Model RM4-I4 and RM4-V4
Four input
DIN Rail 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-I4 and RM4-V4 Arithmetic or Scanning DIN rail mount monitor. The RM4 is a special purpose instrument which may be configured to accept up to four inputs of ±20mA or 4 to 20mA (model RM4-I4) or ±1VDC or ±10VDC (model RM4-V4). Two basic modes of operation are available, namely arithmetic and scanning modes. The choice between arithmetic and scanning modes is made at the **SEt OPEr** function.

ArtH mode - In arithmetic mode the instrument may programmed to perform an arithmetic function on the four inputs and provide a resultant display in engineering units. In arithmetic mode the primary display (channel 0) is the result of the arithmetic function performed by the instrument. Each channel (0 to 4 if four inputs are selected) may be individually displayed via the ▲ or ▼ pushbuttons.

SCAn mode - In scanning mode the inputs are individually scanned and displayed at a user programmable rate or manually scanned via the ▲ and ▼ buttons. Arithmetic functions are not available in scanning mode.

Each input channel may be individually calibrated to display the input in engineering units.

Various combinations of one or two optional extra relays, analog (4-20mA, 0-1V or 0-10V) retransmission (single or dual retransmission) or serial (RS232, RS485 or RS422) communications and an isolated 12 or 24VDC isolated transmitter supply may also be provided as an option. Alarms and retransmission may be set to operate from any channel or the result when arithmetic mode is used. The analog retransmission can alternatively be programmed to operate from the highest channel, the lowest channel, the average value or the retransmit the value of each channel in turn with a marker pulse to identify the start of the cycle.

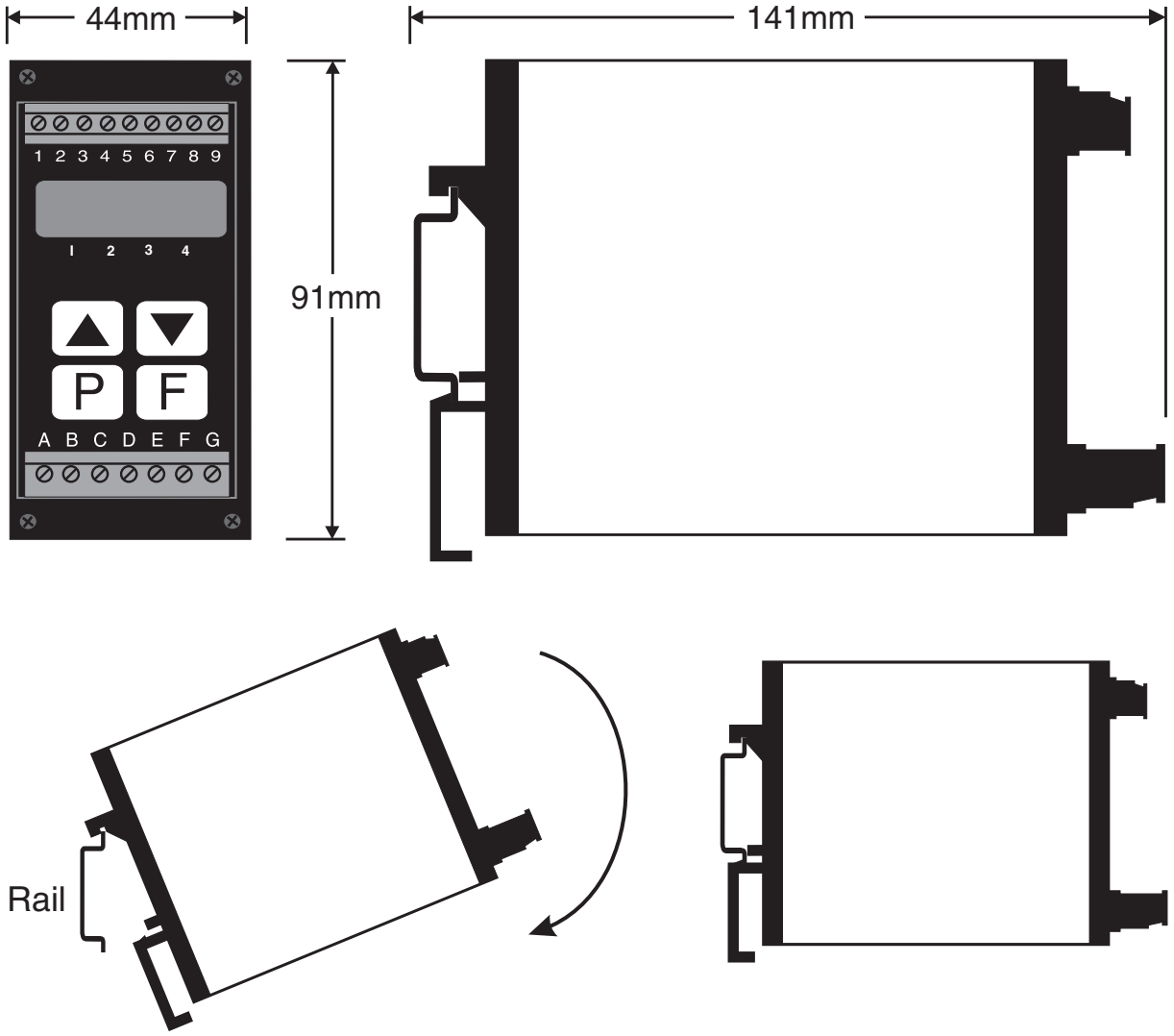
Unless otherwise specified at the time of order, your RM4 has been factory set to a standard configuration. Like all other RM4 series instruments the configuration and calibration is easily changed by the user. Initial changes may require dismantling the instrument to alter PCB links, other changes are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

Electrical isolation between power supply, input voltage or current and retransmission output is provided by the RM4, thereby eliminating grounding and common mode 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-IV 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.

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.

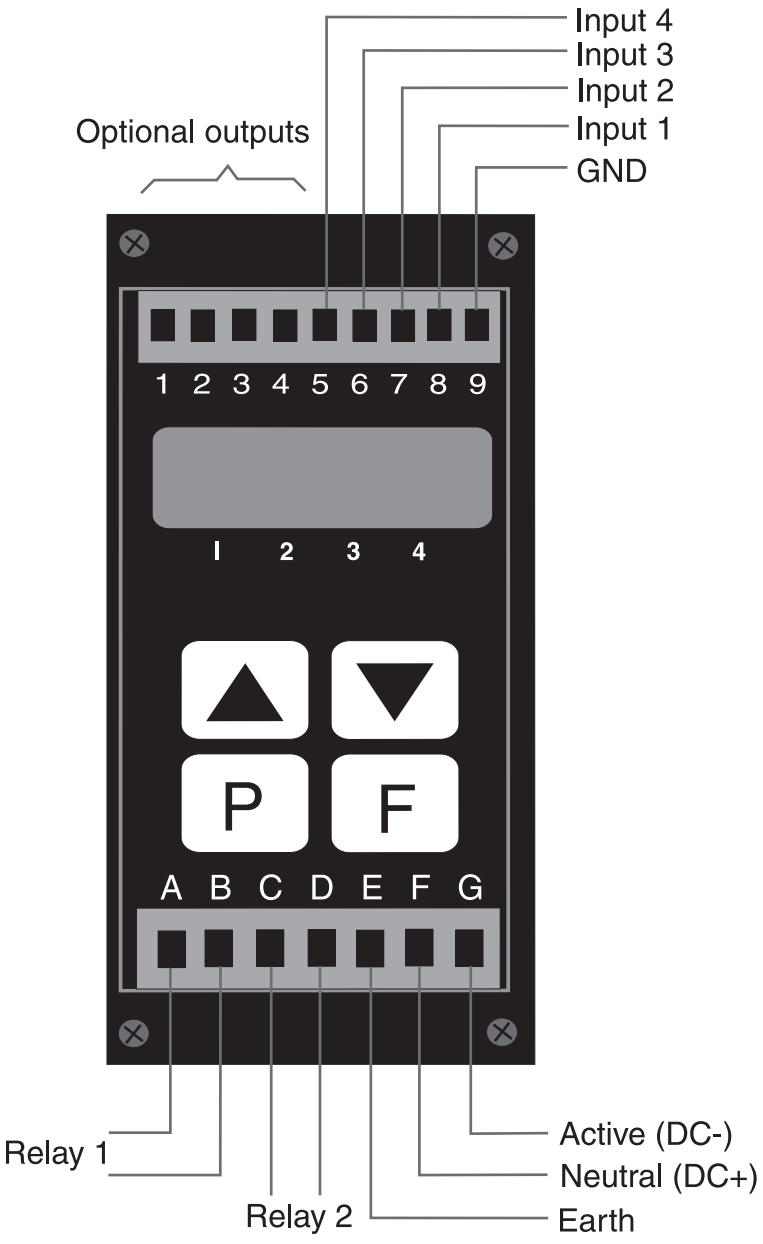


3 Electrical installation

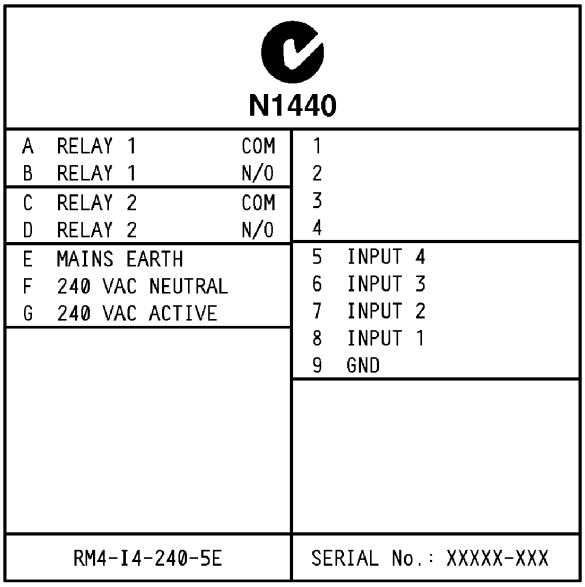
The RM4 Meter is designed for continuous operation and no power switch is fitted to the unit. It is recommended that an external switch and fuse be provided to allow the unit to be removed for servicing. The terminal blocks allow for wires of up to 2.5mm^2 to be fitted for power supply and relays 1 and 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 data label example.

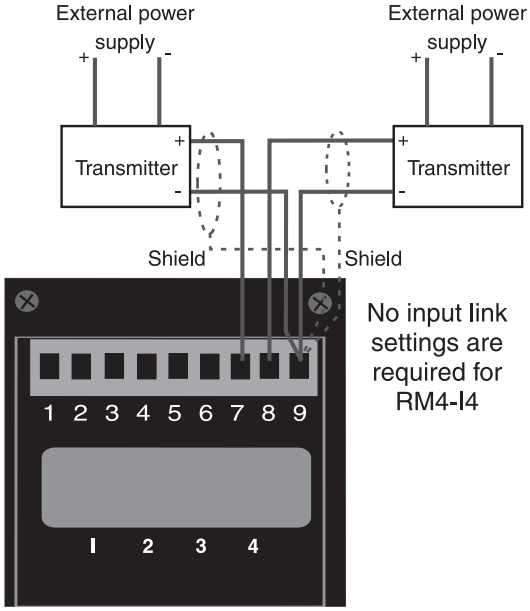

N1440
A RELAY 1 COM
B RELAY 1 N/O
C RELAY 2 COM
D RELAY 2 N/O
E MAINS EARTH
F 240 VAC NEUTRAL
G 240 VAC ACTIVE
1
2
3
4
5 INPUT 4
6 INPUT 3
7 INPUT 2
8 INPUT 1
9 GND
RM4-I4-240-5E
SERIAL No.: XXXXX-XXX

Check power supply type before connecting. Relay outputs are voltage free contacts.

3.1 Signal input connections

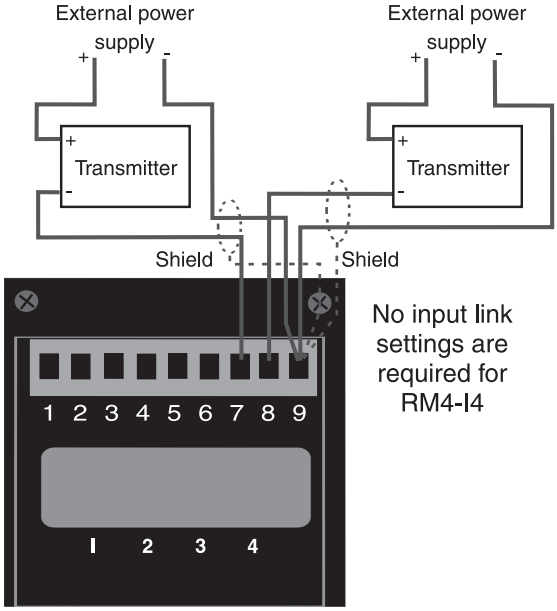
See section 3.3 for details of link settings.

Model RM4-I4
4 wire ±20 or 4-20mA.
Externally powered.
Two input example shown.



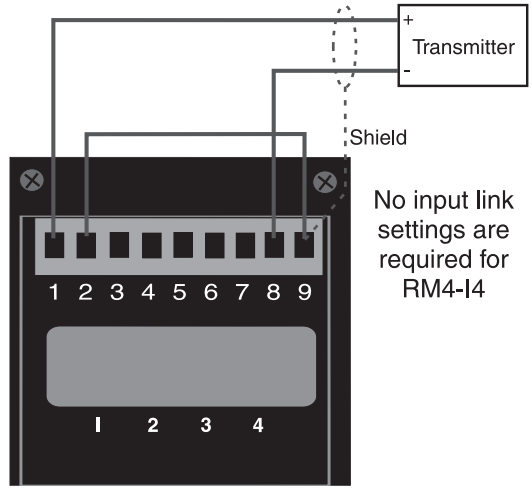
No input link settings are required for RM4-I4

Model RM4-I4
2 wire ±20 or 4-20mA.
Externally powered.
Two input example shown.



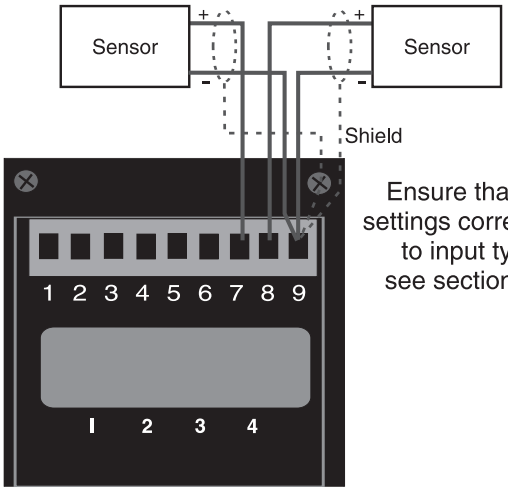
No input link settings are required for RM4-I4

Model RM4-I4
2 wire ±20 or 4-20mA.
Powered via optional
12 or 24V regulated.
One input example shown.



No input link settings are required for RM4-I4

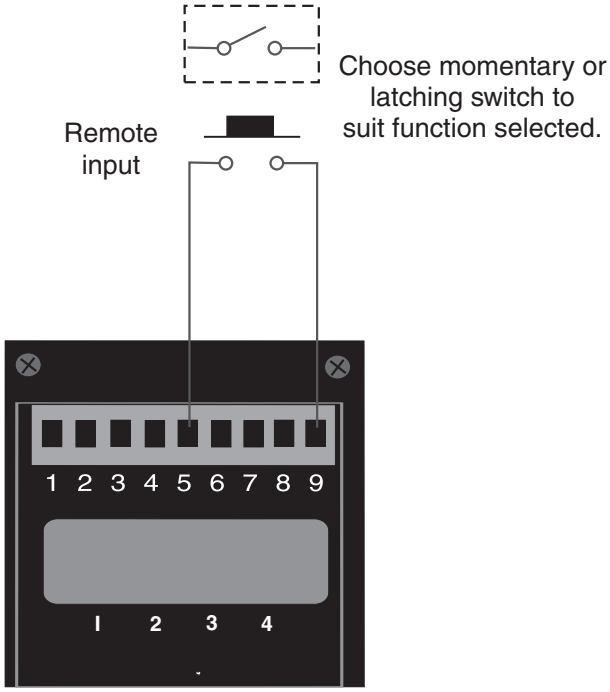
Model RM4-V4
DC voltage input.
Two input example shown.
Note, sensor may require
supply voltage connections.



Ensure that link settings correspond to input type, see section 3.3.

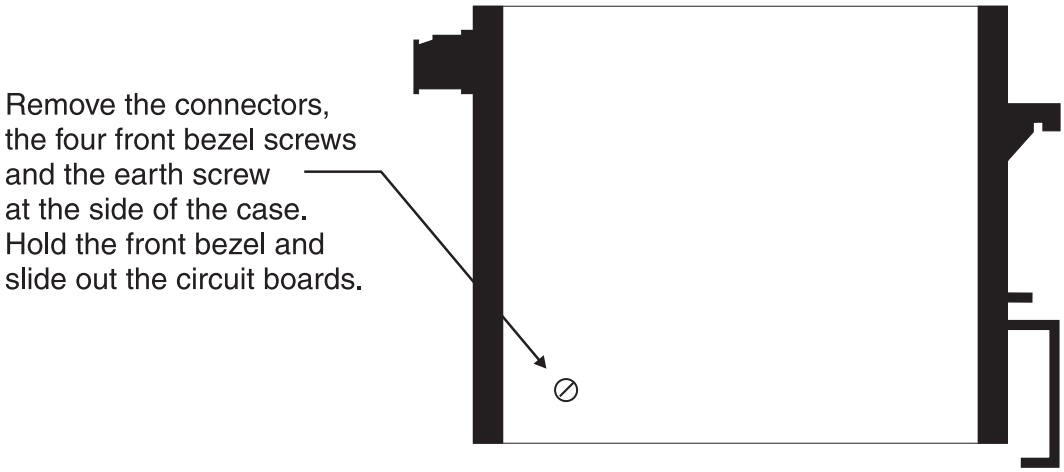
3.2 Remote input connections

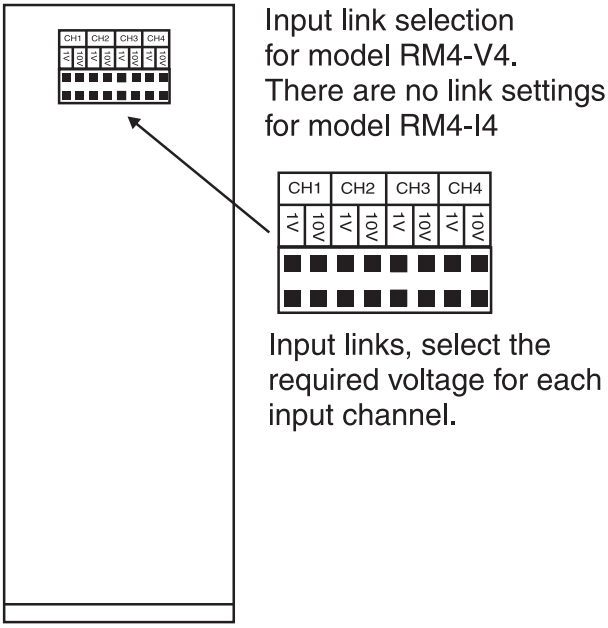
The selected remote input function can be operated via an external contact closure via a switch, relay or open collector transistor switch.



3.3 Configuring the input board

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




CH1
CH2
CH3
CH4
1V
10V
Input link selection
for model RM4-V4.
There are no link settings
for model RM4-I4
Input links, select the
required voltage for each
input channel.

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.

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

Display	Function	Range	Default	Your record	Ref/Page
A*x*Lo	Low setpoint value for designated alarm relay *x*	Any display value or **OFF**	**OFF**	See 4.1	5.1 / 17
A*x*Hi	High setpoint value for designated alarm relay *x*	Any display value or **OFF**	**OFF**	See 4.1	5.2 / 17
A*x*HY	Hysteresis value for the designated alarm relay *x*.	**0** to **9999**	**10**	See 4.1	5.3 / 18
A*x*tt	Trip time delay for the designated alarm relay *x*.	**0** to **9999**	**0**	See 4.1	5.4 / 19
A*x*rt	Reset time delay for the designated alarm relay *x*.	**0** to **9999**	**0**	See 4.1	5.5 / 19
A*x*n.o or **A*x*n.c**	Alarm relay *x* action to normally open (de-energised) or normally closed (energised)	**A*x*n.o** or **A*x*n.c**	**A*x*n.o**	See 4.1	5.6 / 19
A*x*SP or **A*x*t 1** etc.	Relay operation independent setpoint or trailing setpoint (*__Optional__)	**A*x*SP** or **A*x*t 1** etc.	**A*x*SP**	See 4.1	5.7 / 20
brgt	Display brightness level	**1** to **15**	**15**		5.8 / 20
dULL	Display remote brightness switching	**0** to **15**	**1**		5.9 / 20
d.oFF SECS	Auto display dimming timer	**0** to **9999**	**0**		5.10 / 21
rEC_	Analog output option low display value (*__Optional__)	Any display value	**0**		5.11 / 21
rEC¯	Analog output option high display value (*__Optional__)	Any display value	**1000**		5.12 / 21
rEC_ Ch2	Second analog output option low display value (*__Optional__)	Any display value	**0**		5.13 / 22
rEC¯ Ch2	Second analog output option high display value (*__Optional__)	Any display value	**1000**		5.14 / 22

(*__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
drnd	Display rounding	1 to 5000	1		5.15 / 22
dCPt	Decimal point for arithmetic operation	0, 0.1 etc.	0		5.16 / 22
FLtr	Digital filter	0 to 8	2		5.17 / 23
Chno.	Number of active channels	1 to 4	4		5.18 / 23
Ch 1 dCPt	Decimal point for channel 1	0, 0.1 etc.	0		5.19 / 23
Ch2 dCPt	Decimal point for channel 2	0, 0.1 etc.	0		5.20 / 24
Ch3 dCPt	Decimal point for channel 3	0, 0.1 etc.	0		5.21 / 24
Ch4 dCPt	Decimal point for channel 4	0, 0.1 etc.	0		5.22 / 24
EA1	EA1 value for arithmetic formula	-19999 to 32767	1		5.23 / 25
Eb1	Eb1 value for arithmetic formula	-19999 to 32767	0		5.24 / 25
EC1	EC1 value for arithmetic formula	-19999 to 32767	1		5.25 / 25
EA2	EA2 value for arithmetic formula	-19999 to 32767	1		5.26 / 26
Eb2	Eb2 value for arithmetic formula	-19999 to 32767	0		5.27 / 26
EC2	EC2 value for arithmetic formula	-19999 to 32767	1		5.28 / 26
EA3	EA3 value for arithmetic formula	-19999 to 32767	1		5.29 / 26
Eb3	Eb3 value for arithmetic formula	-19999 to 32767	0		5.30 / 26
EC3	EC3 value for arithmetic formula	-19999 to 32767	1		5.31 / 27
EA4	EA4 value for arithmetic formula	-19999 to 32767	1		5.32 / 27
Eb4	Eb4 value for arithmetic formula	-19999 to 32767	0		5.33 / 27
EC4	EC4 value for arithmetic formula	-19999 to 32767	1		5.34 / 27

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

OP 1	Arithmetic operation between channels 1 and 2	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE, COS or C.Sub	Add		5.35 / 27
OP2	Arithmetic operation between channel 3 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		5.36 / 28
OP3	Arithmetic operation between channel 4 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		5.37 / 28
Ch0	Channel 0 polarity	both, POS or nEG	both		5.38 / 29
Ch 1	Channel 1 polarity	both, POS or nEG	both		5.39 / 29
Ch2	Channel 2 polarity	both, POS or nEG	both		5.40 / 29
Ch3	Channel 3 polarity	both, POS or nEG	both		5.41 / 30
Ch4	Channel 4 polarity	both, POS or nEG	both		5.42 / 30
Ch 1 CAL 1	First calibration scaling point for channel 1 input	Any display value	n/a		5.43 / 30
Ch 1 CAL2	Second calibration scaling point for channel 1 input	Any display value	n/a		5.44 / 30
Ch2 CAL 1	First calibration scaling point for channel 2 input	Any display value	n/a		5.45 / 30
Ch2 CAL2	Second calibration scaling point for channel 2 input	Any display value	n/a		5.46 / 31
Ch3 CAL 1	First calibration scaling point for channel 3 input	Any display value	n/a		5.47 / 31
Ch3 CAL2	Second calibration scaling point for channel 3 input	Any display value	n/a		5.48 / 31
Ch4 CAL 1	First calibration scaling point for channel 4 input	Any display value	n/a		5.49 / 31
Ch4 CAL2	Second calibration scaling point for channel 4 input	Any display value	n/a		5.50 / 31
UCAL Ch 1	Uncalibrate channel 1	n/a	n/a		5.51 / 32
UCAL Ch2	Uncalibrate channel 2	n/a	n/a		5.52 / 32

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

UCAL Ch3	Uncalibrate channel 3	n/a	n/a		5.53 / 32
UCAL Ch4	Uncalibrate channel 4	n/a	n/a		5.54 / 32
P.but	P button function	NONE, HI, LO, HI LO or ZERO	NONE		5.55 / 33
r.INP	Remote input (external input) function	NONE, P.HLd, d.HLd, HI, LO, HI LO, ZERO, SP.Ac, No.Ac or dULL	NONE		5.56 / 33
ACCS	Access mode	OFF, EASY, NONE or ALL	OFF		5.57 / 34
SPAC	Setpoint access mode (*Optional)	A1, A1-2 etc.	A1		5.58 / 34
SCAN PEr d	Scan period	0 to 240	0		5.59 / 35
A1 OPEr, A2 OPEr etc.	Alarm relay channel allocation	Arth, CH1, CH2 or CH3	Arth		5.60 / 35
rEC OPEr	First analog output operation mode (*Optional)	Arth, Ch1, Ch2, Ch3, HI 9H, Lo, AUGE, S.PLS or S.rLY	Ch1		5.61 / 35
rEC PLSE	First analog output pulse width (*Optional)	0 to 10	0		5.62 / 37
rEC2 OPEr	Second analog output operation mode (*Optional)	Arth, Ch1, Ch2, Ch3, HI 9H, Lo, AUGE, S.PLS or S.rLY	Ch1		5.63 / 37
rEC2 PLSE	Second analog output pulse width (*Optional)	0 to 10	0		5.64 / 37
SEt OPEr	Set operation mode	ArtH or SCAN	ArtH		5.65 / 37
bAUd rAtE	Baud rate for serial communications (*Optional)	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	9600		5.66 / 38

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

PrtY	Parity for serial communications (*Optional)	nONE, EUEn or odd	nONE		5.67 / 38
O.Put	Output for serial communications (*Optional)	dI SP, Cont, POLL, A.buS or ñ.buS	Cont		5.68 / 38
Addr	Instrument address for serial communications (*Optional)	0 to 3 1	0		5.69 / 39

(*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
A*x*Lo				
A*x*H,				
A*x*HY				
A*x*tt				
A*x*rt				
A*x*n.o or A*x*n.c				
A*x*SP or A*x*t 1 etc.	n/a			
A 1, A2 etc.				

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.

Entering CAL Mode

1. Remove power from the instrument. Hold in the F button and reapply power. The display will indicate CAL as part of the "wake up messages" when the CAL message is seen you can release the button.

2. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the F button.

3. Within 2 seconds of releasing the F button press, then release the ▲ and ▼ buttons together. The display will now indicate FUNC followed by the first function.

Note: If step 1 above has been completed then the instrument will remain in this CAL mode state until power is removed. i.e. there is no need to repeat step 1 when accessing function unless power has been removed.

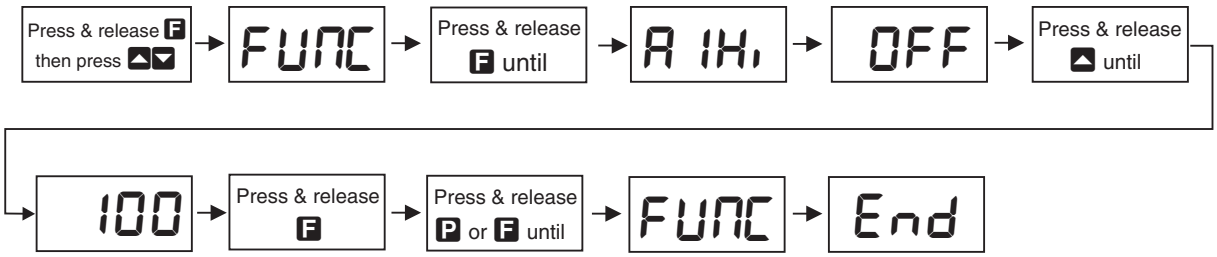
Entering FUNC Mode

No special power up procedure is required to enter FUNC mode.

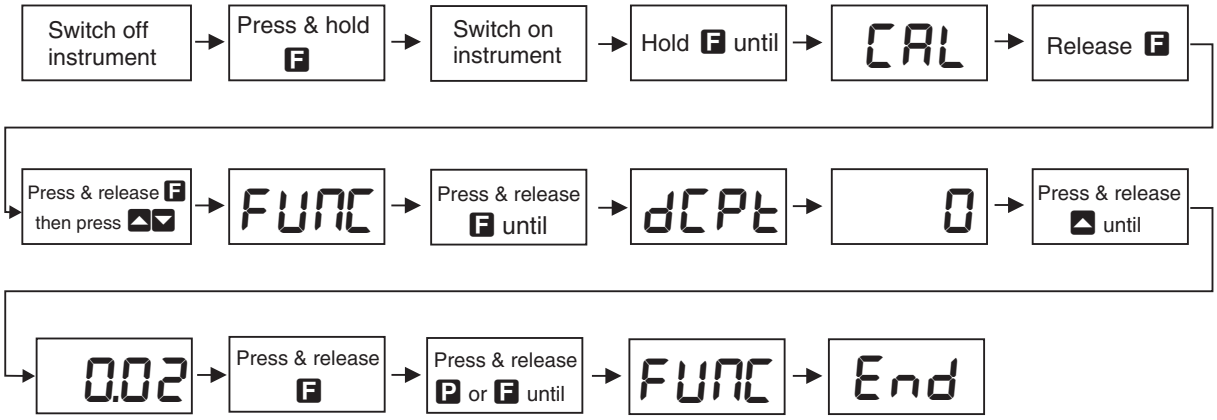
1. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the F button.

2. Within 2 seconds of releasing the F button press, then release the ▲ and ▼ buttons together. The display will now indicate FUNC followed by the first function.

Example: Entering FUNC mode to change alarm 1 high function A 1H, 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.1 nP 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 A 1-2 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.

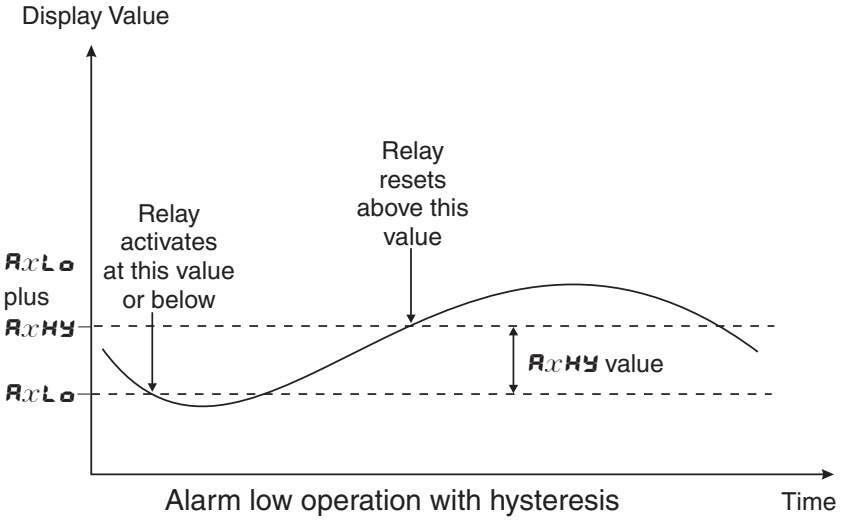
Explanation of Functions

5.1 Alarm relay low setpoint

Display: RxLo
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. R 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 RxLo 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 RxHY function.

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

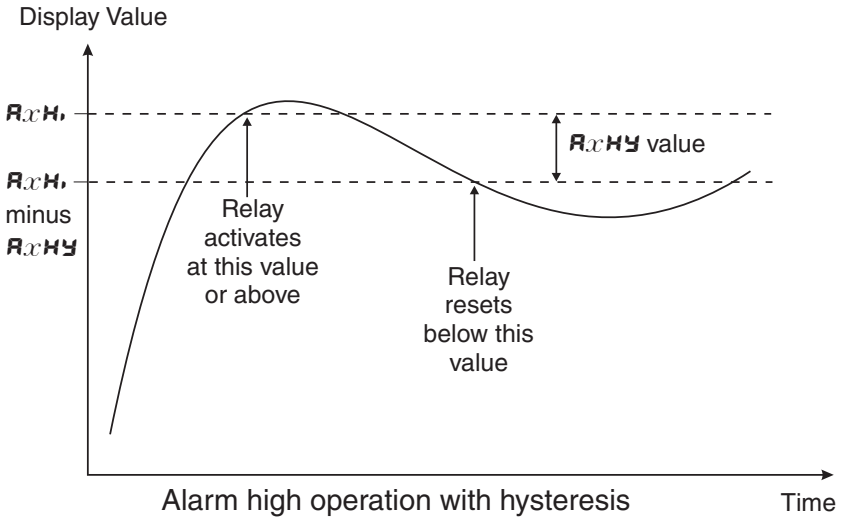


5.2 Alarm relay high setpoint

Display: RxH,
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. R 1H, 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 RxH, 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 RxHY function.

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



5.3 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 1H, 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 1H, 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.

5.4 Alarm relay trip time

Display: Axtt
Range: 0 to 9999
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 9999 seconds. To set a trip time value go to the Axtt 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.

5.5 Alarm relay reset time

Display: Axrt
Range: 0 to 9999
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 9999 seconds. To set a reset time value go to the Axrt 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.

5.6 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.

5.7 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 A1H, is set to 1000 and A2H, 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).

5.8 Display brightness

Display: brgt
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 brgt function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

5.9 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.i 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 brgt function 5.8 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 brgt set to 15 and the F.1 inP 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.

5.10 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 brgt 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.

5.11 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.

5.12 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.

5.13 Second analog output option low value

Display: rEC_ Ch2
Range: Any display value
Default Value: 0

See rEC_ function 5.11 for description of operation.

5.14 Second analog output option high value

Display: rEC^ Ch2
Range: Any display value
Default Value: 1000

See rEC^ function 5.12 for description of operation.

5.15 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.

5.16 Decimal point for arithmetic operation

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

Displays and sets the decimal point for the arithmetic result, this function only applies when the SEt OPEr function is set to ArtH. 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) etc. up to 5 decimal places. Note if the decimal point is altered the display will need to be recalibrated and alarm etc. settings checked. The

arithmetic calculation will assume that all channel decimal places are the same as the arithmetic channel e.g. a channel 1, 2 or 3 display of **1.00** will be interpreted for calculation purposes as **10.0** if **dCPt** is set to **0.1**. If necessary adjustment for this can be made using the arithmetic formula.

5.17 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.

5.18 Number of active channels

Display: **Chno.**
Range: **1** to **4**
Default Value: **4**

Displays and selects the number of active input channels to be used. The instrument will automatically display functions only for the number of channels selected. For example if this functions is set to 3 channels the only inputs 1, 2 and 3 will be scanned and the functions for channel 4 will not be seen.

5.19 Decimal point for channel 1

Display: **Ch 1dCPt**
Range: **0**, **0.1** etc.
Default Value: **0**

Displays and sets the individual decimal point setting for input channel 1. 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) etc. Note if the decimal point is altered the channel will need to be recalibrated and alarm etc. settings checked. Note that in arithmetic mode all channels will be treated as having the same decimal points as Channel 0 for calculation purposes e.g. if the channel zero decimal point function (**dCPt**) is set to **0.02** and **Ch 1dCPt** is set to **0.1** then a value of **100.0** on channel 1 will be treated as a value of **10.00** when the arithmetic operation takes place.

5.20 Decimal point for channel 2

Display: Ch2dCPt
Range: 0, 0.1 etc.
Default Value: 0

Displays and sets the individual decimal point setting for input channel 2. 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) etc. Note if the decimal point is altered the channel will need to be recalibrated and alarm etc. settings checked. Note that in arithmetic mode all channels will be treated as having the same decimal points as Channel 0 for calculation purposes e.g. if the channel zero decimal point function (dCPt) is set to 0.02 and Ch2dCPt is set to 0.1 then a value of 100.0 on channel 2 will be treated as a value of 10.00 when the arithmetic operation takes place.

5.21 Decimal point for channel 3

Display: Ch3dCPt
Range: 0, 0.1 etc.
Default Value: 0

Displays and sets the individual decimal point setting for input channel 3. 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) etc. Note if the decimal point is altered the channel will need to be recalibrated and alarm etc. settings checked. Note that in arithmetic mode all channels will be treated as having the same decimal points as Channel 0 for calculation purposes e.g. if the channel zero decimal point function (dCPt) is set to 0.02 and Ch3dCPt is set to 0.1 then a value of 100.0 on channel 3 will be treated as a value of 10.00 when the arithmetic operation takes place.

5.22 Decimal point for channel 4

Display: Ch4dCPt
Range: 0, 0.1 etc.
Default Value: 0

Displays and sets the individual decimal point setting for input channel 4. 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) etc. Note if the decimal point is altered the channel will need to be recalibrated and alarm etc. settings checked. Note that in arithmetic mode all channels will be treated as having the same decimal points as Channel 0 for calculation purposes e.g. if the channel zero decimal point function (dCPt) is set to 0.02 and Ch4dCPt is set to 0.1 then a value of 100.0 on channel 4 will be treated as a value of 10.00 when the arithmetic operation takes place.

5.23 Channel 1 EA 1 value for arithmetic formula

Display: EA 1

Range: -19999 to 32767

Default Value: 1

Seen only in SEt OPEr = ArtH mode. Displays and sets the EA 1 value to be used in the arithmetic formula. A range from -19999 to 32767 is available for this function. This value is used together with the input value for channel 1, the Eb 1 and EC 1 to produce the a value to be used together with the OP 1, OP2, OP3 and OP4 options in the formula below (4 channel example shown):

$$\frac{EA\,1 * (\text{Ch1} + Eb\,1)}{EC\,1} \{OP\,1\} \frac{EA2 * (\text{Ch2} + Eb2)}{EC2} \{OP2\} \frac{EA3 * (\text{Ch3} + Eb3)}{EC3} \{OP3\} \frac{EA4 * (\text{Ch4} + Eb4)}{EC4}$$

As the formula shows the EA 1, Eb 1 and EC 1 values entered are used to manipulate the display value for channel 1 (Ch1). This value then acts on the similarly manipulated channel 2 value using the operation selected at the OP 1 function etc. for the remaining active channels. A full expansion of the formula showing the OP 1, OP2 and OP3 options is given below.

$$\frac{EA\,1 * (\text{Ch1} + Eb\,1)}{EC\,1} \left\{ \begin{array}{l} Add \\ Sub \\ Prod \\ d.U \\ hi\,9h \\ Lo \\ S.nE \\ CoS \\ C.Sub \end{array} \right\} \frac{EA2 * (\text{Ch2} + Eb2)}{EC2} \left\{ \begin{array}{l} Add \\ Sub \\ Prod \\ d.U \\ hi\,9h \\ Lo \\ S.nE \\ CoS \\ C.Sub \end{array} \right\} \frac{EA3 * (\text{Ch3} + Eb3)}{EC3} \left\{ \begin{array}{l} Add \\ Sub \\ Prod \\ d.U \\ hi\,9h \\ Lo \\ S.nE \\ CoS \\ C.Sub \end{array} \right\} \frac{EA4 * (\text{Ch4} + Eb4)}{EC4}$$

Note: A and C are whole numbers, b has the same decimal place setting as its associated channel.

5.24 Channel 1 Eb 1 value for arithmetic formula

Display: Eb 1

Range: -19999 to 32767

Default Value: 0

Seen only in SEt OPEr = ArtH mode. Displays and sets the Eb 1 value to be used in the arithmetic formula. See function 5.23 for further details.

5.25 Channel 1 EC 1 value for arithmetic formula

Display: EC 1

Range: -19999 to 32767

Default Value: 1

Seen only in SEt OPEr = ArtH mode. Displays and sets the EC 1 value to be used in the arithmetic formula. See function 5.23 for further details.

5.26 Channel 2 EA2 value for arithmetic formula

Display: EA2
Range: -19999 to 32767
Default Value: 1

Seen only in SEt OPEr = ArtH mode. Displays and sets the EA2 value to be used in the arithmetic formula. See function 5.23 for further details.

5.27 Channel 2 Eb2 value for arithmetic formula

Display: Eb2
Range: -19999 to 32767
Default Value: 0

Seen only in SEt OPEr = ArtH mode. Displays and sets the Eb2 value to be used in the arithmetic formula. See function 5.23 for further details.

5.28 Channel 2 EC2 value for arithmetic formula

Display: EC2
Range: -19999 to 32767
Default Value: 1

Seen only in SEt OPEr = ArtH mode. Displays and sets the EC2 value to be used in the arithmetic formula. See function 5.23 for further details.

5.29 Channel 3 EA3 value for arithmetic formula

Display: EA3
Range: -19999 to 32767
Default Value: 1

Seen only in SEt OPEr = ArtH mode. Displays and sets the EA3 value to be used in the arithmetic formula. See function 5.23 for further details.

5.30 Channel 3 Eb3 value for arithmetic formula

Display: Eb3
Range: -19999 to 32767
Default Value: 0

Seen only in SEt OPEr = ArtH mode. Displays and sets the Eb3 value to be used in the arithmetic formula. See function 5.23 for further details.

5.31 Channel 3 EC3 value for arithmetic formula

Display: EC3
Range: -19999 to 32767
Default Value: 1

Seen only in SEt OPEr = Arth mode. Displays and sets the EC3 value to be used in the arithmetic formula. See function 5.23 for further details.

5.32 Channel 4 EA4 value for arithmetic formula

Display: EA4
Range: -19999 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EA4 value to be used in the arithmetic formula. See function 5.23 for further details.

5.33 Channel 4 Eb4 value for arithmetic formula

Display: Eb4
Range: -19999 to 32767
Default Value: 0

Seen only in CodE = Arth mode. Displays and sets the Eb4 value to be used in the arithmetic formula. See function 5.23 for further details.

5.34 Channel 4 EC4 value for arithmetic formula

Display: EC4
Range: -19999 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EC4 value to be used in the arithmetic formula. See function 5.23 for further details.

5.35 Arithmetic operation between channels 1 and 2

Display: OP 1
Range: Add, Sub, Prod, di U, Hi 9h, Lo, SI nE, COS or C.Sub
Default Value: Add

Displays the arithmetic operation to be undertaken between the formula for channels 1 and 2. See also function 5.23 which illustrates the formula.
Choices are:

- Add - channel 1 formula plus channel 2 formula

- **Sub** - channel 1 formula minus channel 2 formula
- **Prod** - channel 1 formula times channel 2 formula
- **di U** - channel 1 formula divided by channel 2 formula
- **Hi 9h** - highest of channel 1 formula or channel 2 formula
- **Lo** - lowest of channel 1 formula or channel 2 formula
- **Si nE** - channel 1 formula times the sine of the angle represented by channel 2 formula
- **COS** - channel 1 formula times the cosine of the angle represented by channel 2 formula
- **C.Sub** - channel 1 formula clock time input minus channel 2 formula clock time.
  Note: **C.Sub** is meant to be used when connecting to two clocks with compatible serial outputs.

5.36 Arithmetic operation between channel 3 and previous operation

Display:	**OP2**
Range:	**Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **Si nE** or **COS**
Default Value:	**Add**

Displays the arithmetic operation to be undertaken between the channel 3 formula and the previous result. See also function 5.23 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** plus channel 3 formula
- **Sub** - mathematical result of **OP 1** minus channel 3 formula
- **Prod** - mathematical result of **OP 1** times channel 3 formula
- **di U** - mathematical result of **OP 1** divided by channel 3 formula
- **Hi 9h** - highest of mathematical result of **OP 1** or channel 3 formula
- **Lo** - lowest of mathematical result of **OP 1** or channel 3 formula
- **Si nE** - mathematical result of **OP 1** times the sine of the angle represented by channel 3 formula
- **COS** - mathematical result of **OP 1** times the cosine of the angle represented by channel 3 formula

5.37 Arithmetic operation between channel 4 and previous operation

Display:	**OP3**
Range:	**Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **Si nE** or **COS**
Default Value:	**Add**

Displays the arithmetic operation to be undertaken between the channel 4 formula and the previous result. See also function 5.23 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** and **OP2** plus channel 4 formula
- **Sub** - mathematical result of **OP 1** and **OP2** minus channel 4 formula
- **Prod** - mathematical result of **OP 1** and **OP2** times channel 4 formula
- **di U** - mathematical result of **OP 1** and **OP2** divided by channel 4 formula
- **Hi gh** - highest of mathematical result of **OP 1** and **OP2** or channel 4 formula
- **Lo** - lowest of mathematical result of **OP 1** and **OP2** or channel 4 formula
- **Si nE** - mathematical result of **OP 1** and **OP2** times the sine of the angle represented by channel 4 formula
- **COS** - mathematical result of **OP 1** and **OP2** times the cosine of the angle represented by channel 4 formula

5.38 Channel 0 polarity

Display: **Ch0**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 0. Channel 0 is the channel which displays the result of the arithmetic operations. If set to **bOtH** then the display will be able to indicate both positive and negative values. If set to **POS** the display will allow only positive values with any values below zero being rounded to zero. If set to **NEG** then the display will allow only negative values with any value above zero being rounded to zero. Channel 0 polarity applies to Arithmetic mode **ArtH** only.

5.39 Channel 1 polarity

Display: **Ch 1**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 1. If set to **bOtH** then the display will be able to indicate both positive and negative values. If set to **POS** the display will allow only positive values with any values below zero being rounded to zero. If set to **NEG** then the display will allow only negative values with any value above zero being rounded to zero.

5.40 Channel 2 polarity

Display: **Ch2**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 2. See function 5.39 for further information.

5.41 Channel 3 polarity

Display: Ch3
Range: both, POS or NEG
Default Value: both

Displays and sets the polarity selection for the display of the engineering value for channel 3. See function 5.39 for further information.

5.42 Channel 4 polarity

Display: Ch4
Range: both, POS or NEG
Default Value: both

Displays and sets the polarity selection for the display of the engineering value for channel 4. See function 5.39 for further information.

5.43 First calibration scaling point for channel 1 input

Display: Ch1 CAL 1
Range: Any display value
Default Value: n/a

First scaling point for 2 point calibration scaling - See “Calibration” chapter

5.44 Second calibration scaling point for channel 1 input

Display: Ch1 CAL2
Range: Any display value
Default Value: n/a

Second scaling point for 2 point calibration scaling - See “Calibration” chapter

5.45 First calibration scaling point for channel 2 input

Display: Ch2 CAL 1
Range: Any display value
Default Value: n/a

First scaling point for 2 point calibration scaling - See “Calibration” chapter

5.46 Second calibration scaling point for channel 2 input

Display: Ch2 CAL2
Range: Any display value
Default Value: n/a

Second scaling point for 2 point calibration scaling - See “Calibration” chapter

5.47 First calibration scaling point for channel 3 input

Display: Ch3 CAL 1
Range: Any display value
Default Value: n/a

First scaling point for 2 point calibration scaling - See “Calibration” chapter

5.48 Second calibration scaling point for channel 3 input

Display: Ch3 CAL2
Range: Any display value
Default Value: n/a

Second scaling point for 2 point calibration scaling - See “Calibration” chapter See “Calibration” chapter

5.49 First calibration scaling point for channel 4 input

Display: Ch4 CAL 1
Range: Any display value
Default Value: n/a

First scaling point for 2 point calibration scaling - See “Calibration” chapter

5.50 Second calibration scaling point for channel 4 input

Display: Ch4 CAL2
Range: Any display value
Default Value: n/a

Second scaling point for 2 point calibration scaling - See “Calibration” chapter See “Calibration” chapter

5.51 Uncalibrate channel 1

Display: UCAL Ch 1
Range: n/a
Default Value: n/a

Uncalibrate, resets calibration for channel 1 - required only when a calibration problem occurs and it is necessary to clear the calibration memory. At the UCAL Ch 1 function press the ▲ and ▼ buttons simultaneously. The message CAL CLr should be seen to indicate that the calibration memory has been cleared.

5.52 Uncalibrate channel 2

Display: UCAL Ch2
Range: n/a
Default Value: n/a

Uncalibrate, resets calibration for channel 2 - required only when a calibration problem occurs and it is necessary to clear the calibration memory. At the UCAL Ch2 function press the ▲ and ▼ buttons simultaneously. The message CAL CLr should be seen to indicate that the calibration memory has been cleared.

5.53 Uncalibrate channel 3

Display: UCAL Ch3
Range: n/a
Default Value: n/a

Uncalibrate, resets calibration for channel 3 - required only when a calibration problem occurs and it is necessary to clear the calibration memory. At the UCAL Ch3 function press the ▲ and ▼ buttons simultaneously. The message CAL CLr should be seen to indicate that the calibration memory has been cleared.

5.54 Uncalibrate channel 4

Display: UCAL Ch4
Range: n/a
Default Value: n/a

Uncalibrate, resets calibration for channel 4 - required only when a calibration problem occurs and it is necessary to clear the calibration memory. At the UCAL Ch3 function press the ▲ and ▼ buttons simultaneously. The message CAL CLr should be seen to indicate that the calibration memory has been cleared.

5.55 P button function

Display: P.but
Range: NONE, Hi, Lo, Hi Lo or ZERO
Default Value: NONE

P button function - The P button (5, 6 or 8 digit LED models only) may be set to operate some of the remote input functions. With the zero function to prevent accidental operation, the P button must be held pressed for 2-3 seconds before the display will zero. If both the remote input and P button function are operated simultaneously the P button will override the remote input. The functions below are as described in the r.i nP function below. Functions available are: NONE, Hi, Lo, Hi Lo or ZERO

5.56 Remote input function

Display: r.i nP
Range: NONE, P.HLd, d.HLd, Hi, Lo, Hi Lo, ZERO, SP.Ac, No.Ac or dULL
Default Value: NONE

Remote input function - When remote input terminals 7 and 8 are short circuited, via a switch, relay, keyswitch etc. the instrument will perform the selected remote input function. A message will flash (e.g. ZERO 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 - rate peak hold. The display will show the peak rate 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 - rate display hold. The rate 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. The totaliser will still be active and will sample the live input rather than the held input whilst the rate is held i.e. the rate display hold does not affect the totaliser operation.
- Hi - rate peak memory. The rate 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 - rate valley memory. The rate minimum value stored in memory will be displayed. Otherwise operates in the same manner as the Hi function described above.
- Hi Lo - rate toggle between Hi and Lo displays. This function allows the remote input to be used to toggle between rate 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. PHi or PLo will flash before each display to give an indication of display type.

- **ZERO** - rate display zero. Zeroes the rate display when the remote input is shorted. The input at the time of the **ZERO** operation will become the new zero point. The zero operation shifts the calibration in the same manner as a calibration offset operation.
- **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.

5.57 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.

5.58 Setpoint access mode

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

Setpoint access - seen only if more than 1 relay fitted. Sets the access via **FUNC** mode and "easy alarm access" mode to the alarm relay setpoints. The following choices are available:
A 1 - Allows setpoint access to alarm 1 only.
A 1-2 - Allows setpoint access to alarms 1 and 2 only.
A 1-3 - Allows setpoint access to alarms 1, 2 and 3 etc. up to the maximum number of relays fitted.
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 1H,** is set to **OFF** then there will be no access to the **A 1H,** function when **SPAC** is used.

5.59 Scan period

Display: SCAN PERd
Range: 0 to 240
Default Value: 0

Seen only when SEt OPEr function is set to SCAN operation mode. The scan rate set the automatic display scrolling period between channels and is selectable between 0 and 240 seconds. This setting affects the display scrolling only, not sample time or retransmission scan rates. If 0 seconds is selected then the instrument will not scan i.e. the display will show one channel. To alter the displayed channel, when the scan rate is set to 0, use the ▲ or ▼ push button. The display will flash Ch 1, Ch 2 or Ch 3 before the reading (and periodically every 5 seconds) to indicate which channel is selected.

5.60 Alarm relay channel allocation

Display: A 1OPEr, A2 OPEr etc.
Range: ArtH, CH 1, CH2 or CH3
Default Value: ArtH

Alarm relay channel allocation - In scanning mode the selected alarm relay can be set to operate from either channel 1, channel 2 or channel 3. Select CH 1, CH2 or CH3 for the required operation. In arithmetic mode the selected alarm relay can be set to operate from any of these channels but can alternatively be set to operate from the result of the arithmetic operation by selecting ArtH at this function.

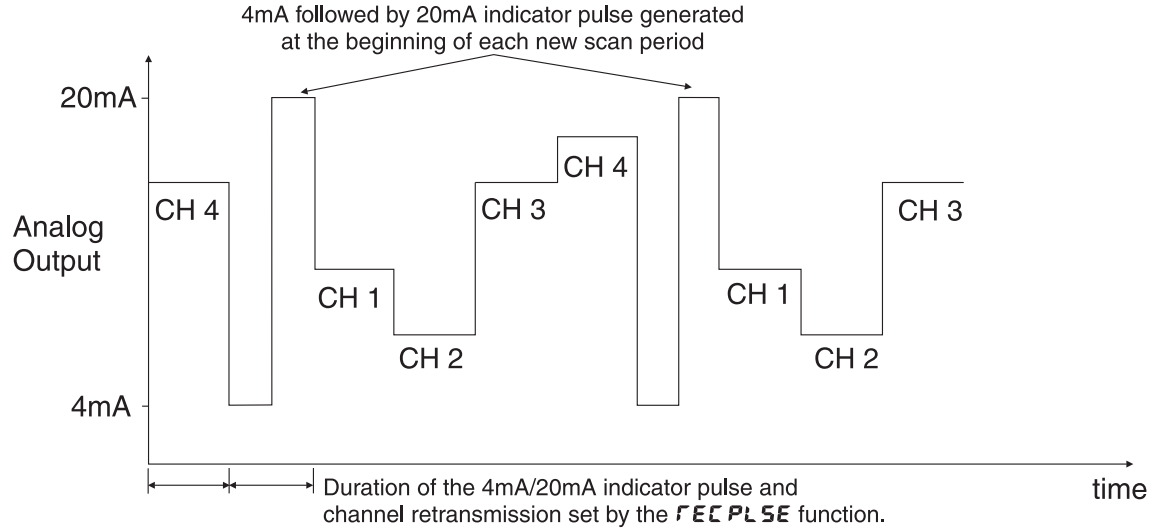
5.61 First analog output operation mode

Display: rEC OPEr
Range: ArtH, Ch 1, Ch2, Ch3, HI 9H, Lo, AUSE, S.PLS or S.rLY
Default Value: Ch 1

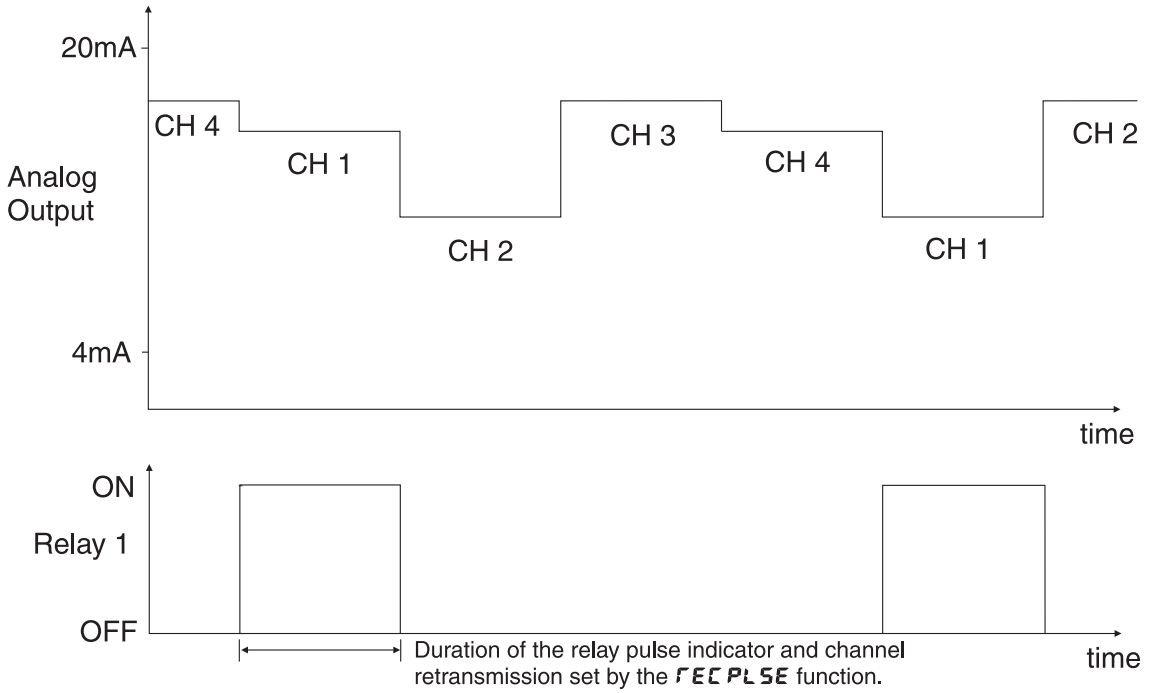
Displays and sets the operation of the recorder output when in scan mode. The rEC_ and rEC¯ functions also need to be set as required for the recorder output to operate correctly. Note that when the retransmission mode is set to HI 9H, Lo, AUSE, S.PLS or S.rLY the retransmission scaling will use the decimal point selection from channel 1 for all active channels e.g. with rEC_ set to 0.0 and rEC¯ set to 100.0 , 20mA will be retransmitted for a channel 1 display of 100.0 and channel 2 display of 10.00 and a channel 3 display of 1.000 i.e. all three are treated as the same number as far as any of the retransmission output modes are concerned since they are all taken as having the decimal point in the same place as channel 1. With the retransmission mode set to ArtH, Ch 1, Ch2 or Ch3 the rEC_ and rEC¯ settings will take on the same number of decimal points as the channel selected. Allow 200mS, for each channel change, for the retransmission output to settle down if scanning. The selections available are as follows.

- ArtH - causes the recorder output to retransmit the channel 0 value only (arithmetic result) - valid only in arithmetic (ArtH) mode).
- Ch 1 - causes the recorder output to retransmit the channel 1 value only.
- Ch2 - causes the recorder output to retransmit the channel 2 value only.

- **Ch 3** - causes the recorder output to retransmit the channel 3 value only.
- **HI 9H** - causes the recorder output to retransmit whichever input channel is giving the highest reading at that time.
- **Lo** - causes the recorder output to retransmit whichever input channel is giving the lowest reading at that time.
- **AUGE** - causes the recorder output to retransmit the average value of all active channels.
- **S.PLS** - causes the recorder output to retransmit each active channel in turn. As an indication that a new scan cycle is beginning the output will drop to 4mA then rise to 20mA (or 0 to 1V/0 to 10V for voltage retransmission), this indication can be used to communicate to a PLC etc. that a new cycle is beginning. The time duration of the 20mA pulse is determined by the setting of the **rEC PLSE** function.



- **S.rLY** - causes the recorder output to retransmit each active channel in turn. An alarm relay contact closure (relay 1) is activated at the beginning of each new scan to give an indication to a PLC etc. that a new scan is beginning. The time duration of the relay closure is determined by the setting of the **rEC PLSE** function.



Refer to the separate RM4 Din Rail Meter Optional Output Addendum booklet for description of the analog PI control functions and wiring details.

5.62 First analog output pulse width

Display: rEC PLSE
Range: 0 to 10
Default Value: 0

Applicable only to SCAN operation mode. Refer to the separate PM4 Panel Meter Optional Output Addendum booklet supplied when this option is fitted. Displays and sets the time duration of the relay indicator closure (when rEC OPEr is set to S.rLY) or the 20mA indicator pulse (when rEC OPEr is set to S.PLS). The time is variable from 1 to 10 seconds. When the pulse width is increased or decreased the total retransmission time for each cycle will increased or decreased in proportion.

5.63 Second analog output operation mode

Display: rEC2 OPEr
Range: ArtH, Ch 1, Ch2, Ch3, HI 9H, Lo, AUGE, S.PLS or S.rLY
Default Value: Ch 1

Sets operation mode for analog output 2 and has the same choice of modes as analog output 1, refer to rEC OPEr function 5.61 for details.

5.64 Second analog output pulse width

Display: rEC2 PLSE
Range: 0 to 10
Default Value: 0

Seen only when the optional dual analog retransmission is fitted. Sets the indicator pulse width for analog output 2 and has the same choices as analog ouptut 1, refer to rEC PLSE function 5.62 for details.

5.65 Set operation mode

Display: SEt OPEr
Range: ArtH or SCAN
Default Value: ArtH

The set operating mode function allows the selection of either arithmetic (ArtH) or scanning (SCAN) mode operation. In arithmetic mode the selected inputs will be combined according to the arithmetic values and operation types selected and the display will indicate the result. In scanning mode the inputs will be scanned and displayed one at a time at a rate determined by the SCAN PErd function.

5.66 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.

5.67 Parity for optional serial communications

Display: PrtY

Range: nONE, EUEn 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**, **EUEn** or **odd**. The parity should be set to match the device being communicated with.

5.68 Output mode for optional serial communications

Display: O.Put

Range: di SP, Cont, POLL, A.buS or ñ.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:

di SP - 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.

ñ.buS - Modbus RTU protocol.

5.69 Instrument address for optional serial communications

Display: Addr

Range: 0 to 31

Default Value: 0

Set unit address for polled (POLL) or n.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 n.bus mode.

6 Calibration

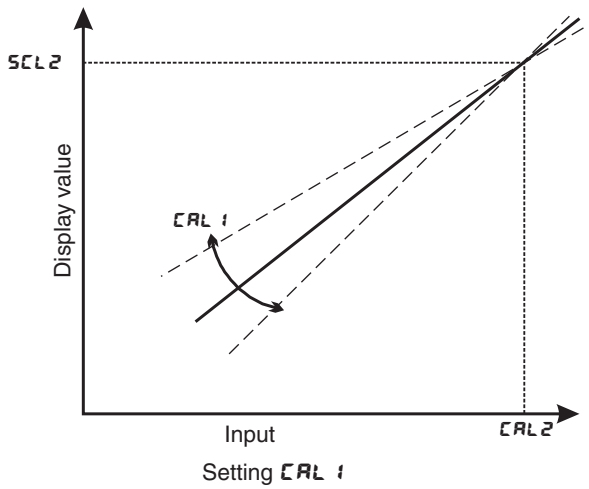
The instrument can be calibrated via a two point live input calibration method using functions CAL 1 and CAL2. For 4-20mA inputs only an alternative method allows display scaling without live inputs using the USEr En4 and USEr En20 functions. An offset calibration scaling adjustment using the CAL OFSt function is available which allows the scaling to be adjusted by a fixed amount over the entire scale. Each of these methods and other calibration scaling function are described in this chapter.

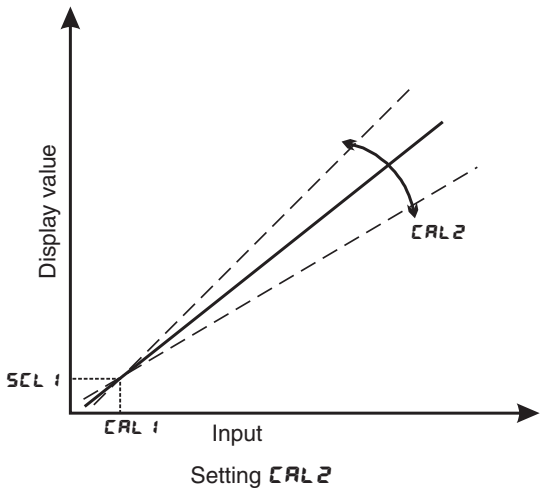
In order to gain access to the calibration functions you must be in CAL mode, refer to Chapter 5 page 17 which shows the method of entering CAL mode.

6.1 Live signal input calibration

CAL 1 and CAL2 - The functions CAL 1 and CAL2 are used together to scale the instruments display, values for both CAL 1 and CAL2 must be set when using this scaling method. The CAL 1 function sets the first calibration point for live input calibration. When using this method different signals inputs must be present at the input terminals for CAL 1 and CAL2. Note: CAL 1 and CAL2 can be set independently.

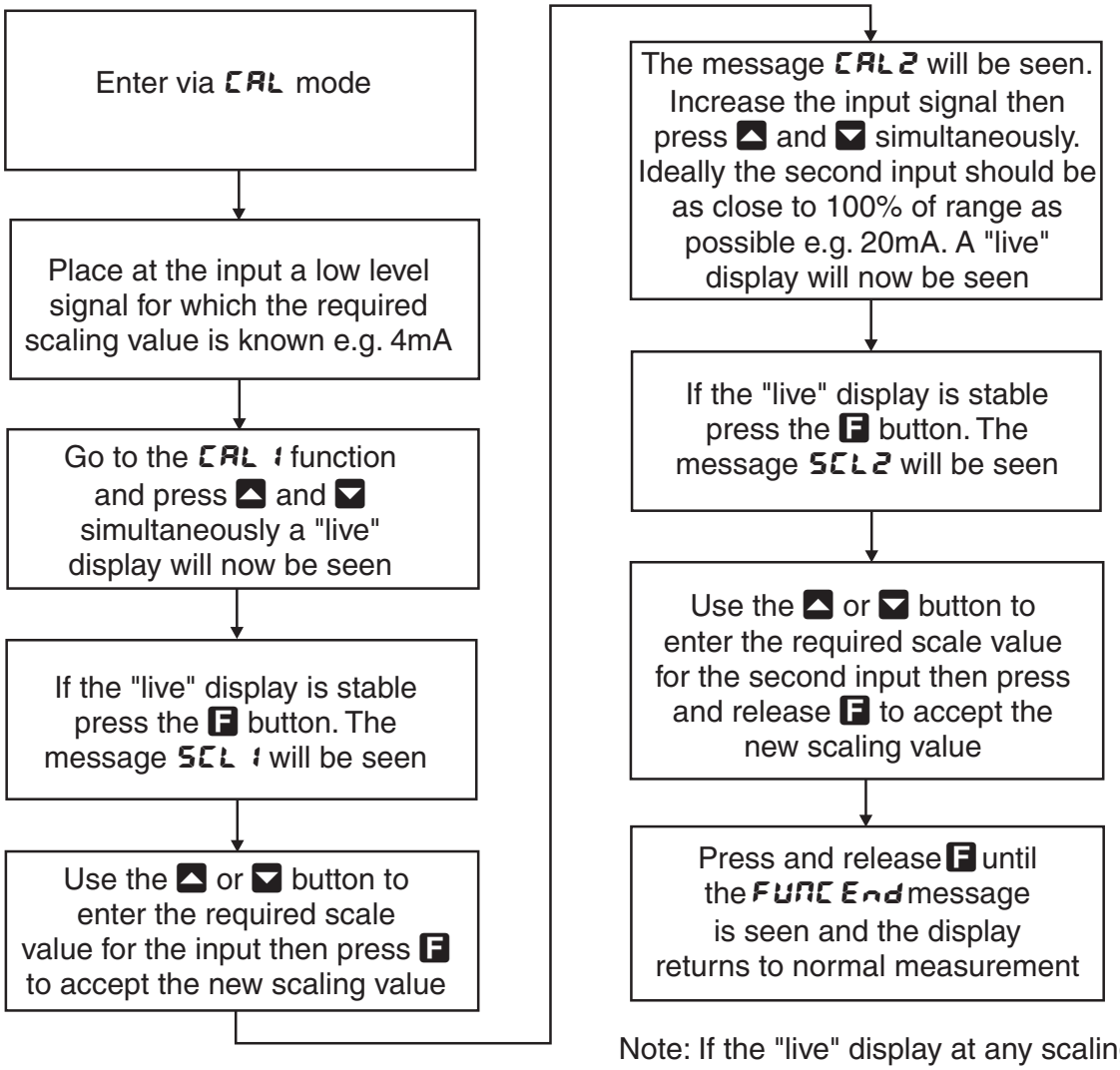
The procedure for entering the first scaling point CAL 1 is as follows:
a. Ensure that an input signal is present at the input terminals, this will usually be at the low end of the signal range e.g. 4mA for a 4-20mA input.
b. At the CAL 1 function press ▲ and ▼ simultaneously then release them. The display will show the live input value. Do not be concerned at this stage if the live input display value is not what is required. It is important that the live input value seen is a steady value, if not then the input needs to be investigated before proceeding with the scaling.
c. 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 required display value at this input. e.g. if 4mA was input and the required display at 4mA was 0 then ensure 0 is entered at SCL 1. Press the F button to accept changes or the P button to abort the scaling. If the scaling has been accepted the CAL End message should be seen.





The procedure for entering the second scaling point CAL 2 is as follows:
a. Ensure that an input signal is present at the input terminals, this will usually be at the high end of the signal range e.g. 20mA for a 4-20mA input. The change in input signal from the CAL 1 input must be at least 10% of the input range full scale.
b. At the CAL 2 function press ▲ and ▼ simultaneously then release them. The display will show the live input value. Do not be concerned at this stage if the live input display value is not what is required. It is important that the live input value seen is a steady value, if not then the input needs to be investigated before proceeding with the scaling.
c. Press then release the F button. The display will indicate SCL 2 followed by a value. Use the ▲ or ▼ button to change this value to the required display value at this input. e.g. if 20mA was input and the required display at 20mA was 500 then ensure 500 is entered at SCL 2. Press the F button to accept changes or the P button to abort the scaling. If the scaling has been accepted the CAL End message should be seen.

Example - Flow chart showing scaling using two live inputs



Note: If the "live" display at any scaling point is not stable then check the input signal for stability.

6.2 Alternative 4-20mA scaling

USEr En4 - 4mA input scaling without a live input - this calibration method can be used with 4-20mA inputs only. The instrument can be scaled for a 4-20mA input without a live input i.e. this is an alternative method to the **CAL 1** and **CAL2** method of scaling. To perform the first point (**En4**) scaling simply press the ▲ and ▼ buttons simultaneously when the **USEr En4** function is displayed. The display will now indicate a value. Use the ▲ or ▼ button to change this value to the display value required for a 4mA input. Press the **F** button to accept changes or the **P** button to abort the scaling. If the scaling has been accepted the **CAL End** message should be seen.

USEr En20 - 20mA input scaling without a live input - this calibration method can be used with 4-20mA inputs only. To perform the second point (**En20**) scaling simply press the ▲ and ▼ buttons simultaneously when the **USEr En20** function has been reached. The display will now indicate a value. Use the ▲ or ▼ button to change this value to the display value required for a 20mA input. Press the **F** button to accept changes or the **P** button to abort the scaling. If the scaling has been accepted the **CAL End** message should be seen.

Note: the **USEr En4** and **USEr En20** method relies on the accuracy of the signal input. If the sensor output is found to have an offset use the **CAL OFSt** function to correct for the offset. If the slope of the sensor output is not correct then **CAL 1** and **CAL2** methods will have to be used.

6.3 Offset calibration

CAL OFSt - Calibration offset - the calibration offset is a single point adjustment which can be used to alter the calibration scaling values across the entire measuring range without affecting the calibration slope. This method can be used instead of performing a two point calibration when a constant measurement error is found to exist across the entire range. To perform a calibration offset press the ▲ and ▼ buttons simultaneously at the **CAL OFSt** function. A "live" reading from the input will be seen, make a note of this reading. Press the **F** button, the message **SCLE** will now be seen followed by the last scale value in memory. Use the ▲ or ▼ button to adjust the scale value to the required display value for that input. For example if the "live" input reading was **50** and the required display value for this input was **70** then adjust the **SCLE** value to **70**. Press the **F** button to accept changes or the **P** button to abort the scaling. If the scaling has been accepted the message **OFSt End** should be seen. If the **2Er0 rn9E Err** message is seen refer to the **2Er0 rn9E** and **CAL 2Er0** functions.

6.4 Zero range

2Er0 rn9E - Zero Range - the zero range function allows a limit value to be set (in engineering units) above which the display will not zero i.e. if a zero operation is attempted via the **P** button, remote input or set zero function when the display value is greater than the zero range setting the display will refuse to zero and give a **2Er0 rn9E Err** message (note that the **CAL OFSt** function is also affected by the **2Er0 rn9E** setting). For example if the zero range setting is **10** the instrument will only respond to a zero operation if the display reading at the time is between **-10** and **10**. If the zero range function is not required it can be set to **OFF** by pressing the ▲ and ▼ buttons simultaneously at this function. When switched off the instrument can be zeroed no matter what the display value. Note that the instrument keeps track of the value being zeroed at each operation, when the total amount zeroed from repeated operations becomes greater than the zero range value the instrument will reject the zero operation and a **2Er0 rn9E Err** message will

be seen. To allow a zero operation beyond this point either the ZERO RNGE function value will need to be raised or a new zero reference point introduced via the CAL ZERO function. If repeated zero operations are required the ZERO RNGE function should be set to OFF or alternatively the TARE operation could be considered.

6.5 Zero range zero calibration

CAL ZERO - Zero range zero calibration - a CAL ZERO zero operation can be used to ensure that the display zero and the ZERO RNGE reference zero are at the same point after a calibration. After a calibration the CAL ZERO operation can also be used to select a zero point other than the display zero as the reference for the ZERO RNGE function. For example if the CAL ZERO operation is carried out with a display reading of 500 and a ZERO RNGE reading of 10 the zero range function will allow the display to zero only if the current display reading is between 490 and 510. To perform a calibration zero press the ▲ and ▼ buttons simultaneously at the CAL ZERO function, a live reading will be seen, press the F button, the message CAL ZERO End should now be seen indicating that the instrument has accepted the zero point. Although the display reading will not change as a result of the calibration zero the input value on the display at the time of the operation will be the new zero reference point for the ZERO RNGE function.

6.6 Uncalibration

UCAL - Uncalibrate - used to set the instrument back to the factory calibration values. This function should only be used when calibration problems exist and it is necessary to clear the calibration memory. To clear the calibration memory press the ▲ and ▼ buttons simultaneously at the UCAL function. The message CAL CLr will be seen to indicate that the memory has cleared.

7 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 **Rx OPEr** function. Note that the **Rx OPEr** function will not be seen until a value has been set for the low or high alarm e.g. for **R 1Lo** or **R 1H**. 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.

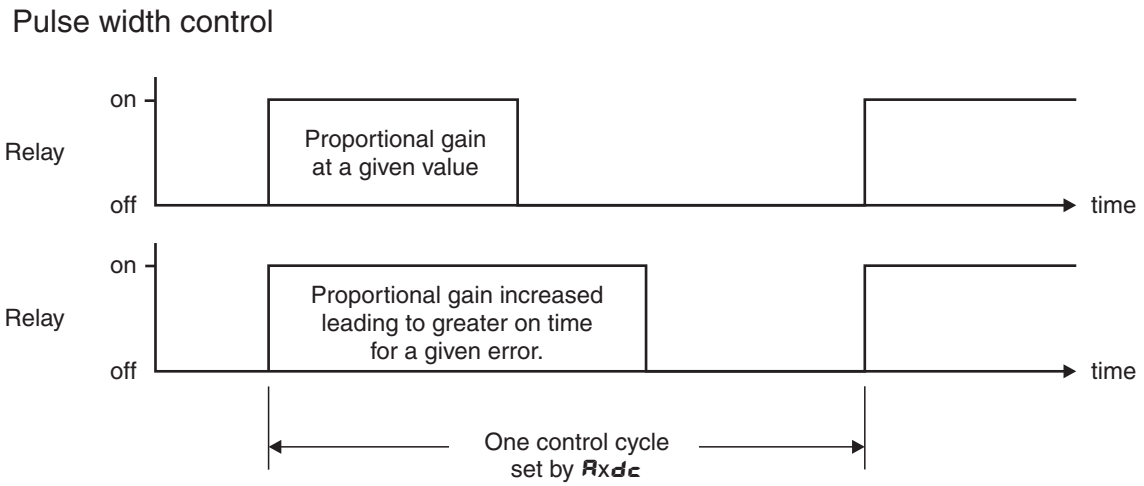
Relay 1 and , if fitted, relay 2 can be set to operate in PI control mode. Any other relays fitted will only operate in normal, non PI operation. The "*x*" in the **Rx OPEr** and other functions indicates the chosen relay i.e. for relay 1 the display will show **R 1 OPEr**, **R 1.SP** etc. The **Rx OPEr**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

7.1 Relay pulse width modulation control mode

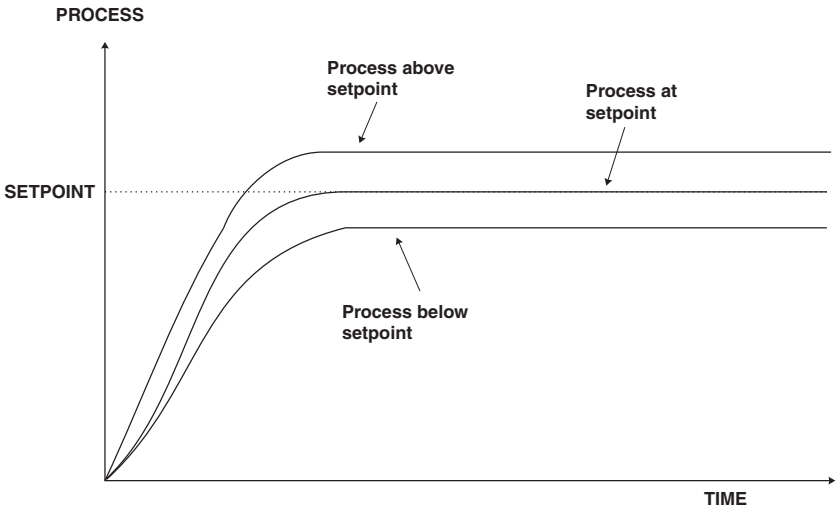
To use pulse width modulation control **Rx.tP** must be selected at the **Rx OPEr** function.



7.2 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.



7.3 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 70 and the ctrl SPAN is 20 and Ax.Pb is set to 1.000 then an error of 20 from the setpoint will cause a 100% change in proportional control output. For example with Ax.SP at 70, ctrl SPAN at 20, Ax.Pb at 1.000 and Axbs at 0.000 a display reading of 50 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.

7.4 PI relay proportional gain

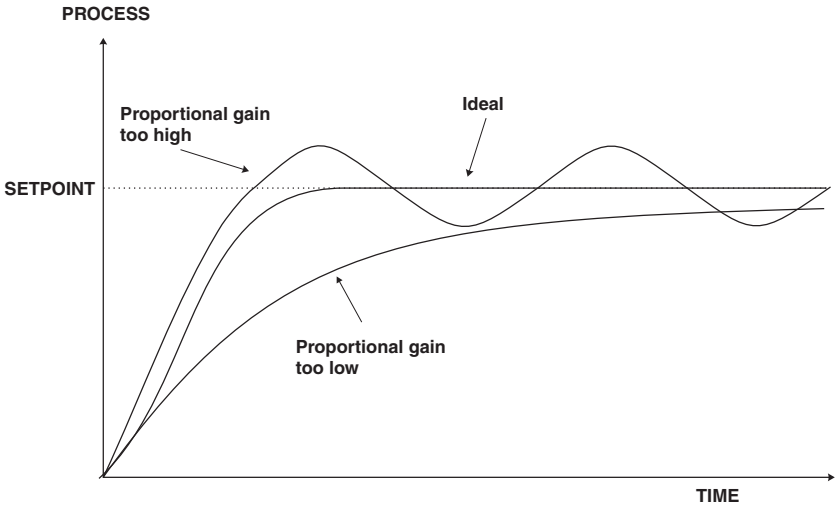
Display: *Rx.P9*

Range: *-32.767* to *32.767*

Default Value: *0.0 10*

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 *10* or more (with control span set at *10*) the controller will increase the frequency by 100% if possible. With a proportional gain of *0.500* an error of *10* or more (with control span set at *10*) 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 = 20, A 1.dc = 1.0, A 1.1 9 = 0.000			
A 1.SP	**A 1.P9**	**A 1.bS**	**Effect on relay operation**
70	1.000	0.0	Reading of 50 or below - relay permanently on. Reading of 50 to 70 - relay pulses with off time increasing as value approaches 70. Reading 70 or above - relay permanently off.
70	1.000	100.0	Reading of 70 or below - relay permanently on. Reading of 70 to 90 - relay pulses with off time increasing as value approaches 90. Reading 90 or above - relay permanently off.
70	1.000	50.0	Reading of 60 or below - relay permanently on. Reading of 60 to 70 - relay pulses with off time increasing as value approaches 70. Reading 70 - relay pulses at 50% on and 50% off. Reading 70 to 80 - relay pulses with off time increasing as value approaches 80. Reading 80 or above - relay permanently off.
70	0.500	50.0	Reading 50 or below - relay permanently on. Reading 50 to 70 - relay pulses with off time increasing as value approaches 70. Reading 70 - relay pulses at 50% on and 50% off. Reading 70 to 90 - relay pulses with off time increasing as value approaches 90. Reading 90 or above - relay permanently off.
70	- 1.000	50.0	Reading of 60 or below - relay permanently off. Reading of 60 to 70 - relay pulses with on time increasing as value approaches 70. Reading 70 - relay pulses 50% on and 50% off. Reading 70 to 80 - relay pulses with on time increasing as value approaches 80. Reading 80 or above - relay permanently on.

7.5 PI relay integral gain

Display: A*x*.1 9

Range: -32.767 to 32.767

Default Value: 0.000

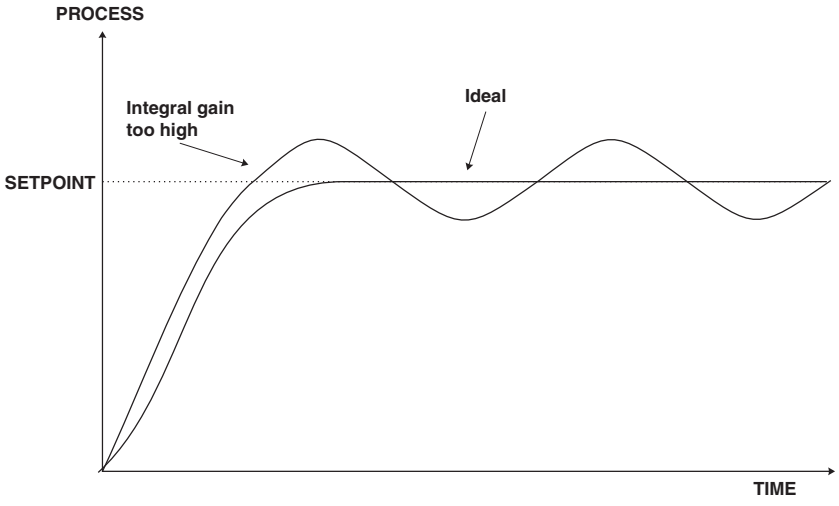
Note: the range value may be restricted if the number of display digits does not allow viewing of the full range.

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 **10** or more (with control span set at **10**) 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 **10** 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 9**.



7.6 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.

7.7 PI relay integral control low limit

Display: Rx.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 (Rx.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.

7.8 PI relay control output bias

Display: Rx.bS
Range: 0.0 to 100.0
Default Value: 50.0

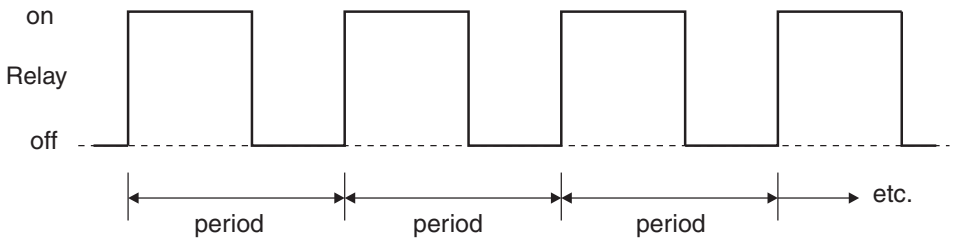
The control bias sets the ideal steady state output required once the setpoint is reached. Settings are in % from 0.0 to 100.0. When set at 0.0 the relay will be de-activated for the entire control period when the measured input is at the setpoint (depending on proportional and integral gain settings). 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.

7.9 PI relay control cycle period

Display: Rx.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.



7.10 Setting up the PI pulse width controller

1. Set the Rx OPEr function to Rx.tP.
2. Set the control setpoint Rx.SP to the required setting.
3. Set the control span ctrl SPAN to the required setting.
4. Set the proportional gain Rx.P9 to an arbitrary value e.g. 0.500.
5. Set the integral gain Rx.I 9 to 0.000 (i.e. off).
6. Set the low and high integral Rx.I L and Rx.I H limits to an arbitrary value e.g. 20.00.
7. Set the bias Rx.bS to 50.0.
8. Set the cycle Rx.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.

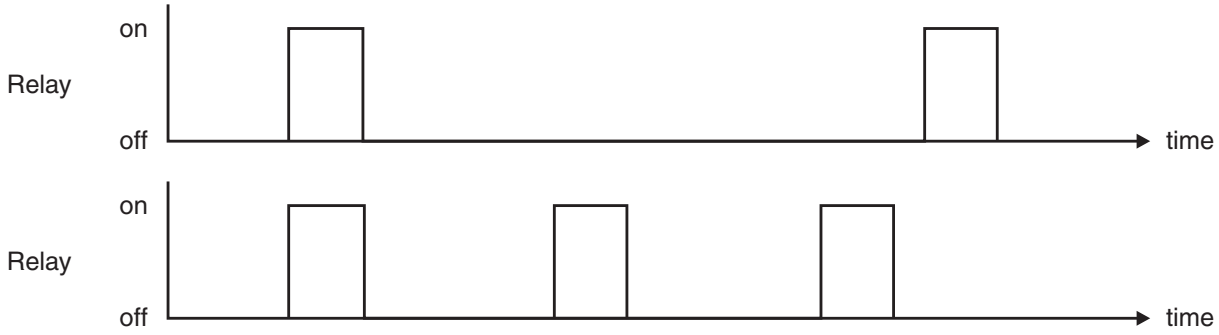
Create a step change to the process conditions and observe the control results. It may be necessary to fine tune the settings and use integral limits to obtain optimum results.

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

7.11 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 control - pulse frequency varies according to settings and control requirement



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 7.2
ctrl SPAN (Control span) - refer to section 7.3
Ax.Pb (Proportional gain) - refer to section 7.4
Ax.I b (Integral gain) - refer to section 7.5
Ax.I L (Integral control low limit) - refer to section 7.7
Ax.I H (Integral control high limit) - refer to section 7.6
Ax.bS (PI control bias) - refer to section 7.8
Ax.dc (PI control cycle period) - refer to section 7.9. 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 = 20, A 1.dc = 1.0, A 1.1 9 = 0.000			
A 1.SP	**A 1.P9**	**A 1.65**	**Effect on relay operation**
70	1.000	0.0	Reading of 50 or below - relay pulses at maximum frequency. Reading of 50 to 70 - relay pulses with frequency decreasing as value approaches 70. Reading 70 or above - relay permanently off.
70	1.000	100.0	Reading of 70 or below - relay pulses at maximum frequency. Reading of 70 to 90 - relay pulses with frequency decreasing as value approaches 90. Reading 90 or above - relay permanently off.
70	1.000	50.0	Reading of 60 or below - relay pulses at maximum frequency. Reading of 60 to 80 - relay pulses with frequency decreasing as value approaches 80. (period increased by 50% at 70 compared to minimum period e.g. if minimum period is 4 seconds the period at 70 will be 6 seconds) Reading 80 or above - relay permanently off.
70	0.500	50.0	Reading 50 or below - relay pulses at maximum frequency. Reading 50 to 90 - relay pulses with frequency decreasing as value approaches 90. (period increased by 50% at 70 compared to minimum period e.g. if minimum period is 4 seconds the period at 70 will be 6 seconds) Reading 90 or above - relay permanently off.
70	- 1.000	50.0	Reading of 60 or below - relay permanently off. Reading of 60 to 80 - relay pulses with frequency decreasing as value approaches 80. (period increased by 50% at 70 compared to minimum period e.g. if minimum period is 4 seconds the period at 70 will be 6 seconds) Reading 80 or above - relay pulses at maximum frequency.

7.12 PI relay on duration

Display: A*x*.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.

7.13 Setting up the PI frequency controller

1. Set the A*x* OPEr function to A*x*Fr.
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 **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**
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Integral gain	Slow response	Increase integral gain
Integral gain	Instability or oscillations	Decrease integral gain