CEMENT TEST EQUIPMENT, INC.

Tulsa, Oklahoma, USA

Low Pressure (3K-5Kpsi) Curing Chamber Instruction Manual

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Chapter 1

Introduction

This chapter contains general information about the Curing Chamber and its uses as well as detailed specifications for the instrument and installation instructions.

What is a Curing Chamber used for?

ICON KEY	
	Important information
	Potential Danger or Safety Hazard
!	Operational Warning

Cements are a critical element in the drilling, completion, workover, and abandonment of wells. For each application, cement slurry is designed with specific properties and is given additives that provide predictable slurry density, volume, viscosity, compressive strength, fluid loss, gas migration, and thickening time. A curing chamber is used to cure a number of two inch square cement cubes under elevated temperature and pressure for the purpose of determining the compressive strength of each cement cube.

Description of Instrument

The CTE curing chambers consist of a pressure vessel that is capable of achieving pressures up to 40,000 psig/272 Mpa and temperatures up to 700°F/371°C (depending on model). The pressure is applied through the use of an air operated hydraulic pump. Heat is applied to the cylinder through band heaters attached to the outside of the pressure vessel. Internal cooling coils are also standard.

The major features of the CTE Curing Chambers are listed below:

- **Simple operation.**
- **Reliable, Modified Bridgeman Seal.**
- **Digital temperature controller.**

- **High strength bronze and stainless steel molds conform to API Specification.**
- **Optional data acquisition system is available.**

Instrument Specifications

The specifications below apply to all CTE, Inc. curing chamber models with pressure ranges between 3,000psi and 5,000psi.

ELECTRICAL

Input Voltage:	230 VAC (±5%)
Input Power:	6,000W Single, 12,000W Dual
Input Current:	30A Single/50 A Dual
Input Frequency:	50-60 Hz

MECHANICAL

Height:	61 in. (155 cm)
Width:	33 in. (84 cm) single
	48 in. (122 cm) dual
Depth:	30 in. (76.2 cm)
Weight:	700 lb. (318 kg) single
	1400 lb (645 kg) dual

ENVIRONMENTAL

Operating Temperature:	(32 to 120°F) 0-50°C
Operating Humidity:	0-95% non-condensing

HEATER

Heater Power:	Up to 6,000W
Heater Type:	Band heaters
Heater Control:	Solid state relay

UTILITIES - WATER AND AIR

Compressed air:	up to 150 psig (10.2 bar)
Cooling Water Pressure:	100 psig (6.8 bar) maximum
Utility Inlets:	¼ inch female NPT

Installation

Upon uncrating the instrument, verify that the instrument and any spare parts on the packing list have been received and are undamaged. Notify CTE if anything is missing or damaged.

It is a good idea to leave room behind the instrument so that qualified personnel may have service access. If this is not possible, try to make the unit easy to disconnect and move for service.

Once the instrument has been moved to its desired location, compressed air, water, and electrical connections can be made. The air inlet, air exhaust, water inlet, and water drain connections are each ¼ inch female NPT connections and are located on the rear of the instrument. A number of ¼ inch male NPT tube fittings are included for international locations.

Connect filtered water to the connector labeled **WATER INLET** on the rear panel of the instrument. The fitting has a ¼ inch female N.P.T. connection. The water must be clean and free of debris. The water must be clean and free of debris that could cause failure of the pump or relief valve. A water filter (C-0739) is included and must be installed on the water inlet to promote trouble free pump and relief valve operation. Depending on the quality of the water supply, the filter may need to be replaced more frequently. Follow the water filter manufacturer's recommended replacement interval. Neglecting to install the water inlet filter will void the instrument warranty. Water inlet supply water must be filtered at 5µ or better and have a viscosity between 1 - 100 cst. Pump performance is affected by many operating conditions. Extreme temperatures, pressures, and high duty cycles will increase maintenance frequency. All units are lubricated at the factory with silicone free semi-synthetic grease. After 2-3 months of normal (50% duty) operation, the standard spool seals should be inspected for wear and relubricated. Based on this inspection, future maintenance intervals can be planned and further disassembly and lubrication of other moving seals may be necessary.

Connect the water drain line to the connector labeled **WATER DRAIN** on the rear panel of the instrument. The fitting has a ¼ inch female N.P.T. connection. The drain system should be metal as it may be required to carry very hot water or steam up to 700 F periodically.

If the AIR EXHAUST connector discharges anything other than air, a malfunction has probably occurred.

Connect compressed air to the connector labeled **AIR INLET** on the rear of the instrument. The fitting has a ¼ inch female N.P.T. connection. The compressed air must be dry and free from contamination. The air should be supplied at a pressure of 20-100 psig (1.4-6.8 bar). Compressed nitrogen may also be used in place of the compressed air if necessary. Drive air should be filtered between 5µ and 40µ and have a maximum dewpoint of 50°F. Very wet

air will wash out lubricant and cause exhaust icing. Very dry air (dew point below 0°F) will dry out lubricant and cause premature failure of spool o-rings.

No connection is required for the **AIR EXHAUST** connector. It is simply used to vent air when removing water from the pressure vessel.

Electrical connections are made using the receptacle on the rear of the instrument. An appropriate power cord and plug is supplied with the instrument. Please observe the following precautions when making the wiring connections.

- Wiring should be done by a qualified installer in accordance with local electrical codes.
- The instrument should be securely connected to a separate earth ground. The ground wire must be larger in diameter than the supply conductors. A 10 gauge or larger ground wire is recommended.
- An 8BC or larger fire extinguisher to fight electrical and oil fires should be placed within 50 feet of the instrument.

Before attempting to operate the instrument, it is recommended that the operators read the remainder of the manual and study the drawings that appear in the Drawings/Schematics section of this manual to become familiar with the curing chamber operation.

Chapter 2

Using the Temperature Controller

The complete temperature controller manual is included for reference. This chapter contains brief instructions on how to use the most common functions of the temperature controller.

About the Temperature Controller

The temperature controller is a fully functional, self-tuning, digital controller. This manual will briefly describe the two functions most often used by operators – ramp and dwell programming. All other features of the controller have been pre-set at the CTE factory and should not be changed in most circumstances. It may be beneficial to refer to the Temperature Controller's Installation and Operation Handbook.

FRONT PANEL LAYOUTS

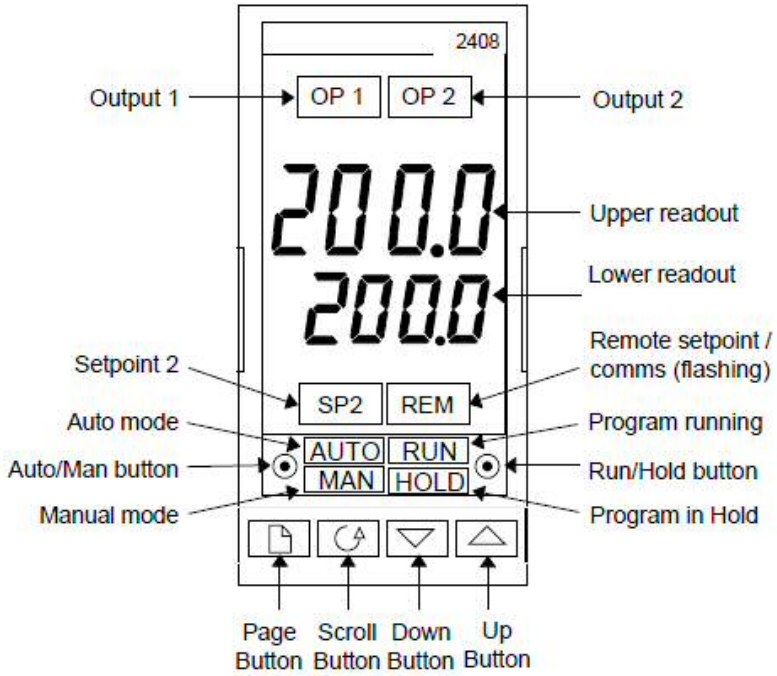


Figure 2-1 Model 2408 front panel layout

Button or indicator	Name	Explanation
OP1	Output 1	When lit, it indicates that the output installed in module position 1 is on. This is normally the heating output on a temperature controller.
OP2	Output 2	When lit, it indicates that the output installed in module position 2 is on. This is normally the cooling output on a temperature controller.
SP2	Setpoint 2	When lit, this indicates that setpoint 2, (or a setpoint 3-16) has been selected.
REM	Remote setpoint	When lit, this indicates that a remote setpoint input has been selected. 'REM' will also flash when communications is active.
AUTO MAN	Auto/Manual button	When pressed, this toggles between automatic and manual mode: • If the controller is in automatic mode the AUTO light will be lit. • If the controller is in manual mode, the MAN light will be lit. The Auto/Manual button can be disabled in configuration level.
RUN HOLD	Run/Hold button	• Press once to start a program (RUN light on.) • Press again to hold a program (HOLD light on) • Press again to cancel hold and continue running (HOLD light off and RUN light ON) • Press and hold in for two seconds to reset a program (RUN and HOLD lights off) The RUN light will flash at the end of a program. The HOLD light will flash during holdback.
	Page button	Press to select a new list of parameters.
	Scroll button	Press to select a new parameter in a list.
	Down button	Press to decrease a value in the lower readout.
	Up button	Press to increase a value in lower readout.

WHAT IS SETPOINT PROGRAMMING?

Many applications need to vary temperature, or process value, with time. Such applications need a controller which varies a setpoint as a function of time; all 2408 and 2404 models can do this.

The setpoint is varied by using a *setpoint program*. Within each 2408 and 2404 controller, there is a software module called *the programmer*, which stores one, or more, such programs and drives the setpoint according to the selected program. The program is stored as a series of 'ramp' and 'dwell' segments, as shown below.

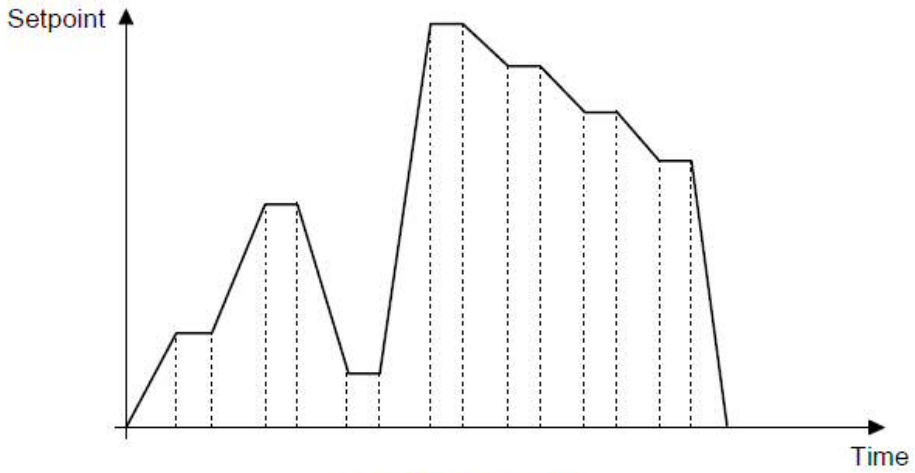


Fig 5-1 Setpoint profile

Programming a Ramp and Dwell Temperature Profile

To program a single or dual ramp and dwell profile, follow the steps below. Refer to Chapter 5-11 in the Temperature Controller Operation Handbook for more complete instructions on temperature controller programming. The example below will describe how to program a ramp from 20°C (room temperature) to 180°C in 90 minutes, a second ramp from 180°C to 200°C in 240 minutes, and a continuous dwell at 200°C.

1. **ProG/LiSt > From the home display press the page button until you reach the ProG/LiSt header.**

   Press

2. **Hb/OFF > Leave the holdback disabled in the OFF position.**

Press ↻

3. Hb U/0 > Leave the holdback value at 0.

   Press ↻

4. rmP.U/min > Select min for ramp units

   Press ↻

5. dwL.U/min > Select min for dwell units

   Press ↻

6. CYC.n/1 > In this example we are only running one program cycle, select 1.

   Press ↻

7. SEG.n/1 > Select 1.

   Press ↻

8. tYPE/rmP.t > For this segment type we will choose to ramp to a new setpoint in a set time. Select rmP.t.

   Press ↻

9. tGt/180 > For this example the target setpoint is 180 degrees Celsius. Select 180.

   Press ↻

10. dur/90 > For this example our duration time in this segment is 90 minutes. Select 90.

    Press ↻

11. SEG.n/2 > Select 2.

    Press ↻

12. tYPE/rmP.t > Select rmP.t.

    Press ↻

13. tGt/200 > For this example, our second ramp is to 200 degrees Celsius. Select 200.

    Press ↻

14. dur/240 > Duration time for segment two is 240 minutes. Select 240.

    Press ↻

15. SEG.n/3 > Select 3.

    Press ↻

16. tYPE/End > For this example, we have chosen to dwell at 200 degrees Celsius continuously. Select End.

    Press ↻

17. End.t/dwEll > Select dwell for an indefinite dwell.

    Press ↻ to return to the ProG/LiSt header.

Running a program using the RUN/HOLD Button

If there are multiple programs programmed into the controller, you must first select the number of the program that you want to run. Do this in the 'run' list. Then:

RUN / HOLD	RUN / HOLD button	Press once to run a program (RUN light on) Press again to hold a program (HOLD light on) Press again to cancel hold and continue running (HOLD light off, RUN light on) Press and hold in for two seconds to reset a program (RUN and HOLD lights off).

The heater power switch on the front panel must be turned on after you have initiated a program!

Warning: Never operate the controller in manual set point mode. Always run the controller in automatic mode as this allows the controller to properly control the relays and heaters and prevent component failure or even fire. The curing chamber was designed to run in automatic mode only. To prevent temperature overshoot it is advised to program at least a dual ramp into the controller with the second ramp being much shallower in rate than the first. Because there is a large amount of thermal mass in the system, temperature control is only predictive and does not necessarily have any immediate feedback from heat input. The PID control has been set at the factory and should not be changed.

Chapter 3

Front Panel Controls

Chapter 3 will discuss in detail each front panel control found on the curing chamber.

It may be convenient to refer to the piping drawings when studying this section.

All the functions of the curing chamber are controlled from the front panel. It is very important for the user to have a thorough understanding of each control and its effect on the operation of the curing chamber.

The front panel controls can be roughly divided into four different sections: the hydraulic pressure controls, the pneumatic controls, the cooling water controls, and the electrical/electronic controls. This chapter will discuss each section in detail.

The Hydraulic Pressure Controls

This section consists of the **PRESSURE** gauge, the **PRESSURE RELEASE** valve, the **RELIEF VALVE**, and the **WATER SUPPLY** valve. Components that make up this section are used to control the flow and pressure of the water used to pressurize the cylinder and to display the cylinder pressure.

The pressure gauge displays pressure in both English and SI units.

The **PRESSURE** gauge is used to display the pressure inside the pressure vessel. The part number for the pressure gauge is C-0558-1.

The **PRESSURE RELEASE** valve is used to release pressure from the pressurized cylinder. The **PRESSURE RELEASE** valve must also be fully opened to remove water from the cylinder. The part number for the **PRESSURE RELEASE** valve is C-0656.

The **RELIEF VALVE** may be used to set the upper limit on the system pressure up to 3,000 psig/204 bar or 5,000 psig/340 bar depending on model. When the hydraulic force on the relief valve exceeds the spring force of the

relief valve, the relief valve will open and release pressure until the hydraulic and spring forces balance again. The relief valve will then close preventing any additional pressure release until the hydraulic force again exceeds the spring force. Turn the **RELIEF VALVE** knob clockwise to increase pressure and counterclockwise to reduce pressure. The use of the pump and **RELIEF VALVE** to control pressure automatically will be discussed in *Chapter 4*. The **RELIEF VALVE** part number is C-0078-1 (3,000 psi) or C-0078-3 (5,000 psi).

The unit may be equipped with a **WATER SUPPLY** valve. If so, this valve must be opened to fill the cylinder or operate the pump. It must be closed when draining water from the cylinder or when the curing chamber is not in operation. Failure to close the **WATER SUPPLY** valve before draining the cylinder will cause the cylinder to refill with water and may create a flooding hazard.

The Pneumatic Controls

The pressure gauge displays pressure in both English and SI units.

The pneumatic section consists of the air pressure **REGULATOR**, the **PUMP AIR PRESSURE** gauge, and the **AIR TO CYLINDER** valve. The components in this section are used to fill and drain water from the pressure vessel and to power the air driven hydraulic pump that applies pressure to the cylinder.

If the PUMP AIR PRESSURE drops significantly when the pump is operating, an air line may be blocked or the compressor may be insufficient to deliver the volume of air required.

The **PUMP AIR PRESSURE** gauge shows the pressure of the air delivered to the pump. The air pressure to the pump is controlled by adjusting the air pressure **REGULATOR** as described below. The part number of this gauge is C-0364. If there is no pressure indicated on this gauge, the pump will not operate.

The air pressure **REGULATOR** is used to control the air pressure to the air driven hydraulic pump. Higher hydraulic pressures require higher air pressures. To adjust the pressure of the air supplied to the pump, pull the knob on the regulator out to unlock it. Turn the regulator knob clockwise to increase the pressure and counterclockwise to decrease the pressure. When the adjustment is complete, push the knob in to lock it in place if desired. The part number of this regulator is C-0021.

Under no circumstances should the AIR TO CYLINDER valve be opened when pressure is on the cylinder. To do so will flood the air lines with water

The **AIR TO CYLINDER** valve is used to introduce pressurized air into the test cylinder for the purpose of forcing the water out of the cylinder at the completion of a test. The **PRESSURE RELEASE** valve must be open in order to drain the water using the **AIR TO CYLINDER** valve. The part number for this valve is C-0656.

The Cooling Water Controls

The cooling water controls are used to cool the test cylinder at the completion of a test. The CTE pressurized curing chambers are equipped with internal cooling coils for quick cooling of the cylinder and faster turnaround between tests. The cooling water control consists of a **COOLING WATER** valve or switch.

The **COOLING WATER** valve allows water to flow through the cooling coils inside the pressure vessel. This valve should be turned on at the completion of a test to cool the pressure vessel. The part number for this valve is C-0056-1. Some curing chambers may have a switch and solenoid valve instead of a manual valve. Operation is virtually the same.

The Electrical Controls

The primary electrical controls are the **POWER**, **HEATER**, **PUMP**, and **TIMER** switches. The unit may also have a **WATER SUPPLY** switch if not equipped with a **WATER SUPPLY** valve. These controls, along with the rest, are discussed in detail below.

The switch labeled **POWER** controls electrical power to the entire instrument. Nothing else is operable if this switch is not on. The switches labeled **HEATER, PUMP** and **TIMER** turn on power to the heater, hydraulic pump, and elapsed timer, respectively.

The unit may be equipped with a **WATER SUPPLY** switch. If so, this switch must be in the ON position to fill the cylinder or operate the pump. It must be in the OFF position when draining water from the cylinder or when the curing chamber is not in operation. Failure to turn the **WATER SUPPLY** switch OFF before draining the cylinder will cause the cylinder to refill with water and may create a flooding hazard.

The number for the **POWER**, **HEATER** and **PUMP** switches is C-0186 and the part number for the **TIMER** and **WATER SUPPLY** switches is C-0489. The timer itself is a C-0200.

A part number C-0970-1 thermocouple is plugged into the **THERMOCOUPLE** connector so the centerline temperature of the cement cubes may be monitored.

This completes our tour of the front panel components. The operation of these components will be discussed in greater detail along with examples in Chapter 4, *Operation and Calibration*.

Chapter 4

Operation

Chapter 4 will discuss in detail the steps required to operate a curing chamber. Examples will be provided when necessary.

The majority of common operational errors may be avoided by observing the two following rules.

- **When you are ready to run a test, before doing anything in the way of operating the instrument, make certain every valve is closed and the WATER SUPPLY valve (if equipped) is in the OFF position. The same is true when stopping a test.**
- **Never open the AIR TO CYLINDER valve when the instrument is under pressure**

How to Run a Test

This section provides detailed instructions on curing chamber operation.

1. **Close all the valves on the front panel.**
2. **Turn POWER switch to the ON position. This supplies power to the entire instrument. Wait a few seconds until the temperature controller initializes.**
3. **Program the temperature ramp and soak parameters into the temperature controller. Refer to the section *Programming a ramp and dwell profile* in this manual or section 5-11 in the temperature controller Installation and Operation Handbook for detailed information.**

- CAUTION: Be sure the pressure vessel is sealed and the thermocouple in place before turning the heater on.

3. Assemble each pair of mold bodies. The inside of the molds may be lightly greased, if desired. Place a mold body on the mold bottom and fill with cement slurry in accordance with API Specification 10. Place a cover on each mold with the slotted side down. Repeat for remaining mold sets, stacking the molds as they are filled.

Be careful not to damage the metal sealing surfaces of the pressure vessel when lowering the molds into the vessel.

4. Clamp the molds together using the threaded rod provided.

5. Lower the molds into the pressure vessel.

6. Make certain the cylinder plug threads are thoroughly lubricated. Thread the plug into the cylinder and tighten securely by hand. Do not tighten with a hammer. Doing so my cause permanent damage to the cylinder.

Do not tighten the set screws when the instrument is under pressure.

7. Tighten the set screws in the plug according the drawing 5-0066 included with this operation manual. The screws must be tightened in the order shown and in three torque increments of 15, 30, and 40 ft-lbs.

8. Insert the thermocouple into the opening in the center of the cylinder plug, but do not tighten completely. The air will be vented through the thermocouple opening as the cylinder fills. Be sure to plug the thermocouple into the receptacle on the rear of the instrument.

9. Fill the pressure vessel with water as follows. With all valves closed, open the **WATER SUPPLY** valve or turn the WATER SUPPLY switch to the ON position. This allows water to flow into the pressure vessel. As the pressure vessel fills with water, air will be exhausted from the pressure cylinder at the thermocouple connection. You should hear a hissing sound and feel air escaping as the cylinder fills. As soon as the hissing stops and water appears, tighten the thermocouple gland securely. Do not tighten the thermocouple connector until water appears or air may be trapped in the vessel preventing pressurization.

10. Adjust the pressure in the vessel as desired for the start of the test. This is accomplished by placing the **PUMP** switch in the ON position, adjusting the pump air pressure and adjusting the pressure relief valve until the desired pressure is reached.

11. Turn **HEATER** switch to the ON position and press the **RUN** key on the temperature controller. Refer to *Chapter 2* for complete instructions on operating the temperature controller.

12. **Turn the TIMER switch to the ON position.**

CAUTION: Top of curing chamber may become extremely hot. Severe burns can result from touching the pressure vessel or plug.

13. **The test will now run until stopped by the operator.**

Pressure Control

This section describes the steps used to control pressure in the Model 3-700 Curing Chamber. Use of the internal pump and relief valve will also be discussed.

Follow the steps below to configure the pump and relief valve for automatic pressure control.

1. Make certain the **PUMP** switch is in the OFF position, the **WATER SUPPLY** valve is turned to the ON position, the **COOLING WATER** valve is in the OFF position, and the instrument is supplied with compressed air.

2. Turn the **PUMP AIR PRESSURE ADJUST** regulator clockwise until air pressure is sufficient to raise pressure to the desired pressure set point. The air pressure should not exceed 100 psig (690 kPa).

3. Turn the **RELIEF VALVE** knob clockwise until the regulator pressure is sufficient to prevent the regulator from opening at the required pressure set point.

4. Turn the **PUMP** switch to the ON position and increase pressure until the pressure exceeds the desired set point. Turn the **PUMP** switch to the OFF position. Make certain the system is holding pressure before proceeding. The pump contains metal-to-metal inlet and outlet check valves that may not be bubble tight, so a small amount of pressure leakage is to be expected. This should not be a problem under normal operation.

5. Turn the **RELIEF VALVE** knob counterclockwise slowly until the test cylinder pressure begins to drop. Continue turning the regulator knob slowly until the pressure in the test cell is at the upper limit of the desired test pressure.

6. Release pressure in the test cell using the **PRESSURE RELEASE** valve.

7. Turn the **PUMP AIR PRESSURE ADJUST** regulator counterclockwise until the **PUMP AIR PRESSURE** is approximately zero.

8. Turn the **PUMP** switch to the ON position.

9. Slowly turn the **PUMP AIR PRESSURE ADJUST** regulator knob clockwise until the pump actuates. Continue to slowly turn the regulator knob clockwise until the lower limit for the control pressure is reached.

As the test cylinder gets hot, pressure in the test cylinder will increase. When the pressure in the test cylinder exceeds the control pressure upper set point, the relief valve will open and pressure will be reduced. If the heating rate is reduced, as during the transition from a temperature ramp to a temperature soak, the pressure in the test cylinder may decrease. If the pressure falls below the control pressure lower limit, the pump will actuate and bring the pressure back within the established limits.

The pump and relief valve will have hysteresis or a "deadband" in their operation. For example, if the relief valve is set to open at 2000 psig, it may open at 2000 psig, but may not close until the pressure falls to some lower value, perhaps 1900 psig. This 100 psig differential between opening and closing is referred to as the deadband or hysteresis. As another example, the pump may be set to actuate if the pressure falls to 2000 psig, but the pressure may reach perhaps 2100 psig before the pump stops. This 100 psig differential between the initial pressure and the final pressure is also known as deadband or hysteresis. If the upper and lower set points are too close together, this deadband may overlap and cause system instability. The system will then go into a continuous oscillation where the pump increases pressure and the relief valve releases all the pressure the pump is able to build. The solution to this problem is to decrease the lower set point, raise the upper set point, or both.

Stopping a Test

When the cement cubes have cured for the desired time and it becomes necessary to stop the test, follow the steps below.

1. **Turn the HEATER switch to the OFF position.**

2. **Press the RUN/HOLD key for two seconds on the temperature controller to stop the program.**

3. **Slowly open the CYLINDER COOLING valve to start the flow of cooling water through the internal cooling coils.**

- Do not remove the thermocouple or cylinder plug until the instrument has cooled below 200°F/93°C. Doing so may cause water in the cylinder to turn to steam causing a hazardous condition. Also maintain a pressure of at least 500 psig (34 bar) to prevent steam from forming inside the vessel.

4. When the cylinder and plug have cooled sufficiently, close the **WATER SUPPLY** valve or turn the **WATER SUPPLY** switch to the OFF position.

5. Slowly open the **PRESSURE RELEASE** valve to vent the pressure.

6. With all pressure released from the cylinder and the **PRESSURE RELEASE** valve open, open the **AIR TO CYLINDER** valve. This transfers the water from the pressure vessel to the drain. A hissing sound will be heard when the pressure vessel is empty.

7. Unscrew the thermocouple in the cylinder plug and remove.

8. Loosen set screws on the cylinder plug.

9. Unscrew the cylinder plug and remove. Tap the handles lightly with a hammer if necessary.

10. Remove the molds from the pressure vessel.

11. The curing of the cement cubes is now complete.

Pressure Relief Valve/Regulator Cooling

The blue pressure relief valve may be equipped with an automatic solenoid cooling valve. This is to prevent failure of temperature sensitive parts within the valve by protecting them from excessive heat. This feature maybe turned off by shutting off the water supply to the pressure relief solenoid cooling valve. There is a small brass toggle valve connected to the automatic solenoid valve. This valve turns the pressure relief valve cooling on or off. We recommend leaving this turned on if you continually run high temperature tests or turning it off if your tests generally do not run very hot. If left on, the unit will consume large amounts of water. We give the option to not use it if you are so inclined to save water. Some curing chambers may only have a coiled tube "heat exchanger" type of cooling.

Long-Term Testing

Beginning January, 2014 all curing chambers will come equipped with an isolation valve between the pump and cylinder. The valve handle is typically red in color and has a part #

C-0640. The use of the isolation valve was determined to be useful in case of pump, release valve and/or pressure regulator failure. The test cell may be isolated by turning the valve to the closed position. Any one of those components may then be replaced or repaired without interrupting the test in progress.

Chapter

5

Maintenance and Troubleshooting

This chapter contains information about the necessary periodic maintenance of the curing chamber as well as common service and troubleshooting guidelines.

Maintenance

Curing chambers can be relatively reliable and trouble free – provided they are serviced and maintained properly. Instruments that are neglected and receive infrequent service or are subject to abuse are certain to cause trouble. The maintenance requirements for the curing chamber are very simple and should consume little time.

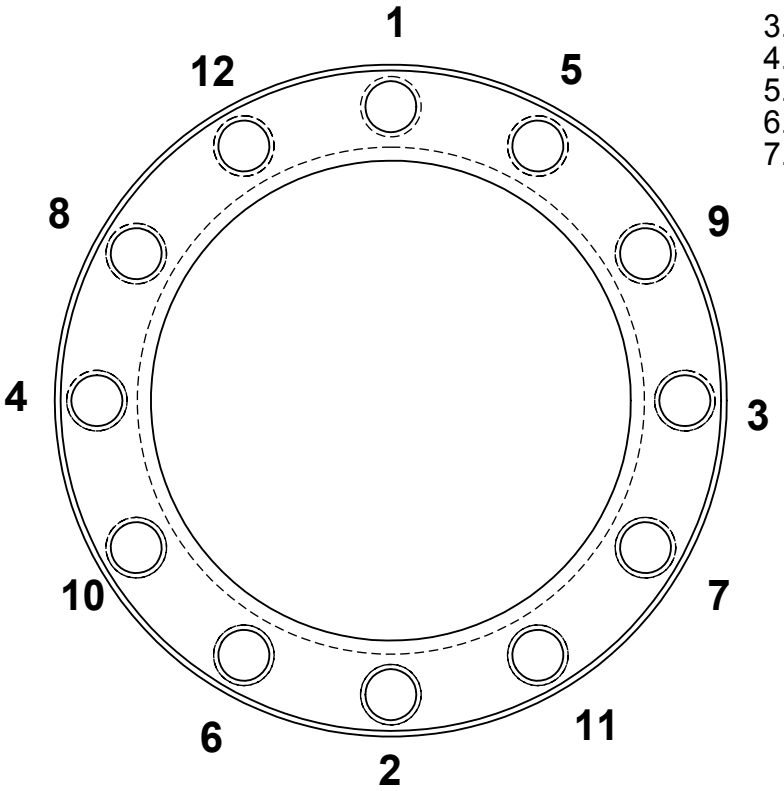
1. Thoroughly clean the test cylinder after every test.
2. Coat the cylinder and plug threads with high-temperature black molybdenum grease or the equivalent.
3. Lubricate the sealing surfaces of the plug and pressure vessel before each test.
4. Replace the low pressure water filter element periodically.
5. Clean all cube mold parts after cement cube removal.

Troubleshooting

The following section consists of a table listing possible remedies for the most common curing chamber problems.

Symptom	*Cause*	*Remedy*
Pump will not stroke and/or water comes out AIR EXHAUST fitting	AIR TO CYLINDER valve has been opened while cylinder is pressurized, flooding the air lines and pump pneumatic side with water.	Remove air lines and drain water. Remove pump and disassemble pump pneumatic side to remove water. If contamination is not too severe, you may let the pump stroke under no pressure until the water is removed.
System builds pressure but will not hold pressure	Leak	Check fittings for leaks and tighten fittings.
	PRESSURE RELEASE and AIR TO CYLINDER valves are not closed tightly	Close valves tightly.
	PRESSURE RELEASE or AIR TO CYLINDER valves are worn out.	Replace valve stem or entire valve. PRESSURE RELEASE valve is most likely to wear out.
System builds pressure and water runs out between pressure vessel and top plug.	Metal seal surfaces on plug and cylinder are dirty.	Clean sealing surfaces.
	Sealing surfaces are worn, pitted, or scratched.	Lap sealing surfaces. Instructions are available from CTE.
	Set screws were not torqued properly.	Refer to drawing in *Chapter 6* and torque properly.
Instrument not receiving power	Instrument not plugged in.	Connect instrument to the correct power source.
	Blown fuse or thrown breaker on circuit supplying power.	Check fuses and breakers on electrical supply circuit.
Heater will not get hot.	Blown fuse.	Check fuses inside electrical box. Replace any that are blown.
	HEATER switch not in the ON position.	Turn **HEATER** switch to ON position.
	Faulty heater.	Replace.
	Faulty solid state relay.	Replace.
Temperature display is erratic.	Faulty thermocouple.	Replace thermocouple.

Symptom	*Cause*	*Remedy*
	Loose connection in thermocouple wiring.	Check for loose wiring and correct if necessary.
Temperature displays ---- instead of temperature	Open circuit in thermocouple. Open circuit in thermocouple circuitry	Replace thermocouple. Check thermocouple circuitry for open circuits or loose connections.
Pump strokes but little or no pressure is obtained.	Valve open, severe leak, blown rupture disc. Pressure vessel has trapped air. AIR SUPPLY valve not opened or air not connected to instrument. Severely clogged low pressure filter. Faulty pump check valve.	Locate problem and correct. Open thermocouple connector slightly and release trapped air. Connect air supply and open AIR SUPPLY valve. Replace low pressure filter element. Clean and/or overhaul pump outlet check valve.
Pump builds and maintains pressure to a certain level than then stops.	If water is coming from pump muffler, the pump high pressure seal is probably worn out.	Overhaul or replace pump.
Pressure cannot be released.	Stainless steel lines are plugged with cement.	Remove lines and inspect for blockage. Replace any that are plugged.



CLOSURE INSTRUCTIONS

1. MAKE CERTAIN ALL THREADS AND SEALING SURFACES ARE PROPERLY LUBRICATED.
2. TIGHTEN THE SET SCREWS IN THE ORDER SHOWN IN THE DIAGRAM AT LEFT.
3. TIGHTEN IN THREE STEPS.
4. FIRST, TIGHTEN ALL SET SCREWS TO 15 FT-LB.
5. NEXT, TIGHTEN ALL SET SCREWS TO 30 FT-LB.
6. FINALLY, TIGHTEN ALL SET SCREWS TO 40 FT-LB
7. FAILURE TO FOLLOW THESE PROCEDURES MAY CAUSE CYLINDER LEAKAGE OR DAMAGE.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ±1/32 DECIMALS .XX ±.01 .XXX ±.005 ANGLES ±1°

MATERIAL

FINISH

DO NOT SCALE DRAWING

CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE

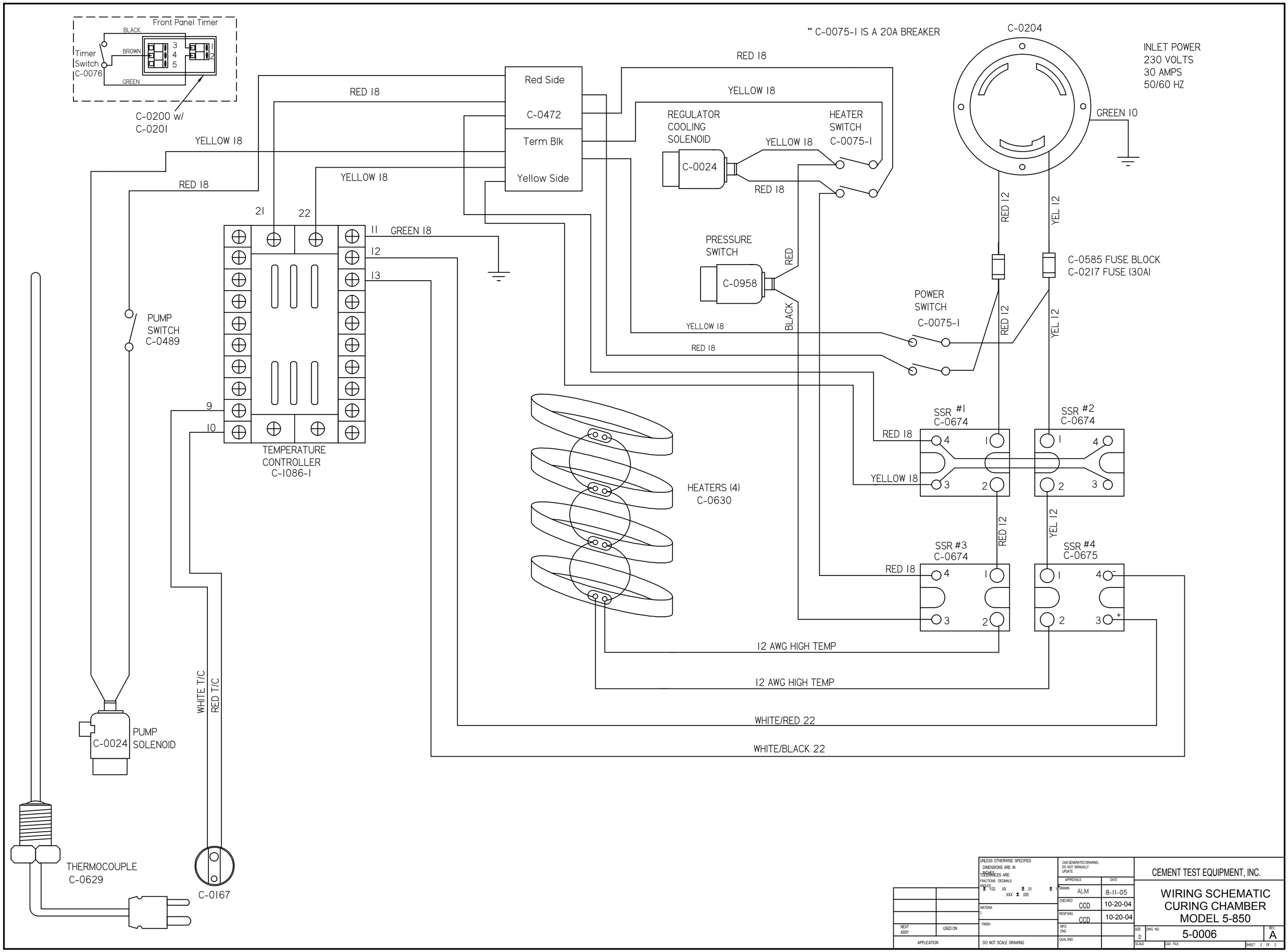
APPROVALS		DATE
DRAWN	CCD	3-15-00
CHECKED	CCD	3-15-00
RESP ENG	CCD	3-15-00
MFG ENG	CCD	3-15-00
QUAL ENG	CCD	3-15-00

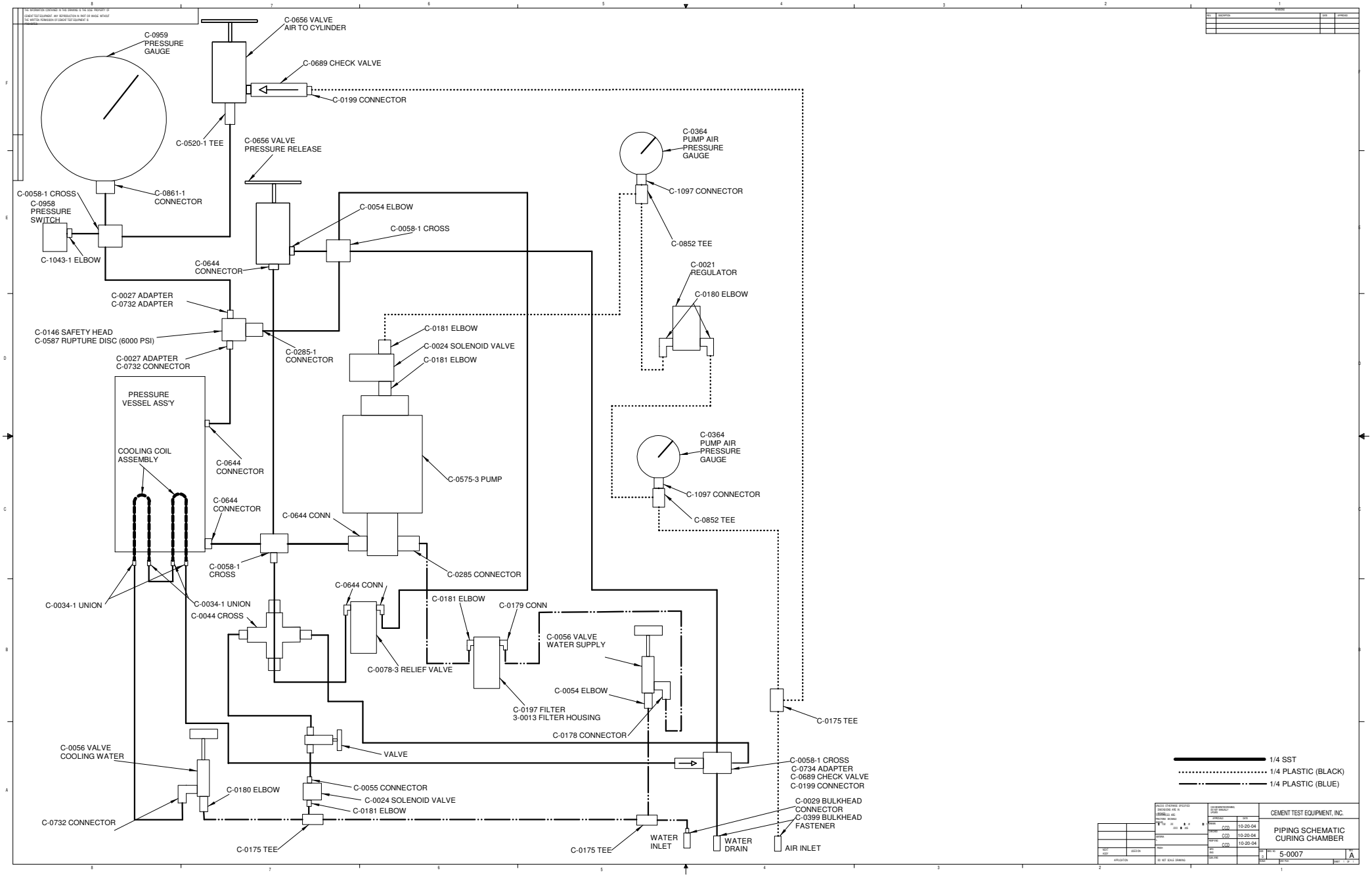
CEMENT TEST EQUIPMENT, INC.

CYLINDER CLOSURE INSTRUCTIONS

SIZE A | DWG. NO. 5-0066 | REV. A

SCALE | CAD FILE: | SHEET 1 OF 1


Front Panel Timer
BLACK
BROWN
GREEN
Timer Switch C-0076
3
4
5
1
2
C-0200 w/ C-0201
** C-0075-1 IS A 20A BREAKER
C-0204
INLET POWER 230 VOLTS 30 AMPS 50/60 HZ
GREEN 10
RED 18
YELLOW 18
Red Side
C-0472
Term Blk
Yellow Side
REGULATOR COOLING SOLENOID
C-0024
HEATER SWITCH C-0075-1
PRESSURE SWITCH
C-0958
RED
BLACK
RED 12
YEL 12
C-0585 FUSE BLOCK
C-0217 FUSE (30A)
POWER SWITCH C-0075-1
PUMP SWITCH C-0489
21
22
11
12
13
GREEN 18
9
10
TEMPERATURE CONTROLLER C-1086-1
HEATERS (4) C-0630
SSR #1 C-0674
SSR #2 C-0674
SSR #3 C-0674
SSR #4 C-0675
12 AWG HIGH TEMP
WHITE/RED 22
WHITE/BLACK 22
WHITE T/C
RED T/C
PUMP SOLENOID
C-0024
THERMOCOUPLE C-0629
C-0167
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
DO NOT SCALE DRAWING
CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE
APPROVALS
DATE
DRAWN ALM 8-11-05
CHECKED CCD 10-20-04
RESP ENG CCD 10-20-04
MFG ENG
QUAL ENG
NEXT ASSY
USED ON
APPLICATION
CEMENT TEST EQUIPMENT, INC.
WIRING SCHEMATIC
CURING CHAMBER
MODEL 5-850
SIZE D
DWG. NO. 5-0006
REV A
SCALE
CAD FILE:
SHEET 2 OF 2



REV	DESCRIPTION	DATE	APPROVED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCE UNLESS ANG.
FRACTIONS DECIMALS
± 1/16 .XX ± .02 .XXX ± .005

DRAWN	CCD	10-20-04
CHECKED	CCD	10-20-04
ENGR/PROJ	CCD	10-20-04
MFG		
QA		

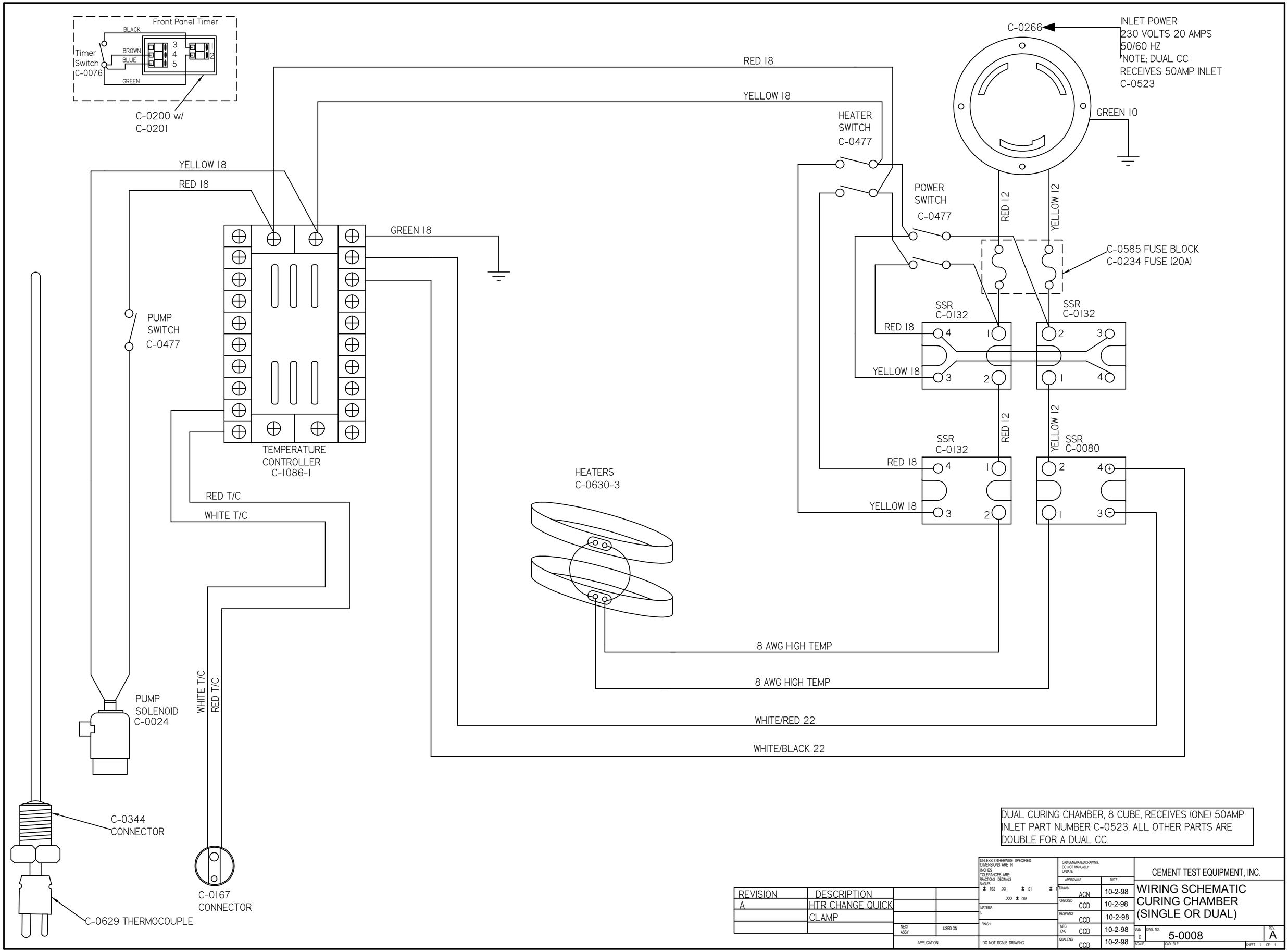
DO NOT SCALE DRAWING

CEMENT TEST EQUIPMENT, INC.

PIPING SCHEMATIC
CURING CHAMBER

DWG NO. 5-0007 REV A

SCALE NONE SHEET 1 OF 1



DUAL CURING CHAMBER, 8 CUBE, RECEIVES (ONE) 50AMP INLET PART NUMBER C-0523. ALL OTHER PARTS ARE DOUBLE FOR A DUAL CC.

REVISION	DESCRIPTION
A	HTR CHANGE QUICK CLAMP

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
± 1/32 .XX ± .01 ± 1°
.XXX ± .005

MATERIAL

FINISH

DO NOT SCALE DRAWING

CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE

APPROVALS		DATE
DRAWN	ACN	10-2-98
CHECKED	CCD	10-2-98
RESP ENG	CCD	10-2-98
MFG ENG	CCD	10-2-98
QUAL ENG	CCD	10-2-98

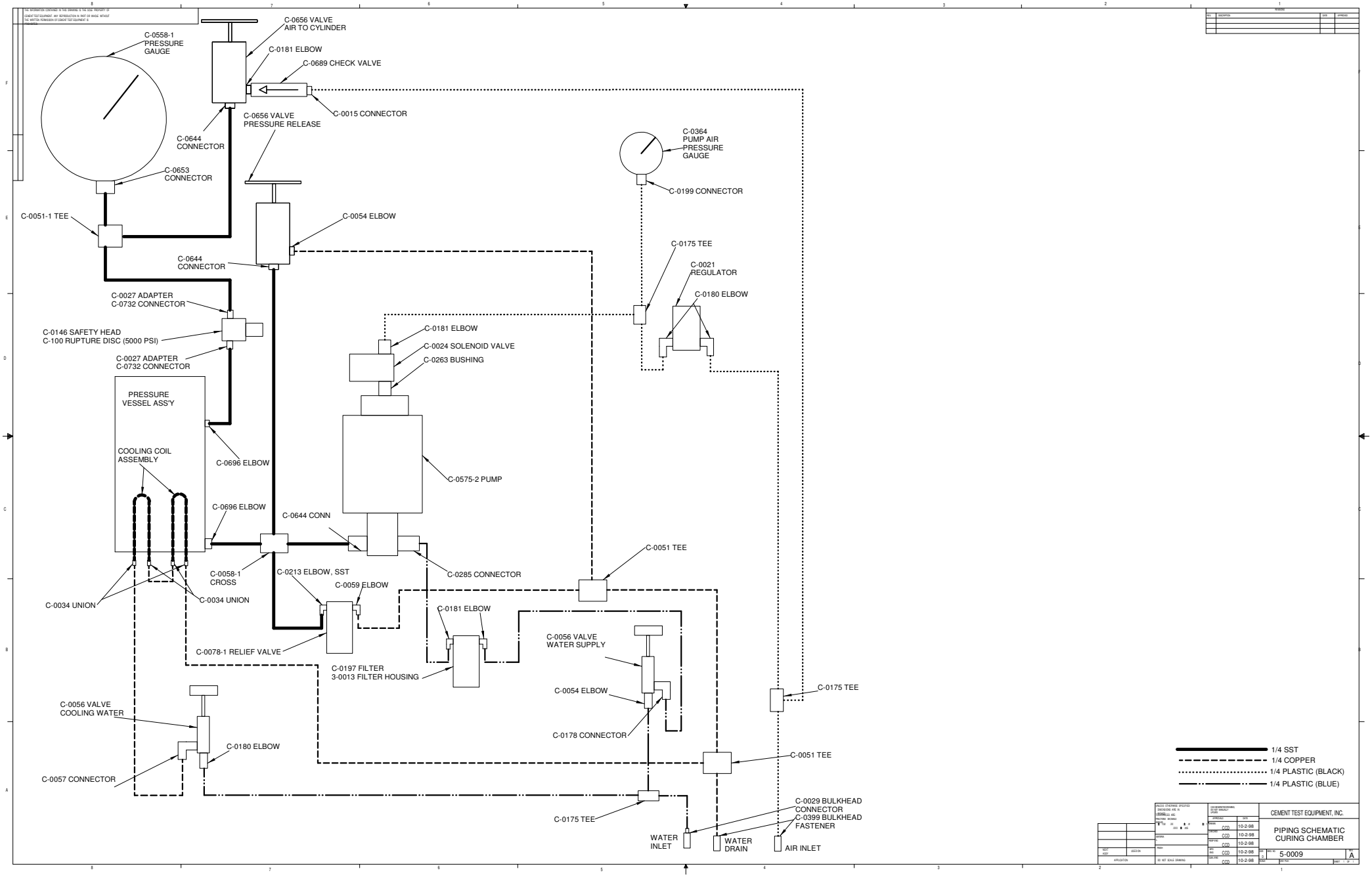
CEMENT TEST EQUIPMENT, INC.

WIRING SCHEMATIC
CURING CHAMBER
(SINGLE OR DUAL)

SIZE D | DWG. NO. 5-0008 | REV A

SCALE | CAD FILE | SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED



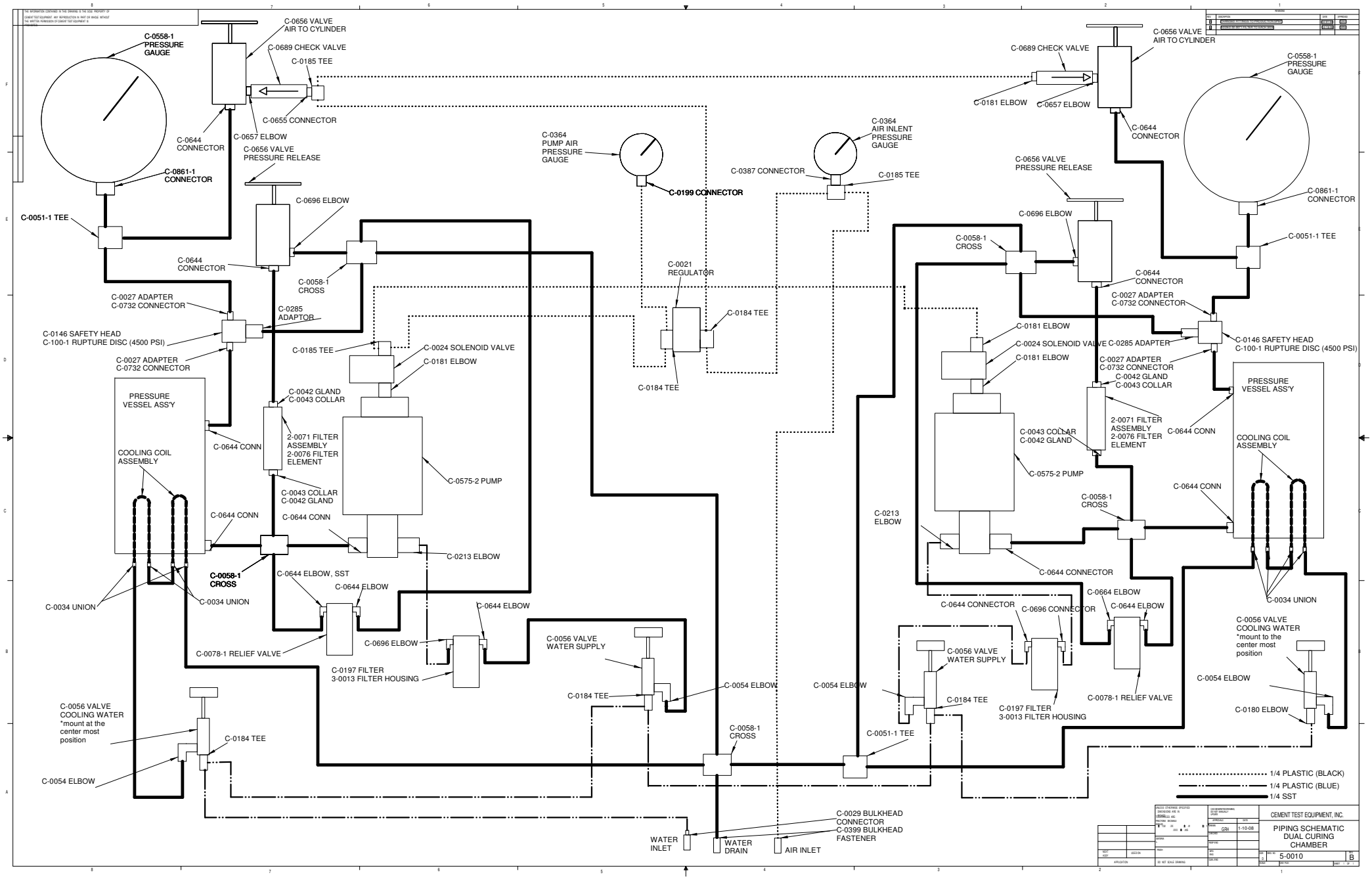
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ±1/16 DECIMALS .X ±.1 .XX ±.03 .XXX ±.005 ANGLES ±1°	DESIGN ENGINEERING DO NOT SCALE DRAWING! UNLESS	APPROVALS	DATE
		DRAWN CCD	10-2-98
		CHECKED CCD	10-2-98
		ENGRG CCD	10-2-98
		MFG CCD	10-2-98
		QA CCD	10-2-98
NEXT ASSY	USED ON		
APPLICATION	DO NOT SCALE DRAWING		

CEMENT TEST EQUIPMENT, INC.

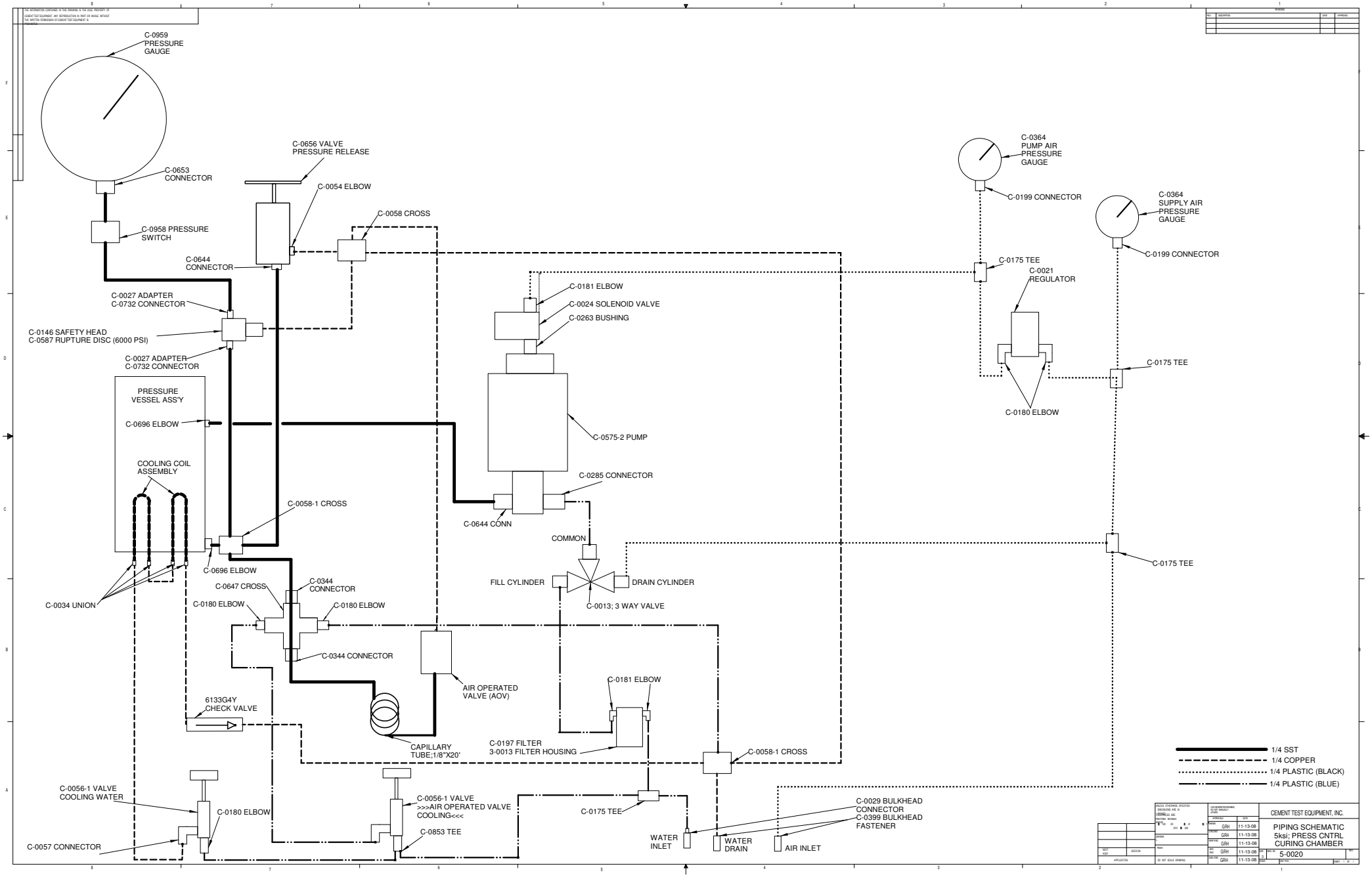
PIPING SCHEMATIC
CURING CHAMBER

SIZE A | DWG NO. 5-0009 | REV A

SCALE: NONE | SHEET 1 OF 1


C-0558-1 PRESSURE GAUGE
C-0656 VALVE AIR TO CYLINDER
C-0689 CHECK VALVE
C-0185 TEE
C-0655 CONNECTOR
C-0644 CONNECTOR
C-0657 ELBOW
C-0656 VALVE PRESSURE RELEASE
C-0861-1 CONNECTOR
C-0051-1 TEE
C-0696 ELBOW
C-0644 CONNECTOR
C-0058-1 CROSS
C-0027 ADAPTER C-0732 CONNECTOR
C-0285 ADAPTOR
C-0146 SAFETY HEAD C-100-1 RUPTURE DISC (4500 PSI)
C-0027 ADAPTER C-0732 CONNECTOR
C-0185 TEE
C-0024 SOLENOID VALVE
C-0181 ELBOW
PRESSURE VESSEL ASS'Y
C-0042 GLAND C-0043 COLLAR
2-0071 FILTER ASSEMBLY 2-0076 FILTER ELEMENT
C-0644 CONN
COOLING COIL ASSEMBLY
C-0575-2 PUMP
C-0043 COLLAR C-0042 GLAND
C-0644 CONN
C-0644 CONN
C-0213 ELBOW
C-0058-1 CROSS
C-0644 ELBOW, SST
C-0644 ELBOW
C-0034 UNION
C-0034 UNION
C-0644 ELBOW
C-0078-1 RELIEF VALVE
C-0696 ELBOW
C-0197 FILTER 3-0013 FILTER HOUSING
C-0056 VALVE COOLING WATER *mount at the center most position
C-0184 TEE
C-0054 ELBOW
C-0364 PUMP AIR PRESSURE GAUGE
C-0199 CONNECTOR
C-0021 REGULATOR
C-0184 TEE
C-0184 TEE
C-0056 VALVE WATER SUPPLY
C-0184 TEE
C-0054 ELBOW
C-0058-1 CROSS
C-0029 BULKHEAD CONNECTOR
C-0399 BULKHEAD FASTENER
WATER INLET
WATER DRAIN
AIR INLET
C-0387 CONNECTOR
C-0364 AIR INLENT PRESSURE GAUGE
C-0185 TEE
C-0656 VALVE AIR TO CYLINDER
C-0689 CHECK VALVE
C-0181 ELBOW
C-0657 ELBOW
C-0644 CONNECTOR
C-0558-1 PRESSURE GAUGE
C-0656 VALVE PRESSURE RELEASE
C-0861-1 CONNECTOR
C-0696 ELBOW
C-0051-1 TEE
C-0058-1 CROSS
C-0644 CONNECTOR
C-0027 ADAPTER C-0732 CONNECTOR
C-0181 ELBOW
C-0024 SOLENOID VALVE
C-0285 ADAPTER
C-0146 SAFETY HEAD C-100-1 RUPTURE DISC (4500 PSI)
C-0181 ELBOW
C-0027 ADAPTER C-0732 CONNECTOR
C-0042 GLAND C-0043 COLLAR
PRESSURE VESSEL ASS'Y
2-0071 FILTER ASSEMBLY 2-0076 FILTER ELEMENT
C-0644 CONN
C-0043 COLLAR C-0042 GLAND
COOLING COIL ASSEMBLY
C-0575-2 PUMP
C-0644 CONN
C-0058-1 CROSS
C-0213 ELBOW
C-0644 CONNECTOR
C-0664 ELBOW
C-0644 CONNECTOR
C-0696 CONNECTOR
C-0644 ELBOW
C-0034 UNION
C-0056 VALVE COOLING WATER *mount to the center most position
C-0056 VALVE WATER SUPPLY
C-0054 ELBOW
C-0054 ELBOW
C-0184 TEE
C-0197 FILTER 3-0013 FILTER HOUSING
C-0078-1 RELIEF VALVE
C-0180 ELBOW
C-0051-1 TEE
1/4 PLASTIC (BLACK)
1/4 PLASTIC (BLUE)
1/4 SST
CEMENT TEST EQUIPMENT, INC.
PIPING SCHEMATIC DUAL CURING CHAMBER
5-0010
B

REV	DESCRIPTION	DATE	APPROVED



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ±1/64 DECIMALS .X ±.1 .XX ±.03 .XXX ±.005 ANGLES ±0°	DO NOT SCALE DRAWING	APPROVALS: DRAWN GRH 11-13-08; CHECKED GRH 11-13-08; ENGINEERING GRH 11-13-08; MFG GRH 11-13-08; QA GRH 11-13-08	CEMENT TEST EQUIPMENT, INC.
NEXT ASSY	USED ON	APPLICATION	PIPING SCHEMATIC 5ksi; PRESS CNTRL CURING CHAMBER
			SIZE A; CAGE CODE; 5-0020; REV
			SCALE: NONE; SHEET 1 OF 1

MODELS 2408 and 2404 PID CONTROLLERS

INSTALLATION AND OPERATION HANDBOOK

Contents **Page**

Chapter 1 INSTALLATION

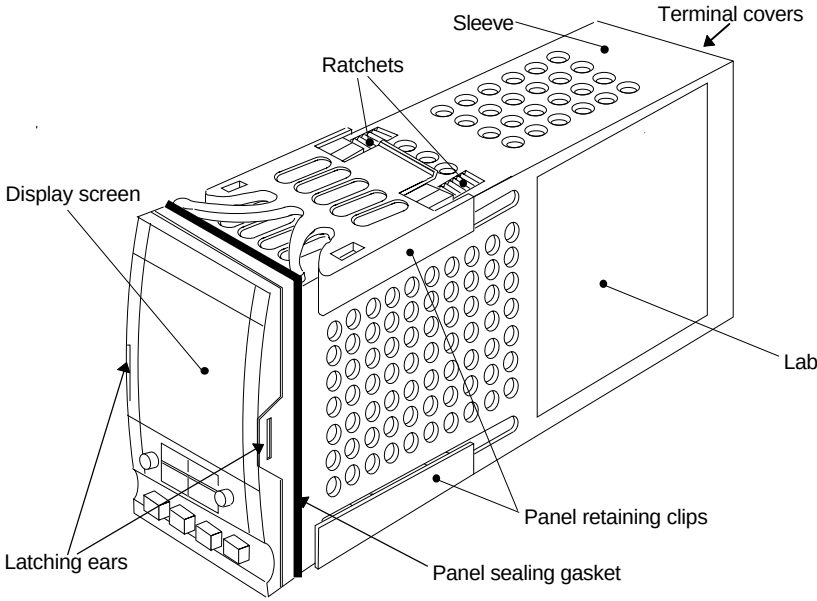


Figure 1-1 2408 1/8 DIN controller

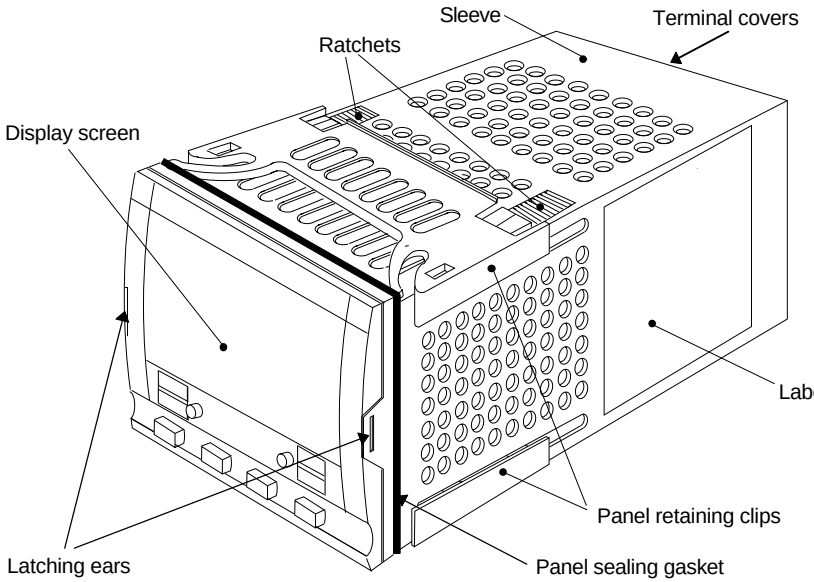


Figure 1-2 2404 1/4 DIN controller

Outline dimensions Model 2408

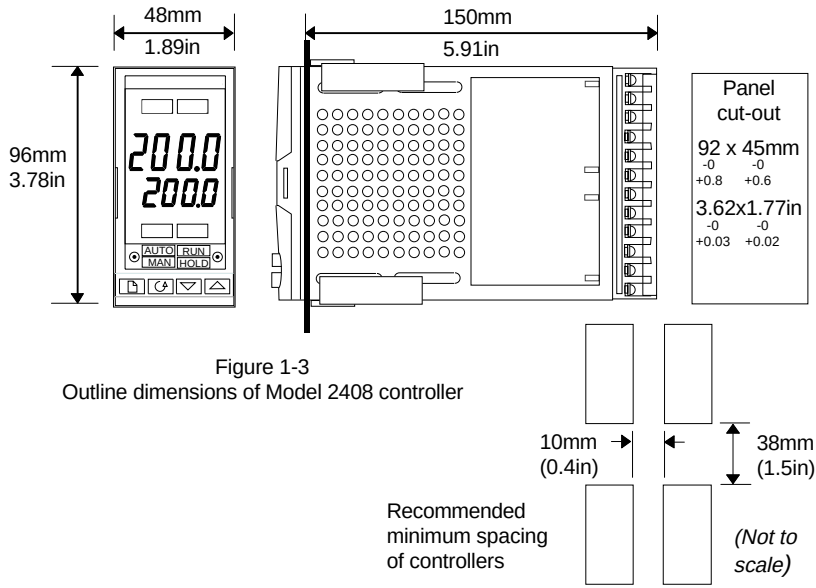


Figure 1-3
Outline dimensions of Model 2408 controller

Outline dimensions Model 2404

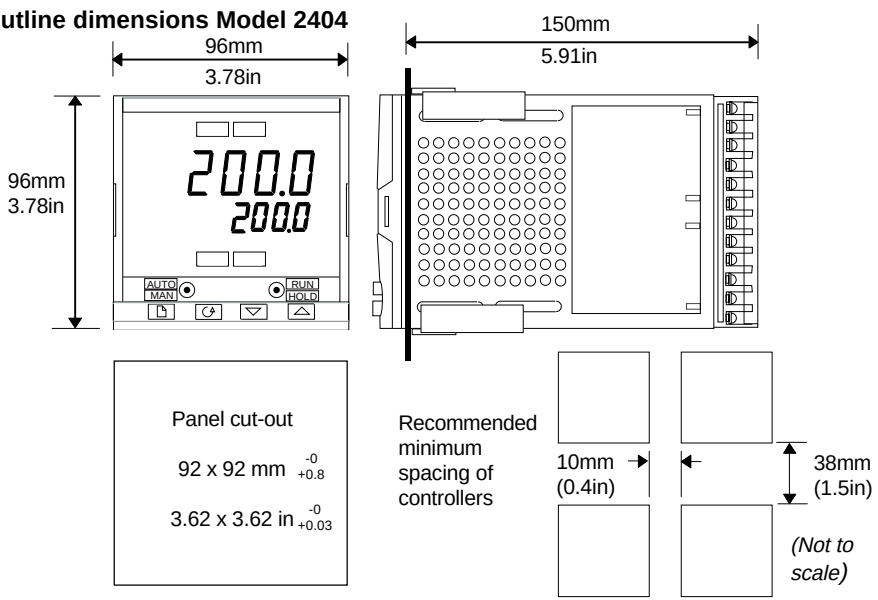


Figure 1-4 Outline dimensions Model 2404 controller

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 Figures 1-3 and 1-4.

INTRODUCTION

Models 2408 and 2404 are high stability, temperature or process controllers with self and adaptive tuning. They have a modular hardware construction which accepts up to three plug-in Input/Output modules and two interface modules to satisfy a wide range of control requirements. Two digital inputs and an optional alarm relay are included as part of the fixed hardware build. In addition, the Model 2404 has an optional plug-in 10A heating output.

The instruments are available as:

standard controllers - which include a basic 8-segment programmer
Models 2408/CC and 2404/CC

setpoint programming controllers: Models 2408/CP, P4, CM and 2404/CP, P4, CM

motorised valve controllers - which include a basic 8-segment programmer
Models 2408/VC and 2404/VC

setpoint programming motorised valve controllers: Models 2408/VP, V4, VM and 2404/VP, V4, VM

Before proceeding, please read the chapter called, *Safety and EMC Information.*

Controller labels

The labels on the sides of the controller identify the ordering code, the serial number, and the wiring connections.

Appendix A, *Understanding the Ordering Code*, explains the hardware and software configuration of your particular controller.

MECHANICAL INSTALLATION

To install the controller

1. Prepare the control panel cut-out to the size shown in Figure 1-3, or 1-4.
2. Insert the controller through the panel cut-out.
3. Spring the upper and lower panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.

Note: If the panel retaining clips subsequently need removing, in order to extract the controller from the control panel, they can be unhooked from the side with either your fingers, or a screwdriver.

Unplugging and plugging-in the controller

If required, the controller can be unplugged from its sleeve by easing the latching ears outwards and pulling it forward out of the sleeve. When plugging the controller back into its sleeve, ensure that the latching ears click into place in order to secure the IP65 sealing.

Finally, peel off the plastic film protecting the front of the indicator.

ELECTRICAL INSTALLATION

This section consists of five topics:

- Rear terminal layouts
- Fixed connections
- Plug-in module connections
- Typical wiring diagrams
- Motorised valve connections.

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 6, *Configuration*.

Model 2408 rear terminal layout

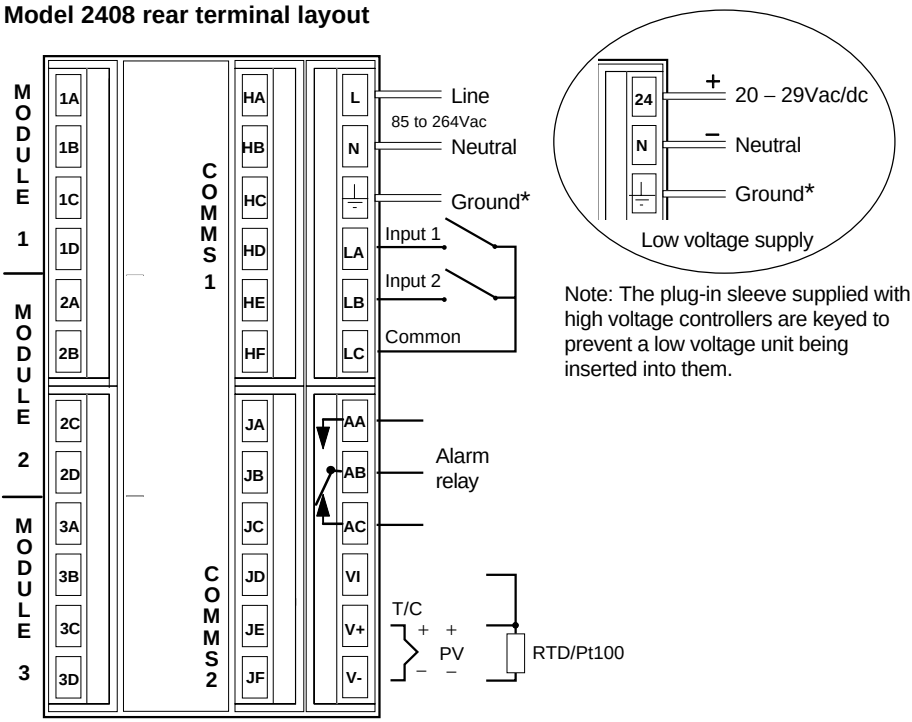


Figure 1-5 Rear terminal layout – Model 2408

* The ground connection is provided as a return for internal EMC filters. It is not required for safety purposes, but must be connected in order to satisfy EMC requirements.

All electrical connections are made to the screw t
They accept wire sizes from 0.5 to 1.5 mm^2 (16 to
torque of 0.4Nm (3.5lbin). If you wish to use crin
part number 349262-1. The terminals are protecte
prevent hands, or metal, making accidental contac

Rear terminal layouts

The rear terminal layouts are shown in Figures 1-5
the connections to the power supply, digital inputs
The second and third columns from the right carry
The connections depend upon the type of module
plug-in modules are fitted, refer to the ordering co
labels. The Model 2404 has the option of 10Amp

Model 2404 rear terminal layout

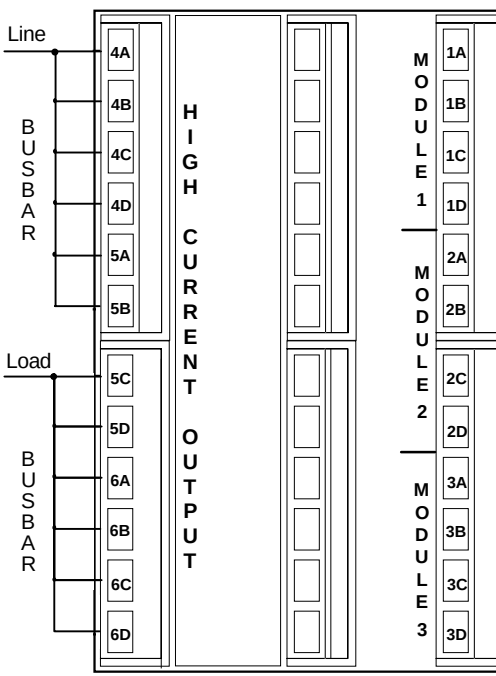
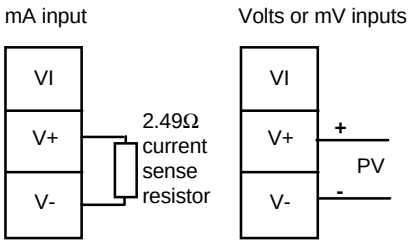


Figure 1-6 Rear terminal la

ensor input are shown below.



sor input connections

NS

odules. They can be either two terminal modules
erminal modules of the types shown in Table 1-9.

nodule and the functions that they can perform.
l module 2 for cooling although the actual
oller has been configured.

ng Input/Output'. This is a proprietary technique
l transmission of analogue and digital data over a

e to control a Eurotherm TE10S solid state relay

e to control a Eurotherm TE10S solid state relay,
back the load current for display on the

Two terminal modules

Note: Module 1 is connected to terminals 1A and 1B
Module 2 is connected to terminals 2A and 2B
Module 3 is connected to terminals 3A and 3B.

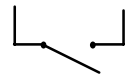
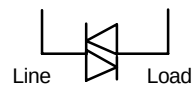
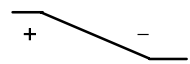
	Terminal identity				
Module type	A	B	C	D	Possible functions
Relay: 2-pin *(2A, 264 Vac max.)*			Unused		Heating, cooling, alarm, program event, valve raise, or valve lower
Logic - non-isolated *(18Vdc at 20mA)*			Unused		Heating, cooling, PDSIO mode 1, PDSIO mode 2, program event
Triac *(1A, 30 to 264Vac)*			Unused		Heating, cooling, program event, valve raise, or valve lower
DC output: - non-isolated *(10Vdc, 20mA max.)*			Unused		Heating, or cooling, or retransmission of PV, setpoint, or control output

Table 1-1 Two terminal module connections

Snubbers

The relay and triac modules have an internal 15nF/100Ω ‘snubber’ connected across their output, which is used to prolong contact life and to suppress interference when switching inductive loads, such as mechanical contactors and solenoid valves.

WARNING

When the relay contact is open, or the triac is off, 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 on low power electrical loads. It is your responsibility as the installer to ensure that this does not happen. If the snubber circuit is not required, it can be removed from the relay module (BUT NOT THE TRIAC) by breaking the PCB track that runs crosswise, adjacent to the edge connectors of the module. This can be done by inserting the blade of a small screwdriver into one of the two slots that bound it, and twisting.

Four terminal modules

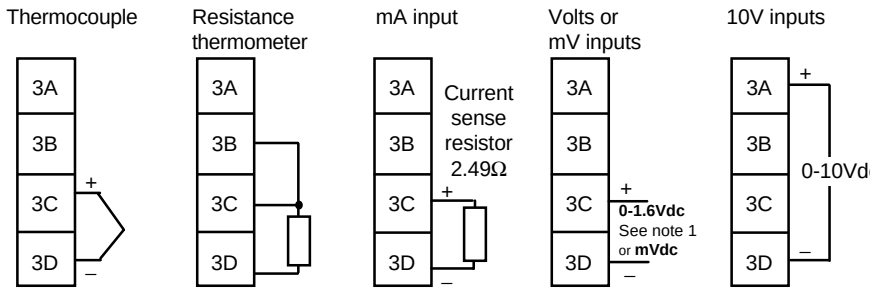
Note: Module 1 is connected to terminals 1A, 1B, 1C and 1D
Module 2 is connected to terminals 2A, 2B, 2C and 2D
Module 3 is connected to terminals 3A, 3B, 3C and 3D

Module type	Terminal identity				Possible functions
	A	B	C	D	
Relay: changeover *(2A, 264 Vac max.)*	N/O		N/C		Heating, cooling, alarm, or program event output
DC control: Isolated *(10V, 20mA max.)*	+	–			Heating, or cooling
24Vdc transmitter supply (20mA)	+	–			To power process inputs
Potentiometer input 100Ω to 15KΩ		+0.5Vdc		0V	Motorised Valve Position feedback
DC retransmission	+	–			Retrans. of setpoint, or process value
DC remote input or Process Value 2 *(Module 3 only)*	0-10Vdc	RT source	±100mV 0-20mA	COM	Remote Setpoint Second PV
	(Refer to Fig. 1-8)				
Dual output modules					
Dual relay *(2A, 264 Vac max.)*					Heating + cooling Dual alarms Valve raise & lower
Dual Triac *(1A, 30 to 264Vac)*	Line	Load	Line	Load	Heating + cooling Valve raise & lower
Dual logic + relay (*Logic* is non-isolated)	+	–			Heating + cooling
Dual Logic + triac (*Logic* is non-isolated)	+	–	Line	Load	Heating + cooling
Triple logic input and output modules - *see ratings on the next page*					
Triple contact input	Input 1	Input 2	Input 3	Common	
Triple logic input	Input 1	Input 2	Input 3	Common	
Triple logic output	Output 1	Output 2	Output 3	Common	Program events

Table 1-2 Four terminal module connections

Connections for Process Value 2 in module position 3

The diagrams below show the connections for the various types of input.
The input will have been configured in accordance with the ordering code.



Note 1: This is a high impedance input > 100 Mohm

Figure 1-8 Connections for Process Value 2 (PV2)

Triple Logic Input and output ratings

1. Triple logic input (current sinking)

OFF state:	–3 to 5Vdc
ON state:	10.8 to 30Vdc(max), at 2 to 8mA

2. Triple contact closure or open collector transistor input

Internally generated switching Vdc & mA:	15 to 19Vdc at 10 to 14mA
OFF state	>28KΩ input resistance
OFF state voltage	>14Vdc
ON state	<100Ω resistance
ON state voltage	<1.0Vdc

3. Triple logic output (current sourcing)

OFF state output	0 to 0.7Vdc.
ON state output	12 to 13Vdc, at up to 8mA.

Communication modules 1 and 2

The Models 2408 and 2404 will accept two plug-in communications modules.
The possible module types are shown in the table below.

Only one of the two modules can be for serial communications and this will normally be installed in position COMMS 1, as shown below. However, it is possible to install the serial communications module in position COMMS 2.
The serial communications can be configured for either Modbus, or EI bisynch protocol.

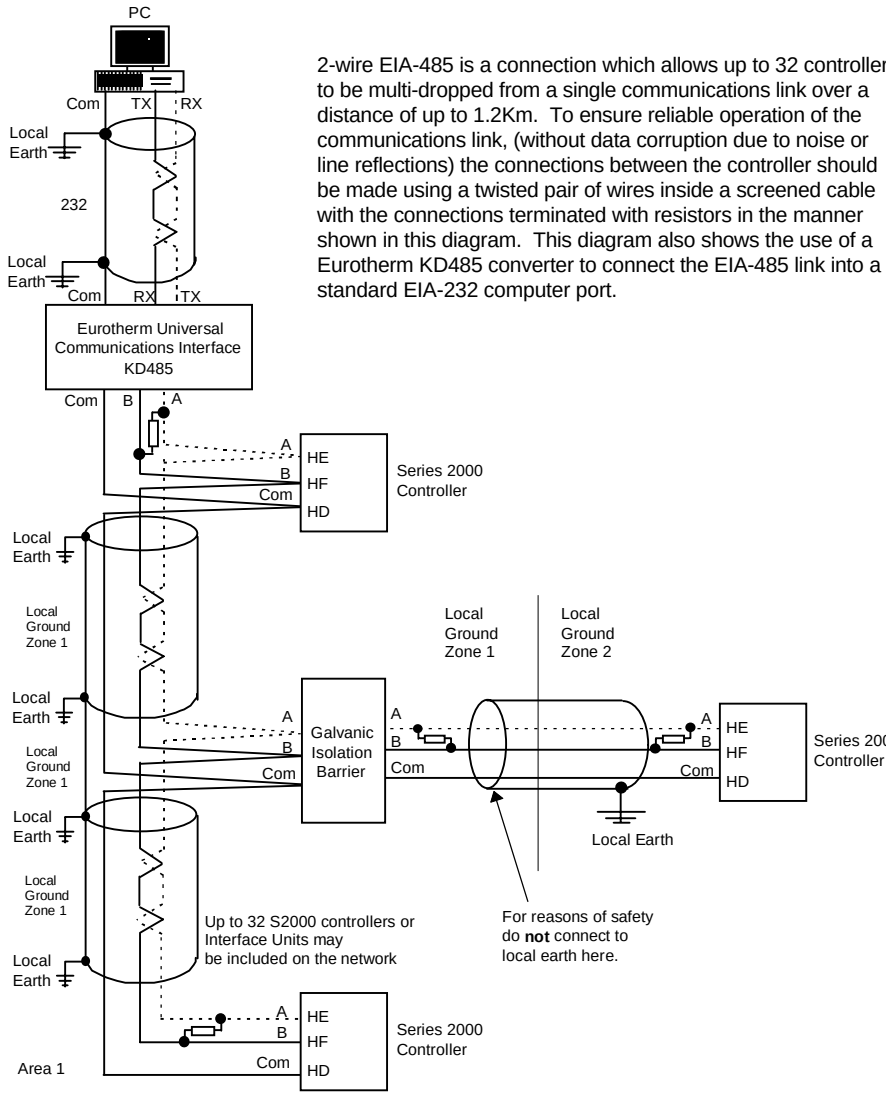
Communications module 1	Terminal identity (COMMS 1)					
Module type	HA	HB	HC	HD	HE	HF
2-wire EIA-485 serial communications	–	–	–	Common	A (+)	B (–)
EIA-232 serial communications	–	–	–	Common	Rx	Tx
4-wire EIA-485 serial communications	–	A′ (Rx+)	B′ (Rx–)	Common	A (Tx+)	B (Tx–)
PDSIO Setpoint retransmission	–	–	–	–	Signal	Common

Communications module 2	Terminal identity (COMMS 2)		
Module type	JD	JE	JF
PDSIO Setpoint retransmission	–	Signal	Common
PDSIO Setpoint input	–	Signal	Common

Table 1-3 Communication modules 1 and 2 connections

Wiring of 2-wire EIA-485 serial communications link

2-wire EIA-485 is a connection which allows up to 32 controllers to be multi-dropped from a single communications link over a distance of up to 1.2Km. To ensure reliable operation of the communications link, (without data corruption due to noise or line reflections) the connections between the controller should be made using a twisted pair of wires inside a screened cable with the connections terminated with resistors in the manner shown in this diagram. This diagram also shows the use of a Eurotherm KD485 converter to connect the EIA-485 link into a standard EIA-232 computer port.



Note:
All resistors are 220 ohm 1/4W carbon composition.
Local grounds are at equipotential. Where equipotential is not available wire into separate zones using a galvanic isolator.
Use a repeater (KD845) for more than 32 units.

Figure 1-9 EIA-485 wiring

TYPICAL WIRING DIAGRAM

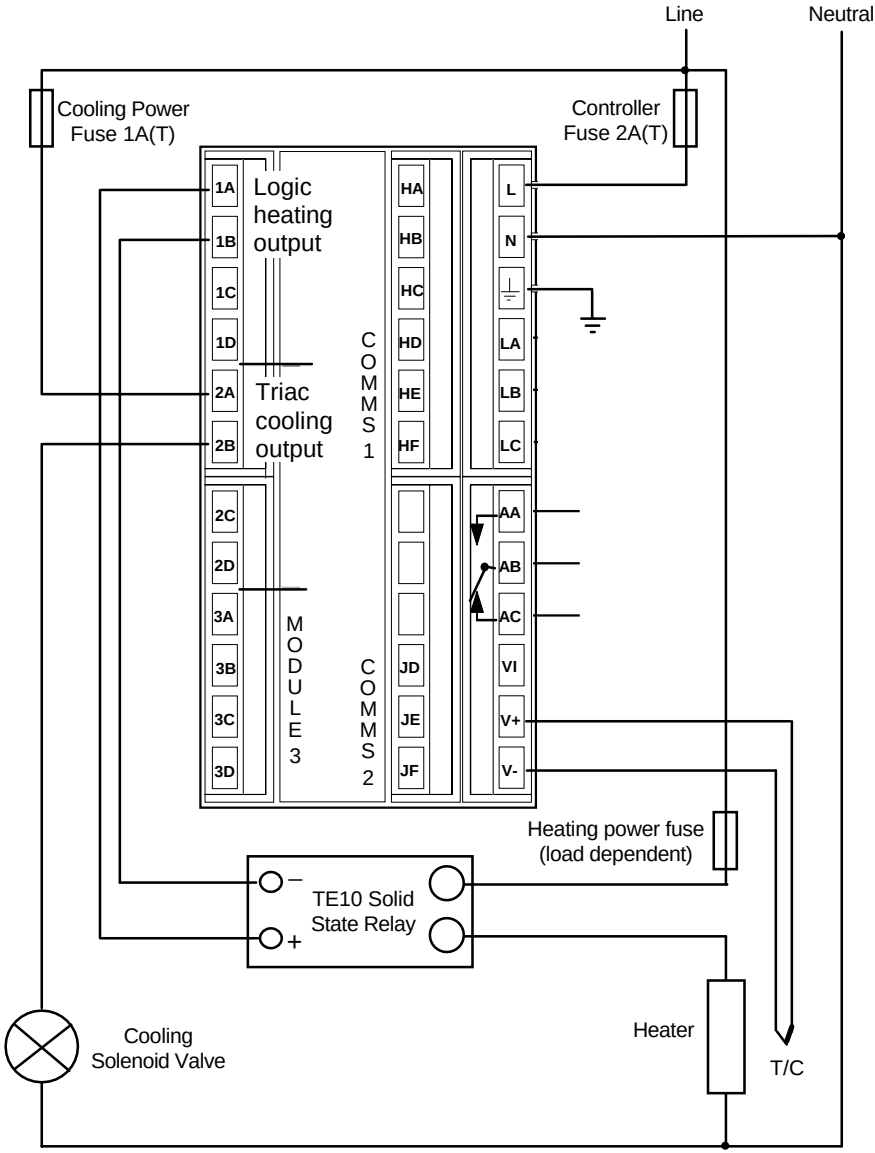


Fig 1-10 Typical wiring diagram, Model 2408 Controller

MOTORISED VALVE CONNECTIONS

Motorised valves will normally be wired either to dual relay, or dual triac, output modules installed in the Module 1 position, or to single channel relay and triac outputs installed in Module positions 1 and 2. In the latter case, the convention is to configure output 1 as the raise output and output 2 as the lower output.

Depending on the configuration, control of the valve is achieved in one of three ways:

1. With no position feedback potentiometer.
2. With a feedback potentiometer used to monitor the valve's position. It does not influence the control.
3. With a feedback potentiometer, where the valve's position is controlled in response to the signal from it.

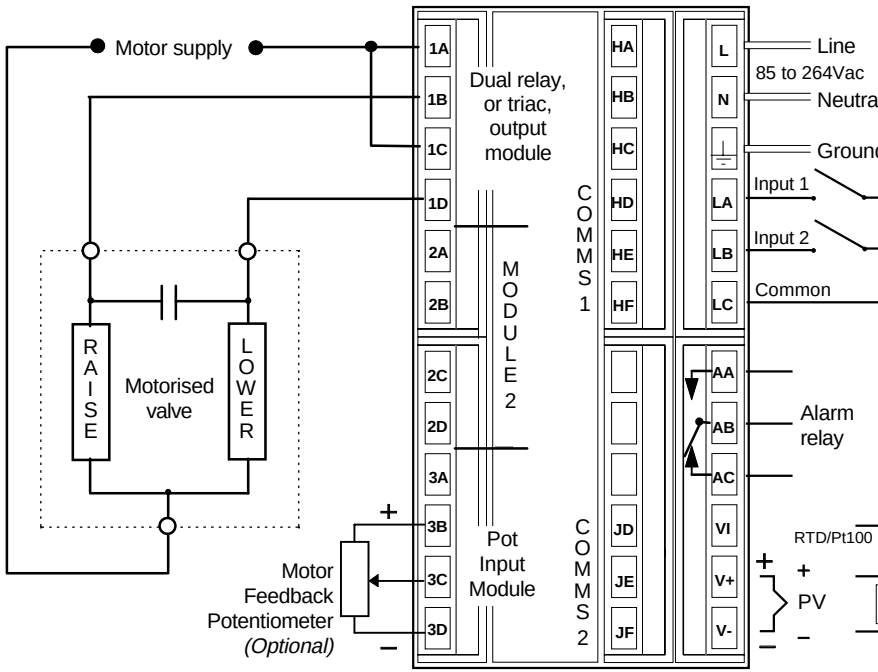
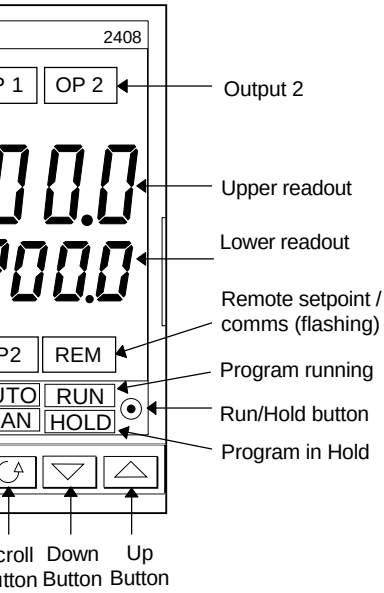


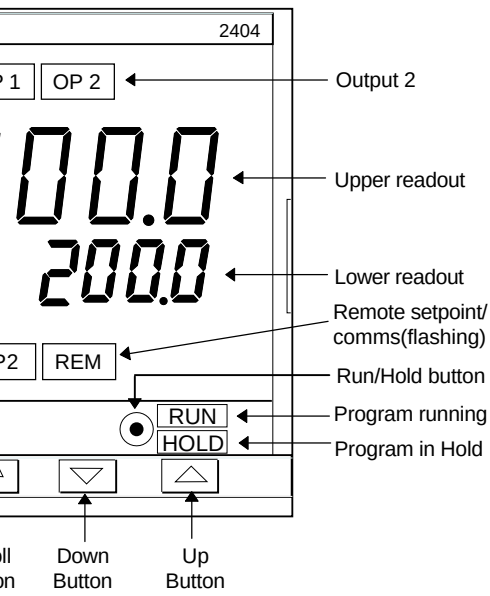
Fig 1-11 Motorised valve connections

Chapter 2 OPERATION

This chapter has nine topics:



el 2408 front panel layout

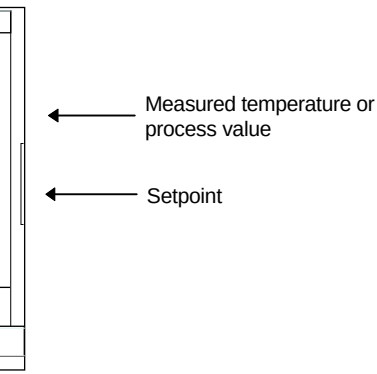


el 2404 front panel layout

Button or indicator	Name	
OP1	Output 1	When lit, i module p output on
OP2	Output 2	When lit, i module p output on
SP2	Setpoint 2	When lit, t 3-16) has
REM	Remote setpoint	When lit, t has been ‘REM’ will
AUTO MAN	Auto/Manual button	When pre manual m If the co light wil If the co will be l The Auto/ configurat
RUN HOLD	Run/Hold button	Press o Press a Press a (HOLD Press a progra The RUN The HOL
	Page button	Press to s
	Scroll button	Press to s
	Down button	Press to d
	Up button	Press to i

Figure 2-3 Controller butt

uns through a self-test sequence for about three
perature, or process value, in the upper readout
the lower readout. This is called the **Home**



e ▲ or ▼ buttons. Two seconds after
to show that the controller has accepted the new

This is normally the heating output when used as

This is normally the cooling output when used as

any time by pressing ↻ and 🗎 together.
to this display if no button is pressed for 45
on.

, it flashes an alarm message in the Home
es, their meaning and what to do about them, see

OPERATING MODES

The controller has two basic modes of operation:

Automatic mode in which the output is auton
temperature or process value at the setpoint.

Manual mode in which you can adjust the ou

You toggle between the modes by pressing the AU
appear in each of these modes are explained in thi

Two other modes are also available:

Remote Setpoint mode, in which the setpoint
In this mode, the REM light will be on.

Programmer mode which is explained in Cha

er in automatic mode. If the MAN light is on,
omatic mode. The AUTO light comes on.

ome display

that the AUTO light is on.
per readout shows the measured temperature.
wer readout shows the setpoint.
ust the setpoint up or down, press ▲ or ▼.
If Setpoint Rate Limit has been enabled, then the readout will show the active setpoint. If ▲ or pressed, it will change to show and allow ment of, the target setpoint.)

once.

ay units

le press of will flash the display units for 0.5 ls, after which you will be returned to the **Home** y.
ng of the display units may have been disabled in uration in which case a single press will take you t to the display shown below.

twice

tput power demand

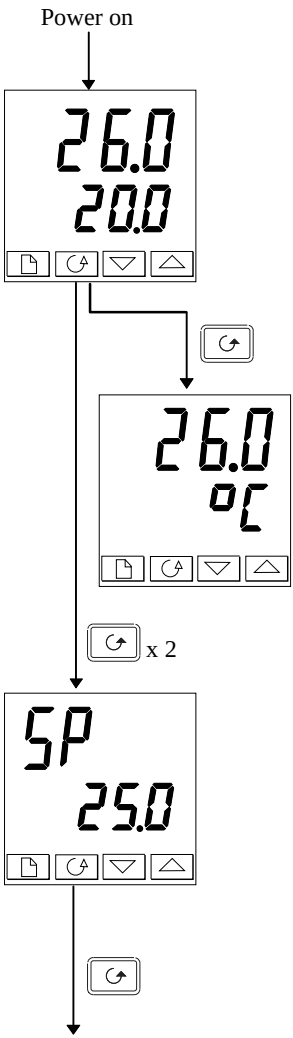
output power demand is displayed in the lower t. This is a read-only value. You cannot adjust

and together to return to the **Home** y.

ay may access further parameters. These may be as been used (see Chapter 3, *Edit Level*). When ng will return you to the **Home** display.

MANUAL MODE

If the AUTO light is on, press the AUTO/MAN bu
light comes on.



The Home dis

Check that the
The upper read
process value.
To adjust the ou
(Note: If Outpu
lower readout v
is pressed,
adjustment of, t

Press once

Display units

A single press o
seconds, after v
display.
Flashing of the
configuration, i
straight to the d

Press twic

Setpoint

To adjust the se

Press .

Pressing from the Output Power display may a
in this scroll list if the 'Promote' feature has been
you reach the end of this scroll list, pressing v

CESS THEM

ler, that determine how the controller will
parameters that set the points at which alarms
eters are arranged in lists as shown in the
1. The lists are:

Communications list
Information list
st *Access list.*

t

List name

Always displays 'L1 SE'

pical list header display

t that it always shows 'L1 SE' in the lower
f the list. In the above example, 'AL' indicates
r displays are read-only.

. Depending upon how your controller has
entarily flash the display units. If this is the case,
ou to the first list header. Keep pressing to
eturning you to the Home display.

a particular list, press .
ill return to the list header.
rrent list header at any time can by pressing .
nce again.

Parameter names

In the navigation diagram, each box shows the dis
The Operator parameter tables, later in this chapte
meanings.

The navigation diagram shows all the parameters
controller. In practice, a limited number of them
configuration.

The shaded boxes in the diagram indicate paramet
To view all the available parameters, you must sel
information about this, see Chapter 3, *Access Leve*

Parameter displays

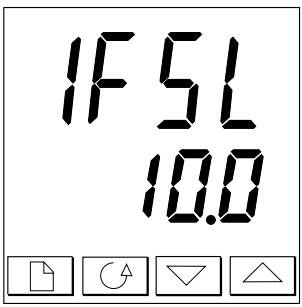


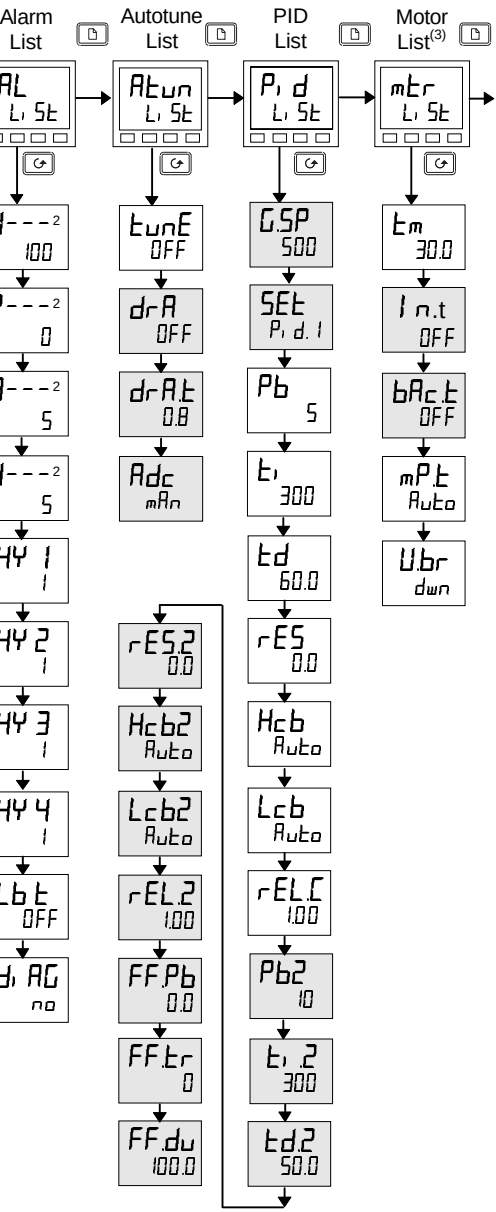
Figure 2-6 Typical para

Parameter displays show the controller's current s
is always the same: the upper readout shows the p
value. In the above example, the parameter name
low), and the parameter value is 10.0.

To change the value of a parameter

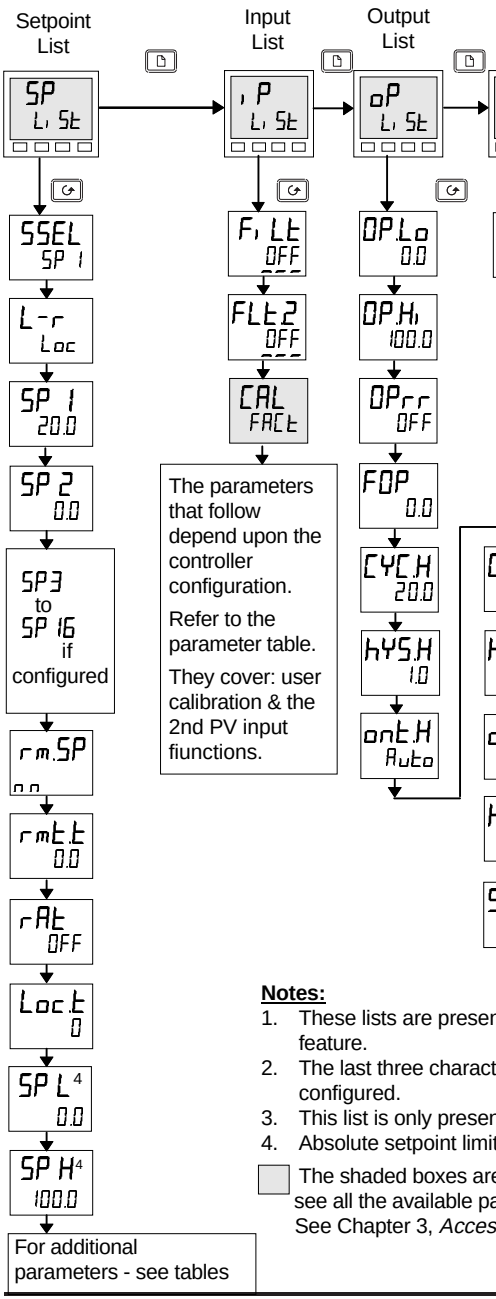
First, select the required parameter.
To change the value, press either ▲ or ▼. Duri
value by one digit.
Keeping the button pressed speeds up the rate of c
Two seconds after releasing either button, the disp
accepted the new value.

*) *(The parameters that appear depend upon how*



vigation diagram (Part A)

NAVIGATION DIAGRAM *(PART B)*



vigation diagram (Part B)

ode)
ode 2)
number
has been used (see Chapter 3, *Edit Level).*

ly in setpoint programming controllers
on 4, or 20, program versions)
oLd, HbAc, End)
the program
segment units
rs
YES)
(*not 8-segment programmer*)
YES) (*not 8-segment programmer*)
e lower readout of the home display (no / YES)

Name	Description

ProG	**Program edit list** – *Present only in set* *For a fuller explanation of these parame*
PrG.n	Select program number (Only on 4, or
Hb	Holdback type for the program as a who
Hb U	Holdback value (in display units)
rmP.U	Ramp units (SEc, mi n, or Hour) [*for*
dwL.U	Dwell units (SEc, mi n, or Hour)
CYC.n	Number of program cycles (1 to 999, o
SEG.n	Segment number
tYPE	Segment type:(End) (rmP.r=ramp rate) (r

The following parameters depend on the tYPE *sele*

	End	rmP.r	rmP.t	dwEll	StEP	cALL	
Hb							Holdba
tGt		✓	✓		✓		Target
rAtE		✓					Ramp
dur			✓	✓			'dwEll'
PrG.n						✓	cALLe
cYc.n						✓	No. of
outn	✓	✓	✓	✓	✓		Event
SYnc		✓	✓	✓	✓		Segme
Endt	✓						End of
Pwr							Power

Name	Description
P, d	**PID list**
G.SP	If Gain Scheduling has been enabled (see Chapter 4), this parameter sets the PV below which 'P, d. 1' is active and above which 'P, d.2' is active.
SEt	'P, d. 1' or 'P, d.2' selected
Pb	Proportional Band (in display units) (SEt 1)
t,	Integral Time in secs (SEt 1)
td	Derivative Time in secs (SEt 1)
rES	Manual Reset (%) (SEt 1)
Hcb	Cutback High (SEt 1)
Lcb	Cutback Low (SEt 1)
rEL.C	Relative Cool Gain (SEt 1)
Pb2	Proportional Band (SEt 2)
t, 2	Integral Time in secs (SEt 2)
td2	Derivative Time in secs (SEt 2)
rES.2	Manual Reset (%) (SEt 2)
Hcb2	Cutback High (SEt 2)
Lcb2	Cutback Low (SEt 2)
rEL.2	Relative Cool Gain (SEt 2)
The following three parameters are used for cascade control. If this facility is not being used, then they can be ignored.	
FF.Pb	SP, or PV, feedforward propband
FF.tr	Feedforward trim %
FF.du	PID feedforward limits ± %

mtr	**Motor list -** *see Table 4-3*
tm	Valve travel time in seconds
In.t	Valve inertia time in secs
bAc.t	Valve backlash time in secs
mP.t	Minimum ON time of output pulse
U.br	Valve sensor break strategy

Name	Description

SP	Setpoint list
SSEL	Select SP 1 to SP 16, depending on configuration
L-r	Local (Loc) or remote (rmt) setpoint select
SP 1	Setpoint one value
SP 2	Setpoint two value
rm.SP	Remote setpoint value
rmt.t	Remote setpoint trim
rAt	Ratio setpoint
Loc.t	Local setpoint trim
SP L	Setpoint 1 low limit
SP H	Setpoint 1 high limit
SP2.L	Setpoint 2 low limit
SP2.H	Setpoint 2 high limit
SPrr	Setpoint Rate Limit
Hb.ty	Holdback Type for setpoint rate limit (OFF, Lo, Hi , or bAnd)
Hb	Holdback Value for setpoint rate limit in display units. (Hb.ty ≠ OFF)

i P	Input list
Fi Lt	IP1 filter time constant (0.0 - 999.9 seconds).
FLt.2	IP2 filter time constant (0.0 - 999.9 seconds).
Hi J P Lo J P	Transition of control between i P. 1 and i P.2. (*if configured*) The transition region is set by the values of 'Lo J P' and 'Hi J P'. PV = i P. 1 below 'Lo J P' PV = i P.2 above 'Hi J P'
F. 1 F.2	Derived function, (*if configured*) PV = (F. 1 x i P 1) + (F.2 x i P2). 'F. 1' and 'F.2' are scalars with the range -9.99 to 10.00
PUi P	Selects 'i P. 1' or 'i P.2'
Continued in next column	

Name	Description
inFo	**Information list - *continued***
rESL	Logging Reset - 'YES/no'
The following set of parameters is for diagnostic purposes.	
mCt	Processor utilisation factor
w.OP	Working output
FF.OP	Feedforward component of output
UO	PID output to motorised valve
P OP	Proportional component of output
I OP	Integral component of output
d OP	Derivative component of output

ACCS	**Access List**
codE	Access password
Goto	Goto level - OPEr, FuLL, Edit or conF
ConF	Configuration password

ALARMS

Alarm annunciation

Alarms are flashed as messages in the Home displ
double flash followed by a pause, old (acknowled
a pause. If there is more than one alarm conditior
relevant alarm messages. Table 2-1 and Table 2-2
and their meanings.

Alarm acknowledgement and resetting

Pressing both [ ] and [ ] at the same time will ac
latched alarms.

Alarm modes

Alarms will have been set up to operate in one of

Non-latching, which means that the alarm wil
Value is no longer in the alarm condition.

Latching, which means that the alarm messag
condition no longer exists and will only clear

Blocking, which means that the alarm will on
a safe state on power-up.

Alarm types

There are **two** types of alarm: **Process alarms** and

Process alarms

These warn that there is a problem with the proces
control.

Alarm Display	What it means
_FSL*	PV Full Scale Low alarm
_FSH*	PV Full Scale High alarm
_dEu*	PV Deviation Band alarm
_dHi *	PV Deviation High alarm
_dLo*	PV Deviation Low alarm
_LCr*	Load Current Low alarm
_HCr*	Load Current High alarm

** In place of the dash, the first character*

Table 2-1 Process

the controller or the connected devices.

What to do about it
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 Eurotherm Controls.
Check that the sensor is correctly connected.
Check that the heating and cooling circuits are working properly.
This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 1 - see Chapter 1, *Electrical Installation*. It indicates either an open or short circuit SSR, blown fuse, missing supply or open circuit heater.
This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 2 - see Chapter 1, *Electrical Installation*. It indicates either an open or short circuit condition in the SSR.
This is an alarm generated by feedback from a Eurotherm TE10S solid state relay (SSR) operating in PDSIO mode 2 - see Chapter 1, *Electrical Installation*. It indicates either a blown fuse, missing supply, or open circuit heater.
Indicates that the PDS input is open circuit. Mode 5 only
Indicates that the PDS input is short circuit Mode 5 only
Check that the correct modules are fitted.

no io	*No I/O* None of the expected I/O modules is fitted.	This er configu require

Table 2-2a Diagno

Diagnostic alarms (continued)

These indicate that a fault exists in either the cont

Display shows	What it means	Wha
rmt.F	*Remote input failure.* Either the PDSIO input, or the remote DC input, is open or short circuit	Chec PDS
LLLL	*Out of range low reading*	Chec
HHHH	*Out of range high reading*	Chec
Err 1	*Error 1:* ROM self-test fail	Retu
Err2	*Error 2:* RAM self-test fail	Retu
Err3	*Error 3:* Watchdog fail	Retu
Err4	*Error 4:* Keyboard failure Stuck button, or a button was pressed during power up.	Swit touch
Err5	*Error 5:* Faulty internal communications.	Chec the f for re

Table 2-2b Diagno

Chapter 3 ACCESS LEVELS

This chapter describes the different levels of access
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

Full level, which is used to commission the con

Edit level, which is used to set up the paramete
see and adjust when in Operator level.

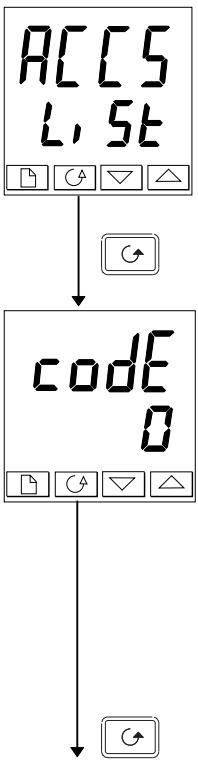
Configuration level, which is used to set up th
controller.

Access level	Display shows	What you can do
Operator	OPEr	In this level, operato value of parameters below).
Full	FuLL	In this level, all the p particular configurati parameters may be
Edit	EdiE	In this level, you can parameters an opera adjust in Operator le reveal, complete lists within each list and y read-only or alterabl end of this chapter).
Configuration	conF	This special level all fundamental charact

Figure 3-1 Acce

SELECTING AN ACCESS LEVEL

Access to Full, Edit or Configuration levels is protected by a password to prevent unauthorised access.
If you need to change the password, see Chapter 6, *Configuration*.



Access list header

Press [D] until you reach the access list header 'ACCS'.

Press [↻]

Password entry

The password is entered from the 'codE' display.
Enter the password using [▲] or [▼]. Once the correct password has been entered, there is a two second delay after which the lower readout will change to show 'PASS' indicating that access is now unlocked.
The pass number is set to '1' when the controller is shipped from the factory.

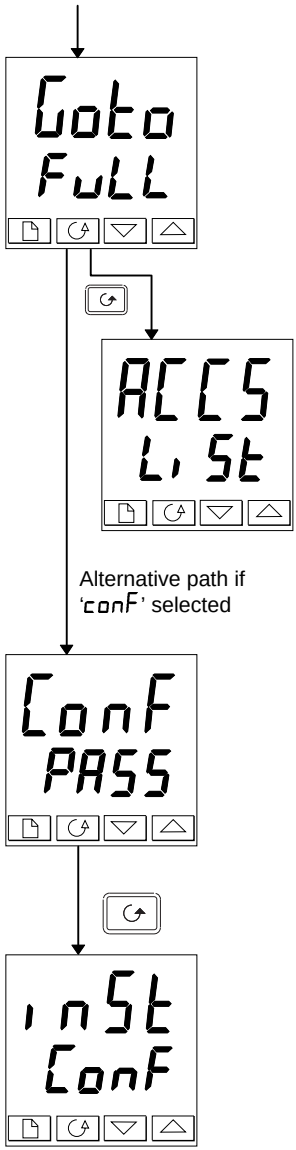
Note; A special case exists if the password has been set to '0'. In this case access will be permanently unlocked and the lower readout will always show 'PASS'.

Press [↻] *to proceed to the* 'Goto' *page*.

(If an *incorrect* password has been entered and the controller is still 'locked' then pressing [↻] returns you to the 'ACCS' list header.)

Access to Read-only Configuration

From this display, pressing [▲] and [▼] together will take you into Read-Only Configuration without entering a password. This will allow you to view all of the configuration parameters, but not adjust them. If no button is pressed for ten seconds, you will be returned to the Home display. Alternatively, pressing [D] and [↻] together takes you immediately back to the Home display.



Level selection

The 'Goto' display allows you to select the required access level.

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

	OPEr:	Operator level
	FuLL:	Full level
	EdIt:	Edit level
	conF:	Configuration level

Press ↻

If you selected either 'OPEr', 'FuLL' or 'EdIt' level you will be returned to the 'ACCS' list header in the level that you chose. If you selected 'conF', you will get a display showing 'ConF' in the upper readout (see below).

Configuration password

When the 'ConF' display appears, you must enter the Configuration password in order to gain access to this level. Do this by repeating the password entry procedure described in the previous section.

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 6, *Configuration.*

Press ↻

Configuration level

The first display of configuration is shown. See Chapter 6, *Configuration,* for details of the configuration parameters.

For instructions on leaving configuration level, see Chapter 6, *Configuration.*

Returning to Operator Level

To return to operator level from either 'FuLL' or 'EdIt' level, repeat entry of the password and select 'OPEr' on the 'Goto' display.

In 'EdIt' level, the controller will automatically return to operator level if no button is pressed for 45 seconds.

EDIT LEVEL

Edit level is used to set which parameters you can view and adjust in Operator level. It also gives access to the 'Promote' feature, which allows you to select and add ('Promote') up to twelve parameters into the Home display list, thereby giving simple access to commonly used parameters.

Setting operator access to a parameter

First you must select Edit level, as shown on the previous page.
Once in Edit level, you select a list, or a parameter within a list, in the same way as you would in Operator, or Full, level – that is to say, you move from list header to list header by pressing [D], and from parameter to parameter within each list using [G].
However, in Edit level what is displayed is not the value of a selected parameter, but a code representing that parameter's availability in Operator level.
When you have selected the required parameter, use [▲] 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:

The parameter selected is Alarm 2, Full Scale Low

It will be alterable in Operator level

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 always displays the code: 'Li St'.)

Promoting a parameter

Scroll through the lists to the required parameter and choose the 'PrO' code. The parameter is then automatically added (promoted) into the Home display list. (The parameter will also be accessible, as normal, from the standard lists.) A maximum of twelve parameters can be promoted. Promoted parameters are automatically 'alterable'.

Please note, in the 'PrOGLi St', the parameters from segment number (SEG.n) onwards *cannot* be promoted.

Chapter 4 TUNING

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

This chapter has five topics:

WHAT IS TUNING?
AUTOMATIC TUNING
MANUAL TUNING
COMMISSIONING OF MOTORISED VALVE CONTROLLERS
GAIN SCHEDULING

WHAT IS TUNING?

In tuning, you match the characteristics of the controller to those 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
No overshoot, or undershoot, of the temperature setpoint
Quick response to deviations from the setpoint caused by external disturbances, thereby rapidly restoring the temperature to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed in Table 4-1. These parameters appear in the ‘Pid’ list.

Parameter	Code	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.
High Cutback	Hcb	The number of display units, above setpoint, at which the controller will increase the output power, in order to prevent undershoot on cool down.
Low cutback	Lcb	The number of display units, below setpoint, at which the controller will cutback the output power, in order to prevent overshoot on heat up.
Relative cool gain	rEL	Only present if cooling has been configured and a module is fitted. Sets the cooling proportional band, which equals the Pb value divided by the rEL value.

Table 4-1 Tuning parameters

AUTOMATIC TUNING

Two automatic tuning methods are provided in the 2408 and 2404:

A one-shot tuner, which automatically sets up the initial values of the parameters listed in Table 4-1 on the previous page.

Adaptive tuning, which continuously monitors the error from setpoint and modifies the PID values, if necessary.

One-shot Tuning

The ‘one-shot’ tuner works by switching the output 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.

If the process cannot tolerate full heating or cooling being applied during tuning, then the level of heating or cooling can be restricted by setting the heating and cooling power limits in the ‘oP’ list. However, the measured value *must* oscillate to some degree for the tuner to be able to calculate values.

A One-shot Tune can be performed at any time, but normally it is performed 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 re-tune again 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 which 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.

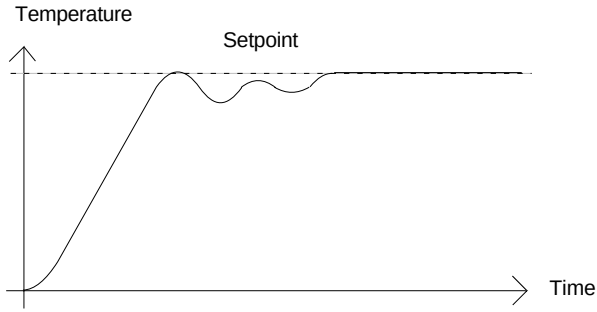
4. The controller induces an oscillation in the temperature by first turning the heating on, and then off. The first cycle is not complete until the measured value has reached the required setpoint.

5. After two cycles of oscillation the tuning is completed and the tuner switches itself off.

6. The controller then calculates the tuning parameters listed in Table 4-1 and resumes normal control action.

If you want ‘Proportional only’, ‘PD’, or ‘PI’ control, you should set the ‘ti ’ or ‘td’ parameters 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 are fixed at three times the proportional band, and are not changed during automatic tuning.

Adaptive tune

Adaptive tuning is a background algorithm, which continuously monitors the error from setpoint and analyses the control response during process disturbances. If the algorithm recognises an oscillatory, or under-damped, response it recalculates the Pb, ti and td values.

Adaptive tune is triggered whenever the error from setpoint exceeds a trigger level. This trigger level is set in the parameter 'drA.t', which is found in the Autotune list. The value is in display units. It is automatically set by the controller, but can also be manually re-adjusted.

Adaptive tune should be used with:
1. Processes whose characteristics change as a result of changes in the load, or setpoint.
2. Processes that cannot tolerate the oscillation induced by a One-shot tune.

Adaptive tune should not be used:
1. Where the process is subjected to regular external disturbances that could mislead the adaptive tuner.
2. On highly interactive multiloop applications. However, moderately interactive loops, such as multi-zone extruders, should not give a problem.

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 Integral Time ‘ti’ and the Derivative Time ‘td’ to OFF.
2. Set High Cutback and Low Cutback, ‘Hcb’ and ‘Lcb’, to ‘Auto’.
3. Ignore the fact that the temperature may not settle precisely at the setpoint.
4. 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 for the loop to stabilise. Make a note of the proportional band value ‘B’ and the period of oscillation ‘T’.
5. Set the Pb, ti, td parameter values according to the calculations given in Table 4-2.

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

Table 4-2 Tuning values

Setting the cutback values

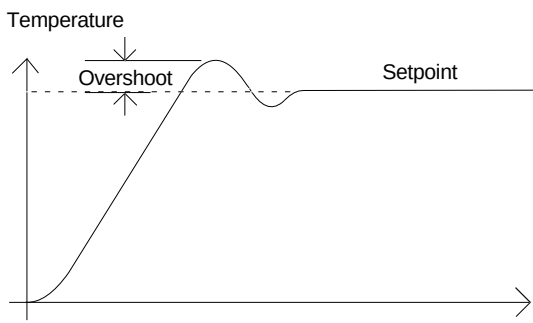
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in temperature, then manually set the cutback parameters 'Lcb' and 'Hcb'.

Proceed as follows:

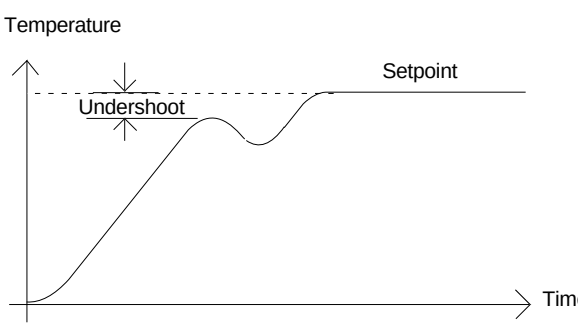
1. Set the low and high cutback values to three proportional bandwidths (that is to say, Lcb = Hcb = 3 x Pb).
2. Note the level of overshoot, or undershoot, that occurs for large temperature changes (see the diagrams below).

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.

Integral 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* (code ‘rES’) appears in the ‘Pi dLi SE’ in ‘FuLL’ level. 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 the steady state error.

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 stabilise. Then, in the autotune parameter list, you must set ‘Adc’ to ‘cALc’. The controller will then calculate a new value for manual reset, and switch ‘Adc’ to ‘mAn’.

‘Adc’ can be repeated as often as you require, but between each adjustment you must allow time for the temperature to stabilise.

Tune Error

If any one stage of the automatic tuning process is not completed within two hours a diagnostic alarm will occur. The display shows tU.Er - Tune Error.
This alarm could occur if:

1. The process to be tuned has a very slow response time
2. The sensor has failed or is incorrectly aligned
3. The loop is broken or not responding correctly

MOTORISED VALVE CONTROL

The 2408 and 2404 can be configured for motorised valve control as an alternative to the standard PID control algorithm. This algorithm is designed specifically for positioning motorised valves.
These are ordered pre-configured as Model numbers:

2408/VC and 2404/VC motorised valve controllers

2408/VP and 2404/VP motorised valve controllers with a single setpoint programmer

2408/V4 and 2404/V4 motorised valve controllers storing four setpoint programs.

2408/VM and 2404/VM motorised valve controllers storing twenty setpoint programs.

Figure 1-11 in Chapter 1 shows how to connect a motorised valve controller. The control is performed by delivering open, or close, pulses in response to the control demand signal.

The motorised valve algorithm can operate in one of three ways:

1. The so-called *boundless* mode, which does not require a position feedback potentiometer for control purposes; although one can be connected and used purely to display the valve's position.
2. Bounded, (*or position*), control mode, which requires a feedback potentiometer. This is closed-loop control determined by the valve's position.

The desired control mode is selected in the 'inSt' list in configuration level.

The following parameter list will appear in the navigation diagram shown in Chapter 2, if your controller is configured for motorised valve control.

Name	Description	Values		
mtr	**Motor list**	**Min**	**Max**	**Default**
tm	Valve travel time in seconds. This is the time taken for the valve to travel from its fully closed position to its fully open position.	0.1	240.0	30.0
Int	Valve inertia time in seconds. This is the time taken for the valve to stop moving after the output pulse is switched off.	OFF	20.0	OFF
bAct	Valve backlash time in seconds. This is the minimum on-time required to reverse the direction of the valve. i.e. the time to overcome the mechanical backlash.	OFF	20.0	OFF
mPt	Output pulse minimum on-time, in seconds.	Auto	100.0	Auto
Ubr	Valve sensor break strategy.	rESt, uP, dwn		rESt

Table 4-3 Motorised valve parameter list

COMMISSIONING THE MOTORISED VALVE CONTROLLER

The commissioning procedure is the same for both bounded and boundless control modes, except in bounded mode you must first calibrate the position feedback potentiometer, as described in the section below.
Proceed as follows:

1. Measure the time taken for the valve to be raised from its fully closed to its fully open position and enter this as the value in seconds into the 'tm' parameter.
2. Set all the other parameters to the default values shown in Table 4-3.

The controller can then be tuned using any of the automatic, or manual, tuning procedures described earlier in this chapter. As before, the tuning process, either automatic or manual, involves setting the values of the parameters in Table 4-1. The only difference with boundless control is that the derivative term 'td', although present, will have no effect.

Adjusting the minimum on-time 'mPt'

The default value of 0.2 seconds is satisfactory for most processes. If, however, after tuning the process, the valve activity is excessively high, with constant oscillation between raise and lower pulses, the minimum on-time can be increased.
The minimum on-time determines how accurately the valve can be positioned and therefore the control accuracy. The shorter the time, the more precise the control. However, if the time is set too short, process noise will cause an excessively busy valve.

Inertia and backlash settings

The default values are satisfactory for most processes, i.e. 'OFF'.
Inertia is the time taken for the valve to stop after the output pulse is turned off. If this causes a control problem, the inertia time needs to be determined and then entered into the parameter, 'Int'. The inertia time is subtracted from the raise and lower output pulse times, so that the valve moves the correct distance for each pulse.
Backlash is the output pulse time required to reverse the direction of the valve, i.e. the time taken to overcome the mechanical backlash of the linkages. If the backlash is sufficient to cause a control problem, then the backlash time needs to be determined and then entered into the parameter, 'bAct'.
The above two values are not part of the automatic tuning procedure and must be entered manually.

CALIBRATING THE POSITION FEEDBACK POTENTIOMETER

Before proceeding with the feedback potentiometer calibration, you should ensure, in configuration level, that module position 2 (2A), or 3 (3A), has its 'id' indicating 'Pot1', (meaning *Potentiometer Input*). Continue to scroll down the module configuration list. 'Func' should be set to 'UPoS', 'VAL.L' must be set to '0' and 'VAL.H' to '100'.
Exit from configuration and you are now ready to calibrate the position feedback potentiometer. Proceed as follows.

1. In Operator level, press the AUTO/MAN button to put the controller in Manual mode.
2. Drive the valve to its fully open position using [▲].

3. Press [D] until you get to ‘P-L1 St’.
4. Press [↻] to get to ‘PCAL-OFF’.
5. Press [▲] or [▼] to turn ‘PCAL’ to ‘on’.
6. Press [↻] and the upper readout indicates ‘Pot’.
7. Press [▲] or [▼] to get to ‘Pot-3A.H1’. *(Assuming that the Potentiometer Input Module is in module position 3.)*
8. Press [↻] to go to ‘GO-no’.
9. Press [▲] or [▼] to see ‘GO-YES’, which starts the calibration procedure.
10. Calibration is complete when the display returns to ‘GO-no’.
11. Press [D] and [↻] together to return directly to the Operator level.
12. The controller should still be in Manual mode.
13. Drive the valve to its fully closed position using [▼].
14. Press [D] until you get to ‘P-L1 St’.
15. Press [↻] to get to ‘PCAL-OFF’.
16. Press [▲] or [▼] to turn ‘PCAL’ to ‘on’.
17. Press [↻] and the upper readout indicates ‘Pot’.
18. Press [▲] or [▼] to get to ‘Pot-3A.Lo’
19. Press [↻] to go to ‘GO-no’.
20. Press [▲] or [▼] to see ‘GO-YES’, which starts the calibration procedure.
21. Calibration is complete when the display returns to ‘GO-no’.
22. Press [D] and [↻] together to return directly to the Operator level.
23. Press the AUTO/MAN button to place the controller in AUTO and the calibration of the position feedback potentiometer is now complete.

GAIN SCHEDULING

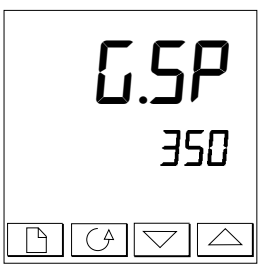
Gain scheduling is the automatic transfer of control between one set of PID values and another. In the case of the 2408 and 2404 controllers, this is done at a presettable process value. It is used for the more difficult to control processes which exhibit large changes in their response time or sensitivity at, for example, high and low temperatures, or when heating or cooling.

The 2408 and 2404 has two sets of PID values. You can select the active set from either a digital input, or from a parameter in the PID list, or you can transfer automatically in gain scheduling mode. The transfer is bumpless and will not disturb the process being controlled.

To use gain scheduling, follow the steps below:

Step1: Enable in configuration level

Gain scheduling must first be enabled in Configuration level. Goto the InSt ConF list, select the parameter GSch, and set it to YES.



Step 2: Set the transfer point

Once gain scheduling has been enabled, the parameter G.SP will appear at the top of the Pid list in FuLL access level. This sets the value at which transfer occurs. PID1 will be active when the process value is below this setting and PID2 when the process value is above it. The best point of transfer depends on the characteristics of the process. Set a value between the control regions that exhibit the greatest change.

Step 3: Tuning

You must now set up the two sets of PID values. The values can be manually set, or automatically tuned as described earlier in this chapter. When tuning automatically you must tune twice, once above the switching point G.SP and again below the switching point. When tuning, if the process value is below the transfer point G.SP the calculated values will automatically be inserted into PID1 set and if the process value is below G.SP, the calculated values will automatically be inserted into PID2 set.

Chapter 5 PROGRAMMER OPERATION

This chapter deals with the setpoint programming option. All 2408 / 2404 instruments have a basic 8-segment programmer built-in as standard. This facility must be enabled by the user, as explained in the section, *Configuring the Programmer*.

Other programmer versions are listed below, and have 16-segments in each program.

16-segment programmer with:		
	a single program:	Models 2408/CP and 2404/CP.
	four stored programs:	Models 2408/P4 and 2404/P4.
	twenty stored programs:	Models 2408/CM and 2404/CM.
16-segment Motorised Valve programmer with:		
	a single program:	Models 2408/VP and 2404/VP.
	four stored programs:	Models 2408/V4 and 2404/V4.
	twenty stored programs:	Models 2408/VM and 2404/VM.

The 8-segment programmer differs from the other programmers in that it will not provide event outputs and program synchronisation. Otherwise they all operate in the same way.

There are eight topics:

WHAT IS SETPOINT PROGRAMMING?

PROGRAMMER STATES

RUNNING A PROGRAM FROM THE RUN LIST

RUNNING A PROGRAM USING THE RUN/HOLD BUTTON

AUTOMATIC BEHAVIOUR

CONFIGURING THE PROGRAMMER

CONFIGURING DIGITAL INPUTS TO SELECT PROGRAM NUMBER

CREATING A NEW PROGRAM, OR MODIFYING AN EXISTING PROGRAM.

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

WHAT IS SETPOINT PROGRAMMING?

Many applications need to vary temperature, or process value, with time. Such applications need a controller which varies a setpoint as a function of time; all 2408 and 2404 models can do this.

The setpoint is varied by using a *setpoint program*. Within each 2408 and 2404 controller, there is a software module called *the programmer*, which stores one, or more, such programs and drives the setpoint according to the selected program. The program is stored as a series of 'ramp' and 'dwell' segments, as shown below.

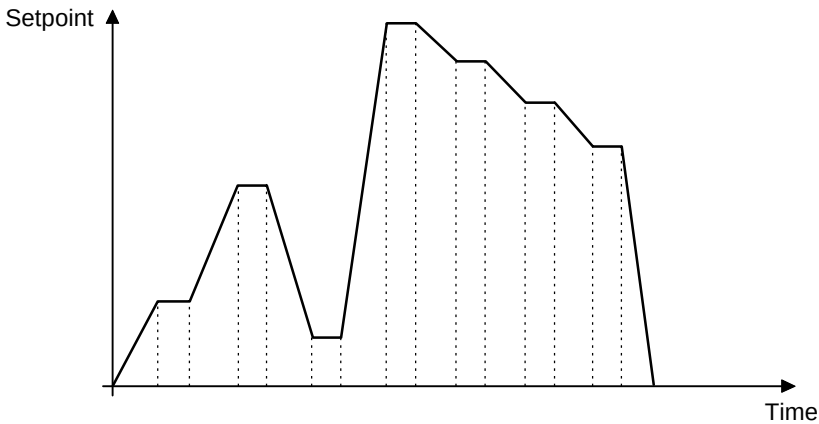


Fig 5-1 Setpoint profile

(*If the 8-segment programmer is being used, then the information in the next paragraph does* ***not*** *apply*.)
In each segment you can define the state of up to eight (8) digital outputs, each of which can be used to trigger external events. These are called *event outputs* and can drive either relay, logic, or triac outputs, depending on the modules installed.

A program is executed either, once, repeated a set number of times, or repeated continuously. If repeated a set number of times, then the number of cycles must be specified as part of the program.

There are five different types of segment:

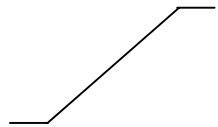
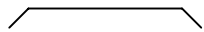
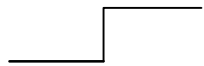
Ramp		**The setpoint ramps linearly**, from its current value to a new value, either at a set rate (called *ramp-rate programming*), or in a set time (called *time-to-target programming*). You must specify the ramp rate or the ramp time, and the target setpoint, when creating or modifying a program.
Dwell		**The setpoint remains constant** for a specified period.
Step		**The setpoint steps instantaneously** from its current value to a new value.
Call		**The main program calls another program as a subroutine**. The called program then drives the setpoint until it returns control to the main program. This facility is available on those controllers with 4, or 20, stored programs.
End		**The program either ends in this segment, or repeats.** You specify which is the case when you create, or modify, the program (see the final topic in this chapter). When the program ends, the programmer is put into either, a continuous Dwell state with all outputs staying unchanged, or the Reset state, or to a settable power level.

Table 5-1 Segment Types

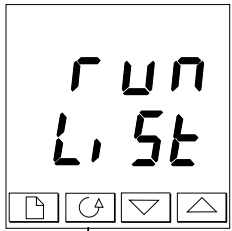
PROGRAMMER STATES

The programs have five states: *Reset, Run, Hold, Holdback* and *End.*

State	Description	Indication
Reset	In Reset, the programmer is inactive and the controller behaves as a standard controller, with the setpoint determined by the value set in the lower readout.	**Both the RUN and HOLD lights are OFF**
Run	In Run, the programmer varies the setpoint according to the active program.	**RUN light on**
Hold	In Hold, the program is frozen at its current point. In this state you can make temporary changes to any program parameter (for example, a target setpoint, a dwell time, or the time remaining in the current segment). **Such changes will only remain effective until the program is reset and run again, when they will be overwritten by the stored program values.** ***Note:*** When a program is running, you cannot alter a **cALLed** program until it becomes active within that program.	**HOLD light on**
Holdback	Holdback indicates that the measured value is lagging the setpoint by more than a preset amount and that the program is in Hold, waiting for the process to catch up. See *Holdback* in the section on Automatic behaviour later this chapter.	**HOLD light flashes**
	A master controller can re-transmit a setpoint value to a number of slave units using PDSIO setpoint retransmission. Any of the slave units can generate a holdback signal which will also flash the **HOLD** light. Holdback will also occur if the PDSIO output is open circuit. This can be disabled in configuration by selecting the PdS output as SP.nH - 'setpoint retransmission without holdback'	**HOLD light flashes**
End	The program is complete.	**RUN light flashes**

Table 5-2 Program States

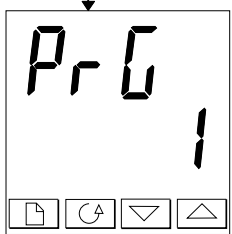
RUNNING A PROGRAM FROM THE RUN LIST



The Run List

From the Home display, press [D] until you reach the 'run' list header.

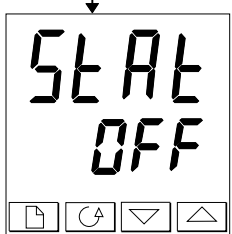
Press [↻]



Program number

This display only appears on programmers that can store more than one program. Use [▲] or [▼] to select the required program number, from 1 to 4, or 1 to 20, depending on the particular controller.
Alternatively, the program number can be selected remotely, using digital inputs on the rear terminals. See the section on *Configuring Digital Inputs to Select a Program Number* for information on how this is done.

Press [↻]



Status selection

Use [▲] or [▼] to select:

run:	Run program.
hold:	Hold program.
OFF:	Program reset.

After two seconds, the lower readout blinks and the chosen state is now active.

To return to the Home display press [↻] *and* [D] *together.*

Other parameters

To access the other parameters in the 'run' list, continue to press [↻]. These parameters are shown in the 'Program run list' in Chapter 2, Parameter Tables. They show the current status of the active program.

Temporary changes

Temporary changes can be made to the parameters in this 'run' list, (for example a setpoint, ramp rate, or an unelapsed time), by first placing the programmer into 'hold'. Such changes remain active only for the duration of the segment; the segment parameters will revert to their original (stored) values whenever the segment is re-executed.

RUNNING A PROGRAM USING THE RUN/HOLD BUTTON

If you are using a 4, or 20, program version of the controller, you must first select the number of the program that you want to run. Do this in the 'run' list – see the previous topic, *Running a program from the Run list.*
Then:

RUN HOLD	RUN / HOLD button	Press once to run a program (RUN light on) Press again to hold a program (HOLD light on) Press again to cancel hold and continue running (HOLD light off, RUN light on) Press and hold in for two seconds to reset a program (RUN and HOLD lights off).

Note: The RUN/HOLD button can be disabled, either when ordering the controller, or subsequently in configuration. This will force you to operate the programmer from the 'run' list all the time. The main advantage of this method is that it will reduce the chance of accidentally changing the state of a program.

AUTOMATIC BEHAVIOUR

The preceding topics explain how to operate the programmer manually.
The following topics cover aspects of its automatic behaviour: *Servo*, *Holdback* and *Power Failure*.

Servo

When a program is RUN, the setpoint can start either from the initial controller setpoint, or from the process value. Whichever it is, the starting point is called the 'servo' point and you set it up in configuration. When the program starts, the transition of the setpoint to its starting point is called 'servoing'.

The normal method is to servo to the process value, because this will produce a smooth and bumpless start to the process. However, if you want to guarantee the time period of the first segment, you should set the controller to servo to its setpoint.

Holdback

As the setpoint ramps up, or down (or dwells), the measured value may lag behind, or deviate from, the setpoint by an undesirable amount. 'Holdback' is available to freeze the program at its current state, should this occur. The action of Holdback is the same as a deviation alarm. It can be enabled, or disabled. Holdback has **two** parameters - a *value* and a *type*.
If the error from the setpoint exceeds the set 'holdback' value, then the Holdback feature, if enabled, will automatically freeze the program at its current point and flash the HOLD light. When the error comes within the holdback value, the program will resume normal running.

There are *four* different Holdback types. The choice of type is made by setting a parameter

when creating a program, and may be one of the following:–

'OFF' – **Disables Holdback** – therefore no action is taken.

'Lo' – **Deviation Low Holdback** holds the program back when the process variable deviates *below* the setpoint by more than the holdback value.

'Hi' – **Deviation High Holdback** holds the program back when the process variable deviates *above* the setpoint by more than the holdback value.

'bAnd' – **Deviation Band Holdback** is a combination of the two. It holds the program back when the process variable deviates *either above, or below,* the setpoint by more than the holdback value.

There is a single Holdback Value which applies to the whole program. However, the Holdback type and whether or not it is enabled, can be applied to the program as a whole, or individually in each segment.

Power failure

If power is lost and then restored, while a program is running, the behaviour of the programmer is determined by the setting of the parameter 'Pwr.F' *Power fail strategy* in Programmer configuration. This can have one of three settings:– cont (Continue), rmP.b (Ramp from PV), or rSEt (Reset).

If 'cont' is selected, then when power is restored the program continues from where it was interrupted when power was lost. All parameters, such as the setpoint and time remaining in the active segment, will be restored to their power-down values. For applications that need to bring the measured process value to the setpoint as soon as possible, this is the best strategy.

If 'rmP.b' is selected, then when power is restored the setpoint starts at ('servos to') the current measured value, and then ramps to the target setpoint of the active segment at the last ramp rate used by the program. This strategy provides a smoother recovery. The two diagrams below illustrate the respective responses, Fig 5-2 if power fails during a dwell segment and Fig 5-3 if it fails during a ramp segment.

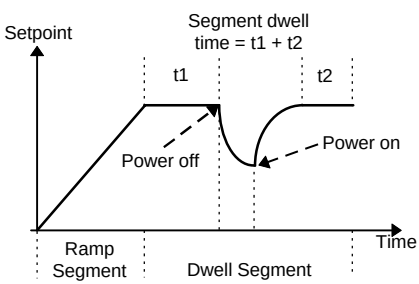


Figure 5-2 Continue after a power fail

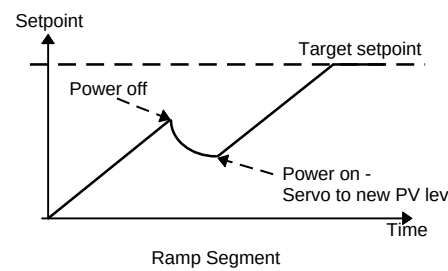


Figure 5-3 Ramp back after a power fail

If 'rSEt' is selected, then when power is restored the program terminates.

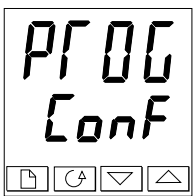
CONFIGURING THE PROGRAMMER

When first installing a programmer you should check that the configuration conforms to your requirement.

Configuration defines:

the number of stored programs	(*multi-programmer only*)
the holdback strategy	
the power fail strategy	
the servo type	
if event outputs are available	(*not 8-segment programmer*)
if program synchronisation is available.	(*not 8-segment programmer*)
selection of program number using digital inputs	(*multi-programmer only*)

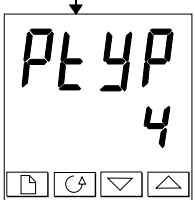
To check, or change, the configuration, select Configuration level. See Chapter 6.



Programmer list header

After selecting Configuration mode, press [D] until the PrOG ConF header is displayed.

Press [G]



Number of programs

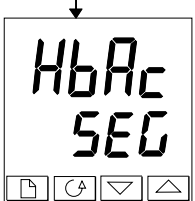
Use [▲] or [▼] to select:

- nonE: Disable built-in 8-segment programmer
- 1: Enable built-in 8-segment programmer

For 16-segment programmers:

- nonE: no programs
- 1: One stored program
- 4: Four stored programs
- 20: Twenty stored programs

Press [G]



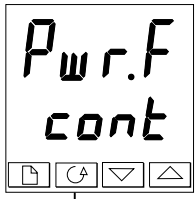
Holdback Strategy

Use [▲] or [▼] to select:

- SEG: Holdback type to be set in each segment
- ProG: Holdback type to be set for the whole program

Press [G]

Continued on the next page.

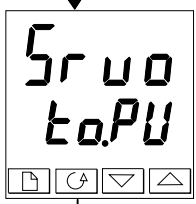


Power fail strategy

Use ▲ or ▼ to select

cont:	Continue from last setpoint
rmP.b:	Ramp from PV to setpoint at last ramp rate
rSEt:	Reset the program.

Press ↻

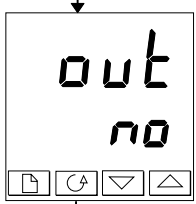


Servo type

Use ▲ or ▼ to select:

to.PV:	Servo to PV
to.SP:	Servo to SP

Press ↻

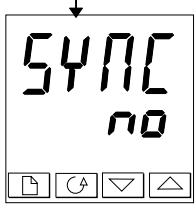


Event Outputs (***not in*** **8-segment** ***programmer***)

Use ▲ or ▼ to select:

no:	Event outputs disabled
YES:	Event outputs enabled

Press ↻



Synchronisation (***not in*** **8-segment** ***programmer***)

Use ▲ or ▼ to select:

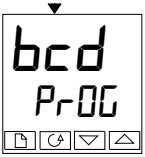
no:	Synchronisation disabled
YES:	Synchronisation enabled

Press ↻ *to return the list header.*

CONFIGURING DIGITAL INPUTS TO SELECT PROGRAM NUMBER

The program number can be selected by external BCD inputs from, for example, a thumbwheel switch.
The appropriate number of digital inputs must be installed in the controller and be configured for this function - see Chapter 6, *Configuration.*
To invoke this mode of operation, the parameter ‘bcd’ in ‘ nSt -ConF’ must be set to ‘PrOG’.

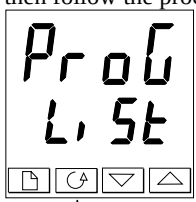
Press until you reach ‘bcd’.



Use the ▲ or ▼ buttons, to select ‘PrOG’.

CREATING A NEW PROGRAM, OR MODIFYING AN EXISTING ONE

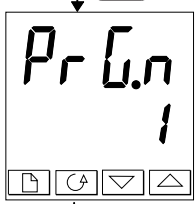
The only difference between creating a new program, and modifying an existing one, is that a new program starts with all its segments set to End in the tYPE parameter. The procedure for both consists of setting up the parameters in the PrOG list of the Operator Navigation Diagram shown in Chapter 2. As explained earlier under 'Programmer states', temporary changes can be made to these parameters while in the HOLD state but permanent changes (to the stored values) can only be made when the programmer is in the Reset state. So, before modifying a stored program first make sure that it is in Reset and then follow the procedure below.



Program edit list

From the Home display press [D] until you reach the PrOG LiSt header.

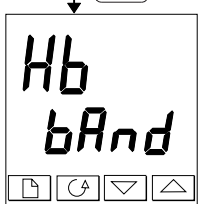
Press [↻]



Program number

This display appears only on the multi-program controllers. Use [▲] or [▼] to select the number of the program which you wish to modify (from 1 to 4, or 1 to 20).

Press [↻]



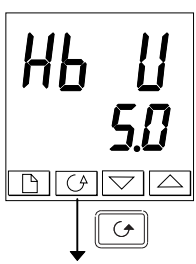
Holdback type

[Only appears when Holdback has been selected for the <u>whole</u> program.]

Use [▲] or [▼] to select:

OFF:	Holdback disabled
Lo:	Deviation Low Holdback
Hi:	Deviation High Holdback
bAnd:	Deviation Band Holdback

Press [↻]



Holdback value

<u>Note!</u> The value set in this parameter is always for the <u>whole</u> program.

Use [▲] or [▼] to set the value.

Press [↻]

Continued on the next page.

to select:

to select:

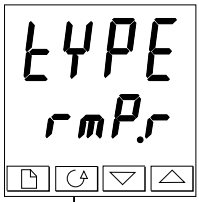
rogram cycles

to set the number of program cycles required
, or ‘cont’ for continuous cycling.

nber

to select the number, from 1 to 16.
ment programmers)
s that follow ‘SEG.n’ set up the characteristics of
y-selected segment number. By defining the
of each segment of the program, you define the
.

Continued on the next page.



Segment type

Select the segment typ

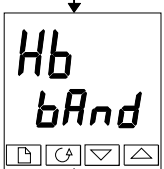
rmP.r:	Ramp t
rmP.t:	Ramp t
dwEll:	Dwell f
StEP:	Step to
cALL:	Call an (*only av*
End:	Make t

Press

The parameters that follow 'tYPE' d shown in the table below. The functi

Parameter	Segment type s	
	rmP.r	rmP.t
Hb	✓	✓
tGt	✓	✓
rAtE	✓	
dur		✓
PrG.n		
cYc.n		
outn	✓	✓
SYnc	✓	✓
End.t		
Pwr		

Table 5-3 Parameters that f



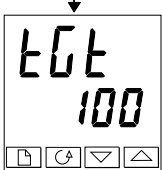
Holdback type

Only appears when Ho

Use ▲ or ▼ to selec

OFF:	Holdba
Lo:	Deviati
Hi:	Deviati
bAnd:	Deviati

Press



Target setpoint

Target setpoint for 'rm

Set the target setpoint u

Press

rmP.r ' segments
, set a value for the ramp rate, ranging from 0.0
units are the ramp units (rmP.U) set earlier in

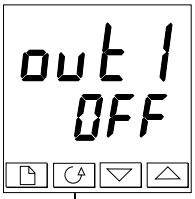
e
E11' segment, or time to target for a 'rmP.t'

ing ▲ or ▼. You have set the units earlier in
['dwL.U' defines the units for 'dwE11' segments:
s the units for 'rmP.t' segments.]

am number
or 'cALL' segments. *(multi-program controllers only)*
ogram number from 1 to 4, or from 1 to 20, using

ycles of the cALLed program
or 'cALL' segments. *(multi-program controllers only)*
r of cycles of the cALLed program from 1 to 999,
.

Continued on the next page.



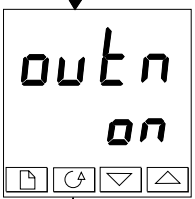
Event output 1

Appears in all segment

Use ▲ or ▼ to set ou

OFF:	Off in t
on:	On the

Press ↻



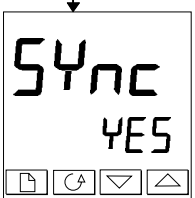
Further event outpu

Up to eight (8) event o
event number.

Pressing ↻ will step t

Note: *If you are not us*
immediately to the next

Press ↻



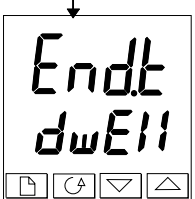
Synchronisation ev

Use ▲ or ▼ to select

YES:	Synchro
no:	Synchro

Note: This event outpu
'outB'.

Press ↻



End segment

Use ▲ or ▼ to select

dwEll:	An inde
rSEt:	Reset.
SOP:	End Seg

Press ↻

[End Segment]

to set the power value in the range ±100.0%.
el is clipped by the parameters ‘OP.Hi’ and
being applied to the process.

rammer/controller software versions 3.56
parameter has been replaced by a parameter
ppears at the end of the Output List, see

eturn to the ProG-Li St *header.*

Chapter 6 CONFIGURATION

This chapter consists of six topics:

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

In configuration level you set up the fundamental
These are:

The type of control (e.g. reverse or direct acti
The Input type and range
The Setpoint configuration
The Alarms configuration
The Programmer configuration
The Digital input configuration
The Alarm Relay configuration
The Communications configuration
The Modules 1, 2 & 3 configuration
Calibration
The Passwords.

WARNIN

Configuration is protected by a password and s person, authorised to do so. Incorrect configur process being controlled and/or personal injury commissioning the process to ensure that the co

EVEL

cting Configuration level:
follow the access instructions given in Chapter 3,

ether when powering up the controller. This will
ord display.

ord entry

he ‘ConF’ display appears, you must enter the
uration password (which is a number) in order to
cess to Configuration level.
e password using the ▲ or ▼ buttons.
nfiguration password is set to ‘2’ when the
ler is shipped from the factory.

e correct password has been entered, there is a
ond delay, after which the lower readout will
to ‘PASS’ indicating that access is now unlocked.

A special case exists if the password has been set
In this situation, access is permanently unlocked
lower readout will always show ‘PASS’.

to enter configuration.

ncorrect password has been entered and the
ler is still ‘locked’ then pressing at this point
e you to the ‘EXIT’ display with ‘no’ in the
eadout. Simply press to return to the ‘ConF’
)

ll obtain the first display of configuration.

LEAVING CONFIGURATION LEVEL

To leave the Configuration level and return to Op
display appears.

Alternatively, pressing and together wil

Use or
delay, the displ
display in Oper

SELECTING A CONFIGURATION PARA

The configuration parameters are arranged in lists
Figure 6.1.

To step through the list headers, press the Page

To step through the parameters within a particu
When you reach the end of the list you will return

You can return directly to the list header at any ti

Parameter names

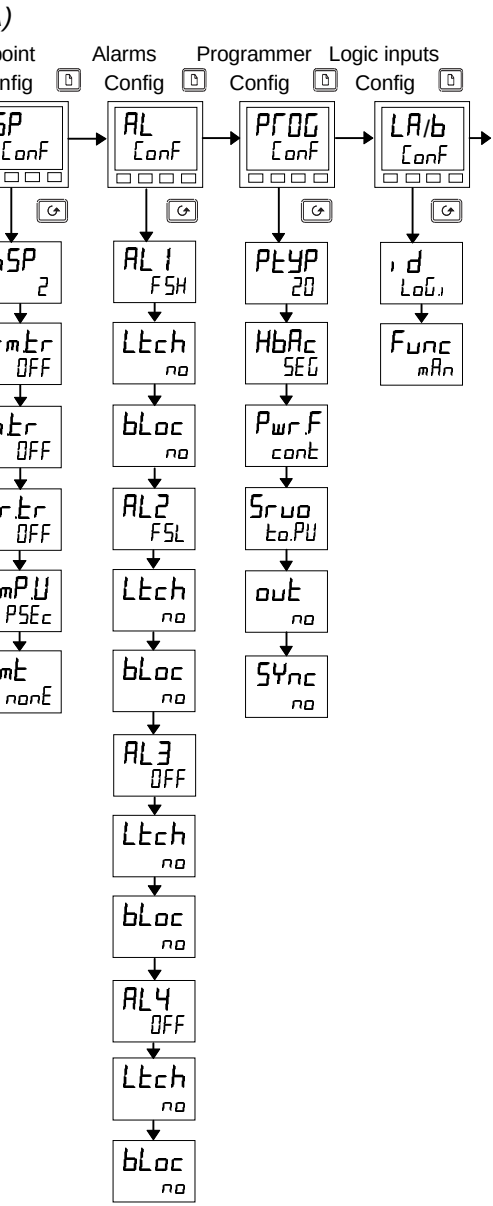
Each box in the navigation diagram shows the dis
upper readout shows the name of the parameter ar
definition of each parameter, see the Configuratio
chapter. To change the value of a selected param

The navigation diagram shows all the lists header
present in the controller. In practice, those actual
particular configuration choices you make.

CHANGING THE PASSWORDS

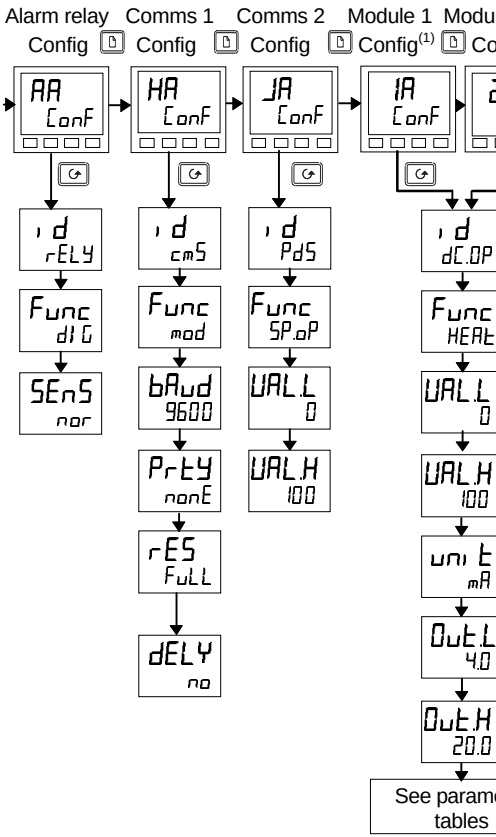
There are TWO passwords. These are stored in th
selected and changed in the same manner as any o
The password names are:

'ACC.P' which protects
'cnF.P' which protects



gation Diagram (Part A)

NAVIGATION DIAGRAM *(PART B)*



Note:

1. Additional headers, carrying the suffixes b and C will appear if dual-, or triple-, channel modules have been installed. The header denotes the labelling of the terminal to which the output function is connected.
2. Module 4 is the High Current Switch Module. This is only available in the Model 2404 controller.
3. 8-point custom linearisation. Only appears when either '3A or 1 P-ConF' has '1 nPt' = 'mU.C', or 'mA.C', or 'U.C'.
4. The navigation diagram shows typical parameters, but is dependant upon the exact configuration of the instrument. The following sheets show the full list of parameters.

Fig 6.1b Navigation Dia

C)

ation Diagram (Part C)

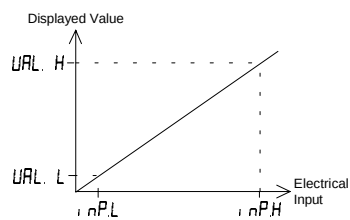
CONFIGURATION PARAMETER TABLE

Name	Description	Valu
inSt	**Instrument configuration**	
CtrL	Control type	Pid On.C UP UP
Act	Control action	rEv dir
CooL	Type of cooling	Lin oiL H2O FAn on.C
ti.td	Integral & derivative time units	SEc min
dtYP	Derivative type	PU Err
m-A	Front panel Auto/Man button	EnA dis
r-h	Front panel Run/Hold button	EnA dis
PwrF	Power feedback	on OFF
Fwdt	Feed forward type	non FEE SP.F PU.F
Pdtr	Manual/Auto transfer when using PD control	no YES
Sbrt	Sensor break output	Sb.C HoL
FOP	Forced manual output	no trA StE
bcd	BCD input function	non Pro SP
GSch	Gain schedule enable	no YES

alues	Meaning
C F K onE	Celsius Fahrenheit Kelvin Display units blanked
nnn nn.n n.nn	None One Two
	Low range limit. Also setpoint limit for alarms and programmers
	High range limit. Also setpoint limit for alarms and programmers

plied for pyrometer inputs (not Exergen K80),
tom Input. The parameter, Emi S, Pyrometer
on page 2-15. This parameter is also now

gative display and setpoint ranges were limited to
The range has been increased to -199.9 by
figure one. This allows Setpoints, Process
ammers to be set to -199.9.

Name	Description	Values	Meaning
inP	**Input configuration**		
inPt	Input type	Jtc	J thermocouple
		ktc	K thermocouple
		Ltc	L thermocouple
		rtc	R thermocouple (Pt/Pt13%Rh)
		btc	B thermocouple (Pt30%Rh/Pt6%Rh)
		ntc	N thermocouple
		ttc	T thermocouple
		Stc	S thermocouple (Pt/Pt10%Rh)
		PL2	PL 2 thermocouple
		Ctc	Custom downloaded t/c (default = type C)
		rtd	100Ω platinum resistance thermometer
		mV	Linear millivolt
		volt	Linear voltage
		mA	Linear milliamps
		Sr V	Square root volts
		Sr A	Square root milliamps
	* see CUSt List.	mVC	8-point millivolt custom linearisation*
		VC	8-point Voltage custom linearisation*
		mAC	8-point milliamp custom linearisation*
CJC	Cold Junction Compensation	Auto	Automatic internal compensation
		0°C	0°C external reference
		45°C	45°C external reference
		50°C	50°C external reference
		OFF	No cold junction compensation
imP	Sensor Break Impedance	OFF	Disabled (applies to any input) **Caution: If sensor break is disabled the controller will not detect open circuit faults**
		Auto	Factory set *(Default i.e. enabled)*
		Hi	Impedance of input > 5KΩ
		Hi.Hi	Impedance of input > 15KΩ
Linear Input Scaling – *The next 4 parameters only appear if a linear or sq rt input is chosen.*			
inPL			Input value low
inPH			Input value high
VALL			Displayed reading low
VALH			Displayed reading high

Name	Description	Values	Meaning
SP	**Setpoint configuration**		
nSP	Number of setpoints	2, 4, 16	Select number of setpoints available
rm.tr	Remote Tracking	OFF trAc	Disable Local setpoint tracks remote setpoint
m.tr	Manual Track	OFF trAc	Disable Local setpoint tracks PV when in manual
Pr.tr	Programmer Track	OFF trAc	Disable Local setpoint tracks programmer SP
rmP.U	Setpoint rate limit units	PSEc Pmin PHr	Per second Per minute Per hour
rmt	Remote setpoint configuration	nonE SP Loc.t rmt.t	Disable Remote setpoint Remote setpoint + local trim Remote trim + local setpoint

AL	Alarm configuration	Values
The controller contains four 'soft' alarms, which are configured in this list. Once configured, they can be attached to a physical output as described in the alarm relay configuration list, 'AA ConF'.		
AL 1	Alarm 1 Type	*see Table A*
Ltch	Latching	no/YES/Eunt/mAn*
bLoc	Blocking	no/YES
AL2	Alarm 2 Type	*see Table A*
Ltch	Latching	no/YES/Eunt/mAn*
bLoc	Blocking	no/YES
AL3	Alarm 3 Type	*see Table A*
Ltch	Latching	no/YES/Eunt/mAn*
bLoc	Blocking	no/YES
AL4	Alarm 4 Type	*see Table A*
Ltch	Latching	no/YES/Eunt/mAn*
bLoc	Blocking (not if 'AL4' = 'rAt')	no/YES

Table A - Alarm types	
Value	**Alarm type**
OFF	No alarm
FSL	PV Full scale low
FSH	PV Full scale high
dEu	PV Deviation band
dHi	PV Deviation high
dLo	PV Deviation low
LCr	Load Current low
HCr	Load Current high
FL2	Input 2 Full Scale low
FH2	Input 2 Full Scale high
LOP	Working Output low
HOP	Working Output high
LSP	Working Setpoint low
HSP	Working Setpoint high
rAt	PV Rate of change *AL4 only*
Ct.OP	CT open circuit
Ct.Sh	*CT short circuit*

*** Alarm Modes**

'no' means that the alarm will be non-latching.

'YES' means that the alarm will be latched, with automatic resetting. Automatic resetting means that if a reset is actioned before the alarm has cleared, then it will automatically reset when it clears.

'Eunt' means that the alarm is used to trip an external event. If this option is selected the front panel alarm message will not appear.

'mAn' means that the alarm will be latched, and can only be reset after it has first cleared (called 'manual reset mode').

*The following parameters apply if the **standard 8-segment programmer** is to be configured.*			
PROG	**Programmer configuration**	**Values**	**Meaning**
PtYP	Programmer type	nonE 1	Programmer disabled (***factory setting***) 8-segment programmer enabled
HbAc	Holdback	SEG ProG	Holdback is individually selectable in each segment. Holdback is applied across the whole Program.
PwrF	Power fail recovery	cont rmP.b rSEt	Continue from last setpoint (SP) Ramp from PV to SP at last ramp rate Reset the program
Srvo	Starting setpoint of a program (Servo point)	to.PV to.SP	From the Process Value (PV) From the setpoint

*The following parameters apply if a **16-segment programmer** is to be configured.*			
PROG	**Programmer configuration**	**Values**	**Meaning**
PtYP	Programmer type	nonE 1 4 20	Programmer disabled Single program Four programs Twenty programs
HbAc	Holdback	SEG ProG	Holdback is individually selectable in each segment. Holdback is applied across the whole Program.
PwrF	Power fail recovery	cont rmP.b rSEt	Continue from last setpoint (SP) Ramp from PV to SP at last ramp rate Reset the program
Srvo	Starting setpoint of a program (Servo point)	to.PV to.SP	From the Process Value (PV) From the setpoint
out	Programmable event outputs	no YES	Disabled Enabled
SYNC	Synchronisation of programs of several programmers	no YES	Disabled Enabled

Name	Description	Values	Meaning
LA	**Digital input 1 configuration**		**Action on contact closure**
id	Identity	LoGi	Logic input
Func	Function of input *The function is active when the input has a contact closure to the common terminal - LC*	nonE	No function
		mAn	Manual mode select
		rmt	Remote setpoint select
		SP2	Setpoint 2 select
		Pid2	PID set 2 select
		ti H	Integral hold
		tunE	One-shot self-tune enable
		drA	Adaptive tune enable
		AcAL	Acknowledge alarms
		AccS	Select Full access level
		Loc.b	Keylock
		uP	Simulate pressing of the ▲ button
		dwn	Simulate pressing of the ▼ button
		ScrL	Simulate pressing of the button
		PAGE	Simulate pressing of the button
		run	Run program
		HoLd	Hold program
		r-H	Run program (*closed*) / Hold (*open*)
		rES	Reset program
		Skip	Skip to End of Current Segment, without changing the setpoint
		HbAc	Program holdback enabled
	These BCD inputs are used to select either a program number or the setpoint number according to the setting of the parameter 'bcd' in the 'nSt' configuration list	bcd.1	Least significant BCD digit
		bcd2	2nd BCD digit
		bcd.3	3rd BCD digit
		bcd.4	4th BCD digit
		bcd.5	5th BCD digit
		bcd.6	Most significant BCD digit
		rmP.E	Setpoint Rate Limit Enable
		SYnc	Program waits at the end of the current segment
		rrES	Program Run *(closed)* / Reset *(open)*
		rESr	Program Reset *(closed)* / Run *(open)*
		StbY	Standby - ALL control outputs turned OFF (alarm Outputs are not affected)
		PU.SL	PV Select: Closed = PV1 / Open = PV2
		AdU	Advance to End of Segment and to Target Setpoint

Lb	**Digital input 2 configuration**		**Action on contact closure**
As per **Digital input 1** configuration plus AmPS in the Func list			

Name	Description	Values	Meaning
AA	**Alarm relay configuration**		
id	Identity	rELY	Relay output
Func	Function	nonE dIG	No function Digital output
SEnS	Digital output sense	nor inu	Normal *(output energises when TRUE, e.g. program events)* Inverted *(output de-energises when TRUE, e.g. alarms)*
The following digital events appear after 'SEnS'. Any one, or more, of the events can be combined on to the output (see Fig. 6-2) by selecting 'YES' in the lower readout.			
1---	Alarm 1 active	YES / no	(---) *= alarm type (e.g.* FSL*). If an alarm has not been configured in* 'AL ConF' *list, then display will differ:- e.g.* Alarm 1 = 'AL 1'.
2---	Alarm 2 active	YES / no	
3---	Alarm 3 active	YES / no	
4---	Alarm 4 active	YES / no	
mAn	Controller in manual mode	YES / no	
Sbr	Sensor break	YES / no	
SPAn	PV out of range	YES / no	
Lbr	Loop break	YES / no	
LdF	Load failure alarm	YES / no	
tunE	Tuning in progress	YES / no	
dcF	Voltage output open circuit, or mA output open circuit	YES / no	
rmtF	PDSIO module measurement connection open circuit	YES / no	
iP1F	Input 1 failure	YES / no	
nwAL	New Alarm has occurred	YES / no	
End	End of setpoint rate limit, or end of program	YES / no	
SYnc	Program Synchronisation active	YES / no	
PrGn	Programmer event output active, where 'n' = event number from 1 to 8. *(Not available with 8-segment programmer.)*	YES / no	

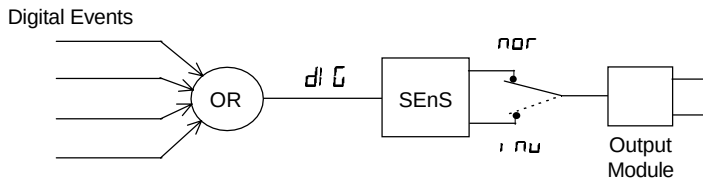
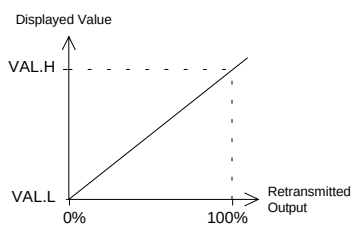
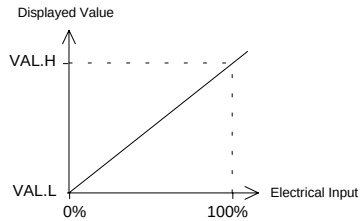


Figure 6-2 Combining several digital events on to one output

Name	Description	Values	Meaning
HA	**Comms 1 module config**		
id	Identity of the module installed	cmS	EIA-232, or 2-wire EIA-485, or 4-wire EIA-485 comms
		PdS	PDSIO retransmission
		PdS.i	PDSIO input

For 'id' = 'cmS' (Digital communications) use this parameter table:			
Func	Function	mod	Modbus protocol
		EI.bi	Eurotherm Bisynch protocol
bAud	Baud Rate	1200, 2400, 4800, 9600, 19.20 (19,200)	
dELY	Delay - quiet period, required by some comms adaptors	no	No delay
		YES	Delay active - 10mS
The following parameters only appear if the function chosen is Modbus *protocol.*			
PrtY	Comms Parity	nonE	No parity
		EuEn	Even parity
		Odd	Odd parity
rES	Comms Resolution	FuLL	Full resolution
		Int	Integer resolution

For 'id' = 'PdS' (PDSIO retransmission output) use this parameter table:			
Func	Function *i.e. Retransmitted output*	nonE	No PDSIO function
		SP.oP	PDSIO setpoint retransmission
		PV.oP	PDSIO PV retransmission
		OP.oP	PDSIO output power retransmission
		Er.OP	PDSIO error signal retransmission
		SP.nH	PDSIO setpoint retransmission - no holdback
Output Scaling			
VALL			Retransmitted value low
VALH			Retransmitted Value High

Name	Description	Values	Meaning
For 'i d' = 'PdSi' (PDSIO setpoint input) use this parameter table:			
Func	Function	SP, P	PDSIO setpoint input
VALL			Setpoint Displayed Value - Low
VALH			Setpoint Displayed Value - High

Note: Having configured the module function as remote setpoint you must then specify the type of remote setpoint in the SP-conf list

JA	**Comms 2 module config**		
As per Comms 1 module configuration			

	Values	Meaning
	nonE	Module not fitted
	rELY	Relay output
	dC.OP	Non-isolated DC output
nel	LoG	Logic/PDSIO output
st	LoG,	Logic input
ear	SSr	Triac output
	dc.rE	DC retransmission (isolated)
	dc.OP	Isolated DC output

e this parameter table:		
	nonE	Function disabled
	dI G	Digital output function
can be	HEAt	Heating output
Cooling)	COOL	Cooling output
	uP	Open motorised valve
	dwn	Close motorised valve
= 'LoG')	SSr.1	PDSIO mode 1 heating
= 'LoG')	SSr.2	PDSIO mode 2 heating
		% PID demand signal giving minimum output – 'OutL'
		% PID demand signal giving maximum output – 'OutH'
		Minimum average power
.H Electrical Output		Maximum average power
	nor	Normal *(output energises when TRUE, e.g program events)*
	inu	Inverted *(output de-energises when TRUE, e.g. alarms)*

meters are available.
F' list on Page 6-13.
set below the Val.L

Name	Description	Values	Meaning

For 'id' = 'dC.OP', 'dc.rE', or 'dc.OP' use this parameter table:			
Func	Function	nonE	Function disabled
		HEAt	Heating output
		COOL	Cooling output
		PV	Retransmission of PV
		wSP	Retransmission of setpoint
		Err	Retransmission of error signal
		OP	Retransmission of OP power
VAL.L	%PID, or Retransmission Value		% PID, or Retrans'n Value, giving minimum output
VAL.H	VAL.H		% PID, or Retrans'n Value, giving maximum output
unit			volt = Volts, mA = milliamps
Out.L	VAL.L		Minimum electrical output
Out.H	Out.L Out.H Electrical Output		Maximum electrical output

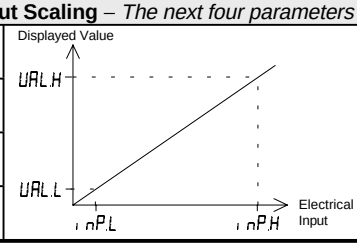
For 'id' = 'LoG' (i.e logic input) use the LA ConF' list on Page 6-11.

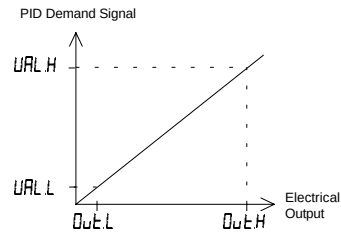
2A/b/C	Module 2 configuration		
As per module 1 configuration, but excluding the 'SSr.1', 'SSr.2' functions.			
id	Identity of module installed. As per module 2 plus:	tPSU Pot	Transmitter power supply Potentiometer input

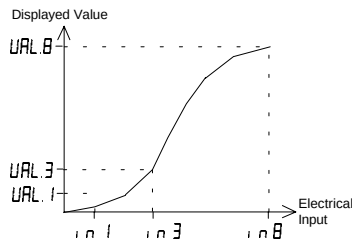
For 'id' = 'Pot' (i.e. potentiometer input module) use this parameter table:			
Func	Function	nonE rSP Fwd rOP.h rOP.L VPoS	Function disabled Remote Setpoint Feedforward input Remote OP power max. Remote OP power min. Motorised valve position
VAL.L	Displayed value VAL.H VAL.L 0% 100% Potentiometer position		Displayed value low equivalent to 0% potentiometer position
VAL.H			Displayed value high equivalent to 100% potentiometer position

3Ab1C	**Module 3 configuration**		
As per module 2 configuration, plus 'i d' = 'dC, P'			

For 'i d' = 'dC, P' use this parameter table.
THIS INCLUDES THE SECOND PV FUNCTIONS

Func	Function	nonE	Function disabled
		rSP	Remote Setpoint
		Fwd,	Feedforward input
		rOP.h	Remote OP power max.
		rOP.L	Remote OP power min.
		Hi	PV = The highest of i P. 1, or i P.2
		Lo	PV = The lowest of i P. 1, or i P.2
		Ftn	Derived function, where PV = (F. 1 x i P 1) + (F.2 x i P2). 'F. 1' and 'F.2' are scalars which are found in 'i P-L, SE' of Operator Level
		SEL	Select i P. 1, or i P.2 via Comms, front panel buttons, or a digital input
		trAn	Transition of control between i P. 1 and i P.2. The transition region is set by the values of 'Lo.] P' and 'Hi] P', which are found in 'i P-L, SE' of Operator Level. PV = i P. 1 below 'Lo.] P' PV = i P.2 above 'Hi] P'
i nPt	Input type	Refer to 'i P ConF' for all types, + the following:	
		Hi I n	High Impedance (range = 0 to 2 volt)
C.]C	Cold Junction Compensation	OFF	No cold junction compensation
		Auto	Automatic internal compensation
		0°C	0°C external reference
		45°C	45°C external reference
		50°C	50°C external reference
i mP	Sensor Break Impedance	OFF	Disabled (applies to any input) **Caution: If sensor break is disabled the controller will not detect open circuit faults**
		Auto	Factory set
		Hi	Impedance of input > 15KΩ
		Hi .Hi	Impedance of input > 30KΩ
Linear Input Scaling – *The next four parameters only appear if a linear input is chosen.*			
i nP.L			Input value low
i nP.H			Input value high
UAL.L			Displayed value low
UAL.H			Displayed value high

Name	Description	Values	Meaning
4A	**Module 4 configuration**		
id	Identity of module installed	HCS	High Current Switch
Func	Function	nonE dIG HEAt COOL	Function disabled Digital output function Heating output Cooling output
VAL.L			% PID demand signal giving minimum output – 'OutL'
VAL.H			% PID demand signal giving maximum output – 'OutH'
OutL			Minimum electrical output
OutH			Maximum electrical output
SEnS	Sense of output *(Only if 'Func' = 'dIG')*	nor inu	Normal *(output energises when TRUE, e.g. program events)* Inverted *(output de-energises when TRUE, e.g. alarms)*
When 'SEnS' appears, then further parameters are available. *These are identical to those in the 'AA ConF' list on Page 6-12.*			

CuSt	**8-point Custom Linearisation** (1)	
in 1		Custom input 1
VAL.1		Linearisation Value representing in 1
⋮		⋮
in 8		Custom input 8
VAL.8		Linearisation Value representing in 8

Note:

1. Custom Linearisation is only available when '3A-ConF' or iP- ConF list has 'inPt' set to 'mU.C', or 'mA.C', or 'U.C'.
2. The values and inputs must be continuously increasing or decreasing

Name	Description	Values	Meaning
CAL	**Calibration**		
In this mode you can *1. Calibrate the instrument using a mV source - rcAL or ref source cal.* *2. Offset the calibration to account for errors in actual sensor measurement and a ref sensor - UCAL or user calibration* *3. Return to factory set calibration - FACt or factory set calibration.*			
rcAL	Calibration point	nonE	No calibration
		PU	Calibrate main Process Value input.
		PU.2	Calibrate DC input, or PV 2.
		1A.Hi	Calibrate DC output high - Module 1
		1A.Lo	Calibrate DC output low - Module 1
		2A.Hi	Calibrate DC output high - Module 2
		2A.Lo	Calibrate DC output low - Module 2
		3A.Hi	Calibrate DC output high - Module 3
		3A.Lo	Calibrate DC output low - Module 3

Goto User calibration table-See also chapter 7

Go to input Calibation table

Go to DC Output Calibration table

INPUT CALIBRATION

For 'CAL' = 'PU', or 'PU.2', the following parameters apply.

PU	PV Calibration Value	IdLE	Idle
		muL	Select 0mV as the calibration point
		muH	Select 50mV as the calibration point
		U 0	Select 0Volt as the calibration point
	1. Select calibration value	U 10	Select 10V as the calibration point
	2. Apply specified input	CJC	Select 0°C CJC calibration point
	3. Press ⟲ to step to 'GO'	rtd	Select 400Ω as the calibration point
		HI 0	High impedance: 0Volt cal'n point
		HI 1.0	High impedance: 1.0 Volt cal'n point
	See **Note** *below.*	FACt	Restore factory calibration
GO	Start calibration *Select 'YES' with ▲ or ▼* *Wait for calibration to complete.*	no	Waiting to calibrate PV point
		YES	Start calibration
		buSY	Busy calibrating
		donE	PV input calibration completed
		FAIL	Calibration failed

Note. When a DC input module is installed for the first time, or there is a requirement to change one, then the microprocessor in the controller needs to read the factory calibration data stored in the module. Select 'FACt' as the calibration value. Step to 'GO' and start calibration.

DC Output Calibration			
The following parameters apply to DC output modules ie for rcAL = 1A.Hi to 3ALo			
cAL.H	Output Calibration High	0	0 = Factory set calibration. Trim value until output = 9V, or 18mA
cAL.L	Output Calibration Low	0	0 = Factory set calibration. Trim value until output = 1V, or 2mA

User calibration		
UCAL	User calibration enable	Yes/no
Pt 1L	Low calibration point for Input 1	The factory calibration point at which the low point offset was performed.
Pt 1H	High calibration point for Input 1	The factory calibration point at which the high point offset was performed.
OF 1L	Offset Low for Input 1	Calculated offset, in display units.
OF 1H	Offset High for Input 1	Calculated offset, in display units.
Pt2L	Low calibration point for Input 2	The factory calibration point at which the low point offset was performed.
Pt2H	High calibration point for Input 2	The factory calibration point at which the high point offset was performed.
OF2L	Offset Low for Input 2	Calculated offset, in display units.
OF2H	Offset High for Input 2	Calculated offset, in display units.

Name	Description	Values	Meaning
PASS	**Password configuration**		
ACCP	FuLL or Edit level password		
cnFP	Configuration level password		
Exit	**Exit configuration**	no/YES	

Chapter 7 USER CALIBRATION

This chapter has five topics:

WHAT IS THE PURPOSE OF USER CALIBRATION?
USER CALIBRATION ENABLE
OFFSET 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 a single point, or two-point, offset onto the factory set calibration.

enabled in configuration level by setting the
'YES'. This will make the User calibration
vel.
apter 6, *Configuration.*

on Configuration List

til you reach the 'CAL-ConF' list.

l you reach 'UCAL'.

tion Enable

▼ to select:
ibration enable
bration disabled

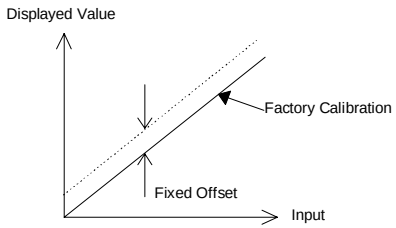
d 🗋 *together to go to the* Exit *display.*

ation

▼ to select 'YES' to return to Operator level.

OFFSET CALIBRATION

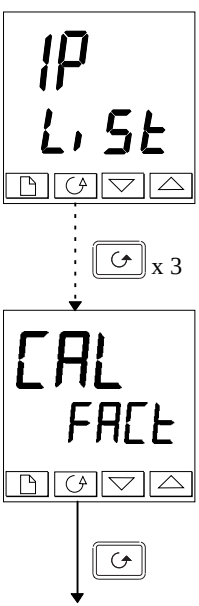
Offset calibration is used to apply a single fixed o
controller.



To calibrate, proceed as follows:

1. Connect the input of the controller to the sour
2. Set the source to the desired calibration value.
3. The controller will display the current measur
4. If the displayed value is correct, then the cont
   further action is necessary. If it is incorrect, t

Select 'FuLL' access level, as described in Chapt



Input list header

Press until you rea

Press until you reac

Calibration type

FACt: Factory C
USEr: User Calib

Use or to sel

Selecting 'FACt' reinsta
application of a single fix

Press

▼ to set the offset value of Process Value 1

ue is in display units.

▼ to set the offset value of Process Value 2
igured.
ue is in display units.

ow shows the parameters which appear after
ese are all read only values and are for
Press ↻ to step through them.

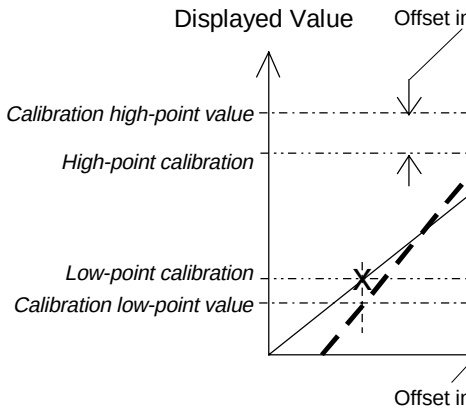
measured value (at terminals)
measured value (at terminals), if DC input in Module osition
Cold Junction Compensation
Cold Junction Compensation
Linearised Value
Linearised Value
ows the currently selected input

want to look at these parameters, then press 🗎
ns you to the ‘ P-L, SE ’ header.

calibration against unauthorised adjustment,
rator level and make sure that the calibration
e hidden. Parameters are hidden using the ‘Edit’
oed in Chapter 3, *Access Levels*.

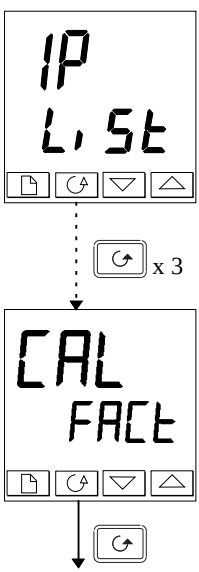
TWO-POINT CALIBRATION

The previous section described how to apply a off
fixed offset over the full display range of the cont
calibrate the controller at two points and applies a
readings above, or below, the two calibration poir
line. For this reason it is best to calibrate with th



Proceed as follows:

1. Decide upon the low and high points at which
2. Perform a two point calibration in the manne



Input list header

Press until you

Press until you

Calibration type

FACt: Facto
USEr: User

Use or t
Selecting 'USEr' e
[If two-point calibra
return to the factory

Press

-point Calibration

alibration Status display. This display shows
t is selected for calibration.

No selection
Input 1 (PV1) calibration low-point selected
Input 1 (PV1) calibration high-point selected
Input 2 (PV2) calibration low-point selected
Input 2 (PV2) calibration high-point selected

to select the parameter for the Low Calibration
ut 1, ‘P 1L’.

-point calibration

isplay for adjusting the Low Calibration point of
e lower readout is a live reading of the process
changes as the input changes.
hat the calibration source is connected to the
Input 1, switched on and feeding a signal to the
It should be set to the desired low-point
alue. If the lower readout does not show this
se ▲/▼ to adjust the reading to the required

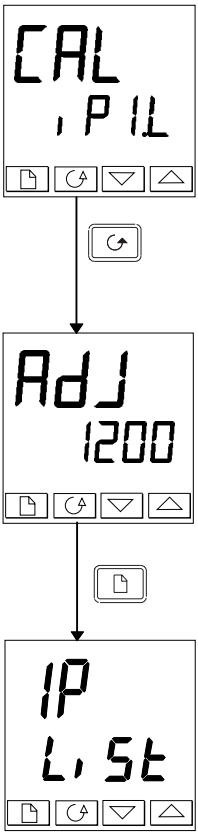
o return to the ‘P-L SE’ header.

the High-point Calibration, repeat the above
electing ‘P 1.H’ in the ‘CAL.S’ display for

hree times.

type

selected for the Low-point Calibration, and has
ected.



Select High-point

This is the Calibratio

Use ▲/▼ to select
Calibration of Input

Press ↻

Adjust High-point

This is the display fo
Input 1. The lower
value, which change

Feed the desired hig
controller, from the
does not show this v
reading to the requir

Press 🗋 to return

To protect the calibr
return to Operator le
parameters are hidde
'Edit' facility desc

To perform a User C
Input 1 above, excep
press ▲/▼ until '
as with Input 1. Re

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, then these are shown in Configuration, in 'CAL-ConF'.
The parameters are:

Name	Parameter description	Meaning
Pt 1L	Low calibration point for Input 1	The factory calibration point at which the low point offset was performed.
Pt 1H	High calibration point for Input 1	The factory calibration point at which the high point offset was performed.
OF 1L	Offset Low for Input 1	Calculated offset, in display units.
OF 1H	Offset High for Input 1	Calculated offset, in display units.
Pt2L	Low calibration point for Input 2	The factory calibration point at which the low point offset was performed.
Pt2H	High calibration point for Input 2	The factory calibration point at which the high point offset was performed.
OF2L	Offset Low for Input 2	Calculated offset, in display units.
OF2H	Offset High for Input 2	Calculated offset, in display units.

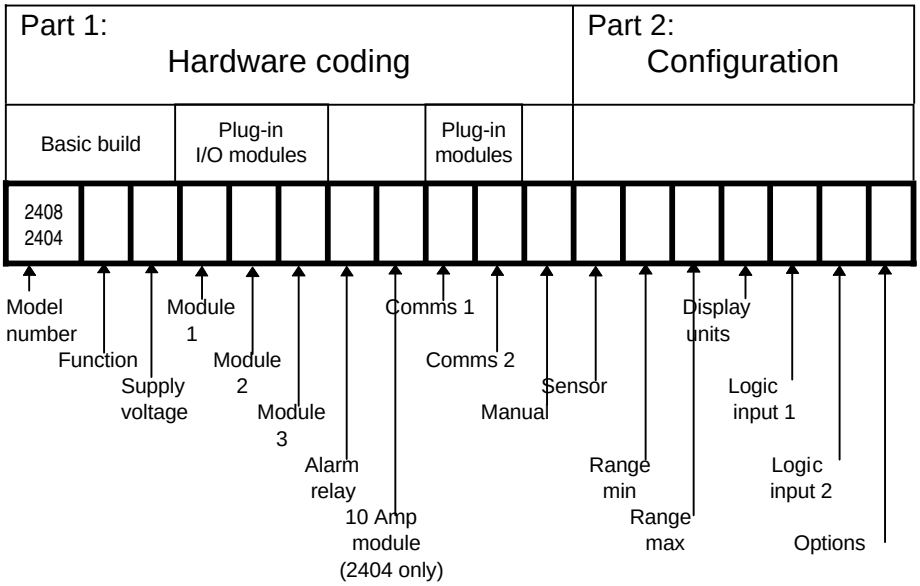
Note: The value of each of the parameters in the above table may also be altered by using the ▲/▼ buttons.

Appendix A

UNDERSTANDING THE ORDERING CODE

The 2408 and 2404 controllers have a modular hardware construction, which accepts up to three plug-in Input/Output modules and two communications modules to satisfy a wide range of control requirements. Two digital inputs and an optional alarm relay form part of the fixed hardware build. Additionally, the Model 2404 has the option of a 10A heating output.

The ordering code is in two parts. The hardware coding and an optional configuration coding. The hardware coding specifies the basic build of the controller and the plug-in modules that are fitted.



The controller may have been ordered with just the hardware build specified, or with configuration included. This is indicated by the ordering code on the side of the controller.

Part 1A: Hardware coding			
Basic build			Plug-in modules
Model number	Function	Supply voltage	Module 1
2408	CC	VH	LH

Continued next page

Model Number	
2408	1/8 DIN Controller
2404	1/4 DIN Controller

Function	
Standard PID control	
CC	Controller
CG	1 x 8 seg prog
CP	1 x 16 seg prog
P4	4 x 16 seg prog
CM	20 x 16 seg prog
On/Off control	
NF	Controller only
NG	1 x 8 seg prog
NP	1 x 16 seg prog
N4	4 x 16 seg prog
NM	20 x 16 seg prog
Motorised valve control	
VC	Valve positioner (VP)
VG	1 x 8 seg prog
VP	1 x 16 seg prog
V4	4 x 16 seg prog
VM	20 x 16 seg prog

Supply voltage	
VH	85 to 264Vac
VL	20 to 29Vac/dc

Module 1	
XX	Not fitted
Relay: 2-pin	
R2	Fitted unconfigured
RH	PID heating
RU	Valve raise output
Relay: change-over	
R4	Fitted unconfigured
YH	PID heating
Or Alarm 1: select from table A	
Logic: (Non-isolated)	
L2	Fitted unconfigured
LH	Heating output
M1	PDS heater break detect (note 1)
M2	PDS current monitoring (note2)
Triac	
T2	Fitted unconfigured
TH	Heating output
TU	Valve raise output
DC control (isolated)	
D4	Fitted unconfigured
H6	0-20mA PID heating
H7	4-20mA PID heating
H8	0-5V PID heating
H9	1-5V PID heating
HZ	0-10V PID heating
Digital I/O (unconfigured)	
TK	Triple contact input
TL	Triple logic input
TP	Triple logic output
Dual relay	
RR	Fitted unconfigured
RD	PID heat + PID cool
RM	Valve raise and lower
Dual triac	
TD	PID heat + PID cool
TM	Valve raise and lower
Logic + relay	
LD	PID heat + PID cool
Dual Logic + triac	
GD	PID heat + PID cool

Table A : Alarm relay functions	
FH	High alarm
FL	Low alarm
DB	Deviation band
DL	Low dev. alarm
DH	High dev alarm

Table B : DC retransmission	
D6	Fitted unconfigured
First character	
V-	PV retrans
S-	Setpoint retrans
O-	Output retrans
Z-	Error retrans
Second character	
-1	0-20mA
-2	4-20mA
-3	0-5V
-4	1-5V
-5	0-10V

continued

Part 1B: Hardware coding						
Plug-in modules				Plug-in modules		
Module 2	Module 3	Alarm relay	10A output	Comms 1	Comms 2	Manual
RC	FL	FH	Not 2408	YM	TS	ENG

Module 2	
XX	Not fitted
Relay: 2-pin	
R2	Fitted unconfigured
RC	Cooling output
RW	Valve lower output
Relay: change-over	
R4	Fitted unconfigured
YC	Cooling Output
PO	Program event output 1 *(not with 8 seg prog)*
PE	Program END segment
Or Alarm 2: select from table A	
Dual relay	
RR	Fitted unconfigured
PP	Program events 1 & 2
Logic	
L2	Fitted unconfigured
LC	PID cooling
Triac	
T2	Fitted unconfigured
TC	PID cooling
TW	Valve lower output
DC control isolated	
D4	Fitted unconfigured
C6	0-20mA PID cooling
C7	4-20mA PID cooling
C8	0-5V PID cooling
C9	1-5V PID cooling
CZ	0-10V PID cooling
Digital I/O (unconfigured)	
TK	Triple contact input
TL	Triple logic input
TP	Triple logic output
Power supply	
MS	24Vdc transmitter
DC retran (isolated)	
Selct from table S	
Potentiometer input	
VU	Fitted unconfigured
VS	Valve position feedback
VR	Setpoint input

Note 1: PDS heater break detect will transmit the power demand signal to a TE10 SSR and read back a heater break alarm

Note2: PDS current monitoring will transmit the power demand signal to a TE10 SSR and read back load current and open and short circuit alarms

Module 3	
XX	Not fitted
Relay: 2-pin	
R2	Fitted unconfigured
Relay: change-over	
R4	Fitted unconfigured
PO	Program event 4 *(not with 8 seg prog)*
PE	Program END output
Or Alarm 3 select from table A	
Logic	
L2	Fitted unconfigured
Triac	
T2	Fitted unconfigured
Dual relay	
RR	Fitted unconfigured
PP	Program event 4 & 5
Digital I/O (unconfigured)	
TK	Triple contact input
TL	Triple logic input
TP	Triple logic output
Power supply	
MS	24V transmitter
DC remote input	
D5	Fitted unconfigured
W2	4 to 20mA setpoint
W5	0 to 10V setpoint
WP	Second PV input
DC retran (isolated)	
Select from table B	
Potentiometer input	
VU	Fitted unconfigured
VS	VP feedback
VR	Setpoint input

Alarm relay	
XX	Not fitted
Alarm 4 relay	
RF	Fitted unconfigured
Table A alarm options plus:	
RA	Rate of change
PDS alarms	
LF	Heater break detect
HF	Current monitoring heater break
SF	Current monitoring SSR failure
PO	Program event 7 *not with 8 seg prog*
PE	Program END output

10A output	
XX	Not fitted
R6	Fitted unconfigured
RH	PID heating

Comms 1	
XX	None
2-wire EIA-485	
Y2	Fitted unconfigured
YM	Modbus protocol
YE	EI Bisynch protocol
EIA-232	
A2	Fitted unconfigured
AM	Modbus protocol
AE	EI Bisynch protocol
4-wire EIA-485	
F2	Fitted unconfigured
FM	Modbus protocol
FE	EI Bisynch protocol
PDS output	
M7	Fitted unconfigured
PT	PV retransmission
TS	Setpoint retrans
OT	Output retrans

Comms 2	
XX	Not fitted
PDS input	
M6	Fitted unconfigured
RS	Setpoint input
PDS output	
M7	Fitted unconfigured
PT	PV retransmission
TS	Setpoint retrans
OT	Output retrans

Manual	
XXX	No manual
ENG	English
FRA	French
GER	German
NED	Dutch
SPA	Spanish
SWE	Swedish
ITA	Italian

Hardware coding	Part 2: Configuration				
	Sensor input	Range min	Range max	Display Units	Continued next page
	K	*See note 2* 0	1000	C	▶

Sensor input		Range min &max	
Standard sensor inputs		°C	°F
J	J thermocouple	-210 to 1200	-340 to 2192
K	K thermocouple	-200 to 1372	-325 to 2500
T	T thermocouple	-200 to 400	-325 to 750
L	L thermocouple	-200 to 900	-325 to 650
N	N thermocouple	-250 to 1300	-418 to 2370
R	Type R - Pt13%Ph/Pt	-50 to 1768	-58 to 3200
S	Type S - Pt10%Rh/Pt	-50 to 1768	-58 to 3200
B	Type B - Pt30%Rh/Pt6%Rh	0 to 1820	32 to 3308
P	Platinel II	0 to 1369	32 to 2496
Z	RTD/PT100	-200 to 850	-325 to 1562
Process inputs			
F	+/- 100mV	0 to 9999	
Y	0-20 mA Linear	0 to 9999	
A	4-20 mA Linear	0 to 9999	
W	0-5V DC Linear	0 to 9999	
G	1-5V DC Linear	0 to 9999	
V	0-10V DC Linear	0 to 9999	
Factory downloaded input			
C	*Type C W5%Re/W26%Re (Hoskins)*	0 to 2319	32 to 4200
D	Type D - W3%Re/W25%Re	0 to 2399	32 to 4350
E	E thermocouple	-270 to 1000	-450 to 1830
1	Ni/Ni18%Mo	0 to 1399	32 to 2550
2	Pt20%Rh/Pt40%Rh	0 to 1870	32 to 3398
3	W/W26%Re (Englehard)	0 to 2000	32 to 3632
4	W/W26%Re (Hoskins)	0 to 2010	32 to 3650
5	W5%Re/W26%Re (Englehard)	10 to 2300	50 to 4172
6	W5%Re/W26%Re (Bucose)	0 to 2000	32 to 3632
7	Pt10%Rh/Pt40%Rh	200 to 1800	392 to 3272
8	Exergen K80 I.R. pyrometer	-45 to 650	-50 to 1200

Display Units	
C	Centigrade
F	Fahrenheit
K	Kelvin
X	Linear input

Note 3: Setpoint limits include the decimal points required in the displayed value; - up to one for temperature inputs; up to two for process inputs

continued	Part 2: Configuration						
	Digital input 1	Digital input 2	Control	Power feedback	Cooling	Buttons	Program
▶	AM	S2	XX	XX	XX	MD	XX

Digital inputs 1 & 2			
XX	Disabled	AT	Adaptive tune enable
AM	Manual select	FA	Select full access level
SR	Remote setpoint select	RB	Simulates UP button
S2	Second setpoint select	LB	Simulates DOWN button
EH	Integral hold	SB	Simulates SCROLL button
AC	Alarm acknowledge	PB	Simulates PAGE button
RP	Setpoint rate limit enable	B1	Least sig. BCD dig.
RN	Run program	B2	2nd BCD digit
HO	Hold program	B3	3rd BCD digit
RE	Reset program	B4	4th BCD digit
RH	Run/hold program	B5	5th BCD digit
KL	Keylock	B6	Most sig. BCD digit
NT	Run/Reset program	SY	Standby - ALL ops OFF
TN	Reset/Run program	SG	Skip segment (without changing SP)
HB	Prog. holdback en'ble	SC	Program synch.
P2	PID2 select	PV	Select PV2
ST	One-shot tune enable	AG	Advance to end of segment (& step to target setpoint)
		M5	CTX (mode 5) (input 2 only)

Options	
Control action	
XX	Reverse acting (standard)
DP	Direct acting PID control
Power feedback	
XX	Enabled on logic, relay & triac heating
PD	Feedback disabled
Cooling options	
XX	Linear cooling
CF	Fan cooling
CW	Water cooling
CL	Oil cooling
CO	On/off cooling
Front panel buttons	
XX	Enabled
MD	Auto/man button disabled
MR	Auto/man & run/hold disabled
RD	Run/hold button disabled
Programmer time units	
XX	Dwell & ramp in minutes
HD	Dwell time in hours
HR	Ramp rate in units/hour

The example given in the coding is for 2408 PID controller, 85 to 264 Vac, logic heating, relay cooling, low alarm relay, high alarm relay, RS485 Modbus comms, PDSIO setpoint retransmission, type K thermocouple, 0 to 1000°C, Auto/manual select, second setpoint select, manual button disabled.

Notes:

1. **PDSIO** is a proprietary technique developed by Eurotherm for bi-directional transmission of analogue and digital data between instruments.
   Mode 1: provides logic heating to a Eurotherm TE10S (fitted with option PDS1) solid state relay with feedback of a general load fault alarm.
   Mode 2: provides logic heating to a Eurotherm TE10S (fitted with option PDS2) solid state relay with feedback of load current and two alarms: solid state relay failure and heater circuit failure.

2. **Range min and Range max:** Thermocouple and RTD sensor inputs will always display over the full operating range shown in Sensor input table. For these inputs, the values entered here are the low and high setpoint limits. For process inputs, the values are the display scaling. corresponding to the minimum and maximum input values.

SAFETY and EMC INFORMATION

Please read this section carefully before installing the controller

This controller is intended for industrial temperature and process control applications when it will meet the requirements of the European Directives on Safety and EMC. Use in other applications, or failure to observe the installation instructions of this handbook may impair the safety or EMC protection provided by the controller. It is the responsibility of the installer to ensure the safety and EMC 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.

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. This instrument satisfies the general requirements of an industrial environment as described by EN 50081-2 and EN 50082-2. For more information on product compliance refer to the Technical Construction File.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your nearest Eurotherm Controls agent for repair.

Caution: Charged capacitors

Before removing an instrument from its sleeve, disconnect the supply and wait at least two minutes to allow capacitors to discharge. Failure to observe this precaution will expose capacitors that may be charged with hazardous voltages. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the sleeve.

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, before handling the unplugged controller discharge yourself to ground.

Cleaning

Do not use water or water based products to clean labels or they will become illegible. Isopropyl alcohol may be used to clean labels. A mild soap solution may be used to clean other exterior surfaces of the product.

INSTALLATION SAFETY REQUIREMENTS

Safety Symbols

Various symbols are used on the instrument, they have the following meaning:

⚠ Caution, (refer to the accompanying documents)

⏚ Functional earth (ground) terminal

The functional earth connection is not required for safety purposes but to ground RFI filters.

Personnel

Installation must only be carried out by qualified personnel.

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.

Caution: Live sensors

The fixed digital inputs, non-isolated dc, logic and PDSIO outputs and the logic output of dual output modules, are all electrically connected to the main process variable input. If the temperature sensor is connected directly to an electrical heating element then these non-isolated inputs and outputs will also be live. The controller is designed to operate under these conditions. However you must ensure that this will not damage other equipment connected to these inputs and outputs and that service personnel do not touch connections to these i/o while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor and non-isolated inputs and outputs must be mains rated.

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 other low level inputs and outputs. Only use copper conductors for connections (except thermocouple inputs) and ensure that the wiring of installations comply with all local wiring regulations. For example in the in the UK use the latest version of the IEE wiring regulations, (BS7671). In the USA use NEC Class 1 wiring methods.

Power 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.

Earth leakage current

Due to RFI Filtering there is an earth leakage current of less than 0.5mA. This may affect the design of an installation of multiple controllers protected by Residual Current Device, (RCD) or Ground Fault Detector, (GFD) type circuit breakers.

Overcurrent protection

To protect the internal PCB tracking within the controller against excess currents, the AC power supply to the controller and power outputs 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:

- line or neutral to any other connection;
- relay or triac output to logic, dc or sensor connections;
- any connection to ground.

The controller should not be wired to a three phase supply with an unearthed 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

Electrically conductive pollution must be excluded from the cabinet in which the controller is mounted. For example, carbon dust is a form of electrically conductive 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 at low temperatures, include a thermostatically controlled heater in the cabinet.

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;
- thermocouple wiring becoming short circuit;
- 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 the alarm relays within the controller will not give protection under all failure conditions.

Grounding of the temperature sensor shield

In some installations it is common practice to replace the temperature sensor while the controller is still powered up. Under these conditions, as additional protection against electric shock, we recommend that the shield of the temperature sensor is grounded. Do not rely on grounding through the framework of the machine.

INSTALLATION REQUIREMENTS FOR EMC

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

For general guidance refer to Eurotherm Controls EMC Installation Guide, HA025464.

When using relay or triac outputs it may be necessary to fit a filter suitable for suppressing the emissions. The filter requirements will depend on the type of load. For typical applications we recommend Schaffner FN321 or FN612.

If the unit is used in table top equipment which is plugged into a standard power socket, then it is likely that compliance to the commercial and light industrial emissions standard is required. In this case to meet the conducted emissions requirement, a suitable mains filter should be installed. We recommend Schaffner types FN321 and FN612.

Routing of wires

To minimise the pick-up of electrical noise, the wiring for low voltage dc and particularly the sensor input 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.

TECHNICAL SPECIFICATION

Main Process Value Input and Second DC Input

Low level range	±100mV
High level range	0 to 10Vdc or 0-20mA with external 2.49Ω current shunt. All configurable between limits
Sample Rate	9Hz (110mS)
Resolution	<2∝V for low level range, <0.2mV for high level range
Linearity	Better than 0.2°C
Calibration accuracy	The greater of 0.25% of reading or ± 1°C or ±1LSD
User calibration	Low and high offsets can be applied
Input filter	Off to 999.9 secs
Thermocouple types	Refer to the ordering code sensor input table
Cold junction compensation	>30 to 1 rejection of ambient temperature changes in automatic mode. Uses INSTANT ACCURACY™ cold junction sensing technology to eliminate warm up drift and to respond quickly to ambient temperature changes. External references 0, 45, and 50°C
RTD/PT100 input	3-wire, Pt100 DIN43750. Bulb current 0.3mA. Up to 22Ω in each lead without error
Potentiometer input	330 to 15Kohm
Analogue input functions	Process value, remote setpoint, setpoint trim, external power limit, feedforward input,, valve position feedback
Second process value input functions	Select min, select max, derived value, transfer to 2nd PV

Digital inputs

Isolated except for fixed digital inputs 1 & 2

Contact closure inputs	Open circuit voltage: 24 to 30 Vdc Short circuit current: 24 to 29mA Off state: < 100 ohms input resistance On state: > 28Kohm input resistance
Logic inputs (current sinking)	Off state: -3 to 5Vdc @ <-0.4mA On stare: 10.8 to 30Vdc @ 2.5mA
Digital input functions	Refer to the ordering code

Digital Outputs

Relay rating	Min: 12V, 100mAdc. Max:2A, 264Vac resistive
Single logic output	18Vdc, 20mA. This output is not isolated from the main process value input
Triple logic output	12Vdc, 8mA per channel (isolated)
Digital o/p functions	As per the ordering code
High current output	10Amp, 264Vac resistive
Triac rating	1A, 30 to 264Vac resistive (isolated)

Analogue outputs

Range	Scaleable between 0-20mA and 0-10Vdc (isolated)
Resolution	1 part in 10,000 for analogue retransmission
Analogue output functions	Refer to ordering code

Transmitter supply

Rating	20mA, 24Vdc

Control functions

Control modes	On/Off, PID, or motorised valve control, with or without feedback potentiometer
Cooling algorithms	Linear, water (non-linear), fan (min on time), oil
Tuning	One shot (automatic tune of PID and overshoot inhibition parameters) and continuous adaptive tuning
Number of PID sets	Two
Auto/manual control	Bumpless transfer or forced manual output available
Setpoint rate limit	Display units per second, minutes or hour

Alarms

Number of alarms	Four
Alarm types	Absolute high or low. Deviation band, deviation high, deviation low. Rate of change
Alarm modes	Latching or non-latching. Blocking. Energised or de-energised in alarm

Setpoint programming

Number of programs	Up to sixteen
Segments per program	16
Event outputs	Up to eight

Communications (all modules are isolated)

Profibus	High speed, RS485. Up to 1.5Mb/s
Modbus ®	RS232,2-wire,RS 485 and 4 wire RS485 modules
Baud rate	1200, 2400, 4800, 9600 and 19,200 baud

PDSIO

Slave input (isolated)	Remote setpoint input with holdback to master
Master output	Isolated from main PV. Retransmission of setpoint, process value or output

General

Display	Dual, 4 digit x 7 segment LED. Up to two decimal places
Supply	85 to 264Vac, 48 to 62 Hz, 10 W max OR 24Vdc or ac -15%, +20%. 10W max
Operating ambient	0 to 55°C and 5 to 90% RH non-condensing
Storage temperature	-10 to +70°C
Panel sealing	IP54
Dimensions	2408: 48mm wide x 96mm high x 150mm deep 2404: 96mm wide x 96mm high x 150mm deep
Weight	250g
EMC standards	EN50081-2 & EN 50082-2 generic standards for industrial environments
Safety standards	Meets EN61010, installation category II (voltage transients must not exceed 2.5kV), pollution degree 2
Atmospheres	Not suitable for use above 2000m or in explosive or corrosive atmospheres. Electrically conductive pollution must be excluded from the cabinet in which this controller is mounted

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Appendix E LOAD CURRENT MONITORING AND DIAGNOSTICS

Current flowing in a system of electrical heating elements (the 'Load') can be displayed on the controller by using a Eurotherm TE10 SSR fitted with intelligent current transformer, PDCTX, or an SSR or contactor with an external PDCTX.
Load current monitoring and diagnostics may be used with any time proportioned output, fitted in module position 1A, and uses the logic output wires which drive the SSR to return signals back to the controller These signals represent the RMS value of the load current during the ON period, or load related alarm conditions. It is not designed for analogue outputs i.e. phase angle control.
It is also designed for single phase operation only.
There are three modes of operation:-

1. Mode 1
Detects if there is a **break in the heater circuit**. This includes heater or SSR open circuit. A single **Load Failure** alarm message is displayed on the lower readout of the controller.

2. Mode 2
Provides the following:-

Display of true RMS load current On the lower readout of the controller	Displays the true RMS current in the ON state to the load.
Low current alarm Analogous to Partial Load Failure (PLF) supplied in some Eurotherm SSRs	Provides advanced warning of failure of one or more heaters in parallel
High current alarm Activated when the heater exceeds a set limit	Typically used where element bunching may occur
SSR short circuit	This will apply full power to the heaters which could result in an over temperature condition. This alarm provides early warning.
Heater failure	Indicates open circuit load conditions

3. Mode 5
Provides the same features as mode 2 with two additional alarms. This mode is for use with contactors or other devices which do not use the PDS logic output from the controller as the drive signal. For example, a time proportioning logic, relay or triac output to operate a contactor. Mode 5, therefore, requires an additional input to the controller to display the load conditions. It uses the LB digital input terminals for this, as shown in Figure E.2.

Current Transformer Open Circuit	Alarm is shown if the PDSIO connection to PDCTX or SSR become disconnected
Current Transformer Short Circuit	Alarm is shown if the PDSIO connection from PDCTX or SSR are short circuited

EXAMPLE WIRING DIAGRAM (FOR MODE 1 & 2 OPERATION)

Hardware Required

1. Eurotherm SSR type **TE10/PDS2** OR
2. Eurotherm intelligent current transformer type **PD/CTX + contactor or zero voltage switching SSR**

2408 or 2404 controller configured for PDSIO mode 2 option using logic output. This module must be fitted in module position 1. (order code **M2**).

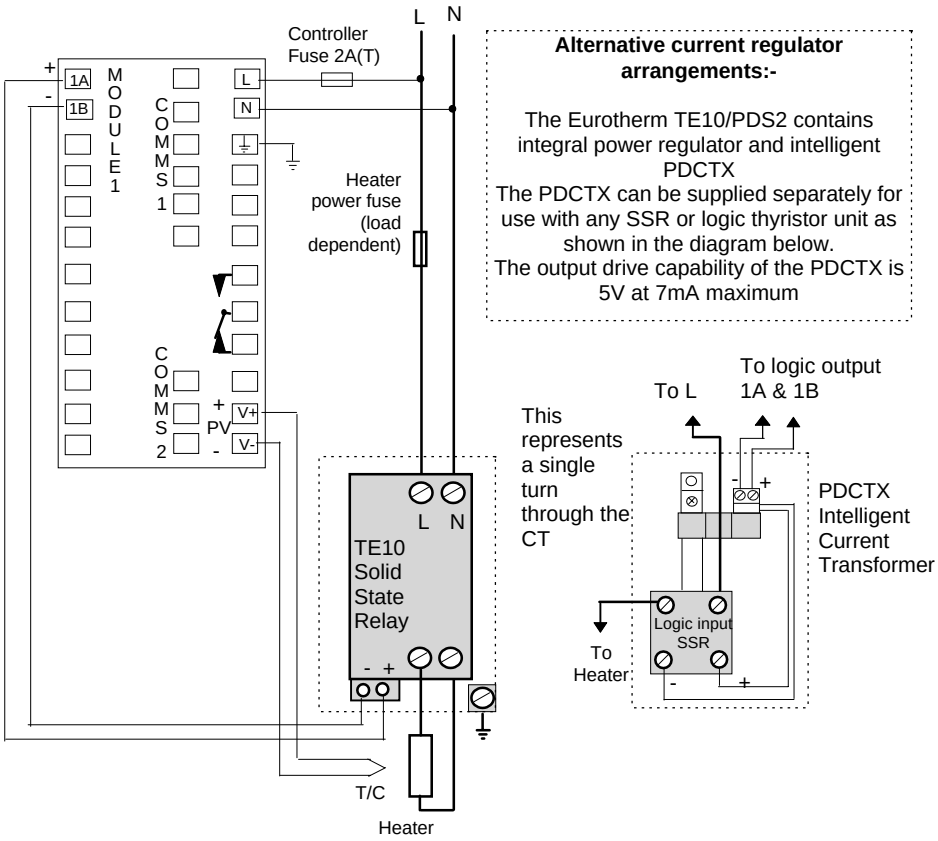


Figure E.1 Connections for Mode 1 & 2

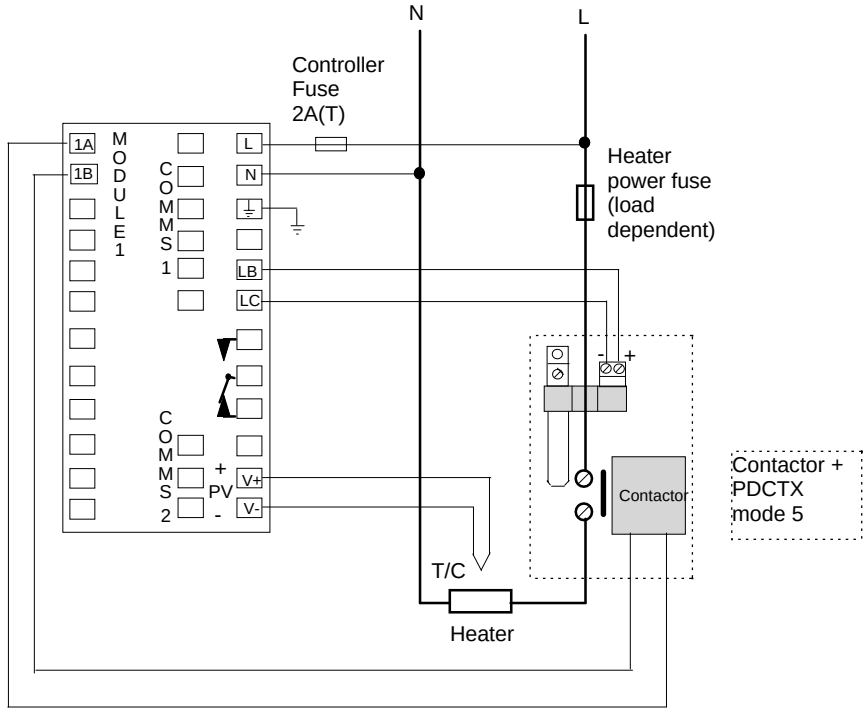
WARNING!

Take care that the controller is correctly wired for the mode of operation which is configured. Failure to do so may be hazardous in some situations.

EXAMPLE WIRING DIAGRAM (FOR MODE 5 OPERATION)

Hardware Required

1. Eurotherm intelligent current transformer type **PD/CTX + contactor**
2. 2408 or 2404 controller configured for PDSIO mode 5 option using logic, relay or triac output. This module must be fitted in module position 1. Digital input LB (order code **M5)** must be configured to accept PDCTX input as described in the configuration section of this appendix.



The controller will have the order code M5 in the Logic Input position.

Figure E.2 Example Wiring Connections For Contactor Operation (mode 5)

WARNING!

Take care that the controller is correctly wired for the mode of operation which is configured. Failure to do so may be hazardous in some situations.

To Read Load Current (modes 2 and 5 only)

Do This	This Is The Display You Should See		Additional Notes
From the 'I nFo' list Press ↻ until AmPS is shown in the upper display	AmPS 5	Current will be displayed in the lower readout. See also 'Display Modes' below.	It will revert to the HOME display after 45 seconds or 10 seconds if an alarm is present
	AmPS - - - -	This display will be shown if: I. The controller is unable to resolve the reading II. The controller is obtaining a reading III. The measurement has timed out i.e. current has not flowed for 15 seconds, in mode 2.	

To Display Load Current Continuously in the Lower Readout (modes 2 and 5 only)

Do This	This Is The Display You Should See	Additional Notes
From the 'HOME' display, Figure 1.4, Press ↻ until di SP is shown in the upper display Press ▲ or ▼ until AmPS is displayed in the lower display	di SP AmPS	Current will be displayed in the lower readout continuously when the controller reverts to the HOME display, see also 'Display Modes' below.

Display Modes

SSR RMS On State Current

This is the default state when high or low current alarms are configured. The load current displayed is the steady state true rms current measured during the ON period.

The minimum on times are:-

Mode 2	0.1second
Mode 5	3 seconds

Meter Mode

Meter mode applies to mode 5 only. If low current alarms are **not** configured the current displayed is a filtered instantaneous RMS value. This behaves like a damped analogue meter. It may be used in applications where the current sensor is not linked to control, for example, telemetry, indication.

How Heater Alarms Are Displayed

Do This	This Is The Display You Should See	Additional Notes
If an alarm is present it will flash a four character mnemonic in the lower display	HOME Display Actual Temperature → (PV) 	If more than one alarm is active, the display will alternate between the alarm messages and the default parameter in the lower display

The Alarm Messages are:-

Mnemonic	Meaning	Description
The following two messages are alarms which are produced as a result of failure within the process. In place of dashes the alarm number will appear i.e 1, 2, 3, or 4		
-LCr	Alarm number - Low Current	Used for partial load failure detection. To avoid nuisance tripping due to supply voltage variations set to a value at least 15% below the minimum normal operating current
-HCr	Alarm number - High Current	Used for load overcurrent protection. To avoid nuisance tripping due to supply voltage variations set to a value at least 15% above the maximum normal operating current. **Note: This alarm is not intended to provide instantaneous safety protection from short circuit fault conditions**
The following message is a diagnostic alarm which appears for mode 1 operation only.		
LdF	Load Fail	This includes failure of the heater circuit or the SSR
The following four messages are diagnostic alarms produced as a result of failure within the equipment or wiring connections. They appear for modes 2 and 5 operation only. They may be enabled using the diAG parameter in the AL Li St, see 'SHORT CIRCUIT SSR ALARM AND HEATER FAIL ALARM'		
HtrF	Heater Fail	No current is being drawn while the controller output demand signal is on
SSrF	SSR Fail	The load is continuously on while the controller output demand signal is off
CtOP	Current Transformer Open Circuit	Indicates that the PDS input is open circuit. Mode 5 only
CtSh	Current Transformer Short Circuit	Indicates that the PDS input is short circuit Mode 5 only

TO SET THE ALARM TRIP LEVELS

Do This	This Is The Display You Should See	Additional Notes
From the HOME display press [D] until the AL LiSt is displayed	AL LiSt	To select the Alarm List header
Press [G] button until the desired alarm number is displayed Press [▲] or [▼] to adjust the alarm trip level	1--- 123 1 2 3 or 4 indicates the alarm number; --- indicates the alarm type:- e.g. LCr or HCr	To select the diagnostic alarm parameter found under the Alarm List header The alarm trip level is set to 123

SHORT CIRCUIT SSR ALARM AND HEATER FAIL ALARM

These alarms exist as **Diagnostic Alarms** in the controller. To make the alarm active it is only necessary to turn on the diagnostic alarm feature in the Alarm List in the Operator Level

Do This	This Is The Display You Should See	Reason
From the HOME display press [D] button until the AL LiSt is displayed	AL LiSt	This opens the list which contains the diAG mnemonic
Press [G] until diAG is displayed Press [▲] or [▼] to select YES	diAG YES	This activates the diAG mnemonic to allow Diagnostic Alarms to be displayed in the lower readout of the HOME display

RELAY OUTPUTS

The fixed relay output connected to terminals AA to AC in a 1/8 or 1/4 DIN controller is normally used for alarm purposes. In addition, any plug in module can be used for alarms provided they are not already being used for another purpose , such as control. Any one or more alarms can be attached to an output, which will operate when an alarm occurs. Contacts are rated at 2A 264Vac for operating external beacons or audible devices.

TO CONFIGURE PDS LOAD CURRENT DIAGNOSTICS

Configuration of PDS load current diagnostics is in four parts:-

1. Configure the Logic Module for PDSIO Mode 1 or 2 operation. If the control device is a contactor or standard SSR, configure the LA digital input for mode 5 operation.
2. Configure the Low and High Current trip alarms.
3. Attach the alarms to operate an output relay.
4. Set up the Scaling Factor.

First enter Configuration Level. See Chapter 5

TO CONFIGURE THE LOGIC MODULE FOR PDSIO MODES 1 OR 2

Do This	This Is The Display You Should See	Additional Notes
Press [D] until the 1A ConF is displayed	1A ConF	This opens the configuration list associated with module position 1A
Press [G] to show Id	Id LoG	This shows the identity of the module The module identity is logic output
Press [G] to show Func Press [▲] or [▼] to show SSr 1 or SSr 2 as required.	Func SSr 1	This shows the function of module The module function is set to PDSIO mode 1
Press [G] to show VALL Press [▲] or [▼] to show 0.0	VALL 0.0	This is the lower PID demand level To set the minimum PID signal to 0%

Press ⟲ to show VAL.H) Press ▲ or ▼ to show 100.0	VAL.H 100.0	This is the upper PID demand level To set the maximum PID signal to 100%
Press ⟲ to show OUT.L Press ▲ or ▼ to show 0.0	OUT.L 0.0 **Warning!** If OUT.L is set to any figure other than 0 the minimum output power will be limited to this level. You must ensure that this does not present an unsafe condition for the process	This is the minimum output power To set the min output power to 0
Press ⟲ to show OUT.H Press ▲ or ▼ to show 100.0	OUT.H 100.0	This is the maximum output power To set the max output power to 100
Press ⟲ to show SEnS Press ▲ or ▼ to show nor	SEnS nor	This sets the output signal to normal for heating control

TO CONFIGURE LOGIC INPUT A FOR PDSIO (MODE 5 ONLY)

Do This	This Is The Display You Should See	Additional Notes
Press button until the Lb ConF is displayed	Lb ConF	
Press to show id	id LoGi	This identifies the LA input as logic and is read only
Press to show Func Press or to select AmPS	Func AmPS	To configure the input for the PDCTX.

The system is designed to operate in either mode 2 or mode 5 configuration only. Selecting both simultaneously will disable the output. However, mode 1 and mode 5 can be used together.

TO CONFIGURE LOW AND HIGH CURRENT TRIP ALARMS

Alarm 1 will be configured as Load Current Low (LCr)
Alarm 2 will be configured as Load Current High (HCr)

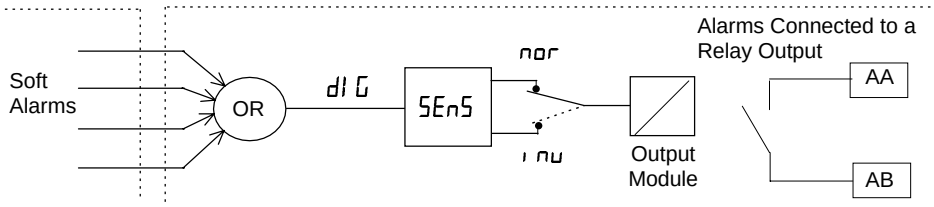
Do This	This Is The Display You Should See	Additional Notes
Press button until the AL ConF is displayed	AL ConF	This opens the configuration list which contains the Alarms
Press to show AL 1 (alarm 1) Press or to show LCr	AL 1 LCr After 0.5 sec the display will blink to show the alarm type has been accepted	To select alarm 1 To make alarm 1 = Low Current
Press until AL2 (alarm 2) appears Press or to show HCr	AL2 HCr After 0.5 sec the display will blink to show the alarm type has been accepted	To select alarm 2. To make alarm 2 = High Current

Note:- The above alarms are known as SOFT ALARMS because they are indication only.

TO ATTACH SOFT ALARMS TO A RELAY OUTPUT

Any one alarm indicated above may be attached to an output (normally a relay). Alternatively any combination of alarms may be attached to operate a relay using the procedure below:-

Do This	This Is The Display You Should See	Additional Notes
Press “PAGE” key as many times as necessary to AA ConF	AA ConF	To select the output which you want to operate when the alarm condition occurs. You may also choose 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C or 4A depending upon the controller and the number and type of modules fitted
Press until 1--- is displayed Press or to select YES or Repeat the above step for every alarm to be attached to the output	1--- YES 1---- denotes alarm 1 followed by three letters which denote the alarm type e.g. LCr	YES means that the selected output will activate when an alarm occurs in normal operation no means the output will not activate



THE SCALING FACTOR

The value of the current displayed on the controller is scaled using the scaling factor. This is found in the inSt ConF list. It is set, by default, to 100 and assumes a single turn through the current transformer. If two turns are made through the current transformer it will be necessary to adjust the scaling factor to 50 to obtain the same reading.
Under normal conditions you should not need to change the scaling factor.
If, however, you wish to change the sensitivity of the current reading, for example, to read very low currents you may need to change the number of turns through the PDCTX and/or adjust the scaling factor to compensate. See also note 1 below.

TO ADJUST THE SCALING FACTOR

Do This	This Is The Display You Should See	Additional Notes
Press button until inSt ConF is displayed	inSt ConF	
Press until LC.Hi is displayed Press or to change the scaling factor	LC.Hi 100	

Note 1:-
Minimum Resolvable Current
TE10 4A RMS. It is not possible to read currents lower than 4A when using a TE10.
PDCTX 4A RMS for a single turn through the PDCTX
Should you wish to read currents lower than 4A using a PDCTX it is necessary to increase the number of turns through the PDCTX and adjust the scaling factor to compensate.
For example: To read 1.0A wind 4 turns through the PDCTX and adjust the scaling factor to 25 as shown in the table below.

Scalar = 100/N Where N = Turns through PDCTX			
N	Scalar	N	Scalar
1	100	5	20
2	50	10	10
4	25		

Maximum Resolvable Current
TE10 Determined by the maximum range of the SSR
PDCTX 100A (or 100 ampere turns)

Finally Exit configuration level. See Chapter 5.