Engineering Exhibit in Support of Certification FCC Form 731

for the

Mobile Data Platform Transceiver (800 MHz MDP)

With the

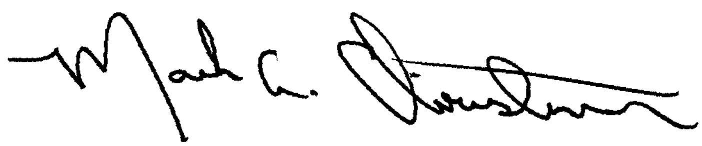
Data Radio Gemini Modem

Trade Name: GEMINI/PD

November 19, 1999

AFFIDAVIT

The technical data included in this report has been accumulated through tests that were performed by me or by engineers under my direction. To the best of my knowledge, all of the data is true and correct.



Mark Christensen
Director of Engineering, Dataradio COR Ltd.

Dataradio COR Ltd.
Waseca, Minnesota

ENGINEERING STATEMENT
OF CHRIS LUDEWIG

The application consisting of the attached engineering exhibit and associated FCC form 731 has been prepared in support of a request for Certification. Certification is requested for the Dataradio COR Ltd. (DRL) Mobile Data Platform (MDP) 800 MHz Transceiver with the Data Radio Gemini Modem. The modem/transceiver will operate in the frequency range 806-824 MHz in Transmit and 851-869 MHz in Receive. Dataradio, Canada, will buy the MDP from DRL, Waseca, with the part# 242-608C-MRB (see page 6 for part# description). Dataradio will install the modem and perform final assembly. Along with the modem a GPS receiver option is also available. The MDP Transceiver mated with the Gemini Modem and GPS receiver will be identified by the Data Radio part number GPDD-6085-xyz and marketed under the Model name GEMINI/PD. The Transceiver/Modem/GPS will be identified by the FCC number EOTGPDB. The transceiver operates pursuant to Part(s) 90 of the Rules and Regulations. The MDP Transceiver RF power is continuously variable from 5-40 watts.

EXISTING CONDITIONS

The units utilized for these Certification measurements were obtained from prototypes. The transceiver is designed to operate on frequencies ranging from 806.000 MHz to 824.000 MHz. The frequency tolerance of the transceiver is .00015% or 1.5 parts per million. The frequency stability of the transceiver is controlled by a temperature compensated crystal oscillator (TCXO) operating at 17.5 MHz.

PROPOSED CONDITIONS

It is proposed to Certify the GEMINI/PD, 806-824 MHz Transceiver/Modem/GPS 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 Certification measurements were conducted in accordance with the Rules and Regulations Section 2.1041of Pike & Fischer Inc., CD ROM revision 9/99. Equipment performance measurements were made in the engineering laboratory and on the FCC certified Open Area Test Site at the Transcrypt International / E.F. Johnson Radio Products located at 299 Johnson Avenue in Waseca, Minnesota. All measurements were made and recorded by myself or under my direction. The performance measurements were made between Nov 10, 1999 and Nov 18,1999.

CONCLUSION

Given the results of the measurements contained herein, the applicant requests that Certification be granted for the GPDD-6085-xyz, 806-824 MHz Transceiver/Modem/GPS as tested for data communications.

______________________________ 11/19/99

Chris Ludewig
Engineering Section Manager, Dataradio COR Ltd.

TABLE OF CONTENTS

ANNEXES:

QUALIFICATIONS OF ENGINEERING PERSONNEL

NAME:	**Chris Ludewig**
TITLE:	Engineering Section Manager
TECHNICAL EDUCATION:	Bachelor of Science in Electrical and Electronic Engineering (1984) From North Dakota State University
TECHNICAL EXPERIENCE:	15 years experience in design of portable and mobile radio equipment

NAME:	**Mike Dickinson**
TITLE:	Senior Engineer
TECHNICAL EDUCATION:	Bachelor of Science in Electrical Engineering (1994) from University of Illinois
TECHNICAL EXPERIENCE:	13 years experience in radio frequency measurements 5 years experience in radio frequency design

NAME:	**Constantin Pintilei**
TITLE:	R&D Test Engineer
TECHNICAL EDUCATION:	Bachelor of Science Degree in Radiotechnique Electronic Engineering (1993) Technical University of Iasi, Romania.
TECHNICAL EXPERIENCE:	6 Years experience in radio frequency measurements.

NAME:	**Allen Frederick**
TITLE:	Certified Technologist
TECHNICAL EDUCATION:	Bachelor of Science Degree in Electronic Engineering Technology (1998) from Mankato State University.
TECHNICAL EXPERIENCE:	3 years experience in analog and radio frequency communications.

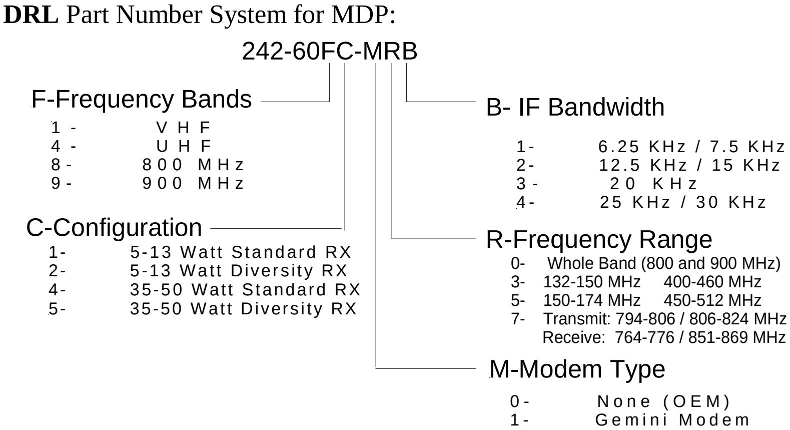
GENERAL INFORMATION - Rule Part Number: 2.1033 (c).(1),(2),(4),(5),(6),(7)

APPLICANT	Dataradio Inc., 5500 Royalmount Ave, suite 200, Town of Mount Royal, Quebec, Canada, H4P 1H7
MANUFACTURER:	Dataradio COR Ltd., Waseca, MN 56093 (MDP Transceiver) DATARADIO Inc., Town of Mount Royal, Quebec, Canada, H4P 1H7 (Gemini- final assembly)
MODEL NUMBER:	GEMINI/PD
PART NUMBER:	GPDD-6085-xyz
SERIAL NUMBER (S):	813.000 MHz – FCC#1 822.000 MHz – FCC#1
FCC ID NUMBER:	EOTGPDB
FCC RULES AND REGS:	FCC Part (s) 90
FREQUENCY RANGE:	806.000 MHz - 824.000 MHz (806-821/851-866 and 821-824/866-869 MHz Bands)
TYPE OF EMISSION:	12.5KHz BW (9600bps) **8K60F1D** 25KHz BW (16.0Kbps) **15K3F1D** 25KHz BW (19.2Kbps) **15K0F1D**
MAXIMUM POWER RATING:	40.00 Watts (5-40 watts variable).
NUMBER OF CHANNELS:	16 Channel Modem
INPUT IMPEDANCE:	50 ohms, Nominal
VOLTAGE REQUIREMENTS:	10.9-16.3VDC (13.6 VDC Nominal)

EQUIPMENT IDENTIFICATION:

TRADE NAME	DESCRIPTION	DRI PART NUMBER
MDP6000	806-824/851-869MHz XCVR	242-608C-MRB
Gemini	Modem	050-03322-00x

DRL Part Number System for MDP:



OTHER DATA- Rule Part Number: 2.1033 (c).(8),(13),(15),(16)

DC VOLTAGES AND CURRENTS INTO FINAL AMPLIFIER
RULE PART NUMBER 2.1033(c).(8)
refer to Test#1 (Transmitted Rated Output Power) in section Test results pag .9

DIGITAL MODULATION TECHNIQUES
RULE PART NUMBER 2.1033(c).(13)
refer to Test#2 (Transmitter Occupied Bandwidth) in section Test results pag .15,19,23

Data addressing RULE PART NUMBER 2.1033(c) 15, 16: this unit is not designed for the mentioned purposes

LIST OF ANNEXES: - Rule Part Number: 2.1033 (c).(3),(9),(10),(11),(12)

INSTRUCTION BOOK
RULE PART NUMBER: 2.1033 (c) (3)
Annex D. The attached Service Manual for the GEMINI/PD Transceiver/Modem/GPS is a preliminary version.

TRANSMITTER TUNE UP PROCEDURE
RULE PART NUMBER: 2.1033 c (9)
Annex F

DESCRIPTION OF CIRCUITRY
RULE PART NUMBER: 2.1033 (c)(10)
Annex A

SCHEMATICS
RULE PART NUMBER : 2.1033 (c)(10)
Annex B

TRANSISTOR, DIODE, AND IC FUNCTIONS
RULE PART NUMBER: 2.1033 c (10)
Annex E

FCC LABEL:
RULE PART NUMBER: 2.1033 c (11)
Annex C, section1

PHOTOGRAPHS:
RULE PART NUMBER: 2.1033 c (12)
Annex C, sections 2,3

.
TEST DATA Section Rule Part Number: 2.1033 (c)(14)

All applicable test data according to:
- -Part 2: 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, and 2.1057
- -Part 90, Subpart I: 90.209, 90.210, 90.211 and 90.213

are provided in next section of this Engineering Report

The following reports have been generated for FCC Certification of the Data Radio 806-824 MHz Transceiver/Modem/GPS, part number GPDD-6085-xyz. Unless otherwise noted, all of the measurements were conducted following the procedures set forth in the TIA/EIA-603 standards.

NAME OF TEST:
Transmitter Rated Power Output

RULE PART NUMBER: 2.1033 c (6)(7) and 2.1046 (a)

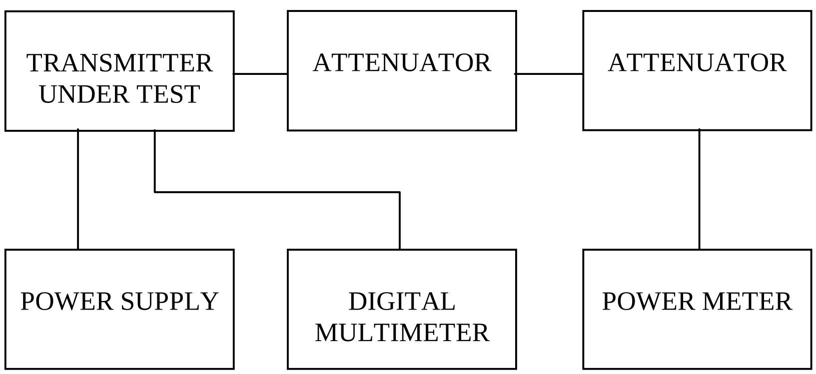
TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT:
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6024A
Power Meter, HP 436A

PERFORMED BY: Allen Frederick DATE: 11/12/99

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)
813	13.4	7.68	102.9	40.0
813	13.4	6.71	89.91	35.0
813	13.4	1.89	25.33	5.0

NAME OF TEST:
Transmitter Occupied Bandwidth

RULE PART NUMBER: 2.201, 2.202, 2.1033 c (14), 2.1049 (h), 2.1041

Emission Designator Determination

This radiomodem uses digital modulation signals, passing through a linear 8th order low-pass filter (Raise-Cosine alpha 1 approximation), to an FM transceiver. The necessary bandwidth calculation for this type of modulation (DRCMSK) is not covered by paragraphs (1), (2) or (3) from 2.202(c). Therefore, the approach outlined in (2.202(c)(4)) is applicable in this case.

The measurement explanations are provided in its "Annex" (following pages)

Necessary Bandwidth Measurement:

Peak deviation = ±4 kHz
Modulator signal bit rate 19200 bps,

Bn=14980 Hz
The corresponding emission designator prefix for necessary bandwidth = 15K0

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Table 1 - Measurements results for the Gemini unit: bit rates (9600 bps BT=.3 , 16000bps BT=.4 and 19200 bps BT= .3) and frequency deviations settings vs. necessary bandwidth values .

unit's software settings	measured data (kHz)		Emission designator
bit rate (data settings)	freq. dev	99% occupied BW	
9600 BT= .3	2.5	8.54 KHz	8K60
16000 BT= .4	4.0	15.26 KHz	15K3
19200 BT= .3	4.0	14.98 KHz	15K0

****

Spectrum efficiency: 4800 bits per second per 6.25 kHz of channel bandwidth.
19200bps=4*4800bps, meets efficiency requirement for 25 kHz channel
9600bps=2*4800bps, meets efficiency requirement for 12.5 kHz channel

ANNEX

Occupied Bandwidth Measurement

Theory of Measurement

The way to define the ***Occupied Bandwidth*** is “the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission” (FCC 2.202), so the mathematics for it are:

$$0.005*TP=P_{(f1)}=\int_0^{f1} PSD_{(f)}df$$

$$0.995*TP=P_{(f2)}=\int_0^{f2} PSD_{(f)}df$$

$$OBW=f2-f1$$

where TP (total mean power) is

$$TP=\int_0^{+\infty} PSD_{(f)}df =(1/t)\int_{-\infty}^{+\infty} |z_{(t)}|^2dt$$

and PSD (power spectral distribution) is

$$PSD_{(f)}=|Z_{(f)}|^2+|Z_{(-f)}|^2 \qquad 0\leq f<4$$

and expresses the positive frequency representation of the transmitter output power for z(t) signal.

By applying these mathematics to the measurements, it is possible to measure the Occupied Bandwidth using the RF signal’s trace provided by a digital spectrum analyzer and processed further by computational methods.

The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a computational part related to measured trace.

Getting an equally-sampled RF power spectrum profile requires a Digital Spectrum Analyzer. In addition to the instrument’s usual requirements, a special attention must be paid to the analyzer’s span (bandwidth to be investigated).

This bandwidth must be large enough to contain all the power spectral components created by the transmitter. The frequency step, where the samples are picked, is directly dependent on the span’s value.

Δf= span/number of points displayed

The frequency resolution will determine the measurement accuracy. So for greater accuracy, less bandwidth will give better values because of the constant number of points that can be displayed. Taking into account the purpose of transmitter, an acceptable balance can be set. For channel-limited transmitters all the power spectral components can be found in main channel and a number of adjacent channels, upper and lower, from the main channel. The relation between these two requirements, number of channels and accuracy, is depicted by:

$a(\%) \cong (2*k*n/N)*100$,

where a is desired accuracy, in percentage units, n is the number of channels in span, including main channel, N is displayed number of points and k= (authorized bandwidth) /channel bandwidth.

For usual spectrum analyzers N≅500, k=0.8 (20/25) for 25kHz channel transmitters or k=0.9 (11.25/12.5) for 12.5kHz channel transmitters, so a ≅ n/2.5 (%) can estimate the expected precision for measurement.

All other requirements for spectrum analyzer are the same as they are for mask compliance determination.

The second part has computational requirements related to the trace's values processing.

The following operations must be performed over the trace's (x,y) points:

1. convert y value in dBm (or the analyzer's display y units) units power sample
2. convert y value in W units power sample,
3. add to total power every power sample and get total power value (W units for total power)
4. set low level (0.5%*total power)
5. detect x1-sample which pass low level (convert f1 integrals to sample summing)
6. convert (x1-1)-sample value in frequency units (the x-sample is already in occupied bandwidth),
7. store first frequency correspondent to (x1-1)-sample
8. set up level (99.5%*total power)
9. detect x2-sample which pass up level (convert f2 integrals to sample summing)
10. convert (x2)-sample value in frequency units (the x-sample is now out of occupied bandwidth),
11. store second frequency correspondent to (x2)-sample
12. read the frequency difference , this is ***Occupied Bandwidth***, and display the result.

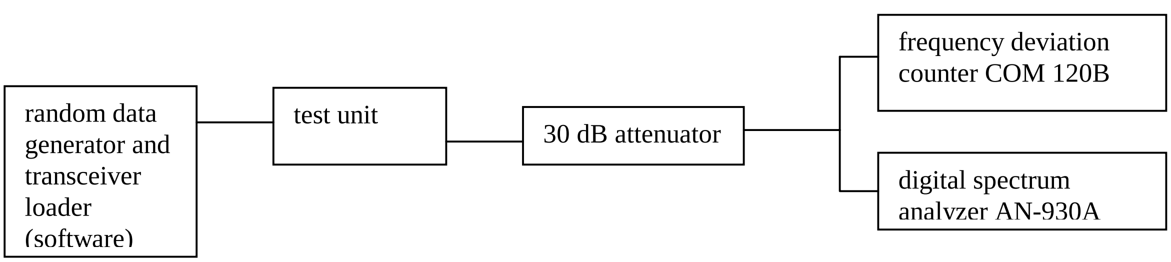
Standard calculation precision is all that is required. The main error factor being the y display resolution is covering calculation precision.

The absolute error for this measurement is -0/+2*)f. It is not possible to decrease span bandwidth under 2 channels bandwidth because this will affect the significance of result by cutting off the power's spectral distribution edges.

2. Dataradio's Measurement Set-Up

For the above requirements, the occupied bandwidth of a transmitter was measured using an IFR AN930 A spectrum analyzer having adequate macrofunction to perform computational part. The number of power spectrum samples (N) is 500. Because in test results frequency deviation was also a parameter, measurement instruments were completed with an IFR COM-120 B for frequency deviation determination.

The measurement set-up is:



The AN-930 A spectrum analyzer's parameters are adjusted as follow:
-total span is adjusted at 2.8*channel space this means 70 kHz for 25 kHz channel and 35 kHz for 12.5 kHz channel. This setting will result in frequency sample step (f) of 140 Hz for 25 kHz channel and 70 Hz for 12.5 kHz channel.
-RBW is set to 300 Hz, this is better than 1% of total span bandwidth.
-video filter is set to 1Khz;
-all other parameter of the instrument are automatically adjusted to obtain calibrated measurements (sweep time 4s).

-central frequency and reference level are adjusted to the unmodulated carrier frequency and level.

The AN 930 A spectrum analyzer's Occupied Bandwidth macrofunction input parameters are:
-central frequency, same as above, the unmodulated carrier frequency.
-channel spacing, 25 kHz or 12.5 kHz according to the signal,
-percentage of Occupied Bandwidth 99%.

The macro operations are:
-the trace is read;
-follow all the computational steps required.

Each sample is converted from dBm to mW and add to total power (tpow) variable. Then are computed the limits of 0.5% and 99.5% by using variable remaining percent (RemPer), and in same time are stored sample number where these two percentage meet. Then are assigned to the markers the correspondent frequencies of numbers.

- Occupied Bandwidth is then displayed as Delta mode marker (difference between markers).
-return to operational mode.

NOTE 1: The computational part could be performed on every device featured with data acquisition.
NOTE 2: An approximation of the occupied bandwidth calculation can be performed by measuring at the points at which the spectrum, measured with a spectrum analyzer of 300 Hz resolution bandwidth, is 25dB down relative to the unmodulated carrier reference level.

Using this same measurement procedure the occupied bandwidth was determined for 16000bps and 9600bps.

NAME OF TEST: Transmitter Occupied Bandwidth
GEMINI Modem at 9600 bps
In Support of Emission Designator **8K60F1D**

RULE PART NUMBER: 2.201, 2.202, 2.1033 c (14), 2.1049 (h), 2.1041, 90.209 (b)(5), 90.210 (H)

MINIMUM STANDARD: Mask H
Sidebands and Spurious [Rule 90.210 (h)]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]

Fo to 4.0 kHz	Attenuation = 0 dB.
>4.0 kHz to 8.5 kHz	Attenuation= 107*log(f_d KHz /4) dB
>8.5 kHz to 15 kHz	Attenuation= 40.5*log(f_d KHz /1.16) dB
>15 kHz to 25 kHz	Attenuation= 116*log(f_d KHz /6.1) dB
>25 kHz	Attenuation = 43+10*log(P) dB

Corner Points:

Fo to 4.0 kHz	Attenuation = 0 dB.
>4.0 kHz to 8.5 kHz	Attenuation= 0 dB to 35 dB
>8.5 kHz to 15 kHz	Attenuation= 35 dB to 45 dB
>15 kHz to 25 kHz	Attenuation= 45 dB to 71.1 dB
>25 kHz	Attenuation = 44.6 dB (40 Watts)
	Attenuation = 43.7 dB (5 Watts)

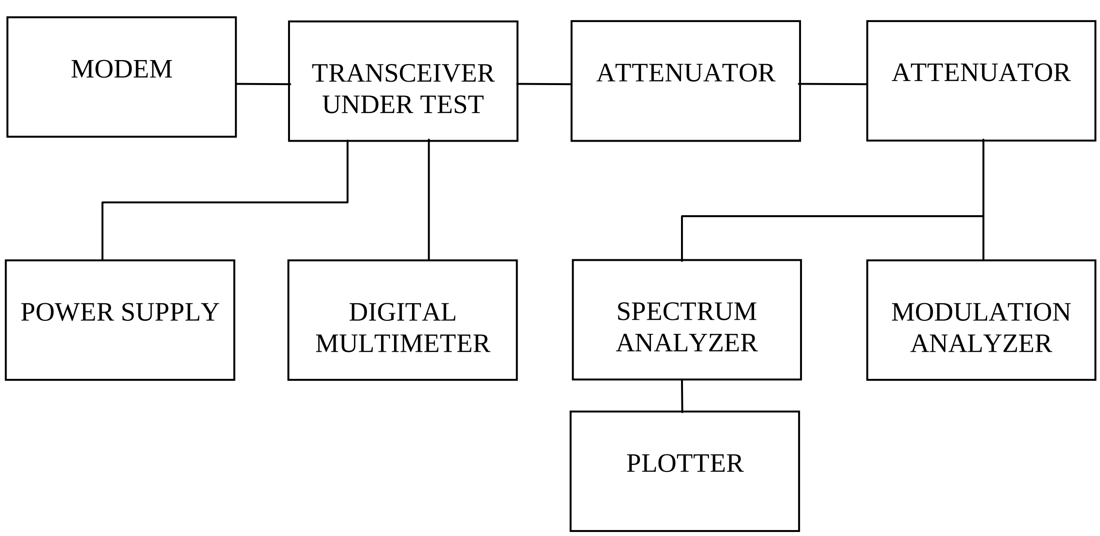
TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6024A
Modulation Analyzer, Model HP8901A
Spectrum Analyzer, Model HP8563E
Plotter, HP7470A

PERFORMED BY: Allen Frederick DATE: 11/12/99
Allen Frederick

TEST SET-UP:



NAME OF TEST: Transmitter Occupied Bandwidth (Continued)
GEMINI Modem at 9600 bps
In Support of Emission Designator **8K60F1D**

MODULATION SOURCE DESCRIPTION:

The Gemini/PD modem generates Differential Gaussian Frequency Shift Keying (DGFSK). This digital modulation scheme is produced by the main CPU in conjunction with the DSP processor.

The main CPU processes incoming binary data, applying Forward Error Correction (FEC), interleaving and scrambling, from it, generates an NRZ signal that is fed to the DSP processor for encoding and pulse shaping. That digital signal is digitally filtered (Gaussian pulse shaping) by the DSP then fed to the CODEC for digital to analog conversion. This DGFSK waveshape applied to the FM modulator will then produce a compact RF spectrum, when using proper frequency deviation, to fit inside the restrictive masks inherent to the intended channel bandwidth.

The transmitter deviation level and digital filter cutoff frequency (which is based on the Gaussian “Bt” factor) are set according to the bit rate selected and channel bandwidth as follows:

Bit rate	Bt factor	Deviation	Occupied Bandwidth
9600 b/s	.3	± 2.5 KHz	8.6 KHz
16000 b/s	.4	± 4.0 KHz	15.3 KHz
19200 b/s	.3	± 4.0 KHz	15.0 KHz

TX Data Test Pattern:

The transmit “test data” pattern command produces a 2047 bit pseudo-random pattern. This pattern is generated by the internal software using the polynomial $X^{11}+X^{9}+1$ form and a 12-bit shift register. Initial value of the register is 111111111110 (FFE hex). The 2047 bit sequence is repeated thereafter as long is necessary to complete the test duration (55 sec). This pattern is applied to the DSP processor data input for encoding and pulse shaping as described above.

NECESSARY BANDWIDTH (Bn) CALCULATION

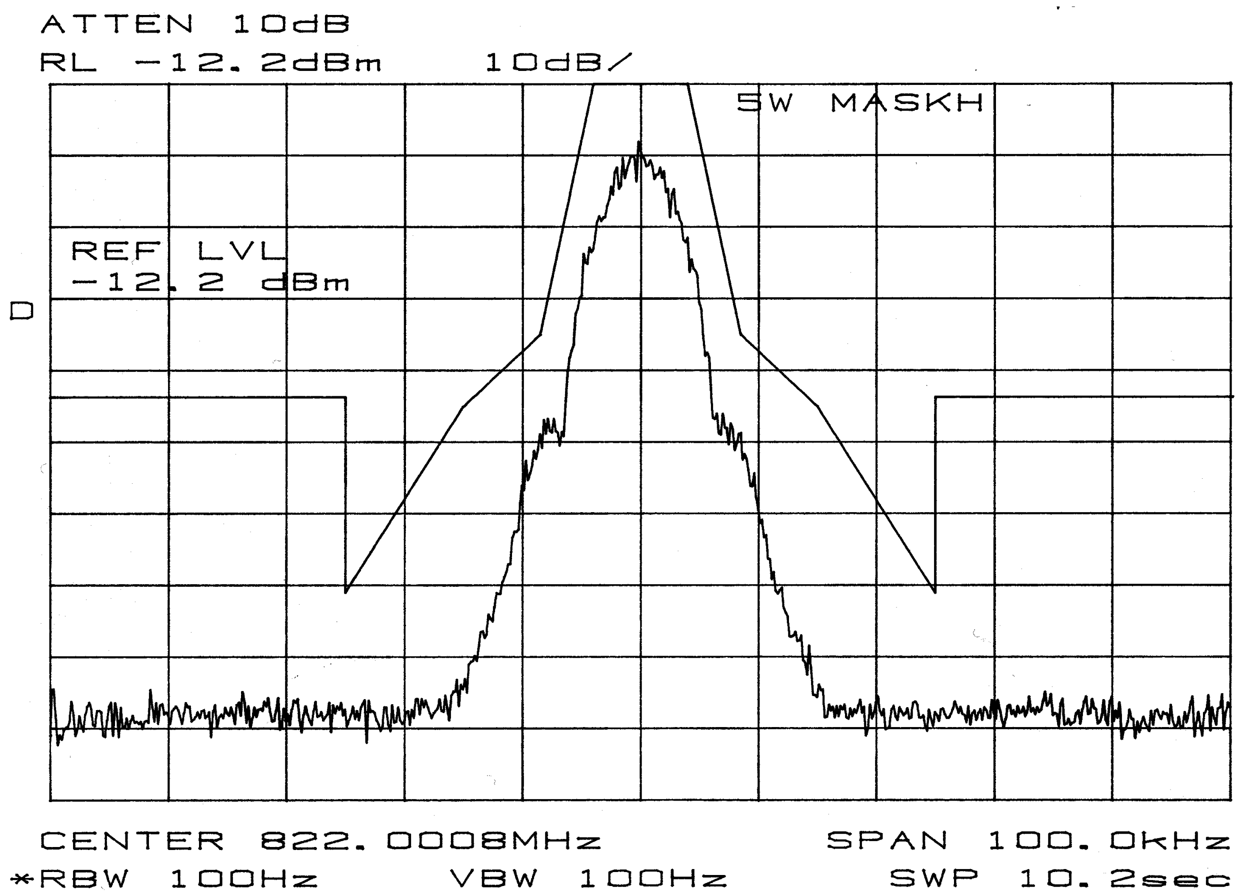
See Page 10 for emission designator determination.

The corresponding emission designator prefix for necessary bandwidth = **8K60**

TEST DATA: Refer to the following graphs:

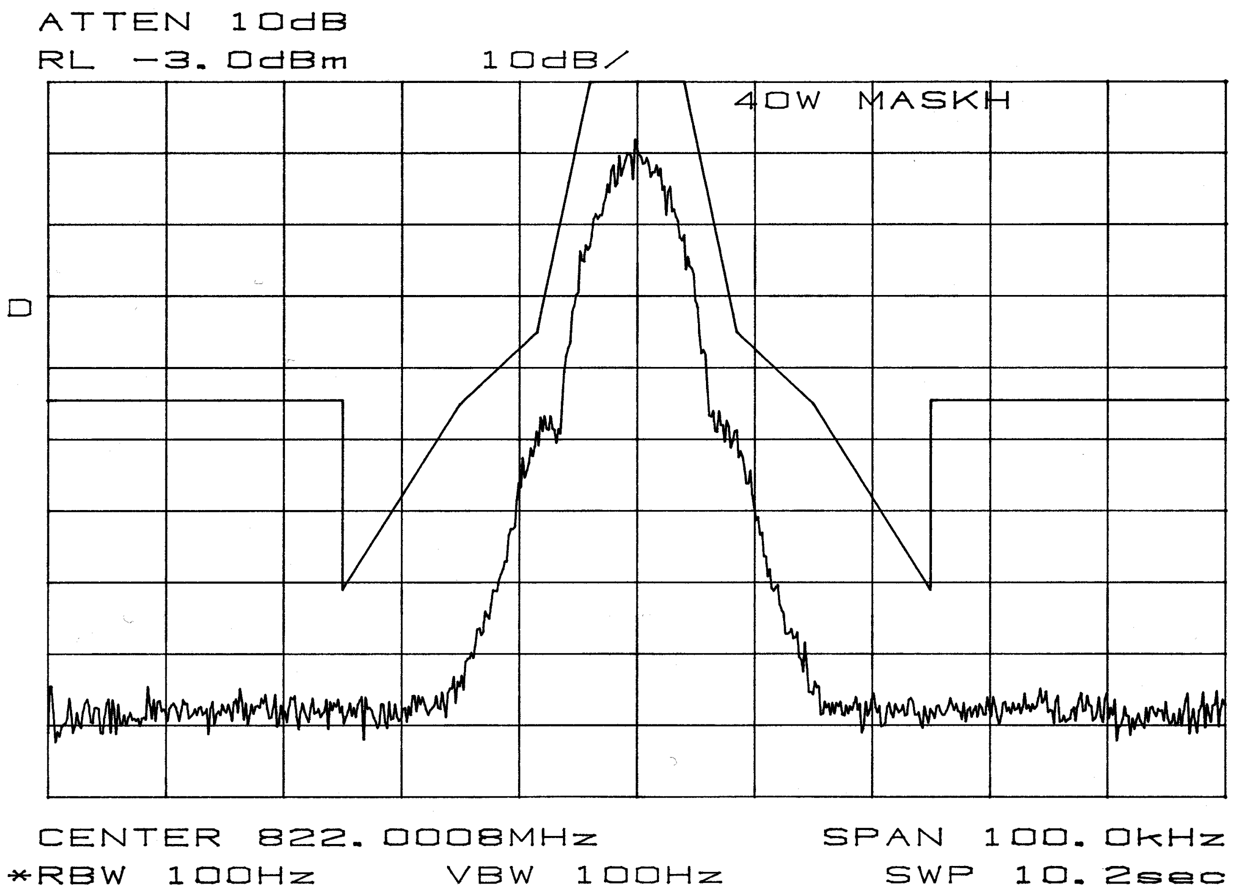
MASK: H , 8K60F1D, 5W

SPECTRUM FOR EMISSION **8K6F1D**
OUTPUT POWER: 5 Watts
9600 bps
PEAK DEVIATION = 2500 Hz
SPAN = 100 kHz



MASK: H , 8K60F1D, 40W

SPECTRUM FOR EMISSION **8K60F1D**
OUTPUT POWER: 40 Watts
9600 bps
PEAK DEVIATION = 2500 Hz
SPAN = 100 kHz



NAME OF TEST:	Transmitter Occupied Bandwidth GEMINI Modem at 16000 bps In Support of Emission Designator **15K3F1D**
RULE PART NUMBER:	2.201, 2.202, 2.1033 c (14), 2.1049 (h), 2.1041, 90.209 (b)(5), 90.210 (g)
MINIMUM STANDARD:	Mask G Sidebands and Spurious [Rule 90.210 (g)] Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]

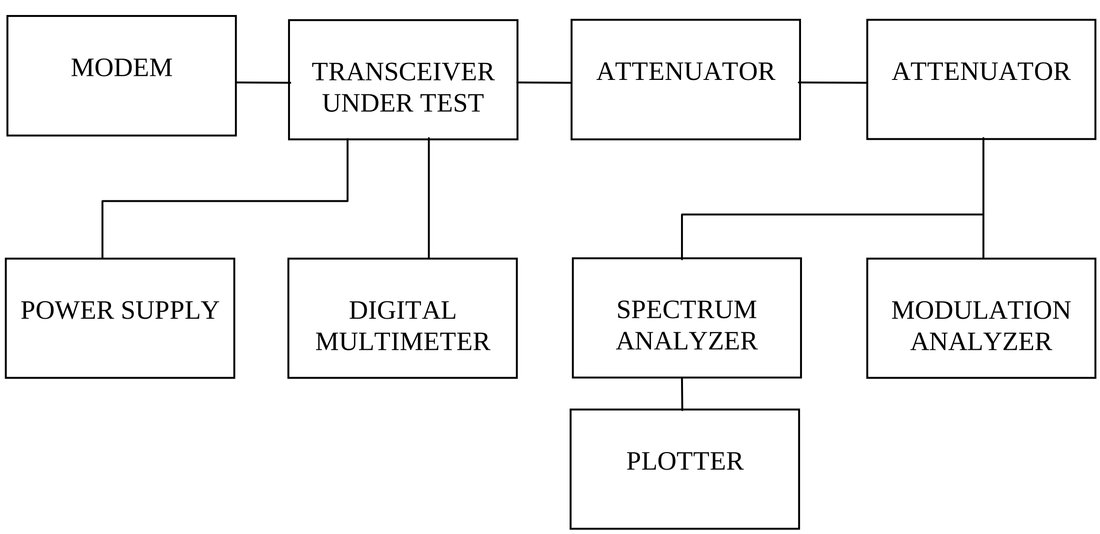
Fo to 5.0 kHz	Attenuation = 0 dB
>5.0 kHz to 10.0 kHz	Attenuation= 83*log(f_d KHz /5) dB
>10.0 kHz to 250% Auth BW	Attenuation = Lesser of: 116*log(f_d KHz /6.1) dB, 50+10$\log_{10}$(P) OR 70 dB
>250% Auth BW	43 + 10*log(P) dB
Corner Points:	
Fo to 5.0 kHz	Attenuation = 0 dB
>5.0 kHz to 10.0 kHz	Attenuation= 0 dB to 25 dB
>10.0 kHz to 22.61 KHz	Attenuation = 24.9 dB to 66 dB (40 Watts)
>10.0 kHz to 18.91 KHz	Attenuation = 24.9 dB to 57 dB (5 Watts)
>250% Auth BW	Attenuation = 59 dB (40 W), 50 dB (5 W)

TEST RESULTS:	Meets minimum standard (see data on the following pages)
TEST CONDITIONS:	Standard Test Conditions, 25 C
TEST EQUIPMENT:	Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt Digital Voltmeter, Fluke Model 8012A DC Power Source, Model HP6024A Modulation Analyzer, Model HP8901A Spectrum Analyzer, Model HP8563E Plotter, HP7470A

PERFORMED BY: Allen Frederick (signed) DATE: 11/12/99

Allen Frederick

TEST SET-UP:



NAME OF TEST: Transmitter Occupied Bandwidth (Continued)
GEMINI Modem at 16000 bps
In Support of Emission Designator **15K3F1D**

MODULATION SOURCE DESCRIPTION:

The Gemini/PD modem generates Differential Gaussian Frequency Shift Keying (DGFSK). This digital modulation scheme is produced by the main CPU in conjunction with the DSP processor.

The main CPU processes incoming binary data, applying Forward Error Correction (FEC), interleaving and scrambling, from it, generates an NRZ signal that is fed to the DSP processor for encoding and pulse shaping. That digital signal is digitally filtered (Gaussian pulse shaping) by the DSP then fed to the CODEC for digital to analog conversion. This DGFSK waveshape applied to the FM modulator will then produce a compact RF spectrum, when using proper frequency deviation, to fit inside the restrictive masks inherent to the intended channel bandwidth.

The transmitter deviation level and digital filter cutoff frequency (which is based on the Gaussian “Bt” factor) are set according to the bit rate selected and channel bandwidth as follows:

Bit rate	Bt factor	Deviation	Occupied Bandwidth
9600 b/s	.3	± 2.5 KHz	8.6 KHz
16000 b/s	.4	± 4.0 KHz	15.3 KHz
19200 b/s	.3	± 4.0 KHz	15.0 KHz

TX Data Test Pattern:

The transmit “test data” pattern command produces a 2047 bit pseudo-random pattern. This pattern is generated by the internal software using the polynomial $X^{11}+X^{9}+1$ form and a 12-bit shift register. Initial value of the register is 111111111110 (FFE hex). The 2047 bit sequence is repeated thereafter as long is necessary to complete the test duration (55 sec). This pattern is applied to the DSP processor data input for encoding and pulse shaping as described above.

NECESSARY BANDWIDTH (Bn) CALCULATION

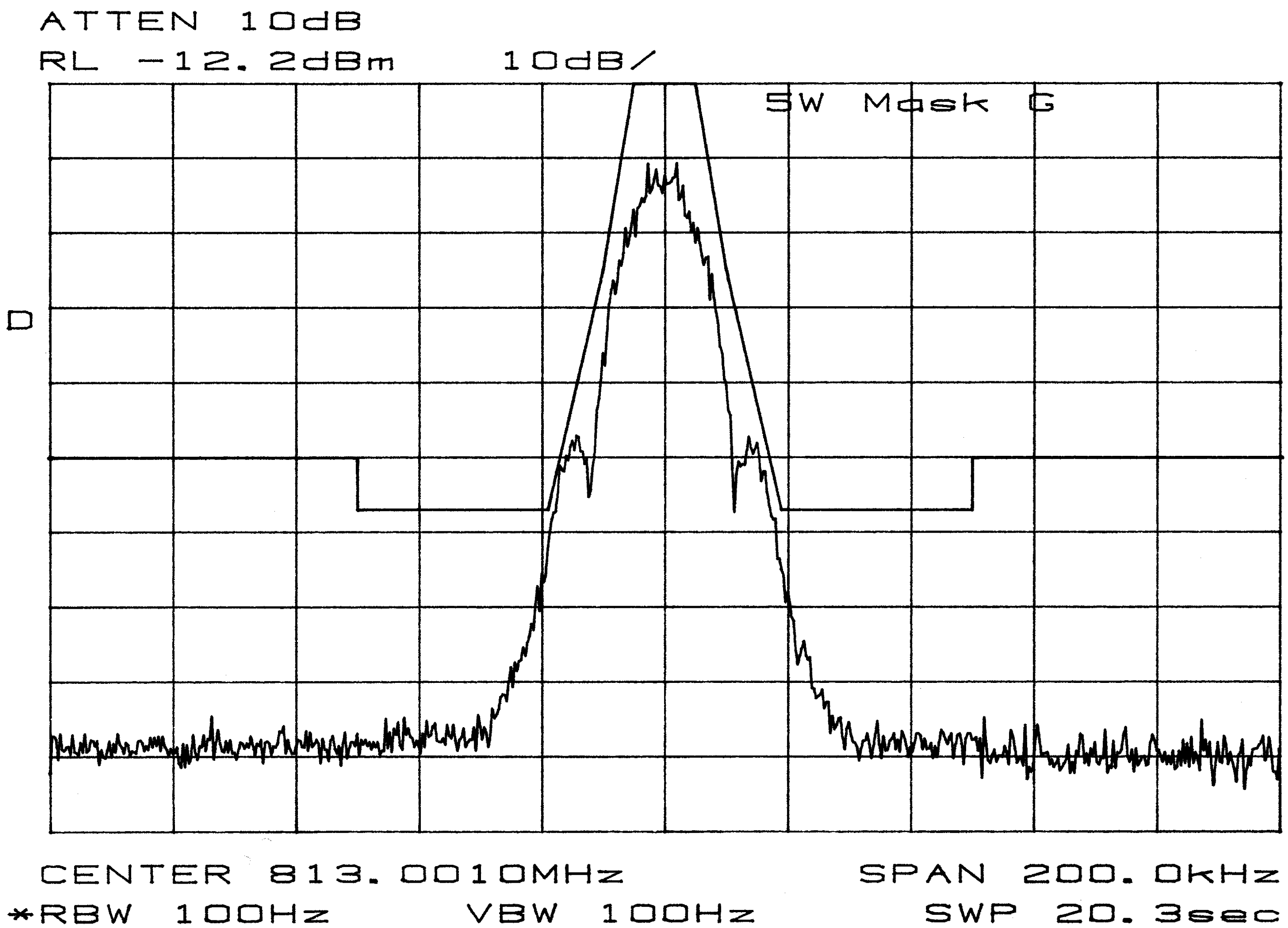
See Page 10 for emission designator determination.

The corresponding emission designator prefix for necessary bandwidth = **15K3**

TEST DATA: Refer to the following graphs:

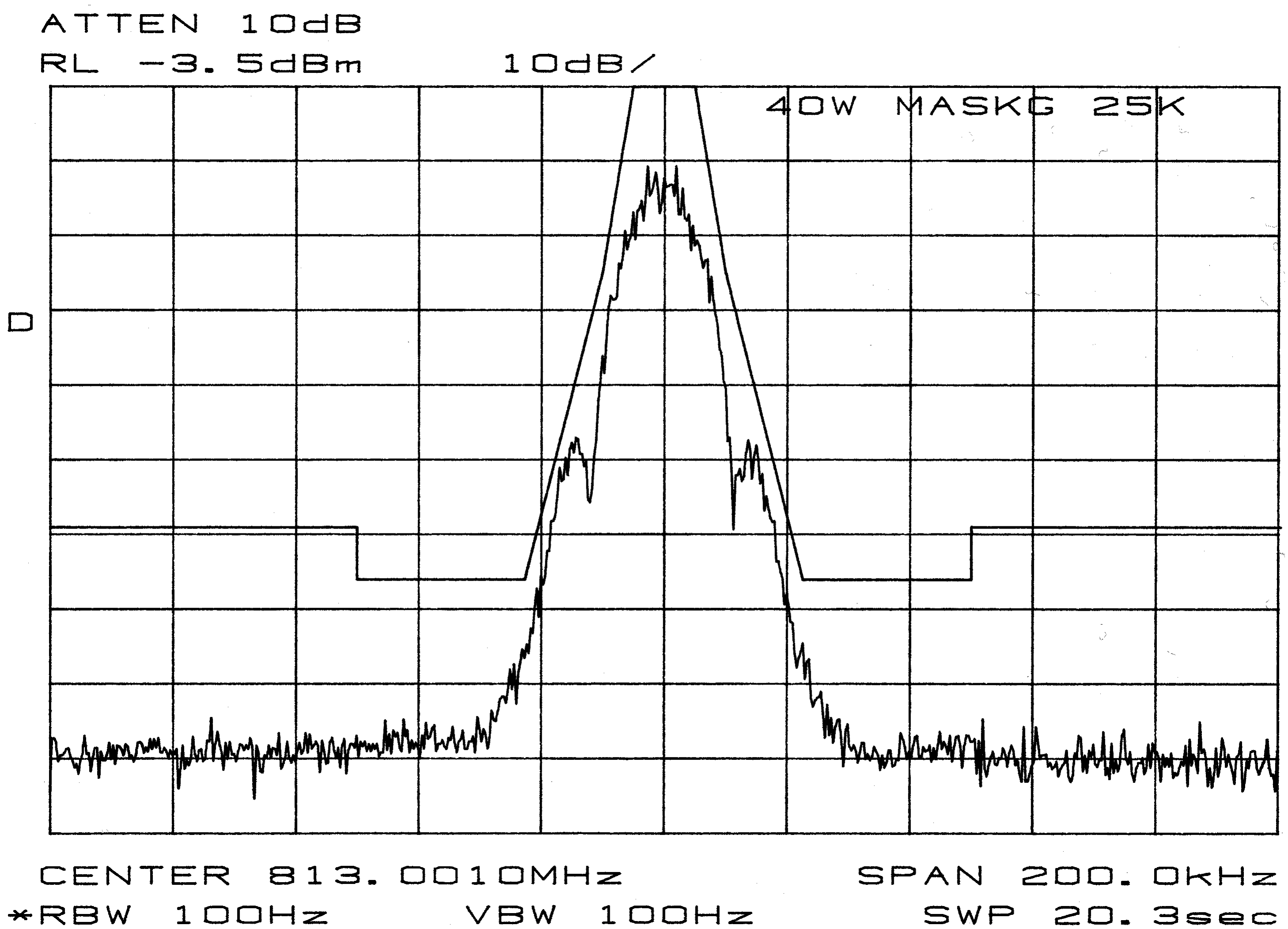
MASK: G , 15K3F1D, 5W

SPECTRUM FOR EMISSION **15K3F1D**
OUTPUT POWER: 5 Watts
16000 bps
PEAK DEVIATION = 4000 Hz
SPAN = 200 kHz



MASK: G, 15K3F1D, 40W

SPECTRUM FOR EMISSION **15K3F1D**
OUTPUT POWER: 40 Watts
16000 bps
PEAK DEVIATION = 4000 Hz
SPAN = 200 kHz



NAME OF TEST:	Transmitter Occupied Bandwidth GEMINI Modem at 19200 bps In Support of Emission Designator **15K0F1D**
RULE PART NUMBER:	2.201, 2.202, 2.1033 c (14), 2.1049 (h), 2.1041, 90.209 (b)(5), 90.210 (g)

MINIMUM STANDARD: Mask G
Sidebands and Spurious [Rule 90.210 (g)]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]

Fo to 5.0 kHz	Attenuation = 0 dB
>5.0 kHz to 10.0 kHz	Attenuation= 83*log(f_d KHz /5) dB
>10.0 kHz to 250% Auth BW	Attenuation = Lesser of: 116*log(f_d KHz /6.1) dB, 50+10$\log_{10}$(P) OR 70 dB
>250% Auth BW	43 + 10*log(P) dB

Corner Points:

Fo to 5.0 kHz	Attenuation = 0 dB
>5.0 kHz to 10.0 kHz	Attenuation= 0 dB to 25 dB
>10.0 kHz to 22.61 KHz	Attenuation = 24.9 dB to 66 dB (40 Watts)
>10.0 kHz to 18.91 KHz	Attenuation = 24.9 dB to 57 dB (5 Watts)
>250% Auth BW	Attenuation = 59 dB (40 W), 50 dB (5 W)

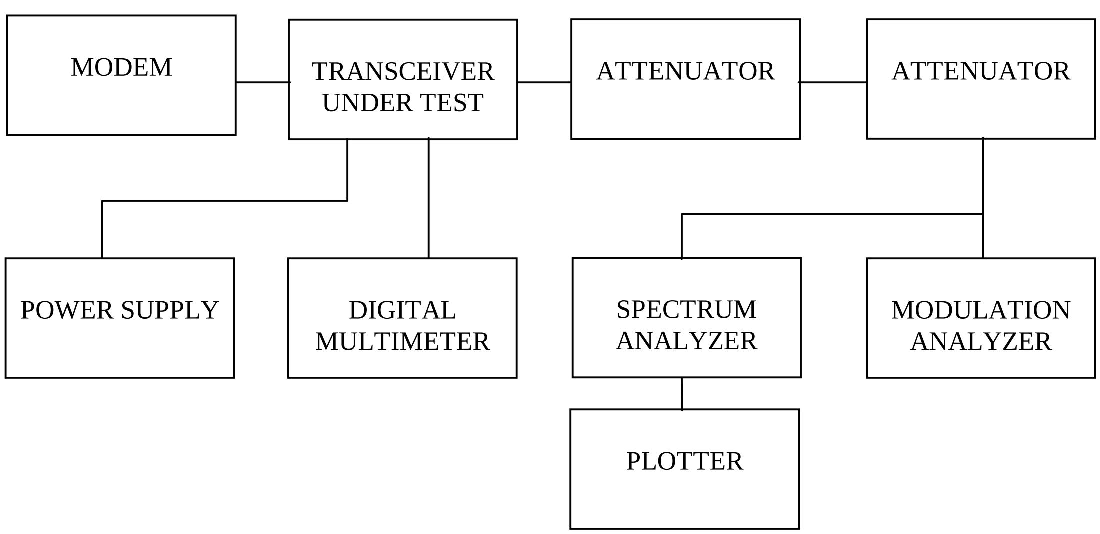
TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT:
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6024A
Modulation Analyzer, Model HP8901A
Spectrum Analyzer, Model HP8563E
Plotter, HP7470A

PERFORMED BY: ______________________ DATE: 11/12/99
Allen Frederick

TEST SET-UP:



NAME OF TEST: Transmitter Occupied Bandwidth (Continued)
GEMINI Modem at 19200 bps
In Support of Emission Designator **15K0F1D**

MODULATION SOURCE DESCRIPTION:

The Gemini/PD modem generates Differential Gaussian Frequency Shift Keying (DGFSK). This digital modulation scheme is produced by the main CPU in conjunction with the DSP processor.

The main CPU processes incoming binary data, applying Forward Error Correction (FEC), interleaving and scrambling, from it, generates an NRZ signal that is fed to the DSP processor for encoding and pulse shaping. That digital signal is digitally filtered (Gaussian pulse shaping) by the DSP then fed to the CODEC for digital to analog conversion. This DGFSK waveshape applied to the FM modulator will then produce a compact RF spectrum, when using proper frequency deviation, to fit inside the restrictive masks inherent to the intended channel bandwidth.

The transmitter deviation level and digital filter cutoff frequency (which is based on the Gaussian "Bt" factor) are set according to the bit rate selected and channel bandwidth as follows:

Bit rate	Bt factor	Deviation	Occupied Bandwidth
9600 b/s	.3	± 2.5 KHz	8.6 KHz
16000 b/s	.4	± 4.0 KHz	15.3 KHz
19200 b/s	.3	± 4.0 KHz	15.0 KHz

TX Data Test Pattern:

The transmit "test data" pattern command produces a 2047 bit pseudo-random pattern. This pattern is generated by the internal software using the polynomial $X^{11}+X^{9}+1$ form and a 12-bit shift register. Initial value of the register is 111111111110 (FFE hex). The 2047 bit sequence is repeated thereafter as long is necessary to complete the test duration (55 sec). This pattern is applied to the DSP processor data input for encoding and pulse shaping as described above.

NECESSARY BANDWIDTH (Bn) CALCULATION

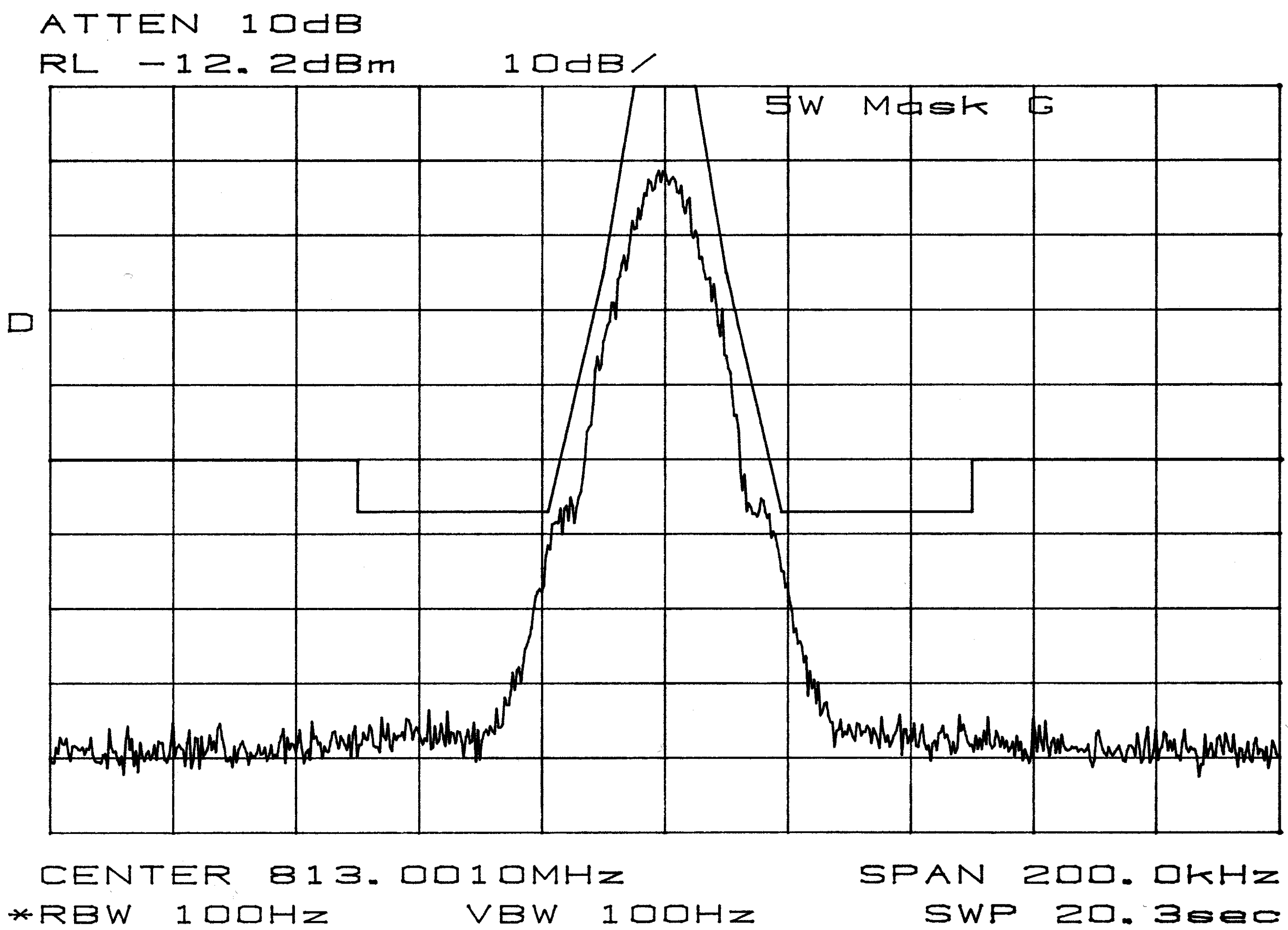
See Page 10 for emission designator determination.

The corresponding emission designator prefix for necessary bandwidth = **15K0**

TEST DATA: Refer to the following graphs:

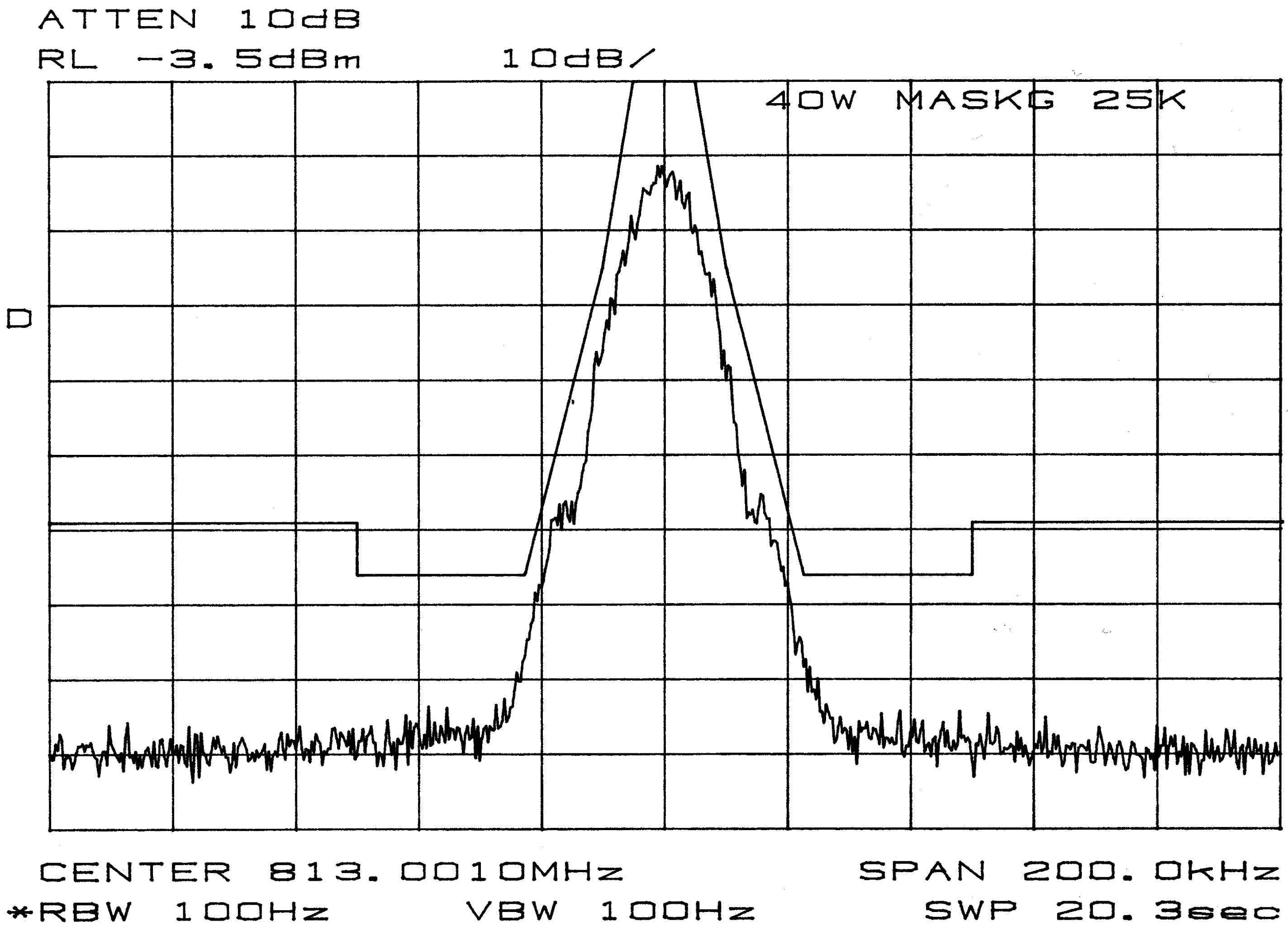
MASK: G, 15K0F1D, 5W

SPECTRUM FOR EMISSION **15K0F1D**
OUTPUT POWER: 5 Watts
19200 bps
PEAK DEVIATION = 4000 Hz
SPAN = 200 kHz



MASK: G , 15K0F1D, 40W

SPECTRUM FOR EMISSION **15K0F1D**
OUTPUT POWER: 40 Watts
19200 bps
PEAK DEVIATION = 4000 Hz
SPAN = 200 kHz



NAME OF TEST:
Transmitter Spurious and Harmonic Outputs

RULE PART NUMBER: 2.1033 c (14), 2.1041, 2.1051, 90.210 (d)(3)

MINIMUM STANDARD: For 40 Watt:
$50+10\text{Log}_{10}(40 \text{ Watts}) = 66$ dBc
or 70 dBc whichever is the lesser attenuation.
For 5 Watt:
$50+10\text{Log}_{10}(5 \text{ Watts}) = 57$ dBc
or 70 dBc whichever is the lesser attenuation.

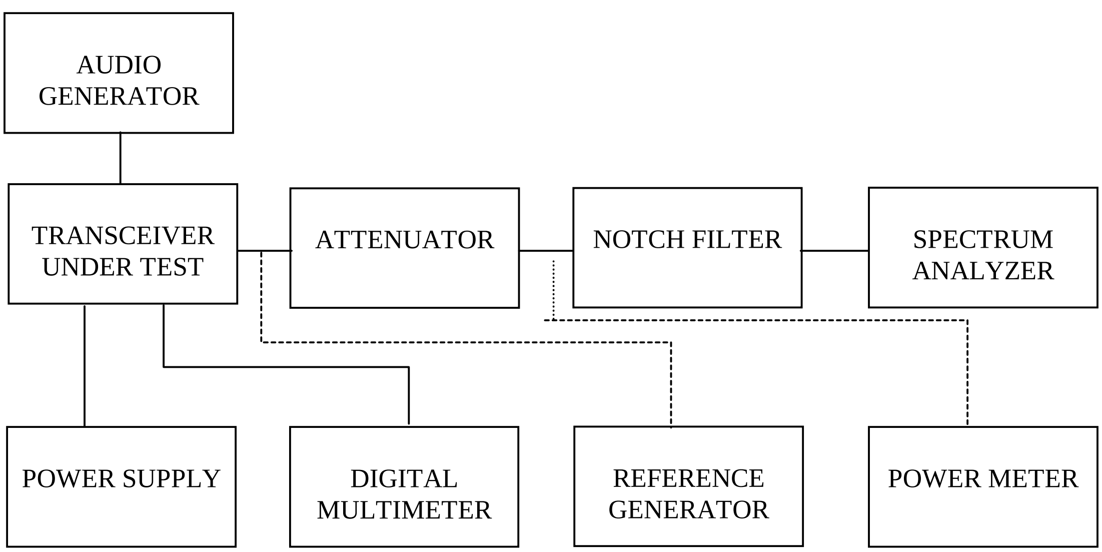
TEST RESULTS: Meets minimum standard (see data on the following page)

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

TEST PROCEDURE: TIA/EIA - 603, 2.2.13

TEST EQUIPMENT:
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Digital Voltmeter, Fluke Model 8012A
DC Power Source, Model HP6024A
Spectrum Analyzer, Model HP8563E
Plotter, HP7470A
Reference Generator, Model HP83732B
Power Meter, Model HP436A
Audio Generator, Model HP8903B

PERFORMED BY: ______________________ Date:11/11/99
Allen Frederick



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

MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 806 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: See following page.

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

Frequency:	806 MHz	Spec =	-66.0	dBc
Power:	40 Watts	Highest Spur =	-79.0	dBc
	46.0 dBm			

Relation to Fo	Spurious Level (dBm)	Path Loss (dB)	Substitution Generator (dBm)	Spurious Level dBc
2	-80.0	31.0	-49.0	95.0
3	-73.0	32.3	-40.7	86.7
4	-90.0	39.0	-51.0	97.0
5	-84.0	51.0	-33.0	79.0
6	-100.0	55.0	-45.0	91.0
7	-92.0	55.0	-37.0	83.0
8	-118.0	69.0	-49.0	95.0
9	-118.0	80.0	-38.0	84.0
10	-118.0	74.0	-44.0	90.0

Frequency:	806 MHz	Spec =	-57.0	dBc
Power:	5 Watts	Highest Spur=	-84.0	dBc
	37.0 dBm			

Relation to Fo	Spurious Level (dBm)	Path Loss (dB)	Substitution Generator (dBm)	Spurious Level dBc
2	-100.0	31.0	-69.0	115.0
3	-88.0	32.3	-55.7	101.7
4	-96.0	39.0	-57.0	103.0
5	-100.0	51.0	-49.0	95.0
6	-103.0	55.0	-48.0	94.0
7	-113.0	55.0	-58.0	104.0
8	-118.0	69.0	-49.0	95.0
9	-118.0	80.0	-38.0	84.0
10	-118.0	74.0	-44.0	90.0

NAME OF TEST:
Field Strength of Spurious Radiation

RULE PART NUMBER: 2.1033 c (14), 2.1041, 2.1053, 90.210 (d)(3)

MINIMUM STANDARD: For 40 Watts: $50+10Log_{10}(40) = 66$ dBc
For 5 Watts: $50+10Log_{10}(5) = 57$ dBc

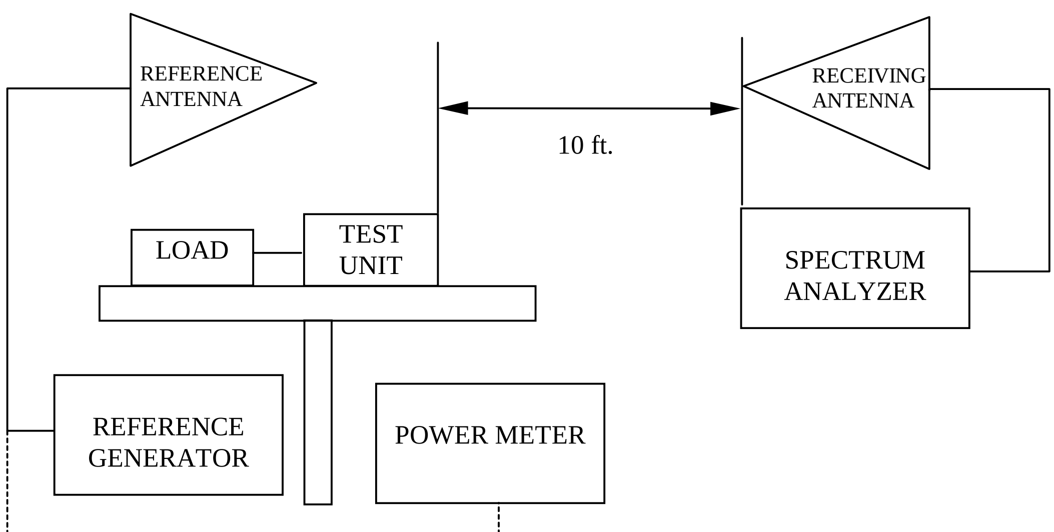
TEST RESULTS: Meets minimum standard (see data on the following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
TEST PROCEDURE: TIA/EIA - 603, 2.2.12

TEST EQUIPMENT:
Log Spiral Antenna, Model 93491-2
Horn Antenna, Model EMCO 3115
Reference Generator, Model HP83732A
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Spectrum Analyzer, Model HP8563E
Power Meter, Model HP436A
Power Supply, Model HP-6024A

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

TEST SET-UP:



PERFORMED BY: Allen Frederick DATE: 11/10/99

NAME OF TEST: Spurious Radiation Attenuation (Continued)

Frequency: 806 MHz
Power: 40 Watts
46.0 dBm

Spec = -66.0 dBc
Highest Spur = -71.3 dBc

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
1612	H	-73.0	-31.0	6.67	1.20	3.0	-85.5
	V	-67.0	-26.0	6.67	1.20	3.0	-80.5
2418	H	-70.0	-23.0	7.80	1.20	3.0	-78.6
	V	-70.0	-21.0	7.80	1.20	3.0	-76.6
3224	H	-67.0	-14.0	9.50	1.20	3.0	-71.3
	V	-68.0	-14.0	9.50	1.20	3.0	-71.3
4030	H	-85.0	-25.0	12.50	1.20	3.0	-85.3
	V	-78.0	-19.0	12.50	1.20	3.0	-79.3
4836	H	-84.5	-21.5	12.80	1.20	3.0	-82.1
	V	-83.0	-21.0	12.80	1.20	3.0	-81.6
5642	H	-94.0	-28.0	13.80	1.20	3.0	-89.6
	V	-92.0	-27.0	13.80	1.20	3.0	-88.6
6448	H	-99.0	-29.0	15.30	1.20	3.0	-92.1
	V	-96.0	-27.0	15.30	1.20	3.0	-90.1
7254	H	-101.0	-27.0	17.30	1.20	3.0	-92.1
	V	-95.0	-22.0	17.30	1.20	3.0	-87.1
8060	H	-102.0	-24.5	19.30	1.20	3.0	-91.6
	V	-94.0	-18.0	19.30	1.20	3.0	-85.1

Frequency: 806 MHz
Power: 5 Watts
37.0 dBm

Spec = -57.0 dBc
Highest Spur = -66.3 dBc

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
1612	H	-79.0	-37.0	6.67	1.20	3.0	-82.5
	V	-78.5	-37.5	6.67	1.20	3.0	-83.0
2418	H	-81.0	-34.0	7.80	1.20	3.0	-80.6
	V	-78.5	-29.5	7.80	1.20	3.0	-76.1
3224	H	-73.0	-20.0	9.50	1.20	3.0	-68.3
	V	-72.0	-18.0	9.50	1.20	3.0	-66.3
4030	H	-90.0	-30.0	12.50	1.20	3.0	-81.3
	V	-91.0	-32.0	12.50	1.20	3.0	-83.3
4836	H	-96.0	-33.0	12.80	1.20	3.0	-84.6
	V	-92.0	-30.0	12.80	1.20	3.0	-81.6
5642	H	-101.0	-35.0	13.80	1.20	3.0	-87.6
	V	-100.0	-35.0	13.80	1.20	3.0	-87.6
6448	H	-105.0	-35.0	15.30	1.20	3.0	-89.1
	V	-108.0	-39.0	15.30	1.20	3.0	-93.1
7254	H	-102.0	-28.0	17.30	1.20	3.0	-84.1
	V	-107.0	-34.0	17.30	1.20	3.0	-90.1
8060	H	-105.0	-27.5	19.30	1.20	3.0	-85.6
	V	-105.0	-29.0	19.30	1.20	3.0	-87.1

CALCULATIONS FOR FIELD STRENGTH OF SPURIOUS RADIATION TESTS:

The transmitter carrier frequency was set to 806.000 MHz. The reference oscillator frequency of all of the transceivers is 17.50 MHz. The output of the transceivers was searched from 17.50 MHz to the tenth harmonic of the carrier frequencies. The tests were conducted with the transceiver/modem/GPS inside of the enclosure.

Because the antennas used for the measurements recorded above 1 GHz were not flat in gain and differed from a dipole, the generator output was corrected for gain at each spurious frequency. The cable loss in the measurements is the loss in the cable between the signal generator and the substitution antenna. An additional 3 dB correction was also made to the spurious responses measured above 1 GHz to correct for the 3 dB polarization loss in the reference path.

EXAMPLE:

At 1612 MHz (806 MHz tuned), 40 Watts and horizontal polarization.

r = Substitution Gen - Cable Loss   -31.0 - 6.67   = -37.67

R = Reference Generator (dBm)   -37.67

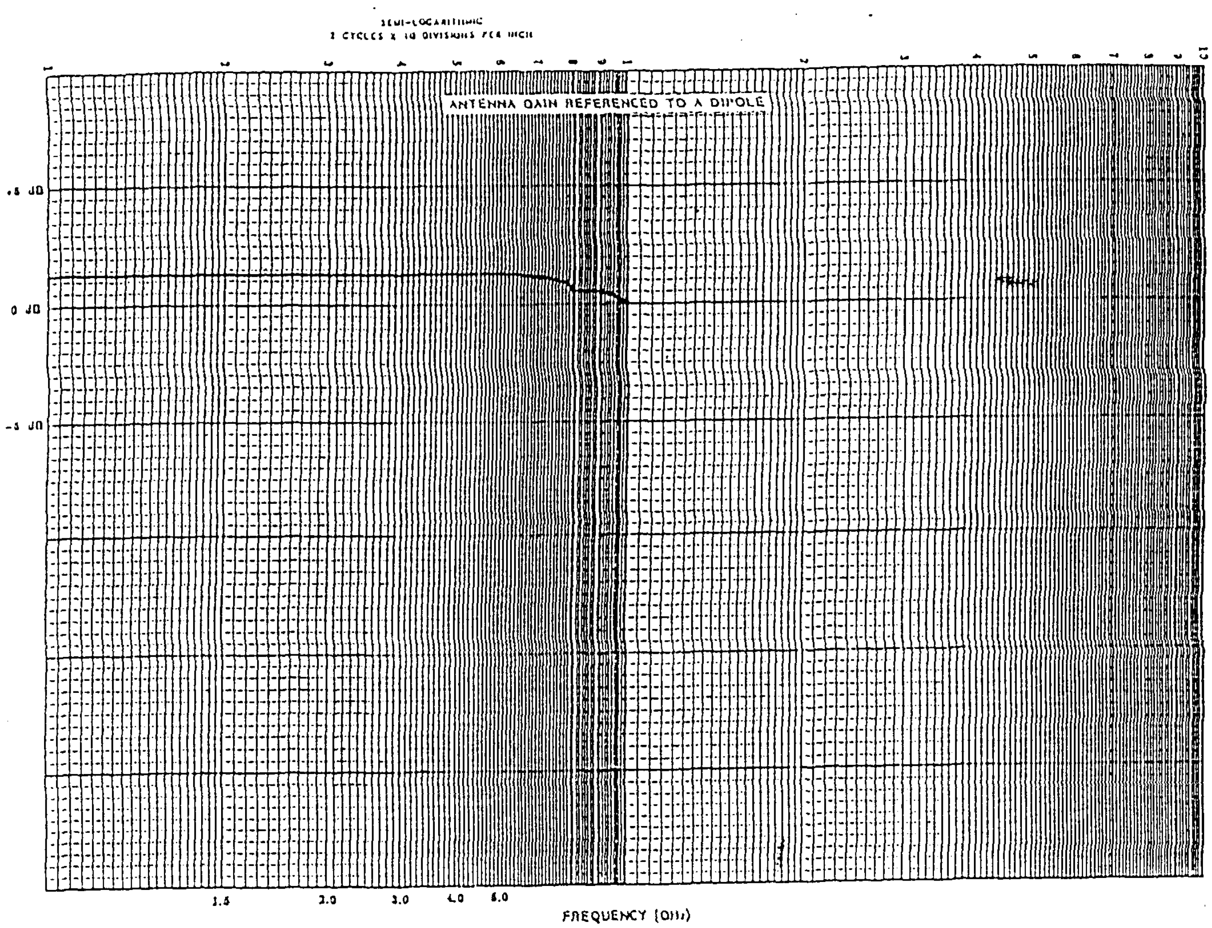
A = Antenna Gain (dB)   1.2

P = Polarization Correction Factor (dB)   3.0

R’ (Corrected Reference (dBm)) = R + A - P => -37.67+ 1.2 - 3.0 = -39.47 dBm

Po = Radiated Carrier Power (dBm)   40 Watts = 46.0 dBm

Radiated Spurious Emission (dBc) = Po - R’ => -39.47 - (+46.0) = **-85.47 dBc**



ANTENNA GAIN GRAPH OF SUBSTITUTION ANTENNA
REFERENCED TO A DIPOLE

NAME OF TEST:
Frequency Stability with Variation in Ambient Temperature

RULE PART NUMBER: 2.1033 c (14), 2.1041, 2.1055(a), 90.213 (a)

MINIMUM STANDARD: Shall not exceed ± 0.000150% from test frequency, or 1.50 ppm

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

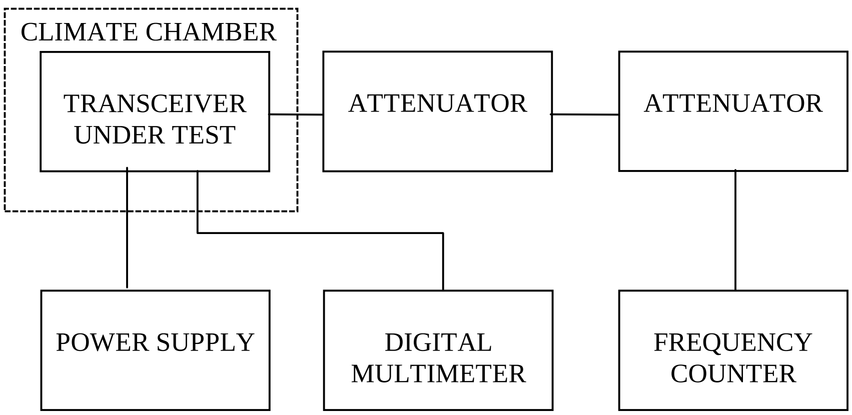
TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT:
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Frequency Counter, HP 5383A
Digital Voltmeter, Model HP6656A
DC Power Source, Model HP6656A
Climate Chamber, TempGard III, Tenney Jr.

PERFORMED BY: Allen Frederick DATE: 11/18/99

Allen Frederick

TEST SET-UP:

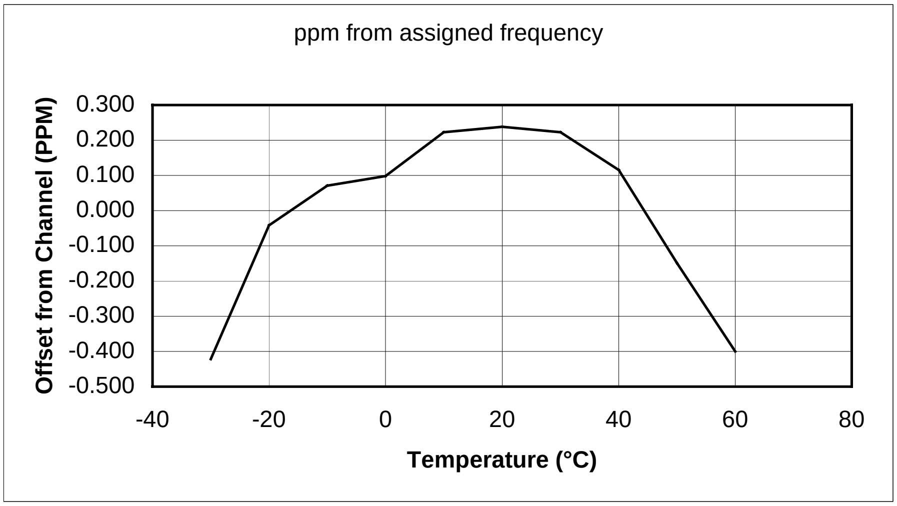


(Test data on next page)

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

Specification: 1.5 ppm
Greatest Variation: -0.422 ppm

806	Frequency (MHz)	Freq. Delta (Hz)	ppm from assigned frequency
-30	805.999660	-340.15998	-0.422
-20	805.999966	-33.880001	-0.042
-10	806.000057	57.46666	0.071
0	806.000079	78.9599919	0.098
10	806.000179	179.262208	0.222
20	806.000192	191.799985	0.238
30	806.000179	179.262208	0.222
40	806.000093	93.28888	0.116
50	805.999880	-119.85333	-0.149
60	805.999678	-322.24887	-0.400



NAME OF TEST:
Frequency Stability with Variation in Supply Voltage

RULE PART NUMBER: 2.1033 c (14), 2.1041, 2.1055(d), 90.213 (a)

MINIMUM STANDARD: Shall not exceed ± 0.000150% from test frequency, 1.50 ppm for ±15% change in supply voltage

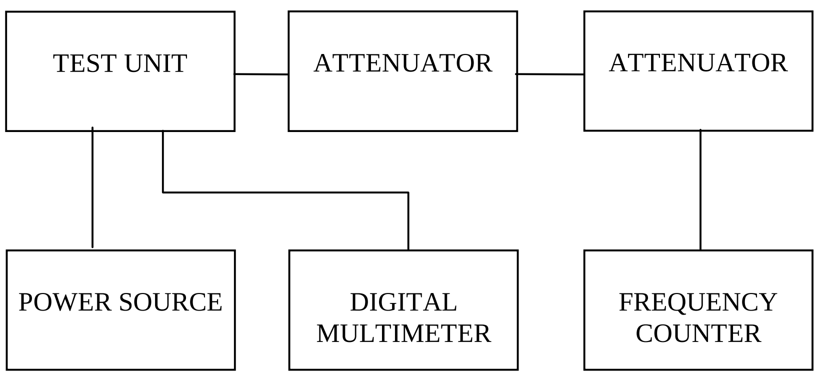
TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT:
Attenuator, BIRD Model / 100-A-MFN-20 / 20 dB / 100 Watt
Attenuator, BIRD Model / 50-A-MFN-03 / 3 dB / 50 Watt
Frequency Counter, HP 5383A
Digital Voltmeter, Model HP6656A
DC Power Source, Model HP6656A

PERFORMED BY: ______________________ DATE: 11/18/99
Allen Frederick

TEST SET-UP:



MEASUREMENTS TAKEN:

<u>1.5 ppm Reference Oscillator</u>

Specification: 1.5 ppm
Greatest Variation: 0.291 ppm

806	Frequency (MHz)	Freq. Delta % of assigned frequency)	Spec Limit (% of assigned frequency)	ppm from assigned frequency
10	806.000235	0.00003	0.00015	0.291
13	806.000233	0.00003	0.00015	0.289
16	806.000226	0.00003	0.00015	0.280