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Load Compensation Kit Operating Instructions

Chapter 1: LCK-100 Kit Components

The following list summarizes the equipment received with your kit:

Standard Equipment:

- ◆ LCK-100 Valve Block with Flow Control Cartridge Valve Stroke Adjuster
- ◆ Model T-3030 Digital Hydraulic Pressure Gauge
- ◆ HF2000M Male Quick Disconnect to mate with the Model T-3030
- ◆ Power Supply and Trigger Board Assembly

Optional Equipment:

- ◆ Modified Flow Switch with Indicator Light
- ◆ Model T-920C Digital Fill Time Monitor

If there are questions regarding the delivery of any of this equipment, please call RJG, Inc. – Customer Service department at (616) 947-3111.

In addition to the optional equipment listed above, RJG's DART Module system is available at an additional cost. The basic system consists of a single DART module, DARTWin™ or DARTNet software and all of the necessary cabling to install of this system on your computer.

Chapter 2: Load Compensation Objective

The machine upgrade consists of relatively minor modifications to machine hydraulics and the addition of key variable digital displays to allow precise, accurate and repeatable control of machine injection rates. This load compensated upgrade is founded on fundamental hydraulic concepts in conjunction with good engineering practices utilizing load compensation circuits which are properly installed and tuned to achieve repeatable injection rates comparable to new injection molding machines.

Load compensation, which is sometimes called load sensing, uses a form of hydraulic feedback which allows the injection main relief valve to respond to changes in the viscosity of plastic which normally causes changes in injection speed on a standard molding machine. Load sensing, which is used on many of the new molding machines, allows the machine's injection speed to be controlled solely by the injection speed control. **Thus, it is possible to inject into the mold and to purge into the air and have the same injection speed!**

What does this mean with respect to process capability? **It means that a machine can absorb variations with incoming material instead of amplifying them.** If the viscosity of material goes down (becomes easier to flow) the pressure in the injection cylinder needed to push the plastic at the set injection speed is reduced. It is reflected back into the pilot circuit and the pump pressure, thus, reducing the supplied pressure, keeping the pressure difference across the flow control constant and thus injection speed constant.

If the viscosity of material increases, the pressure in the injection cylinder, necessary to flow the material at the set flow rate increases. This increase is reflected back into the pilot circuit, which raises the pump pressure via the main relief valve, to provide a fixed pressure drop across the flow control. This keeps the material flowing at a constant controlled speed.

Load compensation does **not** give the machine the capability of injection profile or changing injection speed during fill. This is known as Programmed Injection. However, **if molds can make good parts on conventional machines, programmed injection is not necessary. What is needed is the consistency of injection and the ability to set it.**

As an integral part of the machine upgrade kit, the installation of a digital fill time clock and a digital peak reading hydraulic gauge are essential for the correct operation of this circuit. Due to non-Newtonian characteristics, the plastic viscosity changes dramatically with even small changes in injection speed. This makes it essential for processes to be repeated so that the injection fill times be controlled to within 100ths of a second. The ability to set this variable can only be achieved by having a fill time clock on the machine which times from the start of injection until 1st Stage cutoff is achieved.

With a load compensator on the machine, hydraulic pressure during 1st Stage only builds up to the pressure required to push the plastic at the set injection speed. It is therefore important to be able to detect peak hydraulic pressure during 1st Stage. This incidentally also gives a true measure of viscosity of plastic when multiplied by the fill time. The gauge also allows very accurate and repeatable settings of 2nd Stage and backpressure adjustments. Machines of different injection unit ratios (normally 10:1 on American machines) can be normalized using a non-standard calibration on the digital gauge. RJG's Model T-3030 Digital Pressure gage can be configured to measure both Hydraulic pressure **and** Fill Time as outlined in the *Chapter 3 Installation – Electrical – T-3030 Digital Gage* section.

Another large benefit of load compensation is in power savings and machine wear. You will notice with the load compensator installed that the machine sounds different. Load compensation makes the pump work only hard enough to achieve the flow rate. It therefore relieves excess oil back to tank at a much lower pressure than when using a normal machine. This makes the machine run cooler and saves tremendous amounts of power. It has been estimated by users of load compensation that as much as 30% of the power of the molding machine is wasted during injection and thus can be recouped by the use of this technique. Much of the savings depends on how you are molding currently, however in all cases; machine power consumption during injection is optimized.

Chapter 3: Installation

Hydraulics

Valve Block and Compensator Circuit

RJG's valve block with manual flow control adjustment will be the ram speed control the operator now uses instead of the control originally on the machine. Figure 1 shows a generic application of the valve on a machine. Your machine may not be identical to the one shown, but you can use this diagram as a guideline. The valve is installed in-line to the cylinder in the circuit for proper operation. If the machine currently has an in-line flow control, simply replace it with RJG's valve block.

If you sent us a hydraulic schematic of your machine, Ports A, B, P, and T are identified on the marked print of your original drawing to show installation specific to your machine. Also, Figure 1 shows the generic installation of those points where "A" is Flow In, "B" is Flow Out, Port "P" is tee'd into the pilot line of the remote pressure head, and "T" plumbed into a tank line.

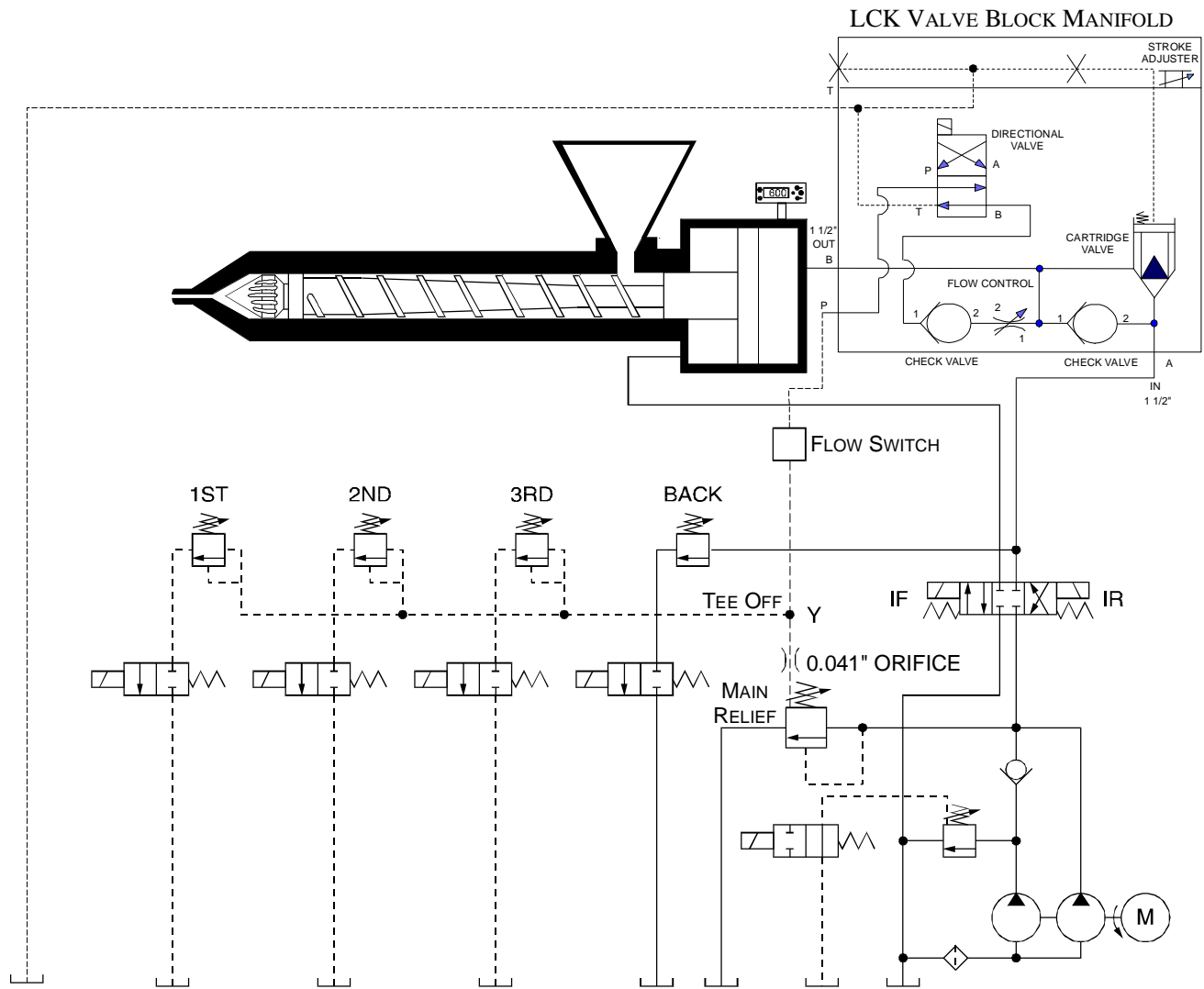


Figure 1

Figure 1 also shows the valve schematic and compensator circuit with an optional directional valve. The directional valve turns the compensator on **only** during 1st Stage injection. Though not necessary in many machines, those that require the directional valve have other metering functions that will be interfered with if the compensator is not turned off. The compensator should only do its job during 1st Stage injection. If your valve is not equipped with a directional valve, there is a blocking plate in its place to allow the compensator circuit to always be in the circuit.

Figure 2 shows the final part of the load compensation package is an optional flow switch to detect the absence of oil flow to the compensator. This switch allows the installer to hook up a simple light to tell the operator when insufficient pressure is available on 1st Stage to allow the compensator to do its job. The use of the load compensating switch and light makes operator training in the proper use of load compensation a straightforward task.

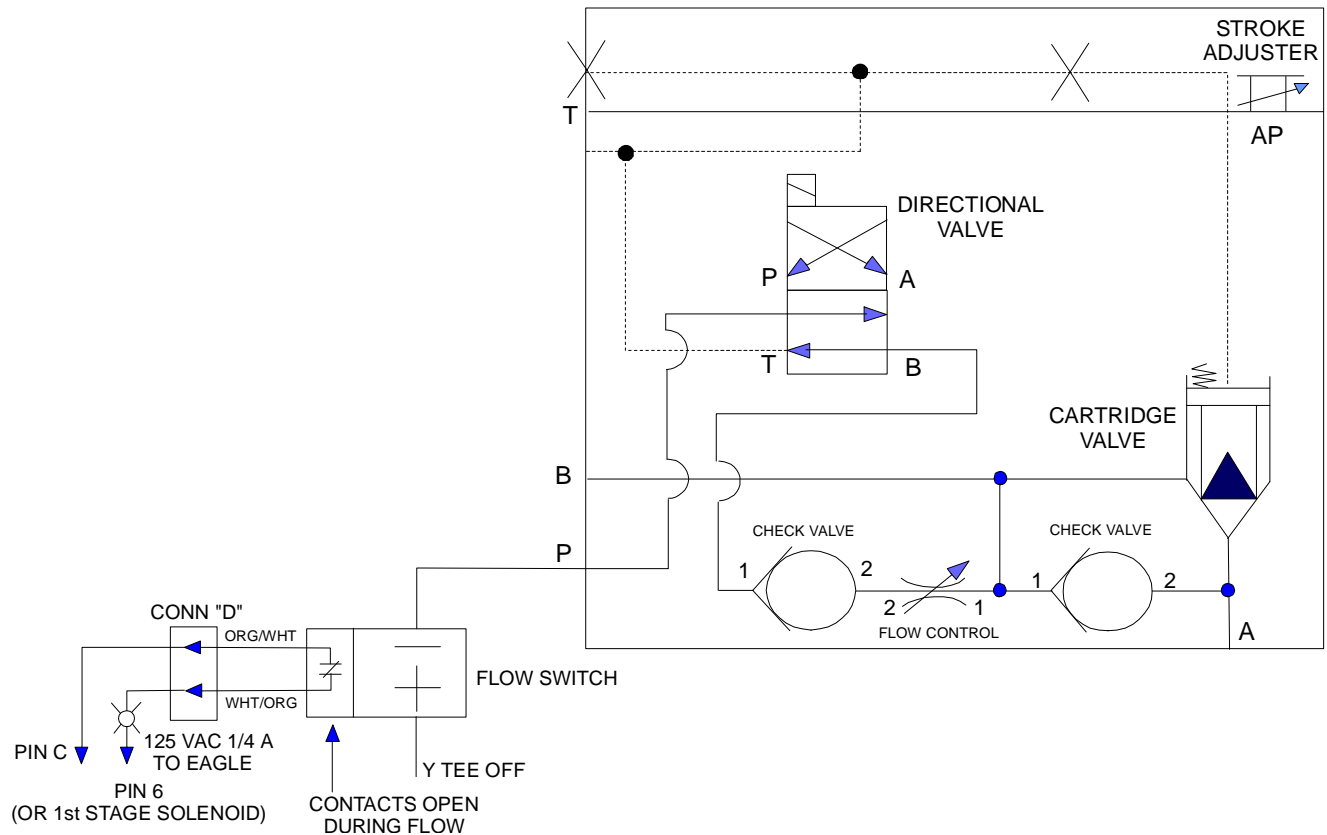


Figure 2

During injection, the pilot flow is being diverted away from the remote valve heads and into the cylinder of the machine through the compensator circuit on the valve block. Essentially, this pilot diversion creates a fixed pressure drop across the flow control orifice of the block in order to regulate the volume of oil going to the cylinder from the pump. Proper installation will cause the pump to seek only the pressure it needs to keep a constant volume of oil going to the cylinder during injection. Consequently, injection speed will remain constant independent of changing load in front of the screw.

Electrical

T-3030 Digital Gage

Install a HF2000M Hydraulic Male Quick Disconnect fitting at a location that will tap the **Injection Cylinder** pressure. The Model T-3030 will swivel when adapted to the HF2000M to allow its visibility by operators during molding. See the *T-3030 Operating Instructions* section for digital gage operation.

Using For Pressure Readings Only

15 VDC regulated power is provided to the Model T-3030 from a Model T-1115 Wall Transformer Plug-in Power Supply. Pressure will register on the display each cycle, while in the Track (TRK) mode. No other wiring is necessary for reading pressure, only.

Using For Pressure and Fill Time Readings

The gage will require an input "trigger" from the machine for the display to also readout a fill time in addition to pressure. This wiring is not necessary if using the Eagle Fill Timer control option described below in *Installation – LCK-100 (T-3030) Relay Board Interface – Fill Timer Start/Autozeroing* section. Alternatively, if

the machine has a 1st Stage sequence signal available, the gage will read the time this signal is "ON" and it will correspond to fill time.

The gage can trigger off Injection Forward (or Injection Total) to start the gage's clock and fill time can be displayed on the gage when the peak pressure is reached. The gage is set in the Peak Mode at the factory to read this time. See *T-3030 Operating Instructions – T-3030 Front Panel Description – Mode Select Switch – DATA* section for selecting available timer modes.

Any residual pressure present on the gage will be zeroed out with each autozero (Trigger) cycle, and the gage will begin timing at the start of this trigger. The timer will stop timing based on either reaching a peak pressure (standard configuration preset at the factory), or when the trigger turns "OFF."

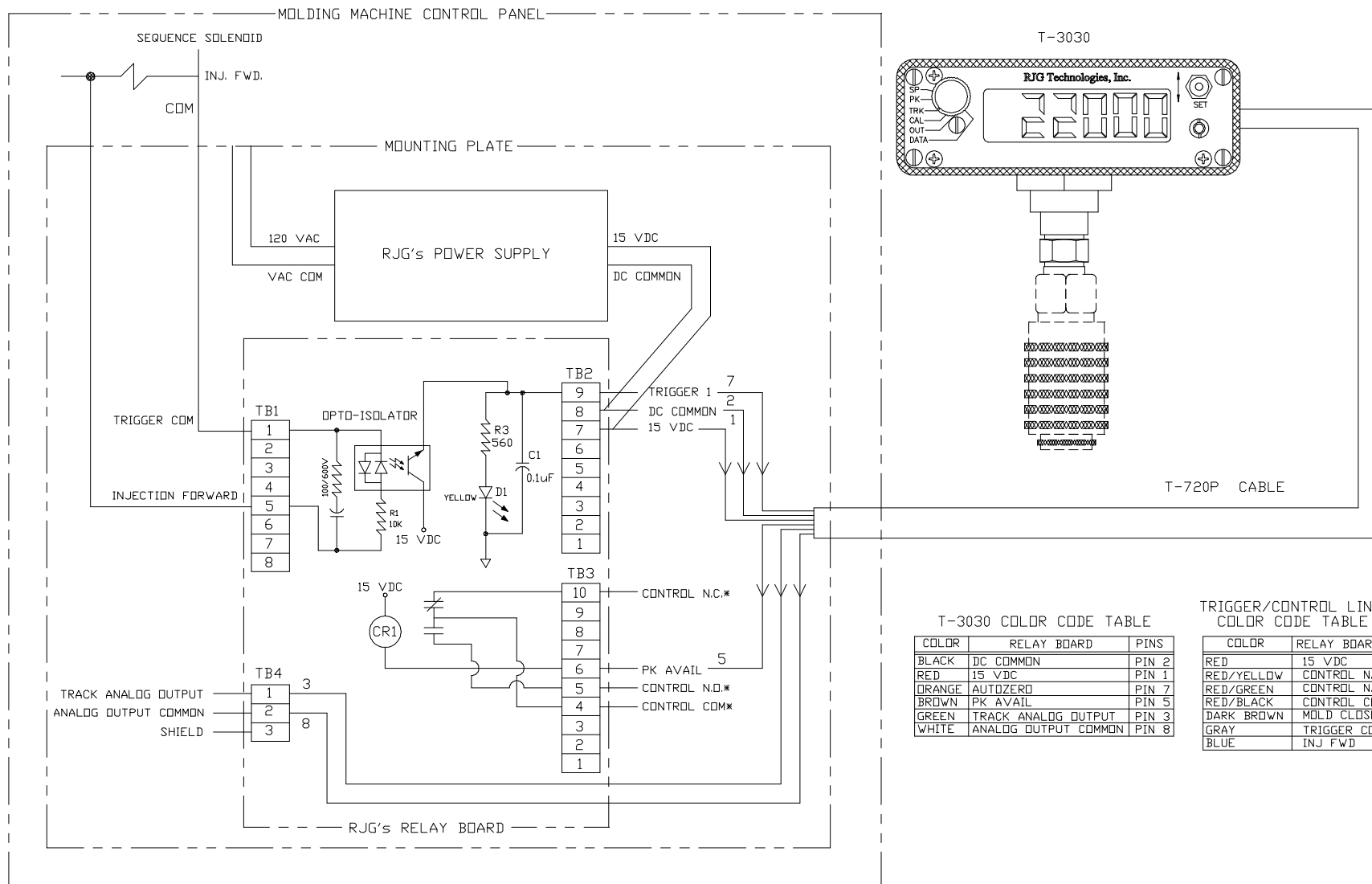


Figure 3

NOTE: The contacts on TB3 Pins 4, 5 & 10 are not horse-power rated and should not be used to switch relay coils or solenoids directly.

LCK-100 Relay Board Interface with T-3030 Fill Time Kit

The schematic below (Figure 3) shows the output and input connections required for powering the T-3030 Digital Hydraulic Pressure Gage and using the Fill Timer function on the gage.

Power

TB2 Pin 7 (+ 15 VDC) and Pin 8 (DC Common) is input for + 15 VDC power from the regulated power supply provided as part of the equipment package. The power supply needs to be sourced with 120 VAC power from an isolated AC power source inside of the machine panel.

Alarm

TB3 Pin 6 provides a current return path to the T-3030 Digital Gage to allow energizing of CR-1 when reaching the Alarm set-point on the T-3030. TB3 Pins 4, 5 and 10 are relay contacts used to turn on a light or audible alarm, or abort the machine. Logic Input for transfer. The contacts close or open when CR-1 is energized. The contacts can optionally be used to control transfer of the machine with a hydraulic pressure set-point.

NOTE: RJG does not recommend using hydraulic pressure as a basis to transfer the machine.

Fill Time Start/Autozeroing

TB1 Pin 5 and 1 require a 120 VAC or 24 VDC input (momentary or continuous each cycle), when Injection Forward occurs. This signal energizes Trigger 1 and autozeros the Model T-3030 Digital Pressure gage for maximum repeatability. The trigger signal is supplied through TB2 Pin 9. When an Injection Forward signal is applied to TB1 Pin 5 and 1, TB2 Pin 9 goes high, signaling the Model T-3030 to begin timing and to autozero the display.

Directional Valve (Optional)

The directional valve solenoid option is wired to the machine's 1st Stage solenoid. Only when 1st Stage is "ON", will oil then flow into Port "P" of the manifold through the solenoid and through the compensator circuit.

Can Style Eagle Fill Timer, T-920C/Controller (Optional)

Optionally, RJG offers a plug-in Can Style Timer/Controller to set up your machine to transfer by position with the simple addition of a Limit switch. Figure 5 shows the wiring installation of this Model T-920C timer.

The timer will display time as a dependent variable of 1st Stage cutoff. When Injection Forward is initiated on Pin 1, the timer begins counting. It is stopped by one of the optional methods in Figure 5, such as by reaching a stroke position to trip a limit switch. The timer will display the time it took to reach 1st Stage cut off from the start of injection. Pins 3 and 4 are a normally open set of horse-power rated contacts (and Pins 4 and 5 are normally closed), which are used to interface to the machine for transfer. Figure 6 shows a typical Control hookup, where a Series mode or Parallel mode of wiring is used. In the Series mode, the timer contacts "Open" to transfer the machine. In the Parallel mode, the timer contacts "Close" to transfer the machine.

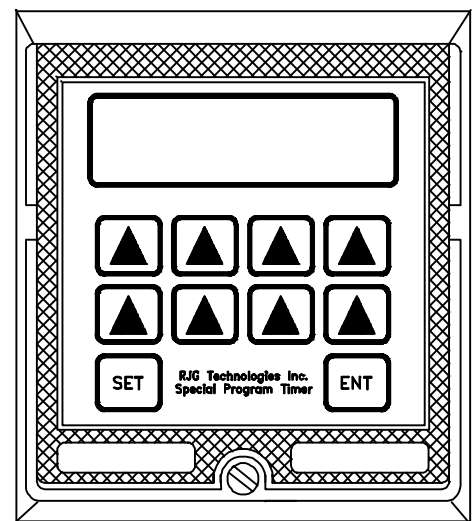


Figure 4

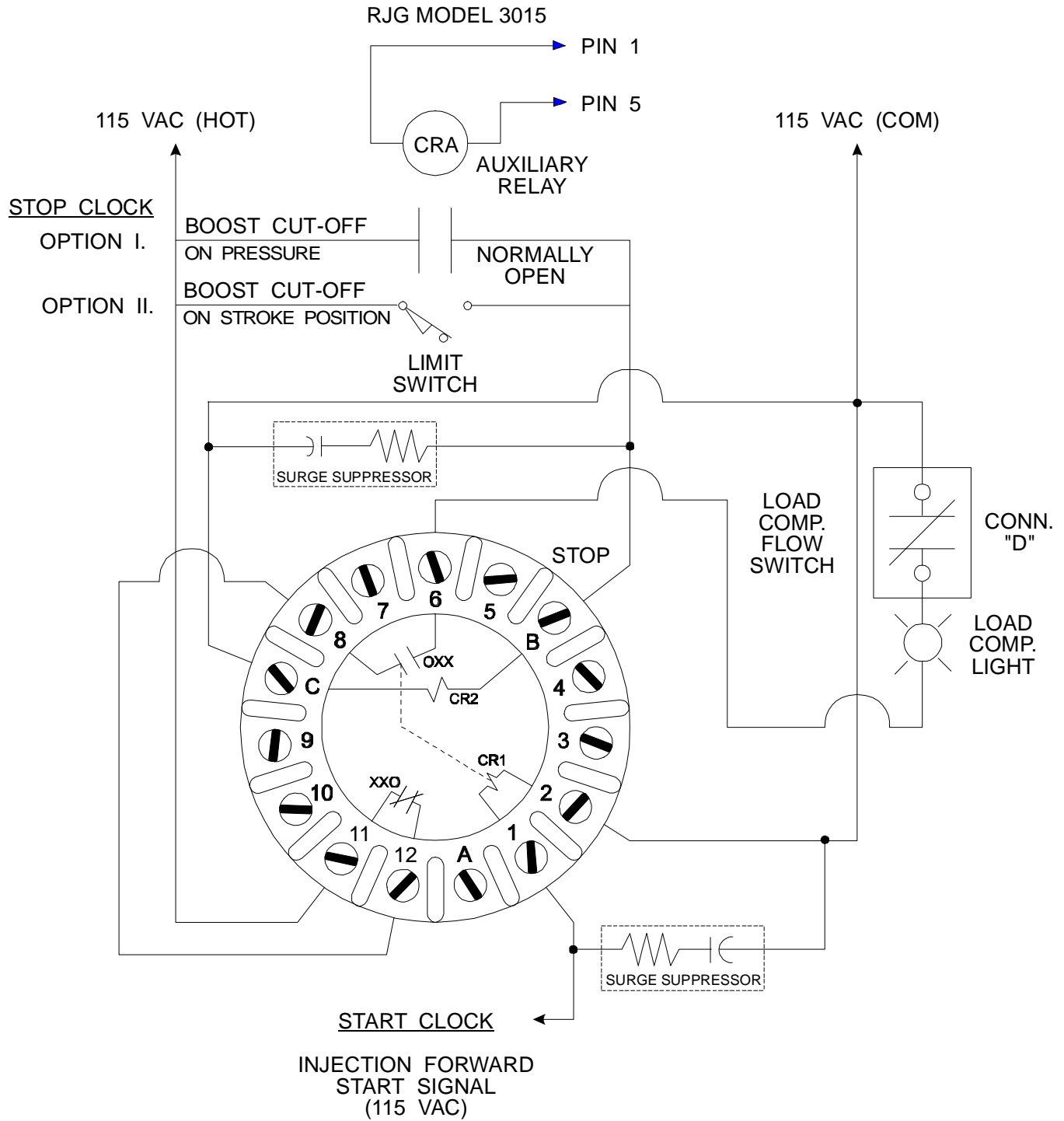


Figure 5

NOTE: If an existing Timer "Can" is being utilized, leave the existing wiring in place and add the wiring shown in this Figure.

NOTE: When installing the LCK kit on a machine with an RJG CPC-110, or SP-110 Process control kit, the T-920C is already pre-wired to the process controller. Wiring instructions on the process control manual therefore should be used for hooking up the controller to the machine instead of Figure 6, the T-920C clock installation in this LCK manual.

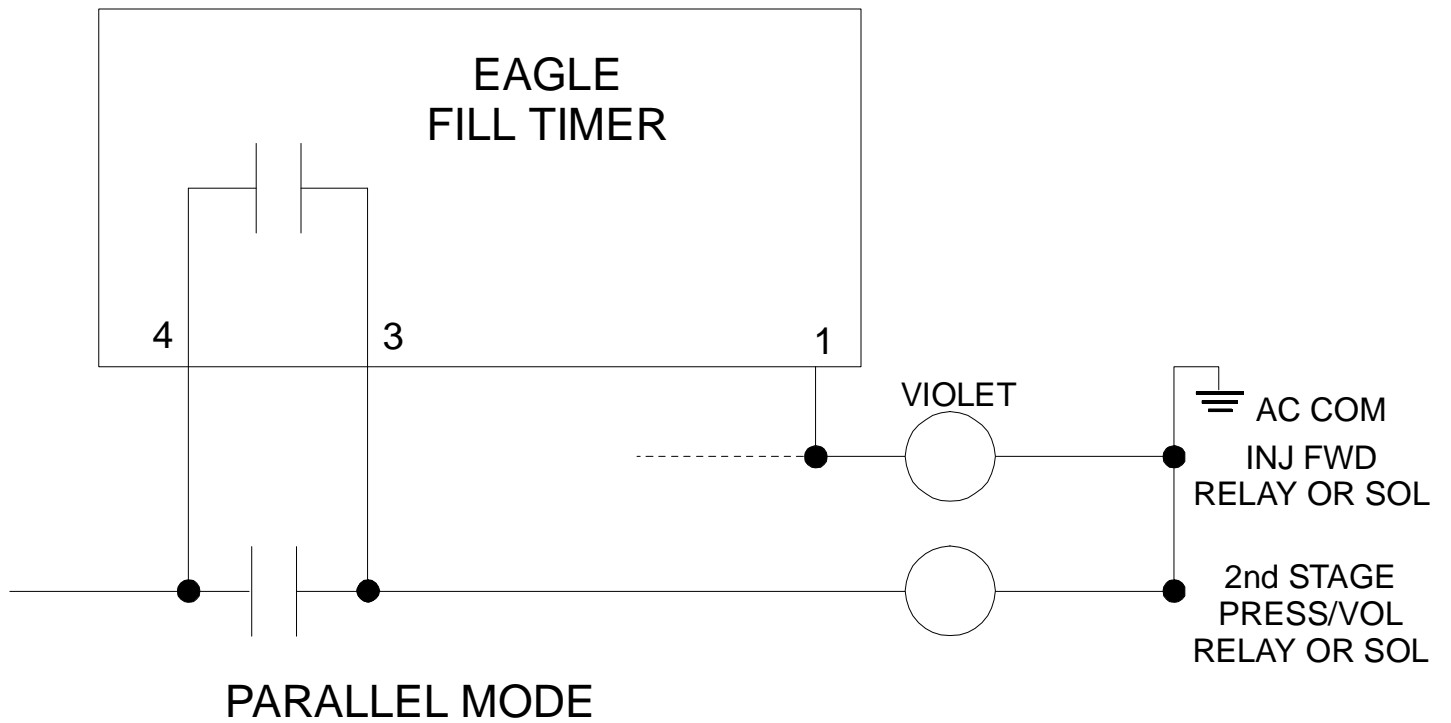
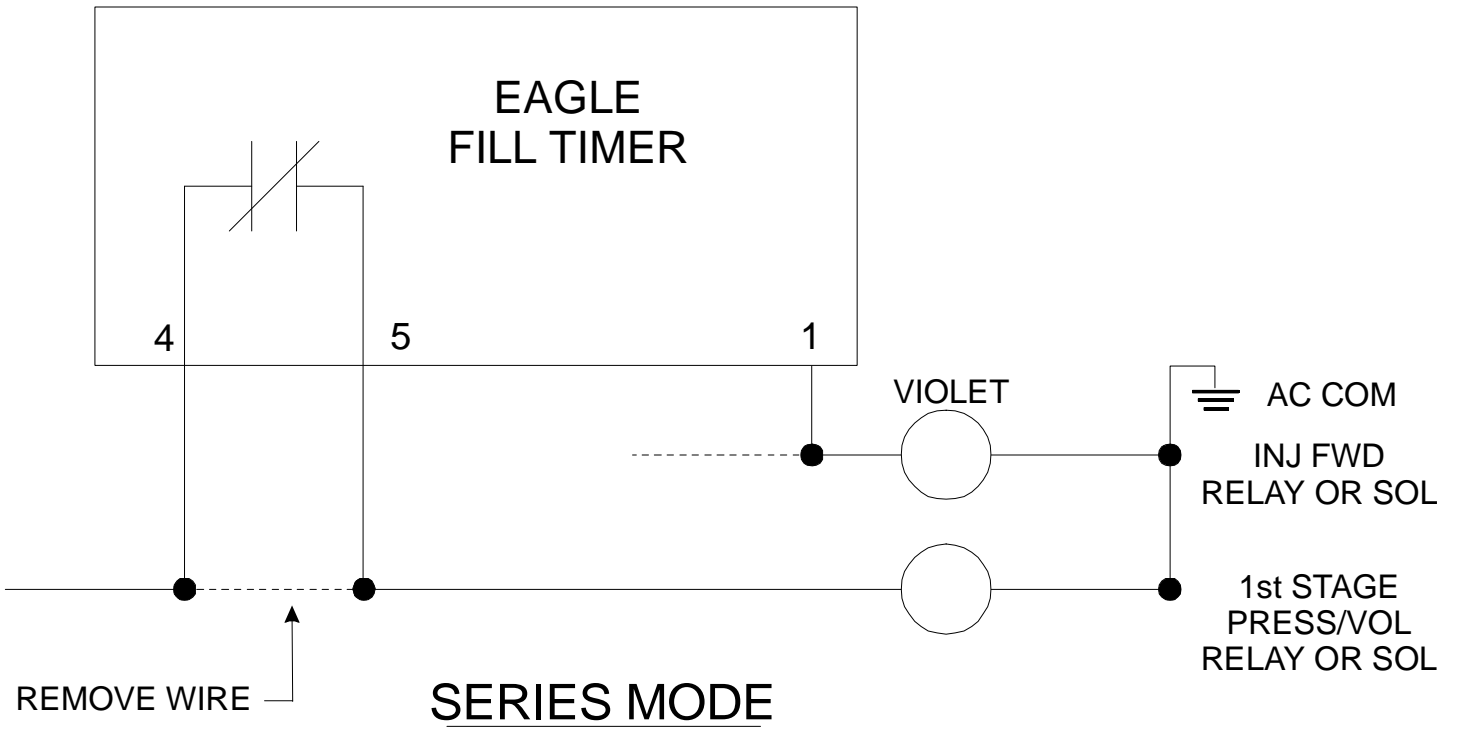


Figure 6

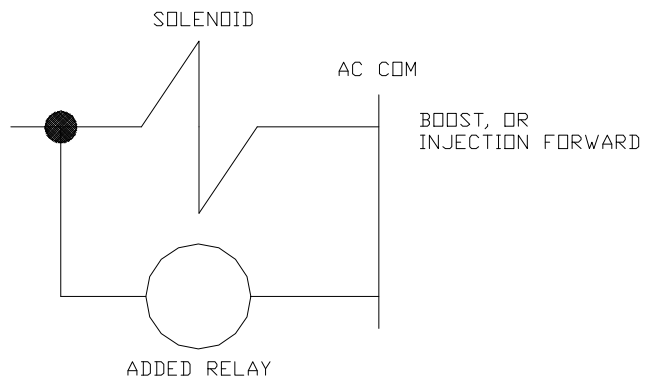
Program the Eagle as follows:

1. Depress the Set button once. Press the appropriate arrow key pads to increment or decrement the display. Set this time to a number greater than the expected fill time. This is to **prevent** the time out function from stopping the clock prematurely. Setting this time equal to injection total is usually acceptable. Once set, press ENT to insert the time into memory.
2. Momentarily press and hold the Set button three times until the **UP** or **dn** annunciator prompt appears in the display. Use the arrow keys to enter **UP** on the display, then press ENT to enter that mode into memory. This puts the Eagle into a up-counting mode when injection starts.

Hardwiring a Trigger (Autozero) Input

Pins 7 and 1 are used on the Power Input connector for enabling a trigger, or autozero function of the gage. These short pin wires can be found under the heat shrink on the connector end of the power supply cable. Remove the heat shrink and wire as outlined below.

Wire the T-3030 to the machine by interfacing with a relay. As shown in Figure 7, connect the relay's dry N.O. contacts to Pins 7 and 1, so that the contact closure will enable the trigger, or autozero. The relay coil should be wired to a sequence signal from the machine at the start of the cycle, such as Injection Forward, or boost on an injection molding machine.



Flow Switch (Optional)

As shown in Figure 2, the valve block Port "P" can optionally be plumbed through a flow switch and a light, which will warn an operator when the 1st Stage pressure setting is too low, or in other words, when the machine becomes fill rate uncontrolled (see *Chapter 3 Installation - Calibration Adjustment - Alarm Indicator Light (Optional)* section for details). Figure 5 shows the switch wired to the Fill Time Clock to indicate an alarm only during 1st Stage. The light will turn "ON" during injection if there is **no** flow of oil through the compensator, indicating load sensitivity. Follow adjustment instructions outlined in *Chapter 3 Installation - LCK-100 (T-3030) Relay Board Interface* section if equipped with this option.

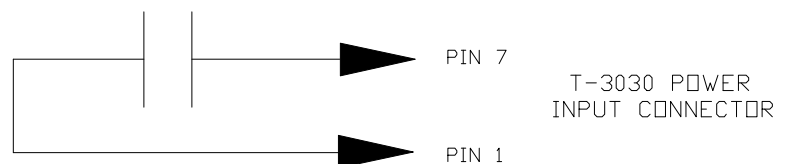


Figure 7

Calibration Adjustment

Compensator Tuning

The compensator circuit is pre-calibrated at the factory for your convenience. After installation, the machine should fill into a mold and purge into the air at the same speed. A load sensitivity test can be run after installation to verify this. The fill time into the air should be within 5% of the fill time into the mold. See the *Chapter 6 Load Sensitivity Test* section for the fine tuning procedure.

Alarm Indicator Light (Option)

The compensator circuit Port P is plumbed with a flow switch, which is wired to an indicator light. The light is used as an alarm to indicate a lighted condition when the compensator is **not** doing its job, or when there is no flow through the circuit. This condition will occur when not enough 1st Stage pressure is being used. When there is flow through the switch during injection the light will be "OFF".

If the flow switch needs adjusting, loosen the set screws on the top of the unit to allow movement of the element by gently sliding the cable strain-relief back and forth. Measure the switch contacts with an ohmmeter, **without** the switch connected to power. Adjust the switch element to the position that makes the N.C. contacts open at the start of injection (when oil begins flowing through the switch). After connecting the switch back up to power, the light will then come "ON" when oil stops flowing through the switch during 1st Stage injection. This can be tested and verified by decreasing 1st Stage pressure on successive shots. Slowly decrease 1st Stage pressure on successive shots and observe the fill time clock. The first notice of a fill time increase indicates insufficient 1st Stage pressure is being used to allow compensation. The light should come on at this point.

Chapter 4: T-3030 Operating Instructions

The T-3030 Digital Hydraulic Pressure gage has a built-in pressure transducer for sensing pressure directly from a hydraulic, water, air or gas source and displaying the reading digitally. Generally, in an injection molding application the unit is installed to sense pressure at the injection cylinder of the machine. The display will track or follow the pressure or will catch and hold the peak. A level detector set-point can be adjusted to automatically reset the peak each cycle. In addition, the set-point option can be used as an output to activate an external device, such as a conveyor or robot, for high alarming. Models are pre-calibrated at the factory for 1psi resolution ranging from 200 psi to 10,000 psi. The gage also has an analog output signal available, which is user-selectable to a full scale level of 2, 5, or 10 Volts.

T-3030 Technical Specifications

Input Range	From 100 To 10,000 psi Capacities
Overload Capacity	200% Full Scale
Proof Test	300% Full Scale
Operating Temperature	32° To 150 ° F
Accuracy (NI, H, R)	.5% Full Scale
Repeatability	.1 F.S.
Resolution	1 Part In 4095
Sample Rate	250 Samples Per Second
Zero Adjustment Range	- 5% To + 100% Full Scale
Input Power	See The Model Number Designation Above
Transducer Cavity Material	17-4PH Stainless Steel
Fitting	HF2000F - Female Quick Disconnect; HF2000M - Male Mating

Table 1 – T-3030 Technical Specifications

T-3030 Front Panel Description

Refer to Figure 8 for the following description of the front panel controls:

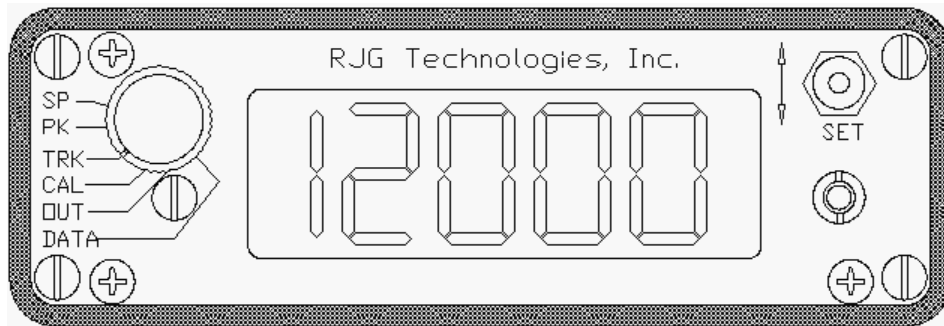


Figure 8

Mode Select Switch

This is a rotary switch (knob located on left hand side of faceplate) which defines the function to be displayed on the readout. There are six features available from which to choose, as described below:

SP (Set-Point)

This is the threshold level of pressure the gage will measure in order to trip a set-point. The letter "L" appears on the left hand side of the display indicating "level." The set-point can be used as a high alarm to turn on an open collector transistor output to interface to a conveyor, parts flipper, or robot for diverting parts. The set-point is also used to select a level where the peak/hold reading on the display will automatically reset each cycle. When the incoming pressure drops below the set-point, the Peak is reset, and the display will track the incoming pressure. Figure 9 shows an example of using the set-point as a peak reset function in an injection molding application.

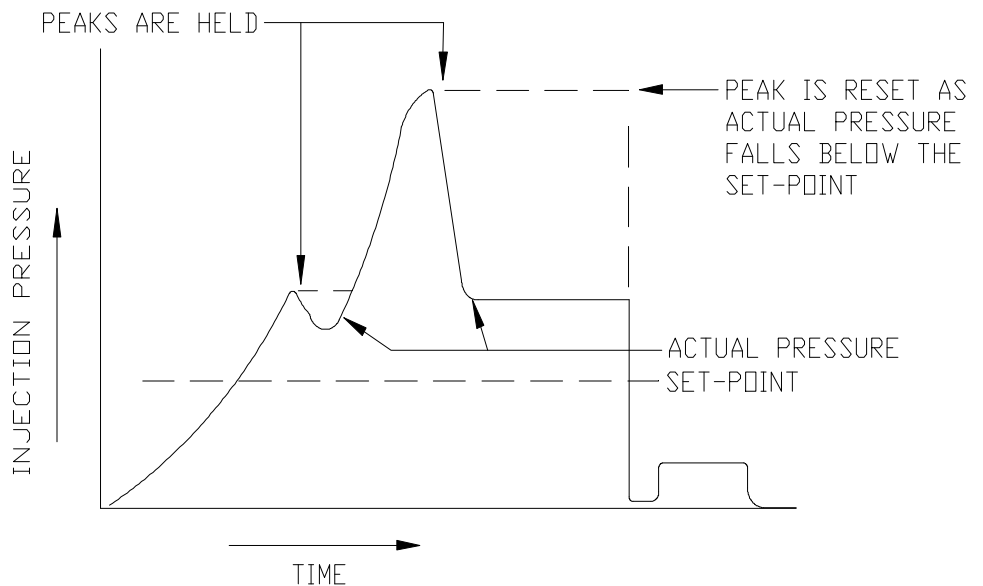


Figure 9

NOTE: If the set-point is set at zero, the signal conditioner will hold the peak value until an autozero signal is applied or the Set switch on the front panel is pressed. Negative [-] values entered for a set-point value will default to zero.

PK (Peak)

The PK setting displays and holds the peak detected for a cycle based on the duration of time the incoming pressure is above the selected set-point. The letter "P" appears on the left-hand side of the display indicating peak. When the incoming pressure is below the set-point, the display tracks the pressure, thus the symbol "┌" appears on the left hand side of the display. The peak is reset when the input falls below the set-point.

TRK (Track)

This displays the incoming pressure by tracking or following it as it goes up or down over time.

CAL (Calibration)

This mode displays the scale factor the gage was calibrated to at the factory. The number 1.000 represents a 1:1 relationship between the pressure applied to the transducer and the readout. The CAL number can be changed to adjust the relationship to satisfy particular applications.

Setting the Intensification Ratio for Reading Plastic Pressure

The gage can be used on the injection cylinder of a molding machine and calibrated to readout in the representative plastic pressure in front of the ram at the nozzle. By considering the injection ram intensification ratio and applying it to the CAL of the gage, the gage will readout in plastic pressure even though it senses hydraulic pressure. If the intensification ratio is 11.2:1, reset the CAL number to 11.200 to accomplish the appropriate scaling. Use the Set switch to change the CAL number.

NOTE: Changing the CAL number will only be recognized if the change is made when there is no pressure being applied to the gage, and the gage has first been zeroed.

To assure accurate calibration, a provision is made to assure signal stability before accepting a new CAL number change. When attempting to calibrate, the display may show "U----" or "F----" at times. This represents an unstable condition or a problem with the transducer, respectively. The operator may need to attempt the CAL procedure again in order for the new CAL number to be accepted. The CAL number can be changed to have the display readout in engineering units other than psi.

OUT (Analog Output)

This allows setting of the analog output voltage to correspond to the full scale number on the display. This feature is pre-set at the factory for either a 0-2, 5, or 10 VDC output signal corresponding to the rated full scale pressure range of the gage identified on the part number. For example, a T- 3030-02T-3K is set for 2 VDC (-02T) at 3000 psi full scale (-3K).

The output voltage can be changed to correspond to any selected display reading. There are two possible ways to reset this feature. Option I allows the output voltage to be kept the same and the full scale to be changed. When the Mode Select switch is initially set in the Out position, the symbol "F" appears on the left hand side of the display to represent the full scale reading, which when reached, will output the full scale analog voltage. Typically, the display will read "F 3000" for a 3,000 psi gage. It can be changed to any value by entering the security code (outlined in *T-3030 Operating Instructions – Set Toggle Switch – Number changing (Prior Security Sequence Required for OUT)* section), and using the Set switch. The value will then correspond to the full scale voltage setting.

Option II allows the output voltage to be changed, but the full scale to be kept the same. To change the full scale voltage setting, rotate the Mode Select switch back and forth from the CAL position to the Out position. When a "t" symbol appears on the left-hand side of the display this represents the full scale output voltage of the track signal display. It can be changed to 2, 5, or 10 Volts F/S by entering the security code (outlined in *T-3030 Operating Instructions – Set Toggle Switch – Security Sequence Activation* section), and using the Set switch. The full scale voltage setting can also be taken from the Peak <PK> value instead of from the Track value. In the Track Output mode, the analog output follows or tracks the TRK display. In the Peak Output mode, the output follows the PK display and holds peaks when the set-point is reached.

DATA

The DATA position shows multiple pieces of information. Toggling the Set switch UP while in the Data position will make the symbol [] appear on the left side of the display. When [] appears, the number to the right indicates the version of the program chip being used internal to the unit.

If a Trigger Input (Autozero) is being applied to the Model T-3030, then Fill Time can be monitored on the display. While in the Data position, toggling the Set switch UP until the letter "F" appears on the left of the display selects Fill Time. The Fill Timer starts when a Trigger Input is applied, and is stopped by one of three operating methods:

Reaching the Set-Point Value (Set-Point Mode)

This method stops the clock when the pressure reaches the set-point. It is appropriate if the Model T-3030 is being used to transfer a molding machine from 1st Stage to 2nd Stage injection pressure.

Reaching A Peak (Peak Mode)

This method is generally used when making measurements of hydraulic pressure where the peak pressure occurs at transfer from 1st Stage to 2nd Stage on the machine thus stopping the clock. This is the default configuration set up at the factory.

Trigger (Autozero) Input "ON" (Trigger Time Mode)

In this mode, the timer will run for the duration that the Trigger signal stays on. Using a "Boost" solenoid signal from the molding machine will allow a fill time reading on the Model T-3030.

To determine which mode the Fill Timer is in, or to change the Fill Timer mode, perform the following:

1. From the DATA position of the Mode Select switch, toggle the Set switch UP twice to show the T-3030 Program Version number.
2. With the version number displayed, enter the security code (5 seconds UP, 3 seconds DOWN) with the Set switch. The display will show a "P", "h" or "t" to the left, and a zero to the right. (The zero has no meaning.)
3. Press the Set switch DOWN to change between "P" (Time to Set-Point mode), "h" (Time to Peak mode), and "t" (Trigger Time Duration mode).
4. Switch the Mode Select switch out of the DATA position to "save" the selected Fill Time mode operation.

The Data position also displays a reading for an integral calculation. This is used in injection molding applications for reading relative viscosity of the material during filling of the part. Toggling the Set switch UP while in the Data position will make the symbol [|] appear on the left of the display. This signifies the number on the display is a relative viscosity reading calculated from the start of the pressure reaching the set-point setting until the peak reading is reached. In this application, the set-point should be set to a low reading, such as 100, so the viscosity measurement will begin shortly after injection.

Set Toggle Switch

The Set switch is an UP and DOWN toggle switch (located on right hand side of the front panel) utilized for changing each numerical digit on the display after the Mode Select switch has been selected. All changes are only registered when switching out of the Mode Select position of interest. To prevent accidental changing of the numbers, there is a security sequence, which must be followed to activate toggling only when in the Out mode. The security sequence is outlined below. There are two primary uses for the switch: Zeroing and Number Changing.

Zeroing (Security Sequence Not Required)

With no pressure applied and with the Mode Select switch in the Track <TRK> position, toggle the Set switch DOWN once to zero the display. The signal conditioner is ready to be used after zeroing. Move the Mode Select switch to the Peak <PK> position to read peaks, if so desired, or leave the Mode Select switch in the Track <TRK> position, and apply pressure.

Number Changing (Prior Security Sequence Required For OUT)

In the Mode Select switch positions SP, CAL, and OUT, the user may need to set different numbers for differing uses. After entering the security sequence (this applies to OUT only), the flashing digit is the one active for incrementing or decrementing by momentarily toggling the Set switch UP and DOWN, respectively. To move the flashing digit to another position, toggle and hold the Set switch down and after about 1 second, the flashing digit will scroll across the display. Release the Set switch when the flashing digit is at the appropriate position for the required number change.

Security Sequence Activation

With the Mode Select switch in the OUT position, the Set switch must be activated by a security sequence to allow changing of the numbers on the display. This prevents accidental changing of the numbers while the signal conditioner is in use. The security sequence is as follows: Press and hold the Set switch UP for about 5 seconds, release, then press and hold the same switch DOWN for about 3 seconds and release. The display will show a flashing digit to indicate the security has been passed. The Set switch can now be used for changing the numbers.

Hydraulic Fittings

The gage is outfitted with a Parker Female Quick Disconnect Part #: PD-242, which mates with a male PD-323. The male fitting installs on the machine allowing the gage to swivel at the female/male connection so the application is forgiving of accidental contact, which could possibly damage the unit. The gage can be plumbed permanently into a hydraulic circuit without use of the quick disconnect, but precautions should be taken to protect the unit from accidental contact.

NOTE: If the female quick disconnect is removed, care should be taken to separate the 1/4" NPTM from the quick disconnect without loosening the bronze colored pressure transducer. **Accidental loosening of the transducer from the case may twist and stress the wires inside causing damage.**

Chapter 5: Operation

Molding Techniques

To make **full** use of the load compensation circuit, the molding technique used to transfer from 1st Stage to 2nd Stage pressure should be examined. The following outline identifies Traditional techniques versus DECOUPLED MOLDINGSM techniques as a guideline. RJG advocates use of a DECOUPLED MOLDINGSM approach with transfer accomplished by forward screw position, or better yet cavity pressure, to assure the most consistent and repeatable results from the LCK kit. Contact RJG, Inc. at (616) 946-3111 for details and further information on seminars and in-plant training regarding these methods.

Traditional Molding

- The original method of molding
- Fill and pack on 1st Stage
- Use only enough 1st Stage pressure to pack the mold

DECOUPLED MOLDINGSM

- Use excessive 1st Stage pressure
- Separate the filling or velocity phase of molding from the packing or pressurization phase

The objective of DECOUPLED MOLDINGSM

- Fill fast
- Fill at a constant or controlled consistent speed
- Do not flash
- Reduce part variations due to material variations
- Pack consistently
- Make the process capable of always making good parts

Procedure for 1ST Stage Cut-off Control on Stroke by Position

The overall objective of using injection 1st Stage cutoff control by position rather than time, as in traditional molding, is to improve the consistency and the overall capability of the injection process. This will give more consistent dimensions and molded-in stresses and result in fewer short shots and other rejects.

The primary reason that this technique works better is that injection fill rates are more consistent. It also allows the mold to be filled quicker without overpacking. On molds, where fill must be done slowly, this technique provides more consistent slow fills such as on imbalanced tools or molds that tend to be easily flashed if filled too rapidly. So, on any mold, there should be more consistency and a greater molding latitude using this technique. The technique, however, does necessitate using procedures, which may seem unnerving for those who have used only traditional molding techniques, employing only enough 1st Stage

pressure to fill and pack the mold. **A fundamental necessity for this technique to work properly is to always have an excess amount of 1st Stage pressure available to fill and pack the mold.** It is this abundance of 1st Stage pressure which allows the pressure compensating flow control valve to do its job of controlling injection rate and fill time.

In order to use an abundance of 1st Stage pressure it is **very important** that a technique be utilized which will not allow overpacking of the mold with this 1st Stage pressure. It is also important to realize that you do not control speed anymore by lowering 1st Stage pressure. Controlling injection speed, or injection rate, is done only by adjusting the flow control setting. Generally, if flashing occurs **during filling**, it is usually caused by too much **or too little** injection speed, rather than **too much** pressure. In the past, pressure adjustments have been made to change this condition, however, what was really being changed was the **rate** of injection, not the actual pressure that the plastic sees during fill.

Initial Mold Set-Up Using Position Cut-Off for Fully DECOUPLED MOLDINGSM

The objective is to fill the mold quickly on initial shots at high 1st Stage pressure under controlled flow rates without overpacking and on successive shots fill out the mold until a slight short shot exists. Then the mold can be packed using 2nd Stage for a sufficient time to allow gate sealing when appropriate.

1. With the press stopped, set the 1st Stage pressure at about 1900 psi, and 2nd Stage at zero.
2. Purge the screw forward and then decompress about 1/4".
3. Set screw forward position cut off control to energize at this position. This will allow no more than 1/4" excess of plastic from entering the mold in case of malfunction.
4. Set the injection speed for start up by purging and observing the speed of injection and adjusting the flow control setting until the proper speed is observed.
5. Set the screw back setting or limit switch at a position where you are **sure** the mold will not be filled out.
6. Set the 1st Stage time higher than will be needed. It can be the same as injection total.
7. Make sure that the rest of the timers are set where you want to run them. Then purge the barrel and retract the screw when ready to run.
8. Make a shot. The fullness of the parts will tell you how well you judged the shot size. If you guessed too high, chip out the flash.
9. Slowly increase the screw back position setting until the parts are just barely short.
10. Inspect the parts for signs of flash. If flash exists, slow the injection speed gradually and keep checking the parts. Do not let the 1st Stage timer get in the way of the cut-off.
11. When the flash is acceptable, fine tune the screw back position to make the parts just short. Lock down the injection speed control.
12. Turn up the 2nd Stage pressure to finalize fill and properly pack the part

13. You may be able to reduce the 2nd Stage time if freeze-off is before the timer times out. This can be determined by running shots at various injection total times (2nd Stage) and determine where the part weight changes. Too short will make parts lighter due to discharging of plastic from gates.

NOTE: On most hot runner molds, gates never seal so this test may not be proper.

Initial Mold Set-Up Using Position Cut Off for Partially DECOUPLED MOLDINGSM

The objective is to fill the mold quickly on initial shots at high 1st Stage pressure under controlled flow rates without overpacking and on successive shots to completely fill out the mold using 1st Stage and ram inertia. Then the mold can be packed using 2nd Stage for a sufficient time to allow gate sealing when appropriate.

1. With the press stopped, set the 1st Stage pressure at about 1900 psi, and 2nd Stage at zero.
2. Purge screw forward and then decompress about 1/4".
3. Set screw forward position cut off control to energize at this position. This will allow no more than 1/4" excess of plastic from entering the mold in case of malfunction.
4. Set the injection speed for start up by purging and observing speed of injection and adjusting the flow control setting until the proper speed is observed.
5. Set the screw back setting or limit switch at a position where you are **sure** the mold will not be filled out.
6. Set the 1st Stage time higher than will be needed. It can be the same as injection total.
7. Make sure that the rest of the timers are set where you want to run them. Then purge the barrel and retract the screw when ready to run.
8. Make a shot. The fullness of the parts will tell you how well you judged the shot size. If you guessed too high, chip out the flash.
9. Slowly increase the screw back position setting until the parts are just barely short.
10. Inspect the parts for signs of flash. If flash exists, slow the injection speed gradually and keep checking the parts. Do not let the 1st Stage timer get in the way of the cut-off.
11. When the flash is acceptable, fine tune the screw back position to completely fill and pack the parts without 2nd Stage. Lock down the injection speed control.
12. Turn up the 2nd Stage pressure for proper holding.
13. You may be able to reduce the 2nd Stage time if freeze-off is before the timer times out. This can be determined by running shots at various injection total times (2nd Stage) and determine where the part weight changes. Too short will make parts lighter due to discharging of plastic from gates.

NOTE: On most hot runner molds, gates never seal so this test may not be proper.

Take Over Approach

When using the takeover approach the idea is to mold good parts in the traditional fashion of filling and packing under the influence of 1st Stage. Then, gradually but systematically, take over using the new 1st Stage cut off technique using position. This will be done while keeping the molding conditions the same, from the plastic's point of view.

1. With the molding machine running on cycle, record 2nd Stage pressure and reduce to zero. Observe whether or not the mold is being filled on 1st or 2nd Stage (are the parts still full but not packed out, or are they short.)
2. The next objective is to only fill the mold on 1st Stage. This will be done by adjusting the cut off position so that 1st Stage cut off is being accomplished by stroke. Adjusting the stroke setting to a higher number on successive shots will eventually result in reduced fill and a short shot because there will be no 2nd Stage pressure available to pack the mold.
3. Continue to adjust the setting until a substantial short shot exists. This will insure that the mold will **not** be filled and packed on 1st Stage because of any increase in injection rate during set up.
4. Note the fill time on the fill time clock, which now should be operational and record it for future reference.
5. Reduce the blue flow control valve setting on successive shots until the fill time gets longer. This insures that the Flow Control valve is set such that it will control the injection velocity.
6. Adjust the flow control until the fill time **increases** approximately 10%. This will insure that when the 1st Stage pressure is increased, the increased injection rate will not cause too short a fill time, and thus overpack or flash the mold.
7. Now, **raise the 1st Stage pressure slowly** on successive shots and watch the fill time clock reading. Initially, it will get lower, indicating that there has not been sufficient pressure to allow the flow control valve to control flow rate. At some point, the fill time will stop decreasing. The 1st Stage hydraulic pressure at which this occurs should be noted. This is the **minimum** hydraulic pressure necessary for adequate injection speed or fill time control.
8. The injection pressure should now be increased approximately 200 psi above this point. This will insure that there is enough energy available for fill time control even with wide changes in plastic viscosity during material changes or temperature changes, or during start up and shut downs.
9. If fill time seems too slow or too fast, based either on experience or on the data from the initial set up, adjust the fill time using the **Flow Control Valve**.
10. During all this time, the parts should be short. Once the desired fill time is set using the flow control, adjust the 1st Stage cut off position to fill the mold as far as possible without flashing or excessively overpacking it.

NOTE: There will still be sink marks, because there is no 2nd Stage pressure. The object here would be to fill the entire mold without flashing it. However, on severely imbalanced tools this may not be possible. It may be necessary to go back and forth on the fill time and the cut off position to achieve an essentially full part without flashing. On imbalanced molds, this technique can be used, but will not change the balance. It will only help run the part more consistently once set up.

NOTE: When you change the 1st Stage cut-off position, the fill time will change because the distance the ram has to travel before cutting off 1st Stage pressure has changed.

11. When the proper amount of filling on 1st Stage is achieved, **NOTE: The new Fill Time reading and record.** Also, **record the shot weight.** This will allow resetting the fill position and fill time accurately on another setup, **even on another machine.** 2nd Stage should be increased on successive cycles to hold plastic in the mold. It should generally be approximately, what it was before the 1st Stage cut off on stroke technique was used.
12. With this set up complete, note the peak hydraulic pressure at transfer using a digital peak reading gauge if available. This is the amount of pressure used to fill the mold. 1st Stage pressure must be set at least 200 psi above this reading.
13. Note the cut-off position, the Flow Control valve setting (for start up purposes only), the 1st Stage setting and the 2nd Stage setting, as well as all other normal set up information. This will allow systematic start up using this technique on future set-ups.

NOTE: 1st Stage pressure setting can only be determined by bottoming the screw under 1st Stage pressure with 1st Stage cut-off on stroke turned off.

Restarting the Tool

Once the initial set up using position cut off is used, it should only be necessary to dial in the proper settings and make minor adjustments. It is important to realize that if some cavities are blocked or if the injection unit is different on the machine then the set up will have minor differences, namely in the 1st Stage cut off position, and/or the screw back position. This is not as significant if mold pressure cutoff is used.

1. If in doubt, start with a 1st Stage cut off position further back than normal. This means a screw forward position further back to insure that the mold will not be filled.
2. Start up with no 2nd Stage pressure so that no packing will be done on 2nd Stage. The amount of fill can be observed on initial shots.
3. Dial in the excess 1st Stage pressure, and the flow control settings from the set up sheet of previous runs. Start molding. A short shot should be produced.
4. If the screw back and the 1st Stage cut off positions are identical to those previously used (no blocked cavities, no different machine), it should only be necessary to add 2nd Stage pressure back to its original setting and the set up should be complete.
5. If a different 1st Stage cut off position set-point is used it will be necessary to slowly move that position forward to achieve optimum filling of the mold prior to adding the 2nd Stage pressure. (Determine this precisely by weighing a shot with runners).
6. In any event, the 2nd Stage pressure should be the same as it was on previous set -ups.
7. Fine tune the fill time to the previous setup fill time by adjusting the flow control valve setting. **The Fill Time, not the Flow Control valve setting is the primary variable to duplicate.**

Using the LCK with RJG'S CPC-110 Cavity Process Control Kit

Load compensation optimally works hand-in-hand with the ability to Stage the machine transfer based on reaching a cavity pressure that makes a good part. Since the LCK kit keeps injection speed constant, ram inertia consequently follows the same consistency. Therefore, it becomes possible to predict the overshoot of the forward screw movement **after** cutoff. Since this overshoot stays constant, cavity pressure control can account for this overshoot. Cavity pressure can then be a much more effective means of staging the machine as opposed to stroke position.

If you are currently installing an RJG CPC-110 Cavity Pressure controller, refer to the CPC-110 manual for operation details.

Chapter 6: Load Sensitivity Test

Two-Shot Procedure for Testing the Machine's Load Sensitivity

1. Set up **any** mold so you are transferring on Forward Screw position (go from Fill to Pack/Hold based on the ram reaching a fixed stroke position).
2. Be sure you are using a cushion.
3. Fill **into the mold** and measure the time it takes from the start of injection to when transfer occurs. Record T_{MOLD} _____.
4. On the same shot, read the **Peak** hydraulic pressure at the ram with the Digital gauge. This is the Peak pressure it took to reach the transfer cutoff point. Record P_{MOLD} _____.

NOTE: To use the Digital gauge on the injection cylinder, with switch in TRK, first zero the display to a 000 reading with no pressure. Put the switch in SP and then adjust SP knob to about 100. Put the switch in PK and start test. (If you want the gauge to hold the Peak until manually reset, set SP to a -010 or lower)

5. On cycle, pull back the carriage and purge into the air. **Do not change the Stroke Transfer position.** (2nd Stage must be set lower than 1st Stage Peak. Set to zero if possible.)
6. On this air-shot, record the time it takes from the start of the shot to reach the same stroke position set up in Step 1. Record T_{AIR} _____
7. On the same air-shot, record the Peak Injection pressure on the digital gauge. Record P_{AIR} _____.
8. Compute the results:

$$\text{Load Sensitivity} = \frac{\frac{T_{MOLD} - T_{AIR}}{T_{MOLD}} \times 100}{\frac{P_{MOLD} - P_{AIR}}{1000 \text{ psi}}} \times 1000 = \frac{\%}{1000 \text{ psi}}$$

$$= \frac{\frac{(3.4 - 2.5)\text{sec}}{3.4 \text{ sec}} \times 100}{\frac{(1850 - 325) \text{ psi}}{1000 \text{ psi}}} \times 1000 = \frac{17\%}{\text{KPSI}}$$

What does this mean? This test measures the machine's sensitivity to changes in material viscosity due to all causes, including a change in the material, plastic temperature or mold temperature. A number less than 4%/1000 is state of the art. Slightly negative numbers are best. Even 10% is unsatisfactory.

Chapter 7: Tuning Procedure

(One time calibration of the machine independent of any molds to be run - Position cut-off must be used for this procedure)

1. Select any mold for the machine calibration.
2. Set up the machine to shoot air shots with the same shot size used into the mold.
3. Be sure the Forward Screw position cut-off in 1st Stage allows for approximately a ½" to 1" cushion from bottom.
4. Set the injection 1st Stage timer to one second greater than the desired or normal 1st Stage fill time.
5. Open completely the Allen Head Tuning adjustment on the side of the Valve block as a starting point. (The machine will probably inject slower now.)
6. Set 1st Stage pressure to maximum to assure enough pressure is available for this tuning procedure. (Since this setting will be left at maximum, also in Step 10a below, be sure that the mold used will not be filled by the shot.)*

***NOTE:** 1st stage pressure settings when running production jobs should be set at 200 psi above the known fill pressure required.

7. Adjust the blue Flow Control knob on the top of the valve (not the tuning adjustment) to obtain the desired fill time normally used for the mold currently in this machine even though you are injecting into the air.
8. If the maximum fill speed is too slow and cannot be attained by opening the Flow Control knob, close the tuning adjustment 1/4 turn and go to Step 7 again.
9. If the maximum fill speed is still too slow and the tuning adjustment is now only slightly cracked, or even fully shut, go to *Chapter 8 Troubleshooting – Problem A* section of this manual.
10. When the proper fill time is set up using the Flow Control knob:
 - a. Shoot into the mold by cutting off 1st Stage at the same forward screw position as used into the air.
 - b. Note the fill time into the mold.
 - c. If the air fill time is within the mold fill time by 5%, the load compensation circuit is set properly.

- d. Lock down the tuning adjustment to avoid accidental movement. **This adjustment should NOT require readjustment after this calibration for any mold.**
12. If not within 5%, or tuner has no effect on speed into air versus into mold, see *Chapter 8 Troubleshooting - Problems B, C and D* section of this manual.

Chapter 8: Troubleshooting

Problem I: Cannot Achieve A Fast Enough Fill Speed When The Compensator Tuning Adjustment Is Cracked Open Or Even Fully Shut.

Is the fill time you are unable to achieve less than 1.0 second? If yes, this condition may require a special compensator component to achieve more speed. There is a tradeoff, however, to this special adaptation that should be considered before implementing. Allowing for more speed will limit the range of injection pressure you have available to use before reaching a ram stall condition. Ram stall causes the fill time into the mold to slow down at the end of the mold filling phase and the compensator thus fails to continue to control. See *Chapter 8 Troubleshooting - Problem II* section below.

Problem II: Fill Time Is Faster Into Air than Into Mold by More Than 5%.

1. Is 1st Stage pressure set to maximum? If yes, is the injection pressure measured at the cylinder while filling into the mold at least 200 psi less than the 1st Stage setting? If not, you are reaching a ram stall condition at the very end of the fill phase during 1st Stage. This means the available machine pressure set at the remote pilot head isn't allowing the compensator to control fill speed for 100% of the fill phase duration. Though the compensator is working, speed control is not being maintained throughout the entire fill phase with this particular mold.
2. Is there a slight delay at the start of injection before the ram starts to move forward or, does the ram start moving forward very slowly then pick up speed? If yes, there is air in the injection cylinder and/or the compensator circuit and pilot line. This keeps the machine from building pressure rapidly in the cylinder to achieve immediate controlled forward movement. Generally, the air will work itself out of the system by cycling the machine, although this may take **many** shots. Most of the air can be bled off by opening a port hole in the cylinder and pulling the screw back and forth the full stroke numerous times before cycling. If the problem is not resolved after numerous cycling, verify the machine is equipped with at least a 0.041" diameter orifice on the pilot line between the main relief valve and where the compensator tees off at the pilot. This orifice assists the machine in building pressure immediately at the start of injection. In addition, check to see if the problem is present **without** the compensator tee off installed in the pilot line by plugging the line.
3. Does injection speed slow down as the tuning orifice is turned out (opened)? Opening the tuner should display a larger number on the fill time clock. If not, verify the installation of the compensator tee off is in the appropriate pilot line for 1st Stage injection pressure. The adjustment range of the tuner should provide about a 10 - 15% change in fill time in the compensator is in the correct pilot line. Also, verify oil is flowing from the pilot into the Port P of the block. The flow is only about 2-3 gpm, so a simple test is to fill into a bucket through the compensator by disconnecting and plugging Port P.

Problem III: The Compensator Is Affecting the Metering Operation of the Machine.

The compensator circuit should be only activated during injection and not, during screw rotate. If the hydraulic architecture of the machine does not already provide for separation of these operations, a solenoid operated directional valve must be installed in series with the compensator circuit before the tee-off at the pilot line. The solenoid should be wired to activate the compensator circuit **only** during injection.

Problem IV: The Pressure Measured At The Cylinder Into The Air Is The Same, Or Only Slightly Different, From The Pressure Measured Into The Mold.

There is not a significant difference in load, or resistance in front of the screw, into the air compared to into the mold to show up as a change in pressure at the ram. The nozzle restriction is causing the load instead of the mold. This should be addressed as a potential mismatch in nozzle size to the mold being run.