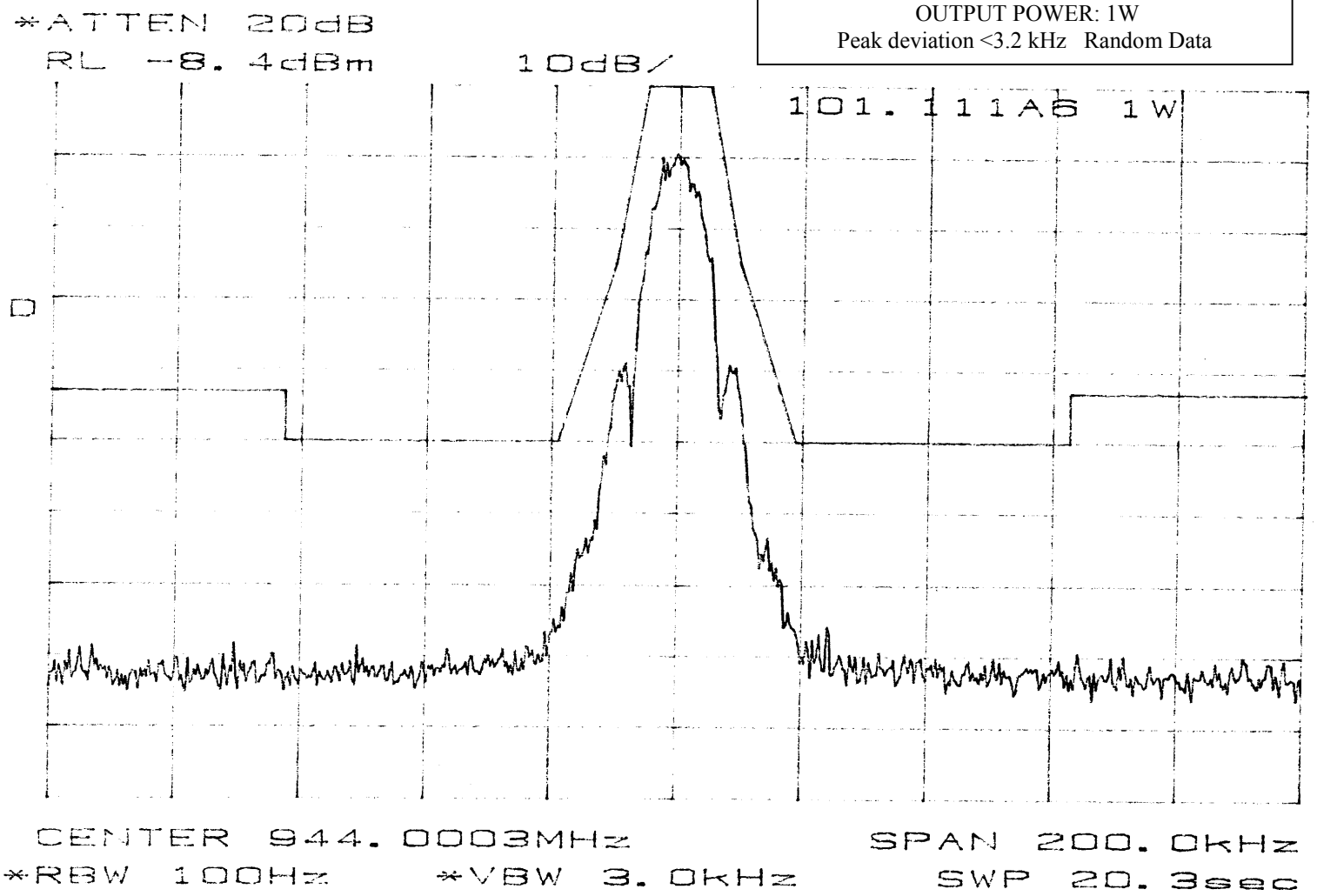
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D MASK B (90.210)(b)
OUTPUT POWER: 1W
Peak deviation <3.2 kHz Random Data



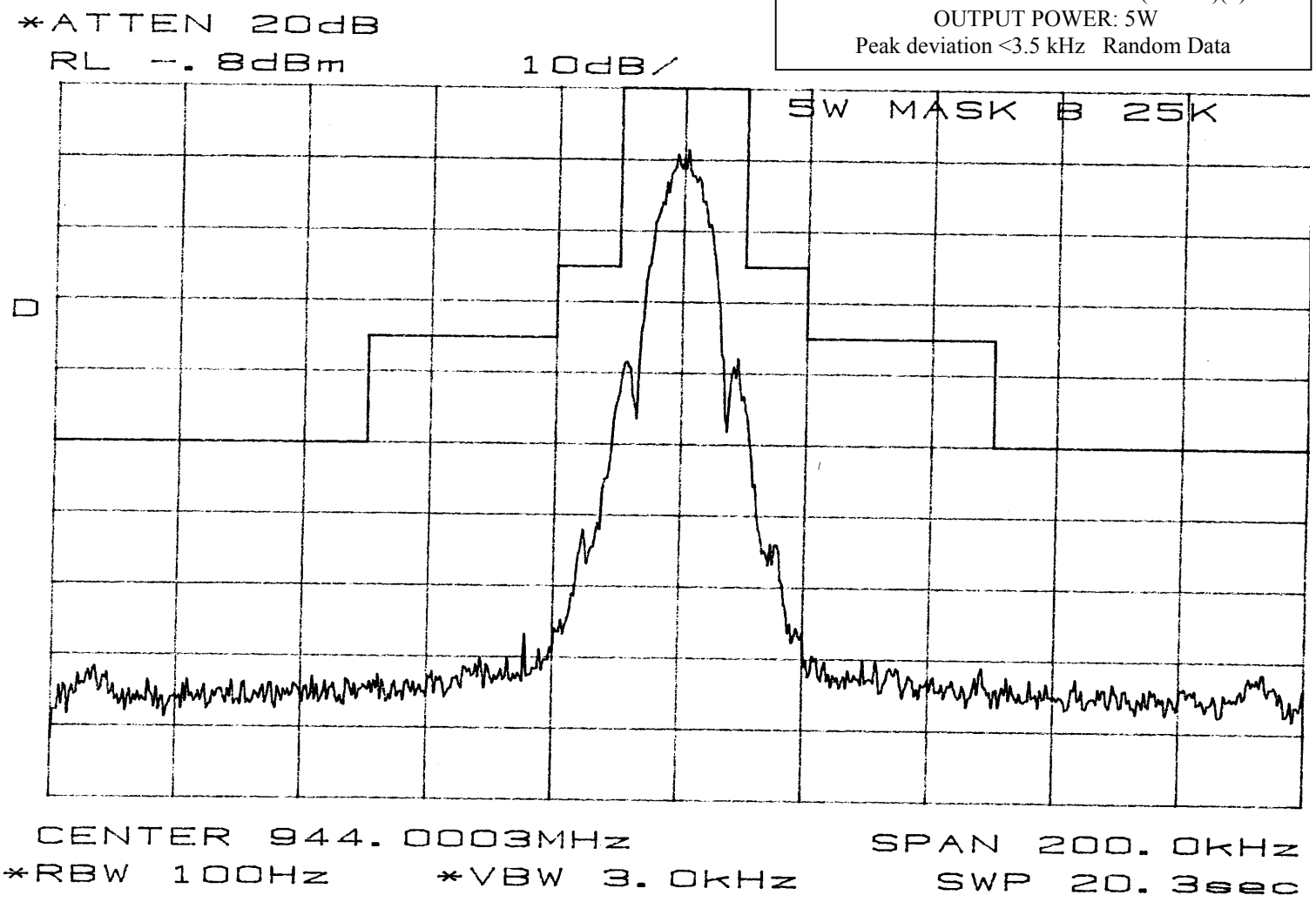
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K0F1D MASK (101.111)(a)(6)
OUTPUT POWER: 1W
Peak deviation <3.2 kHz Random Data



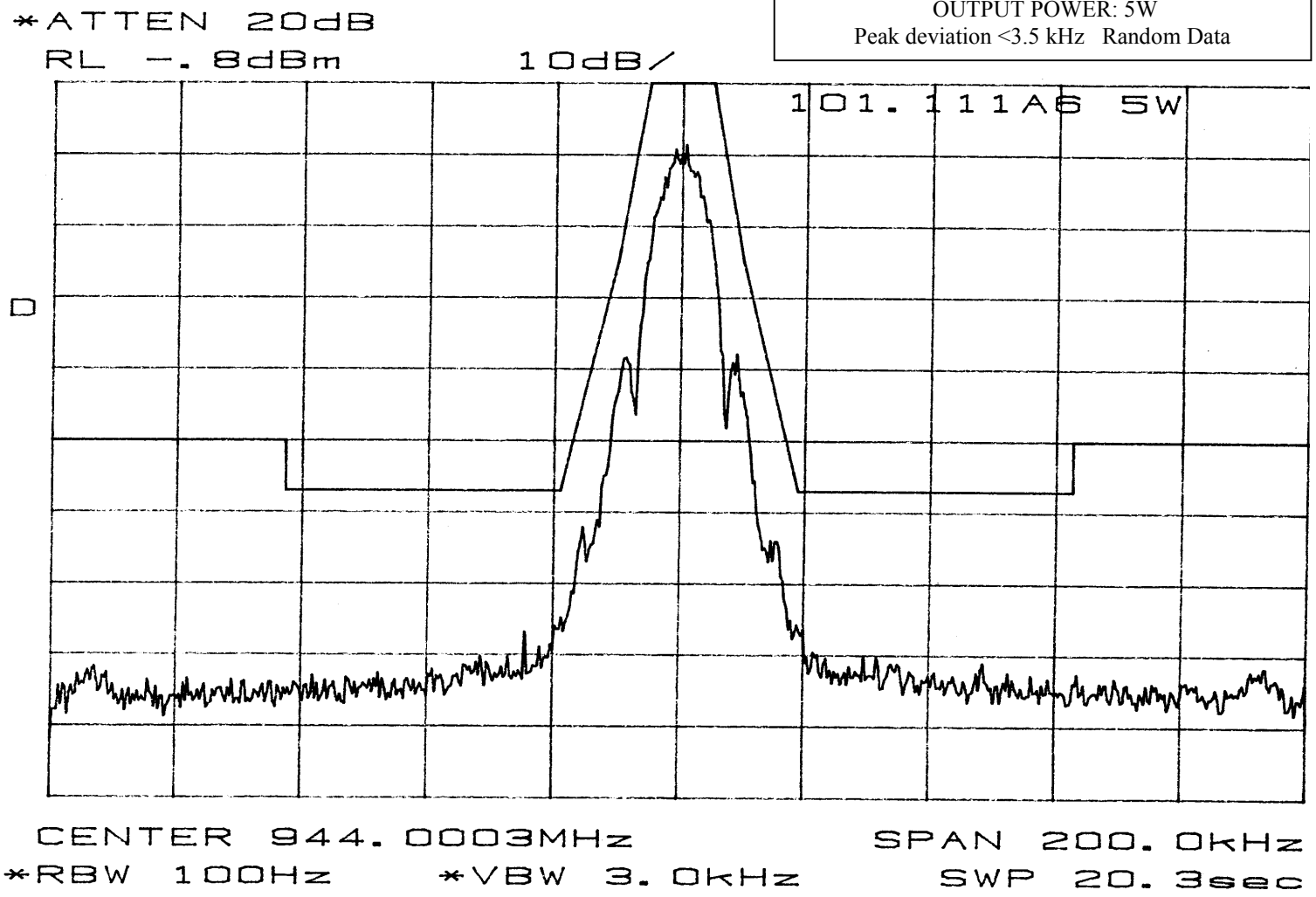
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K6F1D MASK B (90.210)(b)
OUTPUT POWER: 5W
Peak deviation <3.5 kHz Random Data



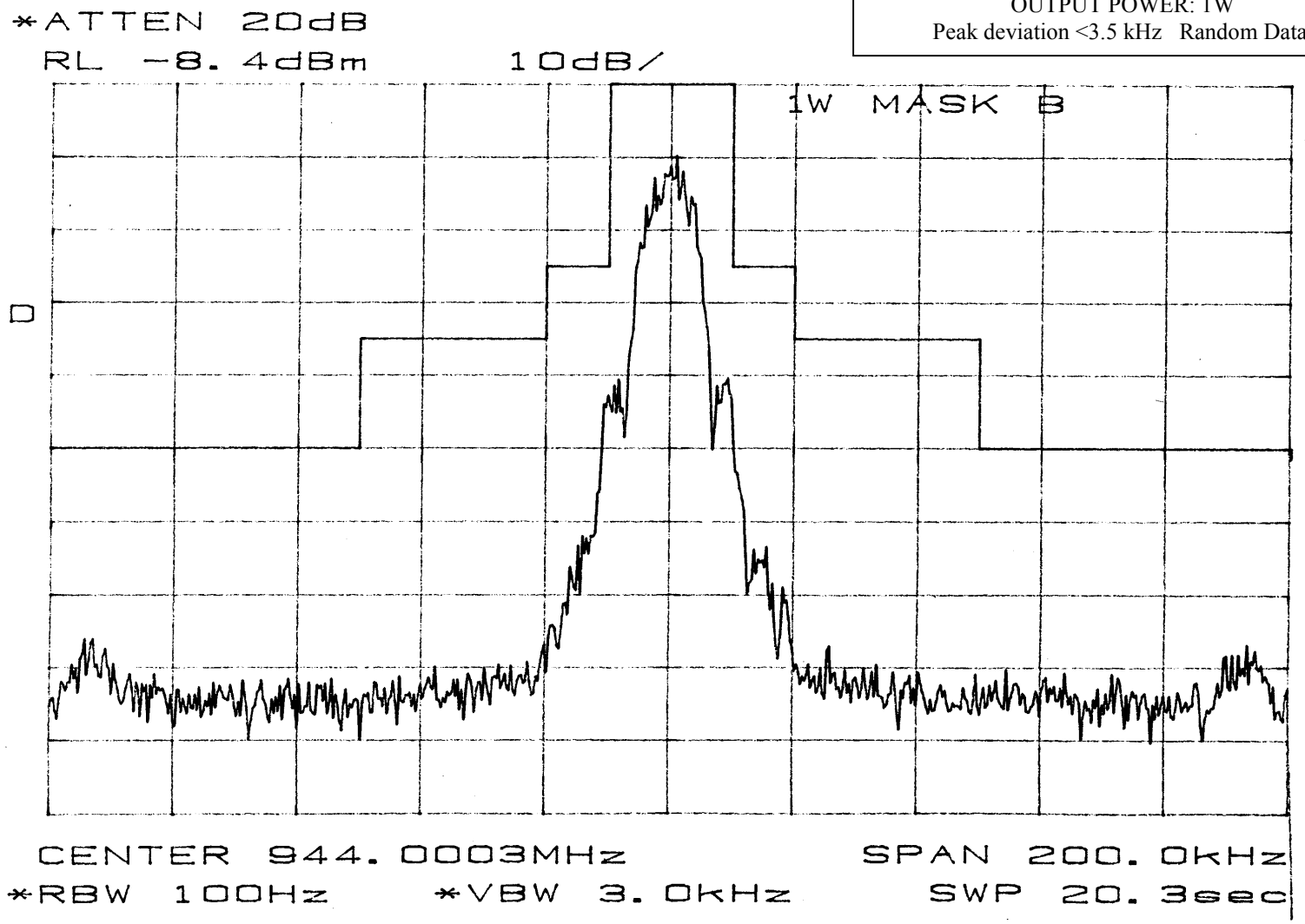
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K6F1D MASK (101.111)(a)(6)
OUTPUT POWER: 5W
Peak deviation <3.5 kHz Random Data



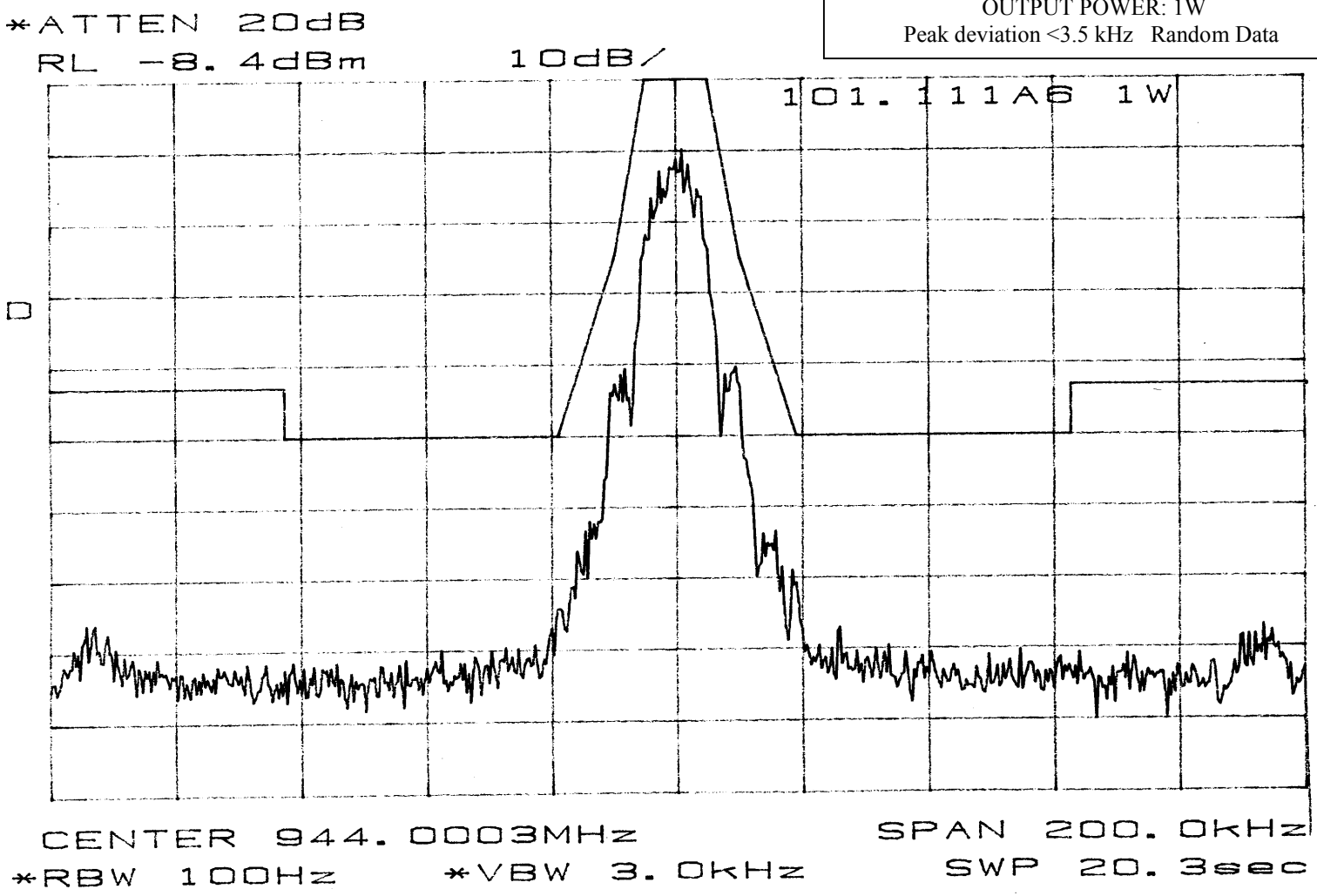
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K6F1D MASK B (90.210)(b)
OUTPUT POWER: 1W
Peak deviation <3.5 kHz Random Data



NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 16K6F1D MASK (101.111)(a)(6)
OUTPUT POWER: 1W
Peak deviation <3.5 kHz Random Data



part 2. In Support of Emission Designator 9K80F1D (MCU 3246 modem at 4800 Baud)

RULE PART NUMBER: 2.989 (h),
2.201, 2.202, 90.209 (b)(5), 101.109(c) for Authorized Bandwidth calculation
90.210 (d), 101.111 (a)(5) for emission limitations

MINIMUM STANDARD: Mask 90.210 (d) - Mask D
Sidebands and Spurious [Rule 90.210 (d), P = 5 Watts]
Authorized Bandwidth = 11.25 kHz [Rule 90.209(b) (5)]
From Fo to 5.625 kHz, down 0 dB. Greater than 5.625 kHz to 12.5 kHz, down 7.27(f_d-2.88kHz) dB. Greater than 12.5 kHz, at least 50+10$\log_{10}$(P) or 70 dB, whichever is the lesser of the attenuation.
Values:
Attenuation = 0 db at Fo to 5.625 kHz
Attenuation = 20 dB at 5.625 kHz and 70 dB at 12.5 kHz
Attenuation = 57 dB at > 12.5 kHz

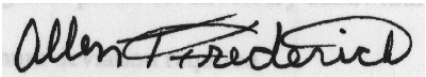
Mask 101.111(a)(5)
Sidebands and Spurious [Rule 101.111(a)(5), P = 5 Watts]
Authorized Bandwidth = 12.5 kHz [Rule 101.109]
From Fo to 2.5 kHz, down 0 dB.
Greater than 2.5 kHz to 6.25 kHz, down 53log(fd/2.5)
Greater than 6.25 kHz to 9.5 KHz, down 103log(fd/3.9)
Greater then 9.5 to 15 KHz, 157log(fd/5.3)
Greater then 15 KHz,, 50+10log(P) or 70 dB
Values:
Attenuation = 0 db at Fo to 6.25 kHz
Attenuation = 21.1dB at 6.25 kHz
Attenuation = 39.8 dB at 9.5 KHz
Attenuation = 70.9 dB at 15 kHz
Attenuation = 57 dB at > 15 KHz

TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST PROCEDURE: TIA/EIA - 603, 2.2.11

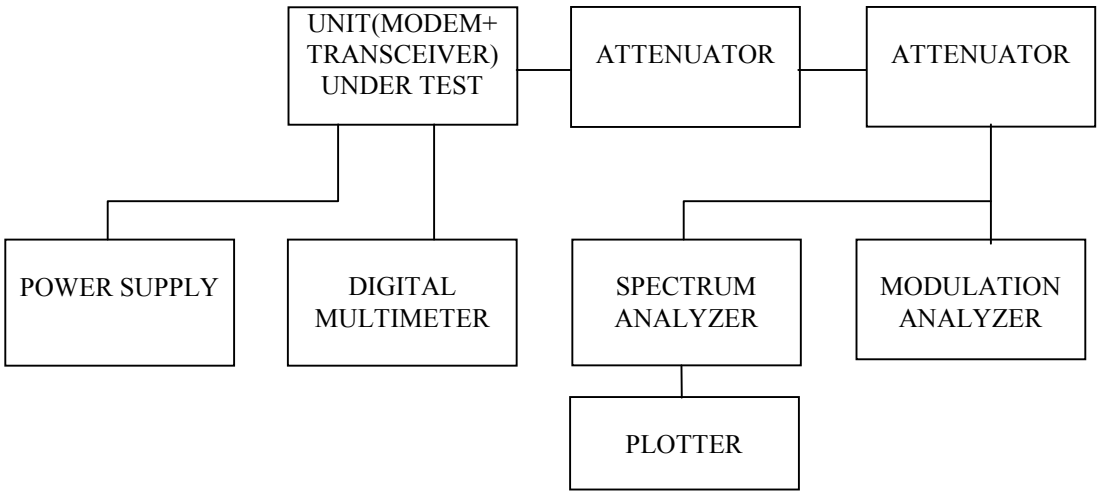
TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Attenuator, Tenuline Model 8340 / 10 dB / 25 Watt
Modulation Analyzer, Model HP8901A
Power Supply, Model HP-6284A
Digital Voltmeter, Fluke Model 8012A
Spectrum Analyzer, Model HP8563E
Plotter, HP7470A

PERFORMED BY:  DATE: 7/3/98
Allen Frederick

NAME OF TEST: Transmitter Occupied Bandwidth (continued)
In Support of Emission Designator 9K80F1D (MCU-3246 Modem at 4800 BAUD)

TEST SET-UP:



MODULATION SOURCE DESCRIPTION:

The MCU 3246 modem was used as the modulating source for this test configuration.
The deviation was set to +/- 2.5 KHz . A Pseudo-random test pattern was generated by the modem. The baud rate was set to 4800 BPS.

NECESSARY BANDWIDTH (Bn) CALCULATION

Bn = 2M + 2DK

M= 2400 Hz. This is the highest modulating frequency corresponding to 4800 baud with MSK-type digital modulation.

D = 2500 Hz. This is the maximum deviation.

K = 1.0

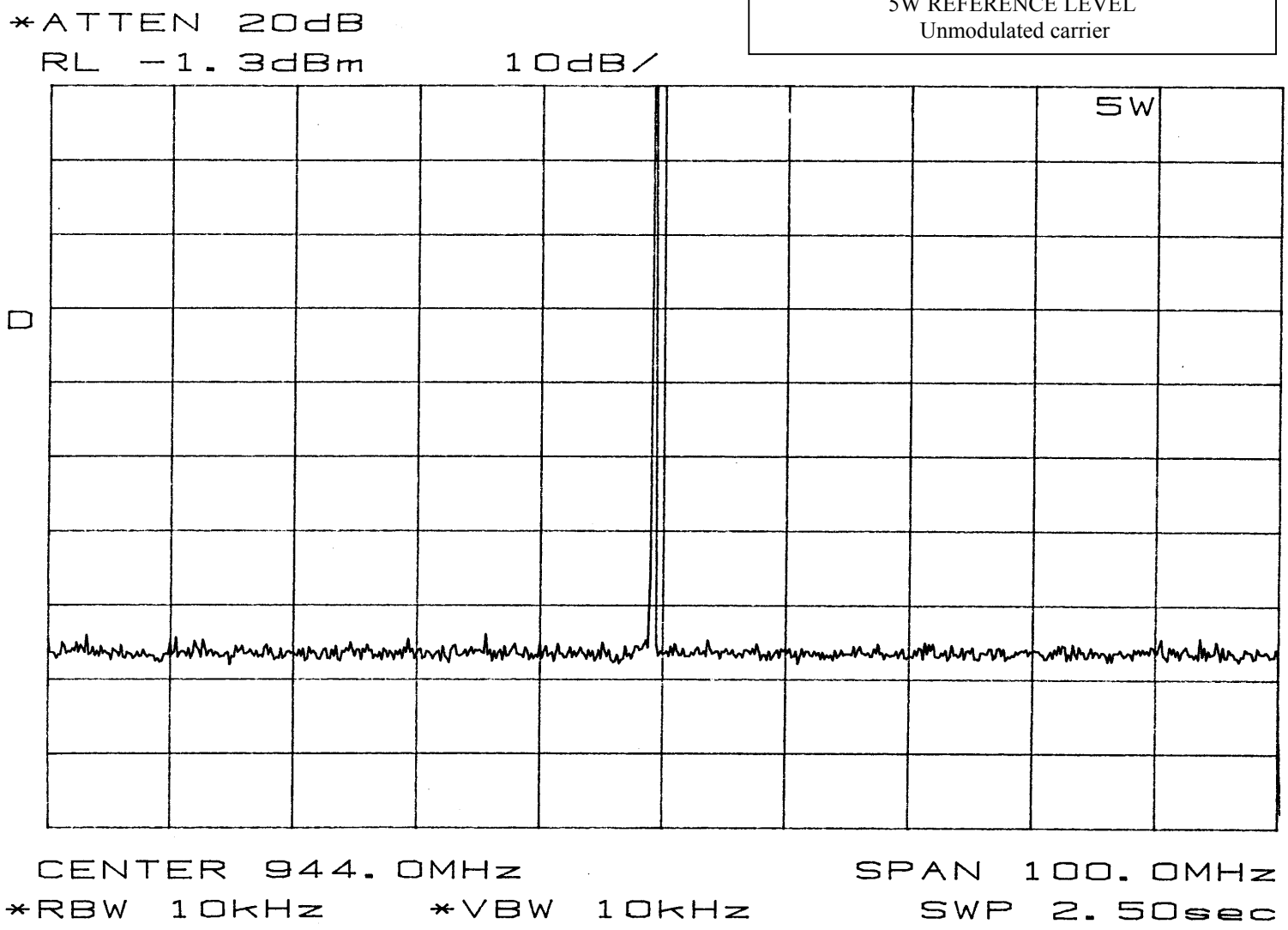
Bn = 2(2400) + 2(2500)(1.0) = 9.800 Hz.

The corresponding emission designator prefix for necessary bandwidth = **9K80.**

TEST DATA: Refer to the following graphics pages:

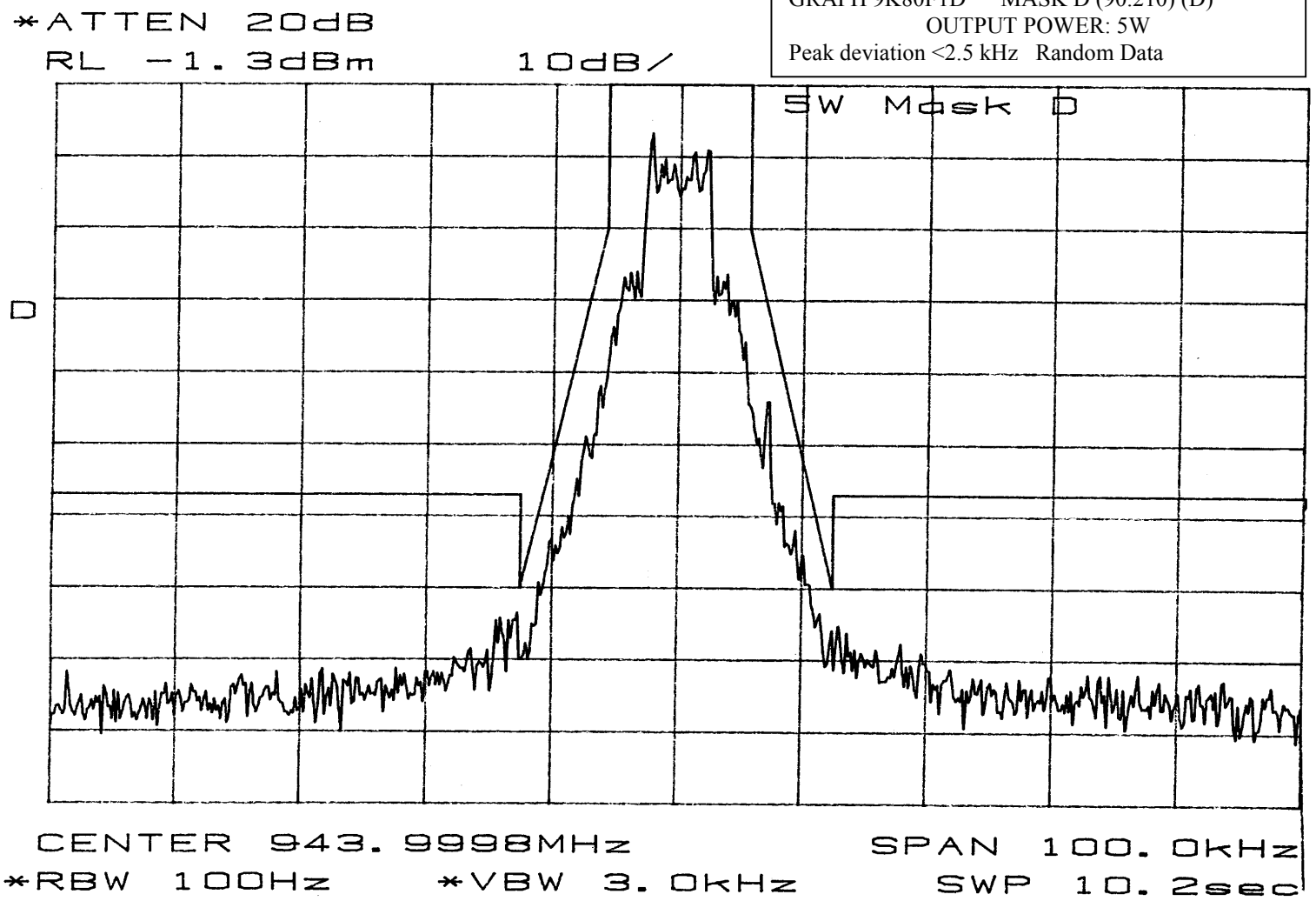
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 9K80F1D
5W REFERENCE LEVEL
Unmodulated carrier



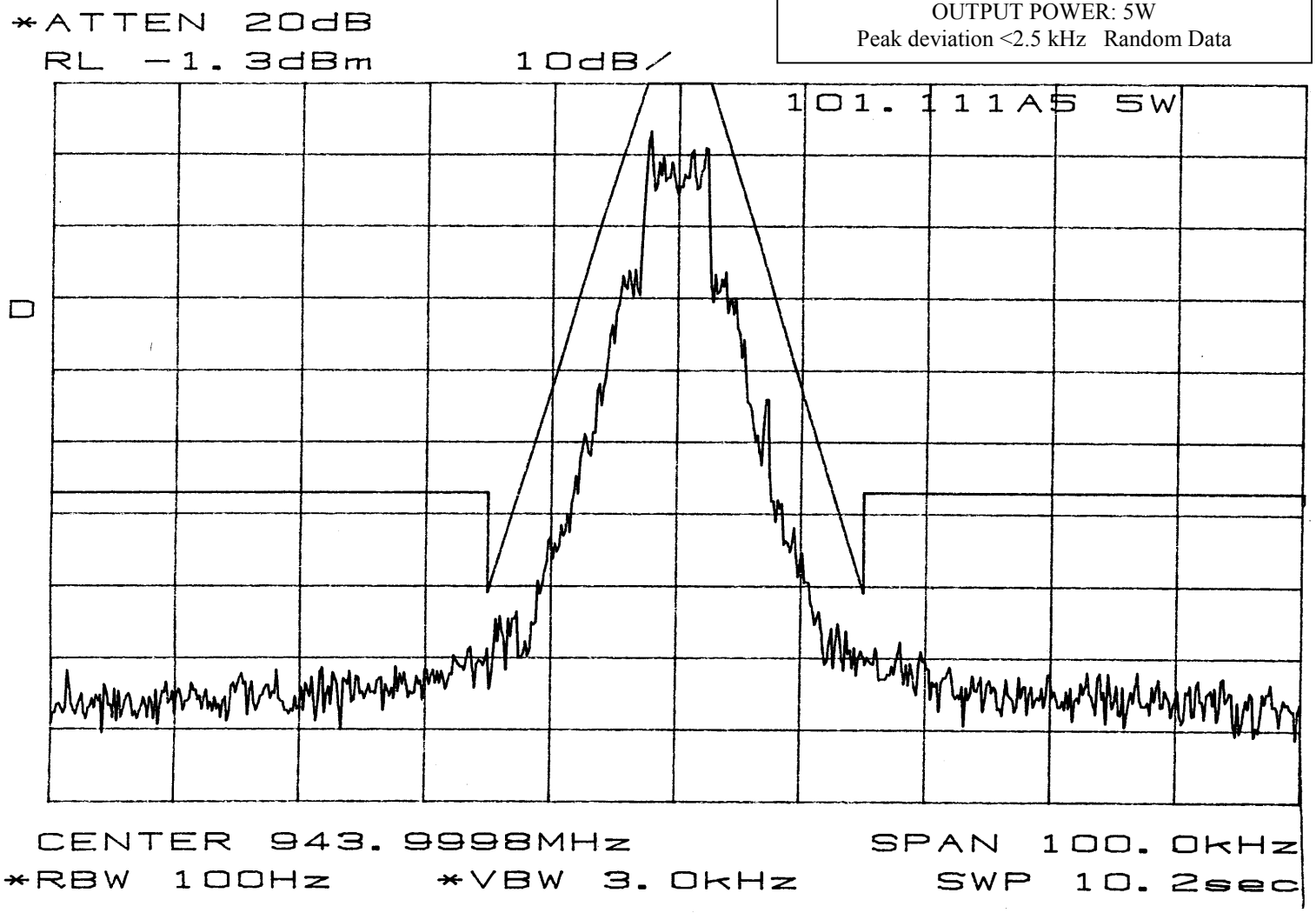
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 9K80F1D MASK D (90.210) (D)
OUTPUT POWER: 5W
Peak deviation <2.5 kHz Random Data



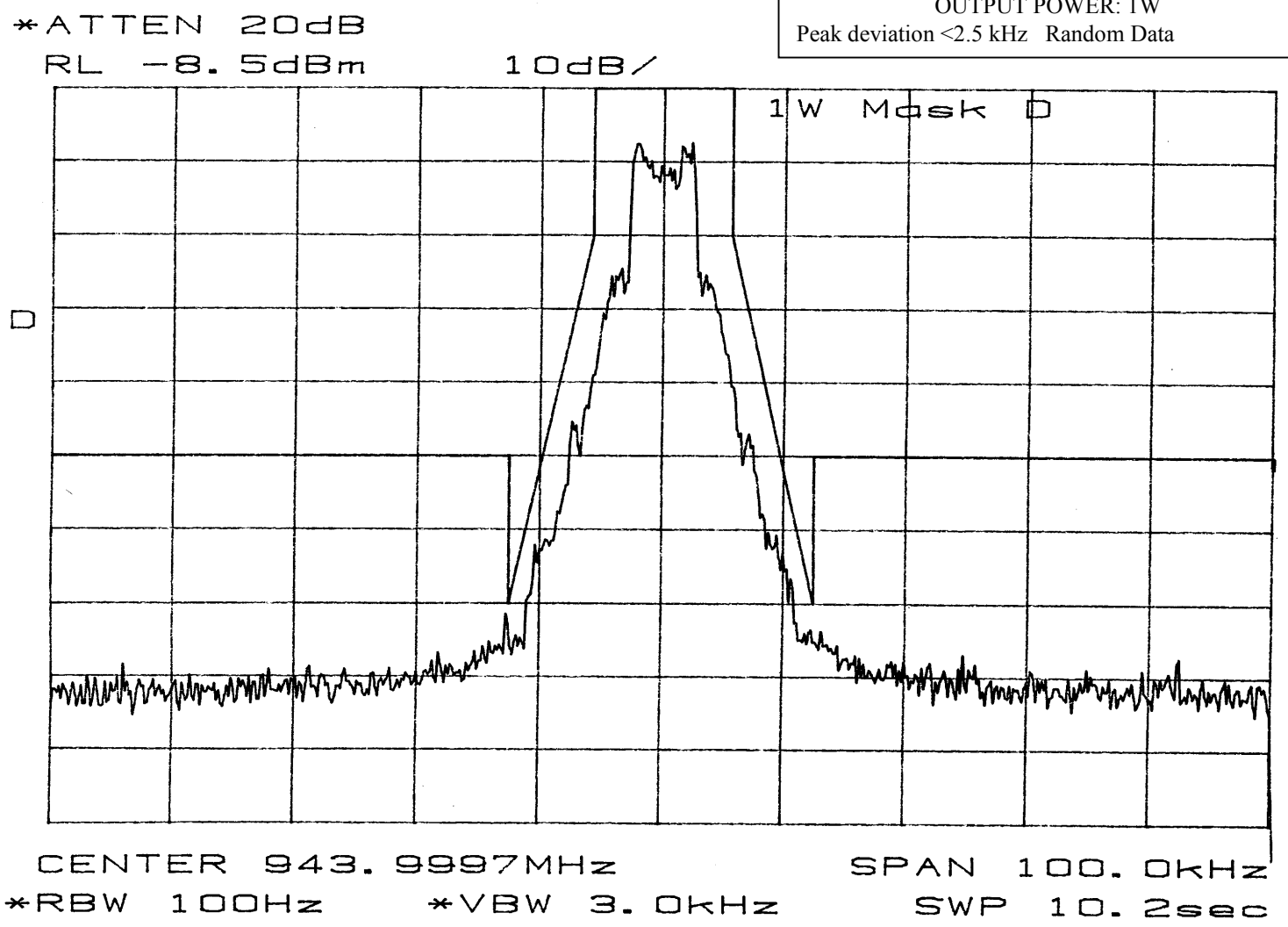
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 9K80F1D MASK (101.111) (a)(5)
OUTPUT POWER: 5W
Peak deviation <2.5 kHz Random Data



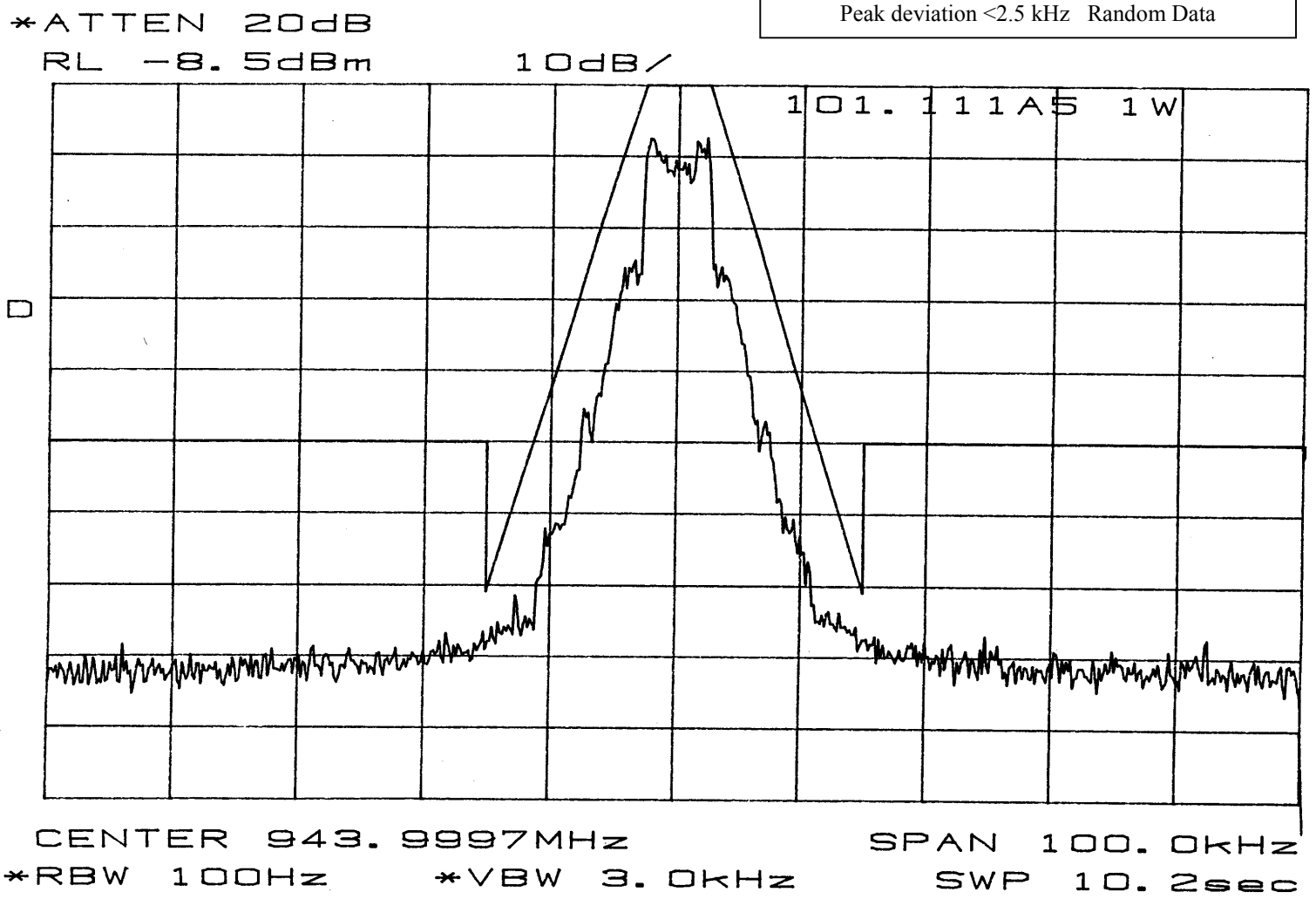
NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 9K80F1D MASK D (90.210) (D)
OUTPUT POWER: 1W
Peak deviation <2.5 kHz Random Data



NAME OF TEST: Transmitter Occupied Bandwidth (continued)

GRAPH 9K80F1D MASK (101.111) (a)(5)
OUTPUT POWER: 1W
Peak deviation <2.5 kHz Random Data



NAME OF TEST: Transmitter Spurious and Harmonic Outputs (2.991)

RULE PART NUMBER: 2.991, 90.210 (d)(3)

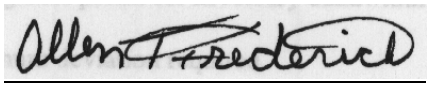
MINIMUM STANDARD: For 5 Watt; $50+10\text{Log}_{10}(5\text{ Watts}) = -57$ dBc
or -70 dBc whichever is the lesser attenuation.

TEST RESULTS: Meets minimum standard (see data on the following page)

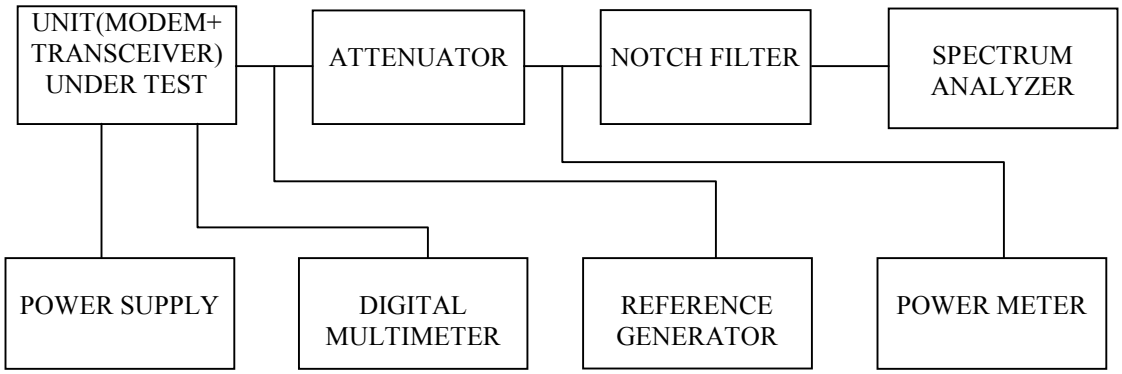
TEST CONDITIONS: Standard Test Conditions, 25 C
RF voltage measured at antenna terminals

TEST PROCEDURE: TIA/EIA - 603, 2.2.13

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Power Supply, Model HP-6284A
Audio Generator, Model HP8903B
Digital Voltmeter, Fluke Model 8012A
Reference Generator, Model HP83732A
Spectrum Analyzer, Model HP8563E
Power Meter, Model HP436A

PERFORMED BY:  DATE: 7/23/98
Allen Frederick

TEST SET-UP:



NAME OF TEST: Transmitter Spurious and Harmonic Outputs (Continued)

MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 928.000, 944.000 and 960.000 MHz. The reference oscillator frequency is 17.5000 MHz.

2. After carrier reference was established on spectrum analyzer, the notch filter was adjusted to null the carrier Fc to extend the range of the spectrum analyzer for harmonic measurements.

3. At each spurious frequency, Generator substitution was used to establish the true spurious level.

4. The spectrum was scanned to the 10th harmonic.

TEST DATA:

F_o = 928.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative to Carrier (dBc)
1856	2 F_o	-37.5	-74.5
2784	3 F_o	-47.5	-84.5
3712	4 F_o	-55.0	-92.0
4640	5 F_o	-47.0	-84.0
5568	6 F_o	-45.5	-82.5
6496	7 F_o	-69.0*	-106.0
7424	8 F_o	-61.0*	-98.0
8352	9 F_o	-60.0	-97.0
9280	10F_o	-54.5	-91.5

NOTE: * means spectrum analyzer could not read any lower, the level specified is the RF level of the substitution generator at the point where the signal was submersed in noise on the spectrum analyzer.

F_o = 944.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative to Carrier (dBc)
1888	2 F_o	-32	-69
2832	3 F_o	-33	-70
3776	4 F_o	-31	-68
4720	5 F_o	-58	-95
5664	6 F_o	-31	-68
6608	7 F_o	-47	-84
7552	8 F_o	-37	-74
8496	9 F_o	-50	-87
9440	10F_o	-60	-97

NAME OF TEST: Transmitter Spurious and Harmonic Outputs (Continued)

F_o = 960.000 MHz

5 Watts = 37dBm Transmitter Spurious and Harmonics

Frequency (MHz)	Relation	Level (dBm)	Level Relative to Carrier (dBc)
1920	2 F_o	-41.5	-78.5
2880	3 F_o	-45.0	-82.0
3840	4 F_o	-56.5	-93.5
4800	5 F_o	-47.0	-84.0
5760	6 F_o	-48.0	-85.0
6720	7 F_o	-54.5	-91.5
7680	8 F_o	-55.5	-92.5
8640	9 F_o	-60.5	-97.5
9600	10F_o	-64.0	-101.0

NAME OF TEST: Field Strength of Spurious Radiation (2.993)

RULE PART NUMBER: 2.993, 90.210 (d)(3)

MINIMUM STANDARD: For 5 Watts; $50+10\text{Log}_{10}(5) = -57$ dBc

TEST RESULTS: Meets minimum standard (see data on the following page)

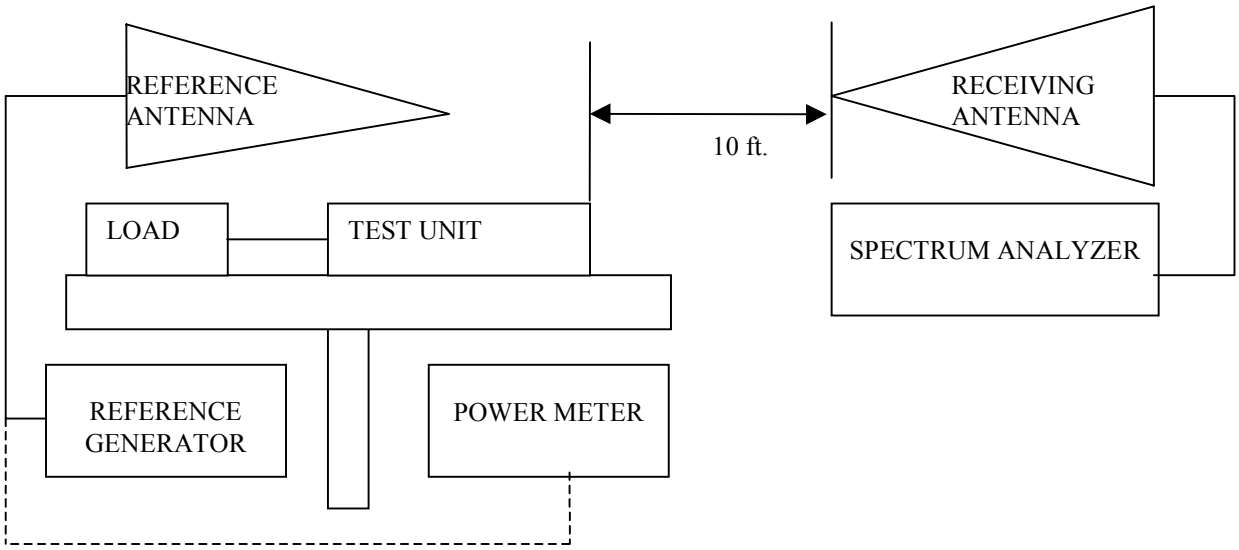
TEST CONDITIONS: Standard Test Conditions, 25 C

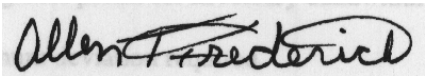
TEST PROCEDURE: TIA/EIA - 603, 2.2.12

TEST EQUIPMENT:
Log Spiral Antenna, Model 93491-2
Log Periodic Antenna, Model LPA-112
Reference Generator, Model HP83732A
Load, Lucas Weinschel 58-30-43
Spectrum Analyzer, Model HP8563E
Power Meter, Model HP436A
Power Supply, Model HP-6284A

MEASUREMENT PROCEDURE: Radiated spurious attenuation was measured according to TIA/EIA Standard 603 Section 2.2.12

TEST SET-UP:



PERFORMED BY:  DATE: 7/1/98
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NAME OF TEST: Field Strength of Spurious Radiation (Continued)

Frequency: 928 MHz Power: 5 Watts= 37.0 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
1856	H	-85.83	-41.50	7.00	1.20	3.00	-87.30
	V	-84.83	-39.50	7.00	1.20	3.00	-85.30
2784	H	-74.33	-23.50	9.00	1.20	3.00	-71.30
	V	-72.33	-16.00	9.00	1.20	3.00	-63.80
3712	H	-92.67	-41.50	11.00	1.20	3.00	-91.30
	V	-92.00	-37.50	11.00	1.20	3.00	-87.30
4640	H	-82.50	-28.00	12.33	1.20	3.00	-79.13
	V	-86.33	-30.00	12.33	1.20	3.00	-81.13
5568	H	-88.50	-29.00	14.00	1.20	3.00	-81.80
	V	-93.00	-28.50	14.00	1.20	3.00	-81.30
6496	H	-89.00	-27.00	15.83	1.20	3.00	-81.63
	V	-94.50	-30.00	15.83	1.20	3.00	-84.63
7424	H	-98.50	-28.00	17.50	1.10	3.00	-84.40
	V	-103.00	-24.50	17.50	1.10	3.00	-80.90
8352	H	<-113	-28.00	20.00	0.50	3.00	-87.50
	V	<-115	-29.00	20.00	0.50	3.00	-88.50
9280	H	<-116	-38.00	22.50	0.50	3.00	-100.00
	V	<-116	-37.00	22.50	0.50	3.00	-99.00

Frequency: 944 MHz Power: 5 Watts= 37.0 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
1888	H	-83.00	-39.50	6.83	1.20	3.00	-85.13
	V	-78.50	-32.50	6.83	1.20	3.00	-78.13
2832	H	-71.30	-19.00	9.67	1.20	3.00	-67.47
	V	-70.83	-13.00	9.67	1.20	3.00	-61.47
3776	H	-88.00	-32.50	11.00	1.20	3.00	-82.30
	V	-87.00	-32.00	11.00	1.20	3.00	-81.80
4720	H	-87.67	-34.00	12.50	1.20	3.00	-85.30
	V	-84.50	-29.00	12.50	1.20	3.00	-80.30
5664	H	-83.83	-18.50	13.83	1.20	3.00	-71.13
	V	-91.00	-25.50	13.83	1.20	3.00	-78.13
6608	H	-88.83	-24.00	16.17	1.20	3.00	-78.97
	V	-91.83	-28.00	16.17	1.20	3.00	-82.97
7552	H	-107.00	-30.50	17.67	1.10	3.00	-87.07
	V	-102.50	-32.50	17.67	1.10	3.00	-89.07
8496	H	-108.30	-21.50	20.33	0.50	3.00	-81.33
	V	-108.30	-27.50	20.33	0.50	3.00	-87.33
9440	H	-111.00	-24.50	22.83	0.50	3.00	-86.83
	V	-108.70	-18.50	22.83	0.50	3.00	-80.83

NAME OF TEST: Field Strength of Spurious Radiation (Continued)

Frequency: 960 MHz Power: 5 Watts= 37.0 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Circular Polarization Correction (dB)	Spurious Attenuation dBc
1920	H	-83.2	-38.0	8.83	1.20	3.00	-85.63
	V	-79.2	-33.5	8.83	1.20	3.00	-81.13
2880	H	-73.8	-20.5	11.33	1.20	3.00	-70.63
	V	-69.3	-15.0	11.33	1.20	3.00	-65.13
3840	H	-93.0	-40.0	12.67	1.20	3.00	-91.47
	V	-86.9	-30.5	12.67	1.20	3.00	-81.97
4800	H	-89.7	-37.5	13.67	1.20	3.00	-89.97
	V	-87.8	-32.5	13.67	1.20	3.00	-84.97
5760	H	-101.0	-37.5	16.00	1.20	3.00	-92.30
	V	-99.3	-30.0	16.00	1.20	3.00	-84.80
6720	H	-92.7	-28.0	17.67	1.20	3.00	-84.47
	V	-95.7	-27.0	17.67	1.20	3.00	-83.47
7680	H	-103.7	-25.0	20.00	1.10	3.00	-83.90
	V	-106.5	-31.5	20.00	1.10	3.00	-90.40
8640	H	-106.3	-28.0	23.67	0.50	3.00	-91.17
	V	-105.0	-18.5	23.67	0.50	3.00	-81.67
9600	H	< -123	-40.5	27.67	0.50	3.00	-107.67
	V	< -126	-41.0	27.67	0.50	3.00	-108.17

CALCULATIONS FOR FIELD STRENGTH OF SPURIOUS RADIATION TESTS:

Since the reference antenna used above 1 GHz has gain that differed from a dipole, the generator output was corrected for antenna gain at each spurious frequency. The power was measured directly at the reference antenna and therefore requires no coaxial cable loss correction. An additional correction was made for the 3 dB polarization loss in the reference path.

EXAMPLE:

At 1856 MHz, 5 Watts and horizontal polarization.

R - Reference Generator (dBm)	-41.50
A - Antenna Gain (dB)	+1.2
P - Polarization Correction Factor (dB)	3.0
Cl-Cable loss (dB)	7.0

R' - Corrected Reference (dBm)

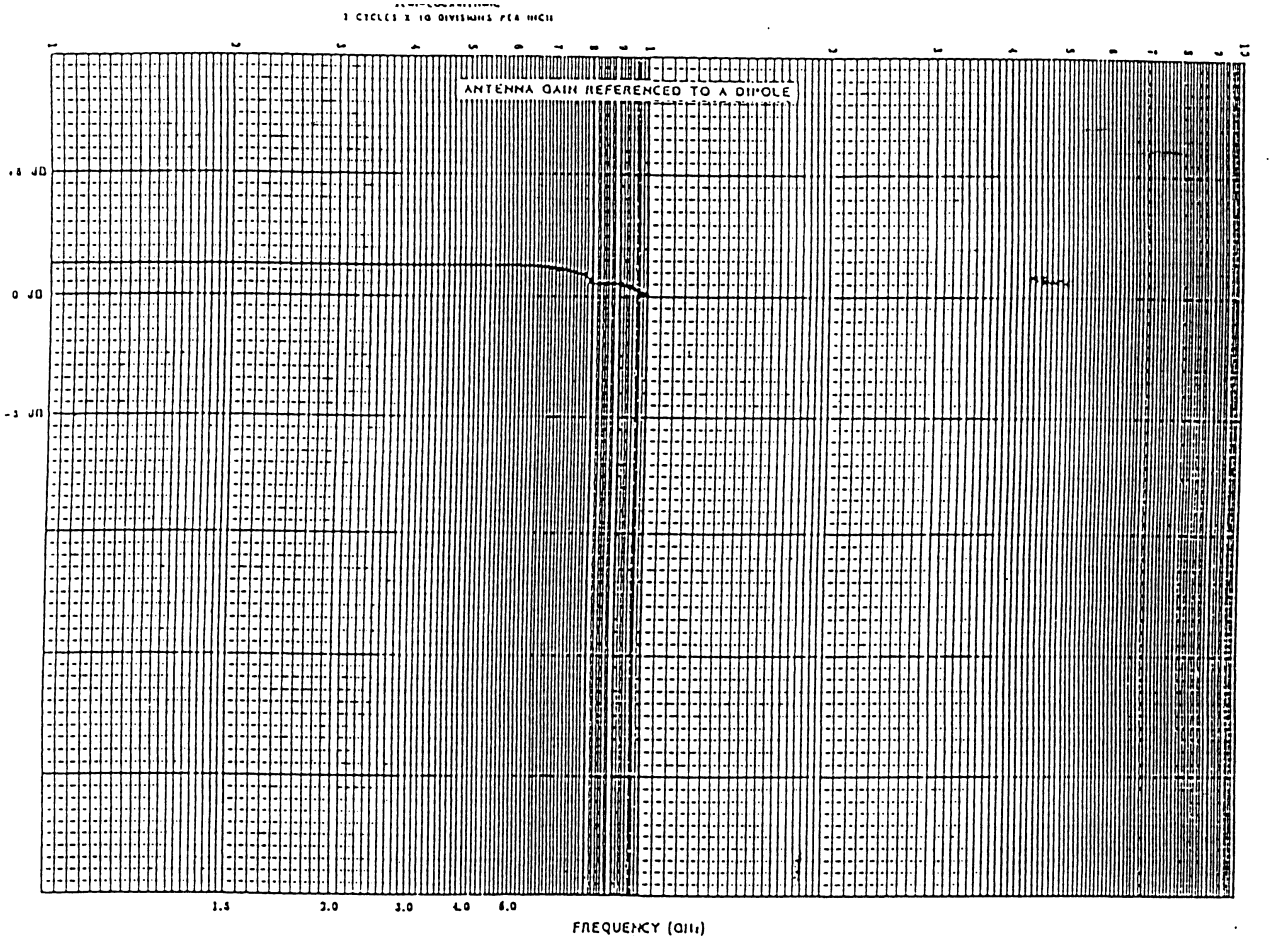
R' = R + A - P -Cl= -41.50 + 1.2 - 3.0-7.0 = -50.30 dBm

Po - Radiated Carrier Power (dBm)

5 Watts = 37 dBm

Radiated Spurious Emission (dBc) = Po - R' = -50.30 - (+37.0) = -87.30 dB

NAME OF TEST: Field Strength of Spurious Radiation (Continued)



ANTENNA GAIN GRAPH

NAME OF TEST: Frequency Stability (2.995)

part 1. According with Variation in Ambient Temperature

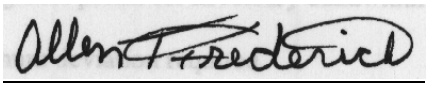
RULE PART NUMBER: 2.995 (a)(1), 90.213 (a) , 101.107(a)

MINIMUM STANDARD: 90.213 (a): Shall not exceed ± 0.000150% from test frequency, or 1.50 ppm
101.107 (a): the worst case: shall not exceed ± 0.000150% from test frequency, or 1.50 ppm

TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Attenuator, Tenuline Model 8340 / 10 dB / 25 Watt
Frequency Counter, Fluke Model 1920A
Power Supply, Model HP-6284A
Digital Voltmeter, Fluke Model 8012A
Thermometer, Fluke Model 80T-150U
Climate Chamber, Thermotron Model SM-8C

PERFORMED BY:  DATE: 7/23/98
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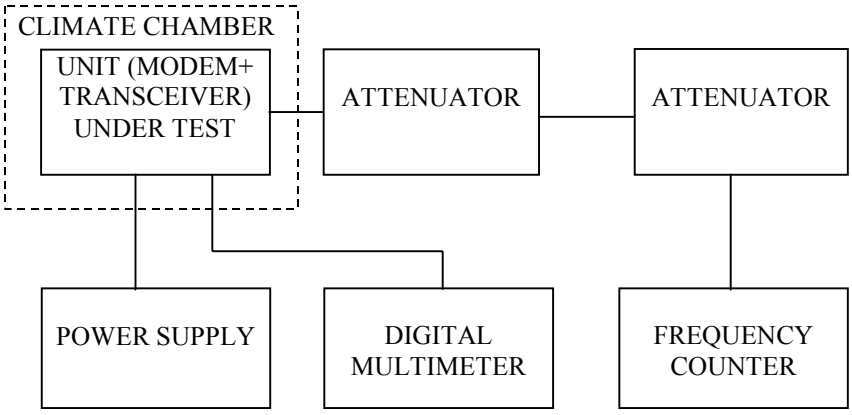
TEST SET-UP:



(Test data on next page)

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature (Continued)

Channel Frequency:	944.000000	MHz
Tolerance Requirement:	1.50	ppm
Highest Variation:	0.698	ppm

Temperature (Deg C)	Measured Frequency (Hz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	944000659	659	0.698
-20	944000409	409	0.433
-10	944000129	129	0.137
0	943999994	-6	0.006
10	944000058	58	0.061
20	944000099	99	0.105
30	943999800	-200	0.212
40	943999947	-53	0.056
50	944000020	20	0.021
60	944000061	61	0.065

part 2. According with Variation in Supply Voltage

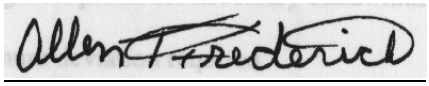
RULE PART NUMBER: 2.995 (d) 90.213 (a) , 101.107(a)

MINIMUM STANDARD: 90.213 (a): Shall not exceed ± 0.000150% from test frequency, or 1.50 ppm
101.107 (a): the worst case: shall not exceed ± 0.000150% from test frequency, or 1.50 ppm

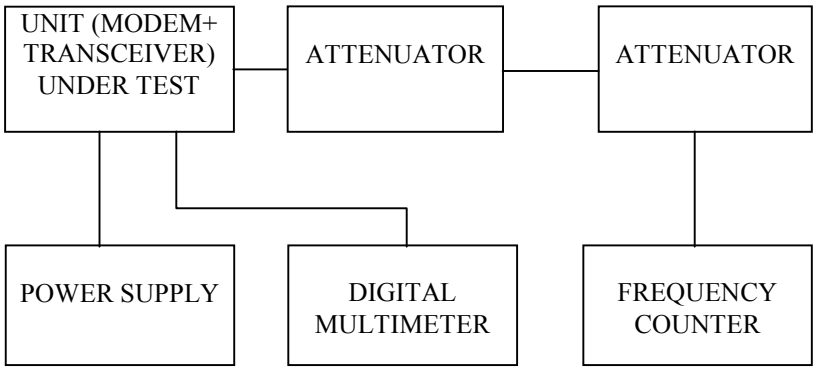
TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, Tenuline Model 8340 / 20 dB / 25 Watt
Attenuator, Tenuline Model 8340 / 10 dB / 25 Watt
Frequency Counter, Fluke Model 1920A
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6624A

PERFORMED BY:  DATE: 7/23/98
Allen Frederick

TEST SET-UP:



TEST SET-UP

(Test data on next page)

NAME OF TEST: Frequency Stability with Variation in Supply Voltage (Continued)

MEASUREMENTS TAKEN:

1.5 ppm Reference Oscillator

Frequency Reference Set at 25° C: 944.00008 MHz
Tolerance Requirement: 0.00015 %
Highest Variation (%): 0.00000000 %
Highest Variation (ppm): 0.000 ppm

SUPPLY VDC	FREQUENCY MHz	DELT FREQ % of assigned f	SPEC LIMIT % of assigned f	ppm from assigned frequency
10	944.00008	0.00000000	0.00015	0.000
13	944.00008	0.00000000	0.00015	0.000
16	944.00008	0.00000000	0.00015	0.000

Attachments:

Description of Circuitry, Attachment A

File:\op_desc.doc

Schematics, Attachment B

MCU 3246 loader/modem board- file :\ D3246-1.dxf
\D3246-2.dxf
\D3246-3.dxf
\D3246-4.dxf

DL 3492 transceiver board -file :\3492sch.dxf

Technical manual, Attachment C

File:\ intt100.doc

Photographs, Attachment D

External photograph –file:\ext_phot.doc
Internal photograph - file:\int_phot.doc
Label photograph and affix description- file:\lab_phot.doc