FCC Certification Test Report

FCC Certification Test Report
for
Cattron-Theimeg, Inc.
FCC ID: CN2EPH-A90

November 18, 2003

Prepared for:

Cattron-Theimeg, Inc.
58 Shenango Street
Sharpsville, PA 16150

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

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for the
Cattron-Theimeg, Inc.
P03-A Paddle Controller
FCC ID: CN2EPH-A90

November 18, 2003

WLL JOB# 7482

Prepared by: Brian J. Dettling
Documentation Specialist

Reviewed by: Gregory M. Snyder
Chief EMC Engineer

Abstract

This report has been prepared on behalf of Cattron-Theimeg, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Transceiver under Part 90 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Cattron-Theimeg, Inc. P03-A Paddle Controller.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Cattron-Theimeg, Inc. P03-A Paddle Controller complies with the limits for a Transceiver device under Part 90 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Cattron-Theimeg, Inc. P03-A Paddle Controller complies with the requirements for a Transceiver device under Part 90 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 2001 version of ANSI C63.4 and TIA/EIA-603-93. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Cattron-Theimeg, Inc. 58 Shenango Street Sharpsville, PA 16150
Purchase Order Number:	126567
Quotation Number:	60678

1.4 Test Dates

Testing was performed from March 21, 2003 to April 24, 2003.

1.5 Test and Support Personnel

Washington Laboratories, LTD Steve Koster, James Ritter

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Cattron-Theimeg, Inc. P03-A Paddle Controller is a heavy industrial remote controller designed to duplicate the operating characteristics of the controls most commonly found on applicable heavy equipment. It can be used with all CATTRON-THEIMEG™ AT Series or MP Series receiver/decoder units as well as being used with existing CATTRON-THEIMEG™ PRRC systems as either a replacement or spare controller.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Cattron-Theimeg, Inc.
FCC ID Number	CN2EPH-A90
EUT Name:	Radio Transceiver
Model:	P03-A
FCC Rule Parts:	§90
Frequency Range:	447MHz to 473MHz
Maximum Output Power:	0.450 Watts
Modulation:	FSK
Occupied Bandwidth:	5.47 kHz (20dB Bandwidth)
Keying:	Manual
Type of Information:	Control
Number of Channels:	3
Power Output Level	Fixed
Antenna Type	1/8ë Whip
Frequency Tolerance:	2.5 ppm = 1150 Hz
Emission Type(s):	F1D
Interface Cables:	None
Power Source & Voltage:	15Vdc from battery

2.2 Test Configuration

The P03-A was tested in a stand-alone configuration.

2.3 Testing Algorithm

The P03-A was operated by being powered on and set for continuous operation.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\,(2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Site 1 List:

Equipment	Serial Number	Calibration Due
Sunol Science JB1 Biconilog Antenna	A090501	10/03/03
Hewlett-Packard Spectrum Analyzer: HP 8568B (Site 1)	2928A04750	7/02/03
Hewlett-Packard Quasi-Peak Adapter: HP 85650A (Site 1)	3303A01786	7/05/03
Hewlett-Packard RF Preselector: HP 85685A (Site 1)	3146A01296	7/02/03
Solar Electronics LISN 8012-50-R-24-BNC	8379493	6/20/03

4 Test Results

4.1 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to an attenuator and then to the input of an HP 438A RF power meter. The transmitter was set to transmit a constant carrier for the test and the RF output power was recorded.

Table 3. RF Power Output

Frequency	Level
460 MHz	448 mW (26.5dBm)

4.2 Modulation Characteristics: (FCC Part §2.1047)

Occupied Bandwidth:

The Occupied Bandwidth (FCC Part §2.1049) was measured by coupling the output of the transmitter to the spectrum analyzer. The Occupied Bandwidth plot is shown in Figure 1. The modulation consisted of a 4000 baud test pattern and the peak deviation measured 3.2 kHz on a Boonton 82AD modulation analyzer.

Bandwidth computation at 4000 bps:

2D + 2F = 6.4 + 8

= 14k4F1D

Emission Mask:

Per Section 90.210(d) of the FCC Rules, for transmitters designed to operate 12.5kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB

2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88 \text{ kHz})$ dB.

3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log P dB.

For the EUT:

50 + 10 Log (0.450) W = 47 dB

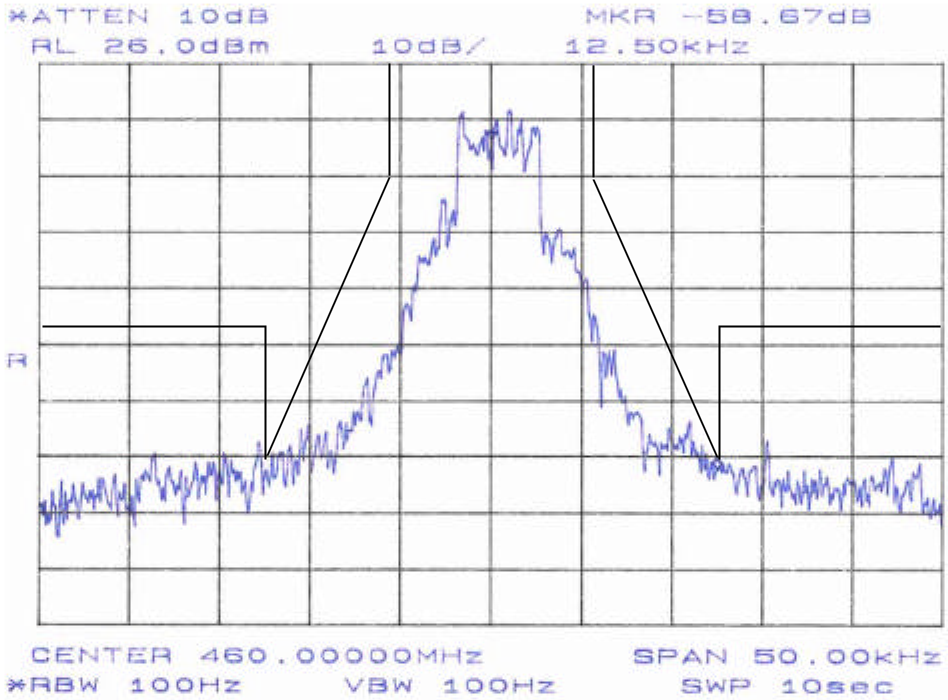

Figure 1. Occupied Bandwidth

Figure 1 provides a summary of the Occupied Bandwidth Results.

4.3 Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. All spurious emissions greater than 12.5 kHz removed from the center of the authorized bandwidth must be reduced from the fundamental by the at least 50 + 10 log P dB.

For the EUT:

$$50 + 10 \text{ Log } (0.450) \text{ W} = 47 \text{ dB}$$

Plots of the conducted spurious emissions are included as Figures 2 through 5.

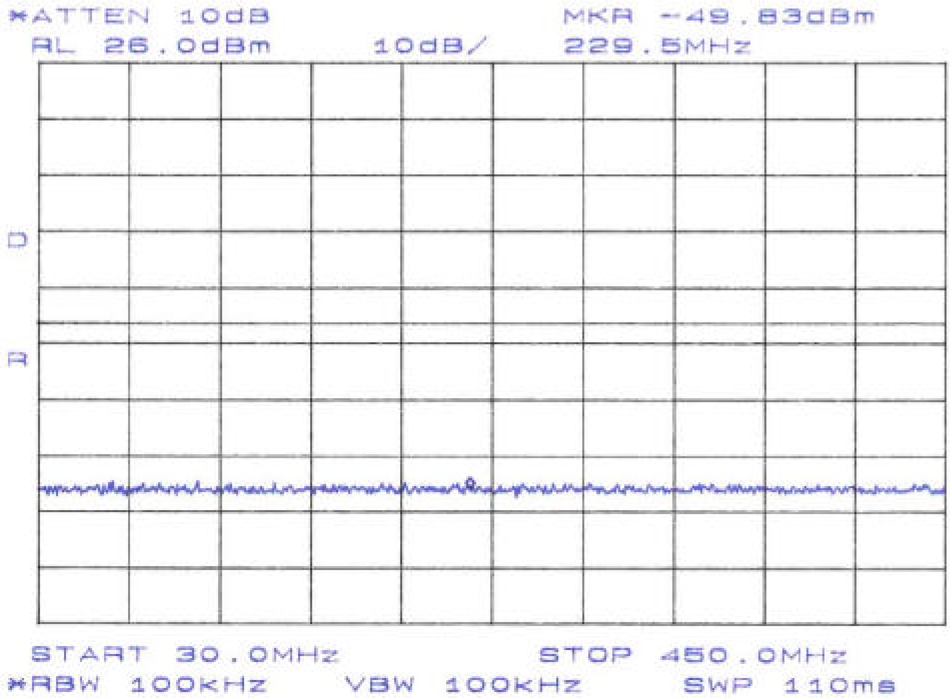

Figure 2. Conducted Spurious Emissions, 30 – 450MHz

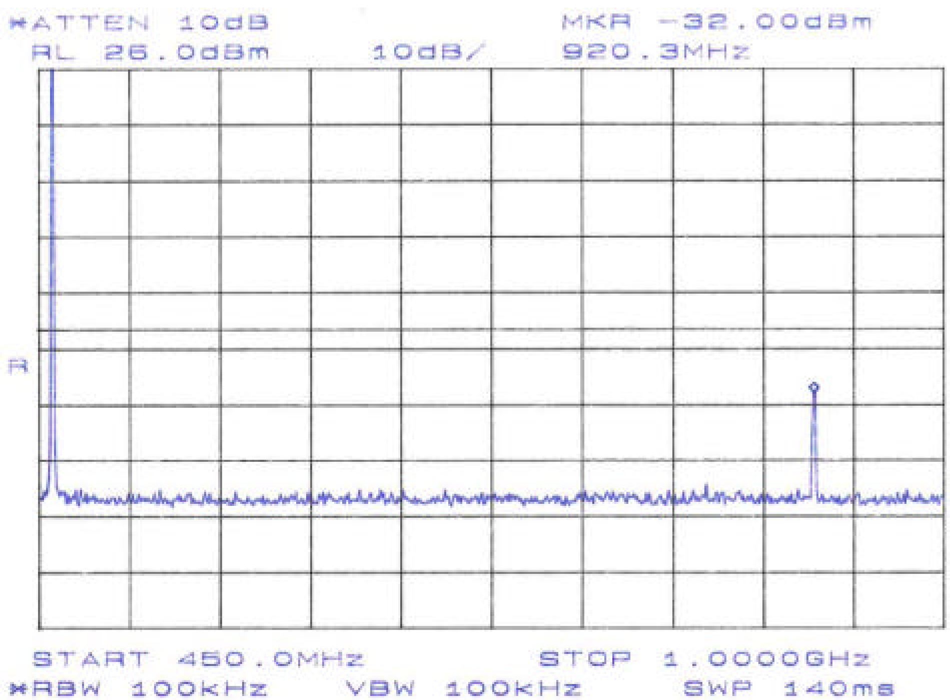

Figure 3. Conducted Spurious Emissions, 450 – 1000MHz

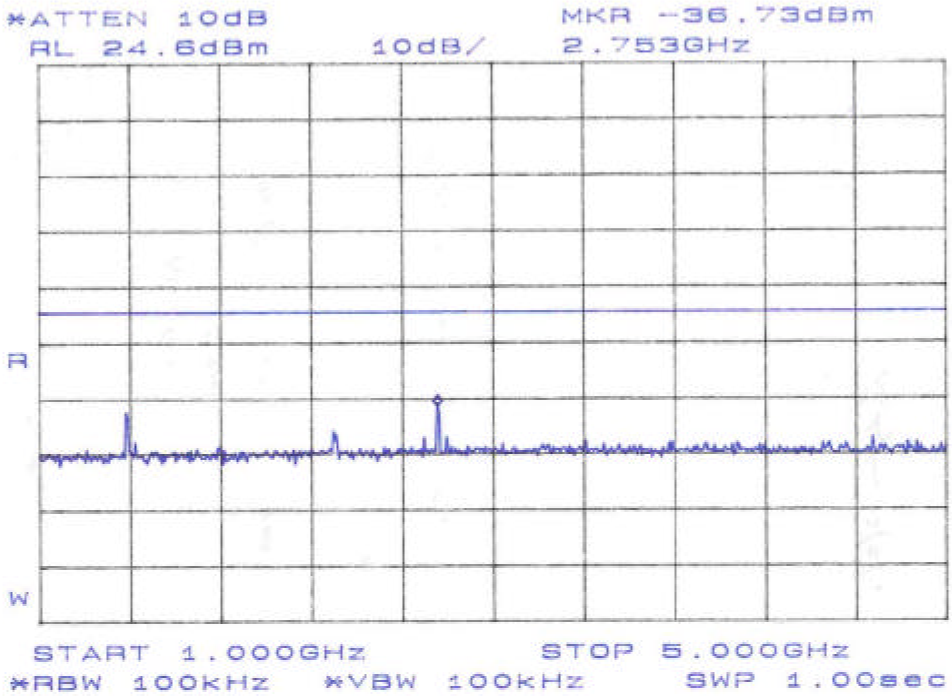

Figure 4. Conducted Spurious Emissions, 1 – 5GHz

4.4 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with requirements for radiated spurious emissions emanating from the equipment case. The limit for the case radiated spurious emissions is 50 + 10 log P dB.

For the EUT:

50 + 10 Log (0.450) W = 47 dB

4.4.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The RF output of the transmitted was terminated into a 50 ohm load. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

After detection of a spurious emission was made the E-field level was recorded and the EUT was replaced with an antenna. A signal generator was then connected to the antenna and the output level was increased until the equivalent E-field level of the spurious emission was obtained. The power level of the signal generator was then recorded and corrected for any cable loss and antenna gain to compute the EIRP level in dBm to be compared to the limit.

Table 4 lists the radiated spurious emissions of the EUT.

Table 4: Radiated Emissions Test Data

CLIENT:	Cattron	DATE:	4/1/03
TESTER:	James Ritter/ Ken Gemmell	JOB #:	7482
EUT Information:		**Test Requirements:**	
EUT:	P03-A	TEST STANDARD:	FCC Part 90
S/N:	62135031	DISTANCE:	3m
CONFIGURATION:	TX at 460 MHz into dummy load Ch2	CLASS:	A
Test Equipment/Limit:			
ANTENNA:	A_00007	LIMIT:	LFCC_10m_Class_A
CABLE:	CSITE1_3m	AMPLIFIER (dB)	None

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (Peak) (dBμV)	Ant. Gain dBi	Sig. Gen. Level dBm	EIRP Level dBm	Limit (dBm)	Margin dB
181.88	V	45.0	1.0	5.6	-1.2	-72.8	-74	-21	-53
196.62	V	0.0	1.0	8.0	-1.5	-68.9	-70.4	-21	-49.4
201.54	V	0.0	1.0	7.6	4.8	-75.7	-70.9	-21	-49.9
206.44	V	0.0	1.2	7.7	5.1	-79.4	-74.3	-21	-53.3
216.30	V	180.0	1.0	6.8	6.2	-82.1	-75.9	-21	-54.9
427.65	V	170.0	1.4	5.8	7.0	-78.6	-71.6	-21	-50.6
457.55	V	90.0	1.5	8.9	6.8	-75.7	-68.9	-21	-47.9
462.46	V	90.0	1.4	9.4	6.8	-72.4	-65.6	-21	-44.6
920.00	V	225.0	2.0	34.7	7.8	-36.9	-29.1	-21	-8.1
181.88	H	45.0	2.4	9.8	-1.2	-72.8	-74	-21	-53
196.62	H	180.0	2.4	20.5	-1.5	-67.9	-69.4	-21	-48.4
201.54	H	350.0	2.2	19.0	4.8	-67.7	-62.9	-21	-41.9
206.44	H	180.0	2.4	19.9	5.1	-69.0	-63.9	-21	-42.9
216.30	H	180.0	2.0	18.4	5.8	-71.5	-65.7	-21	-44.7
218.72	H	190.0	2.3	13.9	6.3	-76.1	-69.8	-21	-48.8
228.84	H	180.0	2.2	12.9	6.6	-79.4	-72.8	-21	-51.8
457.55	H	180.0	2.5	7.7	6.8	-75.5	-68.7	-21	-47.7
462.46	H	90.0	2.3	10.8	6.8	-71.1	-64.3	-21	-43.3
920.00	H	180.0	1.6	33.3	7.8	-44.2	-36.4	-21	-15.4

Table 4: Radiated Emissions Test Data, continued

High Frequency Emissions

CLIENT:	Cattron	DATE:	4/25/03
TESTER:	Ken Gemmell/ James Ritter	JOB #:	7482
EUT Information:		**Test Requirements:**	
EUT:	T01	TEST STANDARD:	FCC Part 15
S/N: 62135031		DISTANCE:	3m
CONFIGURATION:	Transmit at 460 MHz into dummy load Ch2	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_0000	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE2_HF	AMPLIFIER (dB)	A_00312

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (Peak) (dBμV)	Ant. Gain dBi	Sig. Gen. Level dBm	EIRP Level dBm	Limit (dBm)	Margin dB
1380.00	V	180.0	1.0	68.8	6.0	-46.5	-40.5	-21	-19.5
1840.00	V	180.0	1.0	63.1	6.9	-50.2	-43.3	-21	-22.3
2300.00	V	180.0	1.0	66.3	7.8	-43.5	-35.7	-21	-14.7
2760.00	V	180.0	1.0	63.4	8.6	-42.8	-34.2	-21	-13.2
3220.00	V	180.0	1.0	57.9	9.6	-50.2	-40.6	-21	-19.6
3680.00	V	180.0	1.0	58.6	10.5	-49.3	-38.8	-21	-17.8
4140.00	V	180.0	1.0	51.2	11.0	-55.5	-44.5	-21	-23.5
4600.00	V	180.0	1.0	52.7	10.7	-54.6	-43.9	-21	-22.9
1380.00	H	180.0	1.0	65.9	6.0	-44.5	-38.5	-21	-17.5
1840.00	H	180.0	1.0	64.0	6.9	-48.8	-41.9	-21	-20.9
2300.00	H	180.0	1.0	68.2	7.8	-43.5	-35.7	-21	-14.7
2760.00	H	180.0	1.0	61.3	8.6	-48.0	-39.4	-21	-18.4
3220.00	H	180.0	1.0	56.4	9.6	-54.5	-44.9	-21	-23.9
3680.00	H	180.0	1.0	57.4	10.5	-52.3	-41.8	-21	-20.8
4140.00	H	180.0	1.0	50.6	11.0	-59.8	-48.8	-21	-27.8
4600.00	H	180.0	1.0	50.2	10.7	-58.0	-47.3	-21	-26.3

4.5 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The EUT is powered by DC voltage supplied externally. The EUT was tested at 115% of the nominal operating voltage down to the manufacturer's specified operating range as follows:

Low DC Voltage of 12 Vdc (80% of manufacturer's specification)

High DC Voltage of 17.25 Vdc (115% of 15Vdc)

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter. The following table contains the data for the frequency stability testing.

Table 5. Frequency Deviation as a Function of Temperature

Temperature (Celsius)	Frequency (MHz)	Deviation (Hz)	Limit (Hz) 0.00025%
Mid Channel Ambient	459.99989000	0.00	1150.00
-30	459.99960000	290.00	1150.00
-20	459.99964000	250.00	1150.00
-10	459.99937000	520.00	1150.00
0	459.99993000	-40.00	1150.00
10	459.99946000	430.00	1150.00
20	459.99968000	210.00	1150.00
30	459.99993000	-40.00	1150.00
40	460.00019000	-300.00	1150.00
50	460.00042000	-530.00	1150.00

Table 6. Frequency Deviation as a Function of Voltage

Channel	Voltage (Volts DC)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)
Mid Channel	15	460.00009000	0.00	1150
	17.25	460.00001400	76	1150
	12	459.99946000	630	1150

4.6 Transient Frequency Response (Part 90.214)

The transient frequency behavior of the transmitter was tested using the procedure described in TIA/EIA 603, Section 1.2.19.

The following equipment was used to perform the measurement:

- Spectrum Analyzer: HP 8593A
- Oscilloscope: Tektronix TDS 540
- RF Detector: HP 8471D
- Signal Generator: HP 8648C
- Combiner: Minicircuits: ZFSC-2-4
- Directional Coupler: Minicircuits: ZDC-10-2

The equipment listed above was setup in accordance with the procedure of TIA/EIA 603, Section 1.2.19. The spectrum analyzer was tuned to the carrier frequency of the transmitter. The demodulated AUX Video Output of the spectrum analyzer was connected to the Channel 1 of the oscilloscope to provide a signal that is proportional to the frequency deviation of the input from the RF combiner.

The transmitter was keyed on and the waveform was captured on the oscilloscope. The EUT was modulated, however, the modulation did not come on until some time after the transmitter was keyed. The turn-off transient frequency behavior plot shows the stability of the transmitter with the modulation. This procedure was repeated while turning off the transmitter and capturing the turn-off waveform.

The following plots depict the "turn-off" and "turn-on" time intervals for the unit under test. The transmitter meets the requirements for transient frequency behavior.

Figure 5 shows the "turn-on" time of the transmitter depicting the transmitter behavior during t_1, t_2 and t_3. The frequency deviation for the time following t_2 to the beginning of t_3 must meet the requirements of Part 90.213.

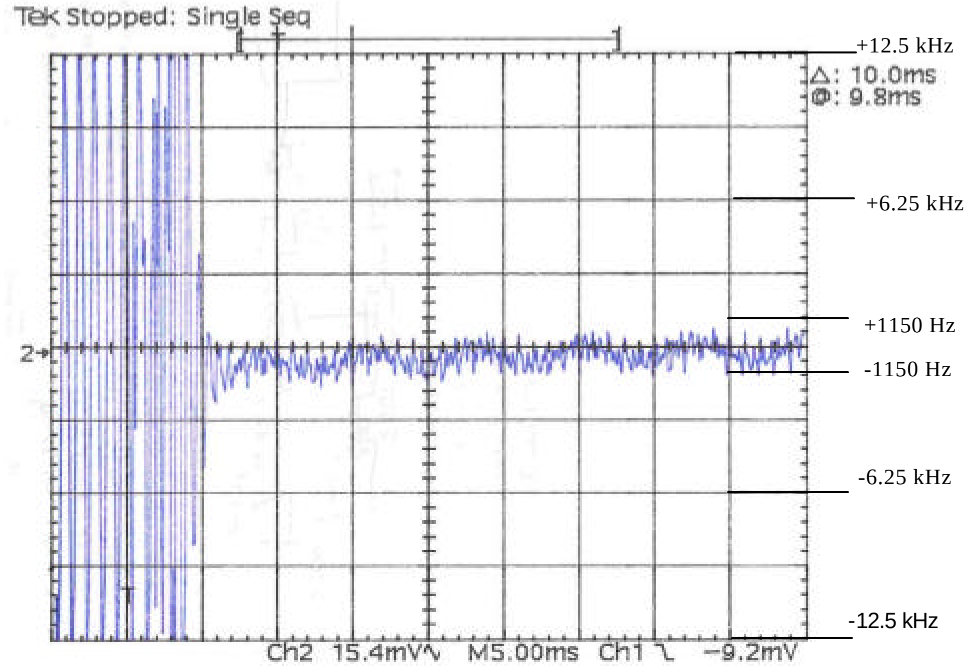

Figure 5. Transient Frequency Behavior, Turn-On

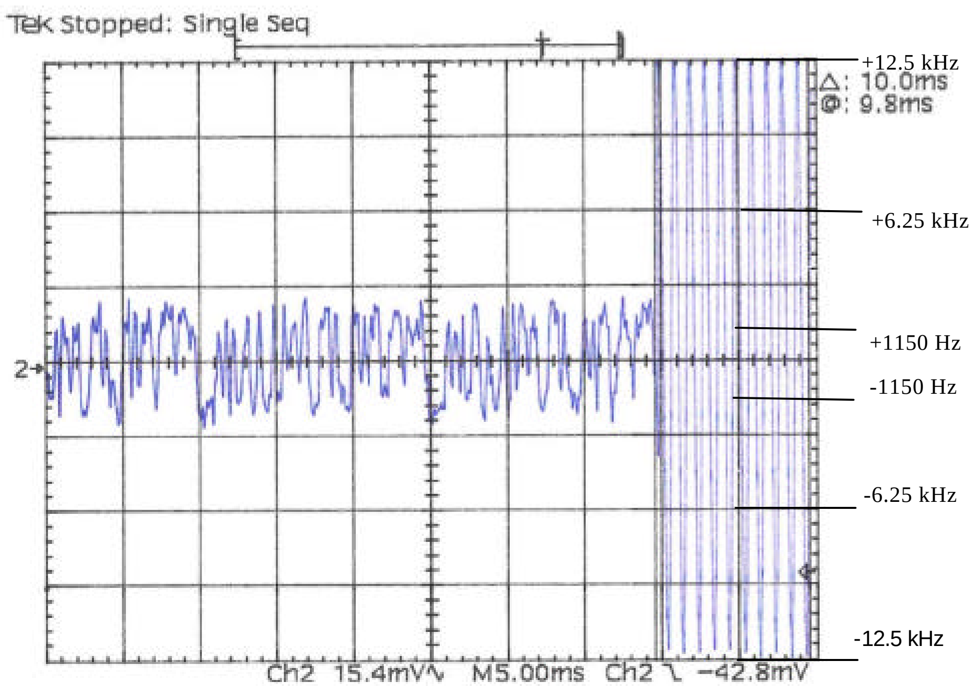

Figure 6. Transient Frequency Behavior, Turn-Off With Modulation

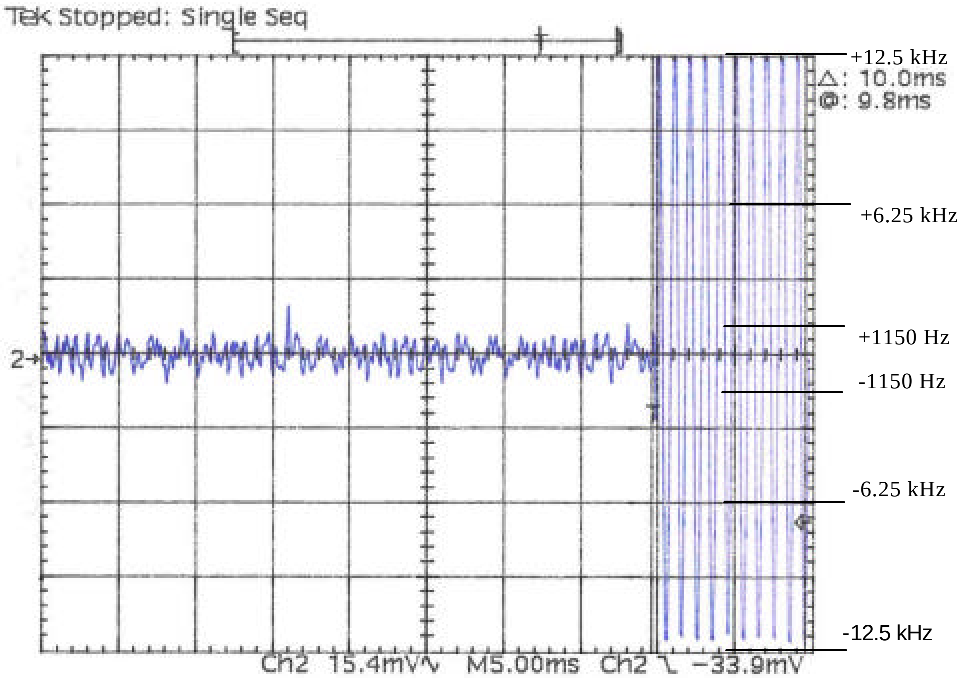

Figure 7. Transient Frequency Behavior, Turn-Off Without Modulation