APPRECIATES YOUR BUSINESS

We thank you for purchasing a Thermcraft, Inc. heat treating furnace. Since our establishment in 1971, Thermcraft, Inc., has manufactured reliable, high quality, electric resistance and gas equipment. Our products are used in a variety of applications both domestically and around the world.

For over 40 years, Thermcraft, Inc. has manufactured furnaces and ovens to comply with predetermined custom and industrial specifications. This furnace has been completely checked for mechanical and electrical compliance prior to shipment**.**

We trust you have received your furnace in acceptable condition and that you will find it meets or exceeds your expectations and requirements.

Prior to installation and operation of your new Thermcraft, Inc. furnace, we strongly urge you to read this manual it its entirety and comply with all instructions herein.

If you have any questions, feel free to contact us.

Made in the U.S.A

Sincerely,

Thermcraft, Inc.
3950 Overdale Road
Winston-Salem, NC 27117-2037, U.S.A.
Telephone (336) 784-4800
Fax (336) 784-0634
Email: tci@thermcraftinc.com
Web: www.thermcraftinc.com

THERMCRAFT, INC.
INSTRUCTION MANUAL

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1.) FURNACE SPECIFICATIONS

Furnace Type: Compact Split Tube Furnace, eXPRESS-LINE Protégé

Model numbers covered by this manual:

XST-2-0-12-1V1-E28
XST-2-0-12-1V1-E29
XST-2-0-12-1V2-E28
XST-2-0-12-1V2-E29

Maximum Temperature: 1100°C

Heater Type: Vacuum formed with embedded electrical resistance wire

Incoming Power:

Models XST-2-0-12-1V1-E28 and XST-2-0-12-1V1-E29

Volts	120
Amps	15
Watts	1200
Phase	1
Hertz	60

Models XST-2-0-12-1V2-E28 and XST-2-0-12-1V2-E29

Volts	208-240
Amps	8 @ 220V
Watts	1200
Phase	1
Hertz	50/60

2.) INSPECTION AND DAMAGED INSTRUCTIONS

INSPECTION

Upon receipt of your new furnace, inspect for visible exterior damage. Note and describe any damage found on the freight bill and file a claim with the carrier.

Once unpacked, carefully inspect for concealed loss or damage on the unit itself, both the interior and exterior. If necessary, the carrier will arrange for official inspection to substantiate your claim.

Verify that all of the equipment shown on the packing slip is included with the unit. Carefully check all packing materials.

RETURN SHIPMENT

Save the shipping box/crate until you are sure all is well. If for any reason you must return the unit, first contact our Sales Department at 336-784-4800. Please have the unit's serial number and model number available when you call (located on the rating plate). Note: all returns MUST have a Return Authorization Number.

3.) ASSEMBLY

The furnace will arrive pre-assembled; however, some assembly may be required prior to start-up.

NOTE: These furnaces are heavy and care should be taken to use lifting devices which are sufficiently rated for these loads. Doors, handles and knobs are not adequate for lifting or stabilization. The unit should be completely restrained to prevent tipping during lifting and transport.

For larger furnaces some parts such as doors, door tracks, car bottom tracks, elevator lifts, blower motors, and conveyors may have been disassembled from the furnace to accommodate shipping. Before proceeding with installation, review all of drawings and diagrams included in this manual.

1. Refer to designs, making sure all furnace stands, control boxes, terminal boxes, doors, etc., are in place and secure. If not, locate the appropriate parts that are included in the shipment and follow the furnace design drawings in order to complete the assembly.
2. Locate the thermocouple hole and carefully pull out the alignment pin. Carefully slide thermocouple into the hole, do not force.

If any questions arise concerning assembly of the furnace, please contact Thermcraft, Inc. at 336-784-4800.

4.) CONTROL ENVIRONMENTAL CONDITIONS

Normal Operating Conditions

1. Ambient temperature: 0 – 50°C
2. Rate of change in temperature: 10°C/h or less
3. Ambient humidity: 20-90% RH (no condensation allowed)
4. Altitude: 2000m or less above sea level

Maximum Effects from Operating Conditions

1) Temperature effects
    - 1.1. Thermocouple, DC mV and DC V input: +/- 2u V/°C or +/-0.02% of F.S/°C, whichever is the larger
    - 1.2. Resistance temperature detector: +/-0.05°C/°C
    - 1.3. Analog output: +/-0.05% of F.S./°C
2) Effect from fluctuation of power supply voltage (within rated voltage range)
    - 2.1. Analog input: +/- 0.2u V/V or +/-0.002% of F.S/V, whichever is the larger
    - 2.2. Analog output: +/-0.05% of F.S./V

Transportation and Storage Conditions

1) Temperature: -25 to 70°C
2) Humidity: 5 to 95% RH (no condensation allowed)

5.) INSTALLATION AND POWER CONNECTION

After the above assembly procedures have been completed, the furnace is ready for connection to incoming power as follows:

1. Open the furnace and remove the protective packing covering the heating elements.
2. Consult an electrical professional and the NEC (National Electric Code) specifications to select wire size to adequately carry the line amperage shown in section 1.) Furnace Specifications. Connect electrical service to a fused power source disconnect. Such disconnect device shall be marked as a disconnect device for the furnace.
3. For overcurrent protection device selection, please refer to amperage shown on the furnace rating plate.

NOTE: Be sure to check all external strain relief fittings for tightness. See Torque Recommendation for Strain Relief Fittings chart below:

TORQUE RECOMMENDATIONS FOR STRAIN RELIEF FITTINGS
Torque in Inch Pounds - in lb (Newton Meters - Nm)

	METAL STRAIN RELIEF FITTINGS		PLASTIC STRAIN RELIEF FITTINGS	
	DOME NUTS	THREAD AND LOCK NUTS	DOME NUTS	THREAD AND LOCK NUTS
PG 7, M12x1.5	36.9 (4.17)	55.3 (6.25)	14.4 (1.62)	22.1 (2.50)
PG 9, PG 11, M16, PG 13.5, 3/8" NPT, 1/2" NPT, M16x1.5, M20x1.5	36.9 (4.17)	55.3 (6.25)	22.1 (2.50)	33.2 (3.75)
PG 16, 1/2"NPT-E	44.2 (5.00)	66.4 (7.50)	29.5 (3.33)	44.2 (5.00)
PG 21, PG 29, PG 36, PG 42, PG 48, 3/4"NPT, 1"NPT, 1-1/4"NPT, 1-1/2"NPT, M25x1.5, M32x1.5, M40x1.5, M50x1.5, M63x1.5	59.0 (6.67)	88.5 (10.00)	44.2 (5.00)	66.4 (7.50)

Note: The values shown above are for reference only.

Note: Nylon strain relief fittings installed in a threaded connection and exposed to elevated temperature should be retained with a sealant such as Locktite® to avoid a loose connection when temperature fluctuates.

6.) OPERATIONAL SAFETY

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Safe operation of your new furnace is mandatory. As manufacturer of your furnace, we at Thermcraft, Inc. have adhered to all known safety standards and strongly suggest you install your furnace in accordance with national electric and fire protection codes. Do not exceed the electrical and temperature rating printed on the furnace rating plate.

It is important to pay particular attention to those regulations that are applicable to the specific governing operations entities including, but not limited to legislated and accredited national and local industry standards and the type of facility in which the furnace will be employed, including zoning requirements, local building codes, and local electrical codes.

SYMBOLS USED ON THE EQUIPMENT

 Caution: risk of electric shock.

 Caution: hot surface.

 Caution: refer to accompanying documents.

The potential for electric shock is always present when electrically operated equipment is in use. The following suggestions are recommended for your protection:

1. Before beginning service / maintenance procedures on your furnace, the power source must be locked out and tagged out per Occupational Safety and Health Administration (OSHA) regulations.
2. Insure the furnace is properly grounded and electrically protected. Grounding lugs and ground wires have been installed prior to shipment. The ground wire will terminate within the external terminal box and is visible to the installer / operator. If unsure of the grounding status of the equipment, consult the NEC (National Electric Code) or a licensed professional.
3. If <u>electrically conductive material</u> is to be heat treated, the operator must be protected from becoming a conductor to the ground. To avoid electric shock observe the following operating practices:
   a. Wear insulated gloves specific to the task that guard against electric shock if the operator will be in contact with an electric current.
   b. When using any metallic instrument to introduce items into the furnace, <u>insure the handle is properly insulated and the instrument is adequately grounded.</u>
   c. Install rubber mats in front of and behind the equipment to protect the operator.

 **CAUTION:** If this equipment is used in a manner other than described in this manual, protection provided by the equipment may be compromised or impaired. To preclude hazard and minimize risk, follow all instructions and operate within the design limits noted on the rating plate.

Do not use components or materials not specifically designed for this equipment. Failure to comply with this precaution could result in damage to the equipment used or the furnace and may create an overheat situation. Also, do not use anything other than OEM exact replacement parts. Not using OEM replacement parts could cause faulty instrumentation readings, inoperative equipment, or a temperature overshoot.

Avoid combustible product which generate toxic or hazardous vapor or fumes. Work should be done in a properly vented environment.
Observe the following precautions:

* Never stand in front of an open hot furnace.
* Wear protective eyewear.
* Wear protective gloves.
* Use tongs to insert and remove furnace load.
* Do not allow the load to touch the furnace walls.

WARNING: Do not use combustible gases directly in this furnace. Process gasses must always be contained in a separate tube.

Modification of equipment for use other than that for which it is explicitly designed for could cause severe injury or death. Any customer after market retrofit violates the warranty.

Do not modify or disconnect any safety features provided. Disconnection of the units safety features could allow the unit to become overheated and start on fire, causing personal injury or death, product and property damage.

Periodically disconnect power from the equipment and allow it to cool completely. Once cool, inspect for loose or broken heaters and for worn wire coils on the inside of the heated chamber. Heaters may have to be replaced if damage is severe. Avoid contact with any exposed heater coils / elements. Do not touch elements with bare hands or oily gloves. Contact Thermcraft, Inc. if unsure of the safety of the heating elements in the conditions you have observed.

Only qualified electrical professionals should remove the upper and lower terminal covers of the terminal boxes. Keep all guards (guide-tabs, backstops, upper and lower terminal covers) provided with the equipment in place while the furnace is in operation. Observe all safety labels. If questions arise concerning the operation of your furnace, contact Thermcraft, Inc. at (336) 784-4800, fax at (336) 784-0634 or email at sales@thermcraftinc.com.

7.) FURNACE START UP PROCEDURE

Follow your company's lock-out/tag-out procedures before beginning any work on the heaters or heated chamber of your furnace.

The following procedures should be performed by a trained electrical professional due to potential hazard.

Check to ensure that the thermocouple is securely mounted and undamaged. Check the thermocouple wiring connections.

 **CAUTION!** Failure to check thermocouple wiring connection before initial start up could result in damage to the furnace.

DRYING OUT PROCEDURE

1. It is imperative that the furnace is allowed to vent the moisture out of the furnace. For split tube furnaces make sure that either the tube is slightly open or that the vestibules are open for venting.
2. Heat furnace up to 300°F. This will dry the moisture out of the refractory lining.
3. Maintain the furnace at 300°F for four to six hours or till all smoke/steam has subsided.
4. Ramp the furnace up to 600°F and hold this temperature until all steam/smoke has dissipated.
5. If the furnace is still steaming/smoking after 600F, repeat this step 4 at 900°F.
6. After all steam/smoke is gone, run furnace up to operating temperature.
7. If steam/smoke appears at any time during run up, do not increase temperature until steaming/smoking stops.

   Be careful when moving the furnace once the furnace has reached normal operating temperatures. The insulation becomes brittle and could possibly crack or break apart. With prolonged use, hairline cracks can develop in the insulation material. These minor cracks will not affect the furnace's performance.

SHUT DOWN INSTRUCTIONS

Open main circuit breaker or disconnect switch (Note: the incoming side of the main circuit breaker still has voltage, even after main device is open.)

8.) PREVENTIVE MAINTENANCE

CAUTION: Maintenance should only be performed by trained personnel.

WARNING: Prior to performing maintenance to the furnace or the controls, the main power must be disconnected.
Prior to maintaining this equipment, read the applicable MSDS at the back of the manual.

General Furnace Maintenance

1. Inspect and verify all electrical connections for tightness. Due to thermal expansion during the heat- up/cool-down cycles electrical connection may become loosened.
2. Inspect the heating elements. Do not allow build up of foreign material on the element. Oil should be cleaned off of any part of the furnace prior to heating. Use caution not to displace the heating elements as the wire may be brittle and break easily.
3. If furnace has a door, verify that the door safety switch is operating and cutting the power to the heaters once the door is opened.
4. If your furnace is equipped with a blower motor, or has moving parts, lubricate grease fittings as required.
5. Check all hardware fasteners to ensure that they are tight.
6. Inspect the tip of the thermocouple for excessive heat deterioration.

General Control Cabinet Maintenance

1. Verify that all electrical connections are tight.
2. If applicable, clean the cabinet cooling fan filter.
3. Check all cabinet to furnace interconnection wiring.
4. If applicable, check to ensure that all signal lamps light.
5. If applicable, check to ensure that all alarms sound.

9.) THERMOCOUPLE

A thermocouple is used to measure the voltage that is generated as the temperature increases. It provides an input signal for the control system that monitors the temperature of the heated chamber.

At high temperatures, the elements within the thermocouple may undergo some oxidation or corrosion causing the signals to be read incorrectly by the control system.

To monitor temperature, If possible, the tip of the thermocouple must be inside the heated chamber at least 1/8 deep. Also, the thermocouple tip must not be blocked or shielded by items being heat treated.

If the control system indicates that a thermocouple is no longer functioning, it is important to replace the malfunctioning thermocouple with the same type model thermocouple that was originally provided with the furnace. Replacement extension wires and connectors must also be compatible with the thermocouple and the controller. If your system has a Eurotherm controller a failed thermocouple will be indicated by SBR on the display and for a Yokogawa controller it will indicate B.OUT. Refer to the replacement parts list to determine the type of thermocouple required.

For optimal performance the thermocouple should be replaced one a year. In some cases a more frequent replacement schedule may be required.

NOTE: Polarity of the thermocouple extension wires is the OPPOSITE of the polarity of typical electrical wiring. The red leg is always negative for thermocouples while the black leg is always positive.

10.) CERAMIC FIBER INSULATION SAFETY

Dear Valued Customer:

Please keep in mind that your Thermcraft, Inc. furnace is completely safe when used for its intended purpose and with the precautions listed herein. The following information is to make you aware of the potential health effects of the ceramic and insulation components incorporated into your furnace.

Thermcraft, Inc. manufactures a broad range of high temperature furnace systems. These systems incorporate various ceramic materials. Airborne particulates produced in the handling of these materials should be considered nuisance dust. Always wear a dust mask and safety glasses to avoid such irritation due to inhalation of, or eye contact with, this or any other ceramic dust.

Chronic Effect – there has been no increased incidence of respiratory disease in the Refractory Ceramic Fiber Coalition's studies examining occupationally exposed workers. In their animal testing, long-term laboratory exposure to doses hundreds of times higher than normal occupational exposures has produced fibrosis, lung cancer, and mesothelioma in rats or hamsters. The fibers used in those studies were specially sized to maximize rodent reparability. Please go to the Refractory Ceramic Fiber Coalition's website at www.rcfc.net for up-to-date information.

The recommended handling procedures for these ceramic materials are outlined on the next page (Section 9) as well as in the Fibercraft Material Safety Data Sheets (MSDS) at the end of this manual. Please make sure this information is available to all personnel who may be operating, handling or repairing this furnace.

As always, if you have any questions or concerns, please feel free to contact Thermcraft, Inc. at (336) 784-4800, fax at (336) 784-0634 or email at sales@thermcraftinc.com.

Recommended Safe Handling Procedures For Ceramic Fiber Products

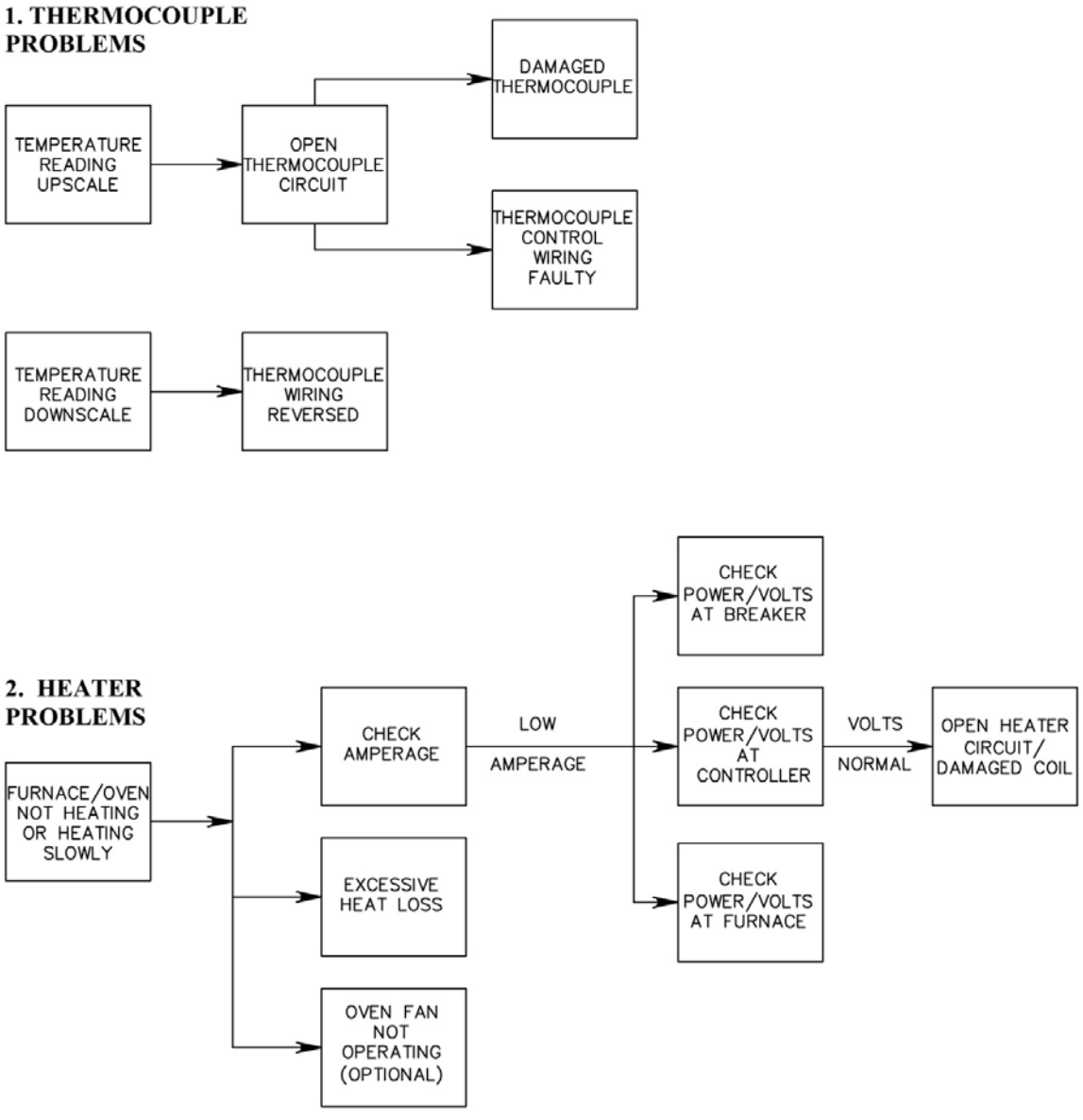
1. Minimize presence of airborne fiber at all times by avoiding applications of pressurized air from air canisters or pneumatic systems to any fibers that have already been heated.
2. Wear an appropriate NIOSH – or MSHA-approved high efficiency air purifying respirator mask when handling any ceramic fiber products.
3. Wear long-sleeved, loose-fitting clothing when handling ceramic fiber products. Use protective coveralls over clothing. Do not wear contact lenses and always wear safety glasses. Do not allow employees to take soiled clothing, or any clothing in which fibers have become embedded from the facility where the furnace is employed to his/her dwelling. Have employees store, maintain and wash work clothing on site separately from other clothing. Rinse washing machine thoroughly after washing clothing worn when handling ceramic fibers.
4. Wear eye protection (safety glasses or goggles) and protective gloves at all times.
5. Wash exposed skin areas gently with soap and **cold** water immediately after handling ceramic fiber product.
6. Particular care should be taken when working with “used” material which has been in service at elevated temperatures (greater than 1600° F). Such products may undergo partial conversion to Cristobalite, a form of crystalline silica that can cause respiratory disease.

11.) REPLACEMENT PARTS LIST

Description	Quantity Required
FH-1212393-L (Lower heating element, includes thermocouple)	1
FH-1212393-U (Upper heating element)	1

12.) FURNACE TROUBLE SHOOTING

TROUBLE SHOOTING FOR FURNACE / OVEN PROBLEMS



13) MSDS/SDS

MATERIAL SAFETY DATA SHEET

MSDS No. 1 **Effective Date: 03/19/2013**

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Trade Names: ***Fibercraft***

Product Group: **REFRACTORY CERAMIC FIBER PRODUCT**
Chemical Name: VITROUS ALUMINOSILICATE FIBER
Synonym(s): RCF, ceramic fiber, synthetic vitreous fiber (SVF), man-made vitreous fiber (MMVF), man-made mineral fiber (MMMF)
Manufacturer/Supplier:

Thermcraft, Inc.
3950 Overdale road
Winston-Salem, N.C. 27107
336-784-4800

Product Stewardship Information Hotline
1-800-322-2293 (Monday - Friday 8:00 a.m. - 4:30 p.m. EST)

CHEMTREC Assist: CHEMTREC will provide assistance for chemical emergencies.
Call **1-800-424-9300**

2. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	% BY WEIGHT
Refractories, Fibers, Aluminosilicate	142844-00-6	100

(See Section 8 "Exposure Controls / Personal Protection" for exposure guidelines)

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

WARNING!
POSSIBLE CANCER HAZARD BY INHALATION.
(See Section 11 for more information)

CHRONIC EFFECT

There has been no increased incidence of respiratory disease in studies examining occupationally exposed workers. In animal studies, long-term laboratory exposure to doses hundreds of times higher than normal occupational exposures has produced fibrosis, lung cancer, and mesothelioma in rats or hamsters. The fibers used in those studies were specially sized to maximize rodent respirability.

OTHER POTENTIAL EFFECTS

TARGET ORGANS:
Respiratory Tract (nose & throat), Eyes, Skin
RESPIRATORY TRACT (nose & throat) IRRITATION:
If inhaled in sufficient quantity, may cause temporary, mild mechanical irritation to respiratory tract.Symptoms may include scratchiness of the nose or throat, cough or chest discomfort.
EYE IRRITATION:

May cause temporary, mild mechanical irritation. Fibers may be abrasive; prolonged contact may cause damage to the outer surface of the eye.

SKIN IRRITATION:
May cause temporary, mild mechanical irritation. Exposure may also result in inflammation, rash or itching.
GASTROINTESTINAL IRRITATION:
Unlikely route of exposure.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:
Pre-existing medical conditions, including dermatitis, asthma or chronic lung disease may be aggravated by exposure; individuals who have a history of allergies may experience greater amounts of skin and respiratory irritation.

HAZARD CLASSIFICATION

Although studies, involving occupationally exposed workers, have not identified any increased incidence of respiratory disease, results from animal testing have been used as the basis for hazard classification. In each of the following cases, the conclusions are qualitative only and do not rest upon any quantitative analysis suggesting that the hazard actually may occur at current occupational exposure levels.

In October 2001, the **International Agency for Research on Cancer (IARC)** confirmed that Group 2b (possible human carcinogen) remains the appropriate IARC classification for RCF.

The Seventh Annual Report on Carcinogens (1994), prepared by the **National Toxicology Program (NTP),** classified respirable RCF as "reasonably anticipated" to be a carcinogen.

The **American Conference of Governmental Industrial Hygienists (ACGIH)** has classified RCF as “A2-Suspected Human Carcinogen.”

The **Commission of The European Communities (DG XI)** has classified RCF as a substance that should be regarded as if it is carcinogenic to man.

The **State of California**, pursuant to Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986, has listed "ceramic fibers (airborne fibers of respirable size)" as a chemical known to the State of California to cause cancer.

The **Canadian Environmental Protection Agency (CEPA)** has classified RCF as "probably carcinogenic" (Group 2).

The **Canadian Workplace Hazardous Materials Information System (WHMIS)** – RCF is classified as Class D2A – Materials Causing Other Toxic Effects

The **Hazardous Materials Identification System (HMIS)** –
Health 1* Flammability 0 Reactivity 0 Personal Protection Index: X (Employer Determined)
(* denotes potential for chronic effects)

4. FIRST AID MEASURES

FIRST AID PROCEDURES
RESPIRATORY TRACT (nose & throat) IRRITATION:
If respiratory tract irritation develops, move the person to a dust free location. Get medical attention if the irritation continues. See Section 8 for additional measures to reduce or eliminate exposure.

EYE IRRITATION:
If eyes become irritated, flush immediately with large amounts of lukewarm water for at least 15 minutes.
Eyelids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes. Get medical attention if irritation persists.
SKIN IRRITATION:
If skin becomes irritated, remove soiled clothing. Do not rub or scratch exposed skin. Wash area of contact thoroughly with soap and water. Using a skin cream or lotion after washing may be helpful.
GASTROINTESTINAL IRRITATION:
If gastrointestinal tract irritation develops, move the person to a dust free environment.
NOTES TO PHYSICIANS:
Skin and respiratory effects are the result of temporary, mild mechanical irritation; fiber exposure does not result in allergic manifestations.

5. FIRE FIGHTING MEASURES

NFPA Codes: Flammability: 0 Health: 1 Reactivity: 0 Special: 0

NFPA Unusual Hazards: None
Flammable Properties: None
Flash Point: None
Hazardous Decomposition Products: None
Unusual Fire and Explosion Hazard: None
Extinguishing Media: Use extinguishing media suitable for type of surrounding fire.

6. ACCIDENTAL RELEASE MEASURES

SPILL PROCEDURES
Minimize creating airborne dust. Dust suppressing cleaning methods such as wet sweeping or vacuuming should be used to clean the work area. If vacuuming, the vacuum must be equipped with a HEPA filter. Compressed air or dry sweeping should not be used for cleaning.

7. HANDLING AND STORAGE

STORAGE
Store in original container in a dry area. Keep container closed when not in use.
HANDLING
Handle ceramic fiber carefully. Limit use of power tools unless in conjunction with local exhaust. Use hand tools whenever possible. Frequently clean the work area with HEPA filtered vacuum or wet sweeping to minimize the accumulation of debris. Do not use compressed air for clean-up.
EMPTY CONTAINERS
Product packaging may contain residue. Do not reuse.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE GUIDELINES

COMPONENTS	OSHA PEL	MANUFACTURER REG
Refractories, Fibers, Aluminosilicate	None Established*	0.5 f/cc, 8-hr. TWA**

***** There is no specific regulatory standard for RCF in the U.S. OSHA's "Particulate Not Otherwise Regulated (PNOR)" standard [29 CFR 1910.1000, Subpart Z, Air Contaminants] applies generally; Total Dust 15 mg/m³;Respirable Fraction 5 mg/m³.

** The Refractory Ceramic Fibers Coalition (RCFC) has sponsored comprehensive toxicology and epidemiology studies to identify potential RCF-related health effects [see Section 11 for more details],
consulted experts familiar with fiber and particle science, conducted a thorough review of the RCF-related scientific literature, and further evaluated the data in a state-of-the-art quantitative risk assessment. Based on these efforts and in the absence of an OSHA PEL, RCFC has adopted a recommended exposure guideline, as measured under NIOSH Method 7400 B. The manufacturers' REG is intended to promote occupational health and safety through prudent exposure control and reduction and it reflects relative technical and economic feasibility as determined by extensive industrial hygiene monitoring efforts undertaken pursuant to an agreement with the U.S. Occupational Safety and Health Administration (OSHA).

OTHER OCCUPATIONAL EXPOSURE LEVELS (OEL)

RCF-related occupational exposure limits vary internationally. Regulatory OEL examples include: Canada –0.2 to 1.0 f/cc; Non-regulatory OEL examples include: ACGIH TLV 0.2 f/cc; RCFC REG 0.5 f/cc. The objectives and criteria underlying each of these OEL decisions also vary. The evaluation of occupational exposure limits and determining their relative applicability to the workplace is best performed, on a case-by case basis, by a qualified Industrial Hygienist.

ENVIRONMENTAL CONTROLS

Use environmental controls such as local exhaust ventilation, point of generation dust collection, down draft work stations, emission controlling tool designs, and materials handling equipment designed to minimize airborne fiber emissions.

PERSONAL PROTECTION EQUIPMENT

Respiratory Protection – RCF:

When engineering and/or administrative controls are insufficient to maintain workplace concentrations within the 0.5 f/cc REG, the use of appropriate respiratory protection, pursuant to the requirements of OSHA Standards 29 CFR 1910.134 and 29 CFR 1926.103, is recommended. The following information is provided as an example of appropriate respiratory protection for aluminosilicate fibers. The evaluation of workplace hazards and the identification of appropriate respiratory protection is best performed, on a case by case basis, by a qualified Industrial Hygienist.

MANUFACTURER'S RESPIRATORY PROTECTION RECOMMENDATIONS WHEN HANDLING RCF PRODUCTS

Respirable Airborne Fiber Concentration (levels are 8-hr. time-weighted averages)	**Respirator Recommendation**†
Not yet determined but expected to be below 5.0 f/cc based on operation	A respirator with a filter efficiency of at least 95%
"Reliably" less than 0.5 f/cc	Optional
0.5 f/cc to 5.0 f/cc	A single use respirator or half-face, air purifying respirator with a filter efficiency of at least 95%
5.0 f/cc to 25 f/cc	Full-face piece, air purifying respirator equipped with a NIOSH certified particulate filter cartridge with a filter efficiency of at least 95% or PAPR
Greater than 25 f/cc	PAPR with tight-fitting full face piece or a supplied air respirator in continuous flow mode
When individual workers request respiratory use Protection as a matter of personal comfort least or choice where exposures are "reliably" below .0.5 f/cc	A NIOSH certified respirator, such as a single particulate respirator with a filter efficiency of a 95%

†The 95% filter efficiency recommendation is based on NIOSH respirator selection logic sequence for exposure to particulates. Selection of filter efficiency (i.e. 95%, 99% or 99.9 7%) depends on how much filter leakage can be accepted. Higher filter efficiency means lower filter leakage. Other factors to consider are the NIOSH filter series N, R or P. (N) **N**ot resistant to oil, (R) **R**esistant to oil and (P) oil **P**roof. These recommendations are not designed to limit informed choices, provided that respiratory protection decisions comply with 29 CFR 1910.134.

Other Information
-Concentrations based upon an eight hour time weighted average (TWA) as determined by air samples collected and analyzed pursuant to NIOSH method 7400 (B) for airborne fibers.
-The manufacturer recommends the use of a full face piece air purifying respirator equipped with an appropriate particulate filter cartridge during furnace tear out events and the removal of used RCF to control exposures to airborne fiber and the potential presence of crystalline silica. If exposure levels are known, the respiratory protection charge provided above may be applied. -Potential exposure to other airborne contaminants should be evaluated by a qualified industrial hygienist for the selection of appropriate respiratory protection and air monitoring.

Skin Protection:
Wear gloves, head coverings and full body clothing as necessary to prevent skin irritation. Washable or disposable clothing may be used. If possible, do not take unwashed clothing home. If soiled work clothing must be taken home, employers should ensure employees are thoroughly trained on the best practices to minimize non-work dust exposure (e.g., vacuum clothes before leaving the work area, wash work clothing separately, rinse washer before washing other household clothes, etc.).
Eye Protection:
Wear safety glasses with side shields or other forms of eye protection in compliance with appropriate OSHA standards to prevent eye irritation. The use of contact lenses is not recommended, unless used in conjunction with appropriate eye protection. Do not touch eyes with soiled body parts or materials. If possible, have eye-washing facilities readily available where eye irritation can occur.

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR AND APPEARANCE:	White, odorless, fibrous material
CHEMICAL FAMILY:	Vitreous Aluminosilicate Fibers
BOILING POINT:	Not Applicable
WATER SOLUBILITY (%):	Not Soluble in Water
MELTING POINT:	1760˚ C (3200˚ F)
SPECIFIC GRAVITY:	2.50 – 2.75
VAPOR PRESSURE:	Not Applicable
pH:	Not Applicable
VAPOR DENSITY (Air = 1):	Not Applicable
% VOLATILE:	Not Applicable
MOLECULAR FORMULA:	Not Applicable

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY:	Stable under conditions of normal use.
INCOMPATIBILITY:	Soluble in hydrofluoric acid, phosphoric acid, and concentrated alkali.
CONDITIONS TO AVOID:	None.
HAZARDOUS DECOMPOSITION PRODUCTS:	None.
HAZARDOUS POLYMERIZATION:	Not Applicable.

11. TOXICOLOGICAL INFORMATION

HEALTH DATA SUMMARY

Epidemiological studies of RCF production workers have indicated no increased incidence of respiratory disease nor other significant health effects. In animal studies, long-term, high-dose inhalation exposure resulted in the development of respiratory disease in rats and hamsters.

EPIDEMIOLOGY

In order to determine possible human health effects following RCF exposure, the University of Cincinnati in the United States and the Institute of Occupational Medicine (IOM) in Europe have conducted medical surveillance studies on RCF workers in U.S. and European manufacturing facilities. The University of Cincinnati study has been in progress for over 20-years, collecting data from respiratory questionnaires, lung function tests, and chest X-rays, exposure monitoring, and worker mortality.

The results of this study of RCF plant workers exposed from 1953 to the present have shown (LeMasters *et al*, 2003): No excess mortality related to all deaths, all cancers, or lung cancer No statistically significant increase in interstitial findings (fibrosis), and
No mesotheliomas or increase in lung cancer The initial cross-sectional spirometry studies in the U.S. (LeMasters *et al.*1998) and Europe (Cowie *et al.*2001) revealed lung function decrements in the RCF-exposed cohort that were associated with heavier historical exposures. Subsequently, longitudinal studies have revealed no RCF exposure related decrements in lung function associated with current exposure levels.

Through 1996, pleural plaques seen on chest X-rays in 2.7% of the workers. Pleural plaques are considered a marker of exposure and not disease. The prevalence of pleural plaques has remained relatively constant over time, perhaps as a result of lower current exposure levels. Thus, this long term epidemiology study has demonstrated an absence of interstitial fibrosis, no increased mortality risk and no decrement in lung function associated with current exposures.

TOXICOLOGY

Early animal studies of RCF effects by intraperitoneal and intrapleural injections, as well as by inhalation, resulted in mostly negative results. In an effort to eliminate any questions posed by the results of these early studies, a definitive *Maximum Tolerated Dose Study* (MTD) by nose only, lifetime inhalation in rats and hamsters, was designed in the 1980s. The MTD study appeared to confirm that RCF was an animal carcinogen under certain test conditions, e.g., extremely high concentrations of approximately 200 f/cc inhaled directly into the lungs.
A later review of the MTD pathology indicated that the animals' lungs were likely "overloaded" because of large quantities of non-fibrous particles, and that this overload condition was likely responsible for the disease observed. In fact, evaluation of the aerosol samples used confirmed the presence of significant quantities of particulate matter.
In a subsequent multi-dose animal inhalation study at 25 f/cc, 75 f/cc, and 115 f/cc; a *no observed effect level* (NOEL) was found at 25 f/cc. This level is 50 times the RCFC recommended REG of 0.5 f/cc for
humans.

12. ECOLOGICAL INFORMATION

No ecological concerns have been identified.

13. DISPOSAL CONSIDERATIONS

WASTE MANAGEMENT

To prevent waste materials from becoming airborne during waste storage, transportation and disposal, a covered container or plastic bagging is recommended.

DISPOSAL

RCF, as manufactured, is not classified as a hazardous waste according to Federal regulations (40 CFR 261). Any processing, use, alteration or chemical additions to the product, as purchased, may alter the disposal requirements. Under Federal regulations, it is the waste generator's responsibility to properly characterize a waste material, to determine if it is a "hazardous" waste. Check local, regional, state or provincial regulations to identify all applicable disposal requirements.

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

Hazard Class: Not Regulated United Nations (UN) Number: Not Applicable
Labels: Not Applicable North America (NA) Number: Not Applicable
Placards: Not Applicable Bill of Lading: Product Name

INTERNATIONAL

Canadian TDG Hazard Class & PIN: Not regulated
Not classified as dangerous goods under ADR (road), RID (train) or IMDG (ship).

15. REGULATORY INFORMATION

UNITED STATES REGULATIONS

EPA: **Superfund Amendments and Reauthorization Act (SARA)** Title III – This product does not contain any substances reportable under Sections 302, 304, 313, (40 CFR 372). Sections 311 and 312 (40 CFR 370) apply (delayed hazard).
Toxic Substances Control Act (TSCA) - RCF has been assigned a CAS number; however, it is an "article" under TSCA and therefore exempt from listing on the TSCA inventory.
Comprehensive Environmental Response, Compensation and Liability Act (**CERCLA)** and the **Clean Air Act (CAA)** - RCF contains fibers with an average diameter greater than one micron and thus is not considered a hazardous air pollutant.

OSHA: Comply with **Hazard Communication Standards** 29 CFR 1910.1200 and 29 CFR 1926.59 and the **Respiratory Protection Standards** 29 CFR 1910.134 and 29 CFR 1926.103.
Ceramic fibers (airborne particles of respirable size)" is listed in **Proposition 65, The California**: **Safe Drinking Water and Toxic Enforcement Act of 1986** as a chemical known to the State of California to cause cancer.

Other States: RCF products are not known to be regulated by states other than California however, state and local OSHA and EPA regulations may apply to these products. If in doubt, contact your local regulatory agency.

INTERNATIONAL REGULATIONS

Canada: **Canadian Workplace Hazardous Materials Information System (WHMIS)** – RCF is classified as Class D2A – Materials Causing Other Toxic Effects
Canadian Environmental Protection Act (CEPA) - All substances in this product are listed, as required, on the Domestic Substance List (DSL)

European **European Directive 97/69/EC** classified RCF as a Category 2 carcinogen; that is it "should be regarded as if it is carcinogenic to man."

16. OTHER INFORMATION

RCF DEVITRIFICATION

As produced, all RCF fibers are vitreous (glassy) materials which do not contain crystalline silica. Continued exposure to elevated temperatures may cause these fibers to devitrify (become crystalline). The first crystalline formation (mullite) begins to occur at approximately 985° C (1805° F). Crystalline phase silica may begin to form at temperatures of approximately 1200° C (2192° F). When the glass RCF fibers devitrify, they form a mixed mineral crystalline silica containing dust. The crystalline silica is trapped in grain boundaries within a matrix predominately consisting of mullite. The occurrence and extent of crystalline phase formation is dependent on the duration and temperature of exposure, fiber chemistry and/or the presence of fluxing agents. The presence of crystalline phases can be confirmed only through laboratory analysis of the "hot face" fiber.

IARC's evaluation of crystalline silica states "Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1)" and additionally notes "carcinogenicity in humans was not detected in all industrial circumstances studied." IARC also studied mixed mineral crystalline silica containing dusts such as coal dusts (containing 5 – 15 % crystalline silica) and diatomaceous earth without seeing any evidence of disease. (IARC Monograph Vol. 68, 1997). NTP lists all polymorphs of crystalline silica amongst substances which may "reasonably be anticipated to be carcinogens".

IARC and NTP did not evaluate after-service RCF, which may contain various crystalline phases. However, an analysis of after-service RCF samples obtained pursuant to an exposure monitoring agreement with the USEPA, found that in the furnace conditions sampled, most did not contain detectable levels of crystalline silica. Other relevant RCF studies found that (1) simulated after-service RCF showed little, or no, activity where exposure was by inhalation or by intraperitoneal injection; and (2) after-service RCF was not cytotoxic to macrophage-like cells at concentrations up to 320 g/cm² - by comparison, pure quartz or cristobalite were significantly active at much lower levels (circa 20 g/cm²).

RCF AFTER-SERVICE REMOVAL

Respiratory protection should be provided in compliance with OSHA standards. During removal operations, a full face respirator is recommended to reduce inhalation exposure along with eye and respiratory tract irritation. A specific evaluation of workplace hazards and the identification of appropriate respiratory protection is best performed, on a case by case basis, by a qualified industrial hygiene professional.

PRODUCT STEWARDSHIP PROGRAM

The Refractory Ceramic Fibers Coalition (RCFC) and the U.S. Occupational Safety and Health Administration (OSHA) introduced a voluntary worker protection program entitled PSP HTW (High Temperature Wools), a comprehensive, multi-faceted risk management program designed to control and reduce workplace exposures to refractory ceramic fiber (RCF). For more information regarding PSP HTW, please refer to the RCFC web site: http://www.rcfc.net.

MSDS Prepared By: RISK MANAGEMENT DEPARTMENT

DISCLAIMER

The information presented herein is presented in good faith and believed to be accurate as of the effective date of this Material Safety Data Sheet. Employers may use this MSDS to supplement other information gathered by them in their efforts to assure the health and safety of their employees and the proper use of the product. This summary of the relevant data reflects professional judgment; employers should note that information perceived to be less relevant has not been included in this MSDS. Therefore, given the summary nature of this document, Thermcraft, Inc. does not extend any warranty (expressed or implied), assume any responsibility, or make any representation regarding the completeness of this information or its suitability for the purposes envisioned by the user.

DEFINITIONS

ACGIH: American Conference of Governmental Industrial Hygienists
ADR: Carriage of Dangerous Goods by Road (International Regulation)
CAA: Clean Air Act
CAS: Chemical Abstracts Service
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act
DSL: Domestic Substances List
EPA: Environmental Protection Agency
EU: European Union
f/cc: Fibers per cubic centimeter
HEPA: High Efficiency Particulate Air
HMIS: Hazardous Materials Identification System
HTW: High Temperature Wools
IARC: International Agency for Research on Cancer
IATA: International Air Transport Association
IMDG: International Maritime Dangerous Goods Code
mg/m³: Milligrams per cubic meter of air
mmpcf: Million particles per cubic meter
NFPA: National Fire Protection Association
NIOSH: National Institute for Occupational Safety and Health
OSHA: Occupational Safety and Health Administration
29 CFR 1910.134 & 1926.103: OSHA Respiratory Protection Standards
29 CFR 1910.1200 & 1926.59: OSHA Hazard Communication Standards
PEL: Permissible Exposure Limit (OSHA)
PIN: Product Identification Number
PNOC: Particulates Not Otherwise Classified
PNOR: Particulates Not Otherwise Regulated
PSP: Product Stewardship Program
RCFC: Refractory Ceramic Fibers Coalition
RCRA: Resource Conservation and Recovery Act
REG: Recommended Exposure Guideline (RCFC)
REL: Recommended Exposure Limit (NIOSH)
RID: Carriage of Dangerous Goods by Rail (International Regulations)
SARA: Superfund Amendments and Reauthorization Act
SARA Title III: Emergency Planning and Community Right to Know Act
SARA Section 302: Extremely Hazardous Substances
SARA Section 304: Emergency Release
SARA Section 311: MSDS/List of Chemicals and Hazardous Inventory
SARA Section 312: Emergency and Hazardous Inventory
SARA Section 313: Toxic Chemicals and Release Reporting
STEL: Short Term Exposure Limit`
SVF: Synthetic Vitreous Fiber
TDG: Transportation of Dangerous Goods
TLV: Threshold Limit Value (ACGIH)
TSCA: Toxic Substances Control Act
TWA: Time Weighted Average
WHMIS: Workplace Hazardous Materials Information System (Canada)

14.) CONTROL SYSTEM OPERATION

The temperature control system controls the amount of power to the resistive heating elements in order to achieve and maintain the desired temperature as measured through the control thermocouple.

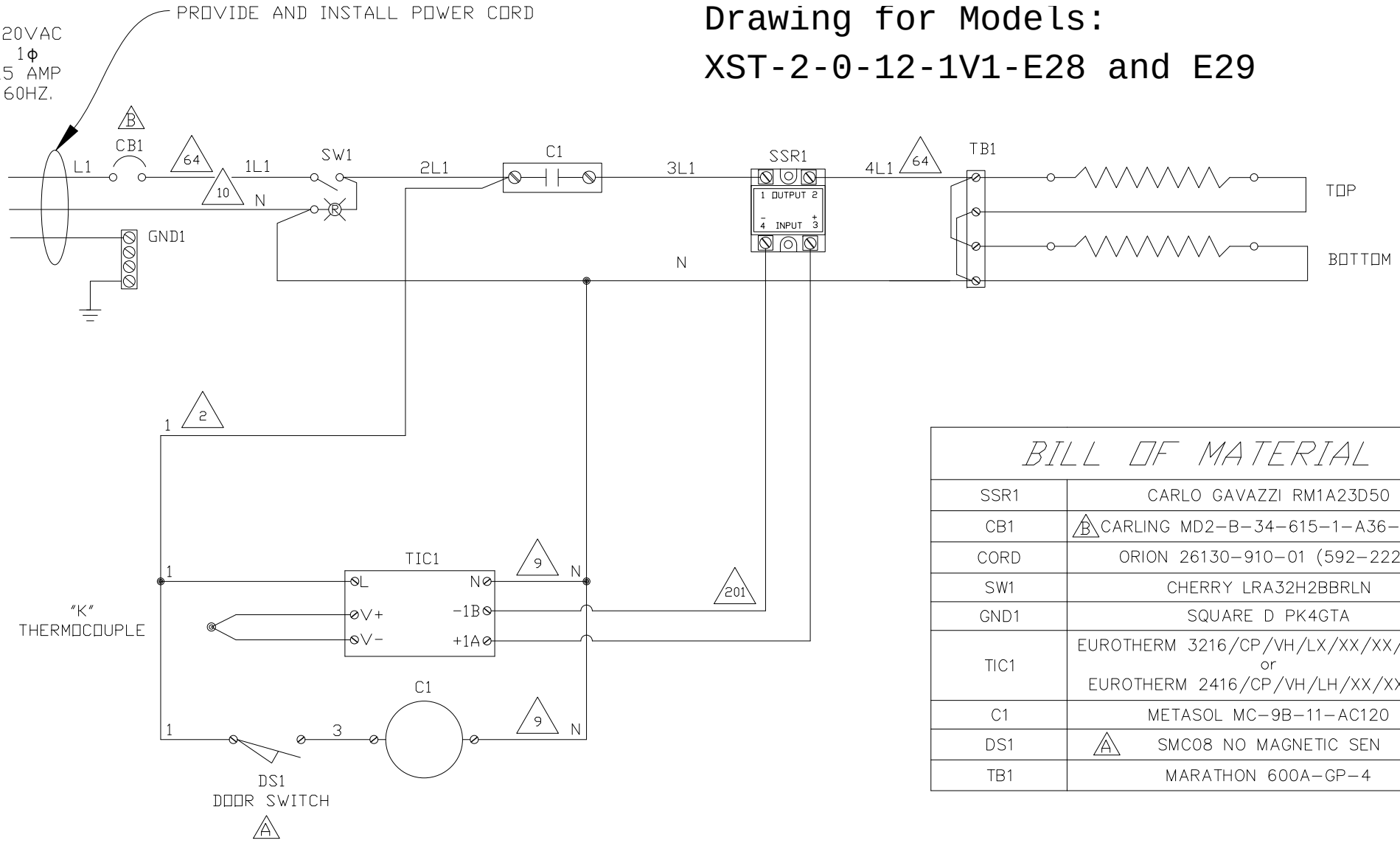
The temperature control system consists of the following:
1. Setpoint temperature controller
2. Solid state power controller or mechanical contactor
3. Matching control thermocouple

Heat/cool control systems provide heating control to the unit in addition to cooling control.

Additional optional features include:
1. Over-temperature controller
2. Current limit SCR power controller
3. Multiple zone independent control

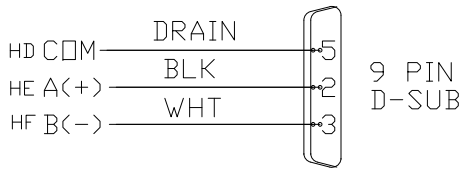
INSTALLATION
1. Position control cabinet in the desired location making sure it is permanently secured. NOTE: Do not position controller in such a manner as to be difficult to operate disconnect.
2. Study all instrument manuals before energizing the control system and furnace.
3. Review all electrical wiring diagrams.
4. Make all external wire connections specified in the electrical wiring diagrams including connection of the cables between the furnace and the control console. All conduit supplied shall be permanently secured / mounted during the installation process. CAUTION: Control system must be grounded according to local wiring requirements.
5. Connect the thermocouple to the control system.
6. Close main circuit breaker or disconnect switch.
7. Turn on main power.
8. Check red and green indicating lights on control cabinet and temperature controller for control power indication.
9. Set temperature controller and over temperature controller to desired temperature setting. (Check instrument control manuals for fine-tuning).
10. Turn on control cabinet power. The furnace will continue to heat until the controller setpoint is reached. The controller will start cycling to maintain selected setpoint.

Drawing for Models:
XST-2-0-12-1V1-E28 and E29



BILL OF MATERIAL	
SSR1	CARLO GAVAZZI RM1A23D50
CB1	B CARLING MD2-B-34-615-1-A36-B-C
CORD	ORION 26130-910-01 (592-2225)
SW1	CHERRY LRA32H2BBRLN
GND1	SQUARE D PK4GTA
TIC1	EUROTHERM 3216/CP/VH/LX/XX/XX/G/ENG or EUROTHERM 2416/CP/VH/LH/XX/XX/ENG
C1	METASOL MC-9B-11-AC120
DS1	A SMC08 NO MAGNETIC SEN
TB1	MARATHON 600A-GP-4

COMMUNICATIONS (if equipped)



THERMOCOUPLE WIRING

SIZE - 22GA, THERMOPLASTIC OUTER LAYER TO 200°F, COLOR BASED ON T/C TYPE.
SIZE - 22GA, FIBERGLASS HEAT SHIELDING OUTER LAYER TO 900°F, BASED ON T/C TYPE.

LET	REVISION	DFTMN	DATE
B	CHG BREAKER PART NUMBER	RK	02/16
A	CHG DOOR SWITCH TO MAG SENSOR	TB	01/14

APPROVAL		DATE
DRN.		05/10
CHK.		
APP'D		
APP'D		

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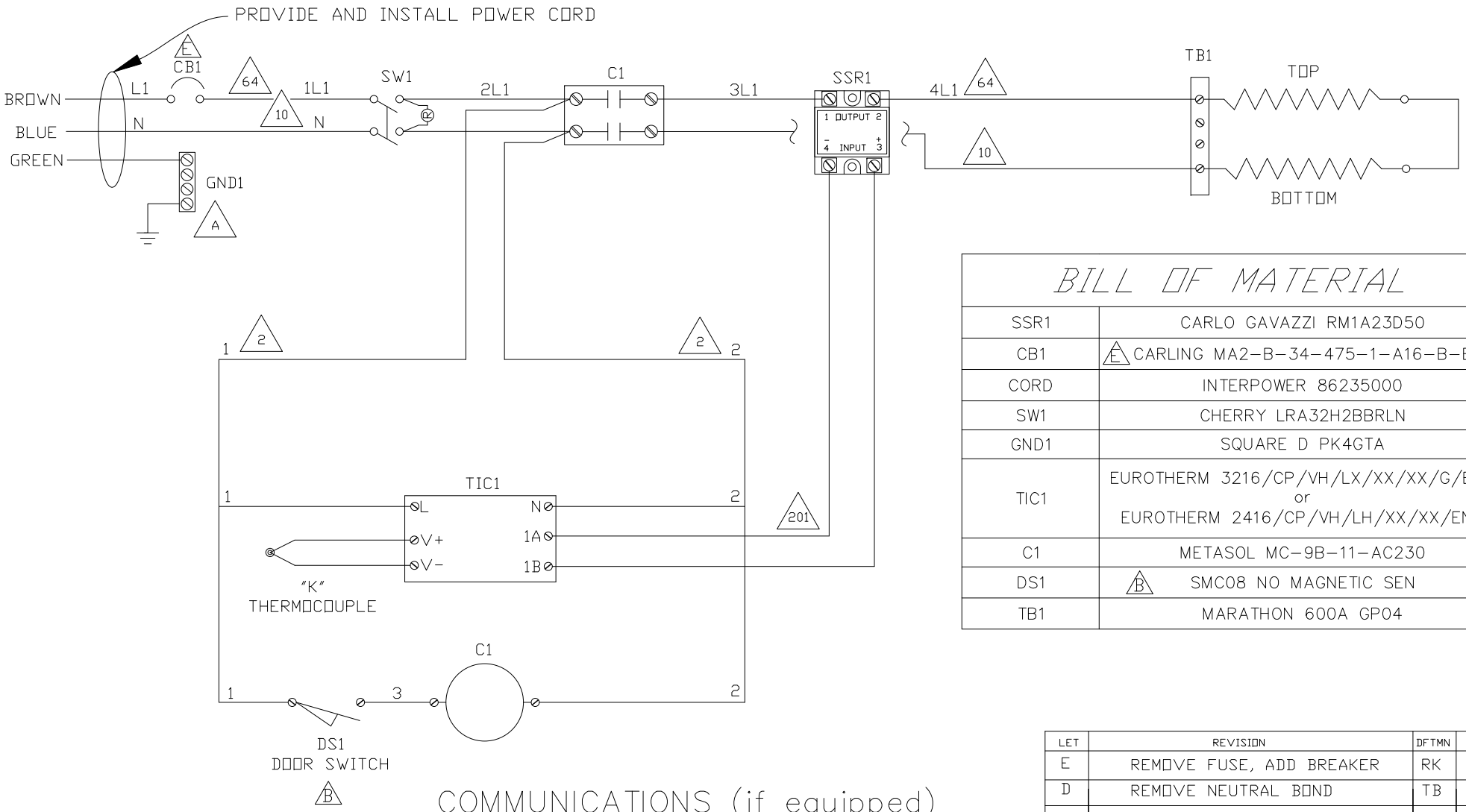
Winston-Salem, N.C. 27107

PROTEGE TUBE FURNACE
XST-2-0-12-1V1-E28/29

JOB	SCALE	DRAWING NO.	REV	SHEET OF
	N/A	EXX16-120	B	1-1

VOLTAGE RANGE FROM 208-240 VAC
* VOLTAGE VARIATIONS WILL ALTER WATTAGE AND CURRENT*
8 AMPS @ 220 1ϕ
50/60HZ.

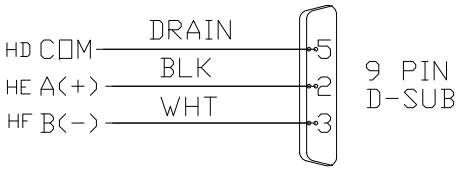
Drawing for Models:
XST-2-0-12-1V2-E28 and E29



BILL OF MATERIAL

SSR1	CARLO GAVAZZI RM1A23D50
CB1	E CARLING MA2-B-34-475-1-A16-B-E
CORD	INTERPOWER 86235000
SW1	CHERRY LRA32H2BBRLN
GND1	SQUARE D PK4GTA
TIC1	EUROTHERM 3216/CP/VH/LX/XX/XX/G/ENG or EUROTHERM 2416/CP/VH/LH/XX/XX/ENG
C1	METASOL MC-9B-11-AC230
DS1	B SMC08 NO MAGNETIC SEN
TB1	MARATHON 600A GP04

COMMUNICATIONS (if equipped)



THERMOCOUPLE WIRING

SIZE - 22GA, THERMOPLASTIC OUTER LAYER TO 200°F, COLOR BASED ON T/C TYPE.
SIZE - 22GA, FIBERGLASS HEAT SHIELDING OUTER LAYER TO 900°F, BASED ON T/C TYPE.

LET	REVISION	DFTMN	DATE
E	REMOVE FUSE, ADD BREAKER	RK	02/16
D	REMOVE NEUTRAL BOND	TB	06/14
C	REMOVE BREAKER, ADD FUSE	TB	03/14
B	CHG DOOR SWITCH TO MAG SENSOR	TB	01/14
A	BOND NEUTRAL	TB	12/13

APPROVAL		DATE
DRN.		05/10
CHK.		
APP'D		
APP'D		

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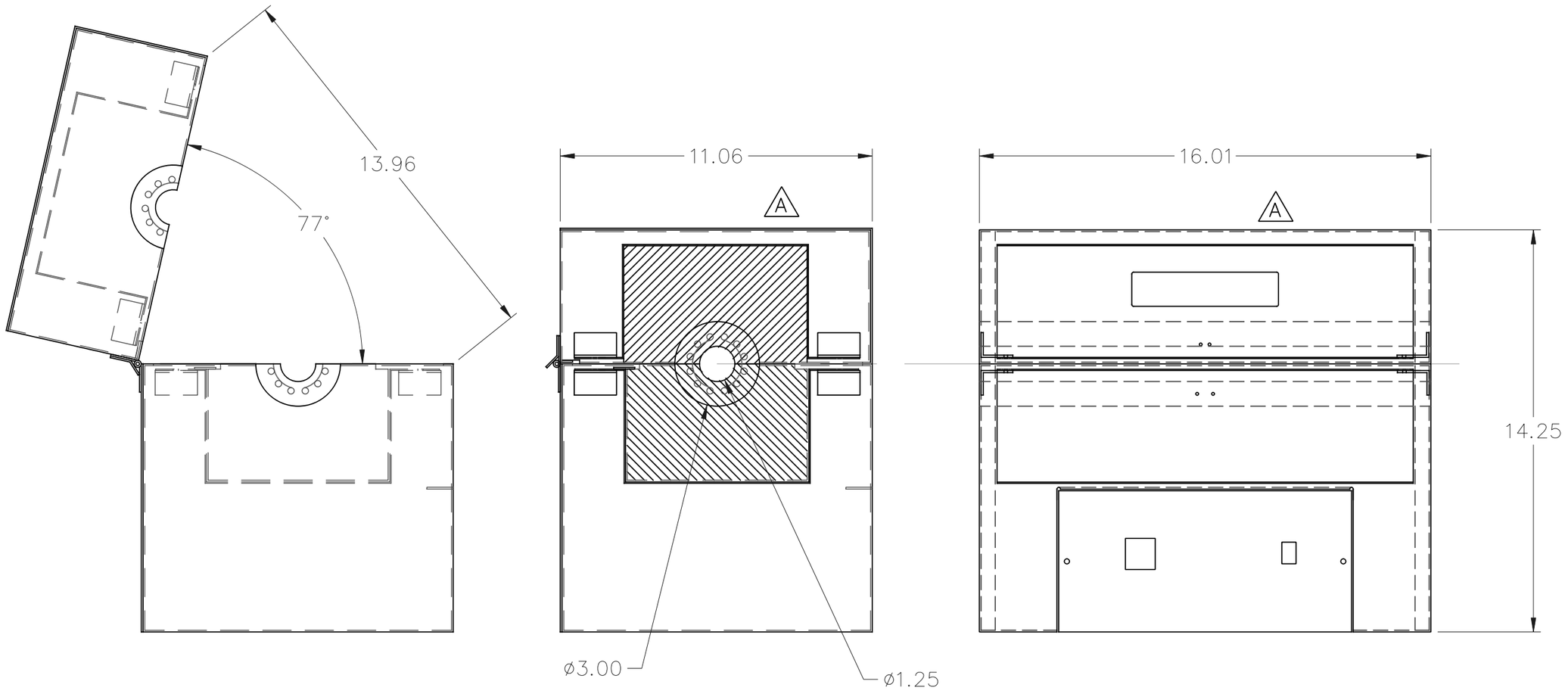
PROTEGE TUBE FURNACE
XST-2-0-12-1V2-E28/29

JOB	SCALE	DRAWING NO.	REV	SHEET	OF
	N/A	E-XX16-240	E	1	1

Drawing for 120V Model



PROTEGE
MODEL: XST-2-0-12-1V1 (B)
EXTERNAL DIMENSIONS (APPROX.): 14.25" H X 11" W X 16" L
HEATED CHAMBER DIMENSION: 2" ID X 12" L
MAX. TEMP.: 2012°F / 1100°C
POWER: 1200 WATTS, 120 VOLTS, 1 PH, 50/60 HZ, 10 AMPS
HEATER: (2) FH-1111427/1
SPLIT SHELL: CARBON STEEL
PAINT: BEIGE POWDER COAT
THERMOCOUPLE: (1) TYPE K
MOUNT: HORIZONTAL (BENCHTOP)

LET	REVISION	DFTMN	DATE
B	CHANGED NAME TO NEW STANDARD	JBL	7/28/15
A	REMOVE LOUVRE REPRESENTATIONS	MLJ	12/16/13

APPROVAL		DATE
DRN.	–	2/7/11
CHK.		
APP'D		
APP'D		
CORPORATION/COMPANY		

UNLESS NOTED, DIMENSIONAL TOLERANCES ARE AS SHOWN

PRODUCT TYPE	MACH. METAL PARTS	METAL FAB. ASSYS	CERAMIC FIBER PRODUCT	CAST CERAMIC PRODUCT
DECIMALS XX	+/-.01	+/-.06	+/-.09	+/-.12
DECIMALS XXX	+/-.005	+/-.062	+/-.060	+/-.093
ANGLES	+/- .05'	+/- 2'	+/- 3'	+/- 3'

REMOVE ALL BURRS BREAK ALL CORNERS

12753

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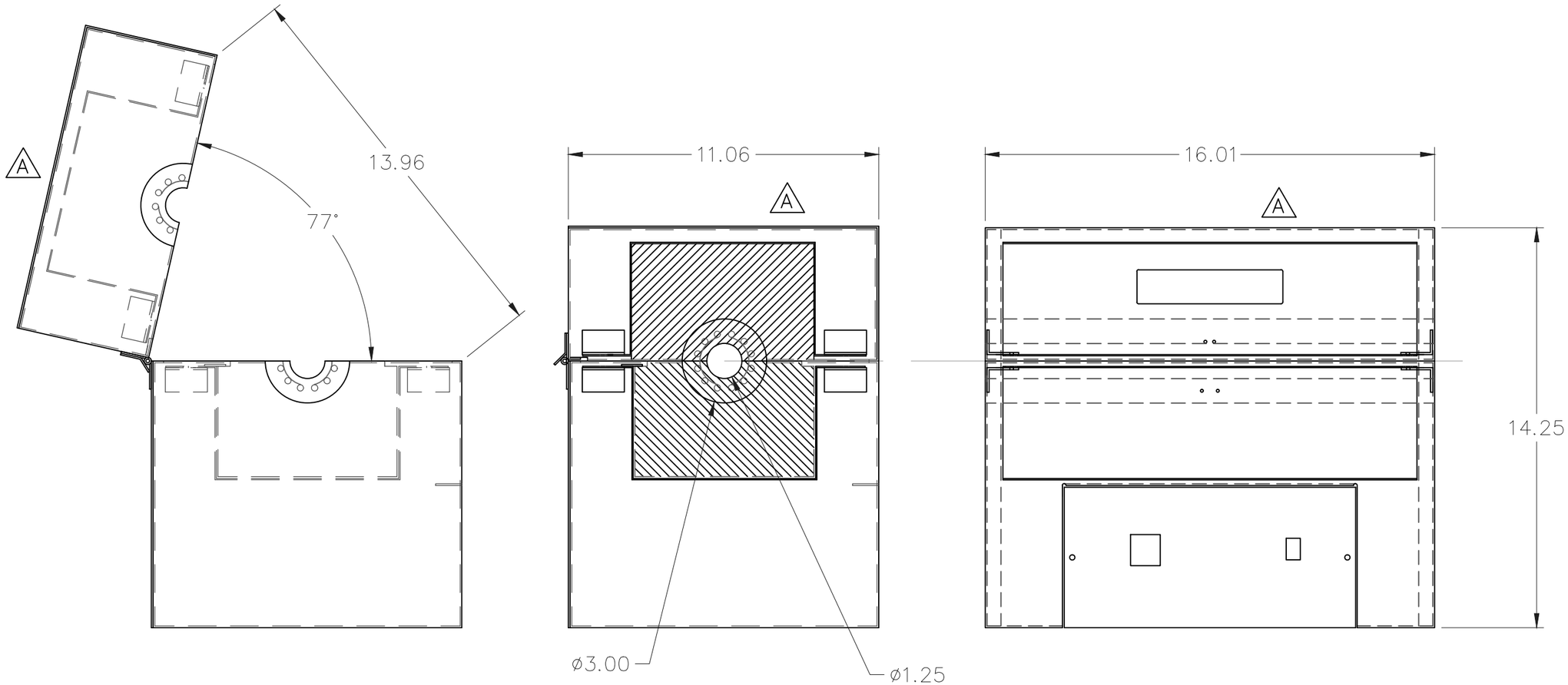
PROTEGE
XST-2-0-12-1V1

JOB	PLOT SCALE	DRAWING NO.	REV	SHEET OF
	NTS	PROTEGE_ASSM1	B	1-1

Drawing for 240V Model



eXPRESS–LINE SPLIT TUBE W/ CONTROLS – PROTEGE (B)
MODEL: XST–2–0–12–1V2
EXTERNAL DIMENSIONS (APPROX.): 14.25" H X 11" W X 16" L
HEATED CHAMBER DIMENSION: 2" ID X 12" L
MAX. TEMP.: 2012°F / 1100°C
POWER: 1200 WATTS, 240 VOLTS, 1 PH, 50/60 HZ, 5 AMPS
HEATER: (2) FH–1212393
SPLIT SHELL: CARBON STEEL
PAINT: BEIGE POWDER COAT
THERMOCOUPLE: (1) TYPE K
MOUNT: HORIZONTAL (BENCHTOP)

LET	REVISION	DFTMN	DATE
B	UPDATED PART NUMBER TO NEW STANDARD	JBL	7/28/15
A	REMOVE LOUVRE REPRESENTATIONS	MLJ	12/16/13

APPROVAL		DATE
DRN.	–	2/7/11
CHK.		
APP'D		
APP'D		
CORPORATION/COMPANY		
BJFWS		

UNLESS NOTED, DIMENSIONAL TOLERANCES ARE AS SHOWN

PRODUCT TYPE	MACH. METAL PARTS	METAL FAB. ASSYS	CERAMIC FIBER PRODUCT	CAST CERAMIC PRODUCT
DECIMALS XX	+/–.01	+/–.06	+/–.09	+/–.12
DECIMALS XXX	+/–.005	+/–.062	+/–.060	+/–.093
ANGLES	+/– .05°	+/– 2'	+/– 3'	+/– 3'

REMOVE ALL BURRS BREAK ALL CORNERS

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3950 Overdale Road
Winston–Salem, N.C. 27107

PROTEGE
XST–2–0–12–1V2

JOB	PLOT SCALE	DRAWING NO.	REV	SHEET OF
F14375	NTS	PROTEGE_ASSM2	B	1–1

invensys
Eurotherm

3216, 3208, 3204

User Manual

3200 Range Process Controller

HA028651/11
Aug 2012

3200 Series PID Temperature Controllers

User Manual Part Number HA028651 Issue 11.0 July-12

Includes 3216, 3208, 32h8 and 3204 Controllers.

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Issue Status of this Manual

Issue 5 of this Handbook applies to software versions 2.09 and above for PID controller and 2.29 and above for Valve Position controllers and includes:-

- Remote Setpoint Input Option RCL
- Programmer Cycles
- Triac output
- EIA422 4-wire Digital Communications, Option 6XX available in 3216 only

It also applies to firmware versions 2.11 and includes new parameters:-
Inverted status word, section 17.7.3.
Rate of change alarms, section 12.3.
Setpoint retransmission limits, section 10.1.
Input filter, section 8.1.

Note:-
The 3116 controller is no longer available. Details may be found in issue 4 of this manual.

Issue 6 includes parameter 'AT.R2G', section 11.4.

Issue 7 corrects range limits in section 8.1.1. Change to definition of LOC.T. in section 10.1. Correct description of enumerations for parameter IM section 15.6.

Issue 8 includes the following changes:

The description of the Programmer in sections 5.8 and 13.2.

A more detailed description of loop tuning.

Updates to Appendix A, Technical Specification.

Issue 9 includes the following changes:

Clarification of order codes for isolated and non- isolated outputs in appropriate sections

Add Tune Hi and Tune Lo limit parameters to the Control table in section 11.2.

Issue 10 applies to software versions 2.13 for PID controllers and 2.32 for Valve Position controllers and includes the following changes:

Warning added to section 15.1.3. ref number of writes to EEPROM.

Notes column in section 13.2.4. - changes to the resolution of Dwell units and Ramp Rate refers to section 10.1.

Sections 2.8 and 4.4.3. clarify remote setpoint operation.

Issue 11 corrects instruction 3) in section 11.4; adds Certificate of Conformity; adds a new section 15.3 EEPROM Write Cycles; update DIN3440 to EN14597TR in the Approvals section 18.

1. Installation and Basic Operation

1.1 What Instrument Do I Have?

Thank you for choosing this 3200 series Temperature Controller/Programmer.

The 3200 series provide precise temperature control of industrial processes and is available in three standard DIN sizes:-

- 1/16 DIN Model Number 3216
- 1/8 DIN Model Number 3208
- 1/8 DIN Horizontal Model Number 32h8
- 1/4 DIN Model Number 3204

A universal input accepts various thermocouples, RTDs or process inputs. Up to three (3216) or four (3208, 32h8 and 3204) outputs can be configured for control, alarm or re-transmission purposes. Digital communications and a current transformer input are available as options.

The controller may have been ordered to a hardware code only or pre-configured using an optional 'Quick Start' code.

The label fitted to the side of the sleeve shows the ordering code that the controller was supplied to.

The last two sets of five digits show the Quick Start Code.

If the Quick Start Code shows *****/***** the controller was supplied with default parameters and will need to be configured when it is first switched on.

This Manual takes you through all aspects of installation, wiring, configuration and use of the controller.

1.2 Unpacking Your Controller

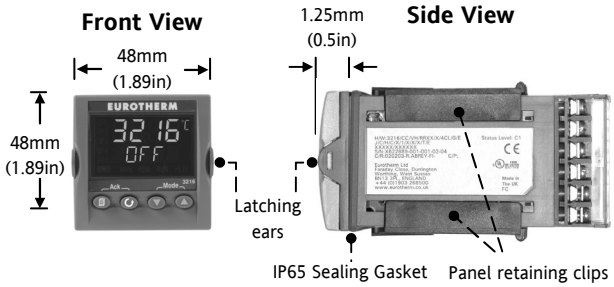
The controller is supplied with:-

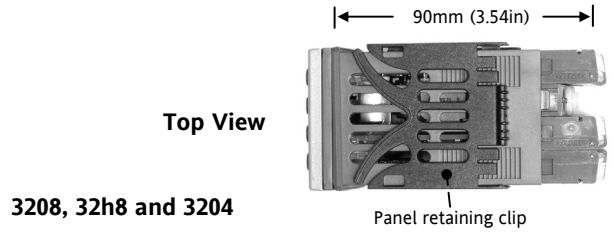
- Sleeve (with the controller fitted in the sleeve)
- Two panel retaining clips and IP65 sealing gasket mounted on the sleeve
- Component packet containing a snubber for each relay output (see section 2.12) and a 2.49Ω resistor for current inputs (see section 2.6)
- Installation sheet Part Number HA029714

1.3 Dimensions

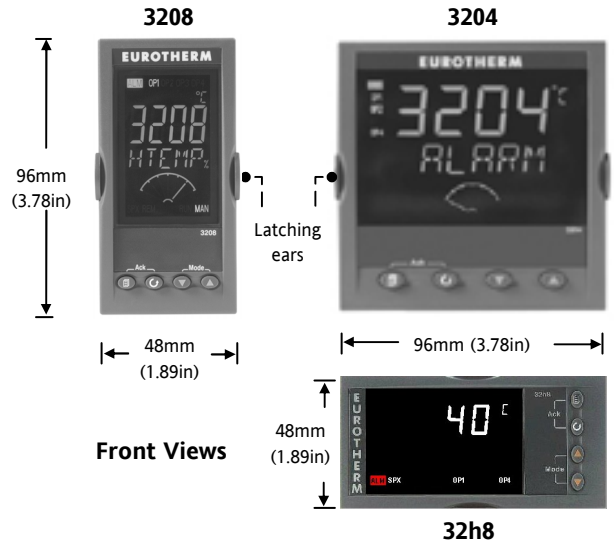
General views of the controllers are shown below together with overall dimensions.

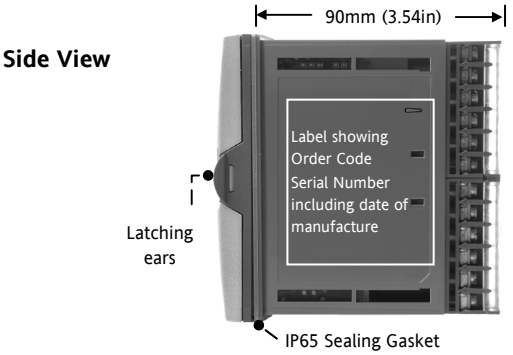
3216





3208, 32h8 and 3204





1.4 Step 1: Installation

This instrument is intended for permanent installation, for indoor use only, and enclosed in an electrical panel

Select a location which is subject to minimum vibrations the ambient temperature is within 0 and 55ºC (32 - 131ºF) and humidity 5 to 95% RH non condensing.

The instrument can be mounted on a panel up to 15mm thick.

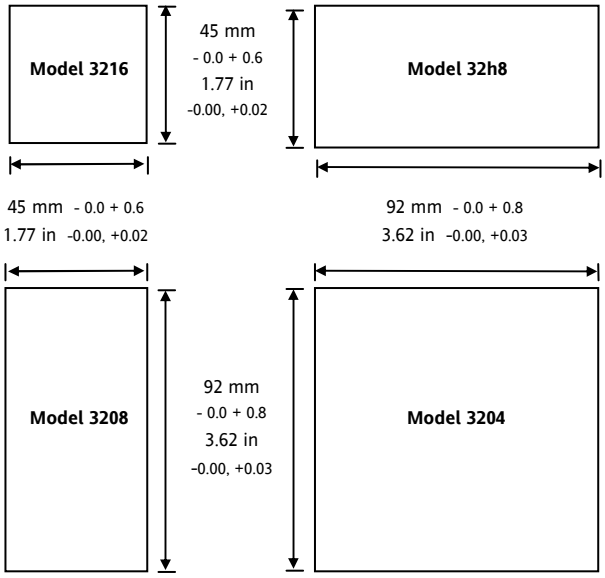
To ensure IP65 and NEMA 4 front protection, mount on a non-textured surface.

Please read the safety information in section 3 before proceeding. The EMC Booklet part number HA025464 gives further installation information.

1.4.1 Panel Mounting the Controller

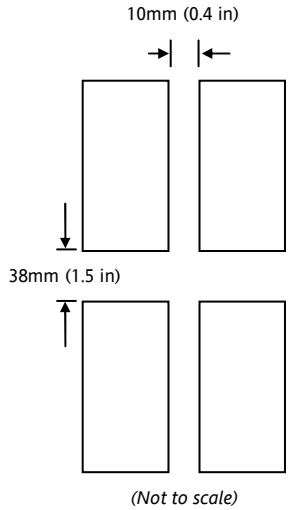
1. Prepare a cut-out in the mounting panel to the size shown. If a number of controllers are to be mounted in the same panel observe the minimum spacing shown.
2. Fit the IP65 sealing gasket behind the front bezel of the controller
3. Insert the controller through the cut-out
4. Spring the panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.
5. Peel off the protective cover from the display.

1.4.2 Panel Cut Out Sizes



1.4.3 Recommended minimum spacing of controllers

Applies to all models.



(Not to scale)

1.4.4 To Remove the Controller from its Sleeve

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

1.5 Order Code

1	2	3	4	5	6	7	8	9	10	11	12	13	14

1. Model No.	
1/16 DIN size	3216
1/8 DIN size vertical	3208
1/8 DIN horizontal	32h8
1/4 DIN size	3204

2. Function	
Controller	CC
Programmer	CP
valve controller	VC
Valve programmer	VP

3. Power Supply	
24Vac/dc	VL
100–240Vac	VH

4. Output 1 & 2 3216			
OP1	OP2		
L	X	X	X
L	R	X	X
R	R	X	X
L	L	X	X
L	D	X	X
D	D	X	X
D	R	X	X
R	C	X	X
L	C	X	X
D	C	X	X
Not available with low voltage supply option.			
L	T	X	X
T	T	X	X
L = Logic			
R = Relay			
T = Triac			
D = 0-20mA **non-isolated**			
C = 0-20mA **isolated**			

4. Outputs 1, 2 and 3 3208/H8/04			
OP1	OP2	OP3	
L	R	R	X
R	R	R	X
L	L	R	X
L	R	D	X
R	R	D	X
D	D	D	X
L	L	D	X
L	D	D	X
D	R	D	X
Not available with low voltage supply option.			
L	T	R	X
T	T	R	X
L	T	D	X
T	T	D	X
L = Logic			
R = Relay			
T = Triac			
D = 0-20mA **non-isolated** outputs 1 and 2			
D = 0-20mA **isolated** output 3			

5. AA Relay (OP4)	
Disabled	X
Relay (Form C)	R

6. Options	
Not fitted	XXX
EIA485 & Digital input A	4XL*
EIA232 & Digital input A	2XL*
EIA485, CT & Dig in A	4CL
EIA232, CT & Dig in A	2CL
Digital input A	XXL*
CT & Digital input A	XCL
Remote SP and Logic IP	RCL
4-wire EIA485 (EIA422) Comms (3216 only)	6XX
* 3216 only	

7. Fascia colour/type	
Green	G
Silver	S
Wash down fascia (not 32h8/04)	W

8/9 Product/Manual Language	
English	ENG
French	FRA
German	GER
Italian	ITA
Spanish	SPA

10. Extended Warranty	
Standard	XXXXX
Extended	WL005

11. Certificates	
XXXXX	None
Cert of conformity	CERT1
Factory calibration	CERT2

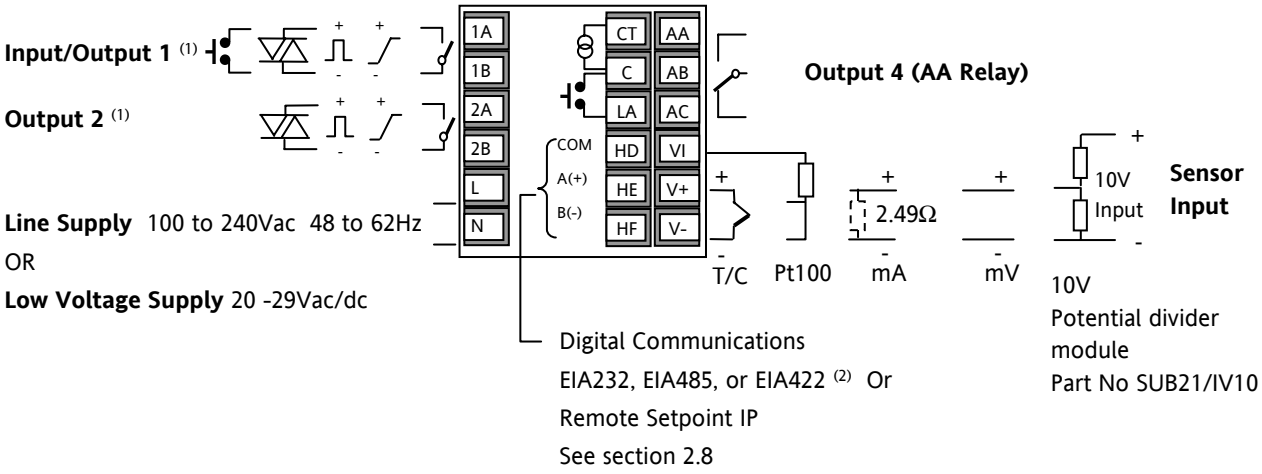
12. Custom Label	
None	XXXXX

13. Specials Number	
None	XXXXXX
250Ω ; 0-5Vdc OP	RES250
500Ω ; 0-10Vdc OP	RES500

2. Step 2: Wiring

2.1 Terminal Layout 3216 Controller

⚠ Ensure that you have the correct supply for your controller
Check order code of the instrument supplied



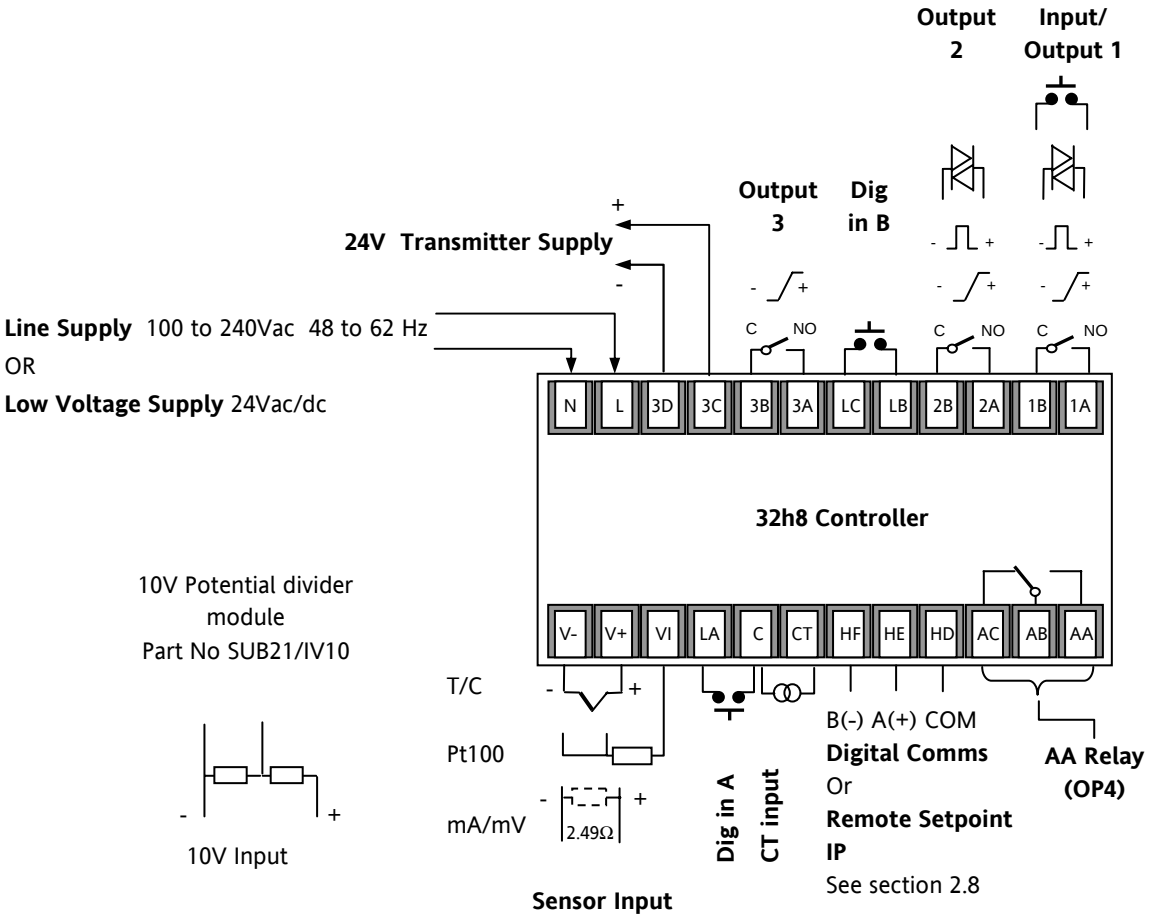
(1) If I/0 1 is fitted with a 0-20mA analogue output then this output is always non-isolated (order code D). Output 2 may be fitted with an isolated 0-20mA output, order code C, or a non-isolated 0-20mA output, order code D.

(2) Option 6XX - EIA232 digital communications uses terminals C to HF.
When this option is fitted, CT/LA inputs are not available see section 0

Key to symbols used in the wiring diagrams					
⎍	Logic (SSR drive) output	—/—	Relay output		Contact input
⎎	mA analogue output		Triac output		Current transformer input

2.2 Terminal Layout 32h8 Controllers

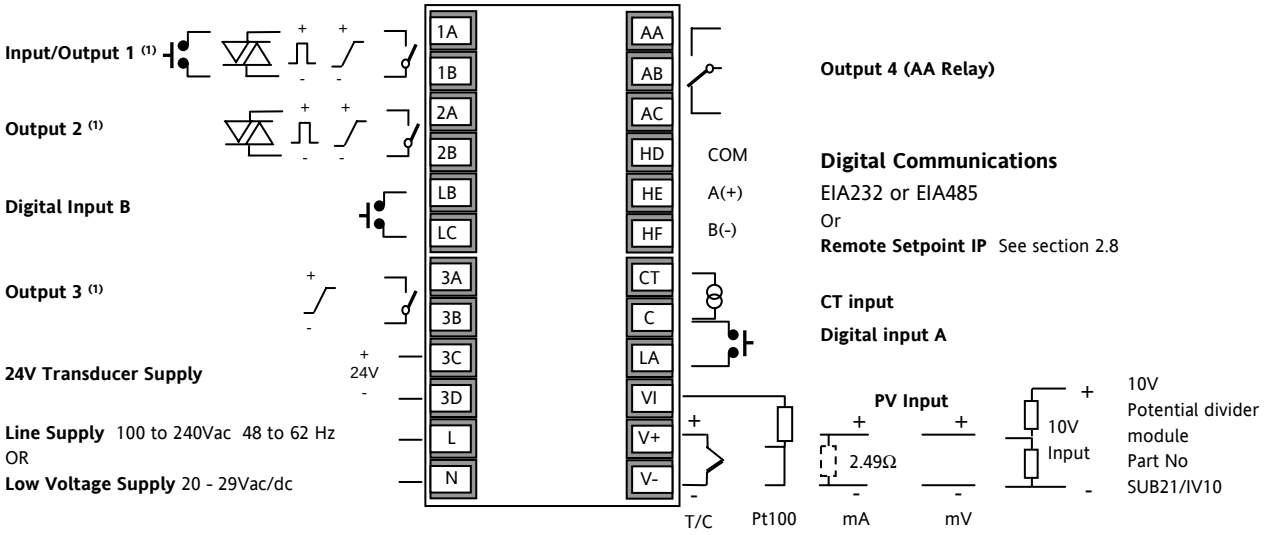
⚠ Ensure that you have the correct supply for your controller
Check order code of the instrument supplied



Key to symbols used in the wiring diagrams					
⎍	Logic (SSR drive) output		Relay output		Contact input
⎎	mA analogue output		Triac output		Current transformer input

2.3 Terminal Layout 3208 and 3204 Controllers

⚠ Ensure that you have the correct supply for your controller
Check order code of the instrument supplied



(1) If I/0 1 or OP2 are fitted with a 0-20mA analogue output then these outputs are always non-isolated. If OP 2 is fitted with a 0-20mA analogue output this output is isolated 240Vac. The order code D applies to isolated or non-isolated outputs in 3208, 32h8 and 3204 instruments.

Key to symbols used in the wiring diagrams					
⎍	Logic (SSR drive) output	⊸	Relay output	⊣	Contact input
⎎	mA analogue output	⊳	Triac output	⊖	Current transformer input

2.4 Wire Sizes

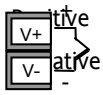
The screw terminals accept wire sizes from 0.5 to 1.5 mm (16 to 22AWG). Hinged covers prevent hands or metal making accidental contact with live wires. The rear terminal screws should be tightened to 0.4Nm (3.5lb in).

2.5 Precautions

- Do not run input wires together with power cables
- When shielded cable is used, it should be grounded at one point only
- Any external components (such as zener barriers, etc) connected between sensor and input terminals may cause errors in measurement due to excessive and/or un-balanced line resistance or possible leakage currents
- Not isolated from the logic outputs & digital inputs
- Pay attention to line resistance; a high line resistance may cause measurement errors

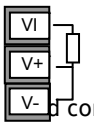
2.6 Sensor Input (Measuring Input)

2.6.1 Thermocouple Input



- Use the correct compensating cable preferably shielded

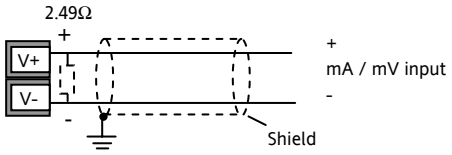
2.6.2 RTD Input



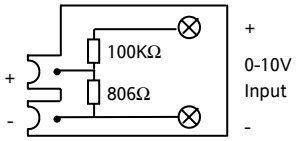
compensation

- The resistance of the three wires must be the same. The line resistance may cause errors if it is greater than 22Ω

2.6.3 Linear Input (mA or mV)



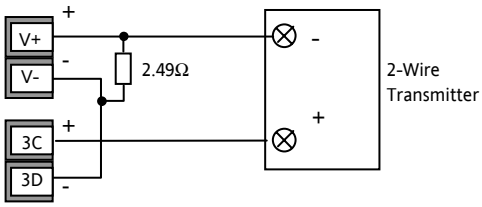
- If shielded cable is used it should be grounded in one place only as shown
- For a mA input connect the 2.49Ω burden resistor supplied between the V+ and V- terminals as shown
- For a 0-10Vdc input an external input adapter is required (not supplied). Part number: SUB21/IV10



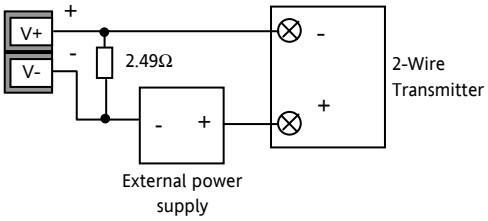
Sensor break alarm does not operate with this adaptor fitted.

2.6.4 Two-Wire Transmitter Inputs

Using internal 24V power supply (3208, 32h8 and 3204 only)



Using external power supply

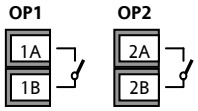


2.7 Input/Output 1 & Output 2

These outputs can be logic (SSR drive), or relay, or mA dc. In addition the logic output 1 can be used as a contact closure input.

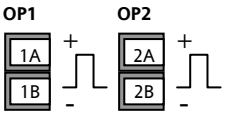
For input/output functions, see Quick Start Code in section 4.1.1.

2.7.1 Relay Output (Form A, normally open)



- Isolated output 240Vac CAT II
- Contact rating: 2A 264Vac resistive

2.7.2 Logic (SSR drive) Output



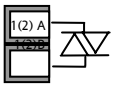
- Not isolated from the sensor input
- Output ON state: 12Vdc at 40mA max
- Output OFF state: <300mV, <100µA

- **The output switching rate must be set to prevent damage to the output device in use. See parameter 1.PLS or 2.PLS in section 5.3.**

2.7.3 DC Output

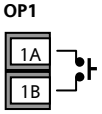
- Order code C (OP2 only) isolated 240Vac
- Order code D not isolated from the sensor input
- Software configurable: 0-20mA or 4-20mA.
- Max load resistance: 500Ω
- Calibration accuracy: ±(<1% of reading + <100µA)

2.7.4 Triac Output



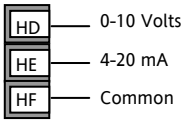
- Isolated output 240Vac CATII
- Rating: 0.75A rms, 30 to 264Vac resistive

2.7.5 Logic Contact Closure Input (I/O 1 only)



- Not isolated from the sensor input
- Switching: 12Vdc at 40mA max
- Contact open > 500Ω. Contact closed < 150Ω

2.8 Remote Setpoint Input

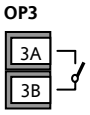


- There are two inputs; 4-20mA and 0-10 Volts which can be fitted in place of digital communications
- It is not necessary to fit an external burden resistor to the 4-20mA input

- If the 4-20mA remote setpoint input is connected and valid (>3.5mA; < 22mA) it will be used as the main setpoint. If it is not valid or not connected the controller will try to use the Volts input. Volts sensor break occurs at <-1; >+11V. The two inputs are not isolated from each other
- If neither remote input is valid the controller will fall back to the internal setpoint, SP1 or SP2 and flash the alarm beacon. The alarm can also be configured to activate a relay (see section 12.1.1) or read over digital communications.
- To calibrate the remote setpoint, if required, see section 16.3.5
- A local SP trim value is available in access level 3 (see section 10.1).

Note: If remote setpoint is configured ensure that the remote input is connected or the relevant rear terminals are linked. If the remote setpoint input is left open circuit the alarm beacon will light.

2.9 Output 3



Output 3 is available only in the models 3208, 32h8 and 3204. It will be either a relay or a mA output.

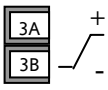
For output functions, see Quick Start Code in section 4.1.1.

Relay Output (Form A, normally open)

Isolated output 240Vac CAT II

- Contact rating: 2A 264Vac resistive

DC Output



- Isolated output 240Vac CAT II
- Software configurable: 0-20mA or 4-20mA
- Max load resistance: 500Ω
- Calibration accuracy: 0.5%, ±100µA

2.10 Summary of DC Outputs

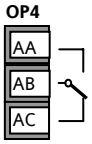
	3216	3208	32h8	3204	Order code
OP1	Non-isolated in all instruments				D
OP2	Non-isolated Isolated	Non-isolated	Non-isolated	Non-isolated	D C
OP3	Not available	Isolated	Isolated	Isolated	D

2.11 Output 4 (AA Relay)

Output 4 is a relay and optionally available in all models.

For output functions, see Quick Start Code in section 4.1.1.

Relay Output (Form C)



- Isolated output 240Vac CAT II
- Contact rating: 2A 264Vac resistive

2.12 General Note About Relays and Inductive Loads

High voltage transients may occur when switching inductive loads such as some contactors or solenoid valves. Through the internal contacts, these transients may introduce disturbances which could affect the performance of the instrument.

For this type of load it is recommended that a 'snubber' is connected across the normally open contact of the relay switching the load. The snubber recommended consists of a series connected resistor/capacitor (typically 15nF/100Ω). A snubber will also prolong the life of the relay contacts.

A snubber should also be connected across the output terminal of a triac output to prevent false triggering under line transient conditions.

WARNING

When the relay contact is open or it is connected to a high impedance load, the snubber passes a current (typically 0.6mA at 110Vac and 1.2mA at 240Vac). You must ensure that this current will not hold on low power electrical loads. If the load is of this type the snubber should not be connected.

2.13 Digital Inputs A & B

Digital input A is an optional input in all 3200 series controllers. Digital input B is always fitted in models 3208, 32h8 and 3204, but is not available in 3216.

- Not isolated from the current transformer input or the sensor input
- Switching: 12Vdc at 40mA max
- Contact open > 500Ω. Contact closed < 200Ω
- Input functions: Please refer to the list in the quick codes.

☺ If EIA232 digital communications is fitted (3216 only), Digital Input A is not available.

2.14 Current Transformer

The current transformer input is an optional input in all 3200 series controllers.

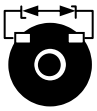
☺ If EIA232 digital communications is fitted (3216 only), Current Transformer Input is not available.

It can be connected to monitor the rms current in an electrical load and to provide load diagnostics. The following fault conditions can be detected: SSR (solid state relay) short circuit, heater open circuit and partial load failure. These faults are displayed as alarm messages on the controller front panel.

CT Input

Note: C terminal is common to both the CT input and Digital input A. They are, therefore, not isolated from each other or the PV input.

- CT input current: 0-50mA rms (sine wave, calibrated) 50/60Hz
- A burden resistor, value 10Ω, is fitted inside the controller.
- It is recommended that the current transformer is fitted with a voltage limiting device to prevent high voltage transients if the controller is unplugged. For example, two back to back zener diodes. The zener voltage should be between 3 and 10V, rated at 50mA.

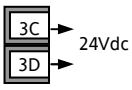


- CT input resolution: 0.1A for scale up to 10A, 1A for scale 11 to 100A
- CT input accuracy: ±4% of reading.

2.15 Transmitter Power Supply

The Transmitter Supply is not available in the Model 3216. It is fitted as standard in the Models 3208, 32h8 and 3204.

Transmitter Supply



- Isolated output 240Vac CAT II
- Output: 24Vdc, +/- 10%. 28mA max.
- inside the controller

2.16 Digital Communications

Optional.

Digital communications uses the Modbus protocol. The interface may be ordered as EIA232 or EIA485 (2-wire).

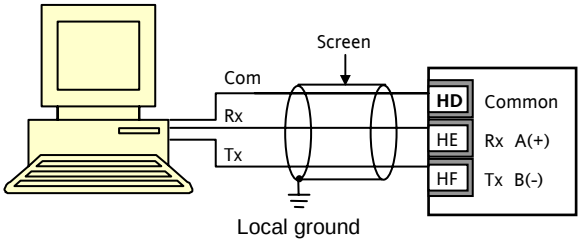
In 3216 controllers only, EIA422 (4-wire) is available as option 6XX.

☺ Digital communications is not available if Remote Setpoint is fitted

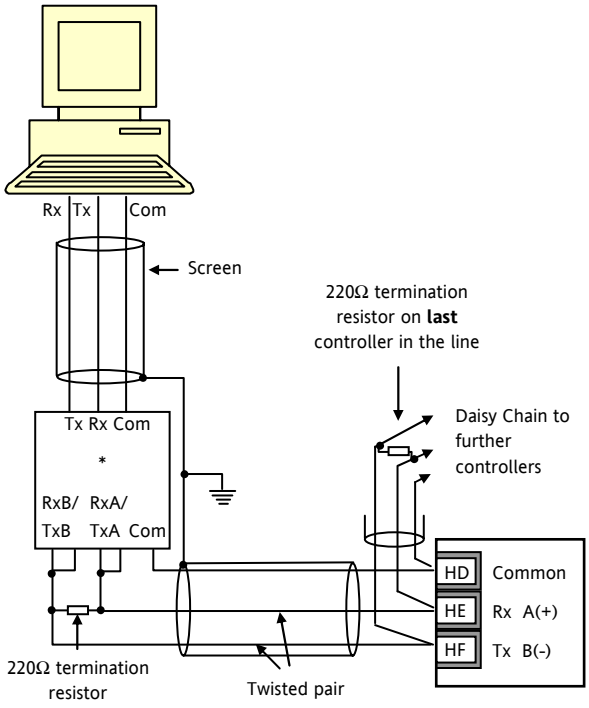
☺ Cable screen should be grounded at one point only to prevent earth loops.

- Isolated 240Vac CAT II.

EIA232 Connections

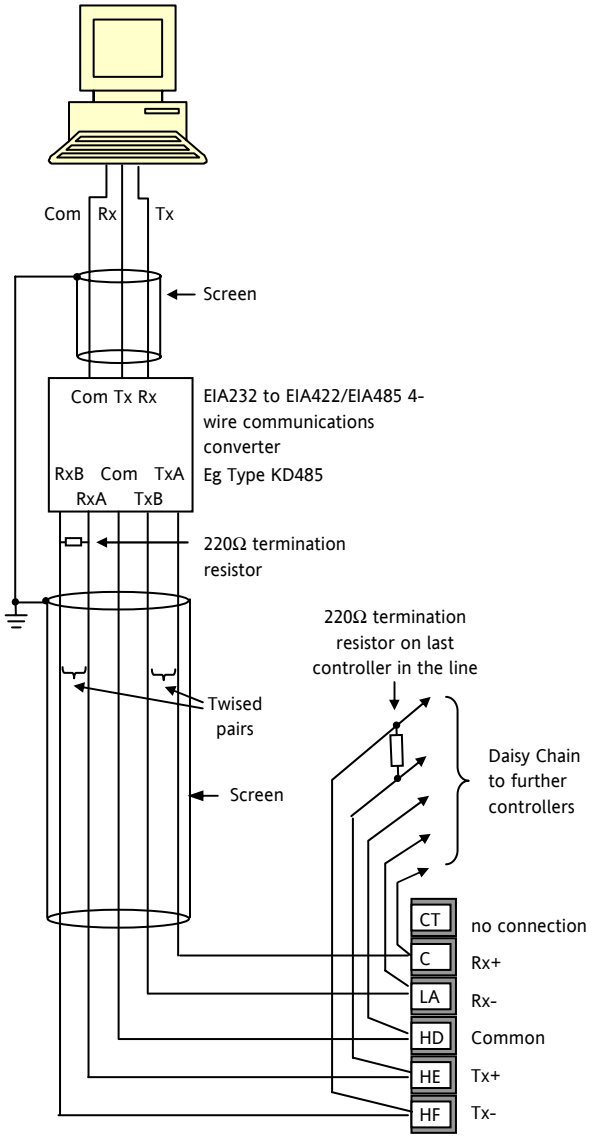


EIA485 Connections



* EIA232/EIA485 2-wire communications converter eg Type KD485

EIA422 Connections (3216 only)



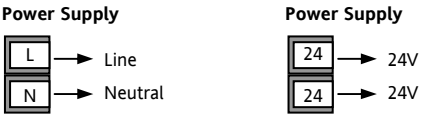
☺ If EIA422 serial communications is fitted, the CT and LA digital input option is not possible since EIA422 shares the same terminals as the CT and LA.

☺ The KD485 communications converter is recommended for:

- Interfacing 4-wire to 2-wire connections.
- To buffer an EIA422/485 network when more than 32 instruments on the same bus are required
- To bridge 2-wire EIA485 to 4-wire EIA422.

2.17 Controller Power Supply

1. Before connecting the instrument to the power line, make sure that the line voltage corresponds to the description on the identification label.
2. Use copper conductors only.
3. For 24V the polarity is not important
4. The power supply input is not fuse protected. This should be provided externally



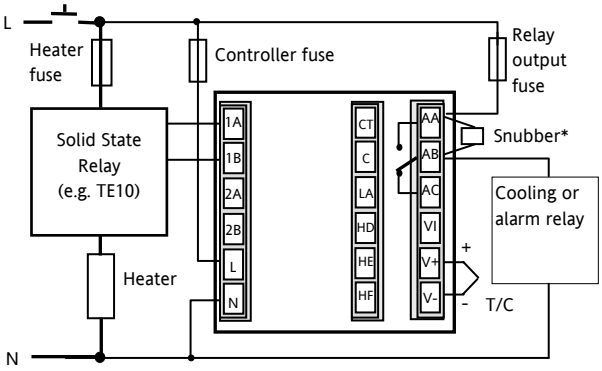
- High voltage supply: 100 to 240Vac, -15%, +10%, 48 to 62 Hz
- Low voltage supply: 24Vac/dc, -15%, +10%
- Recommended external fuse ratings are as follows:-

  For 24 V ac/dc, fuse type: T rated 2A 250V

  For 100-240Vac, fuse type: T rated 2A 250V.

2.18 Example Heat/Cool Wiring Diagram

This example shows a heat/cool temperature controller where the heater control uses a SSR and the cooling control uses a relay.



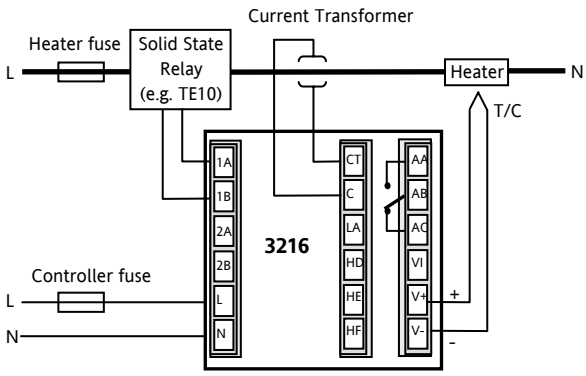
Safety requirements for permanently connected equipment state:

- A switch or circuit breaker shall be included in the building installation
- It shall be in close proximity to the equipment and within easy reach of the operator
- It shall be marked as the disconnecting device for the equipment

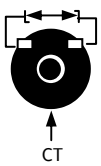
☺ A single switch or circuit breaker can drive more than one instrument

2.18.1 Example CT Wiring Diagram

This diagram shows an example of wiring for a CT input.



Note: the burden resistor value 10Ω is mounted inside the controller. It is recommended that the current transformer is fitted with a voltage limiting device such as two back to back zener diodes between 3 and 10V and rated for 50mA.



3. Safety and EMC Information

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 safety or EMC. The installer must ensure the safety and EMC of any particular installation.

Safety

This controller complies with the European Low Voltage Directive 73/23/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, by the application of a Technical Construction File. This instrument satisfies the general requirements of the industrial environment defined in EN 61326. For more information on product compliance refer to the Technical Construction File.

GENERAL

The information contained in this manual is subject to change without notice. While every effort has been made to ensure the accuracy of the information, your supplier shall not be held liable for errors contained herein.

Unpacking and storage

The packaging should contain an instrument mounted in its sleeve, two mounting brackets for panel installation and an Installation & Operating guide. Certain ranges are supplied with an input adapter.

If on receipt, the packaging or the instrument are damaged, do not install the product but contact your supplier. If the instrument is to be stored before use, protect from humidity and dust in an ambient temperature range of -30ºC to +75ºC.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your supplier 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. It may be convenient to partially withdraw the instrument from the sleeve, then pause before completing the removal. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the sleeve.

Failure to observe these precautions may cause damage to components of the instrument or some discomfort to the user.

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.

3.1 Installation Safety Requirements

Safety Symbols

Various symbols may be used on the controller. They have the following meaning:

⚠ Caution, (refer to accompanying documents)

☺ Helpful hints

⧈ Equipment protected throughout by DOUBLE INSULATION

Personnel

Installation must only be carried out by suitably qualified personnel in accordance with the instructions in this handbook.

Enclosure of Live Parts

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

Caution: **Live sensors**

The controller is designed to operate if the temperature sensor is connected directly to an electrical heating element. However you must ensure that service personnel do not touch connections to these inputs while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor must be mains rated.

Wiring

It is important to connect the controller in accordance with the wiring data given in this guide. 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 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.

Overcurrent protection

The power supply to the system should be fused appropriately to protect the cabling to the units.

Voltage rating

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

- relay output to logic, dc or sensor connections;
- any connection to ground.

The controller must 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.

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.

This product has been designed to conform to BSEN61010 installation category II, pollution degree 2. These are defined as follows:-

Installation Category II (CAT II)

The rated impulse voltage for equipment on nominal 230V supply is 2500V.

Pollution Degree 2

Normally only non conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

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.

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.

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 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 low voltage DC connections and the sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at both ends. In general keep cable lengths to a minimum.

4. Switch On

The way in which the controller starts up depends on factors described below in sections 4.1, 4.2 and 4.3.

4.1 New Controller

If the controller is new AND has not previously been configured it will start up showing the 'Quick Configuration' codes. This is a built in tool which enables you to configure the input type and range, the output functions and the display format.

⚠ Incorrect configuration can result in damage to the process and/or personal injury and must be carried out by a competent person authorised to do so. It is the responsibility of the person commissioning the controller to ensure the configuration is correct

4.1.1 Quick Start Code

The quick start code consists of two 'SETS' of five characters. The upper section of the display shows the set selected, the lower section shows the five digits which make up the set.

Adjust these as follows:-.

1. Press any button. The characters will change to '-', the first one flashing.
2. Press ▲ or ▼ to change the flashing character to the required code shown in the quick code tables – see below. Note: An ✕ indicates that the option is not fitted.
3. Press ↻ to scroll to the next character.

☺ You cannot scroll to the next character until the current character is configured.

☺ To return to the first character press ⎙

4. When all five characters have been configured the display will go to Set 2.
5. When the last digit has been entered press ↻ again, the display will show 

Press ▲ or ▼ to 

The controller will then automatically go to the operator level, section 4.3.

SET 1

Input type		Range	
Thermocouple		**Full range**	
B	Type B	C	°C
J	Type J	F	°F
K	Type K	**Centigrade**	
L	Type L	0	0-100
N	Type N	1	0-200
R	Type R	2	0-400
S	Type S	3	0-600
T	Type T	4	0-800
C	Custom	5	0-1000
RTD		6	0-1200
P	Pt100	7	0-1400
Linear		8	0-1600
M	0-80mV	9	0-1800
2	0-20mA	**Fahrenheit**	
4	4-20mA	G	32-212
		H	32-392
		J	32-752
		K	32-1112
		L	32-1472
		M	32-1832
		N	32-2192
		P	32-2552
		R	32-2912
		T	32-3272

Input/Output 1		Output 2		Output 4
X	Unconfigured			
H	PID Heating [logic, relay (1) or 4-20mA] or motor valve open [VC and VP only]			**Note (1)** O/P4 is relay only.
C	PID Cooling [logic, relay (1) or 4-20mA] or motor valve close [VC and VP only]			
J	ON/OFF Heating [logic or relay (1)], or PID 0-20mA heating			
K	ON/OFF Cooling [logic or relay (1)], or PID 0-20mA cooling			
Alarm (2): energised in alarm		**Alarm (2): de-energised in alarm**		
0	High alarm	5	High alarm	**Note (2)** OP1 = alarm 1, OP2 = alarm 2, OP3 = alarm 3, OP4 = alarm 4
1	Low alarm	6	Low alarm	
2	Deviation high	7	Deviation high	
3	Deviation low	8	Deviation low	
4	Deviation band	9	Deviation band	
DC Retransmission (not O/P4)				
D	4-20mA Setpoint	N	0-20mA Setpoint	
E	4-20mA Temperature	Y	0-20mA Temperature	
F	4-20mA output	Z	0-20mA output	
Logic input functions (Input/Output 1 only)				
W	Alarm acknowledge	V	Recipe 2/1 select	
M	Manual select	A	Remote UP button	
R	Timer/program run	B	Remote DOWN button	
L	Keylock	G	Timer/Prog Run/Reset	
P	Setpoint 2 select	I	Timer/Program Hold	
T	Timer/program Reset	Q	Standby select	
U	Remote SP enable			

SET 2 IWRDT

Input CT Scaling	
X	Unconfigured
1	10 Amps
2	25 Amps
5	50 Amps
6	100 Amps

Digital Input A	Digital Input B (2)
X	Unconfigured
W	Alarm acknowledge
M	Manual select
R	Timer/Program Run
L	Keylock
P	Setpoint 2 select
T	Timer/Program reset
U	Remote SP enable
V	Recipe 2/1 select
A	Remote UP button
B	Remote DOWN button
G	Timer/Prog Run/Reset
I	Timer/Program Hold
Q	Standby select

Output 3 (2)			
X	Unconfigured		
H	PID heating or motor valve open (3)		
C	PID cooling or motor valve close (3)		
J	ON/OFF heating (not shown if VC or VP)		
K	ON/OFF cooling (not shown if VC or VP)		
Alarm Outputs (1)			
Energised in alarm		De-energised in alarm	
0	High alarm	5	High alarm
1	Low alarm	6	Low alarm
2	Dev High	7	Dev High
3	Dev Low	8	Dev Low
4	Dev Band	9	Dev Band
DC outputs			
H	4-20mA heating		
C	4-20mA cooling		
J	0-20mA heating		
K	0-20mA cooling		
Retransmission output			
D	4-20 Setpoint		
E	4-20 Measured Temperature		
F	4-20mA output		
N	0-20 Setpoint		
Y	0-20 Measured Temperature		
Z	0-20mA output		

Lower Display	
T	Setpoint (std)
P	Output
R	Time remaining
E	Elapsed time
1	Alarm setpoint
A	Load Amps
D	Dwell/Ramp Time/Target
N	None
C	Setpoint with Output meter (2)
M	Setpoint with Ammeter (2)

Note (1)
OP1 = alarm 1 (I/O1)
OP2 = alarm 2
OP3 = alarm 3
OP4 = alarm 4 (AA)

Note (2)
3208 & 3204 only

Note (3)
VP, VC only

4.2 To Re-Enter Quick Code mode

If you need to re-enter the 'Quick Configuration' mode this can always be done as follows:-

1. Power down the controller
2. Hold down the button, and power up the controller again.
3. Keep the button pressed until CODE is displayed.
4. Enter the configuration code (this is defaulted to 4 in a new controller)
5. The quick start codes may then be set as described previously

☺ Parameters may also be configured using a deeper level of access. This is described in later chapters of this handbook.

☺ If the controller is started with the button held down, as described above, and the quick start codes are shown with dots (e.g. J.C.X.X.X), this indicates that the controller has been re-configured in a deeper level of access and, therefore, the quick start codes may not be valid. If the quick start codes are accepted by scrolling to YES EXIT then the quick start codes are reinstated.

4.3 Pre-Configured Controller or Subsequent Starts

A brief start up sequence consists of a self test during which the software version number is shown followed briefly by the quick start codes.

It will then proceed to **Operator Level 1**..

You will see the display shown below. It is called the HOME display.

The ALM beacon will show red if an alarm is present.

The OP4 beacon will be on if output 4 is active

Measured Temperature (or Process Value 'PV')

Target Temperature (Setpoint 'SP')

☺ If the quick start codes do not appear during this start up, it means that the controller has been configured in a deeper level of access, see the note in section 4.2. The quick start codes may then not be valid and are therefore not shown.

4.4 Front Panel Layout

Measured Temperature (or Process Value 'PV')

Target Temperature (Setpoint 'SP')

Meter (3208 and 3204 only) –configurable as:
- Off
- Heat or cool output
- Output (Centre zero)
- Load Amps from CT
- Error signal

ALM Alarm active (Red)

OP1 lit when output 1 is ON (normally heating)

OP2 lit when output 2 is ON (normally cooling)

OP3 lit when output 3 is ON

OP4 lit when output 4 relay is ON (normally alarm)

SPX Alternative setpoint in use (e.g. setpoint 2)

REM Remote digital setpoint. Also flashes when digital communications active

RUN Timer/programmer running

RUN (flashing) Timer/programmer in hold

MAN Manual mode selected

Operator Buttons:-

From any view - press to return to the HOME display

Press to select a new parameter. If held down it will continuously scroll through parameters**.**

Press to decrease a value

Press to increase a value

4.4.1 To Set The Target Temperature.

From the HOME display:-

Press to raise the setpoint

Press to lower the setpoint

The new setpoint is entered when the button is released and is indicated by a brief flash of the display.

4.4.2 Alarms

Process alarms may be configured using the Quick Start Codes section 4.1.1. Each alarm can be configured for:-

Full Scale Low	The alarm is shown if the process value falls below a set threshold
Full Scale High	The alarm is shown if the process value rises above a set threshold
Deviation Low	The alarm is shown if the process value deviates below the setpoint by a set threshold
Deviation High	The alarm is shown if the process value deviates above the setpoint by a set threshold
Deviation Band	The alarm is shown if the process value deviates above or below the setpoint by a set threshold

If an alarm is not configured it is not shown in the list of level 2 parameters, section 5.3.

Additional alarm messages may be shown such as CONTROL LOOP BROKEN. This occurs if the controller does not detect a change in process value following a change in output demand after a suitable delay time.

Another alarm message may be INPUT SENSOR BROKEN (SBr). This occurs if the sensor becomes open circuit; the output level will adopt a 'SAFE' value which can be set up in Operator Level 3, see section 11.2.

☺ From firmware version 2.11 two further alarm types have been made available. These are:-

Rising rate of change	An alarm will be detected if the rate of change (units/minute) in a positive direction exceeds the alarm threshold
Falling rate of change	An alarm will be detected if the rate of change (units/minute) in a negative direction exceeds the alarm threshold

These alarms cannot be configured by the Quick Start Code – they can only be configured in Configuration Mode, see section 12.3.

4.4.3 Alarm Indication

If an alarm occurs, the red ALM beacon will flash. A scrolling text message will describe the source of the alarm. Any output (usually a relay) attached to the alarm will operate. An alarm relay can be configured using the Quick Start Codes to be energised or de-energised in the alarm condition. It is normal to configure the relay to be de-energised in alarm so that an alarm is indicated if power to the controller fails.

Press and (ACK) together to acknowledge

If the alarm is still present the ALM beacon will light continuously otherwise it will go off.

The action which takes place depends on the type of alarm configured:-

Non latching	A non latching alarm will reset itself when the alarm condition is removed. By default alarms are configured as non-latching, de-energised in alarm.
Auto Latching	An auto latching alarm requires acknowledgement before it is reset. The acknowledgement can occur BEFORE the condition causing the alarm is removed.
Manual Latching	The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur AFTER the condition causing the alarm is removed.

By default alarms are configured as non-latching, de-energised in alarm. To configure latched alarms, refer to section 12.3.1.

Note: If remote setpoint is configured ensure that the remote input is connected or the relevant rear terminals are linked. If the remote setpoint input is left open circuit the alarm beacon will light.

4.4.4 Auto, Manual and Off Mode

The controller can be put into Auto, Manual or Off mode – see next section.

Auto mode is the normal operation where the output is adjusted automatically by the controller in response to changes in the measured temperature.

In Auto mode all the alarms and the special functions (auto tuning, soft start, timer and programmer) are operative

Manual mode means that the controller output power is manually set by the operator. The input sensor is still connected and reading the temperature but the control loop is 'open'.

In manual mode the MAN beacon will be lit, Band and deviation alarm are masked, the auto-tuning timer and programmer functions are disabled.

The power output can be continuously increased or decreased using the ⊙ or ⊙ buttons.

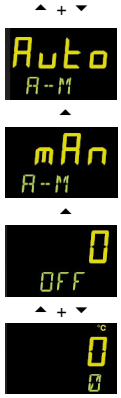
⚠ **Manual mode must be used with care. The power level must not be set and left at a value that can damage the process or cause over-heating. The use of a separate 'over-temperature' controller is recommended.**

Off mode means that the heating and cooling outputs are turned off. The process alarm and analogue retransmission outputs will, however, still be active while Band and deviation alarm will be OFF.

4.4.5 To Select Auto, Manual or Off Mode

Press and hold ⊙ and ⊙ (Mode) together for more than 1 second.

This can only be accessed from the HOME display.



1. 'Auto' is shown in the upper display. After 5 seconds the lower display will scroll the longer description of this parameter. ie 'LOOP MODE – AUTO MANUAL OFF'
2. Press ⊙ to select 'mAn'. Press again to select 'OFF'. This is shown in the upper display.
3. When the desired Mode is selected, do not push any other button. After 2 seconds the controller will return to the HOME display.
4. If **OFF** has been selected, OFF will be shown in the lower display and the heating and cooling outputs will be off
5. If manual mode has been selected, the **MAN** beacon will light. The upper display shows the measured temperature and the lower display the demanded output power.

☺ The transfer from Auto to manual mode is 'bumpless'. This means the output will remain at the current value at the point of transfer. Similarly when transferring from Manual to Auto mode, the current value will be used. This will then slowly change to the value demanded automatically by the controller.

6. To manually change the power output, press ⊙ or ⊙ to lower or raise the output. The output power is continuously updated when these buttons are pressed
7. To return to Auto mode, press ⊙ and ⊙ together. Then press ⊙ to select 'Auto'.

4.4.6 Level 1 Operator Parameters

A minimal list of parameters are available in operator Level 1 which is designed for day to day operation. Access to these parameters is not protected by a pass code.

Press ⟳ to step through the list of parameters. The mnemonic of the parameter is shown in the lower display. After five seconds a scrolling text description of the parameter appears.

The value of the parameter is shown in the upper display. Press ▲ or ▼ to adjust this value. If no key is pressed for 30 seconds the controller returns to the HOME display

The parameters that appear depend upon the functions configured. They are:-

Parameter Mnemonic	Scrolling Display and Description	Alterability
WRK.OP	WORKING OUTPUT The active output value	Read only. Appears when the controller is in AUTO or OFF mode. In a motorised valve controller (option VC or VP) this is the 'inferred' position of the valve
WKG.SP	WORKING SETPOINT The active setpoint value.	Read only. Only shown when the controller is in MAN or OFF mode.
SP1	SETPOINT 1	Alterable
SP2	SETPOINT 2	Alterable
T.REMN	TIME REMAINING Time to end of set period	Read only 0:00 to 99.59 hh:mm or mm:ss
DWELL	SET TIME DURATION Timer set time	Alterable. Only shown if timer (not programmer) configured.
A1.xxx	ALARM 1 SETPOINT	Read only. Only shown if the alarm is configured. xxx = alarm type as follows:- HI = High alarm LO = Low alarm d.HI = Deviation high d.LO = Deviation low d.HI = Deviation high rrc = Rising rate of change (units/minute) Frc = Falling rate of change (units/minute)
A2.xxx	ALARM 2 SETPOINT	
A3.xxx	ALARM 3 SETPOINT	
A4.xxx	ALARM 3 SETPOINT	
LD.AMP	LOAD CURRENT	Read only. Only shown if CT is configured

5. Operator Level 2

Level 2 provides access to additional parameters. Access to these is protected by a security code.

5.1 To Enter Level 2

1. From any display press and hold ⟳.
2. After a few seconds the display will show:-

3. Release ⟳.

(If no button is pressed for about 45 seconds the display returns to the HOME display)

4. Press ▲ or ▼ to choose LEu 2 (Level 2)

5. After 2 seconds the display will show:-

6. Press ▲ or ▼ to enter the pass code. Default = '2'

- If an incorrect code is entered the controller reverts to Level 1.

5.2 To Return to Level 1

1. Press and hold ⟳
2. Press ▼ to select LEu 1

The controller will return to the level 1 HOME display.
Note: A security code is not required when going from a higher level to a lower level.

5.3 Level 2 Parameters

Press ⟳ to step through the list of parameters. The mnemonic of the parameter is shown in the lower display. After five seconds a scrolling text description of the parameter appears.

The value of the parameter is shown in the upper display. Press ▲ or ▼ to adjust this value. If no key is pressed for 30 seconds the controller returns to the HOME display

Backscroll is achieved when you are in this list by pressing ▲ while holding down ⟳.

The following table shows a list of parameters available in Level 2.

Mnemonic	Scrolling Display and description	Range	
WKG.SP	**WORKING SETPOINT** is the active setpoint value and appears when the controller is in Manual mode. It may be derived from SP1 or SP2, or, if the controller is ramping (see SP.RAT), it is the current ramp value.	SP.HI to SP.LO	
WRK.OP	**WORKING OUTPUT** is the output from the controller expressed as a percentage of full output. It appears when the controller is in Auto mode. In a motorised valve controller (option VC or VP) this is the 'inferred' position of the valve For a time proportioning output, 50% = relay or logic output on or off for equal lengths of time. For On/Off control: OFF = <1%. ON = >1%	Read only value 0 to 100% for heating 0 to –100% for cooling -100 (max cooling) to 100% (max heating	
T.STAT	**TIMER STATUS** is the current state of the timer: Run, Hold, Reset or End It is only appears when a timer is configured.	rES	Reset
		run	Running
		hoLd	Hold
		End	Timed out
UNITS	**DISPLAY UNITS** Temperature display units. 'Percentage' is provided for linear inputs	°C	Degrees C
		°F	Degrees F
		°K	Degrees K
		nonE	None
		PErc	Percentage
SP.HI	**SETPOINT HIGH** High setpoint limit applied to SP1 and SP2.	Alterable between range limits	
SP.LO	**SETPOINT LOW** Low setpoint limit applied to SP1 and SP2		
	By default the remote setpoint is scaled between SP.HI and SP.LO. Two further parameters (REM.HI and REM.LO) are available in access level 3 to limit the Remote SP range if required. See section 10.1.		
SP1	**SETPOINT 1** allows control setpoint 1 value to be adjusted	Alterable: SP.HI to SP.LO	
SP2	**SETPOINT 2** allows control setpoint 2 value to be adjusted	Alterable: SP.HI to SP.LO	
SP.RAT	**SETPOINT RATE LIMIT** Rate of change of setpoint value.	OFF to 3000 display units per minute	
The next section applies to the Timer only – see also section 5.4.			
TM.CFG	**TIMER CONFIGURATION** Configures the timer type:- Dwell, Delay, Soft Start or none. The timer type can only be changed when the timer is reset. The Programmer option only appears if the programmer has been ordered.	nonE	None
		dwEll	Dwell
		dELY	Delayed switch on
		SFSt	Soft start
		ProG	Programmer
TM.RES	**TIMER RESOLUTION** Selects the resolution of the timer. This can only be changed when the timer is reset.	Hour	Hours
		min	Minutes
THRES	**TIMER START THRESHOLD** The timer starts timing when the temperature is within this threshold of the setpoint. This provides a guaranteed soak temperature. The threshold can be set to OFF in which case it is ignored and the timing starts immediately. If a setpoint ramping is set, then the ramp completes before the timer starts.	OFF or 1 to 3000	
END.T	**TIMER END TYPE** This determines the behaviour of the timer when it has timed out. This value can be changed while the timer is running.	OFF	Control OP goes to zero
		dwEll	Control continues at SP1
		SP2	Go to SP2
		rES	Reset programmer
SS.PWR	**SOFT START POWER LIMIT** This parameter only appears if the timer configuration is set to SFSt (Softstart). It sets a power limit which is applied until the measured temperature reaches a threshold value **(SS.SP)** or the set time **(DWELL)** has elapsed. The timer starts automatically on power up.	-100 to 100%	

Mnemonic	Scrolling Display and description	Range
SS.SP	**SOFT START SETPOINT** This parameter only appears if the timer configuration is set to SFSt (Softstart). It sets the threshold value below which the power is limited	Between SP.HI and SP.LO
DWELL	**SET TIME DURATION** - Sets the dwell timing period. It can be adjusted while the timer is running.	0:00 to 99.59 hh:mm: or mm:ss
T.REMN	**TIME REMAINING** Timer time remaining. This value can be increased or decreased while the timer is running	0:00 to 99.59 hh:mm: or mm:ss
The following parameters are available when the timer is configured as a programmer – see also section 13.2		
SERVO	**SERVO MODE**. Sets the starting point for the ramp/dwell programmer and the action on recovery from power failure.	SP Setpoint PU Process variable SPrb Ramp back to SP PUrb Ramp back to PV
TSP.1	**TARGET SETPOINT 1**. To set the target value for the first setpoint	
RMP.1	**RAMP RATE 1.** To set the first ramp rate	OFF, 0:01 to 3000 units per min or hour as set by TM.RES
DWEL.1	**DWELL 1**. To set the period of the first dwell	OFF, 0:01 to 99:59 hh:mm or mm:ss as set by TM.RES
The above three parameters are repeated for the next three program segments, i.e. TSP.2 (3 & 4), RMP.2 (3 & 4), DWEL.2 (3 & 4)		
This section applies to Alarms only If an alarm is not configured the parameters do not appear		
A1.--- - to A4.---	**ALARM 1 (2, 3 or 4) SETPOINT** sets the threshold value at which an alarm occurs. Up to four alarms are available and are only shown if configured. The last three characters in the mnemonic specify the alarm type:-	SP.HI to SP.LO
	LO Full Scale Low; HI Full Scale High;	
	dHI Deviation High; dLO Deviation Low; bND Deviation Band	
	RRC Rising rate of change; FRC Falling rate of change	1 to 9999 units/minute
The following parameter is present if a motorised valve controller has been ordered		
MTR.T	**MOTOR TRAVEL TIME.** Set this value to the time that it takes for the motor to travel from its fully closed to its fully open position. Note: In motorised valve control only the PB and TI parameters are active – see below. The TD parameter has no effect on the control.	0.0 to 999.9 seconds
This section applies to control the parameters. A further description of theses parameters is given in section 11		
A.TUNE	**AUTOTUNE** automatically sets the control parameters to match the process characteristics.	OFF Disable On Enable
PB	**PROPORTIONAL BAND** sets an output which is proportional to the size of the error signal. Units may be % or display units.	1 to 9999 display units Default 20
TI	**INTEGRAL TIME** removes steady state control offsets by ramping the output up or down in proportion to the amplitude and duration of the error signal.	OFF to 9999 seconds Default 360
TD	**DERIVATIVE TIME** determines how strongly the controller will react to the rate of change in the process value. It is used to prevent overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.	OFF to 9999 seconds Default 60 for PID control Default 0 for VP control
MR	**MANUAL RESET** applies to a PD only controller i.e. the integral term is turned off. Set this to a value of power output (from +100% heat, to -100% cool which removes any steady state error between SP and PV.	-100 to 100% Default 0
R2G	**RELATIVE COOL GAIN** adjusts the cooling proportional band relative to the heating proportional band. Particularly necessary if the rate of heating and rate of cooling are very different. **(Heat/Cool only**)	0.1 to 10.0 Default 1.0
HYST.H	**HEATING HYSTERESIS** Sets the difference in temperature units between heating turning off and turning on when ON'OFF control is used. **Only appears if channel 1(heating) control action is On/Off**	0.1 to 200.0 display units 0.2 Default 1.0
HYST.C	**COOLING HYSTERESIS** Sets the difference in temperature units between cooling turning off and turning on when ON/OFF control is used. **Only appears**	0.1 to 200.0 display units Default 1.0

Mnemonic	Scrolling Display and description	Range	
	if channel 2 (cooling) control action is On/Off		
D.BAND	**CHANNEL 2 DEADBAND** adjusts a zone between heating and cooling outputs when neither output is on. Off = no deadband. 100 = heating and cooling off. **Only appears if On/Off control configured.**	OFF or 0.1 to 100.0% of the cooling proportional band	
OP.HI	**OUTPUT HIGH** limits the maximum heating power applied to the process or a minimum cooling output.	+100% to OP.LO	
1. (2, 3 or 4) PLS.	**OUTPUT 1 (2, 3 or 4) MINIMUM PULSE TIME** Sets the minimum on and off time for the control output. ⚠ **Ensure this parameter is set to a value that is suitable for the output switching device in use. For example, if a logic output is used to switch a small relay, set the value to 5.0 seconds or greater to prevent damage to the device due to rapid switching.**	Relay outputs 0.1 to 150.0 seconds – default 5.0. Logic outputs Auto to 150.0 - Default Auto = 55ms	
This section applies to current transformer input only. If the CT option is not configured the parameters do not appear.			
LD.AMP	**LOAD CURRENT** is the measured load current when the power demand is on	CT Range	
LK.AMP	**LEAK CURRENT** is the measured leakage current when the power demand is off.	CT Range	
LD.ALM	**LOAD CURRENT THRESHOLD** Sets a low alarm on the load current measured by the CT. Used to detect partial load failure.	CT Range	
LK.ALM	**LEAK CURRENT THRESHOLD** sets a high alarm on the leakage current measured by the CT.	CT Range	
HC.ALM	**OVERCURRENT THRESHOLD** Sets a high alarm on the load current measured by the CT	CT Range	
ADDR	**ADDRESS** - communications address of the controller. 1 to 254	1 to 254	
HOME	**HOME DISPLAY** Defines the parameter which appears in the lower section of the HOME display.	Std	Standard
		OP	Output power
		tr	Time remaining
		ELAP	Time elapsed
		AL	First alarm setpoint
		Ct	Load current
		CLr	Clear (blank)
		tmr	Combined setpoint and time display
ID	**CUSTOMER ID** Sets a number from 0 to 9999 used as a custom defined identification number for the controller.	0 to 9999	
REC.NO	**CURRENT RECIPE NUMBER** Displays the current recipe number. If this number is changed, the parameter values stored under the selected recipe number will be loaded. See the engineering manual for more information about recipes.	nonE or 1 to 5 or FAIL if no recipe set stored	
STORE	**RECIPE TO SAVE** Saves the current parameter values into a selected recipe number. Up to 5 recipes can be saved.	nonE or 1 to 5 donE when stored	

☺ Press ⊜ at any time to return immediately to the HOME screen at the top of the list.

☺ Hold ⊜ down to continuously scroll through the above list

5.4 Timer Operation

An internal timer can be configured to operate in one of four different modes. The mode is configured in Level 2 by the **'TM.CFG'** (timer configuration) parameter. Each Timing Mode is described in the pages that follow.

Operation	Action	Indication
To **Run** the timer	Press and quickly release ⊙ + ⊙	Beacon -- RUN = On Scrolling text display:- TIMER RUNNING
To **Hold** the timer	Press and quickly release ⊙ + ⊙	Beacon -- RUN = Flashing Scrolling text display:- TIMER HOLD
To **Reset** the timer	Press and hold ⊙ + ⊙ for more than 1 second	Beacon -- RUN = Off If the timer is a Dwell Type and configured to turn power off at the end of the timing period OFF will be displayed
	Timer has timed out (END state)	Beacon -- RUN = Off SPX = On if End Type = SP2 Scrolling display:- TIMER END. Note:- The timer can be re-run from the end state without the need to reset it.

The timer can also be RUN, HELD or RESET by the parameter 'T.STAT' (Timer status). It can also be controlled via digital inputs (if configured).

5.5 Dwell Timer

A dwell timer ('**TM.CFG' = 'dwEll**') is used to control a process at a fixed temperature for a defined period.

In reset the controller behaviour depends on the configuration of the END state parameter. See opposite.

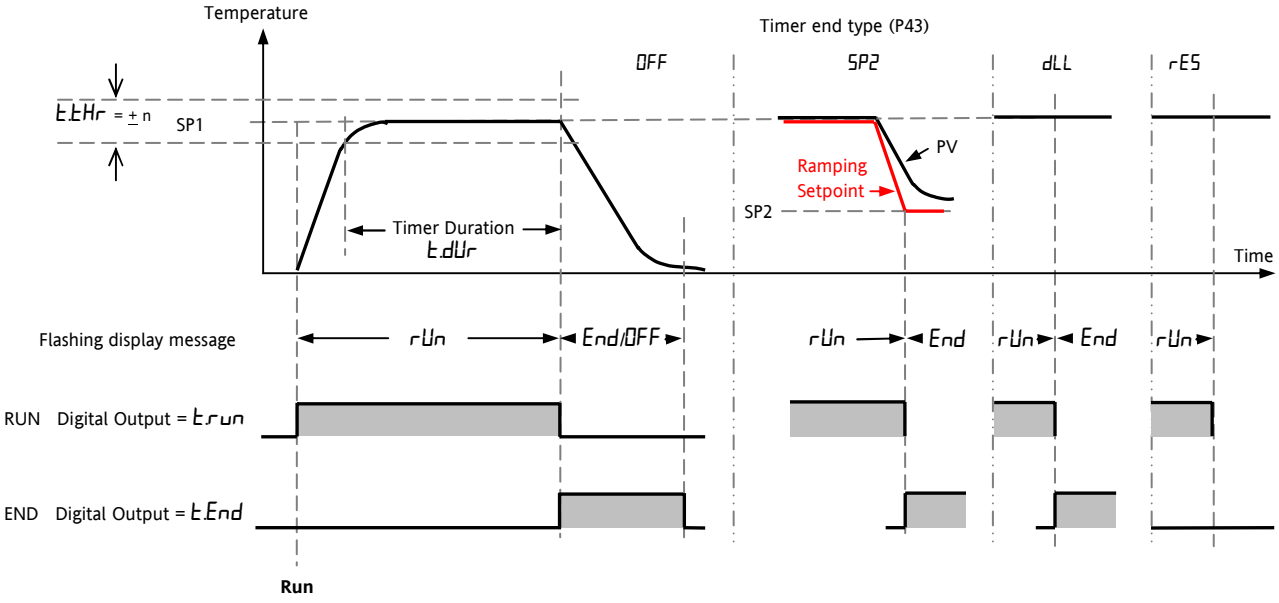
In run the heating or cooling will come on. Timing starts when the temperature is within the threshold '**THRES'** of the setpoint. If the threshold is set to OFF the timing starts immediately.

If setpoint ramping is enabled, then the ramp completes before the timer starts.

In the END state the behaviour is determined by the parameter '**END.T'** (End type):

- **OFF** The heating and cooling is turned OFF (resets to Off)
- **dwEll** Controls at setpoint1 (resets to Setpoint 1)
- **SP2** Controls at setpoint 2 (resets to Setpoint 1)
- **rES** Reset reverts to SP1.– (added from version V2.13)

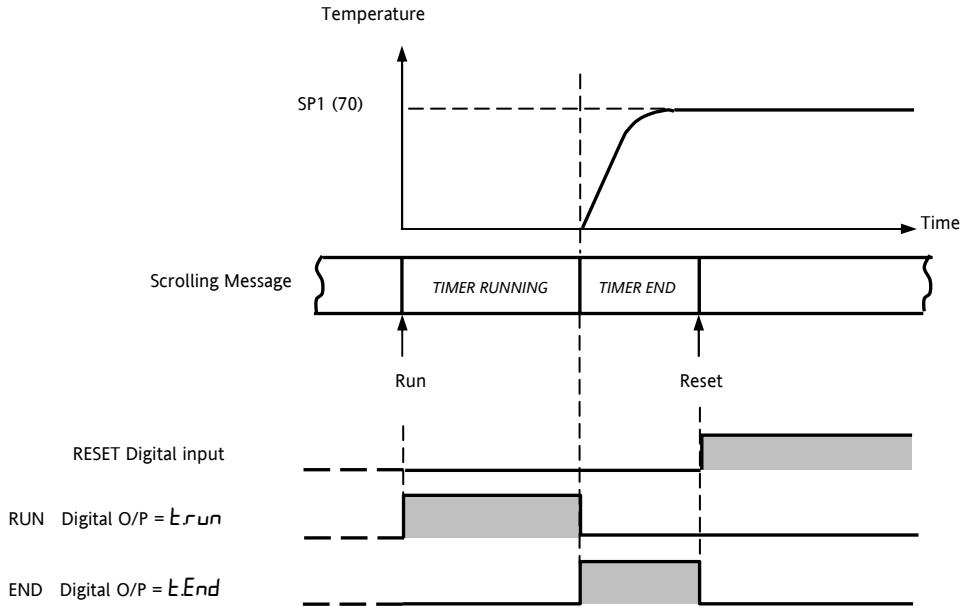
Note: The dwell period can be reduced or increased while the timer is running.



5.6 Delayed Timer

'TM.CFG' = 'dELY'. The timer is used to switch on the output power after a set time. The timer starts immediately on power-up, or when run.

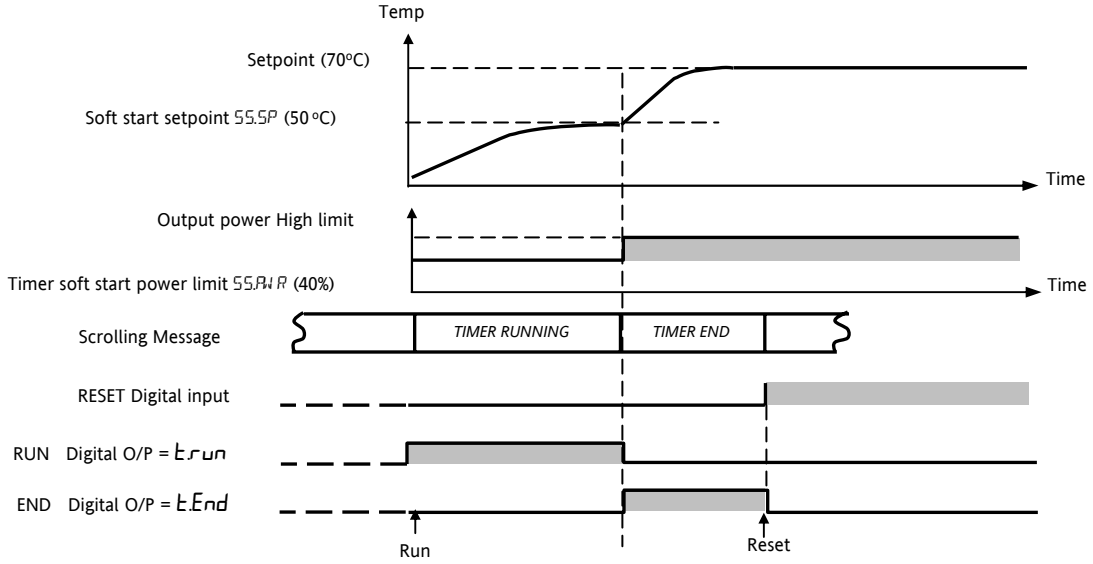
The controller remains in standby with heating and cooling off until the time has elapsed. After the time has elapsed, the instrument controls at the target setpoint.



5.7 Soft Start Timer

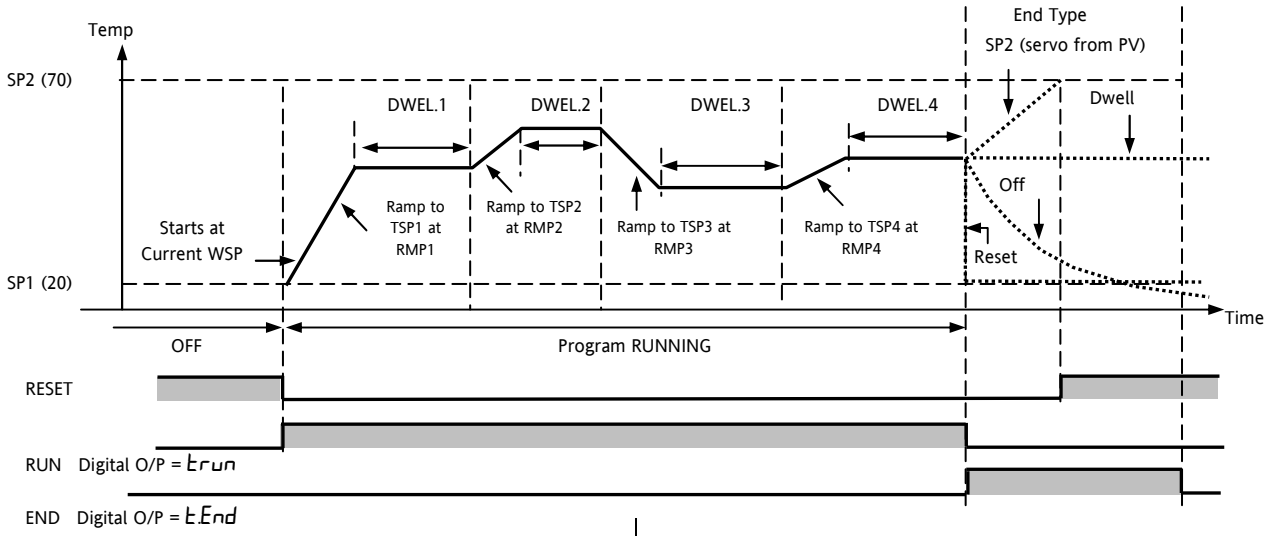
'**TM.CFG' = '**55.5t'.

A Soft Start timer starts automatically on power up. It applies a power limit ('**SS.PWR')** until the temperature reaches a threshold value ('**SS.SP')** or the timer times-out after the dwell period ('dwEll'**)**. It is typically use to dry-out heaters in Hot Runner control systems



5.8 Programmer

'**TM.CFG' = 'ProG**'. Function code CP is an eight segment programmer consisting of four ramp/dwell pairs. Each ramp consists of a controlled rate of change of setpoint to a target level. Each ramp is followed by a dwell at that level. The ramp rate, target level and dwell time are set by the user. The program profile is shown in the diagram below.



Notes:-

1. When a step change is required, the ramp rate should be set to 'OFF'.
2. Where ramp/dwell pairs are not required, the ramp rate should be set to 'OFF' and the target setpoint, TSP, the same as the preceding segment
3. TIMER END - when the end type is SP2, Timer END does not occur until the ramp is complete or SP2 is achieved. It is more usual to use a DWELL (default) or RESET end type

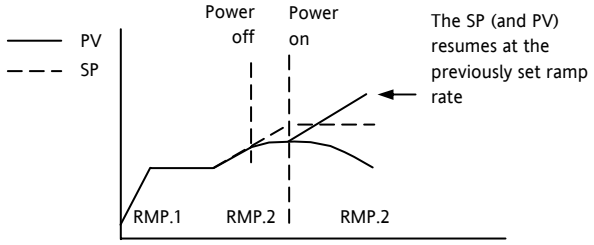
A single program event output is also available. To use this refer to section 13.2.3.

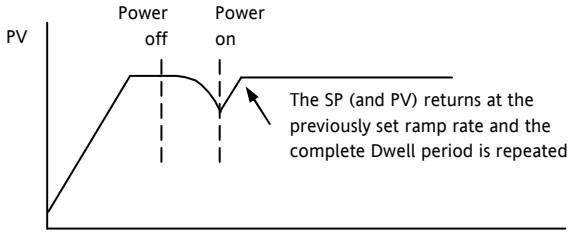
5.8.1 Programmer Servo Mode and Power Cycling

The way in which the program starts when 'Run' is selected or after the power is turned off and on again, is determined by the SERVO MODE parameter, as follows:-

SERVO MODE	
SP	The program will start from the current **setpoint** value. On recovery from power failure, the program will reset. It will require to be run again manually. The working setpoint will revert to SP1 or SP2 (depending on which was selected) and the whole program is repeated.
PV	The program will start from the **measured temperature**. On recovery from power failure, the program will reset. It will require to be run again manually, but it will start at the value of the PV at the point when the programmer is run again.
SP.rb	On recovery from power failure, the program will automatically run at the **last** ramp rate from the **current setpoint value**, see the sketches below.
PV.rb	The program will start from the **measured temperature**. On recovery from power failure, the program will automatically run at the **last** ramp rate from the **current measured temperature**, see the sketches below.

The behaviour of the programmer following a power failure is shown graphically below for SERVO = SP.rb and PV.rb:-





5.8.2 To Operate the Programmer

Operation of the programmer is the same as the timer.

Operation	Action	Indication
To Run a program	Press and quickly release ⊙ + ⊙	Beacon -- RUN = On Scrolling display - TIMER RUNNING
To Hold a program	Press and quickly release ⊙ + ⊙	Beacon -- RUN = Flashing Scrolling display - TIMER HOLD
To Reset a program	Press and hold ⊙ + ⊙ for more than 1 second	Beacon -- RUN = Off If End Type = Off then OFF will be displayed at the end of the program
	Program ended	Beacon -- RUN = Off SPX = On if End Type = SP2 Scrolling display - TIMER END
Repeat the above to Run the programmer again (Note: it is not essential to reset it after the End state is reached)		

Programs can also be operated from the **'T.STAT'** parameter found in the level 2 parameter list.

5.8.3 To Configure the Programmer

Select Access Level 2 – see section 5.

Operation	Action	Indication	Notes
Configure the Timer as a **Programmer**	1. Press ⟳ to select 'TM.CFG' 2. Press ▼ or ▲ to 'PrOG'		
Set the **Resolution**	3. Press ⟳ to select 'TM.RES' 4. Press ▼ or ▲ to 'Hour' or 'mi n'		In this example the ramp rate and dwell period are set in hours
Set the **Threshold**	5. Press ⟳ to select 'THRES' 6. Press ▼ or ▲ to adjust		In this example the dwell periods will not start until the PV is within 5 units of the setpoint
Set the action when the programmer times out	7. Press ⟳ to select 'END.T' 8. Press ▼ or ▲ to 'OFF' or 'SP2' or 'dwEll' or 'rSt'		In this example the controller will continue to control indefinitely at the last setpoint. OFF will turn the output power. SP2 will control at setpoint 2 Reset will control at the selected setpoint
Set the **Servo Mode**	9. Press ⟳ to select 'SERVO' 10. Press ▼ or ▲ to 'PV', 'SP', 'SPrb', or 'PVrb'		In this example the program will start from the current value of the process temperature. See also section 5.8.1.
Set the first **Target Setpoint**	11. Press ⟳ to select 'TSP.1' 12. Press ▼ or ▲ to adjust		In this example the setpoint will ramp from the current value of the PV to the first target - 100
Set the first **Ramp Rate**	13. Press ⟳ to select 'RMP.1' 14. Press ▼ or ▲ to adjust		In this example the setpoint will ramp to 100 at 8.0 units per hour
Set the first **Dwell**	15. Press ⟳ to select 'DWEL.1' 16. Press ▼ or ▲ to adjust		In this example the setpoint will remain at the start value for 2 hours 11 minutes
Repeat the above three steps for all segments			

Notes:-

- It is possible to set, in a deeper level of access, Event Outputs and Programmer Cycles. See sections 13.2.3 and 13.2.4.
- 'Event Outputs' is available in software version 2 and above. A digital event may be configured to operate in any segment of the program. This event may be configured to operate a digital output.
- 'Programmer Cycles' is available from software versions 2.09 (PID controllers) and 2.29 (Valve Position controllers). This allows the programmer to repeat the set program up to 100 times.

6. Access to Further Parameters

6.1 Parameter Levels

Parameters are available under different levels of security and are defined as Level 1 (LEV 1), Level 2 (LEV2), Level 3 (LEV 3) and Configuration (CONF).

Level 1 has no passcode since it contains a minimal set of parameters generally sufficient to run the process on a daily basis.

Level 2 allows access to parameters which may used in commissioning a controller or settings between different products or batches.

Level 1 and Level 2 operation has been described in the previous sections.

Level 3 and Configuration level parameters are also available as follows:-

6.1.1 Level 3

Level 3 makes all operating parameters available and alterable (if not read only). It is typically used when commissioning a controller.

Examples of parameters available in Level 3 are:-

Range limits, setting alarm levels, communications address.

The instrument will continue to control when in Levels 1, 2 or 3.

6.1.2 Configuration Level

This level makes available all parameters including the operation parameters so that there is no need to switch between configuration and operation levels during commissioning. It is designed for those who may wish to change the fundamental characteristics of the instrument to match the process.

Examples of parameters available in Configuration level are:-

Input (thermocouple type); Alarm type; Communications type.

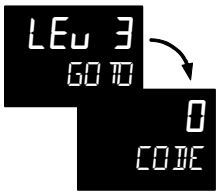
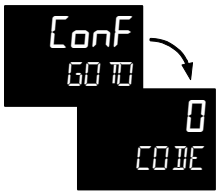
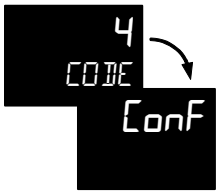
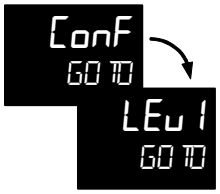
WARNING

Configuration level gives access to a wide range of parameters which match the controller to the process. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is the responsibility of the person commissioning the process to ensure that the configuration is correct.

In configuration level the controller is not controlling the process or providing alarm indication. Do not select configuration level on a live process.

Operating Level	Home List	Full Operator	Configuration	Control
Level 1	✓			Yes
Level 2	✓			Yes
Level 3	✓	✓		Yes
Conf	✓	✓	✓	No

6.1.3 To Select Access Level 3 or Configuration Level

Do This	The Display You Should See	Additional Notes
1. From any display press and hold ⊜ for more than 5 seconds	**To Select Level 3** 	The display will pass from the current operating level, for example, LEu 1 to LEu 3 as the button is held down. (If no button is then pressed for about 50 seconds the display returns to the HOME display)
2. Press ▲ or ▼ to enter the passcode for Level 3		The default code is 3: If an incorrect code is entered the display reverts to 'GOTO'. The controller is now in the level 3 will then revert to the HOME display
3. When the LEU3 GOTO view is shown, as in paragraph 1 above, press ▲ to select 'ConF'	**To Select Configuration level** 	Note: ▲ must be pressed quickly before the controller requests the code for level 3
4. Press ▲ or ▼ to enter the passcode for Configuration level		The default code is 4: If an incorrect code is entered the display reverts to 'GOTO'. The controller is now in Configuration level will now show ConF
5. Press and hold ⊜ for more than 3 seconds 6. Press ▲ to select the required level eg LEV 1	**To Return to a Lower Level** 	The choices are: LEU 1 Level 1 LEU 2 Level 2 LEU 3 Level 3 ConF Configuration It is not necessary to enter a code when going from a higher level to a lower level. Alternatively, press ⊜ and scroll to the ACCES list header, then press ↻ to select the required level. The display will then flash 'ConF' for a few seconds and the controller will then go through its start up sequence, starting in the level selected. Do not power down while ConF is flashing. If a power down does occur an error message will appear – see section **12.4** 'Diagnostic Alarms'

☺ A special case exists if a security code has been configured as '0'. If this has been done it is not necessary to enter a code and the controller will enter the chosen level immediately.

☺ When the controller is in configuration level the ACCESS list header can be selected from any view by holding down the ⊜ button for more than 3 seconds. Then press ⊜ again to select 'ACCES'

6.2 Parameter lists

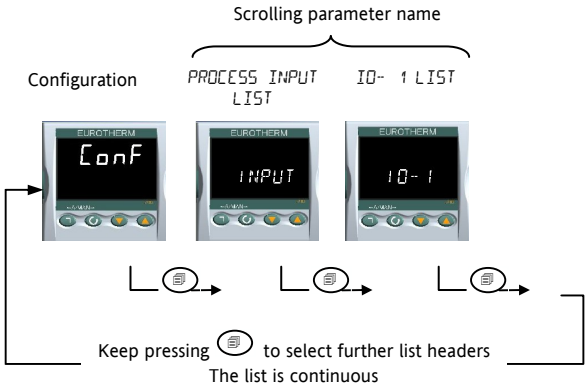
Parameters are organised in lists. The top of the list shows the list header only. The name of the list header describes the generic function of the parameters within the list. For example, the list header 'ALARM' contains parameters which enable you to set up alarm conditions.

6.2.1 To Choose Parameter List Headers

Press . Each list header is selected in turn every time this key is pressed.

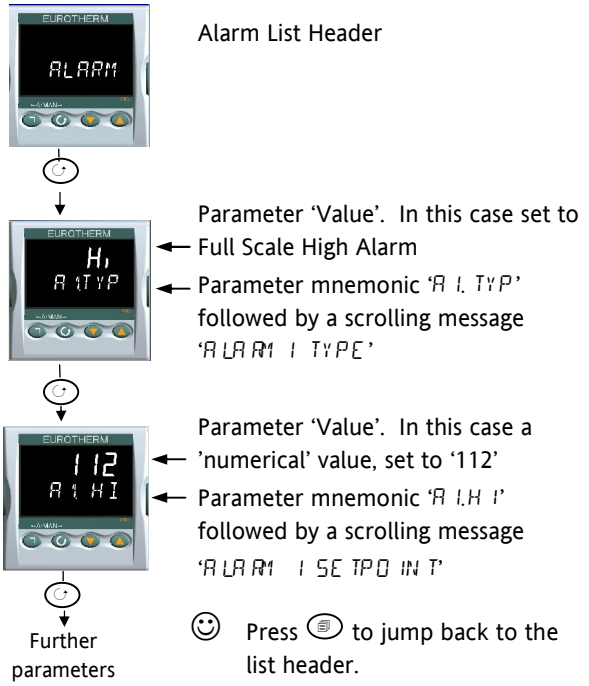
The name of the list header appears in the lower display, followed, after a few seconds, by a scrolling longer description of the name.

The following example shows how to select the first two list headers. (Views are shown for 3216 controllers).



6.2.2 To Locate a Parameter

Choose the appropriate list, then press . Each parameter in the list is selected in turn each time this button is pressed. The following example shows how to select the first two parameters in the ALARM List. All parameters in all lists follow the same procedure. (Views are shown for 3216 controllers).

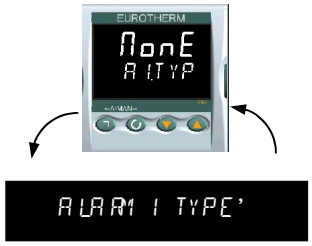


6.2.3 How Parameters are Displayed

As shown above. whenever a parameter is selected it is displayed as a mnemonic, of four or five characters, for example 'A1TYP'.

After a few seconds this display is replaced by a scrolling banner which gives a more detailed description of the parameter. In this example 'A1TYP' = 'ALARM 1 TYPE'. The scrolling banner is only shown once after the parameter is first accessed. (Views are shown for 3216 controllers).

The name of the list header is also displayed in this way.



The upper part of the display shows the value of the parameter.

The lower part shows its mnemonic followed by the scrolling name of the parameter

6.2.4 To Change a Parameter Value

With the parameter selected, press to increase the value, press to decrease the value. If either key is held down the analogue value changes at an increasing rate.

The new value is entered after the key is released and is indicated by the display blinking. The exception to this is output 'Power' when in manual. In this case the value is entered continuously.

The upper display shows the parameter value the lower display shows the parameter name.

6.2.5 To Return to the HOME Display

Press + .

On release of the keys the display returns to the HOME list. The current operating level remains unchanged.

6.2.6 Time Out

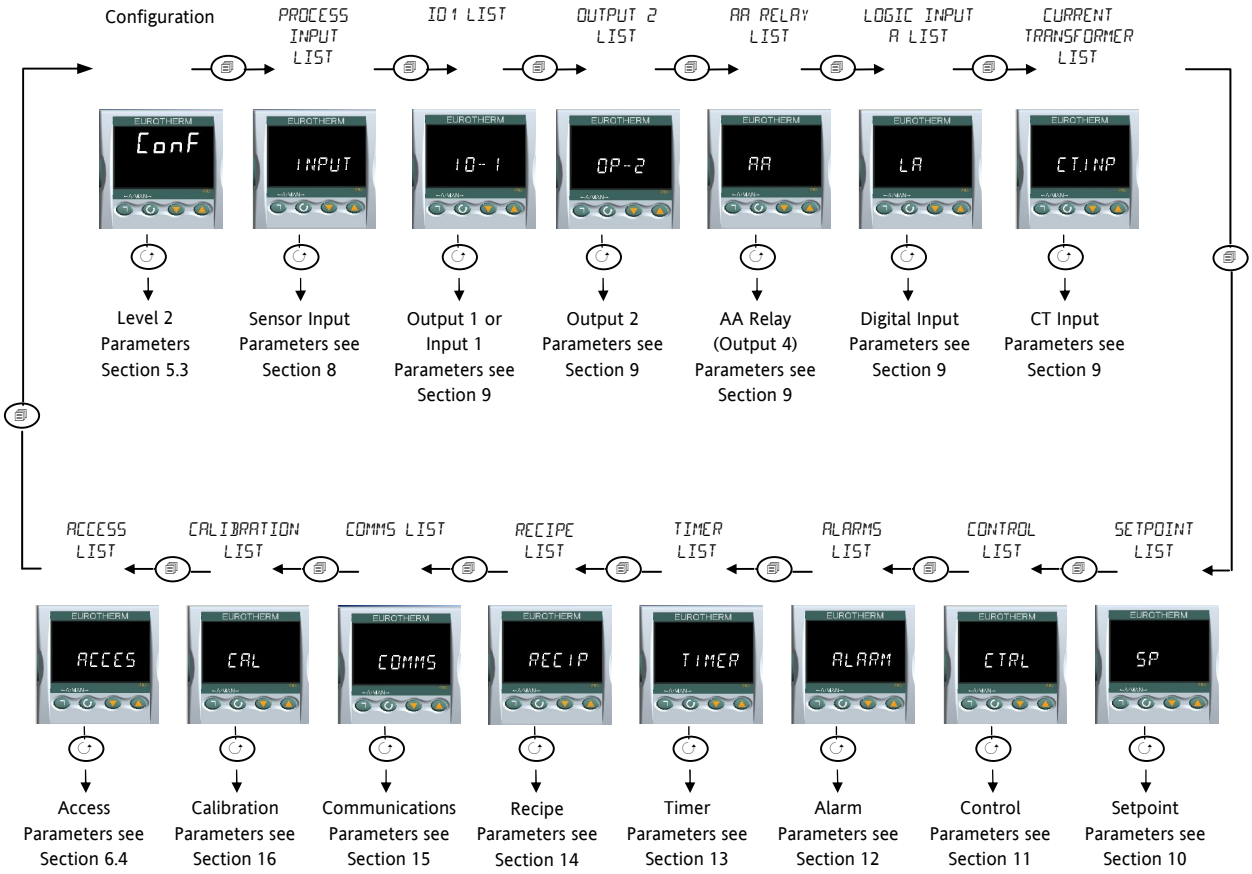
A time out applies to the 'Go To' and 'Control Mode' parameters. If no key presses are detected within a period of 5 seconds the display will revert back to the HOME list.

Press and hold to scroll parameters forward through the list. With depressed, press to scroll parameters backward.

6.3 Navigation Diagram

The diagram below shows the all list headings available in configuration level for 3216 controllers.

The parameters in a list are shown in tables in the following sections of this manual together with explanations of their meanings and possible use.



For 3208 and 3204 controllers additional lists are available, for example Output 3 and Digital Input B

6.4 Access Parameters

The following table summarises the parameters available under the ACCESS list header

⚠ The Access List can be selected at any time when in configuration level by holding ⧉ key down for 3 seconds, then press ▲ or ▼ with ⧉ still held down.

ACCESS LIST		'ACCS'				
Name	Scrolling Display	Parameter Description	Values Allowed		Default	Access Level
GOTO	SELECT ACCESS LEVEL	Allows you to change the access level of the controller. Passwords prevent unauthorised change	LEu.1	Operator level 1	LEu.1	Conf
			LEu.2	Operator level 2		
			LEu.3	Operator level 3		
			ConF	Configuration level		
LEV2P	LEVEL 2 PASSCODE	The Level 2 passcode	0-9999 0 = no passcode will be requested		2	Conf
LEV3P	LEVEL 3 PASSCODE	The Level 3 passcode			3	Conf
CONF.P	CONFIG PASSCODE	To set a Configuration level passcode			4	Conf
ID	CUSTOMER ID	To set the identification of the controller	0-9999			Conf
HOME	HOME DISPLAY See Note 1	To configure the parameter to be displayed in the lower line of the HOME display	Std	Setpoint	Std	Conf
			OP	Output demand		
			tr	Time remaining		
			ELAP	Time elapsed		
			AL	Alarm 1 setpoint		
			Ct	Current transformer		
			CLr	No parameter		
			tmr	Time remaining		
			t.SP	Target setpoint		
			no.PV	PV is not displayed		
			StbY	PV is not displayed when the controller is in standby mode		
K.LOC	KEYBOARD LOCK	To limit operation of the front panel buttons when in operator levels. ☺ If ALL has been selected, then to restore access to the keyboard, power up the controller with the ⧉ button held down and enter the configuration level passcode as described in section 6.1.3. This will take you to the Quick Code mode. Press ↺ to EXIT and select YES. The front panel buttons can then be operated as normal.	nonE	Unlocked	nonE	Conf
			ALL	All buttons locked		
			Edit	Edit keys locked See Note 2		
			mod	Mode keys locked See Note 3		
			mAn	Manual mode locked		
			StbY	Press ▲ and ▼ to toggle between normal operation and standby mode		
			tmr	Prevents Auto/Manual/Off but allow timer operation using ▲ and ▼		
COLD	COLD START ENABLE/ DISABLE	**Use this parameter with care.** When set to yes the controller will return to factory settings on the next power up	no	Disable	no	Conf
			YES	Enable		
STBY.T	STANDBY TYPE	Turn ALL outputs off when the controller is in standby mode. Typical use when event alarms are used to interlock a process.	AbS.A	Absolute alarms to remain active	AbS.A	Conf
			OFF	All alarms off in standby		
PASS.C	FEATURE PASSCODE	To select chargeable features		Contact Eurotherm. Note 5		Conf
PASS.2	FEATURE PASSCODE	To select chargeable features				Conf
METER	METER CONFIGURATION See Note 4	To configure the analogue meter to indicate any one of the parameters listed. This is only applicable to 3208 and 3204 controllers.	OFF	Meter display disabled		Conf
			HEAt	Heat Output demand		
			COOL	Cool output demand		
			w.SP	Working setpoint		
			PV	Process value		
			OP	Heat output demand		
			C.OP	Cool output demand		
			Err	Error (SP – PV)		
			AmPS	Output current		
			LCur	Load current from CT		

Note 1

Home Display Configuration

The upper display always shows PV, the lower display is configurable.

StAd In automatic control the lower display shows setpoint. In manual mode output power is shown.

OP Output power is shown in both automatic and manual modes.

tr Timer time remaining

ELAP Timer elapsed time.

AL 1 First configured alarm setpoint

Ct CT current

CLr Blank display

tmr The display shows setpoint while the timer is not running and time remaining when the timer is active.

t.SP The display shows target setpoint so that the target for a ramp may be viewed rather than the current working setpoint

no.Pu The upper display is blank

StbY The upper display blanks when the controller is in standby mode.

Note 2

Edit keys locked. Parameters cannot be changed but viewed only. However, it is possible to run, hold and reset timer and acknowledge alarms.

Note 3

Mode key locked. Timer run, hold, reset and Auto/Manual cannot be operated from the Mode key.

The following sections in this handbook describe the parameters associated with each subject. The general format of these sections is a description of the subject, followed by the table of all parameters to be found in the list, followed by an example of how to configure or set up parameters.

Note 4

Meter Configuration

HEAt The meter shows a representation of the heat output being applied by the control loop to the load. It is scaled between 0 and 100% full scale deflection.

OP The meter displays the current Control Output setting scaled between the low and high output power limits. In a motorised valve controller (option VC or VP) this is the 'inferred' position of the valve

COOL The meter shows a representation of the cool output being applied by the control loop to the load. It is scaled between 0 and 100% full scale deflection.

C.OP The meter displays the current output power setting scaled between -100 and 100%, so that a value of zero is centred in the display. This indicates whether the controller is currently applying heating or cooling.

w.SP The meter shows a representation of the current working setpoint, scaled between the setpoint high and low limits. It may be used to indicate at what point in the setpoint range the instrument is currently operating.

PV The meter displays the current Process Variable scaled between the range high and low values. Provides an indication of the current temperature relative to the range of a process.

Err The meter displays the process error (i.e. the difference between the current temperature and the setpoint), scaled between +10 degrees and -10 degrees. This provides a visual indication of whether the process is close to setpoint.

AmPS The meter shows a representation of the instantaneous current through a load monitored using a current transformer, scaled between 0 Amps and the configured range of the Current Transformer. It may be used to visually indicate the health of the heating elements, since in normal use it will tend to flick from a low reading when the heating is off, to a higher reading when the heating is on. If the needle does not return to a low value, the SSR may be conducting regardless of the logic signal driving it. If the needle does not reach the expected level it is likely that one or more of the heater elements has burned out.

Lcur The meter displays a representation of the On State Current in a load monitored by the current transformer option. In normal operation it will tend to remain static and provides an alternative means of monitoring the health of a heating element to the 'Amps' option.

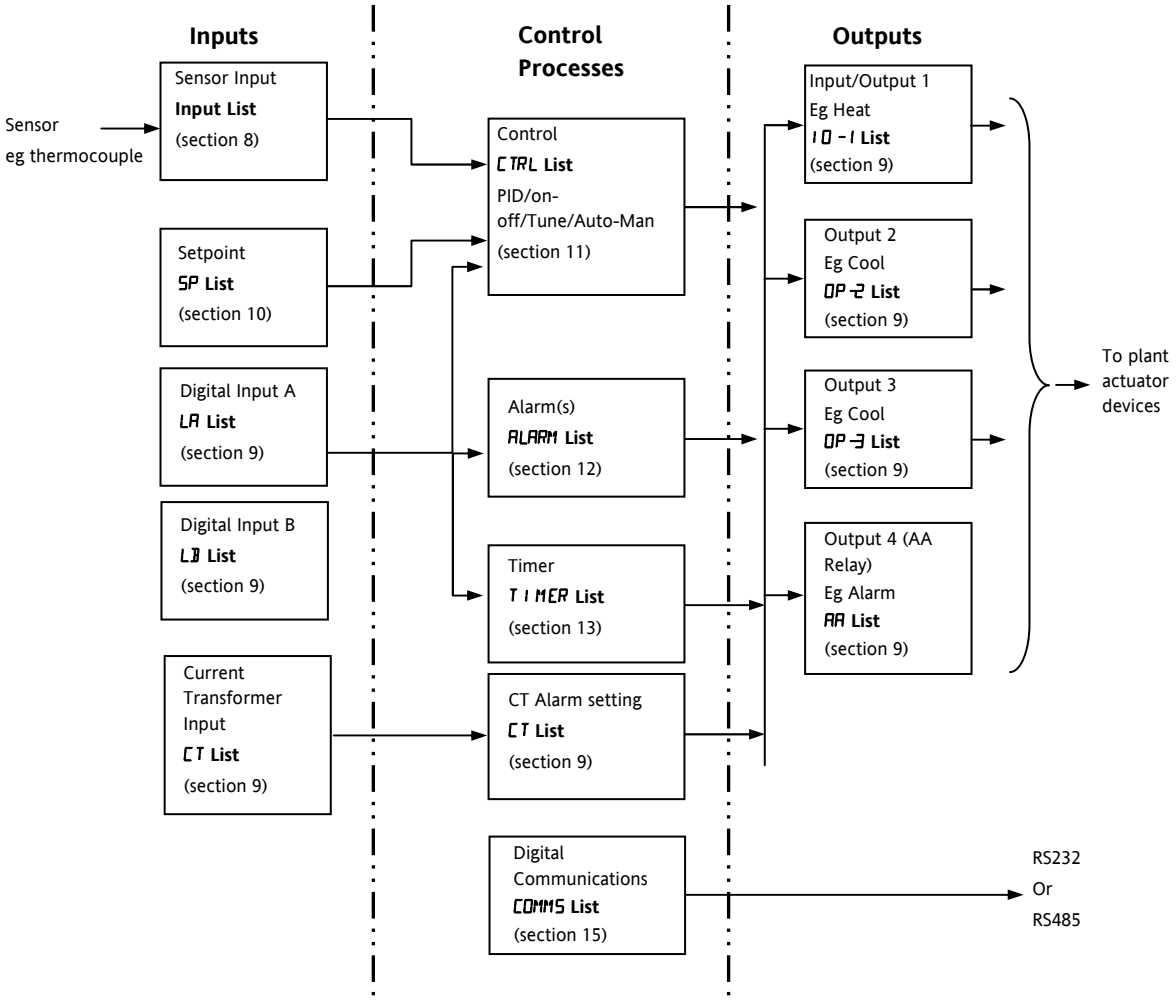
Note 5

Feature Passcodes These parameters were added in controllers with software versions 2.09 (PID controller) and 2.29 (VP controller) and above. They allow the controller to be field upgraded with additional chargeable features. To upgrade, contact Eurotherm and provide the existing number codes. 'Pass2' is read only and is required to provide Eurotherm with the current instrument features. You will be given a numeric code to enter as the new 'PassC' parameter.

7. Controller Block Diagram

The block diagram shows the simple building blocks which make up the controller. Each block has a list of parameters headed by a list name. For example the 'Input List' contains parameters which define the input type.

The quick start code automatically sets the parameters to match the hardware.



The Temperature (or Process Value, PV) is measured by the sensor and compared with a Setpoint (SP) set by the user.

The purpose of the control block is to reduce the difference between SP and PV (the error signal) to zero by providing a compensating output to the plant via the output driver blocks.

The timer and alarms blocks may be made to operate on a number of parameters within the controller, and digital communications provides an interface to data collection and control.

The way in which each block performs is defined by its internal parameters. Some of these parameters are available to the user so that they can be adjusted to suit the characteristics of the process which is to be controlled.

These parameters are found in lists and the name of each list corresponds with the name of the function block shown in the above diagram.

The above block diagram applies to 3208, 32h8 and 3204 controllers.

For 3216 Output 3 and Logic Input B are not present.

8. Temperature (or Process) Input

Parameters in the input list configure the input to match your sensor. These parameters provide the following features:-

Input Type and linearisation	Thermocouple (TC) and 3-wire resistance thermometer (RTD) temperature detectors Linear input (-10 to +80mV). 0-10V using external voltage divider. mA assumes a 2.49Ω external shunt. See the table in section 0. for the list of input types available
Display units and resolution	The change of display units and resolution will all the parameters related to the process variable
Input filter	First order filter to provide damping of the input signal. This may be necessary to prevent the effects of excessive process noise on the PV input from causing poor control and indication. More typically used with linear process inputs.
Fault detection	Sensor break is indicated by an alarm message '**SBr**'. For thermocouple it detects when the impedance is greater than pre-defined levels; for RTD when the resistance is less than 12Ω.
User calibration	Either by simple offset or by slope and gain. See section 8.2. for further details.
Over/Under range	When the input signal exceeds the input span by more than 5% the PV will flash indicating under or over range. If the value is too high to fit the number of characters on the display 'HHHH' or 'LLLL' will flash. The same indications apply when the display is not able to show the PV, for example, when the input is greater than 999.9°C with one decimal point.

8.1 Process Input Parameters

INPUT LIST INPUT						
Name	Scrolling Display	Parameter Description	Value		Default	Access Level
IN.TYP	INPUT TYPE	Selects input linearisation and range	See section 8.1.1. for input types available			Conf L3 R/O
UNITS	DISPLAY UNITS	Display units shown on the instrument	nonE	No units - only for custom linearisation	°C	L3
			°C	Celsius		
			°F	Fahrenheit		
			°K	Kelvin		
			PErc	%		
DEC.P	DISPLAY POINTS	Decimal point position	nnnn	No DP	nnnn	Conf L3 R/O
			nnn.n	One DP		
			nn.nn	Two DP		
MV.HI	LINEAR INPUT HIGH	High limit for mV (mA) inputs	-10.00 to +80.00mV		80.00	Conf
MV.LO	LINEAR INPUT LOW	Low limit for mV (mA) inputs	-10.00 to +80.00mV		-10.00	Conf
RNG.HI	RANGE HIGH LIMIT	Range high limit for thermocouple RTD and mV inputs	From the high limit of the selected input type to the 'Low Range Limit' parameter minus one display unit.			Conf L3 R/O
RNG.LO	RANGE LOW LIMIT	Range low limit for thermocouple RTD and mV inputs	From the low limit of the selected input type to the 'High Range Limit' parameter minus one display unit.			Conf L3 R/O
PV.OFS	PV OFFSET	A simple offset applied to all input values. See section 8.2.	Generally one decimal point more than PV			L3
FILT.T	FILTER TIME	Input filter time	OFF to 100.0 seconds		1.6	L3
CJ.TYP	CJC TYPE	Configuration of the CJC type	Auto	Automatic	Auto	Conf and if T/C L3 R/O
			0°C	Fixed at 0°C		
			50°C	Fixed at 50°C		
SB.TYP	SENSOR BREAK TYPE	Defines the action which is applied to the control output if the sensor breaks (open circuit). See also section 8.1.2	oFF	No sensor break will be detected	on	Conf L3 R/O
			on	Open circuit sensor will be detected		
			LAt	Latching		
CJC.IN	CJC TEMPERATURE	Temperature measured at the rear terminal block. Used in the CJC calculation	Read only			Conf L3 R/O and if T/C
PV.IN	PV INPUT VALUE	Current measured temperature	Minimum display to maximum display range			Conf L3 R/O

INPUT LIST	INPUT				
Name	Scrolling Display	Parameter Description	Value	Default	Access Level
MV.IN	MILLIVOLT INPUT VALUE	Millivolts measured at the rear PV Input terminals	xx.xx mV - read only		Conf L3 R/O
RC.FT	ROC FILTER TIME	This provides a first order filter for the rate of change filtering function and can be used to avoid nuisance alarm triggers due to short duration noise on the calculated rate of change,	oFF to 0.1 to 999.9 minutes Off means no filtering applied	1.6	L3
RC.PV	PV DERIVATIVE	Provides a measure of the calculated rate of change of the temperature or measurement input as used by the Rate of Change Alarm functions. Useful when commissioning to determine the level of filtering required on the Rate of Change alarm.			L3

8.1.1 Input Types and Ranges

Input Type		Min Range	Max Range	Units	Min Range	Max Range	Units
JtC	Thermocouple type J	-210	1200	°C	-346	2192	°F
ktC	Thermocouple type K	-200	1372	°C	-328	2502	°F
LtC	Thermocouple type L	-200	900	°C	-328	1652	°F
rtC	Thermocouple type R	-50	1700	°C	-58	3092	°F
btC	Thermocouple type B	0	1820	°C	32	3308	°F
ntC	Thermocouple type N	-200	1300	°C	-328	2372	°F
ttC	Thermocouple type T	-200	400	°C	-328	752	°F
StC	Thermocouple type S	-50	1768	°C	-58	3215	°F
rtd	Pt100 resistance thermometer	-200	850	°C	-328	1562	°F
mu	mV or mA linear input	-10.00	80.00				
CmS	Value received over digital communications (modbus address 203). This value must be updated every 5 seconds or the controller will show sensor break						

8.1.2 Operation of Sensor Break

Sensor break type (SB.TYP) can be set to operate in three different modes:-

1. Off
2. On
3. Latching

SB.TYP = Off

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	OP.HI (100%) Safe value has no effect	No alarm indication will be displayed
For heat only OP.HI and OP.LO can be set between 0.0% and +100%	OP.HI (100%) Safe value has no effect	
For cool only OP.HI and OP.LO can be set between -100.0% and 0%	OP.HI (0%) Safe value has no effect	

SB.TYP = on

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	'SAFE' value provided it is not set outside the output limits, otherwise it will adopt OP.HI	ALM beacon flashes when an alarm occurs. Output alarm relay activates. ACK has no effect. When the sensor break condition is no longer applicable the alarm indication and output cancel.
For heat only OP.HI and OP.LO can be set between 0.0% and +100%		
For cool only OP.HI and OP.LO can be set between -100.0% and 0%		

SB.TYP = Lat (Alarm latching)

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	'SAFE' value provided it is not set outside the output limits. i.e. the same as Sbrk = on	ALM beacon flashes when an alarm occurs. Output alarm relay activates. ACK has no effect. When the sensor break condition is no longer applicable it is necessary to press ACK to cancel the alarm.
For heat only OP.HI and OP.LO can be set between 0.0% and +100%		
For cool only OP.HI and OP.LO can be set between -100.0% and 0%		

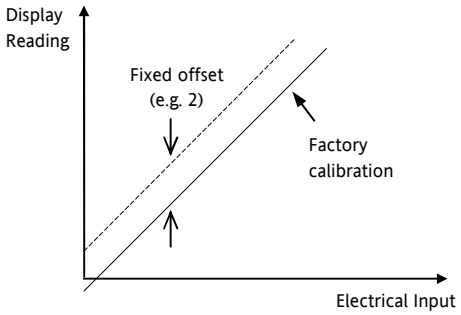
Note:- When the SAFE output value is outside the OP.LO and OP.HI limits it will be clipped into range and the controller will use the value (i.e. adjusting OP.LO or OP.HI changes the SAFE value so that it is in range).

It could take either the lower or higher OP limit depending on its value and which limit has changed. Therefore, if SAFE = 0 and OP.LO is changed to 10, SAFE will also be set to 10. If SAFE = 50 and OP.HI is changed to 40, SAFE will change to 40.

8.2 PV Offset

All ranges of the controller have been calibrated against traceable reference standards. This means that if the input type is changed it is not necessary to calibrate the controller. There may be occasions, however, when you wish to apply an offset to the standard calibration to take account of known errors within the process, for example, a known sensor error or a known error due to the positioning of the sensor. In these instances it is not advisable to change the reference (factory) calibration, but to apply a user defined offset.

PV Offset applies a single offset to the temperature or process value over the full display range of the controller and can be adjusted in Level 3. It has the effect of moving the curve up a down about a central point as shown in the example below:-



8.2.1 Example: To Apply an Offset:-

Connect the input of the controller to the source device which you wish to calibrate to

Set the source to the desired calibration value

The controller will display the current measurement of the value

If the display is correct, the controller is correctly calibrated and no further action is necessary. If you wish to offset the reading:-

Do This	Display	Additional Notes
1. Select Level 3 or Conf as described in section 6.1.3. Then press ⓘ to select 'INPUT'	INPUT	Scrolling display 'PROCESS INPUT LIST'
2. Press ⟳ to scroll to 'PV/OFS' 3. Press ▲ or ▼ to adjust the offset to the reading you require	2.0 PV.OFS	Scrolling display 'PV OFFSET' In this case an offset of 2.0 units is applied

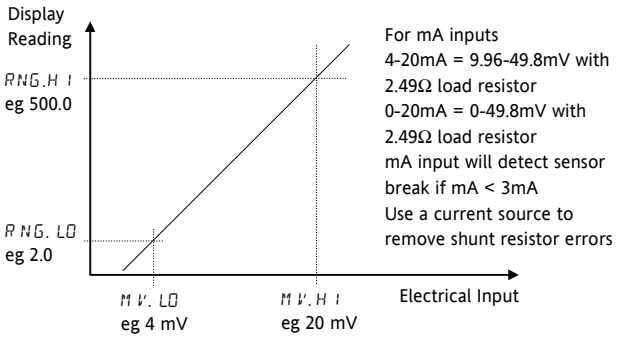
It is also possible to apply a two point offset which adjusts both low and high points. This is done in Level 3 using the CAL List, and the procedure is described in the Calibration section 16.

8.3 PV Input Scaling

Input scaling applies to the linear mV input range only. This is set by configuring the INPUT TYPE parameter to mV and has an input range of –10 to 80mV. Using an external burden resistor of 2.49Ω, the controller can be made to accept 4-20mA from a current source. Scaling of the input will match the displayed reading to the electrical input levels from the transducer. PV input scaling can only be adjusted in Configuration level and is not provided for direct thermocouple or RTD inputs.

The graph below shows an example of input scaling, where it is required to display 2.0 when the input is 4mV and 500.0 when the input is 20mV .

If the input exceeds ±5% of the mV.Lo or mV.Hi settings, sensor break will be displayed.



8.3.1 Example: To Scale a Linear Input

Select Configuration level as described in section 6.1.3. Then:-

Do This	Display	Additional Notes
1. Then press ⓘ to select 'INPUT'	INPUT	Scrolling display 'PROCESS INPUT LIST'
2. Press ⟳ to scroll to 'IN.TYP' 3. Press ▲ or ▼ to 'mV'	mV IN.TYP	Scrolling display 'INPUT TYPE'
4. Press ⟳ to scroll to 'MV.HI' 5. Press ▲ or ▼ to '20.00'	20.00 MV.HI	Scrolling display 'LINEAR INPUT HIGH'
6. Press ⟳ to scroll to 'MV.LO' 7. Press ▲ or ▼ to '4.00'	4.00 MV.LO	Scrolling display 'LINEAR INPUT LOW'
8. Press ⟳ to scroll to 'RHG.HI' 9. Press ▲ or ▼ to '500.0'	500.0 RHG.HI	In operator level the controller will read 500.0 for a mV input of 20.00
10. Press ⟳ to scroll to 'RNG.LO' 11. Press ▲ or ▼ to '2.0'	2.0 RHG.LO	In operator level the controller will read 2.0 for a mV input of 4.00

9. Input/Output

This section refers to:-

- Digital Inputs
- Current Transformer Input
- Relay/Logic Outputs.

The availability of these is shown in the following table:-

Name	Availability			Output	Input	Output Function	I/O Sense	Beacon (lit when active)	Terminal
	3216	3208 & 32h8	3204						
I/O-1	✓	✓	✓	✓	✓	Heat Cool Alarm Retransmission (setpoint, temperature, output)	Normal Inverted	OP1	1A, 1B
OP-2	✓	✓	✓	✓		Heat Cool Alarm Retransmission (setpoint, temperature, output)	Normal Inverted	OP2	2A, 2B
OP-3		✓	✓	✓		Heat Cool Alarm Retransmission (setpoint, temperature, output)	Normal Inverted	OP3	3A, 3B
OP4 (AA Relay)	✓	✓	✓	✓		Heat Cool Alarm	Normal Inverted	OP4	AA, AB, AC
LA	✓	✓	✓		✓		Normal Inverted		C, LA
LB		✓	✓		✓		Normal Inverted		LB, LC
CT	✓	✓	✓		✓				C, CT
Digital Comms	✓	✓	✓						HD, HE, HF

9.1 Input/Output Parameters

9.1.1 Input/Output 1 List (IO-1)

May be configured as relay, logic or DC output or to accept a digital input from external switch contacts. Connections are made to terminals 1A and 1B. OP1 beacon is operated from the IO-1 channel when it is configured as an output.

INPUT/OUTPUT LIST 1 'IO -1'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
I.I I	I/O 1 TYPE	I/O channel 1 hardware type defined by the hardware fitted	nonE	No input or output fitted	As ordered	Read only
			dC.OP	DC output - non-isolated (see note 1)		
			rELY	Relay output		
			LJO	Logic Input/Output		
			SSr	Triac output		
1FUNC	I/O 1 FUNCTION	I/O channel function. If the instrument is ordered as valve positioner (codes VC or VP), only options available are , nonE, d.outt, UP, or dwn **Note: If output 1 is set to UP ensure the other valve position output is set to dwn and vice versa**	nonE	Disabled. If disabled no further parameters are shown	HEAt	Conf
			d.outt	Digital output		
			UP	Valve open codes VC and VP only		
			dwn	Valve close codes VC and VP only		
			HEAt	Heat output		
			CoolL	Cool output		
			di n	Digital input if 'I I I' = 'LJ O'		
			w.SP	Working setpoint re-transmission	Shown if I/O 1 TYPE = dc.OP Retransmission	
			PU	Process variable re-transmission		
			OP	Output power demand re-transmission		
1SRC.A	I/O 1 SOURCE A	These parameters only appear when the channel function is a Digital output, i.e. 1.FUNC = d.outt Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.4	nonE	No event connected to the output	nonE	Conf
1SRC.B	I/O 1 SOURCE B		AL 1	Alarm 1		
1SRC.C	I/O 1 SOURCE C		AL2	Alarm 2		
			AL3	Alarm 3		
1SRC.D	I/O 1 SOURCE D		AL4	Alarm4		
			ALL.A	All alarms		
			nw.AL	Any new alarm		
			CtAL	CT alarm, load, leak & overcurrent		
			Lbr	Loop break alarm		
			Sbr	Sensor break alarm		
			t.End	Timer end status		
			trun	Timer run status		
			mAn	Manual status		
			rmt.F	Remote fail - see section 9.1.2		
			Pwr.F	Power fail		
			PrG.E	Programmer event. See also section 13.2.3		
I.I. IN	DIGITAL INPUT FUNCTION	This parameter is only applicable to I/O 1 and only appears if the channel function is a Digital IP i.e. 1.FUNC = di n Only one function may be activated by a physical input	nonE	Input not used	AcAL	Conf
			AcAL	Alarm acknowledge		
			SP2	Setpoint 2 select		
			Loc.b	Front keypad disable (keylock)		
			trES	Timer/programmer reset		
			trun	Timer/programmer run		
			trrS	Timer/programmer run/reset. Make to run, break to reset		
			t.HLd	Timer/programmer hold		
			mAn	Manual status		
			StbY	Standby mode. In this mode control outputs go to zero demand		
			rmt	Remote digital setpoint select		
			rEc	Recipe select through IO1 digital input		
			UP	Remote key 'Up'		
			dwn	Remote key 'Down'		

INPUT/OUTPUT LIST 1 'IO -1'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
I.PLS	OUTPUT 1 MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 1.0 to 150.0 seconds Auto = 110mS	5.0 sec for relay. Auto for logic	Conf
ISENS	I/O 1 SENSE	To configure the sense of the input or output channel See also section 9.1.3	nor Inu	Normal Inverted	nor	Conf
I.RNG	DC OUTPUT RANGE	To configure 0-20mA or 4-20mA output Only appears if the output module is DC output	0.20	0-20mA output		L3
			4.20	4-20mA output		

Note 1:-

A DC output may require calibration. This is described in section 16.3.4.

9.1.2 Remote Digital Setpoint Select and Remote Fail

These parameters were added in software version 1.11, and subsequent versions, and are associated with the retransmission of remote setpoint through master comms (see section 15.2.1). '*rmt*' allows the remote setpoint to be selected via a digital input and '*rmt.F*' is a flag which is set if no comms activity is detected for 5 seconds or more when writing to the remote setpoint. The flag is reset when writing to the remote setpoint resumes.

9.1.3 Sense

If the module is an output, 'normal' means a relay output is energised for 100% PID demand. For a heating or cooling output, set this parameter to '*nor*'.

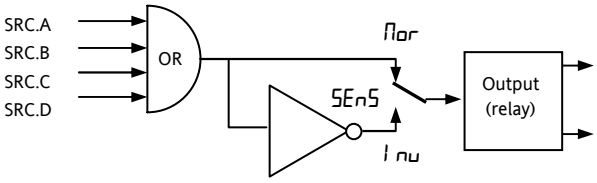
'Inverted' means a relay output is energised for 0% PID demand

For an alarm output set this parameter to '*Inu*' so that it de-energises to the alarm state.

If the module is an input, 'normal' means the function is activated when the input contact is closed, and 'inverted' means the function is activated when the input contact is open.

9.1.4 Source

The four parameters SOURCE A, SOURCE B, SOURCE C, and SOURCE D appear when the output is configured as a digital output i.e. '*1.FUNC*' = '*d.Out*' and provide the facility to connect up to four alarms or events to operate a single output (normally configured as a relay). If any one of the events becomes true then the output relay will operate.



9.1.5 Power Fail

An output, configured as a digital output, can be made to operate following a power fail. It can be acknowledged in the same manner as an alarm but no alarm message is given.

9.1.6 Example: To Configure IO-1 Relay to Operate on Alarms 1 and 2:-

Do This	Display	Additional Notes
1. From any display, press ▤ as many times as necessary to select 'I O -1'		Scrolling display '*IO -I LIST*'
2. Press ⟳ to scroll to '1.I D '		This is the identification of the hardware fitted and cannot be adjusted.
3. Press ⟳ to scroll to '1. F U N C ' 4. Press ▲ or ▼ to select '*d.out*'		The output is configured as a digital output function. Scrolling display '*IO I FUNCTION*'
5. Press ⟳ to scroll to '1.SRC.A' 6. Press ▲ or ▼ to select the event which you want to operate the output, eg '*AL.1*'		The output will activate if either alarm 1 or alarm 2 occur . Scrolling display '*IO I SOURCE A*'
7. If a second event is required to operate the same output, press ⟳ to select '1.SRC.B' 8. Press ▲ or ▼ to select the second event which you want to operate the output, eg '*AL2*'		Scrolling display '*IO I SOURCE B*' Continue to select up to four events if required using '*1.SRC.C* and *1.SRC.D*'
9. Press ⟳ to scroll to '**1.SENS**' 10. Press ▲ or ▼ to select '*Inu*'		'Inverted' means a relay output is energised for 0% PID demand 'Normal' means a relay output is energised for 100% PID demand Scrolling display '*IO I SENSE*'

9.1.7 Output List 2 (OP-2)

This is an optional normally open relay or logic output and is available on terminals 2A and 2B. The way in which this output operates is determined by parameters in the OP- 2 List. OP2 beacon is operated from this output channel.

OUTPUT LIST 2 'OP-2'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
2.1O	OUTPUT 2 TYPE	Output channel 2 hardware type	nonE	Output not fitted		As ordered	Read only
			rELY	Relay output			
			L.OP	Logic output (3200 only)			
			dC.OP	0-20mA output - non-isolated.	See note 1		
			dc.rt	0-20mA output - isolated. This parameter appears in 3216 controllers only when an isolated output is fitted (order code C)	See note 1		
			SSr	Triac output			
2.FUNC	FUNCTION	Output channel 2 function If the instrument is ordered as valve positioner (codes VC or VP), only options available are , nonE, d.out, UP, or dwn **Note: If output 2 is set to UP ensure the other valve position output is set to dwn and vice versa**	nonE	Disabled. If disabled no further parameters are shown		d.out	Conf
			d.out	Digital output			
			UP	Valve open codes VC and VP only			
			dwn	Valve close codes VC and VP only			
			HEAt	Heat output			
			CooL	Cool output			
			w.SP	Working setpoint re-transmission		Shown if I/O 2 TYPE = dc.OP Retransmission	
			PV	Process variable re-transmission			
			OP	Output power demand re-transmission			
2.SRC.A	I/O 2 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 2.FUNC = d.Out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.4.	nonE	No event connected to the output		nonE	Conf
2.SRC.B	I/O 2 SOURCE B		AL 1	Alarm 1 *			
2.SRC.C	I/O 2 SOURCE C		AL2	Alarm 2 *			
2.SRC.D	I/O 2 SOURCE D		AL3	Alarm 3 *			
			AL4	Alarm4 *			
			ALL.A	All alarms			
			nw.AL	Any new alarm			
			CtAL	CT alarm, load, leak & overcurrent			
			Lbr	Loop break alarm			
			Sbr	Sensor break alarm			
			t.End	Timer end status			
			t.run	Timer run status			
			mAn	Manual status			
			rmt.F	Remote fail - see section 9.1.2			
			Pwr.F	Power fail			
			PrG.E	Programmer event. See also section 13.2.3.			
2.PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 1.0 to 150.0 seconds Auto = 110mS		5.0 sec for relay Auto for logic	Conf
2.SENS	SENSE	To configure the polarity of output channel 2 See also section 9.1.3	nor	Normal		nor	Conf
			Inv	Inverted			
2.RNG	DC OUTPUT RANGE	To configure 0-20mA or 4-20mA output Only appears if the output module is DC output	0.20	0-20mA output			L3
			4.20	4-20mA output			

* The mnemonic for the alarm will change depending upon the alarm configuration.

Note 1:- A DC output may require calibration. This is described in section 16.3.4

9.1.8 Output List 3 (OP-3)

This is an optional normally open relay or 0-20mA isolated dc output and is available on terminals 3A and 3B on 3208 and 3204 only. The way in which this output operates is determined by parameters in the OP- 3 List. OP3 beacon is operated from this output channel.

OUTPUT LIST 3 'OP-3'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
3.I D	OUTPUT 3 TYPE	Output channel 3 hardware type	none	Output not fitted	As ordered	Read only
			rELY	Relay output		
			dC.OP	0-20mA output See note 1		
3.FUNC	FUNCTION	Output channel 3 function If the instrument is ordered as valve positioner (codes VC or VP), only options available are , none, d.out, UP, or dwn **Note: If output 3 is set to UP ensure the other valve position output is set to dwn and vice versa**	none	Disabled. If disabled no further parameters are shown	d.out	Conf
			UP	Valve open codes VC and VP only		
			dwn	Valve close codes VC and VP only		
			HEAt	Heat output		
			CooL	Cool output		
			w.SP	Working setpoint re-transmission	Shown if I/O 3 TYPE = dc.OP Retransmission	
			PV	Process variable re-transmission		
			OP	Output re-transmission		
3.SRC.A	I/O 3 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 3.FUNC = d.Out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.4.	none	No event connected to the output	none	Conf
3.SRC.B	I/O 3 SOURCE B		AL 1	Alarm 1 *		
3.SRC.C	I/O 3 SOURCE C		AL2	Alarm 2 *		
3.SRC.D	I/O 3 SOURCE D		AL3	Alarm 3 *		
			AL4	Alarm4 *		
			ALL.A	All alarms		
			nw.AL	Any new alarm		
			Lt.AL	CT alarm, load, leak & overcurrent		
			Lbr	Loop break alarm		
			Sbr	Sensor break alarm		
			t.End	Timer end status		
			t.run	Timer run status		
			mAn	Manual status		
			rmt.F	Remote fail - see section 9.1.2.		
			Pwr.F	Power fail		
			PrG.E	Programmer event. See also section 13.2.3.		
3.PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 1.0 to 150.0 seconds Auto = 110mS	5.0 sec for relay Auto for logic	Conf
3.SENS	SENSE	To configure the polarity of output channel 3 See also section 9.1.3.	nor	Normal	nor	Conf
			Inv	Inverted		
3.RNG	DC OUTPUT RANGE	DC output calibration. Only shown if 3.I D = dC.OP	4.20	4-20mA	4.20	Conf
			0.20	0-20mA		

Note 1:-

A DC output may require calibration. This is described in section 16.3.4

9.1.9 AA Relay (AA) (Output 4)

This is a changeover relay and is optionally available in 3200 controllers. Connections are made to terminals AA, AB, and AC. The way in which this relay operates is determined by parameters in the AA List. OP4 beacon is operated from the AA relay output channel.

AA RELAY 'AA'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
4TYPE	OUTPUT 4 TYPE	Output channel 4 hardware type	rELY	Relay output	rELY	Read only
4FUNC	FUNCTION	Output channel 4 function If the instrument is ordered as Valve Position (codes VC or VP), only values nonE, d.out, UP, or dwn are available **Note: If output 4 is set to uP ensure the other valve position output is set to dwn and vice versa**	nonE	Disabled	d.OUt	Conf
			d.OUt	Digital output		
			UP	Valve open codes VC and VP only		
			dwn	Valve close codes VC and VP only		
			HEAt	Heat output		
			CooL	Cool output		
4SRC.A	I/O 4 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 4.FUNC = d.Out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.4.	nonE	No event connected to the output	nonE	Conf
4SRC.B	I/O 4 SOURCE B		AL 1	Alarm 1 *		
4SRC.C	I/O 4 SOURCE C		AL2	Alarm 2 *		
4SRC.D	I/O 4 SOURCE D		AL3	Alarm 3 *		
			AL4	Alarm4 *		
			ALL.A	All alarms		
			nwAL	Any new alarm		
			CtAL	CT alarm, load, leak & overcurrent		
			Lbr	Loop break alarm		
			Sbr	Sensor break alarm		
			t.End	Timer end status		
			t.run	Timer run status		
			mAn	Manual status		
			rmt.F	Remote fail - see section 9.1.2.		
			Pwr.F	Power fail		
			PrG.E	Programmer event. See also section 13.2.3.		
4PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	0 to 150 seconds	5.0 sec	Conf
4SENS	SENSE	To configure the polarity of output channel 4 See also section 9.1.3.	nor	Normal	nor	Conf
			Inv	Inverted		

* The mnemonic for the alarm will change depending upon the alarm configuration.

9.1.10 Digital Input Parameters

Digital Input A. This is an optional input wired to terminals C and LA. The input is typically from a voltage free contact, which can be configured to operate a number of functions as determined by parameters in the LA List.

☺ 3216 controllers can be fitted with optional EIA232 digital communications. In this case the digital input is not available.

Note: Terminal C is common to the CT input and is, therefore, not isolated from the CT.

Digital Input B. This is wired to terminals LB and LC and is available in 3208 and 3204 controllers only.

The parameter lists are identical as shown below:-

LOGIC INPUT LIST 'LA' / 'LB'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
L.TYPE	LOGIC INPUT TYPE	Input channel type	LJP	Logic input	As order code	Conf Read only
L.I.IN	LOGIC INPUT FUNCTION	To configure the function of the digital input	nonE	Input not used	AcAL	Conf
			AcAL	Alarm acknowledge		
			SP2	Setpoint 2 select		
			Loc.b	Front keypad disable		
			t.rES	Timer/programmer reset		
			t.run	Timer/programmer run		
			t.rrS	Timer/programmer run/reset. Make to run, break to reset		
			t.HLd	Timer/programmer hold		
			mAn	Manual status		
			Sby	Standby mode. In this mode control outputs go to zero demand		
			rmt	To allow a remote setpoint to be selected through the LA digital input. See section 9.1.2		
			rEc	Recipe select through IO1 digital input		
			UP	Remote key 'Up'		
			dwn	Remote key 'Down'		
L.SENS	LOGIC INPUT SENSE	To configure the polarity of the input channel	nor	Normal	nor	Conf
			Inu	Inverted		
			4.20	4-20mA output		

9.2 Current Transformer Input Parameters

This is optional on 3200 controllers and can measure, via an external current transformer, the current flowing through the electrical load when the heat output is 'on' (load current) and also when it is 'off' (leakage current).

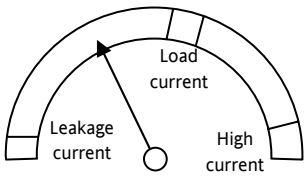
☺ 3216 controllers can be fitted with optional EIA232 digital communications. In this case the current transformer input is not available.

Alarm — If the load current is lower than a threshold limit or the leakage current is higher than a threshold limit, then an alarm triggers. The hysteresis to exit from either of these alarm conditions is fixed at 2% of the current transformer span.

Full scale value — Selectable from 10 to 1000A

CURRENT TRANSFORMER LIST 'CT-INP'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
CT.ID	MODULE TYPE	CT module identity	CtIn	CT input circuit fitted	As order code	Conf read only
CT.SRC	CT SOURCE	Selects the output controlling the current measured by the CT input. The source can only be selected if the output has been configured for Heat or Cool	nonE	None		
			IO-1	Input/output 1		
			OP-2	Output 2		
			AA	AA Relay		
CT.RNG	CT RANGE	Sets the CT inputs range	0 to CT full scale value (1000)		As order code	Conf
CT.LAT	CT ALARM LATCH TYPE	To configure the latch mode of the CT input alarm. A description of alarm latching is given in the alarm section	nonE	No latching	no	Conf if CT alarm enabled
			Auto	Latched with automatic reset		
			mAn	Latched with manual reset		
LD.ALM	LOAD CURRENT THRESHOLD	Load open circuit alarm threshold – low alarm	OFF to CT full scale value (settable to 3000)			Read only
LK.ALM	LEAK CURRENT THRESHOLD	Leakage current in the off state alarm threshold – high alarm	OFF to CT full scale value (settable to 3000)			Read only
HC.ALM	OVER CURRENT THRESHOLD	Overcurrent threshold – high alarm	OFF to CT full scale value (settable to 3000)			
LD.AMP	LOAD CURRENT	Measured load current				L3 if CT input enabled
LK.AMP	LEAK CURRENT	CT input leakage current				L3 if CT input enabled
CT.MTR	CT METER RANGE	To set the range of the meter. 3208 and 3204 only.	0 to 1000			L3

9.2.1 Analogue Representation of Current Alarms



The meter is available in 3208 and 3204 controllers only.

10. Setpoint Generator

The setpoint generator provides the target value at which it is required to control the process. It is shown in the controller block diagram, Section 7. The following functions are available:-

Number of setpoints: Two - setpoint 1 (SP1) and setpoint 2 (SP2).
Each may be selected by a dedicated parameter or externally switched via a digital input suitably configured as described in section 9.1.10.
An application example might be to use SP1 for normal operation and SP2 to maintain a low overnight temperature.

Setpoint limits: High and low limits can be pre-set to prevent inadvertent adjustment of the setpoint beyond that allowable for the process

Set point rate limit: Allows the setpoint to change from its current level to a new level at a fixed rate.

Direct setpoint access: The selected setpoint is accessible directly from the HOME display by pressing the raise or lower buttons

10.1 Setpoint Parameters

SETPOINT LIST 'SP'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
SP.SEL	SETPOINT SELECT	This enables the main or secondary setpoint to be selected form the front panel buttons	SP1	Setpoint 1 selected	SP1	L3
			SP2	Setpoint 2 selected		
SP1	SETPOINT 1	Main or normally selected setpoint	Low to high setpoint limits		0	L3
SP2	SETPOINT 2	Secondary or standby setpoint	Low to high setpoint limits		0	L3
SP.HI	SETPOINT HIGH LIMIT	Maximum allowable setpoint setting	Setpoint low limit (SP.LO) to high range limit. Also limited by the RNG.HI and RNG.LO parameters		Range High Limit	L3
SP.LO	SETPOINT LOW LIMIT	Minimum allowable setpoint setting	Low range limit to Setpoint high limit (SP.HI). Also limited by the RNG.HI and RNG.LO parameters		Range Low Limit	L3
REM.SP	REMOTE SETPOINT	Reads the current remote setpoint value when remote setpoint is in use				Read only
L-R	REMOTE SETPOINT SELECT	To select the remote digital communications setpoint	no	Not selected	no	Conf
			YES	Selected		
SP.RAT	SETPOINT RATE LIMIT	Limits the rate of change of the setpoint. Operates on both SP1 and SP2	Step change (OFF) or 0.1 to 3000 display units per minute. Resolution one decimal place more than PV		OFF	L3
RAMPU	SETPOINT RAMP UNITS	To set the units for the setpoint rate limit	min	Minutes	min	L3
			Hour	Hours		
			SEC	Seconds		
LOC.T	LOCAL SETPOINT TRIM	Local trim on remote setpoint. Applies a fixed offset to the remote setpoint	-199.9 to 300.0		0.0	L3
REM.HI	REMOTE INPUT HIGH SCALAR	Sets the maximum scale limit for the remote setpoint	Between Setpoint High and Low Limits up to firmware version 2.11. From 2.11 the values can be varied within the entire instrument range. This allows, for example, a 0-5V device to be used with a 0-10V input such that the 5V can correspond to the full setpoint range.			L3
REM.LO	REMOTE INPUT LOW SCALAR	Sets the minimum scale limit for the remote setpoint				
ROP.HI	SETPOINT RETRANS HIGH	Sets the upper limit for the setpoint retransmission	These two parameters have been added from firmware version 2.11. They replace Setpoint High and Low Limits as the outer limits for a retransmitted setpoint. In versions prior to 2.11 the transmitted setpoint is scaled against its full range. Setpoint Retrans High & Low allow the retransmitted setpoint to be scaled against a sub-range. The values correspond to the setpoint transmitted at 4 and 20mA – if the setpoint is outside this range then it is clipped.			L3
ROP.LO	SETPOINT RETRANS LOW	Sets the lower limit for the setpoint retransmission				L3

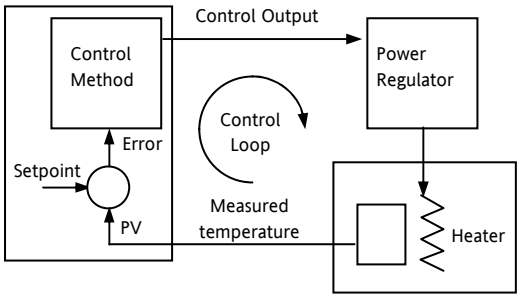
10.2 Example: To Set Ramp Rate

This is available in Level 3.

Do This	The Display You Should See	Additional Notes
1. Press ⓘ as many times as necessary to select **'SETPOINT LIST'**		
2. Press ⟳ as many times as necessary to scroll to 'SP1' 3. Press ▲ or ▼ to adjust setpoint 1		This step can be repeated for the lower setpoint limit 'SP.LO'
4. Press ⟳ to scroll to 'SP2' 5. Press ▲ or ▼ to adjust setpoint 2		
6. Press ⟳ as many times as necessary to scroll to 'SP.RAT' 7. Press ▲ or ▼ to set the rate at which you require the setpoint to change		Whenever the setpoint is changed, the controller will ramp from its current setpoint to the new value at the rate set in units per second, minute or hours as set by the 'RAMPU' parameter. It will also change at the same rate when switching between SP2 and SP1 (but not between SP1 and SP2) The setpoint rate resolution is generally one decimal point more than setpoint/PV resolution

11. Control

Parameters in this section allow the control loop to be set up for optimum control conditions. An example of a temperature control loop is shown below:-



The actual temperature measured at the process (PV) is connected to the input of the controller. This is compared with a setpoint (or required) temperature (SP). If there is an error between the set and measured temperature the controller calculates an output value to call for heating or cooling. The calculation depends on the process being controlled but normally uses a PID algorithm. The output(s) from the controller are connected to devices on the plant which cause the heating (or cooling) demand to be adjusted which in turn is detected by the temperature sensor. This is referred to as the control loop or closed loop control.

11.1 Types of Control

Three types of control loop may be configured. These are On/Off control, PID control or control of motorised valves

11.1.1 On/Off Control

On/Off control is the simplest means of control and simply turns heating power on when the PV is below setpoint and off when it is above setpoint. As a consequence, On/Off control leads to oscillation of the process variable. This oscillation can affect the quality of the final product and may be used on non-critical processes. A degree of hysteresis must be set in On/Off control if the operation of the switching device is to be reduced and relay chatter is to be avoided.

If cooling is used, cooling power is turned on when the PV is above setpoint and off when it is below.

It is suitable for controlling switching devices such as relays, contactors, triacs or digital (logic) devices.

11.1.2 PID Control

PID, also referred to as 'Three Term Control', is an algorithm which continuously adjusts the output, according to a set of rules, to compensate for changes in the process variable. It provides more stable control but the parameters need to be set up to match the characteristics of the process under control.

The three terms are:

Proportional band PB

Integral time TI

Derivative time TD

The output from the controller is the sum of the contributions from these three terms. The combined output is a function of the magnitude and duration of the error signal, and the rate of change of the process value.

It is possible to turn off integral and derivative terms and control on proportional only (P), proportional plus integral (PI) or proportional plus derivative (PD).

PI control might be used, for example, when the sensor measuring an oven temperature is susceptible to noise or other electrical interference where derivative action could cause the heater power to fluctuate wildly.

PD control may be used, for example, on servo mechanisms.

In addition to the three terms described above, there are other parameters which determine how well the control loop performs. These include Cutback terms, Relative Cool Gain, Manual Reset and are described in detail in subsequent sections.

11.1.3 Motorised Valve Control

This algorithm is designed specifically for positioning motorised valves. It operates in boundless mode (sometimes called unbounded) which does not require a position feedback potentiometer to operate. It is a velocity mode algorithm which directly controls the direction and velocity of the movement of the valve in order to minimise the error between the setpoint and the PV. It uses triac or relay outputs to drive the valve motor.

11.1.3.1 Motorised Valve Control in Manual mode

When manual is selected the algorithm predicts where the valve will move to based on the edit of the manual power. Effectively, when the raise or lower key is pressed, +100% or –100% velocity is used for the duration of the key press and the raise or lower output is turned on. In boundless mode it is essential that the Motor Travel Time, 'MTR.T' is set correctly in order for the integral time to calculate correctly. Motor travel time is defined as **valve** fully open – **valve** fully closed - it is not necessarily the time printed on the motor since, if mechanical stops have been set on the motor, the travel time of the actual valve may be different. Also, if the travel time for the valve is set correctly, the position indicated on the controller will fairly accurately match the actual valve position.

Every time the valve is driven to its end stops the algorithm is reset to 0% or 100% to compensate for any changes which may occur due to wear in linkages or other mechanical parts.

11.2 Control Parameters

The control loop is configured by the parameters listed in the following table:-

CONTROL LIST 'CTRL'					
Parameter Name	Parameter Description (Scrolling Display)	Value		Default	Access Level
CTRL.H	HEATING TYPE Selects the channel 1 control algorithm. Different algorithms may be selected for channels 1 and 2. In temperature control applications, Ch1 is usually the heating channel, Ch2 is the cooling channel.	Pid	PID	As order code	Conf
		oFF	Heating off		
		onoF	On/Off		
		mtr	Valve position control		
CTRL.C	COOLING TYPE Selects the channel 2 Control algorithm. Different algorithms may be selected for channels 1 and 2. This is not available if the instrument is a valve position controller	oFF	Cooling disable	As order code	Conf
		Pid	PID		
		onoF	On/Off		
CTRL.A	CONTROL ACTION Selects the direction of the control. i.e reverse or direct acting.	rEu	Reverse acting. Output decreases as PV increases	rEu	Conf
		dir	Direct acting. Output increases as PV decreases		
PB.UNT	PROPORTIONAL BAND UNITS	EnG	In engineering units		
		PErc	In percent		
ATUNE	AUTO-TUNE ENABLE	OFF	Auto-tune off	OFF	L3
		On	Set to 'on' to start auto-tuning		
		FAIL	Displayed if Autotune cannot be completed		
AT.R2G	AUTOTUNE CONFIGURES R2G See section 11.4 for an explanation.	YES	R2G will be set by Auto-tune	YES	Conf
		No	Allows a value for R2G to be entered manually		
PB	PROPORTIONAL BAND See also section 11.2.1	0.1 to 9999 display units or 1 to 999.9% if proportional band expressed as %		20	L3
TI	INTEGRAL TIME See also section 11.2.2	OFF to 9999 seconds		360 sec	L3
TD	DERIVATIVE TIME See also section 11.2.3	OFF to 9999 seconds TD defaults to OFF for valve position control		60 sec	L3
R2G	RELATIVE COOL GAIN See also section 11.2.4	0.1 to 10.0		1.0	L3
CBHI	CUTBACK HIGH See also section 11.2.5	Auto or 1to 3000 display units		Auto = 3xPb	L3
CBLO	CUTBACK LOW See also section 11.2.5	Auto or 1 to 3000 display units		Auto = 3XPb	L3
MR	MANUAL RESET	0.0 to 100.0% (heat only) -100.0 to 100.0% (heat/cool)		0.0%	L3
LBT	LOOP BREAK TIME The loop break alarm attempts to detect loss of restoring action in the control loop by checking the control output, the process value and its rate of change. Loop break detection works for all control algorithms: PID, VP and ON-OFF. Note: This is not to be confused with load failure and partial load failure.	OFF	Setting loop Break Time to OFF disables the Loop Break Alarm	OFF	L3
		1 to 9999 minutes			

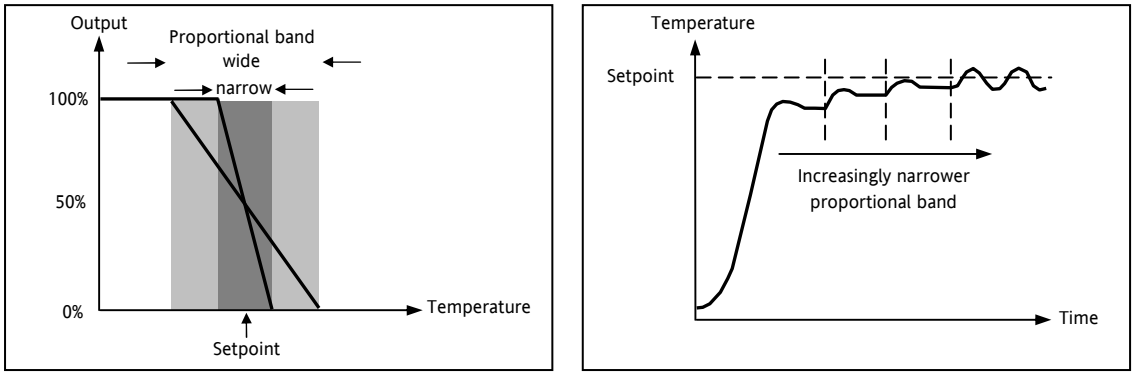
CONTROL LIST 'CTRL'					
Parameter Name	Parameter Description (Scrolling Display)	Value		Default	Access Level
OP.HI	OUTPUT HIGH Adjust to limit the maximum heating power applied to the process	±100.0%		100.0%	L3
OP.LO	OUTPUT LOW Adjust to limit the maximum cooling power applied to the process or to apply a minimum heating power	±100.0%		0.0 (heat only) -100 (cool)	L3
MTR.T	MOTOR TRAVEL TIME Set this value to the time that it takes for the motor to travel from its fully closed to its fully open position.	0.0 to 999.9 seconds Note: In motorised valve control only the PB and TI parameters are active. The TD parameter has no effect on the control.		0.0	L3
D.BAND	CHANNEL 2 DEAD BAND Period when no output is demanded from either channel 1 or channel 2 Adjust, for example, to increase the period when no heating or cooling power is applied	OFF or 0.1 to 100.0% of the cooling proportional band		OFF	L3
HYST.H	HEATING HYSTERESIS	1 to 9999 display units		1	L3 On/off only
HYST.C	COOLING HYSTERESIS			1	
SAFE	SAFE OUTPUT POWER To set the output level in a sensor break (open circuit) condition	-100.0 to 100.0% limited by OP.HI and OP.LO		0.0%	L3
F.MOD	FORCED MANUAL OUTPUT MODE Selects how the loop behaves on transfer from Auto to Manual. Transfer from Manual to Auto is always bumpless.	none	Transfer between Auto/Manual/Auto is bumpless	none	L3
		STEP	Transfer from Auto to Manual, the output goes to a pre-set value (F.OP)		
		LAST	Transfer from Auto to Manual, the output goes to the previously set manual value		
COOL T	NON-LINEAR COOLING TYPE This selects an algorithm most suited to the type of cooling. Typically used in extruders.	Lin	Linear	As order code	Conf
		OIL	Oil cooling		
		H2O	Water cooling		
		FAn	Forced air cooling		
F.OP	FORCED OUTPUT To pre-set a value for the Manual output when F.MOD = STEP	-100.0 to 100.0% limited by OP.HI and OP.LO		0.0	L3
A-M	LOOP MODE – AUTO MANUAL OFF see also section 4.4.4.	Auto	To select automatic operation		L3
		mAn	To select manual operation		
		OFF	Control outputs inhibited		
LBR	LOOP BREAK STATUS	No	Shows the current status of loop break.		Read only
		YES			
TU.HI	TUNE HIGH LIMIT. Set this to limit the maximum heating output during autotune		Range between OP.HI and OP.LO		L3
TU.LO	TUNE LOW LIMIT. Set this to limit the maximum cooling output during autotune				

Parameters are further described in the following sections.

11.2.1 Proportional Band 'PB'

The proportional band, or gain, delivers an output which is proportional to the size of the error signal. It is the range over which the output power is continuously adjustable in a linear fashion from 0% to 100% (for a heat only controller). Below the proportional band the output is full on (100%), above the proportional band the output is full off (0%) as shown in the diagram below.

The width of the proportional band determines the magnitude of the response to the error. If it too narrow (high gain) the system oscillates by being over responsive. If it is too wide (low gain) the control is sluggish. The ideal situation is when the proportional band is as narrow as possible without causing oscillation.



The diagram also shows the effect of narrowing proportional band to the point of oscillation. A wide proportional band results in straight line control but with an appreciable initial error between setpoint and actual temperature. As the band is narrowed the temperature gets closer to setpoint until finally becoming unstable.

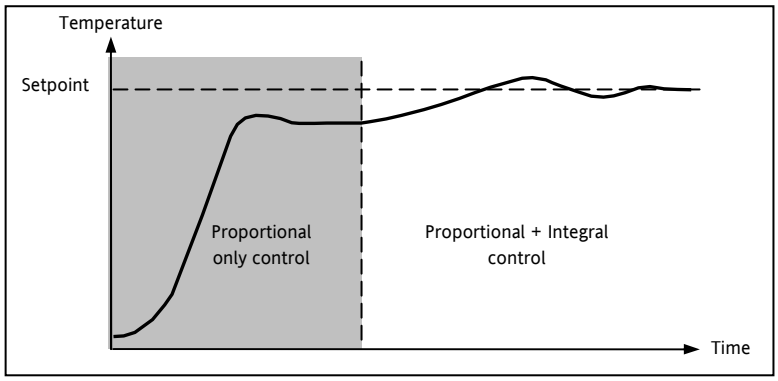
The proportional band may be set in engineering units or as a percentage of the controller range.

11.2.2 Integral Term 'TI'

In a proportional only controller, an error between setpoint and PV must exist for the controller to deliver power. Integral is used to achieve **zero** steady state control error.

The integral term slowly shifts the output level as a result of an error between setpoint and measured value. If the measured value is below setpoint the integral action gradually increases the output in an attempt to correct the error. If it is above setpoint integral action gradually decreases the output or increases the cooling power to correct the error.

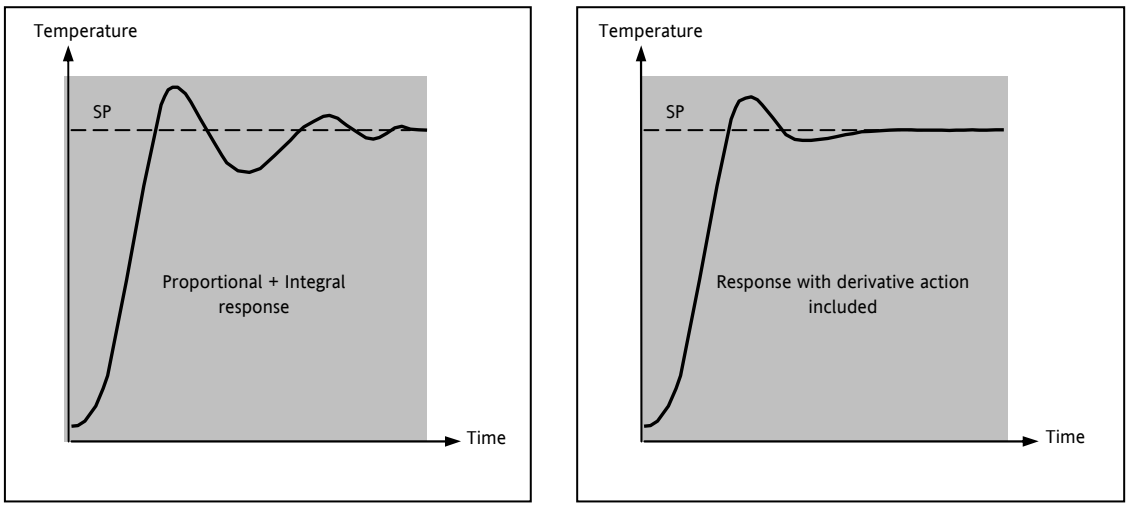
The diagram below shows the result of introducing integral action.



The units for the integral term are measured in time (1 to 9999 seconds in 3200 controllers). The longer the integral time constant, the more slowly the output is shifted and results in a sluggish response. Too small an integral time will cause the process to overshoot and even oscillate. The integral action may be disabled by setting its value to Off.

11.2.3 Derivative Term 'TD'

Derivative action, or rate, provides a sudden shift in output as a result of a rapid change in error. If the measured value falls quickly derivative provides a large change in output in an attempt to correct the perturbation before it goes too far. It is most beneficial in recovering from small perturbations.



The derivative modifies the output to reduce the rate of change of error. It reacts to changes in the PV by changing the output to remove the transient. Increasing the derivative time will reduce the settling time of the loop after a transient change.

Derivative is often mistakenly associated with overshoot inhibition rather than transient response. In fact, derivative should not be used to curb overshoot on start up since this will inevitably degrade the steady state performance of the system. Overshoot inhibition is best left to the approach control parameters, High and Low Cutback, section 11.2.5.

Derivative is generally used to increase the stability of the loop, however, there are situations where derivative may be the cause of instability. For example, if the PV is noisy, then derivative can amplify that noise and cause excessive output changes, in these situations it is often better to disable the derivative and re-tune the loop.

If set to Off(0), no derivative action will be applied.

In 3200 controllers derivative is calculated on change of PV. For applications such as furnace temperature control, it is common practice to use Derivative on PV to prevent thermal shock caused by a sudden change of output as a result of a change in setpoint.

11.2.4 Relative Cool Gain 'R2G'

The proportional band parameter 'PB' adjusts the proportional band for the heating output. Relative cool gain adjusts the cooling proportional band relative to the heating proportional band. If the rate of heating and rate of cooling are widely different it may be necessary to manually adjust Relative Cool Gain to achieve the optimum settings for the cooling proportional band. A nominal setting of around 4 is often used.

Note, This parameter is set automatically when Auto-tune is used unless the parameter 'AT.R2G' is set to 'No' - see section 11.4.

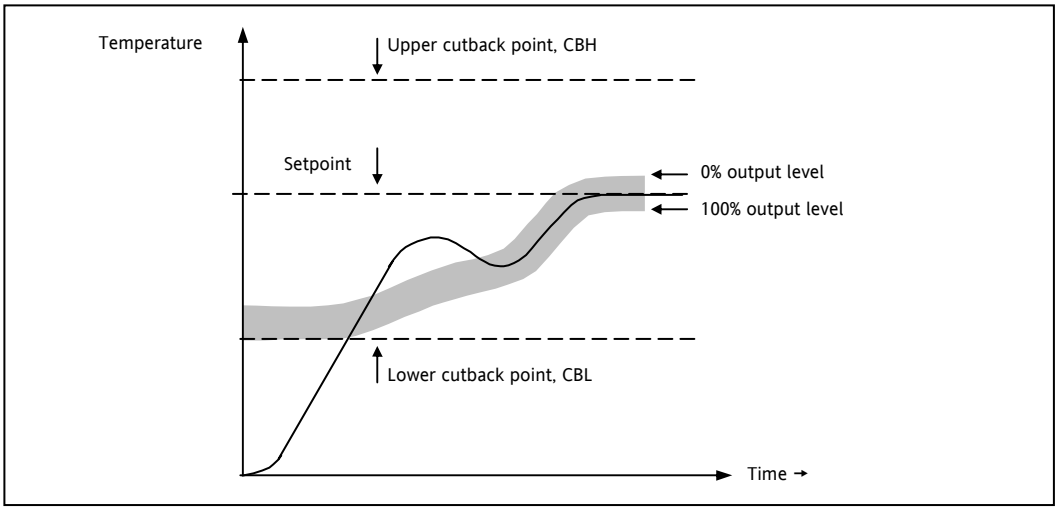
11.2.5 High and Low Cutback

Cutback high **'CBHI'** and Cutback low '**CBLO**' are values that modify the amount of overshoot, or undershoot, that occurs during large step changes in PV (for example, under start-up conditions). They are independent of the PID terms which means that the PID terms can be set for optimal steady state response and the cutback parameters used to modify any overshoot which may be present.

Cutback involves moving the proportional band towards the cutback point nearest the measured value whenever the latter is outside the proportional band and the power is saturated (at 0 or 100% for a heat only controller). The proportional band moves downscale to the lower cutback point and waits for the measured value to enter it. It then escorts the measured value with full PID control to the setpoint. In some cases it can cause a 'dip' in the measured value as it approaches setpoint, as shown in the diagram below, but generally decreases the time needed to bring the process into operation.

The action described above is reversed for falling temperature.

If cutback is set to Auto the cutback values are automatically configured to 3*PB.



11.2.6 Manual Reset

In a full three-term controller (that is, a PID controller), the integral term automatically removes the steady state error from the setpoint. If the controller is set as a PD controller, the integral term will be set to 'OFF'. Under these conditions the measured value may not settle precisely at setpoint. The Manual Reset parameter (MR) 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.

11.2.7 Control Action

When set to reverse (rEv) the output increases when the PV is below setpoint. This is the best setting for heating control.

For cooling control only set Control Action to direct (dIr).

11.2.8 Loop Break

The loop is considered to be broken if the PV does not respond to a change in the output. Since the time of response will vary from process to process the **Loop Break Time** parameter allows a time to be set before a **Loop Break Alarm** is initiated. In these circumstances the output power will drive to high or low limit. For a PID controller, if the PV has not moved by 0.5 x Pb in the loop break time the loop is considered to be in break. The loop break time is set by the Auto-tune, a typical value is 12 x Td. For an On/Off controller Loop Break Time is not shown and loop break alarm is inhibited.

11.2.9 Cooling Algorithm

The method of cooling may vary from application to application.

For example, an extruder barrel may be cooled by forced air (from a fan), or by circulating water or oil around a jacket. The cooling effect will be different depending on the method. The cooling algorithm may be set to linear where the controller output changes linearly with the PID demand signal, or it may be set to water, oil or fan where the output changes non-linearly against the PID demand. The algorithm provides optimum performance for these methods of cooling.

11.3 Tuning

In tuning, you match the characteristics (PID parameters) 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 PV at setpoint without fluctuation
- No overshoot, or undershoot, of the PV setpoint
- Quick response to deviations from the setpoint caused by external disturbances, thereby rapidly restoring the PV to the setpoint value.

Tuning involves setting the following parameters:-

Proportional Band 'PB', Integral Time 'TI', Derivative Time 'TD', Cutback High 'CBHI', Cutback Low 'CBLO', and Relative Cool Gain 'R2G' (applicable to heat/cool systems only).

The controller is shipped with these parameters set to default values. In many cases the default values will give adequate stable straight line control, however, the response of the loop may not be ideal. Because the process characteristics are fixed by the design of the process it is necessary to adjust the control parameters in the controller to achieve best control. To determine the optimum values for any particular loop or process it is necessary to carry out a procedure called loop tuning. If significant changes are later made to the process which affect the way in which it responds it may be necessary to retune the loop.

Users have the choice of tuning the loop automatically or manually. Both procedures require the loop to oscillate and both are described in the following sections.

11.3.1 Loop Response

If we ignore the situation of loop oscillation, there are three categories of loop performance:

Under Damped - In this situation the terms are set to prevent oscillation but do lead to an overshoot of the Process Value followed by decaying oscillation to finally settle at the Setpoint. This type of response can give a minimum time to Setpoint but overshoot may cause problems in certain situations and the loop may be sensitive to sudden changes in Process Value. This will result in further decaying oscillations before settling once again.

Critically Damped - This represents an ideal situation where overshoot to small step changes does not occur and the process responds to changes in a controlled, non oscillatory manner.

Over Damped - In this situation the loop responds in a controlled but sluggish manner which will result in a loop performance which is non ideal and unnecessarily slow.

The balancing of the P, I and D terms depends totally upon the nature of the process to be controlled.

In a plastics extruder, for example, a barrel zone will have a different response to a die, casting roll, drive loop, thickness control loop or pressure loop. In order to achieve the best performance from an extrusion line all loop tuning parameters must be set to their optimum values.

11.3.2 Initial Settings

In addition to the tuning parameters listed in section 11.3 above, there are a number of other parameters which can have an effect on the way in which the loop responds. Ensure that these are set before either manual or automatic tuning is initiated. Parameters include, but are not limited to:-

Setpoint. Set this as closely as practicable to the actual setpoint in normal operation.

Load Conditions. Set the load conditions as closely as possible to those which will be met in practice. For example, in a furnace or oven application a representative load should be included, an extruder should be running, etc.

Heat/Cool Limits. The minimum and maximum power delivered to the process may be limited by the parameters 'OUTPUT LOW' and 'OUTPUT HIGH' both of which are found in the Control list. For a heat only controller the default values are 0 and 100%. For a heat/cool controller the defaults are -100 and 100%. Although it is expected that most processes will be designed to work between these limits there may be instances where it is desirable to limit the power delivered to the process. For example, if driving a 220V heater from a 240V source the heat limit may be set 80% to ensure that the heater does not dissipate more than its maximum power.

☺ The measured value *must* oscillate to some degree for the tuner to be able to calculate values. The limits must be set to allow oscillation about the setpoint.

Channel 2 Deadband. In controllers fitted with a second (cool) channel a parameter 'D.BAND' is also available in the Control list, which sets the distance between the heat and cool proportional bands. The default value is 0% which means that heating will turn off at the same time as cooling turns on. The deadband may be set to ensure that there is no possibility of the heat and cool channels being on together, particularly when cycling output stages are installed.

Minimum Pulse Time. If either or both of the output channels is fitted with a relay, triac or logic output, the parameter **'-.PLS'** will appear in the relevant output list (IO-1 list, OP-2 list, OP-3 list or AA Relay Output list). This is the cycling time for a time proportioning output and should be set correctly before tuning is started.

Input Filter Time Constant. The parameter 'FILTER TIME' should be set before tuning the loop. It is found in the INPUT List.

Valve Travel Time. If the output is a motor valve positioner the parameter 'MTR.T' (Control List) should be set to the time that it takes for the motor to travel from its fully closed to its fully open position.

Other Considerations

- If a process includes adjacent interactive zones, each zone should be tuned independently.
- It is always better to start a tune when the PV and setpoint are far apart. This allows start up conditions to be measured and cutback values to be calculated more accurately.
- In a programmer/controller tuning should only be attempted during dwell periods and not during ramp stages. If a programmer/controller is tuned automatically put the controller into Hold during each dwell period whilst autotune is active. It may be worth noting that tuning, carried out in dwell periods which are at different extremes of temperature may give different results owing to non linearity of heating (or cooling).

11.3.3 Automatic Tuning

Auto Tune automatically sets the following parameters:-

Proportional Band '**PB'**	
Integral Time '**Ti'**	If '**Ti**' and/or '**Td**' is set to OFF, because you wish to use PI, PD or P only control, these terms will remain off after an autotune.
Derivative Time '**Td'**	
Cutback High '**CBHI'**	If CBH and/or CBL is set to '**Auto'** these terms will remain at Auto after an autotune, i.e. 3*PB. For autotune to set the cutback values, CBHI and CBLO must be set to a value (other than Auto) before autotune is started. Autotune will never return cutback values which are less than 1.6*PB.
Cutback Low '**CBLO'**	
Relative Cool Gain '**R2G'**	R2G is only calculated if the controller is configured as heat/cool. Following an autotune, '**R2G'** is always limited to between 0.1 and 10. If the calculated value is outside this limit a 'Tune Fail' alarm is given.
Loop Break Time '**LBT'**	Following an autotune, '**LBT**' is set to 2*Ti (assuming the integral time is not set to OFF). If 'Ti' is set to OFF then 'LBT' is set to 12*Td.

Auto tune uses the 'one-shot' tuner which works by switching the output on and off to induce an oscillation in the process value. From the amplitude and period of the oscillation, it calculates the tuning parameter values. The autotune sequence for different conditions is described in sections 11.3.5 to 0.

11.3.4 To Start Autotune

In operator levels 2 or 3, set the 'AUTO-TUNE ENABLE' parameter to 'On'.

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.

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), it may be necessary to tune again for the new conditions.

The auto tune algorithm reacts in different ways depending on the initial conditions of the plant. The explanations given in this section are for the following conditions:-

1. Initial PV is below the setpoint and, therefore, approaches the setpoint from below for a heat/cool control loop
2. Initial PV is below the setpoint and, therefore, approaches the setpoint from below for a heat only control loop
3. Initial PV is at the same value as the setpoint. That is, within 0.3% of the range of the controller if '**PB.UNT**' is set to '**percent**' or ±1 engineering unit (1 in 1000) if the '**PB.UNT**' is set to '**Eng**'. Range is defined as 'Range High Limit' to 'Range Low Limit' for process inputs or the range defined in section 8.1 for temperature inputs.

☺ If the PV is just outside the range stated above the autotune will attempt a tune from above or below SP.

☺ If the controller is autotuning and sensor break occurs, the autotune will abort. Autotune must be re-started when the sensor break condition is no longer present.

☺ If an Autotune cannot be performed an error message, $Etun$, will be flashed in the display

11.3.5 Autotune from Below SP – Heat/Cool

The point at which Automatic tuning is performed (Tune Control Point) is designed to operate just below the setpoint at which the process is normally expected to operate (Target Setpoint). This is to ensure that the process is not significantly overheated or overcooled. The Tune Control Point is calculated as follows:-

Tune Control Point = Initial PV + 0.75(Target Setpoint – Initial PV).

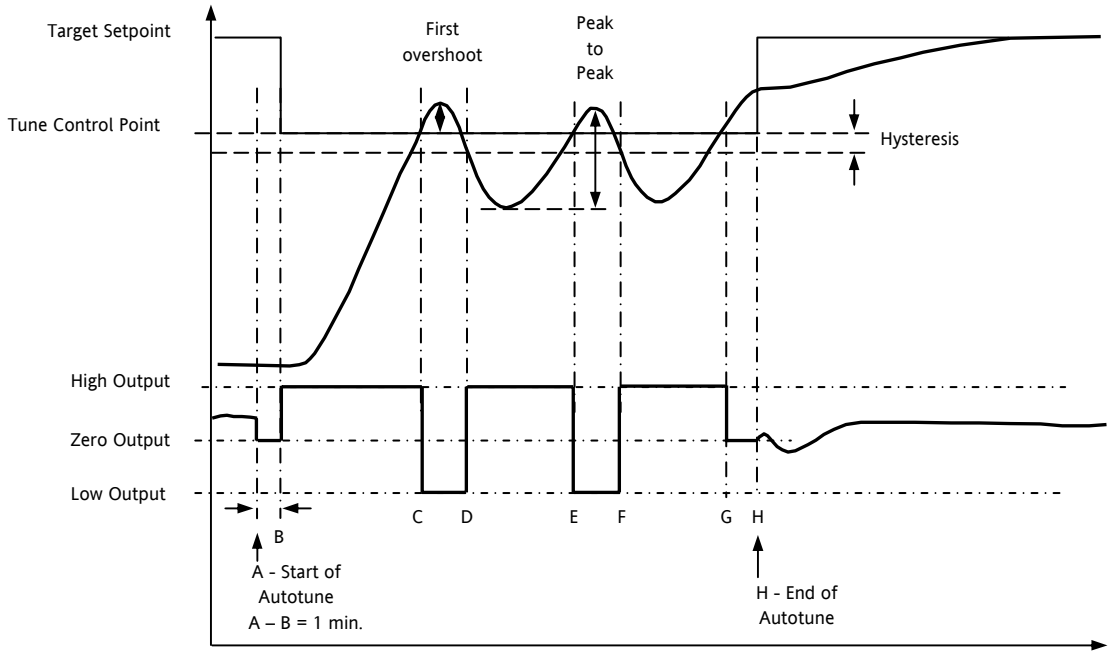
The Initial PV is the PV measured at 'B' (after a 1 minute settling period)

Examples: If Target Setpoint = 500^{O}C and Initial PV = 20^{O}C, then the Tune Control Point will be 380^{O}C.

If Target Setpoint = 500^{O}C and Initial PV = 400^{O}C, then the Tune Control Point will be 475^{O}C.

This is because the overshoot is likely to be less as the process temperature is already getting close to the target setpoint.

The sequence of operation for a tune from below setpoint for a heat/cool control loop is described below:-



Period	Action
A	Start of Autotune
A to B	Both heating and cooling power remains off for a period of 1 minute to allow the algorithm to establish steady state conditions.
B to D	First heat/cool cycle to establish first overshoot. 'CBLO' is calculated on the basis of the size of this overshoot (assuming it is not set to Auto in the initial conditions).
B to F	Two cycles of oscillation are produced from which the peak to peak response and the true period of oscillation are measured. PID terms are calculated
F to G	An extra heat stage is provided and all heating and cooling power is turned off at G allowing the plant to respond naturally. Measurements made during this period allow the relative cool gain 'R2G' to be calculated. 'CBHI' is calculated from CBLO*R2G.
H	Autotune is turned off at and the process is allowed to control at the target setpoint using the new control terms.

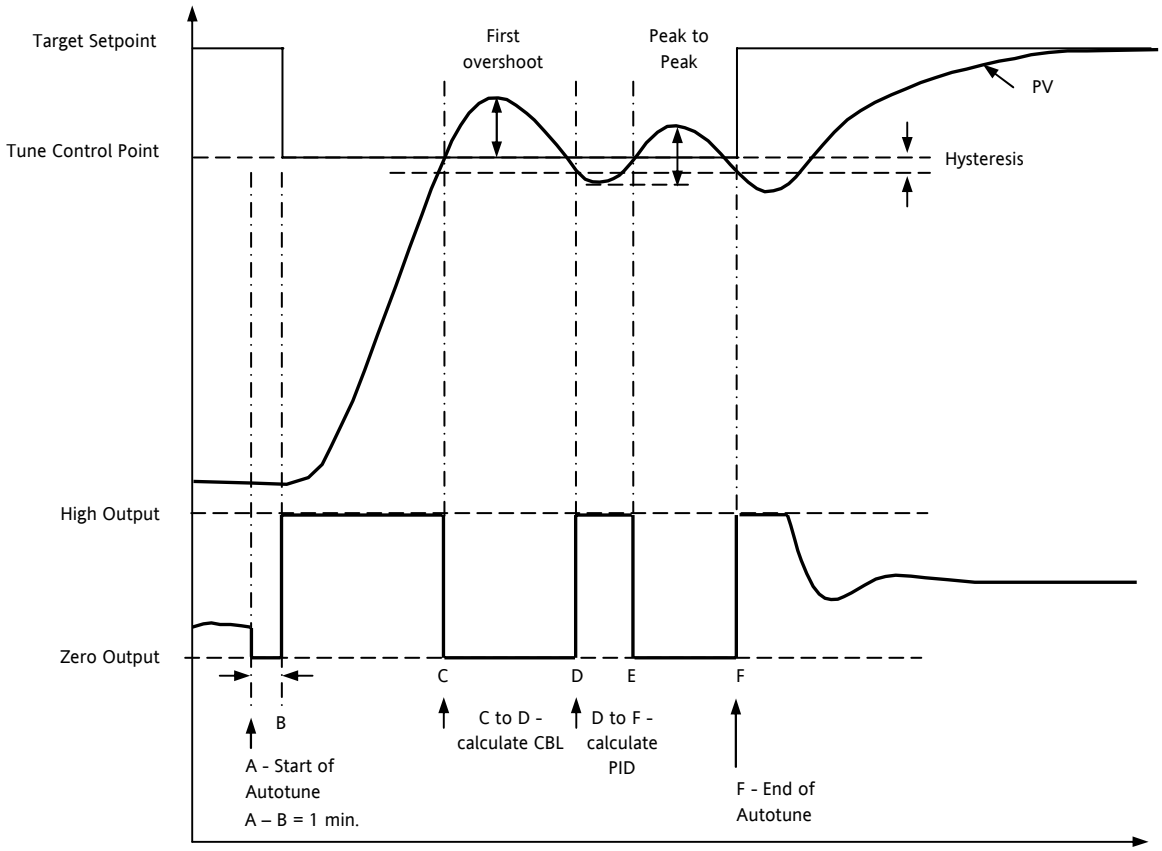
Autotune can also occur when the initial PV is above SP. The sequence is the same as tuning from below setpoint except that the sequence begins with full cooling applied at 'B' after the first one minute settling time.

11.3.6 Autotune From Below SP – Heat Only

The sequence of operation for a heat only loop is the same as that previously described for a heat/cool loop except that the sequence ends at 'F' since there is no need to calculate 'R2G'.

At 'F' autotune is turned off and the process is allowed to control using the new control terms.

Relative cool gain, '**R2G'**, is set to 1.0 for heat only processes.



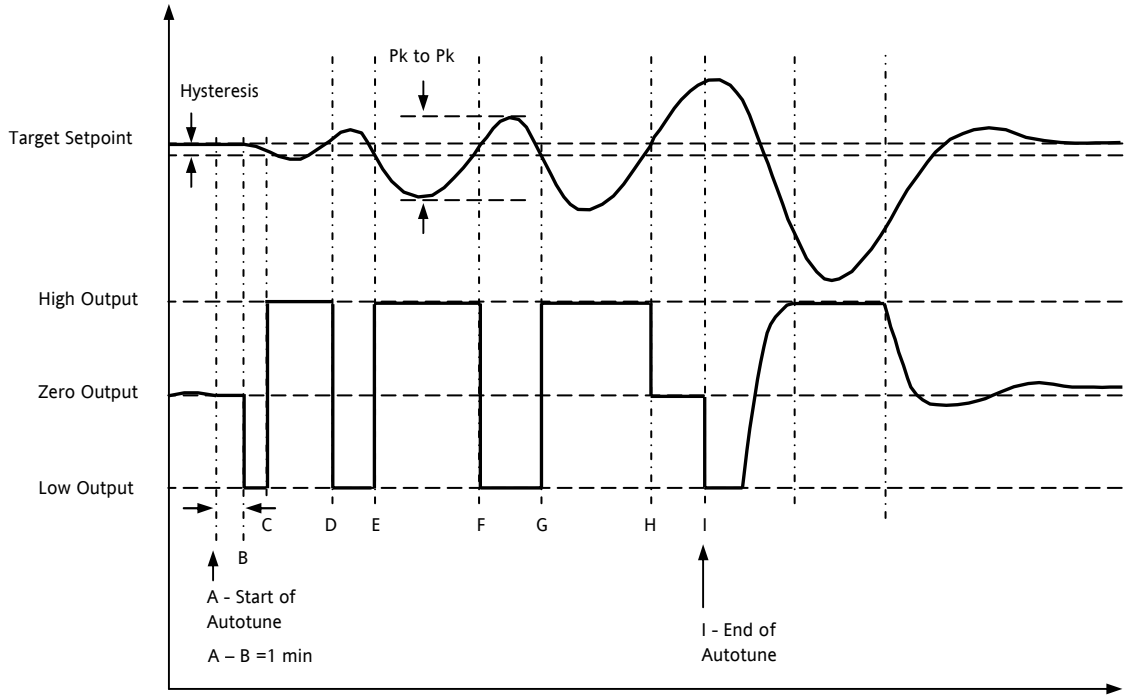
For a tune from below setpoint **'CBLO'** is calculated on the basis of the size of the overshoot (assuming it was not set to Auto in the initial conditions). CBHI is then set to the same value as CBLO.

Note:- As with the heat/cool case, Autotune can also occur when the initial PV is above SP. The sequence is the same as tuning from below setpoint except that the sequence starts with natural cooling applied at 'B' after the first one minute settling time.

In this case CBHI is calculated – CBLO is then set to the same value as CBHI.

11.3.7 Autotune at Setpoint – Heat/Cool

It is sometimes necessary to tune at the actual setpoint being used. This is allowable in 3200 series controllers and the sequence of operation is described below.



Period	Action
A	Start of Autotune. A test is done at the start of autotune to establish the conditions for a tune at setpoint. The conditions are that the SP must remain within 0.3% of the range of the controller if 'PB.UNt' is set to 'Percent'. If 'PB.UNT' is set to 'Eng' then the SP must remain within +1 engineering unit (1 in 1000). Range is defined as 'RNG.HI' – 'RNG.LO' for process inputs or the range defined in section 0 for temperature inputs.
A to B	The output is frozen at the current value for one minute and the conditions are continuously monitored during this period. If the conditions are met during this period autotune at setpoint is initiated at B. If at any time during this period the PV drifts outside the condition limits a tune at setpoint is abandoned. Tuning is then resumed as a tune from above or below setpoint depending on which way the PV has drifted. Since the loop is already at setpoint there is no need to calculate a Tune Control Setpoint – the loop is forced to oscillate around the Target Setpoint
C to G	Initiate oscillation - the process is forced to oscillate by switching the output between the output limits. From this the period of oscillation and the peak to peak response is measured. PID terms are calculated
G to H	An extra heat stage is provided and all heating and cooling power is turned off at H allowing the plant to respond naturally. Measurements made during this period allow the relative cool gain 'R2G' to be calculated.
I	Autotune is turned off and the process is allowed to control at the target setpoint using the new control terms.

For a tune at setpoint autotune does not calculate cutback since there was no initial start up response to the application of heating or cooling. The exception is that the cutback values will never be returned less than 1.6*PB.

11.3.8 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.

Adjust the setpoint to its normal running conditions (it is assumed this will be above the PV so that heat only is applied)

Set the Integral Time 'TI' and the Derivative Time 'TD' to 'OFF'.

Set High Cutback 'CBHI' and Low Cutback 'CBLO' to 'Auto'.

Ignore the fact that the PV may not settle precisely at the setpoint.

If the PV is stable, reduce the proportional band so that the PV just starts to oscillate. Allow enough time between each adjustment for the loop to stabilise. Make a note of the proportional band value 'PB' and the period of oscillation 'T'. If PV is already oscillating measure the period of oscillation 'T', then increase the proportional band until it just stops oscillating. Make a note of the value of the proportional band at this point.

Set the proportional band, integral time and derivative time parameter values according to the calculations given in the table below:-

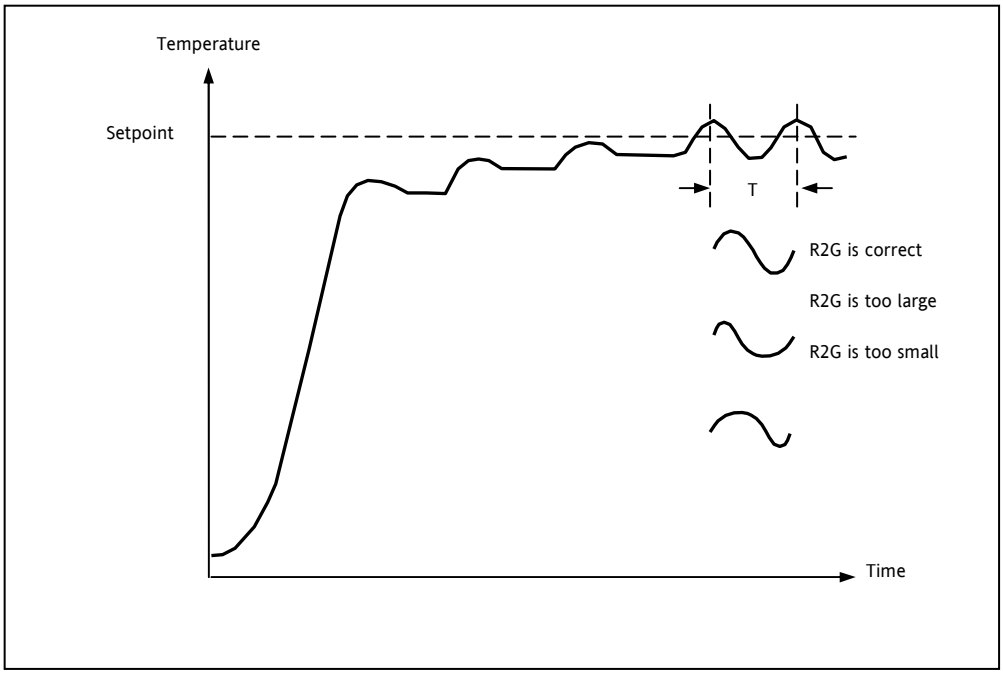
Type of control	Proportional band (PB)	Integral time (TI) seconds	Derivative time (TD) seconds
Proportional only	2xPB	OFF	OFF
P + I control	2.2xPB	0.8xT	OFF
P + I + D control	1.7xPB	0.5xT	0.12xT

11.3.9 Manually Setting Relative Cool Gain

If the controller is fitted with a cool channel this should be enabled before the PID values calculated from the table above are entered.

Observe the oscillation waveform and adjust R2G until a symmetrical waveform is observed.

Then enter the values from the table above.



11.3.10 Manually Setting the Cutback Values

Enter the PID terms calculated from the table in section 11.3.8 before setting 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 PV, then manually set the cutback parameters.

Proceed as follows:

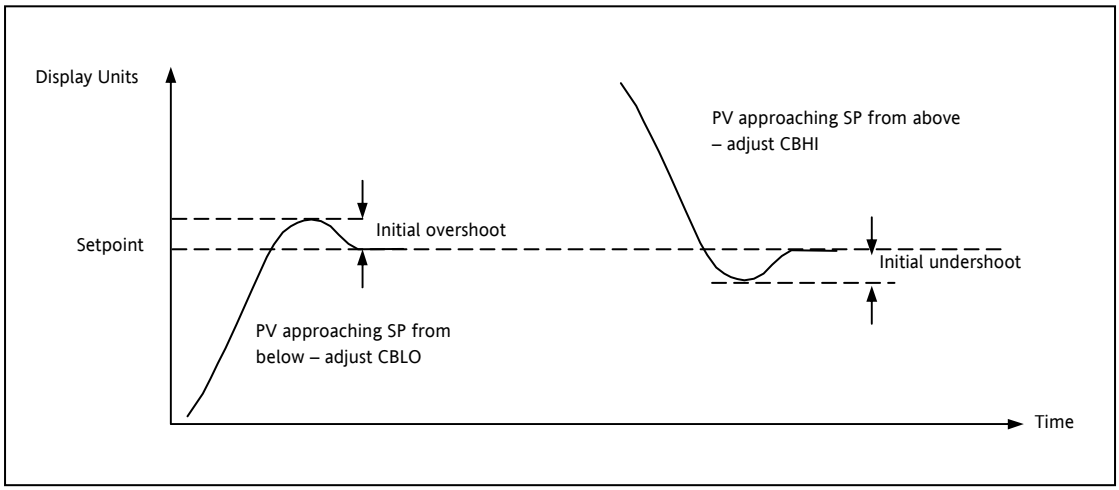
Initially set the cutback values to one proportional bandwidth converted into display units. This can be calculated by taking the value in percentage that has been installed into the parameter 'PB' and entering it into the following formula:-

PB/100 * Span of controller = Cutback High and Cutback Low

For example, if PB = 10% and the span of the controller is 0 -1200^{O}C, then

Cutback High and Low = 10/100 * 1200 = 120

If overshoot is observed following the correct settings of the PID terms increase the value of 'CBLO' by the value of the overshoot in display units. If undershoot is observed increase the value of the parameter 'CBHI' by the value of the undershoot in display units.



11.4 Auto-tune Configures R2G

In a system which controls both heating and cooling the parameter R2G sets the cooling proportional band to compensate for differences between the power available to heat, and that available to cool a process, see section 11.2.4.

There are certain load conditions where auto-tune may set an incorrect value for R2G. This will be seen as instability in the control of the process after an auto-tune has been completed. In these circumstances check the value of R2G. If it is low (approaching 0.1) AND the process is unstable it is necessary to manually determine a value of R2G and enter this before carrying out a second auto-tune.

Note: it is only necessary to do this if the process causes the condition described above.

A parameter has been added (in 3200 controllers supplied after Dec 08) which provides the option to suppress the auto tuning of R2G allowing it to be set manually. The parameter is called AT.R2G (Auto-tune R2G) and may be set to YES or NO. YES is the default which means that R2G will be set automatically. NO requires a value for R2G to be entered manually.

The sequence is as follows:-

1) Set AT.R2G to NO.

2) Enter a value for R2G. See the example below.

3) Calculate and enter a value for the TUNE LOW LIMIT from 'OP.LO' = -OP.HI x R2G. See Note 2.

4) Start Auto-tune

Example - To establish a value for R2G.

One way to approximate a suitable value for R2G is to measure the heating and cooling rates around the normal operating temperature of the system.

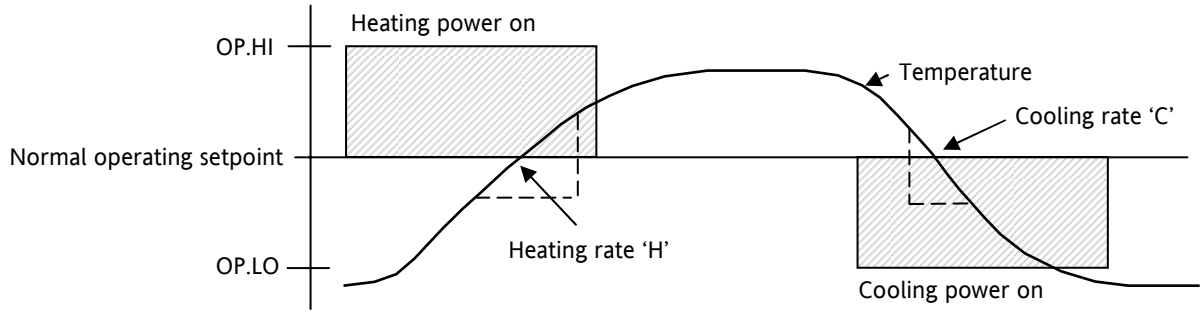
1) Measure the heating and cooling rates of the process:-

a) Put the controller into Manual mode and turn heating power ON (limited by OP.HI).

b) Allow the process to heat from below normal operating setpoint and for the actual temperature to pass through the normal operating setpoint. When the actual temperature is (say 10%) above normal working temperature turn off the heat.

c) Allow the temperature to settle then turn cooling power ON (limited by OP.LO). Allow the temperature to fall below normal working setpoint.

A graphical example of the results is shown below:-



2) Calculate R2G from R2G = (H/C) * (OP.LO/OP.HI)

For example Heating rate 'H' = 10°C per minute, Cooling rate 'C' = 25 °C per minute, OP.HI = 80%, OP.LO = 40% then R2G = 0.2

Enter a value of 0.2 for R2G

Note 1: This calculation will compensate for the different output limits set by OP.HI and OP.LO.

Note 2: If the calculated value for TU.LO is greater than the output limit set by OP.LO, continue to enter the calculated value.

Note 3: It is envisaged that this procedure would normally be carried out by the equipment manufacturer. However, once the value of R2G has been determined and AT.R2G has been set to NO, autotuning your process from then on can be repeated by simply selecting ATUNE = On (assuming, of course, that the characteristics of the process have not changed significantly).

11.5 Example: To Configure Heating and Cooling

Enter configuration level as described. Then:-

Do This	The Display You Should See	Additional Notes
1. Press ⊜ as many times as necessary to select 'CTRL'		
2. Press ↻ to scroll to 'CTRLH' 3. Press ▲ or ▼ to select the **Heating Type**		Heating Type choices are:- PId PID (3 term) control on.oF On/Off control oFF No heating output configured
4. Press ↻ to select 'CTRL.C' 5. Press ▲ or ▼ to select the **Cooling Type**		Cooling Type choices are:- oFF No cooling output configured PId PID (3 term) control on.oF On/Off control
6. Press ↻ to select 'CTRL.A' 7. Press ▲ or ▼ to 'rEu'		Control Action choices are:- rEu Reverse - heating control dIr Direct - cooling only control
8. Press ↻ to scroll to 'PB.UNT' 9. Press ▲ or ▼ to choose units		Proportional Band Units choices are:- EnG Engineering units PErc Percentage
10. Continue to select parameters using ↻ for example 'OP.HI' 11. Press ▲ or ▼ to change their values		When **PID control** is selected, this places a limit on the output demand from the PID which can be applied to the heating circuit. 'OP.LO' can be set up in the same way if required. If **on/off control** is selected these parameters do not apply. They are replaced by 'HYST.H' and 'HYST.L' to set the difference between the output switching off to switching on.

11.5.1 Effect of Control Action, Hysteresis and Deadband

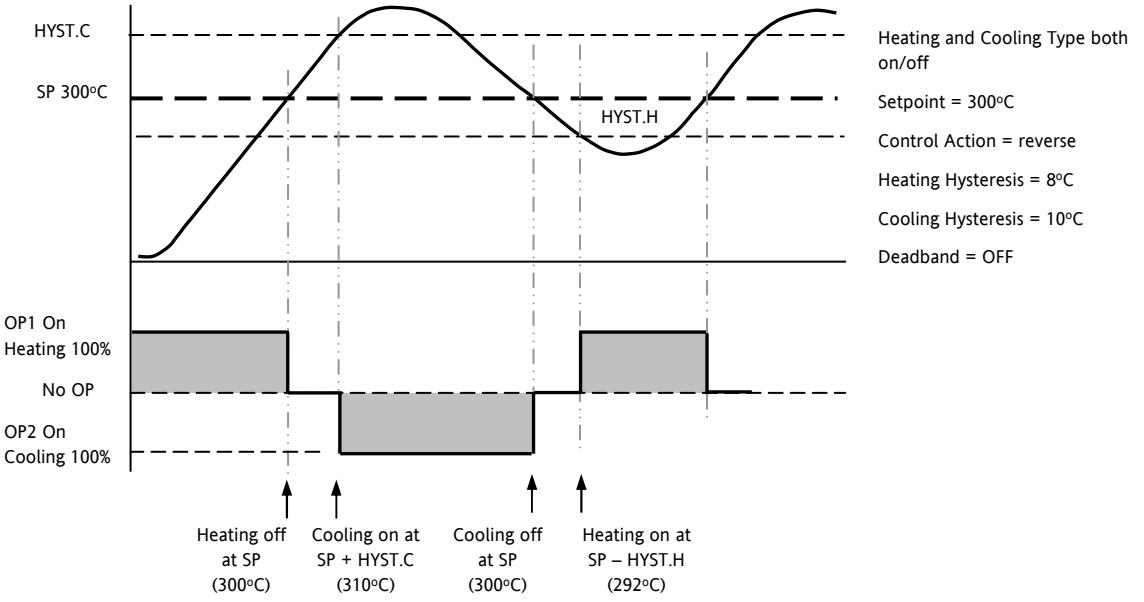
For temperature control 'CONTROL ACTION' will be set to 'rEu'. For a PID controller this means that the heater power decreases as the PV increases. For an on/off controller output 1 (usually heat) will be on (100%) when PV is below the setpoint and output 2 (usually cool) will be on when PV is above the setpoint

Hysteresis applies to on/off control only. It defines the difference in temperature between the output switching off and switching back on again. The examples below shows the effect in a heat/cool controller.

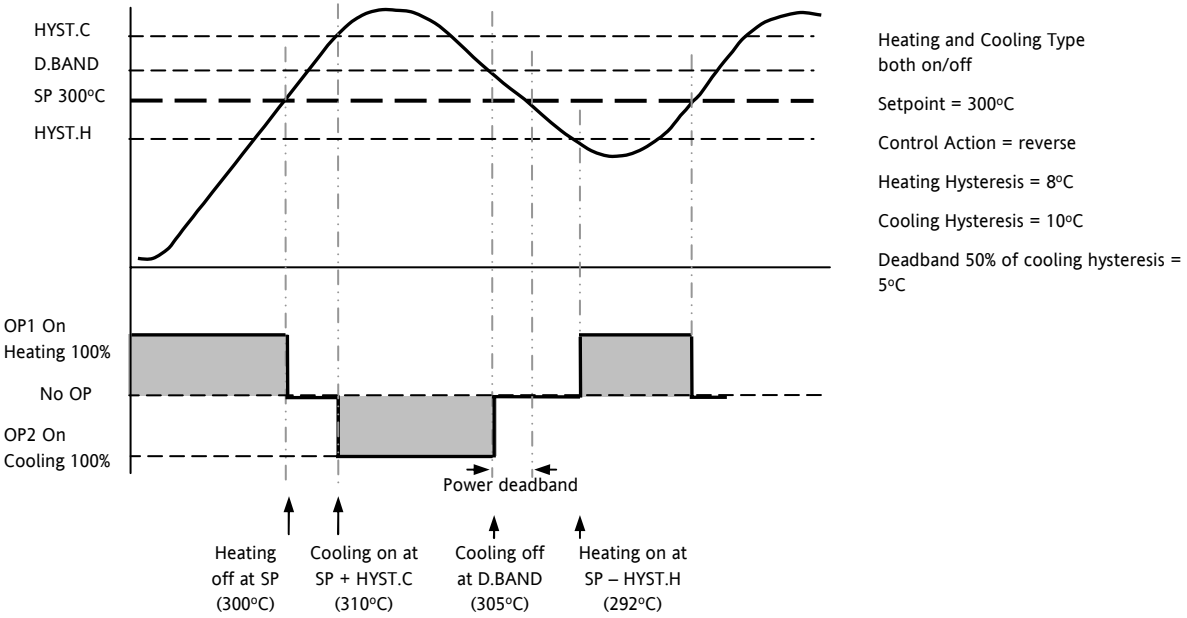
Deadband can operate on both on/off control or PID control where it has the effect of widening the period when no heating or cooling is applied. However, in PID control its effect is modified by both the integral and derivative terms. Deadband might be used in PID control, for example, where actuators take time to complete their cycle thus ensuring that heating and cooling are not being applied at the same time. Deadband is likely to be used, therefore, in on/off control only. The second example below adds a deadband of 20 to the above example.

In an on/off controller, if CONTROL ACTION = rev then OP2 will be on when PV is below SP. OP1 will be on when the PV is above SP. The outputs are, therefore, reversed in the above example.

Deadband OFF



Deadband ON



12. Alarms

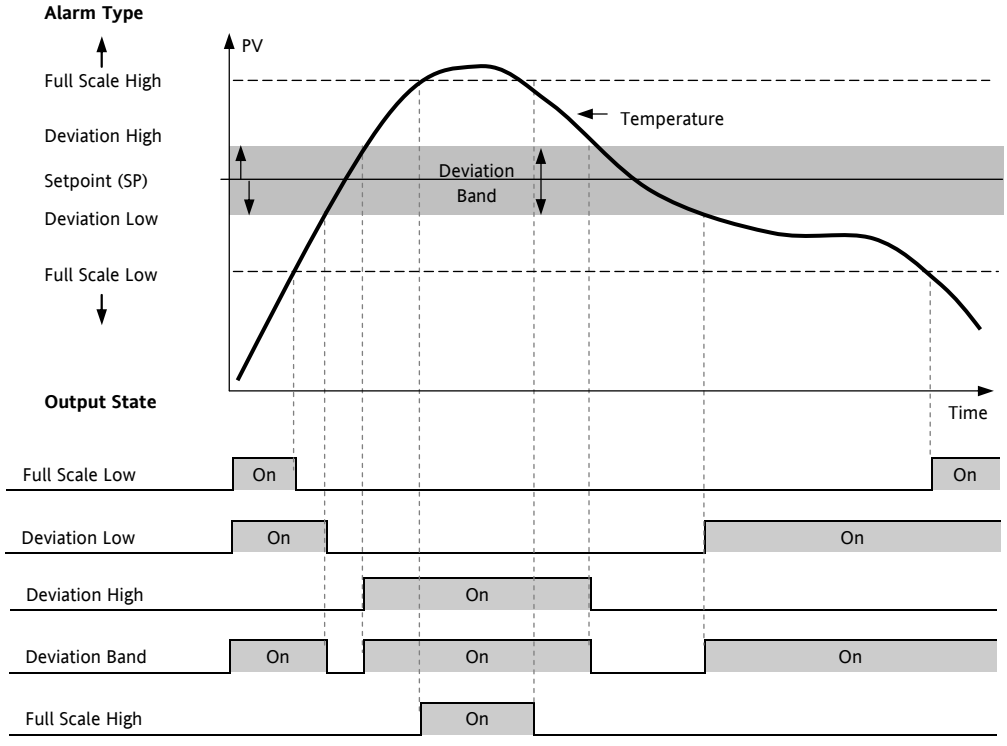
Alarms are used to alert an operator when a pre-set level has been exceeded. They are indicated by a scrolling message on the display and the red ALM beacon. They may also switch an output– usually a relay (see section 12.1.1) – to allow external devices to be operated when an alarm occurs. Alarms only operate if they have been ordered and configured.

Up to eight different alarms are available:-

- **Alarm 1**: configurable as full scale high or low, band or deviation high or low
- **Alarm 2**: configurable as full scale high or low, band or deviation high or low
- **Alarm 3**: configurable as full scale high or low, band or deviation high or low
- **Alarm 4**: configurable as full scale high or low, band or deviation high or low
- **Sensor Fault alarm.** An alarm condition - INPUT SENSOR BROKEN (5.br) is indicated if the sensor or the wiring between sensor and controller becomes open circuit. the output level will adopt a 'SAFE' value which can be set up in Operator Level 2, see section 11.2.
- For a PRT input, sensor break is indicated if any one of the three wires is broken.
  For mA input sensor break will not be detected due to the load resistor connected across the input terminals.
  For Volts input sensor break may not be detected due to the potential divider network connected across the input terminals.
- Loop Break alarm. Displayed as CONTROL LOOP BROKEN. This occurs if the controller does not detect a change in process value following a change in output demand after a suitable delay time.
- Current Transformer alarms – Leak, Load Fail, Overcurrent (see C/T section 9.2)
- Remote Fail Alarm This alarm operates on the remote setpoint input. If a value is not received after a period of 5 seconds, then the Remote Fail Alarm is shown.

12.1 Types of Alarm

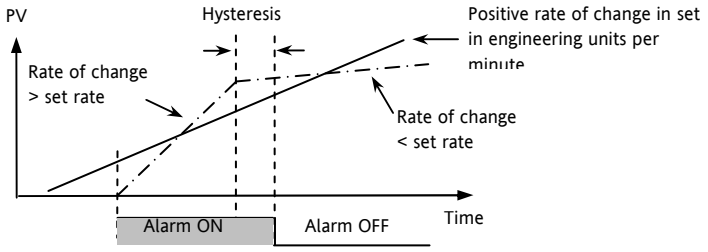
This section shows graphically the operation of different types of alarm used in the controller. The graphs show changes in temperature plotted against time. (Hysteresis set to zero)



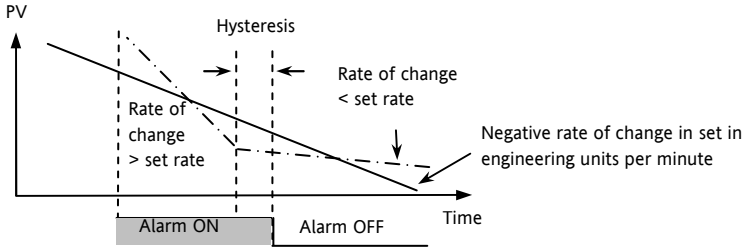
Hysteresis	Hysteresis is the difference between the point at which the alarm switches 'ON' and the point at which it switches 'OFF'. It is used to provide a definite indication of the alarm condition and to prevent alarm relay chatter.		
Latching Alarm	Latching is used to maintain the alarm condition once an alarm has been detected. It may be configured as:-		
	nonE	Non latching	A non latching alarm will reset itself when the alarm condition is removed
	AutO	Automatic	An auto latching alarm requires acknowledgement before it is reset. The acknowledgement can occur **BEFORE** the condition causing the alarm is removed.
	mAn	Manual	The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur **AFTER** the condition causing the alarm is removed.
	EvE	Event	ALM beacon does not light but an output associated with this parameter will activate. A scrolling message may be configured using iTools, as described in section 17.7. If a message has been configured it will scroll across the display while the event is true.
Blocking Alarms	The alarm may be masked during start up. Blocking prevents the alarm from being activated until the process has first achieved a safe state. It is used to ignore start up conditions which are not representative of running conditions. A blocking alarm is re-initiated after a setpoint change. See section 12.2 for an explanation of the behaviour of blocking alarms under different conditions.		

From firmware version 2.11, two rate of change alarms are available. These are:-

Rising rate of change (units/minute)	An alarm will be detected if the rate of change in a positive direction exceeds the alarm threshold



Falling rate of change (units/minute)	An alarm will be detected if the rate of change in a negative direction exceeds the alarm threshold



12.1.1 Alarm Relay Output

Alarms can operate a specific output (usually a relay). Any individual alarm can operate an individual output or any combination of alarms, up to four, can operate an individual output. They are either supplied pre-configured* in accordance with the ordering code or set up in configuration level.

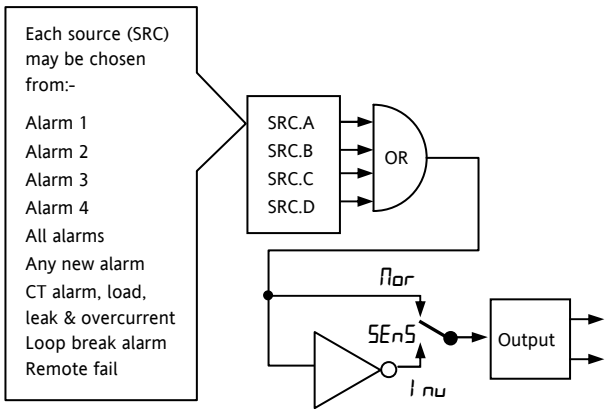
* When supplied pre-configured, the default is:-

IO1 is always AL1

OP2 is always AL2

OP3 is always AL3

OP4 (AA) is always AL4



12.1.2 Alarm Indication

- ALM beacon flashing red = a new alarm (unacknowledged)
- This is accompanied by a scrolling alarm message. A typical default message will show the source of the alarm followed by the type of alarm. For example, 'ALARM 1 FULL SCALE HIGH'
- Using Eurotherm iTools configuration package, it is also possible to download customised alarm messages. An example might be, 'PROCESS TOO HOT'.
- If more than one alarm is present further messages are flashed in turn in the main display. The alarm indication will continue while the alarm condition is present and is not acknowledged.
- ALM beacon on continuously = alarm has been acknowledged

12.1.3 To Acknowledge An Alarm

Press and together.

The action, which now takes place, will depend on the type of latching, which has been configured.

Non-Latched Alarms

Alarm condition present when the alarm is acknowledged.

- ALM beacon on continuously.
- The alarm message(s) will continue to scroll

This state will continue for as long as the alarm condition remains. When the alarm condition disappears all indication also disappears.

If a relay has been attached to the alarm output, it will de-energise when the alarm condition occurs and remain in this condition until acknowledged or the alarm is no longer present.

If the alarm condition disappears before it is acknowledged the alarm resets immediately.

Latched Alarms

See description in section 12.1.

12.2 Behaviour of Alarms After a Power Cycle

The response of an alarm after a power cycle depends upon the latching type, whether it has been configured to be a blocking alarm, it's state and the acknowledge status of the alarm.

The response of active alarms after a power cycle is as follows:

For a non-latching alarm or an event alarm blocking will be re-instated, if configured. If blocking is not configured the active alarm will remain active. If the alarm condition has gone safe during the down time the alarm will return inactive.

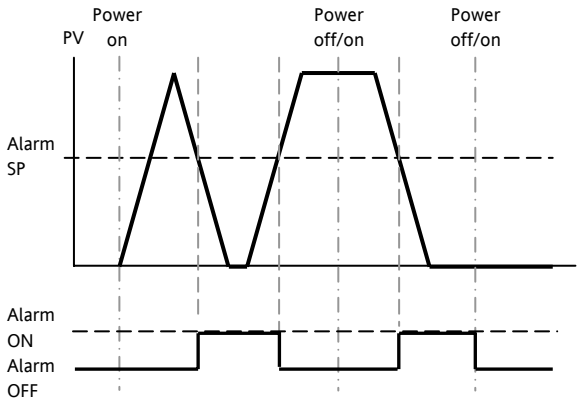
For an auto-latching alarm blocking will be re-instated, if configured, only if the alarm had been acknowledged prior to the power cycle. If blocking is not configured or the alarm had not been acknowledged the active alarm will remain active. If the alarm condition has gone safe during the downtime the alarm will return inactive if it had been acknowledged prior to the power cycle else it will return safe but not acknowledged. If the alarm was safe but not acknowledged prior to the power cycle the alarm will return safe but not acknowledged.

For a manual-latching alarm blocking will not be re-instated and the active alarm will remain active. If the alarm condition has gone safe during the downtime the alarm will return safe but not acknowledged. If the alarm was safe but not acknowledged prior to the power cycle the alarm will return safe but not acknowledged.

The following examples show graphically the behaviour under different conditions:-

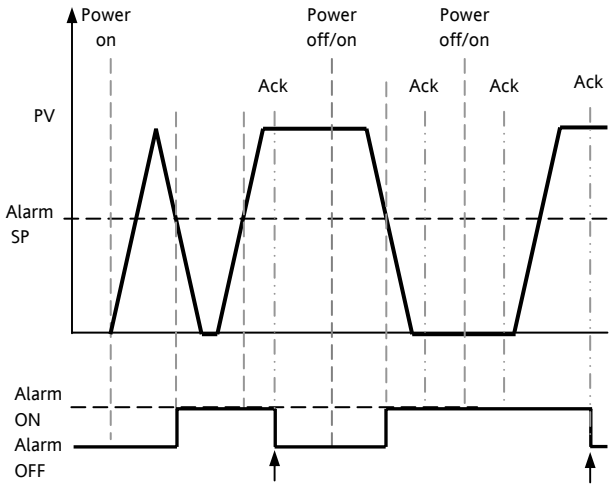
12.2.1 Example 1

Alarm configured as Absolute Low; Blocking: No Latching



12.2.2 Example 2

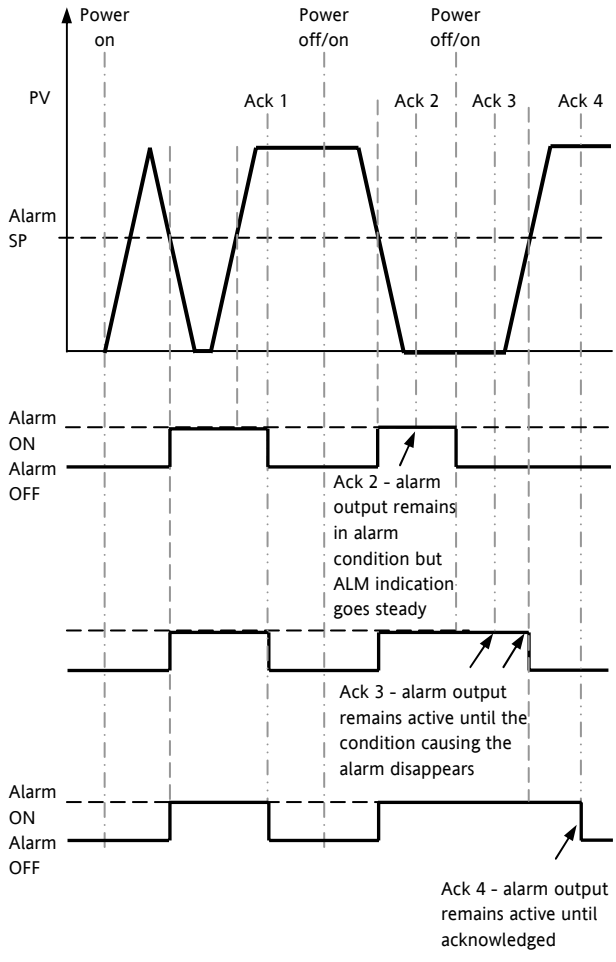
Alarm configured as Absolute Low; Blocking: Manual Latching



Note: The alarm will only cancel when the alarm condition is no longer current AND then it is acknowledged

12.2.3 Example 3

Alarm configured as Absolute Low; Blocking: Auto Latching



12.3 Alarm Parameters

Four alarms are available. Parameters do not appear if the Alarm Type = None. The following table shows the parameters to set up and configure alarms.

ALARM LIST 'ALARM'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
A1TYP	ALARM 1 TYPE	Selects the type of alarm	nonE	Alarm not configured	As order code	Conf
			Hi	Full Scale High		
			Lo	Full Scale Low		
			dHi	Deviation High		
			dLo	Deviation Low		
			bnd	Deviation band		
			rrc	Rising rate of change, set in 1-9999 eng units/min		
			Frc	Falling rate of change set in 1-9999 eng units/min		
A1.---	ALARM 1 SETPOINT	Alarm 1 threshold value. The last three characters show the type of alarm configured from the above list	Instrument range		0	L3
A1.STS	ALARM 1 OUTPUT	Indicates the status of the alarm	OFF	Alarm off		Read only
			On	Alarm on		
A1HYS	ALARM 1 HYSTERESIS	See description at the beginning of this section	0 to 9999			Conf
A1LAT	ALARM 1 LATCHING TYPE	See description at the beginning of this section	nonE	Non-latching	As order code	Conf
			AutO	Latching with automatic resetting		
			mAn	Latching with manual resetting		
			EvE	Event (no alarm flashing beacon but messages can be displayed)		
A1BLK	ALARM 1 BLOCKING	See description at the beginning of this section	no	No blocking	no	Conf
			YES	Blocking		
The above parameters are repeated for Alarm 2, A2; Alarm 3, A3; Alarm 4, A4						

12.3.1 Example: To Configure Alarm 1

Enter configuration level as described. Then:-

Do This	The Display You Should See	Additional Notes
1. Press ⊜ as many times as necessary to select 'ALARM'		
2. Press ⊙ to select 'A1.TYP' 3. Press ▲ or ▼ to select the required alarm type		Alarm Type choices are:- nonE Alarm not configured Hı Full Scale High Lo Full Scale Low d.Hı Deviation High d.Lo Deviation Low bnd Deviation Band
4. Press ⊙ to select 'A1.- - -' 5. Press ▲ or ▼ to set the alarm trip level		This is the alarm threshold setting for. The last three characters (- - -) will show the type of alarm configured from the above list. The alarm threshold is shown in the upper display. In this example the high alarm will be detected when the measured value exceeds 215
6. Press ⊙ to select 'A1 STS'		This is a read only parameter which shows the status of the alarm output
7. Press ⊙ to select 'A1 HYS' 8. Press ▲ or ▼ to set the hysteresis		In this example the alarm will cancel when the measured value decreases 2 units below the trip level (at 213 units)
9. Press ⊙ to select 'A1 LAT' 10. Press ▲ or ▼ to select the latching type		Latching Type choices are:- nonE No latching Auto Automatic mAn Manual Evt Event See the introduction to the alarm section for an explanation
11. Press ⊙ to select 'A1 BLK' 12. Press ▲ or ▼ to 'YES' or 'no' 13. Repeat the above to configure alarms 2, 3 and 4 if required		

12.4 Diagnostic Alarms

Diagnostic alarms indicate a possible fault within the controller or connected devices.

Display shows	What it means	What to do about it
E.ConF	A change made to a parameter takes a finite time to be entered. If the power to the controller is turned off before the change has been entered then this alarm will occur. Do not turn the power off to the controller while ConF is flashing	Enter configuration mode then return to the required operating mode. It may be necessary to re-enter the parameter change since it will not have been entered in the previous configuration.
E.CAL	Calibration error	Re-instate Factory calibration
E2Er	EEPROM error	Return to factory for repair
EE.Er	Non-vol memory error	Note the error and contact your supplier
EL.in	Invalid input type. This refers to custom linearisation which may not have been applied correctly or may have been corrupted.	Go to the INPUT list in configuration level and set a valid thermocouple or input type
Emod	IO1, OP2, or OP3 has been changed	If this has been field changed by the installation of a new board, enter config level, then exit back to operator level. If the message occurs at any other time return to factory for repair.

12.4.1 Out of Range Indication

If the input is too high HHHHH will be displayed

If the input is too low LLLLL will be displayed

13. Timer/Programmer

A timer can be configured to operate in one of four different modes. These can be selected in Level 3 or configuration level as:-

1. Dwell timer
2. Delay timer
3. Soft start timer
4. Programmer – this is an orderable option

Operation of the timer has been described in section 5.

13.1 Timer Parameters

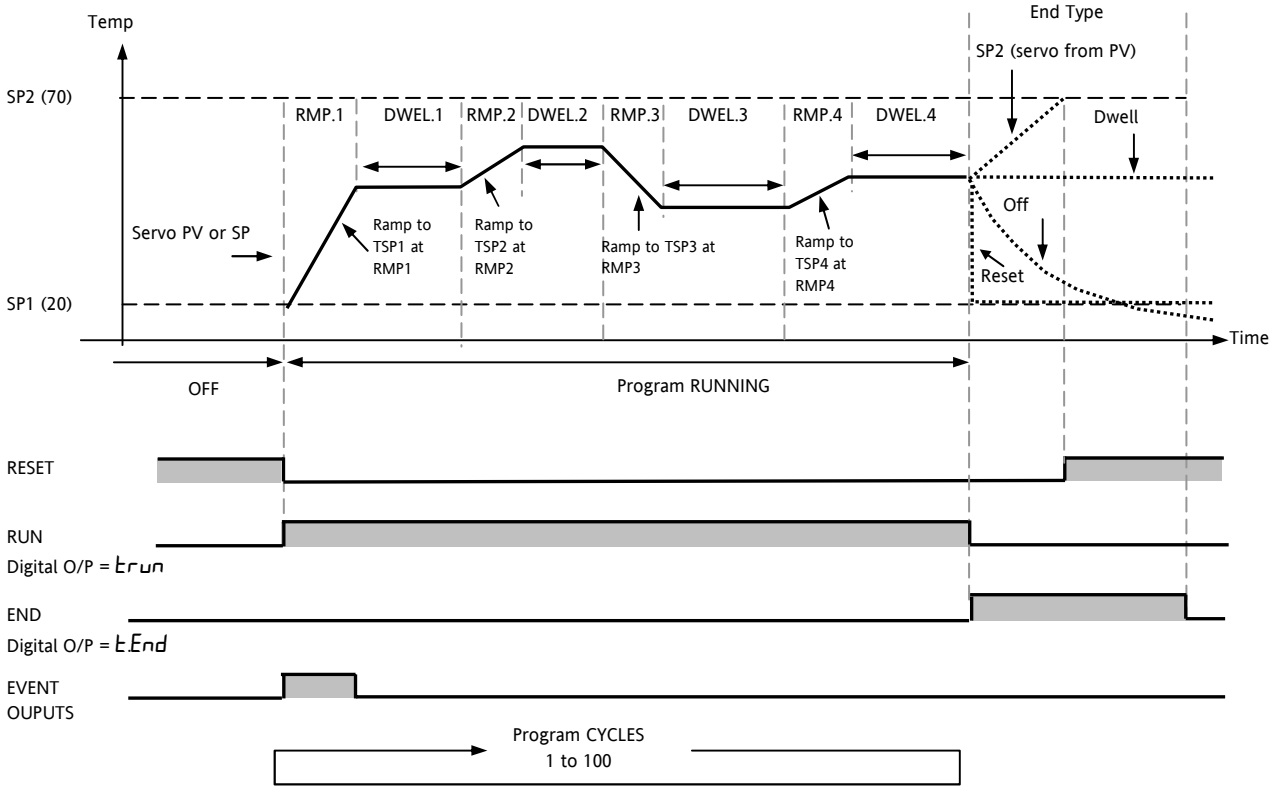
The full list of all available parameters in configuration level is given in the following table.

TIMER LIST	'TIMER'					
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
TM.CFG	TIMER CONFIGURATION	Timer type configuration	nonE	Timer disabled	As order code	L3
			dwEll	Dwell		
			dELY	Delayed switch on		
			SFSt	Soft start		
			ProG	Programmer		
TM.RES	TIMER RESOLUTION	To set the time units	Hour	Hours HH:MM		Conf R/O L3
			min	Minutes MM:SS		
THRES	TIMER START THRESHOLD	To set the maximum deviation between SP and PV before the timer starts. **Dwell timer and Programmer only**	OFF or 1 to 3000 Units above and below setpoint		OFF	L3
END.T	TIMER END TYPE	To determine the action which takes place when the timer has timed out. **Dwell timer and Programmer only**	OFF	Control outputs go to zero %		Conf
			dwEll	Control continues at SP1		
			SP2	Go to setpoint 2		
			rES	Reset programmer		
SS.SP	SOFT START SETOINT	Sets the threshold below which the power is limited **SFSt timer only**	Controller input range		0	Conf
SS.PWR	SOFT START POWER LIMIT	Sets the limit to the power output during start up **SFSt timer only**	0 to 100%		0	Conf
T.STAT	TIMER STATUS	Timer status	rES	Reset		L3
			run	Running (counting)		
			hoLd	Running (hold)		
			End	Timed out		
SERVO	SERVO MODE	Defines the way in which the programmer starts and how it recovers from a power failure See also section 5.8.1. **Programmer only**	SP	Starts at SP1 (or SP2). The program must be re-started after a power failure.	SP	
			PV	Starts at the current Process value. The program must be re-started after a power failure.		
			SPrb	Starts at SP1 (or SP2). The program will continue to run from the original setpoint value at the last ramp rate.		

TIMER LIST	'TIMER'					
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
			PurB	Starts at the current Process value. The program will continue to run from the current process value and ramp back at the last ramp rate		
TSP.1	TARGET SETPOINT 1	To set the target value for the first setpoint	Controller input range		0	L2
RMP.1	RAMP RATE 1	To set the rate at which the setpoint changes to reach TSP.1	OFF, 0:1 to 3000 units per min or hour		OFF	L2
DWEL.1	DWELL 1	To set the time at which the setpoint remains at TSP.1	OFF, 0:01 to 99:59 hh:mm or mm.ss		OFF	L2
The above three parameters are repeated for the next 3 program segments, i.e. TSP.2, (3 & 4), RMP.2 (3 & 4), DWEL.2 (3 & 4)						
DWELL	SET TIMER DURATION	To set the time duration **(not programmer)**	0:00 to 99:59 hh:mm or mm.ss		0	L3
T.ELAP	ELAPSED TIME	Time elapsed from when the timer starts to run	0:00 to 99.59 hh:mm or mm.ss			L3 read only
T.REMN	TIME REMAINING	Time remaining to reach the set time.	0:00 to 99.59 hh:mm or mm.ss			L3
EVENT	EVENT OUTPUTS	Event output operates during the selected segment **Programmer only** See section 13.2.3	0 = No events operate in any segment 255 -= Events operate in all segments		0	L3
P.CYCL	PROGRAM CYCLES	Sets the number of times that a program is repeated	1 to 100		1	L3
CYCLE	PROGRAM CYCLE	Displays the current cycle when the program is running	1 to 100			L3
The timer can be restarted from the Reset condition by changing the time remaining parameter.						

13.2 Programmer

Function code CP is an eight segment programmer consisting of four ramp/dwell pairs. Each ramp consists of a controlled rate of change of setpoint to a target level. Each ramp is followed by a dwell at that level. The ramp rate, target level and dwell time are set by the user. The program profile is shown in the diagram below.



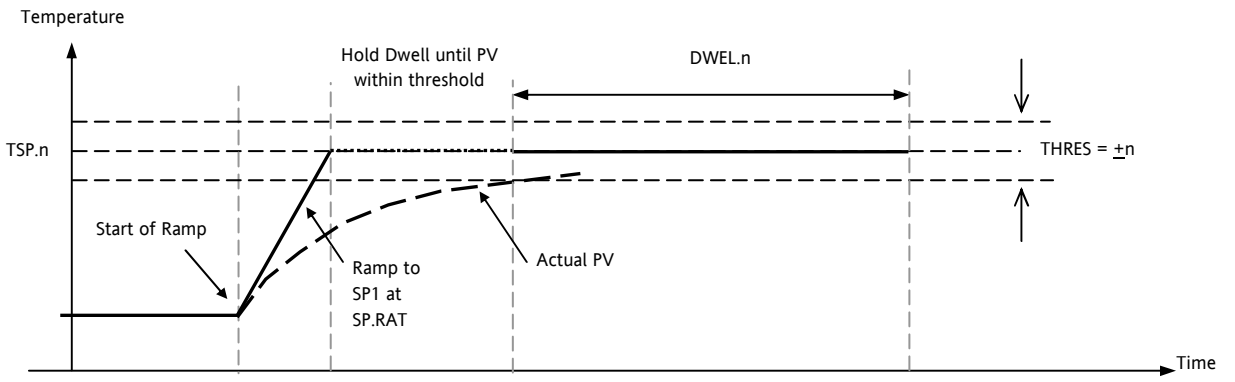
Notes:-

Where steps are required, the ramp rate in the ramp/dwell pair should be set to 'OFF'.

1. Where ramp/dwell pairs are not required, the ramp rate should be set to 'OFF' and the TSP the same as the preceding segment
2. TIMER END – when end type is SP2, Timer END does not occur until the ramp is complete or SP2 is achieved. It is more usual to use a DWELL End Type (the default setting)

13.2.1 Threshold

A single threshold value is available to provide a holdback on the entry to the dwell part of the ramp/dwell pair. It holds back the dwell until the PV has reached the band defined by +/- threshold around the PV as shown below:-



13.2.2 Run/End Digital Outputs

Digital outputs (normally relay) may be made to operate while the program is in Run mode or End mode, as shown in the diagram in section 13.2. These outputs are set up in configuration level by selecting the appropriate output parameter list - IO-1, OP-2, OP-3, or AA and assigning the parameter 'PrG.E' to the 'SRC.A' (B, C, or D) parameter.

The following example describes how to configure OP-2 to operate when the programmer is running and OP-3 to operate when the programme is complete. It is assumed that IO-1 is configured as the control output for a heat only controller.

1. Select Configuration level.
2. Press ⓘ to scroll to OP-2
3. Press ⟳ to scroll to 2.FUNC and select d.out using ▼ or ▲.
4. Press ⟳ to scroll to 2.SRC.A (or B or C or D) and select t.run using ▼ or ▲.
5. Press ⓘ to scroll to OP-3
6. Press ⟳ to scroll to 3.FUNC and select d.out using ▼ or ▲.
7. Press ⟳ to scroll to 3.SRC.A (or B or C or D) and select t.End using ▼ or ▲.

13.2.3 Event Output During a Segment

This feature was added after software version 2.

A digital event may be configured to operate in any segment of the program. This is set up in the TIMER List by the parameter 'EVENT'.

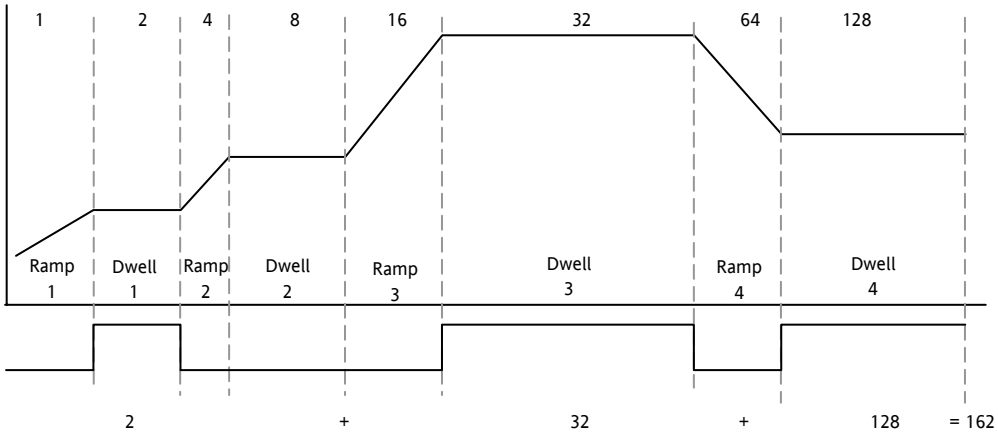
To turn an output on in a segment, use the table and diagram, below to obtain the ***weighting*** value for that segment. Note down the weightings for each segment in which the output is to be turned on and add them together. Set the Event Settings value to this number.

For example, to switch an output on in the first ramp segment and the second dwell, the weightings would be 1 and 8. So the Event Setting would be 9. To turn the event on in Ramp 1 and Dwell 3 the weightings would be 1 and 32, so the event setting would be 33. To turn the event on in Dwell 1, Dwell 3 and Dwell 4 the weightings would be 2 + 32 + 128 = 162. This is shown in the diagram below.

See also the example 'To Configure the Programmer' section 13.2.4.

Segment	Weighting
Ramp 1	1
Dwell 1	2
Ramp 2	4
Dwell 2	8
Ramp 3	16
Dwell 3	32
Ramp 4	64
Dwell 4	128

Example: Digital output ON in dwell segments 1, 3 and 4

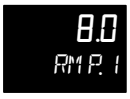


This event may be configured to operate an output. The following section (13.2.4.) configures output 4 to operate during a segment.

13.2.4 To Configure the Programmer

The programmer can be configured in Level 2 as explained in section 4. The Event outputs, however, can only be configured in Level 3 or Configuration level as follows:-

Select Access Level 3 or Configuration level as described in section 6.1.3.

Operation	Action	Display View	Notes
Select the **TIMER** page	Press ▤ as many times as necessary to 'TIMER'		
Configure the Timer as a **Programmer**	Press ↻ to select 'TM.CFG' Press ▼ or ▲ to 'ProG'		
Set the **Resolution**	Press ↻ to select 'TM.RES' Press ▼ or ▲ to 'Hour or 'mi n''		This sets the dwell function in seconds, minutes or hours. In this example the dwell period is set in hours.
Set the **Threshold**	Press ↻ to select 'THRES' Press ▼ or ▲ to adjust		In this example the dwell periods will not start until the PV is within 5 units of the setpoint
Set the action when the programmer times out	Press ↻ to select 'END.T' Press ▼ or ▲ to 'OFF' or 'SP2' or 'dwEll'		In this example the controller will continue to control indefinitely at the last setpoint. OFF will turn the output power off and SP2 will control at setpoint 2
Set the **Servo Mode**	Press ↻ (twice) to select 'SERVO' Press ▼ or ▲ to 'PV' or 'SP'		In this example the program will start from the current value of the process variable
Set the first **Target Setpoint**	Press ↻ to select 'TSP.1' Press ▼ or ▲ to adjust		In this example the setpoint will ramp from the current value of the PV to the first target - 100
Set the first **Ramp Rate**	Press ↻ to select 'RMP.1' Press ▼ or ▲ to adjust		In this example the setpoint will ramp to 100 at 8.0 units per hour. The ramp units are set up in the Setpoint List see section 10.1.
Set the first **Dwell**	Press ↻ to select 'DWEL.1' Press ▼ or ▲ to adjust		In this example the setpoint will dwell at 100 for 2 hours 11 minutes
Repeat the above three steps for all segments			
Set the segment in which the relay operates	Press ↻ to select 'EVENT' Press ▼ or ▲ to adjust		Set as described in section 13.2.3. In this example the event output will be active during Ramp 2.
Set the number of times the whole program repeats	Press ↻ to select 'P.CYCL' Press ▼ or ▲ to adjust		1 = Program runs once To 100 = Program repeats 100 times
Configure Output 4 (AA Relay) as the Event output	Press ▤ to select 'AA' List Press ↻ to select '4.SRC.A' Press ▼ or ▲ to select 'PrGE'		This can only be done in Configuration level. You can also select 4.SRC.B, 4.SRC.C, or 4.SRC.D or assign these to other functions, for example 'trun' or 'tEnd' so that the relay also operates when the timer is running or when it ends. Note, however, if the same output is used to operate when the program is running it cannot also operate during a segment. In this case use an alternative output is described in section 13.2.2.

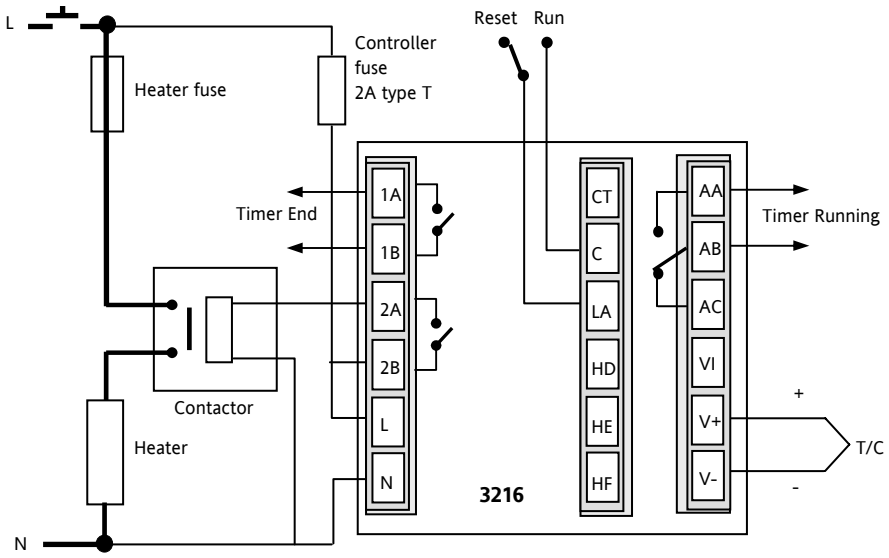
13.3 Example: To Configure a Dwell Timer as a Simple Two Step Programmer

If the instrument has been ordered as controller only, it is still possible to configure a simple ramp/dwell; ramp/dwell programmer.

This example assumes a hardware configuration as follows:-

Output 2	Heat output relay
I/O 1	Timer End digital output
AA Relay	Timer running digital output
Dig Input	Run/Reset input

A typical wiring diagram for this example is shown below:-



Configure the I/O as follows:-

Enter configuration level described in section 6.1.3. Then:-

Operation	Do This	Display View	Additional Notes
Select the IO-1 page header	1. Press ▣ as many times as necessary to select 'I O -1'	IO-1	**To configure the timer end digital output signal** Scrolling display 'IO-1 LIST'
Set the output function to digital out	2. Press ○ (twice) to select '1.FUNC' 3. Press ▲ or ▼ to choose d.out	d.out 1.FUNC	Scrolling display 'IO-1 FUNCTION'
Wire source A so that IO-1 operates when the timer end status is true	4. Press ○ to scroll to '1.SRC.A' 5. Press ▲ or ▼ to choose t.End	t.End 1.SRC.A	Also 1.SRC.B 1.SRC.C 1.SRC.D =nonE and 1.SENS =nor to energise the relay when the timer is in the end state Scrolling display 'IO-1 SOURCE'
Select the OP-2 page header	6. Press ▣ as many times as necessary to select 'OP-2'	OP-2	**To configure the control output** Scrolling display 'OUTPUT 2 LIST'
Set the output function to heat	7. Press ○ to select '2.FUNC' 8. Press ▲ or ▼ to choose HEAt	HEAt 2.FUNC	Also 2.PLS = 5.0 and 2.SENS = nor Scrolling display 'OUTPUT 2 FUNCTION'

Select the AA relay output list header	9. Press ▤ as many times as necessary to select 'A A '		**To configure the AA relay timer run digital output signal** Scrolling display 'AA RELAY'
Set the output function to digital out	10. Press ↻ to select '4. FUNC' 11. Press ▲ or ▼ to choose d.out		Scrolling display 'OUTPUT 4 FUNCTION'
Wire source A so that the AA relay operates when the timer run status is true	12. Press ↻ to select '4.SRC.A' 13. Press ▲ or ▼ to choose t.run		Also 4.SRC.B 4.SRC.C 4.SRC.D =nonE and 4.SENS =nor to energise the relay when the timer is in the running state Scrolling display 'OUTPUT 4 SOURCE'
Select the LA digital input list header	14. Press ▤ as many times as necessary to select 'L A '		**To configure the LA digital input to Run/Reset the timer from an external contact**
Set the input to Run/Reset the timer	15. Press ↻ to select 'L .D.I N ' 16. Press ▲ or ▼ to choose t.rrS		Make to Run, break to Reset

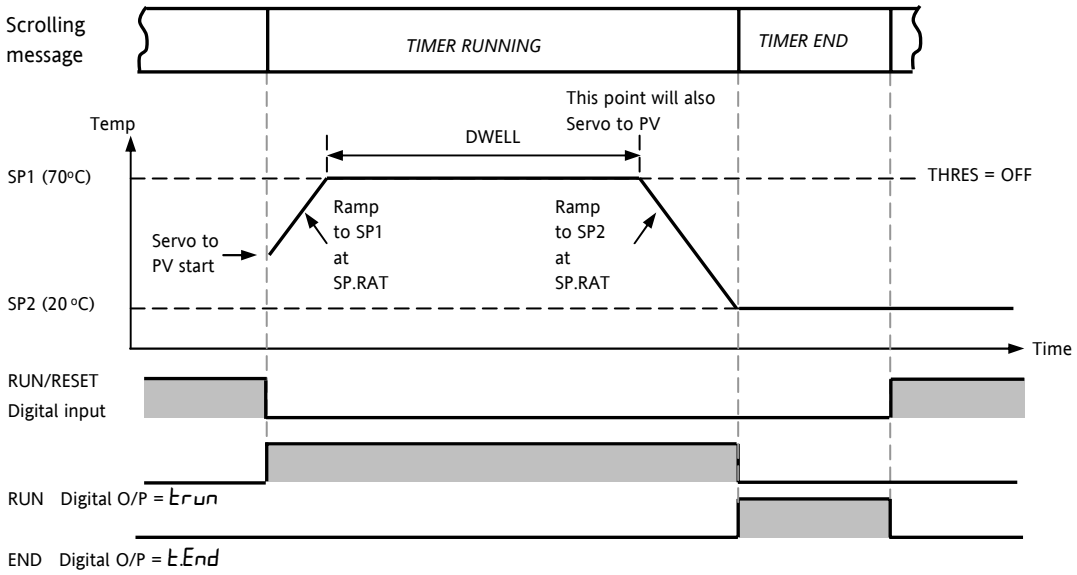
Configure the Timer

Operation	Do This	Display View	Additional Notes
Select the Timer list header	17. Press ▤ as many times as necessary to select 'T I M E R '		**To configure the timer.** This can also be done in Level 3. Scrolling display 'TIMER LIST'
Configure the timer as a Dwell type	18. Press ↻ to select 'TM.CFG' 19. Press ▲ or ▼ to choose dwEll		Also TM.RES = min or Hour as required Scrolling display 'TIMER CONFIGURATION'
Set the threshold to a level acceptable to the process	20. Press ↻ to select 'THRES' 21. Press ▲ or ▼ to choose 2		**To ensure the dwell starts when PV reaches 2° of setpoint** Scrolling display 'TIMER START THRESHOLD'
When the timer times out reset it to setpoint 2	22. Press ↻ to select 'END.T' 23. Press ▲ or ▼ to choose SP2		Also set DWELL to the time period required Scrolling display 'TIMER END TYPE'
Return to Level 3 and operate the timer as previously described below			

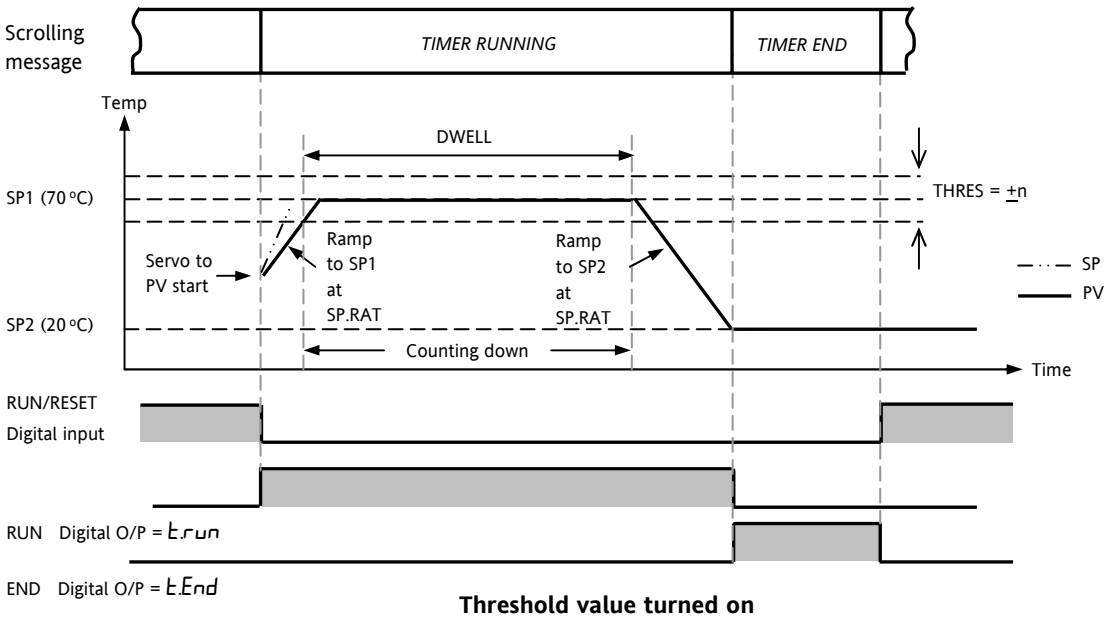
Assume the following settings

SP1 = 70ºC End.T = SP2 = 20ºC Ramp Rate (SP.RAT) = 20ºC/min

The threshold value behaves like a holdback value and can be turned off. A digital output can be configured to operate an external buzzer, or other form of indication, to alert the operator to the end of the process. It is cancelled by pressing 'Ack ' (page) and (up).



Threshold value turned off



Threshold value turned on

This now behaves as a simple four segment programmer of two ramps two dwells.

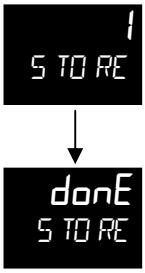
14. Recipe

A recipe can take a snapshot of the current values and store these into a recipe number.

There are five recipes available, which can store a range of parameter values for different processes. The list of parameters is shown in section 14.3.1.

Each recipe can be given a name using iTools configuration software. It is also possible to reconfigure which parameters are included in the recipe list using iTools, see section 17.

14.1 To Save Values in a Recipe

Do This	The Display You Should See	Additional Notes
1. Press ⊜ as many times as necessary to select 'R E C I P '		Scrolling display REC IPE LIST
2. Press ⊙ to scroll to 'S T O R E ' 3. Press ▲ or ▼ to choose the recipe number to store eg 1		Scrolling display REC IPE TO SAVE The current parameter values are stored in Recipe 1

14.2 To Save Values in a Second Recipe

In this example the proportional band will be changed and stored in recipe 2. All other values will remain the same as recipe 1:-

Do This	The Display You Should See	Scrolling display **Additional Notes**
1. Press ⊜ to scroll to 'C T R L '		Scrolling display CONTROL LIST
2. Press ⊙ to scroll to PB 3. Press ▲ or ▼ to change the value eg 22		Scrolling display PROPORTIONAL BAND
4. Press ⊜ to scroll to ' R E C I P '		Scrolling display REC IPE LIST
5. Press ⊙ to 'S T O R E ' 6. Press ▲ or ▼ to 2		Scrolling display REC IPE TO SAVE

14.3 To Select a Recipe to Run

Do This	The Display You Should See	Additional Notes
1. Press (page) as many times as necessary to select 'R E C I P '		Scrolling display REC IPE LIST
2. Press (↻) to select 'R E C . N O ' 3. Press (▲) or (▼) to choose recipe number e.g. 1		Scrolling display CURRENT RECIPE NUMBER The values stored in Recipe 1 will now be loaded. If a recipe number is chosen which has not been saved then FAIL will be displayed

14.3.1 List of Default Recipe Parameters:

Instrument resolution is always saved and restored, as are instrument units, proportional band units and dwell resolution. The following parameters are the other default recipe parameters.

PB	Proportional Band	A1.xx	Alarm 1 threshold1
TI	Integral time	A2.xx	Alarm 2 threshold2
TD	Derivative time	A3.xx	Alarm 3 threshold3
D.BAND	Channel 2 deadband	A4.xx	Alarm 4 hreshold4
CB.LO	Cutback low	LBT	Loop break time
CB.HI	Cutback high	HYST.H	Channel 1 hysteresis
R2G	Relative cool gain	HYST.C	Channel 2 hysteresis
SP1	Setpoint 1	HOME	Home Display
SP2	Setpoint 2	SP.HI	Setpoint High limit
MR	Manual reset On/off only	SP.LO	Setpoint Low limit
OP.HI	Output high limit	TM.CFG	Timer configuration
OP.LO	Output low limit	TM.RES	Timer reset
SAFE	Safe Output	SS.SP	Soft start setpoint
SP.RAT	Setpoint rate limit	SS.PWR	Soft start power limit
A1.HYS	Alarm 1 hysteresis	DWELL	Set time duration
A2.HYS	Alarm 2 hysteresis	THRES	Timer Threshold
A3.HYS	Alarm 3 hysteresis	END.T	Timer End Type
A4.HYS	Alarm 4 hysteresis	RAMPU	Ramp Units
		T.STAT	Programmer/Timer status

Recipes can also be set up using iTools configuration software – see section 17.10.

15. Digital Communications

Digital Communications (or 'comms' for short) allows the controller to communicate with a PC or a networked computer system.

This product conforms to MODBUS RTU protocol a full description of which can be found on www.modbus.org.

Two ports are available both using MODBUS RTU communication facilities:

1. a configuration port - intended to communicate with a system to download the instrument parameters and to perform manufacturing tests and calibration
2. an optional EIA232 or EIA485 port on terminals HD, HE and HF - intended for field communications using, for example, a PC running a SCADA package.

The two interfaces cannot operate at the same time.

For a full description of digital communications protocols (Modbus RTU) refer to the 2000 series Communications Handbook, part number HA026230, available on www.eurotherm.co.uk.

Each parameter has its own unique Modbus address. A list of these is given at the end of this section.

15.1 Digital Communications Wiring

15.1.1 EIA232

To use EIA232 the PC will be equipped with an EIA232 port, usually referred to as COM 1.

To construct a cable for EIA232 operation use a three core screened cable.

The terminals used for EIA232 digital communications are listed in the table below. Some PC's use a 25 way connector although the 9 way is more common.

Standard Cable	PC socket pin no.		PC Function *	Instrument Terminal	Instrument
Colour	9 way	25 way			Function
White	2	3	Receive, RX	HF	Transmit, TX
Black	3	2	Transmit, TX	HE	Receive, RX
Red	5	7	Common	HD	Common
Link together	1 4 6	6 8 11	Rec'd line sig. detect Data terminal ready Data set ready		
Link together	7 8	4 5	Request to send Clear to send		
Screen		1	Ground		

* These are the functions normally assigned to socket pins. Please check your PC manual to confirm.

15.1.2 EIA485 (2-wire)

To use EIA485, buffer the EIA232 port of the PC with a suitable EIA232/EIA485 converter. The Eurotherm Controls KD485 Communications Adapter unit is recommended for this purpose. The use of a EIA485 board built into the computer is not recommended since this board may not be isolated, which may cause noise problems, and the RX terminals may not be biased correctly for this application.

To construct a cable for EIA485 operation use a screened cable with one (EIA485) twisted pair plus a separate core for common. Although common or screen connections are not necessary, their use will significantly improve noise immunity.

The terminals used for EIA485 digital communications are listed in the table below.

Standard Cable Colour	PC Function *	Instrument Terminal	Instrument Function
White	Receive, RX+	HF (B) or (B+)	Transmit, TX
Red	Transmit, TX+	HE (A) or (A+)	Receive, RX
Green	Common	HD	Common
Screen	Ground		

- These are the functions normally assigned to socket pins. Please refer to your PC manual.

See section 2.16 for wiring diagrams

15.1.3 Wiring EIA422 or 4-wire EIA485

EIA422 is available as option 6XX in 3216 controllers only.

To use EIA422, buffer the EIA232 port of the PC with a suitable EIA232/EIA422 converter. The KD485 Communications Converter unit is recommended for this purpose. Instruments on a EIA422 communication network should be chain connected and not star connected.

To construct a cable for EIA422 operation use a screened cable with two twisted pairs plus a separate core for common. Although common or screen connections are not necessary, their use will significantly improve noise immunity.

The terminals used for EIA422 digital communications are listed in the table below.

Standard Cable Colour	PC socket pin no. 25 way	PC Function *	Instrument Terminal	Instrument Function
White	3	Receive (RX+)	HE	Transmit (TX+)
Black	16	Receive (RX-)	HF	Transmit (TX-)
Red	12	Transmit (TX+)	HB	Receive (RX+)
Black	13	Transmit (TX-)	HC	Receive (RX-)
Green	7	Common	HD	Common
Screen	1	Ground		

* These are the functions normally assigned to socket pins. Please check your PC manual to confirm.

⚠ **Warning. The 3200 series has a limited number of writes to EEPROM. Please ensure that parameters which do not require updating on a regular basis (for example, setpoints, alarm trip levels, hysteresis, etc) are only written to when a change in the parameter value occurs. Failure to do this could result in permanent damage to the internal EEPROM. See also section 15.3.**

15.2 Digital Communications Parameters

The following table shows the parameters available.

DIGITAL COMMUNICATIONS LIST 'COMMS'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
ID	MODULE IDENTITY	Comms identity	none	No module fitted	As order code	Conf L3 R/O
			r232	RS 232 Modbus interface		
			r485	EIA485 Modbus interface		
			r422	EIA422 Modbus 3216 only		
			dcP	Remote setpoint input. If fitted this ID replaces the above and no further parameters are shown		
ADDR	COMMUNICATIONS ADDRESS	Communications address of the instrument	1 to 254		1	L3
BAUD	COMMUNICATIONS BAUD RATE	Communications baud rate	1200	1200	9600	Conf L3 R/O
			2400	2400		
			4800	4800		
			9600	9600		
			19.20	19,200		
PRTY	COMMUNICATIONS PARITY	Communications parity	none	No parity	none	Conf L3 R/O
			EuEn	Even parity		
			Odd	Odd parity		
DELAY	RX/TX DELAY TIME	To insert a delay between Rx and Tx to ensure that drivers have sufficient time to switch over.	OFF	No delay		Conf L3 R/O
			on	Fixed delay applied		
RE TRAN	COMMS RETRANSMISSION	Master comms broadcast parameter. See section 15.2.1	none	None	none	
			w.SP	Working setpoint		
			PV	Process Variable		
			OP	Output demand		
			Err	Error		
REG.AD	COMMS RETRANSMISSION ADDRESS	Parameter added in the Slave address to which the master communications value will be written See section 15.2.1.	0 to 9999		0	

15.2.1 Broadcast Communications

Broadcast communications as a simple master is available on 3200 controllers from software versions 1.10 or greater. Broadcast master communications allows the 3200 controller to send a single value to any number of slave instruments. Modbus broadcast using function code 6 (Write single value) must be used. This allows the 3200 to link with other products, without the need for a supervisory PC, to create a small system solution. Example applications include multi-zone setpoint programming applications or cascade control using a second controller. The facility provides a simple and precise alternative to analogue retransmission.

The retransmitted parameter (address 12551) can be selected from Working Setpoint, Process Variable, Output Demand or Error. The controller will cease broadcast when it receives a valid request from a Modbus master - this allows iTools to be connected for commissioning purposes.

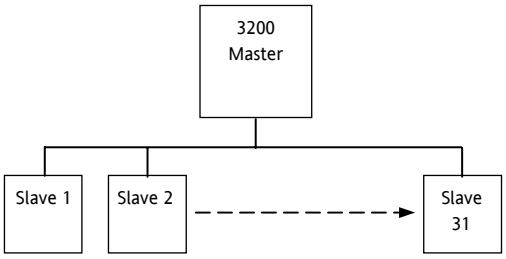
15.2.2 Broadcast Master Communications

The 3200 broadcast master can be connected to up to 31 slaves if no segment repeaters are used. If repeaters are used to provide additional segments, 32 slaves are permitted in each new segment. The master is configured by setting the 'RETRN' parameter to w.SP, PU, OP or Err.

Once the function has been enabled, the instrument will send this value out over the communications link every control cycle (250ms).

Notes:-

1. The parameter being broadcast must be set to the same decimal point resolution in both master and slave instruments.
2. If iTools, or any other Modbus master, is connected to the port on which the broadcast master is enabled, then the broadcast is temporarily inhibited. It will restart approximately 30 seconds after iTools is removed. This is to allow reconfiguration of the instrument using iTools even when broadcast master communications is operating.



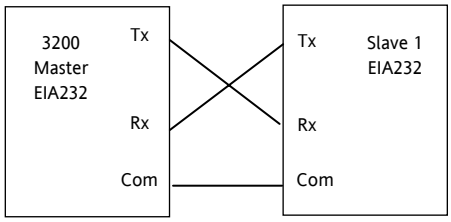
15.2.3 Wiring Connections

The Digital Communications module for use as a master or slave is fitted in Comms Module slot H and uses terminals HA to HF.

☺ EIA232

Rx connections in the master are wired to Tx connections of the slave

Tx connections in the master are wired to Rx connections of the slave

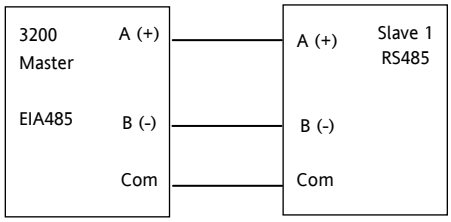


☺ EIA485 2-wire

Connect A (+) in the master to A (+) of the slave

Connect B (-) in the master to B (-) of the slave

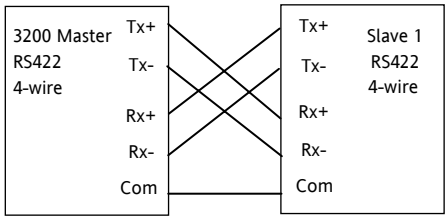
This is shown diagrammatically below



☺ EIA422 (4-wire) 3216 Only (option 6XX)

Rx connections in the master are wired to Tx connections of the slave

Tx connections in the master are wired to Rx connections of the slave



15.3 EEPROM Write Cycles

⚠ **Warning**

In common with most instruments in its class, the 3200 Range uses a non-volatile memory with a limited number of specified writes. Non-volatile memory is used to hold information that must be retained over a power cycle. Typically, this includes setpoint and status information, including alarm latch status.

Please ensure that parameters which do not require updating on a regular basis (for example, setpoints, alarm trip levels, hysteresis, etc) are only written to when a change in the parameter value occurs. Failure to do this could result in permanent damage to the internal EEPROM.

When using the 3200 range, use the 'AltSP' variable at Modbus address 26, which has no write restrictions, if you need to write to a temperature setpoint. A local trim value may also be applied using the 'SPTrim' parameter at Modbus address 27.

Some examples of parameters which could cause this limit to be exceeded over a period of time are given below.

Setpoint Ramping

Continuous changing of setpoint via digital communications – for example a ramping value – is the most common cause of EEPROM wear.

One solution, as stated above, is to enable the "Alternate Setpoint" (address 276), then write values directly to the "Alternate Setpoint, AltSP" (address 26). These parameters may be found in the SP list in iTools and are L-R and REM.SP in the controller. Note that an approximately 5 second timeout is applied to writes to Modbus address 26. This, therefore requires regular updating which, for setpoint ramping, is ideally suited.

In other applications where regular updating may not be ideal, this may be avoided by writing to the "Target Setpoint" at address 02. The Alternate Setpoint must also be enabled at address 276. The value written to address 02 will then be written permanently to address 26. Note, however, that any value written to the Target Setpoint will not be retained over a power fail since the controller then reverts to the setpoint selected (for example, SP1 or SP2).

It is **critically important** to select the Alternate Setpoint if updating the setpoint on a regular basis otherwise the setpoint change will be saved to non-volatile memory and EEPROM wear will result.

Alarms and other Status Changes

Alarm status is saved in non-volatile memory and this includes status alarms such as sensor break, loop break, remote fail and individual alarm and alarm latching status. Every transition into and out of an alarm condition triggers an EEPROM write. Thus, if there is any fast toggling of an alarm status, EEPROM wear can result within the expected lifetime of an instrument.

An example of this is where event alarms are used to provide an on/off control loop. 3200 instruments should on no account be used in this manner since the toggling of the output will rapidly use up the 100,000 writes. The On/Off control in the PID algorithm should be used instead. However, any situation where alarm states can change rapidly should be avoided.

Mode and Timer/Programmer Changes

Rapid changes to instrument mode (Auto/Manual) or the Timer/Programmer operation can cause EEPROM wear because the status (run/hold/reset) or the segment number are stored in EEPROM on each transition.

In normal use where segments or timer sequences are relatively long, it is unlikely that problems will be seen. However, in some applications where a sequence is run frequently, EEPROM wear will occur. An example of this is where a digital input is used in an application to trigger a timer sequence and the operation is performed as fast as possible by the operator.

Digital Inputs

Care should be taken with any rapid cycling digital inputs. Typically a digital input triggering timer or mode changes (as above) should be carefully considered so that they do not switch more than 100,000 times during the expected lifetime of the instrument.

.

15.4 Example: To Set Up Instrument Address

This can be done in operator level 3:-

Do This	Display View	Additional Notes
1. Press ⊜ as many times as necessary to select **'COMMS LIST'**		Scrolling display 'COMMS LIST'
2. Press ⊙ to scroll to 'ID'		Scrolling display 'ID'. This displays the type of communications board fitted
3. Press ⊙ to scroll to 'ADDR' 4. Press ▲ or ▼ to select the address for this controller		Up to 254 can be chosen but note that no more than 33 instruments should be connected to a single EIA232 link. Scrolling display 'ADDRESS'

For further information see 2000 Series Communications Handbook Part No. HA026230.

15.5 DATA ENCODING

☺ Note that the Eurotherm iTools OPC server provides a straightforward means of accessing any variable in the 3200 controller in the correct data format without the need to consider data representation. However if you wish to write your own communications interface software, you will need to take the format used by the 3200 comms software into account.

Modbus data is normally encoded into a 16 bit signed integer representation.

Integer format data, including any value without a decimal point or represented by a textual value (for example 'off', or 'on'), is sent as a simple integer value.

For floating point data, the value is represented as a 'scaled integer', in which the value is sent as an integer which gives the result of the value multiplied by 10 to the power of the decimal resolution for that value. This is easiest to understand by reference to examples:

FP Value	Integer Representation
FP Value	Integer Representation
9.	9
-1.0	10
123.5	1235
9.99	999

It may be necessary for the Modbus master to insert or remove a decimal point when using these values.

It is possible to read floating point data in a native 32 bit IEEE format. This is described in the Eurotherm Series 2000 Communications Handbook (HA026230), Chapter 7.

For **time** data, for example, the length of a dwell, the integer representation depends on the resolution. For 'hours' resolution, the value returned is the number of minutes the value represents, so for example a value of 2:03 (2 hours and three minutes) would be returned as an integer value of 123. For 'minutes' resolution, the value used is the number of seconds the value represents, so that 12:09 (12 minutes and 9 seconds) would be returned as 729.

It is possible to read time data in a native 32 bit integer format, in which case it returns the number of milliseconds the variable represents regardless of the resolution. This is described in the Eurotherm Series 2000 Communications Handbook (HA026230), Chapter 7.

15.6 Parameter Modbus Addresses

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
PV.IN	PV (Temperature) Input Value (see also Modbus address 203 which allows writes over Modbus to this variable).	1
TG.SP	Target Setpoint. ***NB – do not write continuously changing values to this variable. The memory technology used in this product has a limited (100,000) number of write cycles. If ramped setpoints are required, consider using the internal ramp rate function or the remote comms setpoint (Modbus address 26)in preference.***	2
MAN.OP	Manual Output Value	3
WRK.OP	Working Output	4
WKG.SP	Working Setpoint (Read Only)	5
PB	Proportional Band	6
CTRL.A	Control Action 0 = Reverse Acting 1 = Direct Acting	7
Ti	Integral Time (0 = No Integral Action)	8
Td	Derivative Time (0 = No Derivative Action)	9
RNG.LO	Input Range Low Limit	11
RNG.HI	Input Range High Limit	12
A1.---	Alarm 1 Threshold	13
A2.---	Alarm 2 Threshold	14
SP.SEL	Active Setpoint Select 0 = Setpoint 1 1 = Setpoint 2	15
D.BAND	Channel 2 Deadband	16
CB.Lo	Cutback Low	17
CB.HI	Cutback High	18
R2G	Relative Cool/Ch2 Gain	19
MTR.T	Motor Travel Time	21
T.STAT	Timer Status 0 = Reset 1 = Run 2 = Hold 3 = End	23
SP1	Setpoint 1 ***NB – do not write continuously changing values to this variable. The memory technology used in this product has a limited (100,000) number of write cycles. If ramped setpoints are required, consider using the internal ramp rate function or the remote comms setpoint (Modbus address 26)in preference.***	24
SP2	Setpoint 2 ***NB – do not write continuously changing values to this variable. The memory technology used in this product has a limited (100,000) number of write cycles. If ramped setpoints are required, consider using the internal ramp rate function or the remote comms setpoint (Modbus address 26)in preference.***	25
Rm.SP	Remote (comms) setpoint. If selected using the remote setpoint selection (address 276 below, may also be controlled using the instrument HMI or a digital input) then this is used as a setpoint providing a value has been received within a window of about 5 seconds. If no value is received then the controller falls back to the currently selected setpoint (SP 1 or SP 2) with an error indication. The Remote Setpoint may have a local trim (SP Trim, address 27) added to it to compensate for variations in temperature in a particular zone. This parameter is not saved when the instrument is switched off. It may be written to continuously over communications without risk of damage to the instrument non-volatile memory.	26
LOC.t	Local Trim – added to the remote setpoint to compensate for local temperature variations in a control zone.	27
MR	Manual Reset	28
OP.HI	Output High Limit	30
OP.LO	Output Low Limit	31
SAFE	Safe Output Value for Sensor Break or other fault conditions.	34
SP.RAT	Setpoint Rate Limit Value (0 = no rate limit)	35
P.Err	Calculated Error (PV-SP)	39
A1.HYS	Alarm 1 Hysteresis	47
A2.HYS	Alarm 2 Hysteresis	68
A3.HYS	Alarm 3 Hysteresis	69

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
A4.HYS	Alarm 4 Hysteresis	71
StAt	Instrument Status. This is a bitmap: B0 – Alarm 1 Status B1 – Alarm 2 Status B2 – Alarm 3 Status B3 – Alarm 4 Status B4 – Auto/Manual Status B5 – Sensor Break Status B6 – Loop Break Status B7 – CT Low load current alarm status B8 – CT High leakage current alarm status B9 – Program End B10 – PV Over-range (by > 5% of span) B11 – CT Overcurrent alarm status B12 – New Alarm Status B13 – Timer/Ramp Running B14 – Remote (comms) SP Fail B15 – Auto-tune Status In each case, a setting of 1 signifies 'Active', 0 signifies 'Inactive'.	75
-	Inverted Instrument Status. This is an inverted (bitwise) version of the preceding parameter and is provided so that scrolling messages can be triggered when a condition is not active. Bit mappings are as the "Instrument Status", Modbus address 75	76
LL.AMP	Load Leakage Current	79
LD.AMP	Load ON Current	80
A3.---	Alarm 3 Threshold	81
A4.---	Alarm 4 Threshold	82
LBT	Loop Break Time	83
F.OP	Forced manual output value	84
F.MOD	Forced manual output mode 0 – None 1 - Step 2 - Last	85
HYST.H	Ch1 On/Off Hysteresis in Eng Units	86
Di.IP	Digital Inputs Status. This is a bitmap: B0 – Logic input 1A B1 – Logic input LA B2 – Logic input LB B7 – Power has failed since last alarm acknowledge A value of 1 signifies the input is closed, otherwise it is zero. Values are undefined if options are not fitted or not configured as inputs.	87
HYST.C	Ch2 On/Off Hysteresis in Eng Units	88
FILT.T	Input Filter Time	101
RC.FT	Filter time constant for the rate of change alarm.	102
RC.PV	Calculated rate of change of the temperature or process variable in engineering units per minute.	103
Home	Home Display. 0 – Standard PV and SP display 1 – PV and Output Power display 2 – PV and Time remaining display 3 – PV and Timer elapsed time display 4 – PV and Alarm 1 setpoint 5 – PV and Load Current 6 – PV only 7 – PV and Composite SP/Time remaining 8 – Target setpoint 9 – No PV 10 – PV is not displayed when controller in Standby	106
-	Instrument version number. Should be read as a hexadecimal number, for example a value of 0111 hex is instrument V1.11	107
SP.HI	Setpoint High Limit	111
SP.LO	Setpoint Low Limit	112
-	Instrument type code.	122
ADDR	Instrument Comms Address	131

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
PV.OFS	PV Offset	141
C.Adj	Calibration Adjust	146
IM	Instrument Mode 0 – Operating mode - all algorithms and I/O are active 1 – Standby - control outputs are off 2 – Config Mode - all outputs are inactive	199
MV.IN	Input value in millivolts	202
PV.CM	Comms PV Value. This may be used to write to the Process Variable (temperature) parameter over Modbus when a linearisation type of 'Comms' is selected, allowing the instrument to control to externally derived values. If sensor break is turned on, it is necessary to write to this variable once every 5 seconds. Otherwise a sensor break alarm will be triggered as a failsafe. If this is not required, turn sensor break off.	203
CJC.IN	CJC Temperature	215
SBR	Sensor Break Status (0 = Off, 1 = Active)	258
NEW.AL	New Alarm Status (0 = Off, 1 = Active)	260
LBR	Loop Break (0 = Off, 1 = Active)	263
A.TUNE	Auto-tune Enable (0 = Off, 1 = Enabled)	270
A-M	Mode of the Loop (0 = Auto, 1 = Manual)	273
Ac.All	Acknowledge all alarms (1 = Acknowledge	274
L-R	Local Remote (Comms) Setpoint Select	276
	Remote setpoint in percent	277
REM.HI	Remote input high scalar – sets high range for setpoint input, corresponding to 20mA or 10V depending on the input type.	278
REM.LO	Remote input low scalar – sets low range for setpoint input, corresponding to 4mA or 0V depending on the input type.	279
ROP.HI	Sets the high range limit for the retransmitted setpoint. Allows a subset of the setpoint range to be retransmitted, and also allows the 3208/3204 setpoint range meter to display a range indication other than full scale. By default this is set to the setpoint high limit.	280
ROP.LO	Sets the low range limit for the retransmitted setpoint. Allows a subset of the setpoint range to be retransmitted, and also allows the 3208/3204 setpoint range meter to display a range indication other than full scale. By default this is set to the setpoint low limit.	281
A1.STS	Alarm 1 Status (0 = Off, 1 = Active)	294
A2.STS	Alarm 2 Status (0 = Off, 1 = Active)	295
A3.STS	Alarm 3 Status (0 = Off, 1 = Active)	296
A4.STS	Alarm 4 Status (0 = Off, 1 = Active)	297
LD.ALM	Low Load Current Threshold	304
LK.ALM	High Leakage Current Alarm (0 = Off, 1 = Active)	305
HC.ALM	Over Current Alarm Threshold	306
LOAD.A	Load Alarm Status (0 = Off, 1 = Active)	307
LEAK.A	Leak alarm Status.	308
HILC.A	Over Current alarm Status (0 = Off, 1 = Active)	309
REC.NO	Recipe to Recall	313
StOrE	Recipe to Save	314
TM.CFG	Timer type configuration 0 – No Timer 1 – Dwell Timer 2 – Delay Timer 3 – Soft Start Timer 10 – Programmer (Programmer Option only)	320
TM.RES	Timer Resolution 0 – Hours:Mins 1 – Mins:Secs	321
SS.SP	Soft Start Setpoint	322
SS.PWR	Soft Start Power Limit	323
DWELL	Requested Timer Duration	324
T.ELAP	Elapsed Time	325
T.REMN	Time Remaining	326
THRES	Timer Start threshold	327

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
End.T	Timer End Type 0 – Off 1 – Dwell at current setpoint 2- Transfer to Setpoint 2 and dwell 3 – Reset programmer when the program ends	328
SERVO	'Servo' Mode (programmer option only) 0 – Start first ramp from current Working Setpoint. Program must be restarted after power failure 1 - Start first ramp from current PV (temperature). Program must be restarted after power failure 2 - Start first ramp from current Working Setpoint. Program will continue to run after power failure 3 - Start first ramp from current PV (temperature). Program must be restarted after power failure	329
EVENT	Event outputs	331
P.CYCL	Number of program cycles	332
CYCLE	Currently running program cycle	333
CTRL.H	Heat/Ch1 Control Type 0 – Off 1 – On/Off Control 2 – PID Control 3 – mtr Valve Position Control	512
CTRL.C	Cool/Ch2 Control Type 0 – Off 1 – On/Off Control 2 – PID Control	513
PB.UNT	Proportional Band Units 0 – Engineering Units 1 – Percent of Span	514
Lev2.P	Level 2 Code	515
UNITS	Display Units 0 – Degrees C 1 – Degrees F 2 – Kelvin 3 – None 4 – Percent	516
Lev3.P	Level 3 Code	517
Conf.P	Config Code	518
Cold	If set to 1 instrument will reset to factory defaults on next reset or power cycle.	519
PASS.C	Feature passcode C	520
PASS.2	Feature passcode 2	521
COOL.t	Cooling Algorithm Type: 0 – Linear 1 – Oil 2 – Water 3 – Fan	524
DEC.P	Decimal Point Position 0 – XXXX. 1 – XXX.X 2 – XX.XX	525
STBY.T	Standby Type 0 – Absolute Alarm Outputs Active – others off 1 – All outputs inactive	530
RAMP UNITS	0 – Ramp per Minute 1 – Ramp per Hour 2 – Ramp per Second	531
Meter	(3208/3204 Only). Ammeter configuration 0 – No ammeter 1 – Heat Output (0-100%) 2 – Cool Output (0-100% cooling) 3 – Working Setpoint (scaled within SP limits) 4 – PV (scaled within range) 5 – Output Power (scaled within Op Low and OP High limits) 6 – Output centered between –100% and 100% 7 – Error (PV-SP) (scaled between +/- 10 degrees) 8 – Instantaneous Amps (scaled 0 to CT Span)	532

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
	9 – Load Current (scaled 0 to CT Span)	
uCAL	User Calibration Enable	533
A1.TYP	Alarm 1 Type 0 – Off 1 –Absolute High 2 – Absolute Low 3 – Deviation High 4 – Deviation Low 5 – Deviation Band	536
A2.TYP	Alarm 2 Type (as Alarm 1 Type)	537
A3.TYP	Alarm 3 Type (as Alarm 1 Type)	538
A4.TYP	Alarm 4 Type (as Alarm 1 Type)	539
A1.LAT	Alarm 1 Latching Mode 0 – No latching 1 – Latch - Automatic Reset 2 – Latch – Manual Reset	540
A2.LAT	Alarm 2 Latching Mode (as Alarm 1 Latching Mode)	541
A3.LAT	Alarm 3 Latching Mode (as Alarm 1 Latching Mode)	542
A4.LAT	Alarm 4 Latching Mode (as Alarm 1 Latching Mode)	543
A1.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)	544
A2.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)	545
A3.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)	546
A4.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)	547
Di.OP	Digital Outputs Status. This is a bitmap: B0 – Output 1A B1 – Output 2A B2 – Output 3 on 32h8 and 3208 controllers B3 – Output 4/AA It is possible to write to this status word to use the digital outputs in a telemetry output mode. Only outputs whose function is set to 'none' are affected, and the setting of any bits in the Digital Output Status word will not affect outputs used for heat (for example) or other functions. Thus it is not necessary to mask in the settings of these bits when writing to this variable.	551
OFS.HI	Adjust High Offset	560
OFS.LO	Adjust Low Offset	561
PNT.HI	Adjust High Point	562
PNT.LO	Adjust Low Point	563
CT.RNG	CT Range	572
Sb.tyP	Sensor Break Type 0 – No Sensor Break 1 – Non-Latching Sensor Break 2 – Latching Sensor Break	578
Id	Customer ID – May be set to any value between 0-9999 for identification of instruments in applications. Not used by the instrument itself.	629
PHASE	Calibration Phase 0 – None 1 – 0 mv 2 – 50 mv 3 – 150 Ohm 4 – 400 Ohm 5 – CJC 6 – CT 0 mA 7 – CT 70 mA 8 – Factory Defaults 9 – Output 1 mA low cal 10 – Output 1 mA high cal 11 – Output 2 mA low cal	768

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
	12 – Output 2 mA high cal 13 – Output 3 ma low cal (3208/3204 only) 14 – Output 3 ma high cal (3208/3204 only) 15 – Remote setpoint input low volts 16 - Remote setpoint input high volts 17 - Remote setpoint input low current 18 - Remote setpoint input high current	
GO	Calibration Start 0 – No 1 – Yes (start cal) 2 – Cal Busy 3 – Cal Pass 4 – Cal Fail Note values 2-4 cannot be written but are status returns only	769
-	Analogue Output Calibration Value	775
K.LOC	Allows instrument to be locked via a key/digital input 0 - unlocked, 1 – all keys locked 2 – Edit keys (raise and lower) disabled 3 – Mode key disabled 4 – Manual mode disabled 5 – Enter standby mode when Mode combination pressed 6 – Timer keys disabled	1104
Dwel.1	Programmer Dwell 1 Duration	1280
TSP.1	Programmer Target Setpoint 1	1281
RMP.1	Programmer Ramp Rate 1	1282
Dwel.2	Programmer Dwell 2 Duration	1283
TSP.2	Programmer Target Setpoint 2	1284
RMP.2	Programmer Ramp Rate 2	1285
Dwel.3	Programmer Dwell 3 Duration	1286
TSP.3	Programmer Target Setpoint 3	1287
RMP.3	Programmer Ramp Rate 3	1288
Dwel.4	Programmer Dwell 4 Duration	1289
TSP.4	Programmer Target Setpoint 4	1290
RMP.4	Programmer Ramp Rate 4	1291
AT.R2G	Auto-tune Configures R2G 0 - YES 1 - No	4176
IN.TYP	Input Sensor Type 0 – J Type Thermocouple 1 – K Type Thermocouple 2 – L Type Thermocouple 3 – R Type Thermocouple 4 – B Type Thermocouple 5 – N Type Thermocouple 6 – T Type Thermocouple 7 – S Type Thermocouple 8 – RTD 9 – millivolt 10 – Comms Input (see Modbus address 203) 11 – Custom Input (Downloadable)	12290
CJ.tyP	CJC Type 0 – Auto 1 – 0 Degrees C 2- 50 Degrees C	12291
mV.HI	Linear Input High	12306
mV.LO	Linear Input Low	12307
L.TYPE	Logic Input A channel hardware type 0 – None 1 – Logic Inputs	12352
L.D.IN	Logic input A function	12353

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
	40 – None 41 – Acknowledge all alarms 42 – Select SP1/2 43 – Lock All Keys 44 – Timer Reset 45 – Timer Run 46 – Timer Run/Reset 47 – Timer Hold 48 – Auto/Manual Select 49 – Standby Select 50 – Remote setpoint 51 – Recipe select through IO1 52 – Remote key UP 53 – Remote key DOWN	
L.SENS	Configures the polarity of the logic input channel A (0 = Normal, 1 = Inverted)	12361
L.TYPE (LB)	Logic Input B channel hardware type (3208/3204 only) 0 – None 1 – Logic Inputs	12368
L.D.IN (LB)	Logic input B function (3208/3204 only) 40 – None 41 – Acknowledge all alarms 42 – Select SP1/2 43 – Lock All Keys 44 – Timer Reset 45 – Timer Run 46 – Timer Run/Reset 47 – Timer Hold 48 – Auto/Manual Select 49 – Standby Select 50 – Remote setpoint 51 – Recipe select through IO1 52 – Remote key UP 53 – Remote key DOWN	12369
L.SENS (LB)	Configures the polarity of the logic input channel B (0 = Normal, 1 = Inverted) (3208/4 only)	12377
ID	Comms Module Type 0 – None 1 – EIA232 2 – EIA232 3 – EIA232 4 – Remote setpoint input	12544
BAUD	Baud Rate 0 – 9600 1 – 19200 2 – 4800 3 – 2400 4 – 1200	12548
PRTY	Parity setting 0 – None 1 – Even 2 – Odd	12549
DELAY	RX/TX Delay – (0 = no delay, 1 = delay) Select if a delay is required between received and transmitted comms messages. Sometimes required when intelligent EIA232 adaptors are used.	12550
RETRN	Comms Retransmission Variable selection: 0 – Off 1 – Working Setpoint 2 – PV 3 – Output Power 4 – Error	12551
REG.AD	Modbus register address to broadcast retransmission to. For example if you wish to retransmit the working setpoint from one 3200 to a group of slaves, and receive the master working setpoint into the slaves' remote setpoint, set this variable to 26 (the address of the remote setpoint in the slave units).	12552
Ct.Id	Current Transformer	12608
CT.SRC	CT Source 0 – None	12609

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
	1 – IO1 2 – OP2 8 – AA (OP4)	
CT.LAT	CT Alarm Latch Type 0 – No latching 1 – Latch – Automatic Reset 2 – Latch – Manual Reset	12610
1.ID	IO channel 1 hardware type 0 – None 1 – Relay 2 – Logic I/O 3 – DC OP 4 – Triac (SSR)	12672
1.D.IN	IO1 Digital input function Logic input function 40 – None 41 – Acknowledge all alarms 42 – Select SP1/2 43 – Lock All Keys 44 – Timer Reset 45 – Timer Run 46 – Timer Run/Reset 47 – Timer Hold 48 – Auto/Manual Select 49 – Standby Select 50 – Remote setpoint 51 – Recipe select through IO1 52 – Remote key UP 53 – Remote key DOWN	12673
1.Func	I/O Channel Function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position 4 – Digital Input 10 – DC Output no function 11 – DC Output Heat 12 – DC Output Cool 13 – DC Output WSP retransmission 14 – DC Output PV retransmission 15 – DC Output OP retransmission	12675
1.RNG	IO Channel 1 DC Output Range 0 – 0-20mA 1 – 4-20mA	12676
1.SRC.A	IO Channel 1 Source A 0 – None 1 – Alarm 1 2 – Alarm 2 3 – Alarm 3 4 – Alarm 4 5 – All Alarms (1-4) 6 – New Alarm 7 – CT Alarm (Load, Leak or Overcurrent) 8 – Loop Break Alarm 9 – Sensor Break Alarm 10 – Timer End (or Not Ramping) 11 – Timer Run (or Ramping) 12 – Auto/Manual 13 – Remote fail 14 – Power fail 15 – Programmer event	12678
1.SRC.B	IO Channel 1 Source B As IO Channel 1 Source A (Modbus address 12678)	12679
1.SRC.C	IO Channel 1 Source C As IO Channel 1 Source A (Modbus address 12678)	12680

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
1.SRC.D	IO Channel 1 Source D As IO Channel 1 Source A (Modbus address 12678)	12681
1.SENS	Configures the polarity of the input or output channel (0 = Normal, 1 = Inverted)	12682
1.PLS	IO1 Time proportioning Output minimum pulse time	12706
2.ID	Output 2 Type 0 – None 1 – Relay 2 – Logic Output 3 – DC OP 4 – Triac (SSR)	12736
2.FUNC	Output 2 Channel function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position 10 – DC Output no function 11 – DC Output Heat 12 – DC Output Cool 13 – DC Output WSP retransmission 14 – DC Output PV retransmission 15 – DC Output OP retransmission	12739
2.RNG	IO Channel 2 DC Output Range 0 – 0-20mA 1 – 4-20mA	12740
2.SRC.A	Output 2 source A As IO Channel 1 Source A (Modbus address 12678)	12742
2.SRC.B	Output 2 source B As IO Channel 1 Source A (Modbus address 12678)	12743
2.SRC.C	Output 2 source C As IO Channel 1 Source A (Modbus address 12678)	12744
2.SRC.D	Output 2 source D As IO Channel 1 Source A (Modbus address 12678)	12745
2.SENS	Output 2 Polarity (0 = Normal, 1 = Inverted)	12746
2.PLS	Output 2 Time proportioning Output minimum pulse time	12770
3.ID	Output 3 Type 0 – None 1 – Relay 2 - 3 – DC OP	12800
3.FUNC	Output 3 Channel function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position 10 – DC Output no function 11 – DC Output Heat 12 – DC Output Cool 13 – DC Output WSP retransmission 14 – DC Output PV retransmission 15 – DC Output OP retransmission	12803
3.RNG	IO Channel 3 DC Output Range 0 – 0-20mA 1 – 4-20mA	12804
3.SRC.A	Output 3 source A As IO Channel 1 Source A (Modbus address 12678)	12806
3.SRC.B	Output 3 source B As IO Channel 1 Source A (Modbus address 12678)	12807
3.SRC.C	Output 3 source C As IO Channel 1 Source A (Modbus address 12678)	12808
3.SRC.D	Output 3 source D As IO Channel 1 Source A (Modbus address 12678)	12809
3.SENS	Output 3 Polarity (0 = Normal, 1 = Inverted)	12810
3.PLS	Output 3 Time proportioning Output minimum pulse time	12834

Parameter Mnemonic	Parameter Name	Modbus Address Decimal
4.TYPE	Output AA Type 0 – None 1 – Relay	13056
4.FUNC	Output 4 Channel function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position	13059
4.SRC.A	Output AA source A As IO Channel 1 Source A (Modbus address 12678)	13062
4.SRC.B	Output AA source B As IO Channel 1 Source A (Modbus address 12678)	13063
4.SRC.C	Output AA source C As IO Channel 1 Source A (Modbus address 12678)	13064
4.SRC.D	Output AA source D As IO Channel 1 Source A (Modbus address 12678)	13065
4.SENS	Output Polarity (0 = Normal, 1 = Inverted)	13066
4.PLS	Output AA Time proportioning Output minimum pulse time	13090

16. Calibration

The controller is calibrated during manufacture using traceable standards for every input range. It is, therefore, not necessary to calibrate the controller when changing ranges. Furthermore, the use of a continuous automatic zero correction of the input ensures that the calibration of the instrument is optimised during normal operation.

To comply with statutory procedures such as the Heat Treatment Specification AMS2750, the calibration of the instrument can be verified and re-calibrated if considered necessary in accordance with the instructions given in this chapter.

For example AMS2750 states:- "Instructions for calibration and recalibration of "field test instrumentation" and "control monitoring and recording instrumentation" as defined by the NADCAP Aerospace Material Specification for pyrometry AMS2750D clause 3.2.5 (3.2.5.3 and sub clauses), including Instruction for the application and removal of offsets defined in clause 3.2.4."

16.1 To Check Input Calibration

The PV Input may be configured as mV, mA, thermocouple or platinum resistance thermometer.

16.1.1 Precautions

Before checking or starting any calibration procedure the following precautions should be taken:-

1. When calibrating mV inputs make sure that the calibrating source output is set to less than 250mV before connecting it to the mV terminals. If accidentally a large potential is applied (even for less than 1 second), then at least one hour should elapse before commencing the calibration.
2. RTD and CJC calibration must not be carried out without prior mV calibration.
3. A pre-wired jig built using a spare instrument sleeve may help to speed up the calibration procedure especially if a number of instruments are to be calibrated.
4. Power should be turned on only after the controller has been inserted in the sleeve of the pre-wired circuit. Power should also be turned off before removing the controller from its sleeve.
5. Allow at least 10 minutes for the controller to warm up after switch on.

16.1.2 To Check mV Input Calibration

The input may have been configured for a process input of mV, Volts or mA and scaled in Level 3 as described in section 8.3. The example described in section 8.3.1 assumes that the display is set up to read 2.0 for an input of 4.000mV and 500.0 for an input of 20.000mV.

To check this scaling, connect a milli-volt source, traceable to national standards, to terminals V+ and V- using copper cable as shown in the diagram below.

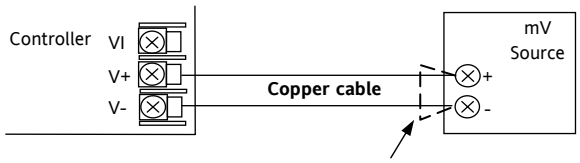


Figure 1: Connections for mV Input Calibration

☺ Ensure that no offsets (see sections 8.2.1 and 16.2) have been set in the controller.

Set the mV source to 4.000mV. Check the display reads 2.0 ±0.25% ± 1LSD (least significant digit).

Set the mV source to 20.000mV. Check the display reads 500.0 ±0.25% ± 1LSD.

16.1.3 To Check Thermocouple Input Calibration

Connect a milli-volt source, traceable to national standards, to terminals V+ and V- as shown in the diagram below. The mV source must be capable of simulating the thermocouple cold junction temperature. It must be connected to the instrument using the correct type of thermocouple compensating cable for the thermocouple in use.

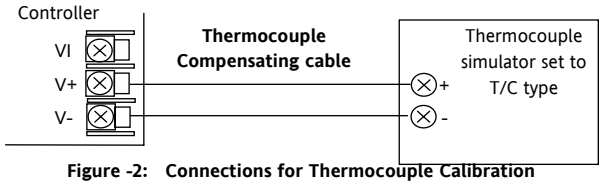


Figure -2: Connections for Thermocouple Calibration

Set the mV source to the same thermocouple type as that configured in the controller.

Adjust the mV source for to the minimum range. For a type J thermocouple, for example, the minimum range is -210°C. However, if it has been restricted using the Range Low parameter then set the mV source to this limit. Check that the reading on the display is within ±0.25% of reading ± 1LSD.

Adjust the mV source for to the maximum range. For a type J thermocouple, for example, the minimum range is 1200°C. However, if it has been restricted using the Range High parameter then set the mV source to this limit. Check that the reading on the display is within ±0.25% of reading ± 1LSD.

Intermediate points may be similarly checked if required.

16.1.4 To Check RTD Input Calibration

Connect a decade box with total resistance lower than 1K and resolution to two decimal places in place of the RTD as indicated on the connection diagram below **before the instrument is powered up**. If at any instant the instrument was powered up without this connection then at least 10 minutes must elapse from the time of restoring this connection before RTD calibration check can take place.

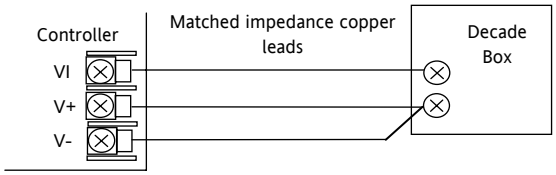


Figure -3: Connections for RTD Calibration

The RTD range of the instrument is -200 to 850^{O}C. It is, however, unlikely that it will be necessary to check the instrument over this full range.

Set the resistance of the decade box to the minimum range. For example 0^{O}C = 100.00Ω. Check the calibration is within ±0.25% of reading ± 1LSD.

Set the resistance of the decade box to the maximum range. For example 200^{O}C = 175.86Ω. Check the calibration is within ±0.25% of reading ± 1LSD.

16.2 Offsets

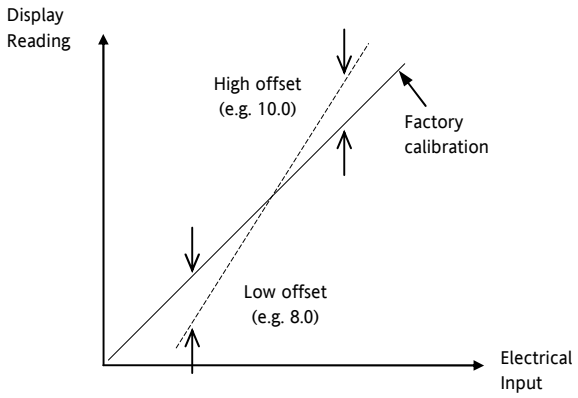
The process value can be offset to take into account known errors within the process. The offset can be applied to any Input Type (mV, V, mA, thermocouple or RTD).

A single offset can be applied - the procedure is carried out in the *INPUT* list and has been described in section 8.2.

It is also possible to adjust the low and high points as a two point offset. This can only be done in **Level 3** in the '*CAL*' list and is described below.

16.2.1 Two Point Offset

A two point offset adjusts both a low point and a high point and applies a straight line between them. Any readings above and below the calibration points will be an extension of this straight line. For this reason it is best to calibrate with the two points as far apart as possible as shown in the example below:-



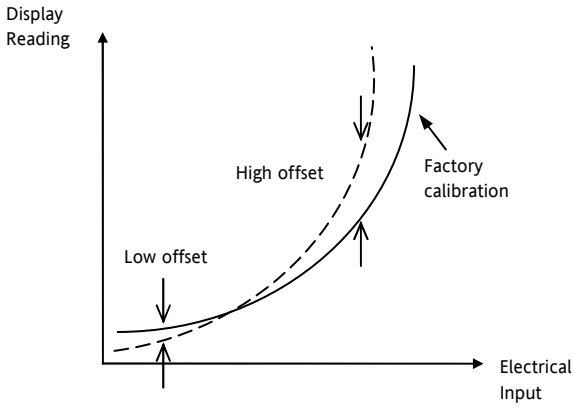


Figure 4 Two Point Offset Applied to Linear and Non-linear Inputs

16.2.2 To Apply a Two Point Offset

Assume the instrument is set up (as described in section 8.3.1) to display 0.0 for an input of 4.00mV and 500.0 for an input of 20.00mV. Assume that a particular sensor in use has known errors such that the instrument is required to read 8.0 for an input of 4.00mV and 490.0 for an input of 20.00mV. To compensate for these errors in the process a low point offset of 8.0 and a high point offset of 10.0 can be set as follows:-

Operation	Do This	Display View	Additional Notes
Select Calibration list header	**1.** Select **Level 3** as described in section 6.1.3. Then press ▣ to select 'CAL'		Two pint offset can only be carried out in Level 3
Set mV input to 4.00mV			
Select User Calibration	2. Press ↻ to scroll to 'U.CAL'		Scrolling 2message USER CALIBRATION
Select Low calibration point	3. Press ▲ or ▼ to 'LO'		
Set the low offset value	4. Press ↻ to scroll to 'C.ADJ' 5. Press ▲ or ▼ to set the low offset value eg 8.0		This applies an offset over the whole range in the same way as a simple offset section 8.2.
	6. The controller then reverts to the CAL list header		This is the same as 1 above
Set mV input to 20.00mV			
Select User Calibration	7. Press ↻ to scroll to 'U.CAL'		This is the same as 2 above
Select the high calibration point	8. Press ▲ or ▼ to 'HI'		
Select the high calibration offset parameter	9. Press ↻ to scroll to 'C.ADJ'		The reading will show 508.0
Set the high offset value	10. Press ▲ or ▼ to set the high offset value to read 490.0		
Under normal operating conditions the controller will now read 8.0 for an input of 4.000mV and 490.0 for an input of 20.000mV.			

16.2.3 To Remove the Two Point Offset

Operation	Do This	Display View	Additional Notes
In level 3 select the Calibration list header	**1.** In **Level 3**, press ▣ to select 'CAL'		Two point offset can only be carried out in Level 3
Select User Calibration	2. Press ↻ to scroll to 'U.CAL'		Scrolling message USER CALIBRATION
Reset to no offset	3. Press ▲ or ▼ to select 'rSEt'		
The display will revert to 2 above and the two point offsets will be removed.			

16.3 Input Calibration

If the calibration is not within the specified accuracy follow the procedures in this section:-

In 3200 series instruments, inputs which can be calibrated are:-

- **mV Input.** This is a linear 80mV range calibrated at two fixed points. This should always be done before calibrating either thermocouple or resistance thermometer inputs. mA range calibration is included in the mV range.
- **Thermocouple** calibration involves calibrating the temperature offset of the CJC sensor only. Other aspects of thermocouple calibration are also included in mV calibration.
- **Resistance Thermometer**. This is also carried out at two fixed points - 150Ω and 400Ω.

16.3.1 To Calibrate mV Input

Calibration can only be carried out in configuration level.

Calibration of the mV range is carried out using a 50 milli-volt source, connected as described in section 16.1.2. mA calibration is included in this procedure.

For best results 0mV should be calibrated by disconnecting the copper wires from the mV source and short circuiting the input to the controller

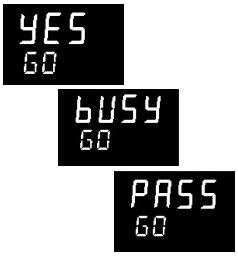
To calibrate the mV Input, select **Conf Level** as described in section 6.1.3, set the controller input to mV range, then:-

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	**1.** From any display press ▤ as many times as necessary until the 'CAL' page header is displayed.	CAL	Scrolling display 'CALIBRATION LIST'
Select the Calibration Phase	**2.** Press ⟳ to select 'PHASE'	nonE PHASE	Scrolling display 'CALIBRATION PHASE'
Set mV source for 0mV			
Select the low calibration point	**3.** Press ▲ or ▼ to choose '0'	0 PHASE	
Calibrate the instrument to the low calibration point (0mV)	4. Press ⟳ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'	YES GO bUSY GO PASS GO	Scrolling display 'CALIBRATION START' The controller automatically calibrates to the injected input mV. The display will show bUSY then PASS, (if calibration is successful.) or 'FAIL' if not. Fail may be due to incorrect input mV
Set mV source for 50mV			
Select the high calibration point	6. Press ⟳ to select 'PHASE' 7. Press ▲ or ▼ to choose '50' 8. Repeat 5 and 6 above to calibrate the high point	50 PHASE	The controller will again automatically calibrate to the injected input mV. If it is not successful then 'FAIL' will be displayed

16.3.2 To Calibrate Thermocouple Input

Thermocouples are calibrated, firstly, by following the previous procedure for the mV ranges, then calibrating the CJC.

Connect a mV source as described in section 16.1.3. Set the mV source to '**internal compensation'** for the thermocouple in use and set the output for **0mV**. Then:-

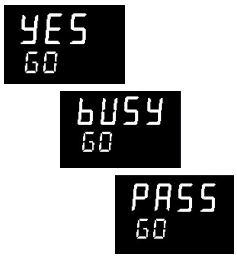
Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ▤ as many times as necessary until the 'C A L ' page header is displayed.		
Select the calibration phase	2. Press ↻ to select 'P H A S E '		Scrolling display 'CALIBRATION PHASE'
Select CJC calibration	3. Press ▲ or ▼ to select 'CJC'		
Calibrate CJC	4. Press ↻ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'		The controller automatically calibrates to the CJC input at 0mV. The display will show bUSY then PASS, (if calibration is successful) or 'FAIL' if not. Fail may be due to an incorrect input mV

16.3.3 To Calibrate RTD Input

The two points at which the RTD range is calibrated are 150.00Ω and 400.00Ω.

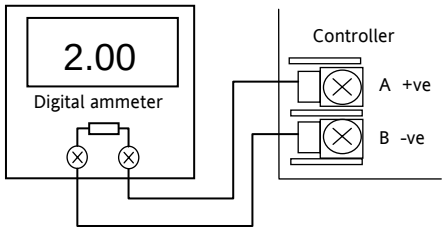
Before starting RTD calibration:

- A decade box with total resistance lower than 1K must be connected in place of the RTD as indicated on the connection diagram in section 16.1.4 **before the instrument is powered up**. If at any time the instrument was powered up without this connection then at least 10 minutes must elapse from the time of restoring this connection before RTD calibration can take place.
- The instrument should be powered up for at least 10 minutes.
- Before calibrating the RTD input the mV range must be calibrated first

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ▤ as many times as necessary until the 'C A L' page header is displayed.		Scrolling display 'CALIBRATION LIST'
Select the calibration phase	2. Press ⟳ to select 'P H A S E'		Scrolling display 'CALIBRATION PHASE'
Set the decade box for 150.00Ω			
Select the low calibration point (150Ω)	3. Press ▲ or ▼ to choose '150r		
Calibrate the low point	4. Press ⟳ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'		Scrolling display 'CALIBRATION START'
The controller automatically calibrates to the injected 150.00Ω input. The display will show bUSY then PASS (if calibration is successful) or 'FAIL' if not. Fail may be due to an incorrect input resistance			
Set the decade box for 400.00Ω			
Select the high calibration point (400Ω)	7. Press ▲ or ▼ to choose '400r		
Calibrate the high point	8. Repeat 5 and 6 above to calibrate the high point		
The controller will again automatically calibrate to the injected 400.00Ω input. If it is not successful then 'FAIL' will be displayed			

16.3.4 To Calibrate mA Outputs

I/O1, Output 2 and/or Output 3 may be supplied as mA outputs. The outputs may be adjusted as follows:-
Connect an ammeter to the output – terminals 1A/1B, 2A/2B or 3A/3B as appropriate.



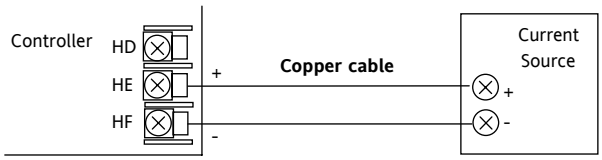
Then, in configuration level:-

Operation	Do This	Display View	Additional Notes
Select low point calibration phase for the mA output to be calibrated (eg OP1)	1. From the 'CAL' list header press ⟳ to select 'PHASE' 2. Press ▲ or ▼ to choose ' ImAL '	I.mA.L PHASE	Scrolling message 'CALIBRATION PHASE'
Set the low point output	3. Press ⟳ to select 'V A L U E ' 4. Press ▲ or ▼ to adjust this value so that it reads the same value as shown on the ammeter. For example if the meter reads 2.06 then set the controller reading for 206. The decimal point is not displayed on the controller so that 200 represents 2.00.	200 VALUE	Scrolling message 'DC OUTPUT READING'
Select high point calibration phase for the mA output to be calibrated (eg OP1)	5. Press ⟳ to go back to 'PHASE' 6. Press ▲ or ▼ to choose ' ImAH'	I.mA.H PHASE	Scrolling message 'CALIBRATION PHASE'
Set the high point output	7. Press ⟳ to select 'V A L U E ' 8. Press ▲ or ▼ to adjust this value so that it reads the same value as shown on the ammeter. The value represents 18.00mA	1800 VALUE	Scrolling message 'DC OUTPUT READING'

The above procedure may be repeated for outputs 2 and 3 if they are fitted with analogue output modules.

16.3.5 To Calibrate Remote Setpoint Input

Connect a milli amp source to terminals HD and HE as shown.



Select **Conf Level** as described in section 6.1.3, then:-

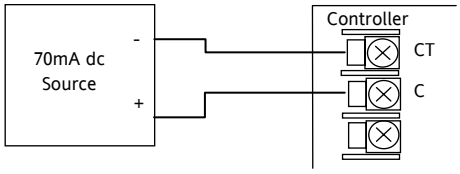
Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ▤ as many times as necessary until the 'CAL' page header is displayed.	CAL	Scrolling display 'CALIBRATION LIST'
Select the Calibration Phase	2. Press ↻ to select 'PHASE'	nonE PHASE	Scrolling display 'CALIBRATION PHASE'
Set mA source for 4mA			
Select the low calibration point	3. Press ▲ or ▼ to choose 'rmCL'	rm.CL PHASE	
Calibrate the instrument to the low calibration point (4mA)	4. Press ↻ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'	YES GO bUSY GO PASS GO	Scrolling display 'CALIBRATION START' The controller automatically calibrates to the injected input. The display will show bUSY then PASS, (if calibration is successful.) or 'FAIL' if not. Fail may be due to incorrect input. mA
Set mV source for 20mA			
Select the high calibration point	9. Press ↻ to select 'PHASE' 10. Press ▲ or ▼ to choose 'rmCH' 11. Repeat 4 and 5 above to calibrate the high point	rm.CH PHASE	The controller will again automatically calibrate to the injected input mV. If it is not successful then 'FAIL' will be displayed

To calibrate the voltage input, connect a volts source to terminals HD (negative) and HF (positive). The procedure is the same as described above but the calibration points are:-

Parameter	Calibration Voltage
rmUL	0 Volts
rmUH	10 Volts

16.3.6 CT Calibration

To calibrate the current transformer input, connect the current transformer to terminals CT and C.



Then in configuration level

Operation	Do This	Display View	Additional Notes
Select the current transformer low point calibration phase	1. From the 'C A L ' list header press ⟳ to select 'PHASE' 2. Press ▲ or ▼ to choose 'CL 0'	CL 0 PHASE	Scrolling display 'CALIBRATION PHASE'
Adjust the CT for no current applied to the input			
Calibrate the CT low point	3. Press ⟳ to select 'GO' 4. Press ▲ or ▼ to 'YES'	YES GO BUSY GO PASS GO	Scrolling display 'CALIBRATION START'
The controller automatically calibrates to the zero current input. As it does this the display will show BUSY then PASS, assuming a successful calibration. If it is not successful then 'FAIL' will be displayed. This may be due to an incorrect input current			
Select the current transformer high point calibration phase	6. Press ▲ or ▼ to choose 'CL 70'	CL70 PHASE	
Adjust the CT for a current of 70mA dc			
	7. Press ⟳ to select 'GO' 8. Press ▲ or ▼ to 'YES'	YES GO BUSY GO PASS GO	The controller again automatically calibrates to 70mA If it is not successful then 'FAIL' will be displayed

16.3.7 To Return to Factory Calibration

It is always possible to revert to the factory calibration as follows:-

Operation	Do This	Display View	Additional Notes
Select the calibration phase	1. From the 'CAL' list header press ⟳ to select 'PHASE'	nonE PHASE	
Select factory calibration values	2. Press ▲ or ▼ to choose 'FACt'	FACt PHASE	
Confirm	3. Press ⟳ to select 'GO' 4. Press ▲ or ▼ to choose 'YES'	YES GO PASS GO	The controller automatically returns to the factory values stored during manufacture

16.4 Calibration Parameters

The following table gives the parameters available in the Calibration List.

The User Calibration is available in Level 3 only and is used to calibrate 'Offset' see section 8.2.

CALIBRATION PARAMETER LIST			'CAL'			
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
UCAL	USER CALIBRATION	To select low and high offset state or reset to no offsets. See section 16.2.2.	IdLE	Normal operating state	IdLE	L3 only
			Lo	Low offset		
			Hi	High offset		
			rESt	Remove high and low offsets		
The following parameters appear when calibrating the controller ie UCAL = Lo or Hi						
C.ADJ	CALIBRATION ADJUST	To set an offset value. See section 16.2.2.	-1999 to 9999			L3 only

Input and Output calibration can only be done in ConF level.

CALIBRATION PARAMETER LIST			'CAL'			
Name	**Scrolling Display**	**Parameter Description**	**Value**	**Default**	**Access Level**	
PHASE	CAL PHASE	To calibrate low and high offset	nonE	Not selected	nonE	Conf only
			0	Select mV low calibration point		
			50	Select mV high calibration point		
			150r	Select PRT low cal point		
			400r	Select PRT high cal point		
			CJC	Select CJC calibration		
			Ct 0	Select CT low cal point		
			Ct 70	Select CT high cal point		
			FAct	Return to factory settings		
			1mA.L	Low mA output from I/O 1		
			1mA.H	High mA output from I/O 1		
			2mA.L	Low mA output from output 2		
			2mA.H	High mA output from output 2		
			3mA.L	Low mA output from output 3		
			3mA.H	High mA output from output 3		
			rm.UL	Remote setpoint input low volts		
			rm.UH	Remote setpoint input high volts		
			rm.CL	Remote setpoint input low current		
			rm.CH	Remote setpoint input high current		
GO		To start the calibration sequence	no		no	Conf only
			YES	Start		
			buSY	Calibrating		
			PASS	Calibration successful		
			FAiL	Calibration unsuccessful		

17. Configuration Using iTools

iTools is a configuration and monitoring package which will edit, store and 'clone' complete controller configurations.

iTools can be used to configure all the functions of 3200 series controllers described in this manual. It is also possible using iTools to configure additional functions such as customised messages and parameter promotion. These features are described in this chapter.

You may also wish to refer to the iTools Help Manual Part No. HA028838 which can be downloaded from www.eurotherm.co.uk. for further information on how to install, connect and generally operate iTools.

17.1 Loading an IDM

An IDM is a software file which defines the parameter addresses of a particular build of instrument. This is normally included with your iTools CD and iTools will then recognize the software version of your instrument. Alternatively, download the latest version of iTools. This may be found in www.eurotherm.co.uk.

If the build of your instrument is a non-standard, it may be necessary for you to download the IDM from the Eurotherm web site. The file will be of the format id32i_v107.exe, where id 32i is the instrument and V--- is the software version number of the instrument.

To load the IDM

From windows START., select Programs → Eurotherm iTools → Advanced Tools → IDM Manager. Then Install New IDM.

To register the new IDM

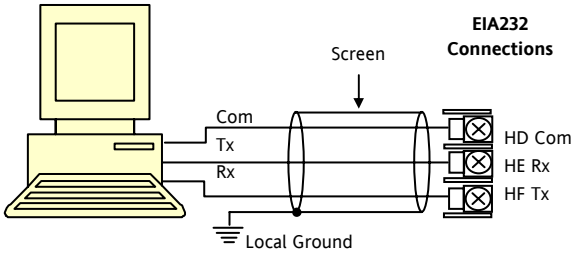
Copy the file to c:\Program Files\Eurotherm\iTools\Devices.

17.2 Connecting a PC to the Controller

In 3200 series controllers this may be done using digital communications port H or by a configuration clip.

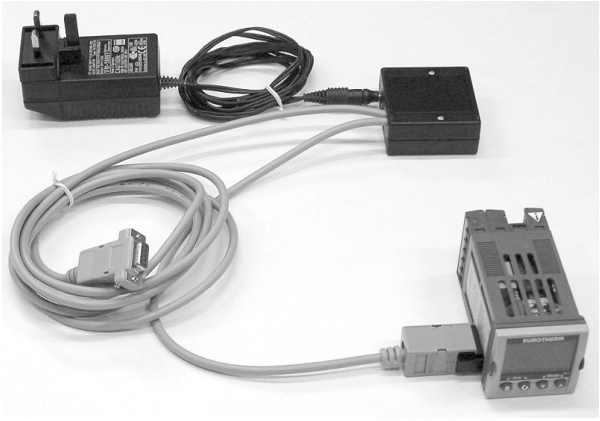
17.2.1 Using the H Communications Port

Connect the controller to the EIA232 serial comms port of the PC shown in the diagram below.



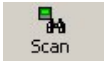
17.2.2 Configuration Clip

A Configuration Clip is available with iTools by quoting part number 3000CK in the iTools ordering code. The clip can be fitted into the side of a controller as shown below.



The benefit of using this arrangement is that it is not necessary to power the controller, since the clip provides the power to the internal memory of the controller.

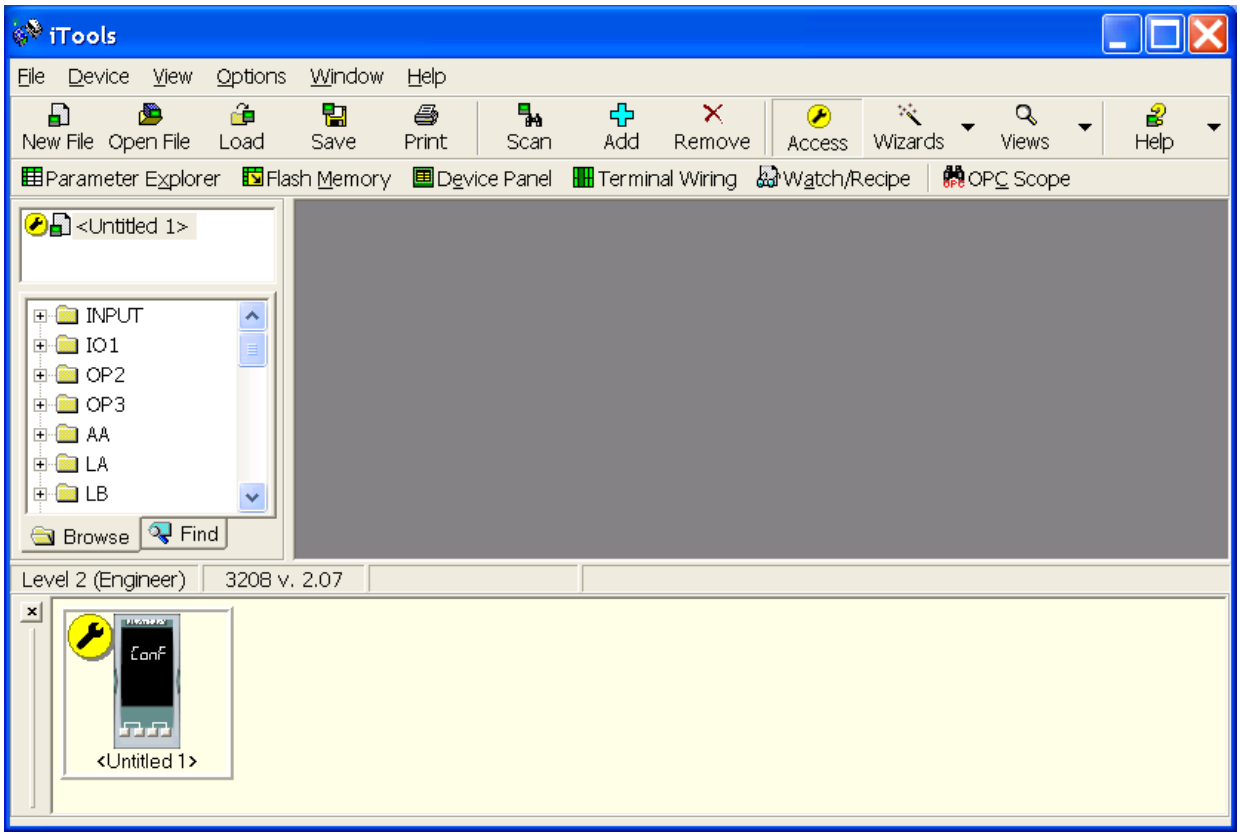
17.3 Starting iTools

Open iTools and, with the controller connected, press 

on the iTools menu bar. iTools will search the communications ports and TCPIP connections for recognisable instruments. Controllers connected with the configuration clip (CPI), will be found at address 255 regardless of the address configured in the controller.

When the instrument is detected a screen view similar to the one shown below will be displayed. The browser on the left shows the List Headers. To display parameters within a list double click the Header or select 'Parameter Explorer'. Click on a list header to display parameters associated with this list.

The instrument view may be turned on or off using the 'View' menu and selecting 'Panel Views'.



The instrument may be configured using a **Wizard** or from the **Browser** view above. The following pages show a number of examples of how to configure various functions using either of these features.

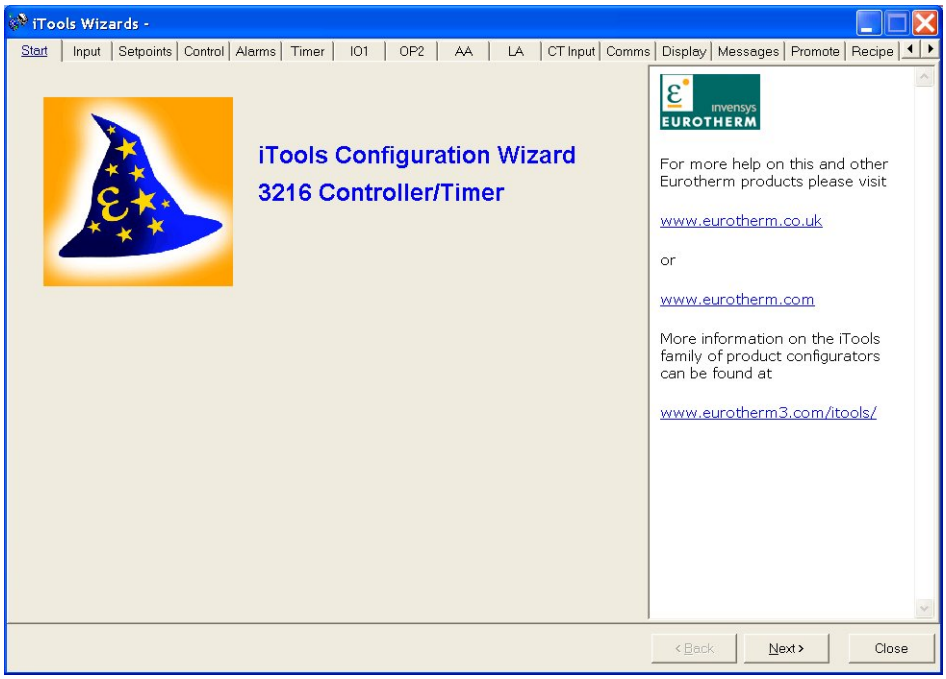
It is assumed that the user is generally familiar with iTools and has a general understanding of Windows.

17.4 Starting the Wizard

From the opening view shown in section 17.3, press 

.

The controller will be set to configuration level. Since it will not operate the process in configuration level a warning message appears. When this is accepted the Wizard start up screen is shown:-



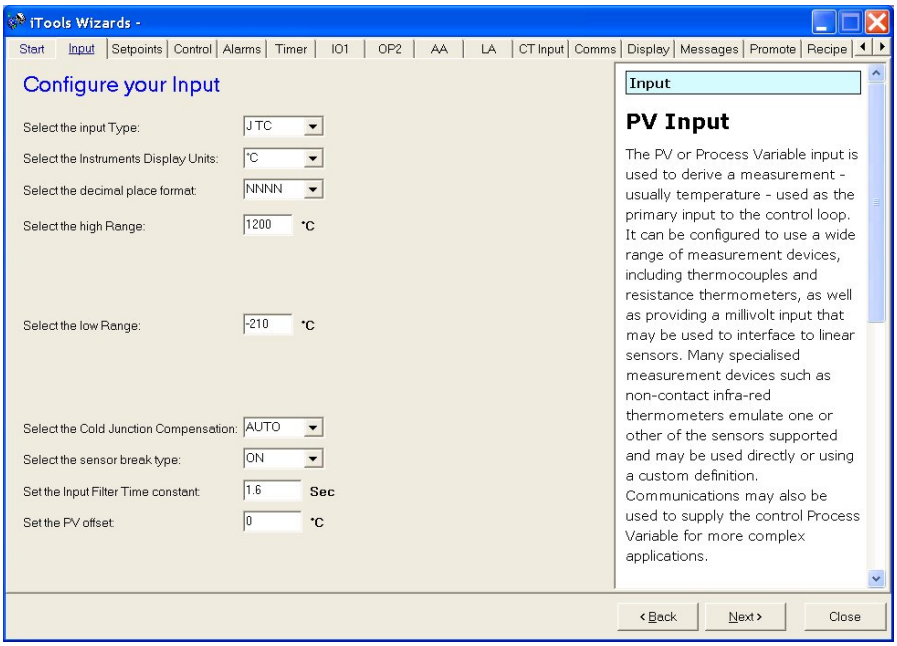
Select a tab to configure a function.

17.5 To configure the Input

17.5.1 Example 1 - Using the Wizard

Select the 'Input' tab

To configure the input type, open the drop down box and select the input to match the sensor in use on your process. When the drop down box is opened the parameter 'help' description is also displayed. This example configures the controller for a type J thermocouple



A 'help' text is shown to the right of the wizard. This describes the feature which is selected.

A list of parameters which need to be configured follows this general description. Click on the parameter for a description of its function.

Other functions may be configured using the appropriate tab.

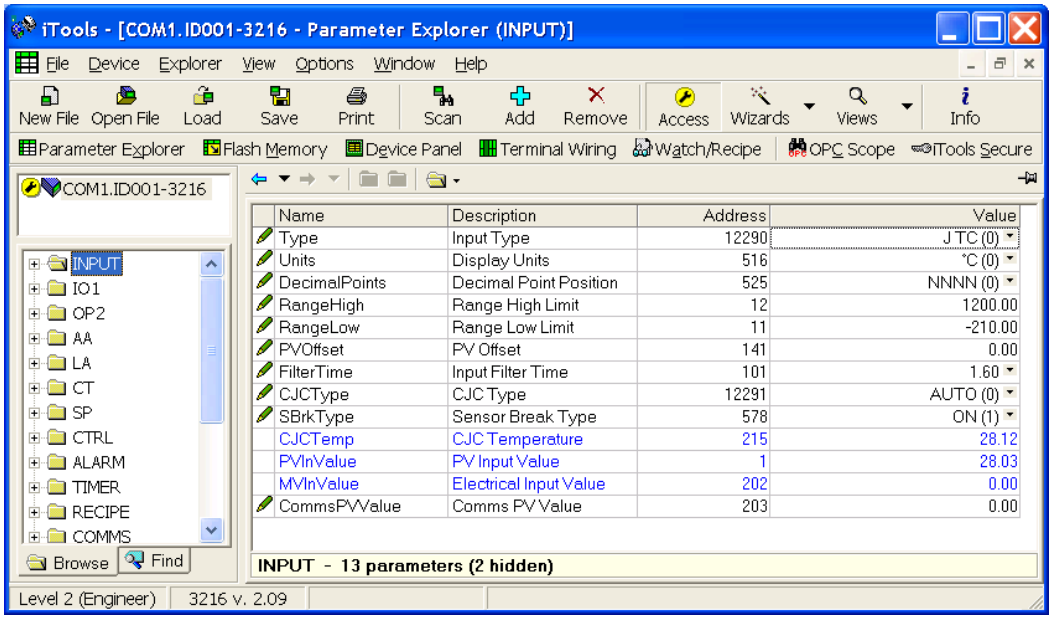
17.5.2 Example 2 – Using the Browser View

Press Access (if necessary) to put the controller into configuration level.

Open the parameter list by double clicking INPUT in the browser or selecting 'Parameter Explorer'.

Select input type from the drop down. Other parameters can also be set using the drop downs or by setting the analogue values.

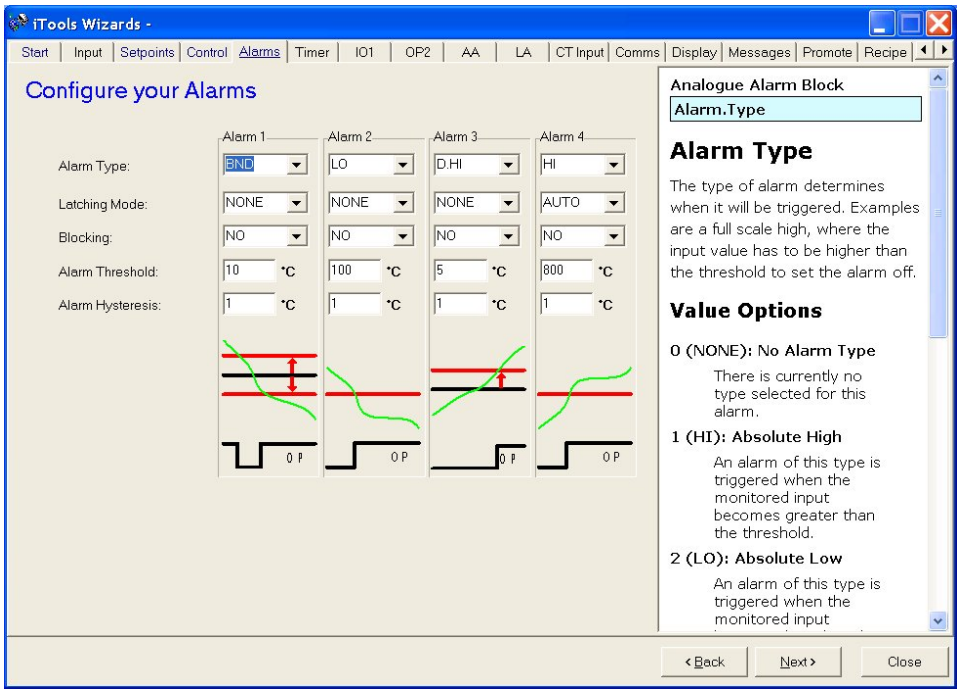
Parameters shown in blue, in the iTools view, are not alterable.



17.6 To Configure Alarms

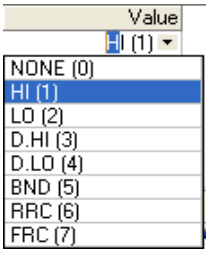
17.6.1 Example 1: Using the Wizard

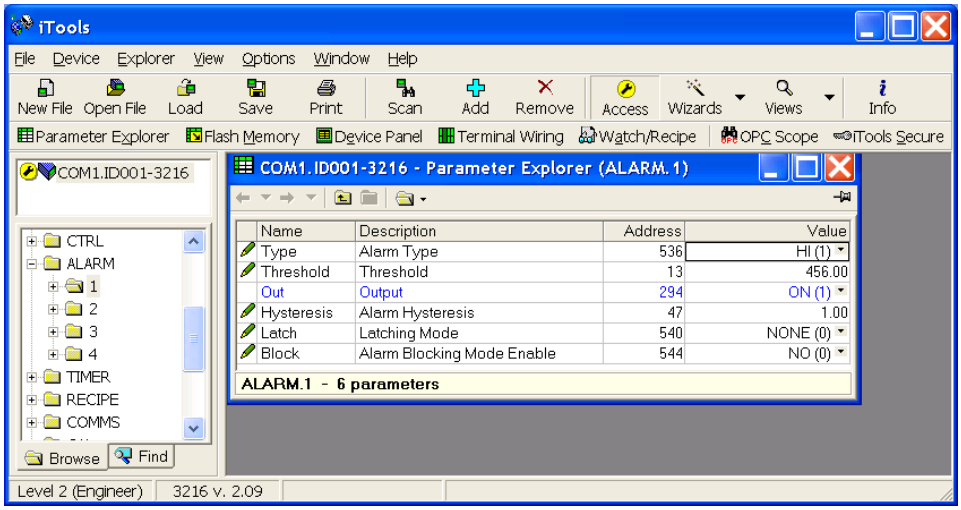
Up to four alarms are available in 3200 series controllers. Set the type of alarm, latching mode, blocking, threshold and hysteresis from drop down menus. Help text is shown together with a pictorial representation of the alarm operation.



17.6.2 Example 2: Using the Browser View

1. Press  to put the controller into Configuration level
2. Select the list header from the browser – in this case ‘ALARM’ ‘1’
3. To configure ‘Alarm Type’ open the drop down under the ‘Value’ column





4. Select the alarm type – in this example HI. (1) is the enumeration of the parameter.
5. Select and set all other parameters using the same procedure

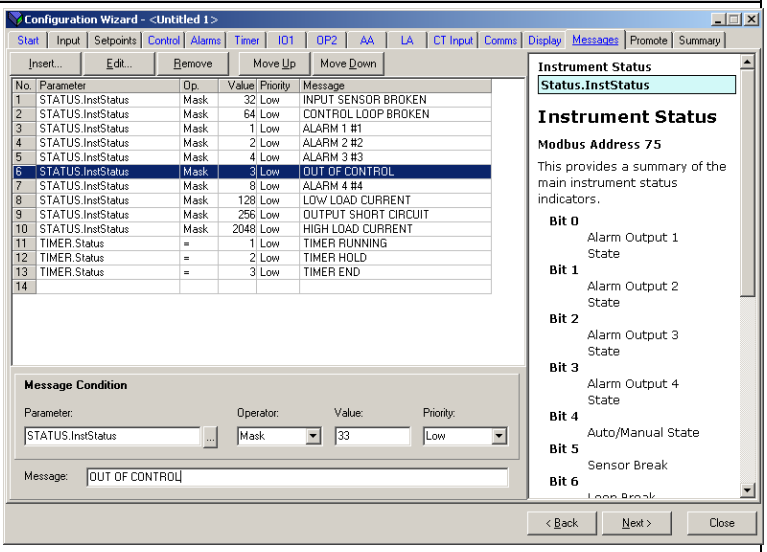
17.7 To Customise Messages

The message which scrolls across the controller display during normal operation may be customised.

17.7.1 Example 1: Using the Wizard

Select the 'Messages' tab.

Display the message 'OUT OF CONTROL' if both Alarm 1 and Alarm 2 are active.

Operation	Action	Indication
Add a parameter	Click where the parameter is required Select 'Insert' Choose the parameter from the pop up box eg 'STATUS InstStatus' The parameter may be edited, removed or its position changed by selecting the relevant tab	
Set the Operator	From the 'Operator:' drop down box select 'Mask' – see Note 1. Alternatively a message may be configured to appear if the enumeration of the parameter:- = equals the 'Value' <> is greater or less than the 'Value' > is greater than the 'Value' < is less than the 'Value'	

Set the value The bitmap list is given here and in the Digital Comms chapter	1. Click in the 'Value' box and press enter 2. From the pop up box either tick the bit field values or type in the decimal equivalent in 'New Value'. In this example 3 (alarm 1 + alarm 2).	**Instrument Status - Bitmap** B0 – Alarm 1 Status B1 – Alarm 2 Status B2 – Alarm 3 Status B3 – Alarm 4 Status B4 – Auto/Manual Status B5 – Sensor Break Status B6 – Loop Break Status B7 – CT Low load current alarm status B8 – CT High leakage current alarm status B9 – Program End B10 – PV Over-range (by > 5% of span) B11 – CT Overcurrent alarm status B12 – New Alarm Status B13 – Timer/Ramp Running B14 – Remote Fail, New Alarm B15 – Auto-tune Status In each case, a setting of 1 signifies 'Active', 0 signifies 'Inactive'.
Set the priority	3. From the drop down select Low Medium or High	
Enter the message	4. In the message section enter OUT OF CONTROL	
Download to the controller	5. Press <Back, Next> or Close to download the settings	

Note 1:- Mask allows any combination of parameters in the above bitmap field to activate the custom message. The table below shows how this operates for the four alarm fields.

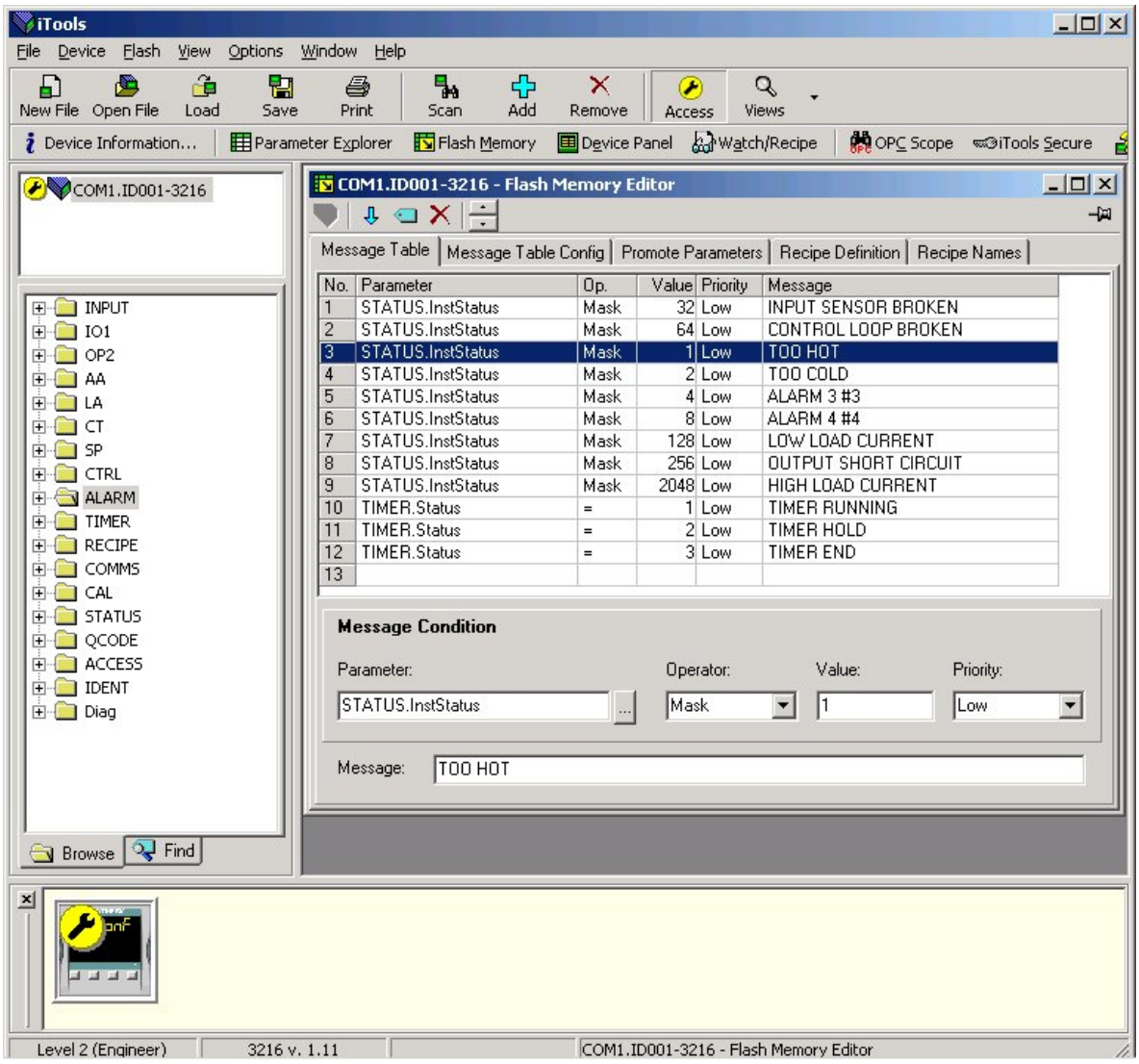
Value	Bitmap	Parameter (Alarm) active	Value	Bitmap	Parameter (Alarm) active
1	0001	Alarm 1	5	0101	Alarm 3 + Alarm 1
2	0010	Alarm 2	6	0110	Alarm 2 + Alarm 3
3	0011	Alarm 1 + Alarm 2	7	0111	Alarm 1 + Alarm 2 + Alarm 3
4	0100	Alarm 3	8	1000	Alarm 4

Other parameters can be added by extending this table.

17.7.2 Example 2: Using the Browser View

In this example the alarm 1 message will read 'TOO HOT'.

1. Press Flash Memory and select the 'Message Table' tag.
2. Select Parameter 'ALARM1 #1'.
3. In the 'Message Condition' area change 'Message' to TOO HOT.
4. Press 'Update Device Flash Memory' button.



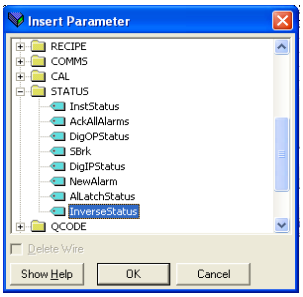
17.7.3 Example 3: Inverted Status Word

The Inverted Status Word is available in firmware versions 2.11+. It is used to generate a message when a bit in a status word is not true. For example, it may be applied to an alarm or event to indicate that the process is operating normally.

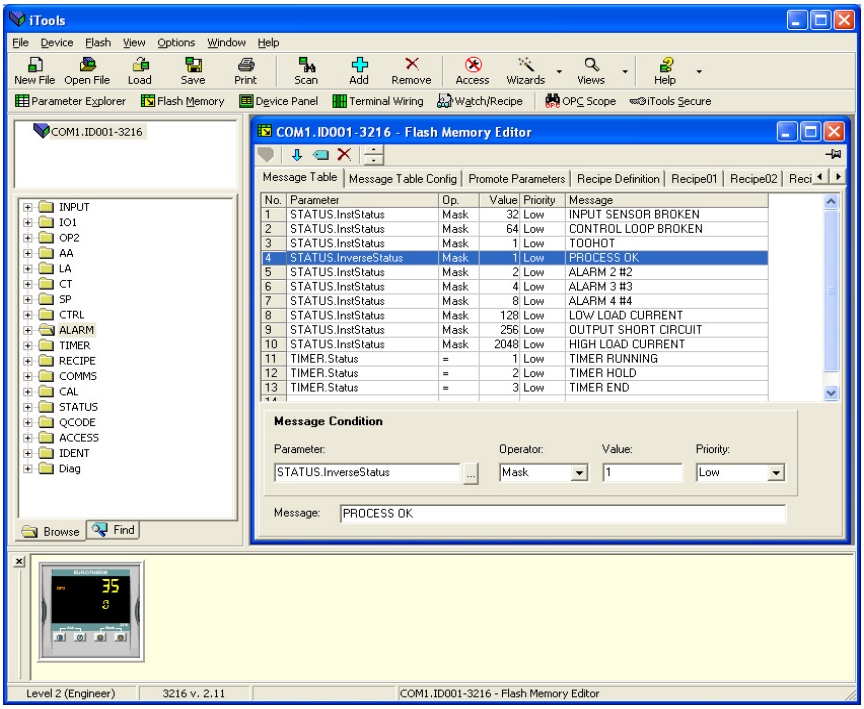
The example below continues from the previous example and adds the message PROCESS OK on the controller when the Alarm 1 condition is not true.

1. Press 

and select the 'Message Table' tag.
2. Add the 'InverseStatus' parameter as follows:-
   a. Click where the parameter is required.
   b. Select 'Insert' 
   c. Select 'STATUSInverseStatus' from the pop up.



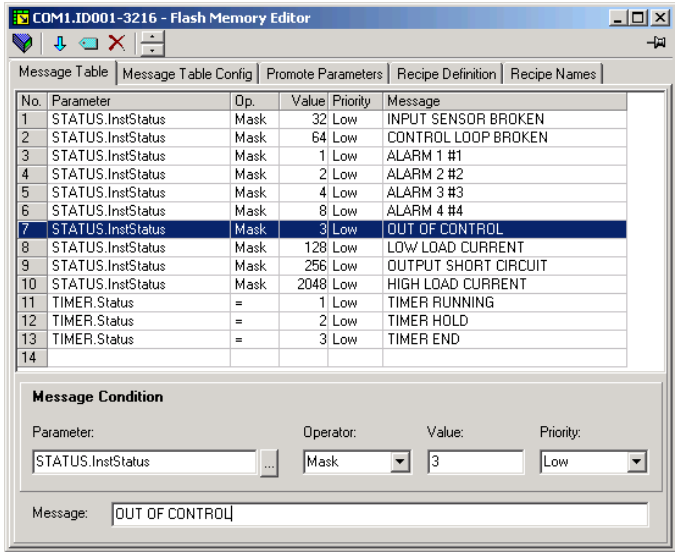
3. In the Operator box select 'Mask'.
4. In the Value box select 1 (Alarm 1 only).



5. In the message box enter 'PROCESS OK'.
6. Press  'Update Device Flash Memory' button.

The controller will now indicate the scrolling message PROCESS OK when Alarm 1 is not true and TOO HOT when Alarm 1 is exceeded.

17.7.4 Example 4: Display the message 'OUT OF CONTROL' if both Alarm 1 and Alarm 2 are active.

Operation	Action	Indication
Add a parameter	1. Right click where the parameter is required 2. Select 'Insert Item' 3. Choose the parameter from the pop up box eg **'STATUS InstStatus'**	
Set the Operator	4. From the Operator drop down box select **'Mask'** See also note 1 below Alternatively a message may be configured to appear if the enumeration of the parameter:- = equals the 'Value' != is not equal to the 'Value' > is greater than the 'Value' < is less than the 'Value'	
Set the value The bitmap list is given here and in the Digital Comms chapter	5. Click in the 'Value' box and press enter 6. From the pop up box either tick the bit field values or type in the decimal equivalent in 'New Value'. In this example 3.	**Instrument Status - Bitmap** B0 – Alarm 1 Status B1 – Alarm 2 Status B2 – Alarm 3 Status B3 – Alarm 4 Status B4 – Auto/Manual Status B5 – Sensor Break Status B6 – Loop Break Status B7 – CT Low load current alarm status B8 – CT High leakage current alarm status B9 – Program End B10 – PV Over-range (by > 5% of span) B11 – CT Overcurrent alarm status B12 – New Alarm Status B13 – Timer/Ramp Running B14 – Remote Fail, New Alarm B15 – Auto-tune Status In each case, a setting of 1 signifies 'Active', 0 signifies 'Inactive'.
Set the priority	7. From the drop down select Low Medium or High	
Enter the message	8. In the message section enter OUT OF CONTROL	
Download to the controller	9. Press <Back, Next> or Close to download the settings	

No.	Parameter	Op.	Value	Priority	Message
1	STATUS.InstStatus	Mask	32	Low	INPUT SENSOR BROKEN
2	STATUS.InstStatus	Mask	64	Low	CONTROL LOOP BROKEN
3	STATUS.InstStatus	Mask	1	Low	ALARM 1 #1
4	STATUS.InstStatus	Mask	2	Low	ALARM 2 #2
5	STATUS.InstStatus	Mask	4	Low	ALARM 3 #3
6	STATUS.InstStatus	Mask	8	Low	ALARM 4 #4
7	STATUS.InstStatus	Mask	3	Low	OUT OF CONTROL
8	STATUS.InstStatus	Mask	128	Low	LOW LOAD CURRENT
9	STATUS.InstStatus	Mask	256	Low	OUTPUT SHORT CIRCUIT
10	STATUS.InstStatus	Mask	2048	Low	HIGH LOAD CURRENT
11	TIMER.Status	=	1	Low	TIMER RUNNING
12	TIMER.Status	=	2	Low	TIMER HOLD
13	TIMER.Status	=	3	Low	TIMER END
14					

Note 1: Mask allows any combination of parameters in the above bitmap field to activate the custom message. The table below shows how this operates for the four alarm fields.

Value	Bitmap	Parameter (Alarm) active
1	0001	Alarm 1
2	0010	Alarm 2
3	0011	Alarm 1 + Alarm 2
4	0100	Alarm 3
5	0101	Alarm 3 + Alarm 1
6	0110	Alarm 2 + Alarm 3
7	0111	Alarm 1 + Alarm 2 + Alarm 3
8	1000	Alarm 4

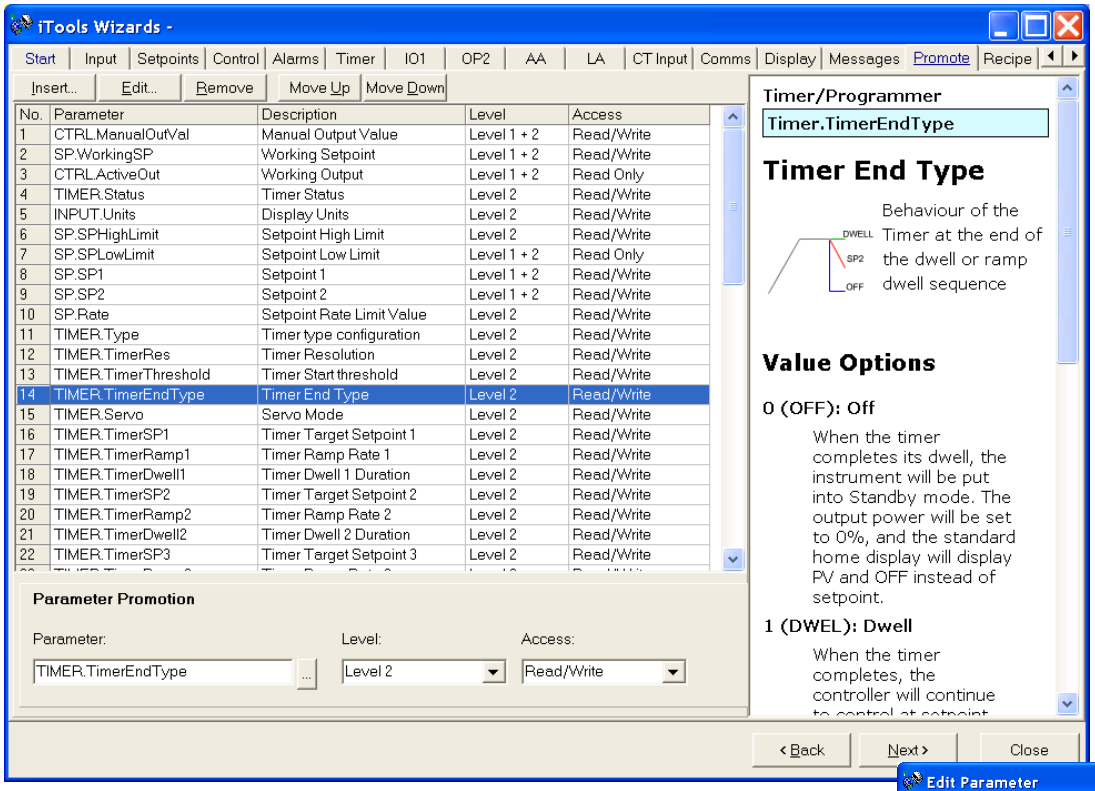
Other parameters can be added by extending this table.

17.8 To Promote Parameters

The list of parameters which are available in operator levels 1 or 2 can be changed using the 'Promote' wizard. Access can be set to Read Only or Read/Write.

17.8.1 Example 1: Using the Wizard

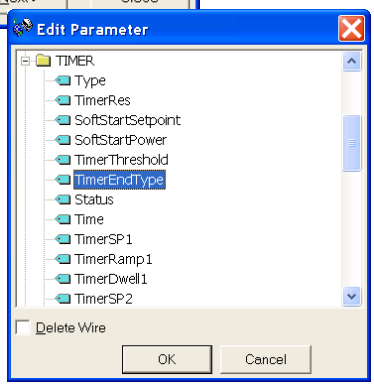
Select 'Promote' tab



Parameters can be Inserted, Edited, Removed or Moved up or down the list.

When inserting or editing a pop up box appears as shown.

Highlight a parameter and in the **Parameter Promotion** section, select the level of access you wish to be available to the available to the operator and whether it should be Read/Write or Read only.

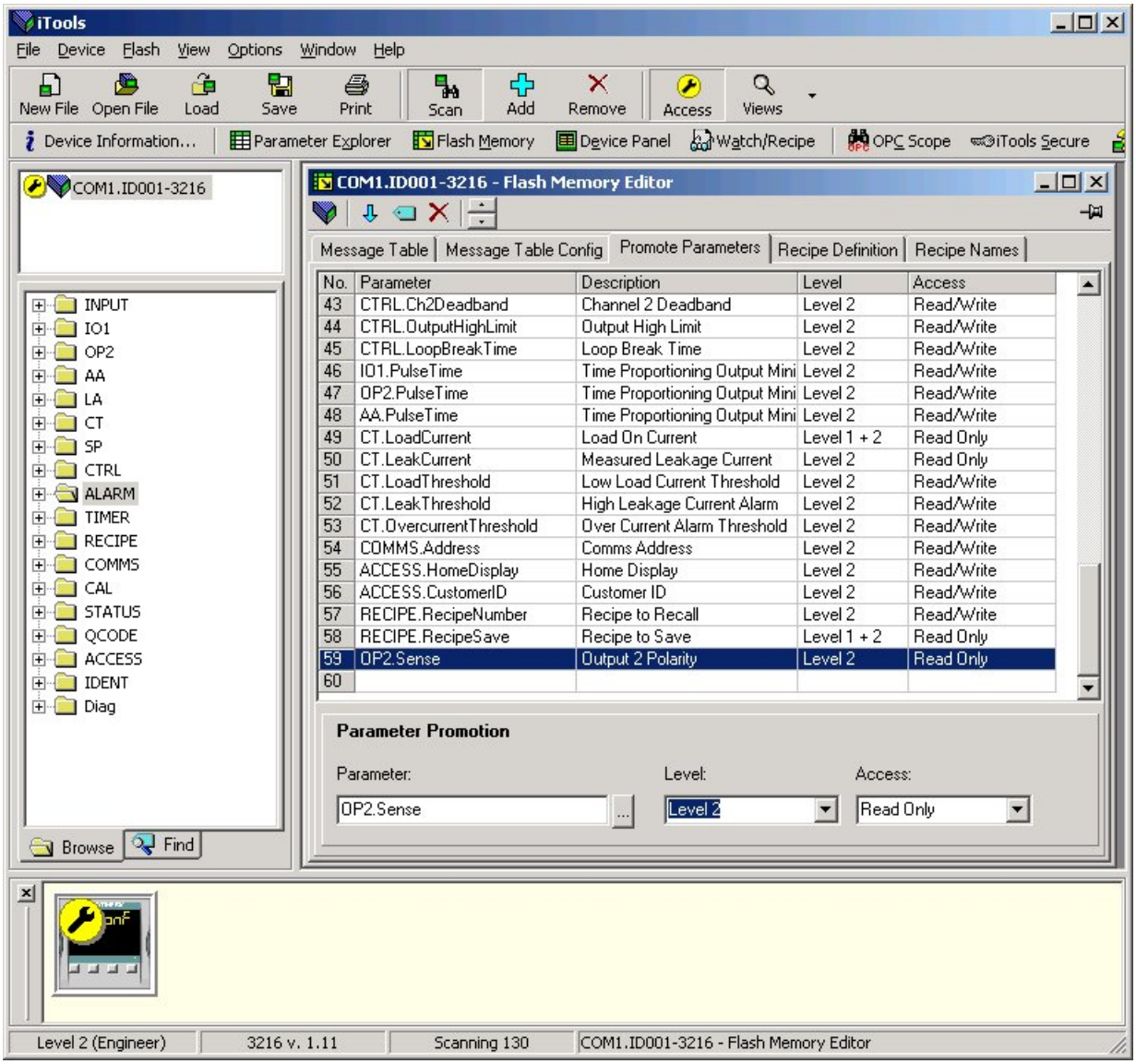


The list of parameters which are available in operator levels 1 or 2 can be changed using iTools.

17.8.2 Example 2: Using the Browser view

In this example the parameter 'OP2.Sense' is added to the to the Level 2 list.

1. Press Flash Memory and select the Memory Table tab
2. Select the 'Promote Parameters' tab
3. Highlight the position where you want the new parameter to be placed
4. Press ... button and from the pop up window select the required parameter. Alternatively use the ↓ button.
5. In the Level box select Level 2 (or Level 1 + 2 if it is required to display this parameter in Level 1 as well)
6. In the Access box select 'Read Only' or 'Read/Write' as required
7. Press ✕ to remove a selected parameter
8. Press 'Update Device Flash Memory' button



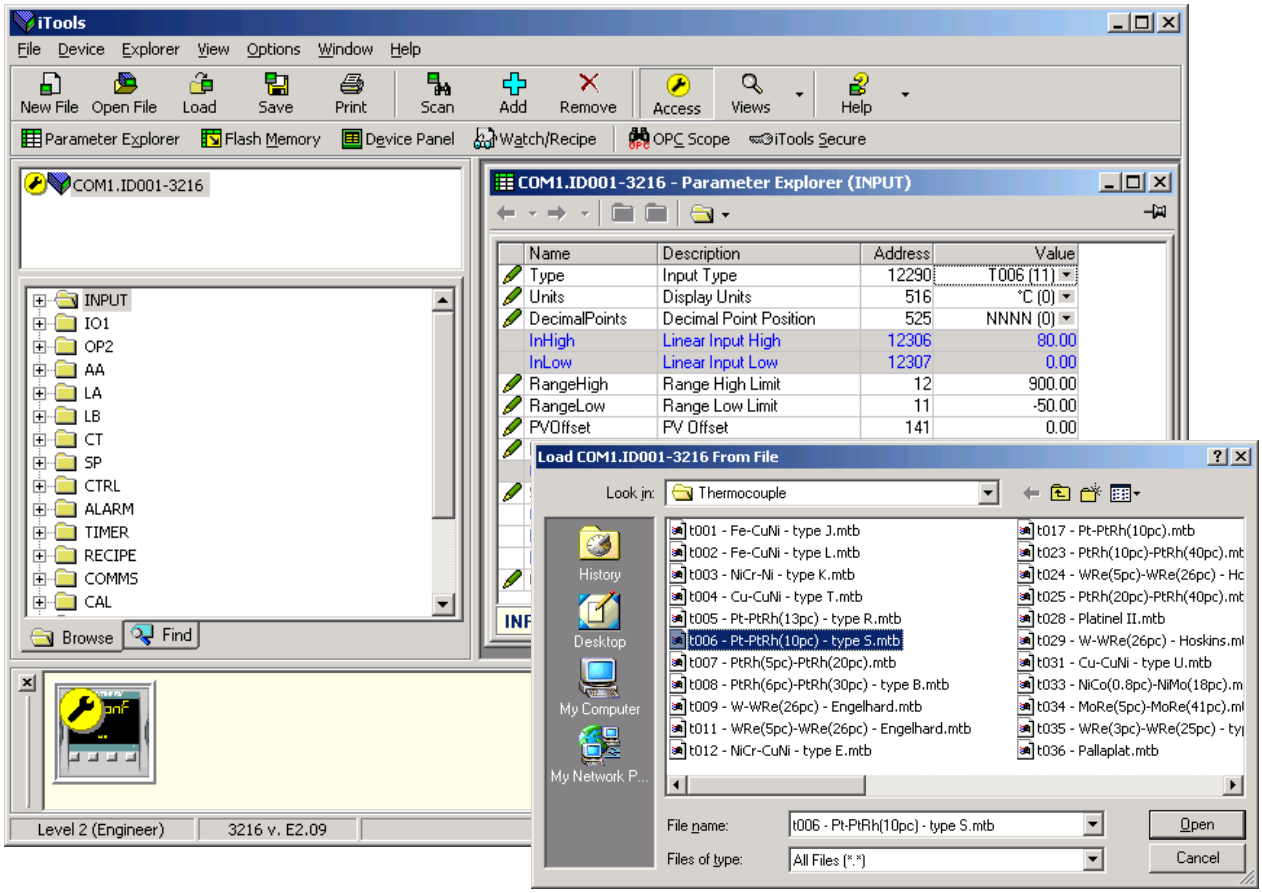
17.9 To Load A Special Linearisation Table

In addition to the built in standard linearisation tables, custom tables can be downloaded from files.

17.9.1 Example: Using the Browser view

1. Press 

2. Select the linearisation table to be loaded from files with the extension .mtb. Linearisation files for different sensor types are supplied with iTools and may be found in Program Files → Eurotherm → iTools → Linearisations → Thermocouple etc.



3. In this example a Pt-PTRh(10%) thermocouple has been loaded into the controller. The controller will display the linearisation table downloaded:- 

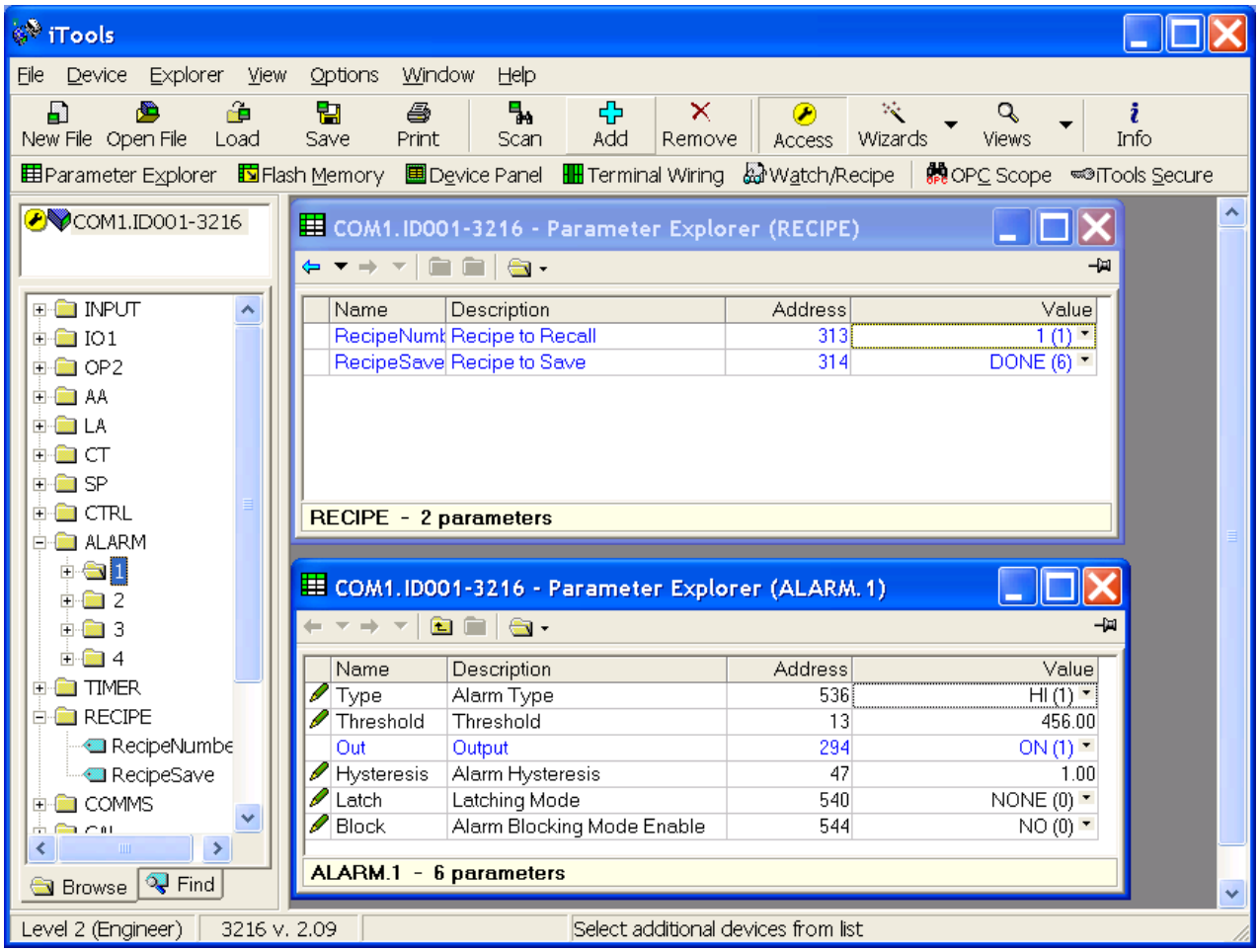
17.10 To Set up Recipes

A recipe can store up to 38 parameters, as listed in section 14.3.1. Up to five recipes are available in 3200 series controllers, as described in section 14.

17.10.1 Example 1: Using the Browser view

Set Two Different Alarm Thresholds and Store in Recipes 1 and 2

1. Set an alarm threshold - see example 17.6.2.
2. Select 'RECIPE' in the browser
3. In RecipeSave, select the recipe number e.g. 1
4. Set the alarm threshold to another value and save in Recipe 2
5. In RecipeNumber choose the recipe to run. This can also be done through the controller user interface



Any of the 38 parameters can be set up in any of the five recipes using the above procedure.

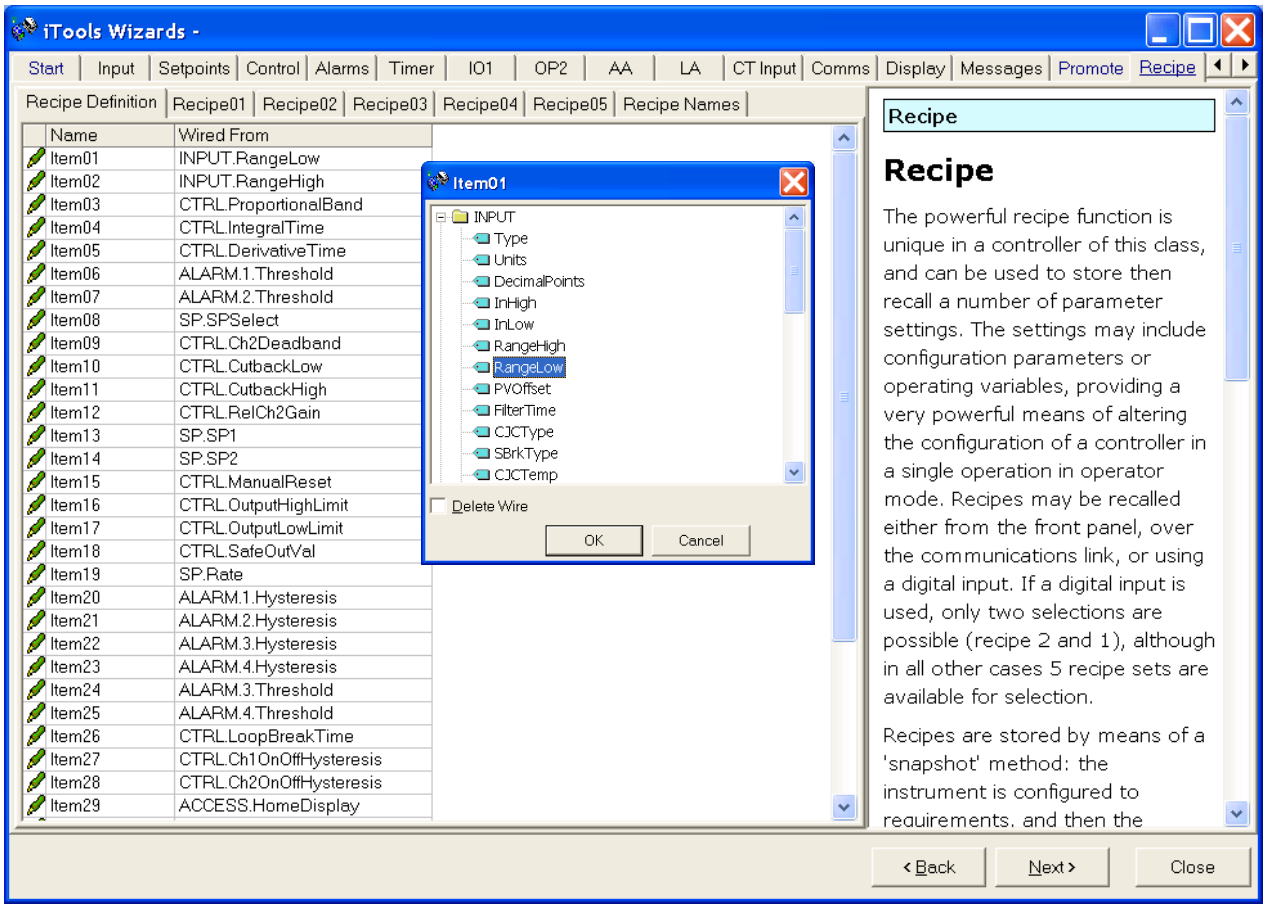
It may be more convenient to open more than one parameter list as shown in the above view. To do this, double click on each list header in turn. The lists can be arranged using Window in the main menu and choose Tile Vertically, Tile Horizontally or Cascade.

17.10.2 Example 2: Using the Wizard

Select the 'Recipe' tab

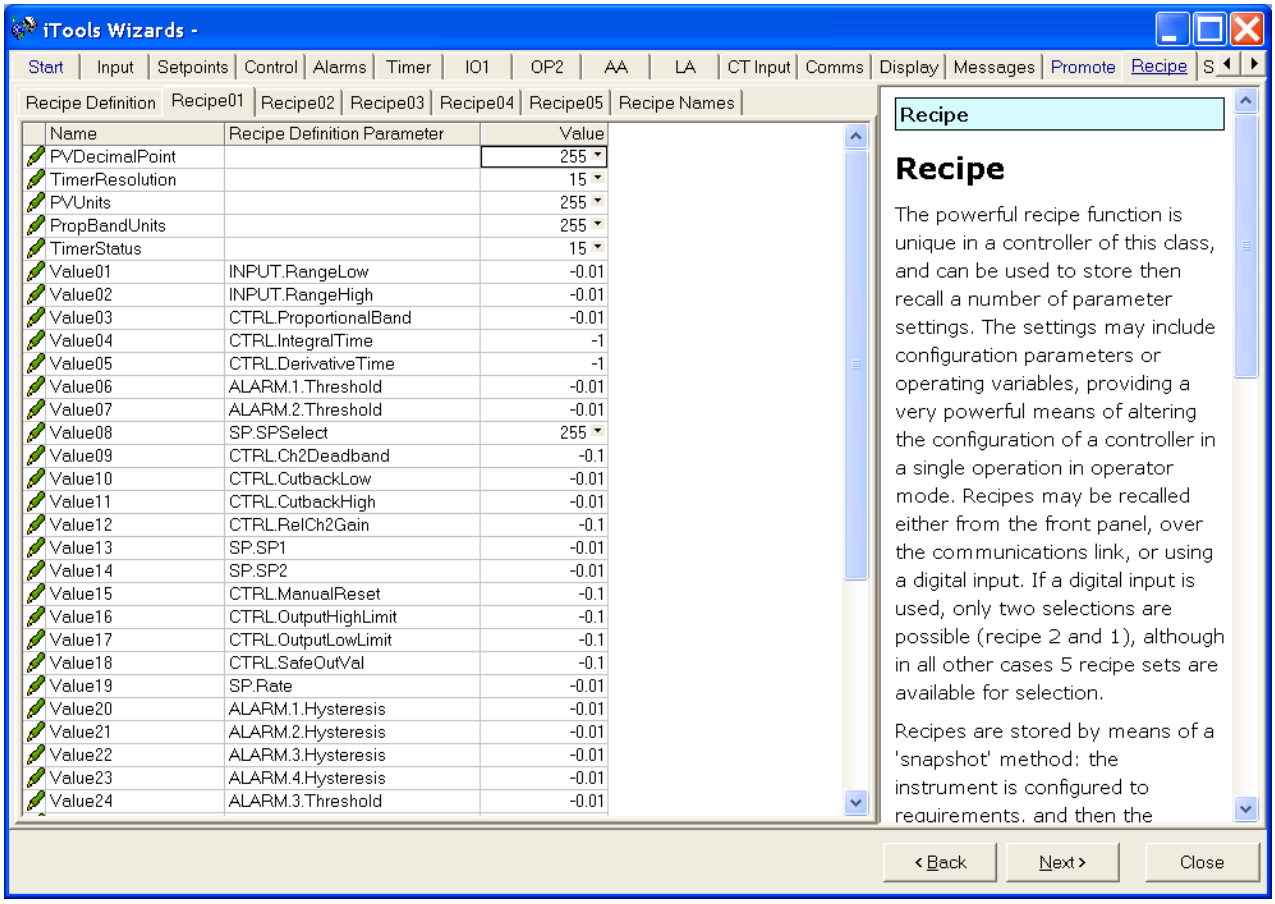
17.10.2.1 Recipe Definition

Select 'Recipe Definition' tab to display the default parameters available to be stored in recipe. Double click on the parameter in the 'Wired From' column, a pop up allows you to delete or change to a different parameter.



17.10.2.2 Editing Recipe Values

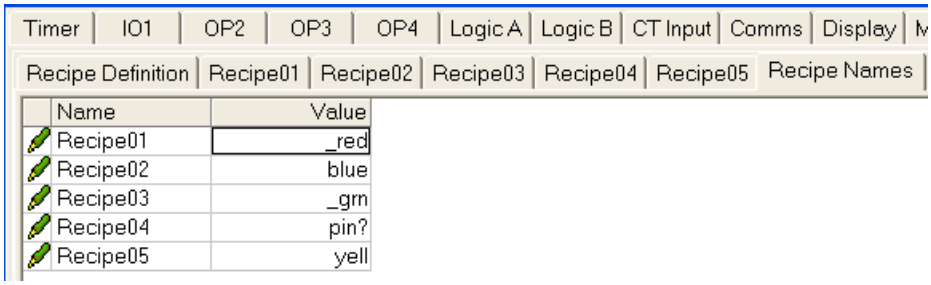
Select any one of the Recipe01 to 05 tabs. It is necessary to set the values of all parameters. Start with the first followed by all other parameters.



To download the new values, press Next> or select any other tab. There is a delay whilst the recipe updates. To ensure the controller accepts the new recipe values, select another recipe in the controller itself, then go back to the recipe in which the changes were made.

17.10.2.3 Recipe Names

Names can be given to each of the five recipes. Each name is limited to a maximum of four characters – this being the limit of the characters which can be displayed on the front panel of the controller. A character shown as '?' signifies that it cannot be displayed on the controller due to font limitations. To download a new recipe name press Next (or Back or select any other tab).

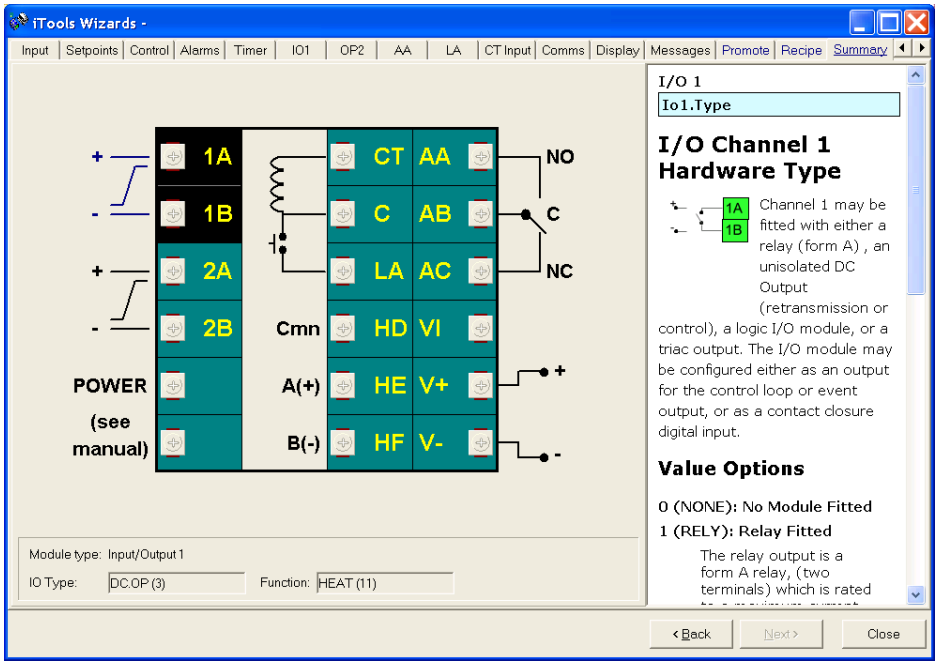


17.11 Summary

The terminal connections for the functions which have been configured together with a description of each function.

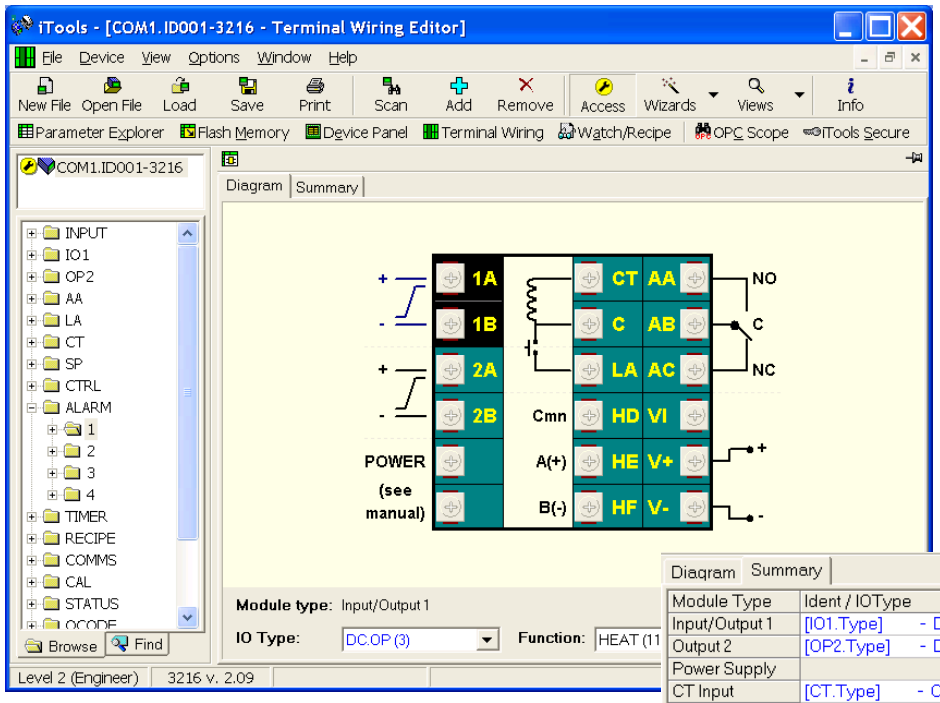
17.11.1 Example 1: Using the Wizard

Press 'Summary' tab.



17.11.2 Example 2: Using the browser view.

Press 



A summary of the features configured may be selected using the 'Summary' tab.

Diagram | Summary

Module Type	Ident / IOType	Function
Input/Output 1	[IO1.Type] - DC.OP (3)	[IO1.Function] - HEAT (11)
Output 2	[OP2.Type] - DC.OP (3)	[OP2.Function] - COOL (12)
Power Supply		
CT Input	[CT.Type] - CT.IN (1)	
Logic Input A	[LA.Type] - L.IP (1)	[LA.InputFunction] - SBY (49)
Digital Comms	[COMMS.Id] - R485 (1)	
Output AA	[AA.Type] - RELY (1)	[AA.Function] - D.OUT (1)
Sensor Input	[INPUT.Type] - CMS (10)	

17.12 Cloning

The cloning feature allows the configuration and parameter settings of one instrument to be copied into another. Alternatively a configuration may be saved to file and this used to download to connected instruments. The feature allows new instruments to be rapidly set up using a known reference source or standard instrument. Every parameter and parameter value is downloaded to the new instrument which means that if the new instrument is used as a replacement it will contain exactly the same information as the original. Cloning is generally only possible if the following applies:

- The target instrument has the same hardware configuration as the source instrument
- The target instrument firmware (i.e. Software built into the instrument) is the same as or a later version than that of the source instrument. The instrument firmware version is displayed on the instrument when power is applied.
- Generally, cloning will copy all operational, engineering and configuration parameters that are writable. **The communications address is not copied.**

Every effort has been made to ensure that the information contained within the clone files is a replica of that configured in the instrument. It is the users responsibility to ensure that the information cloned from one instrument to another is correct for the process to be controlled, and that all parameters are correctly replicated into the target instrument.

Below is a brief description of how to use this feature. Further details are available in the iTools Handbook.

17.12.1 Save to File

The configuration of the controller made in the previous sections may be saved as a clone file. This file can then be used to download the configuration to further instruments.

From the File menu use ‘Save to File’ or use the ‘Save’ button on the Toolbar.

17.12.2 To Clone a New Controller

Connect the new controller to iTools and Scan to find this instrument as described at the beginning of this chapter.

From the File menu select ‘Load Values From File’ or select ‘Load’ from the toolbar. Choose the required file and follow the instruction. The new instrument will be configured to this file.

18. Appendix A TECHNICAL SPECIFICATION

General				
Temperature limits	Operation: 0 to 55°C (32 to 131°F), Storage: -10 to 70°C (14 to 158°F)			
Humidity limits	Operation: RH: 5 to 90% non-condensing Storage: RH: 5 to 90% non-condensing			
Panel sealing	IP 65, Nema 4X			
Shock	BS EN61010			
Vibration	2g peak, 10 to 150Hz			
Altitude	<2000 metres			
Atmospheres	Not suitable for use above 2000m or in explosive or corrosive atmospheres.			
Electromagnetic compatibility (EMC)	EN61326-1 Suitable for domestic, commercial and light industrial as well as heavy industrial environments. (Class B emissions, Industrial Environment immunity). Low supply voltage versions are suitable for industrial environments only.			
Installation category II	The rated impulse voltage for equipment on nominal 230V supply is 2500V			
Pollution degree 2	Normally only non conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.			
Physical	3216	3208	3204	32h8
Panel mounting	1/16 DIN	1/8 DIN	1/4 DIN	1/8 DIN
Weight grams	250	350	420	350

Operator interface			
Type	LCD TN with backlight		
Main PV display	4 digits green		
Lower display	3216	3208	3204
	5 character starburst green		
	32h8 9 character starburst green		
Status beacon	Units, outputs, alarms, active setpoint		

Power requirements	
3216	100 to 240Vac, -15%, +10% 48 to 62Hz, max 6W 24Vac, -15%, +10% 24Vdc, -15%, +20%, ±5% ripple voltage, max 6W
3208, 3204, 32h8	100 to 240Vac, -15%, +10% 48 to 62Hz, max 8W 24Vac, -15%, +10% 24Vdc, -15%, +20%, ±5% ripple voltage, max 8W

Approvals	
	CE, cUL listed (file ES7766), Gost, Suitable for use in Nadcap and AMS2750D applications under Systems Accuracy Test calibration conditions
EN14597TR	Automatic electronic control Type 1A mandatory automatic reset A with full disconnection, number of automatic cycles for each automatic action is 250000. Approval number TR1229.

Transmitter PSU	
Isolation	264Vac double insulated
Output Voltage	24Vdc, >28mA, <33mA

Communications: serial communications option	
Protocol	Modbus RTU slave Modbus RTU Master broadcast (1 parameter)
Isolation	264Vac double insulated
Transmission standard	EIA232 or EIA485 2-wire 3216 only EIA485 4-wire optional

Process Variable Input	
Calibration accuracy	<±0.25% of reading ±1LSD (1)
Sample rate	4Hz (250mS)
Isolation	264Vac double insulated from the PSU and communications
Resolution (µV)	< 0.5µV when using a 1.6 second filter
Resolution (effective bits)	>17 bits
Linearisation accuracy	<0.1% of reading
Drift with temperature	<50ppm (typical) <100ppm (worst case)
Common mode rejection	48 - 62 Hz, >-120db
Series mode rejection	48 - 62 Hz, >-93db
Input impedance	100MΩ
Cold junction compensation	>30 to 1 rejection of ambient temperature
External cold junction	Reference of 0°C
Cold junction accuracy	<±1°C at 25°C ambient
Process Linear	-10 to 80mV, 0 to 10V with external potential divider module 100KΩ/806Ω
Thermocouple Types	K, J, N, R, S, B, L, T, C, custom download (2)
RTD/PT100 Type	3-wire, Pt100 DIN43760
Bulb current	0.2mA
Lead compensation	No error for 22 ohms in all 3 leads
Input filter	Off to 59.9 seconds
Zero offset	User adjustable over the full display range
User calibration	2-point gain & offset

Notes

(1) Calibration accuracy quoted over full ambient operating range and for all input linearisation types.

(2) Contact Eurotherm for details of availability of custom downloads for alternative sensors.

AA relay	
Type	Form C changeover
Rating	Min: 12V, 100mA dc Max: 2A, 264Vac resistive
Functions	Control, alarms or events

Current Transformer Input	
Input current	0 to 50mA rms 48/62Hz, 10Ω burden resistor fitted inside the module
Calibration accuracy	<1% of reading (typical) <4% of reading (worst case)
Isolation	By using external CT
Input impedance	<20Ω
Scale	10, 25, 50 or 100Amps
Functions	Partial load failure, SSR fault

Digital input (DigIn A/B, B not in 3216)	
Contact closure	Contact open >600Ω Contact closed <300Ω
Input current	<13mA
Isolation	None from PV or system 264Vac double insulated from PSU and communications
Functions	Include alarm acknowledge, SP2 select, manual keylock, timer functions, standby select, RSP select

Logic I/O module Output	
Rating	On/High 12Vdc at <44mA Off/Low <300mV at 100µA
Isolation	None from PV or system 264Vac double insulated from PSU and communications
Functions	Control, alarms or events

Logic I/O module Digital input	
Contact closure	Contact open >500Ω Contact closed <150Ω
Isolation	None from PV or system 264Vac double insulated from PSU and communications
Functions	Include alarm acknowledge, SP2 select, manual keylock, timer functions, standby select, RSP select

Relay output channels	
Type	Form A (normally open)
Rating	Min: 12V, 100mA dc Max: 2A, 264Vac resistive
Functions	Control, alarms or events

Triac output	
Rating	0.75A rms 30 to 264V rms (resistive load)
Isolation	264Vac double insulated
Functions	Control, alarms or events

Analogue output (3) OP1, OP2 and OP3 (OP3 not available in 3216)	
Rating	0-20mA into <500Ω
Accuracy	± (<1% of reading + <100µA) [<50µA for OP3]
Resolution	13.5 bits [13.6 bits for OP3]
Isolation	264Vac double insulated from PSU and communications. Module code C and OP3 provides full 264V double insulated
Functions	Control, retransmission

Note (3) Voltage output can be achieved by external adaptor

Remote SP input	
Calibration Accuracy	<± 0.25% of reading ± 1LSD
Sample Rate	4Hz (250mS)
Isolation	264Vac double insulated from instrument
Resolution	<0.5mV for 0-10V input, or <2µA for 4-20mA
Resolution (effective bits)	>14 bits
Drift with temperature	<50ppm typical, <150ppm worst case
Common mode rejection	48 - 62 Hz, >-120db
Series mode rejection	48 - 62 Hz, >-90db
Input Impedance	>222Kohm (Volts) 2.49R (Current)
Normal input range	0 – 10V and 4 – 20mA
Max input range	-1V to 11V and 3.36mA to 20.96mA

Software features	
Control	
Number of loops	1
Loop update	250mS
Control types	PID, ON/OFF, VP
Cooling types	Linear, fan, oil, water
Modes	Auto, manual, standby, forced manual
Overshoot inhibition	High, low
Alarms	
Number	4
Type	Absolute high and low, deviation high, low or band, rate of change
Latching	Auto or manual latching, non-latching, event only
Output assignment	Up to four conditions can be assigned to one output
Setpoint programmer	
Program function	1 program x 8 segments with one event output (by using recipes five SP programs can be stored)
Start mode	Servo from PV or SP
Power fail recovery	Continue at SP or ramp back from PV
Guaranteed soak	Inhibits dwell timing until PV within limits
Timer	
Modes	Dwell when SP reached, delayed control action, soft start limits power below PV threshold
Current monitor	
Alarm types	Partial load failure, over current, SSR short circuit, SSR open circuit
Indication type	Numerical or ammeter
Custom messages	
Number	15 scrolling text messages
No. of characters	127 characters per message max
Languages	English, German, French, Spanish, Italian
Selection	Active on any parameter status using conditional command
Recipes	
Number	5 with 38 parameters
Selection	Key press, via communications or dig. IO

19. Parameter Index

This is a list of parameters used in 3200 series controllers in alphabetical order together with the section in which they are to be found.

Mnemonic	Parameter Description	Location
1.ID	I/O 1 TYPE	IO1 List Section 9.1
1.D.IN	DIGITAL INPUT FUNCTION	IO1 List Section 9.1
1.FUNC	I/O 1 FUNCTION	IO1 List Section 9.1
1.PLS	OUTPUT 1 MINIMUM PULSE TIME	IO1 List Section 9.1
1.RNG	DC OUTPUT RANGE	IO1 List Section 9.1.1
1.SENS	I/O 1 SENSE	IO1 List Section 9.1
1.SRC.A	I/O 1 SOURCE A	IO1 List Section 9.1
1.SRC.B	I/O 1 SOURCE B	IO1 List Section 9.1
1.SRC.C	I/O 1 SOURCE C	IO1 List Section 9.1
1.SRC.D	I/O 1 SOURCE D	IO1 List Section 9.1
2.FUNC	FUNCTION	OP2 List Section 9.1.7
2.ID	OUTPUT 2 TYPE	OP2 List Section 9.1.7
2.PLS	OUTPUT MINIMUM PULSE TIME	OP2 List Section 9.1.7
2.RNG	DC OUTPUT RANGE	OP2 List Section 9.1.7
2.SENS	SENSE	OP2 List Section 9.1.7
2.SRC.A	I/O 2 SOURCE A	OP2 List Section 9.1.7
2.SRC.B	I/O 2 SOURCE B	OP2 List Section 9.1.7
2.SRC.C	I/O 2 SOURCE C	OP2 List Section 9.1.7
2.SRC.D	I/O 2 SOURCE D	OP2 List Section 9.1.7
3.FUNC	FUNCTION	OP3 List Section 9.1.8
3.ID	OUTPUT 3 TYPE	OP3 List Section 9.1.8
3.PLS	OUTPUT MINIMUM PULSE TIME	OP3 List Section 9.1.8
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A1.BLK	ALARM 1 BLOCKING	Alarm Parameters Section 12.3
A1.HYS	ALARM 1 HYSTERESIS	Alarm Parameters Section 12.3
A1.LAT	ALARM 1 LATCHING TYPE	Alarm Parameters Section 12.3
A1.STS	ALARM 1 OUTPUT	Alarm Parameters Section 12.3
A1.TYP	ALARM 1 TYPE	Alarm Parameters Section 12.3
ADDR	COMMUNICATIONS ADDRESS	Digital Comms Section 15.2
A-M	LOOP MODE - AUTO MANUAL OFF	Control List Section 11.10
ATUNE	INTEGRAL TIME	Control List Section 11.10
AT.R2G	AUTO-TUNE CONFIGURES R2G	Control List Section 11.10
BAUD	COMMUNICATIONS BAUD RATE	Digital Comms Section 15.2
C.ADJ	CALIBRATION ADJUST	Calibration Section 16.4
CBHI	CUTBACK LOW	Control List Section 11.10
CBLO	CUTBACK HIGH	Control List Section 11.10
CJ.TYP	CJC TYPE	Input List Section 8.1
CJC.IN	CJC TEMPERATURE	Input List Section 8.1
COLD	COLD START ENABLE/ DISABLE	Access List Section 6.4
CONF.P	CONFIG PASSCODE	Access List Section 6.4
COOL.T	NON LINEAR COOLING TYPE	Control List Section 11.10
CT.ID	MODULE TYPE	CT List Section 9.2
CT.LAT	CT ALARM LATCH TYPE	CT List Section 9.2
CT.MTR	CT METER RANGE	CT List Section 9.2
CT.RNG	CT RANGE	CT List Section 9.2
CT.SRC	CT SOURCE	CT List Section 9.2
CTRL.A	CONTROL ACTION	Control List Section 11.10
CTRL.C	COOLING TYPE	Control List Section 11.10
CTRL.H	HEATING TYPE	Control List Section 11.10
CYCLE	PROGRAM CYCLE	Timer Parameters Section 13.1
D.BAND	CHANNEL 2 DEAD BAND	Control List Section 11.10
dC.OP	0-20mA output non-isolated	Output List I/O1 Section 9.1.1. Output List OP2 Section 9.1.7. Output List OP3 Section 9.1.8.
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DEC.P	DISPLAY POINTS	Input List Section 8.1
DELAY	RX/TX DELAY TIME	Digital Comms Section 15.2
DWEL.1	DWELL 1	Timer Parameters Section 13.1
DWELL	SET TIMER DURATION	Timer Parameters Section 13.1
ENT.T	TIMER END TYPE	Timer Parameters Section 13.1
EVENT	EVENT OUTPUTS	Timer Parameters Section 13.1
F.MOD	FORCED MANUAL OUTPUT MODE	Control List Section 11.10
F.OP	FORCED OUTPUT	Control List Section 11.10
FILT.T	FILTER TIME	Input List Section 8.1

Mnemonic	Parameter Description	Location
GO	START CALIBRATION	Calibration Section 16.4
GOTO	SELECT ACCESS LEVEL	Access List Section 6.4
HC.ALM	OVER CURRENT THRESHOLD	CT List Section 9.2
HOME	HOME DISPLAY See Note 1	Access List Section 6.4
HYST.C	COOLING HYSTERESIS	Control List Section 11.10
HYST.H	HEATING HYSTERESIS	Control List Section 11.10
ID	CUSTOMER ID	Access List Section 6.4
I D	MODULE IDENTITY	Digital Comms Section 15.2
I M	INSTRUMENT MODE	Modbus Address Section 15.6
IN.TYP	INPUT TYPE	Input List Section 8.1
K.LOC	KEYBOARD LOCK	Access List Section 6.4
L.D.IN	LOGIC INPUT FUNCTION	Logic Input List Section 9.1.10
L.SENS	LOGIC INPUT SENSE	Logic Input List Section 9.1.10
L.TYPE	LOGIC INPUT TYPE	Logic Input List Section 9.1.10
LBR	LOOP BREAK STATUS	Control List Section 11.10
LBT	LOOP BREAK TIME	Control List Section 11.10
LD.ALM	LOAD CURRENT THRESHOLD	CT List Section 9.2
LD.AMP	LOAD CURRENT	CT List Section 9.2
LEV2.P	LEVEL 2 PASSCODE	Access List Section 6.4
LEV3.P	LEVEL 3 PASSCODE	Access List Section 6.4
LK.ALM	LEAK CURRENT THRESHOLD	CT List Section 9.2
LK.AMP	LEAK CURRENT	CT List Section 9.2
L O C . T	LOCAL SETPOINT TRIM	Setpoint List Section 10.1
L - R	REMOTE SETPOINT SELECT	Setpoint List Section 10.1
METER	METER CONFIGURATION	Access List Section 6.4
MR	MANUAL RESET	Control List Section 11.10
MTR.T	MOTOR TRAVEL TIME	Control List Section 11.10
MV.HI	LINEAR INPUT HIGH	Input List Section 8.1
MV.IN	MILLIVOLT INPUT VALUE	Input List Section 8.1
MV.LO	LINEAR INPUT LOW	Input List Section 8.1
OP.HI	OUTPUT HIGH	Control List Section 11.10
OP.LO	OUTPUT LOW	Control List Section 11.10
P.CYCL	PROGRAM CYCLES	Timer Parameters Section 13.1
PASS.2	FEATURE PASSCODE	Access List Section 6.4
PASS.C	FEATURE PASSCODE	Access List Section 6.4
PB	DERIVATIVE TIME	Control List Section 11.10
PB.UNT	Proportional band units	Control List Section 11.10
PHASE	CAL PHASE	Calibration Section 16.4
PRTY	COMMUNICATIONS PARITY	Digital Comms Section 15.2
PV.IN	PV INPUT VALUE	Input List Section 8.1
PV.OFS	PV OFFSET	Input List Section 8.1
R2G	INTEGRAL TIME	Control List Section 11.10

Mnemonic	Parameter Description	Location
R A M P U	SETPOINT RAMP UNITS	Setpoint List Section 10.1
R C . F T	Filter time constant for the rate of change alarm.	Modbus addresses section 15.6
R C . P V	Calculated rate of change of PV in engineering units per minute.	Modbus addresses section 15.6
REG.AD	COMMS RETRANSMISSION ADDRESS	Digital Comms Section 15.2
R E M . H I	REMOTE INPUT HIGH SCALAR	Setpoint List Section 10.1
R E M . L O	REMOTE INPUT LOW SCALAR	Setpoint List Section 10.1
R E M . S P	REMOTE SETPOINT	Setpoint List Section 10.1
RETRAN	COMMS RETRANSMISSION	Digital Comms Section 15.2
R M P . 1	RAMP RATE 1	Timer Parameters Section 13.1
RNG.HI	RANGE HIGH LIMIT	Input List Section 8.1
RNG.LO	RANGE LOW LIMIT	Input List Section 8.1
ROP.HI	SETPOINT RETRANS HIGH	Setpoint parameters section 10.1
ROP.LO	SETPOINT RETRANS LOW	Setpoint parameters section 10.1
SAFE	SAFE OUTPUT POWER	Control List Section 11.10
SB.TYP	SENSOR BREAK TYPE	Input List Section 8.1
S E R V O	SERVO MODE	Timer Parameters Section 13.1
S P . H I	SETPOINT HIGH LIMIT	Setpoint List Section 10.1
S P . L O	SETPOINT LOW LIMIT	Setpoint List Section 10.1
S P . R A T	SETPOINT RATE LIMIT	Setpoint List Section 10.1
S P . S E L	SETPOINT SELECT	Setpoint List Section 10.1
S P 1	SETPOINT 1	Setpoint List Section 10.1
S P 2	SETPOINT 2	Setpoint List Section 10.1
SS.PWR	SOFT START POWER LIMIT	Timer Parameters Section 13.1
SS.SP	SOFT START SETOINT	Timer Parameters Section 13.1
STBY.T	STANDBY TYPE	Access List Section 6.4
T.ELAP	ELAPSED TIME	Timer Parameters Section 13.1
T.REMN	TIME REMAINING	Timer Parameters Section 13.1
T.STAT	TIMER STATUS	Timer Parameters Section 13.1
TD	DERIVATIVE TIME	Control List Section 11.10
THRES	TIMER START THRESHOLD	Timer Parameters Section 13.1
TI	RELATIVE COOL GAIN	Control List Section 11.10
TM.CFG	TIMER CONFIGURATION	Timer Parameters Section 13.1
TM.RES	TIMER RESOLUTION	Timer Parameters Section 13.1
T S P . 1	TARGET SETPOINT 1	Timer Parameters Section 13.1
T U . H I	TUNE HIGH LIMIT	Control section 11.2
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21. Certificate of Conformity

invensys
Eurotherm

Declaration of Conformity

Manufacturer's name:	Eurotherm Limited
Manufacturer's address:	Faraday Close, Worthing, West Sussex, BN13 3PL, United Kingdom
Product type:	Temperature controllers and indicators
Models:	3116 Status level A1 and above 3204 Status level A1 and above 3208 Status level A1 and above 32H8 Status level A1 and above 3216 Status level A1 and above
Safety specification:	EN61010-1: 2001
EMC emissions specification:	EN61326-1: 2006 Class B
EMC immunity specification:	EN61326-1: 2006 Industrial locations

Eurotherm Limited hereby declares that the above products conform to the safety and EMC specifications listed. Eurotherm Limited further declares that the above products comply with the EMC Directive 2004/108/EC, and also with the Low Voltage Directive 2006/95/EC.

Signed: K Shaw Dated: 07/07/10

Signed for and on behalf of Eurotherm Limited.
Kevin Shaw
(R&D Director)

CE

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HA028651/11 (CN28836)

Model 2416
Process Controller

User Manual

Part No HA025041_12

Date August 2014

Eurotherm®

by Schneider Electric

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MODEL 2416 PID CONTROLLER

INSTALLATION AND OPERATION HANDBOOK

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1. Chapter 1 INSTALLATION

The 2416 controller is a versatile, high stability temperature or process controller, with self and adaptive tuning, in 1/16 DIN size (48 x 48mm). It has a modular hardware construction, which accepts up to three plug-in output modules and one communications module, to satisfy a wide range of control requirements. All 2416 controllers have a basic 8-segment programmer built-in as standard.

The 2416 is available as either a:

- standard controller: Model 2416/CC
- setpoint programming controller: Models 2416/CP and 2416/P4
- motorised valve controller: Model 2416/VC
- setpoint programming motorised valve controller: Models 2416/VP and 2416/V4

This chapter consists of two parts:

- MECHANICAL INSTALLATION
- ELECTRICAL INSTALLATION

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

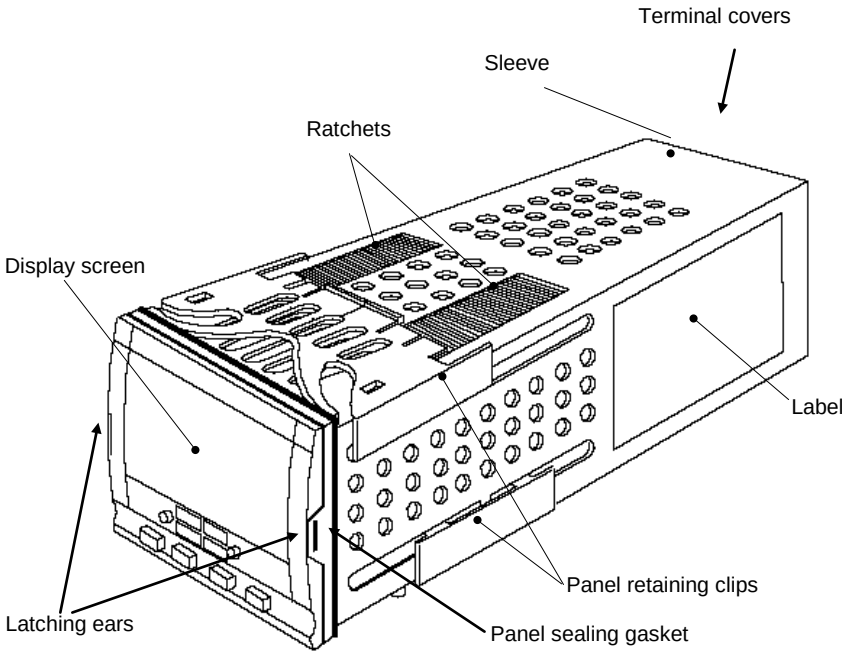


Figure 1-1: 2416 1/16 DIN controller

1.1 MECHANICAL INSTALLATION

1.1.1 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.

1.1.2 Outline dimensions

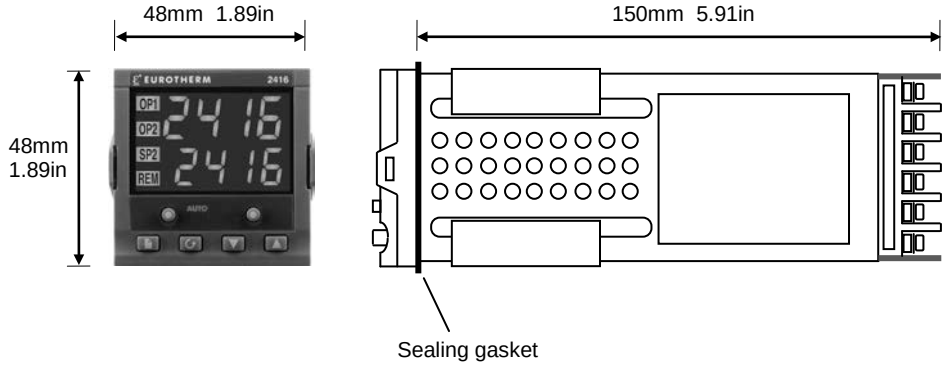


Figure 1-2: Outline Dimensions

The electronic assembly of the controller plugs into a rigid plastic sleeve, which in turn fits into the standard DIN size panel cut-out shown in Figure 1-3.

1.1.3 Panel cut-out and recommended minimum spacing of controllers

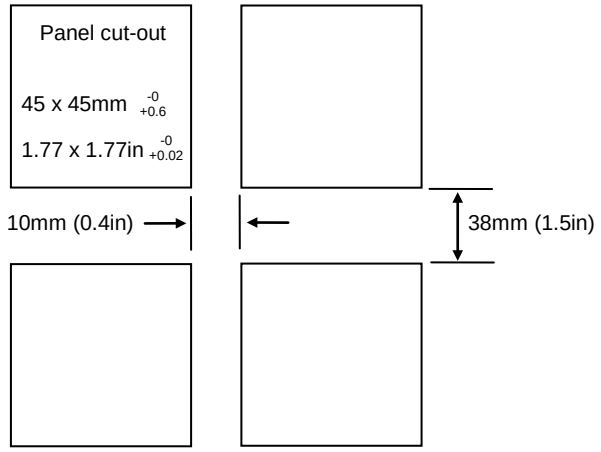


Figure 1-3: Panel cut-outs and minimum spacing

1.1.4 To install the controller

1. Prepare the control panel cut-out to the size shown in Figure 1-3.
2. Insert the controller through the panel cut-out.
3. Spring the upper and lower panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.
4. Peel off the plastic film protecting the front of the indicator.

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.

1.1.5 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.

1.2 ELECTRICAL INSTALLATION

This section consists of five topics:

- Rear terminal layout
- Fixed connections
- Plug-in module connections
- Typical wiring diagram
- 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.

All electrical connections are made to the screw terminals at the rear of the controller. These screw terminals accept wire sizes from 0.5 to 2.5mm^2 (14 to 22 awg) and should be tightened to a torque of 0.4 Nm (3.5 lb in). If you wish to use crimp connectors, we recommend AMP part number 16500. These accept wire sizes from 0.5 to 1.5 mm^2 (16 to 22 AWG).

1.2.1 Rear Terminal Layout

Terminals are arranged in three columns at the rear of the controller. Each column is protected by a clear plastic hinged cover to prevent hands or metal making accidental contact with live wires. Viewed from the rear and with the controller upright, the right-hand column carries the connections for the power supply and sensor input. The other two columns carry the connections to the plug-in modules. The connections depend upon the type of module installed, if any. To discover which plug-in modules are installed in your controller, please refer to the ordering code and wiring data on the labels on the sides of the controller.

The rear terminal layout is shown below.

Note: The plug-in sleeve supplied with high voltage controllers are keyed to prevent a low voltage unit being inserted into them.

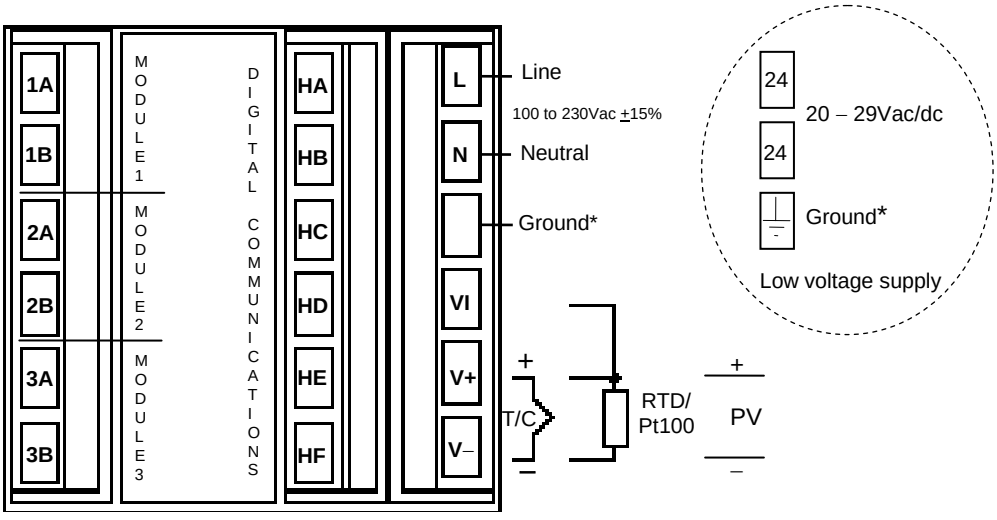


Figure 1-4: Rear terminal layout

*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.

1.2.2 Fixed connections

The power supply and sensor inputs are always wired to the same fixed positions whatever plug-in modules are installed.

Power supply connections

These are as shown in Figure 1-4.

Sensor input connections

The diagrams below show the connections for the various types of input.

The input will have been configured in accordance with the ordering code.

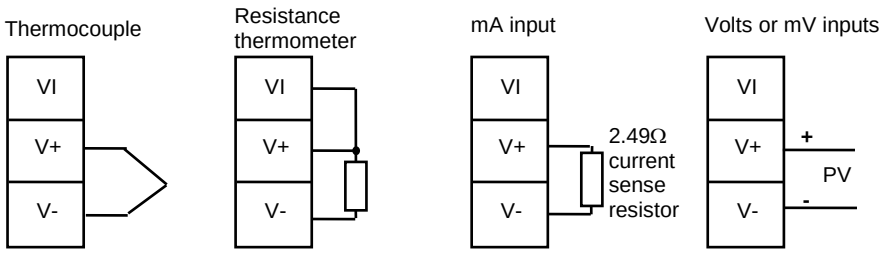


Figure 1-5: Sensor input connections

Warning: Do not connect more than one sensor to any one input

1.2.3 Plug-in module connections

In Figure 1-4, Modules 1, 2 and 3, and Comms are plug-in modules.

Modules 1, 2 and 3

Module positions 1, 2 and 3 each have two terminals. They will accept four types of module: Relay, Logic (non-isolated), Triac, and DC (non-isolated) output.

Collectively, these can be configured to operate in six different ways:

Heating control

Cooling control

Alarm output

Program event output

PDS mode 1*, which provides logic heating using a Eurotherm TE10S solid state relay with feedback of a load failure alarm.

PDSIO mode 2*, which provides logic heating using a Eurotherm TE10S solid state relay, with feedback of the load current reading and two alarms: solid state relay failure and heater circuit failure.

***** PDS stands for ‘Pulse Density Signalling Input/Output’. This is a proprietary technique developed by Eurotherm for bi-directional transmission of analogue and digital data over a simple 2-wire connection.

1.2.4 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. Insert the blade of a screwdriver into one of the two slots that bound it, and twist.

The table below shows the module connections and which functions each module can perform. The heating output is normally connected to module 1, the cooling output to module 2 and the alarm output to module 3, although the actual function of each module will depend upon how your controller has been configured.

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.

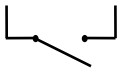
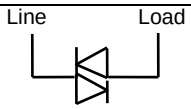
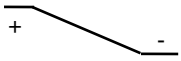
Module type	Terminal identity		Possible functions
	A	B	
Relay: 2-pin *(2A, 264 Vac max.)*			Heating, Cooling, or Alarm output Program event output Valve raise or lower
Logic: non-isolated *(18Vdc at 20mA)*			Heating, Cooling, or Alarm output PDSIO mode 1, PDSIO mode 2, Program event
Triac *(1A, 30 to 264Vac)*			Heating, Cooling, Program event Valve raise or lower
DC control: non-isolated *(10Vdc, 20mA max.)*			Heating, Cooling. Retransmission of PV, setpoint or control output

Table 1-1: Module 1, 2 and 3 connections

To check which modules are installed in your particular controller, and which functions they are configured to perform, refer to the ordering code and the wiring information on the controller side labels.

1.2.5 Communications module

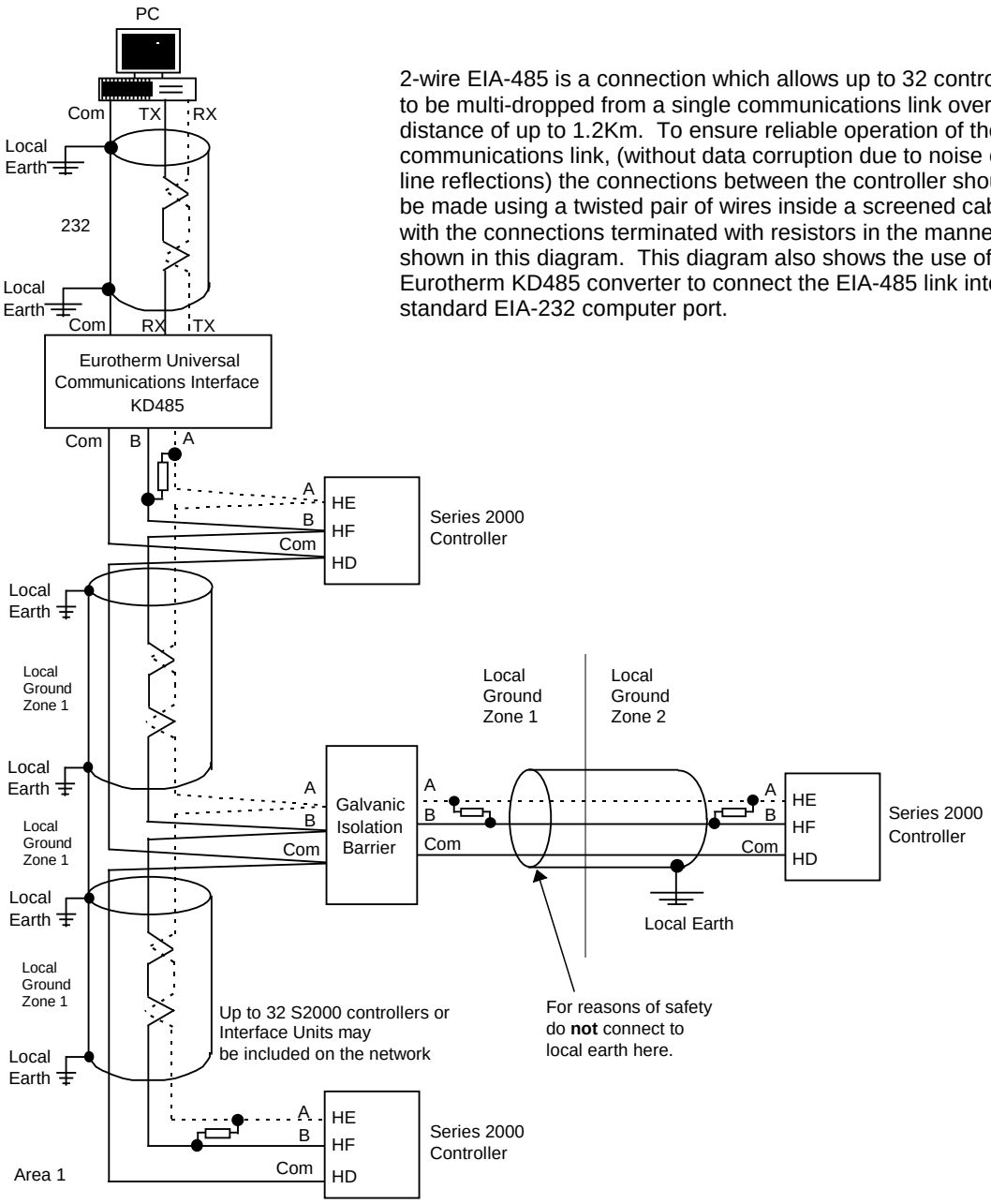
The Communications module position will accept any of the modules listed in Table 1-2 below.

The serial communications can be configured for either Modbus, or EI bisynch protocol.

Communications module	Terminal identity (COMMS)					
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
PDSIO remote setpoint input	--	--	--	--	Signal	Common

Table 1-2: Communications connections

1.2.6 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 1-6: EIA-485 wiring

1.3 TYPICAL WIRING DIAGRAM

The example shown in Figure 1-7 is a 2416 heat and cool temperature controller with thermocouple input, logic output driving a solid state relay to provide regulation of power to a heater and triac output driving a cooling solenoid valve.

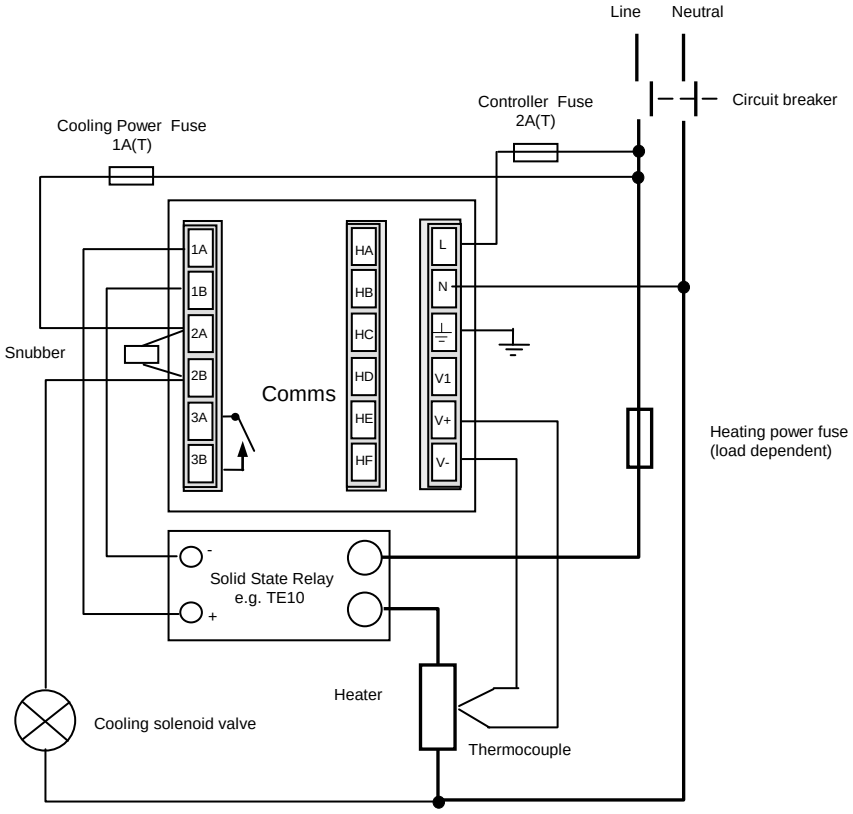


Figure 1-7: Typical wiring diagram

Safety requirements for permanently connected equipment state:

- A switch or circuit breaker shall be included in the building installation
- It shall be in close proximity to the equipment and within easy reach of the operator
- It shall be marked as the disconnecting device for the equipment.

Note: a single switch or circuit breaker can drive more than one instrument.

For logic drive capability see following chart:-

1.3.1 Logic Drive Fan Out

The logic outputs from the 2400 series controllers are capable of driving more than one solid state relay (SSR) in series or parallel. The following table shows the number of SSRs which can be driven depending on type of SSR. S = Series; P = Parallel.

	Drive mA	SVDA	RVDA	TE10S	425S		
		Logic DC	Logic DC	Logic DC	Logic 10V	Logic 24V	Logic 20mA
Logic	18V @20mA	4S6P	4S3P	3S2P	3S3P	1S2P	6S1P
Triple logic	12V @9mA	3S3P	2S1P	2S1P	2S1P	1	4S1P

	450			TC1027CE	TE200S	TC2000CE	RS3DA
	Standard	TTL	Multi-drive	Logic V	Logic DC	Logic DC	Logic DC
Logic	2S3P	1S2P	6S1P	3S3P	3S3P	3S1P	4S2P
Triple logic	1	1	4S1P	2S1P	2S1P	0	0

1.4 MOTORISED VALVE CONNECTIONS

Motorised valves are wired to relay, or triac, outputs installed in module positions 1 and 2. The convention is to configure Output 1 as the RAISE output and Output 2 as the LOWER output. The controller does not require a position feedback potentiometer.

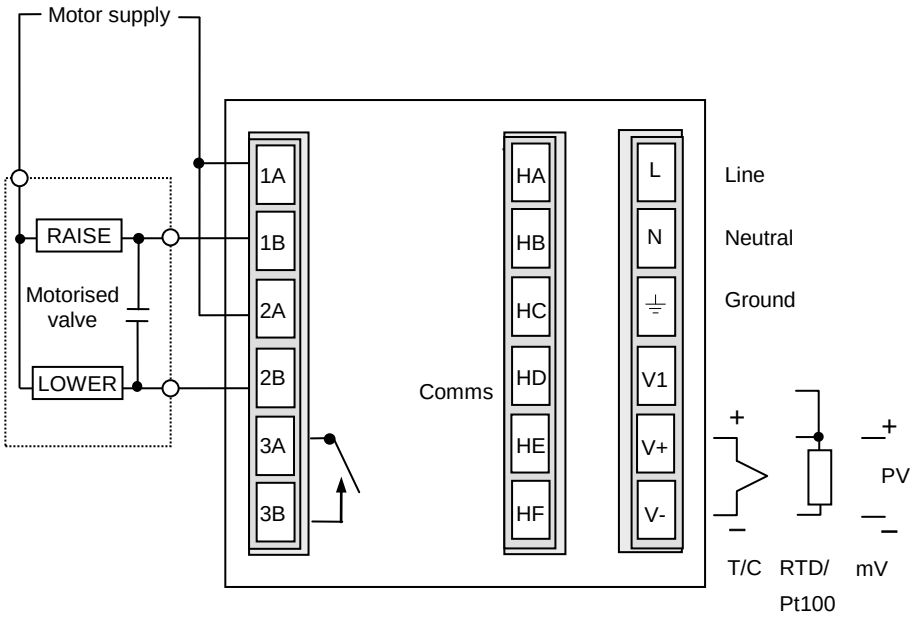


Figure 1-8: Motorised valve controller connections

2. Chapter 2 OPERATION

This chapter has nine topics:

- FRONT PANEL LAYOUT
- BASIC OPERATION
- OPERATING MODES
- AUTOMATIC MODE
- MANUAL MODE
- PARAMETERS AND HOW TO ACCESS THEM
- NAVIGATION DIAGRAM
- PARAMETER TABLES
- ALARM MESSAGES

2.1 FRONT PANEL LAYOUT

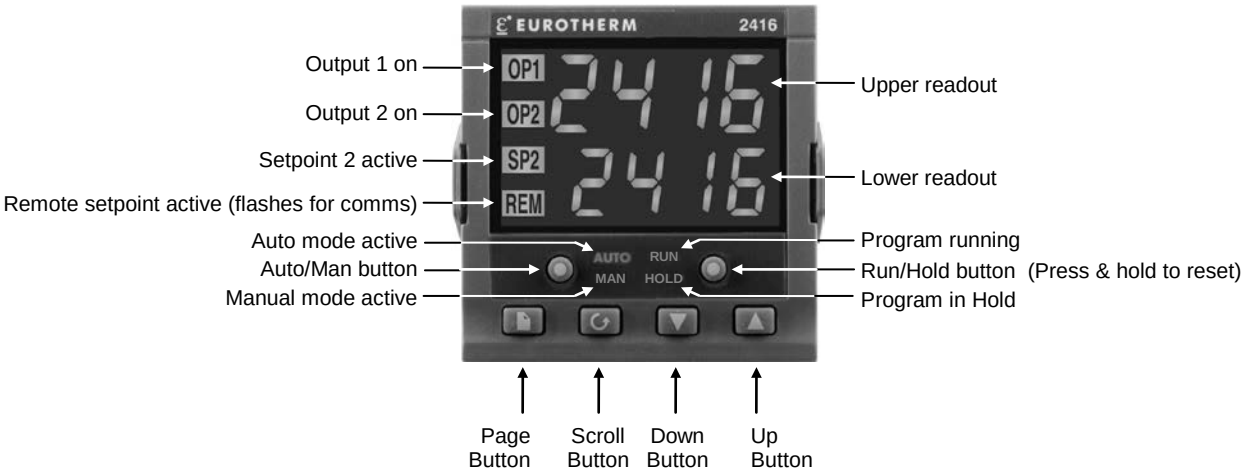


Figure 2-1: Front panel layout

Button or indicator	Name		Explanation
OP1	Output 1	If a DC output is installed, OP1 & OP2 will not light	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/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 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 or when a PDS retransmission output is open circuit.
	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.

Table 2-1: Buttons and indicators

2.2 BASIC OPERATION

Switch on the power to the controller. It runs through a self-test sequence for about three seconds and then shows the temperature, or process value, in the upper readout and the setpoint in the lower readout. This is called the Home display. It is the one that you will use most often.

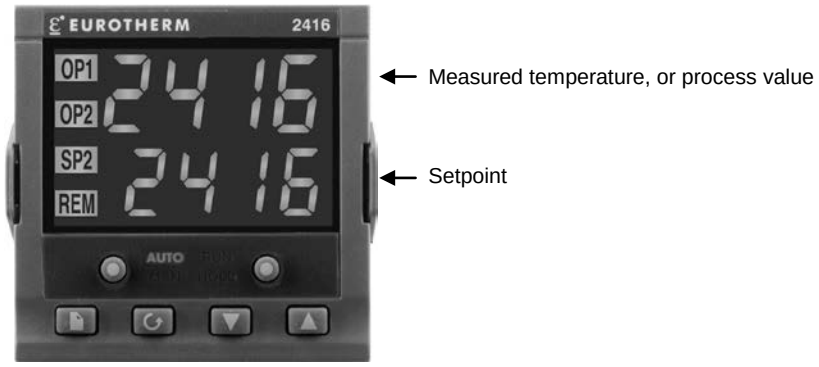


Figure 2-2: Home display

On this display you can adjust the setpoint by pressing the ▲ or ▼ buttons. Two seconds after releasing either button, the display blinks to show that the controller has accepted the new value.

Note: You can get back to the Home display at any time by pressing ↺ and ☐ together. Alternatively you will always be returned to the Home display if no button is pressed for 45 seconds, or whenever the power is turned on. If, however, a flashing alarm message is present the controller reverts to the Home display after 10 seconds.

2.2.1 Alarms

If the controller detects an alarm condition, it flashes an alarm message in the Home display. For a list of all the alarm messages, their meaning and what to do about them, see *Alarms* at the end of this chapter.

2.3 OPERATING MODES

The controller has two basic modes of operation:

- **Automatic mode** in which the output power is automatically adjusted to maintain the temperature or process value at the setpoint.
- **Manual mode** in which you can adjust the output power independently of the setpoint.

You toggle between the modes by pressing the AUTO/MAN button. The displays which appear in each of these modes are explained in this chapter.

Two other modes are also available:

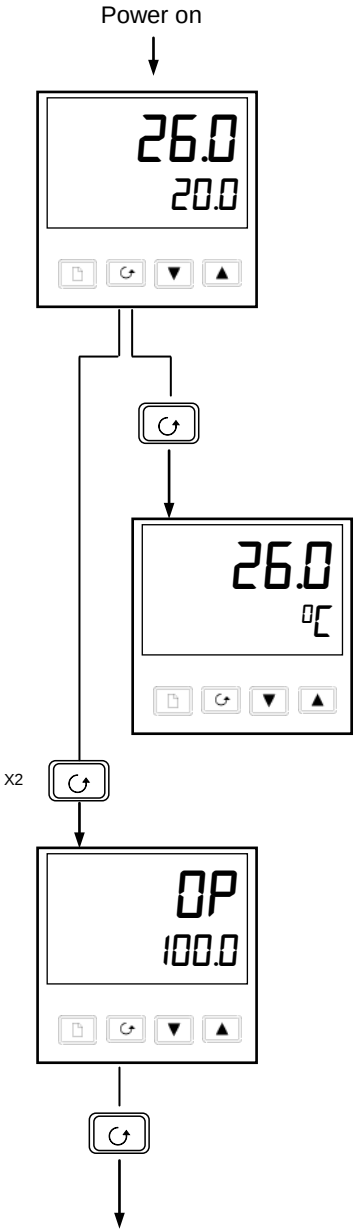
- **Remote Setpoint mode** in which the setpoint is generated from an external source.

In this mode the REM light will be on.

- **Programmer mode** which is explained in Chapter 5, *Programmer Operation.*

2.3.1 Automatic mode

You will normally work with the controller in automatic mode. If the MAN light is on, press the AUTO/MAN button to select automatic mode. The AUTO light will come on.



The Home display

Check that the AUTO light is on.

The upper readout shows the measured temperature, or process value. The lower readout shows the setpoint.

To adjust the setpoint up or down, press ▲ or ▼.

(Note: If Setpoint Rate Limit has been enabled, then the lower readout will show the active setpoint. If ▲ or ▼ is pressed, it will change to show and allow adjustment of, the target setpoint.)

Press ↻ once

Display units

A single press of the ↻ button will flash the display units for 0.5 seconds, after which you will be returned to the **Home** display.

Flashing of the display units may have been disabled in configuration, in which case a single press will take you straight to the display shown below.

Press ↻ twice

% Output power demand

The % output power demand is displayed in the lower readout. This is a read-only value. You cannot adjust it.

Press ☐ and ↻ together to return to the **Home** display.

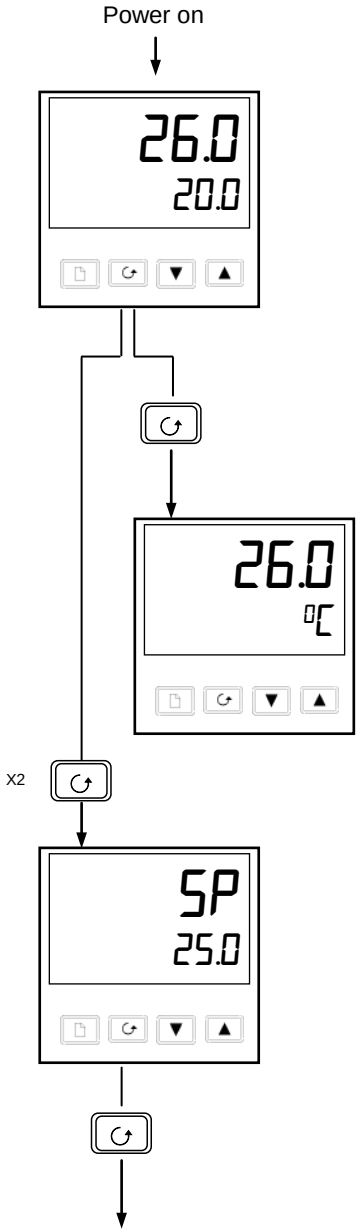
If the controller is configured as Valve Position and Manual is selected the Output Power is displayed as UPOS. This is the inferred position of the valve

Press ↻

Pressing ↻ from the Output Power display may access further parameters. These may be in this scroll list if the 'Promote' feature has been used (see Chapter 3, *Edit Level*). When you reach the end of this scroll list, pressing ↻ will return you to the **Home** display.

2.3.2 Manual mode

If the AUTO light is on, press the AUTO/MAN button to select manual mode. The MAN light will come on



The Home display

Check that the MAN light is on.

The upper readout shows the measured temperature or process value. The lower readout shows the % output.

To adjust the output, press ▲ or ▼.

(Note: If Output Rate Limit has been enabled, then the lower readout will show the working output. If ▲ or ▼ is pressed, it will change to show and allow adjustment of, the target output.)

Press ↻ once

Display Units

A single press of ↻ will flash the display units for 0.5 seconds, after which you will be returned to the Home display.

Flashing of the display units may have been disabled in configuration in which case you a single press will take you straight to the display shown below.

Press ↻ twice

Setpoint

To adjust the setpoint value, press ▲ or ▼.

Press ↻

Pressing ↻ from the Output Power display may access further parameters. Other parameters may be in this scroll list if the 'Promote' feature has been used (see Chapter 3, *Edit Level).* When you reach the end of this scroll list, pressing ↻ will return you to the **Home** display.

2.4 PARAMETERS AND HOW TO ACCESS THEM

Parameters are settings, within the controller, that determine how the controller will operate. For example, alarm setpoints are parameters that set the points at which alarms will occur. For ease of access, the parameters are arranged in lists as shown in the navigation diagram – section **Error! Reference source not found.**. The lists are:

Home list

Run list

Programming list

Alarm list

Autotune list

PID list

Motor list

Setpoint list

Input list

Output list

Communications list

Information list

Access list.

Each list has a 'List Header' display.

2.4.1 List header displays

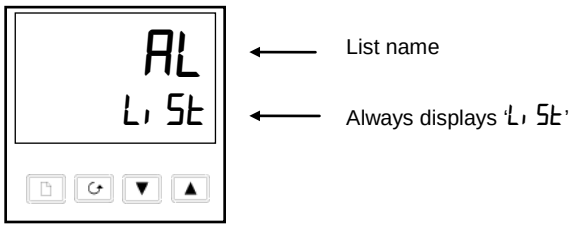


Figure 2-3: Typical list header display

A list header can be recognised by the fact that it always shows 'LiSt' in the lower readout. The upper readout is the name of the list. In the above example, 'AL' indicates that it is the Alarm list header. List header displays are read-only.

To step through the list headers, press .

Depending upon how your controller has been configured, a single press may momentarily flash the display units. If this is the case, a double press will be necessary to take you to the first list header. Keep pressing to step through the list headers, eventually returning you to the Home display.

To step through the parameters within a particular list, press .

When you reach the end of the list, you will return to the list header.From within a list you can return to the current list header at any time can by pressing . To step to the next list header, press once again.

2.4.2 Parameter names

In the navigation diagram, (Figure 2-5) each box depicts the display for a selected parameter.

The upper readout shows the name of the parameter and the lower readout its value.

The Operator parameter tables later in this chapter list all the parameter names and their meaning.

The navigation diagram shows all the parameters that can, *potentially*, be present in the controller. In practice, only those associated with a particular configuration will appear.

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

2.4.3 Parameter displays

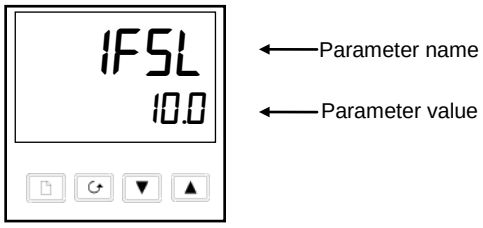


Figure 2-4: Typical parameter display

Parameter displays show the controller's current settings. The layout of parameter displays is always the same: the upper readout shows the parameter name and the lower readout its value. Alterable parameters can be changed using ▲ or ▼. In the above example, the parameter mnemonic is 1FSL (indicating *Alarm 1, full scale low*), and the parameter value is 10.0.

2.4.4 To change the value of a parameter

First, select the required parameter. The parameter name is shown in the upper readout and the parameter value in the lower readout.

To change the parameter value, press either ▲ or ▼. During adjustment, single presses change the value by one digit.

Keeping the button pressed speeds up the rate of change.

Two seconds after releasing either button, the display blinks to show that the controller has accepted the new value.

2.5 NAVIGATION DIAGRAM

PART A

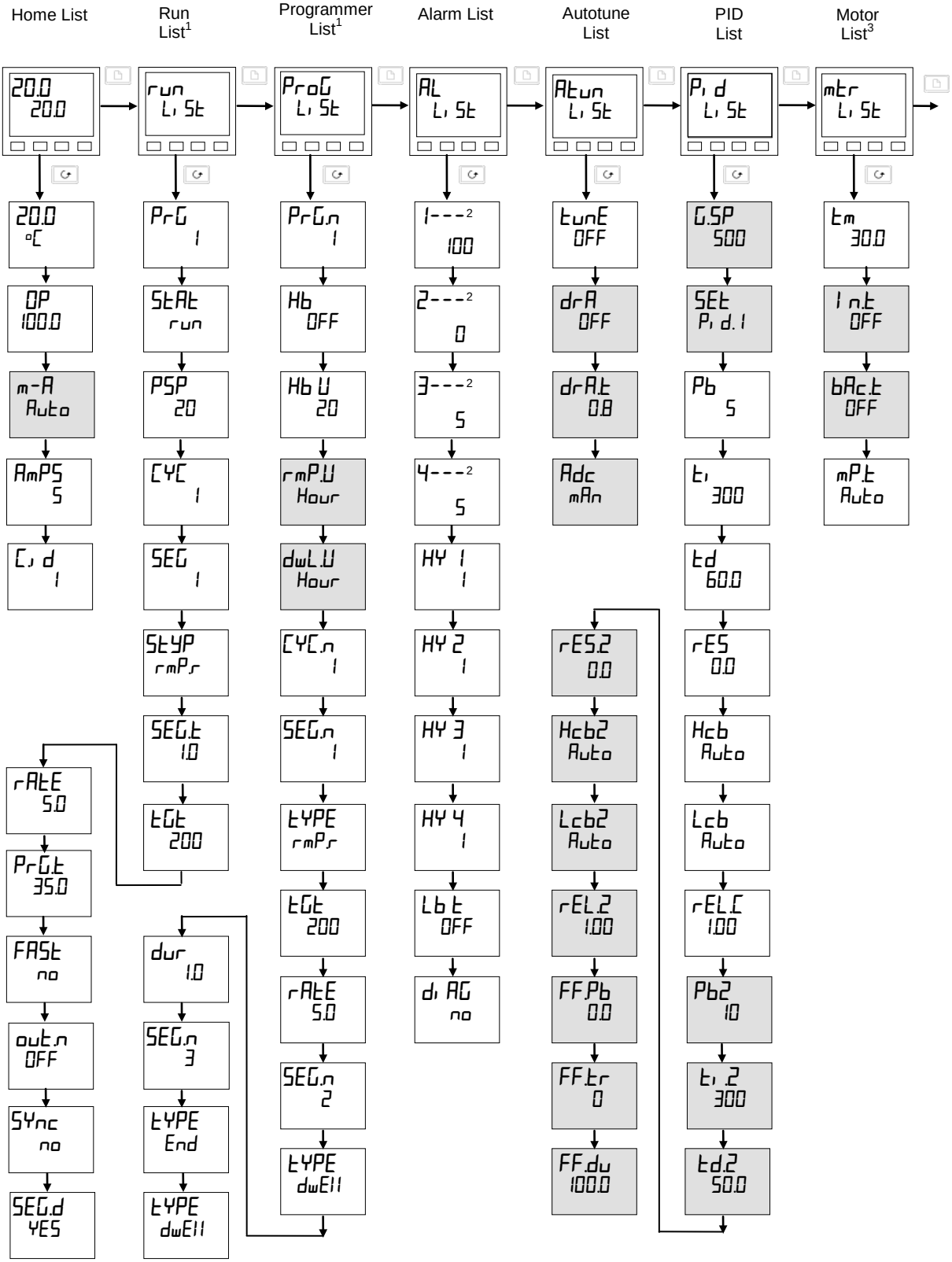
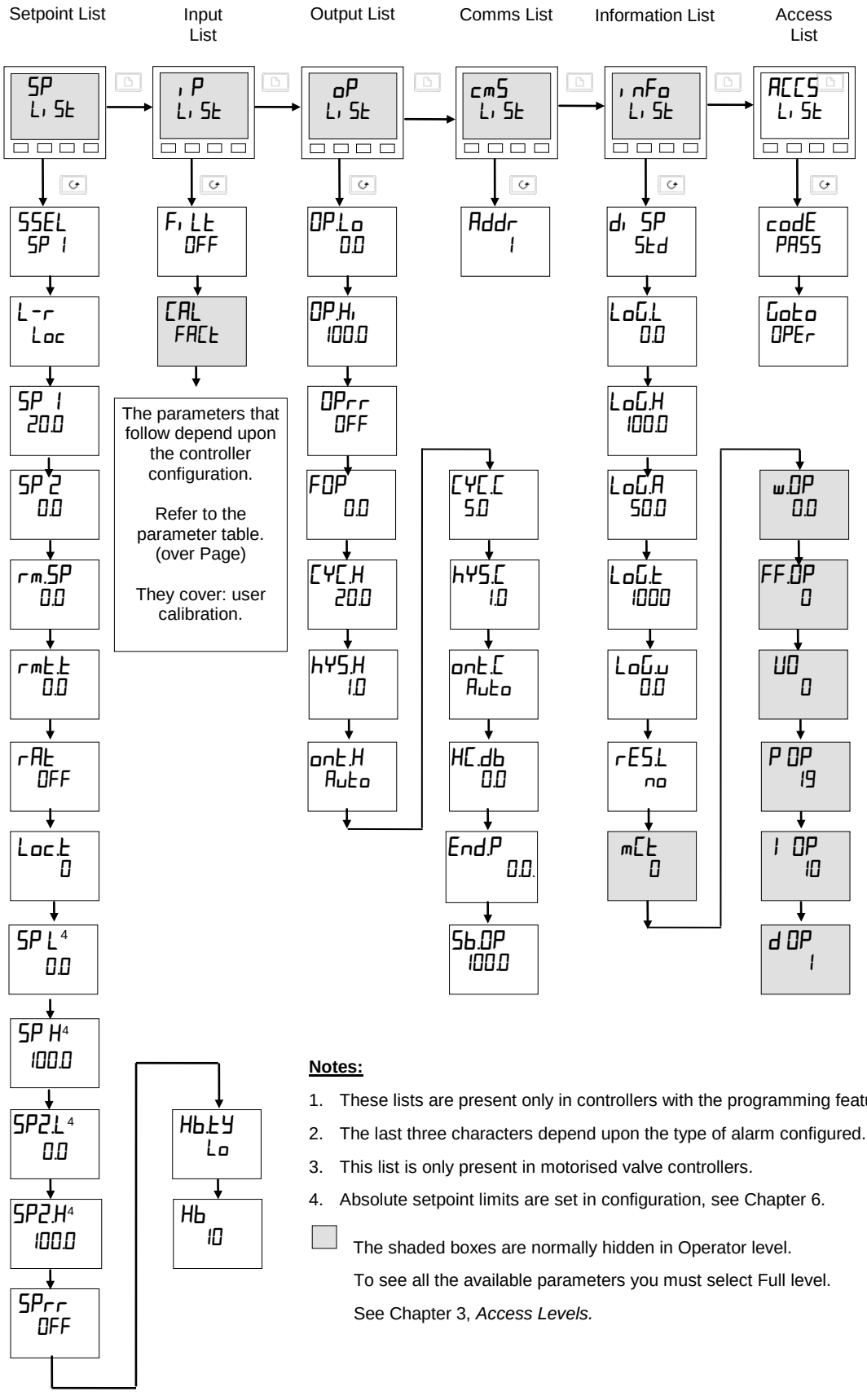


Figure 2-5: Navigation diagram
Part A

NAVIGATION DIAGRAM

(PART B)



Notes:

1. These lists are present only in controllers with the programming feature.
2. The last three characters depend upon the type of alarm configured.
3. This list is only present in motorised valve controllers.
4. Absolute setpoint limits are set in configuration, see Chapter 6.

The shaded boxes are normally hidden in Operator level.
To see all the available parameters you must select Full level.
See Chapter 3, *Access Levels.*

Figure 2-5: Navigation diagram (Part B)

2.6 PARAMETER TABLES

Name	Description

	Home list *Extra parameters may be present if promote feature has been used.*
Home	Measured value and Setpoint
OP	% Output level
SP	Target setpoint (if in Manual mode)
m-A	Auto-man select
AmPS	Heater current (With PDSIO mode 2)
C, d	Customer defined identification number

run	**Program run list** – *Present only in setpoint programming controllers*
PrG	Active program number (Only on 4 program versions)
StAt	Program status (OFF, run, hoLd, HbAc, End)
PSP	Programmer setpoint
CYC	Number of cycles remaining in the program
SEG	Active segment number
StYP	Active segment type
SEG.t	Segment time remaining in the segment units
tGt	Target setpoint
rAtE	Ramp rate (if a rate segment)
PrG.t	Program time remaining in hours
FASt	Fast run through program (no / YES)
outn	Event output states (OFF / on) (*not 8-segment programmer*)
SYnc	Not operational in 2416. Set to no.
SEG.d	Flash active segment type in the lower readout of the home display (no / YES) This parameter can only be changed when the program is in reset

ProG	**Program edit list** – *Present only in setpoint programming controllers*
PrGn	Select program number (Only on 4 program versions)
Hb	Holdback type (OFF, Lo, Hi , or bAnd)
Hb U	Holdback value (in display units)
rmP.U	Ramp units (SEc, mi n, or Hour) [*for both rmPr and rmPt type segments*]
dwL.U	Dwell units (SEc, mi n, or Hour)
CYCn	Number of program cycles (1 to 999, or 'cont')
SEGn	Segment number
tYPE	Segment type:(End) (rmPr=ramp rate) (rmPt=ramp time) (dwEll) (StEP) (cALL)

The following parameters depend on the tYPE selected, as shown below.							
	End	rmPr	rmPt	dwEll	StEP	cALL	
Hb		✓	✓	✓	✓		Holdback type: OFF Lo Hi or bAnd
tGt		✓	✓		✓		Target setpoint for a 'rmP' or 'StEP' segment
rAtE		✓					Ramp rate for a 'rmPr' segment
dur			✓	✓			'dwEll' time / time to target for a 'rmPt' segment
PrGn						✓	cALLed PrGram number
cYcn						✓	No. of cycles of cALLed program
outn	✓	✓	✓	✓	✓		Event output: OFF/on (*not 8-segment programmer*)
SYnc		✓	✓	✓	✓		Not operational in 2416. Set to no.
End.t	✓						End of prog – dwEll, rSEt, S OP

Name	Description

	Alarm list
1---	Alarm 1 setpoint value
2---	Alarm 2 setpoint value
3---	Alarm 3 setpoint value
4---	Alarm 4 setpoint value
In place of dashes, the last three characters indicate the alarm type as follows: *Note: It is possible to indicate only up to four alarm conditions (known as soft alarms). They can be "wired" to operate relays within the limitations of the number of output modules available. For more information see Configuration - Chapter 6.*	
-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
-FL2	Not available in 2416
-FH2	Not available in 2416
-LOP	Working Output low alarm
-HOP	Working Output high alarm
-LSP	Working Setpoint low alarm
-HSP	Working Setpoint high alarm
rAtE	Rate of change alarm (*AL 4 only*)
HY 1	Alarm 1 Hysteresis (display units)
HY 2	Alarm 2 Hysteresis (display units)
HY 3	Alarm 3 Hysteresis (display units)
HY 4	Alarm 4 Hysteresis (display units)
Lbt	Loop Break Time in **min**utes
di AG	Enable Diagnostic alarms 'no' / 'YES'

	Autotune list
tunE	One-shot autotune enable
drA	Adaptive tune enable
drAt	Adaptive tune trigger level in display units. Range = 1 to 9999
Adc	Automatic Droop Compensation (PD control only)

Name	Description

Pid	**PID list**
G.SP	If Gain Scheduling has been enabled (see Chapter 4), this parameter sets the PV below which 'Pid.1' is active and above which 'Pid.2' is active.
SEt	'Pid.1' or 'Pid.2' selected
Pb	Proportional Band (SEt 1) (in display units)
ti	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)
rELC	Relative Cool Gain (SEt 1)
Pb2	Proportional Band (SEt 2)
ti2	Integral Time in secs (SEt 2)
td2	Derivative Time in secs (SEt 2)
rES2	Manual Reset (%) (SEt 2)
Hcb2	Cutback High (SEt 2)
Lcb2	Cutback Low (SEt 2)
rEL2	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
bAct	Valve backlash time in secs
mPt	Minimum ON time of output pulse
U.br	Not available in 2416

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	
Loc.L	Local trim low	Theses parameters only appear if PDSIO is fitted and Loct (remote setpoint + local trim) in SP Config list is selected
Loc.H	Local trim high	
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)	

iP	Input list
Fi.Lt	IP filter time constant (0.0 - 999.9 seconds).
Emi.S	Emissivity - when the input is configured for a pyrometer
The next 3 parameters appear only if User Calibration has been enabled. (*Refer to Chapter 7.) By default they are hidden when in Operator level. To prevent unauthorised adjustment, we recommend that they are only made available in* FuLL *access level.*	
CAL	'FACt' - *reinstates the factory calibration and disables User calibration. Next 2 parameters will not appear.* 'USEr' - *reinstates any previously set User calibration. All parameters below now appear.*
CAL.S	Selected calibration point – 'nonE', 'i P 1L', 'i P 1H'
AdJ	User calibration adjust, if CAL.S = 'i P 1L', 'i P 1H' *Do not make adjustments using the* AdJ *parameter unless you wish to change the controller calibration.*
OFS.1	IP calibration offset
mU.1	IP measured value (at terminals)
CJC.1	IP Cold Junction Compensation
Li.1	IP Linearised Value
PU.SL	PV Select. Not operational in 2416

Name	Description

oP	Output list
Does not appear if Motorised Valve control configured.	
OP.Lo	Low power limit (%)
OP.Hi	High power limit (%)
OPrr	Output Rate Limit (% per sec)
FOP	Forced output level (%)
CYC.H	Heat cycle time (0.2S to 999.9S)
hYS.H	Heat hysteresis (display units)
ont.H	Heat output min. on-time (secs) Auto (0.05S), or 0.1 - 999.9S
CYC.C	Cool cycle time (0.2S to 999.9S)
hYS.C	Cool hysteresis (display units)
ont.C	Cool output min. on-time (secs) Auto (0.05S), or 0.1 - 999.9S
HC.db	Heat/cool deadband (display units)
End.P	Power level in programmer in end segment. This is a single parameter for all programs
Sb.OP	Sensor Break Output Power (%)

cmS	Comms list
Addr	Communications Address

inFo	Information list
di SP	Configure lower readout of Home display to: nonE, Std, Lcur, OP, StAt, PrG.t
LoG.L	PV minimum
LoG.H	PV maximum
LoG.A	PV mean value
LoG.t	Time PV above Threshold level
LoG.u	PV Threshold for Timer Log
rES.L	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, Edi t or conF
ConF	Configuration password

2.7 ALARMS

2.7.1 Alarm annunciation

Alarms are flashed as messages in the Home display. A new alarm is displayed as a double flash followed by a pause, old (acknowledged) alarms as a single flash followed by a pause. If there is more than one alarm condition, the display cycles through all the relevant alarm messages. Table 2-1 and Table 2-2 list all of the possible alarm messages and their meanings.

2.7.2 Alarm acknowledgement and resetting

Pressing both  and  at the same time will acknowledge any new alarms and reset any latched alarms.

2.7.3 Alarm modes

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

- **Non-latching**, which means that the alarm will reset automatically when the Process Value is no longer in the alarm condition.
- **Latching**, which means that the alarm message will continue to flash even if the alarm condition no longer exists and will only clear when reset.
- **Blocking,** which means that the alarm will only become active after it has first entered a safe state on power-up.

2.7.4 Alarm types

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

2.7.5 Process alarms

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

Alarm Display	What it means
_FL2*	Not available in 2416
_FH2*	Not available in 2416
_LOP*	Working Output Low alarm
_HOP*	Working Output High alarm
_LSP*	Working Setpoint Low alarm
_HSP*	Working Setpoint High alarm
4rAt	PV Rate of change alarm Always assigned to Alarm 4

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

Table 2-2: Process Alarms

2.8 DIAGNOSTIC ALARMS

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

Display shows	What it means	What to do about it
EE.Er	*Electrically Erasable Memory Error:* The value of an operator, or configuration, parameter has been corrupted.	This fault will automatically take you into Configuration level. Check all of the configuration parameters before returning to Operator level. Once in Operator level, check all of the operator parameters before resuming normal operation. If the fault persists, or occurs frequently, contact Eurotherm.
S.br	*Sensor Break:* Input sensor is unreliable or the input signal is out of range.	Check that the sensor is correctly connected.
L.br	*Loop Break* The feedback loop is open circuit.	Check that the heating and cooling circuits are working properly.
LdF	*Load failure* Indication that there is a fault in the heating circuit or the solid state relay.	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.
SSrF	*Solid state relay failure* Indication that there is a fault in the solid state relay.	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.
HtrF	*Heater failure* Indication that there is a fault in heating circuit.	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.
Ct.OP	Current Transformer Open Circuit	Indicates that the PDS input is open circuit. Mode 5 only
Ct.Sh	Current Transformer Short Circuit	Indicates that the PDS input is short circuit Mode 5 only
Hw.Er	*Hardware error* Indication that a module is of the wrong type, missing, or faulty.	Check that the correct modules are fitted.
no.o	*No I/O* None of the expected I/O modules is fitted.	This error message normally occurs when pre-configuring a controller without installing any of the required I/O modules.
rmtF	*Remote input failure.* Either the PDSIO input, or the remote DC input, is open or short circuit	Check for open, or short circuit wiring on the PDSIO, or remote DC, input.
LLLL	*Out of range low reading*	Check the value of the input.
HHHH	*Out of range high reading*	Check the value of the input.
Err 1	*Error 1:* ROM self-test fail	Return the controller for repair.
Err2	*Error 2:* RAM self-test fail	Return the controller for repair.
Err3	*Error 3:* Watchdog fail	Return the controller for repair.
Err4	*Error 4:* Keyboard failure Stuck button, or a button was pressed during power up.	Switch the power off and then on, without touching any of the controller buttons.
Err5	*Error 5:* Faulty internal communications.	Check printed circuit board interconnections. If the fault cannot be cleared, return the controller for repair.
Err6	Digital filter chip faulty or loose board inside controller	Return the controller for repair.
Err7	PV id failure/PSU failure	Return the controller for repair.
Err8	Module 1 id error	Faulty or loose module or may be isolation problem
Err9	Module 2 id error	Faulty or loose module or may be isolation problem
ErrA	Module 3 id error	Faulty or loose module or may be isolation problem
dCF	DC output fail	Return the controller for repair
tu.Er	Tune error – shown If any one stage of the auto-tuning process exceeds two hours	Check response time of process: check that the sensor has not failed: check that the loop is not broken. Acknowledge by pressing 'page' key and 'scroll' key together
Pbr	Potentiometer break	Check that the feedback potentiometer is correctly connected or the pot is not open circuit

Table 2-3: Diagnostic Alarms

3. Chapter 3 ACCESS LEVELS

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

There are three topics:

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

3.1 THE DIFFERENT ACCESS LEVELS

There are four access levels:

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

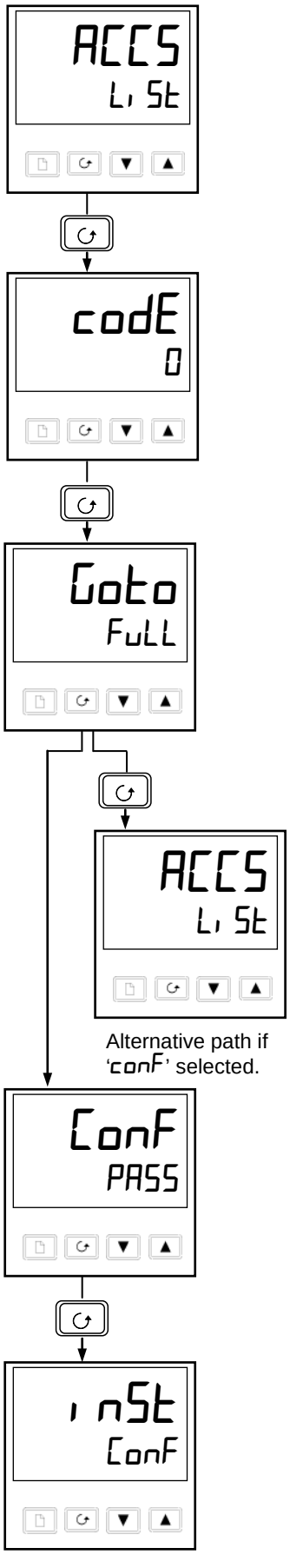
Access level	Display shows	What you can do	Password Protection
Operator	OPEr	In this level, operators can view and adjust the value of parameters defined in Edit level (see below).	No
Full	FuLL	In this level, all the parameters relevant to a particular configuration are visible. All alterable parameters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

Table 3-1: Access levels

3.2 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 [page] 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.

(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.)

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

Access to Read-only configuration

From the '**ACCS**' list display, press [↻] to '**codE**'. Then press [▲] 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 [page] and [↻] together takes you immediately back to the Home display.

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.

3.3 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.

3.3.1 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 , and from parameter to parameter within each list using .

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).*
- HI dE Hides a parameter, or list header.

For example:

The parameter selected is Alarm 2, Full Scale Low

It will be alterable in Operator level

3.3.2 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 HI dE.

(It is not possible to hide the 'ACCS' list, which always displays the code: 'Li St'.)

3.3.3 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 'PrOG Li St', the parameters from segment number (SEGn) onwards *cannot* be promoted.

3.3.4 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.

4. Chapter 4 TUNING

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

This chapter has five main topics:

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

4.1 WHAT IS TUNING?

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

- Stable 'straight-line' control of the temperature at setpoint without fluctuation
- No overshoot, or undershoot, of the temperature setpoint
- Quick response to deviations from the setpoint caused by external disturbances, thereby restoring the temperature rapidly to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed in Table 4-1. 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

4.2 AUTOMATIC TUNING

Two automatic tuning procedures are provided in the 2416:

- **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.

4.2.1 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.

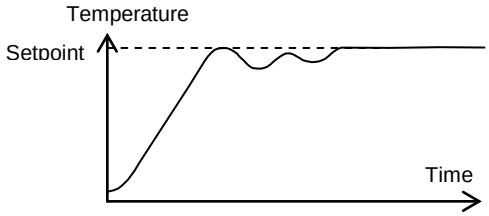
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

4.2.2 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.

4.2.3 Typical automatic tuning cycle



4.2.4 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.

4.2.5 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 '$drAt$', 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.

4.3 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 't_i' 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, t_i and 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

4.3.1 Setting the cutback values

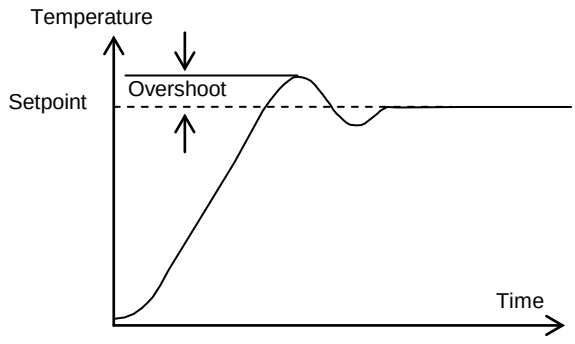
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in temperature, then manually set the cutback parameters 'Lcb' and 'Hcb'.

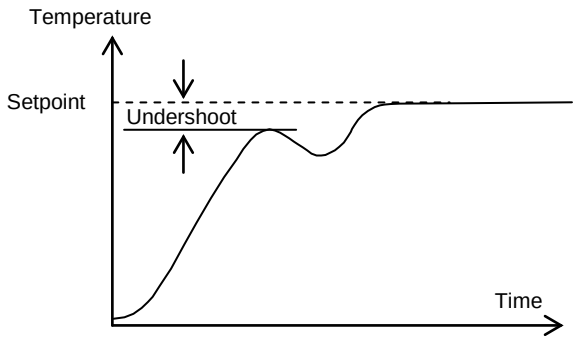
Proceed as follows:

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.

4.3.2 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 'Pid SEt' 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.

4.3.3 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.

4.3.4 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 tUEr - 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

4.4 MOTORISED VALVE CONTROL

The 2416 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:

- 2416/VC motorised valve controllers
- 2416/VP motorised valve controllers with a single setpoint programmer
- 2416/V4 motorised valve controllers storing four setpoint programs.

Figure 1-8 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 operates in the so-called *boundless* mode, which does not require a position feedback potentiometer for control purposes.

The desired control mode is selected in the '$\imath$ nSt' 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

4.4.1 Commissioning the Motorised Valve Controller

The commissioning procedure for bounded control mode is 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.

4.4.2 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.

4.4.3 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. f this causes a control problem, the inertia time needs to be determined and then entered into the parameter, '$In.t$'. 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, '$bAc.t$'.

The above two values are not part of the automatic tuning procedure and must be entered manually.

4.5 GAIN SCHEDULING

Gain scheduling is the automatic transfer of control between one set of PID values and another. In the case of the 2416 controller, 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 2416 has two sets of PID values. You can select the active set from either 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 above `G.SP`, the calculated values will automatically be inserted into PID2 set.

5. Chapter 5 PROGRAMMER OPERATION

This chapter deals with the setpoint programming option. All 2416 instruments have a basic 8-segment programmer built-in as standard. This facility must be enabled by the user, as explained in section 5.6, *Configuring the Programmer*.

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

Standard controller with:

a single program: Model 2416/CP.

four stored programs: Model 2416/P4.

Motorised valve controller with:

a single program: Model 2416/VP.

four stored programs: Model 2416/V4.

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

There are seven 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
- CREATING A NEW PROGRAM, OR MODIFYING AN EXISTING PROGRAM.

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

5.1 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 2416 programmer models will do this.

The setpoint is varied by using a *setpoint program*. Within each 2416 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.

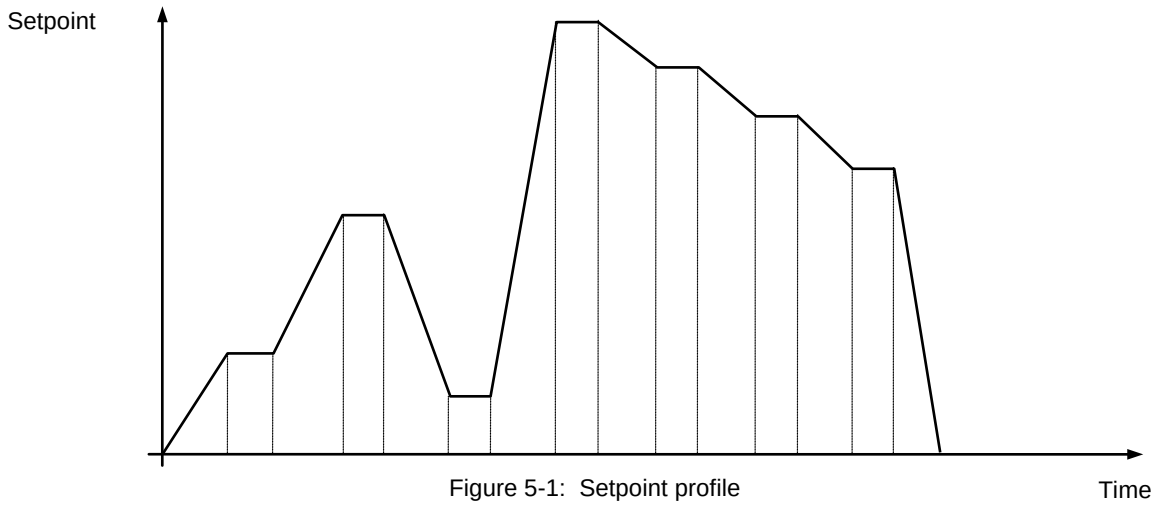


Figure 5-1: Setpoint profile

(*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 two 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:

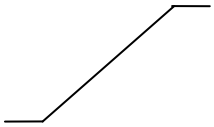
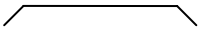
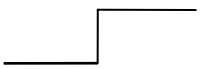
Ramp		**The setpoint ramps linearly,** from its current value to a new value, either at a set rate (called *ramp-rate programming*), or in a set time (called *time-to-target programming*). You must specify the ramp rate, or the ramp time, and the target setpoint, when creating or modifying a program.
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 only available on those controllers capable of storing 4 programs.
End		**A program either ends in this segment, or repeats.** You specify which is the case when you create, or modify, a program (see the final topic in this chapter). When a program ends, the programmer is put into either, a continuous Dwell state with all outputs staying unchanged, or the Reset state.

Table 5-1: Segment types

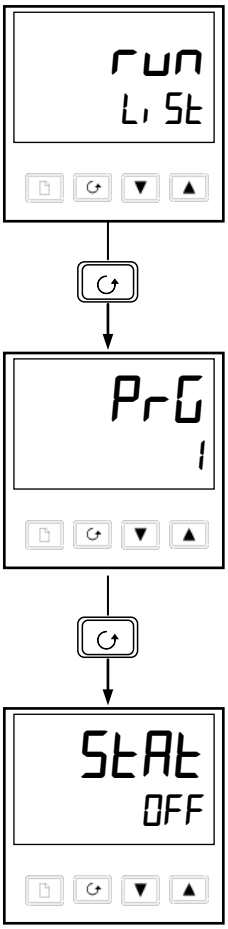
5.2 Programmer States

Programs has 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 will be 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 only remain effective until the program is reset and run again, when they are 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 deviating from the setpoint by more than a pre-set 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 SPnH - 'setpoint retransmission without holdback'	**HOLD light flashes**
End	The program is complete.	**RUN light flashes**

Table 5-2: Program states

5.3 Running A Program From The Run List



The Run List

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

Press [ ]

Program number

This display will only appear on controllers that can hold more than one program (Models 2416/P4 & 2416/V4). Use [▲] or [▼] to select the required program number, from 1 to 4.

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* [ ] *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 will 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.

5.4 Running A Program Using The Run/Hold Button

If you are using a four (4) 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 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.

5.5 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*.

5.5.1 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 program. However, if you want to guarantee the time period of the first segment, you should set the controller to servo to its setpoint.

5.5.2 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.

5.5.3 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 '**PwrF**' *Power fail strategy* in Programmer configuration. This can have one of three settings:– **cont** (Continue), **rmPb** (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* 'rmPb' *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, Figure 5-2 if power fails during a dwell segment and Figure 5-3 if it fails during a ramp segment.

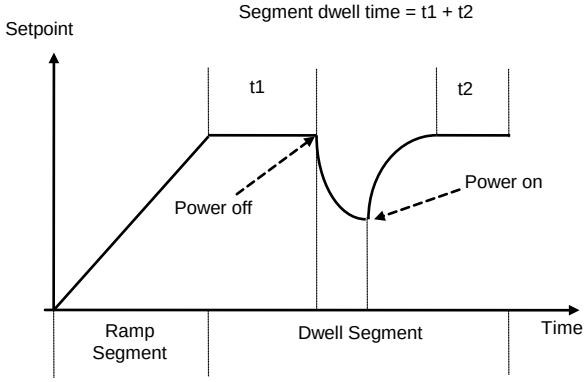


Figure 5-2: Continue after a power fial

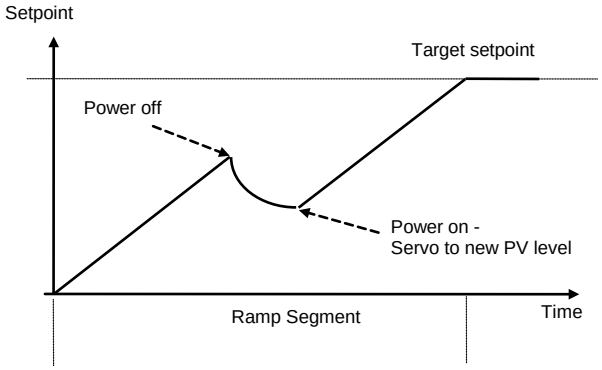


Figure 5-3: Ramp back after a power fail

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

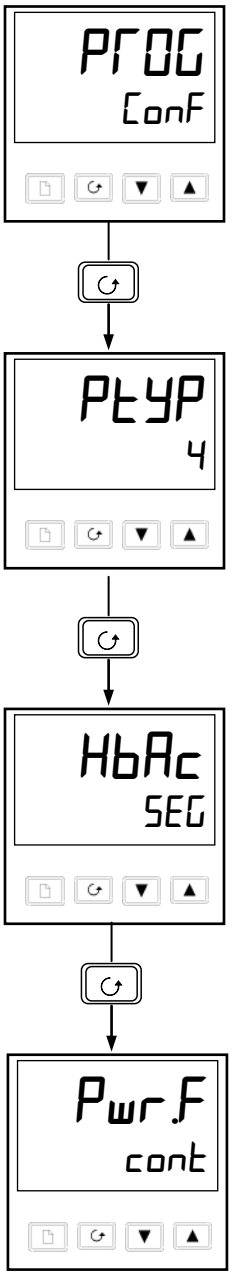
5.6 Configuring The Programmer

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. (*Multi programmer only*)

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

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



Programmer list header

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

Press [ ]

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

Press [ ]

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

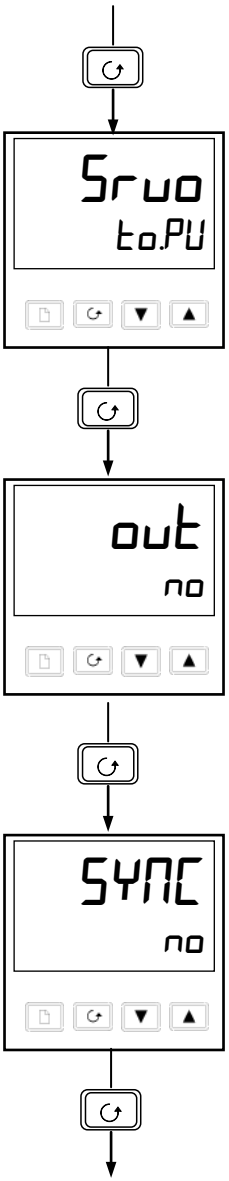
Press [ ]

Power fail strategy

Use [▲] or [▼] to select:

- cont: Continue from last setpoint
- rmPb: Ramp from PV to setpoint at last ramp rate
- rSEt: Reset the program

Continued on next page



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:

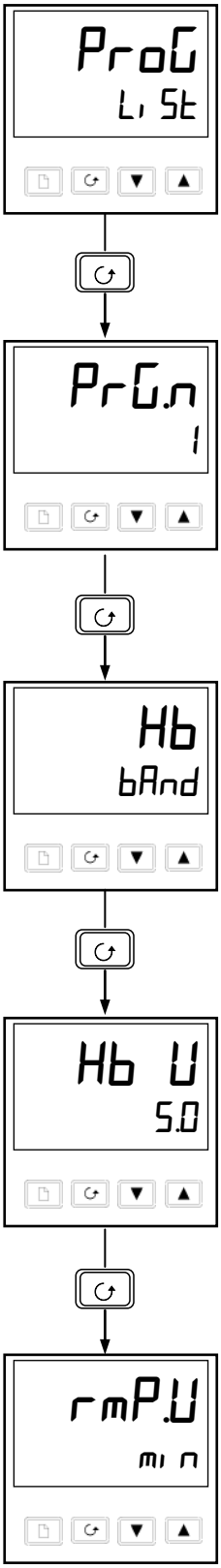
- no: Event outputs disabled
- YES: Event outputs enabled

Note: The term Sync appears on 2416 but is not operational and should be set to no. It appears in order to maintain software consistency with 2408 and 2404 controllers.

Press ↻ *to return to the list header*

5.6.1 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 Operation 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 [page] until you reach the '*ProG Li St*' header.

Press [↻]

Program number

This display only appears on the four-program controllers.

Use [▲] or [▼] to select the number of the program which you wish to modify (from 1 to 4).

Press [↻]

Holdback type

[Only appears when Holdback has been selected for the whole program.]

Use [▲] or [▼] to select:

- *OFF* Holdback disabled
- *Lo* Deviation Low Holdback
- *Hi* Deviation High Holdback.
- *bAnd* Deviation Band Holdback

Press [↻]

Holdback value

Use [▲] or [▼] to set a value.

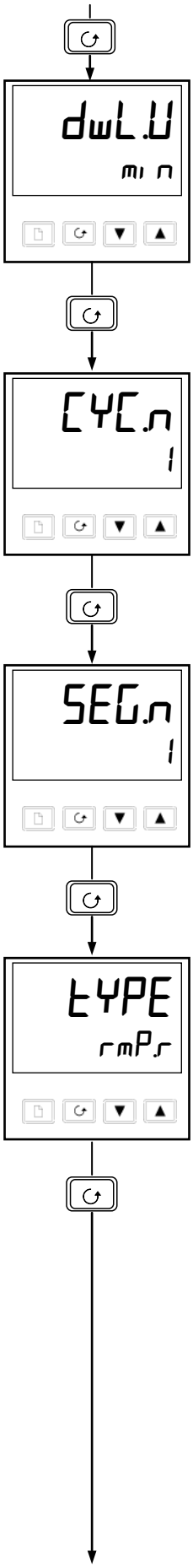
Press [↻]

Ramp units

Use [▲] or [▼] to select:

- *SEc*
- *min*
- *Hour*

Continued on the next page.



Press ↻

Dwell units

Use ▲ or ▼ to select:

- SEc
- mi n
- Hour

Press ↻

Number of program cycles

Use ▲ or ▼ to set the number of program cycles required from 1 to 999, or 'cont' for continuous cycling.

Press ↻

Segment number

Use ▲ or ▼ to select the number, [1 to 8 (8-seg programmer)], or 1 to 16.

The parameters that follow 'SEG.n' set up the characteristics of the individually-selected segment number. By defining the characteristics of each segment of the program, you define the whole program.

Press ↻

Segment type

Select the segment type using ▲ or ▼:

- rmPr Ramp to a new setpoint at a set rate
- rmPt Ramp to a new setpoint in a set time
- dwEll Dwell for a set time
- StEP Step to a new setpoint
- cALL Call another program as a subroutine
  (only available in 4-program controllers)
- End Make this segment end of program.

Press ↻

The parameters that follow 'tYPE' depend on the type of segment selected.

Parameter	Segment type selected					
	rmPr	rmPt	dwEll	StEP	cALL	End
Hb	✓	✓	✓	✓		
tGt	✓	✓		✓		
rAtE	✓					
dur		✓	✓			
PrG.n					✓	
outn	✓	✓	✓	✓		✓
cYc.n					✓	
dwEll						✓
EndE						✓
Pwr						✓

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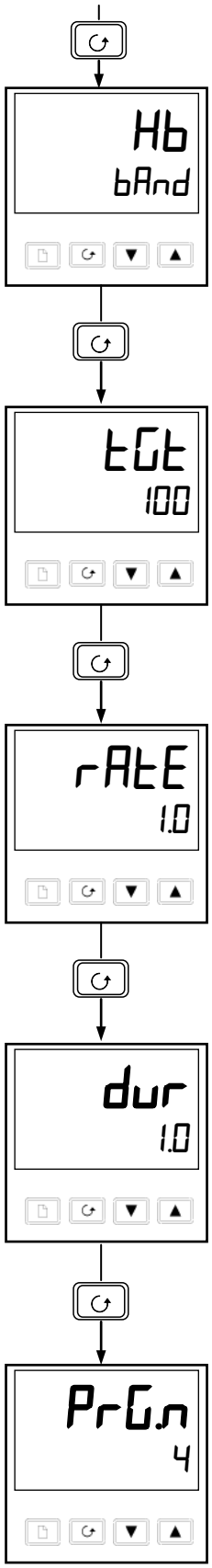


Press [↺]

Holdback type

[Only appears when Holdback per segment has been selected.]

Use [▲] or [▼] to select:

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

Press [↺]

Target setpoint

Target setpoint for 'rmP.r', 'rmP.t' or 'StEP' segments.

Set the target setpoint using [▲] or [▼].

Press [↺]

Ramp Rate

Ramp rate for 'rAtE' segments.

Using [▲] or [▼], set a value for the ramp rate, ranging from 0.00 to 999.9 (the units will be the ramp units ('rmP.U') set earlier in this sequence).

Press [↺]

Duration time

Time for a 'dwEll' segment, or time to target for a 'rmP.t' segment.

Set the time using [▲] or [▼]. You have set the units earlier in this sequence.

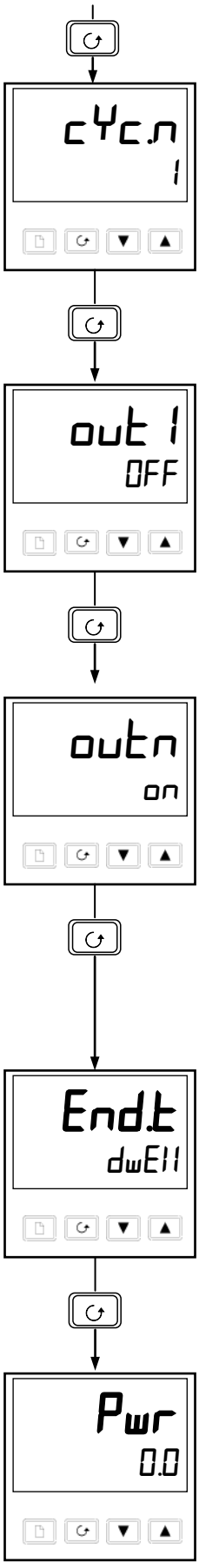
Press [↺]

Called program number

Only appears for 'cALL' segments. *(4-program controllers only)*

Set a called program number from 1 to 4, using [▲] or [▼].

Continued on next page



Press ↻

Number of cycles of the called program

Only appears for '**cALL**' segments. *(4-program controllers only)*

Set the number of cycles of the cALLed program from 1 to 999, using ▲ or ▼.

Press ↻

Event output 1 *(not 8-segment programmer)*

Appears in all segments, except '**cALL**' segments.

Use ▲ or ▼ to set output 1:

- **OFF** Off in the current segment
- **on** On the current segment.

Press ↻

Further event outputs ***(not 8-segment programmer)***

Up to eight (8) event outputs may appear in this list where 'n' = event number .

Pressing ↻ will step through all the remaining event outputs. **In practice**, the 2416 has a **maximum of three physical outputs**, although more than one event can be combined onto a single physical output. See Chapter 6, *Configuration.*

Use ▲ or ▼ to set:

- **OFF** Off in the current segment
- **on** On the current segment.

Press ↻

End segment type

Use ▲ or ▼ to select:

dwEll An indefinite dwell

rSEt Reset

SOP End Segment Output Power Level

Press ↻

Power Value [End Segment]

Use ▲ or ▼ to set the power value in the range ±100.0%.

This power level is clipped by the parameters '**OP.Hi**' and '**OP.Lo**' before being applied to the process.

In programmer/controller software versions 3.56 onwards, this parameter has been replaced by a parameter EndP which appears at the end of the output list, see Chapter 2.

Press ↻ *to return to the* **ProG-Li St** *header*

6. Chapter 6 CONFIGURATION

This chapter consists of six topics:

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

In configuration level you set up the fundamental characteristics of the controller.

These are:

- The type of control (e.g. reverse or direct acting)
- The Input type and range
- The Setpoint configuration
- The Alarms configuration
- The Programmer configuration
- The Communications configuration
- The Modules 1, 2 & 3 configuration
- Calibration
- The Passwords

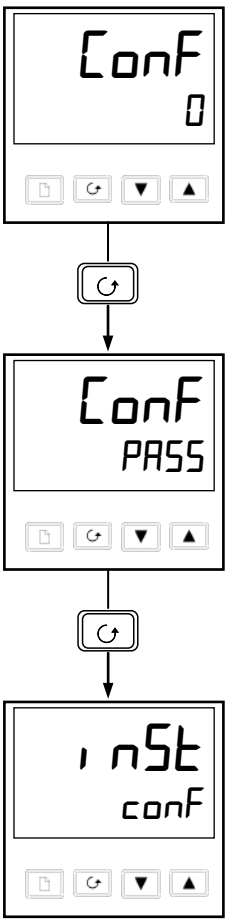
Warning: **Configuration is protected by a password and should only be carried out by a qualified person, authorised to do so. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is the responsibility of the person commissioning the process to ensure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

Caution: It is recommended to maintain a record of instrument configurations or use Eurotherm iTools to make clone copies of fully working instruments. Store this securely as a back up record to be used to restore the configuration and other settings should the instrument need to be replaced in the future.iTools and the iTools Help Manual HA028838 is available from www.eurotherm.co.uk.

6.1 Selecting Configuration Level

There are two alternative methods of selecting Configuration level:

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



Password entry

When the '[onF' display appears, you must enter the Configuration password (which is a number) in order to gain access to Configuration level.

Enter the password using the ▲ or ▼ buttons.

The configuration password is set to '2' when the controller is shipped from the factory.

Press ↺

Once the correct password has been entered, there is a two second delay, after which the lower readout will change to 'PASS' indicating that access is now unlocked.

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

Press ↺ *to enter configuration.*

(If an incorrect password has been entered and the controller is still 'locked' then pressing ↺ at this point will take you to the 'Ex, t' display with 'no' in the lower readout. Simply press ↺ to return to the '[onF' display.)

You will obtain the first display of configuration.

6.2 Selecting a Configuration Parameter

The configuration parameters are arranged in lists as shown in the navigation diagram in

Figure 6.5.

To step through the list headers, press the Page button.

To step through the parameters within a particular list press the Scroll button.

When you reach the end of the list you will return to the list header.

You can return directly to the list header at any time by pressing the Page button.

6.2.1 Parameter names

Each box in the navigation diagram shows the display for a particular parameter. The upper readout shows the name of the parameter and the lower readout its value. For a definition of each parameter, see the Configuration Parameter Tables at the end of this chapter. To change the value of a selected parameter, use the ▲ and ▼ buttons.

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

6.3 Changing the Passwords

There are TWO passwords. These are stored in the Password configuration list and can be selected and changed in the same manner as any other configuration parameter.

The password names are:

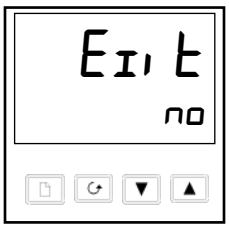
'ACCP' which protects access to Full level and Edit level

'cnFP' which protects access to Configuration level.

6.4 Leaving Configuration Level

To leave the Configuration level and return to Operator level Press until the 'EntE' display appears.

Alternatively, pressing and together will take you directly to the 'EntE' display.



Use ▲ or ▼ to select 'YES'. After a two-second delay, the display will blank then revert to the Home display in Operator level.

6.5 NAVIGATION DIAGRAM *(PART A)*

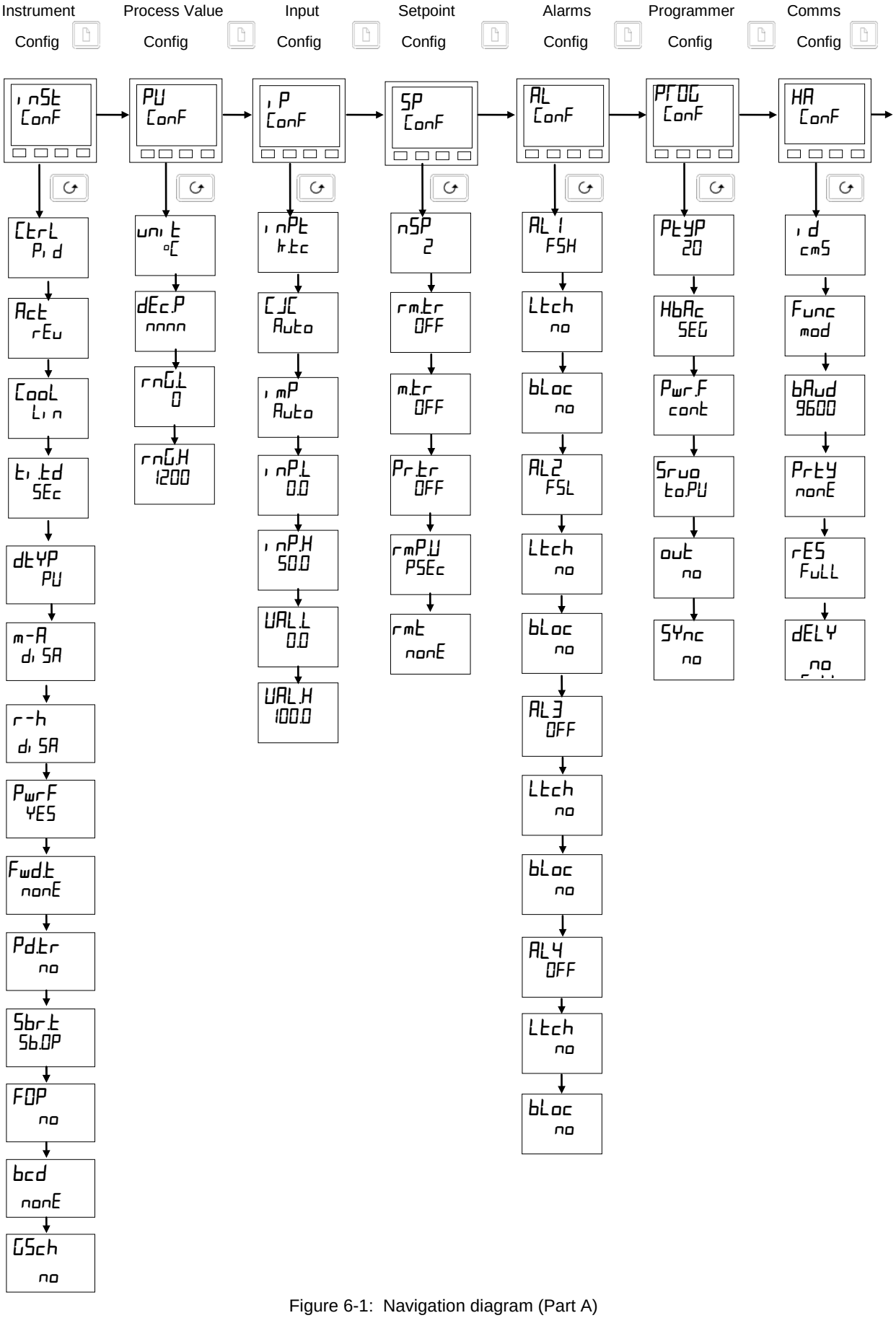
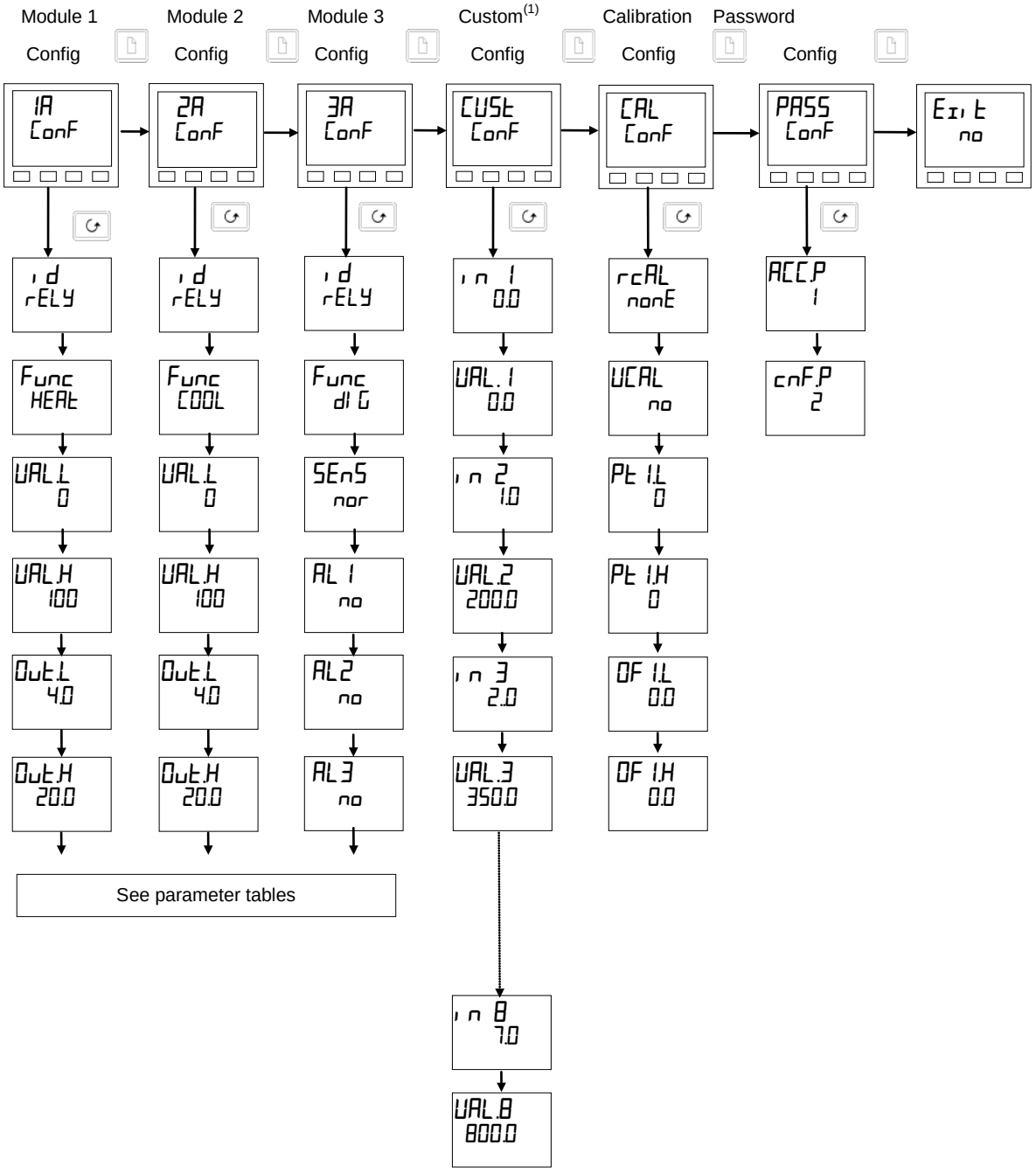


Figure 6-1: Navigation diagram (Part A)

NAVIGATION DIAGRAM *(PART B)*



Note:

1. 8-point custom linearisation. Only appears when '`i P-conF`' has '`i nPt`' = '`mV.C`', or '`mA.C`', or '`U.C`'.
2. 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.

Figure 6.1: Navigation diagram (Part B)

6.6 Configuration Parameter Tables

Name	Description	Values	Meaning
i nSt	**Instrument configuration**		
CtrL	Control type	Pid	PID control
		On.OF	On/off control
		VP	Boundless motorised valve control - *no feedback required*
Act	Control action	rEv	Reverse acting
		dir	Direct acting
CooL	Type of cooling	Lin	Linear
		oil	Oil (50mS minimum on-time)
		H2O	Water (non-linear)
		FAn	Fan (0.5S minimum on-time)
		on.OF	On/off cooling
ti td	Integral & derivative time units	SEc	Seconds, OFF to 9999
		min	Minutes, OFF to 999.9
dtYP	Derivative type	PV	Operates on rate of change of PV
		Err	Operates on rate of change of error
m-A	Front panel Auto/Man button	EnAb	Enabled
		diSA	Disabled
r-h	Front panel Run/Hold button	EnAb	Enabled
		diSA	Disabled
PwrF	Power feedback	on	On
		OFF	Off
FwdE	Feed forward type	nonE	None
		FEEd	Normal feed forward
		SPFF	Setpoint feed forward
		PVFF	PV feed forward
Pdtr	Manual/Auto transfer when using PD control	no	Non-bumpless transfer
		YES	Bumpless transfer - *(Pre-loads Manual Reset value)*
Sbrt	Sensor break output	Sb.OP	Go to pre-set value
		HoLd	Freeze output
FOP	Forced manual output	no	Bumpless Auto/Manual transfer
		trAc	Returns to the Manual value that was set when last in Manual mode
		StEP	Steps to forced output level. Value set in '*FOP*' of '*oP-Lo St*' in Operator Level
bcd	BCD input function	nonE	Not used
		PrOG	*Only functional in Models 2408 & 2404. Set 'bcd' to 'nonE'*
		SP	Select setpoint number
GSch	Gain Schedule Enable	no	Disabled
		YES	Enabled

Name	Description	Values	Meaning
PU	**Process value config**		
unit	Instrument units	°C	Celsius
		°F	Fahrenheit
		°K	Kelvin
		none	Display units blanked
dECP	Decimal places in the displayed value	nnnn	None
		nnn.n	One
		nn.nn	Two
rnGL	Range low		Low range limit. Also setpoint limit for alarms and programmers
rnGH	Range high		High range limit. Also setpoint limit for alarms and programmers

Note:

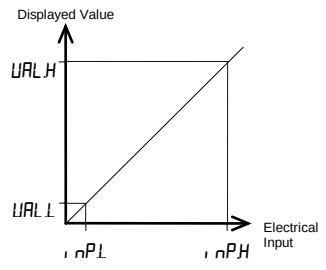
Pyrometer Emmisivity

Controllers which are specifically supplied for pyrometer inputs (not Exergen K80), have the curve downloaded in the Custom Input. The parameter, Emi S, Pyrometer Emmisivity, appears in the Input List on page 2-15. This parameter is also now correctly adjusted

Note:

Range

If a decimal point was configured, negative display and setpoint ranges were limited to -99.9 in previous software versions. The range has been increased to -199.9 by combining the negative sign with the figure one. This allows Setpoints, Process Variables, Alarm Setpoints and Programmers to be set to -199.9.

Name	Description	Values	Meaning
, P	**Input configuration**		
, nPt	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)
		PL 2	PL 2 thermocouple
		CtC	Custom downloaded t/c (default = type C)
		rtd	100Ω platinum resistance thermometer
		mU	Linear millivolt
		uoLt	Linear voltage
		mA	Linear milliamps
		Sr U	Square root volts
		Sr A	Square root milliamps
	* See 'CuSt' List.	mUC	8-point millivolt custom linearisation*
		UC	8-point Voltage custom linearisation*
		mAC	8-point milliamp custom linearisation*
CJC	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
, 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.*			
, nPL			Input value low
, nPH			Input value high
VAL L			Display reading low
VAL H			Display reading high

Name	Description	Values	Meaning
SP	**Setpoint configuration**		
nSP	Number of setpoints	2, 4, 16	Select number of setpoints available
rmtr	Remote Tracking	OFF	Disable
		trAc	Local setpoint tracks remote setpoint
mtr	Manual Track	OFF	Disable
		trAc	Local setpoint tracks PV when in manual
Prtr	Programmer Track	OFF	Disable
		trAc	Local setpoint tracks programmer SP
rmPU	Setpoint rate limit units	PSEc	Per second
		Pmin	Per minute
		PHr	Per hour
rmt	Remote setpoint configuration	nonE	Disable
		SP	Remote setpoint
		Loct	Remote setpoint + local trim
		rmtt	Remote trim + local setpoint

AL	Alarm configuration	Values
The controller contains four 'soft' alarms, (indication only) which are configured in this list. Once configured, they can be attached to a physical output in module positions 1A 2A or 3A.		
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	*Not usable on 2416*
FH2	*Not usable on 2416*
LOP	Working Output low
HOP	Working Output high
LSP	Working Setpoint low
HSP	Working Setpoint high
rAt	PV Rate of change *AL4 only*

*** 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').

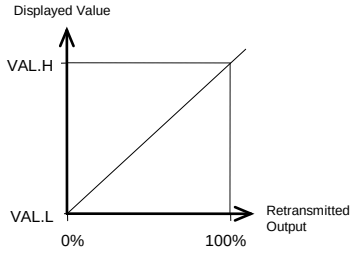
Name	Description	Values	Meaning

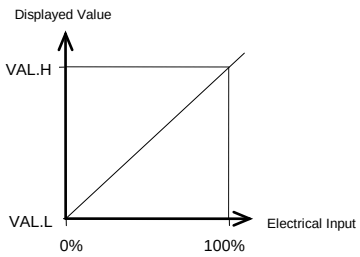
*The following parameters apply if the **standard 8-segment programmer** is to be configured.*			
PROG	**Programmer configuration**	**Values**	**Meaning**
PtYP	Programmer type	nonE	Programmer disabled (***factory setting***)
		1	8-segment programmer enabled
HbAc	Holdback	SEG	Holdback is individually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

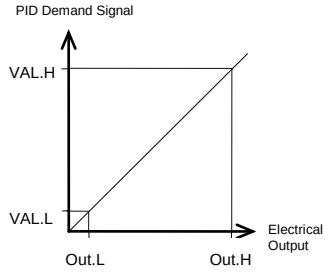
*The following parameters apply if a **16-segment programmer** is to be configured.*			
PROG	**Programmer configuration**	**Values**	**Meaning**
PtYP	Programmer type	nonE	Programmer disabled
		1	Single program
		4	Four programs
HbAc	Holdback	SEG	Holdback is individually selectable in each segment.
		ProG	Holdback is applied across the whole Program.
PwrF	Power fail recovery	cont	Continue from last setpoint (SP)
		rmPb	Ramp from PV to SP at last ramp rate
		rSEt	Reset the program
Srvo	Starting setpoint of a program (Servo point)	to.PV	From the Process Value (PV)
		to.SP	From the setpoint
out	Programmable event outputs	no	Disabled
		YES	Enabled
SYNC	Synchronisation of programs of several programmers **Not usable in Model 2416**	no	Disabled
		YES	Enabled
			Select '**no**'

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
		PdSI	PDSIO input

Name	Description	Values	Meaning
For 'id' = 'cmS' 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
		I nt	Integer resolution
dELY	Delay - quiet period, required by some comms adaptors	no	No delay
		YES	Delay active - 10mS

For 'id' = 'PdS' use this parameter table:			
Func	Function	nonE	No PDSIO function
		SPoP	PDSIO setpoint retransmission
		PVoP	PDSIO PV retransmission
		ErOP	PDSIO error signal retransmission
		OPoP	PDSIO output power retransmission
VAL.L			Retransmitted Value Low
VAL.H			Retransmitted Value High

For 'id' = 'PdSi' use this parameter table:			
Func	Function	SP, P	PDSIO setpoint input
VAL.L			Setpoint Displayed Value - Low
VAL.H			Setpoint Displayed Value - High

Name	Description	Values	Meaning
1A	**Module 1 configuration**		
1 d	Identity of module installed	rELY	Relay output
		dC.OP	Non-isolated DC output
		LoG	Logic/PDSIO output
		SSr	Triac output
For '1 d' = 'rELY', 'LoG', or 'SSr' use this parameter table:			
Func	Function	nonE	Function disabled
		dI G	Digital output function
		HEAt	Heating output
		COOL	Cooling output
		uP	Open motorised valve
		dwn	Close motorised valve
	(*Only if* '1 d' = 'LoG')	SSr.1	PDSIO mode 1 heating
	(*Only if* '1 d' = 'LoG')	SSr.2	PDSIO mode 2 heating
UALL			% PID demand signal giving minimum output – 'OutL'
UALH			% PID demand signal giving maximum output – 'OutH'
OutL			Minimum average power
OutH			Maximum average power
SEnS	Sense of output	nor	Normal *(output energises when TRUE, e.g program events)*
	(Only if 'Func' = 'dI G')	1 nu	Inverted *(output de-energises when TRUE, e.g. alarms)*
When 'SEnS' appears, then further parameters are available. See the table on the next page.			

Name	Description	Values	Meaning
The following digital events appear after 'SEnS'. Any one, or more, of the events can be combined on to the output (see Fig. Figure 6-2*) by selecting 'YES' in the lower readout.*			
1 - - -	Alarm 1 active	YES / no	(- - -) = *alarm type (e.g.* FSL*).*
2 - - -	Alarm 2 active	YES / no	*If an alarm has not been configured*
3 - - -	Alarm 3 active	YES / no	*in* 'AL ConF' *list, then display will*
4 - - -	Alarm 4 active	YES / no	*differ:- e.g.* Alarm 1 = 'AL 1'.
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	* PDS module connection or remote input open circuit	YES / no	
i P 1F	* Input 1 fail (*not usable on 2416)*	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	*(Not available in 2416 - set to '**no**')*
PrGn	* Programmer event output active, where 'n' = event number from 1 to 8. *(Not available with 8-segment programmer.)*	YES / no	

* These alarms are always non-latching. Process alarms 1, 2, 3 and 4 are configurable as alarm latching or non-latching, see the 'AL' List

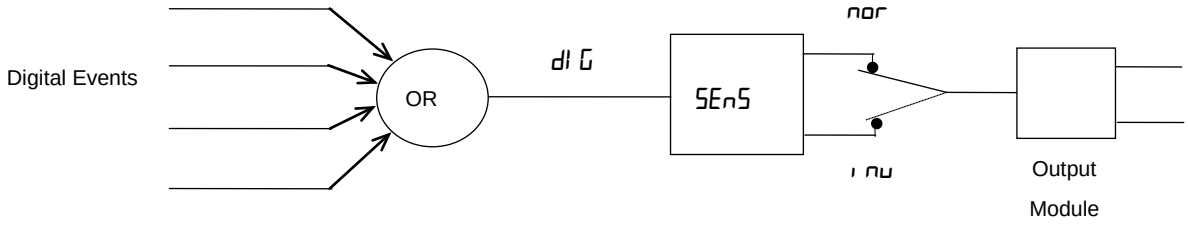
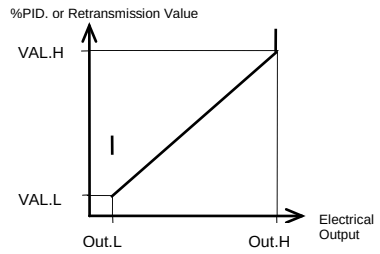
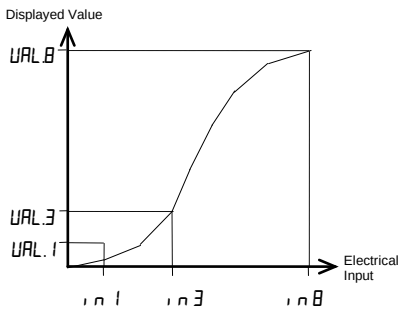


Figure 6-2: Combining several digital events on to one output

Name	Description	Values	Meaning
For 'io.d' = '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 Retrans'n Value, giving minimum output
VAL.H			% PID, or Retrans'n Value, giving maximum output
unit			volt = Volts, mA = milliamps
Out.L			Minimum electrical output
Out.H			Maximum electrical output

2A	Module 2 configuration		
As per module 1 configuration, but excluding the 'SSr.1', 'SSr.2' options on a logic output.			

3A	Module 3 configuration		
As per module 2 configuration.			

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 'ip- ConF list has 'inpt' set to 'mV.C', or 'mA.C', or 'V.C'
2. Custom curves must be continuously increasing or decreasing in value and input.

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.(not 2416)
		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 *1. Select calibration value* *2. Apply specified input* *3. Press ↺ to step to 'GO'*	I dLE	Idle
		mu.L	Select 0mV as the calibration point
		mu.H	Select 50mV as the calibration point
		U 0	Select 0Volt as the calibration point
		U 10	Select 10V as the calibration point
		C.JC	Select 0°C CJC calibration point
		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
		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

DC Output Calibration			
The following parameters apply to DC output modules ie for rcAL = 1A.Hi to 3A.Lo			
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 1.L	Low calibration point for Input 1	The factory calibration point at which the low point offset was performed.
Pt 1.H	High calibration point for Input 1	The factory calibration point at which the high point offset was performed.
OF 1.L	Offset Low for Input 1	Calculated offset, in display units.
OF 1.H	Offset High for Input 1	Calculated offset, in display units.

Name	Description	Values	Meaning
PASS	**Password configuration**		
ACCP	Full or Edit level password		
cnFP	Configuration level password		

Note: When passwords are changed please make a note of the new numbers

Exit	**Exit configuration**	no/YES	

7. 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.*

7.1 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 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.

7.2 USER CALIBRATION ENABLE

The User calibration facility must first be enabled in configuration level by setting the parameter '**UCAL**' in the **CAL CONF** list to '**YES**'. This will make the User calibration parameters visible in Operator '**FULL**' level. This procedure is described in Chapter 6, *Configuration,* but for convenience is summarised below: .

The Calibration Configuration List

Press [page] until you reach the '**CAL-CONF**' list.

Press [scroll] *until you reach* '**UCAL**'.

User Calibration Enable

Use [▲] or [▼] to select:

YES: Calibration enable

no: Calibration disabled

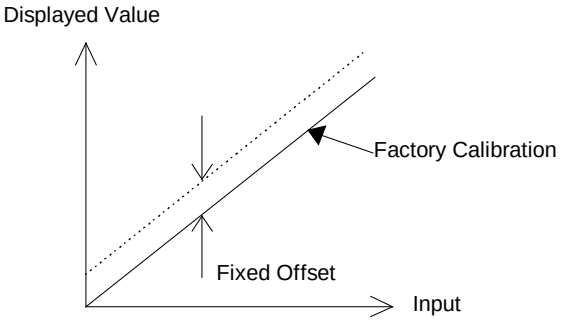
Press [scroll] *and* [page] *together to go to the* **EXIT** *display.*

Exit configuration

Use [▲] or [▼] to select '**YES**' to return to Operator level.

7.3 Offset Calibration

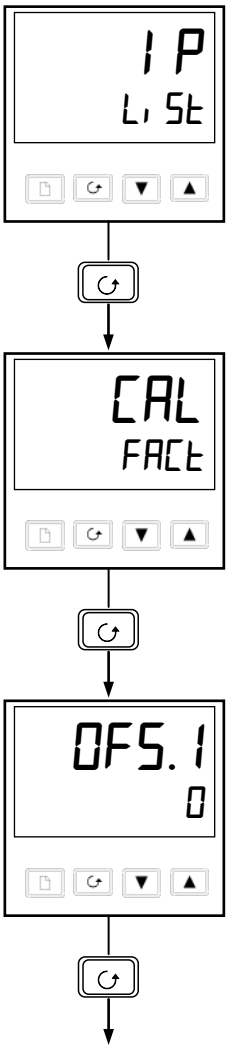
Offset calibration is used to apply a single fixed offset over the full display range of the controller.



To calibrate, proceed as follows:

1. Connect the input of the controller to the source device to which you wish to calibrate.
2. Set the source to the desired calibration value.
3. The controller will display the current measurement of the value.
4. If the displayed value is correct, then the controller is correctly calibrated and no further action is necessary. If it is incorrect, then follow the steps shown below.

Select '**FuLL**' access level, as described in Chapter 3.



Input list header

Press [D] until you reach the input list header.

Press [C] *until you reach the '**CAL**' display.*

Calibration type

- **FACt**: Factory Calibration
- **USEr**: User Calibration

Use [▲] or [▼] to select '**FACt**'.

Selecting '**FACt**' reinstates the factory calibration and allows the application of a single fixed offset.

Press [C]

Set Offset 1

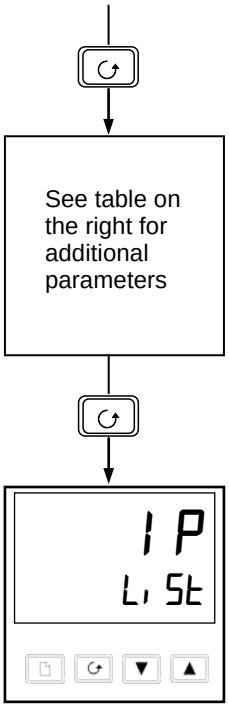
Use [▲] or [▼] to set the offset value of Process Value 1 (PV1).

The offset value is in display units.

Press [C]

Continued on next page

The following table shows the parameters which appear after '**OFS.1**'. These are all read only values and are for information.



Press ↻ to step through them.

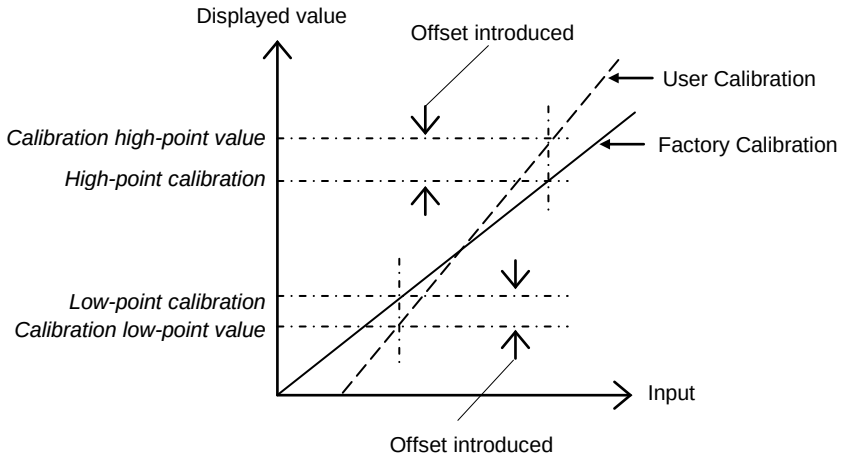
mU.1	IP1 measured value (at terminals)
CJC.1	IP1 Cold Junction Compensation
L1.1	IP1 Linearised Value
PU.SL	*Not available in Model 2416*

If you do not want to look at these parameters, then press 🗋 and this returns you to the 'P-L1 St' header.

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

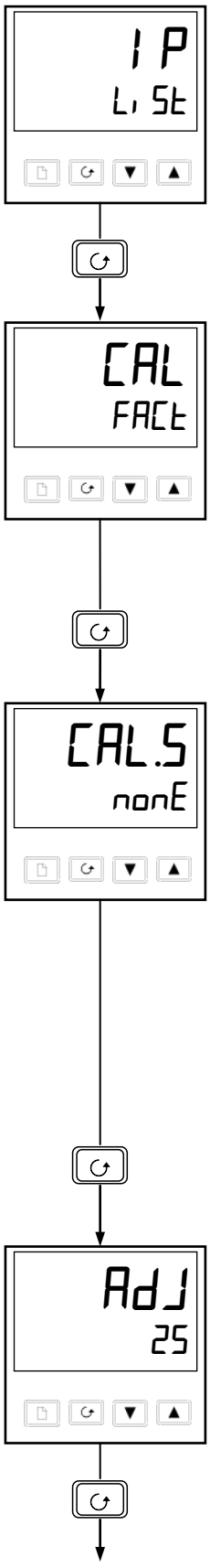
7.4 TWO-POINT CALIBRATION

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



Proceed as follows:

1. Decide upon the low and high points at which you wish to calibrate.
2. Perform a two point calibration in the manner described below.



Input list header

Press [ ] until you reach the input list header, 'iP LiSt'.

Press [ ] until you reach the 'CAL' display.

Calibration type

- FACt: Factory Calibration
- USEr: User Calibration

Use [▲] or [▼] to select 'USEr'.

Selecting 'USEr' enables two-point calibration.

[If two-point calibration is unsatisfactory, select 'FACt' to return to the factory set calibration.]

Press [ ]

Select Low-point Calibration

This is the Calibration Status display. This display shows that no input is selected for calibration.

- nonE: No selection. If nonE selected go to page 7-4
- iP1L: Input 1 (PV1) calibration low-point selected
- iP1H: Input 1 (PV1) calibration high-point selected
- iP2L: Not available in Model 2416
- iP2H: Not available in Model 2416

Use [▲]/[▼] to select the parameter for the Low Calibration point of Input 1, 'iP1L' & follow route shown on this page.

Press [ ]

Adjust low-point calibration

This is the display for adjusting the Low Calibration point of Input 1. The lower readout is a live reading of the process value, which changes as the input changes.

Make sure that the calibration source is connected to the terminals of Input 1, switched on and feeding a signal to the controller. It should be set to the desired low-point calibration value. If the lower readout does not show this value, then use [▲]/[▼] to adjust the reading to the required value.

Press [ ] to return to the 'iP-Li SE' header.

Continued on next page

To perform the High-point Calibration, repeat the above procedure, selecting '**, P 1.H**' in the '**CAL.S**' display for adjustment.

Press twice.

Calibration type

'**USEr**' was selected for the Low-point Calibration, and has remained selected.

Press

Select High-point Calibration

This is the Calibration Status display, again.

Use / to select the parameter for the High-point Calibration of Input 1, '**, P 1.H**'.

Press

Adjust High-point Calibration

This is the display for adjusting the High Calibration point of Input 1. The lower readout is a live reading of the process value, which changes as the input changes.

Feed the desired high-point calibration signal to the controller, from the calibration source. If the lower readout does not show this value, then use / to adjust the reading to the required value.

Press to return to the '**, P-L, SE**' header.

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

7.5 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
PE 1.L	Low calibration point for Input 1	The factory calibration point at which the low point offset was performed.
PE 1.H	High calibration point for Input 1	The factory calibration point at which the high point offset was performed.
OF 1.L	Offset Low for Input 1	Calculated offset, in display units.
OF 1.H	Offset High for Input 1	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.

8. Chapter 8 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 two 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

8.1 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**
3. 2416 controller configured for PDS mode 2 option using logic output. This module must be fitted in module position 1. (order code **M2**).

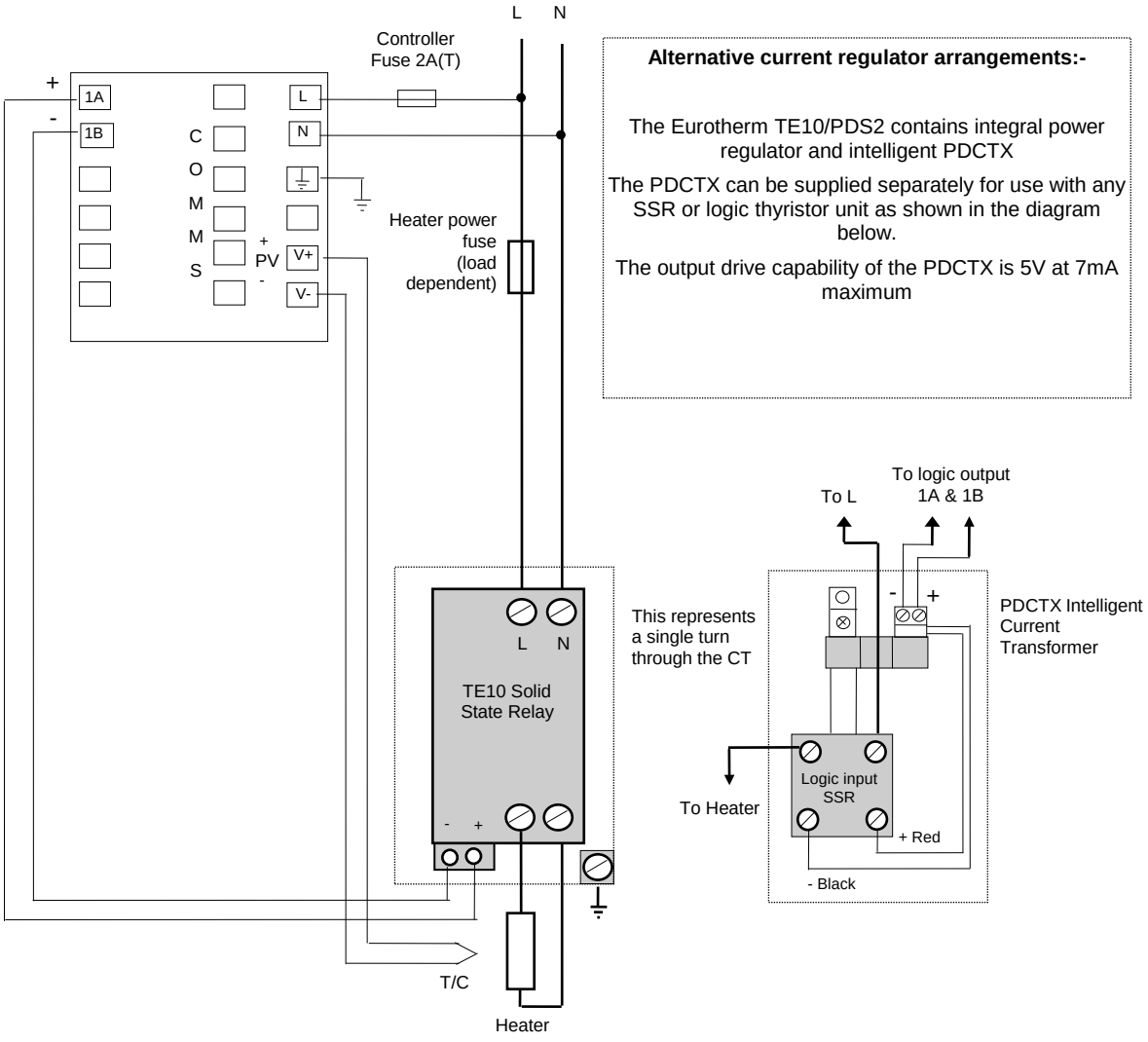
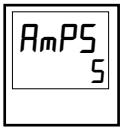
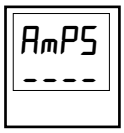


Figure 8-1: Connections for Mode 1 & 2

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.

8.2 OPERATION

8.2.1 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	 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
	 This display will be shown if: 1. The controller is unable to resolve the reading 2. The controller is obtaining a reading 3. The measurement has timed out i.e. current has not flowed for 15 seconds, in mode 2.	

8.2.2 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, **Error! Reference source not found.**. Press ↻ until di SP is shown in the upper display Press ▲ or ▼ until AmPS is displayed in the lower display		Current will be displayed in the lower readout continuously when the controller reverts to the HOME display, see also 'Display Modes' below.

8.2.3 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

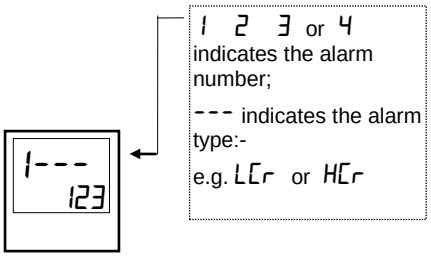
8.2.4 How Heater Alarms Are Displayed

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 two 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 di AG parameter in the AL 1, 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

8.3 To Set the Alarm Trip Levels

Do This	This Is The Display You Should See	Additional Notes
From the HOME display (Figure 2.3) press [ ] until the AL LiSt is displayed		To select the Alarm List header
Press [ ] button until the desired alarm number is displayed Press [▲] or [▼] to adjust the alarm trip level		To select the diagnostic alarm parameter found under the Alarm List header The alarm trip level is set to 123

8.4 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 [ ] button until the AL LiSt is displayed		This opens the list which contains the diAG mnemonic
Press [ ] until diAG is displayed Press [▲] or [▼] to select YES		This activates the diAG mnemonic to allow Diagnostic Alarms to be displayed in the lower readout of the HOME display

8.5 Relay Outputs

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.

8.6 To Configure PDS Load Current Diagnostics

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

1. Configure the Logic Module for PDS Mode 1 or 2 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 6.

8.7 To Configure the Logic Module For PDS Modes 1 or 2

Do This	This Is The Display You Should See	Additional Notes
Press [ ] until the 1A ConF is displayed		This opens the configuration list associated with module position 1A
Press [↺] to show id		This shows the identity of the module The module identity is logic output
Press [↺] to show Func Press [▲] or [▼] to show SSr 1 or SSr 2 as required.		This shows the function of module The module function is set to PDS mode 1
Press [↺] to show VAL.L Press [▲] or [▼] to show 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		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		This is the minimum output power To set the min output power to 0
	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.	
Press [↺] to show OUt.H Press [▲] or [▼] to show 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		This sets the output signal to normal for heating control

8.8 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)

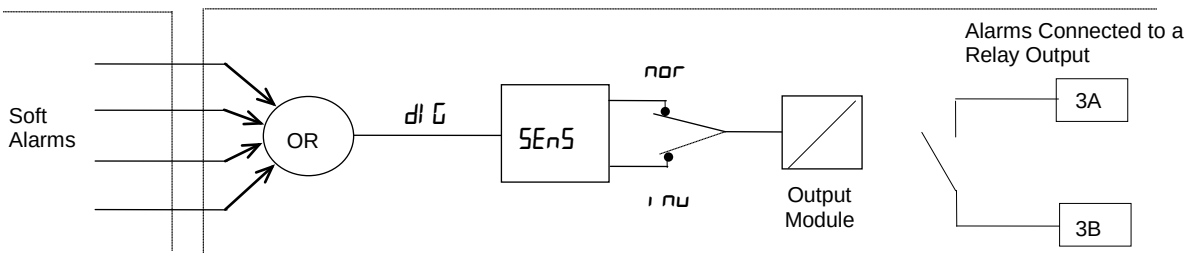
Do This	This Is The Display You Should See	Additional Notes
Press [page] button until the AL ConF is displayed		This opens the configuration list which contains the Alarms
Press [↻] to show AL 1 (alarm 1) Press [▲] or [▼] to show LCr		To select alarm 1 To make alarm 1 = Low Current
Press [↻] until AL2 (alarm 2) appears Press [▲] or [▼] to show 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.

8.9 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 [page] as many times as necessary to 3A ConF		Any output module can be configured for an alarm output provided it is not used for any other purpose, eg as a control output. In place of 3A you should select the module required, i.e. 1A or 2A
Press [page] until 1--- is displayed Press [▲] or [▼] to select YES or Repeat the above step for every alarm to be attached to the output	 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



8.10 The Scaling Factor

The value of the current displayed on the controller is scaled using the scaling factor. This is found in the ı nSt 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.

8.10.1 To Adjust the Scaling Factor

Do This	This Is The Display You Should See	Additional Notes
Press [page] button until ı nSt ConF is displayed		
Press [↻] until LCHı is displayed Press [▲] or [▼] to change the scaling factor		

Note: **MinimumResolvable 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		

Note: **Maximum Resolvable Current**

TE10 Determined by the maximum range of the SSR

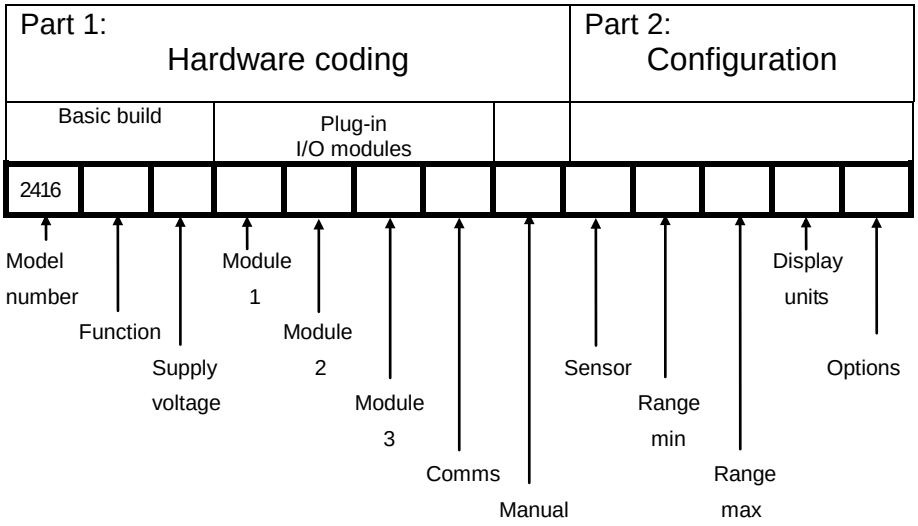
PDCTX 100A (or 100 ampere turns)

Finally Exit configuration level. See Chapter 5

Appendix A UNDERSTANDING THE ORDERING CODE

The 2416 controller has a modular hardware construction, which accepts up to three plug-in Input/Output modules and one communications module, to satisfy a wide range of control requirements.

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.

Basic build			Plug-in modules				
Model number	Function	Supply voltage	Module 1	Module 2	Module 3	Comms	Manual
2416	CC	VH	LH	RC	RH	MB	ENG

Function	
CC	Controller/8-seg Programmer
CP	Single 16-segment Programmer
P4	Four Program 16-segment
VC	Valve positioner (VP) /8 segment Prog.
VP	VP/Single Prog. 16-segment
V4	VP/Four Program. 16-segment

Supply voltage	
VH	100 to 230Vac
VL	20 to 29Vac/dc

Comms	
XX	None
EIA-485 (2 wire)	
Y2	Fitted unconfigured
YM	Modbus protocol
YE	EI Bisynch protocol
EIA-232	
A2	Fitted unconfigured
AM	Modbus protocol
AE	EI Bisynch protocol
EIA-485 (4 wire)	
F2	Fitted unconfigured
FM	Modbus protocol
FE	EI Bisynch protocol
PDSIO input	
M6	Fitted unconfigured
RS	Setpoint input
PDSIO output	
M7	Fitted unconfigured
PT	PV retransmission
TS	Setpoint retrans
OT	Output retrans

Module 1	
XX	None
Relay: 2-pin	
R2	Fitted unconfigured
RH	PID heating
RU	Valve raise output
Or Alarm 1: select from table A	
Logic non-isolated	
L2	Fitted unconfigured
LH	PID heating
M1	PDSIO mode 1(1)
M2	PDSIO mode 2(1)
Triac	
T2	Fitted unconfigured
TH	PID heating
TU	Valve raise output
DC control non-isolated	
D2	Unconfigured
H1	0-20mA heating
H2	4-20mA heating
H3	0-5Vdc heating
H4	1-5Vdc heating
H5	0-10Vdc heating

Manual	
XXX	No manual
ENG	English
FRA	French
GER	German
ITA	Italian

Module 2	
XX	None
Relay: 2-pin	
R2	Fitted unconfigured
RC	PID cooling
RW	Valve lower output
PO	Program event output 1
Or Alarm 2: select from table A	
Logic non- isolated	
L2	Fitted unconfigured
LC	PID cooling
Triac	
T2	Fitted unconfigured
TC	PID cooling
TW	Valve lower output
DC control non-isolated	
D2	Unconfigured
C1	0-20mA cooling
C2	4-20mA cooling
C3	0-5Vdc cooling
C4	1-5Vdc cooling
C5	0-10Vdc cooling

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

Module 3	
XX	None
Relay: 2-pin	
R2	Fitted unconfigured
PO	Program event 2
LF	PDSIO load failure
HF	PDSIO heater failure
SF	PDSIO SSR failure
Or Alarm 4 select from table A	
Other modules	
L2	Logic unconfigured non-isolated
T2	Triac unconfigured
D2	DC unconfigured non- Isolated
First character	
V–	PV retransmission
S–	Setpoint retransmission
O–	Output retransmission
Z–	Error retransmission
Second character	
–1	0 to 20mA
–2	4 to 20mA
–3	0 to 5V
–4	1 to 5V
–5	0 to 10V

The Hardware code is followed by the Configuration code listed in the following page.

Hardware coding	Part 2: Configuration				
▶ Continued	Sensor input	Range min	Range max	Units	Options
	K	0	1000	C	CF

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
C	*Type C W5%Re/W26%Re (Hoskins)*	0 to 2319	32 to 4200
Z	RTD/PT100	-200 to 850	-325 to 1562
Process inputs			
F	-9.99 to + 80mV	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	
Custom Sensor inputs *(* replaces type C thermocouple)*			
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

Units	
C	Centigrade
F	Fahrenheit
K	Kelvin
X	Blank

Options	
Add as many options as required	
Control options	
NF	On/Off control
DP	Direct acting PID control
PD	Power feedback disabled
Cooling options	
CF	Fan cooling
CW	Water cooling
CL	Oil cooling
Front panel buttons	
MD	Auto/man button disabled
RD	Run/hold button disabled
Programmer options	
HD	Dwell time in hours
HR	Ramp rate in units/hour (minutes is standard)

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.

Note: 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 solid state relay with feedback of a general load fault alarm.

Mode 2: provides logic heating to a Eurotherm TE10S solid state relay with feedback of load current and two alarms: solid state relay failure and heater circuit failure.

Appendix B SAFETY and EMC INFORMATION

This controller is manufactured in the UK by Eurotherm Ltd.

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.

GENERAL

The information contained in this manual is subject to change without notice. While every effort has been made to ensure the accuracy of the information, your supplier shall not be held liable for errors contained herein.

Safety

This controller complies with the European Low Voltage Directive 2006/95/EC, by the application of the safety standard EN 61010.

Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 2004/108/EC, by the application of appropriate product specific international standards.

This instrument satisfies the general requirements of the commercial and industrial environments defined in EN 61326. For more information on product compliance refer to the Technical Construction File.

Unpacking and storage

The packaging should contain an instrument mounted in its sleeve, two mounting brackets for panel installation and an Installation & Operating guide. Certain ranges are supplied with an input adapter.

If on receipt, the packaging or the instrument are damaged, do not install the product but contact your supplier. If the instrument is to be stored before use, protect from humidity and dust in an ambient temperature range of -20^{o}C to +70^{o}C.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your nearest Eurotherm 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

Symbols

If any of the symbols shown below are used on the instrument they have the following meaning:

CE Mark. Refer to manual. Risk of electric shock. Take precautions against static ESD symbol. Earth symbol. TCA-tick Australia (ACA) and New Zealand (RSM). Dispose of properly

China RoSH (Wheel) Logo. Complies with the RoHS2 (2011/65/EU) directive. Earlier RoHS symbol (RoSH1). Protected by DOUBLE INSULATION. cUL Mark.

Personnell

Installation must only be carried out by suitably 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

All isolated inputs and outputs have reinforced insulation to provide protection against electric shock. The non-isolated dc, logic and PDSIO outputs are all electrically connected to the main process variable input, (thermocouple etc.). 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 DC or logic inputs and output. Only use copper conductors for connections (except thermocouple inputs) and ensure that the wiring installations comply with all local wiring regulations. For example 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 230Vac +15%:

- relay output to logic or dc 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.

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 , 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.

This product has been designed to conform to BSEN61010 installation category II, pollution degree 2. These are defined as follows:-

Installation Category II

The rated impulse voltage for equipment on nominal 230V supply is 2500V.

Pollution Degree 2

Normally only non conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

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 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.
- 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.

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. In general keep cable lengths to a minimum.

Appendix C Technical Specification

Input

Range	±100mV and 0 to 10Vdc (auto ranging)
Sample Rate	9Hz (110mS)
Resolution	<1μV for ±100mV range, <0.2mV for 10Vdc 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 seconds
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

Digital Outputs

Relay rating	Min: 12V, 100mAdc. Max:2A, 264Vac resistive
	Application: heating, cooling, alarms or program event
Single logic output	18Vdc, 20mA. This output is not isolated from the main process value input. Application: heating, cooling, alarms or program event
Digital o/p functions	As per the ordering code
Triac rating	1A, 30 to 264Vac resistive (isolated)

Analogue outputs

Range	Scaleable between 0-10Vdc
	0-20mA (non-isolated)
Analogue output functions	Refer to ordering code

Control functions

Control modes	PID or PI with overshoot inhibition, PD, PI, P, or On/Off, or motorised valve control
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. Automatic calculation of manual reset value when using PD control.
Auto/manual control	Bumpless transfer or forced manual output
Setpoint rate limit	0.00 to 999.9 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	One or four
Segments per program	16
Event outputs	Up to two

Communications (all modules are isolated)

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	100 to 230Vac $\pm$15%, 48 to 62 Hz, 10 W max OR
	24Vdc or ac -15%, +20%. 10W max
Operating ambient	0 to 55^{o}C and 5 to 90% RH non-condensing
Storage temperature	-10 to +70^{o}C
Panel sealing	IP65
Dimensions	48mm wide x 48mm 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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