RM4-LN Lineariser
DIN Rail Process Monitor/Controller
Inputs from 0-20mA, 4-20mA,
±100mV, ±1V,±10VC, ±100VDC
or slidewire.
Operation & Instruction Manual

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1 Introduction

This manual contains information for the installation and operation of the RM4-LN lineariser monitor/controller. The RM4 may be configured to accept inputs of 0 to 20mA, 4 to 20mA, ±100mV, ±1V, ±10V, ±100VDC or slidewire.

The RM4-LN offers the choice of linear, square root or linearised display. Two separate sets of calibration scaling values can be stored with the display choice being made via the remote input. In lineariser operation up to 50 points may be entered. These points and any function settings and scaling values are stored in EEPROM memory. The lineariser points are stored in a “lineariser table”. A written copy of the table should be maintained for reference, a table is provided in Chapter 8 for this purpose. The lineariser table stores the display values for each point and the input values (scaled or otherwise) associated with these display values.

The display may be toggled between “live input” and linearised values via the front ▲ and ▼ pushbuttons. The display will indicate InPt prior to a live input reading and Li nr prior to a linearised reading. This feature may be used at any time to check the live input readings against the lineariser table. The remote input or P button can also be programmed for this display toggling function.

The instrument may be calibrated to display the input in engineering units. Two standard inbuilt relays provide alarm/control functions. Relay 1 can be configured for basic setpoint operation or for PI control operation (pulse frequency control or pulse duration control). A standard transmitter supply of 24VDC unregulated is also provided on both AC and DC powered models.

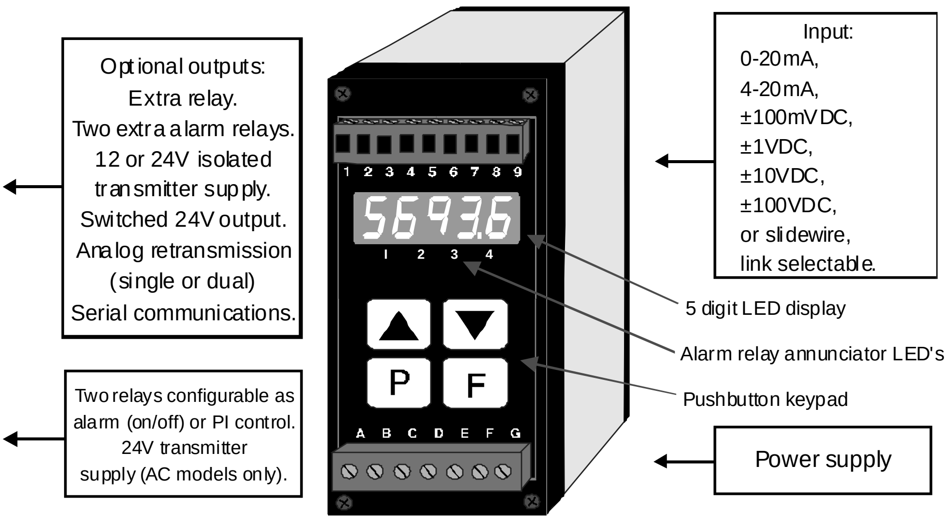
Various combinations of one or two optional extra relays (setpoint operation only, not PI control), analog (4-20mA, 0-1V or 0-10V) retransmission/PI control or serial (RS232, RS485 or RS422) communications and an isolated 12 or 24VDC isolated transmitter supply may also be provided as an option. Alarms and retransmission may be set to operate from the live input value, the display value or to follow either the tare, peak hold, display hold, peak memory or valley memory 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.

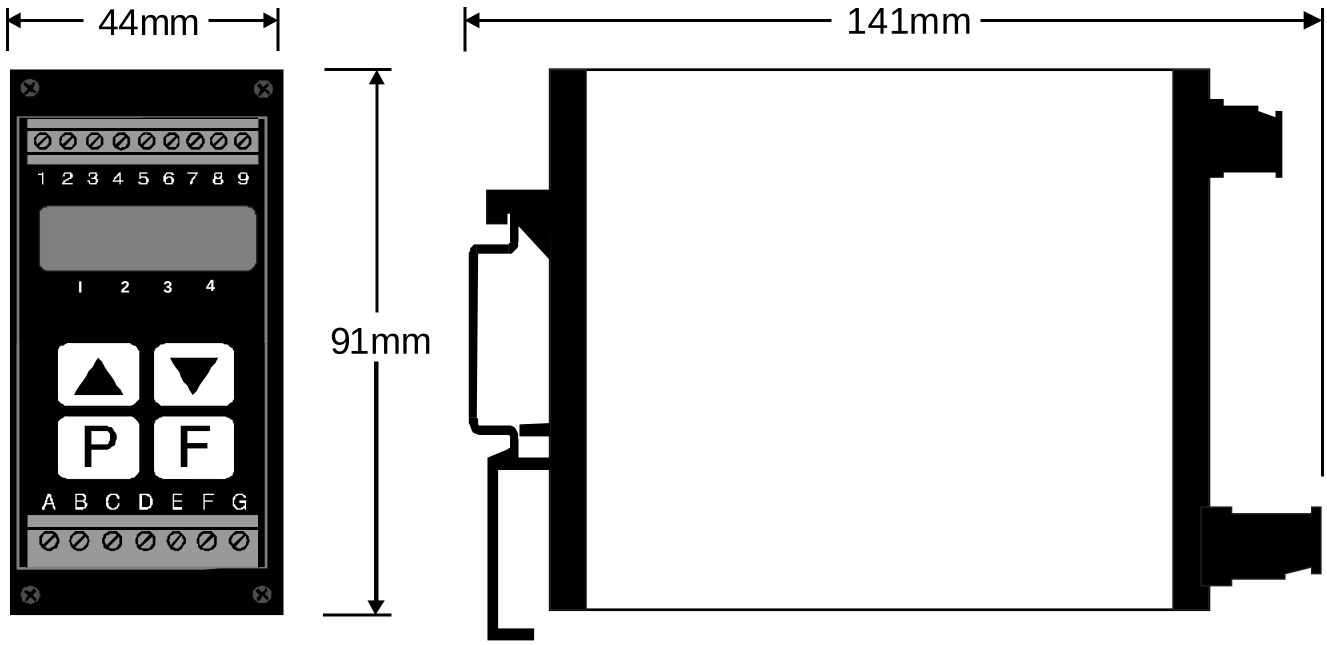
The RM4 series of DIN Rail Process Modules are designed for high reliability in industrial applications. The 5 digit LED display provides good visibility, even in areas with high ambient light levels. A feature of the RM4-IV is the programmable display brightness function, this allows the unit to be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

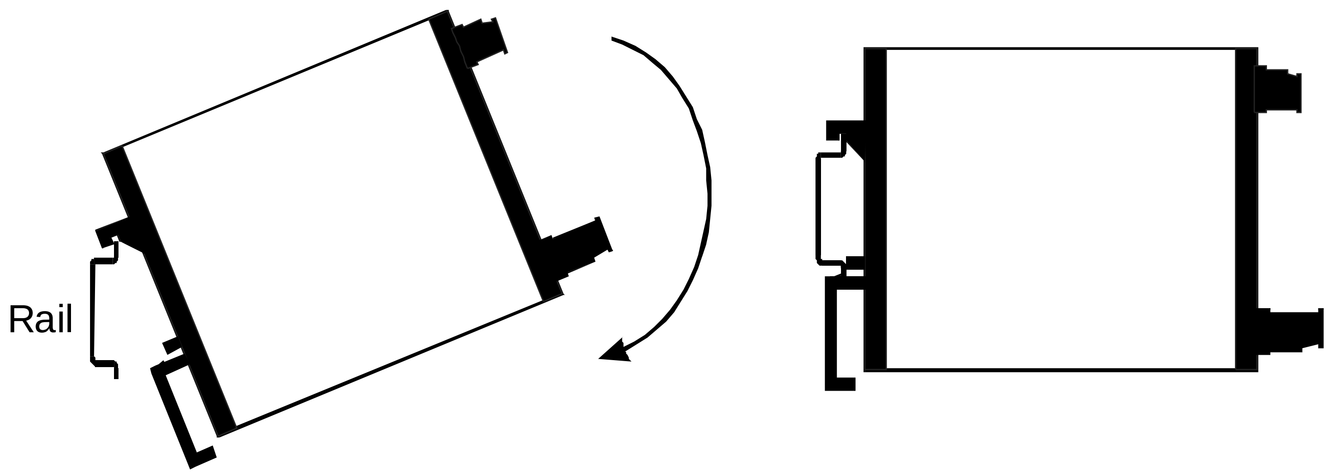
Inputs & outputs



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.





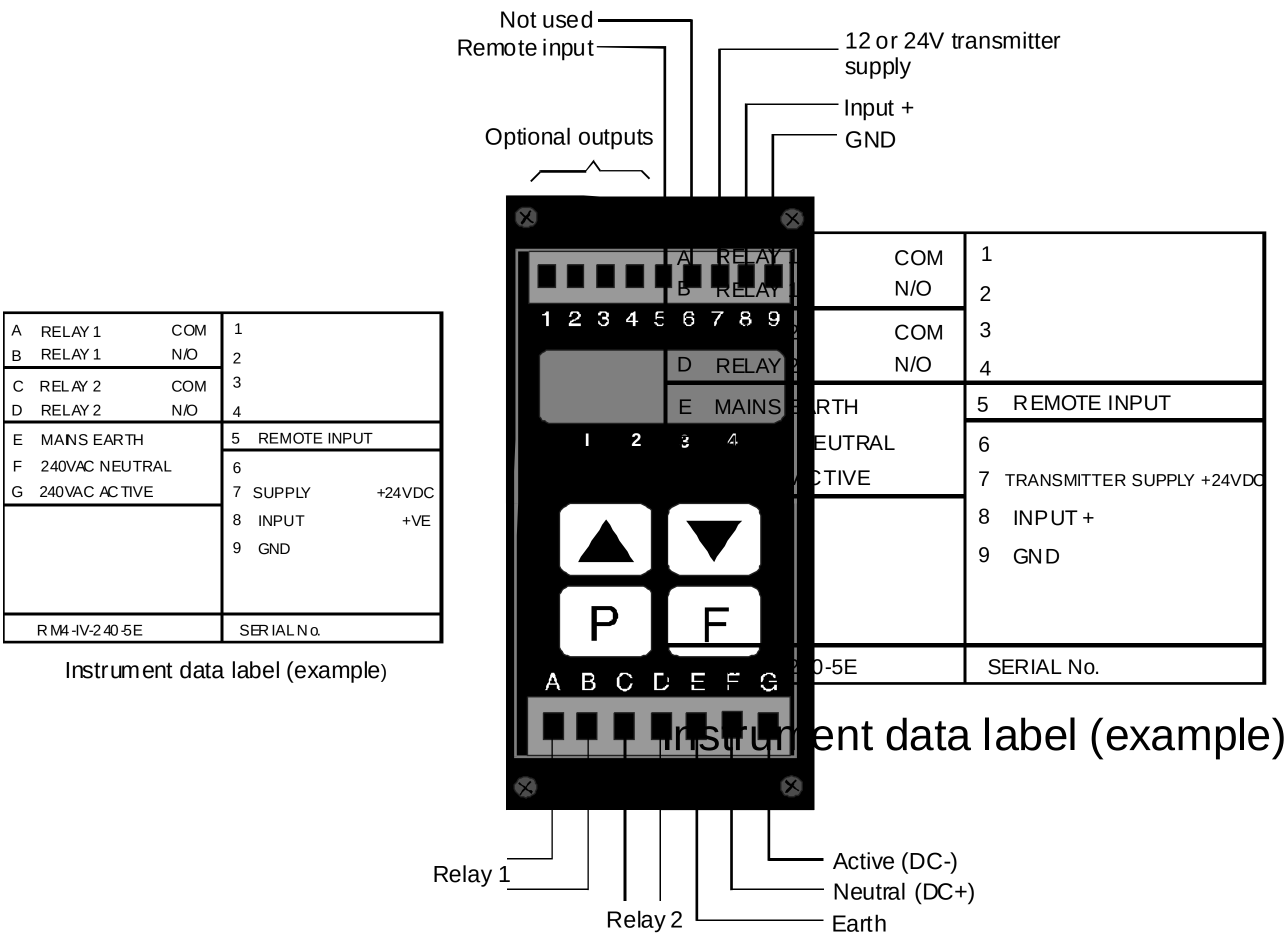
3 Electrical installation

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.

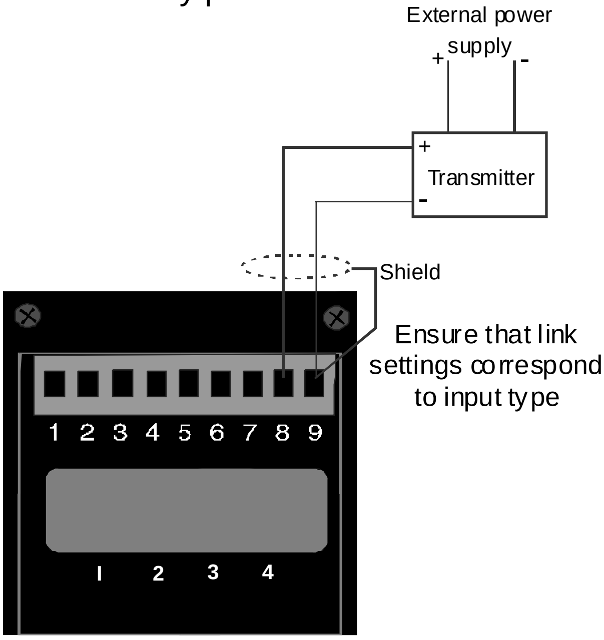
The terminal blocks allow for wires of up to 2.5mm^2 to be fitted for power supply and relays 1 and 2 or 1.5mm^2 for input signal connections and optional outputs. Connect the wires to the appropriate terminals as indicated below. Refer to other details provided in this manual to confirm proper selection 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

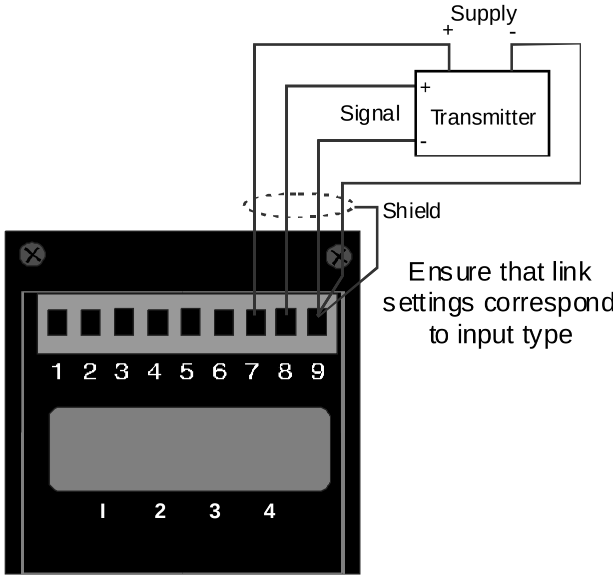
Examples continued overleaf.



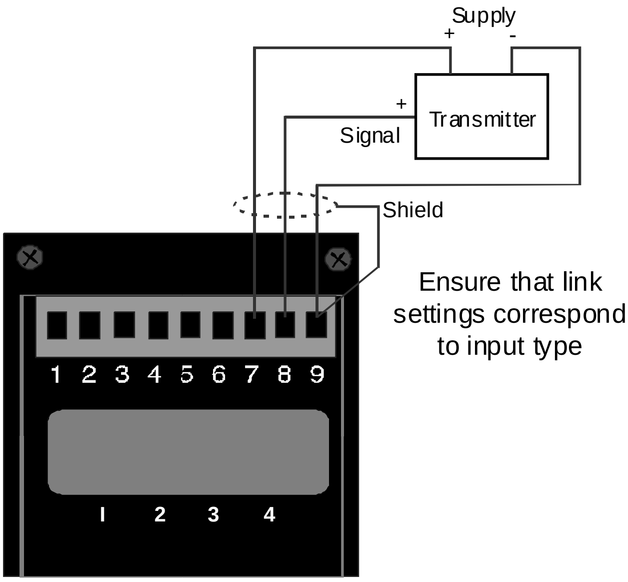
4 wire 4-20mA.
Externally powered.



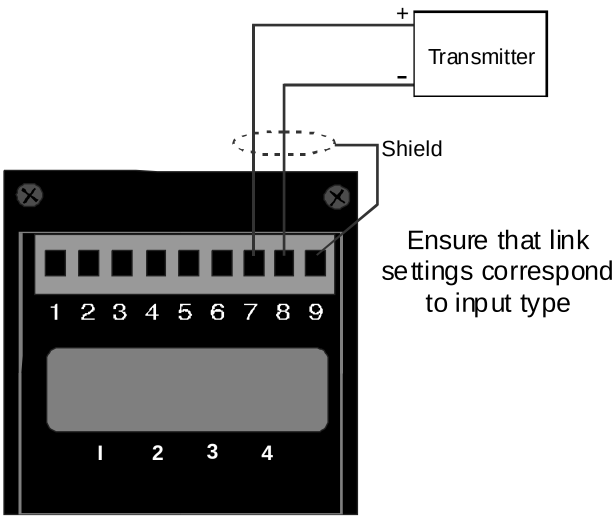
4 wire 4-20mA.
Powered via standard
24V unregulated.



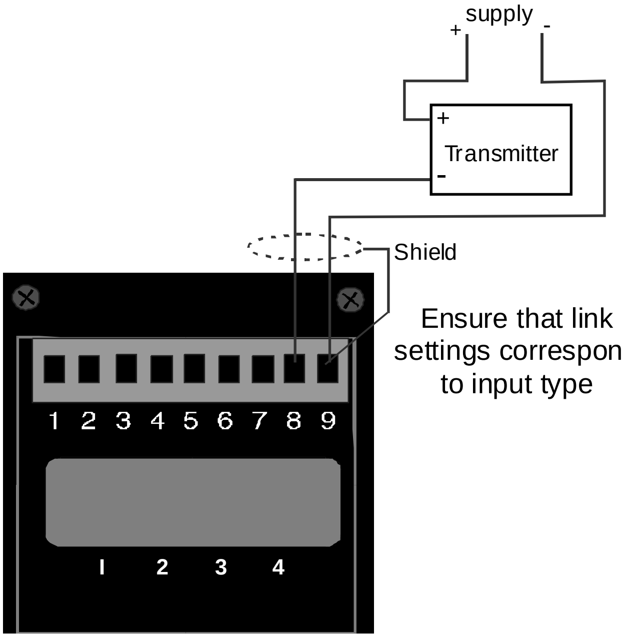
3 wire 4-20mA.
Powered via standard
24V unregulated.



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

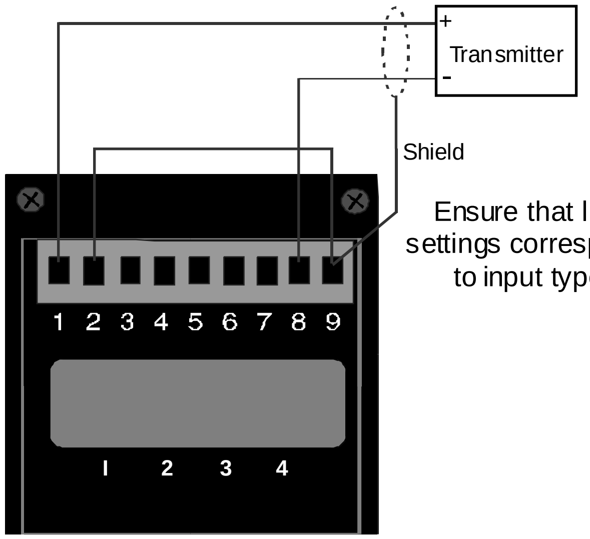


2 wire 4-20mA. Externally powered.



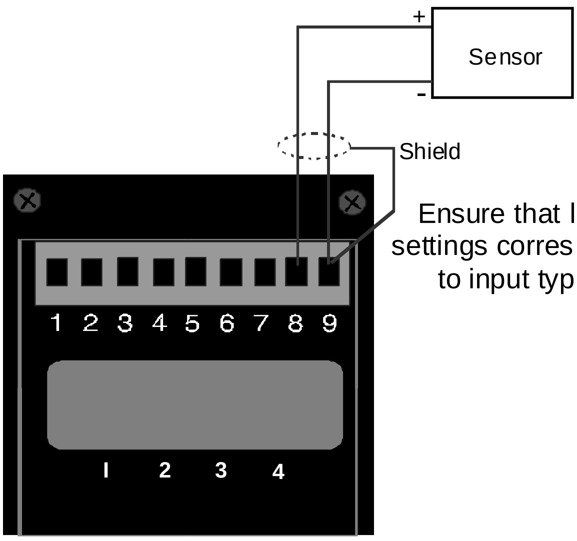
Ensure that link settings correspond to input type

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



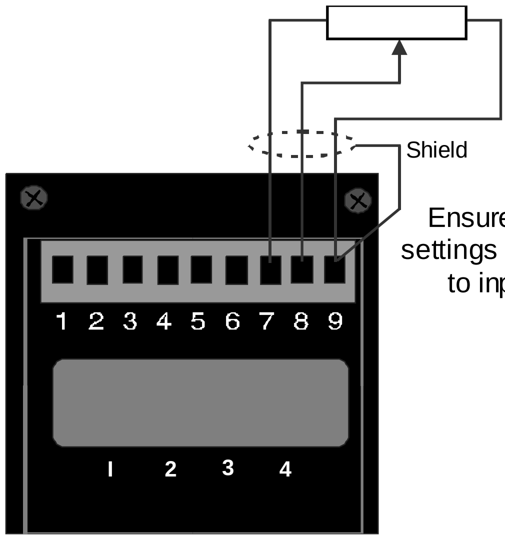
Ensure that link settings correspond to input type

DC voltage input



Ensure that link settings correspond to input type

Slidewire input

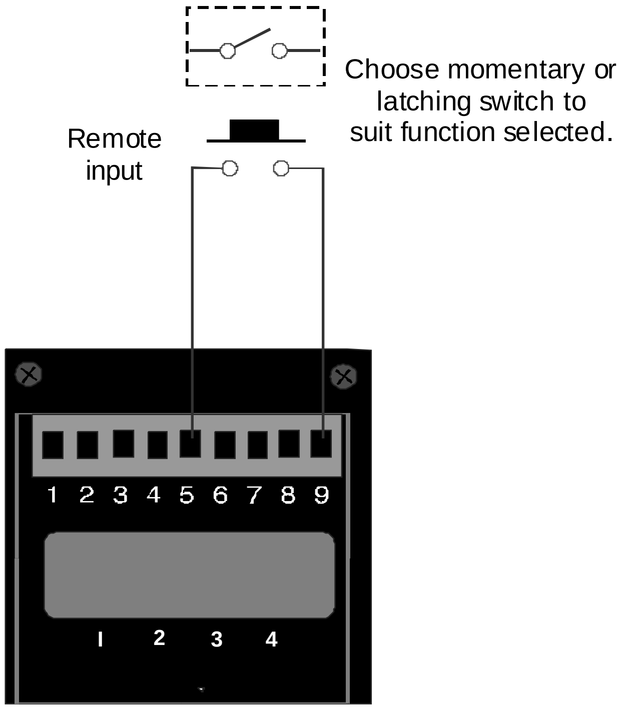


Ensure that link settings correspond to input type

3 .2 Remote input connections

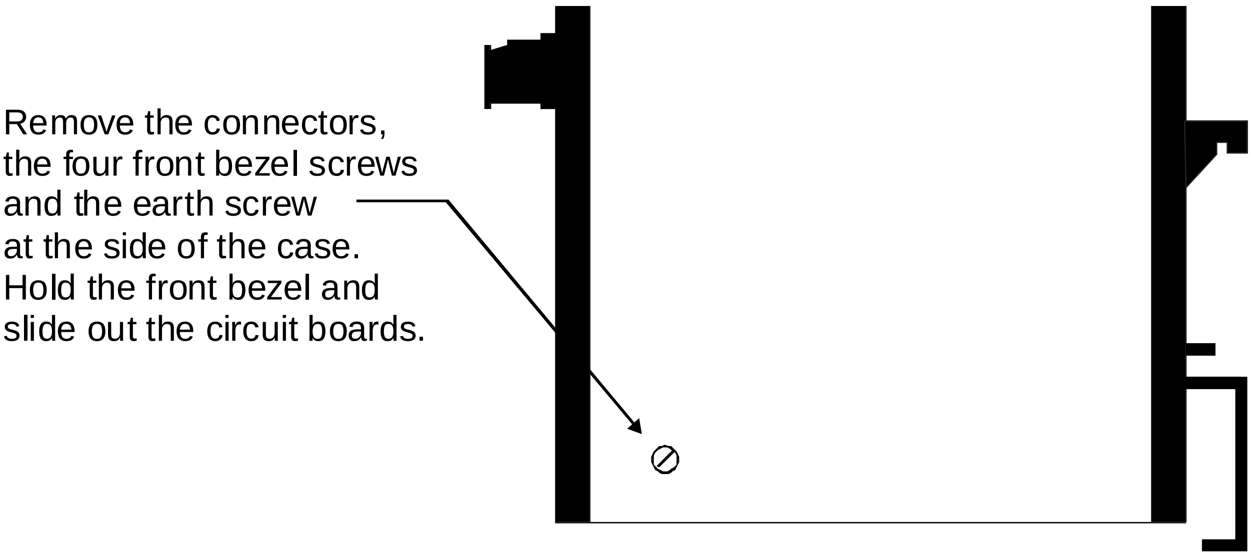
The selected remote input function can be operated via an external contact closure via a switch, relay or open collector transistor switch.

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.

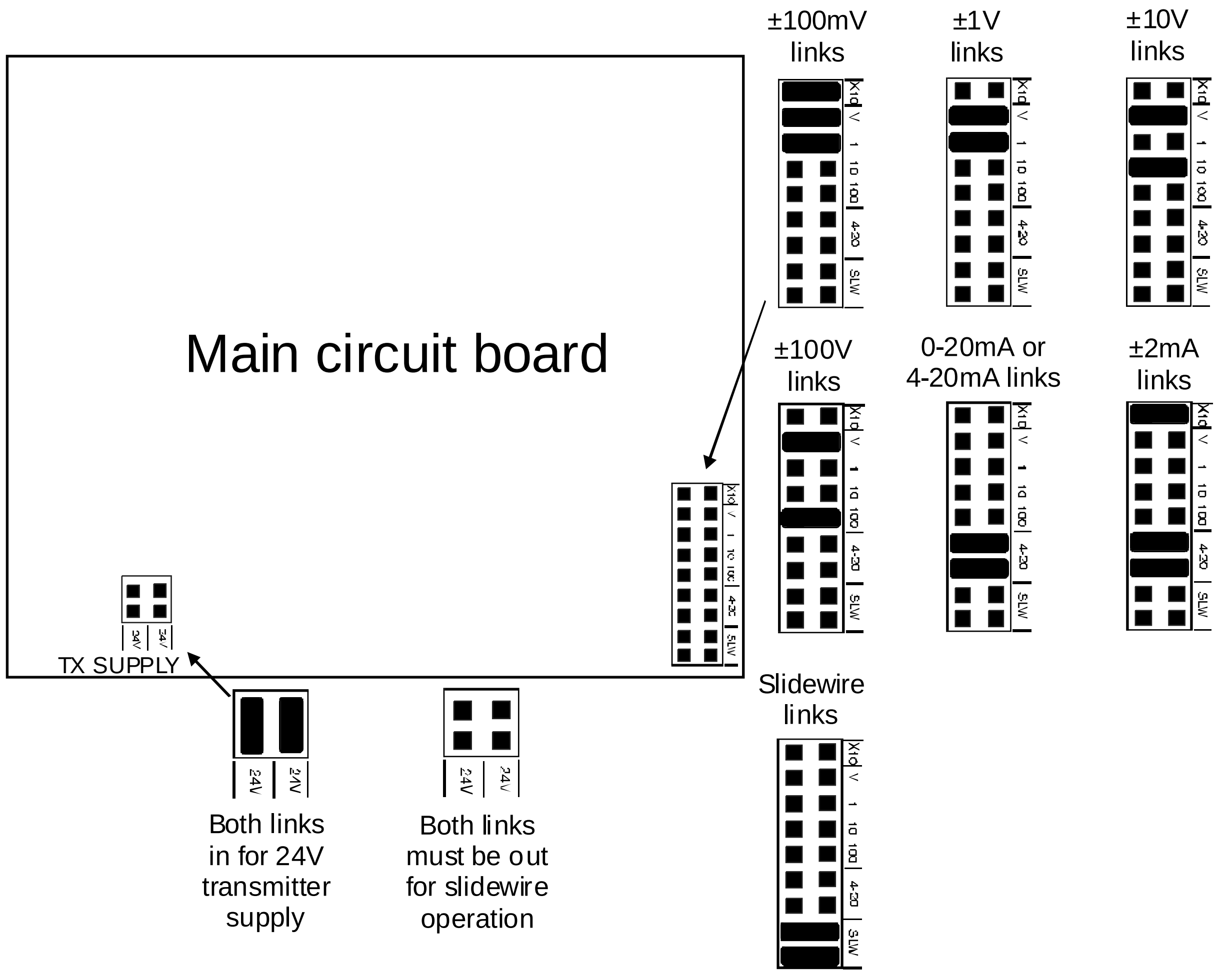


3 .3 Configuring the input board

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.

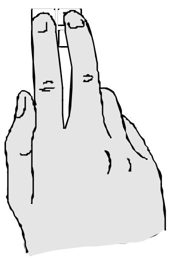
CAL mode (power up sequence plus push button sequence) allows access to all functions including calibration parameters.

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.



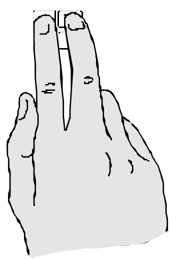
3. Within 2 seconds of releasing the F button press, then release the ▲ and ▲ buttons together. The display will now indicate FUNC followed by the first function.

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.

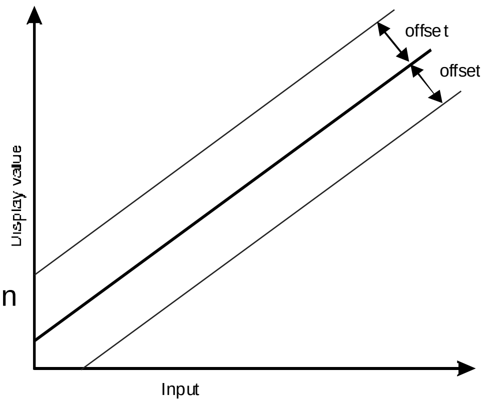
1. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the F button.



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	Range	Description
C.SEt	-19999 to 99999	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.
A1.SP	-19999 to 99999	Alarm relay 1 control setpoint. Seen only when A1OPEr is set to A1.tP or A1.Fr. See "Setting up the relay PI controller" appendix.
AxLo	-19999 to 99999 or OFF	Alarm relay low setpoint - see "Alarm relays" chapter. Displays and sets each alarm low setpoint value. Note "x" will show up as the relay number e.g. A1Lo etc.
AxHi	-19999 to 99999 or OFF	Alarm relay high setpoint - see "Alarm relays" chapter. Displays and sets each alarm high setpoint value. Note "x" will show up as the relay number e.g. A1Hi etc.
AxHY	0 to 9999	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. Note "x" will show up as the relay number e.g. A1HY etc.
Axtt	0 to 9999	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. Note "x" will show up as the relay number e.g. A1tt etc.
Axrt	0 to 9999	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. Note "x" will show up as the relay number e.g. A1rt etc.
Axn.o or Axn.c	Axn.o or Axn.c	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. Note "x" will show up as the relay number e.g. A1n.o etc.
A2.SP, A2.t1, A3.t2 etc.	A2.SP, A2.t1, A3.t2 etc.	Alarm relay operation independent setpoint or trailing - see "Alarm relays" chapter.
brGt	1 to 15	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	0 to 15	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.
d.oFF SECS	0 to 9999 seconds	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.
CAL mode functions Entry via CAL mode must be made in order to view and adjust the functions which follow. Alternativeley setting ACCS function to all will allow access to these funcitons.		
A1 OPEr	A1AL, A1.tP or A1.Fr	Alarm relay 1 operation mode - sets the mode of operation for relay 1. Choices are A1.AL (setpoint relay operation), A1.tP (time period PI control operation) or A1.Fr (frequency PI control operation).

ctrl SPAN	1 to 99999	PI relay control span - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.PG	-19.999 to 32.767	PI relay proportional gain - seen only when the Ax OPEr is set to Ax.tP or Ax.Fr. See “Setting up the relay PI controller” appendix.
A1.I G	-19.999 to 32.767	PI relay integral gain - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.I L	0.0 to 100.0	PI relay integral low limit - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.I H	0.0 to 100.0	PI relay integral high limit - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.bS	0.0 to 100.0	PI relay bias - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.dc	0 to 250	PI relay duty cycle - seen only when the A1 OPEr is set to A1.tP or A1.Fr. See “Setting up the relay PI controller” appendix.
A1.dr	0.0 to 25.0	PI relay duration - seen only when the A1 OPEr is set to A1.Fr. See “Setting up the relay PI controller” appendix.
rEC_	-19999 to 99999	Analog recorder/retransmission 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.
rEC¯	-19999 to 99999	Analog recorder/retransmission 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_ Ch 2	-19999 to 99999	Second analog recorder/retransmission output low value - seen only when the dual analog retransmission option is fitted. See rEC_ function for description of operation. See also rEC2 function (analog output 2 mode).
rEC¯ Ch 2	-19999 to 99999	Second analog recorder/retransmission output high value - seen only when the dual analog retransmission option is fitted. See rEC¯ function for description of operation. See also rEC2 function (analog output 2 mode).
drnd	0 to 5000	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	0 to 0.0004	Decimal point selection - displays and sets the decimal point. 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	0 to 8	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	on or OFF	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	0 to 99999	Control span - 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.
C.PG	-19.999 to 32.767	Control proportional gain - 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.
C.PO	0.0 to 100.0	Control proportional offset - 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.
C.I G	-19.999 to 32.767	Control integral gain - 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.
CI L.H	0.0 to 100.0	Control integral limit high - 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.
CI L.L	0.0 to 100.0	Control integral limit low - 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.
rEC SPAC	on or OFF	Control setpoint access on or off - 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.
CAL 1 & CAL2	n/a	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	-19999 to 99999	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. 

ZERO RNGE	-19999 to 99999 or OFF	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 ZERO RNGE Err message (note that the CAL OFSt function is also affected by the ZERO RNGE 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 ZERO RNGE 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.
CAL ZERO	n/a	Calibration zero - the calibration zero function is used following a calibration via CAL 1 and CAL2. A calibration zero operation at this time ensures that the display zero and the ZERO RNGE reference zero are at the same point after a calibration. After a calibration the calibration zero 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.
USER En4	-19999 to 99999	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	-19999 to 99999	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	n/a	Uncalibration- see “Calibration” chapter. Used to set the instrument back to the factory calibration values.
P.but	NONE, Hi, Lo.Hi.Lo, tARE or ZERO	P button function - the function of the P button is programmable in the same manner as the remote input (see r.INP below). The P button selection will override the selection made under the r.INP 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 or ZERO 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 Allows toggling via the P button between the live input value (preceded by the message INPt) and the lineariser table value (preceded by the message Li nr).

r.I NP	NONE, P.HLd, d.HLd, Hi .Lo, Hi Lo, tArE, ZErO, SP.Ac, No.Ac, CAL.S, dI SP or duLL	Remote input - displays and sets the special function input selection, see “Remote input functions” chapter.
NEtt FLSH	on or OFF	Nett value display mode - The nett value is only seen when the remote input or **P** button is used to toggle between the nett and gross values. The NEtt FLSH function can be set to on or OFF. If set to on then the message NEtt will flash briefly approximately every 6 seconds when the operator toggles to a nett display to remind the operator that a nett value is being viewed. If set to OFF then the message NEtt will flash briefly once only when the operator toggles to the nett value.
ACCS	OFF, EASY, NONE or ALL	Alarm relay access mode - see “Alarm relays” chapter.
SPAC	A 1, A 1-2 etc.	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	on or OFF	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.
tAbL tAbL StOP SCLE tbIE tAbL PntS SEt tAbL		Lineariser funcitons. See “Lineariser operation” chapter
A1 to A4	Li uE, tArE, P.HLd, d.HLd, Hi, Lo or dI SP	Alarm mode - The alarms can be set to operate from the live input value (Li uE), the tare value (tArE), the peak hold value (P.HLd), the display hold (dHLd), the peak memory (Hi) or the valley memory (Lo). Ensure that the r.I NP or P.but function is also set to the desired operation. See “Alarm relays” chapter for further information. If the linearising table is turned on then the Li uE value will be the linearised value.

rEC	Li uE, tArE, P.HLd, d.HLd, Hi, Lo or di SP	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: Li uE - live input mode. If the linearising table is turned on then the Li uE value will be the linearised value.The retransmission will follow the electrical input and will not necessarily follow the 7 segment display. For example if the remote input is set for peak hold operation then when the remote input is closed the 7 segment display will only show the peak value but the retransmission will be free to change to follow the electrical input. tArE - tare mode. The retransmission value will tare (fall to zero) along with 7 segment display when the remote input tare function is operated. If the remote input toggles the 7 segment display to show gross (9rOS) then the 7 segment display will change to show the gross value but the retransmission will not respond (see Li uE for alternative operation). P.HLd - peak hold mode. The 7 segment display and retransmission value will indicate the peak value only whilst the peak value function is operated via a contact closure on the remote input i.e. the 7 segment display and retransmission can rise but not fall whilst the remote input switch is closed. When the remote input switch is opened the retransmission value will remain fixed i.e. it will not rise or fall, although the 7 segment display value will be free to alter. This peak retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument. Note: In this mode the retransmission will show a zero reading until the remote input is operated for the first time after switch on. d.HLd - display hold mode. The 7 segment display and retransmission value will be held whilst the remote input display hold switch is closed. When the switch is opened the retransmission value will remain fixed at the held value although the 7 segment display value will be free to alter. The held retransmission output can be cleared by closing the remote input switch for another operation or by removing power from the instrument. Hi - peak (max.) memory mode. With the peak remote input switch open the retransmission will indicate the peak value in memory i.e. the retransmission output can rise but not fall. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument. Lo - valley (min.) memory mode. With the valley remote input switch open the retransmission will indicate the valley (min.) value in memory i.e. the retransmission output can fall but not rise. The retransmission output can be reset by clearing the memory. The memory may be cleared either by closing the remote input switch for approximately 2 seconds or by removing power to the instrument. di SP - display mode. The retransmission output will follow whatever value is on the 7 segment display. 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 9rOS. If the rEC function had been set to tArE rather than di SP then the retransmission output would not respond to the 9rOS toggle.
rEC2	See above	Analog retransmission mode for optional second analog output - see rEC function for description. Refer to the separate “RM4 DIN Rail Meter Optional Output Addendum” booklet supplied when this option is fitted.
Lo di SP	Value or OFF	Low overrange limit value - the display can be set to show an overrange message if the display value falls below the Lo di SP setting. For example if Lo di SP is set to 50 then once the display reading falls below 50 the message -or- or the display value (see di SP function) will flash instead of the normal display units. This message can be used to alert operators to the presence of an input which is below the low limit. If this function is not required it should be set to OFF by pressing the ▲and ▼ buttons simultaneously at this function.

HI 9H dI SP	Value or OFF	High overrange limit value - the display can be set to show an overrange message if the display value rises above the HI 9H dI SP setting. For example if HI 9H dI SP is set to 1000 then once the display reading rises above 1000 the message -or- or the display value (see dI SP function) will flash instead of the normal display units. This message can be used to alert operators to the presence of an input which is above the high limit. If this function is not required it should be set to OFF.
dI SP	FLSH or -or-	Display overrange warning flashing mode - this function is used in conjunction with the Lo and HI 9H dI SP functions. The dI SP function can be set to FLSH or -or-. If the value set at the Lo or HI 9H dI SP function is exceeded and the dI SP function is set to FLSH then the display value will flash on for approximately one second and off for approximately one second as a warning. If the value set at the Lo or HI 9H dI SP function is exceeded and the dI SP function is set to -or- then the -or- message will flash on for approximately one second and off for approximately one second as a warning. The warning flashes will cease and the normal display value will be seen when the value displayed is higher than the low limit and lower than the high limit.
bAud	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4.	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.
PrtY	nonE, EUEn or odd.	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, EUEn or odd.
O.Put	dI SP, Cont, POLL, A.buS or m.buS	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, POLL, A.buS or m.buS 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 required. A.buS A special communications mode used with Windows compatible optional PC download software. Refer to the user manual supplied with this optional software. m.buS Modbus RTU protocol.
Addr	0 to 31	Set unit address for polled (POLL, A.buS or m.buS) mode (0 to 31)) - Refer to the separate "RM4 DIN Rail Meter Optional Output Addendum" booklet supplied when this option is fitted. Note: address 0 should not be used in modbus mode. 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	Li uE. tArE. P.HLd. d.HLd. Hi .Lo. di SP or Hi Lo	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

Li nr tbl E Err - lineariser table entry error. This message indicates that there is an error in the figures in the table e.g. all P and Y values are identical. Return to the SEt tAbL function and check the entries.

SPAn Err - scaling span error. This message indicates that the live inputs used in CAL 1 and CAL2 were either identical or too close together. Recalibrate ensuring that the live input used at CAL 1 is significantly different to that used at CAL2.

CAL FAI L - scaling failure. This message indicates that the instrument has not accepted the live inputs used during a CAL 1 and CAL2 scaling operation. Try recalibrating again ensuring that the inputs used are correct for the input range and input link settings chosen, you may find that the input links have been set to a different range. If you have checked the inputs and find that the CAL FAI L message is still appearing then perform a UCAL operation prior to the CAL 1 and CAL2 operation.

COP FAI L - this message indicates that the instrument power has been interrupted, usually due a spike on the power supply or signal input lines. The instrument will show this error message and then reset itself i.e. the "wake up" display messages will be seen after the COP FAI L message. Check the power supply and input lines for spikes, usually caused by something with a large inductance (e.g. solenoid, motor etc.) on the same supply circuit switching on or off. It may be necessary to suppress the interference at the source and/or place the RM4 on a different supply line. Screened cables are recommended for the signal input lines, the screen should be grounded at the RM4 end only.

- - - - the bars across the screen indicate that the instrument is seeing an input which is out of its range. e.g. if the input links are set to 0-1V and the signal input is much greater than 1V then this error message will be seen. Check the input signal and input links.

-or- this message indicates that the display is "overrange" i.e. it is being asked to display a number larger than its display range. e.g. larger than 9999 for a 4 digit instrument. Check that the input signal is within the input range chosen by the link settings. Check also that the scaling values given are correct e.g. if, for a 0-1V input on a 4 digit instrument, the instrument was scaled using 0V = 0 and 0.4V = 8000, then an input of 0.5V or above will cause the error message to be seen.

5 Function table

Initial display	Meaning of display	Next display	Default Setting	Record Your Settings
C.SEt	Analog PI control setpoint	Value in memory	0	
A 1.SP	Relay 1 control setpoint	Value in memory	OFF	See following table
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
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
br9t	Digital display brightness	1 to 15 (15 = highest brightness)	15	
dULL	Remote brightness control	0 to 15 (15 = highest brightness)	1	
d.oFF SECS	Display auto dimming timer (seconds)	0 to 9999	0	
Functions below are accessible via CAL mode only or if ACCS function is set to ALL				
A 1 OPEr	Alarm relay operation mode	A 1.AL , A 1.tP or A 1.Fr	A 1.AL	
ctrl SPAn	Relay control span	Value in memory	100	
A 1.P9	Relay control proportional gain	- 19.999 to 32.767	0.010	
A 1.I 9	Relay control integral gain	- 19.999 to 32.767	0.000	
A 1.I L	Relay control integral limit low	0.0 to 100.0	100.0	
A 1.I H	Relay control integral limit high	0.0 to 100.0	100.0	
A 1.bS	Relay control bias	0.0 to 100.0	50.0	
A 1.dc	Relay control cycle period (duty cycle)	0 to 250	10	
A 1.dr	Relay control minimum on time	0.0 to 25.0	1.0	
rEC_	Analog output low limit	Value in memory	0	
rEC‾	Analog output high limit	Value in memory	100	
rEC_ch2	Second analog output low limit	Value in memory	0	
rEC‾ch2	Second analog output high limit	Value in memory	100	
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	
rEC ctrl	Analog PI control on or off.	on or OFF	OFF	
C.SPn	Analog PI control Span	Value in memory	0	
C.P9	Analog PI control proportional gain	- 19.999 to 32.767	1.000	

C.PO	Analog PI control proportional offset	0 to 100	0	
C.IG	Analog PI control integral gain	-19.999 to 32.767	0	
CIL.H	Analog PI control integral limit high	0 to 100	100	
CIL.L	Analog PI control integral limit low	0 to 100	100	
rEC SPAC	Analog PI control setpoint access on	on or OFF	on	
CAL 1	Calibration - first point	See calibration chapter	n/a	
CAL2	Calibration - second point	See calibration chapter	n/a	
CAL OFSt	Offset to calibration	Live reading	n/a	
ZErO rNGE	Zero range limit	Value in memory		
CAL ZErO	Zero point calibration	Value in memory		
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 or ZErO	NONE	
r.INP	Remote Input 1	NONE, P.HLd, d.HLd, Hi, Lo, Hi Lo, tArE, ZErO, SP.Ac, No.Ac, CAL.S, dISP or dULL	NONE	
nEtt FLSH	Nett warning on or off	on or OFF	OFF	
ACCS	Setpoint access mode	OFF, EASY or NONE	OFF	
SPAC	Setpoint access (only seen if 2 or more relays fitted)	A1, A1-2, A1-3 etc.	A1	
SQrt	Square root	OFF or on	OFF	
tAbL	Lineariser table on or off	OFF or on	OFF	
tAbL StOP	Table limits stop	OFF or on	OFF	
SCLE tblE	Scale table	1, 2, 5, 10, 20, 25, 50, 100, 200, 250, 500 or 1000	1	
tAbL PntS	Number of lineariser points	2 to 50	2	
SEt tAbL	Set table	A & Y points	n/a	
Ax	Alarm mode for relays	LivE, tArE, P.HLd, d.HLd, Hi, Lo or dISP	LivE	
rEC	Retransmission mode for first analog output	LivE, tArE, P.HLd, d.HLd, Hi, Lo or dISP	LivE	
rEC2	Retransmission mode for second analog output	LivE, tArE, P.HLd, d.HLd, Hi, Lo or dISP	LivE	
Lo dISP	Display low overrange	Limit value or OFF		
HIGH dISP	Display high overrange	Limit value or OFF		
dISP	Overrange display warning flashing mode	FLSH or -or-		
bAUd rAtE	Baud rate	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	9600	
PrtY	Parity select	NONE, EVEN or Odd	NONE	
O.Put	Output continuous or controlled	NONE, dISP, Cont, POLL, A.buS or M.buS	Cont	
Addr	Set unit address for poll mode	0 to 31	0	
SErL	Serial communications mode	LivE, tArE, P.HLd, d.HLd, Hi, Lo, dISP or Hi Lo	LivE	

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 these options are fitted.

Settings for setpoint relays - record settings here				
	A1	**A2**	**A3**	**A4**
AxLo				
AxHi				
AxHY				
Axtt				
Axrt				
Axn.o or Axn.c				
Ax.SP or Ax.t1	n/a			
A1OPEr		n/a	n/a	n/a
Ax				

6 Calibration

A calibration scaling must be undertaken prior to entering values into the linearisation table. Two decimal point places will automatically be used when scaling the instrument i.e. scaling values in the range -199.99 to 999.99 can be used. When deciding on scaling to be used it is important to understand that the scaling used will determine the range of values which can be entered as the **P** values in the lineariser table. Typically the scale values used will reflect either the electrical input e.g. 4.00 to 20.00 for a 4-20mA input or a percentage of full range e.g. 0.00 to 100.00. Once the display is scaled the required linearised display values can be calculated or measured, these values will be entered as the **y** values in the table.

Two methods of calibration scaling are provided, only one of these should be used. The 2 point calibration method (**CAL 1** & **CAL2**) may be used on any of the input ranges to scale the display. For 4-20mA inputs only an alternative method is also provided (**USEr En4** and **USEr En20**).

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 En 4** 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:

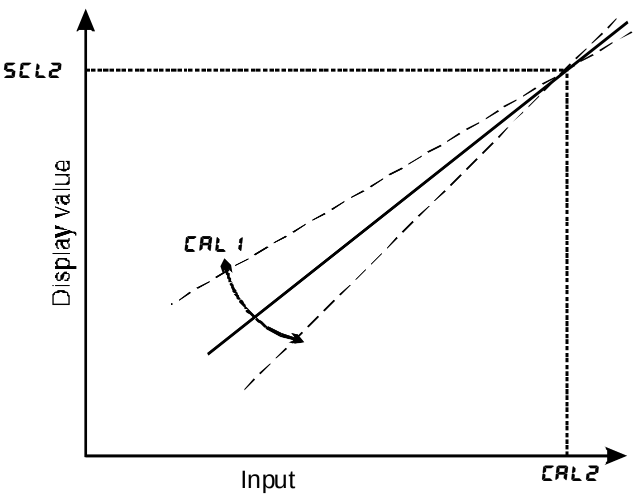
a. Ensure that an input signal is present at the input terminals, this will usually be at the low end of the signal range e.g. 4mA for a 4-20mA input.

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.

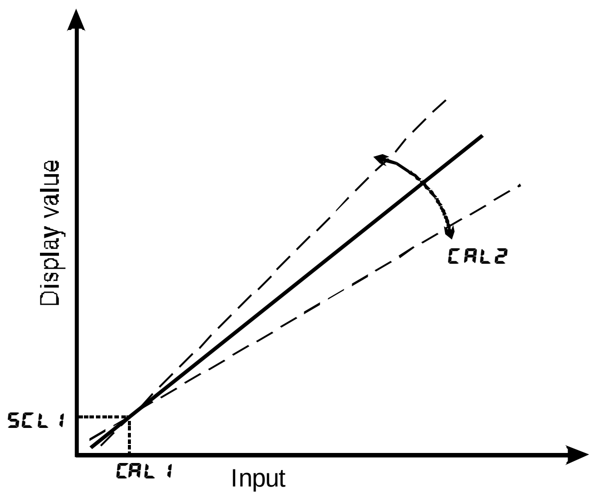
c. Press, then release the **F** button. The display will indicate **SCL 1** followed by a value. Use the ▲ or ▼ button to change this value to the required display value at this input. e.g. if 4mA was input and the required display at 4mA was **4.00** then ensure **4.00** is selected at **SCL 1**. Press the **F** button to accept changes or the **P** button to abort the scaling.

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

The second point scaling using **CAL2** and **SCL2** is performed in exactly the same manner as the **CAL 1** described in steps a. to c. above. It is essential that the live input is different in value to the **CAL 1** input e.g. for a 4-20mA input with 4mA being the live input for **CAL 1** you could 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.



Setting **CAL 1**



Setting **CAL2**

Example - Scaling using two points

Enter via CAL mode

↓

Place a known input into the instrument

↓

Go to the CAL 1 function then press ▲ and ▼ simultaneously

↓

If the "live" display is stable press the F button. The message SCL 1 will be seen

↓

Use the ▲ or ▼ button to enter the required scale value for the input then press F

↓

The message CAL2 will be seen. Change the input value then press ▲ and ▼ simultaneously.

↓

If the "live" display is stable press the F button. The message SCL2 will be seen

↓

Use the ▲ or ▼ button to enter the required scale value for the input then press F

↓

The two scaling points are now stored in the instrument

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 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 (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.

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.

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 functions. The message CAL CLr will be seen to indicate that the memory has cleared.

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.

7 Lineariser operation

The following five functions are used to set up the lineariser table. The lineariser is of the X,Y type with space for up to 50 points to be programmed and stored. All points are stored in battery backed memory and will be retained when power is removed. Chapter 8 contains a table in which you can make a permanent written record of the points entered.

Before the lineariser can be used the instrument must be calibrated using one of the methods described in the "Calibration" chapter.

The X values for each point will actually be indicated as **P** (e.g. **P 1**, **P2** etc.) since the seven segment display cannot show an X. The **P** values are normally entered either as a percentage of full scale input or as a direct representation of the input signal e.g. for a 4-20mA input you could either enter 4mA = **0.00** and 20mA = **100.00** or 4mA = **4.00** and 20mA = **20.00**. The **P** values entered into the table must correspond with the initial calibration values (**CAL 1** & **CAL2** or **USEr En4** & **USEr En20**). For example if a 4-20mA input is initially scaled to read from **0.00** to **100.00** then the P values must also be entered as **0.00** to **100.00**.

The Y values are indicated as **Y** (e.g. **Y 1**, **Y2** etc.). These **Y** values represent the display required for the given **P** value entered. For example if **P3** = **25.00** and **Y3** = **1500** then **1500** will be displayed whenever that input is present.

Y values to be entered into the lineariser table must be either calculated or measured via a live input. Refer to the "Example" later in this chapter for an example of creating a lineariser table using live inputs.

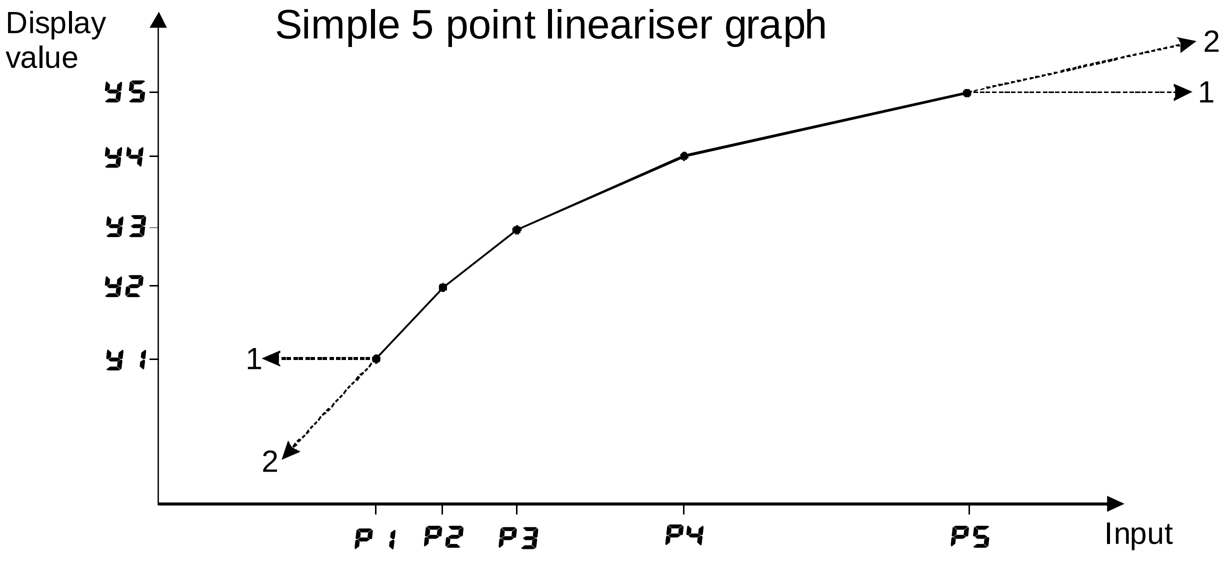
tAbL (lineariser on or off)

Allows the lineariser to be switched on (**on**) or off (**OFF**). If it is switched off then none of the other lineariser functions will be seen on the display and the instrument will either operate as a linear display using the **CAL 1** & **CAL2** or **USEr En4** & **USEr En20** scaling values or as a square root law display if the **SQrt** function is set to **on**.

tAbL StOP (mode of operation at points outside the table range)

This function sets the mode in which the instrument will behave when a value is input which is higher than the largest value entered in the table or lower than the smallest value entered in the table. Refer to the graph below.

If set to **on** then the display value will remain equal to the nearest table entry value. For example if the lowest table entry is made at 8mA and the display indicates **500** at this value then any input lower than 8mA will also cause the display to indicate **500**. If set to **OFF** then the display value will continue to change when an input outside the table limits in encountered. The instrument will extrapolate the reading using the slope of the previous pair of points.



Arrows labelled "1" show the effect of **tAbL StOP** function = **on**
Arrows labelled "2" show the effect of **tAbL StOP** function = **OFF**

SCLE tblE (table rounding value)

This function allows a rounding value to be set for y entries. Options provided are 1, 2, 5, 10, 20, 25, 50, 100, 250, 500 or 1000 . For example if the rounding value is set to 25 then the y entries will jump in steps of 25 i.e. 0, 25, 50, 75 etc. (or 0.00, 0.25 etc. depending on decimal place setting). This rounding factor is useful in that it allows the speeding up of entries into the table, it does not cause the final display value to jump in steps. Use the drnd function if you wish to cause the final display value to also jump in these steps.

tAbL PntS (number of table points)

Displays and sets the number of points in the lineariser table. Select the number you require and enter that number of points. If you wish to increase or decrease the number of points then the tAbL PntS value can be changed at a later stage.

SEt tAbL (enter values into the table)

This function allows values to be entered into the lineariser table. Entries to the table do not need to be in any ascending or descending order since the instrument will automatically arrange the points in order at the end of the entry sequence. The procedure for entering points is:

1. Ensure that the correct number of points required has been set in the tAbL PntS function.
2. Complete the lineariser table given in Chapter 8 by calculation or measurement of values.
3. At the SEt tAbL function press the ▲ and ▼ buttons simultaneously.
4. The display will show P 1 indicating the first linearising point followed by the first P value in memory, use the ▲ or ▼ button to adjust this to the required first input point value.
5. Press the F button, the display will indicate y 1 followed by the first y value in memory, again use the ▲ or ▼ to make any changes to the value required.
6. Press the F button, the display will indicate P2 followed by the second P value in memory. Repeat the process described in steps 4 and 5 until all points have been entered.

Example

A pressure transmitter with a 4-20mA output is installed near the base of an irregularly shaped tank, see picture above, which contains a liquid. The transmitter is connected to a RM4-LN and 10 linearising points are required to measure the number of litres in the tank. The output from the transmitter will be linear between P9 and P10 since the sides of the tank are straight. Most of the lineariser points are concentrated on the non linear (curved) parts of the tank i.e. the parts of the tank in which the output from the transducer will not be linear. The procedure used is as follows, steps a. to n.:

a. All general functions are set as required i.e. display rounding etc.

c. Set the tAbL function to on. The and SQrt function should be set to OFF.

c. Use CAL 1 & CAL 2 or USEr En4 & USEr En20 to scale the RM4 to show 4mA= 4.00, 20mA= 20.00.

d. The tank is emptied and the transmitter is connected to the display, the tank will need to be gradually filled whilst the lineariser table (Chapter 8) record is completed. Note that the reverse process is equally valid i.e. starting with a full tank and gradually emptying it.

e. The first reading is taken from the display (4.20 in this case) with the tank virtually empty this represents a reading of zero litres. The lineariser table is filled in for the first point, P 1 = 4.20, y 1 = 0.

f. The tank is now gradually filled and a flowmeter is used to measure the number of litres entering the tank. The panel meter reading will change as the tank is filled.

g. The second reading is taken from the display (4.72 in this case), at this point 105 litres had been added to the tank. The lineariser table is filled in for the second point, P2 = 4.72, y2 = 105.

h. Repeat the filling procedure until all 10 points are recorded, the results in this example are shown in the example diagram and table.

j. The figures from the written table record now need to be transferred to the instruments lineariser table memory. Set the tAbL function to on and the tAbL PntS function to 10.

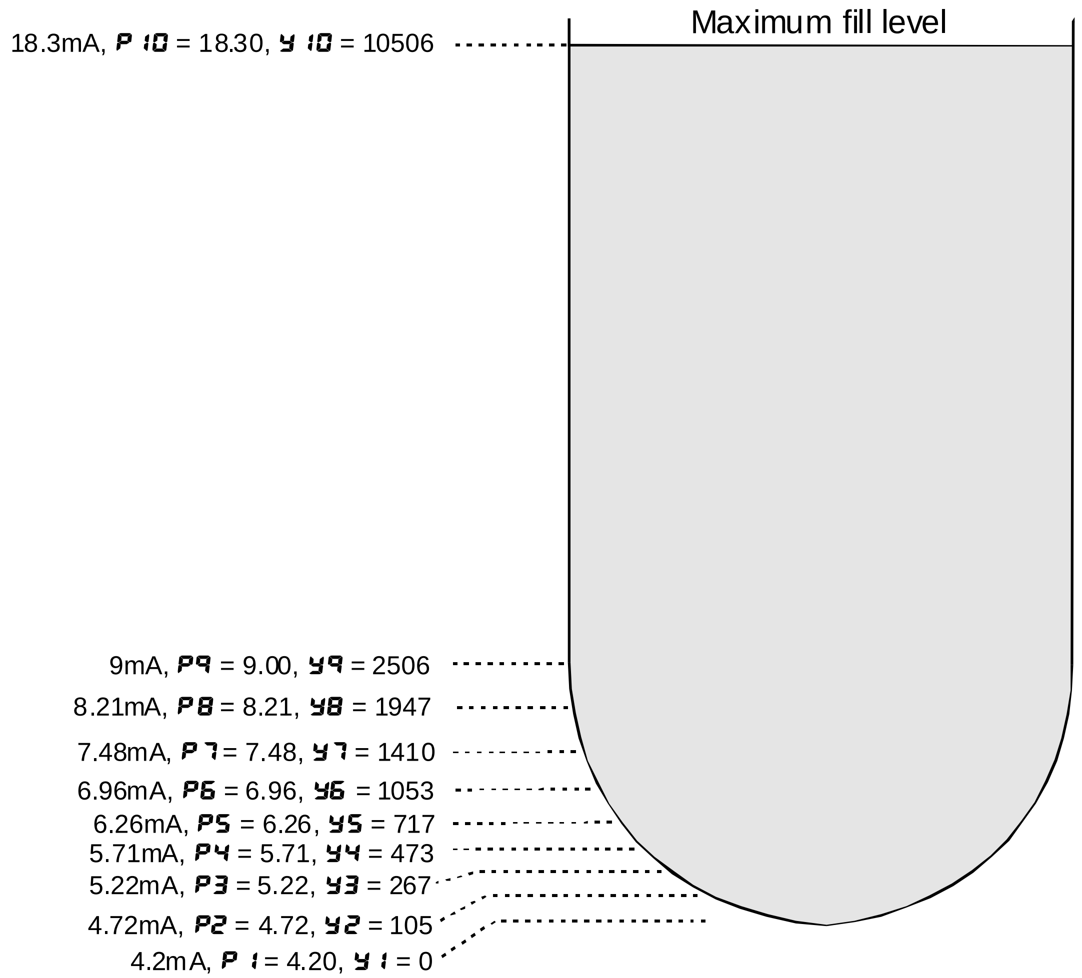
k. At the SEt tAbL function press the ▲ and ▼ button simultaneously. The display will show P 1 followed by a number, use the ▲ or ▼ button to change this number to 4.20.

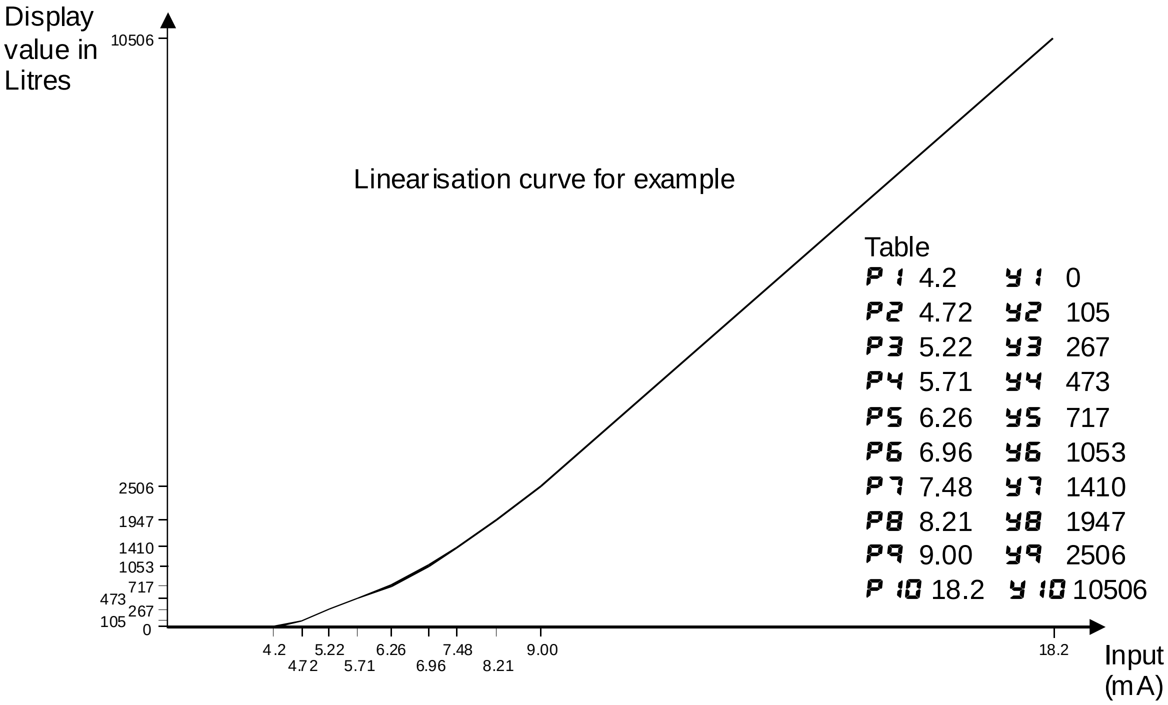
l. Press, then release, the **F** button. The display will indicate y 1 followed by a number. Use the ▲ or ▼ button to change this to 0.

m. Press, then release, the **F** button. The display will indicate P2 followed by a number. Use the ▲ or ▼ button to change this to 4.72.

n. Repeat the process until all the P and y values have been entered.

Continue pressing, then releasing, the **F** button until the FUNC End message is seen and the display returns to measurement mode.





8 Lineariser table

Lineariser Table Complete and retain for reference							
P Value		Y Value (Value to be displayed)		P Value		Y Value (Value to be displayed)	
P1		Y1		P26		Y26	
P2		Y2		P27		Y27	
P3		Y3		P28		Y28	
P4		Y4		P29		Y29	
P5		Y5		P30		Y30	
P6		Y6		P31		Y31	
P7		Y7		P32		Y32	
P8		Y8		P33		Y33	
P9		Y9		P34		Y34	
P10		Y10		P35		Y35	
P11		Y11		P36		Y36	
P12		Y12		P37		Y37	
P13		Y13		P38		Y38	
P14		Y14		P39		Y39	
P15		Y15		P40		Y40	
P16		Y16		P41		Y41	
P17		Y17		P42		Y42	
P18		Y18		P43		Y43	
P19		Y19		P44		Y44	
P20		Y20		P45		Y45	
P21		Y21		P46		Y46	
P22		Y22		P47		Y47	
P23		Y23		P48		Y48	
P24		Y24		P49		Y49	
P25		Y25		P50		Y50	

9 Alarm relays

The RM4 is provided with 2 alarm relays as standard. These two relays can be configured for either alarm on/off operation or as PI control relays. See "Setting up the relay PI control" addendum for details of PI control operation. One or two extra optional independent alarm relays may also be provided, Relays are designated A1 , A2 etc in the function settings. The "x" shown in the exaples below will be seen on the display as a relay number e.g. AxLo will be seen as A1Lo or A2Lo on the display. 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 (normally open) or N/C (normally closed) relay operation
7. Independent or trailing alarms (available on relays 2 and upwards)
8. Alarm to follow a special mode e.g. peak hold

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.

Alarm low setpoint

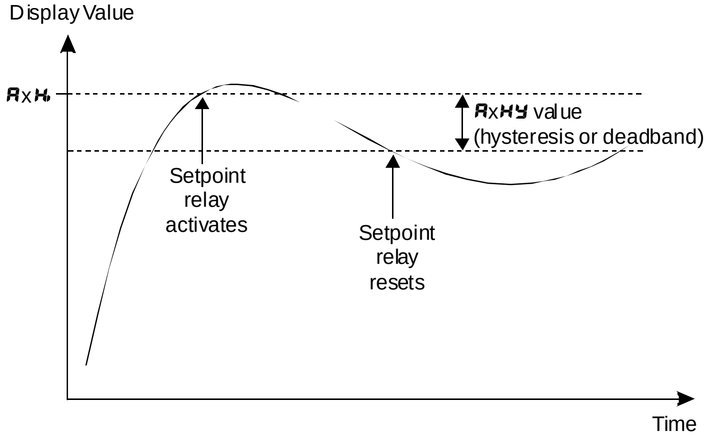
Displays and sets the low setpoint value for the designated alarm relay. The low alarm setpoint may be disabled by pressing the ▲ and ▼ keypads simultaneously. When the alarm is disabled the display will indicate OFF . Use ▲ or ▼ to adjust the setpoint value if required. The alarm will activate when 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.

Alarm high setpoint

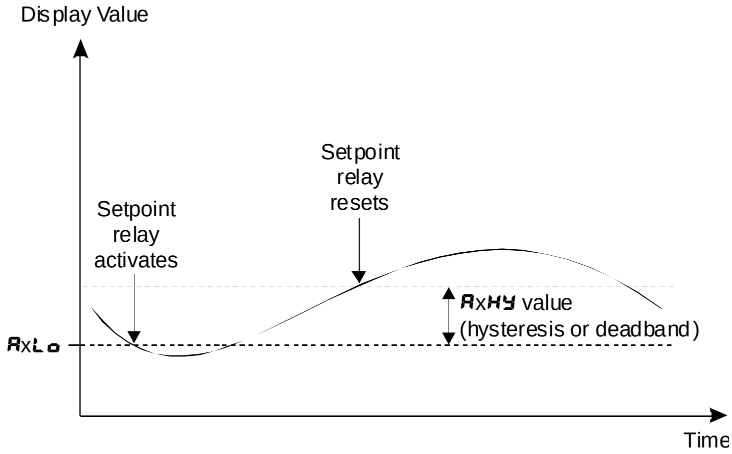
Displays and sets the high setpoint value for the designated alarm relay. The high alarm setpoint may be disabled by pressing the ▲ and ▼ keypads simultaneously. When the alarm is disabled the display will indicate OFF. Use ▲ or ▼ to adjust the setpoint value if required. The alarm will activate when 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.

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 (AxHY 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 A 1Hi is set to 50.0 and A 1HY is set to 3.0 then the setpoint output relay will activate once the display value goes 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 A 1Lo is set to 20.0 and A 1HY 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.

Alarm trip time

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 9999 seconds.

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 9999 seconds.

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.

Trailing or independent set points

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

Access mode

The access mode function ACCS has three possible settings namely OFF, EASY and NONE. 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.

9.1 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.I NP function must be set to SP.AC. If the ACCS function is used the remote input function r.I NP 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.

9.2 Alarm mode

The alarm mode functions (A1 to A4) allow the alarm relays to follow either the live input value (LI VE), the tare function (tArE), the peak hold function (P.HLd), the display hold (d.HLd), the peak memory (HI), valley memory (Lo) or display value (dI SP). Other than LI VE or dI SP operation a remote input or P button must also be set to the function required.

Example 1- A1 is set to LI VE

With the alarm function set to follow the live input value the alarm will activate at the alarm high/low settings. Thus if A 1Lo is set to 50 and A 1HI is set to 100 then alarm 1 will activate if the display reading falls below 50 or goes above 100. For example if the remote input is set to operate the peak hold the alarm will still be free to operate from the rising and falling live input value even if the display is showing a held value.

Example 2 - A 1 is set to tArE and r.I NP (remote input special function) is set to tArE.

Assume that A 1HI is set to 100 and that the instrument is given a remote tare when the display reads 40. Once the instrument is tared the display will read 0. Alarm 1 is set to follow the tare value and will therefore operate when the (nett) display becomes greater than 100.

Note: If the instrument had been tared when A1 was set to dI SP then the alarm will follow the gross value not the tared value and will operate if the nett display is above 60 (i.e. the gross value is above 100). The low alarm setting operates in the same manner e.g. if A 1Lo was set to 100 and the display was tared at a reading of 40 then the low alarm would operate when the display reads 60 or below.

Example 3 - A 1 is set to P.HLd and r.I NP is set to P.HLd

If A 1HI is set to 100 then it will operate whenever the display shows a value over 100. If the peak value exceeds 100 when the remote input is closed then alarm 1 will activate and will not reset until the remote input opens and the display value falls below 100.

Example 4 - A 1 is set to d.HLd and r.I NP is set to d.HLd

If A 1Lo is set to 5 then it will operate whenever the display shows a value below 5. If the display hold remote input is operated at a value above 5 then the alarm will not activate whilst the remote input remains closed, no matter what the electrical input. Likewise if the remote input is operated at a value below 5 then alarm will not de activate until the remote input is opened and the display value goes above 5.

Example 5 - A1 is set to Hi and r.inP is set to Hi

If A1Hi is set to 50 and the peak memory value becomes greater than 50 then alarm 1 will be constantly activated at this point and will only become de activated when the memory is reset at a value below 50. The memory can be reset by holding the remote input closed for 2-3 seconds. Note that in this case the alarm can be activated even if the display value is less than the alarm setting, this is because the alarm is activated by the value in peak memory rather than the display value.

Example 6 - A1 is set to Lo and r.inP is set to Lo

If A1Lo is set to 280 and the valley memory value becomes less than 280 then alarm 1 will be constantly activated at this point and will only become de activated when the memory is reset at a value above 280. The memory can be reset by holding the remote input closed for 2-3 seconds. Note that in this case the alarm can be activated even if the display value is greater than the alarm setting, this is because the alarm is activated by the value in valley memory rather than the display value.

Example 7 - A1 is set to diSP

With the alarm function set to follow the display value the relays will operate from whatever value happens to be on the display at the time. For example if the display is toggled to the peak memory value and this peak value is above the high setpoint limit then the relay will activate even if the live input at the time is below the high setpoint limit.

Optional relays

Two alarm relays are fitted as standard. One or two extra relays are optionally available. See appropriate appendix in this manual 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.

10 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. Each 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 reading, when the contact input is closed i.e. the maximum value from the time of contact closure. When the contact is open the display indicates the live reading. A two position toggle switch or normally closed momentary action switch would be commonly used for peak hold.
dHLd	Display hold - the display hold function is similar to peak hold, except that the held reading is the value displayed at the time the switch contact is closed.
Hi	Peak Memory - the peak 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.
Lo	Valley memory - the 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.
Hi Lo	Peak memory/valley memory - The display may be toggled between peak and valley memory indications.
tArE	Pushbutton tare - when the remote pushbutton is closed for 2 to 3 seconds the current input 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 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.
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. The switch input for this function is usually a key switch between terminals 5 and 9.
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. The switch input for this function is usually a key switch between terminals 5 and 9.
CAL.S	Select calibration - one set of 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 calibration memories. When the external input is open one 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 metres on one set of calibrations and litres on the second set. The CAL.S function also allows different decimal point settings between the two calibrations. The CAL.S function does not allow two separate tables to be entered.

dISP	Display toggle - allows toggling via the remote input between the live input value (preceded by the message InPt) and the lineariser table value (preceded by the message Linr).
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 brgt 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.

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.InP followed by the selected function. Use the ▲ and ▼ buttons to select the required function.

With functions requiring a latching switch (peak hold and display hold) the r.InP value will be used when the switch is ON and the display value when the switch is OFF.

11 Specifications

11 .1 Technical Specifications

Input Types:	Link selectable ±0 to 20mA, ±4 to 20mA or DC Volts ±100mV, ±1V, ±10V, ±100V or Slidewire, 3 wire 0-1kΩ to 0-1MΩ value slidewires
Lineariser points:	Up to 50 points (X,Y)
Impedance:	80Ω (4 to 20mA) & 1MΩ on DC Voltage
ADC Resolution:	1 in 20,000
Accuracy:	0.1% when calibrated
Sample Rate:	4 per second
Conversion Method:	Dual Slope ADC
Microprocessor:	MC68HC11F CMOS
Ambient Temperature:	-40 to 60^{o}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 display type & options)
Output (standard):	2 x relays, form A rated 5A resistive 240VAC configurable for on/off or PI control operation 24V unregulated transmitter supply (common ground) rated at 25mA
Relay Action:	Programmable N.O. or N.C. (relay 1 alternatively configurable for PI control operation)

11 .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. Dual analog version also available, two isolated analog output channels, 12 bit. First analog output can be configured for retransmission or PI control 4 to 20mA output can drive into 1kΩ load maximum
Serial Communications:	RS232, RS485 or RS422 factory configured
Transmitter supply:	Isolated & regulated. Link selectable12VDC (50mA max) or 24VDC (25mA max)

11 .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

Appendix - Setting up the relay PI controller

PI control functions will only be seen if PI control software is fitted.

The Relay Proportional + Integral Controller can be made to operate in either pulse width control or frequency control mode via the Ax OPEr 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.

The “x” in the Ax OPEr and other functions indicates the chosen relay i.e. for relay 1 the display will show A1 OPEr, A1 SP etc. The Ax OPEr function allows three choices of operating mode for the chosen relay, namely Ax.AL, Ax.tP and Ax.Fr. If Ax.AL is selected the chosen relay will operate as a setpoint relay whose operation is controlled by the 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.

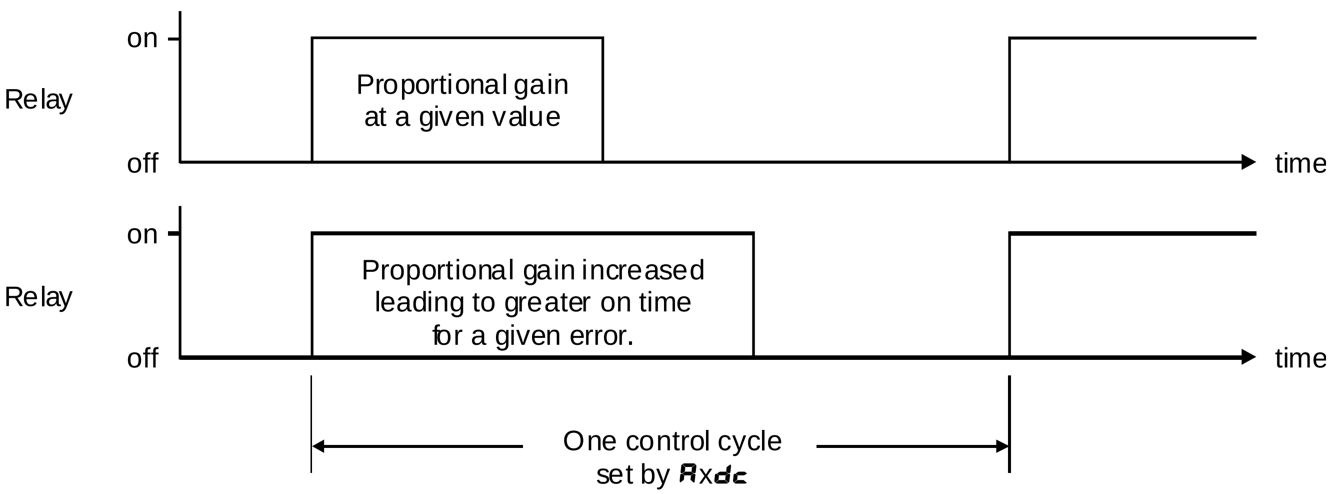
Pulse width control operates by controlling the on to off time ratio of the relay. In a typical application this could be used to control the length of time for which a dosing pump is switched on during a control cycle i.e. the pump or other device will continuously dose for the length of time the relay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

Frequency control operates by controlling the rate (frequency) at which the relay switches on and off.

Pulse width modulation control mode

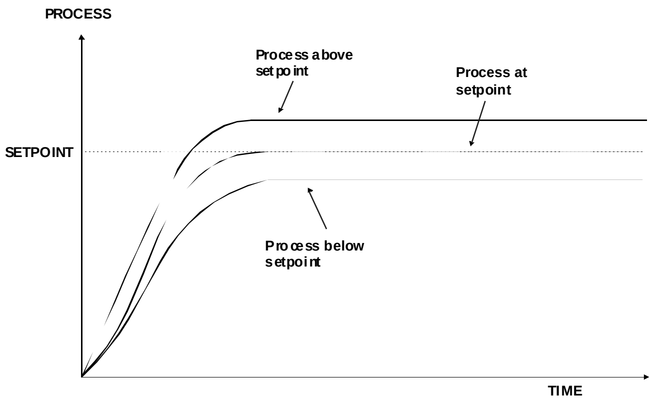
To use pulse width modulation control Ax.tP must be selected at the Ax OPEr function.

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.



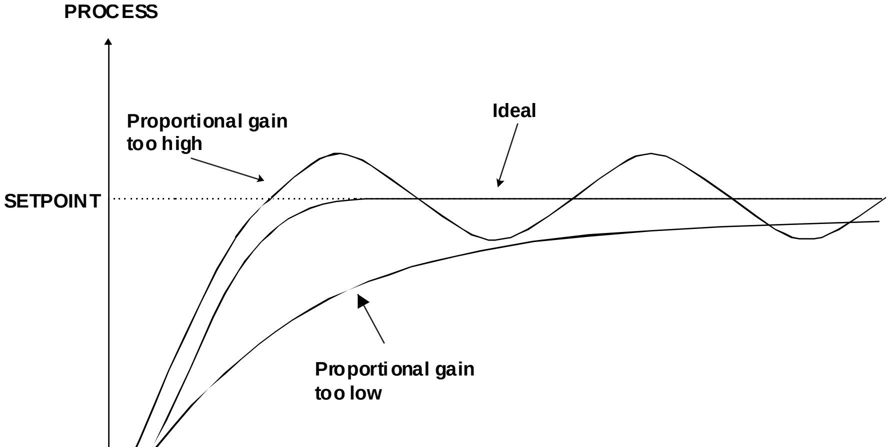
ctrl SPAN (proportional control span)

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 250.0 and the ctrl SPAN is 15.0 then an error of 15.0 measured units from the setpoint will cause a 100% change in proportional control output. For example with AxSP at 250.0, ctrl SPAN at 15.0. AxPG at 1.000 and AxbS at 0.000 a display reading of 235.0 or lower (AXSP - 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.

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 on time during the cycle will be extended (or will be shortened if the error is on the other side of the setpoint) i.e. the relay will be on for a longer time and off for a shorter time. 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 at a 100% error the controller will increase the output by 100% if possible. With a proportional gain of 0.500 at the same error the controller will increase the output pulse width 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)

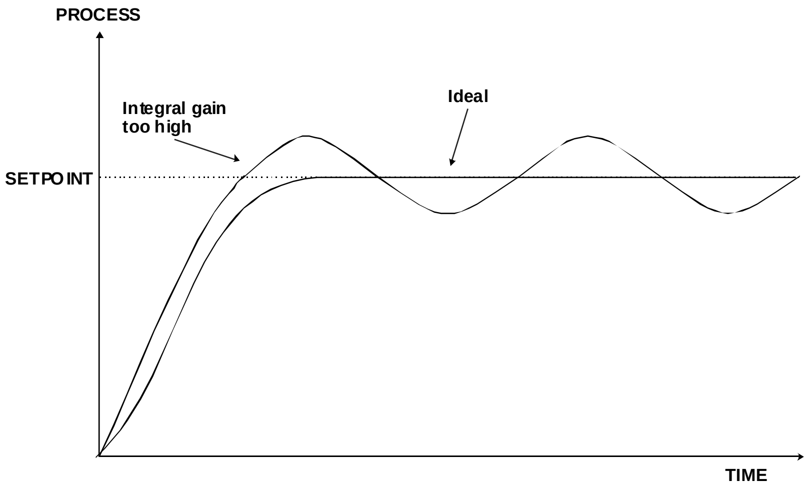
The Integral action will attempt to correct for any offset which the proportional control action is unable to correct e.g. errors caused by changes in the process load. When the integral gain is correctly adjusted the control output is varied to maintain control by keeping the process variable at the 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 relay on time for each cycle will be increased compared to the previous on time. 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 a 100% error will cause the integral action to try to correct at the rate of 100%/minute. With an integral gain of 0.200 the same error 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 32.767 to -19.999. 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:

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

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



Ax**I L** (Minimum limit of integral term)

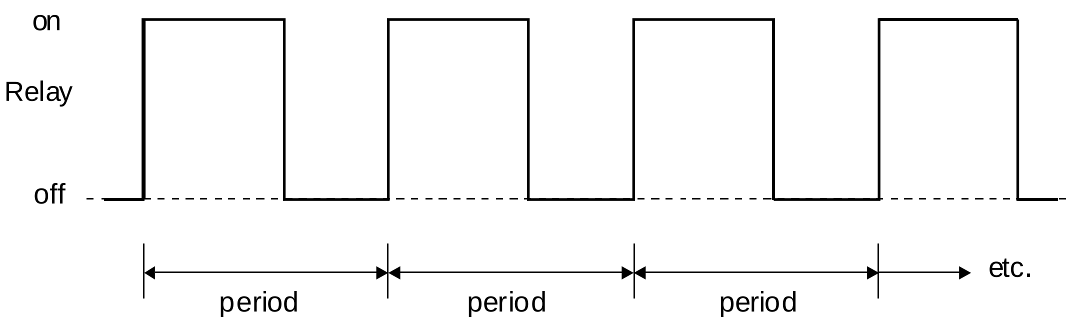
The minimum limit can be used to reduce overshoot of the control setpoint when the control output is being reduced i.e. falling below the setpoint. The low limit reduces the available output swing by a percentage of the maximum output. Without a limit the integral output can be very large at the time the setpoint is reached and a large overshoot 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. in a temperature control application the system may respond very quickly to an increasing reading but the system may take a long time to recover if the setpoint is overshot. Separate high and low limit settings allow independent limiting of the integral control swing below and above the setpoint.

Ax**I 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.

Ax**bS** (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 value is at the setpoint. If set at 50.0 then the relay will be activated for 50% of the time and de-activated for 50% of the time when the measured value is at the setpoint. If set at 100.0 then the relay will be activated for 100% of the time when the measured value 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.

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

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.

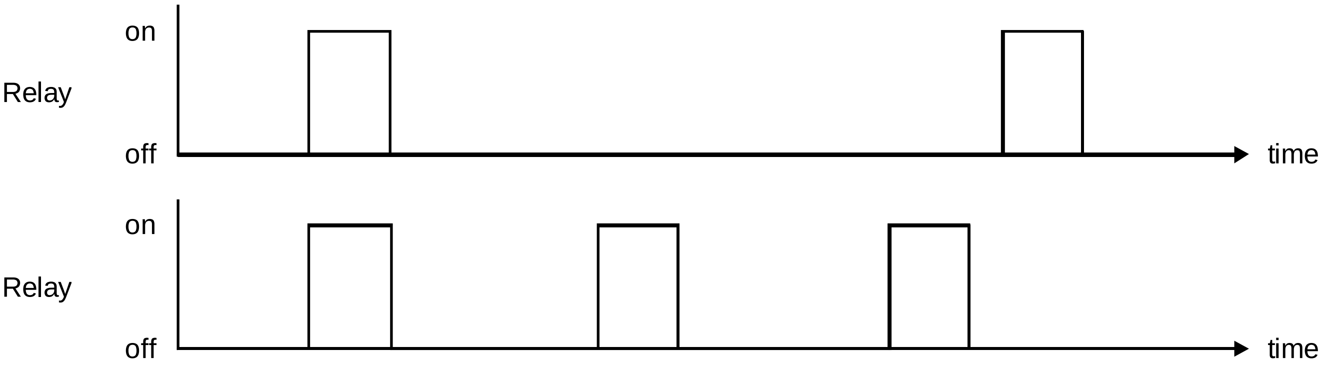
Gradually increase the integral gain until the process begins to oscillate. Then reduce the integral gain slightly to regain the control without this added oscillation.

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.

Frequency modulation control mode

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

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



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 value at the time. For example if extra input 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.

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 250.0 and the ctrl SPAn is 15.0 then an error of 15.0 from the setpoint will cause a 100% change in proportional control output. For example with AxSP at 250.0, ctrl SPAn at 15.0 . AxPG at 1.000 and Axbs at 0.000 a display reading of 235.0 or lower (AXSP - 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 at a 100% error the controller will increase the output by 100% if possible. With a proportional gain of 0.500 for the same error the controller will increase the output pulse width 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 a 100% error will cause the integral action to try to correct at the rate of 100%/minute. With an integral gain of 0.200 a 100% error 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. 32.767 to -19.999. 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:

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

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. in a temperature control application the system may respond very quickly to an increasing reading but the system may take a long time to recover if the 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 value is at the setpoint (depending on proportional and integral gain settings). If set at 50.0 then the relay operation frequency will be lower than the maximum when the measured value is at the setpoint. If set at 100.0 then the relay will be at its maximum frequency when the measured value 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

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

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.

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.