User Guide –
Modbus Communication Supplement

IM/4600–MOD_5

4600 Series Analyzers

All Models

ABB

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 UKAS 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 9001:2000

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EN 29001 (ISO 9001)

RINA — *CISQ*
QUACER ISO 9001

Lenno, Italy – Cert. No. 9/90A

Stonehouse, U.K.

UKAS
CALIBRATION
0255

Electrical Safety

This instrument complies with the requirements of BS EN 61010-1:1993 "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:

Symbol	Description	Symbol	Description
⚠	**Warning** – Refer to the manual for instructions	⎓	Direct current supply only
⚡	**Caution** – Risk of electric shock	∼	Alternating current supply only
⏚	Protective earth (ground) terminal	≂	Both direct and alternating current supply
⏚	Earth (ground) terminal	▢	The equipment is protected through double insulation

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

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 manual must be read in conjunction with the appropriate Operating Instructions, depending on the instrument type:

- Models 4620, 4621, 4625 & 4626
  Conductivity Transmitters   – IM/4600–CON
- Models 4623 & 4628 Conductivity
  Transmitters to meet USP 23   – IM/4600–USP
- Models 4630 & 4635
  pH Monitors   – IM/4630–PH
- Models 4640 & 4645
  Dissolved Oxygen Monitors   – IM/4600–DO
- Models 4670 & 4675
  Turbidity Monitors   – IM/4670

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 4600 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 4600 Series 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 is as given in the *Operating Instructions* – see Section 1, 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 7 of the Operating Instructions*. Serial data programming details are given in Section 7 of this manual.

Standard parameter settings for the serial data programme are as follows:

Instrument Identity	01
Parity	none
Transmission Rate	9600 baud.

3 INSTALLATION

Observe the limitations outlined in the *Operating Instructions* – see Section 1. 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.	Computer Type
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. 4.3 and 4.4 of the *Operating Instructions* – see Section 1.

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 (4600 Transmitters) 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 processor board links as shown in Fig. 4.2. The type of cable used is dependent on the transmission speed and cable length:

4.1.1 Five-wire Cable
(refer also to Fig. 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 (refer also to Fig. 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.
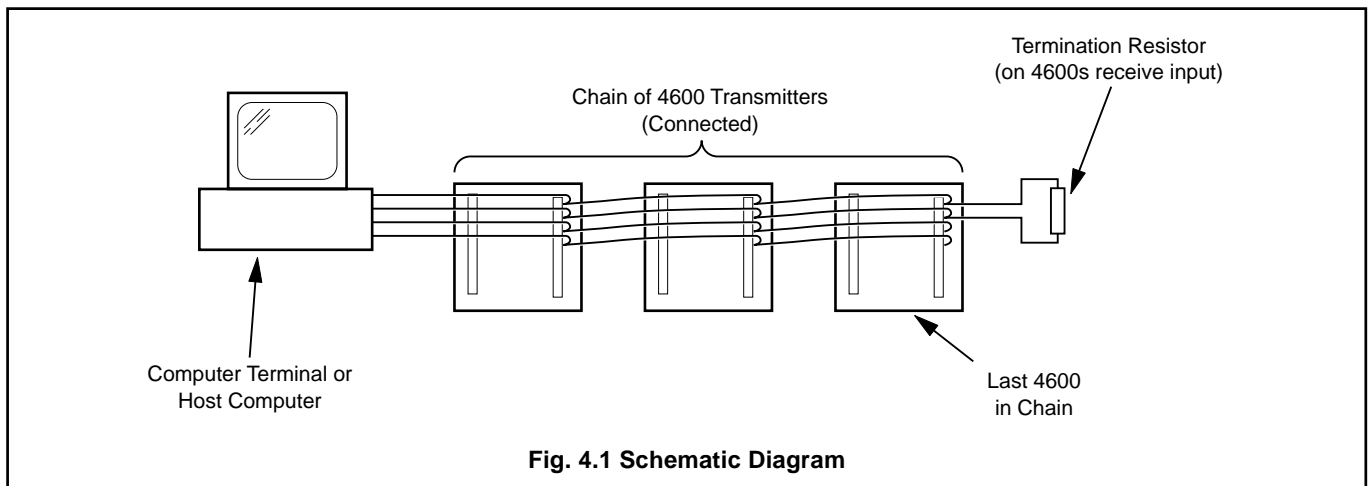
Fig. 4.1 Schematic Diagram

…4 ELECTRICAL CONNECTIONS

…4.1 Serial Connections

TBA   TBB

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

Common (0V) 1
Rx–   2
Rx+   3
Tx–   4
Tx+   5

A – Five-wire Connections

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

Common (0V) 1
             2
             3
Rx/Tx–   4
Rx/Tx+   5

B – Three-wire Connections

Processor Board

IC22   IC23

IC24   IC25 ✳

3-wire

5-wire
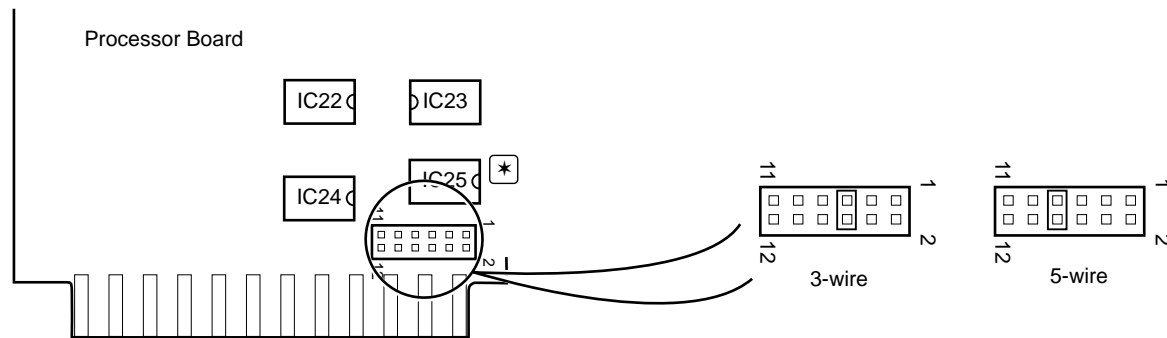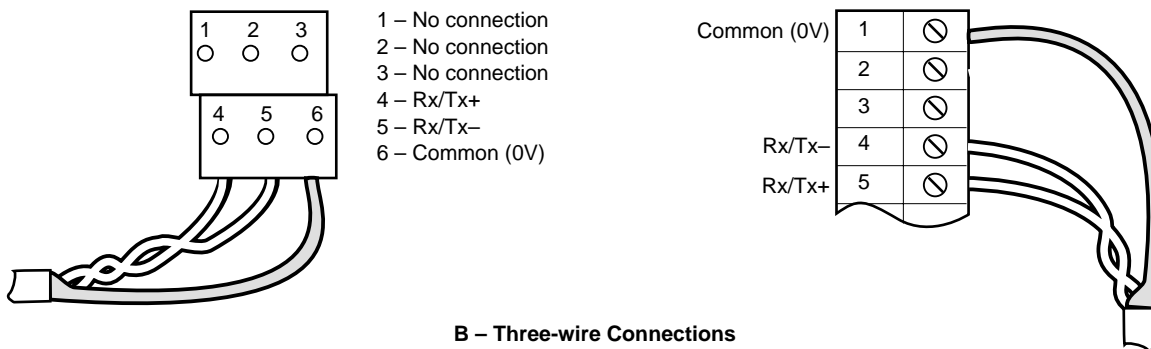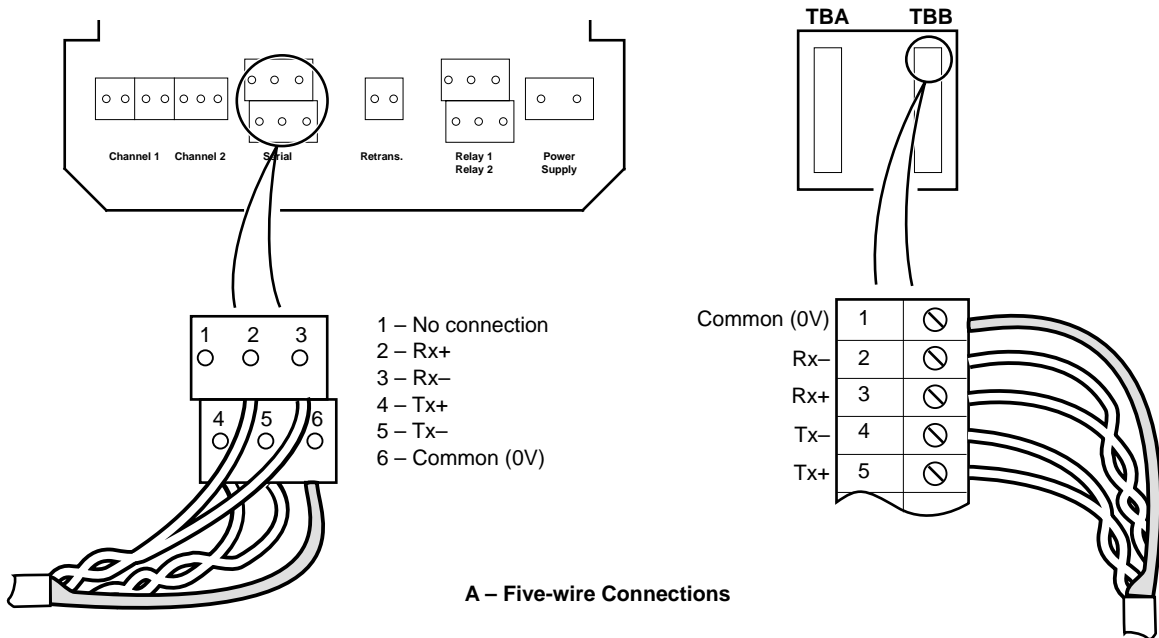
Note. For 3-wire applications IC25 must be removed and the 3-wire link positioned as shown.

C – Three- and Five-wire Links

Fig. 4.2 Serial Connections

Channel 1   Channel 2   Serial   Retrans.   Relay 1 Relay 2   Power Supply

5   SETTING UP

For all aspects other than serial data transmission the transmitter is set up as shown in the *Operating Instructions* – see Section 1. 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 4600 Transmitter in the chain and at the host computer/computer terminal. Under normal operating conditions the resistors are required at the last 4600 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 processor board *(Section 4 in the Operating Instructions).* Set the termination resistor links as shown in Fig. 5.1.

Processor Board

IC22   IC23

IC24   IC25

Termination
Resistors
IN

Termination
Resistors
OUT

Fig. 5.1 Termination Resistor Links
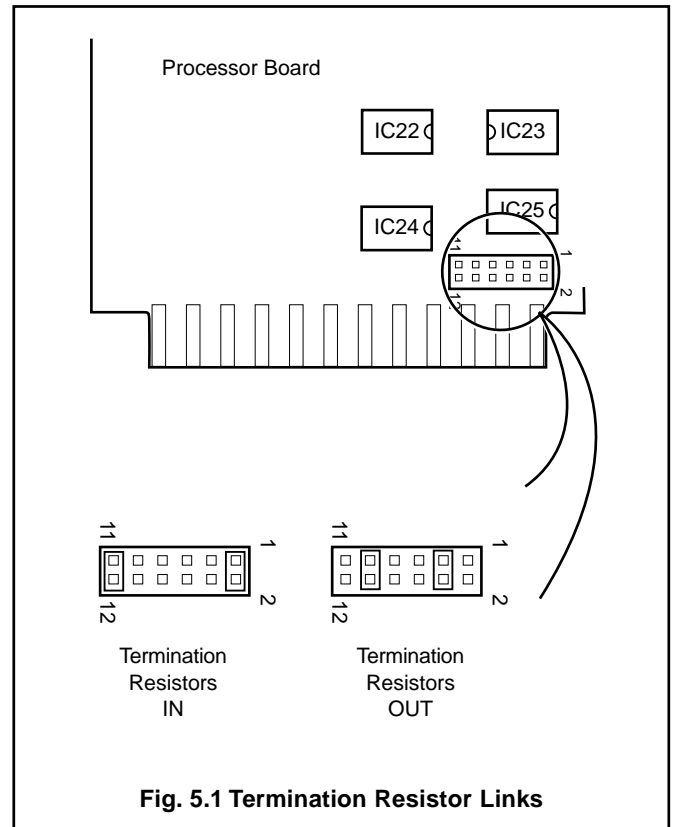
6 PROGRAMMING

The general programming procedure is as detailed in the *Operating Instructions* but with an additional **Serial Interface** page between the **Set Up Outputs** and **Electrical Cal** pages.
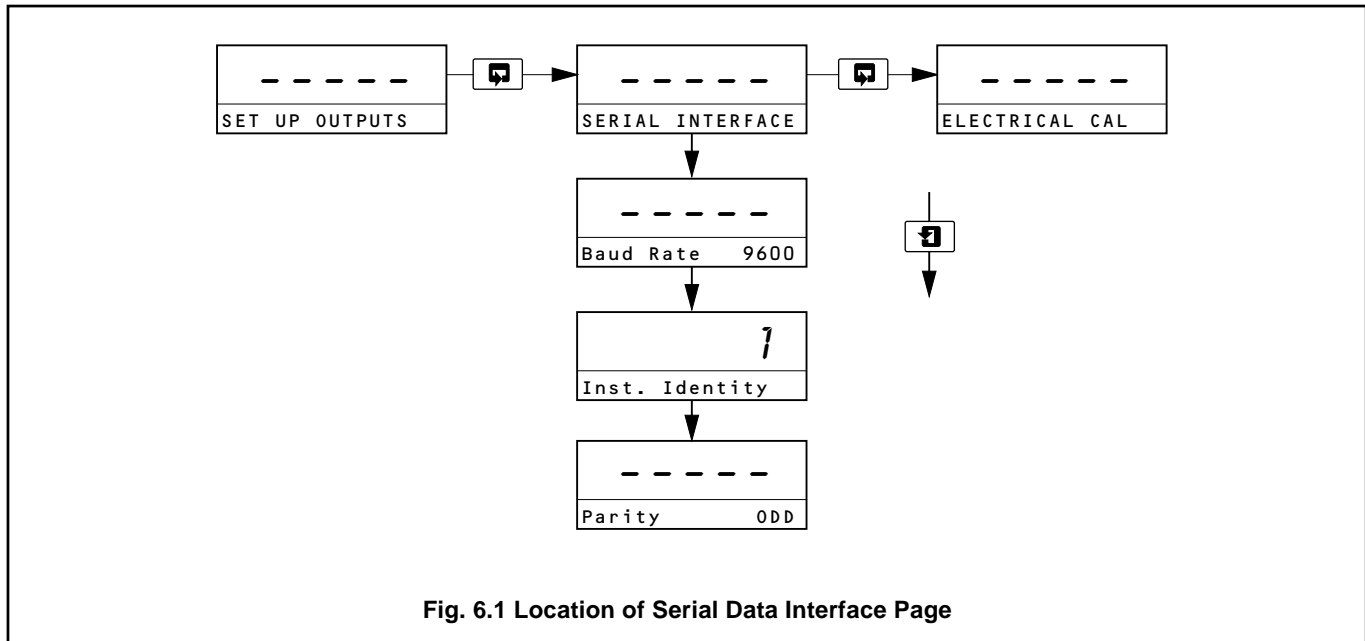
Fig. 6.1 Location of Serial Data Interface Page

6.1 Serial Interface Page
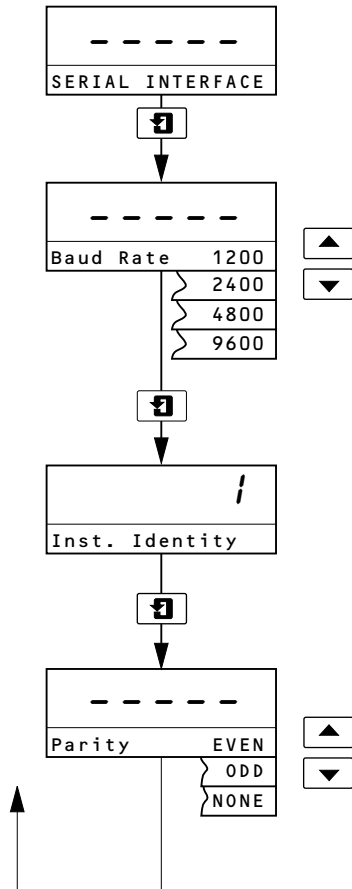
Page Header – **Serial Interface**

Transmission Rate
Select the retransmission rate required (1200 slowest, 9600 fastest).

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.

Parity
Select the appropriate parity to match the computer terminal or host computer.

Return to the top of the **Serial Interface Page** or advance to the next page.

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 4600 uses only 1 stop bit.

7.2 Modbus Function Codes – Table 7.1

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 4600 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 4600 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 4600 NAKs this if the point is not currently writeable.
06	Preset Single Register	Write one register. The 4600 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 4600 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 7 coils from slave (01) starting at coil 11 (Alarm 1 Relay State) 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	0A	00	07	5D	CA

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:
Relay alarm state 1 OFF
Relay alarm state 2 OFF
No coil at this address
Channel 1 input error
Channel 2 input error
No coil at this address
NV check sum error

Address	Function	Byte Count	Data Coil Status 11 to 18	Error Check Field (CRC-16)	
01	01	01	03	D0	49

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 6 holding registers from slave (01) starting at holding address 121 (alarm trip A1) 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	0A	00	04	C1	CA

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:

Measured conductivity	–	60.0µS/cm (Range: 0 to 100µS/cm)	
Conductivity set point 1	–	80.0µS/cm	
Conductivity set point 2	–	20.0µS/cm	
Measured temperature	–	49°C (Range: –10 to 110°C)	

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	09	99	0C	CC	03	33	07	E1	0C	F9

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 50, the coil address 49(31H) 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 50 (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	31	FF	00	DD	F5

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	31	FF	00	DD	F5

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 60.0 to holding register address 12 (alarm trip A1) in slave 01 is shown below.

Since all register values for measured variables and alarm set points (scaled parameters) are ranged to 12 bits (for RTU), then to calculate the Data Value High and Data Value Low for a setpoint of 60.0 the following method is used:

Instrument Range $=$ 0 to 100.0

therefore $\dfrac{60.0 \times 4095}{100.0} = 2457_{10}$

converted to hexadecimal $2457_{10} = 0999_{16}$

therefore Data Value High = 09

Data Value Low = 99

> **Note.** To write to a register, the register's offset address must be used, e.g. to write to register 12, the offset address 11(0B) is transmitted.

Address	Function	Register Offset High	Register Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	06	00	0B	09	99	3E	32

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	0B	09	99	3E	32

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	0B	09	99	57	F3

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	0B	09	99	57	F3

 * 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 90.0 to the register address (Alarm Set Point 1) and the value 30.0 to the register address (Alarm Set Point 2) in slave 01 is shown below.

Address	Function	Register Start Offset		Number of Registers		Byte Count	Holding Register 02		Holding Register 03		Error Check Field (CRC-16)	
		High	Low				High	Low	High	Low		
01	10	00	0B	00	02	04	0E	65	04	CC	A2	7E

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	0B	00	02	30	0A

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 instrument.
02	Illegal Data Address	The address reference in the data field is not an allowable address for the instrument.
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		Number of Registers		Error Check Field (CRC-16)	
		High	Low	High	Low		
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	C0	F1

10   MODBUS COILS AND REGISTERS

10.1   Conductivity Transmitters Models 4620/25

10.1.1   Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	
015	R	Channel 2 Input Error	0 = O.K.
017	R	NV Check Sum Error	1 = Error
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

…10.1 Conductivity Transmitters Models 4620/25

10.1.2 Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Conductivity	✓	⎫
012	R/W	Conductivity Set Point A1	✓	⎬ Within programmed display range
013	R/W	Conductivity Set Point A2	✓	⎭
014	R	Measured Temperature	✓	–10 to 110°C (14 to 230°F)
016	R/W	Megohms Set Point A1	✓	
017	R/W	Megohms Set Point A2	✓	
019	R/W	Temperature Set Point A1	✓	
020	R/W	Temperature Set Point A2	✓	
021	R	Conductivity Units		0 = microsiemens/cm 1 = microsiemens/m 2 = millisiemens/cm 3 = millisiemens/m 4 = T.D.S. 5 = Salinity
022	R	Cell Constant		0.05 to 1.00
023	R	Conductivity Span		Refer to the *Operating Instructions (IM/4600–CON)* for maximum and minimum ranges which must not be exceeded
024	R	Conductivity Zero		Zero (for UM 0 to 5)
025	R	Decimal Point Position		0 = xxxxx 1 = xxxx.x 2 = xxx.xx 3 = xx.xxx Refer to the *Operating Instructions (IM/4600–CON)* for maximum and minimum ranges which must not be exceeded
027	R	Temperature Units		0 = °C 1 = °F
031	R	Temperature Compensation		0 = No 1 = Yes
032	R	Sol. Temp. Coefficient		0.000 to 0.030 (0 to 3%/°C)
034	R	Reference Temperature		0 = 20°C or 68°F 1 = 25°C or 77°F
037	R	Dissolved Solids Factor		
041	R	Alarm A1 Action		⎫ 0 = Low
042	R	Alarm A2 Action		⎭ 1 = High
044	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20 mA
047	R	Alarm A1 Type		0 = Off
048	R	Alarm A2 Type		1 = Cond 2 = Temp 3 = Fail
050	R	Retransmission Curve		0 = Linear 1 = Bi-Linear 2 = 2-Decade Logarithmic 3 = 3-Decade Logarithmic 4 = 2-Decade Hyperbolic 5 = ABB Semi-Logarithmic
051	R	Retransmission Span		
052	R	Retransmission Zero		

10.2 Conductivity Transmitters Multi-electrode Versions Models 4621/26

10.2.1 Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	
015	R	Channel 2 Input Error	0 = O.K.
017	R	NV Check Sum Error	1 = Error
020	R	Cell Fouling Error	
021	R	Over/Under Temperature	0 = O.K. 1 = Error
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

10.2.2 Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Value	✓	
012	R/W	Set Point A1	✓	Within programmed display range
013	R/W	Set Point A2	✓	
015	R	Measured Temperature	✓	–10 to 110°C (14 to 230°F)
021	R	Units of measure		0 = microsiemens/cm 1 = microsiemens/m 2 = millisiemens/cm 3 = millisiemens/m 4 = T.D.S. 5 = Salinity
023	R	Span Value		Refer to the *Operating Instructions (IM/4600–MEC)* for maximum and minimum ranges which must not be exceeded
027	R	Temperature Units		0 = °C 1 = °F
031	R	Temperature Compensation *		0 = No 1 = Yes
032	R	Temperature Coefficient *		0 = No 1 = Yes
034	R	Reference Temperature *		0 = 20°C or 68°F 1 = 25°C or 77°F
041	R	Alarm A1 Action		0 = Low
042	R	Alarm A2 Action		1 = High
044	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20 mA
047	R	Alarm A1 Type		0 = Off
048	R	Alarm A2 Type		1 = Cond 2 = Temp 3 = Fail
050	R	Retransmission Curve		0 = Linear 1 = Bi-Linear
051	R	Retransmission Span		
052	R	Retransmission Zero		

 * Ignore if the units of measure are not mS/cm. Temperature compensation is automatically carried out on all other units.

10.3   Conductivity Transmitters to meet USP Regulations Models 4623/28

10.3.1   Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	0 = O.K.
015	R	Channel 2 Input Error	1 = Error
017	R	NV Check Sum Error	
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

10.3.2   Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Conductivity	✓	
012	R/W	Set Point A1	✓	Within programmed display range
013	R/W	Set Point A2	✓	
015	R	Measured Temperature	✓	−10 to 110°C (14 to 230°F)
019	R	Alarm 1 Set Point (Temp)	✓	
020	R	Alarm 2 Set Point (Temp)	✓	
022	R	Cell Constant		0.05 to 1.00
023	R	Span Value		Refer to the *Operating Instructions (IM/4600–USP)* for maximum and minimum ranges which must not be exceeded
027	R	Temperature Units		0 = °C 1 = °F
041	R	Alarm A1 Action		0 = Low
042	R	Alarm A2 Action		1 = High
044	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20 mA
047	R	Alarm A1 Type		0 = Off
048	R	Alarm A2 Type		1 = Cond 2 = Temp 3 = Fail 4 = USP (Alarm A2 Type only)
050	R	Retransmission Curve		0 = Linear 1 = Bi-Linear
051	R	Retransmission Span		
052	R	Retransmission Zero		

…10   MODBUS COILS AND REGISTERS

10.4   pH Transmitters Models 4630/35 and 4631/36

10.4.1   Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	0 = O.K.
015	R	Channel 2 Input Error	1 = Error
017	R	NV Check Sum Error	
018	R	Wash in Progress*	0 = No 1 = Yes
019	R	Outputs Held	0 = Not Held 1 = Held
020	R	Calibration in Progress	0 = In Progress 1 = Not in Progress
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

* Models 4631 and 4636 only.

…10.4   pH Transmitters Models 4630/35 and 4631/36

10.4.2   Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured pH Value	✓	Within programmed display range
012	R/W	pH Set Point A1 (A1 Type =1)*	✓	
013	R/W	pH Set Point A2 (A2 Type =1)†	✓	
014	R	Measured Temperature	✓	−10 to 110°C (14 to 230°F)
015	R	Preset Temperature	✓	−10 to 110°C (14 to 230°F)
017	R	pH Slope Value		Refer to the *Operating Instructions (IM/4600–pH)*
018	R	pH Check Value		
019	R/W	Temperature Set Point A1	✓	
020	R/W	Temperature Set Point A2	✓	Within programmed display range
021	R	Measured Millivolts Value	✓	
022	R/W	mV Set Point A1 (A1 Type =1)*	✓	
023	R/W	mV Set Point A2 (A2 Type =1)†	✓	
031	R	Input Type		0 = Redox (ORP), no decimal point 1 = pH Glass, 2 decimal points 2 = pH Antimony, 2 decimal points
033	R	pH Span		14 pH
034	R	pH Zero		0 pH
036	R	mV Span		1000mV
037	R	mV Zero		−1000mV
039	R	Temperature Units		0 = °C 1 = °F
041	R	Temperature Compensation		0 = No 1 = Yes
042	R	Sample Temp. Compensation		0 = No (Not used with the Antimony Electrode) 1 = Yes
043	R	Sample Temp. Coefficient		Not used with the Antimony Electrode, 3 decimal points
045	R	Alarm A1 Action		0 = Low
046	R	Alarm A2 Action		1 = High
047	R	Alarm A1 Type		0 = Off 0 = Off
048	R	Alarm A2 Type		1 = pH **OR** 1 = Redox 2 = Temp 2 = Water Wash (Alarm A2 Type only) 3 = Fail 4 = Water Wash (Alarm A2 Type only)
049	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20 mA
051	R	Retransmission Span		
052	R	Retransmission Zero		

* If Alarm A1 Type is set to Off or Fail, Then Alarm A1 Set Point = 0.
† If Alarm A2 Type is set to Off, Fail or Water Wash, Then Alarm A2 Set Point = 0.

10.5 Dissolved Oxygen Analyzers Models 4640/45 and 4642/47

10.5.1 Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	0 = O.K.
015	R	Channel 2 Input Error	1 = Error
017	R	NV Check Sum Error	
018	R	Wash in Progress*	0 = No 1 = Yes
019	R	Outputs Held	0 = Not Held 1 = Held
020	R	Calibration in Progress	0 = In Progress 1 = Not in Progress
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

 * Models 4642 and 4647 only.

10.5.2 Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Dissolved Oxygen	✓	
012	R/W	Dissolved OxygenSet Point A1	✓	Within programmed display range
013	R/W	Dissolved OxygenSet Point A2	✓	
014	R	Measured Temperature	✓	0 to 40°C (32 to 104°F)
021	R	Input Type		0 = ppm, 2 decimal points 1 = %Sat, 1 decimal point
023	R	Dissolved Oxygen Span		3.00 to 20.00 ppm or 30.0 to 200.0 %Sat
024	R	Dissolved Oxygen Zero		0.00 ppm or 0.0%Sat
026	R	Temperature Units		0 = °C 1 = °F
028	R	Salinity Correction		0 = No (not used with %Sat) 1 = Yes
029	R	Salinity (ppt)		Salinity (no decimal points) This mnemonic is not used with %Sat
033	R	Alarm A1 Action		0 = EA
034	R	Alarm A2 Action		1 = EB
036	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20mA

10.6   Low Level Dissolved Oxygen Analyzers Models 4641/46

10.6.1   Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	0 = O.K.
015	R	Channel 2 Input Error	1 = Error
017	R	NV Check Sum Error	
020	R	Calibration in Progress	0 = In Progress
			1 = Not in Progress
050	R/W	Enable writes to the non-volatile memory	0 = Disable
			1 = Enable

10.6.2   Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Dissolved Oxygen	✓	Within programmed display range
012	R/W	Dissolved Oxygen Set Point A1	✓	
013	R/W	Dissolved Oxygen Set Point A2	✓	
014	R	Measured Temperature	✓	0 to 40°C (32 to 104°F)
021	R	Input Type		0 = µg/kg
				1 = mg/kg;
				2 = ppb
				3 = ppm
023	R	Dissolved Oxygen Span		20.0 ppb to 20.0 ppm or 20.0 µg/kg to 20 mg/kg
024	R	Dissolved Oxygen Zero		0.00 ppm or 0.00 mg/kg
025	R	Decimal Point Position		0 = XXXXX
				1 = XXXX.X
				2 = XXX.XX
026	R	Temperature Units		0 = °C
				1 = °F
033	R	Alarm A1 Action		0 = EA
034	R	Alarm A2 Action		1 = EB
036	R	Retransmission Type		0 = 0 to 10 mA
				1 = 0 to 20 mA
				2 = 4 to 20mA

10.7   Turbidity Analyzers Models 4670 and 4675

10.7.1   Coils

Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable
012	R	Alarm 2 Relay State	1 = Enable
014	R	Channel 1 Input Error	0 = O.K.
017	R	NV Check Sum Error	1 = Error
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

10.7.2   Holding Registers

Input Number	Read/Write	Description	Scaled Parameter	Response/Entry
011	R	Measured Value	✓	
012	R/W	Set Point A1	✓	Within programmed display range
013	R/W	Set Point A2	✓	
021	R	Turbidity Sensor Type		0 = 7997-100 1 = 7997-200 2 = 7997-201 3 = 7007-300 4 = 7007-400/-401
023	R	Turbidity Units		0 = Turbidity NTU 1 = Turbidity FNU 2 = Suspended Solids mg/l 3 = Suspended Solids ppm 4 = Turbidity FTU 5 = Turbidity FAU
025	R	Turbidity Span		See the *Operating Instructions (IM/4670)*
027	R	ppm/NTU Coefficient		
041	R	Alarm A1 Action		0 = EA
042	R	Alarm A2 Action		1 = EB
044	R	Retransmission Type		0 = 0 to 10 mA 1 = 0 to 20 mA 2 = 4 to 20mA

10.8   Biocide Cleaning Control (4691)

10.8.1   Coils

| Input Number	Read/Write	Description	Response/Entry
011	R	Alarm 1 Relay State	0 = Disable 1 = Enable
013	R	Biocide Cleaning Failed	0 = O.K. 1 = Failed
016	R	Channel 2 Input Error	0 = O.K.
018	R	NV Check Sum Error	1 = Error
021	R/W	Initiate Biocide Cleaning	0 = No 1 = Yes
050	R/W	Enable writes to the non-volatile memory	0 = Disable 1 = Enable

10.8.2   Holding Registers

Input Number	Read/Write	Description	Scaled Parameters	Response/Entry
011	R	Measured Temperature	✓	0 to 40°C (32 to 104°F)
012	R/W	Temperature Set Point	✓	
015	R	Temperature Units		0 = °C 1 = °F
017	R	Alarm A1 Action		0 = EA 1 = EB
019	R	Retransmission Type		0 = 0 to 10mA 1 = 0 to 20mA 2 = 4 to 20mA

11 OPERATION

Before attempting any serial communication, first ensure that the 4600 Transmitters connected to the computer terminal or host computer by serial link are functioning correctly as individual instruments. This is achieved by connecting all analog inputs, applying the input signals and checking that the digital display reads appropriately.

Ensure that the serial data connections to 4600 Transmitter 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)
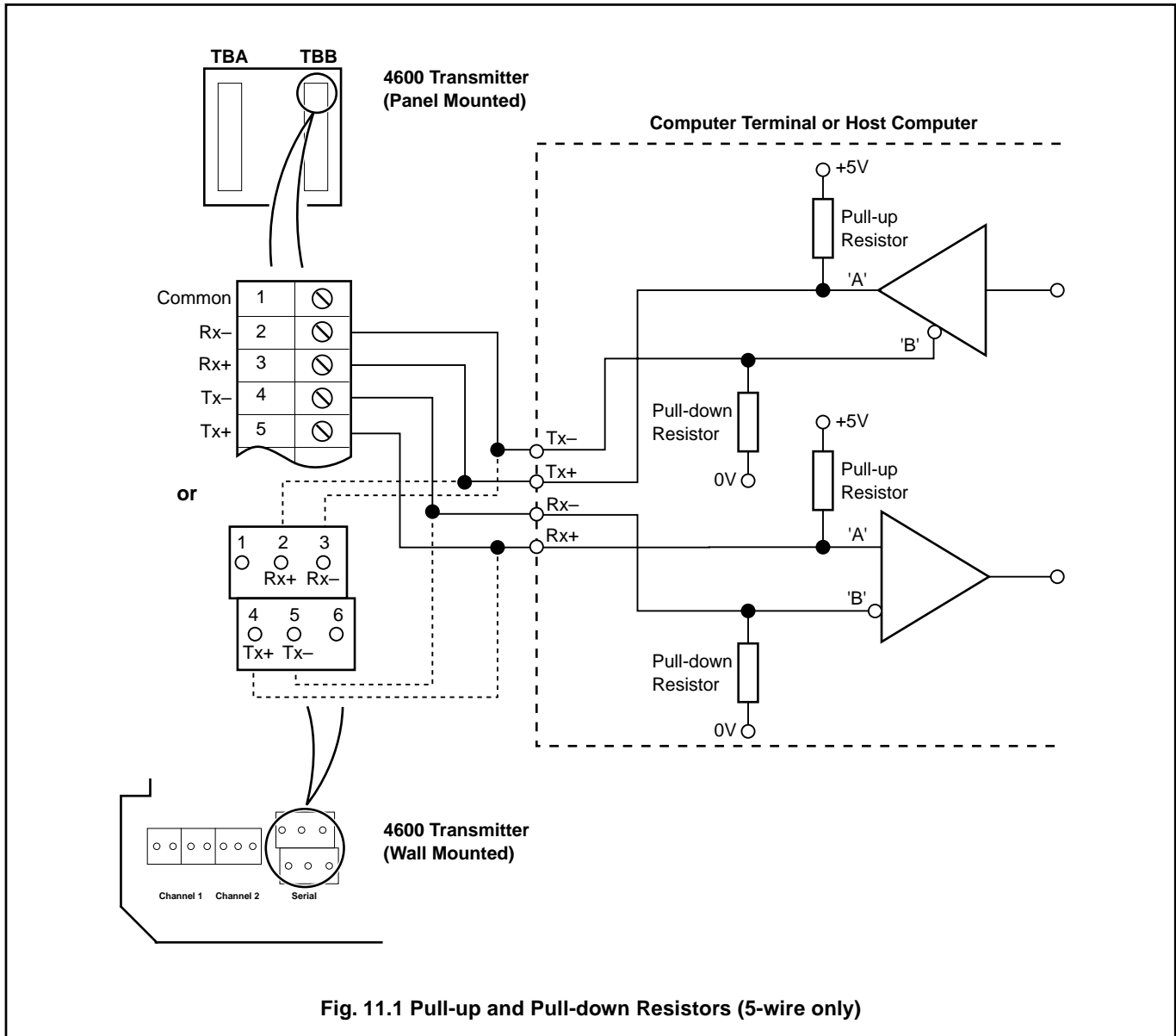
Check that the parameters programmed in the instrument's **Serial Data Communication Page** are compatible with those of the computer terminal or host computer – see Section 7.

If communication is still not possible or is erratic, check that the computer terminal or host computer interface has pull-up and 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.
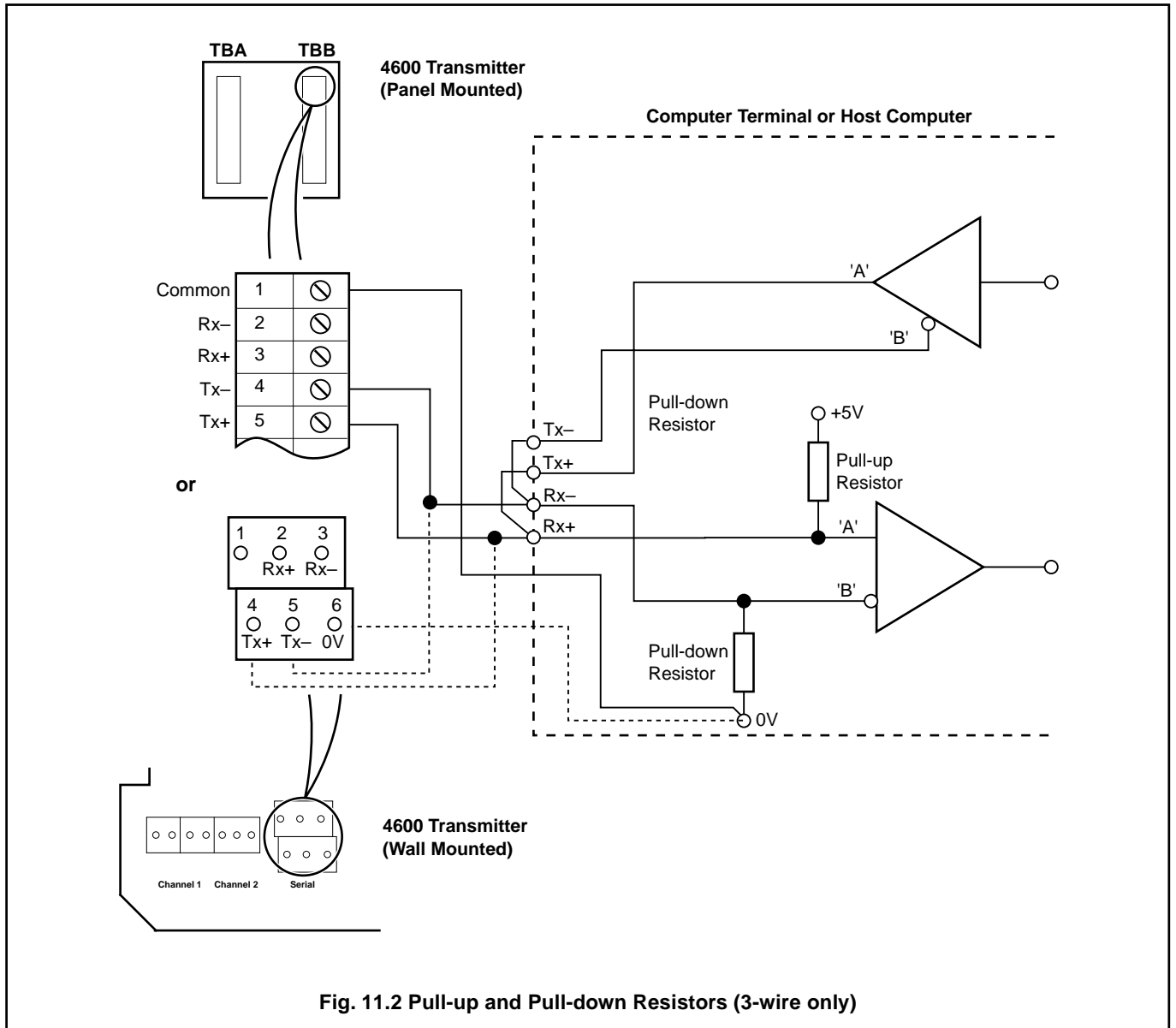
Fig. 11.2 Pull-up and Pull-down Resistors (3-wire only)

12 SPECIFICATION

The specification for each instrument is as detailed in the *Operating Instructions* for the instrument (see Section 1), 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.

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- *Zirconia oxygen analyzers, katharometers, hydrogen purity and purge-gas monitors, thermal conductivity.*

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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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