Vorne Industries

87/100
Serial Display
User's Manual

Notice Of Disclaimer

While the information in this manual has been carefully reviewed for accuracy, Vorne Industries, Inc. assumes no liability for any errors, or omissions in the information. Vorne Industries also reserves the right to make changes without further notice to any products described in this manual.

Chapter 1   Setting Up Your Display For Operation

1.1 Operation

The 87 Series AndOn display is designed for panel applications where a group of displays (PC Boards) will be mounted in an enclosure and will all be controlled from a single logic board. The displays can be grouped into one to eight digit fields with up to 64 different virtual displays.

This chapter describes how to set up the display hardware for operation, including setting the dip switches, connecting power, and wiring to the serial communication port. There are many references in this chapter to the term **host device**. Simply stated, the host device is whatever device will be sending serial data to the 87/100 display. Some typical host devices are PLC BASIC modules, computers, scales, master clock systems, panel meters, etc.

1.2   Accessing Wiring Connections And Selection Switches

All external power and communication line connections to the display are made to printed circuit board mounted terminal strips. These terminal strips, as well as a 10 position DIP switch, and COM PORT selection switch are easily accessible.

1.3   Setting The DIP Switches For Your Application

Note: Changes to the DIP switches are only acknowledged at power up. Factory default settings are shown in gray.

Run and Program Modes

1	Mode
ON	Program
OFF	Run

For normal operation the Run/Program switch should be set to Run (off). Setting the unit to Program mode allows the unit to be customized using VDP4 and to run one of two diagnostic routines. If DIP switch 2 is off, the display cycles thru the following display diagnostic.

        a. Error status   Should show E0. E1 or E2 indicates a memory error.
        b. Unit Address   Default value is 00. This will not match the DIP switch address.
        c. Red segment test   The unit will turn on 1 segment at a time A thru F and DP.
        d. Green segment test. For a single color display a blank screen will be displayed.
        e. All segments ON.
        f. Unit type.   1 = 87/100
        g. --.   This is a separator between the Unit type and the Software version.
        h. Software version. This number is displayed on two consecutive screens (Ex: 1.1.3).

If DIP switch 2 is on, the display runs a DIP switch diagnostic. This diagnostic displays the HEX value of DIP switches 3 thru 10. (switches 3 to 6 = MSD, switches 7 to 10 = LSD)

DIP Switch Settings

Most And On applications will be setup using VDP4. The display field size and number of virtual displays must be programmed into the unit. If VDP4 mode is selected, DIP switches 3 thru 10 are ignored. For normal operation the Settings DIP switch should be set to DIP switch (on). In program mode, Switch 2 selects between Display test (off) and DIP switch test (on).

2	Settings
ON	DIP Switch
OFF	VDP4

Baud Rate

The **baud rate** of your 87 series display determines how fast serial data will be communicated to the display. In all cases this setting must match the baud rate of the device that will be sending serial data to the display (the host device).

3	4	Baud Rate
OFF	OFF	300
OFF	ON	1,200
ON	OFF	9,600
ON	ON	19,200

Data Bits

The number of Data Bits selected must match the number of data bits transmitted by the host.

5	Data Bits
ON	8
OFF	7

Terminator

The Terminator selection specifies which character ends the transmission. In cases where the host device transmits a <CR><LF> combination as the terminator, select <CR>.

6	Terminator
ON	<LF>
OFF	<CR>

Communication Protocol And Address

The first communication protocol is **Terminator Only**. This is for applications where you can control the data being transmitted to the display, and wish to use the very simplest form of communication possible. We define this simplest form of communication as sending the data to be displayed, followed by a carriage return or line feed character. If this seems to be the best communication protocol for your application, refer to Chapter 2 Using Terminator Only Protocol.

To select Terminator Only protocol, set DIP switches 7, 8, 9, and 10 to the ON position.

The second communication protocol is the **Simple Packet** protocol. This is for applications where you can control the data being transmitted to the display, but where you would like to access some advanced features. These features include independently addressing multiple displays, sending an optional checksum to validate the data, receiving an optional acknowledgment from the display to verify the receipt of data, flashing the display, or controlling an optional relay in the display. If this seems to be the best communication protocol for your application, please refer to Chapter 3 Using The Simple Packet Protocol.

7	8	9	10	Address	Protocol
OFF	OFF	OFF	OFF	0	Simple Packet
OFF	OFF	OFF	ON	1	Simple Packet
OFF	OFF	ON	OFF	2	Simple Packet
OFF	OFF	ON	ON	3	Simple Packet
OFF	ON	OFF	OFF	4	Simple Packet
OFF	ON	OFF	ON	5	Simple Packet
OFF	ON	ON	OFF	6	Simple Packet
OFF	ON	ON	ON	7	Simple Packet
ON	OFF	OFF	OFF	8	Simple Packet
ON	OFF	OFF	ON	9	Simple Packet
ON	OFF	ON	OFF	10	Simple Packet
ON	OFF	ON	ON	11	Simple Packet
ON	ON	OFF	OFF	12	Simple Packet
ON	ON	OFF	ON	13	Simple Packet
ON	ON	ON	OFF	14	Simple Packet
ON	ON	ON	ON	None	Terminator Only

1.4   Designing an 87/100 Andon Display System

This section describes in detail how to design an Andon Display System, a task which should be performed only by qualified electricians or electrical engineers. These instructions apply to systems built with 92-0365-A Repeater Boards. Please consult the factory for assistance with systems built with earlier version Repeater Boards.

WARNING!

Completely disconnect power from all components before wiring. Wiring while power is applied can cause permanent damage to the Logic and Display Boards.

CAUTION: ELECTROSTATIC SENSITIVE DEVICES

Observe precautions for handling Electrostatic sensitive devices.

Overview

An Andon Display System consists of the following main electrical components:

- Logic Board – Provides an interface between the external host and the Andon Display System, and is responsible for refreshing data on the Display Boards
- Display Boards – Responsible for the actual display of data, with up to 64 digits supported per Logic Board
- Repeater and Terminator Boards – Used to maintain signal integrity of data signals between the Logic Board and all Display Boards
- Power Supply – One or more 12VDC power supplies, specified and provided by the company building the Andon Display System
- Ribbon Cables – Provides electrical interconnections between Logic, Display, Repeater and Terminator boards.

System Design Issues

All system components must be mounted in a single enclosure, as logic level signals are used to transfer data between Boards, and these signals are subject to EMI (Electro-Magnetic Interference).

Standard practices for minimizing the effects of EMI must be followed when laying out component locations and wire routing within the enclosure. For example, all cable lengths should be kept as short as possible, and different classes of wiring (AC line to Power Supply, 12VDC from Power Supply, Ribbon Cables) should be routed separately and independently from each other.

Logic Board

The Logic Board provides the interface (a serial communication port) between the external host (typically a computer or PLC) and the Andon Display System.

The Logic Board must have a separate 12VDC power connection brought directly from the Power Supply. Power connections are made to the Logic Board via two PC mount screw terminal connections, marked 12VDC and 0VDC.

The DIS1 connector is the output connector of the Logic Board, which is used to interface to a maximum of 64 Display Boards (which are all daisy chain connected from DIS1).

Display Boards

Each Display Board group (reference the Power Supply section below for more information on Display Board groups) must have a separate 12VDC power connection brought directly from the Power Supply, to the centermost digit of the group. Power connections are made to the Display Board via two PC mount screw terminal connections, marked 12VDC and 0VDC.

The DIS2 connector is the input connector of the Display Board and the DIS3 connector is the output connector of the Display Board.

Repeater Boards

Repeater Boards buffer data signals to Display Boards. This allows the signals to operate over longer distances with less signal degradation. One Repeater Board is normally installed between each group of up to (8) Display Boards.

The Repeater Board has a series of jumpers that must be carefully and correctly configured:

- Jumpers J1 to J4 are used to break the 12VDC supply connection between the input and output connectors of the Repeater Board in cases where Display Board groups on each side of the Repeater Board are wired to different Power Supplies. In systems with only one Power Supply, J1 to J4 must be installed on every Repeater Board. In systems with multiple Power Supplies, J1 to J4 are removed ONLY on Repeater Boards where Display Board groups on each side of the Repeater Board are wired to different Power Supplies.

- J5 is used to break the 5VDC supply connection (generated by the Repeaters themselves) between groups of Display Boards. It must be removed in any case where there are (3) Display Boards or less, or a Logic Board, connected to DIS2 (the Repeater Board input connector). In all other cases it must be installed.

- J6 and J7 are used to "terminate" the data signals on each Repeater Board (this improves the signal integrity as data passes through cables and Display Boards), and must be installed on all but one Repeater Board (the one which is connected to the Logic Board).

As a general rule, a Repeater Board must be placed:

- Near the Logic Board, between the Logic Board and the first Display Board (J5 must be removed, J6 and J7 must be removed)
- After every (8) Display Boards, or every 10' of cable (J6 and J7 must be installed)

The DIS2 connector is the input connector of the Repeater Board and the DIS3 connector is the output connector of the Repeater Board.

Terminator Board

The Terminator Board electrically terminates data signals used in the system. There must be one Terminator Board for each system, and its DIS2 connector must be connected to the DIS3 connector of the last Display Board in the system.

Power Supply

The only customer supplied power supply voltage that is required is a well-regulated 12VDC ±5%. It is very important to select one or multiple Power Supplies, with a combined current capacity sufficient to operate the entire system. The following table describes the current required for each component type.

Model Number	Description	Red or Yellow –YL Option	Green -GR Option	Tri-Color –TR Option
87/100-L	Logic Board		0.10A	
87/100-4D	4" Discrete Segment	0.14A	0.14A	0.28A
87/100-6D	6" Discrete Segment	0.26A	0.28A	N/A
87/100-8D	8" Discrete Segment	0.38A	0.40A	N/A
87/100-12D	12" Discrete Segment	0.50A	N/A	N/A

The maximum number of Display Boards in a Display Board group is the lesser of (8) or the number of Display Boards that draw up to 3A of current (for example six 12" Discrete Segment Red Display Boards).

For best system power stability, as well as improved EMI immunity, a separate set of power connections (12VDC and 0 VDC) must be brought to the Logic Board and to each Display Board group. It is highly recommended to always connect power to the centermost digit of each Display Board group. The gauge of wire must be rated at least three times the amount of current drawn.

Ribbon Cables

Ribbon Cables are used to interconnect system Boards (Logic, Display, Repeater and Terminator), and as such they provide both data and power connections. The Ribbon Cables can carry up to 3A of 12VDC between Boards. Vorne provides Ribbon Cables in a variety of lengths as shown in the following table.

Part Number	Length
93-0116	2.0"
93-0114	6.0"
93-0121	8.0"
93-0122	10.0"
93-0115	14.0"
93-0136	18.0"
93-0117	36.0"
93-0155	48.0"

The Ribbon Cable assemblies use 2 Row 7 Conductor sockets with 0.1" spacing, and 14 Conductor 0.05" 28 AWG ribbon cable. Be very careful to route the Ribbon Cables separate from AC power, and keep all connections as short as reasonably possible.

Wiring Diagram

The diagram below shows a typical wiring example for a small Andon Display System.

1.5 Basic Information About Serial Communication Ports

This section provides some basic background information regarding different types of serial communication ports. Each 87/100 display contains both an RS-232 port and an RS-485 port (which is also compatible with RS-422 communication), however, *only one of the two ports can be used at any given time to communicate with a host device*.

RS-232 ports are the most common type of serial ports, although they are more common in an office environment than an industrial environment. This is because RS-232 can only be run for short distances (under 50 feet), and in environments where EMI (electromagnetic interference) is minimal. Also, one host RS-232 port is normally limited to directly communicating with one device. Every 87/100 display has a built in data converter that overcomes this limitation.

RS-422 ports are very common in industrial environments. They are well suited for distances up to 4000 feet, and have substantially superior EMI immunity characteristics. Additionally, one host RS-422 port can communicate with a minimum of 10 devices without repeating the signal.

RS-485 ports are basically an improved version of RS-422, and in most cases are completely compatible with RS-422 devices (and vice versa). In fact, many newer products with built in RS-422 ports actually use driver circuits that meet the RS-485 specification (87 series displays fall into this class). RS-485 offers better EMI immunity characteristics, and improved drivers that have the ability to communicate with up to 32 devices without repeating the signal. There is sometimes confusion regarding RS-485 because it has an additional ability to communicate in both directions over one pair of wires, a feature not supported by RS-422 or by 87 series displays.

20 mA current loop was commonly used for industrial applications in the past but is less common today. To use a 20mA current loop serial port with an 87/100 display, all that is required is an external 20 mA current loop to RS-422 converter. Vorne can provide such a converter if your application requires it.

1.6 RS-232 Communication To A Single Display

This section provides the information necessary to successfully interface a host RS-232 port to one 87/100 display. If you would like to interface a host RS-232 port to multiple 87/100 displays, read this section as well as sections 1.6 and 1.7.

Selecting RS-232 Communication

A printed circuit board mounted COM PORT slide switch, located approximately one inch below the COM PORT terminal strip, is used to select between RS-232 and RS-422/RS-485 communication. Set this switch to the **RS-232** position.

RS-232 Connectors

The RS-232 port is fully opto-isolated and is available on pins 3 to 5 of the 9 pin communication port terminal strip (marked P2). The RS-232 portion of this terminal strip is shown below.

9 Pin COM PORT Terminal Strip (P2)	Pin	Function
Pins 3 to 5 RS-232 Port	3	RS-232 Transmit Data (TxD)
	4	RS-232 Receive Data (RxD)
	5	Isolated Communication GROUND
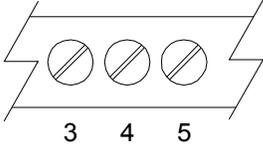
Many host devices use either DB25 or DB9 connectors for their RS-232 ports. For your reference, two common RS-232 DB interfaces are shown below. They are the standard male DB25 interface, and the standard male IBM/AT® style DB9 interface.

Standard Host Device RS-232 DB Connectors

DB25 MALE

Data Carrier Detect (DCD)
Signal Ground
Data Set Ready (DSR)
Clear To Send (CTS)
Request To Send (RTS)
Receive Data (RxD)
Transmit Data (TxD)

Data Terminal Ready (DTR)

Ring Indicator (RI)

DB9 MALE

Data Carrier Detect (DCD)
Receive Data (RxD)
Transmit Data (TxD)
Data Transmit Ready (DTR)
Signal Ground

Ring Indicator (RI)
Clear To Send (CTS)
Request To Send (RTS)
Data Set Ready (DSR)

Wiring Diagram For An RS-232 Host Device To One Display

The only connections necessary for two way communication between a host device and an 87/100 display are the ones shown in the diagram below. Please refer to the Guidelines For Wiring RS-232 Devices section below for important wiring recommendations. For one way communication from the host to the display, the transmit data (TxD) line from the display (pin 3) does not need to be connected to the host device.

PLC

Receive Data (RxD) —————————— Transmit Data (TxD) 3
Transmit Data (TxD) —————————— Receive Data (RxD) 4
Signal GROUND —————————— Isolated GROUND 5

HOST DEVICE

87/232 DISPLAY

2345
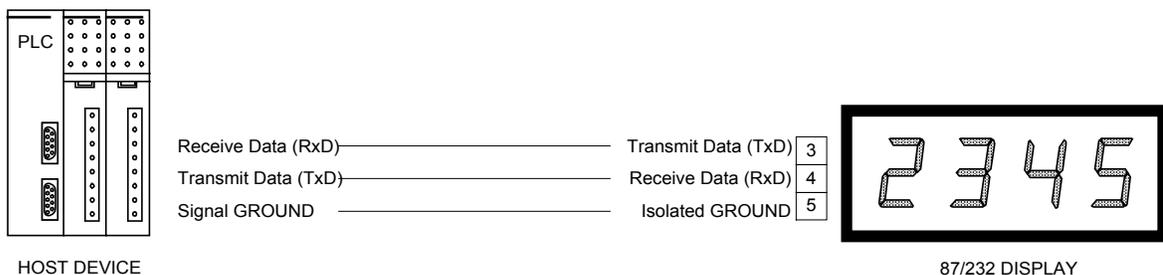
Guidelines For Wiring RS-232 Devices

For best results when wiring RS-232 devices please follow these guidelines:

1. Use a 50 foot maximum cable length.

2. Use a baud rate of 19,200 or less.

3. Use a shielded cable with the shield connected to Earth Ground *only at the 87/100 display.* Belden 9842 is a recommended cable.

4. Carefully check your equipment and cable to ensure that Earth Ground is *not* connected at both ends of the cable. If there is a significant difference in Earth Ground potential between the two ends of the cable, it could cause data transmission errors, or even damage to the RS-232 communication ports.

5. Keep the cable length as short as possible, and do not run the RS-232 cable parallel to any power cables.

1.7 RS-422 Or RS-485 Communication To One Or More Displays

This section provides the information necessary to successfully interface a host RS-422 or RS-485 port to one or more 87/100 displays. Note that the 87/100 display contains an opto-isolated RS-485 port which is also fully compatible with RS-422 host devices.

Selecting RS-422/RS-485 Communication

A printed circuit board mounted COM PORT slide switch, located approximately one inch below the COM PORT terminal strip, is used to select between RS-232 and RS-422/RS-485 communication. Set this switch to the **RS-485** position.

RS-422/RS-485 Connectors

The RS-422/RS-485 port is fully opto-isolated and is available through the last five pins of the nine pin communication port terminal strip (marked P2). The RS-422/RS-485 portion of this terminal strip is shown below.

| 9 Pin COM PORT Terminal Strip (P2)	Pin	Function
Pins 5 to 9 RS-422/RS-485 Port	5	Isolated Communication GROUND
	6	RS-422/RS-485 Transmit Data (TxD) +
	7	RS-422/RS-485 Transmit Data (TxD) -
	8	RS-422/RS-485 Receive Data (RxD) +
5 6 7 8 9	9	RS-422/RS-485 Receive Data (RxD) -
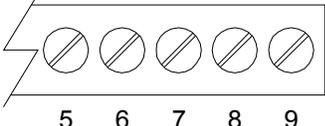
Wiring Diagram For An RS-422 Or RS-485 Host Device To One Display

Below is a diagram which shows how to wire an RS-422 (or RS-485) host device to one display. Please refer to the Guidelines For Wiring RS-422 Or RS-485 Devices section below for important wiring recommendations, and take special note of the four terminating resistors shown in the diagram below. For one way communication from the host to the display, the transmit data (TxD) lines from the display (pins 6 and 7) do not need to be connected.

HOST DEVICE

87/232 DISPLAY
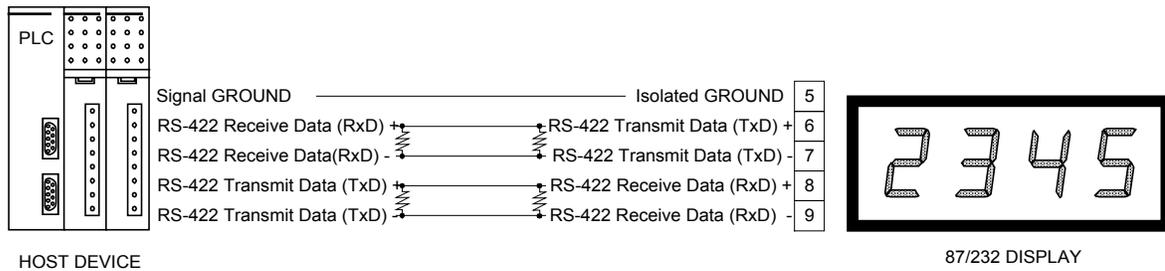
Wiring Diagram For An RS-422 Or RS-485 Host Device To More Than One Display

Below is a diagram which shows how to wire an RS-422 (or RS-485) host device to multiple displays. Please refer to the Guidelines For Wiring RS-422 Or RS-485 Devices section below for important wiring recommendations, and take special note of the four terminating resistors shown in the diagram below.

HOST DEVICE

1ST 87/232 DISPLAY

2ND 87/232 DISPLAY

LAST 87/232 DISPLAY
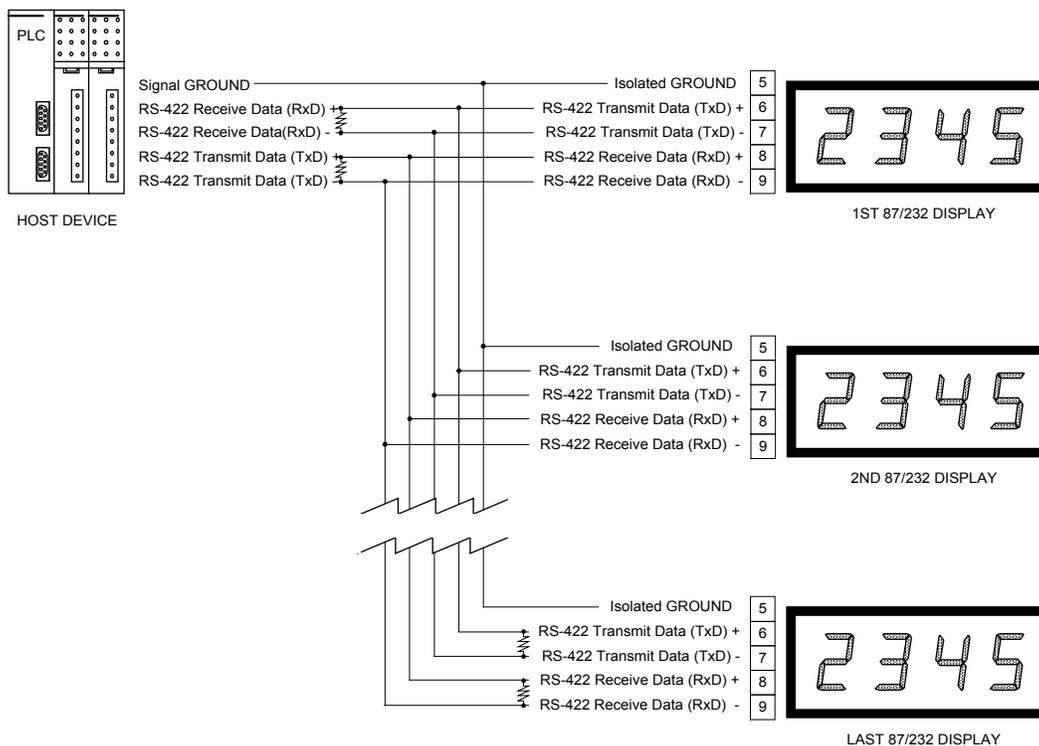
Guidelines For Wiring RS-422 Or RS-485 Devices

For best results when wiring RS-422 or RS-485 devices please follow these guidelines:

  1. Use a 4,000 foot maximum total cable length.

  2. Use a maximum of 10 displays connected to one RS-422 host port, or 32 displays connected to one RS-485 host port unless your host device specifies a higher number.

  3. Use a shielded cable with the shield connected to Earth Ground *only at the 87/100 display.* Belden 9843 is a recommended cable.

  4. Carefully check your equipment and cable to ensure that Earth Ground is *not* connected at both ends of the cable. If there is a significant difference in Earth Ground potential between the two ends of the cable, it could cause data transmission errors, or even damage to the RS-422 or RS-485 communication ports.

  5. Terminate the cables. *In all RS-422 and RS-485 installations, the cable must be correctly terminated with two sets of resistors, one set at each end of the network. This applies even if you are only using one display connected to one host device.* The terminating resistors prevent reflection problems that can interfere with data transmission. The resistance value of the terminating resistors should match the characteristic impedance of the cable. A typical value is 120 ohms. The terminating resistors must be placed at the two farthest ends of the RS-422 or RS-485 network, regardless of where the host device is. In some cases host device RS-422 and RS-485 ports have built in or optional terminating resistors. Take care to check that your network (whether it has one display or 32 displays) has only two sets of terminating resistors.

  6. In applications with multiple displays, bring the communication wiring point to point. In other words do not run stubs from the "backbone" network wiring to each display. If you find it absolutely necessary to run a stub from the backbone network wiring, make sure it is under one foot in length.

1.8   RS-232 Communication To More Than One Display

87/100 displays have a built in data converter that can be used to convert host device RS-232 data to RS-485 data and vice versa. This allows the host device to communicate via RS-232 to one 87/100 display (called the **converting display**), which will retransmit any RS-232 data received from the host device as RS-485 data to all other displays in the network. Likewise, any RS-485 data received by the converting display from other displays in the network will be retransmitted out its RS-232 port to the host device.

To wire a network of displays that can be communicated to from one host device RS-232 port, follow these steps:

Step 1:   Wire your host device RS-232 port to the first display's RS-232 port as described in Section 1.5 RS-232 Communication To A Single Display. This display will be the converting display. Make sure to set the COM PORT slide switch to the **RS-232** position *only* for the converting display. All other displays in the network should have the COM PORT slide switch set to the **RS-485** position.

Step 2:   Use the converting display's RS-485 port to connect to other displays in the network as described in Section 1.6 RS-422 Or RS-485 Communication To One Or More Displays.

Where RxD+ of the converting display is connected to RxD+ of the other displays in the network and RxD- of the converting display is connected to RxD- of the other displays in the network.

1.9 Understanding The General Display Format

The default display format is right justified, leading zeroes blanked and no fixed decimal point. These settings can be changed with *VDP4. VDP4* is a Windows™ based utility that allows customization of the 87/100 display. See Chapter 4 for additional details.

Chapter 2   Using Terminator Only Protocol

This chapter describes the communication protocol of **Terminator Only**. This is for applications where you can control the data being transmitted to the display, and wish to use the very simplest form of communication possible.

2.1 Terminator Only Protocol Communication Format

The format of **Terminator Only** communication is:

Data Terminator

Data　　　　　Any ASCII characters you wish to display (refer to Appendix B for a full character set listing).

Terminator　　A special ASCII character which marks the end of the data (and thus immediately follows it). The terminator character is a dip switch setting. Note that the symbol **<CR>** represents the ASCII "Carriage Return" character (0D hex/13 decimal), and the symbol **<LF>** represents the ASCII "Line Feed" character (0A hex/10 decimal). In cases where the host device transmits a <CR><LF> combination as the terminator, select <CR>.

Examples

The following examples assume that the default Terminator of **<CR>** is selected.

To Show On The Display...	Transmit
1234	1234<CR>
888.8	888.8<CR>

Chapter 3   Using The Simple Packet Protocol

This chapter describes the communication protocol of **Simple Packet**. This is for applications where you can control the data being transmitted to the display, but where you would like to access advanced features. These features include independently addressing multiple displays, flashing the display, or controlling an optional relay in the display.

3.1   Simple Packet Communication Format

The format of **Simple Packet** communication is:

<SOH> Type Address ; Virtual Display Address : Command Data Terminator Checksum

<SOH> The symbol **<SOH>** represents the ASCII "Start Of Header" character   (01 hex/1 decimal), and must be the first character of every transmission. Since the purpose of the **<SOH>** character is to mark the beginning of a new packet, it cannot appear anywhere else within the transmission.

Type Can be one of two ASCII characters (**S** or **s**), and must be the second character of every transmission. This character lets the display know if the serial data is meant for an individual address or a group address.

S   Serial data for an individual address.
s   Serial data for a group address.

If your application does not require addressing individual displays or groups of displays, you should use the type **s**. This will allow data that you send to be acted upon by every display that receives it (as explained below).

Address Can range from **0** to **255**, and is an optional part of the packet that specifies an actual unit or group address. If no address is included in the packet, the default address of **0** will be used. Addresses 0 to 14 are selectable using the internal DIP switch. Setting a unit to addresses 15 to 255 requires VDP4.

Note that a transmitted *group* address of **0** is a broadcast to all units, regardless of what the internal address of each display is set to. Thus, when no addressing is required, you can skip the **Address** part of the packet, and rely on the fact that a default address of 0 will automatically be substituted. In this case, the complete header before the data would be **<SOH>s:** and the data will be acted on by all displays that receive it.

For more information about individual and group addressing see Section 3.3 Addressing Multiple Displays.

; The ASCII "Semicolon" character (3B hex/59 decimal) must be included in every transmission, and is used to separate the address part of the packet from the virtual display address.

Virtual Display

Address   This parameter specifies which virtual display will receive the data portion of the Simple Packet string. A virtual display can consist of one to eight digits. The Virtual Display Address can range from 0 to 63. Virtual Display Address 0 is the first display connected to the logic board. The size and quantity of virtual displays must be programmed into the logic board using VDP4. VDP4 is a Windows based utility that allows customizing the operation of the unit.

:   The ASCII "Colon" character (3A hex/58 decimal) must be included in every transmission, and is used to separate the header part of the packet from the data.

Command   Can contain one command string for the display. Command strings can be used to display data, set the clock, flash data on the display, or control the optional relay. The available commands are fully described in Section 3.2 Simple Packet Commands.

Data   Any ASCII characters you wish to display (refer to Appendix B for a full character set listing). The control characters **<SOH>**, **<CR>** and **<LF>** cannot be used in the **Data** part of the packet, as they are reserved for marking the beginning and end of packets.

Terminator   A special ASCII character which marks the end of the data (and thus immediately follows it). The Terminator character is a DIP switch selection. Note that the symbol **<CR>** represents the ASCII "Carriage Return" character (0D hex/13 decimal), and the symbol **<LF>** represents the ASCII "Line Feed" character (0A hex/10 decimal). In cases where the host device transmits a <CR><LF> combination as the terminator, select <CR>.

Checksum   This is an optional part of the packet that can be used to provide an extra level of data validation. If used, the checksum immediately follows the Terminator character. Please request the Advanced Applications Guide if you are interested in using a checksum.

3.2   Simple Packet Commands

The command portion of the packet can contain one (and only one) command string for the display. Command strings can be used to display data, set the clock, flash data on the display, change display color on tri-color displays, or control the optional relay. Each of these commands is fully described below.

To accomplish more than one command (e.g. flash data on the display and turn the relay on), you must send a separate packet for each command.

Remember that the control characters **<SOH>**, **<CR>** and **<LF>** cannot be used anywhere in the data portion of the packet, as they are reserved for marking the beginning and end of packets.

Display Data

Data to be displayed is preceded by the ASCII character **D** (44 hex/68 decimal). Note that the **D** must be upper case. The data will be displayed in a fixed (non-flashing) manner.

The following examples assume that addressing is not being used, and that Terminator has been selected as **<CR>**. Also note that the header of the packet **<SOH>s:** has the effect of broadcasting to all displays, overriding any group or individual address a display might be set to.

To Show On The Display...	Transmit
1234	<SOH>s:D1234<CR>
888.8	<SOH>s:D888.8<CR>

Flash Data

Data to be displayed flashing is preceded by the ASCII character **F** (46 hex/70 decimal). Note that the **F** must be upper case. The data will be displayed flashing.

The following examples assume that addressing is not being used, and that Terminator has been selected as **<CR>**. Also note that the header of the packet **<SOH>s:** has the effect of broadcasting to all displays, overriding any group or individual address a display might be set to.

To Flash On The Display ...	Transmit
1234	<SOH>s:F1234<CR>
888.8	<SOH>s:F888.8<CR>

Change Color (For Tri-color Display's)

Some 87 series displays are available with a tri-color display option. With the tri-color option, each digit color can be individually set to red, yellow or green.

The **Color** command string begins with the ASCII character **C** (43 hex/67 decimal). Note that the **C** must be upper case. The rest of the data consists of a string of upper case ASCII characters which represent the color each digit of the display should be set to, starting with the most significant (left most) digit. The available colors are:

Color	ASCII Character	Hex/Decimal Representation
Red	**R**	52 hex/82 decimal
Yellow	**Y**	59 hex/89 decimal
Green	**G**	47 hex/71 decimal

If the **C** command is sent with only one color character (for example **CR**), the entire display will be set to that color. The **Color** command takes effect as soon as it is received.

The following examples assume that addressing and checksums are not being used, and that **Terminator** has been selected as **<CR>**. Also note that the header of the packet **<SOH>s:** has the effect of broadcasting to all displays, overriding any group or individual address a display might be set to.

To Set The Display Color To...	Transmit
All Yellow	<SOH>s:CY<CR>
2 Digits Red, 2 Digits Green	<SOH>s:CRRGG<CR>

Activate Relay

An optional relay output board can be added to the 87/100 display, to be used for additional annunciation.

WARNING

Use the relay for annunciator applications only. Do not use it for control.
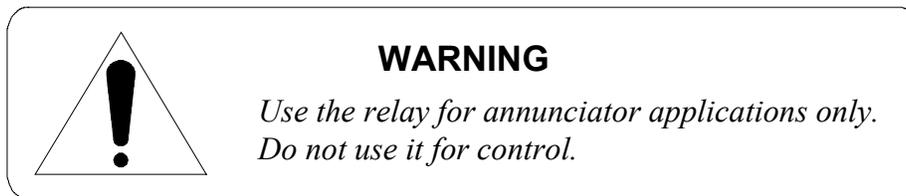
The **Relay** command string begins with the ASCII character **R** (52 hex/82 decimal). Note that the **R** must be upper case, and must be followed by one character (which determines what relay action will occur). The available actions are:

Action	ASCII Character	Hex/Decimal Representation
Turn relay on	1	31 hex/49 decimal
Turn relay off	0	30 hex/48 decimal
Sequence A	A	41 hex/65 decimal

Sequence A is a user definable relay sequence (e.g. cycle the relay 20 times with each cycle consisting of 1.0 second on and 2.0 seconds off), which can be triggered with one command. For more information about the user definable relay sequence, please refer to Chapter 4 Advanced Features Of The 87/100 Display.

The following examples assume that addressing and checksums are not being used, and that **Terminator** has been selected as **<CR>**. Also note that the header of the packet **<SOH>s:** has the effect of broadcasting to all displays, overriding any group or individual address a display might be set to.

To....	Transmit
Turn the relay on	<SOH>s:R1<CR>
Turn the relay off	<SOH>s:R0<CR>
Trigger Sequence A	<SOH>s:RA<CR>

3.3 Addressing Multiple Displays

Using an RS-422 or RS-485 network (described in Section 1.6 RS-422 Or RS-485 Communication To One Or More Displays) together with addressing allows a host computer or PLC to communicate with specific individual displays or groups of displays in a network. Each display in the network may be assigned a unit address *and* a group address. If you do not need to address individual displays, or groups of displays, simply leave the display set to the default setting of Terminator only (DIP switches 7, 8, 9 and 10 ON), and skip this section.

Unit Address

Unit Address is a DIP switch selection that allows you to select an individual unit address. Individual unit addresses can range from **0** to **255**, allowing up to 256 displays to be individually addressed in a network. Using the DIP switch, up to 15 addresses (0 to 14) can be selected.

If a packet is directed to a specific unit address, only units set to that address will respond to the data. More than one display may use the same unit address. Remember, if the data in the packet is meant for a specific unit address, the serial data type **S** must follow the **<SOH>** character in the transmission packet (as shown in the examples below).

The following examples assume that Unit Address is set to **10**, checksums are not being used, and that Terminator has been selected as **<CR>**. Also note that an upper case **S** follows the **<SOH>** indicating that the serial data is intended for an individual display address, and the **D** command character is being used to display data.

To Show Only On Displays With A Unit Address Of 10...	Transmit
1234	<SOH>S10:D1234<CR>
888.8	<SOH>S10:D888.8<CR>

3.4 Addressing Virtual Displays

Virtual displays can be addressed individually. The logic board must be programmed with the field size, and quantity of virtual displays.
The following examples assume that eight four digit fields have been defined, the unit address is not being used, and that Terminator has been selected as **<CR>**. Also note that the header of the packet **<SOH>s:** has the effect of broadcasting to all units, overriding any group or individual address a display might be set to.

To Show ...	On Virtual Display...	Transmit
1234	0	<SOH>s;0:D1234<CR>
5678	1	<SOH>s;1:D5678<CR>
9012	2	<SOH>s;2:D9012<CR>
888.8	3	<SOH>s;3:D888.8<CR>
1122	4	<SOH>s;4:D1122<CR>
3344	5	<SOH>s;5:D3344<CR>
5566	6	<SOH>s;6:D5566<CR>
7788	7	<SOH>s;7:D7788<CR>

3.5 Using Checksums And Command Acknowledgments

Using checksums and command acknowledgments can improve the reliability of data transfer between the host device and the display. They are optional features of the simple packet protocol - either or both can be used.

Checksums allow the display to check if data has become corrupted during transmission from the host device to the display. Command acknowledgments are used to let the host device know if data received by the display can be acted upon (i.e. the data is valid for the command transmitted, and the command and data are appropriate for the particular display). If checksums are being used, command acknowledgments also provide a means of letting the host device know that the data was received with a proper checksum.

If you are interested in using checksums and/or command acknowledgment to improve data transfer reliability, please request the Advanced Applications Guide.

Chapter 4   Advanced Features Of the 87/100 Display

The 87/100 has been designed in such a way that it can be customized to meet a users specific requirements. The unit is shipped from the factory set to DIP switch settings. The DIP switch settings allow the user to select the baud rate (300, 1200, 9600, or 19200), number of data bits (7 or 8), line terminator (<CR> or <LF>), and Unit Address (0 to 14 or Terminator Only). The DIP switch settings have been selected so that a majority of users can setup the display with minimal effort.

Additional settings such as right justified data, leading zeroes blanked, and no fixed decimal point are programmed at the factory and are not DIP switch selectable. Applications that do not fit the DIP switch settings can be accommodated by using VDP4 to customize the operation of the 87/100 display. *VDP4* is a Windows^{TM} based utility that is available from Vorne. To bypass the DIP switch settings, DIP switch 2 should be set to VDP4 (off). Setting the unit to VDP4 allows the unit to operate with the settings that are stored in a EEPROM on the logic board.

For additional information on topics discussed in this chapter, request the Advanced Applications Guide.

4.1   VDP4 Options

The following is a list of 87/100 options that can be programmed using VDP4.

Baud Rate

Available selections are 300, 600, 1200, 2400, 4800, 9600, 19200, or 57600.

Data Bits

Available selections are 7 or 8.

Display Justification

Available selections are Left or Right Justify.

Leading Zeroes

Available selections are Do Not Blank or Blank leading zeroes.

Fixed Decimal Point After Digit

Available selections are None, 1, 2, 3, 4, 5, 6, 7, or 8.

Virtual Display Format

The display field size and quantity of virtual displays can be specified. The field size can be set from 1 to 8 digits. Up to 64 virtual displays can be specified.

Header

The header is used by the display to identify the beginning of a matching data stream. This parameter is only available in Universal Protocol mode, and is limited to 16 characters.

Terminator

The Terminator selection specifies which character ends the transmission. Available selections are <CR> or <LF>. Additional selections are available in Universal Protocol mode.

Checksum

This is an optional part of the packet that can be used to provide an extra level of data validation. If used, the checksum immediately follows the Terminator character.

Command Acknowledgment

Command acknowledgments are used to let the host device know if data received by the display can be acted upon (i.e. the data is valid for the command transmitted, and the command and data are appropriate for the particular display). If checksums are being used, command acknowledgments also provide a means of letting the host device know that the data was received with a proper checksum.

Unit Address

Unit Address allows you to select an individual unit address. Individual unit addresses can range from **0** to **255**, allowing up to 256 displays to be individually addressed in a network.

Member of Group(s)

Member of Group(s) allows you to select any combination of up to eight display groups that the display can belong to. A packet addressed to a specific group or combination of groups will only be acted on by displays belonging to the group(s). Available selections are 1 to 8.

Relay Setup

Relay Sequence A is user definable as either a Delay On Relay or Cycle Relay. The Delay On Relay selection allows adjustment of the delay and duration time. These settings are adjustable from .1 to 25.5 seconds. The Cycle Relay selection allows specifying the ON time (.1 to 25.5 sec.), OFF time (.1 to 25.5 sec.), and number of cycles (adjustable from 1 to 255 times).

Selecting A Communication Protocol

The **communication protocol** is a very important selection, as it determines the basic manner in which you will be communicating to the display. Different types of applications lend themselves naturally to different communication protocols. We have divided typical applications into four groups, each with it's own communication protocol. This section gives guidance in which communication protocol will best suit your application.

Terminator Only: This is for applications where you can control the data being transmitted to the display, and wish to use the very simplest form of communication possible.
Terminator Only protocol is available by setting the address DIP switch to Terminator Only (switches 7, 8, 9 and 10 ON).

Simple Packet: This protocol is for applications where you can control the data being transmitted to the display, but where you would like to access advanced features. These features include independently addressing multiple displays, flashing the display, or controlling an optional relay in the display. Simple Packet protocol is available by setting the address DIP switch to settings 0 to 14. VDP4 allows defining addresses 0 to 255.

This protocol can also be used for applications where you simply want to connect one or more 87/100 displays to a keypad, and display whatever you type in. It is also used for clock applications where the time is to be periodically set from a keypad. Vorne manufactures a low cost and simple to operate hand held terminal for Keypad applications called the Mini-T. Or, if you prefer, you can use our free Windows™ software utility *87 Express*, to read or set values right from your PC. If after reviewing the remainder of this section, this seems to be the best communication protocol for your application, please request the Advanced Applications Guide.

Universal protocol. This is for applications where you have limited or no control of the data being transmitted to the display, and would like the display to intelligently process incoming data and select a portion of it to be displayed. Example applications include interfacing to scales, clock systems, panel meters, or any other device where the data stream has already been defined. If after reviewing the remainder of this section, this seems to be the best communication protocol for your application, please request the Advanced Applications Guide.

77 Series protocol. This is for applications where you want to connect 87/100 displays to the same communication bus as 77/232 displays (an earlier Vorne product line), or where you want to use existing software drivers written for 77/232 displays. If this seems to be the best communication protocol for your application, please request the Advanced Applications Guide. Note that for new applications we recommend using the Simple Packet protocol described in Chapter 3 instead of the 77 Series protocol, as it is a more flexible and robust protocol, and is supported by other Vorne products (such as the 2100 series of alphanumeric displays).

Appendix A   Operating Specifications

LED Life   100,000 hours typical

Serial Input   RS-232, RS-485

Optional Relay Output
>   Single Pole Double Throw
>   Rated 120VAC @ 1A

Power Supply   12 VDC +/- 5%

Temperature Range Operating   32 to 122 degrees F (0 to 50 degrees C)

Humidity   5% to 95% non-condensing

| Available Options	
Serial Interface Logic Board	87/100-L
4" Discrete Display	87/100-4D*
4" Solid Segment	87/100-4S
6" Discrete Display	87/100-6D*
8" Discrete Display	87/100-8D*
12" Discrete Display	87/100-12D*
Repeater Board	87/100-R
Terminator Board	87/100-TM
8 Relay Output module	87/100-O

* This part number is for a red display. For a yellow display append -YL to the part number. For a green display append -GR to the part number. Tri-color (-TR) is only available in 4" Discrete.

Appendix B   Character Set Listing

This table lists the full 87/100 character set in a standard ASCII format. As a primarily numeric, seven segment display, many non-numeric characters can be displayed in only a limited fashion. The hex and decimal ASCII codes are shown for each character. The upper and lower case alpha character sets are identical. They are designed to be as readable as possible, within the constraints of a seven segment display. If a character is not listed it will be displayed as blank (as will all characters 20h and below).

20h 32d	21h	22h	23h 35d	24h 36d	25h 37d	26h 38d	27h
28h 40d	29h 41d	2Ah 42d	2Bh 43d	2Ch 44d	2Dh 45d	2Eh 46d	2Fh 47d
30h 48d	31h 49d	32h 50d	33h 51d	34h 52d	35h 53d	36h 54d	37h 55d
38h 56d	39h 57d	3Ah 58d	3Bh 59d	3Ch 60d	3Dh 61d	3Eh 62d	3Fh 63d
40h 64d	41h 65d	42h 66d	43h 67d	44h 68d	45h 69d	46h 70d	47h 71d
48h 72d	49h 73d	4Ah 74d	4Bh 75d	4Ch 76d	4Dh 77d	4Eh 78d	4Fh 79d
50h 80d	51h 81d	52h 82d	53h 83d	54h 84d	55h 85d	56h 86d	57h 87d
58h 88d	59h 89d	5Ah 90d	5Bh 91d	5Ch 92d	5Dh 93d	5Eh 94d	5Fh 95d
60h 96d	61h 97d	62h 98d	63h 99d	64h 100d	65h 101d	66h 102d	67h 103d
68h 104d	69h 105d	6Ah 106d	6Bh 107d	6Ch 108d	6Dh 109d	6Eh 110d	6Fh 111d
70h 112d	71h 113d	72h 114d	73h 115d	74h 116d	75h 117d	76h 118d	77h 119d
78h 120d	79h 121d	7Ah 122d	7Bh 123d	7Ch 124d	7Dh 125d	7Eh 126d	7Fh 127d

Appendix C   Display Dimensions
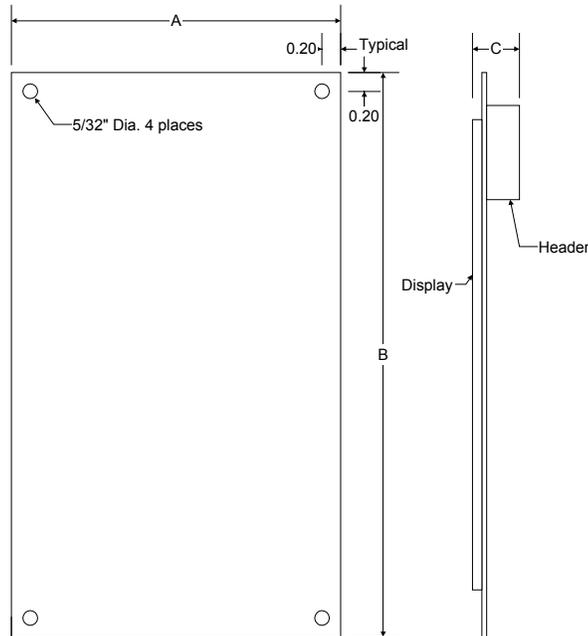
The 87/100 display was designed to be mounted to a panel at four corner mounting holes.

All Dimensions in inches.

	Model #	A	B	C
4" Discrete Display	87/100-4D*	3.55	6.00	0.60
6" Discrete Display	87/100-6D*	5.40	8.00	0.60
8" Discrete Display	87/100-8D*	6.90	10.00	0.60
12" Discrete Display	87/100-12D*	10.35	14.00	0.60
4" Discrete Colon Board	87/100-4D-C*	1.63	6.00	0.60
6" Discrete Colon Board	87/100-6D-C*	2.40	8.00	0.60
8" Discrete Colon Board	87/100-8D-C*	3.20	10.00	0.60
12" Discrete Colon Board	87/100-12D-C*	4.80	14.00	0.60
Repeater Board	87/100-R	3.30	1.25	0.90
Terminator Board	87/100-TM	3.30	1.25	0.90
8 Relay Output module	87/100-O	4.45	4.85	0.80
Serial Interface Logic Board	87/100-L	5.70	4.00	1.00

* This part number is for a red display. For a yellow display append -YL to the part number. For a green display append -GR to the part number.