

TRIBOTRAK

OPERATION MANUAL

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DACA
instruments

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WARNINGS



High operating temperatures and moving parts of DACA's processing instruments are potentially dangerous; therefore the user should observe the following safety precautions and be aware of the possible dangers at all times.

OPERATOR SAFETY

Users who are to install and operate the equipment should study this User Guide and all referenced documentation prior to installation and/or operation of the equipment. Carefully read installation instructions and operating instructions; observe all WARNINGS and CAUTIONS.

Ensure that the equipment setup and the actual use do not present a hazard to personnel. Common sense and good judgment are the best safety precautions.

GENERAL SAFETY

The following statements apply to all users of DACA's processing instruments.

1. HIGH SPEEDS AND FORCES

Be aware at all times of moving components which are potentially dangerous due to high speeds and forces. Do not permit anyone to operate a processing system who is unaware of its function or unskilled in its use.

2. SUPPLY VOLTAGES EXCEEDING 50V

DACA Instruments designs do not permit the operator to be exposed to voltages exceeding 50V under normal operation of the instrument. However, if any covers are removed from the instrument, all safety precautions should be strictly observed when carrying out servicing procedures. Also, always disconnect the instrument from the main power source whenever checking or changing fuses.

3. ROTATING MACHINERY

The source of power for rotating machinery is electrical. Always disconnect the test instrument or equipment from the power source before removing any cover which gives access to rotating machinery, (e.g., belts, gears, screws or shafts.)

4. MEDIUM AND HIGH TEMPERATURE COMPONENTS

It is essential to display a WARNING notice concerning high temperature operation whenever high temperature equipment is in use; always use special handling gear and protective clothing under these conditions. High temperature refers to all equipment with a temperature exceeding 60°C (165°F). Note that the hazard from high temperature can extend beyond the immediate area of the instrument.

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INTRODUCTION

GENERAL DESCRIPTION

The Tribotrak has been designed for accurate and consistent deposition of oriented poly(tetrafluoroethylene) [PTFE] thin films in accordance with U.S. Patent 5,180,470. The equipment is comprised of two parts; a lower movable stage and a pivoting PTFE holder. The speed and travel distance of the stage are controlled by a precision micro-stepper motor. The temperature-controlled sample support can accommodate substrates of different lengths up to 80 mm.

The upper section is a counter-balanced, temperature controlled support for the PTFE rod. Holders are included to support the PTFE rod perpendicular or parallel to the substrate to be coated. This section is adjustable to accommodate substrates of different thicknesses.

The interfacial pressure between the PTFE rod and the substrate is controlled by varying the weights loaded onto the PTFE holder.

SPECS & SCHEMATICS

MECHANICAL

Traverse speed	0.01 - 30 mm/sec
Traverse distance	adjustable, 95 mm max.
Specimen size	80 mm x 75 mm max.
Traverse mechanism	Ball bearing linear stage, lead screw drive
Specimen loading	Dead weight, 5 kg min. (higher ranges possible)

HEATERS

Specimen heater (upper)	350°C, 250 W, 110V AC
Platen heater (lower)	350°C, (4x150 W), 110V AC
Temperature controls	EUROTHERM 94: Digital auto tune PID closed loop
Thermocouples	Type K

MOTOR AND MOTION CONTROL

Motor	Compumotor microstepper motor, NEMA23 frame size
Control	Compumotor programmable microstepper drive/indexer, 23,000 - 50,000 steps/revolution.
Control variables	Traverse distance, traverse speed, starting position
User input	Compumotor RP240 Operator Interface

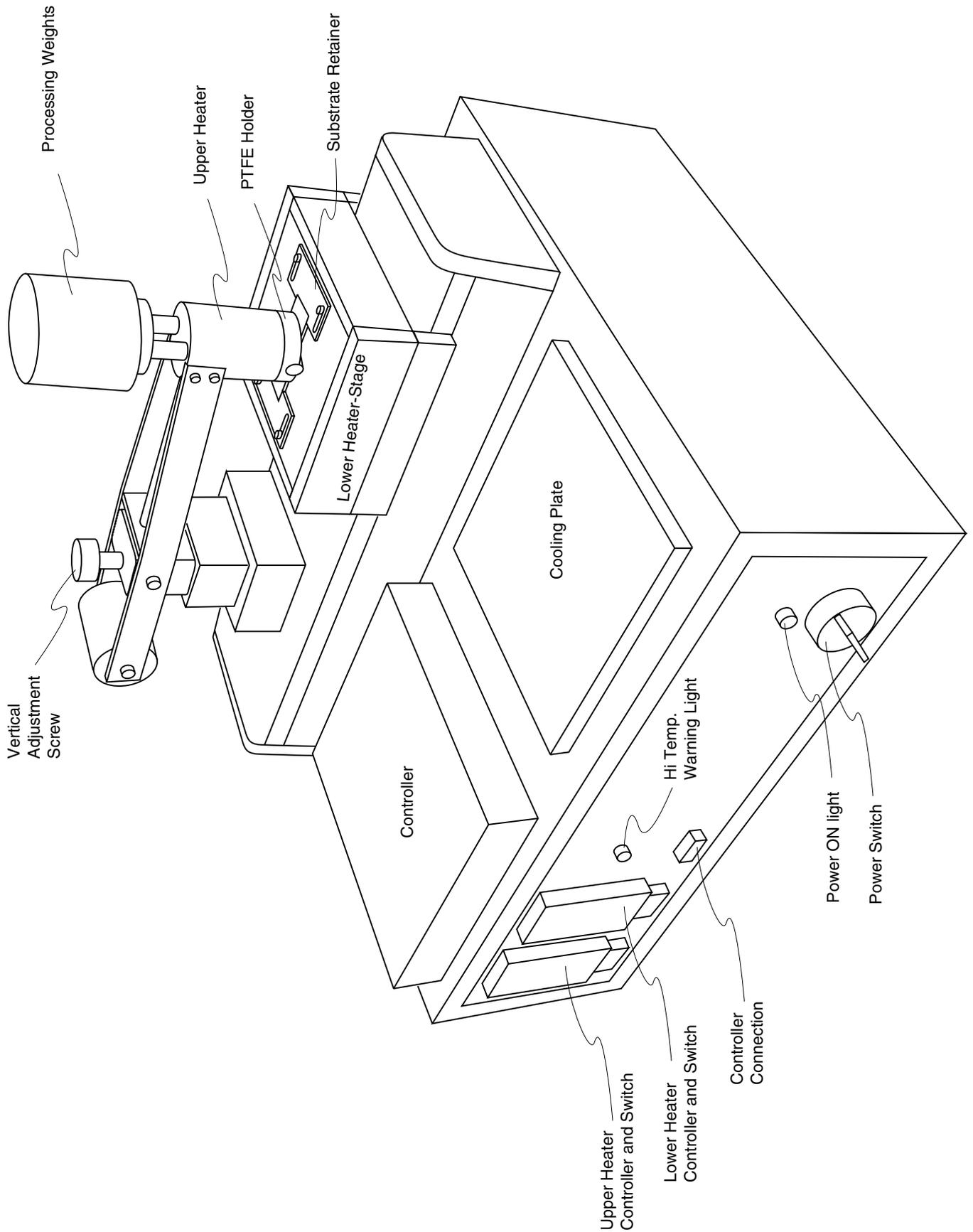
ELECTRICAL

Voltage	220 V AC
Frequency	50/60 Hz
Max. current	6A

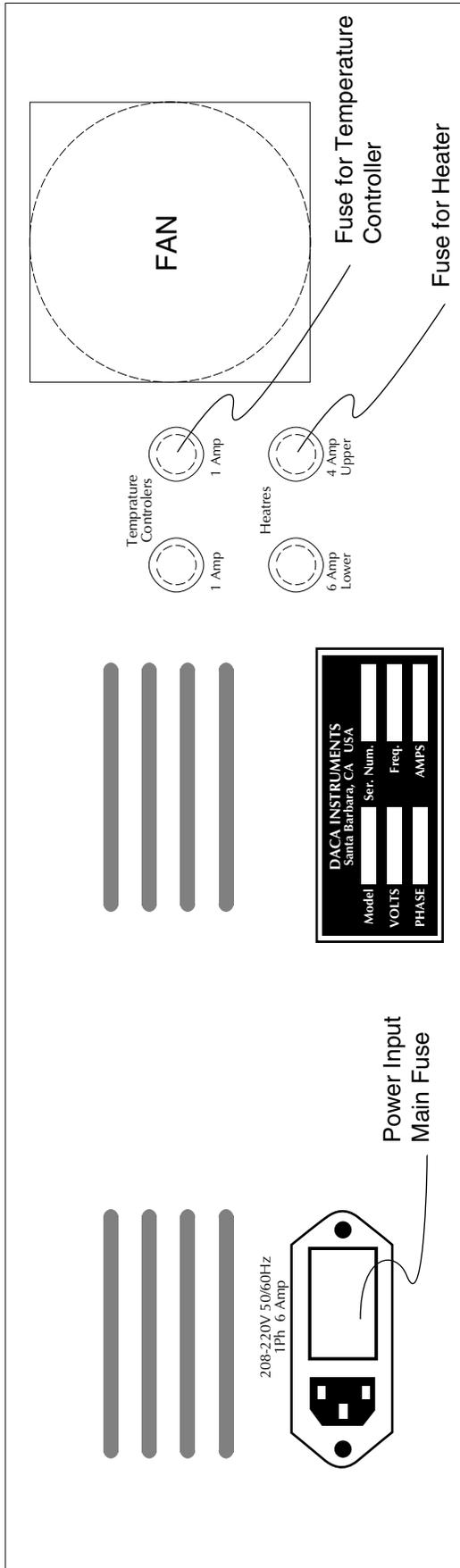
PHYSICAL

Dimensions	52.5 cm W x 46 cm D x 42 cm high (excluding processing weights)
Weight	37 Kg (excluding processing weights)

GENERAL SCHEMATIC



SCHEMATIC OF BACK PANEL



INSTALLATION

UNPACKING

SHIPMENT DAMAGE

Merchandise shipped is carefully packed in compliance with carrier requirements. Claims for loss or damage in transit must be made with the carrier by the customer. All shipments should be unpacked and inspected immediately upon receipt. If damage is concealed and does not become apparent until shipment is unpacked, the customer must make a request for inspection by the carrier's agent and file a claim with the carrier. Any external evidence of loss or damage must be noted on the freight bill or carrier's receipt and signed by the carrier's agent. Failure to do this will result in the carrier refusing to honor the claim. For the customer's protection, DACA Instrument's billings include insurance for damage or loss in transit.

The wooden crate should contain the following items:

- 1 Tribotrak
- 1 Cardboard box containing the brass weights used during operation
- 1 Box with a glass container for cleaning glass slides
- 1 Plastic Bag containing:
 - This User's Manual
 - 1 Power cords
 - 1 Flat tip tweezers
 - 1 Controller (RP240)
 - 1 Set of metric Allen wrenches
 - PTFE rods
 - Vertical PTFE holder
 - Registration Card

If any of these items are missing, please contact DACA Instruments immediately to receive the missing items.

INSTALLATION

LOCATION

The Tribotrak should be set up on a leveled, sturdy table or bench. The normal operating temperature of the Tribotrak can be as high as 400 °C (750 °F); therefore, the instrument should be placed away from other heat-sensitive equipment. The Tribotrak should also be away from high traffic areas where other people might accidentally come in contact with the hot instrument. Parts of the machine have been labeled as HOT and a small sign is provided to warn people of the potential danger.

ELECTRICAL

The Tribotrak requires only one electrical connection. The instrument operates at 220V 50/60Hz.

Two power cords have been supplied with instruments shipped to destinations other than the United States. One power cord has a plug which should match electrical outlets available in the country of destination. The second power cord has no plug installed. The bare cables have been labeled for fitting with the appropriate customer-provided plug. It is the customer's responsibility to provide the appropriate electrical connector in this case. Please contact DACA Instruments if there is any confusion on how to attach your electrical connector to the power cord supplied.

OPERATOR INTERFACE

Motion of the Tribotrak is controlled with a Compumotor RP240 Keypad. This keypad is capable of communicating through ASCII commands with the stepper motor controller/indexer inside the electrical enclosure. The keypad provides a user friendly interface to the controlling program which is stored in the controller/indexer for the stepper motor. The keypad is connected to the RS232 port in front of the instrument prior to turning the instrument on. The control panel might be placed in front of the Tribotrak or on top of the Tribotrak console, next to the aluminum cooling plate.

INITIAL SET UP

Please read and execute these instructions BEFORE turning the TRIBOTAK ON.

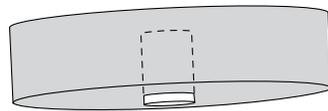
POSITION OF SUBSTRATE HOLDER

The Tribotrak comes set up to coat standard microscope glass slides (75 x 25 x 1 mm). The substrate retainers (H shaped metal pieces bolted on top of the stage) have been positioned to accommodate these slides. If a different size substrate is being used, these sample retainers might have to be repositioned. Use the set of Allen wrenches provided to loosen and reposition the retainers. The retainers can be reversed to accommodate samples wider than 25 mm. Please note that the width of the coated area is limited by the maximum width of the PTFE bar used.

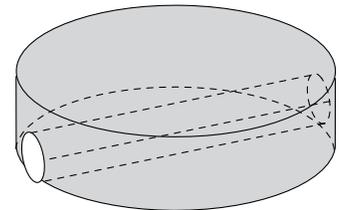
When repositioning the sample retainers care must be taken to insure that the substrate to be coated remains parallel to the direction of deposition.

LOADING OF PTFE BAR AND INITIAL POSITION

The Tribotrak is supplied with two PTFE holders. One supports the PTFE rod with its axis perpendicular to the substrate to be coated (vertical holder). The other holder supports the rod with its axis parallel to the substrate (horizontal holder). In general the horizontal holder is more versatile and yields better PTFE films than the vertical holder. The holders are attached to the upper section with two screws.



Vertical Holder



Horizontal holder

PTFE for depositions is provided in long rods (15 cm x 10 mm) which need to be cut to the desired length. If the vertical PTFE holder is used, it is recommended that the PTFE bar be cut to 15 mm. Care must be taken to make a perpendicular cut to avoid high points at the end of the rod which will be in contact with the substrate.

When the horizontal PTFE holder is used, the PTFE rod can be cut to any length up to 40 mm. This maximum length insures even pressure over the entire PTFE rod. The PTFE rod is soft enough to be cut with a razor blade or knife. The edges might be smoothed with some sandpaper to ensure even contact of the entire length of the rod with the substrate.

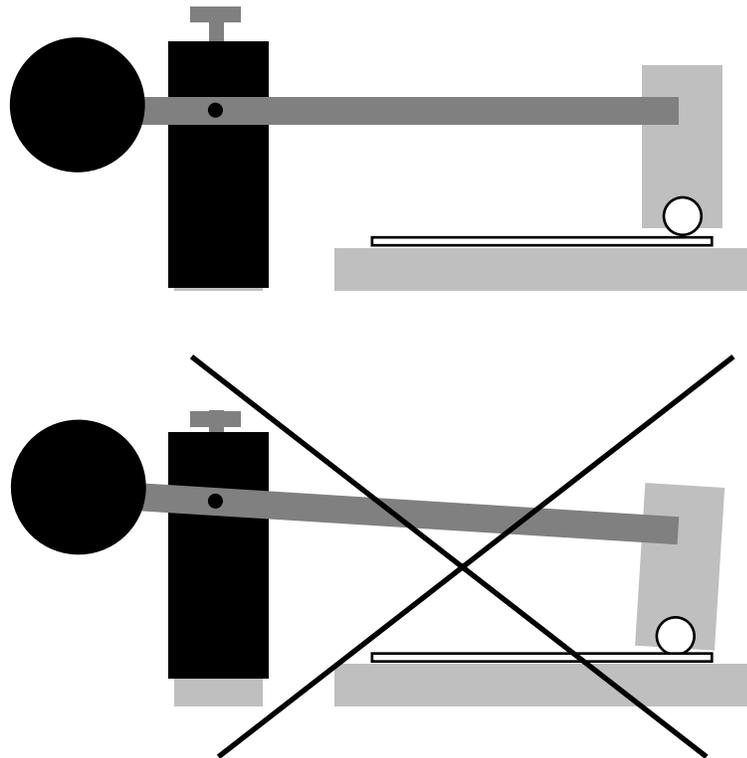
Once the PTFE rod is cut and placed in the holder. If the horizontal holder is being used, the PTFE rod must be centered over the substrate to be coated.



NOTE: The horizontal holder has been pre-installed on the upper heater and is pre-loaded with a PTFE rod

VERTICAL ADJUSTMENT OF PTFE HOLDER

The upper section of the instrument can be adjusted vertically to accommodate substrates of different thicknesses or different PTFE holders. Once the PTFE holder is in place and the PTFE rod has been loaded, place a sample of the desired substrate on the stage and load a small weight on to the upper section. Use the vertical adjustment knurled nut to set the vertical position of the upper section. For optimal operation the pivoting arm should be horizontal when the PTFE rod is in contact with the substrate to be coated.



SELECTION OF WEIGHT

For glass substrates it is recommended that a **minimum** of 5 kg be used. In some cases higher weight (10 kg) will produce better results, especially at temperatures below 300°C. The weights can be added or removed at any time.

ITO coated substrates also require the full 10 kg stack to yield uniform films. A higher operating temperature (330°C) is also recommended for these substrates.

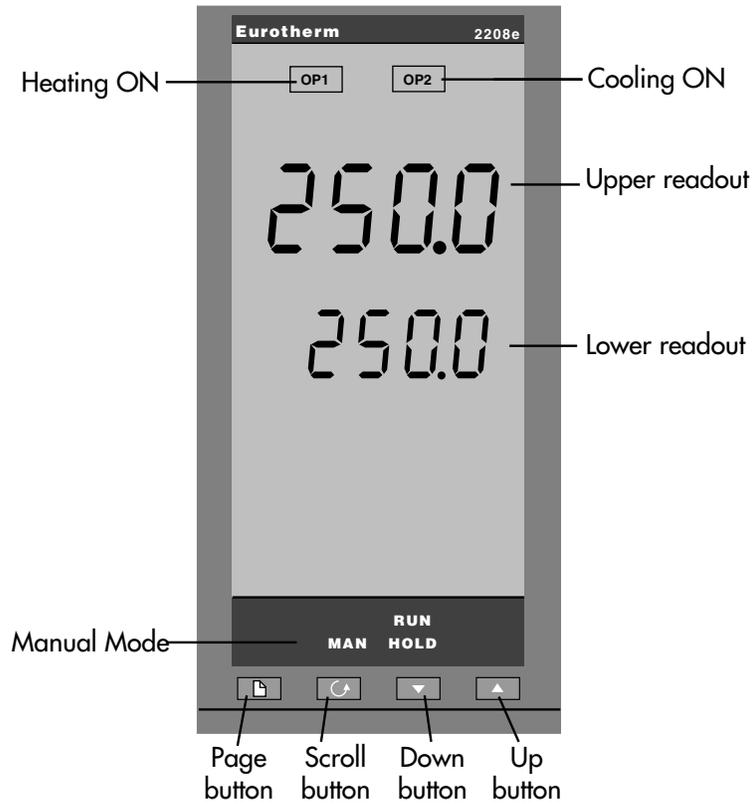
OPERATION

TEMPERATURE CONTROL

Portions © EURO THERM CONTROLS Inc.

Temperature of the barrel is controlled by a EURO THERM model 2208 temperature controller.

FRONT PANEL LAYOUT



Button or Indicator	Name	Explanation
OP1	Output 1	When lit, it indicates that heating output is on.
OP2	Output 2	When lit, it indicates that cooling output is on.
REM	Remote Setpoint	When lit, this indicates that the PDS remote Setpoint input has been selected. 'REM' is also used to indicate that user comms is active.
MAN	Manual light	When lit, it indicates that manual mode has been selected
RUN	Run light	When lit, it indicates that Setpoint rate limit is active.
	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.

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.

BASIC OPERATION

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.

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 to show the

% 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.

Pressing  from the Output Power display may access further parameters if the access level of the controller has been changed (see Appendix B). When you reach the end of this scroll list, pressing  will return you to the Home display.

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.

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 T-1 and Table T-2 list all of the possible alarm messages and their meanings.

ALARM ACKNOWLEDGEMENT AND RESETTING

Pressing both  and  at the same time will acknowledge any new alarms and reset any latched alarms.

ALARM MODES

Alarms have been set up to operate as:

- **Non-latching**, which means that the alarm will reset automatically when the Process Value is no longer in the alarm condition.

ALARM TYPES

There are two types of alarm: Process alarms and Diagnostic alarms.

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
tUEr	Tune Error. Press page and Re-tune

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

Table T-2 Process alarms

DIAGNOSTIC ALARMS

These indicate that a fault exists in either the controller or the connected devices. See following page.

HI TEMP. WARNING INDICATOR

Power to the heaters is managed by solid state relays (SSR) which are regulated by the temperature controllers. In the event of SSR failure, uncontrolled power could be supplied to the heaters. In this case, the Alarm 2 condition will be quickly reached and the safety relay will be tripped terminating power to the heaters. The HI TEMP. WARNING indicator will light up on the front panel. If the setpoint is set close to 400°C the temperature might overshoot while heating causing the light to turn ON.

If you feel that the Alarm 2 was reached due to SSR failure, turn the Tribotrak OFF and allow it to cool for a few hours. The safety relay will reset itself when the temperature drops below 400°C. Turn the instrument ON and set the setpoint temperature to 300°C. If the controller reaches Alarm 2 condition again, turn the machine off and contact DACA Instruments for replacement SSR.

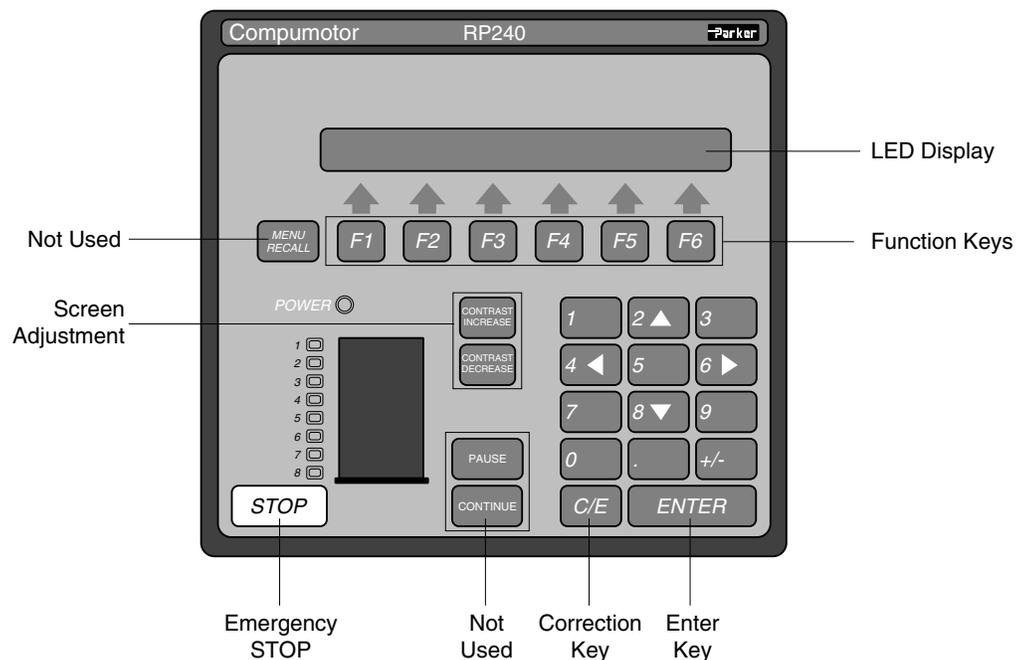
NOTE: Although the setpoints for Alarms 1 and Alarm 2 can be accessed and changed by pressing  4 and 5 times respectively, the maximum value of 360 and 400°C have been separately set and are protected from change. If you feel that you need to work at temperatures > 350°C, please contact DACA Instruments for detailed instructions on how to change the maximum values for the Alarms.

Display shows	What it means	What to do about it
<i>EE.Er</i>	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 Controls.
<i>S.br</i>	Sensor Break: Input sensor is unreliable or the input signal is out of range.	Check that the sensor is correctly connected.
<i>L.br</i>	Loop Break The feedback loop is open	Check that the heating and cooling circuits are working properly.
<i>Ld.F</i>	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 It indicates either an open or short circuit SSR, blown fuse, missing supply or open circuit heater.
<i>SSr.F</i>	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 It indicates either an open or short circuit condition in the SSR.
<i>Htr.F</i>	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 It indicates a blown fuse, missing supply, or open circuit heater.
<i>Hw.Er</i>	Hardware error Indication that a module is of the wrong type, missing, or faulty.	Check that the correct modules are fitted.
<i>no.iO</i>	No I/O None of the expected I/O modules are fitted.	This error message normally occurs when pre-configuring a controller without installing any of the required I/O modules.
<i>rmE.F</i>	Remote input failure. Either the PDSIO input, or remote DC input, is open or short circuit	Check for open, or short circuit wiring on the PDSIO, or remote DC, input.
<i>LLLL</i>	Out of range low reading	Check the value of the input.
<i>HHHH</i>	Out of range high reading	Check the value of the input.
<i>Err 1</i>	Error 1: ROM self-test fail	Return the controller for repair.
<i>Err 2</i>	Error 2: RAM self-test fail	Return the controller for repair.
<i>Err 3</i>	Error 3: Watchdog fail	Return the controller for repair.
<i>Err 4</i>	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.
<i>Err 5</i>	Error 5: Faulty internal communications.	Check printed circuit board interconnections. If the fault cannot be cleared, return the controller for repair.

STAGE CONTROL

GENERAL INFORMATION

Motion of the lower stage is controlled by a program stored in the indexer for the stepper motor (see the appendix for a printout of this program). Interaction with the indexer is accomplished through the Compumotor RP240 operator interface. This keypad has a 2 line, 40 character per line LCD display which shows commands in English.



Once the Tribotrak is turned on the program is executed and the following greeting appears on the LED display:

```
TRIBOTRAK PROGRAM  DACA INSTRUMENTS 1998
ACCESS                                                    EXIT
```

Press F1 (ACCESS) to continue with the program. EXIT ends the program and clears the screen. The Tribotrak must be turned off and on again to access the program. Once F1 is pressed the following Motion Display appears on the LED.

MOTION DISPLAY

```
NEW          NEW
POS         VEL      GO      RET      JOG      EXIT
```

The six F-keys of the keypad (F1, F2, ..., F6) access the command displayed above the respective F-key. Thus pressing F1 will execute the command NEW POS which then causes the indexer to prompt you for the position the stage will go to after the GO command is executed.

MOTION DISPLAY COMMANDS

NEW POS:

Causes the controller to prompt the operator for absolute position, in mm, of the lower stage for the next move. The maximum position allowed is 95 mm, however the actual maximum position might be less than 95 mm depending on the starting position of the stage. Hardware limits will prevent motion of the stage past a certain position regardless of the number entered through software. Only positive values are accepted which move the stage from left to right (Positive move). After typing the number press ENTER on the keypad.

```
ENTER NEW POSITION IN MM: (0-95.0)
NEW POSITION=XX.X
```

NEW VEL:

Causes the controller to prompt the operator for the travel speed, in mm/sec, of the lower stage. The minimum speed is 0.01 mm/sec. The maximum is 30 mm/sec. You will be prompted for the speed in a manner similar to the position

GO:

Causes the stage to move to the position POS and at the speed VEL. These values will be used every time GO is pressed until a new value is entered.

RET:

Causes the stage to return to the zero position at a preset speed of 8 mm/sec regardless of the speed entered using VEL.

EXIT:

Ends the program and returns to the first screen (TRIBOTRAK PROGRAM...)

JOG:

Accesses the Jog Display which enables easy movement of the stage to set its initial position.

The Jog Display appears as follows:

JOG DISPLAY

```
FAST    SLOW    SLOW    FAST    STOP    NEW
<<<<    <        >        >>>>    MOTION  ZERO
```

JOG DISPLAY COMMANDS

FAST<<<<: Causes the stage to move from right to left at 4 mm/s.

SLOW<: Causes the stage to move from right to left at 1 mm/s.

FAST>>>>: Causes the stage to move from left to right at 4 mm/s.

SLOW>: Causes the stage to move from left to right at 1 mm/s.

STOP MOTION: Stops the motion of the stage.

NEW ZERO: Stops the motion of the stage and sets the current location as the starting or 0 (zero) position.

The instrument will then request a new position (NEW POS) which will be referenced to this new zero location.

SETTING THE STARTING POSITION OF THE LOWER STAGE

To set the starting position of the PTFE rod over the substrate press F5 (JOG) from the Motion Display to access the Jog Display. Place a substrate on the stage and lower the PTFE rod (upper section) over the substrate. Press F1—F4 and position the PTFE rod at the desired starting position on the substrate. You may press F1—F4 again during the motion to change speed or direction. Motion will continue until F5 (STOP MOTION) or F6 (NEW ZERO) are pressed or a hardware limit is encountered..

NOTE: The Tribotrak is equipped with hardware limits which prevent the stage from moving past certain preset positions. This is done to avoid damages to the mechanical stage. If a limit is triggered during JOG or normal motion, an LED will be turned on to indicate the limit triggered. The stage will automatically back away 2mm from the activated limit. A message will be displayed on the screen to alert you of the situation. After 4 seconds, the MOTION Display appears to allow further manipulation of the stage.

When the desired position is achieved, press F6 (NEW ZERO) to set the current position as the starting or 0 (zero) position. All distances entered with POS are referenced to this new zero location.

OPERATION OF THE STAGE

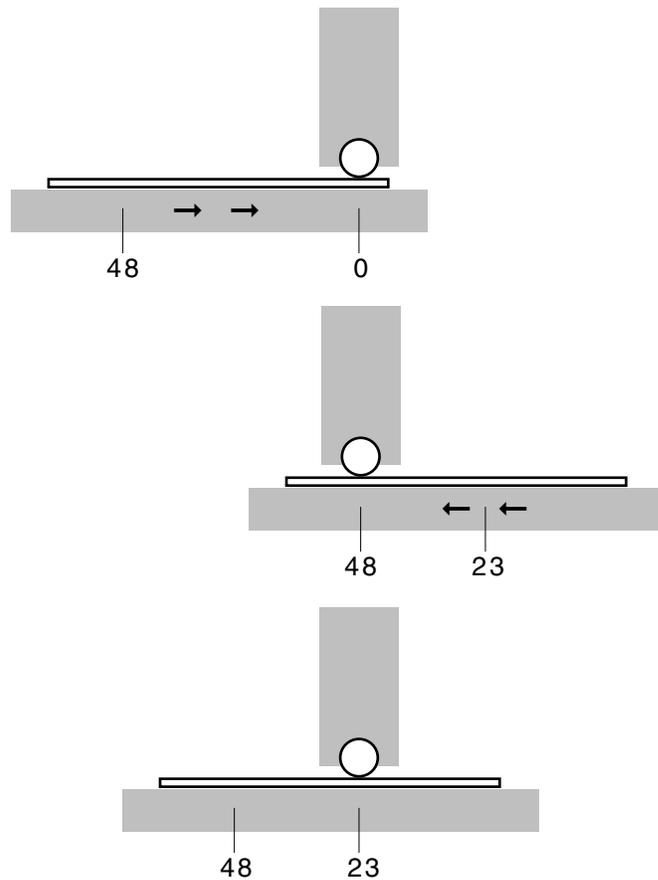
STEP BY STEP SLIDE COATING

- Once the initial position is entered you are returned to the Motion display. Enter the desired final position and speed using the F1 (NEW POS) and F2 (NEW VEL) keys respectively. A number must be entered for both values before any motion can be achieved with the GO command.
- Load the substrate on the stage.
- Load the weights on top of the PTFE holder.
- Pressing F3 (GO) to cause the stage to move to the position entered with POS at the speed entered with VEL.
- When the travel is finished and the stage stops, remove the weights from the PTFE holder.
- Pivot the PTFE holder away from the substrate.
- Remove the coated substrate and place it on the cooling aluminum block.
- Carefully place a new substrate on the stage making sure that it lays completely flat on the stage and it is not held up by the substrate holder.
- Press F4 (RET) and the stage will quickly return to the starting position.
- Load the weight on to the upper stage and repeat the process by pressing F3 (GO) again. The velocity and distance need only be entered once. They will remain the same for every run until changed by the operator.

The velocity must be entered in mm/s and the range is 0.01–30 mm/s. Distances must be specified in mm and the allowed range is 0-95 mm. The Tribotrak relies on hardware limits to prevent damage to the stage. If a hardware limit is activated the stage will stop and only motion away from the limit is allowed.

NOTE: The Tribotrak is initialized to operate in absolute position mode. That is to say, when the machine is turned on and the initialization routine is executed the stage position at that time is defined as zero (0). When a new position (POS) is entered, it is always referenced to this initial zero point until the zero point is changed using software. If the stage is currently at the zero position, a positive value moves the lower stage away from the support of the upper PTFE holder (left to right). Negative values are not allowed.

In addition the direction of an absolute move also depends on the position of the stage at the beginning of the move and the position you specify for the end of the move. If the stage is at position 48 mm and you specify POS: 23 mm for the next move, the stage will execute a negative movement (right to left) to arrive at 23 mm.



BEFORE TURNING OFF

After the last substrate is coated, it is recommended that the stage be returned to the starting position before turning the instrument off. This will make setting up the Tribotrak easier the next time if similar substrates are being used.

USEFUL HINTS

Once a slide is coated, it can be removed from the heated stage and placed on the metal cooling block in front of the moving stage. This will quickly cool the slide before it is placed on a slide carrier.

It is also useful to place a second slide on the free area of the heated stage while a slide is being coated. This will heat the second slide uniformly before being coated. Once the first slide is coated, move the coated slide to the cooling block, move the preheated slide to the substrate holder and place a new clean slide to the free area of the heated stage.

MAINTANANCE

PTFE CHANGE

The PTFE rod should last a long time depending on the number of substrates coated and the deposition temperature. It is recommended to use a new piece of PTFE after ~100 substrates have been coated at 300°C. Usually the surface of the PTFE rod can be renewed by lightly sanding it using a sandpaper with 400 or 600 grit. The PTFE rod subsequently must be cleaned carefully with acetone or alcohol to remove any sand particles left on the surface.

If the deposition temperature is 340-350°C the PTFE rod will deform significantly during the operation and it should be discarded after cooling.

CLEANING

The stage and the upper heater are manufactured from aluminum and have been anodized for protection. If you must clean them, do not use corrosive liquids or strong bases since the finish will be damaged. Wait until the machine is cool and use acetone, alcohol or a mild soap solution to try to remove the stains. In general the instrument should be covered after it cools off to protect it from dust which could be transferred to the substrates during deposition.

LUBRICATION

The positioning stage has been lubricated at the factory and should not require any lubrication for at least 1 year. Lubrication is accomplished by placing a few drops of light oil on the steel rails and screw visible through the slot on the side of the rail table and moving the stage several times using the RP240 controller. Using the Jog move the stage all the way to one side and oil the two rails and the screw. Move the stage to the other side and oil the portion of the rails and the screw visible from the new position. After oiling move the stage back and forth several times to insure uniform distribution of the oil throughout the components.

TROUBLESHOOTING

If you experience any problem with the Tribotrak, please contact DACA Instruments for help.

DACA Instruments
6483 Calle Real, Suite H
Goleta, CA 93117
Phone: +1 (805) 967-6959
FAX: +1 (805) 967-4331
e-mail: daca@daca.com

MOTION PROBLEMS

STAGE DOES NOT MOVE

There are several conditions which may lead to improper function of the stage:

ELECTRICAL PROBLEMS

If the stage does not move after setting up all the parts, first check the electrical fuses. The Tribotrak is equipped with a 6A fuse to protect the entire instrument. If this fuse is damaged, the power indicator will not light up when power is turned on. This fuse is located inside the cover for the power entry module. To change, open the power entry module cover, pull out the fuse and replace the burned out fuse. Carefully close the power entry module lid and restart the instrument.

A spare fuse is provided inside the power entry module. However, if after replacing a fuse, the new fuse is burned out immediately, a more serious problem is present. Please contact DACA Instruments for further assistance.

HARDWARE LIMITS

The Tribotrak is equipped with electrical limit switches to prevent the stage from sliding past the ends. The stage cannot be moved via software commands past these limits. Once the stage has activated a hardware limit, only movement in the opposite direction is possible with software. For example, if the left limit switch has been activated, only movement away from the supporting post for the upper heater will be allowed. Use the Jog Display to move away from the activated limit.

SOFTWARE PROBLEMS

Another possibility for a lack of motion is the input of improper values via the controller. Some examples are:

VEL = 0

POS = 0 (if currently at 0)

POS = current POS

Also pressing GO without returning to the zero position or changing the POS from the current location will produce no motion. For example, if current POS = 65 and you press GO reaching 65, pressing GO again will produce no motion. You must press RET first or enter a new POS to produce any motion.

HEATERS AND TEMPERATURE CONTROLLER PROBLEMS

SOFTWARE ERASED

The software that controls the stage is stored in battery-backed RAM in the indexer inside the electrical enclosure. If upon start-up, the screen of the RP240 does not show the greeting TRIBOTRAK PROGRAM DACA INSTRUMENTS 2001, it is possible that the software has been erased from RAM. Please contact DACA Instruments for assistance with reloading the controlling software to the indexer.

If the POWER LED does not turn on, the connection between the RP240 and the Tribotrak might be faulty. Please verify the connection.

HEATERS

Under normal operating conditions, the lower stage (without substrate) should heat from room temperature to 300°C in 9.5–10 min. If the heating time for the lower stage is several minutes longer than this time it is possible that one of the heaters is damaged. The message **LP.br** should be displayed on the temperature controller if one of the heaters is faulty.

If a problem occurs with the upper heater, the upper section will not heat up and the heater will have to be replaced.

The temperature controller can detect if there is a break in the control loop due to a fuse burn out, heater burn out, faulty output device or loose wiring. The operator is warned by the message **LP.br**. The message is latching, resetable by touching any button on the front panel. The controller assumes a break in the control loop if the output to the heaters remains at 0% or 100% and the measured value moves less than 1/2 of the **PROP** setting (proportional band) towards the setpoint within the setting of **LP.br** (loop break time). These two values are determined during the autotune procedure.

Causes:	Solutions:
Fuse Burnout	Check the appropriate fuse in the rear panel. Replace if necessary.
Heater damaged or burned out	Replace heater. Contact DACA Instruments for instructions

TEMP. CONTROL TUNING & SET UP

TUNING

WHAT IS TUNING?

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

- Stable ‘straight-line’ control of the temperature at setpoint without fluctuation
- 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 T4. These parameters appear in the ‘Pi d’, list.

Parameter	Code	Meaning of Function
Proportional band	P_b	The bandwidth, in display units, over which the output power is proportioned between minimum and maximum.
Integral time	t_i	Determines the time taken by the controller to remove steady state error signals.
Derivative time	t_d	Determines how strongly the controller will react to the rate-of change of the measured value.
High Cutback	H_{cb}	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	L_{cb}	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 P_b value divided by the rEL value.

Table T4. Tuning parameters

AUTOMATIC TUNING

The ‘one-shot’ tuner works by switching the output on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.

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

A One-shot Tune can be performed at any time, but normally it is performed only once during, the initial commissioning of the process. However, if the process under control subsequently becomes unstable (because its characteristics have changed), you can re-tune again for the new conditions.

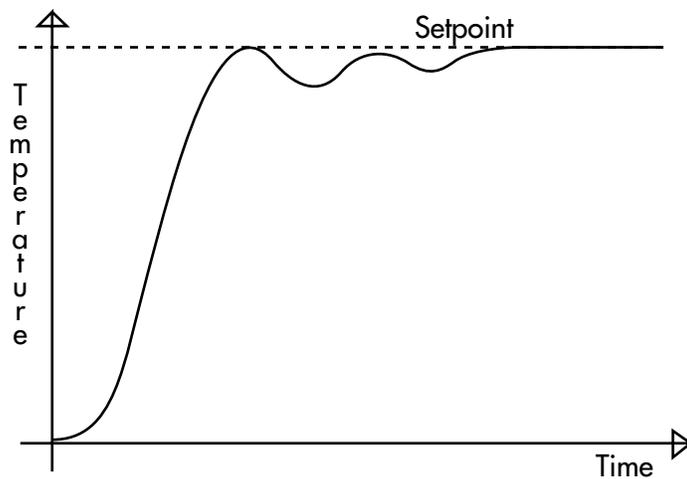
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

HOW TO TUNE

1. Set the setpoint to the value at which you will normally operate the process.
2. In the 'MENU' 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 'I' or 'I D' parameters to 'OFF' before commencing the tuning cycle. The tuner will leave them off and will not calculate a value for them.

TYPICAL AUTOMATIC TUNING CYCLE



CALCULATION OF THE CUTBACK VALUES

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

ACCESS LEVELS

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

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 and the process being controlled.
- **Edit level**, which is used to set up the parameters that you want an operator to be able to see and adjust when in Operator level.
- **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	<i>OPER</i>	In this level, operators can view and adjust the value of parameters defined in Edit level (see below).	No
Full	<i>FULL</i>	In this level, all the parameters relevant to a particular configuration are visible. All alterable parameters may be adjusted.	Yes
Edit	<i>Edit</i>	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	<i>CONF</i>	This special level allows access to set up the fundamental characteristics of the controller.	Yes

Table T5. Access levels list

SELECTING AN ACCESS LEVEL

Access to Full, Edit or Configuration levels is protected by a password to prevent unauthorised access.

ACCESS LIST HEADER

Press  until you reach the access list header 'ACCESS'.

Press .

PASSWORD ENTRY

The password is entered from the 'codE' display. Enter the password using ▲ or ▼. Once the correct password has been entered, there is a two second delay after which the lower readout will change to show 'PASS' indicating that access is now unlocked.

The pass number is set to '1' when the controller is shipped from the factory.

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

Press  to proceed to the *GoE* page.

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

ACCESS TO READ-ONLY CONFIGURATION

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

LEVEL SELECTION

The *GoE* display allows you to select the required access level.

Use ▲ and ▼ to select from the following display

codes: *OPER*: Operator level
FULL: Full level
Edit: Edit level
CONF: Configuration level

Press .

If you selected *OPER*, *FULL*, or *Edit* level you will be returned to the *ALLS* 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.

Press 

CONFIGURATION LEVEL

Contact DACA Instruments about changing the configuration of the controller.

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 *CONF* display.

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

EDIT LEVEL

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

SETTING OPERATOR ACCESS TO A PARAMETER

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

Once in *Edit* level, you select a list, or a parameter within a list, in the same way as you would in Operator, or Full, level - that is to say, you move from list header to list header by pressing , 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:

ALTER Makes a parameter alterable in Operator level.

PROM Promotes a parameter into the Home display list.

READ Makes a parameter, or list header, read-only (it can be viewed but not altered).

HIDE Hides a parameter, or list header.

HIDING OR REVEALING A COMPLETE LIST

To hide a complete list of parameters, all you have to do is hide the list header. If a list header is selected, only two selections are available: *READ* and *HIDE*. (it is not possible to hide the *ALLS* list, which always displays the code: *to LIST*.)

PROMOTING A PARAMETER

Scroll through the lists to the required parameter and choose the *PROM* 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 *PROM LIST* the parameters from segment number (*SEG.N*) onwards *cannot* be promoted.

For additional information on calibration and configuration of the temperature controller, please contact DACA Instruments.

PARAMETERS AND HOW TO ACCESS THEM

Parameters are settings within the controller that determine how it 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 on the following page. The names of these lists are called the *list headers*. The lists are:

Home list	Input list
Alarm list	Output list
Autotune list	Communications list
PID list	Access list.
Setpoint list	

Each list has a ‘List Header’ display.

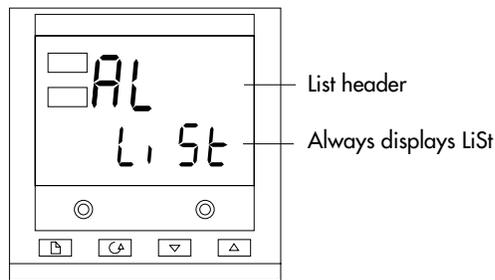


Figure T6. Typical list header display

A list header can be recognized by the fact that it always shows ‘Li St’ 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. In this case, a double press will be necessary to take you to the first list header. Continued pressing of will 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 list header at any time can by pressing . To step to the next list header, press once again.

PARAMETER NAMES

In the navigation diagram, 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 read section 7.1.3, *Access Levels*.

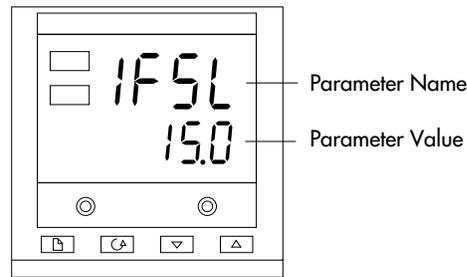


Figure T7. Typical parameter display

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 IFSL (indicating *Alarm 1, full scale low*), and the parameter value is 10.0.

TO CHANGE THE VALUE OF A PARAMETER

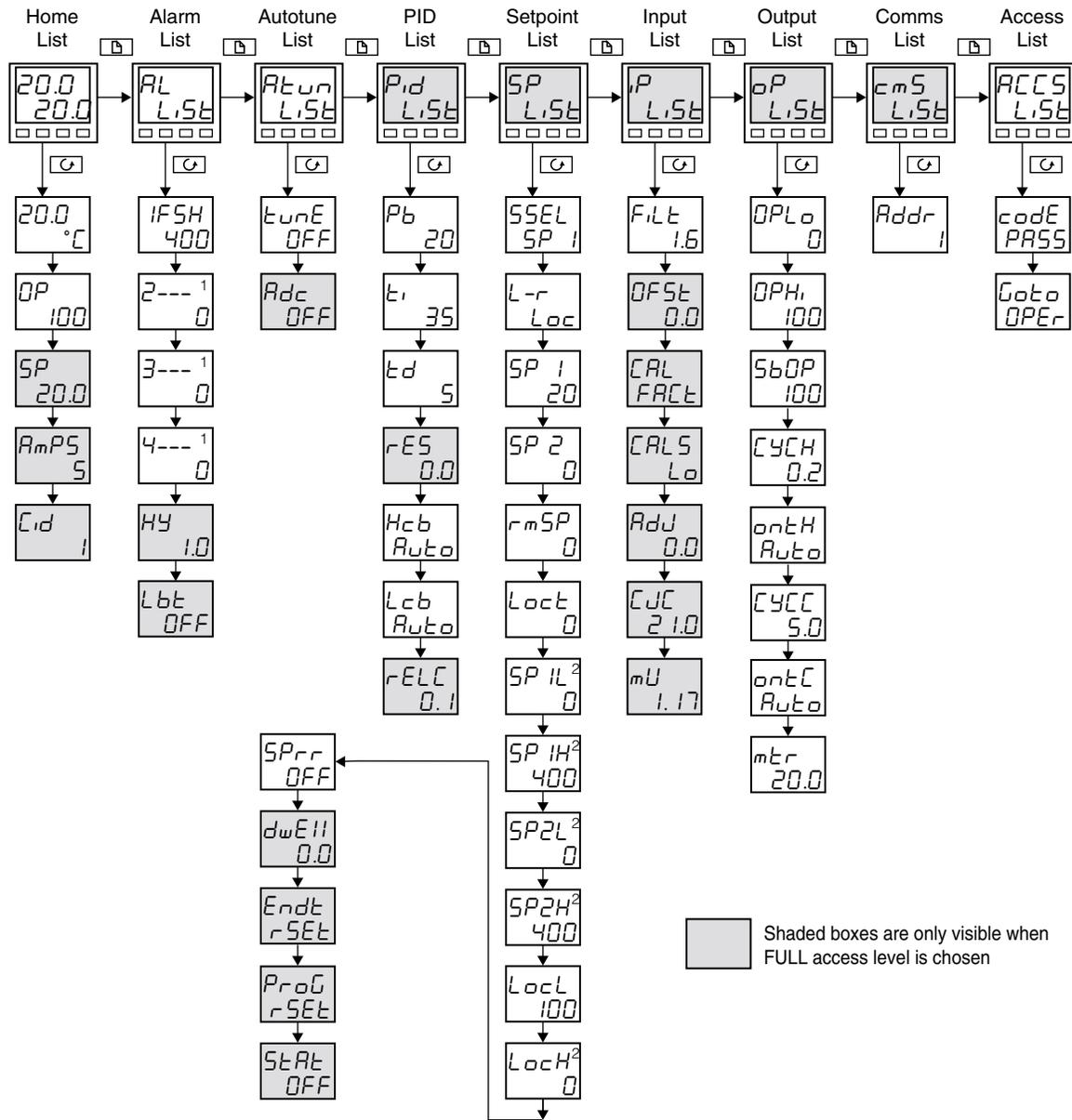
First, select the required parameter. The parameter name is shown in the upper readout and the parameter value in the lower readout.

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.

NAVIGATION DIAGRAM



PARAMETER TABLES

The tables which follow list all parameters that are available in full operator level. The controller comes preconfigured from DACA Instruments. This tables are provided for information pupose only.

HOME DISPLAY

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
Home	Measured Value and Setpoint	SP=25°C			as display
<i>uPOS</i>	Valve positioner output power		0.0	100.0	% of mtr
<i>OP</i>	% Output Level		-100.0	100.0	%
<i>wSP</i>	Working setpoint				as display
<i>SP</i>	Setpoint		-999	9999	as display
<i>AmPS</i>	Heater current (PDS modes 2 and 5)		0	100	AmPS
<i>m-R</i>	Auto/manual select	Auto			
<i>disP</i>	Configure lower readout of home	Std			
<i>cid</i>	Customer ID	0	0	9999	

AUTOTUNE LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
Atun	Autotune List				
<i>TunE</i>	Self tune enable	<i>OFF</i>	<i>OFF</i>	<i>On</i>	
<i>Rdc</i>	Automatic droop compensation (Manual Reset) enable (only present if <i>b</i> set to OFF)	<i>mRn</i>	<i>mRn</i>	<i>CALLC</i>	

ACCESS LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
ACCS	Access list				
<i>codE</i>	Full and Edit level password	1	0	9999	
<i>Goto</i>	Goto level <i>OPER</i> <i>FULL</i> <i>Edit</i> or <i>conf</i>	<i>OPER</i>	<i>OPER</i>	<i>conf</i>	
<i>CONF</i>	Configuration level password	2	0	9999	

ALARM LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
AL	Alarm List				
1--	Alarm 1 set point value	0			as display
2---	Alarm 2 set point value	0			as display
3---	Alarm 3 set point value	0			as display
4---	Alarm 4 set point value	0			as display
In place of dashes, the last three characters indicate the alarm type, as follows:					
-F5H	Full Scale High alarm		-999	9999	as display
-F5L	Full Scale Low alarm		-999	9999	as display
-dEu	Deviation band alarm		0	9999	as display
-dHi	Deviation High alarm		0	9999	as display
-dLo	Deviation Low alarm		0	9999	as display
-Lcr	Low current alarm		0	100	AmPS
-Hcr	High current alarm		-0	100	AmPS
Hy	Hysteresis		0	9999	as display
Lbt	Loop break time	OFF	0	9999	secs

OUTPUT LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
oP	Optput List				
OPLo	Low (power) output limit	-100.0	-100.0	100.0	%
OPHi	High (power) output limit	100.0	-100.0	100.0	%
SbOP	output setting when in sensor break	0.0	-100.0	100.0	%
CYCH	Heat cycle time	1.0	0.2	999.9	secs
ontH	Heat output min on time	0.1	Auto	999.9	
CYCL	Cool cycle time	1.0	0.2	999.9	secs
ontC	Cool output min. on time	0.1	Auto	999.9	
mtt	VP motor travel time		0.0	999.9	secs

PID LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
Pid	PID List				
<i>Pb</i>	Proportional band	20.0	1	9999	as display
<i>ti</i>	Integral time	360	OFF	9999	seconds
<i>td</i>	Derivative time	60	OFF	9999	seconds
<i>rES</i>	Manual reset (appears when <i>ti</i> set to OFF)	0.0	0.00	100.0	%
<i>Lcb</i>	Cutback low	Auto	0	9999	as display
<i>Hcb</i>	Cutback high	Auto	0	9999	as display
<i>rELC</i>	Relative cool gain (set 1)	1.00	0.01	9.99	

INPUT LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
IP	Input list				
<i>FiLt</i>	Input filter time constant	1.6	oFF	999.9	secs
<i>oFSEt</i>	PV Offset		-999	9999	as display
The next 5 parameters will appear if User calibration has been enabled in configuration level					
<i>CAL</i>	<i>FACt</i> will re-instate factory settings and disable User Calibration. <i>USEr</i> will re-instate any previously set User Calibration offsets and make available User Calibration parameters as follows:				
<i>CAL.S</i>	User calibration select	nonE			
<i>AdJ</i>	Adjust calibrated reference source				
The following parameters are allways present in Full Access but not in Operator level.					
<i>CJC</i>	Cold Junction compensation temperature				
<i>mU</i>	Millivolt input				

SETPOINT LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
SP	Set Point List				
<i>SEL</i>	Select	SP1	SP 1	SP2	
<i>L-r</i>	Local or remote setpoint select	Loc	Loc	rmt	
<i>SP 1</i>	Setpoint 1 value	25	As display range		
<i>SP 2</i>	Setpoint 2 value	25	As display range		
<i>rm.SP</i>	Remote setpoint	0	As display range		
<i>Loc.t</i>	Local trim	0	As display range		
<i>SP 1L</i>	Setpoint 1 low limit	0	As display range		
<i>SP 1H</i>	Setpoint 1 high limit	1000	As display range		
<i>SP 2.L</i>	Setpoint 2 low limit	0	As display range		
<i>SP 2.H</i>	Setpoint 2 high limit	1000	As display range		
<i>Loc.L</i>	Local setpoint trim low limit	-210	As display range		
<i>Loc.H</i>	Local setpoint trim high limit	1200	As display range		
<i>SPrr</i>	Setpoint rate limit	OFF	As display range		
<i>dwEll</i>	Dwell time	OFF	0.1 to 999.9 minutes		
<i>End.t</i>	End type	<i>rSEt</i>	<i>rSEt</i> <i>hold</i> <i>Stby</i> <i>dwEll</i>		
<i>Prog</i>	Program control	<i>rES</i>	<i>run</i> <i>rSEt</i>		
<i>Stat</i>	Status of program	<i>OFF</i>	<i>rmP</i> <i>dwEll</i> <i>End</i> <i>OFF</i>		

APPENDICES

APPENDIX A: PREPARATION OF GLASS SUBSTRATES

Substrates to be coated must be very clean, free of grease and dust. What follows is the normal procedure for cleaning microscope glass slides since they would be the primary substrate to be used with the Tribotrak. A special glass jar has been included with the instrument to clean glass slides.

CLEANING SOLUTION:

Two cleaning solutions have been successfully used to clean glass slides.

- a. Alcoholic KOH — This solution is prepared by dissolving 10 g of Potassium Hydroxide (KOH) in 10 ml of deionized water. After dissolution, the liquid is mixed with 200 ml of ethanol.
- b. Another effective solution is prepared by mixing 8 ml of standard ultrasonic cleaning solution (such as MicroClean™) with 150 ml of deionized water.

IDENTIFICATION MARK:

The PTFE layer deposited on to the substrate is very difficult to detect visually. For this reason, it is advisable to place a mark on one side of the substrates before coating. The mark on the substrates should be made before cleaning in order to minimize handling of the cleaned substrates. A carbide scribe can be used to mark the glass slides. A useful mark is shown in the following diagram. The word UP will be readable only one way and the PTFE should be deposited on the marked surface.



CLEANING:

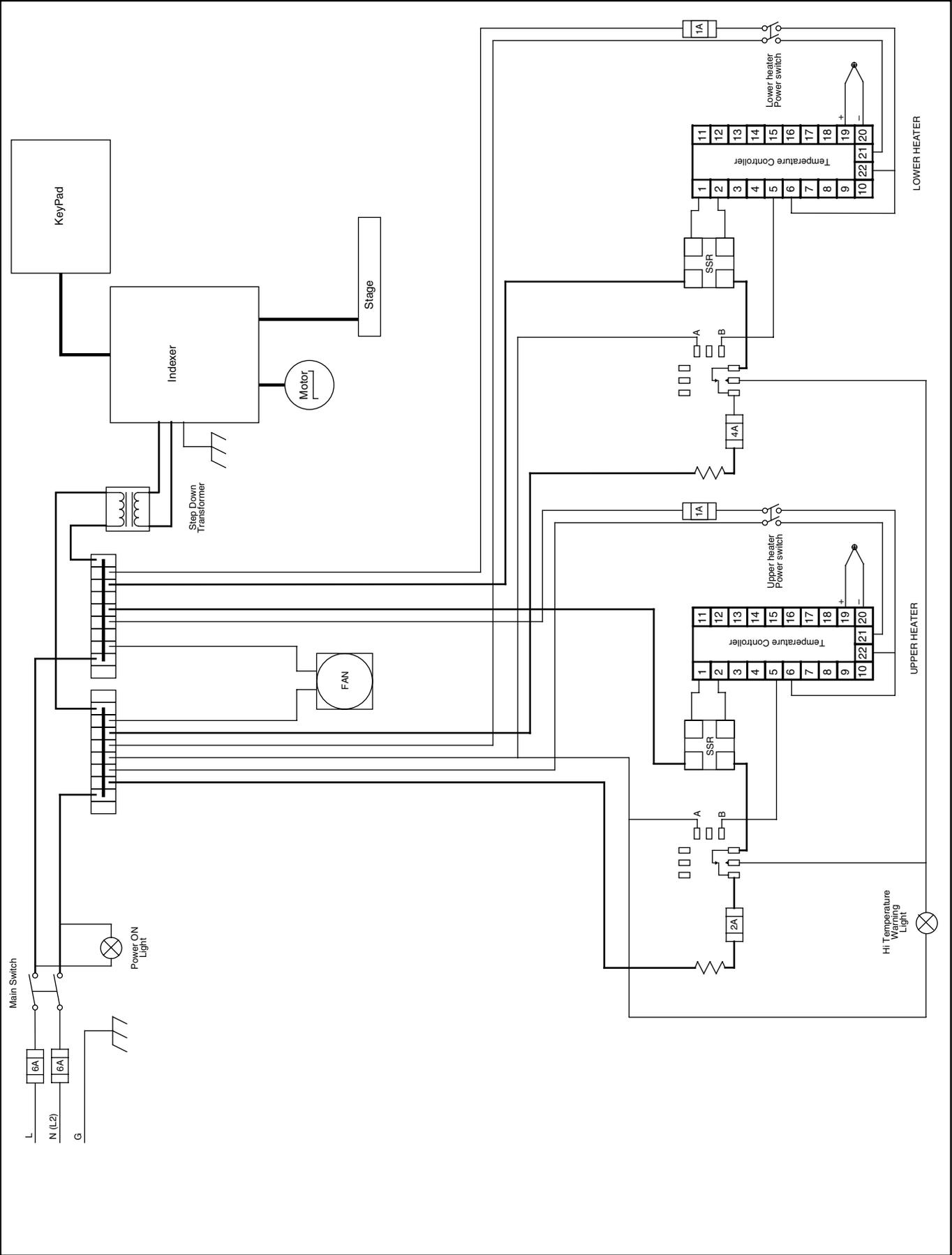
Once the glass slides have been loaded in the cleaning jar, cover them with the cleaning solution and place the jar in an ultrasonic bath for 15 minutes. (If an ultrasonic bath is not available, keep the slides in the solution for 30 min.)

Remove the glass slide “basket” from the sonic bath and thoroughly rinse the glass slides with water. If the KOH solution was used, it is important to remove all the KOH before drying.

It is recommended that hot tap water be used to remove the KOH more quickly. Finally, rinse the slides with deionized water.

After rinsing, remove the water by blow drying the slides with high pressure air or nitrogen. Try to dry the slides as much as possible this way to minimize residues. Finally place the slides in a drying oven (~100°C) for 20 minutes.

APPENDIX B: SCHEMATIC OF THE ELECTRICAL WIRING



APPENDIX C: WARRANTY

Our Pledge

It is the goal of DACA Instruments to have every article bearing the DACA name give you, the Customer, complete satisfaction. To achieve this end, we maintain the highest standards for our workmanship and materials, and for the inspection of our products. If the article you have purchased should experience any problem during its lifetime, contact us and we will do all we can to fix the problem. (We will fix it almost for free during the first year.) However, if you abuse the article or accidentally “drop it on your foot,” it’s your problem!

PLEASE COMPLETE AND RETURN THE WARRANTY CARD WHICH IS INCLUDED WITH YOUR INSTRUMENT SHIPMENT. Although it is not a requirement to validate the warranty, it will allow us to send you (and not the purchasing department) information about new products, as well as modifications to the product you purchased.

LIMITED WARRANTY

DACA Instruments warrants this equipment to be free of defects in materials and workmanship for a period of thirteen (13) months from date of shipment. DACA’s Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling, shipping and set-up time. This ensures that our customers receive maximum coverage on each product. Our liability under this warranty is limited to the repair and replacement, at our expense, of any defective item or part thereof with a similar item or part thereof free from defect. This warranty does not apply to any equipment altered by Customer or which malfunctions because of Customer’s fault or negligence or to components which experience normal wear. If during the warranty period the equipment malfunctions and the Customer contacts DACA Instruments, describing the problem being encountered, DACA Instruments will analyze the problem to the extent possible and either advise of corrective action that the Customer can perform or request the return of the equipment to DACA Instruments for factory repair. If factory repair is required, Customer will return the equipment in accordance with DACA Instruments’ instructions at Customer’s expense. Upon receipt, DACA Instruments shall either repair the equipment or replace it with an equivalent unit(s), and return such equipment to Customer at DACA Instruments’ expense. THE WARRANTIES CONTAINED IN THIS PARAGRAPH ARE IN LIEU OF ALL OTHER WARRANTIES, AND NO OTHER WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY OR FITNESS, APPLY TO THIS EQUIPMENT, AND NO EXPRESS WARRANTY OR GUARANTY, EXCEPT AS MENTIONED ABOVE, GIVEN BY ANY PERSON, FIRM OR CORPORATION WITH RESPECT TO THIS EQUIPMENT, SHALL BIND DACA INSTRUMENTS.

This warranty gives the Customer specific legal rights, and the Customer may also have other rights that vary from state to state, province to province, or country to country.

LIABILITY

These units are inherently dangerous and are intended to be installed and used only by qualified personnel. Our liability is conditioned upon the installation, operation, maintenance, storage, service and repair of the item in accordance with written plans and instructions prepared or approved by us. In no event will DACA Instruments be liable for any damages, including any lost revenue or other indirect, incidental, special, consequential, punitive or exemplary damages arising out of the use or inability to use equipment purchased from DACA Instruments. By accepting this equipment, the Customer will assume all liability for any damages which may result from its use or misuse by the purchaser, his/hers/its employees or by others. No warranty extended herein will apply if such unit is installed or used by unqualified personnel. Further, the customer agrees that any liability of DACA Instruments for all claims if any shall not exceed the amount actually paid by customer.

Further, the Customer and/or its End Users shall indemnify and hold harmless DACA Instruments from all loss, damage, costs and expenses of whatever nature, including attorney's fees, arising from or in any way connected with any injury to person or damage to property resulting from an unauthorized modification or alteration of the Product.

Equipment manufactured to Customer's design is quoted on Customer's drawings and bills of material; any costs incurred as a result of errors in the Customer's drawings or bills of material shall be paid for by the Customer.

PATENTS: The sale of any product or products by DACA Instruments pursuant to this order does not convey to the Purchaser any license, by implication, estoppel, or otherwise, respecting any patent, trademark or trade name claims or rights of DACA Instruments covering said product or products or any combination thereof with or without other devices or elements.

MODIFICATIONS TO THE TERMS OF SALE: No addition to, deletion from, nor modification of any of the provisions of the Terms & Conditions of Sale of this order shall be binding upon DACA Instruments unless acknowledged and accepted in writing by DACA Instruments. Any change made by DACA Instruments will be deemed accepted by Customer unless, within ten (10) days from written notice of such change, Customer notifies DACA Instruments. Any waiver of the Terms & Conditions of Sale shall not be deemed to be a continuing waiver or a waiver of any other default or of any other of these Terms & Conditions of Sale, but shall apply solely to the instance to which the waiver is directed. Any agreed upon modifications shall be specified on both the Customer's purchase order and DACA's order acknowledgement document.

MISCELLANEOUS PROVISIONS: This Agreement is entered into, shall be governed by, and is to be construed according to the laws of the State of California. Any dispute, controversy, or claim arising out of or relating to the enforcement, interpretation, or alleged breach of this Agreement shall be submitted to and resolved by binding arbitration in the Santa Barbara County, California before one (1) neutral arbitrator appointed in accordance with the Commercial Arbitration Rules of the American Arbitration Association and judgment upon the award may be entered in and enforceable by any court having jurisdiction. In the event that any matter respecting this Agreement is submitted to arbitration or if either party hereto files suit to enforce and/or interpret this Agreement, the prevailing party in such proceedings shall be entitled to reasonable attorney's fees and costs. In addition, jurisdiction and venue of any claim filed to enforce and/or interpret this Agreement shall lie with the appropriate State of California court in the County of Santa Barbara

The parties hereto agree that if any provision of this Agreement or the application thereof is held to be invalid, then such invalidity shall not effect any other provisions of this Agreement or the application thereof and to this end the provisions of this Agreement are declared severable.

This Agreement contains the entire agreement of the parties concerning any and all matters described herein, and supersedes any prior or contemporaneous agreements with respect thereto. As such, the provisions of this Agreement may only be modified by an instrument in writing signed by the parties.



NOTES

