Laboratory Equipment Pty Ltd

INSTRUCTION MANUAL
FOR LABEC FLAME PROOF OVENS

Laboratory Equipment Pty Ltd
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Caution !

Ensure the fan motor runs in the correct direction as marked after connecting wiring.

Failure to ensure correct fan direction may result in vapours collecting in the element cavity and causing explosion!

Introduction
Congratulations on the choice of an Australian made quality product. Labec products are manufactured, tested and calibrated to meet published standard specifications under our strict quality assurance guidelines!

Unpacking
Remove all packing and protective wrapping from both interior and exterior of the unit. Check the unit for the possible transit damage. Ensure all ordered accessories are present. If any physical damage or shortage is evident, do not discard the packaging material until the unit is inspected by the distributor, agent or manufacturer.

NOTE: All claims for shortage or damage must be made within fourteen days (14) from delivery.

Subject to our standard published conditions of sale, we have reasonable grounds to believe that we have ensured, so far as is reasonably practical, that the products listed in our catalogue and brochures have been designed and constructed so as to be safe and without risk to health when properly installed and used in their environment by appropriate and trained personnel, and where applicable, in accordance with our published instructions.

Caution;
Please observe the following safety measures before using your LABEC equipment.
1. These units are flame proof and only under controlled conditions should inflammable, combustible or explosive material be placed in the unit.
2. Low ignition temperature materials and those materials which give off inflammable or explosive vapours may be placed in the unit provided the unit is operating correctly and has purged prior to the operation of the heaters.
3. Avoid heating substances which give off corrosive vapour.
4. Users are advised of the dangers of heating combustible materials. The manufacturer can recommend special types of elements which will prohibit the units temperature reaching known ignition points.
5. Observe those rules pertaining to wiring and installation of electrical appliances as recommended by the local supply authority.
6. Loading the Oven -Shelves shall be of such design as will not impede the circulation of fresh air or the exhaust from the oven. It has been demonstrated experimentally, that the use of grid-type shelves covering more than one half of the shelf area may lead to considerable increase temperature differential. Notwithstanding the requirements of this clause, serious blockage may occur when the oven is heavily loaded with stock. The best procedure in such cases is to insert the loaded shelves after heating up the oven. To ensure even heat and air distribution leave gaps between the products on the shelves and a minimum of 50mm from each of the walls, back and door to allow air to pass around the product.

WARNING
It is detrimental for any of the substances on the following list to be inside this equipment. The interior of the unit may be damaged if exposed to any of them. Corrosion of the stainless steel and other surfaces will be directly attributable to the presence of one or more of these substances and will not be a defect or failure for which the manufacturer will accept responsibility.

ORGANIC SUBSTANCES	SALT	ACIDS	MISCELLANEOUS
ALKAFORM	AMMONIUM BROMIDE	ACETIC	BROMIDE
ANAESTHESIA	AMMONIUM CHLORIDE	BORIC	CHLORINE
CARBON	CALCIUM CHLORIDE	CARBOLIC (PHENOL)	FLUORINE
TETRACHLORIDE	CALCIUM HYPOCHLORITE	CHROMIC	IODINE
FORMALDEHYDE	FERRIC CHLORIDE	HYDROCYAIC	SULPHUR DIOXIDE
LYSOL (CRESOLS ETC)	HYDROGEN PEROXIDE	NITRIC	
TRICHLORETHYLENE	MAGNESIUM CHLORIDE	OXALIC	
	MERCURIC CHLORIDE	HYDROCHLORIC	
	POTASSIUM CHLORIDE	PHOSPORIC	
	POTASSIUM HYPOCHLORITE	SULPHURIC	
	SODIUM CHLORIDE	SULPHUROUS	
	SODIUM HYPOCHLORITE	TARTARIC	

Loading the Oven

Shelves shall be of such design as will not impede the circulation of fresh air or the exhaust of vapours from the oven.

Note: it has been demonstrated experimentally, that the use of grid-type shelves covering more than one half of the shelf area may lead to considerable increase in pressure if there is an explosion. Notwithstanding the requirements of this clause, serious blockage may occur when the oven is heavily loaded with stock. The best procedure in such cases is to insert the loaded shelves after heating up the oven.

Door closure

The door must be closed firmly before the oven will operate at all. Once closed the purge will begin for the required time then the controller will switch on and begin to heat the oven.

Installation Electrical

<u>This equipment must be tagged and tested according to AS/NZS3760:2010 prior to use and thereafter on a regular basis dependent upon the environment.</u>

Three phase, 415 volts with neutral is required. It is preferable to locate the unit close to a powerpoint and recommended that double adaptors are not used. Check the total wattage if connecting to multipoint outlets.

The fan motor must be connected to run the correct direction or the heaters will not operate.

Location

Select a location fee from draught and away from direct sunlight or other heat source.

Heating

Heating of the oven is by means of low-density elements located in the air duct below the working chamber.

Temperature Control

Labec ovens are fitted with solid state proportional action temperature controllers which operate from a sensitive thermocouple or Rtd inserted in the working space of the chamber. The controller has been calibrated at 100ºC and before any adjustments to temperature settings are made allow the oven temperature to stabilise for at least one hour. A blow out port is located in the top of the cabinet and it is important to ensure that the port is not blocked at any time. If a digital controller is fitted please read the enclosed operating instructions when setting the controller temperature - **Appendix A.**

Safety Controller

A safety controller is fitted which prevents the temperature from going over the set point temperature. Set the safety controller a few degrees above the set point temperature, should the main controller fail then this will hold the temperature steady at the slightly higher temperature.

Fan

A flame proofed fan motor is mounted below the working chamber where it draws fresh air in through the side wall then forces it across the elements, laterally through the chamber and then exhausts all of the air out of the chamber through the top mounted duct. At high temperatures it may be necessary to reduce the airflow in or out of the chamber to ensure a stable temperature is achieved. The fan is wired to run continuously and operates when the mains are on.

The fan will switch on and run for a period of 4 minutes before the control system switches on, this is to ensure that all vapours inside the chamber have been removed before the heaters switch on. If the fan does not switch on or it has failed the air sensor will switch off the power to the controller and prevent the unit from heating.

Operation

Connect the chamber to an alternating current supply of voltage specified on the rating plate mounted on the side or rear of the chamber.

<u>DANGER; THIS UNIT MUST NOT BE CONNECTED TO DIRECT CURRENT SUPPLY!</u>

Switch on the mains and let the unit run the fan for the preset 4 minutes.

Then set the desired temperature on the digital controller (see back page).

An indicating lamp on the controller will illuminate when the heaters are operating.

Final adjustment of the temperature controller may be required after the chamber has

reached operating temperature and this should be checked with a suitable thermometer located in the chamber (A thermometer is not supplied with the chamber)

Maintenance

The cabinet is finished with stainless steel and to maintain appearance should be wiped over with a non-abrasive cleanser. The chamber is manufactured from stainless steel and may be cleaned with a solvent and if grained stainless steel chamber a stainless steel scratch pad may be used. The pad should be rubbed in the same direction as the grain pattern of the stainless steel.

The silicone door gasket should be cleaned with detergent only ensuring it is dried completely after washing.

Trouble Shooting

Should the unit fail to heat or maintain temperature check the following;

- Unit mains power is on and the indicator is lit.
- The door is firmly closed on the micro switch.
- The temperature controller set point is above ambient.
- If a safety controller is fitted check that its temperature setting is above the main controller setting.
- Check the internal RCD has not tripped.
- The fan is operating and is wired to run the correct position.
- Check mains power supply point with an appliance known to working satisfactorily.
- If the fault cannot be found call your distributor or the manufacturer quoting the serial number of the unit from the manufacturers label.

Appendix A

Eurotherm Controllers 3216, 2416 and 2404 Instructions

General
The control panel is fitted with two controls: an ON/OFF SWITCH, and a TEMPERATURE CONTROLLER.

On/Off Switch
The On/Off switch isolates mains power to the temperature controller and to the solid state relay.

If access to electrical connections inside the equipment is required, ensure that the electrical power is switched off where the equipment is connected to the main supply.

Temperature Controller
The Eurotherm microprocessor temperature controller has the facility for a single ramping rate and then hold function. To set up a full program in °C/seconds/minutes/hours you must purchase the fully programmable optioned controller.

Indicator and Button Functions
The Eurotherm controller has the following buttons and indicators:

Indicator or button	Name	Function
OP1	Output 1	When lit, this indicates that the element output is on.
ALM	Alarm 4	When lit, this indicates that an alarm condition exists.
	Page button	Press to select a new list of parameters.
	Scroll button	Press to select a new parameter in a list.
	Down button	Press and release to view the set point or a selected parameter. Keep pressed to decrease the value.
	Up button	Press and release to view the set point or a selected parameter. Keep pressed to increase the value

Display
The display normally indicates actual temperature or parameter mnemonic and it will indicate set point temperature or parameter value when up or down keys are pressed.

Changing the Set Point (standard model)
Press the up and down arrows until the desired set point is displayed. Allow the controller to flash (store the value into memory). Nothing else is required to set or change the temperature. If a non programmable controller is fitted now set the safety thermostat or set Alarm point (AL4) if required.

Changing the Set Point, Ramp Rate and Hold Timer (if programmable model is fitted)
The temperature controller's normal display shows the actual temperature. The set point can be changed using the /\ or \/ buttons and the equipment will hold at that temperature.

Pressing the scroll button once changes the display to **oP** or % output power.

Pressing the scroll button again changes the display to **Sprr** or set point ramp rate and can be set to either OFF or from 1 to 60°C/min

Pressing the scroll button again changes the display to **dwEll** or set point hold time and can be set to either off or 999.9 minutes.

Pressing the scroll button again changes the display to **StAt** or program status and can be set to **on** or **off**. In the on status, the dwell timer will function, in the off status the controller ignores the dwell setting. The status will change to off automatically when the dwell period ends.

Autotune List (only perform if fault found or recalibrating)
Pressing the Page key once changes the display to the Autotune list **Atun**.

Pressing the Scroll key changes the display to **tune** or tune function selection. Auto tune may now be selected using the /\ or \/ buttons.

PID List
Pressing the Page key again changes the display to the PID List **PID**.

Pressing the Scroll key changes the display to **Pb**, **ti**, **td**, **Hcb**, and **Lcb**. The values for these may be accessed and changed using the /\ or \/ buttons. A full description of their meanings is in the Tuning section.

Operating the Equipment
When the equipment is first turned on the controller will carry out self checks and then start controlling at the set point value.

Set the parameters detailed in the manual.

To reset the controller after dwell end (**End**) or other alarm press the PAGE and SCROLL keys simultaneously. If a ramp dwell program is to be run again set status back to **on**.

When running the equipment at a new temperature that varies more than about 25% from the previous temperature it may be necessary to run the autotuning program to reset the PID parameters. **The equipment will overshoot the set point when running the autotune program especially at low temperatures.**

Error Messages

Alarm	What it means	What to do about it
FSH1	*Full Scale High Alarm:* The equipment measured temperature has exceeded the equipment maximum temperature.	This fault may be caused by a faulty solid state relay or by exothermic reaction of the equipment load. Reset the alarm by pressing the Page and Scroll buttons simultaneously and check operation of solid state relay.
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 Laboratory Equipment Pty Ltd.
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.
Ld.f	*Heater circuit fault:* Indication that the power controller device has detected a fault in the heating circuit.	Check the functioning of the power control device and heating circuit. (E.g. fuse failure).
LLLL	*Out of range low reading*	Check the value of the input
HHHH	*Out of range high reading*	Check the value of the input
Err1	*Error 1:* ROM selftest fail	Return the controller for repair
Err2	*Error 2:* RAM selftest 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.

Tuning

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

- Stable, ‘straightline’ control of the temperature at set point without fluctuation.
- No overshoot, or undershoot, of the temperature set point.
- Quick response to deviations from the set point caused by external disturbances, thereby rapidly restoring the temperature to the set point value.

Tuning involves calculating and setting the value of the parameters listed in Table 41. These parameters appear in the ‘Pid’ list.

Table 41 Tuning parameters

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 steadystate error signals.
Derivative time	td	Determines how strongly the controller will react to the rateofchange of the measured value.
High Cutback	Hcb	The number of display units, above set point, 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 set point, 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: divide the Pb value by the rEL value.

AUTOMATIC TUNING

TWO AUTOMATIC TUNING PROCEDURES ARE PROVIDED IN THE 2408 AND 2404: ● A oneshot tuner, which automatically sets up the initial values of the parameters listed in Table 41 on the previous page.

- **Adaptive tuning,** which continuously monitors the error from set point and modifies the PID values, if necessary.

Oneshot Tuning

The ‘oneshot’ 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 Oneshot 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 return again for the new conditions.

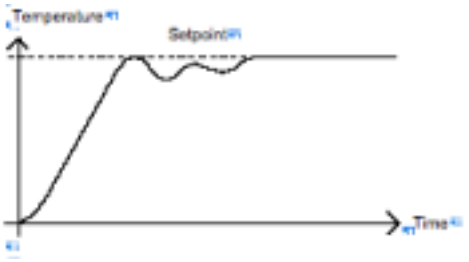
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

How to tune

1. Set the set point 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 set point.
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 41 and resumes normal control action.

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

Typical automatic tuning cycle



Calculation of the cutback values

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

Adaptive tune

Adaptive tuning is a background algorithm, which continuously monitors the error from set point and analyses the control response during process disturbances. If the algorithm recognises an oscillatory, or underdamped response, it recalculates the Pb, ti and td values. Adaptive tune is triggered whenever the error from set point exceeds a trigger level. This trigger level is set in the parameter ‘drA.t’, which is found in the Auto tune list. The value is in display units. It is automatically set by the controller, but can also be manually readjusted.

Adaptive tune should be used with:

1. Processes whose characteristics change as a result of changes in the load, or set point.
2. Processes that cannot tolerate the oscillation induced by a Oneshot 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 multi loop applications. However, moderately interactive loops, such as multizone extruders, should not give a problem.

MANUAL TUNING

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

With the process at its normal running temperature:

Set the Integral Time ‘ti’ and the Derivative Time ‘td’ to OFF.

Set High Cutback and Low Cutback, ‘Hcb’ and ‘Lcb’, to ‘Auto’.

Ignore the fact that the temperature may not settle precisely at the set point. 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’.

Set the Pb, ti, td parameter values according to the calculations given in Table 42.

Table 42 Tuning values

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

Setting the cutback values

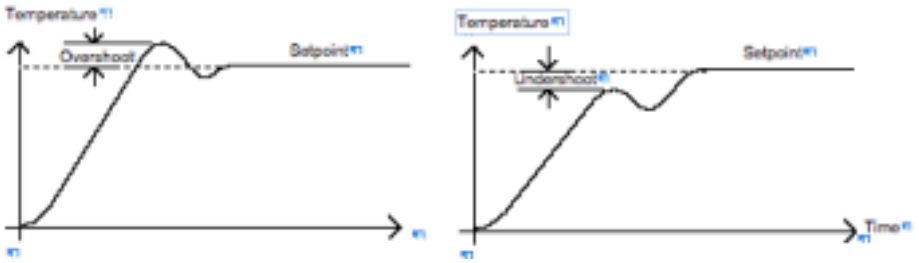
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in temperature, then manually set the cutback parameters ‘Lcb’ and ‘Hcb’.

Proceed as follows:

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

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

Example (a) Example (b)



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

Integral action and manual reset
In a full three term controller (that is, a PID controller), the integral term ‘ti’ automatically removes steady state errors from the set point. 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 set point. When the integral term is set to ‘OFF’ the parameter *manual reset* (code ‘rES’) appears in the ‘Pid LiSt’ in ‘FuLL’ level. This parameter represents the value of the power output that will be delivered when the error is zero. You must set this value manually in order to remove the steady state error.

Automatic droop compensation (Adc)
The steady state error from the set point, 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 auto tune parameter list, you must set ‘Adc’ to ‘on’. The controller will then calculate a new value for manual reset, and switch ‘Adc’ to ‘OFF’. ‘Adc’ can be repeated as often as you require, but between each adjustment you must allow time for the temperature to stabilise.

Safety Thermostat (if fitted)
The chamber is fitted with an overheat safety protection thermostat. It must be set to slightly above the desired set point temperature and will prevent overheating. It will maintain the set value only and will not switch off the chamber. Change the thermostat value to slightly above the set point temperature once the temperature has stabilized at the set value on the controller, then turn back the thermostat until it “clicks” at this point it will switch off the heaters. Turn it clockwise again until it “clicks” on again and then continues turning so it is around 5°C above the set value on the controller. The safety thermostat is now set to turn off the heaters should it overheat. Setting the thermostat simply by using the numbers on the dial may cause the thermostat to interfere with the operation of the chamber. To be sure, set it using the “click” method outlined above.

Eurotherm Controller Instructions for Manual Calibration

Indicator and Button Functions
The Eurotherm controller has the following buttons and indicators:

Indicator or button	Name	Function
	Page button	Press to select a new list of parameters. (Left most key)
	Scroll button	Press to select a new parameter in a list.(2nd key from left)
	Down button	Press and release to view the set point or a selected parameter. Keep pressed to decrease the value.
	Up button	Press and release to view the set point or a selected parameter. Keep pressed to increase the value

1. Press and hold in the Menu (left most key) until LVL3 appears on the screen.
2. The controller will then ask for the COD (password) enter 3 using the up arrow.
3. If successful push Menu once to display INPUT.
4. Press (not hold) the Scroll buttons (2nd key from left) until it displays PV.OFS. Change this value using up and down keys only to calibrate the temperature on your external logger.
5. Then press the Menu key until ACCES is displayed. Press the Scroll button once to display LVL3 and GOTO. Use the down arrow to change to LVL1.
6. Controller will flash and return to the main user screen.