MODEL CN2116 PID CONTROLLER

INSTALLATION AND OPERATION HANDBOOK

Contents ..... **Page**

SAFETY and EMC INFORMATION

Please read this section before installing the controller

This controller meets the requirements of the European Directives on Safety and EMC, however it is the responsibility of the installer to ensure the safety and EMC compliance of any particular installation.

SAFETY

This controller complies with the European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC, by the application of the safety standard EN 61010(93).

Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 89/336/EEC, amended by 93/68/EEC, by the application of a technical construction file.

INSTALLATION REQUIREMENTS FOR EMC

To ensure compliance with the European EMC directive certain installation precautions are necessary as follows:

- When using the relay output it may be necessary to fit a filter suitable for suppressing the emissions. The filter requirements will depend on the type of load.

Routing of wires

To minimise the pick-up of electrical noise, the logic output wiring and the sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at both ends.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact Omega Engineering, Inc. for repair.

TECHNICAL SPECIFICATION FOR SAFETY PURPOSES.

Equipment ratings

Supply voltage:	100 to 240Vac -15%, +10%
Supply frequency:	48 to 62Hz ac.
Power consumption:	2.5 Watts maximum
Relay output:	Maximum of 264Vac. Minimum 30Vac or dc. Maximum current, 2A resistive.
Leakage current:	The leakage current through the relay contact suppression components is less than 2mA at 264Vac, 50Hz.
Over current protection:	External over current protection devices are required that match the wiring of the installation. A minimum of $0.5mm^2$ or 16awg wire is recommended. Use independent fuses for the instrument supply and the relay output. Suitable fuses are T type, (IEC 127 time-lag type) as follows; Instrument supply: 85 to 264Vac, 2A, (T). Relay output: 2A (T).

DC Pulse Output

Rating	9Vdc, 18mA (non-isolated)
Application	Heating, cooling or alarms

Environmental ratings

Panel sealing:	Instruments are intended to be panel mounted. The rating of panel sealing is defined by EN 60529: IP 65.
Operating temperature:	0 to 55°C. Ensure the enclosure provides adequate ventilation.
Relative humidity:	5 to 90%, non condensing.
Atmosphere:	The instrument is not suitable for use above 2000m or in explosive or corrosive atmospheres.

Electrical safety

Standard:	EN 61010, Installation category II, pollution degree 2.
Installation category II:	Voltage transients on any mains power connected to the instrument must not exceed 2.5kV.
Pollution degree 2:	Conductive pollution must be excluded from the cabinet in which the instrument is mounted.
Isolation:	All inputs and outputs, have a reinforced isolation which provides protection against electric shock, except the Logic output which is electrically connected to the main process variable input, (thermocouple etc.).

INSTALLATION SAFETY REQUIREMENTS

Personnel

Installation must be carried out by qualified personnel only.

Enclosure of live parts

To prevent hands or metal tools touching parts that may be electrically live, the controller must be installed in an enclosure.

Wiring

It is important to connect the controller in accordance with the wiring data given in this handbook. Take particular care not to connect AC supplies to the low voltage sensor input or the logic output. Wiring installations must comply with all local wiring regulations.

Isolation

The installation must include a power isolating switch or circuit breaker. This device should be in close proximity to the controller, within easy reach of the operator and marked as the disconnecting device for the instrument.

Overcurrent protection

To protect the internal PCB tracking within the controller against excess currents, the AC power supply to the controller and relay output must be wired through the fuse or circuit breaker specified in the technical specification.

Voltage rating

The maximum continuous voltage applied between any of the following terminals must not exceed 264Vac:

- power supply to relay, logic or sensor connections;
- relay output to logic or sensor connections;

The controller should not be wired to a three-phase supply with an ungrounded star connection. Under fault conditions such a supply could rise above 264Vac with respect to ground and the product would not be safe.

Voltage transients across the power supply connections, and between the power supply and ground, must not exceed 2.5kV. Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include a transient limiting device.
These units will typically include gas discharge tubes and metal oxide varistors that limit and control voltage transients on the supply line due to lightning strikes or inductive load switching. Devices are available in a range of energy ratings and should be selected to suit conditions at the installation.

Conductive pollution

Conductive pollution must be excluded from the cabinet in which the instrument is mounted. For example, carbon dust is a conducting pollution. To secure a suitable atmosphere in conditions of conductive pollution, fit an air filter to the air intake of the cabinet. Where condensation is likely, for example in low temperatures, include a thermostatically controlled heater in the cabinet.

Grounding

The logic output is not isolated from the sensor input. Because of this, two possible conditions need to be considered:

- The temperature sensor may be connected to the electrical heating element and hence be at the heater supply voltage. The controller is designed to operate under these conditions but the logic output will also be at the heater potential. You must ensure that this will not damage the power control device that is connected to the logic output and that someone servicing the equipment does not touch the sensor connections or the logic output while they are live.
- In some installations it is a requirement to replace the temperature sensor while the controller is still powered up. Under these conditions, we recommend that the shield of the temperature detector is grounded. Do not rely on grounding through the framework of the machine.

Electrostatic discharge precautions

When the controller is removed from its sleeve, some of the exposed electronic components are vulnerable to damage by electrostatic discharge from someone handling the controller. To avoid this, when handling the unplugged controller you should discharge yourself to ground through a wrist strap with a 1MΩ series resistor.

Over-temperature protection

When designing any control system it is essential to consider what will happen if any part of the system should fail. In temperature control applications the primary danger is that the heating will remain constantly on. Apart from spoiling the product, this could damage any process machinery being controlled, or even cause a fire.

Reasons why the heating might remain constantly on include:

- the temperature sensor becoming detached from the process;
- the controller failing with its heating output constantly on;
- an external valve or contactor sticking in the heating condition;
- the controller setpoint set too high.

Where damage or injury is possible, we recommend fitting a separate over-temperature protection unit, with an independent temperature sensor, which will isolate the heating circuit.
Please note that using the relay within the controller as an alarm output will not give protection under all failure conditions.

Chapter 1 INSTALLATION

The CN2116 controller is a compact 1/16 DIN (48x48mm) PID or On/Off temperature controller with automatic tuning. It has a single input, which is configurable on-site for either thermocouple, resistance thermometer, linear millivolts, or linear milliamps. It has two outputs: a relay output and a logic output for operating a solid state relay, either of which is configurable for heating, cooling, or alarms.

This chapter consists of two parts:

- MECHANICAL INSTALLATION
- ELECTRICAL INSTALLATION

Before proceeding please read *Safety and EMC Information.*

WARNING

You must ensure that the controller is correctly configured for your application. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is your responsibility as the installer to ensure that the configuration is correct. The controller may either have been configured when ordered, or may need configuring now. See Chapter 5, *Configuration*.

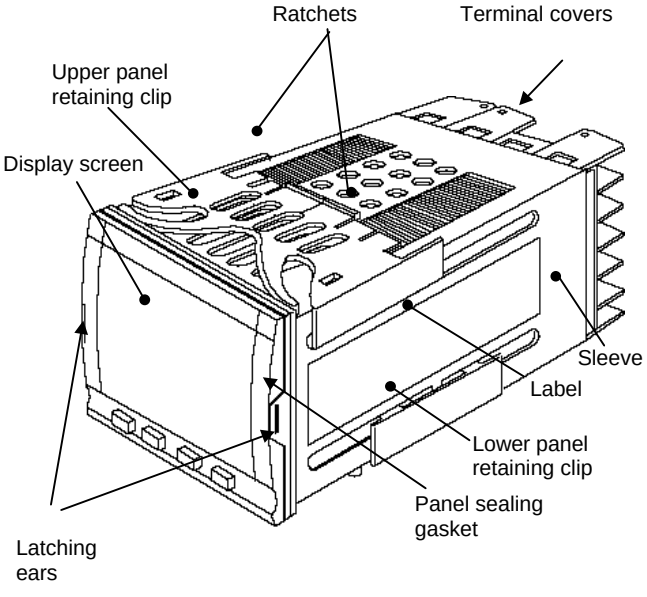


Figure 1-1 CN2116 1/16 DIN controller

MECHANICAL INSTALLATION

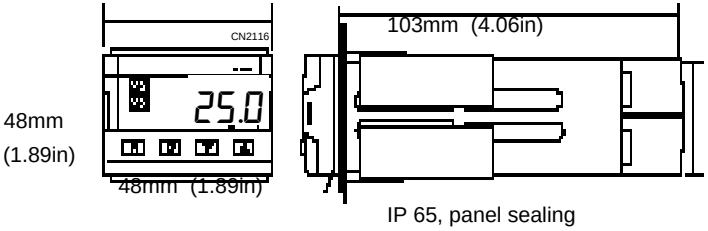


Figure 1-2 Outline dimensions

Panel cut-out and recommended minimum controller spacings

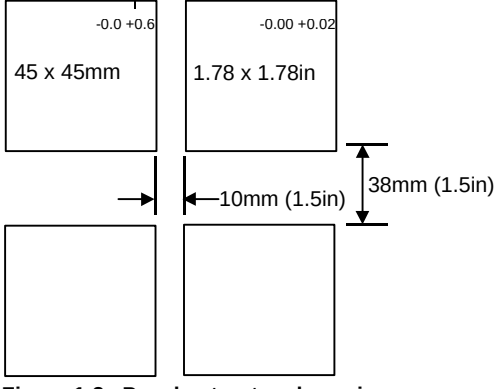


Figure 1-3 Panel cut-out and spacings

Unplugging and plugging-in the controller

The electronic assembly of the controller plugs into a rigid plastic sleeve, which in turn fits into the standard DIN size panel cut-out shown in Figure 1-3. The controller can be unplugged from it's sleeve by easing the latching ears outwards and pulling it forward out of the sleeve. When plugging the controller back into it's sleeve, ensure that the latching ears click into place in order to secure the IP65 sealing.

To install the controller

1. Prepare the control panel cut-out to the size shown in Figure 1-3.
2. Insert the controller through the panel cut-out.
3. Spring the upper and lower retaining clips in place. Secure the controller in position by holding it level and pushing both retaining clips forward.

Note: If you subsequently need to remove the controller sleeve from the control panel, unhook the retaining clips from the side with either your fingers or a screwdriver.

ELECTRICAL INSTALLATION

All electrical connections are made to the screw terminals at the rear of the controller. If you wish to use crimp connectors, use those which accept wire sizes from 0.5 to 1.5 mm^2 (16 to 22 awg).

Milliamp Inputs

If a milliamp input has been ordered a 2.5Ω sense resistor will be supplied which must be wired across terminals V- and V+.

Snubber

When switching inductive loads such as contactors and solenoid valves, the 15nF/100Ω 'snubber' provided with the controller should be wired across the relay terminals AA and AB to prolong contact life and to suppress interference.

WARNING

When the relay contact is open, the snubber circuit passes 0.6mA at 110Vac and 1.2mA at 240Vac. You must ensure that this current, passing through the snubber, will not hold in low power electrical loads. It is your responsibility as the installer to ensure that this does not happen.

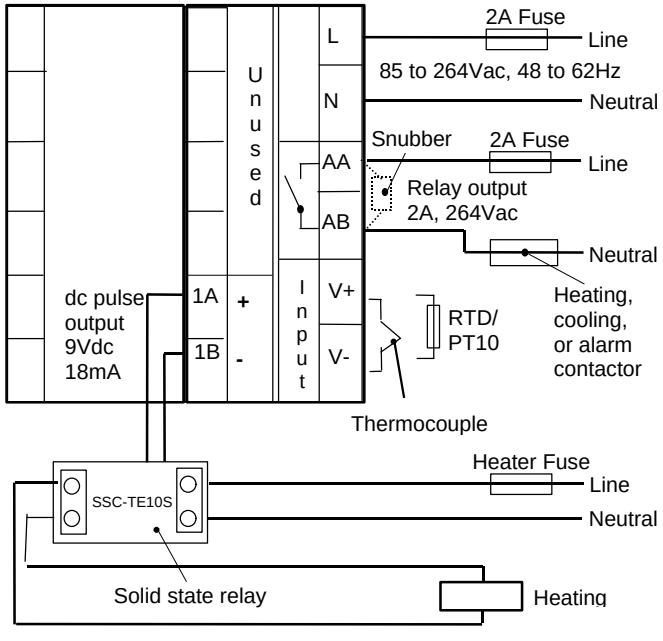


Figure 1-4 Electrical connections

Chapter 2 OPERATION

This chapter has six main topics:

- FRONT PANEL LAYOUT
- POWER ON
- PARAMETERS AND HOW TO ACCESS THEM
- PARAMETER NAVIGATION DIAGRAM
- OPERATOR PARAMETER TABLES
- TIMER FUNCTION
- ALARMS

FRONT PANEL LAYOUT

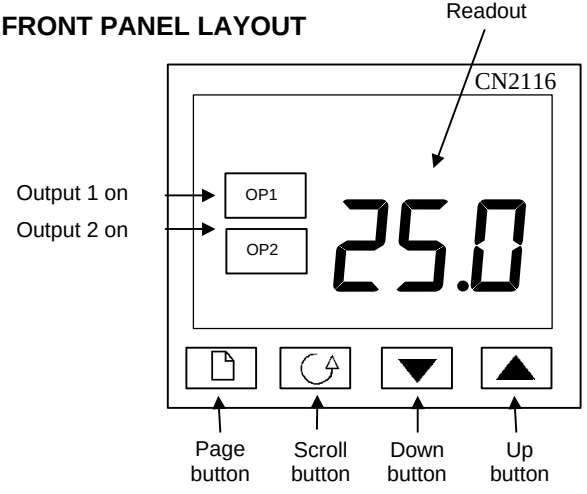


Figure 2-1 Front Panel Layout

Indicator or button	Name	Function
OP1	Output 1	When lit, this indicates that the logic output is on.
OP2	Output 2	When lit, this indicates that the relay output is on.
	Page button	Press to select a new list of parameters.
	Scroll button	Press to select a new parameter in a list.
	Down button	Press and release to view the setpoint or a selected parameter. Keep pressed to decrease the value.
	Up button	Press and release to view the setpoint or a selected parameter. Keep pressed to increase the value

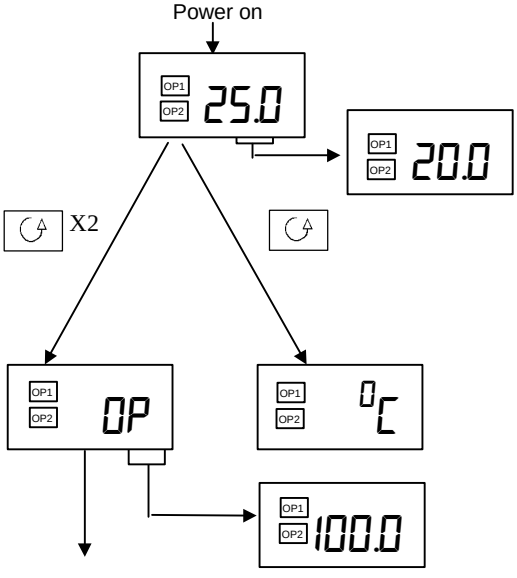
Figure 2-2 Indicators and buttons

POWER ON

Switch on the power to the controller. It runs through a self-test sequence for about three seconds and then displays the measured value. This is called the Home display. It is the one you will use most often. From this display you can view and adjust the setpoint as shown below:

The Home display

The measured value is displayed.



To view the setpoint, press and release either ▼ or ▲.
To change the setpoint, keep pressing. Two seconds after releasing the button, the new value will be accepted and the display will revert to showing the measured value.

Press the *Scroll* button once.

Display units

The display units will be shown for 0.5 seconds after which the display will revert to the Home display.

From the Home Display press the *Scroll* button twice.

Output power

To view the % output power, press and release ▼ or ▲.
This is a read-only value. You cannot change it.

Press [ ] and [ ] together to return to the Home display.

Other parameters

Pressing the *Scroll* button from the Output Power display may access further parameters. If setpoint rate limit is enabled then the 'w. SP' display will enable the working setpoint to be accessed. Other parameters may be in the scroll list if the 'promote' feature has been used (see *Edit Level*, Chapter 3*)*.

PARAMETERS AND HOW TO ACCESS THEM

Parameters are settings within the controller that determine how the controller will operate. For example, alarm setpoints are parameters that set the points at which alarms will occur. For ease of access, the parameters are arranged in lists, as shown in the navigation diagram (Figure 2-3). In each list the first item to be displayed is the name of the list, called the *list header*. The lists are:

Home list	*PID list*	*Output list*
Alarm list	*Setpoint list*	*On/Off list*
Autotune list	*Input list*	*Access list.*

To step through the list headers press the Page button 
You will eventually return to the Home display.
To step through the parameters within a particular list,

press the Scroll button  .
When you reach the end of a parameter list you will return to the list header. From within a list you can return to the list header at any

time by pressing the Page button. 

To step to the next list header press the Page button  once again.

Returning to the Home display

You can get back to the Home display at any time by pressing 

and  together.
Alternatively, you always get the Home display either if no button is pressed for 45 seconds or when the power is first turned on.

Parameter names

In the navigation diagram (Figure 2-3) each box depicts the display for a selected list header or parameter within a list. The Operator parameter tables later in this chapter list all the parameter names and their meaning.

The navigation diagram shows all the parameters that *potentially* can be present in the controller. In practice, only those associated with a particular configuration will appear. For example, if no alarms are configured no alarm parameters will be present and the alarm list will not appear.

The shaded boxes in the diagram indicate parameters that are hidden in normal operation. To see all the available parameters, you must select Full access level. For more information about this, see Chapter 3, Access *Levels*.

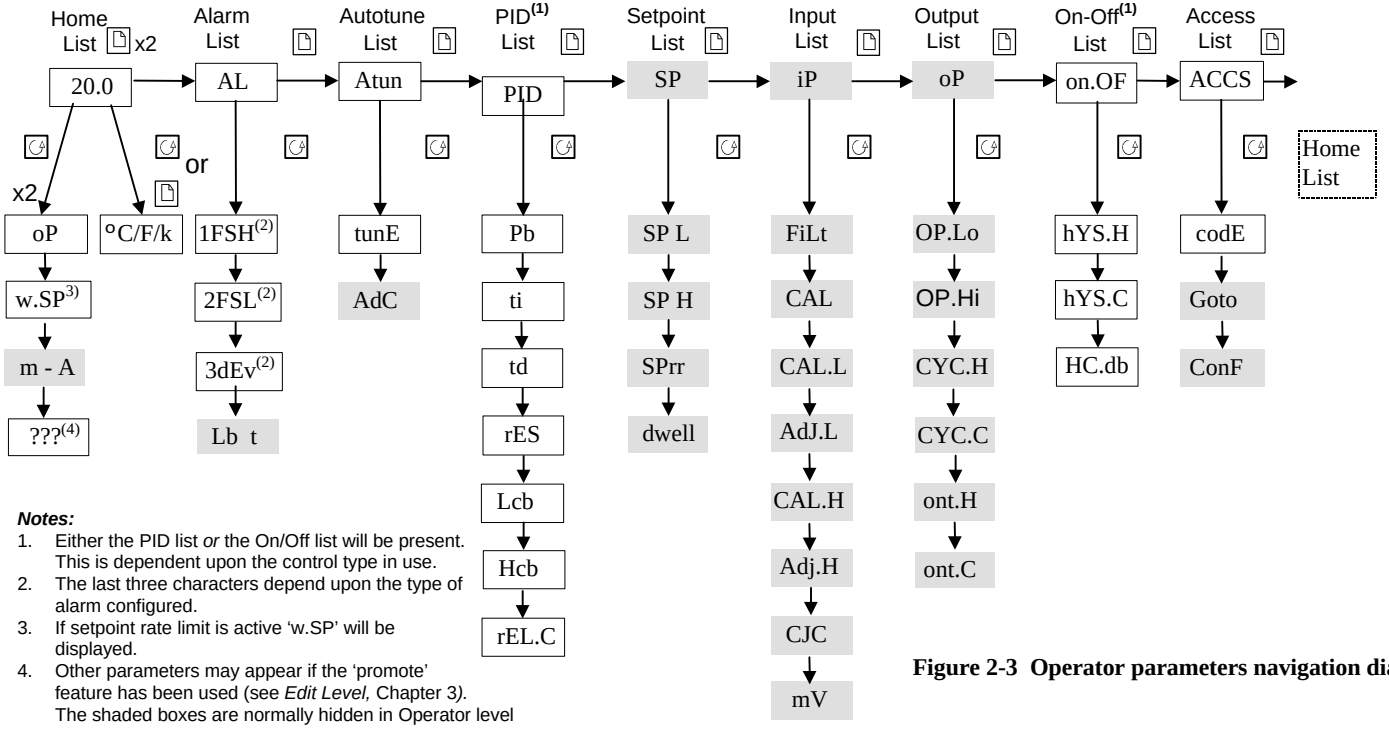
To change the value of a parameter

First, select the required parameter. The parameter name will be displayed.
To view the parameter value, press and release

either  or  .

To change the parameter value, press either  or  .
In this adjustment, pressing once changes the value by one digit.
Keeping the button pressed speeds up the rate of change.
Two seconds after releasing either button, the readout blinks to show that the controller has accepted the new value.

PARAMETER NAVIGATION DIAGRAM



Notes:

1. Either the PID list *or* the On/Off list will be present. This is dependent upon the control type in use.
2. The last three characters depend upon the type of alarm configured.
3. If setpoint rate limit is active 'w.SP' will be displayed.
4. Other parameters may appear if the 'promote' feature has been used (see *Edit Level,* Chapter 3*).* The shaded boxes are normally hidden in Operator level

Figure 2-3 Operator parameters navigation diagram

OPERATOR PARAMETER TABLES

Name	Parameter description

	Home display list
Home	Process Value / setpoint
OP	Output power (%)
w.SP	Working Setpoint (if setpoint rate limit enabled)
m - A	Auto/manual select
+ Additional parameters may appear in the Home display list if the 'promote' feature has been used (see *Edit Level*, Chapter 3*)*.	

AL	Alarm list
1 - - -	Alarm 1 setpoint value
2 - - -	Alarm 2 setpoint value
3 - - -	Alarm 3 setpoint value
Lb_t	Loop Break Time (secs)
In place of dashes, the last three characters indicate the alarm type as follows:	
-FSH	Full scale high
-FSL	Full scale low
-dEV	Deviation band alarm
-dLo	Deviation low alarm
-dHi	Deviation high alarm

Atun	Automatic tuning list
tunE	Automatic tuning enable
Adc	Automatic droop compensation

Pid	PID list
Pb	Proportional Band -in display units
ti	Integral Time (secs)
td	Derivative Time (secs)
rES	Manual Reset (%)
Lcb	Cutback Low (in display units)
Hcb	Cutback High (in display units)
rEL.C	Relative Cool Gain

SP	Setpoint list
SP L	Setpoint low limit
SP H	Setpoint high limit
SPrr	Setpoint Rate Limit
dwEll	Dwell time, OFF to 999.9mins

IP	Input list
FiLt	Input filter time (in secs)
CAL	'FACt' or 'USEr' ('FACt' will reinstate the factory calibration. 'USEr' will reinstate any previously set User calibration)
CAL.L	User low point calibration 'Yes/No
AdJ.L*	User low point calibration adjust
CAL.H	User high point calibration' Yes/No
Adj.H*	User high point calibration adjust
CJC°	Cold junction temperature
mV	Millivolt inputs

OP	Output list
OP.Lo	Low power limit (%)
OP.Hi	High power limit (%)
CYC.H	Heat Cycle Time (secs)
CYC.C	Cool Cycle Time (secs)
ont.H	Heat minimum On time (secs)
ont.C	Cool minimum On time (secs)

onOF	On off list*
hYS.H	Heating hysteresis (in display units)
hYS.C	Cooling hysteresis (in display units)
HC.db	Heat/cool deadband (in display units)

*Replaces the PID list when On-Off is configured

ACCS	Access list
CodE	Access pass number
Goto	Selected access level
ConF	Configuration pass number

Timer Function

The CN2116 contains a timer which is adjustable from 0.1 to 999.9 minutes. This timer can be used to turn on or turn off the dc pulse or relay output at the end of the set period. The dc pulse or relay output may then be used to start or stop a heating process.
The timing period is set by the parameter 'dwell' in the Setpoint list. If the value is set to OFF the timer will be inactive and have no effect on the operation of the controller.

Starting the timer

The timer will start immediately that a value is entered into the 'dwEll' parameter.
At the end of the timing period the message 'End' will be flashed in the controller display. This 'End' message can be made to turn on or turn off the relay or logic output by defining it as a digital output function, see C*onfiguration level* Chapter 5.

Restarting the timer

To restart the timer, either:

1. Turn the dwell parameter to OFF and then back to a set time.
2. Change the setpoint.
3. Switch the power off and then on again.

Notes:

1. If the power to the controller is switched off in the middle of a timing period, when power is restored, the elapsed time will reset to zero and the timer will time for the full period.
2. A convenient way of accessing the timer is to promote the dwell' parameter into the home list - see 'edit level' in chapter 3.
3. If setpoint rate limit has been enabled then the timer will start when the working setpoint reaches the target setpoint.

Alarms

Alarm annunciation

If the controller detects an alarm condition, it will flash a message in either the upper or lower readout of the Home display. If there is more than one alarm, the display cycles through all the relevant alarm messages. Figures 2-4 and 2-5 list all of the possible alarm messages and their meaning.

Alarm modes

Alarms will have been set up to operate in one of several modes, either:

- **Non-latching**, which means that the alarm will automatically clear when the alarm condition no longer exists.
- **Latching**, which means that the alarm message will continue to flash even if the alarm condition no longer exists. Latched alarms are cleared (*acknowledged)* by pressing either the Page or Scroll button.
- **Blocking,** which means that the alarm will only become active after it has first entered a safe state after powering up

Alarm types

There are tw o kinds of alarm: **Process alarms** and **Diagnostic alarms**

Process alarms

These warn that there is a problem with the process that the controller is trying to control.

Figure 2-4 Process alarms

**In place of the dash the first character will indicate the alarm number*

Alarm message	What it means
_FSH	Full Scale High
_FSL	Full Scale Low
_dHi	Deviation High
_dLo	Deviation Low
_dEV	Deviation Band

Diagnostic alarms

These warn that a fault exists in either the controller or the connected devices.

Alarm	What it means	What to do about it
EE.Er	*Electrically Erasable Memory Error:* *The* value of an operator or configuration parameter has been corrupted.	This fault will automatically take you into configuration level. Check all of the configuration parameters before returning to operator level. Once in operator level, check all of the operator parameters before resuming normal operation. If the fault persists or occurs frequently, contact Omega.
S.br	*Sensor Break: Input* sensor is unreliable or the input signal is out of range.	Check that the sensor is correctly connected.
L.br	*Loop Break:* T he feedback loop is open circuit.	Check that the heating and cooling circuits are working properly.
Ld.f	*Heater circuit fault:* Indication that the power controller device has detected a fault in the heating circuit.	Check the functioning of the power control device and heating circuit. (e.g. fuse failure).
LLLL	*Out of range low reading*	Check the value of the input
HHHH	*Out of range high reading*	Check the value of the input
Err1	*Error 1:* ROM self-test fail	Return the controller for repair
Err2	*Error 2:* RAM self-test fail	Return the controller for repair
Err3	*Error 3:* Watchdog fail	Return the controller for repair
Err4	*Error 4: Keyboard failure* *Stuck* buttons, or a button was pressed during power up.	Switch the power off and then on without touching any of the controller buttons.

Figure 2-5 Process alarmS

Chapter 3 Access Levels

This chapter describes the different levels of access to the operating parameters within the controller.

There are three topics:

- THE DIFFERENT ACCESS LEVELS
- SELECTING AN ACCESS LEVEL
- EDIT LEVEL.

THE DIFFERENT ACCESS LEVELS

There are four access levels:

- **Operator level**, which you will normally use to operate the controller
- **Configuration level**, which is used to set up the fundamental characteristics of the controller
- **Full level**, which is used to commission the controller and the process being controlled
- **Edit level**, which is used to set up the parameters that you want an operator to be able to see and adjust when in Operator level.

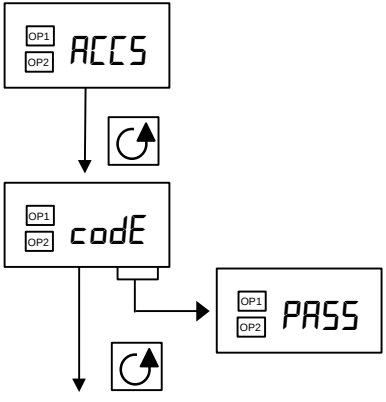
Access level	Display shows	What you can do	Password Protection
Operator	OPEr	In this level operators can view and adjust the value of parameters defined in Edit level. (see below)	No
Full	FULL	In this level all the parameters relevant to a particular configuration are visible. All alterable parameters may be adjusted.	Yes
Edit	Edit	In this level you can set which parameters an operator in Operator level is able to view and adjust. You can hide or reveal complete lists and individual parameters within each list, and you can make parameters read-only or alterable. (See *Edit level* at the end of the chapter).	Yes
Configuration	ConF	This special level allows access to set up the fundamental characteristics of the controller.	Yes

Figure 3-1 Access levelS

SELECTING AN ACCESS LEVEL

Access list header

Press [ ] until you reach the access list header ‘ACCS’ and then press *Scroll*.



Password entry

The password is entered from the ‘codE’ display.

Press [▼] or [▲] once only to view the password.
If the display shows ‘PASS’ then this indicates that the access is already unlocked and that a password is *not* required.
A display of ‘0’ indicates that you are currently in Operator level and that a password *is* required.

The password is set to ‘1’ when the controller is shipped from the factory.

To set the password continue to press [▼] or [▲] until the required value is shown. After two seconds the display should flash ‘PASS’ to verify that the password was entered correctly. The ‘codE’ display will return.

Pressing [▼] or [▲] once again allows a further check that the password was entered correctly. The display ‘PASS’ shows that the access was successfully unlocked. Otherwise you need to repeat the step above.

If you need to change the password, see Chapter 5, *Configuration*. Setting the password to ‘0’ is a special case that will cause the controller to be permanently unlocked.

Press *Scroll* to access the ‘Goto’ display.
(If a password was not entered correctly and the controller is still ‘locked’ then pressing *Scroll* at this point will simply return to the access list header.)

Level selection

The 'Goto' display allows selection of the required access level.

Use ▼ and ▲ to select from the following displayed codes:

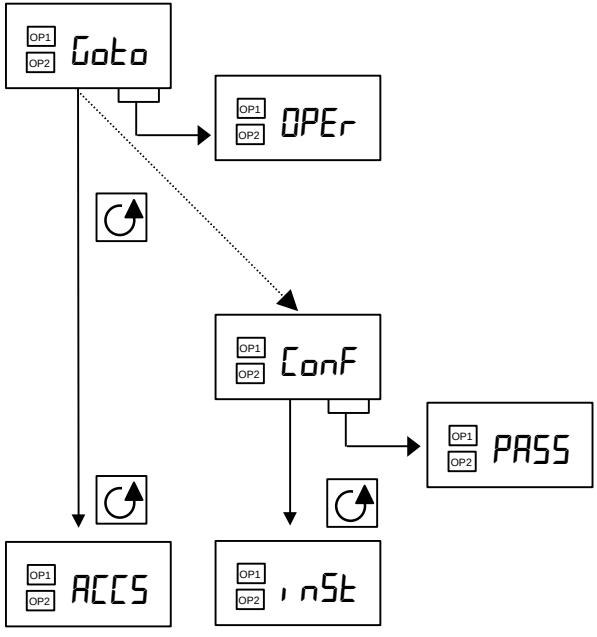
OPEr:	Operator level
FULL:	Full level
Edit:	Edit level
ConF:	Configuration level

After two seconds the 'Goto' display will return.

Press *Scroll*

You are either returned to the list header in the level you selected, or, if you selected 'ConF', you will get an additional password entry screen displaying 'ConF'. To gain access to the configuration level repeat the password entry procedure described in the previous section using the configuration password.

The configuration password is set to 2' when the controller is shipped from the factory. If you need to change the configuration password, see Chapter 5, *Configuration.*



Return to Operator Level

After using one of the alternate access levels the user should normally return to the Operator level.
From either 'FULL' or 'Edit' levels follow the previous instructions for level selection and choose 'OPEr'. After two seconds the 'Goto' display will return, and the access will be locked. For instructions to return from 'ConF' see Chapter 5, There is also a built in facility when returning from 'Edit' level. In this case the controller *automatically* reverts to Operator level after about 45 seconds of inactivity.
.

EDIT LEVEL

Edit level is used to set which parameters you can see and adjust in Operator level. It also gives access to the 'Promote' feature, which provides customization of the Home display list.

Setting operator access to a parameter

First you must select Edit level, as shown on the previous page.

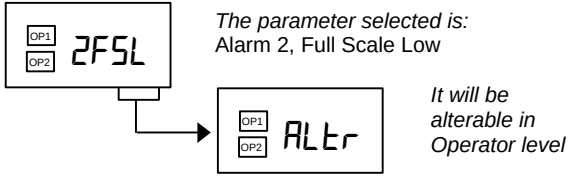
Once in Edit level, select a list or a parameter within a list in the same way as you would in Full level, move from list header to list header using the Page button, and from parameter to parameter within each list using the Scroll button. However, in Edit level what is displayed is not the value of a selected parameter but a code representing the parameter's availability in Operator level.

When you have selected the required parameter, use the ▼ and ▲ buttons to set its availability in operator level.

There are four codes:

Altr	Makes a parameter alterable in Operator level
Pro	Promotes a parameter into the Home display list.
REAd	Makes a parameter or list header read-only *(it can be viewed but not altered)*
HidE	Hides a parameter or list header

For example:



Hiding or revealing a complete list

To hide a complete list of parameters, all you have to do is hide the list header. If a list header is selected only two selections are available: REAd and HidE.
(It is not possible to hide the 'ACCS' list, which will always display the code: 'LiSt'.)

Promoting a parameter

The Home display list can be customized for use by adding selected parameters with the 'Promote' feature. Scroll through the lists to the required parameter and choose the 'Pro' code.
The parameter is then automatically added at the end of the Home display list (the parameter will also be accessible as normal from the standard lists).
The operator interface of the controller can be greatly enhanced by using this feature to add a small selection of commonly used parameters. A maximum of twelve parameters can be Promoted.

Promoted parameters are automatically 'alterable'.

Chapter 4 TUNING

Before tuning please read Chapter 2, *Operation*, to learn how to select and change a parameter.

This chapter has three main topics:

- WHAT IS TUNING?
- AUTOMATIC TUNING
- MANUAL TUNING.

WHAT IS TUNING?

In tuning you match the characteristics of the controller to that of the process being controlled in order to obtain good control. Good control means:

- Stable 'straight-line' control of the temperature at setpoint without fluctuation
- Acceptable overshoot or undershoot of the temperature setpoint
- Quick response to deviations from the setpoint caused by external disturbances, thereby restoring the temperature rapidly to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed in Table 4-1 opposite. These parameters appear in the PID list.

Table 4-1 Tuning parameters

Parameter	Displayed name	Meaning or Function
Proportional band	Pb	The bandwidth in display units over which the output power is proportioned between minimum and maximum.
Integral time	ti	Determines the time taken by the controller to remove steady-state error signals.
Derivative time	td	Determines how strongly the controller will react to the rate-of-change of the measured value.
Low cutback	Lcb	The number of display units below setpoint at which the controller will cutback the output power in order to prevent overshoot.
High Cutback	Hcb	The number of display units above setpoint at which the controller will increase the output power in order to prevent undershoot.
Relative cool gain	rEL	Only present if cooling has been configured. Sets the cooling proportional band by multiplying the Pb value by the rEL value.

AUTOMATIC TUNING

This method automatically determines the value of the parameters listed in Table 4-1. The CN2116 controller uses a 'one-shot' tuner which works by switching the heating on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.

When to tune

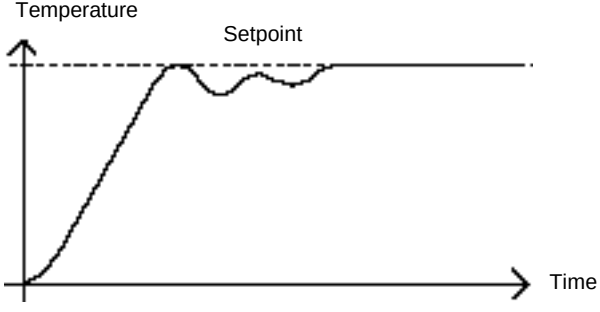
You will normally need to tune the controller only once, during the initial commissioning of the process. However, if the process under control subsequently becomes unstable (because its characteristics have changed), you can retune again at any time for the new conditions.
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values that restrict the amount of overshoot or undershoot.

How to tune

1. Set the setpoint to the value at which you will normally operate the process.
2. In the 'Atun' list, select 'tunE' and set it to 'on'.
3. Press the Page and Scroll buttons together to return to the Home display. The display will flash 'tunE' to indicate that tuning is in progress.
4. The controller will induce an oscillation in the temperature by turning the heating on and then off. The first cycle will not complete until the measured value has reached the required setpoint.
5. After two cycles of oscillation the tuning will be completed and the tuner will switch itself off.
6. The controller will then calculate the tuning parameters listed in Table 4-1 and will resume normal control action.

If you want ‘Proportional only’ or ‘PD’ or ‘PI’ control, you should set both ‘Ti’ or ‘Td’ parameters, respectively, to OFF before commencing the tuning cycle. The tuner will leave them off and will not calculate a value for them.

Typical automatic tuning cycle



Calculation of the cutback values

Low cutback and *High cutback* are values that restrict the amount of overshoot or undershoot that occurs during large step changes in temperature (for example, under start-up conditions).
If either low cutback or high cutback is set to ‘AUTO’ the values will be fixed at three times the proportional band, and will not be changed during automatic tuning.

MANUAL TUNING

If for any reason automatic tuning gives unsatisfactory results, you can tune the controller manually. There are a number of standard methods for manual tuning. The one described here is the Ziegler-Nichols method.

With the process at its normal running temperature:

1. Set the parameters ‘Hcb’ and ‘Lcb’ to ‘Auto’

2. Ignore the fact that the temperature may not settle precisely at the setpoint

3. If the temperature is stable, reduce the proportional band ‘Pb’ so that the temperature just starts to oscillate. If the temperature is already oscillating, increase the proportional band until it just stops oscillating. Allow enough time between each adjustment to see if the loop will stabilize. Make a note of the proportional band value ‘B’ and the period of oscillation ‘T’.

4. Set the Pb, ti, and td parameter values according to the calculations given in Table 4-2.

Table 4-2 Tuning values

Type of control	Proportional band ‘Pb’	Integral time ‘ti’	Derivative time ‘td’
Proportional only	2xB	OFF	OFF
P + I control	2.2xB	0.8xT	OFF
P + I + D control	1.7xB	0.5xT	0.12xT

Setting the cutback values

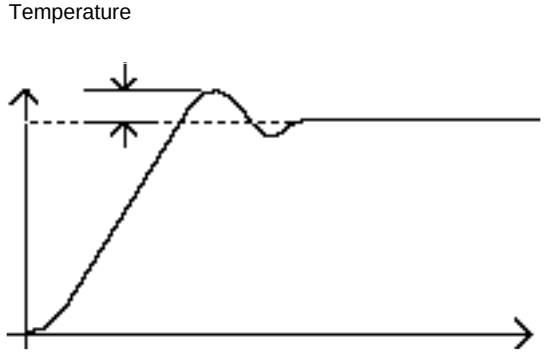
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up or for large step changes in temperature, then manually set the cutback parameters Lcb and Hcb.

Proceed as follows:

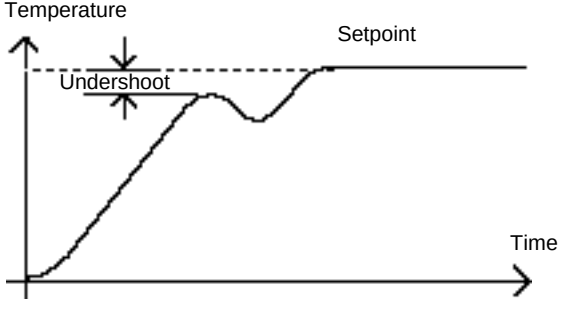
1. Set the low and high cutback values to three proportional bandwidths (that is to say, Lcb = Hcb = 3 x Pb).
2. Note the level of overshoot or undershoot that occurs for large temperature changes (see the diagrams below).

In example (a) increase Lcb by the overshoot value. In example (b) reduce Lcb by the undershoot value.

Example (a)



Example (b)



Where the temperature approaches setpoint from above, you can set Hcb in a similar manner.

REMOVING STEADY-STATE ERRORS

Integrating action and manual reset

In a full three-term controller (that is, a PID controller), the integral term ‘ti’ automatically removes steady state errors from the setpoint. If the controller is set up to work in two-term mode (that is, PD mode), the integral term will be set to ‘OFF’. Under these conditions the measured value may not settle precisely at setpoint. When the integral term is set to OFF the parameter *manual reset* (rES) appears in the PID list. This parameter represents the value of the power output that will be delivered when the error is zero. You must set this value manually in order to remove steady state error signals.

Automatic droop compensation (ADC)

The steady state error from the setpoint, which occurs when the integral term is set to ‘OFF’, is sometimes referred to as ‘droop’. ADC automatically calculates the manual reset value in order to remove this droop. To use this facility, you must first allow the temperature to stabilize. Then, in the autotune parameter list, you must set ADC to ‘ON’. The controller will then calculate a new value for manual reset, and switch ADC to ‘OFF’.

ADC can be repeated as often as you require, but between each adjustment you must allow time for the temperature to stabilize.

Chapter 5 CONFIGURATION

This chapter consists of five topics:

- SELECTING CONFIGURATION LEVEL
- LEAVING CONFIGURATION LEVEL
- SELECTING A CONFIGURATION PARAMETER
- CHANGING THE PASSWORDS
- CONFIGURATION NAVIGATION DIAGRAM
- CONFIGURATION PARAMETER TABLES.

In Configuration level you set up the fundamental characteristics of the controller, which are:

- The type of control (PID or On-Off)
- Input type and range
- User calibration
- Alarms configuration
- Output functions
- Passwords.

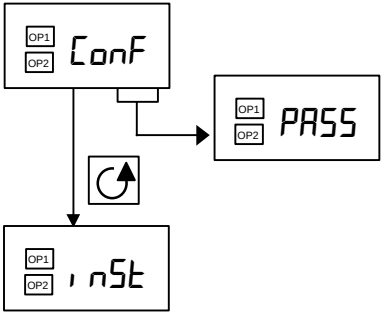
WARNING

Configuration is protected by password and should only be carried out by a suitably qualified person authorised to do so. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is the responsibility of the person commissioning the process to ensure that the configuration is correct.

SELECTING CONFIGURATION LEVEL

There are two alternative methods to select the Configuration:

- If you have already powered up, then follow the access instructions given in Chapter 3: *Access levels*.
- Alternatively press ▲ and ▼ together when powering up the controller. This will take you straight to the 'ConF' password display.



Password entry

To view the password press ▲ or ▼ once only. If the display shows 'PASS' then this indicates that the access is already unlocked and that a password is *not* required. To enter the configuration password continue to press ▲ or ▼ until the required value is shown. After two seconds the display should flash 'PASS' to verify that the number was entered correctly. The 'ConF' page display will then return.

The configuration password is set to '2' when the controller is shipped from the factory. If you need to change the password then follow the instructions in this chapter and select the CnF.P parameter. Setting the password to '0' is a special case that will cause the controller configuration level to be permanently unlocked.

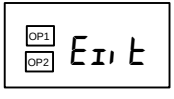
Press *Scroll* to access the 'inSt' list.

LEAVING CONFIGURATION LEVEL

To leave Configuration level and return to Operator level, proceed as follows:

Press ▢ until the 'Exit' display appears.

Alternatively pressing ↺ and ▢ together will take you straight to the correct display.



Press ▲ or ▼ to display 'YES'.

After a two-second delay, the display will flash and revert to the Home display in Operator level.

SELECTING A CONFIGURATION PARAMETER

The configuration parameters are arranged in lists as shown in the navigation diagram (Figure 5-1) on the next page. The names of the lists are as follows:

Instrument list	*AA list (relay output)*
Input list	*1A list (logic output)*
User calibration list	*Password list*
Alarm list	*Exit.*

To step through the list headers, press the Page button 
You will eventually return to the initial Instrument list.

To step through the parameters within a list, press the Scroll Button  When you reach the end of the list you will return to the list header.

From within a list, you can return to the list header at any time by pressing the Page button  .

Press the Page button  again to step to the next list header.

Parameter names

In the navigation diagram (Fig 5.1) each box shows the display for a selected list header or a particular parameter within a list. For an explanation of each parameter, see the configuration parameter tables at the end of this chapter.

To changed the value of a selected parameter, use the  and  buttons.

The diagram shows all the lists headers and parameters that *potentially* can be present in the controller. In practice, those actually present will correspond to the particular configuration choices you make.

CHANGING THE PASSWORDS

There are two passwords. They are stored in the Password configuration list and can be selected and changed in the same manner as any other configuration parameter.
The passwords names are:

- ‘ACC.P’ which protects access to Full level and Edit level
- ‘cnF. P’ which protects access to configuration level.

CONFIGURATION NAVIGATION DIAGRAM

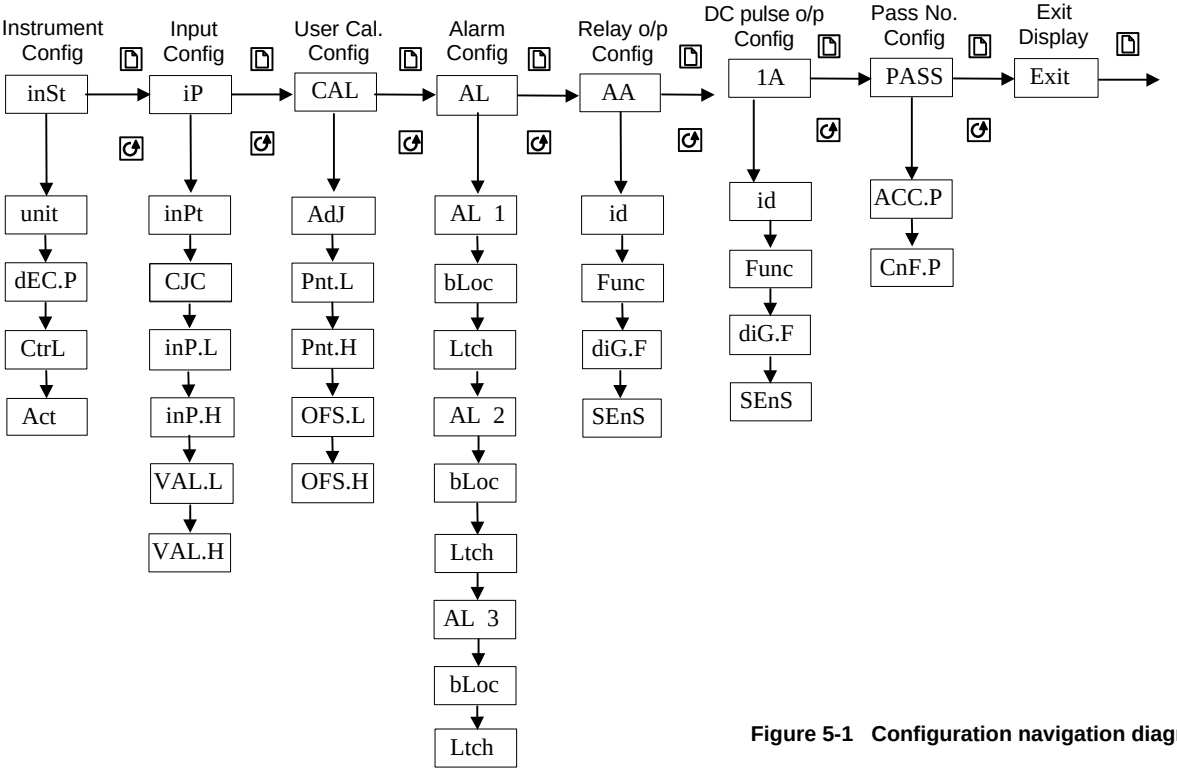


Figure 5-1 Configuration navigation diagram

CONFIGURATION PARAMETER TABLES

Name	Parameter description

inSt	Instrument config.	Value	Description
unit	Instrument units	°C °F °K nonE	Centigrade Fahrenheit Kelvin Blank
dEc.P	Decimal places in displayed value	nnnn nnn.n nn.nn	None One Two
CtrL	Control type	On.O F Pid	On/off PID
Act	Control action	rEv dir	Reverse Direct
Pd.tr	Bumpless Manual/Auto transfer when using PD control	HoLd trAc	Non-bumpless transfer Bumpless transfer

Name	Parameter description

iP	Input Configuration	Value	Description
inPt	Sensor input type	J.tc	J thermocouple
		K.tc	K thermocouple
		L.tc	L thermocouple
		r.tc	R thermocouple
		b.tc	B thermocouple
		n.tc	N thermocouple
		t.tc	T thermocouple
		S.tc	S thermocouple
		PL2	Platinell II thermocouple
		rtd	100Ω pt thermometer
		mV	Linear millivolts
		E.tc	E thermocouple Note: This is the default custom input. If a different custom input has been downloaded, then the name of the downloaded custom input will be displayed.
The following parameters will appear if the input type is a thermocouple.			
CJC	CJC reference temp.	Auto	Automatic cold junction compensation
		0°C	0°C external ref.
		45°C	45°C external ref.
		50°C	50°C external re
The following parameters will appear if the input type is linear millivolts.			
InP.H	Linear mV input high		inP.L value to 80.00mV
inP.L	Linear mV input low		-9.99mV to inP.H value
VAL.H	Display reading high		VAL.L to 9999
VAL.L	Display reading low		-999 to VAL.H

Name	Parameter description

CAL	User calibration config.	Values
AdJ	User calibration enable	YES/no
Pnt.L	User low calibration point	This is the value (in display units) at which a User last performed a low point calibration
Pnt.H	User high calibration point	This is the value (in display units) at which a User last performed a high point calibration
OFS.L	Low point calibration offset	Offset (in display units) at the low calibration point 'Pnt.L'. This value is automatically calculated when performing a low point calibration
OFS.H	High point calibration offset	Offset (in display units) at the low calibration point 'Pnt.H'. This value is automatically calculated when performing a high point calibration

Name	Parameter description

AL	Alarm configuration	Values
AL1	Alarm 1 Type	Select from table A
bLoc	Alarm 1 Blocking(1)	no/YES
Ltch	Alarm 1 latching	no/YES
AL2	Alarm 2 Type	Select from table A
bLoc	Alarm 2 Blocking(1)	no/YES
Ltch	Alarm 2 latching	no/YES
AL3	Alarm 3 Type	Select from table A
bLoc	Alarm 3 Blocking(1)	no/YES
Ltch	Alarm 3 latching	no/YES
Table A: Alarm types		
OFF	No alarm	
FSL	Full scale high	
FSH	Full scale low	
dEv	Deviation band	
dLHI	Deviation high	
dLO	Deviation low	

(1) Alarm Blocking allows the alarm to become active only after it has first entered a safe state.

Name	Parameter description

AA	Relay output configuration	Functions	Description
id	Identity of output	rELY	Relay
Func	Function	HEAt COOL diG	Heating Cooling Function set by diG.F
DiG.F	Digital output functions. Any number of the functions listed can be combined onto the logic output. Use the ▲ and ▼ buttons to select a desired output function. After two seconds the display will blink and return to the 'diG. F' display. Use the arrows again to scroll through the function list. The previously selected function display will show two decimal points indicating that it has been added to the output	noch CLr 1 - - - 2 - - - 3 - - - S.br L.br Ld.F mAN End	No change Clear all existing functions Alarm 1* Alarm 2* Alarm 3* Sensor break Loop break Load failure Manual mode End of timer
SEnS	Sense of output	nor inv	Normal *(heat and cool outputs*) Inverted *(alarms - de-energizes in the alarm state*)

*****In place of the dashes, the last three characters indicate the alarm type. If an alarm is not configured the displayed name will differ: e.g. for the first alarm AL 1' will be shown.

Name	Parameter description

1A	DC pulse output configuration	Functions	Description
id	Identity of output	LoG	DC pulse
Func	Function	HEAt COOL SSr.1 diG	Heating Cooling PDLINK mode 1 Function set by diG.F
diG.F	Digital output functions Any number of the functions listed can be combined onto the logic output. Use the ▲ and ▼ buttons to select a desired output function. After two seconds the display will blink and return to the 'diG. F' display. Use the arrows again to scroll through the function list. The previously selected function display will show two decimal points indicating that it has been added to the output.	noch Clr 1 - - - 2 - - - 3 - - - S.br L.br LdF mAN End	No change Clear all existing functions Alarm 1* Alarm 2* Alarm 3* Sensor break Loop break Load failure Manual mode End of timer
SEnS	Sense of output	nor inv	Normal *(heat and cool outputs*) Inverted *(alarm de-energizes in the alarm state*)

*In place of the dashes, the last three characters indicate the alarm type. If an alarm is not configured the displayed name will differ: e.g. for the first alarm 'AL 1' will be shown

Name	Parameter description	
PASS	***Password* entry**	
ACC.P	Access level password	
CnF.P	Configuration level password	

Exit	**Exit configuration**	**YES/no**

Chapter 6 USER CALIBRATION

This chapter has four topics:

- WHAT IS THE PURPOSE OF USER CALIBRATION?
- USER CALIBRATION ENABLE
- SINGLE POINT CALIBRATION
- TWO POINT CALIBRATION
- CALIBRATION POINTS AND CALIBRATION OFFSETS

To understand how to select and change parameters in this chapter you will need to have read Chapter 2 - *Operation*, Chapter 3- *Access Levels* and Chapter 6 - *Configuration.*

WHAT IS THE PURPOSE OF USER CALIBRATION?

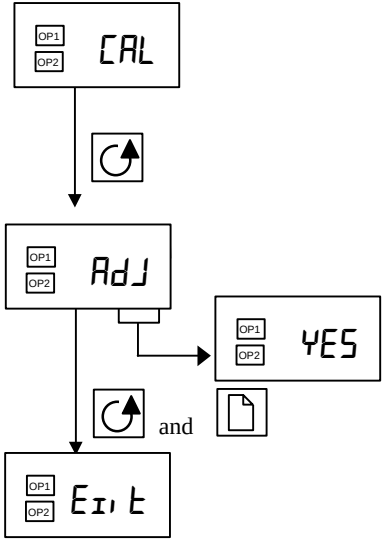
The basic calibration of the controller is highly stable and set for life. User calibration allows you to offset the 'permanent' factory calibration to either:

1. Calibrate the controller to the your reference standards
2. Match the calibration of the controller to that of a particular transducer or sensor input
3. Calibrate the controller to suit the characteristics of a particular installation
4. Remove long term drift in the factory set calibration.

User calibration works by introducing zero and span offsets onto the factory set calibration.

USER CALIBRATION ENABLE

The User calibration facility must first be enabled in configuration level by setting the parameter ‘AdJ' in the User calibration conf list to 'YES'. This will make the User calibration parameters appear in ‘Full’ access level. Select configuration level as shown in Chapter 5, Configuration.



The User calibration list

Press [ ] until you reach the ‘IP’ conf list.

Press the Scroll button until you reach

User calibration enable

Use [ ] or [ ] to select:

- **YES:** Calibration enable
- **no:** Calibration disabled.
-

Press [ ] *and* [ ] *together to go to the Exit display*

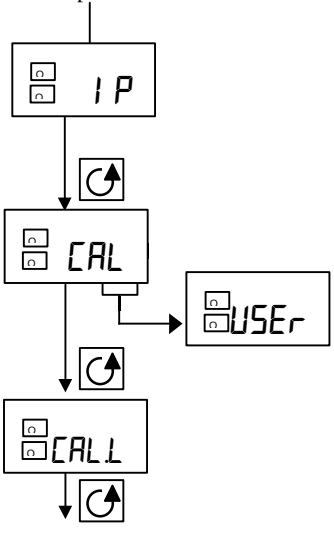
Exit configuration

Use [▼] or [▲] to select ‘YES’ and return to Operator level.

SINGLE POINT CALIBRATION

A single point calibration is used to apply a fixed offset over the full display range of the controller. To calibrate at a single point proceed as follows:

1. Connect the input of the controller to the source device to which you wish to calibrate.
2. Set the calibration source to the desired calibration value.
3. Press ▼ or ▲ to display the measured input.
4. If the displayed value is correct then the controller is correctly calibrated and no further action is necessary. If it is incorrect then follow the steps shown below. Select 'Full' Access level as described in Chapter 3.



The input configuration list

Press 🗋 until you reach the 'IP' conf list.

Press the Scroll button until you reach the 'CAL' display

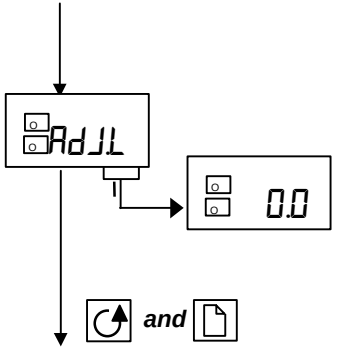
User calibration enable

Use ▼ or ▲ to select either 'FACt' or 'USEr'.
Selecting 'FACt' will reinstate the factory calibration and hide the User calibration parameters that follow.
Selecting 'USEr' will reinstate any previously set User calibration and make available the next set of parameters.

Press the Scroll button

Calibrate low point?

Use ▼ or ▲ to select 'YES'.
Selecting 'no' will hide the next parameter.
Press the Scroll button- Continued on the next page.



Adjust the low point calibration

Press ▼ or ▲ to display the measured input value.
Set the calibration source to the desired calibration value and allow it to stabilize.
You can calibrate at any point over the entire display range.

Use ▼ or ▲ to adjust the reading to the correct value.
After a two second delay the display will blink and the reading will change to the new, calibrated value.
The calibration is now complete. You can return to the factory calibration at any time by select FACt in the CAL display shown earlier.

Press ☐ *and* ↺ *together to go to the Home display*

.

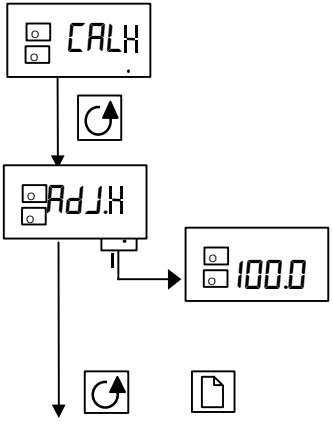
To protect the calibration against unauthorized adjustment, return to Operator level and make sure that the calibration parameters are hidden. Parameters are hidden using the 'Edit' facility described in Chapter 3.

TWO POINT CALIBRATION

The previous section described how to perform a single point calibration which applies a fixed offset over the full display range of the controller. A two-point calibration is used to calibrate the controller at two points and apply a straight line between them. Any readings above or below the two calibration points will be an extension of this straight line. For this reason it is best to calibrate with the two points as far apart as possible.

Proceed as follows:

1. Decide upon the low and high points at which you wish to calibrate.
2. Perform a single point calibration at the low calibration point in the manner described in the previous section. After adjusting the low calibration point 'AdJ.L', continue to the high calibration point by pressing the Scroll button to obtain the display shown on the next page.



Calibrate high point?

Use ▼ or ▲ to select 'YES'.
Selecting 'no' will hide the next parameter.

Press the Scroll button

Adjust the high point calibration

Set the calibration source to the desired high point calibration value. You can calibrate at any point over the entire display range.

Press ▼ or ▲ to display the measured input value. If the value is incorrect, use ▼ or ▲ to adjust the value to the correct reading.
The calibration is now complete. You can return to the factory calibration at any time by select 'FACt' in the CAL display shown earlier.

Press 🗋 *and* ↺ *together to return to the Home display*

CALIBRATION POINTS AND CALIBRATION OFFSETS

If you wish to see the points at which the User calibration was performed and the value of the offsets introduced these are shown in Configuration, in the User calibration list. The parameters are:

Name	Parameter description	Meaning
Pnt.L	User low calibration point	This is the value (in display units) at which a User last performed an 'AdJ.L' (adjust low calibration).
Pnt.H	User high calibration point	This is the value (in display units) at which a User last performed an 'AdJ.H' (adjust high calibration).
OFS.L	Low point calibration offset	Offset, in display units, at the user low calibration point 'Pnt.L
OFS.H	High point calibration offset	Offset, in display units, at the user high calibration point 'Pnt.H'.

Appendix A UNDERSTANDING THE ORDERING CODE

To Order (Specify Model Number)	
Dual Output Controllers, (dc Pulse and mechanical relay outputs)	
Model Number	**Description**
CN2132	1/32 DIN, 85-264 Vac power
CN2116	1/16 DIN, 85-264 Vac power
CN2132-LV	1/32 DIN, 20-29 Vac/Vdc power
CN2116-LV	1/16 DIN, 20-29 Vac/Vdc power

Ordering Example: CN2132-LV, Dual output controller with one solid state driver output, one relay output, power supply voltage: 20-29 Vac/dc.

Accessories	
Model Number	Description
SSC-TE10S*	Solid State Contactor
CNQUENCHARC	Noise Suppression Kit 110-230 Vac
BD2100-RELAY Driver output	Converts Solid State to a relay output

**For specifications and ordering, refer to the SSC-TE10S specifications sheet·*

Linear Process Input	Scalable
-12 to 80 mV, 0 to 20 mA**	(999 to 9999)

*-*Custom sensor inputs available. Consult engineering for details.*
***Note: 0-20 mA (When used with 2.5½ resistor, supplied with unit).*

Input Types and Ranges**		
Type		**Range**
J	Iron Constantan	-350 to 2192°F -210 to 1200°C
K	CHROMEGA¨ ALOMEGA¨	-325 to 2500°F -200 to 1372°C
T	Copper- Constantan	-325 to 750°F -200 to 400°C
N	OMEGA¨-P- OMEGA¨-N	-325 to 2370°F -200 to 1300°C
R	Pt/13%Rh-Pt	-60 to 3200°F -50 to 1768°C
S	Pt/10%Rh-Pt	-60 to 3200°F -50 to 1768°C
B	Pt/30%Rh- Pt6%Rh	32 to 3310°F 0 to 1820°C
E	CHROMEGA¨- Constantan*	-450 to 1830°F -270 to 1000°C
L	J DIN	-325 to 1650°F -200 to 900°C
Platinel II		32 to 2500°F 0 to 1369°C
RTD	Pt, 385 100 ohm-	-325 to 1560°F 200 to 850°C)