

RM4 Din Rail Meter Optional Output Addendum

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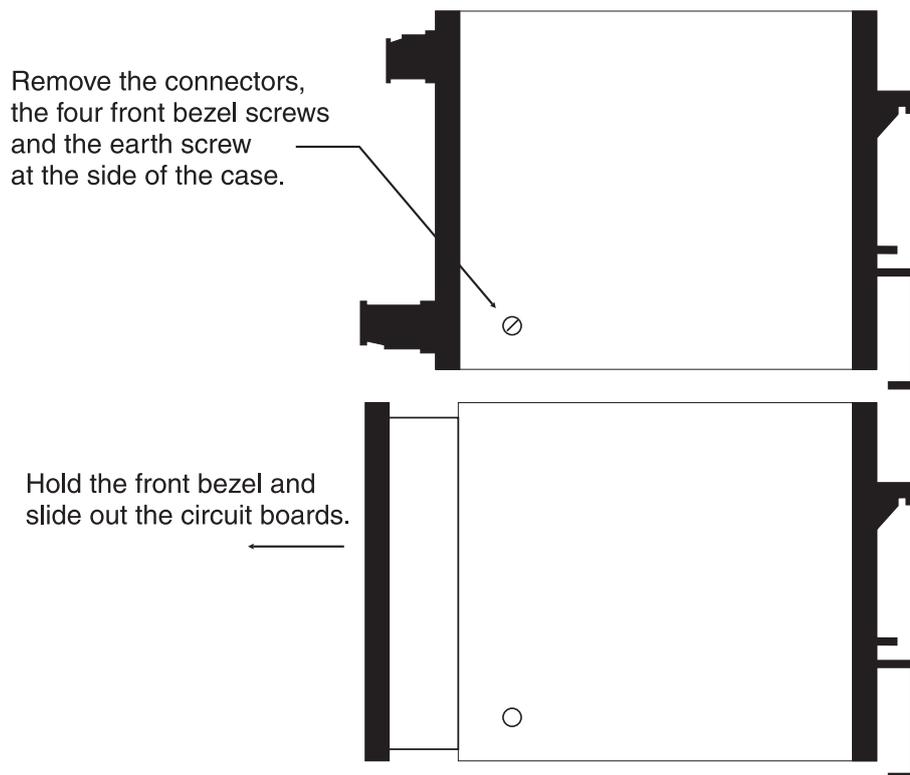
1 Introduction

This manual addendum contains information on the RM4 optional outputs. This manual is supplied whenever a RM4 DIN rail meter is supplied with an optional output fitted. Refer to the standard manual for the RM4 model purchased for information not covered in this addendum.

Note: Not all options are available on all instruments. Check the instruction manual or brochure for the instrument to be used to see which options are available or contact supplier.

1.1 Configuring the output board

If changes to the link settings are required on the option board the circuit board will need to be removed from the case. Remove the circuit board from the case following the instructions below.



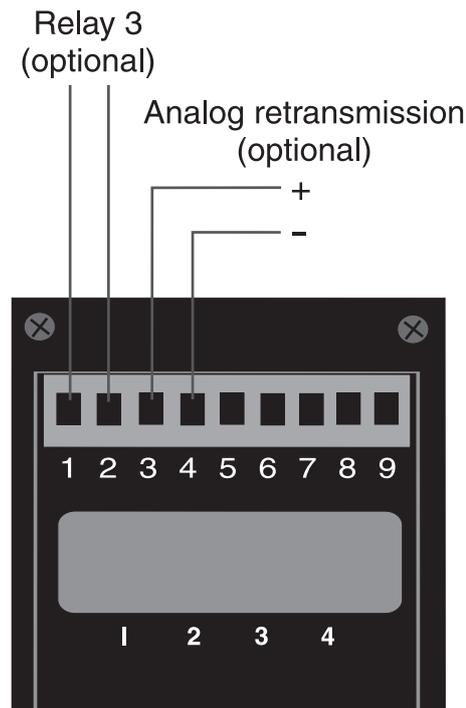
2 Analog plus one extra relay output option (-A, -AR and -AHR options)

The optional output board is factory supplied with the necessary components for the output options required. Combinations of output types available on this board are:

Option code	Options fitted to the board
-A	Isolated analog retransmission, 12 bit (4-20mA, 0-1V or 0-10V link selectable)
-AR	Analog retransmission, 12 bit plus third relay, form A, rated 0.5A at 30VAC or 0.5A at 48VAC into resistive load
-AHR	Isolated analog retransmission, 16 bit (4-20mA, 0-1V or 0-10V link selectable) plus third relay

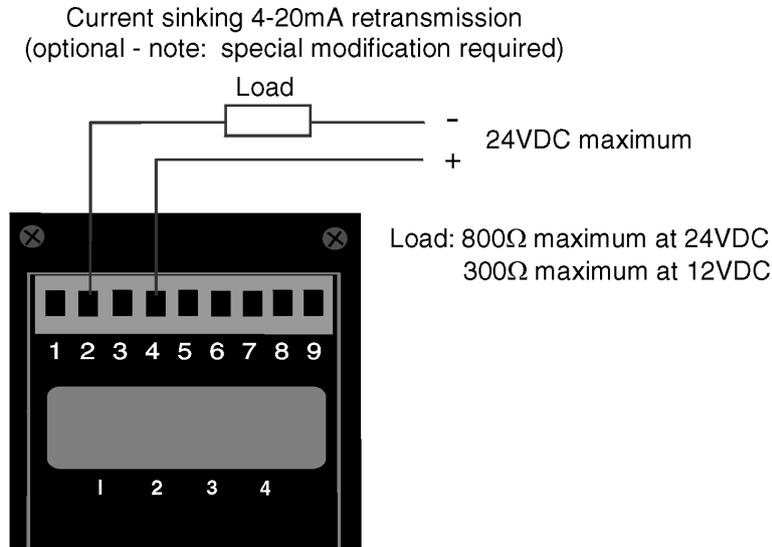
2.1 Electrical Connections

See wiring diagram below. If 4–20mA output is used the RM4 provides voltage to drive the 4–20mA loop (800Ω maximum load). The 4–20mA connections shown are for current sourcing output, see the next section for current sinking connections if you have an instrument converted to current sinking type output. The relay is voltage free and can be programmed for normally open or normally closed operation.



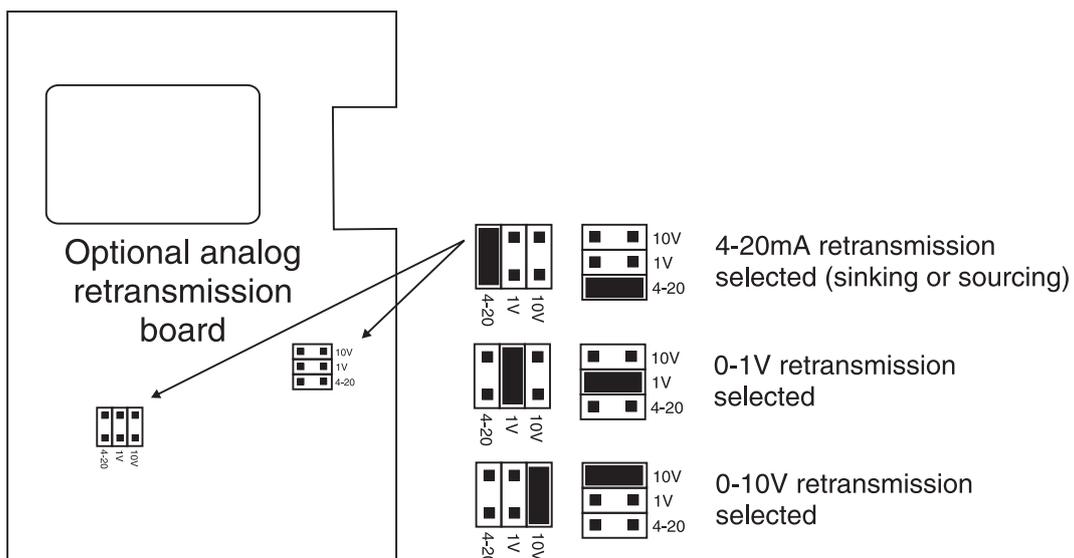
2.2 Electrical Connections - current sinking 4–20mA output

Note that the current sinking output is not a standard 4–20mA output option. Do not use the connections below unless the output has been factory modified for current sinking mode (check the label on the side of the instrument to confirm connections). Maximum voltage to be applied to the terminals for current sinking mode is 24VDC.



2.3 Configuring the output board

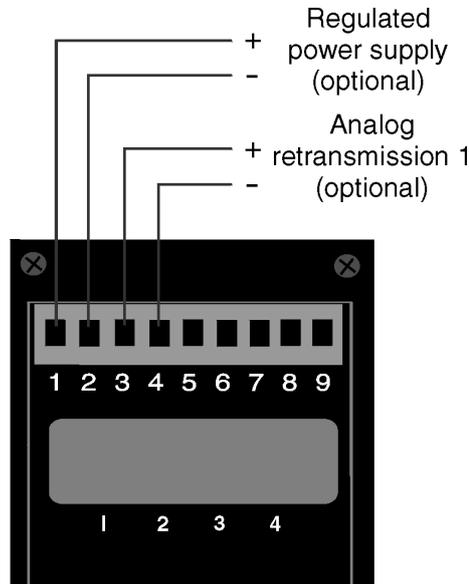
PCB links are fitted to the circuit board to provide data to the microprocessor and to connect the electronic components for the correct output types. It may be necessary to alter the PCB links to change the analog output type (see link settings below). See chapter 1, page 3 for details on removal of the circuit boards.



3 Analog output and transmitter supply output option (-AE option)

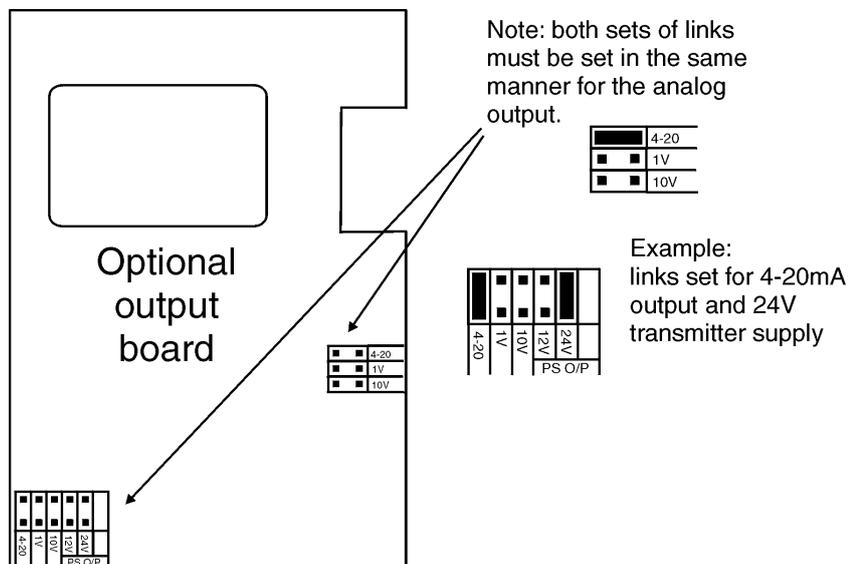
3.1 Electrical Connections

Note that the 4-20mA analog output is current sourcing and does not require any other power supply. Regulated power supply can be selected as 12 or 24VDC via internal links.



3.2 Configuring the output board

PCB links are fitted to the circuit board to provide data to the microprocessor and to connect the electronic components for the correct output types. On the output board shown below the link selection allows the choice of isolated and regulated transmitter supply voltage, 12VDC (50mA max.) or 24VDC (25mA max.). The links also allow selection of either 4-20mA, 0-1VDC or 0-10VDC retransmission. See chapter 1, page 3 for details on removal of the circuit boards.

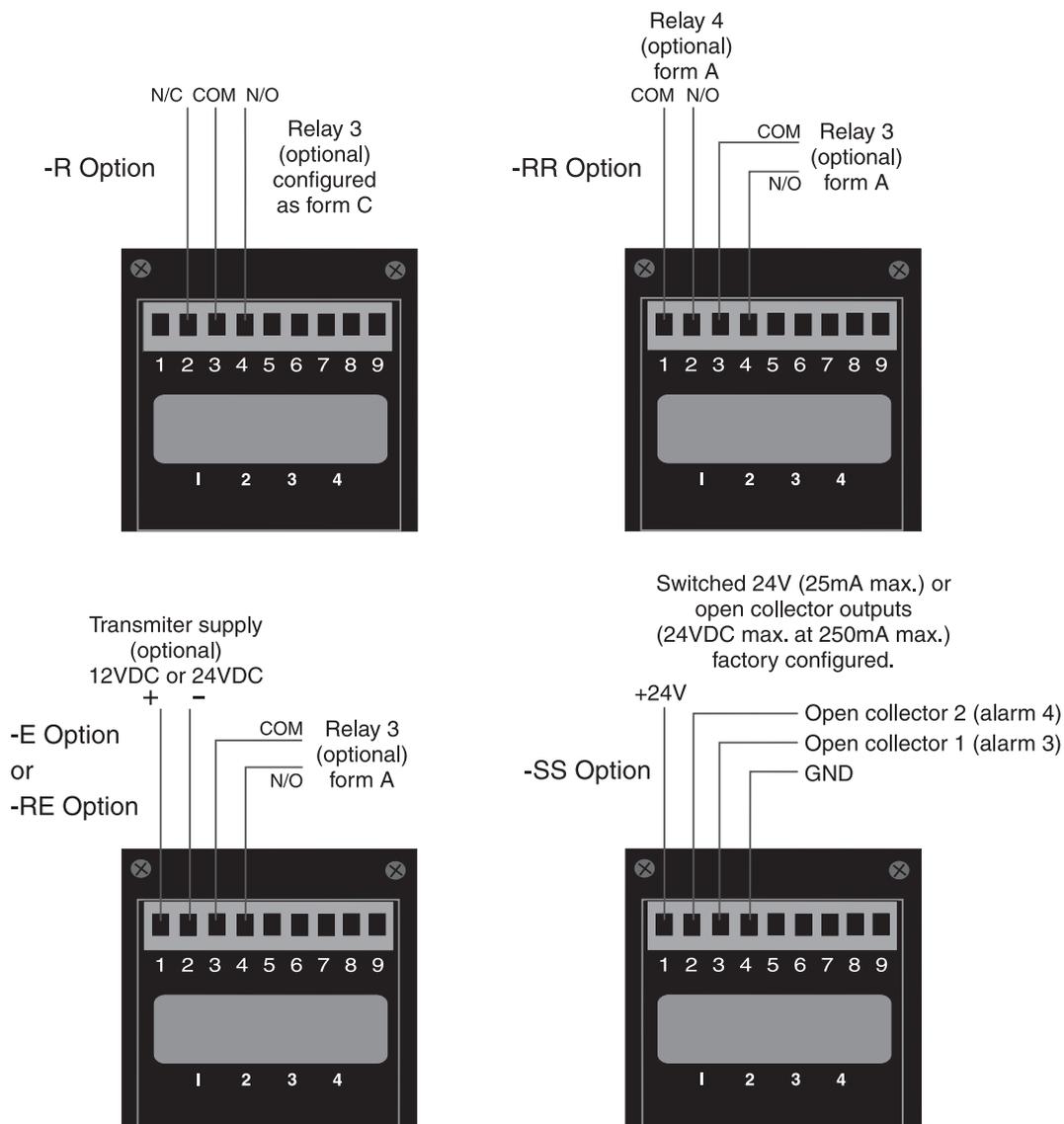


4 Two Relay and transmitter supply output option (-R, -RR, -SS, -E and -RE options)

The optional output board is factory supplied with the necessary components for the output options required. The relay is voltage free and can be programmed for normally open or normally closed operation. Combinations of output types available on this board are:

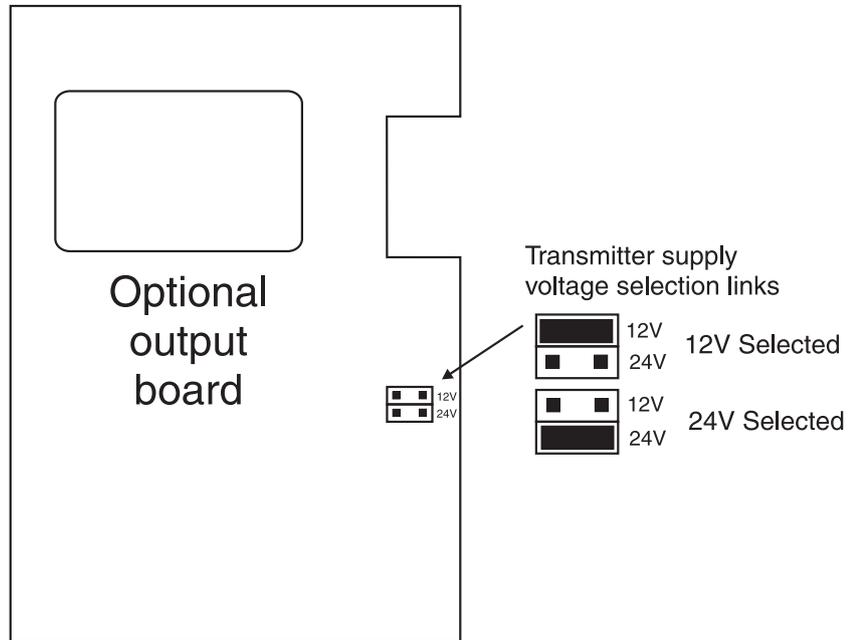
Option code	Options fitted to the board
-R	Third relay output, form C, rated 0.5A at 30VAC or 0.5A at 48VAC into resistive load
-RR	Third and fourth relay outputs, form A, rated 0.5A at 30VAC or 0.5A at 48VAC into resistive load
-E	Isolated transmitter supply (12V (50mA max.) or 24VDC (24mA max.))
-RE	Third relay output, form A, rated 0.5A at 30VAC or 0.5A at 48VAC into resistive load plus isolated transmitter supply (12V (50mA max.) or 24VDC (24mA max.))
-SS	Dual open collector or switched 24VDC outputs

4.1 Electrical Connections



4.2 Configuring the output board

PCB links are fitted to the circuit board to provide data to the microprocessor and to connect the electronic components for the correct output types. On the output board shown below the link selection allows the choice of isolated and regulated transmitter supply voltage, 12VDC (50mA max.) or 24VDC (25mA max.) See chapter 1, page 3 for details on removal of the circuit boards.



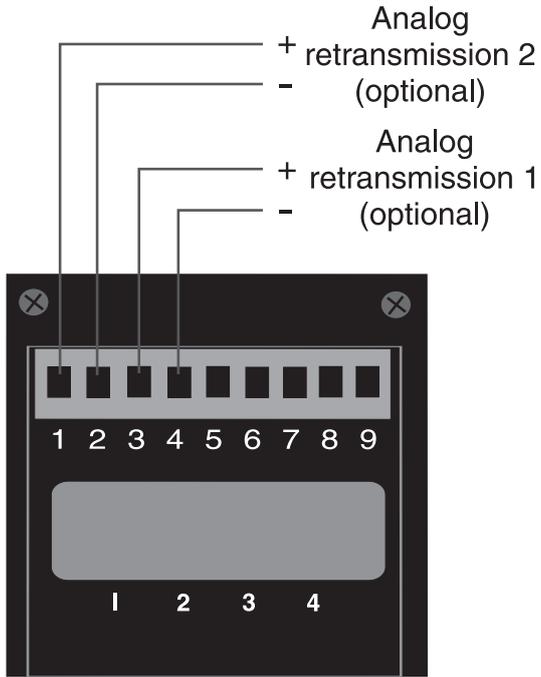
5 Dual analog option (-AA option)

The optional output board is factory supplied with the necessary components for the output options required. When 4–20mA output is chosen the RM4 provides voltage to drive the 4–20mA loops (800Ω maximum load).

Option code	Options fitted to the board
-AA	Dual isolated analog retransmission, 12 bit (4–20mA, 0-1V or 0-10V link selectable)

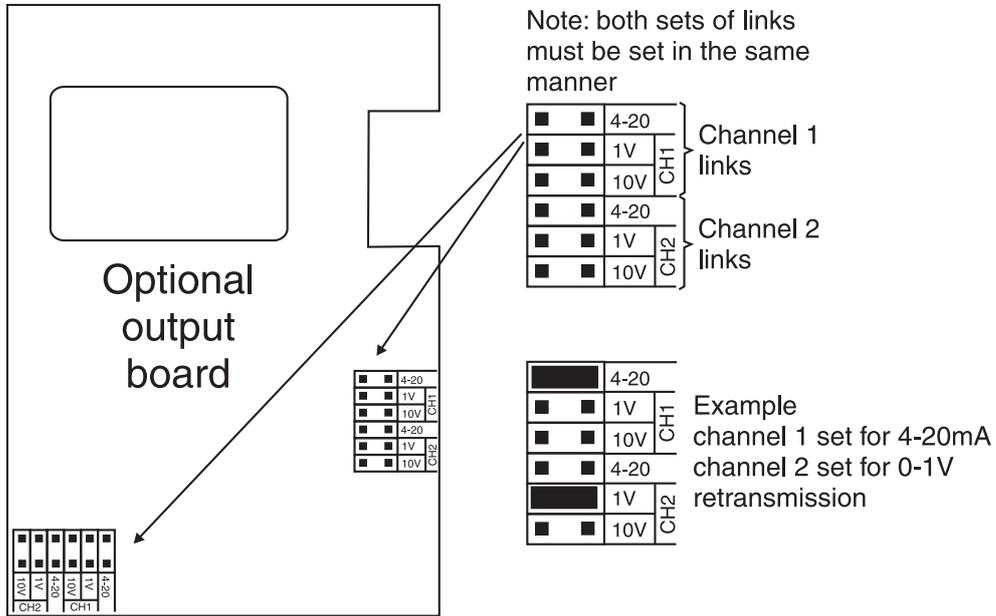
5.1 Electrical Connections

See wiring diagram below.



5.2 Configuring the output board

PCB links are fitted to the circuit board to provide data to the microprocessor and to connect the electronic components for the correct output types. It may be necessary to alter the PCB links to change the analog output type (see link settings below). See chapter 1, page 3 for details on removal of the circuit boards.



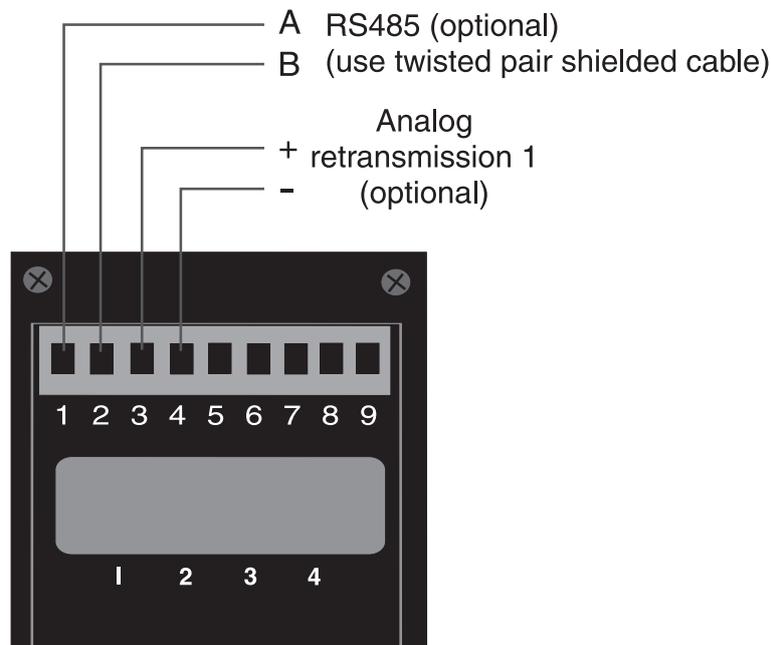
6 Analog plus RS485 option (-A4 option)

The optional output board is factory supplied with the necessary components for the output options required. If the 4–20mA output is used the RM4 provides voltage to drive the 4–20mA loop (800Ω maximum load)

Option code	Options fitted to the board
-A4	Analog retransmission, 12 bit (4-20mA, 0-1V or 0-10V link selectable) plus RS485 communications

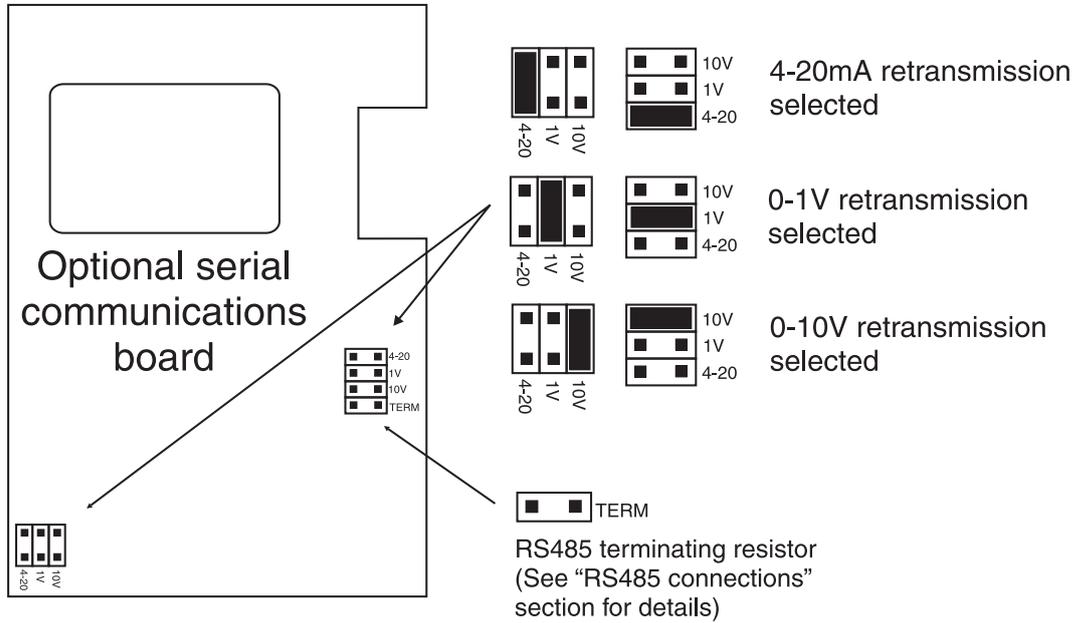
6.1 Electrical Connections

See wiring diagram below.



6.2 Configuring the output board

PCB links are fitted to the circuit board to provide data to the microprocessor and to connect the electronic components for the correct output types. It may be necessary to alter the PCB links to change the analog output type (see link settings below). See chapter 1, page 3 for details on removal of the circuit boards.



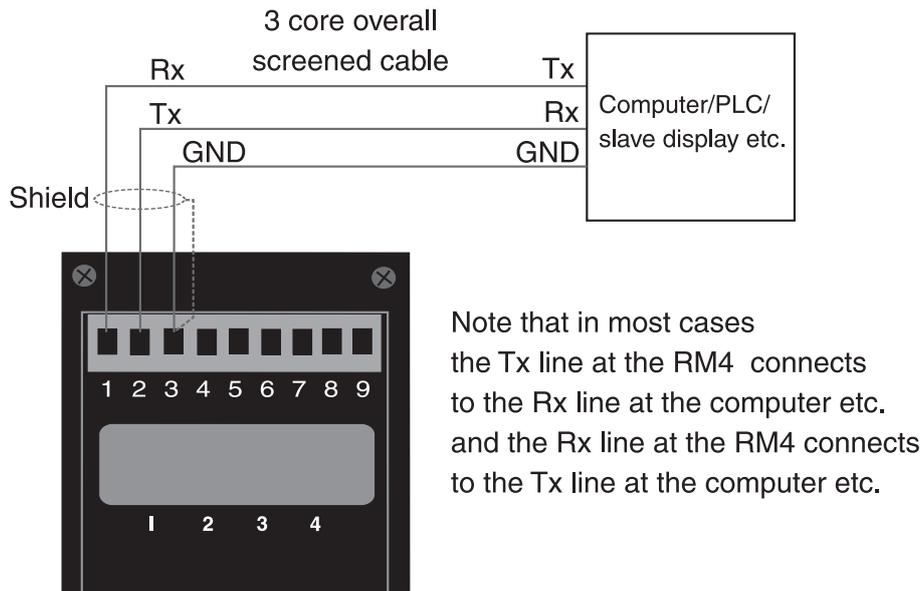
7 Serial communications output options (-232, -485 or -422 options)

RS232/RS485/RS422 communications option The information provided in this appendix relates to RM4 din rail meters with RS232, RS485 or RS422 outputs using the serial output board. Refer to the Configuring the output board section which follows for details of link settings. The functions associated with serial communications are **bAud**, **PrtY**, **G.Put** and **Addr**, refer to the main instrument manual for details of these functions.

Option code	Options fitted to the board
-232	RS232 serial communications
-485	RS485 serial communications
-422	RS422 serial communications

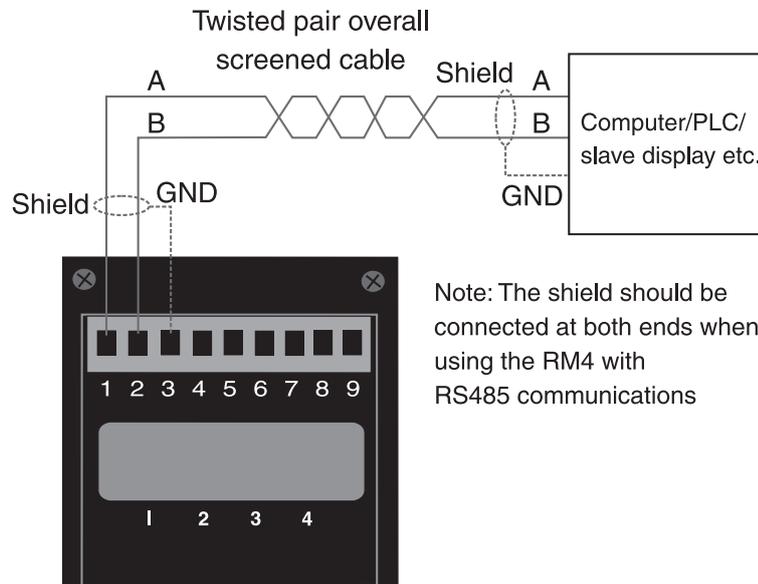
7.1 RS232 interconnections

Use 3 core shielded cable for RS232 connections. RS232 connections generally have Rx at the RM4 connected to Tx at the PLC/Computer etc. and TX at the RM4 connected to Rx at the PLC/Computer etc. RS232 connections are generally rated to a maximum cable length of approximately 15 metres and are single ended in operation i.e. only one device can be connected to the RM4.



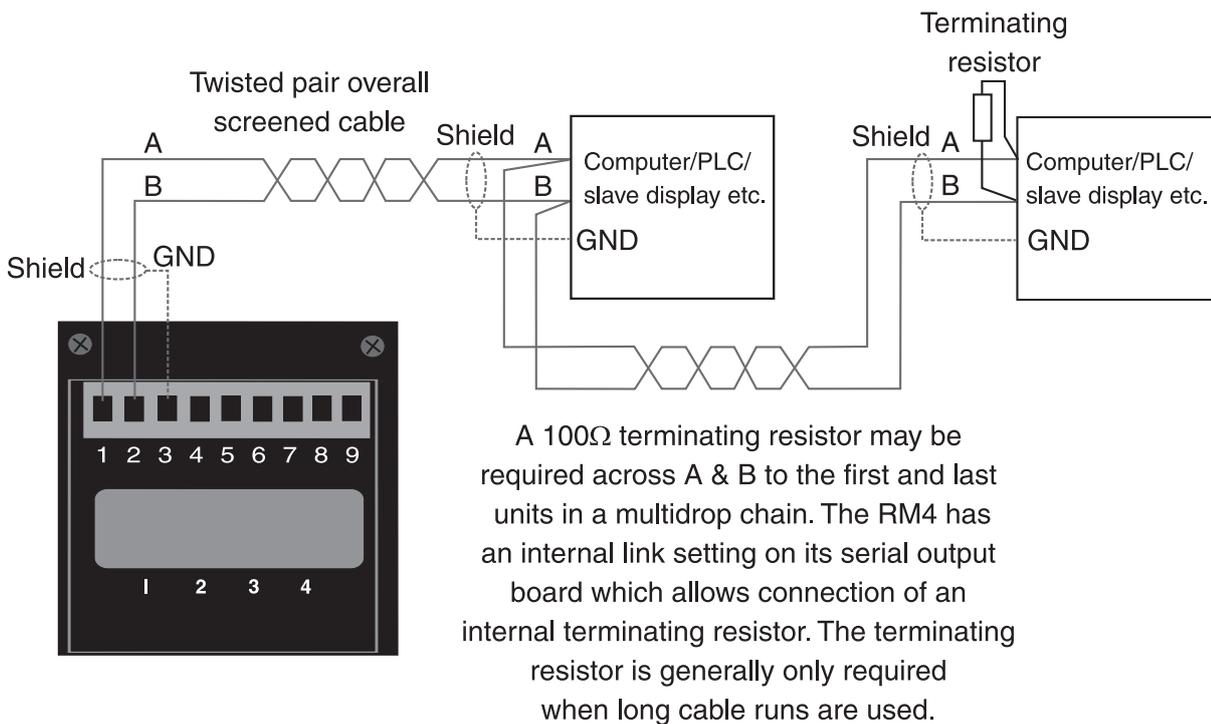
7.2 RS485 interconnections

RS485 connections use shielded, twisted pair wires. RS485 is rated to a maximum cable length of approximately 1200 metres and will allow connection of up to 32 drivers/receivers on the serial link. For long cable runs terminating resistors may be required across the A and B terminals to reduce the possibility of signal corruption due to line reflections. The terminating resistors are only required at the first and last units on the RS485 link. An internal terminating resistor is supplied and may be link selected on the output board.



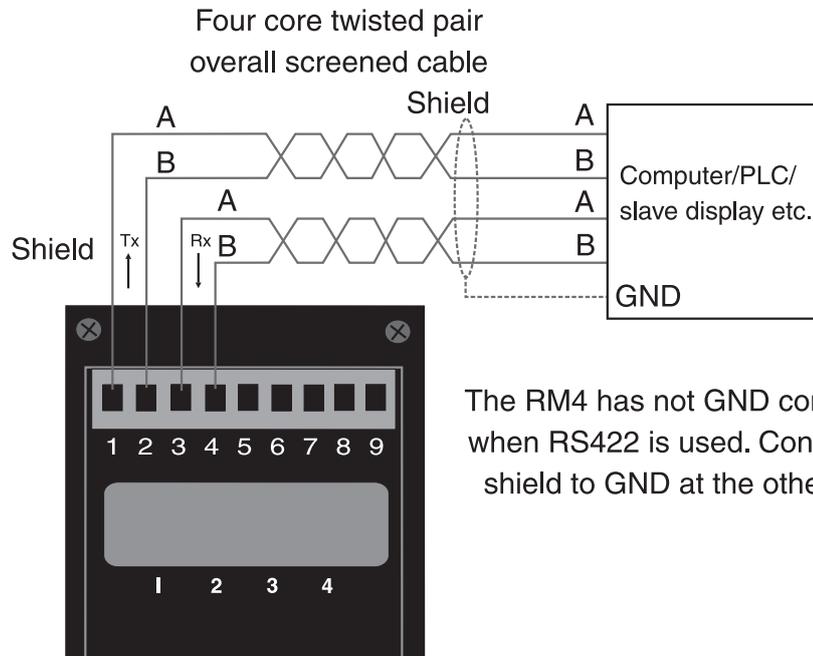
7.3 Multidrop RS485 interconnections

Up to 32 RS485 devices can be connected on one multidrop chain.

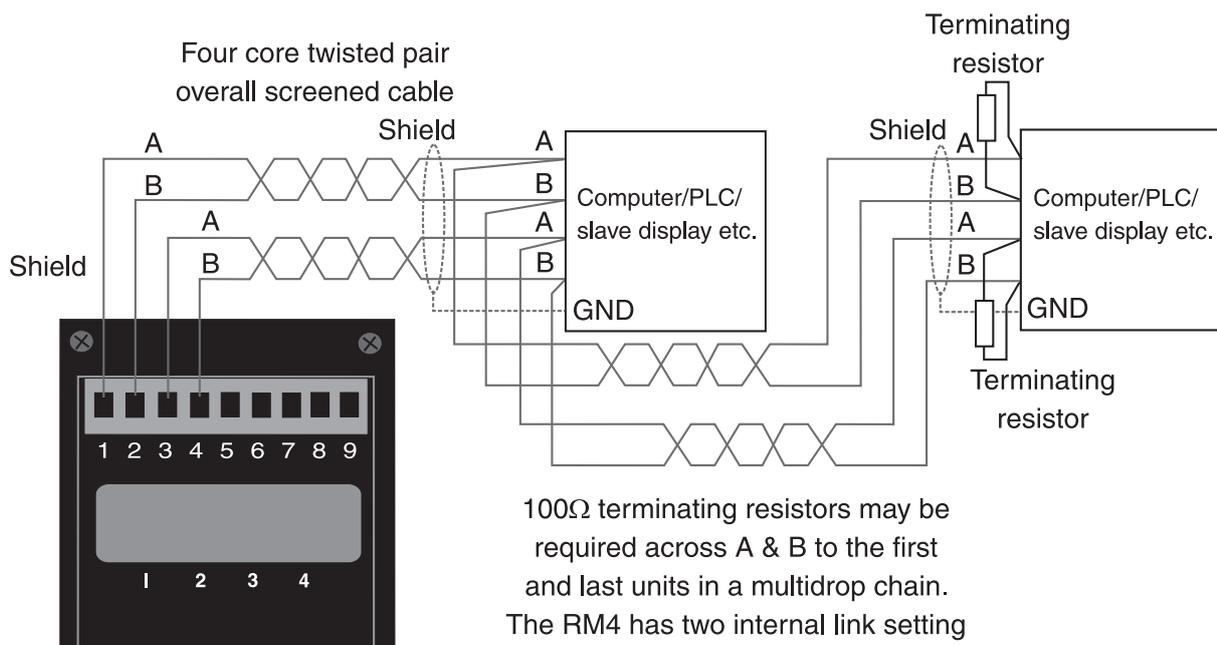


7.4 RS422 connections

RS422 connections use four core shielded, twisted pair wires. RS422 is rated to a maximum cable length of approximately 1200 metres and will allow connection of 1 driver and up to 10 receivers on the serial link. For longer cable runs terminating resistors (typically 100Ω) may be required across the A and B terminals to reduce the possibility of signal corruption due to line reflections. The terminating resistors are only required at the first and last units on the RS422 link. Internal terminating resistors are fitted and can be link selected on the output board.



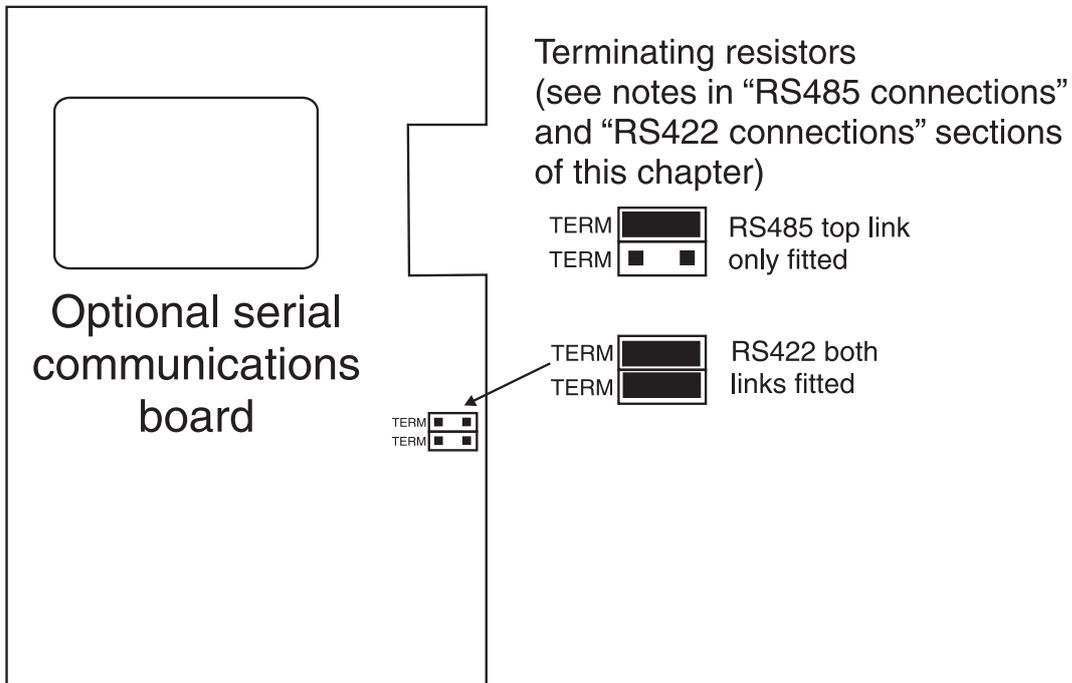
7.5 Multidrop RS422 connections



100Ω terminating resistors may be required across A & B to the first and last units in a multidrop chain. The RM4 has two internal link setting on its serial output board which allows connection of internal terminating resistors for Rs422. The terminating resistors are generally only required when long cable runs are used.

7.6 Configuring the output board

The serial output board has facilities for either RS232 or RS485 or RS422 communications. The configuration is factory configured and is not user alterable with the exception of terminating resistor links shown below. See chapter 1, page 3 for details on removal of the circuit boards.



8 Serial (RS232, RS485 and RS422) commands

The serial interface communication mode is user selectable at the **Q.Put** function. The selections available at the **Q.Put** function other than **̄.buS** and **A.buS** are covered in this section of the addendum. Refer to chapter 9, page 26 for details of the **̄.buS** mode. The **A.buS** mode is a special communications mode used only with the optional Windows live data and logging software option currently which is not available on all RM4 instruments. The **di SP.Cont** and **POLL** modes available operate as follows:-

8.1 **di SP** - Image display mode

This is a one way communications mode in which the display value on the instrument is sent as raw data in the following format:

<ESC>IXYYYY

Where <ESC> is the ASCII Escape character (27 Dec., 1B Hex.)
I is the ASCII character "I" (73 Dec., 49 Hex.)
X is the number of image bytes in ASCII (31 to 38 Hex)
YYYY is the raw 8 bit display data.

This information is output every display update (typically approx. 4 times per second). The number of image bytes sent depends on the number of display digits present. This mode is suitable only when the receiving unit is produced by the same manufacturer as the RM4. The most common usage would be to provide slave displays for the measuring instrument. The slave displays would automatically detect the image mode data and display the correct value accordingly. The data is in seven segment display image i.e. Bit 0 is segment A, Bit 1 is segment B etc.

8.2 **Cont** - Continuous output mode

In this mode the display value is continually sent via the serial interface in ASCII format with 8 data bits + 1 stop bit. Data will be updated at slightly less than the sample rate for the instrument being used. Note: some instruments have a function named **SEFL** which allows special selection of **Cont** output e.g. peak held value in continuous mode, check this function setting and the instruction manual for the instrument to determine the output if this function is fitted. The standard format for **Cont** mode is as follows:-

<STX>XYYYYY<CR>

Where <STX> is the ASCII Start of text character (2 Dec., 02 Hex.)
X is an ASCII Space character (32 Dec., 20 Hex.) for a positive value
X is the ASCII character "I" (45 Dec., 2D Hex) for a negative value
YYYYY is the display value in ASCII
<CR> is the ASCII Carriage return character (13 Dec., 0D Hex.)

e.g.: If the display is showing 12345 then the instrument will send 02 31 32 33 34 35 0D (HEX) to the host. The table below shows the outputs for instruments with more than one possible display value.

Model	Continuous output Note decimal points will also be sent if displayed
RM4-CO	<p><STX>YYYYY,XZZZZZ<CR> where: YYYYY is the measured value e.g. conductivity (5 characters/spaces) “,” is a comma (44 dec, 2C hex) X is a space or “-” sign ZZZZZ is the temperature value (5 characters/spaces)</p>
RM4-I4 or -V4	<p>In arithmetic mode: <STX>XUUUUU, XVVVVV,XWWWWW,XYYYYY ,XZZZZZ<CR> Where: X can be a number, space or“-” sign i.e. number range available is -9999 to 99999 UUUUU is the arithmetic result VVVVV is channel 1 value WWWW is channel 2 value YYYYY is channel 3 value ZZZZZ is channel 4 value</p> <p>In scan mode: <STX> XVVVVV,XWWWWW,XYYYYY,XZZZZZ<CR> Where: X can be a number, space or “-” sign i.e. number range available is -9999 to 99999 VVVVV is channel 1 value WWWW is channel 2 value YYYYY is channel 3 value ZZZZZ is channel 4 value</p>
RM4-IVT	<p>With SEFL function set to L, UE: <STX>XYYYYY<CR> where: X is a space or “-” sign YYYYY is the rate value (5 characters/spaces)</p> <p>With SEFL function set to totL: <STX>XZZZZZ<CR> where: X is a space or “-” sign ZZZZZ is the total value (5 characters/spaces)</p> <p>With SEFL function set to d, SP the value displayed at the time i.e. total or rate value will be transmitted in the formats described above.</p> <p>With SEFL function set to both: <STX>XYYYYY,XZZZZZ<CR> where: X is a space or “-” sign YYYYY is the rate value (5 characters/spaces),ZZZZZ is the total value (5 characters/spaces)</p>
RM4-PH	<p><STX>XYYYYYY<CR> where: X is a space or “-” sign YYYYYY is the pH or Redox (ORP) value (5 characters/spaces) Note: temperature value is not transmitted in this mode.</p>
RM4-TR or RM4-QC	<p>Rate mode: <STX>XYYYYY<CR> where: X is a space or “-” sign YYYYY is the rate value (5 characters/spaces)</p> <p>Total mode: <STX>XZZZZZ<CR> where: X is a space or “-” sign ZZZZZ is the total value (5 characters/spaces)</p> <p>Both mode (rate/total): < STX>XYYYYY,XZZZZZ<CR> where: X is a space or “-” sign YYYYY is the rate value (5 characters/spaces) “,” is a comma (44 dec, 2C hex) ZZZZZ is the total value (5 characters/spaces)</p>

8.3 **POLL** - Host Controlled Transmit Mode

This mode requires a host computer or PLC to poll the instrument to obtain display or other information or reset various setpoint parameters. Terminal communications software is required when using **POLL** mode with a PC. Data is in ASCII format with 8 data bits + 1 stop bit. Addresses are offset by 32 Dec. i.e. address 1 is 33 Dec. When polling the RM4 it is essential that the command characters are sent with less than a 10mS delay between them. This normally means that each command line must be sent as a whole string e.g. <STX>PA<CR> is sent as one string rather than <STX> on one line followed by P etc. If testing using at terminal program this is normally achieved by allocating a command string to a function key. Whenever the function key is operated the whole string is sent. The format used is ASCII (8 data bits + 1 stop bit) so, for instance, if address 1 is used then the string <STX>PA<CR> must be put into the terminal program as:

^BP!^M

where: ^B is the ASCII character for STX
P is the command line to transmit the primary display value
! is the ASCII character for address 1 (33 Dec of 21 Hex)
^M is the ASCII character for CR

A typical format for the host command is as follows:-

<STX>CA<CR> (Standard read etc.)
<STX>CA<CR>N<CR>XYYYYY (Set Value Command)

Where: <STX> is Start of Text Character (2 Dec, 02 Hex, ^B ASCII)
C is the command character (see following commands)
A is the unit address (Range: 32 to 63 Dec, 20 to 3F Hex, "SPACE" to ? ASCII the address is offset by 32 Dec, 20 Hex)
<CR> is Carriage Return (13 Dec, 0D Hex, ^M ASCII)
N is the setpoint number in ASCII e.g.: 1 for alarm 1 etc.
X SPACE for positive and "-" for negative
YYYYY is the setpoint value in ASCII

The **POLL** commands available and instrument responses are as follows:

1. Transmit Primary Display Value: <STX>PA<CR>

e.g. ^BP!^M using a terminal program (address 1). Instructs unit to return the primary display value. The primary value is the main reading.

Format of returned data is:

<ACK>PAXYYYYY<CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
P echo command received "P" (80 Dec, 50 Hex)
A is the responding units address
X SPACE for positive and "-" for negative
YYYYY is the display value in ASCII
<CR> is a Carriage Return (13 Dec, 0D Hex)

If the decimal point is non zero then it will be sent in the appropriate place as "." (46 Dec, 2E Hex). The primary display for most instruments is the main reading, in some instruments the main reading may not be obvious, for those instruments the primary display value is shown in the table

below.

Model	Primary display value
RM4-I4 OR V4	Channel 0 (result) in AFtH mode Use <STX>1A<CR> or <STX>2A<CR> or <STX>3A<CR> or <STX>4A<CR> to poll for channels 1, 2, 3 and 4 respectively in either AFtH or SCAN mode operation Use <STX>QA<CR> to poll for all channels. The format of returned data will be the same as that sent in continuous cont mode (see previous section)
RM4-IVT	Rate value
RM4-LN	Linearised value from table
RM4-pH	pH or Recox (ORP) value
RM4-TR and RM4-QC	Total in both mode, rate in both rALE and both modes

2. Transmit Secondary Display Value: <STX>SA<CR>

e.g. ^BS!^M using a terminal program (address 1). Instructs unit to return the secondary display value. If no secondary display value is used the instrument will return the primary display value. Format of returned data is:

<ACK>SAXYYYYY<CR>

Where:

<ACK>	is Acknowledge (6 Dec, 06 Hex)
S	echo command received "S" (83 Dec, 53 Hex)
A	is the responding units address
X	SPACE for positive and "-" for negative
YYYYYY	is the display value in ASCII
<CR>	is a Carriage Return (13 Dec, 0D Hex)

The number of display characters returned depends on the number of display digits present. If the decimal point is non zero then it will be sent in the appropriate place as "." (46 Dec, 2E Hex). The secondary display value, for instruments using a second display value rather than repeating the primary display value or returning the special function value, is shown in the table below.

Model	Secondary display value
RM4-C0	Temperature value
RM4-IVT	Total value
RM4-TR and RM4-QC	Total in both mode
Other RM4s	Returns primary display value or remote input special function value

3. Transmit Tertiary Display Value: <STX>TA<CR>

e.g. ^BT!^M using a terminal program (address 1). Instructs unit to return the tertiary display value. If no tertiary display value is used the instrument will return an invalid command character "?".

Format of returned data is:

<ACK>TAXYYYYY<CR>

Where:

<ACK>	is Acknowledge (6 Dec, 06 Hex)
T	is the echo command received "S" (84 Dec, 54 Hex)
A	is the responding units address
X	SPACE for positive and "-" for negative
YYYYYY	is the display value in ASCII
<CR>	is a Carriage Return (13 Dec, 0D Hex)

The number of display characters returned depends on the number of display digits present. If the decimal point is non zero then it will be sent in the appropriate place as “.” (46 Dec, 2E Hex). The tertiary display value, for instruments using a tertiary display value, is shown in the table below.

Model	Tertiary display value
RM4-IVT	Total value
RM4-LN	Input (I NP) value if linearising table is on
RM4-LNT	Input (I NP) value if linearising table is on
RM4-PH	Temperature value
Other RM4s	Returns invalid command “?” character

4. Reset Special Function Value: <STX>RA<CR>

e.g. \wedge BR” \wedge M using a terminal program (address 2). Instructs the unit to reset the remote input function value if applicable. For example the **ZERO** remote input function (**I NP**) can be used to reset the total or zero the display via the serial link i.e. with **I NP** set to **ZERO** a <STX>RA<CR> command sent to the instrument via the serial line will cause the display to zero.

Format of returned data is:-

<ACK>RA<CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
 R is the echo command received “R” (82 Dec, 52 Hex)
 A is the responding units address
 <CR> is a Carriage Return (13 Dec, 0D Hex)

If special functions are not active then the invalid command message will be returned (refer Invalid Command later).

5. Read Low Alarm Setpoint: <STX>LA<CR>N<CR>

e.g. \wedge BL” \wedge M2 \wedge M to read alarm 2 low setpoint value using a terminal program (address 2). Instructs the unit to return the low alarm setpoint value of the relay requested by the N character. i.e. when this command is sent the RM4 will return the alarm low setpoint value. The alarm value can be altered if required via the “Set low alarm setpoint” command which follows.

Format of returned data is:

<ACK>LANYYYYY<CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
 L is the echo command received “L” (76 Dec, 4C Hex)
 A is the responding units address
 N is the relay number in ASCII
 e.g.: 31 Hex would be alarm 1 etc.
 X is SPACE for positive and “-” for negative
 YYYYY is the setpoint value in ASCII
 <CR> is a Carriage Return (13 Dec, 0D Hex)

If relay number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>LA0).

6. Read High Alarm Setpoint: <STX>HA<CR>N<CR>

e.g. \wedge BH” \wedge M1 \wedge M to read alarm 1 high setpoint value using a terminal program (address 10). Instructs the unit to return the high alarm setpoint value of the relay requested by the N character. i.e. when this command is sent the RM4 will return the alarm high setpoint value. The alarm value can be altered if required via the “Set high alarm setpoint” command which follows.

Format of returned data is:

<ACK>HANXYYYYY<CR>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	H	is the echo command received "H" (72 Dec, 48 Hex)
	A	is the responding units address
	N	is the setpoint number in ASCII e.g.: 31 Hex would be alarm 1 etc.
	X	is SPACE for positive and "-" for negative
	YYYYY	is the setpoint value in ASCII
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>HA0).

7. Set Low Alarm Setpoint: <STX>lA<CR>N<CR>

e.g. ^Bl!^M1^M500^M to set alarm 1 low setpoint to 500 using a terminal program (address 1). Instructs unit to change value of low alarm setpoint of the relay selected by the N character. The alarm value can be examined if required via the "Read low alarm setpoint" command which has been described previously.

Format of returned data is:-

<ACK>lANXYYYYY<R>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	l	is the echo command received "l" (108 Dec, 6C Hex)
	A	is the responding units address
	N	is the setpoint number in ASCII e.g.: 31 Hex would be alarm 1 etc.
	X	is SPACE for positive and "-" for negative
	YYYYY	is the setpoint value in ASCII
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>lA0XYYYYY).

8. Set High Alarm Setpoint: <STX>hA<CR>N<CR>

e.g. ^Bh!^M1^M1000^M to set alarm 1 high setpoint to 1000 using a terminal program (address 1). Instructs unit to change value of high alarm setpoint of the relay selected by the N character. The alarm value can be examined if required via the "Read high alarm setpoint" command which has been described previously.

Format of returned data is:-

<ACK>hANXYYYYY<CR>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	h	is the echo command received "h" (104 Dec, 68 Hex)
	A	is the responding units address
	N	is the setpoint number in ASCII e.g.: 31 Hex would be alarm 1 etc.
	X	is SPACE for positive and "-" for negative
	YYYYY	is the setpoint value in ASCII
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>hA0XYYYYY).

9. Transmit Instrument Model and Version: <STX>IA<CR>

e.g. ^BI!^M using a terminal program (address 1) Instructs unit to return the model and software version number of the instrument.

Format of returned data is:-

<ACK>IACCX.X<CR>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	I	is echo command received "I" (73 Dec, 49 Hex)
	A	is the responding units address
	CC	is a 2 character model identifier (e.g.: tr)
	X.X	is the version number (e.g.: "0.1")
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

10. Invalid Command

If the command received from the host is not valid then the unit will return the following:-

<ACK>?A<CR>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	?	is the character "?" (63 Dec, 3F Hex)
	A	is the responding units address
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

If the address received from the host does not match the units address then the unit will not respond at all. Other commands may be added to suit the particular configuration of each instrument. Value read commands will have the same format as the "Transmit Primary Value" command. Set Value commands will have the same format as the "Set Low Alarm Setpoint" command etc.

8.4 Functions applicable to model RM4-WT only

The serial commands which follow are available for use with model RM4-WT only

A. Tare Using Current Display Value: <STX>TA<CR>

e.g. ^BT!^M using a terminal program (address 1). Instructs the unit to tare the instrument using the current display value (if tare has been selected in special functions mode).

Format of returned data is:-

<ACK>TA<CR>

Where:	<ACK>	is Acknowledge (6 Dec, 06 Hex)
	T	is echo command received "T" (84 Dec, 54 Hex)
	A	is the responding units address
	<CR>	is a Carriage Return (13 Dec, 0D Hex)

If tare is not valid then the invalid command message will be returned (refer to "Invalid Command").

B. Read Default Calibration Channel: <STX>CA<CR>

e.g. ^BC!^M using a terminal program (address 1) This command reads the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If

using the serial interface to change the default calibration channels then the **P** button or external input settings should not be set to **C.SEL**.

Format of returned data is:-

<ACK>CA<channel number> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
 C is echo command received "C" (67 Dec, 43 Hex)
 A is the responding units address
channel number is the channel number 1 or 2
 <CR> is a Carriage Return (13 Dec, 0D Hex)

C. Set Default Calibration Channel: <STX>cA<CR> <channel number> <CR>

e.g. ^Bc!^M2^M to set default channel to 2 using a terminal program (address 1). This command sets the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If using the serial interface to change the default calibration channels then the **P** button or external input settings should not be set to **CAL.S**.

Format of returned data is:-

<ACK>cA<channel number> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
 c is echo command received "c" (99 Dec, 63 Hex)
 A is the responding units address
channel number is the channel number 1 or 2
 <CR> is a Carriage Return (13 Dec, 0D Hex)

D. Read ADC Calibration Gain: <STX>GA<CR>

e.g. ^BG"^M using a terminal program (address 2).

This is set for the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If using the serial interface to change the default calibration channels then the P button or external input settings should not be set to **CAL.S**. Note: The gain reading is only valid on the actual instrument it is read from and may give errors if used with other instrument. Format of returned data is:-

<ACK>GA<adc gain> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
 G is echo command received "G" (71 Dec, 47 Hex)
 A is the responding units address
adc gain is the adc gain as a floating point number
 <CR> is a Carriage Return (13 Dec, 0D Hex)

E. Set ADC Calibration Gain: <STX>gA<CR> <adc gain> <CR>

e.g. ^Bg"^M0.0002134^M using a terminal program (address 2). This is set for the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If using the serial interface to change the default calibration channels then the P button or external input settings should not be set to **CAL.S**. Note: The value returned may not be exactly the same as the number sent. The internal floating point accuracy is only to around 24 bits and some rounding in the last digits may occur.

Format of returned data is:-

<ACK>gA<adc gain> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
g is the echo command received "g" (103 Dec, 67 Hex)
A is the responding units address
adc gain is the adc gain as a floating point number
<CR> is a Carriage Return (13 Dec, 0D Hex)

F. Read ADC Zero Offset: <STX>ZA<CR>

e.g. ^BZ!^M using a terminal program (address 1). This is set for the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If using the serial interface to change the default calibration channels then the P button or external input settings should not be set to **CAL.5**.

Format of returned data is:-

<ACK>ZA<adc zero> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
Z is the echo command received "Z" (90 Dec, 5A Hex)
A is the responding units address
adc zero is the adc gain as a floating point number
<CR> is a Carriage Return (13 Dec, 0D Hex)

G. Set ADC Calibration Zero: <STX>zA<CR><adc zero> <CR>

e.g. ^Bz!^M-00120.321^M using a terminal program (address 1). This is set for the default calibration channel. If the external inputs or the P button are configured to change the calibration channel selection then the channel used for the actual gain may not be the default calibration channel. If using the serial interface to change the default calibration channels then the P button or external input settings should not be set to **CAL.5**. Note: The value returned may not be exactly the same as the number sent. The internal floating point accuracy is only to around 24 bits and some rounding in the last digits may occur.

Format of returned data is:-

<ACK>zA<adc zero> <CR>

Where: <ACK> is Acknowledge (6 Dec, 06 Hex)
z is the echo command received "z" (122 Dec, 7A Hex)
A is the responding units address
adc zero is the adc gain as a floating point number
<CR> is a Carriage Return (13 Dec, 0D Hex)

Host Timing Requirements for RS485 Operation:

RS485 operation requires the host to switch the RS485 transceiver to transmit before a command is sent. The instrument is capable of replying after 1 to 2 milliseconds. Therefore the host should switch the RS485 transceiver back to receive mode within 0.5 milliseconds after the last character of the command has been sent to ensure correct operation.

9 Modbus communication

This section covers the use of Modbus RTU communications when using the RM4 monitor. When using Modbus communications the instrument must be set up electrically for serial communications and the RM4 **0.Pvt** function must be set to **̄.b.u.S**. The Modbus option is not available on all RM4 models, see details later in this chapter. In all models in which Modbus is provided Functions 1 and 3 are available. Function 6 and 16 are currently only available on the RM4-CO, RM4-PH, RM4-RS and RM4-WT instruments.

Modbus commands

Note: the maximum recommended baud rate is 9600, do not use Modbus address 0. The following commands are available:

9.1 Function 1 - Read coil status

Reads the ON/OFF status of the relay coils. Broadcast is not supported. Relays 1 to 4 are addressed as 0 to 3. Logic 1 = ON, Logic 0 = OFF. To read the coil status a query is sent to the RM4, the RM4 then responds to the query. An example of a query to read coils 1 to 4 from the RM4 at address 2 is given below.

Field name	Example (Hex)
Unit address	02
Function	01
Starting address Hi	00
Starting address Lo	00
Number of points Hi	00
Number of points Lo	04
Error check (LRC or CRC) Hi	– (automatically generated number)
Error check (LRC or CRC) Lo	– (automatically generated number)

An example of a response is given in the table below:

Field name	Example (Hex)
Unit address	02
Function	01
Byte count	01
Data coils (7 to 1)	04
Error check (LRC or CRC) Hi	– (automatically generated number)
Error check (LRC or CRC) Lo	– (automatically generated number)

The status of the relay coils is shown in the Data 04 (hex) or binary 0100. Relay 1 is indicated by the LSB. The status of the relays is therefore: Relay 1 - OFF, Relay 2 - OFF, Relay 3 - ON, Relay 4 - OFF

9.2 Function 3 - Read holding registers

This function reads the binary contents of the holding registers in the RM4 being addressed. Each value is stored in the RM4 as a 32 bit value stored in two 16 bit registers per set of values i.e. 4 bytes per set of values. Note: an overrange indication value depends on the number of display digits e.g. for a 5 digit display 100,000 decimal or 186A0 hex indicates a positive overrange and -20,000 decimal or FFFFB1E0 hex will represent a negative overrange since these numbers are just

outside the display range of a 5 digit display (99999 to -19999). The register allocation depends on model type, see the register table overleaf. An example of a query to read holding registers 1 to 8 from the RM4 at address 1 is given below.

Field name	Example (Hex)
Unit address	01
Function	03
Starting address Hi	00
Starting address Lo	00
Number of points Hi	00
Number of points Lo	08
Error check (LRC or CRC) Hi	44 (automatically generated number)
Error check (LRC or CRC) Lo	0C (automatically generated number)

This would be transmitted as 01 03 00 00 00 08 44 0C where:

01 is the unit address (set at the RM4 Addr function)

03 is the function number (function 3)

00 00 is the starting address of zero. Note addresses 0 to 7 correspond to registers 1 to 8.

00 08 is the number of points required (08 hex.)

44 0C is the error check (generated by the modbus program)

An example of a response is given below:

Field name	Example (Hex)
Unit address	01
Function	03
Byte count	10
Data Hi (register 1)	00
Data Lo (register 1)	00
Data Hi (register 2)	00
Data Lo (register 2)	3E
Data Hi (register 3)	00
Data Lo (register 3)	00
Data Hi (register 4)	00
Data Lo (register 4)	3E
Data Hi (register 5)	00
Data Lo (register 5)	00
Data Hi (register 6)	01
Data Lo (register 6)	3D
Data Hi (register 7)	00
Data Lo (register 7)	00
Data Hi (register 8)	05
Data Lo (register 8)	8B
Error check (LRC or CRC) Hi	84 (automatically generated number)
Error check (LRC or CRC) Lo	65 (automatically generated number)

An example of the entire message transmitted and received in this example is:

tx: 01 03 00 00 00 08 44 0C

rx: 01 03 10 00 00 00 3E 00 00 00 3E 00 00 01 3D 00 00 05 8B 84 65

If the instrument were model RM4-TR (see register table which follows) then the data received (rx:) is interpreted as follows:

01 is the address of the RM4-TR

03 denotes function 3

10 is the byte count (10 hex., 16 decimal) i.e. 16 bytes at 4 bytes per set of data

00 00 00 3e is the rate value 3e hex., 62 decimal (requires 4 bytes i.e. 2 registers)

00 00 00 3e is the same rate value again

00 00 01 3d is the total value (13d hex., 317 decimal)

00 00 05 8b is the grand total value (58b hex., 1419 decimal)

84 65 is the error check value generated

9.3 Register table

Address	Register	Modbus available in RM4 models CO, FX, I4, IV, IVT, LN, PH, QC, RS, TCR, TR, V4 and WT (rate val- ues returned for IVT, linearised val- ues for LN, no temperature for PH)	Comments/variations
0x00	1	Display value high word	RM4-I4 or -V4 Arithmetic result (Channel 0) high word
0x01	2	Display value low word	RM4-I4 or -V4 Arithmetic result (Channel 0) low word
0x02	3	Valley memory high word	RM4-TR or -QC Rate high word RM4-CO Temperature high word
0x03	4	Valley memory low word	RM4-TR or -QC Rate low word RM4-CO Temperature low word
0x04	5	Peak memory high word	RM4-TR or -QC Total high word RM4-CO Valley memory high word
0x05	6	Peak memory low word	RM4-TR or -QC Total low word RM4-CO Valley memory low word
0x06	7	Display hold high word	RM4-TR or -QC Grand total high word RM4-CO Peak memory high word
0x07	8	Display hold low word	RM4-TR or -QC Grand total low word RM4-CO Peak memory low word
0x08	9	A1H , setpoint high word	
0x09	10	A1H , setpoint low word	
0x0A	11	A2H , setpoint high word	
0x0B	12	A2H , setpoint low word	
0x0C	13	A3H , setpoint high word	
0x0D	14	A3H , setpoint low word	
0x0E	15	A4H , setpoint high word	
0x0F	16	A4H , setpoint low word	
0x10	17	A1Lo setpoint high word	
0x11	18	A1Lo setpoint low word	
0x12	19	A2Lo setpoint high word	
0x13	20	A2Lo setpoint low word	
0x14	21	A3Lo setpoint high word	
0x15	22	A3Lo setpoint low word	
0x16	23	A4Lo setpoint high word	
0x17	24	A4Lo setpoint low word	
0x18	25	Decimal point value	RM4-TR or -QC rate decimal point RM4-CO Conductivity/resistivity decimal point RM4-I4 or -V4 Arithmetic result (Channel 0) decimal point

0x19	26	Decimal point, multi channel instruments	RM4-TR or -QC total decimal point RM4-I4 or -V4 Channel 1 decimal point
0x1A	27	Decimal point, multi channel instruments	RM4-I4 or -V4 Channel 2 decimal point
0x1C	28	Decimal point, multi channel instruments	RM4-I4 or -V4 Channel 3 decimal point
0x1C	29	Decimal point, multi channel instruments	RM4-I4 or -V4 Channel 4 decimal point
0x20	33	Display value, multi channel instruments	RM4-I4 or -V4 Channel 1 display high word
0x21	34	Display value, multi channel instruments	RM4-I4 or -V4 Channel 1 display low word
0x22	35	Display value, multi channel instruments	RM4-I4 or -V4 Channel 2 display high word
0x23	35	Display value, multi channel instruments	RM4-I4 or -V4 Channel 2 display low word
0x24	37	Display value, multi channel instruments	RM4-I4 or -V4 Channel 3 display high word
0x25	38	Display value, multi channel instruments	RM4-I4 or -V4 Channel 3 display low word
0x26	39	Display value, multi channel instruments	RM4-I4 or -V4 Channel 4 display high word
0x27	3A	Display value, multi channel instruments	RM4-I4 or -V4 Channel 4 display low word

Note: the peak memory, valley memory and display hold will only respond to the command if a remote input or P button function (**P.but**) is set for the function required.

9.4 Function 6 Preset single register and function 16 Preset multiple registers

The registers for these modes are shown below, this mode is currently only available on model RM4-CO, RM4-PH, RM4-RS and RM4-WT din rail meters. Note that when using these modes the alarm values are not stored in EPROM memory. If power is removed the alarm setpoints will revert to those manually set via the instrument keypads once the instrument is powered up again. To set a relay setpoint to its OFF state set the high word for the relay to 80(hex) and the low word to 00(hex). The alarm values viewed on the RM4 seven segment display will be those stored in EPROM and not those entered via Modbus commands. Two relays are provided as standard on the instruments above, an extra two optional relays are available on the RM4-RS only.

Address	Register	Description
0x100	257	Alarm relay 1 high setpoint high word
0x101	258	Alarm relay 1 high setpoint low word
0x102	259	Alarm relay 2 high setpoint high word
0x103	260	Alarm relay 2 high setpoint low word
0x104	261	Alarm relay 3 high setpoint high word
0x105	262	Alarm relay 3 high setpoint low word
0x106	263	Alarm relay 4 high setpoint high word
0x107	264	Alarm relay 4 high setpoint low word
0x108	265	Alarm relay 1 low setpoint high word
0x109	266	Alarm relay 1 low setpoint low word
0x10A	267	Alarm relay 2 low setpoint high word
0x10B	268	Alarm relay 2 low setpoint low word
0x10C	269	Alarm relay 3 low setpoint high word
0x10D	270	Alarm relay 3 low setpoint low word
0x10E	271	Alarm relay 4 low setpoint high word
0x10F	272	Alarm relay 4 low setpoint low word

Relays 1 and 2 are standard on most RM4 instruments (only 1 relay is standard on RM4-AI and RM4-AV instruments). Relays 3 and 4 shown in the table above are optional.

An example of using function 6 to set Alarm 1 high setpoint to 2C (44 dec.) at an RM4 with address 2 is:

Field name	Example (Hex)
Unit address (node number)	02
Function	06
Register address Hi	01
Register address Lo	00
Value Hi	00
Value Lo	2C
Error check (LRC or CRC)	–

An example of a function 6 response is given below:

Field name	Example (Hex)
Unit address (node number)	02
Function	06
Register address Hi	01
Register address Lo	00
Value Hi	00
Value Lo	2C
Error check (LRC or CRC)	–

An example of using function 16 to set Alarm 1 high setpoint to 2C (44 dec.) and Alarm 2 high setpoint to 50 (80 dec.) at an RM4 with address 2 is:

Field name	Example (Hex)
Unit address (node number)	02
Function	10
Register starting address Hi	01
Register starting address Lo	00
Number of registers Hi	00
Number of registers Lo	02
Byte count	04
Data Hi	00
Data Lo	2C
Data Hi	00
Data Lo	50
Error check (LRC or CRC)	–

An example of a function 16 response is as follows:

Field name	Example (Hex)
Unit address (node number)	02
Function	10
Register starting address Hi	01
Register starting address Lo	00
Number of registers Hi	00
Number of registers Lo	02
Error check (LRC or CRC)	–

10 Analog PI control output

PI control functions will only be seen if PI control software is available for the instrument and if the optional isolated analog or dual isolated analog output is fitted. In dual analog instruments only the first output can be set for PI control output.

The PI (proportional + integral) control output may be configured for proportional only (i.e. integral gain set to 0.000) or proportional + integral control. The control output may be link selected as either a 4-20mA, 0-1VDC or 0-10VDC signal. Using the control function settings described below the instrument will vary the control output signal in such a way that the process being monitored is kept as close as possible to the control setpoint. The control may be turned on or off via the **FEECtrl** function. When the **FEECtrl** function is set to **OFF** the output will act as a retransmission output rather than a control output and the PI control functions will not be seen. When set to **on** the PI control functions will be seen but the standard retransmission functions (e.g. **FEE-** and **FEE+**) will not.

The  or  buttons may be used to view the control setpoint when PI control is used. The best PI control results are usually achieved by initially configuring as a proportional only controller and introducing the Integral control once stable results have been obtained from proportional only control.

10.1 Proportional control output

For proportional only control the output is found from:

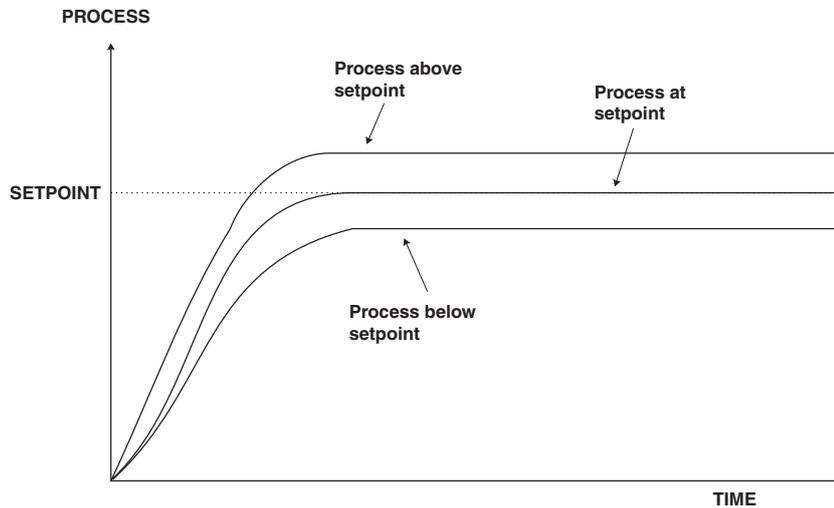
$$\textit{Proportional control output} = \textit{Error} \times \textit{Proportional gain} + \textit{Offset}$$

Where the Error is defined by the **C.SPn** function, the Proportional gain is set by the **C.PG** function and the Offset is set by the **C.PO** function.

10.2 PI analog control setpoint

Display: **C.SET**
Range: Any display value
Default Value: **0**

The control setpoint is set to the value in displayed engineering units required for control of the process. The controller will attempt to vary the control output to keep the process variable at the setpoint. Note that the control setpoint can be made available in **FUNC** mode and in some cases in “easy access” mode via the **FEE SPAC** function described in this chapter.



10.3 PI analog control on or off

Display: **FEC ctrl**
 Range: **on** or **OFF**
 Default Value: **OFF**

This function determines whether the analog output will be used as a PI control output or as a retransmission output. When **on** is selected the analog output will be used as a control output, all of the control functions will be seen but no analog retransmission functions will be seen. When set to **OFF** the analog output will be used as a retransmission output, the retransmission functions, such as **FEC**, **FEC-** and **FEC+** will be seen and the control functions will not appear on the display.

10.4 PI analog control span

Display: **C.SPAN**
 Range: **0** to any positive display value
 Default Value: **0**

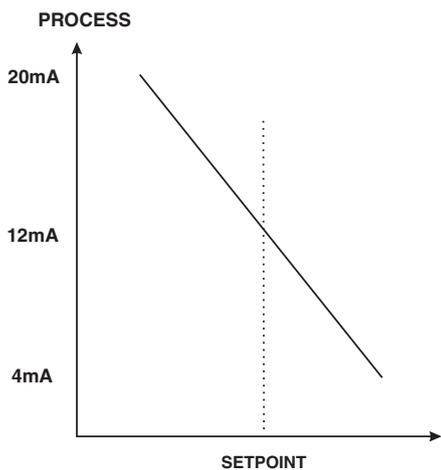
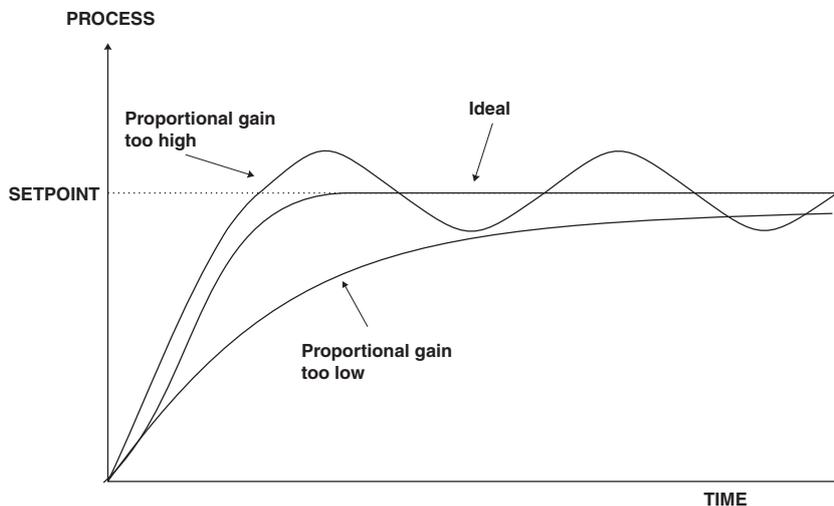
The function of the control span is to define the limit to which the proportional control values will relate. The span value defines the range over which the input must change to cause a 100% change in the control output when the proportional gain is set to 1.000. This function affects the overall gain of the controller and is normally set to the process value limits that the controller requires for normal operation. For example if the control setpoint (**C.SET**) is **50.0** and the **C.SPAN** is **15** then an error of 15 from the setpoint will cause a 100% change in proportional control output. For example, assuming that the control output is a 4-20mA signal, with **C.SET** at **50.0**, **C.SPAN** at **15.0**, **C.PG** at **1.000** and **C.PO** at **0.000** a display reading of **35.0** or lower (**C.SET - C.SPAN**) the control output will be at 100% i.e. 20mA. The control output will then gradually fall as the display value reaches the setpoint.

10.5 PI analog proportional gain

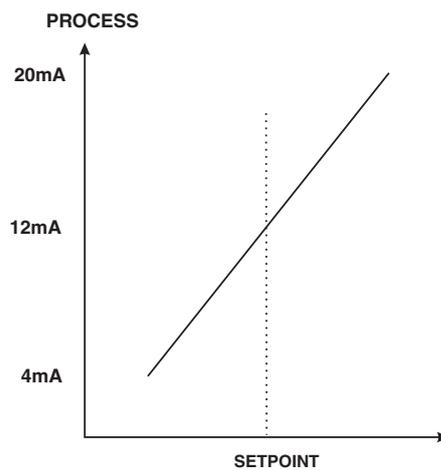
Display: **C.PG**
 Range: **-32.767** to **32.767** number of display digits allowing
 Default Value: **0.000**

The proportional gain is the ratio between the change in measured input and change in control

output. Too much proportional gain will result in instability. Example 1, if the proportional gain is set to **1.000** and the measured input changes by 100% of the span set in **C.SPn** then the output will change by 100%. Example 2, if the proportional gain is set to **2.000** and the measured input changes by 50% of the range set in **C.SPn** then the output will change by 100%. Example 3, if the proportional gain is set to **2.000** and the measured input changes by 25% of the range set in **C.SPn** then the output will change by 50%. Setting a negative proportional gain will reverse the control output.



Positive **C.P9** value e.g. **1.000**



Negative **C.P9** value e.g. **-1.000**

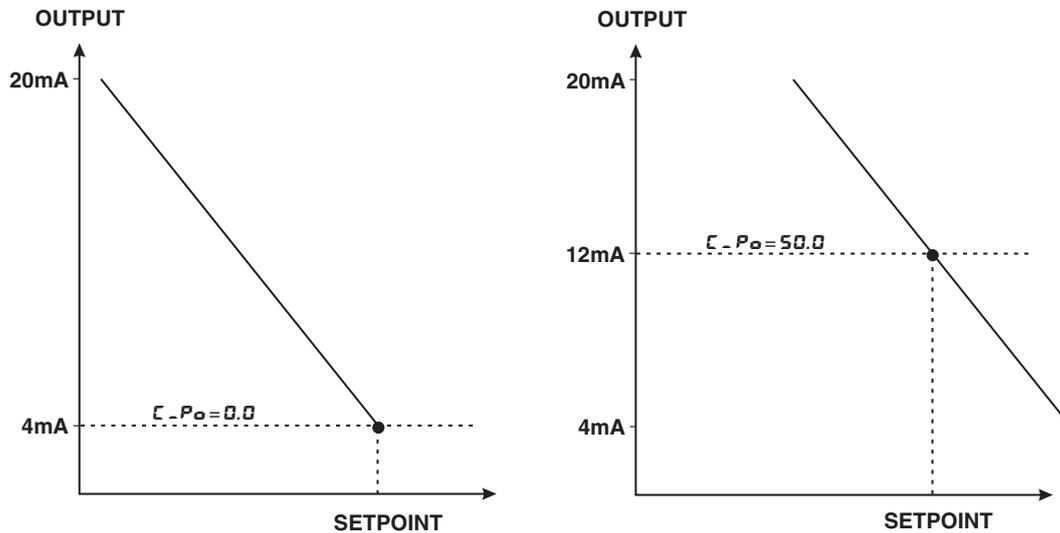
This table shows the effect of the output current of changing proportional gain and offset with the following settings: **C.SPn = 2.00, C.I 9 = 0.000**

C.SET	C.P9	C.Po	Effect on analog output (4-20mA used in this example)
7.00	1.000	0.0	Reading of 5.00 or below - 20mA output Reading of 5.00 to 7.00 - mA output decreasing as reading approaches 9.00 Reading 7.00 or above - 4mA output
7.00	1.000	100.0	Reading of 7.00 or below - 20mA output Reading of 7.00 to 9.00 - mA output decreasing as reading approaches 9.00 Reading 9.00 or above - 4mA output
7.00	1.000	50.0	Reading of 6.00 or below - 20mA output Reading of 6.00 to 8.00 - mA output decreasing as reading approaches 8.00 with 12mA output at 7.00 Reading 8.00 or above - 4mA output
7.00	0.500	50.0	Reading 5.00 or below - 20mA output Reading 5.00 to 9.00 - mA output decreasing as reading approaches 9.00 with 12mA output at 7.00 Reading 9.00 or above - 4mA output
7.00	- 1.000	50.0	Reading of 6.00 or below - 4mA output Reading of 6.00 to 8.00 - mA output increasing as reading approaches 8.00 with 12mA output at 7.00 Reading 8.00 or above - 20mA output

10.6 PI analog proportional offset %

Display: **C.Po**
 Range: **0.0** to **100.0**
 Default Value: **0.0**

The proportional offset is initially used to set the output value when operating the instrument as a proportional only controller. The proportional offset determines what % of the proportional control output will be given when the process value reaches the setpoint value. If set to **0.0** then there will be zero output (e.g. 4mA for a 4-20mA output) when the process value reaches the setpoint value. If set to **50.0** then there will be a 50% output (e.g. 12mA for a 4-20mA output) when the process reaches the setpoint value. If set to **100.0** then there will be a 100% output (e.g. 20mA for a 4-20mA output) when the process reaches the setpoint value. If using proportional only control then when stable control is established there may be a difference between the process and the setpoint values. By altering the proportional offset value the difference may be minimised.



Proportional only control examples

For a 4-20mA control output (0% = 4mA and 100% = 20mA) the setpoint is 7.0, the span is 2.0, the proportional gain is 1.000 and the offset is 0.0. If the reading on the display is 6.8 then the error is 10% (i.e. 10% of the span figure).

$$\text{Proportional control output} = \text{Error} \times \text{Proportional gain} + \text{Offset}$$

$$\text{Proportional control output} = 10\% \times 1 + 0\% = 10\% \text{ or } 5.6\text{mA}$$

If the proportional gain were to be changed to 2.000 then:

$$\text{Proportional control output} = 10\% \times 2 + 0\% = 20\% \text{ or } 7.2\text{mA}$$

If the proportional gain were to be changed to 0.500 then:

$$\text{Proportional control output} = 10\% \times 0.5 + 0\% = 5\% \text{ or } 4.8\text{mA}$$

If the offset were now to be changed to 50.0 (50%) then:

$$\text{Proportional control output} = 10\% \times 2 + 50\% = 55\% \text{ or } 12.8\text{mA}$$

10.7 Integral control output

The integral control output can be found from:

$$\text{Integral control output} = \frac{\text{Error} \times \text{IG} \times \text{time}(\text{secs})}{60} + \text{previous integral control output}$$

Where IG is the integral gain is set by the **C.19** function.

10.8 PI analog integral gain

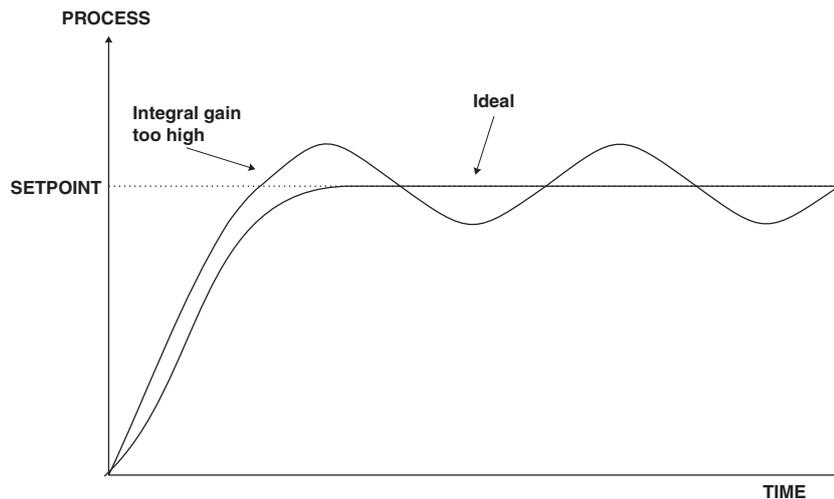
Display: **C.19**

Range: **-32.767** to **32.767** number of display digits allowing

Default Value: **0.000**

The integral control action will attempt to correct any offset which the proportional control action is unable to correct (e.g. errors due to a changing load). When the integral gain is correctly adjusted

the control output is ramped up or down to maintain control by keeping the process variable at the same value as the control setpoint. An integral gain which is too large will cause a rapid response to any error but can also lead to overshooting and oscillation. An integral gain which is too small will slow the time taken to reach the setpoint. The optimum value chosen will depend on the lag time of the process and other control settings. Start with a low figure and increase until a satisfactory response time is reached. The integral gain figure has units of gain/minute. Setting a negative integral gain will reverse the integral control action. If introduction of an integral gain figure causes the error to increase i.e. the process value is moving further away from the setpoint then check the sign of the integral gain e.g. if it is negative change it to a positive value. Note that the sign of the integral gain value should be the same as the proportional gain value i.e. they should either both be positive or both be negative.



10.9 PI analog integral limit high

Display: **ILH**
Range: **0.0 to 100.0**
Default Value: **0.0**

The high limit sets the maximum control output for the integral term i.e. puts a high level limit to the integral control current or voltage output. The limit is used to reduce available output swing and hence limit the effect of integral control output build up which can cause overshoot and instability in the system. If the process value is not close to the setpoint value then the integral control will see a large error. Since integral control output increases with time, the longer an error is seen the more the integral control output will build up. Unless the output is limited then once the process reaches the setpoint the integral control output can be very large (e.g. 100%) causing the process value to overshoot the control setpoint. A setting which is too high will result in allowing the integral control output to cause overshooting. A setting which is too low will result in the integral control output being limited to an extent which means that the setpoint cannot be reached. Start with a low figure e.g. 10.0 and increase the value until a satisfactory response is reached. Maximum setting is 100.0 (100%). Having separate high and low limits is particularly useful if the process response is very one directional. For example in temperature control a heater may be used to give a fast response in heating a tank of liquid when the temperature falls below the setpoint. The heat of the liquid rises quickly but any overshoot will mean that the temperature is too high. The heater will be switched off but the tank of liquid will take a long time to cool to the setpoint level.

10.10 PI analog integral limit low

Display: **C I L L**
Range: **0.0** to **100.0**
Default Value: **0.0**

This function sets the minimum control output for the integral term value and works in the same manner as **C I L H** described above except that the setting controls the low swing.

10.11 PI analog setpoint access

Display: **F E C S P A C**
Range: **o n** or **O F F**
Default Value: **O F F**

This function determines whether the control setpoint function **C S E t** can be accessed via **F U N C** mode or whether entry via **C A L** mode is needed to access **C S E t**. If the operator is to have access to the **C S E t** function (via **F U N C** mode) then set the **F E C S P A C** function to **o n**. To make the access to the **C S E t** function more difficult (**C A L** mode) then set the **F E C S P A C** function to **O F F**. Note that in some models the control setpoint value can be reached and adjusted via the “easy access” mode (see “Explanation of functions” chapter in the main manual). The **A C C S** function must be set to **E A S Y** and the **F E C S P A C** function set to on to allow “easy access”. This feature could be useful if the setpoint is to be frequently changed. If no **F E C S P A C** is set to **o n** and **A C C S** is set to **E A S Y** but the easy access is not functioning then the “easy access” facility may not be available on that instrument.

10.12 Setting up the PI analog controller

1. Set the **F E C c t r l** function to **o n**.
2. Set the control setpoint **C S E t** to the required setting.
3. Set the proportional control span **C S P n** as required.
4. Set the proportional gain **C P g** to an arbitrary value e.g. 1.000.
5. Set the proportional offset **C P O** to 0.0 (0%).
6. Set the integral gain **C I g** to 0.000 (i.e. off).
7. Set the integral high and low limits to an arbitrary value e.g. 20.00.

Initialise the control system and monitor the control results. If the original settings causes process oscillations then gradually decrease the proportional gain until the oscillations decrease to an acceptable steady cycle. If the original settings do not cause process oscillations then gradually increase the proportional gain until a steady process cycling is observed. Once the steady state is achieved note the difference between the display value and the control setpoint value. Gradually increase or decrease the proportional offset value until the displayed value matches the control setpoint value. If process load changes occur then the proportional offset value may no longer be valid for offset free control. By introducing the integral action, setpoint offset caused by the process load changes will be minimised. Gradually increase the integral gain until the process begins to

oscillate. Then reduce the integral gain slightly to regain the control with minimum oscillation. Alter the high and low integral limits to give the best regulation with minimum oscillation. Create a step change to the process conditions and observe the control results. It may be necessary to fine tune the settings to obtain optimum results. The table below summarises the effect of the main function settings.

Setup functions	Symptom	Solution
Proportional gain	Slow response	Increase proportional gain
	High overshoot or oscillation	Decrease proportional gain
Proportional offset	Process continually either above or below setpoint	Increase or decrease offset to compensate
Integral gain	Slow response	Increase integral gain
	Instability or oscillation	Decrease integral gain

11 Guarantee and service

The product supplied with this manual is guaranteed against faulty workmanship for a period of 2 years from the date of dispatch.

Our obligation assumed under this guarantee is limited to the replacement of parts which, by our examination, are proved to be defective and have not been misused, carelessly handled, defaced or damaged due to incorrect installation. This guarantee is VOID where the unit has been opened, tampered with or if repairs have been made or attempted by anyone except an au authorised representative of the manufacturing company.

Products for attention under guarantee (unless otherwise agreed) must be returned to the manufacturer freight paid and, if accepted for free repair, will be returned to the customers address in Australia free of charge.

When returning the product for service or repair a full description of the fault and the mode of operation used when the product failed must be given. In any event the manufacturer has no other obligation or liability beyond replacement or repair of this product.

Modifications may be made to any existing or future models of the unit as it may deem necessary without incurring any obligation to incorporate such modifications in units previously sold or to which this guarantee may relate.

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