User Guide –
Modbus (RTU) Communications Option

IM/SR100AMOD_2

100mm Advanced Process Recorder

SR100A

ABB

The Company

EN ISO 9001:2000

Cert. No. Q05907

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.

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

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.

Stonehouse, U.K.

0255

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.

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 equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

One or more of the following symbols may appear on the equipment 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.

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Information. The Modbus protocol is the standard for PLC to system communications and digital controller to PC and/or PLC communications. It supports open communications and provides more information with a greater degree of interchangeability and connectability of all process control and recording devices.

1 INTRODUCTION

Information.

- The advanced process recorder is extended by the addition of a serial data communication option designed for use with SCADA systems.
- RS422/485 Communication Standard.
- Modbus RTU protocol – for master (host computer) to slave (process recorder) system.
- Isolated (500V) from rest of instrument.
- 5-wire communication supported.
- Baud rate – from 1200 to 9600.
- Parity-checking – odd, even or none.

2 ELECTRICAL INSTALLATION

2.1 Selection of Serial Communication Adaptors for Personal Computers

Information.

- A RS422/485 communication board is required in the host PC.
- Observe the limitations outlined in *Section 7* of the *User Guide*. The maximum serial data transmission line length for both RS422 and RS485 systems is 1200m.

An RS422/485 communications adaptor 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.

2.2 Recommended OPTO22 Boards

The following OPTO22 boards are recommended for use with the advanced process recorder:

Part No.	Computer Type
AC24 AT	AT Bus IBM PC compatible
AC34	Microchannel IBM PC.

2.3 Pull-up and Pull-down Resistors – Fig. 2.1

To prevent false triggering of the slave (process recorder) by the presence of noise when the master (host computer) is inactive, 1.8kΩ pull-up and pull-down resistors must be fitted to the RS422/485 adaptor card – see Fig. 2.1.

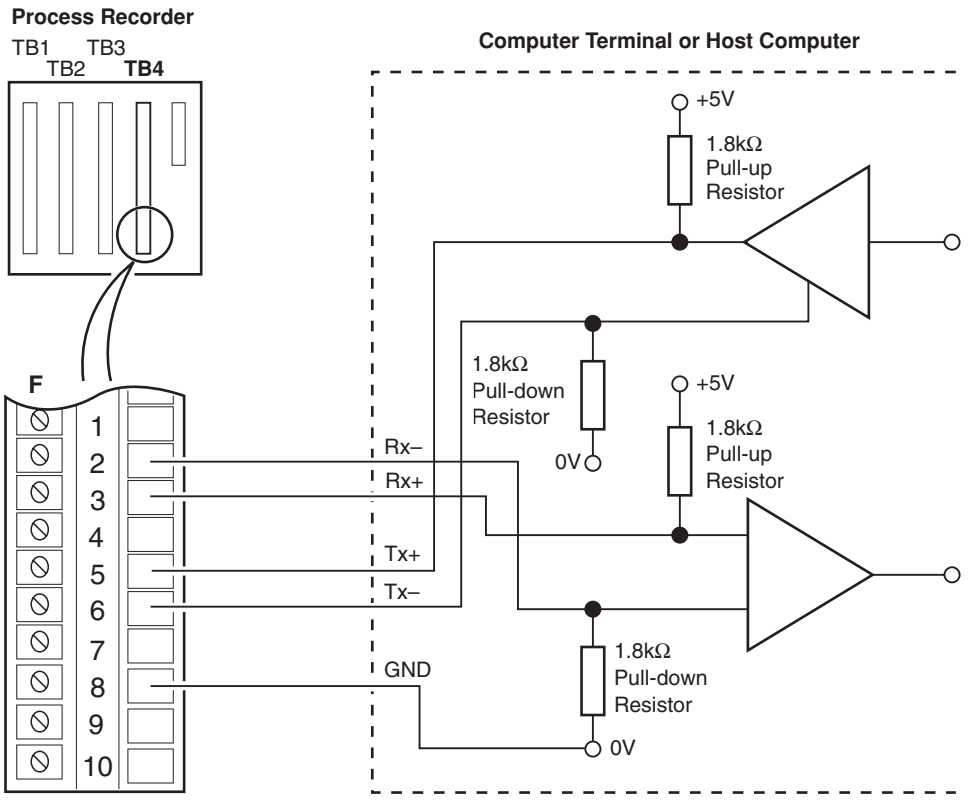


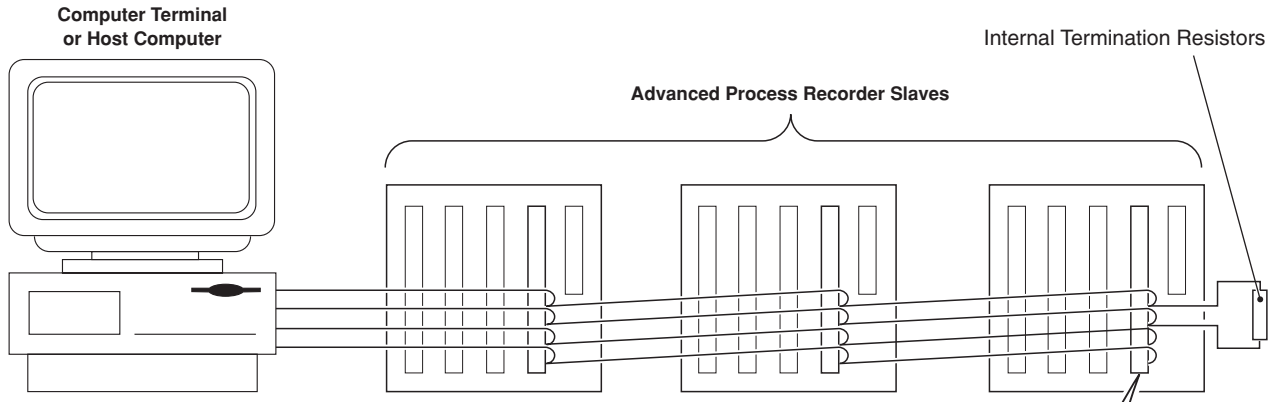
Fig. 2.1 Pull-up and Pull-down Resistors

2.4 Termination Resistors – Fig. 2.2

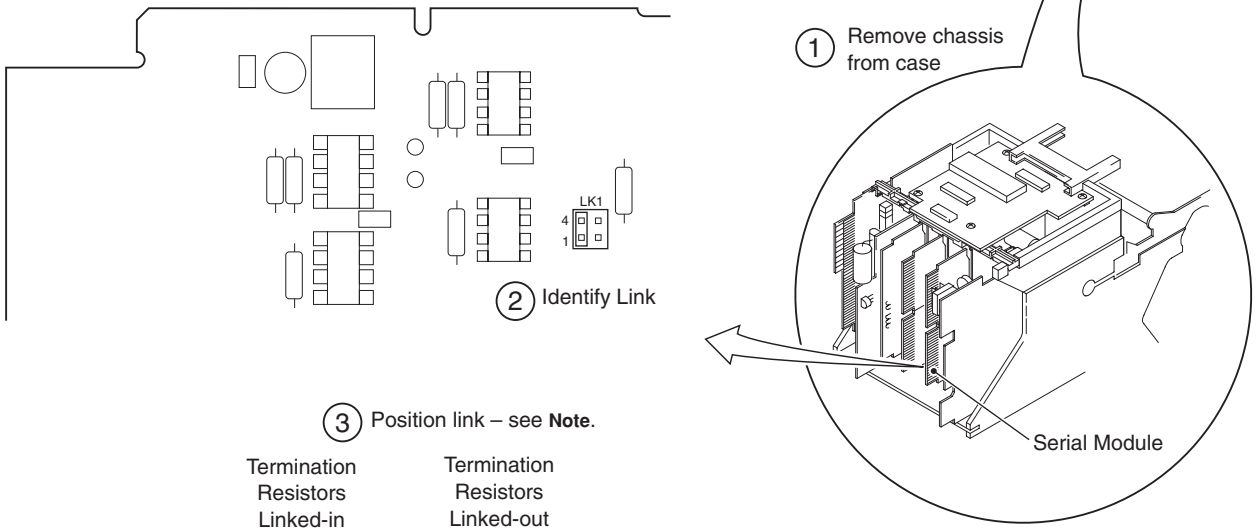
Under normal operating conditions the slave termination resistors are linked out. For long transmission lines, termination resistors are required on the last slave in the chain and the host computer/computer terminal – see Fig. 2.2A. The slaves termination resistors are linked-in using plug-in link (LK1) on the serial module – see Fig. 2.2B.

2.5 RS485/422 Standard

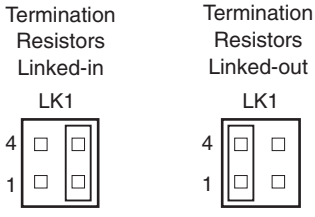
The RS485 standard quotes connection of thirty-two slaves maximum, to any single driver (computer terminal or host computer); the RS422 standard quotes connection of up to ten slaves. However, these numbers can be increased if the driver's serial port permits.



A – Schematic Diagram



3 Position link – see **Note**.



B – Termination Link Positions

Note. For long transmission lines, the internal termination resistors on the last slave in the chain must be linked-in.

Fig. 2.2 Slave Termination Resistors

2.6 Serial Connections – Fig. 2.3

Information.

- Up to **10 slaves** can be connected to a single **RS422** adaptor card on a PC.
- Up to **32 slaves** can be connected to a single **RS485** adaptor card on a PC.
- The maximum serial data transmission line length for both **RS422** and **RS485** systems is 1200m.

All connections, apart from those for serial data communication, are made as shown in *Section 7* of the *User Guide*.

Make serial data connections as shown in Fig. 2.3. The type of cable used is dependent on the cable length:

Up to 6m – 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.

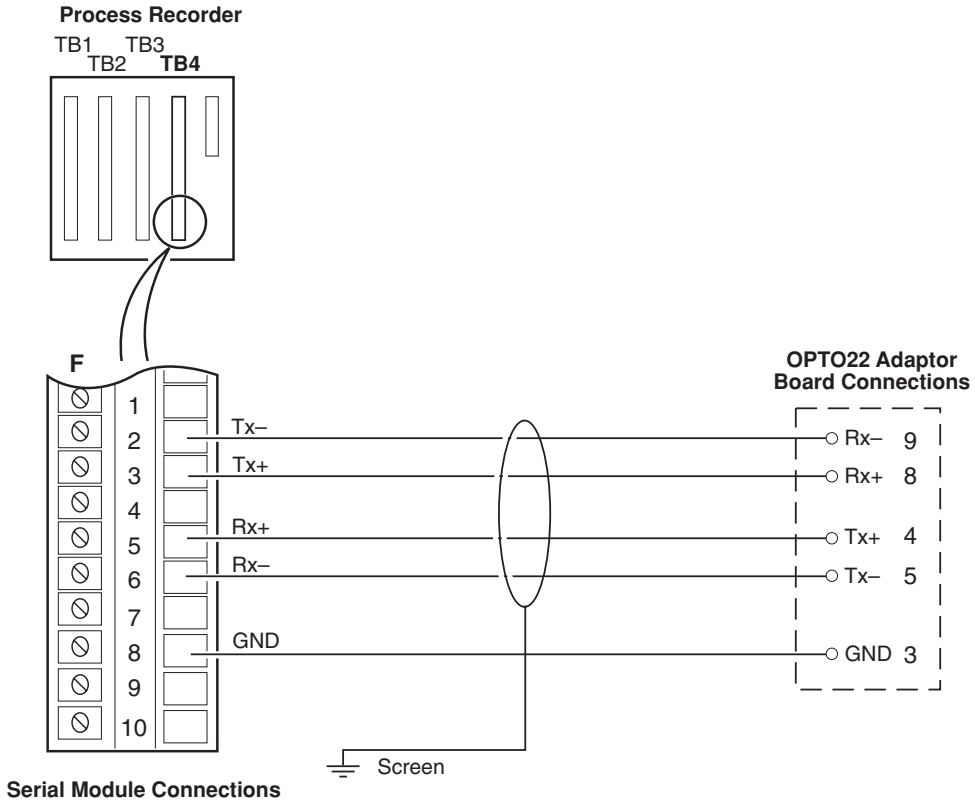


Fig. 2.3 Serial Module Connections

Process Recorder Serial Module		OPTO22 Board Pin Identification	
Terminal Number	**Connections**	**Part Number AC24 AT & AC34**	**Connections**
2	TX–	9	RX–
3	TX+	8	RX+
5	RX+	4	TX+
6	RX–	5	TX–
8	GND	3	GND

Table 2.1 Terminal and Pin Identification

3 ADVANCED CONFIGURATION LEVEL

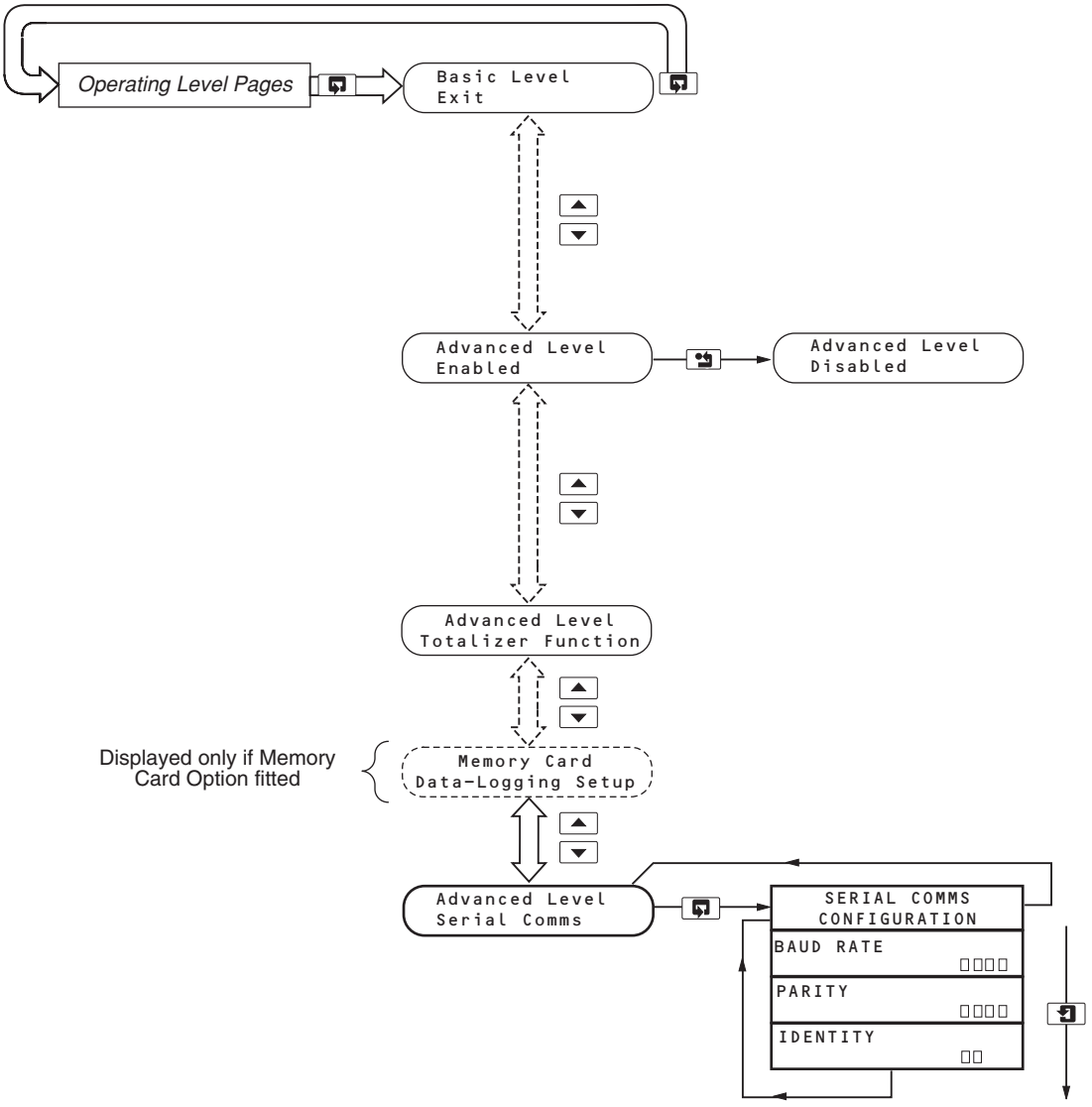


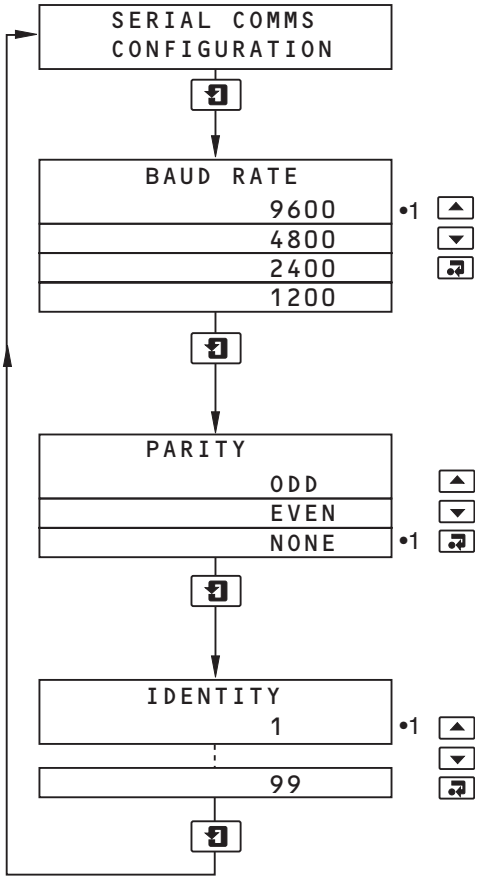
Fig. 3.1 Location of the Serial Communication Configuration Page

…3 ADVANCED CONFIGURATION LEVEL

3.1 Serial Communication Configuration Page

Information.
- Modbus protocol.
- Programmable baud rate (1200 to 9600 baud).
- Odd or even parity.

The general programming procedure is as detailed in the *User Guide – Section 2*.



Page Header – **Serial Communication Configuration Page**.

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

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

Identity
Assign the recorder an identification number (1 to 99). The identification number allows more than one recorder to be accessed via the communications channel.

Return to **Serial Communication Configuration** frame.

•1 The instrument is dispatched programmed with these Company Standard Settings

4 MODBUS PROTOCOL

Information.

- The advanced process recorder operates as a Modbus, Remote Terminal Unit (RTU) slave.
- Parity checking – used to detect transmission errors in individual characters.
- Cyclic redundancy checking – used to detect errors in the master messages and slave responses.
- Non-volatile memory save command.

4.1 Introduction to Modbus Protocol

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 90 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.

4.1.1 Non-volatile Memory Limitations

Caution. If the number of write cycles to any particular non-volatile memory register exceeds 10^4 cycles, the data stored may not be retained.

Any changes made to a parameter via the serial link, e.g. Alarm A Trip Point value, 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 non-volatile memory access when making changes to parameters which do not need to be retained following a power-down. This is achieved using the **Non-volatile Save State** (NV) Coil 061 – see Section 7.1.

When the **Non-volatile Save State** is set to '1=Saved', any parameter changes made via the serial link are written to non-volatile memory and are retained on power-down. If the **Non-volatile Save State** is set to '0=Not Saved', parameter changes made via the serial link are not retained on power down.

The **Non-volatile Save State** must be adjusted only when necessary and must be reset to the required state each time the instrument is or the host computer is powered down or the instrument is replaced.

4.2 Modbus Function Codes

The function code field instructs the addressed slaves what function to perform. Table 4.1 shows the function codes, their definitions, and the actions they initiate.

Modbus Function Code	Modbus Message Name	Process Recorder Definition
01	Read Coil Status	Read up to 16 consecutive discrete (boolean) points (coils) from a specific starting point. The instrument returns zeros for points which do not contain defined data. An exception response is returned if any request for point numbers is greater than 90.
02	Read Input Status	Read up to 16 consecutive discrete (boolean) points (inputs) from a specific starting point. The instrument returns zeros for points which do not contain defined data and returns an exception response if any request for point numbers is greater than 120.
03	Read Holding Registers	Read up to 12 consecutive holding registers from a specific starting register. The instrument returns zeros from registers which do not contain defined data. An exception response is returned if any request for register numbers is greater than 90.
04	Read Input Registers	Read up to 12 consecutive input registers from a specific starting register. The instrument returns zeros from registers which do not contain defined data and returns an exception response if any request for register numbers is greater than 300.
05	Force Single Coil	Write one discrete (boolean) point (coil). The instrument returns an exception response if the point is not currently writeable.
06	Preset Single Register	Write one holding register. The instrument returns an exception response if the register is not currently writeable. This function code also applies any currently applicable limits to the value before storage in the database.
08	Loopback Diagnostic Test	Data diagnostic code 0000 returns query data. Other diagnostic codes return exception responses.
15	Force Multiple Coils	Write up to 16 consecutive discrete (boolean) points (coils) from a specific starting point. The instrument returns an exception response if any of the registers are not currently writeable, but still carries out all the writes which are valid. The function code is available only if ‘write to non-volatile memory’ is disabled – see coil number 61.
16	Preset Multiple Registers	Write up to 12 consecutive holding registers from a specified starting register. The instrument returns an exception response if any of the registers are not currently writeable, but still carries out all the writes which are valid. This function code also applies any currently applicable limits to the value before storage in the database. The function code is available only if ‘write to non-volatile memory’ is disabled – see coil number 61.
65	User Defined	Supports internal function 24 only ‘read instrument version’. Other internal function values return an exception response.

Table 4.1 Modbus Function Codes

5 MODBUS FUNCTIONS

This section shows typical examples of Modbus function codes 01, 02, 03, 04, 05, 06, 08, 15, 16 and 65.

5.1 Read Coil Status – Function Code 01

5.1.1 Read Coil Status Query

This function allows the user to obtain the ON/OFF status of logic coils within 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 the initial coil offset address to be read (starting address) and the number of locations to be interrogated.

Note. The coil offset address is the coil number minus one, e.g. to start at coil 21 the data start value must be set to 20 (14H).

Example – a read coil status request to read 12 coils from slave (01) starting at coil 21 (alarm A status) 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	14	00	0C	7C	0B

5.1.2 Read Coil Status Response

The data is packed one bit for each coil (1 = active, 0 = inactive). 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:

Alarm A status – active
Alarm B status – acknowledged or inactive
Alarm C status – active
Alarm D status – acknowledged or inactive
Alarms E to M status – acknowledged or inactive.

Address	Function	Byte Count	Data Coil Status 21 to 28	Data Coil Status 29 to 36	Error Check Field (CRC-16)	
01	01	02	05	00	BA	AC

5.2 Read Input Status – Function Code 02

5.2.1 Read Input Status Query

This function allows the user to obtain the ON/OFF status of logic inputs within the addressed slave. Broadcast mode is not supported with this function code. In addition to the slave address and function fields, the message requires the initial input offset address to be read (starting address) and the number of locations to be interrogated.

Note. The input offset address is the input number –1, e.g. to start at input 01 the data start value must be set to 00.

Example – a read input status request to read 16 inputs from slave (01) starting at input 01 (module A digital input 1) is shown below.

Address	Function	Input Start Offset High	Input Start Offset Low	Number of Inputs High	Number of Inputs Low	Error Check Field (CRC-16)	
01	02	00	00	00	10	79	C6

5.2.2 Read Input Status Response

The data is packed one bit for each input (1 = active, 0 = inactive). 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 input and the remainder follow. For input 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 input status query shows the following:

Digital input A1 – active
Digital input B1 – inactive
Digital input B2 – active
Digital input B3 – inactive
Digital inputs C1, C2, C3 – inactive
Digital inputs D1, D2, D3 – inactive
Digital inputs E1, E2, E3 – inactive
Digital inputs G1, G2, G3 – inactive

Address	Function	Byte Count	Data Input Status 01 to 08	Data Input Status 09 to 16	Error Check Field (CRC-16)	
01	02	02	05	00	BA	E8

5.3 Read Holding Register – Function Code 03

5.3.1 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 5, the data start register must be set to 50 (32H).

Broadcast mode is not allowed.

Example – a read holding register request to read 6 holding registers from slave (01) starting at holding address 51 (alarm A trip point) 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	32	00	06	64	07

5.3.2 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 is two bytes, the first byte contains the high order bits and the second the low order bits.

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

Alarm A trip point – 150
Alarm B trip point – 50
Alarm C trip point – 100
Alarm D trip point – 400
Alarm E trip point – 0
Alarm F trip point – 0.

Address	Function	Byte Count	Holding Register 51 High	Holding Register 51 Low	Holding Register 52 High	Holding Register 52 Low	Holding Register 53 High	Holding Register 53 Low	Holding Register 54 High	Holding Register 54 Low	Holding Register 55 High	Holding Register 55 Low	Holding Register 56 High	Holding Register 56 Low	Error Check Field (CRC-16)	
01	03	0C	00	96	00	32	00	64	01	90	00	00	00	00	D9	91

5.4 Read Input Register – Function Code 04

5.4.1 Read Input Register Query

The read input registers allow the user to obtain the binary contents of input 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 01, the data start register must be set to 00.

Broadcast mode is not allowed.

Example – a read input register request to read 6 input registers from slave (01) starting at input address 01 (A1 analog input) 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	04	00	00	00	06	70	08

5.4.2 Read Input 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 is two bytes, the first byte includes the high order bits and the second the low order bits.

Example – with an input range of 0 to 1000mV, the response to the read input register query shows the following:

A1 analog input – 200
A2 analog input – 200
A3 analog input – 200
A4 analog input – 200
A5 analog input – 200
A6 analog input – 200.

Address	Function	Byte Count	Input Register 01		Input Register 02		Input Register 03		Input Register 04		Input Register 05		Input Register 06		Error Check Field (CRC-16)	
			High	Low	High	Low	High	Low	High	Low	High	Low	High	Low		
01	04	0C	03	32	03	32	03	32	03	32	03	32	03	32	92	EA

5.5 Force Single Coil – Function Code 05

5.5.1 Force Single Coil Query

This message forces a single coil into the active or inactive state. The data value 65,280 (FF00 HEX) renders the coil active and the value zero renders the coil inactive. 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 41, the coil address 40 (28H) 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 set coil address 41 active (print operator message command) 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	28	FF	00	0C	32

5.5.2 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	28	FF	00	0C	32

5.6 Preset Single Register – Function Code 06

5.6.1 Preset Single Register Query

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

Note. To write to a register, the register's offset address must be used, e.g. to write to register 31, the offset address 30 (1EH) is transmitted.

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

Example – a preset single register request to write the value 500 to holding register address 31 (maths 1 constant a) in slave 01 is shown below.

Address	Function	Register Offset High	Register Offset Low	Data Value High	Data Value Low	Error Check Field (CRC-16)	
01	06	00	1E	01	F4	E9	DB

5.6.2 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	1E	01	F4	E9	DB

5.7 Loopback Diagnostic Test – Function Code 08

5.7.1 Loopback Diagnostic Test Query

The purpose of the loopback diagnostic 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 – a loopback test query of slave 01 is shown below.

Address	Function	Data Diagnostic Code High	Data Diagnostic Code Low	Data *	Data *	Error Check Field (CRC-16)	
01	08	00	00	A5	37	DA	8D

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

5.7.2 Loopback Diagnostic 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	00	A5	37	DA	8D

5.8 Force Multiple Coils – Function Code 15

5.8.1 Force Multiple Coils Query

Coils existing within the recorder can have their contents changed by this message (a maximum of 16 coils). When used with slave address zero (broadcast mode) all slave controllers load the selected coils with the contents specified.

Note. To write to multiple coils, the initial coil offset address must be used, e.g. to write to coil 45 onwards, the offset address 44 (2CH) is transmitted.

Example – a preset multiple coils request to set coil address 45 (total 1 print command) active, coil address 46 (total 2 print command) inactive, coil address 47 (total 3 print command) active and coil address 48 (total 4 print command) active in slave 01 is shown below.

Address	Function	Coil Start Offset High	Coil Start Offset Low	Number of Coils		Byte Count	Coil Status 45 to 52	Coil Status 53 to 60	Error Check Field (CRC-16)	
01	0F	00	2C	00	04	02	0D	00	E4	EC

5.8.2 Force Multiple Coils Response

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

Example:

Address	Function	Coil Start Offset High	Coil Start Offset Low	Number of Coils		Error Check Field (CRC-16)	
01	0F	00	2C	00	04	95	C1

5.9 Preset Multiple Registers – Function Code 16

5.9.1 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 10 to the register address 02 (chart speed 1) and the value 100 to the register address 03 (chart speed 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	01	00	02	04	00	0A	00	64	13	8A

5.9.2 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	01	00	02	10	08

5.10 User Defined – Function Code 65

5.10.1 User Defined Query

The user defined function makes available to the user a range of non-standard Modbus query responses. The information field comprises of a control byte which defines control type, an internal function byte designating the action to be taken, a qualifier byte the usage of which is dependent on the user defined task and a byte specifying the number of bytes to follow in the information data string.

Example – a user defined read instrument version (internal function 24) of slave 01 is shown below.

The control byte has no effect, valid qualifier and byte counts are zero only and other values return an exception response.

Address	Function	Control	Internal Function	Qualifier	Byte Count	Error Check Field (CRC-16)	
01	41	09	18	00	00	BE	5E

5.10.2 User Defined Response

The addressed slave responds with its address and function code followed by the information field. The information field comprises of the control byte, one byte defining the quantity of data bytes in the response information string and the data string.

Example:

Address	Function	Control	Byte Count	Data	Error Check Field (CRC-16)	
01	41	09	0D	5620202020312E302020202020	F5	F6

6 EXCEPTION RESPONSES

The exception response codes sent by the slave are shown in Table 6.1. 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.
04	Failure in Associated Device	Unable to respond correctly, abortive error in slave.
07	Negative Acknowledgment	Received message error.
08	Memory Parity Error	Parity check indicates an error in one or more of the characters received.

Table 6.1 Exception Response Codes

6.1 Examples

A read register request to read holding register address 91 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	5A	00	06	E5	DB

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

7 MODBUS REGISTERS

7.1 Coils

Coil Number	Read/Write	Description	Response Entry
		Totalizer Settings	
001	R/W	Totalizer 1 Stop/Go	
002	R/W	Totalizer 2 Stop/Go	
003	R/W	Totalizer 3 Stop/Go	0 = Stop
004	R/W	Totalizer 4 Stop/Go	1 = Go
005	R/W	Totalizer 5 Stop/Go	
006	R/W	Totalizer 6 Stop/Go	
007	W	Totalizer 1 Reset	
008	W	Totalizer 2 Reset	
009	W	Totalizer 3 Reset	0 = Inactive
010	W	Totalizer 4 Reset	1 = Reset to Preset Value
011	W	Totalizer 5 Reset	
012	W	Totalizer 6 Reset	
		Alarm Status	
021	R/W	Alarm A	
022	R/W	Alarm B	
023	R/W	Alarm C	
024	R/W	Alarm D	
025	R/W	Alarm E	
026	R/W	Alarm F	
027	R/W	Alarm G	
028	R/W	Alarm H	0 = Alarm State Acknowledged or Inactive
029	R/W	Alarm J	1 = Alarm State Active Not Acknowledged
030	R/W	Alarm K	
031	R/W	Alarm L	
032	R/W	Alarm M	
033	R/W	Real Time Alarm 1	
034	R/W	Real Time Alarm 2	
035	R/W	Line (Power) Fail	
		Print Commands	
041	W	Print Operator Message	
042	W	Print Channel Data	
043	W	Print Channel Values	
044	W	All Totals Print	
045	W	Total 1 Print	
046	W	Total 2 Print	
047	W	Total 3 Print	
048	W	Total 4 Print	0 = Inactive
049	W	Total 5 Print	1 = Active
050	W	Total 6 Print	
051	W	Scale 1 Print	
052	W	Scale 2 Print	
053	W	Scale 3 Print	
054	W	Scale 4 Print	
055	W	Scale 5 Print	
056	W	Scale 6 Print	
		Memory Access Commands	
061	R/W	Non-volatile Save State*	0 = Not Saved, 1 = Saved

*See Section 4.1.1

7.2 Inputs

Input Number	Read/Write	Description	Response Entry
		Digital Input State	
001	R	Digital Input A1	
002	R	Digital Input B1	
003	R	Digital Input B2	
004	R	Digital Input B3	
005	R	Digital Input C1	
006	R	Digital Input C2	
007	R	Digital Input C3	
008	R	Digital Input D1	0 = Inactive
009	R	Digital Input D2	1 = Active
010	R	Digital Input D3	
011	R	Digital Input E1	
012	R	Digital Input E2	
013	R	Digital Input E3	
014	R	Digital Input G1	
015	R	Digital Input G2	
016	R	Digital Input G3	
		Analog Input Fail States	
031	R	A1 Fail State	
032	R	A2 Fail State	
033	R	A3 Fail State	
034	R	A4 Fail State	
035	R	A5 Fail State	
036	R	A6 Fail State	0 = Inactive
037	R	B1 Fail State	1 = Active
038	R	B2 Fail State	
039	R	B3 Fail State	
040	R	B4 Fail State	
041	R	B5 Fail State	
042	R	B6 Fail State	
		Alarm States	
051	R	Alarm A	
052	R	Alarm B	
053	R	Alarm C	
054	R	Alarm D	
055	R	Alarm E	
056	R	Alarm F	
057	R	Alarm G	0 = Inactive
058	R	Alarm H	1 = Active
059	R	Alarm J	
060	R	Alarm K	
061	R	Alarm L	
062	R	Alarm M	
063	R	Real Time Alarm 1	
064	R	Real Time Alarm 2	

Continued…

…7.2 Inputs

Input Number	Read/Write	Description	Response Entry
		Logic Equation Result State	
071	R	Logic Equation 1 Result	0 = Inactive 1 = Active
072	R	Logic Equation 2 Result	
073	R	Logic Equation 3 Result	
074	R	Logic Equation 4 Result	
075	R	Logic Equation 5 Result	
076	R	Logic Equation 6 Result	
077	R	Logic Equation 7 Result	
078	R	Logic Equation 8 Result	
079	R	Logic Equation 9 Result	
080	R	Logic Equation 10 Result	
		Instrument Status	
091	R	Recording Stopped	0 = Recording 1 = Recording Stopped
092	R	Paper Out State	0 = Paper Available 1 = Less Than 0.5m of Paper
093	R	Line (Power) Failure State	0 = Inactive, 1 = Fail

7.3 Input Registers

Register Number	Read/Write	Description	Response Entry
		Analog Inputs	
001	R	Analog Input A1	0 to 4095 (0 to 100% input range) $\text{Value} = \frac{\text{Response} \times (FS - Z)}{4095} + Z$ Where FS = Engineering range Full Scale for the appropriate input Z = Engineering range Zero for the appropriate input
002	R	Analog Input A2	
003	R	Analog Input A3	
004	R	Analog Input A4	
005	R	Analog Input A5	
006	R	Analog Input A6	
007	R	Analog Input B1	
008	R	Analog Input B2	
009	R	Analog Input B3	
010	R	Analog Input B4	
011	R	Analog Input B5	
012	R	Analog Input B6	

Continued…

…7.3 Input Registers

Register Number	Read/Write	Description	Response Entry
		Analog Input Configuration	
021	R	A1 Engineering range Full Scale	– 0999 to +9999
022	R	A1 Engineering range Zero	– 0999 to +9999
023	R	A1 Engineering range Decimal Point	0 to 3 Decimal Places
024	R	A2 Engineering range Full Scale	– 0999 to +9999
025	R	A2 Engineering range Zero	– 0999 to +9999
026	R	A2 Engineering range Decimal Point	0 to 3 Decimal Places
027	R	A3 Engineering range Full Scale	– 0999 to +9999
028	R	A3 Engineering range Zero	– 0999 to +9999
029	R	A3 Engineering range Decimal Point	0 to 3 Decimal Places
030	R	A4 Engineering range Full Scale	– 0999 to +9999
031	R	A4 Engineering range Zero	– 0999 to +9999
032	R	A4 Engineering range Decimal Point	0 to 3 Decimal Places
033	R	A5 Engineering range Full Scale	– 0999 to +9999
034	R	A5 Engineering range Zero	– 0999 to +9999
035	R	A5 Engineering range Decimal Point	0 to 3 Decimal Places
036	R	A6 Engineering range Full Scale	– 0999 to +9999
037	R	A6 Engineering range Zero	– 0999 to +9999
038	R	A6 Engineering range Decimal Point	0 to 3 Decimal Places
039	R	B1 Engineering range Full Scale	– 0999 to +9999
040	R	B1 Engineering range Zero	– 0999 to +9999
041	R	B1 Engineering range Decimal Point	0 to 3 Decimal Places
042	R	B2 Engineering range Full Scale	– 0999 to +9999
043	R	B2 Engineering range Zero	– 0999 to +9999
044	R	B2 Engineering range Decimal Point	0 to 3 Decimal Places
045	R	B3 Engineering range Full Scale	– 0999 to +9999
046	R	B3 Engineering range Zero	– 0999 to +9999
047	R	B3 Engineering range Decimal Point	0 to 3 Decimal Places
048	R	B4 Engineering range Full Scale	– 0999 to +9999
049	R	B4 Engineering range Zero	– 0999 to +9999
050	R	B4 Engineering range Decimal Point	0 to 3 Decimal Places
051	R	B5 Engineering range Full Scale	– 0999 to +9999
052	R	B5 Engineering range Zero	– 0999 to +9999
053	R	B5 Engineering range Decimal Point	0 to 3 Decimal Places
054	R	B6 Engineering range Full Scale	– 0999 to +9999
055	R	B6 Engineering range Zero	– 0999 to +9999
056	R	B6 Engineering range Decimal Point	0 to 3 Decimal Places
		Math Function Results	
081	R	Math Block 1 Function Result	Math Block n Engineering range FS +10%
082	R	Math Block 2 Function Result	Math Block n Engineering range Zero –10%
083	R	Math Block 3 Function Result	$\text{Result} = \frac{\text{Response x (FS – Z)}}{4095} + Z$
084	R	Math block 4 Function Result	Where FS = Engineering range Full Scale for the appropriate math block Z = Engineering range Zero for the appropriate math block
		Math Function Configuration	
091	R	Math 1 Engineering range Full Scale	–0999 to +9999
092	R	Math 1 Engineering range Zero	–0999 to +9999
093	R	Math 1 Engineering range Decimal Point	0 to 3 decimal places
094	R	Math 2 Engineering range Full Scale	–0999 to +9999
095	R	Math 2 Engineering range Zero	–0999 to +9999
096	R	Math 2 Engineering range Decimal Point	0 to 3 decimal places
097	R	Math 3 Engineering range Full Scale	–0999 to +9999
098	R	Math 3 Engineering range Zero	–0999 to +9999
099	R	Math 3 Engineering range Decimal Point	0 to 3 decimal places
100	R	Math 4 Engineering range Full Scale	–0999 to +9999
101	R	Math 4 Engineering range Zero	–0999 to +9999
102	R	Math 4 Engineering range Decimal Point	0 to 3 decimal places

Continued…

…7.3 Input Registers

Register Number	Read/Write	Description	Response Entry
		Totalizer Settings	
		Predetermined Value Channel 1	
121	R	High Word	The Limit for High Word : Low Word linked
122	R	Low Word	together is 0 to 99,999,999
		Preset Value	
123	R	High Word	The Limit for High Word : Low Word linked
124	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 1	
125	R	High Word	The Limit for High Word : Low Word linked
126	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 1	
127	R	High Word	The Limit for High Word : Low Word linked
128	R	Low Word	together is 0 to 99,999,999
129	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier
		Predetermined Value Channel 2	
130	R	High Word	The Limit for High Word : Low Word linked
131	R	Low Word	together is 0 to 99,999,999
		Preset Value	
132	R	High Word	The Limit for High Word : Low Word linked
133	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 2	
134	R	High Word	The Limit for High Word : Low Word linked
135	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 2	
136	R	High Word	The Limit for High Word : Low Word linked
137	R	Low Word	together is 0 to 99,999,999
138	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier
		Predetermined Value Channel 3	
139	R	High Word	The Limit for High Word : Low Word linked
140	R	Low Word	together is 0 to 99,999,999
		Preset Value	
141	R	High Word	The Limit for High Word : Low Word linked
142	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 3	
143	R	High Word	The Limit for High Word : Low Word linked
144	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 3	
145	R	High Word	The Limit for High Word : Low Word linked
146	R	Low Word	together is 0 to 99,999,999
148	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier
		Predetermined Value Channel 4	
148	R	High Word	The Limit for High Word : Low Word linked
149	R	Low Word	together is 0 to 99,999,999
		Preset Value	
150	R	High Word	The Limit for High Word : Low Word linked
151	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 4	
152	R	High Word	The Limit for High Word : Low Word linked
153	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 4	
154	R	High Word	The Limit for High Word: Low Word linked
155	R	Low Word	together is 0 to 99,999,999
156	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier

Continued…

…7.3 Input Registers

Register Number	Read/Write	Description	Response Entry
		Predetermined Value Channel 5	
157	R	High Word	The Limit for High Word : Low Word linked
158	R	Low Word	together is 0 to 99,999,999
		Preset Value	
159	R	High Word	The Limit for High Word : Low Word linked
160	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 5	
161	R	High Word	The Limit for High Word : Low Word linked
162	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 5	
163	R	High Word	The Limit for High Word : Low Word linked
164	R	Low Word	together is 0 to 99,999,999
165	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier
		Predetermined Value Channel 6	
166	R	High Word	The Limit for High Word : Low Word linked
167	R	Low Word	together is 0 to 99,999,999
		Preset Value	
168	R	High Word	The Limit for High Word : Low Word linked
169	R	Low Word	together is 0 to 99,999,999
		Front-Panel Totalizer Value Channel 6	
170	R	High Word	The Limit for High Word : Low Word linked
171	R	Low Word	together is 0 to 99,999,999
		Secure Totalizer Value 6	
172	R	High Word	The Limit for High Word : Low Word linked
173	R	Low Word	together is 0 to 99,999,999
174	R	Value Decimal Point Position	8 = No Dec. Places, 0 = 8 Dec. Places 9 = x10 Multiplier, 10 = x100 Multiplier
		Alarm Configuration	
195	R	Process Alarm A Type	0 = None, 1 = High, 2 = Low Process
196	R	Alarm A Decimal Point	0 to 3 Decimal Places
197	R	Process Alarm B Type	0 = None, 1 = High, 2 = Low Process
198	R	Alarm B Decimal Point	0 to 3 Decimal Places
199	R	Process Alarm C Type	0 = None, 1 = High, 2 = Low Process
200	R	Alarm C Decimal Point	0 to 3 Decimal Places
201	R	Process Alarm D Type	0 = None, 1 = High, 2 = Low Process
202	R	Alarm D Decimal Point	0 to 3 Decimal Places
203	R	Process Alarm E Type	0 = None, 1 = High, 2 = Low Process
204	R	Alarm E Decimal Point	0 to 3 Decimal Places
205	R	Process Alarm F Type	0 = None, 1 = High, 2 = Low Process
206	R	Alarm F Decimal Point	0 to 3 Decimal Places
207	R	Process Alarm G Type	0 = None, 1 = High, 2 = Low Process
208	R	Alarm G Decimal Point	0 to 3 Decimal Places
209	R	Process Alarm H Type	0 = None, 1 = High, 2 = Low Process
210	R	Alarm H Decimal Point	0 to 3 Decimal Places
211	R	Process Alarm J Type	0 = None, 1 = High, 2 = Low Process
212	R	Alarm J Decimal Point	0 to 3 Decimal Places
213	R	Process Alarm K Type	0 = None, 1 = High, 2 = Low Process
214	R	Alarm K Decimal Point	0 to 3 Decimal Places
215	R	Process Alarm L Type	0 = None, 1 = High, 2 = Low Process
216	R	Alarm L Decimal Point	0 to 3 Decimal Places
217	R	Process Alarm M Type	0 = None, 1 = High, 2 = Low Process
218	R	Alarm M Decimal Point	0 to 3 Decimal Places
		Instrument Status	
231	R	Remaining Paper	0 to 320 Decimetres
232	R	Remaining Chart Time (Hours)	49 = No Warning (hours remaining >48) 0 to 48 = Hours Remaining

7.4 Holding Registers

Register Number	Read/Write	Description	Response Entry
		Chart Speed	
001	R/W	Operating Chart Speed	0 = Chart Speed 1, 1 = Chart Speed 2 2 = Chart Speed 3
002	R/W	Chart Speed 1	0 to 1500 mm/h
003	R/W	Chart Speed 2	
004	R/W	Chart Speed 3	
		Operator Message	
011	R/W	Operator Message (Start of Message)	User Defined 2 Characters per Word (In Total 20 Characters) Refer to Section 8 for Character Code Conversion.
012	R/W	Operator Message	
013	R/W	Operator Message	
014	R/W	Operator Message	
015	R/W	Operator Message	
016	R/W	Operator Message	
017	R/W	Operator Message	
018	R/W	Operator Message	
019	R/W	Operator Message	
020	R/W	Operator Message (End of Message)	
		Math Constants	
031	R/W	Math 1 Constant a	–9999 to +9999
032	R/W	Math 1 Constant b	
033	R/W	Math 1 Constant c	
034	R/W	Math 2 Constant a	
035	R/W	Math 2 Constant b	
036	R/W	Math 2 Constant c	
037	R/W	Math 3 Constant a	
038	R/W	Math 3 Constant b	
039	R/W	Math 3 Constant c	
040	R/W	Math 4 Constant a	
041	R/W	Math 4 Constant b	
042	R/W	Math 4 Constant c	
		Alarm Trip Points	
051	R/W	Alarm A Trip Point	–9999 to +9999
052	R/W	Alarm B Trip Point	
053	R/W	Alarm C Trip Point	
054	R/W	Alarm D Trip Point	
055	R/W	Alarm E Trip Point	
056	R/W	Alarm F Trip Point	
057	R/W	Alarm G Trip Point	
058	R/W	Alarm H Trip Point	
059	R/W	Alarm J Trip Point	
060	R/W	Alarm K Trip Point	
061	R/W	Alarm L Trip Point	
062	R/W	Alarm M Trip Point	

8 QUERY/RESPONSE DATA CODES

8.1 Operator Message Character Code Conversion

Character	Decimal	Hexadecimal
Space	32	20
!	33	21
"	34	22
#	35	23
$	36	24
%	37	25
&	38	26
'	39	27
(	40	28
)	41	29
*	42	2A
+	43	2B
,	44	2C
–	45	2D
.	46	2E
/	47	2F
0	48	30
1	49	31
2	50	32
3	51	33
4	52	34
5	53	35
6	54	36
7	55	37
8	56	38
9	57	39
:	58	3A
;	59	3B
<	60	3C
=	61	3D
>	62	3E
?	63	3F
@	64	40
A	65	41
B	66	42
C	67	43
D	68	44
E	69	45
F	70	46
G	71	47
H	72	48
I	73	49
J	74	4A
K	75	4B
L	76	4C
M	77	4D
N	78	4E
O	79	4F
P	80	50

Character	Decimal	Hexadecimal
Q	81	51
R	82	52
S	83	53
T	84	54
U	85	55
V	86	56
W	87	57
X	88	58
Y	89	59
Z	90	5A
[	91	5B
\	92	5C
]	93	5D
^	94	5E
_	95	5F
`	96	60
a	97	61
b	98	62
c	99	63
d	100	64
e	101	65
f	102	66
g	103	67
h	104	68
i	105	69
j	106	6A
k	107	6B
l	108	6C
m	109	6D
n	110	6E
o	111	6F
p	112	70
q	113	71
r	114	72
s	115	73
t	116	74
u	117	75
v	118	76
w	119	77
x	120	78
y	121	79
z	122	7A
α	123	7B
β	124	7C
Ω	125	7D
Σ	126	7E
μ	127	7F
π	128	80
°	129	81

PRODUCTS & CUSTOMER SUPPORT

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- *for the following industries:*
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- *Zirconia Oxygen Analyzers, Katharometers, Hydrogen Purity and Purge-gas Monitors, Thermal Conductivity*

Customer Support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

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United States of America

ABB Inc.
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Fax: +1 (0) 775 850 4808

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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The Company's policy is one of continuous product improvement and the right is reserved to modify the information contained herein without notice.

Printed in UK (02.08)

IM/SR100A Issue 2

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