

**SpinLine**

# **OPERATION MANUAL**

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p/n 30900

**DACA**  
instruments

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# WARNINGS



High operating temperatures and moving parts of DACA Instruments' 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 Operation Manual 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 does 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 Instruments' 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 performing any service including 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. 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.

### **5. HIGH PRESSURE COMPRESSED AIR**

The Piston Extruder uses compressed air for cooling. High pressure compressed air is potentially dangerous. Always follow the operating instructions. Before releasing a air connection, disconnect the air supply and reduce to zero any system pressure and stored pressure.

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# INTRODUCTION

## **GENERAL DESCRIPTION**

### **SPINLINE**

The SpinLine is a multipurpose tool designed to process small quantities of polymer fibers in a precise and controlled way. The equipment employs computer controlled supply and take up rolls, heating elements, and winders, to accurately control fiber drawing speed, draw ratio, and processing temperature. This equipment is designed to be used in conjunction with the Piston Extruder to serve as a small fiber production facility.

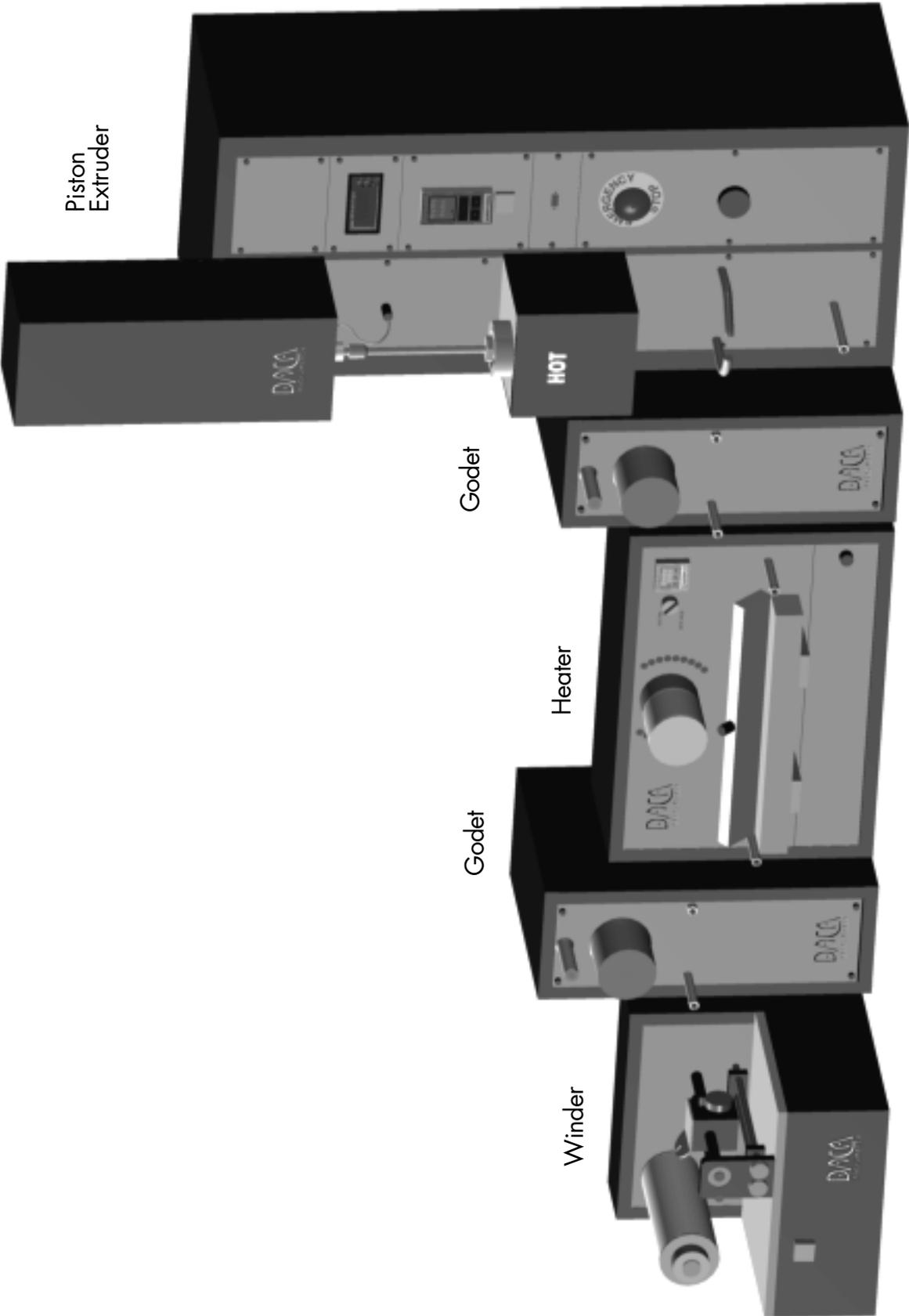
### **HIGH-PRESSURE PISTON EXTRUDER**

This instrument is a computer controlled, piston-driven extruder for polymer melts, polymer solutions, or more generally, any kind of highly viscous fluid. The apparatus is particularly useful for the production of miniature size samples of fibers, without the need for optimization of continuous extrusion parameters.

# SPECIFICATIONS

	Piston Extruder	Godet	Winder	Heater
Electrical Volts Amps Freq. (Hz) Phase	120 220 10 7 50/60 1	120 220 5 3 50/60 1	120 220 5 3 50/60 1	120 220 5 3 50/60 1
Motor Torque Nm oz.in.	2.8 400	7.1 1000	2.14 300	—
Gear Reduction	15:1	—	—	—
Temp. Controller	Eurotherm 94 Digital AutoTune PID, Closed loop			Eurotherm 91c Digital AutoTune PID, Closed loop
Thermocouple	K Type	—	—	Pin: K Type Shoe: K Type
Heater	2x350W	—	—	Pin: 225W Shoe: 150W
Physical Dimensions cm inches	W x D x H 39 51 123 15.5 20 48.5	W x D x H 19 43 48 7.5 17 19	W x D x H 35.5 38 34 14 15 13.5	W x D x H 53 33 38 21 13 15
Weight Kg lb	70 154.3	30 66	24 53	18 40
Other Sensors	Load Sensor 5000 N Limit Alarm	—	—	—

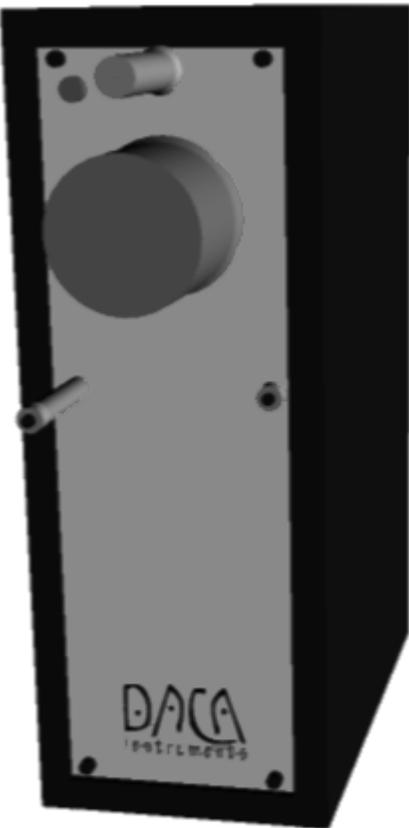
# ILLUSTRATION OF COMPLETE SYSTEM IN STANDARD CONFIGURATION



# ILLUSTRATION OF PISTON EXTRUDER



**ILLUSTRATION OF GODET**



**ILLUSTRATION OF WINDER**



# ILLUSTRATION OF FIBER HEATER



# 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 Instruments' billings include insurance for damage or loss in transit.

The SpinLine is shipped in two crates

Crate 1 should contain the following items:

- 1 Piston Extruder
  - 1 Controller
  - 1 Bag containing
    - 5 power cords
    - 3 interconnect data cables
    - Cleaning brush, cleaning tool, charging tool
    - Set of English Hex wrenches
    - Set of Metric Hex wrenches
    - Open end whrench for barrel
    - Tool to remove Barrel Cap
  - 1 Bag with 10 spools for the winder
  - 1 Small plastic box containing:
    - Additional O-rings for the barrel
    - Additional O-rings for the piston
    - Extra spinnerets if ordered
  - 1 Bag containing:
    - This Manual
    - Registration Card
- Any other optional accessories ordered

Crate 2 should contain the following items:

- 2 Godets
- 1 Heater module
- 1 Winder

If any of these items is missing, please contact DACA Instruments immediately so that we may ship replacements.

## INSTALLATION

### LOCATION

The SpinLine should be set up on a leveled, sturdy table or bench. The SpinLine is a modular system that can take a significant amount of bench space depending on how it is configured. The table should be well supported to accommodate the weight of the complete system (172 Kg/380 lb).

### ELECTRICAL

The SpinLine modules require electrical connections. The modules operate with 120 or 220VAC, 50/60Hz, 3-10Amp, single phase. For proper operations outside the U.S., the plug on the power cord might have to be replaced with a different one. Consult you local electrical code for the appropriate cable and plug.

## OPERATOR INTERFACE

A separate control console is provided. The unit connects to the front of the piston extruder with the cable provided.

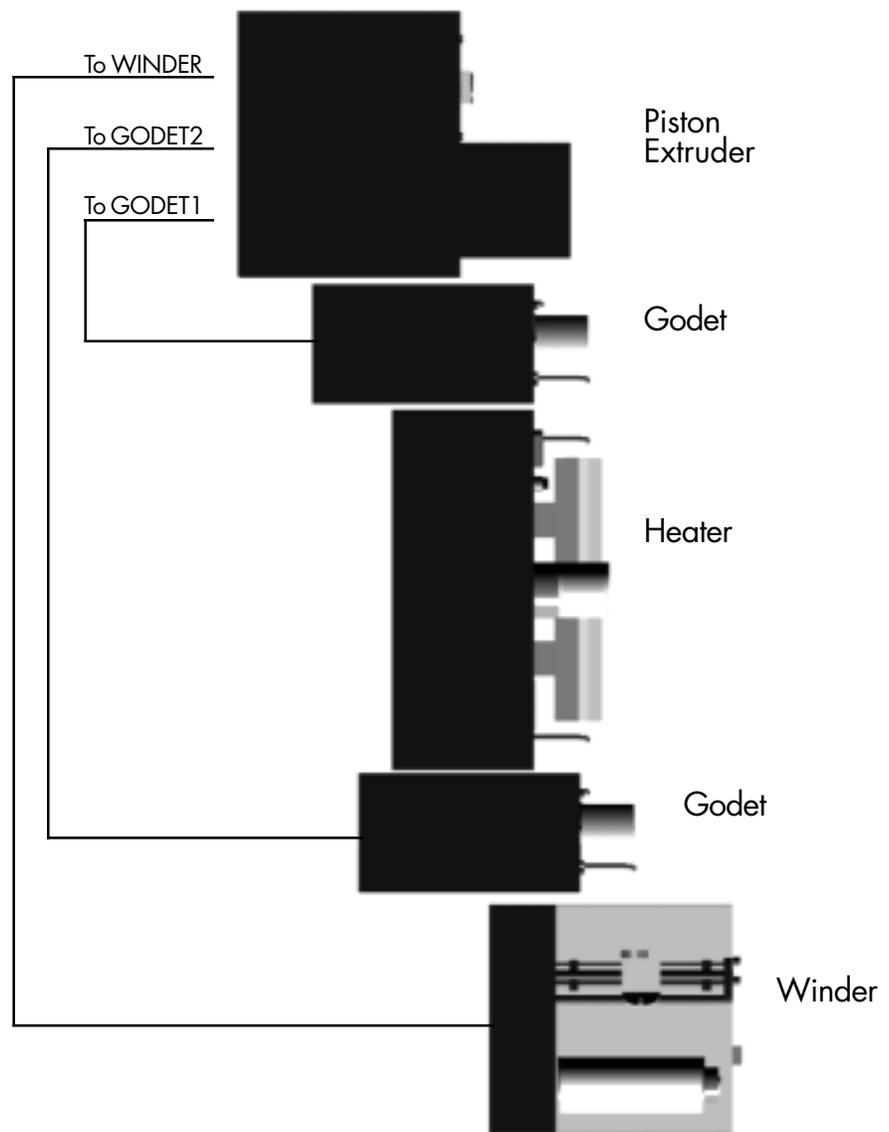
## INTERCONNECT DATA CABLES

Three data cables are provided to connect the Godets and Winder module to the Piston Extruder. The cables are interchangeable. The connectors on the back of the extruder are labeled to indicate the proper connection. It is important that the Godet which receives the fibers from the extruder be connected to the GODET1 port. The Godet placed before the winder must be connected to the GODET2 port (see diagram below).

## COOLING AIR SUPPLY

A fixture is provided on the back of the Piston Extruder to connect a compressed air line used for cooling the fiber as it comes out of the extruder. The normal operating pressure should be 2.8 BAR (40 PSIG) or less. Lower pressures provide better flow control of the air. Excessive pressure will cause damage to the gas lines inside the instrument.

## TOP VIEW SHOWING THE DATA CABLE CONNECTIONS AND THE OVERALL ALIGNMENT OF THE COMPONENTS



# OPERATION

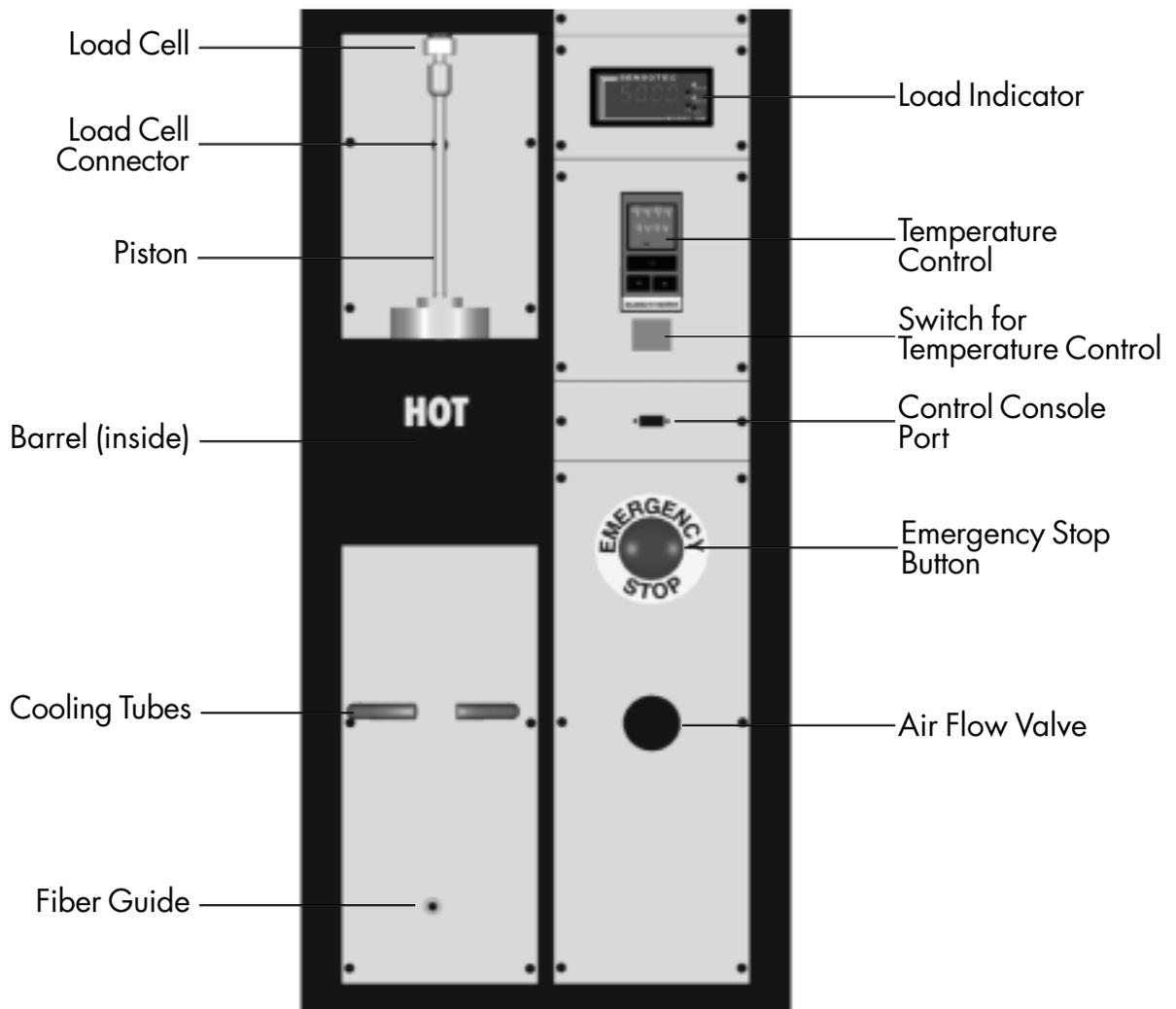
## PISTON EXTRUDER

The Piston Extruder is a batch extruder for polymers or high viscosity fluids. The instrument consists of a heated barrel and a computer controlled piston that pushes the molten polymer in the barrel through a small orifice (spinneret) at a very precisely controlled rate. The instrument can generate over 5000 N of force on the polymer to extrude it out of the spinneret. This unit is also the heart of the system since it contains the computer that also controls the Godets and the Winder. Consequently this unit must be turned ON even if only the Winder is going to be used.

### SET UP

The Piston Extruder requires only a connection to electrical power and a connection to high pressure air (< 2.8 BAR/40 psig) to supply air to the cooling Tubes. In addition the control console must be connected to the front panel connector in order to control the instrument. If the other components (Godets and Winder) will be used they must be connected to the back of the Piston Extruder using the data cables provided. These units should be turned ON before turning ON the Piston Extruder.

### COMPONENTS OF THE HIGH PRESSURE PISTON EXTRUDER



# TEMPERATURE CONTROL FOR EXTRUDER

Portions © EUROTHERM CONTROLS Inc.

Temperature of the barrel is controlled by a EUROTHERM model 94 temperature controller. A separate power switch has been provided for the temperature controller.



## START UP AND PARAMETER SECURITY

The controller has been pre-configured as follows:

Maximum Allowable Set Point: 400°C

Measured Temperature Unit: °C

Heat and Cool Control: PID control on both channels

The controller configuration and parameter values are stored in nonvolatile EPROM. This memory provides data retention for the life of the controller with or without power supplied. When the controller is powered up, it performs a self test to verify that all the memories and internal electronics are operating properly before controlling the temperature.

### SELF DIAGNOSTIC MESSAGES

MESSAGE*	DISPLAY CONDITION	USER ACTION/COMMENTS
<b>tEst</b> <b>1111</b>	Internal self test upon power up.	Replace unit if all four <b>1</b> 's do not light up or fails to go to " <b>8888</b> ". Do not touch front panel during self test.
<b>8888</b> <b>8888</b>	Display test after above self test. Lasts for approximately 3 seconds.	User should verify that all digits and lamps light up to prevent erroneous readings.
<b>E E</b> <b>FAIL</b>	Memory corruption.	Verify and correct all parameter and configuration values. If display persists, replace unit.

\* The two lines in the message box refer to what will be displayed in the upper and lower display lines of the controller. *measured value* refers to the temperature currently measured by the controller. *param. mnemonic* refers to the 2-4 letter code used for a particular parameter such as **AL** for alarm.

## BASIC OPERATION

### SETPOINT CHANGE

To light up the buttons: touch any key on the front panel.

To modify the set point: press ▲ or ▼ to increase or decrease the set point respectively.

## PROCESS RELATED SAFETY FEATURES

### MEASURED VALUE ALARM

The temperature controller has been configured for one HI temperature alarm condition:

Alarm 1: HI temperature alarm (>360°C)

When the Alarm 1 condition is reached (measured temperature = 360°C), a red annunciation LED –AL1– on the controller lights up to indicate the over temperature condition. This alarm condition is non-latching and when the temperature drops below 360°C the AL1 LED turns off.

### SENSOR BREAK ALARM AND SHUTDOWN

If the controller detects that the sensor circuit (thermocouple) has failed, then the output power level is forced to 0% and the annunciation **SnSr FAIL** is displayed. Upon reinstatement of the input sensor, the controller resumes controlling with the same output power level used at the moment of the break.

A failed sensor is detected if:

- the input signal is out of the selected sensor's range
- the input is open circuit
- the controller's operating temperature is outside of the specified operating range (thermocouple inputs only)

### LOOP BREAK ALARM

The temperature controller can detect if there is a break in the control loop due to a fuse burnout, heater burnout, 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. During a loop break alarm condition, the controller output is determined by the control algorithm.

### LOOP STATUS MESSAGES

MESSAGE*	DISPLAY CONDITION	USER ACTION/COMMENTS
<b>Sn Sr FAIL</b>	Sensor fail. Input open or reversed; measured value outside of configured range.	Verify input sensor and connections. Message disappears when input signal is reinstated
measured value <b>LP.br</b>	Break detected in control loop.	Verify output device, fuses, wiring and heater. Check that input wiring is not shorted. Acknowledge by touching any key.
measured value <b>SP.rr</b>	Setpoint ramping in progress.	Setpoint and "SP.rr" parameter still user-adjustable during ramping.
measured value <b>SP 2</b>	Setpoint 2 selected.	Setpoint 1 may be adjusted in protected list
<b>HHHH</b> setpoint	Measured value greater than high sensor limit.	Unit should not be used in this range.
<b>LLLL</b> setpoint	Measured value less than low sensor limit.	Unit should not be used in this range
param. mnemonic <b>LLLL or HHHH</b>	Parameter value out of range. May have resulted from change of configuration code	In general, check (and reset if required) parameter values after reconfiguration

## TUNING AND ADJUSTMENTS

### SELF-TUNING GENERAL INFORMATION

The temperature controllers incorporate a self-tuning algorithm that automatically determines values for the PID parameters for the heating and cooling loops. The algorithm is operative when changing the setpoint or upon start-up. A unique feature of the algorithm minimizes overshoot when the tuning operation is started with the barrel at ambient temperature.

The operator can simply select "tuning" from the controller. The algorithm does not require that the operator load any initial PID parameter values to initialize the procedure. During the tuning operation, the message **tunE** is displayed alternately with the setpoint. When the algorithm has successfully finished tuning the loop, **tunE** is no longer displayed and the calculated parameter values are loaded into memory. These results can be inspected by the operator.

If selected, the self-tuner can automatically determine values for the overshoot inhibition parameters (high and low cutback), as well as the time setting for the loop break alarm.

The controller has been pre-tuned at the factory for optimal operation at 180 °C. If you feel that the response of the system is not adequate, it is easy to autotune the controller to recalculate the PID parameters at anytime. It might also be necessary to perform the tuning procedure to compensate for differences in the cooling air flow rate between the factory and your location.

### PID SELF-TUNING PROCEDURE

USE THIS PROCEDURE WHEN THE INSTRUMENT HAS COOLED TO ROOM TEMPERATURE.

- After turning the controllers ON, dial the setpoint temperature to 180 °C (or your normal operating temperature)
- press  until **tunE** shows up in the upper display
- press  or  until **Ht.CI** shows up in the lower display and pause
- the **tunE** message will flash in the lower display
- wait for the tuning operation to finish: **tunE** will no longer be displayed

### SELF-TUNE MESSAGES

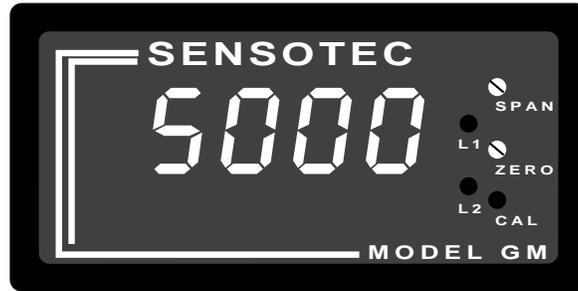
MESSAGE	DISPLAY CONDITION	USER ACTION/COMMENTS
measured value <b>tunE</b>	Self tuning in progress.	Annunciation only. Adjustment of setpoint and PID values inhibited during self tuning
<b>tunE FAIL</b>	Self tuning operation has failed because controller cannot maintain setpoint.	Acknowledge by touching any key. Remove cause of failure: e.g. heater fuse blown, etc.
<b>LinE FAIL</b>	Loss of controller power during self-tuning operation renders sampled data questionable.	Acknowledge by touching any key. Verify power supply. Reinitiate self tuning procedure.

## LOAD INDICATOR

The load sensor and indicator are provided to monitor the load that the piston applies on the polymer during extrusion. The load sensor also acts as a limit to prevent excessive loads from damaging the instrument.

For a constant volume of material extruded, the load generated will be proportional to the viscosity of the material and to the extrusion speed, and inversely proportional to the spinneret diameter. This load is monitored using a load sensor placed above the piston on the lead screw and is displayed in the load indicator. The force is measured and displayed in Newtons and it has a range of

0–5000 N. The load sensor is also a safety device which monitors the process load and cuts power to the motor if the load exceeds 5000 N. The main purpose of this limit is to protect the instrument, particularly the piston and barrel, against damage.



### SAFETY LIMITS

Two limits are pre-programmed into the indicator.

L1 (Low limit):

This limit has been programmed to activate at 4500 N. Once activated, a light will turn on below the L1 as a warning of excess load.

L2 (High limit):

This limit has been programmed to activate at 4585 N. Once activated, the **entire system will stop**, thus ending the process. In addition to the warning light below the L2 reset button the program will also display a message that the limit has been reached. Please read the Software Control section for the correct procedure to follow in such an emergency.

Two conditions will cause the load to exceed the allowed setting:

- the viscosity of the material being compounded is too high
- the spinneret is blocked preventing proper flow of the material out of the barrel

In either case, the barrel should be opened and manually emptied before continuing with other tests. Do NOT continue to extrude the material which triggered the alarm since damage to the Piston Extruder will occur.

Some adjustments might be necessary from time to time to maintain the load indicator working within the proper parameters. These include adjusting the FINE ZERO and FINE SPAN if they have changed. Allow the instrument to warm up for 15 minutes before making any adjustments.

### FINE ZERO ADJUSTMENT

The load transducer usually has a small amount of zero drift as a result of temperature change at the transducer itself. If the indicator does not read zero when the barrel is open and no load is placed on the load pin, the transducer can be readjusted to zero by changing the position of the ZERO adjustment screw with a small screwdriver.

### FINE SPAN ADJUSTMENT

After the FINE ZERO is readjusted, press the CAL button to determine if the span is correct. With the CAL button pressed, the indicator should read\_\_\_\_\_. If the reading is different change the position of the SPAN adjustment screw with a small screwdriver until the display reads\_\_\_\_\_. Release the CAL button and verify that the display returns to zero. Repeat both steps if necessary.

## COOLING AIR VALVE

A precision needle valve is provided to control the flow of cooling air out of the repositionable hoses. These hoses have come prefitted with the wide tip to broaden the cooling area. Additional round nozzles are provided to change the pattern of the air flow. The pressure of the incoming air should be low to achieve the best flow control of the air.

## BARREL AND HEATING JACKET

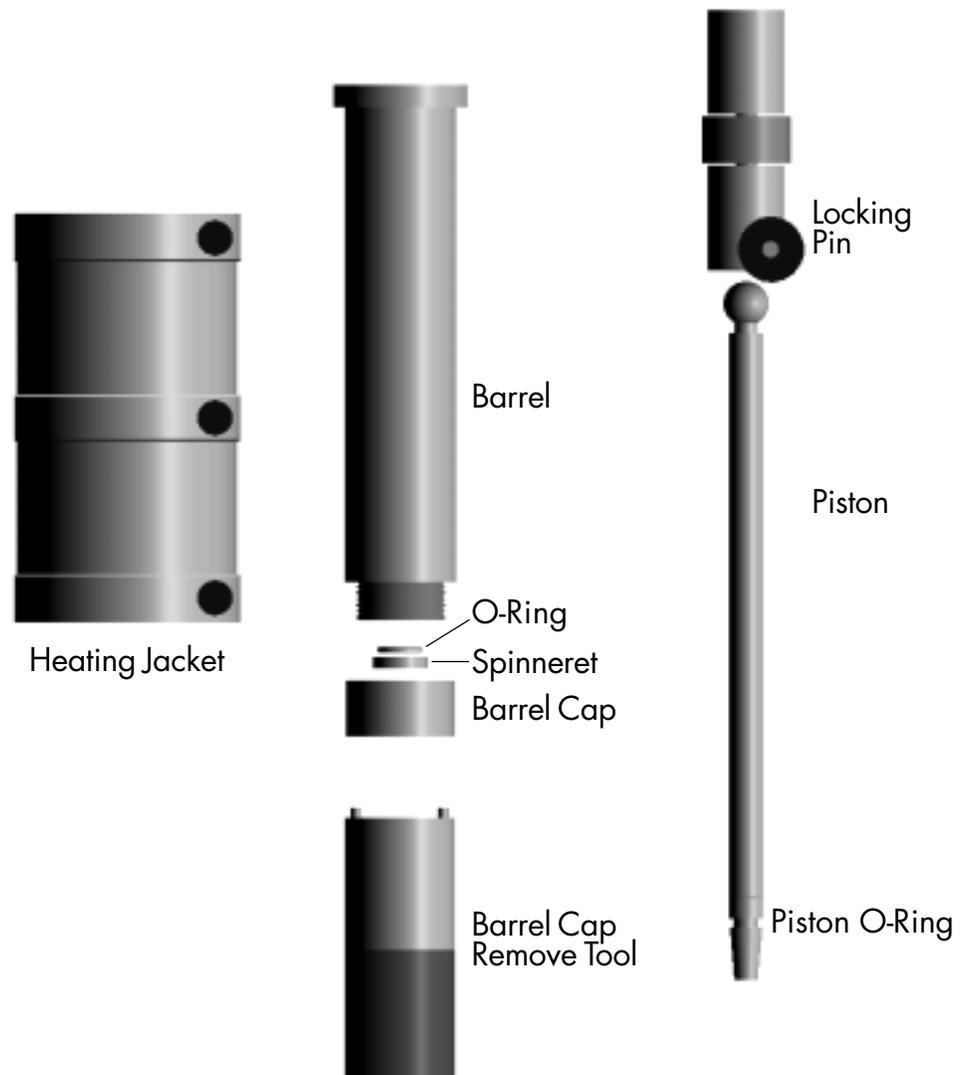


The barrel has been designed with an independent heating jacket to allow the use of different barrels with the same heating jacket.

**WARNING** Assembly and disassembly of the barrel should be performed when the unit is at room temperature.

To remove the barrel and heating jacket from the Piston Extruder disconnect the electrical connector from the front panel. To separate the heating jacket from the barrel, loosen the three screws that tighten the jacket. It is not necessary to fully remove the screws or to loosen the screws for the heating bands. Once the heating jacket is removed, the barrel can be lifted from the top of the support structure.

The spinneret on the barrel can be changed by removing the barrel cap at the end of the barrel. This can be accomplished while the barrel is in place. Use the open end wrench and the cap removal tool to change the spinneret. A PTFE (Teflon®) O-ring is used to provide a seal between the barrel and the spinneret. Several additional O-rings have been provided for replacement.



## **OPERATION OF PISTON EXTRUDER**

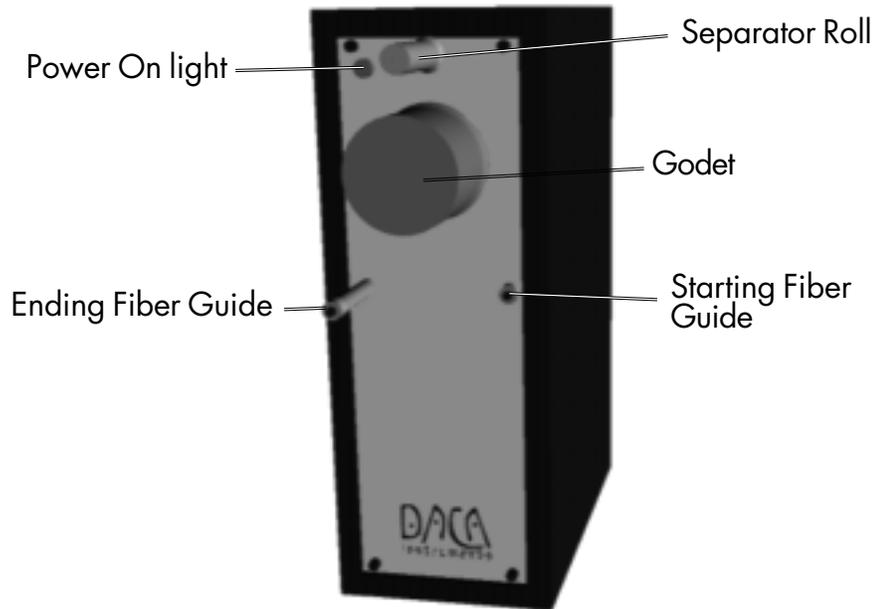
A smaller PTFE O-ring is used at the tip of the piston to provide a seal between the piston and the barrel. The ring is slightly oversized and will compress after a few times of use. After this compression it becomes easier to push the piston in slightly into the barrel to load it on to the ball assembly. The locking pin is provided to maintain the piston attached to the ball assembly when extrusion is finished and the piston is withdrawn from the barrel, since it could become stuck to the bottom of the barrel due to polymer friction.

Once the barrel is put back on the Piston Extruder and the heating jacket is reassembled, the system is ready to be heated and loaded with polymer. Turn on the temperature controller and set the desired temperature as described in the Temperature Control section on pp 16. Polymer can be loaded into the barrel at any point during the heating cycle but it is easier to load the maximum amount of polymer when the barrel is heated since the molten polymer can be manually pushed down the barrel with the piston. A funnel is provided to facilitate loading of the polymer onto the barrel.

Once the polymer is loaded, the piston is installed in place by first inserting the tip slightly into the barrel holder and then moving up onto the ball assembly. After the piston is in place, install the locking pin in the hole provided.

Once the barrel temperature is stable and the piston is in place proceed with the program using the control panel to operate the Piston Extruder, Godets and the Winder. The Fiber Heater unit should be turned on and the temperature stable before running fibers over either heater.

**GODET UNIT** This component is used to pull the filament from the piston extruder and to stretch the filament either through the heater unit or cold from one Godet to the other. The speed of the high torque stepper motor in the Godet unit is computer controlled from 0.05 to 300 m/min.



## SET UP

There are two Godets units in the system. The two units are identical and are only differentiated when they are connected to the ports on the back of the piston extruder. On the back of each Godet there are two ports, one for electrical power and the other (labeled To Controller) is for the data cable. The Godet connected to the GODET 1 port on the Piston Extruder, becomes the Main Godet. This Godet is intended to pull the filament from the Piston Extruder or another fiber source. The unit connected to the GODET 2 port on the Piston Extruder, becomes the secondary or stretch Godet. This Godet stretches the filament by rotating faster than the first Godet. For correct positioning, GODET 1 should be placed on the left side of the Piston Extruder (see figure on page 14)

## OPERATION OF GODETS

The main parts of each Godet unit are the actual rotating Godet and the separator roll. In addition there are two filament guides to control the starting and ending position of the filament over the Godet. The path of the filament should start on the inside of the Godet, wrap a number of times around the Godet and the separator roll ending on the outside of the Godet. Usually 8 to 10 wraps over the Godet and separator roll are necessary to build enough friction on the filament to prevent sliding during stretching.



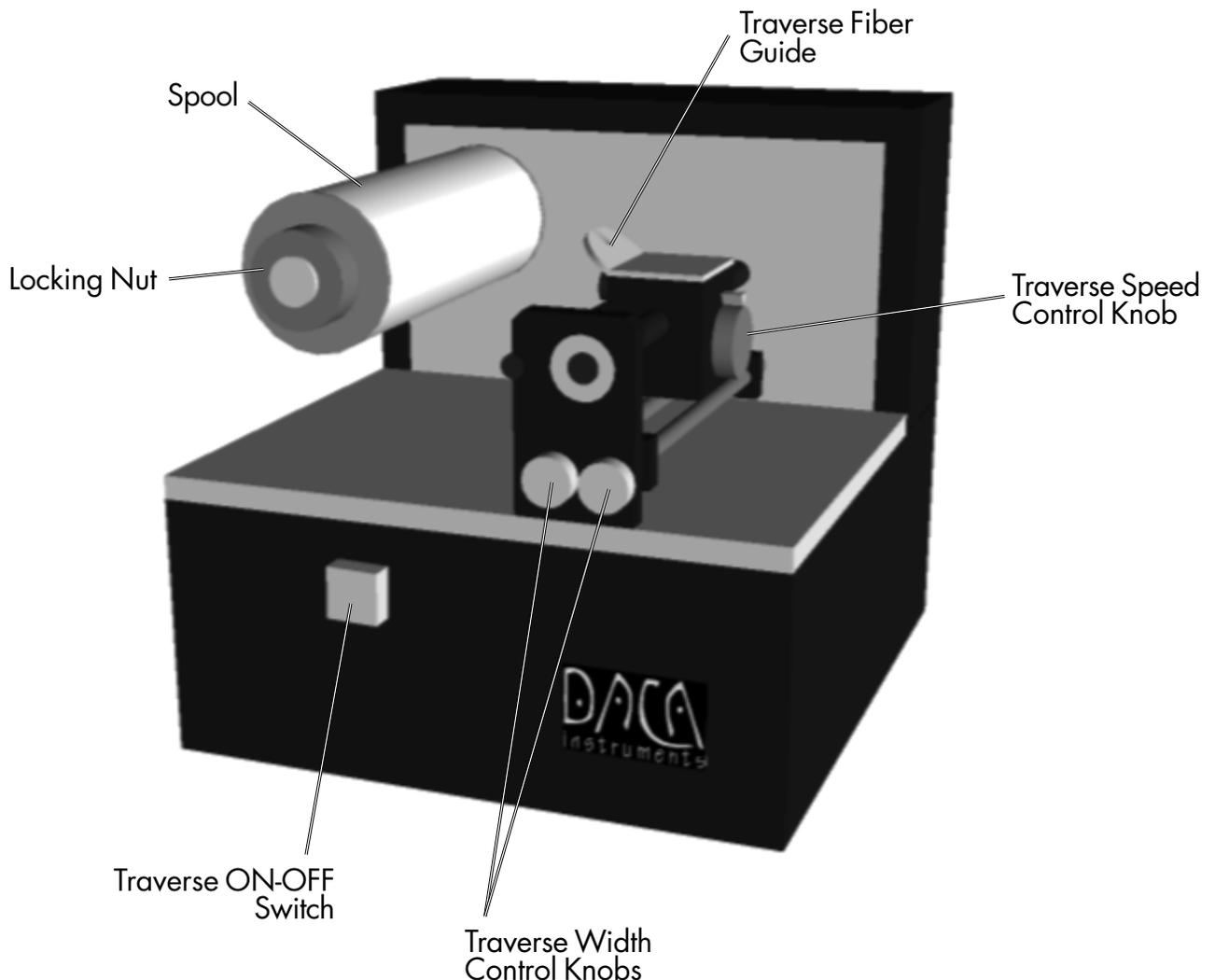
# WINDER

The Winder is the last unit on the SpinLine. There are two connections for the Winder, an electrical power connection and a data/control connector which must be plugged into the back of the Piston Extruder. When assembling the SpinLine, the Winder will be the unit at the left end of the assembly. As mentioned before, the normal travel of the filament is right to left along the assembly.

## OPERATION OF WINDER

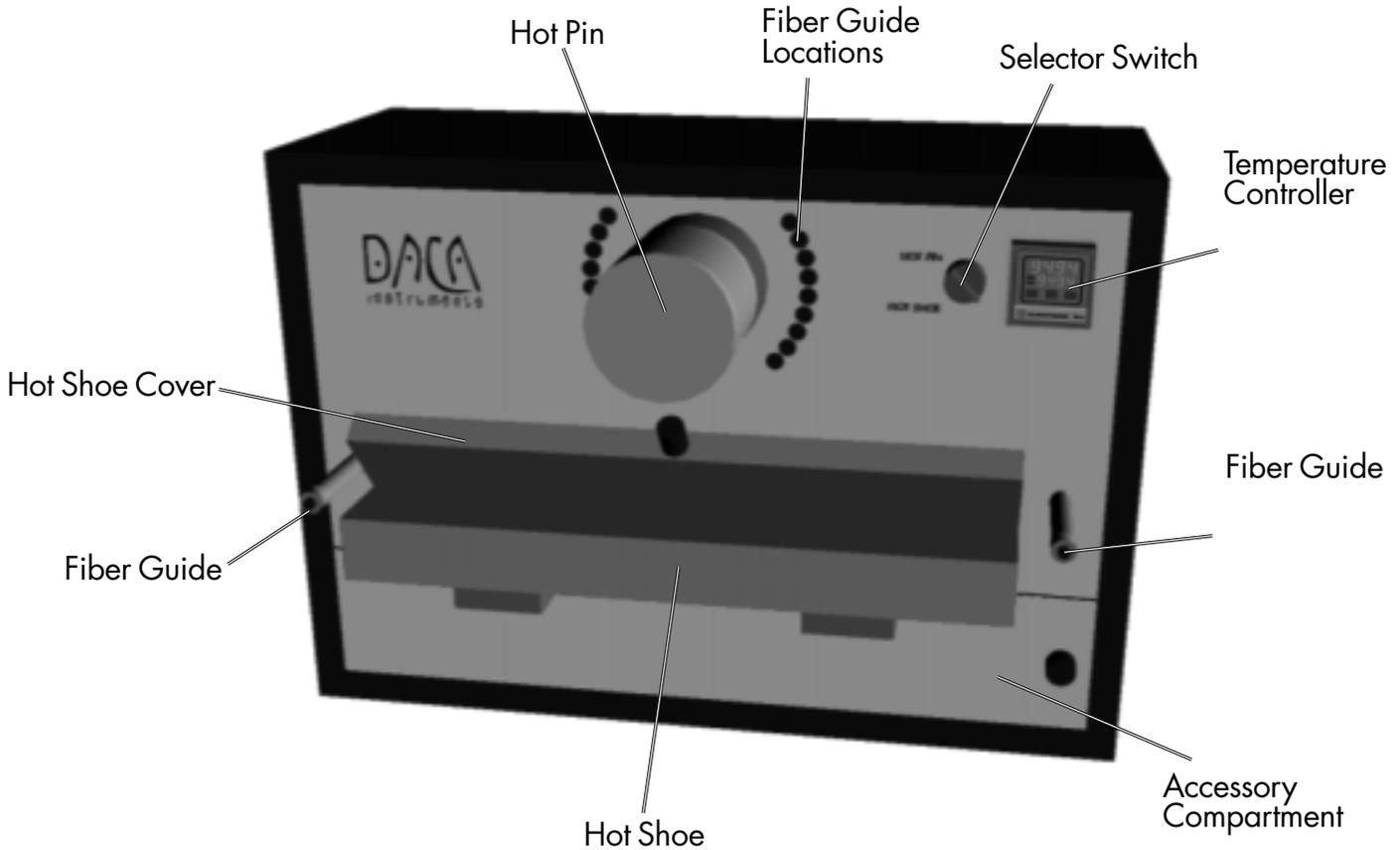
The Winder uses standard 80 mm diam. spools for collecting the processed fibers. The speed of the spool is proportional to the speed of the second Godet and calibrated to take up the filament with a small amount of tension. The filament must travel over the traverse guide and under the spool. During operation the spool rotates counterclockwise while the two Godets rotate clockwise. Once the filament reaches the spool, it can either be taped to the spool or held onto the spool for several turns until the filament remains on the spool without slipping.

The movement of the traverse guide is activated by the square ON-OFF switch located in front of the Winder unit. The speed of the traverse guide relative to the spool is independently controlled by the speed selector knob located on the traverse unit. This controller permits a variety of overlap patterns from 0.5 mm to 27 mm between filament windings. The width of the movement of the traverse guide is also controllable by adjusting the two knobs in front of the traverse guide.



# HEATERS MODULE

The Heaters Module is an independent unit which only requires electrical power. As such it is optional and can be left out of the set up if the filament drawing (stretching) process requires no heating.



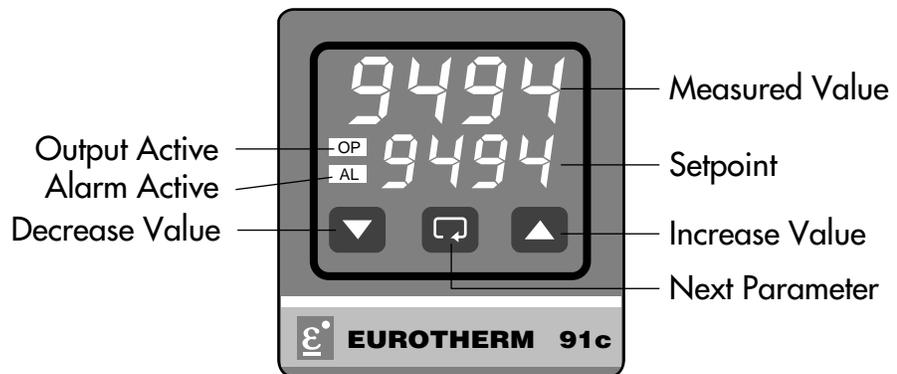
## OPERATION OF HEATERS MODULE

There are two independent heaters in the heater unit: a small round Hot Pin and a long Hot Shoe. The selection of the heater is made by the switch next to the temperature controller. There are two filament guides provided with the unit and they can be placed in any of the threaded positions found on the unit. There is one position at each end of the Hot Shoe and eight positions on each side of the Hot Pin. The different positions around the Hot Pin permit control of the length of filament in contact with the hot surface during stretching.

## TEMPERATURE CONTROL FOR HEATER MODULE

Portions © EUROTHERM CONTROLS Inc.

The temperature of the heaters is controlled by a Eurotherm 91c temperature controller. The following figure illustrates the controls and indicators of the unit.



## ADJUSTING SETPOINT

- To light up buttons: touch any button on front panel.
- To modify setpoint: press ▲ or ▼ to increase or decrease the set point respectively.

### MEASURED VALUE ALARM

The temperature controller has been configured for one HI temperature alarm condition:

Alarm 1: HI temperature alarm (>400°C)

When the Alarm 1 condition is reached (measured temperature = 400°C), a red annunciation LED –AL1– on the controller lights up to indicate the over temperature condition. This alarm condition is non-latching and when the temperature drops below 400°C the AL1 LED turns off.

### SENSOR BREAK ALARM AND SHUTDOWN

If the controller detects that the sensor circuit (thermocouple) has failed, then the output power level is forced to 0% and the annunciation **SnSr FAIL** is displayed. Upon reinstatement of the input sensor, the controller resumes controlling with the same output power level used at the moment of the break.

A failed sensor is detected if:

- the input signal is out of the selected sensor's range
- the input is open circuit
- the controller's operating temperature is outside of the specified operating range (thermocouple inputs only)

### LOOP BREAK ALARM

The temperature controller can detect if there is a break in the control loop due to a fuse burnout, heater burnout, 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. During a loop break alarm condition, the controller output is determined by the control algorithm.

### LOOP STATUS MESSAGES

MESSAGE*	DISPLAY CONDITION	USER ACTION/COMMENTS
<b>Sn Sr FAIL</b>	Sensor fail. Input open or reversed; measured value outside of configured range.	Verify input sensor and connections. Message disappears when input signal is reinstated
measured value <b>LP.br</b>	Break detected in control loop.	Verify output device, fuses, wiring and heater. Check that input wiring is not shorted. Acknowledge by touching any key.
measured value <b>SP.rr</b>	Setpoint ramping in progress.	Setpoint and "SP.rr" parameter still user-adjustable during ramping.
Flashing value	Display overrange or out of specified accuracy.	Unit should not be used in this range.

\* The two lines in the message box refer to what will be displayed in the upper and lower display lines of the controller. *measured value* refers to the temperature currently measured by the controller. *param. mnemonic* refers to the 2-4 letter code used for a particular parameter such as **AL** for alarm.

# AUTOTUNE

## PID SELF-TUNING PROCEDURE

USE THIS PROCEDURE WHEN THE INSTRUMENT HAS COOLED TO ROOM TEMPERATURE.

- After turning the controllers ON, dial the setpoint temperature to 180 °C (or your normal operating temperature)
- press  until **tunE** shows up in the upper display
- press **▲** or **▼** until **Ht.CI** shows up in the lower display and pause
- the **tunE** message will flash in the lower display
- wait for the tuning operation to finish: **tunE** will no longer be displayed

## SELF-TUNE MESSAGES

MESSAGE	DISPLAY CONDITION	USER ACTION/COMMENTS
measured value <b>tunE</b>	Self tuning in progress.	Annunciation only. Adjustment of setpoint and PID values inhibited during self tuning
<b>tunE</b> <b>FAIL</b>	Self tuning operation has failed because controller cannot maintain setpoint.	Acknowledge by touching any key. Remove cause of failure: e.g. heater fuse blown, etc.
<b>LinE</b> <b>FAIL</b>	Loss of controller power during self-tuning operation renders sampled data questionable.	Acknowledge by touching any key. Verify power supply. Reinitiate self tuning procedure.

# SOFTWARE CONTROL

The software is the main component of the SpinLine. The software was carefully written to give the user the most control over all the operations of the entire SpinLine. There are four programs built into the SpinLine: one to control the Piston Extruder only, one to control the Winder only, one to control the Godets and Winder without affecting the extruder and the last program controls all four components simultaneously. The following description will cover this last program.

After all the cables are properly connected, turn on the Winder, the two Godets then turn on the Piston Extruder. On the controller the following text will appear

```
DACA INSTRUMENTS 2000
CONTINUE                               QUIT
```

## QUIT

Causes the program to end. The new screen is the starting point for programming the SpinLine controller using the front panel display or to upload and download new programs from a computer. To change the existing programs contact DACA Instruments. If this button is pressed, the only way to return to the start up screen is to turn off the piston extrude and then turn it back on.

## CONTINUE

Presents you with a new screen which has the four programs available for the SpinLine

## PROGRAM SELECTION

```
SELECT THE PROGRAM TO USE
```

```
EXTRD  WINDR  GODET  EXTRD  FULL
  ONLY  ONLY  WINDR  WINDR  SYS  QUIT
```

## EXTRD ONLY

This option operates only the Piston Extruder. The Godets and the winder should be turned OFF if this option is chosen. This option is useful if the material extruded does not have to be processed into fibers or if the filament is spun into a coagulating bath (wet spinning).

## WINDR ONLY

This option operates only the final winder. The Piston Extruder and the GODETS will not operate with this program. This option is useful to collect fibers created with an instrument other than the piston extruder (i.e. Micro-Compounder).

## GODET+WINDR

This option operates the two Godets and the Winder. The Piston Extruder will NOT operate if this option is selected. This option is useful to perform tensile deformation on filaments already on a spool or if the filaments are being produced by a different extruder.

## EXTRD+WINDR

This option operates the PistonExtruder and the Winder. This option is useful for quick spinning of fibers without using the Godets.

## FULL SYS

This option operates all four components of the SpinLine. Only this program will be described in detail since the other two are subsets of this main program.

When F5 is pressed the following screen is displayed,

```
THIS PROGRAM CONTROLS ALL MODULES
EXTRUDER, GOSETS, AND WINDER
```

## CONTINUE

The program first searches for the upper hardware limit and then asks a series of questions regarding the choice of barrel and the initial speeds of the piston and Godets. Once the data is entered and motion is started, the main screen offers control of all the speeds individually and as a unit.

## HARDWARE LIMIT

```
PRESS F1 TO FIND HARDWARE LIMIT
```

```
HW LIMIT
```

```
QUIT
```

```
QUIT
```

Ends the program.

```
HW LIMIT
```

Finds the starting (upper or home) position of the piston. The piston will move upwards until it finds the upper limit switch then come down 3 mm and stop at the home position. If the instrument was turned OFF properly during the previous experiment, the piston will be at the starting position and will only move a short distance.

During the movement the following screen is displayed:

```
SEARCHING FOR LIMIT SWITCH
STOP
```

Once the limit is found, the following screen is displayed:

## BARREL SELECTION

```
PRESS F1-F3 TO SELECT BARREL IN USE
```

```
NORM-JECT PISTON^
```

```
5ML 10ML &CYL.
```

```
QUIT
```

Here you need to tell the program which of the three cylinders is attached to the piston extruder.



### WARNING

It is important that the correct choice is made at this point. The stop point for the piston is controlled programmatically. If the choice made does not match the barrel attached to the instrument, the piston could crash against the bottom of the barrel damaging the unit.

The choices are:

NORM-JECT 5ML

This is used for the 5 ml syringe barrel.

NORM-JECT 10ML

This is used for the 10 ml syringe barrel.

PISTON & CYL.

This is used for the stainless cylinder and piston.

After the choice is made, the following screen appears.

## LOADING MATERIAL INTO BARREL

```
WHEN SYRINGE/CYLINDER IS LOADED, PRESS  
F1 TO PLACE PISTON AT START POSITION
```

```
ST. POS.
```

```
QUIT
```

The barrel/or syringe must be filled with material and in place before proceeding. At the starting position, the tip of the piston is 3-5 cm into the barrel. The only way to remove the piston at this point is to quit the experiment. Pressing F1 will lower the piston to the starting position. During this motion, the following screen is shown which allows you to stop the process should it be necessary.

```
MOVING PISTON TO START POSITION  
STOP QUIT
```

When the starting position is reached, the program asks for the initial speed of the piston,

## INITIAL SETTINGS

```
INITIAL SETTINGS FOR PISTON EXTRUDER
```

```
ENTER INITIAL PISTON SPEED (MM/MIN):
```

The piston speed is the vertical downward velocity of the piston. Type the speed using the numerical key pad and press the enter key. Fractional numbers (x.xx) are allowed. To calculate the extrusion speed of the filament use the following equation,

piston speed by the ratio  $x \text{ (barrel internal radius}^2 \div \text{spinneret internal radius}^2)$

For example, if the piston is moving at 0.1 mm/min and the 0.5 mm spinneret is used (barrel ID 9.53 mm), the filament speed would be

$$0.1 \times ((4.76)^2 / (0.25)^2) = 36.25 \text{ mm/min}$$

```
ENTER ADJUSTMENT INCREMENT (MM/MIN):
```

Adjustment increment is the change of speed the piston will have when the velocity is increased or decreased. For example, if the initial speed is 1.5 mm/min and the adjustment is 0.1 mm/min, when the increase button is pressed (later), the new speed will be 1.6 mm/min.

After these two numbers are entered the program asks for similar data for the speed of the main Godet.:

```
INITIAL SETTINGS FOR MAIN GODET  
ENTER INITIAL SPEED (M/MIN):
```

```
ENTER ADJUSTMENT INCREMENT (M/MIN):
```

Next the program asks for the stretch factor

```
INITIAL SETTINGS FOR STRETCH  
ENTER INITIAL STRETCH FACTOR:
```

This data refers to how much faster the second Godet rotates with respect to the first one. For example, if the main Godet speed is set to 93 m/min and the STRETCH FACTOR is set to 1.3, the second Godet will rotate at (93 x 1.3) 121 m/min.

```
ENTER ADJUSTMENT INCREMENT:
```

## MAIN SOFTWARE MENU

After the requested data is entered, the main screen is displayed:

```
MAIN MENU
```

```
PISTON MAIN STRETCH          START/  
EXTR  GODET FACTOR WINDER STOPALL QUIT
```

## MAIN -> PISTON EXTR

PISTON EXTR

Adjusts the speed of the piston extruder. A new screen is displayed to make the changes:

```
PISTON EXTRUDER MENU  
CURRENT SPEED SETTING (MM/MIN):  
          ADJ          START  MAIN  
INC  DEC  INC  HOME /STOP  MENU
```

INC

Increases the speed by the amount specified in Adjustment Increment

DEC

Decreases the speed by the amount specified in Adjustment Increment

ADJ INC

Shows a new screen to change the Adjustment Increment. The following screen comes up:

## PISTON EXTRUDER

CURRENT ADJ. INCREMENT (MM/MIN) = x.xx  
ENTER NEW ADJ. INCREMENT (MM/MIN):  
Type the new value at the prompt and press ENTER.

### HOME

Returns the piston to the upper (home) position.

### START/STOP

Starts or stops the piston independently of the other units.

### MAIN MENU

Returns to the main menu

## MAIN -> MAIN GODET

### MAIN GODET

Adjusts the speed of the main Godet. A new screen is displayed to make the changes:

```
                MAIN GODET MENU
CURRENT SPEED SETTING (M/MIN):
      INC      DEC      ADJ      DATA      MAIN
                INC                MENU
```

The main advantage of the SpinLine is the precise control it offers over all the speeds. In addition, once the spinning process has been stabilized at a certain extrusion and drawing speed, changing the speed of the Main Godet will change the speed of the rest of the system proportionally.

See MAIN -> PISTON EXTR for the explanation of INC, DEC, ADJ INC, and MAIN MENU

### DATA

Displays the current values of the speeds for all the axes. See DATA DISPLAY for a sample screen output.

## MAIN -> STRETCH FACTOR

### STRETCH FACTOR

Adjusts how much faster the second Godet is with respect to the first one. A new screen is displayed to make the changes:

```
                STRETCH FACTOR MENU
CURRENT STRETCH FACTOR:
      INC      DEC      ADJ      DATA      MAIN
                INC                MENU
```

See MAIN -> PISTON EXTR for the explanation of INC, DEC, ADJ INC, and MAIN MENU

## MAIN -> WINDER

### WINDER

Because of small fluctuations in diameters of the spools, the tension of the fiber might vary from spool to spool at the winder. This variation can also be noticeable if there is enough filament wound on the bobbin to change its diameter. The WINDER selection will enable you to make small adjustments to the winder velocity with respect to the velocity of the second Godet. A small amount of tension must be maintained on the fiber at the winder to prevent the fiber from slipping from the spool.

### WINDER MENU

CURRENT WINDER FACTOR:

				MAIN
INC	DEC		DATA	MENU

The standard winder factor is 1.009. This means that the winder is spinning 1.009 times faster than the Godet. When the INC or DEC buttons are pressed this factor is changed by  $\pm 0.001$  respectively.

## MAIN -> START/STOP ALL

### START/STOP ALL

Starts or stops the motion of all axes. The motors accelerate slowly from zero to full speed. Stopping is instantaneous.

## MAIN -> QUIT

### QUIT

Stops all axes, returns the piston to the top position and ends the program.

When quit is pressed, all the motors are stopped and the piston of the extruder is returned to the starting position.

### RETURNING TO HOME POSITION

### STOP

#### STOP

Allows the user to stop the piston travel in case of a problem.

## DATA DISPLAY

When the piston is at the starting position, the final settings for all the axes are displayed

DATA:	EXTRUDR	GODET 1	GODET 2	WINDER
SET Q:	1.23	78	5.5	1.009
M/MIN:		78	429	433
MM/MIN:	1.23			F6-DONE

When the F-6 key is pressed, the program returns to the starting screen:

### DACA INSTRUMENTS 1998

CONTINUE

QUIT

## **EMERGENCY CONDITIONS**

There are two emergency conditions that will stop the normal flow of the program:

### **EMERGENCY STOP BUTTON**

When the emergency stop button is pressed, all the units will immediately stop moving and the following screen is displayed

```
EMERGENCY STOP PRESSED  
PROGRAM WILL QUIT
```

The program will wait until the emergency stop button is released and will proceed to quit. The piston will then move to the Home (top) position while all other units will not move. If the emergency button is not released, a screen will remind you to do so before returning the piston to the starting position.

```
IF CONDITIONS ARE SAFE  
PLEASE RELEASE THE EMERGENCY STOP
```

This screen will also be displayed if the instrument is turned on while the emergency stop button is still depressed.

### **OVERLOAD**

If the load on the piston exceeds 5000 N the system will stop all units and quit the program. At the overload condition the following screen is displayed:

```
OVERLOAD CONDITION  
PROGRAM WILL QUIT
```

```
QUIT
```

The piston will slowly back away a few mm to release the load and wait for the user to press F1 to proceed with QUIT.

# MAINTENANCE

Maintenance of the SpinLine is relatively simple. The Godets require no maintenance. The other units require only minimum maintenance.

## **WINDER**

The winder requires periodic lubrication of the main shaft of the traverse guide. Use a few drops of a light machine oil such as WD-40® or TriFlo™ directly on the shaft while it is rotating.

## **HEATER MODULE**

If the surface of the heaters become contaminated with polymer, they should be cleaned with a brass brush or steel wool. Take special care not to scratch the surface of the heaters since it would impair smooth passage of the fibers over the heaters.

## **PISTON EXTRUDER**

The piston extruder requires periodic lubrication to assure optimal operation of the moving components.

- Lubrication of the lead screw

The screw should be lubricated every twelve months or more often depending on use. Use a high temperature grease such as Lubriplate™. For complete lubrication the cover of the lead screw should be removed to access the top section of the screw.

- Lubrication of barrel bearing

The bearing that supports the barrel should be lubricated every three months. Use a high temperature grease such as Lubriplate™ for best protection. Remove the barrel and pivot the bearing until the rounded surface of the bearing is visible. Use a small amount of grease and rotate the bearing in order to coat the entire rounded surface. Pivot the bearing back to its original position.

Periodically the barrel should be cleaned thoroughly to remove all polymer particles attached to any of the surfaces. Use the brass brushes provided to aid with the cleaning. Steel tools (except brushes) may be used, but take extreme care not to scratch the surfaces.

# TROUBLESHOOTING

If you experience any problem with the SpinLine or Piston Extruder, please contact DACA Instruments for assistance.

DACA Instruments  
P.O. Box 991  
Goleta, CA 93116  
Phone: +1 (805) 967-6959  
FAX: +1 (805) 967-4331  
e-mail: [daca@daca.com](mailto:daca@daca.com)

## HARDWARE PROBLEMS

### FUSES

If any of the units fails to turn ON, check the fuse located in the fuse drawer of the power entry module of the unit. The small drawer can be pulled open with a small screwdriver. If the fuse is damaged, replace it with a fuse of the same rating. The fuse rating is printed above the power entry module.

### E-STOP

If the emergency stop button is locked in the depressed position the following message will appear on the control console upon start-up.

IF CONDITIONS ARE SAFE  
PLEASE RELEASE THE EMERGENCY STOP

Release the emergency stop button in order to proceed with testing.

### CABLES

If one of the Godets or the Winder is not moving (when they are supposed to) check that the power is ON and its data cable is properly connected into the back of the unit and in the proper location on the Piston Extruder.  
Load Cell Connector: If the load display makes noise when the Piston Extruder is turned ON, the Load Cell is not properly connected. Make sure that the Load Cell connector is properly inserted in the receptacle and locked in place. The load cell should be connected whenever the Piston Extruder is turned ON.

## PISTON EXTRUDER HEATER MODULE

### HEATERS

The message **LP.br** should be displayed on the temperature controller if one of the heaters is faulty or if they are not properly connected to the port on the Piston Extruder.

The temperature controllers can detect if there is a break in the control loop due to a fuse burnout, heater burnout, faulty output device or loose wiring. The operator is warned by the message **LP.br**. The message is latching, resettable 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.

- Verify first that the connection is properly made.
- If heater damage is suspected, contact DACA instruments for replacement heaters.

## SOFTWARE PROBLEMS

### THERMOCOUPLE

The message **Sn Sr Fail** will appear on the temperature controller if the thermocouple is disconnected or the sensor is malfunctioning.

- Verify first that the connection is properly made.
- Is thermocouple damage is suspected, contact DACA instruments for a replacement.

### TEMPERATURE CONTROLLER

Please refer to the tables in the temperature control section (pp.16) for descriptions of the messages that might show up on the temperature controller during faulty operation.

### E-STOP

If the emergency stop button is locked in the depressed position the following message will appear on the control console upon start-up.

```
IF CONDITIONS ARE SAFE  
PLEASE RELEASE THE EMERGENCY STOP
```

Release the emergency stop button in order to proceed with testing.

### PROGRAM ERASED

If upon start up the following screen does not appear

```
DACA INSTRUMENTS 1998
```

```
CONTINUE
```

```
QUIT
```

the programs were erased from the memory of the controller. Please contact DACA Instruments for replacement software.

# APPENDICES

## APPENDIX A: BARRELS FOR PLASTICS SYRINGES

Two optional barrels are available for the Piston Extruder. These barrels are designed to support 5cc and 10cc all-plastic syringes respectively. The use of plastic syringes is useful to process highly corrosive fluids or very small amounts of solution at low temperatures.

If the syringe barrels have been ordered they are supplied with 100 non-sterile, specially modified syringes and with a piston tip. The piston tip is pressed onto the end of the metal piston and enlarges its end surface area. This enlarged area provides even pressure to the syringe plunger.

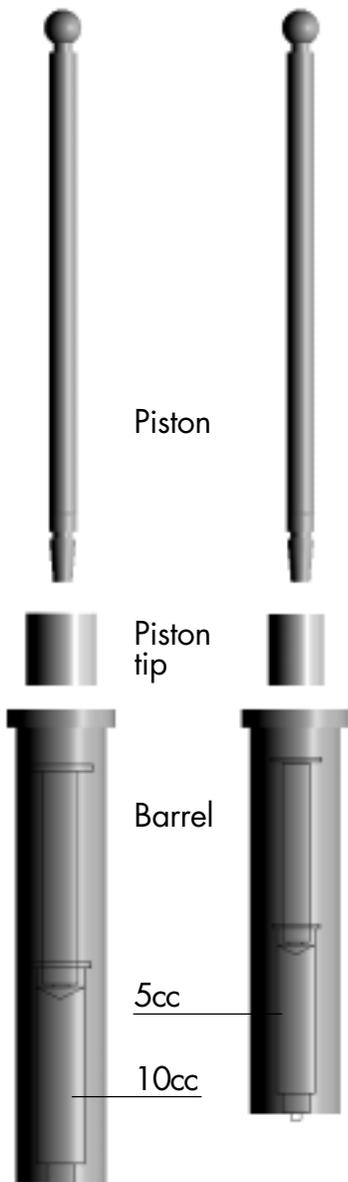
Additional syringes can be obtained from DACA Instruments.

The barrels are loaded on the Piston Extruder as described on page 20. The 10cc barrel is long enough to accept the heating jacket during operation, however do not operate this barrel at temperatures above 60°C since the syringe will begin to soften and operate improperly.

The filled syringes are loaded into the barrel through the top opening. The starting position for the piston (pp. 29) accommodates a fully loaded syringe.

Use only blunt-cut needles for fiber spinning. Standard, sharp point needles will yield very poor fibers. These needles can be obtained from DACA Instruments or directly from:

Newark Electronics  
 325 Hillcrest Drive  
 Thousand Oaks, CA 91360  
 Phone: (805) 449-1480  
 FAX: (805) 449-1460



Catalog No	Description	ID Inches (mm)	Hub Color	~cost \$/50
52F9944	18 GA 1/2' long	.033 (.84)	green	7.62
52F9947	20 GA 1/2' long	.024 (.61)	pink	7.62
52F9948	21 GA 1/2' long	.024 (.50)	purple	7.62
52F9949	22 GA 1/2' long	.016 (.40)	blue	7.62
52F9950	23 GA 1/2' long	.013 (.33)	orange	6.24
52F9951	25 GA 1/2' long	.010 (.25)	red	7.62
16F8269	27 GA 1/4' long	.008 (.20)	clear	7.22
52F9954	30 GA 1/4' long	.006 (.15)	lavender	8.81

# LIMITED 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 setup 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.

**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 acknowledgment 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.



# NOTES