Alligator Communications
2888Transceiver

FCC ID: JIL2888
Model Nos: 2888A (analog), 2888D (digital)
FCC Rule Part: 101

General Overview

A description of the theory of operation and product configuration is found in an attachment to this application and report.

SPECIFICATIONS

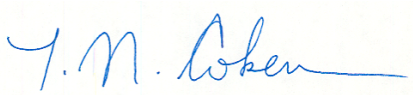
Transmitter

TX operating frequency:	928-929 MHz
TX output power:	5 watts
Modulation:	FSK
	Modulation is internally generated and limited
Power requirements:	11-16.5 VDC, approx. 2 A maximum current draw
Antenna connector:	N- type
Frequency Tolerance	.00015% , ±1392 Hz
	-30 to +50 C
	85%-115% supply voltage at 20C

Test Site

Radiated emissions tests, power output, and occupied bandwidth tests were performed at Compliance Certification Services. Frequency stability and emissions masks tests were performed at Alligator Communications.

Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.



THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals
Agent for Alligator Communications

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2.

1.1307(b) RF exposure information is provided in a separate attachment in the form of maximum permissible exposure (MPE) data.

2.1033(c)1 Applicant: Alligator Communications Inc.
317 Brokaw Road
Santa Clara CA 95050

2.1033(c)2 FCC ID: JIL2888

2.1033(c)3 Installation instructions are found in separate document.

2.1033(c)4 Emission type: FSK from internal modem

Emission designator: 12.5 kHz bandwidth: 8K00F3D (analog)
9K64F1D (digital)

25 kHz : 15K1F3D (analog)
13K7F1D (digital)

2.1033(c)5 Frequency range: 928-929 MHz

2.1033(c)6 Range of Operating Power

5 watts nominal (37.0 dBm)

2.1033(c)7 Maximum Power Rating

37.7 dBm measured = 5.89 watts

Maximum allowed per 101.113(a): 25 watts ERP (44 dBm ERP)

2.1033(c)8 Applied voltages and currents into the final transistor elements

Refer to schematics, separate submission accompanying this application

2.1033(c)9 Tune-up procedure

Refer to installation instructions..

2.1033(c)10 Circuit and Functional Block Diagram, Description of Circuitry

Complete product schematics are provided in separate attachments.
Circuit description and theory of operation are found in separate attachment.

2.1033(c)11 FCC ID Label

Refer to separate attachment.

2.1033(c)12 Product Photographs

Refer to separate attachment.

2.1033(c)13 Description of Modulation System

1200 bps analog or 300-4800 bpsFSK digital, from internal modems. Internal modem is analog(1200 baud Direct Interface, Asynchronous: RS-232), or digital (300-4800 baud Direct Interface, Asynchronous: RS-232), depending on model.

2.1033(c)14 Test Data per 2.1046 – 2.1057

CCS Test Equipment

Preamplifier, 1 ~ 26 GHz	**HP**	**8449B**	**3008A00931**	**06/24/2006**
Spectrum Analyzer 3 Hz ~ 44 GHz	**Agilent**	**E4446A**	**MY45300064**	**12/19/2006**
Spectrum Analyzer, 26.5 GHz	**HP**	**8593EM**	**3710A00205**	**07/26/2006**
Preamplifier, 1300 MHz	**HP**	**8447D**	**1937A02062**	**01/23/2007**
Antenna, Bilog 30 MHz ~ 2 Ghz	**Sunol Sciences**	**JB1**	**A121003**	**03/03/2006**
Antenna, Horn 1 ~ 18 GHz	**EMCO**	**3115**	**6717**	**04/22/2006**
Attenuator (3)	**Pasternack**	**PE7014-10**	**N/A**	**N/A**

Alligator Test Equipment

Tenney Engineering, Inc Model Tenney Jr. Temperature Chamber

Mfr.	**Model**	**Description**	**Cal Due**
Hewlett Packard	HP 8648C	Signal Generator	15July2006
Hewlett Packard	HP 8920A	Service Monitor	
Hewlett Packard	HP 8561B	Spectrum Analyzer	
Tenney Engineering	Tenney Jr.	Temperature Chamber	

Note: Analyzer frequency and amplitude readings confirmed by signal substitution with calibrated signal generator

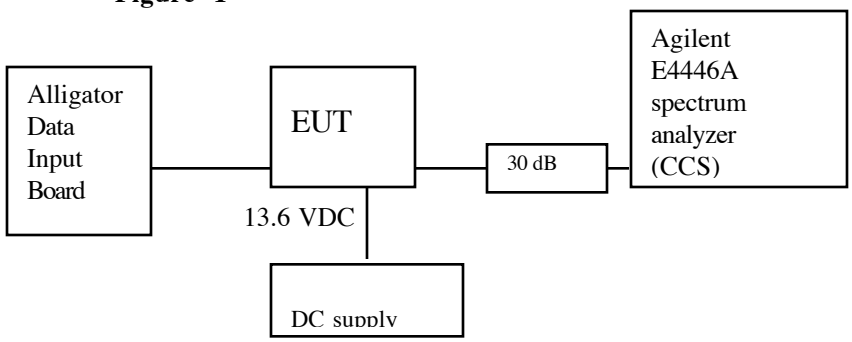
2.1046 RF Output Power Measurements

Measurement equipment used:

Spectrum Analyzer
Attenuator, 30 dB

Test set-up:

Figure 1



Test Procedures

1. Set the transmitter to produce maximum modulated power at the desired frequency
2. Set analyzer RBW and VBW to 100 kHz greater than 99% BW
3. Read PEAK output power

Test Results

F(MHz)	TX Mode	Pout, dBm
928.5	12.5 kHz analog	37.36
928.5	25 kHz analog	37.2
928.5	12.5 kHz digital	37.7
928.5	25 kHz digital	37.44

Section 2.1047 Modulation Characteristics
Requirement/Limit: 101.111(a)5

101.111 Emission limitations

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) When using transmissions other than those employing digital modulation techniques:

(i) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 decibels;

(ii) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 decibels;

(iii) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43+10 Log_{10} (mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

(5) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a 12.5 KHz bandwidth, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 $\log_{10}$ (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 $\log_{10}$ (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 $\log_{10}$ (fd/5.3) decibels; and

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 $\log_{10}$(P) or 70 decibels, whichever is the lesser attenuation.

(6) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a bandwidth greater than 12.5 KHz, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

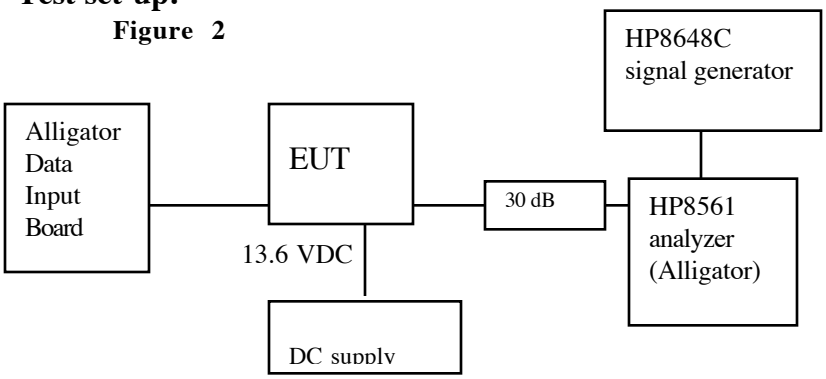
(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 5 KHz up to and including 10 KHz: At least 83 $\log_{10}$ (fd/5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 10 KHz up to and including 250 percent of the authorized bandwidth: At least 116 $\log_{10}$ (fd/6.1) decibels or 50 plus 10 $\log_{10}$ (P) or 70 decibels, whichever is the lesser attenuation; and

(iii) On any frequency removed from the center of the authorized bandwidth by more that 250 percent of the authorized bandwidth: At least 43 plus 10 $\log_{10}$ (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

Test set-up:

Figure 2



Test Procedures

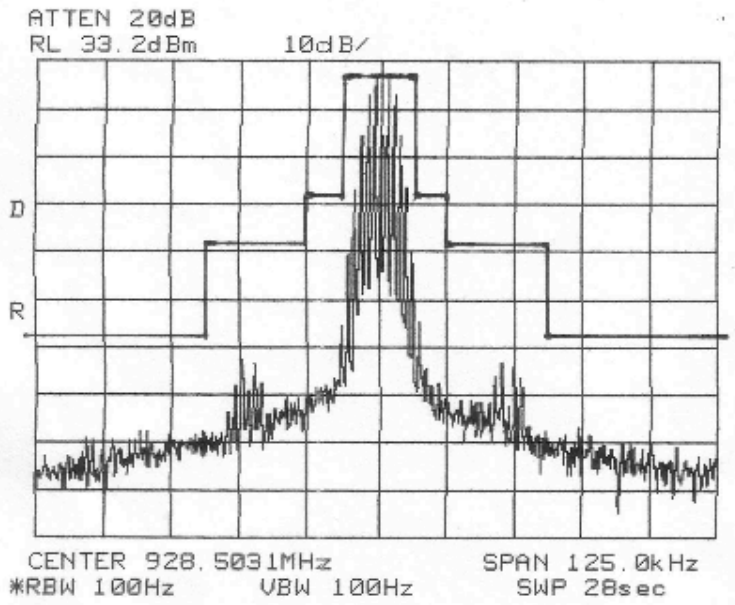
a. Set the transmitter to produce maximum modulated power at the desired frequency
b. Set RBW and VBW to required values and record emission masks.

Test Results

PASS. Refer to attached spectrum analyzer charts .

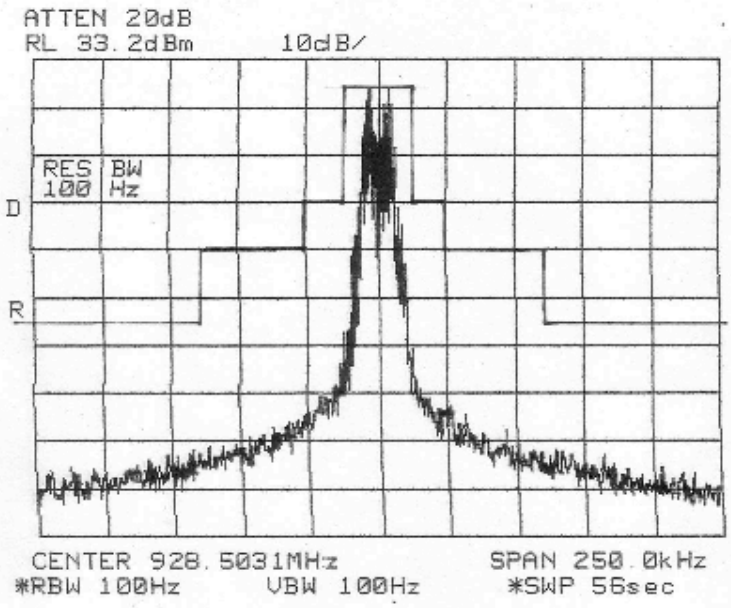
Emissions are shown with mask lines superimposed on spectrum analyzer charts.

Channel Mask for fo = 928.5 MHz, 12.5 kHz Analog



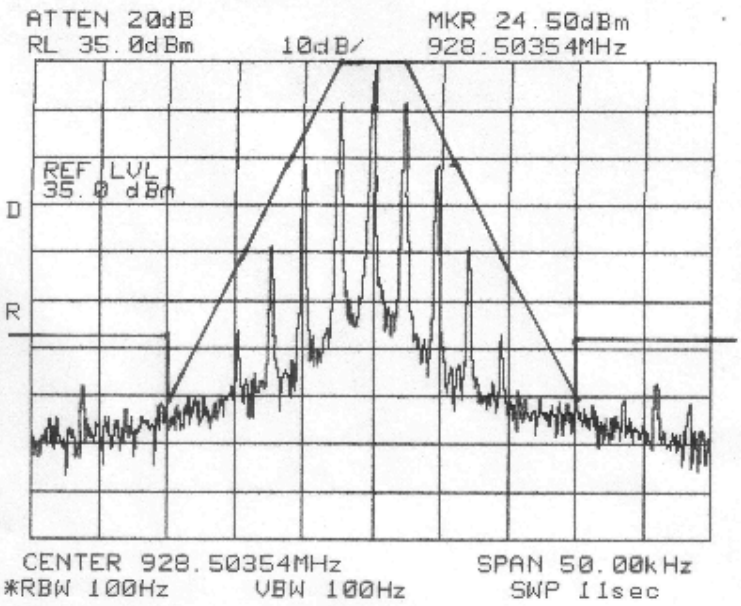
1 Analog 12.5 KHz bandwidth

Channel mask for fo= 928.5 MHz 25 kHz channel



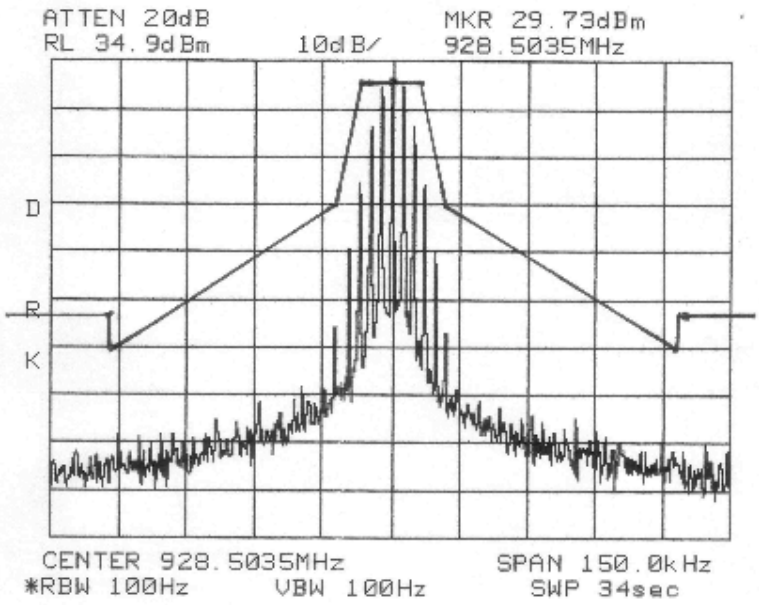
2 Analog 25.0 KHz bandwidth

Channel Mask for fo = 928.5 MHz Digital 12.5 kHz channel



3 Digital 12.5 KHz bandwidth

Channel mask for fo = 928.5 MHz Digital 25 kHz channel



4 Digital 25.0 KHz bandwidth

Section 2.1049 Occupied Bandwidth
Requirement/Limit: 101.109

(c) The maximum bandwidth which will be authorized per frequency assigned is set out in the table that follows. Regardless of the maximum authorized bandwidth specified for each frequency band, the Commission reserves the right to issue a license for less than the maximum bandwidth if it appears that a lesser bandwidth would be sufficient to support an applicant's intended communications

Frequency band (MHz)	Maximum authorized bandwidth
928 to 929.....	25 kHz 1 5 6

\1\ The maximum bandwidth that will be authorized for each particular frequency in this band is detailed in the appropriate frequency table in § 101.147. If contiguous channels are aggregated in the 928-928.85/952-952.85/956.25-956.45 MHz, the 928.85-929/959.85-960 MHz, or the 932-932.5/941-941.5 MHz bands, then the bandwidth may exceed that which is listed in the table.

\5\ A 12.5 kHz bandwidth applies only to frequencies listed in § 101.147(b)(1) through (4).
\6\ For frequencies listed in § 101.147(b)(1) through (4), consideration will be given on a case-by-case basis to authorizing bandwidths up to 50 kHz.

Measurement equipment used:

HP 8563E Spectrum Analyzer
Coaxial attenuators (3dB and 10 dB)
Coaxial cable, 3ft

Test set-up:

Refer to Fig. 1

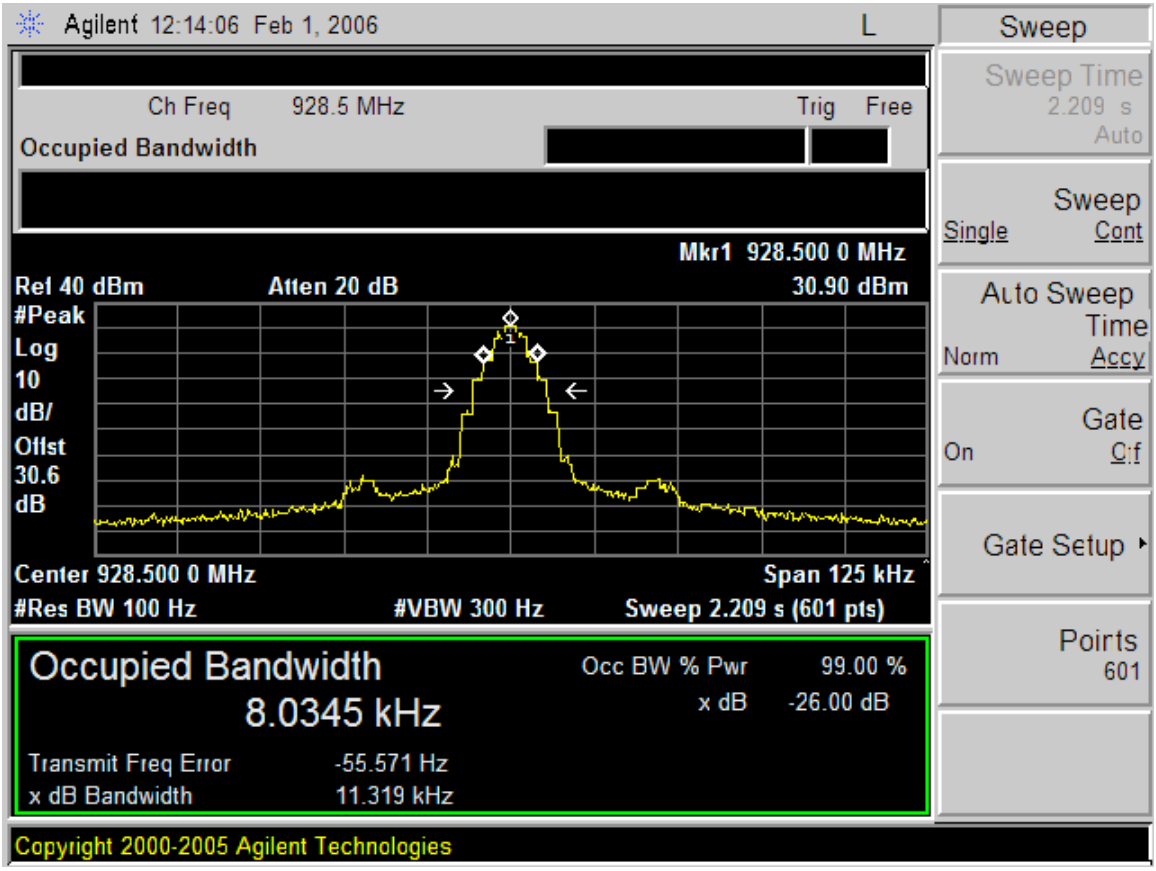
Test Procedures and Results:

Occupied bandwidth was measured manually using analyzer internal Occupied Bandwidth measurement function.

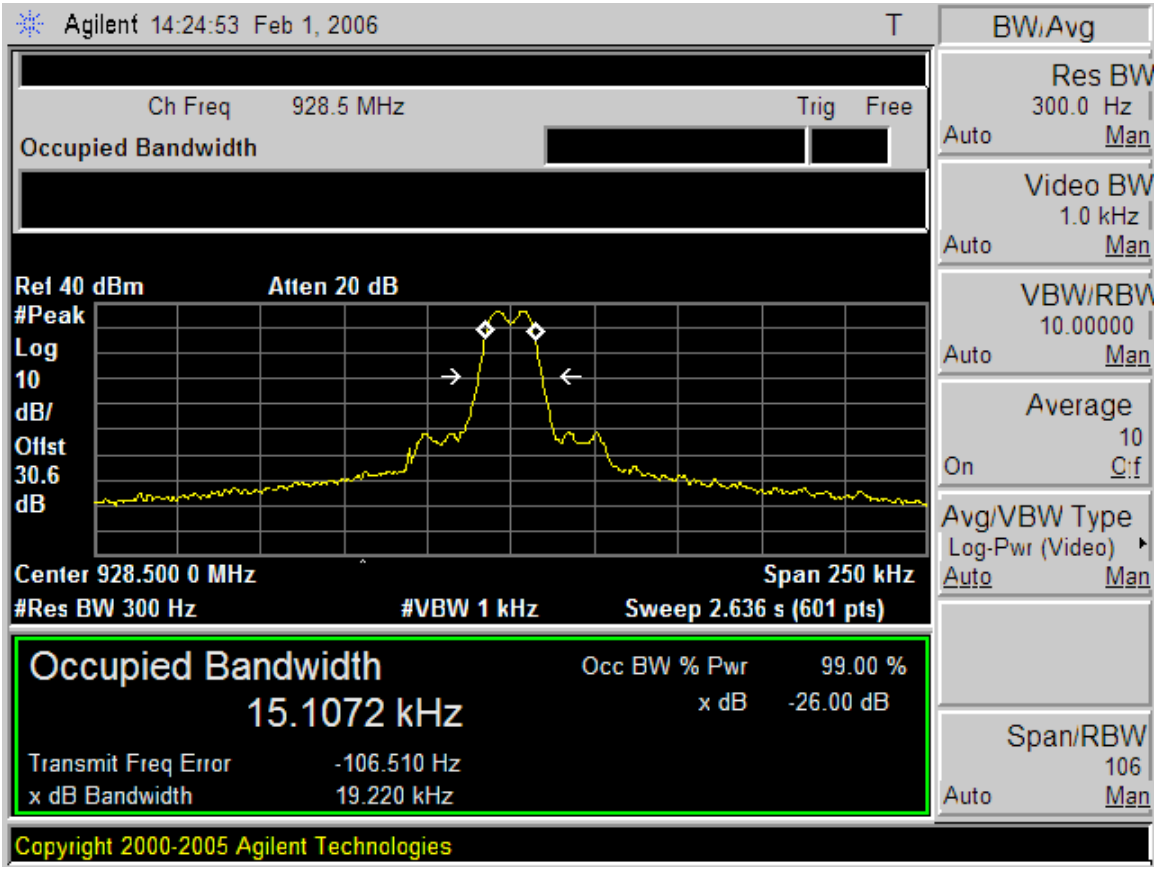
Test Results

Refer to spectrum analyzer plots below

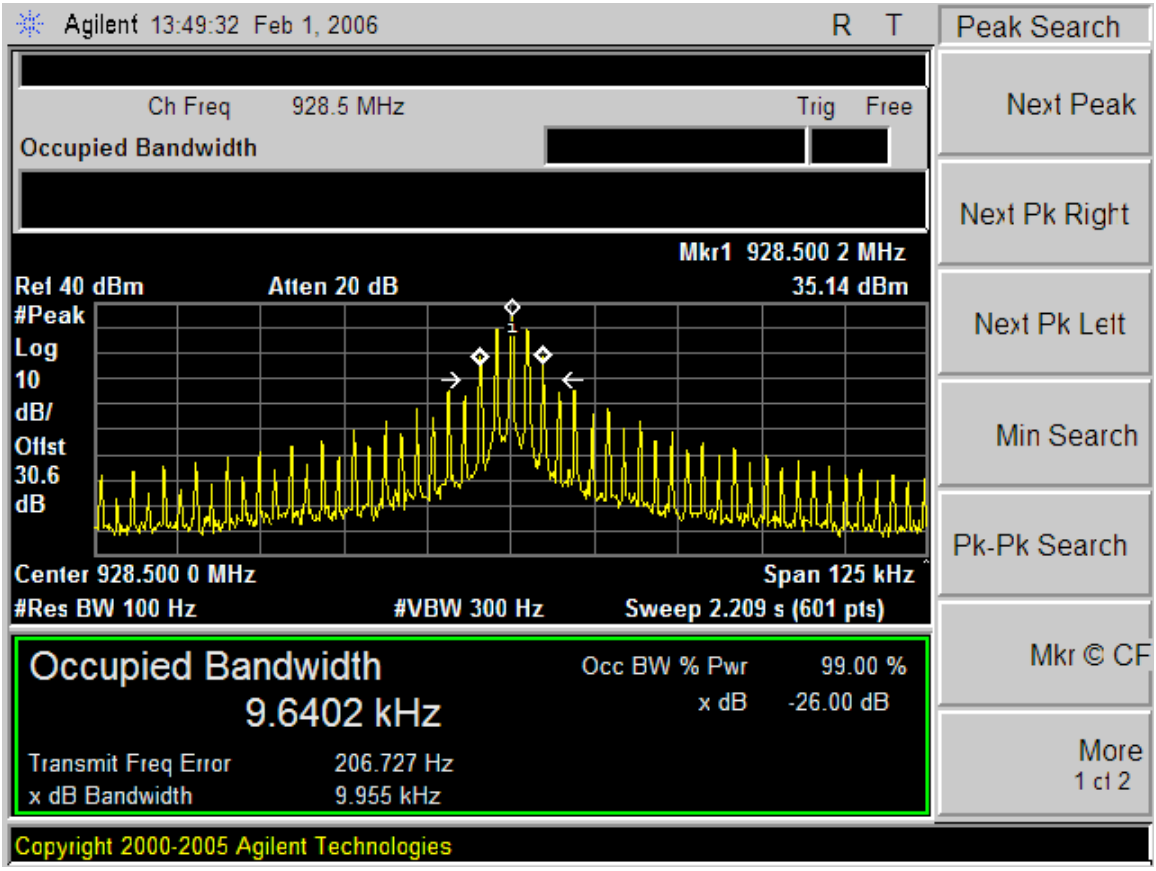
Occupied Bandwidth, Analog, 12.5 kHz channel



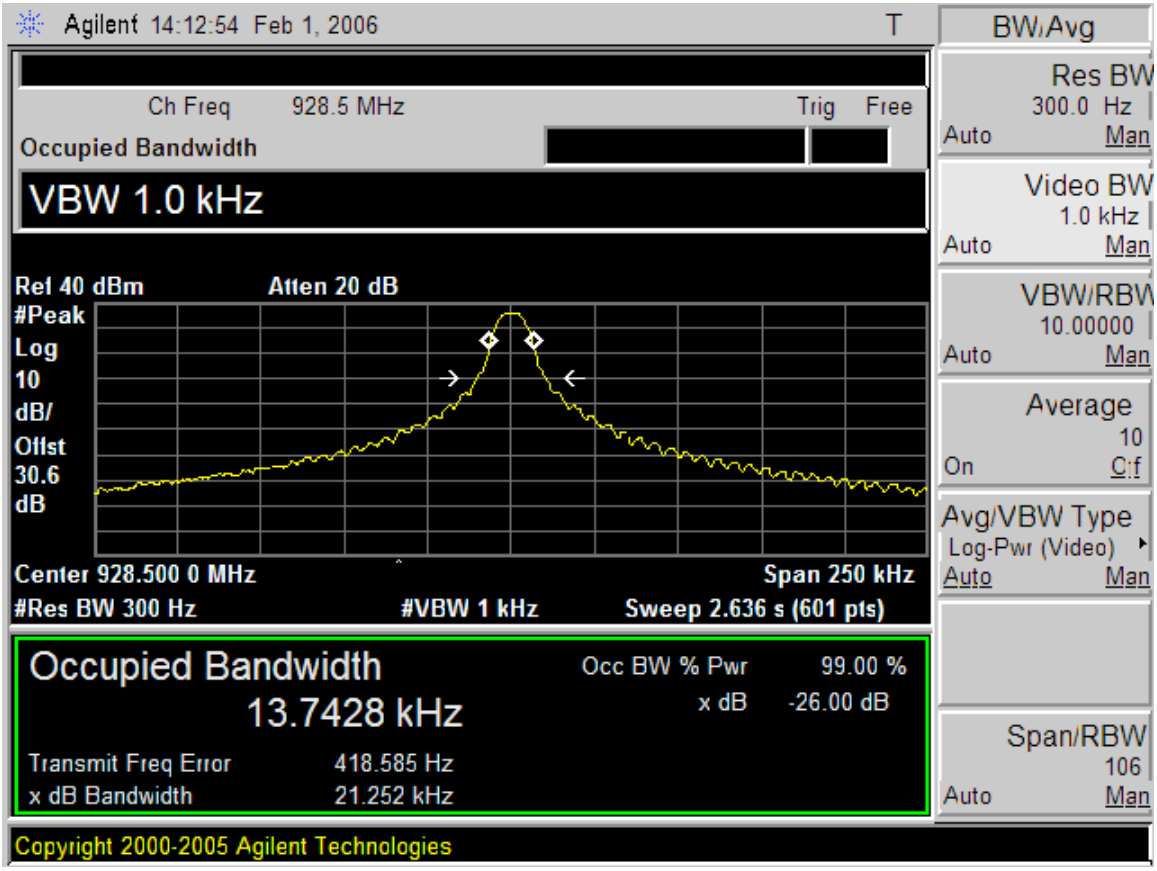
Occupied Bandwidth, Analog, 25 kHz channel



Occupied Bandwidth, Digital, 12.5 kHz channel



Occupied Bandwidth, Digital, 25 kHz channel



Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals
Requirement/Limit: 101.111(a)5

101.111 Emission limitations
(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) When using transmissions other than those employing digital modulation techniques:

(i) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 decibels;

(ii) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 decibels;

(iii) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43+10 Log_{10} (mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

(5) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a 12.5 KHz bandwidth, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 $\log_{10}$ (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 $\log_{10}$ (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 $\log_{10}$ (fd/5.3) decibels; and

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 $\log_{10}$(P) or 70 decibels, whichever is the lesser attenuation.
(6) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a bandwidth greater than 12.5 KHz, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 5 KHz up to and including 10 KHz: At least 83 $\log_{10}$ (fd/5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 10 KHz up to and including 250 percent of the authorized bandwidth: At least 116 $\log_{10}$ (fd/6.1) decibels or 50 plus 10 $\log_{10}$ (P) or 70 decibels, whichever is the lesser attenuation; and

(iii) On any frequency removed from the center of the authorized bandwidth by more that 250 percent of the authorized bandwidth: At least 43 plus 10 $\log_{10}$ (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

Test set-up:

Refer to Figure 1 above

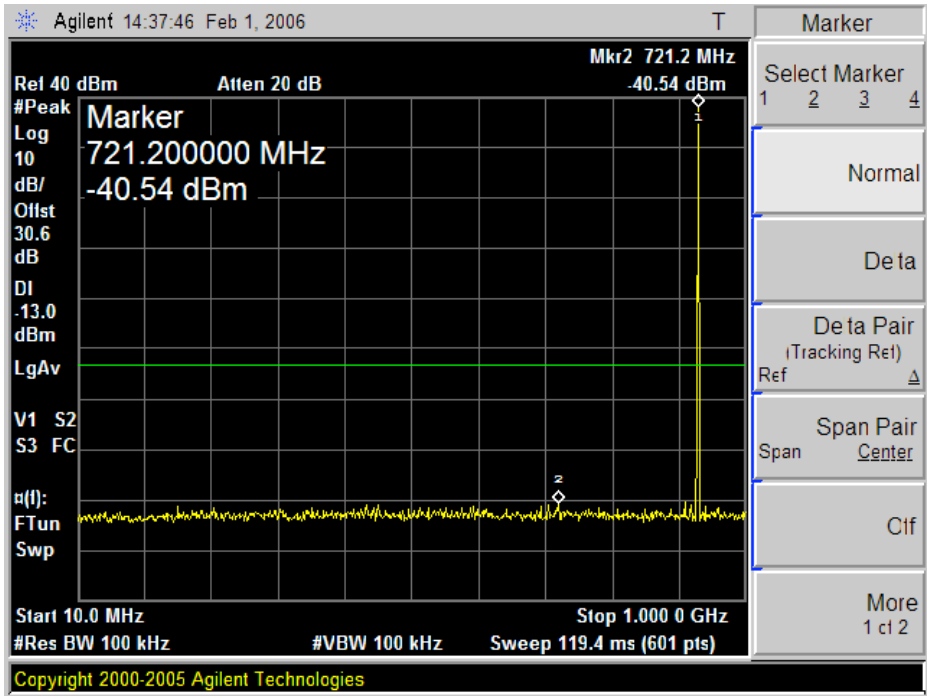
Test Procedures

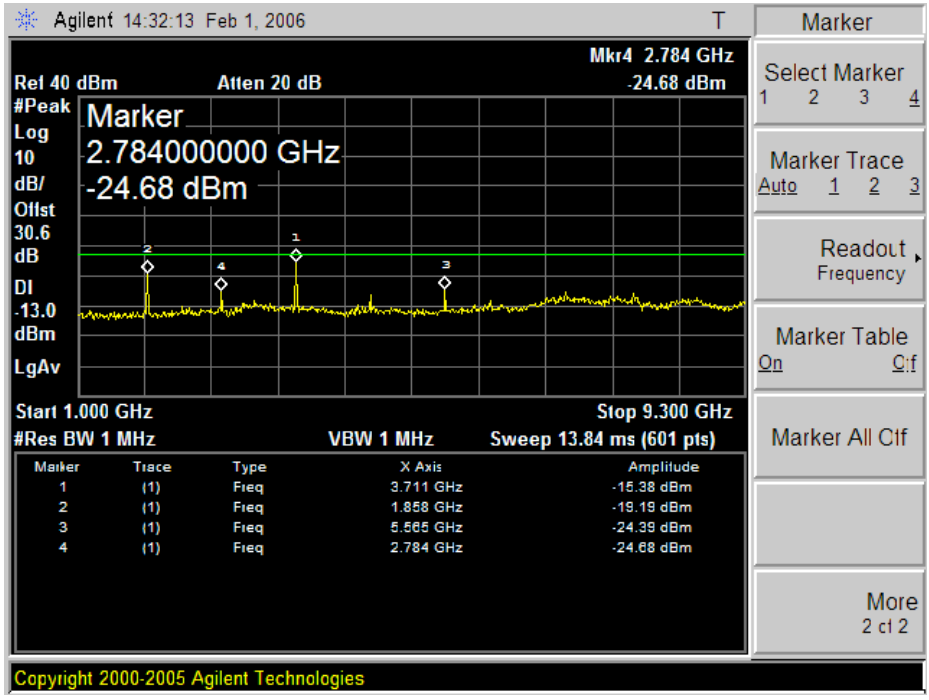
1. Record transmitter output spectrum from 1 MHz to 10th harmonic of TX output frequency
2. Plot spectrum analyzer output traces.

Test Results

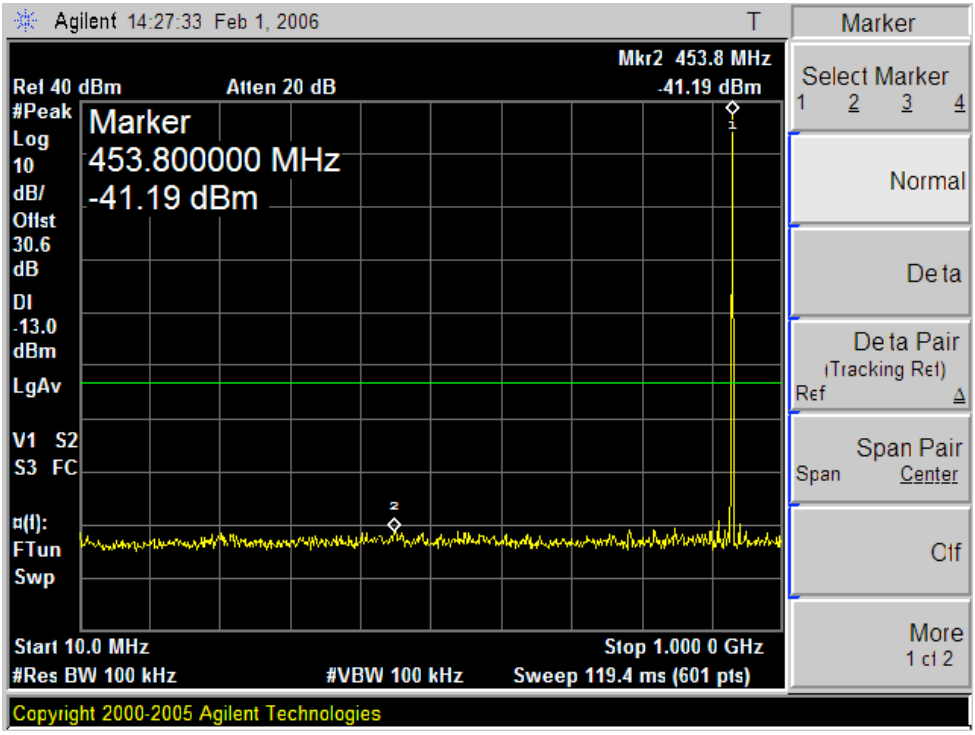
PASS. Refer to data plots below.

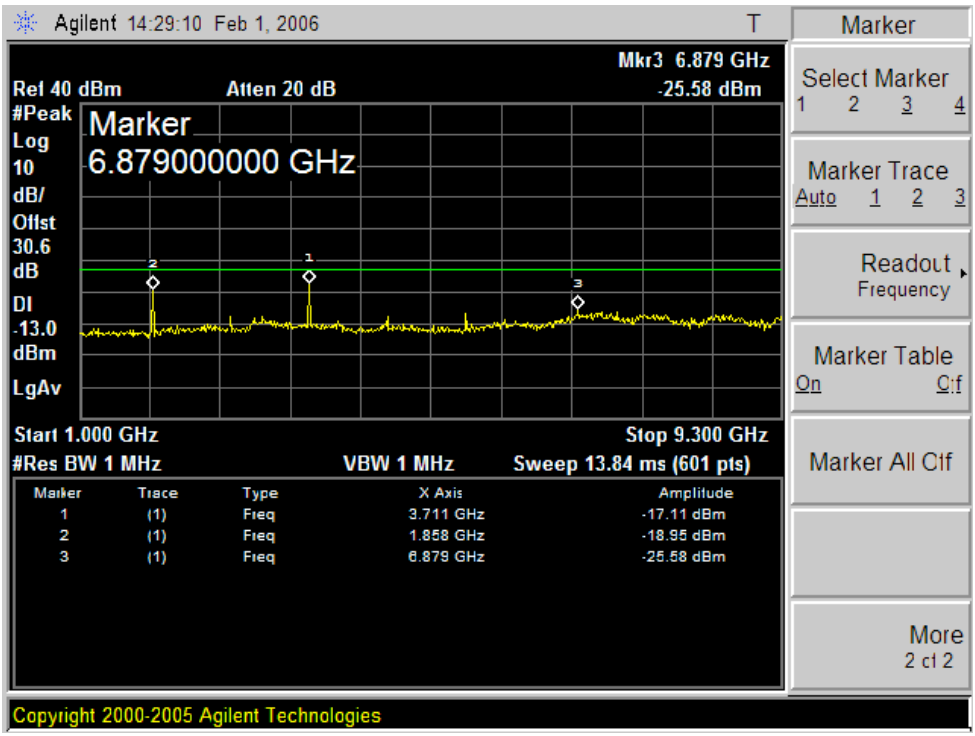
Spurious emissions, Analog, 12.5 kHz channel



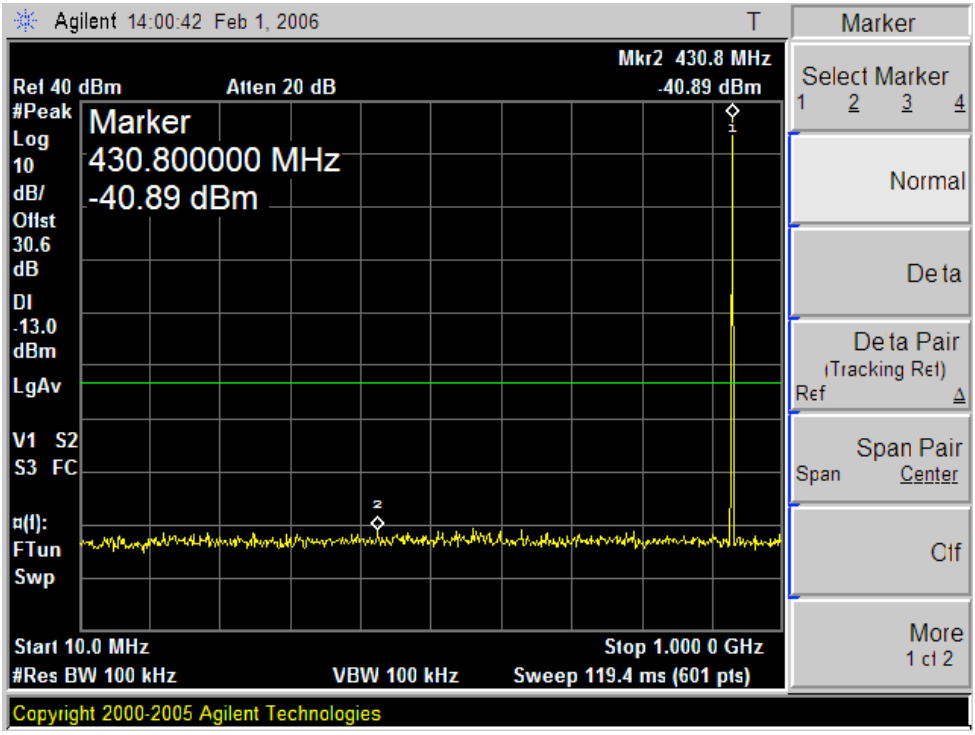


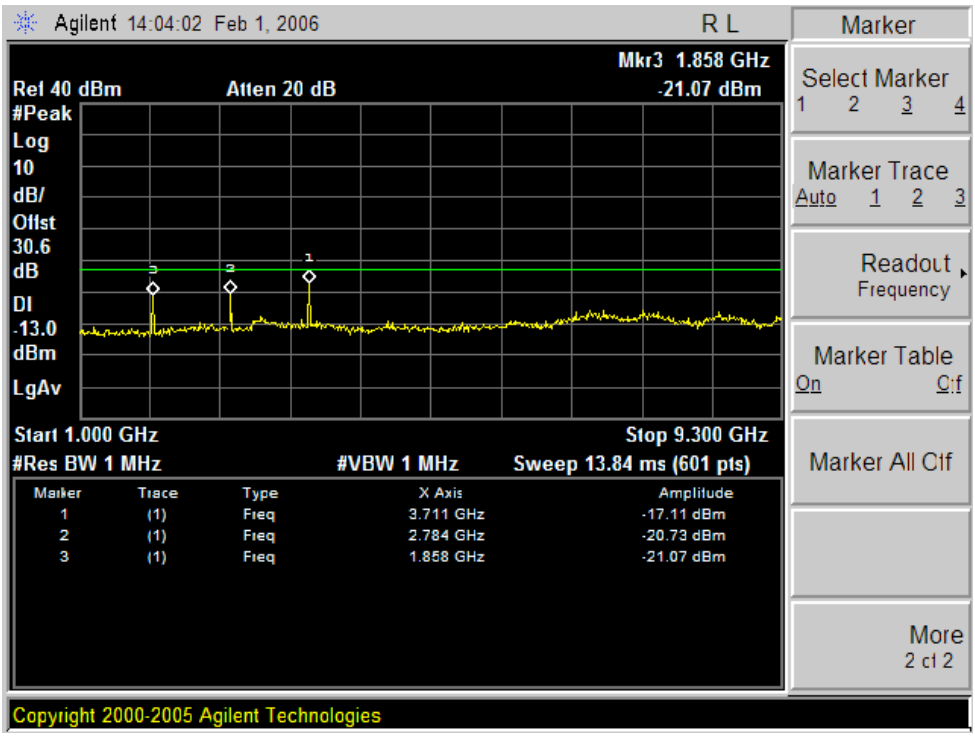
Spurious emissions, Analog, 25 kHz channel



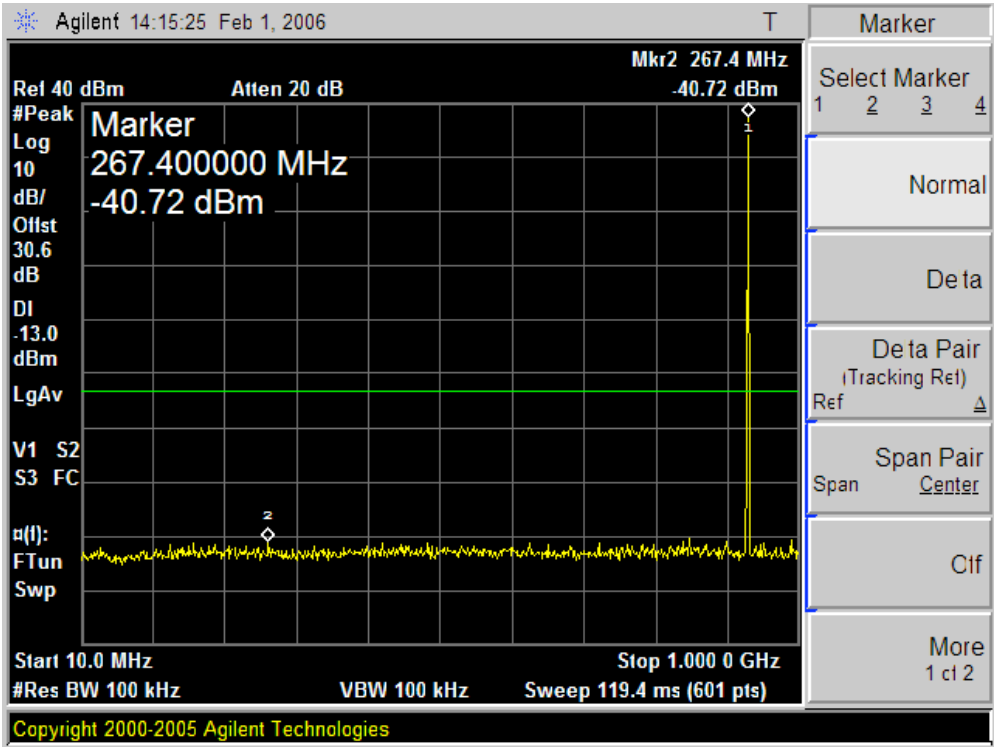


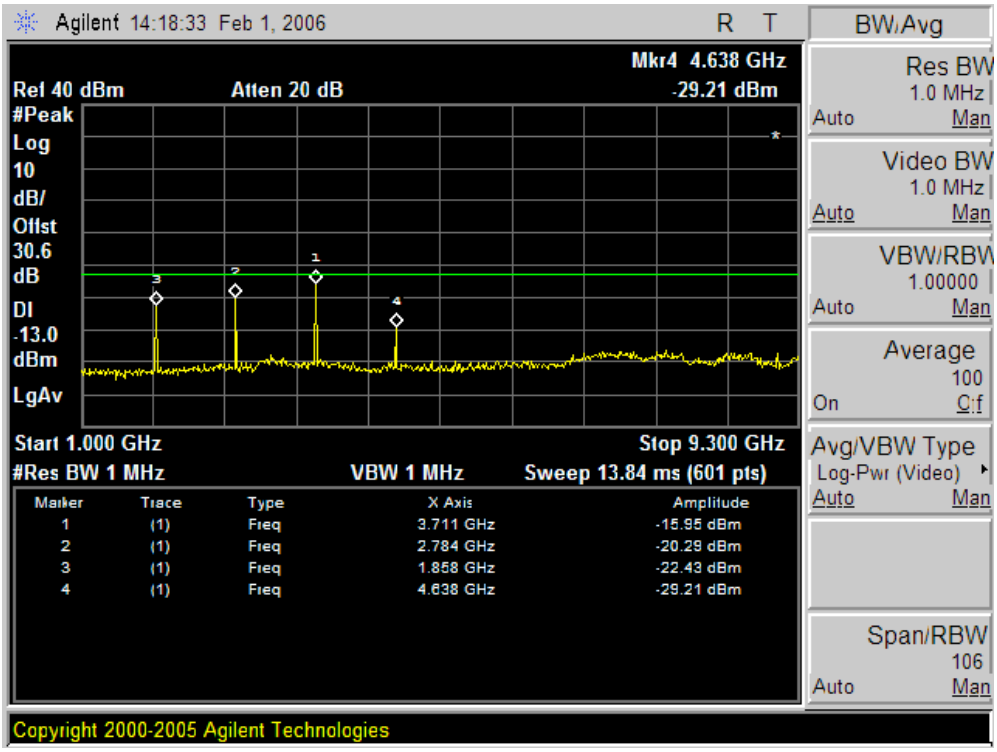
Spurious emissions, Digital, 12.5 kHz channel





Spurious emissions, Analog, 25 kHz channel

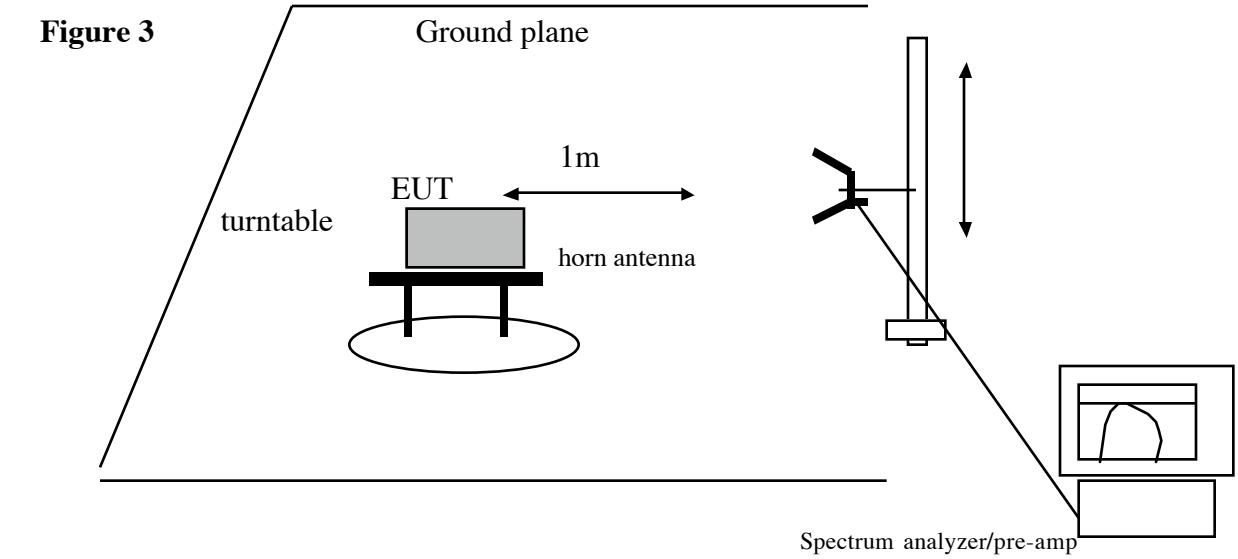


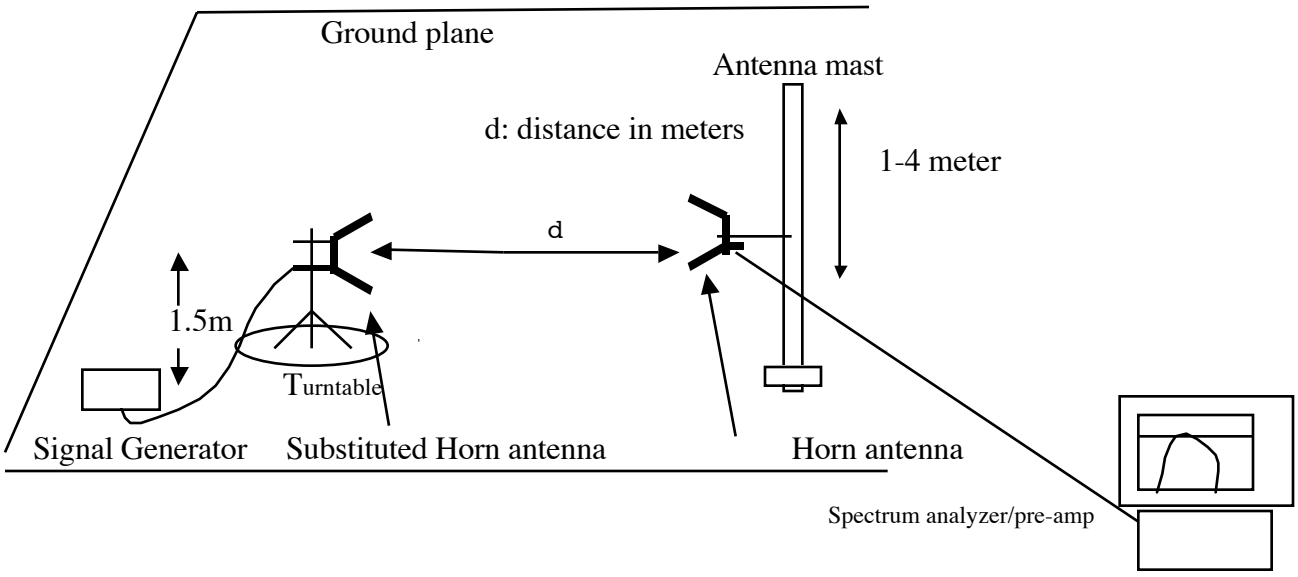


Section 2.1053 Field Strength of Spurious and Harmonic Radiation
Requirement/Limit: 101.111(a)5

Test Set-Up

Figure 3





Minimum Requirement

-20 dBm ERP beyond 250% of authorized bandwidth

Test Method

The antenna output port of the EUT was terminated with a 50 ohm load. With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was raised and lowered in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 10 fo.

The EUT was removed and was replaced by a substitution antenna connected via coax to a signal generator. The generator output was set to each emission frequency detected, the search antenna was raised and lowered, the turntable was rotated, until the maximum emission level was obtained. The signal generator output level was adjusted to match the radiated emission level from the EUT. After correcting for substitution antenna factor and generator cable loss, output power level is compared to the limit.

Test Results

Pass. All emissions detected were at least 25 dB below limits. Refer to worst-case data below.

02/01/06 **High Frequency Substitution Measurement**
Compliance Certification Services, Morgan Hill 5m Chamber Site

Test Engr: Vien Tran
Project #: 06U10059
Company: Alligator
EUT Descrip.: 928-925 MHz Radio
EUT M/N:
Test Target: Part 90
Mode Oper: Tx (Analog)

Test Equipment:

EMCO Horn 1-18GHz: T73; S/N: 6717 @3m
Horn > 18GHz:
Limit: ERP

Hi Frequency Cables
☐ (2 ft) ☑ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Pre-amplifer 1-26GHz: T144 Miteq 3008A00
Pre-amplifer

f GHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)
1.857	69.5	V	-43.4	1.7	8.6	6.4	-38.6	-13.0	-25.6
3.713	50.4	V	-55.1	2.4	9.5	7.3	-50.2	-13.0	-37.2
5.573	48.8	V	-52.3	3.2	10.8	8.6	-46.9	-13.0	-33.9
1.857	63.5	H	-48.7	1.7	8.6	6.4	-43.9	-13.0	-30.9
3.713	55.0	H	-50.4	2.4	9.5	7.3	-45.5	-13.0	-32.5
4.640	49.3	H	-53.7	2.8	10.0	7.8	-48.7	-13.0	-35.7
	No other emissions were detected up to 10th harmonic								

02/01/06 **30 - 1000MHz Substitution Measurement**
Compliance Certification Services, Morgan Hill 5m Chamber Site

Test Engr: Vien Tran
Project #: 06U10059
Company: Alligator
EUT Descrip.: 928-925 MHz Radio
EUT M/N:
Test Target: Part 90
Mode Oper: Tx (Analog))

Test Equipment:

Bilog Antenna	Cable	Pre-amplifer 8447D	Limit
5m Chamber Sunol Bilog	5m Chamber Cable	T5 8447D	ERP

f MHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)	Notes
54.60	45.2	V	-70.8	1.1	-3.6	-5.8	-77.7	-13.0	-64.7	
76.80	39.8	V	-72.6	1.2	-0.9	-3.1	-76.8	-13.0	-63.8	
89.20	40.7	H	-73.1	1.3	-0.2	-2.4	-76.8	-13.0	-63.8	
163.50	40.4	H	-68.6	1.6	1.6	-0.6	-70.8	-13.0	-57.8	
	No other emissions were detected above system noise floor									

2.1055 Frequency Stability

Requirement/Limit: Section 101.107

Frequency Tolerance : .00015% (1.5 parts per million)
= ±1434 Hz at 956 MHz
= ±1428 Hz at 952 MHz

101.107 Note 5
For private operational fixed point-to-point microwave systems, with a channel greater than or equal to 50 KHz bandwidth, ±0.0005%; for multiple address master stations, regardless of bandwidth, ±0.00015%; for multiple address remote stations with 12.5 KHz bandwidths, ±0.00015%; for multiple address remote stations with channels greater than 12.5 KHz bandwidth, ±0.0005%.

Temperature Range: -30C to +50 C
Supply Voltage Range: 85% - 115% nominal 13.6 VDC (11.6 - 15.6 VDC)

Temperature v Frequency, -30C to +50C

c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

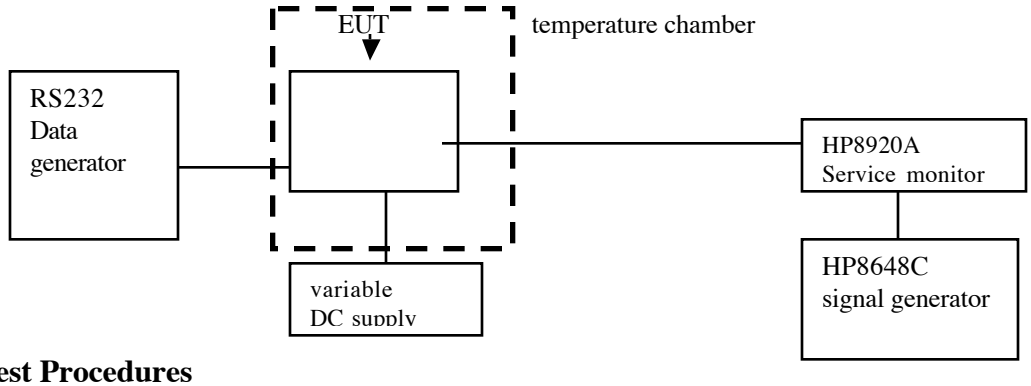
(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0[deg] centigrade and +30[deg] centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10[deg] centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

Test Setup

Figure 4



Test Procedures

1. The temperature stabilization characteristics of the OCXO were determined first. At –30C, the transmitter was allowed to stabilize with TX power off. The transmitter was activated, the frequency was measured and recorded. The frequency was measured once per minute after that until it was determined that frequency had stabilized. This process was repeated at 0C and +30C.
2. After stabilization tests in 1 were concluded the transmitter was allowed to stabilize at every 10 degrees C from –30C to +50C.

Test Results

Refer to table below.

Operating Voltage v Frequency

Measurement Equipment Used

HP 8593EM Spectrum analyzer

Test Setup

Refer to Figure 3

Test Procedures

At 25C the power supply voltage was varied between 85% and 115% nominal.

Test Results

No detectable variation. over voltage excursion.

Frequency stability over temperture

Output frequency = 928.500000 MHz

Max. deviation limit = 0.00015%, 13927 Hz

Temp °C	Δ freq. Hz
-30	284
-20	258
-10	143
0	141
10	129
20	21
30	-118
40	-279
50	-388

Supply voltage, Vdc	F, MHz	Δ Hz	Limit, Hz
15.025(115 %)	928.500	35	13927
13.75(100 %)	928.500	5	13927
11.475(85%)	928.500	70	13927

15.109 Receiver Radiated Emissions

Receiver radiated emissions tests were performed concurrently with TX radiated emissions tests. No emissions were detected from receiver portion of the EUT.