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Technical Report No. 98-022.

**"EMI Evaluation of the J-Tech, Inc.
Uni-Box Telephone Interface to FCC
Conducted and Radiated Emission Requirements."**

Performed: 10 & 19 March 1998

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Director, FAU EMI R & D Laboratory

1. INTRODUCTION

The J-Tech, Inc. Uni-Box Telephone Interface Unit was connected to a Condor #DV-9319B Power Supply unit and the transmitter was terminated into a dummy load. Evaluation results reported in this 8 page document apply only to the specific items of equipment, configurations (including software and unit operation), and procedures supplied to the Florida Atlantic University EMI Research Lab by J-Tech, Inc. under the test conditions listed herein.

2. OBJECTIVE

This evaluation was performed to verify conformance of the J-Tech, Inc. Uni-Box Telephone Interface Unit with reference to the U.S. Federal Communications Commission (FCC) Code of Federal Regulations (CFR), Title 47 - Telecommunication, Part 90 - Section 90.210 (d) (3) and Radio Frequency Devices, Subpart B - Unintentional Radiators, Section 15.107(b) Conducted limits.

Section 90.210 (d)(3) states any emission must be attenuated below the power (P) of the highest emission by at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser. The Uni-Box has a power rating of 2 watts, therefore, the attenuation factor is 50 + 10 log 2 or -53 dB. Assuming 2 watts of power and 1.67 dB gain of a dipole over isotropic and a distance of 3 meters, the rms voltage would be 3.3 volts per meter or 130.3 dBuV/m at the receiving antenna. Therefore, the allowable limit at 3meters will be 130.3 dBuV/m -53dB or 77.3 dBuV/m (7328 uV/m).

3. CONCLUSION

The J-Tech, Inc. Uni-Box Telephone Interface Unit met the FCC radiated requirements of Section 90.210 (d) (3) and Class "B" conducted emission requirements as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1 TEST PROCEDURES

The measurement techniques identified in measurement procedure ANSI C63.4-1992 *"American National Standard of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"* were followed as close as practical during this evaluation. Complete details and specific procedures used are discussed in the respective Tests Results sections.

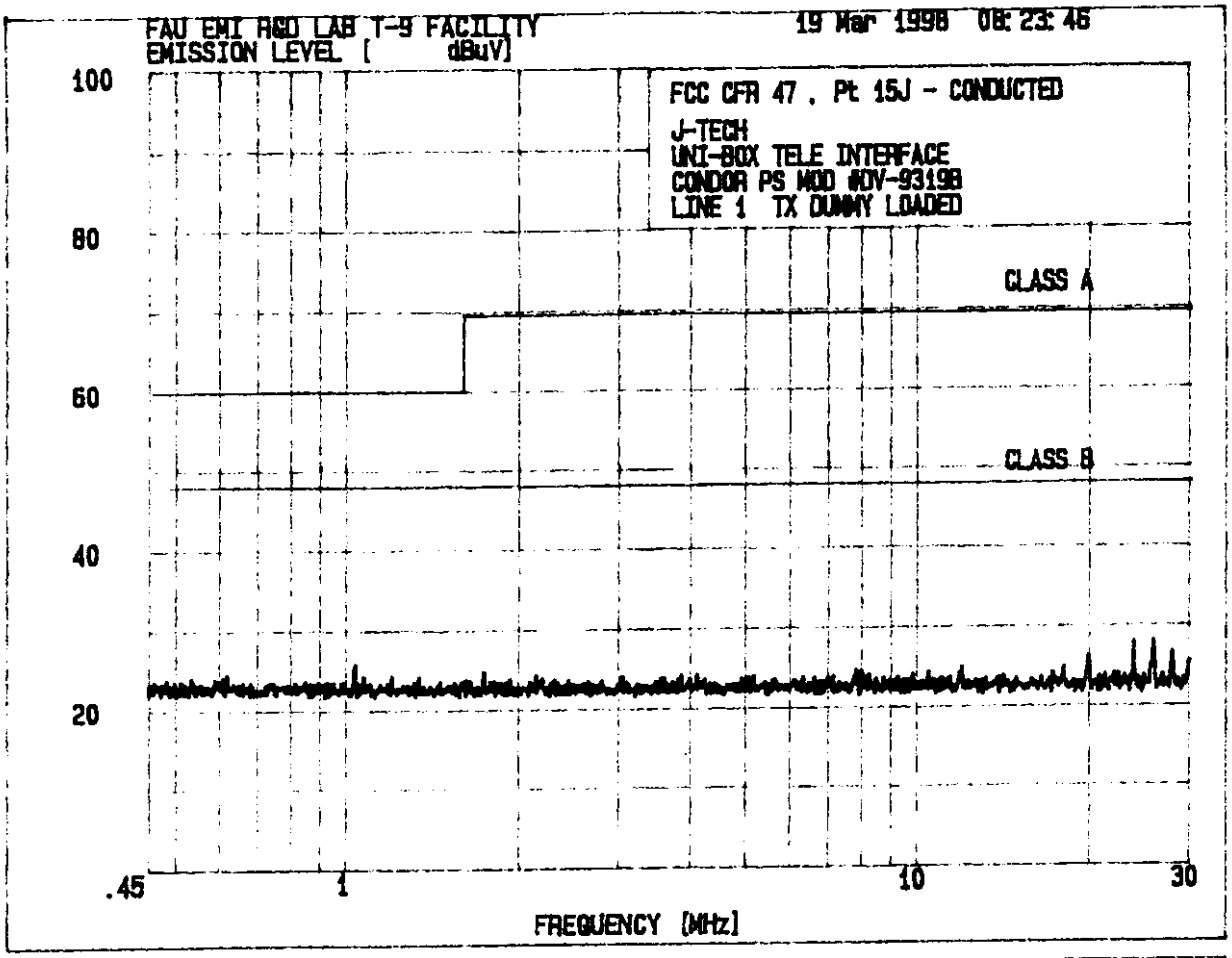
4.2 TEST RESULTS

4.2.1 CONDUCTED POWERLINE EMISSIONS

The J-Tech, Inc. Uni-Box Telephone Interface Unit and support devices were set up at the FAU T-9 EMI facilities conducted emissions screenroom enclosure. The unit was placed on a test table 80 centimeters above the ground plane floor and 40 centimeters from the rear wall of the RF screen room as defined in the referenced FCC adopted measurement procedure ANSI C63.4-1992. Photographs 1 and 2 show the physical positioning of the Uni-Box during the conducted emissions.

The AC power cord of the J-Tech, Inc. Condor #DV-9319B Power Supply unit was plugged into a Solar model 8028-50, 50 ohm/50 uH Line Impedance Stabilization Network (LISN). Conducted power line emissions were measured on both the phase and neutral lines in reference to earth ground over the specified 450kHz to 30MHz range on a Hewlett Packard HP 8566B Spectrum Analyzer. The spectrum analyzer was operated in the 'peak' detector mode with a bandwidth of 9kHz obtained through an HP 85650A Quasi-Peak Adapter. The HP 85864C EMI test program collected the conducted emissions over the specified frequency range and plotted the results.

Figure 1 shows the 'peak' detected conducted emissions from the Uni-Box Telephone Interface Unit to be below the FCC Class "B" conducted emission limit over the entire specified frequency range.



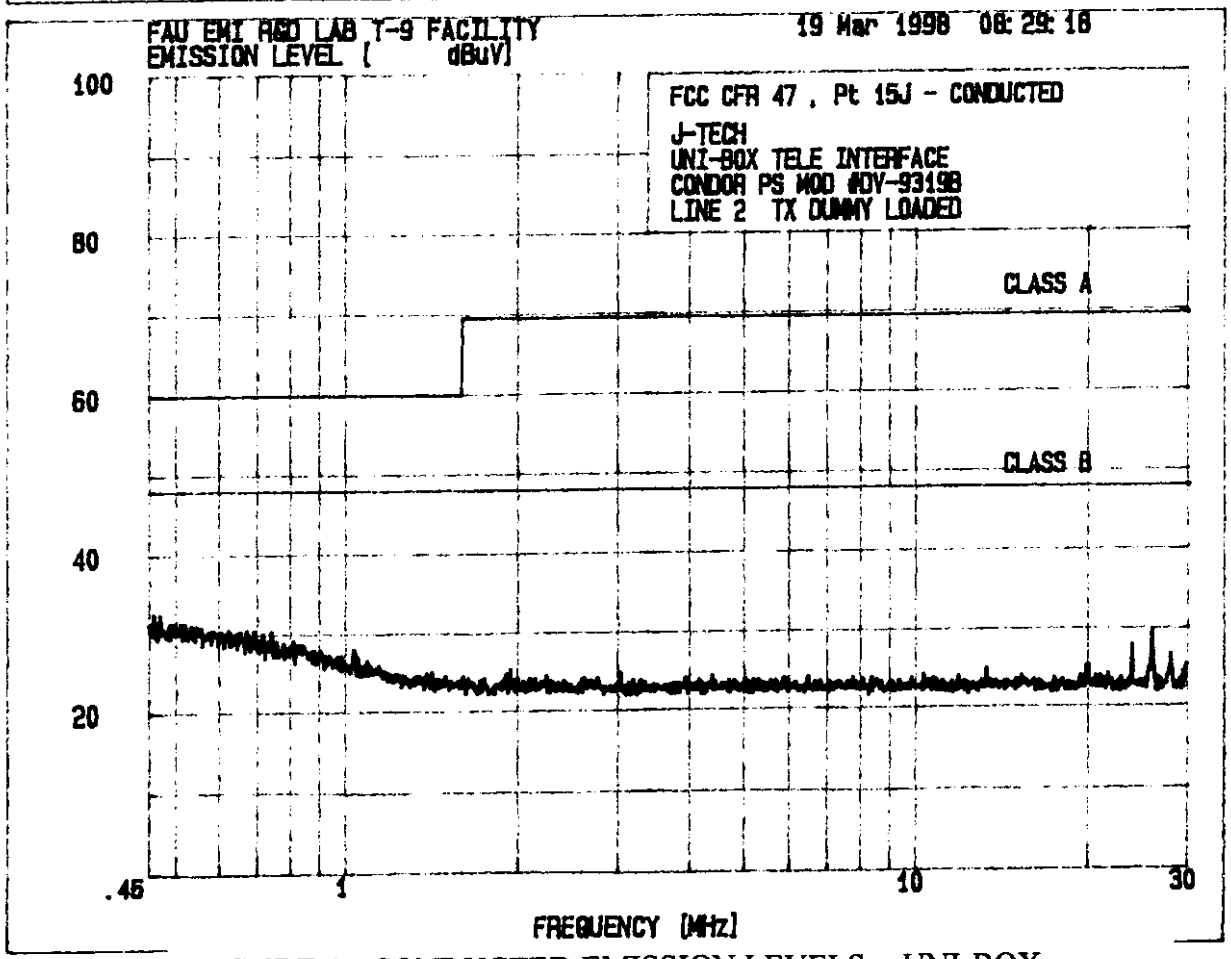


FIGURE 1: CONDUCTED EMISSION LEVELS - UNI-BOX .

4.2.2 RADIATED EMISSIONS

The J-Tech, Inc. Uni-Box Telephone Interface Unit and associated power supply was set up on a wooden turntable 80 centimeters above the ground plane of the FCC listed Open Area T-9 radiated emission test site. A 30 dB attenuator and a 10 watt 50 ohm resistive load terminated the RF output port of the unit. Photographs 3 and 4 show the physical configuration used during the radiated emissions testing from the system.

An EMCO model 3146 S/N 1385 Log Periodic antenna was installed on a Compliance Design Antenna Mast at a distance of 3 meters from the system. The output of the antenna fed a 30 foot low loss coax cable to a Tunable Notch Filter Type 6367 Model #6367-5 (provided by J-Tech), which was tuned to the Uni-Box fundamental operating frequency of 465.8875 MHz. The output of the filter was connected to a 83017A Amplifier which was fed through a low loss heliax coax cable to a HP 8566B Spectrum Analyzer. The turntable was rotated, and the antenna was scanned in height from 1 to 4 meters in both the horizontal and vertical polarizations while the 2nd harmonic frequency was monitored. The 3146 Log Periodic antenna was then replaced with an EMCO Model 3115 S/N 2573 Horn antenna and the above procedure was repeated for the 3rd to 10th harmonics.

Table 1 shows the worstcase 'peak' emission levels detected for both vertical and horizontal antenna polarizations for the 2nd through the 10th harmonic.

The following are explanation notes for data in Table 1:

FREQ = Frequency in MHz.

ANT. POL. = Test antenna polarization.

IND. dBuV = Induced emission level in dBuV.

CL 1 dB = Cable loss in dB of Grey cable.

CL 2 dB = Cable loss in dB of Heliax cable.

GA dB = Gain of 83017A Amplifier including loss of notch filter.

AF dB = Antenna factors for EMCO 3146 log periodic or 3115 Horn.

TOTAL dBuV/M = Total field intensity measured at 3 meters.
(IND. dBuv + CL 1 dB + CL 2 dB - GA dB + AF dB)

RNL = Receiver Noise Level

NOTE: See paragraph 2. OBJECTIVE for limit used.

FREQ.	ANT.	IND.	C.L. 1	C.L. 2	G.A.	A.F.	TOTAL	TOTAL	LIMIT
(MHz)	POL.	(dBuV)	(dB)	(dB)	(dB)	(dB)	(dBuV/m)	(uV/M)	(uV/M)
931.7750	HOR	53.95	2.53	1.08	29.82	24.58	52.32	413	7328
931.7750	VERT	50.40	2.53	1.08	29.82	24.58	48.77	274	7328
1397.6625	HOR	50.95	3.22	1.31	28.22	30.44	57.70	767	7328
1397.6625	VERT	57.70	3.22	1.31	28.22	30.44	64.45	1669	7328
1863.5500	HOR	48.25	3.99	1.58	26.94	33.72	60.60	1072	7328
1863.5500	VERT	49.35	3.99	1.58	26.94	33.72	61.70	1216	7328
2329.4375	HOR	45.35	4.2	1.71	24.34	34.44	61.36	1169	7328
2329.4375	VERT	46.10	4.2	1.71	24.34	34.44	62.11	1275	7328
2795.3250	HOR	45.90	4.98	2.06	27.00	35.80	61.74	1221	7328
2795.3250	VERT	47.30	4.98	2.06	27.00	35.80	63.14	1435	7328
3261.2125	HOR	45.70	5.03	2.34	26.24	36.54	63.37	1475	7328
3261.2125	VERT	47.40	5.03	2.34	26.24	36.54	65.07	1794	7328
3727.1000	HOR	49.20	5.58	2.48	24.73	37.73	70.26	3259	7328
3727.1000	VERT	50.20	5.58	2.48	24.73	37.73	71.26	3656	7328
4192.9875	HOR	44.60	5.82	2.61	26.40	38.99	65.62	1909	7328
4192.9875	VERT	43.90	5.82	2.61	26.40	38.99	64.92	1761	7328
4658.8750	HOR	42.30 RNL	6.41	3.21	20.69	39.06	70.29	3270	7328
4658.8750	VERT	42.85	6.41	3.21	20.69	39.06	70.84	3484	7328

TABLE 1. RADIATED EMISSION DATA - UNI-BOX.

J-Tech Technical Report 98-022.

System Specifications

J-Tech, Inc. Premise Paging System Series-450TXI UNI-BOX

Master Base Paging Transmitter with phone Interface

Protocol: Serial ASCII
Data Format: RS-232-C
Communication Rate: Data rate via the serial bus is 4800 BPS, N,8,1 with hardware flow control

J-Tech Pager Network

Protocol: J-Tech with wide area repeater broadcast
Communication: FSK Manchester II format 1024 BPS

Transmitter

Frequency Range: 450-470MHz. 12.5 kHz single splinter channels
Power Output: 2 watt maximum
Antenna: 1/4 wave whip
Frequency Stability: .00025% (2.5 ppm)
Modulation: FSK/ direct FM 1024 BPS
Emission: 11K250F1D

Physical and Environmental

Operating Temperature: -30°C to + 60°C (paging master station)
0°C to + 70°C (belt worn pager)
Storage Temperature: -30°C to +60°C

Humidity: 0% to 90% non-condensing

Size: Master Base Paging Transmitter: 2.7in (67mm) Height x 14in (355mm) Width x 6.1in (155mm) Depth

Weight: Master Base Paging Transmitter: 1.2lbs. (.543 Kg.)

Technical Description Detail Pager Master Transmitter

Frequency Synthesizer

a. Reference Oscillator and VCTCXO

The reference oscillator provides the frequency stability vs. temperature characteristic for the transmitter. The reference element is compensated to better than 2.5 ppm and is supplied as a pre-packaged hybrid unit or equivalent. Modulation is direct FM introduced to a varactor port and provides low frequency data modulation. The output of the reference at 9.6 MHz. is applied to the synthesizer U7 where it is internally divided to provide a reference frequency of 12.5 KHz.

b. PLL Synthesizer, Data Modulation, and Loop Filter

The PLL system consists of three (3) main devices; the synthesizer IC U7, VCO U10, and the reference oscillator. Control of the synthesizer U7 is provided by microcontroller and resident firmware. The synthesizer uses a dual modulus prescaler and is a standard indirect PLL technique. The IC U7 consists of phase/frequency detector, 1/N counter or main divider, two modulus counter and control, and reference counter. Main control of these internal circuit blocks within U7 is via control over an I2C bus to PIN 10 of U7. Data clock is provided to PIN 9. The reference oscillator operating at 9.6MHz. is divided to a fixed 12.5 kHz. Control of the 450-470 MHz VCO is via U7 phase frequency comparator and charge pump circuit with external loop filter. Appropriate value of the 1/N counter can be obtained from the 2 modulus equation with the 2 modulus count equal to 31/32, the reference frequency at 12.5KHz. and the VCO frequency equal to the transmit channel. The loop filter is a conventional low pass with phase lead compensation provided by R12 and C60. Pre-integration of the charge pump pulses is provided by C34 and additional reference filtering of the charge pump pulses is provided by R39 and C35. Modulation fidelity is maintained by introducing the data signal at 2 points in the loop. One data signal is applied to the VCO control line voltage via the loop filter. The other is introduced to the reference oscillator. In order to modulate the VCO correctly, and introduce a summing junction for modulation and VCO control, the modulation signal voltage is converted into a current. R38 provides this function. Data shaping for the VCO modulation is provided by low pass filter R40 and 41 and C61. Data shaping for the reference oscillator and VCO modulation port is provided by a low pass data filter. U4.and U3 along with R20, R26, R28, and C47 through C49 provide a low pass filter. Additional filtering is provided by R40, 41 and C61. Since 2 point modulation is used it is necessary to control the amount of deviation contributed to each modulation port. An imbalance of signal at one port or the other will produce either excessive integration or differentiation of the modulation. Since the modulation gain of the reference is much less than the VCO, deviation adjustment is directly connected to U9 the reference oscillator and controlled by R5,R4. Deviation compensation is controlled by R54.

Transmitter Controller (Master controller board)

c. Microcontroller

Test and Alignment Procedure

UHF 450 Master Base Paging Transmitter UNI-BOX

The tuning of the transmitter consists of four (4) adjustments. The carrier center frequency is adjusted via a trimmer capacitor contained within TCXO reference module U9. The modulation level which controls deviation is set by R4, R5 and R54. These three adjustments also work together to control modulation fidelity of the phase lock loop. The final adjustment factory presets RF output power via setting R52.

1. The RF center frequency is adjusted by activation of the 5 volt TX line by de-asserting the "shutdown" pin, pin 2 of U3. This action continually provides +5 volts to the VCO, TCXO, and phase lock loop IC U7. The PLL frequency is programmed into U7 by the microprocessor upon power up and continued application of +5 volts to U7 allows the IC to retain this programming. All RF measurements except RF power output are performed by monitoring the output of the VCO via a 1K series impedance.

2. The RF center frequency is adjusted by monitoring the VCO output without modulation. The operating frequency is counted and adjusted to within +/- 200 Hz.

3. The frequency deviation and modulation fidelity are measured with a nominal 250 Hz (one fourth data rate) square wave provided and the microprocessor modulation output pin. Demodulation of the transmitted data on a service monitor provides a scope readout of the deviation. Adjust R33 for symmetrical deviation of 4 kHz peak.

4. Modulation fidelity, the rise and fall time of the data modulation signal, is observed on the service monitor. Adjustment of the compensation control R54 controls the undershoot and overshoot of the waveform to ensure flat response.
5. With these adjustments made, deviation is limited and held constant, since the signal level swings are limited and constant as set by the controller logic. With the data fidelity set and checked the modulation bandwidth is limited by a combination of data filters and phase lock loop bandwidth.

6. RF final output power is measured into a 50 ohm system load at J3 and is adjusted by a factory preset adjustment R52. Power output is set at +33 dBm (2 watts maximum).

Technical Description Overview

A. Series 450 Premise Paging System

The JTECH Series 450 Premise Paging system consists of frequency synthesized transmitter and telephone interface designed to provide paging from private phone system.. A RS-232-C port is available so that a terminal or desktop computer can be used to input alpha numeric messages.. This capability allows the transmitter data input and paging message to be input by standard telephone touch tone keypad.
The Series 450 operates on 12.5 kHz or 25 kHz UHF assigned channels. The RF transmitter maximum output power is 2 watts and the encode data rate is 1024 bps. Emission type is 7K0F1D.

B. Series 450 Master Base Paging Transmitter UNI-BOX

The paging transmitter is frequency synthesized and uses a phase lock loop (PLL) design. The reference oscillator is a voltage controlled temperature compensated crystal oscillator (VC-TCXO) and determines the temperature frequency stability of the final output. The design uses a number of control elements to insure that the final transmit channel is achieved before enabling the power amplifier. Modulation of the loop requires modulating the voltage controlled oscillator (VCO) and the reference oscillator. A 2 port modulation scheme insures good fidelity modulation for the low frequency paging data. Additional circuits under control of the micro processor via an I2C bus control factory set channel frequency, RS-232-C interface .

C. Major Component Count and Active Devices on transmitter board

Integrated and hybrid circuits 10 and transistors 2

U1 Voltage regulator + 8 volts	78T08CT
U2 Voltage regulator + 5 volts	TK11950M
U3 Analog switch	CD4053
U4 Quad Operational Amplifier	LMC6582
U5 RS-232 Serial Interface integrated circuit	MAX232A
U6 RF Power Module Hybrid integrated circuit	BGY113F
U7 PLL synthesizer integrated circuit	UMA1014T
U8 Quad operational amplifier integrated circuit	MC33174P
U9 TCXO Hybrid integrated circuit	TEW TX1824M
U10 Voltage control oscillator VCO hybrid	MQC403-457
Q1 Power MOS switch	BRF7203
Q2 Digital Transistor	DTC114EKA
Q3 Power control voltage follower	MMBV2222

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Transmitter Controller (Master controller board)

c. Microcontroller

The controller 80c32 provides via an I2C interface bus programming of the synthesizer U7. In addition the microcontroller encodes the keyboard input data with additional bits for error correction and finally into Manchester data format. The Manchester format provides modulation signal with no significant low frequency component. Microcontroller firmware also handles power management routines including switching the power amplifier on after frequency and phase lock is achieved, if no keyboard activity is The controller clock is 12 MHz. set by C1 and C2 and crystal Y1. External communication via a serial port Jp5 with the controller is handled by an RS-232 interface U5. This device contains an internal voltage charge pump with C22 through C26. RF decoupling of the RS-232 port is provided for via L14 through L16 and C68 through C70. Remaining ports of the controller are dedicated to the I 2C bus with serial data, serial clock, and the power amplifier enable line. A set of 5 volt regulators provide low noise stable supply voltage for the PLL and components. U2 provides continuous 5 volts while U3 provides 5 volts only in transmit. Shut down is provided by the controller U1 to conserve battery drain.

RF Power and Supply Distribution

e. Power amplifier and Low Pass RF Filter

The VCO output U10 is applied to a resistive power splitter and attenuator using R10 and R19. This split and reduced power is input to the synthesizer prescaler at PIN 8 and the power amplifier hybrid module U6 PIN 1. A one milliwatt signal (0 dbm) input to the PA module provides rated output power and is factory set via power adjust R52. Low source impedance voltage control for PA power adjust is provided by follower Q3. Power amplifier enable is controlled by a series power MOS switch. An out of lock condition forced by the PLL will cause Q1 to an OFF state. With these pins low no output power will occur. During transmit maximum current passes to PIN 6. All low level current is handled by Q1 the MOS switch. RF output is obtained at PIN 7 and is low pass filtered by a 7 section Chebychev filter using C36 through C38 and C42 along with L6 through L8. port.

f. Power Distribution

Main power supply distribution is from an 12 volt external power supply. This supply is rated at 4.5 amps maximum, 25 watt and has built in shut down protection for short circuit protection. Reverse polarity protection is provided by D3. This could occur if incorrectly polarized DC plug or incorrect power supply is used. Supply via J1 is RFI filtered via L1, L1 and C5 . Additional voltage regulators on transmitter board provide constant 5 and 8 volts Transient control of power and frequency is maintained by shaping the transmit enable signal controlling Q1. This is accomplished by voltage divider R37 and R37(a) along with C75 and C75(a).

Test and Alignment Procedure

UHF 450 Master Base Paging Transmitter UNI-BOX

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2. The RF center frequency is adjusted by monitoring the VCO output without modulation. The operating frequency is counted and adjusted to within +/- 200 Hz.

3. The frequency deviation and modulation fidelity are measured with a nominal 250 Hz (one fourth data rate) square wave provided and the microprocessor modulation output pin. Demodulation of the transmitted data on a service monitor provides a scope readout of the deviation. Adjust R33 for symmetrical deviation of 4 kHz peak.

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5. With these adjustments made, deviation is limited and held constant, since the signal level swings are limited and constant as set by the controller logic. With the data fidelity set and checked the modulation bandwidth is limited by a combination of data filters and phase lock loop bandwidth.

6. RF final output power is measured into a 50 ohm system load at J3 and is adjusted by a factory preset adjustment R52. Power output is set at +33 dBm (2 watts maximum).

Test Results

Power Output

RF Power Output vs. Temperature and Line Voltage

FCC rules: 2.983 (d) 5, 2.985 (a), 90.267 (a) 1

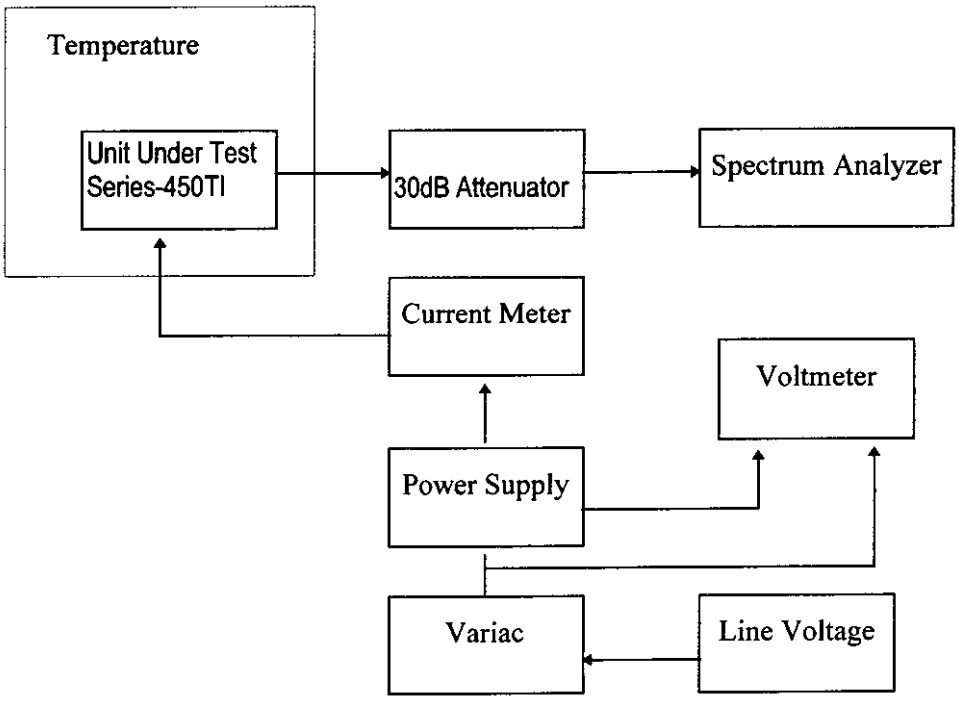
Specification: 2 watt maximum

Test Results: Unit tested comply with FCC specification

Test Conditions: Room Temperature (+25°C.)
Nominal DC Supply voltage 12 VDC (line voltage at 115 volts)
Unit under test in transmit with no modulation

Test Equipment: Variac	Staco Energy Products Model 6020CT
30 dB attenuator PAD	Weinschel 9305-30
Spectrum analyzer	Anritsu MS2601A
Voltmeter	Fluke 77
Temperature chamber	Tenny Model Series 942
Power Supply	International Power Sources, Inc. Model No. PUP30-10-1-B1

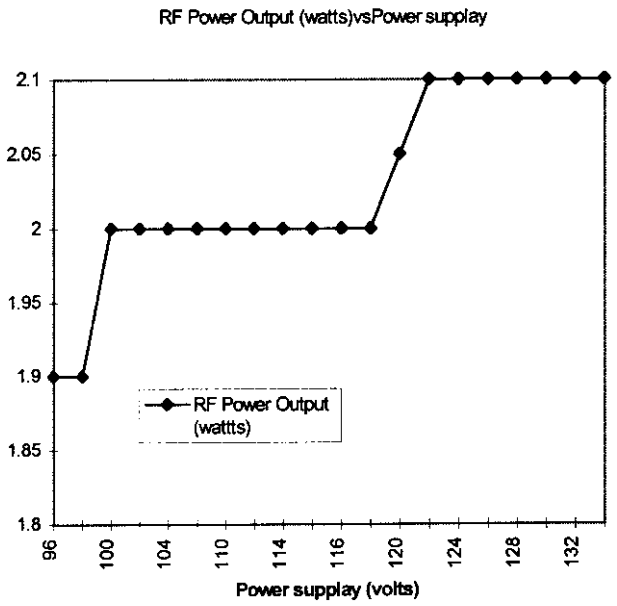
Test Setup:



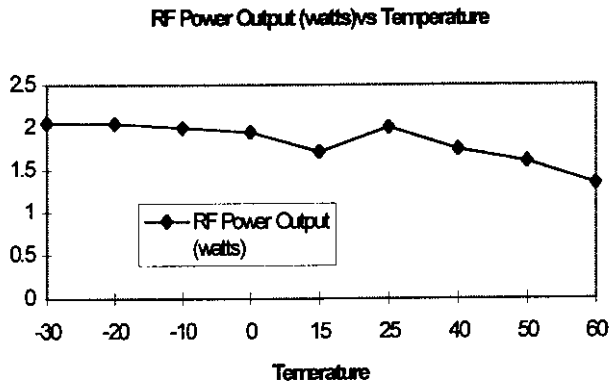
Test Results... RF Power Output vs. Temperature and Line Voltage

Test Transmit Frequency: 465.8875 MHz.
Reference Temperature: 25°C
Reference Line Voltage: 115 volts
Power Output: 33dBm Supply Voltage: 12 volts Supply Current: 1380 ma. Final Current: 1300 ma.

Line Voltage (volts)	RF Power Output
96	1.9
98	1.9
100	2
102	2
104	2
108	2
110	2
112	2
114	2
115	2
116	2
118	2
120	2.05
122	2.1
124	2.1
126	2.1
128	2.1
130	2.1
132	2.1
134	2.1



Temperature (degrees C)	RF Power Output (watts)
-30	2.05
-20	2.04
-10	1.99
0	1.94
15	1.71
25	2
40	1.74
50	1.6
60	1.34



Frequency Stability vs. Line Voltage

FCC rules: 2.995 (a), (b), (d), (2), ; 90.213 (a), (b)

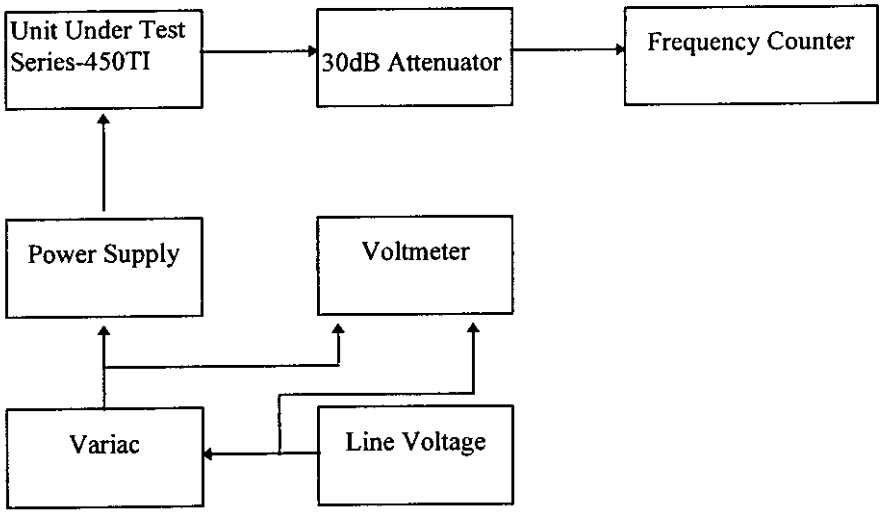
Specification: +/- .00025% (2.5ppm) from minimum line voltage to maximum line voltage (+/- 15%)

Test Results: Unit tested comply with FCC specifications

Test Conditions: Room temperature (+25°C) Unit Under Test in Transmit

Test Equipment: Power Supply	International Power Sources, inc. Model No. PUP30-10-1-B1
30dB attenuator pad	Weinschel 9305-30
Voltmeter	Fluke 77
Frequency counter	HP 5300B with HP 5305B
Variac	Staco Energy Products Model 6020CT

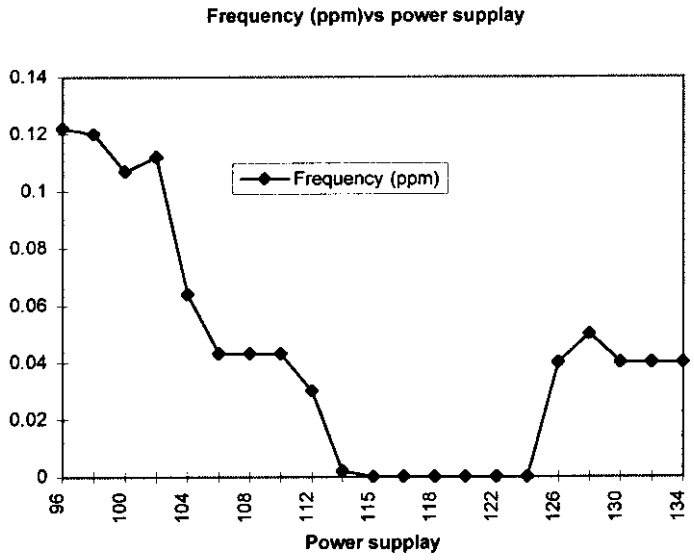
Test Setup:



Test Results... Frequency Stability vs. Line Voltage

Test Frequency: 465.8875 MHz.

Line Voltage (volts)	Frequency (ppm)
96	0.122
98	0.12
100	0.107
102	0.112
104	0.064
106	0.043
108	0.043
110	0.043
112	0.03
114	0.002
115	0
116	0
118	0
120	0
122	0
124	0
126	0.04
128	0.05
130	0.04
132	0.04
134	0.04



Frequency Stability vs. Temperature

FCC rules: 2.995 (a), (b), (d), (2), 90.213 (a), (b)

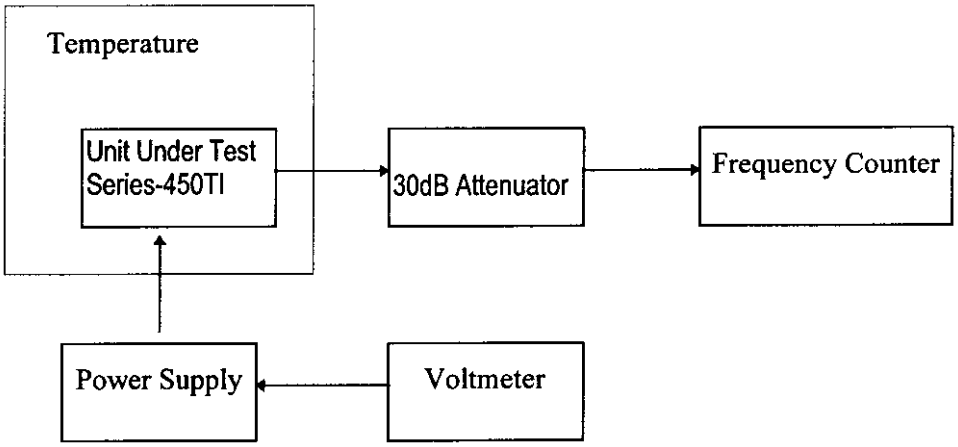
Specification: +/- .00025 % (2.5 ppm) from -30°C to +50°C

Test results: Unit tested comply with FCC specification

Test conditions: Line voltage 115 volt supply voltage 12 volts DC
Unit under test in transmit with no modulation

Test Equipment:	Power Supply	International Power Sources Model No. PUP30-10-1-B1
	30 dB attenuator	Weinschel 9305-30
	Voltmeter	Fluke 77
	Frequency counter	HP 5300B with 5305B
	Temperature chamber	Tenny Model Series 942

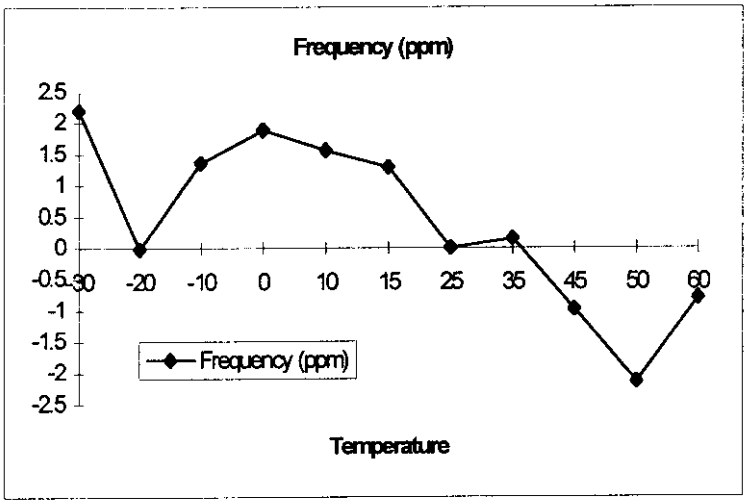
Test Setup:



Test Results... Frequency Stability vs. Temperature

Test Frequency: 465.8875MHz.
Reference Temperature: 25°C

Temperature (degress C)	Frequency (ppm)
-30	2.19
-20	-0.02
-10	1.36
0	1.88
10	1.56
15	1.29
25	0
35	0.15
45	-0.98
50	-2.14
60	-0.8



Modulation Characteristics/ Occupied Bandwidth

FCC Rules: 2.910 (d), Emission Mask D for 12.5Khz channel bandwidth equipment

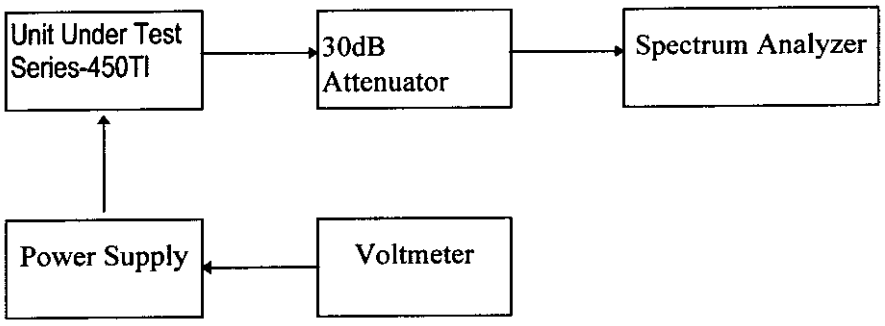
Specification: Fo to 5 KHz. Zero (0)dB
From 5.625KHz but more the 12.5KHz less then 7.27(Fd-2.88Khz)dB
Greater then 12.5Khz less 50 +10log(P) dB or 70 whichever is the lesser

Test Results: Unit tested comply with FCC specification

Test Conditions: Room temperature (+25°C)
Line voltage 115 volts, supply voltage 12 volts DC
Unit under test in transmit with 1024 Hz modulation

Test Equipment: Power Supply	International Power Sources, Inc. Model No. PUP30-10-1-B1
30 dB attenuator pad	Weinschel 9305-30
Spectrum Analyzer	Anritsu MS2601A
Voltmeter	Fluke 77

Test Setup:



Test Results... Modulation Characteristics/ Occupied Bandwidth

Nominal Transmit Frequency: 465.8875 MHz
RF Carrier Level: +33 dBm

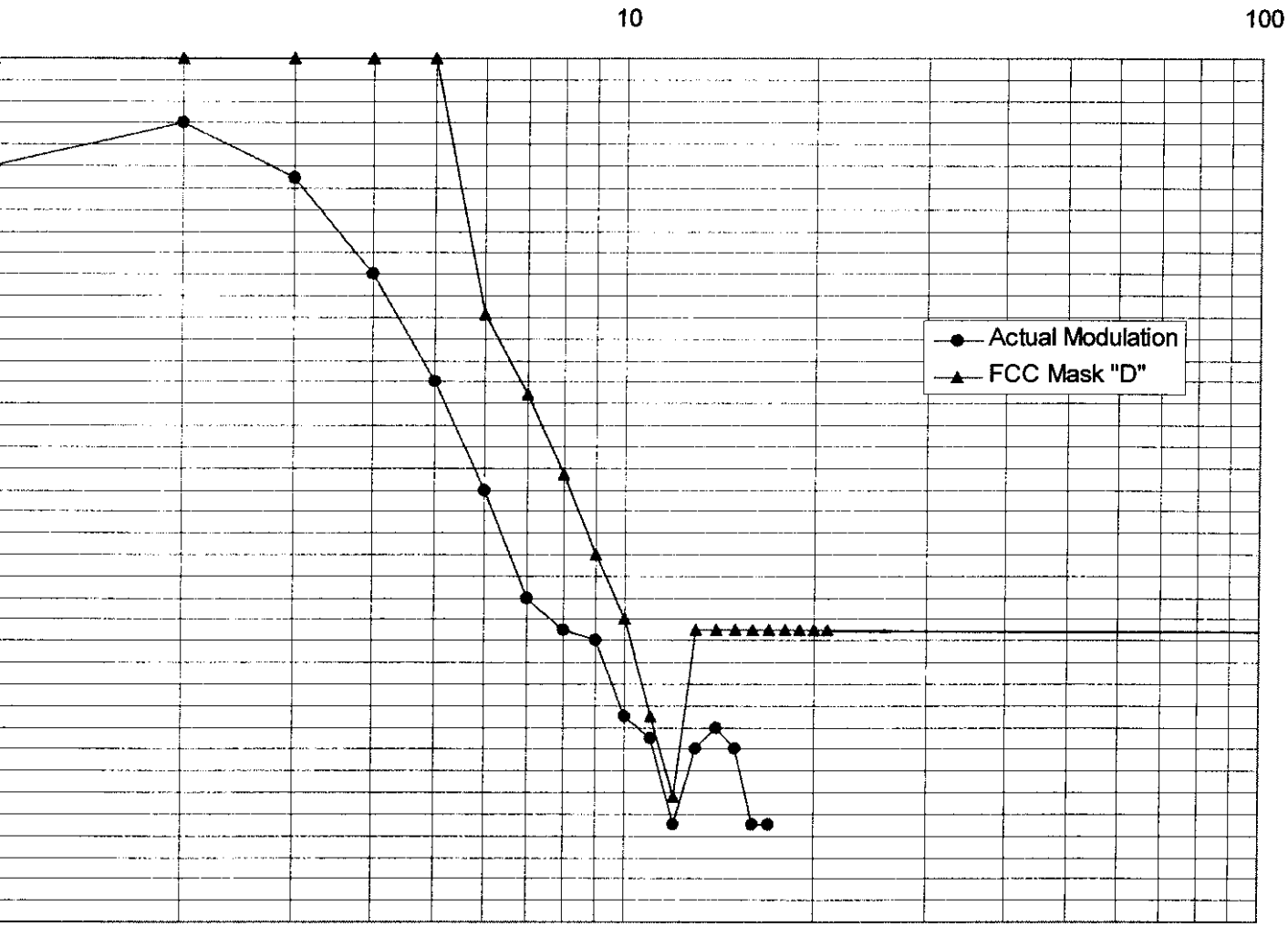
Zero and up to 5.625Khz from carrier and more then 5.625Khz and no more then 12.5 Khz from the carrier

Emission Freq.	Measured Level	dBc	FCC Specification
1024 Hz.	-6.7dBm	10	0dBc
2048 Hz.	-2.7 dBm	6	0dBc
3072 Hz.	-7.7dBm	11	0dBc
4096 Hz.	-16.7dBm	20	0 dBc
5120 Hz.	-26.7 dBm	30	0 dBc
6144 Hz	-36.7 dBm	40	23.73 dBc
7168 Hz.	-46.7dBm	50	31.17 dBc
8192 Hz.	-49.7 dBm	53	38.62dBc
9216 Hz.	-50.7dBm	54	46.06dBc
10024 Hz.	-57.7 dBm	61	51.94 dBc
11264 Hz.	-59.7 dBm	63	60.95 dBc
12288 Hz	-67.7 dBm	71	68.40dBc

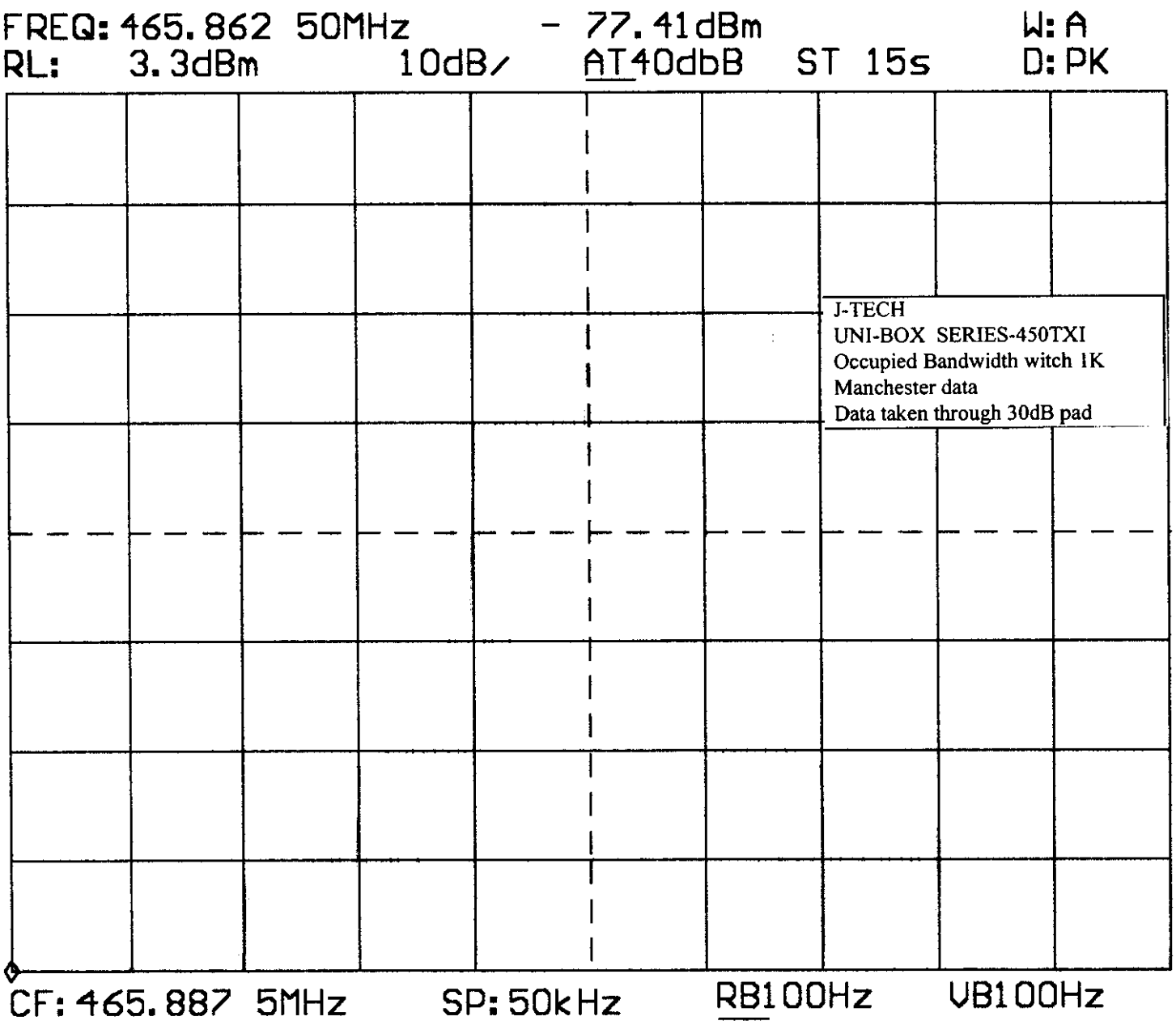
Emission Freq.	Measured Level	dBc	FCC Specification
13312 Hz.	-60.7 dBm	64	53 dBc
14336 Hz	-58.7 dBm	62	53 dBc
15360 Hz	-62.7dBm	64	53 dBc
16384 Hz	-67.7 dBm	71	53 dBc
17408 Hz	-67.7 dBm	71	53 dBc
18432 Hz	-71.7 dBm	>75	53 dBc
19456 Hz	do	>75	do
20480 Hz	do	>75	do
beyond 20 KHz.	do	>75	do

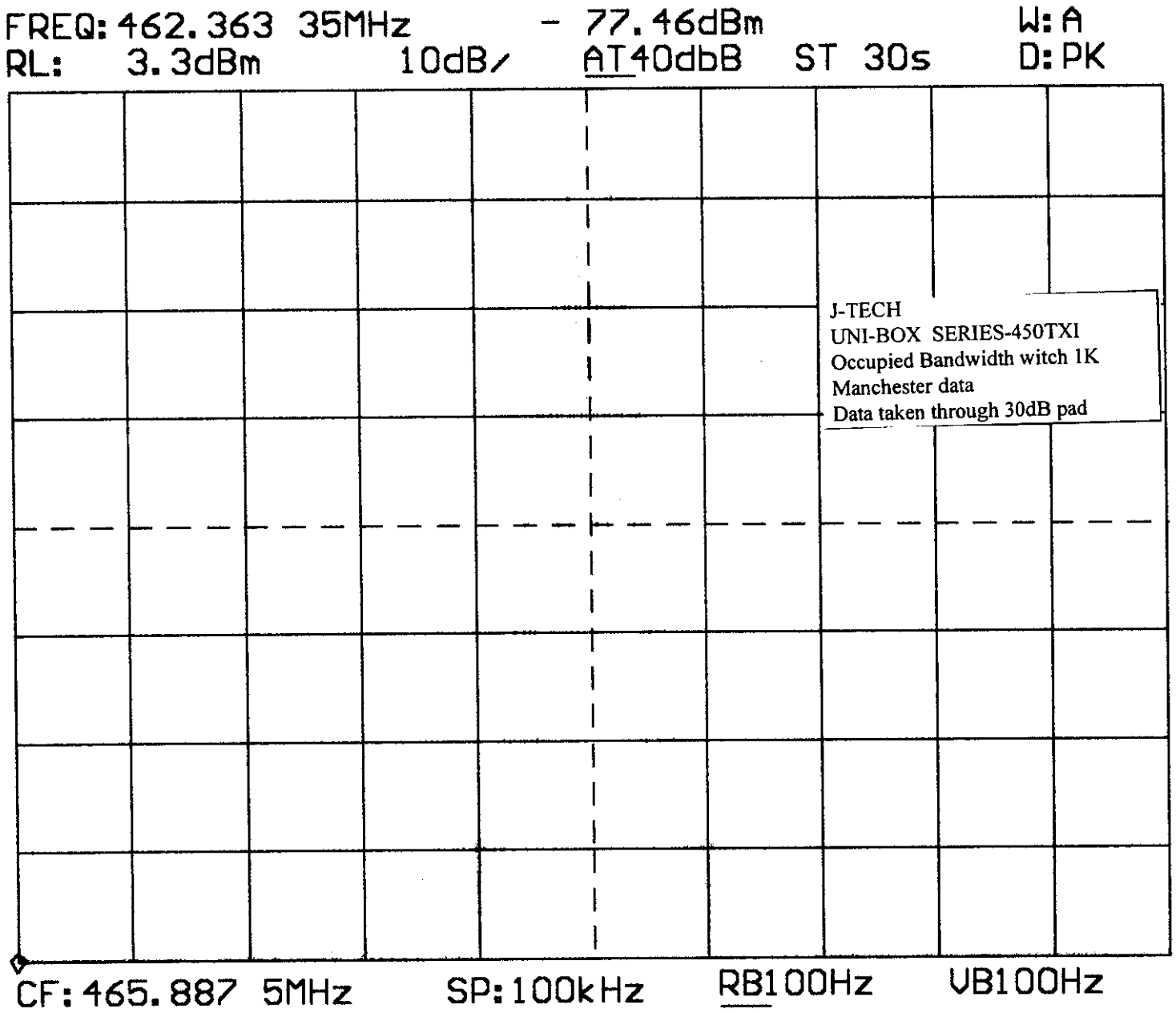
Emission Freq.	Measured Level	dBc	FCC Specification
Beyond 20 KHz.	>-70 dBm	>75	53dBc

UHF FCC MODULATION TEMPLATE



Frequency displacement from carrier KHz


FREQ: 465.862 50MHz
- 77.41dBm
W: A
RL: 3.3dBm
10dB/
AT40dbB
ST 15s
D: PK
J-TECH
UNI-BOX SERIES-450TXI
Occupied Bandwidth witch 1K
Manchester data
Data taken through 30dB pad
CF: 465.887 5MHz
SP: 50kHz
RB100Hz
VB100Hz


FREQ: 462.363 35MHz
- 77.46dBm
W: A
RL: 3.3dBm
10dB/
AT 40dbB
ST 30s
D: PK
J-TECH
UNI-BOX SERIES-450TXI
Occupied Bandwidth witch 1K
Manchester data
Data taken through 30dB pad
CF: 465.887 5MHz
SP: 100kHz
RB 100Hz
VB 100Hz

Spurious Emissions at Antenna Terminals

FCC rules: 2.991, 2.997, 90.209 (c), (1), (2), (3)

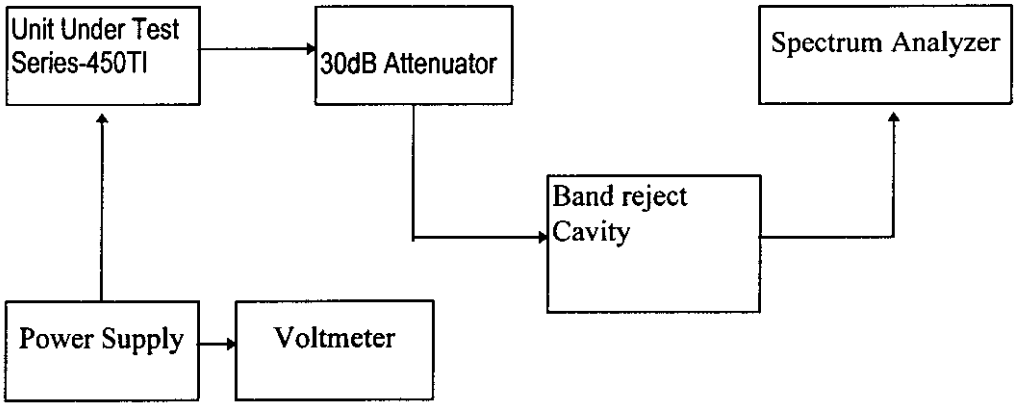
Specification: 50 to 100 % of authorized BW, 25 dB below carrier
100 to 250 % of authorized BW, 35 dB below carrier
> 250 % of authorized BW, 43 + 10Log10(Power Out)

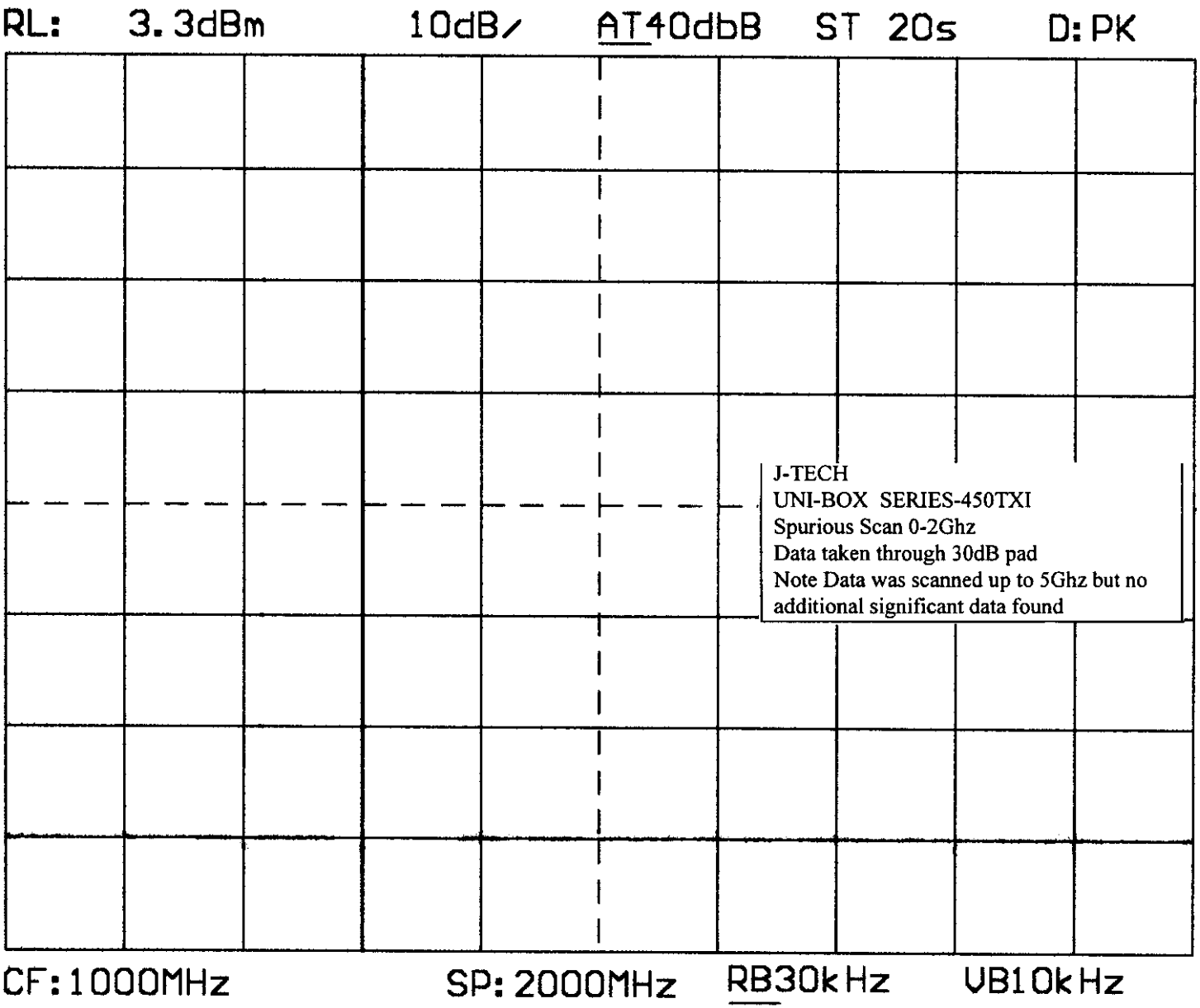
Test Results: Unit tested comply with FCC specification

Test conditions: Room temperature (+25°C)
Line voltage 115 volts, supply voltage 12 volts DC
Unit under test in transmit with no modulation

Test Equipment: Power supply	International Power Sources, Inc. Model PUP30-10-1-B1
30 dB attenuator pad	Weinschel 9305-30
Spectrum analyzer	Anritsu MS 2601A
Voltmeter	Fluke 77
Bandreject cavity filter	Microwave Filter Co, Inc. Model 6367-5

Test setup:




RL: 3.3dBm
10dB/
AT40dbB
ST 20s
D:PK
J-TECH
UNI-BOX SERIES-450TXI
Spurious Scan 0-2Ghz
Data taken through 30dB pad
Note Data was scanned up to 5Ghz but no additional significant data found
CF:1000MHz
SP:2000MHz
RB30kHz
VB10kHz

Test Results... Spurious Conducted Emissions at Antenna Terminal

Nominal Transmit Frequency: 465.8875 MHz.
Carrier level: +33.1 dBm.

50 to 100 % of authorized BW, 25 dB below carrier

All spurious emissions in this range were greater than 60 dB below carrier reference level.

100 to 250 % of authorized BW, 35 dB below carrier

All spurious emissions in this range were greater than 60 dB below carrier reference level.

> 250 % of authorized BW = 43 + 10Log10(Power Output) dB

All spurious emissions in this range were greater than 60 dB below carrier reference level.

Per the attached spectral plot, no emissions were noted that exceeded the required limits

Field Strength of Spurious Radiated Emissions at Antenna Terminal

FCC rules: 2.993 (a), (b), (2), (3), 2.997, 90.209 (c), (1), (2), (3)

Specifications:

Nominal Transmit Frequency: 465.8875 MHz.
Carrier level: +33.1 dBm.

50 to 100 % of authorized BW, 25 dB below carrier

100 to 250 % of authorized BW, 35 dB below carrier

> 250 % of authorized BW = 43 + 10Log10(Power Output) dB

Test Conditions: Room temperature (+25°C)
Line voltage 115 volt, supply voltage 12 volts DC
Unit under test in transmit with no modulation

Test Equipment: FCC Approved Test Site and see attached report which follows:
Test Setup: see attached report which follows:

Test Results... conducted and radiated emission Requirements

EMI Research and Development Laboratory
Department of Electrical Engineering
Florida Atlantic University
Boca Raton, Florida 33431
(561)297-2266

Technical Report No. 98-022.

"EMI Evaluation of the J-Tech, Inc. Uni-Box Telephone Interface to FCC Conducted and Radiated Emission Requirements."

Performed: 10 & 19 March 1998

Customer: J-Tech, Inc.
Attn: Richard Hoo
6413 Congress Ave, Suite 150
Boca Raton, FL 33487

Company Official responsible
for product(s) tested: _____
Richard Hoo
Tel. (561) 997-0772 ext 148

Performed by: J.R. Nicholson

Reported by: _____
J.R. Nicholson & Sharib Wasi
FAU EMI R & D Laboratory

Approved by: _____
Vichate Ungvichian Ph.D., P.E.
Director, FAU EMI R & D Laboratory

1. INTRODUCTION

The J-Tech, Inc. Uni-Box Telephone Interface Unit was connected to a Condor #DV-9319B Power Supply unit and the transmitter was terminated into a dummy load. Evaluation results reported in this 8 page document apply only to the specific items of equipment, configurations (including software and unit operation), and procedures supplied to the Florida Atlantic University EMI Research Lab by J-Tech, Inc. under the test conditions listed herein.

2. OBJECTIVE

This evaluation was performed to verify conformance of the J-Tech, Inc. Uni-Box Telephone Interface Unit with reference to the U.S. Federal Communications Commission (FCC) Code of Federal Regulations (CFR), Title 47 - Telecommunication, Part 90 - Section 90.210 (d) (3) and Radio Frequency Devices, Subpart B - Unintentional Radiators, Section 15.107(b) Conducted limits.

Section 90.210 (d)(3) states any emission must be attenuated below the power (P) of the highest emission by at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser. The Uni-Box has a power rating of 2 watts, therefore, the attenuation factor is 50 + 10 log 2 or -53 dB. Assuming 2 watts of power and 1.67 dB gain of a dipole over isotropic and a distance of 3 meters, the rms voltage would be 3.3 volts per meter or 130.3 dBuV/m at the receiving antenna. Therefore, the allowable limit at 3meters will be 130.3 dBuV/m -53dB or 77.3 dBuV/m (7328 uV/m).

3. CONCLUSION

The J-Tech, Inc. Uni-Box Telephone Interface Unit met the FCC radiated requirements of Section 90.210 (d) (3) and Class "B" conducted emission requirements as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1 TEST PROCEDURES

The measurement techniques identified in measurement procedure ANSI C63.4-1992 *"American National Standard of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"* were followed as close as practical during this evaluation. Complete details and specific procedures used are discussed in the respective Tests Results sections.

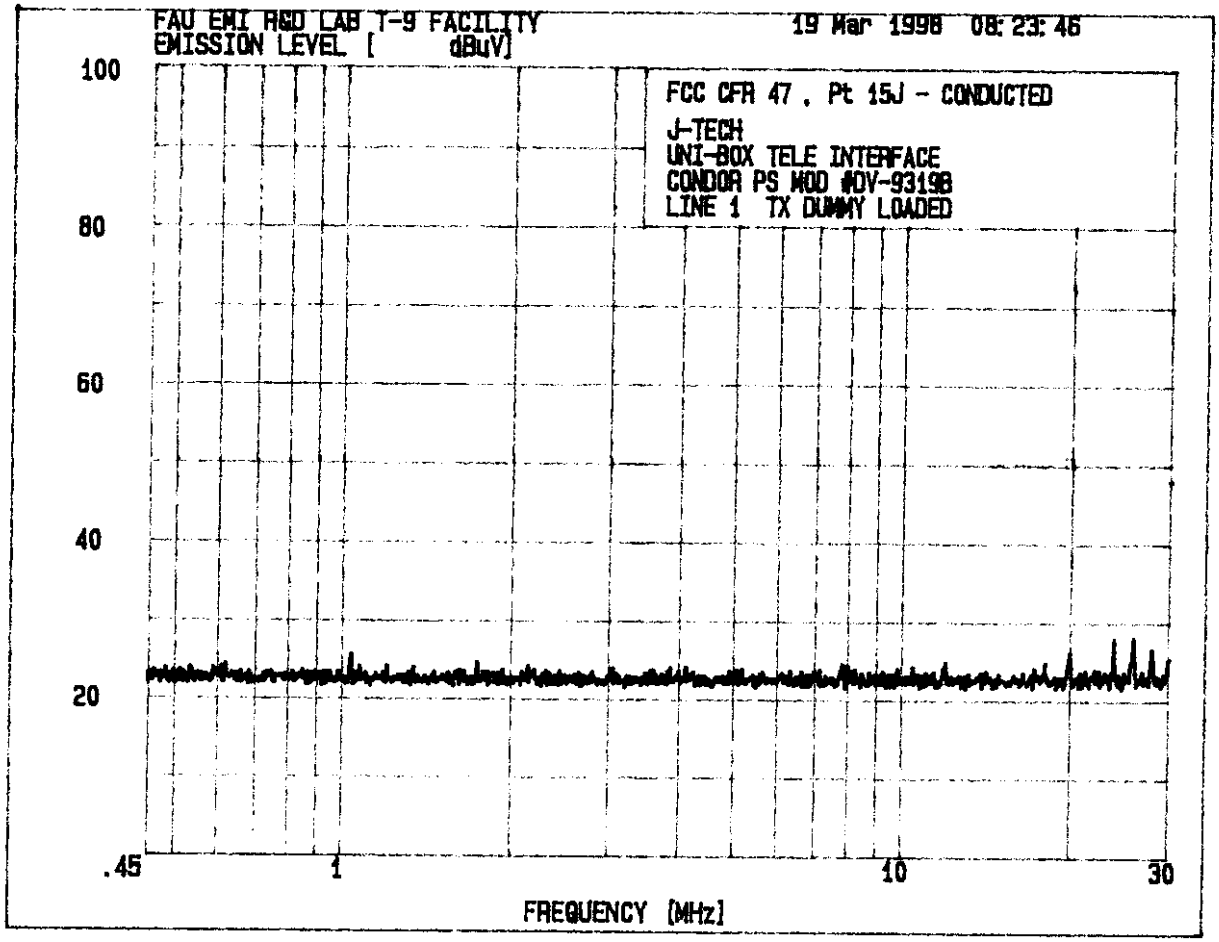
4.2 TEST RESULTS

4.2.1 CONDUCTED POWERLINE EMISSIONS

The J-Tech, Inc. Uni-Box Telephone Interface Unit and support devices were set up at the FAU T-9 EMI facilities conducted emissions screenroom enclosure. The unit was placed on a test table 80 centimeters above the ground plane floor and 40 centimeters from the rear wall of the RF screen room as defined in the referenced FCC adopted measurement procedure ANSI C63.4-1992. Photographs 1 and 2 show the physical positioning of the Uni-Box during the conducted emissions.

The AC power cord of the J-Tech, Inc. Condor #DV-9319B Power Supply unit was plugged into a Solar model 8028-50, 50 ohm/50 uH Line Impedance Stabilization Network (LISN). Conducted power line emissions were measured on both the phase and neutral lines in reference to earth ground over the specified 450kHz to 30MHz range on a Hewlett Packard HP 8566B Spectrum Analyzer. The spectrum analyzer was operated in the 'peak' detector mode with a bandwidth of 9kHz obtained through an HP 85650A Quasi-Peak Adapter. The HP 85864C EMI test program collected the conducted emissions over the specified frequency range and plotted the results.

Figure 1 shows the 'peak' detected conducted emissions from the Uni-Box Telephone Interface Unit to be below the FCC Class "B" conducted emission limit over the entire specified frequency range.



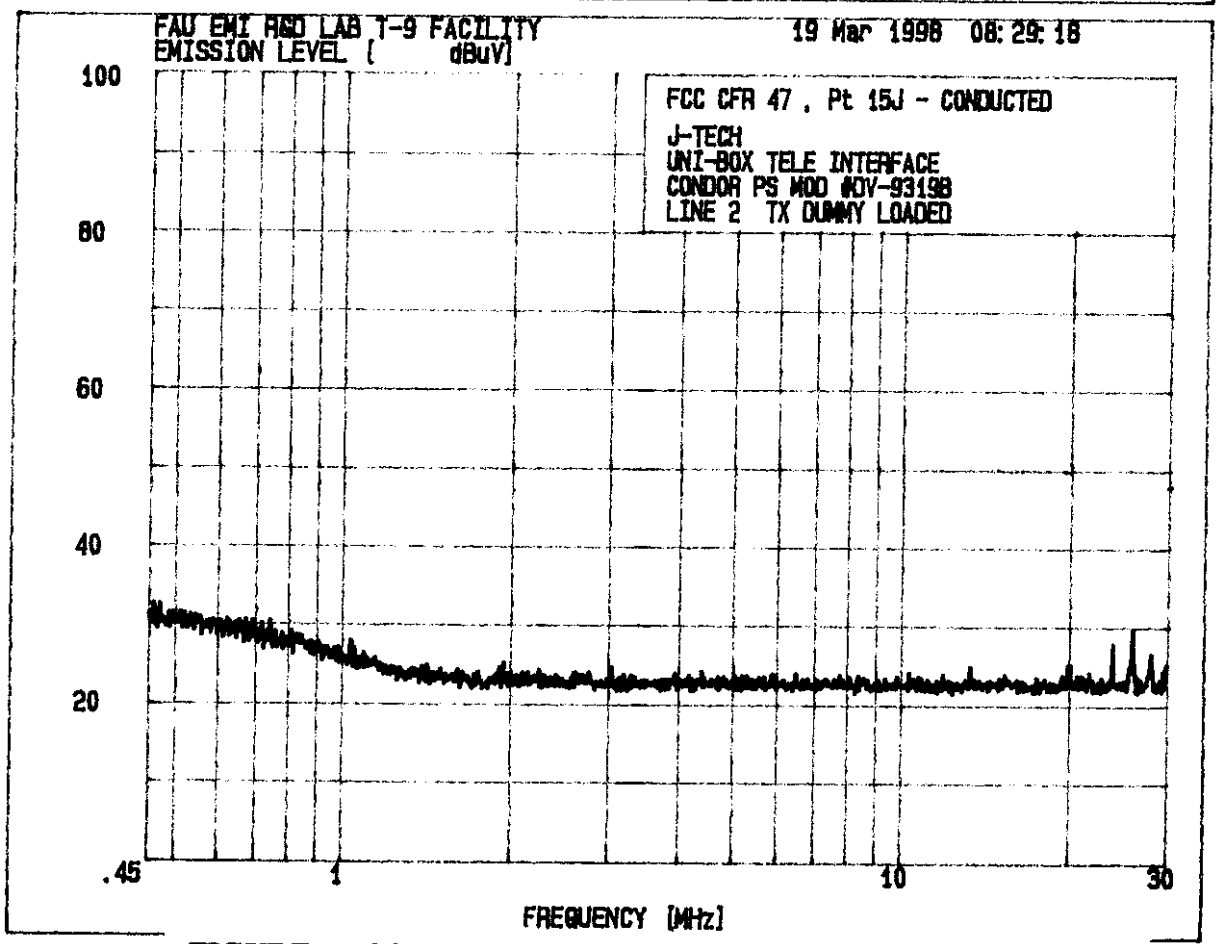


FIGURE 1: CONDUCTED EMISSION LEVELS - UNI-BOX .

4.2.2 RADIATED EMISSIONS

The J-Tech, Inc. Uni-Box Telephone Interface Unit and associated power supply was set up on a wooden turntable 80 centimeters above the ground plane of the FCC listed Open Area T-9 radiated emission test site. A 30 dB attenuator and a 10 watt 50 ohm resistive load terminated the RF output port of the unit. Photographs 3 and 4 show the physical configuration used during the radiated emissions testing from the system.

An EMCO model 3146 S/N 1385 Log Periodic antenna was installed on a Compliance Design Antenna Mast at a distance of 3 meters from the system. The output of the antenna fed a 30 foot low loss coax cable to a Tunable Notch Filter Type 6367 Model #6367-5 (provided by J-Tech), which was tuned to the Uni-Box fundamental operating frequency of 465.8875 MHz. The output of the filter was connected to a 83017A Amplifier which was fed through a low loss heliax coax cable to a HP 8566B Spectrum Analyzer. The turntable was rotated, and the antenna was scanned in height from 1 to 4 meters in both the horizontal and vertical polarizations while the 2nd harmonic frequency was monitored. The 3146 Log Periodic antenna was then replaced with an EMCO Model 3115 S/N 2573 Horn antenna and the above procedure was repeated for the 3rd to 10th harmonics.

Table 1 shows the worstcase 'peak' emission levels detected for both vertical and horizontal antenna polarizations for the 2nd through the 10th harmonic.

The following are explanation notes for data in Table 1:

FREQ = Frequency in MHz.

ANT. POL. = Test antenna polarization.

IND. dBuV = Induced emission level in dBuV.

CL 1 dB = Cable loss in dB of Grey cable.

CL 2 dB = Cable loss in dB of Heliax cable.

GA dB = Gain of 83017A Amplifier including loss of notch filter.

AF dB = Antenna factors for EMCO 3146 log periodic or 3115 Horn.

TOTAL dBuV/M = Total field intensity measured at 3 meters.
(IND. dBuv + CL 1 dB + CL 2 dB - GA dB + AF dB)

RNL = Receiver Noise Level

NOTE: See paragraph 2. OBJECTIVE for limit used.

FREQ.	ANT.	IND.	C.L. 1	C.L. 2	G.A.	A.F.	TOTAL	TOTAL	LIMIT
(MHz)	POL.	(dBuV)	(dB)	(dB)	(dB)	(dB)	(dBuV/m)	(uV/M)	(uV/M)
931.7750	HOR	53.95	2.53	1.08	29.82	24.58	52.32	413	7328
931.7750	VERT	50.40	2.53	1.08	29.82	24.58	48.77	274	7328
1397.6625	HOR	50.95	3.22	1.31	28.22	30.44	57.70	767	7328
1397.6625	VERT	57.70	3.22	1.31	28.22	30.44	64.45	1669	7328
1863.5500	HOR	48.25	3.99	1.58	26.94	33.72	60.60	1072	7328
1863.5500	VERT	49.35	3.99	1.58	26.94	33.72	61.70	1216	7328
2329.4375	HOR	45.35	4.2	1.71	24.34	34.44	61.36	1169	7328
2329.4375	VERT	46.10	4.2	1.71	24.34	34.44	62.11	1275	7328
2795.3250	HOR	45.90	4.98	2.06	27.00	35.80	61.74	1221	7328
2795.3250	VERT	47.30	4.98	2.06	27.00	35.80	63.14	1435	7328
3261.2125	HOR	45.70	5.03	2.34	26.24	36.54	63.37	1475	7328
3261.2125	VERT	47.40	5.03	2.34	26.24	36.54	65.07	1794	7328
3727.1000	HOR	49.20	5.58	2.48	24.73	37.73	70.26	3259	7328
3727.1000	VERT	50.20	5.58	2.48	24.73	37.73	71.26	3656	7328
4192.9875	HOR	44.60	5.82	2.61	26.40	38.99	65.62	1909	7328
4192.9875	VERT	43.90	5.82	2.61	26.40	38.99	64.92	1761	7328
4658.8750	HOR	42.30 RNL	6.41	3.21	20.69	39.06	70.29	3270	7328
4658.8750	VERT	42.85	6.41	3.21	20.69	39.06	70.84	3484	7328

TABLE 1. RADIATED EMISSION DATA - UNI-BOX.

RF Power and Frequency Transient vs. Time

FCC rules: 90.214

Specification: In the 421-512 MHz frequency band, transient frequencies must be within the maximum frequency difference limits during the following time intervals:

From 0 to 10 msec: within +/- 12.5 kHz at a detected ON threshold power of -30dBm.
From 10 to 35 msec: within +/- 6.25 kHz.
From 35 to 45 msec: within +/- 12.5 kHz. at a detected OFF threshold power of -30dBm.

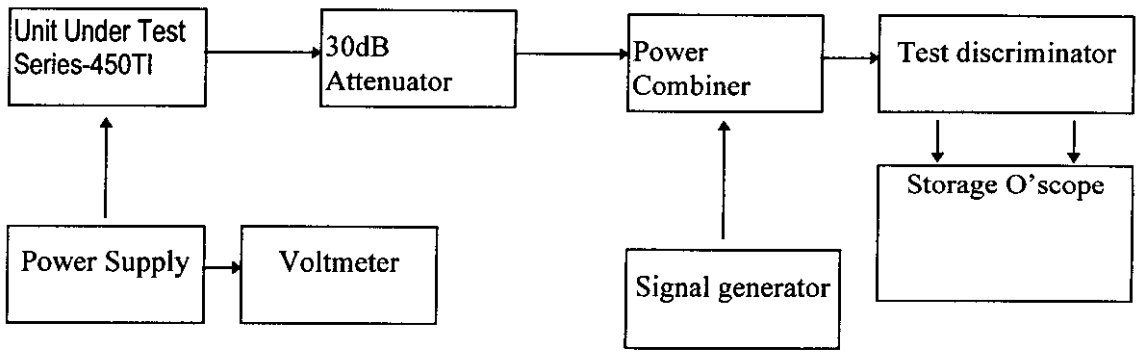
Test Results:
0-10msec -9.3kHZ
10 to 35 msec <+/- 5kHz
35 to 45 msec +3.8, -3.6 frequency error (the average of data +100Hz)
Unit tested comply with FCC specifications

Test Conditions: Line voltage 115 volts, supply voltage 12volts DC

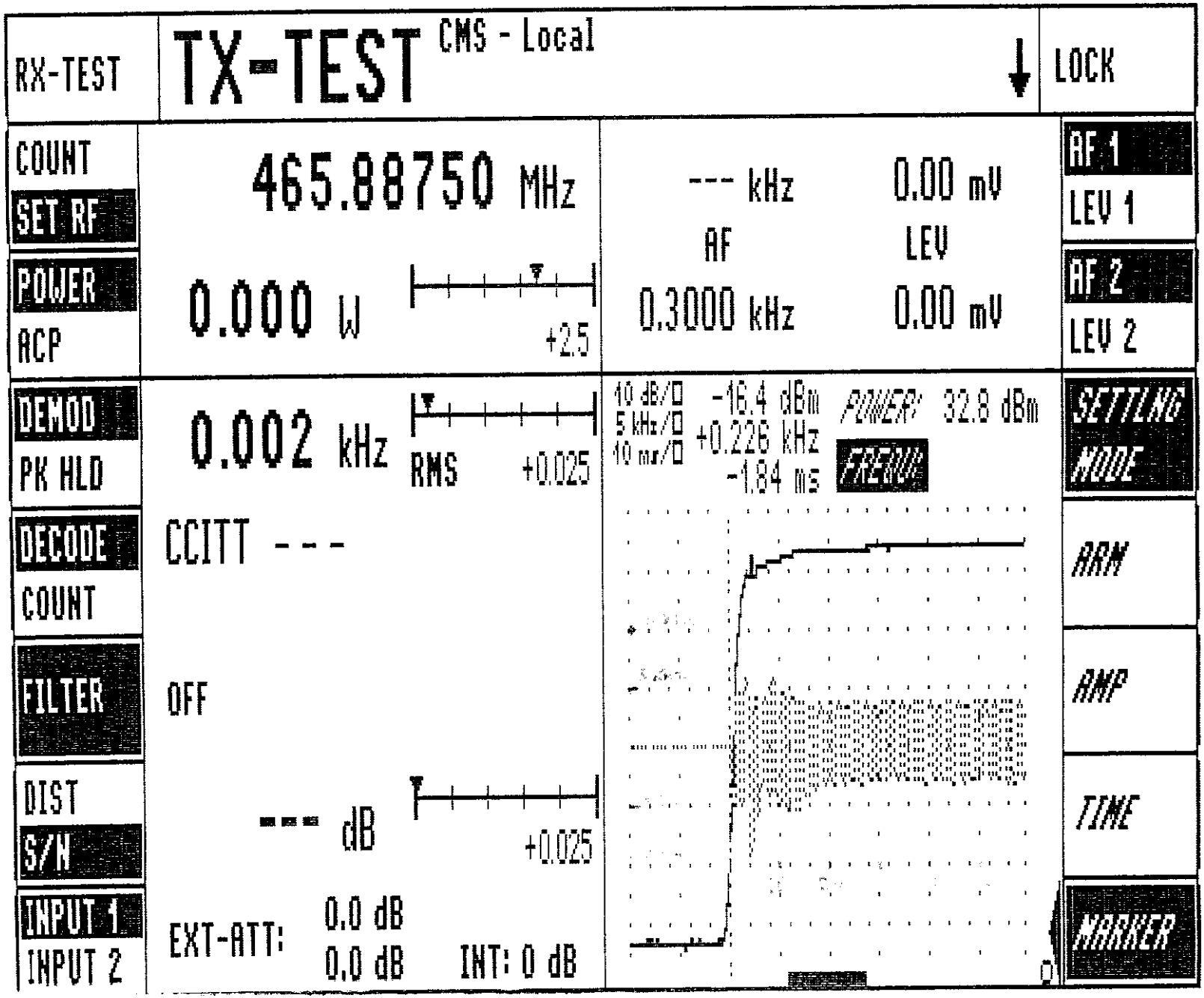
Test Equipment: Power Supply — International Power Sources Model PUP30-10-1-B1
30 dB attenuator pad — Weinschel 9305-30
*Signal generator
*Combining network
*Test discriminator receiver — *Rohde and Schwartz Model CMS 54 radiocommunication service monitor
*Storage oscilloscope

* These devices are combined in the test discriminator receiver Rohde and Schwartz CMS 54

Test Setup:



Test Results... RF Power and Frequency Transient vs. Time


RX-TEST
TX-TEST
CMS - Local
LOCK
COUNT
SET RF
465.88750 MHz
--- kHz
AF
0.00 mV
LEV
RF 1
LEV 1
POWER
RCP
0.000 W
+2.5
0.3000 kHz
0.00 mV
RF 2
LEV 2
DEMOD
PK HLD
0.002 kHz
RMS
+0.025
10 dB/□
5 kHz/□
10 ms/□
-16.4 dBm
+0.226 kHz
-1.84 ms
POWER
32.8 dBm
FREQ
SETTING MODE
DECODE
COUNT
CCITT ---
ARM
FILTER
OFF
AMP
DIST
S/N
--- dB
+0.025
TIME
INPUT 1
INPUT 2
EXT-ATT:
0.0 dB
0.0 dB
INT: 0 dB
MARKER

The controller 80c32 provides via an I2C interface bus programming of the synthesizer U7. In addition the microcontroller encodes the keyboard input data with additional bits for error correction and finally into Manchester data format. The Manchester format provides modulation signal with no significant low frequency component. Microcontroller firmware also handles power management routines including switching the power amplifier on after frequency and phase lock is achieved, if no keyboard activity is The controller clock is 12 MHz. set by C1 and C2 and crystal Y1. External communication via a serial port Jp5 with the controller is handled by an RS-232 interface U5. This device contains an internal voltage charge pump with C22 through C26. RF decoupling of the RS-232 port is provided for via L14 through L16 and C68 through C70. Remaining ports of the controller are dedicated to the I 2C bus with serial data, serial clock, and the power amplifier enable line. A set of 5 volt regulators provide low noise stable supply voltage for the PLL and components. U2 provides continuous 5 volts while U3 provides 5 volts only in transmit. Shut down is provided by the controller U1 to conserve battery drain.

RF Power and Supply Distribution

e. Power amplifier and Low Pass RF Filter

The VCO output U10 is applied to a resistive power splitter and attenuator using R10 and R19. This split and reduced power is input to the synthesizer prescaler at PIN 8 and the power amplifier hybrid module U6 PIN 1. A one milliwatt signal (0 dbm) input to the PA module provides rated output power and is factory set via power adjust R52. Low source impedance voltage control for PA power adjust is provided by follower Q3. Power amplifier enable is controlled by a series power MOS switch. An out of lock condition forced by the PLL will cause Q1 to an OFF state. With these pins low no output power will occur. During transmit maximum current passes to PIN 6. All low level current is handled by Q1 the MOS switch. RF output is obtained at PIN 7 and is low pass filtered by a 7 section Chebychev filter using C36 through C38 and C42 along with L6 through L8. port.

f. Power Distribution

Main power supply distribution is from an 12 volt external power supply. This supply is rated at 4.5 amps maximum, 25 watt and has built in shut down protection for short circuit protection. Reverse polarity protection is provided by D3. This could occur if incorrectly polarized DC plug or incorrect power supply is used. Supply via J1 is RFI filtered via L1, L1 and C5 . Additional voltage regulators on transmitter board provide constant 5 and 8 volts Transient control of power and frequency is maintained by shaping the transmit enable signal controlling Q1. This is accomplished by voltage divider R37 and R37(a) along with C75 and C75(a).

Technical Description Overview

A. Series 450 Premise Paging System

The JTECH Series 450 Premise Paging system consists of frequency synthesized transmitter and telephone interface designed to provide paging from private phone system.. A RS-232-C port is available so that a terminal or desktop computer can be used to input alpha numeric messages.. This capability allows the transmitter data input and paging message to be input by standard telephone touch tone keypad.
The Series 450 operates on 12.5 kHz or 25 kHz UHF assigned channels. The RF transmitter maximum output power is 2 watts and the encode data rate is 1024 bps. Emission type is 7K0F1D.

B. Series 450 Master Base Paging Transmitter UNI-BOX

The paging transmitter is frequency synthesized and uses a phase lock loop (PLL) design. The reference oscillator is a voltage controlled temperature compensated crystal oscillator (VC-TCXO) and determines the temperature frequency stability of the final output. The design uses a number of control elements to insure that the final transmit channel is achieved before enabling the power amplifier. Modulation of the loop requires modulating the voltage controlled oscillator (VCO) and the reference oscillator. A 2 port modulation scheme insures good fidelity modulation for the low frequency paging data. Additional circuits under control of the micro processor via an I2C bus control factory set channel frequency, RS-232-C interface .

C. Major Component Count and Active Devices on transmitter board

Integrated and hybrid circuits 10 and transistors 2

U1 Voltage regulator + 8 volts	78T08CT
U2 Voltage regulator + 5 volts	TK11950M
U3 Analog switch	CD4053
U4 Quad Operational Amplifier	LMC6582
U5 RS-232 Serial Interface integrated circuit	MAX232A
U6 RF Power Module Hybrid integrated circuit	BGY113F
U7 PLL synthesizer integrated circuit	UMA1014T
U8 Quad operational amplifier integrated circuit	MC33174P
U9 TCXO Hybrid integrated circuit	TEW TX1824M
U10 Voltage control oscillator VCO hybrid	MQC403-457
Q1 Power MOS switch	BRF7203
Q2 Digital Transistor	DTC114EKA
Q3 Power control voltage follower	MMBV2222