User Guide Supplement – MODBUS Communications Option

IM/8240–MOD_4

Analyzers

8240 Series

ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company, and is indicative of our dedication to quality and accuracy.

EN ISO 9001:1994

Cert. No. Q05907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.

0255

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. If the instrument is used in a manner NOT specified by the Company, the protection provided by the instrument may be impaired.

Symbols

One or more of the following symbols may appear on the instrument labelling:

	**Warning –** Refer to the manual for instructions
	**Caution –** Risk of electric shock
	Protective earth (ground) terminal
	Earth (ground) terminal

	Direct current supply only
	Alternating current supply only
	Both direct and alternating current supply
	The equipment is protected through double insulation

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

1 INTRODUCTION

This Supplement must be read in conjunction with the Instruction Manual supplied with the instrument:

Instrument	Manual Reference
• *Model 8241 Colorimetric Silica Monitor*	– *IM/8241*
• *Model 8242 Colorimetric Phosphate Monitor*	– *IM/8242*

For repeatable and reliable serial communication to take place between a master (host computer) and slaves (instruments) it is essential that the two conditions detailed in this section are met.

1.1 Electrical Connection

A standard method of electrical connection is used between the master and the slaves, with defined voltage levels and characteristics. The transmitter and receiver integrated circuits within the instrument meet the requirements of the EIA (Electronic Industries Association, American) RS485 and RS422 Serial Interface Standards.

The RS422/485 communication standard is used with the following logic levels:

a) for logic '1' (MARK condition or IDLE state) the 'A' terminal of the transmitter is negative (0V) with respect to the 'B' terminal (+5V)

b) for logic '0' (SPACE condition or ACTIVE state) the 'A' terminal of the transmitter is positive (+5V) with respect to the 'B' terminal (0V).

Note. The 'A' terminal is Tx + or Rx + and the 'B' terminal is Tx – or Rx –.

1.2 Protocol

A standard language or protocol must be used in both the master and the slaves for messages (commands and data) to be interpreted and acted upon. To achieve this second condition, MODBUS Protocol is utilized on the 8240 Monitor using the Remote Terminal Unit (RTU) mode only.

Two methods of message error checking are used. Parity checking is used, if selected, to detect transmission errors in individual characters.

Parity is used for simple error checking. The parity bit is a one-bit code which is transmitted in addition to the ASCII character. It can detect only one error per character, since two errors may cancel out. Parity is calculated by finding the sum of logic '1's in the character and either:

a) setting the parity bit to logic '1' if the sum is odd, or logic '0' if the sum is even, when using even parity.

or

b) setting the parity bit to logic '0' if the sum is odd, or logic '1' if the sum is even, when using odd parity.

Cyclic Redundancy Checking (CRC-16) is used to detect errors in the Master messages and Slave responses. This therefore detects errors in the complete message sent and also the replies.

2 PREPARATION

Preparation of the instrument is detailed in the relevant Instruction Manual, with additions as detailed in this Section.

2.1 Company Standard Settings

Only those parameters detailed on the customer order are programmed at the factory. If any parameters are unsuitable for the application they can be reprogrammed – *see Section 6 of the relevant Instruction Manual*. Serial data programming details are given in Section 7 of this manual.

Standard settings for the serial data parameters are as follows:

Instrument Identity	01
Parity	None
Transmission Rate	9600 baud

3 INSTALLATION

Observe the limitations outlined in the installation information of the relevant Instruction Manual. The maximum serial data transmission line length for both RS422 and RS485 systems is 1200m.

3.1 Serial Communication Adaptors for Personal Computers

An RS422/485 communications adaptor board is required for serial links. It is strongly recommended that the card used has galvanic isolation to protect the computer from lightning damage and increase immunity from noise pick-up from cables.

3.1.1 Five-wire Configuration

The following OPTO22 boards are recommended for use with the 4600 serial instruments:

Part No.	ComputerType
AC24	XT Bus IBM PC compatible
AC24 AT	AT Bus IBM PC compatible
AC34	Microchannel IBM PC.

The following 'jumper' selections are required on OPTO22 boards (usually supplied as the default configuration):

RX & TX	install line termination jumper Install pull-up and pull-down jumpers
CTS & RTS	disable jumper installed.

Select board address and interrupts as described in the OPTO22 manual.

3.1.2 Three-wire Configuration

The adaptor card must have the provision for disabling the transmitter after each message is transmitted, so that bus contention does not occur. This is often implemented by the use of the RTS signal to control the transmitter enable. Consult the adaptor card manufacturer to determine suitability.

Caution. Install the pull-up/pull-down resistors on either the RX **or** TX lines. The resistors **must not** be connected on **both** pairs of lines.

4 ELECTRICAL CONNECTIONS

All connections, apart from those for serial data communication, are made as shown in Figs. 2.3 and 2.5 of the relevant Instruction Manual.

4.1 Serial Connections – Figs. 4.1 and 4.2

The transmitters must be connected in parallel as shown in the schematic diagram – Fig. 4.1. The RS485 standard quotes connection of maximum thirty two slaves (8240 Monitors) to any single driver (computer terminal or host computer); the RS422 standard quotes connection of up to ten slaves. However, these numbers can be increased if the driver's serial port permits.

Make serial data connections and check the output board links as shown in Fig. 4.2c. The type of cable used is dependent on the transmission speed and cable length:

4.1.1 Five-wire Cable – Figs. 4.2a and 11.1

Up to 6m (all speeds) – standard screened or twisted pair cable.

Up to 300m – twin twisted pair with overall foil screen and an integral drain wire, e.g. Belden 9502 or equivalent

Up to 1200m – twin twisted pair with separate foil screens and integral drain wires for each pair, e.g. Belden 9729 or equivalent

4.1.2 Three-wire Cable – Figs. 4.2b and 11.2

Up to 6m (all speeds) – standard screened or twisted pair cable.

Up to 1200m – single twisted pair with overall foil screen and integral drain wire, e.g. Belden 9501 or equivalent.

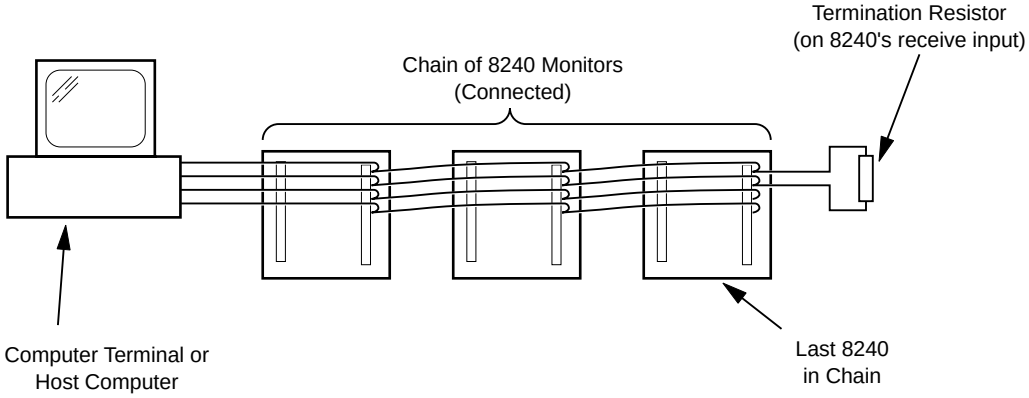
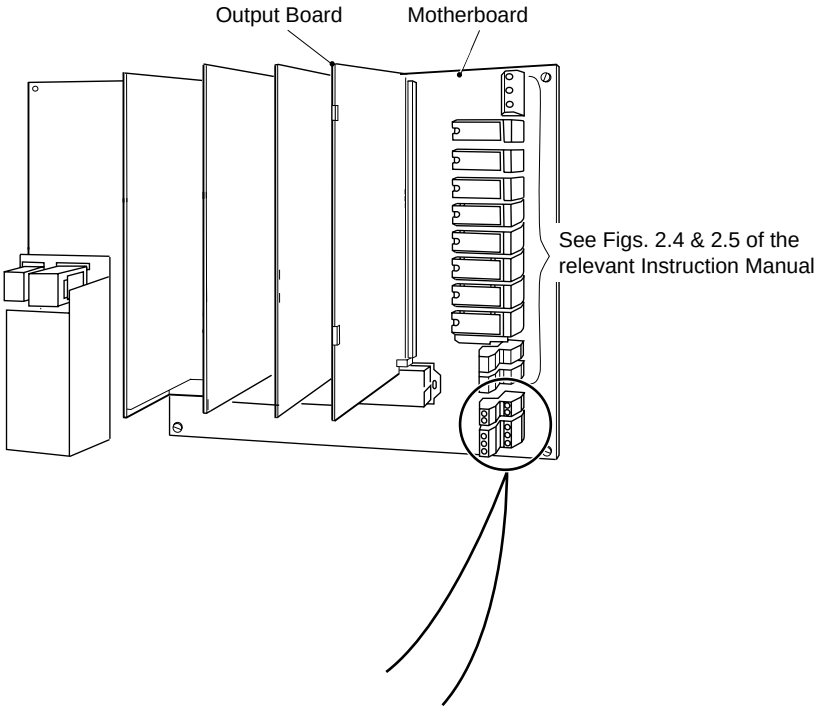


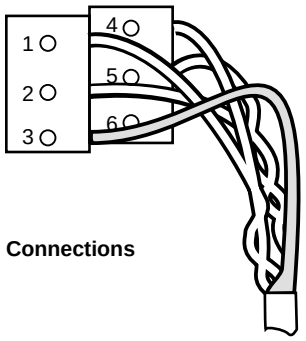
Fig. 4.1 Schematic Diagram

…4 ELECTRICAL CONNECTIONS

…4.1 Serial Connections

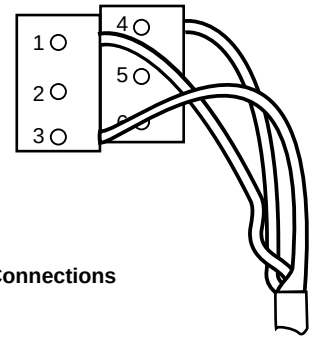


1 – Tx+
2 – Rx+
3 – Common (0V)
4 – Tx–
5 – Rx–
6 – No connection

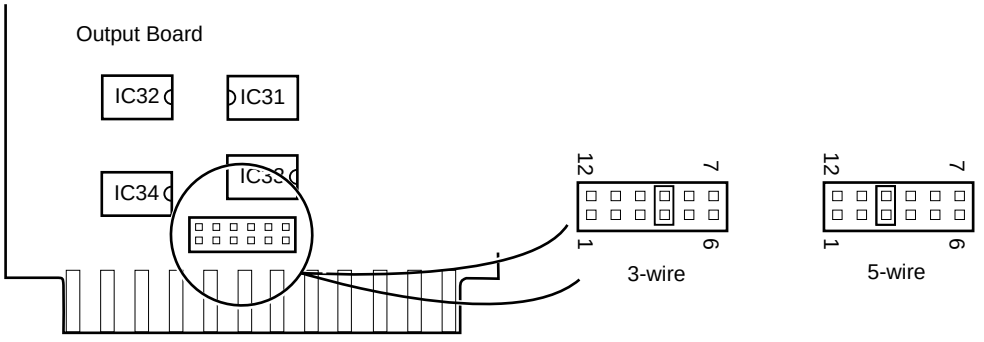


A – Five-wire Connections

1 – Tx+/Rx+
2 – Not Connected
3 – Common (0V)
4 – Tx–/Rx–
5 – Not Connected
6 – Not Connected



B – Three-wire Connections



C – Three- and Five-wire Links

Fig. 4.2 Serial Connections

5 SETTING UP

For all aspects other than serial data transmission the transmitter is set up as shown in the relevant Instruction Manual. Unless otherwise requested, the instrument is despatched with a transmission rate of 9600 baud and transmission line termination resistors linked-out. If the resistors are to be linked-in (see Fig. 5.1) carry out the following Section.

5.1 Termination Resistors – Fig. 5.1

For long transmission lines, termination resistors are required on the last 8240 Monitor in the chain and at the host computer/ computer terminal. Under normal operating conditions the resistors are required at the last 8240 receive inputs only – see Fig. 4.1. The transmitter's resistors are selected using plug-in links – see Fig. 5.1.

Switch off the supply and gain access to the output board – see relevant Instruction Manual. Set the termination resistor links as shown in Fig. 5.1.

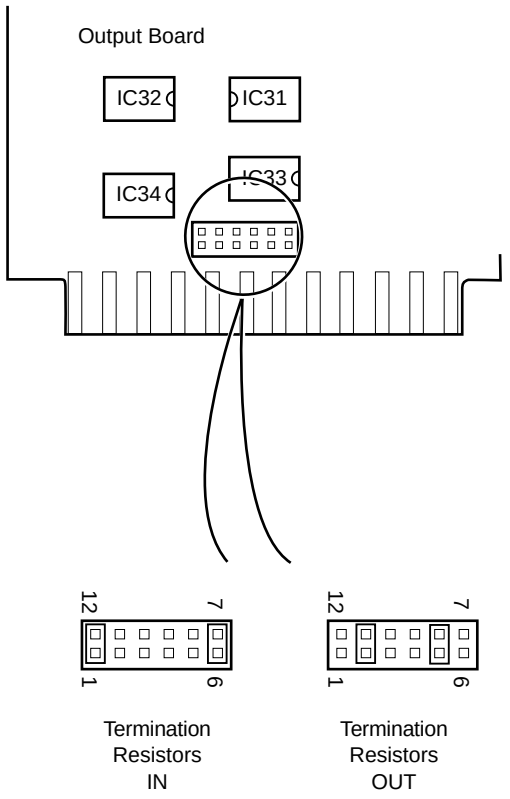


Fig. 5.1 Termination Resistor Links

6 PROGRAMMING

The general programming procedure is as detailed in the relevant Instruction Manual, but with an additional **Set Up Serial Interface** frame in the **Set Up Instrument** page.

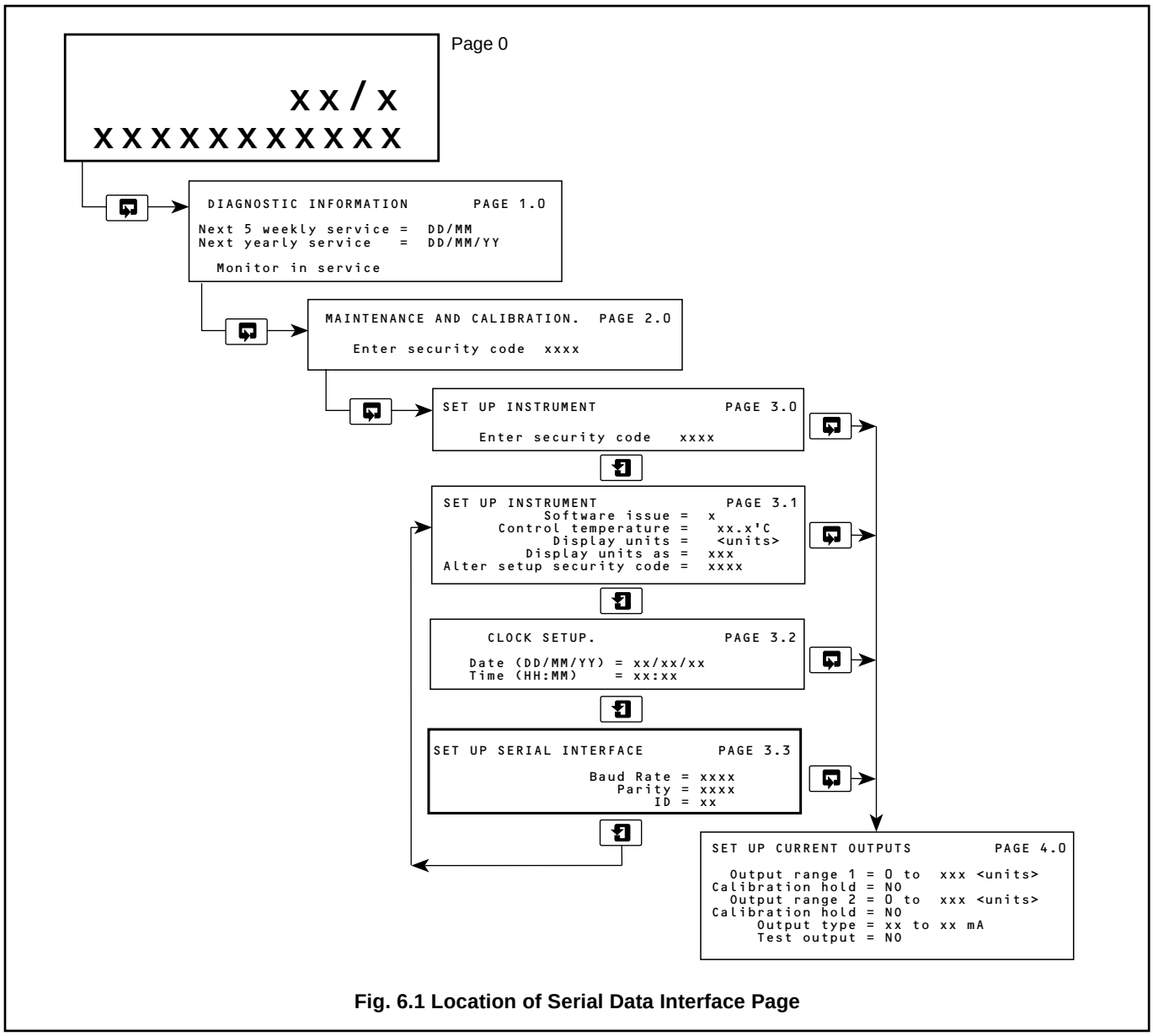
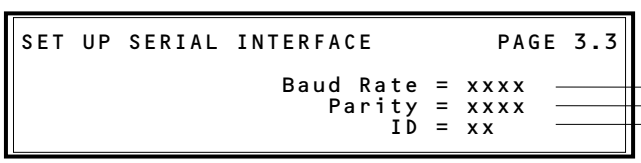


Fig. 6.1 Location of Serial Data Interface Page

6.1 Serial Interface Page

Refer to Section 6.3 (Set Up Instrument) in the relevant Instruction Manual.



Baud Rate
Select the transmission rate required (1200 slowest, 9600 fastest).

Parity
Select the appropriate parity (None, Odd or Even) to match the computer terminal or host computer.

Transmitter Identification
Assign the transmitter an identification number (1 to 99) – see Section 4.1. The identification number allows more than one transmitter to be accessed via the communication channel.

7 MODBUS PROTOCOL

7.1 Introduction to MODBUS Protocol (RTU only)

MODBUS communication is based on a master and a slave arrangement. The master sends a message to one slave at a time and waits for a reply.

The slave cannot accept a new message until the existing message is processed and a reply sent to the master (maximum response time 250 milliseconds). The slave monitors the elapsed time between receipt of characters. If the elapsed time without a new character is $3^1/_2$ character times, the slave assumes the next character received is the start of a new message.

To allow the master to differentiate between more than one slave in a system, each slave is given a unique identity address (between 1 and 99).

A broadcast address (address zero) can be used to access all slave devices with one command. This is limited to write messages only and there is no slave acknowledgment.

Note. MODBUS RTU requires 1 start bit, 8 data bits, 1 parity bit (optional) and 1 or 2 stop bits. The 8240 uses only 1 stop bit.

7.2 MODBUS Function Codes – Table 4.1

The function code field instructs the addressed slaves which function to perform.

MODBUS Function Code	MODBUS Message Name	4600 MODBUS Definition
01	Read Coil Status	Read up to 16 consecutive discrete (boolean) points from a specific point. The 8240 returns zeros for points which do not contain defined data and NAKs* any request for point numbers greater that 100.
03	Read Holding Register	Up to 8 consecutive registers from a specific starting register. The 8240 returns zeros from registers which do not contain defined data and NAKs any request for register numbers greater than 100.
05	Force Single Coil	Write one discrete (boolean) point. The 8240 NAKs this if the point is not currently writeable.
06	Preset Single Register	Write one register. The 8240 NAKs if the register is not currently writeable. This function code also applies any existing limits to the register before storage in the database.
08	Loopback Diagnostic Test	Echo the message, only 'Return of Query' is supported.
16	Preset Multiple Registers	Write up to 8 consecutive registers from a specified starting register. The 8240 NAKs if any of the registers are not currently writeable, but still carries out all the writes which are valid, applying any currently applicable limits to the value before storage in the database.

*NAK = Negative Acknowledgement

Table 7.1 MODBUS Function Codes

8 MODBUS FUNCTIONS

This section shows typical examples of MODBUS function codes 01, 03, 05, 06, 08 and 16.

8.1 Read Coil Status – Function Code 01

8.1.1 Read Coil Status Query

This function allows the user to obtain the ON/OFF status of logic coils used to control discrete outputs from the addressed slave only. Broadcast mode is not supported with this function code. In addition to the slave address and function fields, the message requires that the information field contain the initial coil offset address to be read (starting address) and the number of locations to be interrogated must obtain status data.

Note. The coil offset address is the coil number minus one, e.g. to start at coil 31 the data start value must be set to 30 (1EH).

Example – a read coil status request to read 5 coils from slave (01) starting at coil 01 (Out of Service) is shown below.

Address	Function	Coil Start Offset High	Coil Start Offset Low	Number of Coils High	Number of Coils Low	Error Check Field (CRC-16)	
01	01	00	00	00	05	FC	09

8.1.2 Read Coil Status Response

The data is packed one bit for each coil (1 = ON, 0 = OFF). The response includes the slave address, function code, quantity of data characters, the data characters and error checking. The low order bit of the first character contains the first addressed coil and the remainder follow. For coil quantities that are not even multiples of eight, the last characters are filled in with zeros at high order end.

Example – the response to the read coil status query shows the following:

Monitor Out of Service
Monitor Not in Calibration
Monitor in Hold Mode
Pumps On
Control Temperature Not 'Out of Range'

Address	Function	Byte Count	Data Coil Status 1 to 6	Error Check Field (CRC-16)	
01	01	01	0D	90	4D

8.2 Read Holding Register – Function Code 03

8.2.1 Read Holding Register Query

The Read holding registers allow the user to obtain the binary contents of holding registers in the addressed slave.

Note. The data start register must contain the offset address of the first register to be accessed, e.g. to start at register 11 the data start register must contain 10 (0AH).

Broadcast mode is not allowed.

Example – a read holding register request to read 5 holding registers from slave (01) starting at holding address 05 (Time Hour) is shown below.

Address	Function	Register Start Offset High	Register Start Offset Low	Data Number of Registers High	Data Number of Registers Low	Error Check Field (CRC-16)	
01	03	00	04	00	05	C4	08

8.2.2 Read Holding Register Response

The addressed slave responds with its address and function code, followed by the information field. The information field contains 1 byte describing the quantity of data bytes to be returned. The contents of each register requested (DATA) is two bytes, the first byte includes the high order bits and the second the low order bits.

Example – the response to the read holding register query shows the following:

Time (Hour) = 15
Time (Minutes) = 20
Time (Date) = 25
Time (Month) = February

Address	Function	Byte Count	Holding Register 11 High	Holding Register 11 Low	Holding Register 12 High	Holding Register 12 Low	Holding Register 13 High	Holding Register 13 Low	Holding Register 14 High	Holding Register 14 Low	Error Check Field (CRC-16)	
01	03	08	00	0F	00	14	00	19	00	02	0A	D2

8.3 Force Single Coil – Function Code 05

8.3.1 Force Single Coil Query

This message forces a single coil either ON or OFF. The data value 65,280 (FF00 HEX) sets the coil ON and the value zero turns it OFF. All other values are illegal and do not affect the coil.

Note. To write to a coil the coil offset address must be used, e.g. to write to coil 10, the coil address 09(09H) is transmitted.

The use of slave address zero (broadcast mode) forces all attached slaves to modify the desired coil.

Example – a force single coil request to switch ON coil address 10 (NV Memory Save) in slave 01 is shown below.

Address	Function	Coil Offset High	Coil Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	05	00	09	FF	00	5C	38

8.3.2 Force Single Coil Response

The response is confirmation of the query after the coil state has been altered.

Example:

Address	Function	Coil Offset High	Coil Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	05	00	09	FF	00	5C	38

8.4 Preset Single Register – Function Code 06

8.4.1 Preset Single Register Query

The preset single register allows the user to modify the contents of a holding register.

Note. Function codes 5, 6 and 16 are the only messages that are recognized as valid for broadcast.

Example – a preset single register request to write the value 501 to holding register address 50 (Output Range 1) in slave 01 is shown below.

Since all register values for measured variables and alarm set points are ranged to 12 bits (for RTU), then to calculate the Data Value High and Data Value Low for a setpoint of 501 the following method is used:

Instrument Range = 0 to 2000

therefore $\frac{501 \times 4095}{2000} = 1026_{10}$

converted to hexadecimal $1026_{10} = 402_{8}$

therefore Data Value High = 04

Data Value Low = 02

Note. To write to a register, the register's offset address must be used, e.g. to write to register 50, the offset address 49(31) is transmitted.

Address	Function	Register Offset High	Register Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	06	00	31	04	02	5B	04

8.4.2 Preset Single Register Response

The normal response to a preset single register request is to retransmit the query message after the register has been altered.

Example:

Address	Function	Register Offset High	Register Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	06	00	31	04	02	5B	0B

8.5 Loopback Test – Function Code 08

8.5.1 Loopback Test Query

The purpose of the loopback test is to test the MODBUS system, it does not affect the content of the controller. Variations in the response may indicate faults in the MODBUS system. The information field contains 2 bytes for the designation of the diagnostic code followed by 2 bytes to designate the action to be taken.

Example:

Address	Function	Register Offset High	Register Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	08	00	31	04	02	32	C5

8.5.2 Loopback Test Response

The response always echoes the query, only diagnostic code 0 (bytes 3 and 4) can be used.

Example:

Address	Function	Data Diagnostic Code High	Data Diagnostic Code Low	Data *	Data *	Error Check Field (CRC-16)	
01	08	00	31	04	02	32	C5

*These are considered to be the information fields for diagnostic mode.

8.6 Preset Multiple Registers – Function Code 16

8.6.1 Preset Multiple Registers Query

Holding registers existing within the controller can have their contents changed by this message. When used with slave address zero (Broadcast mode) all slave controllers load the selected registers with the contents specified.

Note. To write to multiple registers, the initial register offset address must be used, e.g. to write to register 02 onwards, the offset address 01 is transmitted.

Example – a preset multiple registers request to write the value 1000 to the register address (Output Range 1) and the value 2000 to the register address (Output Range 2) in slave 01 is shown below.

Address	Function	Register Start Offset High	Register Start Offset Low	Number of Registers	Byte Count	Holding Register 02 High	Holding Register 02 Low	Holding Register 03 High	Holding Register 03 Low	Error Check Field (CRC-16)	
01	10	00	31	00 02	04	08	00	0F	FF	76	A7

8.6.2 Preset Multiple Registers Response

The response confirms slave identification, function code, starting register address and quantity only.

Example:

Address	Function	Register Start Offset High	Register Start Offset Low	Number of Registers		Error Check Field (CRC-16)	
01	10	00	31	00	02	10	07

9 EXCEPTION RESPONSES

The exception response codes sent by the slave are shown in Table 9.1. When a slave detects one of these errors, it sends a response message to the master consisting of slave address, function code, error code and error check fields.

Exception Response Code	Exception Response Name	Exception Response Definition
01	Illegal Function	The message function received is not an allowable action for the 8240.
02	Illegal Data Address	The address reference in the data field is not an allowable address for the 8240.
03	Illegal Data Value	The value referenced in the data field is not allowable in the addressed slave location.
07	Negative Acknowledgement	The function just requested cannot be performed.
08	Memory Parity Error	Parity check indicates an error in one or more of the characters received.

Table 9.1 Exception Response Data

9.1 Examples

A read register request to read holding register address 251 of slave 01 (undefined address for slave, beyond address limit) is shown below.

Slave Address	Function	Register Start Offset High	Register Start Offset Low	Number of Registers High	Number of Registers Low	Error Check Field (CRC-16)	
01	03	00	FA	00	06	E5	F9

The response is an exception response sighting ‘illegal data address’. To indicate that the response is a notification of an error, the most significant bit of the function code is set to 1.

Slave Address	Function	Exception Code	Error Check Field (CRC-16)	
01	83	02	CO	F1

10 MODBUS COILS AND REGISTERS

10.1 Single-stream Silica Monitor, Model 8241/185

10.1.1 Coils

Input Number	Read/Write	Description	Response/Entry
001	R	Monitor Status	0 = Monitor In Service 1 = Monitor Not In Service
002	R	Monitor Calibration Status	0 = Monitor Not In Calibration 1 = Monitor In Calibration
003	R	Hold Mode	0 = Hold Mode Off 1 = Hold Mode On
004	R	Pump Status	0 = Pumps Off 1 = Pumps On
005	R	Upper Limit Control Temperature Status	0 = Control Temperature + In Range 1 = Control Temperature + Out Of Range
006	R	Lower Limit Control Temperature Status	0 = Control Temperature – In Range 1 = Control Temperature – Out Of Range
007	R	Reagent Status	0 = Monitor Not Out Of Reagent 1 = Monitor Out Of Reagent
008	R	Five-weekly Service Status	0 = Five-weekly Service Not Overdue 1 = Five-weekly Service Overdue
009	R	Yearly Service Status	0 = Yearly Service Not Overdue 1 = Yearly Service Overdue
010	R/W	Non-Vol Memory Mode	0 = Disable Write To Non-Volatile Memory 1 = Enable Write To Non-volatile Memory
011	R	Calibration Offset Alarm	0 = Calibration Offset Inside Of Limits 1 = Calibration Offset Outside Of Limits
012	R	Lower Calibration Slope Alarm	0 = Calibration Slope Inside Of Lower Limits 1 = Calibration Slope Outside Of Lower
013	R	Upper Calibration Slope Alarm	0 = Calibration Slope Inside Of Higher Limits 1 = Calibration Slope Outside Of Higher Limits
014	R	Sample Status	Monitor In Sample Monitor Out Of Sample

…10 MODBUS COILS AND REGISTERS

…10.1 Single-stream Silica Monitor, Model 8241/185
10.1.2 Holding Registers

Input Number	Read/Write	Description	Response/Entry
001	R	Units	0=ppb, 1=µg/L, 2=µg/kg
002	R	Maximum Output Range	0=0-2000, 1=0-5000
003	R	Optical System Temperature	Scaled between 0.0 and 100.0 °C
004	R	Reaction Block Temperature	Scaled between 0.0 and 100.0 °C
005	R	Real-time Clock	Hours
006	R	Real-time Clock	Minutes
007	R	Real-time Clock	Date
008	R	Real-time Clock	Month
009	R	Real-time Clock	Year
010	R/W	Set Real-time Clock	Date
011	R/W	Set Real-time Clock	Month
012	R/W	Set Real-time Clock	Year
013	R/W	Set Real-time Clock	Hour
014	R/W	Set Real-time Clock	Minutes
015	R/W	Load New Time	0=Disable New Time Load 1=Enable New Time Load
016	R	Next Auto Zero Calibration Date	Date
017	R	Next Auto Zero Calibration Month	Month
018	R	Next Auto Zero Calibration Year	Year
019	R	Last Auto Zero Calibration Date	Date
020	R	Last Auto Zero Calibration Month	Month
021	R	Last Auto Zero Calibration Year	Year
022	R	Next Secondary Calibration Date	Date
023	R	Next Secondary Calibration Month	Month
024	R	Next Secondary Calibration Year	Year
025	R	Last Secondary Calibration Date	Date
026	R	Last Secondary Calibration Month	Month
027	R	Last Secondary Calibration Year	Year
028	R/W	Relay Alarm Hysteresis	0 to 5 %
029	R/W	Relay Alarm Failsafe	0=No, 1=Yes
030	R/W	Current Output Type	0=0-10mA, 1=0-20mA, 2=4-20mA
031	R/W	Calibration Type	0=None, 1=Routine, 2=Baseline
032	R/W	Do Secondary Calibration	0=No, 1=Yes
033	R/W	Do Remote Calibration	0=No, 1=Yes
034	R/W	Secondary Calibration Concentration	Scaled 0 to 2000 or 0 to 5000
035	R/W	Next Auto Cal Day	Date
036	R/W	Next Auto Cal Month	Month
037	R/W	Next Auto Cal Year	Year
038	R/W	Next Auto Cal Hours	Hours
039	R/W	Next Auto Cal Minutes	Minutes
040	R/W	Auto Zero Cal Frequency	0 = Off, 1 = 12 Hrs, 2 = 1 Day, 3 = 2 Days ... 8 = 7 Days
041	R/W	No Of Auto Zeros Between Secondary Calibrations	0 = 0, 1 = 1 ... 10 = 10,11=Off
042	R	Time To Auto Zero Compensation	Minutes
043	R	Time To Sec Cal Compensation	Minutes
044	R	Time To Recovery	Minutes
045	R	Displayed Offset	–100.0 to 100.0

…10.1 Single-stream Silica Monitor, Model 8241/185
…10.1.2 Holding Registers

Input Number	Read/Write	Description	Response/Entry
046	R	Displayed Slope	0.0 – 100.0
047	R	Silica Concentration	Scaled 0 to 2000 or 0 to 5000 with decimal point
048	R	Silica Concentration	Scaled 0 to 2000 or 0 to 5000 with no decimal doint
049	R	Silica Concentration Decimal Point Status	0=0 dp, 1=1 dp
050	R/W	Current Output 1 Range	Scaled 0 to 2000 or 0 to 5000
051	R/W	Current Output 2 Range	Scaled 0 to 2000 or 0 to 5000
052	R/W	Alarm 1 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
053	R/W	Alarm 1 Relay On/Off Status	0=Off, 1=On
054	R/W	Alarm 1 Relay Action	
055	R/W	Alarm 2 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
056	R/W	Alarm 2 Relay On/Off Status	0=Off, 1=On
057	R/W	Alarm 2 Relay Action	0=Low, 1=High
058	R/W	Alarm Relay Delay	0 to 99 Minutes
059	R/W	Current Output 1 Hold Status	0=No, 1=Yes
060	R/W	Current Output 2 Hold Status	0=No, 1=Yes

10.2 Multi-stream Silica Monitor, Model 8241/195

10.2.1 Coils

Coils used on Multi-stream monitors are identical to those used on single-stream versions – see Section 10.1.1.

10.2.2 Holding Registers

In addition to the Holding Registers listed in Section 10.1.2 above, Multi-stream monitors use the following Holding Registers:

Input Number	Read/Write	Description	Response/Entry
100	R	Silica Concentration, Stream 1	Scaled 0 to 2000 or 0 to 5000 with decimal point
101	R	Silica Concentration Stream 2	Scaled 0 to 2000 or 0 to 5000 with decimal point
102	R	Silica Concentration Stream 3	Scaled 0 to 2000 or 0 to 5000 with no decimal doint
103	R	Silica Concentration, Stream 4	Scaled 0 to 2000 or 0 to 5000 with decimal point
104	R	Silica Concentration Stream 5	Scaled 0 to 2000 or 0 to 5000 with decimal point
105	R	Silica Concentration Stream 6	Scaled 0 to 2000 or 0 to 5000 with no decimal doint
106	R/W	Stream 1 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
107	R/W	Stream 2 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
108	R/W	Stream 3 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
109	R/W	Stream 4 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
110	R/W	Stream 5 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
111	R/W	Stream 6 Decimal Point	0 = 0 d.p., 1 = 1 d.p.
112	R/W	Alarm 1 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
113	R/W	Alarm 1 Relay On/Off Status	0=Off, 1=On
114	R/W	Alarm 1 Relay Action	0=Low, 1=High
115	R/W	Alarm 2 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
116	R/W	Alarm 2 Relay On/Off Status	0=Off, 1=On
117	R/W	Alarm 2 Relay Action	0=Low, 1=High
118	R/W	Alarm 3 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
119	R/W	Alarm 3 Relay On/Off Status	0=Off, 1=On
120	R/W	Alarm 3 Relay Action	0=Low, 1=High
121	R/W	Alarm 4 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
122	R/W	Alarm 4 Relay On/Off Status	0=Off, 1=On
123	R/W	Alarm 4 Relay Action	0=Low, 1=High
124	R/W	Alarm 5 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
125	R/W	Alarm 5 Relay On/Off Status	0=Off, 1=On
126	R/W	Alarm 5 Relay Action	0=Low, 1=High
127	R/W	Alarm 6 Relay Setpoint	Scaled 0 to 2000 or 0 to 5000
128	R/W	Alarm 6 Relay On/Off Status	0=Off, 1=On
129	R/W	Alarm 6 Relay Action	0=Low, 1=High
130	R/W	Relay Configuration	0=Concentration, 1=Out of Sample
131	R/W	Current Output 4 Range	Scaled 0 to 2000 or 0 to 5000
132	R/W	Current Output 5 Range	Scaled 0 to 2000 or 0 to 5000
133	R/W	Current Output 6 Range	Scaled 0 to 2000 or 0 to 5000
134	R/W	Current Output 1 Range	Scaled 0 to 2000 or 0 to 5000
135	R/W	Current Output 2 Range	Scaled 0 to 2000 or 0 to 5000
136	R/W	Current Output 3 Range	Scaled 0 to 2000 or 0 to 5000

10.3 Single-stream Phosphate Monitor, Model 8242/185

10.3.1 Coils

Input Number	Read/Write	Description	Response/Entry
001	R	Monitor Status	0 = Monitor In Service 1 = Monitor Not In Service
002	R	Monitor Calibration Status	0 = Monitor Not In Calibration 1 = Monitor In Calibration
003	R	Hold Mode	0 = Hold Mode Off 1 = Hold Mode On
004	R	Pump Status	0 = Pumps Off 1 = Pumps On
005	R	Upper Limit Control Temperature Status	0 = Control Temperature + In Range 1 = Control Temperature + Out Of Range
006	R	Lower Limit Control Temperature Status	0 = Control Temperature – In Range 1 = Control Temperature – Out Of Range
007	R	Reagent Status	0 = Monitor Not Out Of Reagent 1 = Monitor Out Of Reagent
008	R	Five-weekly Service Status	0 = Five-weekly Service Not Overdue 1 = Five-weekly Service Overdue
009	R	Yearly Service Status	0 = Yearly Service Not Overdue 1 = Yearly Service Overdue
010	R/W	Non-Vol Memory Mode	0 = Disable Write To Non-Volatile Memory 1 = Enable Write To Non-volatile Memory
011	R	Calibration Offset Alarm	0 = Calibration Offset Inside Of Limits 1 = Calibration Offset Outside Of Limits
012	R	Lower Calibration Slope Alarm	0 = Calibration Slope Inside Of Lower Limits 1 = Calibration Slope Outside Of Lower
013	R	Upper Calibration Slope Alarm	0 = Calibration Slope Inside Of Higher Limits 1 = Calibration Slope Outside Of Higher Limits
014	R	Sample Status	Monitor In Sample Monitor Out Of Sample

…10 MODBUS COILS AND REGISTERS

…10.3 Single-stream Phosphate Monitor, Model 8242/185
…10.3.2 Holding Registers

Input Number	Read/Write	Description	Response/Entry
001	R	Units	3=ppb, 4=mg/L, 5=mg/kg
002	R	Optical Filter	0=Filter 1, 1=Filter 2
003	R	Optical System Temperature	Scaled between 0.0 and 100.0 °C
004	R	Reaction Block Temperature	Scaled between 0.0 and 100.0 °C
005	R	Real-time Clock	Hours
006	R	Real-time Clock	Minutes
007	R	Real-time Clock	Date
008	R	Real-time Clock	Month
009	R	Real-time Clock	Year
010	R/W	Set Real-time Clock	Date
011	R/W	Set Real-time Clock	Month
012	R/W	Set Real-time Clock	Year
013	R/W	Set Real-time Clock	Hour
014	R/W	Set Real-time Clock	Minutes
015	R/W	Load New Time	0=Disable New Time Load 1=Enable New Time Load
016	R	Next Auto Zero Calibration Date	Date
017	R	Next Auto Zero Calibration Month	Month
018	R	Next Auto Zero Calibration Year	Year
019	R	Last Auto Zero Calibration Date	Date
020	R	Last Auto Zero Calibration Month	Month
021	R	Last Auto Zero Calibration Year	Year
022	R	Next Secondary Calibration Date	Date
023	R	Next Secondary Calibration Month	Month
024	R	Next Secondary Calibration Year	Year
025	R	Last Secondary Calibration Date	Date
026	R	Last Secondary Calibration Month	Month
027	R	Last Secondary Calibration Year	Year
028	R/W	Relay Alarm Hysteresis	0 to 5 %
029	R/W	Relay Alarm Failsafe	0=No, 1=Yes
030	R/W	Current Output Type	0=0-10mA, 1=0-20mA, 2=4-20mA
031	R/W	Calibration Type	0=None, 1=Routine, 2=Baseline
032	R/W	Do Secondary Calibration	0=No, 1=Yes
033	R/W	Do Remote Calibration	0=No, 1=Yes
034	R/W	Secondary Calibration Concentration	Scaled 0 to 20.0 or 0 to 60.0
035	R/W	Next Auto Cal Day	Date
036	R/W	Next Auto Cal Month	Month
037	R/W	Next Auto Cal Year	Year
038	R/W	Next Auto Cal Hours	Hours
039	R/W	Next Auto Cal Minutes	Minutes
040	R/W	Auto Zero Cal Frequency	0 = Off, 1 = 12 Hrs, 2 = 1 Day, 3 = 2 Days ... 8 = 7 Days
041	R/W	No Of Auto Zeros Between Secondary Calibrations	0 = 0, 1 = 1 ... 10 = 10,11=Off
042	R	Time To Auto Zero Compensation	Minutes
043	R	Time To Sec Cal Compensation	Minutes
044	R	Time To Recovery	Minutes
045	R	Displayed Offset	–100.0 to 100.0

…10.3 Single-stream Phosphate Monitor, Model 8242/185
…10.3.2 Holding Registers

Input Number	Read/Write	Description	Response/Entry
046	R	Displayed Slope	0.0 to 100.0
047	R	Phosphate Concentration	Scaled 0 to 10.00 with 2 decimal places
048	R	Phosphate Concentration	Scaled 0 to 60.0 with 1 decimal place
049	R	Phosphate Concentration Decimal Point Status	0=1 dp, 1=2 dp
050	R/W	Current Output 1 Range	Scaled 0 to 20.0 or 0 to 60.0
051	R/W	Current Output 2 Range	Scaled 0 to 20.0 or 0 to 60.0
052	R/W	Alarm 1 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
053	R/W	Alarm 1 Relay On/Off Status	0=Off, 1=On
054	R/W	Alarm 1 Relay Action	
055	R/W	Alarm 2 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
056	R/W	Alarm 2 Relay On/Off Status	0=Off, 1=On
057	R/W	Alarm 2 Relay Action	0=Low, 1=High
058	R/W	Alarm Relay Delay	0 to 99 Minutes
059	R/W	Current Output 1 Hold Status	0=No, 1=Yes
060	R/W	Current Output 2 Hold Status	0=No, 1=Yes
081	R/W	Unit Type	0 = P, 1 = PO_4
082	R/W	Colour Compensation Applied	Scaled 0.0 to 60.00
083	R/W	Colour Compensation Frequency	0=Off, 1=Man, 2=24hr, 3=12hr, 4=6hr, 5=3hr, 6=1hr
084	R/W	Next Colour Compensation	Date
085	R/W	Next Colour Compensation	Month
086	R/W	Next Colour Compensation	Year
087	R/W	Next Colour Compensation	Hour
088	R/W	Next Colour Compensation	Minute

10.4 Multi-stream Phosphate Monitor, Model 8242/195

10.4.1 Coils

Coils used on Multi-stream monitors are identical to those used on single-stream versions – see Section 10.3.1.

10.4.2 Holding Registers

In addition to the Holding Registers listed in Section 10.3.2 above, Multi-stream monitors use the following Holding Registers:

Input Number	Read/Write	Description	Response/Entry
100	R	Phosphate Concentration, Stream 1	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
101	R	Phosphate Concentration Stream 2	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
102	R	Phosphate Concentration Stream 3	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
103	R	Phosphate Concentration, Stream 4	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
104	R	Phosphate Concentration Stream 5	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
105	R	Phosphate Concentration Stream 6	Scaled 0 to 20.0 or 0 to 60.0 with decimal places
106	R/W	Stream 1 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
107	R/W	Stream 2 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
108	R/W	Stream 3 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
109	R/W	Stream 4 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
110	R/W	Stream 5 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
111	R/W	Stream 6 Decimal Point	0 = 1 d.p., 1 = 2 d.p.
112	R/W	Alarm 1 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
113	R/W	Alarm 1 Relay On/Off Status	0=Off, 1=On
114	R/W	Alarm 1 Relay Action	0=Low, 1=High
115	R/W	Alarm 2 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
116	R/W	Alarm 2 Relay On/Off Status	0=Off, 1=On
117	R/W	Alarm 2 Relay Action	0=Low, 1=High
118	R/W	Alarm 3 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
119	R/W	Alarm 3 Relay On/Off Status	0=Off, 1=On
120	R/W	Alarm 3 Relay Action	0=Low, 1=High
121	R/W	Alarm 4 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
122	R/W	Alarm 4 Relay On/Off Status	0=Off, 1=On
123	R/W	Alarm 4 Relay Action	0=Low, 1=High
124	R/W	Alarm 5 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
125	R/W	Alarm 5 Relay On/Off Status	0=Off, 1=On
126	R/W	Alarm 5 Relay Action	0=Low, 1=High
127	R/W	Alarm 6 Relay Setpoint	Scaled 0 to 20.0 or 0 to 60.0
128	R/W	Alarm 6 Relay On/Off Status	0=Off, 1=On
129	R/W	Alarm 6 Relay Action	0=Low, 1=High
130	R/W	Relay Configuration	0=Concentration, 1=Out of Sample
131	R/W	Current Output 4 Range	Scaled 0 to 20.0 or 0 to 60.0
132	R/W	Current Output 5 Range	Scaled 0 to 20.0 or 0 to 60.0
133	R/W	Current Output 6 Range	Scaled 0 to 20.0 or 0 to 60.0
134	R/W	Current Output 1 Range	Scaled 0 to 20.0 or 0 to 60.0
135	R/W	Current Output 2 Range	Scaled 0 to 20.0 or 0 to 60.0
136	R/W	Current Output 3 Range	Scaled 0 to 20.0 or 0 to 60.0

11 OPERATION

Before attempting any serial communication, first ensure that the 8240 Monitors connected to the computer terminal or host computer by serial link are functioning correctly as individual instruments.

Ensure that the serial data connections to the 8240 Monitor have been made correctly with respect to the computer terminal, or host computer, interface. If the above check appears satisfactory, test the serial communication by sending an appropriate message from the computer terminal or host computer to a transmitter and observe if it replies; thus establishing communication. If communication is not established, check that the computer terminal, or host computer, interface is set up correctly and that the plug-in links within each transmitter are correctly positioned – see Section 5.

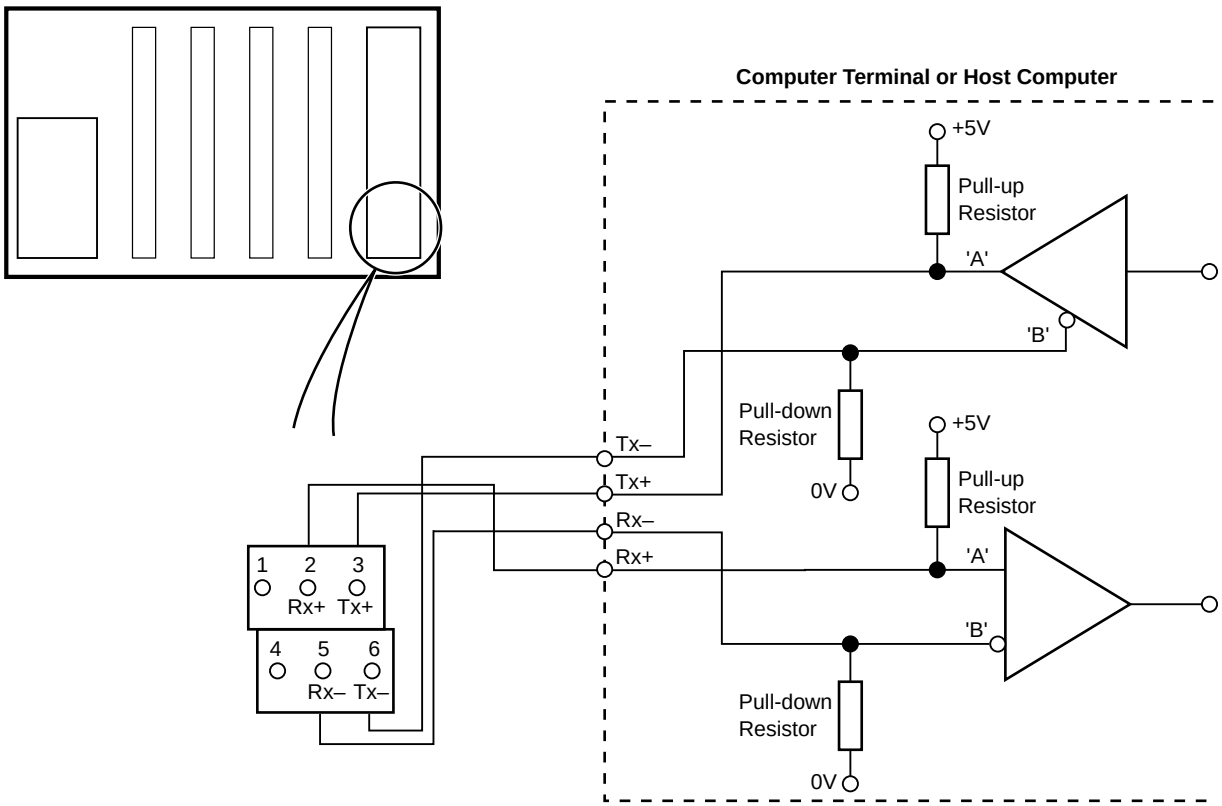


Fig. 11.1 Pull-up and Pull-down Resistors (5-wire only)

…11 OPERATION

Check that the parameters programmed in the instrument's **Serial Data Communication Page** are compatible with those of the computer terminal or host computer – see Section 7.

If communication is still not possible or is erratic, check that the computer terminal, or host computer, interface has pull-up ant pull-down resistors connected as shown in Figs. 11.1 and 11.2.

Note. If no reply is received from the instrument within 160ms, retransmit the command. If after five command re-entries a satisfactory reply has not been received, the communication link has been broken and must be re-checked.

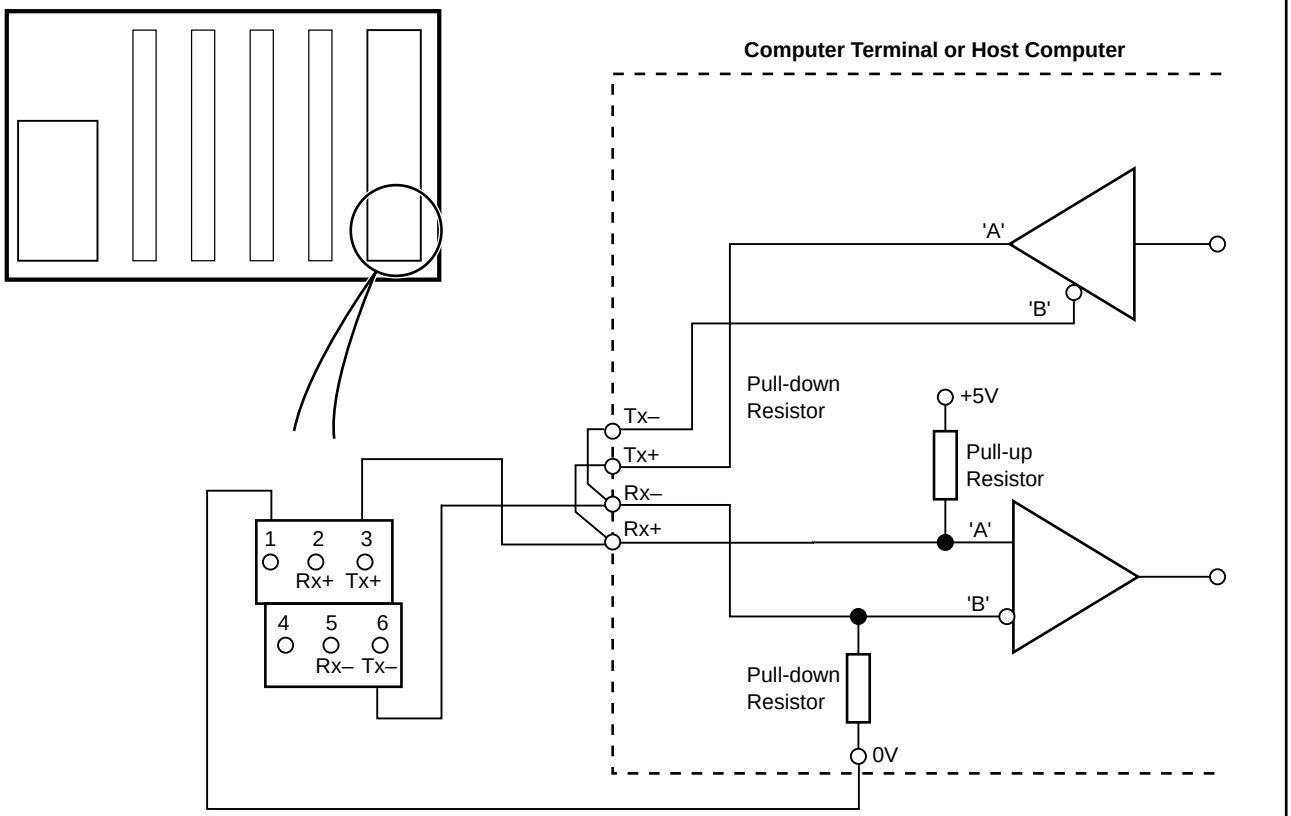


Fig. 11.2 Pull-up and Pull-down Resistors (3-wire only)

12 SPECIFICATION

As detailed in the relevant Instruction Manual, with the following additions:

EIA Communication Standards	RS422, RS485 2-wire or 4-wire modes	
Parity	None Odd Even	Programmable
Transmission line length	1200m max.	
Transmission speeds	1200 baud 2400 baud 4800 baud 9600 baud	Programmable

APPENDICES

A1 Non-volatile Memory Limitations

Note. If the number of write cycles to any particular non-volatile memory register exceeds 10^4 write cycles, the register's contents may not be retained.

Any changes made to a parameter, e.g. Alarm trip value, via the serial link are stored in a non-volatile memory register assigned to that parameter.

The number of write cycles to a particular register can be reduced by disabling the non-volatile memory access when making changes to parameters which do not need to be saved on power-down. This is done by using the **non-volatile save state (coil number 50)**.

When the **non-volatile save state** is set to 'Enable', any parameter changes made via the serial link are written to the non-volatile memory register and retained on power-down. If the **non-volatile save state** is set to'Disable', parameter changes made via the serial link are not retained on power-down.

The **non-volatile save state** is not retained on power-down and must be reset to the required state each time the instrument is powered down, replaced with another instrument or the host computer is powered down.

NOTES

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Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification.

Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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