# Engineers Manual


# Series 2000

**FGH Controls Ltd**
Openshaw Way,Letchworth
Herts. SG6 3ER
Tel: (01462) 686677
Fax: (01462) 480633
Email: sales@fghltd.demon.co.uk
www.fgh.co.uk

S2000/P2000 ENGINEERS MANUAL

## CONTENTS.

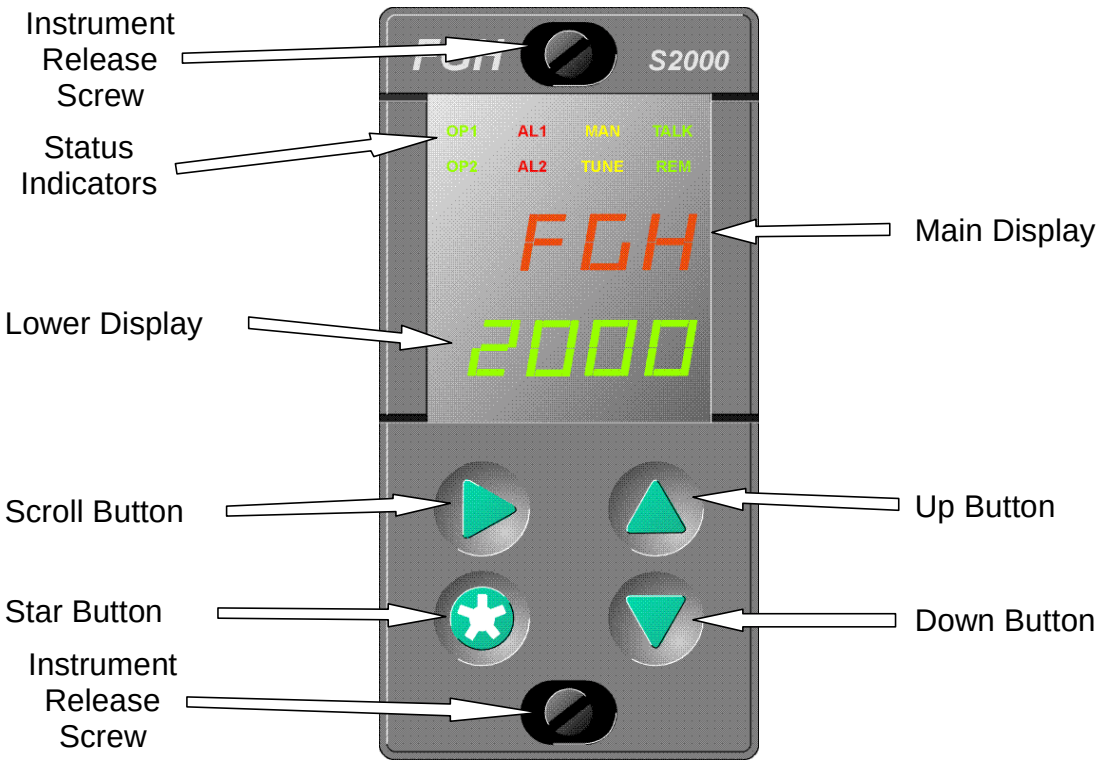
# SECTION A - GENERAL

## 1.0 Introduction

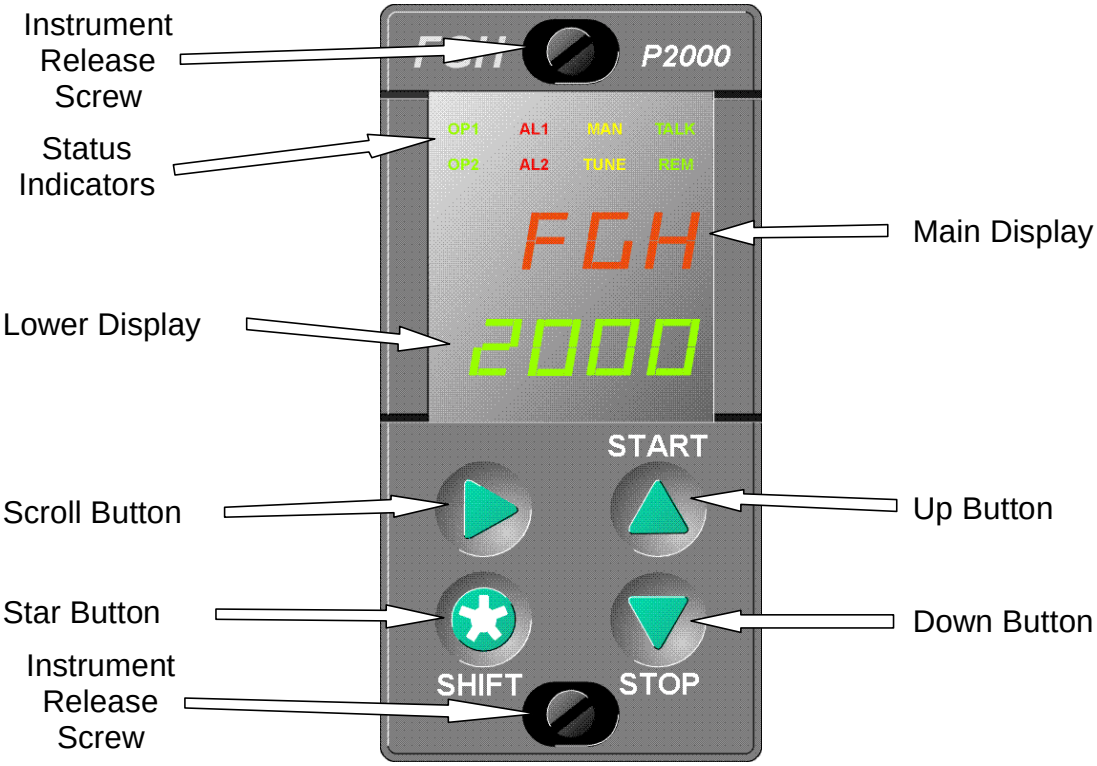
This manual is designed to be read by an engineer configuring the P2000 programmer or S2000 Controller to customer requirements before delivering a new instrument, or the reconfiguring of an existing instrument to accommodate new requirements. It covers selection and fitting of option boards, hardware configuration of these boards with patch links, and software configuration and calibration of the instruments programmer and controller parameters.

The task of installing the S2000/P2000 is covered in a separate installation manual provided with the instrument. Also, the installation, configuration and use of the serial communications option is covered by the S2000/P2000 communications manual.

**S2000 FRONT PANEL**



## P2000 FRONT PANEL




### 1.1 Displays

The main display on the S2000/P2000 normally shows the process variable (PV), while the lower display parameter is shown by the illuminated mode indicator; setpoint, output, valve position, time, segment or event.

### 1.2 Status indicators

The status indicators provide information on the status of the instrument. The following is a brief explanation of each of the legends.

**OP1** The output 1 relay (normally the heat or raise output) is on. Not used for analogue outputs.

**OP2** The output 2 relay (normally the cool or lower output) is on. Not used for analogue outputs.

**AL1** Alarm 1 is active, if alarms are latched then this indication is also latched until cleared.

**AL2** As alarm 1, but for alarm 2

**MAN** The instrument output is under manual (hand) control.

**TUNE** If flashing, then instrument is in pretune, if on and steady then the instrument is in autotune (adaptive tune)

**TALK** The instrument is being addressed via serial comms.

**REM** The controller is using a setpoint from a remote source, this may be either a digital or analogue remote setpoint.

## 2.0 Buttons

The Series 2000 front panel buttons have the following functions:

The right button (called the scroll button) is used to select which parameter is to be displayed on the display. Pressed on its own it causes the next parameter in the scroll list to be displayed. When pressed in conjunction with the star button it causes the previous parameter to be displayed. In short scroll this button is also used to enter the long scroll or profile scroll.


These buttons are used only to change the value of the parameter selected in the long scrolls or emode, or to change the value of setpoint or output in the short scroll.

The star button is used to show different information on the main display during calibration (section E), and to unlatch a latched alarm when the relevant alarm level in the controller long scroll is being displayed. The star button is used on the P2000 profile generator to access the alternative functions assigned to the up and down buttons ( STOP and START ). To access these functions, press and hold the star button and then press the button for the desired function.

## 3.0 Short scroll

Short scroll is the normal operating condition of the instrument. The short scroll consists of a short list of the most commonly used parameters. The upper display will usually show the current process variable with the setpoint shown on the lower display.

The function of the lower display may be changed by pressing the left arrow button. This will proceed through the short scroll list showing the value of the parameter on the upper display and the parameter name on the lower display.

The number and type of parameters in the short scroll list depends on the configuration of the instrument.

The short scroll list will only include time, segment and events if the instrument is a P2000, but in addition, events will only be included in the scroll if one or more of the option slots have been configured as an event output or event driver.

The instrument may be left showing any of the short scroll parameters desired.

## 4.0 Long scrolls

In the S2000 controller, the long scroll is a controller scroll. This contains all the control parameters and commissioning data. The P2000 programmer has two long scrolls, the

controller scroll, which is the same as the long scroll in the S2000, and the programmer scroll, which allows access to the profile data stored in the instrument.

## 4.1 Entry and exit

To enter the controller scroll of the instrument, press and hold the scroll button. After two seconds the display will change to show the mnemonic of the first of the long scroll parameters on the lower display and the value of that parameter on the main display.

To enter the programmer scroll on the P2000 Programmer, hold down the star button and then press and hold the scroll button. After two seconds the first programmer parameter, delay, will be shown on the lower display and its value on the upper display.

To exit any long scroll, press and hold the scroll button. After two seconds the display will change back to that of the short scroll. Alternatively, if no buttons are pressed for about 20 seconds, then the instrument will automatically revert to short scroll.

## 4.2 Controller long scroll

Controller long scroll parameters include commissioning PID terms, setpoint and alarm levels. Only relevant parameters are included in the long scroll list, eg. if alarm 2 is not used then alarm 2 levels will not be on the long scroll list. Similarly, valve action time, for example, is only listed if the instrument is configured as a valve positioner.

Scroll between parameters using the left arrow button (for forward scroll) or star and left (for backward scroll) as usual. When the end of the long scroll list is reached the list wraps round to the beginning again.

The following is a complete list of the Controller long scroll parameters with their associated mnemonics and explanation of contents.

| Mnemonic | Parameter | Meaning |
|---|---|---|
| **PASS** | password entry | If the password is set to other than 'clear' then the password sequence of four button presses must be entered here in order to allow any of the long scroll parameters to be modified. See para 5.0<br><br>After the password has been entered, '**good**' or '**bad**' is briefly displayed to indicate if the password was correct. |
| **SP-L** | set point local | Local set point in displayed units |
| **StyP** | setpoint type | Setpoint to be used<br><br>**Loc** Local, set point = SP-L<br>**rE** Remote, set point is remote<br>**ind** Indexed, set point is sum of local set point and remote set point<br>**Lo** Set point is remote, but never lower than local set point (lo clamp) |

| | | |
|---|---|---|
| | | **Hi** Set point is remote, but never higher than local set point (hi clamp) |
| **rAtE** | rate of setpoint | Maximum rate of change of control set point in display units per hour (S2000 only) |
| **SP1** | aux setpoint 1 | Setpoint value selected by digital input 1 |
| **SP2** | aux setpoint 2 | Setpoint value selected by digital input 2 |
| **thr** | threshold | Amount the PV can deviate from setpoint before autotune begins, in displayed units |
| **Ptun** | pretune | On or off, perform one shot pre-tune if on |
| **Atun** | autotune | On or off, if on then adaptive autotune enabled if PV deviates by more than 'thr' from set point |
| **PrOP** | propband | Heating proportional band in % if positive, or on/off hysteresis in digits if negative. |
| **IAt** | integral time | Integral action time in seconds |
| **rSEt** | reset value | Manual reset value for output in % when **IAt** set to **OFF**. |
| **dAt** | derivative | Derivative action time in seconds |
| **dAPr** | derivative approach | Band around set point in prop bands, in which derivative action can occur when **dAt** is active. |
| **VAt** | action time | Time in seconds for full travel of motorised valve |
| **rEL** | relative | Cool propband in multiples of heat propband |
| **dbnd** | deadband | For heat/cool, if positive, the % output band in which neither heat nor cool outputs are on. If negative, the amount of heat output power at which cool comes on<br><br>For motor valve, the % output band around the required position when the valve is not driven at all |
| **rAt** | output ratio | Ratio of thermal head to difference between set point and load temperature |
| **bAnd** | Ratio band | This the width of a band around the setpoint in displayed digits. When the process variable falls inside this band the ratio value decreases linearly to 1.0 at zero error. Outside this band the ratio value is as programmed. This feature |

| | | |
|---|---|---|
| | | may be disabled by setting the band parameter to off. |
| **HiOP** | High Output | The absolute maximum air setpoint output allowed. This parameter is usually set to protect the furnace or kiln from excessive temperatures. |
| **tHHI** | thermal head high | High limit of positive thermal head. Usually set to prevent damage to the surface of the load. |
| **rEFH** | ratio reference high | Parameter to which ratio limit tHHi is referenced<br><br>**SEtP** Air set point output is limited to tHHi above load set point<br>**LOAd** Air set point output is limited to tHHi above load temperature<br>**OFF** No limit on positive thermal head |
| **loOP** | low output | Lower limit of air set point output on ratio controllers |
| **tHLo** | thermal head low | Maximum amount of negative thermal head |
| **rEFL** | ratio reference low | Parameter to which ratio limit tHLo is referenced<br><br>**SEtP** Air set point output is limited to tHLo below load set point<br>**LOAd** Air set point output is limited to tHLo below load temperature<br>**OFF** No limit on negative thermal head |
| **Alr1** | alarm 1 | Alarm 1 level.<br>The type of alarm set can be seen if the star key is pressed.<br>A latched alarm 1 can be reset at this point by pressing the star key. |
| **Alr2** | alarm 2 | Alarm 2 level.<br>The type of alarm set can be seen if the star key is pressed.<br>A latched alarm 2 can be reset at this point by pressing the star key. |
| **OP1** | output 1 | Auxiliary output power (or power limit) selected by digital input 1. |
| **OP2** | output 2 | Auxiliary output power (or power limit) selected by digital input 2. |

| | | |
|---|---|---|
| **H PL** | h power limit | Heat power limit, in %, for heat/cool controllers, and high power limit for heat only units |
| **L PL** | low power limit | Low power limit in %, for heat only controllers |
| **C PL** | cool power limit | Cool power limit in %, for heat/cool controllers |
| **HCyC** | heat cycle | Heat output T.P cycle time in seconds |
| **CCyC** | cool cycle | Cool output T.P cycle time in seconds |

### 4.3 Programmer long scroll

The programmer long scroll gives access to all the parameters governing profile generation in the P2000 Programmer. The programmer scroll is entered by pressing and holding the left scroll button.

As with the controller scroll, movement forwards and backwards through the programmer scroll is by use of the scroll button and the scroll wraps around at the end back to the beginning.

The programmer scroll consists of two parts, the first group of parameters relate to the whole instruments profile generation facilities, such as the delay before the chosen program starts, and the other part is the editing of each of segments of the program number selected by the '**Prog**' parameter.

All parameters in the programmer scroll are always present except for those that relate to the setting of the event relays, which are only present if one or more of the instruments option slots are configured as event outputs or as an event driver.

| Mnemonic | Parameter | Meaning |
|---|---|---|
| **dELy** | delay start | settable in hours and minutes up to a limit of 99 hours 59 minutes. This is the period of time that will elapse after the selected profile has been told to start but before the conditions of segment 1 of the selected profile are applied. |
| **er-r** | event relay-ready | This parameter shows what state the eight event relays will assume during a ready condition. ie. when a profile is not running, and when a delay start is executing.<br><br>This and other event relay parameters, show the setting of the eight event relays, numbered 1 to 8, left to right, on the upper display. The relays are represented as high marks for on and low marks for off. The relays are edited one at a time, the one being edited flashes. press the star button to change the relay being edited. Use the up and down buttons to turn the relay being edited on and off. |

| | | |
|---|---|---|
| **ProG** | program | This parameter is the program number to be examined in the rest of the programmer scroll. Use the up and down buttons to change this setting as usual. |
| **Hold** | hold band | The hold band is the band outside which the programmer will go into hold, ie. pause the program running, and represents the difference between measured variable and set point (error). The band is in the same units as the measured variable display and is settable between 1 and 100 digits. This parameter works in conjunction with the next to provide the comprehensive hold facility. |
| **HtyP** | hold type | The hold type shows under what conditions, if any, the programmer will hold a running program when the error exceeds the hold band. The upper display consists of four digits or dashes. The digits represent hold conditions that are active, a dash indicates that the programmer would not go into hold during that condition.<br>**d** dwell, hold during dwells, ie. segments with an aiming level the same as the previous segment.<br>**r** ramps, hold during ramps, ie. segments with an aiming level different to that of the previous level and having a non-zero time.<br>**b** below, hold when the measured variable is more than a hold band below the control set point.<br>**a** above, hold when the measured variable is more than a hold band above the control set point.<br><br>note that for a hold to function then one or both of dwell or ramp must be set on ***and*** one or both of below or above must be set on. |
| **rEPS** | repeats | The number of times that a program will repeat itself between segment 1 and an END or GO instruction, may be set between 0 (execute only once, do not repeat at all) and 999 (execute 1000 times in all). Pressing the star key will cause the number of repeats remaining to be shown. |
| **ti 1** | time-1 | time segment 1, the time taken for segment 1 of the program selected to execute<br>Note that a time of zero causes a step change in the setpoint when that segment is executed. |
| **LE 1** | level-1 | level segment 1, the aiming level for segment 1 of the selected program |
| **Er 1** | event relays-1 | event relay setting for segment 1. Interpretation of settings and adjustment is as for 'event relay-ready' |

| | | |
|---|---|---|
| **ti 2** | time-2 | time set in hours and minutes for segment 2 (and so on up to segment 25) to execute. In addition this parameter may be set to 'End' by pressing the down button when the time indicated is zero. This would cause the program to terminate when this segment is executed. Also, further presses of the down button will cause this parameter to be set to 'Go 9', 'Go 8' etc. When executed, this would cause program execution to switch to the beginning of the appropriately numbered program. |
| **LE 2** | level-2 | level set as the aiming point for segment 2 (and so on until level-10).<br>Note that if this level is the same as that for the previous segment then this segment is known as a dwell. |
| **Er 2** | event relays-2 | event relay settings for segment 2 (and so on up to segment 10), displays interpreted and settings adjusted as in 'event relay-ready' |

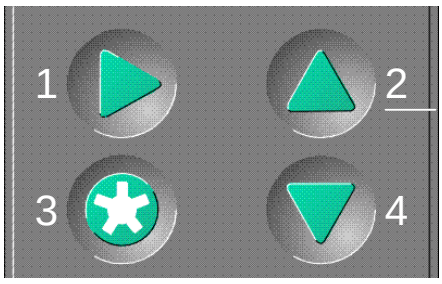
Note that the programmer long scroll sequence is such that the three parameters time, level and event relays are presented in identical fashion, in sequence, for segments 2 through to 10 and that this section of the scroll along with the segment 1 parameters, hold and hold type are related to the program number set at the beginning of the scroll.

NOTE. Special versions of the P2000 may be available with more than the standard ten segments or profiles.

## 5.0 Passwords

### 5.1 General

The Series 2000 is equipped with multi-zone password protection, enabling some parameters to be password protected while leaving others unprotected if desired.




The essence of the password is a four digit code representing a sequence of four button presses. When the password is being entered any of the four front panel buttons are valid, they are arbitrarily assigned values 1 to 4 with the scroll button as 1 etc.

### 5.2 Factory settings

When initially set up, the 2000 has its password set to 0000. This is the clear condition, when this is set then no password protection is provided.

### 5.3 Setting the password

In order to set the password the instrument must be put into 'E' mode. (See para 6.1). This consists of removing it from its sleeve, flicking the Engineers mode switch and replacing the instrument in its sleeve.

With the instrument in 'E' mode repeatedly press the scroll button until the **PASS** parameter group mnemonic is displayed on the lower display. Pressing the star button allows access to this group and the upper display will show the current password, or 0000 if the password is clear.

Pressing the scroll button again causes **CHGE** to be displayed on the lower display. This is a question as to whether to change the current password. The up and down buttons are used to select **yES**, **no** or **CLr** (clear) in response to the question. To leave the password unchanged select '**no**', to set the password to 0000 select '**CLr**' to modify the password select '**yES**'.

Press the scroll button. If **CLr** was selected then the password has now been cleared, if **yES** was selected then **PASS** is now displayed and the new password should be entered. Press your selection of four buttons. On the fourth button press the display will change to request the scope of the new password.

## 5.4 Setting the scope

With the controller in 'E' mode and **SCOP** on the lower display then the zones protected by the password may be selected.

**P** (P2000 only) When set, the password must be entered before any of the programmer long scroll parameters (except '**PROG**') can be modified.

**S** When set, the password must be entered before the setpoint value, type, rates or auxiliary setpoints can be modified.

**A** When set, the two alarm levels are protected.

**H** When set, the auto/man status of the instrument is protected.

Use the up and down buttons to select the zones requiring protection. This completes the setting of the password scope. Note that if the password is not clear then all the parameters of the controller long scroll not mentioned above are protected by the password.

# SECTION B - SOFTWARE CONFIGURATION

## 6.0 General

The Series 2000 is capable of being configured as any of a multitude of different instruments. This is because all the software necessary to accommodate any of the sensor types, control formats and output types supported is built into the basic instrument. All that is required to produce a controller customised to a specific application is to fit the appropriate option boards (section D - hardware configuration), configure the instrument in 'E' mode and calibrate it.

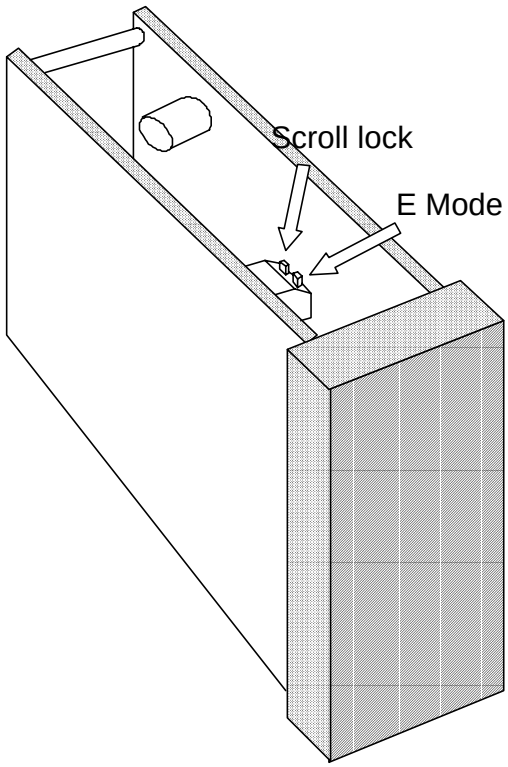
## 6.1 'E' Mode

'E' mode, or Engineers mode, is used to initially configure the instrument and modify seldom used parameters. It is also used for calibration.

To enter E mode, remove the instrument from its sleeve by undoing the two screws visible on the instrument front panel. The instrument should now withdraw smoothly.

It will now be seen that on the left hand board, is a two way DIL switch. Push down switch 1.

The instrument may now be replaced in its sleeve. The instrument is now in E mode, reset switch 1 to off to return the instrument to normal operating mode when required.




## 6.2 Lock mode

Next to the 'E' mode switch is the 'LOCK' switch. The purpose of this switch is to provide a means of protecting the parameters in the long scroll from unauthorised tampering. If the switch is on then no long scroll parameters can be modified from the front panel until the switch is turned off. In other words, the LOCK mode works as if a password with maximum scope had been set and could not be satisfactorily answered.

## 7.0 Emode parameter groups

The engineer mode scroll consists of a large number of parameters, so to improve ease and speed of use, the parameters are presented to the user in groups. At the start of each group, the group name is shown on the lower display with the upper display blank. Pressing the star button will gain access to the parameters within that group. Pressing the scroll button will advance the scroll to the start of the next group.

If the group is entered (by means of the star button), then the parameters are listed in sequence in the usual way when the scroll button is pressed. At the end of the group the group name is displayed again. This enables the user to re-enter the same group again if required.

Some parameter groups are always present ( such as the **IP** group ), while others are present only if they contain parameters applicable to the current instrument configuration.

## 7.1 Group 'IP'

The **IP** group contains the parameters used to set up the primary measurement input.

### 7.1.1 Input type

The first parameter listed in this group is **I-P**. This is the input sensor type and temperature units to be displayed. The number displayed is adjustable between 0 and 35. The meaning of this code is as follows.

| | | | | |
|---|---|---|---|---|
| 0 | Type S, | (Pt-10% Rh / Pt), | BS 4937, | -50 to 1767ºC |
| 1 | Type R, | (Pt-13% Rh / Pt), | BS 4937, | -50 to 1767ºC |
| 2 | Type J, | (Fe / Cu-Ni), | BS 4937, | -210 to 1200ºC |
| 3 | Type K, | (Ni-Cr / Ni-Al), | BS 4937, | -270 to 1373ºC |
| 4 | Type T, | (Cu / Cu-Ni), | BS 4937, | -270 to 400ºC |
| 5 | Type E, | (Ni-Cr / Cu-Ni), | BS 4937, | -270 to 1000ºC |
| 6 | Type B, | (Pt-30%Rh/Pt-6%Rh) | BS 4937, | 0 to 1820ºC |
| 7 | Type N, | (Ni-Cr-Si / Ni-Si) | BS 4937, | -270 to 1300ºC |
| 8 | Type W, | (W / W-26% Re) | | 0 to 2300ºC |
| 9 | Type W3, | (W-3% Re / W-25% Re) | | 0 to 2300ºC |
| 10 | Type W5, | (W-5% Re / W-26% Re) | | 0 to 2300ºC |
| 11 | Type NM, | (Ni / Ni-18% Mo) | | 0 to 1300ºC |
| 12 | Type L, | (Fe /Cu-Ni) | DIN 43710, | -200 to 900ºC |
| 13 | K10, | Type K in 1/10 C, | BS 4937, | -50.0 to 500.0ºC |
| 14 | T10, | Type T in 1/10 C, | BS 4937, | -50.0 to 400.0ºC |
| 15 | RT10, | (PT100) in 1/10 C, | BS 1904, | -150.0 to 260.0ºC |
| 16 | RT, | (PT100), | BS 1904, | -150 to 260ºC |
| | | | | |
| 17 | Type S, | (Pt-10% Rh / Pt), | BS 4937, | -58 to 3200ºF |
| 18 | Type R, | (Pt-13% Rh / Pt), | BS 4937, | -58 to 3200ºF |
| 19 | Type J, | (Fe / Cu-Ni), | BS 4937, | -340 to 2150ºF |
| 20 | Type K, | (Ni-Cr / Ni-Al), | BS 4937, | -450 to 2500ºF |
| 21 | Type T, | (Cu / Cu-Ni), | BS 4937, | -450 to 750ºF |
| 22 | Type E, | (Ni-Cr / Cu-Ni), | BS 4937, | -450 to 1800ºF |
| 23 | Type B, | (Pt-30% Rh / Pt-6% Rh) | BS 4937, | 32 to 3300ºF |
| 24 | Type N, | (Ni-Cr-Si / Ni-Si) | BS 4937, | -450 to 2350ºF |
| 25 | Type W, | (W / W-26% Re) | | 32 to 4150ºF |
| 26 | Type W3, | (W-3% Re / W-25% Re) | | 32 to 4150ºF |
| 27 | Type W5, | (W-5% Re / W-26% Re) | | 32 to 4150ºF |
| 28 | Type NM, | (Ni / Ni-18% Mo) | | 32 to 2350ºF |
| 29 | Type L, | (Fe /Cu-Ni) | DIN 43710, | -300 to 1650ºF |
| 30 | K10, | Type K in 1/10 F, | BS 4937, | -58.0 to 400.0ºF |
| 31 | T10, | Type T in 1/10 F, | BS 4937, | -58.0 to 400ºF |
| 32 | RT10, | (PT100) in 1/10 F, | BS 1904, | -148.0 to 500.0ºF |
| 33 | RT, | (PT100), | BS 1904, | -148 to 500ºF |
| 34 | Linear | | | |
| 35 | Root | | | |

### 7.1.2 Cold junction compensation

A press of the scroll button scrolls to the next parameter, **CjC**. This parameter will only be presented if a thermocouple input type is selected. The normal setting for this is **Auto**, since

the instrument will then automatically compensate for the temperature of the cold junction at the instruments rear terminals. Fixed cold junction compensation temperatures of **0ºC**, **20ºC** and **50ºC** are also provided.

### 7.1.3 Input high and low scalars

Linear and root input ranges must be scaled to suit the users application. Unless otherwise specified, the instrument is shipped from the factory with the default scaling of 0 to 1000.
**IPLH** is the input high scalar and should be set to the value which the instrument is required to display at 100% input.
**IPLL** is the input low scalar and should be set to the value which the instrument is required to display at zero input.

For example. If the instrument is connected to a transducer which transmits 4 - 20mA equivalent to 200ºC - 1600ºC, then **IPLH** should be set to 1600 and **IPLL** should be set to 200.( also the input **bias** should be set to 20%. see 7.1.6)

There are a few rules which must be obeyed when setting **IPLH** and **IPLL**:-

1. **IPLH** must be greater than **IPLL**.
2. **IPLH** minus **IPLL** must not be too large. (The instrument will warn the user if this is true by means of a fault code. see Appendix A)
3. **IPLH** must be greater than zero.

### 7.1.4 High and low setpoint limits

The high and low setpoint limits **SPLH** and **SPLL** are the limits outside which the setpoint cannot be set. They should be set to the maximum and minimum safe limits for the plant and its contents. The values of these limits are set by default to the max and min of the input sensor range selected.

### 7.1.5 Decimal point

If a linear or root range has been chosen, then the parameter '**dPnt**' will be displayed. This enables the user to position the decimal point as desired using the up and down buttons to provide a display with a custom scale.

### 7.1.6 Input Bias

**bIAS** can be set as a percentage between 0 and 25% if the input type is root or linear. This allows the input to be scaled for live zero signals such as 4 to 20 mA. in this example, 4mA being 20% of 20mA, if '**bIAS**' were set to 20(%) then an input of 4mA would be taken as 0 and an input of 20mA as 100%. For true zero inputs, set the bias to 0.

## 7.2 Group 'Cont'

The **Cont** group contains primary controller and programmer setup information.

### 7.2.1 Number of profiles (P2000 only).

The parameter **Prog** is used to specify the number of programs available to the operator from one to the maximum allowed.

### 7.2.2 Control format

**CtyP** may be set to any of the following types.

**AHS** The instrument behaves as an auto/manual station. In auto the instrument will retransmit the measured input ( as a percentage of the setpoint range SPLH to

SPLL) to the selected control output. In manual, the operator has sole control of the control output.

**So** The PID controller provides a single control output.

**HC** The PID controller provides Heat and Cool outputs.

**VP** The PID controller provides two outputs (raise and a lower) to position a motorised valve (with or without slidewire feedback).

**rAt** The controller provides an air setpoint output for connection to an air temperature controller in a thermal head ratio system.

### 7.2.3 Control action

If the control format is of 'single output' or 'valve positioner' types, then **CAct** provides a means of causing the control action to be **F'd** (forward) or **rev** (reverse)

### 7.2.4 Tuner enable/disable

A one shot and adaptive autotuner is available for use with all proportional controller types. The **tunE** parameter allows this feature to be enabled or disabled as required.

**diSb** The tuner is disabled and may not be invoked from long scroll.

**EnbL** The tuner is enabled and appears in long scroll.

## 7.3 Group 'IO'

This group contains the parameters to configure the input/output slots. The Series 2000 has three general purpose slots available called SLOT1, SLOT2 and SLOT3. Each slot can be programmed as a two channel digital output, a single channel analogue output or a single channel analogue input. The parameters present in this group are used by the instrument to direct the required inputs and outputs to the correct slots.

### 7.3.1 Slot 1 type

Parameter SLt1 is used to set the slot 1 outputs to be analogue or digital.

**diG** The slot is to be a two channel digital output slot defined as channels A & B.

**An** The slot is to be a single channel analogue output.

### 7.3.2 Slot 1 digital channel A function

If slot 1 is set to be digital, then parameter ChA selects the function of the channel A part of the card. Please note that this output function will be repeated as the slot 3A digital function.

**OFF** no option board fitted in this slot
**tP** time proportional output
**H-tP** heat, time proportional output
**C-tP** cool, time proportional output
**OPEn** valve positioner, open valve.
**SHUt** valve positioner, shut valve.
**AL-1** alarm 1 output
**AL-2** alarm 2 output
**EVnt** event, Programmer single internal event output

**E-dr** event driver, Programmer external event driver

Note the actual options presented by the instrument will depend upon the controller type selected earlier.

### 7.3.3 Slot 1 digital channel B function

If slot 1 is set to be digital, then parameter Chb selects the function of the channel B part of the card.
The parameter meanings are the same as for channel A.

### 7.3.4 Slot 1 analogue function

If slot 1 is set to be analogue, then parameter tyPE selects the function of the analogue output.

**An** analogue. Voltage or current output
**H-An** heat, analogue. Voltage or current output
**C-An** cool, analogue. Voltage or current output
**rEtr** retransmission voltage or current output
**rAt** thermal head ratio air setpoint, voltage or current output

### 7.3.5 Slot 2 type

Parameter SLt2 is used to set the slot 2 outputs to be analogue or digital.

**diG** The slot is to be a two channel digital output slot.

**An** The slot is to be a single channel analogue output.

### 7.3.6 Slot 2 digital channel A function

If slot 2 is set to be digital, then parameter ChA selects the function of the channel A part of the card.
The parameter meanings are the same as for slot 1.

### 7.3.7 Slot 2 digital channel B function

If slot 2 is set to be digital, then parameter **Chb** selects the function of the channel B part of the card.

The parameter meanings are the same as for channel A.

### 7.3.8 Slot 2 analogue function

If slot 2 is set to be analogue, then parameter **tyPE** selects the function of the analogue output.
The parameter meanings are the same as for slot 1.

### 7.3.9 Slot 3 type

Parameter **SLt3** is used to set the slot 3 function to be analogue or digital.

**diG** The slot is to be a two channel digital output slot.

**An** The slot is to be a single channel analogue output.

**IP2** The slot is to be used as analogue input 2.

### 7.3.10 Slot 3 digital channel A function

If slot 3 is set to be digital, then parameter **ChA** selects the function of the channel A part of the card. This slot channel is a repeat of the slot 1A digital function.

The parameter meanings are the same as for slot 1.

### 7.3.11 Slot 3 digital channel B function

If slot 3 is set to be digital, then parameter **Chb** selects the function of the channel B part of the card.
The parameter meanings are the same as for channel A.

### 7.3.12 Slot 3 analogue output function

If slot 3 is set to be an analogue output, then parameter **tyPE** selects the function of the analogue output.
Since slot 3 is a low resolution output the following options alone are available.

**An** analogue. Voltage or current output
**H-An** heat, analogue. Voltage or current output
**C-An** cool, analogue. Voltage or current output

### 7.3.13 Slot 3 analogue input function

If slot 3 is set to be an analogue input, then parameter **tyPE** selects the function of the analogue input.

**r-SP** analogue remote set point input
**S-Fb** valve positioner, slidewire feedback input card
**E-Pr** external program select input (P2000 only)

The following is a table of which functions are permitted in each slot.

| | SLOT | | | | | |
|---|---|---|---|---|---|---|
| FUNCTION | 1A | 1B | 2A | 2B | 3A | 3B |
| HEAT TP | * | | | | * | |
| HEAT ANALOGUE | * | | * | | * | |
| COOL TP | | * | * | | | * |
| COOL ANALOGUE | * | | * | | * | |
| VALVE OPEN | * | | | | * | |
| VALVE CLOSE | | * | | | | * |
| ALARM 1 | * | * | * | * | * | * |
| ALARM 2 | | * | * | * | | * |
| RETRANSMIT | * | | * | | | |
| RATIO OUT | * | | * | | | |
| REMOTE SETPOINT | | | | | * | |
| SLIDEWIRE | | | | | * | |
| INTERNAL EVENT | P | P | P | P | P | P |
| EXT' EVENT DRIVER | | | | P | | P |
| REM' PROGRAM SELECT | | | | | P | |

NOTE. The function specified in slot 1A is duplicated in slot 3A since these two slots are physically wired to the same output pin.

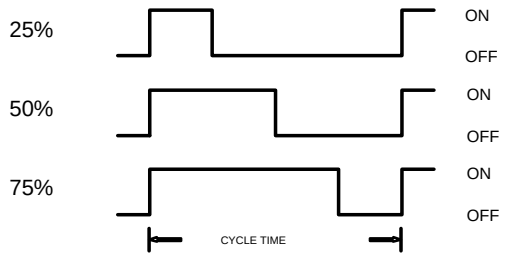
### 7.3.14 Time proportional output type

If a slot is defined as a time proportional output then an extra parameter **htPt** is displayed. This is used to select the type of time proportional output required **CyC** or **ton**.

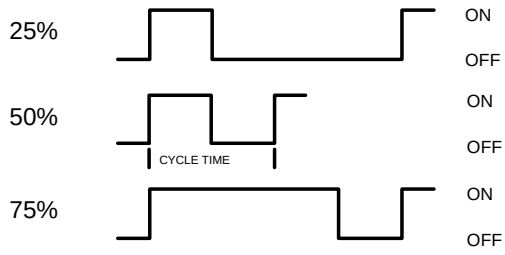
**CyC**.(Constant cycle time). The TP algorithm attempts to maintain a constant cycle time (set as **HCyC** or **CCyC**), except when the ON time falls below the time selected in **tPon**, in which case the OFF time is extended pro rata.

**ton**.(Constant on/off time). The TP algorithm maintains a constant ON time (for output powers between 0 to 50%) or a constant OFF time (for output powers between 50 and 100%). In either case the minimum ON or OFF time is never smaller than half of the set cycle time **HCyC** or **CCyC**. For this type of TP output the cycle time is defined only at 50% output power.

**CONSTANT CYCLE TIME PROPORTIONAL OUTPUT**




**CONSTANT TON/TOFF TIME PROPORTIONAL OUTPUT**




### 7.3.15 Constant cycle TP minimum on time

If any slot is configured as a TP output of constant cycle time, then a small minimum on time may be set using the parameter **tPon**. The purpose of this parameter is to prevent the control device (such as a contactor) from receiving pulses from the controller which are too short for it to respond. If, on small output power levels, the time proportional ON time tries to fall below the set minimum value, then the tp OFF time will be extended to preserve the correct ON/OFF ratio. This has the effect of lengthening the perceived cycle time. The minimum on time is programmable on slot 1A from 0.02 to 0.30 seconds in increments of 20mS, and from 0.05 to 0.75 seconds in increments of 50mS on any other slot.

### 7.3.16 Live and True zero analogue control outputs

If any of slots 1 to 3 were configured as analogue control outputs then, after each slot the Zero will be present. This refers to a live or true zero being used for the analogue output of the current slot. The options are as follows;

**LIVE** When set to live, the analogue output set in the previous scroll element will have a fixed live zero of 20% This means that if, for example, the analogue output was a 0 - 20mA type, then when zero control output was required, 4mA would be delivered, thus turning the 0 - 20mA output into a 4 - 20mA one.

**TrUE** When set to true, the analogue output set in the previous scroll element will have a true zero. This means that if, for example, the analogue output was a 0 - 20mA type, then when zero control output was required then 0mA would be delivered.

## 7.4 Group 'dinS'

### 7.4.1 Digital inputs

**din1** and **din2** are the two digital inputs which are always available on the Series 2000 instrument. These inputs may be configured to control a variety of features on the instrument usually controlled by hand. When the digital input is used to control a feature then it has absolute priority and manual control of the feature will be disabled. If the two digital inputs are configured to control the same feature, then digital input 2 will override input 1.

**OFF** this digital input is unused

**A-H** Auto-Hand Select.
When contact is made MANUAL mode is selected.
When contact is broken AUTO mode is selected.

**r-SP** Remote setpoint select.
When contact is made the controller is forced to obey its REMOTE setpoint type set as parameter **StyP**.
When contact is open the controller obeys its LOCAL setpoint.

**HOld** Profile hold (P2000 only).
When contact is made the executing profile will be held.

**A-tU** Auto tune enable.
When contact is made the adaptive tuner is enabled.
When contact is open the adaptive tuner is disabled.

**SCrL** Scroll Lock.
When contact is made all of the parameters in the controller long scroll are protected and may not be altered from the front panel.
When contact is open normal password security is active.

**F-OP** Freeze Output.
When contact is made the controller is frozen at its present value.
When contact is open the controller operates normally.

**UL-A** Unlatch alarms.

When contact is made latched alarms will be unlatched and inhibited from latching.

**In-A** Inhibit alarms.
When contact is made all alarms are inhibited from operating. Latched alarms are left latched.

**A-OP** Select Auxiliary output.
When contact is made the controller output is forced to the Auxiliary output power selected. See para 4.2.

**A-SP** Select Auxiliary setpoint.
When contact is made the controller uses the selected auxiliary setpoint.
When contact is open the controller uses the normal setpoint.

**Strt** Profile Start.(P2000 only)
When contact is made the profile generator will start execution of the selected program.

**L-OP** Auxiliary low output limit.
When contact is made the auxiliary output setting is used as a low limit for the current control output.

**H-OP** Auxiliary high output limit.
When contact is made the auxiliary output setting is used as a high limit for the current control output.

**d-rA** Disable Ramp.(S2000 only)
When contact is made the setpoint ramp facility is disabled.

**Stop** Profile Stop.(P2000 only)
When contact is made the profile generator will cease program execution and return to the ready state.

**St-H** Profile Start/Hold.(P2000 only)
This is a double function input.
If the profile generator is in the ready state.
When the contact is made the profile generator will commence execution of the selected program.
If the profile generator is running when the contact is made then profile execution will be held.

**run** Profile Run/Reset.(P2000 only)
When the contact is made the selected profile will be started and run until an end segment is encountered at which point the setpoint will be frozen at the last target value before the end segment.
When the contact is open the profile will be stopped and held in the ready state.

**StEP** Profile Segment Step.(P2000 only)
When the contact is made the currently running profile will step to the start of the next segment. One step per contact closure will be performed.

## 7.5 Group 'ALrS'

### 7.5.1 Alarms in general

The S2000 controller/P2000 programmer has the ability to drive two independent alarms implemented as relay outputs or isolated logic drivers. They may be configured to be energised or de-energised on alarm, and be latching or non latching. They may be of type high, low or indexed (high, low or both) alarms, and have independent hysteresis. In addition, there are several miscellaneous alarm functions available. The following configuration parameters will appear in the 'E' mode scroll if the alarm option **AL-1** or **AL-2** have been allocated to any of the slots. (See para 7.3)

### 7.5.2 Alarm sense and latching

A1SE and A2SE sense may be set to the following:

| | |
|---|---|
| **nE** | non-latching, energise on alarm |
| **nd** | non-latching, de-energise on alarm |
| **LE** | latching, energise on alarm |
| **Ld** | latching, de-energise on alarm |

### 7.5.3 Alarm type

**A1ty** and **A2Ty** may be set to the following

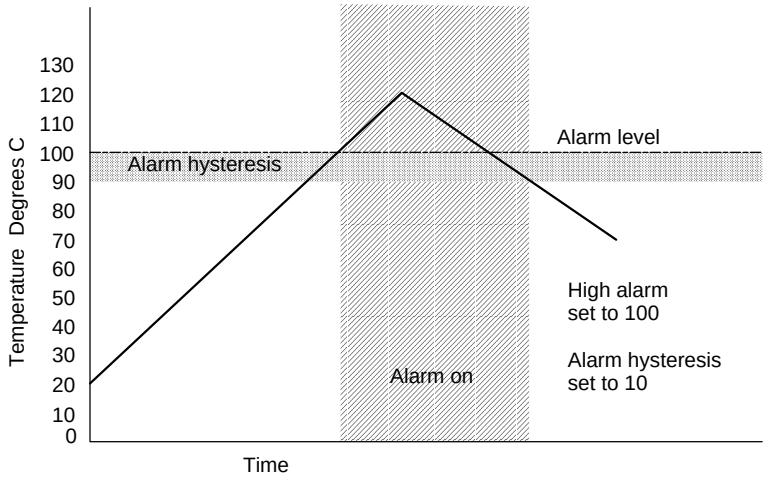
| | |
|---|---|
| **HI** | alarm when PV >= alarm level |
| **LO** | alarm when PV <= alarm level |
| **ind** | alarm when PV >= setpoint + alarm level or PV <= setpoint - alarm level |
| **in-h** | alarm when PV >= setpoint + alarm level |
| **in-L** | alarm when PV <= setpoint - alarm level |
| **H-A** | hand (manual) acknowledge. Alarm when controller is in manual. |
| **RE-A** | Remote setpoint acknowledge. Alarm when the control setpoint is a function of the remote setpoint. |

***The following further alarm types are only available on a P2000 Programmer. These alarm types may not be latched or have inverted sense.***

| | |
|---|---|
| **P-rL** | alarm output will be on when profile is running |
| **r-rL** | alarm output will be on when profile is ready (not running) |
| **U-rL** | alarm output will be on when profile setpoint is ramping up |
| **d-rL** | alarm output will be on when profile is ramping down |
| **S-rL** | alarm output will be on when profile is in a soak (dwell) |

### 7.5.4 Alarm hysteresis

A1Hy and A2Hy are the hysteresis values for alarm levels 1 and 2. This may be set between 0 and 100 displayed units (for example degrees), and is the amount the process variable (measured value) must return within the alarm threshold after exceeding it, before the alarm condition is removed. For example, if alarm 1 were set to be a high alarm at 100 C and alarm 1 hysteresis for alarm 1 set to 10 ( C) then a process temperature rising from 20 C to 120 C will cause an alarm to be generated when the temperature gets to 100 C. If the process temperature then falls to 50 C the alarm will be maintained until the temperature reaches 90 C, below which the alarm would be cleared. (If the alarm were of the latched type then the alarm would be maintained until cleared externally (see 7.12.4) .

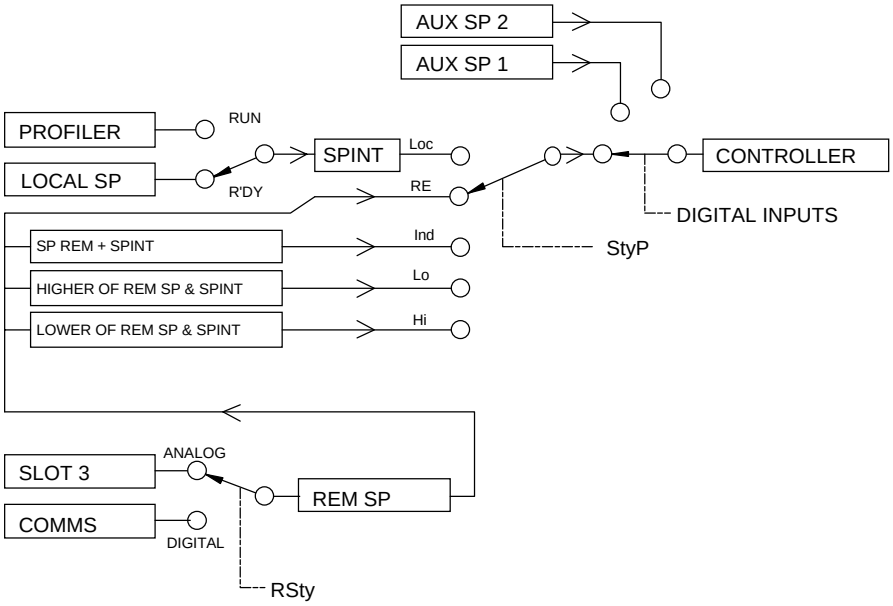



### 7.5.5 Unlatching alarms

An alarm set to be latching, when triggered, will continue to indicate an alarm until manually unlatched. This may be achieved in one of three ways; via serial comms (see the S2000/P2000 communications manual), by operating an appropriately configured digital input (see para 7.4 of this manual) or by operating the star button when the alarm level of the latched alarm is being displayed in the controller long scroll. The alarm will be automatically unlatched if the mains power is removed from the instrument.

## 7.6 Group 'rSP'

### 7.6.1 Remote set points in general




The Series 2000 instrument may have many different setpoint sources for its internal controller. Setpoints may be input from external devices in either digital or analogue form and combined with the internal setpoints in various ways before being passed to the controller.

### 7.6.2 Remote set point type

**rSty**, The type of remote set point, may be set from the list presented. Options will include any that are valid, in particular, analogue remote set point will only be included if slot 3 is occupied by the remote set point, **r-SP**. The following is the fullest list of options that will ever be offered.

**OFF** no remote set point used
**dIG** Digital remote set point via digital serial comms.
**A-bt** Analogue remote set point, via remote setpoint card, Bipolar, (input swings both sides of zero) True zero (no input offset).
**A-Ut** Analogue remote set point, via remote setpoint card, Unipolar, (input is always positive) True zero (lowest magnitude input is zero).
**A-UL** Analogue remote set point, via remote setpoint card, Unipolar, (input is always positive) Live zero fixed at 20%. (lowest magnitude input is some percentage of maximum).

### 7.6.3 Remote set point limits

The next two parameters in the configuration scroll are the remote set point high and low range limits, **rSHI** and **rSLO** (+9999 to -9999). These will be included in the configuration scroll as long as remote set point type, **rSty**, is not set to **OFF**.

These parameters are scaling factors for the remote set point input and quite separate from the setpoint limits encountered earlier. Their purpose is to specify the resulting range of remote set point for the full span of the input. For example, if the remote set point input is of a 0 - 10V type, and is configured in software as a unipolar true zero type, (positive input only, minimum input = 0V) then the remote set point with 0V input would be whatever is set for **rSLO**, and with 10V input then the remote setpoint would be whatever is set for **rSHI**.

In this way any convenient input could be used to produce the range of remote setpoint required. For example, if the desired range of resulting remote setpoint was -1000ºC to +1000ºC, it is not necessary to use a bipolar input. Simply set **rSLO** to -1000 and **rSHI** to +1000, then with the 0 -10V unipolar true zero input, a remote setpoint of -1000 would result from a 0V input and a +1000 remote setpoint from a 10V input.

## 7.7 Group 'rEtr'

### 7.7.1 Retransmission

If any slot is dedicated to **rEtr**, (retransmission) then the controller may be configured to retransmit one of a number of parameters as an analogue voltage. The retransmission range and bias are set in software.

### 7.7.2 Retransmission parameter

**PAr**, the retransmission parameter dictates which of the parameters are to be retransmitted.

**OFF** no retransmission
**PrOC** Process variable, the value of the controlled process
**SP** set point, current set point value being used
**Err** error, the difference between the process variable and the set point
**OP** The current output level in %. Note this value can be negative on a heat/cool type controller.
**USEr** The value to be retransmit is supplied by the user via the serial communications parameter 'M'.

### 7.7.3 Retransmission limits

The next two parameters in the configuration scroll are the retransmission high and low range limits, **rtHi** and **rtLo** (+9999 to -9999). These will be included in the configuration scroll as long as the retransmission parameter, **PAr**, is not set to **OFF**. The selected parameter is scaled between these limits before retransmission to provide 100% output when the selected parameter has a value greater than or equal to **rtHI** and 0% output when less than or equal to **rtLo**.

Note. The user may specify **rtLo** to be greater than **rtHi**. This has the affect of inverting the retransmission output.

### 7.7.4 Retransmission bias

The next configuration parameter is retransmission bias, **bIAS**. This may be used to provide a live zero output. If, for instance, the retransmission output has been arranged to provide a 0 to 20mA output over the range of values of interest, then if the retransmission bias is set to 20% the output will now be 4 to 20mA.

## 7.8 Group 'ConS'

### 7.8.1 Digital serial communications

All Series 2000 instruments are equipped with digital serial communications as standard. If this feature is used then the following parameters should be set up to suit the device to which the instrument is connected.

**bAUd** select the baud rate required

**AddrS** select the controller address required, between 0 and 99. Bear in mind if it is desired to address groups of instruments simultaneously by use of the wildcard address then the address must be selected accordingly. (see the S2000/P2000 communications manual provided with the instrument).

Remember that with a P2000 the address set relates to the ***controller*** part of the instrument and the ***profile generator*** part of the instrument will have an address of the controller address+16.

### 7.8.2 Digital setpoint retransmission (P2000 Only

It is possible to utilise the serial communications facility to transmit the profile setpoint to one or more remote controllers. This however precludes the use of the serial communications network with a host computer.

The parameter **Sout** is provided to direct the digital setpoint to the controller group required.

**OFF** Digital setpoint transmission is disabled.

**1**_ The setpoint is directed to instruments with addresses 10 to 19 inclusive.
up to
**9**_ The setpoint is directed to instruments with addresses 90 to 99 inclusive.

External instruments required to receive this digital setpoint should be set up with remote setpoints of type **diG**.

# SECTION C - PROGRAMMING THE PROFILE GENERATOR

## 8.0 General

Although the Series 2000 instrument can be employed to control a wide variety of variables, for the sake of simplicity this explanation will assume that the process variable being controlled is temperature. The P2000 programmer creates a time/temperature profile from a sequence of time and temperature (level) co-ordinates. the resultant profile therefore consists of linear rates of change of temperature with time. Each linear section of the profile is referred to as a segment.

The following three aspects of operation are fairly complex and should be fully understood if the behaviour of the instrument is not to be confusing

## 8.1 Start sequence

When the profile generator is in it's ready state (ie a profile is not running and the '**Stat**' element of the short scroll shows **r'dy**) then the controller obeys its internal (local or remote) setpoint. When the start instruction is given a complex sequence of events occurs that results in the controller obeying the profile generator setpoint. The start sequence is:

1. Scroll through the short scroll until the 'Prog' element is displayed. Now use the up and down buttons to select the number of the program to be started.

2. The profile may be started in one of three ways: Manually by pressing and holding the star button and momentarily pressing the up (START) button, via serial communications by sending a 'SXXS<CR>' string to the profile generator (where XX is the address of the profile generator) or via one of the instruments digital inputs when it is configured as a START or a START/HOLD function. See para 7.4, Digital inputs.

3. The controller continues to obey its internal setpoint until the delay start time has elapsed

4. When the delay start time has elapsed the instrument advances to the first segment of the profile.

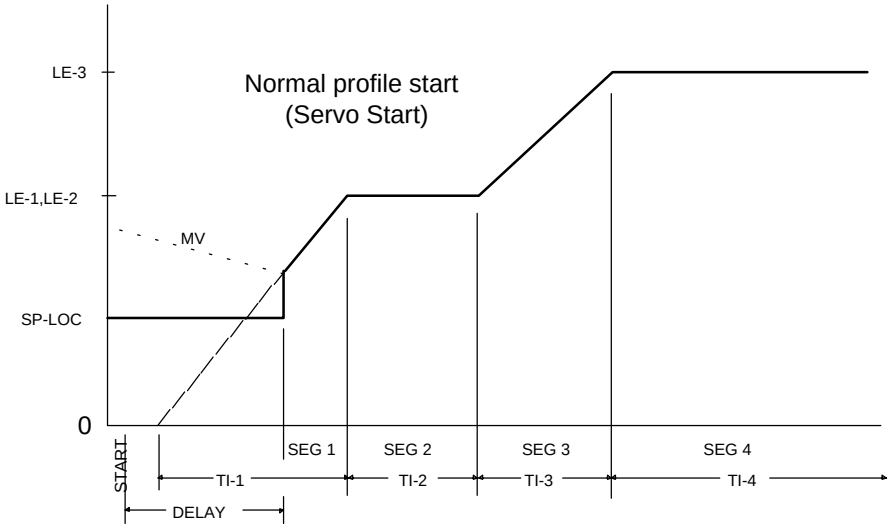
5. If the time of the first segment (**ti 1**) is zero then the profile step changes immediately to the first segment's level (**LE 1**) and the controller henceforth obeys the profile generator setpoint. The profile then advances and begins execution of the second segment.

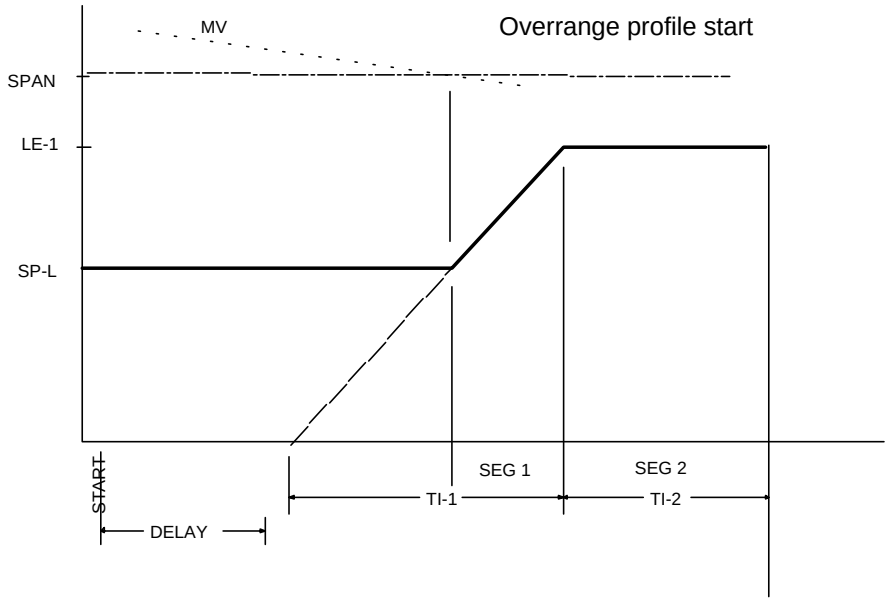
6. If the time of the first segment (**ti 1**) is not zero then the instrument considers the measured value.

7. If the measured value is within the nominal range of the instrument then the profile setpoint jumps to equal the measured value and henceforth the controller obeys the profile generator setpoint. The profile then executes the first segment. The first segment will be a ramp that begins at the measured value and ends at segment 1 level (**LE 1**). ***The rate of the first segment will be as if segment 1 had started from a level of zero.***

8. If the measured value is outside the nominal range of the instrument then the profile setpoint jumps to equal the local setpoint and henceforth the controller obeys the profile generator. Since the measured value is out of range, the profile generator goes into a hold condition and the profile remains stationary. When the measured value comes into range

the hold condition is freed and the profile executes the first segment. The first segment will be a ramp that begins at the local setpoint and ends at segment 1 level (**LE 1**). ***The rate of the first segment will be as if segment 1 had started from a level of zero.***




## 8.2 Supply interruption

If the mains supply to the instrument is interrupted whilst a profile is being executed then a complex sequence of events occurs that attempts to minimise the disturbance to the process. ***The instruments behaviour after a supply interruption will result in an unexpectedly long total profile time.*** Upon restoration of the supply the sequence is:

1. The instrument delays for approximately 10 seconds whilst other controllers etc recover after the mains failure.

2. If the interrupted segment is a ramp and the measured value is within the nominal range and a hold is in existence, then the profile setpoint is made equal to the measured value, (Servo Start) and the ramp continues at the previous rate towards the segments target level.

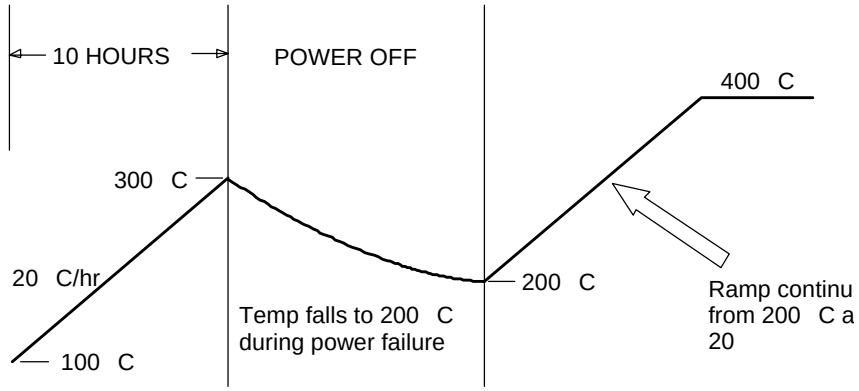
3. If the interrupted segment is a ramp and the measured value is out of range then the profile remains at the point it had reached before the interruption. Since the measured value is out of range the profile generator goes into a hold condition and the profile remains stationary. When the measured value comes within range the ramp continues.

4. If the interrupted segment is a dwell and the measured value is within the nominal range and a hold is in existence, then the profile setpoint is made equal to the measured value (Servo Start). The profile generator then calculates the rate of the last ramp performed and then brings the profile back to the dwell level at that rate. If the last ramp happened to be a step change then the profile step changes. Once the dwell level is reached then the dwell continues from where it was interrupted.

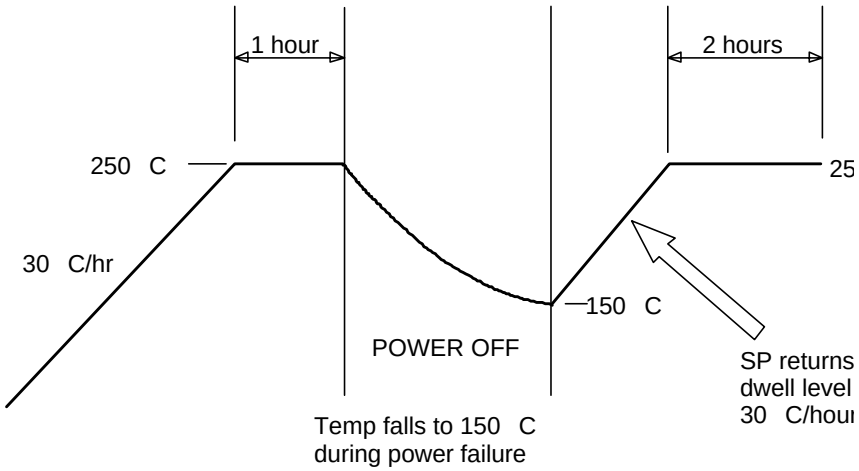
5. If the interrupted segment is a dwell and the measured value is out of range then the profile remains at the dwell level. Since the reading is out of range the profile generator goes into a hold condition; when the measured value comes back into range the dwell continues from where it was interrupted.

6. If, on recovery after a mains failure no hold conditions exist, then it is assumed that the mains failure was of very short duration and therefore the instrument does not servo start, but continues with the profile as if nothing had happened

INTERRUPTION OF RUNNING RAMP




INTERRUPTION OF A 3 HOUR DWELL PERIOD




## 8.3 Hold condition

At certain times during the execution of a profile, the profile generator may go into a hold condition. ***A hold condition causes the normal progress of the profile to be modified and the total duration of the profile will longer than expected.*** When the instrument is in hold the decimal points on the upper display will flash to indicate this. Holds can originate from any of three sources:

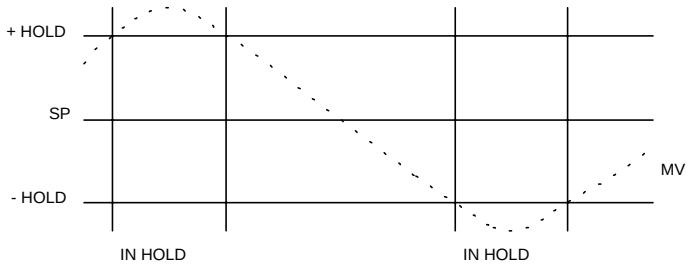
1. A communicating profile generator may have its running profile held via the serial communications link by sending a 'SXXH<CR>' to it (where XX is the address of the profile generator, ie 16 greater than the address of the controller). This hold is freed by sending a 'SXXF<CR>' to the instrument or upon cycling of the mains supply.

2. A hold may be generated via a contact closure on one of the instruments digital inputs. In order for this to work, the appropriate digital input must be configured in 'E Mode' as a Hold. A digital input could also be configured and used as a 'Start/Hold'. see para 7.4, Digital inputs.

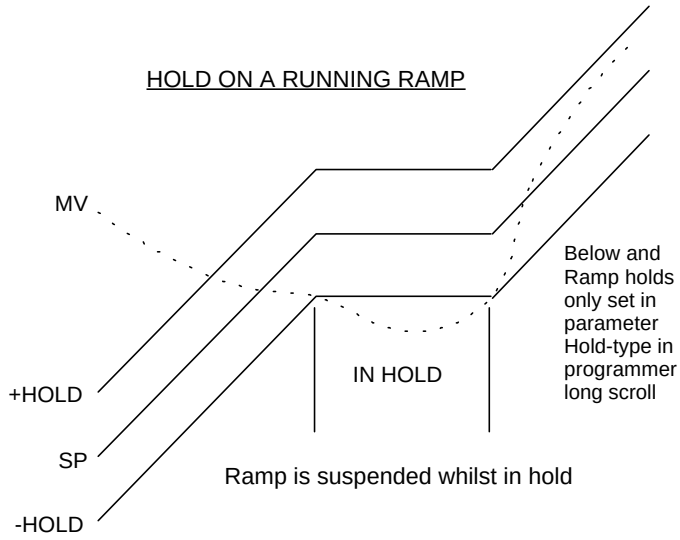
3. A hold will be generated internally by the profile generator if the difference between the measured value and the control set point exceeds the hold band parameter set in the programmer long scroll ***and*** the hold is active for an error in that direction (Above or Below) as set on the hold-type parameter in the programmer long scroll ***and*** the part of the profile currently executing (Ramp or Dwell) is also set on the hold-type parameter in the programmer scroll.

4. If a hold occurs during a ramp segment then the ramp will remain stationary for the duration of the hold. If a hold occurs during a dwell then the dwell time is extended by an amount equal to the period of the hold.

Holds during a dwell




Dwell timer suspended during hold. Note that 'Above', 'Below' and 'Dwell' holds at least are set on in the hold-type parameter of the programmer long scroll.




## 8.4 Ending a profile

A profile can be ended manually at any time during the profile or can be programmed to end at any segment of the profile. The profile will also end as a matter of course when the last segment finishes or an end segment is encountered. When the profile ends control reverts to the controllers local set point and the profile generator becomes ready. The profile may be ended by:

1. Holding the star button pressed and pressing the down (STOP) button.

2. Closure of a contact on one of the instruments digital inputs which has been configured as a 'STOP'. See para 7.4, Digital inputs.

3. Via the serial communications facility by sending a 'SXXR<CR>' string to the programmer (where XX is the programmer address).

4. Encountering an END instruction programmed into the profile. A segment is programmed with an end instruction if the segments time is reduced down to and past zero so that the lower display shows the mnemonic 'End'. The end instruction tells the programmer to see if the profile is to be repeated, and if so, if the required number of repeats are done. If there are no repeats, or if they have all been done then the profile ends.

## 8.5 Repeating the profile

The profile is always run once when the start instruction is given, but it can also be programmed to repeat itself up to 999 times by setting the 'rEPS' parameter in the programmer scroll to the required number of repeats. 0 means don't repeat at all. The profile will execute until either the last segment has finished or an 'End' or 'Go' instruction is encountered. At this point the profile returns to segment 1 and begins again

If the first segment is a step change then all repeats of segment 1 will be a step change; these steps will be from the last segments level to segment 1's level

If the first segment is a ramp then all repeats of segment 1 will be a ramp; these ramps will be from the last segments level to segment 1's level in segment 1's time.

While the profile is running the value of parameter 'rEPS' remains unchanged, but the number of repeats remaining can be seen by viewing this parameter and pressing the star button. When the profile generator returns to the ready condition the number of repeats are restored.

## 8.6 Chaining profiles

If the segments available in one program are not enough for the profile desired then two or more programmes may be linked together to form a more complex profile. A segment may be set to a '**Go**' if the segment's time is reduced down to and past zero to '**End**' and then further down to '**Go 9**', '**Go 8**' etc down to '**Go 0**'.

A program segment is set to a **Go** in place of an **End**. When the executing program encounters a **Go** segment it checks to see if any repeats are left, and if so these are performed between segment 1 and the **Go** segment. When all the repeats are complete (or if there are none) then program control is transferred to the start of the program number specified in the **Go** segment, this new program will have its own unique number of repeats and may include its own **Go** segment to transfer control to yet another program.

## 8.7 Delay start timer

The programmer may be set to run a profile at some convenient time in the future. For example, if the time is now 4:30 pm and it is desired to run a process that we know lasts 2 hours so that it just completes in time for the start of work tomorrow morning at 8:00, clearly we would like the profile to begin in 13 hours 30 minutes time. To achieve this, simply select the program required to be run in the short scroll, enter the programmer long scroll and set the first element (**dELy**) to 13.30 and exit the long scroll. Now start the profile and we know that the instrument will continue to control at the local set point until the profile generator takes over the process at 6 am and that the process will just complete in time for our 8 o'clock start

# SECTION D - HARDWARE CONFIGURATION

## 9.0 General

The S2000 controller/P2000 Programmer consists of a basic model which is capable of being configured as many different types of instrument and expanded using option cards. Only the option cards required for performing the desired task are fitted and waste is therefore minimised.

The S2000 Controller/P2000 Programmer comprises a 'basic' instrument, which consists of a circuit board assembly that slides into channels in a metal case and plugs into the terminal assembly at the rear. The board assembly, which has the display unit fixed to the front of it, is then held in place with the two captive screws visible on the front panel.

## 9.1 Gaining access to the option boards

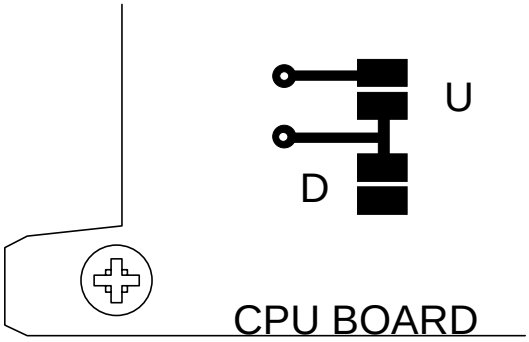
In order to gain access to the option boards the instrument must be removed from its case. This is achieved by unscrewing the two captive screws on the front panel, the instrument may then be drawn out from the case

On the power supply board are three 'slots', slot 1, slot 2 and slot 3. These are positions in which an options board may be fitted.

## 9.2 Broken sensor drive selection

On the CPU (PC 1575) board there is provision for the selection of sensor burn out direction. This is the direction in which the measured input signal will move if the thermocouple sensor should break. On most systems using reverse acting control this should be up scale. Systems using forward acting control, or other special cases, may require down scale burnout.
Linear or resistance thermometer inputs should have the burnout drive disabled.

The burnout direction is selected by bridging the 'blob pads' as required. To select upscale drive, then bridge the pads marked **U** with an excess of solder. To select downscale drive bridge the pads marked **D**. For no drive then bridge neither pad. **DO NOT BRIDGE BOTH PADS.**




## 10.0 Options boards

There are 7 different options boards which provide the additional facilities on the S2000 Controller. Each board is provided with two plastic spacers, so it is simply clicked into place. They available I/O boards are as follows;

### 10.1 Two form A Relay board PC1578

This board provides two form 'A' (normally open) relay outputs. Both relays share a common and have a C-R snubber circuit fitted from each contact to common. The relay board option may be used to provide time proportioning control outputs, alarm outputs and motorised valve drive.

### 10.2 Remote setpoint board PC1580

This board enables the instrument to accept a remote analogue set point. The standard input to the board is ±10V, but if the push-on jumper link is fitted then the input range is changed to ±1V. The input is isolated from all other supplies and decoupled to earth.

### 10.3 Analogue output board PC1579

This board enables the controller to generate an analogue output, 0 to 20mA or, if the two push-on links are fitted, 0 to 10v. The output is isolated from all other supplies and decoupled to earth.

### 10.4 Slide wire input board PC1581

This board enables the instrument to accept position feedback from a motorised valve with slide wire feedback. The board provides three wire connection to an unpowered slide wire as the board provides its own supply. The input is isolated from all other supplies and decoupled to earth.

### 10.5 Isolated logic output board PC1582

This board provides two 'logic' outputs. Providing a nominal 12V for driving Solid State Relays etc. and the External Event Module. The 12v outputs are current limited to a nominal 20mA. Both outputs are isolated from all other supplies and decoupled to earth.

### 10.6 Remote program select input board PC1580A

This board may only be fitted to P2000 instruments and enables the user to select remotely the profile number to be run by the instrument. The input is actually an analog input with a link selectable 1V or 10V span. For a board set to the 10V range, the program number is selected at the rate of 0.4V per program allowing programs 0 to 24 to be selected remotely by a plc or other means. For example an input of 0V +/- 0.1V will select program 0, and an input of 4V +/- 0.1V will select program 10.
For front of panel selection the 'FGH remote program selector switch' card PC1559 may be used to select programs 0 to 9.

### 10.7 Two form B relay board PC1587

This board provides two form 'B' (normally closed) relay outputs. Both relays share a common and have a C-R snubber circuit fitted from each contact to common. This board may be reconfigured as a single form 'C' ( change over ) contact by the removal and fitting of some links. Please contact your local distributor if this modification is required.

## 11.0 Slot availability

When configuring the hardware of the instrument it is important to note that each option board can only go in certain slots, so the following table should be consulted to find an acceptable arrangement

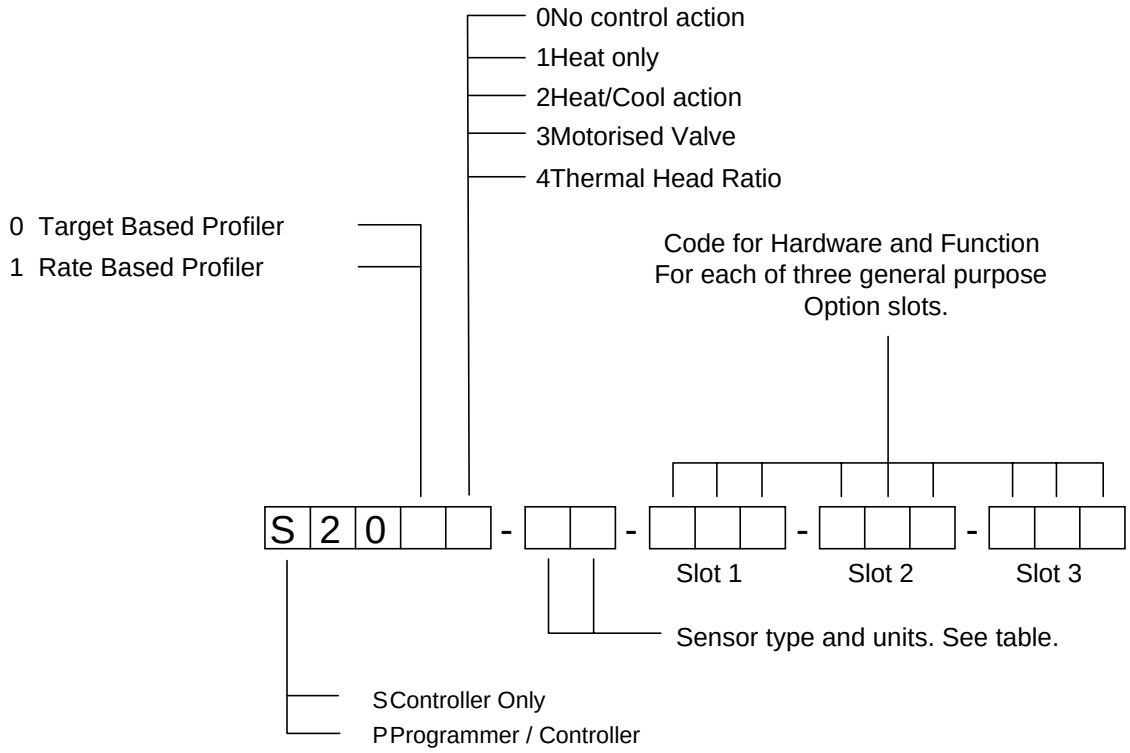
| | SLOT | | | | | |
|---|---|---|---|---|---|---|
| FUNCTION | 1A | 1B | 2A | 2B | 3A | 3B |
| HEAT TP | * | | | | * | |
| HEAT ANALOGUE | * | | * | | * | |
| COOL TP | | * | * | | | * |
| COOL ANALOGUE | * | | * | | * | |
| VALVE OPEN | * | | | | * | |
| VALVE CLOSE | | * | | | | * |
| ALARM 1 | * | * | * | * | * | * |
| ALARM 2 | | * | * | * | | * |
| RETRANSMIT | * | | * | | | |
| RATIO OUTPUT | * | | * | | | |
| REMOTE SETPOINT | | | | | * | |
| SLIDEWIRE | | | | | * | |
| INTERNAL EVENT | P | P | P | P | P | P |
| EXT' EVENT DRIVER | | | | P | | P |
| REM PROG' SELECT | | | | | P | |

Key: * Valid option P Valid only on P2000

NOTE.
The function specified in slot 1A is duplicated in slot 3A since these two slots are physically wired to the same output pin.

## 12.0 Part number coding

The part number consists of three parts, the instrument type, eg S2000, a two or three digit code showing the sensor type, and two or five pairs of digits which give the function of each of the expansion slots and what hardware is plugged into it.




Example 1. S2001-03-4BB-3II-1GH This describes a controller only, with a heat only analogue control. Input via a type K thermocouple working in degrees C. The option slots configured as follows:-

| | |
|---|---|
| Slot 1 | 0-20mA analogue control output may be set by the user in software, to have a live zero, for example, 4-20mA. |
| Slot 2 | 0-10V analogue retransmission. (Parameter and range is programmable). |
| Slot 3 | Alarms 1 and 2 relay outputs. |

Example 2. P2003-15-1EF-2GH-8LL This describes a programmer/controller, set up to drive a motorised valve, using a resistance thermometer sensor and working in tenths of degrees C. With the following options.

| | |
|---|---|
| Slot 1 | Raise and lower relay signals to motorised valve. |
| Slot 2 | Alarms 1 and 2 Logic outputs. |
| Slot 3 | Unpowered slidewire input. |

Two digit input type code

| | | |
|---|---|---|
| = 00 Type S, | (Pt-10% Rh / Pt) | Degrees C |
| = 01 Type R, | (Pt-13% Rh / Pt) | Degrees C |
| = 02 Type J, | (Fe / Cu-Ni) | Degrees C |
| = 03 Type K, | (Ni-Cr / Ni-Al) | Degrees C |
| = 04 Type T, | (Cu / Cu-Ni) | Degrees C |
| = 05 Type E, | (Ni-Cr / Cu-Ni) | Degrees C |
| = 06 Type B, | (Pt-30% Rh / Pt-6% Rh) | Degrees C |
| = 07 Type N, | (Ni-Cr-Si / Ni-Si) | Degrees C |
| = 08 Type W, | (W / W-26% Re) | Degrees C |

| | | | |
|---|---|---|---|
| | = 09 Type W3, | (W-3% Re / W-26% Re) | Degrees C |
| | = 10 Type W5, | (W-5% Re / W-26% Re) | Degrees C |
| | = 11 Type NM, | (Ni / Ni-18% Mo) | Degrees C |
| | = 12 Type L, | (Fe /Cu-Ni) | Degrees C |
| | = 13 K10, | Type K in 1/10 ºC | Degrees C |
| | = 14 T10, | Type T in 1/10 ºC | Degrees C |
| | = 15 RT10, | (PT100) in 1/10 ºC | Degrees C |
| | = 16 RT, | (PT100) | Degrees C |
| input type | = 17 Type S, | (Pt-10% Rh / Pt) | Degrees F |
| | = 18 Type R, | (Pt-13% Rh / Pt) | Degrees F |
| | = 19 Type J, | (Fe / Cu-Ni) | Degrees F |
| | = 20 Type K, | (Ni-Cr / Ni-Al) | Degrees F |
| | = 21 Type T, | (Cu / Cu-Ni) | Degrees F |
| | = 22 Type E, | (Ni-Cr / Cu-Ni) | Degrees F |
| | = 23 Type B, | (Pt-30% Rh / Pt-6% Rh) | Degrees F |
| | = 24 Type N, | (Ni-Cr-Si / Ni-Si) | Degrees F |
| | = 25 Type W, | (W / W-26% Re) | Degrees F |
| | = 26 Type W3, | (W-3% Re / W-26% Re) | Degrees F |
| | = 27 Type W5, | (W-5% Re / W-26% Re) | Degrees F |
| | = 28 Type NM, | (Ni / Ni-18% Mo) | Degrees F |
| | = 29 Type L, | (Fe /Cu-Ni) | Degrees F |
| | = 30 K10, | Type K in 1/10 ºF | Degrees F |
| | = 31 T10, | Type T in 1/10 ºF | Degrees F |
| | = 32 RT10, | (PT100) in 1/10 ºF | Degrees F |
| | = 33 RT, | (PT100) | Degrees F |
| | = 34 Linear, | 0 to +90mV input | |
| | = 35 Square Root, | 0 to +90mV input | |


| | |
|---|---|
| 0 | Not Fitted |
| 1 | Dual form A Relay Output |
| 2 | Dual Logic Output |
| 3 | 0 - 10V Analogue Output |
| 4 | 0 - 20mA Analogue Output |
| 5 | 4 - 20mA Analogue Output |
| 6 | +/- 1V Analogue Input |
| 7 | +/- 10V Analogue Input |
| 8 | Slidewire Input |
| 9 | Dual form B Relay Output |

| | |
|---|---|
| 0 | Not Fitted |
| A | Heat TP |
| B | Heat Analogue |
| C | Cool TP |
| D | Cool Analogue |
| E | MV Raise Output |
| F | MV Lower Output |
| G | Alarm 1 |
| H | Alarm 2 |
| I | Retransmission (1,2) |
| J | Ratio Setpoint Output |
| K | Remote Setpoint (3) |
| L | MV Slidewire Input (3) |
| M | External Event Driver (P) |
| N | Internal Event Output (P) |
| R | Remote Profile Select Input (3P) |

Notes for Slot function

(1) Available only in slot 1.
(2) Available only in slot 2.
(3) Available only in slot 3.
(P) Available only on P2000 programmer/controller.

# SECTION E - CALIBRATION

## 13.0 General

The following procedure enables the S2000/P2000 Controller to be calibrated in the field if the reference equipment is available.

The reference equipment consists of a precision voltage and current source with an accuracy of at least 10 times better than the instrument such as the FGH Ezecal 5.

If the controller will also be required to work on resistance thermometer ranges then a reference resistance source and appropriate range tables will also be required.

A voltage reference source will also be required for calibrating the remote set point input.

A digital volt meter (DVM) will be required if it is intended to calibrate analog outputs.

## 13.1 Preparation

The environment in which the instrument is to be calibrated should be clean and dry, with a temperature between 15 and 25ºC, humidity 0 to 80% Rh non-condensing.

The instrument and any reference sources being used to calibrate it should have been in the calibration area and switched on for at least an hour prior to calibration.

## 13.2 Main input

**Important Note.**
The Series 2000 instrument is primarily a voltage input device. However the instrument does provide an internal shunt for the purpose of measuring current inputs. This shunt is highly stable but is not accurately calibrated, hence If the instrument is calibrated for a current input, it will not be possible to change ranges to a voltage or RT input range without recalibrating the input.

To preserve the range changing ability of the instrument (between voltage TC or RT inputs), the main input should be calibrated in linear mode with any external signal conditioning removed. **ALL** of the steps detailed below are necessary for perfect calibration.

### 13.2.1 Main input voltage span

Connect an FGH EZECAL or other precision voltage source to the instrument in place of the thermocouple, using ordinary copper wires.

Place the instrument into 'E' mode by removing the instrument from its sleeve, and switching on the engineers mode switch. (See para 6). Replace the instrument into its sleeve.
Select the linear input range by setting the **I-P** parameter in group **IP** to 34 (Linear). Set the input high limit **IPLH** to 4500 and the input low limit **IPLL** to 0. Scroll on and enter the **CAL** group until the **SPN1** parameter is displayed.

Set the EZECAL or precision voltage source to deliver +80.000mV and, using the up and down keys, adjust the input span until the display just changes from 3999 to 4000.

When satisfied, press the star key and note down the displayed calibration constant for future reference.

### 13.2.2 Resistance span

Connect a precision decade resistance box to the input terminals in the manner of a resistance thermometer. Use three wires of equal length and gauge.

Select the RT input range by setting the **I-P** parameter in group **IP** to 15. Scroll on and access the **CAL** group until the **SPNr** parameter is displayed.

Set the decade resistance box to a value of 175.83 Ohms. Adjust the resistance span using the up and down keys until the display just changes from 199.9 to 200.0.

When satisfied, press the star key and note down the displayed calibration constant for future reference.

Return the input type **I-P** and the range limits **SPLH** and **SPLL** to the required values and return to normal working mode using the EMODE switch.

### 13.2.3 Span adjustment for external signal conditioning

If the instrument is fitted with an external signal conditioning card, then the span may be adjusted by using the on board potentiometer. Connect up a precision signal source to the signal conditioning board and inject an appropriate signal (current or voltage) near the span of the instrument. Adjust the on board span potentiometer until the instrument display is correct.

## 13.3 Cold junction zero

The cold junction is extremely difficult to adjust on site. Should it become necessary to adjust this then please refer back to your local distributor

## 13.4 Remote set point input calibration

NOTE. The main input must be calibrated and connected before any attempt is made to calibrate the remote setpoint input.

Input 2 can be configured as a remote set point input, or in the case of a valve positioner unit, a motorised valve slidewire input. The following is the calibration procedure for a remote set point card.

Place the instrument in the 'E' mode configuration scroll, see para 6.1

Ensure that a remote set point board is fitted in slot 3, that in the 'E' mode configuration scroll **SLt3** is set to **IP2** and **rSP** (remote set point) and that **rSty** (remote set point type) is set to **A-bt** (analogue, bipolar true zero). Connect the link on the remote set point board to give it an input span of ±1V or remove it for ±10V span as required.

Set **rSHI**, which is the setpoint reading required with a maximum analogue remote set point input, to 3000. Set **rSLO**, which is the setpoint reading required with a minimum (most negative) analogue remote set point input, to -3000.

Set the current scroll element to **ZEr2** and use a calibrated voltage source to inject -1V or -10V as appropriate, into the remote set point board input terminals.

At this point, as before, there are two ways of calibrating this parameter, either hold down the star button and use the up/down keys to restore the input 2 zero calibration factor, or without using the star button, use the up/down buttons to set the display to -2999 and then carefully

use repeated presses of the down button until the display ***just*** reads -3000. Record the input 2 zero calibration factor for future use

Set the scroll to **SPn2** and change the calibrated input voltage to +1V or +10V as appropriate. Again either restore the **SPn2** calibration factor by holding in the star button and using the up/down buttons or just use the up/down buttons to set the display to 2999, and then repeated presses of the up button until the display ***just*** reads 3000. Record the **SPn2** calibration factor for future use.

Return the scroll to **ZEr2**, reset the input to -1V or -10V and check that the display reads -3000. Set the input to 0V and check that the display reads 0. If so then all is well.

Now that input 2 is calibrated you should return to **rStYP** in the configuration scroll and set the remote set point type to the one required for operation. Adjust also the scaling factors **rSHI** and **rSLO** to whatever is required in use. Changing these parameters will not affect the calibration of the instrument. However, changing the input span between ±1V and ±10V will necessitate recalibration.

### 13.5 Slidewire input calibration

If input 2 is being used as a slidewire input, then it may be calibrated in the following manner.

First of all ensure that the instrument is configured as a motorised valve positioner, (**CTyP** is **VP**), that a slidewire input board in fitted in slot 3 (**SLt3** is **IP2** and **S-Fb**, slidewire feedback) and that the motorised valve to be used is correctly connected to the instrument rear terminals. (see installation manual ).

Invoke 'E' mode as described in para 6.1 and scroll on to the **ZEr2** parameter in the **CAL** group, this shows the currently measured valve position on the upper display. While viewing this parameter the valve close output will be energised. This will cause the valve to motor to its fully closed position. When the reading has settled, press the star button to automatically calibrate the slidewire zero. The message **donE** will be displayed when this is complete. At this point the user may use the up and down buttons to make any fine adjustments required.

Scroll on to the next parameter **SPn2**, again the current measured valve position will be displayed on the upper display. This time the valve open output will be energised causing the valve to motor to its fully open position. When the reading has settled, press the star button to automatically calibrate the slidewire span. The message **donE** will be displayed when this is complete. As before the user may make any fine adjustments required by using the up and down buttons.

### 13.6 Remote program selection input (P2000 only)

This input is actually an analog input which is used to select remotely the program number to be used by the profiler, and therefore must be calibrated like any other analog input. Calibration may be performed as follows:-

This procedure is given for a 10V input, the voltages required for a 1V input are given in brackets.

Connect a voltage signal source in place of the remote program select input. Activate Engineers mode and ensure that slot 3 is configured as a remote program select input by setting parameter **SLt3** to **IP2** and **E-Pr**. Scroll on to the parameter **ZEr2** and inject -10.0V (-

1.0V) from the signal source. Using the up and down keypads, adjust the displayed reading until it just changes from 1 to 0.
Inject +10.0V (+1.0V) from the signal source and scroll on to the parameter **SPn2** , use the up and down keypads to adjust the reading until 1024 is displayed. Repeat these two operations until both readings are correct.

Finally note down the zero and span constants for future reference. ( these values are obtained by holding down the star key whilst showing **ZEr2** or **SPn2** ).

### 13.7 Analog output calibration

There are 3 possible analog outputs on the series 2000 instrument. These may be fitted any available slots. Slots 1 and 2 are high resolution outputs and are capable of very fine calibration. Slot 3 however, is a low resolution output and can only be calibrated to 0.5%. This section will describe the calibration of an analog output fitted in slot 2, but is equally applicable to slots 1 and 3.

Disconnect the wiring from the terminals of slot 2 and connect instead a digital volt meter (a 4½ digit DVM is desirable). Select the DVM range appropriate to the type of analog output (20mA or 10V).

Enter EMODE as previously described and scroll on until the parameter **OP2Z** is displayed. This is the output 2 zero adjustment. The instrument is now delivering 0V or 0mA, adjust the zero setting by using the up and down keys until the DVM reads 0V or 0mA as appropriate.

Scroll on one parameter until **OP2S** is displayed. This is the output 2 span adjustment. The instrument is now trying to deliver its full scale output of 20mA or 10V. Adjust the span setting by using the up and down keys until the DVM reads 20.000mA or 10.000V as appropriate. (remember slot 3 cannot be adjusted this finely).

Back scroll one parameter to **OP2Z** and check that the zero reading is still correct, if not then repeat the zero and span adjustment until no further adjustment is necessary.

Finally note down the zero and span constants for future reference. (these values are obtained by holding down the star key whilst showing **OP2Z** or **OP2S**).

Turn off the EMODE switch to return the instrument into its normal operating mode.

## Appendix A - Fault codes

In the rare event that one of the stored parameters is invalid, for example, after replacing the RAM or memory back-up battery, then when power is first applied to the instrument a fault number will be displayed. When multiple faults occur the lowest numbered fault is generally shown first. Faults should be cleared one at a time until the fault indication disappears. This table shows which parameter must be corrected to restore operation.

| Fault number | parameter at fault |
|---|---|
| 1 | input type |
| 2 | output type |
| 3 | cjc type |
| 4 | alarm 1 type |
| 5 | alarm 1 sense |
| 6 | alarm 1 hysteresis |
| 7 | alarm 1 level |
| 8 | alarm 2 type |
| 9 | alarm 2 sense |
| 10 | alarm 2 hysteresis |
| 11 | alarm 2 level |
| 12 | setpoint type |
| 13 | ratio |
| 14 | ratio limit 1 |
| 15 | ratio limit 2 |
| 16 | ratio limit 3 |
| 17 | ratio limit 4 |
| 18 | valve action time |
| 19 | valve dead band |
| 20 | rel (relative cool power versus heat power) |
| 21 | manual reset value |
| 22 | local setpoint |
| 23 | auxiliary set point 1 |
| 24 | auxiliary set point 2 |
| 25 | cool power limit |
| 26 | heat/cool dead band |
| 27 | cool cycle time |
| 28 | heat prop band |
| 29 | heat integral time |
| 30 | heat integral approach band |
| 31 | heat derivative time |
| 32 | heat derivative approach band |
| 33 | heat high power limit |
| 34 | heat low power limit |
| 35 | heat cycle time |
| 36 | comms baud rate |
| 37 | comms address |
| 38 | retransmission parameter |
| 39 | retransmission high |
| 40 | retransmission low |
| 41 | retransmission bias |
| 42 | ratio reference high |
| 43 | ratio reference low |
| 44 | setpoint rate |

| | |
|---|---|
| 45 | slot 1 live zero |
| 46 | slot 3 live zero |
| 47 | invalid password |
| 48 | set point limits crossed over |
| 49 | set point limits too far apart |
| 50 | setpoint high limit out of limits |
| 51 | setpoint low limit out of limits |
| 52 | auxiliary output 1 out of limits |
| 53 | auxiliary output 2 out of limits |
| 54 | tuner threshold out of limits |
| 55 | forward/reverse value invalid |
| 56 | digital input 1 type invalid |
| 57 | digital input 2 type invalid |
| 58 | remote set point type invalid |
| 59 | remote set point hi limit invalid |
| 60 | remote set point lo limit invalid |
| 61 | remote set point limits crossed |
| 62 | OP 1 tp type |
| 63 | OP 1 tp minimum on time |
| 64 | OP 2 tp type |
| 65 | OP 2 tp minimum on time |
| 66 | input 1 hi scalar (IPLH) |
| 67 | input 1 lo scalar (IPLL) |
| 68 | input 1 scalars crossed over |
| 69 | input 1 scalars too far apart |
| 70 | slot 2 live zero |
| 71 | ratio band |
| 72 | digital setpoint address range |
| 73 | input 1 bias |
| 74 | retransmission type |
| 75 | retransmission characteriser range |