Emissions Testing
Performed
on the
Comtec Information Systems
Modular Transmitter
Model: CC 15431-1

To

FCC Part 15 Subpart C, 15.249

Date of Test: April 5, 2000

Report Number: J20009612A
MJP/Rbt

Contact: Mr. William Genett

Table of Contents

I – Introduction and Summary

TO: Mr. William Genett

FROM: Michael J. Peters, Senior Project Engineer
DATE: April 5, 2000
JOB #: J20009612A

RE: Emissions Testing Performed on the Modular Transmitter, Model: CC 15431-1

On April 5, 2000 we tested the Modular Transmitter, Model: CC 15431-1 to determine if it was in compliance with the FCC Part 15 , Subpart C, Section 15.249 requirements. A Prototype version of the sample was received on Wednesday, April 5, 2000 in good condition. We found that the unit met the Part 15 requirements when tested as received.

The following Table summarizes the results of testing.

Test	Frequency (MHz)	Measurement	Requirement	Pass/Fail	Section of FCC Rules	Section of Test Report
Fundamental Field Strength	916.5	38,459.2 µV(1) 26,302.7 µV(2) 29,174.3 µV(3)	50,000 µV 50,000 µV 50,000 µV	Pass Pass Pass	15.249	Table 1 Table 2 Table 3
Rectricted Band and Spurioud Emissions	1833.45 9167.8 9167.8	446.7 µV 359.0 µV 359.0 µV	500 µV 500 µV 500 µV	Pass Pass Pass	15.205, 15.209 & 15.249	Table 1 Table 2 Table 3
Line-conducted Emissions	Not applicable the device is solely battery powered					
Bandwidth	Not applicable, 15.249 does not specify Bandwidth requirements					
Antenna Conducted Emissions – Transmit	Not applicable, 15.249 does not specify antenna conducted requirements					
Duty Cycle	A duty cycle was not applied to the device, it is amplitude modulated					
Frequency Deviation Temperature	Not applicable, 15.249 does not specify Frequency Deviation Requirements					
Frequency Deviation Voltage	Not applicable, 15.249 does not specify Frequency Deviation Requirements					
Modifications	No modifications were installed by Intertek Testing Services					

(1) Dipole Antenna, (2) Monopole Antenna, (3) PCB Antenna

In summary, this report confirms that the Model: CC 15431-1 is compliant with the FCC Part 15, Subpart C Section 15.249 requirements when production units conform with the initial sample. Please address all questions and comments concerning this report to Andrew Bellezza, Senior Project Engineer.

Modular Transmitter Justification

FCC ID: I28MD-TRCV-9CMHZ is a modular low power radio transceiver designed to operate and FCC Rules Part 15.249. The following steps have been taken to insure that I28MD-TRCV-9CMHZ (referred to below as "the module") meets the FCC requirements for a modular approval:

1) All electronic components used on the module are on one side of the printed circuit board and are completely covered by metal shielding. There is an internal ground plane in the circuit board itself to complete the shielding. Only the connectors are exposed.

2) The TXDATA input is buffered on the module itself. Input voltage variations on TXDATA will not effect the modulation or the transmitter output power.

3) The module has it's own on-board 3-volt regulator. All RF circuitry operates from this 3 volts.

4) The antenna connector used on the module has only one manufacturer and is not readily available. We have used the same connector on previous modular approvals and the FCC has considered it a non-standard connector. In addition, the module will only be used in devices with internal antennas of the type specified in the application. These internal antennas are not user serviceable or user replaceable. Therefore the antenna system meets the requirements of Section 15.203.

5) The module was tested in a stand-alone configuration using three different antennas.

6) Each module will be labeled with the FCC ID# and warning message as shown on the AA15431-1 drawing which is included with this application.

II – Technical Requirements

15.1 Scope

The device is an intentional radiator intended to operate in accordance with

Section 15.249 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz, and 24.0 – 24.25 GHz

Of Part 15 of the FCC rules without a license.

15.15 General Technical Requirements

There are no controls accessible to the user that would cause the device to operate in violation of the FCC rules.

15.27 Special Accessories

No special accessories are necessary to meet compliance requirements.

15.31 Measurement Standards

The measurement procedures specified by ANSI C63.4:1992 were used to setup and test the device. See Section IV of this test report for detailed description of the test procedure.

A new 9 Volt battery was used during testing.

The transmitter was tested standalone.

15.33 Frequency range of measurement

The device was scanned for spurious and harmonic emissions from lowest clock frequency generated/used to the 10^{th} harmonic of the fundamental emission.

15.35 Measurement detector functions and bandwidth

The following table illustrates the detector functions and bandwidth used to test the device.

No deviations to the following were made.

Frequency Range	Measurement Detector	Measurement Bandwidth
450 kHz to 30 MHz	Quasi-Peak	9 kHz
30 MHz to 1000 MHz	Quasi-Peak	120 kHz
1000 MHz to 10th harmonic	Average	1 MHz

The quasi-peak detector meets the requirements of CISPR 16.

An averaging factor was not used or determined for the device because it is meant to transmit continuously using AM modulation.

15.36 Transition Provisions

Transition provisions were not applied to the device.

The device is a transceiver. The intended receiver is not covered under this test report.

The device does not operate in the band 902-905 MHz.

15.201 Certification

The device is required to be certified in accordance with Part 2 of the FCC rules, Subpart J.

15.203 Antenna Requirements

The antenna connector (Type: SSMT) used on the module has only one manufacturer (M/A Comm P/N: 2367-5002-54) and is not readily available. They have used the same connector on previous modular approvals and the FCC has considered it a non-standard connector. In addition, the module will only be used in devices with internal antennas of the type specified in the application. These internal antennas are not user serviceable or user replaceable. Therefore the antenna system meets the requirements of Section 15.203.

15.204 External Radio Amplifier

The device is not an amplifier.

15.205 Restricted bands of operation

Section 15.249 specifies that harmonic and spurious emission be attenuated at least 50 dB or to the general requirements of 15.209. All emissions except for the fundamental were compared to the general requirements which are also specified for restricted band emissions.

Below 1000 MHz a Peak detector was employed to measure emissions
Above 1000 MHz an Peak detector was employed to measure emissions. Since peak measurements meet the average limit the Peak limiting requirement is satisfied.

15.207 Conducted limits

The device is only battery powered. Line conducted emissions testing is not applicable.

15.209 Radiated emission limits; general requirements

All Emissions except the fundamental were applied to the general requirements.

15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz

The Field strength limit for the device was based on the operating frequency of 916.5 MHz:

Frequency (MHz)	Emission Limit Fundamental (mV/m)	Emission Limit Harmonics (dBμV/m)	Test Distance (meters)
916.5	50	500	3

The emission requirement for harmonic emission is identical to the general requirement of 15.209. Spurious emission measurements were compared to the general requirement of 15.209.

The fundamental emission was measured with a peak detector. For above 1000 MHz, measurements were made with a peak detector to insure that peak measurements meet the peak emission limiting requirement.

Part 2

2.201 Emission Modulation and transmission characteristics

The emission designator is determined as follows

Bandwidth as specified by Comtec is : 292 kHz

The main carrier modulation is Amplitude Modulated. Therefore the first symbol is A

The modulating signal is Single channel containing digital information. Therefore the second symbol is 1

The type of information transmitted is Data Transmission. Therefore the third symbol is D

The emissions designator is:

292KA1D

2.1041 Measurement Procedures

Only the measurement procedures of Part 15 are required for this device. The device was not evaluated to the requirements of 2.1046 through 2.1057.

2.1091 Radiofrequency radiation exposure evaluation: Mobile Devices

The device does not meet the definition of a mobile device. The user may be touching the device while it is in operation.

2.1093 Radiofrequency radiation exposure evaluation: Portable Devices

The device is considered a Portable Transmitter. However, the device does not fall under any of the categories that require routine RF exposure measurements and is therefore exempt from the requirements of this section.

III - Attestation

LABORATORY MEASUREMENTS

Pursuant To
Part 15, Subpart C
For
Intentional Radiators

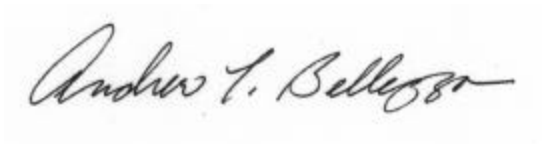
Company Name:	Comtec Information Systems
Address:	30 Plan Way Warwick, RI 02886
Model:	CC 15431-1
Date of Test(s):	April 5, 2000
Test Site Location:	INTERTEK TESTING SERVICES NA INC. 70 Codman Hill Road Boxborough, MA 01719
Site:	2

We attest to the accuracy of this report:

Signature

Michael J. Peters
Testing Performed By:

Senior Project Engineer
Title



Signature

Andrew Bellezza
Reviewer

Senior Project Engineer
Title

IV - Site Description

Introduction

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C, General Requirements.

A. **Test Set-Up**: The test set-up and procedures described below are designed to meet the requirements of ANSI C63.4 (1992).

1. The test site is a Plastic/Fiberglass structure with a groundplane. The site has attenuation characteristics which meet the requirements of ANSI C63.4 (1992). Information on the site has been filed with the FCC as required by Rule 2.948. The address of the site is 70 Codman Hill Road, Boxborough, MA 01719.

2. Power to the site is nominal line voltage of 117 V_{AC} and 230 V_{AC}, 60 Hz.

3. The equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately one meter in height above the groundplane. During the radiated emissions test, the turntable is rotated 360 degrees and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The antenna height and polarization are also varied during the search for maximum signal levels. The height of the antenna is varied from one meter to four meters. Body-worn, hand-held and small portable devices are mounted on a non-conductive box and emissions are investigated on three orthogonal axis.

4. Detector function for radiated emissions is in peak or quasi-peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings according to the following formula:

   Averaging Factor in dB = 20 LOG (duty cycle)

   The time period over which the duty cycle is measured is 100 msec. The worst-case (highest percentage on) duty cycle is used and described specifically in the data section. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix 465 Oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities.

5. Antennas used below 1000 MHz were EMCO Model 3142 Biconolog Antennas and Compliance Designe Inc. Model A100 tuned Dipole Antennas. For measurements between 1000 MHz and 18000 MHz above 1 GHz, an EMCO Model: 3115 Horn Antenna is used. The Antennas used are listed in the Test Equipment Summary in Section V.
6. The field strength measuring equipment used included:

V - Measurement Equipment

The following equipment was used to make measurements for emissions testing:

Description	Manufacturer	Model	Serial #	Cal Due
HORN ANTENNA	EMCO	3115	9602-4675	11/04/2000
PREAMPLIFIER	MITEQ	NSP4000-NF	507145	11/25/2000
SPECTRUM ANALYZER	TEKTRONIX	2784	B010153	11/26/2000
RECEIVER	HEWLETT PACKARD	85422E	3520A00125	12/12/2000
RF FILTER	HEWLETT PACKARD	85420E	3427A00126	12/12/2000
ANTENNA	EMCO	3142	9711-1225	12/30/2000
TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	402	07/26/2000

7. The frequency range to be scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency, or 40 GHz, whichever is lower. For line-conducted emissions, the range scanned is 450 kHz to 30 MHz.

8. The EUT is warmed up for 15 minutes prior to the test. AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new battery is used.

9. Conducted measurements were made as described in ANSI C63.4 (1992). An IF bandwidth of 9 kHz is used, and peak or quasi-peak detection is employed.

10. The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application No. 150-2. A discussion of whether pulse desensitivity is applicable to this unit is included in this report. Above 1000 MHz, a bandwidth of 1 MHz is generally used.

11. Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

12. For measurements made in the 9 kHz to 30 MHz range, a distance of 30 meters was used unless a good signal-to-noise ratio could not be obtained. In that case, a closer distance was used and that distance is so marked in the data table.

VI – Summary of Equipment Under Test

1	**Manufacturer**:	Comtec Information Systems
2	**Grantee**:	Comtec Information Systems
3	**Model No.**:	CC 15431-1
4	**Trade Name**:	
5	**Serial No.**:	27
6	**Date of Test**:	April 5, 2000
7	**Frequencies to which device can be tuned**:	916.5 MHz
8	**Can customer tune device?**	No
9	**Detailed description of operation pursuant to 15.209**:	See Below
10	**Applicable emissions limits**:	15.209 and 15.249
11	**Additional Comments**:	

9. Detailed description of operation pursuant to 15.209

The device was tested standalone as a modular transmitter. It was tested with the three types of antenna that would be used with the device (Dipole, Monople and PCB). For simplicity of testing it was wired to transmit continuously an unmodulated carrier. All inputs and circuitry were active during testing.

SRRF RADIO TECHNICAL DESCRIPTION

The SRRF (Short Range Radio Frequency) Radio is a combination AM (Amplitude Modulated) Transmitter and a tuned RF Receiver, with both using SAW (Surface Acoustic Wave) filters in the 902 – 928 MHz band.

The Transmitter is digitally amplitude modulated (on - off keyed). It uses two SAW filters at approximately 916.5 MHz to determine the oscillation frequency and filter the transmitter output. The power supply voltage is regulated on board the module to prevent increases in power output with any power supply variations. The data input is buffered to prevent any spurious or over-modulation products.

The Receiver is a TRF (Tuned Radio Frequency) type, and uses a SAW filter at approximately 916.5 MHz to select the incoming RF signal. (There is no local oscillator.) The SAW filter is followed by an RF amplifier feeding another 916.5 MHz. SAW filter used as a delay line. A second RF amplifier feeds an RF detector/demodulator which recovers the digital signal. The Receiver RF amplifiers are controlled by a duty cycle regulator. The RF detector is followed by a few digital data conditioning and shaping stages.

The non-standard antenna connector goes directly to the Transmitter/Receiver through a matching network, which also protects against ESD (Electro-Static Discharges).

Transmission or reception is determined by the Bias Control stages of the Transmitter/
Receiver, which, in turn, are controlled by the TX/RX control line.

All signal and control input/output lines are filtered with ceramic capacitors and ferrite bead chokes to prevent signal or noise leakage in or out of the shielded module.

Justifications

For maximizing emissions, the system was rotated through 360o, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed.

The unit was operated standalone and placed in the center of the turntable.

The device was powered from a new, fully charged 9Volt battery.

For simplicity of testing, the unit was wired to transmit continuously.

VII - Configuration Information

Equipment Under Test:	Modular Transmitter
Model:	CC 15431-1
Serial No.:	27
FCC Identifier:	I28MD-TRCV-9CMHZ

Support Equipment:

Device was tested standalone.

Cables:

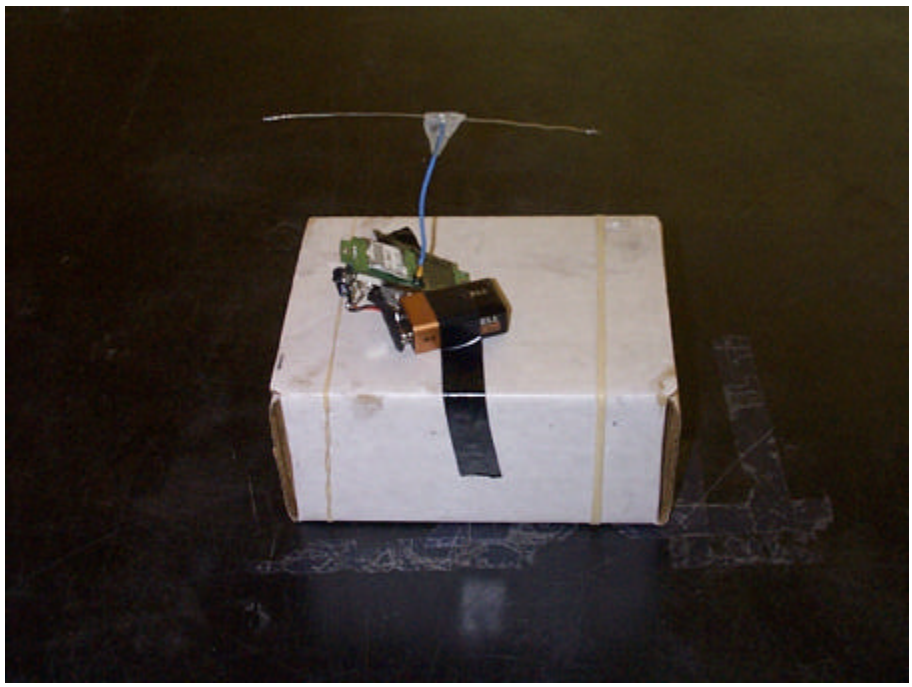
QTY	Description	Shield Description	Hood Description	Length (m)

None

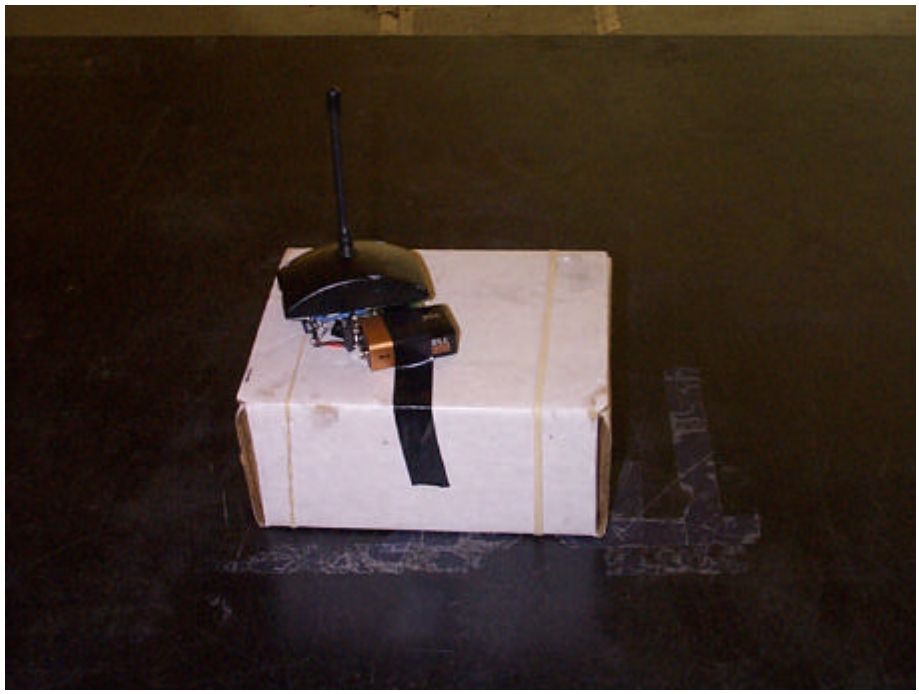
VIII - Configuration Photographs

Worst-Case Radiated Emissions

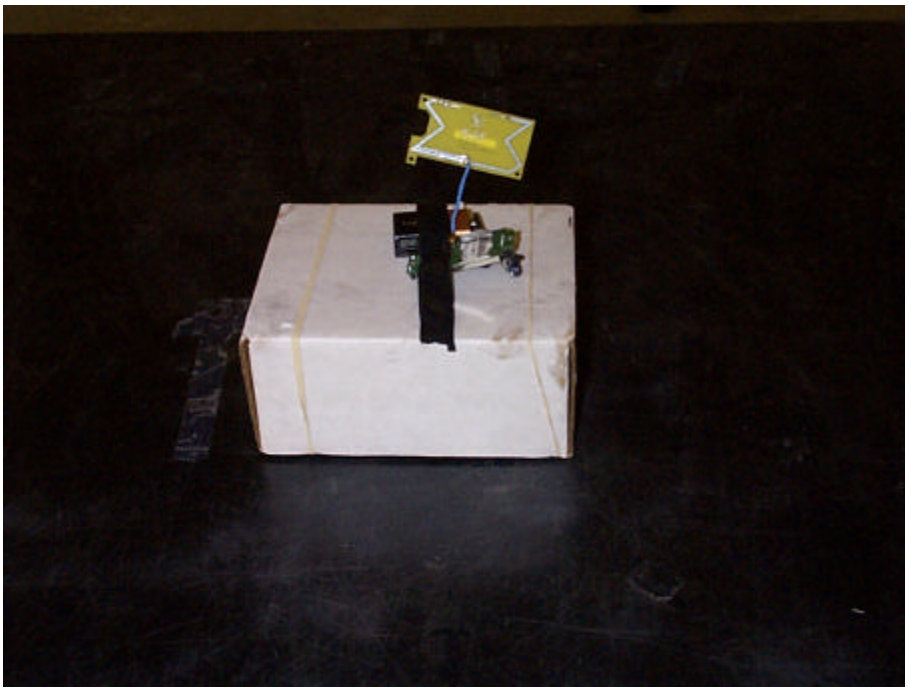
Dipole Antenna



Monopole Antenna



PCB Antenna



IX - Sample Calculation

The following is how net field strength readings were determined:

NF = RF + AF + CF + PF + DF

Where,

NF = Net Reading in dBµV/m
RF = Reading from receiver in dBµV/m
AF = Antenna Correction Factor in dB
CF = Cable Correction Factor in dB
PF = Preamplifier Correction Factor in dB
DF = Distance Factor in dB (using 20 dB/decade), from 3 to 1 meters 10.5 dB was added for measurements performed at 1 meter

To convert from dBµV/m to µV/m or mV/m the following was used:

$UF = 10^{(NF / 20)}$

Where,

UF = Net Reading in µV/m

Example:
For the fundamental field strength measurement at 916.5 MHz (distance = 3 meters) see table 1.

NF = NF = RF + AF + CF + PF + DF = 60.1 + 27.7 + 3.9 + 0 + 0 = 91.7 dBµV/m at 3 meters

$UF = 10^{(91.7\ dB\mu V / 20)}$ = 38,459.2 µV/m

X - Data Tables

Note for all tables: Above 1000 MHz a resolution bandwidth of 1 MHz was used.
For below 1000 MHz a resolution bandwidth of 120 kHz was used.

For emissions marked with a 9.5 dB distance factor, a measurement distance of 1 meter was used.

Radiated Emissions / Interference

Table: 1

Company: **Comtec Information Systems, Inc**
Model: **CC 15431-1**
Job No.: **J20009612**
Date: 04/05/00
Standard: FCC15
Class: 15.249 Group: None
Notes: For Fundamental used diple and HP 8542E

Tested by: Michael Peters
Location: Site 2C
Detector: TEK 2784
Antenna: HORN2 11-4-99 H3m
PreAmp: PRE8 11-25-99
Cable(s): CBL004 1-18-00 216
Distance: **3** meters

	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
	Transmit antenna is the dipole (Unit: #27)									
	H	916.500	60.1	27.7	3.9	0.0	0.0	91.7	94.0	-2.3
	V	916.500	51.3	27.7	3.9	0.0	0.0	82.9	94.0	-11.1
	H	1833.450	43.9	28.1	2.6	21.6	0.0	53.0	54.0	-1.0
	H	2750.300	32.2	30.6	3.3	21.8	0.0	44.3	54.0	-9.7
	H	3667.100	33.2	33.0	4.0	22.0	0.0	48.2	54.0	-5.8
nf	H	4583.900	33.6	34.4	4.7	22.0	9.5	41.2	54.0	-12.8
nf	H	5500.700	33.6	36.0	5.4	21.5	9.5	44.0	54.0	-10.0
nf	H	6417.400	35.0	36.4	6.1	20.7	9.5	47.3	54.0	-6.7
nf	H	7334.200	31.0	38.0	6.9	20.1	9.5	46.4	54.0	-7.6
nf	H	8250.990	30.0	38.8	8.2	20.0	9.5	47.4	54.0	-6.6
nf	H	9167.800	30.5	39.7	10.0	19.7	9.5	51.1	54.0	-2.9

No other emissions were detected above the measurement equipment noise floor

Radiated Emissions / Interference

Table: 2

Company: **Comtec Information Systems, Inc**
Model: **CC 15431-1**
Job No.: **J20009612**
Date: 04/05/00
Standard: FCC15
Class: 15.249 Group: None
Notes: For Fundamental used diple and HP 8542E

Tested by: Michael Peters
Location: Site 2C
Detector: TEK 2784
Antenna: HORN2 11-4-99 H3m
PreAmp: PRE8 11-25-99
Cable(s): CBL004 1-18-00 216
Distance: **3** meters

	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
	Transmit antenna is the monople (Unit: #27)									
	H	916.500	44.7	27.7	3.9	0.0	0.0	76.3	94.0	-17.7
	V	916.500	56.8	27.7	3.9	0.0	0.0	88.4	94.0	-5.6
	V	1833.450	39.8	28.1	2.6	21.6	0.0	48.9	54.0	-5.1
nf	H	2750.300	32.2	30.6	3.3	21.8	0.0	44.3	54.0	-9.7
nf	H	3667.100	33.2	33.0	4.0	22.0	0.0	48.2	54.0	-5.8
nf	H	4583.900	33.6	34.4	4.7	22.0	9.5	41.2	54.0	-12.8
nf	H	5500.700	33.6	36.0	5.4	21.5	9.5	44.0	54.0	-10.0
nf	H	6417.400	35.0	36.4	6.1	20.7	9.5	47.3	54.0	-6.7
nf	H	7334.200	31.0	38.0	6.9	20.1	9.5	46.4	54.0	-7.6
nf	H	8250.990	30.0	38.8	8.2	20.0	9.5	47.4	54.0	-6.6
nf	H	9167.800	30.5	39.7	10.0	19.7	9.5	51.1	54.0	-2.9

No other emissions were detected above the measurement equipment noise floor

Radiated Emissions / Interference

Table: 3

Company: **Comtec Information Systems, Inc**
Model: **CC 15431-1**
Job No.: **J20009612**
Date: 04/05/00
Standard: FCC15
Class: 15.249 Group: None
Notes: For Fundamental used diple and HP 8542E

Tested by: Michael Peters
Location: Site 2C
Detector: TEK 2784
Antenna: HORN2 11-4-99 H3m
PreAmp: PRE8 11-25-99
Cable(s): CBL004 1-18-00 216
Distance: **3** meters

	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
	Transmit antenna is the PCB, tuned to free space (Unit: #27)									
	H	916.500	57.7	27.7	3.9	0.0	0.0	89.3	94.0	-4.7
	V	916.500	54.6	27.7	3.9	0.0	0.0	86.2	94.0	-7.8
	V	1833.450	38.9	28.1	2.6	21.6	0.0	48.0	54.0	-6.0
nf	H	2750.300	32.2	30.6	3.3	21.8	0.0	44.3	54.0	-9.7
nf	H	3667.100	33.2	33.0	4.0	22.0	0.0	48.2	54.0	-5.8
nf	H	4583.900	33.6	34.4	4.7	22.0	9.5	41.2	54.0	-12.8
nf	H	5500.700	33.6	36.0	5.4	21.5	9.5	44.0	54.0	-10.0
nf	H	6417.400	35.0	36.4	6.1	20.7	9.5	47.3	54.0	-6.7
nf	H	7334.200	31.0	38.0	6.9	20.1	9.5	46.4	54.0	-7.6
nf	H	8250.990	30.0	38.8	8.2	20.0	9.5	47.4	54.0	-6.6
nf	H	9167.800	30.5	39.7	10.0	19.7	9.5	51.1	54.0	-2.9

No other emissions were detected above the measurement equipment noise floor