ALLEN-BRADLEY

Plastic Molding Module

(Cat. No. 1771-QDC)

Application Guide

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use **ATTENTION** and **Important** to alert you to the following:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

ATTENTION helps you:

- identify a hazard
- avoid a hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

Summary of Changes

Summary of Changes

This manual is a revision of the October 1991 edition. It contains the following new information:

- Screw RPM control during plastication
- QDC module mode for Inject, Clamp, and Eject operation

For this New Information:	Refer to Page:
Screw RPM control during plastication	1-7, 1-17, 1-23
The Inject, Clamp, and Eject mode	1-3, 1-24, 1-34 thru 1-36 2-12 thru 2-17

To help you find this new information, we added change bars as shown to the left.

Using This Manual

Manual Objectives

Use this preface to familiarize yourself with the QDC module's control capabilities so you can:

- determine what mode of the QDC module your application requires
- apply the QDC module to the hydraulic configuration of your machine

The two chapters of this manual give you this information:

For This Information:	Refer to:
Overview of the QDC module's control of Inject, Clamp, and/or Eject operations.	Chapter 1
Examples of different hydraulic configurations and how to apply the QDC module to the hydraulics of your molding machine.	Chapter 2

Audience

Before attempting to apply the QDC module to a molding machine, we assume that you are:

- an injection molding professional
- an experienced PLC® programmer
  (especially with the Allen-Bradley PLC-5 family of processors)
- familiar with hydraulic circuits and their application

Use of Terms

We use an abbreviated catalog number when referring to Allen-Bradley equipment:

Abbreviated Name:	Item:
QDC module	1771-QDC Plastic Molding Module
PLC Processor	PLC-5 Programmable Controller
T45 T47 or T50 terminal	1784-T45 1784-T47 1784-T50 Industrial Terminal
Pro-Set™ 600 Software	Pro-Set 600 Injection Molding Operator Interface Software (6500-PS600)
PanelView™ Color display	PanelView Operator Interface Terminal (2711-KC1)
ERC™	Expert Response Compensation

The following table presents other terms we used throughout this manual:

Term:	Definition:
Selected Valve	In multi-valve systems, depending on the configured profile, the QDC module controls one valve and presets the setting of the remaining valves to produce molding-machine profiles. We call the valve being controlled by the QDC module's algorithms the selected valve. Multiple axis of control, such as the clamp and ejector cylinders, may require additional control valves.
Un-selected Valves	In multi-valve systems, depending on the configured profile, the QDC module controls one valve and presets the remaining valves to produce molding-machine profiles. We call the valves that are preset with an open loop percentage setpoint the un-selected valves.
Profile	A group of part-specific setpoints which define a given machine operation to the QDC module.
Command Block	A data block downloaded from the PLC-5 data table to the QDC module to make configuration changes or to initiate machine actions.
Status Block	A data block used by the QDC module to relay information to the PLC-5 data table about the QDC module's current operating status.
Profile Block	Command block containing part-specific setpoints.
Configuration Block	Command block containing machine-specific setpoints.
Direct Acting Valve	An analog control valve that delivers greater velocities or pressures with increasing signal input.
Reverse Acting Valve	An analog control valve that delivers greater velocities or pressures with decreasing signal input.

Related Publications

The following table lists documentation available for the successful application of the QDC Module:

Publication #:	Use this documentation:	To:
1785-6.6.1	PLC-5 Family Programmable Controller Installation Manual	Install the PLC processor and I/O modules.
6200-N8.001	6200 PLC-5 Programming Software Documentation Set	Select instructions and organize memory when writing ladder logic to run your machine.
1771-6.5.88	Plastic Molding Module Reference Manual	Information on block transfers between PLC processor and QDC module. Also, information on PLC data transfer logic.
1771-6.5.93	Plastic Molding Module User Manual, 1771-QDC Inject, Clamp and Eject Operation	Install and configure your QDC module to control inject, clamp, and eject operations.
1771-6.5.87	Plastic Molding Module User Manual, 1771-QDC Clamp and Eject Operation	Install and configure your QDC module to control clamp and eject operations.
1771-6.5.86	Plastic Molding Module User Manual, 1771-QDC Inject and Clamp Operation	Install and configure your QDC module to control inject and clamp operations.
1771-6.5.85	Plastic Molding Module User Manual 1771-QDC Inject Operation	Install and configure your QDC module to control inject operations.
6500-6.5.11	Pro-Set 600 Operator Interface Software for Injection Molding Designer's Guide	Select the Pro-Set 600 software that matches the requirements of your molding machine.
6500-6.5.12	Pro-Set 600 Operator Interface Software for Injection Molding Assembly Manual	Transfer your Pro-Set 600 software from a floppy to your hard drive. Add overlays into your PLC-5 and PanelView application files.
6500-6.5.13	Pro-Set 600 Operator Interface Software for Injection Molding Overlay Installation Manual	Install Pro-Set 600 overlay(s) into your application files.
6500-6.5.14	Pro-Set 600 Operator Interface Software for Injection Molding Customization Manual	Customize your Pro-Set 600 build for your machine control requirements.
6500-6.5.15	Pro-Set 600 Operator Interface Software for Injection Molding Reference Manual	Support customizing your software control system.

Chapter 1

Overview of the Plastic Molding System

Chapter Objectives

This chapter presents an overview of the 1771-QDC Plastic Molding Module (QDC). Topics include:

- an overview of the Allen-Bradley Plastic Molding System
- the role of the QDC module
- application of the QDC module to simple molding operations
- application of the QDC module to complex molding operations
- a description of the Inject Mode Operation
- a description of the Inject and Clamp Mode Operation
- a description of the Clamp and Eject Mode Operation
- a description of the Inject, Clamp, and Eject Mode Operation
- the role of Pro-Set 600 Software

System Overview

The Allen-Bradley Plastic Molding System lets you program the control of injection molding machines as part of your plant-floor control system. It lets you create machine-phase profiles that match the complexities of your mold to solve a variety of difficult molding problems. The system also provides production flexibility and reporting capabilities.

The Allen-Bradley equipment required for a molding system and the function each performs are as follows:

- **Programmable Logic Controller (PLC) -** coordinates sequential machine control with the automatic operation of the QDC module.

- **Plastic Molding Module (QDC) -** controls the clamp, inject, and/or ejector movements of the molding machine per selected mode. The QDC module operates independently of the PLC-5 processor

- **1771 I/O chassis/power supply -** holds the PLC-5 processor, QDC module, and additional I/O modules

- **Programming terminal (T45, T47, T50, or equivalent) -** lets you enter control data into and read status data from data storage areas in the PLC-5 processor

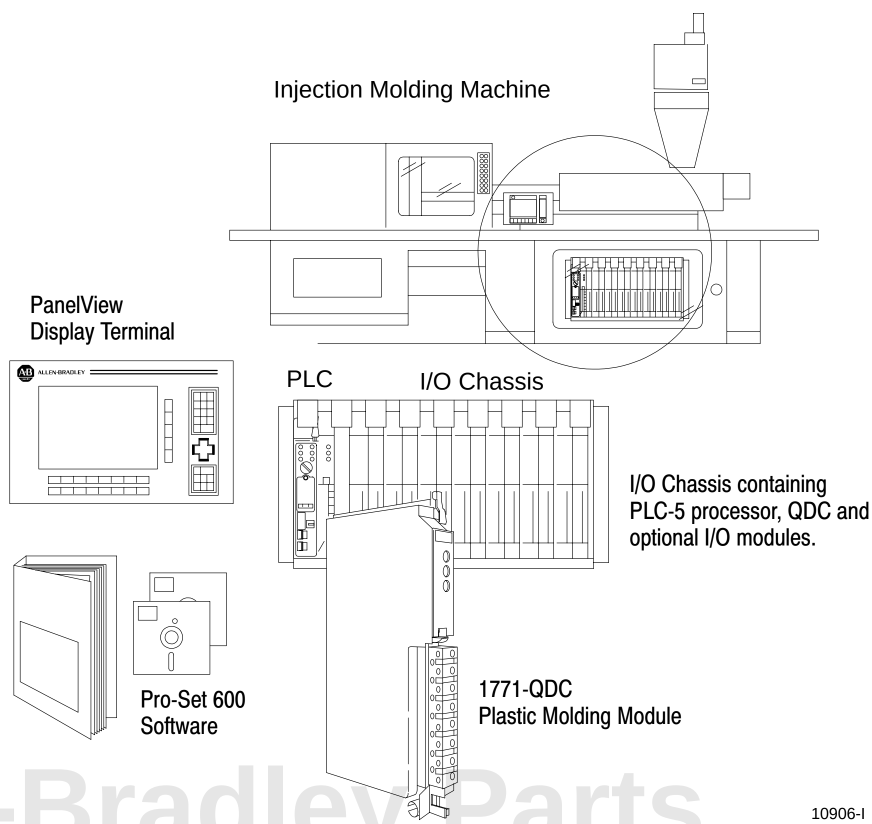
- **Pro-Set 600 Software -** controls communication between the display terminal, PLC-5 processor, and QDC module. Also displays the control and status data of your injection molding system

- **PanelView Display Terminal -** operator interface graphics terminal to monitor system operations
- **Optional discrete and analog I/O modules -** interface to barrel temperatures, limit switches, push buttons, solenoid values and other machine inputs and outputs as needed

As an Allen-Bradley injection molding customer, you must:

- provide the injection molding machine and its hydraulics
- develop ladder logic that:
  - controls sequential machine operation not provided by the QDC module
  - sends commands to the QDC module
  - handles permissives
  - responds to hardwired safeties and E-STOPs
- determine profile setpoints, process limits, and other application-specific parameters used by the QDC module to control your injection molding process
- comply with ANSI B151.1-1984 safety standards

Figure 1.1
Primary Components of the Allen-Bradley Injection Molding System



The QDC Module's Role

Your 1771-QDC Plastic Molding Module (QDC) provides closed-loop control for both the Injection and Clamp ends of an injection molding machine. The QDC module's inputs and outputs can be configured to match your specific application that may require injection, clamp, and/or ejection pressure and velocity control.

Configure your QDC module for any of the following three phases:

- Inject:

Performs this Operation:	Which Is Called:
Shoots hot resin into the mold	The Injection profile
Detects when injection is complete	Transition
Pressurizes the part as it cools	The Pack (optional), and Hold profiles
Reloads for the next shot	The Plastication profile

- Inject and Clamp:

Performs this Operation:	Which Is Called:
Shoots hot resin into the mold	The Injection profile
Detects when injection is complete	Transition
Pressurizes the part as it cools	The Pack (optional), and Hold profiles
Reloads for the next shot	The Plastication profile
Moves the two platens together	Closing the Clamp
Separates the two platens	Opening the Clamp

- Clamp and Eject:

Performs this Operation:	Which is Called:
Moves the two platens together	Closing the Clamp
Separates the two platens	Opening the Clamp
Advances the ejectors to expel the part	Advance
Retracts the ejectors after the part has been expelled	Retract

- Inject, Clamp, and Eject:

Performs this Operation:	Which Is Called:
Shoots hot resin into the mold	The Injection profile
Detects when injection is complete	Transition
Pressurizes the part as it cools	The Pack (optional), and Hold profiles
Reloads for the next shot	The Plastication profile
Moves the two platens together	Closing the Clamp
Separates the two platens	Opening the Clamp
Advances the ejectors to expel the part	Advance
Retracts the ejectors after the part has been expelled	Retract

Simple QDC Applications

Below, we overview simple applications of the QDC module to control inject, clamp, and eject operations. Later in this chapter, we describe how the QDC module can be used to control more complex applications of these machine operations.

Inject Operations

During Inject, the machine:

Performs this Operation:	Which Is Called:
Shoots hot resin into the mold	The Injection profile
Detects when injection is complete	Transition
Pressurizes the part as it cools	The Pack (optional), and Hold profiles
Reloads for the next shot	The Plastication profile

You control the motion of the ram (screw) with a group of setpoints called a profile. You use a profile for each phase of operation. As an example, you can specify an injection profile with as few as one pair of setpoints, such as:

- velocity of the ram (screw)
- transition position to which it travels at that velocity

More complex profiles would have multiple setpoints.

Injection Profile
During the injection profile, the ram (screw) injects resin into the mold. The manner in which it does this can be critical to the quality of the molded part. We give you a choice of four types of injection:

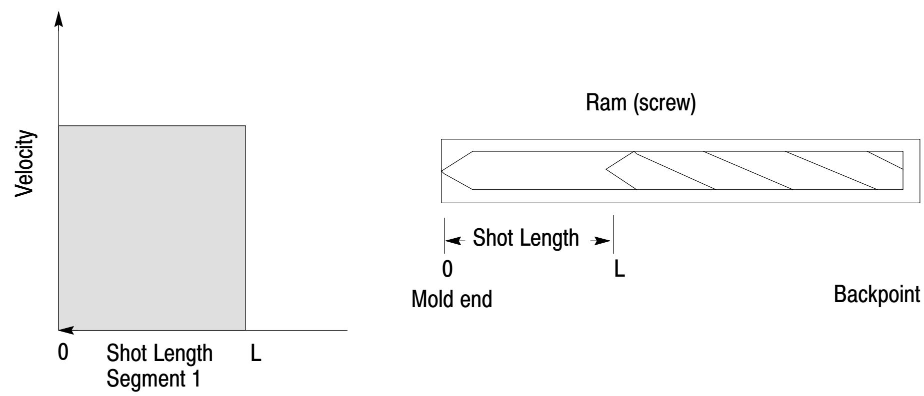
With this Profile:	You Control Injection:	With up to 11 Segments Distributed over the:
Velocity vs. Position	Speed	Length of the shot
Pressure-limited Velocity vs. position	Speed with a Ceiling Pressure	Length of the shot
Pressure vs. Position	Pressure	Length of the shot
Pressure vs. Time	Pressure	Time for a shot to be injected

You specify injection setpoints for the ram (screw) such as Figure 1.2:

- injection velocity (vertical axis)
- the position to which it travels while injecting the shot (horizontal axis)

Pro-Set 600 software presents your setpoints in a bar graph, below, where the ram (screw) moves from right to left during injection. More complex profiles (multiple bars) let you vary the velocity during injection.

Figure 1.2
Simple Injection Profile Example



Transition to Pack

The QDC module completes the injection phase during a transition period when the pressure builds suddenly because the mold cavity becomes full of molten plastic. You select up to four transition triggers:

- time
- position
- ram (screw) pressure
- cavity pressure

The transition to the pack or hold profile occurs when the QDC module detects the FIRST occurrence of the four possible transition conditions you select. Pressure transitions can be inhibited over a portion of the shot size as specified by your configuration.

Pack and Hold Profiles

The next profile is an optional Pack operation to pressurize the molten plastic to a specified density, and a required Hold operation to let the resin cool and shrink slightly in the mold cavity. We give you a choice of two types of pack and hold control:

- ram (screw) pressure
- cavity pressure

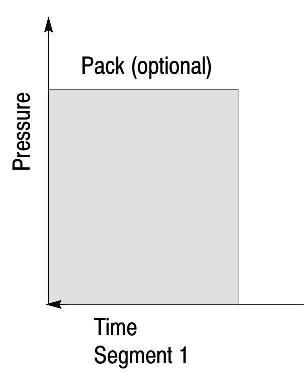
You specify pack and hold setpoints such as:

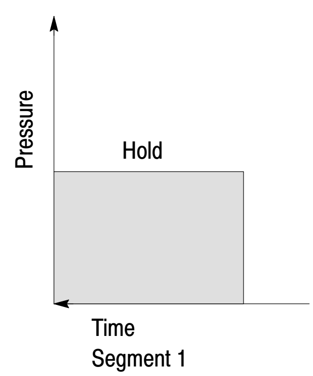
- pressure applied to the ram (screw)
- length of time

Pro-Set 600 software presents your setpoints in a bar graph, below, where your pressure setpoint (vertical axis) is applied to the ram (screw) for a given time setpoint (horizontal axis). More complex profiles (multiple bars) let you vary the pressure over multiple time segments during the pack and hold profiles.

Important: You can control and monitor cavity pressure only when you have configured the QDC module for the singular Inject mode. None of the other mode combinations let you connect a cavity pressure sensor to the QDC module.

Figure 1.3
Simple Pack and Hold Profiles Example





Plastication Profile
During the plastication profile, the screw draws resin into the barrel, refilling for the next shot. As the ram (screw) rotates, it grinds and heats the resin. Applying backpressure to the ram (screw) or controlling screw RPM prolongs grinding and increases the temperature of the new shot of molten plastic. We give you four choices of plastication control:

- backpressure vs. position
- backpressure vs. time
- screw RPM vs. position
- screw RPM vs. time

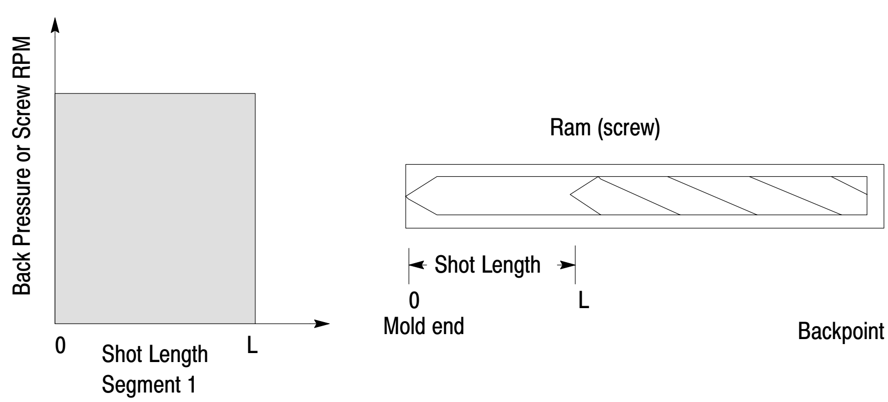
You specify plastication setpoints such as:

- backpressure applied to the ram (screw)
- position (shot size + cushion) to which it backs up

Pro-Set 600 software presents your setpoints in a bar graph, below, where the ram (screw) moves from left to right during the plastication profile. More complex profiles (multiple bars) would let you vary the backpressure or screw RPM during the plastication profile.

Important: With the 1771-QDC/C revision of the module, you can control and monitor screw RPM only when you have configured the QDC module for the singular Inject mode. None of the other mode combinations allow for connecting a screw RPM sensor to the QDC module.

Figure 1.4
Simple Plastication Profile Example

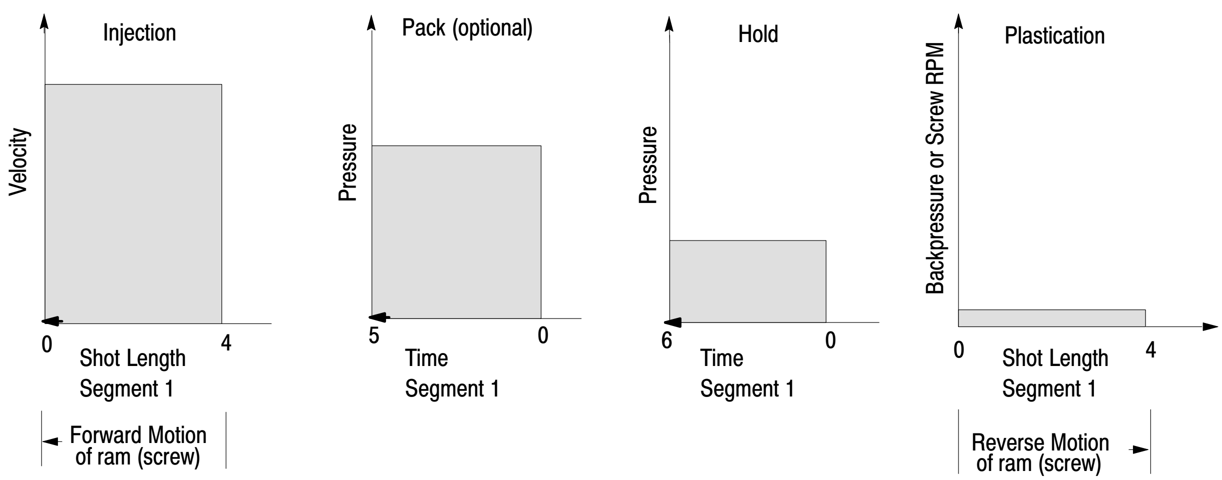


In a simple configuration, you can program the inject cycle with a pair of setpoints for each profile.

Table 1.A
Setpoints for a Simple Example Inject Profile

Setpoints:	Injection:	Transition:	Pack:	Hold:	Plastication:
Velocity (in/sec)	5 in/sec	—	—	—	—
Position (in)	0 in.	0.5 in.[1]	—	—	4 in.
Backpressure (psi)	—	—	—	—	10 psi
Ram (screw) Pressure (psi)	—	900 psi[1, 2]	400 psi	260 psi	—
Time (sec)	—	1 sec.[1]	5 sec.	6 sec.	—

1 whichever comes first
2 pressure transition does not occur until a specified amount of the shot size is injected into the mold

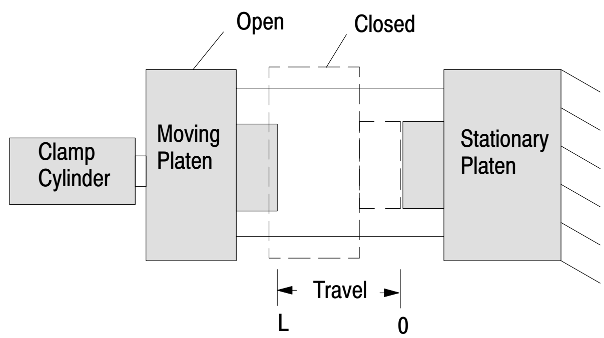


Clamp Phases

While clamping, the machine:

Performs this Operation:	Which Is Called:
Moves the two platens together	Closing the Clamp
Separates the two platens	Opening the Clamp

Figure 1.5
Example Clamp Operation



You can control the motion of the clamping cylinder with a group of setpoints called a profile. You create a profile for each phase of operation. Clamp profiles may be controlled by varying either cylinder velocity or pressure as follows:

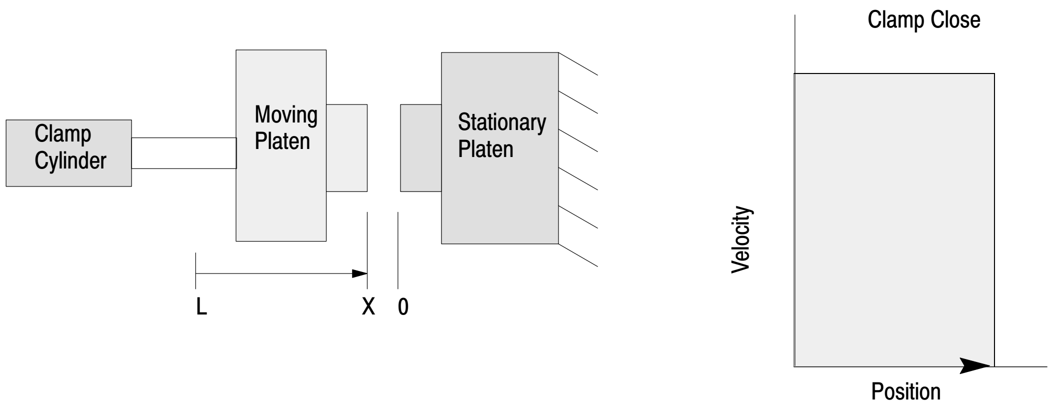
- Velocity of the moving cylinder vs. Position
- Pressure applied to the cylinder vs. Position

Clamp Close

Typically when closing the clamp, at least two different closing profiles are required:

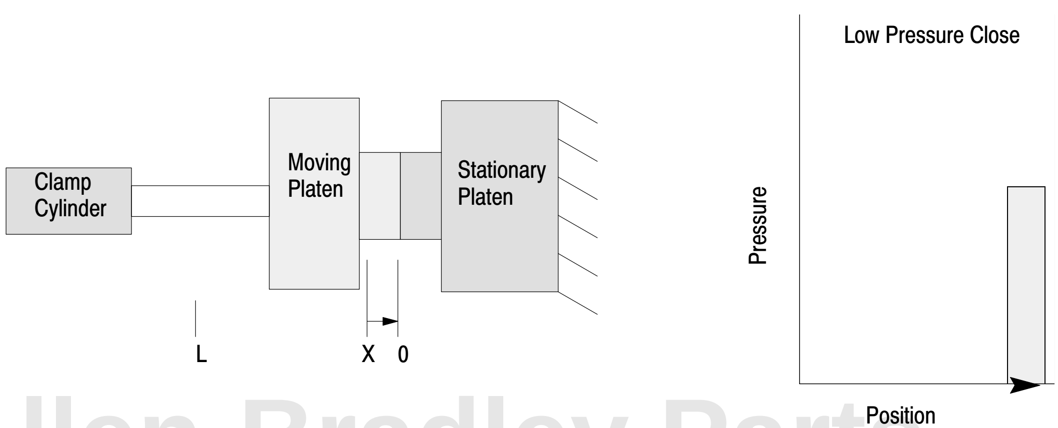
- A high speed close profile is used to rapidly decrease the gap between the two halves of your mold. This Clamp Close profile typically ends before the two mold halves actually contact one another

Figure 1.6
Example High Speed Close Profile



- A low speed close (Low Pressure Close) profile is used to guard against mold damage when bringing the clamp halves together. This Low Pressure Close profile typically covers a short distance at a very slow rate to detect unknown obstructions when the mold halves are brought together.

Figure 1.7
Example Low Pressure Close Profile

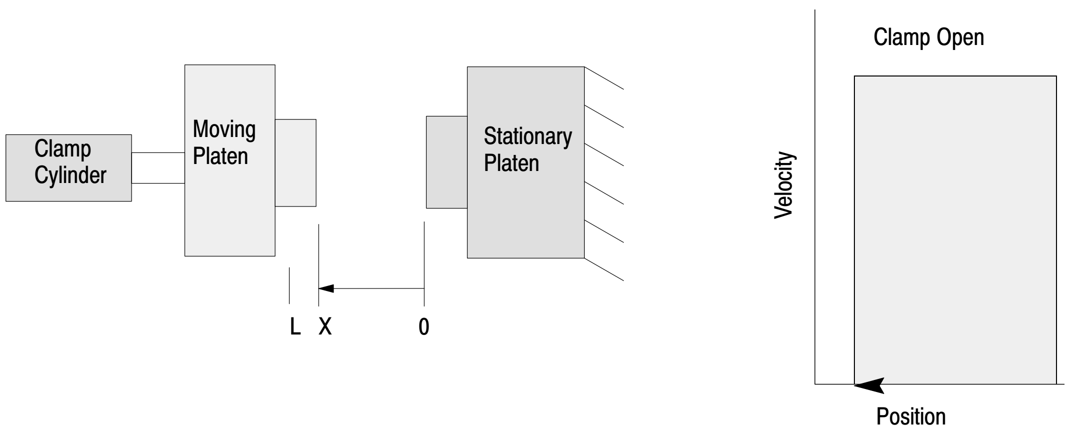


Clamp Open

Typically when opening the clamp, at least two different open profiles are required:

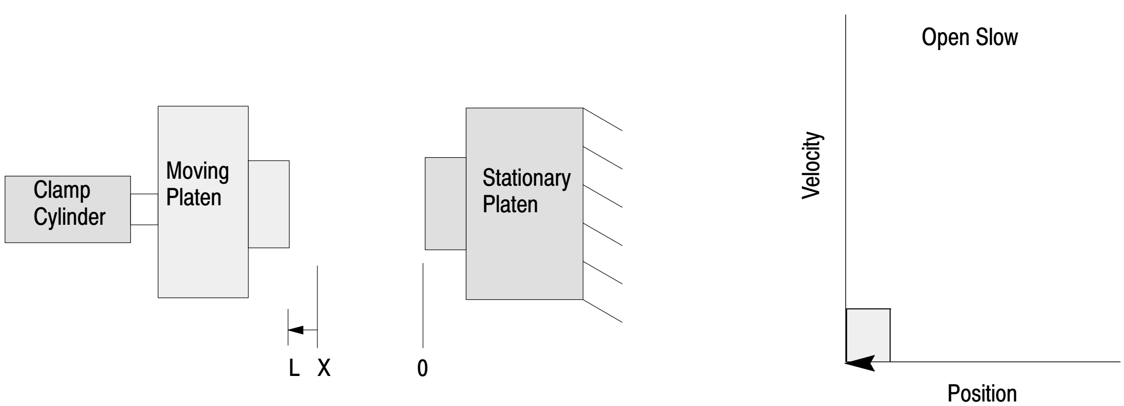
- A high speed open profile is used to rapidly separate the mold halves after the part is cured. This Clamp Open profile typically ends before the mold reaches the full open position.

Figure 1.8
Example High Speed Open Profile



- A low speed open profile is used to accurately position the movable platen before part ejection. This Open Slow profile typically covers a short distance at a very slow rate to increase positioning accuracy before ejecting or removing the part.

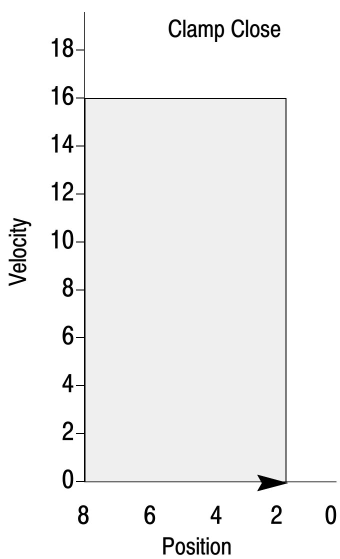
Figure 1.9
Example Low Speed Open Profile

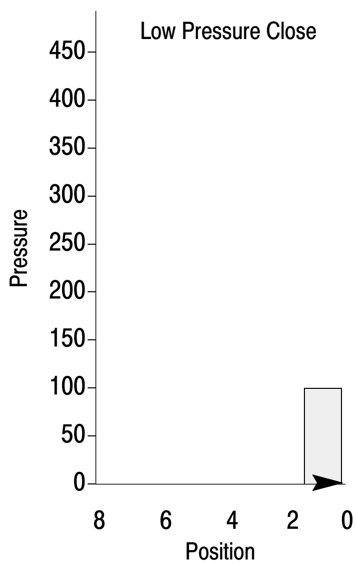


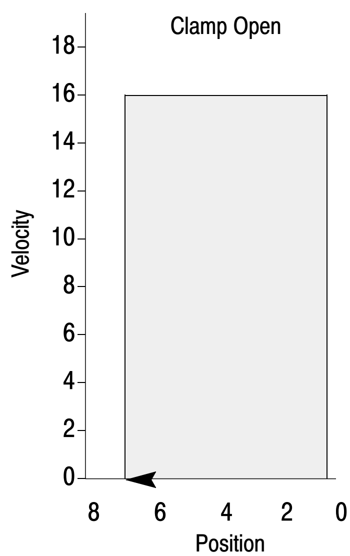
If using fast and slow speeds for moving the clamp, you can specify clamp motion in each direction with two pairs of setpoints. For example, consider a clamp whose open position is at 8” and closed position is at 0”. The following table starts with the clamp wide open (at 8”).

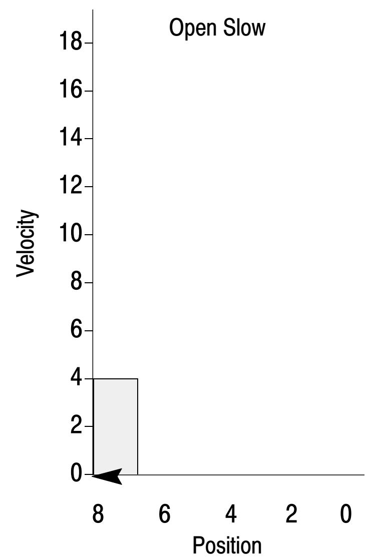
Table 1.B
Setpoints for Example of Simple Clamp Cycle

Setpoints:	Clamp Close:	Low Pressure Close:	Clamp Open:	Open Slow:
Velocity (in/sec)	16 in/sec	__	16 in/sec	4 in/sec
Position (in)	1.75 in.	0 in.	6.75 in.	8 in.
Pressure (psi)	__	100 psi	__	__







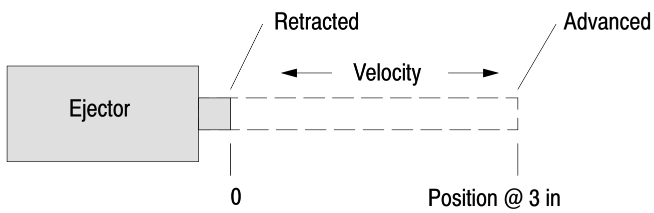


Eject Phases

During eject operations, the machine:

Performs this Operation:	Which is called:
Advances the ejectors to expel the part	Advance
Retracts the ejectors after the part has been expelled	Retract

Figure 1.10
Example Eject Operation



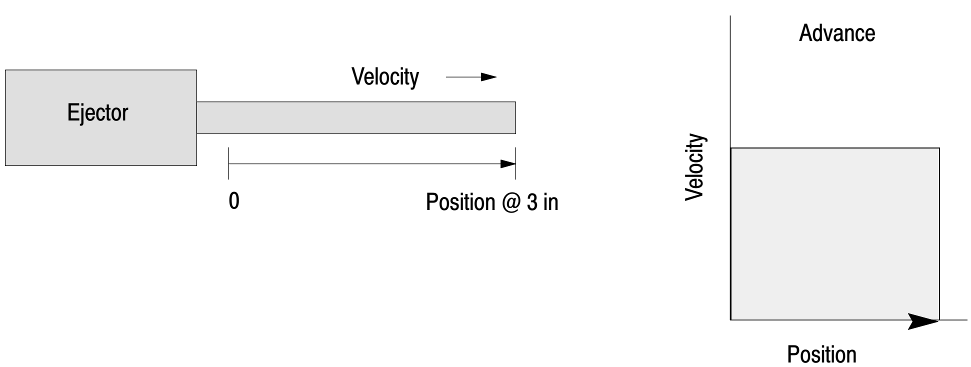
You can specify ejector motion with a pair of setpoints for each direction. These setpoints can be relative to either ejector cylinder pressure or ejector velocity:

- Ejector Pressure vs. Position
- Ejector Velocity vs. Position

Ejector Advance

Typically when advancing the ejector, one speed or pressure setpoint is sufficient. The goal of this movement is to eject the part(s) as quickly as possible without damaging the parts.

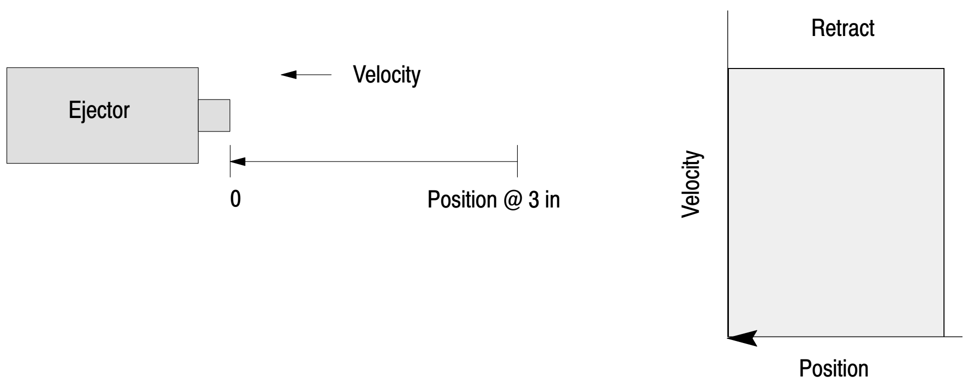
Figure 1.11
Example Ejector Advance



Ejector Retract

Typically when retracting the ejector, one speed or pressure setpoint is sufficient. The goal of this movement is to retract the ejectors as quickly as possible so as to allow mold close to take place with minimal delay.

Figure 1.12
Example Ejector Retract

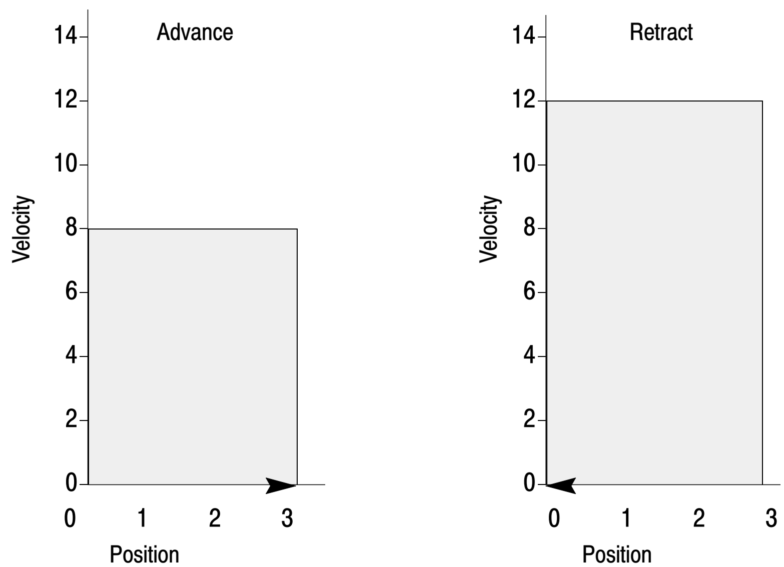


For example, consider an ejector with a retracted position at zero, and an extended position at 3”. The following table starts with the ejector retracted (at 0”).

Table 1.C
Ejector Advance and Retract Setpoints

Setpoints:	Advance:	Retract:
Velocity (in/sec)	8 in/sec	12 in/sec
Position (in)	3 in.	0 in.

Figure 1.13
Example Ejector Advance and Retract



More Complex QDC Applications

The QDC module lets you solve complex molding problems by controlling each phase of the machine cycle with a profile or multi-step control. This lets you vary the velocity or pressure of the ram (screw), clamp, or ejector in steps to achieve quality parts at rapid machine cycles impossible with single-step control.

We discuss the benefits of using profiles to control your machine with examples for each of the four available QDC modes of operation:

- Inject
- Inject and Clamp
- Clamp and Eject
- Inject, Clamp, and Eject

Inject Mode Operation

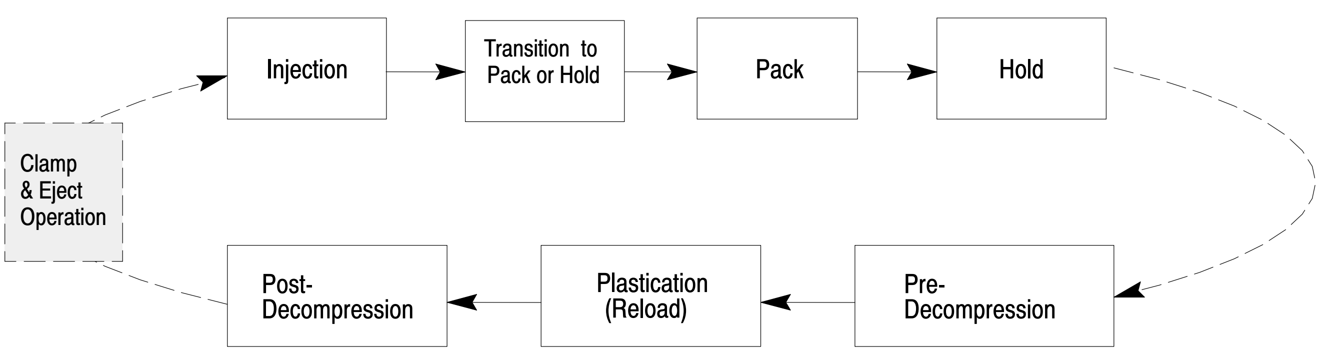
During the inject mode of operation, the ram (screw) injects resin into the mold and reloads the barrel for the next shot. The manner in which it does this can be critical to the quality of the molded part. This mode includes:

Table 1.D
Overview of the Inject Operation

Phase:	Description:
Injection Phase (required)[1]	The ram (screw) injects plastic into the mold. You can control the velocity of the ram (screw), or the pressure driving it, to fill areas of the mold cavity at different rates to achieve uniform quality of the molded part. This phase can be critical to part quality. You vary the velocity or pressure during injection with the injection profile.
Transition	Detects when the injection is complete.
Pack Phase (optional)[1]	Packing pressurizes the plastic to a specified density which determines the flexibility of the molded part. To achieve uniform density, you can release or increase pressure in steps according to cooling gradients across the mold. Thus, as the plastic cools unevenly, the pack profile can compress the plastic uniformly.
Hold Phase (required)[1]	Holding lets the plastic cool and shrink slightly from the mold cavity in preparation for ejection. The effect is similar to packing. You can hold at predetermined pressures and times throughout the hold phase.
Pre-decompression (optional)	This single, backward movement of the ram (screw) separates plastic solidifying in the mold from molten cushion remaining in the barrel prior to plastication. This phase is also referred to as sprue break or suckback.
Plastication Phase (required)[1]	The machine reloads by drawing plastic beads into the barrel containing the ram (screw). The mechanical action of the rotating screw grinds and melts the beads. The longer it grinds, the hotter they get.. You can vary the back pressure on the ram (screw) or its RPM to induce the desired temperature gradient along the length of the shot. You can control and monitor screw RPM only when you configure the QDC module for the singular Inject mode.
Post-decompression (optional)	This single, backward movement of the ram (screw) guards against drooling molten plastic into the open mold during ejection prior to the clamp close. This phrase is also referred to as melt pullback or suckback.

[1] You enter a profile for these phases

Figure 1.14
Inject Operation of a Typical Machine Cycle



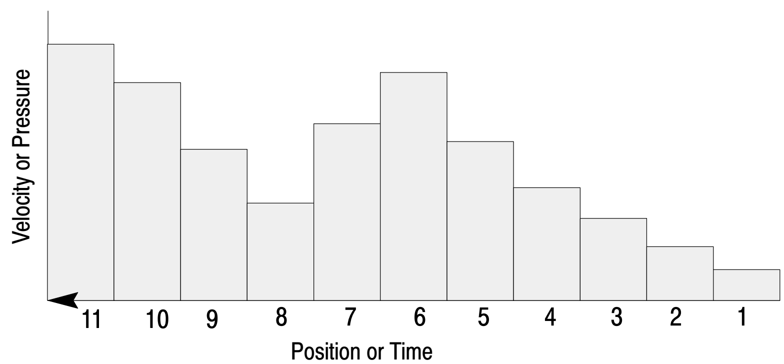
These different inject phases of operation are explained in detail in the following descriptions.

Injection Phase

The injection phase allows you to vary the velocity of the ram (screw), or the pressure driving it so the melt moves through the mold cavity at the desired speed. The pattern of velocity or pressure variation during injection is called the injection profile. The 1771-QDC module lets you choose from four different injection profiles:

- velocity vs. position
- pressure-limited velocity vs. position
- pressure vs. position
- pressure vs. time

Figure 1.15
Injection Phase Example



You enter setpoints to create a profile. You can select from 1 to 11 segments of position or time. Segment numbers represent the order of operation. By convention, the ram (screw) injects plastic by moving from right to left.

With this Profile:	You Control Injection:	With up to 11 Segments Distributed over the:
Velocity vs. Position	Speed	Length of the shot
Pressure-limited[1] Velocity vs. position	Speed with a Ceiling Pressure	Length of the shot
Pressure vs. Position	Pressure	Length of the shot
Pressure vs. Time	Pressure	Time for a shot

[1] Pressure-limited velocity vs. position profile differs from the velocity vs. position profile as follows: during any segment, if the pressure exceeds a preset pressure limit, the module switches to PID pressure control with the pressure limit as the setpoint. Then if velocity exceeds the velocity setpoint, the module returns to velocity vs. position control.

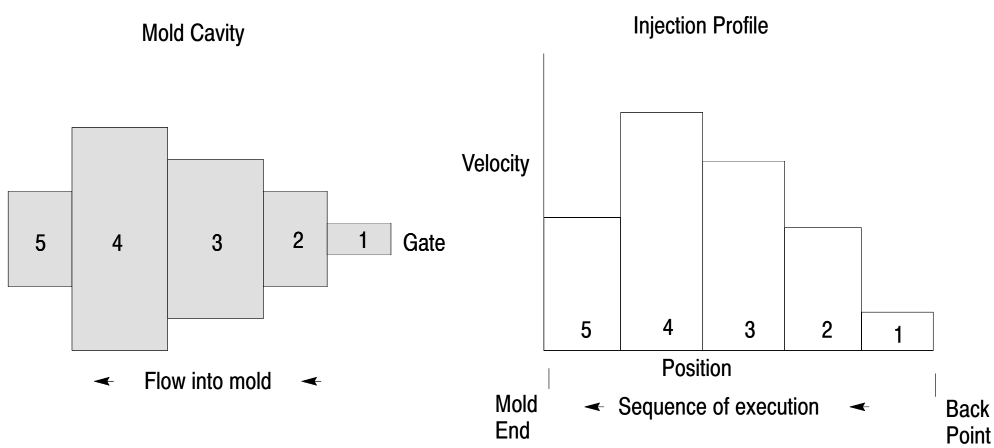
Example Benefits of Profiling an Injection Phase

The injection phase should force the melt through the mold as fast as possible without flashing the mold or burning the plastic going through the mold gates. This should be done while still making good, consistent, quality parts. Two examples of how you can achieve this by profiling the injection phase are:

- velocity
- flash prevention

Velocity - As the leading edge of the melt enters different mold cavities, the flow of plastic through the gate should increase or decrease accordingly to keep the melt front at maximum desired speed without flashing the mold. This reduces injection time and minimizes surface stress due to surface cooling. You achieve this by shaping the injection profile to suit the mold cavity.

Figure 1.16
Velocity Example

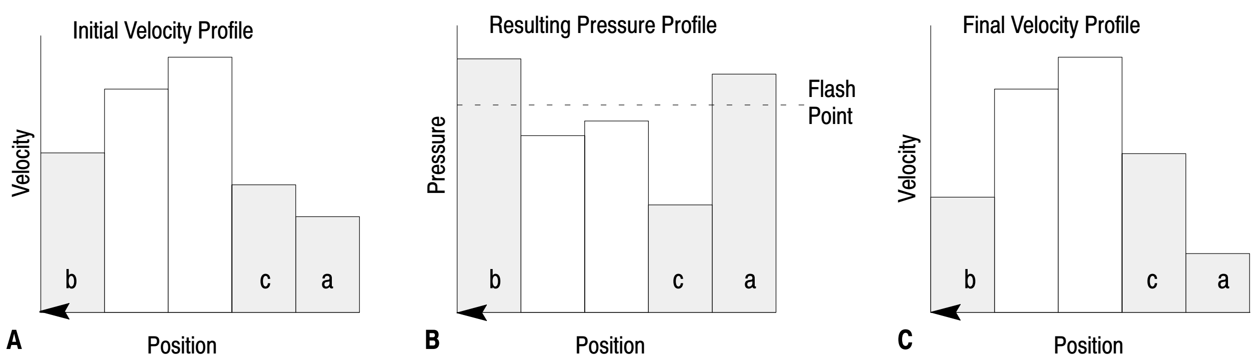


Flash Prevention - The pressure may reach a peak and flash the mold at ram (screw) position segments that correspond to events such as:

- the initial surge (a)
- when the melt front enters a constriction in the mold cavity (b)

You can remedy this by decreasing the ram (screw) velocity at segments (a) and (b) that correspond to flash points. Conversely, you can boost velocity at segment (c) where the resulting pressure is well below the flash point.

Figure 1.17
Flash Prevention Example



Optionally, you may select pressure limited velocity versus position as your method of injection control. With your pressure limit setpoint just below the flash point, the module switches over to pressure control prior to flashing the mold.

Injection-to-pack Transition

The QDC module ends the injection phase and automatically starts the pack or hold profile when it detects the first of up to four events:

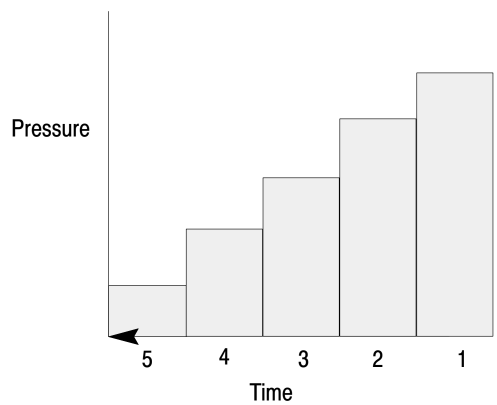
- ram (screw) position becomes less than a preset limit
- ram (screw) pressure exceeds a preset limit
- cavity pressure exceeds a preset limit
- injection phase elapsed time exceeds a preset limit

You select which of these events you want monitored for transition by entering the appropriate setpoint, or zero for ignoring the event. Pressure transitions can be inhibited over a portion of the shot size as specified by the configuration.

Pack Phase

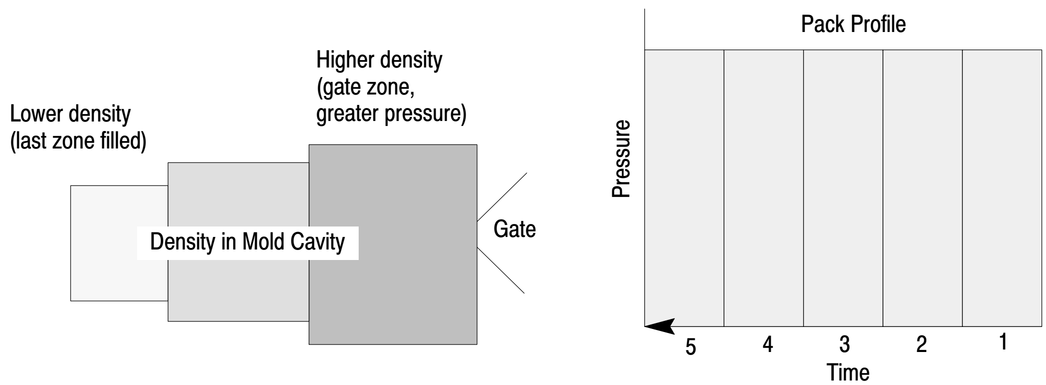
The QDC module controls the Pack phase with a pressure vs. time profile. You create the profile based on controlling the hydraulic pressure against the ram (screw) or by controlling the pressure within the mold cavity resulting from hydraulic pressure against the ram (screw). Either pressure can be controlled using up to five segments. By convention, events occur from right to left on the time axis. You determine the pressure setpoints and time durations for the pack profile based on molding requirements (the Pack Phase is optional).

Figure 1.18
Pack Phase Example



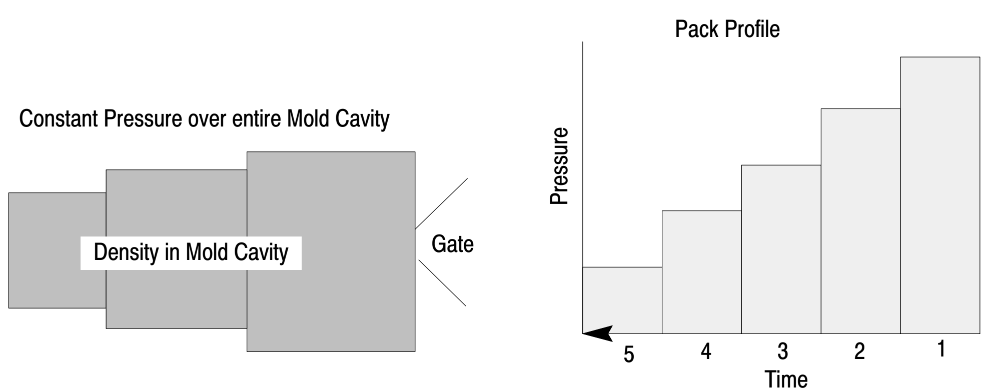
Example Benefits of Profiling a Pack Phase
Molten plastic may cool unevenly in the mold causing variations in density with the end result of warpage and distortion as shown in Figure 1.19.

Figure 1.19
Uneven Cooling in Pack Phase



You can remedy this by decreasing the pack pressure with time so plastic can back out of the mold as shown in Figure 1.20. This is to alleviate gradations in density as the plastic cools from the low-density end of the mold (last zone filled) to the high-density end of the mold cavity (gate zone where pressure is greater).

Figure 1.20
Even Cooling in Pack Phase



After completing the last segment of the Pack phase, the QDC module automatically starts the Hold phase.

Hold Phase

The QDC module controls the Hold phase with a pressure vs. time profile. You create the profile based on controlling the hydraulic pressure against the ram (screw) or by controlling the pressure within the mold cavity resulting from hydraulic pressure against the ram (screw). Either pressure can be controlled using up to five segments. You determine the pressure setpoints and time durations for the hold profile based on your molding requirements.

After completing the last segment of the Hold phase, the QDC module either immediately starts the optional Pre-decompression movement, skips the pre-decompression movement if none is required and immediately starts the Plastication phase, or waits for a command from your PLC-5 program to continue.

Pre-decompression Movement

You select a length of Pre-decompression pull-back for the ram (screw) prior to the Plastication phase to separate plastic solidifying in the sprue from the molten cushion remaining in the barrel.

After completing the Pre-decompression movement, the QDC module either immediately starts the Plastication phase or waits for a command from your PLC-5 program to continue.

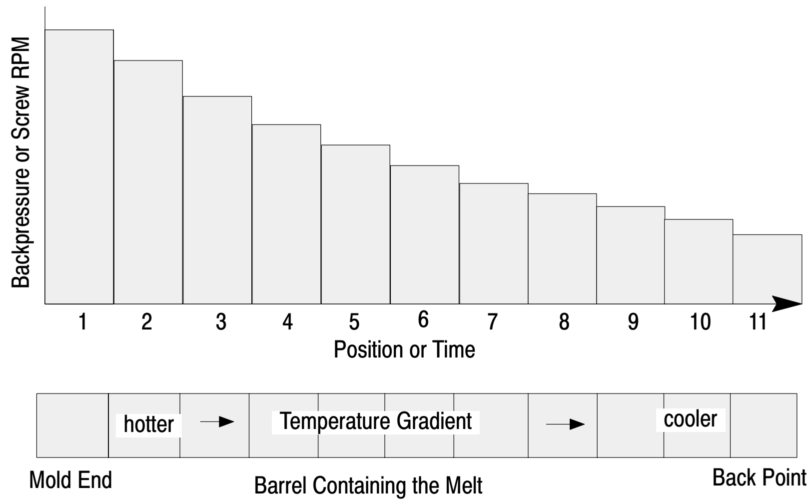
Plastication Phase

The plastication phase lets you achieve a melt temperature gradient with respect to the molten plastic's distance from the nozzle. You then can create the required profile with up to 11 segments of position or time.

You choose from four plastication profiles:

- backpressure vs. position
- backpressure vs. time
- screw RPM vs. position
- screw RPM vs. time

Figure 1.21
Plastication Phase Example



Affects of Profiling a Plastication Phase
Backpressure and/or screw RPM have these affects on plastication:

- The higher the backpressure (or screw RPM) during plastication, the higher the resultant temperature of the melt.
- You can accelerate the backup rate by reducing backpressure (or increasing screw RPM).
- You can increase resultant melt temperature by increasing backpressure (or increasing screw RPM).

After completing the last segment of the Plastication phase, the QDC module either immediately starts the Post-decompression movement or waits for a command from your PLC-5 program to continue.

Post-decompression Movement

You select a length of Post-decompression pull-back of the ram (screw) after the Plastication phase to guard against drooling molten plastic into the open mold during ejection. The QDC module notifies your PLC-5 program when the Post-decompression movement is complete.

Screw Speed

Beginning with the 1771-QDC/C revision of the module, you can control and monitor screw RPM only when you have configured the QDC module for the singular Inject mode. None of the other mode combinations allow for connecting a screw RPM sensor to the QDC module.

Inject and Clamp Mode Operation

When you select the Inject and Clamp mode of operation, you can use all Inject-mode functions *except* for the following:

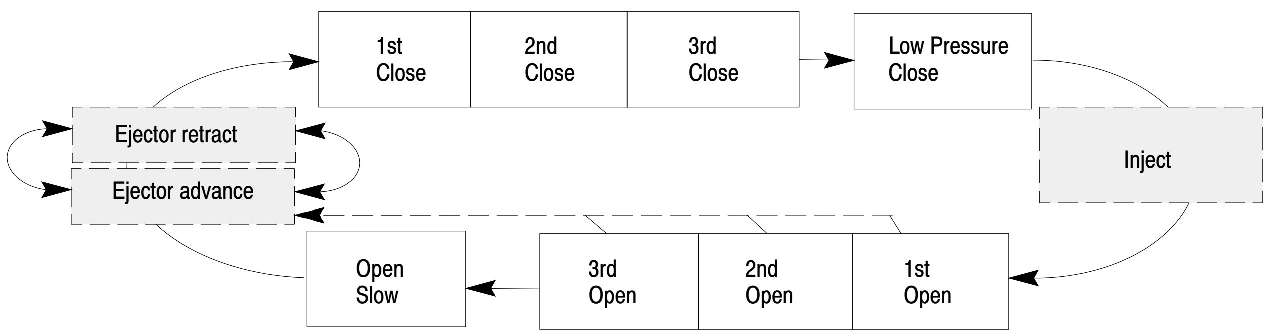
- control and monitor cavity pressure
- control and monitor screw RPM

Table 1.E
Overview of Inject and Clamp Operation

Inject Phase:	Description:
Injection Phase (required)[1]	The ram (screw) injects plastic into the mold. You can vary the velocity of the ram (screw), or the pressure driving it, to fill areas of the mold cavity at different rates to achieve uniform quality of the molded part. This phase can be critical to part quality. The pattern of velocity or pressure variation during injection is called the injection profile.
Transition	Detects when the injection is complete.
Pack Phase (optional)[1]	Packing pressurizes the plastic to a specified density which determines the flexibility of the molded part. To achieve uniform density, you can release or increase pressure in steps according to cooling gradients across the mold. Thus, as the plastic cools unevenly, the pack profile can compress the plastic uniformly.
Hold Phase (required)[1]	Holding lets the plastic cool and shrink slightly from the mold cavity in preparation for ejection. The effect is similar to packing. You can hold at predetermined pressures for predetermined lengths of time throughout the hold phase.
Pre-decompression (optional)	This single, backward movement of the ram (screw) separates plastic solidifying in the mold from molten cushion remaining in the barrel prior to plastication. This phase is also referred to as sprue break or suck back.
Plastication Phase (required)[1]	The machine reloads by drawing plastic beads into the barrel containing the ram (screw). The mechanical action of the rotating ram (screw) grinds and melts the beads. The longer it grinds, the hotter it melts. You can vary the backpressure on the ram (screw) causing it to remain longer in an area. Thus, you can induce any desired temperature gradient along the length of the shot by controlling ram (screw) backpressure.
Post-decompression (optional)	This single, backward movement of the ram (screw) guards against drooling molten plastic into the open mold during ejection prior to the clamp close. This phase is also referred to as melt pullback or suckback.
Clamp Phase:	**Description:**
1st Close[1] 2nd Close[1] 3rd Close[1]	You can program a single-step clamp close profile and not use a second or third profile. Or, you can program up to three clamp close profiles that let you do the following at up to three different points in the clamp close phase: • pick up a third mold plate • set cores • pick up or drop out pumps to change machine speed or pressure
Low Pressure Close[1]	To guard against damaging the mold when the two mold surfaces make contact and to detect obstructions to mold closure, you close the mold slowly with low pressure in closed-loop or open-loop control. You must use pressure vs. position control.
1st Open[1] 2nd Open[1] 3rd Open[1]	You can program a single-step clamp open profile and not use a second or third profile. Or, you can program up to three clamp open profiles that let you do the following at up to three different points in the clamp open phase: • drop out a third mold plate • pull cores • drop out or pick up pumps to change machine speed or pressure • start the ejector before the mold is fully open
Open Slow[1]	To decelerate the moving platen to accurately position it before ejecting the part.

[1] You enter a profile for these phases

Figure 1.22
Clamp Portion of a Typical Machine Cycle



Important: Details of the inject phase of the inject and clamp mode of operation are given in previous sections. Note that only those inject features listed in Table 1.E are available in inject and clamp mode.

You control clamp operation with these phases:

- clamp close
- low pressure close
- clamp open
- open slow

Clamp Close

Three separate clamp close profiles may be configured:

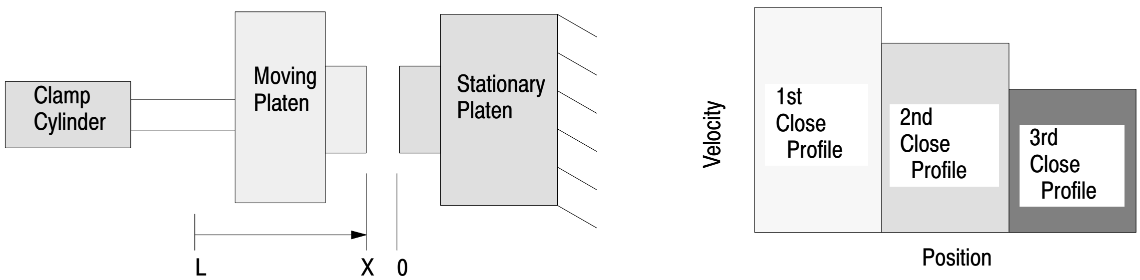
- first close
- second close
- third close

You may select from these control modes:

- velocity vs. position
- pressure vs. position

Use Clamp Close to move the platen from the fully open position (L) to some position X at a relatively high velocity or pressure. X is a position relatively close to the stationary platen yet far enough away to allow deceleration into Low Pressure Close. This prevents the platens from coming together at a high velocity.

Figure 1.23
Example Clamp Close

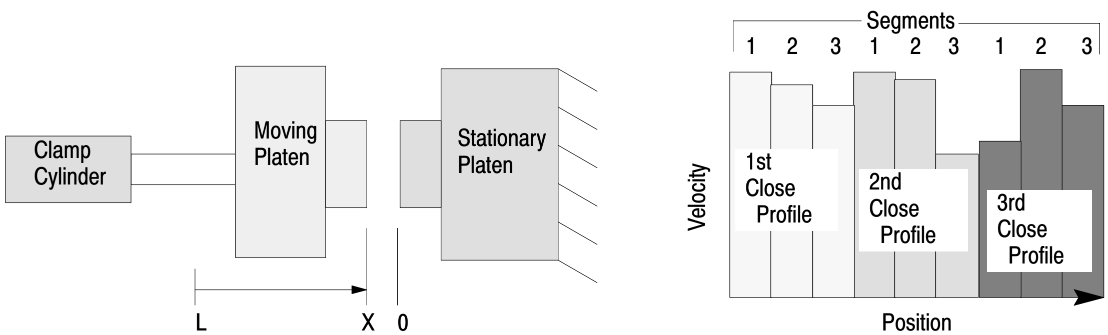


Three different close profiles have been provided to allow you to initiate the following operations between profiles:

- pick up the 3rd plate of a mold (on a floating 3-plate mold) or set cores
- program other events for all valves
- either automatically bridge between profiles or allow user programming to decide when to begin the next profile

Each of these three profiles are subdivided into three position segments (shown above each profile in Figure 1.24). You can change clamp velocity or pressure up to three times in each profile, or up to nine times for the entire clamp close phase.

Figure 1.24
Example Clamp Close Position Segments



Important: You may use as many or as few profiles and/or segments within profiles as needed for your molding application. If using a single close fast motion, use the first segment of the 1st close profile. The Low Pressure Close Profile must follow.

After completing the last segment in each profile, the QDC module either switches immediately to the next programmed segment of the next desired profile or waits for a command from your PLC-5 program to continue.

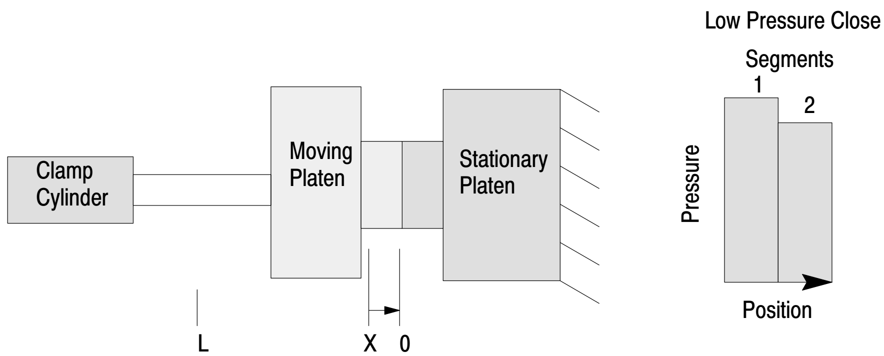
After completing the last configured close profile, the QDC module either switches immediately to the first programmed segment of Low Pressure Close, or waits for a command from your PLC-5 program to continue.

Low Pressure Close

Use the Low Pressure Close Profile to decelerate closing motion to guard against damaging the mold halves. The pressure setpoint that you select to control low pressure close should prohibit the mold from fully closing if their is an obstruction. Up to two low pressure close profile segments may be used.

You must use the pressure vs. position control mode for low pressure close.

Figure 1.25
Example Low Pressure Close



Important: If you need only one Low Pressure Close segment, configure the 1st segment of the Low Pressure Close profile.

The QDC module notifies your PLC-5 program when this profile is complete and automatically uses end-of low pressure close set-output values to build tonnage (on a hydraulic machine) or lockup your toggle (on a toggle machine).

Clamp Open

You can open the mold fast with three profiles of the clamp-open phase:

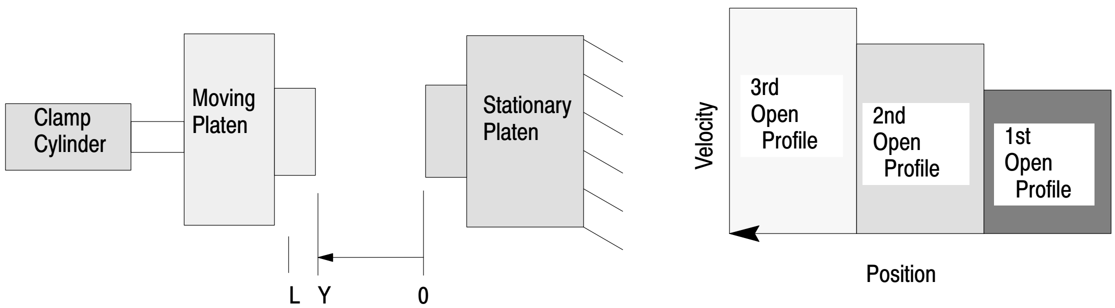
- first open
- second open
- third open

You may select from these control modes:

- velocity vs. position
- pressure vs. position

Use Clamp Open to move the platen from the fully closed position (0) to some position Y at a relatively high velocity or pressure. Y is a position relatively close to your fully open position (L) yet far enough away to allow deceleration into Open Slow. This is to increase positioning accuracy at the full open position (L).

Figure 1.26
Example Clamp Open

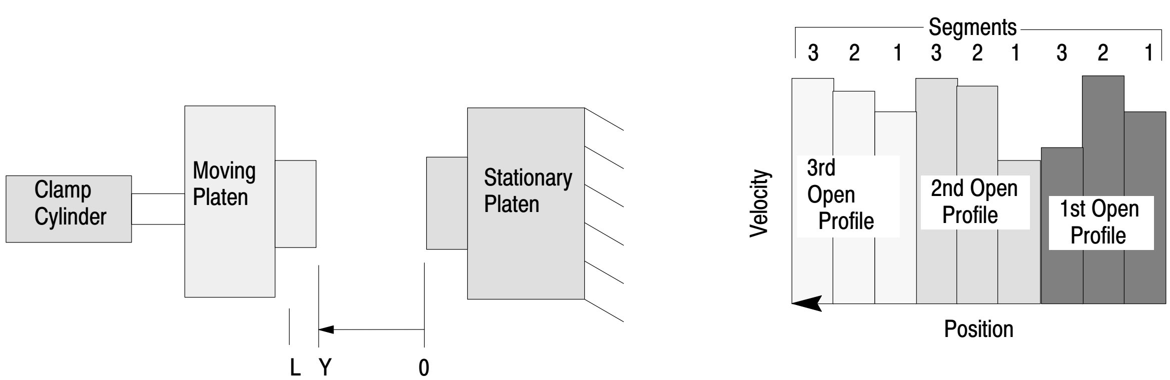


Three different open profiles have been provided to allow you to initiate the following operations between profiles:

- drop off the third plate of a mold (on a floating 3-plate mold) or pull cores
- program other events for all valves
- either automatically bridge between profiles or allow user programming to decide when to begin the next profile.

Each of these three profiles are subdivided into three position segments (shown above each profile in Figure 1.27). You can change setpoints up to three times in each profile, or up to nine times for the entire clamp open phase.

Figure 1.27
Example Clamp Open Position Segments



Important: You may use as many or as few profiles and/or segments within profiles as needed. If using a single open motion, use the first segment of the 1st open profile. The Open Slow Profile must follow.

After completing the last segment in each profile, the QDC module either switches immediately to the next programmed segment of the next programmed profile or waits for a command from your PLC-5 program to continue.

After completing the last configured clamp open profile, the QDC module either switches immediately to the first programmed segment of Open Slow, or waits for a command from your PLC-5 program to continue.

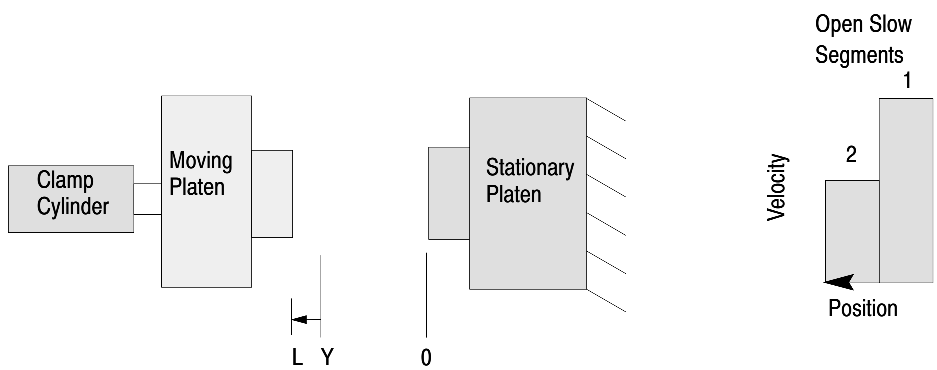
Open Slow

Use the Open Slow Profile to accurately position the clamp for ejecting the part(s). You may decelerate clamp motion twice with this profile using up to two profile segments.

You may select from these control modes:

- velocity vs. position
- pressure vs. position

Figure 1.28
Example Open Slow



Important: If you need only one open slow motion, configure only the 1st segment of the Open Slow Profile.

Clamp and Eject Mode Operation

When you select the Clamp and Eject mode of operation, you can use the following phases:

Table 1.F
Overview of Clamp and Eject Operation

Clamp Phase:	Description:
1st Close[1] 2nd Close[1] 3rd Close[1]	You can program a single-step clamp close profile and not use a second or third profile. Or, you can program up to three clamp close profiles that let you do the following at up to three different points in the clamp close phase: • pick up a third mold plate • set cores • pick up or drop out pumps to change machine speed or pressure
Low Pressure Close[1]	To guard against damaging the mold when the two mold surfaces make contact and to detect obstructions to mold closure, you close the mold slowly with low pressure in closed-loop or open-loop control. You must use pressure vs. position control.
1st Open[1] 2nd Open[1] 3rd Open[1]	You can program a single-step clamp open profile and not use a second or third profile. Or, you can program up to three clamp open profiles that let you do the following at up to three different points in the clamp open phase: • drop out a third mold plate • pull cores • drop out or pick up pumps to change machine speed or pressure • start the ejector before the mold is fully open
Open Slow[1]	To decelerate the moving platen to accurately position it before ejecting the part.
Eject Phase:	**Description:**
Ejector Advance[1]	You advance the ejector in a single-step or in multiple steps using closed-loop or open-loop control. Multiple strokes may be programmed.
Ejector Retract[1]	You retract the ejector in a single-step or in multiple steps using closed-loop or open-loop control. Multiple strokes may be programmed.
Tip Strokes	You can shake the part out of the mold by programming rapid single-stroke interim ejector strokes starting after the first advance stroke and ending before the last retract stroke.
Forward Dwell	You can pause after the first advance stroke or before the last retract stroke to let a robot remove the part when the ejectors are extended.

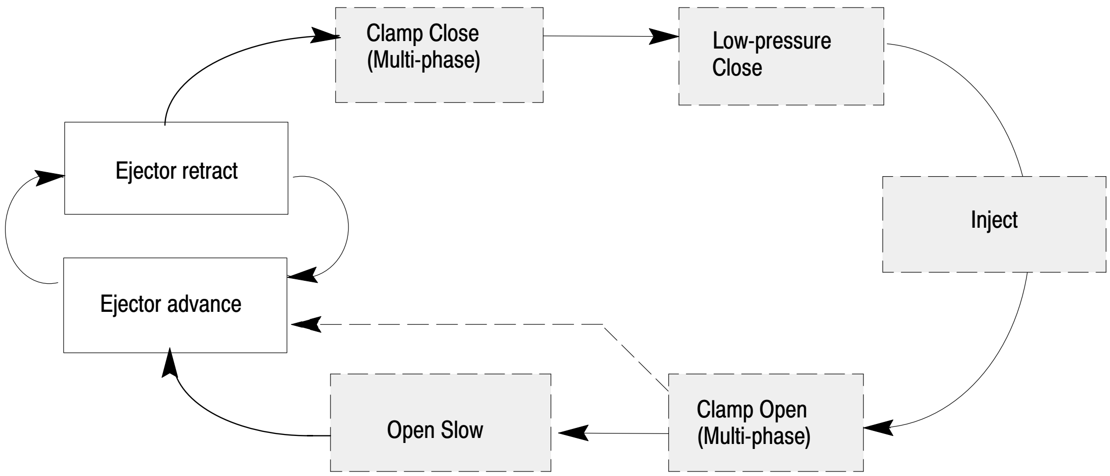
[1] You enter a profile for these phases.

Important: Details of the clamp portion of the Clamp and Eject mode of operation are given in previous sections.

In this section, we describe the Eject operation for expelling the molded parts. The operation consists of:

- ejector advance
- ejector retract

Figure 1.29
Eject Portion of a Typical Machine Cycle



Ejector Advance

The QDC module starts advancing the ejector after detecting either one of these events that you configure/program:

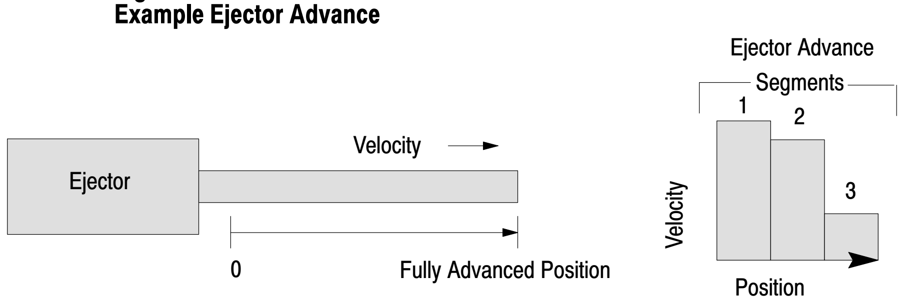
- clamp position reaching a pre-determined setpoint during clamp open
- command from the user PLC-5 program

You may advance the ejector while the clamp is still opening the mold, or wait until the mold is fully open.

Up to three ejector advance profile segments may be used. You may select from these control modes:

- velocity vs. position
- pressure vs. position

Figure 1.30
Example Ejector Advance



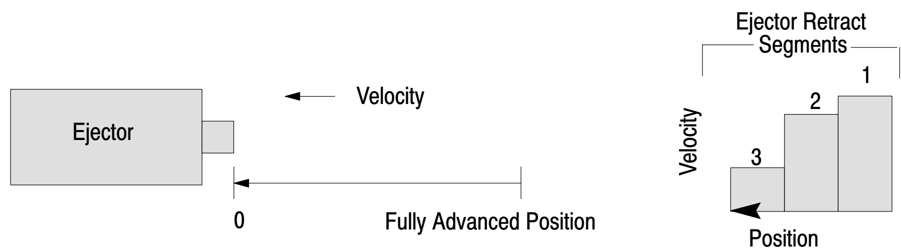
Important: If you need only one ejector advance motion, configure only the 1st Advance segment.

Ejector Retract

After the Ejector Advance is completed, ejector retract is executed. Similar to advancing the ejector, you retract it with up to three profile segments. You may select from these control modes:

- velocity vs. position
- pressure vs. position

Figure 1.31
Example Ejector Retract

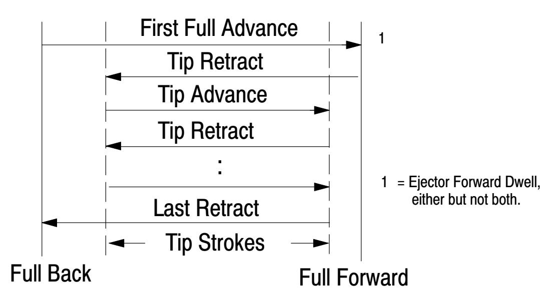


Other Eject Features

The QDC module gives you the following additional features:

- the ability to repeat ejector cycles a number of times changing from advance to retract determined either automatically or by command from your PLC-5 program
- Ejector Forward Dwell -- the ability to pause after completing the first or last ejector advance stroke. Use this feature so a robot can pick off a part when ejectors are fully extended
- Ejector "Tip" Strokes -- the ability to "shake" the part off the ejector. You may program interim single-segment advance and retract tip strokes that occur after the first advance stroke and before the last retract stroke

Figure 1.32
Advance, Retract, and Tip Strokes



Inject, Clamp and Eject Mode Operation

When you select the Inject, Clamp, and Eject mode of operation, you can use the following phases:

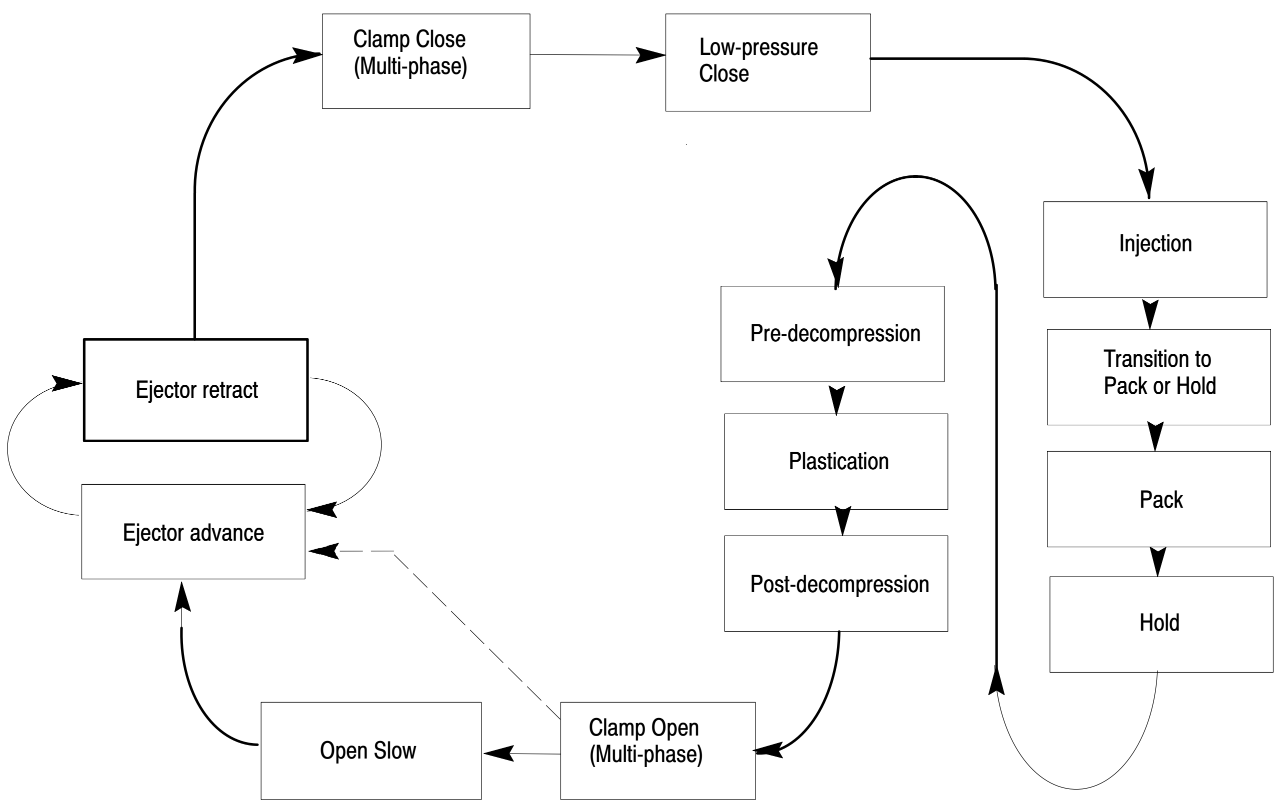
Table 1.G
Overview of Inject, Clamp, and Eject Operation

Inject Phase:	**Description:**
Injection Phase (required)[1]	The ram (screw) injects plastic into the mold. You can control the velocity of the ram (screw), or the pressure driving it, to fill areas of the mold cavity at different rates to achieve uniform quality of the molded part. This phase can be critical to part quality. You can vary the velocity or pressure during injection with the injection profile.
Transition	Detects when the injection is complete.
Pack Phase (optional)[1]	Packing pressurizes the plastic to a specified density which determines the flexibility of the molded part. To achieve uniform density, you can release or increase pressure in steps according to cooling gradients across the mold. Thus, as the plastic cools unevenly, the pack profile can compress the plastic uniformly.
Hold Phase (required)[1]	Holding lets the plastic cool and shrink slightly from the mold cavity in preparation for ejection. The effect is similar to packing. You can hold at predetermined pressures for predetermined lengths of time throughout the hold phase.
Pre-decompression (optional)	This single, backward movement of the ram (screw) separates plastic solidifying in the mold from molten cushion remaining in the barrel prior to plastication. This phase is also referred to as sprue break or suckback.
Plastication Phase (required)[1]	The machine reloads by drawing plastic beads into the barrel containing the ram (screw). The mechanical action of the rotating ram (screw) grinds and melts the beads. The longer it grinds, the hotter it melts. You can vary the backpressure on the ram (screw) causing it to remain longer in an area. Thus, you can induce any desired temperature gradient along the length of the shot by controlling ram (screw) backpressure.
Post-decompression (optional)	This single, backward movement of the ram (screw) guards against drooling molten plastic into the open mold during ejection prior to the clamp close. This phase is also referred to as melt pullback or suckback.
Clamp Phase:	**Description:**
1st Close[1] 2nd Close[1] 3rd Close[1]	You can program a single-step clamp close profile and not use a second or third profile. Or, you can program up to three clamp close profiles that let you do the following at up to three different points in the clamp close phase: • pick up a third mold plate • set cores • pick up or drop out pumps to change machine speed or pressure
Low Pressure Close[1]	To guard against damaging the mold when the two mold surfaces make contact and to detect obstructions to mold closure, you close the mold slowly with low pressure in closed-loop or open-loop control. You must use pressure vs. position control.
1st Open[1] 2nd Open[1] 3rd Open[1]	You can program a single-step clamp open profile and not use a second or third profile. Or, you can program up to three clamp open profiles that let you do the following at up to three different points in the clamp open phase: • drop out a third mold plate • pull cores • drop out or pick up pumps to change machine speed or pressure • start the ejector before the mold is fully open
Open Slow[1]	To decelerate the moving platen to accurately position it before ejecting the part.

Eject Phase:	Description:
Ejector Advance[1]	You advance the ejector in a single-step or in multiple steps using closed-loop or open-loop control. Multiple strokes may be programmed.
Ejector Retract[1]	You retract the ejector in a single-step or in multiple steps using closed-loop or open-loop control. Multiple strokes may be programmed.
Tip Strokes	You can shake the part out of the mold by programming rapid single-stroke interim ejector strokes starting after the first advance stroke and ending before the last retract stroke.
Forward Dwell	You can pause after the first advance stroke or before the last retract stroke to let a robot remove the part when the ejectors are extended.

[1] You enter a profile for these phases.

Figure 1.33
Typical Machine Cycle of Inject, Clamp, and Eject



Important: For details of the Inject, Clamp, and Eject mode, see the following sections:

For this Portion of the Machine Cycle	See this Section	On Page
Inject	Inject Mode Operation	1-17
Clamp	Inject and Clamp Mode Operation	1-25
Eject	Clamp and Eject Mode Operation	1-31

Important: When operating in the Inject, Clamp, and Eject mode, a single system pressure is defined as the pressure read by the system pressure sensor connected to input 2 of the QDC module. Decide which phase of operation must be controlled by a closed-loop pressure profile. Control the other phases with velocity profiles or open-loop pressure profiles.

Role of Pro-Set 600 Software

Pro-Set 600 Software lets you control and monitor the injection molding process. This software is a library of features from which you select and build a custom program that matches the requirements of your molding machine. Allen-Bradley has written the required ladder logic and PanelView programs. You select, then "cut and paste" only those features needed for your specific application. You can further customize your program by modifying standard screens and ladder logic to meet specific requirements.

For details on the operation and use of Pro-Set 600, refer to the Pro-Set 600 Designer's Guide (pub. no. 6500-6.5.11).

Chapter 2

Matching the QDC Module to your Hydraulic System

Chapter Objectives

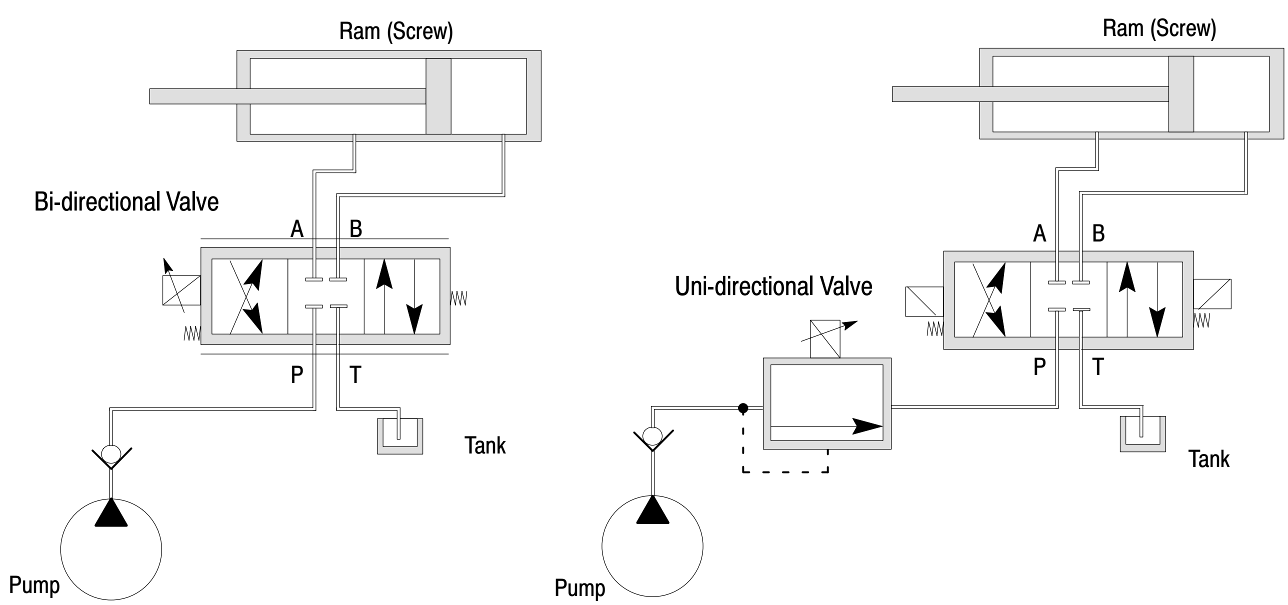
This chapter identifies several valve configurations typical of injection molding machines. This chapter shows how QDC modules can be used to control machine hydraulics based on hydraulic configurations. Application considerations are also discussed for each hydraulics/QDC module example.

We present basic hydraulic circuits showing proportional or servo valves controlled by QDC modules. When necessary to convey the control philosophy of a circuit, we also show directional solenoid valves.

This chapter is not intended to show you all possible injection machine hydraulic configurations and corresponding QDC module applications. Instead, it is meant to give examples of how you can use combinations of QDC modules to solve your injection machine control needs.

This chapter gives configuration examples for bi-directional valve systems only. Many of these bi-directional valve configurations have an equivalent uni-directional valve solution (Figure 2.1). Most of the uni-directional solutions may be configured using the same QDC module application as the bi-directional system. Use the same QDC mode and I/O connections with any uni-directional valves being controlled by your QDC module.

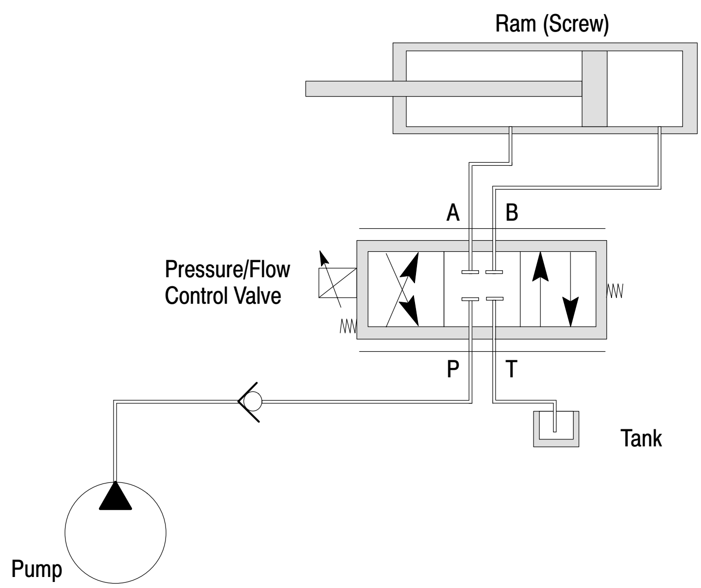
Figure 2.1
Examples of Bi-directional and Uni-directional Ram (Screw) Proportional Valves



Single-valve System for Inject Control

If sized properly (particularly on smaller presses), the same valve may be used to control both the pressure and flow algorithms on certain machines. Figure 2.2 shows a single bi-directional valve used for pressure and flow control.

Figure 2.2
Example Single-valve System for Inject Control



Use a single QDC module in Inject mode for this single-valve application (Table 2.A). In this configuration, the QDC module:

- controls pressure and flow of the appropriate inject phases
- monitors and controls cavity pressure
- monitors screw RPM

The remaining 3 outputs of the module may be used for various machine functions, such as setting:

- the output to an hydraulic motor driving screw speed during plastication
- a pressure reference to a system pressure valve

Table 2.A
Example Single-valve System for Injection Control

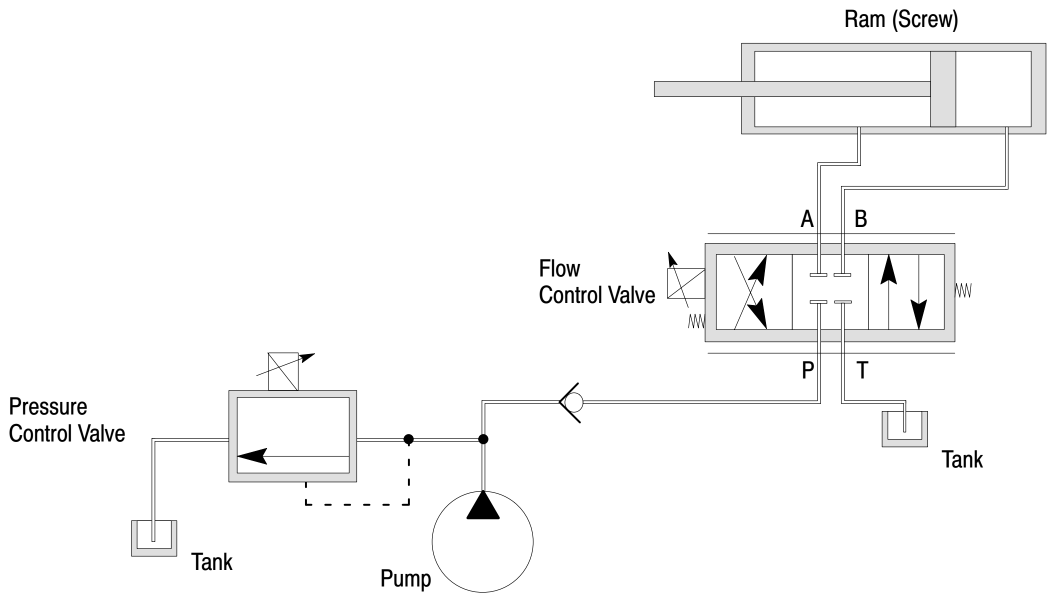
QDC Terminal:	Inject:
Input 1	Ram (Screw) Position
Input 2	Ram (Screw) Pressure
Input 3	Screw RPM
Input 4	Cavity Pressure
Output 1	Injection Pressure/Flow Control
Output 2	[1]
Output 3	[1]
Output 4	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM and System Pressure.

2-valve System for Inject Control

Separate valves are used for controlling pressure and flow in this 2-valve system. Figure 2.3 shows two valves used for inject control.

Figure 2.3
Example 2-valve System for Inject Control



Use a single QDC module in Inject mode for this application (Table 2.B). Valves are connected to two of the four outputs on the QDC module.

In this configuration, the QDC module:

- controls pressure and flow of the appropriate inject phases
- monitors and controls cavity pressure
- monitors screw RPM

The remaining 2 outputs of the module may be used for various machine functions, such as setting:

- the output to an hydraulic motor driving screw speed during plastication
- a pressure reference to a system pressure valve

Table 2.B
Example 2-valve System for Injection Control

QDC Terminal:	Inject:
Input 1	Ram (Screw) Position
Input 2	Ram (Screw) Pressure
Input 3	Screw RPM
Input 4	Cavity Pressure
Output 1	Injection Flow Control
Output 2	Injection Pressure Control
Output 3	[1]
Output 4	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM and System Pressure.

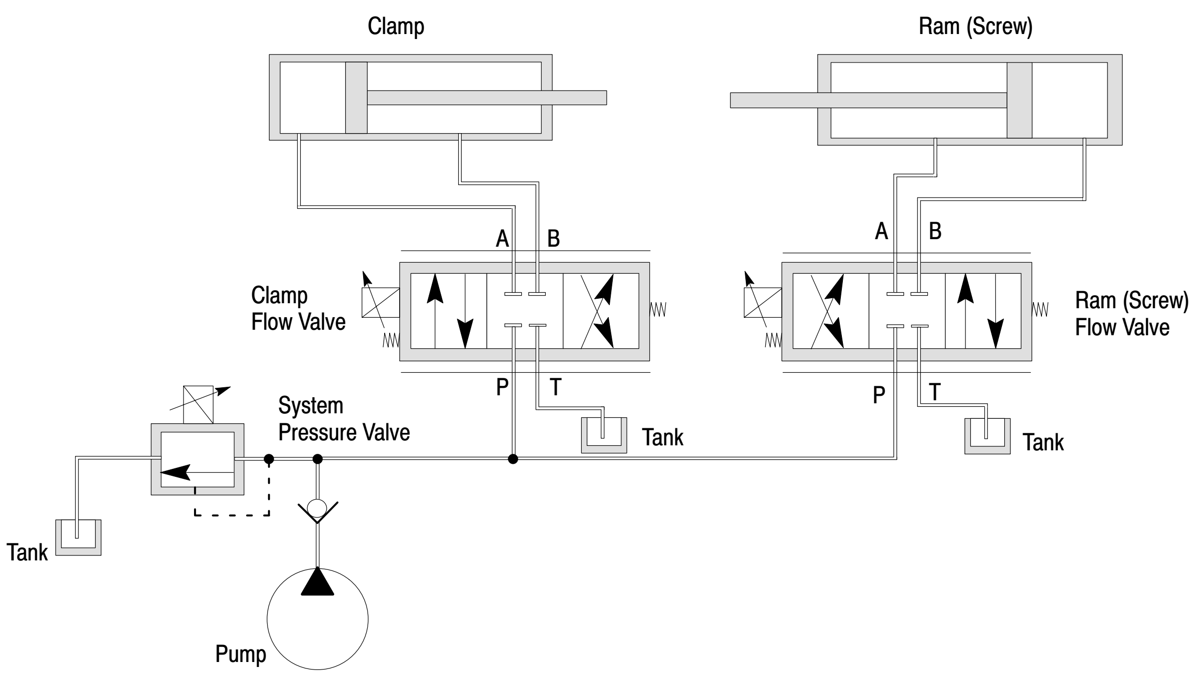
3-valve System for Inject and Clamp Control (without pressure isolation)

The three valves in this system include:

- system pressure
- injection flow
- clamp flow

The system pressure valve is used to control both ram (screw) and clamp pressure. The clamp and ram (screw) each have their own flow valve for controlling velocity algorithms. Figure 2.4 shows one valve for inject and clamp pressure control and separate valves for inject and clamp flow control.

Figure 2.4
Example 3-valve System for Inject and Clamp Control



Use a single QDC module in Inject and Clamp mode for this hydraulic circuit shown in Table 2.C.

In this configuration, the QDC module monitors and controls the pressure and velocity of both the ram (screw) and clamp cylinders using three of the four module outputs. The remaining output may be used for various machine functions such as setting:

- the output to an hydraulic motor driving screw speed during plastication
- a fixed output to a core-control device

Table 2.C
Example 3-valve System for Inject and Clamp Control

QDC Terminal:	Inject and Clamp:
Input 1	Ram (Screw) Position
Input 2	Ram (Screw) Pressure
Input 3	Clamp Position
Input 4	Clamp Pressure
Output 1	Injection Flow
Output 2	Injection and Clamp Pressure
Output 3	Clamp Flow
Output 4	[1]

[1] Additional output may be used to send fixed speed signal for screw rotation or to send a fixed core-set/core-pull.

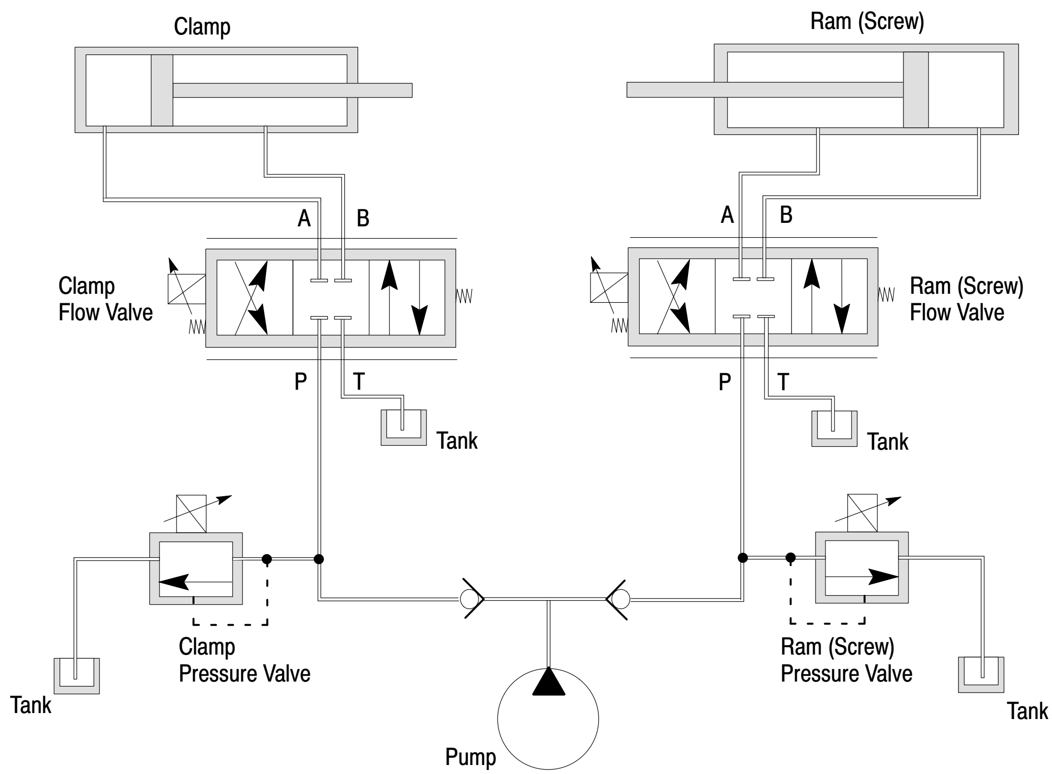
4-valve System for Inject and Clamp Control (with pressure isolation)

The four valves in this system control:

- clamp pressure
- clamp flow
- injection pressure
- injection flow

Figure 2.5 shows four valves used for pressure isolation.

Figure 2.5
Example 4-valve System for Inject and Clamp Control



Use a single QDC module configured for Inject and Clamp mode for this configuration. This example (Table 2.D) provides the same functions as the 3-valve example. However, the 4-valve system provides pressure isolation between the clamp and inject circuits.

Table 2.D
Example 4-valve System for Inject and Clamp Control

QDC Terminal:	Inject and Clamp:
Input 1	Ram (Screw) Position
Input 2	Ram (Screw) Pressure
Input 3	Clamp Position
Input 4	Clamp Pressure
Output 1	Injection Flow
Output 2	Injection Pressure
Output 3	Clamp Flow
Output 4	Clamp Pressure

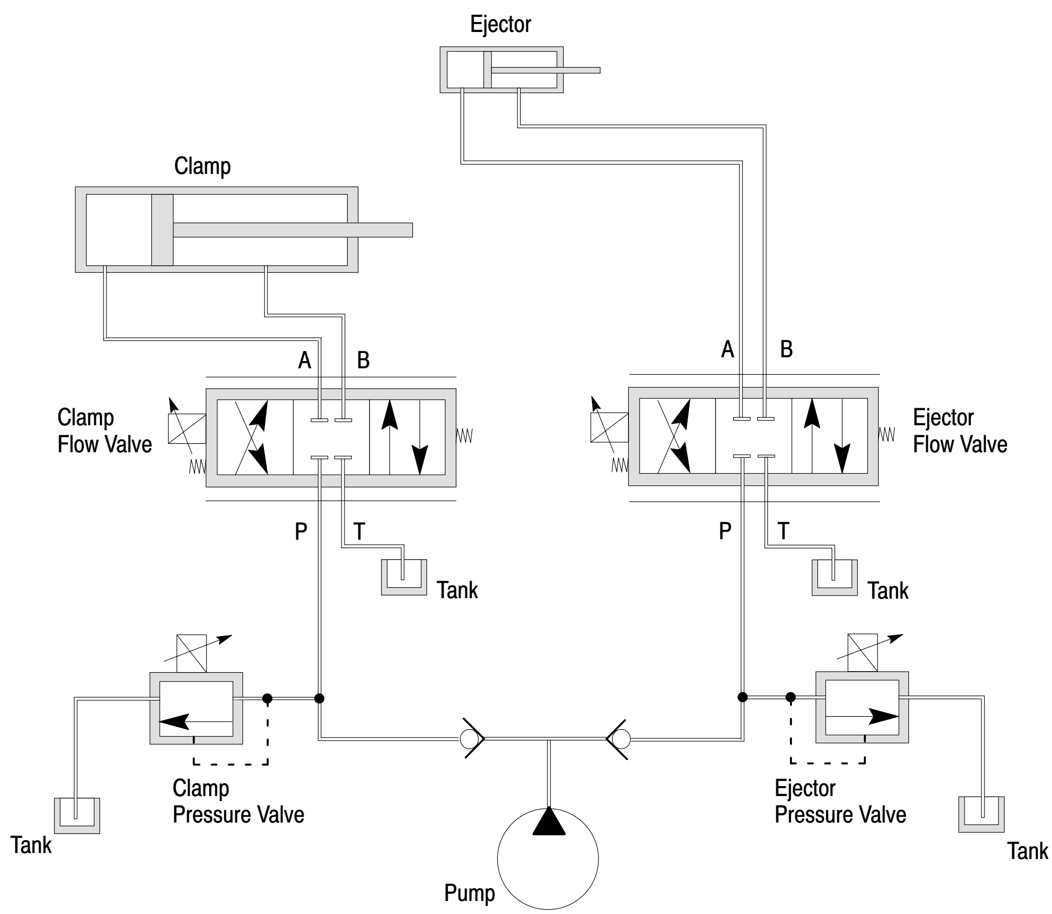
4-valve System for Clamp and Ejector Control (with pressure isolation)

The four valves in this system include:

- clamp pressure and flow valves
- ejector pressure and flow valves

Figure 2.6 shows four valves used for pressure and velocity control.

Figure 2.6
Example 4-valve System for Clamp and Ejector Control



Use a single QDC module configured for Clamp and Eject operation for this configuration, shown in Table 2.E. Full pressure and velocity control capabilities are available when using this combination. The hydraulics of this example provide pressure isolation between clamp and eject circuits.

Table 2.E
Example 4-valve System for Clamp and Ejector Control

Terminal:	Clamp and Eject:
Input 1	Ejector Position
Input 2	Ejector Pressure
Input 3	Clamp Position
Input 4	Clamp Pressure
Output 1	Ejector Flow
Output 2	Ejector Pressure
Output 3	Clamp Flow
Output 4	Clamp Pressure

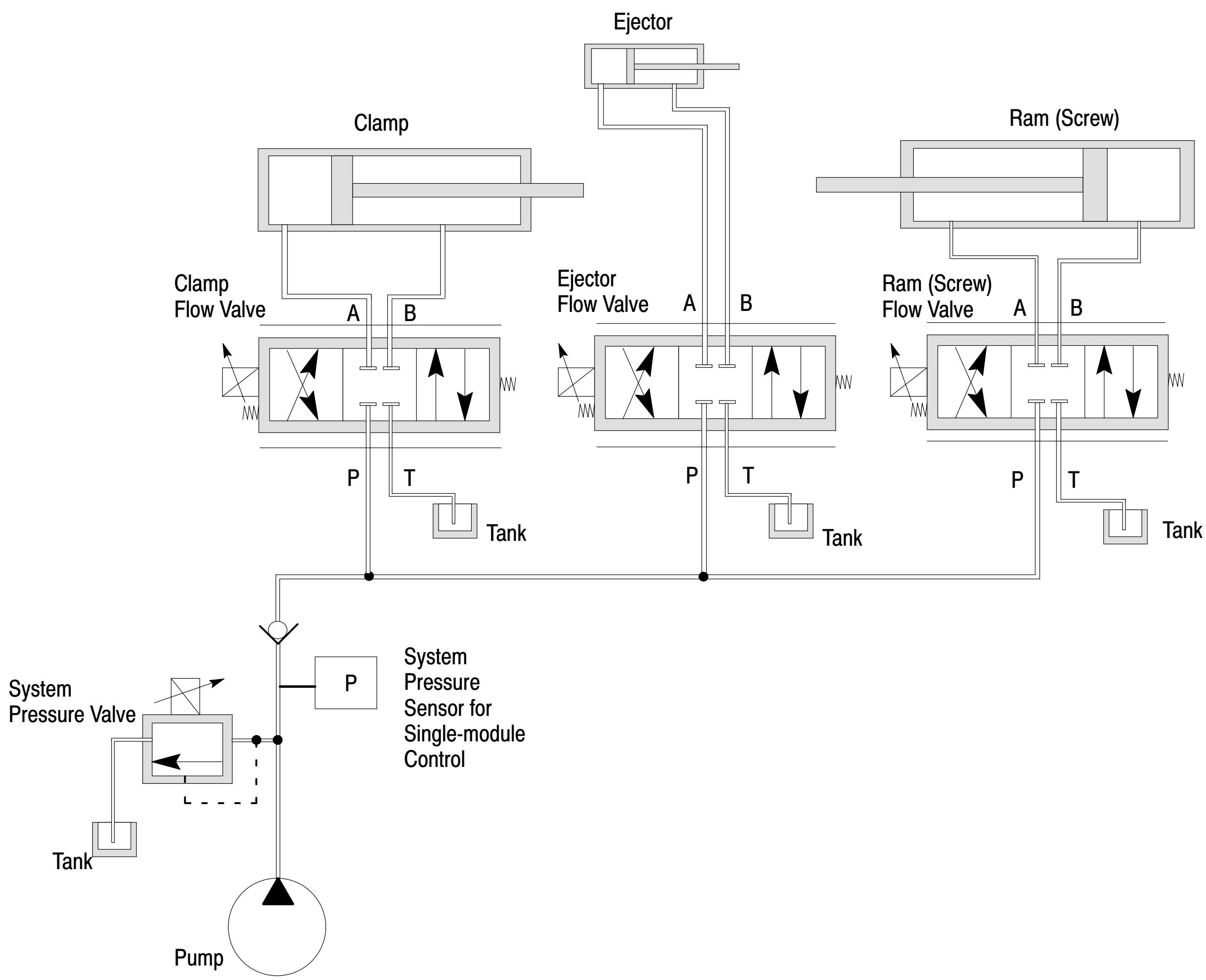
4-valve System for Inject-Clamp-Eject Control (with high-speed clamp and ejector synchronization)

The four valves in this system include:

- system pressure
- injection flow
- clamp flow
- ejector flow

Figure 2.7 shows a four valve system which allows for high-speed clamp and ejector synchronization.

Figure 2.7
Example 4-valve System for Inject-Clamp-Eject Control



Important: You can control this circuit with one or two QDC modules.

Single-module Control

A single QDC module (1771-QDC/C or later) configured for Inject, Clamp, and Eject operation can control this application. Connect inputs and outputs as shown in Table 2.F.

Table 2.F
Single-module Example for Inject -Clamp-Eject Control in a 4–valve System

Terminal:	Inject, Clamp, and Eject
Input 1	Ram (Screw) Position
Input 2	System Pressure
Input 3	Clamp Position
Input 4	Ejector Position
Output 1	Injection Flow
Output 2	System Pressure
Output 3	Clamp Flow
Output 4	Ejector Flow

Dual-module Control

When using two QDC modules for this application, you can use either of the following two combinations with QDC modules configured for:

Combination	Module Configuration	Module Configuration
Example 1	Inject	Clamp and Eject
Example 2	Inject and Clamp	Clamp and Eject

We recommend the Inject / Clamp and Eject module pair (Table 2.G) for high-speed clamp and ejector synchronization independent of the PLC-5 processor. It also allows cavity pressure or screw RPM control on the injection end of the machine. Table 2.H shows the Inject and Clamp / Clamp and Eject module pair.

Table 2.G
Example 1, Inject / Clamp and Eject Control

Terminal:	Inject:	Clamp and Eject:
Input 1	Ram (screw) Position	Ejector Position
Input 2	Ram (screw) Pressure	Ejector Pressure
Input 3	Screw RPM	Clamp Position
Input 4	Cavity Pressure	Clamp Pressure
Output 1	Inject Flow	Ejector Flow
Output 2	Switched System Pressure	Switched System Pressure
Output 3	[1]	Clamp Flow
Output 4	[1]	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM and Cores.

Table 2.H
Example 2, Inject and Clamp / Clamp and Eject Control

Terminal:	Inject and Clamp:	Clamp and Eject:
Input 1	Ram (screw) Position	Ejector Position
Input 2	Ram (screw) Pressure	Ejector Pressure
Input 3	Clamp Position	Clamp Position
Input 4	Clamp Pressure	Clamp Pressure
Output 1	Inject Flow	Eject Flow
Output 2	Switched System Pressure	Switched System Pressure
Output 3	[1]	Clamp Flow
Output 4	[1]	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM and Cores.

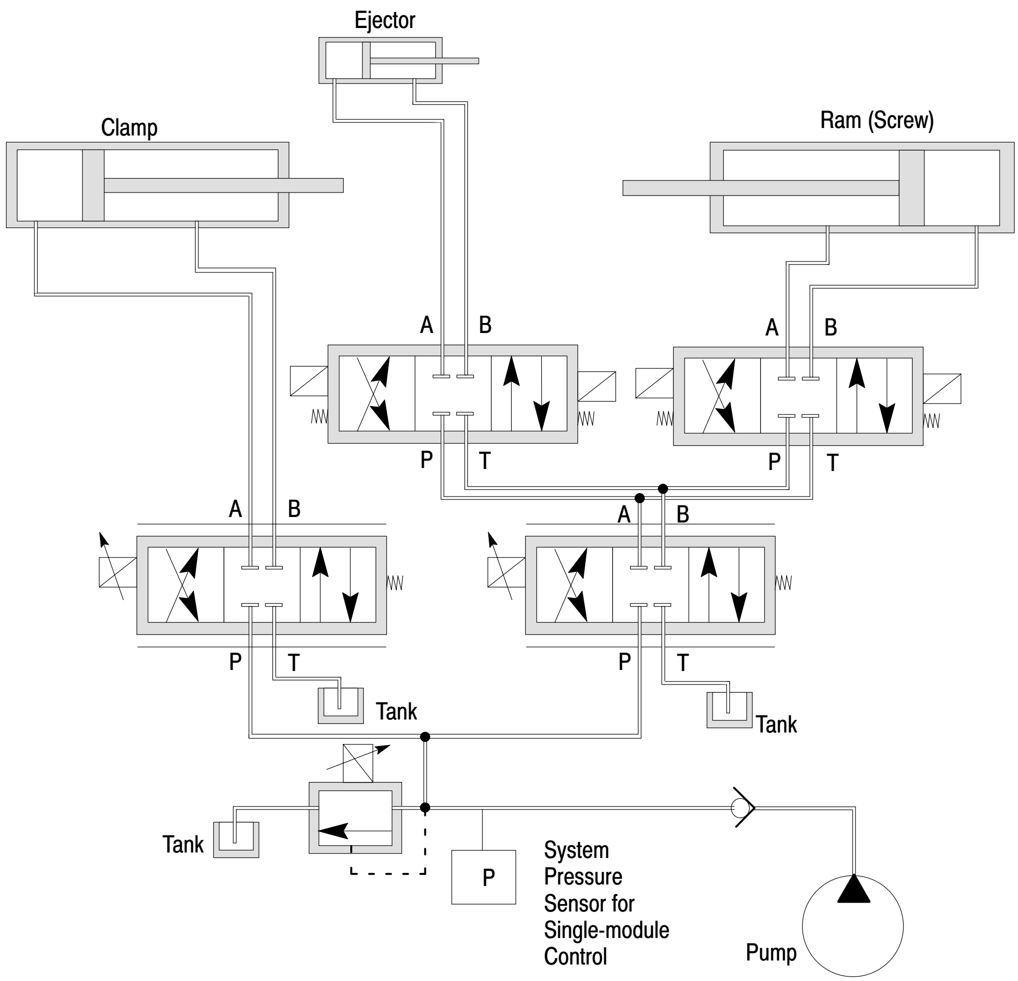
3-valve System for Inject-Clamp-Eject Control

The three valves in this system include:

- a system pressure valve
- a clamp flow valve
- a flow valve shared between injection and ejectors

In addition, two directional solenoid valves control which cylinder the shared proportional valve is controlling. Figure 2.8 shows an example 3-valve system.

Figure 2.8
Example 3-valve System for Inject-Clamp-Eject Control



Important: You can control this circuit with one or two QDC modules.

Single-module Control

A single QDC module (1771-QDC/C or later) configured for inject, clamp, and eject operation can control this application. System pressure is defined as the pressure read from a single pressure sensor connected to input 2. Connect inputs and outputs as shown in Table 2.I.

Table 2.I
Single-module Example for Inject -Clamp-Eject Control

Terminal:	Inject, Clamp, and Eject
Input 1	Ram (Screw) Position
Input 2	System Pressure
Input 3	Clamp Position
Input 4	Ejector Position
Output 1	Injection/Ejection Flow (shared valve)
Output 2	System Pressure
Output 3	Clamp Flow
Output 4	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM and Cores.

Dual-module Control

When using two QDC modules in this application, you may use two separate combinations of two QDC modules configured for:

Combination	Module Configuration	Module Configuration
Example 1	Inject	Clamp and Eject
Example 2	Inject and Clamp	Clamp and Eject

Both applications have their advantages:

Example 1: Inject / Clamp and Eject	Example 2: Inject and Clamp / Clamp and Eject
Screw RPM control available	Clamp and ejector can be better synchronized.
Cavity pressure control available	

For these hydraulic applications, you would configure your QDC module's inputs and outputs as shown in Table 2.J and Table 2.K:

Table 2.J
Example 1: Inject / Clamp and Eject Control

Terminal:	Inject:	Clamp and Eject:
Input 1	Ram (Screw) Position	Ejector Position
Input 2	Ram (Screw) Pressure	Ejector Pressure
Input 3	Screw RPM	Clamp Position
Input 4	Cavity Pressure	Clamp Pressure
Output 1	Inject Flow (Switched Flow)	Ejector Flow (Switched Flow)
Output 2	Injection Pressure (Switched System Pressure)	Switched System Pressure
Output 3	[1]	Clamp Flow
Output 4	[1]	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM or Cores.

Table 2.K
Example 2: Inject and Clamp / Clamp and Eject Control

Terminal:	Inject and Clamp:	Clamp and Eject:
Input 1	Ram (Screw) Position	Ejector Position
Input 2	Ram (Screw) Pressure	Ejector Pressure
Input 3	Clamp Position	Clamp Position
Input 4	Clamp Pressure	Clamp Pressure
Output 1	Inject Flow (Switched Flow)	Ejector Flow (Switched Flow)
Output 2	Injection Pressure (Switched System Pressure)	Switched system Pressure
Output 3	[1]	Clamp Flow
Output 4	[1]	[1]

[1] May be used to send reference signals to other machine hydraulics such as Screw RPM or Cores.

Symbols

A

C

D

E

F

H

I

P

Q

S

T

Customer Support

If you need additional assistance on using your software, Allen-Bradley offers telephone and on-site product support at Customer Support Centers worldwide.

For technical assistance on the telephone, first contact your local sales office, distributor, or system integrator. If additional assistance is needed, then contact your local Customer Support Center or contact System Support Services.

In the United States and Canada

If you have a SupportPlus agreement or your software is under warranty, you can contact System Support Services at: 1-800-289-2279. Have your support contract or software registration number available.

For assistance that requires on-site support, contact your local sales office, distributor, or system integrator. During non-office hours, contact the Allen-Bradley 24-hour Hot Line at 1-800-422-4913.

Outside of the United States

Contact your local Customer Support Center at:

Region or Area	Customer Support Center Telephone Number
Canada (Cambridge, Ontario)	519-623-1810
Latin America (Milwaukee)	414-382-2000
United Kingdom (Milton Keynes)	44-908 838800
Europe (Amsterdam)	31-2975 43500
France (Paris)	(33-1) 4778 1402
Germany (Gruiten)	(49) 2104 6900
Italy (Milan)	(39-2) 4830 0381
Asia Pacific (Hong Kong)	(852) 873-1342

For assistance that requires on-site support, contact your local office, distributor, or system integrator. During non-office hours, contact your local Customer Support Center.

As a subsidiary of Rockwell International, one of the world's largest technology companies — Allen-Bradley meets today's challenges of industrial automation with over 85 years of practical plant-floor experience. More than 11,000 employees throughout the world design, manufacture and apply a wide range of control and automation products and supporting services to help our customers continuously improve quality, productivity and time to market. These products and services not only control individual machines but integrate the manufacturing process, while providing access to vital plant floor data that can be used to support decision-making throughout the enterprise.

With offices in major cities worldwide

WORLD HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (1) 414 382-2000
Telex: 43 11 016
FAX: (1) 414 382-4444

EUROPE/MIDDLE EAST/AFRICA HEADQUARTERS
Allen-Bradley Europe B.V.
Amsterdamseweg 15
1422 AC Uithoorn
The Netherlands
Tel: (31) 2975/43500
Telex: (844) 18042
FAX: (31) 2975/60222

ASIA/PACIFIC HEADQUARTERS
Allen-Bradley (Hong Kong) Limited
Room 1006, Block B, Sea View Estate
28 Watson Road
Hong Kong
Tel: (852) 887-4788
Telex: (780) 64347
FAX: (852) 510-9436

CANADA HEADQUARTERS
Allen-Bradley Canada Limited
135 Dundas Street
Cambridge, Ontario N1R 5X1
Canada
Tel: (1) 519 623-1810
FAX: (1) 519 623-8930

LATIN AMERICA HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (1) 414 382-2000
Telex: 43 11 016
FAX: (1) 414 382-2400

Publication 1771-4.10 December 1992
Supercedes 1771-4.10 October 1991
PN955113-85