

**ACCUTRAC I  
INSTALLATION MANUAL**

**FOR MODELS  
UE5100C-RS, UE5103B-RS and UE5000C**

**January 2001 Edition**

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# 1 SYSTEM OVERVIEW

Industrial Computer Systems manufactures the Accutrac I Code Card Reader System comprised of a family of intelligent microprocessor-based subsystems using the RS-422 Communication protocol for communications between family members.

They provide a very durable, flexible and cost-effective material-tracking system that is ideally suited to many modern-manufacturing applications. The tracking of carriers in a power & free conveyor system is one example of its potential use.

The RS-422 based family consists of several units:

- UE5000C Concentrator,
- UE5100C-RS Code Card Reader,
- UE5103A-RS Junction Box and
- UE5210A Identification Code Card

Each of these units is described further in the following paragraphs.

## 1.1 UE5210A Identification Code Cards

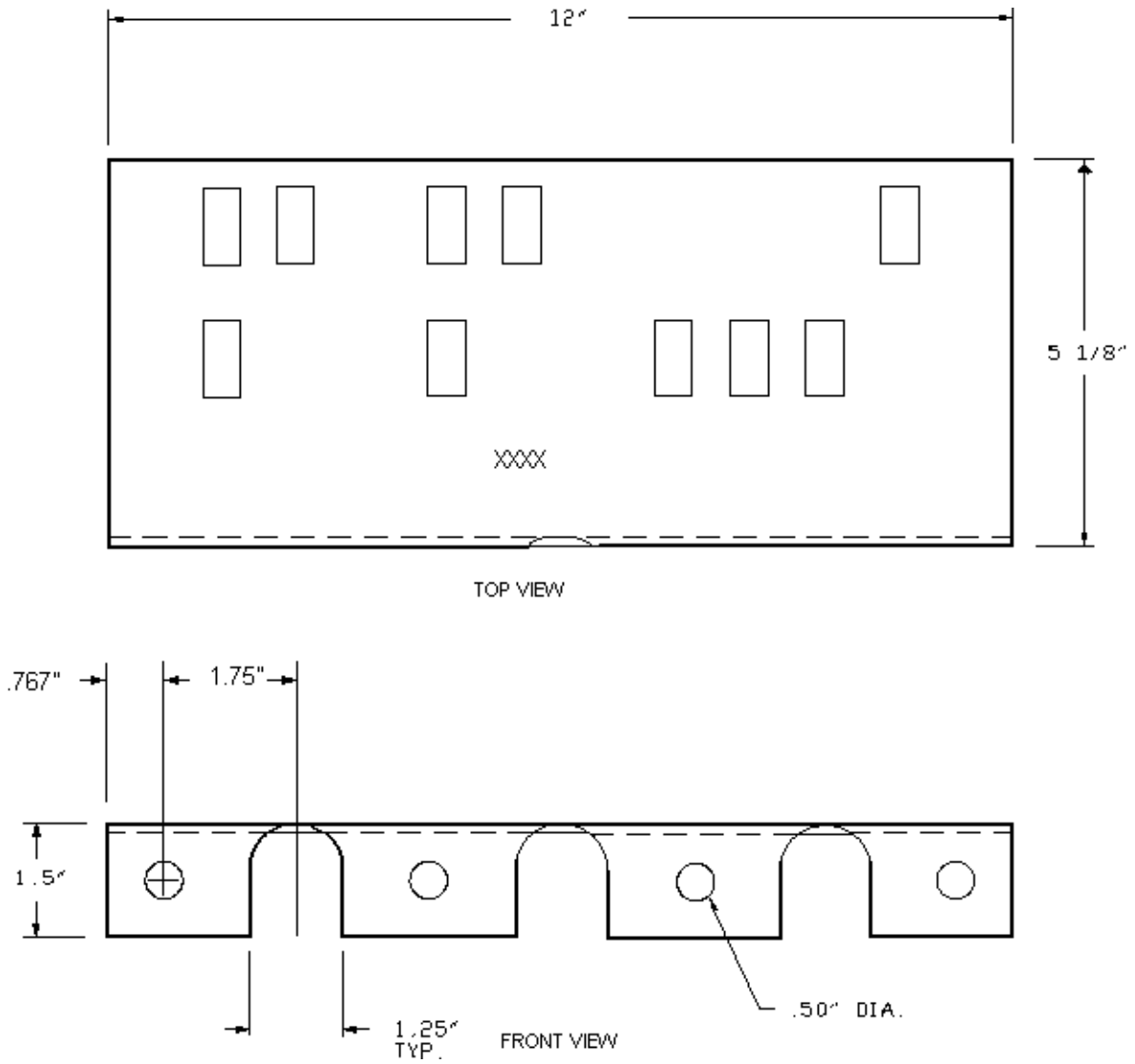
UE5210A Identification Code Card (code card) is constructed of zinc-plated cold-rolled steel stock; see Figure 1.1.1.

The code number associated with each card is represented by a unique system of placing holes and non-holes on the card. The holes will be read by the UE5100C-RS Card Reader as a one and, the non-holes as zeros. The code value of the card is permanently stamped into the code card.

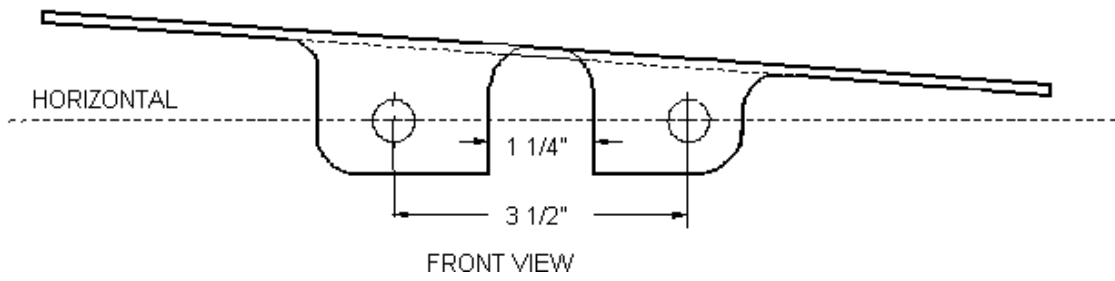
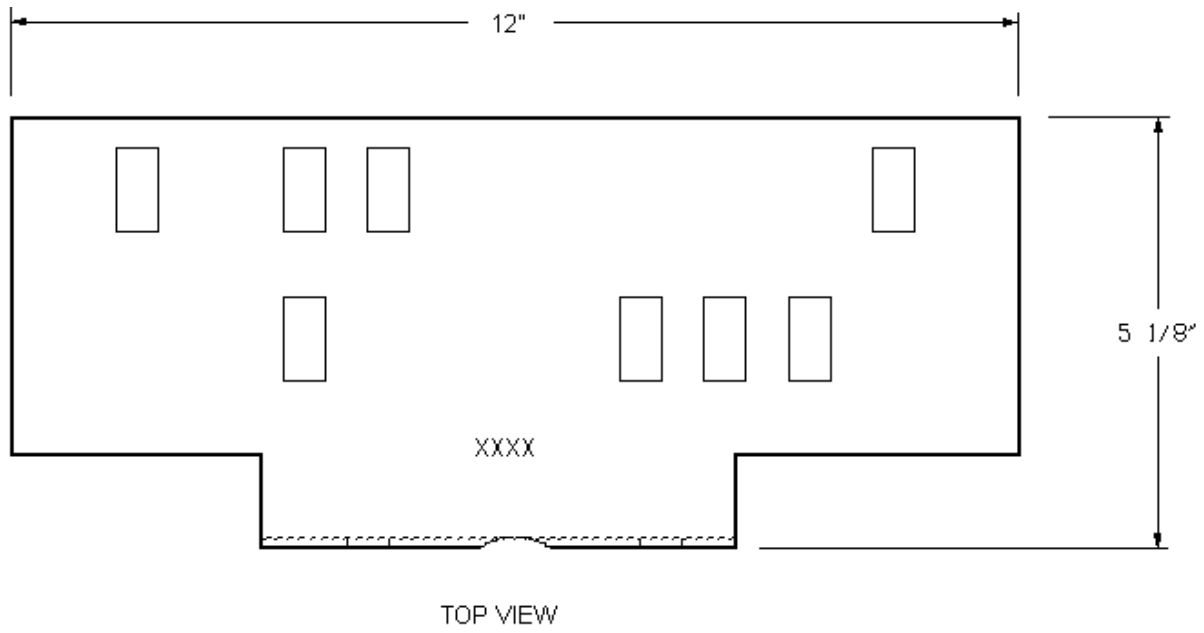
The system is unique in that it has an error detection algorithm built into the code number, thereby producing a card that cannot be misread. It allows over 7,000 codes, and still permits all data, registration, and mounting holes to fit into a 5" by 12" area.

Many variations of code cards are possible within the constraints imposed by the UE5100C-RS reader. Code cards smaller than 5" by 12" have a smaller range of codes than do the full size cards.

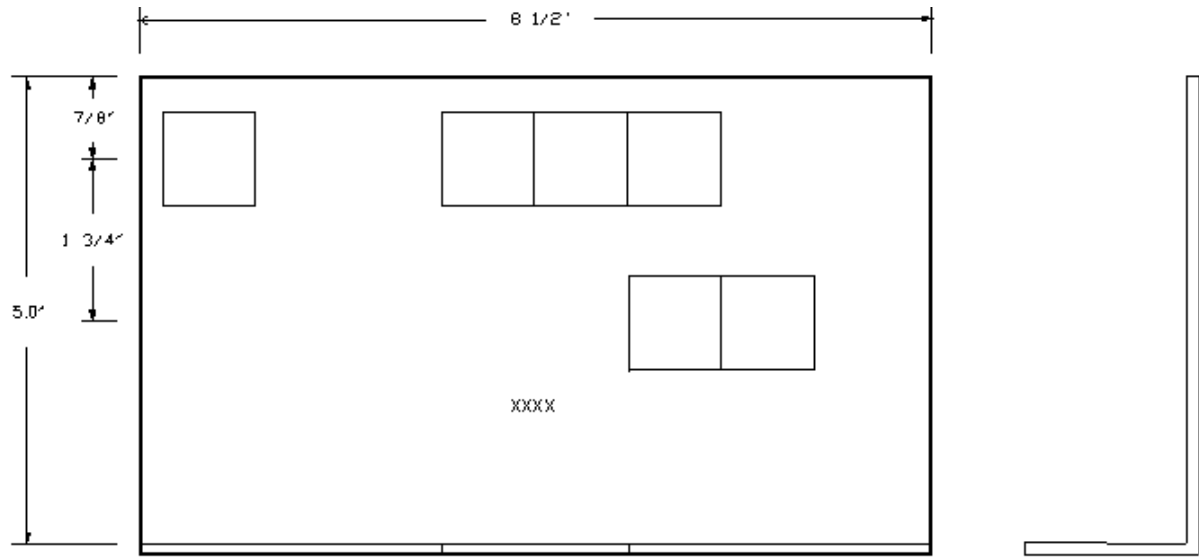
Figure 1.1.2 and 1.1.3 show two of the many code cards developed. The "slanted" code card allows for trolleys to be spaced closer together than the 12" length of the code card, whereas the "shorty" code was developed for motorized monorail application.



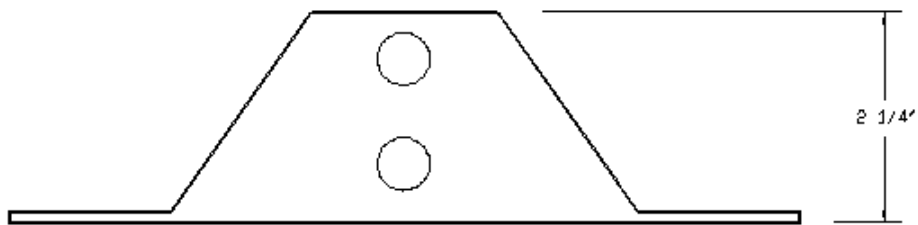
**Figure 1.1.1 UE5210A Code Card Physical Outline**



**Figure 1.1.2 “Slanted” Code Card**



TOP VIEW



FRONT VIEW

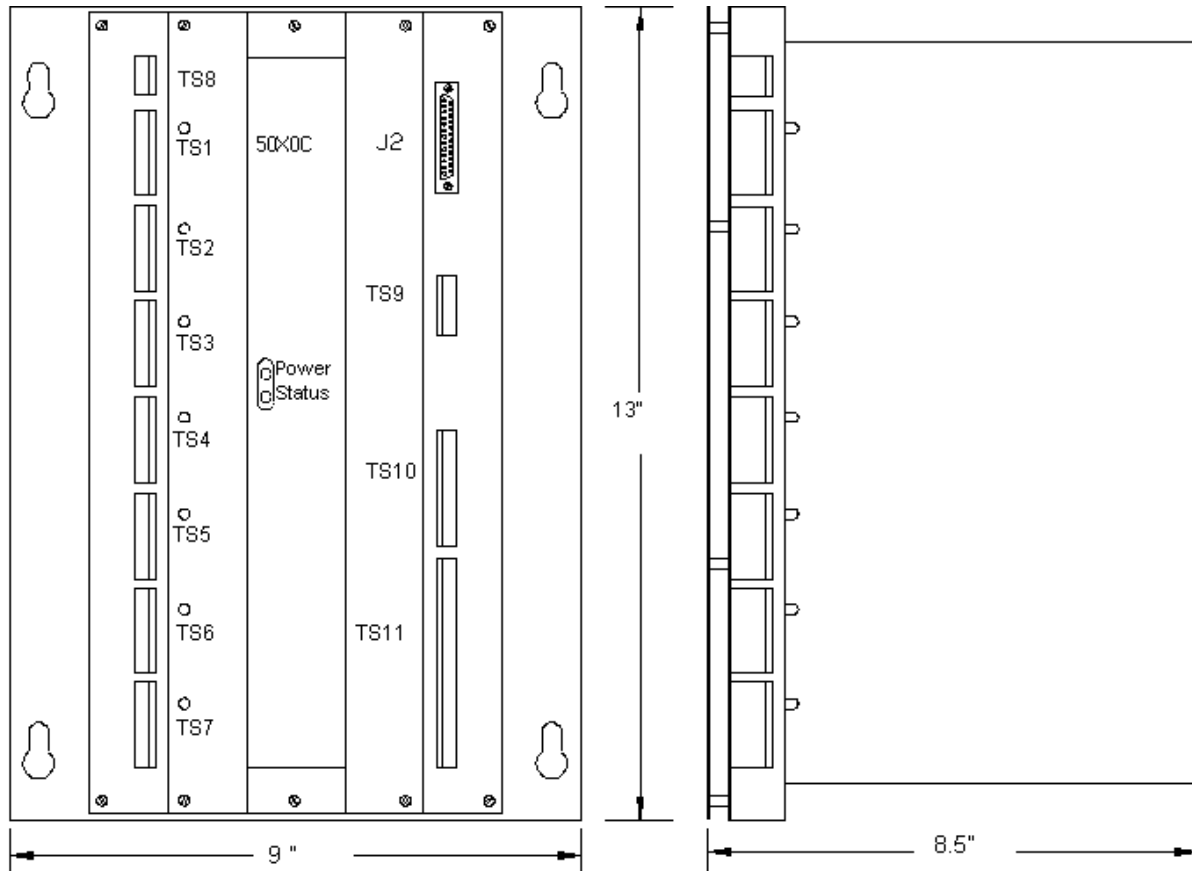
**Figure 1.1.3 “Shorty” Code Card**



## 1.2 UE5000C Card Reader Concentrator

The UE5000C Card Reader Concentrator (See Figure 1.2.1) is a microprocessor-based device that:

- Receives code values from up to seven (7) UE5100C-RS Card Readers simultaneously and independently.
- Places the resulting card codes or error codes, along with their associated card reader numbers (1-7), into an internal memory buffer.
- Communicates with a host programmable controller or computer via either a parallel or serial data interface, and formats the data appropriately.
- Provides the +24 VDC power needed by each UE5100C-RS reader.
- Provides a visual indication of the operational status of each UE5100C-RS reader.
- Supplies expansion capability to allow up to two additional UE5000C Card Concentrators to be connected via the host communication path.
- Allows the parallel outputs to be directly bussed together with the parallel outputs of up to four other concentrators.



**Figure 1.2.1 UE5000C Concentrator**

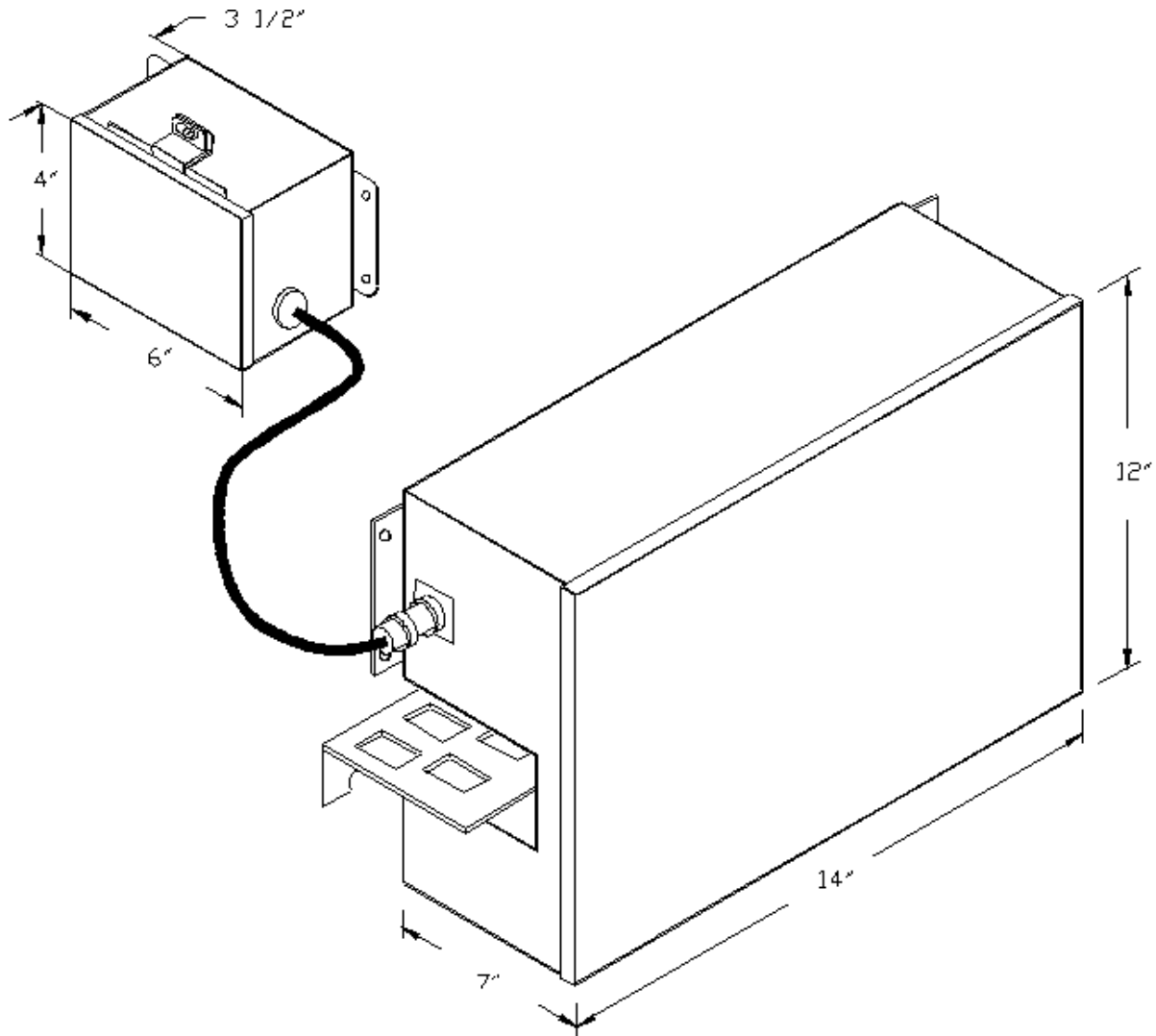
### **1.3 UE5100C-RS Card Reader**

The UE5100C-RS Card Reader (See Figure 1.3.1) consists of multiple LED photo-sensor assemblies connected to a microprocessor. The unique configuration of the UE5100C-RS Card Reader provides for reliable identification of the code card number at speeds up to 200 ft/min regardless of speed variations, direction, and change of direction, start/stop or backup.

In addition to reading code cards, the UE5100C-RS automatically checks the operating margins of the photo-sensor assemblies to provide an indication of performance degradation long before the point at which the card can no longer be read. The result of this margin checking is sent along with the code card value, and is also displayed at the UE5100C-RS on a set of LED indicators.

The UE5100C-RS is connected to the UE5000C Concentrator, using a small diameter low-voltage cable.

The optional UE5103B-RS Junction Box is normally added to the UE5100C-RS to provide a convenient junction box for field wiring convenience.



**Figure 1.3.1 UE5100C-RS and UE5103B-RS Physical Outlines**

## 2 SYSTEM CONFIGURATIONS

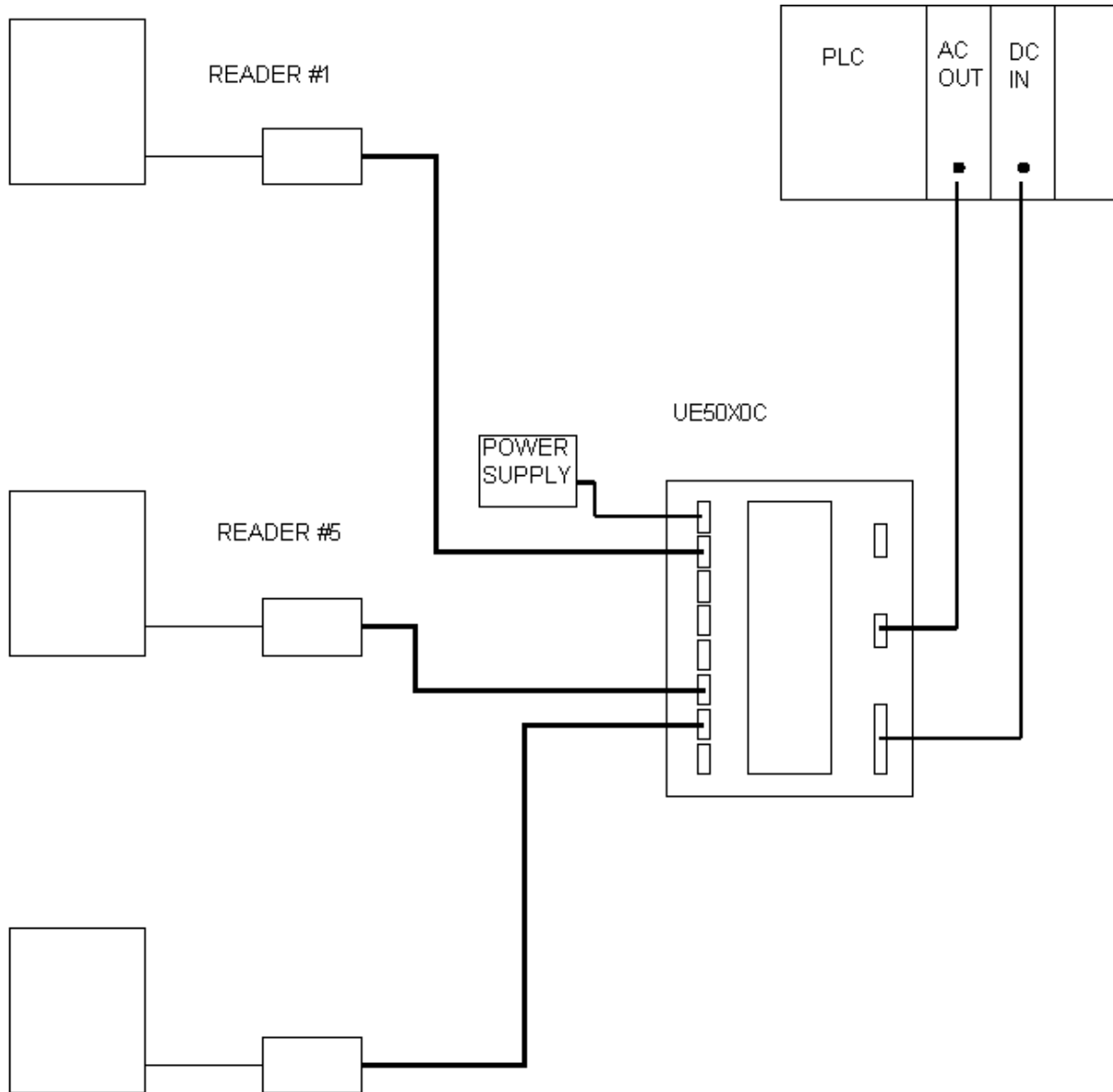
By selectively combining UE5100C-RS Card Readers and UE5000C Concentrators, a system configuration can be tailored for most tracking applications. The following paragraphs and diagrams list a few of the possible combinations.

### 2.1 Small System with Parallel Interface with PLC

Figure 2.1.1 shows the configuration for a small system, (1 to 7 readers) using parallel communication between the PLC and the UE5000C. Two I/O cards are needed in the PLC, an AC output card and a DC input card. The UE5000C must be mounted in the same control panel as the PLC due to length restrictions on the wiring between UE5000C and the PLC.

Each UE5100C-RS reader is connected to the UE5000C concentrator by a small diameter, low voltage cable. The length of the cable can range up to 3000' by proper choice of cable characteristics.

A single DC power supply is used to power all of the UE5100C-RS readers, the UE5000C concentrator, and provide signal power for the PLC DC input module. The DC power supply must be mounted within 2' of the UE5000C concentrator.



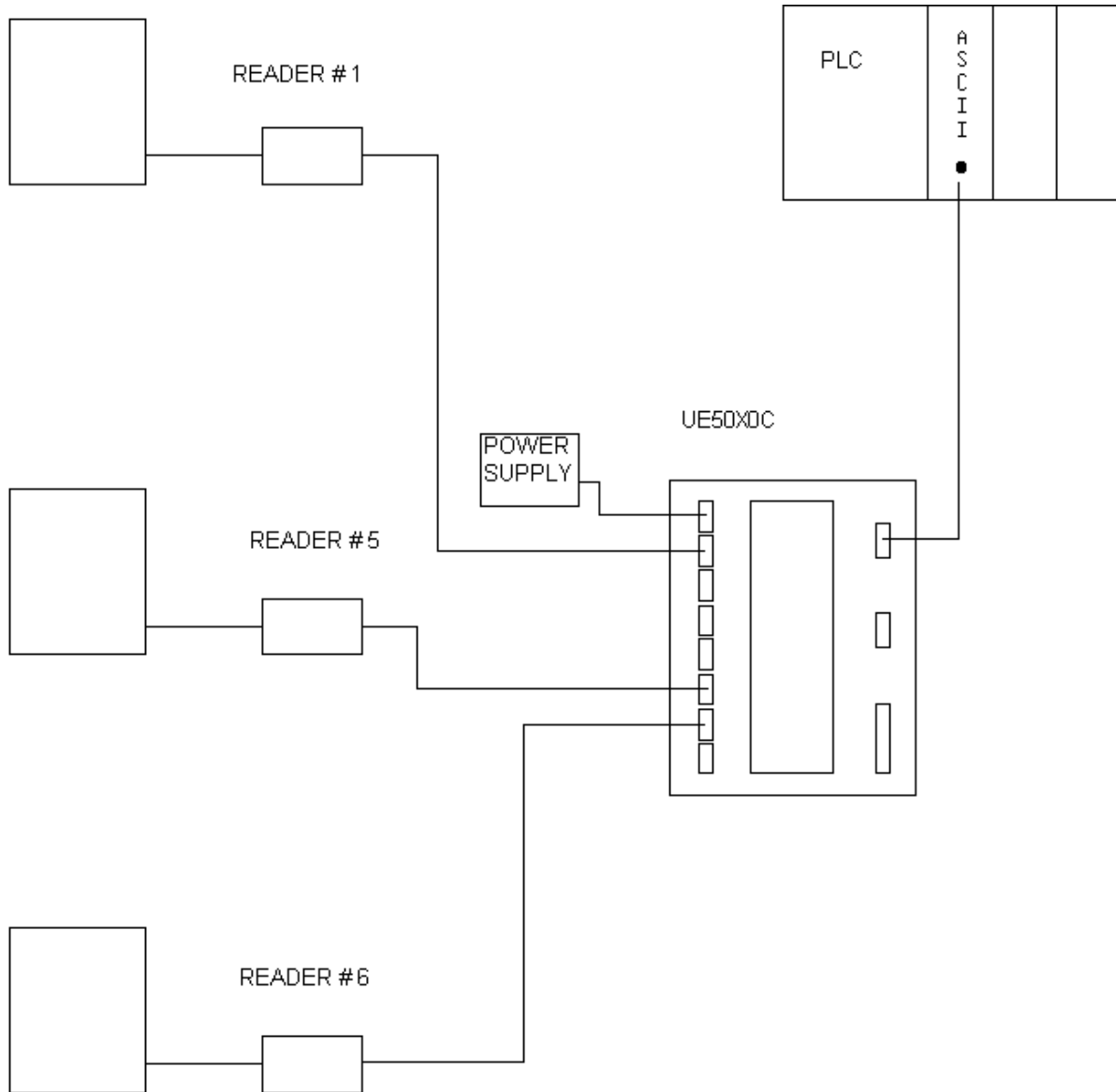
**Figure 2.1.1 Small System Using Parallel I/O with PLC**

## 2.2 Small System with Serial Interface with PLC

Figure 2.2.1 shows the configuration for a small system, (1 to 7 readers) using serial communication between the PLC and the UE5000C. An "ASCII" or "BASIC" module is needed in the PLC to provide the serial connection to the UE5000C. The UE5000C can be mounted up to 5000' away from the PLC if RS422 serial communication is used between the UE5000C and the PLC.

Each UE5100C-RS reader is connected to the UE5000C concentrator by a small diameter, low voltage cable. The length of the cable can range up to 3000' by proper choice of cable characteristics.

A single DC power supply is used to power all of the UE5100C-RS readers, and the UE5000C concentrator. The DC power supply must be mounted within 2' of the UE5000C concentrator.



**Figure 2.2.1 Small System Using Serial Communication with PLC**



### 2.3 Multiplexed Concentrator Using Parallel Interface

Multiple UE5000C concentrators can be connected to a PLC using only a single DC input card and a single AC output card. Figure 2.4.1 shows three (3) UE5000's connected to a single DC input card; however, up to 16 concentrators can be connected depending upon the load characteristics of the DC input module.

The AC output card has one output bit dedicated to each UE5000C. This bit is used to select the associated UE5000C. Only one of the UE5000C's can be selected at a given time. The selected UE5000C will output its data values on the parallel port, from which the DC input of the PLC can input the data. The UE5000C's must all be mounted in the same control panel as the PLC due to length restrictions on the wiring between UE5000C and the PLC.

Each UE5100C-RS reader is connected to the UE5000C concentrator by a small diameter, low voltage cable. The length of these cables can range up to 3000' by proper choice of cable characteristics.

A single DC power supply of sufficient capacity can be used to power all of the UE5100C-RS concentrators and their associated readers, or individual DC power supplies can be used for each concentrator and its associated readers.

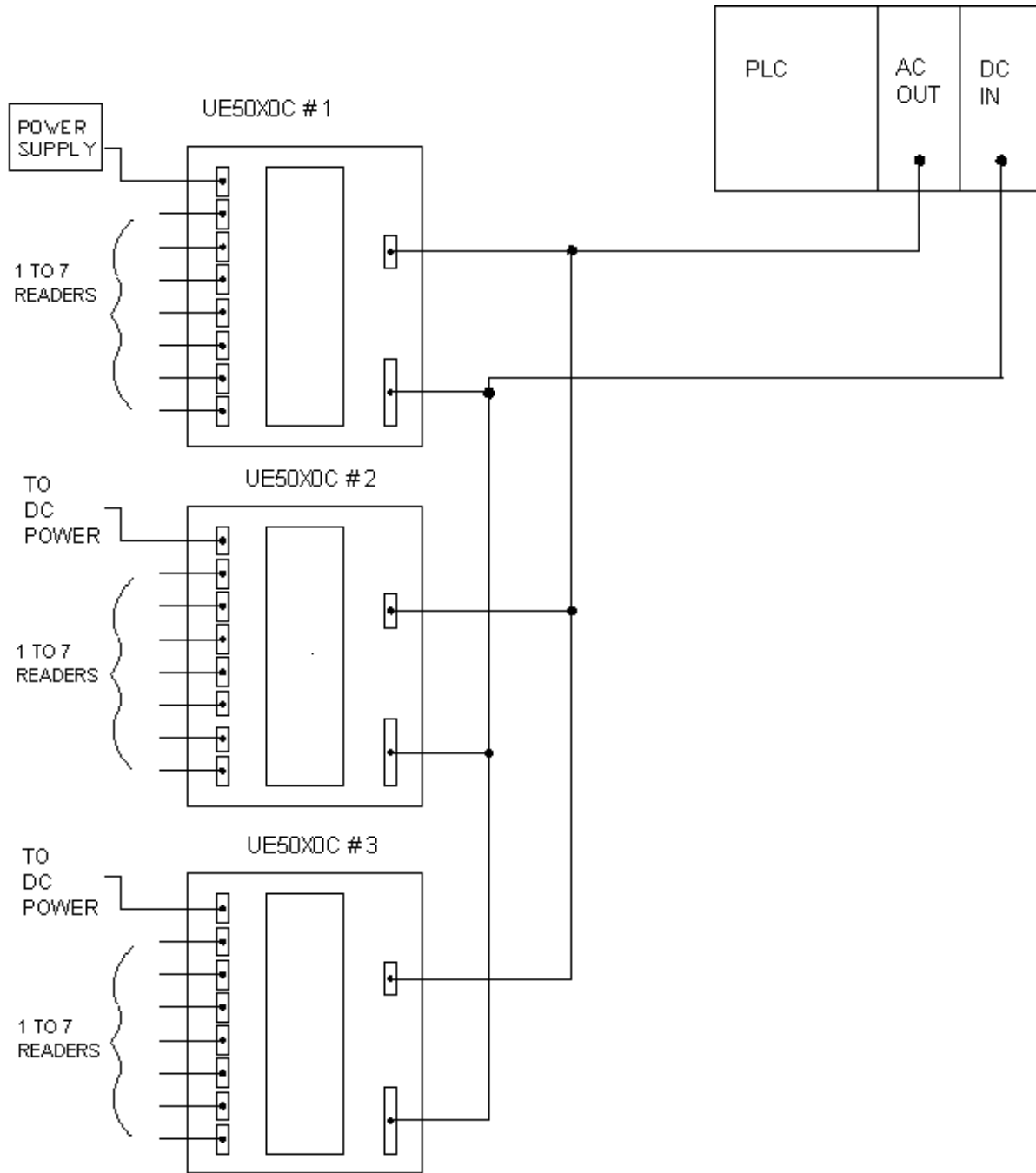


Figure 2.4.1 Multiplexed Concentrator System

## 2.4 Expanded Concentrators Using Serial Interface

Figure 2.5.1 shows how UE5000C concentrators can be used to expand the number of readers that can be connected to a single serial port of a PLC. Because of limitations in the UE5000C hardware and software, the number of UE5100C-RS readers that can be connected to a single serial port is 15.

Each UE5000C has 7 terminal strips for UE5100C-RS connection. The last reader on a UE5000C can be replaced by another UE5000C to expand the number of readers by 6, up to the limit of 15. The UE5000C closest to the PLC controls readers 1-6, the next UE5000C controls reader 7-13 or 7-12, and the third concentrator controls 13-15.

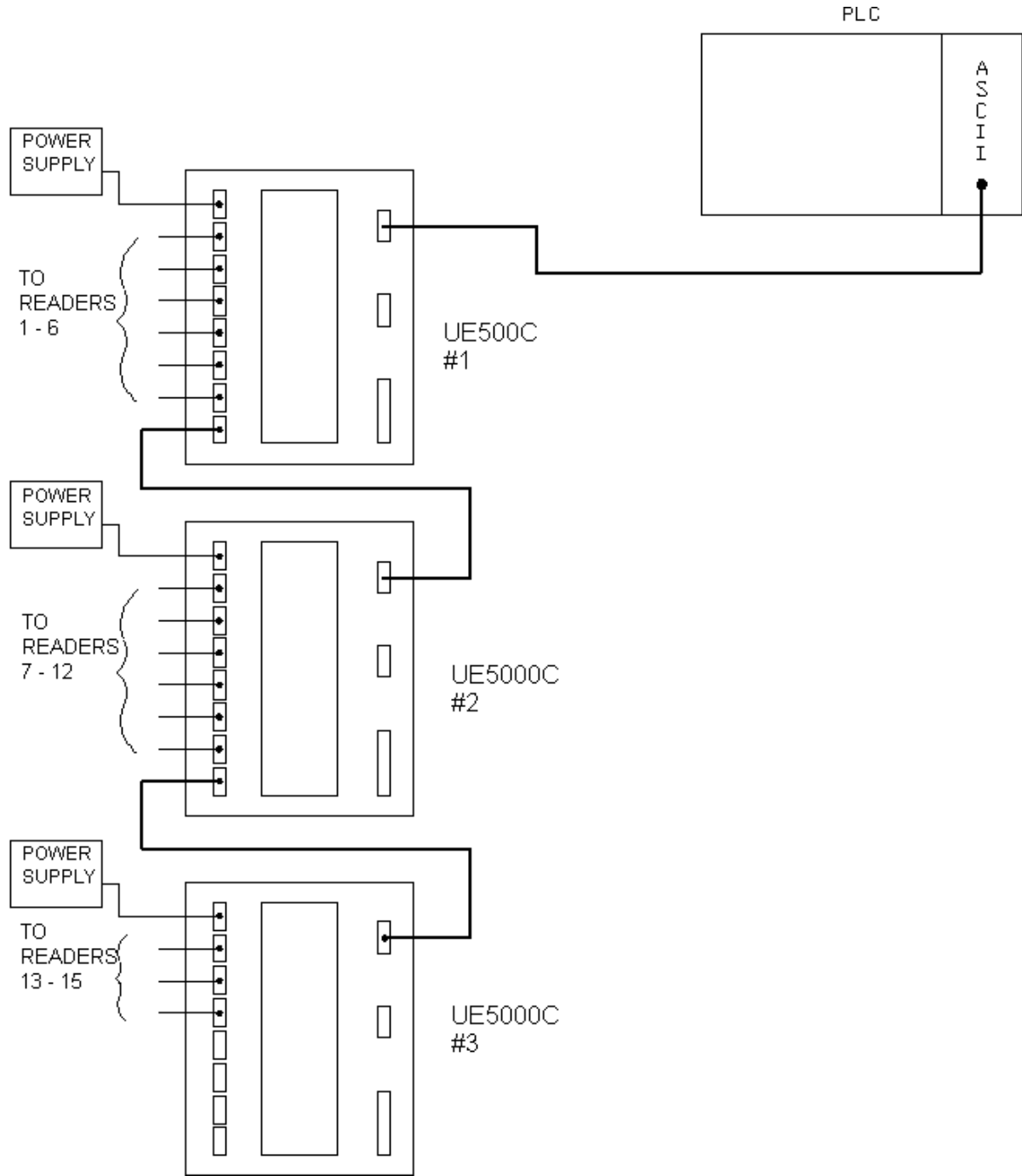
Expansions UE5000Cs can be separated from the host UE5000C by up to 5000'.

Each UE5100C-RS reader is connected to its UE5000C concentrator by a small diameter, low voltage cable. The length of these cables can range up to 3000' by proper choice of cable characteristics.

Since the DC power supply must be no more than 2' from its concentrator, expansion UE5000Cs usually are furnished with their own power supply.

The last UE5000C in the chain can have a UE5102A manual entry station added without reducing the number of readers in the system.

Although Figure 2.5.1 shows the host UE5000C connected to the PLC via a serial interface, the host UE5000C could have used a parallel interface as well.



**Figure 2.5.1 Expanded UE5000C System for 15 Readers.**

### 3 CODE CARD INSTALLATION

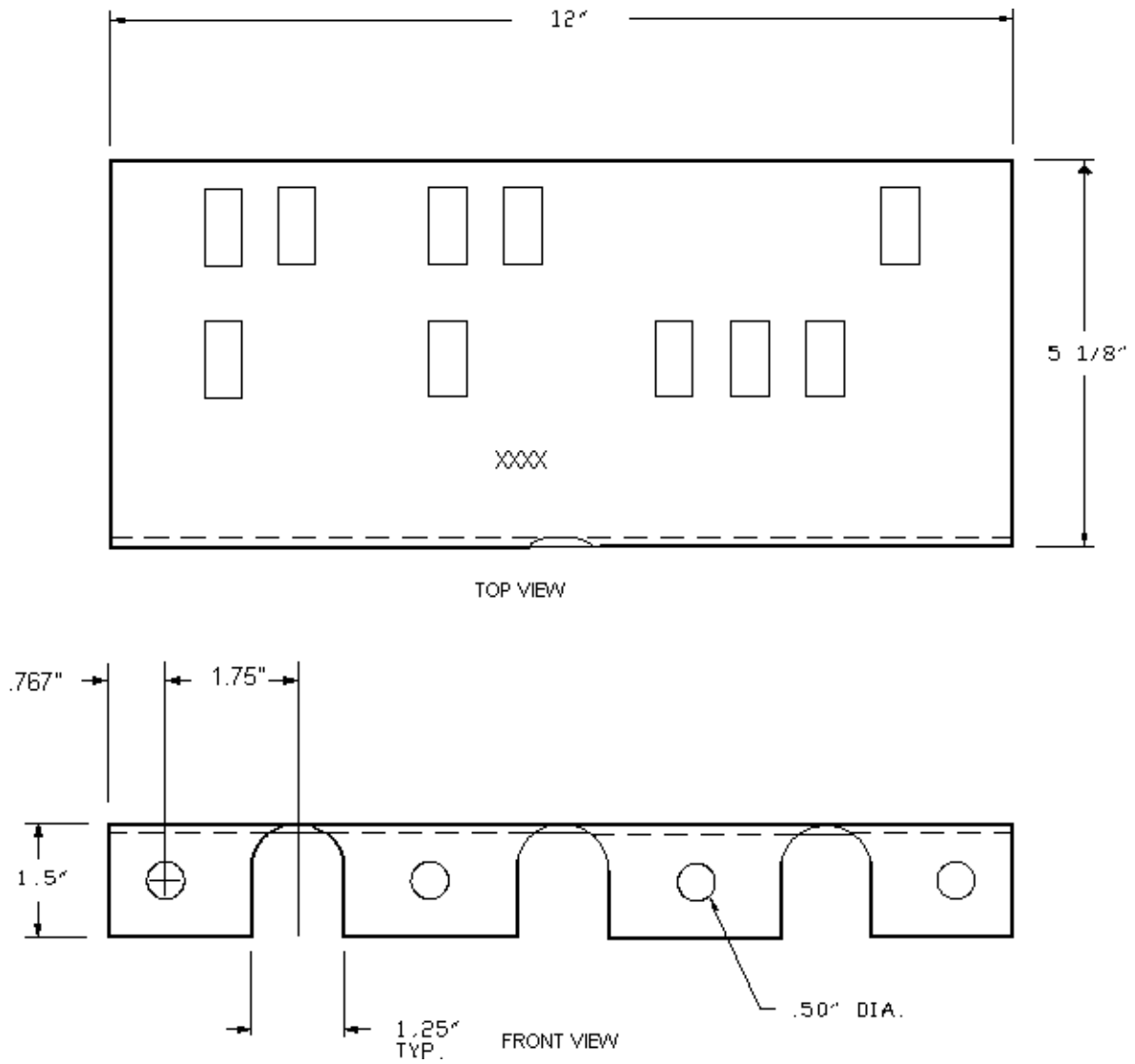
The UE5210A Code Card is the basis for all code cards for the UE5100C-RS Card Reader. The outer dimensions of the UE5210A code card are 5.125" by 12.0" as shown in Figure 3.1.

The UE5210A code card may be mounted directly to the trolley, or onto the load bar. Figure 3.2 shows a trolley mounted code card on an overhead power and free system.

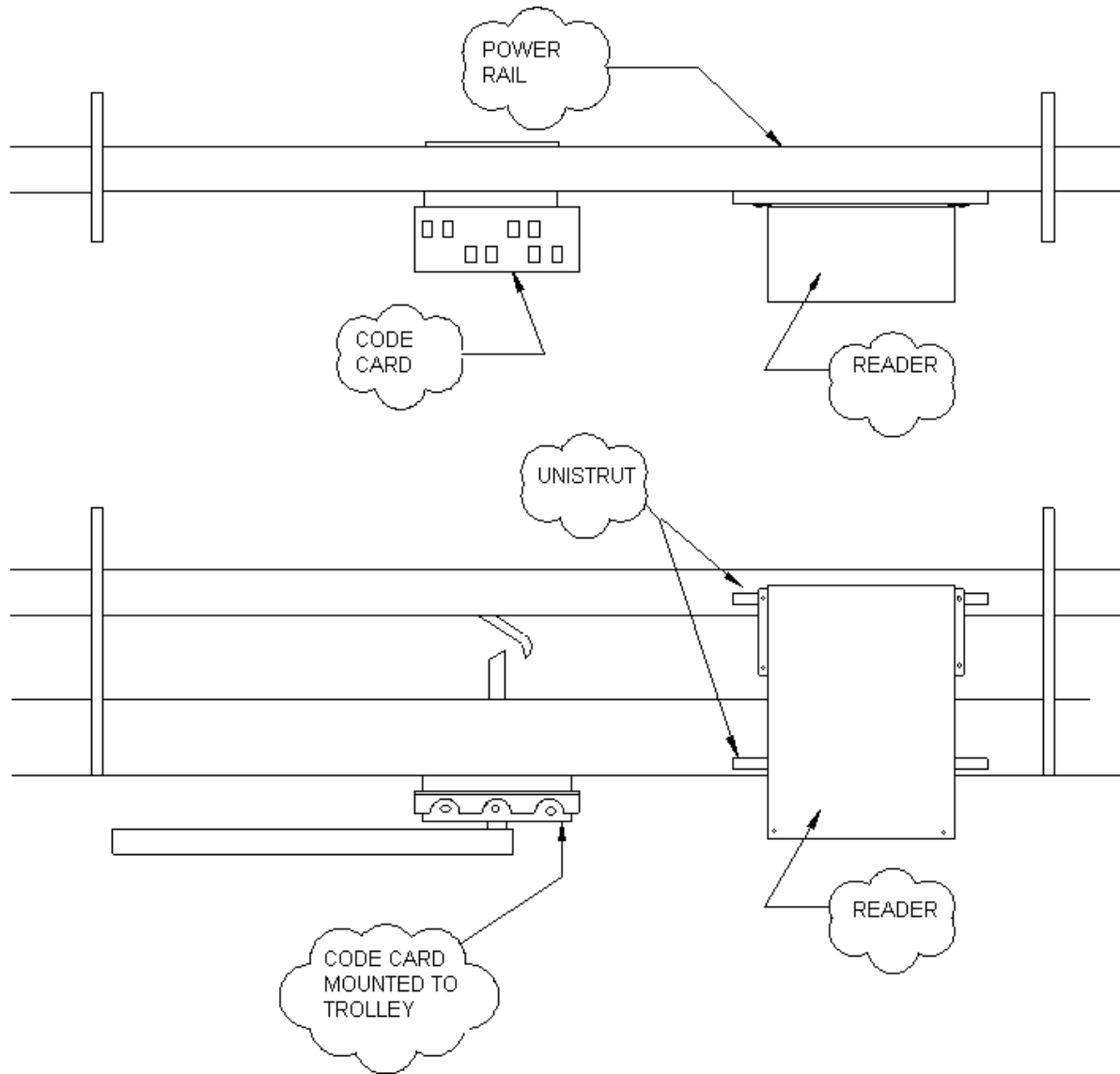
As a general guideline, the code card should be mounted as close to the track as possible to minimize the motion of the code cards relative to the readers.

The surface of the code card containing the stamped code number "NNNN" is called the top side of the code card. It is important that the top side of all of the code cards point in the same direction, and that all of the UE5100C-RS readers be mounted such that the top side of the code card be oriented towards the top of the reader when the code card is "inside the reader". Please see Figure 3.3. Please note that the "top" of the code card and the reader need not be oriented "up" in the normal sense of the word.

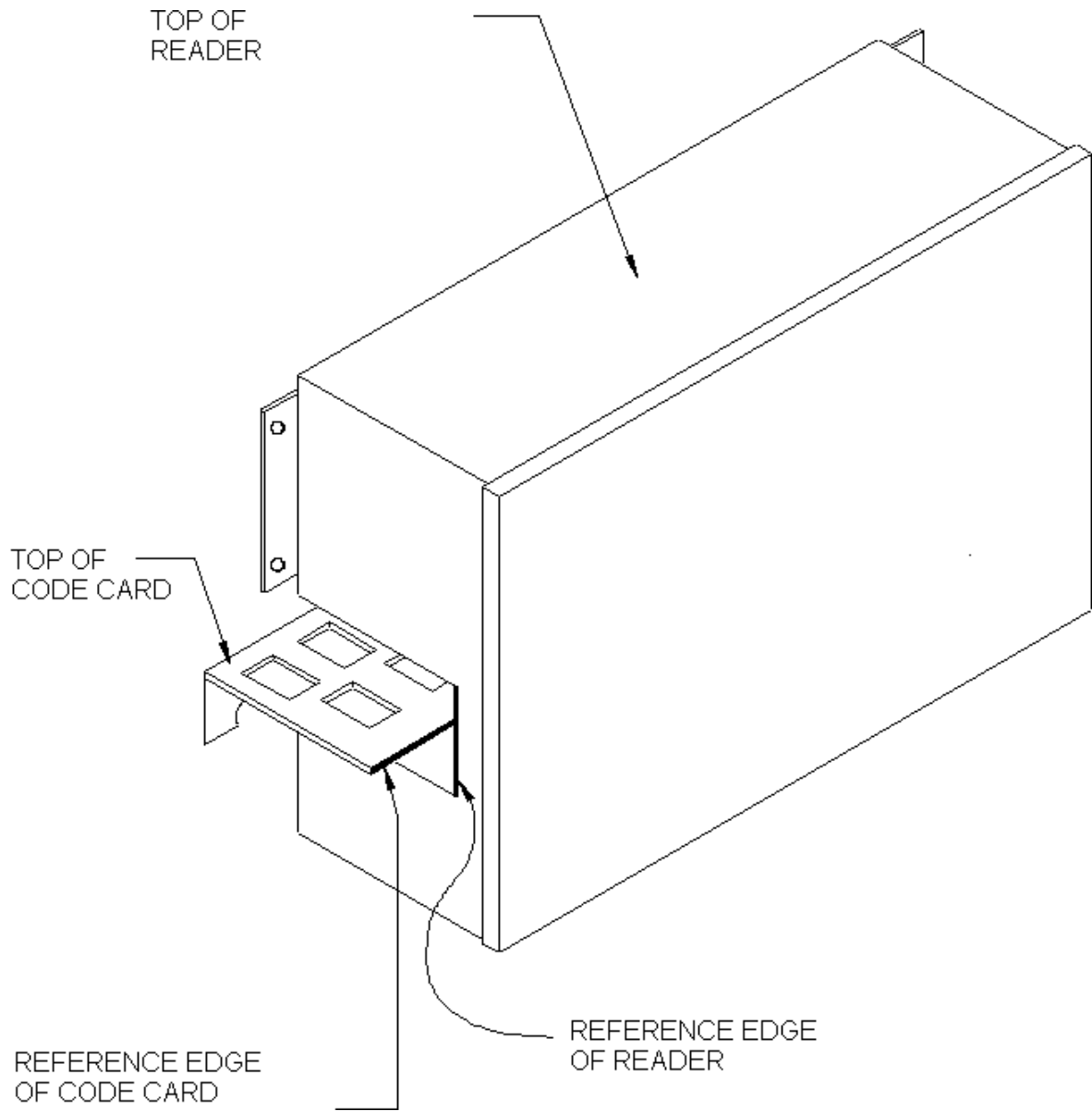
In addition to the orientation restrictions on the code cards, the code card and readers must be installed such that the "reference edge" (see Figure 3.4) of the card is located 1" from the reference surface of the reader (see Figure 3.5)



**Figure 3.1 UE5210A Code Card**

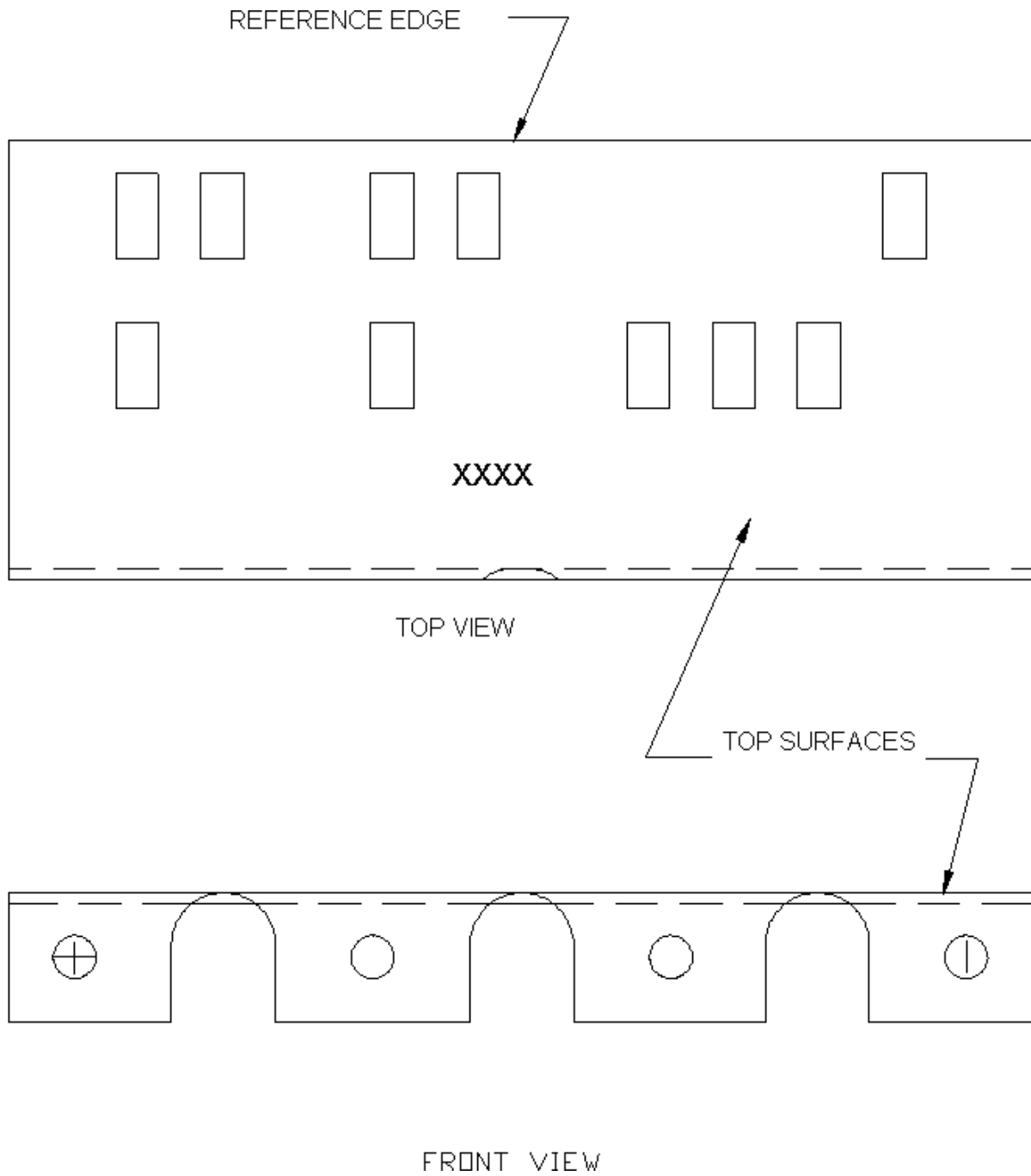


**Figure 3.2 Possible UE5210A Card Mounting Arrangements**

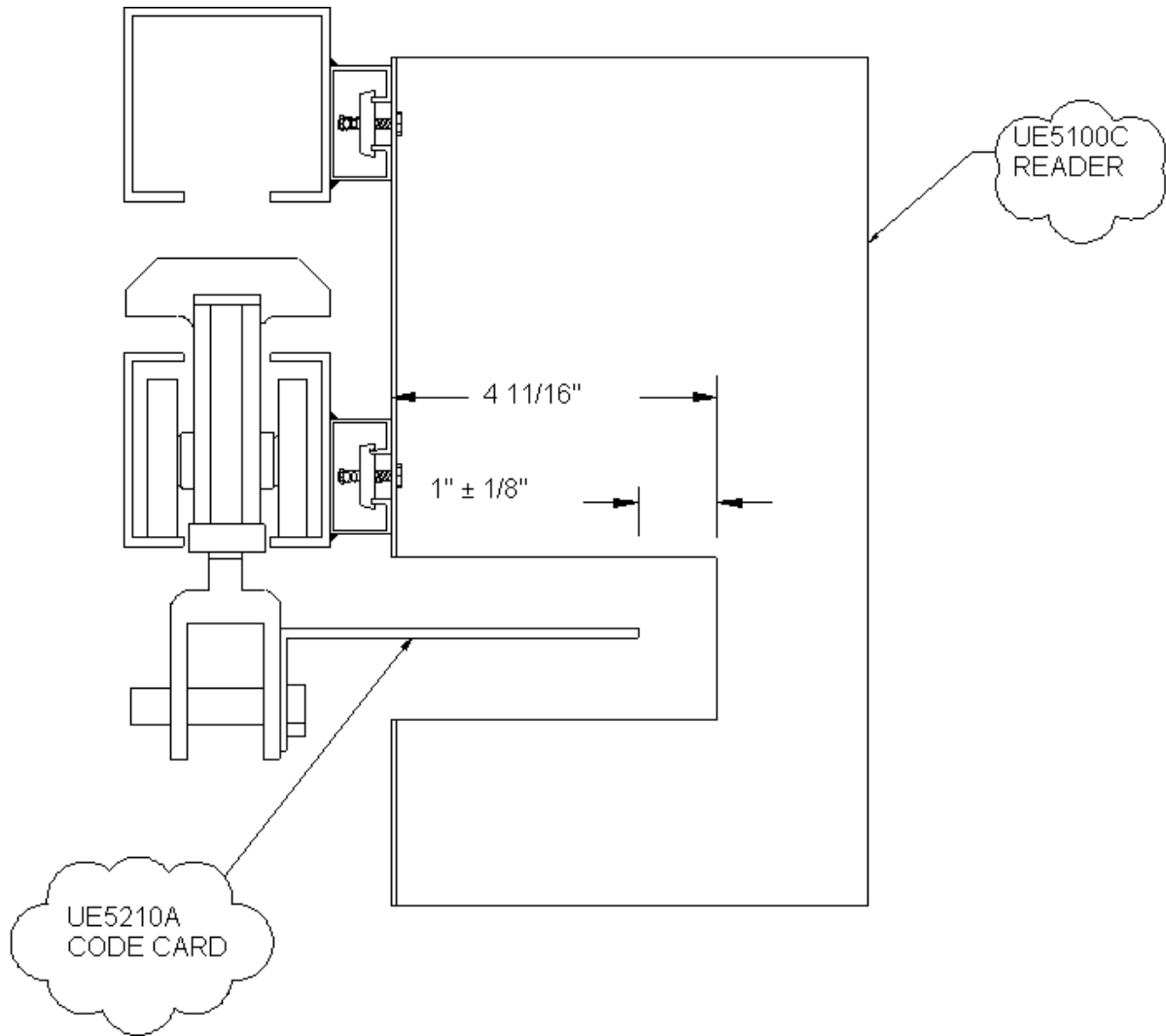


**Figure 3.3 UE5210A Code Card Orientation**





**Figure 3.4 Code Card Reference Points**



**Figure 3.5 Code Card to Reader Mounting Requirements**

## 4 MODEL 5100C-RS READER INSTALLATION

The UE5100C-RS Card Reader is enclosed in a Nema 12 enclosure, approximately 7" by 12" by 14" in dimension.

The UE5100C-RS reader is normally mounted on one side of a material handling system such as an overhead power and free (p&f) conveyor system, however, it can also be used on inverted p&f systems, roller conveyors, automatic guided vehicles, and monorail systems.

In all of these systems, the mounting requirements are similar to those required for an overhead p&f system, hence, in the following sections of this manual, the physical mounting requirements are specified for an overhead p&f system. The general requirements hold true no matter what type of material handling system is actually used.

Figure 4.1 illustrates the overall dimensions of the UE5100C-RS reader as well as the mounting dimensions.

Figure 4.2 and 4.3 illustrate the typical mounting methods used for an overhead p&f system. Typically, lengths of "Unistrut®" channel are fastened to either side of the conveyor, and the UE5100C-RS is simply bolted to the channels. The channels themselves may be bolted or welded to the rails of the conveyor.

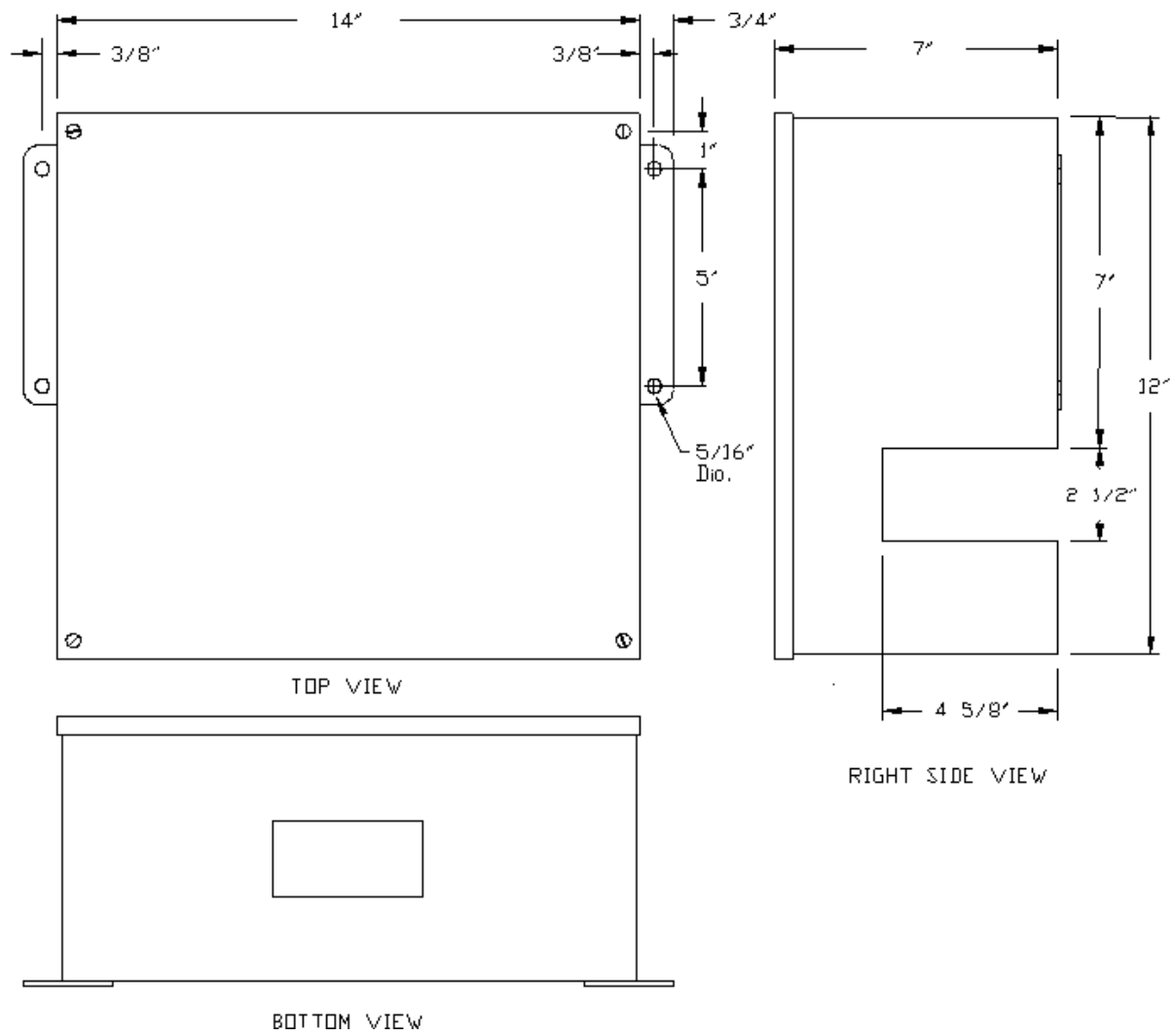
As discussed in Section 3 and shown in Figure 4.2, the UE5100C-RS reader must be mounted such that the code card passes through the middle of the reader "tunnel" and that the reference edge of the code card is 1" from the reference surface of the reader. Industrial Computer recommends that the 1" dimensions be checked at both ends of the reader and that this dimension be held to within 1/8".

The card reader will read the card correctly independent of the direction of travel of the code card as long as the code card is correctly oriented in the reader.

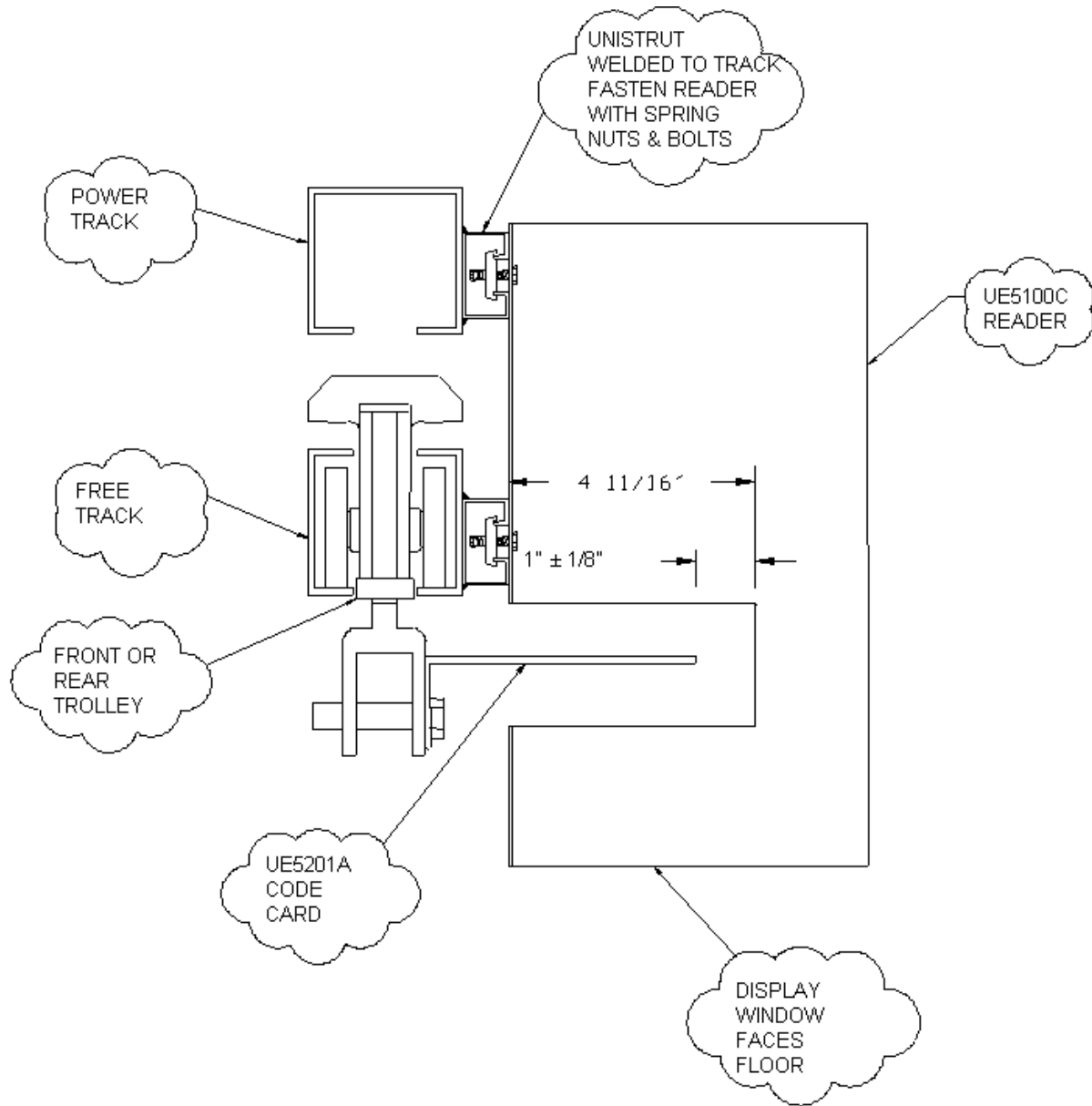
The card reader may be mounted on inclines, vertical curves, or horizontal curves, as long as the code card and reader are parallel to each other at the point where the card passes through the reader.

It is important that the reader be initially mounted as close to the ideal position as possible. This allows the position of the code card to deviate from its ideal position without affecting the reader's ability to detect the code card.

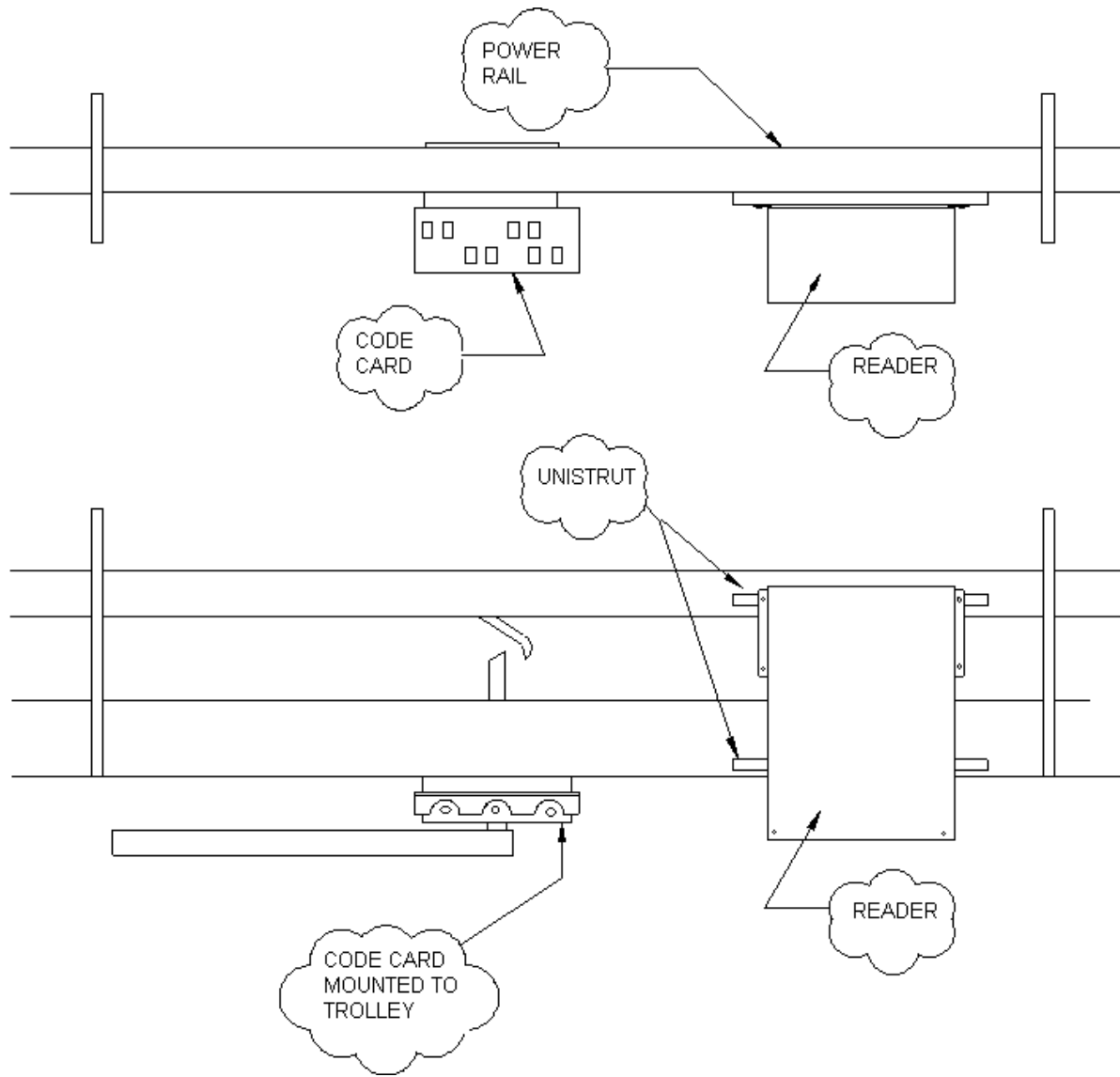
Industrial Computer recommends that the installation of the UE5100C-RS reader be checked against figure 4.3, and that the reader installer hold each dimension to within 1/8" of nominal.



**Figure 4.1 UE5100C-RS Physical Dimensions**



**Figure 4.2 Typical Mounting (View Along the Track)**



**Figure 4.3 Typical Mounting (Side and Top Views)**

## 4.1 Connection to Concentrator

Each UE5100C-RS reader must be connected to one of the 7 reader terminal strips on a UE5000C concentrator. The location of these terminal strips is shown in Figure 4.1.1. Only 1 UE5100C-RS reader can be connected to each terminal strip. Hence, up to 7 UE5100C-RS readers can be connected to a single UE5000C concentrator. If more than 7 readers are used in a system, multiple concentrators must be used.

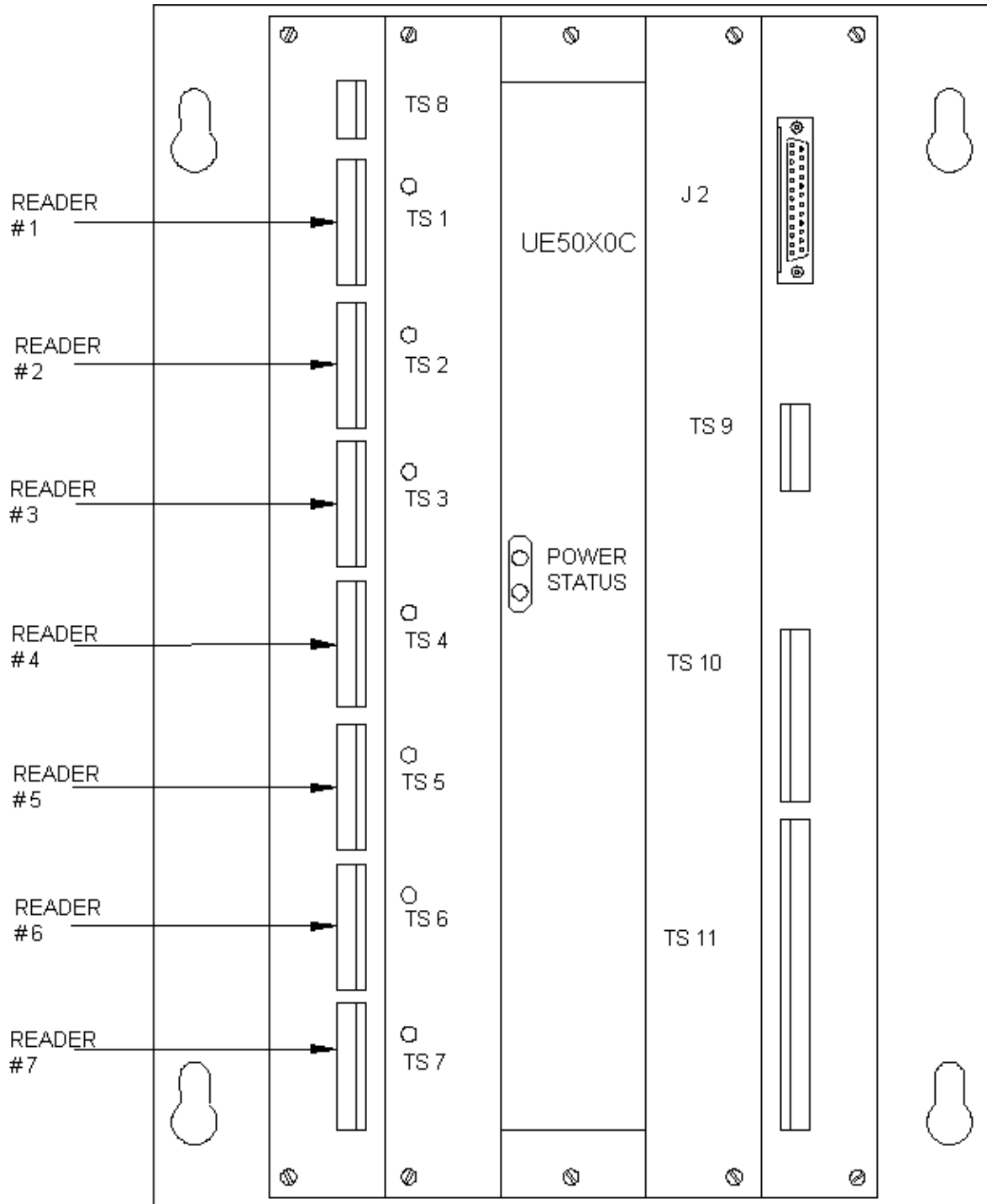
If fewer than 5 readers are connected to a concentrator, the reader must be connected sequentially starting at TS1. The UE5000C concentrator must be configured for the exact number of readers that are connected. If readers are removed from the beginning or middle of the sequence, the concentrator configuration should not be changed.

Each UE5100C-RS reader is supplied with a 6' long "pig-tail" connected to the reader through a weatherproof connector. This cable is normally connected to a UE5103A junction box and then connected to a longer cable running to the concentrator.

Wiring between the UE5100C-RS Reader / UE5103A junction box and its concentrator is accomplished using a single 3-pair shielded jacketed cable. The exact cable used depends on the distance between the reader and its concentrator. Each reader's cable requirement can be calculated separately, i.e. if some readers are located close to the concentrator they can use a different cable than readers which are located at a large distance from the concentrator.

### CAUTION

<p>Do not attempt to supply + 24v Dc power to readers using a different power supply than that used for the concentrator. Each reader must be powered through its corresponding concentrator terminal.</p>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------



**Figure 4.1.1 Location of Reader Terminals on UE5000C**



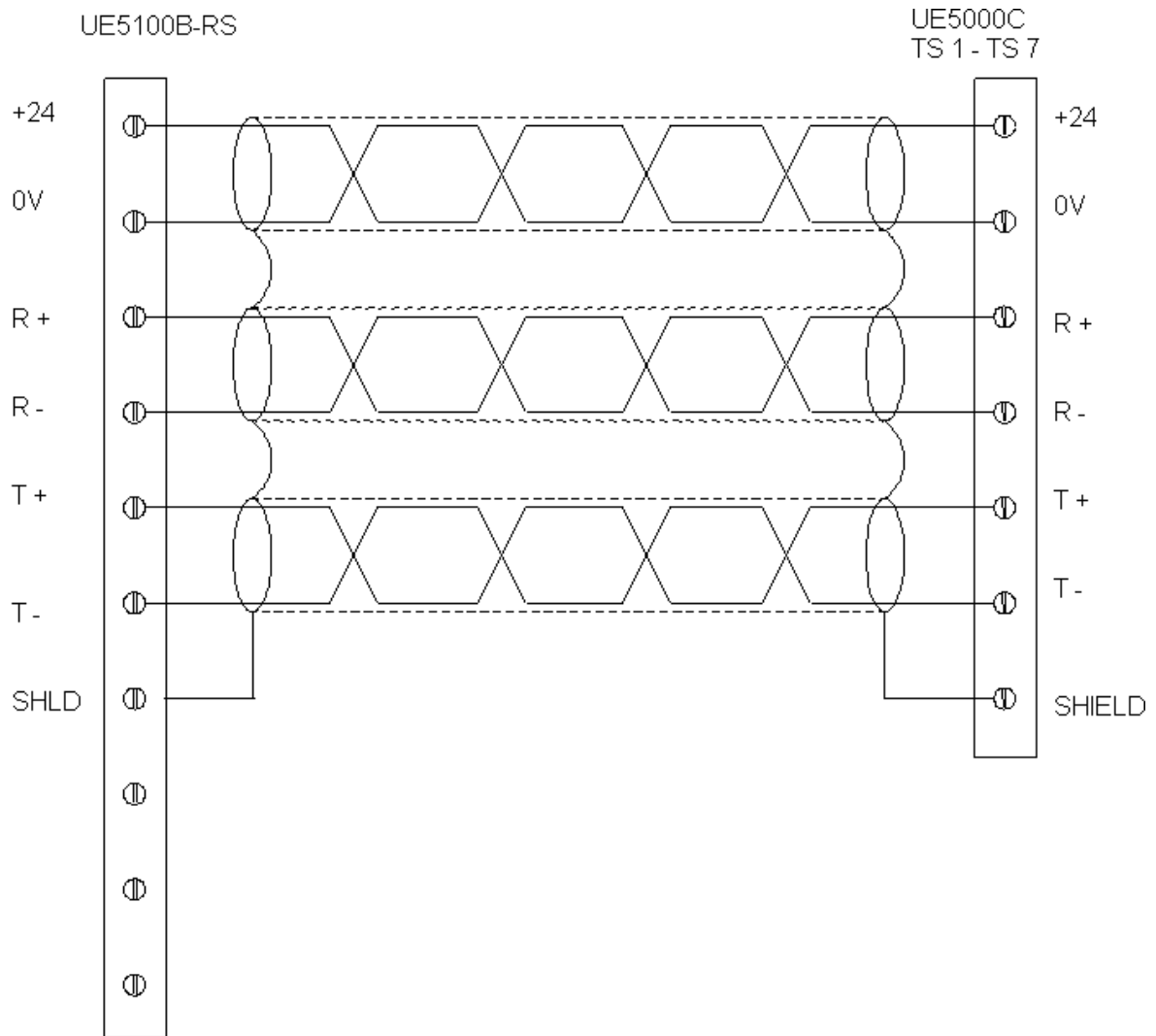
### 4.1.1 Reader Less Than 1200' From Concentrator

When a reader is less than 1200' from its concentrator, a single 3-pair cable can be used. This cable must have three twisted pairs and must be shielded from outside interference. The cable may use a single overall shield, or may use individual shields for each twisted pair. Recommended cables are listed in Table 4.4.1.1.

The recommended interconnection using a Belden #9873 or #9773 cable is shown in Figure 4.1.1.1.

<b>Distance</b>	<b>Recommended Cable</b>
0 to 750'	Belden #9873
750' to 1200'	Belden #9773

**Table 4.1.1.1 Recommended Cable for Distances Under 1200'**



**Figure 4.1.1.1 UE5100C-RS/UE5103B-RS to UE5000C Wiring**

### 4.1.2 Reader To Concentrator Wiring Without A Junction Box

Readers that are purchased without the UE5103B-RS junction box are supplied with a 6' pigtail from the reader. This pigtail is constructed using Belden #9873 cable.

If a Belden #9873 or #9773 cable is used, its wires will have a simple one to one match with the "pigtail" from the reader. The interconnection diagram using a Belden #9873 or #9773 cable is shown in Table 4.1.2.1.

<b>UE5100C-RS Cable</b>	<b>Wire to UE5000C Terminal</b>
<b>Red (red-black pair)</b>	<b>+24</b>
<b>Black (red-black pair)</b>	<b>COM</b>
<b>White (white-black pair)</b>	<b>R+</b>
<b>Black (white-black pair)</b>	<b>R-</b>
<b>Green (green-black pair)</b>	<b>T+</b>
<b>Black (green-black pair)</b>	<b>T-</b>
<b>Shields</b>	<b>SHLD</b>

**Table 4.1.2.1 – UE5100B-RS to UE5000C Wiring**

### 4.1.3 Reader Farther Than 1200' From Concentrator

When a reader is greater than 1200' from its concentrator, a single 3-pair cable cannot be used to connect the reader to its concentrator, since there is too much voltage drop in the +24 and COM leads. The simplest solution is to use a cable with additional pairs and “double up” on the +24 and COM connections.

Using a Belden #9774 (6 pair cable) allows for 4-pairs to be used for the +24 and COM connection and 1-pair each for the R and T connections. This will allow the reader to be located up to 3000' from its concentrator.

An alternative solution is to use a single Belden #9773 and “double up” on the +24 and COM connections using a separate Belden #8477. This connection will also allow up to 3000' between concentrator and reader.

#### 4.1.4 Reader To Concentrator Wiring Guidelines

Communication between the UE5100C-RS reader and the UE5000C concentrator requires the use of a jacketed shielded cable containing three or more twisted pairs. Because of the nature of the communications between the host and the UE5000C, the cable may have an overall shield or may have individually shielded pairs.

The shielded cable does not need to be installed inside of a conduit for protection; however, Table 4.1.3 lists a number of precautions and recommendations that should be followed to prevent physical or electrical damage to the communication path.

- Use a high quality cable such as Belden 9873 or 9773.
- Prevent the cable from coming into contact with abrasive surfaces, like concrete or sharp metal edges, which might cause wear of the cable jacket.
- Route the cable so it will not be tread upon by plant personnel or equipment.
- Do not exert tension on the cable at any time. Allow sufficient slack in the cable so that there is no tension on the cable or connectors when installed.
- Route the cable to avoid contact with open flames, steam or any surface hotter than 60° C.
- Route the cable to avoid grease, acids or other strong chemicals that might damage the jacket of the cable.
- Route the cable to avoid contact with water or other liquids.
- Keep the cable at least one foot away from 120-volt power lines, two feet from 240-volt lines and three feet away from lines carrying 480 volt or more.
- Do not allow the conductors of the cable, including the shield, to come in contact with any surfaces that are electrical conductors.
- Do not install the cable closer than three feet away from electrical motors, transformers, rectifiers, generators, arc welders, induction furnaces, and heaters, or sources of microwave radiation.
- If the cable is installed in a metal conduit of any kind, that conduit must be well grounded along its entire length.
- Tie the "pig tail cable" off away from the travel path of the code card and carriers.

**Table 4.1.3.1 Reader to Concentrator Wiring Guidelines**

## 4.2 Configuration

All readers shipped from Industrial Computer have been configured during manufacturing to be compatible with the UE5000C Concentrator. They do not need any further configuration.

## 5 MODEL UE5000C CONCENTRATOR INSTALLATION

The UE5000C concentrator is used to interface up to seven (7) UE5100C-RS Card Readers to a host controller. This host controller can be a programmable logic controller (PLC), a general-purpose computer, or a coprocessor card in a PLC.

The concentrator can be connected to the host using either a serial communication path or a parallel path. The serial path is normally used when the host is either a computer or a coprocessor card in a PLC. The parallel path is primarily used when interfacing to a PLC without any coprocessors.

### 5.1 Physical Installation

The UE5000C concentrator is normally mounted in a Nema enclosure along with the host computer or PLC. Hence, the concentrator is not supplied in a Nema enclosure, but instead relies on the host enclosure for its protection from the plant floor environment.

The concentrator consists of two printed circuit boards (pcb) enclosed in a protective case. The large PCB serves as a motherboard and holds the field wiring terminal strips as well as a connector into which the logic board is plugged. The motherboard is mounted on a metal back plate suitable for direct attachment to the back plate of the electronic enclosure.

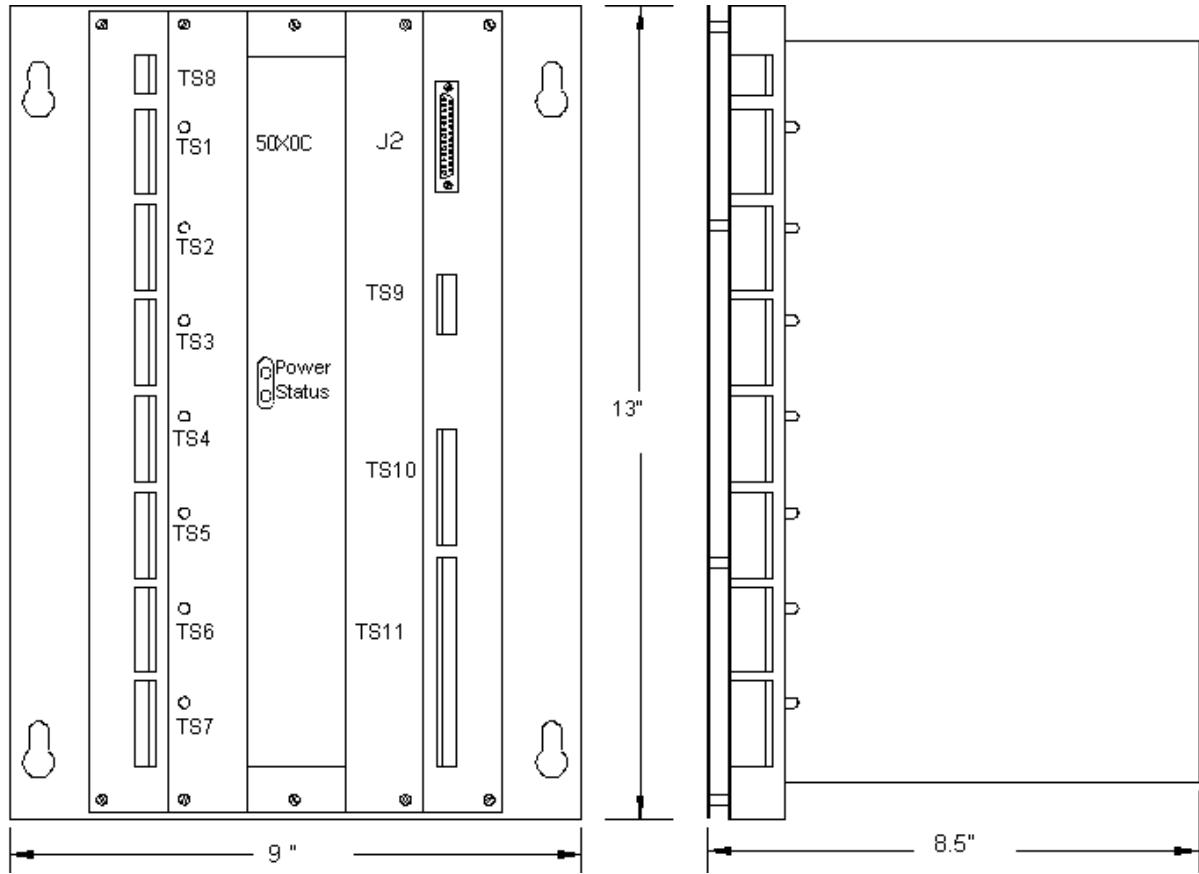
The smaller PCB is the logic board, which contains the microprocessor, and the communication interfaces. The logic board mounts perpendicular to the motherboard.

The overall dimensions of the concentrator are shown in Figure 5.1.1, while the UE5000C mounting dimensions are shown in Figure 5.1.2. The UE5000C should be mounted with both the logic board and the motherboard in the vertical position.

#### CAUTION

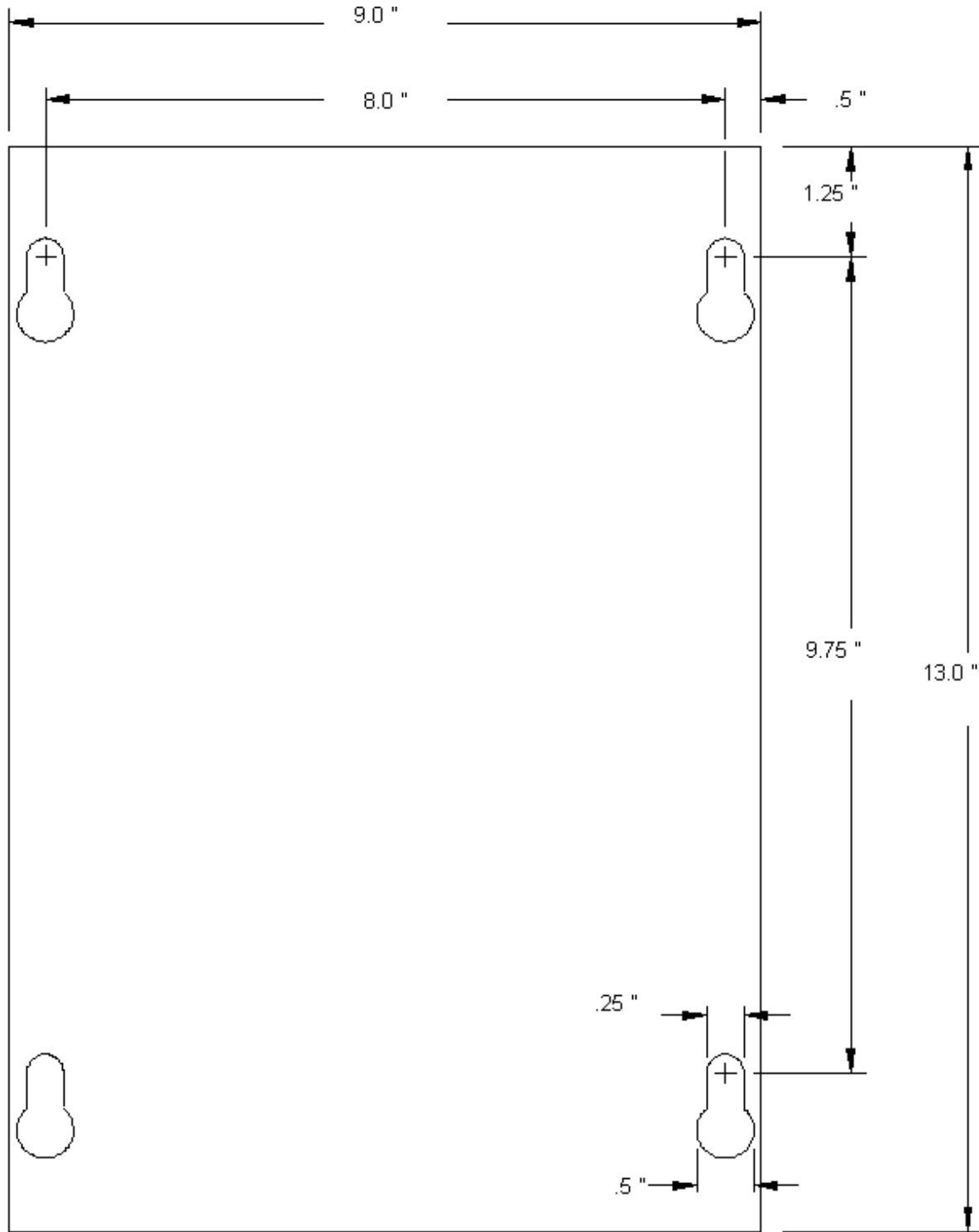
Once the concentrator has been mounted to the enclosure, care must be taken to insure that the electronic boards are protected from any metal shavings and filings. It is recommended that plastic sheets be taped over the UE5000 assembly until all other installation is completed.

Failure to prevent metal contamination will void the warranty.



**Figure 5.1.1 UE5000C Concentrator Physical Outline**





**Figure 5.1.2 UE5000C Mounting Dimensions**

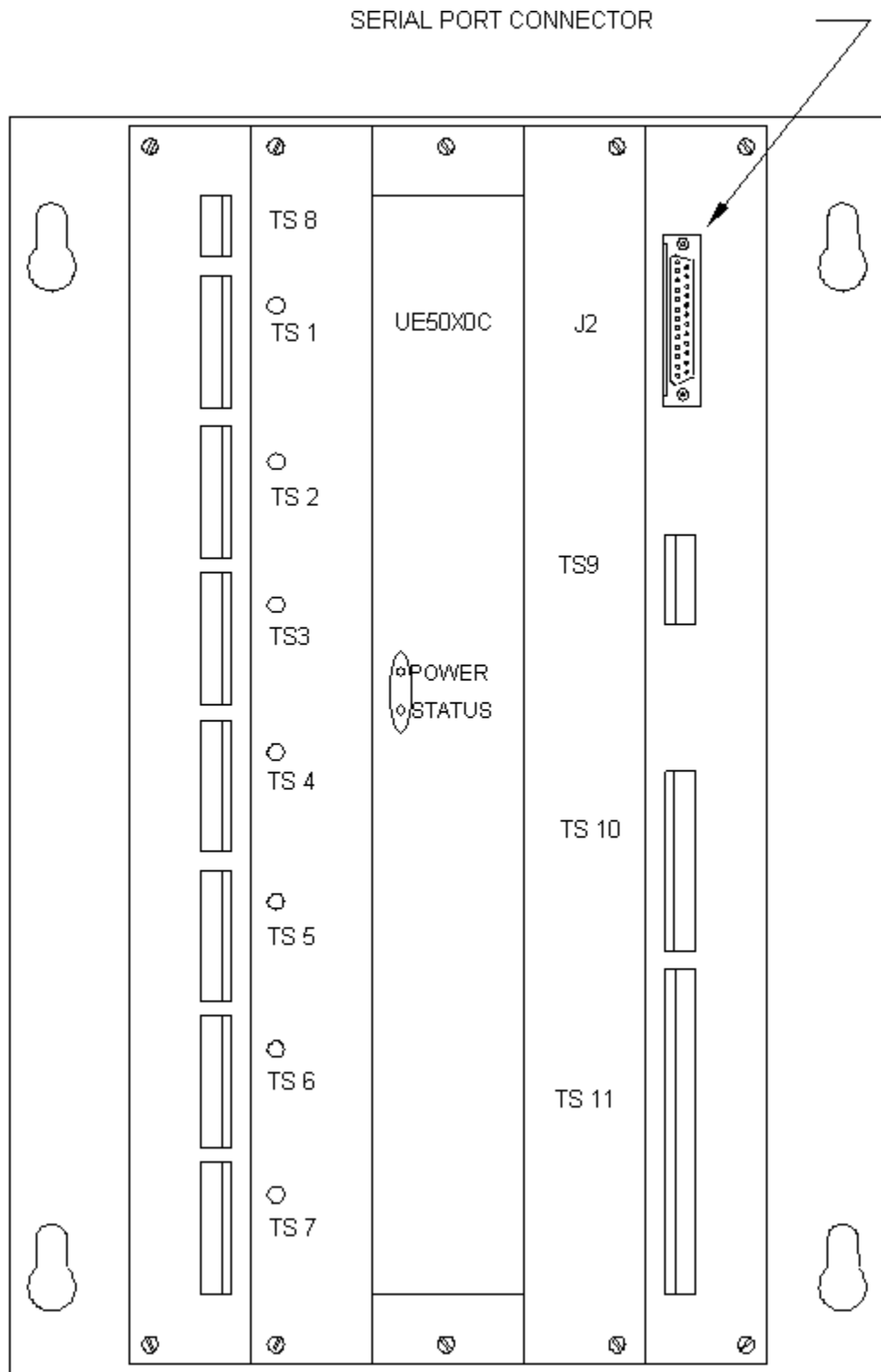
## 5.2 Serial Connection to Host

The UE5000 provides for a serial communication path to a host "computer" via RS232 or RS422 multi-drop communication channels. All connections to this serial port are made via a 25-pin male "D subminiature" connector. The location of this connector is shown on Figure 5.2.1.

In all cases, data is communicated between the UE5000 and the host using the standard "RS232 bit serial asynchronous byte oriented communication protocol". This protocol is the same as is used in the typical PLC communication card such as the Allen Bradley 1771-DA and 1771-DB, as well as the "RS232 serial communication ports" on mini and microcomputers.

### CAUTION

The 25 pin male "D" connector J2 has both RS232 and RS485 signals connected to it. Do not connect to J2 using multiple pin cables. Please insure that the cables used do not connect to pins other than those needed for the appropriate interface.



**Figure 5.2.1 – Location of the Serial Port Connector J2**

## 5.2.1 RS232 Connection

If the host is to communicate with the UE5000C using the RS232 interface, jumper strip H2 must be configured to allow RS232 communication, and a cable must be made to interface the host to J2. Figure 5.2.1.1 illustrates the requirement on this RS232 cable.

### CAUTION

In order for the RS232 communication to work, the RS232 transmitted data signal from the host must be connected to J2 pin 3 and the RS232 received data signal at the host must be connected to J2 pin 2.

<b>PIN #</b>	<b>Name</b>	<b>Description</b>
2	TXD	RS232 serial data sent from the UE5000C to the host.
3	RXD	RS232 serial data sent from the host to the UE5000C.
7	---	RS232 Signal common

**Table 5.2.1.1 - J2 Pinout for RS232 Interface**

## 5.2.2 RS422 Connection

If the host is to communicate with the UE5000C using the RS422 interface, jumper strip H2 must be configured to allow RS422 communication, and a cable must be made to interface the host to J2. Figure 5.2.2.1 lists the requirement on this RS422 cable.

Notice, in order for the RS422 connection to work, the transmitted data leads (T + and T-) from the host must be connected to the corresponding receive data leads (R + and R-) at the UE5000C. Conversely, the receive data leads (R + and R-) at the host must be connected to the corresponding transmit data leads (T + and T-) at the UE5000C. The typical RS422 wiring between host and UE5000C is shown in Figure 5.2.2.2. If the host and UE5000C do not share the same earth ground, it may be necessary to connect the two common terminals together.

At the baud rates used by the UE5000C, RS422 communication can be reliably sustained over a distance up to 4000 feet by following the wiring recommendations listed in Section 4.2.4.

### CAUTION

Some equipment manufacturers switch the sense of R+ and R-, IE, R+ is high during the "stop bit time" and R- is low during this time. The only sure way of determining this is to actually measure the voltage when no RS422 data is being sent.

Pin #	Name	Description
14	T +	RS422 Serial data sent from the UE5000C to the host. During the "stop bit time", T+ = 0v and T- = + 4v.
25	T-	
16	R +	RS422 Serial data sent from the host to the UE5000C. During the "stop bit time", R+ should be held at 0v and R- held at +4v.
18	R-	
7		RS422 Signal common

**Table 5.2.2.1 - J2 Pinout for RS422 Interface**

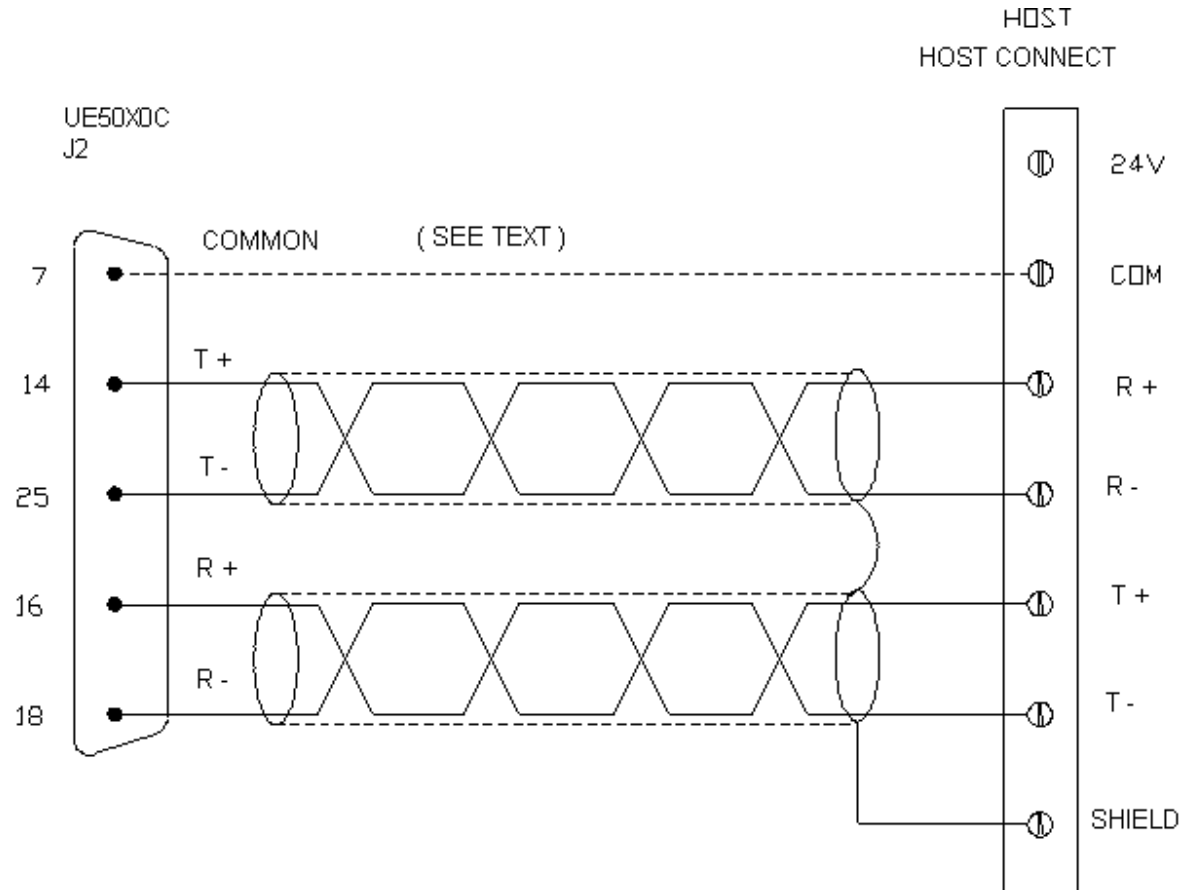


Figure 5.2.2.2 – Typical RS422 Wiring

### 5.2.3 RS422 Wiring Recommendations

RS422 communication requires the use of a jacketed shielded cable containing two twisted pairs. Because of the nature of the communications between the host and the UE5000C, the cable may have an overall shield or may have individually shielded pairs.

The shielded cable does not need to be installed inside of a conduit for protection; however, the precautions and recommendations listed in Table 5.2.5.1 should be followed to prevent physical or electrical damage to the communication path.

- Use a high quality cable such as Beldon 9829, 8102, or 9729 or the equivalent.
- Limit the total length of cable, including drops and stubs to less than 4000 feet.
- Prevent the cable from coming into contact with abrasive surfaces, like concrete or sharp metal edges, which might cause wear of the cable jacket.
- Route the cable so it will not be tread upon by plant personnel or equipment.
- Do not exert tension on the cable at any time. Allow sufficient slack in the cable so that there is no tension on the cable or connectors when installed.
- Route the cable to avoid contact with open flames, steam or any surface hotter than 60° C.
- Route the cable to avoid grease, acids or other strong chemicals that might damage the jacket of the cable.
- Route the cable to avoid contact with water or other liquids.
- Keep the cable at least one foot away from 120-volt power lines, two feet from 240-volt lines and three feet away from lines carrying 480 volt or more.
- Do not allow the conductors of the cable, including the shield, to come in contact with any surfaces that are electrical conductors.
- Do not install the cable closer than three feet away from electrical motors, transformers, rectifiers, generators, arc welders, induction furnaces, and heaters, or sources of microwave radiation.
- If the cable is installed in a metal conduit of any kind, that conduit must be well grounded along its entire length.

**Table 5.2.3.1 - RS422 Wiring Guidelines**

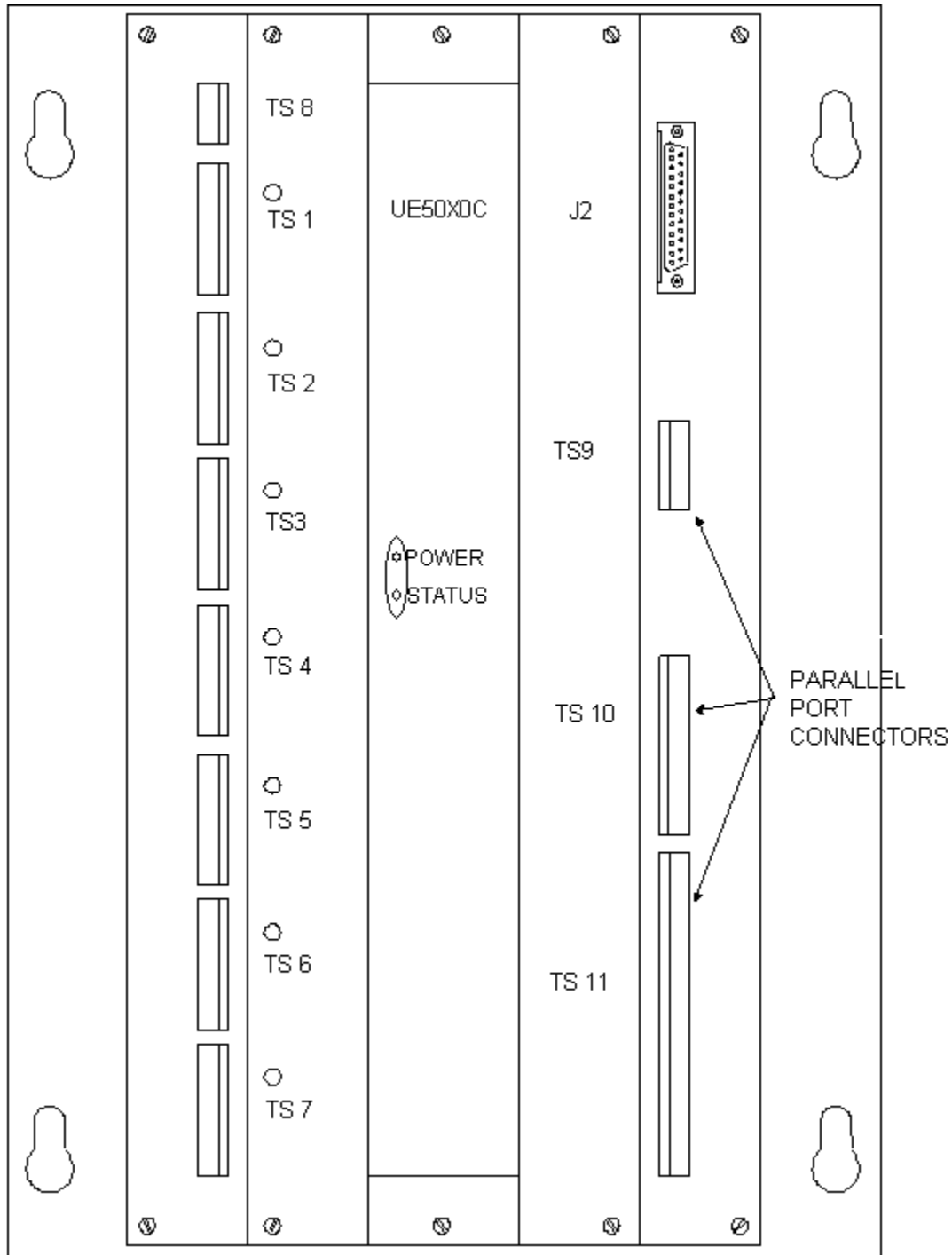
### 5.3 Parallel Connection to Host

The UE5000C provides for a parallel data communication path between the UE5000C and the host. This parallel path uses three terminal strips (TS9, TS10 and TS11) on the UE5000C. The location of these terminal strips is shown on Figure 5.3.1. The function of these terminal strips is summarized in Table 5.3.1.

<b>Strip</b>	<b>Direction</b>	<b>FUNCTION</b>
TS9	Input to UE5000C	Used by host to select the reader whose data is wanted by the host. Also used to synchronize the data transfer on TS10 and TS11.
TS10	Output to Host	Used to send reader number and status flags to the host.
TS11	Output to Host	Used to send code card value or status number to the host.

**Table 5.3.1 - Parallel Communication Terminal Functions**





**Figure 5.3.1 – Location of Parallel Port Connections**

### 5.3.1 Parallel Input Signal Levels

These are four data input terminals, A1, A2, A3, and STRB on terminal strip TS9 that are used by the host to request parallel data over TS10 and TS11. These inputs are optically isolated from the remainder of the UE5000C circuitry and are meant to be driven by a 115-vac current sourcing ac output card such as the AB1771-OA. The equivalent circuit for one of the TS9 inputs is shown in Figure 5.3.1.1.

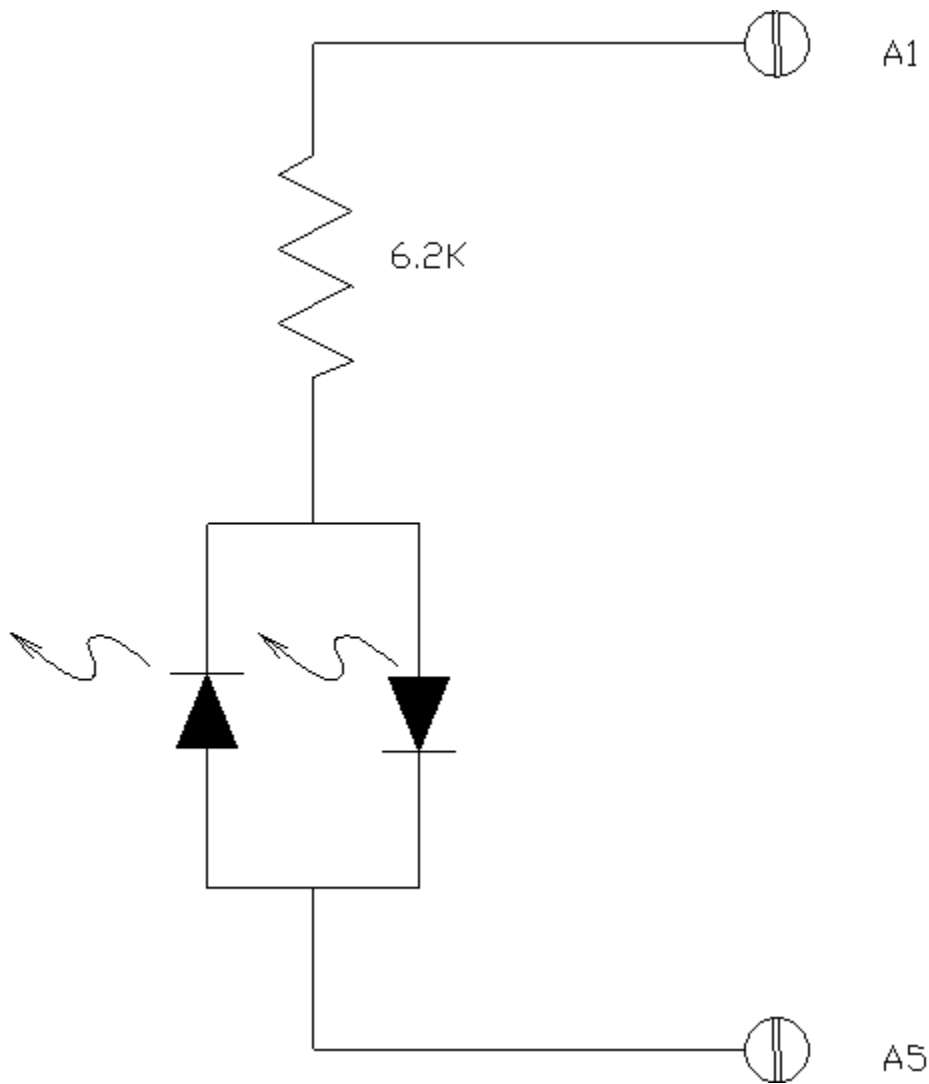


Figure 5.3.1.1 – Equivalent TS9 Input Circuit

### 5.3.2 TS9 - Parallel Data Control Inputs

The UE5000C concentrator can have up to seven UE5100C-RS readers connected to it. Using the parallel interface, the host can request the oldest code value for a particular reader or can request the oldest code value without specifying a reader number.

Table 5.3.2.1 describes the function of each of these terminals on TS9. More information regarding the use of these terminals can be found in Section 6.

Terminal	Function																																				
A1, A2, A3	Used to specify the reader whose data is desired. Applying 115vac forces the bit to be a 1. No voltage is equivalent to a 0.  A1 is the least significant bit. And A3 the most. Select the reader as follows:																																				
	<table border="1"> <thead> <tr> <th>A3</th> <th>A2</th> <th>A1</th> <th>Reader #</th> </tr> </thead> <tbody> <tr> <td>0v</td> <td>0v</td> <td>0v</td> <td>Any reader with data</td> </tr> <tr> <td>0v</td> <td>0v</td> <td>115v</td> <td>#1</td> </tr> <tr> <td>0v</td> <td>115v</td> <td>0v</td> <td>#2</td> </tr> <tr> <td>0v</td> <td>115v</td> <td>115v</td> <td>#3</td> </tr> <tr> <td>115v</td> <td>0v</td> <td>0v</td> <td>#4</td> </tr> <tr> <td>115v</td> <td>0v</td> <td>115v</td> <td>#5</td> </tr> <tr> <td>115v</td> <td>115v</td> <td>0v</td> <td>#6</td> </tr> <tr> <td>115v</td> <td>115v</td> <td>115v</td> <td>#7</td> </tr> </tbody> </table>	A3	A2	A1	Reader #	0v	0v	0v	Any reader with data	0v	0v	115v	#1	0v	115v	0v	#2	0v	115v	115v	#3	115v	0v	0v	#4	115v	0v	115v	#5	115v	115v	0v	#6	115v	115v	115v	#7
	A3	A2	A1	Reader #																																	
	0v	0v	0v	Any reader with data																																	
	0v	0v	115v	#1																																	
	0v	115v	0v	#2																																	
	0v	115v	115v	#3																																	
	115v	0v	0v	#4																																	
	115v	0v	115v	#5																																	
	115v	115v	0v	#6																																	
115v	115v	115v	#7																																		
STRB	Used to synchronize the data transfer on TS10 and TS11																																				
LINE	Connect to the AC common line.																																				

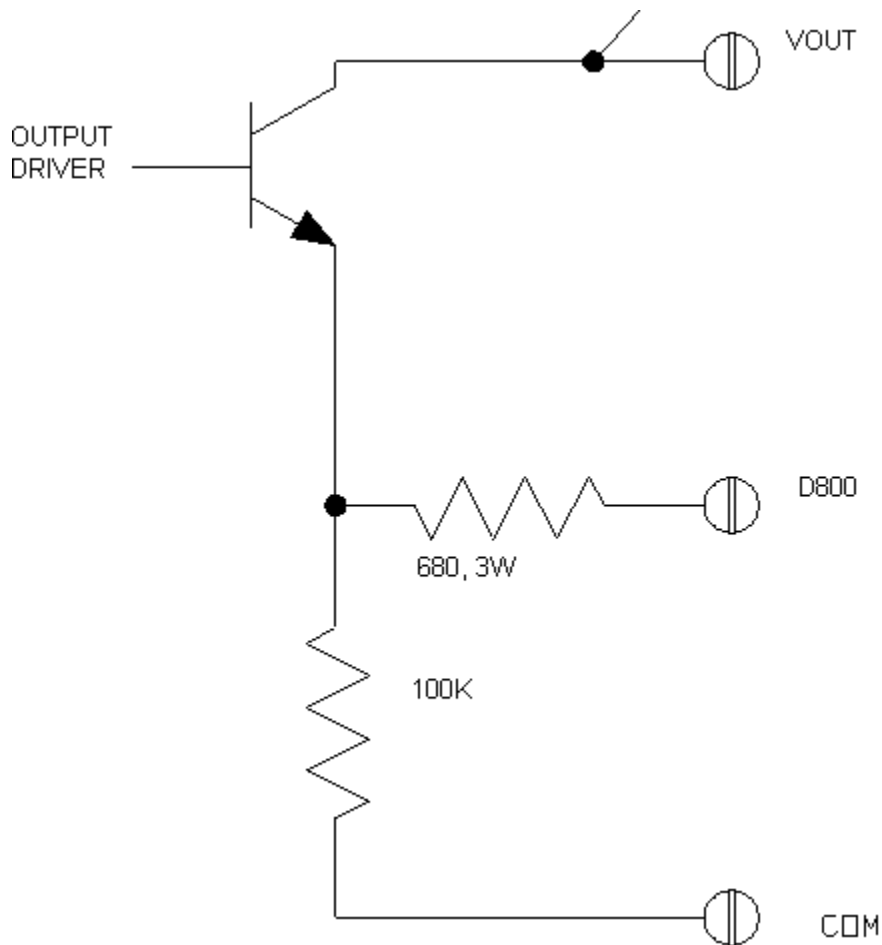
**Table 5.3.2.1 - TS9 Terminal Functions**

### 5.3.3 Parallel Output Signal Levels

There are twenty-four (24) dc output signal terminals spread out over TS10 and TS11. These dc outputs are current sourcing outputs and are designed to interface to high-level true DC input modules such as the AB1771-IBD. The DC power supply input terminal (VOUT) must be connected to the appropriate DC Voltage source: 12-vdc to 48-vdc.

Since the output of these drivers is either an open circuit or a high level dc voltage, several of these dc output circuits can be “wire OR’d” together to allow multiple dc outputs to be connected to a single dc input module.

The equivalent circuit of these outputs is shown in Figure 5.3.3.1. The series 680-ohm resistor protects the dc output drivers against a direct short to COM.



**Figure 5.3.3.1 – Equivalent DC Output Circuitry**

### 5.3.4 TS10 Functions

TS10 is a 12 position terminal strip over which the reader number and various status bits are passed to the host system. The driver voltage for TS11 is obtained from the VOUT terminal of TS10. The data output from TS10 is synchronized with the A4 strobe bit. The data on TS10 is valid only so long as A4 is stable. There is approximately a 40ms delay between the time that the A4 input is stable before the TS10 outputs are stable.

Table 5.3.4.1 describes the function of the various signals found on TS10.

Terminal	Function
+24v	A direct connection to the + 24v power input at TS8.
VOUT	An input supplying + dc power to the output drivers. Normally connected to the + 24v terminal by the user. An external supply in the range of 12vdc to 50vdc can also be connected between here and the COM terminal.
COM	One of several dc common terminals, directly connected to the COM terminal at TS8
MAN	Output is true if the data on the parallel interface came from a manual entry station, false if the data was read from a code card. Normally not used, retained for compatibility with early UE5000A concentrators.
MAR	Output is true if the operating margins at the selected reader have dropped below the 50% mark, false if the operating margins exceed 50%.
STS	Output is true if the data on the parallel interface is a status number, false if the data is a code card value from either a reader or a manual entry station.
DIR	Output is true if the code card entered the reader from right to left, false otherwise.
C3,C2,C1,CO	The 4-bit card reader number whose data or status value is on the parallel interface. The reader number is a binary number with C3 being the most significant and CO the least significant bit.

**Table 5.3.4.1 - TSIO Terminal Definitions**

### 5.3.5 TS11 Functions

TS11 is an 18 position terminal strip over which the code card value or status number is passed to the host system. The driver voltage for TS11 is obtained from the VOUT terminal of TS10. The data output from TS11 is synchronized with the A4 strobe bit. The data on TS11 is valid only so long as A4 is stable.

The actual data format on TS11 can be either BCD or Binary depending upon the parallel data configuration switch SW1-7. The labeling on TS11 assumes that BCD will be used for the parallel interface.

Table 5.3.5.1 describes the function of the various signals found on TS11 for both BCD and Binary format.

<b>Terminal</b>	<b>BCD Function</b>	<b>Binary Function</b>
D8000	8000 bit	Not used
D4000	4000 bit	Not used
D2000	2000 bit	8,192 bit
D1000	1000 bit	4,096 bit
D800	800 bit	2,048 bit
D400	400 bit	1,024 bit
D200	200 bit	512 bit
D100	100 bit	256 bit
COM	One of several dc common terminals	
D80	80 bit	128 bit
D40	40 bit	64 bit
D20	20 bit	32 bit
D10	10 bit	16 bit
D8	8 bit	8 bit
D4	4 bit	4 bit
D2	2 bit	2 bit
D1	1 bit	1 bit
COM	One of several dc Common terminals	

**Figure 5.3.5.1 - TS11 Terminal Definitions**

### 5.3.6 Parallel Interface Configuration Guidelines

There are many variables to be considered, (number of code cards, number of concentrators, and the number of readers per concentrator) in determining the actual wiring diagram to be used for a parallel interface between the UE5000C and a PLC. Most systems do not use all of the 24 outputs contained on TS10 and TS11. In addition, many systems do not use all of the TS9 address inputs.

For example, if only 270 code cards are going to be used in the system, then only enough data leads are required to specify a number between 1 and 270. In this case, if BCD format is used, only leads D 1 to D200 will need to be wired to the host.

The absence of manual entry stations will eliminate the need to connect the MAN lead to the host, since this signal will always be false.

Likewise, the C3 card reader bit need not be wired if expansion UE5000Cs are not used since it corresponds to reader numbers greater than 8. On a normal UE5000C system, this signal is always false.

If anti backup devices are used, then the code cards can only pass through the readers in one direction, and therefore, the DIR signal lead can be ignored.

In the sections that follow, the wiring diagram for several representative systems will be developed. Using these examples, their wiring diagrams can be expanded or contracted to implement larger or smaller systems.

### 5.3.7 Wiring for a System with a Single UE5000C

Figure 5.3.7.1 shows the parallel wiring connections between a single UE5000C and an AB type PLC. Table 5.3.7.1 list the assumptions used in developing this wiring diagram.

<b>Assumption</b>	<b>Effect</b>
Maximum number of code cards is 270.	Limits number of data leads needed to D 1 .. D200
Host will always ask for data from a specific reader	Outputs C0.. C3 are not needed since the reader number is already known. Inputs A1, A2, & A3 are needed to select the reader. STRB is always used as the strobe.
Cards can back up thru reader	DIR bit is required.
No manual entry stations are in system	MAN bit is not needed.

**Table 5.3.7.1 - Assumptions Used in Design**

Notice that the STS bit is always needed for any system in order for the PLC to distinguish between code values and status values. Although the MAR (Margin low/ok) is not required, most systems input this signal as an indication of reader condition.

Figure 5.3.7.2 shows the PLC I/O assignments used for this example.



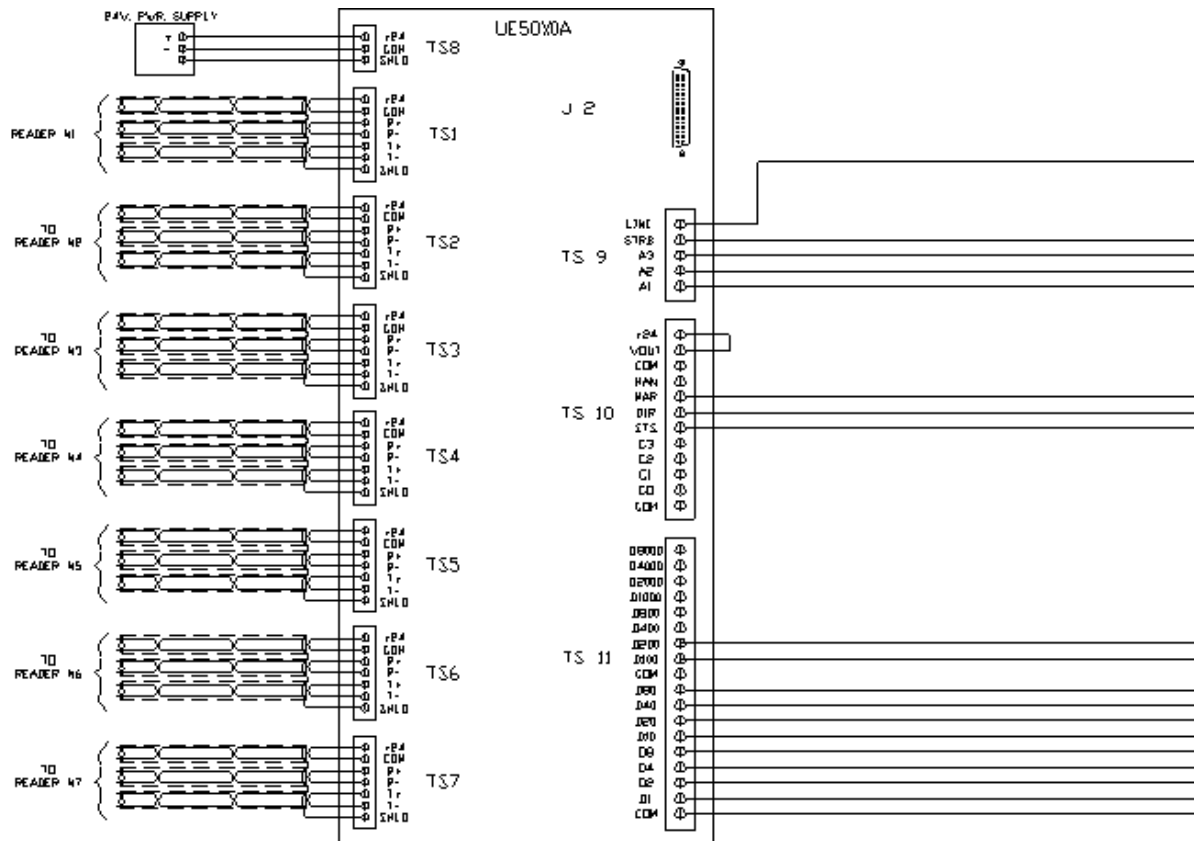
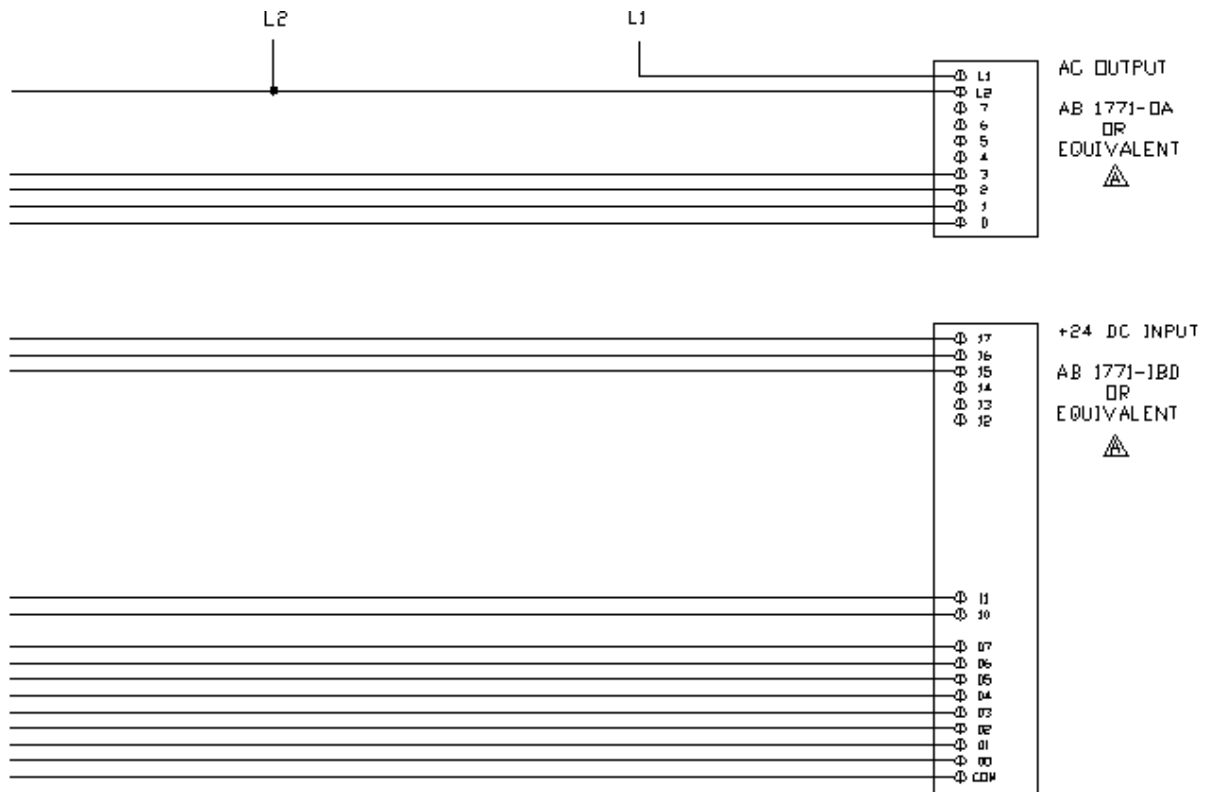
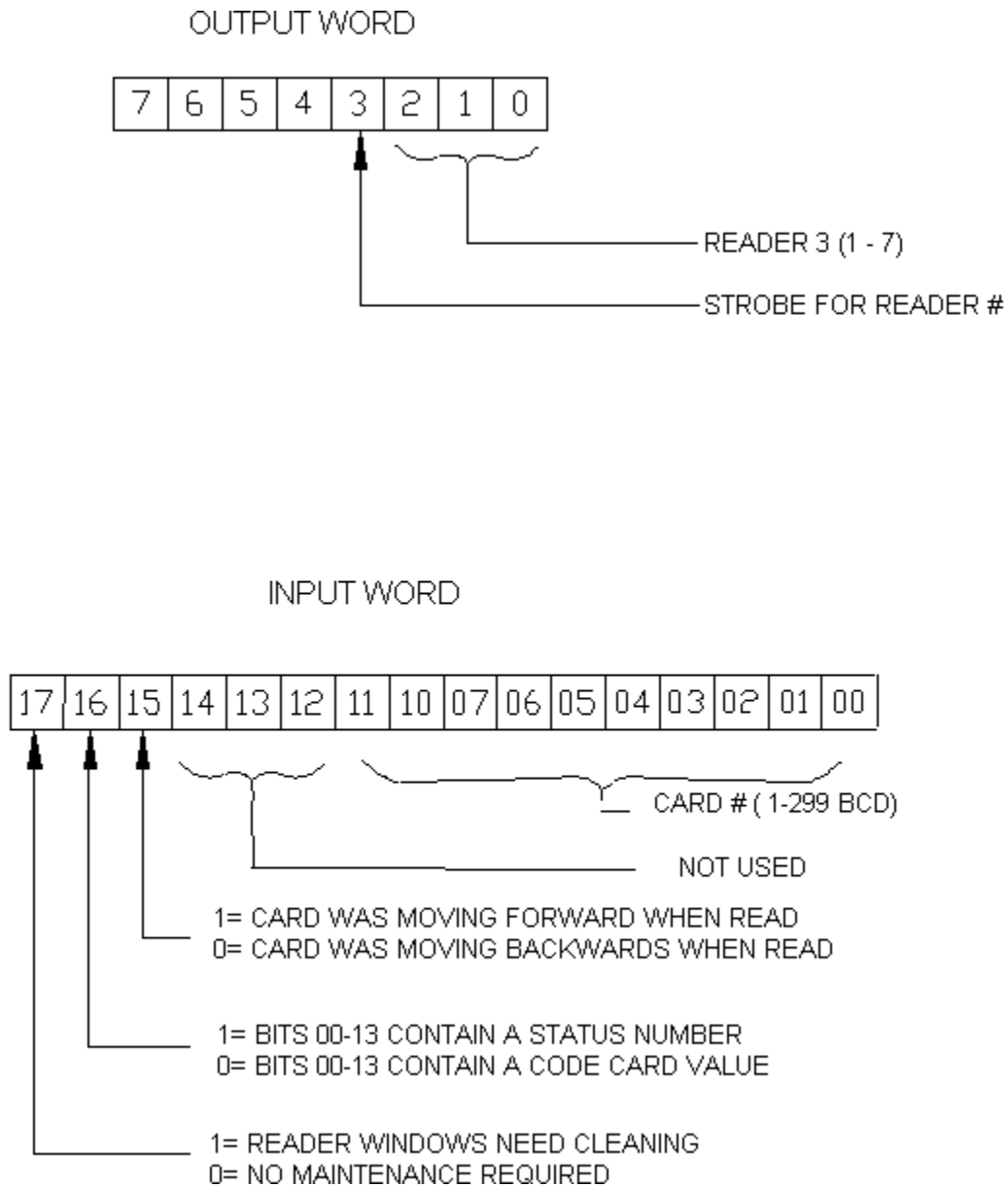


Figure 5.3.7.1 – Single UE5000 A Wiring Diagram



**Figure 5.3.7.1 – Single UE5000 A Wiring Diagram**



**Figure 5.3.7.2 – PLC I/O Assignments for Single UE5000C System**

### 5.3.8 Wiring for Two Multiplexed UE5000Cs

Figure 5.3.8.1 shows the parallel wiring connections between two UE5000Cs and an AB type PLC. Table 5.3.8.1 lists the assumptions used in developing this wiring diagram.

Figure 5.3.8.2 shows the PLC I/O assignments for this system. Because of crowding in Figure 5.3.8.1, Figures 5.3.8.3 through 5.3.8.5 show the wiring details for terminals TS9, TS10 and TS11 respectively.

Assumption	Effect
Maximum number of code cards is 470, and Binary is used.	Limits number of data leads needed to D 1 .. D 100 since binary is used.
Host will ask for data from any reader	Outputs CO.. C3 are needed since the reader number is not known. Inputs A1, A2 and A3 are not needed since they are always OFF to select data from any reader
Cards cannot back up thru reader	DIR bit is not required.
No manual entry stations are in system	MAN bit is not needed.

**Table 5.3.8.1 - Assumptions Used in Design**

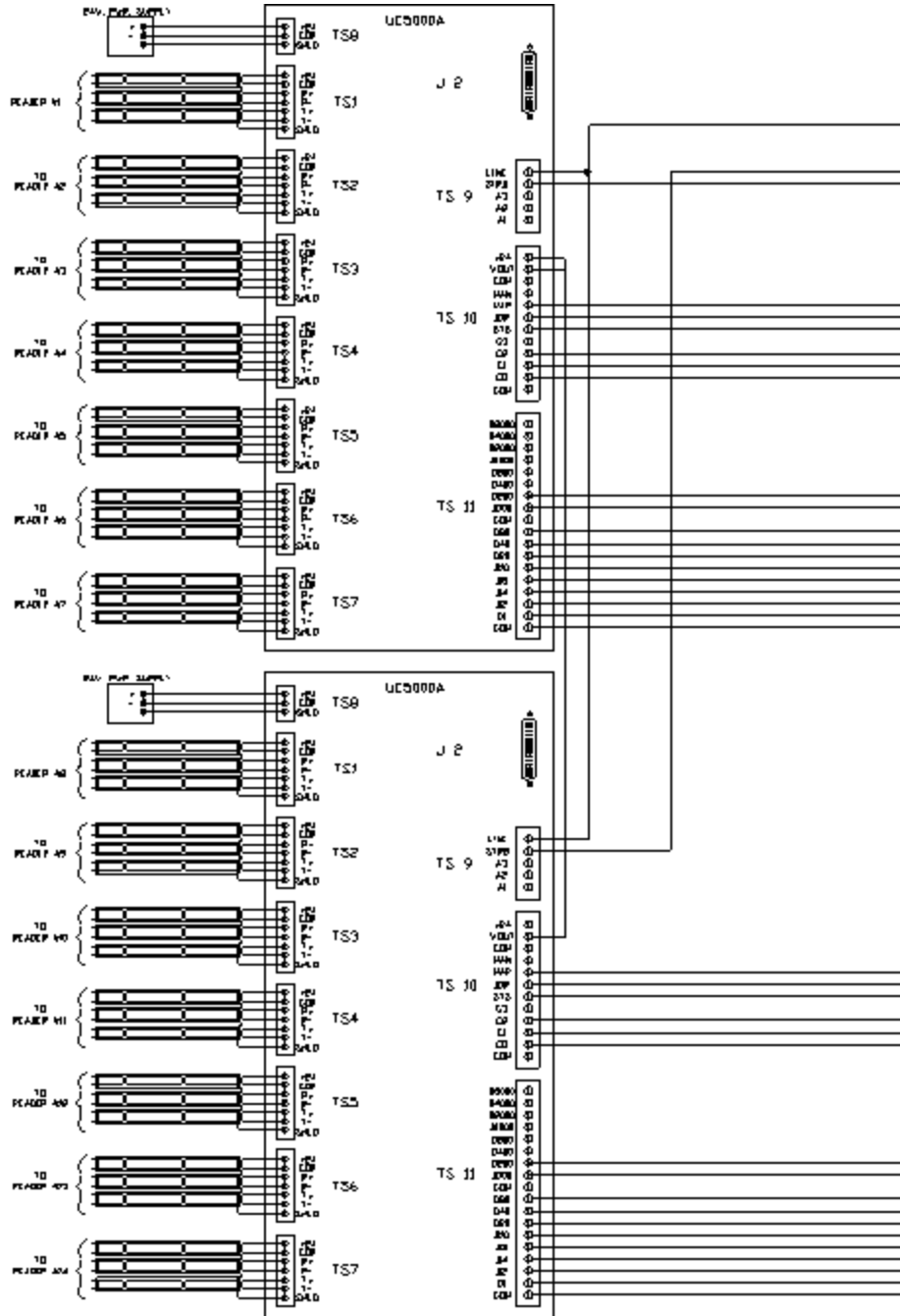
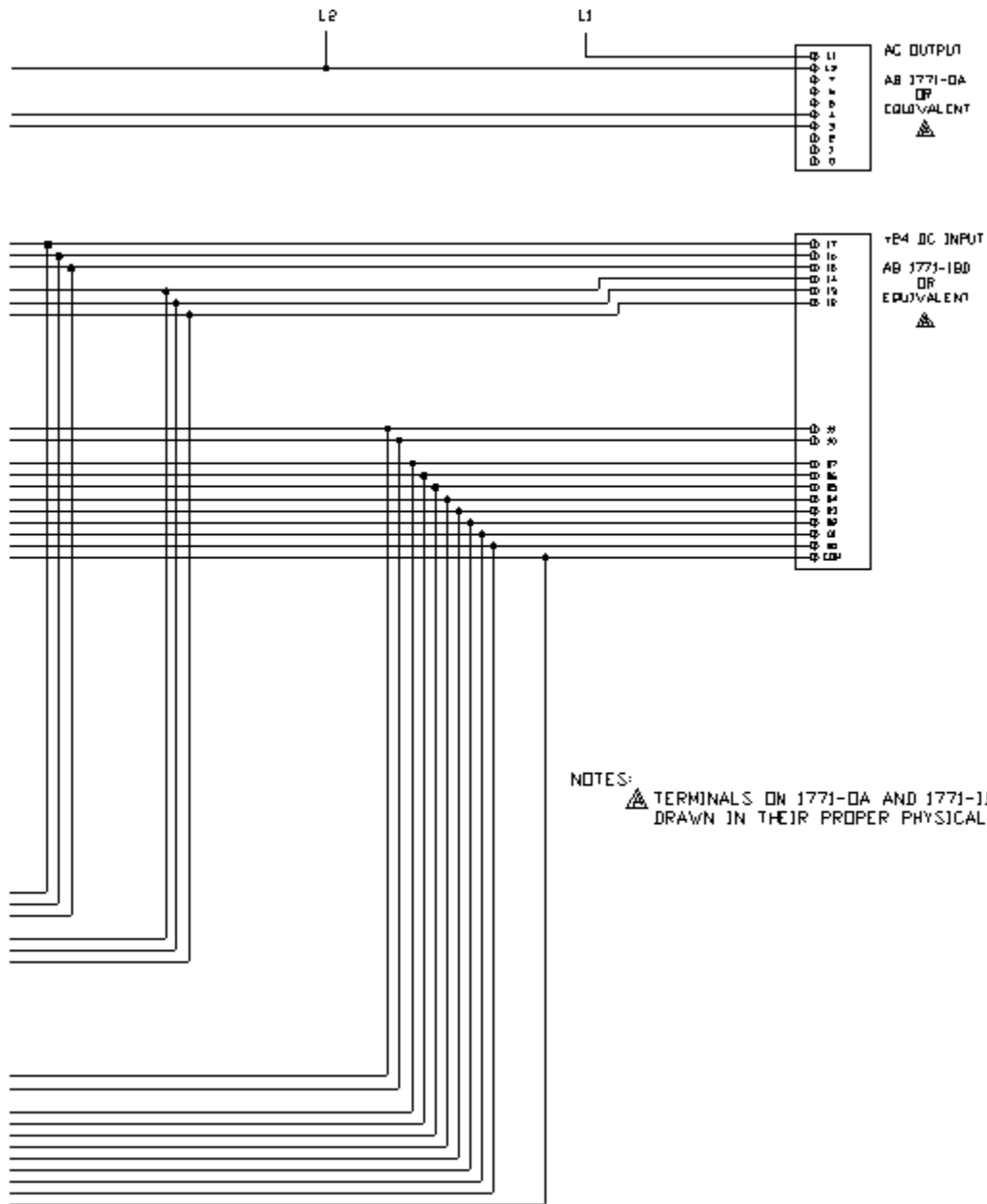
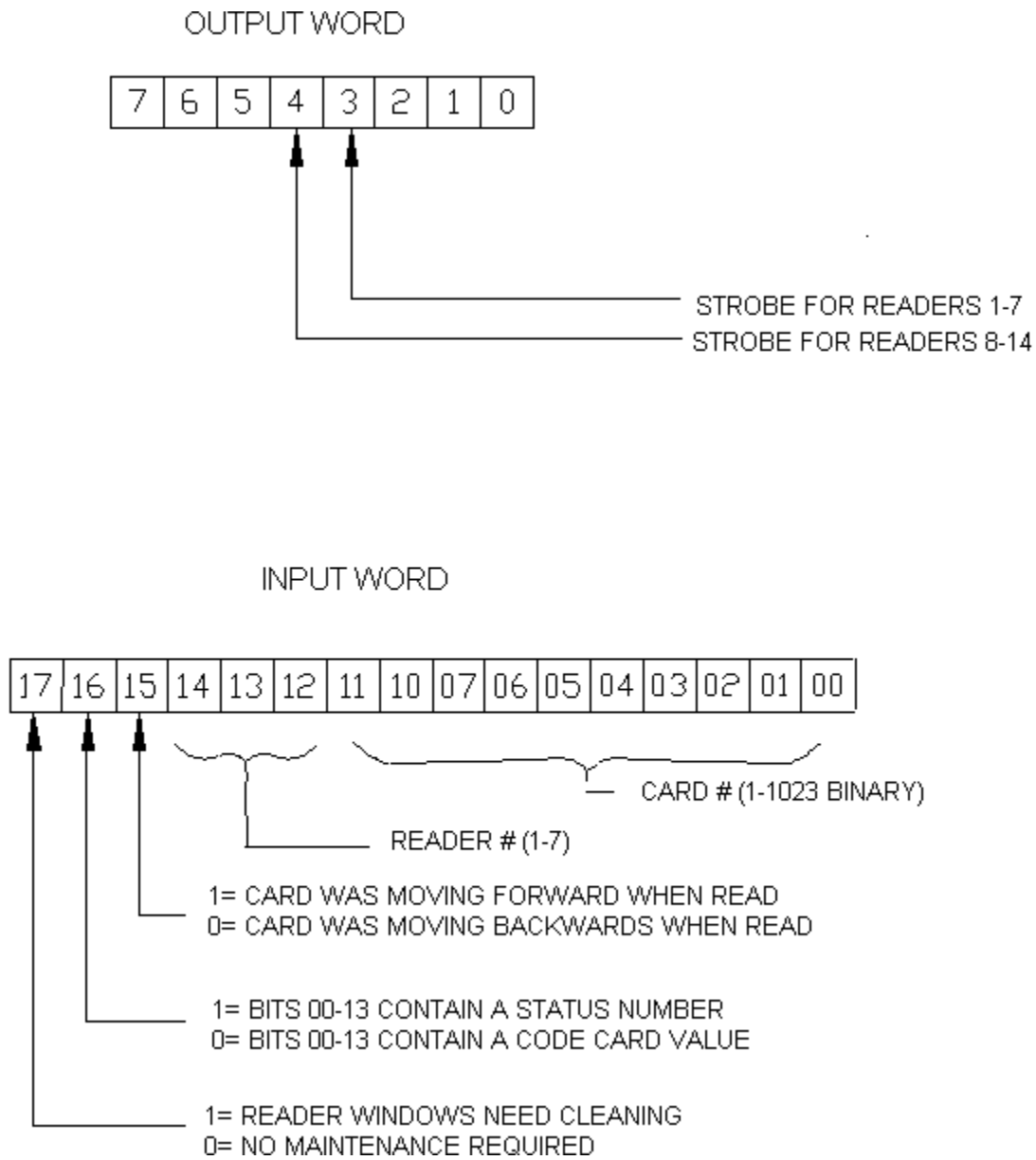


Figure 5.3.8.1 - Dual UE5000C Wiring Diagram



**Figure 5.3.8.1 - Dual UE5000C Wiring Diagram**



**Figure 5.3.8.2 – PLC I/O Assignment for Dual UE5000C System**

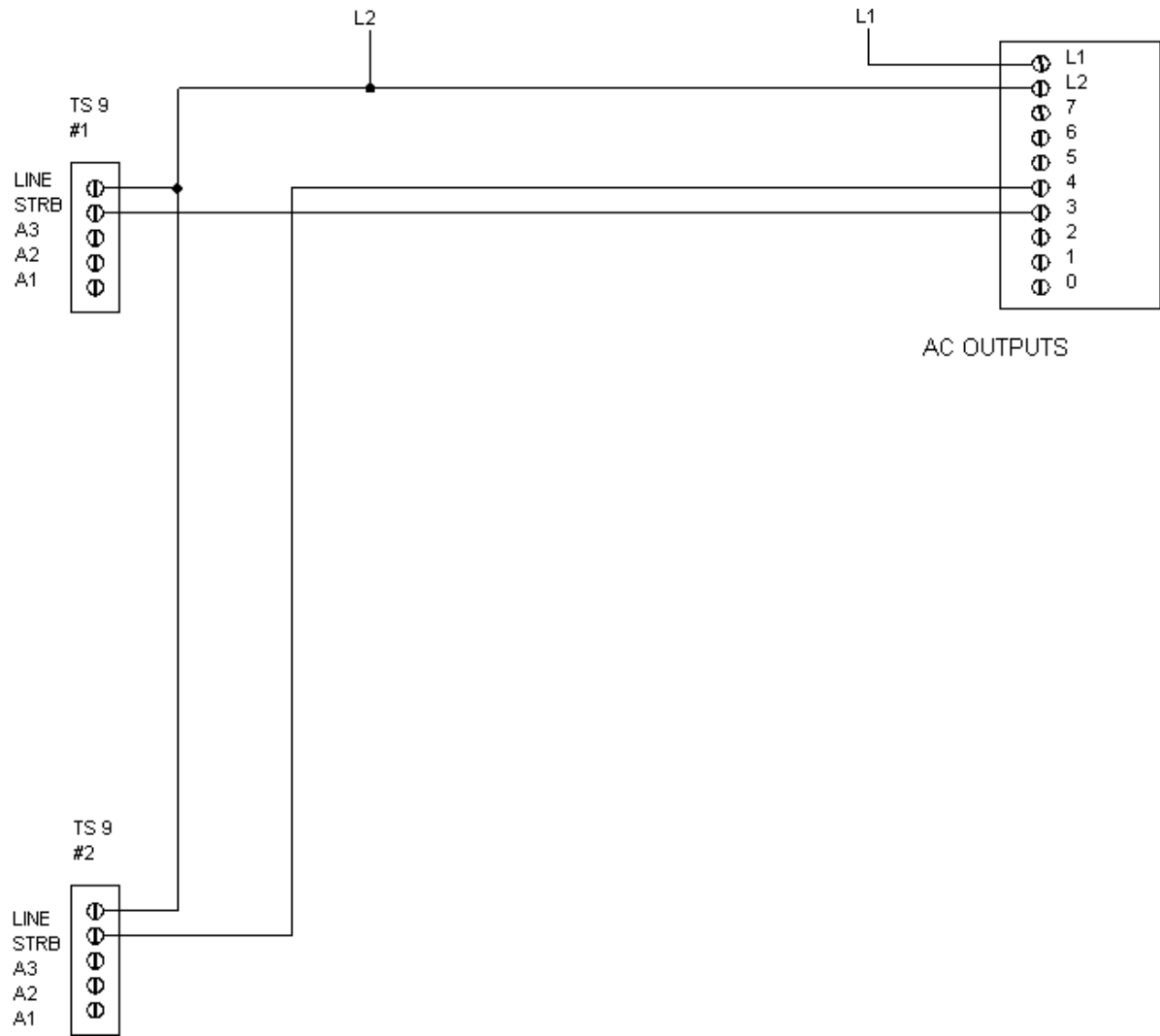


Figure 5.3.8.3 – TS9 Wiring Details for Dual UE5000C System



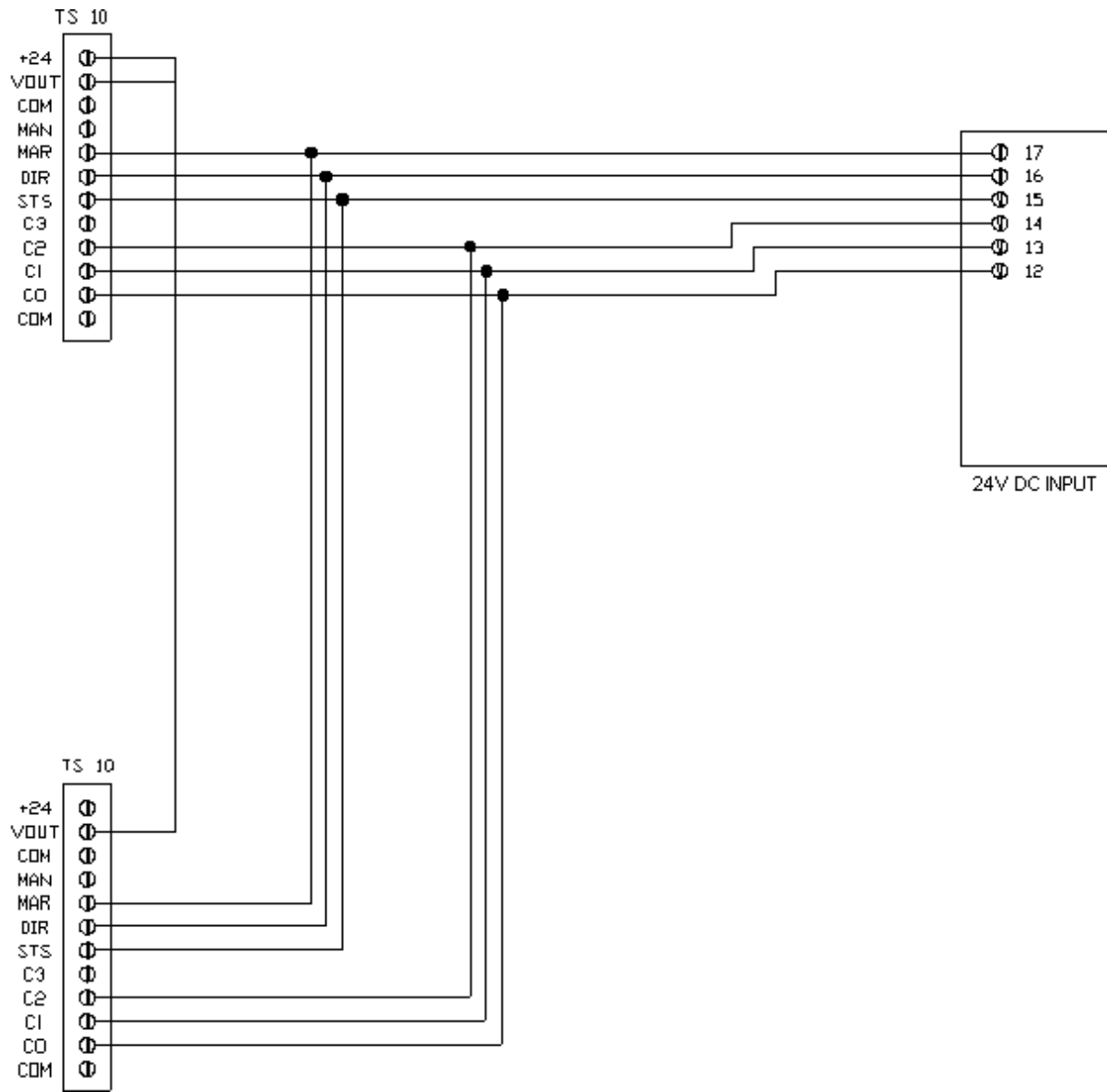
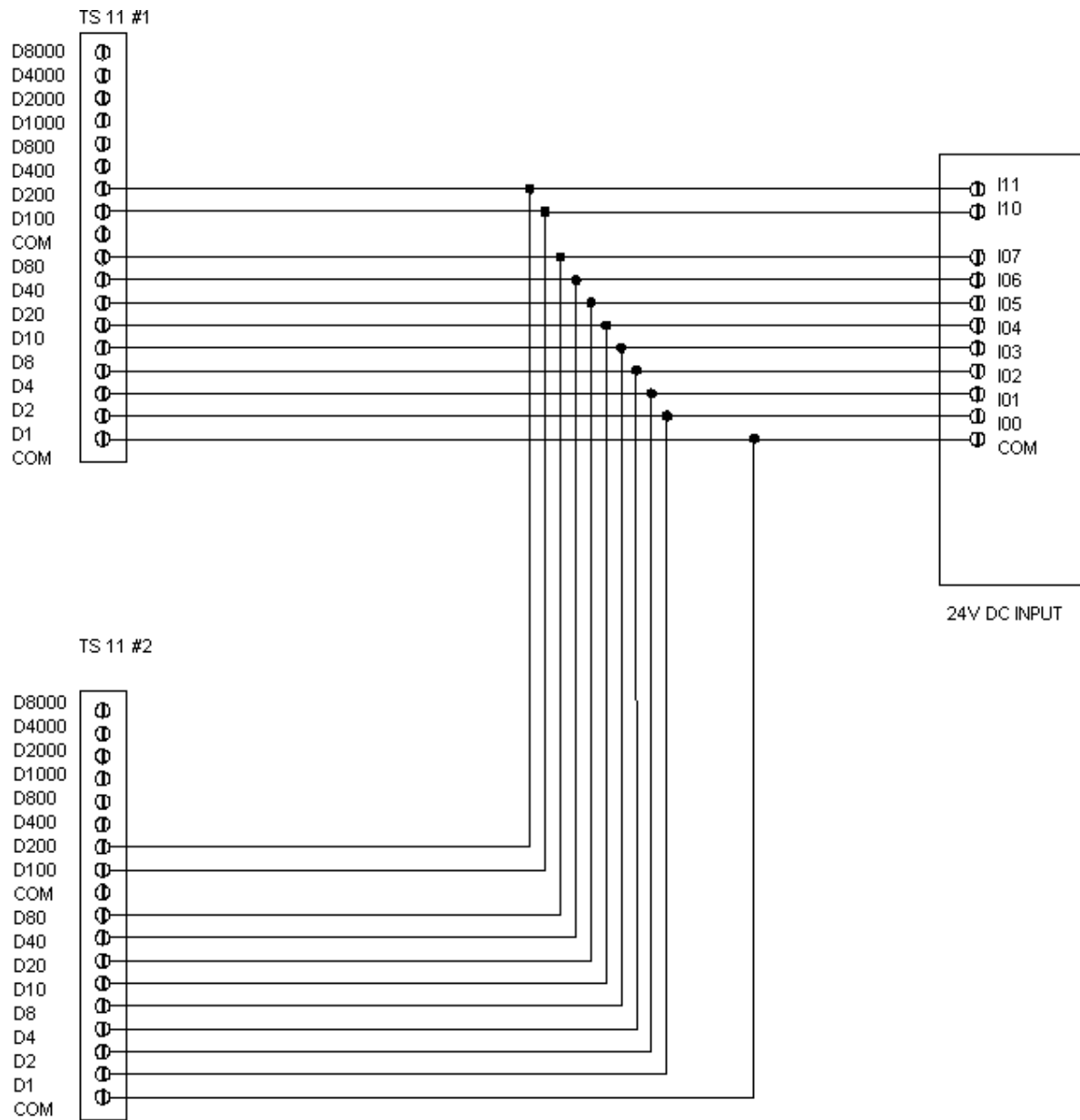


Figure 5.3.8.4 – TS10 Wiring Details for Dual UE5000C System



**Figure 5.3.8.5 – TS11 Wiring Details for Dual UE5000C System**

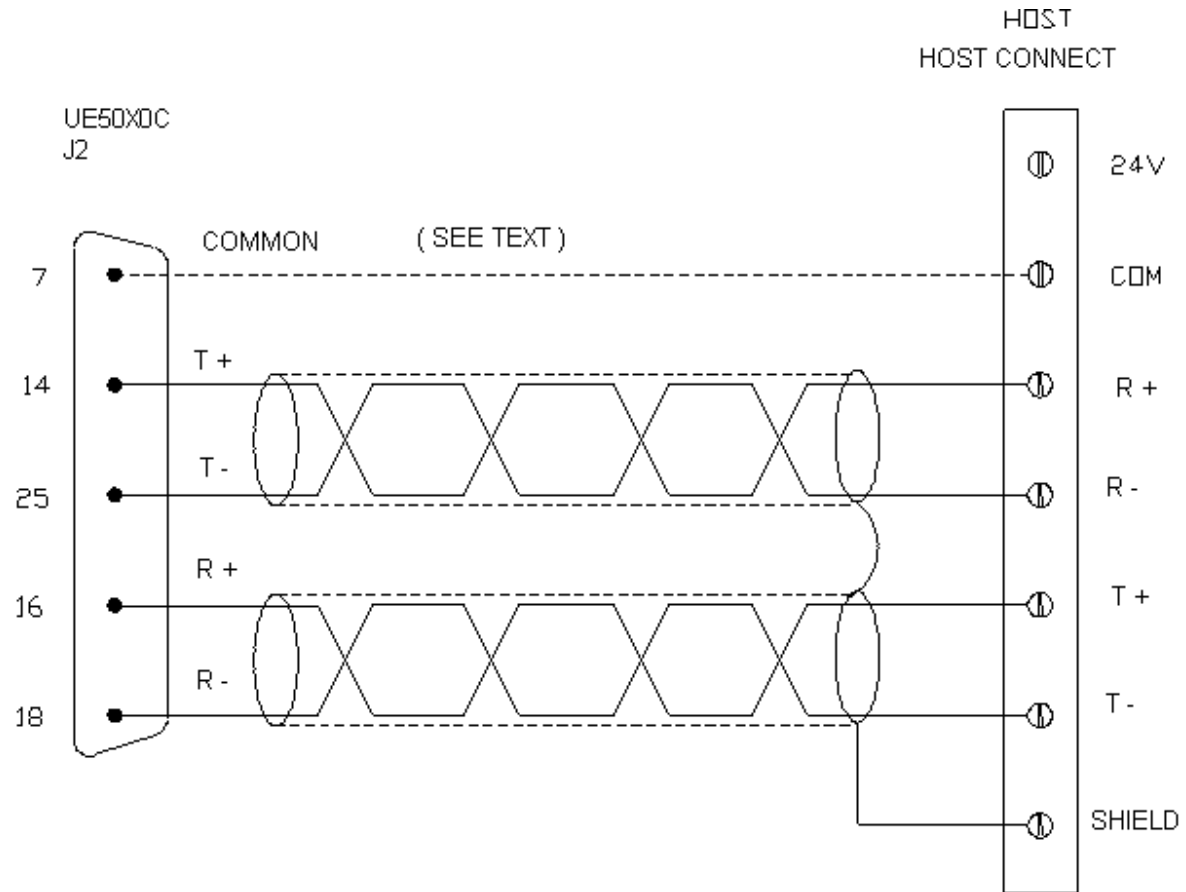
## 5.4 Connecting Expansion UE5000Cs

The UE5000C Concentrator can have up to seven UE5100C-RS readers connected to terminal strips TS1 through TS7. If less than 6 readers are connected, then another UE5000C can be connected to the next unused terminal strip to provide for additional readers. When a system is expanded this way, data from the expansion readers (readers 7 through 15) is automatically transferred from the slave UE5000C and stored in the master UE5000C for rapid access by the host system.

The connection from the expansion UE5000C uses the RS422 interface signals on J2. These signals are then cabled to the appropriate reader terminal strips (TS1 - TS7) on the host UE5000C.

Shielded twisted pair cable must be used for their connections as shown in Figure 5.4.1. Depending upon the distance between the UE5000Cs and any common ground connection, the COM connection may or may not be required.

It is permissible to use the same cable as used for the connection of readers and concentrators. Any used wires should be tied to the shield terminal.



**Figure 5.4.1 Expansion UE5000C Wiring**

## 5.5 Configuration

Once the UE5000C has been physically mounted and connected to the readers and host system, the UE5000C must be configured before it can communicate with the host system. To assist you in performing this configuration, a configuration worksheet is provided in Table 5.5.1. Please fill out this worksheet for your system before attempting the configuration process.

Configuration consists of properly setting two PCB mounted switches on the logic board, and moving some jumper plugs, also on the logic board. To gain access to the logic board switches and jumpers, two 6-32 screws must be removed to release the UE5000C logic board cover. See Figure 5.5.1 for the location of these screws and Figure 5.5.2 for the locations of the switches and jumpers on the logic board.

The two switches, SW1 and SW2 have multiple poles on them. Each pole has its own toggle lever; the first pole on SW1 is referenced as SW1-1 in the text. Likewise, the first pole of SW2 is referenced as SW2-1. Subsequent poles are labeled SW1-2, SW1-3, etc.

For each switch, the appropriate switch lever must be placed in either the ON or OFF position. Use the tip of a pencil or other small diameter device to change the switch settings if required. If the configuration shows that the switch lever must be in the OFF position, depress the side of the lever that is closest to the OFF side of the switch. Conversely, if the switch lever is to be in the ON position, depress the side of the lever closest to the numbers side of the switch. See Figure 5.5.3 for an illustration of the switch settings. When making a switch setting, please make sure that the switch lever has been pushed completely into one state or the other.

STEP	
1.	Select Operating Mode form Table 5.5.1.2.1
2.	Select Host Connection (Select 1 only): A Parallel Interface B RS232 Serial Interface C RS422 Serial Interface
3.	If B, or C was picked, select communication protocol (select 1 from each line D-F): D Baud Rate: 1200, 4800,9600, or 19,200 E Parity: None, Even, Odd F # of data bits: 7 & 8
4.	Specify Data Save option: (select G or H) G Discard old data at power turn on H Retain data during power outage
5.	If A was chosen, select parallel data format: I BCD or Binary
6.	How many readers are connected to the UE5000C? J 1,2,3,4,5,6,7
7.	If less than 7 readers are connected, specify the expansion port. K No Expansion L UE5000C or UE5102A used for expansion
8.	If this UE5000C is used to expand another UE5000C, what are the addresses of the readers connected to the UE5000C? M 7 – 13 N 13 – 15
9.	Specify reader data storage (select O or P). O Store last 10 values in FIFO P Store only the last value

**Table 5.5.1 Configuration Worksheet**

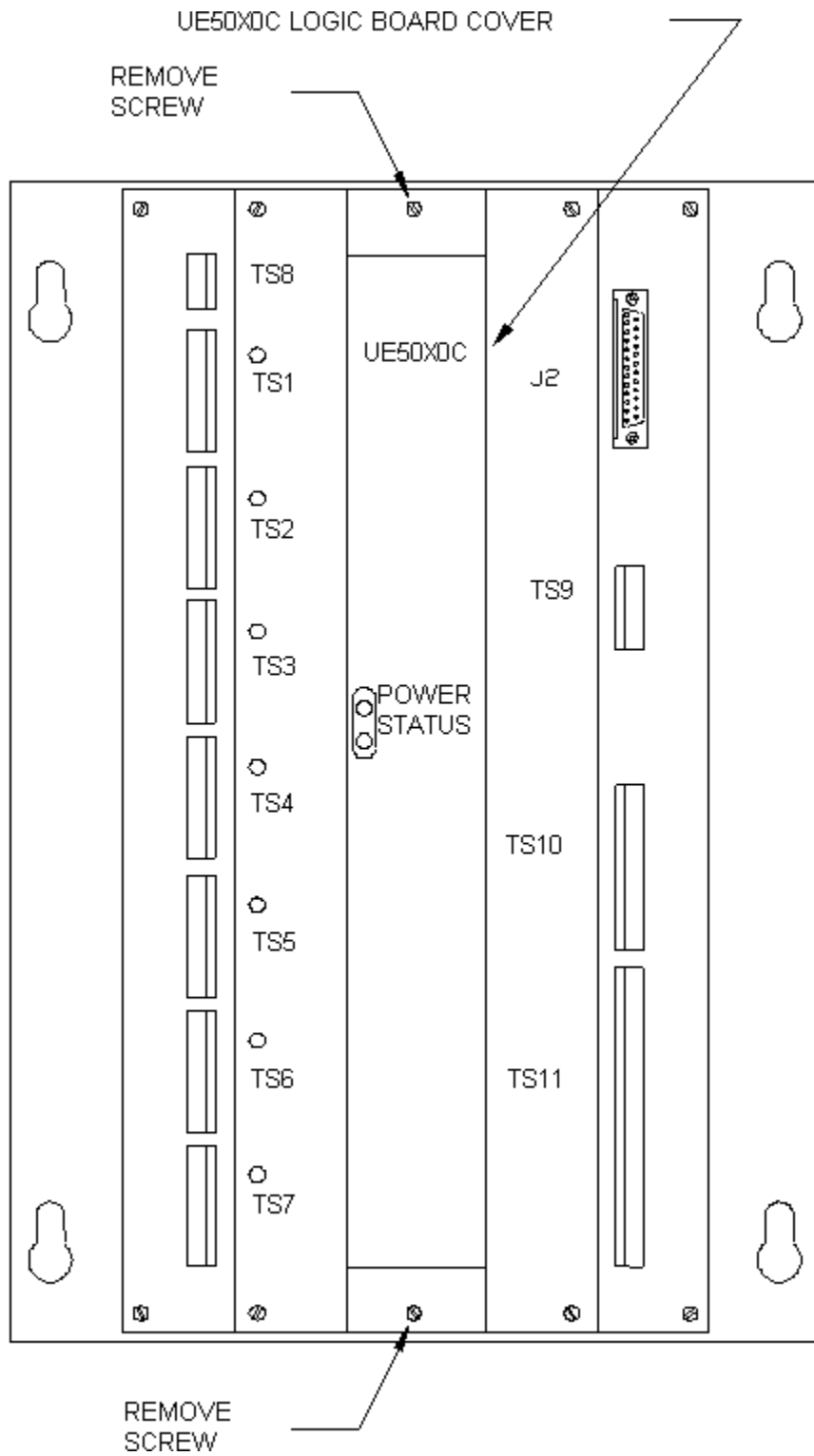


Figure 5.5.1 Access to UE5000C Logic Board

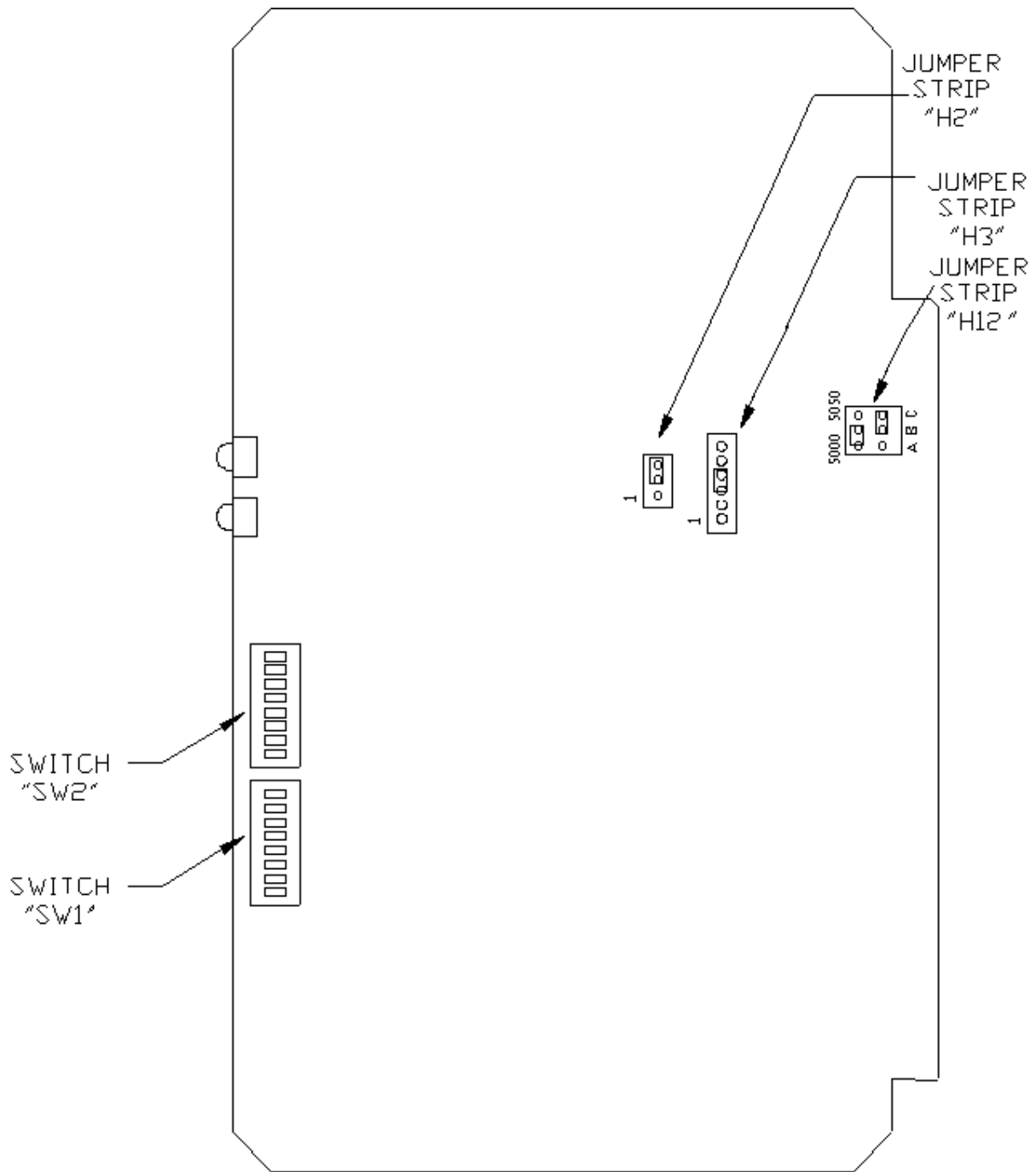
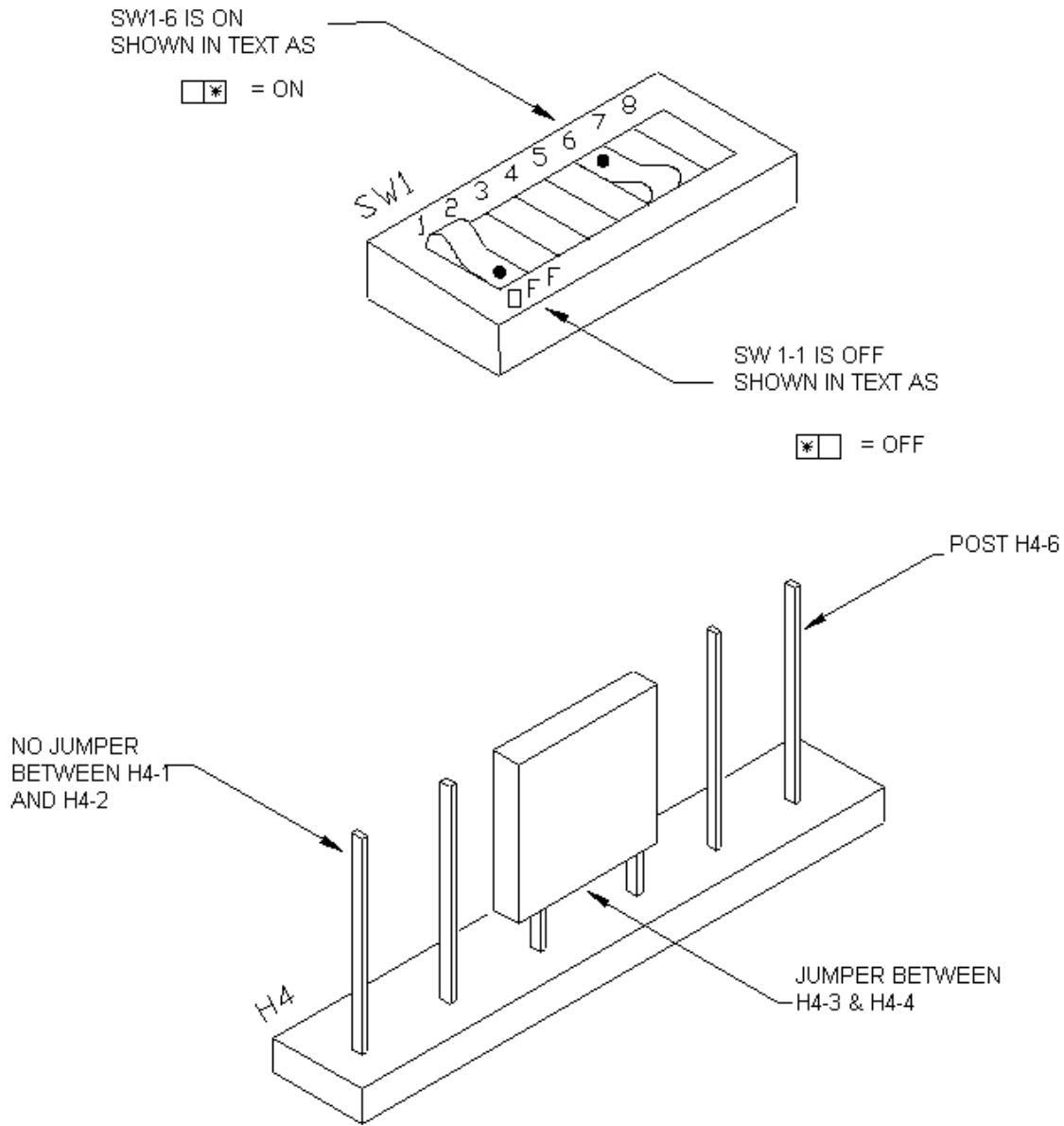


Figure 5.5.2 UE5000C Logic Board Parts Location





**Figure 5.5.3 – Switch and Terminal Strip Configuration**

### **5.5.1 SW1 -Interface Characteristics and Operating Mode**

Switch SW1 configures the serial interface characteristics as well as determines the operating mode of the UE5000C.

The baud rate, parity and data bit selections determine the serial interface characteristics. The serial interface is used for RS232, RS422 communication with the host. The serial interface is also used if one of the "automatic serial output" operating modes is selected by SW1. The characteristics of the UE5000C as determined by SW1 must match the requirements of the host serial interface. If serial communication is not used, then the parity, baud rate and number of data bits settings are ignored.

If FIFO buffering of reader data is not desired, then switch SW1-5 must be turned on, otherwise, set the switch off.

When the UE5000C recovers from a power failure, it examines SW1 to determine the operating mode of the UE5000C. Once the UE5000C is executing its program, it never checks SW1 again.

### 5.5.1.1 Serial Interface Characteristics

The characteristics of this serial interface (baud rate, parity and number of bits) are determined at power-up by the dipswitch SW1 (Figure 5.5.1.1). The possible combinations are listed in Table 5.5.1.1.1.

#### NOTE

If you are going to request and send binary formatted data, than you must select a serial interface mode that transmits 8-bit data.

Serial Interface Mode			Switch SW1			
Baud	Parity	Transmitted Character	#1	#2	#3	#4
1,200	None	8 – bit data only	Off	Off	Off	Off
1,200	Even	7 – bit data plus parity bit	On	Off	Off	Off
1,200	Odd	7 – bit data plus parity bit	Off	On	Off	Off
1,200	Even	8 – bit data plus parity bit	On	On	Off	Off
1,200	Odd	8 – bit data plus parity bit	Off	Off	On	Off
4,800	None	8 – bit data only	On	Off	On	Off
4,800	Even	7 – bit data plus parity bit	On	On	On	Off
4,800	Odd	7 – bit data plus parity bit	On	On	On	Off
4,800	Even	8 – bit data plus parity bit	Off	Off	Off	On
4,800	Odd	8 – bit data plus parity bit	On	Off	Off	On
9,600	None	8 – bit data only	Off	On	Off	On
9,600	Even	7 – bit data plus parity bit	On	On	Off	On
9,600	Odd	7 – bit data plus parity bit	Off	Off	On	On
9,600	Even	8 – bit data plus parity bit	On	Off	On	On
9,600	Odd	8 – bit data plus parity bit	Off	On	On	On
19,200	Odd	8 – bit data plus parity bit	On	On	On	On

**Table 5.5.1.1.1 UE5000C Serial Interface Selection**

### 5.5.1.2 Operating Mode Selection

The UE5000C can operate in one of eight modes, as summarized by Table 5.5.1.2.1. Switch SW1-6, 7 & 8 as specified in Table 5.5.1.2.2, determines the selection of the mode.

Modes	Operating Mode Characteristics
0	Test Mode: The on-board monitor program executes using the serial characteristics as specified on SW1. This mode is used to test the UE5000C
1,2,3, & 4	Normal Operating Modes: The serial interface is active and will accept the message protocol as stated in Section 6. The parallel interface is active and will operate as stated in Section 6. The difference between modes 1,2,3 and 4 concerns the parallel output format and the data save feature.
5 & 6	Serial Data Trace Mode: The parallel interface is used for host communication. In addition, human readable trace messages are sent over the serial interface. The format of these messages is selected by SW2. Used during system startup. Saved data is destroyed during a power outage.
7	Auto Serial Output: The host interface is disabled, and a formatted message is sent over the serial interface every time a card is read by a reader. Used during system startup and during testing.

**Table 5.5.1.2.1 UE5000C Operating Modes Summary**

Mode	Data Save	Parallel Interface	SW2			Mode Features
			-6	-7	-8	
0	Yes	-----	Off	Off	Off	Debug
1	Yes	BCD	On	Off	Off	Normal Operation of Both Serial and Parallel Interfaces
2	Yes	Binary	Off	On	Off	
3	No	BCD	On	On	Off	
4	No	Binary	Off	Off	On	
5	No	BCD	On	Off	On	Parallel Communication
6	No	Binary	Off	On	On	With serial data trace
7	No	-----	On	On	On	Auto Serial output

**Figure 5.5.1.2.2 – Operating Mode Selection**

## 5.5.2 SW2 – Operation Mode Configuration

The UE5000C Concentrator can have up to seven UE5100C-RS Card Readers connected to it via terminal strips TS1 through TS7. If fewer than seven UE5100C-RS's are connected, they must be connected sequentially starting with TS1. The number of UE5100C-RS's actually connected must be set in switch SW2 (Table 5.5.2.1) at configuration time.

The address range of the attached UE5100C-RS Card Readers is controlled by switch SW2 settings (see Figure 5.5.2.1 and Tables 5.5.2.1 and 5.5.5.1). The UE5100C-RS connected to TS1 corresponds to the first card reader address in this range. The UE5100C-RS connected to TS2 corresponds to the second address in this range, and so on.

If operating modes 5,6 or 7 were chosen by switch SW1 (see section 5.5.1.2) then SW2-6 is used to select the data output format according to Table 5.5.2.2.

# Of UE5100C- RS's	SW2		
	-1	-2	-3
0	Off	Off	Off
1	On	Off	Off
2	Off	On	Off
3	On	On	Off
4	Off	Off	On
5	On	Off	On
6	Off	On	On
7	On	On	On

**Table 5.5.2.1 Specifying Number of UE5100C-RS's**

Serial Data Trace Format	SW2
	-6
<b>Original Format (See Section 9.5)</b>	<b>Off</b>
<b>Full Trace Format (See Section 9.6)</b>	<b>On</b>

**Table 5.5.2.2 Serial Data Trace Format Selection**

### 5.5.3 H2 – Select RS232 or RS422 Interface

Two serial interface circuits are provided on the UE5000C, one circuit is used for RS232 communication, and the other is used to provide RS422 communication.

Jumper strip H2, mounted on the UE5000C logic board, is used to select between the RS232 and the RS422 signal levels.

The location of H2 is shown on Figure 5.5.2. H2 is a single jumper strip containing six small gold plated posts. Post #1 is indicated by a small “1” silk-screened on the surface of the logic board. One jumper plug must be inserted on H2 as shown in Table 5.5.3.1.

Interface Desired	Jumper H2
RS232	2-3
RS422	1-2

**Table 5.5.3.1 H2 – RS232 / RS422 Selection**

### 5.5.4 H3 – Terminate RS422 Input Signals

Jumper strip H3 is used to provide termination for the RS422 interface signals from the host system. Insert up to three jumpers as per the Table 5.4.3.2.

Insert Jumper Plug Between Pins	To Accomplish
1 – 2	Pull up RS422 R+ Lead to 5v with 1000 ohm resistor
3 - 4	Terminate RS422 Input signals with a 100 ohm resistor
5 – 6	Pull down RS422 R- Lead to ground with a 1000 ohm resistor

**Table 5.4.3.2 – RS422 Input Signal Termination and Pull Up Resistors**



### 5.5.5 Expansion Port Characteristics

If switch SW2 specifies that less than seven UE5100C-RS readers are connected to the UE5000C, then the remaining terminal strips (TSx – TS7) may be used to expand the UE5000C. These expansion ports may be left unused, or be connected to other UE5000Cs. The number of terminals used for expansion ports must be set on switch SW2 at configuration time. See Figure 5.5.2.1 and Table 5.5.4.1.

It is important that the expansion devices be connected to terminals that are not specified for use by UE5100C-RS readers. For Example, if switch SW2 specified that three (3) UE5100C-RS readers were to be connected, then TS1, TS2, and TS3 are dedicated to the three readers. Any expansion devices must be connected to the UE5000C starting at TS4.

Number of UE5000Cs Connected	SW2	
	-4	-5
None	Off	Off
1	On	Off
2	Off	On
3	On	On

**Table 5.5.4.1 Expansion Port**

### 5.5.6 Configuring Expansion UE5000Cs

Expansion UE5000Cs have restrictions on the allowable configurations. These restrictions are listed in Table 5.5.5.1.

Item	
H2	Must be set for RS422
SW2 – 1, 2, &3	Set as required; note that the second expansion UE5000C can only have a maximum of 3 readers connected.
SW2 – 4 & 5	Set as required
SW2 – 7 & 8	Must be set to 7-13 for the first expansion UE5000C, and 13-15 for the second. See Table 5.5.5.2 for details.

**Table 5.5.5.1 Configuration Restrictions**

Address Range	SW2	
	-7	-8
1-7	Off	Off
7-13	Off	On
13-15	On	Off

**Table 5.5.5.2 Base Address**

## 5.6 Initial Configuration Procedure for UE5000C Concentrators

The following procedure must be followed whenever a UE5000C has been installed for the first time, or, if UE5100C-RS readers are added or removed from a concentrator.

Step	Procedure
1	Turn off the dc power to the UE5000C
2	Remove the cover from the UE5000C logic board
3	<p>Set SW2 on the UE5000C logic board to match the requirements of your system.</p> <p>If you do not have another UE5000C connected to the expansion port, then you must set the “address range” switch to “1-7”.</p>
4	<p>If you will be using the serial interface to communicate with the UE5000C, then set switch SW-1, 2, 3, &amp; 4 to agree with your serial protocol.</p> <p>Expansion UE5000C's must have their SW1 set for 9600 baud, 8 bit data plus odd parity, and mode 2 or 4.</p> <p>If you are not going to use the serial interface, set SW-1, 2, 3, &amp; 4 to OFF.</p>
5	<p>If you will be using the serial interface to communicate with the UE5000C, then set switch SW1-6, 7, &amp; 8 to Mode 3.</p> <p>If you will be using the parallel interface to communicate with the UE5000C, then set switch SW1-6, 7, &amp; 8 to either Mode 3 or 4 depending upon the format requirements for your parallel interface.</p> <p>Do not Select any Mode but 3 or 4 at this time, even if you want to use the “data save” feature.</p>
6	Turn on the power to the UE5000C. At this time, the UE5000C will destroy any data that had been in the memory and will configure itself to your requirements.
7	

## 6 POWER SUPPLY INSTALLATION

The UE5000C Concentrator and the UE5100C-RS Reader are used together to make a cost effective reliable code card tracking system. The UE5000C and the UE5100C-RS are designed to be powered from a nominally 24-volt dc power supply. Figure 8.1 shows the power supply flow for a reader system consisting of a single 24vdc power supply, one or more UE5000C concentrators and a corresponding number of UE5100C-RS readers.

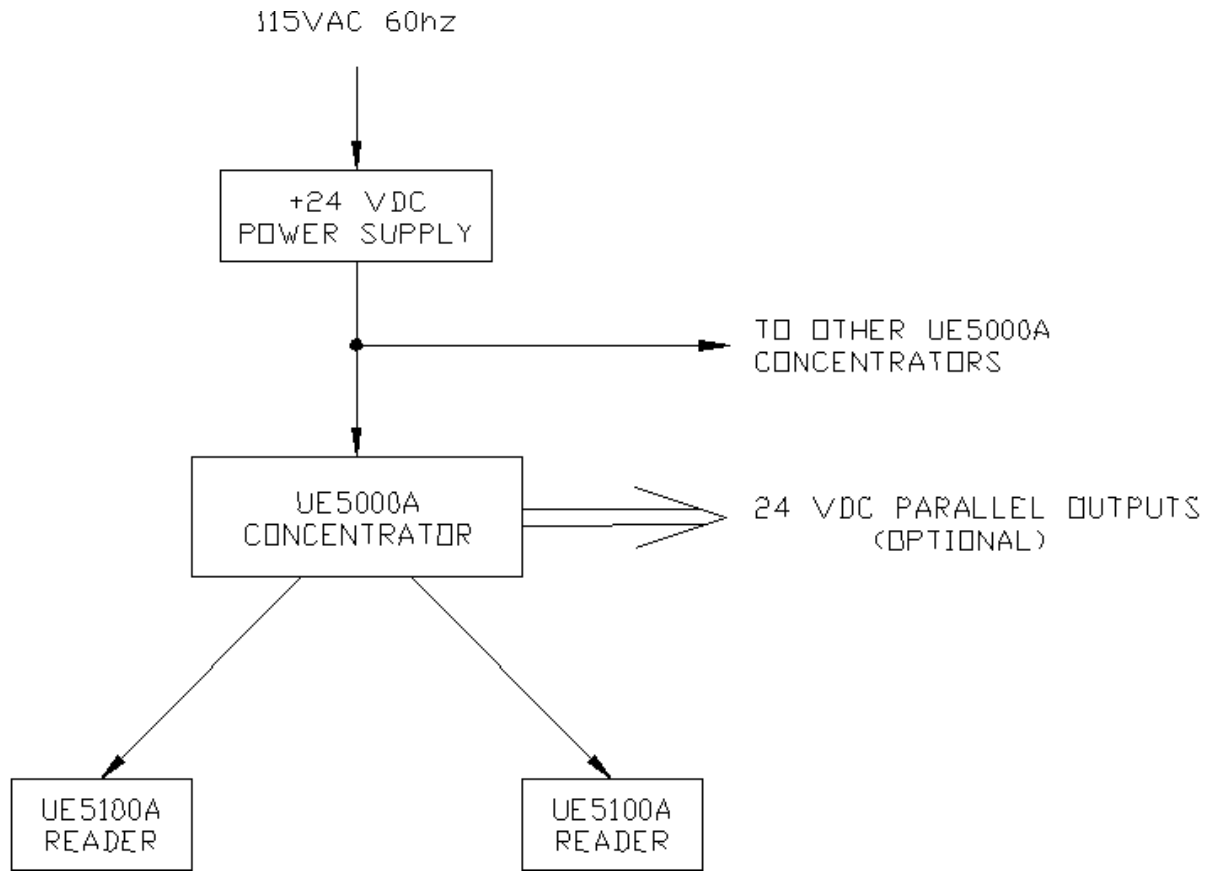
In a large system with multiple concentrators, a single 24vdc supply may be used to power several UE5000C concentrators, or a separate supply may be used for each UE5000C.

### CAUTION

It is essential to the reliable operation of the UE5000C/UE5100C-RS system that the same 24vdc power supply be used to power both the readers and their associated concentrator. Furthermore, the UE5100 readers must receive their 24vdc via the terminals TS1 thru TS7 mounted on the motherboard of their associated UE5050 concentrator.

It is not necessary that the optional Parallel Output circuitry be powered from the same 24vdc supply that is used to power the UE5000C concentrator. This allows the power supply for the parallel output to be independent of the 24vdc supply used for the concentrator and readers.

Although the nominal dc voltage is specified as 24vdc, each of the UE5000C and UE5100C-RS subsystems contain their own dc power converter, which will work over an input voltage range of 16vdc to 40vdc. It is important to realize that although the central power supply may be at 24vdc, the voltage actually applied to the UE5100C-RS readers will be decreased due to voltage drop in the interconnecting cables. The cables recommended in section 4 for the UE5000C to UE5100C-RS interconnection are sized to provide at least a 16vdc voltage at the readers assuming that there is a minimum of 24vdc supplied to the concentrator terminal strip.



**Figure 6.1 UE5000C/UE5100C-RS Power Supply Flow Diagram**

## 6.1 Power Supply Requirements

The nature of the UE5000C and UE5100C-RS power converters results in each unit requiring a constant amount of power. At high voltages, this power is delivered with a low current, at low voltages; the same amount of power will require a corresponding increase in current.

The maximum power supply requirement occurs during power turn on when the output of the power supply is ramping from 0vdc to its normal voltage. This maximum current occurs between 6vdc and 9vdc.

Table 8.1.1 lists the current requirements for each unit based upon the worst case starting current, as well as the normal operating current at 16vdc. Notice, that a power supply that supplies the worst case current during startup may be lightly loaded during normal running conditions.

For example, a single concentrator using parallel output with 7 readers will require a supply that can provide:

$$\text{Starting current} = .3\text{a} + 7 \times .6\text{a} = 4.5\text{a}$$

$$\text{Running current} = 1.1\text{a} + 7 \times .4\text{a} = 3.9\text{a}$$

As a second example, consider a system with two concentrators using parallel output with a total of 14 readers. The resulting power supply will be required to supply: (only one of the concentrators can have its parallel output turned on at a given time)

	UE5000C	UE5100C-RS	Total
Starting current =	(2x.3a)	+ (14 x.6a)	= 9a
Running current =	(1.1a + .15a)	+ (14 x .4a)	= 6.85a

Notice, that a power supply that can provide more current during low output voltages and less at higher voltages has the best match to the requirements of the reader system. This is the characteristic of a simple non-regulated "brute force" power supply.

### CAUTION

Power supplies that "fold over" when overloaded must have their current rating be in excess of the worst case current required, otherwise the system may "lock up" in a low voltage-high current state during startup.

It is not necessary to power the UE5000C and UE5100C-RS units with a tightly regulated power supply, a "simple brute force", unregulated power supply will provide satisfactory power provided that the unloaded voltage does not exceed the 40vdc limit. Unregulated supplies normally can provide the extra current needed during power startup conditions, and hence need not have as high a rating as a typical "switcher" power supply.

Unit Description	Current	Required
	Start Current	Normal Current
UE5000C (no parallel output used)	.3a	.15a
UE5000C (24v parallel output used with 30ma per bit required)	.3a	1.1a
UE5100C-RS	.6a	.25a

**Table 6.1.1 DC Power Supply Current Requirements**

In order to make the selection of a power supply as simple as possible, Table 6.1.2 shows the start-up and normal currents required for up to 21 readers connected to up to 3 concentrators. For convenience, the current is calculated assuming that the parallel outputs will be used to connect to the host system. For example, for this table, it can be seen that current required for a 14-reader system is 9a for start-up and 4.75a for normal operation, which is the same value as was calculated in the previous example.

**Number of UE5000C Concentrators**

# Of Readers	1		2		3	
	Start Current	Normal Current	Start Current	Normal Current	Start Current	Normal Current
1	.90	1.35	1.20	1.50	1.50	1.65
2	1.50	1.60	1.80	1.75	2.10	1.90
3	2.10	1.85	2.40	2.00	2.70	2.15
4	2.70	2.10	3.00	2.25	3.30	2.40
5	3.30	2.35	3.60	2.50	3.90	2.65
6	3.90	2.60	4.20	2.75	4.50	2.90
7	4.50	2.85	4.80	3.00	5.10	3.15
8			5.40	3.25	5.70	3.40
9			6.00	3.50	6.30	3.65
10			6.60	3.75	6.90	3.90
11			7.20	4.00	7.50	4.15
12			7.80	4.25	8.10	4.40
13			8.40	4.50	9.00	4.65
14			9.00	4.75	9.60	4.90
15					10.20	5.15
16					10.80	5.40
17					11.40	5.65
18					12.00	5.90
19					12.60	6.15
20					13.20	6.40
21					13.80	6.65

**Table 6.1.2 Easy Pick Power Supply Requirements**

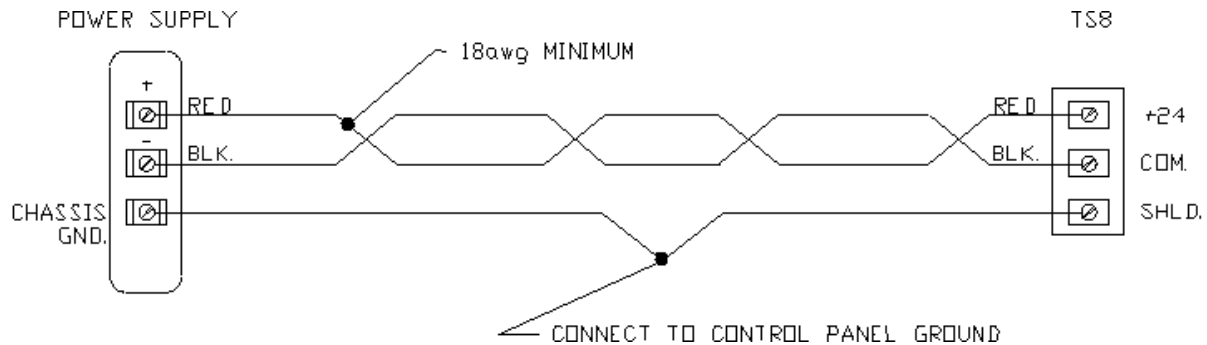


## 6.2 Power Supply Wiring Requirements

The wiring between the 24vdc power supply and terminal TS8 of the UE5000C should be made with as short and heavy wire as is practical. Ideally, the distance should be measured in inches and the wire gage should be at least 18ga.

It is further recommended that the 24vdc power wires be twisted together between the power supply and TS8. The wiring connection is shown in figure 6.2.1. If the power supply does not have a chassis ground, simply connect the “SHLD” terminal on the TS8 to panel ground.

When powering multiple UE5000C concentrators from the same 24vdc power supply, each concentrator must have its own wires to the power supply.



**Figure 6.2.1 Power Supply to UE5000C Wiring**

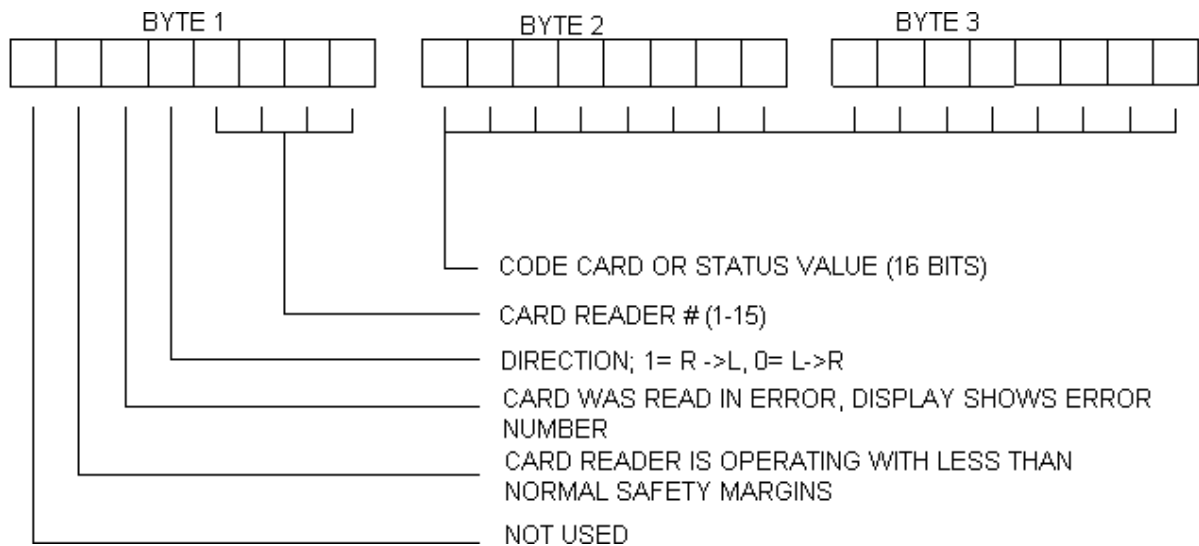
## 7 COMMUNICATION

The basic data passed between the UE5000C concentrator and the host computer is a 24-bit binary number containing the code card number, the reader station number and several status bits relating to error detection, direction and manual data entry. These 24 bits may be transferred to the host in one of several ways: 24-vdc parallel, RS232 serial, or RS422 serial.

When using the serial data transmission mode, the data can be sent as three (3) binary bytes, six (6) ASCII coded hexadecimal characters, or nine (9) ASCII coded decimal characters. The format and protocol for each of these data transmission modes is detailed in the subsequent paragraphs.

### 7.1 Basic Binary Format

The basic parallel binary format is shown in Figure 7.1.1. This binary image is exactly the data that is transferred when using the parallel interface.



**Figure 7.1.1 Basic Binary Format for Code Card Value**

## 7.2 Parallel Transmission Protocol

Using the four data input terminals (TS9) on the UE5000C mother board, the host programmable controller can request to receive a single card reader value at a time, as described in Table 7.2.1.

<u>Step</u>	<u>Action</u>
1	Remove all power from A1 - A4.
2	Output the card reader address on A1 - A3, if desired
3	Wait at least 50ms and assert A4. Depending on the speed of the output card, it may be necessary to wait longer than 50ms.
4	Wait at least 20ms before reading the data on the parallel output leads. Depending on the speed of the DC input cards; it may be necessary to wait longer than 20ms.
5	Remove power from A1 - A4.

**Table 7.2.1 - Parallel Transmission Protocol**

Depending on the operating mode of the UE5000C, the code card value in the lower 2 bytes may be formatted into either BCD or binary.

### 7.2.1 Request For Specific Card Reader Data

If the TS9 inputs, A1 - A3, are non-zero, then the resulting number (1-7) is used as a request for the oldest data from the specified Card Reader.

### 7.2.2 Request For Data From Any Card Reader

If the TS9 inputs, A1 - A3, are zero (no voltage applied), then this is used as a request for the oldest piece of data from all Card Readers.

### 7.2.3 Parallel Data Return Format

If data is found for a particular Card Reader, either by specific request or general request, the reader number is returned on leads CO - C3, along with the appropriate flags and data values. If no data was found for a reader, then the 24-bit parallel data that is returned will be all zeroes except for the status bit, i.e., “no data available” is indicated by a status 0 message.

### 7.3 Status Message Return Protocol

The flag byte of each returned message contains a status bit. When this bit is set, the value bytes contain a status number rather than a code card value.

Status values can originate at either the UE5000C or the UE5100C-RS. Table 9.3.1 lists the status numbers, meanings and origin for these status messages.

Status	Origin	Meaning
0	5000C	No code value is available
1	5100C-RS	One or more of the photo detectors has been dark for an excessive length of time. Could be due to an electronic failure or that a card has been in the reader for that time.
2	5100C-RS	Code card has an illegal pattern of holes.
3	5100C-RS	One or more of the photo detectors failed self-check.
4	5100C-RS	Card data was read inconsistently.
5	5100C-RS	Code card was moving too fast.
6	5100C-RS	Unidentifiable object passed through the reader.
7	5100C-RS	+ 24vdc dropped below 16v threshold.
20	5000C-RS	Reader is not responding to communication requests.
21	5000C-RS	Reader is not connected.

**Table 7.3.1 Status Messages**

## 7.4 Serial Transmission Protocol

The UE5000C Concentrator assumes a slave status with regards to the host system, which is either a computer or Programmable Controller. In other words, the UE5000C "doesn't speak until spoken to".

To initiate transmission from the UE5000C, the host sends one of several request messages. If the UE5000C does not recognize the request message, it returns the character "B" followed by a carriage return and a line feed. If the UE5000C does not have any code card values to send, then it returns the character "o" (a lower case "Oh") followed by a carriage return and line feed characters.

If the UE5000C has data from the prior reading of one or more code cards, it returns a serial message that consists of five (5) fields, each field is shown inside of angle brackets, e.g., < field > with the following general appearance:

< lead-in > < flags & station # > < data value > < checksum > < trailer >

There are basically three serial protocols: binary, hexadecimal and decimal. Each of these formats is detailed in the subsequent sections, along with the host request messages used to initiate the transmission.

### 7.4.1 Host Request Messages

The host computer initiates communication with the UE5000C slave by sending a message consisting of a unique lead-in character followed by one or more modification characters, terminated with a carriage return. The lead-in characters have been chosen so that each lead-in character differs from all other lead-in characters by at least 3 bits and still represents a printable ASCII character. If these lead-in characters are transmitted along with a parity bit, then virtually error-free transmission between host and UE5000C will result.

There are two basic types of request messages: those that request a single code card value based on a particular code card reader, and those that request a single code card value independent of the code card reader. In addition, there are messages that request all such code card values. In each case, the code card reader number is included in the response message.

The messages that request code card values independent of the code card reader number are listed in Table 9.4.1.1, and messages that request code card values from a particular code card reader number are listed in Table 9.4.1.2. The resulting UE5000C response messages are shown in Section 9.4.2 through 9.4.5.

In all cases, a host request message start with the unique lead-in character and ends with a carriage return character. Depending upon the lead-in, there may be additional characters sent.

<u>Request Message</u>	<u>Purpose</u>
!	Host request for data transmission of the oldest code card value using the Binary Protocol.
:	Host request for data transmission of the oldest code card value using the Hexadecimal Protocol.
Y	Host request for data transmission of the oldest code card value using the Decimal Protocol.
&	Host request for data transmission of all of the code card values using Binary Protocol. A maximum of 25 code card values will be returned for each "&" request.
B	Host request for re-transmission of the code card values sent by the previous request.

**Table 7.4.1.1 – Requests for Data from any Reader**

<u>Request Message</u>	<u>Purpose</u>
s**	Host request for data transmission of the oldest code card value for a particular card reader using the Binary Protocol.
t**	Host request for data transmission of the oldest code card value for a particular card reader using the Hexadecimal Protocol.
h**	Host request for data transmission of the oldest code card value for a particular card reader using the Decimal Protocol.
^**	Host request for data transmission of all of the code card value for a particular card reader using the Binary Protocol. A maximum of 25 code card values will be returned by a single “^” request.
B**	Host request for re-transmission of the code card values sent by the previous request.

**NOTE**

For all of these messages, the “\*\*” represents the desired card reader address in hexadecimal. The 15 possible card reader addresses 1-15 are specified by using the characters 1-9 or A-F twice. For example, card reader #10 is specified by substituting “AA” for “\*\*” in the above list.

**Table 7.4.1.2 – Requests for Data from a Specific Reader**



### 7.4.2 Single-Value Binary-Coded Protocol

This protocol is used when the host sends either an "!" or "s" request message. In this protocol, three 8-bit bytes representing the code card value and flags are transferred to the host over the serial interface. The exact protocol is shown in Table 7.4.2. 1.

Byte #	Value	Meaning
1	"!"	Lead-in character
2	"00-FF"	Flags & station # exactly as stored in the Basic Binary Format.
3	"00-FF"	The most significant byte of the code value.
4	"00-FF"	The least significant byte of the code value.
5	"00-FF"	The binary sum of bytes 2, 3, & 4.

**Table 7.4.2.1 - Single-Value Binary Protocol**

### 7.4.3 Single – Value Hexadecimal-Coded Protocol

This protocol is used when the host sends either a “:” or “t” request message.

In this protocol, six (6) 8-bit ASCII bytes representing the hexadecimal value of the three (3) bytes in the Basic Binary Format, along with bytes for the lead-in, checksum and trailer are sent. Each byte in the Basic Binary Format is divided into two (2) 4-bit nibbles. The value of each nibble is coded in hexadecimal using the ASCII characters 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F corresponding to the resulting values of 0 to 15.

The exact character string in this protocol is shown in Table 7.4.3.1.

Byte #	Value	Meaning
1	“:”	Lead-in
2	Hex digit	Flag nibble
3	Hex digit	Station #
4	Hex digit	Most significant nibble of the code card value
5	Hex digit	
6	Hex digit	
7	Hex digit	Least significant nibble of the code card value
8	Hex digit	Most significant nibble of checksum
9	Hex digit	Least significant nibble of checksum
10	OD HEX	Carriage return
11	OA Hex	Line feed

**Table 7.4.3.1 – Single – Value Hexadecimal Protocol**

### 7.4.4 Single-Value Decimal Protocol

This protocol is used when the host sends either a "Y" or "h" request message.

In this protocol nine (9) 8-bytes representing the decimal value of the three bytes in the Basic Binary Format, along with bytes for the lead-in, trailer and checksum are sent.

The exact character string in this protocol is shown in Table 7.4.4. 1.

Byte #	Value	Meaning
1	"Y"	Lead-in
2	"0-1"	Most significant digit of the flag bits
3	"0-9"	Least significant digit of the flag bits
4	"0-1"	Most significant digit of the station #
5	"0-9"	Least significant digit of the station #
6	"0-1"	10,000's digit of code card value
7	"0-9"	1,000's digit of code card value
8	"0-9"	100's digit of code card value
9	"0-9"	10's digit of code card value
10	"0-9"	1's digit of code card value
11	"0-2"	100's digit of checksum of bytes 2-10
12	"0-9"	10's digit of checksum
13	"0-9"	1's digit of checksum
14	OD Hex	Carriage return character
15	OA Hex	Line feed character

**Table 7.4.4.1 - Single-Value Decimal Protocol**

### 7.4.5 Multiple-Value Binary-Coded Protocol

This protocol is used when the host sends either a "&" or "' ' " request message.

In this protocol, multiple values are sent as groups of three (3) 8-bit bytes in a one-to-one correspondence, to the three bytes in the Basic Binary Format. In addition, a count byte is sent representing how many groups are in the message. No more than 25 values will be sent at a time.

The exact protocol is shown in Table 7.4.5.1.

<u>Byte #</u>	<u>Value</u>	<u>Meaning</u>
1	"&"	Lead-in character.
2	"00-19"	The count of the number of values in this message.
3	"00-FF"	Flags & station # for the first code value exactly as stored in the Basic Binary Format.
4	"00-FF"	The most significant byte of the first code value.
5	"00-FF"	The least significant byte of the first code value.
6, 7, 8		The flags, station #, and value for the second code value.
Last	"00-FF"	The binary sum of all bytes starting with 2.

**Table 7.4.5.1 - Multiple-Value Binary Protocol**

## 7.5 Auto Serial Output Message Format

The Auto Serial Output Mode (Mode 7) results in the automatic generation of output messages. These messages are generated using the format shown in Table 7.5.1.

### Basic Message Format

< Value field >, < Dir field >, < Margin field >, < Source field > < cr-lf >

Where:

< Value field >	=	"CARD # = nnnnn," or "STS # = nnnnn "
< Dir field >	=	"FWD" or "REV"
< Margin field >	=	"MARGINS OK" or "MARGINS LOW"
< Source field >	=	"AUTO READER # = nn" or "HAND READER # = nn"
nnnnn	=	5-digit decimal equivalent of the value bit
nn	=	2-digit reader number

**Table 7.5.1 Auto Message Output Format**

## 7.6 Serial Data Trace Message Format

The Serial Data Trace Mode (Mode 5 and 6) results in the automatic generation of output messages. Depending upon the format selected via SW2-6 one of two trace modes are specified.

### 7.6.1 Original Format

This mode is selected when SW2-6 is OFF, the resulting trace messages are identical to messages specified in Section 9.5. These messages are sent over the serial port only in response to a parallel data request from the host.

This mode is retained only for backward compatibility.

### 7.6.2 Full Trace Mode Message Format

When the Full Trace Mode has been selected via Switch SW2, the concentrator sends a “Q message” every time that an attached reader reads a code card and sends a “R” message every time that the parallel interface is used by the host.

The format of these messages is shown below. Note, the “s” is not sent as part of the message, and symbol (cr-lf) is used to indicate that the Carriage Return and Line Feed characters are sent.

- 1 - When a value is placed in the queue for a reader:  
“(cr-lf) Qnnsmdtvvvvv [optional modifier]” is sent.

Where	nn =	reader number,
	s =	A for auto, H for hand
	m =	G for margins good or L for margins low
	d =	F for forward or R for reverse
	t =	S for a status message or C for a Code Card
	vvvvv =	the card or status value

The [optional modifier] may be one of 2 messages:

“\*\*\*LOST\*\*\*” if queuing is enabled and there was no room in the queue. The corresponding data is therefore lost.

“\*\*\*OVERWRITE\*\*\*” if queuing is disabled and the previous data had not yet been sent to the host. The previous data is replaced by this data.

For example: Q03AGFC01234

Is sent if card #1234 is read automatically in the forward direction at reader #7 with good margins.

Q03AGFC01234 \*\*\*LOST\*\*\*

Is sent if card #1234 is read from reader #3 and there was no room in the queue.

2- When the parallel interface requests a value:  
“(cr-lf)Rrr:nnsmdtvvvvv” is sent

Where	rr =	requested reader number for parallel interface
	nn =	reader number in returned response
	s =	A for Auto, H for Hand
	m =	G for margins good or L for margins low
	d =	F for forward or R for reverse
	t =	S for status message or C for a Code Card
	vvvvv =	the card or status value

For example:

R00:03AGFC01234

Would be sent if the data from reader number 3 was requested using the “wild card request” i.e., reader #00.

R03:00AGFS00000

Would be sent if data from reader #3 was requested and there was no data for reader #3.

## 8 VISUAL INDICATORS AND DISPLAYS

Both the UE5000C Concentrator and the UE5100C-RS Reader are equipped with visual status indicators. Various patterns of solid and blinking LEDs are used to convey internal status information.

### 8.1 Reader Status Display

The UE5100C-RS Reader is equipped with a 4-digit numeric display as well as with five (5) discrete LED indicators. The display and indicator LEDs are located behind the red window on the side of the emitter subassembly.

Refer to Figure 8.1.1.1 for the location of these indicators..

#### 8.1.1 4-Digit Display

The 4-digit display is used to indicate the code value of the last card that was read. This value is held until another card is read, the power supply is turned off, or the reader internal self-check detects a possible problem.

When power is first turned on, this 4-digit display will momentarily show "8888" and then turn blank. When the reader electronics detects an internal problem, the 4-digit display is used to provide a status indication. When the 4-digit display is used to display status, the display shows "S--X", where x is the status number. Figure 8.1.2 shows a typical status display. The status numbers are listed in Table 8.1.1.1

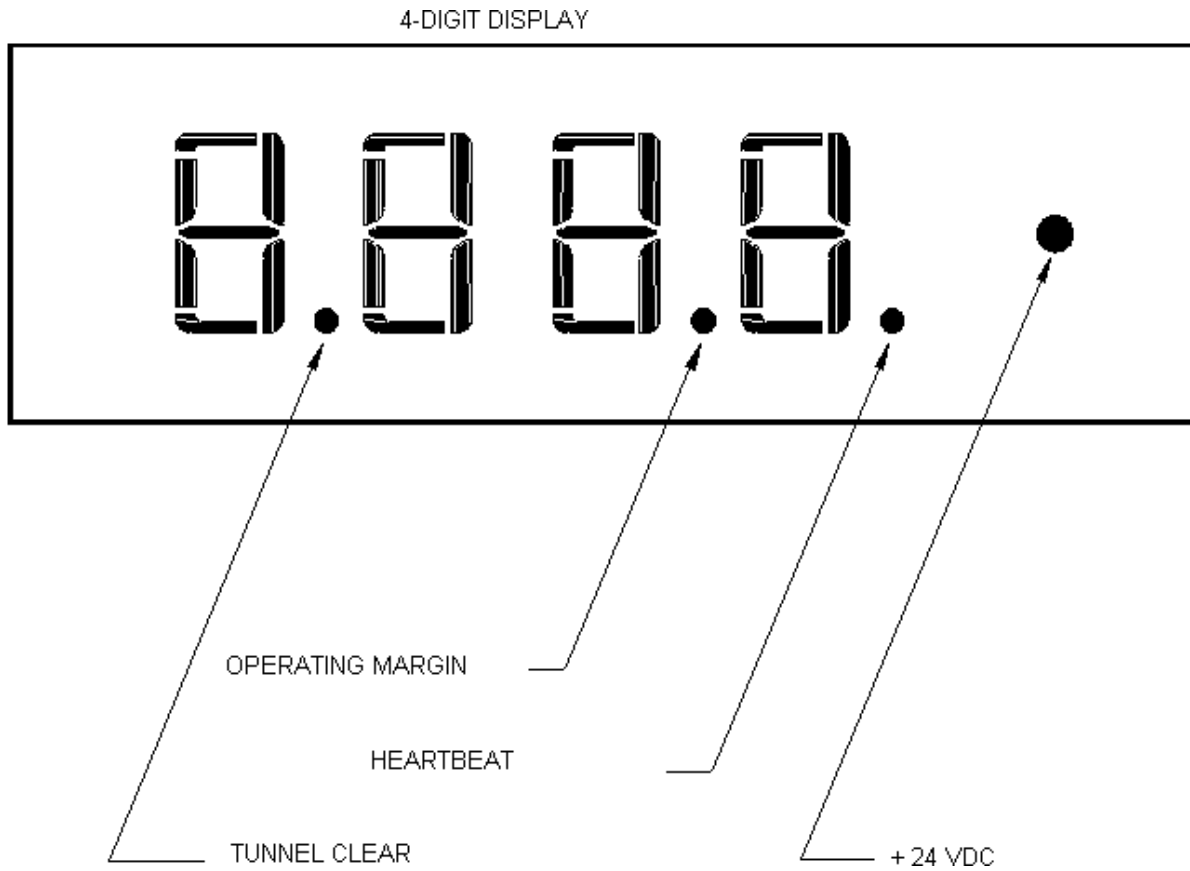
#### NOTICE

Since the seven segment display cannot actually show an "S", it uses the number "5" in place of the "S".
----------------------------------------------------------------------------------------------------------

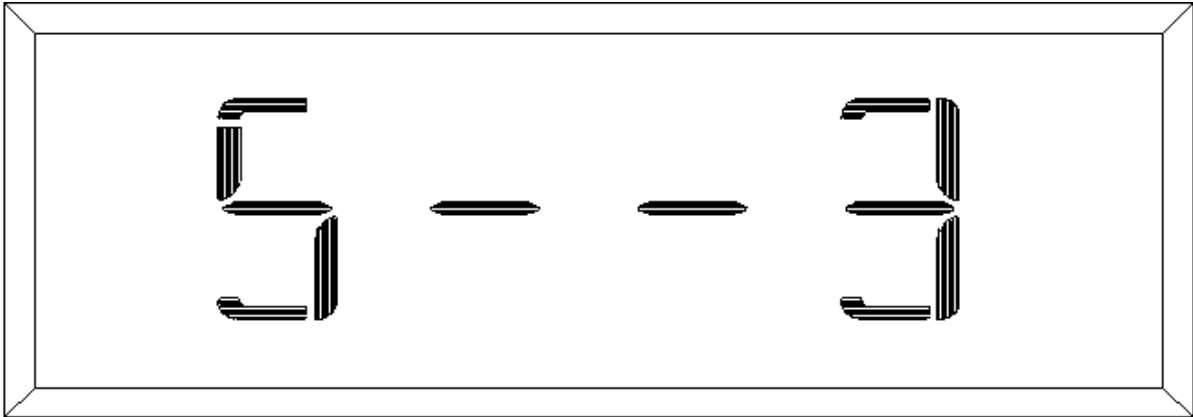


STATUS #	MEANING
1	One or more of the photo-detectors have been dark for an excessive length of time.
2 3	Card had illegal pattern of holes
4	One or more of the photo-detectors will not turn off when its emitter is turned off. Caused by excessive background illumination, or else by component failure.
5	Partially blocked hole in card
6	Line speed is too fast for reliable operation.
7	Non-card passed through reader.
8	+24v dc power dropped below 16v.

**Table 8.1.1.1 - Reader Status Codes**



**Figure 8.1.1 – Reader Display/Indicator Unit**



**Figure 8.1.2 Typical Status Display**

## 8.1.2 Discrete LED Indicators

The four (4) discrete LED indicators are used to indicate various operating conditions as shown in Table 10.1.2. 1.

LED	INDICATIONS
Operating Margin	“SLOW BLINK” – Reader sees the same pattern of light and dark when the emitters operate at 50% power as when they operate at 100% power. This is the preferred condition.
	“FAST BLINK” – At least one of the detectors are dark when the reader operates at 50% power. If continuous, indicates that the windows are dirty, or that a component has become marginal. Occasional margin indications are not cause for serious action.
Heart Beat	Blinks on and off continuously to indicate that the processor is “alive and well”. The heartbeat rate is the “slow blink” for the margin LED.
Tunnel Clear	Is on when there is nothing blocking the passage of light between the emitter and detectors.
+24V	Is ON if the voltage applied to the reader is greater than 16VDC.

**Table 8.1.2.1 - Reader Discrete LED Indications**

## 8.2 Concentrator Indicators

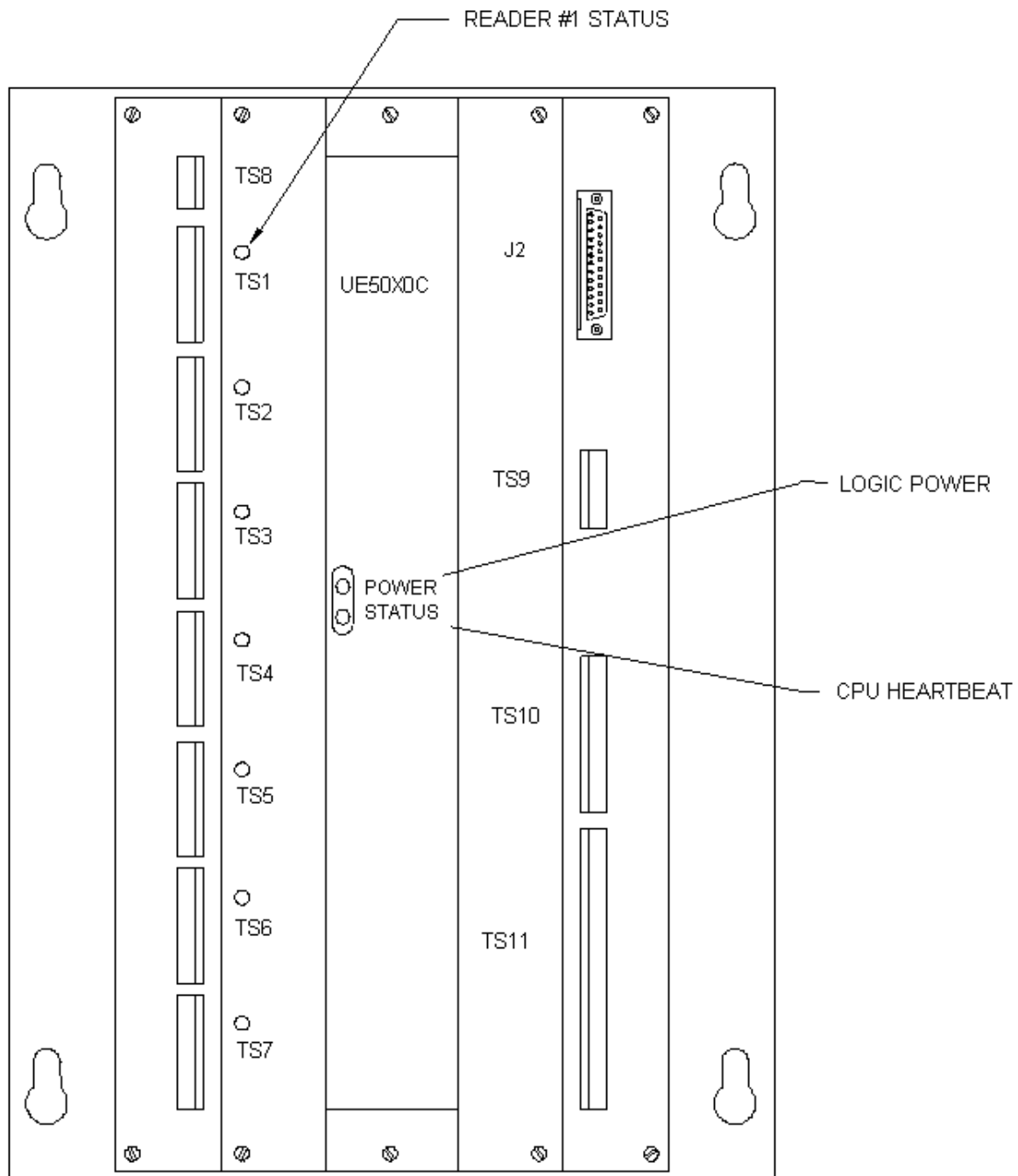
The Concentrator is equipped with nine (9) discrete LED indicators. Refer to Figure 8.2.1 for the location of these indicators.

### 8.2.1 Reader Status Indicators

Indicators TS 1, TS2...TS7 are used to convey the status of each of the possible seven (7) readers that can be connected to the concentrator via the corresponding terminal strips. The information regarding each possible reader is conveyed through the use of steady and flashing LEDs as listed in Table 8.2. 1. 1.

LED STATUS	INDICATES
OFF Continuously	The concentrator is not communicating with this terminal strip.
OFF mostly, blinks ON every 7 seconds	Concentrator can successfully communicate with the reader connected to this terminal.
ON mostly, blinks, OFF every 7 seconds	Concentrator cannot communicate with the reader. If continuous, indicates a failure in the communication path. If intermittent, may be caused by noise on line.
Blinks ON and OFF Every second	Internal reader buffer in the concentrator is full. Concentrator holds up to ten card values from each reader in RAM memory. Caused by lack of host interrogation of data for this reader.

**Table 8.2.1.1 - Reader Status Indicators**



**Figure 8.2.1 –Location of Concentrator Indicators**

## 8.2.2 Concentrator Status Indicators

There are two (2) indicators that convey the internal status of the concentrator itself. These indicators are visible through a slot in the logic board cover. The meaning conveyed is listed in Table 10.2.2.1.

INDICATOR	MEANING
Logic Power	“ON” – Logic board has 5v dc power applied. This LED is connected directly to the +5v dc.
	“OFF” – The +5v dc power converter is not working.
Heartbeat	Should blink ON and OFF about once a second to indicate that the microprocessor is alive and well. If this LED is not blinking, there is a failure in the concentrator.

**Table 8.2.2.1 – Concentrator Status Indicators**

## **9 APPLICATION GUIDELINES**

This section discusses several issues that need to be considered in configuring a tracking system that uses the Accutrac components.



## 9.1 Serial vs. Parallel Communication Between Host and Concentrator

The UE5000C Concentrator can communicate with the host system, (computer or programmable controller), using either a serial or a parallel communication path. Both paths provide exactly the same functionality, only the message format is different.

Serial communication normally requires the use of a "computer based" host. This host could be an actual computer, or could be a coprocessor such as the AB 1771-DB BASIC Module.

The coprocessor program is usually set up to continuously request data from the UE5000C, using the ! message request. The ! message request returns a 3 byte binary message containing the status byte, the reader address and the code value. The program unpacks this message and places it into an array which is then transferred into the PLC's data table using a "block transfer" command in the PLC. This program normally handles all of the low margin and status value checking and only passes good code card values into the PLC data area.

Coprocessor speeds and the time required to perform a "block transfer command" normally limit the serial communication speeds to the equivalent of 10 code cards per second for a PLC with a BASIC card up to 80 code cards per second with a microprocessor based system.

When using the parallel interface, a PLC normally uses a 115-vac output card to send request messages to the concentrator and a 24-vdc input card to receive the code value from the concentrator. The PLC program uses a series of timers or counters to control the delays between reader selection and code value input. Because of the delays in the PLC I/O cards as well as the PLC scan times, the parallel communication method is normally limited to the input of 5 code cards per second.

For many tracking applications, both the serial and the parallel communication technique can provide the communication speed required. For these applications, the choice can be made on other criteria besides speed, such as plant preference, cost and programming convenience.

## 9.2 Response to 'Margin Low' Conditions

In order to properly respond to the "Margin Low" indication, it is necessary to review the process that results in a "Margin Low" indication.

The UE5100C-RS uses an array of infrared light emitting diodes (LEDs) and phototransistors to "read the code cards". Using infrared provides a high degree of immunity to ambient light, especially the commonly used fluorescent lamps.

In order to provide immunity to ambient light that has a high red content, such as incandescent and sodium vapor, the UE5100C-RS generates a very high level of infrared to its LEDs. This high energy level is many times more than is actually needed to accurately respond to the passage of a code card. Hence, the readers have a very high safety margin regarding the amount of infrared energy sent from emitter to detector.

This infrared safety margin will be decreased by excessively dirty windows, and by misalignment of the reader and code card. If this margin decreases below 0, then the reader will not be able to read the coded value on the card. However, the reader will never "misread a code card" due to reduced infrared energy, it will simply stop reading cards at this point.

In order to provide a warning that the safety margin has decreased, the reader periodically tests the emitter detector pairs at reduced infrared energy. If an emitter/detector pair no longer responds at this reduced energy, then a "margin low" condition is said to exist and the margin low indicator is set.

The criteria used to check the operating margins is designed to err on the safe side, and may occasionally generate false "margin low" indications. This happens primarily due to a code card or carrier moving into the reader during a margin check and partially blocking the emitter detector pair. An attempt is made to filter out these false responses, but some of them will get through.

Hence, the appropriate response is to discard the occasional "margin low" indication and only respond to a "continuous margin low indication". This is usually accomplished by incrementing a counter whenever a card is read with a margin low indication and resetting this counter every time that a card is read without a margin low indication. If the counter reaches some reasonable limit, say 10 to 50, then a response is appropriate.

**IMPORTANT**

Since the code card is never read during the reduced power condition, a low margin condition will not cause a code card to be misread. Hence, a "margin low condition" should not be treated as a serious or emergency condition, only as a warning that a reader has lost some of the excess infrared energy that it originally had.

If a reader has a continuous "margin low indication", stop the conveyor and remove all material from between the reader windows. If the "margin low indication" persists even when no code cards are passing through the reader, the windows should be cleaned and the alignment of the reader should be checked.

If a properly aligned and cleaned reader continues to have a "margin low indication" while there is no object between the windows, then the reader should be sent back to Industrial Computer for repair.

### 9.3 Handling “Error Conditions”

The UE5000C Concentrator and the UE5100C-RS Reader have a very high level of internal self-checking. Whenever one of these self-check fails, an "error" condition is generated. While an "error condition" exists, a status message will be returned to the host system indicating that a self-check has failed. Status messages have the same format as a data message; however, the status bit is set to indicate that the value field of the message contains a status number rather than a data number.

Errors can occur continuously, or intermittently. Furthermore, a reader may generate both data messages and status messages "at the same time".

For example, if a large motor or solenoid is energized at just the right time, electrical noise can be generated on the cable connecting the reader and its concentrator. This noise can cause a failure of communications between the reader and the concentrator. If this happens, the concentrator will place an error-20 message in its internal buffer, and set the corresponding LED to indicate that a communications problem has been detected. The concentrator will continue to communicate with the reader in question, and once the electrical noise has diminished, successful communications will occur, and the error condition will be cancelled. However, the original error-20 message will not be removed from the buffer. Hence, the PLC will receive the error-20 message and then will receive the correct data value.

Other transient errors can occur if a foreign object is passed through the reader. This will cause an error condition to exist due to the passage of the object. Once the object has been moved away, the reader will no longer have an error condition and will respond in its normal fashion. Hence, a status message may be placed into the buffer, immediately followed by a perfectly good data message.

Another error occurs if a code card or carrier blocks the reader for a long period of time without any motion. The self-test decides that there is an LED that will no longer work and sends an appropriate message. Once the object moves, there is no longer any error condition and the reader will respond in its normal fashion.

The appropriate response to error indications is to filter out the intermittent errors and only respond to a continuous error condition that interferes with reading the code cards. For example, communication error messages that are surrounded by valid data messages are an indication of a noisy communication line rather than of a "failed system". However, continuous communication errors without any data values are an indicator of a failed system that requires repair.

Since the Accutrak reader system will never incorrectly read a code card, many users simply ignore status messages as long as they are receiving code card values when expected. If a coded card value is not received from a reader when expected, then and only then is the last status message considered to be an "error message". Other users opt to count all status messages and make the accumulated count available for analysis.

## 9.4 Selective vs. Continuous Scanning

There are two broad techniques that can be used to communicate with a UE5000C concentrator and its associated readers.

The first technique requires that the host system watch the field devices and when the appropriate limit switch trips, then and only then is the concentrator requested to send the data regarding the corresponding reader. This technique requires that the host be able to specify the reader whose data is required. This technique also requires that arbitration programming be provided to handle the potential conflict when two field devices call for data at the same time.

The second technique continuously requests information from a concentrator and stores the resulting data, if any, in a data location corresponding to the particular reader. When the main program senses that data is needed, it simply checks the corresponding location and processes any data that is there. Since the host is continuously scanning the concentrator for reader data, this technique is referred to a "continuous scanning".

In general, the continuous scanning method gathers code card values at a higher rate than does the selective scanning, since it normally already has the data when the field device is tripped. However, if there are a large number of readers in a system and the system is heavily loaded with carrier traffic, then the data from a particular reader may not be available when the corresponding field device is tripped. This is particularly true when the conveyor speed is high and the field device is close to the reader. In this case, special programming will have to be used to avoid rejecting a valid carrier whose data has simply not yet been read.

## 10 THEORY OF OPERATION

A brief theory of operation is presented for each of the main components of the Accutrac I carrier-tracking system. The purpose of this section is to provide enough theory of operation to allow the user to be comfortable with the use of the Accutrac I system.

### 10.1 Code Cards

The UE52xxA series of code cards uses a unique coding scheme to encode a decimal number into the pattern of holes/no holes that are part of each code card. Since the code card is punched from heavy gage metal, it is very difficult to generate a new hole in the field, but relatively easy to make a hole "disappear" by blocking the hole with paint buildup or the application of opaque material. The coding scheme guarantees that no matter how many holes are blocked, either completely or partially, the encoded number can never be converted from one value to another.

Unlike other encoding schemes, the nature of the Accutrac encoding scheme does not rely on the card to be in motion, nor does it rely on the edges of the holes to carry information. Hence, the code card is extremely immune to changes in motion and hole degradation due to substance buildup.

### 10.2 Reader Theory of Operation

The UE5100C-RS reader consists of several printed circuit boards (PCBs) enclosed in a Nema-12 enclosure. The logic board contains a microprocessor with memory, dc:dc power converter, and serial interface. The emitter board contains an array of infrared (IR) light emitting diodes (LEDs). The detector board contains an array of infrared detectors. The various PCBs of the reader are connected together by small cables.

When dc power is first turned on, the microprocessor initializes the serial communication port used to communicate with the concentrator, activates the emitter and detector circuits, and enters the background-processing loop.

The emitter circuitry contains circuitry that sequentially pulses each of the IR emitters and checks the corresponding IR detector for the absence or presence of "light". Absence of light implies that some object, such as a code card, is between the emitter and detector pair and corresponds to a 0 value. Conversely, the presence of light implies that there is no blockage of light, i.e. a hole exists in any object between the emitter and detector. The presence of light corresponds to a 1 value.

As each of the IR emitter-detector pairs is energized, the absence or presence of light is converted to a 1/0 binary digit and saved for that pair. After all of the pairs are sampled, the resulting pattern of 1s and 0s is made available to the microprocessor for analysis.

In the background loop, the microprocessor constantly watches the serial communication path for messages from the concentrator, updates the LED display, and inputs the latest "light pattern" from the detector. As each light pattern value is input to the microprocessor, it analysis the pattern to determine if a valid code card is present between the emitter and detector units. Once a valid code card is detected, the microprocessor saves that value in an internal FIFO buffer where it stays until the concentrator requests the data via the serial port.

The "light pattern" is updated frequently enough to guarantee that several images of the code card are obtained even at the highest line speeds. The rate at which the optical image is updated, is not linked in any way to the blink rate for the display unit.

As soon as the reader determines that a valid code card is present, it immediately reduces the power to the IR emitters and checks that the same pattern of light and dark is detected at the reduced power level. If the pattern changes, for several consecutive tests, then the reader issues a "margin warning" to the concentrator where it is converted into the "margin bit" that is sent to the host.

A continuous assertion of the margin bit is an indication that the overall optical power of the reader has dropped below its normal value. Notice that, the reading of a code card always occurs using full optical power; the sole purpose of the margin test is to determine how much excess optical power remains.

The reader uses the RS422 protocol for communication between the reader and its concentrator.

### 10.3 Concentrator Theory of Operation

The UE5000C concentrator consists of two printed circuit boards. The large PCB is the motherboard and contains the field wiring terminal strips, the connector into which the logic board is plugged, and a number of high power resistors used to limit the amount of current to the parallel interface.

In addition, a diode is in series with the main + 24vdc power line to protect against accidental reversal of the dc power wiring. There are no integrated circuits on the motherboard.

The logic board contains a microprocessor, programmable read only memory (PROM) for program storage, random access memory (RAM) for data storage as well as the communication interface circuits that provide serial communication between the concentrator and the readers and the host system. The logic board plugs into a connector on the motherboard. This connector is used to connect the logic board circuitry to the field wiring terminals via the traces and resistors on the motherboard.

When dc power to the concentrator is turned on, the settings of the configuration switches are input to determine the operational characteristics of the concentrator. In addition, if the configuration switches are set to clear RAM, the contents of RAM are cleared at this time.

Once the initial start-up is completed, the microprocessor enables interrupts from the host computer and then enters the background-processing loop. In this loop, the concentrator continuously interrogates the card readers for information. As values are received from the card readers, the concentrator places the values into a FIFO in RAM, and updates the reader status LEDs on the motherboard.

The FIFO has room for about 10 values from each of the possible seven (7) readers connected to the concentrator. This information is retained until the host computer or PLC removes the information from the FIFO.

In addition to continuously interrogating the readers, the concentrator updates the concentrator display LEDs and watches the serial and parallel communication interfaces for data requests. As data request messages are received from the host system, either from the serial or parallel path, the processor honors the host request by removing the appropriate card reader value from the FIFO and sending a response message, over the appropriate path, back to the host.



The speed at which the LEDs blink, is in no way related to the speed at which the corresponding reader is interrogated. LED blinking occurs at a much slower rate than does the communication with the readers. In the worst case, each reader will be interrogated 20 times per second.

## **11 DIFFERENCES BETWEEN UE5100C-RS & Earlier READERS**

The UE 5100C-RS reader is completely equivalent to the earlier readers from Universal Systems (UE5100A, UE5100B-422 reader from a system standpoint. In particular:

- 1 - The UE5100C-RS Reader has the same physical dimensions as the UE5100B-422 and UE5100A Readers.
- 2 - The UE5100C-RS Reader uses the same external cable as the UE5100B-422 and UE5100A Readers.
- 3 - The UE 5100C-RS Reader interfaces with the UE5000C, UE500B and UE000A Concentrators exactly the same as did the earlier readers.

The only areas of differences occur in the internal construction and a minor change in the external display.

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