4181/4250

180/250 mm Chart Recorders

Serial Communications Manual

EUROTHERM

Invensys
An Invensys company

Communications Manual

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COMMUNICATIONS

1 INTRODUCTION

This manual is intended as an aid to those involved in the installation and operation of a serial communications link between one or more chart recorders (or I/O racks) and a host computer.

Section 2 describes the physical installation of a communications option and its hardware set-up and wiring.

Section 3 describes host communications protocol emulation of the 4001 communications protocol allowing customers with model 4001 recorders to transfer their communications programs to more modern recorders without difficulty.

Section 4 deals with the Gould Modicon Modbus RTU protocol.

Section 5 gives a procedure for XMODEM file transfers, for saving and restoring recorder configurations.

2 INSTALLATION

The communications option is in two versions. The original version has a 25-way D-type connector, whilst the newer (isolated) version has two 9-way D-type connectors - one plug; one socket. Before installation is carried out, it is recommended that the links on the circuit board be checked against figure 2.3.4 to ensure correct positioning.

2.1 INSTALLATION OF ORIGINAL VERSION (OLDER 250MM RECORDERS ONLY)

This section describes the installation of the communication option in the box located at the rear of the recorder. For those recorders already fitted with the option, this section may be ignored.

CAUTION

THE CIRCUIT BOARD INCLUDED AS A PART OF THE KIT CONTAINS COMPONENTS WHICH ARE SENSITIVE TO STATIC ELECTRICAL DISCHARGE. ALL RELEVANT PERSONNEL SHOULD BE AWARE OF STATIC HANDLING PROCEDURES. IF IN DOUBT, CONSULT THE RELEVANT SECTIONS OF EITHER THE INSTALLATION AND OPERATION MANUAL OR OF THE TECHNICAL MANUAL.

The communications option kit consists of a circuit board, two screws and two labels. The installation procedure is as follows. Reference should be made to figures 2.1a and 2.1b as required.

a. Remove the battery cover, retaining it and its securing screws for later re-assembly.
b. Remove the communications box by removing the two securing nuts. Retain these nuts and their associated shake-proof washers for use in re-assembly.
c. Knock out the three slots in the box.
d. Fit the labels supplied
e. After taking precautions against static discharge, screw the circuit board to the box.
f. Plug the assembled box into the connector at the rear of the recorder.
g. Fix the box to the recorder using the nuts and shake-proof washers previously removed.
h. Refit the battery cover.
i. Select RS232 or RS422/485 (section 2.1.1 below), then carry out an autoconfigure as described in the installation and operation manual supplied with the recorder.

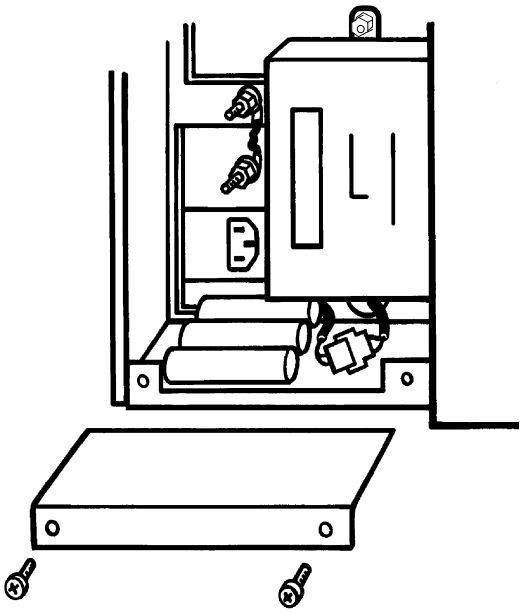


Figure 2.1a Battery cover and communications box location

2.1 INSTALLATION OF ORIGINAL VERSION (Cont.)

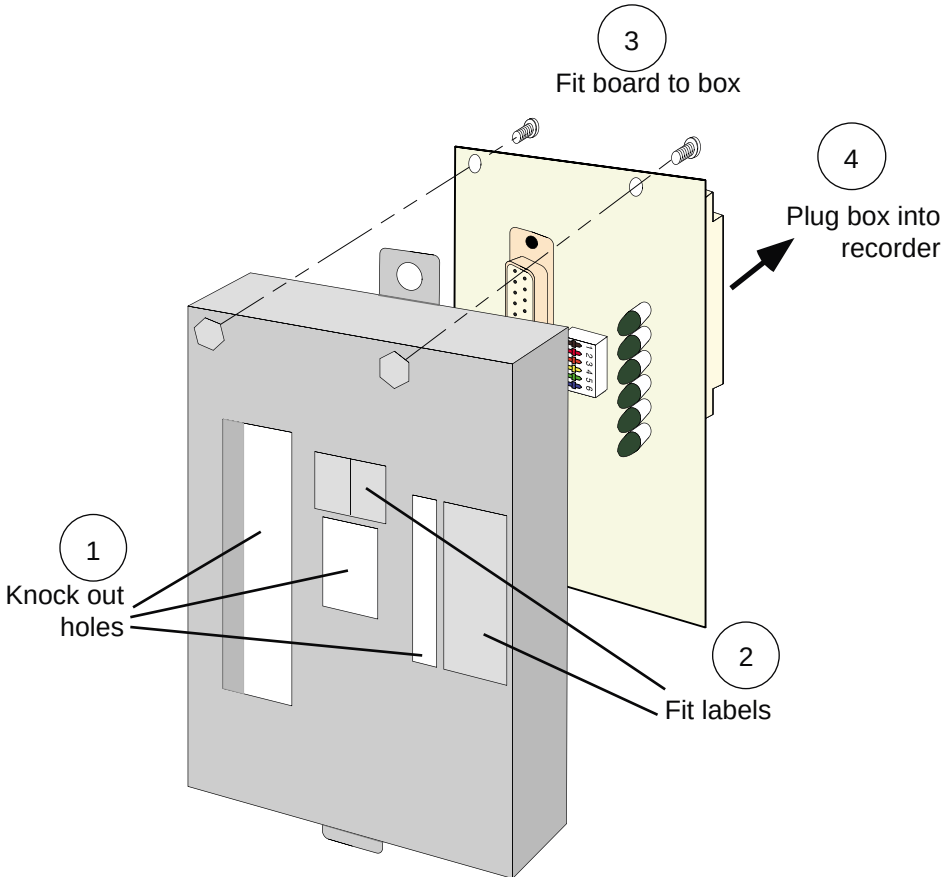


Figure 2.1b Communications option assembly

2.1.1 Mode selection

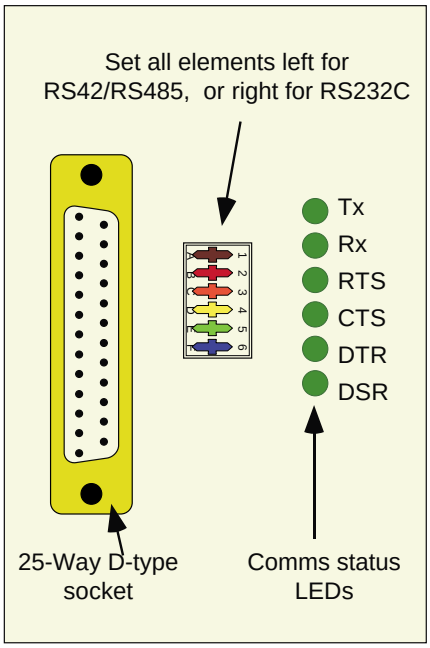


Figure 2.1.1
Communications set-up switches

The communications can be set to RS232 or RS422/RS485 by sliding all the elements of the DIL switch to the right (RS232) or to the left (RS422/485).

In RS232 mode, the LEDs show their stated functions. The LEDs are off when the relevant lines are idle, and are illuminated when they are active.

In RS422/485 mode, only the transmit (Tx) and receive (Rx) LEDs are operative. These LEDs are off when the lines are at idle, and are illuminated when they are active.

The pin allocations for RS422/485 and RS232 are shown in section 2.3.1 below.

Note: Four wire (TXA/B, RXA/B) RS485 is supported; two wire RS485 is not supported.

2.2 ISOLATED VERSION INSTALLATION

2.2.1 Installation for 250 mm recorders

MULTIPOINT RECORDERS

With the recorder isolated from hazardous voltages, remove the battery cover and dummy comms box (if fitted) as described in section 2.1 instructions 'a' and 'b'. Fit the comms module supplied with the kit, ensuring that the connector is correctly mated before tightening the fixings and replacing the battery cover.

Re-apply power to the recorder, switch on and carry out an Autoconfigure, as described in the installation and operation manual supplied with the recorder.

CONTINUOUS TRACE RECORDERS

With the recorder isolated from hazardous voltages, take the ribbon cable supplied with the kit, and plug it into the header on the comms module circuit board.

Pass the ribbon cable through the slot in the rear of the recorder, then secure the comms module to the recorder using two nuts.

Open the recorder door and release the writing system by undoing the two captive screws (fig 2.2.1a)

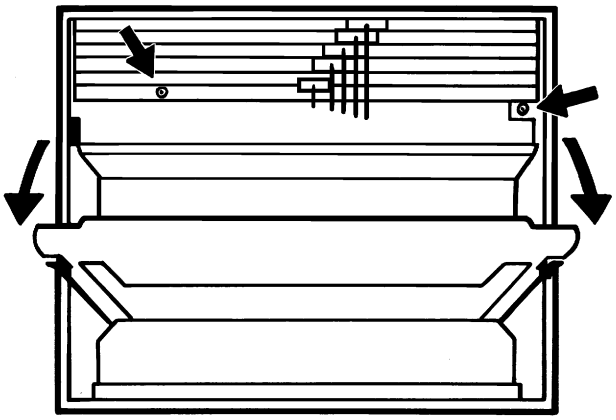


Figure 2.2.1a Writing system securing screws

Pull the writing system forwards until access can be gained to the control board mounted at the rear.

Plug the free end of the ribbon cable into CON 3 on the control board (figure 2.2.1b).

Return the writing system to the case and secure it, using the two captive screws.

Set the comms module to RS232 or RS422/485 as described in section 2.2.3.

Re-apply power to the recorder, switch on and carry out an Autoconfigure, as described in the installation and operation manual supplied with the recorder.

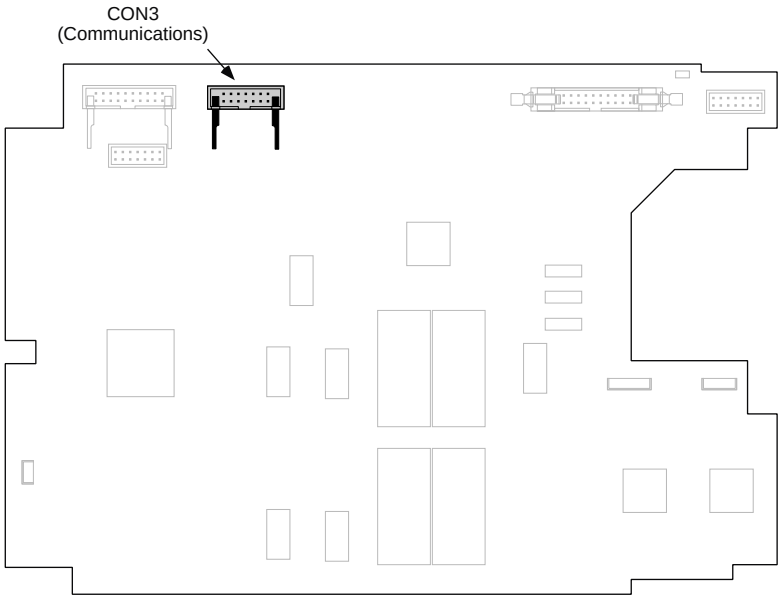


Figure 2.2.1b Communications connector location

2.2.2 Installation for 180 mm recorders

CAUTION

THIS UPGRADE INVOLVES THE HANDLING OF COMPONENTS WHICH ARE SENSITIVE TO STATIC ELECTRICAL DISCHARGE. ALL RELEVANT PERSONNEL MUST BE AWARE OF STATIC HANDLING PROCEDURES. IF IN DOUBT, REFERENCE SHOULD BE MADE TO THE INSTALLATION AND OPERATION MANUAL OR THE TECHNICAL MANUAL.

1. Isolate the recorder from all high voltage sources (both supply and signal)
2. Open the recorder door (by lifting the bottom of the catch, and then turning it clockwise) For convenience, remove the chart and print cartridge.
3. With the cassette open, Release the writing system by undoing the captive screws ('A' in figure 2.2.2a)
4. Pull the writing system forwards until it reaches its stops.
5. Lift the writing system out of the case, releasing the various connectors as they become accessible (figure 2.2.2b).
6. Release the Power supply unit from the front, using screws 'B' in figure 2.2.2b, then from the back, by removing the safety earth (nut 'C' in figure 2.2.2c) and securing screw 'D'.

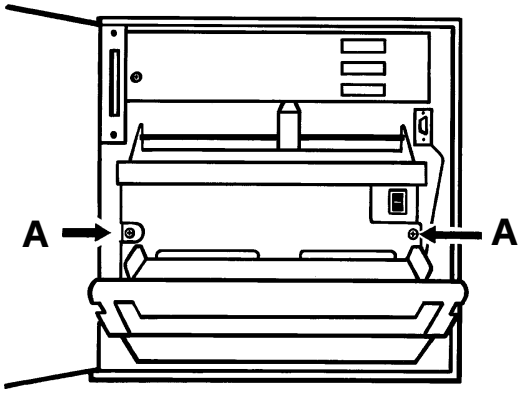


Figure 2.2.2a
Writing system securing screws

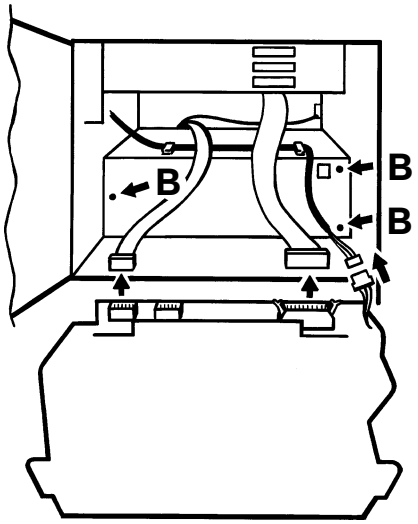


Figure 2.2.2b Writing system removal and PSU securing screw locations

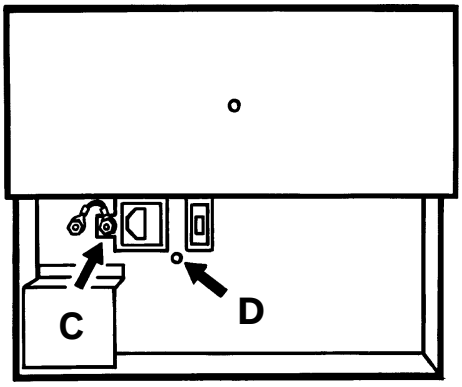


Figure 2.2.2c
PSU release (rear view)

7. Disconnect the battery pack as shown in figure 2.2.2d
8. Rotate and lift out the power supply as shown in figure 2.2.2e, carefully avoiding damage to the battery pack connector.

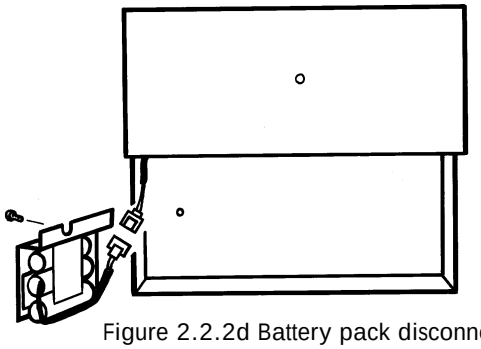


Figure 2.2.2d Battery pack disconnection

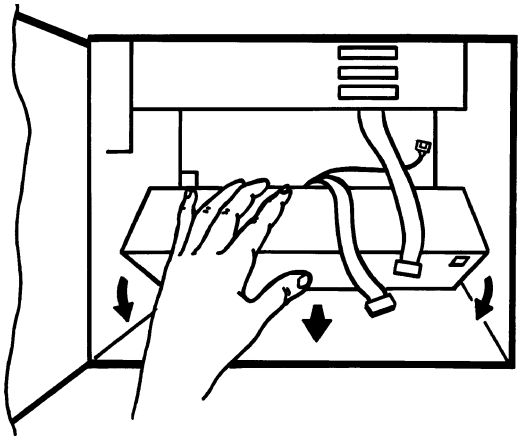


Figure 2.2.2e PSU removal

2.2.2 INSTALLATION FOR 180mm RECORDERS (Cont.)

9. Fit the plastic cable clip as shown in figure 2.2.2f.
10. At the rear of the recorder, remove the blanking plate, and fit the communications module (figure 2.2.2g).
11. Feed the communications module ribbon cable across the inside back of the recorder, secure it with the clip, then fold the cable back on itself and make a right angle turn upwards (figure 2.2.2f).
12. Re-fit the power supply unit, and ensuring that the battery pack connector is passed through its aperture, secure it at the front and at the back, using the four screws and safety earth nut previously removed. **ENSURE THAT THE SAFETY EARTH IS SECURELY TERMINATED.**
13. Return the writing system to the case, ensuring all the connectors are re-made.
14. Re-apply power to the recorder, and carryout an Autoconfigure as described in the Installation and Operation manual suppled with the recorder.

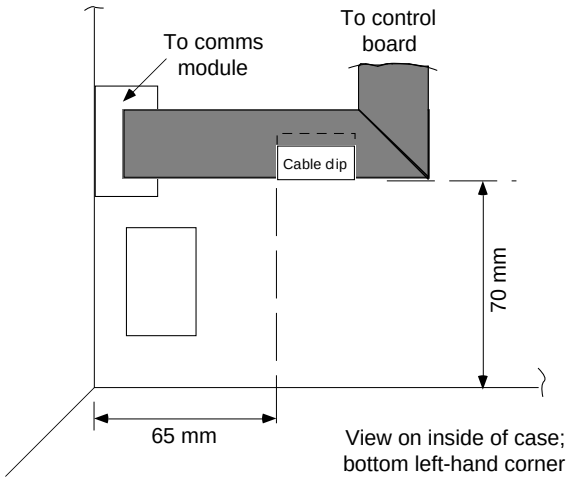


Figure 2.2.2f Cable clip location

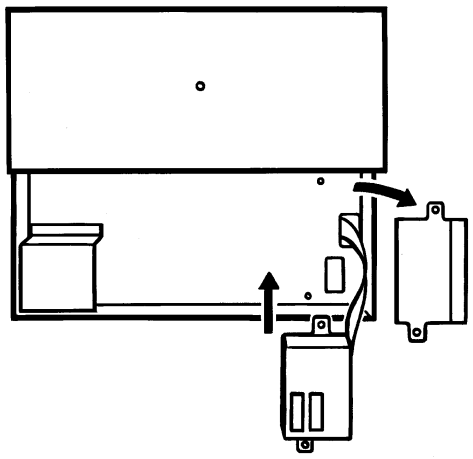


Figure 2.2.2g Comms module fitting

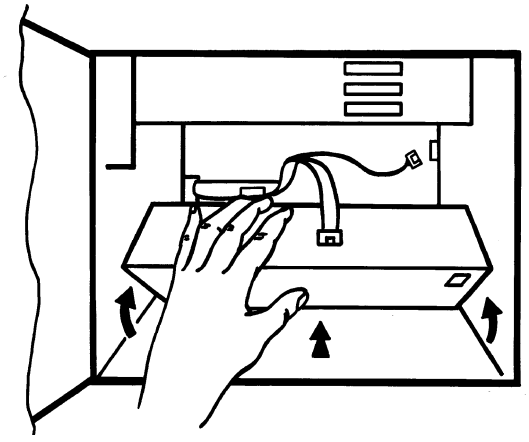


Figure 2.2.2h Routing cables and returning the PSU

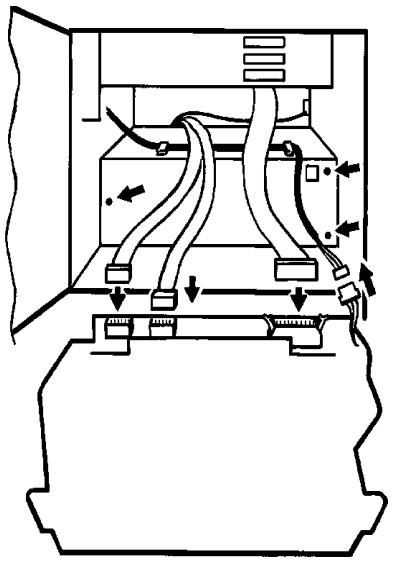


Figure 2.2.2i Communications connector location

2.2.3 Mode selection

Once physical installation is complete, the communications mode should be set up as RS232 (Single drop) or RS422/RS485 (Multiple drop) before electrical connections are made.

The selection of communications mode is made by setting ALL of the switches located between the two 9-way D-types up for RS232 or down for RS422/485*, as shown on the communications module label.

* The module is mounted 'sideways' on Graphics Display Units. The switches should be set left for RS232 or right for RS422/485.

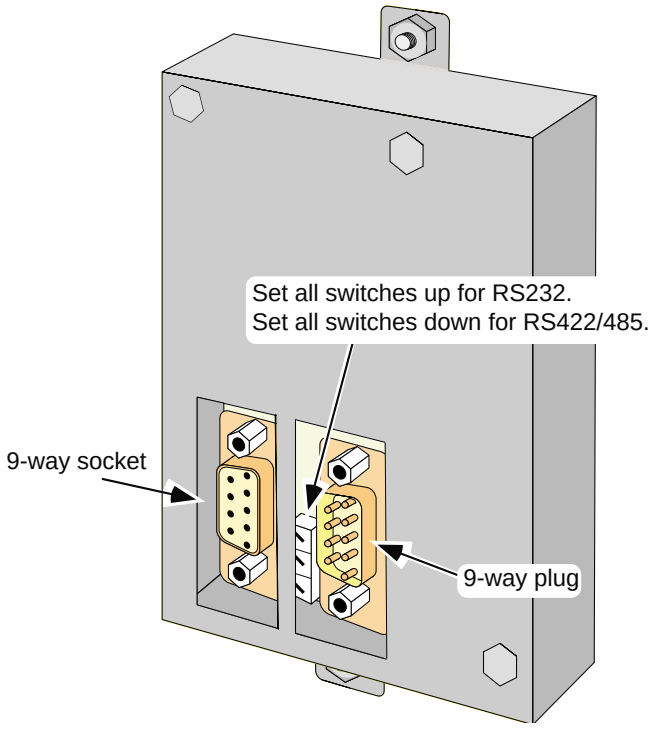


Figure 2.2.3 Set-up switch locations (isolated version)

2.3 COMMUNICATIONS WIRING

2.3.1 Original version

The serial link is implemented using a 25-way D-type (fixed socket) connector. Table 2.3 gives pin-out information for RS232C and for RS422/485. Recorder Tx should be connected to the host Rx and *vice-versa*.

2.3.2 Isolated version

Tx should be connected to Rx at the host and vice-versa.

The serial link is implemented using two 9-way D-type connectors. For non-graphics instruments set to RS422/485, the two connectors are wired in parallel for easy 'daisy-chaining' in multi-drop applications. For non-graphics instruments set to RS232, and for all data acquisition racks, only the 'male' connector (plug) is to be used.

See the graphics unit manual for graphics recorders/display units details.

Note: The signal ground MUST be earthed at one point (only) in the link.

2.3 COMMUNICATIONS WIRING (Cont.)

Isolated Comms
(2 x 9-way D-types)

Pin	Function
1	5V (1k0)
2	RX
3	TX
4	DTR
5	Signal ground
6	DSR
7	RTS
8	CTS
9	Not connected

RS232 Pin out
(Switches up)
(Fixed plug only)

Pin	Function
1	5V (1k0)
2	TXA
3	TXB
4	Not connected
5	Signal ground
6	Not connected
7	RXB
8	RXA
9	Not connected

RS422/485 Pin out
(Switches down)
(Plug or socket)

Comms pinouts for current recorders and I/O (data acquisition) racks.
(I/O racks may use only the fixed male connector (plug) for the serial link)

RS232 Terminations

5v*	Rx	Tx	DTR	0V	DSR	RTS	CTS

RS232 available with upper
connector only (all switches left)

RS422/485 Terminations

5v*	TxA	TxB	NC	0V	NC	RxB	RxA

Lower connector always RS422/485.
Upper connector selectable RS232
(all switches left) or RS424/485
(all switches right)

Comms pinouts for Graphics Display Units

Non-Isolated Comms
(25-way D-type)

Pin	Function
1	Protective ground
2	TX
3	RX
4	RTS
5	CTS
6	DSR
7	Signal ground
19	5V (1k0)
20	DTR

RS232 Pin out
(Switches right)

Pin	Function
1	Protective ground
2	TXB
3	TXA
4	RXB
5	RXA
6	Not connected
7	Signal ground
19	5V (1k0)
20	Not connected

RS422/485 Pin out
(Switches left)

Comms pinouts for previous recorder versions

Table 2.3 Communications module pinouts

2.3.3 Termination and biasing (not RS232)

If the communications line is left open-ended, the end of the cable acts as a reflector, returning what can appear to be 'true' data signals back down the line. A receiver cannot distinguish between 'true' and reflected data, with the result that the 'true' data is corrupted.

In order to avoid this, a termination resistor is fitted across the line at the final instrument. If the value of this resistor is equal to the characteristic impedance of the cable (120 Ohms in this case), then the line appears to be of infinite length and no reflections occur. Such a value however, does not give the best signal-to-noise ratio, so a compromise value (220 Ohms) is chosen to give the optimum performance in reducing unwanted reflections and in improving the signal-to-noise ratio.

The recorder communications port is terminated as shown in figure 2.3.3a, below. In a single point-to-point application, it may be necessary to terminate the instrument with a 220Ω resistor. In multi-drop systems, only the final unit should be terminated in this way, otherwise the transmitted signal levels may be reduced to an unacceptable level.

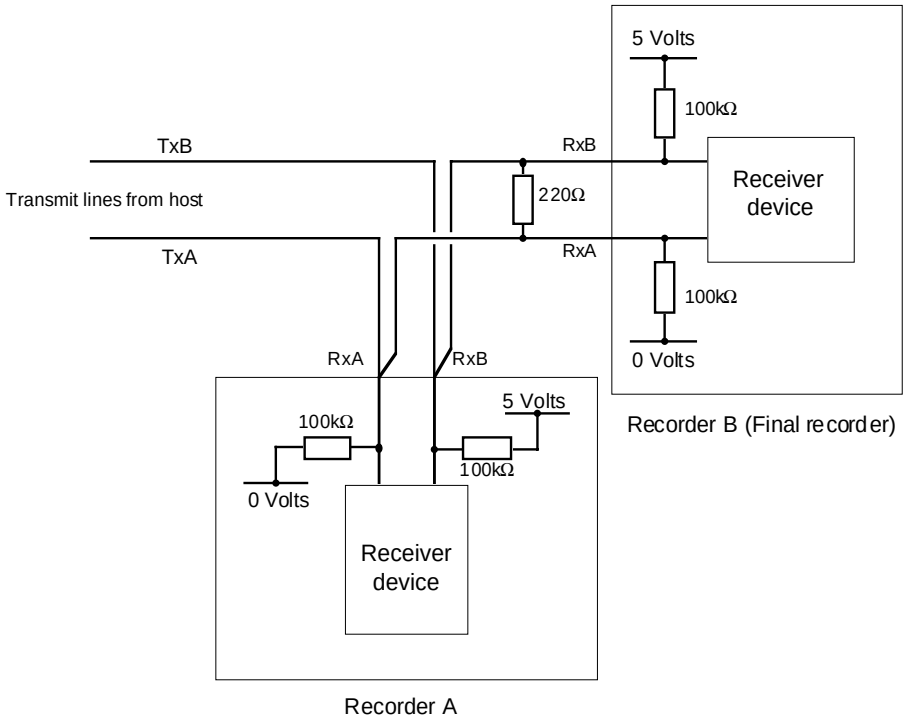


Figure 2.3.3a System termination and biasing

HOST COMPUTER

When not communicating, the instrument outputs go to a high-impedance state to allow multi-drop connection. This will cause a problem if the host computer is not fitted with biasing resistors to pull these essentially open circuit lines to their idle states as defined for the RS422/RS485 standards. To overcome such problems, external biasing resistors can be fitted as shown in figure 2.3.3b (a) below.

With long cable runs it may also be necessary to terminate the transmission line. Figure 2.3.3b (b) shows how this may be done using external biasing resistors. Such a circuit is for use where the host receiver does not have its own internal biasing arrangements. Where the host does have its own internal biasing, the fitting of a 220Ω resistor across the receive inputs (figure 2.3.3b (c)) will terminate the line correctly.

2.3.3 TERMINATION AND BIASSING (Cont.)

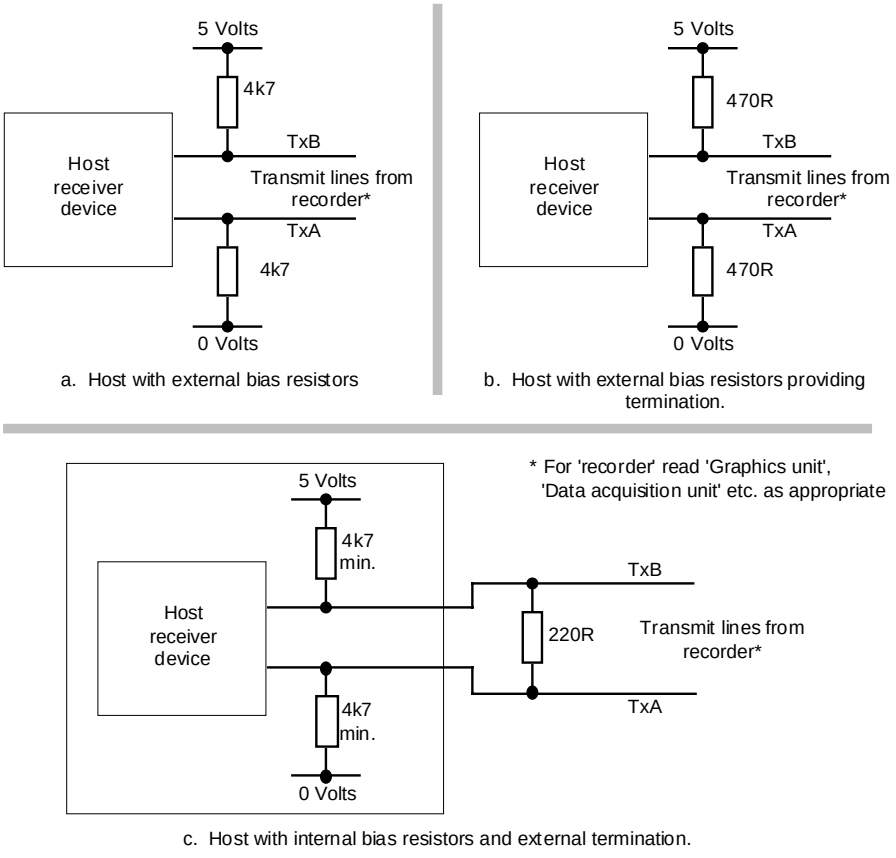
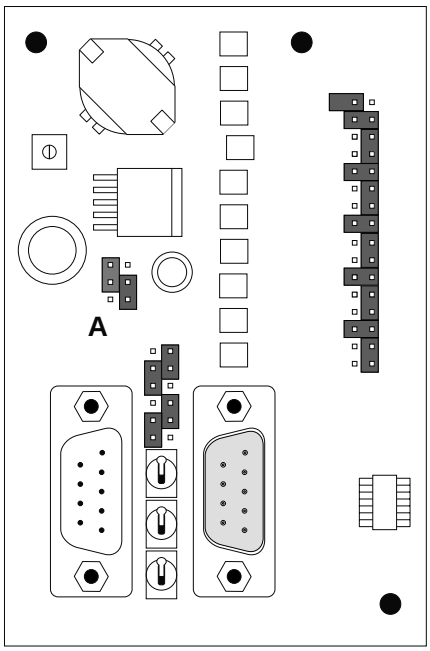


Figure 2.3.3b Host computer termination and biasing

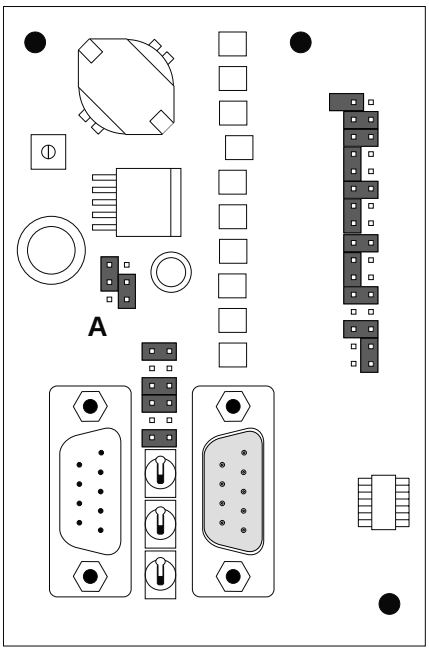
2.3.4 On-board links

When retro-fitting or replacing a communications board, a number of links need to be correctly set. The positions of these links depends on the model as shown in the sketches below. The sketches show an issue 2 board. Issue 1 boards are similar, but do not have links at 'A'. This is important only for I/O rack users.

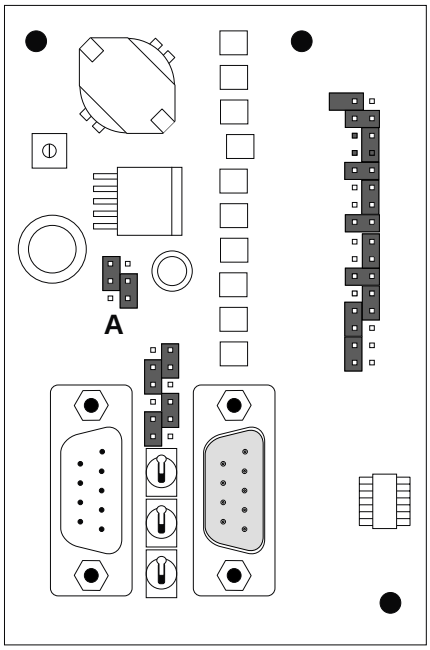
The communications link is set to RS232 by setting all the toggle switches up (as shown in the figures) or to RS422/485 by setting all the switches down.



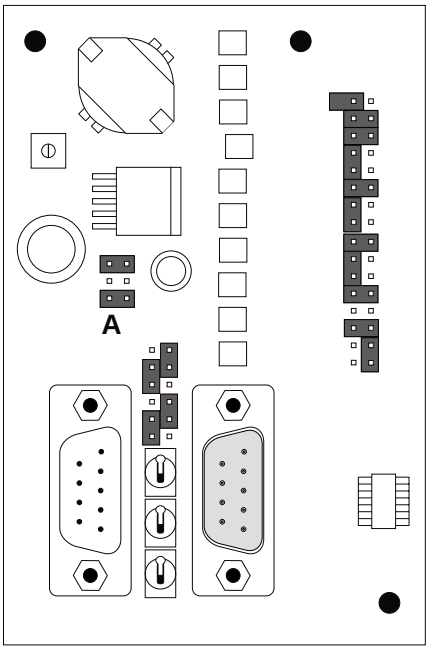
180mm graphics recorder (U100)
250mm graphics recorder (U200)



180/250mm continuous trace recorder (U100)
180mm multipoint recorder (U100)
250mm Multipoint recorder (U200)



Graphics display unit (U200)



I/O (Data acquisition) rack (U200)

Figure 2.3.4 Communications board link positions

2.4 HARDWARE CONFIGURATION

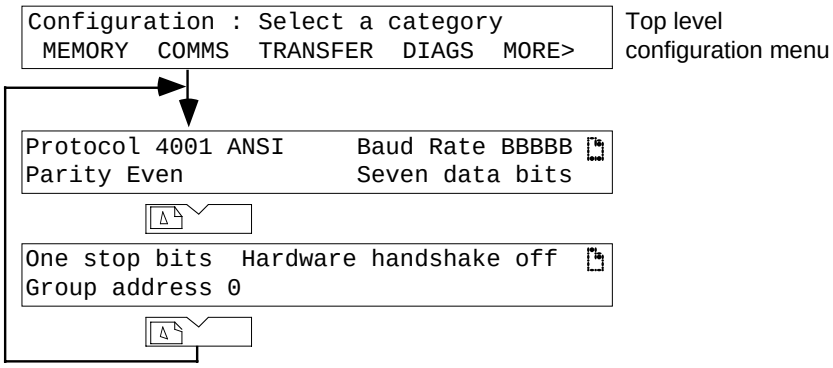


Figure 2.4 Communications configuration

2.4.1 Communications parameters

Protocol	4001 ANSI*	Uses ASCII codes, including control codes (e.g. STX)
	4001 ASCII*	Uses ASCII codes, but control codes are replaced by printing characters (See section 3.1.2 below).
	MODBUS	RTU protocol. Fixed data bits = 8; No handshake.
Baud Rate	110 to 19,200	Scrollable 19,200, 9,600, 4,800, 2,400 1,200, 600, 300, 110
Parity	Odd, even, none	Allows parity to be set.
Data Bits	7, 8	Eight bits required for 'special' characters Hex 80 to E2 in table 3.7.
Stop bits	1, 2	Allows the number of stop bits to be set.
H/W Handshake	On/Off	Enables / Disables handshake.
Group Address	0 to 7	Group address (G) used as a part of the 4001 channel address.
Address	1 to 247	Gould Modicon address

* 4001 ASCII and 4001 ANSI protocols may not be applicable to all recorder models.

2.4.2 Handshake

Handshake is not applicable to MODBUS protocol.

HARDWARE HANDSHAKE

Hardware handshake operates with three signals CTS, RTS and DTR. DSR is ignored by the recorder.

When hardware handshake is 'ON', DTR and RTS outputs are set to their 'ON' condition (voltage +'ve) when the instrument is capable of communication. These signals will therefore be off during power up / initialisation etc. The CTS input high to the instrument enables its transmitter.

When hardware handshake is set 'OFF' DTR and RTS are set to their OFF states (voltage -'ve). The CTS input is ignored.

SOFTWARE HANDSHAKE

XON/XOFF handshaking is implemented in ASCII mode only (section 3.1.2). On receipt of XOFF (ASCII hex 13) the recorder will stop transmitting at the end of the current character, and will not re-start transmission until it receives XON (ASCII hex 11). All bytes received between XOFF and XON are ignored. Multiple XONs are ignored. The instrument does not generate XON or XOFF.

3 MODEL 4001 COMMUNICATIONS

Note: 4001 communications protocols may not be available on all Models.

3.1 COMMUNICATIONS PROTOCOLS

3.1.1 ANSI

This is an implementation of the ANSI standard ANSI - X3.28 - 2.5 - A4 and specifies two modes: POLLING (for reading values from an instrument), and SELECTING (for writing values to an instrument).

POLLING

The sequence of bytes sent to the instrument in order to read a value is:

<EOT>[G][G][U][U][CA][C1][C2]<ENQ>

Where:

G	is the Group Address set up in the communications configuration.
U	is a 'Logical Unit' number, associated with up to eight channel addresses.
CA	is a channel address within the logical unit.
C1C2	is the two character mnemonic which defines the parameter to be read.

See table 3.2 for U and CA allocations, and tables 3.4.1, 3.4.2 and 3.4.3 for a mnemonic / parameter cross reference.

In response to such a polling message, the instrument will reply with one of the following:

POLL COMPLETE MESSAGE

<STX>[CA][C1][C2][D1][D2.....DN]<ETX>[BCC]

Where D1 to DN is the N byte value of the polled parameter. The number of bytes required is a function of the particular parameter polled. BCC is a block check control character which is the result of exclusive ORing bytes [CA] to <ETX> inclusive. After a POLL COMPLETE message, the host can respond with <NAK> (which causes re-transmission of the parameter previously polled), <ACK> (which polls the next parameter in the poll list (see section 3.6)), or with a complete new polling message.

POLL INCOMPLETE MESSAGE

<STX>[CA][C1][C2]<EOT>

This indicates that there was an error in the polling message. The host must send a complete new polling message in order to access the parameter (i.e. sending <ACK> or <NAK> does not have any effect).

NO RESPONSE

The polling message was not recognised.

3.1 COMMUNICATIONS PROTOCOL (Cont.)

SELECTION

The sequence of bytes sent to the instrument in order to write a value to a parameter is:

<EOT>[G][G][U][U]<STX>[CA][C1][C2][D1][D2.....DN]<ETX><BCC>

Where:

G	is the Group Address set up in the communications configuration.
U	is a 'Logical Unit' number, associated with up to eight channel addresses.
CA	is a channel address within the logical unit.
C1C2	is the two character mnemonic which defines the parameter to be read.
D1 to DN	is the N-byte value to be written to the parameter.
BCC	is a block check character calculated by exclusive ORing bytes CA to ETX inclusive.

See table 3.2 for U and CA allocations for current recorders and tables 3.4.1, 3.4.2 and 3.4.3 for a mnemonic / parameter cross reference.

In response to such a selection message, the instrument will reply with one of the following:

SELECTION COMPLETE MESSAGE
The instrument responds with a single <ACK>. The host may now re-enter the selection procedure after <STX> and write a new [CA] to <BCC> message, providing that the new parameter is in the same logical unit as the last one (i.e. [G] and [U] are the same). Alternatively, the host can send a complete new selection message.

SELECTION INCOMPLETE MESSAGE
The instrument responds with a single <NAK>, indicating that there was an error in the selection message. The host must send a complete new selection message (i.e. it may not re-enter after STX)

NO RESPONSE
The selection message was not recognised.

3.1.2 ASCII

This mode is intended for use with simple micros, or 'dumb' terminals, which are unable to transmit ASCII control characters and / or having no hardware handshake. The non-printing control codes are replaced with 'printing' characters as shown in table 3.1.2 below. BCC is omitted, since it might easily be one of the control codes 22 to 26 or 28. XON/XOFF handshaking is supported. In all other respects, the protocol is the same as the ANSI mode, described above.

Control character definition	ANSI standard character	Hex code	Printing character	Hex code
Start of text	STX	2	"	22
End of text	ETX	3	#	23
End of transmission	EOT	4	$	24
Enquiry	ENQ	5	%	25
Acknowledge	ACK	6	&	26
Negative acknowledge	NAK	15	(	28

Table 3.1.2 Printing and non-printing codes

3.2 PARAMETER ADDRESSING

The protocol uses a three element address: Group Address (G) (0 to 7), set up in the communications configuration to identify one of up to eight recorders on a multi-drop link; Logical Unit Address (U) and Channel Address (CA). The recorder can have up to 16 logical units (LUs) associated with it according to the model number. LU 0 is used to access instrument, alarm and control mnemonics. In such cases, the channel address is irrelevant, but a valid CA (0 to F) must still be included in the polling/selecting messages.

As can be seen from table 3.2 below, logical units can have up to 16 associated channel addresses (CAs). For example, to access Measuring Channel 28, the logical unit address (U) would be 7, and CA would be 3. To access Derived Channel 28, the LU address would be 'C' and the CA would be 3.

		LOGICAL UNIT ADDRESS (U)														
		1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
CHANNEL ADDRESS (CA)	0	1	5	9	13	17	21	25	29	D1	D9	D17	D25	D65	D73	D81
	1	2	6	10	14	18	22	26	30	D2	D10	D18	D26	D66	D74	D82
	2	3	7	11	15	19	23	27	31	D3	D11	D19	D27	D67	D75	D83
	3	4	8	12	16	20	24	28	32	D4	D12	D20	D28	D68	D76	D84
	4	33	36	39	42	45	48	51	54	D5	D13	D21	D29	D69	D77	D85
	5	34	37	40	43	46	49	52	55	D6	D14	D22	D30	D70	D78	D86
	6	35	38	41	44	47	50	53	56	D7	D15	D23	D31	D71	D79	D87
	7	57	66	75	84	93				D8	D16	D24	D32	D72	D80	D88
	8	58	67	76	85	94				D33	D41	D49	D57	D89	D97	
	9	59	68	77	86	95				D34	D42	D50	D58	D90	D98	
	A	60	69	78	87	96				D35	D43	D51	D59	D91	D99	
	B	61	70	79	88					D36	D44	D52	D60	D92		
	C	62	71	80	89					D37	D45	D53	D61	D93		
	D	63	72	81	90					D38	D46	D54	D62	D94		
	E	64	73	82	91					D39	D47	D55	D63	D95		
	F	65	74	83	92					D40	D48	D56	D64	D96		

Table 3.2 Logical unit and channel addresses

3.3 DATA FORMATS

Current recorder protocol specifies a variable number of data bytes, according to the parameter being accessed. Three basic formats are used:

3.3.1 Hexadecimal (Hex)

Five data bytes are transmitted in the form >HHHH where > must always be present, followed by four hex bytes (H in the example). The data transferred may represent a single parameter, or a group of parameter values packed into a 16-bit word and then Hex encoded.

3.3.2 Decimal (Floating point)

Five data bytes are transmitted in on of the following formats according to decimal point position and whether the value is positive (use decimal point) or negative (use – sign).

DDDD.	DDDD–
DDD.D	DDD–D
DD.DD	DD–DD
D.DDD	D–DDD
.DDDD	–DDDD

3.3.3 Character

A string of hex data bytes, the number of bytes being defined for each relevant parameter.

3.4 MNEMONICS

The tables which follow, give an alphabetic list of mnemonics with definitions, formats etc. in the following groups. All mnemonics must be in CAPITAL letters. 4001 mnemonics which are not emulated are not included in the tables. In such cases, selection will be ignored, and polling will always return the value 0.

Channel mnemonics (see table 3.4.1)	
CF	Channel flags *
CJ	External CJ temperature.
DH	Output signal high value.
DL	Output signal low value.
EU	Engineering units and print zone.
FH	Function high value.
FL	Function low value.
IL	Input signal low value.
IH	Input signal high value.
LG	Legend string.
LN	Legend number.
MV	Measured value in hex.
NA	Number of alarms assigned.
OC	Constant output value
OF	Offset value
OH	Scale high value.
OL	Scale low value.
OS	Output source configuration†
PV	Process variable (Measured value scaled to engineering units).
SH	Shunt value.
ST	Channel status.

* Channel Flags are:	
CJ type	Scale print enable
Function engineering units	Scale type
Interpolation enable	Trace skip
Linearisation (function) type	Output type

† Output source configuration contents:	
Error drive	Source Channel number
Source type	Value format

Alarm mnemonics (see table 3.4.2)	
A1	Alarm type, hysteresis, average.
A2	Alarm sense, alarm status, rate-of-change alarm period.
A3	Set point as a proportion of channel scale.
A4	Deviation, rate-of-change change value.

Instrument mnemonics (see table 3.4.3)	
BN	Batch number
CS	Chart speeds A and B (See also IF)
DY	Day number
ER	Serial link communications errors
HR	Hours
IF	Instrument flags (Current chart speed, Date format, Internal CJ units)
II	Instrument identifier
IS	Instrument alarm and printer on/off-line flags
L1/2/3	User linearisation tables
MI	(Not M1) Minutes
MO	Month number
M2/3	Mode 2(3) log interval A
PM	Print mode

(Continued)

Instrument mnemonics (continued)

PT	Text string to be printed
RJ	Remote CJ mode (Software versions 3.12 onwards)
SC	Slot configuration
SE	Seconds
T0	Single Remote CJ configuration (Software versions 3.12 onwards)
T1 to Tn	Multiple remote CJ configurations for input boards 1 to n (Software versions 3.12 onwards)
VN	Communications software version number
XT	Enter XModem mode
XE	Modem error code
YR	Year

3.4.1 Channel mnemonics

NOTES:

1) Channel parameter updates are loaded into a buffer, until an EC mnemonic is received. The checks listed below are then carried out, and if the update is valid, it is loaded into the recorder's data base and an ACK is returned. If the update is not valid, the buffer content is discarded and a NAK is returned.

a) OL ≠ OH
b) IL < IH
c) FL < FH
d) Linearisation type is valid for the input type.
e) Output channel is fitted
f) Output channel source exists.
g) 4-digit value format selected for constant output channel
h) DL < DH
i) Output channel constant ≥ 0

2) Further checks are carried out as a background task. This means that an 'ACK' may be returned, as described above, even if one of these checks (listed below) fails, causing the channel not to measure. It is recommended therefore, that a read of channel status (ST -ref. table 3.4.1) is made, 10 seconds (minimum) after an EC has been written, to establish that all the checks have passed. The background checks are as follows:

a) Linearisation limits are not exceeded .
b) External cold-junction lies within the linearisation limits.
c) Maximum input range is not exceeded.

3.4.1 CHANNEL MNEMONICS (Cont.)

Input channels

Mnemonic	Format	Bits	Definition	Permission wrt host
CF	Hex		CHANNEL FLAGS	
		0	SCALE PRINT FLAG ..... R/W Select: Sets scale type A off (0) or automatic (1) Poll: 0 = Scale type A off; 1 = Auto or customised	
		1	Not used	
		2	TRACE SKIP FLAG ..... R/W Select: 0 = Trace on; 1 = Trace off Poll: 0 = Trace on or conditional; 1 = Trace off	
		3	INTERPOLATION ENABLE (1 = on; 0 = off) ..... R/W	
		4 & 5	Not used	
		6 & 7	COLD JUNCTION TYPE ..... R/W 0 = Off 1 = Internal 2 = External 3 = Remote For software versions prior to 3.12, Bits 6/7 are defined as follows: 0 = Off, 1 = Internal, 2 = External (if polling, 2 = External or Remote)	
		8 to 11	LINEARISATION TYPE ..... R/W 0 = Thermocouple type B 1 = Thermocouple type E 2 = Thermocouple type J 3 = Thermocouple type K 4 = Thermocouple type R 5 = Thermocouple type S 6 = Thermocouple type T 7 = Pt100 (100Ω platinum resistance thermometer) 8 = mV (Square root extraction) 9 = Volts / linear A = mv (linear) B = Input type = comms. C = Input type = Off D to F = User linearisation tables 1 to 3 respectively	
		12 & 13	LINEARISATION TYPE ENGINEERING UNITS ..... R/W 0 = Degrees Celsius (˚C displayed) 1 = Degrees Fahrenheit (˚F displayed) 2 = Kelvins (K displayed) 3 = Rankine (R displayed)	
		14 & 15	Not used	
CJ	Hex		COLD JUNCTION TEMPERATURE	
		0 TO 15	CONTROL TEMPERATURE ..... R/W Integer 0 to 999 (Hex 0000 to 03E7)	
EU	Hex		ENGINEERING UNITS AND PRINT ZONE	
		0 to 3	PRINT ZONE A Integer 0 to 9. When polled, returns 0. 0 = 0 to 100% 5 = 50 to 100% 1 = 0 to 75% 6 = 0 to 25% 2 = 25 to 100% 7 = 25 to 50% 3 = 0 to 50% 8 = 50 to 75% 4 = 25 to 75% 9 = 75 to 100% Software version 3.17 onwards. Should the print area be more than 1% different from any of these zone limits, zone 0 is returned. E.G. 24 to 76% would be returned as zone 4, but 23 to 76% would be returned as zone 0.	
		4 to 7	INPUT SIGNAL UNITS ..... R/W Select: Ignored Poll: Returns 0	
		8 to 11	SCALE UNITS ..... R/W Ignored unless value is hex C, in which case the units string is cleared. Always returns 0.	
		12 to 15	Not used. Always returns 8	

Table 3.4.1a Input channel mnemonics (sheet 1)

3.4.1 CHANNEL MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
FH	Decimal	N/A	FUNCTION HIGH VALUE	R/W
FL	Decimal	N/A	FUNCTION LOW VALUE	R/W
IH	Decimal	N/A	INPUT HIGH VALUE	R/W
IL	Decimal	N/A	INPUT LOW VALUE	R/W
LG	Character	N/A	CHANNEL LEGEND 18–character string = 1st 18 characters of channel descriptor. When selected, original characters 19 and 20 left unchanged; When polled, characters 19 and 20 are truncated.	R/W
LN	Hex	0 to 15	LEGEND NUMBER Two digit number 0 to 99 (decimal) written to the last two characters of the descriptor. Numbers greater than 99 give two spaces. When polled, returns zero if final two characters are non-numeric.	R/W
MV*	Hex	0 to 15	MEASURED VALUE Integer F99A to 4665 (-10 to +110% of span) 0000 = Scale zero 3FFF = Full scale A000 = Invalid data 9FFF = Over range data A001 = Under range data	R/W
NA	Hex		NUMBER OF ALARMS Always returns 4	Read only
OH	Decimal	N/A	SCALE HIGH VALUE AND CHART SPAN HIGH	R/W
OL	Decimal	N/A	SCALE LOW VALUE AND CHART SPAN LOW	R/W
PV*	Decimal	N/A	PROCESS VARIABLE Measured value scaled in engineering units. Poll: -9999. = Under range or invalid 9999. = Over range Select: Values outside the current range by more than 10% which are sent to the recorder are represented as being over or under range as appropriate.	R/W
SA	Hex	0 to 15	SPAN ADJUST POINT Select: ignored; Poll: always returns 3FFF	R/W
SH	Hex	0 to 15	SHUNT VALUE Shunt value in Ohms between 1 and 65535 (Hex 0001 to FFFF) Values > 65535 = 0	R/W
ST	Hex	0 to 15	CHANNEL STATUS 0 = Configured and measuring analogue input 1 = Configured and reading comms input 2 = Channel off 5 = Input hardware capabilities exceeded 9 = Channel under range A = Channel over range B = Channel invalid 3, 4, 6, 7, 8 and C to F not used	Read only

* MV and PV may be written-to only when linearisation type (CF bits 8 to 11) is set to COMMS

Table 3.4.1a (cont.) Input channel mnemonics (sheet 2)

3.4.1 CHANNEL MNEMONICS (Cont.)

Output channels

Mnemonic	Format	Bits	Definition	Permission wrt host
CF	Hex		CHANNEL FLAGS	
		0	SCALE PRINT FLAG	R/W
			Select: Set scale type A to off (=0) or Automatic (=1)	
			Poll: 0 = Scale type A off; 1 = Automatic or customised	
		1	Not used	
		2	TRACE SKIP FLAG	R/W
			Select: 0 = trace on; 1 = trace off	
			Poll: 0 = trace on or conditional; 1 = trace off	
		3	INTERPOLATION ENABLE (1 = on; 0 = off)	R/W
		4 to 13	Not used. Always return 0	
		14 & 15	OUTPUT TYPE	R/W
			0 = Off; 1 = Voltage o/p; 2 = Current o/p	
DH	Decimal	N/A	OUTPUT LOW LIMIT (in engineering units)	R/W
			For constant channel, also sets chart span low to this value	
DL	Decimal	N/A	OUTPUT HIGH LIMIT (in engineering units)	R/W
			For constant channel, also sets chart span high to this value	
EU	Hex		PRINT ZONE	
		0 to 3	Selects print zone A Integer 0 to 9. When polled, returns 0.	
			0 = 0 to 100% 5 = 50 to 100%	
			1 = 0 to 75% 6 = 0 to 25%	
			2 = 25 to 100% 7 = 25 to 50%	
			3 = 0 to 50% 8 = 50 to 75%	
			4 = 25 to 75% 9 = 75 to 100%	
			Should the print area be more than 1% different from any of these zone limits, zone 0 is returned. E.G. 24 to 76% would be returned as zone 4, but 23 to 76% would be returned as zone 0.	
		4 to 11	Not used.	
		12 to 15	Not used. Always returns 8	
LG	Character		LEGEND STRING	R/W
			18-character string mapped onto the first 18 characters of the channel descriptor. When selected, the last two characters of the descriptor remain unchanged. When polled they are removed.	
LN	Hex		LEGEND NUMBER	R/W
		0 to 15	When selected,a two digit number 0 to 99 (decimal) written to the last two characters of the descriptor. Numbers greater than 99 give two spaces. When polled, returns zero if final two characters are non-numeric.	
MV	Hex		MEASURED OUTPUT VALUE	Read only
		0 to 15	Integer F99A to 4665 (-10 to +110% of span)	
			0000 = Scale zero	
			3FFF = Full scale	
			A000 = Invalid data	
			9FFF = Over range data	
			A001 = Under range data	

Table 3.4.1b Output channel mnemonics (sheet 1)

3.4.1 CHANNEL MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
NA	Hex		NUMBER OF ALARMS ..... Read only Always returns 4	
OC	Decimal	N/A	CONSTANT OUTPUT VALUE (in engineering units) ..... R/W	
OF	Decimal	N/A	OFFSET VALUE ..... R/W	
OH	Decimal	N/A	SOURCE SPAN HIGH VALUE (in engineering units) ..... R/W Also sets chart span high to the same value. Ignored and returns 0 for constant channels.	
OL	Decimal	N/A	SOURCE SPAN LOW VALUE (in engineering units) ..... R/W Also sets chart span low to the same value. Ignored and returns 0 for constant channels.	
OS	Hex		OUTPUT SOURCE CONFIGURATION	
		0 & 1	SOURCE TYPE. ..... R/W 0 = Input channel; 1 = Derived channel; 2 = Constant	
		2 to 8	SOURCE CHANNEL NUMBER ..... R/W Integer 1 to 96 (Hex 0001 TO 0060) Ignored and returns 0 if Constant.	
		9 to 12	OUTPUT CHANNEL DECIMAL PLACE ..... R/W 0 to F valid for source channel. Only 0 to 4 valid for constant	
			0 = XXXXX. / 4 = X.XXXX / 8 = XXXXX.XXX / C = Scientific 1 = XXXX.X / 5 = XXXXXXXX. / 9 = XXXX.XXXX / D = Time 2 = XXX.XX / 6 = XXXXXXX.X / A = XXX.XXXXX / E = Date 3 = XX.XXX / 7 = XXXXXX.XX / B = XX.XXXXXX / F = Elapsed time	
		13 & 14	ERROR DRIVE ..... R/W 0 = Drive off; 1 = Drive high; 2 = Drive low	
		15	Not used	
PV	Decimal	N/A	PROCESS VARIABLE (OUTPUT VALUE) ..... Read only Measured output value scaled in engineering units. Poll: -9999. = Under range or invalid 9999. = Over range	
SA	Hex		SPAN ADJUST POINT ..... R/W	
		0 to 15	Ignored; Always returns 3FFF	
ST	Hex		CHANNEL STATUS ..... Read only	
		0 to 15	0 = Configured and operating analogue output 2 = Channel off 5 = Output hardware capabilities exceeded 9 = Under range A = Over range 1, 3, 4, 6 to 8 and B to F not used.	
ZA	Hex		ZERO ADJUST POINT ..... R/W	
		0 to 15	Ignored; Always returns 0	

Table 3.4.1b (cont.) Output channel mnemonics (sheet 2)

3.4.1 CHANNEL MNEMONICS (Cont.)

Derived channels

Mnemonic	Format	Bits	Definition	Permission wrt host
CF	Hex		CHANNEL FLAGS	
		0	SCALE PRINT FLAG Select: Set scale type A to off (=0) or Automatic (=1) Poll: 0 = Scale type A off; 1 = Automatic or customised	R/W
		1	LEGEND PRINT ENABLE FLAG Select: ignored Poll: Scale type is off (=0) or Automatic or customised (=1)	R/W
		2	TRACE SKIP FLAG Select: 0 = trace on; 1 = trace off Poll: 0 = trace on or conditional; 1 = trace off	R/W
		3	INTERPOLATION ENABLE (1 = on; 0 = off)	R/W
		4 to 15	Not used	
EU	Hex		ENGINEERING UNITS AND PRINT ZONE	
		0 to 3	PRINT ZONE A Integer 0 to 9. When polled, returns 0. 0 = 0 to 100% 5 = 50 to 100% 1 = 0 to 75% 6 = 0 to 25% 2 = 25 to 100% 7 = 25 to 50% 3 = 0 to 50% 8 = 50 to 75% 4 = 25 to 75% 9 = 75 to 100% Software version 3.17 onwards. Should the print area be more than 1% different from any of these zone limits, zone 0 is returned. E.G. 24 to 76% would be returned as zone 4, but 23 to 76% would be returned as zone 0.	
		4 to 7	Not used	
		8 to 11	CHANNEL ENGINEERING UNITS Ignored unless value is hex C, in which case the units string is cleared. Always returns 0.	R/W
		12 to 15	Not used. Always returns 0	
LN	Hex		LEGEND NUMBER	R/W
		0 to 15	Two digit number 0 to 99 (decimal) written to the last two characters of the descriptor. Numbers greater than 99 give two spaces. When polled, returns zero if final two characters are non-numeric.	
MV	Hex		MEASURED VALUE	R/W
		0 to 15	Integer F99A to 4665 (-10 to +110% of span) 0000 = Scale zero 3FFF = Full scale A000 = Invalid data 9FFF = Over range data A001 = Under range data	
NA	Hex		NUMBER OF ALARMS Always returns 4	Read only
OH	Decimal	N/A	SCALE HIGH VALUE AND CHART SPAN HIGH	R/W
OL	Decimal	N/A	SCALE LOW VALUE AND CHART SPAN LOW	R/W
PV*	Decimal	N/A	PROCESS VARIABLE Measured value scaled in engineering units. Poll: -9999. = Under range or invalid 9999. = Over range	Read only
ST	Hex		CHANNEL STATUS	Read only
		0 to 15	2 = Channel off 7 = Configured and recording derived function 8 = Derived function becoming erroneous in real time 0, 1, 3 to 6 and 9 to F not used.	

Table 3.4.1c Derived channel parameters

3.4.2 Alarm mnemonics

NOTES...

1. Alarm parameters are accessible only with a logical unit address (U) of zero.
2. Before a new alarm can be set-up a “get alarm” mnemonic (GA) must be transmitted. Refer to section 3.5.11 for GA definition.
3. After all the data for the alarm has been set-up, an “enter alarm” mnemonic (EA) must be transmitted to cause the data to be written into the recorder’s data base.
4. When an EA is received the checks listed below are carried out, and if the update is valid, the data is loaded into the recorder’s data base and an ACK is returned. If the update is not valid, the buffer content is discarded and a NAK is returned.
5. In order to access current alarms, a ‘get alarm’ command (GA) must be transmitted in order to copy the relevant alarm’s parameters into the alarm buffer. Refer to section 3.5.11 for GA definition. After any update to the alarm an EA must be transmitted, to write the new data to the recorder’s data base
6. When using inverted scales it is important to note that the alarm sense (e.g. rising or falling) is related to the input signal, but the alarm setpoints are related to the scale.

ALARM BUFFER VALIDATION CHECKS.

a) Deviation out alarms Hysteresis < twice deviation value

3.4.2 ALARM MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
A1	Hex		ALARM PACKET 1	
		0 to 7	Not used; always return 0	R/W
		8 to 9	ALARM TYPE	R/W
			0 = Not used	
			1 = Absolute	
			2 = Deviation	
			3 = Rate-of-change	
		10 to 14	HYSTERESIS (Absolute and deviation alarms only)	R/W
			(Fixed point 0.0 to 9.5% span)	
			{Bit 14 is a binary fraction (logic 1 ≡ 1/2)}	
A2	Hex		ALARM PACKET 2	
		0	SKIP FLAG	R/W
			Poll: 0 = Alarm latched, unlatched or process;	
			1 = Alarm off	
		1	SENSE FLAG	R/W
			For absolute alarms, 1 = high; 0 = low	
			For deviation alarms, 1 = in; 0 = out	
			For rate-of-change alarms, 1 = rise; 0 = fall	
		2 to 7	Not used - always return 0 when polled	R./W
		8	ALARM FLAG (1 = alarm; 0 = no alarm)	Read only
		9	ACKNOWLEDGE FLAG	Read only
			0 = not acknowledged; 1 = acknowledged	
		10	NEEDS ACKNOWLEDGE FLAG	Read only
			0 = Does not need acknowledgement;	
			1 = Needs acknowledgement	
		11 to 13	RATE-OF-CHANGE ALARM PERIOD	R/W
			0 = 1 second 4 = 10 minutes	
			1 = 10 seconds 5 = 30 minutes	
			2 = 30 seconds 6 = 1 hour	
			3 = 1 minute	
		14 to 15	Not used - always return 0 when polled	R/W
A3	Hex		ALARM PACKET 3 (Absolute and Deviation alarms only)	
		0 to 15	SET POINT as a proportion of channel scale	R/W
			Scale low = 0000; scale high = 3FFF	
A4	Hex		ALARM PACKET 4 (Deviation and Rate-of-change alarms)	
		0 to 15	DEVIATION VALUE OR CHANGE VALUE	R/W
			(as a proportion of channel scale)	
			0000 =0.0; 3FFF = |Scale high - Scale low|	

Table 3.4.2 Alarm mnemonics

Note: Because the setpoint is a proportion of full scale, any change in scale will result in a change in the absolute value of any setpoints, deviation values or rates-of-change set up in A3 and A4 above

3.4.3 Instrument mnemonics

Notes
1. Access to instrument parameters may be gained only through the use of logical unit address 0
2. A valid (0 to F) channel address must be present, even though it is not used when accessing instrument parameters.

Mnemonic	Format	Bits	Definition	Permission wrt host
BN	Character		Poll: First eight characters of operator message 1.	R/W
			Select: Sends eight characters (pads with spaces)	
CD	Character		Not used - returns eight strings of 18 spaces each	R/W
CE	Character		Not used - returns 13 strings of five spaces	R/W
CS	Hex		CHART SPEED	
		0 to 7	Chart speed A. Integer 0 to B	R/W
		8 to 15	Chart speed B. Integer 0 to B	R/W
DY	Hex		DAY NUMBER	
		0 to 15	Integer 1 to 31 (Hex 0001 to 001F)	R./W
ER	Hex		COMMS ERROR STATUS	
			(Cleared by reading. ER holds only the last comms. error code.)	
		0 to 15	Integer 0 to 43 (Hex 0 to 2B)	Read only
			00 No error	
			01 Invalid mnemonic	
			02 Checksum error	
			03 Read attempted on write-only parameter	
			04 Write attempted on read-only parameter	
			05 Invalid unit/channel address combination	
			06 No free alarms available	
			07 Access attempted on invalid alarm record.	
			08 Invalid alarm number for this channel.	
			09 Printer buffer not empty	
			0A Invalid time parameter	
			0B Invalid instrument ID string length.	
			0C Invalid batch number string length.	
			0D Invalid channel parameter buffer	
			0E Invalid channel descriptor string length.	
			0F Invalid channel engineering units string length	

Integer	mm/hr	in/hr
0	Off	Off
1	5	0.25
2	10	0.5
3	20	1
4	30	2
5	60	4
6	120	6
7	300	10
8	600	25
9	1200	50
A	1500	5
B	User	User

Table 3.4.3a Instrument mnemonics (sheet 1)

3.4.3 INSTRUMENT MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
ER	Hex		COMMS ERROR STATUS (Cont.)	
			10 Program mode active - cannot disable	
			11 Print line too long	
			12 Invalid colour select code	
			13 Linearisation table too long	
			14 Linearisation table too short	
			15 Invalid slot configuration string length	
			16 Invalid slot configuration	
			17 Invalid print mode	
			18 Invalid paper divisions	
			19 Invalid chart speed parameter	
			1A Invalid log interval - mode 2	
			1B Invalid log interval - mode 3	
			1C Parity error	
			1D Receive overrun error	
			1E Framing error	
			1F Invalid data format	
			20 Channel number out of range	
			21 Alarm number out of range	
			22 Channel not configured for external input	
			23 Data base update pending	
			24 Protected area of RAM is not write enabled	
			25 Printer off line	
			26 Printer on line	
			27 Printer busy	
			28 No log in mode 1	
			2A No resettable channels	
			2B Input not defined for current function	
HR	Hex		HOURS ..... R/W	
		0 to 15	Integer 0 to 23 (Hex 0000 to 0017)	
ID	Character		INSTRUMENT DESCRIPTOR ..... R/W	
			Not used - always returns 24 spaces if polled	
IF	Hex		INSTRUMENT FLAGS	
		0	Not used - always returns 0 if polled	
		1	CURRENT CHART SPEED FLAG (Ref. CS) ..... R/W	
			0 = Speed A; 1 = Speed B	
		2	CHART SPEED UNITS FLAG (0 = mm/hr; 1 = in/hr) ..... R/W	
		3	DATE FORMAT (0 = dd/mm/yy; 1 = mm/dd/yy) ..... R/W	
		4 to 15	Not used - always return 0 when polled ..... R/W	
II	Hex	0 to 15	INSTRUMENT IDENTIFIER ..... Read only	
			Always returns >4001	
IS	Hex		INSTRUMENT STATUS	
		0	INSTRUMENT ALARM FLAG (1 = active) ..... Read only	
		1	PRINTER ON/OFF LINE (1 = Off; 0 = On) ..... Read only	
		2 to 15	Not used - always return 0 ..... Read only	
L1 to L3	Character		LINEARISATION TABLES ..... R/W	
			Not used. Return 'Empty' when polled.	

Table 3.4.3a (Cont.) Instrument mnemonics (sheet 2)

3.4.3 INSTRUMENT MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
MI	Hex		MINUTES	
		0 to 15	Integer 0 to 59 (Hex 0000 to 003B)	R/W
MO (Not M0)	Hex		MONTH	
		0 to 15	Integer 0 to 12 (Hex 0000 to 000C)	R/W
M2	Hex		MODE 2 LOG INTERVAL (0 = Off)	R/W
		0 to 15	Interval in minutes between timed logs (log interval A) Integer 0 to 6039 (Hex 0000 to 1797)	
M3	Hex		MODE 3 LOG INTERVAL (0 = Off)	R/W
		0 to 15	Integer 0 to 36234 (Hex 0000 to 8D8A) Poll: Log interval A in 10s of seconds Select: Truncates to a multiple of minutes	
PM	Hex		PRINT MODE	R/W
		0 to 1	Print mode (1 = trend; 2 = Text; 3 = Text only)	
		2 to 15	Not used - always return 0 when polled.	
PT	Character		TEXT TO BE PRINTED Up to 100 printable characters printed in black. Colour underlining is possible using '!n' embedded in the text string, to select colour n (see table below). Up to 10 colour selections can be embedded in one string. USE OF THE EXCLAMATION MARK (!) IS NOT ALLOWED IN A TEXT STRING EXCEPT TO DEFINE THE UNDERLINE COLOUR	Write only
RJ	Hex		REMOTE CJ (Software versions 3.12 onwards)	R/W
		0	REMOTE CJ MODE 0 = Single remote CJ used for all channels (see 'T0' below) 1 = Remote CJ channel for each input board (see 'T1 to TC' below)	
		1 to 15	Not used	
SC	Character		SLOT CONFIGURATION When polled, gives the type of board fitted at each address as: 0 (8 or 16 channel input), 6 (Relay output), D (8-channel output), E (4-channel output) or F (Empty) Byte 1 contains the type for address 1; byte 2 the type for address 2 etc. Byte 8 always returns 'F' (Empty)	Read only
SE	Hex		SECONDS	
		0 to 15	Integer 0 to 59 (Hex 0000 to 003B) MAY NOT BE WRITTEN TO	Read only
T0 (T zero)	Hex		SINGLE REMOTE CJ CONFIG (Software versions 3.12 onwards) Used only when RJ above is set to 0	R/W
		0	REMOTE CJ ENABLE 0 = Disable remote CJ channel 1 = Enable remote CJ channel	
		1 to 2	REMOTE CJ UNITS 0 = Degrees Celsius 1 = Degrees Fahrenheit 2 = Kelvins 3 = Rankine	
		3	CHANNEL TYPE 0 Input channel; 1 = Derived channel	
		4 to 10	REMOTE CJ CHANNEL ADDRESS See table 3.4.3b	
		11 to 15	Not used	

n	Underline colour	n	Underline colour
1	Red	4	Purple
2	Orange	5	Blue
3	Green	6	None

Table 3.4.3a (Cont.) Instrument mnemonics (sheet 3)

3.4.3 INSTRUMENT MNEMONICS (Cont.)

Mnemonic	Format	Bits	Definition	Permission wrt host
T1 to TC	Hex		MULTIPLE REMOTE CJ CONFIG (S/W versions 3.12 onwards)	R/W
			Used only when RJ above is set to 1	
			Note Tn = Remote CJ config. for input board with address n	
			where n = 1 to C for 250mm recorders	
			n = 1 to 6 for 180mm multipoint recorders	
			n = 1 to 4 for 180/250 mm continuous recorders.	
		0 to 15	As for T0 above	
VN	Character		VERSION NUMBER OF EMULATED 4001 SOFTWARE	Read only
			Returns:	
			7.1LE0 (no maths pack)	
			7.1LE2 (Maths pack level 1 fitted)	
			7.1LE3 (Maths pack level 2 fitted)	
XE	Hex	0 to 3	XMODEM ERROR REPORTING	Read only
			0 Transfer OK, no errors	
			1 Restore failed completely. File incompatible or comms transfer failure. Previous configuration unaffected.	
			2 Restore failed on data. Some records ignored, but restore operation mostly successful.	
			3 Restore failed on transfer - new configuration undefined.	
			16 Save operation had no reply from comms and timed out	
			32 Save operation failed before transfer was completed.	
XT	Hex		ENTER XMODEM MODE	Write only
		0 to 1	0 = as standby; 1 = as receiver; 2 = as sender	
		2 to 15	Not used	
YR	Hex		YEAR	R/W
		0 to 15	Offset from year 1900	
			Integer 88 to 188 (Hex 0058 to 00BC)	

Table 3.4.3a (Cont.) Instrument mnemonics (sheet 3)

Input channel addresses			
All recorders	Multipoint recorders only	250 mm multipoint recorders only	
00 = Reserved	21 = Channel 33	31 = Channel 49	49 = Channel 73
01 = Channel 1	22 = Channel 34	32 = Channel 50	4A = Channel 74
02 = Channel 2	23 = Channel 35	33 = Channel 51	4B = Channel 75
03 = Channel 3	24 = Channel 36	34 = Channel 52	4C = Channel 76
04 = Channel 4	25 = Channel 37	35 = Channel 53	4D = Channel 77
05 = Channel 5	26 = Channel 38	36 = Channel 54	4E = Channel 78
06 = Channel 6	27 = Channel 39	37 = Channel 55	4F = Channel 79
07 = Channel 7	28 = Channel 40	38 = Channel 56	50 = Channel 80
08 = Channel 8	29 = Channel 41	39 = Channel 57	51 = Channel 81
09 = Channel 9	2A = Channel 42	3A = Channel 58	52 = Channel 82
0A = Channel 10	2B = Channel 43	3B = Channel 59	53 = Channel 83
0B = Channel 11	2C = Channel 44	3C = Channel 60	54 = Channel 84
0C = Channel 12	2D = Channel 45	3D = Channel 61	55 = Channel 85
0D = Channel 13	2E = Channel 46	3E = Channel 62	56 = Channel 86
0E = Channel 14	2F = Channel 47	3F = Channel 63	57 = Channel 87
0F = Channel 15	30 = Channel 48	40 = Channel 64	58 = Channel 88
10 = Channel 16		41 = Channel 65	59 = Channel 89
11 = Channel 17		42 = Channel 66	5A = Channel 90
12 = Channel 18		43 = Channel 67	5B = Channel 91
13 = Channel 19		44 = Channel 68	5C = Channel 92
14 = Channel 20		45 = Channel 69	5D = Channel 93
15 = Channel 21		46 = Channel 70	5E = Channel 94
16 = Channel 22		47 = Channel 71	5F = Channel 95
17 = Channel 23		48 = Channel 72	60 = Channel 96
18 = Channel 24			
19 = Channel 25			
1A = Channel 26			
1B = Channel 27			
1C = Channel 28			
1D = Channel 29			
1E = Channel 30			
1F = Channel 31			
20 = Channel 32			

Table 3.4.3b Remote CJ Channel addressing (Mnemonics T0 and T1 to TC - table 3.4.3a)

3.5 COMMAND MNEMONICS

There are a number of mnemonics that do not directly access parameters, but which cause the serial link to perform some action. These mnemonics are write-only i.e. they must be sent as a selection message and cannot be polled.

3.5.1 Alarm acknowledge (AA)

On receipt of this mnemonic, all alarms requiring acknowledgement are acknowledged.

3.5.2 Printer on (CG)

If the printer is off line receipt of this mnemonic will turn it on and return an ACK. If the printer is already on, a NAK is returned.

3.5.3 Chart halt (CH)

No action taken. Always returns ACK

3.5.4 Printer off (CO)

If the printer is on-line, then receipt of this mnemonic causes the it to be switched off-line and an ACK is returned. If the printer is already off, a NAK is returned.

3.5.5 Chart Wind (CW)

Receipt of this command whilst the printer is off-line, causes the chart to wind forward 16 cm. at maximum speed. CW commands received whilst the printer is on-line return a NAK.

3.5.6 Data Dump (DD)

If the printer is on-line, then receipt of this command causes log1 to be printed on the chart and an ACK to be returned. If the printer is off-line then no action is taken and a NAK is returned.

3.5.7 Disable program mode (DP)

If the recorder is not in configuration mode, then the sending of 'DP' causes entry to the configuration mode to be inhibited and an ACK to be returned. If the recorder is in configuration mode, then no action is taken and a NAK is returned. Should the operator attempt to enter configuration, when it has thus been disabled, the message "Configuration access disabled by comms" will appear.

3.5.8 Enter alarm data (EA)

When alarm data is being written to the recorder, the new data is held in a temporary storage area (buffer), which is re-initialised each time new alarm data is entered. On receipt of the 'EA' mnemonic, the data in the buffer is checked, and if valid, it is written to the recorder's data base and an ACK is returned. If the data is not valid, then the buffer content is discarded and a NAK is returned.

3.5.9 Enter channel data (EC)

When channel parameters are being written to (selected), the new data is held in a temporary storage area (buffer), which is re-initialised each time a new channel is written to. On receipt of the 'EC' mnemonic, the data in the buffer is checked, and if valid, it is written to the recorder's data base and an ACK is returned. If the data is not valid, then the buffer content is discarded and a NAK is returned.

3.5.10 Enable program mode (EP)

The sending of 'EP' causes the configuration menu to be enabled regardless of its existing state. ACK is always returned.

3.5.11 Get indicated alarm data (GA)

Allows the channel number and alarm number required to be defined, as follows:

NO MATHS PACK FITTED

Bits	Definition
0 to 5	Alarm number (integer 1 to 4)
6 to 7	Not used
8 to 15	Channel number Integer 1 to 30 (Hex 0001 to 001E) = channels 1 to 30 respectively Integer 63 to 131 (Hex 003F to 0083) = channels 31 to 99 respectively

MATHS PACK FITTED

Bits	Definition
0 to 5	Alarm number (integer 1 to 4)
6 to 7	Not used
8 to 15	Channel number Integer 1 to 30 (Hex 0001 to 001E) = Measuring channels 1 to 30 respectively Integer 31 to 62 (Hex 001F to 003E) = Derived channels 1 to 32 respectively Integer 63 to 131 (Hex 003F to 0083) = Measuring channels 31 to 99 respectively Integer 132 to 198 (Hex 0084 to 00C6) = Derived channels 33 to 99 respectively

3.5.12 Get free alarm (GF)

Implemented only on model 4001

3.5.13 Chart rewind (CR)

Implemented only on model 4001

3.6 PARAMETER SCROLLING

This is a feature which allows a number of parameters to be read one after the other on receipt of an ACK after each poll. The parameters are divided into two types: Block Command and Scroll List.

3.6.1 Block parameters

If the previous command parameter was a Block Command Parameter, the recorder automatically increments the channel address within the logical unit, and transmits the value of the same mnemonic as last time, but for the new channel. The channel address is continuously incremented until it reaches its maximum value for the particular LU / CA entry combination, and is then reset to the minimum, and so on, as follows:

LU	CA sequence	LU	CA sequence
1	0, 1, 2, 3, 0, 1, 2, ...	8	0, 1, 0, 1, 0.....
1	4, 5, 6, 4, 5, 6, ...	8	2, 3, 4, 5, 6, 2, 3, 4,....
1	7, 8, 9, A, B, C, D, E, F, 7, 8, 9,....	9	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
2	0, 1, 2, 3, 0, 1, 2, ...	9	8, 9, A, B, C, D, E, F, 8, 9, A, ...
2	4, 5, 6, 4, 5, 6, ...	A	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
2	7, 8, 9, A, B, C, D, E, F, 7, 8, 9, ...	A	8, 9, A, B, C, D, E, F, 8, 9, A, ...
3	0, 1, 2, 3, 0, 1, 2, ...	B	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
3	4, 5, 6, 4, 5, 6, ...	B	8, 9, A, B, C, D, E, F, 8, 9, A, ...
3	7, 8, 9, A, B, C, D, E, F, 7, 8, 9, ...	C	0, 1, 2, 3, 4, 5, 0, 1, 2, ...
4	0, 1, 2, 3, 0, 1, 2, ...	C	6, 7, 6, 7, 6, ...
4	4, 5, 6, 4, 5, 6, ...	C	8, 9, A, B, C, D, E, F, 8, 9, A, ...
4	7, 8, 9, A, B, C, D, E, F, 7, 8, 9, ...	D	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
5	0, 1, 2, 3, 0, 1, 2, ...	D	8, 9, A, B, C, D, E, F, 8, 9, A, ...
5	4, 5, 6, 4, 5, 6, ...	E	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
5	7, 8, 9, A, B, C, D, E, F, 7, 8, 9, ...	E	8, 9, A, 8, 9, A, ...
6	0, 1, 2, 3, 0, 1, 2, ...	F	0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, ...
6	4, 5, 6, 4, 5, 6, ...		
7	0, 1, 2, 3, 0, 1, 2, ...		
7	4, 5, 6, 4, 5, 6, ...		

Table 3.6.1 Block parameter scroll sequences

3.6.2 Scroll parameters

Alarm and Instrument parameters are all scroll parameters. This means that when an ACK is received, the next parameter in the lists below is accessed.

ALARM PARAMETERS

The alarms are scrolled in order A1, A2, A3, A4, ,A1, A2 —etc

INSTRUMENT PARAMETERS

The instrument parameters are scrolled in order:

SC, IF, PM, PD*, IS, ER, HR, MI, SE, DY, MO, YR, BN, CD*, CE*, II, VN, ID, CS, M2, M3, L1 to L3, J1* to J5*, RJ†, T0†, T1† to Tn†, SC, IF, ... , etc.

* These parameters are not emulated by the recorder. If selected, they are ignored, if polled, they return zero.

† These parameters appear only with software versions 3.12 onwards.
In 'Tn' n = Hex C for 250mm multipoint recorders, n = 6 for 180mm recorders and n = 4 for continuous recorders.

3.7 CHARACTER SET

CHARACTER		CONTROL KEY	BINARY CODE	HEX CODE	DECIMAL CODE
NUL			000 0000	00	0
SOH	(Start of heading)	A	000 0001	01	1
STX	(Start of text) *	B	000 0010	02	2
ETX	(End of text) *	C	000 0011	03	3
EOT	(End of transmission) *	D	000 0100	04	4
ENQ	(Enquiry) *	E	000 0101	05	5
ACK	(Acknowledge) *	F	000 0110	06	6
BEL	(Bell)	G	000 0111	07	7
BS	(Backspace)	H	000 1000	08	8
HT	(Horizontal tab)	I	000 1001	09	9
LF	(Line feed)	J	000 1010	0A	10
VT	(Vertical tab)	K	000 1011	0B	11
FF	(Form feed)	L	000 1100	0C	12
CR	(Carriage return)	M	000 1101	0D	13
SO	(Shift out)	N	000 1101	0E	14
SI	(Shift in)	O	000 1111	0F	15
DLE	(Data link escape)	P	001 0000	10	16
DC1	{Device control 1 (XON)} *	Q	001 0001	11	17
DC2	(Device control 2)	R	001 0010	12	18
DC3	{Device control 3 (XOFF)} *	S	001 0011	13	19
DC4	{Device control 4 (stop)}	T	001 0100	14	20
NAK	(Negative acknowledge) *	U	001 0101	15	21
SYN	(Synchronous idle)	V	001 0110	16	22
ETB	(End of transmission block)	W	001 0111	17	23
CAN	(Cancel)	X	001 1000	18	24
EM	(End of medium)	Y	001 1001	19	25
SUB	(Substitute)	Z	001 1010	1A	26
ESC	(Escape)		001 1011	1B	27
FS	(File separator)		001 1100	1C	28
GS	(Group separator)		001 1101	1D	29
RS	(Record separator)		001 1110	1E	30
US	(Unit separator)		001 1111	1F	31
	(Space)		010 0000	20	32
!	(Exclamation mark)		010 0001	21	33
"	(Double quote)		010 0010	22	34
#	(Hash) (£ sign - ISO 7)		010 0011	23	35
$	{Dollar (or £ sign)}		010 0100	24	36
%	(Per cent)		010 0101	25	37
&	(Ampersand)		010 0110	26	38
`	(Closing single quote)		010 0111	27	39
(	(Opening round bracket)		010 1000	28	40
)	(Closing round bracket)		010 1001	29	41
*	(Asterisk)		010 1010	2A	42
+	(Plus sign)		010 1011	2B	43
,	(Comma)		010 1100	2C	44
–	(Minus sign)		010 1101	2D	45
.	{Full stop (period)}		001 1110	2E	46
/	(Oblique)		010 1111	2F	47

* Only those control characters marked with an asterisk are correctly interpreted by the instrument. The use of other control codes may lead to unrecoverable errors.

Table 3.7 Character set: Sheet 1 Hex 00 to 2F

3.7 CHARACTER SET (Cont.)

CHARACTER	BINARY CODE	HEX CODE	DECIMAL CODE
0	011 0000	30	48
1	011 0001	31	49
2	011 0010	32	50
3	011 0011	33	51
4	011 0100	34	52
5	011 0101	35	53
6	011 0110	36	54
7	011 0111	37	55
8	011 1000	38	56
9	011 1001	39	57
: (colon)	011 1010	3A	58
; semi-colon)	011 1011	3B	59
< (less than)	011 1100	3C	60
= (equals)	011 1101	3D	61
> (greater than)	011 1110	3E	62
? (question mark)	011 1111	3F	63
@	100 0000	40	64
A	100 0001	41	65
B	100 0010	42	66
C	100 0011	43	67
D	100 0100	44	68
E	100 0101	45	69
F	100 0110	46	70
G	100 0111	47	71
H	100 1000	48	72
I	100 1001	49	73
J	100 1010	4A	74
K	100 1011	4B	75
L	100 1100	4C	76
M	100 1101	4D	77
N	100 1110	4E	78
O	100 1111	4F	79
P	101 0000	50	80
Q	101 0001	51	81
R	101 0010	52	82
S	101 0011	53	83
T	101 0100	54	84
U	101 0101	55	85
V	101 0110	56	86
W	101 0111	57	87
X	101 1000	58	88
Y	101 1001	59	89
Z	101 1010	5A	90
[(opening square bracket)	101 1011	5B	91
\ (back slash)	101 1100	5C	92
] (closing square bracket)	101 1101	5D	93
^ (circumflex)	101 1110	5E	94
_ (Underline)	101 1111	5F	95

Table 3.7 (cont.) Sheet 2: Hex 30 to 5F

3.7 CHARACTER SET (Cont.)

CHARACTER	BINARY CODE	HEX CODE	DECIMAL CODE
' opening quote	110 0000	60	96
a	110 0001	61	97
b	110 0010	62	98
c	110 0011	63	99
d	110 0100	64	100
e	110 0101	65	101
f	110 0110	66	102
g	110 0111	67	103
h	110 1000	68	104
i	110 1001	69	105
j	110 1010	6A	106
k	110 1011	6B	107
l	110 1100	6C	108
m	110 1101	6D	109
n	110 1110	6E	110
o	110 1111	6F	111
p	111 0000	70	112
q	111 0001	71	113
r	111 0010	72	114
s	111 0011	73	115
t	111 0100	74	116
u	111 0101	75	117
v	111 0110	76	118
w	111 0111	77	119
x	111 1000	78	120
y	111 1001	79	121
z	111 1010	7A	122
{ (opening curly bracket)	111 1011	7B	123
| (vertical line)	111 1100	7C	124
} (closing curly bracket)	111 1101	7D	125
~ (tilde)	111 1110	7E	126
Not printed	111 1111	7F	127

Table 3.7 (Cont.) Sheet 3: Hex 60 to 7F.

3.7 CHARACTER SET (Cont.)

CHARACTER	BINARY CODE	HEX CODE	DECIMAL CODE
Ç	1000 0000	80	128
ü	1000 0001	81	129
é	1000 0010	82	130
â	1000 0011	83	131
ä	1000 0100	84	132
à	1000 0101	85	133
å	1000 0110	86	134
ç	1000 0111	87	135
ê	1000 1000	88	136
ë	1000 1001	89	137
è	1000 1010	8A	138
ï	1000 1011	8B	139
î	1000 1100	8C	140
ì	1000 1101	8D	141
Ä	1000 1110	8E	142
Å	1000 1111	8F	143
É	1001 0000	90	144
æ	1001 0001	91	145
Æ	1001 0010	92	146
ô	1001 0011	93	147
ö	1001 0100	94	148
ò	1001 0101	95	149
û	1001 0110	96	150
ù	1001 0111	97	151
ÿ	1001 1000	98	152
ö	1001 1001	99	153
ü	1001 1010	9A	154
¢	1001 1011	9B	155
£	1001 1100	9C	156
¥	1001 1101	9D	157
⣾	1001 1110	9E	158
⣿	1001 1111	9F	159
á	1010 0000	A0	160
í	1010 0001	A1	161
ó	1010 0010	A2	162
ú	1010 0011	A3	163
ñ	1010 0100	A4	164
Ñ	1010 0101	A5	165
a	1010 0110	A6	166
o	1010 0111	A7	167
¿	1010 1000	A8	168
⌐	1010 1001	A9	169
¬	1010 1010	AA	170
⢿	1010 1011	AB	171
⣻	1010 1100	AC	172
⡿	1010 1101	AD	173
⣽	1010 1110	AE	174
⣾	1010 1111	AF	175

Table 3.7 (Cont.) Sheet 4: Hex 80 to AF

3.7 CHARACTER SET (Cont.)

CHARACTER	BINARY CODE	HEX CODE	DECIMAL CODE
^{0} (Superscript)	1011 0000	B0	176
^{1} (Superscript)	1011 0001	B1	177
^{2} (Superscript)	1011 0010	B2	178
^{3} (Superscript)	1011 0011	B3	179
^{4} (Superscript)	1011 0100	B4	180
^{5} (Superscript)	1011 0101	B5	181
^{6} (Superscript)	1011 0110	B6	182
^{7} (Superscript)	1011 0111	B7	183
^{8} (Superscript)	1011 1000	B8	184
^{9} (Superscript)	1011 1001	B9	185
$_{0}$ (Subscript)	1011 1010	BA	186
$_{1}$ (Subscript)	1011 1011	BB	187
$_{2}$ (Subscript)	1011 1100	BC	188
$_{3}$ (Subscript)	1011 1101	BD	189
$_{4}$ (Subscript)	1011 1110	BE	190
$_{5}$ (Subscript)	1011 1111	BF	191
$_{6}$ (Subscript)	1100 0000	C0	192
$_{7}$ (Subscript)	1100 0001	C1	193
$_{8}$ (Subscript)	1100 0010	C2	194
$_{9}$ (Subscript)	1100 0011	C3	195
0	1100 0100	C4	196
1	1100 0101	C5	197
2	1100 0110	C6	198
3	1100 0111	C7	199
4	1100 1000	C8	200
5	1100 1001	C9	201
6	1100 1010	CA	202
7	1100 1011	CB	203
8	1100 1100	CC	204
9	1100 1101	CD	205
Not printed	1100 1110	CE	206
Not printed	1100 1111	CF	207
Not printed	1101 0000	D0	208
Not printed	1101 0001	D1	209
Not printed	1101 0010	D2	210
Not printed	1101 0011	D3	211
Not printed	1101 0100	D4	212
Not printed	1101 0101	D5	213
Not printed	1101 0110	D6	214
Not printed	1101 0111	D7	215
Not printed	1101 1000	D8	216
∫	1101 1001	D9	217
{Bell (alarm) symbol}	1101 1010	DA	218
■	1101 1011	DB	219
←	1101 1100	DC	220
→	1101 1110	DD	221
↑	1101 1101	DE	222
↓	1101 1111	DF	223

Table 3.7 (Cont.) Sheet 5: Hex B0 to E2

3.7 CHARACTER SET (Cont.)

CHARACTER	BINARY CODE	HEX CODE	DECIMAL CODE
α	1110 0000	E0	224
β	1110 0001	E1	225
Γ	1110 0010	E2	226
π	1110 0011	E3	227
Σ	1110 0100	E4	228
σ	1110 0101	E5	229
μ	1110 0110	E6	230
τ	1110 0111	E7	231
ϕ	1110 1000	E8	232
θ	1110 1001	E9	233
Ω	1110 1010	EA	234
δ	1110 1011	EB	235
∞	1110 1100	EC	236
∅	1110 1101	ED	237
ε	1110 1110	EE	238
∩	1110 1111	EF	239
≡	1111 0000	F0	240
±	1111 0001	F1	241
≥	1111 0010	F2	242
≤	1111 0011	F3	243
(Minus)	1111 0100	F4	244
(Plus)	1111 0101	F5	245
÷ (Divide)	1111 0110	F6	246
≈	1111 0111	F7	247
°	1111 1000	F8	248
∙	1111 1001	F9	249
·	1111 1010	FA	250
√	1111 1011	FB	251
n	1111 1100	FC	252
2	1111 1101	FD	253
■	1111 1110	FE	254
Not printed	1111 1111	FF	255

Table 3.7 (Concluded) Sheet 6: Hex E0 to FF

3.8 APPLICATION NOTES

3.8.1 Message timing

The recorder can receive a message as a continuous byte stream (i.e. the bytes in a message may be end to end).

3.8.2 Command mnemonics

These mnemonics cause the serial link to perform some action. Command mnemonics which control the chart have the same priority as the operator (i.e. last input from either source overrides previous inputs).

3.8.3 Channel selection

It is not possible to write directly to the recorder data base because of the interdependence of parameters. For this reason, the characters are held in a buffer until an 'EC' command mnemonic is received.

As each parameter is received it is checked, and if it is valid, an ACK is returned and the data is stored in the buffer. (If the data is not valid, a NAK is returned and the data is discarded.) When the EC mnemonic is received the contents of the buffer are checked, and if the data is all valid, the contents of the buffer are stored in the recorder data base, and an ACK is returned. If the data is not valid, a NAK is returned, the data is discarded and an error flag set in 'ER' (See Instrument Mnemonics in section 3.4.3, above).

Note: It is not possible for the user to read the buffer, either before or after the EC mnemonic.

3.8.4 Alarm selection / polling

There is a single buffer through which alarms can be accessed. The relevant alarm is read into the buffer from the data base as the result of a command mnemonic 'GA'. This buffer can then be written to or read, via the instrument address (U = 0). When writing to the buffer, the data is stored until a command mnemonic (EA) is received, as described below.

SELECTION

As each parameter is received it is checked, and if it is valid, an ACK is returned and the data is stored in the buffer. (If the data is not valid, a NAK is returned and the data is discarded.) When the EA mnemonic is received the contents of the buffer are checked, and if the data is all valid, the contents of the buffer are stored in the recorder data base, and an ACK is returned. If the data is not valid, a NAK is returned and the data is discarded. The alarm buffer is marked as 'invalid' and must be refilled before it can again be accessed. A NAK is returned if an attempt is made to read or write to the buffer before it is refilled.

3.8.5 Printed text

If text to be printed is sent via the 'PT' mnemonic (section 3.4.3) it is placed in the instrument's demand message queue, and treated as a standard demand message. If there is insufficient space in the queue, a NAK is returned.

3.8.6 Special characters

ASCII MODE

The printing control characters (table 3.1.2) may be used only as control characters (i.e. they may not be used as a part of a text string). The ASCII control characters (e.g. STX) may not be used at all in ASCII mode.

ANSI MODE

The ASCII control characters may be used only in their correct positions (i.e. they may not be used as a part of a text string).

Notes

1. The special characters shown in table 3.7 sheets 3, 4 and 5, above, require the use of eight data bits, and both the recorder and the host must be configured as such.
2. Model 4001 characters which are not available with curent recorders and vice-versa, are treated as an underline symbol (_).

3.8.7 Multi-parameter data packets

When a parameter which contains a number of different individual items (e.g. channel flags CF - see table 3.4.1) then it is not possible to change only a single item within the parameter; the whole word must be written with the required data for each bit.

When one or more bits in a multi-parameter mnemonic are READ-ONLY, or not used, those bits are ignored. No error flag is set in 'ER'.

3.8.8 Digital input channels

These types of channel cannot be written to using this communications protocol. If an attempt is made to do so, a NAK is returned and code 05 is set into 'ER'.

The process value (PV) for digital channels may be polled (read), with the response 0.0 if the input is open and 1.0 if the input is closed.

The measured value (MV) for digital channels may also be polled (read), with the response 0000 if the input is open and 0001 if the input is closed.

3.8.9 Floating point overflow

Maths channel PVs, scales, alarm setpoints etc. may exceed the floating point range (9999) of the 4001 emulation protocol. In such a case, the value 9999 (with appropriate sign) is returned.

4 GOULD MODICON MODBUS PROTOCOL

When connected to a host computer the recorder acts as a slave Modbus device. The unit address (1 to 247) being set up as a part of the recorder's communications configuration. Only a limited number of function codes have been implemented (ref. Modbus protocol manual) and these are listed in section 4.3

4.1 CHANNEL ADDRESSING

The channel 1 address listed in table 4.3 is the base address at which channel 1 may be accessed.

Note: Addressing starts at zero, whilst channel numbers start at 1

Example: to read a digital input at channel 23, the required address passed with the code 01 would be 22

If an alarm is set for an input or derived channel, the associated alarm parameters can be read using code 03

Example: To read the set point of absolute alarm 1 on channel 8, the required address passed with code 03 should be 1257 (1250 = channel 1; 1251 = channel 2 etc.).

The interpretation of alarm parameters (A1 to A4 and SP1 to SP4 in table 4.3) depends on alarm type as follows:

ALARM TYPE	PARAMETER	DEFINITION
Absolute	A1 to A4	Not used
Absolute	SP1 to SP4	Setpoint values
Deviation	A1 to A4	Deviation values
Deviation	SP1 to SP4	Setpoint values
Rate	A1 to A4	Rate value
Rate	SP1 to SP4	Period value (secs)
Digital	A1 to A4	Not used
Digital	SP1 to SP4	0000 = Open; FFFF = closed

Table 4.1 Alarm paramteter interpretation

Note: Any request to read a nonexistent setpoint value will result in the value 0000 being returned. This should not be taken to mean that the setpoint is at 0.000

4.2 READING ANALOGUE VALUES

4.2.1 16-bit format

The values read are in the range 0000 to FFFF. To obtain the scaled relative value, the following calculation must be carried out:

$$\text{Scaled value} = \left(\frac{\text{High range - Low range}}{\text{FFFF}} \; x \; \text{Analogue measurement} \right) + \text{low range}$$

where the analogue measurement is in hex.

In the event of a hardware error or under-range value, the value is forced to scale zero. Should the analogue value be over range, the scaled value is forced to scale high.

4.2 READING ANALOGUE VALUES (Cont.)

4.2.2 32-bit format

Values read from service code 03 addresses based at:

7250 (Analogue channel scale low value)
7750 (Analogue channel scale high value)
8250 (Derived channel scale low value)
8750 (Derived channel scale high value)

and values read from service code 04 addresses based at:

1500 (Analogue channel value)
2000 (Derived channel value)

are in 32-bit IEEE floating point format. Each value resides in two consecutive 16-bit registers transmitted most significant byte first. Two registers per channel must be requested, and the required address increases by two per channel number, for example:

Analogue channel 1: Code04; address 1500
Analogue channel 2: Code 04; address 1502
or generally:
Analogue channel N: code 04; address 1500 + 2(N-1)

Example 1 Read channel 05

(`0x--` means the two characters following the 'x' are in hexadecimal)

```
<slave address><code><register addr high><register addr low><nº of registers high>
<nº of registers low><CRC high><CRC low>
```

Specifically, to read analogue channel 05 from slave address 2:

```
<0x02><0x04><0x05><0xE4><0x00><0x02><CRC high><CRC low>
```

To which the reply should be:

```
<slave address><code><byte count><most significant byte><next byte><next byte>
<least significant byte>
```

Specifically for channel 5 having a value of 1.123 (0x3F8FBE76 in 32-bit IEEE format)

```
<0x02><0x04><0x04><0x3F><0x8F><0xBE><0x76>
```

TOTALISER VALUES

To read a totaliser value, use the derived channel copy facility to import the totaliser value into a derived channel, and read this derived channel using service code 04 (base address 2000). The returned value will be in 32-bit IEEE float as described above.

4.3 FUNCTION CODES

CODE	FUNCTION	RECORDER ACTION	CHANNEL 1 ADDRESS (DECIMAL)
01	Read coil status	Digital input state (true = >0.5)	0
02	Digital read input status	Digital input state (true = < 0.5)	0
		I/O alarm 1 status	250
		I/O alarm 2 status	500
		I/O alarm 3 status	750
		I/O alarm 4 status	1000
		Derived alarm 1 status	1250
		Derived alarm 2 status	1500
		Derived alarm 3 status	1750
		Derived alarm 4 status	2000
03	Read holding register	I/O channel value	0
		I/O channel A1 (Table 4.1)	250
		I/O channel A2 (Table 4.1)	500
		I/O channel A3 (Table 4.1)	750
		I/O channel A4 (Table 4.1)	1000
		I/O channel SP1 (Table 4.1)	1250
		I/O channel SP2 (Table 4.1)	1500
		I/O channel SP3 (Table 4.1)	1750
		I/O channel SP4 (Table 4.1)	2000
		Derived channel A1 (Table 4.1)	2250
		Reserved (always returns 0000)	2500
		Derived channel A2 (Table 4.1)	2750
		Reserved (always returns 0000)	3000
		Derived channel A3 (Table 4.1)	3250
		Reserved (always returns 0000)	3500
		Derived channel A4 (Table 4.1)	3750
		Reserved (always returns 0000)	4000
		Derived channel SP1 (Table 4.1)	4250
		Reserved (always returns 0000)	4500
		Derived channel SP2 (Table 4.1)	4750
		Reserved (always returns 0000)	5000
		Derived channel SP3 (Table 4.1)	5250
		Reserved (always returns 0000)	5500
		Derived channel SP4 (Table 4.1)	5750
		Reserved (always returns 0000)	6000
		I/O channel status (read only) (flags - see code 04)	6250
		Derived channel status (read only) (flags - see code 04)	6500
		Instrument status (read only) (flags - see code 07)	6750
		Analogue real channel scale low value (32-bit)	7250
		Analogue real channel scale high value (32-bit)	7750
		Derived channel scale low value (32-bit)	8250
		Derived channel scale high value (32-bit)	8750

Table 4.3 Modbus implementation channel addresses (Sheet 1: codes 01 to 03)

4.3 FUNCTION CODES (Cont.)

CODE	FUNCTION	RECORDER ACTION	CHANNEL 1 ADDRESS (DECIMAL)
04	Read input register	Analogue input/output value	0
		I/O channel status	250
		No bits set: Channel OK	
		Bit 0 set: Channel off	
		Bit 1 set: Over range	
		Bit 2 set: Under range	
		Bit 3 set: Hardware error / bad PV	
		Bit 4 set: Ranging error / no data	
		Bit 5 set: Overflow	
		Bits 6 to 15: Always 0.	
		Derived channel value	500
		Reserved (returns 0000)	750
		Derived channel status	1000
		(Bits 0 to 15 as for I/O channel status above)	
		Instrument status (flags - code 7)	1250
		Analogue real channel value (32-bit)	1500
		Derived channel value (32-bit)	2000
05	Force single coil	Sets digital input state for comms channel	0
		0 = 0.000; 1 = 1.000	
06	Preset single register	Preset holding register	As code 03
		(Presets values for comms channels only)	
		(Base addresses 7250, 7750, 8250 and 8750 cannot be preset)	
07	Read exception status	Read instrument status	
		Bit 0: System error	
		Bit 1: Writing system failure	
		Bit 2: Paper out (250 mm non-graphics recorders only)	
		Bits 3 to 7 Always 0	
08	Loopback test	Diagnostic code 0 (Echoes message as sent)	
15	Force multiple coil	Sets digital input code for comms channels in address range.	0
		0 = 0.000 1 = 1.000	
16	Preset multiple registers	Preset holding register for each channel in address range.	As code 03
		(Presets values for comms channels only)	
		(Base addresses 7250, 7750, 8250 and 8750 cannot be preset)	
65	Enter XMODEM mode	Holds 1 byte of data specifying which mode to enter	
		0 = standby; 1 = Receiver; 2 = Sender	
66	Report XMODEM error	Returns 1 byte of data as follows:	
		0: Transfer OK - no errors	
		1: Restore failed completely File was incompatible or comms failed to transfer the file, Original configuration unchanged.	
		2: Restore failed on data. Some records ignored, but transfer mostly successful.	
		3: Restore failed on transfer Some config. transferred before failure. New configuration undefined	
		16: Save had no reply from comms and timed out	
		32: Save failed before transfer completed	

Table 4.3 Modbus implementation channel addresses (Sheet 2)

4.3 FUNCTION CODES (Cont.)

CODE	FUNCTION	RECORDER ACTION	CHANNEL 1 ADDRESS (DECIMAL)
		EXCEPTION RESPONSES	
01	Illegal function	Unsupported or illegal Modbus function	0
02	Illegal data address	Data address out of range for instrument config	0
		Attempt to preset input value of non comms channel	
		Invalid configuration data	
03	Illegal data	Data value out of range for function	
06	Illegal busy	Configuration transfer in progress via another port so unable to action function	

Table 4.3 Modbus implementation channel addresses (Sheet 3)

5 XMODEM TRANSFER

XMODEM transfers take place between a host computer and a single instrument using MODBUS or 4001 protocol. The transfer is used to save or restore recorder configurations. The transfer procedure is as follows

1. Place any other instruments on the communications link into standby mode.
2. Set the required recorder to sender or receiver mode as appropriate.
3. Send or receive file at host.
4. 10 seconds after completion, host communications is restored to normal use.

Notes:

1. 10 seconds of inactivity on the communications link, at any point in the procedure, will cause the host communications to return to normal use for instruments in standby mode.
2. XMODEM transfer is not possible with graphics recorders or graphics display units.

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