Model RM4-PH
DIN Rail Mount
pH/Redox
Process Monitor/Controller
Operation and Instruction Manual

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1 Introduction

1.1 General description

This manual contains information for the installation and operation of the RM4 pH/Redox(ORP) Monitor. The RM4-PH is a general purpose monitor which may be configured to accept an input from a standard pH electrode (E_0=7), an electronic unity gain buffer amplifier or a standard Redox electrode. The instrument is user configurable for use as a pH or Redox monitor. A temperature sensor input is provided for temperature indication and automatic pH temperature compensation. The RM4-PH can accept temperature sensor types Pt100 (100Ω RTD), Pt1000 (1000Ω RTD) or 3kΩ thermistor or a default temperature can be manually set. The display can be toggled between the pH (or Redox) and temperature display via the ▲ and ▼ pushbuttons. A °C message will flash prior to the temperature display. Calibration, setpoint and other set up functions are easily achieved by push buttons located on the front panel.

Alarm relays and optional retransmission may be set to operate from the live input value, the display value (whatever is on the display at the time) or the temperature or to follow remote input operations of peak hold, display hold, peak memory or valley memory.

Unless otherwise specified at the time of order, your RM4 has been factory set to a standard configuration. Like all other RM4 series instruments the configuration and calibration is easily changed by the user. Initial changes may require dismantling the instrument to alter PCB links, other changes are made by push button functions.

Full electrical isolation between power supply, input voltage or current and optional retransmission output is provided by the RM4, thereby eliminating grounding and common voltage problems. This isolation feature makes the RM4 ideal for interfacing to computers, PLCs and other data acquisition devices.

The RM4 series of DIN Rail Process Modules are designed for high reliability in industrial applications. The 5 digit LED display provides good visibility, even in areas with high ambient light levels. A feature of the RM4 is the programmable display brightness function, this allows the unit to be operated with low display brightness to reduce the instrument power consumption and to improve readability in darker areas. To reduce power consumption in normal use the display can be programmed to automatically dim or blank after a set time, the display will return to its normal brightness level if any of the pushbuttons are pressed or if an alarm relay is activated.

1.2 Standard outputs

- Two standard inbuilt relays provides an alarm/control function
  (can be set for on/off alarm/control or PI control using pulse width or frequency control)

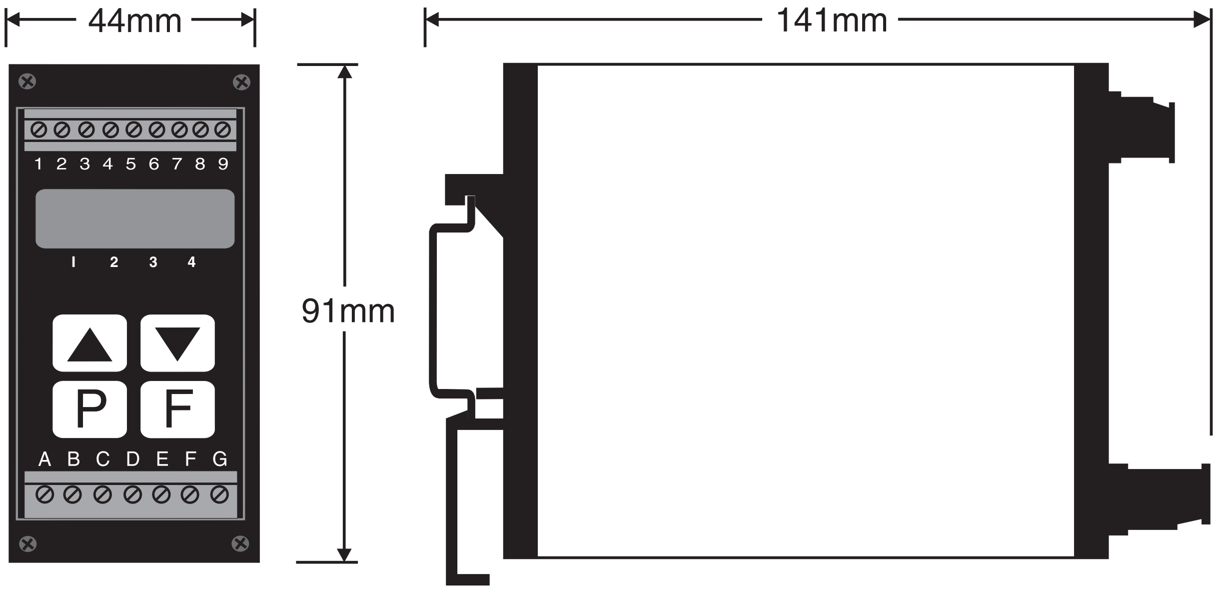
1.3 Output options

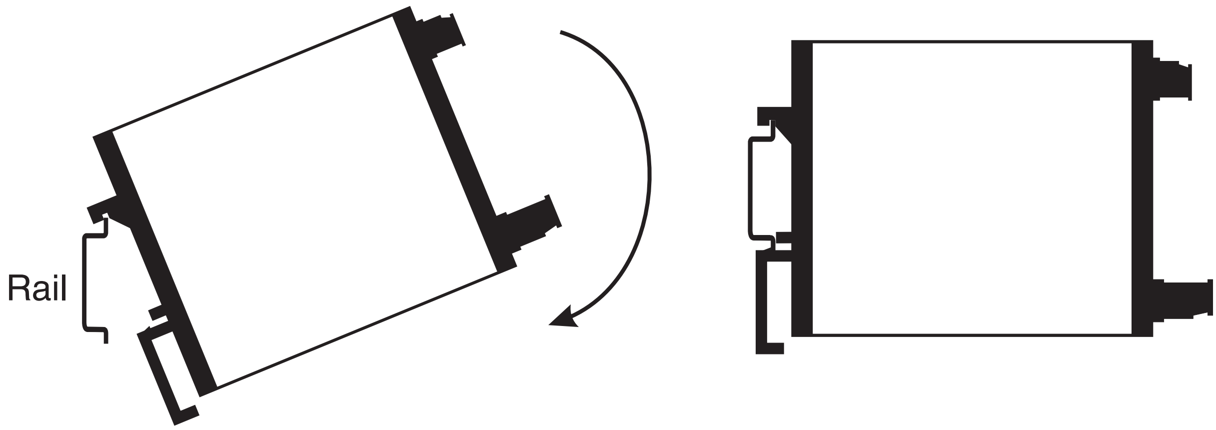
- 1 or 2 extra relays (not configurable for PI control)
- Dual output transistor switched 24VDC (non isolated)
- Isolated 12 bit analog retransmission (single or dual analog output versions available) configurable for 4–20mA, 0–1V or 0–10V. The first analog output is configurable for retransmission or PI control

- Isolated 16 bit analog retransmission configurable for retransmission or PI control plus extra relay
- 12VDC or 24VDC (link selectable) isolated transmitter supply/excitation voltage (25mA max.). Not to be used with the standard 24VDC unregulated transmitter supply
- Isolated RS232, RS485 or RS422 serial communications (8 bit ASCII or Modbus RTU)
- Optional outputs are available in certain combinations e.g. Analog output plus extra relay

2 Mechanical installation

The instrument is designed for DIN rail mounting. The instrument clips on to 35mm DIN standard rails (EN50022). Cut the DIN rail to length and install where required. To install the instrument simply clip onto the rail as shown below. To remove the instrument lever the lower arm downwards using a broad bladed screwdriver to pull the clip away from the DIN rail.





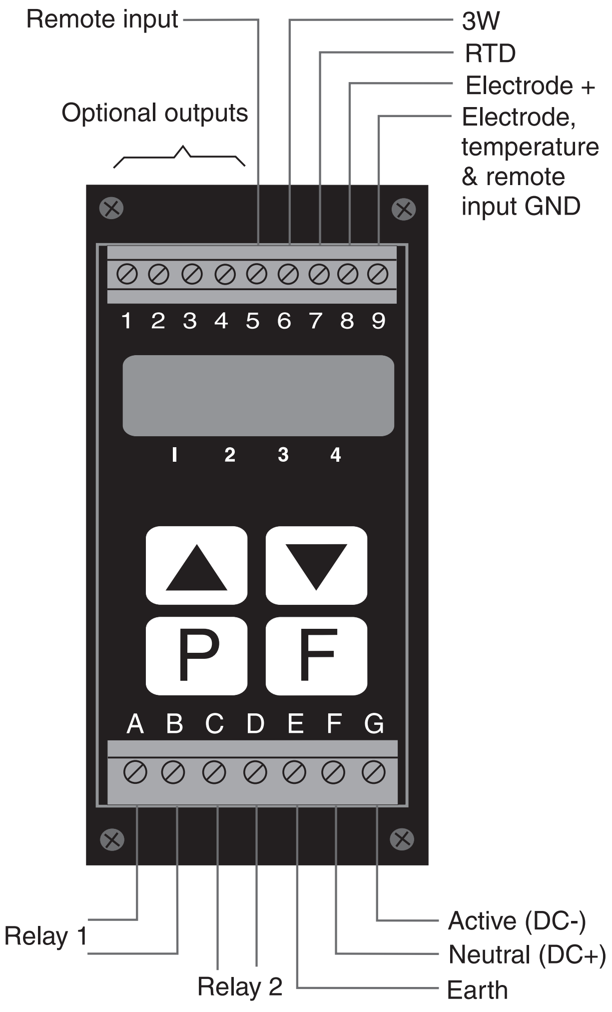
3 Electrical installation

The RM4 Meter is designed for continuous operation and no power switch is fitted to the unit. It is recommended that an external switch and fuse be provided to allow the unit to be removed for servicing. The terminal blocks allow for wires of up to 2.5mm^2 to be fitted for power supply and relays 1 and 2 or 1.5mm^2 for input connections and optional outputs. Connect the wires to the appropriate terminals as indicated below.

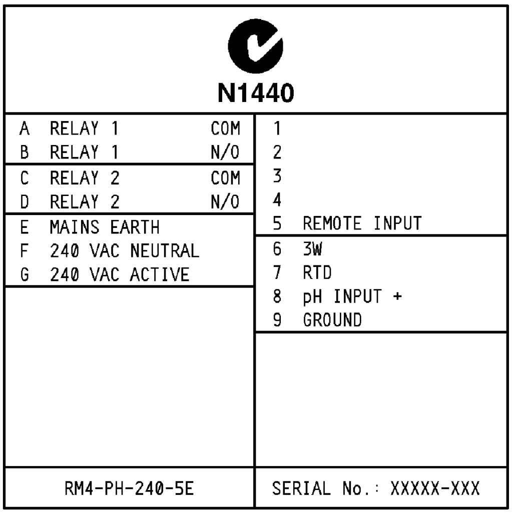
Refer to connection diagrams provided in this manual to confirm proper selection of voltage, polarity and input type before applying power to the instrument. When power is applied the instrument will cycle through a display sequence, indicating the software version and other status information, this indicates that the instrument is functioning. Acknowledgement of correct operation may be obtained by applying an appropriate input to the instrument and observing the resultant reading.

Note that the power supply type is factory configured. Check power supply type before connecting. Relay outputs are voltage free contacts.

Instrument electrical connections - example

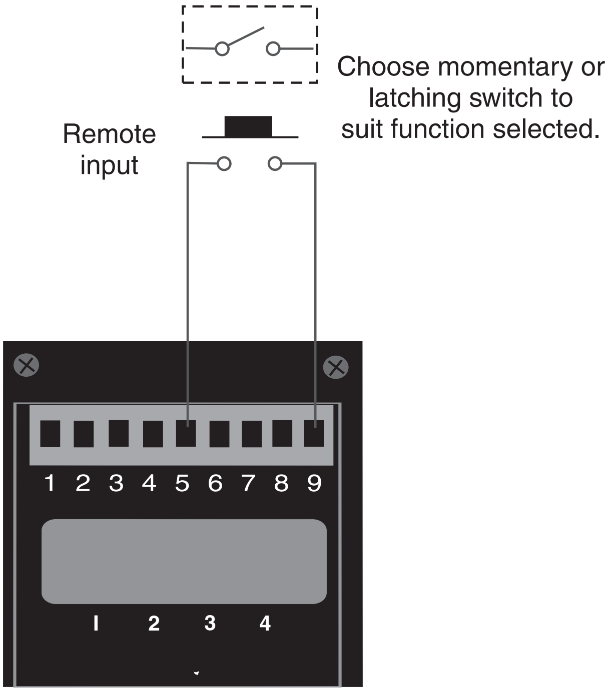


Instrument data label - example



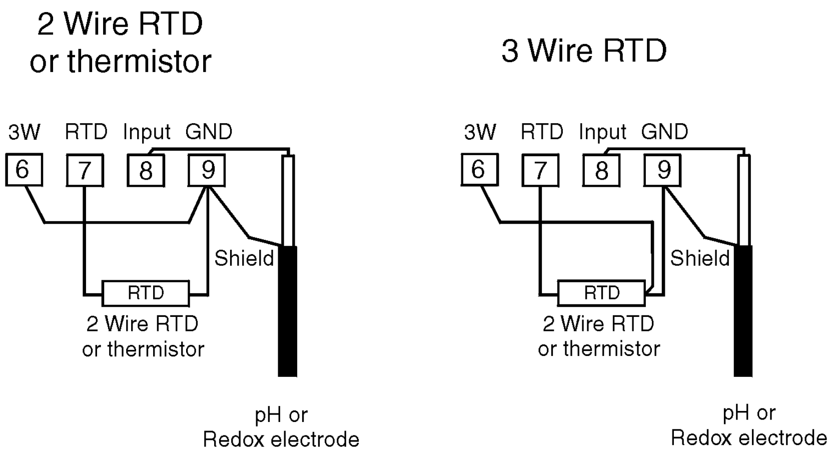
3.1 Remote input connections

The selected remote input function can be operated via an external contact closure via a switch, relay or open collector transistor switch (5VDC max.). See section 5.31 for details of remote input functions available.

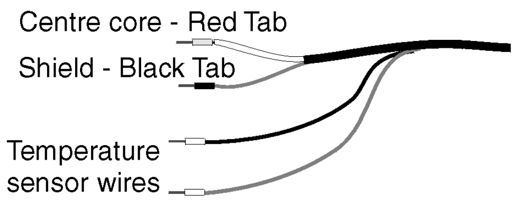


3.2 Signal input connections

See section 3.3 for details of link settings.



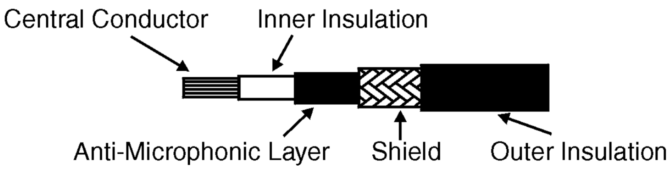
Termination of a typical pH electrode with temperature compensation



If dual temperature sensors are fitted then the colour code is:
Red & Black Pt100, Green & White Pt1000.

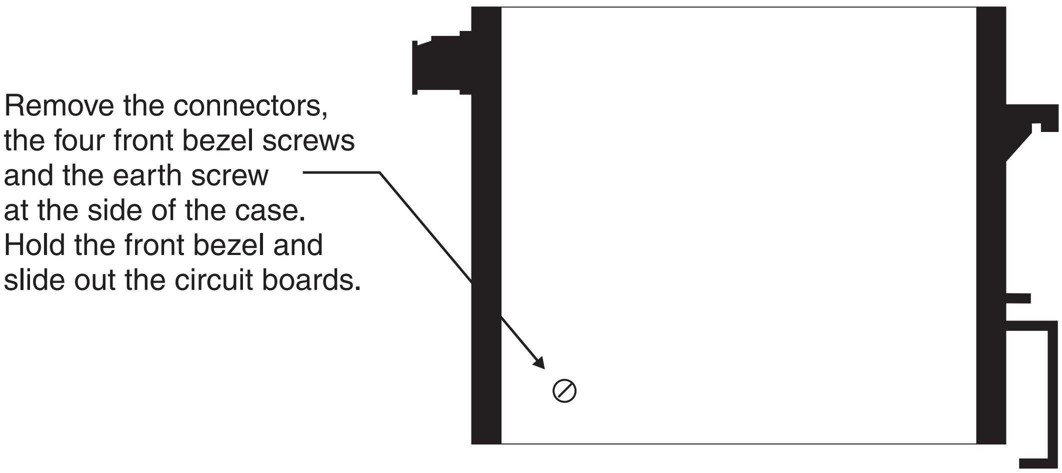
RTD and thermistor temperature sensors are not polarised and therefore the wires may be placed either way around at the temperature input.

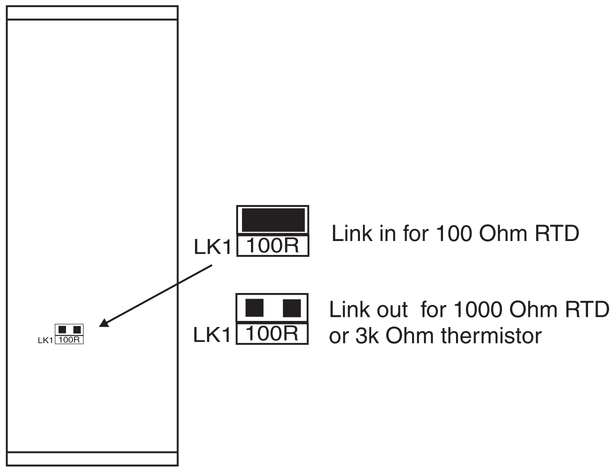
Note: If using low noise pH/Redox coaxial cable with an anti-microphonic layer ensure that this layer is removed from the exposed wiring. This layer is conductive and may cause a short circuit between the centre conductor and the cable shield resulting in an incorrect indication, usually this fault would be seen as a constant 7.00 pH or 0mV indication.



3.3 Configuring the input board

Remove the circuit board from the case following the instructions below. Link settings for the input board are as shown below. For optional output link settings consult the separate "RM4 DIN Rail Meter Optional Output Addendum" booklet.





4 Function tables - summary of setup functions

Note: the order in which the functions appear on the display may not be exactly as shown below. The availability and order of functions is determined by choice of function settings and options fitted. The "x" in the alarm functions listed will be replaced by the relay number when viewed e.g. A1Lo, A2Lo etc.

Functions in this first table are available in FUNC or CAL mode

Display	Function	Range	Default	Your record	Ref/Page
AxLo	Low setpoint value for designated alarm relay x	Any display value or OFF	OFF	See 4.1	5.3 / 16
AxHi	High setpoint value for designated alarm relay x	Any display value or OFF	OFF	See 4.1	5.4 / 17
AxHY	Hysteresis value for the designated alarm relay x.	0 to 9999	10	See 4.1	5.5 / 17
A$x$tt	Trip time delay for the designated alarm relay x.	0 to 60	0	See 4.1	5.6 / 18
A$x$rt	Reset time delay for the designated alarm relay x.	0 to 60	0	See 4.1	5.7 / 18
Axn.o or Axn.c	Alarm relay x action to normally open (de-energised) or normally closed (energised)	Axn.o or Axn.c	Axn.o	See 4.1	5.8 / 19
AxSP or Axt 1 etc.	Relay operation independent setpoint or trailing setpoint (***Optional**)	AxSP or Axt 1 etc.	AxSP	See 4.1	5.9 / 19

(***Optional**)—this function will only be accessible if the relevant option is fitted

Functions in this second table are available only in CAL mode or if ACCS is set to ALL

Display	Function	Range	Default	Your record	Ref/Page
9rAb CAL	Grab calibration	n/a	n/a		8.3 / 36
9rAb SCLE	Grab calibration scale value	Any display value	n/a		5.2 / 16
Ax OPEr	Relay operation mode, alarm or PI control	Ax.AL or Ax.tP or Ax.Fr	Ax.AL	See 4.1	5.10 / 19
br9t	Display brightness level	1 to 15	15		5.11 / 20
duLL	Display remote brightness switching	0 to 15	1		5.12 / 20
d.oFF SECS	Auto display dimming timer	0 to 9999	0		5.13 / 20

(***Optional**)—this function will only be accessible if the relevant option is fitted

OFSt CAL	Calibration offset	Any display value	n/a		5.14 / 21
CAL 1	First live input calibration scaling point	Any display value	n/a		5.15 / 21
CAL2	Second live input calibration scaling point	Any display value	n/a		5.16 / 21
rEC_	Analog output option low display value (*Optional)	Any display value	0		5.17 / 21
rEC‾	Analog output option high display value (*Optional)	Any display value	1000		5.18 / 22
rEC_ Ch2	Second analog output option low display value (*Optional)	Any display value	0		5.19 / 22
rEC‾ Ch2	Second analog output option high display value (*Optional)	Any display value	1000		5.20 / 22
drnd	Display rounding	1 to 5000	1		5.21 / 22
dCPt	Decimal point	0, 0. 1 etc.	0		5.22 / 23
FLtr	Digital filter	0 to 8	2		5.23 / 23
InPt POL	Input polarity	POS or NEG	POS		5.24 / 23
UCAL ION	Uncalibrate	n/a	n/a		5.25 / 23
°C tYPE	Temperature sensor type	NONE, 100, 1000 or 3tc	NONE		5.26 / 24
dEF °C	Default solution temperature	0.0 to 200.0	25.0		5.27 / 24
CAL °C	Calibrate temperature sensor	n/a	n/a		5.28 / 24
UCAL °C	Uncalibrate temperature sensor	n/a	n/a		5.29 / 24
rEc ctrl	Analog output PI control (*Optional)	on or OFF	OFF		5.30 / 24
r.InP	Remote input (external input) function	NONE, P.HLd, d.HLd.Hi, Lo.SP.Ac, No.Ac or dull	NONE		5.31 / 25
Pbut	P button function	NONE, Hi, Lo or Hi Lo	NONE		5.32 / 26
InPt tYPE	Input type	PH or OrP	PH		5.33 / 26
ACCS	Access mode	OFF, EASY, NONE or ALL	OFF		5.34 / 26

(*Optional)—this function will only be accessible if the relevant option is fitted

SPAC	Setpoint access mode	A1.A1-2 etc.	A1		5.35 / 27
GrAb CAL	Grab calibration on or off	on or OFF	OFF		5.36 / 27
Ax	Alarm relay operation mode for each relay e.g. A1, A2 etc.	LivE, °C, P.HLd, d.HLd, Hi, Lo or diSP	LivE		5.37 / 27
rEC	Analog retransmission output mode	LivE, °C, P.HLd, d.HLd, Hi, Lo or diSP	LivE		5.38 / 28
rEC2	Analog retransmission output mode	LivE, °C, P.HLd, d.HLd, Hi, Lo or diSP	LivE		5.39 / 29
bAUd rAtE	Baud rate for serial communications (*Optional)	300.600. 1200.2400. 4800.9600. 19.2 or 38.4	9600		5.40 / 29
PrtY	Parity for serial communications (*Optional)	NONE.EVEN or odd	NONE		5.41 / 30
O.Put	Output for serial communications (*Optional)	diSP.Cont. POLL, A.buS or M.buS	Cont		5.42 / 30
Addr	Instrument address for serial communications (*Optional)	0 to 31	0		5.43 / 30

(*Optional)—this function will only be accessible if the relevant option is fitted

4.1 Relay table

Record your relay settings in the table below. Note: relays 3 and 4 are optionally fitted.

Display	Relay 1	Relay 2	Relay 3	Relay 4
AxLo				
AxHi				
AxHY				
A$x$tt				
A$x$rt				
Axn.o or Axn.c				
AxSP or Axt 1 etc.	n/a			
A 1.A2 etc.				
Ax OPEr			n/a	n/a
Ax.SP			n/a	n/a
ctrl SPAN			n/a	n/a
Ax.PG			n/a	n/a
Ax.I G			n/a	n/a
Ax.I L			n/a	n/a
Ax.I H			n/a	n/a
Ax.bS			n/a	n/a
Ax.dc			n/a	n/a
Ax.dr			n/a	n/a

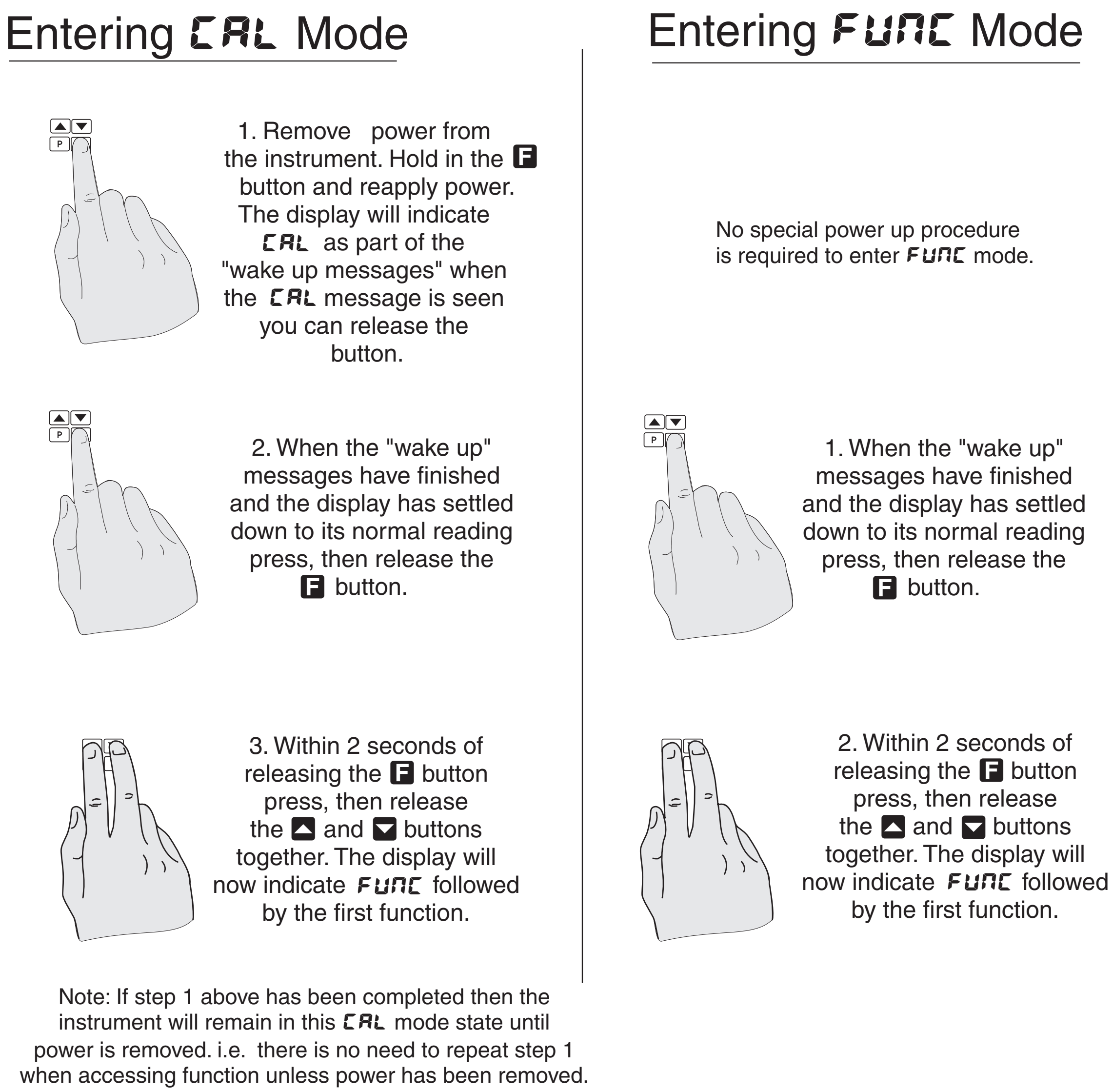
5 Explanation of functions

The RM4 setup and calibration functions are configured through a push button sequence. The push buttons located at the front of the instrument are used to alter settings. Two basic access modes are available:

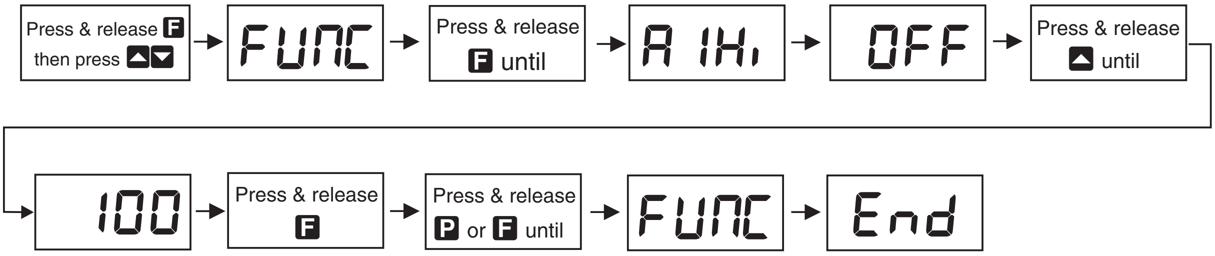
FUNC mode (simple push button sequence) allows access to commonly set up functions such as alarm setpoints.

CAL mode (power up sequence plus push button sequence) allows access to all functions including calibration parameters.

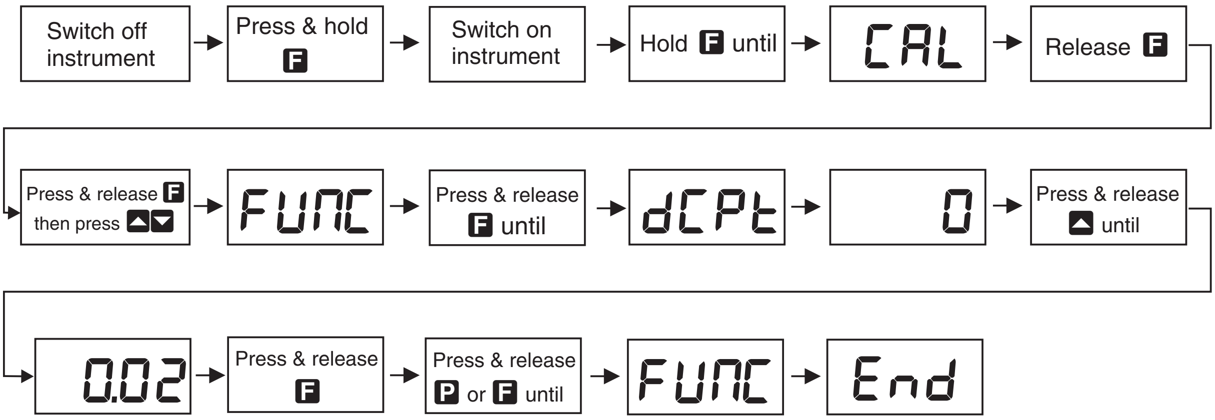
Once CAL or FUNC mode has been entered you can step through the functions, by pressing and releasing the F push button, until the required function is reached. Changes to functions are made by pressing the or push button (in some cases both simultaneously) when the required function is reached. See the flow chart example on the following page.



Example: Entering FUNC mode to change alarm 1 high function A1Hi from OFF to 100



Example: Entering CAL mode to change decimal point function dCPt from 0 to 0.02



Easy alarm relay adjustment access facility

The display has an easy alarm access facility which allows access to the alarm setpoints simply by pressing the F button at the front of the instrument. The first setpoint will then appear and changes to this setpoint may be made to this setpoint via the ▲ or ▼ buttons. Press the F button to accept any changes or to move on to the next setpoint. Note: this easy access also functions in the same manner for the PI control setpoint (relay and/or analog PI output) if PI control is available. The instrument must be set in the manner described below to allow the easy access facility to work:

1. The r.inP function must be set to SPAC or the ACCS function must be set to EASY.
2. At least one alarm must have a setpoint, nothing will happen if all the alarm setpoints are set to OFF.
3. The SPAC function must be set to allow access to the relays required e.g. if set to A1-2 then the easy access will work only with alarm relays 1 and 2 even if more relays are fitted.
4. The instrument must be in normal measure mode i.e. if the instrument is powered up so that it is in CAL mode then the easy access will not function. If in doubt remove power from the instrument, wait for a few seconds then apply power again.
5. If the easy access facility is used then the only way to view or alter any other function settings is to power up via CAL mode i.e. there is no entry to FUNC mode functions unless the instrument is powered up in CAL mode.

Explanation of Functions

5.1 Grab calibration

Display: 9rAb CAL
Range: n/a
Default Value: n/a

Used to initiate grab calibration procedure. See “Calibration” chapter, section 8.3.

5.2 Grab calibration scale value

Display: 9rAb SCLE
Range: Any display value
Default Value: n/a

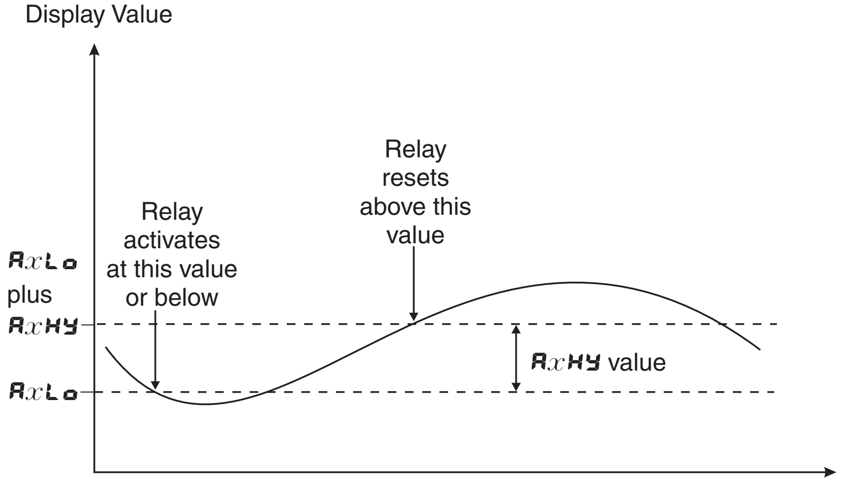
Used to enter grab calibration scale value. See “Calibration” chapter, section 8.3.

5.3 Alarm relay low setpoint

Display: AxLo
Range: Any display value or OFF
Default Value: OFF

Displays and sets the low setpoint value for the designated alarm relay x. Note x will be replaced by the relay number when displayed e.g. A 1Lo for relay 1. Use this low setpoint function if a relay operation is required when the display value becomes equal to or less than the low setpoint value. To set a low alarm value go to the AxLo function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The low alarm setpoint may be disabled by pressing the ▲ and ▼ push buttons simultaneously. When the alarm is disabled the display will indicate OFF. If the relay is allocated both a low and high setpoint then the relay will activate when the value displayed moves outside the band set by the low and high setpoints. The value at which the relay will reset is controlled by the AxHY function.

Example:
If A 1Lo is set to 10 then relay 1 will activate when the display value is 10 or less.



Alarm low operation with hysteresis

5.4 Alarm relay high setpoint

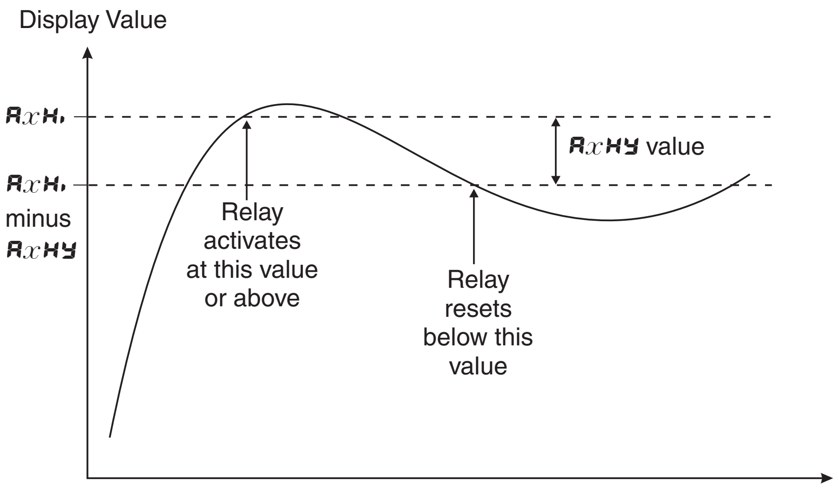
Display: AxHi

Range: Any display value or OFF

Default Value: OFF

Displays and sets the high setpoint value for the designated alarm relay x. Note x will be replaced by the relay number when displayed e.g. A 1Hi for relay 1. Use this high setpoint function if a relay operation is required when the display value becomes equal to or more than the low setpoint value. To set a high alarm value go to the AxHi function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The high alarm setpoint may be disabled by pressing the ▲ and ▼ push buttons simultaneously. When the alarm is disabled the display will indicate OFF. If the relay is allocated both a low and high setpoint then the relay will activate when the value displayed moves outside the band set by the low and high setpoints. The value at which the relay will reset is controlled by the AxHY function.

Example:
If A 1Hi is set to 100 then relay 1 will activate when the display value is 100 or higher.



Alarm high operation with hysteresis

5.5 Alarm relay hysteresis (deadband)

Display: AxHY

Range: 0 to 9999

Default Value: 10

Displays and sets the alarm relay hysteresis limit for the designated relay x. Note x will be replaced by the relay number when displayed e.g. A 1HY for relay 1. To set a relay hysteresis value go to the AxHY function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The hysteresis value is common to both high and low setpoint values. The hysteresis value may be used to prevent too frequent operation of the relay when the measured value is rising and falling around setpoint value. e.g. if A 1HY is set to zero the alarm will activate when the display value reaches the alarm setpoint (for high alarm) and will reset when the display value falls below the setpoint, this can result in repeated on/off switching of the relay at around the setpoint value.

The hysteresis setting operates as follows: In the high alarm mode, once the alarm is activated the input must fall below the setpoint value minus the hysteresis value to reset the alarm. e.g. if

A 1Hi is set to 50.0 and A 1HY is set to 3.0 then the setpoint output relay will activate once the display value goes to 50.0 or above and will reset when the display value goes below 47.0 i.e. at 46.9 or below. In the low alarm mode, once the alarm is activated the input must rise above the setpoint value plus the hysteresis value to reset the alarm. e.g. if A 1Lo is to 20.0 and A 1HY is set to 10.0 then the alarm output relay will activate when the display value falls to 20.0 or below and will reset when the display value goes above 30.0 i.e at 30.1 or above. The hysteresis units are expressed in displayed engineering units.

Example: If A 1Hi is set to 100 and A 1HY is set to 10 then relay 1 will activate when the display value is 100 or higher and will reset at a display value of 89 or lower.

5.6 Alarm relay trip time

Display:	A$x$tt
Range:	0 to 60
Default Value:	0

Displays and sets the alarm trip time in seconds. The trip time is common for both alarm high and low setpoint values. The trip time provides a time delay before the alarm relay will activate when an alarm condition is present. The alarm condition must be present continuously for the whole trip time period before the alarm will activate. If the input moves out of alarm condition during this period the timer will reset and the full time delay will be restored. This trip time delay is useful for preventing an alarm trip due to short non critical deviations from setpoint. The trip time is selectable over 0 to 60 seconds. To set a trip time value go to the A$x$tt function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. **Example:** If A 1tt is set to 5 seconds then the display must indicate an alarm value for a full 5 seconds before relay 1 will activate.

5.7 Alarm relay reset time

Display:	A$x$rt
Range:	0 to 60
Default Value:	0

Displays and sets the alarm reset delay time in seconds. The reset time is common for both alarm high and low setpoint values. With the alarm condition is removed the alarm relay will stay in its alarm condition for the time selected as the reset time. If the input moves back into alarm condition during this period the timer will reset and the full time delay will be restored. The reset time is selectable over 0 to 60 seconds. To set a reset time value go to the A$x$rt function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

Example: If A 1rt is set to 10 seconds then the resetting of alarm relay 1 will be delayed by 10 seconds.

5.8 Alarm relay normally open/closed

Display: Axn.o or Axn.c
Range: Axn.o or Axn.c
Default Value: Axn.o

Displays and sets the setpoint alarm relay x action to normally open (de-energised) or normally closed (energised), when no alarm condition is present. Since the relay will always open when power is removed a normally closed alarm is often used to provide a power failure alarm indication. To set the alarm relay for normally open or closed go to the Axn.o or Axn.c function and use the ▲ or ▼ push buttons to set the required operation then press F to accept this selection. **Example:** If set to A 1n.o alarm relay 1 will be open circuit when the display is outside alarm condition and will be closed (short circuit across terminals) when the display is in alarm condition.

5.9 Alarm relay setpoint or trailing operation

Display: AxSP or Axt 1 etc.
Range: AxSP or Axt 1 etc.
Default Value: AxSP

Relay operation independent setpoint or trailing setpoint, this function only be seen where more than one relay is fitted. Each alarm relay, except relay 1, may be programmed to operate with an independent setpoint value or may be linked to operate at a fixed difference to another relay setpoint, known as trailing operation. The operation is as follows:

Alarm 1 (A1) is always independent. Alarm 2 (A2) may be independent or may be linked to Alarm 1. Alarm 3 (A3) may be independent or may be linked to Alarm 1 or Alarm 2. Alarm 4 (A4) may be independent or may be linked to Alarm 1, Alarm 2 or Alarm 3. The operation of each alarm is selectable by selecting, for example, (Alarm 4) A4.SP = Alarm 4 normal setpoint or A4.t 1 = Alarm 4 trailing Alarm 1 or A4.t2 = Alarm 4 trailing Alarm 2 or A4.t3 = Alarm 4 trailing Alarm 3. For trailing set points the setpoint value is entered as the difference from the setpoint being trailed. If the trailing setpoint is to operate ahead of the prime setpoint then the value is entered as a positive number and if operating behind the prime setpoint then the value is entered as a negative number.

Example: With Alarm 2 set to trail alarm 1, if A 1Hi is set to 1000 and A2Hi is set to 50 then Alarm 1 will activate at 1000 and alarm 2 will activate at 1050 (i.e. 1000 + 50). If Alarm 2 had been set at -50 then alarm 2 would activate at 950 (i.e. 1000 – 50).

5.10 Alarm relay operation mode e.g. A 1 OPEr etc.

Display: Ax OPEr
Range: Ax.AL or Ax.tP or Ax.Fr
Default Value: Ax.AL

Alarm relay operating mode (relays 1 and 2 only) - this function allows selection of standard alarm on/off setpoint operation (A 1.AL or A2.AL) using the alarm functions described in this chapter or PI control operation (A 1.tP or A 1.Fr or A2.tP or A2.Fr). To set the alarm operation mode go to the Ax OPEr function and use the ▲ or ▼ push buttons to choose the required operation then press F to accept this value.

Refer to the "Setting up the relay PI controller" chapter 9 for details of the PI control operations and functions. **Example:**
With Ax OPEr set to A 1.Fr relay 1 will operate as a PI control relay with the frequency of the relay varying.

5.11 Display brightness

Display:	br9t
Range:	1 to 15
Default Value:	15

Displays and sets the digital display brightness. The display brightness is selectable from 1 to 15, where 1 = lowest intensity and 15 = highest intensity. This function is useful for improving the display readability in dark areas or to reduce the power consumption of the instrument. See also the dULL function. To set brightness level go to the br9t function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

5.12 Display remote brightness switching

Display:	dULL
Range:	0 to 15
Default Value:	1

Displays and sets the level for remote input brightness switching, see r.1 NP function. When a remote input is set to dULL the remote input can be used to switch between the display brightness level set by the br9t function 5.11 and the display brightness set by the dULL function. The display dull level is selectable from 0 to 15, where 0 = lowest intensity and 15 = highest intensity. This function is useful in reducing glare when the display needs to be viewed in both light and dark ambient light levels. To set dull level go to the dULL function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The d.oFF SECS function (automatic display blanking or dulling) will also cause the dULL function to appear if the d.oFF SECS function is enabled i.e. set to any value other than 0.

Example: With dULL set to 4 and br9t set to 15 and the r.1 NP function set to dULL the display brightness will change from the 15 level to 4 when a switch connected to the remote input terminals is activated.

5.13 Auto display dimming timer

Display:	d.oFF SECS
Range:	0 to 9999
Default Value:	0

This function allows a time to be set after which the display brightness (set by the br9t function) will automatically be set to the level set at the dULL function. The auto dimming feature can be used to reduce power consumption. The function can be set to any value between 0 and 9999 seconds. A setting of 0 disables the auto dimming. The display brightness can be restored by pressing any of the instruments front push buttons. The display brightness will also be restored whilst one or more alarm relays is activated. In normal display mode (i.e. not in CAL mode) there is a 2 minute delay period after the instrument is switched on during which the automatic display dimming will not operate. If any of the front pusbuttons are pressed during this period this 2 minute delay will be canceled.

5.14 Calibration offset

Display:	OFSt CAL
Range:	Any display value
Default Value:	n/a

Calibration offset - See section 8.1.

5.15 First calibration scaling point

Display:	CAL 1
Range:	Any display value
Default Value:	n/a

First scaling point for 2 point calibration scaling - See “Calibration” chapter, section 8.2.

5.16 Second calibration scaling point

Display:	CAL2
Range:	Any display value
Default Value:	n/a

Second scaling point for 2 point calibration scaling - See “Calibration” chapter, section 8.2.

5.17 Analog output option low value

Display:	rEC_
Range:	Any display value
Default Value:	0

Seen only when analog retransmission option fitted. Refer to the separate “RM4 Din Rail Meter Optional Output Addendum” booklet supplied when this option is fitted for wiring details and link settings. Displays and sets the analog retransmission (4–20mA, 0–1V or 0–10V, link selectable) output low value (4mA or 0V) in displayed engineering units. To set the analog output low value go to the rEC_ function and use the ▲ or ▼ push buttons to set the required value then press F to accept this selection.

Example: If it is required to retransmit 4mA when the display indicates 0 then select 0 in this function using the ▲ or ▼ button.

5.18 Analog output option high value

Display: rEC‾

Range: Any display value

Default Value: 1000

Seen only when analog retransmission option fitted. Refer to the separate “RM4 Din Rail Meter Optional Output Addendum” booklet supplied when this option is fitted for wiring details and link settings. Displays and sets the analog retransmission (4–20mA, 0–1V or 0–10V, link selectable) output high display value (20mA, 1V or 10V) in displayed engineering units. To set the analog output high value go to the rEC‾ function and use the ▲ or ▼ push buttons to set the required value then press **F** to accept this selection.

Example: If it is required to retransmit 20mA when the display indicates 50 then select 50 in this function using the ▲ or ▼ button.

5.19 Second analog output option low value

Display: rEC_ Ch2

Range: Any display value

Default Value: 0

See rEC_ function 5.17 for description of operation.

5.20 Second analog output option high value

Display: rEC‾ Ch2

Range: Any display value

Default Value: 1000

See rEC‾ function 5.18 for description of operation.

5.21 Display rounding

Display: drnd

Range: 1 to 5000

Default Value: 1

Displays and sets the display rounding value. This value may be set to 1 - 5000 displayed units. Display rounding is useful for reducing the instrument resolution without loss of accuracy in applications where it is undesirable to display to a fine tolerance. To set the display rounding value go to the drnd function and use the ▲ or ▼ push buttons to set the required value then press **F** to accept this selection.

Example: If set to 10 the display values will change in multiples of 10 only i.e. display moves from 10 to 20 to 30 etc.

5.22 Decimal point

Display: dCPt
Range: 0, 0.1 etc.
Default Value: 0

Displays and sets the decimal point. By pressing the ▲ or ▼ pushbutton at the dCPt function the decimal point position may be set. The display will indicate as follows: 0 (no decimal point), 0.1 (1 decimal place), 0.02 (2 decimal places), 0.003 (3 decimal places) or 0.0004(4 decimal places). Note if the decimal point is altered the display may need to be recalibrated and alarm etc. settings checked.

5.23 Digital filter

Display: FLtr
Range: 0 to 8
Default Value: 2

Displays and sets the digital filter value. Digital filtering uses a weighted average method of determining the display value and is used for reducing display value variation due to short term interference. The digital filter range is selectable from 0 to 8, where 0 = none and 8 = most filtering. Use ▲ or ▼ at the FLtr function to alter the filter level if required. Note that the higher the filter setting the longer the display may take to reach its final value when the input is changed, similarly the relay operation and any output options will be slowed down when the filter setting is increased. To set the digital filter value go to the FLtr function and use the ▲ or ▼ push buttons to set the required value then press F to accept this selection.

5.24 Input polarity

Display: INPt POL
Range: POS or NEG
Default Value: POS

Allow selection of POS (positive) or NEG (negative) input polarity for the pH or ORP input signal. For most applications POS would be used. Use NEG if the electrode signal has been inverted e.g. if an inverting amplifier is used between the electrode and the display.

5.25 Uncalibrate

Display: UCAL ION
Range: n/a
Default Value: n/a

Uncalibrate, resets calibration. See "Calibration" chapter, section 8.5

5.26 Temperature sensor type

Display: oC tYPE
Range: nonE, 100, 1000 or 3tc
Default Value: nonE

Displays and selects the input sensor type being used. Select from: nonE (no temperature sensor), 100 (100Ω RTD or Pt100), 1000 (1000Ω RTD or Pt1000), or 3tc (3KΩ Balco thermistor temperature sensor used by certain pH electrode manufacturers e.g. TBI, Uniloc and Bradley James Corporation).

5.27 Default solution temperature

Display: dEF oC
Range: 0.0 to 200.0
Default Value: 25.0

Displays and sets the display default solution temperature when no temperature sensor is used. The default solution temperature chosen is used to calculate the pH temperature compensation and so this value should be set as close as possible to the solution temperature. Default temperature can be set from 0.0 to 200.0°C. When a temperature sensor input is selected at the oC tYPE function and connected the default solution temperature is ignored and the live temperature reading used.

5.28 Calibrate temperature sensor

Display: CAL oC
Range: n/a
Default Value: n/a

Temperature sensor calibration function Refer to chapter 8.

5.29 Uncalibrate temperature sensor

Display: UCAL oC
Range: n/a
Default Value: n/a

Temperature sensor uncalibration function. Refer to chapter 8.

5.30 Analog output PI control

Display: rEc ctrl
Range: on or OFF
Default Value: OFF

Analog output mode - seen only when analog output option is fitted. This function allows selection of on or OFF for PI control analog output. If set to OFF the analog output operates as a retransmission output and uses the functions described in this chapter. If set to on the analog output operates as a PI control output.

When this function is set to on the following associated functions will appear: C.SEt, C.SPn, C_PG , C_Po , C.I G, CI L.H, CI L.L and rEC SPAC.

Refer to the separate "RM4 DIN Rail Meter Optional Output Addendum" booklet for description of the analog PI control functions.

5.31 Remote input function

Display: r.I nP

Range: nonE.P.HLd.d.HLd.H1 .Lo.SP.Ac.no.Ac or duLL

Default Value: nonE

Remote input function - When remote input terminals are short circuited, via a switch, relay, keyswitch etc. the instrument will perform the selected remote input function. A message will flash e.g. P.HLd to indicate which function has been selected when the remote input pins are short circuited. The remote input functions are as follows:

- nonE - no remote function required i.e. activating the remote input has no effect.
- P.HLd - peak hold. The display will show the peak value (highest positive value) only whilst the remote input terminals are short circuited i.e. the display value can rise but not fall whilst the input terminals are short circuited. The message P.HLd will appear briefly every 8 seconds whilst the input terminals are short circuited to indicate that the peak hold function is active.
- d.HLd - display hold. The display value will be held whilst the remote input terminals are short circuited. The message d.HLd will appear briefly every 8 seconds whilst the input terminals are short circuited to indicate that the display hold function is active.
- H1 - peak memory. The peak value stored in memory will be displayed if the remote input terminals are short circuited, if the short circuit is momentary then the display will return to normal measurement after 20 seconds. If the short circuit is held for 2 to 3 seconds or the power is removed from the instrument then the memory will be reset.
- Lo - valley memory. The minimum value stored in memory will be displayed. Otherwise operates in the same manner as the H1 function described above.
- H1 Lo - toggle between H1 and Lo displays. This function allows the remote input to be used to toggle between peak and valley memory displays. The first operation of the remote input will cause the peak memory value to be displayed, the next operation will give a valley memory display. PH1 or PLo will flash before each display to give an indication of display type.
- SP.Ac - setpoint access only. This mode blocks access to any functions except the alarm setpoint functions unless the remote input pins are short circuited or entry is made via CAL mode or if the ACCS function is set to either EASY or ALL.
- no.Ac - no access. This mode blocks access to all functions unless the remote input pins are short circuited or entry is made via CAL mode or if the ACCS function is set to ALL.

- **dull** - display brightness control. The remote input can be used to change the display brightness. When this mode is selected the display brightness can be switched, via the remote input terminals, between the brightness level set at the **br9t** function and the brightness level set at the **dull** function.

5.32 **P** button function

Display:	**Pbut**
Range:	**NONE**, **Hi**, **Lo** or **Hi Lo**
Default Value:	**NONE**

P button function. The **P** button may be set to operate some of functions also available via the remote input. If both the remote input and **P** button function are operated simultaneously the **P** button will override the remote input. Functions available are:

- **NONE** - no function required i.e. pressing the **P** button has no effect.
- **Hi** - peak memory. The peak value stored in memory will be displayed if the **P** button is pressed momentarily, the display will return to normal measurement after 20 seconds. If the **P** button is held pressed for 3 seconds or the power is removed from the instrument then the memory will be reset.
- **Lo** - valley memory. The minimum value stored in memory will be displayed. Otherwise operates in the same manner as the **Hi** function described above.
- **Hi Lo** - toggle between **Hi** and **Lo** displays. This function allows the **P** button to be used to toggle between peak and valley memory displays. The first operation of the **P** button will cause the peak memory value to be displayed, the next operation will give a valley memory display. **PHi** or **PLo** will flash before each display to give an indication of display type.

5.33 Input type

Display:	**INPt tYPE**
Range:	**PH** or **OrP**
Default Value:	**PH**

Displays and sets the input type to be used. Choices available are: **PH** (pH electrode input) or **OrP** (ORP/Redox electrode input). If the input type is altered it will be necessary to uncalibrate (**UCAL ION** function) and/or recalibrate the display.

5.34 Access mode

Display:	**ACCS**
Range:	**OFF**, **EASY**, **NONE** or **ALL**
Default Value:	**OFF**

Access mode - the access mode function **ACCS** has four possible settings namely **OFF**, **EASY**, **NONE** and **ALL**. If set to **OFF** the mode function has no effect on alarm relay operation. If set to **EASY** the "easy alarm access" mode will be activated. Refer to "Easy alarm relay adjustment access facility" section. If set to **NONE** there will be no access to any functions via **FUNC** mode, entry via **CAL** mode must be made to gain access to alarm and calibration functions. If set to **ALL** then access to all functions, including calibration functions, can be gained via **FUNC** mode.

5.35 Setpoint access mode

Display:	**SPAC**
Range:	**A 1**, **A 1-2** etc.
Default Value:	**A 1**

Setpoint access - sets the access via **FUNC** mode and "easy alarm access" mode to the alarm relay setpoints. Two relays are fitted as standard, two more are optionally available. The following choices are available:
A 1 - Allows setpoint access to alarm relay 1 only.
A 1-2 - Allows setpoint access to alarm relays 1 and 2 only.
A 1-3 - Allows setpoint access to alarm relays 1, 2 and 3
A 1-4 - Allows setpoint access to alarm relays 1, 2, 3 and 4
The remote input function (**r.I NP**) must be set to **SP.AC** for this function to operate. Note: Only the setpoints which have been given a value will be accessible e.g. if **A 1Hi** is set to **OFF** then there will be no access to the **A 1Hi** function when **SPAC** is used.

5.36 Grab calibration on or off

Display:	**9rAb CAL**
Range:	**on** or **OFF**
Default Value:	**OFF**

Used to allow or not allow grab calibration procedure. See "Calibration" chapter, section 8.3.

5.37 Alarm relay operation mode for each relay e.g. A 1, A2 etc.

Display:	**A**x
Range:	**Li uE**, **°C**, **P.HLd**, **d.HLd**, **Hi** , **Lo** or **di SP**
Default Value:	**Li uE**

Alarm relay operation mode for relays. Note: relays 1 and 2 can only be used in these modes if the **A**x **OPEr** function for the relay required is set to **A**x **.AL**. The following choices are available for alarm operation mode:

- **Li uE** - live input mode for channel 1. The alarm relay operation will always follow the channel 1 electrical input at the time irrespective of the 7 segment display value. e.g. assume the remote input is set to **PHLd** and **A 1Lo** is set to 10. The display may be indicating a peak reading of 12 but if the electrical input changes to correspond with a normal display value of 10 or less then the alarm will operate. This will be the normal setting used unless one of the special modes which follow is required.
- **°C** - temperature mode. When set to temperature mode the alarm relay will operate from the temperature reading i.e. setpoint will be in ^{o}C rather than pH or ORP.

- **P.HLd** - peak hold mode. If the peak hold mode is used and the remote input is set to peak hold then once the peak display goes above any alarm high setpoint the alarm relay will activate and will not de-activate until the peak hold is released and the display value falls below the setpoint value.

- **d.HLd** - display hold mode. If the display hold mode is used and the remote input is set to display hold then the alarm relay will be held in its present state (activated or de-activated) until the display hold is released and the display is free to change.

- **Hi** - peak (max.) memory mode. If the peak memory mode is used and the remote input is set to peak memory then the alarm will be activated if the peak memory value is above the high setpoint value. The alarm will not de-activate until the memory is reset.

- **Lo** - valley (min.) memory mode. If the valley memory mode is used and the remote input is set to valley memory then the alarm relay will be activated if the valley memory value is below the low setpoint value. The alarm will not de-activate until the memory is reset.

- **di SP** - display mode. If the display mode is used then the alarms will operate purely on the display value at the time i.e. if the display is showing above high setpoint or below the low setpoint value then the alarm relay will activate. For example if the remote input were set to peak memory and A1 were set to display mode then, unless the display is actually showing the peak memory value (i.e. the remote input has just been activated), the alarm relay is free to operate from the changing display value i.e. the memory does not have to be reset to clear an alarm condition. Note: in display mode any decimal points on the display will be ignored e.g. a reading of 4.7 will be taken as having a value of 47, this should be borne in mid when setting the **A**x **Lo** and **A**x **Hi** functions.

5.38 Analog retransmission output mode

Display: **rEC**

Range: **Li uE**, **°C**, **P.HLd**, **d.HLd**, **Hi** , **Lo** or **di SP**

Default Value: **Li uE**

The following choices are available for analog retransmission operation mode (note the **rECctrl** function must be set to **OFF** to use these modes):

- **Li uE** - live input mode for channel 1. The retransmission will follow the electrical input on channel 1 and will not necessarily follow the 7 segment display. For example if the remote input is set for peak hold operation then when the remote input is closed the 7 segment display will only show the peak value but the retransmission will be free to change to follow the electrical input. This will be the normal setting used unless one of the special modes which follow is required.

- **°C** - temperature mode. When set to temperature mode the retransmission will follow the temperature reading.

- **P.HLd** - peak hold mode. The 7 segment display and retransmission value will indicate the peak value only whilst the peak value function is operated via a contact closure on the remote input i.e. the 7 segment display and retransmission can rise but not fall whilst the remote input switch is closed. When the remote input switch is opened the retransmission value will remain fixed i.e. it will not rise or fall, although the 7 segment display value will be free to alter. This peak retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument. Note: In this mode the retransmission will show a zero reading until the remote input is operated for the first time after switch on.

- **d.HLd** - display hold mode. The 7 segment display and retransmission value will be held whilst the remote input display hold switch is closed. When the switch is opened the retransmission value will remain fixed at the held value although the 7 segment display value will be free to alter. The held retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument.

- **Hi** - peak (max.) memory mode. With the peak remote input switch open the retransmission will indicate the peak value in memory i.e. the retransmission output can rise but not fall. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument.

- **Lo** - valley (min.) memory mode. With the valley remote input switch open the retransmission will indicate the valley (min.) value in memory i.e. the retransmission output can fall but not rise. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument.

- **di SP** - display mode. The retransmission output will follow whatever value is on the 7 segment display. Note: in display mode any decimal points on the display will be ignored e.g. a reading of 1.4 will be taken as having a value of 14, this must be compensated for when setting the **rEC_** and **rEC‾** functions.

5.39 Analog retransmission output mode

Display:	**rEC2**
Range:	**Li uE**, **oC**, **P.HLd**, **d.HLd**, **Hi**, **Lo** or **di SP**
Default Value:	**Li uE**

Analog output mode for second analog output. Operates in the same manner as the first analog output, see function 5.38.

5.40 Baud rate for optional serial communications

Display:	**bAUd rAtE**
Range:	**300.600.1200.2400.4800.9600.19.2** or **38.4**
Default Value:	**9600**

Set baud rate - seen only with serial output option. Refer to the separate “RM4 Din Rail Meter Optional Output Addendum” booklet supplied when optional outputs are fitted. Select from **300.600.1200.2400.4800.9600.19.2** or **38.4** baud. The baud rate should be set to match the device being communicated with.

5.41 Parity for optional serial communications

Display: PrtY
Range: NONE, EVEN or odd
Default Value: NONE

Set parity - seen only with serial output option. Refer to the separate "RM4 Din Rail Meter Optional Output Addendum" booklet supplied when optional outputs are fitted. Select parity check to either NONE, EVEN or odd. The parity should be set to match the device being communicated with.

5.42 Output mode for optional serial communications

Display: O.Put
Range: diSP, Cont, POLL, A.buS or m.buS
Default Value: Cont

Set serial interface mode - seen only with serial output option. Refer to the separate "RM4 Din Rail Meter Optional Output Addendum" booklet supplied when optional outputs are fitted. Allows user to select the serial interface operation as follows:

diSP - sends image data from the display without conversion to ASCII.

Cont - sends 8 bit ASCII form of display data at a rate typically 90% of the sample rate.

POLL - controlled by computer or PLC as host. Host sends command via RS232/485 and instrument responds as requested.

A.buS - is a special communications mode used with Windows compatible optional PC download software. Refer to the user manual supplied with this optional software.

m.buS - Modbus RTU protocol.

5.43 Instrument address for optional serial communications

Display: Addr
Range: 0 to 31
Default Value: 0

Set unit address for polled (POLL) or m.buS mode (0 to 31) - seen only with serial output option. Refer to the separate "RM4 Din Rail Meter Optional Output Addendum" booklet supplied when optional outputs are fitted. Allows several units to operate on the same RS485 interface reporting on different areas etc. if RS485 is available. The host computer or PLC may poll each unit in turn supplying the appropriate address. The unit address ranges from 0 to 31 (DEC) but is offset by 32 (DEC) to avoid clashing with ASCII special function characters (such as <STX> and <CR>). Therefore 32 (DEC) or 20 (HEX) is address 0, 42 (DEC) or 2A (HEX) is address 10. Do not use address 0 in m.buS mode.

5.44 Returning to normal measure mode

When the calibration has been completed it is advisable to return the instrument to the normal mode (where calibration functions are less likely to be tampered with). To return to normal mode, turn off power to the instrument, wait a few seconds and then restore power.

6 Error messages

- SPAN Err - calibration span error. Live inputs used at CAL 1 and CAL2 too close in value. Recalibrate using inputs further apart in value. If you are certain that the inputs are far enough apart but still see the SPAN Err message then ignore the message and continue with the two point calibration. At the end of the calibration check to see if the display calibration is correct and if not recalibrate using the same inputs.
- GAIN Err or Std Err - these messages indicate a faulty attempt at calibration has been made. Check that the input pH or Redox levels correspond to the scale values input e.g. if you place the electrode in 4pH buffer and try to enter the value for this input as 7pH you may get one of these error messages.
- Unstable display - if the display is not stable the usual cause is either that the input signal is unstable or that the calibration scaling was incorrectly attempted. If the calibration scaling was unsuccessful then uncalibrating the display at the UCAL 1 ON function should return the display to stable readings but the previous calibration scaling values will be lost. If the display is still not stable after uncalibrating then check the sensor.
- Display shows - - - -- this message indicates that the input signal is higher than is acceptable for the pH or ORP expected levels. Check that the INPt tYPE function selection matches the sensor being used or °C tYPE if this error message is seen on the temperature display.
- Display shows -or - - this message indicates either that the number is too big to display e.g. above 99999 on a 5 digit display. Check the input and recalibrate if necessary. If this message is seen as a live reading during calibration ignore the message and continue with the calibration procedure then check the results. If this message is seen as the temperature reading it could indicate a faulty temperature sensor or that the temperature sensor is not fitted.
- Display shows NO ACC - this indicates that the ACCS function has been set to NONE or the F.INP function has been set to no.Ac blocking entry to FUNC mode. Enter functions via CAL mode to gain entry to functions and if required change the ACCS or F.INP function setting.
- Display shows NO SPAC - this indicates that the F.INP function has been set to SP.Ac blocking entry to alarm relay functions. Enter functions via CAL mode to gain entry to functions and if required change the F.INP function setting.

7 Fault finding

General information

For accurate repeatable readings the pH and Redox electrodes must be clean and must be in contact with the process solution at all times. Both pH and ORP electrodes have a finite life and the output from these electrodes will drop over time. When the output becomes too weak calibration will not be possible and a new electrode should be fitted. Most electrodes contain external and internal glass parts and should be handled carefully. Any breakage or cracking of the glass internally or externally will lead to failure of the electrode.

Checking the pH display and electrode:

1. Uncalibrate the display using the UCAL 1 ON function.

2. Disconnect the pH electrode and temperature sensor. Connect a short circuit or pH simulator set for 7pH across the pH input terminals, the display value should be very close to 7pH. If it is close to 7pH then this is a good indication that the display is working correctly in displaying pH value.

3. If a pH simulator is available then check the display reading either side of 7 pH to cover the normal measuring range of the installation.

4. If the readings in 2. and 3. above are not correct then contact the supplier of the display. If the readings in 2. and 3. above indicate that the display is measuring pH correctly then reconnect the pH electrode and temperature sensor (if used) and follow the steps below.

5. If a temperature sensor is used check the temperature reading and recalibrate the temperature display if necessary. It is essential that the temperature reading is correct before checking the pH output from the electrode.

6. Clean the electrode in water (preferably distilled) and dab dry the electrode and place it in a beaker containing a solution of known pH value e.g. 4.00 pH buffer and note the reading then clean and dab dry the electrode and place it in a beaker with a second solution of known pH value e.g. 7.00 pH and note the reading. Ideally the two solutions used should cover the normal measurement range of the application e.g. if the normal expected reading is around 8pH then use 7.00 and 10.00 pH buffers solutions.

7. If the readings in 6. above are more than 1 pH different from the buffer values then it can be assumed that the electrode needs to be replaced. If the readings in 6. above are close to the buffer values the it can be assumed that both the electrode and display are operating satisfactorily, continue on to the steps below.

8. If necessary perform a 2 point calibration to ensure that the display is matched to the electrode at the values of the two buffer solutions used.

9. Take a sample of the process solution and place it in a beaker, make a note of the pH reading after allowing time for the pH electrode to respond to any temperature change.

10. Place the electrode into its normal process pipe or vessel location and compare the reading to that taken in 9. above again allow time for the pH electrode to respond to any temperature change. If the readings are close then it can be assumed that the pH measuring system is operating correctly. If there are large differences or instable readings then problem can be assumed to be caused by the conditions at the normal pH electrode process location. Common problems at the location are:

- Air locks or air bubbles, the electrode must be in contact with the process solution at all times for correct operation.

- Electrical current flowing in the process solution typically caused by leakage from electric motors, pumps, level sensors etc. Removing the leakage is the best solution but if this is not possible it may be necessary to relocate the electrode. Sometimes placing the electrode in a special earthed stainless steel flow chamber can solve the problem.

- Coating of electrode by dyes, paints, oil, fats, solids etc. in the process solution. Filtering to remove the possibility of coating and/or regular cleaning may be necessary in these situations.
- Faulty extensions or junctions made to the electrode cable. Note that pH electrodes require special pH cable, other types of coaxial cable or standard twin cable are not suitable.
- High purity water pH measurement can be particularly difficult and errors such as non repeatability, drift and slow response are often seen. In high purity water measurement there may be problems with static charges and increased susceptibility to electrical noise. Also due to the low ionic strength of high purity water the electrode may be slow to react. Due to an effect known as "Reference junction potential" the slow reaction will be particularly apparent if the sensor has recently (e.g. within 24 hours) been placed in a high ionic strength solution such as pH buffers.
- Pressures which exceed the rating of the sensor will cause contamination of the reference junction leading to eventual failure of the electrode.
- Rapid large temperature changes in the solution can cause erratic reading if the temperature compensation sensor cannot react fast enough to the temperature changes.

Checking the Redox display and electrode:

Redox measurement is affected by any substance capable of taking part in oxidation reactions or inhibiting oxidation reactions. As many substances which will affect Redox measurement are likely to be present in the solution the measurement of Redox and interpretation of the results can be more problematic than pH measurement. For this reason Redox measurement is most commonly used for comparison measurement in specific applications i.e. measurement of change in Redox rather than absolute Redox value.

The solution Redox value will vary with temperature but unlike pH there is no predictable compensation method available for temperature changes hence no compensation is provided by the display. It is therefore possible that the Redox value displayed will alter with temperature.

Redox electrodes react very slowly compared to pH electrodes. When the Redox electrode is placed in a new solution it can take a few hours for the electrode output to stabilise. Once the output has stabilised the electrode output can still take minutes to respond to a change in the Redox level.

The electrode can be cleaned using soapy water and if necessary the metal parts (usually a platinum ring or pin)at the sensor end can be cleaned with a 5% hydrochloric acid solution).

If a simulator or mV source is not available the output from the Redox electrode can be measured directly using a voltmeter or multimeter. If the reading from the electrode is correct but the display is not showing the same value then uncalibrate the display using the **UCAL I ON** function. If necessary perform a 2 point calibration after the uncalibration procedure.

If the display is still not accurate or if error messages persist during calibration check the output from the electrode again, if this is still OK place a short circuit across the Redox input. The display should show 0mV, if it does not show a value very close to 0mV then the display will need to be returned for service.

8 Calibration

General Description

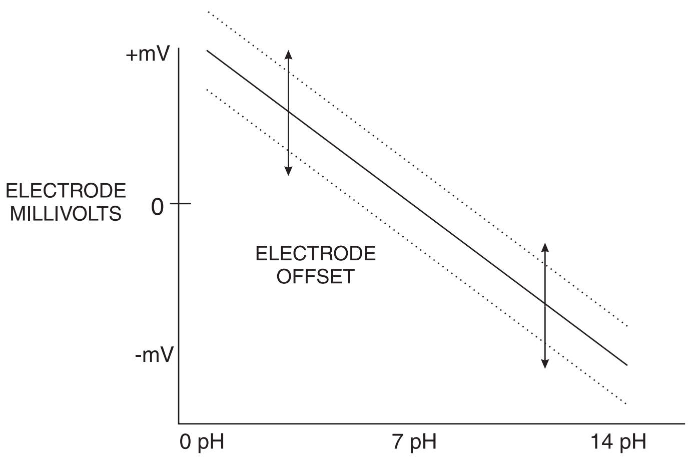
Offset calibration and grab sample calibration methods are provided for single point calibration adjustment. The 2 point calibration method (CAL 1 and CAL2) is used to fully calibrate the display to the pH electrode output slope. The CAL 1 and CAL2 scaling functions may be set independently. The two point calibration method should be undertaken when a new pH electrode is installed and during periodic calibration checks. Single point calibration adjusts the offset of the input whereas two point calibration also adjusts the slope of the input. Whilst single point calibration is acceptable for routine checks it is essential that a two point calibration is carried out periodically. Calibration functions can be used for both pH and Redox inputs but Redox is generally not calibrated.

Refer to Chapter 5 which shows the method of entering CAL mode to gain access to calibration functions.

8.1 Offset calibration

The offset calibration offers a single point adjustment across the whole pH or Redox calibration slope. The offset procedure can be used to adjust the reading when the same error exists at all readings e.g. reading 0.5 pH high.

To enter the offset function press the ▲ and ▼ pushbuttons simultaneously at the OFSt CAL function - the display will indicate the live pH reading for the solution. Place the probe in a known buffer solution or in the process solution if the pH of this solution is accurately known. When the display has stabilised, press the F button - the display will now read OFSt SCLE followed by the value in memory, the offset may now be changed using the ▲ or ▼ pushbuttons to read the correct value of the buffer or process solution. To enter the corrected value into memory press the F button. The display will show OFSt End and the system offset will be adjusted so that the display will match the corrected value.



8.2 Live signal input calibration

CAL 1 first scaling point

CAL 1 and CAL2 functions are used together to scale the instruments display for pH or Redox. Two calibration buffer solutions will be required e.g. 4.00 and 7.00 pH buffers. The CAL 1 function sets the first calibration point. Note: CAL 1 and CAL2 can be set independently and in some applications only one calibration point is used (usually CAL2) for routine calibrations and two points being used periodically for full calibration. The procedure for entering the first scaling point is:

1. If a temperature sensor is used check that the temperature reading is correct. If it is not correct perform a temperature calibration using function 5.28 before proceeding. If a temperature sensor is not used then check that the default temperature setting (function 5.27) is set correctly before proceeding.

2. Place a cleaned and dabbed dry probe into the first buffer solution e.g. 4.00 pH (use distilled water for cleaning the probe).

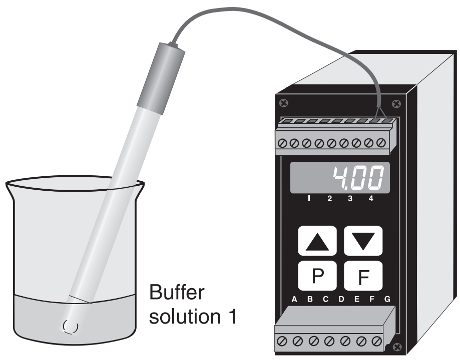
3. At the CAL 1 function press ▲ and ▼ simultaneously, then release them. The display will indicate the live input value. Do not be concerned at this stage if the live input display value is not the pH value required. Allow time for the reading to stabilise. It is important that the live input value seen is a steady value. If the reading does not stabilise then the input needs to be investigated before proceeding with the scaling.

4. Press, then release the F button. The display will indicate SCL 1 followed by a value. Use the ▲ or ▼ button to change this value to the buffer value at this input. e.g. 4.00 for a 4.00 pH buffer. Press the F button to accept changes or the P button to abort the scaling.

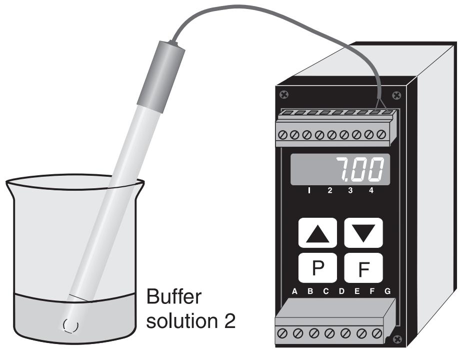
CAL2 Second scaling point for 2 point scaling method

The second point scaling is performed in exactly the same manner as CAL 1 (i.e. at CAL2 press the ▲ and ▼ pushbuttons simultaneously etc.) except that SCL2 will be seen instead of SCL 1. It is essential that the second buffer is different in value to the one used for the CAL 1 input.

Example - First point. Place electrode in buffer 1 e.g. 4.00 ph. At the CAL 1 function press the ▲ and ▼ pushbuttons simultaneously. A live reading will be seen. Allow the reading to stabilise then press the F pushbutton. The display will show SCL 1 followed by a value. Use the ▲ or ▼ pushbutton to make this value equal the first buffer value e.g. 4.00 for a 4.00 pH buffer



Example - Second point. Wash and dab dry the electrode then place the electrode in the second buffer e.g. 7.00 pH At the CAL2 function press the ▲ and ▼ pushbuttons simultaneously. A live reading will be seen. Allow the reading to stabilise then press the F pushbutton. The display will show SCL2 followed by a value. Use the ▲ or ▼ pushbutton to make this value equal the first buffer value e.g. 7.00 for a 7.00 pH buffer



8.3 Grab calibration

grAb CAL and grAb SCLE (grab sample calibration) can be used for pH or Redox (ORP) inputs. The grab sample calibration method can be used to provide a single point offset calibration. This method allows a sample to be taken and the input at that time stored in memory. The sample can then be analysed and the value for this sample entered at a later time. The grab sample offset calibration method operates as follows:

1. Set the grAb CAL function to on (note this is the second grAb CAL function which appears in the table). Press the F button to accept the change then press the P button to exit to normal measurement mode.

2. When ready to perform a grab sample calibration ensure that the electrode is in the solution to be measured. Enter the functions via CAL mode and at the first grAb CAL function press the ▲ and ▼ buttons simultaneously.

3. A live pH or ORP reading will now be displayed. When the reading has settled to a steady value press the F button. The pH or ORP value for that sample will now be stored in memory. The message grAb End and FUNC End will be seen and the display will go back to its normal live reading.

4. When the sample has been analysed or checked with a reference meter if any adjustment to the display reading is needed the true value for the sample can be entered at the grAb SCLE function. Enter the functions via CAL mode and pass by the grAb CAL function to the grAb SCLE function.

5. At the grAb SCLE function press the ▲ and ▼ buttons simultaneously. The previous scale value in memory will be seen. Adjust this value to the required value for the sample using the ▲ or ▼ button.

6. When the required value is displayed press the F button to accept the new value, the message OFSt End will be displayed and the calibration will now be adjusted to the new value.

7. Press the P button to exit to normal measurement mode.

8.4 Redox calibration

Generally Redox displays are not calibrated but if the Redox display scaling needs to be checked or the electrode calibrated then follow the method below.

The method used for pH calibration (see section 8.2) can also be used for Redox calibration. Two Redox buffers may be used if calibrating from the Redox electrode input or two known mV input levels from an external source may be used as the inputs e.g. 0mV for **CAL 1**/**SCL 1** and 500mV for **CAL2**/**SCL2**. The offset and grab calibration methods can also be used for Redox measurement.

Using buffer solutions ensure that the buffers have different mV values. Typical mV buffer solutions are "ZoBell" which has a value of 186mV at 25^{o}C and quinhydrone added to a know pH buffer solution (mV value depends upon concentration and temperature). Ready made buffer solutions of various mV values are commercially available.

Do note whilst calibrating that the output from the Redox electrode can take quite a while to stabilise depending on the solution used. It may be necessary leave the electrode in the solution for a few hours to stabilise before each calibration point.

8.5 pH and Redox uncalibration

Uncalibrate pH or Redox - Used to set the instrument back to the factory calibration values. This function is only used when calibration problems exist and the calibration memory needs to be cleared, other settings are not affected. To uncalibrate the instrument pH or Redox reading press the ▲ and ▼ buttons simultaneously at the **UCAL 1 ON** function. The display message **UCAL End** should be seen and the display will move to the next function.

8.6 Temperature calibration

A single step temperature calibration function is provided. For automatic temperature compensation of pH reading a temperature sensor should be used in most cases the temperature sensor is inside the pH electrode. The temperature can be viewed via the front

The steps for pH temperature sensor calibration are:

- Place the temperature sensor in a solution of known temperature.
- At the **CAL °C** function press the ▲ and ▼ pushbuttons simultaneously. A live input reading from temperature sensor will be seen. Allow the reading to stabilise then press the **F** button.
- The display will show **°C** followed by a value. Use the ▲ or ▼ pushbutton to make the value read the known temperature of the solution.
- Press the **F** button to accept the change, the display should show the message **°C End** then move on to the next function.

8.7 Temperature uncalibration

Used to set the instrument back to the factory temperature calibration values. This function is only used when calibration problems exist and the calibration memory needs to be cleared, other settings are not affected. To uncalibrate press the ▲ and ▼ buttons simultaneously at the UCAL °C function. The display will show the message UCAL End to indicate that the uncalibration process is complete.

9 Setting up the relay PI controller

The Relay Proportional + Integral Controller can be made to operate in either pulse width control or frequency control mode via the Ax OPEr function. Note that the Ax OPEr function will not be seen until a value has been set for the low or high alarm e.g. for A1Lo or A1Hi . The best results are usually achieved by initially configuring as a "Proportional Only" controller and then introducing the Integral functions when stable results are obtained.

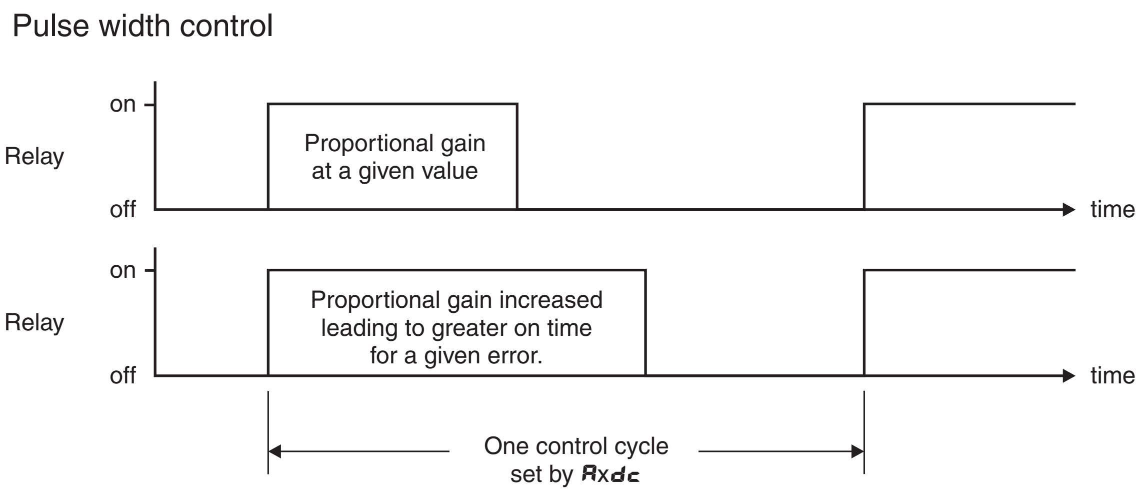
Relay 1 and , if fitted, relay 2 can be set to operate in PI control mode. Any other relays fitted will only operate in normal, non PI operation. The "x" in the Ax OPEr and other functions indicates the chosen relay i.e. for relay 1 the display will show A1 OPEr, A1.SP etc. The Ax OPEr function allows three choices of operating mode for the chosen relay, namely Ax.AL, Ax.tP and Ax.Fr. If Ax.AL is selected the chosen relay will operate as a setpoint relay whose operation is controlled by the AxHi , AxLo etc. settings and the PI control settings will not be seen. See the "Explanation of functions" chapter for details of operation when Ax.AL is selected. If Ax.tP is selected then the chosen relay will operate in pulse width control mode. If Ax.Fr is selected then the chosen relay will operate in the frequency control mode.

Pulse width control - operates by controlling the on to off time ratio of the relay. In a typical application this would be used to control the length of time for which a dosing pump is switched on during a control cycle i.e. the pump or other device will continuously operate for the length of time the relay is activated and will stop operating when the relay is de-activated.

Frequency control - operates by changing the rate at which the relay switches on and off. In a typical control application the frequency control operation is particularly suited for use when one shot dosing is used i.e. the pump or other device puts out a fixed dosing quantity for every pulse received.

9.1 Relay pulse width modulation control mode

To use pulse width modulation control Ax.tP must be selected at the Ax OPEr function.



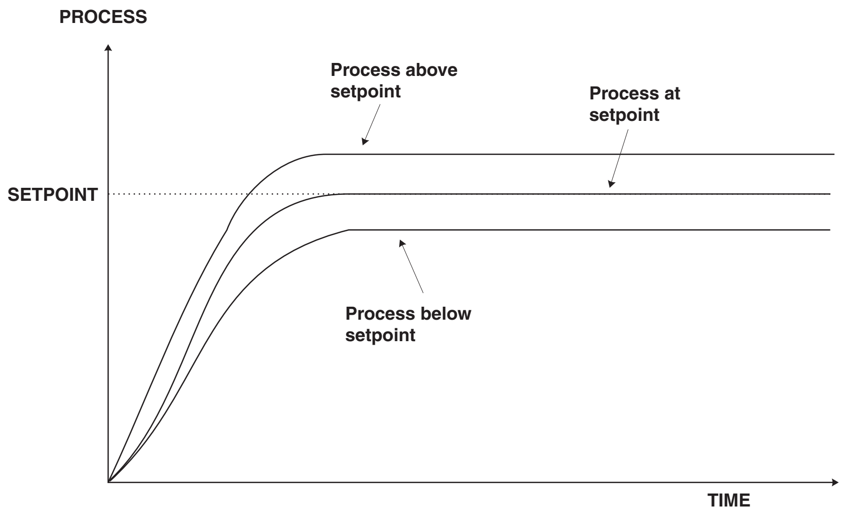
9.2 PI relay control setpoint

Display: Ax.SP

Range: Any display value

Default Value: 0

The control setpoint is set to the value in displayed engineering units required for the control process. The controller will attempt to vary the control output to keep the process variable at the setpoint. Note that the control setpoint value can be reached and adjusted via the "easy access" mode (see "Explanation of functions" chapter) if the ACCS function is set to EASY. This feature could be useful if the setpoint is to be frequently changed.



9.3 PI relay control span

Display: ctrl SPAN

Range: Any display value

Default Value: 100

The function of the control span is to define the limit to which the PI control values will relate. The control span value will be common to all control relays i.e. if more than one control relay output is being used then each of these relays operates from the same control span setting. 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 (Ax.SP) is 7.0 and the ctrl SPAN is 2.0 and Ax.PG is set to 1.000 then an error of 2.0 from the setpoint will cause a 100% change in proportional control output. For example with Ax.SP at 7.0, ctrl SPAN at 2.0, Ax.PG at 1.000 and AxbS at 0.000 a display reading of 5.0 or lower (Ax.SP minus ctrl SPAN) the control output will be at 100% i.e. the relay will be on continuously. The control output will then gradually adjust the on/off time as the display value reaches the setpoint.

For instruments with more than one input where the number of decimal points displayed may vary the control span will take on the value of the main display and so may or may not match the decimal points shown in the input being controlled. e.g. a control span of 2.00 will act as a control span of 20.0 if the input to be controlled is displayed with only 1 decimal point.

9.4 PI relay proportional gain

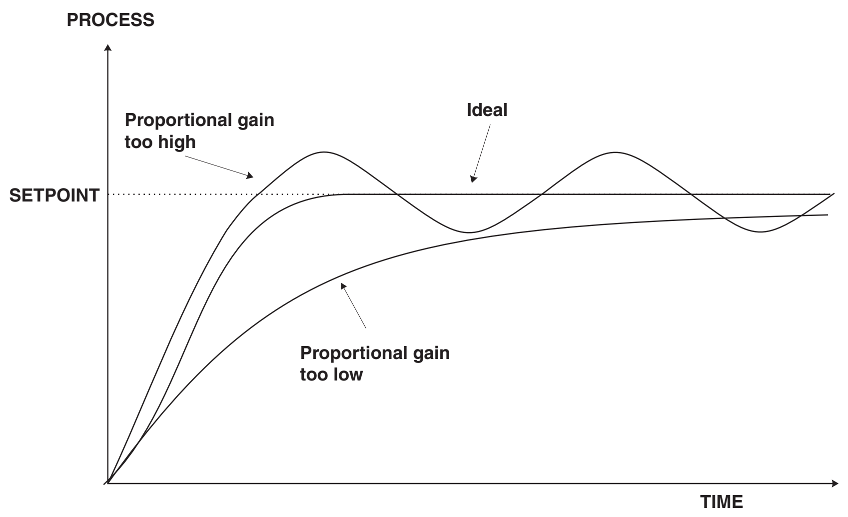
Display: Ax.PG

Range: -32.767 to 32.767

Default Value: 0.010

Note: the range value may be restricted if the number of display digits does not allow viewing of the full range.

The proportional value will determine the degree to which the controller will respond when there is a difference (error) between the measured value and the process setpoint. If the proportional gain is increased then for a given error the relay on time will be increased (or decreased if the error is on the other side of the setpoint). The proportional gain action can be reversed by setting a negative gain i.e. with a negative gain the on time will reduce as the error increases. With a proportional gain of 1.000 and an error of 1.0 or more (with control span set at 1.0) the controller will increase the frequency by 100% if possible. With a proportional gain of 0.500 an error of 1.0 or more (with control span set at 1.0) will cause the controller to increase the frequency by 50%, if possible. Too much proportional gain will result in instability due to excessive overshoot of the setpoint. Too little proportional gain will lead to a slow response.



This table shows the effect of the output frequency of changing proportional gain and bias with the following settings: ctrl SPAN = 2.0, A1.dc = 1.0, A1.I G = 0.000			
A1.SP	**A1.PG**	**A1.bS**	**Effect on relay operation**
7.0	1.000	0.0	Reading of 5.0 or below - relay permanently on. Reading of 5.0 to 7.0 - relay pulses with off time increasing as value approaches 7.0. Reading 7.0 or above - relay permanently off.
7.0	1.000	100.0	Reading of 7.0 or below - relay permanently on. Reading of 7.0 to 9.0 - relay pulses with off time increasing as value approaches 9.0. Reading 9.0 or above - relay permanently off.
7.0	1.000	50.0	Reading of 6.0 or below - relay permanently on. Reading of 6.0 to 7.0 - relay pulses with off time increasing as value approaches 7.0. Reading 7.0 - relay pulses at 50% on and 50% off. Reading 7.0 to 8.0 - relay pulses with off time increasing as value approaches 8.0. Reading 8.0 or above - relay permanently off.
7.0	0.500	50.0	Reading 5.0 or below - relay permanently on. Reading 5.0 to 7.0 - relay pulses with off time increasing as value approaches 7.0. Reading 7.0 - relay pulses at 50% on and 50% off. Reading 7.0 to 9.0 - relay pulses with off time increasing as value approaches 9.0. Reading 9.0 or above - relay permanently off.
7.0	- 1.000	50.0	Reading of 6.0 or below - relay permanently off. Reading of 6.0 to 7.0 - relay pulses with on time increasing as value approaches 7.0. Reading 7.0 - relay pulses 50% on and 50% off. Reading 7.0 to 8.0 - relay pulses with on time increasing as value approaches 8.0. Reading 8.0 or above - relay permanently on.

9.5 PI relay integral gain

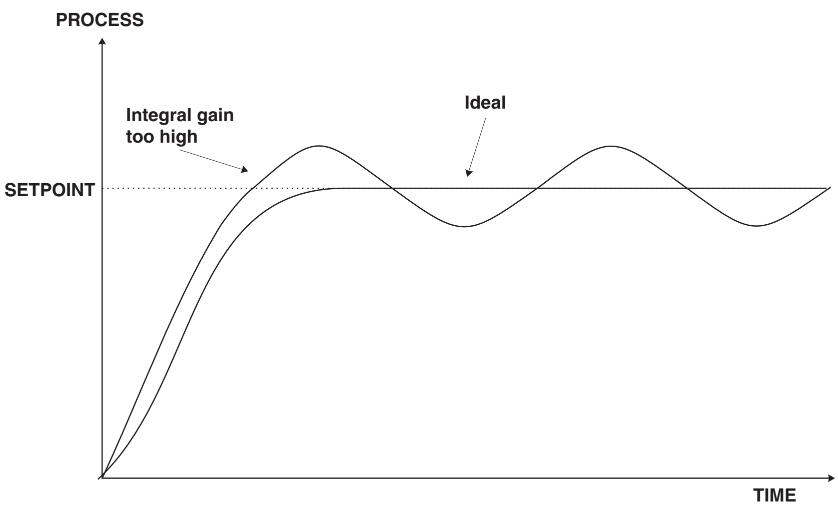
Display: Ax.I G
Range: -32.767 to 32.767
Default Value: 0.000

Note: the range value may be restricted if the number of display digits does not allow viewing of the full range.

The Integral action will attempt to correct for any offset which the proportional control action is unable to correct (e.g. errors caused by changes in the process load). When the integral gain is correctly adjusted the control output is varied to maintain control by keeping the process variable at the same value as the control setpoint. Since the integral gain is time based the output will gradually increase if the error does not decrease i.e. if the measured value remains constant and there is an error (a difference between the measured value and the setpoint) then the frequency will be increased compared to the previous frequency output. The higher the proportional gain, the greater the degree by which the on to off ratio will be affected i.e. the response will be greater at higher integral gain settings. With an integral gain of **1.000** an error of **1.0** or more (with control span set at **1.0**) will cause the integral action to try to correct at the rate of 100% minute. With an integral gain of **0.200** an error of **1.0** or more will cause the integral action to try to correct at the rate of 20% per minute. Too high an integral gain will result in instability. To low an integral gain will slow down the time taken to reach the setpoint. The optimum setting will depend on the lag time of the process and the other control settings. Start with a low figure (e.g. **0.200**) and increase until a satisfactory response time is reached. The integral gain figure has units of gain/minute. The integral action can be reversed by setting a negative gain figure, note that the sign of the integral gain must match the sign of the proportional gain. The integral control output follows the formula:

$$Integral\,control\,output = \frac{error \times Ig \times time\,(seconds)}{60} + previous\,integral\,control\,output$$

Where Ig is the integral gain set via **Ax.I g**.



9.6 PI relay integral control high limit

Display: **Ax.I H**

Range: **0.0** to **100.0**

Default Value: **100.0**

The maximum limit can be used to reduce overshoot of the control setpoint when the control output is increasing i.e. rising above the setpoint. Other than this the limit operates in the same manner as the low limit described previously.

9.7 PI relay integral control low limit

Display: **A**x.**I L**

Range: **0.0** to **100.0**

Default Value: **100.0**

The minimum limit can be used to reduce overshoot of the control setpoint when the control output is being reduced i.e. falling below the setpoint. The low limit reduces the available output swing by a percentage of the maximum output. Without a limit the integral output can be very large at the time the setpoint is reached and a large overshoot of the will then result. Settings available are from **0.0** to **100.0** (%). If the limit setting is too high then overshoot will result. If the setting is too low then the integral output can be limited to such an extent that the setpoint cannot be maintained.

Start with a low value such as **20.0** and increase or decrease the value until a satisfactory result is obtained. The advantage of using separate low and high limits is that in many applications the response is very one directional e.g. the system may respond very quickly to a heat input but may cool down at a much slower rate. Separate high and low limit settings allow independent limiting of the integral control swing below and above the setpoint so a smaller minimum limit can be set to limit swings below the setpoint to compensate for the slower cooling time.

The minimum and maximum limits are used in conjunction with the output bias setting to maintain the control process setpoint value. For example with a bias (**A**x.**bS**) set at 50%, minimum limit set at 20% and a maximum limit of 30% the actual bias when the process is at the setpoint may be anywhere between 30% and 80% i.e. Integral control is being used to alter the bias setting in order to maintain the process at the setpoint. In this case the minimum term will allow the bias to drop to a value between 50% and 30% in order to maintain the setpoint. The maximum term will allow the bias point to rise to a value between 50% and 80% in order to maintain the setpoint.

9.8 PI relay control output bias

Display: **A**x.**bS**

Range: **0.0** to **100.0**

Default Value: **50.0**

The control bias sets the ideal steady state output required once the setpoint is reached. Settings are in % from **0.0** to **100.0**. When set at **0.0** the relay will be de-activated for the entire control period when the measured input is at the setpoint (depending on proportional and integral gain settings). If set at **50.0** then the relay operation frequency will on for 50% and off for 50% of the duty cycle time when the measured input is at the setpoint. If set at **100.0** then the relay will activated for the whole time whist the measured input is at the setpoint.

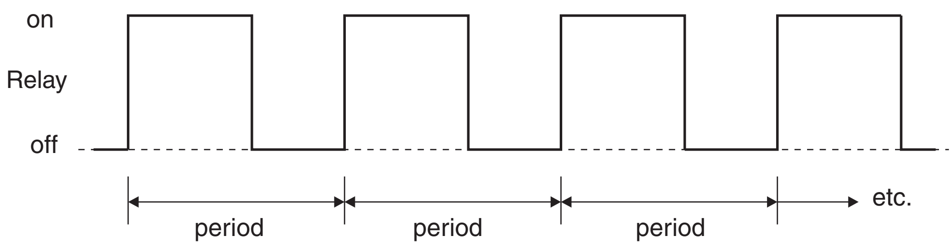
9.9 PI relay control cycle period

Display: **A**x.**dc**

Range: **0** to **250**

Default Value: **10**

Displays and sets the control period cycle from **0** to **250** seconds. The control period sets the total time for each on/off cycle. This time should be set as long as possible to reduce wear of the control relay and the controlling device.



9.10 Setting up the PI pulse width controller

1. Set the **A**x **OPEr** function to **A**x.**tP**.
2. Set the control setpoint **A**x.**SP** to the required setting.
3. Set the control span **ctrl SPAN** to the required setting.
4. Set the proportional gain **A**x.**PG** to an arbitrary value e.g. **0.500**.
5. Set the integral gain **A**x.**I G** to **0.000** (i.e. off).
6. Set the low and high integral **A**x.**I L** and **A**x.**I H** limits to an arbitrary value e.g. **20.00**.
7. Set the bias **A**x.**bS** to **50.0**.
8. Set the cycle **A**x.**dc** period to **20** seconds.

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 cycling state is achieved note the difference between the display value and the control setpoint value. Gradually increase or decrease the bias value until the displayed value matches (or cycles about) the control setpoint value.

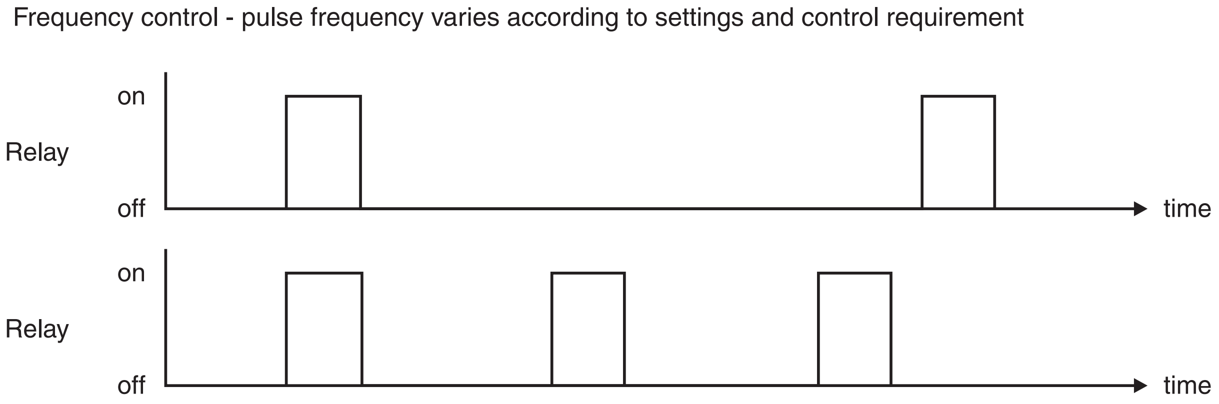
Gradually increase the integral gain until the process begins to oscillate. Then reduce the integral gain slightly to regain the control without this added oscillation.

Create a step change to the process conditions and observe the control results. It may be necessary to fine tune the settings and use integral limits to obtain optimum results.

Set up sequence	Symptom	Solution
Proportional gain	Slow response	Increase proportional gain
Proportional gain	High overshoot or oscillation	Decrease proportional gain
Proportional bias	Process above or below setpoint	Increase or decrease bias as required
Integral gain	Slow response	Increase integral gain
Integral gain	Instability or oscillations	Decrease integral gain

9.11 Relay frequency modulation control mode

To use pulse width modulation control **Ax.Fr** must be selected at the **Ax OPEr** function. In frequency modulation mode the relay on time is fixed. A minimum relay off time can also be set. The control program will vary the actual off time to suit the error seen between the setpoint and the measured temperature at the time. For example if extra dosing is needed to reach the setpoint then the off time will be reduced resulting in more on pulses per period of time i.e. the frequency of the pulses is controlled to allow the setpoint to be maintained.



Frequency PI control operation has many functions in common with PI pulse width control, refer to the appropriate sections as shown below for these common functions.
Ax.SP (Control setpoint) - refer to section 9.2
ctrl SPAN (Control span) - refer to section 9.3
Ax.PG (Proportional gain) - refer to section 9.4
Ax.I G (Integral gain) - refer to section 9.5
Ax.I L (Integral control low limit) - refer to section 9.7
Ax.I H (Integral control high limit) - refer to section 9.6
Ax.bS (PI control bias) - refer to section 9.8
Ax.dc (PI control cycle period) - refer to section 9.9. In frequency mode this function sets the minimum off time. If set to **0** the relay will be disabled. The control program can extend the off time to maintain the setpoint but not reduce it. If a 100% error is seen then the pulse rate will be at its maximum i.e. the off time will equal **Ax.dc**. If a 50% error is seen there will be a pulse every 2 times **Ax.dc**. For a 25% error there will be a pulse every 4 times **Ax.dc** and for a 10% error there will be a pulse every 10 times **Ax.dc**.

This table shows the effect of the output frequency of changing proportional gain and bias with the following settings: ctrl SPAN = 2.0, A1.dc = 1.0, A1.IG = 0.000			
A1.SP	**A1.PG**	**A1.bS**	**Effect on relay operation**
7.0	1.000	0.0	Reading of 5.0 or below - relay pulses at maximum frequency. Reading of 5.0 to 7.0 - relay pulses with frequency decreasing as value approaches 7.0. Reading 7.0 or above - relay permanently off.
7.0	1.000	100.0	Reading of 7.0 or below - relay pulses at maximum frequency. Reading of 7.0 to 9.0 - relay pulses with frequency decreasing as value approaches 9.0. Reading 9.0 or above - relay permanently off.
7.0	1.000	50.0	Reading of 6.0 or below - relay pulses at maximum frequency. Reading of 6.0 to 8.0 - relay pulses with frequency decreasing as value approaches 8.0. (period increased by 50% at 7.0 compared to minimum period e.g. if minimum period is 4 seconds the period at 7.0 will be 6 seconds) Reading 8.0 or above - relay permanently off.
7.0	0.500	50.0	Reading of 5.0 or below - relay pulses at maximum frequency. Reading 5.0 to 9.0 - relay pulses with frequency decreasing as value approaches 9.0. (period increased by 50% at 7.0 compared to minimum period e.g. if minimum period is 4 seconds the period at 7.0 will be 6 seconds) Reading 9.0 or above - relay permanently off.
7.0	- 1.000	50.0	Reading of 6.0 or below - relay permanently off. Reading of 6.0 to 8.0 - relay pulses with frequency decreasing as value approaches 8.0. (period increased by 50% at 7.0 compared to minimum period e.g. if minimum period is 4 seconds the period at 7.0 will be 6 seconds) Reading 8.0 or above - relay pulses at maximum frequency.

9.12 PI relay on duration

Display: Ax.dr
Range: 0.0 to 25.0
Default Value: 1.0

Displays and sets the control relay on duration from 0.0 to 25.0 seconds. If set to 0.0 the relay will be disabled. The duration should be long enough to ensure that the device being controlled receives an acceptable on pulse.

9.13 Setting up the PI frequency controller

1. Set the Ax OPEr function to AxFr.
2. Set the control setpoint Ax.SP to the required setting.

3. Set the control span ctrl SPAN to the required setting.
4. Set the proportional gain Ax.PG to an arbitrary value e.g. 0.500.
5. Set the integral gain Ax.I G to 0.000 (i.e. off).
6. Set the low and high integral Ax.I L and Ax.I H limits to an arbitrary value e.g. 20.00.
7. Set the bias Ax.bS to 50.0.
8. Set the cycle Ax.dc period to 20 seconds.
9. Set the relay on time Ax.dr to an arbitrary value e.g. 1.0

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 cycling state is achieved note the difference between the display value and the control setpoint value. Gradually increase or decrease the bias value until the displayed value matches (or cycles about) the control setpoint value.

Gradually increase the integral gain until the process begins to oscillate. Then reduce the integral gain slightly to regain the control without this added oscillation.

Create a step change to the process conditions and observe the control results. It may be necessary to fine tune the settings and use integral limits to obtain optimum results.

Set up sequence	**Symptom**	**Solution**
Proportional gain	Slow response	Increase proportional gain
Proportional gain	High overshoot or oscillation	Decrease proportional gain
Proportional bias	Process above or below setpoint	Increase or decrease bias as required
Integral gain	Slow response	Increase integral gain
Integral gain	Instability or oscillations	Decrease integral gain

10 Specifications

10.1 Technical specifications

Electrode input:	pH - any electrode where Eo=7pH Redox - any standard Redox (ORP) electrode (-1000mV to 1000mV nominal)
Temperature input:	100Ω RTD, 1000Ω RTD, Balco $3k\Omega$ thermistor or manual setting
Input resistance:	Greater than $10^{10}\Omega$
Measuring range:	0.00 to 14.00 pH and -40 to 130^{o}C temperature or Redox 1000mV nominal
Accuracy:	0.2% of full scale $\pm$1 display digit for alarms and display when calibrated (pH and Redox)
Sample rate:	1 sample per second
ADC Resolution:	1 in 20,000
Display update:	4 per second
Conversion Method:	Quad slope ADC
Microprocessor:	HC68HC11F CMOS
Ambient temperature:	LED -10 to 60^o C, LCD -10 to 50^o C,
Humidity:	5 to 95% non condensing
Display:	LED Models: 4 digit 20mm, 5 digit 14.2mm + status LEDs + 4 way keypad, 6 digit 14.2mm + 4 way keypad LED Bar Graph 20 segment bar + 5 digit 7.6mm + relay status LEDs LED Circular Bar Graph 16 segment + 5 digit 7.6mm + relay status LEDs LCD Models: 4 digit 12.7mm, 6 digit 12.7mm
Power supply:	AC 240V, 110V 32V or 24V 50/60Hz or DC isolated wide range 12 to 48V. Note: supply type is factory configured.
Power consumption:	AC supply 4 VA max, DC supply typically 85mA at 12VDC and 45mA at 24VDC for RM4 with no optional outputs
Output (standard):	2 x relay, Form A, rated 5A resistive. Programmable N.O. or N.C

10.2 Optional outputs

Third relay:	Rated 0.5A resistive 30VAC or DC May be configured as form A or form C if the third relay is the only option fitted
Fourth relay:	Rated 0.5A resistive 30VAC or DC, form A
Analog output:	Isolated 4 to 20mA, 0 to 1V or 0 to 10V link selectable. Single or dual 12 bit or single 16 bit versions available (4-20mA will drive into resistive loads of up to 800Ω) First analog output can be configured for retransmission or PI control.
Serial communications:	Isolated RS232, RS485 or RS422 (8 bit ASCII or Modbus RTU)
DC supply output:	Isolated and regulated 12VDC (50mA max) or 24VDC (25mA max)

Some combinations of optional outputs are available e.g. analog output plus extra relay.
Consult supplier for available combinations.

10.3 Physical characteristics

Case size:	44mm(w) x 91mm(h) x 141mm(d)
Connections:	Plug in screw terminals (max. 2.5mm^2 wire for power and relays, max. 1.5mm^2 wire for load cell and options)
Weight:	470 gms basic model, 500 gms with option card

11 Guarantee and service

The product supplied with this manual is guaranteed against faulty workmanship for a period of two 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 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.

This product is designed and manufactured in Australia.