APPLICATION FOR PART 90 CERTIFICATION TRANSMITTER 450-460 MHz BAND

AMERICAN METER CO.
107 Erskine Lane
Scott Depot, West Virginia 25560

MODEL: Mini-Mobile Interrogator
FCC ID: G8JMMI01

September 16, 1998

This report concerns (check one):	**Original Grant:** X	**Class II Change:**	
Equipment Type: **Transmitter**			
Deferred grant requested per 47 CFR 0.457 (d) (1) (ii)?		**Yes:**	**No**: X
If yes, defer until:		______________ ***Date***	
Company name agrees to notify the Commission by: ____________________(date) of the intended date of announcement of the product so that the grant can be issued on that date.			
Transition Rules Request per 15.37? Yes:		**No:** X	
If no, assumed Part 15, subpart B for unintentional radiators - the new 47 CFR [10-1-90 Edition] provision..			

REPORT PREPARED BY:

EMI Technician: K. Franck Schuppius
Administrative Writer: Linda Harrison

Rhein Tech Laboratories, Inc.

Document Number: 980482 / QRTL98-091

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1.0 GENERAL INFORMATION

The following application for Certification of an FCC Part 90 Transmitter 450-460 MHz Band is prepared on behalf of American Meter Co. in accordance with Part 2, and Part 90, of the Federal Communications Commissions rules and regulations. The Equipment Under Test (EUT) was the American Meter Co. Model: Mini-Mobile Interrogator, FCC ID: G8JMMI01. The test results reported in this document relate only to the item that was tested.

All measurements contained in this application were conducted in accordance with CFR 47, Part 90, ANSI C63.4 Methods of Measurement of Radio Noise Emissions, 1992. The instrumentation utilized for the measurements conforms to the ANSI C63.4 standard for EMI and Field Strength Instrumentation. Some accessories are used to increase sensitivity and prevent overloading of the measuring instruments. These are explained in the appendix of this report. Calibration checks are performed regularly on the instruments, and all accessories including the high pass filter, preamplifier and cables.

All radiated and conducted emission measurements were performed manually at Rhein Tech Laboratories, Inc. The radiated emission measurements required by the rules were performed on the three meter, open field, test range maintained by Rhein Tech Laboratories, Inc., 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. Complete description and site attenuation measurement data have been placed on file with the Federal Communications Commission. Rhein Tech Laboratories, Inc. is on the FCC accepted lab list as a facility available to do measurement work for others on a contract basis.

1.1 PRODUCT DESCRIPTION

General Characteristics

Supply Voltage 13.8V ± 20% (11.0 – 16.6 VDC)
Modulation Type AM, DSB-LC
Signal modulating the carrier 1778 Hz or 2778 Hz at 90% modulation typical sine wave
Operating Temperature –20to +60°C
Weight ~ 65 lbs.
Antenna connector type RX: BNC; TX: N

Transmitter Characteristics

Frequency Range 450 - 460 MHz
Channel Spacing 25 kHz
RF Output Power 5 W @ 13.8 VDC'
Frequency Stability 2.5ppm
LO, IF, XTAL frequencies 166.4 MHz, 616.4 MHz – 626.4 MHz; 12.8 MHz TCXO
Data rate 2778 Hz

1.2 RELATED SUBMITTAL(S)/GRANT(S)

N/A. This is an original submission for Certification.

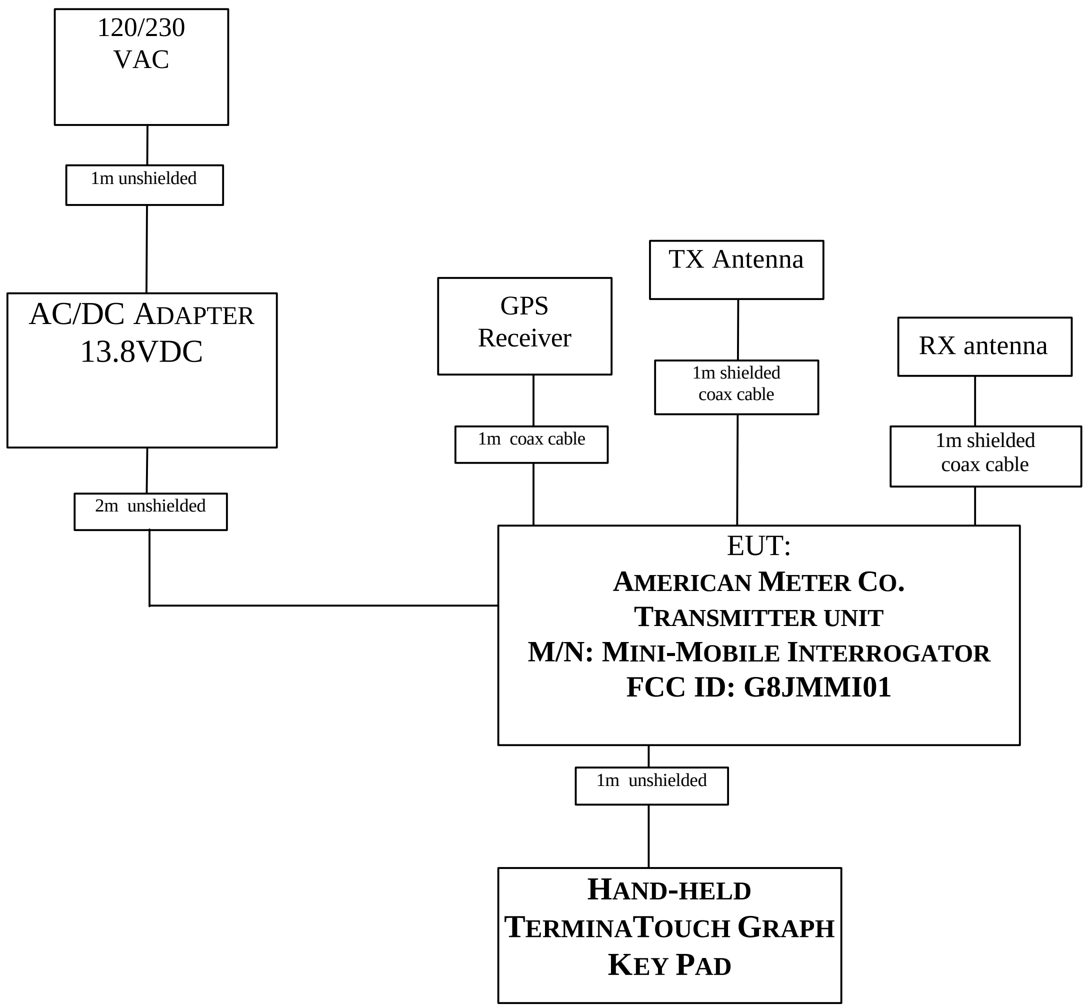
1.3 TEST SYSTEM DETAILS

The FCC Identifiers for all equipment, plus descriptions of all cables used in the tested system (including inserted cards, which have grants) are:

TABLE 1: TEST SYSTEM DETAILS

DESCRIPTION	MANUFACTURER	MODEL	SERIAL NO	FCC ID	CABLE DESCRIPTIONS	RTL BAR CODE
MINI-MOBILE INTERROGATOR (EUT)	**AMERICAN METER CO.**	**MMI**	**0000143**	**G8J**	**UNSHIELDED POWER**	**9607**
POWER SUPPLY	ELECTRONICS	20-13-101	91D-3679	N/A	SHIELDED POWER	9604
TOUCH PAD	TERMIFLEX	TOUCHGRAF	248724	CLASS A DEVICE	UNSHIELDED I/O	9605

1.4 CONFIGURATION OF TESTED SYSTEM



1.5 TEST METHODOLOGY

All tests were performed according to the procedures in FCC Part 90 and FCC Part 2. Field strength of spurious radiation testing was performed at an antenna to EUT distance of 3 meters. Additionally, spectrum efficiency standard, RF power output, spurious emissions at antenna terminal, occupied bandwidth, frequency stability versus temperature and voltage, transient frequency behavior were measured per FCC Rules and Regulations: CFR 47, part 90, October 1, 1997 and Part 2, October 1,1997.

1.6 TEST FACILITY

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report dated March 3, 1994, submitted to and approved by the Federal Communication Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 1992).

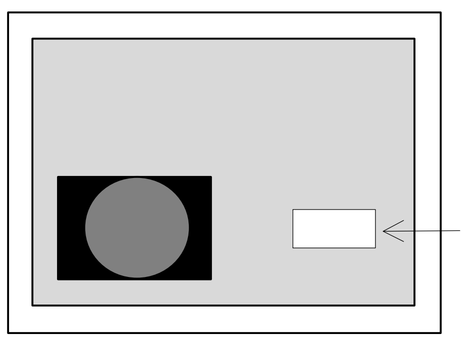
2.0 PRODUCT LABELING

FIGURE 1: FCC ID LABEL

> American Meter Co.
>
> This device complies with the FCC, part 15 rules.
> Operation is subject to the following two conditions:
> 1) This device may not cause harmful interference.
> 2) This device must accept any interference received, including interference that may cause undesired operation.
>
> FCC ID: G8JMMI01

FIGURE 2: LOCATION OF LABEL ON EUT

Back of Unit
Label: 1.2 height, 2.9 width



Location of FCC ID Label

3.0 SYSTEM TEST CONFIGURATION

3.1 JUSTIFICATION

To complete the test configuration required by the FCC, the transmitter was connected to a hand-held terminal for programming. An AC/DC power supply, +13.8VDC, was used to provide power to the transmitter. The EUT was tested in all three orthogonal planes in order to determine worst case emission. EUT channels, available within the range 450-460 MHz, were investigated and tested from 9 kHz to 4.6 GHz. Only worst case emissions are used for final measurement. The following IF, local oscillators, and crystal oscillators namely 166.4 MHz, 616.4 MHz, 626.4 MHz, 12.8 MHz, 24 MHz and 460.0 MHz and their harmonics were investigated and tested.

3.2 EUT EXERCISE SOFTWARE

The EUT was enabled to continuously transmit data. Three transmission modes, representative of the transmitters intended use, TXALL0's, TXALLI's and a default transmission containing both highs and lows, were provided by the manufacturer and used for exercising the device. Light emitting diodes on the EUT were checked and verified that the EUT was turn ON and in a transmitting mode. The carrier was also checked to verify that the information was being transmitted. EUT's input voltage was periodically checked to ensure a maximum output rated power.

3.3 SPECIAL ACCESSORIES

One external transmitting antenna from American Meter Co. was used to perform additional ERP measurement in accordance to FCC Part 90.205(g)(1) and Part 2.

3.4 CONFORMANCE STATEMENT

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. No modifications were made during testing to the equipment in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the FCC Part 90 Type Certification Transmitter 450-460 MHz Band and Part 2 test methodology.

Signature: ______________________________ Date: September 16, 1998

Typed/Printed Name: Bruno Clavier Position: Quality Manager (NVLAP Signatory)

NVLAP *Accredited by the National Voluntary Accreditation Program for the specific scope of accreditation under Lab Code 20061-0.*

Note: This report may not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

4.0 STANDARD REQUIREMENTS

TYPE CERTIFICATION FCC PART 90: PRIVATE LAND MOBILE RADIO SERVICES SUBPART I : GENERAL TECHNICAL STANDARDS AND FCC PART 2 SUBPART J: EQUIPMENT AUTHORIZATION PROCEDURES

4.1 FCC PART 90.203(J)(3): TYPE CERTIFICATION REQUIRED

Since August 1, 1996, type certification is granted for equipment operating on frequencies in the 421-512 MHz band and having a 25 kHz channel bandwidth if the equipment meets the spectrum efficiency standard:

4.1.1 Method of measurement:

The transmitter antenna output port is connected to an EMI receiver/Spectrum analyzer featuring a demodulation output port. This port is then connected to a digital oscilloscope.
The transmitter was set to the High Data Rate mode.

4.1.2 Test results:

The equipment, Mini-Mobile Interrogator from American Meter Co., meets a spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth. The equipment was capable of supporting a minimum data rate of 4800 bits per second per 6.25kHz of bandwidth, that is 19.2 Kbits/s.

See measurement plots, figure 4, section 5.1, part 90.203(j)(3).

4.2 FCC Part 90.211(b) and Part 2.987: Modulation Requirements and characteristics

The Mini-Mobile Interrogator maximum output power is more than 2 watts. The transmitter utilizes digital emissions without and audio-low pass filter. Therefore, it was tested using the modulating signal as specified by Part 2.

4.2.1 Method of measurement:

The transmitter antenna output port is connected to an Hewlett Packard EMI/spectrum receiver analyzer featuring a demodulation output port.

4.2.2 Test results:

Measurement plots, figure 5 to figure 8, section 5.2, part 2.987 show that the equipment meets the modulation requirements of the rules under which the equipment is to be licensed. TXALL1's (1778Hz modulating tone), TXALL0's (2778Hz modulating tone), and default (containing both highs and lows). The following transmission modes are representative of the transmitter intended use. These transmissions feature a continuous stream of data.

4.3 FCC PART 90.205 (G)(1) AND PART 2.985:

4.3.1 RF Power Output (ERP) and antenna height limits: 450-460 MHz band

The maximum allowable effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and is authorized with the following table:

Service area radius (km)	8
Maximum ERP (w) (1)	100
Up to reference HAAT (m) (2)	15

(1) Maximum ERP indicated provides for a 39dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See 73.699, Fig. 10 b).
(2) When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: $ERP_{allow}=ERP_{max} \times (HAAT_{ref}/HAAT_{actual})^2$.

4.3.2 Method of measurement:

Measurements were made using an Hewlett Packard 8441B power meter.

4.3.3 Test Results

Termination	Level (dBuV)	Output Power (W) (Unmodulated)
50 ohm	145.7	7.44

4.4 FCC Part 90.207: Type of Emissions - Emission Designator

The first symbol indicates the type of modulation on the transmitter carrier. The second symbol indicates the type of signal modulating the transmitter carrier. The third symbol indicates the type of transmitted information.

Designator for the Mini-Mobile Interrogator: A1D

4.5 FCC Part 90.209 (a): Bandwidth Limitations

	Necessary bandwidth		
Description of emission	Formula	Calculation	Designation of emission
Double side band Digital modulation Data	Bn=2M+2D	85.6kHz	85K6

with D peak frequency deviation (i.e. half the difference between the maximum and minimum value of the instantaneous frequency - the instantaneous frequency in Hz is the time rate of change in phase in radians divided by 2), M maximum modulation frequency in Hz, and Bn Necessary bandwidth in Hz.

Calculations:
$D = \Delta fp = fm \times m = 21.4$ kHz with m =1 and fm = 21.4kHz
M = 21.4 kHz

4.6 FCC PART 90.209 (5): STANDARD CHANNEL SPACING AND BANDWIDTH

Frequency (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
460.0 (2)	6.25 (1)	20 (1) (3)

(1) For stations authorized on or after August 18, 1995.
(2) Bandwidths for radiolocation stations in the 420-450MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by case basis.
(3) Operations using equipment designed to operate with a 25kHz channel bandwidth will be authorized a 20kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25kHz bandwidth. Operations using equipment designed to operate with a 6.25kHz channel bandwidth will be authorized a 6kHz bandwidth.

4.7 FCC PART 2.997(A)(1): FREQUENCY SPECTRUM TO BE INVESTIGATED

(a) In all of the measurements set forth in 2.991 and 2.993, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10GHz: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

The device under test was investigated from 9 kHz to 4.6 GHz.

4.8 FCC part 90.210 (c) and part 2.991:

Emission masks and spurious emissions at antenna terminal
Occupied bandwidth

4.8.1 Method of measurement:

The transmitter was properly loaded with a 50 Ohm termination and operated under normal condition in its intended use. That is the maximum rated conditions under which the equipment will be operated.

For measuring emissions up to and including 50kHz from the edge of the authorized bandwidth, the resolution bandwidth was adjusted to 100Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps was measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must no be less than the instrument resolution bandwidth. For frequencies more that 50kHz removed from the edge of the authorized bandwidth a resolution of at least 10 kHz was used for frequencies below 1000 MHz. Above 1000 MHz the resolution bandwidth of the instrumentation was at least 1 MHz.

Applicable emission mask for equipment designed to operate with a 25 kHz channel bandwidth:

Frequency (MHz)	Mask for equipment without audio low pass filter
460.0	C

4.9 FCC PART 90.210 (C) (1)(2)(3) :

The power of any emission must be attenuated below the unmodulated carrier output power P as follows:

Frequency range (kHz) Displacement frequency	Reference unmodulated output level (dBuV/W)	Formula	Attenuation (dB) from reference level
Fo + 5 < Fd < Fo + 10 Fo - 10 < Fd < Fo – 5	130.3/0.2138	83 Log (Fd/5)	0 < Att. < 25
Fo + 10 < Fd < Fo + 24.1* Fo - 24.1*< Fd < Fo – 10	130.3/0.2138	29 Log (Fd^2/11)	27.8 < Att. < 50
Fo + 24.1 < Fd < Fo + 62.5** Fo - 62.5 < Fd < Fo - 24.1	130.3/0.2138	50	50
Fo + 62.5 < Fd < 5GHz 9 < Fd < Fo - 62.5	130.3/0.2138	43 + 10 Log P	51.7

Notes:
Measurements of emission power are expressed with the same parameters used to specify the unmodulated transmitter carrier power.
*: The condition 29 Log (Fd^2/11) or 50 dB whichever is the lesser attenuation give the common frequency point of 24.1 kHz
**: 250% of 25 kHz (authorized Bandwidth) = 62.5 kHz
Fo: Carrier fundamental frequency (MHz)
Fd: Displacement frequency
P: Output Power in Watt (Unmodulated)

Figure 9 to figure 17, section 5.3, demonstrate compliance with the emission mask C.

4.10 FCC PART 2.993: FIELD STRENGTH OF SPURIOUS RADIATION

4.10.1 Method of measurement:

A 50 Ohm dummy load is used to terminate the transmitter antenna output port.
A procedure can be found in the following document: ANSI/TIA/EIA-603: 1992 Land Mobile for PM Communications Equipment Measurement and Procedure Standards

See section 1.5 and section 8 for additional information concerning the radiated emissions test methodology.

Data test results are provided in table 2, section 5.4.

4.11 FCC Part 90.213 and Part 2.995(a): Frequency stability function of temperature

4.11.1 Method of measurement:

The transmitter is set in operation with the maximum rated output power specified by the manufacturer. A Thermotron temperature chamber is used to perform the test. The transmitter is exercised with a transmission mode providing a continuous stream of data.
The ambient temperature is varied from -30° to +50°C. The device under test is operated for 15 minutes prior to testing. A sufficient period of time (about 30 minutes) before any measurements was observed to stabilize all the transmitter components for each temperature level.

4.11.2 Minimum frequency stability (ppm):

Frequency range (MHz)	Mobile stations over 2 Watts output power
421 -512	5

See table 3, section 5.5 for data test results.

4.12 FCC Part 2.995(d)(2): Frequency stability function of primary supply voltage

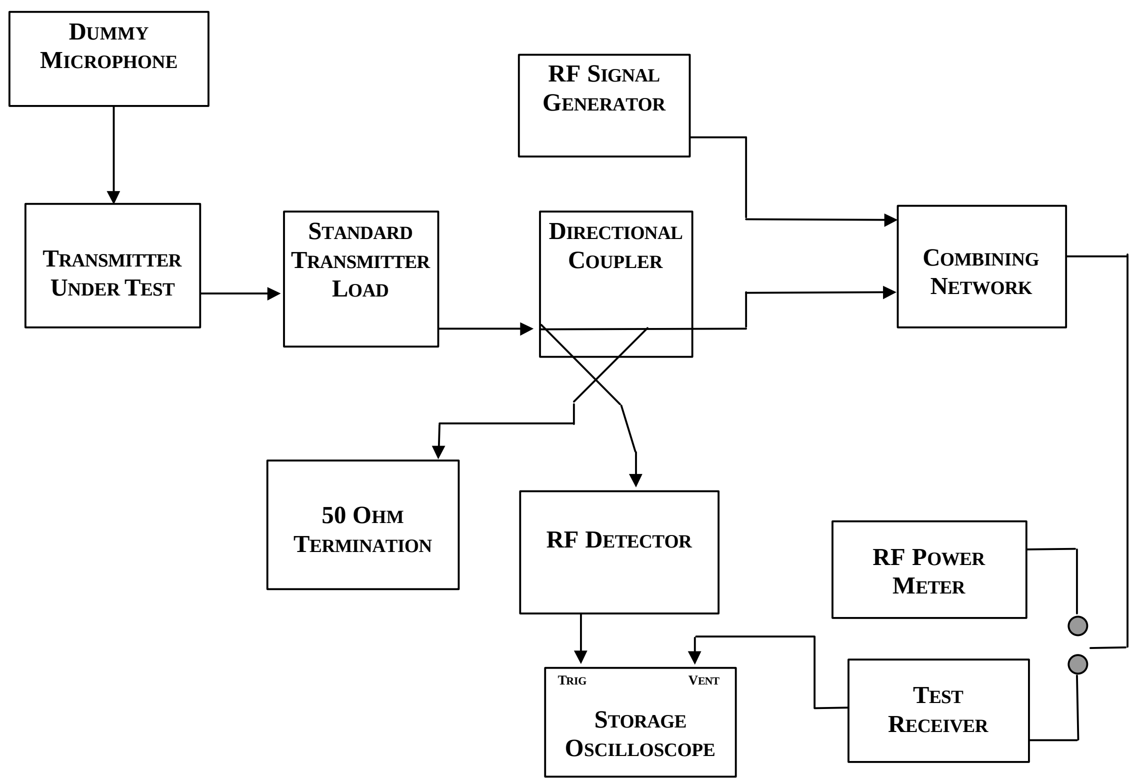
The device under test is powered up and set to a continuous transmission mode. The device is mobile and battery operated therefore the primary supply voltage was reduced to reach the battery operating end point at 11.0V. Below this point the transmitter ceases to transmit.

4.13 FCC PART 90.214: TRANSIENT FREQUENCY BEHAVIOR

Transient frequency behavior is a measure of the difference, as a function in time, of the actual transmitter frequency to the assigned transmitter frequency when the transmitter RF output power is switch off or on.

4.13.1 Method of measurement:
Please refer to the following publication ANSI/TIA/EIA-603: 1992 Land Mobile for PM Communications Equipment Measurement and Procedure Standards

FIGURE 3: TEST SET UP METHOD OF MEASUREMENT PART 90.214



a) The equipment is connected as illustrated in Figure 3.

b) The test receiver's Demodulator Output Port (DOP) is connected to the vertical input channel of the storage oscilloscope. Connect the output of the RF peak detector is connected to the external trigger on the storage oscilloscope. The output of the RF combiner is connected to the RF power meter.

c) The test receiver is set to measure FM deviation with the audio bandwidth set at $\leq$50Hz to $\geq$15,000Hz and the RF frequency is tuned to the transmitter assigned frequency.

d) The signal generator is set to the assigned transmitter frequency and is modulated with a 1kHz tone at $\pm$25kHz deviation and its output level is set to -100dBm.

e) The transmitter is turned on.

f) Sufficient attenuation via the RF attenuator is supplied to provide an input level to the test receiver which is approximately 40dB below the test receiver's maximum allowed input power when the transmitter is operation at its rated power level. Note this power level on the RF power meter.

g) The transmitter is turned off.

h) The RF level of the signal generator is adjusted to provide RF power into the RF power meter 20dB below the level noted in step f). This signal generator RF level is maintained throughout the rest of the measurement.

i) The RF power meter is disconnected and connect the output of the RF combiner network is connected to the input of the test receiver.

j) The horizontal sweep rate on the storage oscilloscope is set to 10 milliseconds per division and the display is adjusted to continuously view the 1000Hz tone from the DOP. The vertical amplitude control of the oscilloscope is adjusted to display the 1000Hz at $\pm$4 divisions vertically centered on the display.

k) The oscilloscope is adjusted so it will trigger on an increasing magnitude from the RF peak detector at 1 division from the left side of the display when the transmitter is turned on. The controls are set to store the display.

l) The attenuation of the RF attenuator is reduced so the input to the RF peak detector and the RF combiner is increased by 30dB when the transmitter is turned on. The controls are set to store the display.

m) The transmitter is turned on and the stored display is observed. The output at the DOP, due to the change in ratio of power between the signal generator input power and the transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it shows the 1kHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display shows the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be $t_{on.}$ The trace should be maintained within the allowed divisions during the period t_1 and $t_{2.}$ During the time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the limit set by the FCC in Part 90.213. That is 2.3 kHz for the 'Mini Mobile Interrogator' device.

u) To test the transient frequency behavior during the period t_3 the transmitter is switched on.

o) The oscilloscope is adjusted so it will trigger at 1 division from the right side of the display, when the transmitter is turned off. The moment when the 1kHz test signal stars to rise is considered to provide t off.

TABLE 2: TRANSIENT FREQUENCY BEHAVIOR FOR EQUIPMENT DESIGNED TO OPERATE ON 25KHZ CHANNELS TABLE

Time Intervals [1, 2]	Maximum Frequency difference[3] (kHz)	Frequency Ranges (MHz)					
		Base stations And Portable Radios			Mobile Radios		
		150-174 (ms)	450-500 (ms)	500-512 (ms)	150-174 (ms)	450-500 (ms)	500-512 (ms)
t_1[4]	±25.0	5.0	10.0	20.0	5.0	10.0	5.0
t_2	±12.5	20.0	25.0	50.0	20.0	25.0	20.0
t_3[4]	±25.0	5.0	10.0	10.0	5.0	10.0	5.0

1 .
ton is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until toff.
toff is the instant when the 1 kHz test signal starts to rise.

2 .
During the time from the end of t2 to the beginning of t3, the frequency difference must not exceed the limits specified in paragraph 90.213.

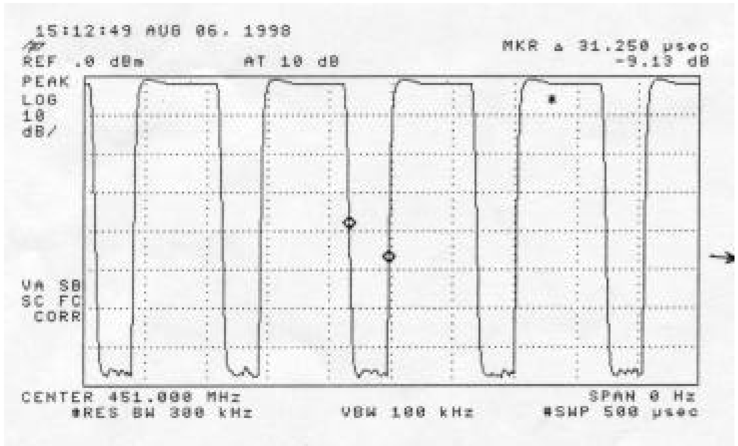
3 .
Difference between the actual transmitter frequency and the assigned transmitter frequency.

4 .
If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

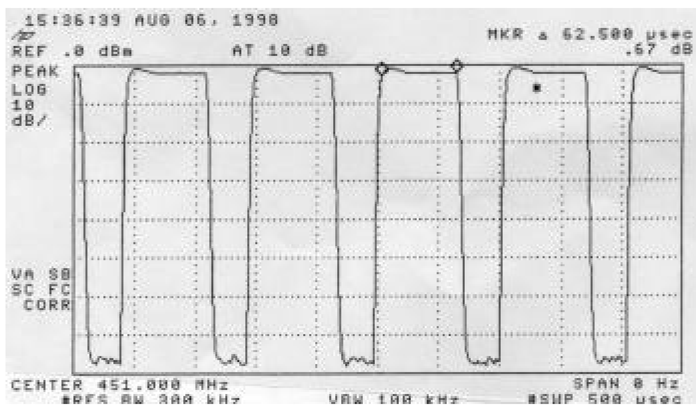
See section 5.6, Part 90.214, Measurement Plots, Figure 19 and Figure 20.

5.0 MEASUREMENT PLOTS

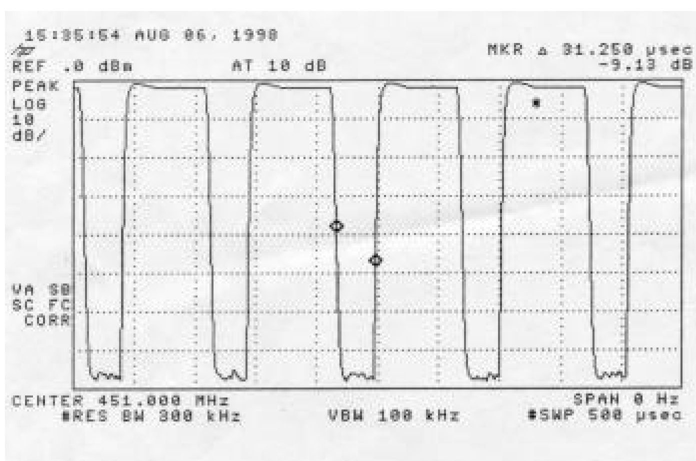
5.1 MEASUREMENT PLOTS; FCC PART 90.203 (j) (3)



31 µ sec BIT period = 32.2 kHz data rate



62.5 µ sec BIT period = 16.0 kHz data rate



$$\text{Avg. data rate} = \left[\ \frac{(31 + 62.5)\ \mu\ \text{sec}}{2}\ \right] = 21.4\ \text{kHz}$$

FIGURE 4: FCC PART 90.203 (j) (3)

5.2 MEASUREMENT PLOTS PART 2.987

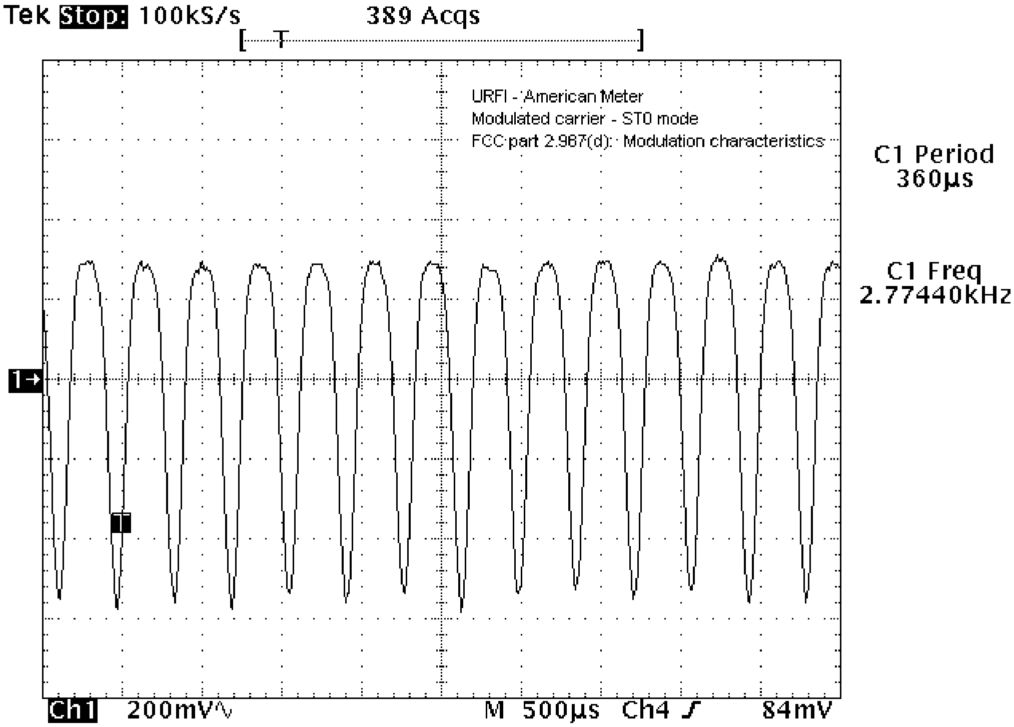


FIGURE 5: PART 90.211(C) AND PART 2.987: MODULATION REQUIREMENTS AND CHARACTERISTICS

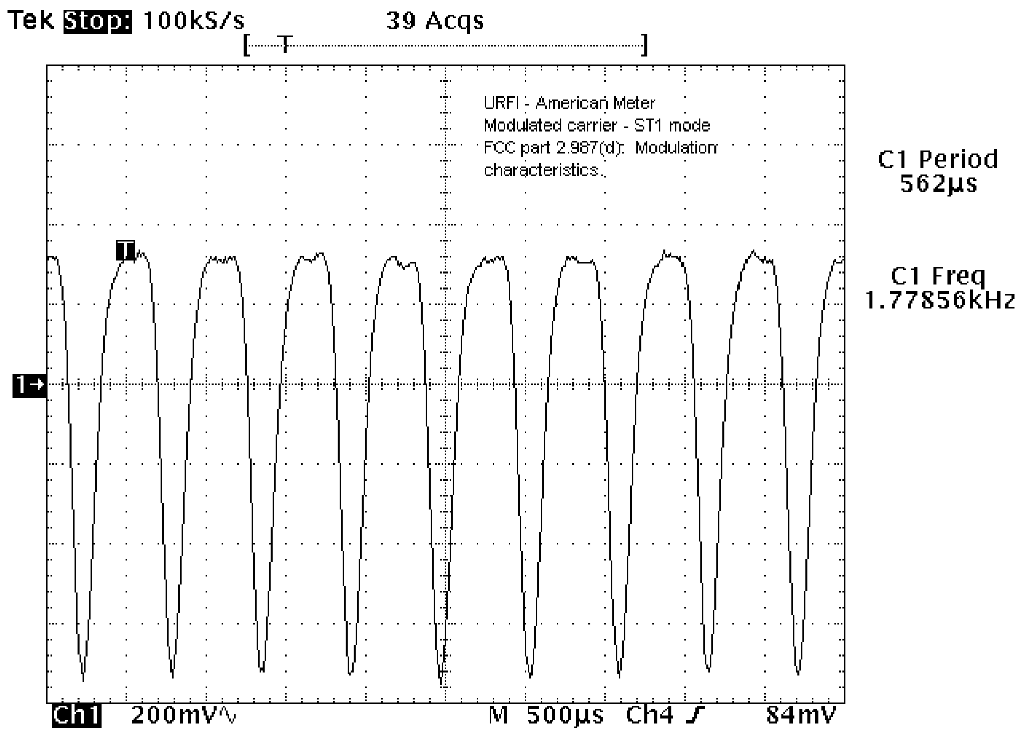
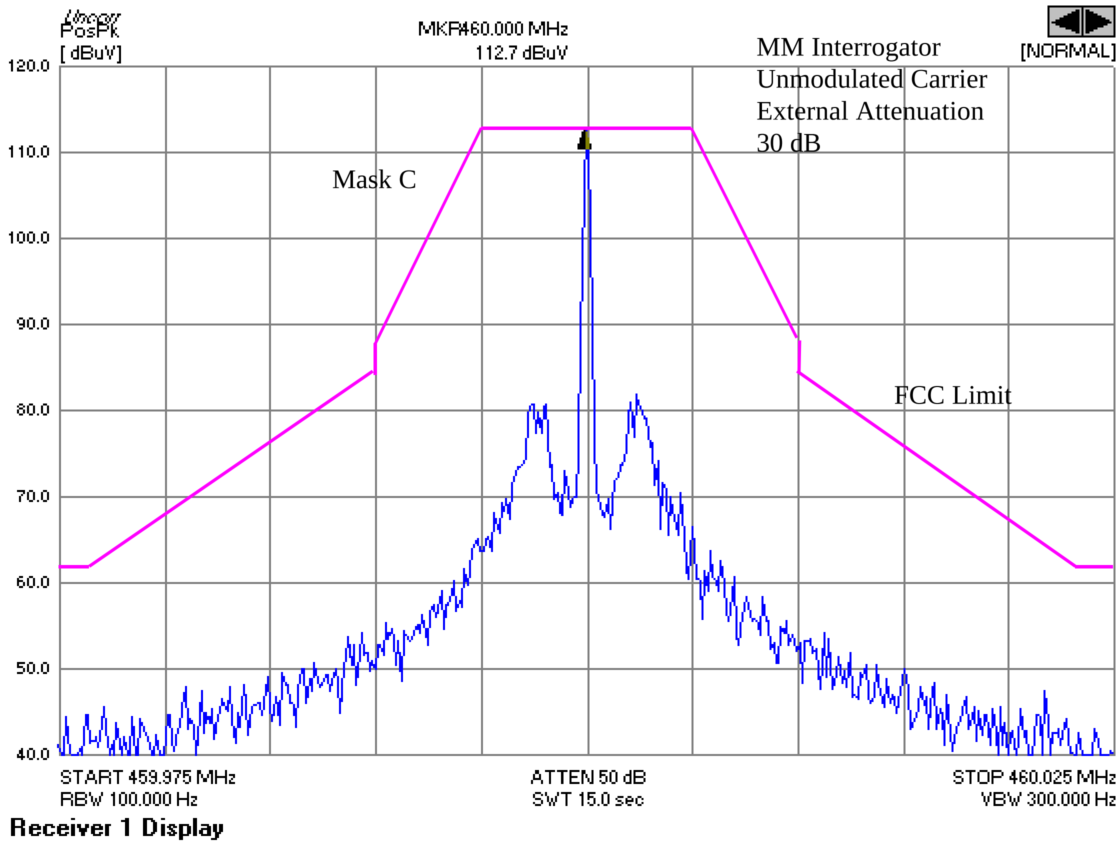


FIGURE 6: PART 90.211(C) AND PART 2.987: MODULATION REQUIREMENTS AND CHARACTERISTICS

5.3 MEASUREMENT PLOTS FCC PART 90.210 (C) (1)(2)(3)

FIGURE 7: FCC PART 90.210 (C) (1)(2)(3)



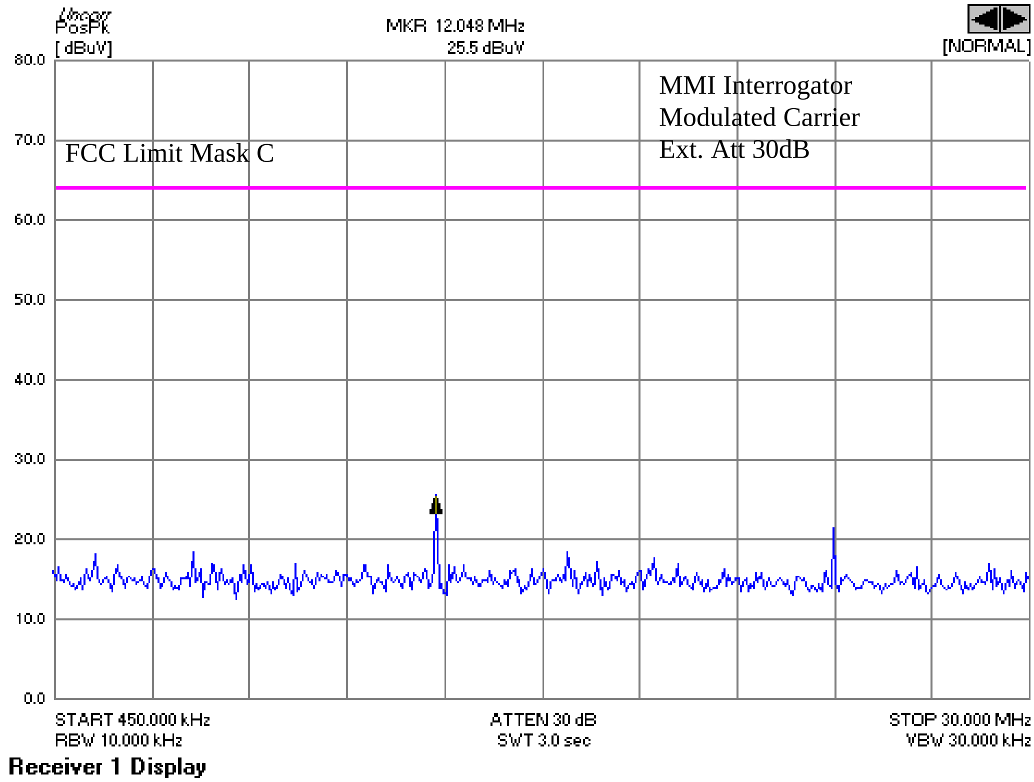


FIGURE 8: PART 90 210(C): EMISSION MASK

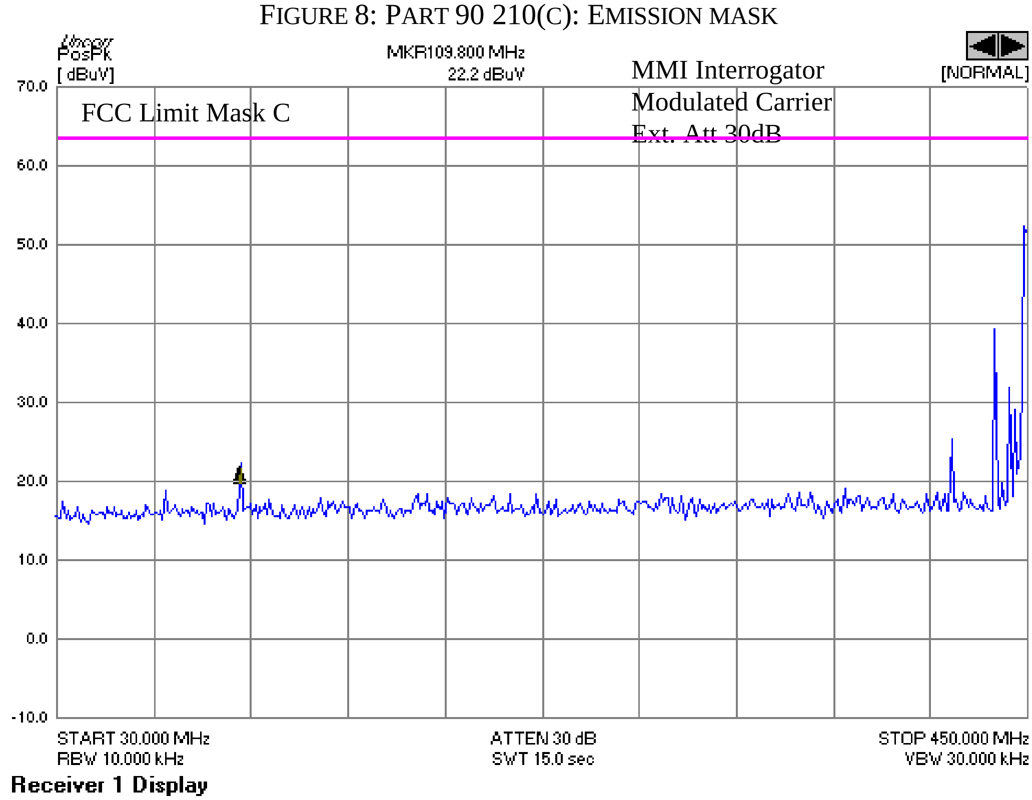


FIGURE 9: PART 90 210(C): EMISSION MASK

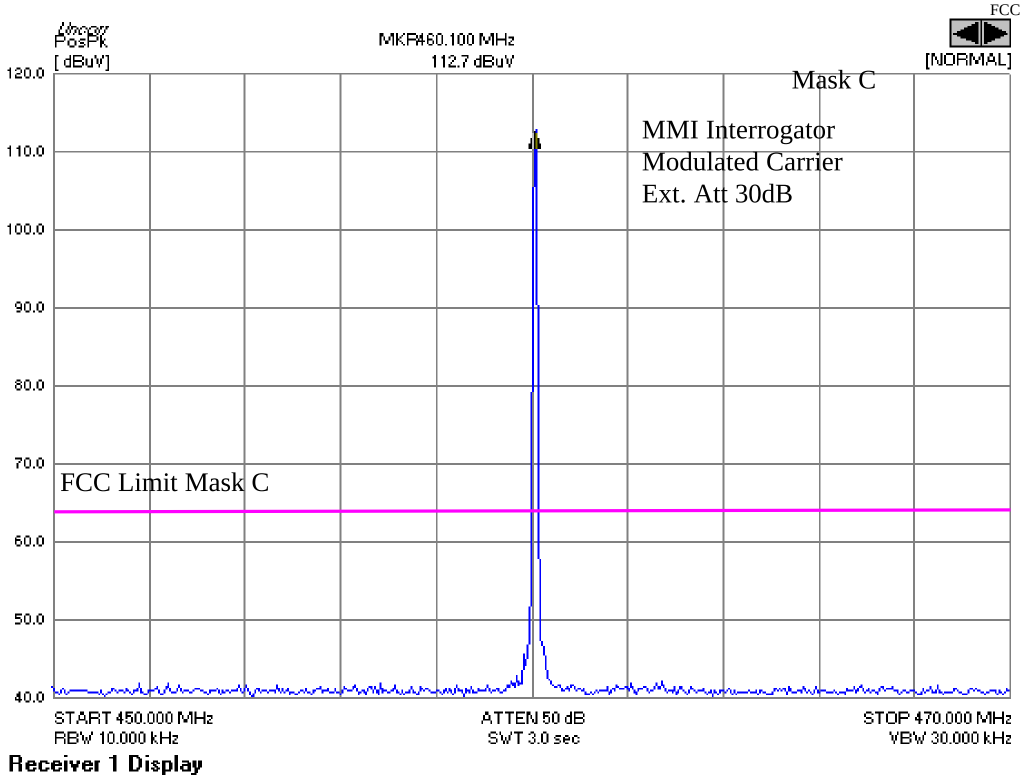


FIGURE 10: PART 90 210(C): EMISSION MASK

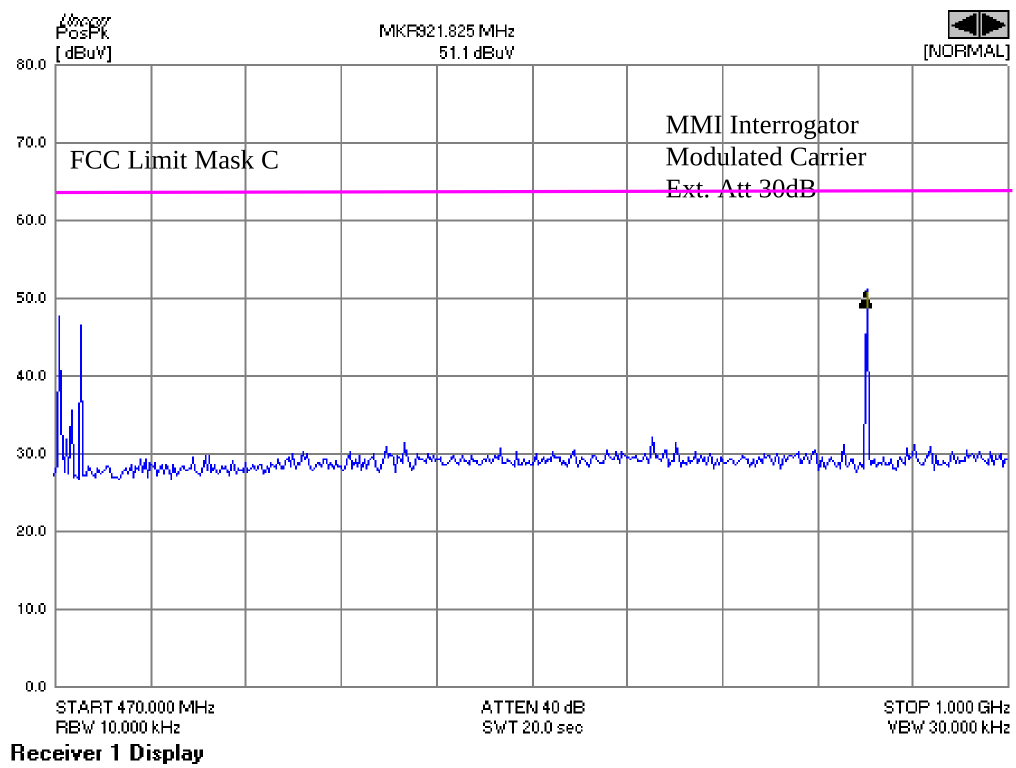


FIGURE 11: PART 90 210(C): EMISSION MASK

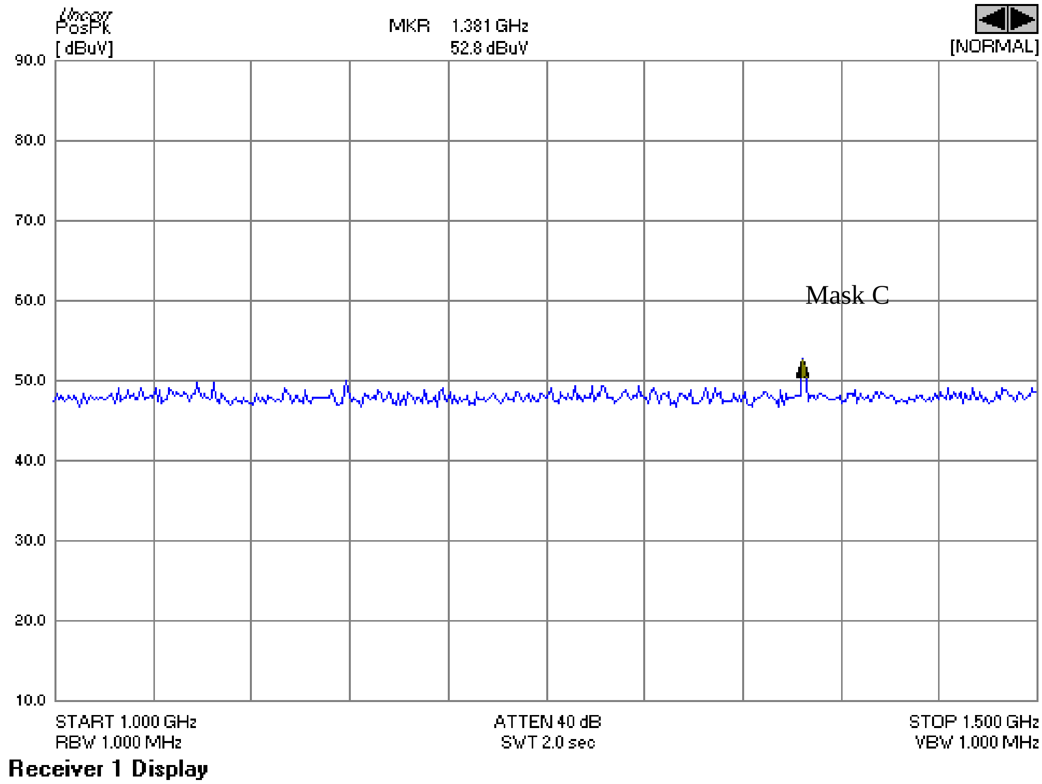


FIGURE 12: PART 90 210(C): EMISSION MASK

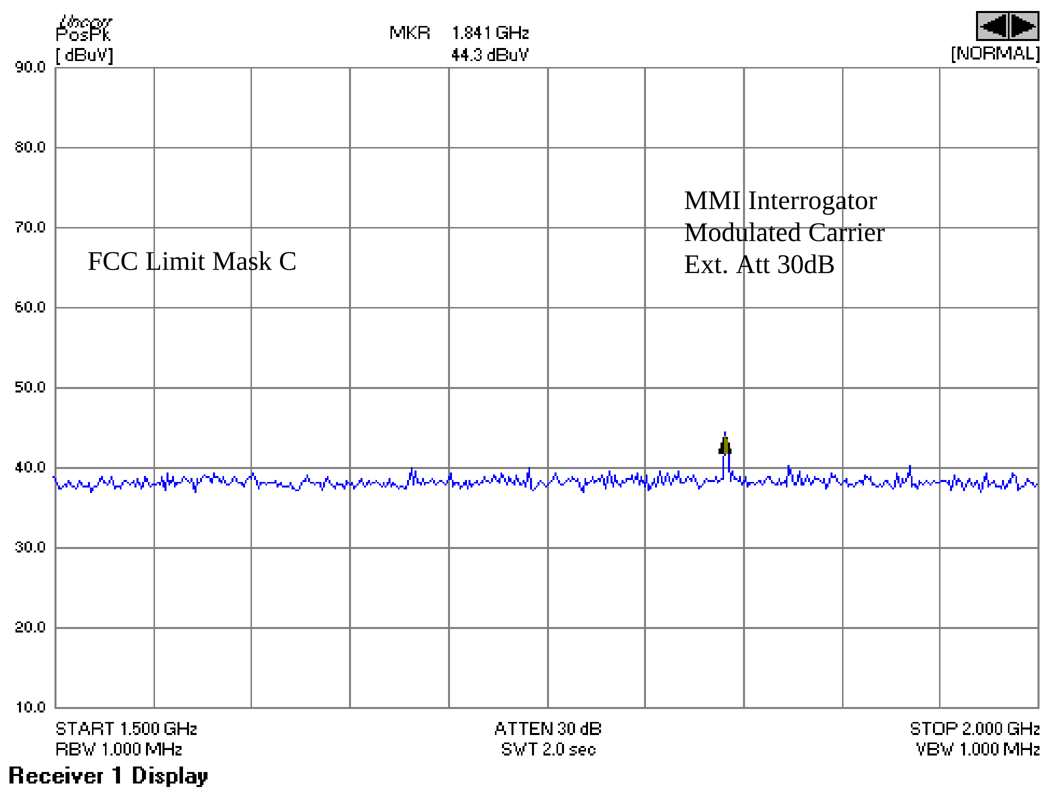


FIGURE 13: PART 90 210(C): EMISSION MASK

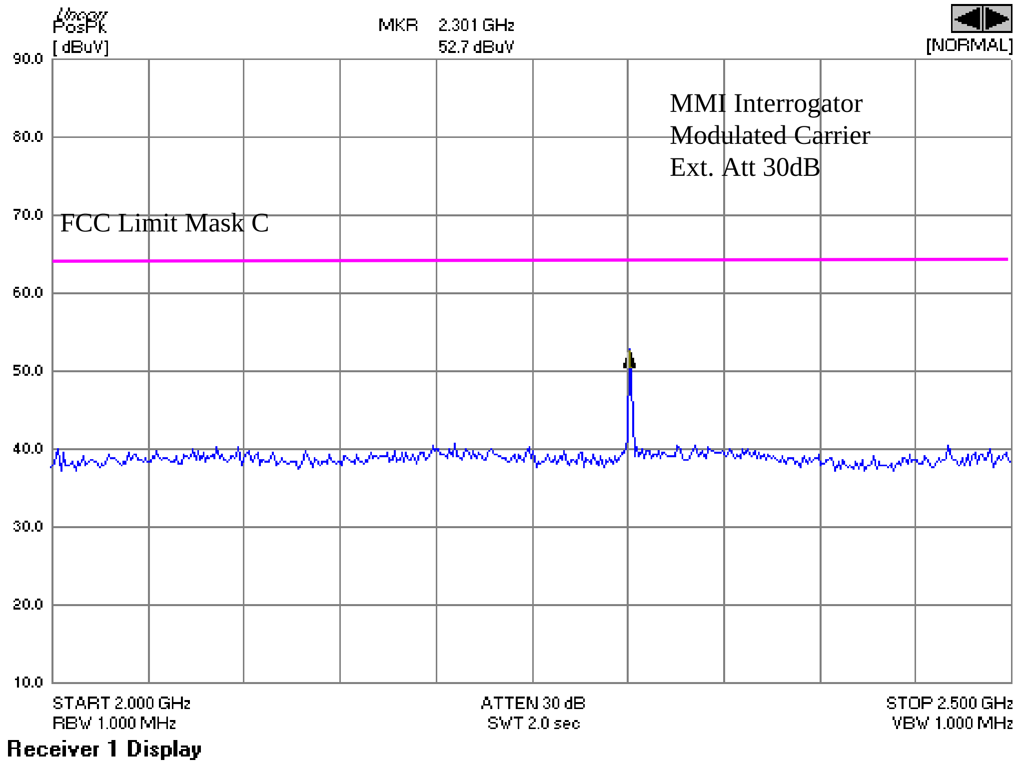


FIGURE 14: PART 90 210(C): EMISSION MASK

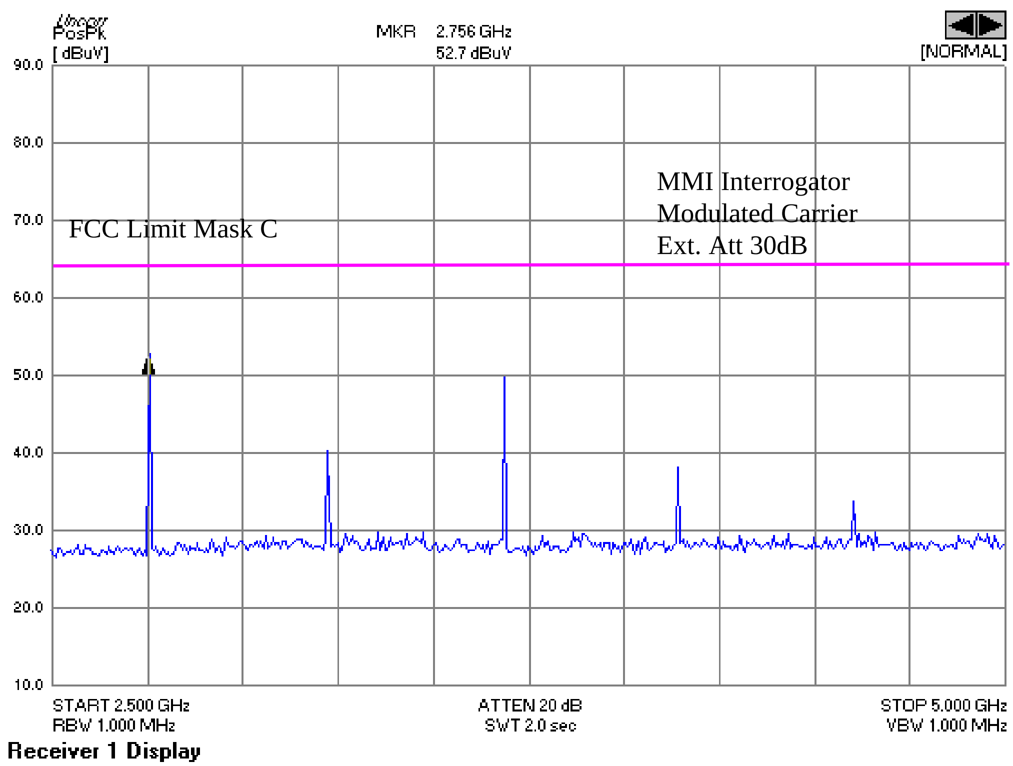


FIGURE 15: PART 90 210(C): EMISSION MASK

5.4 FCC PART 2.993: FIELD STRENGTH OF SPURIOUS RADIATION

The following data lists the significant emission frequencies, measured levels, correction factor (includes cable and antenna corrections), the corrected reading, plus the limit. Explanation of the Correction Factor is given in paragraph 6.0.

TABLE 3: RADIATED EMISSIONS: FCC PART 2.993

Transmitter Section
Distance: 3 Meters
Output Power Measured: P=7.44W = 145.7dBuV
43+10Log P = 51.7 down from P thus 145.7-51.7=94dBuV=-13dBm
Oscillator: 166.4M/616.4M/626.4M; 12.8M; 26M

Freq. MHz	Polar.	CL Ref. dB	S/G level dBm	TX Gain dBi	Gain Diff.* dB	Ref. Reading dBm	EUT Reading dBm	Margin dB	TX Antenna #
920.000	H	11.0	-2.0	N/A	N/A	-10.4	-16.4	-6.0	1.
920.000	V	11.0	-2.0	N/A	N/A	-10.8	-19.5	-8.7	1.
1379.90	H	13.7	-5.0	7.8	5.65	-14.4	-42.5	-28.1	2.
1379.90	V	13.7	-5.8	8.6	6.45	-16.8	-49.3	-32.5	2.
1840.00	H	16.3	-1.6	7.0	4.85	-18.1	-47.9	-29.8	2.
1840.00	V	16.3	-1.45	6.9	4.75	-23.2	-60.1	-36.9	2.

Antenna:
1. Half Wave dipole S/N 274

2. Bilog antenna ARA LPB 2550 S/N 1036

The requirement assumes that all emissions are radiated from half-wave dipole antennas.

*Difference in gain between half-wave dipole and antenna used for the reference power level.

TEST PERSONNEL:

Signature: ________________________ **Date:** 8/19/98

Typed/Printed Name: K. Franck Schuppius

5.5 Frequency stability function of temperature

TABLE 4: FCC part 90.213 and part 2.995(a): Frequency stability function of temperature

Frequency stability function of temperature		
Temperature (°C)	MCF(MHz)	PPM error $[(MCF/ACF)-1]10^6$
-30	459.99828	3.74
-20	459.9988	2.61
-10	459.99912	1.91
0	459.9994	1.30
10	459.99966	0.74
20	460.00001	0.02
30	460.00022	0.48
40	460.0005	1.09
50	460.00061	1.33

where MCF is the Measured Carrier Frequency in MHz, ACF the Assigned Carrier Frequency in MHz. and ACF(MHz)=460.0000

5.6 FCC PART 90.214: TRANSIENT FREQUENCY BEHAVIOR

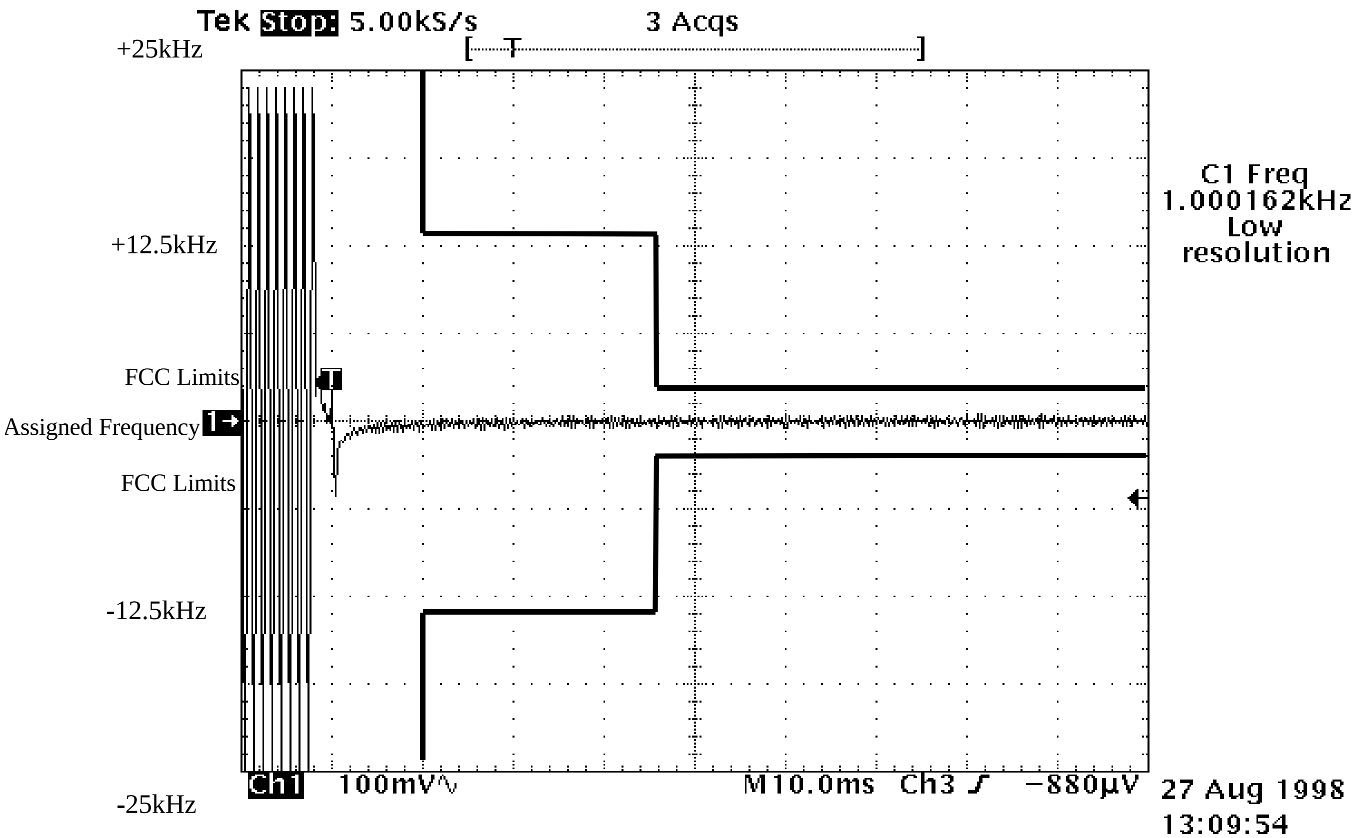


FIGURE 16: PART 90.214, TRANSIENT FREQUENCY BEHAVIOR

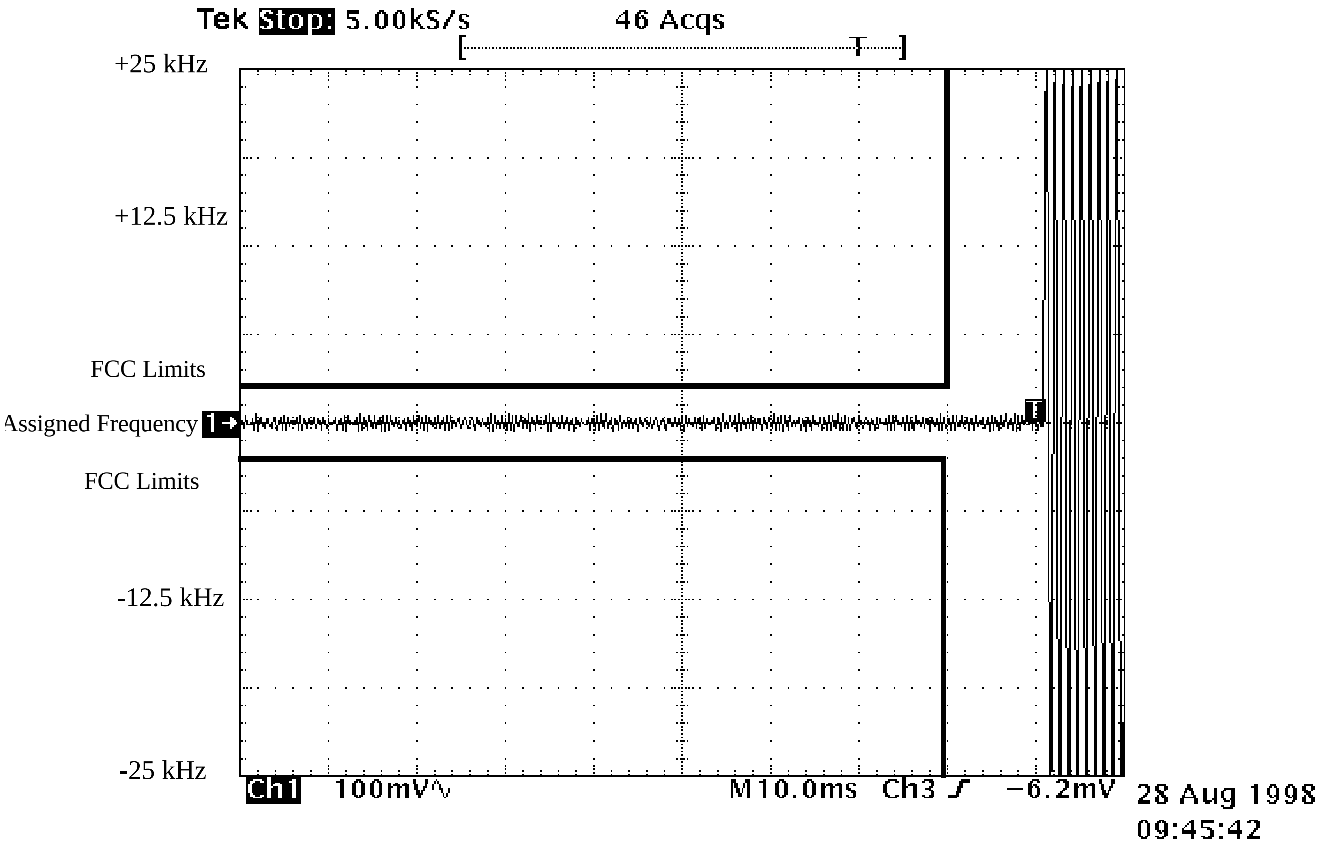


FIGURE 17: PART 90.214, TRANSIENT FREQUENCY BEHAVIOR

6.0 BLOCK DIAGRAM OF UI PRELIMINARY TRANSCEIVER UNIT

Please see following pages.

7.0 MEASUREMENT PHOTOS

7.0 Field Strength Calculation, and Radiated Test Methodology

7.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FI(dBuV/m) = SAR(dBuV) + SCF(dB/m)$$

FI = Field Intensity
SAR = Spectrum Analyzer Reading
SCF = Site Correction Factor

The Site Correction Factor (SCF) used in the above equation is determined empirically, and is expressed in the following equation:

$$SCF(dB/m) = - PG(dB) + AF(dB/m) + CL(dB)$$

SCF = Site Correction Factor
PG = Pre-amplifier Gain
AF = Antenna Factor
CL = Cable Loss

The field intensity in microvolts per meter can then be determined according to the following equation:

$$FI(uV/m) = 10^{FI(dBuV/m)/20}$$

For example, assume a signal at a frequency of 125 MHz has a received level measured as 49.3 dBuV. The total Site Correction Factor (antenna factor plus cable loss minus preamplifier gain) for 125 MHz is -11.5 dB/m. The actual radiated field strength is calculated as follows:

$$49.3\ dBuV - 11.5\ dB/m = 37.8\ dBuV/m$$

$$10^{37.8/20} = 10^{1.89} = 77.6\ uV/m$$

7.2 Radiated measurement

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one meter and three meter distances if necessary in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three-meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The spectrum was examined from 30 MHz to 1000 MHz using a Hewlett Packard 8566B spectrum analyzer, a Hewlett Packard 85650A quasi-peak adapter, and an Antenna Research bilog antenna. In order to gain sensitivity, an RTL PR-1040 preamplifier was connected in series between the antenna and the input of the spectrum analyzer.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations.

Note: Rhein Tech Laboratories, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the Rhein Tech quality manual, section 6.1. Rhein Tech implements the following procedures to minimize errors that may occur: yearly as well as daily calibration methods, technician training, and emphasis to employees on avoiding error.

8.0 PHOTOS OF TESTED EUT

The following photos are attached:

APPENDIX A: Emissions Equipment List

DESCRIPTION	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CAL. LAB
Pre-Amplifier	Hewlett Packard	11975A	2304A00348	TEST EQUITY
Pre-Amplifier	Hewlett Packard			TEST EQUITY
Pre-Amplifier (s/a 1)	Rhein Tech	PR-1040	N/A	RTL
Pre-Amplifier (s/a 2)	Rhein Tech	RTL2	N/A	RTL
Pre-Amplifier (s/a 3)	Rhein Tech	8447F	2944A03783	RTL
Pre-Amplifier (s/a 4)	Rhein Tech	8447D	2727A05397	RTL
Biconical/Log Antenna 1	Antenna Research	LPB-2520	1037	LIBERTY LABS
Biconical/Log Antenna 2	Antenna Research	LPB-2520	1036	LIBERTY LABS
Field Site Source	EMCO	4610	9604-1313	RTL
Filter (Room 1)	Solar	8130	947305	RTL
Filter (Room 2)	Solar	8130	947306	RTL
Harmonic Mixer 1	Hewlett Packard	11970K	2332A00563	TELOGY
Harmonic Mixer 2	Hewlett Packard	11970A	2332A01199	TELOGY
Horn Antenna 1	EMCO	3160-10	9606-1033	EMCO
Horn Antenna 2	EMCO	3160-9	9605-1051	EMCO
Horn Antenna 3	EMCO	3160-7	9605-1054	EMCO
Horn Antenna 4	EMCO	3160-8	9605-1044	EMCO
Horn Antenna 5	EMCO	3160-03	9508-1024	EMCO
LISN (Room 1/L1)	Solar	7225-1	N/A	ACUCAL
LISN (Room 1/L2)	Solar	7225-1	N/A	ACUCAL
LISN (Room 2/L1)	Solar	7225-1	900078	ACUCAL
LISN (Room 2/L2)	Solar	7225-1	900077	ACUCAL
Pre-Amplifier	Hewlett Packard	8449B OPT	3008A00505	TELOGY
Quasi-Peak Adapter (S/A 1)	Hewlett Packard	85650A	3145A01599	ACUCAL
Quasi-Peak Adapter (S/A 2)	Hewlett Packard	85650A	2811A01276	ACUCAL
Quasi-Peak Adapter (S/A 3)	Hewlett Packard	85650A	2521A00473	ACUCAL
Quasi-Peak Adapter (S/A 4)	Hewlett Packard	85650A	2521A01032	ACUCAL
RF Preselector (S/A 1)	Hewlett Packard	85685A	3146A01309	ACUCAL
Signal Generator (HP)	Hewlett Packard	8660C	1947A02956	ACUCAL
Signal Generator (Wavetek)	Wavetek	3510B	4952044	ACUCAL
Spectrum Analyzer 1	Hewlett Packard	8566B	3138A07771	ACUCAL
EMI Receiver	Hewlett Packard	8546A	3325A00159	ACUCAL
Spectrum Analyzer 2	Hewlett Packard	8567A	2841A00614	ACUCAL
Spectrum Analyzer 4	Hewlett Packard	8567A	2727A00535	ACUCAL
Tunable Dipole	EMCO	3121	274	LIBERTY LABS
Harmonic Mixer	Hewlett Packard	11970A	2332A01199	ACUCAL
Harmonic Mixer	Hewlett Packard	11970K	2332A00563	ACUCAL

APPENDIX B:

USER'S MANUAL