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FCC Part 90 Certification Application

FCC Form 731

For The

Guardian
UHF RADIO MODEM

FCC ID: NP4-5046-300

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NAME OF TEST: Transmitter Rated Power Output

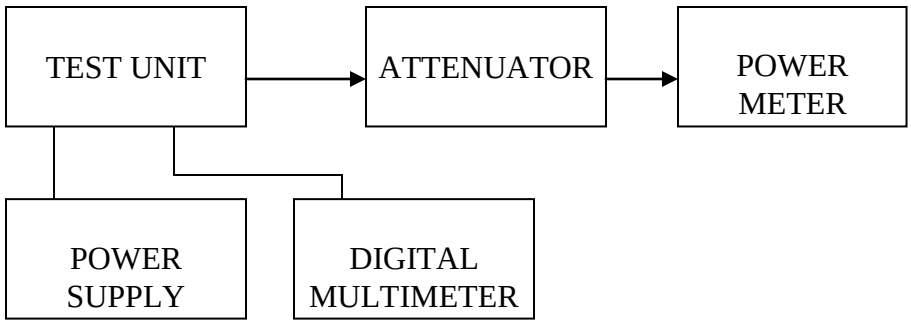
RULE PART NUMBER: 2.1046 (a) (c)

TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Attenuator, Bird 50-A-FFN-20 / 20 dB / 50 Watt
Power Supply, Instek Model GPS-3303
Digital Multimeter, Fluke 87
Power Meter, Model HP-8901B

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)
460.1	13.1	2.22	29.1	12.0
460.1	5.05	0.69	3.46	1.0

NAME OF TEST: Transmitter Spurious and Harmonic Outputs

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

MINIMUM STANDARDS: For 12 Watts: $50+10\text{Log}_{10}(12\text{ Watts}) = -60.8$ dBc
or -65dBc, whichever is the lesser attenuation.

For 1 Watt: $50+10\text{Log}_{10}(1\text{ Watt}) = -50$ dBc
or –70 dBc, whichever is the lesser attenuation.

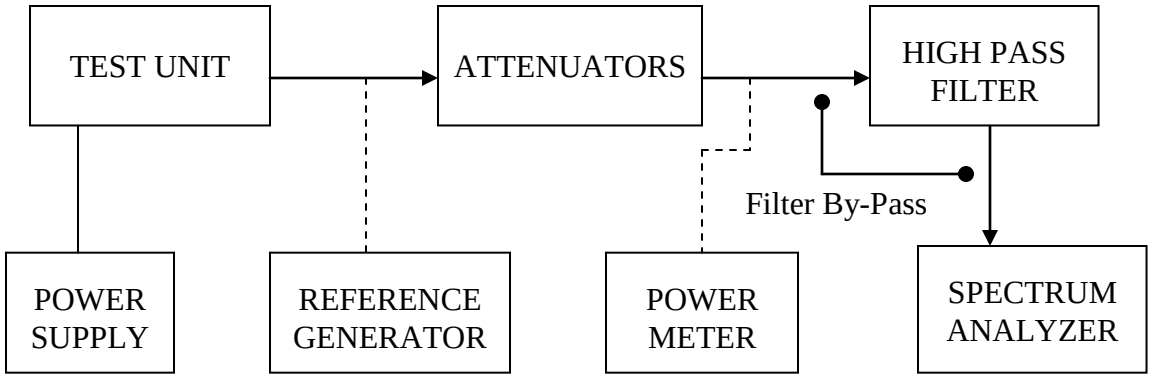
TEST RESULTS: Meets minimum standards (see data on following pages)

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

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Narda 765-10 / 10 dB / 50 Watts
50-Ohm Attenuator, Bird 10-A-MFN-10 / 10 dB / 10 Watts
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, HP-8563E
Reference Generator, Agilent E8257D
High Pass Filter, Mini Circuits VHF-740, Fc = 740 MHz

TEST SET-UP:



MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 406.100, 460.000, and 512.000. The reference oscillator frequency is 23.040 MHz. The power amplifier has voltage levels at 13.1 Volts and 5.05 Volts for 12 watts and 1 watt, respectively.
2. The carrier reference was established on the spectrum analyzer with the filter by-pass in place. Then the spectrum was scanned from DC to 2 Fc. Finally, the high pass filter was inserted to null the carrier fundamental and extend the range of the spectrum analyzer for harmonic measurements above 2 Fc.
3. At each spurious frequency, generation substitution was used to establish the true spurious level.
4. The spectrum was scanned to the 10^{th} harmonic of the highest internally generated frequency.

Tuned Frequency	406.1	MHz
Power	12	Watts
	40.8	dBm
Min. Specification	-60.8	dBc
Worse Case	-88	dBc

Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
812.2	2 fo	-100
1218.3	3 fo	-115
1624.4	4 fo	-117
2030.5	5 fo	-124
2436.6	6 fo	-124
2842.7	7 fo	-122
3248.8	8 fo	-88
3654.9	9 fo	-122
4061.0	10 fo	-141

Tuned Frequency	406.1	MHz
Power	1	Watt
	30.0	dBm
Min. Specification	-50.0	dBc
Worse Case	-94	dBc

Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
812.2	2 fo	-101
1218.3	3 fo	-116
1624.4	4 fo	-119
2030.5	5 fo	-129
2436.6	6 fo	-133
2842.7	7 fo	-130
3248.8	8 fo	-94
3654.9	9 fo	-138
4061.0	10 fo	-138

Tuned Frequency	460.1	MHz
Power	12	Watts
	40.8	dBm
Min. Specification	-60.8	dBc
Worse Case	-105	dBc

Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
920	2 fo	-138
1380	3 fo	-134
1840	4 fo	-106
2300	5 fo	-129
2760	6 fo	-131
3220	7 fo	-105
3680	8 fo	-115
4140	9 fo	-123
4600	10 fo	-138

Tuned Frequency	460.0	MHz
Power	1	Watt
	30.0	dBm
Min. Specification	-50.0	dBc
Worse Case	-109	dBc

Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
920	2 fo	-120
1380	3 fo	-127
1840	4 fo	-127
2300	5 fo	-127
2760	6 fo	-127
3220	7 fo	-109
3680	8 fo	-123
4140	9 fo	-127
4600	10 fo	-127

Tuned Frequency	512.0	MHz
Power	12	Watts
	40.8	dBm
Min. Specification	-60.8	dBc
Worse Case	-87	dBc

Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
1024	2 fo	-120
1536	3 fo	-116
2048	4 fo	-118
2560	5 fo	-128
3072	6 fo	-108
3584	7 fo	-91
4096	8 fo	-109
4608	9 fo	-106
5120	10 fo	-87

Tuned Frequency	512.0	MHz
Power	1	Watt
	30.0	dBm
Min. Specification	-50.0	dBc
Worse Case	-106	dBc

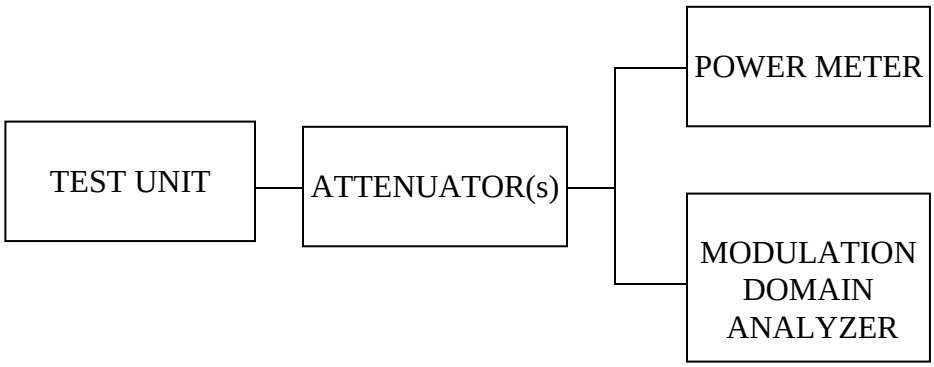
Spurious Frequency (MHz)	Relation to Carrier	Relative to Carrier (dBc)
1024	2 fo	-106
1536	3 fo	-114
2048	4 fo	-124
2560	5 fo	-126
3072	6 fo	-126
3584	7 fo	-126
4096	8 fo	-123
4608	9 fo	-126
5120	10 fo	-126

NAME OF TEST: Transient Frequency Behavior

RULE PART NUMBER: 90.214

MINIMUM STANDARD: 6.25 kHz channel (used worst case numbers from 406.1 to 512 MHz)

TIME INTERVAL	MAXIMUM FREQUENCY DIFFERENCE (kHz)	TIME (ms)
T1	+/- 6.25	10
T2	+/- 3.125	25
T3	+/- 6.25	10



TEST RESULTS: Meets minimum standards, see data on following pages

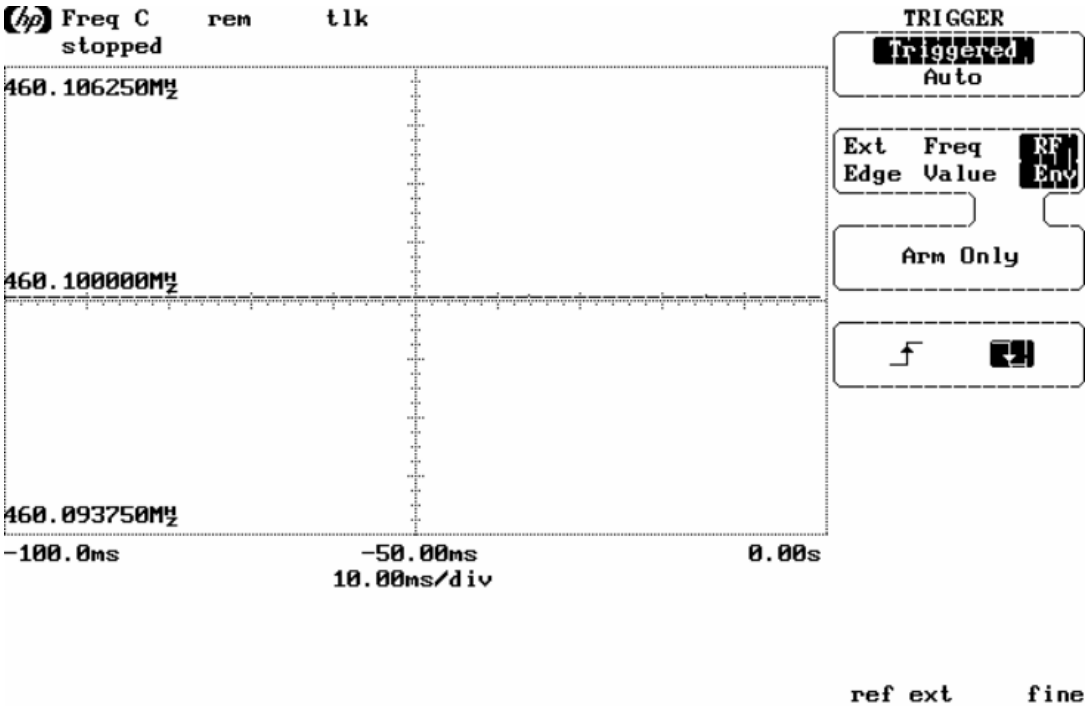
TEST CONDITIONS: RF Power Level = 12 Watts and 1.0 Watt
Standard Test Conditions, 25 C

TEST PROCEDURE: TIA/EIA – 603-C

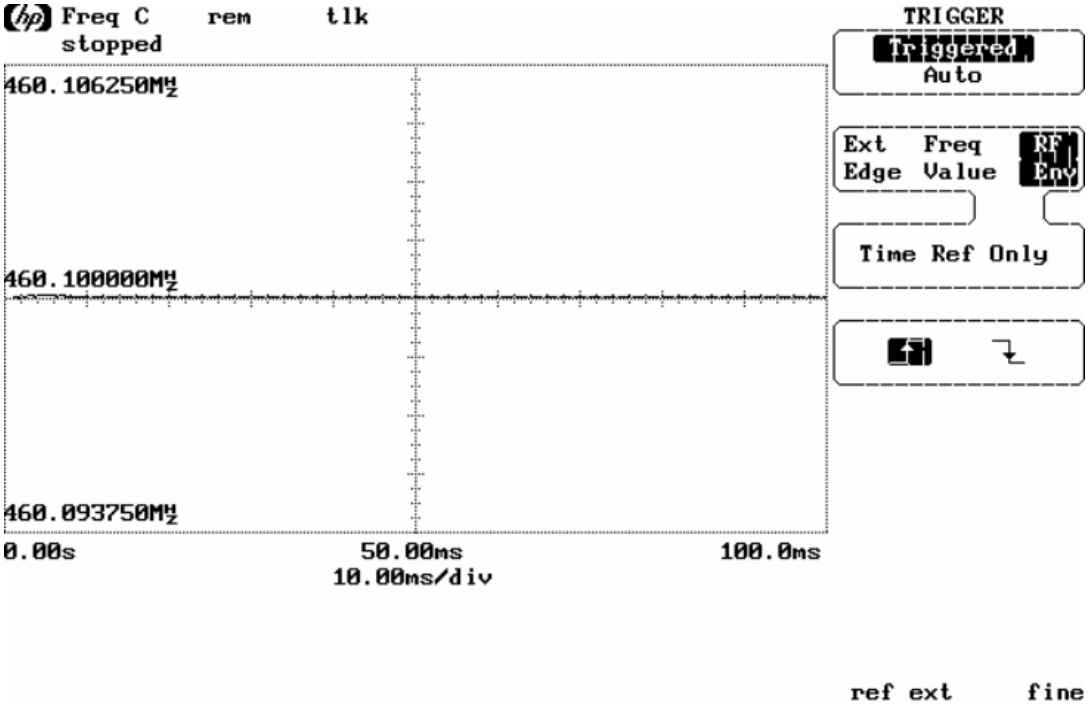
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
Power Supply, Instek Model GPS-2303
Modulation Domain Analyzer, HP-53310A
Power Meter, Model HP436
Signal Generator, Model HP8657A

Frequency : 460.100000 MHz
Power: 12 W

Key-Down

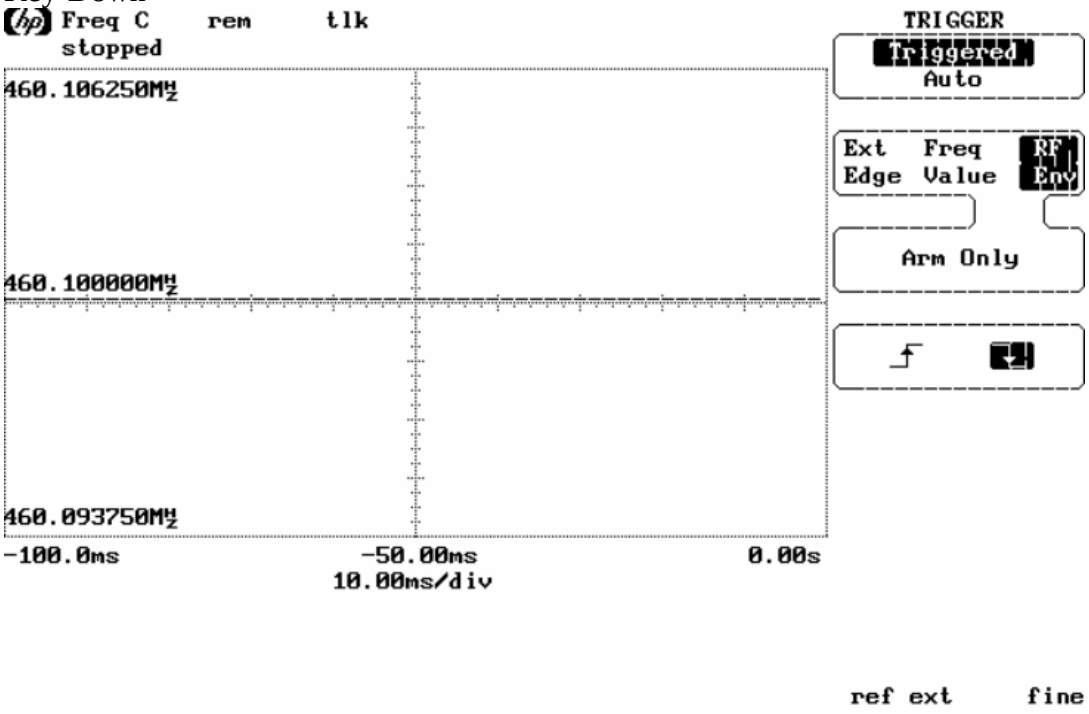


Key-up

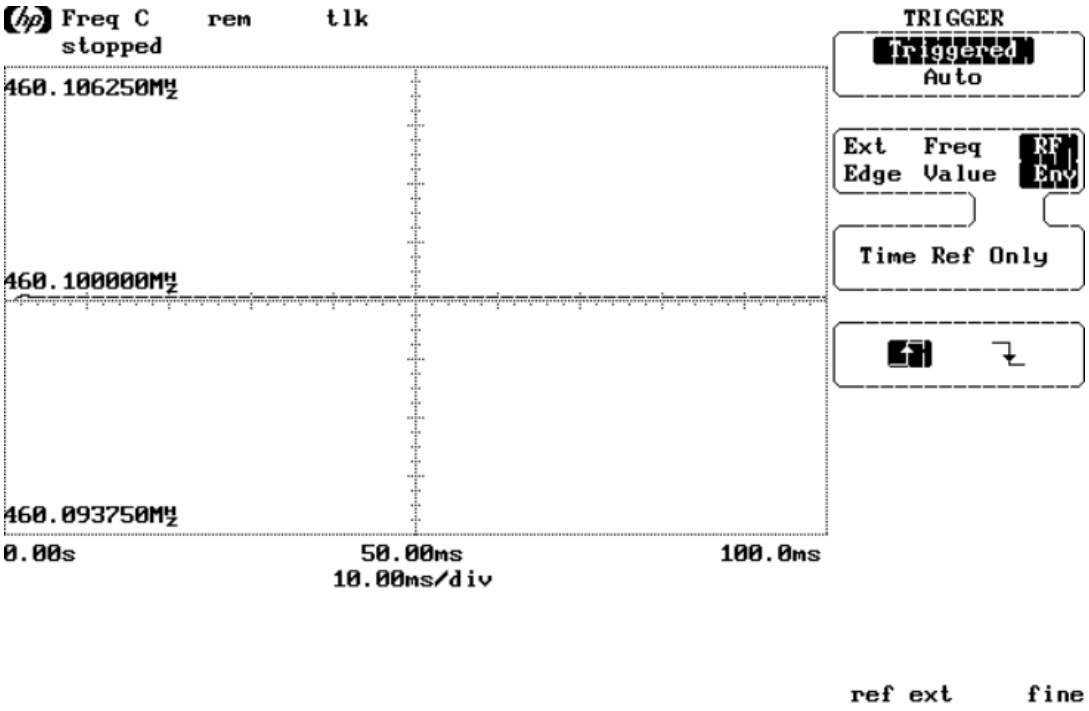


Frequency : 460.100000 MHz
Power: 1.0 W

Key-Down

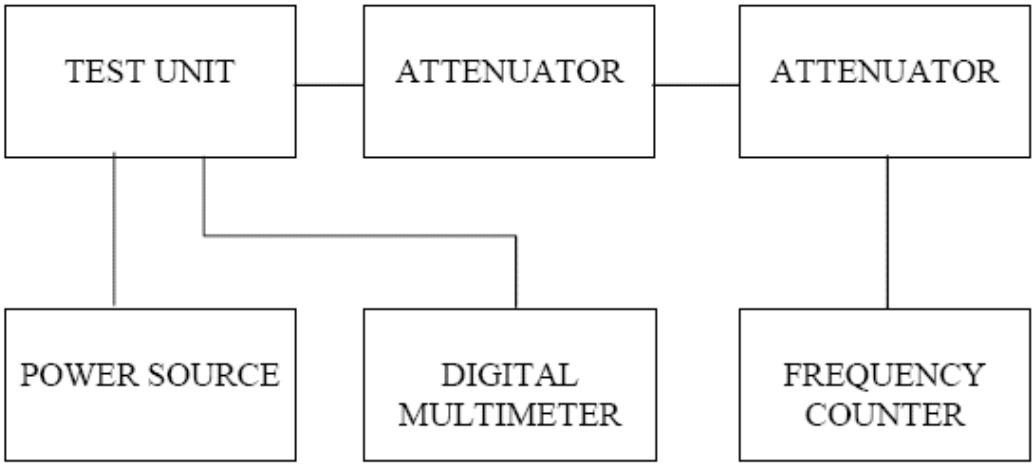


Key-up



NAME OF TEST:	Frequency Stability with Variation in Supply Voltage
RULE PART NUMBER:	2.1055 (d)(1), 90.213 (a)
MINIMUM STANDARD:	Shall not exceed 0.50 ppm.
TEST RESULTS:	Meets minimum standard, see data on following page
TEST CONDITIONS:	Standard Test Conditions, 25 C
TEST EQUIPMENT:	Frequency Counter, Fluke 7220A DC Power Supply, Instek Model GPS-2303 Digital Voltmeter, Fluke Model 8012A 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W) 50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)

TEST SET-UP:



TEST SET-UP

Channel Frequency: 460.1000 MHz
Tolerance Requirements: 0.5ppm
Highest Variation: -0.28 ppm

Input Voltage (Vdc)	Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
10	469.999870	-130	-0.28
20	469.999940	-60	-0.13
30	469.999940	-60	-0.13

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature

RULE PART NUMBER: 2.1055 (a) (b), 90.213 (a)

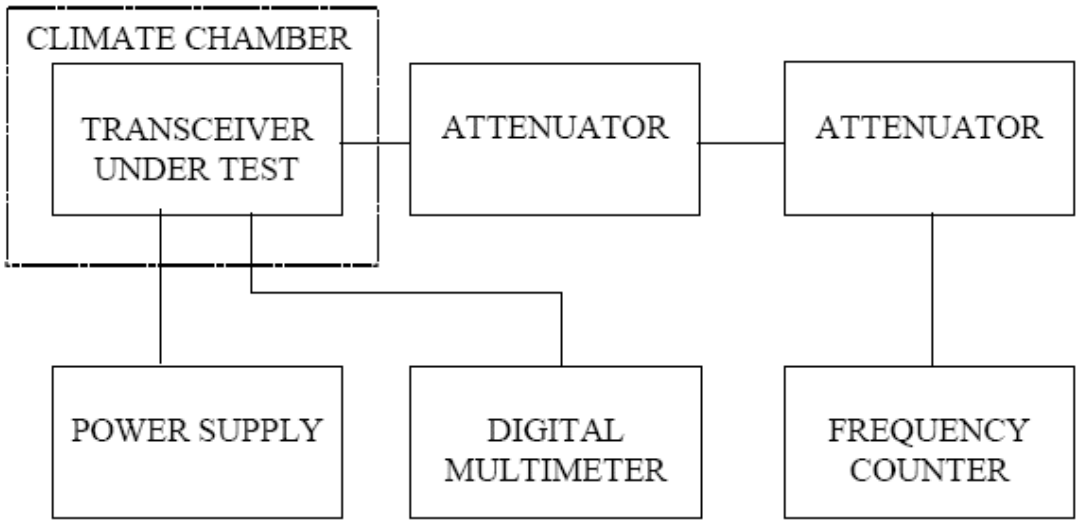
MINIMUM STANDARD: Shall not exceed 0.50 ppm from test frequency

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

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: Frequency Counter, Fluke 7220A
DC Power Supply, Instek Model GPS-2303
Digital Voltmeter, Fluke Model 8012A
50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
Climate Chamber, Test Equity Half Cube Model 105

TEST SET-UP:



Channel Frequency: 460.10000 MHz
Voltage & Power Level: 20 Volts @ 12 Watts
Highest Variation: -0.36 ppm

Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	469.999980	-20	-0.04
-20	469.999880	-120	-0.26
-10	470.000030	30	0.06
0	469.999890	-110	0.23
10	469.999870	-130	-0.28
20	470.000000	0	0.00
30	469.999830	-170	-0.36
40	469.999920	-80	-0.17
50	469.999870	-130	-0.28
60	469.999850	-150	-0.32

Channel Frequency: 460.10000 MHz
Voltage & Power Level: 20 Volts @ 1.0 Watts
Highest Variation: -0.21 ppm

Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	469.999990	-80	-0.17
-20	469.999990	-20	-0.04
-10	469.999990	40	0.09
0	469.999990	10	0.02
10	469.999990	-40	-0.09
20	469.999990	-30	-0.06
30	469.999990	-30	-0.06
40	469.999990	-100	-0.21
50	469.999990	-40	-0.09
60	469.999990	-60	-0.13

NAME OF TEST: Transmitter Occupied Bandwidth

RULE PART NUMBER: 2.201, 2.202, 2.1033 (c)(14), 2.1049 (h), 2.1041;90.203(j)(3)

Necessary Bandwidth Measurement

This radio modem 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 below.

Necessary Bandwidth Measurement:

Channel Spacing	12.5 kHz	12.5 kHz	25 kHz	25 kHz	25 kHz
Emission Type	9K55 F1D	9K35 F1D	11K6 F1D	14K6 F1D	16K4 F1D
Data Rate	4800 bps	9600 bps	4800 bps	9600 bps	19200 bps
Measured Peak Deviation	3.55 Hz	2.76 kHz	4.43 kHz	4.40 kHz	4.30 kHz
Measured 99% Occupied BW	9.55 kHz	9.35 kHz	11.55 kHz	14.55 kHz	16.35 kHz

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), the mathematics are as follows:

$$0.005*TP=P_{(f1)}=\int_{0}^{f1} PSD_{(f)}df$$

$$0.995*TP=P_{(f2)}=\int_{0}^{f2} PSD_{(f)}df$$

$$OBW=f2-f1$$

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

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

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 a digital spectrum analyzer.

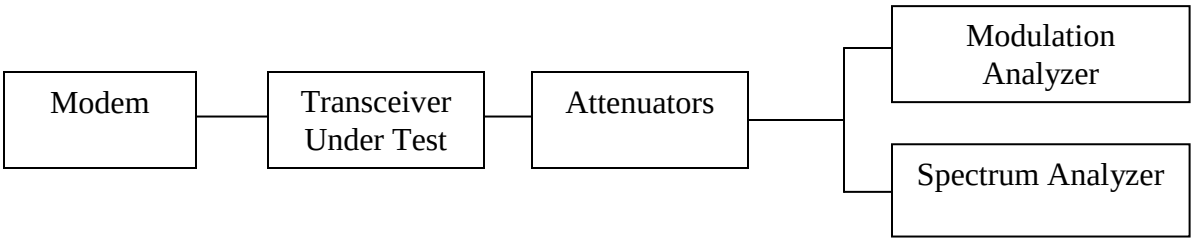
The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a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

TEST EQUIPMENT:

50-Ohm Attenuator, Bird Electronics Model 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits Model ZFSC-3-4 (5.5dB IL at UHF)
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, Advantest Model R3162
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

For the above requirements, the occupied bandwidth of a transmitter was measured using an Advantest Model R3162 using the following settings:
Occupied BW % Power: 99%
Trace: Max Hold A
RBW: 100 Hz (12.5 kHz channels)
RBW: 300 Hz (25 kHz channels)
VBW: 3 kHz
SPAN: 50 kHz (12.5 kHz channels)
SPAN: 150 kHz (25 kHz channels)



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **9K55F1D** and **9K35F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(d), 2.1049 (c)(1)

MINIMUM STANDARDS: **Mask D**
Sidebands and Spurious [Rule 90.210 (d), P = 12 Watts and P=1 Watt]
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 $7.27(f_d\text{-}2.88\text{kHz})$ dB.
Greater than 12.5 kHz, at least $50+10\log_{10}(P)$ or 70 dB, whichever is the lesser attenuation.

Attenuation = 0 dB at Fo to 5.625 kHz
Attenuation = 20 dB at 5.625 kHz and 70 dB at 12.5 kHz
Attenuation = 60.8 dB at frequencies greater than 12.5 kHz @ 12 W
Attenuation = 50 dB at frequencies greater than 12.5 kHz @ 1 W

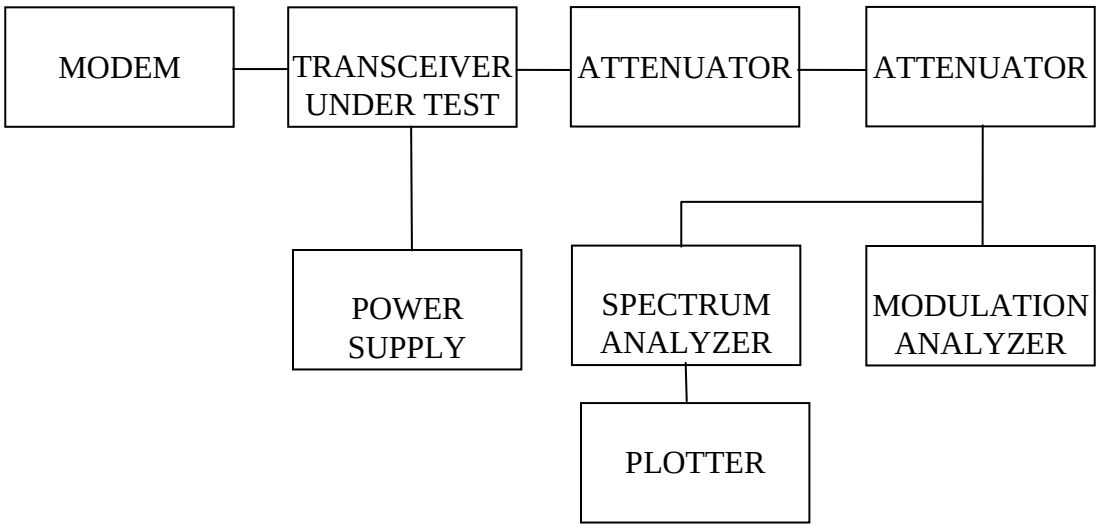
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits ZFSC-3-4 (5.5dB IL at UHF)
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

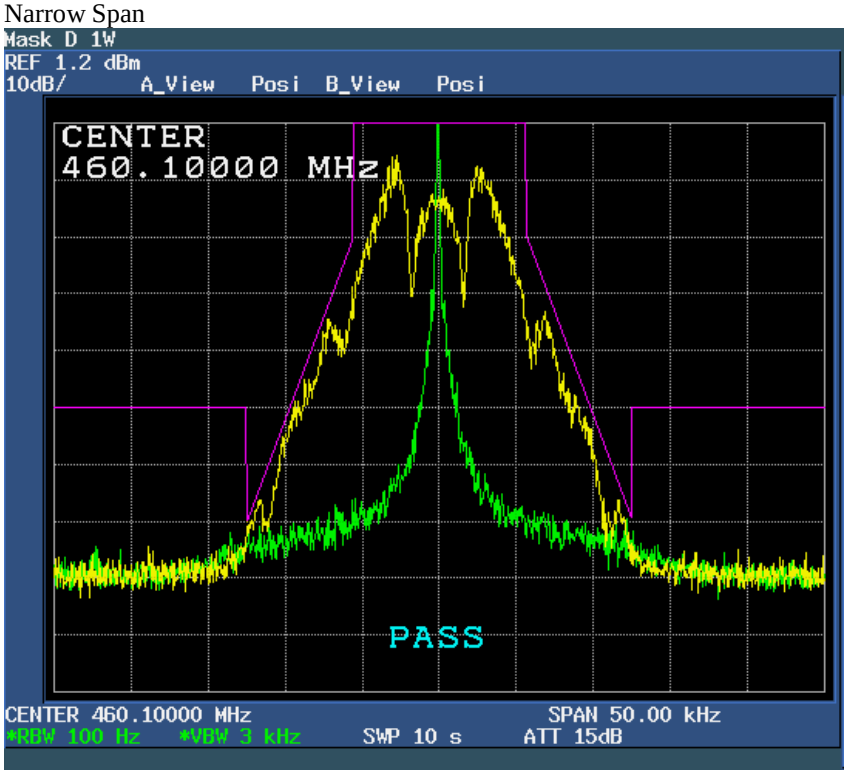
TEST SET-UP:



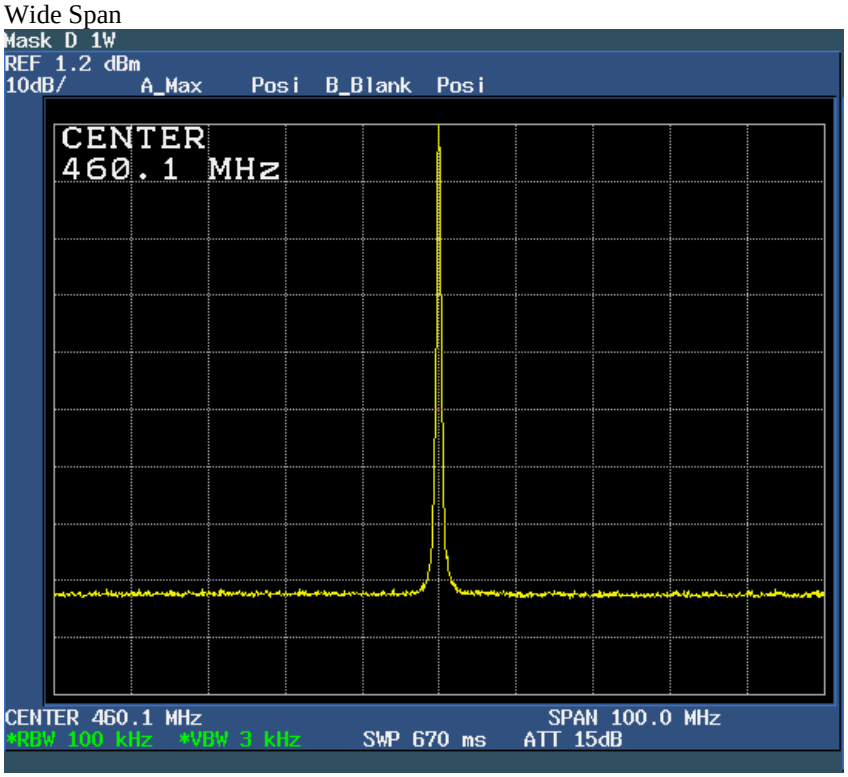
Mask: D, 1W
Output Power = 1 Watt

Spectrum for Emission: 9K55 F1D
Data Rate: 4800 bps Peak Deviation with Data: 3.55 kHz

Narrow Span

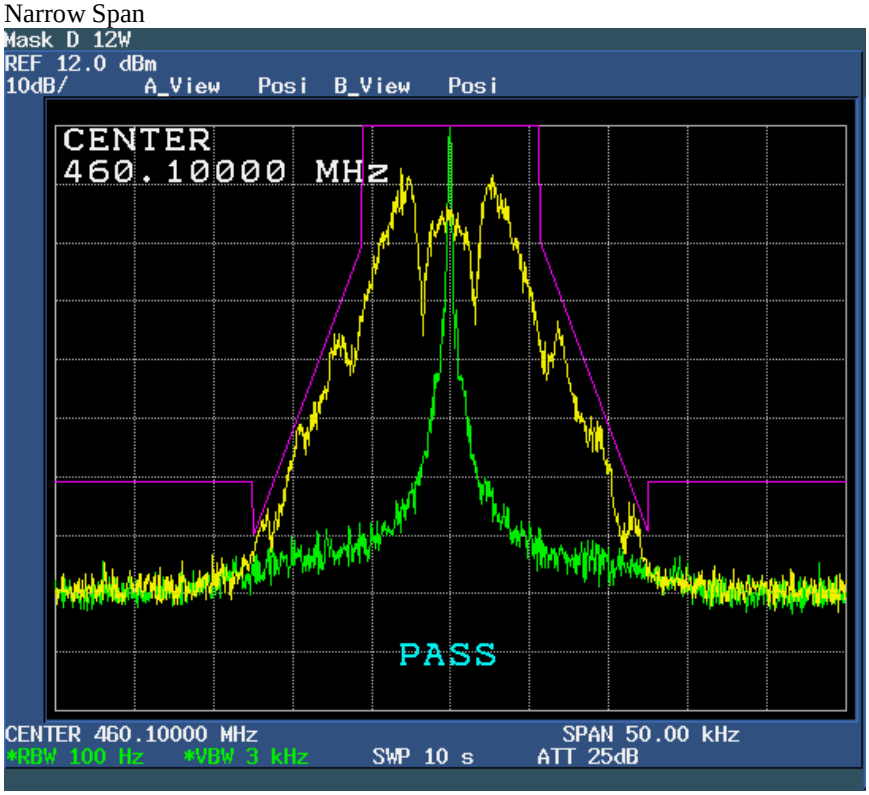


Wide Span

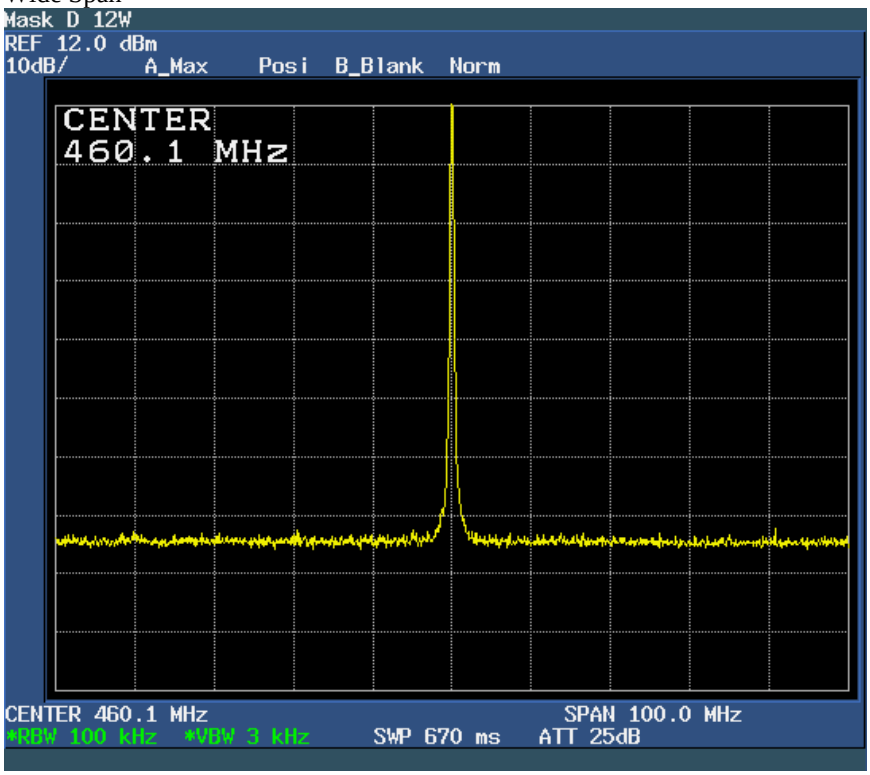


Output Power = 12 Watts

Narrow Span



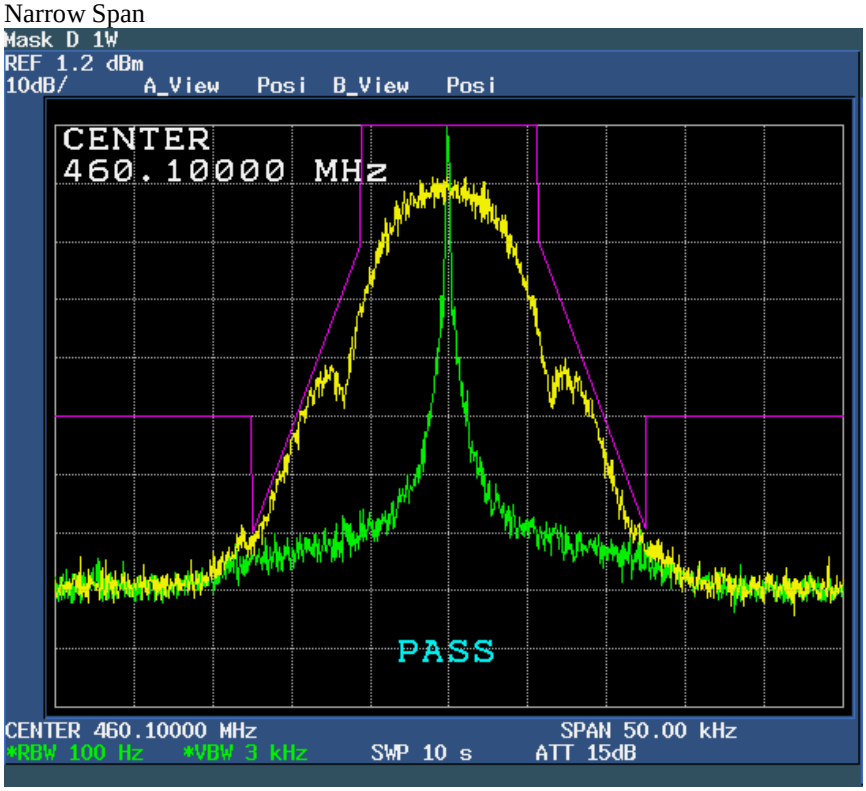
Wide Span



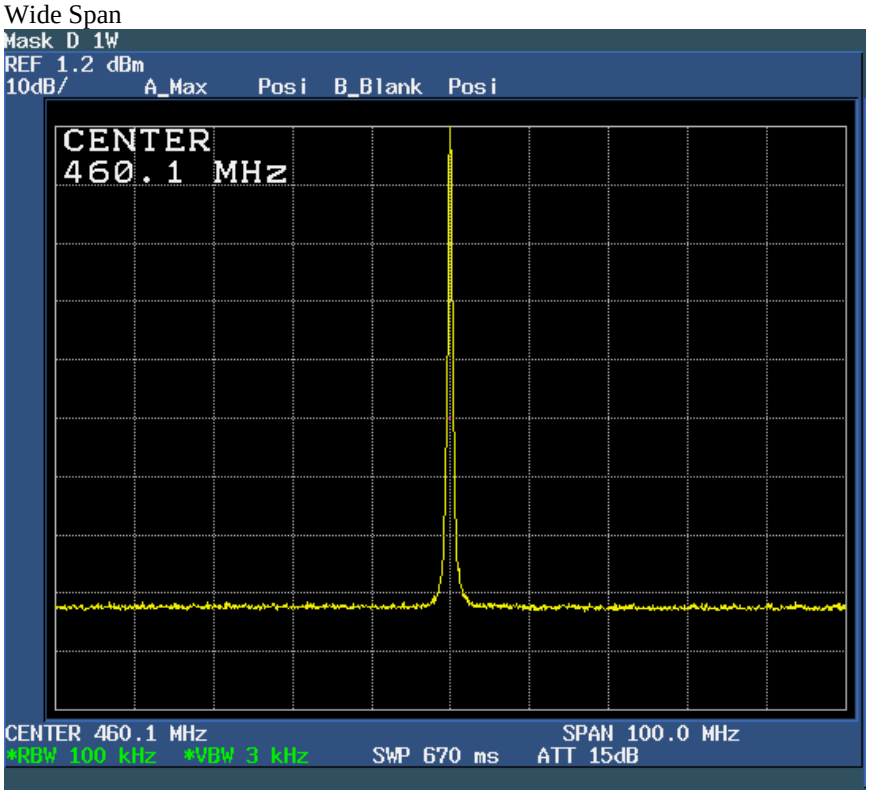
Mask: D, 1W
Output Power = 1 Watt

Spectrum for Emission: 9K35 F1D
Data Rate: 9600 bps Peak Deviation with Data: 2.76 kHz

Narrow Span

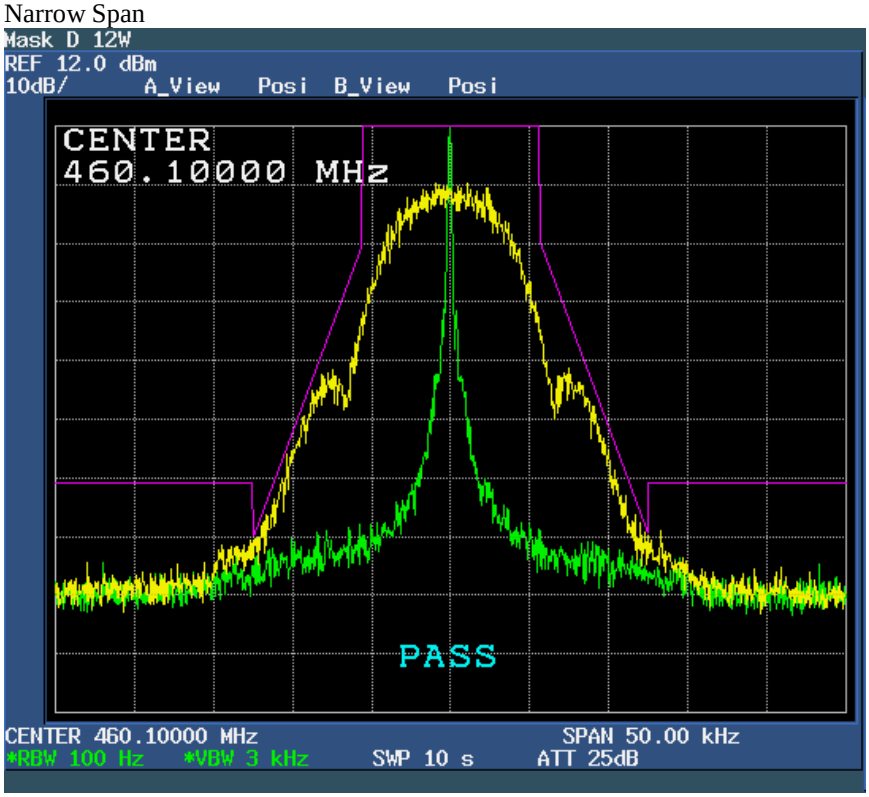


Wide Span

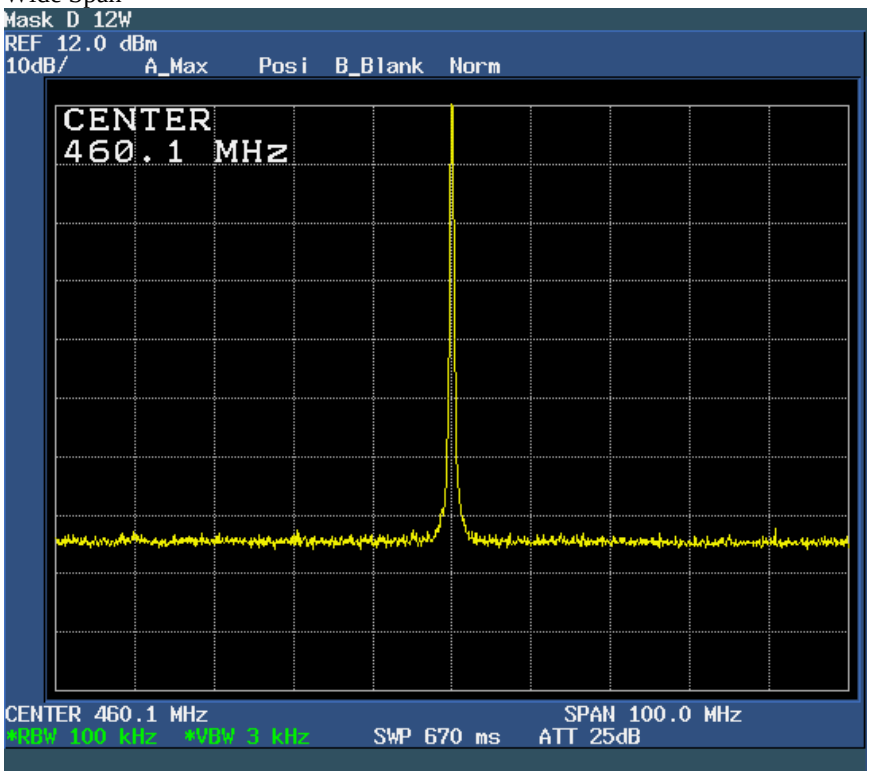


Output Power = 12 Watts

Narrow Span



Wide Span



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **16K5F1D** and **16K8F1D**

RULE PART NUMBER: 2.202, 90.209 (b)(5), 90.210(c), 2.1049 (c)(1)

MINIMUM STANDARDS: **Mask C**
Sidebands and Spurious [Rule 90.210 (c), P = 12 Watts and P=1 Watt]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]
From Fo to 5 kHz, down 0 dB.
Greater than 5 kHz to 10 kHz, down 83 * $\log_{10}(f_d / 5)$ dB.
Greater than 10 kHz to 250% of authorized BW, at least
29 * $\log_{10}(f_d^2 / 11)$ or 50 dB, whichever is the lesser attenuation
Greater than 250% of authorized BW, 43 + $10\log_{10}(P)$

Attenuation = 0 dB at Fo to 5 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 50 dB at 24.1 kHz
Attenuation = 50 dB at 50 kHz
Attenuation = 53.8 dB at frequencies greater than 50 kHz @ 12 W
Attenuation = 43 dB at frequencies greater than 50 kHz @ 1 W

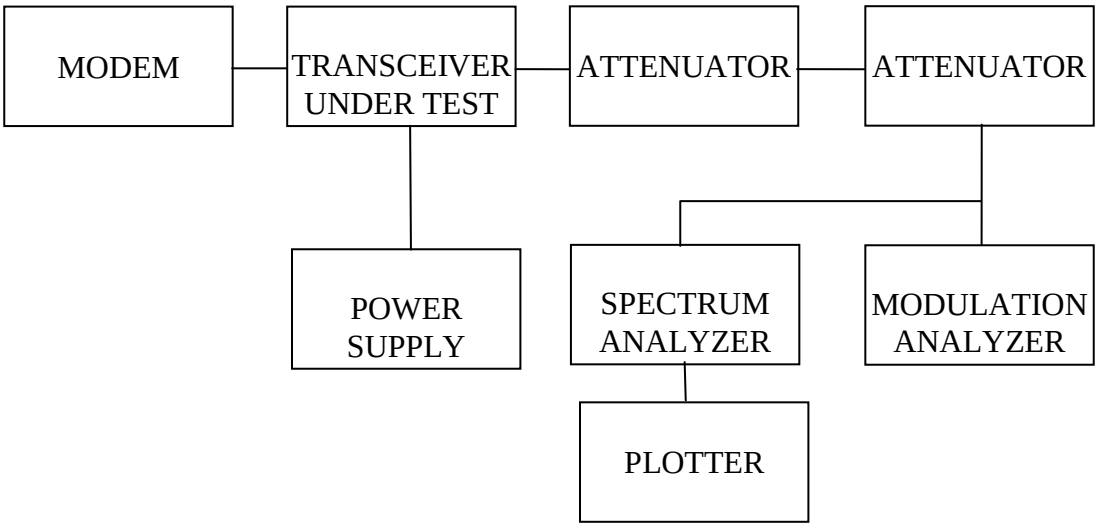
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits ZFSC-3-4 (5.5dB IL at UHF)
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, Advantest Model R3162
Modulation Analyzer, Hewlett Packard Model HP8901A

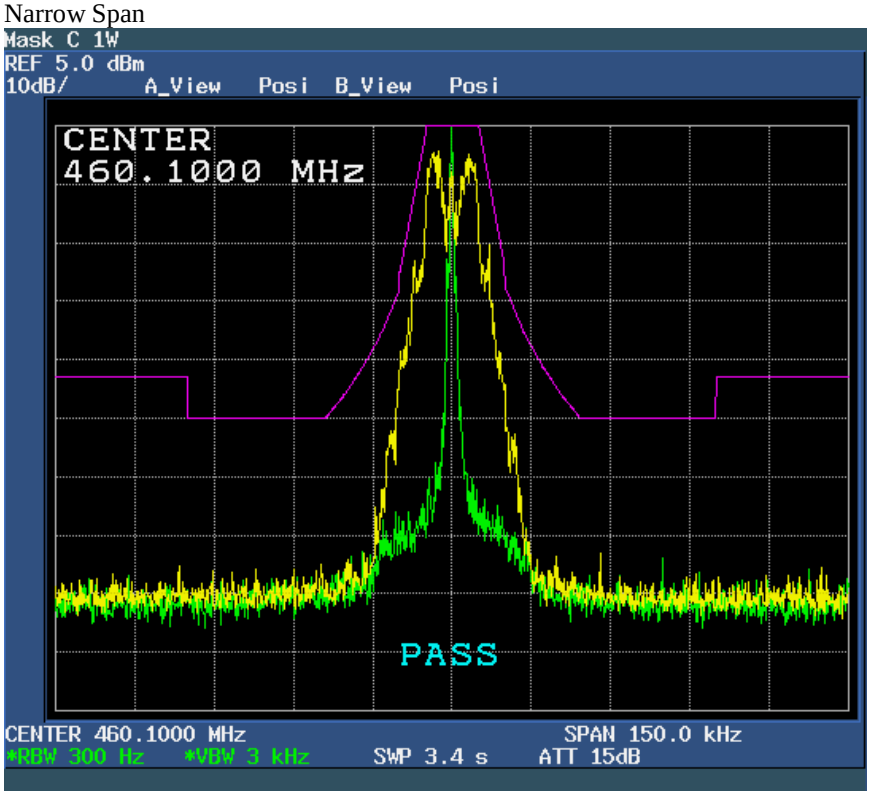
TEST SET-UP:



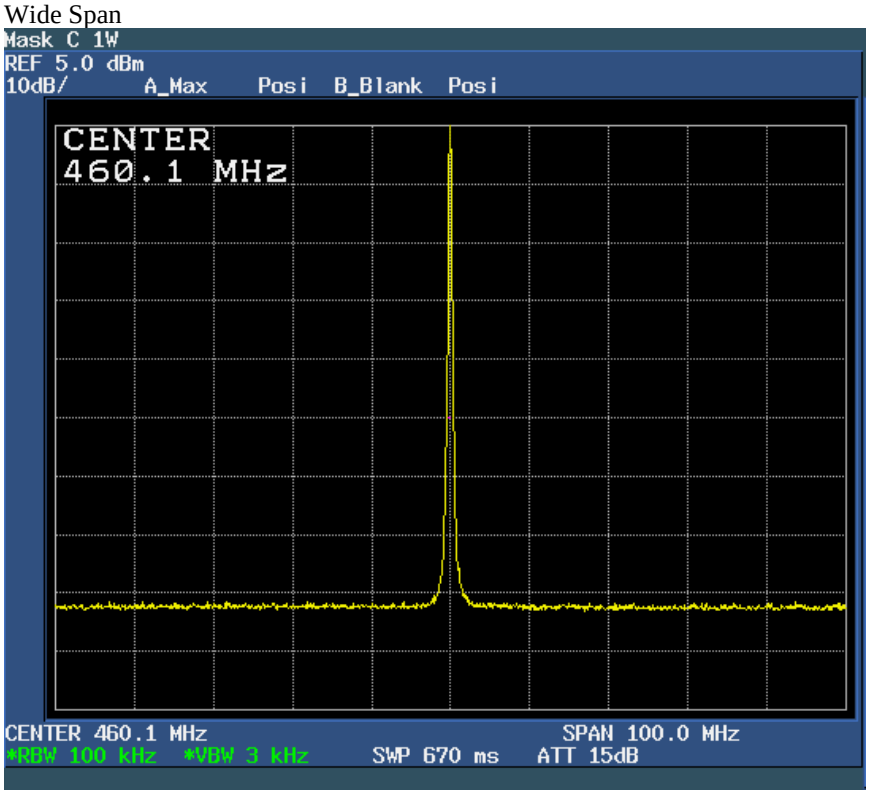
Mask: C, 1W
Output Power = 1 Watt

Spectrum for Emission: 11K6 F1D
Data Rate: 4800 bps Peak Deviation with Data: 4.43 kHz

Narrow Span

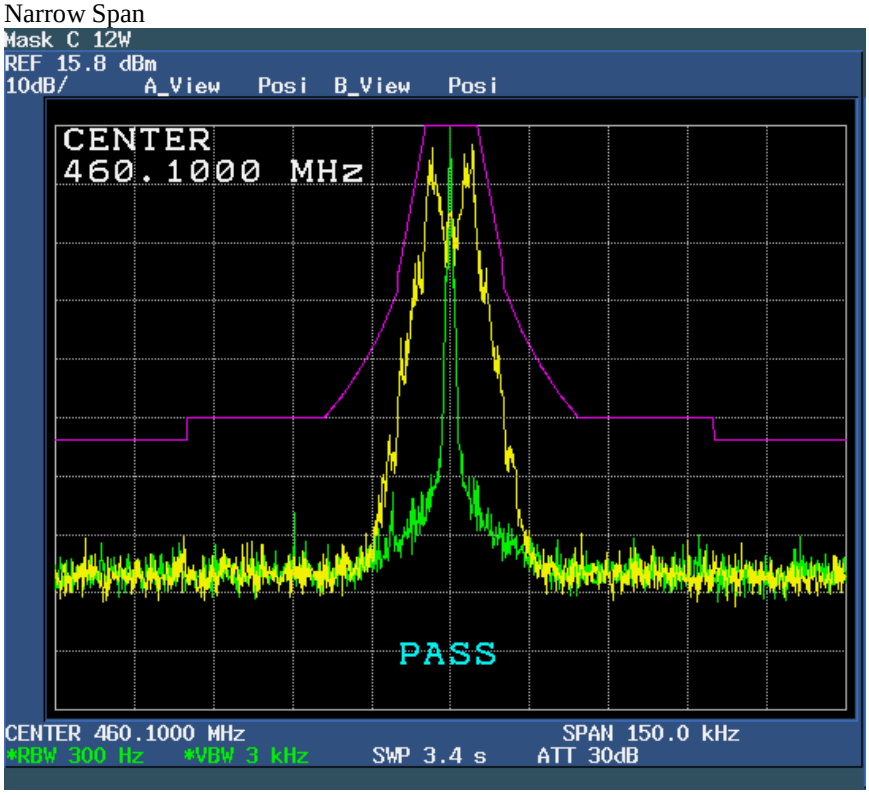


Wide Span

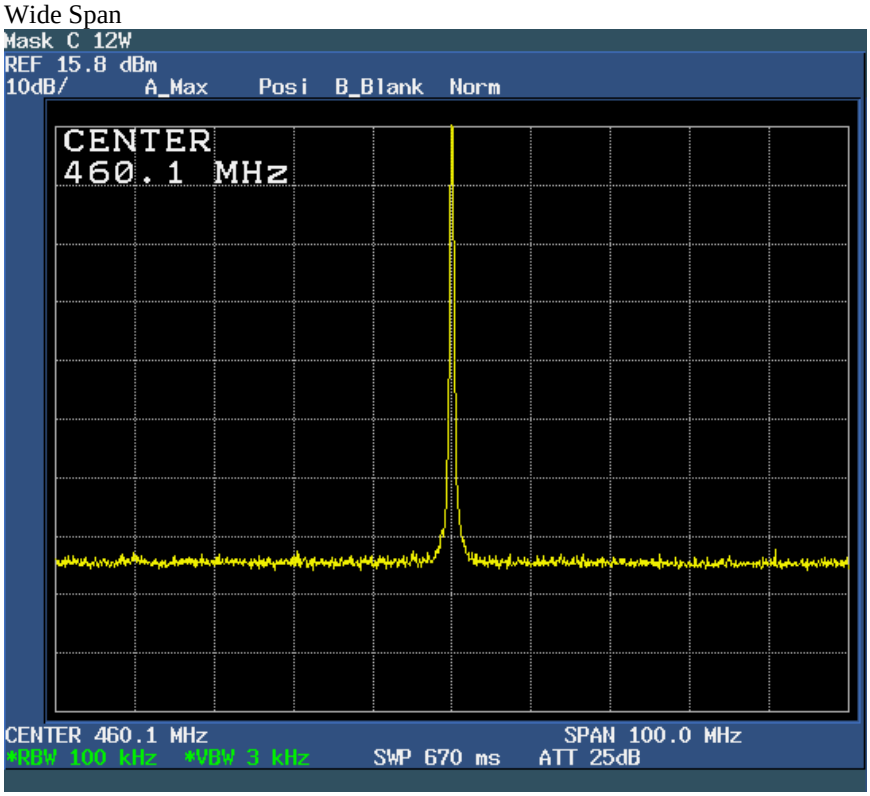


Output Power = 12 Watts

Narrow Span



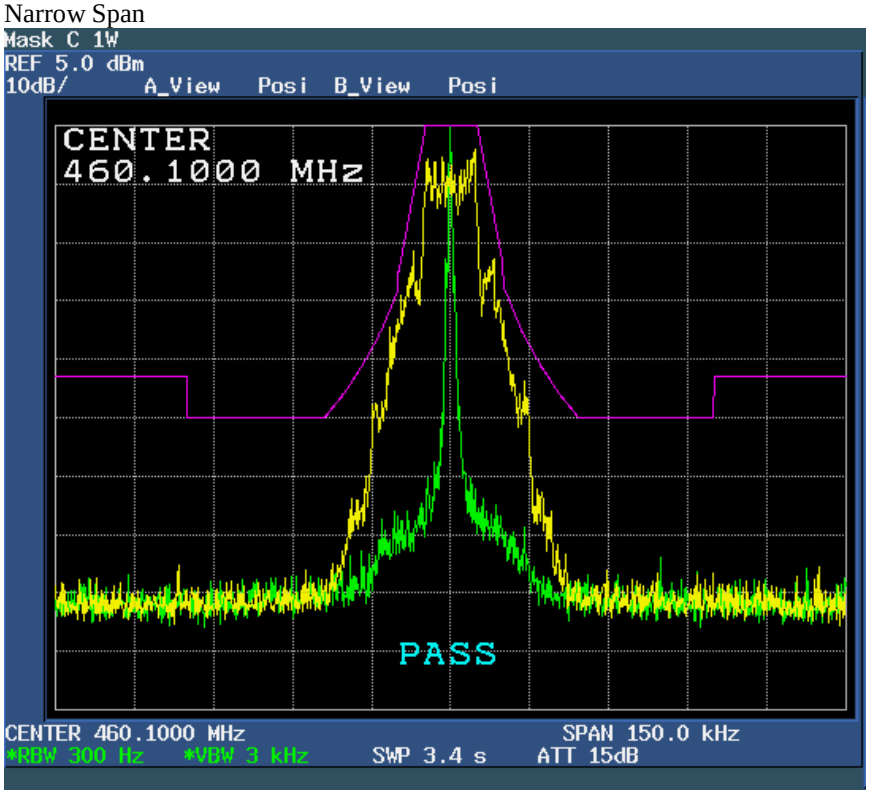
Wide Span



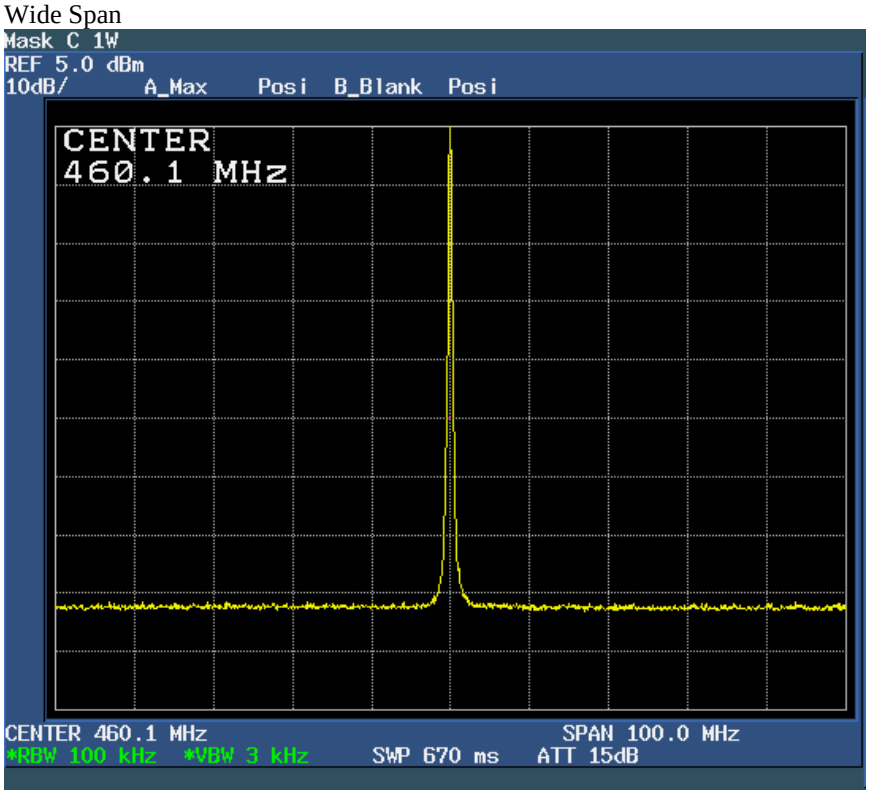
Mask: C, 1W Spectrum for Emission: 14K6 F1D

Output Power = 1 Watt Data Rate: 9600 bps Peak Deviation with Data: 4.40 kHz

Narrow Span

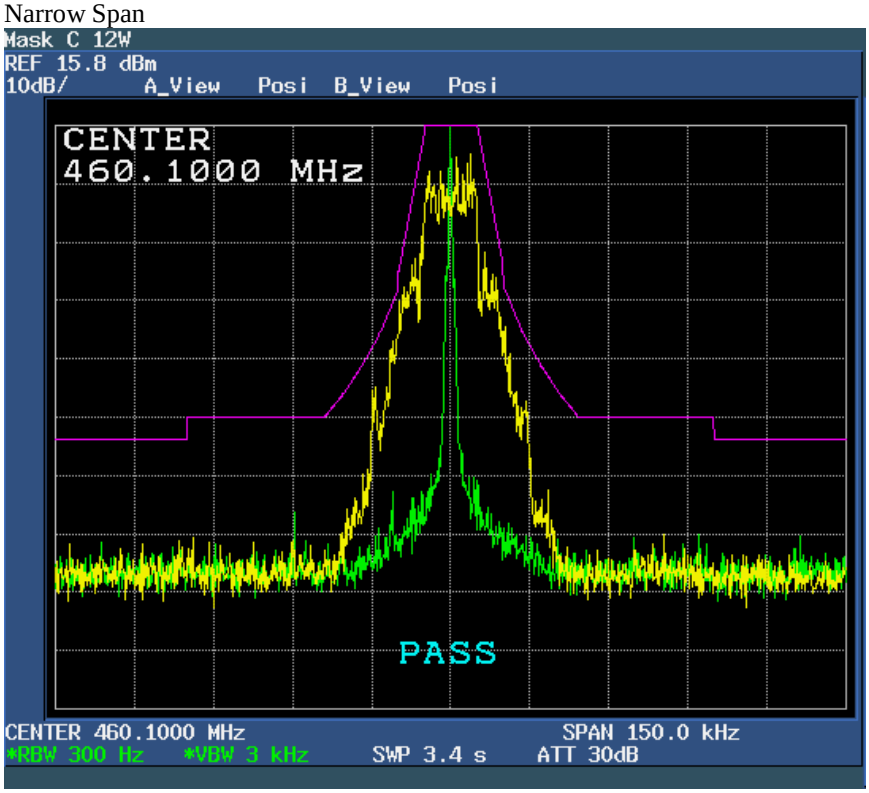


Wide Span

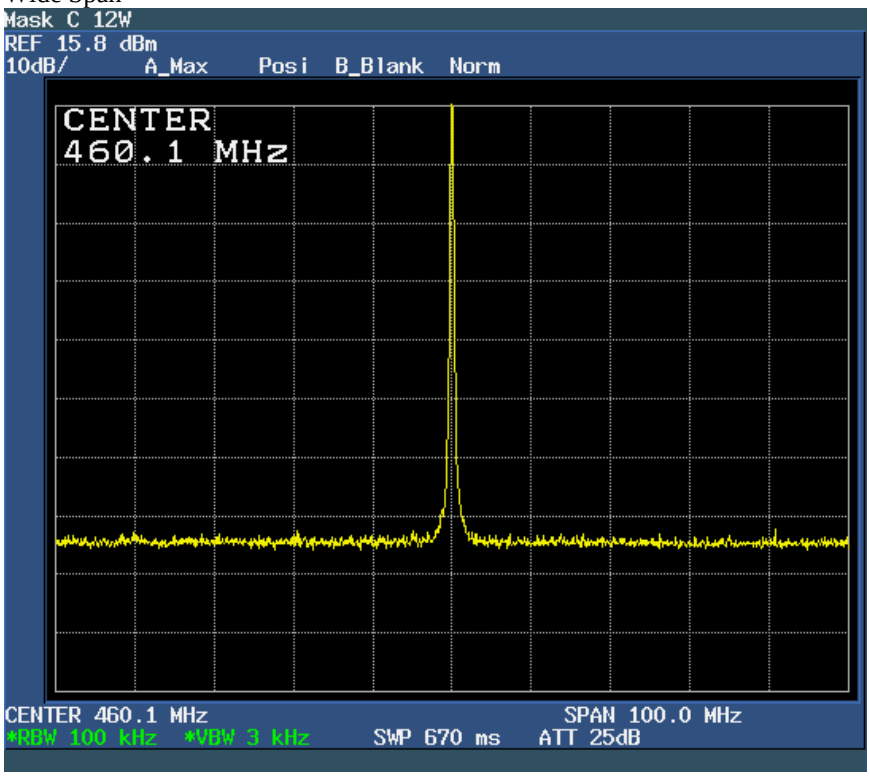


Output Power = 12 Watts

Narrow Span



Wide Span



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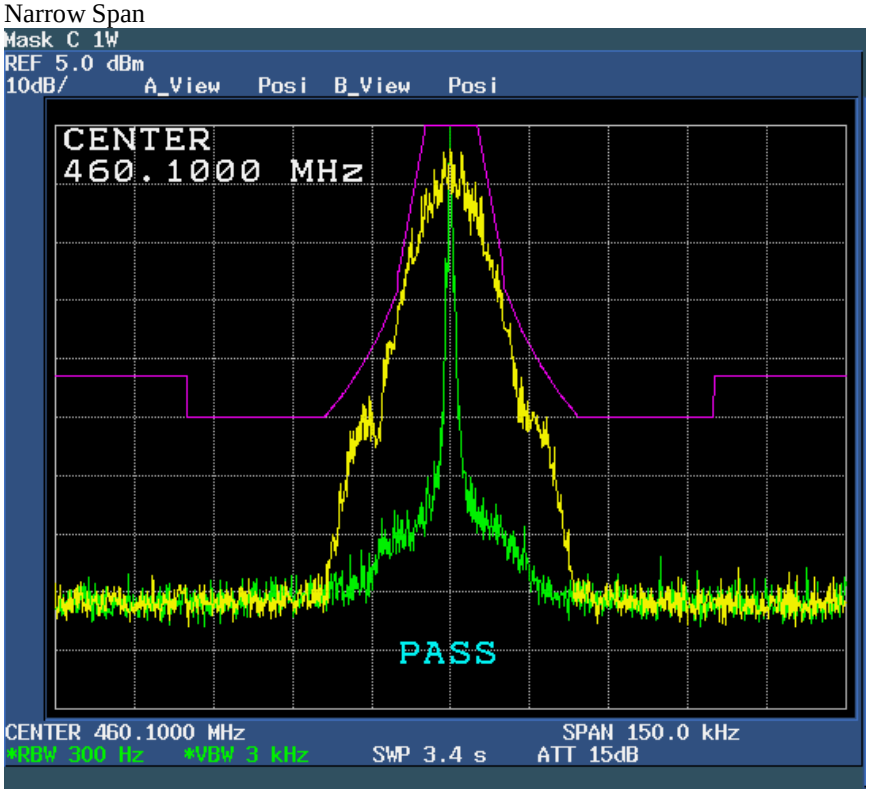
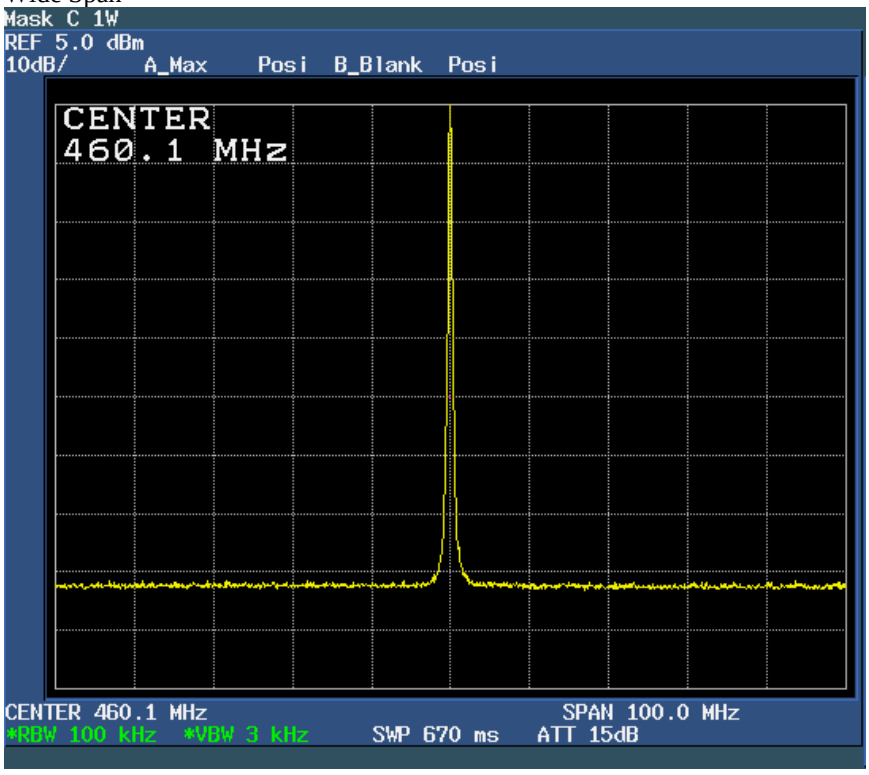
Mask: C, 1W
Output Power = 1 Watt

Spectrum for Emission: 16K4 F1D
Data Rate: 19200 bps Peak Deviation with Data: 4.30 kHz

Narrow Span

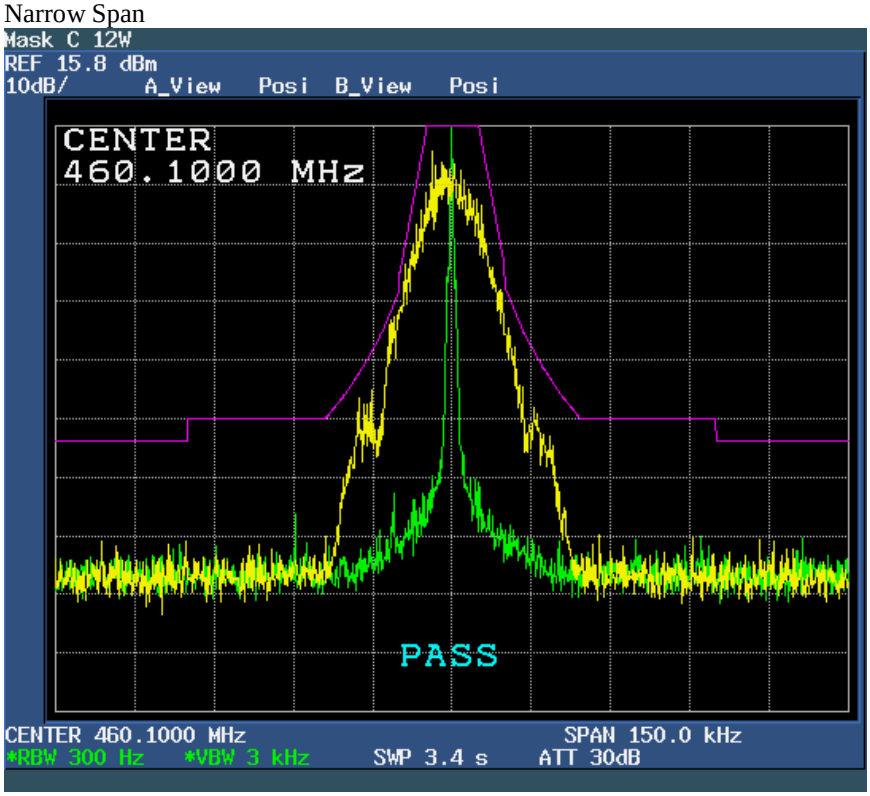


Wide Span

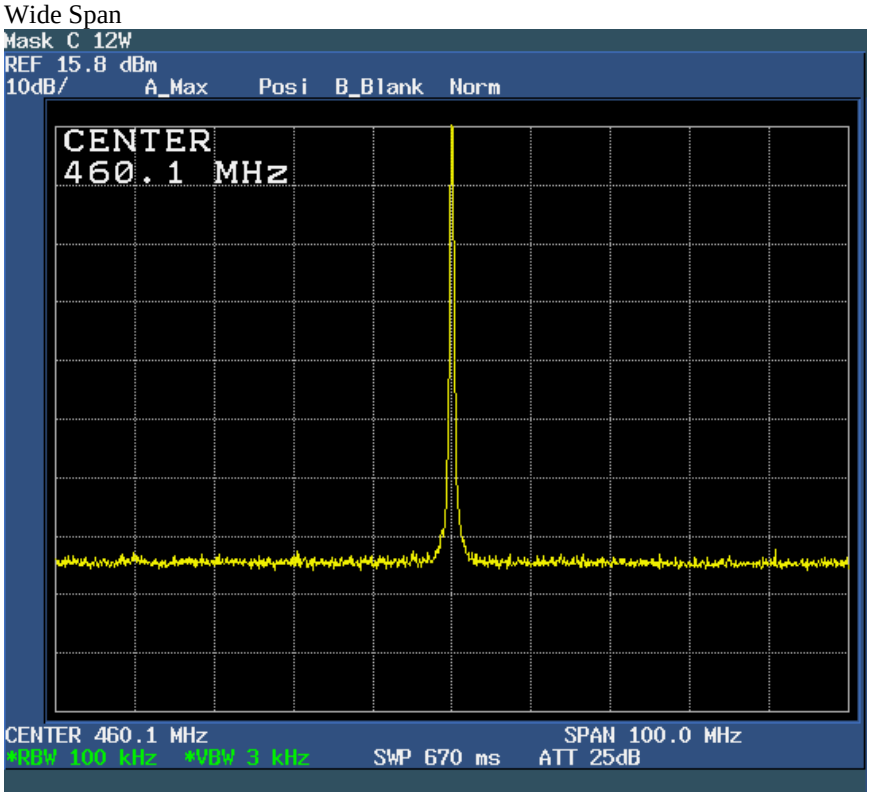


Output Power = 12 Watts

Narrow Span



Wide Span



NAME OF TEST: Field Strength of Spurious Radiation

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

MINIMUM STANDARDS: For 12 Watts: $50+10\text{Log}_{10}(12\text{ Watts}) = -6.8$ dBc
or -65dBc, whichever is the lesser attenuation.

For 1 Watt: $50+10\text{Log}_{10}(1\text{ Watt}) = -50$ dBc
or –70 dBc, whichever is the lesser attenuation.

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

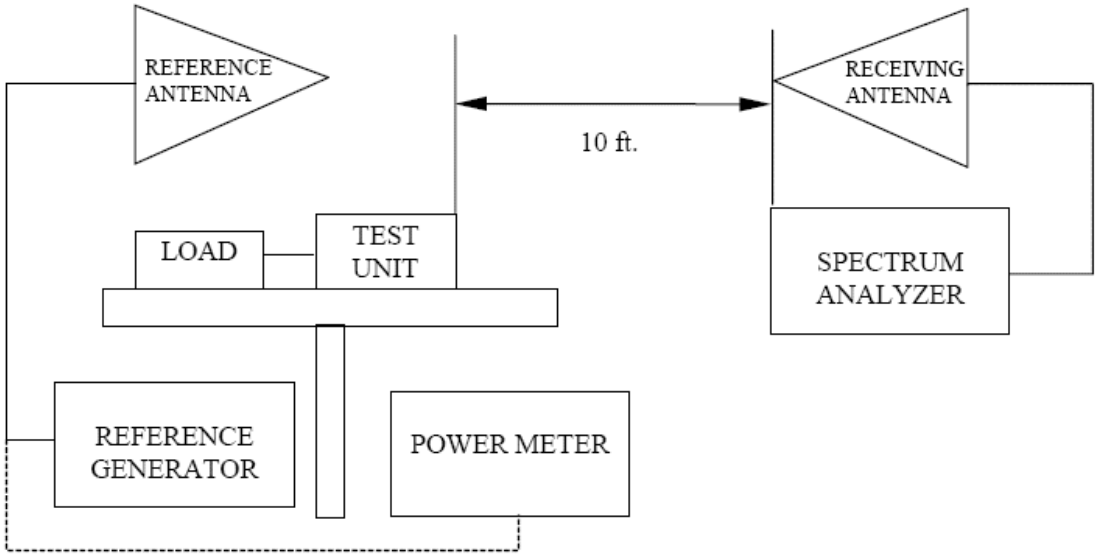
TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: Waveguide Horn Antenna, EMCO Model 3115
Waveguide Horn Antenna, Electro-Metrics EM-6961
Bilog Antenna, Chase Model CBL6111B
Dipole Antenna, Electro-Metrics Model EM-6924
Power Supply, Model Instek GPS-3303
Spectrum Analyzer, Model HP-8563E
Reference Generator, Agilent Model E82570
Power Meter, Model HP436A
50-Ohm Attenuator, Bird Electronics 50-A-FFN-20 (20dB, 50W)
50-Ohm Load, Lucas Weinschel 58-30-43

MEASUREMENT PROCEDURE:
Radiated spurious attenuation was measured according to TIA/EIA Standard 603-C

TEST SET-UP:



Half Duplex

Freqency:	406.125	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-84.3	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
812.25	H	-98.3	-61.5	3.33	-0.46	-106.1
	V	-93.8	-57.2	3.33	-0.46	-101.7
1218.375	H	-94.7	-58.3	4.17	2.75	-100.5
	V	-93.5	-57.6	4.17	2.75	-99.8
1624.5	H	-101.7	-61.0	5.50	4.75	-102.5
	V	-99.3	-62.0	5.50	4.75	-103.5
2030.625	H	-98.2	-57.6	6.00	4.95	-99.5
	V	-92.3	-49.3	6.00	4.95	-91.1
2436.75	H	-110.0	-63.1	7.00	5.55	-105.4
	V	-108.0	-63.3	7.00	5.55	-105.5
2842.875	H	-99.0	-53.0	7.50	5.75	-95.5
	V	-101.3	-56.3	7.50	5.75	-98.8
3249	H	-95.2	-46.8	9.83	5.75	-91.7
	V	-97.8	-45.5	9.83	5.75	-90.3
3655.125	H	-96.5	-41.3	10.83	5.95	-87.0
	V	-95.5	-41.5	10.83	5.95	-87.1
4061.25	H	-94.0	-38.5	11.00	5.95	-84.3
	V	-93.3	-39.5	11.00	5.95	-85.3

Freqency:	406.125	MHz	Spec =	-50.0	dBc
Power:	1	Watts	Highest Spur =	-87.9	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
812.25	H	-106.2	-69.4	3.33	-0.46	-103.2
	V	-101.8	-65.1	3.33	-0.46	-98.9
1218.375	H	-103.0	-66.6	4.17	2.75	-98.1
	V	-110.0	-74.1	4.17	2.75	-105.6
1624.5	H	-110.7	-70.0	5.50	4.75	-100.8
	V	-108.3	-70.9	5.50	4.75	-101.7
2030.625	H	-109.7	-69.2	6.00	4.95	-100.2
	V	-107.2	-64.2	6.00	4.95	-95.2
2436.75	H	-110.7	-63.8	7.00	5.55	-95.3
	V	-111.0	-66.3	7.00	5.55	-97.8
2842.875	H	-110.7	-64.7	7.50	5.75	-96.4
	V	-109.2	-64.2	7.50	5.75	-95.9
3249	H	-110.5	-62.1	9.83	5.75	-96.2
	V	-112.5	-60.1	9.83	5.75	-94.2
3655.125	H	-116.0	-60.8	10.83	5.95	-95.7
	V	-113.0	-59.0	10.83	5.95	-93.9
4061.25	H	-110.0	-54.5	11.00	5.95	-89.5
	V	-106.7	-52.8	11.00	5.95	-87.9

Full Duplex

Freqency:	451.025	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-75.1	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
902.05	H	-83.7	-49.5	3.50	-0.51	-94.3
	V	-82.0	-38.3	3.50	-0.51	-83.1
1353.075	H	-88.3	-49.3	4.83	4.75	-90.2
	V	-87.5	-51.0	4.83	4.75	-91.8
1804.1	H	-86.3	-46.6	5.67	4.95	-88.1
	V	-87.3	-47.0	5.67	4.95	-88.5
2255.125	H	-88.2	-45.5	6.33	5.55	-87.0
	V	-86.2	-43.0	6.33	5.55	-84.5
2706.15	H	-103.5	-57.1	7.50	5.55	-99.9
	V	-101.5	-54.3	7.50	5.55	-97.0
3157.175	H	-90.7	-41.1	9.83	5.75	-86.0
	V	-93.0	-43.3	9.83	5.75	-88.2
3608.2	H	-97.5	-45.0	10.50	5.95	-90.3
	V	-98.5	-43.6	10.50	5.95	-89.0
4059.225	H	-86.0	-30.1	11.17	5.95	-76.1
	V	-83.0	-29.1	11.17	5.95	-75.1
4510.25	H	-113.2	-56.7	11.50	7.05	-101.9
	V	-109.7	-52.2	11.50	7.05	-97.4

Freqency:	451.025	MHz	Spec =	-50.0	dBc
			Highest		
Power:	1	Watts	Spur =	-81.3	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
902.05	H	-87.3	-53.2	3.50	-0.51	-87.2
	V	-91.0	-47.3	3.50	-0.51	-81.3
1353.075	H	-105.2	-66.2	4.83	4.75	-96.3
	V	-105.7	-69.2	4.83	4.75	-99.3
1804.1	H	-104.5	-64.8	5.67	4.95	-95.5
	V	-107.2	-66.8	5.67	4.95	-97.6
2255.125	H	-97.0	-54.3	6.33	5.55	-85.1
	V	-97.5	-54.3	6.33	5.55	-85.1
2706.15	H	-110.8	-64.4	7.50	5.55	-96.4
	V	-108.2	-61.0	7.50	5.55	-93.0
3157.175	H	-109.2	-59.7	9.83	5.75	-93.8
	V	-109.8	-60.1	9.83	5.75	-94.2
3608.2	H	-106.7	-54.2	10.50	5.95	-88.7
	V	-111.0	-56.1	10.50	5.95	-90.7
4059.225	H	-109.0	-53.1	11.17	5.95	-88.4
	V	-104.0	-50.1	11.17	5.95	-85.4
4510.25	H	-112.8	-56.3	11.50	7.05	-90.7
	V	-106.8	-49.3	11.50	7.05	-83.7

Full Duplex

Freqency:	460.1	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-75.8	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
920.2	H	-81.3	-46.7	3.50	-0.48	-91.4
	V	-87.5	-43.8	3.50	-0.48	-88.6
1380.3	H	-92.0	-54.1	5.00	4.75	-95.2
	V	-87.8	-49.6	5.00	4.75	-90.7
1840.4	H	-87.7	-45.5	5.50	4.95	-86.8
	V	-89.3	-49.5	5.50	4.95	-90.8
2300.5	H	-92.0	-49.3	6.83	5.55	-91.4
	V	-90.3	-45.5	6.83	5.55	-87.5
2760.6	H	-110.3	-62.1	7.33	5.75	-104.5
	V	-110.0	-64.8	7.33	5.75	-107.2
3220.7	H	-84.8	-36.5	9.83	5.75	-81.3
	V	-108.3	-56.8	9.83	5.75	-101.6
3680.8	H	-97.8	-42.5	10.33	5.95	-87.6
	V	-100.7	-47.7	10.33	5.95	-92.8
4140.9	H	-88.2	-34.3	11.17	5.95	-80.3
	V	-85.5	-29.8	11.17	5.95	-75.8
4601	H	-105.8	-49.1	12.00	7.05	-94.8
	V	-103.5	-46.5	12.00	7.05	-92.2

Freqency:	460.1	MHz	Spec =	-50.0	dBc
			Highest		
Power:	1	Watts	Spur =	-79.1	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
920.2	H	-84.7	-50.0	3.50	-0.48	-84.0
	V	-88.8	-45.2	3.50	-0.48	-79.1
1380.3	H	-96.8	-59.0	5.00	4.75	-89.2
	V	-100.8	-62.6	5.00	4.75	-92.9
1840.4	H	-94.7	-52.5	5.50	4.95	-83.0
	V	-96.3	-56.5	5.50	4.95	-87.0
2300.5	H	-108.3	-65.6	6.83	5.55	-96.9
	V	-106.5	-61.6	6.83	5.55	-92.9
2760.6	H	-111.3	-63.1	7.33	5.75	-94.7
	V	-109.7	-64.5	7.33	5.75	-96.1
3220.7	H	-103.2	-54.8	9.83	5.75	-88.9
	V	-106.7	-55.2	9.83	5.75	-89.3
3680.8	H	-108.3	-52.9	10.33	5.95	-87.3
	V	-111.8	-58.8	10.33	5.95	-93.2
4140.9	H	-111.3	-57.4	11.17	5.95	-92.7
	V	-108.7	-53.0	11.17	5.95	-88.2
4601	H	-111.7	-55.0	12.00	7.05	-90.0
	V	-111.0	-54.0	12.00	7.05	-88.9

Half Duplex

Freqency:	469.975	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-71.3	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
939.95	H	-98.0	-62.2	3.50	-0.54	-107.0
	V	-101.0	-57.3	3.50	-0.54	-102.2
1409.925	H	-93.7	-57.0	4.67	4.75	-97.7
	V	-95.0	-56.0	4.67	4.75	-96.7
1879.9	H	-90.0	-46.3	5.83	4.95	-88.0
	V	-91.3	-51.0	5.83	4.95	-92.6
2349.875	H	-99.3	-55.3	6.50	5.55	-97.0
	V	-100.2	-54.7	6.50	5.55	-96.4
2819.85	H	-94.2	-47.8	7.33	5.75	-90.2
	V	-90.0	-45.6	7.33	5.75	-88.0
3289.825	H	-109.8	-59.6	10.00	5.95	-104.4
	V	-107.0	-52.8	10.00	5.95	-97.6
3759.8	H	-93.5	-39.3	10.17	5.95	-84.3
	V	-93.8	-41.8	10.17	5.95	-86.8
4229.775	H	-87.0	-31.8	11.33	5.95	-78.0
	V	-82.3	-25.1	11.33	5.95	-71.3
4699.75	H	-101.2	-44.8	11.83	7.05	-90.4
	V	-99.2	-43.1	11.83	7.05	-88.7

Freqency:	469.975	MHz	Spec =	-50.0	dBc
			Highest		
Power:	1	Watts	Spur =	-75.9	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
939.95	H	-106.5	-70.7	3.50	-0.54	-104.7
	V	-103.7	-60.0	3.50	-0.54	-94.1
1409.925	H	-98.3	-61.6	4.67	4.75	-91.6
	V	-98.0	-59.0	4.67	4.75	-88.9
1879.9	H	-94.0	-50.3	5.83	4.95	-81.2
	V	-97.7	-57.3	5.83	4.95	-88.2
2349.875	H	-101.2	-57.2	6.50	5.55	-88.1
	V	-97.7	-52.1	6.50	5.55	-83.1
2819.85	H	-94.8	-48.5	7.33	5.75	-80.0
	V	-94.0	-49.6	7.33	5.75	-81.2
3289.825	H	-102.8	-52.6	10.00	5.95	-86.7
	V	-104.7	-50.5	10.00	5.95	-84.6
3759.8	H	-112.5	-58.3	10.17	5.95	-92.5
	V	-111.0	-59.0	10.17	5.95	-93.2
4229.775	H	-102.3	-47.1	11.33	5.95	-82.5
	V	-97.7	-40.5	11.33	5.95	-75.9
4699.75	H	-116.0	-59.6	11.83	7.05	-94.4
	V	-113.7	-57.7	11.83	7.05	-92.5

Half Duplex

Freqency:	511.975	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-75.2	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
1023.95	H	-101.2	-63.8	3.67	2.75	-105.5
	V	-94.8	-60.6	3.67	2.75	-102.3
1535.925	H	-100.3	-61.1	4.67	4.75	-101.8
	V	-91.0	-53.0	4.67	4.75	-93.7
2047.9	H	-101.2	-60.2	5.67	4.95	-101.7
	V	-103.8	-59.6	5.67	4.95	-101.1
2559.875	H	-102.8	-58.8	7.00	5.55	-101.0
	V	-103.8	-59.1	7.00	5.55	-101.3
3071.85	H	-84.8	-30.5	9.67	5.75	-75.2
	V	-85.8	-36.1	9.67	5.75	-80.8
3583.825	H	-99.8	-48.6	10.00	5.95	-93.5
	V	-97.8	-43.5	10.00	5.95	-88.3
4095.8	H	-94.8	-40.3	11.17	5.95	-86.3
	V	-93.3	-38.8	11.17	5.95	-84.8
4607.775	H	-92.8	-36.0	11.67	7.05	-81.4
	V	-90.2	-33.3	11.67	7.05	-78.7
5119.75	H	-96.5	-37.3	11.83	6.75	-83.2
	V	-91.2	-31.8	11.83	6.75	-77.7

Freqency:	511.975	MHz	Spec =	-50.0	dBc
			Highest		
Power:	1	Watts	Spur =	-78.9	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
1023.95	H	-105.7	-68.3	3.67	2.75	-99.3
	V	-96.0	-61.8	3.67	2.75	-92.7
1535.925	H	-111.5	-72.3	4.67	4.75	-102.2
	V	-109.7	-71.7	4.67	4.75	-101.6
2047.9	H	-113.2	-72.2	5.67	4.95	-102.9
	V	-115.0	-70.8	5.67	4.95	-101.5
2559.875	H	-115.0	-71.0	7.00	5.55	-102.4
	V	-115.0	-70.3	7.00	5.55	-101.8
3071.85	H	-106.8	-52.4	9.67	5.75	-86.4
	V	-108.7	-59.0	9.67	5.75	-92.9
3583.825	H	-106.5	-55.3	10.00	5.95	-89.4
	V	-102.8	-48.4	10.00	5.95	-82.5
4095.8	H	-98.7	-44.1	11.17	5.95	-79.4
	V	-98.2	-43.6	11.17	5.95	-78.9
4607.775	H	-111.0	-54.1	11.67	7.05	-88.8
	V	-110.0	-53.1	11.67	7.05	-87.8
5119.75	H	-111.3	-52.1	11.83	6.75	-87.2
	V	-107.0	-47.6	11.83	6.75	-82.7

Half Duplex

Freqency:	460.1	MHz	Spec =	-60.8	dBc
Power:	12	Watts	Highest Spur =	-75.5	dBc
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
920.2	H	-96.8	-62.2	3.50	-0.48	-106.9
	V	-92.2	-48.5	3.50	-0.48	-93.3
1380.3	H	-94.7	-56.8	5.00	4.75	-97.8
	V	-89.2	-51.0	5.00	4.75	-92.0
1840.4	H	-104.2	-62.0	5.50	4.95	-103.3
	V	-101.5	-61.6	5.50	4.95	-103.0
2300.5	H	-106.0	-63.3	6.83	5.55	-105.4
	V	-103.8	-58.9	6.83	5.55	-101.0
2760.6	H	-105.0	-56.8	7.33	5.75	-99.2
	V	-101.2	-56.0	7.33	5.75	-98.4
3220.7	H	-92.8	-44.5	9.83	5.75	-89.3
	V	-92.8	-41.3	9.83	5.75	-86.2
3680.8	H	-101.7	-46.3	10.33	5.95	-91.5
	V	-101.2	-48.2	10.33	5.95	-93.3
4140.9	H	-86.0	-32.1	11.17	5.95	-78.1
	V	-85.2	-29.5	11.17	5.95	-75.5
4601	H	-106.8	-50.1	12.00	7.05	-95.8
	V	-108.3	-51.3	12.00	7.05	-97.0

Freqency:	460.1	MHz	Spec =	-50.0	dBc
			Highest		
Power:	1	Watts	Spur =	-85.3	dBc
	30.0	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
920.2	H	-102.3	-67.6	3.50	-0.48	-101.6
	V	-96.7	-53.0	3.50	-0.48	-87.0
1380.3	H	-105.7	-67.8	5.00	4.75	-98.1
	V	-100.7	-62.5	5.00	4.75	-92.8
1840.4	H	-111.8	-69.6	5.50	4.95	-100.2
	V	-111.7	-71.8	5.50	4.95	-102.4
2300.5	H	-113.7	-71.0	6.83	5.55	-102.3
	V	-113.0	-68.1	6.83	5.55	-99.4
2760.6	H	-109.2	-61.0	7.33	5.75	-92.6
	V	-108.5	-63.3	7.33	5.75	-94.9
3220.7	H	-105.3	-56.9	9.83	5.75	-91.0
	V	-108.8	-57.3	9.83	5.75	-91.4
3680.8	H	-112.3	-56.9	10.33	5.95	-91.3
	V	-111.0	-58.0	10.33	5.95	-92.4
4140.9	H	-107.5	-53.6	11.17	5.95	-88.9
	V	-105.8	-50.1	11.17	5.95	-85.3
4601	H	-111.2	-54.5	12.00	7.05	-89.5
	V	-112.0	-55.0	12.00	7.05	-89.9

Equipment Calibration Information

Equipment	Serial Number	Cal Date	Cal Due
HP 8563E Spectrum Analyzer	3221A00149	4/15/2010	4/15/2012
Agilent E8257D Signal Generator	MY44320507	4/20/2010	4/20/2012
HP 8901A Modulation Analyzer	2950A05551	4/12/2010	4/12/2012
Advantest R3162	111000901	7/24/2009	7/24/2011
HP 437B Power Meter	3125U13882	4/12/2010	4/12/2012

Instruments have been calibrated using standards with accuracies traceable to NIST standards.