

# C1900

## Circular chart recorder and recorder/controller



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## Electrical safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

## Symbols

One or more of the following symbols may appear on the equipment labelling:



**Warning** – refer to the manual for instructions



**Caution** – risk of electric shock



Protective earth (ground) terminal



Earth (ground) terminal



Direct current supply only



Alternating current supply only



Both direct and alternating current supply



The equipment is protected through double insulation

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Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

## Health and safety

To ensure that our products are safe and without risk to health, the following points must be noted:

- The relevant sections of these instructions must be read carefully before proceeding.
- Warning labels on containers and packages must be observed.
- Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
- Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
- Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
- When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

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# 1 INTRODUCTION

The C1900 Series of documentation is shown in Fig. 1.1.

This supplement provides additional information for the advanced software options, including:

- Ramp/Soak Control
- Totalization
- Maths Functions
- Timer Functions

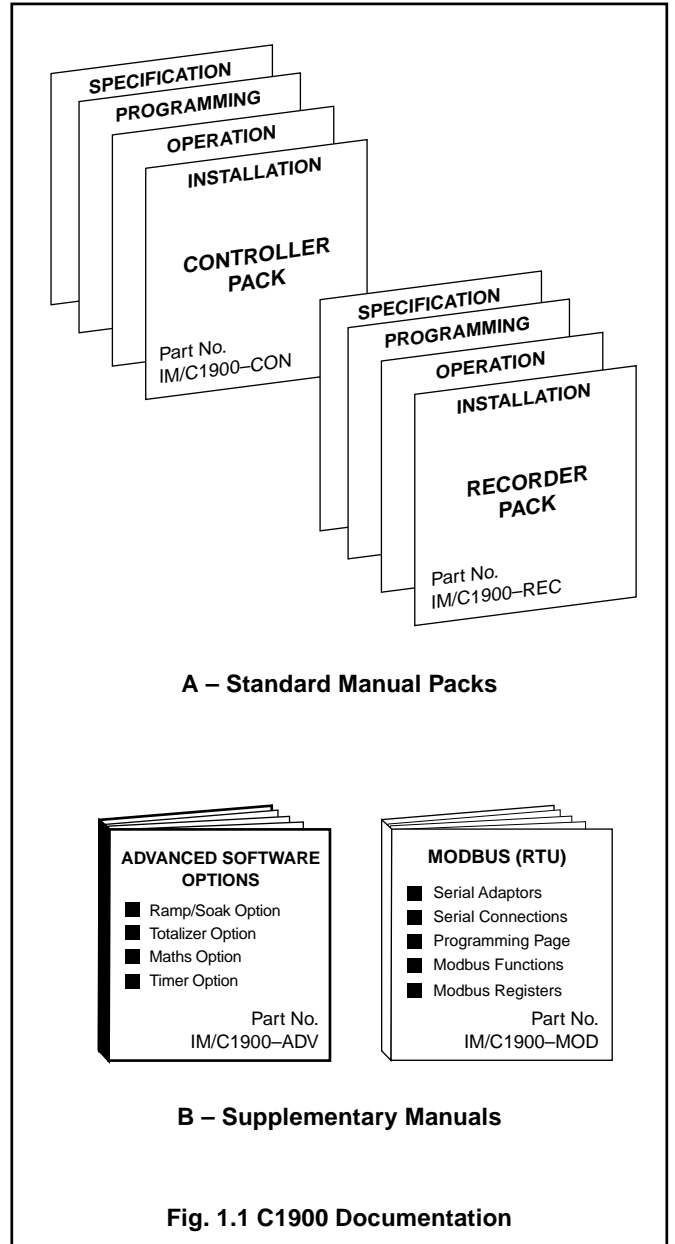


Fig. 1.1 C1900 Documentation

## 2 CONTROL CONFIGURATION LEVEL

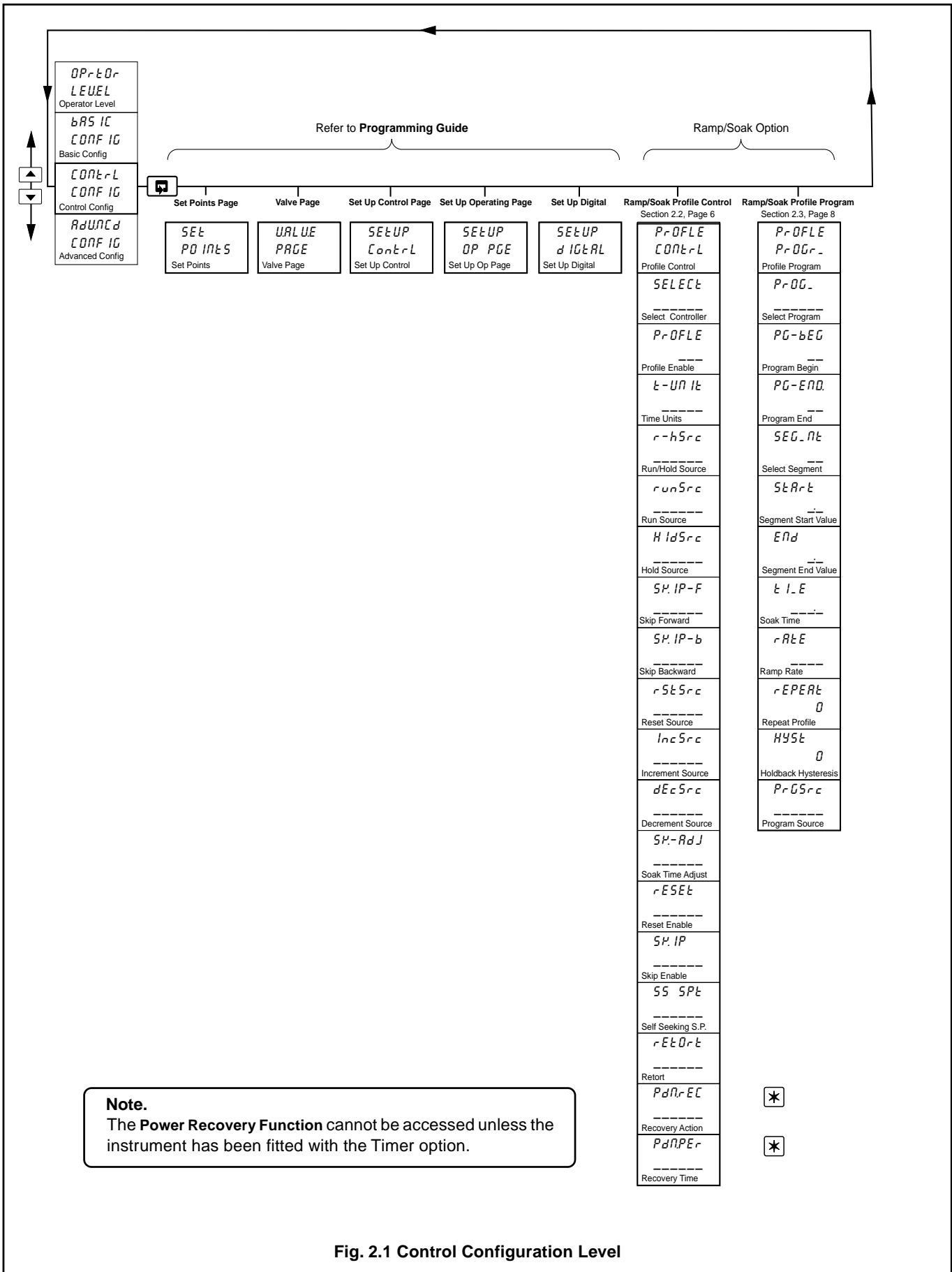


Fig. 2.1 Control Configuration Level

## 2 CONTROL CONFIGURATION LEVEL...

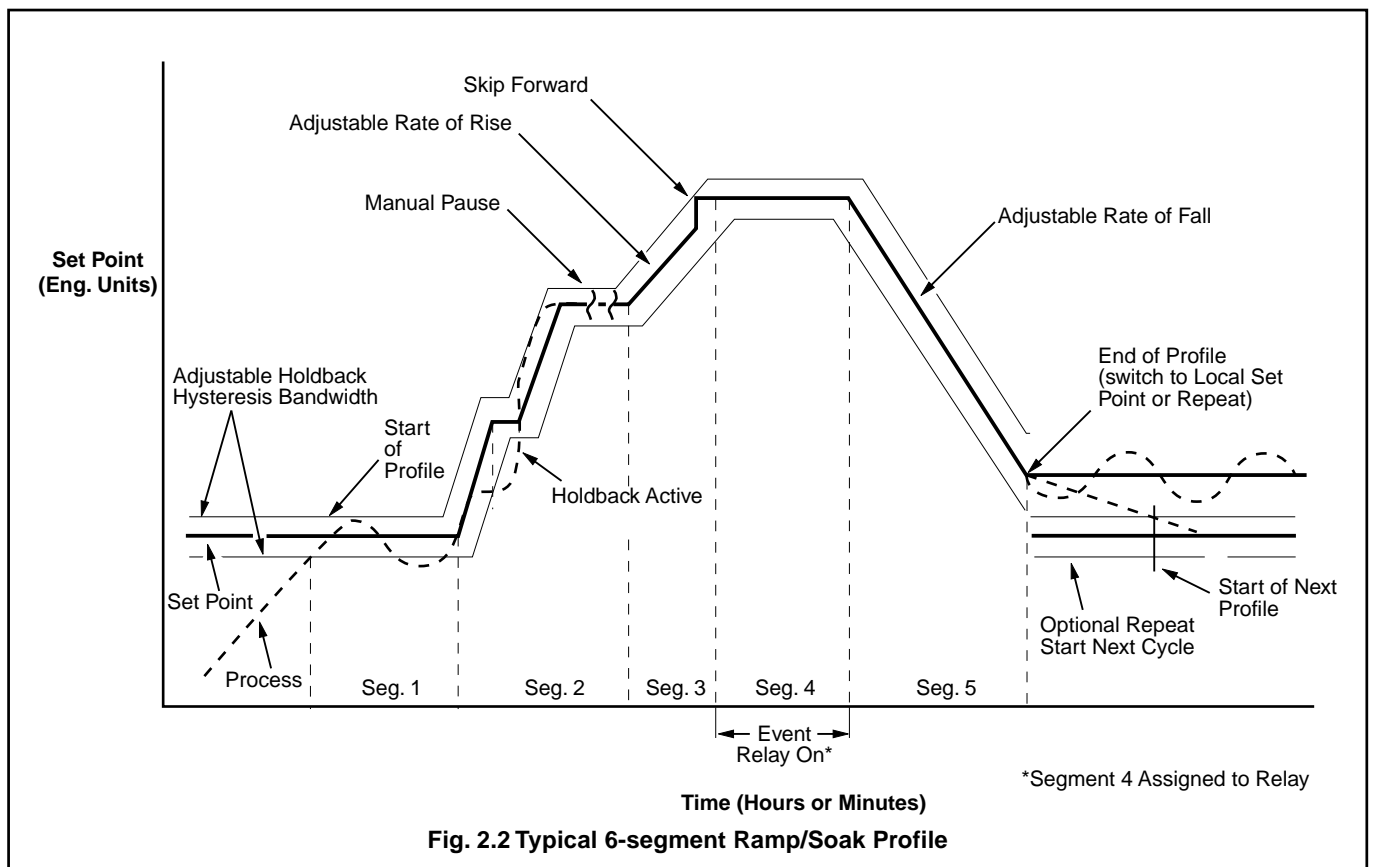
### 2.1 Introduction to Ramp/Soak Profile Control – Fig. 2.2

**Information.**

- **10 programs per control channel.**
- **Digital State program selection** – allows digital inputs to select program to be run.
- **99 programmable segments** – can be shared between programs and controllers – see Fig. 2.3.
- **Programmable time units** – can be programmed in hours or minutes.
- **Program repeat** – 0 to 99 times or continuously.
- **Program holdback hysteresis** – for guaranteed ramps and soaks.
- **5 types of ramp/soak generated events** – segment active event, program active event, end of program event, holdback event and hold active event.
- **6 ramp/soak commands** – can be selected from the front panel or via digital signals to run/hold programs, reset programs, skip forward to next segment, skip backwards to beginning of segment, increase soak time or decrease soak time (refer to Fig. 2.4 for ramp/soak adjust example).
- **Self-seeking set point function** – avoids unnecessary delays when a program is started – see Fig. 2.5.
- **Retort function** – ensures safe operation under fault conditions – see Fig. 2.6.
- **Power recovery function** – determines ramp/soak profile restart position on instruments fitted with the Timer option.

The Ramp/Soak option is a set point profile generator which controls the Local set point and can be used with any type of control process for more complex control. A Profile Program is made up of Ramps (the set point is increased or decreased at a linear rate until it reaches the desired value) and Soaks (the set point is maintained at a fixed value for a set time duration).

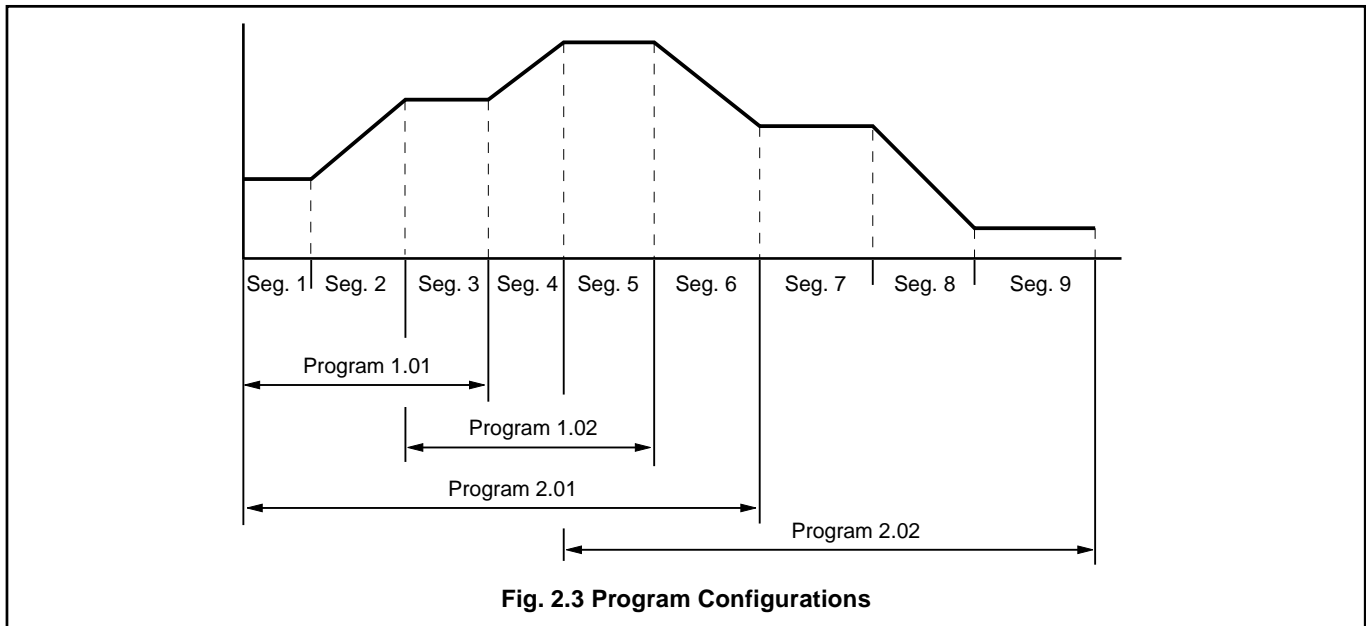
Fig. 2.2 shows a typical Ramp/Soak Profile and some of its features.



## ...2 CONTROL CONFIGURATION LEVEL

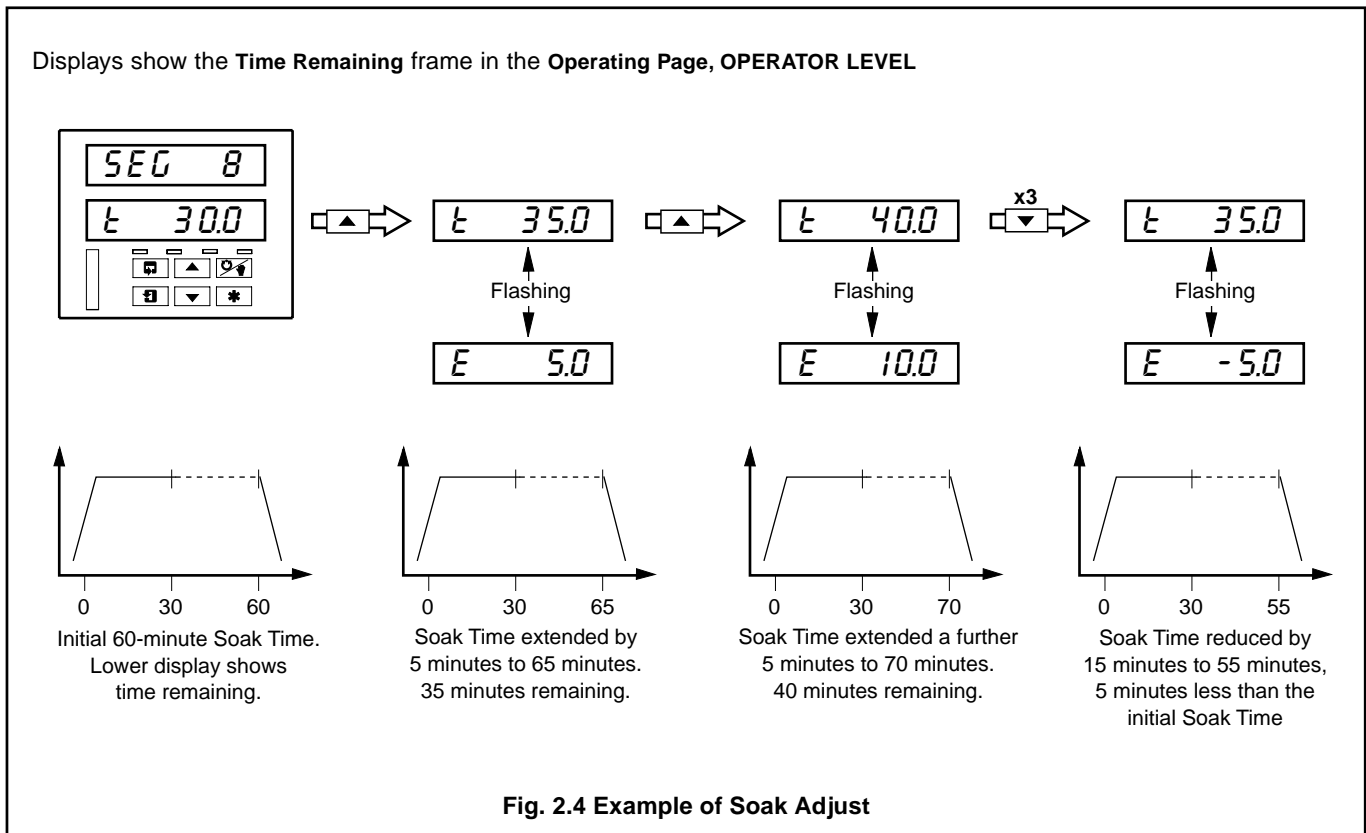
### 2.1.1 Program Configurations – Fig. 2.3

There are 99 segments that can be shared between programs and control channels. For normal applications it is recommended that segments 1 to 50 are assigned to channel 1 and segments 51 to 99 are assigned to channel 2. Fig. 2.3 shows 9 segments, shared between four separate programs on channel 1 and channel 2.



### 2.1.2 Soak Adjust – Fig. 2.4

The Soak Adjust function allows the Soak time of a segment to be extended or reduced by a value preset in the **Soak Adjust** frame in the **Ramp/Soak Profile Control Page**. The soak time can be adjusted repeatedly while the segment is running, either from the front panel of the instrument or by a digital signal.



## 2 CONTROL CONFIGURATION LEVEL...

### 2.1.3 Self-seeking Set Point – Fig. 2.5

The Self-seeking Set Point function reduces the delay between the end of a program and the beginning of the next program. The process variable value is used as the program start point and the set point steps up to the process variable value. This has the effect of changing the overall segment time and maintains a constant ramp rate.

### 2.1.4 Retort Function – Fig. 2.6

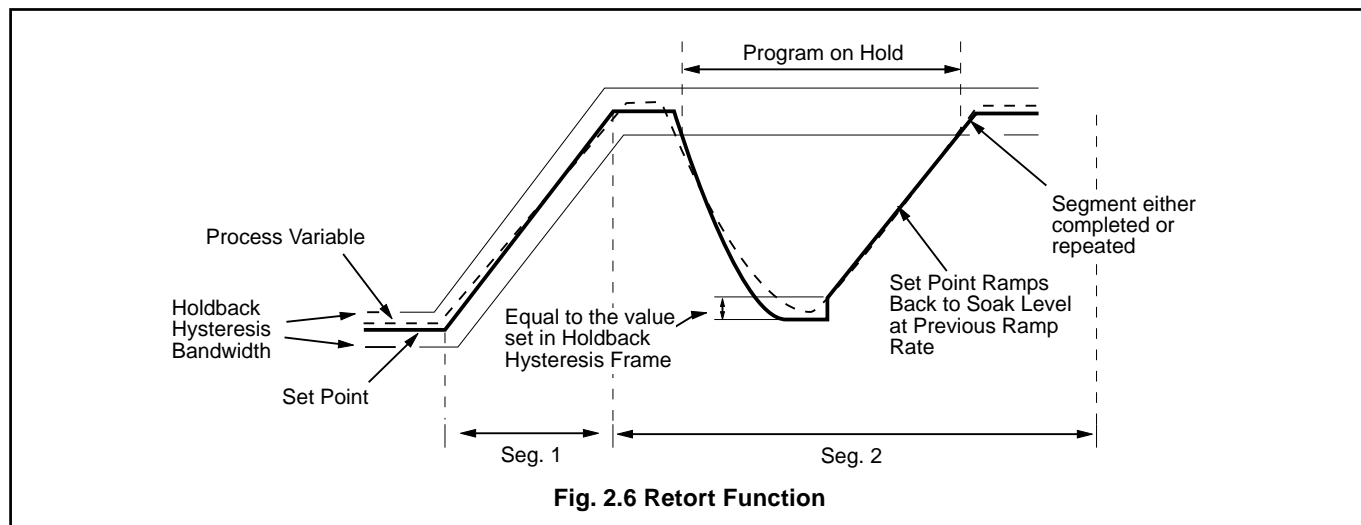
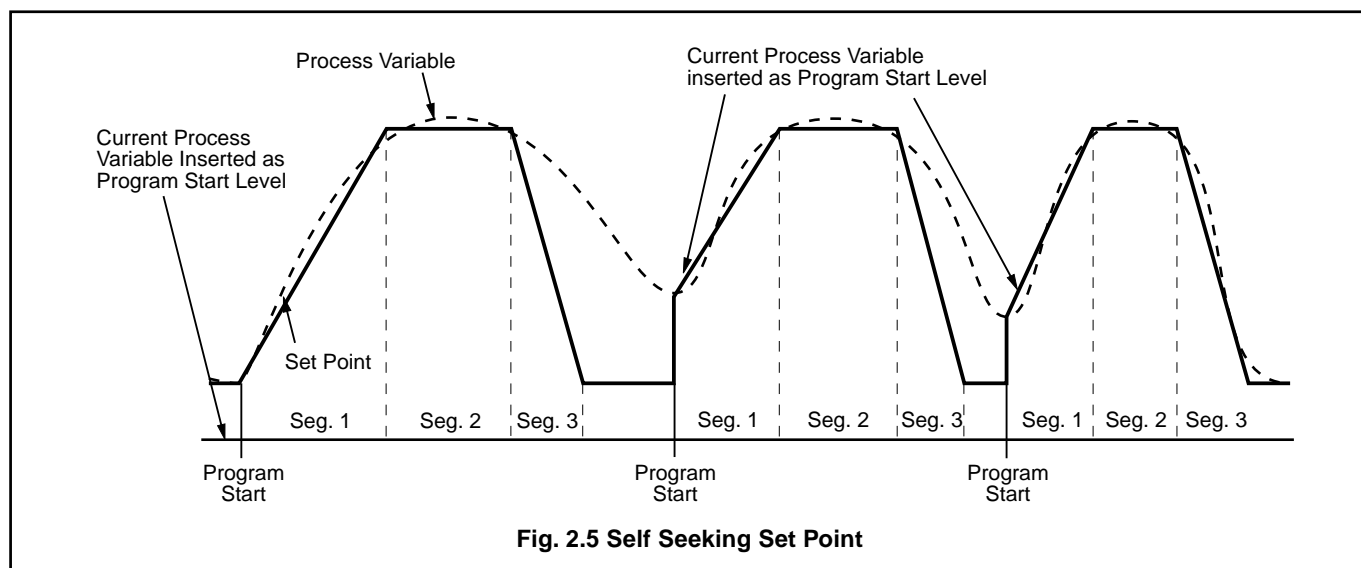
The Retort function ensures safe operation of retorts under fault conditions. When the process variable falls below the holdback hysteresis value the program is put on 'hold' (as for normal operation). The set point then tracks the process variable until the process variable starts to increase. The set point then ramps back up to the soak level at the rate of the previous ramp. When the soak level is reached the program is released from its 'hold' state and depending on the retort mode selected either completes the segment or repeats the entire segment.

The retort mode is selected in the **Ramp/Soak Profile Page, CONTROL CONFIGURATION LEVEL**.

### 2.1.5 Power Recovery Function

**Note.** The **Power Down Recovery Function** is only available on instruments fitted with the Timer option.

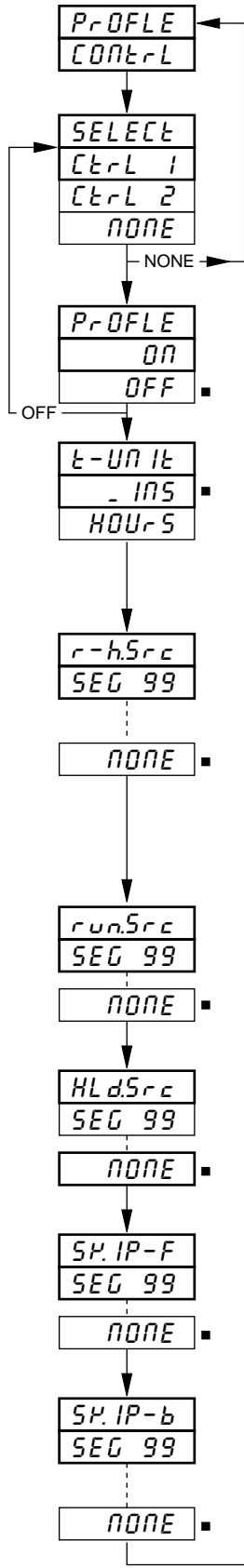
The Power Recovery function allows pre-selection of the restart position within a ramp/soak profile when power is restored after a failure. If power is restored before the **Power Down Time** expires, the ramp/soak profile continues from the point at which power failed. If power is restored after the **Power Down Time** has expired, the profile resumes from one of the following user-selected points: start of the current program; start of the current segment or from the profile position at the time of failure. In all three cases the controller restarts in **HOLD** mode. When power is re-applied to instruments not fitted with the Timer option, the profile is turned off and control resumes at the local set point.



## ...2 CONTROL CONFIGURATION LEVEL

### 2.2 Ramp/Soak Profile Control

In this Section, parameters in the lower display denoted ■ are Company Standard Settings. The instrument is dispatched programmed with these settings.



Page Header – Profile Control.

To advance to the Profile Program page press the switch.

#### Select Controller

Select the Controller to be programmed:

CTRL 1	-	Controller 1
CTRL 2	-	Controller 2 (if fitted)
NONE	-	No controller selected

#### Ramp/Soak Profile Enable

If ON is selected, Profile Control is enabled and the Profile States Page is displayed in the OPERATOR LEVEL. If OFF is selected Profile Control is disabled and the Profile States Page is omitted from the OPERATOR LEVEL.

#### Program Time Units

Select the time units required:

-INS	-	Minutes
HOURS	-	Hours

The time base selected applies to all segments.

#### Program Run/Hold Source

Select the source required to activate program run/hold. The run/hold source is level triggered i.e. the active logic state must be maintained to select the alternative function.

If a program is activated or placed into operator hold mode using Program Run/Hold Source, the Program Run Source and Program Hold Source have no effect.

For description of sources for this and subsequent source frames, refer to table 2.1 on page 10.

#### Program Run Source

Select the source required to run or restart a program. The run source is leading edge triggered i.e. the active logic state can be removed after the function is selected.

#### Program Hold Source

Select the source required to place the program running into operator hold mode. The hold source is leading edge triggered.

The program is restarted using the Program Run Source.

#### Segment Skip Forward Source

Select the source required to skip to the next segment. If the segment running is the last segment of the program, the set point advances to the last set point value of the segment and stops the program. The skip source is leading edge triggered.

#### Segment Skip Backward Source

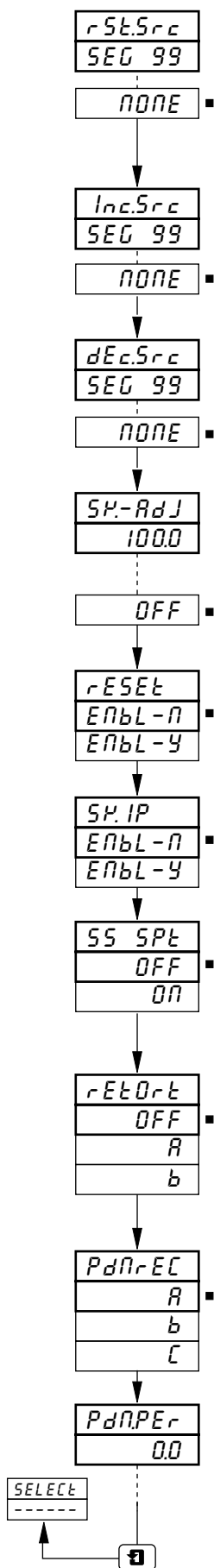
Select the source required to skip back to the beginning of the ramp/soak segment running. The skip source is leading edge triggered.

Continued on next page.



## 2 CONTROL CONFIGURATION LEVEL...

### ...2.2 Ramp/Soak Profile Control



#### Program Reset Source

Select the source required to reset a running program. The reset source is leading edge triggered.

If the program is running normally and is reset, the program returns to the beginning of the first segment and continues to run. If the program is on hold and is reset, the program returns to the beginning of the first segment and stops. No action is taken if a program has already finished.

#### Soak Time Increment Source

Select the source required to increase the soak time. The increment source is leading edge triggered.

#### Soak Time Decrement Source

Select the source required to decrease the soak time. The decrement source is leading edge triggered.

#### Soak Time Adjust

Set the value required to increase or decrease the soak time, between 0.1 and 100.0. The units of time are set in the **Time Units** frame. If *OFF* is selected this function is disabled.

The value set is added or subtracted from the soak time of a running segment via a digital signal or from the front panel controls, when in the **Current Profile Segment** frame of the **Operating Page**.

#### Reset Enable

Select *ENbL-y* to enable or *ENbL-n* to disable the **Profile Reset** frame in the **Profile States Page**, **OPERATOR LEVEL**.

#### Skip Enable

Select *ENbL-y* to enable or *ENbL-n* to disable the **Skip Segment** frames in the **Profile States Page**, **OPERATOR LEVEL**.

#### Self Seeking Set Point

If *00* is selected the controller inserts the current process value as the starting point on initiation of the profile. This value is stored in the profile program and can be overwritten manually or when the program is next initiated. The ramp rate is unaffected. If *OFF* is selected the self seeking set point is disabled.

#### Retort

Select *R* to complete soak segment or *b* to repeat soak segment. If *OFF* is selected the retort mode is disabled.

#### Power-down Recovery Option

Select the profile restart position when power is restored after a failure and the **Power Down Time Period** (see below) has expired: *R* – Start of the current program, controller set to *HoLd* mode; *b* – start of the current segment, controller set to *HoLd* mode; *C* – profile position unchanged, controller set to *HoLd* mode.

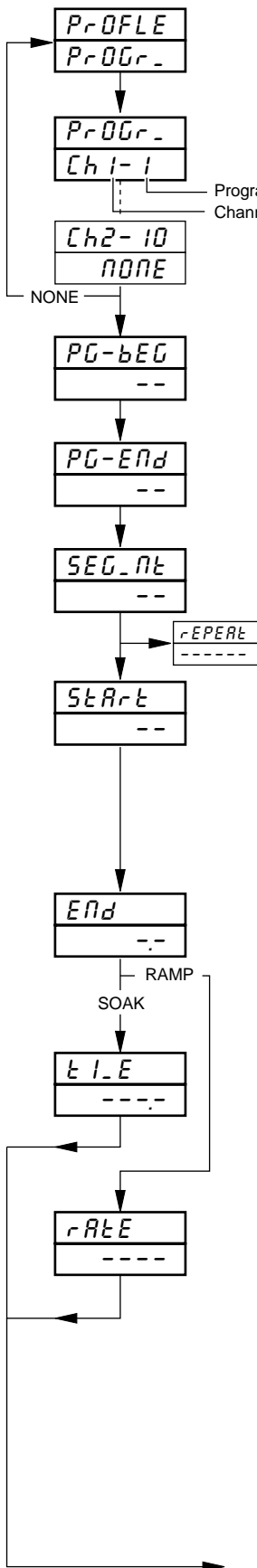
#### Power-down Time Period

Set the time period (0.0 to 99.9 minutes) during which, if power is restored, the profile continues from the point at which power failed. If the **Power-down Time** is exceeded the **Power-down Recovery Option**, selected above, is invoked.

Return to **Select Controller** frame.

## ...2 CONTROL CONFIGURATION LEVEL

### 2.3 Ramp/Soak Profile Program



Page Header – **Profile Program.**

To advance to the **CONTROL CONFIGURATION LEVEL** frame press the switch.

#### Select Program

Select the program to be configured:

Program No.	Ch 1- 1 to Ch 1- 10	–	Channel 1 programs 1 to 10
Channel No.	Ch 2- 1 to Ch 2- 10	–	Channel 2 programs 1 to 10 (if available)
	NONE	–	no program selected

#### Program Begin

Select the program start segment, between 1 and 99.

#### Program End

Select the program end segment between, 1 and 99.

#### Select Segment

Select the segment to be programmed (1 to 99).

When all segments have been programmed, select 0 to advance to **Repeat Program** frame.

#### Segment Start Value

Set the segment start value. The segment start value can only be set if it is the first segment of a program.

A **Ramp** has different start and end set point values. A **Soak** has the same start and end set point values. Adjacent segments of different **Ramp** or **Soak** programs **MUST** have the same start and end values, unless an intermediate 'spacer' segment is used.

#### Segment End Value

Set the segment end value.

If segment start/end values are the same (Soak), advance to the **Soak Time** frame. If segment start/end values are different (Ramp), advance to **Ramp Rate** frame.

#### Soak Time

Set soak time duration required, between 0 and 999.9.

The time units (hours or minutes) are configured in **Ramp/Soak Time Units** frame, **Profile Control Page**.

#### Ramp Rate

Set the ramp rate.

The ramp rate is entered as the number of engineering units that change during the time period (hours or minutes) configured in the **Ramp/Soak Time Units** frame, **Profile Control Page**.

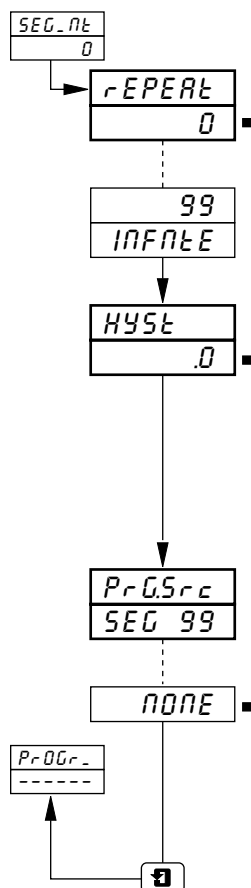
**Example** – if a ramp of 10°F at 2° every minute is required, the ramp rate value entered is 2.0 (in the minutes time base).

Ramp rates set excessively low over a wide range cannot be displayed properly at the **Current Profile Segment (Time Remaining)** frame. This display shows a maximum of 999.9 units of time. The display is decremental when the time remaining is less than 999.9.

Continued on next page.

## 2 CONTROL CONFIGURATION LEVEL...

### ...2.3 Ramp/Soak Profile Program




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#### Repeat Program Profile

Set the number of times the program is to be repeated, between 0 and 99 or infinity.

If infinity is selected the program is repeated until stopped by the operator.

---

#### Holdback Hysteresis

Set the value of the hysteresis band (in engineering units) for guaranteed Ramps and Soaks, between 0.1 and 999.9. The value set applies above and below the Process Variable.

Setting '0' turns off the holdback hysteresis function.

A guaranteed ramp or soak is a segment whose time is counted only if the process variable is within the hysteresis deadband.

---

#### Program Source

Select the source required to select the program.

The program source is leading edge triggered i.e. the active logic state can be removed after the function is selected.

For description of sources, refer to table 2.1 on page 10.

---

Return to **Select Program** frame.

...2 CONTROL CONFIGURATION LEVEL

...2.3 Ramp/Soak Profile Program

Source	Description
<i>RCFR IL</i>	Power Failure
<i>SEG-99</i> ⋮ <i>SEG-0</i> <i>PG-2.10</i> ⋮ <i>PG-1.01</i> <i>END-x</i> <i>HbH-x</i> <i>rUN-x</i> <i>HOLD-x</i>	Profile segment 99 ⋮ Profile segment 0 Profile program 10, Controller 2 ⋮ Profile program 1, Controller 1 Program end (duration 1 second) Program in hold due to holdback hysteresis Profile 1 or 2 running Profile 1 or 2 in hold mode
<i>OPEN-x</i> <i>CLOSE-x</i>	Motorized valve 1 or 2 open Motorized valve 1 or 2 closed
<i>ONOFF-x</i> <i>OP-x</i> <i>OP-xc</i> <i>OP-xh</i>	Control output 1 or 2 on/off Control output 1 or 2 (time proportioning) Control output cool 1 or 2 (time proportioning) Control output heat 1 or 2 (time proportioning)
<i>2nd-x</i> <i>LOC-x</i>	Second set point Local set point
<i>_RN-x</i> <i>AUTO-x</i>	Manual control Automatic control
<i>t1.Er.2</i> <i>t1.Er.1</i>	Real time event 2 Real time event 1
<i>EQN - 8</i> ⋮ <i>EQN - 1</i>	Logic equation 8 ⋮ Logic equation 1
<i>rAP - 4</i> <i>*COUNT. 4</i> ⋮ <i>rAP - 1</i> <i>*COUNT. 1</i>	Wrap-around on total 4 Total 4 external counter drive ⋮ Wrap-around on total 1 Total 1 external counter drive
<i>DIG - 6.8</i> ⋮ <i>DIG - 1.1</i>	Digital Input 6.8 ⋮ Digital input 1.1
<i>AL - d4</i> <i>AL - c4</i> <i>AL - b4</i> <i>AL - A4</i>	Alarm D Alarm C Alarm B Alarm A
<i>AL - d3</i> <i>AL - c3</i> <i>AL - b3</i> <i>AL - A3</i>	Alarm D Alarm C Alarm B Alarm A
<i>AL - d2</i> <i>AL - c2</i> <i>AL - b2</i> <i>AL - A2</i>	Alarm D Alarm C Alarm B Alarm A
<i>AL - d1</i> <i>AL - c1</i> <i>AL - b1</i> <i>AL - A1</i>	Alarm D Alarm C Alarm B Alarm A
<i>NONE</i>	No source required

\*Only available on relays and digital outputs on module types 3 and 5.

Table 2.1 Description of Sources

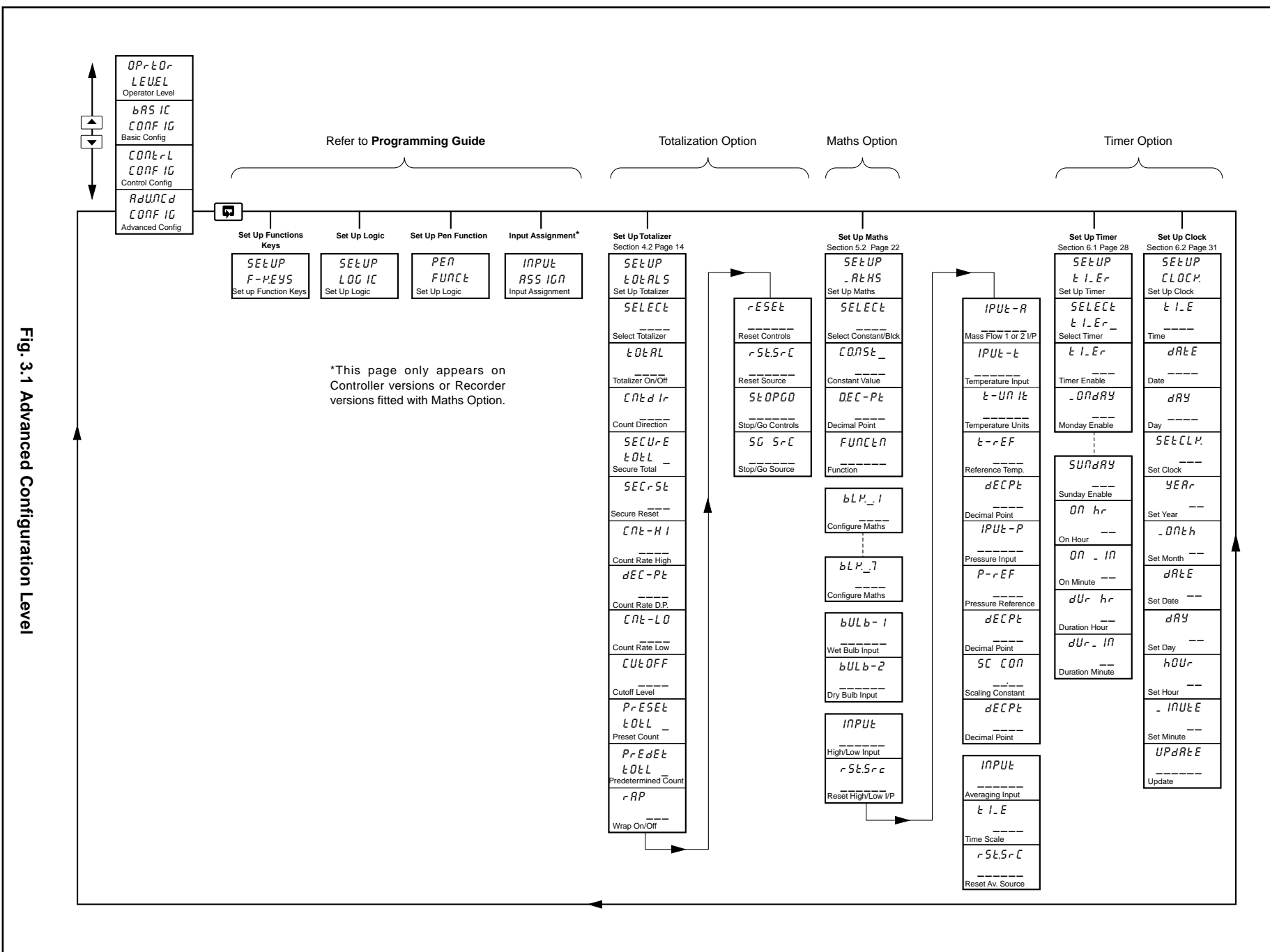


Fig. 3.1 Advanced Configuration Level

## 4 ADVANCED CONFIGURATION LEVEL

### 4.1 Introduction to Totalization

**Information.**

- **One 8-digit totalizer per channel.**
- **Count up or count down.**
- **Count rates** – from 0.001 to 100.0 counts/second.
- **External counter pulse** – can be used to energize relays or digital outputs (a maximum of 4 pulses per second are generated).
- **Wrap function** – with external wrap pulse used to energize relays or digital outputs.
- **Programmable preset and predetermined count values** – for (batch) flow total.
- **Adjustable cut-off values.**
- **Operator level reset and stop/go.**
- **Digital signal reset and stop/go.**

The totalizer option provides indication and recording of flow rates from input signals with linear, square law or power law characteristics. Totalization is available for each channel and may be switched on or off as required.

The flow total for any channel can be viewed on the digital display and reset using faceplate 1. An additional internal 'Secure' total is also provided which can only be reset after gaining access to the **ADVANCED CONFIGURATION LEVEL**.

External counters with their own power supplies can be driven using 4 relay and digital output module options.

#### 4.1.1 Converting the Engineering Flow Rate – Example A and B

To calculate the count rate high the engineering flow rate high must first be converted into units per second. The engineering range (display range) value is limited to **9999**. In some circumstances the engineering flow rate high value may be greater than **9999** and the engineering range must therefore be scaled. In the calculation of units/second the actual engineering flow rate high value must be used.

$$\text{Units/Second} = \frac{\text{Actual Engineering Flow Rate High}}{\text{Engineering Range Units (in seconds)}}$$

#### 4.1.2 Calculating the Count Rate High – Example A and B

The count rate high is calculated from the units per second and the counter factor. The counter factor is the value of the least significant digit shown on the totalizer display (viewed in **Totals Page, OPERATOR LEVEL**). The count rate high must be within the limits of 100.0 to 0.001 pulses per second. If the pulse rate value falls outside these limits, the counter factor (the least significant digit) must be increased – see Example B.

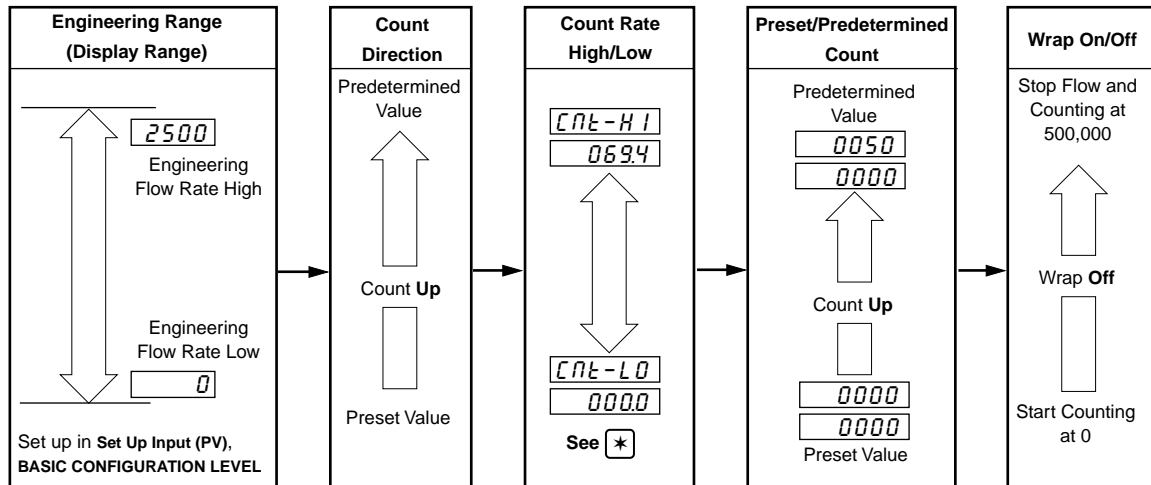
$$\text{Count Rate High} = \frac{\text{units/second}}{\text{counter factor}} \left. \vphantom{\frac{\text{units/second}}{\text{counter factor}}} \right\} \text{ Must be within the limits of 100.0 to 0.001 pulse per second}$$

## 4 ADVANCED CONFIGURATION LEVEL...

### ...4.1 Introduction to Totalization

#### Example A – setting up:

- engineering range of 0 to 2500 representing a range of 0 to 250,000 gallons per hour
- filling a storage tank with a capacity of 500,000 gallons
- least significant digit of 1 gallon shown on totalizer display (viewed in **Totals Page, OPERATOR LEVEL**)
- wrap function off, 1 second wrap pulse generated at predetermined value and combined in a logic equation to stop flow.

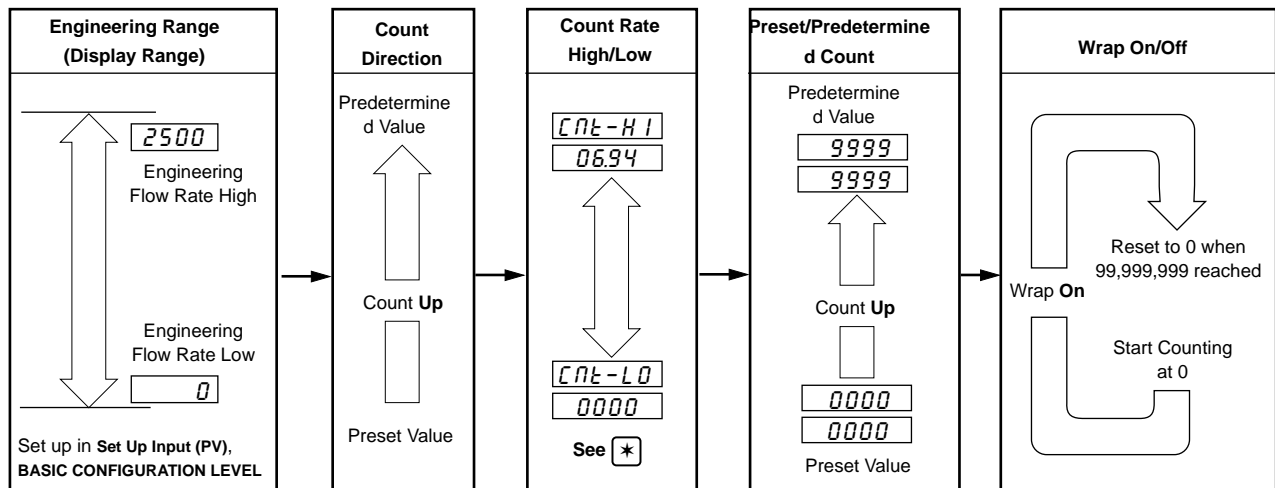


$$\text{Units/Second} = \frac{250,000}{3,600 \text{ (in seconds)}} = 69.4 \text{ gallons/second}$$

$$\text{Count Rate (High)} = \frac{69.4}{1} = 69.4 \text{ pulses/second}$$

#### Example B – setting up:

- engineering range of 0 to 2500 representing a range of 0 to 2,500,000 gallons per hour
- measuring effluent discharge
- last significant digit of 100 gallons shown on totalizer display (viewed in **Totals Page, OPERATOR LEVEL**)
- wrap function on, front panel total automatically reset to 0 and continues counting when predetermined value is reached.



$$\text{Units/Second} = \frac{2,500,000}{3,600} = 694.4 \text{ gallons/second}$$

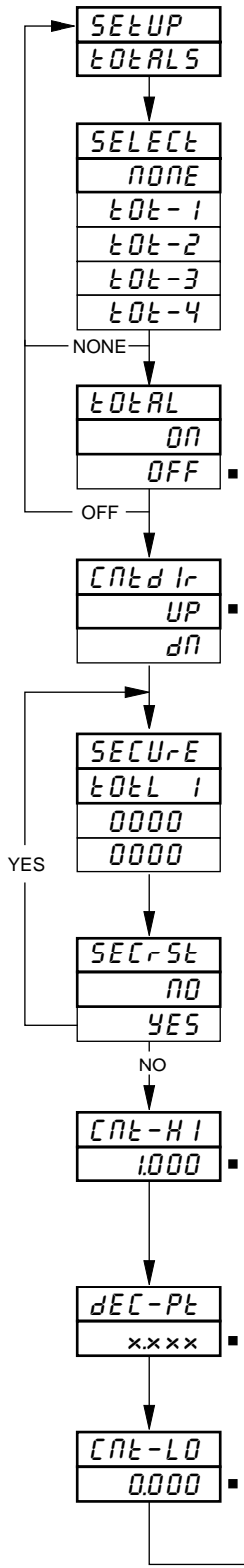
$$\text{Count Rate (High)} = \frac{694.4}{100} = 6.94 \text{ pulses/second}$$

**Note.** For the majority of applications the **Count Rate Low** is set to 0000. Only if the engineering Flow Rate Low is not to zero, is it necessary to calculate the Count Rate Low setting, e.g. when the resultant flow range of several flows added together always ensures a minimum flow is greater than zero.

## ...4 ADVANCED CONFIGURATION LEVEL

### 4.2 Set Up Totalizer

In this Section, parameters in the lower display denoted ■ are Company Standard Settings. The instrument is dispatched programmed with these settings.



#### Page Header – Set Up Flow Totals

To advance to the **Set Up Maths** page press the switch.

#### Select Totalizer

Select totalizer to be programmed.

#### Totalizer On/Off

Turn the totalizer *ON* or *OFF* as required. If turned *OFF* is selected the **Totals Page** is omitted from the **OPERATOR LEVEL**.

#### Count Direction

Select the count direction:

- UP* – Incremental counter (**Preset Value < Predetermined Value**)
- DN* – Decremental counter (**Preset Value > Predetermined Value**).

#### Secure Total

The secure flow total is independent of the **OPERATOR LEVEL** (batch) flow total in **Totals Page**.

Use the switch to move the decimal point to the left or the switch to move the decimal point to the right.

#### Secure Reset

The Secure Total may be reset to either *00000000* or *99999999* (depending on the count direction) if required. Select *YES* to reset the counter or *NO* to retain the current counter value.

#### Count Rate High

Set the required count rate (pulses/second) corresponding to input range high. This value is programmable from 0.0 to 100.0 in 0.1 increments, 0.00 to 10.00 in 0.01 increments or from 0.000 to 1.000 in 0.001 increments, depending on the **Decimal Point** position programmed in the following frame – see **Examples A** and **B**, previous page.

#### Count Rate Decimal Point

Set the decimal point position required for both **Count Rate High** and **Count Rate Low**.

#### Count Rate Low

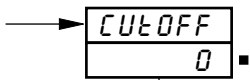
Set the required count rate corresponding to input range low, programmable from 0.0 to 100.0 in 0.1 increments, 0.00 to 10.00 in 0.01 increments or from 0.000 to 1.000 in 0.001 increments.

Continued on next page



4 ADVANCED CONFIGURATION LEVEL...

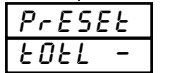
...4.2 Set Up Totalizer



**Cut-off Level**

Set the lowest value at which the totalizer is to stop counting (in engineering units).

**Example** – On differential pressure flow, the inaccuracy of the system at very low flow rates may cause large accumulative totalizer errors due to erroneous counts. If a cut-off level is set above the point where these erroneous counts occur they are ignored.



**Preset Value**

If the OPERATOR LEVEL (batch) flow total is reset it reverts to the value set at this frame.

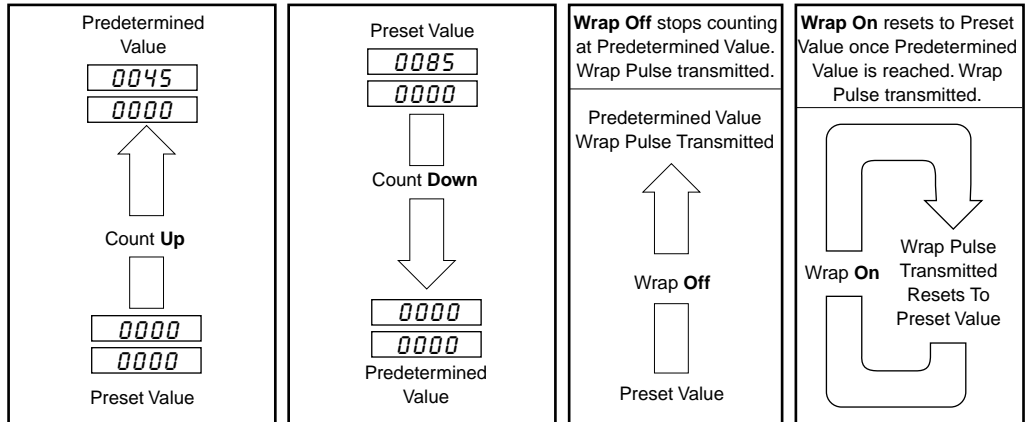
Set the value for the first digit using the / switches. The value is changed by using the switch to advance the flashing cursor ( ) and altering each digit in turn.

Advance to next digit.

/ Set the value for the second digit.

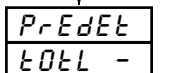
Advance to next digit.

Repeat the above procedure for the remaining digits.



**Note.** The setting of the Preset and Predetermined Values is dictated by the Count Direction:

- Count Ir-UP (incremental counter) – Preset Value < Predetermined Value
- Count Ir-dn (decremental counter) – Preset Value > Predetermined Value.



**Predetermined Value**

If the wrap-around facility is used (see below), the front panel total is automatically reset to the Preset Value once the Predetermined Value is reached. If the wrap-around facility is not used, the front panel total stops when the Predetermined Value is reached.

Set the value for the first digit using the / switches. The value is changed by using the switch to advance the flashing cursor ( ) and altering each digit in turn.

Advance to next digit.

/ Set the value for the second digit.

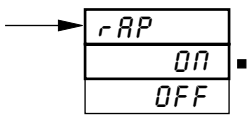
Advance to next digit.

Repeat the above procedure for the remaining digits.

Continued on next page

## ...4 ADVANCED CONFIGURATION LEVEL

### ...4.2 Set Up Totalizer



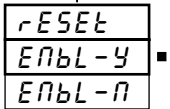
#### Wrap On/Off

If the wrap-around facility is selected, the front panel total is automatically reset to the **Preset Value** once the **Predetermined Value** is reached.

If the wrap-around facility is not selected, the front panel total stops counting when the **Predetermined Value** is reached.

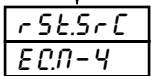
Select *ON* to enable or *OFF* to disable.

**Note.** If a relay or digital output is assigned to the wrap facility the relay or digital output is energized by a wrap pulse for approximately 1 second when the **Predetermined Value** is reached. A wrap pulse is always transmitted when the **Predetermined Value** is reached.



#### Reset Enable

Select *ENbL-Y* to enable or *ENbL-N* to disable the counter reset frame in the **Totals Page, OPERATOR LEVEL**.



#### Reset Source

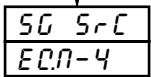
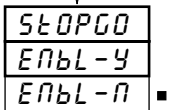
Select the digital source required to reset the totalizer.

For description of source, refer to Table 2.1 on page 10.



#### Counter Stop/Go Enable

Select *ENbL-Y* to enable or *ENbL-N* to disable the counter Stop/Go frame in the **Totals Page, OPERATOR LEVEL**.

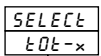


#### Source Stop/Go

Select the digital source required to stop or start the totalizer.

An 'active' source state starts the totalizer and an 'inactive' source stops the totalizer.

For description of source, refer to Table 2.1 on page 10.



Return to **Select Totalizer** frame.

## 5 ADVANCED CONFIGURATION LEVEL

### 5.1 Introduction to Maths

**Information.**

- **Four user-configurable maths blocks** – can be used independently or cascaded together.
- **Each maths block can be configured to perform one of seven functions:**
  - Standard maths block (arithmetic operations)** – add, subtract, divide, multiply, high select, low select and median
  - Relative humidity (RH)** – from wet and dry bulb sensor temperature
  - Mass flow 1** – calculation of mass flow from volume
  - Mass flow 2** – calculation of mass flow from differential pressure
  - High value** – holds the maximum value measured on an input variable
  - Low value** – holds the minimum value measured on an input variable
  - Real time average** – averages a continually varying input over a set period of time.
- **Inputs can be either variables or constants.**

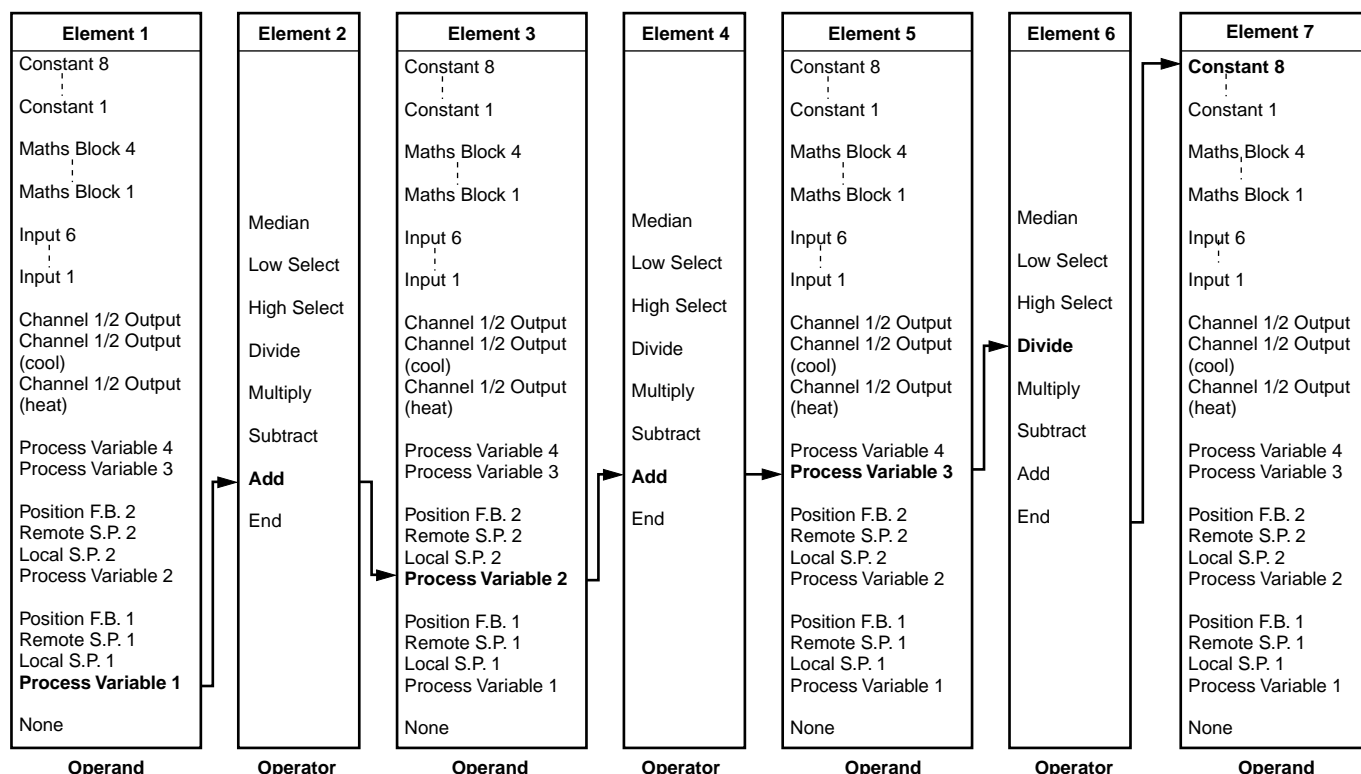
#### 5.1.1 Standard Maths Block

There are four programmable maths blocks. Each maths block can be constructed using four operands and three operators. The four operands can be configured as process variable inputs, set points, constants or other maths results. The three operators can be configured for addition, subtraction, multiplication, division, high value selection, low value selection, median (mid-value selection) or end maths block.

**Note.** The elements in each equation are calculated sequentially. It is therefore important to enter the elements in the correct order to obtain the equation required i.e.  $2 + 3 \times 4 = 20 \neq 14$ . If median is selected as element 2, element 4 automatically becomes median and element 6 automatically becomes end.

The example below shows the construction of a maths block for the following equation:

$$\frac{(PV1 + PV2 + PV3)}{\text{Constant } 8}$$



## ...5 ADVANCED CONFIGURATION LEVEL

### 5.1.2 Relative Humidity (RH)

The relative humidity calculation requires two inputs, one from a wet-bulb sensor and one from a dry-bulb sensor. Both of these inputs are configured as variables. RH tables are based on the use of an aspirated psychrometer having an air velocity of at least 11.5 feet per second or 3.5 meters per second across the bulb sensors.

**Note.** Inputs used for wet- and dry-bulb measurement must be in the ranges 32 to 212°F or 0 to 100°C .

### 5.1.3 Mass Flow 1 and 2

The two types of mass flow calculations available are as follows:

**Mass Flow 1** – applications where a volumetric flow meter is used to measure flow.

**Mass Flow 2** – applications where a differential pressure transmitter is used to measure flow.

The standard formula for mass flow 1 is as follows:

$$M = k \ V \ \frac{P}{T} \ \frac{T_r}{P_r}$$

where:

k = Scaling constant

V = Input a (input from volume flow source)

P = Pressure (pressure input source)

T = Temperature (temperature input source)

T<sub>r</sub> = Reference temperature (for the scaling constant used)

P<sub>r</sub> = Reference pressure (for the scaling constant used)

The temperature units used by the input source must be specified, since all calculations use absolute temperatures and conversion is made if the input uses °F or °C.

The standard formula for mass flow 2 is as follows:

(i)

$$M = k \ \sqrt{\frac{h \ P \ T_r}{T \ P_r}}$$

where:

h = differential pressure head

Some differential pressure sensors incorporate a square root linearizer and therefore produce an output linear to flow. In these instances no additional linearization within the C1900 is required. Where the input from the differential pressure sensor is linear to differential pressure head the square root linearizer within the C1900, must be selected in the **Linearizer Type** frame in the **Set Up Input Page, BASIC CONFIGURATION LEVEL.**

Therefore the formula used internally within the C1900 is:

(ii)

$$M = k \ a \ \sqrt{\frac{P}{T} \ \frac{T_r}{P_r}}$$

where:

a = linearized flow signal

The linearized flow signal is produced by the transmitter or derived from the signal linearized within the C1900.

**5 ADVANCED CONFIGURATION LEVEL...**

**...5.1.3 Mass Flow 1 and 2**

**Example A** – calculating the mass flow of water from the volume flow.

At a temperature of 60°F (520°R) and an absolute pressure of 14.696 p.s.i.a., 1 gallon (US) of water has a mass of 8.334 lbs.

To calculate the mass flow of water from the volume flow the following settings are used:

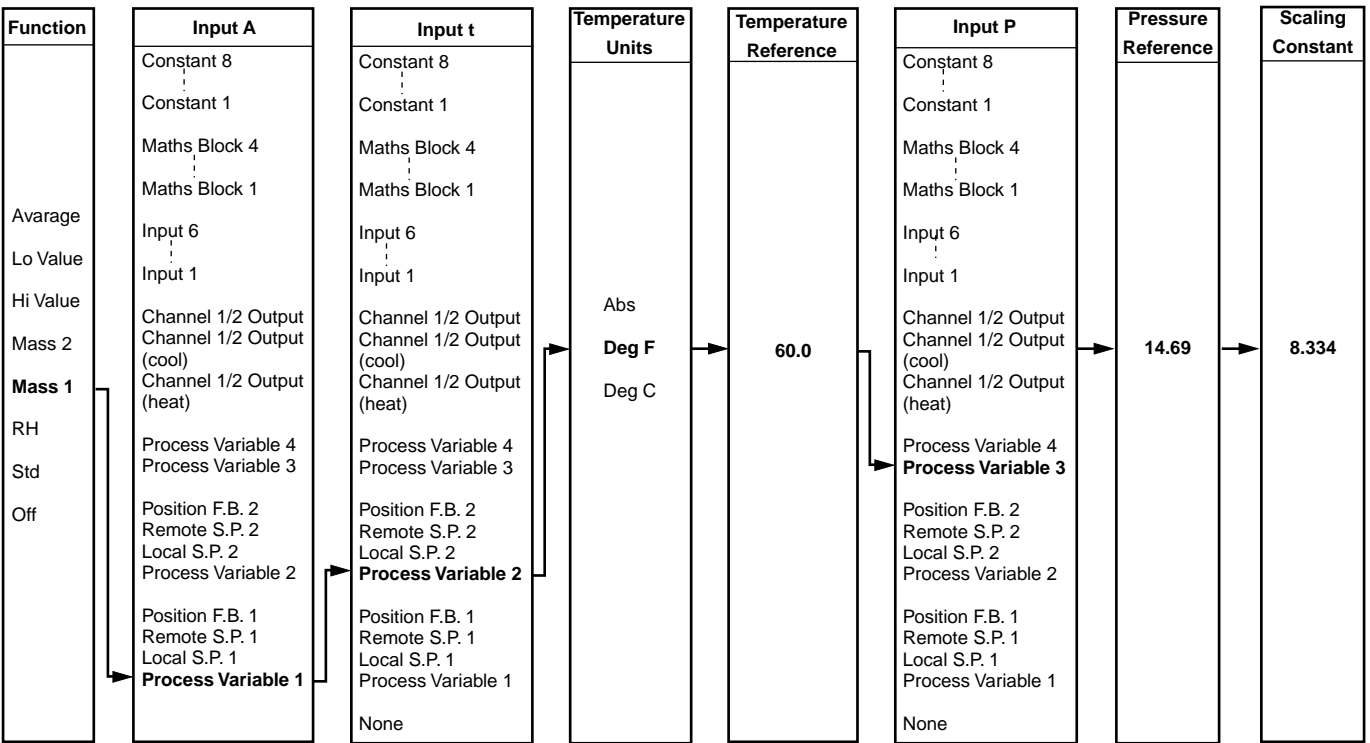
- PV1 – volume flow of water (gal/min)
- PV2 – temperature of water (°F)
- PV3 – pressure of water (p.s.i.a.)
- PV4 – result of maths block 1 (lb/min)

therefore the equation is:

$$M \text{ (lb/min)} = 8.334 \times \text{Volume (gal/min)} \times \frac{\text{measured pressure (p.s.i.a.)}}{14.69 \text{ p.s.i.a.}} \times \frac{(460 + 60)^\circ\text{R}}{\text{measured temperature } ^\circ\text{R}}$$

The example below shows the construction of Maths block 1 with the following selected:

- maths block function– **Mass 1**
- input A source – **Process Variable 1**
- input t source **Process Variable 2**
- temperature units – **Deg F**
- temperature reference (process conditions using maximum flow rate) – **60.0**
- input P source – **Process Variable 3**
- pressure reference (process conditions using maximum flow rate) – **14.69**
- scaling constant – **8.334**



**Note.**

- It is imperative that the temperature input/temperature reference have the same units and the pressure input/pressure reference have the same absolute units.
- The basic mass flow equation must use absolute temperatures (K or °R). The C1900 converts automatically from °C or °F to absolute.
- If temperature or pressure correction is not required the temperature or pressure inputs can be set to *none*.

**...5 ADVANCED CONFIGURATION LEVEL**

**...5.1.3 Mass Flow 1 and 2**

**Example B** – calculating the mass flow of water from the volume flow.

At a temperature of 15.6°C (288.6K) and an absolute pressure of 1013.25 mbar, 1 liter of water has a mass of 1kg.

To calculate the mass flow of water from the volume flow the following settings are used:

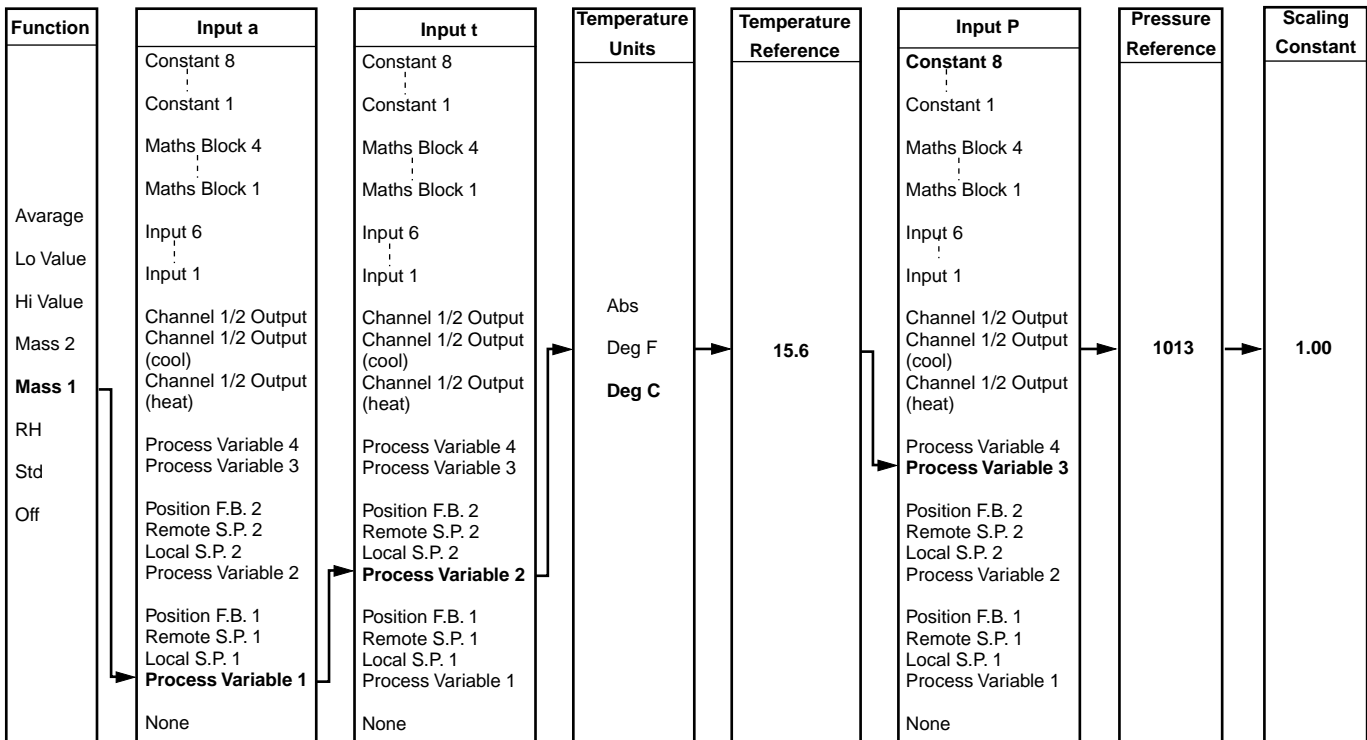
- PV1 – volume flow of water (liters/min)
- PV2 – temperature of water (°C)
- PV3 – pressure of water (mbar (abs))
- PV4 – result of maths block 1 (kg/min)

therefore the equation is:

$$M \text{ (kg/min)} = 1 \times \text{Volume (liters/min)} \times \frac{\text{measured pressure (mbar)}}{1013.25 \text{ mbar}} \times \frac{288.6\text{K}}{\text{measured temperature K}}$$

The example below shows the construction of Maths block 1 with the following selected:

- maths block function – **Mass 1**
- input A source – **Process Variable 1**
- input t source – **Process Variable 2**
- temperature units – **Deg C**
- temperature reference (process conditions using maximum flow rate) – **15.6**
- input P source – **Process Variable 3**
- pressure reference (process conditions using maximum flow rate) – **1013**
- scaling constant – **1.000**



**Note.**

- It is imperative that the temperature input/temperature reference have the same units and the pressure input/pressure reference have the same absolute units.
- The basic mass flow equation must use absolute temperatures (K or °R). The C1900 converts automatically from °C or °F to absolute.
- If temperature or pressure correction is not required the temperature or pressure inputs can be set to *NONE*.

5 ADVANCED CONFIGURATION LEVEL...

5.1.4 Maximum and Minimum Value – Fig. 5.1

If the High Value function is selected the maths result holds the **maximum** value measured on an input variable. If the Low Value function is selected the maths result holds the **minimum** value measured on an input variable. The maths result can be reset to its current value by an internal or external digital signal.

Fig. 5.1 shows the process variable from a flow meter which is continually varying with time. The maximum and minimum values are the highest and the lowest samples taken since an external reset last occurred. The external reset can be independent of the average reset signal.

5.1.5 Real Time Average

The real time average function averages a continually varying input over a set time scale, between 1 and 1440 minutes (24 hours). Any process variable, remote set point or other maths block result can be averaged. The maths result can be reset to its current value by an internal or external signal.

Fig. 5.1 shows the process variable from a flow meter which is continually varying with time. At 0 minutes an external digital input signal resets the average to the current value measured. The process variable is then sampled for 10 minutes. The average function result is the average value of the process variable over the 10 minutes sampled.

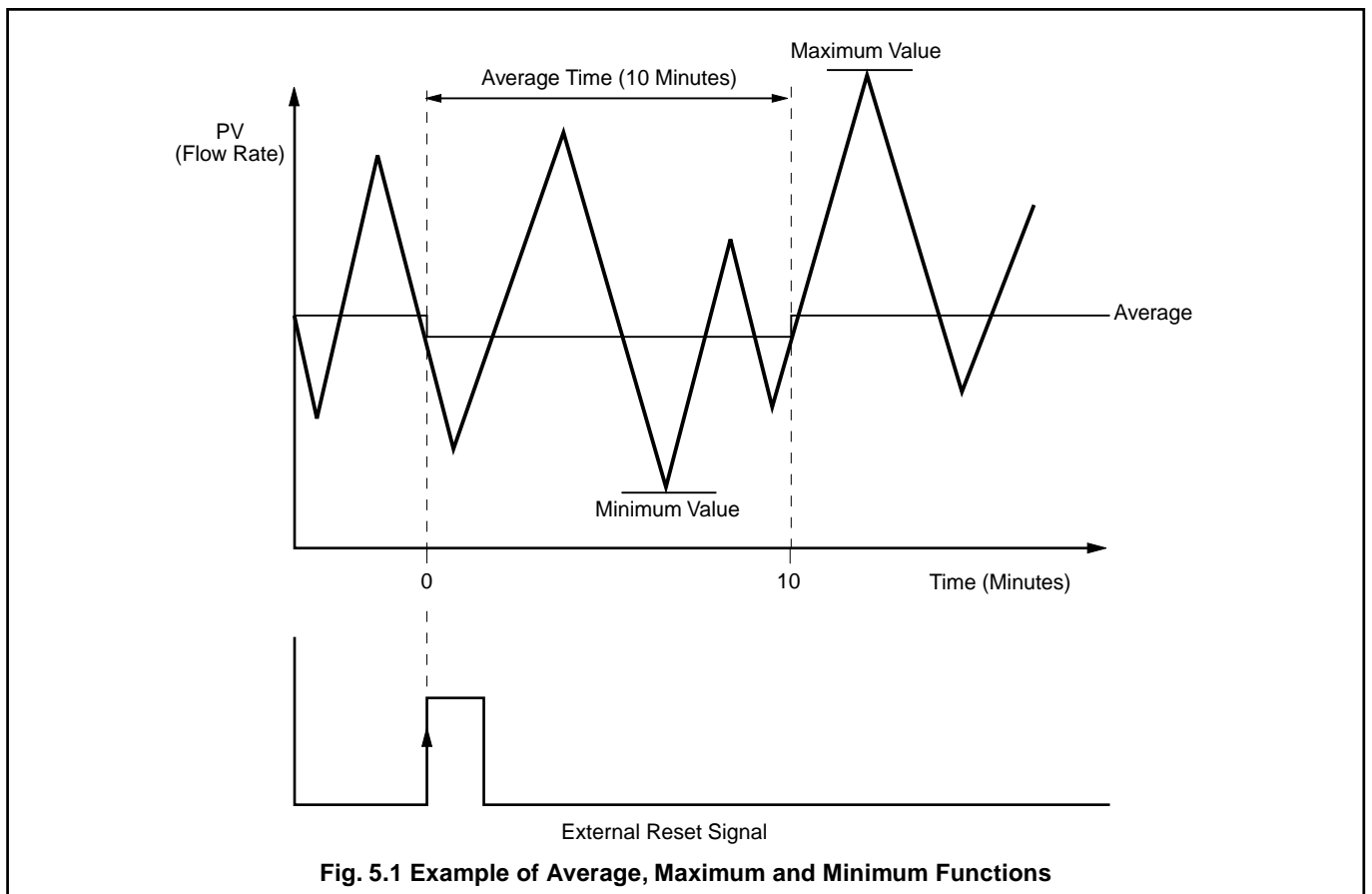
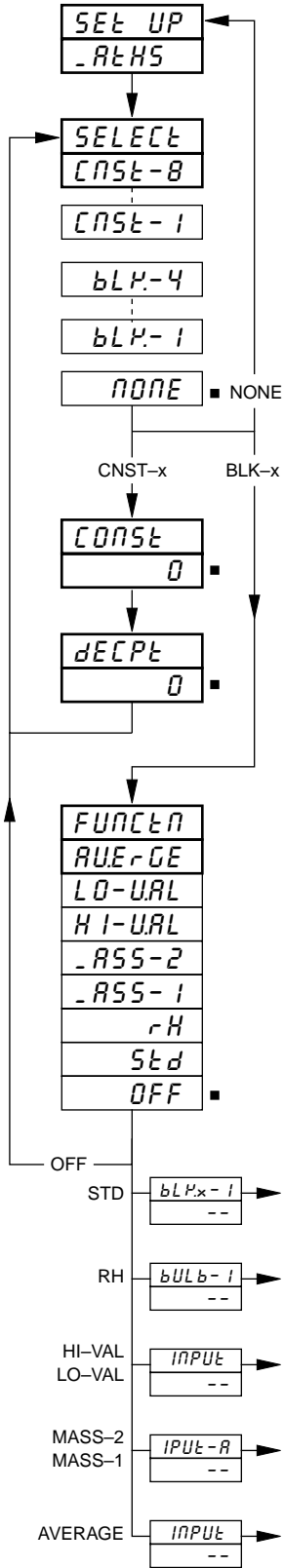


Fig. 5.1 Example of Average, Maximum and Minimum Functions

**...5 ADVANCED CONFIGURATION LEVEL**

**5.2 Set Up Maths**

In this Section, parameters in the lower display denoted ■ are Company Standard Settings. The instrument is dispatched programmed with these settings.



Page Header – **Set Up Maths.**

To advance to the **Set Up Timer** page press the switch.

**Select Maths Function**

Select the maths function or constant to be programmed:

- CNST- 1 to 8* – Constant 1 to 8, arithmetic value used as multiplier/divisor or for addition/ subtraction
- BLK- 1 to 4* – Maths block 1 to 4
- NONE* – No function selected

**Constant Value**

Set an arithmetic value, between –9999 and +9999.

**Constant Decimal Point**

Set the number of decimal places required for the constant value (0 to 3 places).

**Maths Block Function**

Select the maths block function required:

- AVERAGE* – Averages a continually varying input over a set period of time
- LO-URL* – Holds minimum value measured on input variable
- HI-URL* – Holds maximum value measured on input variable
- \_ASS-2* – Calculation of mass flow from differential pressure
- \_ASS-1* – Calculation of mass flow from volume flow
- rH* – Relative Humidity calculation
- Std* – Standard maths block
- OFF* – Maths function not selected

STD Standard maths block selected. Continued on next page.

RH Relative Humidity (RH) selected. Continued on page 24.

HI-VAL LO-VAL High or low value selected. Continued on page 24.

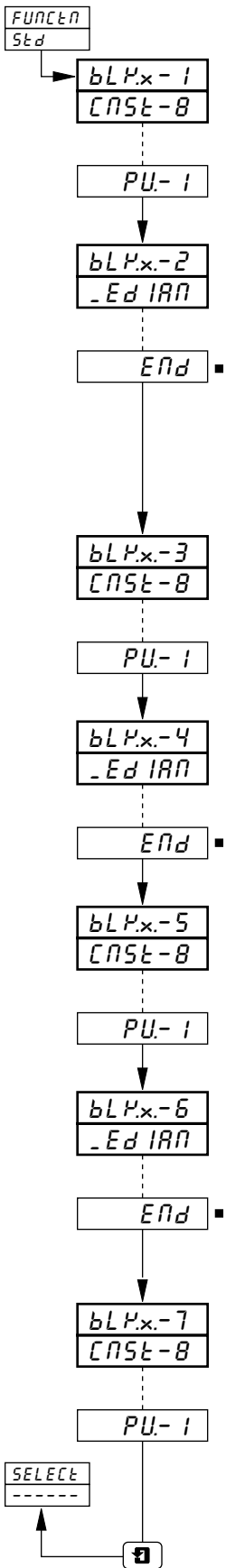
MASS-2 MASS-1 Mass flow 1 or 2 selected. Continued on page 25.

AVERAGE Average selected. Continued on page 26.



5 ADVANCED CONFIGURATION LEVEL...

...5.2 Set Up Maths (Standard Maths Block)



**Maths Block n / Element 1 (operand 1)**

Select the source required for element 1.

For description of operand sources for this and subsequent frames, refer to Table 5.1 on page 26.

**Maths Block n / Element 2 (operator 1)**

Select the operator required for element 2:

- Ed IAN* – median
- LO SEL* – low select
- HI SEL* – high select
- d IU IdE* – divide
- ULt* – multiply
- INUS* – minus
- Add* – add
- ENd* – end

**Maths Block n / Element 3 (operand 2)**

Select the source required for element 3.

**Maths Block n / Element 4 (operator 2)**

Select the operator required for element 4.

For description of operators, refer to **Maths Block n / Element 2** frame.

**Maths Block n / Element 5 (operand 3)**

Select the source required for element 5.

**Maths Block n / Element 6 (operator 3)**

Select the operator required for element 6.

For description of operator sources, refer to **Maths Block n / Element 2** frame.

**Note.** If median is selected in element 2, element 4 automatically becomes median and element 6 becomes end.

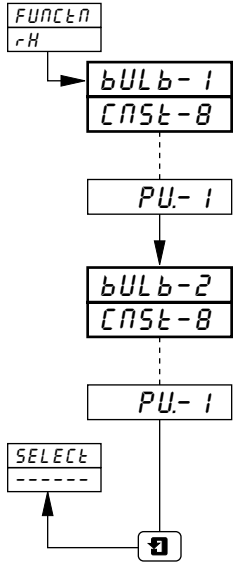
**Maths Block n / Element 7 (operand 4)**

Select source required for element 7.

Return to **Select Maths Function** frame.

**...5.5 ADVANCED CONFIGURATION LEVEL**

**...5.2 Set Up Maths (Relative Humidity)**



**Wet-bulb Input**

Select the process variable source required for wet-bulb input.

For description of process variable sources, refer to Table 5.1 on page 26.

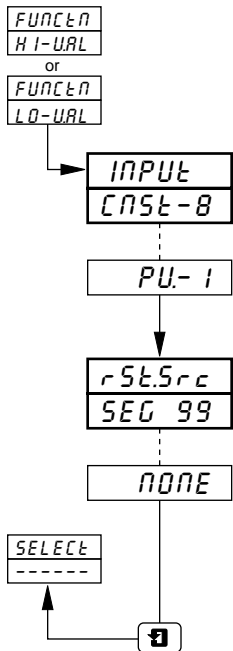
**Dry-bulb Input**

Select the process variable source required for dry-bulb input.

For description of process variable sources, refer to Table 5.1 on page 26.

Return to **Select Maths Function** frame.

**...5.2 Set Up Maths (High and Low Detect)**



**High/low Input**

Select the variable source whose minimum or maximum value is to be detected.

For a description of input/output sources, refer to Table 5.1 on page 26.

**Reset High/low Input**

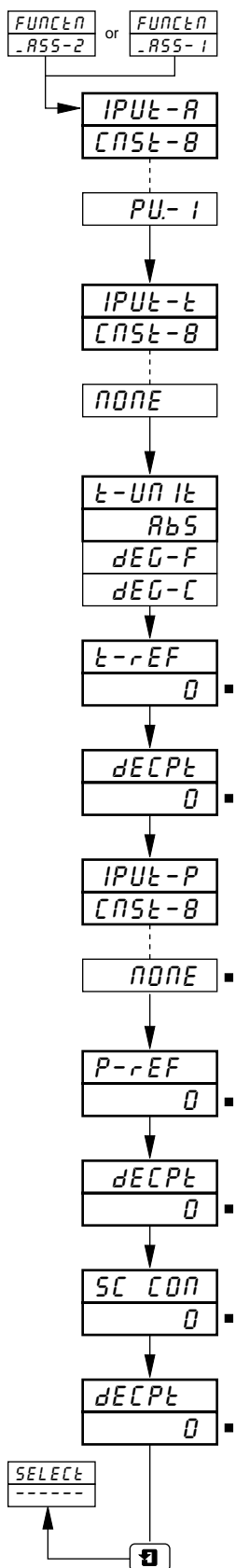
Select the digital source required to reset the minimum or maximum value.

For a description of digital sources, refer to Table 2.1 on page 10.

Return to **Select Maths Function** frame.

5 ADVANCED CONFIGURATION LEVEL...

...5.2 Set Up Maths (Mass Flow)



**Mass Flow 1 or 2 Input**

Select the process variable source required for input A (input A is the input from volume flow or differential pressure).

For description of the process variable sources, refer to Table 5.1 on page 26.

**Temperature Input**

Select the process variable source required for the temperature input.

**Temperature Units**

Select the input source temperature units:

- Abs* - Input source measured in degrees absolute (°K or °R)
- deg F* - Input source measured in °F
- deg C* - Input source measured in °C

**Reference Temperature**

Set the value which represents the reference temperature, between 0 and +9999. The decimal point is set in the next frame.

**Reference Temperature Decimal Point**

Set the number of decimal places required for the reference temperature (0 to 3 places).

**Pressure Input**

Select the process variable source required for the pressure input.

**Pressure Reference**

Set the value which represents the pressure reference, between 0 and +9999. The decimal point is set in the next frame.

**Pressure Reference Decimal Point**

Set the number of decimal places required for the pressure reference (0 to 3 places).

**Scaling Constant**

Set the value which represents the scaling constant (k), between 0.00 and +99.99. The decimal point is set in the next frame.

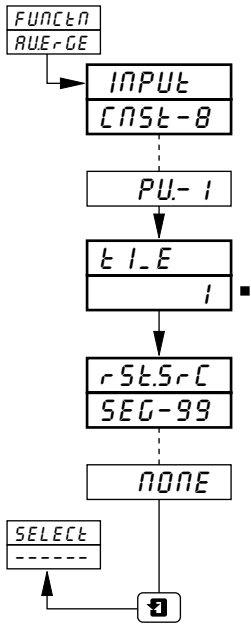
**Scaling Constant Decimal Point**

Set the number of decimal places required for the scaling constant (k) (0 to 3 places).

Return to **Select Maths Function** frame.

**...5 ADVANCED CONFIGURATION LEVEL**

**...5.2 Set Up Maths (Average)**



**Averaging Input**

Select the input variable which is to be averaged.

For description of the process variable sources, refer to **Table 5.1** below.

**Time Scale**

Set the time scale interval over which the input is to be averaged, between 1 and 1440 minutes (24 hours).

**Reset Average Source**

Select the digital source required to reset the average value to the present input value.

The reset is leading edge triggered.

Return to **Select Maths Function** frame.

Source	Description
CONST-8 ⋮ CONST-1	Constant 8 ⋮ Constant 1 } Arithmetic value used as multiplier/divisor or for addition/subtraction
BLK-4 ⋮ BLK-1	Maths block 4 ⋮ Maths block 1 } Programmable maths blocks – see Section 5.2, <b>Set Up Maths</b> page
IP-6 ⋮ IP-1	Input 6 ⋮ Input 1 } Only available if inputs are not already assigned to input functions
OP-2 OC-2 OH-2	Channel 2 output Channel 2 output (cool) Channel 2 output (heat) } Heat/cool only available if control type selected
OP-1 OC-1 OH-1	Channel 1 output Channel 1 output (cool) Channel 1 output (heat) } Heat/cool only available if control type selected
PU-4 PU-3	Process variable 4 Process variable 3 } Process variable 3 and 4 only available if pens 3 and 4 fitted
PFB-2 RSP-2 LSP-2 LSP-2 SP-2 PU-2	Position Feedback 2 Remote set point 2 Local set point 2 Set point 2 Process variable 2 } Controller 2
PFB-1 RSP-1 LSP-1 LSP-1 SP-1 PU-1	Position Feedback 1 Remote set point 1 Local set point 1 Set point 1 Process variable 1 } Controller 1
NONE	No source required

**Table 5.1 Description of Operand Sources**

## 5 ADVANCED CONFIGURATION LEVEL

### 5.3 Maths Input Assignment (for Controller versions refer to Programming Guide)

**Information.**

- **To display or record a maths function** – it must be assigned to a process variable or remote set point.
- **If the maths result is to be assigned to a process variable or remote set point** – it is necessary to set up fault detection levels, broken sensor actions and an engineering range (high/low) in the **Set Up Input Page, BASIC CONFIGURATION LEVEL**. The engineering range is used in totalizer calculations and is used to calculate the fault detect level.
- **If any input to a maths block fails** – the assigned maths result fails.
- **If process variables or remote set points** – are assigned to a maths block result, only the following frames are displayed in the **Set Up Input Page, BASIC CONFIGURATION LEVEL**:

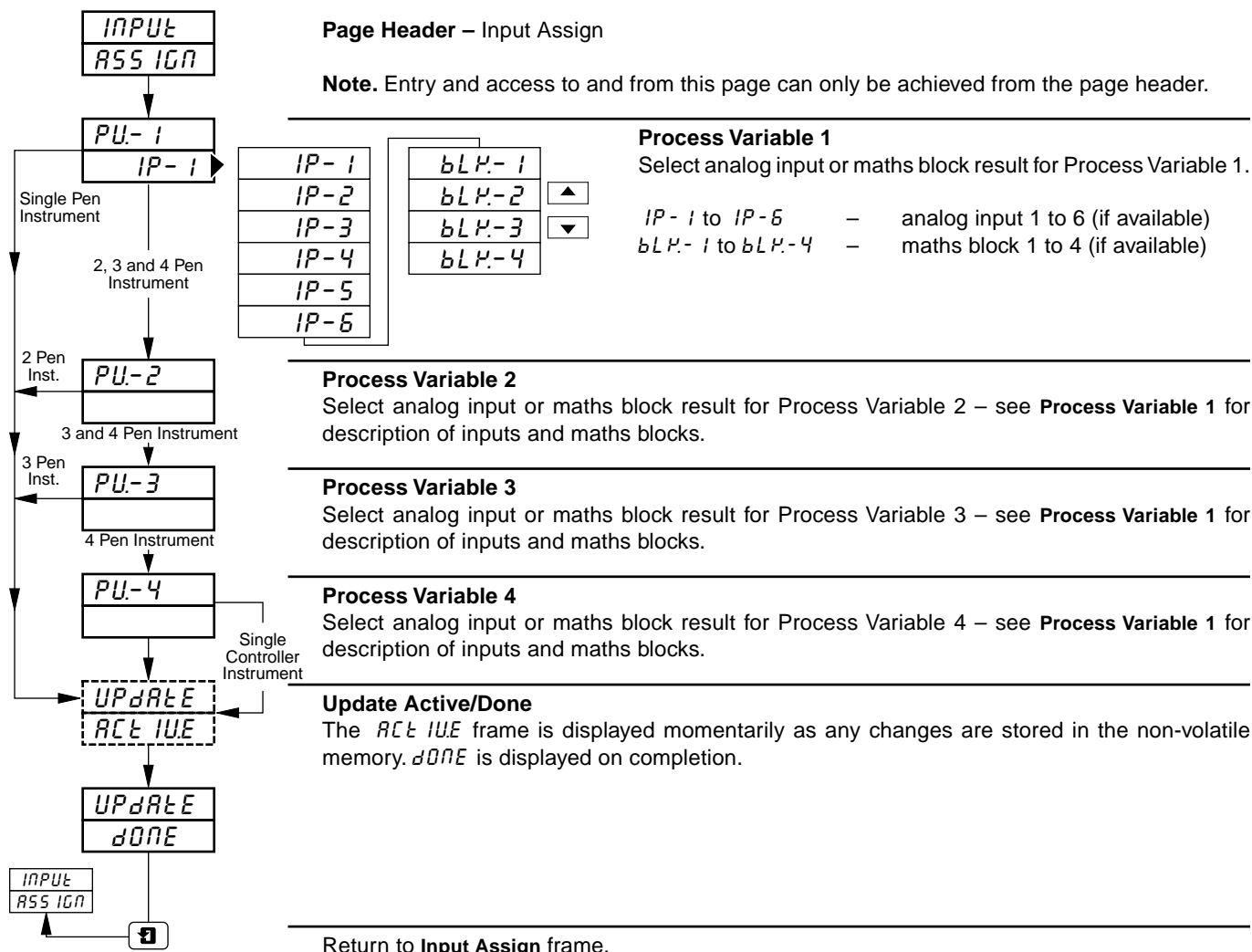
Engineering High Range

Engineering Low Range

Broken Sensor Protection Drive

Fault Detection Level Percentage.

The maths result is assigned to a process variable or remote set point in the **Input Assignment Page, ADVANCED CONFIGURATION LEVEL**. This page is always displayed on controller versions and is only displayed on recorder version when the maths option is fitted. For Recorder versions refer to **Input Assign Page** below and for Controller versions refer to the **Programming Guide**.



- **Timer**

## 6 ADVANCED CONFIGURATION LEVEL

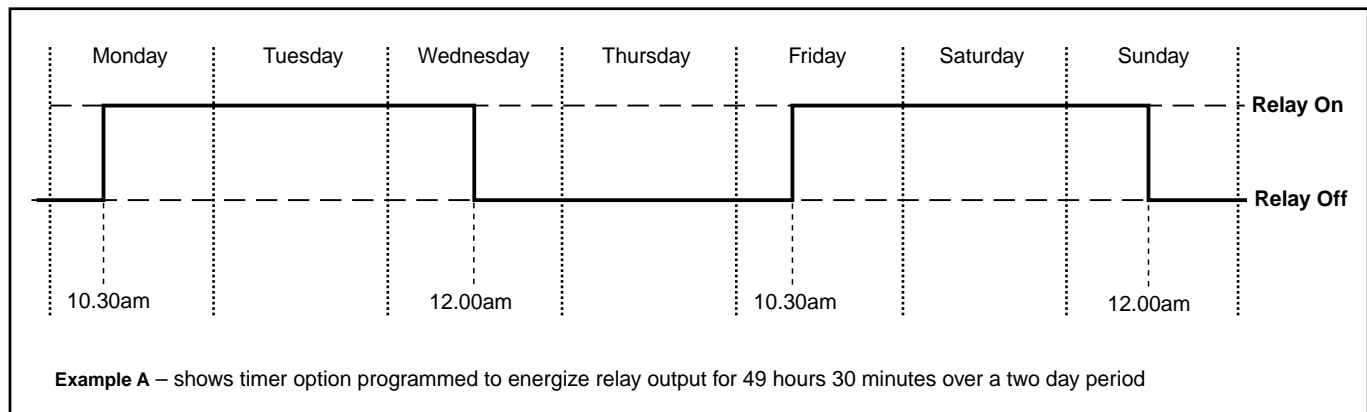
### 6.1 Set Up Timer

**Information.**

- **Two timers available.**
- **'ON' duration of 1 minute to 167 hours 59 minutes (1 week).**
- **Programmable Timers** – can operate on specific days, hours or minutes for an exact period of time.
- **Timer 'ON/OFF' states** – can be used to energize relay outputs, acknowledge alarms, stop the chart, select auto/manual control modes and local/remote set points, in logic calculations, start/stop/reset totalizers, reset maths results or run/hold/reset profile programs/segments.

**Example A** – setting up timer:

- Monday enabled
- Tuesday disabled
- Wednesday disabled
- Thursday disabled
- Friday enabled
- Saturday disabled
- Sunday disabled
- on hour set to 10.00am
- on minute set to 30 minutes
- duration in hours set to 49 hours
- duration in minutes set to 30 minutes

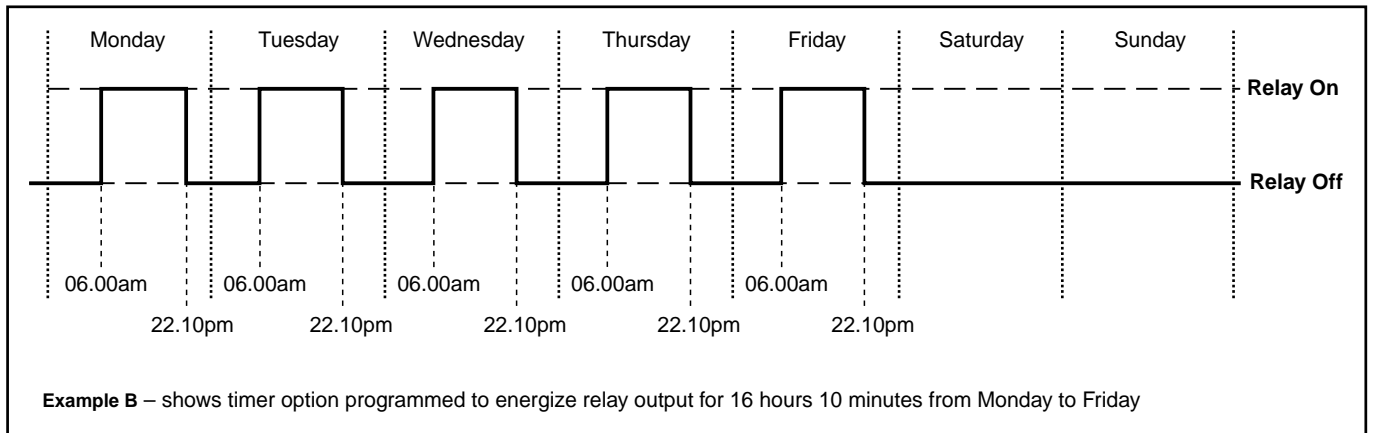


6 ADVANCED CONFIGURATION LEVEL...

...6.1 Set Up Timer

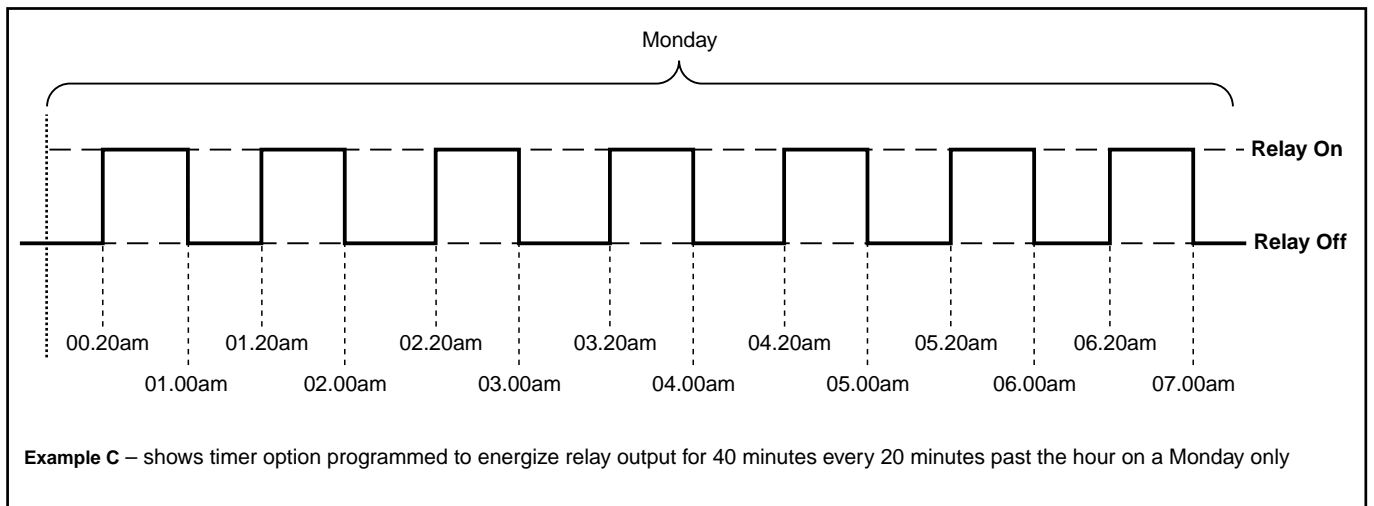
**Example B** – setting up timer:

- Monday enabled
- Tuesday enabled
- Wednesday enabled
- Thursday enabled
- Friday enabled
- Saturday disabled
- Sunday disabled
- on hour set to 06.00am
- on minute set to 0 minutes
- duration in hours set to 16 hours
- duration in minutes set to 10 minutes



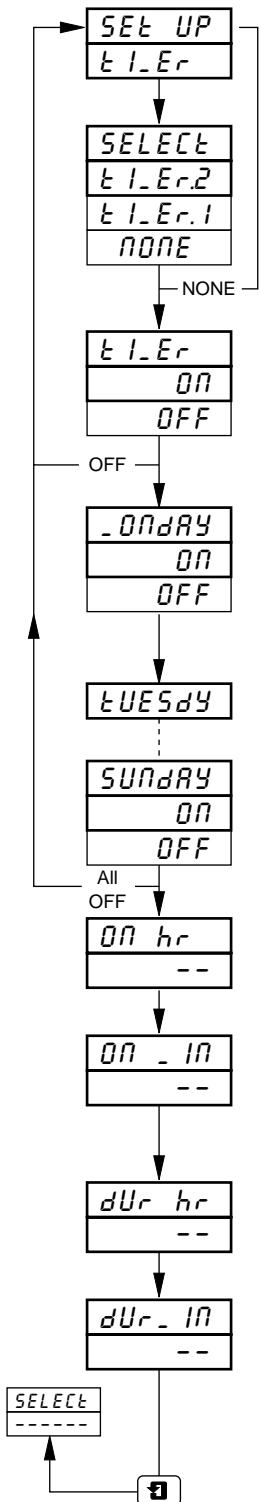
**Example C** – setting up timer:

- Monday enabled
- Tuesday disabled
- Wednesday disabled
- Thursday disabled• Friday disabled
- Saturday disabled
- Sunday disabled
- on hour set to All
- on minute set to 20 minutes
- duration in hours set to 0 hours
- duration in minutes set to 40 minutes



**...6 ADVANCED CONFIGURATION LEVEL**

**...6.1 Set Up Timer**



Page Header – **Set Up Timer**

To advance to the **SET UP CLOCK** frame press the switch.

**Select Timer**

Select timer to be programmed:  
*t1\_Er-1* – Timer 1  
*t1\_Er-1* – Timer 2  
*NONE* – no Timer selected

**Timer On/Off Enable**

Select *ON* to enable or *OFF* to disable.

**Monday Enable**

If Monday is enabled the timer becomes active on Monday. Select *ON* to enable or *OFF* to disable.

**Tuesday Enable**

Repeat as above for Tuesday to Sunday.

**On Hour**

Set the hour at which the timer becomes active. If *ALL* is selected the timer becomes active every hour (*ALL* is located above 24).

**On Minute**

Set the minute at which the timer becomes active.

**Duration Hour**

Set the duration of the timer in hours.

**Duration Minute**

Set the duration of the timer in minutes.

Return to **Select Timer** frame.



## 6 ADVANCED CONFIGURATION LEVEL

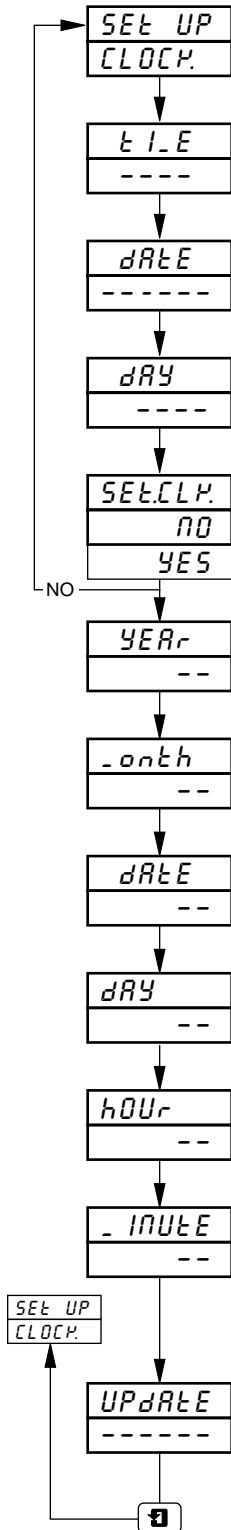
### 6.2 Set Up Clock

**Information.**

- Real time system clock included with timer option.
- Provides date, month, day, hours, minutes.

Page Header – **Set Up Clock**

To return to the top of the **ADVANCED CONFIGURATION LEVEL** frame press the  switch.



**Current Time**

Current time displayed.

**Current Date**

Current date displayed.

**Current Day**

Current day displayed.

**Set Clock**

If the date, day and time are correct in the above frames, select *NO* to return to the **Set Up Clock** frame. To set the clock's date, day or time select *YES*.

**Year**

Set the year.

**Month**

Set the month.

**Date**

Set the date.

**Day**

Set the day – *MON* (Monday), *TUE* (Tuesday), *WED* (Wednesday), *THU* (Thursday), *FRI* (Friday), *SAT* (Saturday), *SUN* (Sunday).

**Hour**

Set the hour (using 24 hour clock).

**Minute**

Set the minute.

**Update**

*RECEIVE* is displayed until update is complete. *DONE* is displayed on completion of update.

Return to **Set Up Clock** frame.

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## NOTES

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Sales



Service



Software



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