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

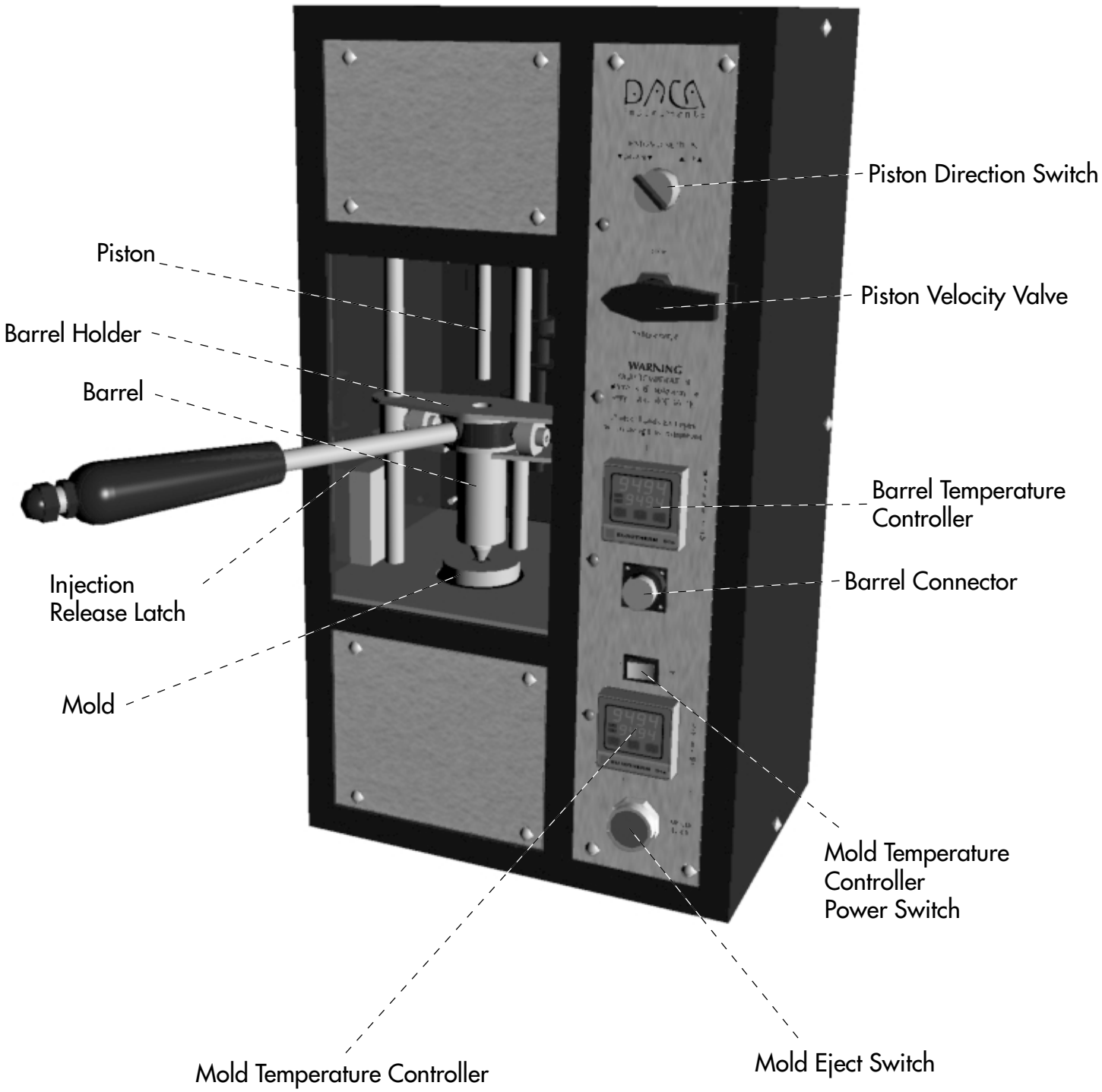
ELECTRICAL

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

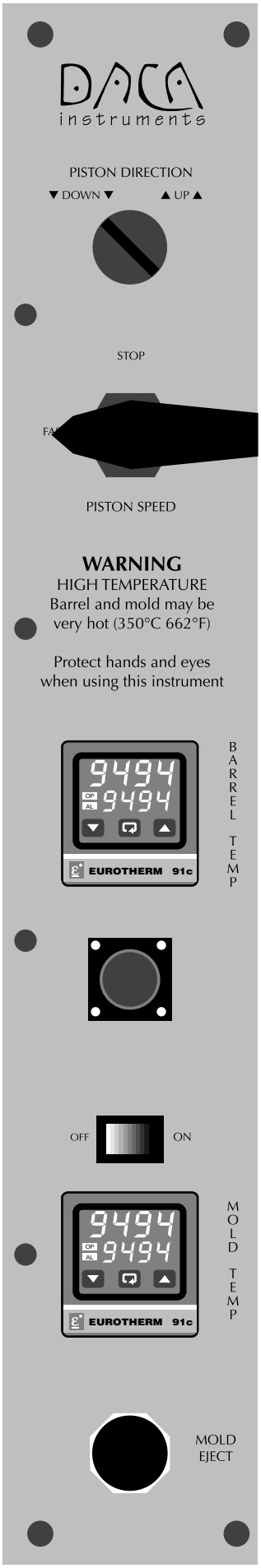
PHYSICAL

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

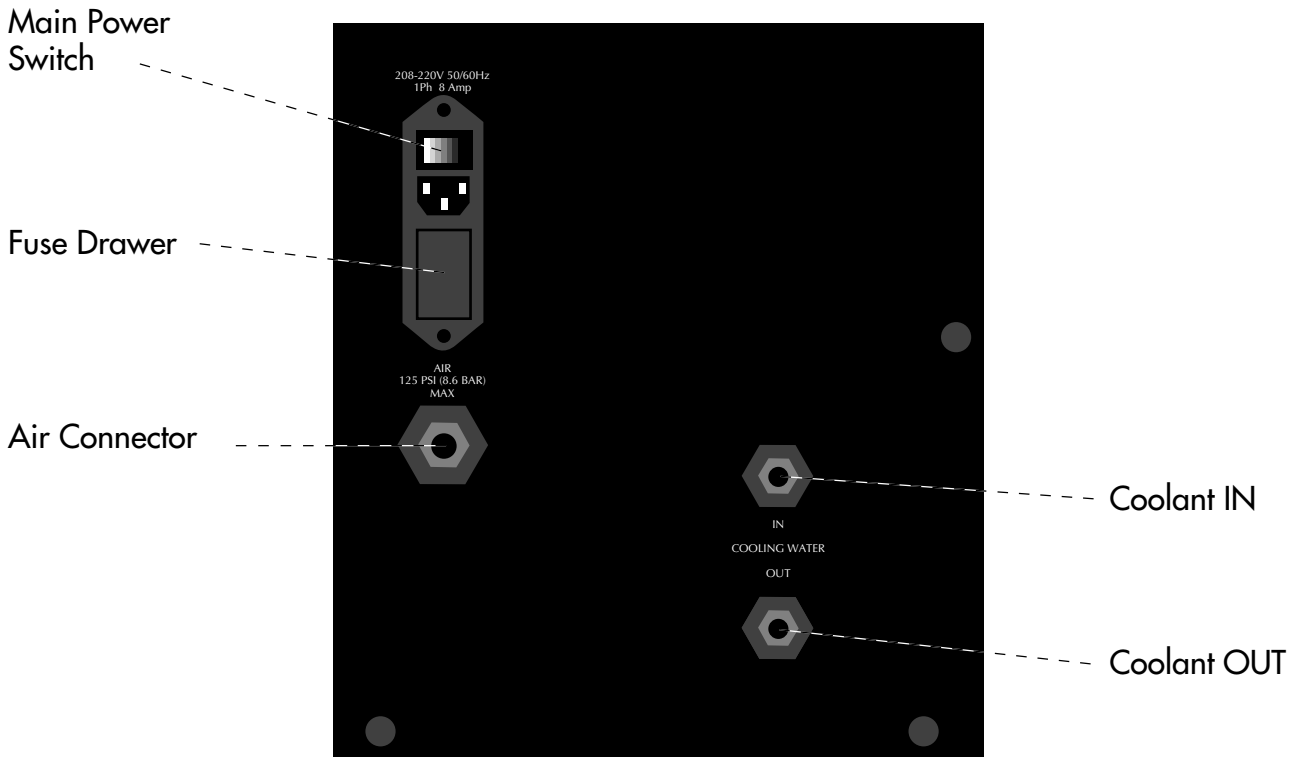
Barrel Connector

Mold Temperature Controller Power Switch

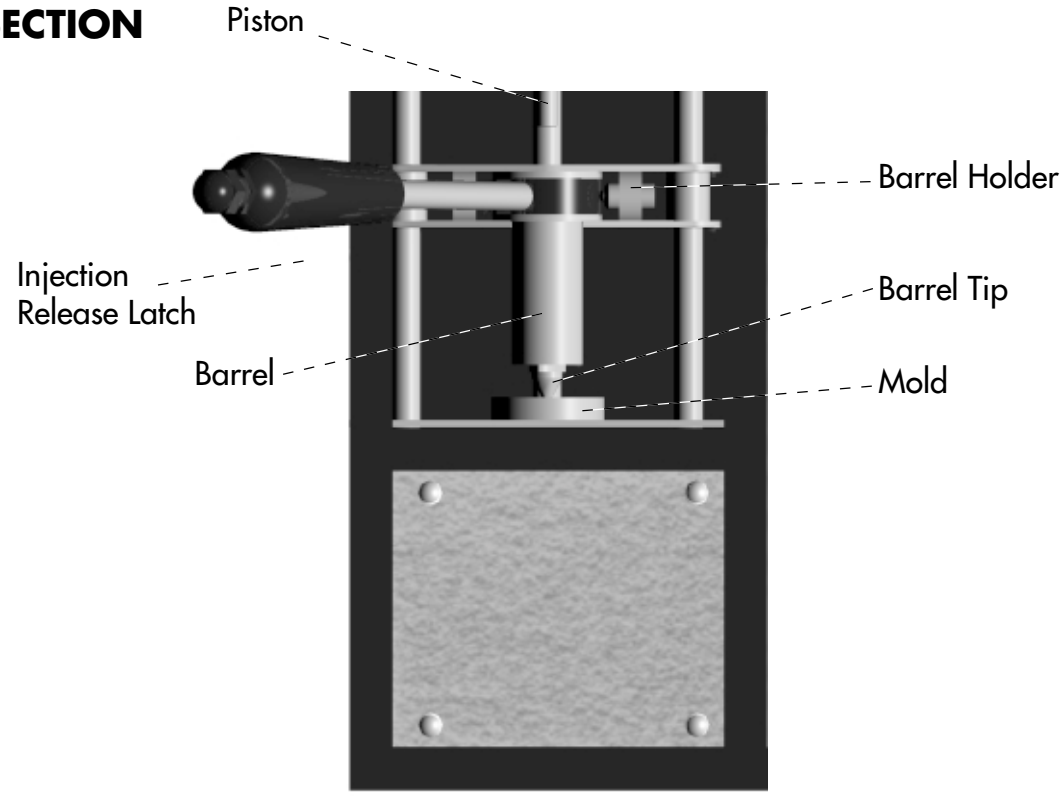
Mold Temperature Controller

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.

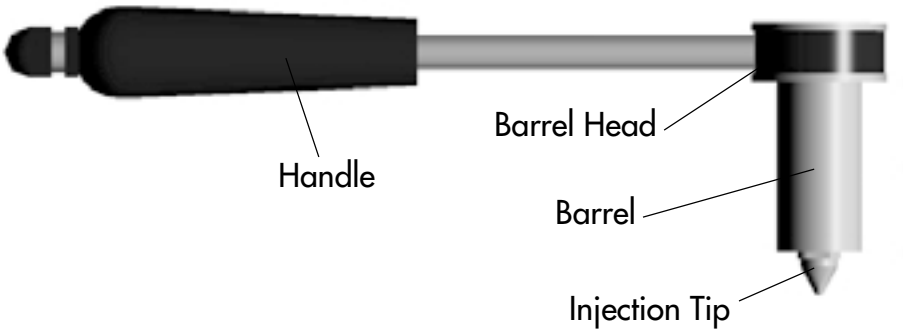
General Operation

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



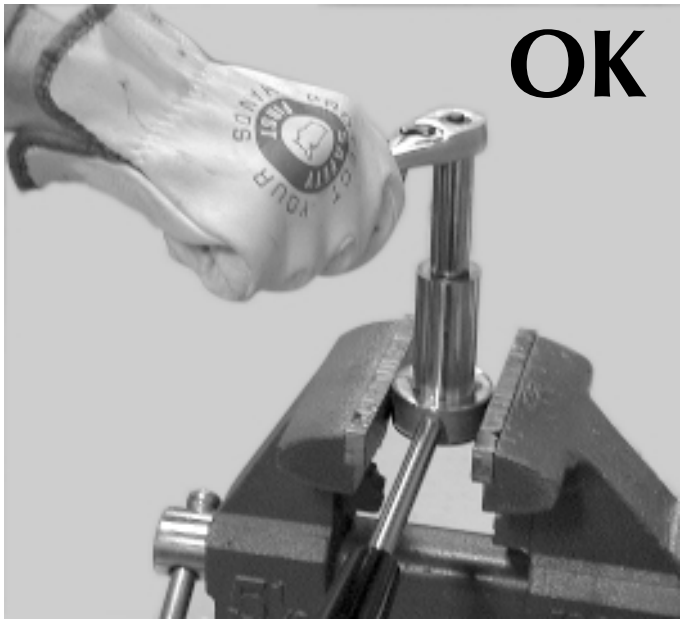
CAUTION!	DO NOT apply any force to the handle to install or remove the injection tips.

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)

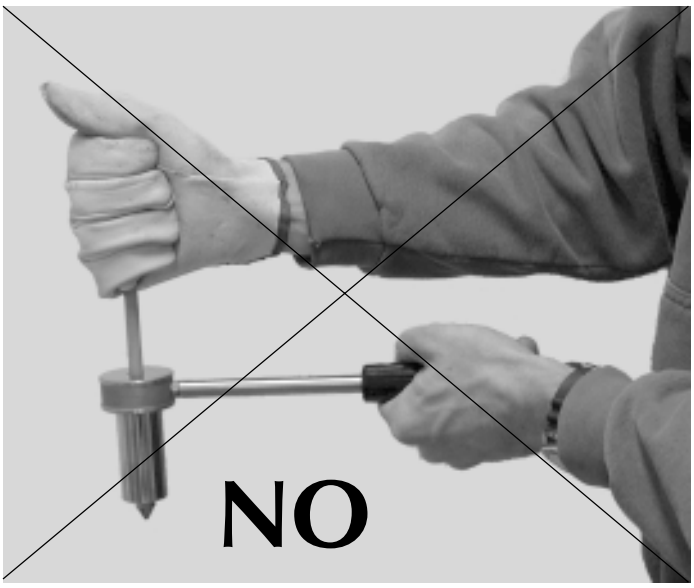


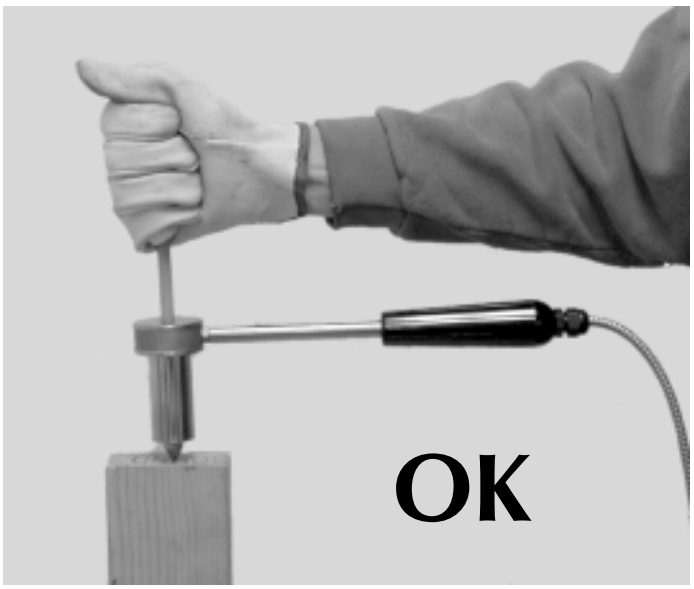
BARREL LOADING

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.



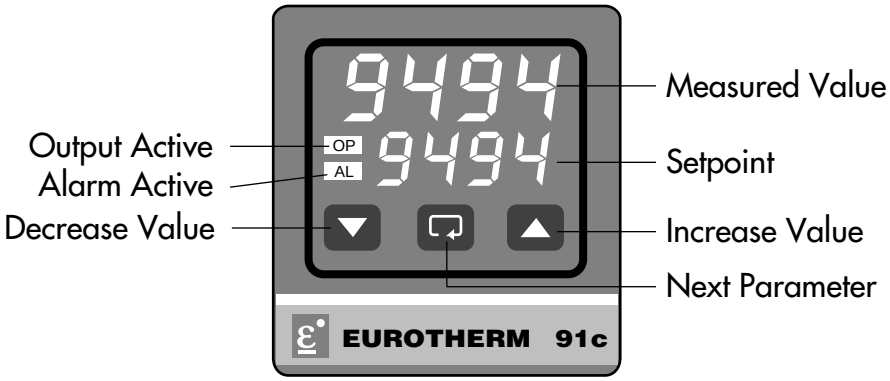


TEMPERATURE CONTROL

TEMPERATURE CONTROL

Portions © EUROTHERM CONTROLS Inc.

The temperature of the barrel and mold are controlled by Eurotherm 91c temperature controllers. The following figure illustrates the controls and indicators of the unit. The barrel must be connected to the front panel of the instrument before turning the MicroInjector on.



BASIC OPERATION

- To light up buttons: touch any button on front panel.
- To modify setpoint: 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 : HI temperature alarm (>400°C)

When the Alarm condition is reached (measured temperature = 400°C), a red annunciation LED –AL– 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
Sn Sr **FAIL**	Sensor fail. Input open or reversed; measured value outside of configured range.	Vefity input sensor and connections. Message disappears when input signal is reinstated
measured value **LP.br**	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 **SP.rr**	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.

TUNING AND ADJUSTMENTS

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 ▲ until **on** shows up in the lower display and pause
- the **tunE** message will flash in the lower display as the temperature ramps to the setpoint
- wait for the tuning operation to finish: **tunE** will no longer be displayed

SELF–TUNE MESSAGES

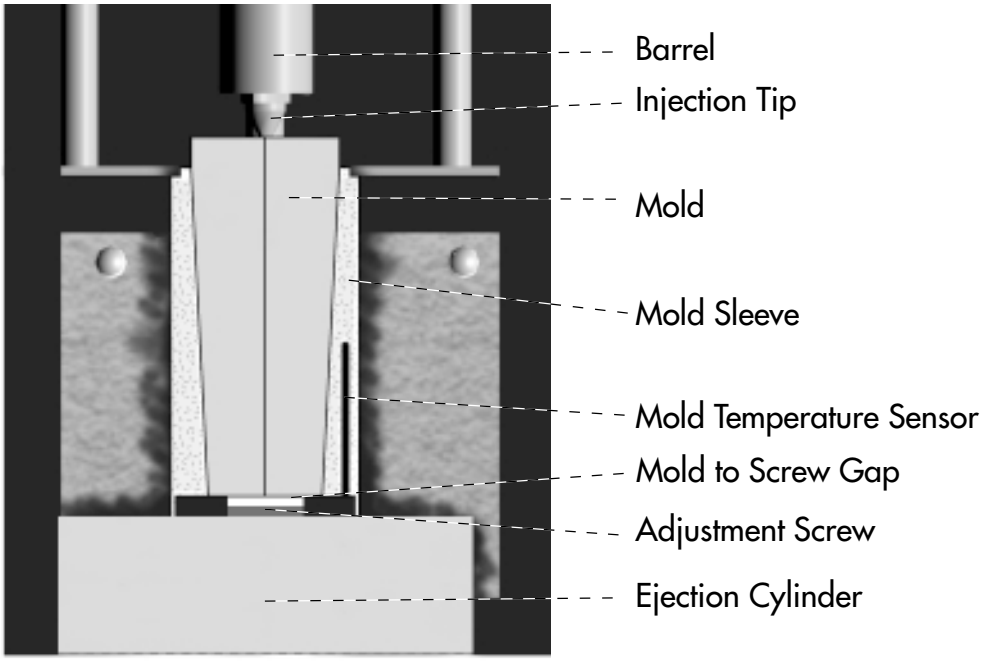
MESSAGE	DISPLAY CONDITION	USER ACTION/COMMENTS
measured value **tunE**	Self tuning in progress.	Annunciation only. Adjustment of setpoint and PID values inhibited during self tuning
tunE **FAIL**	Self tuning operation has failed because controller cannot maintain setpoint.	Acknowledge by touching any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

MOLD LOADING & REMOVAL

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.

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 cooling fluid to leak and possibly damaging other components in the instrument.

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.

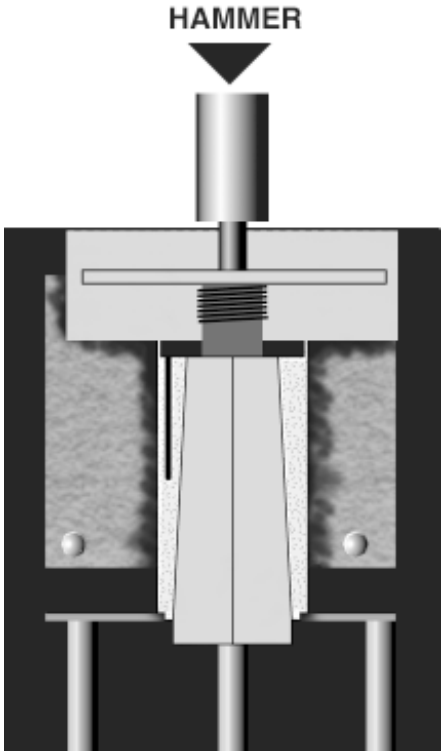
REMOVING A MOLD THAT CAN'T BE EJECTED

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.

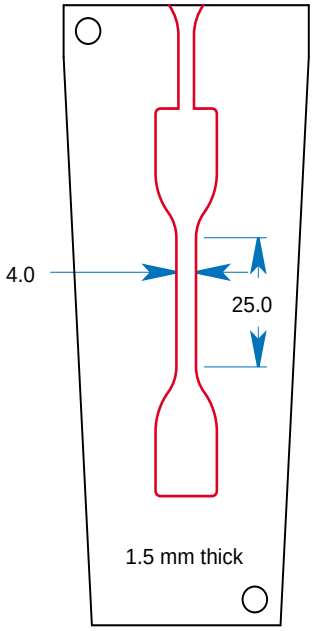
• As recommended earlier, regularly coat the inside of the mold sleeve and the outside of the molds with KRYTOX grease to prevent the mold from sticking to the sleeve.

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

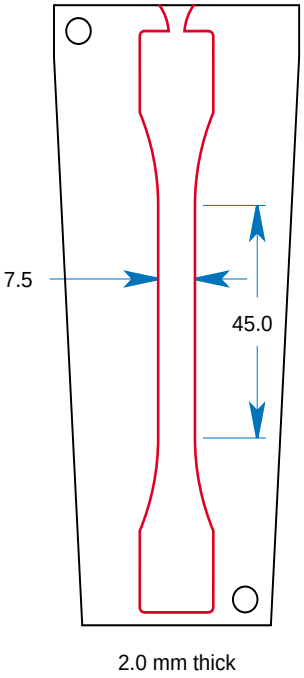
• The mold is made of hardened A2 steel. Protect the mold from rusting by applying a light coat of oil (WD-40 or similar) to the inner surfaces, particularly when not in use.

APPENDICES

APPENDIX A: SAMPLE MOLDS



Part # 51011



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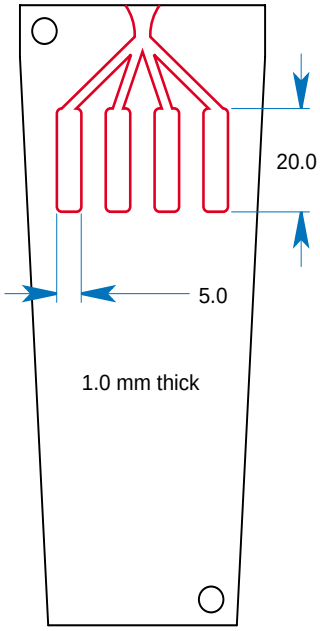

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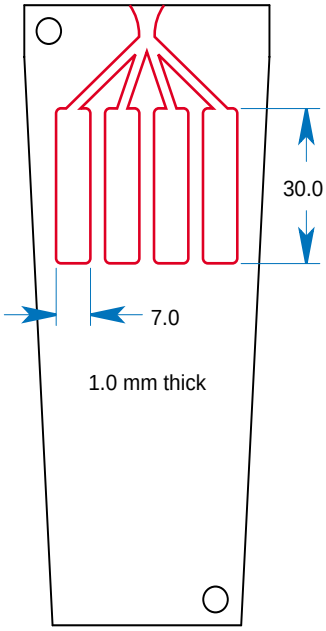

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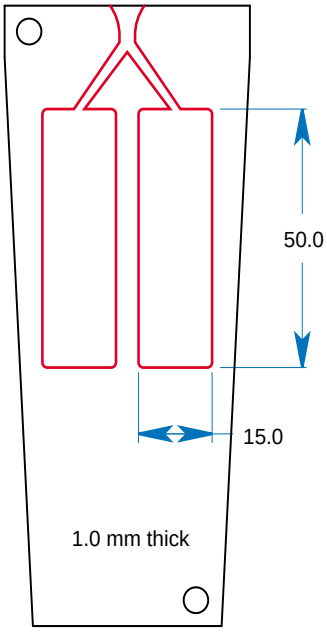

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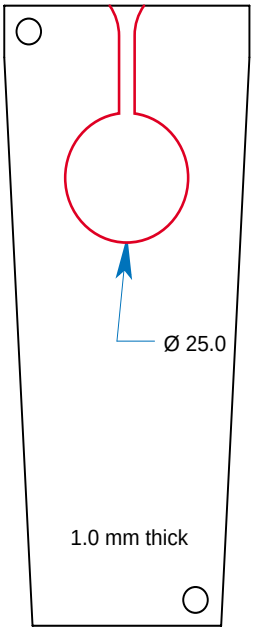
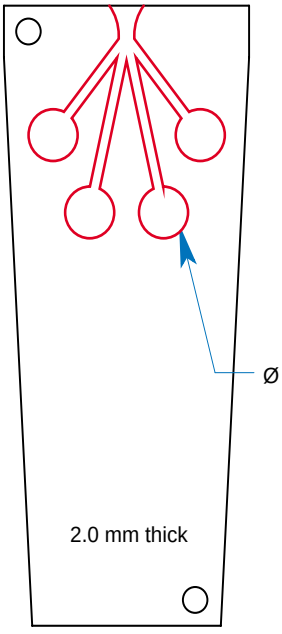
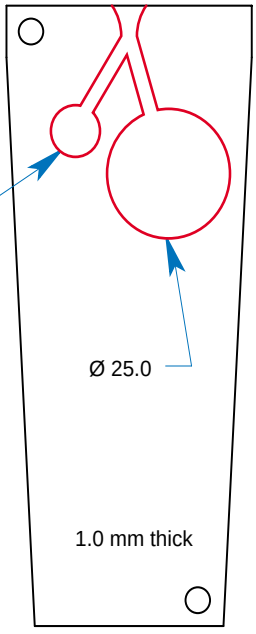


Part # 51021



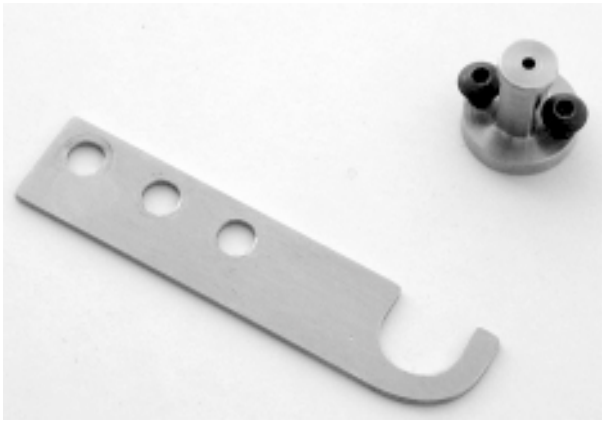
Part # 51020

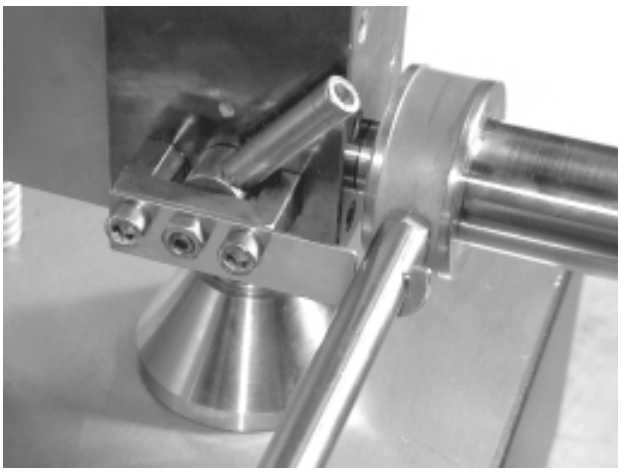


Part # 51022

APPENDIX B: ACCESSORIES

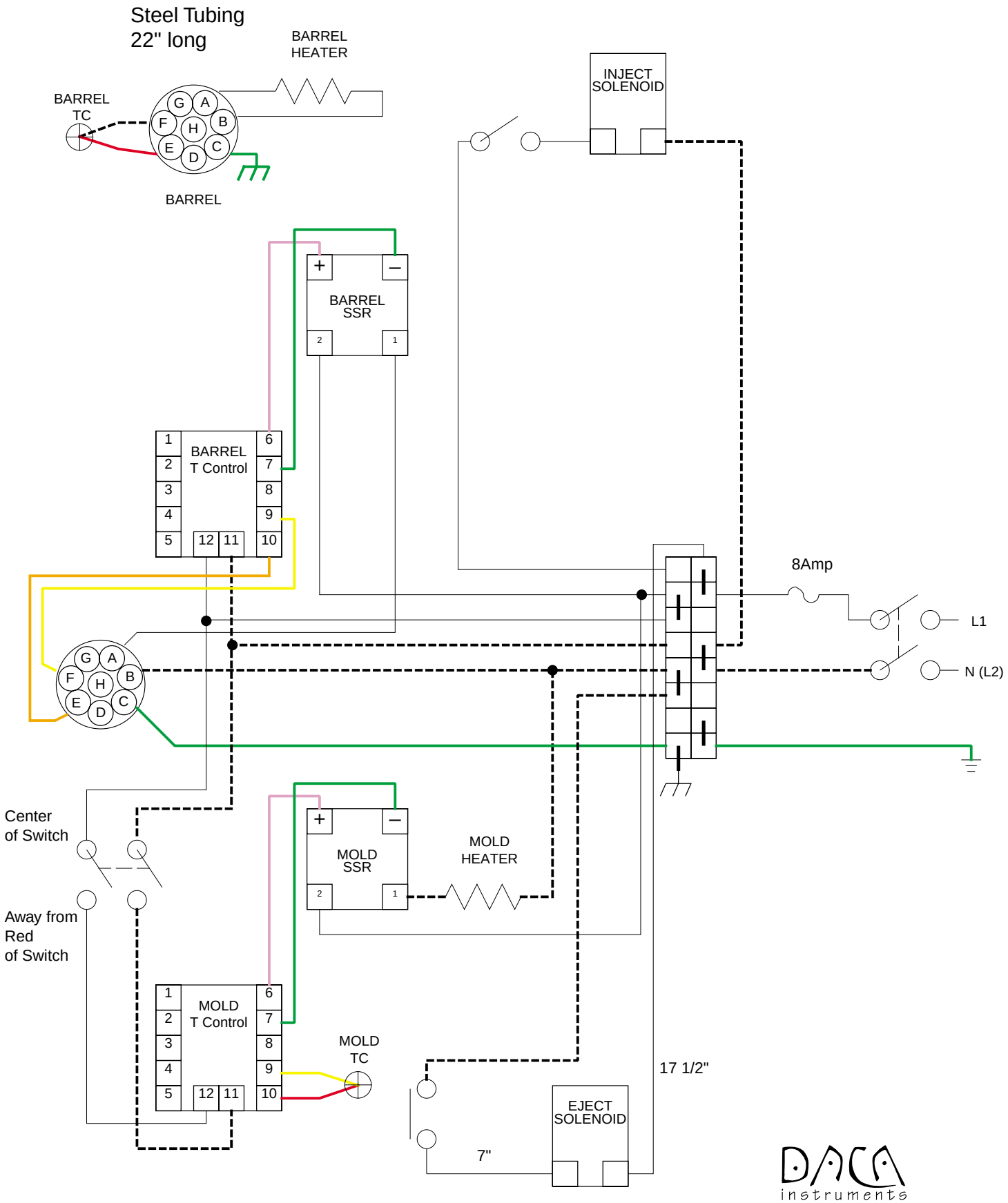
P/N 50010 Vise
This optional vise is useful for holding the barrel of the MicroInjector while loading it with polymer and heating it until the polymer is completely melted. The vise comes with a heavy metal base for added stability.





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



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.

DACA instruments

NOTES