EXHIBIT B.4

Brief Description of Circuit functions.
Description of how the System Operates.
Description of Ground System.
Description of Antenna System.

UNIFIED MONITORING SYSTEM (UMS), DESCRIPTION AND SPECIFICATIONS

Document Classification:

Document Numbering Assignment	Design/Non-Design	ISO 9000 Level	ISO 9000 Category
Support Document	Design	Level 2	Design Control, 4

Confidential Information Statement:

Sign off and Revision Status:

Originator	Date	Approval	Date	New or Change Description	ECO No.	Revision X1, X2, XA, XB, -A, -B,
James L. Rodgers	9/15/97	Rough		Update	None	X2

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1.0 Purpose of Document:

Design of ***Tag Detection, Locating, and Identification System*** - in accordance with the *Product Development Procedure (PDP)*, the ***Documentation Control Procedure (DCP)*** and in accordance with the Corporate Quality System and the requirements of ISO9000.

2.0 Scope of Document:

Overall description and specifications for the UMS system.

3.0 Other Applicable Documents:

Design Documents

Document No.	Description	Computer File # (DC/ENGR)
85001-0001	UMS, Master Control Document (MCD)	85001, MCD, UMS, 6-3-97
65001-0001	UMS, Description and Specifications	65001, UMS, SPECS, 10-16-97
65002-0001	Transmit Card, Description and Specifications	65002, TCARD, SPECS, 10-6-97
65003-0001	Receive Card, Description and Specifications	65003, RCARD, SPECS, 10-8-97
65004-0001	Antennas, Description and Specifications	65004, ANTENNA, SPECS, 10-8-97
65005-0001	Control Unit, Description and Specifications	65005, CTRL UNIT, SPECS, 11-5-96
65006-0001	Tag, Transmisstion and Reception Characteristics	65006, TAG, CHARTRS, 10-21-97
65007-0001	UMS, Software For Setup, Operation And Test	65007, UMS, SOFTWARE, 9-22-97
65008-0001	UMS, Firmware for Setup, Operation And Test	65008, UMS, FIRMWARE, 9-22-97
65009-0001	UMS, Overall System and Software Features	65009, SYS FEATURES, 9-18-97
65011-0001	Tag, Electrical Description and Specifications	65011, TAG, E SPECS, 9-22-97
65022-0001	Power Card, Description and Specifications	65022, P CARD, SPECS, 10-8-97
65030-0001	Interface Card, Description and Specifications	65030, I CARD, SPECS, 10-8-97
65031-0001	Taps Cards, Description and Specifications	65031, TAPCARD, SPECS, 10-10-97
65032-0001	Tag, Physical Description and Specifications	65032, TAG, PHYS SPECS, 9-22-97

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Support Documents

Document No.	Description	Location
90001-0001	Corporate Policy and Procedures Manual	DC/ADM
90002-0001	Corporate Quality Manual	DC/QC
90003-0001	Product Development Procedure (PDP)	DC/ENGR
90004-0001	Documentation Control Procedure (DCP)	DC/ENGR
95001-0001	List of Current Process Instructions	DC/ENGR
95002-0001	List of Current Forms and Templates	DC/ENGR
TBD	ISO 9000 Manual (Reference Information)	DC/QC
TBD	Product Development Plan (PDP)	DC/ENGR
TBD	Document Submittal Form (DSF)	DC/ENGR
TBD	Engineering Change Order (ECO)	DC/ENGR
TBD	Document Change Request (DCR)	DC/ENGR
TBD	Underwriters Laboratories (UL) Publication: Information Processing and Business Equipment UL 1950, March 1989 Santa Clara, CA, USA	DC/ENGR
TBD	Canada Standards Association (CSA) Publication: Information Processing and Business Equipment C22.2 No. 220-M1986, March 1986 Ontario, Canada	DC/ENGR
TBD	International Electrotechnical Commission (IEC Publication: 950 IEC Standards, 1986 Geneva, Switzerland	DC/ENGR
TBD	Federal Communications Commission (FCC) Publication: Subpart J of Part 15 of FCC rules Washington, DC, USA	DC/ENGR
TBD	German/International Safety Specification: VDE Safety, GS Label, DIN IEC 950 / VDE 0806/08.81	DC/ENGR
TBD	German RFI Specification: VDE RFI, VFG 0243/1991 Class B	DC/ENGR
Mil Std 810D	Military Environmental Specifications (Temperature , Shock, Vibration, Humidity, Rain, Salt Spray, Drop, Leakage, Rain, Ice, Sand and Dust Requirements)	QC

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Reference Book	*RF/ID, Radio Frequency Identification, Application 2000*, J.D. Gerdeman, Research Triangle Consultants, Inc., N.C	QC
Reference Container Standards	ANSI Standard, MH 5.1.9 - 1990, for automatic identification of containers	QC
Reference Container Standards	ISO Standard, 10374, for automatic identification of containers	
Reference Trucking Standards	*Automatic Equipment Identification*, American Trucking Association	
Reference Air Transport Standards	*Use of Radio Frequency Technology for Automatic Identification of Unit Load Devices*, International Air Transport Association, Practice 1640	

4.0 Equipment, Material and Tools Required:

Item	Description
1	Windows, Microsoft Word

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5.0 GENERAL DESCRIPTION

5.1 Purpose

The UMS System, as defined herein, operates with tag devices that receive and/or transmit an electronic signal for the purpose of detection, identification, and locating the tag and/or whatever it is attached to, is defined as follows:

- **Detection** means that the tags presence or absence within a specific area is determined.
- **Identification** means that type, category and/or ID number identify it.
- **Locating** means that its approximate location, relative to a reference or base point, within a specific area in a two or three-dimensional space, is determined.

5.2 Operation

The UMS performs the function of creating signals for transmission via an antenna or antennas to tags and then receiving and detecting and processing their response. The UMS operates with the following tags:

- **Family of Frequency ID Tags**
- **Family of Synchronous Time Window and/or Encoded ID Tags**

The UMS system, for Frequency ID Tags, employs of a multiple frequency-scanning transmitter that transmits a magnetic induction field to a tag that has one or more tuned resonance circuits. Upon receipt of a signal that corresponds to the frequency of one of the tag circuits - the tag circuit is then resonate; creating an internal current flow that in turn creates a corresponding radiated magnetic field output from the tag.

The UMS, for Time Window or Encoded tags, sends out a patterned signal that synchronous the tags in proximity and causes them to respond in a manner that prevents collusion.

5.3 System Components

The UMS consists of the following:

- **Tag(s)**
- **Antenna(s)/Taps**
- **UMS Control Unit**
- **Host Computer/Network (option)**

In a simple system, only one transmitter and receiver and their associated antennas are required. However, the tag, transmitter, and receivers are all directional much like a flashlight, requiring in some cases multiple units and/or antennas, to cover all three possible axis or planes corresponding to 6° of freedom in space.

5.4 Tag(s)

Tags, as categorized herein, maybe as follows:

- **Frequency Encoded ID Tags**
- **Time and/or Digital Encoded ID Tags**

Frequency ID Tags operate from a variable frequency, scanning single-pulsed signal created in the Transmit Card - Channel A or Channel B. The received signal from the tag, identified by frequency, consists of a short decaying carrier signal that is converted to a digital code for DSP processing.

Synchronous Encoded or Time-Window ID Tags operate from a fixed frequency time-window or time multiplexed series of pulsed signals created in the Transmit Card - Channel B. The received signal consists of a short carrier signal or a coded FSK signal that is detected and used to identify its specific time period and/or digital code.

In addition, tag are further cauterized as follows:

- **Passive** - means that it has no batteries or active electronic devices such as transistors or integrated circuits.
- **Active** - means that it has batteries and/or other internal power sources and has active components or devices.

5.5 Antenna(s)

The system and associated antennas can be implemented as follows:

- **Goal Post or Pedestal Pattern** - means that a package or person goes past two antenna loops on each side, but does not go through the electrical center or flux vertex of an antenna.
- **Pass Through Pattern** - means that package or person goes through the antenna loops or electrical center or flux vertex of the antenna such as when the antenna is mounted around a door.
- **Hand Held Reader Pattern**- means that an antenna system, located in a hand held reader, will be passed over a package or person.

- **Desk Top** – means that a package or item passes over a surface in a POS or other application

5.6 Transmitter Card

The Transmitter Card creates a magnetic signal that is radiated by an antenna to the ***Tag*** and provides the following functions:

- **Independently controlled dual-channel outputs for simultaneous operation of original Frequency ID Tags and new Synchronous Time-Window and/or Encoded ID Tags (depending on application).**

- **Digitally programmable VCO signal source that operates in three bands from 2 to 13.56 MHz and fixed crystal controlled 10 and 13.56 MHz signal sources.**

- **Two digital waveform generators and two power output driver stages, with digital control outputs, to drive antenna taps.**

- **Drives a wire or hollow copper loop-single ended or differential magnetic induction antenna.**

- **Independent frequency scanning single pulse system to operate Frequency ID Tags and time-window counter system to operate Synchronous Time-Window ID Tags with collision prevention.**

- **Microprocessor to operate the Transmit, Receiver and other cards as an integrated system.**

- **Bi-directional serial RS232 interface to output data and control information and to receive download commands as part of a system or network.**

- **Plug-in backplane bus interface for operation with Receiver, DSP and Interface and other cards as a modular computer peripheral system.**
- **Provides reference clocks, timing and control information output to synchronize and operate the system.**
- **Power regulators for operation off of unregulated power inputs.**
- **Built-in self-check and calibration system.**

5.7 Receive Card

The Receiver Card performs the following functions:

- **Independently controlled dual-channel inputs for simultaneous operation (in certain applications) of Frequency ID and Synchronous Time-Window and/or Encoded Tags.**
- **Digitally selectable set of four bandpass-filters to handle different frequency bands and types of tags.**
- **Analog-to-digital converter and flash memory to convert and store received signals as digital data.**
- **Phase-lock-loop (PLL) to receive and demodulate FSK encoded data.**
- **Full-wave detector to convert received carrier signal into amplitude demodulated output.**
- **Plug-in backplane bus interface for operation with Transmit, DSP, Interface and other cards as a modular computer peripheral system.**
- **Receives input reference, timing and control information from the transmitter local/internal interface in order to synchronize operation.**
- **Power regulators for operation off of unregulated power inputs.**

5.8 Control Unit

The Control Unit consists of an electrically sealed metal fabricated universal case that can house either the transmitter or receiver or both as follows:

- **Size is Inches**
- **Material is AL**

In addition, the case has the following external connections:

- **Antenna Connector (s) - transmit and/or receive or a common copper tube antenna(s).**
- **Internal/Local Interface Connector (15 pin).**
- **External Interface/Power Connector (9 pin).**

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6.0 Detailed Description

6.1 Passive Tags

Passive tags are the simplest and least expensive, with a range or distance of operation to about 1 meter or less, having limited identification coding and limited functionality in close proximity with many other tags.

Passive tags, as further defined by E-Code, consist of one or more printed resonance circuits on or part of a label or other flat surface - as follows:

- **Inductor(s)** - printed polymers, foil, stamped or wire coil.
- **Capacitor(s)** - printed polymers, foil, discrete, or stray.

The inductor and capacitor operate together to create a sharply tuned resonant circuit that oscillates or resonates at a specific defined frequency - determined by the value of the inductor and capacitor(s). The tag resonant circuit(s) will only receive or respond to the signal frequency that it is tuned to and it will only output a signal at that frequency.

6.2 Semi-Active Tags

Semi-Active Tags are a bit more complex and costly with a range of about 1-meter, but with greatly increased identification coding and for operation in close proximity of many tags.

Semi-Active tags, as further defined herein, consist of:

- **One or more resonant circuits**
- **Active circuitry and electronic components**
- **No battery or other permanent internal power source**

6.3 Active Tags

Active tags are the most complex and costly with a potential range of about 3 meters, if operated with both receiving and transmitting capability, and up to 100 feet or more operated only as a transmitter.

Active Tags, as further defined herein, consist of:

- **One or more resonant circuits**
- **Active circuitry and electronic components**
- **Battery or other permanent power source**

6.4 Frequency Coding of the Tags

The Tags have up to 5 bands of frequencies with each band having up to 5 frequencies of operation. The center band of the five bands is set to only one frequency that is used as a reference frequency and a single frequency means to determine if a Tag is present.

The remaining 4 bands each having 1 of 5 different frequencies results in 5 to the 4^{th} or 625 alternatives.

It can be seen that additional tag coding can be accomplished by having tags equipped with differing numbers of tag bands. The absence of a band can then be considered another "zero value" that has the effect of increasing the number of potential alternatives to the following:

Alternatives including those with "zero value" **1395**

The frequencies of the Tags (as presently defined) are as follows:

Band Freq.	A	B	C (Reference)	D	F
1	2.00	3.33	5.55	6.55	10.9
2	2.18	3.63	5.55	7.14	11.89
3	2.38	3.95	5.55	7.78	12.95
4	2.59	4.31	5.55	8.48	14.12
5	2.83	4.70	5.55	9.24	15.39

An individual tag can be read and its code identified. However, in cases where multiple tags are in close proximity it is not possible to identify an individual tag among many. However, a tag having a frequency output that should not occur in a group of tags can be identified by the principle of exception. For example, if all the tags in a group are intended for a particular purpose or destination, a tag exists in the group that outputs a frequency that is not associated with that group - then that anomaly can be detected.

In essence, tag coding can be accomplished as follows:

- **Positive Identification of Individual Tag (single tag or tags spaced physically apart).**
- **Negative Identification of Exception Tag (wrong tag in a close group of tags).**
- **Positive Identification of Missing Tag or Group of Tags (where no tag or tags is detected individually or in a group).**

6.5 Differential Reading of the Tags

Since the tags that have multiple resonant frequencies are manufactured in a common process, the electrical properties tend to track each other. If the reference frequency is lower than intended, then the other circuit frequencies tend to be lower also. In addition, if the tag is bent or is placed in proximity of something that will affect its reference frequency then the other frequencies tend to vary in a corresponding manner.

Therefore, the system reads the frequencies of the tag circuits in a differential manner. Each is read in comparison with the reference frequency and any variations to the reference frequency are accounted for in the other frequency readings. This significantly reduces the manufacturing accuracy required for the tag and allows the tag to bend and otherwise de-tuned somewhat by dielectric, conductive or other external or environmental influences.

6.6 Transmitter Antenna

The antenna has the capability of sending and/or receiving magnetic induction signals, over the frequency range of 2 to 12 MHz, that are used to activate, detect, and identify a tag.

The antenna consists of wire or copper pipe loops that are nickel and silver coated for maximum surface conductivity; to accommodate the signal high frequency skin effect, and that, when used for transmitting, is voltage driven in a resonant manner.

When used for transmitting, the antenna is operated in a resonant mode in order to obtain current multiplication for increased current and magnetic field output with minimum drive current. The frequency of the antenna is tuned by digitally switching five range taps and/or capacitors to select up to five bands and over the frequencies within each band. The output stage is one of the more difficult area of the design since it needs to be resonant for high current output yet operate over a wide range of frequencies.

6.7 Receive Antenna

The two loops of the antenna creates a differential input to the receiver in such a manner as to double the received magnetic induction signal but cancels received electric field energy, such as interference or noise, that is common to both loops.

When used for receiving, the antenna capacitors are switched off, making the antenna non-resonant and the antenna is used to current feed a common emitter low-noise pre-amp stage. It provides a low-impedance load so that the antenna does not self-resonant, ring, or otherwise prevent wide-band video operation.

It is very important that the antenna, operating with the receiver, have nearly instantaneous response to signals received - in order to prevent the storage or stretching of a received transmitter signal that would block the reception of a tag signal.

6.8 Antenna Patterns

Depending on the application, one to three directions can be covered in order to insure that a tag is detected in all directions, axes, or planes. As a result the following basic antenna patterns are defined:

Pass Through Antenna Patterns:

- **"O" One Dimensional Pattern** - single set of transmit and receiver antennas are located so that items or people pass through the center of the antennas. Provides maximum signal strength to the tag as it passes through and is particularly useful for Semi-Active tags that need sufficient power level to activate tag circuitry. Has maximum detection when tag is parallel to the plane of the antenna and minimum when 90° in the other two axis or planes, although it can sometimes detect tags as they move in or out of the detection area at an obtuse angle.

- **"O" Two Dimensional Pattern** - double set of "O" transmit and receive antennas that are at 90° rotary angle around a vertical angle around a vertical axis to each other. Has an increased probability of detecting tags that pass through the field of both single axis antenna systems.

Goal Post Patterns:

- **"H " One Dimension Pattern** - single set of transmit and receive antennas are located across from each other to create a "goal post" single axis "H" pattern (each side of the H represent parallel antenna). Has maximum detection when tag is parallel to each antenna and minimum when 90° in the other two axis or planes, although, it can sometimes detect tags as they move into or out of the detection area at obtuse angles to the antennas.

- **"H" Two Dimension Pattern** - double set of transmit and receive antennas each creating an "H" pattern but together create an overall two dimension pattern where two "H" patterns are at 90° rotary around a vertical axis to each other. Has an increased probability of detecting tags that pass through the field of both single axis antenna systems.

- **"H" Three Dimension Pattern** - triple set of transmit and receive antennas each creating an "H" pattern but in all three axis or directions. A third antenna is placed on a plane on the top and bottom of the pattern created by the other two antenna sets. Has the maximum probability of detecting a tag at any angle.

The transmitter or the receiver, along with their antennas, can be packaged independently in separate universal cases. This provides for a basic "goal post" configuration, as defined below, wherein the transmitter and its antenna are placed in one location and the receiver and its antenna are in another, such as on both sides of a conveyor belt with transmission only in one direction.

As an alternative, the transmitter and receiver can both be placed in the same universal case. However, it will need to be confirmed if the system can operate off of one antenna or two closely mounted together. In theory this should be possible, however, a number of practical problems will have to be overcome. The prototype will provide much of the information to confirm this possibility.

This also provides for transmissions to be made alternately in both directions between separate units or between the transmitter and receiver in the same case. In addition, this provides for "walk through" configurations where the transmitter and receiver can be located in the same unit. In addition, multiple units and/or multiple antennas can be used to cover an area in more than one direction.

6.9 Transmitter Card

The transmitter board consists of the following:

- **Voltage-Controlled Oscillator (VCO)**
- **Dual-Programmable Power Drivers**
- **Micro controller, Timing and Control Circuitry**
- **Power Converter/Regulators**

6.10 Transmitter Card Mechanical Configuration

The card has the following mechanical configuration:

- **Width 4.45"**
- **Length 6.45"**
- **Thickness 0.62"**
- **Material FR4 or G10**

6.11 Receiver Card

The receiver consists of the following:

- **Differential Preamp.**
- **Gain-Control Attenuator**
- **Wide-band Video Amplifier with Gain Selection**
- **Signal Data Analog to Digital Flash Converter (A/D)**
- **Signal Processing Micro-Controller**
- **Linear Power Regulators**

6.12 Case

Because of the close proximity of transmitter and receiver circuitry, and the need for absolute minimum radiation and spurious pickup, the prototype packaging is "sealed" in a kind of "military" style case.

The case has the following mechanical configuration:

- **Width 5.0"**
- **Length 7.5"**
- **Height 1.25"**
- **Material AL**

7.0 SYSTEM SPECIFICATIONS

Tags

Frequency of operation	2 to 12 MHz
Size (Minimum)	
Width	4 inch
Height	2 inch
Depth	0.01 to 0.10 inch
Number of Bands	5 Max
Number of Frequencies/Band	5 Max
Tag Detection Rate	100 CPS
(To be confirmed)	

Transmitter

Frequency of operation	2 to 12 MHz
Number of Antennas	3 Max (3 Axis)
Driver Level	
Voltage	12 VP-P
Current	100 MA Max
Frequency Accuracy	+/- 6 kHz
Frequency Step Resolution	+/- 12 kHz

Receiver

Frequency of operation	2 to 12 MHz
Number of Antennas	3 Max (3 Axis)
Signal A/D Resolution	8 bits (64 Levels)
Conversion Rate	48 Meg Byte/Sec.
Flash Memory	256 to 1024 Byte
External Interface	
Type	Serial RS232 Bipolar/Bi-directional
Baud Rate	19,200
Format	Binary

Overall

Safety approval	Design intent to meet UL, CSA, and VDE and other requirements
RFI approval	Design intent to meet FCC, Part 15, Subpart J for computing devices VCII limit Class-2 German RFI limit for GOP
ESD	12000 Volts, Pulsed
Altitude	Sea Level to 15,000 feet, operating Sea Level to 40,000 feet, non-operating

Environmental

Design Intent to Meet Mil STD 810D, Method 502.2 in final Production Version

Temperature

Operating	Method 501.2, 502.2 -50 °C to + 70 °C
Storage	-55°C to +85 °C
Shock	Method 615.3 Procedure I 30 g for 11 ms, half sine pulse
Vibration	Method 520.0 Procedure II, Ambient Temp.

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Drop	Method 516.3 Procedure II 3.3 Meters, on 5 cm plywood back by concrete
Humidity	Method 507.2 95%, non condensing
Rain	Method 506.1 Procedure II
Salt Spray	Method 509.2 Procedure **I**
Leakage	
Ice/Rain	
Sand/Dust	

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