Microinjector

OPERATION MANUAL

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p/n 50900

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 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 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 checking or changing fuses.

3. CRUSHING INJURY

High speed moving parts. Do not reach into the unguarded mold area where pinch points are created during injection of polymer and during ejection of the mold. Failure to follow safety precautions can cause injury.

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.

5. HIGH PRESSURE COMPRESSED AIR

The MicroInjector uses compressed air to drive the injection and ejection pistons. High pressure compressed air is potentially dangerous. Always follow the operating instructions. Before releasing an air connection, disconnect the air supply and reduce to zero any system pressure and stored pressure.

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INTRODUCTION

GENERAL DESCRIPTION

DACA Instruments' MicroInjector is a small injection molding machine that quickly and efficiently produces parts using a maximum of 4 cc (0.14 oz) of material. The simple yet powerful design will process commodity thermoplastics, making the MicroInjector suitable for prototyping and small production runs. The "tall" configuration of the mold lends itself to producing standard tensile test bars and other long parts that must be injected from the end of the part. Other applications include the production of mechanical and rheological test samples, color testing, and small experimental parts.

The low volume of material required and the ease of operation coupled with the low tooling cost, make this instrument ideal for the research and development of new and exotic polymeric materials. The temperatures of the mold and barrel are precisely controlled to allow processing of materials from room temperature to 400 °C. The mold can be cooled below room temperature to process materials with low melting points.

The instrument consists of a heated block to support the conical, self clamping mold and a heated barrel. The barrel can be easily removed from the frame to be manually filled with powders or pellets. More importantly, the barrel is designed to be easily filled with the melt extruded from DACA Instruments' MicroCompounder, creating a powerful materials development system.

The injection piston is pneumatically driven by a large, 10 cm (4 inches) bore cylinder. This unit can deliver up to 7000 N (1570 pounds) of force to the molten polymer for injection into the mold cavity (@ 8.6 bar (125 psi) air pressure). A separate pneumatic cylinder is used to manually eject the mold at the completion of the each cycle.

SPECS & SCHEMATICS

VOLUMES

Barrel Volume	4.0 cc (0.14 oz)
Max Mold Volume	3.5 cc (0.12 oz)

HEATERS

Barrel Heaters	400°C, (350 W), 220V AC
Barrel Thermocouple	Type J
Mold Heaters	300°C, (2x450 W), 220V AC
Mold Thermocouple	Type K
Temperature Controls	EUROTHERM 91c: Digital auto tune PID closed loop

PNEUMATIC SYSTEM

Inject Piston	10 cm (4") diameter, 10 cm (4") stroke
Mold Eject Piston	10 cm (4") diameter, 0.63 cm (0.25") stroke
Max Air Pressure	8.6 Bars (125 psi)
Mold Clamping Force	~67KN (~7.5 ton) max
Injection Pressure	980 Bar (14200 psi) @ max air pressure
Mold Ejection Force	7000 N (1570 lbs) @ max air pressure

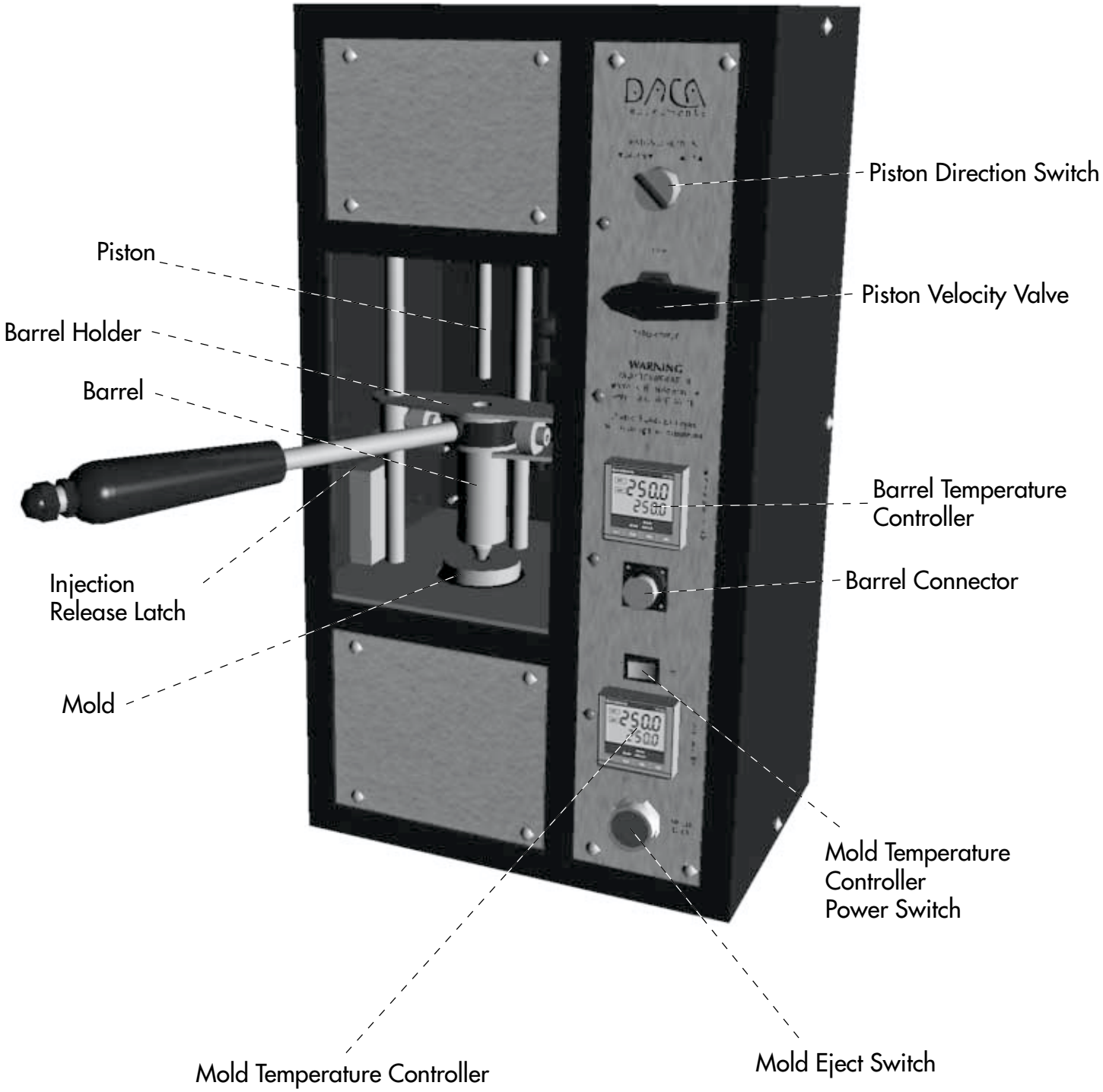
ELECTRICAL

Voltage	208-220V AC
Frequency	50/60 Hz
Max. current	8A
Phase	1

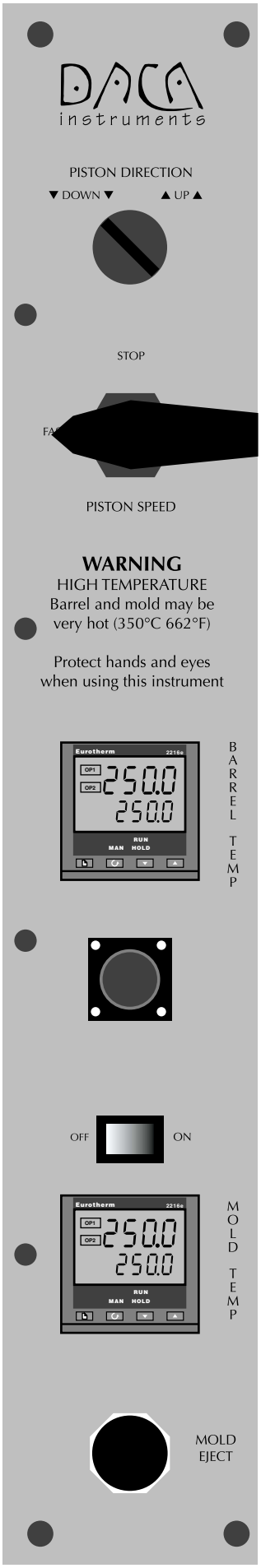
PHYSICAL

Dimensions (excluding barrel)	28.5cm W x 20cm D x 53cm H 11.25" W x 8" D x 21" H
Weight (including barrel and one mold)	25 Kg (55 lbs)

GENERAL SCHEMATIC



SCHEMATIC OF CONTROL PANEL



Piston Direction Switch

Piston Velocity Valve

Barrel Temperature Controller

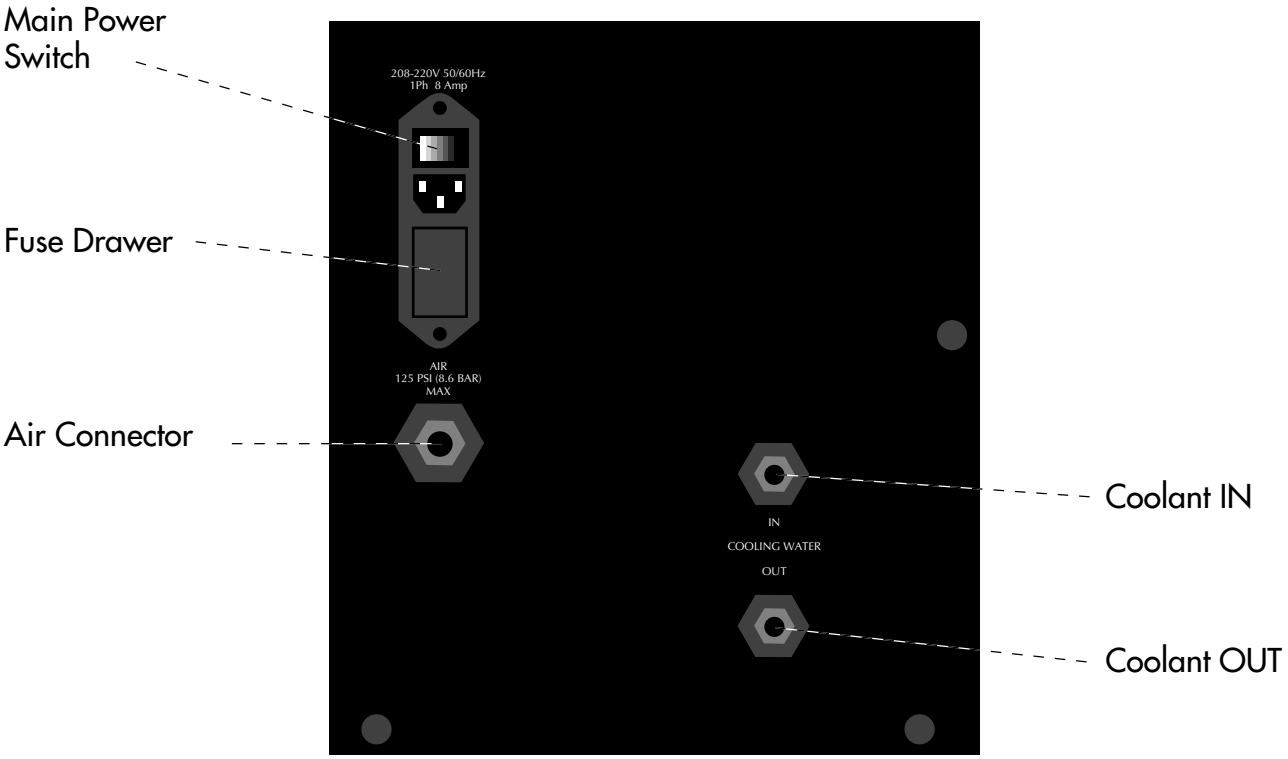
Barrel Connector

Mold Temperature Controller Power Switch

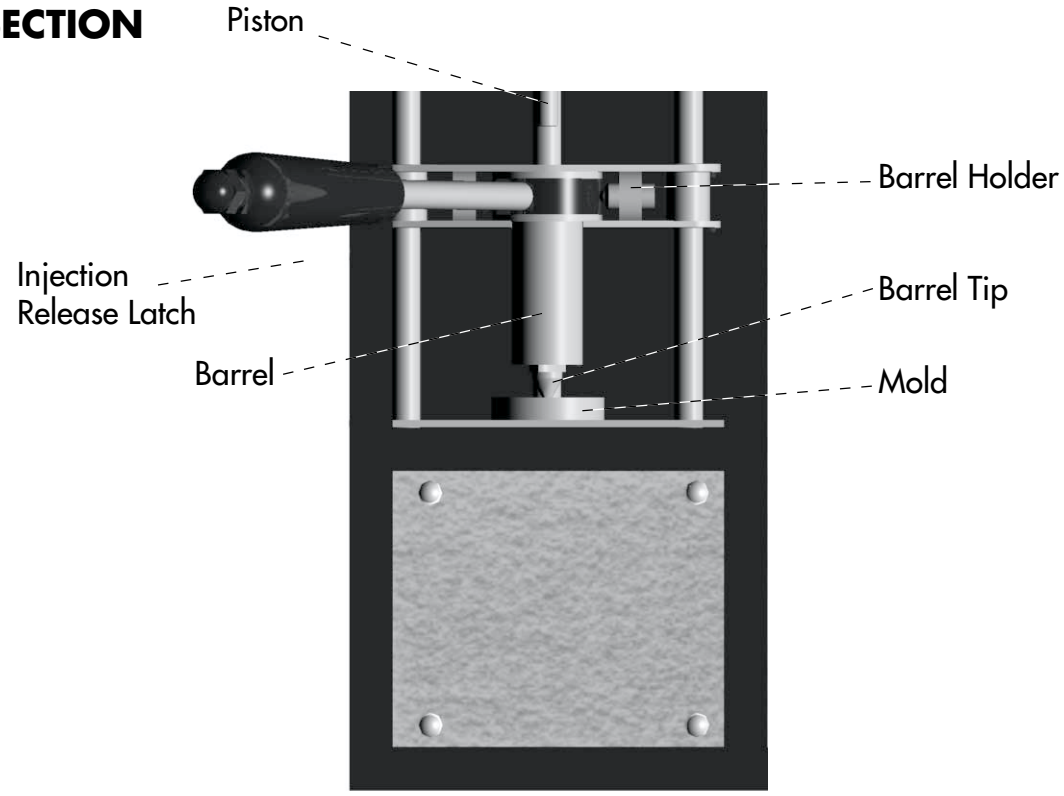
Mold Temperature Controller

Mold Eject Switch

SCHEMATIC OF REAR CONNECTOR PANEL



SCHEMATIC OF BARREL SECTION



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 wooden crate should contain the following Items:

1 MicroInjector
1 Barrel
1 Set of four tips for barrel 1.5, 2, 2.5 and 3 mm ID
1 Power cord
1 Funnel to load barrel
1 3⁄8" L hex wrench to adjust ejector piston
1 1⁄4" L hex wrench for plug at bottom of the instrument
1 9⁄16" socket to remove tips from barrel
1 7⁄16" steel punch to push barrel out from bottom
1 Garolyte Rod (pink) to pack polymer into barrel
1 Curved Jaw Plier to remove hot mold from machine
1 tube of AntiSeize to lubricate the threads of tips
1 tube of Krytox grease to coat inside of mold sleeve
1 Can of Mold Release spray
2 Round brass bushes to clean barrel
1 Manual
1 Registration card
1 Quick operation card

All the molds ordered

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

INSTALLATION

LOCATION

The MicroInjector should be set up on a leveled, sturdy table or bench. The normal operating temperature of the MicroInjector can be as high as 400 °C (750 °F); therefore, the instrument should be placed away from other heat-sensitive equipment and high traffic areas where people might accidentally come in contact with the hot instrument.

ELECTRICAL

The MicroInjector requires an electrical connection. The instrument operates with 220V 50/60Hz, 8Amp, single phase. The power cord has been fitted with a standard 220V plug for operation in the United States. For proper operations outside the U.S. the plug might have to be replaced with a different one. Consult your local electrical code. The wires inside the plug have been labeled for easier connection to a different plug.

COMPRESSED AIR SUPPLY

A fixture is provided on the back of the MicroInjector to connect a regulated, compressed air line used to drive the pneumatic cylinders. **The air must be dry and lubricated in order to insure proper operation and long life of the cylinders.** The MicroInjector is designed to operate at a maximum pressure of 8.6 Bar (125 psi). The pressure must be adjusted according to the viscosity of the polymer. Excessive pressure will damage the gas lines and the pneumatic components inside the instrument. It will also cause flashing of the polymer in the mold which might lock the mold inside the sleeve and prevent mold ejection.

MOLD COOLING FLUID

The mold can be cooled below room temperature by connecting a cooling fluid to the ports provided on the back of the instrument. Cooling water can be supplied from a faucet or a chiller. The output must be an unrestrained hose emptying to a drain or back to the chiller unit. It is very important that the coolant pressure inside the instrument be kept to a minimum. Due to design constraints, the hoses inside the instrument are low pressure, high temperature silicone hoses. High pressure > 0.7 Bar (10 psi) will cause the cooling fluid to leak and possibly damaging other components in the instrument.

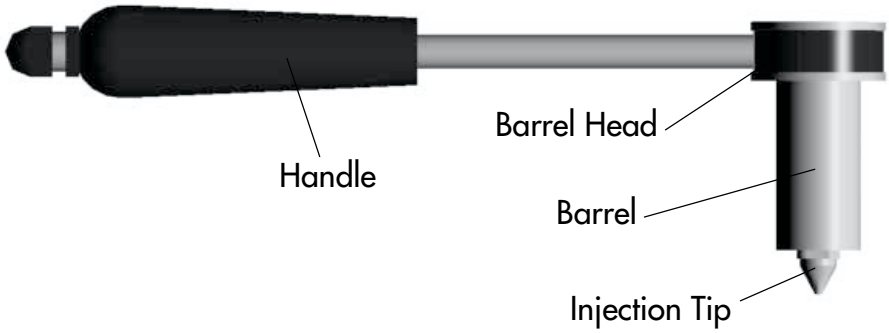
General Operation

The general procedure for operating the MicroInjector is described below. The detailed description of each step is provided in the following pages.

- Turn on the MicroInjector
- Turn on the compressed air supply to and set the appropriate pressure.
- Install the appropriate nozzle on the barrel.
- Set the temperature controller for the barrel to the desired temperature.
- Load the mold in the cavity
- Turn on the mold temperature controller and set to the desired temperature, or leave controller off and connect the cooling water if the mold is to be cooled below room temperature.
- Once the barrel is heated, load the polymer into it using the funnel and the packing tool provided.
- Wait for the polymer to melt and the barrel temperature to stabilize ~ 5 min.
- Place the barrel in the support bracket.
- Turn the direction lever to the down position (fast speed) and when the piston stops wait 5-7 seconds for the polymer to freeze in the mold while under pressure.
- Turn the direction lever to the up position.
- Release the barrel using the small lever on the left side of the instrument.
- Remove the barrel and refill with polymer.
- Eject the mold and remove from the instrument.
- Remove the plastic part from the mold and replace the mold into the cavity.
- Begin a new test.

DETAILED OPERATION

BARREL SET-UP



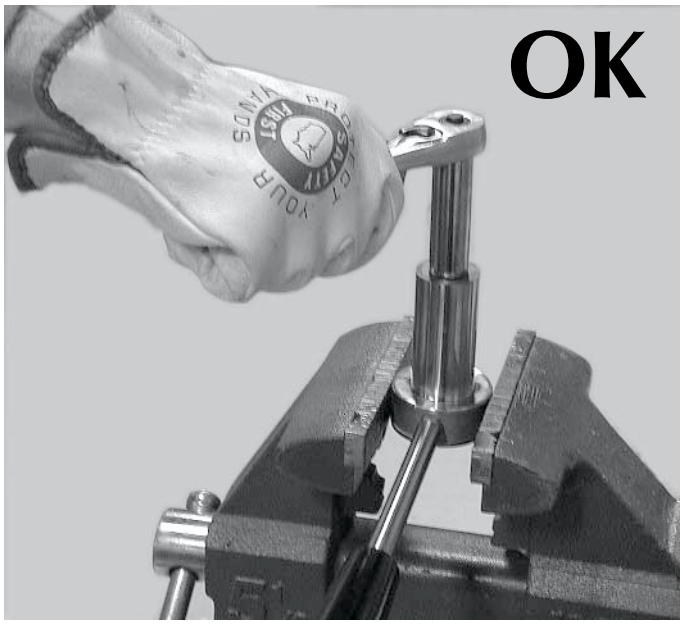
CAUTION!	DO NOT apply any force to the handle to install or remove the injection tips.

CHANGING THE INJECTION TIPS

When the injection tips are installed or removed from the barrel it is important that the barrel be clamped in a vise at the wide part of the barrel. Applying any torque to the handle when removing the tips will likely break the handle and render the barrel unusable.

The instrument is provided with 4 tips with different orifice size to accommodate a variety of polymer viscosities. There must be a small resistance to the flow of polymer at the tip in order that some of the piston pressure be transferred to the mold to provide the clamping force. The small orifice tips are for low viscosity material and the large orifices are for the higher viscosity polymers.

A 9⁄16", deep socket is included to aide with the installation and removal of the tips. In addition, it is recommended that a very thin layer of Anti Seize compound (included) be put on the threads of the tips before installation. This high temperature lubricant will facilitate the removal of the tips after they undergo repeated heat-cool cycles. This lubricant, if used in excess, can contaminate the polymer being processed, therefore use Anti-Seize very sparingly. Tighten the tip to 45 N•m (33 foot•pound)

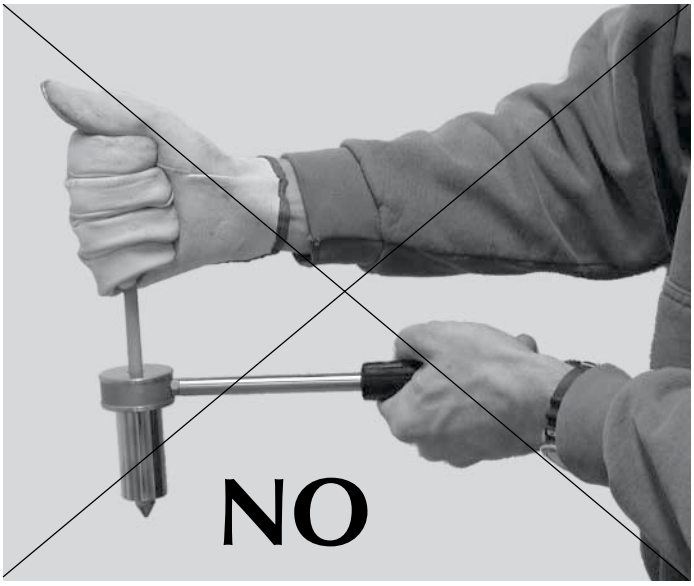


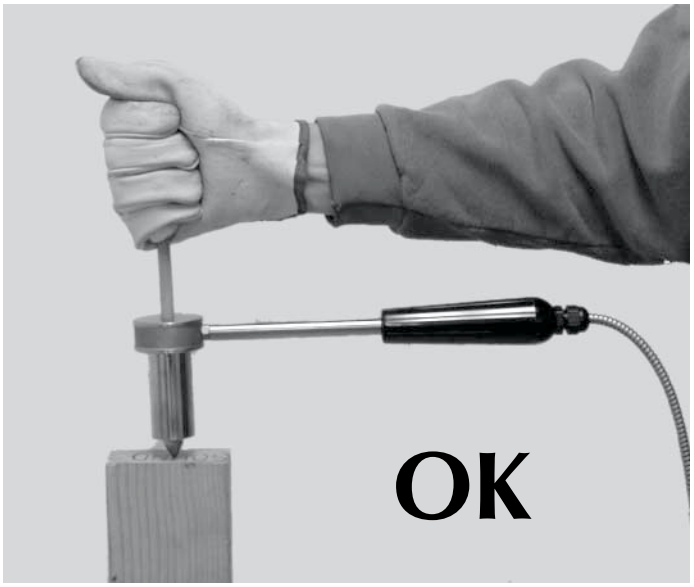
BARREL LOADING

There are at least two ways to fill the barrel with polymer for processing:

1. Polymer powder or pellets can be fed into the barrel directly using the funnel provided. The polymer can be pressed down with the push tool to compact the polymer after it is melted. The volume of the barrel is 5.0 cc (0.3 cu. in.). After the polymer melts, the barrel can be placed back into the holder and the polymer injected into the mold. As explained before, the handle of the barrel is not designed to withstand strong torque. Support the barrel tip when pushing polymer into the barrel. See below

2. The molten, compounded material from a MicroCompounder can be extruded directly into the barrel of the MicroInjector. Waste is thus minimized and the efficiency of the combined test improved. To collect the material this way, just place the MicroInjector barrel against the exit port of the MicroCompounder during the extrusion step. See the accessory to facilitate this process on page 26.



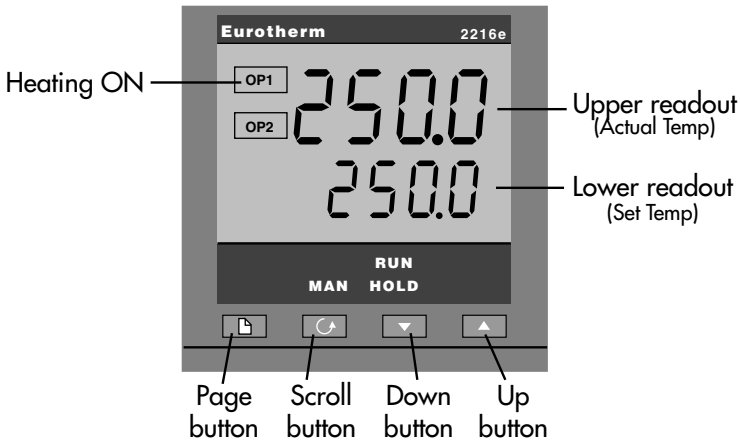


TEMPERATURE CONTROL

Portions © EUROTHERM CONTROLS Inc.

Temperature of the barrel and mols are controlled by a EUROTHEM model 2216 temperature controllers.

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 (in the case of the mold 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 Annuncation

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.

Table T-3 Diagnostic alarms

Display shows	What it means	What to do about it
EE.Er	Electrically Erasable Memory Error: The value of an operator, or configuration, parameter has been corrupted.	This fault will automatically take you into Configuration level. Check all of the configuration parameters before returning to Operator level. Once in Operator level, check all of the operator parameters before resuming normal operation. If the fault persists, or occurs frequently, contact Eurotherm Controls.
S.br	Sensor Break: Input sensor is unreliable or the input signal is out of range.	Check that the sensor is correctly connected.
L.br	Loop Break The feedback loop is open	Check that the heating and cooling circuits are working properly.
Ld.F	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.
SSr.F	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.
Htr.F	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.
Hw.Er	Hardware error Indication that a module is of the wrong type, missing, or faulty.	Check that the correct modules are fitted.
no.io	No I/0 None of the expected I/0 modules are fitted.	This error message normally occurs when pre-configuring a controller without installing any of the required 1/0 modules.
rmt.F	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.
LLLL	Out of range low reading	Check the value of the input.
HHHH	Out of range high reading	Check the value of the input.
Err 1	Error 1: ROM self-test fail	Return the controller for repair.
Err2	Error 2: RAM self-test fail	Return the controller for repair.
Err3	Error 3: Watchdog fail	Return the controller for repair.
Err4	Error 4: Keyboard failure Stuck button, or a button was pressed during power up	Switch the power off and then on, without touching any of the controller buttons.
Err5	Error 5: Faulty internal communications.	Check printed circuit board interconnections. If the fault cannot be cleared, return the controller for repair.

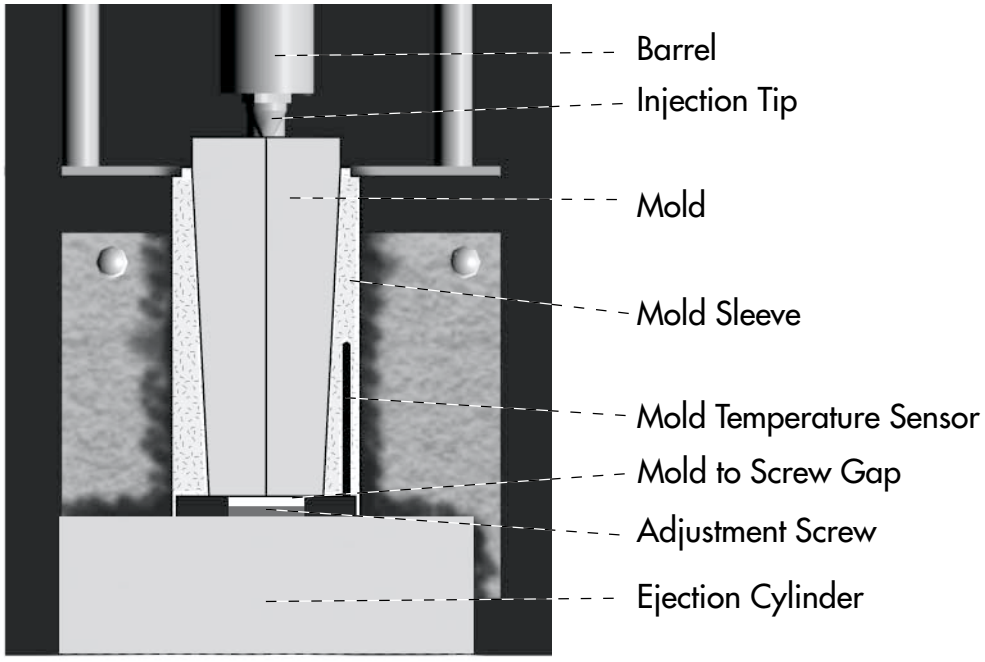
MOLD SETUP

NOTE	The mold is made of hardened A2 steel. It will corrode if exposed to moisture or corrosive agents. Take all precautions to protect the mold from rusting, particularly when not in use.

MOLD LOADING & REMOVAL

An adjustment screw is located inside the barrel sleeve at the top of the mold ejection cylinder (see figure). This screw must be adjusted so that it will push up the mold only 2mm (0.08"). This position produces the optimal ejection force for the mold. Because of small differences in the molds, the screw might have to be adjusted when different molds are used. To adjust the screw use the 3⁄8" hex wrench provided. Place the mold inside the sleeve and press the eject button. Measure how high the mold is raised and if it more 2mm remove the mold and lower the adjustment screw.

If the adjustment screw is set too low, it will not touch the mold when the eject button is pressed and the mold will not come out.
Each revolution of the adjustment screw will change the height of the mold by ~1.5mm (~0.06"). Unless the mold is being ejected, the adjustment screw must never touch the mold. Doing so will prevent the self clamping action of the mold design from keeping the two halves tightly closed.



Before shipment, the inside surface of the mold sleeve was coated with Krytox fluorinated lubricant. This high temperature lubricant 260°C (500°F) will prevent the mold from sticking to the sleeve and will make ejection of the mold easier. Periodically re-coat the sleeve inner surface with the extra lubricant provided since some will be removed by the mold after each use. You may also coat the outer surface of the mold with Krytox before use. This is particularly important if the mold will be heated above room temperature.

Before putting the mold into the sleeve, it is recommended that the mold cavity be coated with mold release agent. This will help release the plastic part after it has solidified. This step is very important when injecting “sticky” polymers such as polyamides and polyesters.

WARNING! 

During ejection the mold might be expelled forcefully from the mold sleeve. Take all precautions to protect hands and eyes during this step. Do not use hands to hold the mold during the ejection step.

Once the polymer is injected and solidified, the mold can be removed from the instrument. Release the barrel bracket using the lever on the side of the instrument and remove the barrel from the machine. Press the mold eject button and remove the mold after it is ejected from the mold sleeve. The mold can be removed by hand, if at room temperature, or using the mold removal tool when the mold is heated. The tips of the soft jaw pliers provided to remove the mold are made of Nylon®. If the mold temperature exceeds 100°C, remove the plastic tips and use the bare metal jaws to grab the mold.

The mold can then be opened to remove the plastic part from the cavity. After the part is removed the mold can be reassembled and placed back into the mold sleeve in the MicroInjector.

HEATING OR COOLING THE MOLD

For most operation, polymer injection should be done into an unheated mold. However, in some cases the polymer might be freezing too quickly and not filling the cavity completely. In those cases it might be desirable to increase the mold temperature.

CAUTION!

There are several problems which might develop if the mold is too hot for a given plastic. The worst one is severe leaking (flashing) of the polymer between the mold halves which, when frozen, will cause the mold to be stuck and the lower piston will not be able to eject it.

Therefore, raise the mold temperature slowly (small incremental steps) and test for performance improvement. It is also important that the mold be stable at the new temperature before injecting the molten polymer into it. If the mold is cooler than the sleeve when the polymer is injected, the mold will become stuck. (See the Troubleshooting section for instructions on how to remove a stuck mold)

The mold temperature is controlled by a separate temperature controller. This controller has a separate power switch located just above it. Because of the large volume of metal, heating of the mold can take up to 40 minutes before steady state temperature is reached. Once turned on, the controller is operated as described on page 16. There is a maximum temperature limit of 150°C for the mold, however, it is possible to modify this limit. Please call DACA Instruments for details on changing this parameter in the temperature controller.

During heating, the temperature of the mold is measured at the mold sleeve. This temperature will be slightly different from the mold temperature until steady state is achieved. To monitor the temperature more accurately, a small hole is built into the top of every mold. An external digital thermometer (not included) might be used to monitor the mold temperature before injection. This external thermocouple must be removed before polymer is injected into the mold.

Mold cooling is performed by circulating cooling fluid through the heat/cool jacket of the mold. When cooling the mold, the temperature is controlled by an outside source and not by the built in temperature controller, therefore the controller must be turned off. The cooling connections are located on the back of the instrument. Any water-based cooling medium might be used to cool the mold. The chiller unit is **not** provided with the instrument and must be acquired separately. The hoses used inside the instruments are low pressure, high temperature, silicone hoses. High pressure > 0.7 Bar (10 psi) will cause the

PISTON DIRECTION & SPEED

Two separate controls are provided to control the direction and speed of the piston. An electrical switch at the top of the control panel moves the piston up or down depending on its position. The valve below controls the speed of the piston. Three positions are available; fast, slow, and stop. Fast speed is the normal speed of injection. Slow speed can be used to pack the polymer into the barrel before injection or to lower the piston into the barrel for heating before injection occurs.

The velocity of the slow speed can be regulated using a special exhaust valve located inside the instrument. To access this valve remove the side panel and the valve will be found attached to the three way valve. Loosen the small nut on this valve and turn the regulating screw counter clockwise to make the “slow” speed faster. Turn the screw clockwise to move the piston slower. Replace the side cover after the adjustment is made.

WARNING!

Disconnect the electrical power before removing the side cover. Removing the side cover will expose the user to high voltage (208-230 VAC) contacts. It is advised that a person familiar with electrical and pneumatic systems perform this operation.

Once the heated, loaded barrel is in the barrel holder, and the mold is in place, set the barrel speed valve to FAST and turn the direction switch to DOWN. The piston will move down and inject the polymer into the mold. Hold the piston down for ~ 5 seconds to allow the polymer to solidify inside the mold while it is under pressure. Then turn the direction switch to UP to retract the piston from the barrel.

Release the barrel from the injection position by pressing the small lever on the left side of the instrument. Remove the barrel from the barrel holder and load more polymer into the barrel to prepare it for the next test.

TROUBLESHOOTING

If you experience any problem with the MicroInjector, please contact DACA Instruments for assistance.

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CAUSES AND SOLUTIONS FOR SPECIFIC DEFECTS IN THE INJECTION MOLDED PARTS

- **BUBBLES AND BLISTERS:**
  – *Mold temperature too low.* The air might be getting trapped in the part because the material is solidifying before the air escapes. Try increasing the mold temperature.
  – *Polymer particles are too coarse*. The large particles might trap air in the melt. Try using smaller particles.
  – *Polymer particles are too small.* Sometimes powders will trap a great deal of air in the melt that cannot be properly displaced during the injection. Try using pellets if available or a smaller nozzle.
  – *Back pressure too low.* The size of the nozzle controls the rate of flow of the polymer and thus the amount of back pressure. At lower flow rate (higher back pressure) the trapped air has a chance to escape towards the piston. Try using nozzles with a smaller orifice.

- **EXCESSIVE PART SHRINKAGE:**
  – *Cycle too short*. The melt inside the polymer must be kept under pressure while it solidifies. Keep the piston in the down position for 3-5 seconds while the polymer hardens.
  - *Pressure too low.* The cycle time might be long enough but the injection pressure too low. The pressure must be high enough to pack the cavity solidly. This ensures that the polymer molecules are held as close to each other as possible during solidification. Try to increase injection pressure.
  - *Mold temperature too high.* If the mold temperature is too high, the polymer will stay molten longer preventing the required skin from forming on the part before it is removed from the mold. Try decreasing the mold temperature in 5°C steps to achieve the optimal parameter.

- **PART INCOMPLETELY FILLED:**
  – *Mold temperature too low.* The polymer is solidifying before the mold is completely filled and under pressure. Increase the mold temperature.
  – *Not enough polymer in the barrel.* Make sure there is enough molten material in the barrel to fill the mold.
  – *Melt temperature too low*. The polymer will solidify in the runners if the barrel temperature is too close to the melting point. Increase the barrel temperature.
  – *Injection velocity too slow.* The polymer might be solidifying before filling the mold because it is being injected too slowly. Try increasing the orifice size, increasing the air pressure, and/or increasing the barrel temperature.

- **FLASHING:**
  - *Mold improperly set*. If the mold is touching the adjustment screw, the self clamping mechanism will not operate and the polymer will leak along the parting line. Lower the height of the adjustment screw until it no longer touches the mold.
  - *Injection pressure too high*. If the pressure is too high for the viscosity of the material injected, flashing might occur. Try lowering the injection pressure.
  - *Viscosity is very low*. If the polymer viscosity is too low, it will be easy for the material to escape through the parting line. Lower the temperature to increase the viscosity or reduce the injection pressure.
  - *Mold not properly closed*. Particles might be present in the mold parting surfaces which prevent it from closing properly. Clean the large flat surfaces of the mold. In addition excessive grease on the sleeve or the outer surface of the mold might cause the mold not to close properly. Remove the excess grease before operation.

- **BLACK SPECKS AND STREAKS**
  - *Excessive residence time*. The material is staying in the barrel too long before injection and degrading. Try to inject 20 - 80% of the barrel load each cycle.
  - *Contaminated raw material*. The material used for injection might be contaminated with dirt or color particles. The barrel might be contaminated with different material from a previous test. Make sure the material used is clean and the barrel is thoroughly cleaned between experiments.
  - *Excessive AntiSeize used*. If too much AntiSeize compound is used when installing the tip on the barrel, some might leak into the polymer during injection. Use the AntiSeize compound sparingly, just enough to lightly coat the threads.

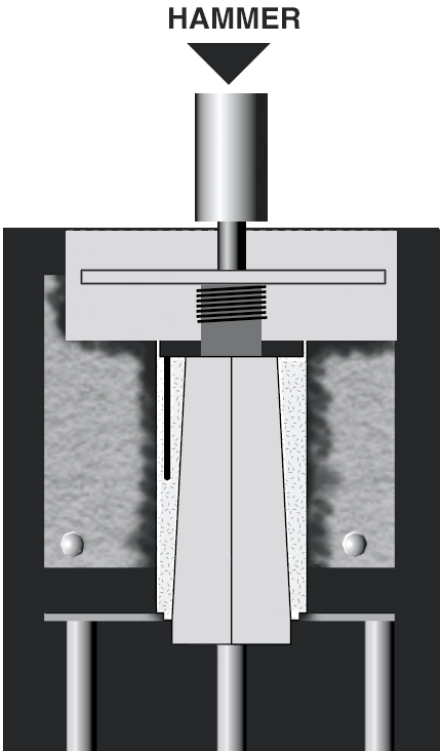
REMOVING A MOLD THAT CAN'T BE EJECTED

On rare occasions the mold will be so stuck after injection of the polymer that the ejector cylinder might not be able to push it out. The most common reason for this problem is excessive leaking (flashing) of polymer during injection due to high mold temperature. Use the following procedure to remove the mold from the instrument.

If the air supply pressure is low, raise the pressure up to the maximum limit of 8.6 bar (125 psi) and try to eject the mold using the ejection button. If the mold does not come out, it must be pounded out with a hammer using the following procedure (see following page for diagram):

- Turn off the instrument and allow it to cool off to room temperature.
- Disconnect the air supply and vent the instrument.
- Disconnect the barrel and remove it from the instrument.
- Manually push down the barrel bracket until it latches in the low position. (Very Important!)
- Place a soft fabric or thin foam on the bench and turn the machine upside down on top of the fabric to protect the paint.
- Using the 1/4" hex wrench remove the bronze plug located at the bottom of the machine (see figure on next page).
- Insert the small end of the steel punch into the hole and push the piston down. There is a spring that retracts the piston when the Eject button is released and you must manually push down against this spring.

- Using a hammer, hit hard on the punch a few times to release the mold. It is important that the piston is being pushed down manually before hitting it with the hammer. Otherwise the impact from the hammer will be absorbed by the spring and none will be transferred to the mold.
- When the mold is released, it will be held by the barrel bracket. Hold the mold and release the bracket to allow complete removal of the mold from the instrument.
- Reassemble the brass plug onto the machine using some Teflon® tape for better seal. Do not overtighten.
- Turn the instrument right side up, reconnect the air and power supply and turn the instrument on.



Sketch of emergency eject procedure

MAINTENANCE

• The MicroInjector is a very easy instrument to maintain. The most important maintenance is to supply the instrument with **dry, lubricated** compressed air for operation. This will maintain the pneumatic cylinders in their optimum operating conditions.

• In addition to cleaning the barrel between experiments, it is also important to clean the piston between experiments. Access to the piston can be achieved by either removing the safety screen or by lowering the piston without the barrel in place.

• As recommended earlier, regularly coat the inside of the mold sleeve and the outside of the molds with KRYTOX grease to prevent the mold from sticking to the sleeve.

• Periodically spray the mold cavity with mold release agent. This is very important when injecting sticky polymers like polyamides and polyesters.

• The mold is made of hardened A2 steel. Protect the mold from rusting by applying a light coat of oil (WD-40 or similar) to the inner surfaces, particularly when not in use.

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 7-1. These parameters appear in the 'Pi d', list.

Parameter	Code	Meaning of Function
Proportional band	Pb	The bandwidth, in display units, over which the output power is proportioned between minimum and maximum.
Integral time	ti	Determines the time taken by the controller to remove steady state error signals.
Derivative time	td	Determines how strongly the controller will react to the rate-of change of the measured value.
High Cutback	Hcb	The number of display units, above setpoint, at which the controller will increase the output power, in order to prevent undershoot on cool down.
Low cutback	Lcb	The number of display units, below setpoint, at which the controller will cutback the output power, in order to prevent overshoot on heat up.
Relative cool gain	rEL	Only present if cooling has been configured and a module is fitted. Sets the cooling proportional band, which equals the Pb value divided by the rEL value.

Table T4 Tuning parameters

AUTOMATIC TUNING

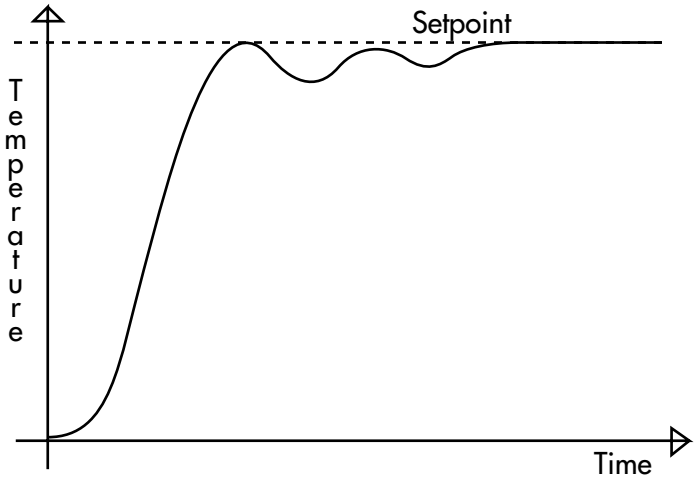
The 'one-shot' tuner works by switching the output on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.
If the process cannot tolerate full heating or cooling being applied during tuning, then the level 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 'AtUn list, select 'tunE and set it to 'on'.
3. Press the Page and Scroll buttons together to return to the Home display. The display will flash 'tunE to indicate that tuning is in progress.
4. The controller induces an oscillation in the temperature by first turning the heating on, and then off. The first cycle is not complete until the measured value has reached the required setpoint.
5. After two cycles of oscillation the tuning is completed and the tuner switches itself off.
6. The controller then calculates the tuning parameters listed in Table 4-1 and resumes normal control action.

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

TYPICAL AUTOMATIC TUNING CYCLE



Calculation of the cutback values

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

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	OPEr	In this level, operators can view and adjust the value of parameters defined in Edit level (see below).	No
Full	FuLL	In this level, all the parameters relevant to a particular configuration are visible. All alterable parameters may be adjusted.	Yes
Edit	Edit	In this level, you can determine which parameters an operator is able to view and adjust in Operator level. You can hide, or reveal, complete lists, individual parameters within each list and you can make parameters read-only or alterable. (See Edit level at the end of this chapter).	Yes
Configuration	conF	This special level allows access to set up the fundamental characteristics of the controller.	Yes

Table 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 'ACCS'.

Press [ ]

PASSWORD ENTRY

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

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

Press [ ] to proceed to the Goto page.

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

ACCESS TO READ-ONLY CONFIGURATION

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

LEVEL SELECTION

The Goto display allows you to select the required access level.
Use ▲ and ▼ to select from the following display
codes: OPEr: Operator level
FuLL: Full level
Edit: Edit level
conF: Configuration level
Press [ ]

If you selected OPEr, FuLL, or EdiT level you will be returned to the ACCS list header in the level that you chose. If you selected conF, you will get a display showing 'ConP 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 Goto display.
In EdiT level, the controller will automatically return to operator level if no button is pressed for 45 seconds.

EDIT LEVEL

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

SETTING OPERATOR ACCESS TO A PARAMETER

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

There are four codes:
ALTr Makes a parameter alterable in Operator level.
Pr0 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 ACCS list, which always displays the code: to Li St.)

PROMOTING A PARAMETER

Scroll through the lists to the required parameter and choose the Pr0 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 Pr0G 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.

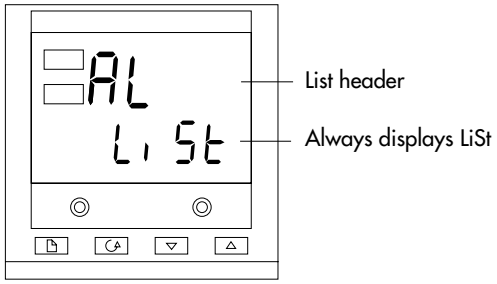


Figure T6. Typical list header display

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.*

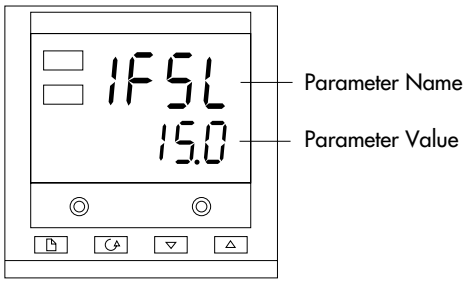


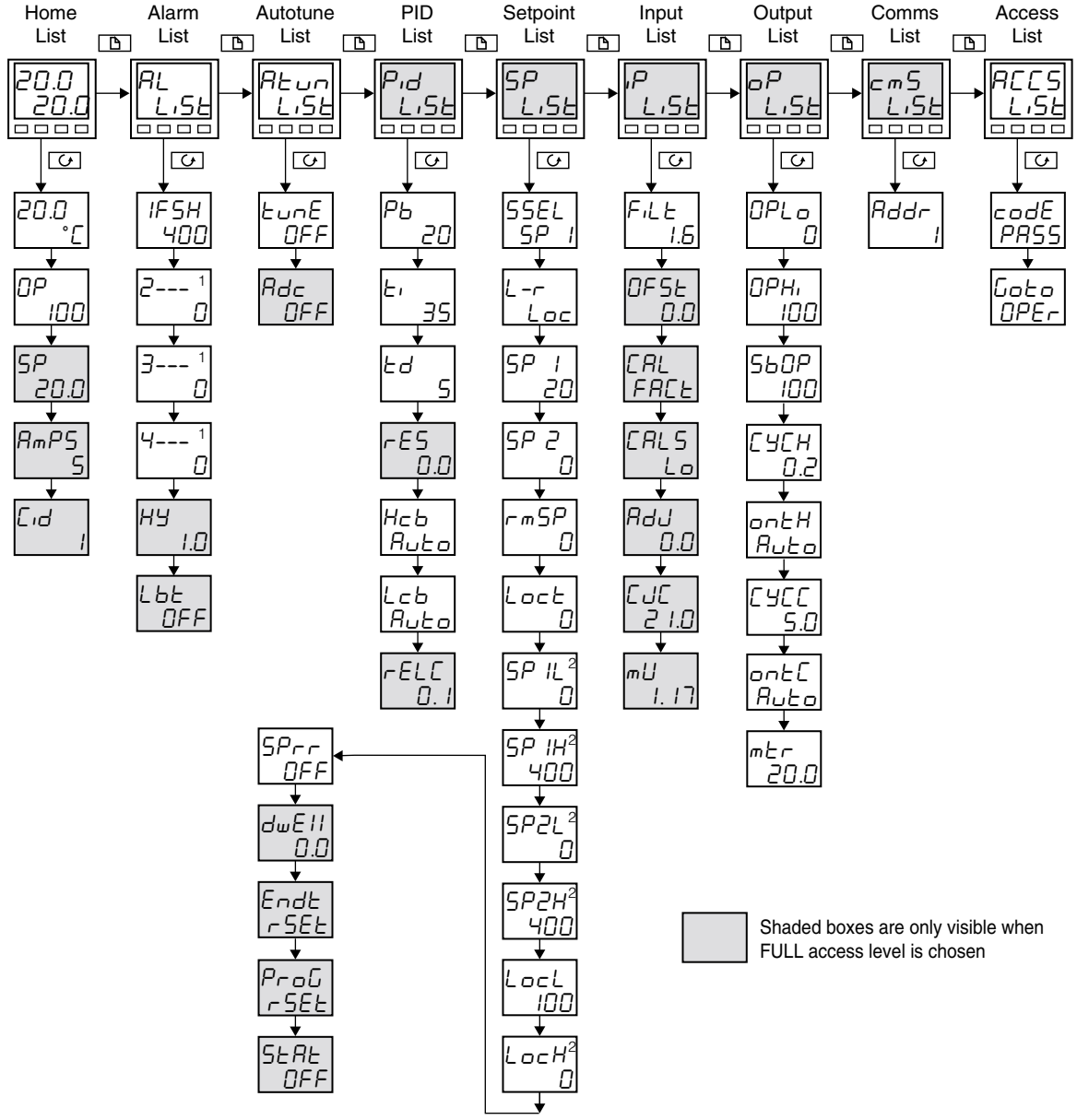
Figure T7. Typical parameter display

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 prconfigured 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
uPoS	Valve positioner output power		0.0	100.0	% of mtr
OP	% Output Level		-100.0	100.0	%
wSP	Working setpoint				as display
SP	Setpoint		-999	9999	as display
AmPS	Heater current (PDS modes 2 and 5)		0	100	AmPS
m-A	Auto/manual select	Auto			
diSP	Configure lower readout of home	Std			
Cid	Customer ID	0	0	9999	

AUTOTUNE LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
Atun	Autotune List				
TunE	Self tune enable	OFF	OFF	On	
Adc	Automatic droop compensation (Manual Reset) enable (only present if Ł set to OFF)	mAn	mAn	CALC	

ACCESS LIST

NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
ACCS	Access list				
codE	Full and Edit level password	1	0	9999	
Goto	Goto level OPErFuLL EdiŁ or conF	OPEr	OPEr	conF	
ConF	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:					
-FSH	Full Scale High alarm		-999	9999	as display
-FSL	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	
CYCC	Cool cycle time	1.0	0.2	999.9	secs
ontC	Cool output min. on time	0.1	Auto	999.9	
mtr	VP motor travel time		0.0	999.9	secs

PID LIST

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

INPUT LIST

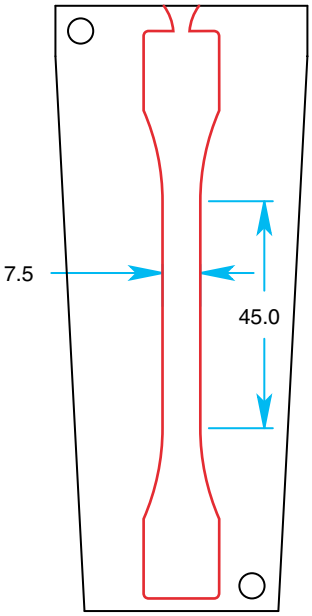
NAME	DESCRIPTION	DEFAULT	MIN VALUE	MAX VALUE	UNITS
IP	Input list				
FiLt	Input filter time constant	1.6	oFF	999.9	secs
OFSt	PV Offset		-999	9999	as display
The next 5 parameters will appear if User calibration has been enabled in configuration level					
CAL	FACt will re-instate factory settings and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

SETPOINT LIST

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

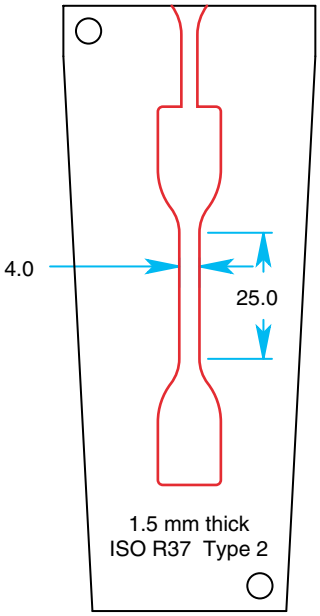
APPENDICES

APPENDIX A: SAMPLE MOLDS

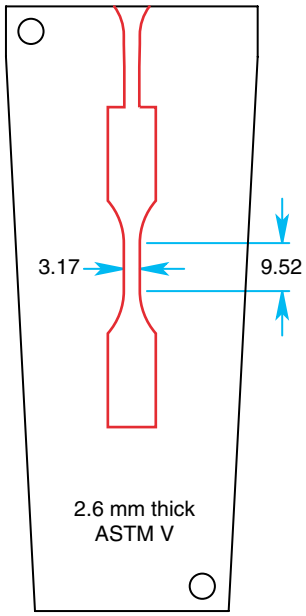


2.0 mm thick

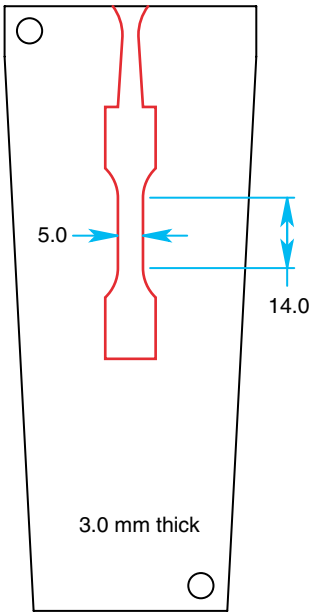
Part # 51010



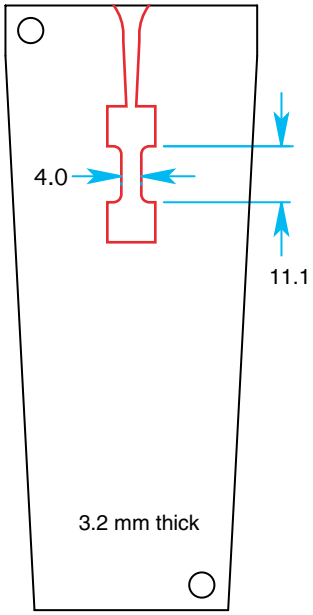
Part # 51011



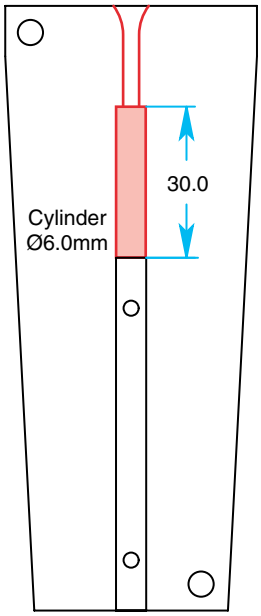
Part # 51012



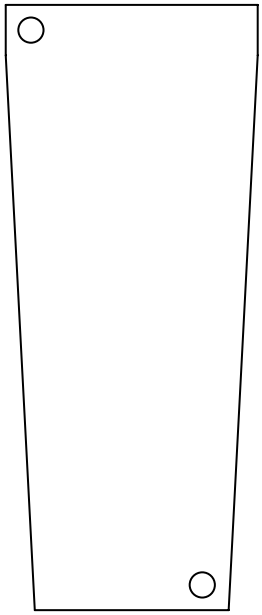
Part # 51013

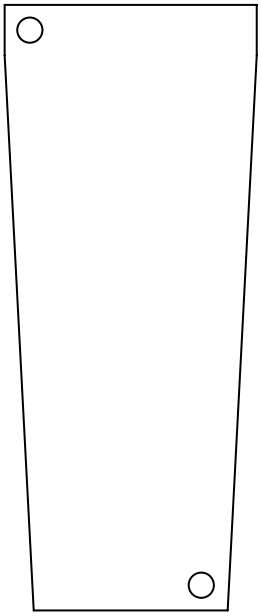


Part # 51014

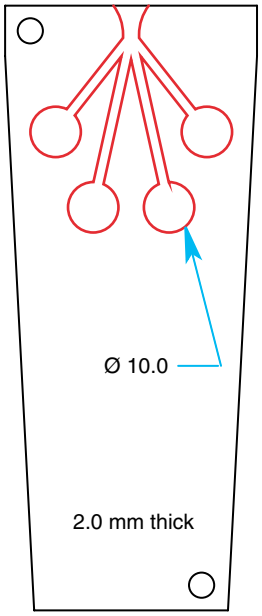


Part # 51040

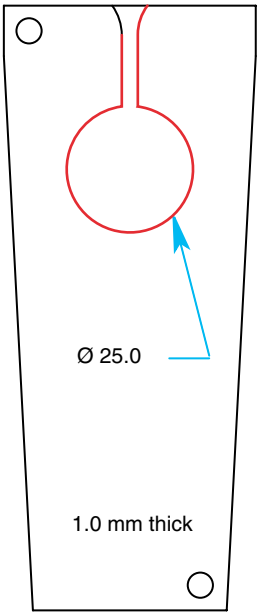




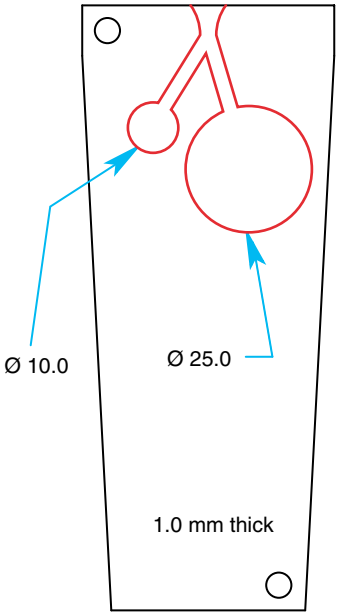
Sample Molds For MicroInjector



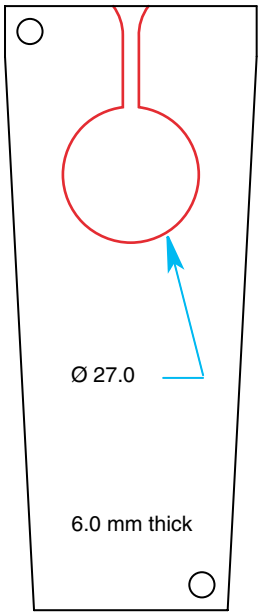
Part # 51020



Part # 51021



Part # 51022



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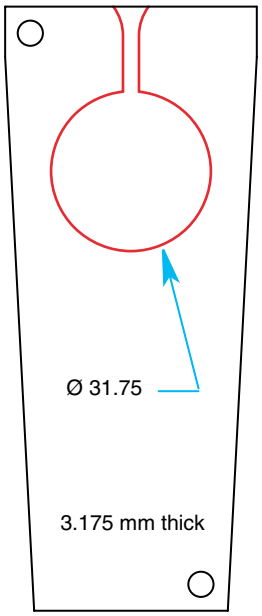

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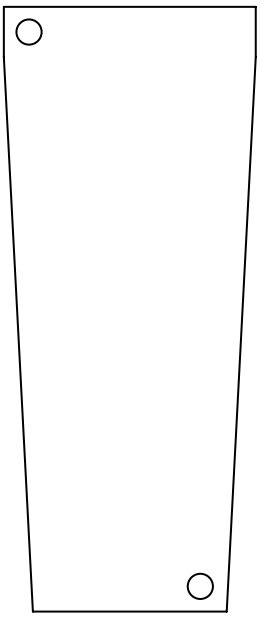
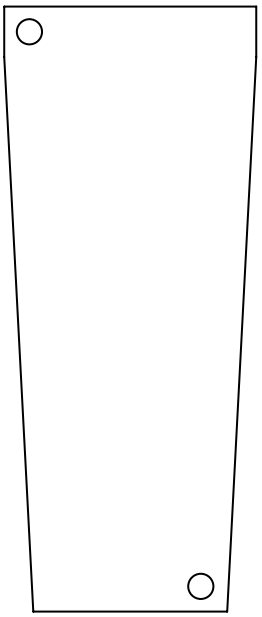
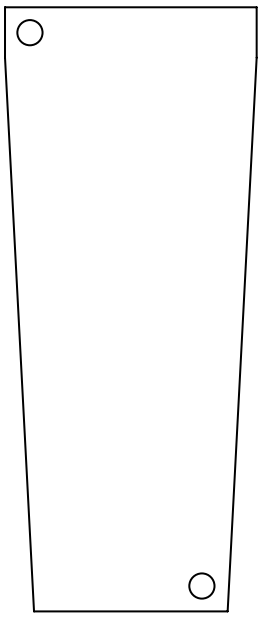
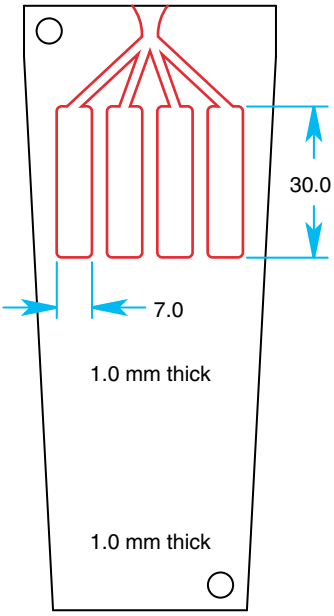






Contact DACA Instruments about your particular mold requirements

Sample Molds For MicroInjector



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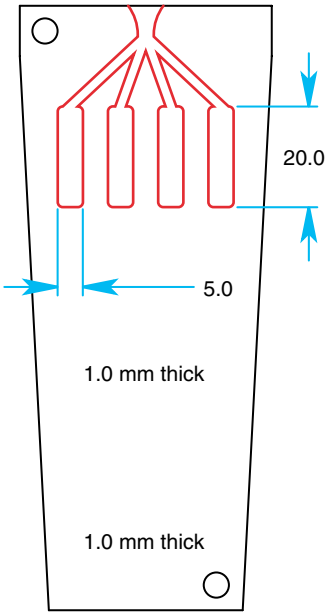

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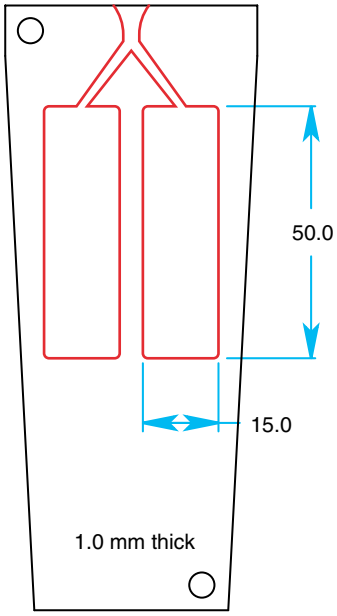

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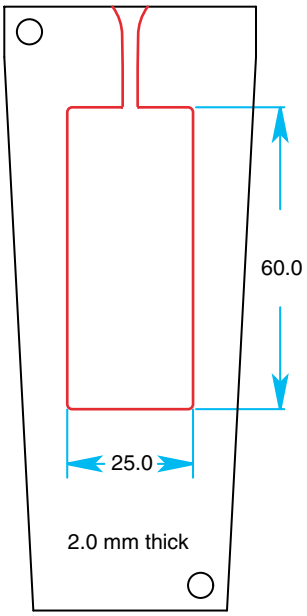

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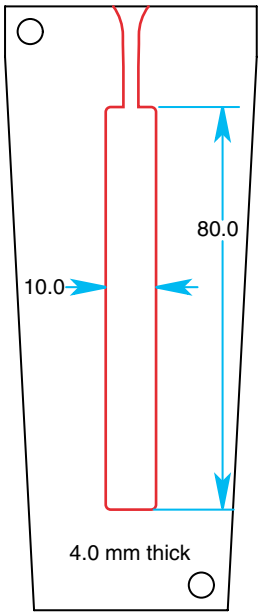

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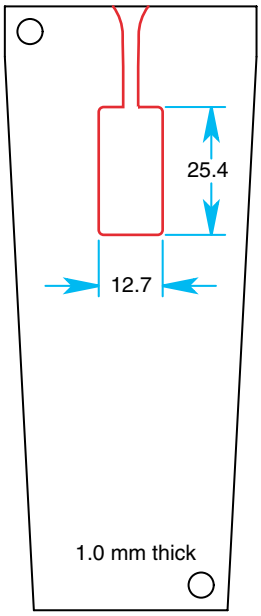

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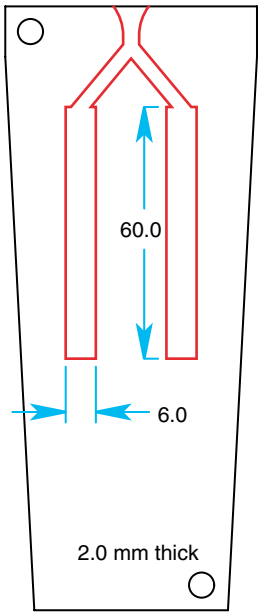

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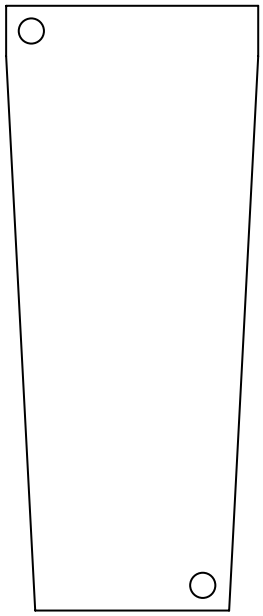
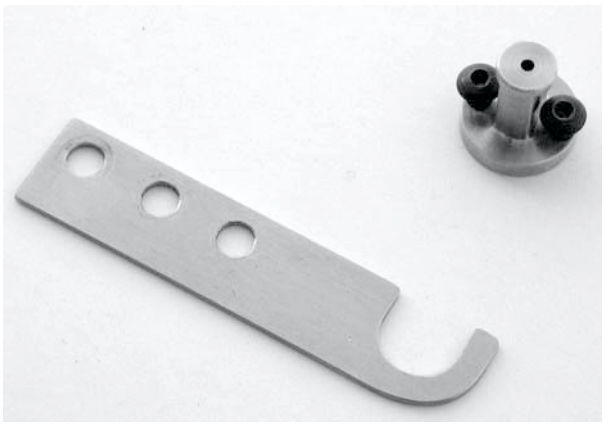
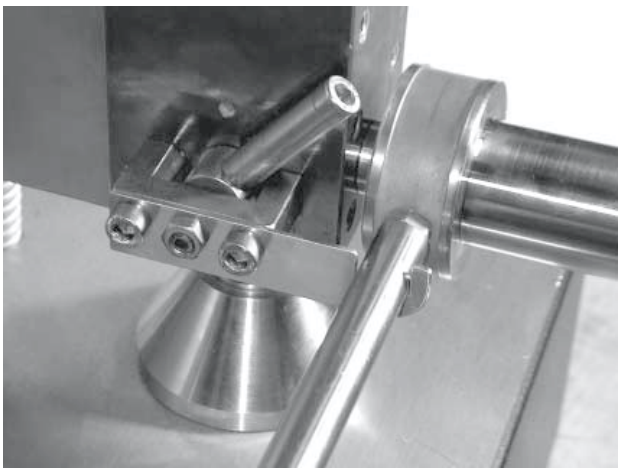


Contact DACA Instruments about your particular mold requirements

APPENDIX B: ACCESSORIES

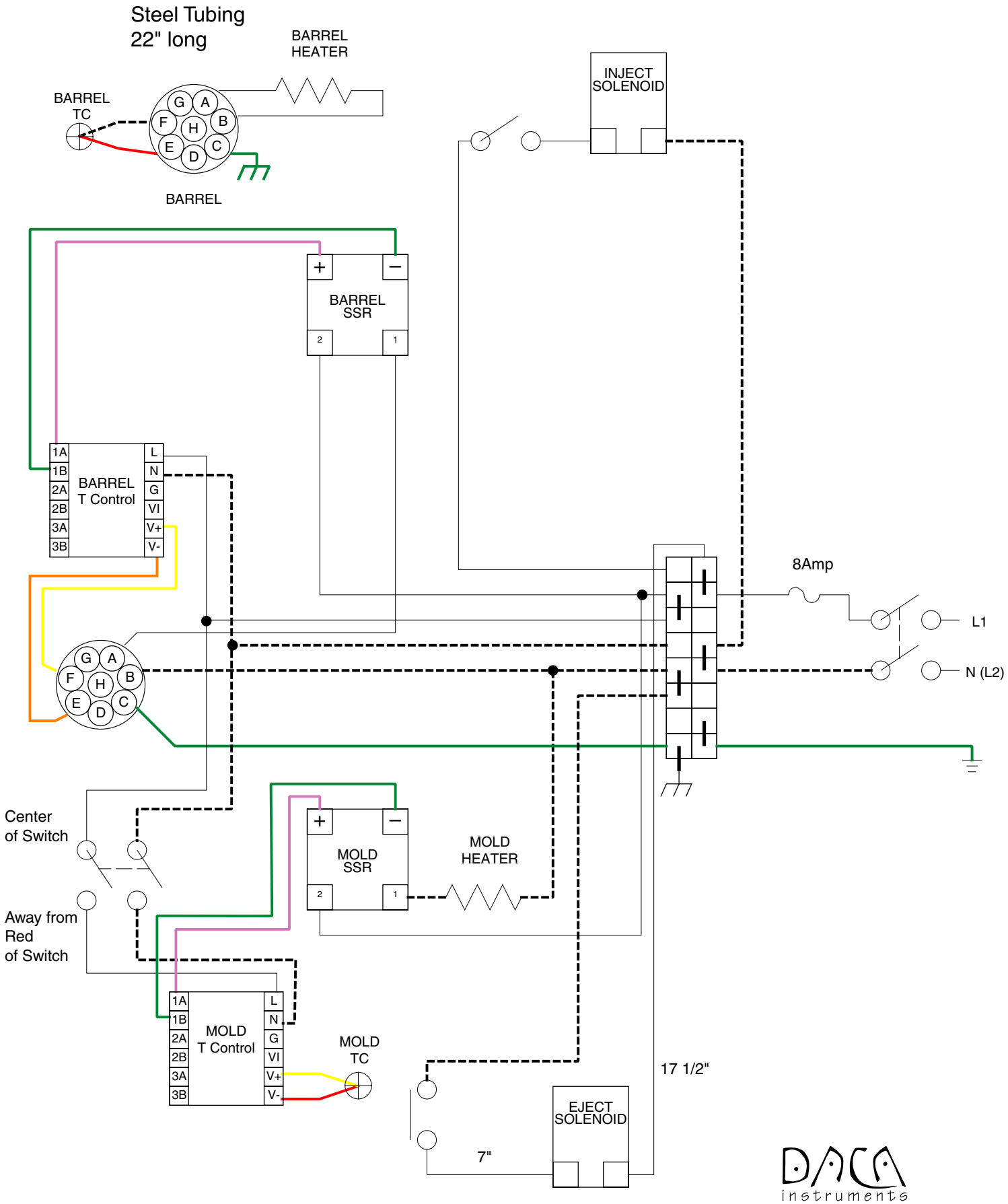
P/N 50010 Vise
This optional vise is useful for holding the barrel of the MicroInjector while loading it with polymer and heating it until the polymer is completely melted. The vise comes with a heavy metal base for added stability.





P/N 20500 MC-MI Transfer bracket
This bracket and nozzle set aids the extrusion of material from the Micro-Compounder into the MicroInjector barrel. The photos show the bracket installed and in use.

APPENDIX C: WIRING DIAGRAM



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MicroInjector Wiring Diagram

APPENDIX D: 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.

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NOTES