Series 370 Stabil-Ion® Gauge Controller with RS-485 Interface Option

Introduction

The RS-485 communications option (See Figure 1) for the Series 370 Stabil-Ion Gauge Controller permits data output to, and gauge control by, a host computer using RS-485 digital communications. Communications handshake is by a command-response mechanism. A variety of baud rates and byte framing options are available. The RS-485 byte format is configured to your system requirements using configuration switches located on the option board. These switches are accessed by removing the controller top chassis cover.

The RS-485 factory defaults are: 9600 BAUD, 8 character bits, no parity, 1 stop bit, Address = 01

Internal switches are read upon power up. Changes in settings will take effect upon next power-up cycle.

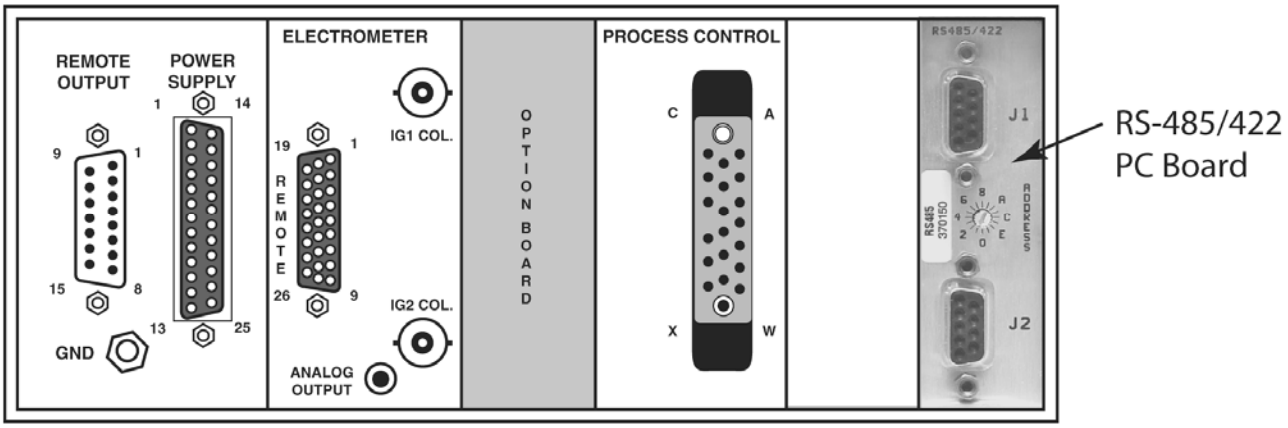
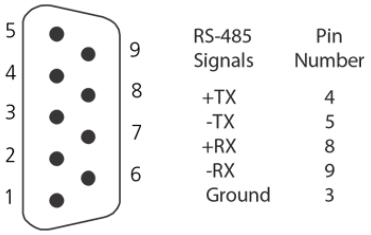


Figure 1. Series 370 Stabil-Ion Gauge Controller – Rear Panel

Connector Pin outs

Connectors J1 and J2, Figure 2, on the rear panel are wired in parallel and are interchangeable. Connection can easily be made by "daisy chaining" gauge controllers together with the signal from the host computer going into one connector then out the other to another gauge controller.



RS-485 Signals	Pin Number
+TX	4
-TX	5
+RX	8
-RX	9
Ground	3

Figure 2 – Output Connector and pin out Configuration

Communications Data Transfer

The Series 370 Controller uses a command-response half-duplex protocol. If the controller recognizes received data as a valid command, it will check the command string address and compare with its own. If the addresses match, the controller will process the command and then respond. In all configurations, only one twisted pair will have data transmissions in one direction at any time. The timing of the data transfer is shown in Figure 3 below. T0 is 10-13 mS + 10 bit times with S2.1 in the OFF position, T0 is greater than 700 microseconds with S2.1 in the ON position, and T1 is greater than 300 microseconds. Adhering to these timing constraints will ensure data is not overwritten.

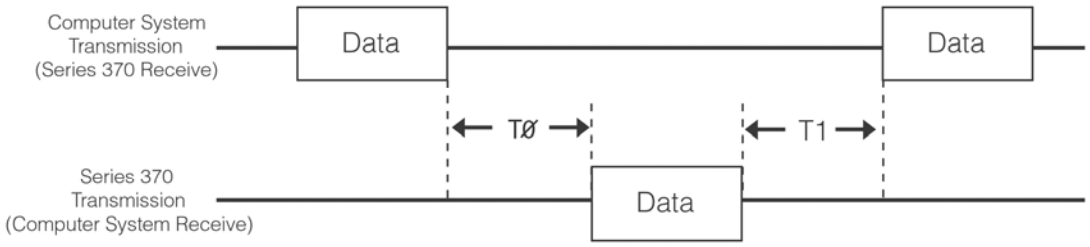


Figure 3 – RS-485 Data Timing

RS-485 Address

The address dial on the RS-485 module on the back of the controller (see Figure 4) and Switch S1 determine the controller's RS-485 address. This address can be any hex code from 00 to FF.

The address dial on the RS-485 module on the back of the controller determines the value of the least significant digit and S1 switches determine the value of the most significant digit. S1 switch positions are binary and the weight of each switch when OFF is given in Table 1.

To prevent data contentions, no two RS-485 nodes should be set with the same address. It is not recommended that address 00 be used because some manufacturers use this address for configuration.

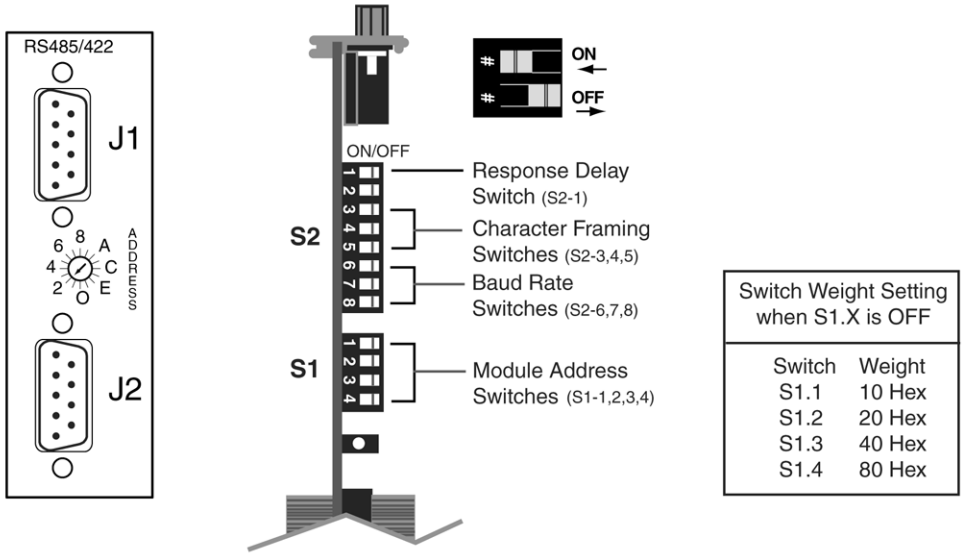


Figure 4 – RS-485 Module PCB and Switches

Selecting the Byte Format Baud Rate

Baud rate for the RS-485 communications is determined by the settings of switches S2.6, S2.7 and S2.8 (see Figure 4). Table 1 defines the baud rate based on the switch settings. *The factory default baud rate setting is 9600.*

Table 1 – Baud Rate Switch Settings

S2.6	S2.7	S2.8	Baud Rate
ON	ON	OFF	9600
ON	OFF	ON	4800
ON	OFF	OFF	2400
OFF	ON	ON	1200
OFF	ON	OFF	600
OFF	OFF	ON	300
OFF	OFF	OFF	150

Character Framing

Character framing for the RS-485 computer interface is determined by setting switches S2.3, S2.4, and S2.5 (see Figure 3). Table 2 defines the character bits, parity, and stop bits based on the switch settings. *The factory default setting is S2.3 ON, S2.4 OFF, and S2.5 OFF, Character Bits set to 8, Parity None, and Stops Bits at 1.*

Table 2 – Character Framing Switch Settings

S2.3	S2.4	S2.5	Character Bits	Parity	Stop Bits
ON	ON	ON	8	None	2
ON	ON	OFF	8	Even	1
ON	OFF	ON	8	Odd	1
ON	OFF	OFF	8	None	1
OFF	ON	ON	7	Even	1
OFF	ON	OFF	7	Odd	1
OFF	OFF	ON	7	Even	2
OFF	OFF	OFF	7	Odd	2

Response Delay

Switch S2.1 (see Figure 4) enables a delay in the response from the module of 10-13 MS + 10 bit times when OFF. When S2.1 is ON the delay is greater than 700 microseconds. *In the factory default setting S2.1 is ON with a delay greater than 700 microseconds*.

Connections

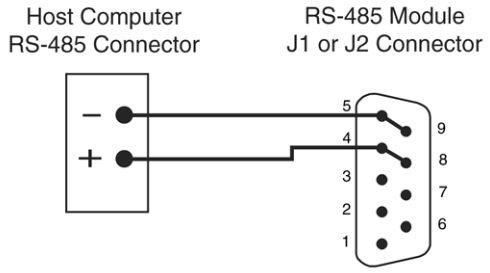
Connectors J1 and J2 on the rear panel are wired in parallel and are interchangeable. Connection between multiple controllers can easily be made by “daisy chaining” gauge controllers together with the signal from the host computer going into one connector then out the other to another gauge controller.

In a four wire configuration connect TX on the gauge controller to RX on the host computer and connect RX on the gauge controller to TX on the host computer. If the computer sends and receives data on 2 wires, connect the RS-485+ from the computer to both the +TX and +RX Pins (Pins 4 and 8), and connect the RS-485- from the computer to both -TX to -RX (Pins 5 and 9). Figure 5 shows the proper wire connections for a 2-wire connection.

The maximum total cable length is 4,000 ft. No more than 32 devices can be connected to one RS-485 communications line. When an RS-485 network is in an idle state, all nodes are in listen (receive) mode. Under this condition there are no active drivers on the network. To maintain the proper idle voltage state, bias resistors must be applied to force the data lines to the idle condition. Figure 6 illustrates the placement of bias resistors on a host computer, 2-wire configuration, for the typical 5 volt and 24 volt systems.

When connecting multiple Series 370 Controllers connect TX to TX and RX to RX on all controllers.

The polarity may have to be reversed on the computer and other instruments—you may have to try it both ways. No damage will result if connections are wrong.



Host Computer (2 Wire)	Host Computer (4 Wire)	RS-485 PCB Signal	Pin Number
+ (B)	+ RX	+ TX	4
– (A)	– RX	– TX	5
+ (B)	+ TX	+ RX	8
– (A)	– TX	– RX	9
Ground	Ground	Ground	3

Figure 5 – Wire Connections for a 2-wire Connection

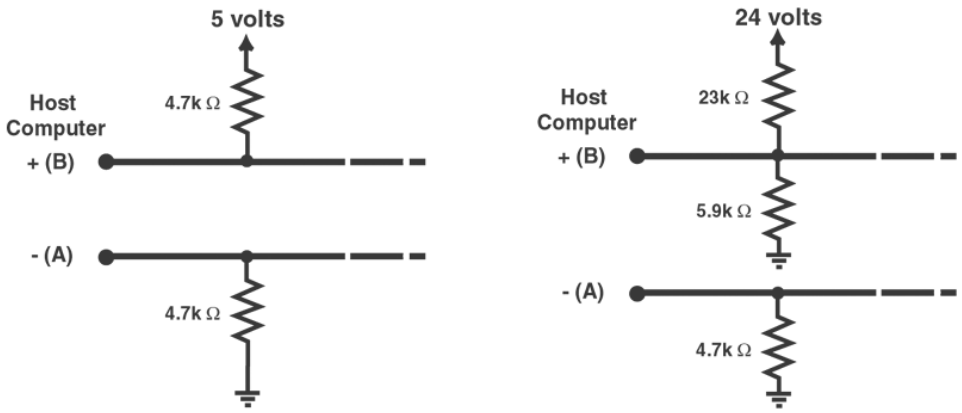


Figure 6 - Bias Resistors

Preparing for Use

Consult the user's manual for the host computer to be sure the character framing settings used are in accord with that established via the switch configuration you have chosen for the RS-485 module.

Communication is via ASCII strings. A message to consists of a start character "#", an address "AA", command, and a command modifier, followed by a terminator. The message may contain leading spaces, and the command and modifier may optionally be separated by spaces. No spaces may appear within the command or the modifier, only between them.

The address expected is programmed via the switch settings on the rear of the module. The syntax is "#AA" where AA is an ASCII representation of the hex address of the controller. The terminator expected is an ASCII carriage-return denoted here by CR. Note that the terminator is sometimes appended automatically, by the host computer's interface software, to the message string supplied by the user. If extra characters are found in the message after it has been successfully interpreted but before the terminator, they will be ignored.

All messages will receive a reply, consisting of an ASCII string terminated with CR. Pressure numbers will be returned in the format X.XXE±XX.

Messages may use upper or lower case alpha characters. The controller will always respond with upper case characters.

RS-485 Command Set

IG1

Definition: Turn **IG1** ON or OFF.

Modifiers: **ON** or **OFF**

Response: **OK** if command accepted, **INVALID** if rejected.

Example: From computer: **#AAIG1 ON CR**

From 370: **OKCR**

NOTES

The **IG1 ON** command will be rejected as **INVALID** if **IG1** is already ON, and **IG1 OFF** will be rejected if **IG1** is already OFF.

A response to the **IG1 ON** command of **OK** indicates only that a signal requesting that IG1 be turned ON has been sent to the electrometer. IG1 may fail to come ON, e.g., if the system pressure is too high or if the gauge is disconnected. To verify that IG1 is ON, use the **DS IG1** command. If the gauge is OFF, or in its first few seconds of operation after being turned on, a pressure of 9.90E+9 will be returned.

IG2

Identical to IG1, but applies to IG2.

DG

Definition: Turn Degas ON or OFF

Modifiers: **ON** or **OFF**

Response: **OK** if command accepted, or **INVALID** if rejected.

Example: From computer: **#AADG ON CR**

From 370: **OKCR**

NOTES

Command is INVALID if neither IG is ON.

A response to the **DG ON** command of **OK** indicates only that a signal requesting degas has been sent to the electrometer. Degas may fail to activate if the pressure is above 5 x 10^{-5} Torr, or if the controller is unable to maintain degas operation. Use the **DGS** command (see below) to verify that degas has been successfully initiated.

DS

Definition: Display pressure reading.

Modifiers: **IG1** or **IG2** or **IG** or **CG1** or **CG2**.

Response: ASCII string representing the pressure for the selected gauge.

Example: From computer: **#AADS CG1 CR**

From 370: **1.20E-03CR**

NOTES

If the requested ion gauge (**IG1** or **IG2**) is turned OFF, or is in its first few seconds of operation the controller will return 9.90E+09.

The **DS IG** command will return pressure from the gauge that is ON, and 9.90E+09 if neither ion gauge is ON.

The **DS CG1** and **DS CG2** commands are used to display the pressures from the lower two display lines with the Convectron Gauge module installed. If data is requested from a Convectron Gauge when none is installed the output will be 9.99E+09.

DGS

Definition:	Display degas status.
Modifiers:	None
Response:	ASCII **1** if degas is ON, **0** if degas is OFF.
Example:	From computer: **#AADGS CR**
	From 370: **1CR**

CATH1

Definition:	Select Filament 1, Filament 2, or both filaments for IG1 operation.
Modifiers:	**1**, **2**, or **B**
Response:	**OKCR**
Example:	From computer: **#AACATH1 2 CR**
	From 370: **OKCR**

NOTES

This function can be implemented from the electrometer front panel or from the remote input connector as well as from the computer interface.

CATH2

Identical to CATH1 except applies to IG2.

PR1

Definition:	Select pressure range for IG1 operation.
Modifiers:	**L** or **H**
Response:	**OKCR**
Example:	From computer: **#AAPR1 L CR**
	From 370: **OKCR**

NOTES

This function can be implemented from the electrometer front panel, the remote input connector as well as from the computer interface.

PR2

Identical to PR1 except applies to IG2.

GAS IG1

Definition: Select the gas calibration for the selected gauge.

Modifiers: **a** or **b**

Response: **OK** if accepted.

Example: From computer: **#AAGAS IG1 a CR**

From Controller: **OKCR**

GAS IG2

Identical to GAS IG1 except applies to IG2.

GAS CGA

Identical to GAS IG1 except applies to CGA.

GAS CGB

Identical to GAS IG1 except applies to CGB.

FPS

Definition: Front Panel Status. Displays the status of the current gauge setup condition.

Modifiers: **None**

Response: **0, 0, 0, 0, 1, 1, 1, 0, 1, 1 CR**

Example: If the Controller is set as follows: for IG1- gas a, pressure range low, single filament operation, filament #1; and for IG2 - gas b, pressure range high, both filaments operating, filament #1; CGA - gas b; CGB - gas b, then the response would be: **0, 0, 0, 0, 1, 1, 1, 0, 1, 1, CR**
See the Example on the following page.

Front Panel Status Display **0 0 0 0 1 1 1 0 1 1 CR**

Function		0	1
IG1	Gas	a	b
	Pressure Range	L	H
	Filament Operation	Single	Both
	Filament #	1	2
IG2	Gas	a	b
	Pressure Range	L	H
	Filament Operation	Single	Both
	Filament #	1	2
CGA	Gas	a	b
CGB	Gas	a	b

SWS

Definition: Display status of gauge control switches/remotes.

Modifiers: **None**

Response: **0, 1, 0, 1, CR**

Example: If the controller is set for IG1 filament #1, IG2 filament #2, IG1 pressure range low, and IG2 pressure range high the response will be : **0, 1, 0, 1 CR**

Switch Status Display

0 1 0 1 CR

Function	0	1
IG1 Filament #	1	2
IG2 Filament #	1	2
IG1 Pressure Range	L	H
IG2 Pressure Range	L	H

PCS

Definition: Display process control channel status.

Modifiers: **1** or **2** or **3** or **4** or b or **6** or **B** or **NONE**.

Response: Depends on modifier:

Modifier = single digit (**1 through 6**) response: **single ASCII digit**, **0** if the corresponding relay is inactive, **1** if active. (See Example 1.)

Modifier = **B** response: A byte of data with bits 0 through 5 set/clear according to whether the corresponding relay is active/inactive. Bit 6 will always be set to one (1) guaranteeing that the returned byte will not appear as a terminator byte. (See Example 2.)

Modifier absent (None): Response will be a string of 6 ASCII 0's and 1's separated by commas giving the status of all six channels, starting with channel 6 and ending with channel 1. (See Example 3.)

Examples: Assume that channels 1 - 3 are active, and 4 - 6 are inactive:

1. From computer: **#AAPCS 1 CR**
   From 370: **1CR**
2. From computer: **#AAPCS B CR**
   From 370: **GCR**

(Note that ASCII "G" corresponds to the bit pattern 01000111 and represents the status of the PC channels in bits 0 through 5).

3. From computer: **#AAPCS CR**
   From 370: **0, 0, 0, 1, 1, 1 CR**

(Note that the string starts with channel 6 and ends with channel 1).

Error Messages

If an error is found in the incoming message, the Series 370 Controller will return the following message in place of the normal response.

OVERRUN ERROR - Returned if the incoming message overflows the buffer.

SYNTAX ERROR - Returned if the message fails to parse as a valid command.

PARITY ERROR - Returned if the parity of a byte in the incoming message does not match that programmed by the switches.

Troubleshooting

In the event of problems with the RS-485 communications verify the following items for proper configuration.

1. Check the configuration switch settings.

Ensure the baud rate, character framing, and interface protocol are matched to the host computer or terminal's requirements. Note that there may be several mismatched parameters.

2. Check the command format.

Ensure that the command strings output from the host computer or terminal to the Series 370 Controller are in accordance with the syntax defined by this addendum.

Microcontroller reset LED CR1 illuminated or flashing	Microcontroller failure.
No response or garbled output.	Baud rate incorrect, character length incorrect, character framing incorrect, or bias resistors do not exist or are incorrect.
Intermittently will not respond.	Poor cable connections, ground fluctuations (the maximum common mode potential across the system is 7 volts) and EMI from other sources. Bias resistors do not exist or are incorrect. If the start character is not received properly, the Series 370 controller may not interpret it as a start character and the controller will not respond. Host software must be prepared to re-send a command if a response is not generated within a reasonable period of time.
OVERRUN ERROR message	Stop bit(s) incorrect. Host software failure.
PARITY ERROR message	Parity incorrect.
SYNTAX ERROR message	Message to Series 370 Controller not in accordance with specified syntax

Specifications

Communications Format	RS-485 or 422, half-duplex, asynchronous
Data rate	9600 (Default), 4800, 24,00, 200, 600, 300, 150 baud
Character length	8 bit or 7 bit ASCII (factory default = 8 bit)
Parity	No parity, even or odd (factory default = none)
Stop bits	1 or 2 (factory default = 1)
Handshake	None (Poll/Response)
Address	256 selectable combinations (factory default = 01)
Number of connections	Up to 32 devices
Total cable length	4,000 feet maximum
Connectors	Two 9-pin D-sub (parallel)