

Subject: <b>RS-422 Communications Protocol for “Pro” Series Bargraphs</b>	Initial Release Date: 02/28/93	Revision Date: 04/04/97	Revision: E
	Product Group: Bargraph		Page: 1 of 8

## 1. Purpose

This Product Information Note describes how to connect the “Pro” Series bargraph’s optional RS-422 serial port to a computer serial port and how to program the bargraph over that serial port.

## 2. Scope

This revision replaces all previous revisions of document 40158. It also includes information from 074-40176 (now obsolete). It is written for those who are familiar with serial port programming and the RS-422 protocol.

## 3. Description

The RS-422 serial port is an option that can be specified at time of order. When so configured, the bargraph is set at the factory to operate in one of two different operating modes: a *Receive Only* mode, or a *Receive and Transmit* mode. You can change the operating mode of your bargraph by sending it to the factory for reprogramming, or you can reprogram it yourself using AMETEK/Dixson’s Programming and Calibration Software kit (available separately as P/N 239-53033).

- **Receive Only Mode** - In this mode, the instrument becomes a slave indicator, receiving its input from a computer via its RS-422 port rather than from remote sensors. The computer sends a series of messages that drive the digital and bargraph displays, the location of the decimal point, whether the minus sign is visible, the locations of the bargraph’s reference and setpoints, and the states of the annunciators and relays.

Each time the instrument is powered up, it automatically resets all annunciators, relays and setpoints to their Off states. The messages are described in Section 5.

- **Receive and Transmit Mode** - In this mode, the instrument functions as a normal analog input bargraph that measures and displays input variables, but with the added ability to transmit, upon request, the current digital display reading via its RS-422 serial port. In this mode, it does not respond to the messages available in the Receive Only mode previously described.

## 4. Connecting the RS-422 Serial Port

### 4.1 What You Need

You will need the following to connect to and communicate with the bargraph’s RS-422 serial port:

- A computer with an RS-232 serial port, cable, and communications software.
- An adapter to convert from an RS-232 interface to an RS-422 interface. One such adapter (Model 485F9), is shown in Figure 2. Adapters can be ordered from distributor *ICS Electronics Corporation* in Milpitas, CA (Phone 800-952-4499) or from the

Subject: <b>RS-422 Communications Protocol for "Pro" Series Bargraphs</b>	Initial Release Date: 02/28/93	Revision Date: 04/04/97	Revision: E
	Product Group: Bargraph	Page: 2 of 8	

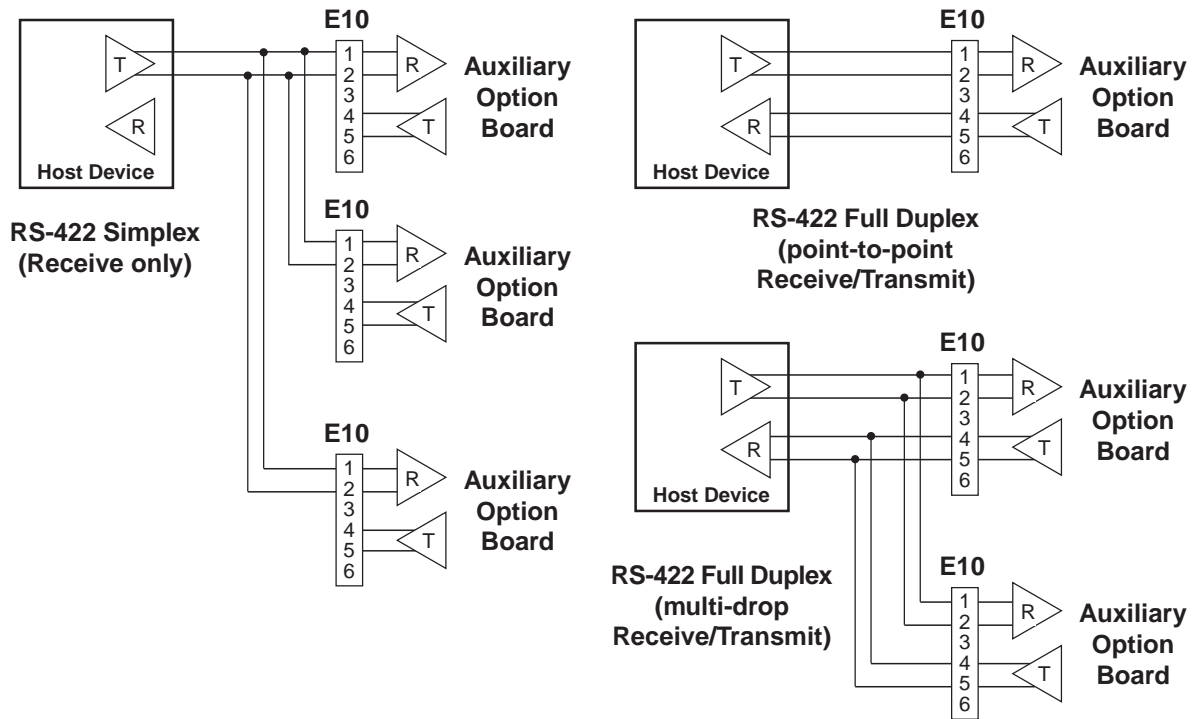
manufacturer *Amplicon Liveline Limited* in the United Kingdom (Phone +441-273-703-331).

- A 6-wire modular phone plug (male) and cable to adapt the RS-422 connector the bargraph's RS-422 input (see Figure 2).

**Note -** Do not wire the phone plug directly to the RS-232 interface—the signal levels are different.

#### 4.2 Connecting More Than One Bargraph to the RS-422 Interface

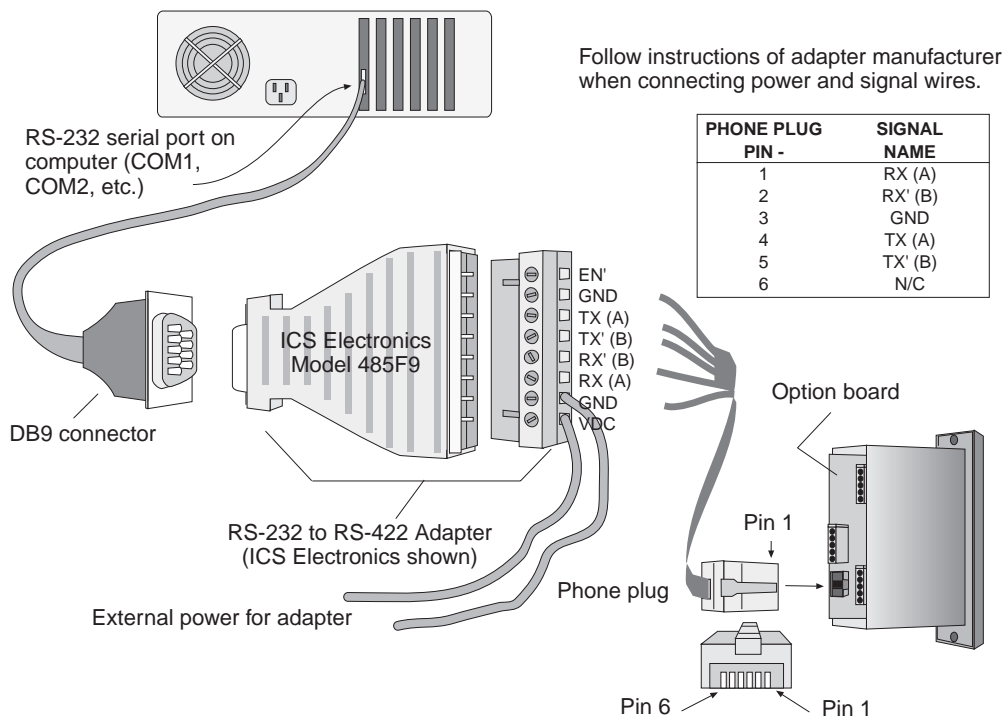
The Pro-Series bargraphs are capable of RS-422 full duplex point-to-point, RS-422 full duplex multi-drop, and RS-422 simplex receive/transmit only. Please refer to Figure 1 for wiring diagrams.



**Figure 1** Multiple RS-422 Connections

You may connect up to 32 devices to the RS-422 interface (including the host). When connecting more than one bargraph, each must have a unique address. Each Pro-Series unit configured for Receive Only or Receive/Transmit operation leaves the factory programmed with the last six digits of its serial number as its address. You can change this address using the Programming and Calibration software. Do not confuse the 6-digit address with the 32-device bus limitation.

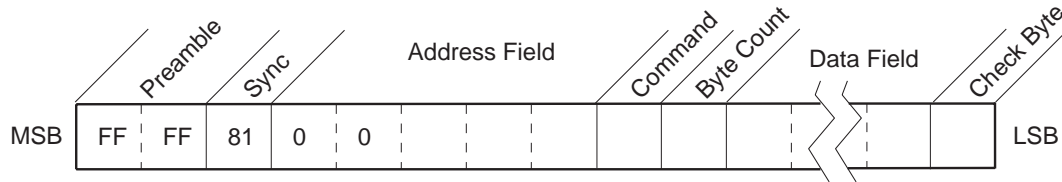
1. Fabricate an adapter cable to connect the 6-wire modular phone plug to the RS-422 connector. Figure 2 shows an example using an ICS Electronics adapter. Other adapters may be different, so be sure to follow the manufacturer's instructions.
2. Connect the serial cable, the RS-232-to-RS-422 adapter, and phone cable as shown in Figure 2. If the RS-232 serial connector is the 25-pin variety, you may also need a 25-pin-to-9-pin serial plug adapter.
3. Following the instructions of the adapter manufacturer, connect the power and signal wires.
4. Power up the computer and the bargraph, and ensure the computer is properly configured for serial configuration (i.e., COM1, COM2, etc.)
5. Use a serial communications application to send commands to the bargraph. The communications protocol is described in Section 5.



**Figure 2** Connecting the RS-422 port to an RS-232 port

## 5. Receive Only/Receive-Transmit Communications Protocol

The protocol is based on the Hart serial communication protocol in which messages are transmitted and received in the *long frame format*. This format is shown in Figure 3.



**Figure 3** Long frame message format.

**Note -** The serial bus must be stable (an uninterrupted, logic-1 state) at least two word times (2.08 milliseconds) immediately prior to any message.

### 5.1 Field Definitions

- Preamble** - Each of the two preamble bytes are always FF<sub>H</sub> (H = hexadecimal).
- Sync Byte** - The sync byte is always 81<sub>H</sub>.
- Address Field** - Because the protocol allows for the connection of multiple devices, the message format provides for a device address. The bargraph's address is the last six digits of its serial number in hexadecimal format. If the address in a message matches the bargraph's address, the bargraph will respond to the message. The first two bytes of the five-byte address field are always 0. The last three bytes contain the bargraph address.

For example, to send a message to a bargraph whose serial number is 9609304207215, convert the last six digits of the serial number to hexadecimal and place that number in the last 3 bytes of the address field. In this example, the address field would then be 00 00 03 29 6F.

- Command Byte** - The bargraph accepts the following commands (defined in Section 5.2):

HEX VALUE	COMMAND	LENGTH OF DATA FIELD	COMMAND TYPE
00 <sub>H</sub>	Receive digital display reading	4 bytes	Receive-Only models
01 <sub>H</sub>	Receive decimal point location	1 byte	
02 <sub>H</sub>	Receive bargraph reading	1 byte	
03 <sub>H</sub>	Receive bargraph reference location	1 byte	
04 <sub>H</sub>	Receive setpoint locations	3 bytes	
05 <sub>H</sub>	Receive annunciator states	1 byte	
06 <sub>H</sub>	Receive relay states	1 byte	
0A <sub>H</sub>	Request to transmit	0 bytes	Receive/Transmit models

Subject: <b>RS-422 Communications Protocol for "Pro" Series Bargraphs</b>	Initial Release Date: 02/28/93	Revision Date: 04/04/97	Revision: E
	Product Group: Bargraph		Page: 5 of 8

5. **Byte Count** - The byte count field tells the device the number of bytes in that message's data field. The preceding command table lists the byte count for each command.
6. **Data Field** - Data fields are defined in Section 5.2.
7. **Check Byte** - This is calculated by exclusive OR-ing the transmitted bytes, beginning with the sync byte and ending with the last data byte. The bargraph also performs the exclusive OR-ing and compares the result to the received check byte. If they match, the bargraph will execute the command.

## 5.2 Commands and Data Field Specifications

### 5.2.1 Digital Display Characters (00H)

This command sends a number to be displayed in the digital display. The first byte in the four-byte data field contains the left-most digit and the last byte contains the right-most digit. Valid values are shown in the following table.

HEX DATA	DISPLAY	HEX DATA	DISPLAY
00H	0	08H	8
01H	1	09H	9
02H	2	0AH	A
03H	3	0BH	1 *
04H	4	0CH	
05H	5	0DH	U
06H	6	0EH	-
07H	7	0FH	blank

\* Shifted to left side of digit.

### 5.2.2 Decimal Point Location (01H)

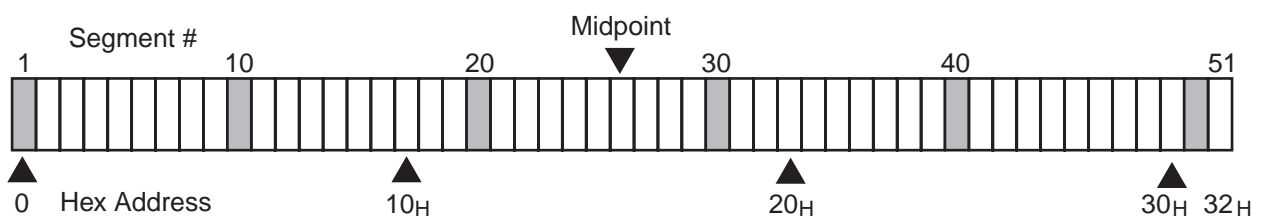
This command sends the location of the digital display decimal point. Valid values for this one-byte data field are:

HEX DATA	DECIMAL LOCATION
00H	XXXX
01H	XXX.X
02H	XX.XX
03H	X.XXX

### 5.2.3 Bargraph Indication (02H)

This command is used with the Bargraph Reference Location command to turn on any contiguous group of bargraph segments. Valid values for its one-byte data field are 0 through FF<sub>H</sub> (255).

Figure 4 identifies the segment numbering for a 51-segment bargraph. The numbers above the bargraph are the actual segment numbers from 1 to 51, and the numbers below the bargraph are the hex addresses of the segments.



**Figure 4** Address scheme for 51-segment bargraph

#### Examples:

- To light segments 12 through 30, send this command with a data field of 1D<sub>H</sub> and send a Bargraph Reference Location command with a data field of 0C<sub>H</sub>.
- To indicate an overrange condition (last segment flashes), send a Bargraph Indication data field greater than 32<sub>H</sub> (51-segment bargraph) or 64<sub>H</sub> (101-segment bargraph).
- To indicate an underrange condition (first segment flashes), send a value of FF<sub>H</sub>.

### 5.2.4 Bargraph Reference Location (03H)

This command determines which segment is the zero-point. Valid values for its one-byte data field are 0 through 64<sub>H</sub> (100).

#### Examples:

- To place the reference location at the bottom or left-most segment of the bargraph, send a value of zero.
- To place the reference location at the center segment, send a data field equal to 19<sub>H</sub> (51-segment bargraphs) or 33<sub>H</sub> (101-segment bargraphs).

### 5.2.5 Setpoint Locations (04H)

This command sets the locations of setpoints #1, #2, and #3. The first byte in the three-byte data field contains the segment address for setpoint #1, the second byte for setpoint #2, and the third byte for setpoint #3. Valid values are 0 through 64<sub>H</sub>. To turn a setpoint completely off, place it off the scale by setting its address to 65<sub>H</sub>.

### 5.2.6 Annunciator State and Minus Sign (05H)

This command turns the three setpoint annunciators (#1, #2, and #3) on, off, or causes them to flash. The bit assignment of this one-byte data field is shown in Figure 5. A value of 1 in a setpoint annunciator’s On/Off bit turns that annunciator on continuously, and a value of 0 turns it off. A value of 1 in a setpoint annunciator’s Flash bit causes that annunciator to flash, regardless of the state of the On/Off bit.

Bit 0 controls the minus sign. A value of 1 turns the minus sign on, and a value of 0 turns it off.

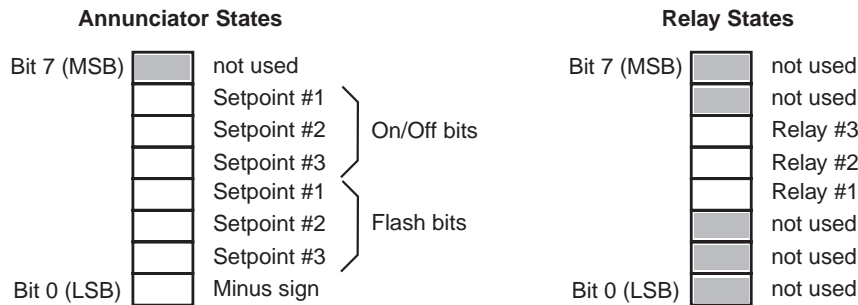


Figure 5 *Annunciator and Relay States data bytes*

### 5.2.7 Relay States (06H)

This command controls the three relays (#1, #2 and #3) using a one-byte data field shown in Figure 5. To energize a relay, set the appropriate bit to 1.

### 5.2.8 Transmit Request (0AH)

This command is not available in Receive-Only models. It instructs the bargraph to return a frame containing its current digital display reading. This command has no data fields and must contain a byte count of zero.

### 5.2.9 Digital Reading Being Transmitted (0BH)

This is not a command as such, but a frame of data the bargraph returns in response to the Transmit Request command previously described. Its four-byte data field contains the current digital display reading with the first byte being the left-most digit and the last byte being the right-most digit. The minus sign and the decimal point location are not transmitted.

## 5.3 Examples of Messages

The following examples show the messages required to display –4.25 on a bargraph having “527079” as the last six digits of its serial number.

Subject:

## RS-422 Communications Protocol for "Pro" Series Bargraphs

Initial Release Date:

02/28/93

Revision Date:

04/04/97

Revision:

E

Product  
Group:

Bargraph

Page:  
8 of 8

This frame causes the bargraph to display " 425" (with leading blank).

FF	FF	81	0	0	08	0A	E7	00	04	0F	04	02	05	6C
----	----	----	---	---	----	----	----	----	----	----	----	----	----	----

This frame places the decimal point between the "4" and the "2".

FF	FF	81	0	0	08	0A	E7	01	01	02	66
----	----	----	---	---	----	----	----	----	----	----	----

This frame displays the minus sign.

FF	FF	81	0	0	08	0A	E7	05	01	01	61
----	----	----	---	---	----	----	----	----	----	----	----

## 6. Technical Support

All bargraph products are supported by the AMETEK/Dixson Bargraph Service Department. The Service Department can be reached at (970) 244-1245, Monday through Thursday from 7:00 a.m. to 5:30 p.m. MST, and on Friday from 7:00 a.m. to 3:30 p.m. You may also leave a message at the following E-Mail address: [service@ametekdixson.com](mailto:service@ametekdixson.com).