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Installation, Operation, and Service Instructions with Parts List

CULLIGAN®
Smart Controller Industrial Communication

For RS-232, RS-485, Modbus RTU (PLC) and Profibus, USB, and Alarm Relays

Culligan®

Printed in USA

Attention Culligan Customer:

Your local independently operated Culligan dealer employs trained service and maintenance personnel who are experienced in the installation, function and repair of Culligan equipment. This publication is written specifically for these individuals and is intended for their use.

We encourage Culligan users to learn about Culligan products, but we believe that product knowledge is best obtained by consulting with your Culligan dealer. Untrained individuals who use this manual assume the risk of any resulting property damage or personal injury.

WARNING! Electrical shock hazard! Prior to servicing equipment, disconnect power supply to prevent electrical shock.

WARNING! If incorrectly installed, operated, or maintained, this product can cause severe injury. Those who install, operate, or maintain this product should be trained in its proper use, warned of its dangers, and should read the entire manual before attempting to install, operate, or maintain this product. Failure to comply with any warning or caution that results in any damage will void the warranty.

CAUTION! This product is not to be used by children or persons with reduced physical, sensory or mental capabilities, or lack of experience or knowledge, unless they have been given supervision or instruction.

CAUTION! Children should be instructed not to play with this appliance.

CAUTION! If the power cord from the transformer to the unit looks or becomes damaged, the cord and transformer should be replaced by a Culligan Service Agent or similarly qualified person in order to avoid a hazard.

WARNING! This device complies with Part 15 of the FCC rules subject to the two following conditions: 1) This device may not cause harmful interference, and 2) This device must accept all interference received, including interference that may cause undesired operation.

This equipment complies with Part 15 of the FCC rules. Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CAUTION! To reduce the risk of fire, use only No. 26 AWG or larger telecommunications line cord.

NOTE This system is not intended for use with water that is microbiologically unsafe or of unknown quality without adequate disinfection either before or after the system.

NOTE Check with your public works department for applicable local plumbing and sanitation codes. Follow local codes if they differ from the standards used in this manual. To ensure proper and efficient operation of the Culligan equipment to your full satisfaction, carefully follow the instructions in this manual.

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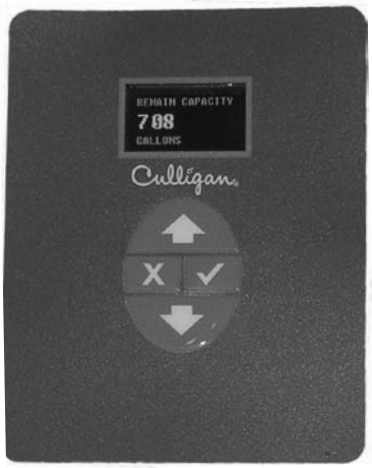

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Contents

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Introduction

Read this Manual First

Before you install and operate the Culligan Industrial Communication equipment, read this manual to become familiar with the product and its capabilities.

About this Manual

This manual:

- familiarizes the operator with the equipment,
- explains installation and setup procedures,
- provides basic programming information,
- explains the various modes of operation, and
- gives specifications and troubleshooting information.

The GBE family of Smart Controllers is designed to control a wide variety of water treatment equipment. In many applications the Smart Controller operates as a single stand-alone controller that performs steps such as opening or closing valves, monitoring flow meters and pressure sensors, turning pumps on and off, or controlling a softener or filtration valve as it completes a regeneration sequence.

The GBE monitors a variety of sensors and condition and is capable of storing this information and displaying it on the main display screen. The GBE also offers many different ways to communicate its collected information with both people and other pieces of electronic equipment.

There are seven main ways the GBE can communicate with external devices:

1. Wireless Remote (local RF wireless remote, 200 ft range)
2. Telephone Modem (landline and cellular phone modems)
3. Dry Contact Alarm Relay
4. Serial Communications (RS-232, RS-485)
5. Modbus RTU (PLC communication)
6. USB (PC or Laptop communication)
7. Profibus

The first two forms of communication are covered in the standard equipment manuals for Culligan softeners, filters, and other equipment. The last five methods of communication are more commonly used in industrial communications networks and are described in this manual.

Comm	Distance (ft.)	Cost	Monitors	End User Programming
USB	6	$	1 RO, Softener, or Filter	None—download from myCulligan.com
RS-232	30	$	1 RO, Softener, or Filter	Required
RS-485	2000+	$	200+ RO, Softeners, or Filters	Required
Modbus	2000+	$$	1 RO, 1 Softener or Filter, or 1 Progressive Flow Group	Easy
Profibus	2000+	$$$$	2 RO, 2 Softeners or Filters, or 2 Progressive Flow Groups	Easy

Table 1. Summary of Culligan C&I communication.

Dry Contact Alarm Relay Output

This mode of communication provides a simple “good” or “bad” signal in the form of a dry-contact output from the GBE board. This signal can be used to tell a remote PLC that the Culligan equipment controlled by this GBE board is either “OK” or “Not OK.” Alternatively, this output dry contact can be directly wired to an alarm, stack light, or buzzer, for example, to alert an operator to a condition on the Culligan equipment that requires attention. This is the simplest and lowest cost means of communication, but it is limited in the amount of information which can be provided.

Serial Communications (RS-232, RS-485)

This mode of communication allows a set of measurements, such as the current flow rate, the total number of gallons, or the percent rejection of a reverse osmosis system, to be sent economically to a wide variety of industrial equipment including printers, touchscreen displays, PLCs, and computers. The information is not in “real time,” but it is updated approximately every one minute, so that it can be used to detect the onset of an alarm condition. While more expensive than dry contact outputs, this form of communication allows far more information to be conveyed. Serial data can be read by a very wide range of industrial equipment. The use of serial data, however, requires that the end user, or whomever is setting up the equipment to which the information is being sent, will typically need to write a computer program to interpret the information coming from the GBE-controlled device so that the receiving computer will be able to understand what each of the numbers coming from the Smart controller mean.

Modbus RTU (also called Serial Modbus, or Two-Wire Modbus)

Modbus is a popular PLC language that makes it very easy for PLCs to read and understand the data coming from another device, such as the Smart Controller. While this communication network is more expensive to set up than simple serial communications, it makes it relatively easy for the device receiving the information to interpret the GBE data—often little or no programming is required when using Modbus. One downside, however, is that the piece of equipment which is receiving the information must be capable of receiving Modbus RTU information. While most PLCs are capable of receiving Modbus RTU, not all PLCs are able to do so.

USB Communication

USB cables are commonly used to allow PCs and laptop computers to communicate with devices such as the GBE controller. These cables are usually used in temporary situations, such as troubleshooting and equipment installation. Culligan has developed an easy-to-use PC software program which can be used to receive and store information coming from a GBE controller via a USB cable. This software can be downloaded from the MyCulligan.com website.

Profibus Communication

This is a specialized communication language used by certain PLCs.

Simple Dry Contact Alarm Output

The optional alarm relay board (PN 01022238) can be plugged into the back of a GBE board as shown in Figure 2. This relay is capable of handling up to 250 VAC at 10A. A common usage of the alarm relay board is to turn on an alarm light or buzzer in the event that the GBE Smart Controller experiences an error condition. The circuit required to accomplish this is shown in Figure 3.

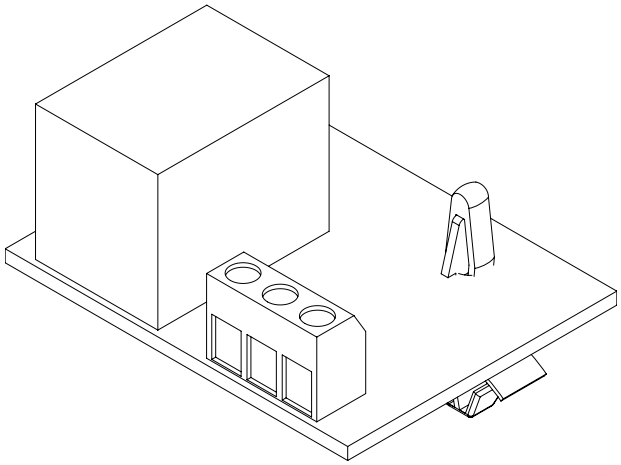


Figure 1.Alarm Relay board.

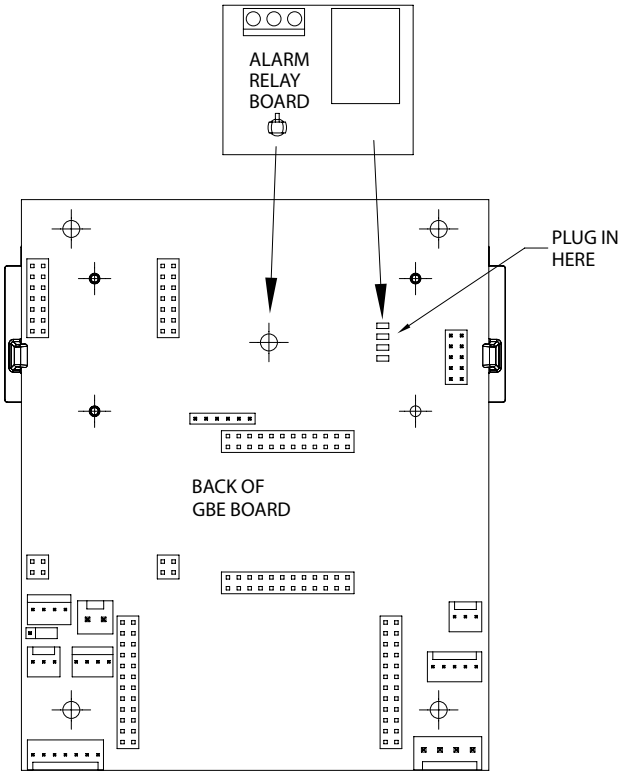


Figure 2.Alarm Relay board installed on GBE board.

Setting Up the Alarm Relay Board

Install the Alarm Relay under the Main Menu /Accessories menu. From the Accessories menu select Relay Mode for standard alarm relay behavior.

```
Softening
JAN-01-11 12:01P
```

1. From the **HOME** screen, press ↓ to view the main menu.

```
 1)INFORMATION
 2)MANUAL MODE
 3)SET DATE/TIME
>4)ACCESSORIES
```

2. The screen displays the main menu. Press ↓ ↓ ↓ ✓ to select **4)ACCESSORIES**.

```
 5)SBT SENSOR
 6)WIRELESS REM
 7)MODEM
>8)CHLORINATOR
```

3. From the Accessories menu, press ↓↓↓↓↓↓↓✓ to select **8)CHLORINATOR**. The screen displays the Chlorinator/Alarm Relay settings. Use these to set up the Chlorinator/Alarm Relay board.

```
CHLORINATOR
INSTALLED
```

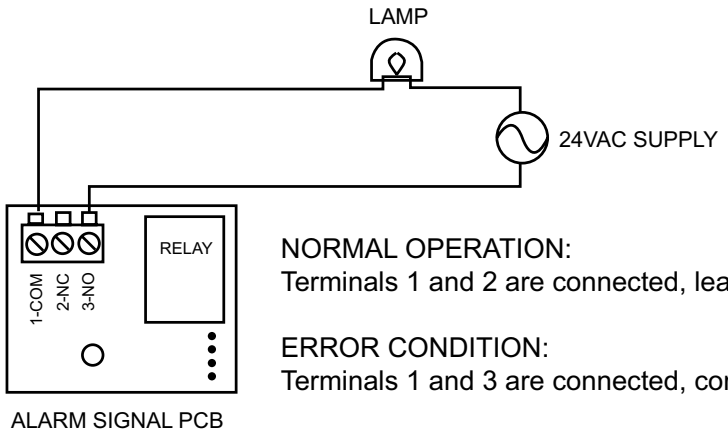
4. Press ✓ ↑ or ↓ and then ✓ to select INSTALLED if a Chlorinator/Alarm Relay board is installed inside the Smart Controller.

```
CHLORINATOR
>ERROR STATUS
```

5. From the Chlorinator menu, press ✓↓✓ to select **ERROR STATUS**. This mode of operation occurs when the relay board is plugged into the GBE board chlorinator socket. When Error Status is selected, this relay is in the Normally Open position when the GBE board has power AND there are no errors present ("Problem Found" is not showing on the Home screen). The relay is in the Normally Closed Position when the GBE is either powered OFF or when there is an error present on the GBE board.

```
Softening
JAN-01-11 12:01P
```

6. Press X X X to save the settings and return to the home screen.



NORMAL OPERATION:
Terminals 1 and 2 are connected, leaving the lamp circuit open (lamp off)

ERROR CONDITION:
Terminals 1 and 3 are connected, completing the lamp circuit (lamp on)

Figure 3. Example of customer wiring for an Alarm Signal Output.

In addition to turning on a simple circuit, the alarm relay board can instead be used to send a dry contact "I'm OK" or "I'm Not OK" signal to a control room PLC as shown in Figure 4. In this example, a triplex softener and an RO are all controlled by GBE boards. By plugging an alarm relay board into each controller board, and wiring these relays to individual PLC inputs, the PLC is able to detect if any or all of the GBE-controlled pieces of equipment are in need of service.

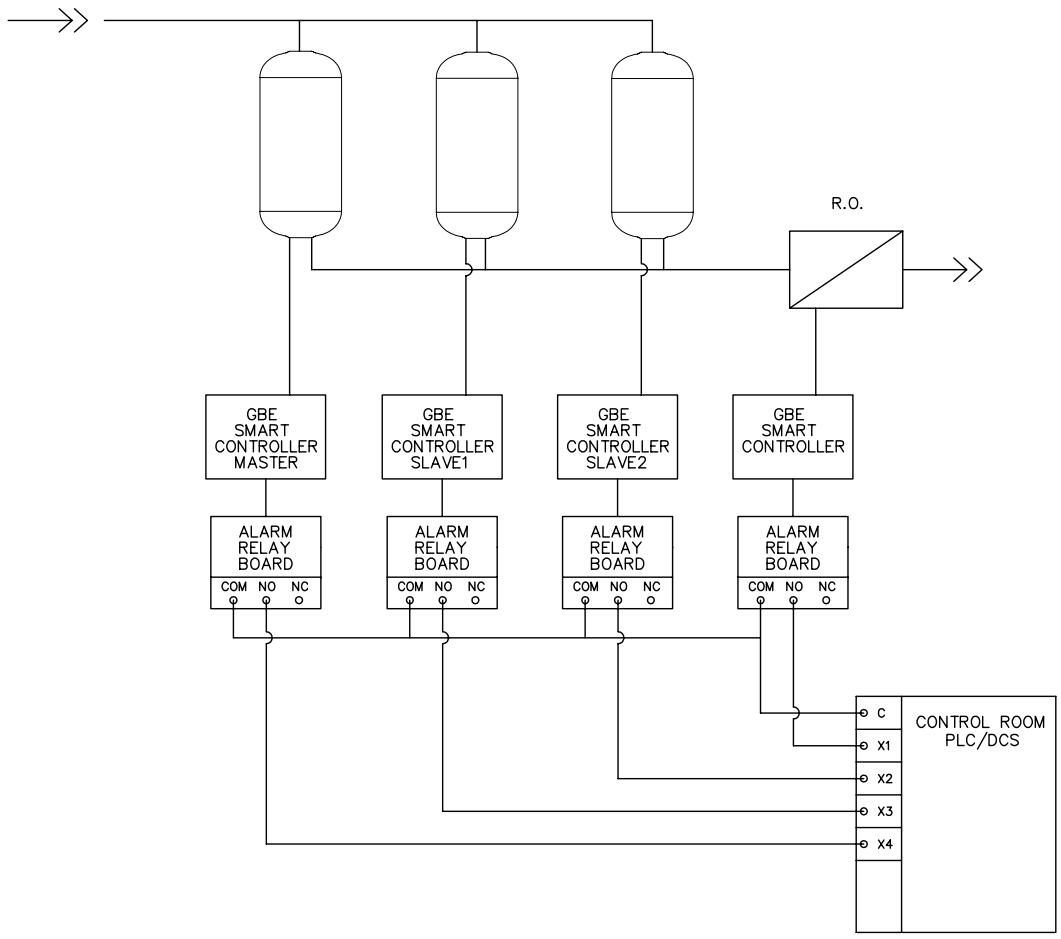


Figure 4. Wiring diagram for alarm relay board.

When wired as shown in Figure 4, with the alarm relays programmed as error status indicators, the PLC will detect a “closed” contact from each GBE board when each piece of equipment is “OK.” The contacts will change to “open” if a piece of equipment either detects an error or if it loses power.

GBE-Serial Communication

One simple method of sending information from a GBE-controlled device to a programmable logic controller (PLC) located in a remote control room is through the use of serial communications. Using this approach, the GBE sends out a single line of comma separated data approximately every minute which describes the state of the equipment at that time. The information can be sent out via a “language” such as RS-232 or RS-485; which language depends on which communication cable is connected to the back of the GBE board (connections to the GBE board are shown in Figure 6 and Figure 7).

The choice to use either RS-232 or RS-485 depends upon two factors. First, it is necessary to determine which communication language the receiving equipment will accept. Second, determine the distance from the GBE board to the receiving equipment. RS-485 is used if the distance is over 30 feet; RS-232 or RS-485 may be used if the distance is under 30 feet.

The following data cable styles are available from Culligan:

Cable Part No.	Description
01021507	USB style output cable
01021508	9-pin female RS-232 output
01021509	9-pin female RS-485 output

The list of comma-separated numbers that is sent using the serial communications port depends upon the device that is being controlled by the GBE. For example, the information coming from a GBE-controlled softener is different from the information coming from a GBE-controlled RO. Because it will be up to the PLC in the control room that is receiving the information from the GBEs to determine the meaning of each of the numbers coming in from the GBE, some small amount of programming is generally required by the customer. The information that the customer needs to know in order to interpret the incoming serial data is explained for Culligan Softeners and Culligan RO equipment in the final portions of this section.

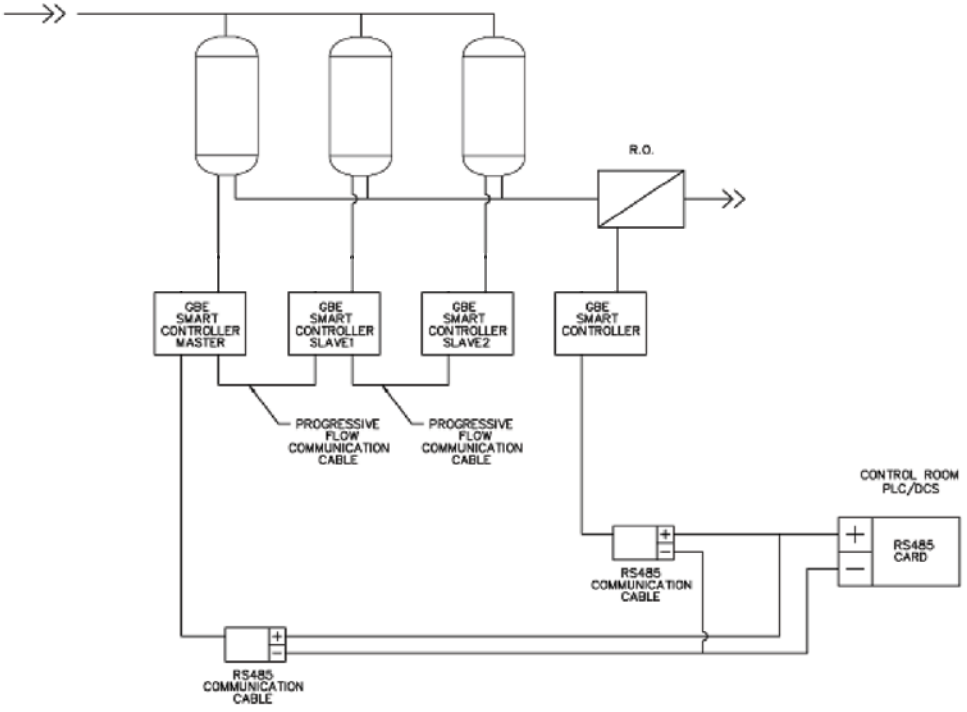


Figure 5. Wiring diagram for RS-485 communication.

If serial communications are used in a multi-device environment, typically one communications cable is required for each Smart Controller. In the case of a progressive flow network, however, it is only necessary to connect a single communication cable to the master Smart Controller in the progressive flow network. An example of a multi-device network with a progressive flow network is shown in Figure 5.

Wiring for an RS-232 network would be similar to Figure 5, except that because RS-232 is not a multi-drop language, the control room PLC/DCS would require one RS-232 card *per RS-232 communication cable*.

Serial Communication from a Culligan RO

The GROC is used to control commercial RO systems.

This controller has the ability to provide status messages to customer equipment using RS-232 and RS-485 communication protocols. These protocols are commonly used to send information from the GROC to either a customer's PC or to a building management system or PLC. The information is one-way; the GROC can send this information, but the GROC cannot receive or respond to any commands sent into the communication port. The GROC sends a status message every ten minutes. The information is sent as a short text (ASCII), comma-separated string of letters and numbers such as CULL,009.30,004.60,1,050,096,0,0,00050202,00000, 000,10231027.

Reverse Osmosis System Report from GROC

The format of the status message is: CULL,A,B,C,D,E,F,G,H,I,J,K.

Example: CULL,009.30,004.60,1,050,096,0,0,00050202,00000, 000,10231027

Where the values for the fields A thru J are as follows:

A = current membrane feed-flow rate in gallons per minute (9.3 means 9.3 gpm)

B = current flow rate in gallons per minute

C = Current Operational Status (1=running, 2=standby, 3=offline, 4=error)

D = Current recovery percentage (050 means 50% recovery)

E = Current reject percentage (096 means 96% rejection)

F = Storage Tank Hi-Level Float Switch (0=open/water is below the float switch, 1=closed/water is above the float switch)

G = Storage Tank Lo-Level Float Switch (0=open, 1=closed)

H = Total gallons of delivered product water since new (50202 means 50202 gallons)

I = Error Code

J = (reserved for future use)

K = Date and Time. i.e. 10231027 is Oct 23 (1023) at 10:27 am (1027). Time is in 24 hr format.

Serial Communication from a Culligan Softener or Filter

The Smart Controller (GBE) is used to control water softeners, filters and commercial RO systems. This controller has the ability to provide status messages to a customer's equipment using RS-232 and RS-485 communication protocols. These protocols are commonly used to send information from the Smart Controller to either a customer's PC or to a building management system or or PLC. The information is one way; the Smart Controller can send this information, but the Smart Controller cannot receive or respond to any commands sent into the communication port. The Smart Controller sends a status message every 60 seconds. The information is send as a short text (ASCII), comma-separated string of letters and numbers.

The information contained in the status message depends upon what type of equipment is being controlled by the GBE.

Single Water Softener or Filter controlled by the Smart Controller

The format of the status message is: CULL,A,B,C,D,E,F,G

Example: CULL,00016524,000051.5,1,00000000,0x0000,1,0329101314

Where the values for the fields A thru F are as follows:

A = total gallons since new

B = current flow rate in gallons per minute (51.5 means 51.5 gallons per minute)

C = Current Status Indicator (0 = initialization, 1=service, 2=prerinse, 3=regen, 4= standby)

D = capacity remaining in gallons

E = Error Flag (see below)

F = 1

G = A ten-digit number representing the date and time (24-hour format)

Error Bit	Meaning
0	Internal Valve Leak
1	Salt Bridging Detected
2	Brine Line Blocked
3	Brine Tank Overfill Error
4	Replace Media Filter
5	No RF Remote Signal
6	AquaSensor Salt Error (possibly low salt or failed eduction)
7	Motor Homing Error
8	Motor Position Sensor Error
9	Low Salt Level in Brine Tank
10	(not used)
11	AquaSensor Probe Fault (probe has failed, not plugged in or AquaSensor transformer failed)
12	Less than 14 Days Salt

The error flag is sent as a hexadecimal number in the format 0xWXYZ as follows:

W				X				Y				Z			
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Each error bit is either 0, meaning that this error is NOT present, or 1, meaning that this error IS present. Each of the four-bit sections (W, X, Y and Z) are then combined into a four digit binary word which is converted to a hexadecimal digit.

For example, if there are no errors present, then the value would be 0x0000. If there were a “Replace Media Filter,” “Aquasensor Salt Err,” and “Motor Position Sensor Error” present then bits 4, 6 and 8 would be set to 1 and all other bits would be 0, respectively. The value of the error flag would be 0x0150 if these three errors are present.

	W				X				Y				Z			
Error Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
hexadecimal	0				1				5**				0			
Error Flag	0x0150*															

*Note that the first two characters of the error flag are always “0x” to signify that this is a hexadecimal number

** In hexadecimal, the number 4 bit equals 1, the number 5 bit equals 2, the number 6 bit equals 4, and the number 7 bit equals 8. Therefore, when you add the #4 bit value to the #1 bit value, you get 5.

NOTE **If the GBE is controlling a filter (instead of a water softener) then the above message definitions are identical, but error flags 1,2,3,6,9 and 11 will always be zero for a filter.**

Progressive Flow System of Smart Controller-Controlled Water Softeners

The format of the status message for a progressive flow network consists of a series of individual lines of information, one line for each of the Smart Controller-controlled softeners. For example, in a triplex progressive flow network, every 60 seconds, the data port on the master unit will send out the following three lines of information:

CULL,A1,B1,C1,D1,E1,1,G1

CULL,A2,B2,C2,D2,E2,2,G2

CULL,A3,B3,C3,D3,E3,3,G3

For example:

CULL,00052754,000003.7,1,00009110,0x0000,1,0329101314

CULL,00042674,000003.5,1,00004321,0x0000,2,0329101314

CULL,00010204,000000.0,4,00005444,0x0000,3,0329101314

The 1 preceding G1 near the end of the first line indicates that this line is the status for the master unit in the progressive flow network. The 2 and 3 on the subsequent lines indicate that this data is for slave unit #1 and slave unit #2, respectively. The information contained on each line is of the same format as described in the Single softener section above.

Electrical Connections for Culligan RS-485 Cable

Both plugs attach to connectors on the back of the GBE board. The screw terminals labeled “A+” and “B-“ are connections for the customer supplied RS-485 network. Typically RS-485 wiring is run inside of shielded, two-conductor wiring. The screw terminal labeled “GND” can be used to connect to the shielding. However, the shielding should be connected ONLY at ONE end: either to this screw terminal provided, or to the customer’s ground connection at the other end of the wiring—but not both.

Figure 6 shows the connections to make between the plugs of the RS-485 cable and the two connectors on the back of the GBE board. It is important to install the plugs in the orientations shown.

NOTE **These connectors do NOT include mechanical retention. The use of mechanical retention, such as light-weight zip ties is recommended to retain the plug connections.**

Figure 6. GBE board connection for RS-485 cable (P/N 01021509).

Electrical Connections for Culligan RS-232 Cable

The Culligan Data Cable Connector is terminated with a D-sub9 style female termination. The customer must provide the following pin connections:

Pin	Function
3 (Input)	TD (data coming FROM the GBE board
2 (Output)	RD (this line is required even though no data is sent TO the GBE board)
7 (Input)	RTS
8 (Output)	CTS
5 (Signal gnd)	GND

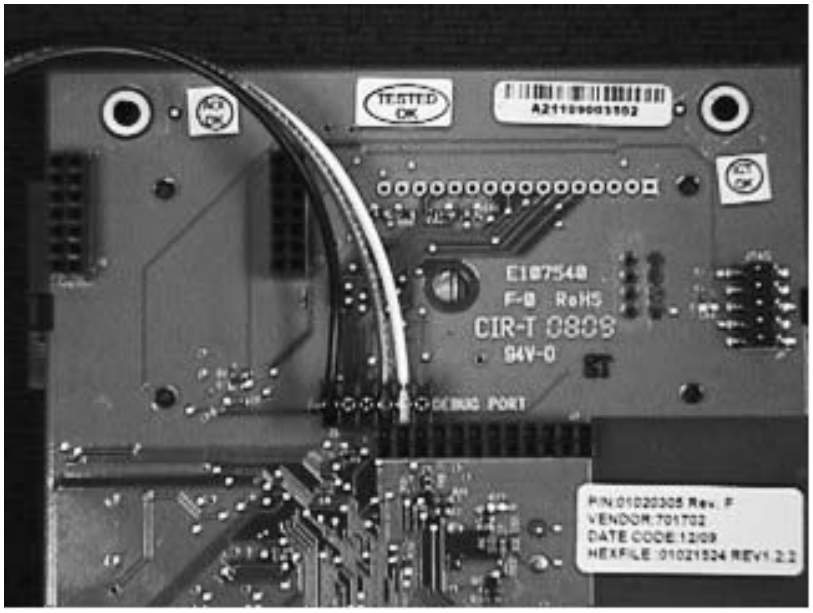


Figure 7. GBE board connection for RS-232 cable (P/N 01021508).

NOTE The RS-232 cable attaches at only one place on the GBE board.

The data coming from the Smart Controller board is at the following conditions:

Bits Per Second: 9600
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

Connecting Multiple GBE Boards to 24 VAC Power Supplies

In progressive flow systems, each GBE circuit board requires electrical power. Because the GBE circuit boards are electrically connected to each other via the communication cable, it is very important to use care in properly wiring these systems to electrical power. Failure to do so can result in, at a minimum, damaging the GBE circuit boards. Culligan STRONGLY RECOMMENDS that every GBE circuit board be provided with its own individual power transformer as shown in Figure 9.

When using individual power supplies, the GBE boards can be connected to each other using communication cables without paying attention to the polarity of the wiring used on the power supplies. Culligan STRONGLY RECOMMENDS AGAINST EVER connecting the Aux-Outputs of multiple GBE boards to the same electrical load (A “load” can be the coils of a relay, or a solenoid valve for example.) If you must connect the Aux Outputs of multiple boards together then it is required that you use a shared 24 VAC power supply as shown in Figure 9. If you elect to follow the wiring shown in Figure 9, take extra care to make absolutely sure that the polarity of every power connection and every aux-output connection are wired exactly as shown. It is very easy to introduce cross-wiring problems during initial installation and it is also easy for troubleshooting personnel to later introduce cross-wiring issues which is why Culligan strongly discourages the use of this form of wiring. The total amperage of the shared power supply must be sufficient to power all GBE boards AND all 24 VAC outputs of those GBE boards.

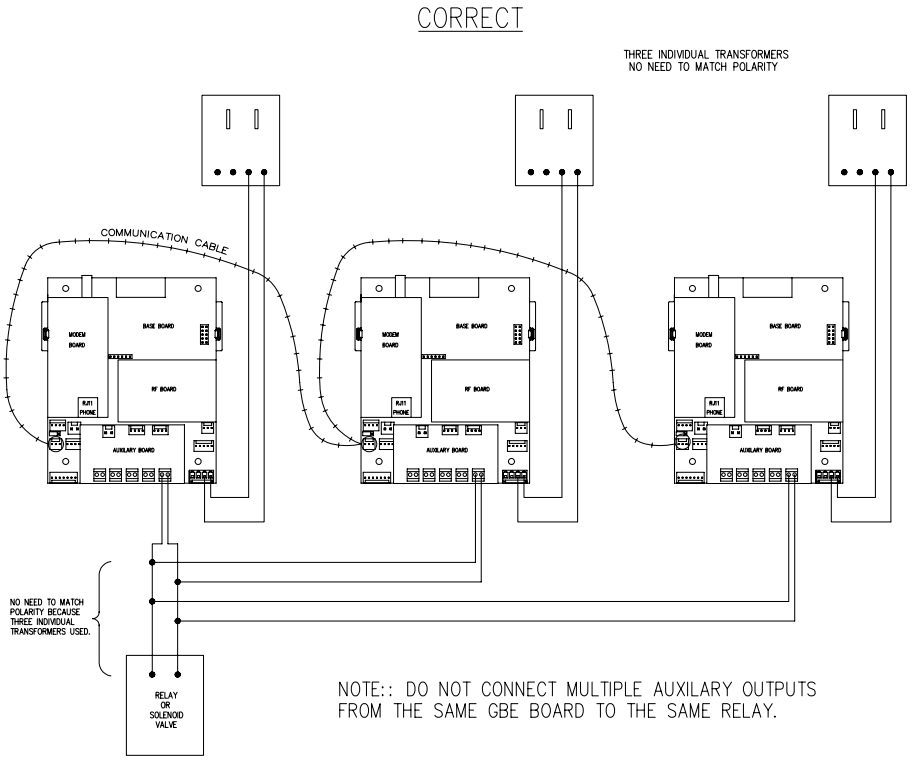


Figure 8. Correct connections for multiple GBE boards to individual 24 VAC power supplies.

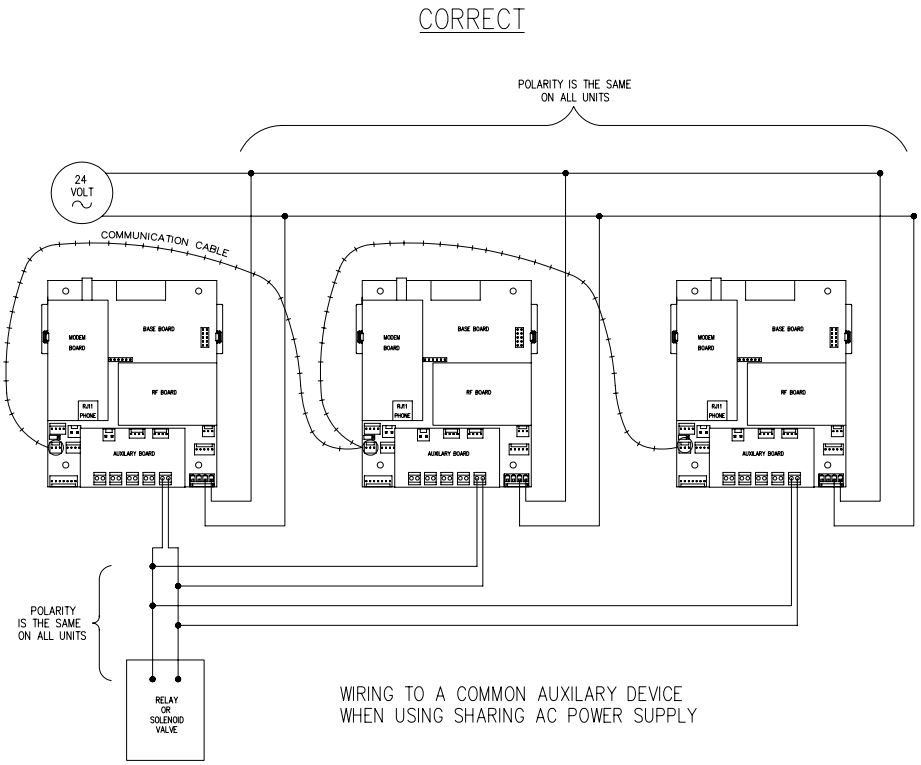


Figure 9. Correct connections for multiple GBE boards to shared 24 VAC.

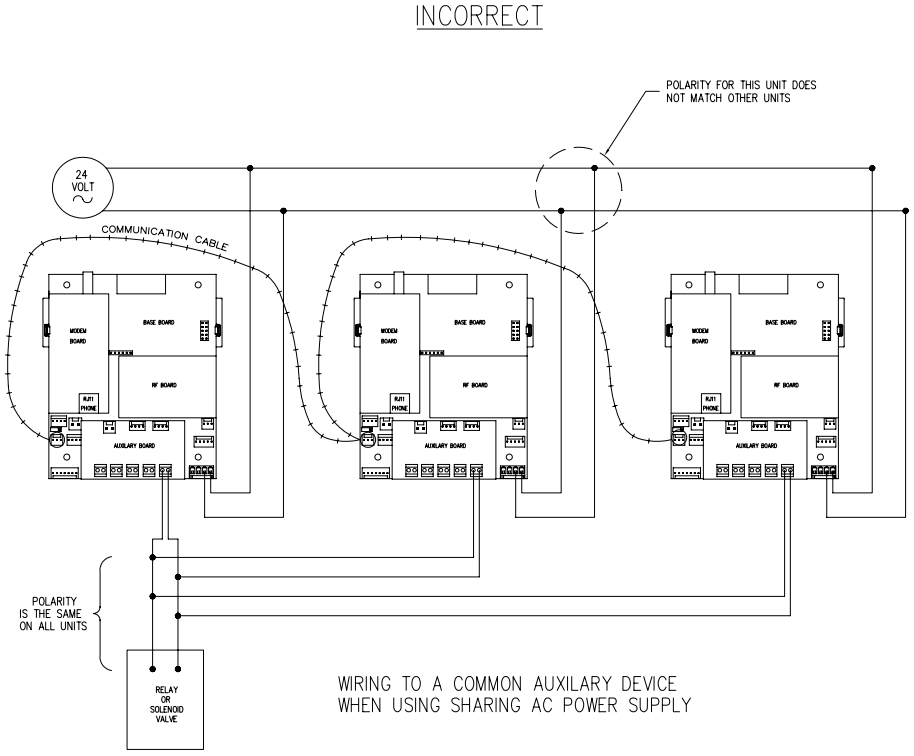


Figure 10. Incorrect connections for multiple GBE boards to 24 VAC.

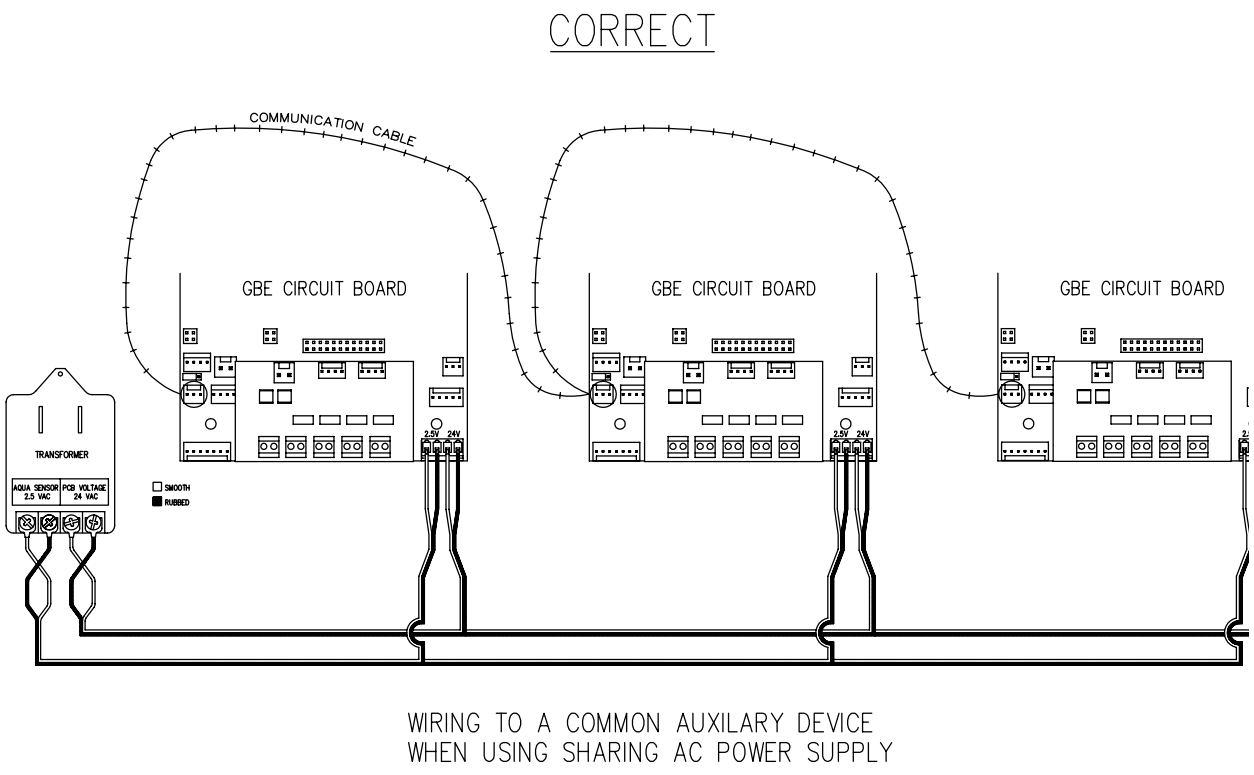


Figure 11. Correct connections for multiple GBE boards to 24 VAC.

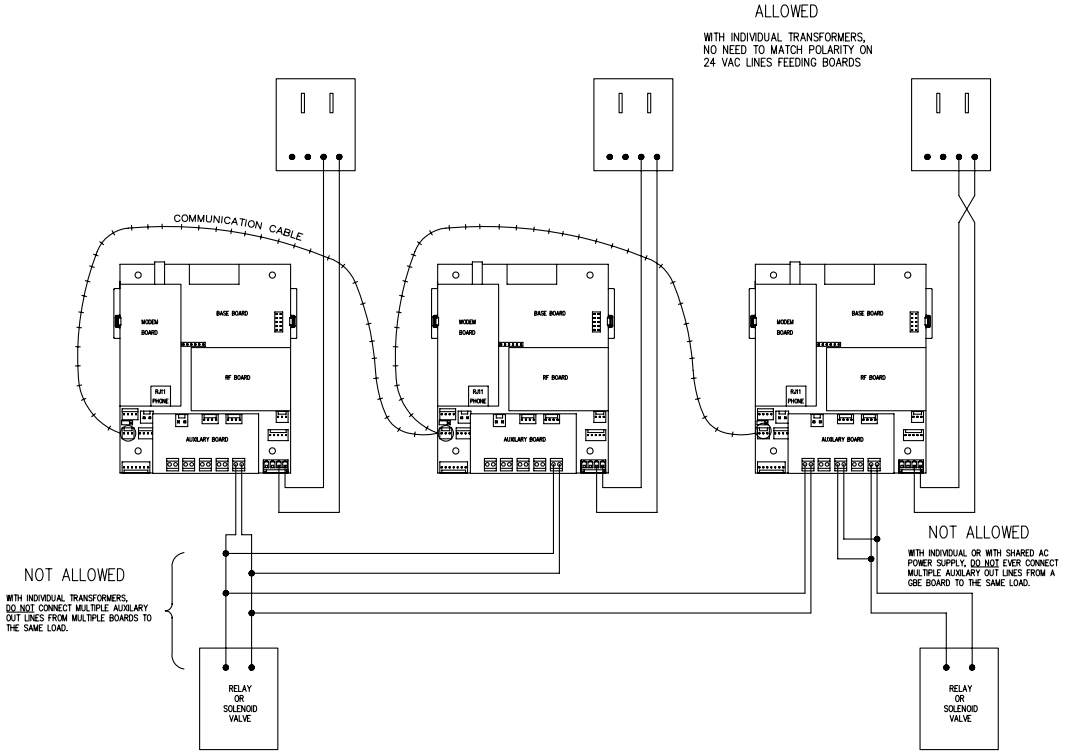


Figure 12. Allowed and non-allowed connections for multiple GBE boards to 24 VAC.

GBE-Modbus Communication

Modbus Communications to and from the GBE

Modbus is probably the most common industrial communications protocol in use today in North America. It is also used in many other parts of the world. Modbus is a multi-drop protocol, meaning that mulitple pieces of equipment can be used on the same network, and it has a range greater than 2000 feet in most implementations.

Unlike the other three protocols (RS-232, RS-485 and USB), Modbus does not simply consist of the GBE dumping out a full set of its status message data every 60 seconds; the Modbus controller (which is the customer's control room PLC system) decides which information it wants and when it wants it. In a Modbus network, every piece of equipment connected to the communications line is assigned an address ID number. Every device on the network has a list of the items of information that this device is capable of supplying to the Modbus master, and each item of information is assigned an item number. The Modbus device then waits for the Modbus master to send a request to "address X" asking for "item of information Y." If the requested address number matches the address number of this particular device then it replies to the request by sending item of information Y back to the Modbus master.

NOTE	**The default address ID for Culligan Modbus unit is 10. These addresses are set at the factory. If you are using more than one modbus module to create a network of modbus devices, you must have a unique node address for each device in the network. Contact Culligan Application Engineering for details.**

The GBE board by itself is not smart enough to handle this type of two-way communication with a Modbus master controller, so Culligan has developed a "smart interface Modbus cable" which consists of a cable the plugs into the GBE DEBUG port and a small "micro brick PLC" that gets wired in between the GBE and the Modbus master. The micro brick PLC receives and stores all of the status messages coming from the GBE status message DATA port transmissions. The micro brick PLC is also listening to the Modbus Master Controller to see if the master is requesting any data from the GBE board. If GBE data is requested, the microbrick PLC answers the request by providing the most recently received information from the GBE DATA port. The wiring of this microbrick PLC cable (PN 01023103 without enclosure; PN 01024633 includes enclosure) and the list of all of the "items of information" which can be supplied by the microbrick PLC are listed in the following section. Note that these next two sections of information are needed by our customer so they can tell their Master controller that, for example, "The current flow rate coming from Culligan softener #2 is stored in item-of-information #428895" and so on.

Culligan GBE Modbus Interface Cable

Modbus Addresses (984 Addressing Scheme)

The GBE Modbus Interface cable will work on a single, stand-alone softener, filter, RO, or on a network of connected softeners or filters such as a progressive flow or alternating flow network. The Interface cable consists of the GBE RS232 cable assembly (01021508) plus a micro-brick PLC. In a network of tanks, each GBE controller board is connected to the other GBE units within that network with a progressive flow communications cable (01016327). Up to four tanks can be connected in this way. When using a GBE Modbus Interface cable with a networked setup, only ONE GBE Modbus Interface cable should be used – and this cable should be connected to the TTL/DEBUG port on the MASTER GBE controller The MASTER GBE controller will send statistics and error information for itself and for all of the connected SLAVE units.

The parameter "CURRENT STATUS" indicates which tanks within a network are currently softening (or filtering) water – these units are identified as being in "Service". When softeners are regenerating, or filters are in backwash mode, these units will be identified as being in "Regeneration". Units which are available for service, but are not currently softening or filter water are identified as being in "standby". A softener or filter may be in any of these "STATUS" states with or without error conditions being present on the unit. If there are NO errors present on a softener or filter, then all of the error flags associated with that unit ID# will have a "0" or "off" state. If one or more errors are present on a unit, then there will be corresponding "1" or "on" states on that unit's error flags.

All GBE Modbus Interface cables leave the factory set as Modbus Network ID #10. If you are installing more than one of the GBE Modbus Interface cables to create a network, then each device must have a unique Modbus Network ID number programmed at the factory. To do this you must contact Culligan Applications Engineering to place a special order. The Modbus interface is set as 38,400 Baud, 8 bits, 1 stop bit, and parity = odd by default. These default values can be modified only at the factory. The cable between the GBE board and the microbrick PLC is a Culligan RS-232 cable. Connect this cable to the GBE board as shown in Figure 14 on page 17.

The GBE Modbus Interface cable connects from the TTL/DEBUG port on the back of the GBE controller board and then plugs into the RJ-11 style jack labeled "PORT 2" on the micro-brink PLC. The Modbus connection is made between the micro-brick PLC "PORT 3" and the customer's Modbus controller network. The micro-brink PLC requires a 24 VDC / 20W power connection to the "+ 24 VDC" and "0 VDC" screw terminal connections on the bottom face of the micro-brick.

The modbus addresses and valid instructions used to retrieve the most recent values received from the Smart Controllers are listed in the following tables.

MODBUS Tags for GBE-Controlled Softeners and Filters

Softener/Filter Number	Modbus Tag	Available Modbus Commands
Current Status (single precision integer: 0 = initialization, 1 = service, 2 = prerinse, 3 = regeneration, 4 = standby)		
Master	400101	3, 6, 16
Slave1	400102	3, 6, 16
Slave2	400103	3, 6, 16
Slave3	400104	3, 6, 16
Current Flow Rate (GPM, single precision integer)		
Master	428893	3, 6, 16
Slave1	428895	3, 6, 16
Slave2	428897	3, 6, 16
Slave3	428899	3, 6, 16
Remaining Capacity (Gallons, Float Type)		
Master	428913	3, 6, 16
Slave1	428915	3, 6, 16
Slave2	428917	3, 6, 16
Slave3	428919	3, 6, 16
Total Gallons Since New (Float Type)		
Master	428873	3, 6, 16
Slave1	428875	3, 6, 16
Slave2	428877	3, 6, 16
Slave3	428879	3, 6, 16

NOTE Single precision integer values range from 0 to 32767.

NOTE It might be necessary to drop the leading numeral 4 in order to recognize these modbus range of addresses for some modbus master devices.

Error Flags: Available Modbus Commands 1,5,15

(0 = error not present, 1=error is present)

Error Flag	Description	Master	Slave1	Slave2	Slave3
1	internal valve leak	16485	16585	16685	16785
2	salt bridge detected	16486	16586	16686	16786
3	brine line blocked	16487	16587	16687	16787
4	brine tank overfill	16488	16588	16688	16788
5	replace external filter	16489	16589	16689	16789
6	No RF signal from remote control	16490	16590	16690	16790
7	AquaSensor Salt Error: possibly low salt or failed eduction	16491	16591	16691	16791
8	Motor Homing Error	16492	16592	16692	16792
9	Motor Position Error	16493	16593	16693	16793
10	Low Salt Level in Brine Tank	16494	16594	16694	16794
11	Aquasensor Probe Fault	16495	16595	16695	16795
12	less than 14 days salt remaining	16496	16596	16696	16796
13	Reserved	16497	16597	16697	16797
14	Reserved	16498	16598	16698	16798
15	Reserved	16499	16599	16699	16799
16	Reserved	16500	16600	16700	16800

NOTE 1. Errors 2,3,4,10 and 12 require the use of a Culligan Smart Brine Tank Probe.
2. Errors 7,11 require the use of a Culligan Aquasensor probe.
3. Error 6 is triggered only if a Wireless Remote controller is installed in the system..

MODBUS Tags for GBE-Controlled RO Systems

NOTE All RO Tags are Single Precision Integers Type Valves.

Available Data	Tag	Modbus Commands
Feed Flow Rate (GPM)	429073	3, 6, 16
Product Flow Rate (GPM)	429075	3, 6, 16
<reserved for future use>	429077	3, 6, 16
Operational Status (1=Running, 2=Standby, 3=Offline, 4=Error)	429079	3, 6, 16
Recovery Percentage	429081	3, 6, 16
Rejection Percentage	429083	3, 6, 16
High Level Float Switch (0=Water is below switch, 1=Water is above switch)	429085	3, 6, 16
Low Level Float Switch (0=Water is below switch, 1=Water is above switch)	429087	3, 6, 16
Total Gallons of Product Since New	429089	3, 6, 16
Hours of Pump Run Time Since New	429091	3, 6, 16

NOTE It might be necessary to drop the leading numeral 4 in order to recognize these modbus range of addresses for some modbus master devices.

Wiring Connections for the GBE Modbus Communications Cable

Converter block will remain inside the Smart Controller box. Black section of the cable is gripped by the strain relief plug in the wall of the GBE controller box. See Figure 13. The RJ-11 style “phone plug” cable should connect to PORT 2. There is NO connection to PORT 1. Customer Modbus wiring should connect to screw terminals at PORT 3.

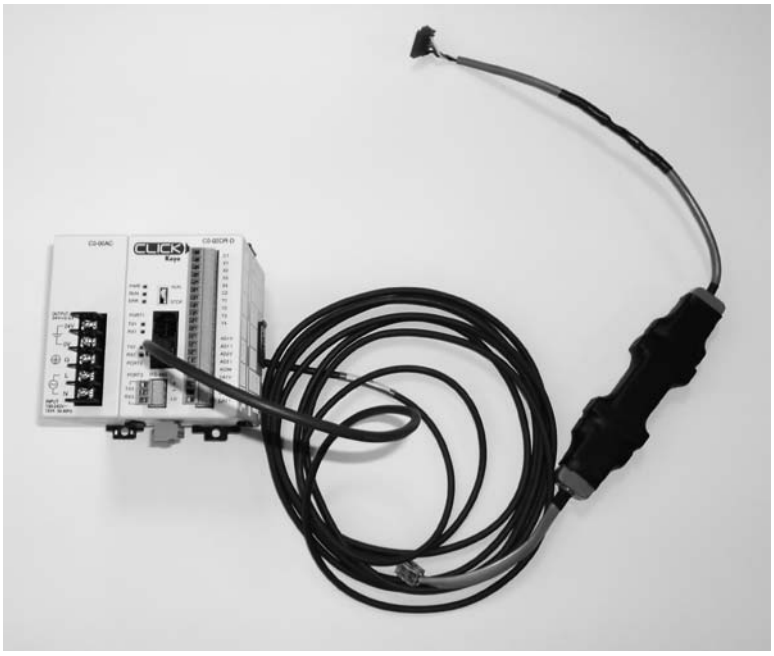


Figure 13. Modbus communication cable.

Figure 14 shows the connection between Modbus cable and the back of the Smart Controller GBE board.

NOTE	**The correct way to connect the cable is with the BLACK wire of the cable farthest from the words “DEBUG PORT.”**

Figure 14. GBE board connection for Modbus connection.

Modbus GBE Assembly Replacement Parts

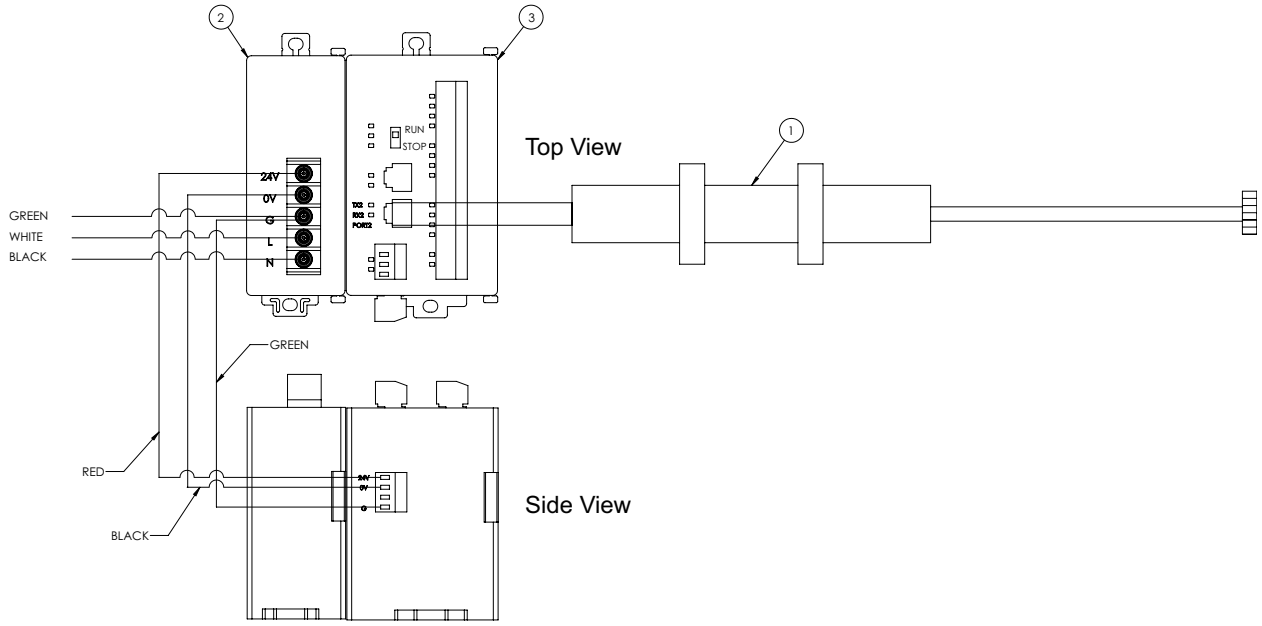


Figure 15. Modbus GBE assembly.

Item	Part No.	Description	Qty
1	01024842	Converter Cable, TTL-GBE, Modbus	1
2	01023495	Power Supply, AC/24V DC, 0.5 Amp	1
3	01023496	PLC MICRO ANLG, 4 DC IN/4 RELAY OUT, 2-CH IN/2-CH OUT	1

GBE-Profibus Communication

For customers interested in connecting GBE-controlled softeners, filters, or ROs to a Profibus PLC network, Culligan offers a Profibus converter, NT100, which can be used in addition to the Culligan Modbus converter.

The Profibus interface NT100-can connect up to two reverse osmosis (RO) modules and two water softener or filter (WS) modules via Modbus RS-485 serial connection.

- Modbus Slave addresses of RO modules must be 10 or 11, referred to as RO#1 and RO#2, respectively.
- Modbus Slave addresses of WS modules must be 12 or 13, referred to as WS#1 and WS#2, respectively.
- The address of NT 100-is 2.

If two RO modules and two WS modules are connected to the NT100, then the top LED above the serial port should be solid green to indicate good communication with all four modules. If fewer than four modules are connected, then this LED will be solid red for some time (while it is looking for the modules that are not connected) and solid green for some time (while it is communicating with the attached modules.) If the LED always solid red, then there is a problem with the Modbus communications.

To establish a Profibus connection to the NT100, load the GSD file “HIL_0C0E.GSD” supplied by Culligan into your Profibus Master configuration software. By default the Profibus Slave address is 125 and is software configurable. When adding the NT100 to your Profibus Master, add the following modules:

Slot	Description	Data Size (Bytes)	Culligan Module
1	20 Words In	40	RO#1
2	20 Words In	40	RO#2
3	32 Words In	64	WS#1
4	32 Words In	64	WS#2

Therefore the total data size added to your Profibus Master will be 208 bytes of input and 0 bytes of output.

Profibus Data Mapping to Culligan RO and WS Modules

No matter how many RO and WS modules are connected to the NT100, your Profibus Master will always receive 208 bytes of data from the NT100, but only the data corresponding to the physically attached modules will be significant. For example, if the NT100 has only WS#1 attached, then the first 80 bytes and last 64 bytes of Profibus data should be ignored.

Data values using two bytes are Integer types, and values using four bytes are double precision integers.

Profibus Data Bytes	Culligan Module	Culligan Submodule	Data Description
0..3	RO#1	N/A	Feed Flow Rate (GPM)
4..7	RO#1	N/A	Product Flow Rate (GPM)
8..11	RO#1	N/A	<reserved for future use>
12..15	RO#1	N/A	Operational Status (1 = Running, 2 = Standby, 3 = Offline, 4 = Error)
16..19	RO#1	N/A	Recovery Percentage
20..23	RO#1	N/A	Rejection Percentage
24..27	RO#1	N/A	High Level Float Switch (0 = Water is below switch, 1 = Water is above switch)
28..31	RO#1	N/A	Low Level Float Switch (0 = Water is below switch, 1 = Water is above switch)
32..35	RO#1	N/A	Total Gallons of Product Since New
36..39	RO#1	N/A	Hours of Pump Run Time Since New

Profibus Data Bytes	Culligan Module	Culligan Submodule	Data Description
40..43	RO#2	N/A	Feed Flow Rate (GPM)
44..47	RO#2	N/A	Product Flow Rate (GPM)
48..51	RO#2	N/A	<reserved for future use>
52..55	RO#2	N/A	Operational Status (1 = Running, 2 = Standby, 3 = Offline, 4 = Error)
56..59	RO#2	N/A	Recovery Percentage
60..63	RO#2	N/A	Rejection Percentage
64..67	RO#2	N/A	High Level Float Switch (0 = Water is below switch, 1 = Water is above switch)
68..71	RO#2	N/A	Low Level Float Switch (0 = Water is below switch, 1 = Water is above switch)
72..75	RO#2	N/A	Total Gallons of Product Since New
76..79	RO#2	N/A	Hours of Pump Run Time Since New
80..81	WS#1	Master	Current Status (0 = Initialization, 1 = Service, 2 = Prerinse, 3 = Regeneration, 4 = Standby)
82..83	WS#1	Slave1	Current Status
84..85	WS#1	Slave2	Current Status
86..87	WS#1	Slave3	Current Status
88..95	WS#1	N/A	<reserved for future use>
96..99	WS#1	Master	Current Flow Rate (GPM)
100..103	WS#1	Slave1	Current Flow Rate (GPM)
104..107	WS#1	Slave2	Current Flow Rate (GPM)
108..111	WS#1	Slave3	Current Flow Rate (GPM)
112..115	WS#1	Master	Remaining Capacity (Gallons)
116..119	WS#1	Slave1	Remaining Capacity (Gallons)
120..123	WS#1	Slave2	Remaining Capacity (Gallons)
124..127	WS#1	Slave3	Remaining Capacity (Gallons)
128..131	WS#1	Master	Total Gallons Since New
132..135	WS#1	Slave1	Total Gallons Since New
136..139	WS#1	Slave2	Total Gallons Since New
140..143	WS#1	Slave3	Total Gallons Since New
144..145	WS#2	Master	Current Status (0 = Initialization, 1 = Service, 2 = Prerinse, 3 = Regeneration, 4 = Standby)
146..147	WS#2	Slave1	Current Status
148..149	WS#2	Slave2	Current Status
150..151	WS#2	Slave3	Current Status

Profibus Data Bytes	Culligan Module	Culligan Submodule	Data Description
152..159	WS#2	N/A	<reserved for future use>
160..163	WS#2	Master	Current Flow Rate (GPM)
164..167	WS#2	Slave1	Current Flow Rate (GPM)
168..171	WS#2	Slave2	Current Flow Rate (GPM)
172..175	WS#2	Slave3	Current Flow Rate (GPM)
176..179	WS#2	Master	Remaining Capacity (Gallons)
180..183	WS#2	Slave1	Remaining Capacity (Gallons)
184..187	WS#2	Slave2	Remaining Capacity (Gallons)
188..191	WS#2	Slave3	Remaining Capacity (Gallons)
192..195	WS#2	Master	Total Gallons Since New
196..199	WS#2	Slave1	Total Gallons Since New
200..203	WS#2	Slave2	Total Gallons Since New
204..207	WS#2	Slave3	Total Gallons Since New

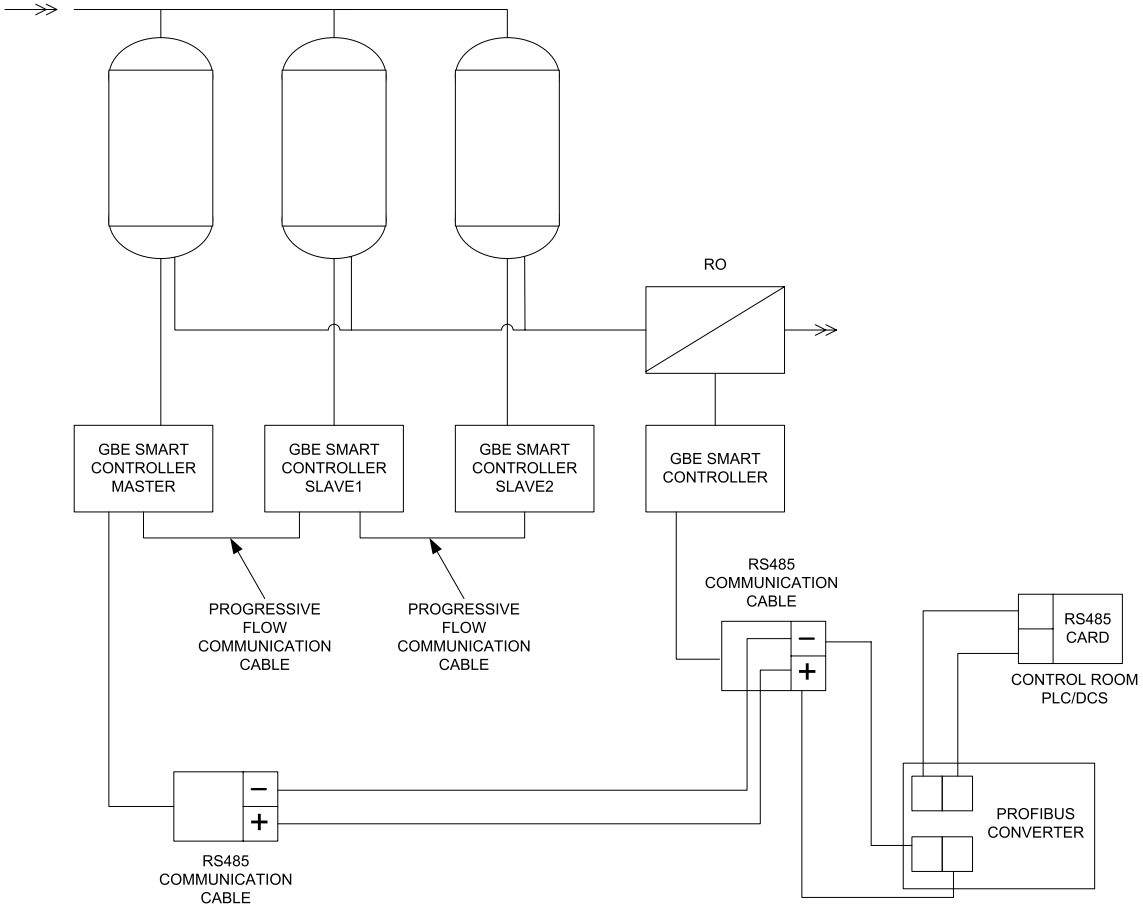


Figure 16. Wiring diagram for RS-485/profibus communication.

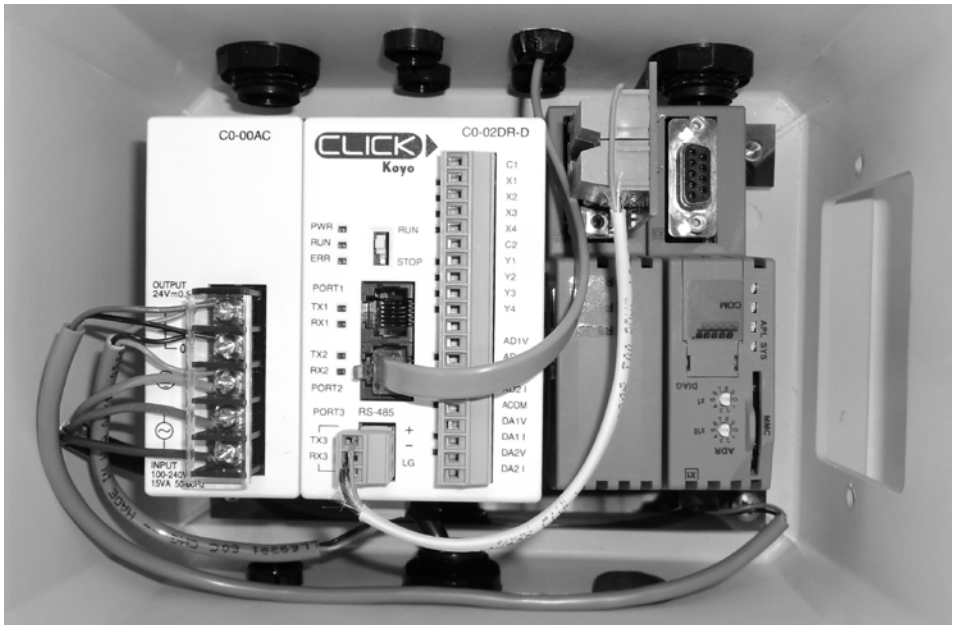


Figure 17. RS-485/profibus electrical connections.

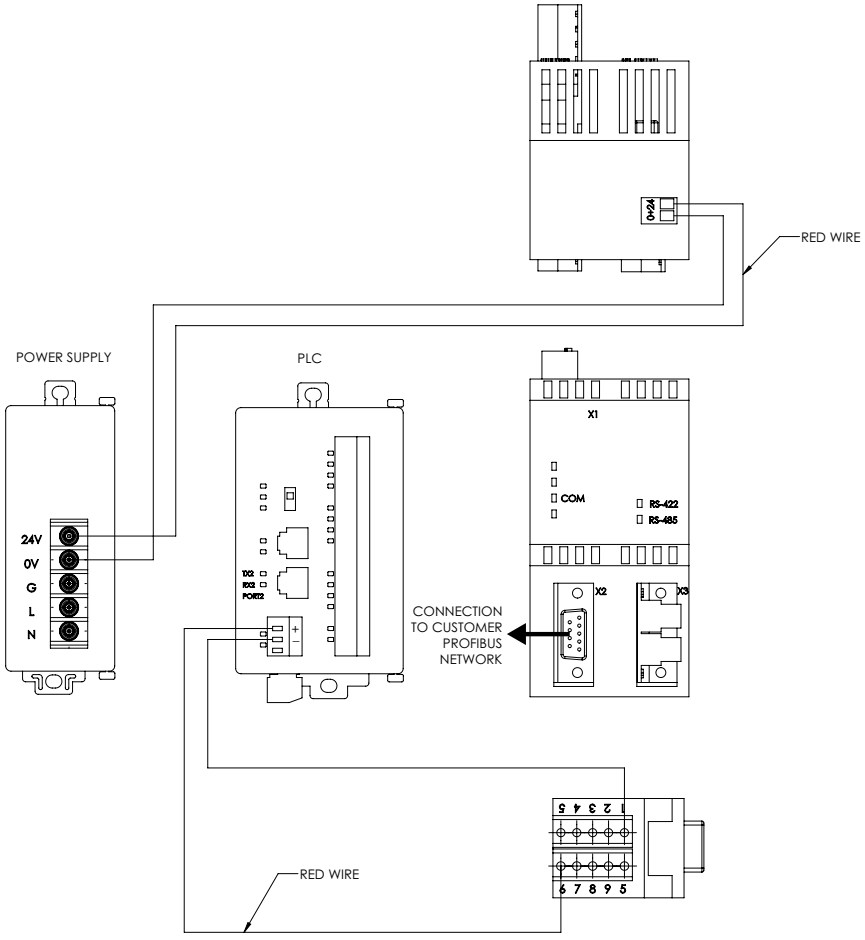


Figure 18. Wiring schematic for modbus/profibus communication.

GBE-USB Communication

Frequently it is useful to be able to quickly see the information that is generated by the GBE board during an installation or troubleshooting session. Culligan has developed an easy to use piece of software which can be downloaded from MyCulligan.com for free. Using this software, and Culligan USB cable (PN 01021507) it is possible to see the data on a laptop or desktop PC screen as it is generated. The Culligan software automatically reads in the data and then displays it on the screen in a more human-readable format.

This data can also be saved to a computer file as it is being read in.

NOTE **In addition to the statistical information that is presented every minute, the USB port is also able to display diagnostic information such as readings from an Aqua-Sensor or Smart Brine Probe, and it can display the system summary information created if you select "USE DATA PORT" from the GBE diagnostic menu.**

*** MINI REPORT ***

SN = 00000041	Pressure = HIGH
FW Version = FWR210LT01	Salt type = NaCl
Valve Type = 4-CYCLE	Resin type = std
Date = 4/30/10	BF Flow control = 0.45 GPM
Time = 11:00	Eductor Flow control = 32.0
Total = 0 GAL	Reserve capacity = 10 %
regen 14d = 0	flow meter trig = yes
trigger = Manual	aquasensor trig = no
type = softener	regen interval = 0
hardness units = US	predict mode = no
Hardness = 26 grains	day of week mode = none
Resin = 1.00 cu/ft	brine type = Downflow
avg mon = 300 GAL	pre-rinse mode = no
avg tue = 300 GAL	prerinse after 24 hours
avg wed = 300 GAL	prerinse for 5 mins
avg thr = 198 GAL	units = US
avg fri = 300 GAL	A/S = not installed*
avg sat = 300 GAL	SBT = not installed*
avg sun gal = 300 GAL	Flow Profile R1 = 0
bw time = 1 min	Flow Profile R2 = 0
BD rinse = 1 min	Flow Profile R3 = 0
F rinse = 10 min	Flow Profile R4 = 0
Fill = 60 sec	Flow Profile R5 = 0
Dosage = 9.0 LBS	Flow Profile R6 = 0
DAS = SOFTEST	
Iron = 0 PPM	

* Softener only.

Figure 19. Example output for USE DATA PORT on a GBE-controlled softener.

Getting Started

To connect the Smart Controller to a computer you will need:

- a GBE circuit board
- a USB-to-GBE cable (Culligan P/N 01021507)
- GBE advanced communication software

Download the Software

1. Log in to your account on the myCulligan.com Web site.
2. Got to Technical > GBE Downloads in myCulligan.com.
3. Go to the Download the compressed archive file (*.zip) named XX.zip.
4. Copy the *.zip file to your computer.
5. Doubleclick on the file name of the *.zip file to extract the four files located in the *.zip file to your local hard drive. See Table 1. You will be asked which directory you want to copy these files to. You may choose any directory name you choose. All four files should be copied to the *same* Windows directory.

File Name	Description
Readme.doc	Important information about the download file
DebugPortReader_win64	The program required to communicate with the GBE board
CDM20600	The Windows® driver file required for the cable
Dbgcfg	The data file required by the DebugPortReader application

Table 2. Advanced communication *.zip file contents.

Install USB Cable Driver Software

Once you have extracted the four files from the *.zip file, you will need to install the driver for the USB cable. The easiest way to do this is to:

1. Click on the START button in MS Windows then choose the “MyDocuments” folder. This will open a MS Windows directory screen.
2. Navigate to, or type the name of, the directory where you installed the four files.
3. Double-click on the file named CDM20600 to install the Windows driver for the USB cable. This is required only on each PC that will communicate with the GBE board.

Attach GBE Communication Cables

1. To set up communication with a GBE board, connect the USB cable to any available USB port on the computer.
2. Connect the other end of the USB cable to the DEBUG PORT connector located on the back of the GBE board behind the display.

NOTE	**The rainbow-colored-wiring-connector from the USB cable will fit either way onto the DEBUG PORT connector. The correct way to connect the cable is with the BLACK wire of the cable farthest from the words “DEBUG PORT” (see Figure 20).**

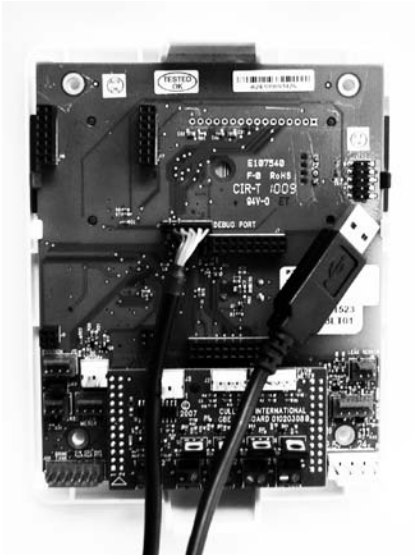


Figure 20. GBE-USB connection.

Begin Communication

1. Double-click on the filename “DebugPortReader_win64” to start the program. This will open a dialog box on the PC: see Figure 21.

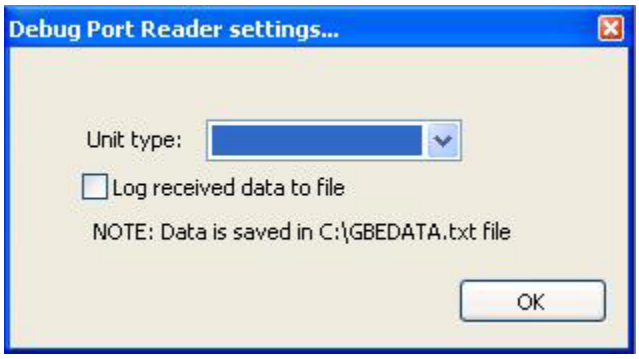


Figure 21. DebugPortReader settings dialog box.

2. Click and pull down the list to choose the Unit Type, which is the GBE board connected to the USB.

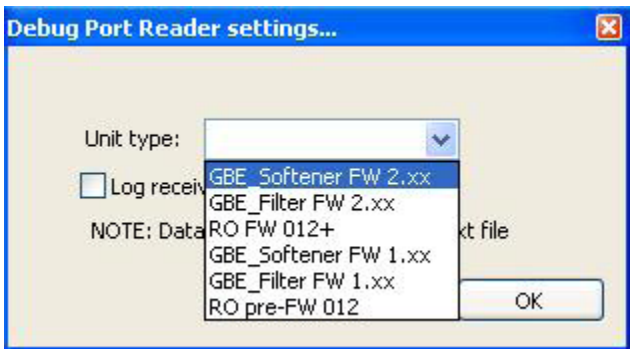
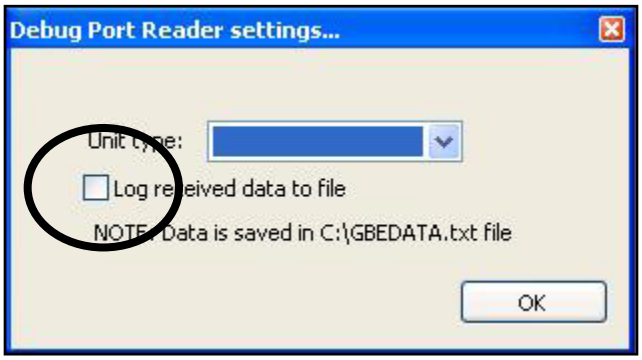


Figure 22. Unit type selection list.

NOTE	**The list items include the board type and the firmware version of that board. For example, if you are connecting to a softener Smart Controller board that uses firmware version 2.1.1, choose "GBE Softener FW 2.11." If you are trying to connect to an older software firmware version, such as 1.19, select "GBE Softener FW 1.19."**

3. Normally this program is used for viewing the output from the GBE board on the computer screen. If you would also like to save all of the data you are seeing to a file on your computer hard drive so that you can, for example, email it to Culligan Engineering for further assistance, click on the small white square box labeled "Log Received Data to File."



4. Click the OK button. The screen displays the data captured via the USB connection. See Figure 23.

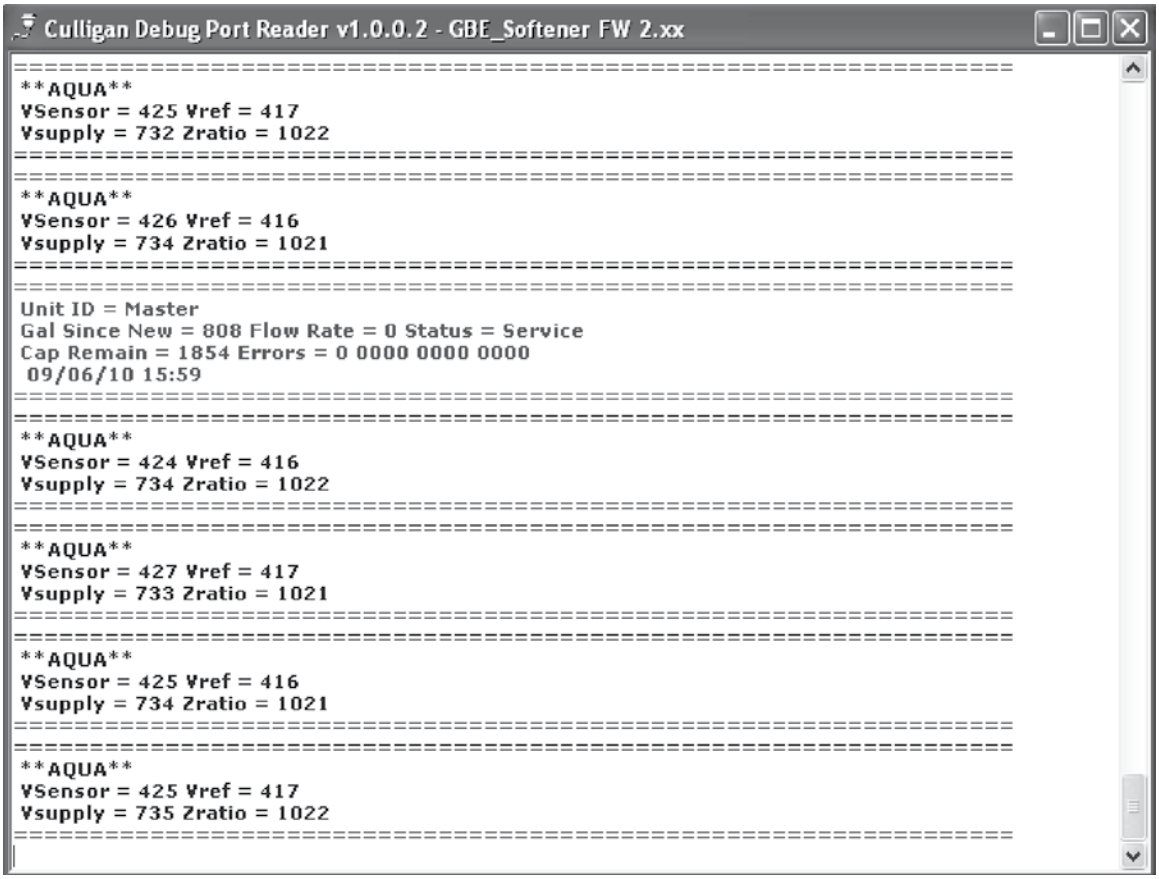


Figure 23. Typical information captured by the USB cable.

All GBE boards send out regular status messages to the DEBUG port. These messages are sent approximately every 60 seconds. Some boards send other information to the DEBUG port.

GBE Softener Debug Port Data	Setup
Status message every 60 seconds	Basic setup.
Aqua-Sensor data every 1 second	Turn on the Aqua-Sensor DEBUG data option using the Accessories > Aqua-Sensor menu. (See the Smart Controller manual, P/N 01021161)
Smart Brine Tank data every 1 second	Set up the GBE menu using the Diagnostics > Check Sensors > SBT Probe menu. (See the Smart Controller manual, P/N 01021161)
Mini Report message any time	Every time the USE DATA PORT option is selected from the Diagnostics menu.

GBE Filter Debug Port Data	Setup
Status message every 60 seconds	Basic setup.
Mini Report message any time	Every time the USE DATA PORT option is selected from the Diagnostics menu.

End Communication

1. Click the red X in the upper right corner of the window to end the program.
2. If you clicked the “Log Received Data to File” check box, then your data will be saved to a file on your C drive named C:\GBEDATA.TXT. The easiest way to send this data to Culligan Engineering is to attach this file to an email message.

There are two important things to know about the GBEDATA.TXT file. First, the data in this file is “raw” data; it will not include all of the human-readable labels that you see on the main display screen. Second, if a GBEDATA.TXT file already exists at your C drive location, when you run the DebugPortReader program it will add the new data to the end of the existing file. It will NOT overwrite your original file. To start a new file, you must erase or rename the existing file before you start the DebugPortReader program.