RM4-IVT

DIN Rail Process Rate/Total Monitor
Inputs from ±20mA, 4-20mA,
±100mV, ±1V,±10VC, ±100VDC
or Slidewire
Operation & Instruction Manual

AMALGAMATED INSTRUMENT CO PTY LTD

Unit 5, 28 Leighton Place Hornsby
NSW 2077 AUSTRALIA

Telephone: +61 2 9476 2244
Facsimile: +61 2 9476 2902

e-mail: sales@aicpl.com.au
Internet: www.aicpl.com.au

Table of Contents

1 Introduction

This manual contains information for the installation and operation of the ratemeter/totaliser model RM4-IVT DIN rail monitor/controller. The RM4 is a general purpose instrument which may be configured to accept inputs of 0 to 20mA, 4 to 20mA, ±100mV, ±1V, ±10V, ±100VDC or 3 wire slidewire (1kΩ slidewire to 1MΩ slidewire values).

The RM4-IVT offers the choice of linear or square root rate display with totalising capability. The totaliser uses the rate display and totaliser scaling values to calculate the total. Two separate sets of calibration scaling values can be stored with the display choice being made via a contact closure at the remote input terminals.

The instrument may be calibrated to display the input in engineering units. Two standard inbuilt relays provide alarm/control functions. Each of these relays can be programmed for on/off control using the rate or total value, PI rate control or totaliser “pass” mode operation. A standard transmitter supply of 24VDC @25mA unregulated is also provided on both AC and DC powered models.

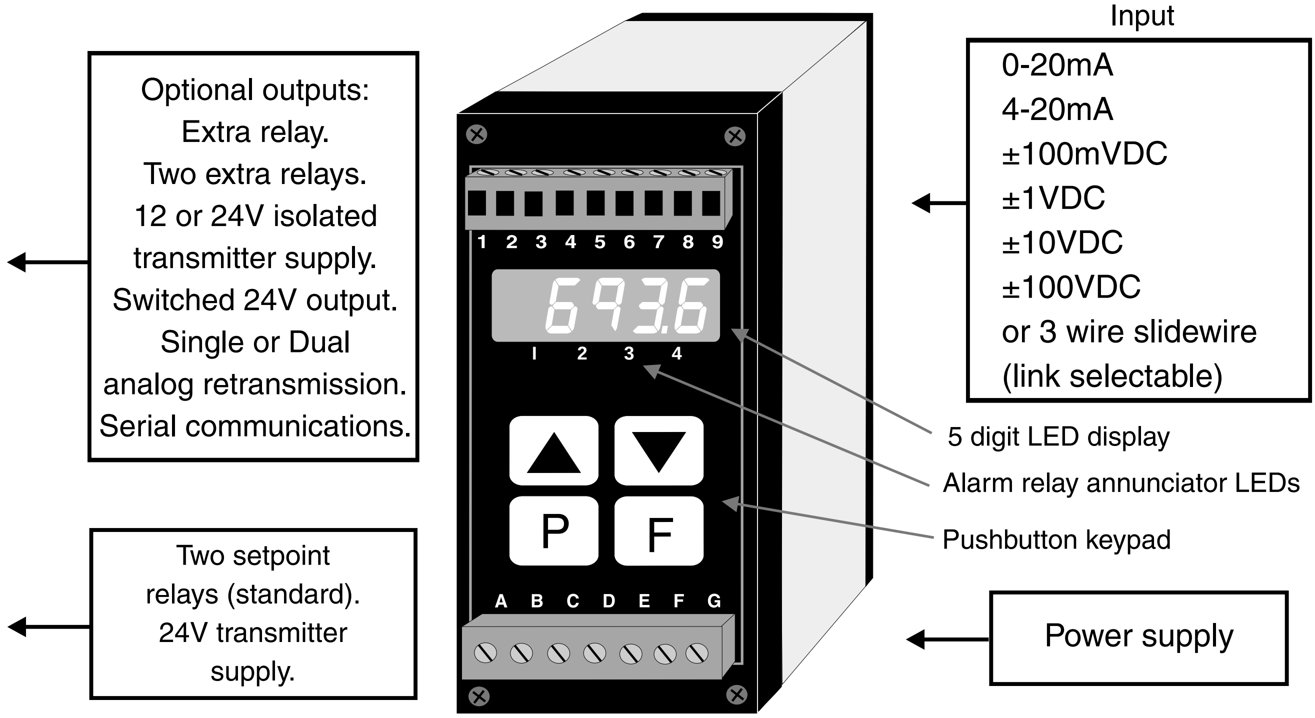
Various combinations of one or two optional extra relays, analog (4-20mA, 0-1V or 0-10V single or dual channel) retransmission, single channel analog PI control or serial (RS232, RS485 or RS422) communications and an isolated 12 or 24VDC isolated transmitter supply may also be provided as an option. Alarms and retransmission may be set to operate from the rate, total tare, peak hold, display hold, peak memory, valley memory or display value remote input operations.

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

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

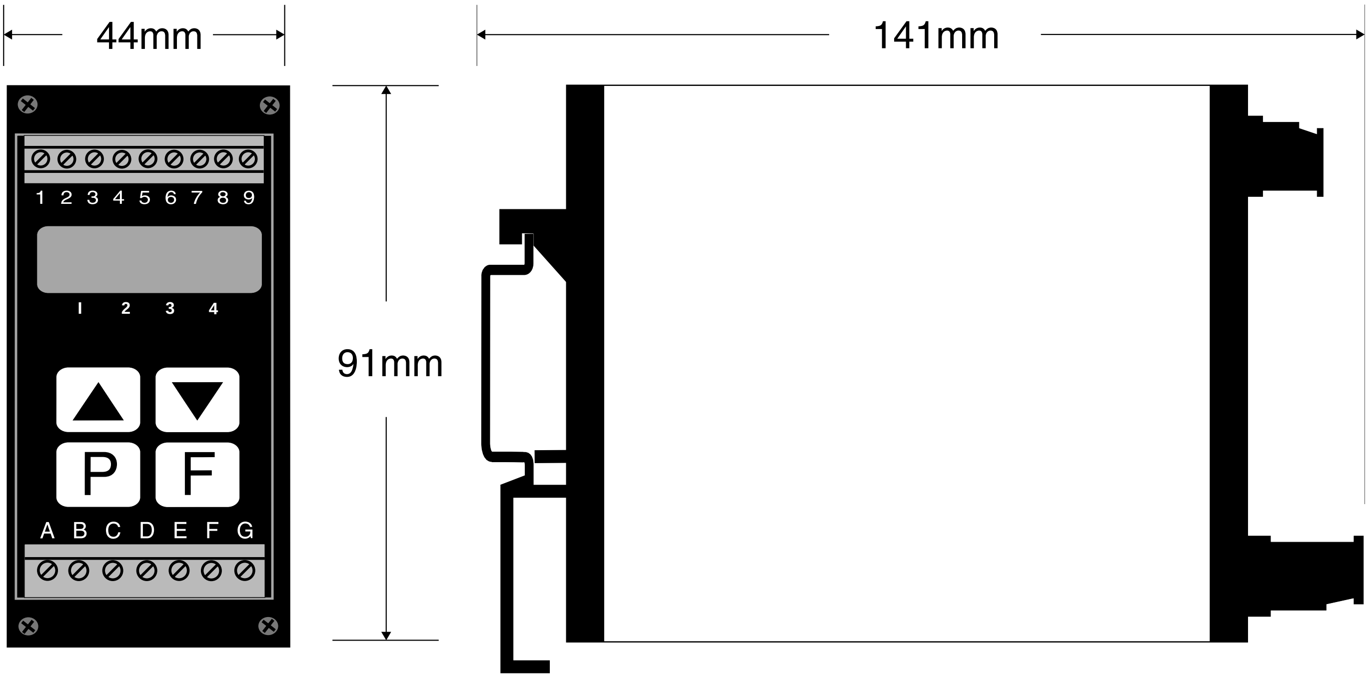
The RM4 series of DIN Rail Process Modules are designed for high reliability in industrial applications. The 5 digit LED display provides good visibility, even in areas with high ambient light levels. A feature of the RM4-IVT is the programmable display brightness function, this allows the unit to be 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.

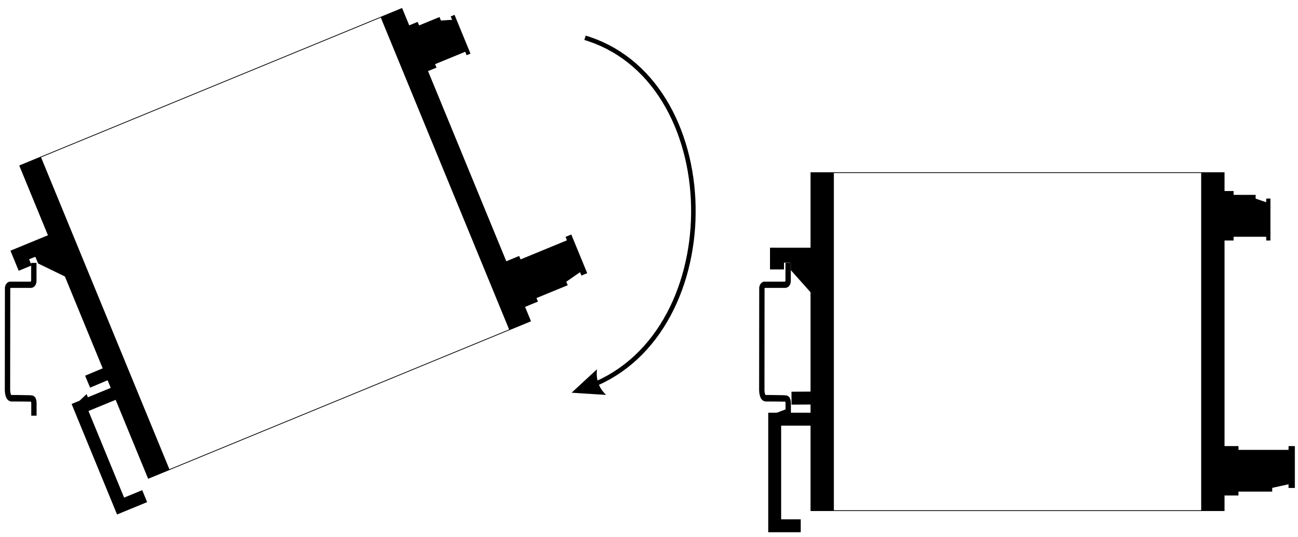
Inputs & outputs



2 Mechanical installation

The RM4 is designed for DIN rail, horizontal mounting. The instrument snaps on 35mm DIN standard rails (EN50022). Cut the DIN rail to length and install where required. To install the RM4, simply clip onto the rail as shown below. To remove the RM4 lever the lower arm downwards using a broad bladed screwdriver to pull the clip away from the DIN rail.





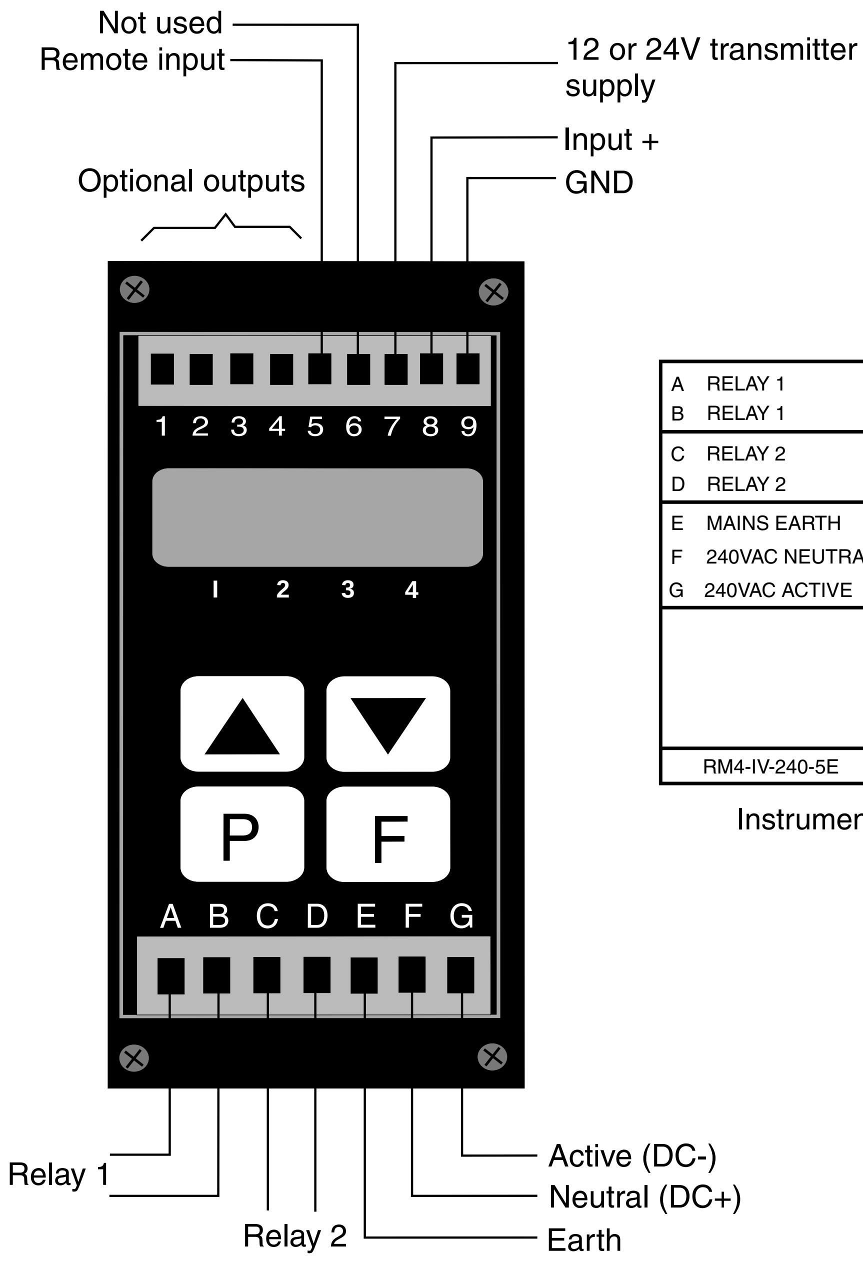
3 Electrical installation

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 signal connections and optional outputs. Connect the wires to the appropriate terminals as indicated below. Refer to other details 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.

3 .1 Signal input connections

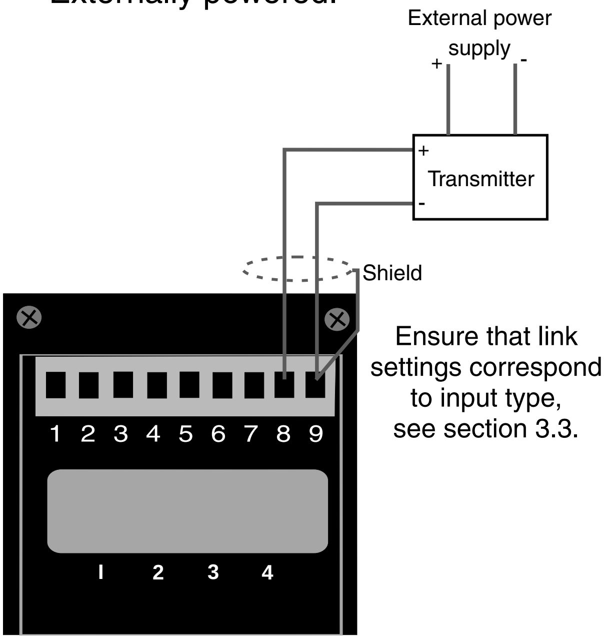
Examples continued overleaf.



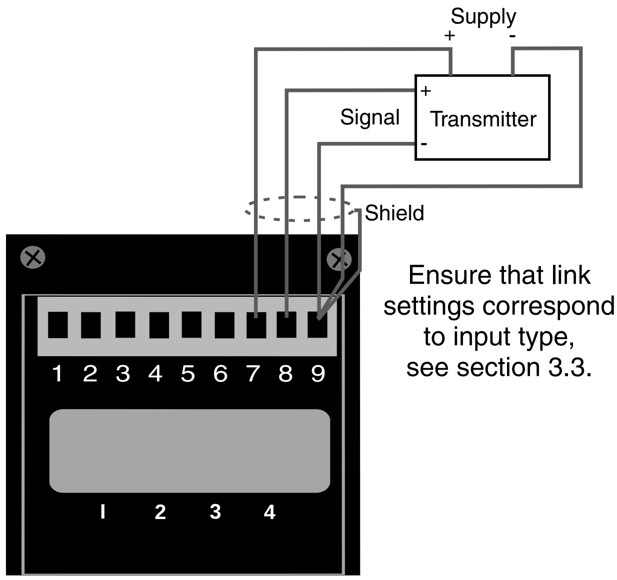
A	RELAY 1	COM	1		
B	RELAY 1	N/O	2		
C	RELAY 2	COM	3		
D	RELAY 2	N/O	4		
E	MAINS EARTH		5	REMOTE INPUT	
F	240VAC NEUTRAL		6		
G	240VAC ACTIVE		7	SUPPLY	+24VDC
			8	INPUT	+VE
			9	GND	
	RM4-IV-240-5E			SERIAL No.	

Instrument data label (example)

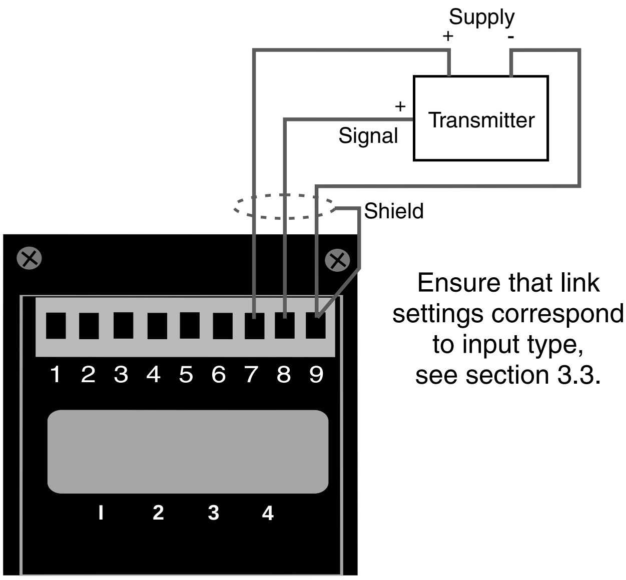
4 wire 4-20mA.
Externally powered.



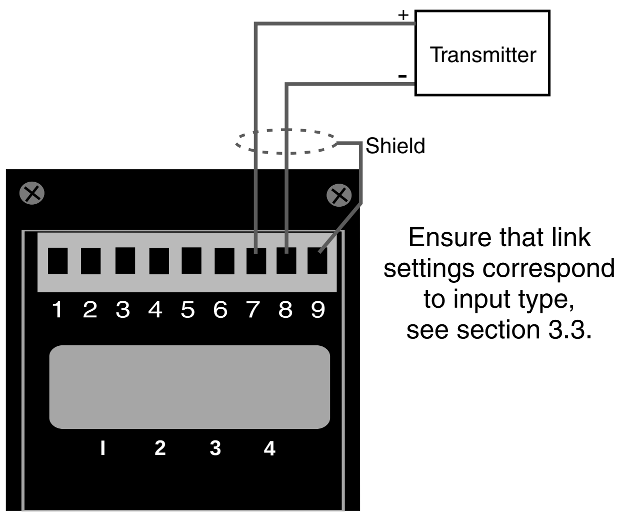
4 wire 4-20mA.
Powered via standard
24V unregulated.



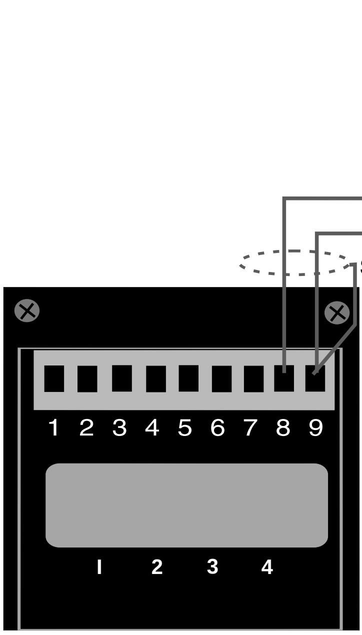
3 wire 4-20mA.
Powered via standard
24V unregulated.



2 wire 4-20mA.
Powered via standard
24V unregulated.

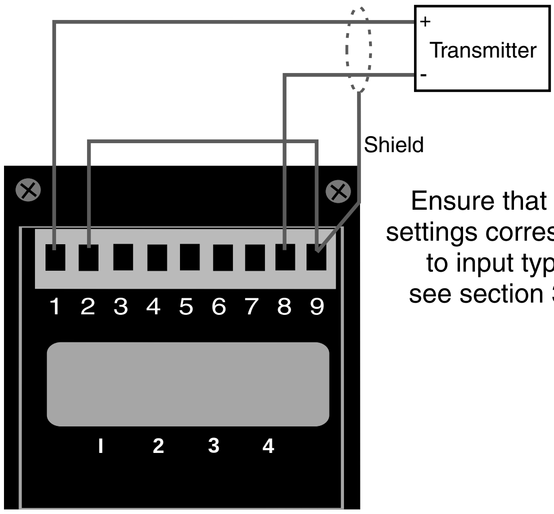


2 wire 4-20mA. Externally powered.



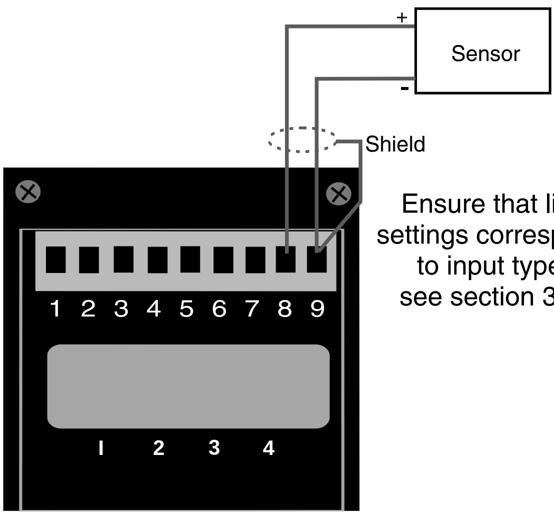
Ensure that link settings correspond to input type, see section 3.3.

2 wire 4-20mA. Powered via optional 12 or 24V regulated.



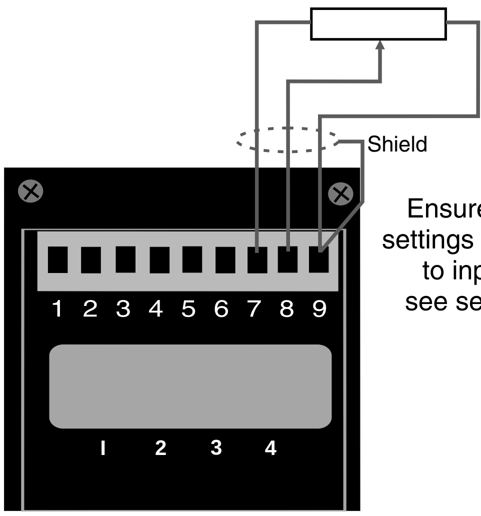
Ensure that link settings correspond to input type, see section 3.3.

DC voltage input



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

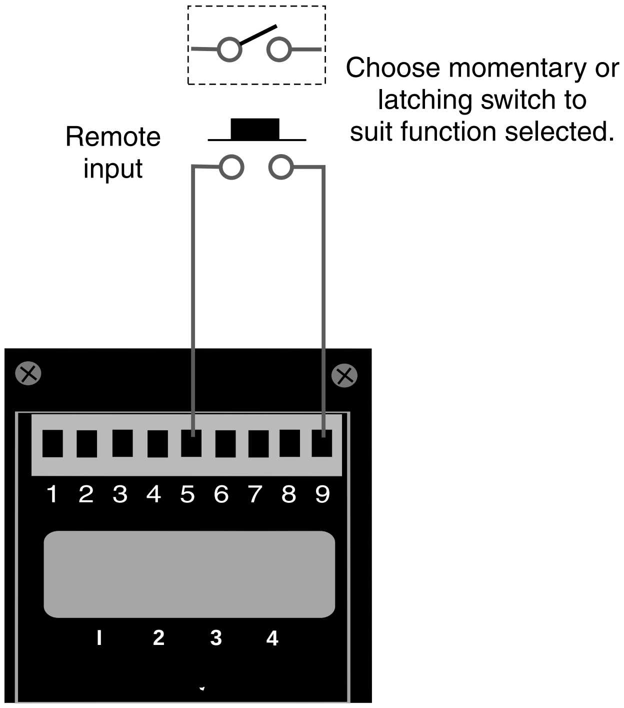
Slidewire input



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

3 .2 Remote input connections

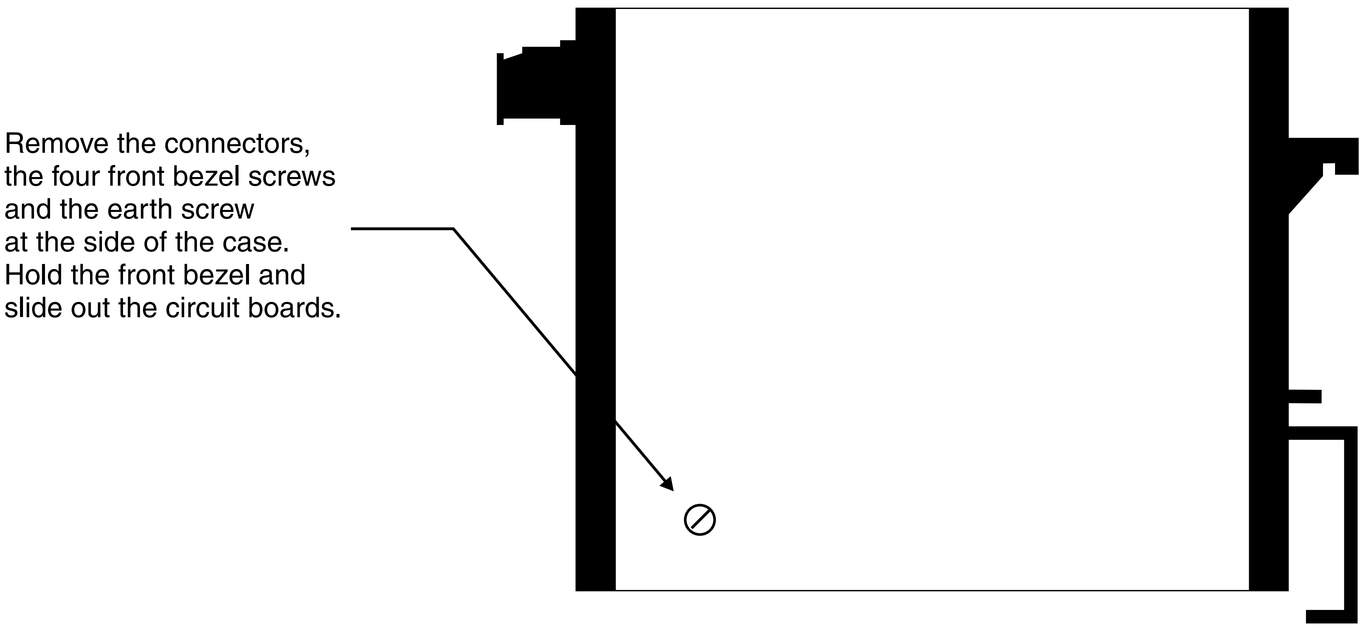
The selected remote input function can be operated via an external contact closure via a switch, relay or open collector transistor switch.



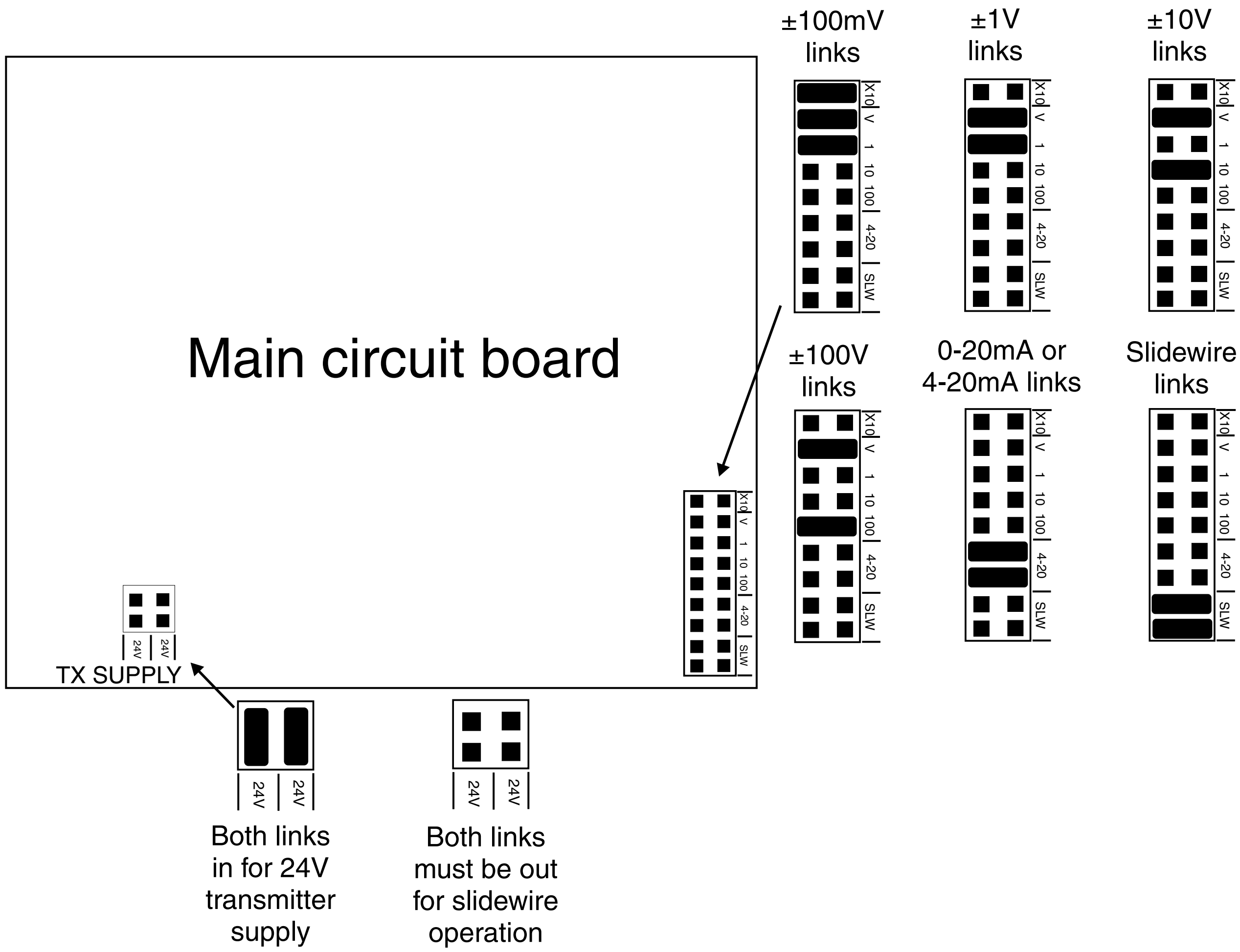
A momentary action is required for functions such as tArE and ZErO, a latching switch or normally closed momentary switch may be required for functions such as peak hold.

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 appropriate appendix in this manual.



4 Explanation of functions

The RM4 setup and calibration functions are configured through a push button sequence. Two levels of access are provided for setting up and calibrating:-

FUNC mode (simple push button sequence) allows access to alarm relay, preset value & display brightness functions.

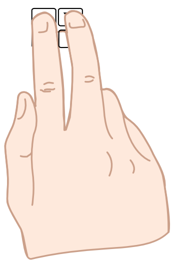
CAL mode (power up sequence plus push button sequence) allows access to all functions including calibration parameters.

Push buttons located at the front of the instrument are used to alter settings. 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.

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.

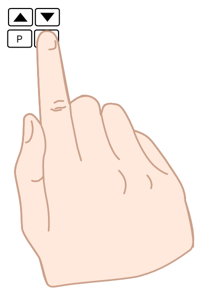


3. Within 2 seconds of releasing the F button press, then release the ▲ and ▼ buttons together. The display will now indicate FUNC followed by the first function.

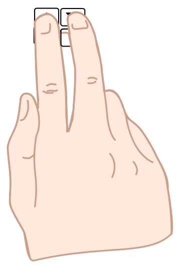
Note: If step 1 above has been completed then the instrument will remain in this CAL mode state until power is removed. i.e. there is no need to repeat step 1 when accessing function unless power has been removed.

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.

Function	Description
A1PS, A2PS. etc.	Alarm relay pass value - only seen if Ax.PA selected at the Ax.PA/Ax.tL/Ax.rt function. Displays and sets the alarm pass value (see Ax.PA/Ax.tL/Ax.rt function). The alarm relay will activate at multiples of the pass value e.g. if AxPS is set to 50 then the relay will activate at a total display value of 50, 100, 150 etc. The time for which the relay remains activated at each pass value is set via the AxPt function. The pass value may be set anywhere in the display range of the instrument.
C.SEt	Analog control setpoint - seen only when the analog retransmission option is fitted and rEC ctrl is set to on. Refer to the separate "RM4 DIN Rail Meter Optional Output Addendum" booklet supplied when this option is fitted.
A1Lo. A2Lo. etc.	Alarm relay low setpoint - see "Alarm relays" chapter. Displays and sets each alarm low setpoint value.
A1Hi . A2Hi . etc.	Alarm relay high setpoint - see "Alarm relays" chapter. Displays and sets each alarm high setpoint value.
A1Pt . A2Pt . etc.	Alarm pass time - only seen if Ax.PS selected at the Ax.PS/Ax.tL/Ax.rt function. Displays and sets the alarm pass time in seconds & tenths of seconds within the range 0.0 to 999.9 seconds. The value set is the time for which the relay will remain energised when activated at a pass value. e.g. if set to 2.0 with a AxPS value of 50 then the relay will remain energised for 2.0 seconds every time the display passes a multiple of 50. **Note:** If the pass time exceeds the time taken to reach consecutive pass values then the RM4 will "store" any relay operations it does not have time to activate and will perform these activation's when the total display update rate allows. For this reason the relay may be seen to activate repeatedly for a period after the total update rate has slowed down or stopped.
A1HY. A2HY. etc.	Alarm relay hysteresis [deadband]) - see "Alarm relays" chapter. Displays and sets the alarm hysteresis limit. This value is common for both high and low setpoint values.
A1tt . A2tt . etc.	Alarm relay trip time - see "Alarm relays" chapter. Displays and sets the alarm trip time in seconds/tenths of seconds. This value is common for both alarm high and low setpoint values.
A1rt . A2rt . etc.	Alarm relay reset time - see "Alarm relays" chapter. Displays and sets the alarm reset time in seconds/tenths of seconds. This value is common for both alarm high and low setpoint values.
A1n.o/ A1n.c , A2n.o/ A2n.c etc.	Alarm relay normally open or normally closed - see "Alarm relays" chapter. Displays and sets the alarm relay action to normally open (de-energised) or normally closed (energised), when no alarm condition is present.
A2.SP, A2.t1 etc.	Alarm relay operation independent setpoint or trailing - see "Alarm relays" chapter.
brgt	Display brightness - 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 reducing glare in darkened areas.
dull	Remote display brightness - displays and sets the level for remote input brightness switching, see "Remote input functions" chapter. See also d.OFF SECS function below.
rEC_	Analog recorder/retransmission 1 output low value - seen only when the analog retransmission option is fitted. Refer to the separate "RM4 DIN Rail Meter Optional Output Addendum" booklet supplied when this option is fitted. Displays and sets the analog retransmission output low value (4mA or 0V) in displayed engineering units. e.g. for a 4-20mA retransmission if it is required to retransmit 4mA when the display indicates 0 then select 0 at this function via the ▲ or ▼ button.

Function	Description
rEC¯	Analog recorder/retransmission 1 output high value - seen only when the analog retransmission option is fitted. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. Displays and sets the analog retransmission output high value (20mA, 1V or 10V) in displayed engineering units. e.g. if it is required to retransmit 20mA when the display indicates 500 then select 500 at this function via the ▲ or ▼ button.
rEC_ ch2	Analog recorder/retransmission 2 output high value - seen only when the dual analog retransmission option is fitted. See rEC_ function above for description.
rEC¯ ch2	Analog recorder/retransmission 2 output high value - seen only when the dual analog retransmission option is fitted. See rEC¯ function above for description.
CAL mode functions - Entry via CAL mode (see first page of this chapter) must be made in order to view and adjust the functions which follow. Alternatively access can be made without entering CAL mode if the ACCS function is set to ALL.	
A1OPEr. A2OPEr	Alarm relay operating mode (relays 1 & 2 only) - this function allows selection of standard alarm on/off operation (Ax.AL) using the alarm functions described in this chapter or PI control operation (AxtP or AxFr). Refer to the "Setting up the relay PI controller" appendix for details of the PI control operations and functions.
ctrl SPAN. A1.PG. A1.I G. A1.I L. A1.I H. A1.bS. A1.dc. A1.dr	PI control functions for relay outputs (relays 1 & 2 only). Refer to the "Setting up the relay PI controller" appendix for details of the PI control operations and functions.
d.oFF SECS	Auto display dimming timer - 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.
drnd	Display rounding - displays and sets the display rounding value. This value may be set to 0 - 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. (example: if set to 10 the instrument will display in multiples of 10).
dCPt	Rate display decimal point selection - displays and sets the decimal point for the rate display. By pressing the ▲ or ▼ keypads the decimal point position may be set. The display will indicate as follows: 0 (no decimal point), 0.1 (1 decimal point place), 0.02 (2 decimal point places), 0.003 (3 decimal point places) or 0.0004 (4 decimal point places).
FLtr	Digital filter - displays and sets the digital filter value. Digital filtering is used for reducing susceptibility to short term interference. The digital filter range is selectable from 0 to 8, where 0 = none and 8 = most filtering. A typical value for the digital filter would be 3. The digital filter uses a weighted averaging method of filtering which will increase the display update time at higher settings.
rEC ctrl	Analog control on or off - seen only when the analog retransmission option is fitted. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted.
C.SPN, C PG C PO C I G C I L.H C I L.L rEC SPAC	Analog output PI control functions - seen only when the analog retransmission option is fitted and rEC ctrl is set to on. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. If the dual analog output option is fitted only the first output can be used for PI control.

Function	Description
CAL 1 & CAL2	Calibration scaling points - see “Calibration” chapter. Displays and sets the independent calibration/scaling points of the input to the display. See “Calibration” chapter for full details of setting up.
CAL OFSt	Calibration offset - see “Calibration” chapter.
ZEro rnGE	Zero range - see “Calibration” chapter.
CAL ZEro	Calibration zero - see “Calibration” chapter.
USEr En 4	4mA input scaling without a live input - see “Calibration” chapter. 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.
USEr En20	20mA input scaling without a live input - see “Calibration” chapter. 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.
UCAL	Uncalibration- see “Calibration” chapter. Used to set the instrument back to the factory calibration values.
P.but	P button function - the function of the P button is programmable in the same manner as the remote input (see r.I nP below). The P button selection will override the selection made under the r.I nP function if both have the same functions selected. Upon reaching the P.but function the choices shown below are available, see "Remote input functions" chapter for a full description of each choice. Note: To prevent accidental operation of the P button in the tArE . ZEro or CLr.t functions it is necessary to hold the button in for approx. 2 seconds to perform the selected operation. When in Lo . HI or HI Lo the high/low values held in memory can be reset (i.e. the memory is cleared) by holding the P button pressed for 2 seconds. Choices available for the P button function are: nonE No function, HI Peak memory, Lo Valley memory, HI Lo Toggles between peak and valley memory, tArE Push button tare or nett or gross display function (toggles), ZEro Push button zero, dI SP toggles between the default display (set for rate or total) and the alternate display, CLr.t clears the totaliser value (resets it to zero).
r.I nP	Remote input - displays and sets the special function input selection, see “Remote input functions” chapter.
ACCS	Alarm relay access mode - see “Alarm relays” chapter.
SPAC	Setpoint access - sets the FUnC mode access to the alarm relays set points. The following choices are available; A 1 - Allows setpoint access to alarm 1 only. A 1-2 - Allows access to alarms 1 and 2 only. A 1-3 - Allows access to alarms 1, 2 and 3 only etc. up to the maximum number of relays fitted. To allow this function to operate the remote input r.I nP function must be set to SPAC.
SQrt	Square root - selects the square root scaling to on or OFF. When set to on a square root function is applied to the input. When set to OFF the calibration is a linear function. Note: It is essential that the display is rescaled, using CAL 1 and CAL2 or USEr En 4 and USEr En20, whenever the square root function is turned on or off. When the square root facility is used the scaled displayed value follows the square root of the percentage of the full scale input value. The upper and lower input limits are set as normal as are the values to be displayed at these limits. For example if, for a 4 - 20mA input, you wish to display 0 at 4mA and 1000 at 20mA the square root function will calculate as follows: At 20mA (100%) the display will be 1000 i.e. $\sqrt{1}\ x$ 1000. At 16mA (75%) the display will be 866 i.e. $\sqrt{0.75}\ x$ 1000. At 12mA (50%) the display will be 707 i.e. $\sqrt{0.50}\ x$ 1000 etc.
tOtI dCPt	Totaliser decimal point selection - displays and sets the decimal point position for the totaliser display. Choices are 0 (no decimal point) . 0. 1 . 0.02, 0.003 or 0.0004.
dI SP SCLE	Display scaling factor - displays and sets the display scaling factor. The scaling factor can be set anywhere in the range from 0 to the maximum display value. This factor is used in the formula to calculate the total display (see E.SCL). See below for examples.

Function	Description
tOtI SECS	Totaliser scaling factor - displays and sets the totaliser scaling factor. The scaling factor can be set anywhere in the range from 0 to the maximum display value. This factor is used in the formula to calculate the total display (see E.SCL). See below for examples.
E.SCL	Exponent scaling factor - displays and sets the exponent factor for the display. The scaling factor can be set anywhere in the range from 0 to 9. This factor allows a larger accumulated total by dividing the rate display value down to a smaller number. For example a rate display in grams can be converted to kilograms by setting E.SCL to 3. The formula used to calculate the accumulated total display from the rate display is as follows: Total = Previous total + $\frac{\text{Rate display x dI SP SCLE}}{\text{tOtI SECS x } 10^{\text{ESCL}}}$ x Ts Where: Ts is the time since the last sample in seconds. ***Examples:*** **Example 1** - The instrument is connected to a flow meter and the rate is scaled to show litres per minute (L/m). The total display is required in mega litres (ML). For a flow indication of 500 L/m the total should increase by 500 litres or 0.0005ML in 1 minute. In the formula the rate display will be 500, there is no display scaling factor (dI SP SCLE) so enter this as 1, the totaliser scaling factor (tOtI SECS) will be 60 (seconds) since we are measuring in litres per minute and Ts will be 60 (seconds) if we wish to see the total after 1 minute. Since we are measuring in mega litres (Litres x 10^6), the E.SCL value will be 6. $Total = Previous\ Total + \frac{500 \times 1}{60 \times 10^6} \times 60 \quad (ML)$ $Total = Previous\ Total + 0.0005 \quad (ML)$ **Example 2** - Rate of fill measured is to be in m^3/hr (cubic metres per hour). It is found that the total fill in one hour equals 1.22 times the rate indication, 122 will be the dI SP SCLE factor since no decimal points are available for this function. tOtL SECS will be 3600 (seconds i.e. 1 hour in seconds), E.SCL will be 2, since both rate and total are in cubic metres no E.SCL is required but it is set to 2 to divide the top line by 100 thereby effectively reducing the dI SP SCLE figure by a factor of 100 to get it back to the required 1.22. For this example we will examine the increase in total after 2 hours (7200 seconds). A rate of 35.8 m^3/hr we would expect an increase in the total of 87.352 m^3 in 2 hours (35.8 x 1.22 x 2). $Total = Previous\ total + \frac{35.8 \times 122}{3600 \times 10^2} \times 7200 \quad (m^3)$ $Total = Previous\ total + 87.352 \quad (m^3)$
tOtI nEG	Negative total select - displays and sets whether negative totals are allowed or not . When set to OFF negative totals are not allowed and the total will not increase when the rate input is negative. Set to on to allow negative totals.
tOtI rAP.F	Wrap around operation - displays and sets the totaliser wrap around operation for displays at full scale. If StOP is selected the display will halt at its maximum or minimum display value. If ZErO is selected then the display will wrap around to zero i.e. will reset itself and start again at zero.
CLr tOtI	Clear totaliser - allows the totaliser value to be cleared via the setup pushbuttons located at the rear of the instrument. To clear the totaliser press ▲ and ▼ simultaneously at this function. The message CLrd will be seen to confirm that the totaliser memory has been cleared. Note: the P button and/or remote input can also be programmed to clear the total.

Function	Description
dFLt dISP	Default display - the default display may be set to total (toTL) or rate (rATE). The instrument will automatically revert to its default display. The ▲ or ▼ button can be used to change from the default to the alternate display and the instrument will then return to the default display after a period of around 20 seconds.
Ax.tL , Ax.rt or Ax.PA	Alarm relay rate or total or pass operation - select Ax.rt if the selected relay is to operate from the rate value or Ax.tL if the relay is to operate from the total value or Ax.PA if the relay is to operate from a pass value (see AxPS function). See “Alarm relays” chapter for further information.
rEC	Analog retransmission mode - The description below applies to both the analog retransmission mode (4-20mA or DC Volts) and the serial (RS232 or RS485) communications. The serial communications mode is set via the SErL function. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. The following choices are available for analog or serial retransmission operation mode: LIvE - rate input mode. The retransmission will follow the rate input value. totL - total mode. The retransmission will follow the total value. tArE - tare rate mode. The retransmission value will tare (fall to zero) along with 7 segment rate display when the remote input tare function is operated. If the remote input toggles the 7 segment display to show gross (grOS) then the 7 segment display will change to show the gross value but the retransmission will not respond (see LIvE for alternative operation). P.HLd - peak rate hold mode. The 7 segment display and retransmission value will indicate the peak rate value only whilst the peak value function is operated via a contact closure on the remote input i.e. the 7 segment display and retransmission can rise but not fall whilst the remote input switch is closed. When the remote input switch is opened the retransmission value will remain fixed i.e. it will not rise or fall, although the 7 segment display value will be free to alter. This peak retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument. Note: In this mode the retransmission will show a zero reading until the remote input is operated for the first time after switch on. d.HLd - display hold mode. The 7 segment rate display and retransmission value will be held whilst the remote input display hold switch is closed. When the switch is opened the retransmission value will remain fixed at the held value although the 7 segment display value will be free to alter. The held retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument. HI - peak (max.) memory mode. With the peak remote input switch open the retransmission will indicate the peak rate value in memory i.e. the retransmission output can rise but not fall. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument. Lo - valley (min.) memory mode. With the valley remote input switch open the retransmission will indicate the valley (min.) rate value in memory i.e. the retransmission output can fall but not rise. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument. dISP - display mode. The retransmission output will follow whatever value is on the 7 segment display. For example if the remote input is set to tArE then the 7 segment and retransmission output will indicate the tared value and both will also be changed if the remote input toggles the displays between nEtt and grOS. If the rEC function had been set to tArE rather than dISP then the retransmission output would not respond to the grOS toggle.
rEC2	Analog retransmission mode for second analog output option. Has the same function choices as rEC above. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted.
bAud	Set baud rate - seen only with serial output option - Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. Select from 300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4.

Function	Description
PrtY	Set parity - seen only with serial output option - Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. Select parity check to either NONE, EVEN or odd.
O.Put	Set RS232/485 interface mode - Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. Select di SP, Cont or POLL Allows user to select the RS232/485 interface operation as follows:- di SP Sends image data from the display without conversion to ASCII. Cont Sends ASCII form of display data every time display is updated. POLL Controlled by computer or PLC as host. Host sends command via RS232/485 and instrument responds as requested. A.buS Used when the RM4 is connected to a computer using the Windows serial communications download software (optionally available). m.buS Modbus RTU output (total not available in this mode).
Addr	Set unit address for polled (POLL) mode (0 to 31)) - Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted. Allows several units to operate on the same RS485 interface reporting on different areas etc. 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) addresses unit 10.
SErL	Serial communications output mode - see rEC function for description. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted.

Returning to the normal measure mode

When the calibration procedure has been completed it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode, turn off power to the instrument, wait a few seconds and then restore power.

4 .1 Error Messages

"----" - This display indicates that the actual input is higher than the selected input range e.g. 0 to 10V range selected but the input is more than 10V. Check the input range selected and if this is OK then measure the input.

"-or -" - This display indicates an overrange reading. This means that the instrument is not being able to display the number because it is too large e.g. above 99999 on a 5 digit display. Check that the calibration scaling figures are correct.

5 Function table for fully optioned instrument

	Initial display	Meaning of display	Next display	Default Setting	Record Your Settings
	AxPS	Alarm pass value	Setpoint value or OFF	OFF	See following table
	C.SEt	Analog PI control setpoint	Value in memory	0	
	AxLo	Alarm x low setpoint value	Setpoint value or OFF	OFF	See following table
	AxHi	Alarm x high setpoint value	Setpoint value or OFF	1000	See following table
	AxPt	Alarm pass time	Pass time in seconds	0	See following table
	AXHY	Alarm x hysteresis	Hysteresis value in measured units	10	See following table
	Axtt	Alarm x trip time	No of seconds before relay x trips	0	See following table
	Axrt	Alarm x reset time	No of seconds before relay x resets	0	See following table
	Axn.o or Axn.c	Alarm x action N/O or N/C	Axn.o or Axn.c	Axn.o	See following table
	Ax.SP or Ax.t 1	Alarm x independent or trailing setpoint 1,2 etc.	Ax.SP or Ax.t 1	Ax.SP	See following table
	brGt	Digital display brightness	1 to 15 (15 = highest brightness)	15	
	dULL	Remote brightness control	0 to 15 (15 = highest brightness)	1	
	rEC_	Analog output 1 low limit	Value in memory	0	
	rEC‾	Analog output 2 high limit	Value in memory	100	
	rEC_ ch2	Analog output 2 low limit	Value in memory	0	
	rEC‾ ch2	Analog output 2 high limit	Value in memory	100	
Functions below are accessible via CAL mode or if ACCS function is set to ALL only					
PI Control	A1 OPEr	Relay 1 operation mode	A1.AL , A1.tP or A1.Fr	A1.AL	See following table
PI Control	A2 OPEr	Relay 2 operation mode	A2.AL , A2.tP or A2.Fr	A2.AL	See following table
PI Control	ctrl SPAN	Span for relay PI control	Value in memory	100	See following table
PI Control	Ax.PG	Proportional gain for relay PI control	- 19.999 to 32.767	1.000	See following table
PI Control	Ax.IG	Integral gain for relay PI control	- 19.999 to 32.767	0.000	See following table
PI Control	Ax.I L	Low integral limit for relay PI control	0.0 to 100.0	100.0	See following table
PI Control	Ax.I H	High integral limit for relay PI control	0.0 to 100.0	100.0	See following table
PI Control	Ax.bS	Bias for relay PI control	0.0 to 100.0	50.0	See following table
PI Control	Ax.dc	Duty cycle for relay PI control	0 to 250	10	See following table
PI Control	Ax.dr	Duration for relay PI control (frequency mode only)	0.0 to 25.0	1.0	See following table
	d.OFF SECS	Display auto dimming timer (seconds)	0 to 9999	0	
	drnd	Display rounding selects resolution	Value in memory	1	
	dCPt	Display decimal point	Decimal Pt position (e.g. 0. 1 or 0.02)	0	
	FLtr	Digital filter range 0 to 8	0 to 8 (8 = most filtering)	2	
PI Control	rEC ctrl	Analog PI control on or off	on or OFF	OFF	
PI Control	C.SPN	Analog PI control span	Value in memory	0	
PI Control	C PG	Analog PI control proportional gain	- 19.999 to 32.767	1.000	
PI Control	C PO	Analog PI control proportional offset	0 to 100	0	
PI Control	C IG	Analog PI control integral gain	- 19.999 to 32.767	0	
PI Control	CI L.H	Analog PI control integral limit high	0 to 100	100	
PI Control	CI L.L	Analog PI control integral limit low	0 to 100	100	
PI Control	rEC SPAC	Analog PI control setpoint access on	on or OFF	on	
	CAL 1	Calibration - first point	See calibration chapter	n/a	
	CAL 2	Calibration - second point	See calibration chapter	n/a	
	CAL OFSt	Offset to calibration	Live Reading	n/a	
	ZEro rNGE	Zero range limit	Limit value or OFF	1000	

CAL ZErO	Zero point calibration	Value in memory	n/a	
USEr En4	4mA input scale	Value in memory	n/a	
USEr En20	20mA input scale	Value in memory	n/a	
UCAL	Uncalibrate	CAL CLr	n/a	
P.but	P Button function	NONE, Hi, Lo, Hi Lo, tArE, ZErO, di SP or CLr.t	NONE	
r.INP	Remote Input 1	NONE, P.HLd, d.HLd, Hi, Lo, Hi Lo, tArE, ZErO, SP.Ac, No.Ac, CAL.S, di SP, duLL or CLr.t	NONE	
ACCS	Setpoint access mode	OFF, EASY, NONE or ALL	OFF	
SPAC	Setpoint access	A1, A1-2, A1-3 etc.	A1	
SQrt	Square root	OFF or on	OFF	
tOtl dCPt	Total display decimal point	0, 0.1, 0.02 etc.	0	
di SP SCLE	Display scale	Value in memory		
totl SECS	Total scale	Value in memory	60	
E.SCL	Exponent scale	0 9	1	
totl NEG	Total display negative	on or OFF	OFF	
totl rAP.F	Total display wrap around	StOP or ZErO	StOP	
CLr totl	Clear total	CLrd	n/a	
dFlt di SP	Default display	rAtE or totl	rAtE	
Ax.rt, Ax.tL or Ax.PA	Alarm relay operation from rate, total or in pass mode	Ax.rt, Ax.tL or AxPA	Ax.rt	
rEC	Retransmission mode	LiuE, totl, tArE, btch, P.HLd, d.HLd, Hi, Lo or di SP	LiuE	
rEC2	Retransmission mode	LiuE, totl, tArE, btch, P.HLd, d.HLd, Hi, Lo or di SP	LiuE	
bAUd rAtE	Baud rate	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	9600	
PrtY	Parity select	NONE, EUEN or Odd	NONE	
O.Put	Serail output mode	di SP, Cont, POLL, A.buS or M.buS	Cont	
Addr	Set unit address for poll mode	0 to 31	0	
SErL	Serial communications mode	LiuE, totL, tArE, P.HLd, d.HLd, Hi, Lo, di SP, Hi Lo or both	LiuE	

Note: Functions in the shaded areas on this table will be displayed only when those particular options are fitted. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when optional outputs are fitted.

Settings for relays - record settings here					
		A1	A2	A3	A4
Ax.PS					
Ax.Pt					
AxSP				n/a	n/a
AxLo					
AxHi					
AxHY					
Axtt					
Axrt					
Axn.o or Axn.c					
Ax.SP or Ax.t 1		n/a			
A 1 OPEr			n/a	n/a	n/a
A2 OPEr		n/a		n/a	n/a
PI Control	ctrl SPAn			n/a	n/a
	Ax.PG			n/a	n/a
	Ax.I G			n/a	n/a
	Ax.I L			n/a	n/a
	Ax.I H			n/a	n/a
	Ax.bS			n/a	n/a
	Ax.dc			n/a	n/a
	Ax.dr			n/a	n/a
Ax.rt , Ax.tI or Ax.PA					

6 Alarm relays

The RM4 is provided with 2 alarm relays as standard. One or two extra optional independent alarm relays may also be provided, these relays are designated A1 , A2 etc. Each alarm has the following parameters which may be set by the user:

1. Low trip point, adjustable in measurement units
2. High trip point, adjustable in measurement units
3. Alarm hysteresis, adjustable in measurement units
4. Alarm trip time, adjustable in one second steps
5. Alarm reset time, adjustable in one second steps
6. N/O or N/C relay operation
7. Independent or trailing alarms (available on relays 2 and upwards)
8. Alarm to operate from rate value or total value or “pass” mode totaliser operation.
9. PI relay operation (relays 1 & 2 only). See - “Setting up the relay PI controller” chapter for a description of PI control operation & functions.

Note that the alarm settings are not changed when calibration scaling channels are changed. The alarms operate in the following way:

If the measured value is above the High Trip Point, or below the Low Trip Point, the alarm trip timer starts. This timer is reset if the measured value drops below the High Trip Point or above the Low Trip point. When the alarm trip timer’s time exceeds the Trip delay time, the alarm is operated.

When the alarm has tripped, the measured value is compared to the High Set Point less the Hysteresis value and the Low Set Point plus the Hysteresis value. If it is less than the High Set Point less the Hysteresis value and greater than the Low Set Point plus the Hysteresis value, the alarm is reset.

A 1Lo, A2Lo etc. (alarm low setpoint).

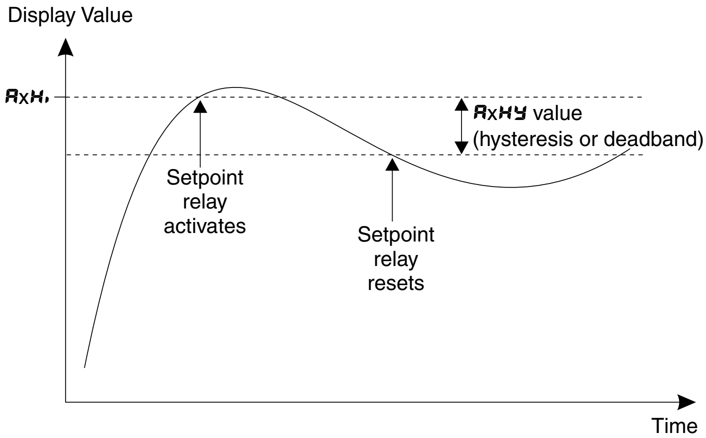
Displays and sets the low setpoint value for the designated alarm relay. The low alarm setpoint may be disabled by pressing the ▲ and ▼ keypads simultaneously. When the alarm is disabled the display will indicate OFF. Use ▲ or ▼ to adjust the setpoint value if required. The alarm will activate when the displayed value is lower than the AxLo setpoint value. Each relay may be configured with both a low and high setpoint if required, if so the relay will be activated when the display reading moves outside the band set between low and high setpoints.

A 1Hi , A2Hi etc (alarm high setpoint).

Displays and sets the high setpoint value for the designated alarm relay. The high alarm setpoint may be disabled by pressing the ▲ and ▼ keypads simultaneously. When the alarm is disabled the display will indicate OFF. Use ▲ or ▼ to adjust the setpoint value if required. The alarm will activate when the displayed value is higher than the AxHi setpoint value. Each relay may be configured with both a low and high setpoint if required, if so the relay will be activated when the display reading moves outside the band set between low and high setpoints.

A 1HY, A2HY etc. (alarm hysteresis).

Displays and sets the alarm hysteresis limit and is common for both high and low setpoint values. The hysteresis value may be used to prevent too frequent operation of the setpoint relay when the measured value stays close to the setpoint. Without a hysteresis setting (A 1HY set to zero) the alarm will activate when the display value goes above 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:

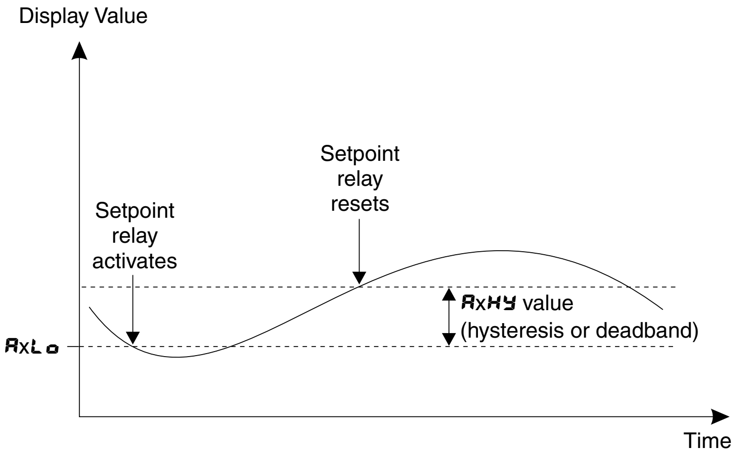


In the high alarm mode, once the alarm is activated the input must fall below the setpoint value minus the hysteresis value to reset the alarm.

e.g. if A1Hi is set to 50.0 and A1HY is set to 3.0 then the setpoint output relay will activate once the display value goes above 50.0 and will reset when the display value goes below 47.0 (50.0 minus 3.0).

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 A1Lo is set to 20.0 and A1HY is set to 10.0 then the alarm output relay will activate when the display value falls below 20.0 and will reset when the display value goes above 30.0 (20.0 plus 10.0).



The hysteresis units are expressed in displayed engineering units.

A1tt.A2tt etc. (alarm trip time delay)

The alarm trip time determines how long the measured value has to be above the high trip point or below the low trip point before an alarm is given. This can be used to prevent false alarms on noisy inputs. The value is set in seconds, with a range of 0 to 60 seconds. For normal operation a delay of three to five seconds is suitable.

A1rt.A2rt etc. (alarm reset time)

The alarm reset time determines how long the measured value has to be below the high trip point or above the low trip point before the alarm is reset. The value is set in seconds, with a range of 0 to 60 seconds. For normal operation a delay of zero seconds is suitable.

A1n.o/A1n.c etc (alarm relay N/O or N/C operation)

Each alarm may be programmed to operate as a normally open (N/O e.g. A1 n.o) or normally closed (N/C e.g. A2n.c) device. A N/O relay is de-energised when no alarm condition is present and is energised when an alarm condition is present. A N/C relay is normally energised and is de-energised when an alarm condition is present. The N/C mode is useful for power failure detection.

A2.SP/A2t 1 etc (alarm setpoint or trailing operation)

A function exists to allow relays, other than relay 1, to be used as independent relays with their own set points or they may be made to “trail” another relays setpoint. For example if A2.SP is selected then alarm 2 will act as an independent relay. If A2.t 1 is selected then the alarm 2 relay will trail alarm 1 relay. With A2.t 1 selected if alarm 1 high setpoint is set to 50 and alarm 2 high set point set to 20 then alarm 2 relay will operate at a display of 70 (50 + 20). Alternatively alarm 2 could be set to operate at 30 (50 - 20) by setting alarm 2 high setpoint to -20.

Trailing Alarm Table
Showing Possible Alarm Assignments

	A2	A3	A4
A1	A2.t 1	A3.t 1	A4.t 1
A2		A3.t2	A4.t2
A3			A4.t3

ACCS (alarm 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, see details below. 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 functions. If set to all then access to all functions can be made via FUNC mode i.e. no need to enter via CAL mode.

6.1 Easy Alarm Access

The RM4 has an easy alarm access facility which allows operator access to the selected alarm setpoints (only to the setpoints selected at the SPAC function) simply by pressing the F button. 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.

The instrument must be set in the manner described below to allow the easy access facility to work:

1. Either the ACCS function must be set to EASY or the r.INP function must be set to SP.AC. If the ACCS function is used the remote input function r.INP can be assigned to a different use.
2. The selected relays must have a setpoint, nothing will happen if all the alarm relay setpoints are set to OFF.
3. The SP.AC 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 then 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 unless the instrument is powered up in CAL mode.

6.2 Alarm rate, total or pass mode

The alarm mode functions (A 1.rt, A 1.tl or A 1.PA etc.) allow the alarm relays to follow either the rate value, the total value or the totaliser pass value.

Examples below use relay 1, the same functions are available for all relays e.g. A 1.PA, A2.PA etc.

If set to A 1.rt relay 1 will operate from the rate value i.e relay 1 will activate if the rate value falls to the A 1Lo value or rises to the A 1Hi value.

If set to A 1.tl then relay 1 will operate from the total value i.e relay 1 will activate if the total value falls to the A 1Lo value or rises to the A 1Hi value.

If set to A 1.PA then the relay will activate on multiples of the alarm relay pass value. The relay pass value is set at the A 1.PS function and the “on” time for the relay is set at the A 1.Pt function. For example if A 1.PS is set at 1000 and A 1.Pt is set at 2.0 seconds. The relay will activate for 2 seconds every time the totaliser display value reaches a multiple of 1000 e.g. 1000, 2000, 3000 etc. The minimum “off” time is the same as the “on” time i.e. if the relay is activated for 2 seconds it will be deactivated for at least 2 seconds.

If the pass value is reached at a faster rate than the relay can operate for its given pass time the RM4 will store the missing relay activations and will activate catch up by activating the relay when the input allows. The setpoint functions for relays 1, 2 etc. e.g. A 1Lo, A 1Hi , A 1HY, A 1tt, A 1rt, A 1SP/A 1tL will not be seen if the A 1.PA mode is selected.

Optional relays

Two alarm relays are fitted as standard. One or two extra relays are optionally available. See “Specifications” chapter for details of optional relays.

Switching Inductive Loads

If the alarm relay is to be used to switch an inductive load, such as a solenoid, it is advisable to use a suppressor circuit either across the load or across the relay contacts. Switching inductive loads without a suppressor circuit can cause arcing at the relay contacts resulting in electrical interference and wear on the contacts. A typical suppressor circuit consists of a 100Ω resistor in series with a 0.1uF capacitor, this circuit is then placed across the load or relay contacts. Ensure that the resistor and capacitor are of sufficiently high rating to cope with the voltage and current encountered.

7 Remote input functions

Remote input operation is via voltage free contacts on the instrument terminal block (terminals 5 and 9) shorting together these terminals will cause the selected function to operate. The remote input may be either a bi-state contact closure (toggle switch, PLC or other external switch) or a momentary or latching switch contact, depending on the function requirements. The remote input function will operate when the switch is closed e.g. for display hold the display value will be held whilst the switch is closed and will be free to follow the live input when the switch is open. The remote input may be configured to perform any **one** of the following functions:

Function	Description
nonE	None - this function is selected when none of the special functions are required.
PHLd	Peak hold - this function displays and holds the peak rate reading, when the contact input is closed i.e. the maximum value from the time of contact closure is displayed. When the contact is open the display indicates the live reading. A two position toggle switch would be commonly used for this function. Note that the total cannot be displayed whist the display is showing the peak rate reading. The operation of the totaliser is not affected by the peak hold action i.e. the total will still be calculated by the live input rather than the peak display value.
dHLd	Display hold - the display hold function is similar to peak hold, except that the held reading is the rate value displayed at the time the switch contact is closed. A two position toggle switch would be commonly used for this function. Note that the total cannot be displayed whist the display is showing the held rate reading. The operation of the totaliser is not affected by the display hold action i.e. the total will still be calculated by the live input rather than the held display value.
Hi	Peak Memory - the peak rate memory (max) is displayed when the pushbutton contact is closed momentarily i.e. the maximum display value since the last reset. The display is returned to the normal display after 20 seconds. To reset the peak memory the button must be held closed for 1 to 2 seconds. Note: the Hi function will be reset 5 seconds after instrument switch on i.e. the Hi readings will only start to be stored once 5 seconds have elapsed. The switch input for this function is usually a momentary action pushbutton switch.
Lo	Valley memory - the rate valley memory (min) operates in a similar way to the peak memory but shows the lowest display value since last reset. Note: the Lo function will be reset 5 seconds after instrument switch on i.e. the Lo readings will only start to be stored once 5 seconds have elapsed. The switch input for this function is usually a momentary action pushbutton switch.
Hi Lo	Peak memory/valley memory - The display may be toggled between rate peak and valley memory indications. i.e. press momentarily once and the message Hi followed by the peak memory value will be displayed, press momentarily a second time and the message Lo followed by the valley memory value will be displayed. The switch input for this function is usually a momentary action pushbutton switch.
tArE	Pushbutton tare - when the remote pushbutton is closed for 2 to 3 seconds the current rate value is tared off. The switch input for this function is usually a momentary action pushbutton switch. Once the display has been tared the "live" display will be interrupted every few seconds by the message nEtt to indicate that the reading has been tared and the nett reading is being displayed. Further operation of the pushbutton will cause the display to toggle between gross reading (the display will indicate this by flashing 9roS periodically) and nett reading (indicated by nEtt). Removing power from the instrument will cause the value tared to be lost so another tare operation may be needed.
ZEro	Pushbutton zero - allows the rate display to be set to zero via momentary operation of the pushbutton. This zero value will be retained even if the power is removed. If the zero operation were to cause the zero to shift beyond the ZEro rn9E function limits the preset will be aborted and a ZEro rn9E Err message will be seen. The switch input for this function is usually a momentary action pushbutton switch.

SP.Ac	Setpoint access only - allows access to the selected (via the SPAC function) alarm set points only, no other functions, when key switch is open. Allows full access with the key switch/remote input closed. A two position toggle switch would be commonly used for this function.
no.Ac	No program access - inhibits access to functions via keypads. The remote input requires a contact closure (short circuit) to allow access to functions. A two position toggle switch would be commonly used for this function.
CAL.S	Select calibration - one set of rate calibrations can be performed with the switch open and a second set with the switch closed. The remote input can then be used to switch between these two separate rate calibration memories. When the external input is open the first set will be displayed and when the switch is closed the next calibration set will be used. This function may be used to select different input devices, different scale values etc. This may also be used to change measuring units. e.g. the unit may be calibrated in litres/sec on one set of calibrations and m^3/hr on the second set. The CAL.S function also allows different decimal point settings and display rounding values between the two calibrations. A two position toggle switch would be commonly used for this function. Note that this method of switching rate scaling is not suitable for use when the totaliser value is required. Only one set of totaliser scaling values can be set. The totaliser will calculate its total using the same set of totaliser scaling values from whichever rate is being displayed at the time.
di SP	Change display - allows toggling between the rate and total displays. When the remote input is activated the display toggles from the default display (set by the dFLt di SP function) to the alternate display. A message of rAtE or toti will flash once every 8 seconds when the alternate display is being shown. The switch input for this function is usually a momentary action pushbutton switch though a latching switch could be used if the changeover was required to be of a long time duration.
duLL	Dull - when the remote input is set to duLL the remote input can be used to switch between the display brightness level set by the br9t function and the display brightness set by the duLL function. The display brightness is selectable from 0 to 15, where 0 = lowest intensity (display off) 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 and for reducing power consumption in battery powered applications. A two position toggle switch would be commonly used for this function.
CLr.t	Clear total - will reset the total to zero when the remote input is activated. The switch input for this function is usually a momentary action pushbutton switch.

Selecting the remote input function

To select the required function, enter CAL mode in the usual way (see “Explanation of functions” chapter) and step through the functions until you reach the remote input indicated by the display message r.i nP followed by the selected function. Use the ▲ and ▼ buttons to select the required function.

8 Rate display calibration

The 2 point live input calibration method (CAL 1 & CAL2) may be used on any of the input ranges to scale the rate display. For 4-20mA inputs only an alternative method is also provided (USEr En4 and USEr En20). The totaliser is scaled using the rate scaling and the scaling functions toti SCLE, toti SECS & E.SCL, see the "Explanation of functions" chapter for description & examples.

If required the remote input function can be programmed to allow two sets of rate calibrations, see r.i nP function in the "Remote input functions" chapter. For example the rate display can be litres/sec and litres/min with a remote switch/relay used to toggle between the readings. The totaliser scaling cannot be changed by this method and the totaliser will respond to whichever scaling is on the display at the time. For this reason rate scale switching is not suitable for use when the totaliser value is required.

CAL 1 (first scaling point for 2 point scaling method)

CAL 1 and CAL2 are used together to scale the instruments display, values for both must be set when using this scaling method (see also USEr En4 and USEr En20 functions for an alternative scaling method when using a 4-20mA input).

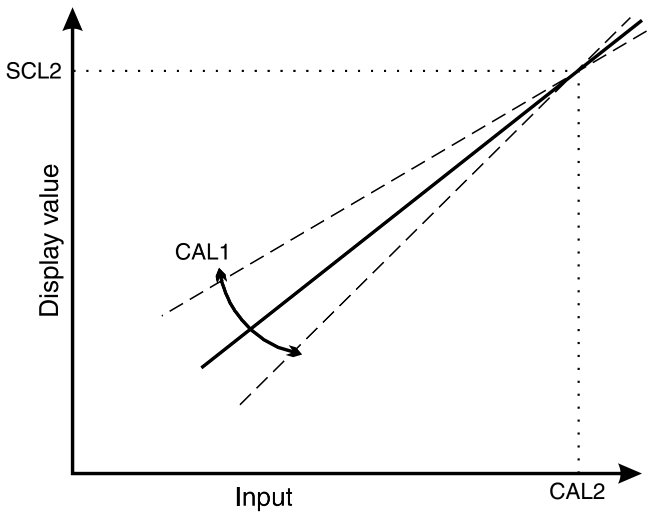
The CAL 1 function sets the first calibration point for live input calibration . When using this method a signal input must be present at the input terminals. Note: CAL 1 and CAL2 can be set independently.

The procedure for entering the first scaling point is:

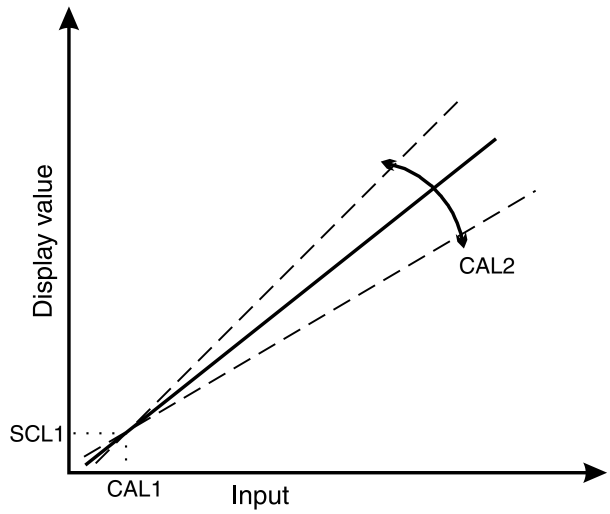
a. Ensure that an input signal is present at the input terminals, this will usually be at the low end of the signal range e.g. 4mA for a 4-20mA input.

b. At the CAL 1 function press ▲ and ▼ simultaneously then release them. The display will indicate 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 selected at SCL 1. Press the F button to accept changes or the P button to abort the scaling.



Setting CAL1

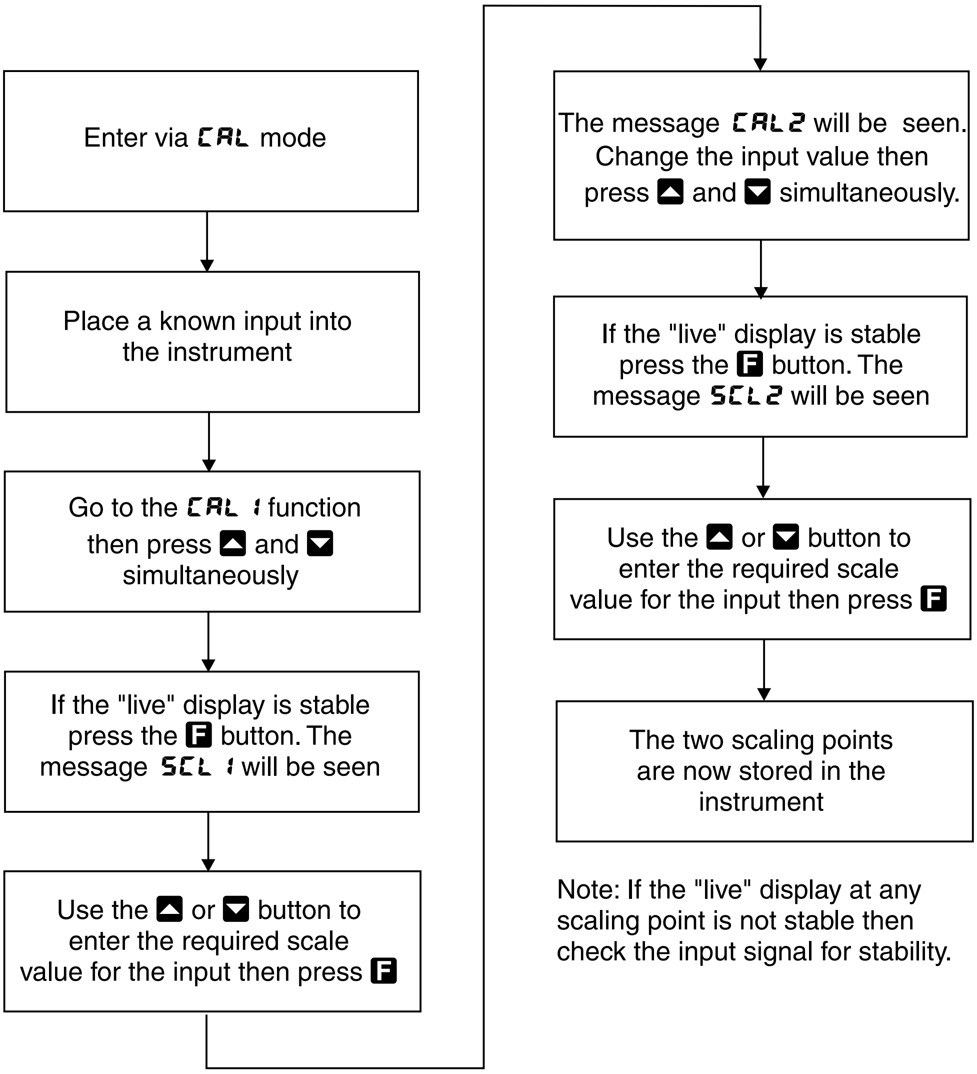


Setting CAL2

CAL2 (second scaling point for 2 point scaling method).

The second point scaling is performed in exactly the same manner as CAL 1 except that SCL2 will be seen instead of SCL 1. It is essential that the live input is different in value to the CAL 1 input e.g. for a 4-20mA input use 20mA as the CAL2 live input. Note; it is not essential that 4 and 20mA are used as the live inputs for a 4-20mA scaling but there must be at least a 10% of full scale difference between the CAL 1 and CAL2 inputs, if this is not the case then a SPAn Err message will be seen and the calibration point will not be accepted.

Example - Scaling using two live inputs



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

USEr En 4 (4mA input scaling without a live input).

This calibration method can be used with 4-20mA inputs only. The rate display 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 (En 4) scaling simply press the ▲ and ▼ buttons simultaneously when the USEr En 4 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 4mA input then press the F button to accept the new value.

USEr En20 (20mA input scaling without a live input).

This calibration method can be used with 4-20mA inputs only. The same method described in USEr En 4 above can be used to scale the instrument for a 20mA input then press the F button to accept the new value.

UCAL (uncalibration).

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 memory press the ▲ and ▼ buttons simultaneously at the UCAL function. The message CAL CLr will be seen to indicate that the memory has cleared. If using the remote input to change rate scales the UCAL function will clear the memory of whichever scale is selected at the time leaving the other scale unaffected.

Returning to the normal measure mode

When the calibration procedure has been completed it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode, turn off power to the instrument, wait a few seconds and then restore power.

9 Setting up the relay PI controller

The Relay Proportional + Integral Controller can be made to operate in either pulse width control or frequency control mode via the AxOPEr function. The best results are usually achieved by initially configuring as a "Proportional Only" controller and then introducing the Integral function 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 can only operate in normal, non PI operation. The "x" in the AxOPEr and other functions indicates the chosen relay i.e. for relay 1 the display will show A1OPEr, A1SP etc. The AxOPEr function allows three choices of operating mode for the chosen relay, namely Ax.AL, Ax.tP and Ax.Fr. If Ax.AL is selected the chosen relay will operate as a setpoint relay whose operation is controlled by the AxLo, AxHi etc. settings and is not affected by any of the PI control settings. See the "Explanation of functions" chapter for details of operation when Ax.AL is selected. If Ax.tP is selected then the chosen relay will operate in pulse width control mode. If Ax.Fr is selected then the chosen relay will operate in the frequency control mode.

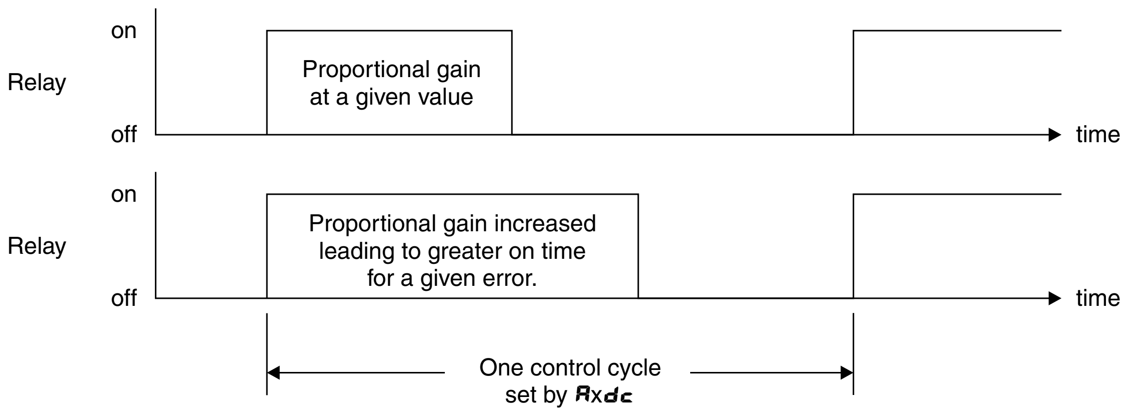
Pulse width control operates by controlling the on to off time ratio of the relay. In a typical application this would be used to control the length of time for which a dosing pump is switched on during a control cycle i.e. the pump or other device will continuously dose for the length of time the relay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

Pulse width modulation control mode

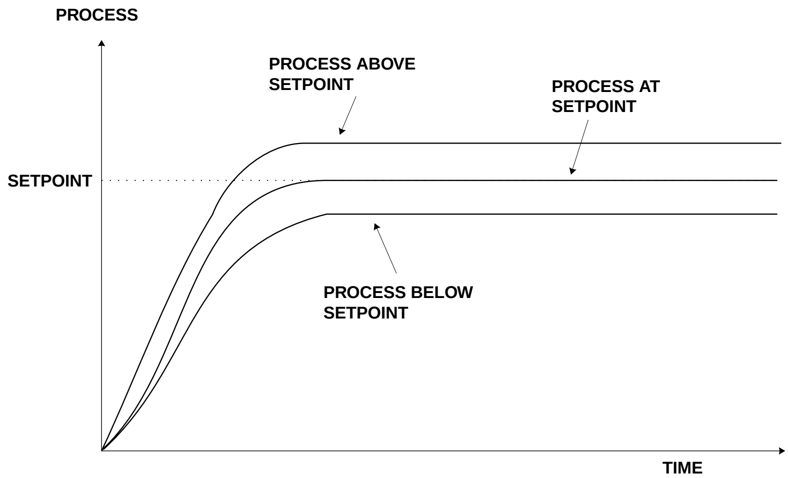
To use pulse width modulation control Ax.tP must be selected at the AxOPEr function.

Pulse width control



AxSP (control setpoint)

The control setpoint is set to the value in displayed engineering units required for control of the process. The controller will attempt to vary the control output to keep the process variable at the setpoint.

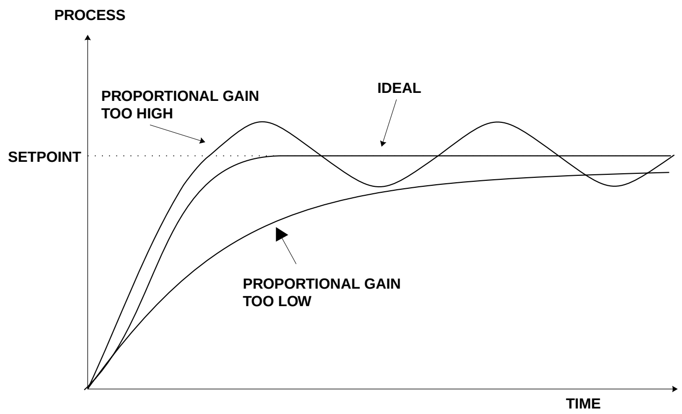


Note that the control setpoint value can be reached and adjusted via the "easy access" mode (see "Explanation of functions" chapter) if the ACCS function is set to EASY. This feature could be useful if the setpoint is to be frequently changed.

ctrl SPAN (proportional control span)

The function of the control span is to define the limit to which the proportional 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 (**A**x**SP**) is 70.0 and the **ctrl SPAN** is 20.0 then an error of 20 degrees from the setpoint will cause a 100% change in proportional control output. For example with **A**x**SP** at 70.0, **ctrl SPAN** at 20.0, **A**x**PG** at 1.000 and **A**x**bS** at 0.000 a display reading of 50.0 or lower (**A**x**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.

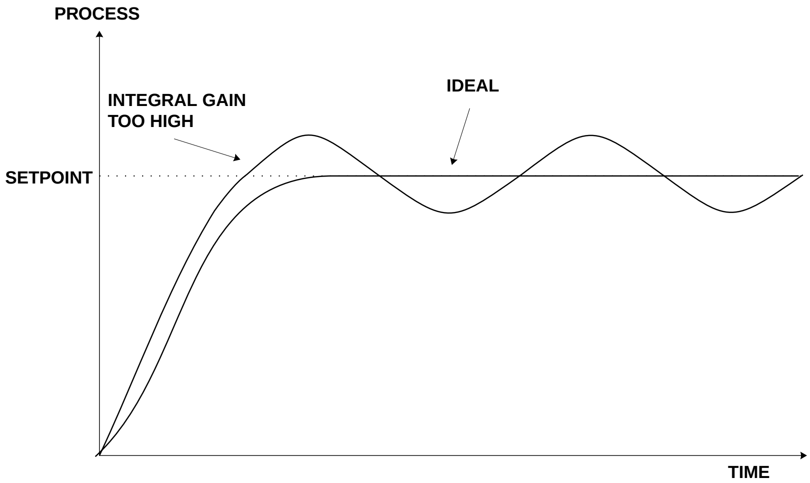
Ax**PG** (proportional gain)



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 frequency will be increased i.e. the period of the control cycle will be decreased. The proportional gain action can be reversed by setting a negative gain i.e. with a negative gain the frequency will reduce as the error increases. With a proportional gain of 1.000 and an error of 10 or more (with control gain 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 gain 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.

Ax**I G** (integral gain)



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%/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 and may be set in the range of approx. 32.000 to -32.000. Note that a display with more than 5 digits is required to show -32.000. 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:

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

Where Ig is the integral gain set via AxI g.

AxI L (minimum limit of integral term)

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.

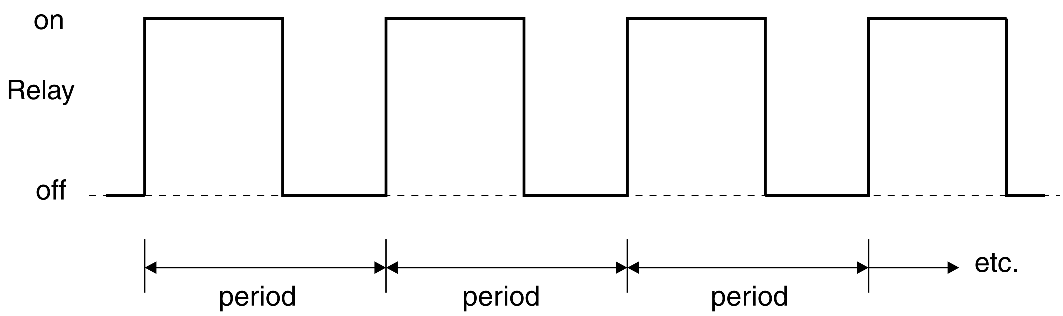
The minimum and maximum limits are used in conjunction with the output bias setting to maintain the control process setpoint value. For example with a bias (AxbS) set at 50%, minimum limit (AxI L) set at 20% and a maximum limit of 30% the actual bias when the process is at the setpoint may be anywhere 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.

AxI H (maximum limit of integral term)

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.

AxbS (control output bias)

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.

Axdc (control cycle period)

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.

Setting up the pulse width controller

1. Set the **Ax OPEr** function to **AxtP**
2. Set the control setpoint **AxSP** to the required setting.
3. Set the control span **ctrl SPAN** to the required setting
4. Set the proportional gain **AxPG** to an arbitrary value e.g. **0.500**.
5. Set the integral gain **AxI G** to **0.000** (i.e. off).
6. Set the low and high integral **AxI L** and **AxI H** limits to an arbitrary value e.g. **20.00**
7. Set the bias **AxbS** to **50.0**.
8. Set the cycle **Axdc** period to 60 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.

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

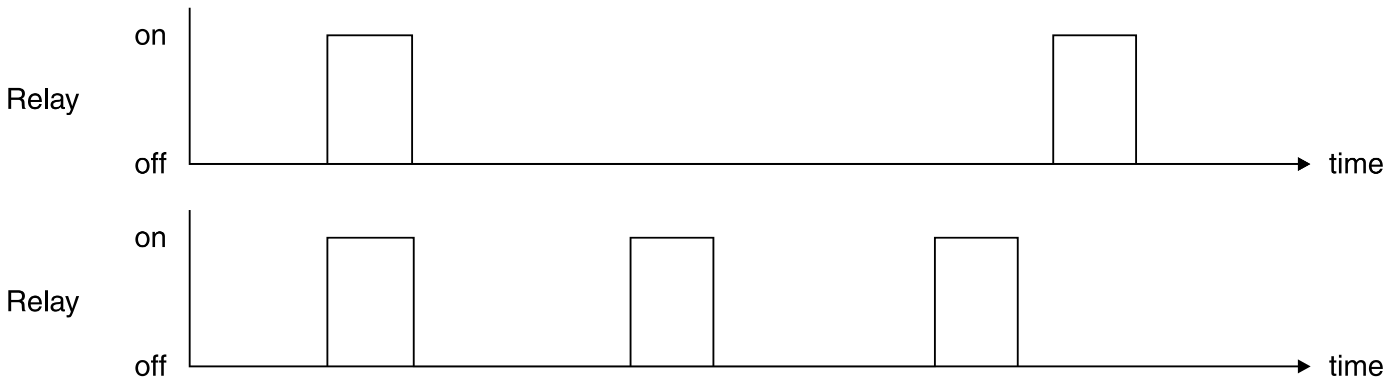
Gradually increase the integral gain until the process begins to oscillate. Then reduce the integral gain slightly to regain the control without this added oscillation.

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.

Frequency modulation control mode

To use pulse width modulation control Ax.Fr must be selected at the AxOPEr function.

Frequency control



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.

AxSP (control setpoint)

The control setpoint is set to the value in displayed engineering units required for control of the process. The controller will attempt to vary the control output to keep the process variable at the setpoint. Note that the control setpoint 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.

ctrl SPAN (proportional control span)

The function of the control span is to define the limit to which the proportional 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 (AxSP) is 70.0 and the ctrl SPAN is 20.0 then an error of 20 degrees from the setpoint will cause a 100% change in proportional control output. For example with AxSP at 70.0, ctrl SPAN at 20.0, AxPG at 1.000 and AxbS at 0.000 a display reading of 66.0 or lower (AxSP minus ctrl SPAN) the control output will be at 100% i.e. the relay will be at its maximum frequency, this frequency will be determined by the Axdr and Axdc functions. The control output will then gradually adjust the off time as the display value reaches the setpoint.

AxPG (proportional gain)

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 frequency will be increased i.e. the period of the control cycle will be decreased. The proportional gain action can be reversed by setting a negative gain i.e. with a negative gain the frequency will reduce as the error increases. With a proportional gain of 1.000 and an error of 10 or more (with control gain 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 gain 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.

AxI G (integral gain)

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%/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 and may be set in the range of approx. 32.000 to -32.000. Note that a display with more than 5 digits is required to show **-32.000**. 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:

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

Where Ig is the integral gain set via **AxI G**.

AxI L (minimum limit of integral term)

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 increasing but the system may take a long time to recover if the temperature setpoint is overshot. Separate high and low limit settings allow independent limiting of the integral control swing below and above the setpoint.

AxI H (maximum limit of integral term)

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.

AxbS (control output bias)

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 be lower then the maximum when the measured input is at the setpoint. If set at 100.0 then the relay will be at its maximum frequency when the measured input is at the setpoint.

Axdc (control relay minimum off time)

Displays and sets the control relay minimum off time from 0 to 250 seconds. If set to 0 the relay will be disabled. This time should be set as long as possible to reduce wear of the control relay and the controlling device. 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 **Axdc**. If a 50% error is seen there will be a pulse every 2 times **Axdc**. For a 25% error there will be a pulse every 4 times **Axdc** and for a 10% error there will be a pulse every 10 times **Axdc**.

Axdr (control relay on duration)

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.

Setting up the frequency controller

1. Set the Ax OPEr function to AxFr
2. Set the control setpoint AxSP to the required setting.
3. Set the control span ctrl SPAN to the required setting.
4. Set the proportional gain to an arbitrary value e.g. 0.500
5. Set the integral gain to 0.000 (i.e. off).
6. Set the high and low integral limits AxI L and AxI H to an arbitrary value e.g. 20.00
7. Set the bias AxbS to 50.0.
8. Set the minimum off time Axdc to 20.
9. Set the relay on time Axdr to an arbitrary value e.g. 1.0

Initialise the control system and monitor the control results. If the original settings causes process oscillations then gradually decrease the proportional gain until the oscillations decrease to an acceptable steady cycle. If the original settings do not cause process oscillations then gradually increase the proportional gain until a steady process cycling is observed.

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

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

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

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

10 Specifications

10 .1 Technical Specifications

Input types:	Link selectable ±0 to 20mA, ±4 to 20mA or DC Volts ±100mV, ±1V, ±10V, ±100V or Slidewire, 3 wire 1kΩ to 1MΩ value slidewires
Impedance:	80Ω (4 to 20mA) & 1MΩ on DC Voltage
ADC resolution:	1 in 20,000
Accuracy:	Rate accuracy of 0.1% when calibrated
Sample rate:	4 per sec
Conversion method:	Dual Slope ADC
Memory retention:	Total retained in memory for 1 week with power removed
Microprocessor:	MC68HC11F CMOS
Ambient temperature:	LED -40 to 60°C
Humidity:	5 to 95% non condensing
Display:	LED 5 digit 7.6mm + alarm annunciator LEDs
Power supply:	AC 240V, 110V, 24V or 32V 50/60Hz. DC 12 to 48V wide range.
Power consumption:	AC supply 4 VA max, DC supply, (depends on options)
Output (standard):	2 x relays, form A rated 5A resistive 240VAC 24VDC unregulated transmitter supply (common ground) rated at 25mA.
Relay action:	Programmable N.O. or N.C.

10 .2 Output Options

Third relay:	Rated 0.5A resistive 30VAC or DC. May be configured for either form A or form C if the third relay is the only option fitted.
Fourth relay:	Rated 0.5A resistive 30VAC or DC, form A.
Switched voltage:	Non isolated 24VDC output to be used for open collector or solid state relay driver output.
Analog retransmission:	Isolated 4 to 20mA or 0 - 1V or 0 - 10V link selectable, 12 bit or 16 bit versions available. Configurable as retransmission or PI control. Dual channel 12 bit analog retransmission.
Serial communications:	RS232, RS485 or RS422 factory configured. RS485 plus analog retransmission version available.
Transmitter supply:	Isolated & regulated. Link selectable12VDC (50mA max) or 24VDC (25mA max)

10 .3 Physical Characteristics

Case size:	44mm (w) x 91mm (h)x 141mm (d)
Connections:	Plug in screw terminals (max 1.5mm^2 wire for input signal and options 2.5mm^2 for power and relays 1 & 2)
Weight:	470 gms basic model, 500 gms with option card

11 Guarantee & Service

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

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

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

When returning the product for service or repair a full description of the fault and the mode of operation used when the product failed must be given.

In any event the manufacturer has no other obligation or liability beyond replacement or repair of this product.

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

This product is designed and manufactured in Australia.